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AMERICAN ENGINEER AND RAILROAD JOURNAL.

JANUARY, 1902.

CONTENTS.

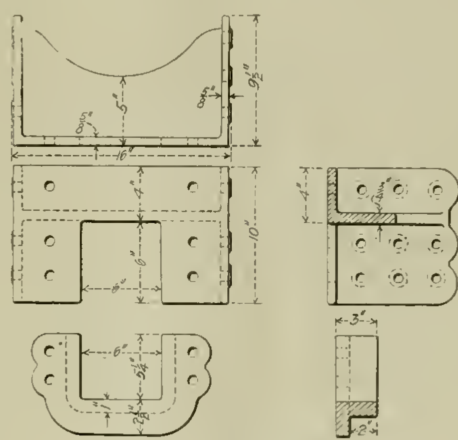
VANDERBILT STEEL TANK CAR, 12,000 GALLONS CAPACITY.

Designed by Cornelius Vanderbilt for the Equitable Land and Oil Company.

The American Steel Foundry Co., of St. Louis, Mo., are building 500 tank cars of 12,000 gals. capacity for the Equitable Land and Oil Company, from designs prepared by Cornelius Vanderbilt. The cars are to be used for transporting oil from the Texas oil fields to St. Louis, and are the largest capacity tank cars in use.

The aim in the design of the car was to dispense with the heavy and unnecessary flat-car arrangement for supporting the tank. The only necessity for an underframing in a tank car, provided the tank is of sufficient diameter and thickness of shell to resist the bending moment due to the load, is to safely resist the shocks and strains to which all freight cars are subject. By providing two 12-in. I-beams, extending the entire length of the tank, in contact with the tank itself, this required stiffness is secured. The points of actual support are the two transoms, which are made of cast steel. The strain in the metal in the tank due to this form of construction is in no case in excess of 1,800 lbs. per square inch. Between the transoms are two cast-steel spacers, securely riveted to the two I-beams, similarly to the transoms, while four straps, each provided with two turnbuckles, serve to preserve contact between the tank and the I-beam. These I-beams also serve to protect the tank from tendency to shear at the points of support. The tank is made secure against longitudinal movement by blocks of wood at either end, braced by a steel casting. The end sill is made of ⅜-in. steel plate reinforced between the draft sills by a steel casting, which compensates for the metal cut away for the coupler shank, and also acts as a buffer casting to receive the shocks from the coupler horn. The drawbar carry iron is made of cast-steel and is secured to the sill plate and the buffer casting by four ⅞-in. bolts. These bolts are in shear. The casting is made of angle section, giving a deep flange extending vertically below the coupler shank.

Another departure from precedent is the location of the running board. In the old type of tank car the space between the tank and the outside of the flat car provides means of passing from car to car, and in some more recent designs the running boards have been placed along the side of the tank nearly level with its center line. It will be noted that this design places the running board on the top of the tank with a guard rail at one side. In this way are secured the best means of communication between cars, making it as easy for a man to pass from a tank car to a box car as from one box car to another. This is a feature that at once commends the design to practical railroad men. The hand brake wheel is also located above the top of the tank, as in most designs of box cars. Malleable iron brackets, riveted to the tank, support the running board. These brackets also support the hand-rail columns. On the right side, at each end of the car, is a ladder secured at the top end to the running board and resting on the end sill platform below. The draft sills are 10-in. channels extending from the end sills to the transoms, where they are securely riveted to a ¾-in. flange on the casting. This transom takes all the shocks from the draft sills, distributing them to the 12-in. I-beams, so that none of the buffing or pulling strains are transmitted through the tank. The draft gear proper is of the twin-spring type, with cast-steel sill plates. The tank is made of ¼-in. plate, with double riveted lap joints, and ⅝-in. rivets. The heads are made of ⅜-in. plates. The dome is



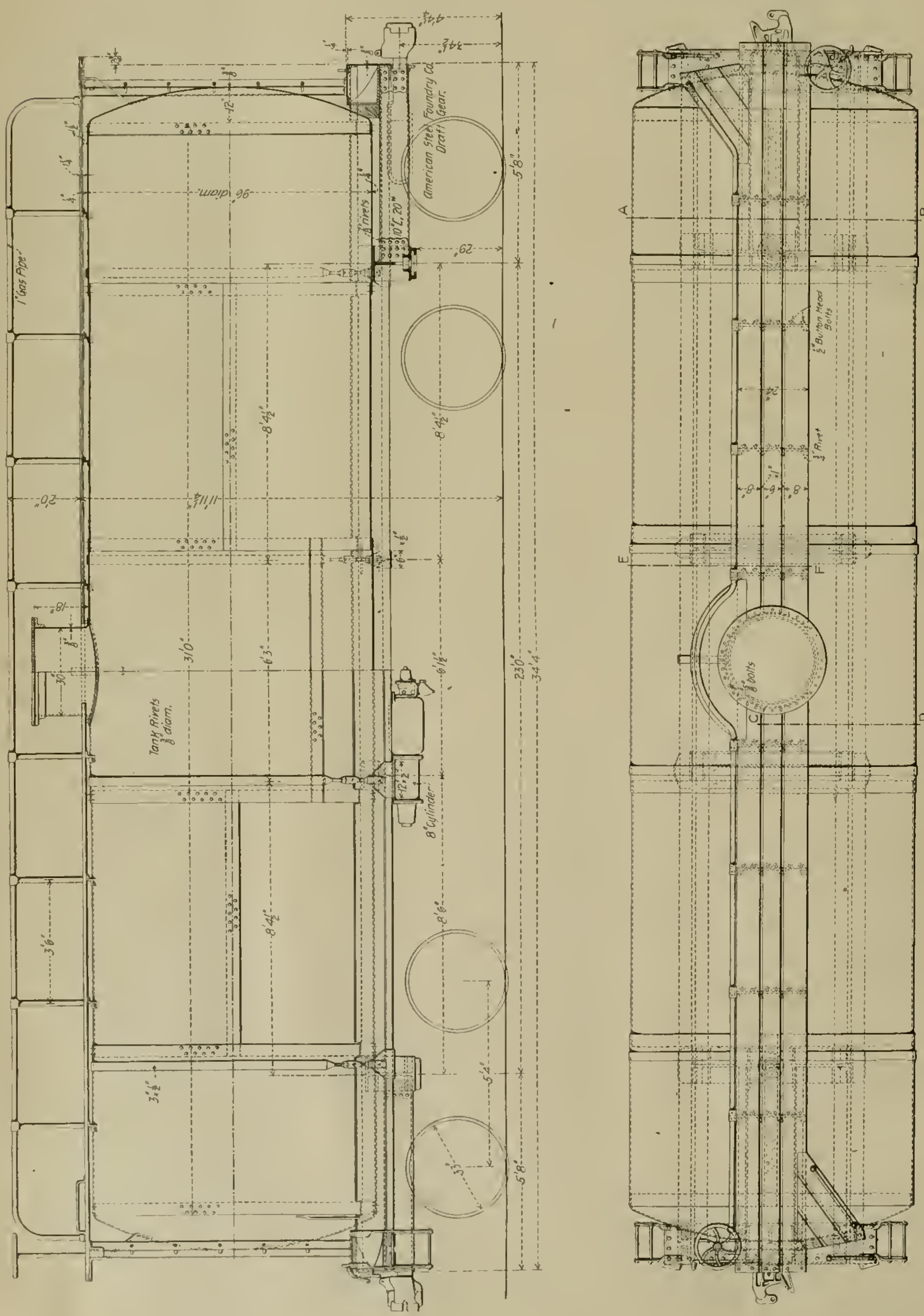
Drawbar Support.

flanged at the bottom and held to the tank by one row of rivets. The trucks are the American Steel Foundry Company standard, with cast-steel bolsters. In the drawings of the details it is apparent that unusual care has been taken in the combination of simplicity and strength. Among them may be noticed the large diameter of the center plate and its combination with the bolster casting. Its large area will increase the stability of the car and tend to relieve the side bearings.

A very important factor in the design of tank cars, as well as freight cars of all other types, is the dead weight to be hauled, and in this design this feature is made prominent. The dead weight is even less than the dead weight of any tank cars of 8,000 gals. capacity that we have seen, whether of wood or steel underframing. The additional capacity, the simplicity of construction and the strength due to this method of construction should make this design a strong competitor in future construction.

The advent of 500 of these cars will help to relieve the famine in oil cars in Texas and will undoubtedly lead to further orders for this large capacity equipment.

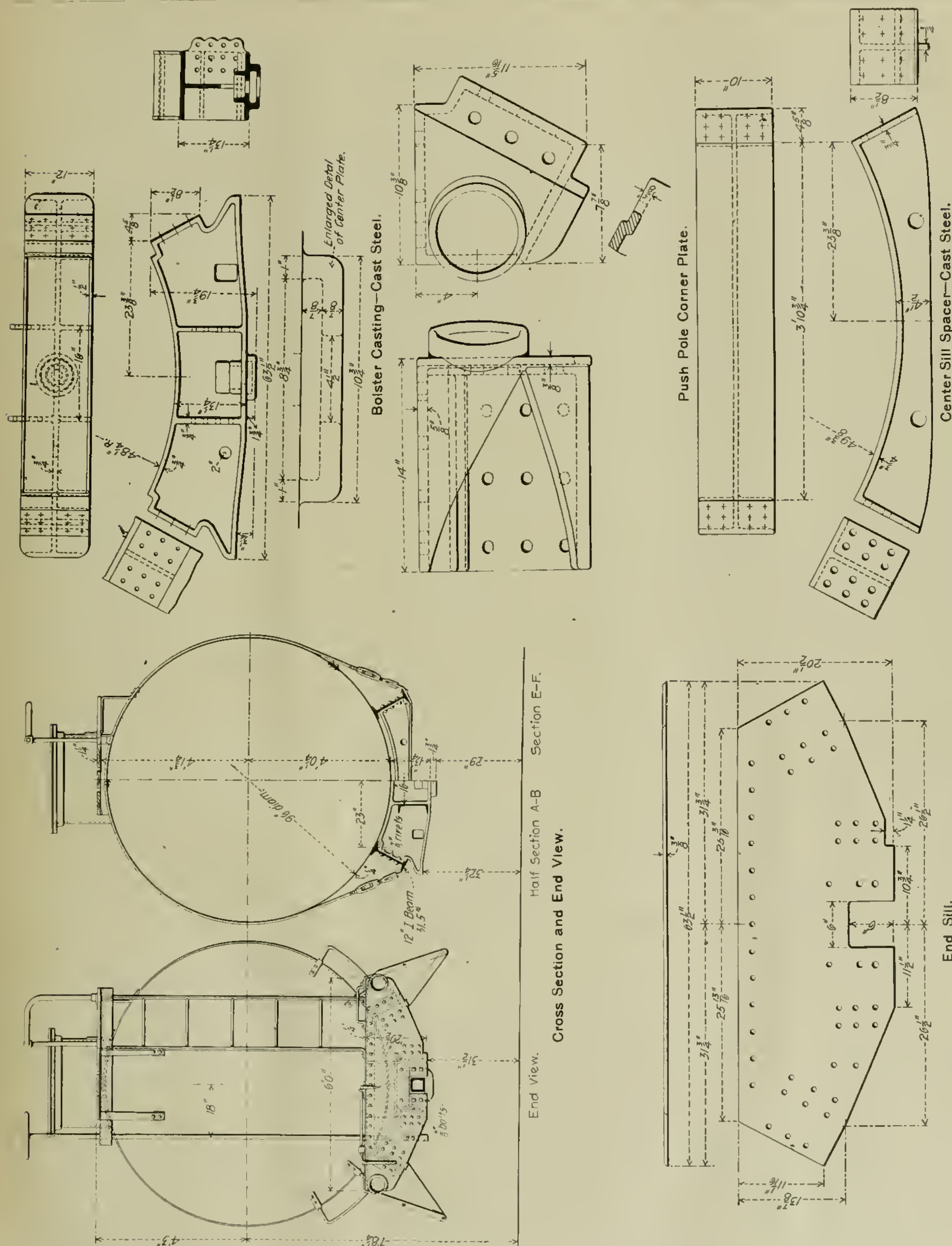
The special equipment includes Missouri Pacific M. C. B. couplers, trucks and bolsters by the American Steel Foundry Company, twin spring draft gear, Damascus brake beams, and



VANDERBILT STEEL TANK CAR—12,000 GALLONS CAPACITY.

Designed by CORNELIUS VANDERBILT.

Built by AMERICAN STEEL FOUNDRY CO.



VANDERBILT STEEL TANK CAR—12,000 GALLONS CAPACITY

Built by AMERICAN STEEL FOUNDRY COMPANY.

Designed by CORNELIUS VANDERBILT.

Westinghouse air brakes. The most important dimensions of the car are as follows:

Vanderbilt Steel Tank Car.

Capacity of tank	12,000 gals.
Inside diameter of tank	8 ft.
Length of tank, outside heads	32 ft. ¾ in.
Length over end sills	34 ft. 4 ins.
Length over running boards	34 ft. 9½ ins.
Height, top of rail to top of guard rail	13 ft.
Height, top of rail to top of brake wheel	13 ft. 11¼ ins.
Height, top of rail to top of running board	11 ft. 11¼ ins.
Height, top of rail to top of end sill platform	4 ft. 4¼ ins.
Width of end sill	6 ft.
Truck centers	23 ft.
Running board, yellow pine	1¼ in.
Guard rail, gas pipe	1 in.

AMERICAN ENGINEER TESTS.

Locomotive Draft Appliances.

IV.

THE THEORIES TO BE INVESTIGATED.*

A Research By H. H. Vaughan,

Member A. S. M. E.

This preliminary discussion does not and cannot explain everything; there are an immense number of contradictory and curious facts in the Hanover tests, but it does explain a great many; for instance in many cases the area of the top of the stack and the nozzle distance seem to be the only dimensions that count, especially in cylindrical stacks. In these cases the action of the jet is practically the same and will continue so up to a point where the entire jet cannot flow out on account of insufficient velocity. At this point the jet suddenly spreads (see Fig. 2 of Master Mechanics' Association report) and this spreading means the conversion of the kinetic energy of the jet into an increase in its pressure and the cessation of entraining action, and from that point on the edges are simply pushed out. There is certainly a sudden spreading close to the top of the stack in all cases when the kinetic energy of the jet is transformed into an increase of pressure. This is the reason for the rapid spread of the jet as measured in the Hanover tests, where successive lengths of stacks were added to measure the jet at different heights, thus getting altogether erroneous results, as in each case the jet was spreading as it lost its velocity in developing atmospheric pressure.

There are a few practical points we can all see at any time that appear to me to support the entraining theory as against the inducing. In an engine smoking badly the smoke certainly passes out over almost the entire area of the stack and is certainly as dense in the center of the jet as at its edges. If the smokebox gases were expelled on account of their induced motion this would not be the case. In an engine exhausting slowly with a rather large stack the center portions of the jet can be seen to move with high velocity, while around the edges are fluffy eddies of steam that do not accelerate with each exhaust and simply curl around and pass up slowly. There is simply not sufficient effluent velocity in the edges of a jet in such a case to allow the air to pass out at the rate we know it is passing into the firebox. In an engine with too large a stack (a very usual combination), while the steam at the edges of the visible jet is not moving at a comparatively slow velocity, no steam or smoke is visible for an inch and sometimes 1½ inches from the rim of the stack. This is not the area through which gases are passing out. It is the space through which air is flowing in on account of the edges of the jet and the small ring of induced gases surrounding it not having sufficient velocity to pass out of the stack or to keep the air outside from flowing in, which is very nearly the same thing. When the exhausts are slow enough to allow the front end vacuum to vary it is evident that such an action as this would account for the relative efficiency of long and short front ends, which may therefore depend to a large extent upon the stack and nozzle. Some little practical experimenting would support this view.

There is evidently some benefit in a stack tapered from 1 in 6 to 1 in 12. I do not see the reason for this, unless it be that when a jet is entraining air and gradually transferring the energy from the center of the jet to its edges, it, for a physical reason dependent on the rate of diffusion of air into steam, expands at an angle of 1 in 6, and that continued expansion at this angle allows the velocity to be evened up, as it were, over the entire area of the jet. Confining the jet in a cylindrical stack after it has expanded to nearly fill the stack prevents this averaging process, and the center of the jet discharges at a high velocity while the edges have lost too much. Upon the entraining theory it is also possible to explain the divergence between the Hanover and the Master Mechanics' Association results. The heavier the gas that is entrained by the jet, the more rapidly it will spread and lose its velocity, so that it would be expected that a greater nozzle distance would be required to give the best results with hot air than with cold, which is the difference actually found. This entraining theory can easily be tested without great expense, and whether correct or not I feel that some such explanation can be found which is capable of being applied quantitatively with a fair amount of accuracy.

As the object of this discussion is chiefly to specify what work requires to be done, I would suggest that I believe that as far as the plain stack and nozzle is concerned, a series of experiments on the steam jet should be carried out to define exactly some such theory as I have outlined. These tests should be made with cold air, and in them the velocity and pressure of the jet at various axial and nozzle distances should be carefully found, as well as the same data for the surrounding air. The temperature and composition should also be obtained if possible. No locomotive is needed for this work, but a large jet of steam is required. After the laws affecting such a jet are fairly well established, sufficient experiments should be repeated with air of a high temperature, to enable the difference in its behavior to be clearly understood with sufficient accuracy for practical purposes. By the aid of such experiments, which need not be expensive or elaborate, I believe we should be in a position to adapt the Hanover experiments to locomotive conditions, and could then avail ourselves of that splendid series of experiments, and the relations of the plain stack and nozzle would be then known with sufficient accuracy to obviate the necessity of any further tests on a locomotive testing plant. If this proposition is accepted as true the balance sheet of what we know and what we want to know on this subject stands about as follows:

BALANCE SHEET.

(1) Efficiency of stacks in various forms in combination with nozzles of any size at variable nozzle distances, with various volumes of air.	To be established with sufficient accuracy by adaptation of Hanover tests to locomotive conditions.
(2) Efficiency of various forms of nozzles.	Established by Master Mechanics' Association experiments.
(3) Efficiency of various heights of bridge walls.	Established by Master Mechanics' Association experiments.
(4) Efficiency of various areas of choke of exhaust pipe.	Established by Master Mechanics' Association experiments.
(5) Relative efficiency of single and double nozzles.	Established by Master Mechanics' Association experiments.
(6) Efficiency of various stacks and nozzles in combination with a petticoat pipe.	Experimented on by Master Mechanics' Association committee, but results not determinate.
(7) Efficiency of various lengths of front ends.	Experimented on by Master Mechanics' Association committee, but results not determinate.
(8) Efficiency of various forms of baffle plates or diaphragms.	No recognized experiments.

Evidently any experiments that are made should be directed to the last three items, and of these only one, the first, presents any serious difficulty. The best length of front end can be tested with ease, and all that is necessary is to provide conditions that are entirely constant in every other way, so as to avoid any question as to this length being the only variable.

Tests, should, however, be made, I believe, with several sizes of stacks, as it is possible that a down draft or rather a partial return of exhausted gases to the front end may occur, and if this is the explanation for some statements that have been made about the drop in efficiency caused by long front ends, it would also be advisable to run a series of tests under actual conditions at several speeds, in each case trying, say three lengths and carefully noting the vacuum and velocity of the gases at several points.

The efficiency, or perhaps it would be preferable to term it the obstruction, caused by the baffle plate, can, I think, be safely stated to be dependent on two variables, the distance of this plate from the flue sheet and the area through which the gases are compelled to flow; a series of experiments with sheets at three different distances, which sheets could be raised or lowered to positions for which this area can be ascertained, would

* Typographical errors in previous article. Page 368, ninth line, below table, for "stuff" read "steam." Page 369, fourth line, second column, read "$A_1 V_1 = A_s V$".

define the increase in smokebox vacuum rendered necessary by this appliance, and determine its best position, so far as permitted by practical reasons.

The investigation of the action of the petticoat pipe will require more extensive tests than either of the above, and while a fairly accurate theory of the action of the steam jet with a plain stack might define that when a petticoat pipe is used, I do not believe that there is much chance of such a result and consider that it must be treated separately. Without doubt, however, the velocity, pressure, and if possible, the temperature and composition of the jet and its surrounding gases should be carefully taken, so that not only are results obtained, but the action may be sufficiently understood to enable such results to be applied to larger or smaller engines. The tests should preferably be conducted in a similar manner to the Master Mechanics' Association test of 1896, except that I should recommend that a steady jet be employed in place of the exhaust from an engine in motion. The flow of steam should be perfectly steady, and means should be provided for accurately measuring the pressure in the exhaust pipe. In order to reduce as much as possible the time and expense of these tests, I should recommend that both petticoat pipes and stacks be so arranged that they can be lengthened or shortened when the test is in progress. This can be easily done in the case of the straight stacks, for the taper stack sections can be arranged so as to be readily removable. At least four stacks should be tested, 14 and 16-in. choke and straight stacks being probably the best sizes. The petticoat pipe can be easily adjusted by the use of a lever attached to the pipe, which can be guided by a bracket similar to that frequently employed for holding adjustable pipes. At least six heights of exhaust pipe should be used, varying from a pipe that is about 36 ins. from the choke of the stack to one that is 6 ins. above the face of the saddles. When the petticoat pipe is once adjusted for the exhaust pipe, the four stacks may be tested without further change, and by the vertical adjustment of the petticoat pipe with each diameter and height of stack a large number of observations may be made in a very short time and at slight expense. It might prove necessary to test two or more sizes and perhaps more than one form of petticoat pipe, but it would not be necessary to try these with each exhaust pipe, once the best of two or three forms was determined it would simply be necessary to check this result for two or three heights of exhaust pipe after the completion of the tests.

It must certainly be the object in these tests to so arrange the apparatus that a large number of observations can rapidly be made, and by making the stacks and petticoat pipes adjustable this can be done and in all probability it will be found unnecessary to complete the series, as judging from the uniformity of the results obtained in the Hanover tests from a steady jet, the first few tests would show in which direction further experimenting would be unnecessary, and we should endeavor to find what forms give the best results and avoid getting a lot of interesting information about those that don't.

Such a series of tests as above outlined should furnish sufficient definite information to permit of making a practically accurate statement of the results that are obtained from any ordinary arrangement of the front ends. It is always possible that improvements will arise that are not foreseen at present, but such an investigation as this would allow these improvements to be rated at their proper value and place the whole subject on a much more rational basis than it is at present.

(To be continued.

The high-speed electric railway experiments which are being carried out in Germany are reported to have reached the speed of 99½ miles per hour up to the present time. This is the series of experiments which are being conducted on a short line of railway specially constructed for the purpose. For this speed a line pressure of 10,000 volts was required, and it is stated that with a few changes in construction the speed mentioned will be entirely practicable.

Piece work and premium systems are usually considered as applicable only to skilled workmen, and until the discussion of the subject at the December meeting of the American Society of Mechanical Engineers it is safe to say that most people would have ridiculed the suggestion that such systems could be applied to the shoveling of earth and coal and coke. On that occasion Mr. F. W. Taylor described an elaborate investigation as to the proper basic prices for shoveling and other work of similar charcter. When the results were put into practice the force of unskilled laborers (shovelers) which numbered between 400 and 500 men, was reduced to 85, who do the same work and whose wages have been advanced from $1.15 to $1.85 per day. The same principle was applied with equal success to the handling of pig iron.

The electric power plant at Niagara Falls has been in operation eight years. If it were to be built to-day and the same thorough-going method used in its design and construction were applied to-day, the eight years of experience since that time would not enable the engineers to improve the plant to affect the cost of power one dollar per kilowatt year. This is the judgment of Mr. L. B. Stillwell, expressed in a paper recently read before the American Institute of Electrical Engineers. No better tribute could possibly be paid to the wisdom of employing the very best available engineering talent in important works involving large expenditures. As industrial progress brings greater and greater engineering problems in all branches of activity, this policy should be widely extended. In such busy times the temptation to provide for the present is very strong. A better policy is to look as far as possible into the future and secure the best because it will last and because it will be good while it lasts. There is little of the engineer's work which does not last many years, whether it is an electrical plant, a bridge, a tunnel, a locomotive or a shop.

A retrogression instead of an advance along steam engineering lines is recorded in regard to the present management of the engineering department of our naval vessels by Admiral Melville in his recent report. The present plan places the engine room forces in charge of warrant machinists who are capable men, but who lack experience in the management of men. The difficulty lies in getting officers to devote themselves to the engineering of ships. The "line" is made more attractive and there is no provision for the needs of the future. If a return to the old plan of a separate staff for the engine room is not practicable, and it appears that it is not, something should be done to compel engine room experience on the part of the line officers. It would seem to be feasible to compel all line officers to serve in the engine room as a part of their qualification for promotion to the higher grades. Something of this sort must be done or engine room service must be made more attractive than it is by special privileges, such, perhaps, as providing better retirement conditions for this department. At present our navy is suffering because there is no inducement to make a specialty of steam engineering and no officer of spirit or promise will voluntarily take it up. Of course there will be an awakening to the results of this condition, but it is hoped that Admiral Melville's warning will be heeded in time to avoid a catastrophe. The present situation will bring one if it is not remedied. Because the safety of a war vessel depends first of all upon its machinery, we take the view that all line officers should have a thorough knowledge of this department as a qualification for commanding. Something radical and drastic seem to be necessary in order to overcome the disadvantages of the engineering department because of its discomforts. No better conclusion could possibly complete Admiral Melville's long record for loyal, able and efficient service than to urge the remedy of the present condition of affairs in this most vitally important department.

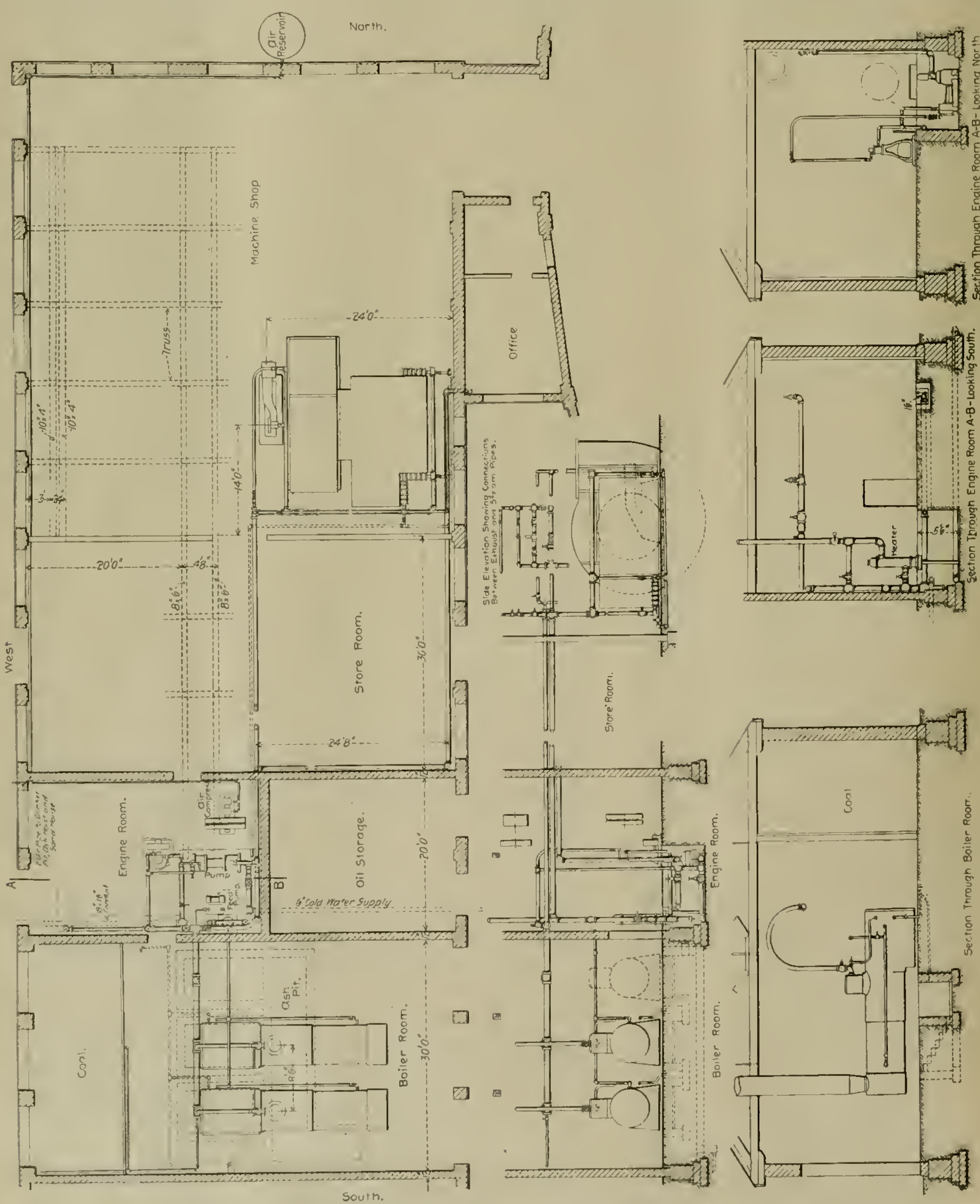
COLLINWOOD ROUNDHOUSE.

Lake Shore & Michigan Southern Railway.

Details and Appliances.

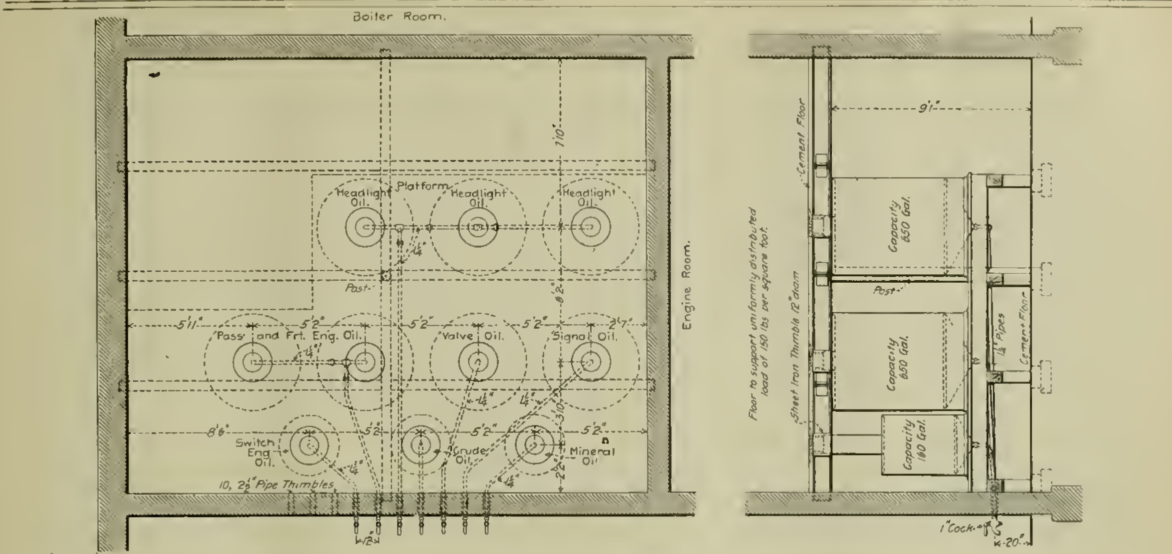
For the track layout and general plan of this complete and interesting locomotive terminal the reader is referred to the issue of October, 1901, page 305.

Nowadays shop facilities are needed at all locomotive terminals and in this case the treatment of roundhouse repairs is specially liberal because of the large amount of running repairs which are required by heavy engines making large mileage. This plan provides for more than doubling the roundhouse capacity, for ultimately using this shop for two large houses and for enlarging the shop when necessary. Among the features of this plan is convenience in handling material, which

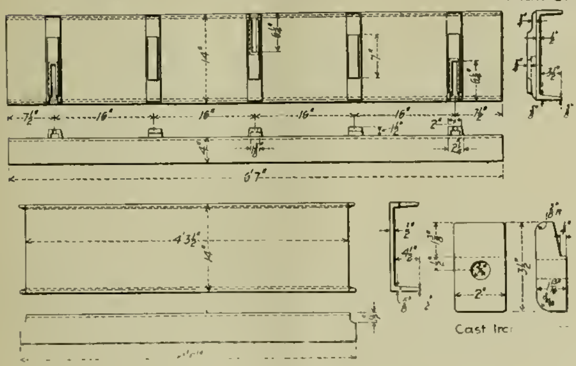


Arrangement of Steam, Air and Water Pipes.

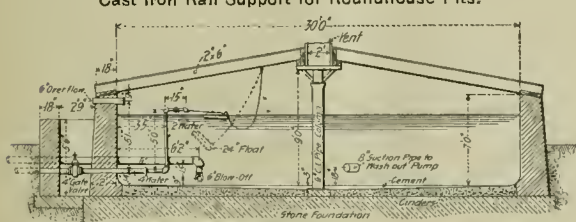
COLLINWOOD ROUNDHOUSE—LAKE SHORE AND MICHIGAN SOUTHERN RAILWAY.



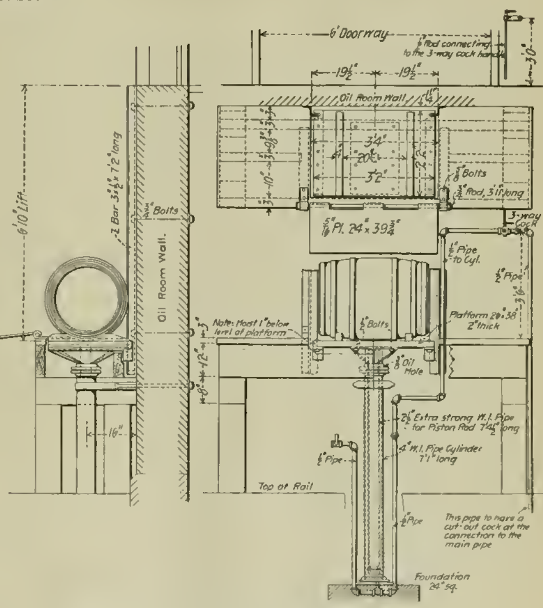
Plan of Oil House.



Cast Iron Rail Support for Roundhouse Pits.



Hot Well.

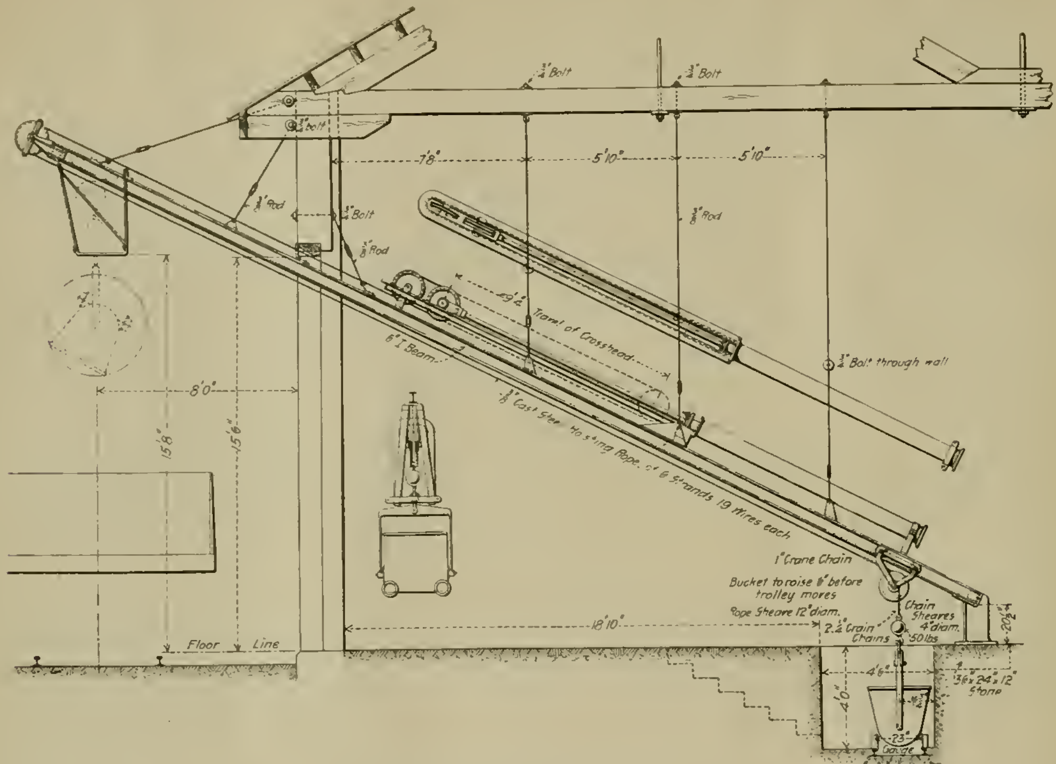


Pneumatic Elevator for Oil House.

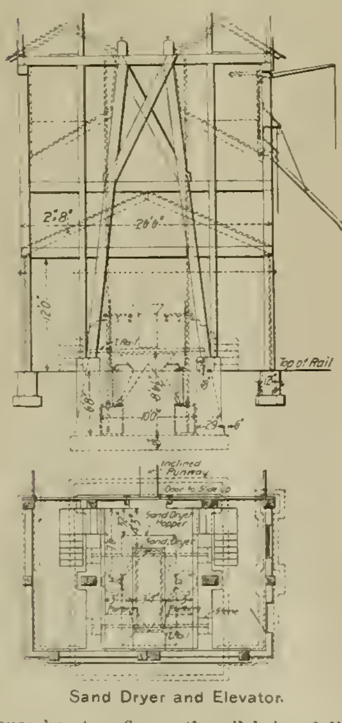
is brought by special tracks whereby the storeroom, oil room, coal storage and shop are easily reached. Wheels are also brought in here and taken directly to the roundhouse wheel pits from the shop, the pits being conveniently located for this purpose. For lighting, current is taken from the city mains to supply the following lights: Machine shop, 16 lamps; storeroom, 10; engine room, 4; oil house, 4; boiler room, 5; locker room, 13; office 5. All these are 16-candle incandescents. The roundhouse has two arc lamps and 107 incandescents of 32 candle power. The yard has four arcs and the sand house two incandescents, making in all 60 16-candle and 107 32-candle incandescents and 6 arc lamps.

The Sturtevant system of heating is used, and the heater is placed in the corner of the machine shop, where it may be duplicated when the second roundhouse is built. An 84 by 72 in. hot air conduit leads directly to the roundhouse, where it divides into two branches, one being 72 by 42-in. and the other 52 by 42-in., as illustrated in the description already referred to.

The present engravings illustrate the plan of the shop building, showing the boilers and piping for steam and water. The feed and washout pumps and heater are placed in a pit in the corner of the engine room. A compact but convenient arrangement of the boiler room is provided, in which the coal is received direct from the cars and kept in front of the boilers and the ashes are dropped into a pit under the boilers. They are received by a bucket which is mounted on small wheels running on a track through the pit. This bucket is run along to the end of the pit to an ingenious air hoist operated by a 7-in. cylinder, as shown in the engraving. This cylinder pulls a small carriage along an inclined 6-in. I-beam reaching from the pit to a car outside of the building. In raising the bucket the air cylinder pulls on the cable, which terminates at its lower end in a chain wound around a pulley suspended from the carriage. The first motion of the cable raises the bucket out of the pit because of the difference in diameters of the pulleys about which the cable and bucket chains are wound. When out of the pit the bucket is drawn up the incline and dumped automatically into the car with a single movement of the controlling valve.



Boiler Room Ash Conveyor.



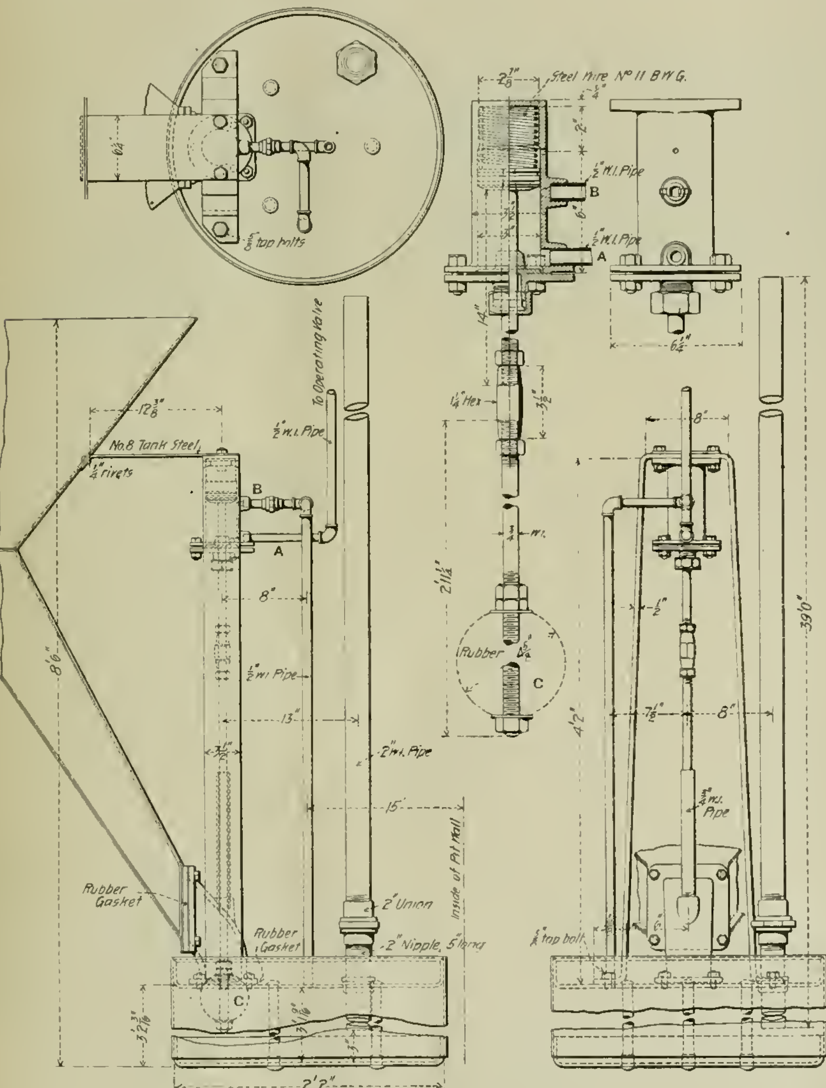
Sand Dryer and Elevator.

The oit house has two floors, the oil being delivered in barrels which are raised to the second floor by a plunger hoist outside of the building. It is dumped into tanks having conical bottoms, which deliver the oil by gravity to faucets in the storeroom. Five 650-gal. and three 160-gal. tanks are provided for storage, and barrels may be stored in the second story. This is a convenient arrangement, which is cared for by a man who has also other duties.

Locomotive sand is received in cars on the coal chute trestle and stored in a large bin at the end of the chute, where it drops to the ground level. It comes by gravity to the dryer room, and when dried runs into a large hopper, from which it is run into either of two large tanks below the ground. From these it is raised by air pressure to two storage pockets above and is delivered to the engines through spouts. In one of the detail views the pneumatic valves for elevating the sand are shown. The dryer operates continuously and when the underground tanks are full an air cock is opened and air is admitted to the pipe, A (see the sectional view of the valve mechanism). This raises the piston of this cylinder and raises the large rubber ball, C, against the delivery opening from the hopper, making an air-tight closure. When the piston of the operating cylinder is raised sufficiently to cut off the hopper opening the air passes out of this cylinder through the pipe B, which leads to the top of one of the underground tanks and raises the sand to the overhead bin by the direct application of the air pressure. This mechanism is arranged to permit of its operation by one of the coal chute men.

Near the roundhouse and shop is a 30-ft. hot water cistern, 7 ft. deep, built of concrete and roofed over. Into this the locomotives are blown off and the hot water is taken from it by the washout or feed pumps for washing out and filling boilers. A float valve automatically fills the well with cold water from the supply mains when the locomotives do not keep it full enough to insure condensing the steam blown into it. All the engines using this house are fited with a globe valve and special fitting upon the top of the steam dome and to this a connection is made to the steam blow off pipe which runs around under the roof of the roundhouse. This flexible connection has couplings for the domes and the blow-off pipe with interrupted threads. These couplings are slipped over each other and a quarter turn of the handles of the special fittings makes a tight joint at each end of the flexible connection. This being too heavy, a hose is now used.

The tool equipment of the shop in connection with this roundhouse includes one each of the following: 26-in. triple geared shaper; 36 by 36 in. by 12 ft. planer; 18-in. engine lathe with 5 ft. bed; 24-in. engine lathe; 30-in. drill press, sensitive drill; 1½-in. single Acme bolt cutter; double arbor emery grinder; blacksmith's forge; pipe bending block and two screw presses.



The Sand Elevator Pipe Is Straight and Will Not Be Cut Away by the Sand.

Pneumatic Sand Elevator.

Throughout the plan of this terminal provides to a greater extent than we have seen elsewhere for facilitating roundhouse work, and special study was given to all features which may contribute to a saving of labor and prompt work on the engines. The impression given in an examination of the terminal is one of judicious investment for the purpose of promoting prompt and efficient service. The details were worked out by Mr. H. L. Ball, Mechanical Engineer, under the direction of Mr. W. H. Marshall, Superintendent of Motive Power of the road.

The famous No. 999, the locomotive on the New York Central which attracted so much attention at the World's Fair in 1893 in Chicago and has done well-known service hauling the "Empire State Express," has come down to hauling a train of eleven milk cars and a caboose on the "West Shore" between Albany and Oneida. This engine is probably as good as it ever was, but the addition of one car to the "Empire State" made it necessary to assign the new "Central Atlantic" type engines to this service. They haul the train with ease, and the other was worked too near its limit of power, which explains the change. It is a marked example of recent progress in locomotive design.

Prof. H. Wade Hibbard in a recent address before the students of the Society of Mechanical Engineers of Sibley College, on the subject of "Engineering Periodicals and the Card Index," said in part: "Subscription to a paper should not be made in a hurry. And yet the reading from the start should be carried on with that end always in view. After the different papers become known, then the heart of the very human editor should be gladdened by a little note of appreciation—with some of that necessity for which he works, though not chiefly. A good engineering paper should be one of the life partners, ready at hand when moments of leisure permit its instruction and enjoyment, better understood and liked as the years roll on, acquaintance or perhaps friendship formed with the editor, contributions made, suggestions given and taken, some share had in its mighty influence in the engineering world."

The adoption of standard threads for pipe unions now seems assured. The committee on this subject reporting to the American Society of Mechanical Engineers at its recent convention had found it impossible to standardize the threads without also including the dimensions and forms of unions. The scope of the work had therefore been extended and plates for standard unions were submitted and accepted by the society. As this organization does not adopt standards, the recommendations will be placed before the Master Mechanics, Master Car Builders' associations and other associations having committees on the subject, and also before manufacturers, with a view of adoption. It is the intention to copyright the plates and give manufacturing privileges for a nominal sum, in order to prevent the use of bogus standards instead of those which are authorized. The subject will come before the Master Mechanics' and Master Car Builders' associations at Saratoga next summer.

HEAVY CONSOLIDATION COMPOUND LOCOMOTIVE.

Atchison, Topeka & Santa Fé Railway.

With Three Corrugated Furnaces

For Oil Fuel.

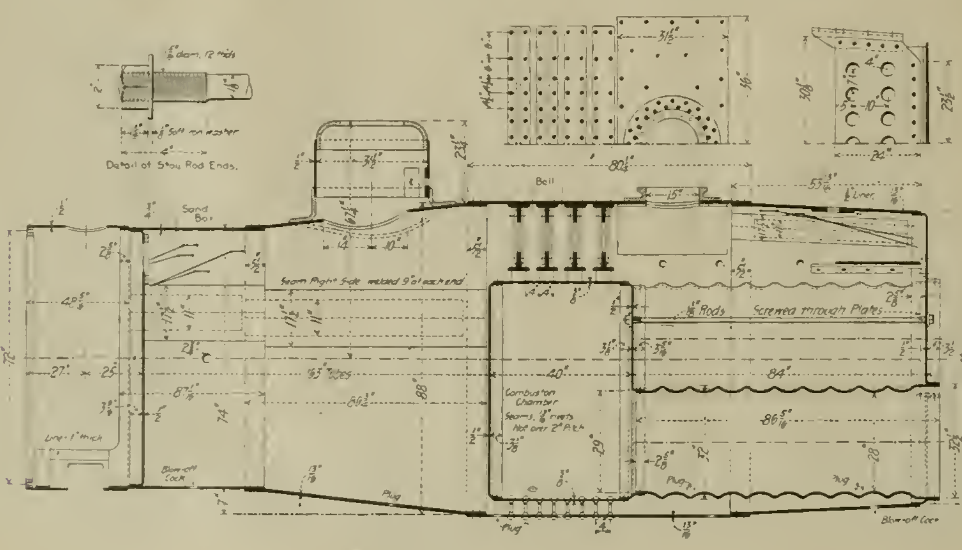
There is nothing in the appearance of this locomotive to indicate that it has a boiler with three corrugated cylindrical furnaces for burning oil, or that the heating surface is the greatest ever used on a locomotive. It is a large, heavy, powerful engine, and is particularly interesting because its boiler is built specially for oil fuel. Its construction practically precludes the possibility of using coal. The design is an important one for this road, because of the possibility of building a large number of even larger engines with this boiler if it proves successful. The engine has a tractive power of 45,500 lbs. when working as a compound, and for starting can exert a pull of nearly 55,000 lbs. with live steam in the low pressure cylinders. Its place as a heavy engine is indicated in the accompanying comparative table.

In the boiler lies the chief interest of this engine. At the front course the diameter is 74 in.; following this is a conical dome course connecting to an 88-in. cylindrical course, and at the back end there is a tapered course. The dome course longitudinal seam is welded for a length of 9 in. at each end. The tubes, 652 in number and 1¾ in. in diameter, are 13 ft. 7 in. long. The three furnaces are 32 in. in diameter by 86 in.

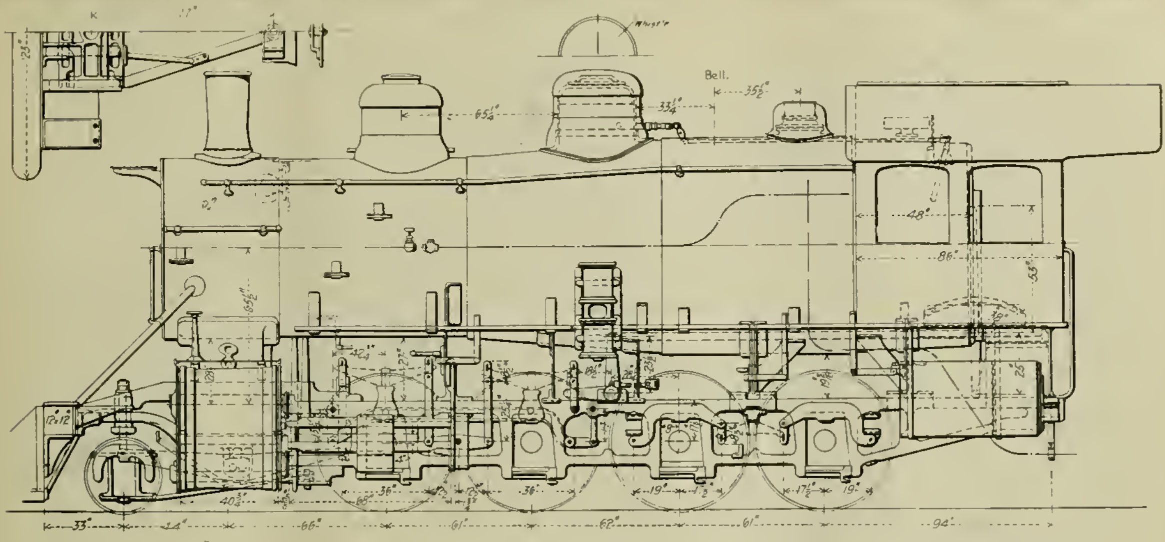
Oil Burning Locomotive with Three Fireboxes—Atchison, Topeka & Santa Fe Railway.
JOHN PLAYER, *Consulting Superintendent Machinery.*
G. R. HENDERSON, *Superintendent Machinery;* BALDWIN LOCOMOTIVE WORKS, *Builders.*

COMPARISON OF HEAVY FREIGHT LOCOMOTIVES.

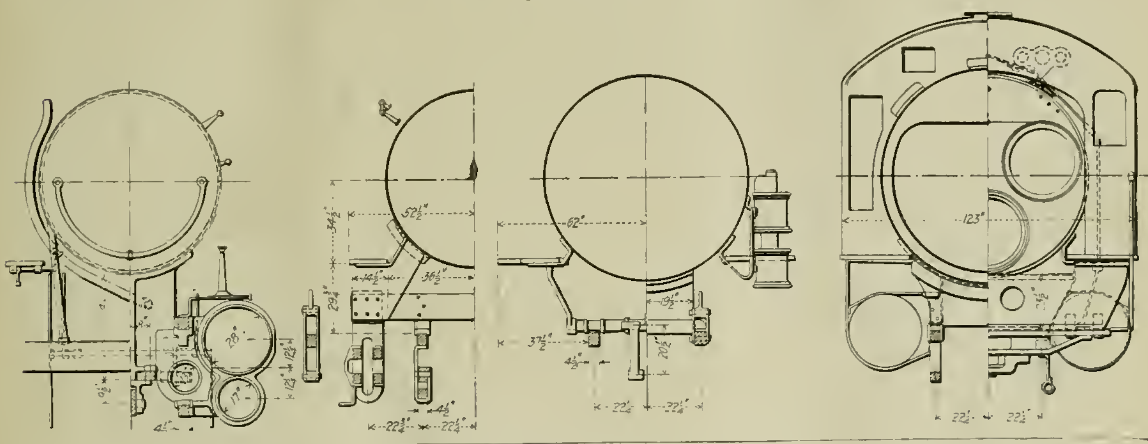
Railroad	P. B. & L. E.	Union	Lehigh Valley	Illinois Central	So. Pacific	Gt. Northern	Atchison.
Builder	Pittsburgh	Pittsburgh	Baldwin	Brooks	Schenectady	Brooks	Baldwin.
Simple or Compound	Simple	Simple	Vauclain Comp'd.	Simple	2-cyl. Comp'd.	Simple	Vauclain Comp'd.
Type	Consolidation	Consolidation	Consolidation	12-wheel	Consolidation	12-wheel	Consolidation.
Total weight	250,300	230,000	225,082	232,200	193,000	212,750	214,600
Weight on drivers	225,200	208,000	202,232	193,200	173,000	172,000	191,400
Size of drivers	54 in.	54 in.	55 in.	57 in.	57 in.	55 in.	57 in.
Cylinders	21 x 32 in.	23 x 32 in.	18 and 30 by 30 in.	23 x 30 in.	23 and 35 x 34 in.	21 x 34 in.	17 and 28 x 32 in.
Heating surface	3,805 sq. ft.	3,322 sq. ft.	4,103.6 sq. ft.	3,500 sq. ft.	3,027.8 sq. ft.	3,280 sq. ft.	4,266 sq. ft.
Grate area	36.8 sq. ft.	33.5 sq. ft.	90 sq. ft.	37.5 sq. ft.	35.3 sq. ft.	34 sq. ft.	None.
Steam pressure	220 lbs.	200 lbs.	200 lbs.	210 lbs.	220 lbs.	210 lbs.	210 lbs.
American Engineer reference	1900, page 214	1898, page 365	1898, page 395	1899, page 315	1899, page 150	1898, page 1	This issue.



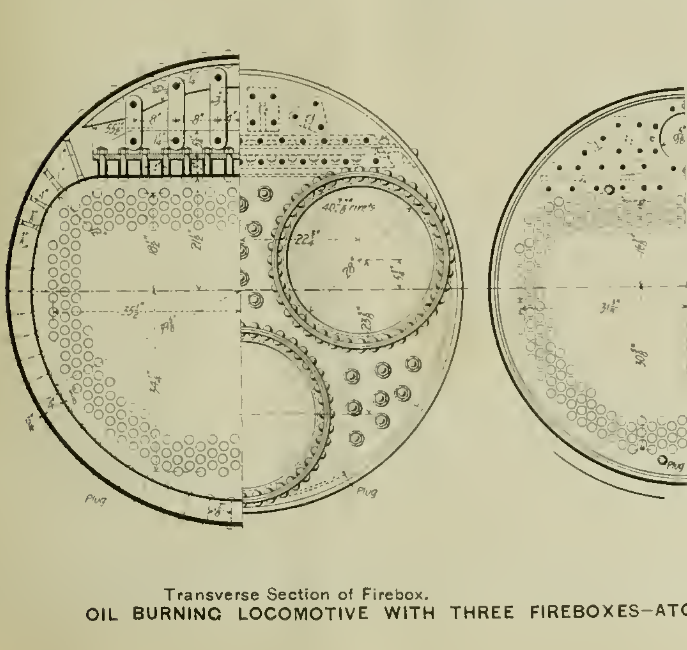
Longitudinal Section of Boiler.



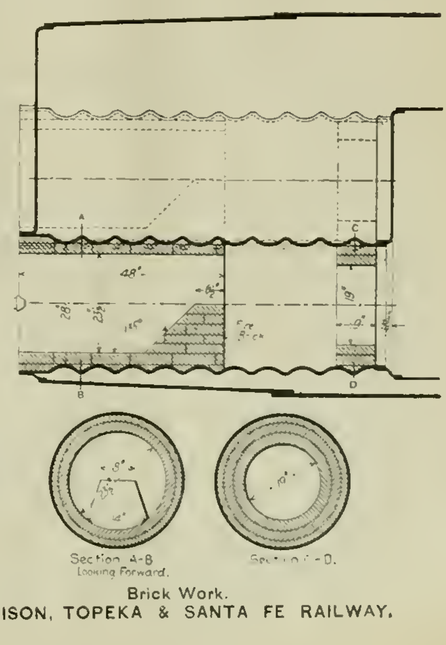
Side Elevation.



Half Rear and Front Elevations and Sections.

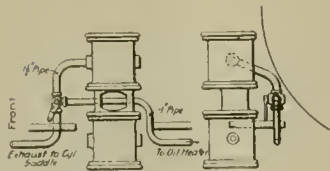


Transverse Section of Firebox.

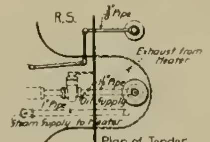


Brick Work.

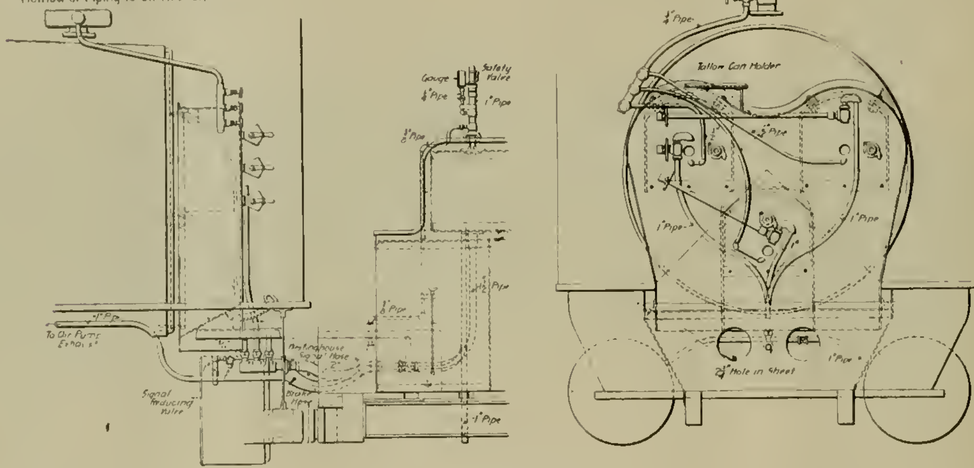
OIL BURNING LOCOMOTIVE WITH THREE FIREBOXES—ATCHISON, TOPEKA & SANTA FE RAILWAY.



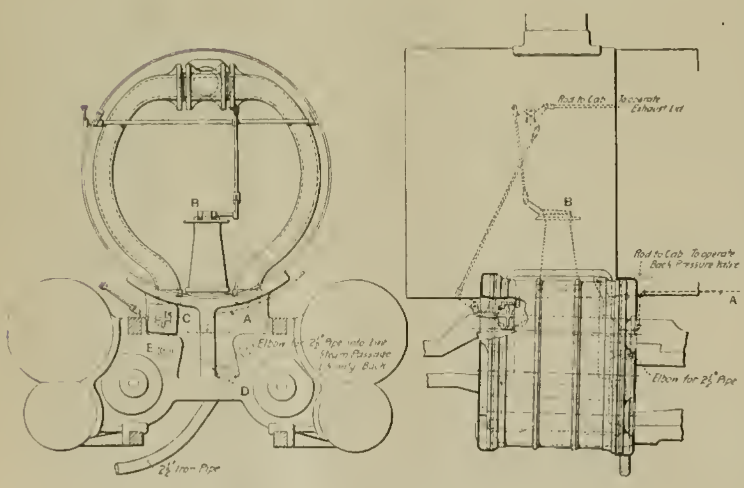
Method of Piping to Oil Heater.



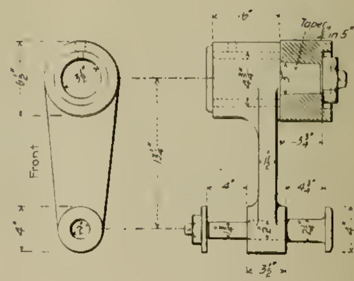
Plan of Tender Piping



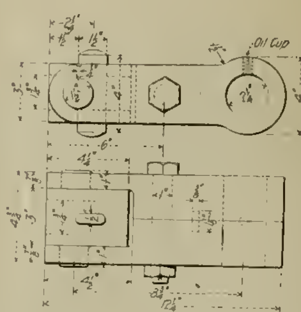
Arrangement of Oil Piping.



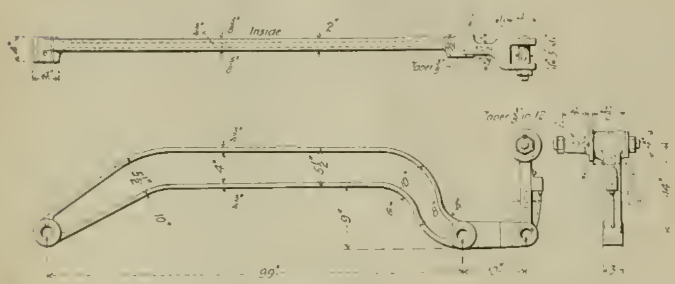
Arrangement of Baldwin Back Pressure Brake.



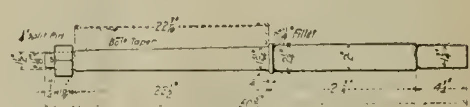
Valve Motion Rocker.



Connection to Valve Stem.



Motion Bar for Valve Motion.



Valve Stem.

OIL BURNING LOCOMOTIVE WITH THREE FIREBOXES, ATCHISON, TOPEKA & SANTA FE RAILWAY.

long, and rolled of ½-in. plate. These are connected to the rear plate of a combustion chamber, 40 in. long, of ⅜-in. plate, stayed by staybolts and sling stays to the shell, and by 1⅛-in. rods to the back head. The upper portion of the combustion chamber is flat and supported by Mr. Player's well-known arrangement of T section crown bars and short bolts. Except at the top of the combustion chamber the water space is 4 in.

One of the engravings shows the fire-brick protection for the furnaces and the brick obstruction to the flame which is built up in the center of each flue. The burners are placed centrally with the furnace flues. Another drawing shows the oil piping and location of the oil regulating valves. Each furnace flue has a 5-in. "fire door" opening, through which to watch the flame, and each has a curved cast-iron shield to protect the engine men in case of explosion of the oil in the furnace flues. Exhaust steam from the air pump is used to heat the oil. The tender carries 2,200 gallons of oil and 6,000 gallons of water.

Among the details are a short smoke box, 52 in. long, having frames of cast steel; main driving journals, 9½ by 12 in., and the other driving journals 9 by 12 in. The equalization system divides between the second and third pairs of driving wheels. To pass the first and second driving axles a long I section motion bar is used. This connects with the rocker, and the rocker connects with the valve stem by means of a short link, which is split lengthwise and at its forward end embraces the trunnions of a block which receives the end of the valve stem. The valves are very large, 13 in. in diameter.

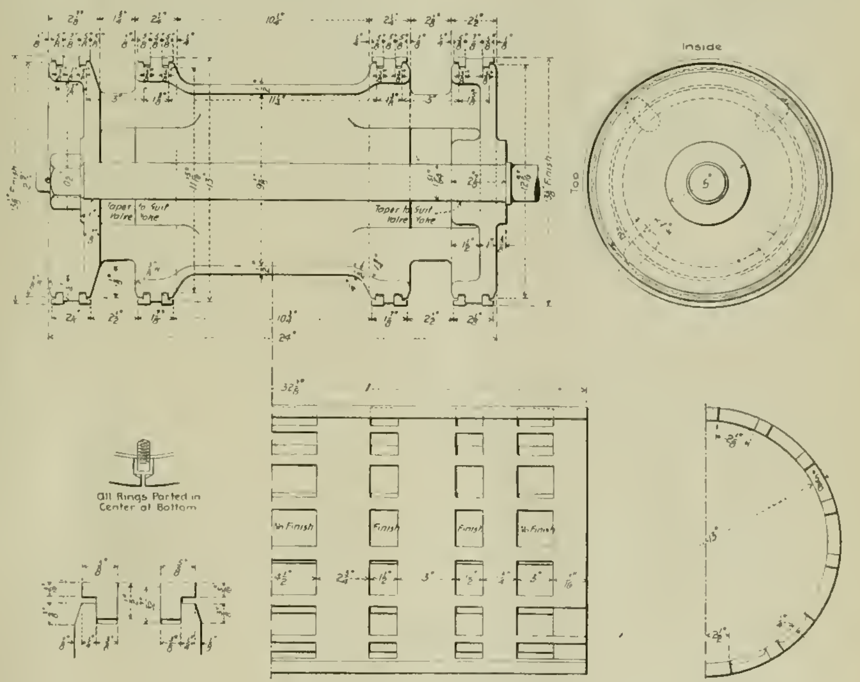
A new form of back pressure brake, on the principle of the Le Chatelier water brake, is used on this engine, and, in fact, on a large number of recent Vauclain compounds, including the large passenger engines for this road, illustrated in our December number. This brake takes air into the exhaust passages through automatic, inwardly opening valves and, when drifting, the smoke box gases are excluded from the exhaust nozzle by a cover. The use of this brake requires the driver brakes to be cut out; the regular employment of the air brake for the tender and train is, however, not interfered with. When the engine is drifting forward, the reverse lever is thrown in to back gear, the Chatelier valve in the cab is opened, supplying steam to the exhaust passages of the cylinder (at A in the engraving), and the damper (B) is closed over the exhaust nozzle, air being admitted to the exhaust passages through the inlet valve (C), and the steam is compressed in the cylinders and steam passages, thus retarding the motion of the pistons, also retarding the wheels, through the medium of the connecting rods. The accumulated pressure may be relieved through the gate valve (D), which is operated by a lever in the cab, so that the engineer may control the pressure to suit the existing conditions. A safety valve (E) is placed in the cylinder saddle to protect the passages against excessive pressure. There are two inlet valves, C, one on each side of the engine. In the side view, shown in dotted lines, is a rod and a plunger to hold these valves open and prevent them from clattering, but it has not been found necessary to use this attachment. The function of the steam is to keep down the temperature from the friction.

The description of this engine is completed by the following table of dimensions:

OIL BURNING CONSOLIDATION LOCOMOTIVE.

Atchison, Topeka and Santa Fe Railway

Fuel	Oil
Weight on drivers	191,400 lbs.
Weight on truck wheels	23,200 lbs.
Weight, total	214,600 lbs.
Weight tender loaded	110,000 lbs.
Wheel base, total, of engine	24 ft. 6 in.
Wheel base, driving	15 ft. 4 in
Wheel base, total (engine and tender)	54 ft 2¾ in.
Length over all, engine	39 ft. 8¾ in
Length over all, total, engine and tender	65 ft 7¼ in
Height, center of boiler above rails	9 ft 2 in.
Height of stack above rails	15 ft. 4 in.
Heating surface, fire-boxes	165 sq. ft.
Heating surface, tubes	1,031 sq. ft.
Heating surface, comb. chamber	70 sq. ft.
Heating surface, total	4,266 sq. ft
Drivers, diameter	57 in
Drivers, centers	Cast steel.
Truck wheels, diameter	30 in
Journals, driving axle, size	Main, 9½ x 12 in.; others, 9 x 12 in
Journals, truck axle, size	6½ x 10½ in.
Main crank pin, size	6¾ x 6¾ in.
Cylinders, diameter	H. P., 17 in.; L. P., 28 in.
Piston, stroke	32 in.



Vauclain Piston Valve.

Piston rod, diameter	4½ in.
Main rod, length center to center	10 ft. 10 in
Steam ports, length (circular)	29¾ in.
Steam ports, width	1½ in.
Exhaust ports, length (circular)	29¾ in.
Exhaust ports, width	4½ in.
Bridge, width	3 and 2¾ in.
Valves	13 in. dia., Balanced piston
Valves, greatest travel	5¾ in
Valves, outside lap	H. P., ⅞ in.; L. P., ¾ in
Valves, inside clearance	H. P., ¼ in.; L. P., ⅜ in
Valves, lead in full gear	H. P., 0 in.; L. P., ⅛ in.
Boiler, working steam pressure	210 lbs
Boiler, material in barrel	Steel.
Boiler, thickness of material in barrel	¾ in. and 13-16 in
Boiler, diameter of barrel	74 in
Seams, kind of horizontal	Butt jointed, double covering strips.
Seams, kind of circumferential	Double riveted, 1¼ in. riv.
Thickness of tube sheets	½ in.
Thickness of crown sheet	⅜ in.
Crown sheet stayed with	Inverted T-iron crown-bars
Dome, diameter	31½ in.
Fire-boxes, length	7 ft. 0 in
Fire-boxes, diam., inside	2 ft. 4 in
Fire-boxes, diam., outside	2 ft. 8 in.
Comb. chamber, length	3 ft 4 in
Fire-boxes, material	Steel.
Fire-boxes, thickness of sheets	½ in.
Tubes, number	652
Tubes, material	Iron, No. 13 W. G.
Tubes, outside diameter	1¾ in

Tubes, length over sheets	13 ft. 7 in.
Smoke-box, diameter inside	74 in.
Smoke-box, length	52 in.
Exhaust nozzle	Single.
Exhaust nozzle, diameter of thimbles	4½, 4¾ and 5 in.
Exhaust nozzle, distance of tip below center of boiler	7 in.
Stack	Taper.
Stack, least diameter	15⅜ in.
Stack, greatest diameter	17⅜ in.
Stack, height above smoke-box	3 ft. 0 in.
Tender.	
Type	Swivel trucks.
Tank capacity for water	6,000 gals.
Oil capacity	2,200 gals.
Kind of material in tank	Steel.
Thickness of tank sheets	¼ in. and 5-16 in.
Type of under-frame	10 in. steel channel.
Type of truck	Player, cast steel.
Truck with swinging motion or rigid bolster	Rigid.
Type of truck spring	Elliptic.
Diameter of truck wheels	34¼ in.
Diameter and length of axle journals	5 x 9 in. M. C. B.
Distance between centers of journals	6 ft. 4 in.
Diameter of wheel fit on axle	6⅜ in.
Diameter of center of axle	5⅜ in.
Type of truck bolster	Player, cast steel.
Type of truck transom	Player, cast steel.
Length of tender frame over bumpers	23 ft. 10½ in.
Length of tank	22 ft. 6 in.
Width of tank	9 ft. 6 in.
Height of tank, not including collar	4 ft. 2 in.
Height of tank over collar	6 ft. 1 in.
Type of back draw-head	Tower coupler, tandem.
Draft rigging	Miner.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The proposed increase of membership dues in the American Society of Mechanical Engineers was rejected at the December convention by a vote of 647 to 191, and the incident, as far as the dues are concerned, is closed. Before the meeting many guessed at the reason for the suggested increase and one guess was as good as another. No one suspected, not even the members of the council, that the society was in debt to the amount of about $13,000, but this unwelcome fact came out in the discussion, and the result is an evident intention on the part of the council to thoroughly investigate the financial affairs for the purpose of remedying the difficulty as it should be remedied, by business-like management rather than by an increase in revenue. As the membership increased the cost of the service to the members, of which printing is the largest item, increased per member instead of decreasing, as it should, and it was made clear in the discussion that other similar societies gave more to their members on a lower scale of dues. A report of the discussion is not necessary here, but we desire to indicate that at present there is no definite authority in direct control of the current expenditures, to whom the secretary must apply before incurring bills. This should be changed, and it probably will be, for the voice of the membership, which was expressed extensively by means of proxies, was clear and definite in favor of retrenchment, although the existence of the debt was not suspected. At a meeting of the council, held before the convention, a possibility of saving $4,000 per year was readily found. Proxy votes in this society under the laws are rare, if they have ever been used before, and one result of this question was the suggestion of a change in the constitution which when enacted will provide for letter ballot in deciding upon future amendments, and this will avoid the necessity for proxies. This question is disposed of, but its effect will probably be important and lasting, for the thorough ventilation of the situation resulted in a clear expression of the necessity for a general improvement in the management which cannot fail to affect beneficially the entire work of the organization. The council should now take all of the membership fully into its confidence and should solicit from all members suggestions which may tend toward placing this society upon the high plane which it should occupy, but at present does not. The good work should not stop until the proceedings reflect in every branch of mechanical engineering the "state of the art." In this they are now deficient. But this must not be left to the secretary alone. The thoughtful and conscientious co-operation of the entire membership is needed if the society is to fill the place it ought to fill as the most important engineering association in the country.

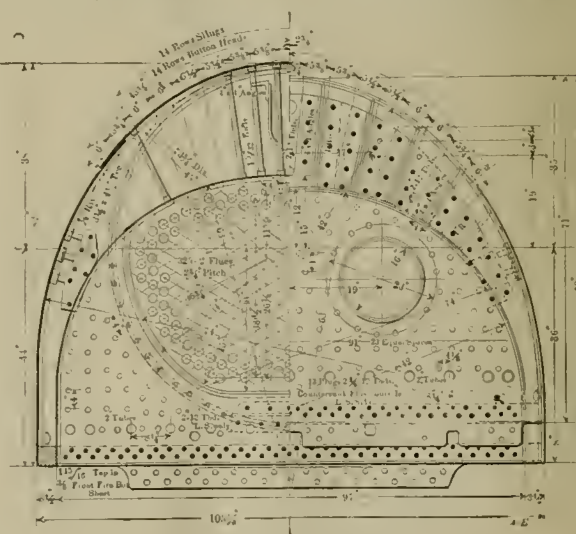
"CHATAUQUA" TYPE PASSENGER LOCOMOTIVES.

Central Railroad of New Jersey.

The Heaviest Four-Coupled Passenger Locomotives.

Three of the locomotives illustrated by these engravings were built at the Brooks Works of the American Locomotive Company and put into service on the Central Railroad of New Jersey last September. They are used in exacting passenger service between New York and Philadelphia, and are proving themselves to be very satisfactory. Having the distinction of being the heaviest of the four-coupled type ever built, they are specially worthy of record. Mr. McIntosh, Superintendent of Motive Power of this road, has long been of the opinion that it is a mistake to sacrifice strength and reliability in service by making the parts of locomotives too light, and this extraordinary total weight of 191,000 lbs. was employed with a view of "preventing the engines from shaking themselves to pieces" rather than to secure the utmost limit of power from the allowable weight. He was, therefore, satisfied with somewhat less heating surface than has been obtained with much lighter engines. In carrying out this idea he was fortunate in being able to take advantage of a boiler fired with anthracite coal on a grate of 82 sq. ft. area. Such boilers are powerfully good steamers, and so they have proved in this case.

The Vauclain 10-wheel compounds of the Lehigh Valley, an outline of which was shown on page 312 of our volume of 1900, have a total weight of 194,758 lbs., but the new Chautauqua type engines, while not the heaviest passenger engines, are heavy enough. We know of no other engines now running in this country having 85-in. driving wheels and very few having as great a weight, 99,400 lbs., on four driving wheels. The Pennsylvania Atlantic type engines, Classes E1 and E2,



Transverse Section of Boiler.
"Chautauqua" Type Passenger Locomotive.

weigh 101,550 and 109,033 lbs. on driving wheels, respectively. These are believed to be the heaviest weights in use on four wheels.

The height of the center of these boilers of the Chautauqua type engines is 9 ft. 8½ ins., which is unusually high, although less than that of the recent 10-wheel freight engines of the Chicago, Rock Island & Pacific, which is 9 ft. 10⅞ ins. above the rail. In this connection it is interesting to know that this combination of large wheels, heavy weight and high boilers results in very easy riding, this feature of the Jersey Central engines being noteworthy. In order to conveniently compare the four leading examples of the "Chautauqua" type, from the

Brooks Works, showing the steps in progression, to the present development, the following table has been prepared:

"Chautauqua" Type Locomotives.

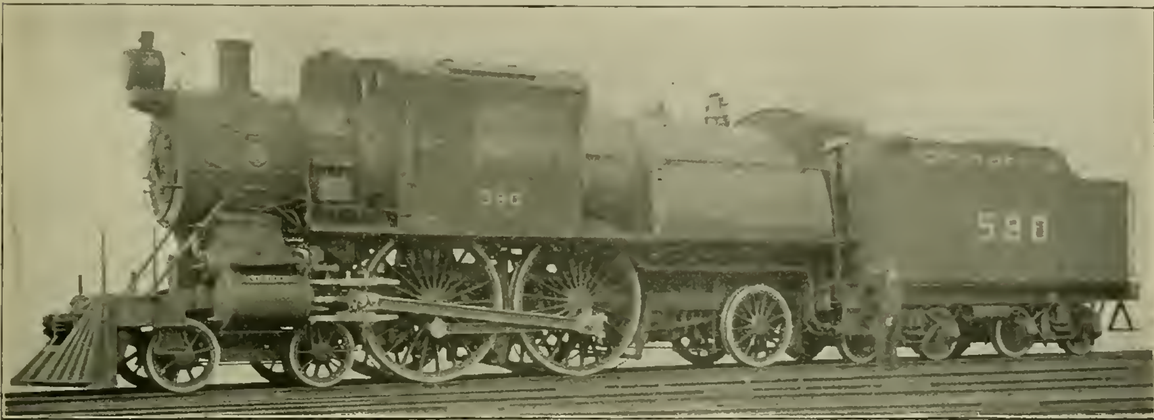
	B.,C.R.&N.	C.,R.I.&P.	B.R.&P.	C.R.R. of N.J.
Total weight, lbs.	158,600	167,000	173,000	191,000
Weight on drivers, lbs.	88,000	93,500	99,000	99,400
Heating surface, sq. ft. ..	2,551	2,806	3,007.9	2,967
Grate area, sq. ft.	45.3	55.7	54.4	82
Boiler pressure, lbs.	210	210	220	210
Clyinders, diameter (ins.)..	19½	20¼	20¼	20½
Cylinder, stroke (ins.).......	26	26	26	26
Drivers, diameter (ins.).....	*75	†78½	‡72	**85

Illustrated in "American Engineer" as follows: * Dec., 1900, p. 375; † April, 1901, p. 101; ‡ This issue; ** This issue.

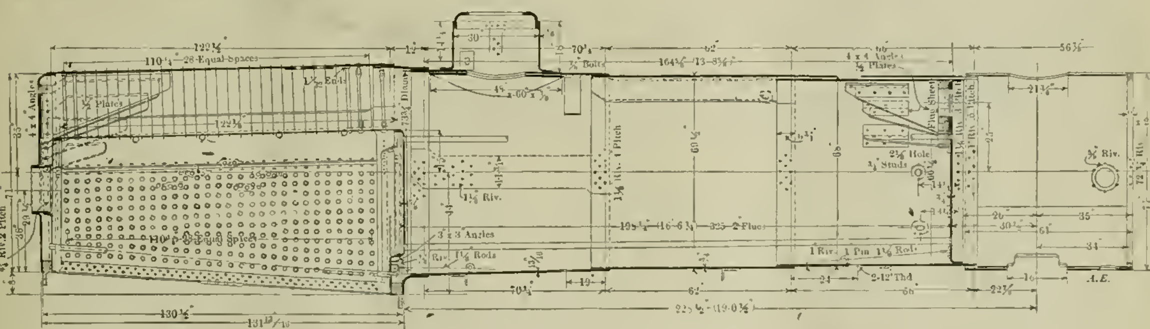
Among the details of the present design the following may be noted. The trailing truck is the Player radial type, similar to that of the "Prairie" type engines of the Lake Shore, illustrated on page 74 of our March number, 1901. The firebox is 123 ins. long and 97 ins. wide, fitted with grates for fine anthracite coal, and having two fire doors. The firebox is supported by plates. The tubes are 16 ft. 6¼ ins. long. The ash-pan doors are hung on compensated links, as shown in the side elevation. A boiler brace extends to the front rails of the frames and another to the grate yoke on each side. At the rear of the main driving boxes the frames are offset downward to secure room for a good slope to the ash pan. Across the engine, and in front of the firebox a transverse equalizer is carried. A cast-steel rocker is used in connection with the valve gear, which is direct motion, the rocker having a double bearing. The piston valve is 11 ins. in diameter. With these weights large journals were required. The driving journals are 9½ by 12 ins., the trailers 8 by 14 ins., and the truck journals 6 by 12 ins. A table of the chief dimensions follows:

CHAUTAUQUA TYPE PASSENGER LOCOMOTIVE.
Central Railroad of New Jersey.

Gauge ....4 ft. 8½ ins.
Kind of fuel to be used..............................Fine anthracite coal
Weight on leading wheels..............................48,000 lbs.
Weight on driving wheels..............................99,400 lbs.
Weight on trailing wheels..............................43,200 lbs.
Weight on total ....191,000 lbs.
Weight tender, loaded ....124,000 lbs.
Wheel base, total of engine..............................29 ft. 10 ins.
Wheel base, driving ....7 ft. 8 ins.
Wheel base, total engine and tender..............................53 ft. 8 ins.
Length over all, engine..............................39 ft. 8⅝ ins.
Length over all, total engine and tender..............................69 ft. 8 ins.
Height center of boiler above rail..............................9 ft. 8½ ins.
Height of stack above rail ....14 ft. 11 ins.
Heating surface, firebox..............................174 sq. ft.
Heating surface, tubes ....2,793 sq. ft.
Heating surface, total ....2,967 sq. ft.
Grate area ....82 sq. ft.
Wheels, leading, diameter ....36 ins.
Wheels, driving, diameter ....85 ins.



"Chautauqua" Type Passenger Locomotive.—Central Railroad of New Jersey.
WM. MCINTOSH, *Superintendent Motive Power.* AMERICAN LOCOMOTIVE CO., *Builders.*



Longitudinal Section of Boiler.

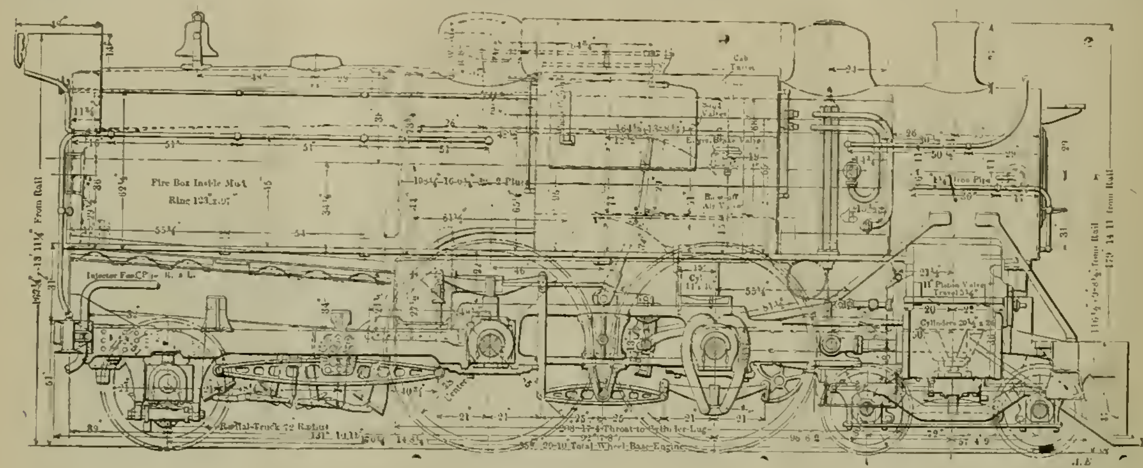
Wheels, trailing, diameter ....51 ins.
Material of wheel centers ....All cast steel
Type of trailing wheels..............................Improved radial axle
Journal, leading axles ....6 by 12 ins.
Journal, leading axles, wheel fit..............................6½ ins.
Journal, driving ....9½ by 12 ins.
Journal, driving axles, wheel fit..............................9½ ins.
Journal, trailing axles ....8 by 24 ins.
Journal, trailing axles, wheel fit..............................7⅞ ins.
Cylinder diameter ....20½ ins.
Cylinder stroke ....26 ins.
Piston rod diameter ....4 ins.
Main rod length center to center..............................140 ins.
Steam ports, length ....25¼ ins.
Steam ports, width ....1¾ ins.
Exhaust ports, leasts area ....75 sq. ins.
Bridge width ....3⅛ ins.
Valves, kind of ....Piston
Valves, greatest travel ....5¾ ins.
Valves, steam lap (inside) ....1¼ ins.
Lead in full gear ....3/32 ins.
Lead, constant or variable ....Variable
Boiler, type of ....Wagon top
Boiler, working pressure ....210 lbs.
Boiler, material in barrel ....Steel
Boiler, thickness of material in shell..¾ ins., 13/16 ins., ½ in., 9/16 in.
Boiler, thickness in tube sheet..............................¾ in.
Boiler, diameter of barrel front..............................68 ins.
Boiler, diameter of barrel at throat..............................73¾ ins.
Seams, kind of horizontal ....Sextuple
Seams, kind of circumferential ....Triple
Crown sheet stayed with ....Radial stays
Dome, diameter inside ....30 ins.
Firebox, type ....Wide
Firebox, length ....123 ins.

Firebox, width .... 97 ins.
Firebox, depth, front .... 59 ins.
Firebox, depth, back .... 48 ins.
Firebox, material .... Steel
Firebox, thickness of sheets..Crown, ⅜ in.; tube, ⅝ in.; side, ⅜ in.
Firebox, brick arch .... None
Firebox, mud ring width ....3½ ins. back, 3½ ins. sides, 4 ins. front
Firebox, water space at top..4½ ins. back, 5½ ins. sides, 4 ins. front
Grates, kind of .... Rocking
Tubes, number of 325
Tubes, material .... Charcoal iron
Tubes, outside .... 2 ins.
Tubes, thickness .... 12 B. W. G.

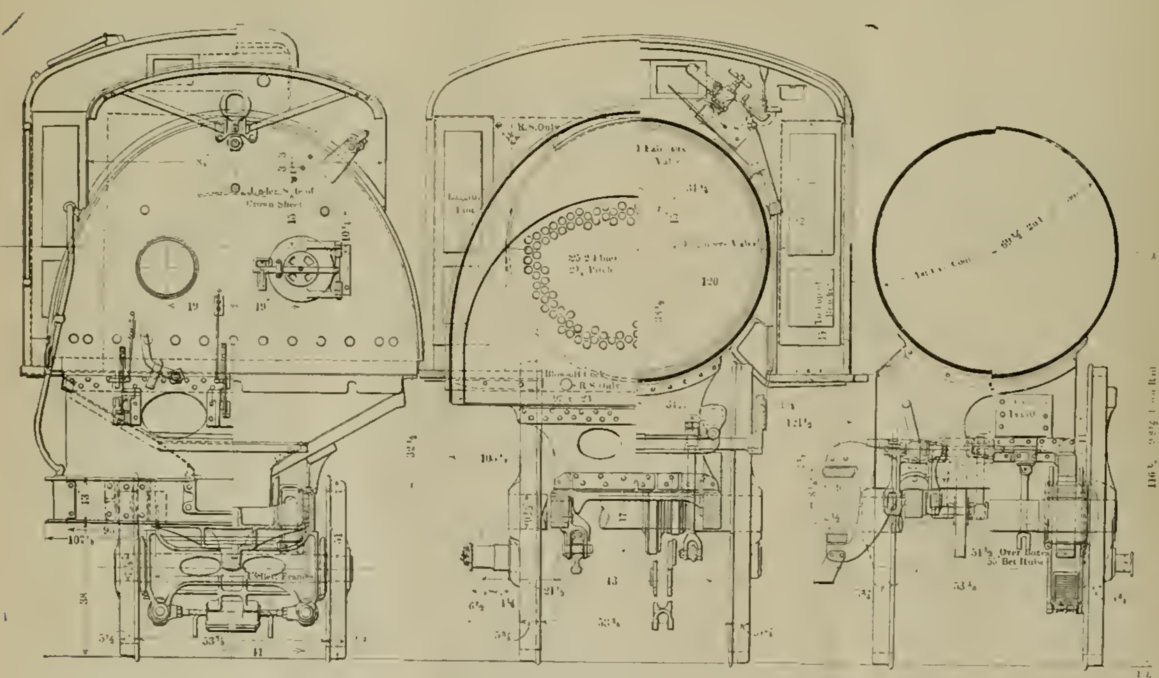
Stack, greatest diameter .... 16⅜ ins.
Stack, height above smokebox .... 27 ins.

Tender.

Type .... 8-wheel steel frame
Tank type .... Slope top
Tank, capacity for water .... 6,000 gals.
Tank, capacity for coal .... 12 tons
Tank material .... Steel
Tank, thickness of sheets .... ¼ in.
Type of under-frame .... Steel channel
Type of trucks .... Brooks all metal trucks



Side Elevation.



Half Rear Elevation and Sections.

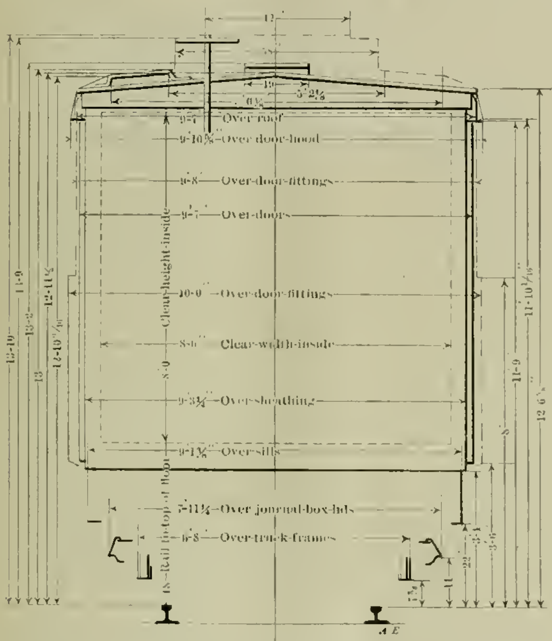
"CHAUTAUQUA" TYPE PASSENGER LOCOMOTIVE—CENTRAL RAILROAD OF NEW JERSEY.

Tubes, length over tube sheet .... 16 ft. 6¼ ins.
Smokebox, diameter outside .... 71 ins.
Smokebox, length from tube sheet .... 65¼ ins.
Exhaust nozzle, single or double .... Single
Exhaust nozzle, variable or permanent .... Permanent
Exhaust nozzle, diameter .... 5 ins., 5 3/16 ins.; 5⅜ ins.
Exhaust nozzle, distance of tip below center of boiler ......5 ins.
Netting, wire or plate .... Netting
Netting, size of mesh or perforations 2½-in. by 2½-in. No. 12 wire
Stack, straight or taper .... Taper
Stack, least diameter taper .... 15 ins.

Type of springs .... Triple elliptic
Diameter of wheels .... 36 ins.
Diameter of length of journals .... 5½ by 10 ins.
Distance between centers of journals .... 6 ft. 5 ins.
Diameter of wheel fit on axle .... 6⅞ ins.
Diameter of center of axle .... 5⅞ ins.
Length of tender over bumper beams .... 21 ft. 7½ ins.
Length of tank inside .... 20 ft.
Width of tank inside .... 10 ft.
Height of tank, not including collar .... 5 ft. 7¼ ins.
Type of draw-gear .... Williamson & Pries tandem

THE STANDARD BOX CAR.

The Master Car Builders' Association has acted with characteristic promptness in beginning its part in the adoption of the standard box car. Immediately upon receipt of the notice of the adoption of the interior dimensions by the American Railway Association, the President of the Master Car Builders' Association appointed a committee to consider the subject, consisting of Messrs. C. A. Schroyer, Chairman; G. W. Rhodes, W. P. Appleyard, J. N. Barr, Joseph Buker. This committee met in Chicago November 30th, and considered the limiting dimensions of important railroad clearances, the pres-



ent established height of loading platforms, the various methods of car body construction and proposed the following exterior dimensions for cars of this class:

For a box car set on the trucks used as standard, where the height from top of rail to top of floor is 1 ft.
Height, top of rail to upper edge of eaves................12 ft. 6¾ in.
The following details were used to determine the above elevation.
Top of rail to upper face of floor..4 ft.
Upper face of floor to under edge of carline.......................8 ft.
Width of carline at end where secured to plate............3 13-16 ins.
Thickness of rafter to which metallic roof is applied...........1⅝ in.
Thickness of purlin to which roof boards are secured..........1⅛ in.
Thickness of roof boards...13-16 in.

12 ft. 7⅜ ins.
Less pitch of roof from inside edge of plate to outside edge of eaves..⅝ in

12 ft. 6¾ ins.
Width, at eaves at above height, maximum..............9 ft. 7⅜ ins.
The following details were used to determine the above dimensions:
Width, between lining..8 ft. 6 ins.
Thickness of lining..1⅝ ins.
Thickness of siding..1⅝ ins.
Thickness of posts and braces...6 ins.
Air space between fascia boards...1 in.
Thickness of fascia boards..1⅝ in.
Projection on each side for roof, ¾ in...............................1½ in.

9 ft. 7⅜ ins.

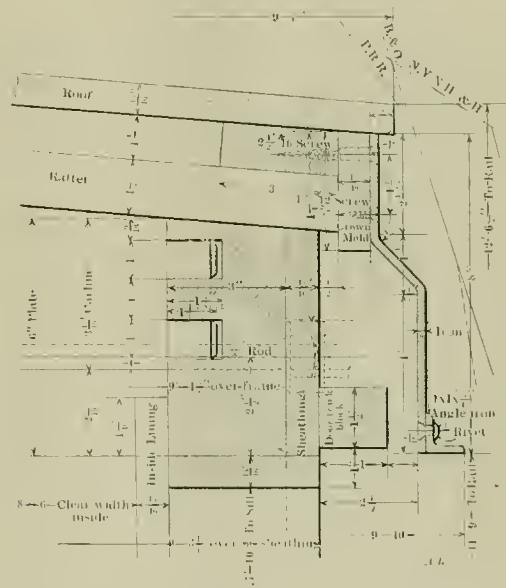
The committee believe that these allowances will present no difficulty in framing a car with metallic roofs, as ordinarily applied. In their circular they recommend not less than 18 ins. as a minimum distance from the top of the rail to the bottom edge of the outside sill. This was to provide for limits at this point determined by girder bridges and viaducts on many roads. The circular also suggests the following dimensions:

For a box car on low trucks, where the height from top of rail to top of floor, is..................3 ft. 6 ins.
Height, top of rail to upper edge of eaves........12 ft. ¾ in.
Width, at eaves, at above height, maximum..........9 ft. 10 ins.

No recommendations are made as to length, but it is the opinion of the committee that the strongest end construction possible should be used, regardless of the exterior longitudinal dimensions.

The subject is placed before the members of the Association by means of this circular, in which replies to the secretary are requested from those who wish the dimensions modified to meet the conditions on their own roads. With this prompt action a definite result may confidently be expected at the June convention of the Master Car Builders' Association.

The principal trouble as to clearances occurs at the eaves, and a diagram furnished us by Mr. John Henney, Superintendent of Motive Power of the New York, New Haven & Hartford, illustrates the construction at this point of cars which



are being built for that road by the Pressed Steel Car Company. In this diagram the full solid line indicates the eaves clearance of the Pennsylvania, the dotted line that of the Baltimore & Ohio, and the dot and dash line that of the New York, New Haven & Hartford. These show the dimensions of cars which will be accepted over all portions of these roads.

Door hoods of metal, pressed into shape, are to be applied in accordance with this drawing. These hoods are brought around on a line with the fascia boards at the ends, and the angle-iron at the bottom extends the full length of the hood. This should give a strong hood, much stiffer than the usual construction, and from the detail drawing it is apparent that wood is out of the question for this purpose.

It has been ascertained that the car shown in the complete clearance diagram can be operated over all of the principal lines east of the Mississippi River, with the exception of a few minor branches, and it is understood that the circular issued by the Master Car Builders' Association giving the proposed limiting dimensions of the heights and widths, is based on this car.

Charles H. Haswell, the first chief engineer of the United States Navy, was appointed in 1836 and was engineer-in-chief from 1844 to 1850. He is now over 90 years of age and was able, last month, to attend the memorable services at the unveiling of the monument erected by the American Society of Mechanical Engineers to the memory of Robert Fulton, in Trinity churchyard, New York. This fact is indeed most impressive of the wonderful progress of engineering in a single generation, when only a few rods away could be found the highest types of merchant and war vessels.

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EDITORIAL ANNOUNCEMENTS.

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

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

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

A fire in our composing room explains the delay in the appearance of this issue. It occurred just as the forms were ready for the press, and we ask the indulgence of our readers for deficiencies which, under the circumstances, could not be avoided.

Roundhouse design now very properly receives an amount of attention which was formerly only given to shops, and the prompt work of locomotive terminals is becoming an important function of the motive power department. Last October we illustrated the general plan of the Collinwood roundhouse of the Lake Shore & Michigan Southern Railway, and in this issue present a number of the interesting details of this terminal as a representative example of the best practice of the time. This plan and equipment very closely covers the ideas as to the "up-to-date" roundhouse which were outlined by the committee on this subject before the Master Mechanics' Association last year, and it is furthermore an example of a plan executed in accordance with the views of the motive power department throughout. An examination of this plan carries the conviction that such an investment as this will earn a high rate of interest to any railroad.

A locomotive coaling plant which actually weighs the coal, and, at the same time, provides for storing it in large chutes with provision for filling the chutes from cars without shoveling, has been greatly needed. In this issue is illustrated a new system which is being installed on a rather large scale on the Chicago & Alton. It not only places the coal in 60-ton chutes, sufficient to take the entire load of the largest coal car in a single chute, but it fills the chutes without shoveling, and also handles ashes and sand in the same plant. In this construction the entire chute and its load is mounted on scales and is weighed by the coal chute attendant, who also does all of the work required about the coaling plant. These scales are housed, which avoids the objection to track scales. A number of roads are putting up coal chutes with one or two large pockets on each side reached by trestle approaches so that 40 or 50-ton hopper cars may be used without a labor charge for handling the coal. The cars are raised on the trestles by switch engines, and the coal dumped by gravity into the pockets from which it is served to the tenders by the usual method. This chute is economical when hopper cars are used, but it has the serious objection of not providing means for weighing the coal. The result is that the individual coal records are not kept with sufficient accuracy to inspire the confidence of the men, and it is impossible to keep a satisfactory record. Without this the most important advantage of the coal record is lost. The construction used on the Chicago & Alton saves the cost and the space required by a trestle, and it also should lead to an immediate reduction of the consumption of fuel, because of the fact that the enginemen see the coal weighed, and if desirable they may be given an autographic record of the weight instead of the usual coal ticket. Because of the vital necessity of the best possible equipment of locomotive terminals and other coaling stations along the road, the design appears to be an attractive and important one.

In the operation of heavy locomotives attention is attracted as it never has been before to the necessity for improved side-track facilities. With a long, heavily-loaded train, it becomes desirable to reduce the number of stops to the minimum, and with the present demand for the utmost possible use to be obtained from locomotives all time lost on the road is expensive, not to mention the cost of delays which involve overtime for the train crews. For either double or single-track roads, with fast-time freights or stock trains and passenger trains using the same tracks, "lap sidings" offer advantages which do not appear to be fully appreciated. The superintendent of motive power of an important Western road having these conditions says: "I wish you would urge upon your readers the use of the 'lap siding,' so that these large engines with heavy trains can run to them, and the dispatcher would know that they were making meeting points. At the end of each of these sidings, which may be from 1 to 4 miles in length, there should be an operator. His duty should be to give the enginemen the signals and throw the switches for them. Then the trains may come along at 20 miles an hour, which would help the coal bills and greatly assist the movement of trains. It would also save the draft gear of cars and avoid the serious delays which are frequently caused by break-in-twos in pulling out of sidings. The value of these facilities to the train dispatcher can hardly be estimated. By a careful study of this idea I believe we could get along with fewer side-tracks and yet do the work more economically."

The Pennsylvania Railroad plan for its terminus in New York City is bold and comprehensive beyond precedent. It combines a number of elements, a single one of which would, a few years ago, have been ridiculed. The Long Island and Pennsylvania will meet in an underground station 1,500 ft. long by 520 ft. wide, situated between 31st and 33d streets and 7th and 10th avenues, this station to be reached by tunnels under the North and East rivers. Connection will be made with the Rapid Transit Subway at 4th avenue and through trains of the Pennsylvania, as well as suburban trains of the Long Island, will come into the heart of the city without change. With electricity as a motive power this plan will undoubtedly exert a great influence on the future of similar transportation problems, and the scheme, as a whole, seems likely to revolutionize methods of managing the terminal problems of large cities. In all respects the plans are worthy of the great railroad by which they are undertaken. A work of this extent is sure to present engineering difficulties from its very size, but added to these is that of supporting a tunnel in the soft material forming the bed of the North River. That this can be overcome is assured by those who are conducting the undertaking and the development of the plans will be watched with an interest never before given to a work of this character. The franchise has not yet been granted, but as the tunnels will run under the streets and deep enough to avoid endangering foundations, there seems to be no reason to expect the least opposition; private land will not be affected. Speculation as to the future steps which will be made possible by this terminal is interesting, but the scheme as outlined is sufficiently large for present contemplation.

Nobody wants additional complication in locomotives, and nobody wants the crank axle. If, however, there is any considerable gain to be had from a divided engine with four cylinders and a balanced arrangement, which of necessity involves both of these undesirable features, they are likely, eventually, to be accepted. There are many theoretical advantages offered for the four-cylinder compound which seem to meet the present need, and this system has been so successful in practice as to justify a thorough, practical investigation of the principles as applied to our conditions. The American Engineer does not advocate greater complication, and it does not urge the crank axle, but it unhesitatingly takes the ground that the four-cylinder balanced compound should be thoroughly exploited in this country, in order to ascertain the truth with respect to the claims of the type, and if the expectations are realized there need be no fear as to the management of the details.

In this issue is illustrated an interesting adaptation to American ideas of the principles of the engines first brought out by Mr. Alfred G. de Glehn in 1886 in France, which have been so successful in Europe. The de Glehn compounds have placed French passenger service, in point of high-speed trains, above that of every other country, including ours, and the trains are by no means light. Their remarkable acceleration has impressed everyone who has investigated the subject carefully. These engines are far too complicated for Americans, but Mr. Muchnic suggests an adaptation which reduces the number of additional parts to a very few.

In the de Glehn compounds the inside (high or low pressure) cylinders are placed at the forward end of the locomotive, driving the crank axle, which is the forward axle of the 8-wheel, 10-wheel and Atlantic types, and the second axle of the consolidation type. The outside (high or low pressure) cylinders are placed outside the frames and in the rear of the others, being as near as possible to the foremost pair of wheels for sufficient clearance between the cylinders and the wheel flanges. The outside cylinders drive the second or third pair of driving wheels. Each cylinder has a separate valve and valve motion, with the ordinary slide valves. An intercepting valve is placed between each pair of cylinders, in order to work all four cylinders with live steam when necessary.

For Mr. Muchnic's plan the reader is referred to the description. He suggests two valves and two ordinary valve gears. The additional complication then becomes a question of rods and the crank axle. As to the rods it may be said that for large engines of the prevailing types the main rods have become so heavy as to be troublesome in the shop. For this reason, and because of the enormous stresses from the large pistons of modern engines, it seems probable that the relief obtained by a division of the work among a larger number of rods will be important. Preparations are now being made to investigate these principles in this country, and it is to be hoped that the experiments will be painstaking and thorough.

In following the records of recent locomotive development in this country, as outlined by Mr. F. J. Cole in his paper before the New York Railroad Club last November, and in the remarkable prairie type engines just put into service on the Atchison, Topeka & Santa Fe, the impression cannot be avoided that the advance in locomotives has outstripped that of the roadway and its structures. This leads to the conclusion that it is necessary to look to those features of locomotive design which tend toward increasing to the utmost the effectiveness of every pound of weight. In an able article in the "Railroad Gazette" of September 27, 1901, Mr. F. F. Gaines, Mechanical Engineer of the Lehigh Valley, presented some important observations in this connection, and in our issue of October the same subject was reviewed.

The fact that a leading Western road applied to the editor of this journal for special apprentices was announced in these columns last month, and the responses are suggestive and interesting. A well-known professor in a technical school was one of the first to reply. He believes that the railroads deprive themselves of the best material for successful mechanical officers by the low wages offered to apprentices, and while firmly believing in the spirit of willingness to accept low salaries while learning one's work, he finds it difficult to induce graduates to refuse positions paying from $60 to $70 per month in order to take apprenticeships. The deluge of applications from students who are about to graduate and want to know about this particular opportunity is, however, encouraging. There is no greater menace to the successful career of a young engineer than the feeling that he is wanted for an important position, and that he can step into one immediately after graduating. At that critical period it is usually positively dangerous for him to feel that he has the choice among a number of good positions. We would like to see educators and others urge boys to seek opportunities to learn and to prepare for the good things later, because of thorough preparation in low positions. They should be led to forget the matter of salary until they have something which is really worth a good salary. We have in our editorial rooms a long list of names of disappointed, discontented technical school graduates to prove that a good start as to salary often means a long and unsatisfactory pause in progress a little later on. Those who ignore the compensation and forget that their education is expected to accelerate their advancement are the ones who reach the higher places.

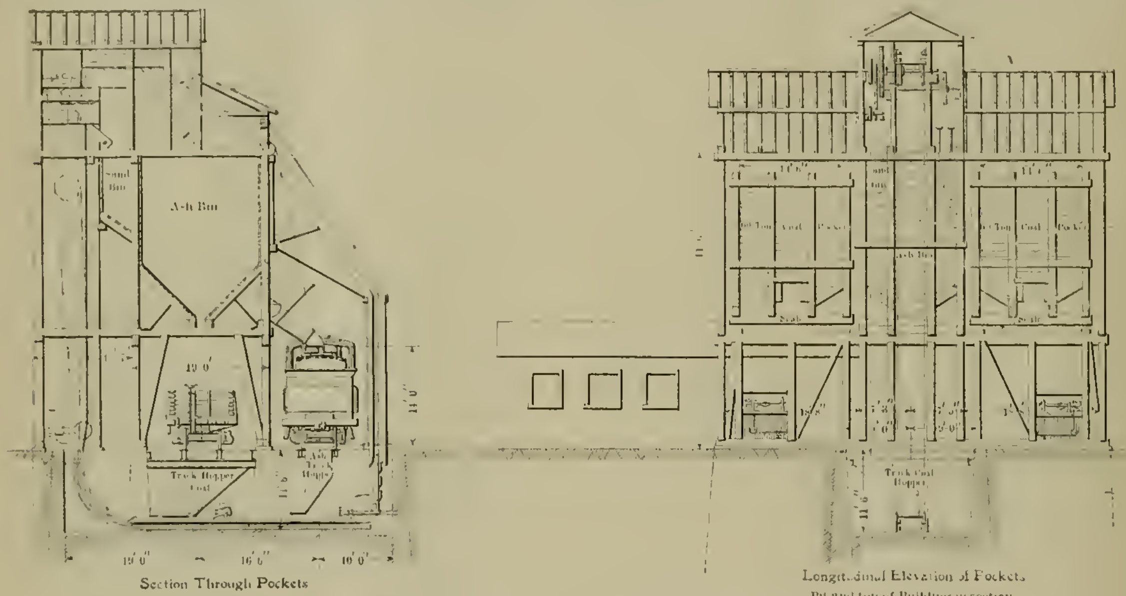
Mr. Clarence P. Day, after eighteen years' experience in connection with advertising departments of leading technical publications, has resigned as Vice-President of the Industrial Press, a position which he has filled for several years, to undertake a unique service for mechanical advertisers—that of Advertising Counselor. The intimate knowledge of the subject of advertising gained in his exceptional experience will be made available to those who desire to obtain the best possible results and greatest effectiveness of their advertising. Mr. Day has a field of his own, and is not in any sense a broker or agent. He institutes a new profession as a student of advertising, and an adviser to produce higher efficiency in mechanical advertising. One of the tendencies of the times is toward discrimination in advertising, and there is a widely-felt need for the services which Mr. Day will give. The client pays for the service and the scheme positively excludes commissions or other renumerations of all descriptions. Here is one who thoroughly understands not only the advertising problem, but the possibilities, methods and means. He is a competent specialist who, from a life study of his subject, is prepared to give expert professional advice with original and detailed plans which are sure to raise the standard of advertising. Mr. Day's plan seems to us most sensible, comprehensive and effective. His pamphlet, "Higher Efficiences and Economy in Mechanical Advertising," we endorse, because it contains the real secret of results. His enterprise will have the cordial support of honest publications in his field. Mr. Day's address is 263 Broadway, New York.

LABOR-SAVING COAL CHUTES.

Chicago & Alton Railway.

The construction of chutes for coaling locomotives seems to be tending toward larger pockets with sufficient capacity to receive the entire contents of a 40 or 50-ton car. A number of chutes of this size are being built in such a way as to save, altogether, the expense of labor in handling the coal because of its being dropped by gravity directly from the car into the delivery chute. By providing an inclined plane to elevate the cars, one man, with the aid of a gasoline engine, can operate the coaling plant. These chutes are very satisfactory in every particular but one. They do not provide means for keeping accurate accounts of the individual coal records of the locomotives. This is a serious defect, and the time has come when we have no hesitation whatever in stating plainly that no method of accounting for coal which does not provide for taking its actual weight can be satisfactory. It is impossible to get men to take the proper interest in their coal records unless they are satisfied with the method of keeping the accounts. This cannot be done in any other way. For this reason the new chutes which are being installed on the Chicago & Alton are specially interesting. They combine the large chute holding an entire carload of coal with the weighing apparatus, and they also include ash and sand handling facilities.

Ten of the most improved chutes have been contracted for by the Chicago & Alton Railroad. These will be at Kansas City, Slater, Vanice, Roodhouse, Bloomington, Farber, Tallula, Ridgley, Odessa and Virden. The accompanying plan shows in a general way the principal features of all of these plants, but there are variations in the details at various places. For example the first four are operated by steam engines. The Farber, Tallula, Ridgley, Odessa and Virden plants will have gasoline engines of 15 horse-power each, furnished by the Otto Gas Engine Works through Mr. T. W. Snow, of Chicago. At Bloomington the company has electric power distribution at the shops, and this plant will be run by an electric motor. The first five are at terminals, while all the others are on the main line and are for use by the locomotives as they pass by. Where it has been possible to do so the water cranes are located at the chutes, in order to avoid the necessity for making another stop for water. In such cases, if the water is pumped, the pump is driven by the gasoline engine. As a rule these plants are operated by one man, and the labor charges are exceedingly low.



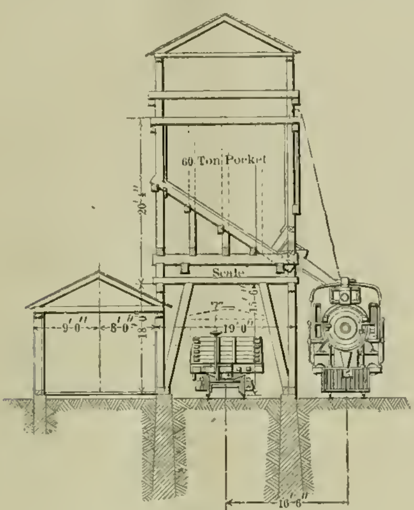
Labor-Saving Coal Chutes—Chicago & Alton Railway.

In the plan view the general arrangement is indicated. This includes two 60-ton pockets on scales, an ash bin, a sand bin, a sand storage building, sand drier, coal and ash elevator and a separate sand elevator. In the corner of the plan a storage pocket for 300 tons of coal is shown. This may be installed at any of the plants. This storage is served by the conveyor, both in filling and discharging. It provides for keeping 300 tons at hand, which may be drawn upon at any time without shoveling.

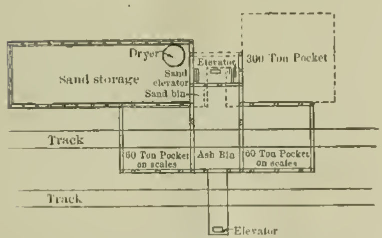
Coal cars are brought into the structure and the coal dropped into the track hopper. It is carried to the coal chute by the conveyor and from here it may be delivered to locomotives. The entire pocket is mounted on scales which have two beams. Before coaling a locomotive the pocket is balanced by the upper beam. When the tender is filled it is again balanced, but by the lower beam, which gives at once the weight of the coal discharged. This may be made to give an autographic record in duplicate for the engineer and the coal chute attendant. An admirable coal valve is employed at the tender chute. It is in the form of a portion of a cylindrical shell, which cuts up into the stream of coal in closing and for this reason cannot become clogged by lumps.

As an engine is taking coal the ash pan is over the ash-track hopper, and the ashes may be dumped into it. This hopper is in a pit 11 ft. 6 ins. deep, and will hold the ashes from a number of engines. Coal and ashes are handled by the same elevator, and when the elevated ash pocket is full it is dumped into a car without shoveling. Of course, these elements admit of a number of combinations, but all of them provide for reducing the necessary labor to a minimum. Other methods of weighing chutes have been proposed. In one of these the chute is hung on rods, which are deflected out of the vertical in such a way as to bring the chute against a measuring device which records the horizontal thrust of the load due to the angularity of the support. This plan was worked out on the Northern Pacific, but its use has not extended, probably because of a lack of sensitiveness of the weighing and a difficulty of inaccuracy when the chutes are only partly filled. By placing the entire chute on scales, large scales are required, but the results are sure to be accurate. In this construction the scales are housed and sheltered, which takes them out of the class of track scales.

This work on the Chicago & Alton is being done under contract in connection with water station improvements. It is attracting considerable attention among railroad men who are anxious to improve their fuel records. The starting point in this direction is accurate knowledge of the amounts of coal delivered. It is also important to reduce the cost of handling the



Section Through Pockets on Scales. A.E.



Plan of Buildings. A.E.

Coal Chute—Chicago & Alton Railway.

coal by labor-saving methods. It is obvious that in such plants as these this cost will be very low.

Working loads for manila rope is a subject upon which there are comparatively little data. In a paper before the American Society of Mechanical Engineers Mr. C. W. Hunt discussed the features concerning loads for hoisting purposes. He gave data in definite and satisfactory terms and presented the results of experiments and also of his wide experience. The tables of the paper include working loads for ropes of various sizes, the minimum diameter of sheaves for various speeds and the ultimate strength of different sizes of rope.

Already more perfectly balanced high-speed engines are demanded, and successful efforts to reduce the weights of the reciprocating parts are noticed in many new designs. Whether this move will take the form of gradually introducing four-cylinder, balanced engines of the De Gheln type, which are running so successfully in France, remains to be seen. Perhaps we are not quite ready at the present time for the added complication of crank axle, extra rods and cross heads; but the fact remains that every effort will be made in the future to reduce, as much as possible, the dynamic weight of the future high-speed engine.—F. J. Cole before the November meeting of the New York Railroad Club.

SOME RUDIMENTARY CONSIDERATIONS CONCERNING THE TREATMENT OF WATER FOR LOCOMOTIVE USE.

By R. P. C. Sanderson.

Superintendent Motive Power, Atlantic Coast Line.

A prominent general manager, when recently directing the attention of motive-power men to lines of usefulness, gave special prominence to the matter of water treatment for boiler use. (J. Kruttschnitt, in "American Engineer," June, 1901, page 170.) It must be a singularly unobservant mechanical officer who can visit boiler shops daily, see fireboxes and flues coming out of the engines on account of scale, cracks, bulges, leaks, etc., who can review the daily failure reports on a bad-water road and not be inspired or driven to do something toward improving the water service.

On very many railroads the water supply is not in the hands of the motive-power department, the division superintendents or engineering departments being held responsible for the water supply, and money expended for this account. As it often happens these officers are men who have been raised on the road, have always heard of the bad water, and feel the indifference bred of long familiarity for the troubles due to the bad quality of the water. As they are directly personally responsible for their division expenditures, and have to make a comparison monthly and yearly for all their maintenance charges, they are reluctant to spend money which will bring them no return, but the benefit for which expenditure will be felt by another department. The general manager, whose duty it should be to order such expenditures, is also often reluctant to spend money on improved water supply, because he has seen so many failures of ill-advised efforts to treat water, and the mechanical officer is unable to tell him what return he can promise for the money to be spent. It is, furthermore, impossible to figure out the saving per engine-mile or ton-mile for some improved water service in advance, as a justification for a proposed outlay.

As a result of painstaking study, and some considerable experience in improving the water supply, both East and West, the following may be of service to mechanical officers and others who are obliged to face this problem without having had opportunities to study the questions involved.

The first thing to do is to have analyses made of all the waters that are to be considered for treatment. These analyses should be checked, and repeated under different conditions of weather, drought, etc., as the quantities of the salts in solution, and matter in suspension, will vary greatly under different weather conditions. Having then learned which water supplies are the worst, it is important to ascertain the quantities used from each source, as there is no justification for spending large sums for bettering a supply that is very little used or is likely to be abandoned in the course of time on account of its inconvenient location. There are two main sub-divisions under which water impurities can be classed.

First, matter in suspension—mud, sand, sewage, etc. Second, matter in solution—principally the salts of soda, lime and magnesia. The first can be readily treated by filtration; the latter cannot be improved in this way.

River waters very generally contain matter in suspension as well as in solution, so that when considering a muddy water, samples should be taken under different conditions of muddiness, carefully filtered, and the remaining water analyzed to see if, after filtration, the water will be fit for boiler use. It would be disappointing to put in an expensive plant for filtration, and find out afterward that the filtered water was too bad for economical use.

When filtration is clearly indicated as necessary the problem is generally a simple one, and must depend on local conditions to some extent. Either settling ponds, or tanks of sufficiently large capacity, can be used and the cleared water drawn off through a natural or artificial sand bed, or one of the improved mechanical filters may be found to be the most economical where the filtration is done under pressure. The first plan usually requires the larger first cost, and is sometimes not practicable for lack of space. The latter requires more attendance, but when intelligently applied and handled is perhaps even more effective.

Matter in Solution.

When we come to consider waters that have excess of lime and soda salts in solution we face a far more difficult problem. Without attempting to go into the chemistry of the matter in detail, or yet pretend to accuracy, speaking generally, the principal troubles from hard water, as such water is called, are due to the salts of lime and soda; the potassium, lithium and magnesium salts are often present, but generally in smaller quantities, and of less consequence.

The salts referred to are, generally:

Lime Salts.	Soda Salts.
Carbonate of Lime,	Carbonate of soda,
Sulphate of lime.	Bicarbonate of soda,
	Sulphate of soda,
	Chloride of soda.

Others are found, but not so frequently, and in minor quantities. The lime salts generally are given up by the water to a large extent when heated; the soda salts are more soluble in hot water than in cold. The lime salts cause most of the scale troubles in boilers; the soda and magnesium salts cause most of the trouble from foaming, pitting and corrosion.

The lime salts can be got rid of largely by heating the water beforehand and filtering or allowing the deposits time to settle, but the amount of fuel needed to do this, as well as the cost of the plant and attendance required, is usually prohibitive. The lime salts are deposited when the water is heated because, the chemists tell us, they are soluble (except in small quantities) only in water that contains carbonic-acid gas in solution; when this gas is driven out of the water by heat the water will no longer retain the lime salts in solution. Generally the carbonic acid and sulphuric acid which is in the carbonate and sulphate of lime has a stronger affinity for the soda than for the lime; consequently it is possible, by adding soda, in the shape of soda ash, to waters containing too much lime salts, to change the nature of the salts. The phosphate of soda treatments are also based on this principle, but it must be clearly remembered that the matter in solution cannot be obliterated; it is still there in some other form, and if the water under consideration is already heavily charged with soda salts as well as lime salts, it is generally unwise to attempt to treat the lime salts by adding still more soda.

Owing to the property of hot water of carrying more soda salts than cold, the amount of salts of soda in a boiler will go on increasing until the solution becomes so heavy and dense that it cannot properly give off steam in boiling, and foams like soap suds. Adding soda salts to water to treat the lime salts helps to produce this condition. In addition to the trouble from foaming there is the corrosion and pitting to reckon with. Just what the chemical actions are that take place in a high-pressure steam boiler while water containing soda or magnesia salts are being evaporated is conjectural, for under the nature of things no investigation can well be made. It is understood that there are changes which liberate the acids and these attack and eat the boiler sheets and tubes. It is considered wise in some cases to add lime to such water, with the idea that the free lime in the water will combine with the acids and save the steel from attack. It is further certain that a thin coating of lime salts is a protection against such corrosion.

Attention is further directed to the bicarbonate of soda which is often present in artesian waters, although it has to be especially searched for in the analyses or it will be classed as carbonate of soda. When water containing bicarbonate of soda is heated in a boiler one part of the carbonic acid gas is given off, causing violent foaming, still leaving the carbonate of soda in solution. This can be remedied somewhat by adding lime, which can take up the extra carbonic acid from the carbonate and leave the carbonate of soda and carbonate of lime, avoiding some of the foaming troubles. The magnesia salts are also corrosive, and the causes are supposed to be the same as for the soda salts.

No attempt is made here to go into the chemistry of the water treatments referred to; simply the salient points are sought to be made clear. Those having no knowledge of chemistry would not understand such an exposition, and those who are chemists know more about it than the writer. When chemical treatment of waters is indicated to be necessary the matter should be placed in the hands of a competent chemist, if the road does not employ one, and his recommendation should govern. Generally it will pay better in the end to go far afield to get a good supply than to try to doctor a bad one.

One thing is certain above all others, a locomotive boiler strained to the utmost to furnish steam is not the proper place to be carrying on chemical processes for purifying the water, which it is busy evaporating; this should be done at the water stations before the water is put in the tenders.

There are still other methods of water doctoring that have given good results under certain conditions; they are by the use of tannins or bark extracts or gums and by certain specially adapted oils; the theory of the use of these is not to change the nature of the waters, but to prevent the scale particles from sticking together and forming a hard skin, by making them settle in the form of soft sludge which can be washed out or blown off at intervals, instead of burning upon the sheets and tubes. Indeed, some of the materials used will actually cause old scale to be detached and come down to the bottom of the boiler. It is, however, important that the quantities of these materials should be carefully regulated to the amount of matter contained in the water, and this is very difficult to govern in service where crews are pooled and engines changed from division to division, using water of widely different characters.

It is hoped that this general discussion will be of service to those who are responsible for the water supply of railroads and will enable them to take up these matters more intelligently, and prevent them from being misled into expensive experiments on lines which are foredoomed to failure for lack of general knowledge of the underlying principles involved.

CORRESPONDENCE.

WHY AIR BRAKES SHOULD BE IN CHARGE OF A RESPONSIBLE OFFICER.

Editor American Engineer:

From time to time correspondents of your valuable and interesting paper have invaded its columns with pleas and recommendations for better air-brake maintenance, and also for the establishment on the various lines of railways of an efficient air-brake department, placed in charge of a competent air-brake inspector or superintendent. That there are good reasons and grounds for complaint with regard to the condition of air brakes on almost every large railway system is generally admitted by everybody, and it does not require any proofs to be brought forward to reinforce the statement or to make it carry weight.

During the past year the Air Brake Association has endeavored, by suggesting ways and means to the proper officers in authority, to improve the air-brake service on all roads, and to stand for better maintenance of the air-brake apparatus, especially on the freight equipment. At a meeting of the New York Railroad Club, recently held in New York City, a paper was read by one of the prominent air-brake experts which dealt with the air-brake problem as it should be handled by the officers—the higher officers—of a railroad. In this paper the importance of the superintendent of air brakes is clearly demonstrated, and his place among the other officials of a railway properly marked out. The ways in which he can save his salary many times over to the railroad company are brought out so clearly that it must indeed be a very dull general manager who cannot perceive the economy in placing in charge of the air brakes on his road a good, bright, competent air-brake inspector, giving him full control of the air brake and holding him responsible for the results obtained in the air-brake practice on his road.

Some very wise suggestions were made in this paper relative to the standing of the air-brake superintendent and to whom he should report, but from the facts there presented it was thoroughly demonstrated that the best showing was made by the air-brake inspector who enjoyed the personal backing and support of the general manager, and who reported directly to that officer.

So important has the question of air-brake maintenance become that the average superintendent of motive power or master mechanic is not able to give it the necessary amount of attention, and he does not possess the technical knowledge of the air-brake apparatus, nor the knowledge of the action of brakes under varying conditions of service which a person should have who is to manage the air-brake department. It would, therefore, be a marked improvement in railroad management if this important branch of the business was placed entirely in the hands of a man thoroughly qualified to take charge of it, who could devote his whole attention to it, and whose orders and instructions relative to the air brake should be carried out to the letter.

In the paper referred to, instances were cited of serious wrecks which occurred, costing thousands of dollars, simply because some seemingly unimportant matter in connection with the air brake was neglected before the train departed from the terminal. Nearly a year ago a collision occurred between a passenger train, on which I was riding, and a freight train, which would not have occurred had the brakes on the passenger train been in even fairly efficient condition. The train consisted of two engines, double heading, and six passenger coaches. There were no brakes whatever applied to the engine trucks, and of the passenger coaches, three were of the six-wheeled truck variety, having brakes applied to only two pairs of wheels in each truck. Several of the coaches had recently been put through the shop and had heavy vestibules put on them, thus increasing their weight, but no additional braking force was provided to hold them during brake applications. One of the cars, a diner, weighed 97,000 lbs., and had only a 10-in. brake cylinder to supply pressure to the foundation brake gear, when it should have a 14-in. brake cylinder, which its weight called for. The total weight of the engines and train and load was a little over 899,400 lbs. As this train approached a distant semaphore signal located about 2,900 ft. from the home signal, under which the freight train was standing with which it collided, the engineer closed the throttle of his engine and applied the brake, as he stated, with a full application, but the train could not be stopped in time to avoid a collision. Although the collision resulted in damage to the three engines, without hurting the passengers or damaging the coaches, yet it was possible for it to have been disastrous in its consequences.

The rate of speed of the passenger train at the instant of passing the distant signal as nearly as could be determined was fifty-four miles per hour, possibly a little higher than this—a little more than 79 ft. per second—and the distance in which to stop without collision was about 3,000 ft. The braking force of the whole train, carefully calculated, did not aggregate 45 per cent. of the weight of the train. Of course, when all these facts were brought out, there was nothing surprising in the fact that the train could not be stopped in the distance allowed. To further delay and weaken the action of the brakes, the piping on the engines was excessively crooked, and contained numerous elbows; so many, in fact, that quick action of the brakes was impossible to obtain from the leading engine.

Right here in connection with the matter of obtaining quick action through two engines that are double heading, it may be interesting to note what Mr. J. W. Thomas, Jr., General Manager of the Nashville, Chattanooga & St. Louis Railroad, had to say at the meeting referred to regarding this matter. He said: "Some time ago, in making tests to demonstrate the fact that an emergency application could be got through the second engine if said engine was properly piped, we failed to get an emergency application. Upon investigation we found the triple valve strainer under a tramp sleeper which was placed next to the engine so stopped up that it required at least ten minutes to charge the reservoir."

After the accident the usual remedy of dismissing the engineer was applied, although he stated—and it could easily be proved—that he applied the brake immediately after passing under the distant signal, 2,900 ft. from the point where the engines collided, and he also stated that that was the first occasion he had had to use the brakes since making the test application at the terminal which he had left only ten or fifteen minutes before.

Here is an instance in which, had an air-brake inspector been allowed to take charge, and had been clothed with sufficient authority to enforce his instructions and orders, he could have saved the company a large sum of money and also the situation of the engineer, and there could have been no question of efficiency of the brakes.

In the course of his remarks before the New York Railroad Club Mr. Thomas said: "But what about the brakes which are not maintained? Is it because we wish to economize? If so, is it not a bad idea to cut down along this line? I am inclined to believe our neglect in this direction arises from the fact the conditions are so variable that it is impossible for us to arrive at even an approximate estimate of the result of our failure to keep the apparatus in good shape. The engine and train crews and a few inspectors realize more fully than the majority of us what poor brakes mean, but if they complain the subject is generally dismissed by saying that the brakes should have been applied sooner."

Such matters as block signals, air brakes, electric headlights, etc., require the services of specialists to keep them at their highest efficiency, and it would seem that the sooner the railroad companies recognize this fact and place competent men in charge of these departments the better it will be for all concerned.

J. P. KELLY,
New York Air Brake Co.

SAND DRYING.

To the Editor:

I noticed an article in your October number, on sand driers, by the Chicago, Milwaukee & St. Paul, and as I believe that they were right in abandoning the hopper stove, I also believe that the rotary drier will not solve the whole problem. They are adopting a drier that is used to dry ore at many mines in the West to dry sand, and this can be done. But the first cost of such a plant is large. There is the machinery to revolve the cylinder, to handle the wet sand, to remove the dry sand, the fire to keep up, and it is necessary to always have a uniform temperature or the sand will not be uniformly dried. The cost of operation is an additional difficulty.

These things have made railroad men desire a more economical machine to install, to operate and to maintain. After some ten years of experience in the maintenance of way department of a railroad, where the drying of sand with hopper stoves was a large factor at times, I feel confident the sand drying departments of all our railroads could be remodelled and brought to a higher degree of efficiency and economy. The old hopper stove must go. It has served its day and generation well. That has been apparent for some time; but the appliance to put in its place was not forthcoming. Only of late has one appeared.

A great many experiments have been tried to dry sand by steam, but they were greater or less failures. The method of doing the work was not right. The steam was not to blame; it was the poor application of it. As to the ability of drying sand thoroughly by steam at a temperature of 212 degrees there is no question. A greater heat would drive off the water of crystallization and ruin the quartz for grit purposes. That was one great objection to the hopper stove. The sand next to the hot stove was burnt and formed paste under the wheels instead of grit.

In my judgment, steam drying will prove the easiest to handle and to apply, as well as the most economical. Steam is not only doing good work drying the crushed stone (sand) for the Pennsylvania Railroad Company at Pittsburgh, but it is doing equally as well on common bank sand for the D., L. & W. R. R. Co. at Scranton, Pa. These driers I believe to be the best yet in service, as they dry thoroughly from forty to fifty tons of sand every ten hours and have but one attendant.

A. D. BLACKINTON.

FOUR-CYLINDER BALANCED COMPOUND LOCOMOTIVE.

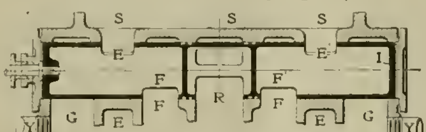
A Design by Charles M. Muchnic.

Mechanical Engineer, Wisconsin Central Railway.

The object of the designer of the four-cylinder compound illustrated by these engravings was to produce a compound locomotive of the divided balanced type, based on the principles of the successful de Glehn compounds, and embodying their chief characteristics in an application in accordance with the ideas of simplicity which characterize American practice. As yet the design has not gone beyond the drawing stage. The ideas involved represent a careful study of the successful compounds abroad—combined with knowledge of American locomotive practice.

Cylinders.—Fig. 1 shows a section through the main steam admission and exhaust passages. Each half saddle includes one high and one low-pressure cylinder for each side, a common valve chamber, V, and an intercepting valve chamber, K. The inside high-pressure cylinder is inclined so that the inside connecting rod clears the forward axle. In the 8-wheel or any other design where the distance between the cylinder and the forward axle is sufficiently long to allow the use of a connecting rod of a proper ratio to the crank, the inside cylinders can be made horizontal, and on the same plane with the outside low-pressure cylinders. The horizontal and vertical center lines of the outside low-pressure cylinders are the same as in the usual simple expansion locomotives; the same may be said with regard to the cylinder frame fastening, top flange adjacent to boiler, position of main steam and exhaust passages or height of saddle. In fact, the general design of the cylinder saddle, in construction, outward appearance or its relation to the frames, boiler or smokebox appliances deviates in no way from the usual modern simple half-cylinder saddle. It is possible, therefore, to substitute this compound cylinder structure for the usual simple cylinder casting without any alteration in the adjacent parts. This can be seen at a glance from reference

Position of Valve when Working Single Expansion



Section C-H-K Fig. 4

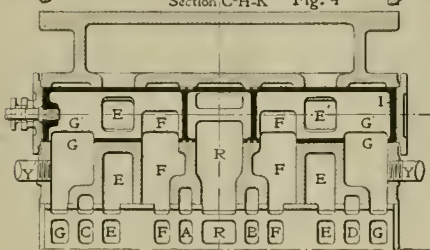


Fig. 3

Section A-B-C-D-E

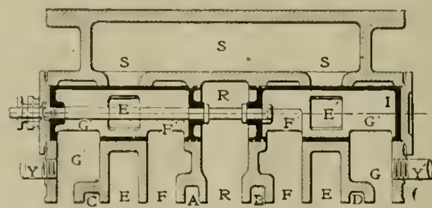


Fig. 5

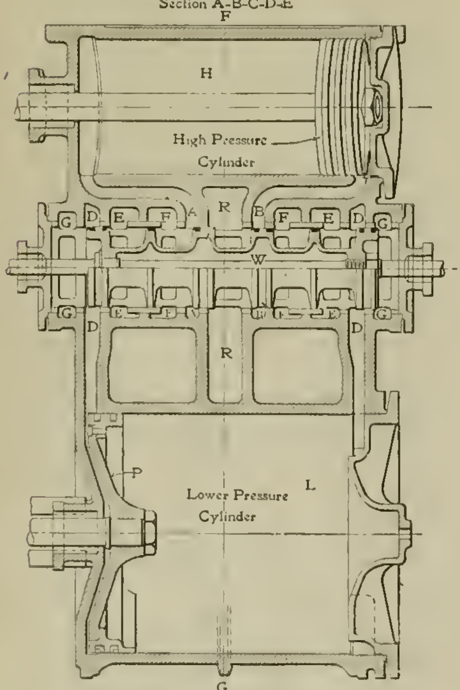


Fig. 2

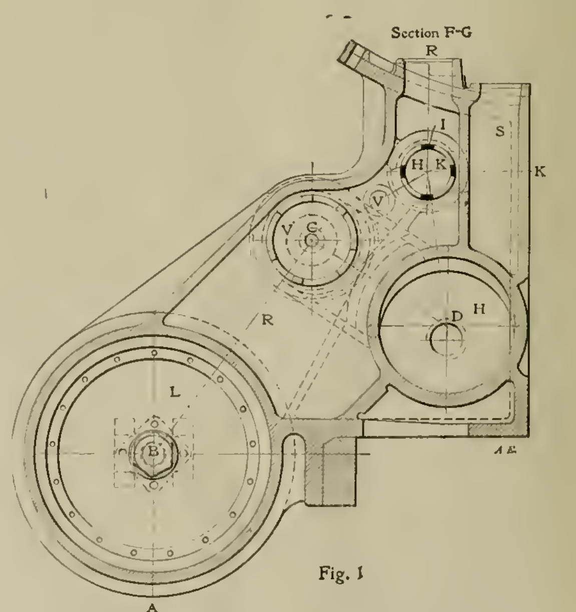


Fig. 1

to Figs. 6 and 7, which show these cylinder saddles applied, as a study, to a well-known American locomotive, and in which no other alteration has been made, except for the substitution of the compound cylinder casting in place of the simple cylinder castings and the addition of their running gear. (In order to work out this design in connection with an actual locomotive Mr. Muchnic selected the Class H 6, consolidation locomotive of the Pennsylvania Railroad as a representative 8-coupled engine, and took the dimensions from the engravings of that engine which were printed on page 177 of the June issue of the American Engineer and Railroad Journal of 1899. It is to be understood that this was done as a study and without the knowledge of the officers of the Pennsylvania Railroad.) Fig. 2 shows a section through the cylinder half-saddle, Fig. 1, and on line A, B, C, D, E, as well as of the single piston valve for both high and low-pressure cylinders in its position.

Piston Valve.—This valve, W, Fig. 2, of the closed piston type, is a single hollow casting, through which the valve rod passes, having a shoulder or collar on its rear end and a nut on the front end; this valve rod extends through the front steam chest cover. The valve is double and controls the admission and exhaust of steam in both high and low-pressure cylinders—being of the internal admission type for the high-pressure cylinder and external admission for the low-pressure cylinder. Its construction is very strong and extremely simple.

Intercepting Valve.—Figs. 3 and 4 show sections through the steam chest and intercepting valve chamber, K, Fig. 1, and on lines C, H, K, also sections of the intercepting valve I. In Fig. 3 the position of the intercepting valve I is normal; that is, when the engine is working compound. In Fig. 4 the position of the intercepting valve, as shown, is when operating all four cylinders in simple expansion—on live steam from the boiler. This intercepting valve is simply a three-way plug and can be made in either one or two sections, as shown in Fig. 5. It serves the purpose, as will be explained further, to direct the high-pressure exhaust steam either to the low-pressure cylinder, when operating compound, or to the atmosphere when working all cylinders in simple expansion—on live steam from the boiler. The valve turns on its axis, and a quarter turn will change the working of the engine from compound into simple and vice-versa. Its control can be manual or by power; in both cases it is manipulated from the cab.

Application.—An elevation and partial plan of the consolidation locomotive referred to with this principle applied are shown in Figs. 6 and 7, which also present a table of the principal data. In this engine the general design has not been altered, as has been already remarked, except for the substitution of the compound cylinder saddles for the simple, a crank axle for the plain one and an addition of a pair of inside rods and guides.

Operation.—The working of this compound system will be readily understood. The piston valve, W, Fig. 2, has moved forward from its central position to uncover the high-pressure steam port, B, through which live steam from the boiler, coming by way of the main steam passage, R (see Figs. 1 and 2), passes into the high-pressure cylinder, H, and pushes the piston, O, to the left. At this movement the volume of steam contained from the previous stroke in the high-pressure cylinder, H, is being exhausted through steam port A into the high-pressure exhaust passage, F, thence through the intercepting valve openings, F' and G', Fig. 3, and passes into the rear end of the steam chest. It will be noted in Fig. 2 that the displacement of the valve, W, from its central position forward has increased simultaneously with the high-pressure cylinder steam port, B, also the low-pressure cylinder steam port, D, which receives the high-pressure exhaust steam coming, as shown above, by way of the intercepting valve into the rear end of the steam chest. In other words the high-pressure exhaust steam goes directly into the low-pressure cylinder and there continues its expansive force in acting on piston P, which moves forward in the opposite direction to piston O.

At this movement, the steam contained in the low-pressure cylinder, L, is being exhausted through the low-pressure steam port, D, into the exhaust passage, E, Fig. 3, directly in communication with the final exhaust passage, S, and thence into the atmosphere. It can now be readily understood that the valve, W, on its return or backward stroke, will uncover simultaneously high and low-pressure steam ports, A and D, respectively, and that the high-pressure cylinder, H, will exhaust through B into the forward part of the steam chest, by way of

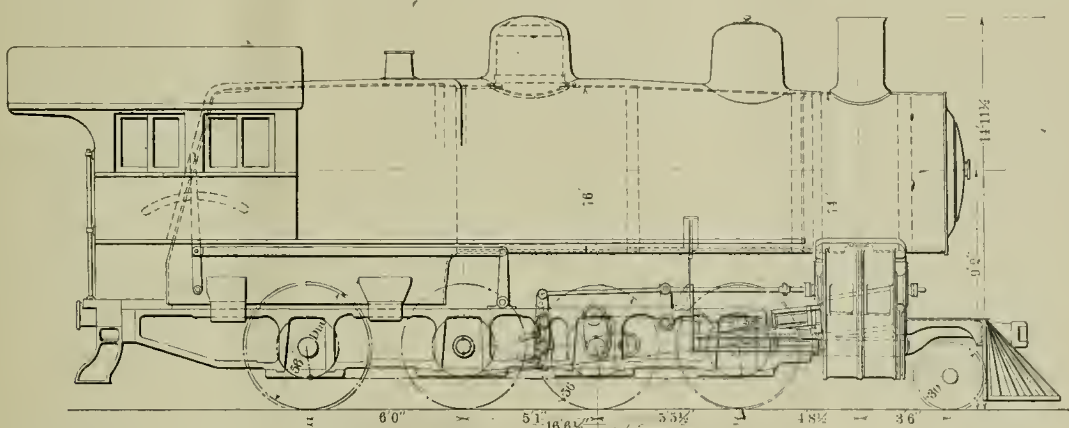


Fig. 6

Cylinders	16 x 28" / 28"
Ratio of Cylinder Volumes	1 3.06
Boiler Steam Pressure	200 Lbs.
Heating Surface	2917 Sq. Ft.
Grate Area	33.3 Sq. Ft.
Weight on Drivers	168000 Lbs.
Total Weight, Working Order	190000 Lbs.
Adhesive Weight .25 of Weight on Drivers	11000 Lbs.

Tractive Force, Working Compound

$$F = \frac{1.6 \cdot P \cdot D_L^2 \cdot S}{D \cdot (R+1)} = \frac{1.6 \cdot 200 \cdot 28^2 \cdot 28''}{56 \cdot 4.06} = 30896 \text{ Lbs.}$$

Working Simple—

$$F = \frac{1.6 \cdot P \cdot D_H^2 \cdot S}{D} = \frac{1.6 \cdot 200 \cdot 16^2 \cdot 28}{56} = 40961 \text{ Lbs.}$$

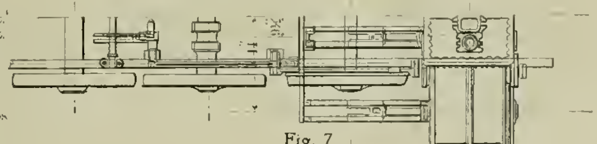


Fig. 7

the intercepting valve, as explained before (see Fig. 3), and pass into the low-pressure cylinder through low-pressure steam port D; there it will continue to exert its expansive force on piston P, which will move in the opposite direction to the piston O, while the expanded steam in the low-pressure cylinder will exhaust through port C to the atmosphere as before.

Change From Compound Into Simple and Vice-versa.—This condition is brought about by a quarter turn of the intercepting valve I and in the following manner: Referring to Fig. 3, it will be clear that each half of the intercepting valve I forms a connecting passage between two similar ends of one high and one low pressure cylinder; that is, when the forward end of a high-pressure cylinder is being exhausted the forward end of the low-pressure cylinder—on the same side of the engine—receives that steam by way of that connecting passage. At that time the rear end of the high-pressure cylinder receives steam from the boiler and the rear end of the low-pressure cylinder exhausts into the atmosphere, as described above. If the intercepting valve, I, is given a quarter turn its position will be like the one shown in Fig. 4, or the communication between the passages P and F is cut off; that is, the communication between two similar ends of one high and one low-pressure cylinder is cut off. But by the same movement of this intercepting valve and by way of this valve through passage F' and E', a communication is established between the high-pressure cylinder exhaust and the main exhaust passage, S. In other words, when the high and low-pressure cylinders do not communicate by way of the intercepting valve the high-pressure cylinder exhausts to the atmosphere. So does the low-pressure cylinder in the usual manner.

When the intercepting valve is turned into a position as shown in Fig. 4—that is, when operating all four cylinders simple expansion—live steam from the boiler is admitted into the front and rear ends of the steam chest. The pipes, Y^1, are tapped into the outer walls forming the passages of G, which lead into the ends of the steam chest, and by proper connections are carried to the dome of the boiler; the admission of steam into the steam chest by way of these connections is regulated and manipulated from the cab.

This arrangement permits of closing the throttle valve and thus cut out from operation the high-pressure cylinders and work the low-pressure cylinders alone on live steam from the boiler. This may be resorted to when a high-pressure cylinder head is blown out, or broken rod, axle, hot pin or journal gives trouble. The inside gear is then disconnected, the piston blocked, the intercepting valve turned into a position as in Fig. 4, live steam admitted from the boiler into the low-pressure cylinders and the engine can handle the train in spite of the accident. The reverse conditions hold when the outside cylinders are disconnected.

When starting the engine after a period of rest or when desirable to temporarily increase the tractive force of the engine, the engine is thrown into simple working, live steam is admitted to both high and low-pressure cylinders and the engine can be run for ten, fifteen or a hundred revolutions of the wheels without in any way disturbing the uniformity and normal running of the mechanism.

Locomotive practice on the Atchison, Topeka & Santa Fe is worth watching, because of the interesting and important developments which are working out on that road. In this issue a large engine with a novel boiler is described, and even greater departures from current practice are to come. A jump to nearly 6,000 sq. ft. of heating surface is suggested for new designs soon to be forthcoming but thus far the details of the new engines have not been settled. The heavy locomotive is to be tried on this road on an unprecedented scale and without waiting for the growth to come as a transition. This is a substantial endorsement of the heavy engine, which is likely to exert an important influence on future practice.

OIL FUEL FOR LOCOMOTIVES.

Practice on the Pacific Coast.

By H. B. Gregg, Engineer of Tests, Santa Fe Pacific Railway.

(Continued from page 386 of previous volume.)

Editorial Note.—It is well understood that practice in fuel oil burning has advanced to a stage which renders the selection of this fuel merely a question of the relative costs of coal and oil. For this reason, and because of the scarcity of data from which to make the comparison, this paper by Mr. Gregg is an important one. It should be emphasized that, thus far, oil has been burned in ordinary locomotive fireboxes, originally designed for coal and not specially favorable to oil. It is fair to expect better results with the new designs of oil burning fireboxes, in which the peculiarities of oil fuel will be studied and provided for. The corrugated cylindrical furnace seems to be especially adapted to this fuel, and the next step in this development is looked upon as a probable means for securing better results than have thus far been obtained. There can be no question of the advisability of designing furnaces specially for oil, in view of the recent developments in the oil fields of Texas, which should remove the hazard of building locomotives in which coal cannot be used.

OIL FUEL TESTS.

Santa Fe Pacific Railway.

Three tests are recorded. The first compares, in freight service, coal from Gallup, New Mexico, with oil from the Bakersfield district, as used in locomotives on the fifth district of the Santa Fe Pacific Railway between Needles and Bagdad, California. The second gives results of oil consumption in passenger and freight service on a mountain division, between San Bernardino and Barstow, and on a comparatively level division between Stockton and Bakersfield. The third compares Texas and California oils. The locomotives were in regular train service.

TEST NO. 1.—FREIGHT SERVICE.

Comparing Coal and Oil.

The engines selected were of the consolidation type, with 21 by 28-in. cylinders, 75-in. wheel centers, 68-in. boilers, weight on drivers 144,500 lbs., on truck 17,000 lbs., total engine 161,500 lbs. Steam pressure carried, 180 lbs. In one instance (engine 563), a 20 by 28-in. cylinder ten-wheeler was coupled with a consolidation engine for one trip. On all runs the engines were double-headed.

Before leaving Needles the engine tanks were coaled up and filled full of water and then weighed. At Bagdad, there being no scales, the coal left on the tank was estimated, the tanks were then coaled up from chutes and the coal chute weights taken. Upon the return to Needles the tanks were first filled with water and then weighed. The difference between the two scale weights, plus the coal-chute weights, gives the total amount used on the round trip. Usually the amount of coal left on the tanks, both at Bagdad and at Needles, was so small that it could be estimated fairly, in some instances the coal being entirely gone. The amount of coal charged to the engines each trip includes that used to fire up or to keep them hot while at terminals. Usually at Needles the engines had to be rekindled, while at Bagdad the engines were kept fired up.

The above is also true of the oil burners. The amount of oil charged to engines includes that used to fire up and to keep the engines hot while at terminals. The amount of oil used was found from the known capacity of the tanks on the engines. In estimating the "Tonnage Hauled" and "Car Mileage" the water car, carrying water for the engines, is counted one load, and its tonnage included. The way car is figured at 16 tons, but is not counted in the number of cars or the car mileage. Three empty cars are figured as equivalent to two loads. Under the column "Time on the road," is included the time between leaving and arriving at terminals. "Running time" includes only the actual time the train was in motion. "Delayed time" includes all time taken up for stops of any kind.

From the tests in road service it was found that between Needles and Bagdad the amount of coal burned in hauling 1,000 tons one mile is 356 lbs., and the amount of oil is 159 lbs., and to haul 1,000 loaded freight cars one mile the amounts are 11,946 lbs. of coal and 5,334 lbs. of oil.

These data are given in Tables 1 and 2. From Needles to Bagdad the distance is 91.7 miles.

consumed per 1,000 ton miles and per 1,000 car miles, is as follows:

Mountain Division.

Oil per 1,000 ton miles, through passenger service, west bound, 189 lbs.; east bound, 321 lbs.

Oil per 1,000 ton miles, freight service, west bound, 142 lbs.; east bound, 246 lbs.

Oil per 1,000 car miles, passenger service, west bound, 7,039 lbs.; east bound, 11,865 lbs.

TEST NO 1. TABLE NO. 1.

Fuel Oil Consumption Per Ton and Car Mile—Needles to Bagdad.

Freight—West Bound.

Date.	Eng. No.	Time on the road. H	M	Delayed time. H	M	Running time. H	M	No. stops.	Ave. speed M. P. H.	Ton miles.	Car miles.	Pounds fuel oil used. Pounds, each engine.	Total used.	Pounds, ton mile.	Pounds, car mile.
4-16-01	713 465	10	21	4	45	5	36	8	16.36	93,982	2,840	6,670 7,138	13,808	.14692	4.862
4-20-01	713 723	10	50	4	23	6	27	8	14.20	101,676	3,115	9,093 9,093	18,186	.17886	5.838
4-22-01	713 723	9	28	3	44	5	44	7	15.97	109,920	3,298	10,003 9,942	19,945	.18145	6.048
4-24-01	713 723	7	15	2	29	4	46	7	19.21	107,722	2,840	6,820 8,032	14,852	.13787	5.229
4-25-01	713 723	13	25	8	6	5	19	13	17.23	97,096	3,298	10,533 11,745	22,278	.22944	6.755
Freight—East Bound.															
4-21-01	713 723	7	20	.	..	.	..	..	....	110,836	3,298	6,971 7,274	14,245	.12852	4.319
4-23-01	713 723	5	43	1	16	4	27	5	20.58	106,989	3,115	7,959 7,274	15,233	.14238	4.890
4-24-01	713 723	5	10	1	8	4	2	2	22.71	113,126	3,206	6,820 7,730	14,550	.12862	4.538
4-26-01	713 723	8	10	.	..	.	..	..	....	99,844	2,931	10,608 6,668	17,276	.17203	5.894

	West bound.	East bound.	West and east.
Total number ton miles made..........	510,396	430,795	941,191
Total number car miles made.........	15,391	12,550	27,941
Total pounds oil consumed..............	89,069	61,304	150,373
Ave. consumption of oil per ton mile..	0.17491	0.1423	0.1586
Ave. consumption of oil per car mile..	5.787	4.880	5.3335

TEST NO. 1. TABLE NO. 2.

Coal Consumption—Needles to Bagdad.

Freight—West Bound.

Date.	Eng. No.	Time on the road. H	M	Delayed time. H	M	Running time. H	M	No. stops.	Ave. speed M. P. H.	Ton miles.	Car miles.	Lbs. coal used. Total used.	Pounds, ton mile.	Pounds, car mile.
4-11-01	653-685	11	18	4	22	6	56	7	13.21	109,920	3,389	43,100	.39210	12.7176
4-13-01	653-685	9	32	3	2	6	30	6	14.09	102,684	3,298	42,240	.41136	12.8077
4-17-01	643-675	13	12	7	34	5	38	7	16.26	110,470	2,840	33,590	.30406	11.8274
4-30-01	650-677	12	20	6	17	6	3	7	15.14	111,844	3,664	38,970	.34843	10.6359
5- 2-01	650-677	8	45	2	27	6	18	6	14.54	109,920	3,298	41,250	.37527	12.5076
Freight—East Bound.														
4-12-01	653-685	7	17	2	20	4	57	6	18.50	107,447	3.023	31,760	.29559	9.7449
4-14-01	653-685	10	39	2	36	8	3	5	11.37	118,164	3,298	44,250	.37448	13.4172
5- 1-01	650-677	10	48	4	3	6	45	8	13.57	141,064	3,939	42,200	.29915	10.7133
5- 3-01	650-677	9	42	2	25	7	17	5	15.30	108,322	3,617	46,400	.41912	12.5518

	West bound.	East bound.	West and east.
Total number ton miles made..........	544,838	474,997	1,019,835
Total number of car miles made......	16,489	13,877	30,366
Total pounds coal consumed...........	199,150	163,610	362,760
Ave. consumption of coal per ton mile.	0.36552	0.34444	0.35574
Ave. consumption of coal per car mile.	12.07774	11.79001	11.9462

TEST NO. 2. TABLE NO. 3.

Fuel Oil Consumption Per Ton and Car-Mile on S. C. Ry. Between San Bernardino and Barstow.

Passenger—West Bound.

Date.	Eng. Nos.	Train No.	Time on the road.	Delayed time.	Running time.	No. stops.	Av. M. P. M.	Ton-miles.	Car-miles.	Pounds oil.	Oil per ton-mile.	Oil per car-mile.
10-2	55	1	3.06	0.13	2.53	6	28.1	24,898	649	5,141	.20648	7.924
10-3	55	1	2.54	0.18	2.36	7	31.1	20,437	568	4,189	.20497	7.378
10-4	58	1	2.49	0.16	2.33	6	31.8	20,437	568	3,743	.18309	6.591
10-6	58	1	3.02	0.11	2.51	5	28.4	28,236	730	4,574	.16199	6.265
Passenger—East Bound.												
10-1	55-51	2	2.51	0.16	2.35	6	31.3	23,276	649	8,224	.35332	12.671
10-2	55-58	2	2.52	0.15	2.37	6	31.0	21,735	608	7,341	.33774	12.074
10-3	58-63	2	2.46	0.16	2.30	8	32.4	24,898	649	7,911	.31773	12.189
10-5	58-62	2	2.48	0.15	2.33	7	31.8	24,898	649	6,832	.27439	10.527
Freight—West Bound.												
9-28	246-51	33	9.18	4.43	4.35	8	17.7	84,425	2,595	11,313	.13400	4.360
9-29	246	33	8.19	2.51	5.28	7	14.8	72,415	2,510	9,348	.12909	3.724
10-8	62	33	6.25	1.57	4.28	5	18.1	37,549	1,180	5,624	.14977	4.766
10-10	57	33	7.03	2.05	4.58	8	16.3	39,354	1,407	5,795	.14725	4.115
10-12	138-92	33	7.20	1.41	5.39	7	14.3	77,311	2,427	11,607	.15013	4.782
Freight—East Bound.												
9-27	246 62-93	34	6.34	2.06	4.28	6	18.2	70,881	2,271	15,847	.22357	6.978
9-29	246 92-58	34	6.48	2.16	4.32	6	17.9	55,975	1,935	15,117	.27007	7.812
10-8	62-246	34	6.23	2.20	4.03	6	20.0	36,657	1,217	8,080	.22042	6.639
10-10	90 62-59	34	8.14	3.20	4.54	11	16.5	62,447	2,109	15,320	.24532	7.264
10-12	138 53-62	34	6.30	2.30	4.00	8	20.2	43,875	1,460	11,958	.27254	8.190
Average for passenger service west-bound................											.18913	7.039
Average for passenger service east-bound................											.32079	11.865
Average for passenger service west and east.............											.25496	9.452
Average for freight service west-bound....................											.14205	4.349
Average for freight service east-bound....................											.24638	7.376
Average for freight service west and east.................											.19421	5.862

TEST NO. 2. TABLE NO. 4.

Fuel Oil Consumption Per Ton and Car-mile Between Stockton and Bakersfield.

Passenger—West Bound.

Date.	Engine No.	Train No.	Time on the road.	Delayed time.	Running time.	No. of stops.	Av. m. per h.	Ton-miles.	Car-miles.	Pounds oil.	Oil per ton-mile.	Oil per car-mile.
10-22	201	1	7.41	1.16	6.25	28	40.2	71.438	1,806	10.031	.1404	5.554
10-25	205	5	7.26	1.20	6.06	21	42.3	39.008	897	7.064	.1811	7.875
Passenger—East Bound.												
10-23	201	2	7.58	1.08	6.50	29	37.7	71,438	1,806	10.611	.1485	5.875
10-26	208	6	8.16	1.08	7.07	21	36.2	39.008	897	7.368	.1889	8.214
Freight—West Bound. Bakersfield to Fresno, via Hanford.												
10-29	90	33	6.24	1.59	4.25	10	25.1	94.256	2,864	6.485	.06880	2.264
10-31	204	33	4.44	0.40	4.04	6	27.3	131.835	4,203	8.064	.06116	1.917
11-7	93	*	7.05	1.40	5.28	10	20.5	130.871	4,435	7.950	.06074	1.791
Freight—West Bound. Fresno to Stockton.												
10-31	204	33	5.17	0.56	4.21	4	28.2	143.411	4,432	8.073	.05629	1.822
11-16	93	33	6.25	1.09	5.16	5	23.3	141.319	4,555	7.450	.05272	1.635
Freight—East Bound. Stockton to Fresno.												
11-1	208	34	8.40	3.02	5.38	8	21.8	107.922	3,795	10.836	.10040	2.855
11-16	93	34	6.00	0.54	5.06	5	24.1	60.100	2,263	6.625	.11023	2.927
Freight—East Bound. Fresno to Bakersfield, via Hanford.												
10-30	103	34	5.38	1.10	4.28	11	24.8	87.374	2.654	7.130	.08160	2.686
11-8	91	34	6.58	1.55	5.03	10	22.0	67.954	2,355	8.283	.12189	3.517
Average for passenger service................................											.1647	6.879
Average for freight service....................................											.07931	2.379

*Ex. W.

TEST NO. 2.—PASSENGER AND FREIGHT.

Mountain and Level Divisions.

Two statements, Tables 3 and 4, contain the records of this test. Table No. 3 is that of the mountain division between San Bernardino and Barstow, and No. 4 that between Stockton and Bakersfield, which is comparatively level.

From these two statements it is found that the amount of oil

Oil per 1,000 car miles, freight service, west bound, 4,349 lbs.; east bound, 7,376 lbs.

Level Division.

Oil per 1,000 ton miles, passenger service, east and west bound, 165 lbs.

Oil per 1,000 ton miles, freight service, east and west bound 79 lbs.

Oil per 1,000 car miles, passenger service, east and west bound, 6,879 lbs.

Oil per 1,000 car miles, freight service, east and west bound, 2,379 lbs.

TEST NO. 3.

Texas and California Oils Compared.

This comparison was made in passenger service between oil from Beaumont, Texas, and from Olinda, California. The engine selected had 18 by 24-in. cylinders and was of the eight-wheel type. In Table 5 the station names are necessarily abbreviated. The third column gives the run from San Bernardino to Los Angeles, via Loop and Pasadena; the fourth, from San Bernardino to Los Angeles, via Riverside and Orange; the fifth, Los Angeles to San Bernardino via Pasadena and Loop, and the sixth, from Los Angeles to San Bernardino, via Orange.

TEST NO. 3. TABLE NO. 5.

Summary of Results. Texas and California Oil Compared.

	Kind of oil.	San Brdo. to Los Ang. via Loop & Pas.	San Brdo. to Los. Ang. via Riverside and Orange.	Los Ang. to San Brdo. via Pas. & Loop.	Los Ang. to San Brdo. via Orange.	General average for all runs.	Grand total, all runs.
Pounds oil used on the road..........	Texas	3,606	3,291	3,888	2,735	....	33,081
	Cal.	3,573	3,620	3,705	2,592	....	33,149
Pounds oil used in roundhouse	Texas	440	440	440	440	....	4,400
	Cal.	440	440	440	440	....	4,400
Pounds oil, total...	Texas	3,946	3,731	4,328	3,175	....	37,481
	Cal.	4,013	4,060	4,145	3,032	....	37,549
Lbs. per ton-mile, excl. amt. in r. h.	Texas	.31728	.29333	.34624	.40144	.33529	......
	Cal.	.32342	.29954	.35154	.38656	.33588	......
Lbs. per ton-mile, incl. amt. in r. h.	Texas	.35706	.33255	.38545	.46606	.37988	......
	Cal.	.36331	.33597	.39329	.45201	.38046	......
Lbs. per car-mile, excl. amt. in r. h.	Texas	9.6480	8.9429	10.7601	11.5401	10.1320	......
	Cal.	9.7455	8.7927	10.6465	10.9395	9.9278	......
Lbs. per car-mile, incl. amt. in r. h.	Texas	10.8585	10.1386	11.9787	13.3966	11.4796	......
	Cal.	10.9478	9.8619	11.9108	12.7918	11.2456	......
En. m. per ton oil, excl. amt. in r. b.	Texas	49.70	59.99	44.43	67.76	52.60	......
	Cal.	48.80	69.05	47.09	60.98	53.45	......
En. m. per ton oil, incl. amt. in r. h.	Texas	44.16	52.91	40.26	49.74	46.42	......
	Cal.	43.44	52.65	42.06	52.12	47.19	......
Lbs. water used, total	Texas	38,324	37,484	44,016	30,162	....	368,461
	Cal.	40,430	43,098	43,608	28,957	....	381.574
Lbs. water wasted	Texas	780	680	900	507	....	7,020
	Cal.	807	830	930	553	....	7,600
Lbs. water evaporated	Texas	37,544	36,304	43,116	29,656	....	361,441
	Cal.	39,624	42,268	42,678	28,404	....	373,974
Lbs. water evap. per lb. oil—actual	Texas	10.707	11.168	11.090	10.842	10.926	....
	Cal.	11.091	11.674	11.515	10.958	11.281	....
Lbs. water evap. per lb. oil, from and at 212 deg.	Texas	12.869	13.393	13.261	13.005	13.099	....
	Cal.	13.286	13.979	13.769	13.129	13.504	....
Ave. steam pressure	Tex.	159.8	159.2	159.	159.8	159.4	....
	Cal.	161.0	161.2	161.2	160.6	161.0	....
Ave. temp. of feed water	Texas	66.2	69.2	72.1	68.6	69.0	....
	Cal.	70.2	70.8	72.5	71.0	71.1	....
Ave. temp. of fuel oil	Texas	69.8	75.7	76.0	68.3	72.4	....
	Cal.	80.4	81.7	86.5	82.5	82.8	....
Av. speed in m. p. hr., deduct. stops	Texas	36.72	37.59	35.43	38.44	37.04	....
	Cal.	36.05	36.17	36.79	36.22	36.06	....
Engine mileage....	Texas	87.1	98.7	87.1	78.9	....	870
	Cal.	87.1	106.9	87.1	78.9	....	886
Car mileage.........	Texas	365	368	361	237	....	3,265
	Cal.	368	413	348	237	....	3,339
Ton-miles	Texas	11,109	11,219	11,232	6,812	....	98,664
	Cal.	11,079	12,128	10,639	6,707	....	98,693

Ten trips were made over the same district with each kind of oil, except in two instances, due to a change in the time card, where the run was extended a distance of 4.1 miles. This accounts for a difference of 16 engine miles and 32 car miles in the total shown on the record.

The results show very little difference in the two oils, the amount of oil per ton mile being very nearly the same, at 0.380 lb. in both cases. The amount per car mile is 2 per cent., and the evaporation 3 per cent. in favor of the California oil, although the net gain in actual service is less on account of steam being used to heat the California oil in the tank. The Texas oil, being much thinner, does not require heating. From a comparative test made in the shop stationary boilers the same evaporation of 10.5 lbs. water per pound of oil—water at 65 degs. temperature steam at 85 lbs. pressure—was obtained.

The gravity of the Texas oil, as found by a Beaume gauge, was 21½, that of the California oil being 15½. Samples of each oil were weighed, and assuming water to weigh 8 1/3 lbs. to the gallon of 231 cub. ins., the Texas oil weighed 7.644 lbs. and the California oil 7.71 lbs. per gallon, which figures were used in these tests.

The amount of oil consumed while on the road or during the evaporation test, was found by noting the depth in the tank at starting the test, usually measured about 15 or 20 minutes before leaving time, and again at the end of the test, immediately after arrival at the terminal. From the scale of gallons per inch of the tank the pounds used were found. The amount of oil consumed while in the round house was found by subtracting the amount used on the road from the total issued. Because of the difference in the amount of oil used in the round house on the different runs, due to difference in length of layovers, it was thought more fair to divide the total amount equally for each trip, which accounts for the uniform figure of 440 lbs. The water consumption was found by noting the several depths of water in the tank at water stations, the initial and final water readings being taken at the same time as the oil readings were taken, and also when the water was at the same level in the boiler. The amount of water wasted is the amount lost at the injector overflow. A continuous counter, connected to the injector and operated by it, recorded the number of times the injector was operated, the amount wasted each time being found by working the injector a number of times and collecting and weighing the water so wasted, it being found to average 20 lbs. for each application.

In general, the steaming quality of the two oils was about the same, it being possible with either oil to keep a uniform pressure with one or both injectors on and with the engine making schedule time, and with very little smoke. The Texas oil was found to be a little more difficult to regulate, which is accounted for by a difference in the thickness of the oils, the Texas oil being very thin, and hence requiring a closer adjustment of the oil valve.

PERSONALS.

Mr. B. R. Moore, who has for several years held the position of chief draftsman in the motive-power department of the Chicago & Northwestern, has been appointed Mechanical Engineer of the Chicago, St. Paul, Minneapolis & Omaha, with headquarters in St. Paul, Minn. He is succeeded on the Chicago & Northwestern by Mr. E. M. Prosser.

Col. Robert Andrews, Vice-President of the Safety Car Heating & Lighting Co., has been elected President of that company, vice Arthur W. Soper, deceased. This election was held Dec. 11, at a meeting of the Board of Directors, in the office of the Safety Car Heating & Lighting Co., 160 Broadway, New York. The vacancy in the Board of Directors was filled by the election of Mr. A. C. Soper, a brother of the late Arthur W. Soper. Colonel Andrews was in active railroad service for many years, and has many friends in railway circles He was born in Wilmington, Del., and his early education was received at the Episcopal Academy at Cheshire, Conn. He is also a graduate of Trinity College, at Hartford, and of the Polytechnic College in Philadelphia. His first position was that of Assistant Engineer of the State Canals of Pennsylvania, in which capacity he served from 1854 to 1857, when he was appointed Principal Assistant Engineer of the Sunbury & Erie R. R., and served that company for three years until 1860. From 1861 to 1864 he was staff officer in the army during the Civil War. From 1864 to 1865 he was Chier Engineer of the Saratoga & Hudson River R. R., and for 20 years, from 1865 to 1885 he served the Wabash Railroad as Division Superintendent, Chief Engineer and General Superintendent. From 1885 to 1888 he was General Superintendent and Engineer of the Virginia Midland R. R., and in 1889 was appointed Vice-President of the Safety Car Heating & Lighting Company and the Pintsch Compressing Company, which position he held up to his present appointment as President of the two last named companies.

"CHAUTAUQUA" TYPE PASSENGER LOCOMOTIVES.

Buffalo, Rochester & Pittsburgh Railway.

Built by American Locomotive Company.

This description applies to two handsome passenger locomotives built last summer at the Brooks Works for the Buffalo, Rochester & Pittsburgh Railway for heavy passenger service. In their general features these engines resemble previous designs of the same type, for the Burlington, Cedar Rapids & Northrn, and the Chicago, Rock Island & Pacific, but the B., R. & P. engines are much more powerful than their predecessors, having greater weight, more heating surface and higher boiler pressure than any of the earlier examples of this type. As to heating surface, this engine leads all of the Chautauqua type engines, even that of the Central Railroad of New Jersey, illustrated in this issue, although it has less total weight by 18,000 lbs. The B., R. & P. engines have 99,000 lbs. on their driving wheels, a weight which is seldom exceeded. The trailing wheels of these engines have radial boxes and are arranged like those of the Prairie type Lake Shore passenger engines, which were fully illustrated on page 74 of our March number, 1901.

"CHAUTAUQUA" TYPE PASSENGER LOCOMOTIVE—BUFFALO, ROCHESTER & PITTSBURGH RAILWAY.

C. E. Turner, *Superintendent of Motive Power.* American Locomotive Co., *Builders.*

The following table gives the leading dimensions:

General Dimensions.

Fuel	Bituminous coal
Weight on leading wheels	40,000 lbs.
Weight on driving wheels	99,000 lbs.
Weight on trailing wheels	34,000 lbs.
Weight, total	173,000 lbs.
Weight tender, loaded	120,000 lbs.
Wheel base, total of engine	20 ft. 2 ins.
Wheel base, driving	8 ft.
Height center of boiler above rail	9 ft. 7½ ins.
Heating surface, firebox	202.3 sq. ft.
Heating surface, tubes	2,805.6 sq. ft.
Heating surface, total	3,007.9 sq. ft.
Grate area	54.43 sq. ft.
Wheels, leading, diameter	33½ ins.
Wheels, driving, diameter	72 ins.
Wheels, trailing, diameter	51 ins.
Material of wheel centers	All cast steel
Type of leading wheels	Standard
Type of trailing wheels	Improved Radial Axle
Journal, leading axles	5½ by 12 ins.
Journal, leading axles, wheel fit	5½ ins.
Journal, driving axles	9½ by 12 ins.
Journal, driving axles, wheel fit	9¾ ins.
Journal, trailing axles	8 by 14 ins.
Journal, trailing axles, wheel fit	7⅞ ins.
Cylinder diameter	20¼ ins.
Cylinder stroke	26 ins.
Piston rod, diameter	3¾ ins.
Main rod, length center to center	139 ins.
Steam ports, length	25½ ins.
Steam ports, width	1⅞ ins.
Exhaust ports, least area	68 sq. in.
Bridge, width	3 ins.
Valves, kind of	11 ins. diameter, improved piston
Valves, greatest travel	5⅜ ins.
Valves, steam lap (inside)	1⅛ ins.
Lead in full gear	3/3 2in.
Boiler, type	Straight top
Boiler, working pressure	220 lbs. per sq. in.
Boiler, material in barrel	Steel
Boiler, thickness of material in shell	¾ in., 9/16 in., ½ in.
Boiler, thickness in tube sheet	¾ in.
Boiler, diameter of barrel front	70⅛ ins.
Boiler, diameter of barrel at throat	71⅝ ins.
Seams, horizontal	Sextuple
Seams, circumferential	Triple
Crown sheet stayed with	Radial stays
Dome, diameter inside	30 ins.
Firebox, type	Wide
Firebox, length	108 ins.
Firebox, width	74 ins.
Firebox, depth, front	73 ins.
Firebox, depth, back	64 ins.
Firebox, material	Steel
Firebox, thickness of sheets	Crown, ⅜ ins.; tube, ⅝ ins.; side, ⅜ ins.; back, ⅜ in.
Firebox, brick arch	On water tubes
Firebox, mud ring width	3½ ins. back, 3½ ins. sides, 4 ins. front
Firebox, water space at top	7 ins. back, 6 ins. sides, 4 ins. front
Grates	Rocking
Tubes, number of	336
Tubes, material	Charcoal iron
Tubes, outside diameter	2 ins.
Tubes, thickness	12 B. W. G.
Tubes, length over tube sheets	16 ft. ¼ in.
Smokebox, diameter outside	73 ins.
Smokebox, length from tube sheet	65 ins.
Exhaust nozzle	Single, permanent
Exhaust nozzle, diameter	5⅛ ins., 5 5/16 ins., 5½ ins.
Exhaust nozzle, distance of tip below center of boiler	6 ins.
Netting	Wire
Netting, size of mesh	2½ by 2½ No. 12 wire
Stack	Taper
Stack, least diameter taper	15 ins.
Stack, greatest diameter taper	16⅞ ins.
Stack, height above smokebox	27 ins.

Tender.

Tank, capacity for water	6,000 gals.
Tank, capacity for coal	10 tons
Type of under-frame	Steel channel
Type of trucks	B. L. W. all metal trucks
Type of springs	Triple elliptic
Diameter of wheels	33½ ins.
Type of draw-gear	B. L. W. twin spring

In 1900, $577,264,841 were disbursed in the United States in railroad wages; 4,916 of these workmen draw an average amount of $10.45 per day; 42,837 engine men draw wages averaging $3.75 per day.

Mr. R. P. C. Sanderson, recently appointed General Purchasing Agent of the Seaboard Air Line, has been transferred to the position of Superintendent of Motive Power. Mr. Sanderson was born in England in 1858, and after receiving his education in that country and in Germany he began his practical experience in connection with marine machinery. In 1882 he entered the service of the Norfolk & Western as draftsman, in connection with the construction of the Roanoke shops. From that time he filled motive-power positions successively, and in 1896 he was made Master Mechanic of the Eastern division of that road. In February, 1900, he was appointed Assistant Superintendent of Machinery of the Atchison, Topeka & Santa Fe.

PERFORMANCE OF LARGE ENGINES ON THE ILLINOIS CENTRAL RAILROAD.

An Analysis by a Motive Power Officer.

From the immediate and general attention given to the record of the tests of the large Illinois Central engines printed in our November number of last year, the performance of heavy locomotives appears to be an exceedingly important subject, and thoroughly worthy of the space we have given it. In the correspondence brought out by the printing of this record is a letter from a leading motive power officer, in which further analysis of these figures is given, and, by permission, it is printed nearly in full as follows:

The large engines are shown by these tests to be more economical than the light ones all through, under the circumstances of the tests, to a comparatively small extent, the total cost to haul 10,000 tons one mile being $1.86 for one of the large engines, as against $1.93 for the 10-wheel, and $2.02 for the mogul. This is a saving of 3½ and 7½ per cent. respectively. This saving is smaller than might have been expected, and some of the reasons for this are apparent upon investigating the figures. Other points which have affected the results are less clear and are indeed puzzling.

A fireman's helper was required on each of the large engines, which is, of course, one element tending to prevent a decrease in their cost of operation, but in spite of this additional expense for the large engines, the cost of enginemen's wages per 10,000 ton miles is about the same for all four engines. The cost of oil and waste and that of repairs is also about the same for all, on the ton-mile basis. The large engines cost 7 and 4 cents respectively more for coal per 10,000 ton miles, and they show an economy of about 15 and 19 cents for trainmen's wages, as compared with the others. In other words, the only apparent advantage to be gained by the use of such large power, entailing the employment of a fireman's helper, would be on account of the saving in the wages of trainmen, and even this is offset to a certain extent by the extra cost of fuel. This is the result on the face of the report, but a close examination of the figures would lead to an inquiry whether any broad assertion to that effect is justified by these tests. In the first place, the large engines do not appear to have been loaded to anything like their capacity; their tonnage rating over ruling grade is 1,800, their average train tonnage was 1,517 and 1,511, practically 84 per cent. of their rating, whereas the other engines pulled 102.5 per cent. and 117.4 per cent. of their ratings respectively. Without knowing the reason for this, it would appear that since the average cars per trip for the large engines were 49 and 50, that the trains were for transportation purposes limited to 50 cars; this is simply a guess, but if it is a fact, the mere loading of these engines up to their capacity would have made the figures very different, and the cost per 10,000 ton miles would then have been far more favorable to the large engines.

The large engines apparently required an excessive amount of repairs, not only in the cost in dollars and cents, but in the time they were held for repairs, 275 and 485 hours for the large engines as against 97 and 142 hours for the smaller ones. It would be interesting to know whether such repairs were liable to be continually required, or whether they were not to some extent owing to each of these engines being the first of its particular design and to a certain extent extraordinary. A slightly greater cost per engine mile would be expected, but on the ton-mile basis, if conditions were normal, a decrease in the cost for the large engines would be looked for, leading to a more favorable statement for them, even if the differences were unimportant.

The extra cost of coal on the large engines is peculiar, especially as their evaporative efficiency is higher than that of Nos. 35 and 489 by 6 per cent. and 7 per cent. The smaller engines show a higher average running speed, 20.24 and 19.05 miles per hour, against 17.71 and 17.95 miles, and in consequence have expended more power per ton mile, but this would be slightly compensated for by the longer standing time in service of the large engines. On the other hand, the evaporation of the large engines is 6.491 and 6.397 lbs. of water per pound of coal, as against 6.028 and 6.003 lbs. for the smaller, practically 6.4 lbs. against 6.0. There appears to be no reason shown for this difference, which might occur from several causes. The weight of the engine is apparently not included in the train loads, but it is closely proportional to the tonnage rating, not varying sufficiently to make a difference.

The grate area is less in proportion to the tonnage rating on the large engines, but is substantially the same in proportion to the average train tonnage. The heating surface in Nos. 639 and 640 bears about the same proportion to the average load as in No. 35, but is far greater than in No. 489; curiously the 489 shows just as good evaporation as the 35. The gallons of water used per running hour per square foot of heating surface, in other words, the rate of evaporation per square foot of heating surface, is the same or slightly greater for the 639 and 640 than for the 35, and is far greater for the 489. The coal per running hour per square foot of grate surface is about the same for all the engines. The ratio of average train tonnage to the tractive power varies considerably, and is very much lower in the large engines than in Nos. 35 and 489.

The figures referred to in the above statements are given in the table below; they are simply reproductions of those given in the report.

Engine No.	35	489	639	640
	10-wheel.	Mogul.	Cons'dat'n.	12-wheel.
Grate area ÷ Average load	.0253	.0222	.0254	.0248
Heating surface ÷ Average load	2.23	1.45	2.11	2.33
Water per lb. coal	6.028	6.003	6.491	6.397
Galls. water per sq. ft. heating surface per hour	.717	1.090	.787	.715
Lbs. coal per sq. ft. grate per hour	84.0	87.6	84.1	83.1
Weight of engine % of gross tonnage per trip	12.1%	9.75%	10.1%	10.8%
$\frac{\text{Average train tonnage}}{Pd^2s \div D}$	.0336	.0389	.0259	.0258
Water per 10,000 ton miles	6,330	6,900	7,820	7,800

In general, the above figures show that although neither the rate of combustion or the rate of evaporation in the large engines differed appreciably from No. 35, yet they show an increased evaporative efficiency of about 7 per cent., while No. 489, with far less heating surface, shows up as well as No. 35; perhaps the boiler of No. 35 was scaled slightly. In spite of this advantage in evaporative efficiency, the coal per 10,000 ton miles is far greater for the large engines, owing to their greater consumption of water, 7,800 as against 6,330, and 6,900 gals. per 10,000 ton miles for Nos. 35 and 489. The only apparent explanation for this is the fact that the big engines were not loaded to capacity, or, perhaps, since their boilers were worked as hard as those of the smaller engines, it would be better to say that they were over-cylindered for their loads.

Whatever the cause may be this report is exceptional as showing a higher cost per ton mile for oil, waste, coal and repairs for large engines than for small. It is needless to remark that a change in the results in these items, even if simply equalizing them, would have made the large engine showing much better. Providing their boiler capacity would allow of it, and this is one of the most interesting questions raised by the report, if Nos. 639 and 640 could have been loaded to capacity, even at the same cost per ton mile for fuel, oil and repairs, the saving in the salary account would have shown them to be economical to the extent of about 15 per cent. instead of 5 per cent., a gain well worth careful notice.

THE JUNE CONVENTIONS.

Saratoga has been decided upon for the conventions of the Master Car Builders' and Master Mechanics' associations for next June. The former will open its first session June 18 and the latter June 23. The headquarters will be at the Grand Union Hotel.

NEW DESIGN OF PLAIN MILLING MACHINE.

The Brown & Sharpe Manufacturing Company has recently placed upon the market a new design of plain milling machine, built for work requiring unusually large table capacity and long cuts. It is provided with very heavy gearing, which especially adapts this machine to the requirements of machine tool builders, engine and railroad shops and in general for the heavier class of milling.

In this design special care has been taken to make the machine as convenient to operate as possible. This is shown in the accompanying engraving. All the working parts are easy of access, and all levers and hand wheels are so placed that the operator has easy control of the various movements of the machine. A wide range of feed changes are obtained by means of transposing gears. With two speeds of the countershaft eight changes of speed are obtained, varying from 15 to 100 revolutions per minute. The advantages of this method of driving are readily appreciated, as the speed of the spindle

New Design of Plain Milling Machine.
Brown & Sharpe Manufacturing Company.

cone is maintained more uniformly than when the changes of speed are wholly dependent upon the number of steps on the cone, and the power is not reduced to such an extent when slow speeds are required for heavy cuts.

The steel spindle has ground and lapped bearings and runs in phosphor bronze boxes provided with means of compensation for wear. A phosphor bronze worm-wheel and worm of steel, hardened, are used to drive the spindle. They are run in oil, and the thrust of the worm is taken by ball bearings. The spindle cone runs idle and in the same direction as the shaft on which it is mounted, thus reducing the friction to a minimum. It has only two steps, the power being transmitted through a system of gearing arranged to give an exceptionally high ratio. An improvement has been made in the method of clamping the spindle head and knee, each being clamped by one lever in place of two as formerly. The arm support is exceptionally rigid and of improved design. It is made in two parts, clamped directly to the front of the knee and can be easily placed in position or removed. The two parts slide upon each other and are clamped in position by bolts passing through the slots. This form admits of a bearing for the outer end of the arbor directly in the support, and allows the adjustable arbor support to be used at any intermediate point on the arbor, thus giving the arbor an exceptionally rigid support. The table has a working surface 72 by 17¼ ins., and can be lowered 19 ins. from the center of the spindle. It is supported directly in the knee, which is exceptionally long for the capacity of the machine. An important feature of the table is that it remains locked in position when the feed is automatically thrown out. A dial, graduated to read 64ths of an inch, indicates the transverse movement of the head of the machine, while adjustable dials, graduated to read to thousandths of an inch, indicate the longitudinal, transverse and vertical movements of the table.

The important feature of this milling machine is its simplicity. This was the object in securing as direct a transmission of power as possible, and at the same time provide for a wide range of feed changes. It is apparent that a drive of this character by chain and sprocket wheels insure a positive and uniform feed for the table.

ARTHUR W. SOPER.

Arthur W. Soper, President of the Safety Car Heating & Lighting Company, and of the Pintsch Compressing Company, died at his home in New York, December 1, after a short illness. He was forceful, energetic and successful, first as a railroad officer, and afterward in the conduct of large business affairs, but combined with business ability, sagacity, perseverance, and all that goes to make success, he had sincerely friendly attributes which always brought a ready response to the needs of others. His death will be mourned by many who knew him well, and others whom he had befriended. In railroad service he spent thirteen years with the Rome, Watertown & Ogdensburg, leaving that road in 1881 as Assistant Superintendent, to take a similar position on the St. Louis, Iron Mountain & Southern. He remained with that road ten years, the last three years of which he was General Manager. In business he was equally successful, the general introduction of the Pintsch system of car lighting being largely due to his leadership. Besides this he had other important interests, being a director in the Wheeling & Lake Erie Railroad, the Standard Coupler Company and other industrial concerns. He was also deeply interested in the application of compressed air to traction problems. He was a typical example of the class of men who have made American railroads what they are.

Mr. George Gibbs, Consulting Engineer of the Baldwin Locomotive Works and the Westinghouse Electric and Manufacturing Company, has been appointed Consulting Engineer for the Rapid Transit Subway Company of New York. He will have charge of all of the essentially railroad problems, including the construction of the tracks, cars and signals, and the plans for the operation of the road, including schedules and all operating problems. This is a fortunate selection, because of the experience of Mr. Gibbs in railway service and his subsequent research in connection with the application of electricity to traction. The consulting board for this work is admirably selected, each member being a specialist of recognized ability and standing. The appointment of Mr. Gibbs brings the only distinctive railroad experience represented, and a wiser selection could not be made.

The most extensively equipped electric railway, for freight business, in this country, is that of the St. Louis & Illinois Suburban Railway. Its equipment for handling freight consists of four 50-ton locomotives, each equipped with four 160 h.p. motors, and 400 coal cars of 80,000 lbs. capacity. Six hundred more cars of similar capacity are to be added. This company operates two coal mines, using current from the trolley wires, and will soon open more mines.

BOOKS AND PAMPHLETS.

Calumet "K.," by Merwin Webster, author of "The Short Line War," etc., with illustrations by Harry C. Edwards. Published by Macmillan Company, 66 Fifth avenue. $1.50.

This story of the building of an enormous grain elevator in an incredibly short time pictures vividly, in the hero, Charlie Bannon, a typical Western "hustler." The ingenious manner in which he overcomes the many difficulties thrown in his way by railway men, business rivals, and "walking delegates" is truly fascinating. Bannon's skilful and successful handling of his large force of workingmen is well described; and the way in which he meets the labor union problem and avoids strikes and other difficulties is worthy of attention. The illustrations and excellent form of the book add much to its attractiveness.

The Indicator Handbook, a Practical Manual for Engineers. Part II., The Indicator Diagram, its Analysis and Calculation. By Charles N. Pickworth, Editor "The Mechanical World." Published by D. Van Nostrand Co., 27 Warren street, New York. Price, $1.50.

This little book of 132 pages supplements Vol. I. by the same author, which described the construction and application of the indicator. The present volume is devoted to the analysis of the indicator diagram and to horse-power calculations. An introductory chapter discusses elementary principles. This is followed by an examination of the diagram in detail and a study of the action of steam in the cylinder. Defective valve gear and its effects on steam distribution follow and then the compound diagram and methods of combining them are taken up. Indicator work in connection with internal combustion engines is treated quite fully, also air compressor and pump cards. Diagram calculations occupy the closing chapter. The use of small sized engravings is commendable; these are quite clear and satisfactory. On page 48 is given a table of results which follow an increase of outside and inside lap, angular advance and valve travel. This will be a convenience to refresh one's memory in valve motion questions. On page 122 the author describes a convenient slide rule horse-power computer for steam, gas and oil engines. This appears to be an excellent labor-saving device. These two volumes constitute the best work on the indicator and indicator diagram that we have seen.

A new book on Small Tools, Standards and Gauges has just been published by the Pratt & Whitney Company. This catalogue of 152 pages, 4¾ by 7¼ ins., is in every way a very creditable one. It treats of taps and dies, die stock sets for bolt and pipe threading, milling cutters, slitting saws, Renshaw ratchet drills, lathe tools, tapping heads, boiler punches, reamers, taper pins and all standard measuring machines, standard size and thread gauges, and gauges for special purposes. The book is neatly printed, with complete index. Those who are interested in this volume may secure a copy by writing to Pratt & Whitney Company, Hartford, Conn.

The advantages of systematic reading of current engineering periodicals, with an argument for the individual card index, forms the basis of a well-directed address by Prof. H. Wade Hibbard, before the student's Society of Mechanical Engineers of Sibley College. The paper lays stress on the importance of technical literature, the selection of a technical paper and how to use it; also the making of a card index. This address has been printed and put in pamphlet form, and to those interested in the subject a copy will be sent upon application to Prof. Hibbard, Sibley College, Ithaca, N. Y.

American Mines Annual. Comprising a careful, accurate and concise compilation of the active gold, silver, copper, lead and zinc mining and milling companies throughout the United States. By George E. Vigouroux, LL.B. Published by Geo. E. Vigouroux & Co., 1278 Broadway, New York. 1901. Price, $5.00.

This is a directory giving the names of companies engaged in the mining industry and profession, also the location of each company, its president, secretary, capitalization and par value of stock; its main business address, the type of reduction plant, together with the name of the manager or superintendent. The book is accurately arranged in so far as a book of this kind can be. It is the first edition of this directory, which promises to be an annual production.

EQUIPMENT AND MANUFACTURING NOTES.

S. E. Moore, the well-known accountant, for many years auditor of the Carnegie Steel Company, has been appointed auditor of the Pressed Steel Car Company.

The large increases in the business of the Handy Car Equipment Company have made it necessary for them to remove their office from 1525 Old Colony Bldg., to more extensive quarters in suite 890 of the same building. This company manufactures the Handy Box Car, and the Snow Car and Locomotive Replacers.

The new plant of the Buckeye Malleable Iron & Coupler Company, at the foot of Parsons street, Columbus, O., is being pushed rapidly toward completion. Both plant and equipment are to be up to date in every detail and nothing seems to have been forgotten or omitted which can tend toward making it so. Thirty-five acres of ground are provided. The plant includes two foundries of 1,000 ft. each, a boiler house, gas house, laboratory, store and shipping rooms. Shipping facilities are exceptionally good, as the works are reached directly by the Hocking Valley and the Toledo & Ohio Central railroads, with the Norfolk & Western near by. This new plant is the largest of its kind in Columbus and one of the largest in the country. It is located near the works of the National Steel and the Columbus Iron & Steel companies.

In the annual report of the Wheeling & Lake Erie Railroad, issued recently, President Joseph Ramsey says the traffic demands on the company greatly exceed the facilities for transportation. This condition of affairs has become aggravated since the Wheeling & Lake Erie was absorbed by the Wabash system. President Ramsey says: "We must at once arrange for at least 2,000 or 2,500 40-ton coal cars and about 25 freight locomotives, to be paid for under an equipment mortgage running 20 years with proper sinking fund provisions. Extensive work of improvement must be spread over several years, as it must be paid for out of the surplus earnings and must be limited each year to the amount available from that source. The Wheeling & Lake Erie is surrounded by railroads owned and operated by the wealthiest and strongest companies in the country, and it must be prepared to carry traffic at as low a cost per ton as any other road, or it must go to the wall."

Among the more recent and important orders received by the Triumph Electric Company, of Cincinnati, O., are the following: For the Krell French Piano Company an entire electrical equipment has been contracted for the factory, consisting of a 250-k.w. generator and 57 motors of various sizes from 1 to 40 h.p. The Globe-Wernicke Company has ordered a 200-k.w. direct-connected generator, five 30-h.p. motors, three 65-h.p. motors, two 20-h.p. motors, and two 10-h.p. motors. This is in addition to their present plant, which already has two generators of 200 k.w. each and motors aggregating 500 h.p. The Commercial Tribune Company, of Cincinnati, O., has also ordered one 200 and one 100-k.w. direct-connected generators. The steady increase in the business of the Triumph Electric Company has made it necessary to operate their factory 24 hours a day with two different shifts of men.

When Joseph Ramsey, Jr., the newly-elected President of the Wabash Railroad, was Superintendent of the Pittsburg Southern, a small road in the coal district, Mr. Joseph Walton, a millionaire coal miner of Pittsburgh, heard of his ability and decided that Ramsey would be just the man to take charge of a road which he was then projecting. Walton went over to the small town where Ramsey made his headquarters, in order to offer him the position. At the office he was told that Mr. Ramsey was out somewhere in the yards, so the "coal king" went out to look for him. The first man he came across was a grimy mechanic who was at work underneath an engine. "Where's Mr. Ramsey?" inquired Mr. Walton. "I'm Ramsey," replied the man, and then, climbing out from under the locomotive, he explained, laughingly, that there was "something wrong with the engine, and as the engineer didn't know how to fix it, I took a hand at it myself." That made Walton desire Ramsey's services more than ever, and indirectly was the cause of Ramsey's rapid advancement.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

FEBRUARY, 1902.

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AMERICAN ENGINEER TESTS.

Locomotive Draft Appliances.

V.

Report of Meeting of Committee of Railroad Representatives.

First Installment of Report by Professor Goss, of Purdue University.

From the inception of these tests the support of the railroads has been hearty, generous and practical. Many offers of assistance have been made, and for the construction of the special apparatus a number of the large roads offered the use of shops and material. Others offered assistance in testing and the use of locomotives.

To secure the advantage of the many years of experience of railroad officers in connection with the tests, copies of Mr. Vaughan's report were sent to a number of motive power men who had expressed an interest in the undertakings. At a meeting called in Chicago May 21, 1901, by the American Engineer, the following gentlemen were present or represented:

Mr. Robert Quayle, Chicago & Northwestern; Mr. A. W. Gibbs, Pennsylvania; Mr. G. R. Henderson, Atchison, Topeka & Santa Fe; Mr. F. H. Clark, representing Mr. F. A. Delano, Chicago, Burlington & Quincy; Mr. W. H. Marshall and Mr. H. F. Ball, Lake Shore & Michigan Southern; Mr. F. M. Whyte, representing Mr. A. M. Waitt, New York Central & Hudson River; Mr. W. S. Morris, Chesapeake & Ohio; Mr. C. H. Quereau, Denver & Rio Grande; Mr. C. A. Seley, Norfolk & Western; Mr. J. E. Sague, American Locomotive Company; Mr. E. M. Herr, who was Assistant Superintendent of Motive Power of the Chicago & Northwestern when the Master Mechanics' Association tests of 1896 were made. Professor Goss, of Purdue University, and Mr. H. H. Vaughan, were also present; the American Engineer and Railroad Journal being represented by Mr. G. M. Basford.

The origin of the plan and its scope were briefly stated by Mr. Basford, also the fact that Professor Goss had made a report upon Mr. Vaughan's paper, that Purdue University had made a generous offer of the laboratory work at its actual cost and that the American Engineer would bear the expense of the tests. He expressed appreciation of the cordial reception of the plan and of the high character of the preliminary work by Mr. Vaughan and Professor Goss. By aid of these gentlemen the subject was presented in concrete form for discussion at the meeting.

It was also explained that the work would be undertaken at Purdue, under the direction of Professor Goss, and that his complete report on the tests would be published in the columns of the American Engineer and Railroad Journal.

The meeting then took up Mr. Vaughan's report, which has already been printed in full in these columns, and a number of points were brought forward and possible explanations offered. Mr. Gibbs asked for opinions as to whether the highest possible vacuum was really the most efficient, giving instances in which contraction of the nozzle with consequent increase in back pressure had led to diminished coal consumption. It was pointed out that the performance of the engine, considered as a whole, might not be at the best when running with the largest possible nozzle, since in that case the action of the draft on the fire might lead to such manipulation by the fireman that the combustion was not complete. As a lighter draft with its consequent decreased action on the fire would lead to a thin fire being caried—with excess of air admission and less efficient combustion as compared with a greater draft, fairly thick fire and economical combustion. The total result certainly depended on the fire to a far greater extent than on the efficiency of the front end; yet such facts would not affect the desirability of using the most efficient stack and nozzle, as when this was obtained the draft could always be increased by reducing the area of the nozzles.

Answering a question of Mr. Gibbs as to the vacuum in the front end being a measure of the efficiency of the stack and nozzle, it was pointed out that with the same conditions in the front end the vacuum will vary with the condition of the fire, a thicker fire causing greater resistance to the flow of air at that point, and thus leading to the vacuum being greater, while the flow of steam from the nozzle remained the same.

Explanations were made by Mr. Herr of the difficulties at first experienced by the Master Mechanics' Association Committee owing to this cause, and the impossibility of obtaining any comparative results until oil was substituted as a fuel. It was also stated that while the variations in front-end vacuum due to variations of the position of the nozzle are comparatively small, those due to the condition of the fire are extremely large, and it was unanimously decided that it would be necessary to use oil in the proposed tests.

The influence of the state of the fire led to an inquiry from Mr. Gibbs as to whether it would not be necessary to include in series No. 1 of Mr. Vaughan's report another variable in addition to those mentioned, namely, variation in grate areas, and it was decided that tests ought to be made with three areas of grate opening, one of which was to be 80.72 sq. ins., the same as used in the Hanover tests; another with 150 sq. ins., used in the tests of the Master Mechanics' Association Committee, and a third with a larger area of about 200 to 220 sq. ins. As pointed out in the report it is probable that the amount of air that is moved by the jet would greatly affect the size of the best stack—a stack that would be the best in the small grate would not be the best with a large grate, and as this question is very important, in view of the increased size in the grate now generally used, as others are not taken into consideration, the tests would not be reliable with respect to the different sizes of grates. A large number of suggestions as to methods of measuring the amount of air handled were offered, but none were regarded as being practically superior to those formerly employed.

It was suggested by Mr. Marshall that it would be advisable to make at first a number of tests on the Purdue locomotive, or a larger one if necessary, in which the stacks and nozzles used should agree closely with those used in the Hanover tests. That if a complete series of tests with one or two series of stacks were made it might be possible to deduce from these the necessary modification that must be made to the Hanover tests to adapt them to locomotive conditions and that afterward by a few observations, checking results here and there in the Hanover tests, sufficient would be known, with the aid of those tests, for all practical purposes.

This was agreed on as the series with which the work should commence, and after further discussion it was decided that the investigation of the petticoat pipe and a final decision as to whether or not advantages were to be gained from its use should be taken up later.

It was decided that tests referring to the length of the front end and the loss in efficiency caused by the baffle plate would not lead to results of much practical advantage at present, and not of such importance as the above outlined series.

In many respects the recommendations in Mr. Vaughan's report were approved, the substitution of the series suggested by Mr. Marshall for the investigation proposed by Mr. Vaughan of the action of the jet being the most important. A great many suggestions were made and features of importance discussed, in fact, so many that it is impossible to refer to all, and the detail methods of conducting the tests were fairly well settled.

Those present resolved themselves into a committee for the presentation of the tests on the locomotive front end, to be known as the American Engineer Tests on Locomotive Draft Appliances, and at Mr. Henderson's suggestion all agreed to forward to Mr. Basford all articles, data, etc., that came under their observation in connection with this subject.

Immediately after this meeting the preparation of designs for the special apparatus began. The work now being sufficiently advanced, Professor Goss has submitted the first installment of his report, as follows:

AMERICAN ENGINEER TESTS OF LOCOMOTIVE DRAFT APPLIANCES.

TESTS OF LOCOMOTIVE STACKS.

Report by Professor W. F. M. Goss.

Engineering Laboratory, Purdue University,
Lafayette, Indiana, January 1, 1902.

The American Engineer,
Mr. G. M. Basford, Editor, New York City.

Sir: In obedience to your direction, the Engineering Laboratory of Purdue University has made certain tests of locomotive stacks, upon which I now submit the following report:

I.

Introductory Statement.

1. The Stack Problem.—A review of published accounts of previous experiments, involving draft appliances, which have been made under service conditions, indicates that but slight attention has hitherto been given the stack. This, probably, is not due to any lack of appreciation of the importance of the stack, but rather to the complicated nature of the whole problem, and doubtless also because the need of information concerning other details has been deemed more urgent. However this may be, the fact remains that but little effort is at present made to accurately proportion the dimensions of stacks for the work they are to accomplish. On the contrary, it not infrequently happens that one engine having 17-in. cylinders and another having 20-in. cylinders are fitted with stacks of the same diameter. The larger engine may develop two or three times as much power as the smaller, and its larger volumes of furnace gases and of steam must all find their way through an opening which apparently is not too large for the smaller engine. It is, in fact, the practice of some roads to make practically all stacks of the same diameter, without reference to the size of the engine upon which they are used. In such cases it is not likely that stacks are often given dimensions such as are required for highest efficiency. Moreover, conditions such as have been described do not prevail from choice, but rather because the information which will serve to guide practice along more logical lines is not available. There is urgent need for facts. So far as we can see, the stack will never be omitted from the steam locomotive, and it is but reasonable to expect that in each individual case some particular diameter, length and contour will give a more efficient result than other dimensions or contour. Upon this theory, the pres-

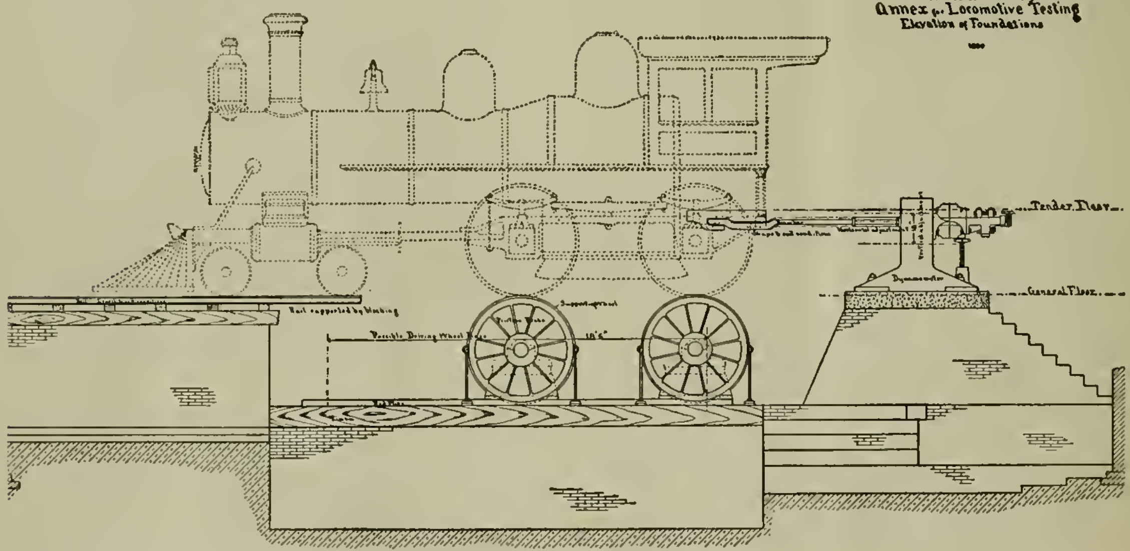


Fig. 1.

ent research has been promoted. It has been the expectation that it would serve to develop a sufficient array of facts to con-

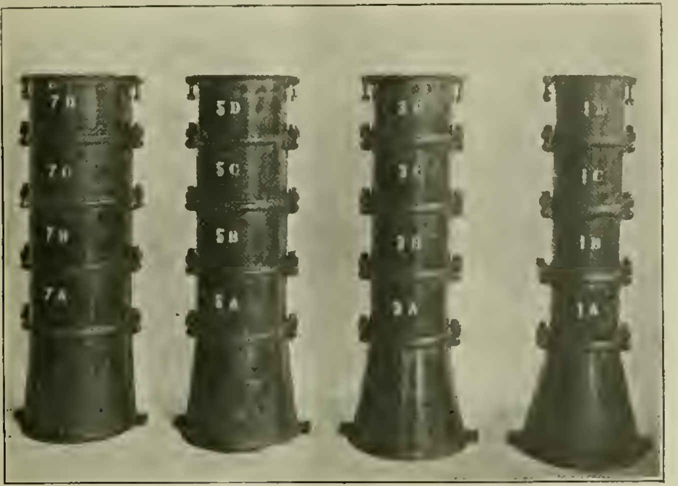


Fig. 2.

stitute a foundation for a theory which may hereafter guide in the logical design of such apparatus.

2. The Purdue Locomotive Testing Plant, in connection with which the tests were made, has been frequently described, and the principles underlying its action are now generally understood. For this reason it need not now be described in detail. It will be sufficient to say that the locomotive employed, known as Schenectady No. 2, is of the eight-wheeled type, and weighs 100,000 lbs. The least diameter of the boiler is 52 ins., and the cylinders which were in use throughout the experiments are 16 by 24 ins. The locomotive is mounted upon supporting wheels in such a way as to provide for its complete operation while occupying a fixed position in the laboratory. It is fired in the same manner as it would be upon the road, and delivers its power from the periphery of its drivers as it would do if it were passing along the track, while its fixed position at all times permits its action to be studied with the same facility as

Fig. 4.

that of a stationary plant. An outline in elevation of the plant is shown by Fig. 1, but the locomotive which is shown in connection therewith is not the one upon which the experiments were made.

3. The stacks employed in the experiments, as designed by Mr. H. H. Vaughan, and as constructed under the direction of Mr. W. H. Marshall, Superintendent of Motive Power of the Lake Shore & Michigan Southern Railway, at the Elkhart shops of that road, are shown by Figs. 2 and 3. The illustrations are from photographs taken before the work began. Fig. 2 embraces four different diameters of straight stacks, and Fig. 3 four different diameters of taper stacks. Each stack is made in sections, by the successive removal of which any desired length within the limits shown may be obtained.

The nozzles used in connection with the different stacks are shown by Fig. 4. These were designed by Prof. William Forsyth and, like the stacks, were constructed under the direction of Mr. W. H. Marshall. When in use the nozzles stand upon a short exhaust pipe, designed in accord with the recommendation of the Master Mechanics' Committee. They consist of a wrought-iron body mounted on a cast-iron base and fitted at the top

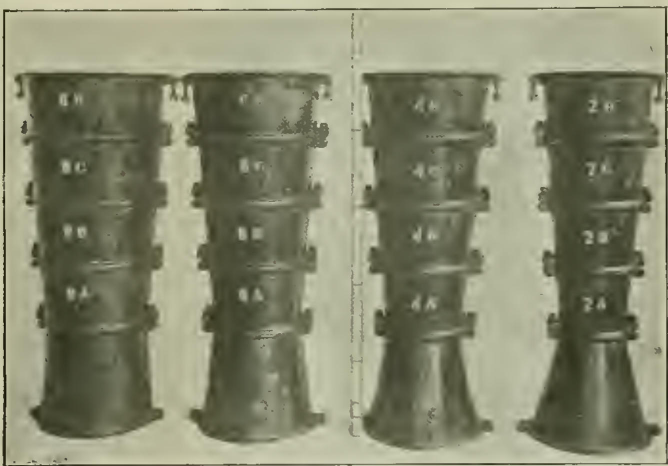


Fig. 3.

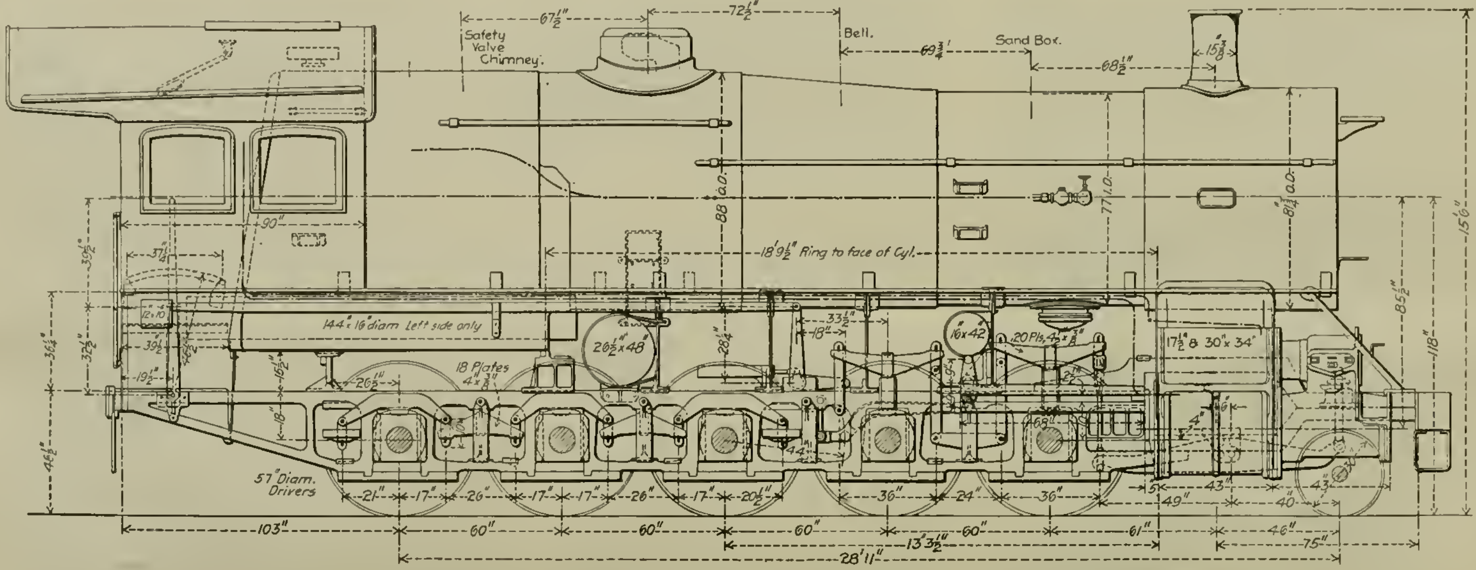
with a suitable tip. All have the same diameter of tip, namely, 4½ ins.

The exact dimensions of all portions of this equipment will be found of record in connection with data obtained therefrom.

(The next subject is the variables.)

(To be continued.)

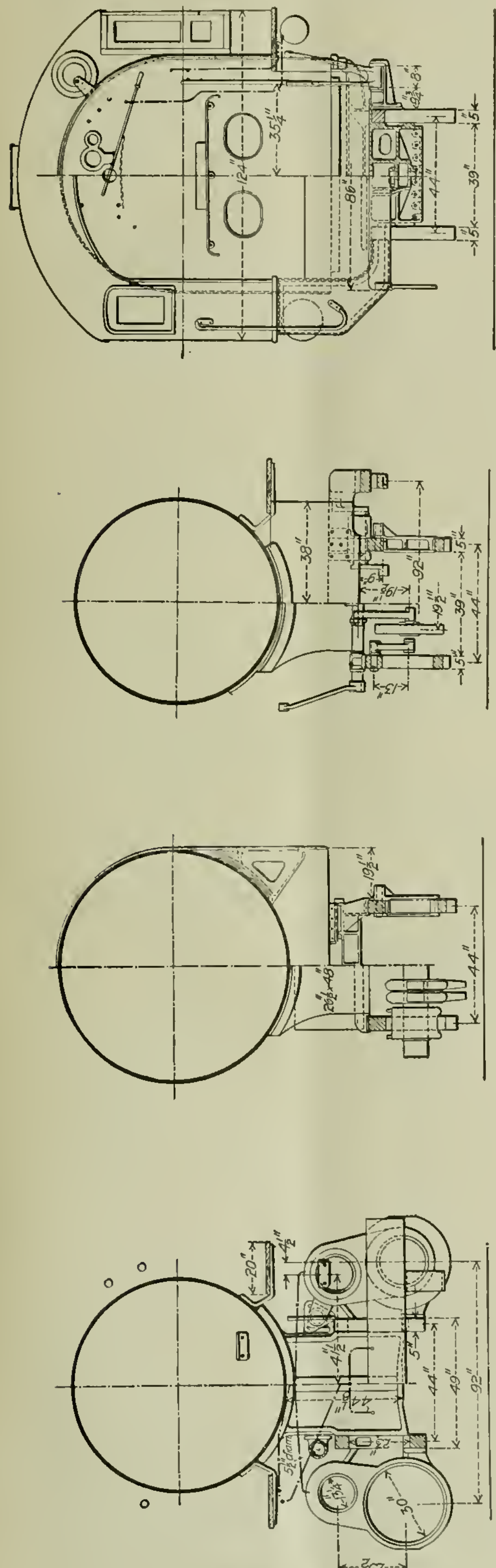
A steamer using oil fuel exclusively is running in the regular service of the Shell Transport and Trading Company, of London, between Borneo and England. A series of oil supply stations has been established by this company between China and Japan and London, and these will be extended. The experience of this company shows that for oil fuel a vessel of 3,500 tons requires but 3 firemen as against from 18 to 24 for coal fuel. One man tends the fireroom in each watch, the water being regulated automatically. For oil the bunker space is about one-half that required for coal, and, furthermore, spaces not available for coal may be used for oil. In this case fuel oil seems to be perfectly successful.



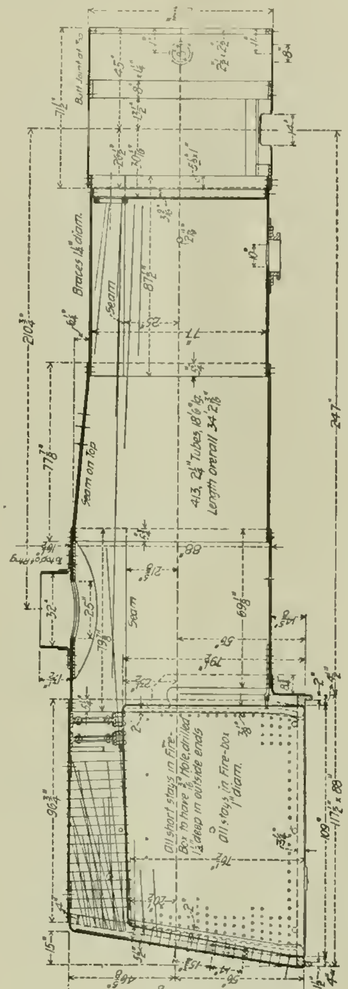
Tandem Decapod Compound Freight Locomotive—Atchison, Topeka & Santa Fe Railway.

THE HEAVIEST AND MOST POWERFUL LOCOMOTIVE EVER BUILT.

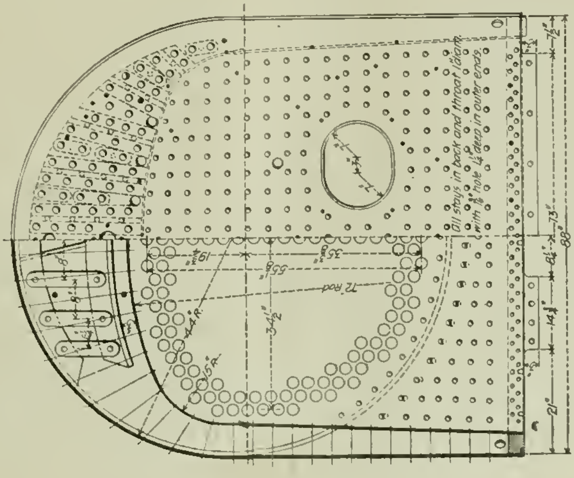
G. R. HENDERSON, *Superintendent of Motive Power.* JOHN PLAYER, *Consulting Superintendent of Motive Power.* AMERICAN LOCOMOTIVE COMPANY, *Builders.*



Half Front and Rear Elevations and Sections.



Longitudinal Section of Boiler.



Transverse Section of Boiler.

Decapod Tandem Compound Locomotive—Atchison, Topeka & Santa Fe Railway.

THE HEAVIEST AND MOST POWERFUL LOCOMOTIVE EVER BUILT.

DECAPOD TANDEM COMPOUND LOCOMOTIVE.

Atchison, Topeka & Santa Fe Railway.

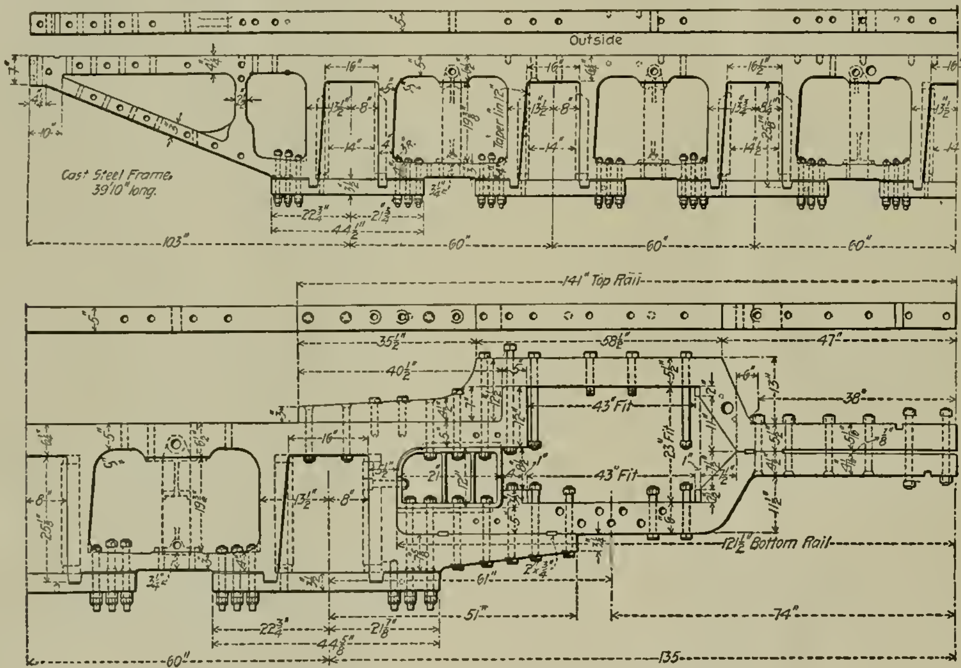
Heaviest Locomotive Ever Built.

Though the past four years have bought out surprising advances in the weight and power of locomotives until the limit was thought to have been reached, the Atchison, Topeka & Santa Fe has surpassed all previous efforts in a design from the Schenectady Works of the American Locomotive Company. This engine, however, is not likely to enjoy the supremacy long, according to rumors of still greater proportions which are promised for the near future. This road is leading in the matter of weight and power of locomotives, and its policy will he studied with deep interest. It is stated that this road will soon have 76 engines as large as this one, or larger. The heavy engine is not therefore considered experimental in this case.

The locomotive illustrated here is for road service, and is intended to replace double heading on mountain grades. Having favored the tandem compound principle for several years, this type was decided upon in this case, and the features of construction are similar to those of the Northern Pacific consolidation compounds, illustrated in our September number of last year, page 273. In fact, the design and construction are so similar to those of the Northern Pacific engines as to render it unnecessary to enter into the new design in minute detail, because of the thorough description of the Northern Pacific engines in the issue referred to. The Atchison engine has a Laird crosshead.

This engine is enormous. Its total wheel base is 28 ft. 11 ins., or 11 ins. greater than any other of our record. Its driving wheel base is 20 ft., or 8 ins. greater than that of the "Soo" engine, illustrated in our volume of 1900, page 319. The total heating surface is 4,681 sq. ft., or 415 sq. ft. greater than that of the oil-burning engine for this road (page 10, January issue), which was the largest heating surface previously used. The tube heating surface is 4,476.5 sq. ft., with 413 2¼-in. tubes, 18 ft. 6 ins. long, these being the longest tubes in our record of freight engines. The tubes are spaced 13-16 ins. apart. As shown in the boiler sections, the grate is 9 ft. long by 6 ft. 7 ins. wide, and the firebox has straight sides with radial and sling stays. These engines have two firedoors. The boiler is 78¾ ins. in diameter, while that of the Pittsburg, Bessemer & Lake Erie engine (volume of 1900, page 214), is 84 ins. The center of the boiler is 118 ins. above the rail, or 1¾ in. less than the engine just referred to. In weight the Santa Fe engine surpasses all, as shown in the accompanying table, which is presented for comparison. The ratio of heating surface to grate area is 78, and the ratio of total weight to heating surface is 55.5. It is interesting to note that while this is the heaviest locomotive ever built, with reference to this ratio it stands third in the list of heavy engines which forms part of this article. A water space of 4½ ins. is provided, all around the mud ring.

The tractive power is 55,300 lbs. when operating as a com-



Cast Steel Frames, Showing Unusually Heavy Splicing.

COMPARISON OF HEAVY FREIGHT LOCOMOTIVES.

Railroad	P. B. & L. E.	Union	Lehigh Valley	Illinois Central	Atchison	N. P.	Atchison.
Builder	Pittsburgh	Pittsburgh	Baldwin	Brooks	Baldwin	Amer. Loco. Co.	Amer. Loco. Co.
Si'ple or Comp'd.	Simple	Simple	Vauclain Comp'd.	Simple	Vauclain Comp'd.	Tandem Comp'd.	Tandem Comp'd.
Type	Consolidation	Consolidation	Consolidation	12-wheel	Consolidation	Consolidation	Decapod.
Total weight	250,300	230,000	225,082	232,200	214,600	198,000 lbs	259,800 lbs.
Weig't on driv'rs.	225,200	208,000	202,232	193,200	191,400	175,000 lbs	232,000 lbs.
Size of drivers	54 in	54 in	55 in	57 in	57 in	63 in	57 in.
Cylinders	24 x 32 in	23 x 32 in	18 and 30 by 30 in.	23 x 30 in	17 and 28 x 32 in.	15 and 28 by 34 in.	17½ and 30 by 34 in.
Heating surface	3,805 sq. ft	3,322 sq. ft	4,103.6 sq. ft	3,500 sq. ft	4,266 sq. ft	2,997.1 sq. ft	4,681 sq. ft.
Grate area	36.8 sq. ft	33.5 sq. ft	90 sq. ft	37.5 sq. ft	None	52.29 sq. ft	59.47 sq. ft.
Steam pressure	220 lbs	200 lbs	200 lbs	210 lbs	210 lbs	225 lbs	225 lbs.
Ratio of total weight to heating surface	65.7	69.2	54.8	66.3	50.3	66.0	55.5.
American Engin'r reference	1900, page 214	1898, page 365	1898, page 395	1899, page 315	1902, page 10	Sept., 1901, p. 271.	Feb., 1902.

pound, as taken from indicator cards in actual service. In general the cylinder and valve arrangement is like that of the Northern Pacific tandems already referred to, the same arrangement of starting and by-pass valves being used. For such a large engine the frames are necessarily very heavy. They are of cast steel, 5 ins. wide, and the jaw braces are 3½ ins. deep, secured by three 1¼-in. bolts at each end. Over the driving boxes the frames are 6¼ ins. deep, and the upper frame splice extends back over the forward jaws. Naturally the driving journals are large, the main journals being 10 by 12 and the others 9 by 12 ins. The main crank pin is 7 by 8 ins., and the engine truck journals are 7 by 12 ins.

These engines are constructed for oil or coal burning, and the oil fittings will be fitted later. The tender has a straight top without a high rim. It weighs 60,000 lbs. empty, and is carried on two Player 50-ton trucks. The wheel base of the engine and tender is 62 ft. Among the special equipment is the Le Chatelier water and Westinghouse brakes, Leach sander, Monarch brake beams, three 3-in. Crosby pop valves, Boyer speed recorder, and Westinghouse friction draft gear.

For a study of this engine in comparison with other heavy ones the accompanying tables have been prepared.

Tandem Compound Decapod Locomotive, A., T. & S. F. Ry.
General Dimensions.

Gauge	4 ft. 8½ ins.
Fuel	Oil and soft coal
Weight in working order	259,800 lbs.
Weight on drivers	232,000 lbs.
Total engine and tender	394,700 lbs.
Wheel base, driving	20 ft
Wheel base, rigid	20 ft.
Wheel base, total	28 ft. 11 ins.

Cylinders.

Diameter of cylinders	17½ ins. and 30 ins.
Stroke of piston	34 ins.
Horizontal thickness of piston	5½ ins.
Diameter of piston rod	H. P. 3¼ ins., L. P. 4½ ins
Kind of piston packing	Plain rings
Kind of piston rod packing	Jerome

Valves.

Kind of slide valves	Piston type
Greatest travel of slide valves	6 ins.
Outside lap of slide valves	⅞ ins.
Inside clearance	H. P. ⅛ in., L. P. ¼ in.
Lead of valves in full gear,	Line and line F. & B., ¼ in. lead at ½ stroke cut-off

Wheels, etc.

Diameter of driving wheels outside of tire	57 ins.
Material of driving wheels, centers	Cast steel
Tire held by	Shrinkage
Driving box material	Main, cast steel; balance steeled cast iron
Diameter and length of driving journals,	Main, 10 ins. by 12 ins.; balance, 9 ins. by 12 ins.
Diameter and length of main crank pin journals,	F. & B., 5 ins. by 4¼ ins., 7 ins. by 8 ins.
Diameter and length of side rod pin journals,	Main side, 8¼ ins. by 5½ ins.; inter., 5½ ins. by 5 ins.
Engine truck, kind	2-wheel swing bolster
Engine truck journals	7 ins. by 12 ins.
Diameter of engine truck wheels	30 ins.
Kind of engine truck wheels	A., T. & F. E. pattern, 3⅜ in. tire

Boiler.

Style	Extended wagon top, with wide fire-box
Outside diameter of first ring	78¾ ins.
Working pressure	225 lbs.
Thickness of plates in barrel and outside of fire-box,	13/16, 9/16, ⅝, 1 ins.
Horizontal seams,	Butt joint sextuple riveted, with welt strip inside and outside.
Circumferential seams	Double riveted
Fire-box, length	108 1/16 ins.
Fire-box, width	79¼ ins.
Fire-box, depth	F., 79½ ins.; B., 76½ ins.
Fire-box, material	Carbon steel
Fire-box plates, thickness,	sides, ⅜ in.; back, ⅜ in.; crown, 7/16 in.; tube sheet, 9/16 in.
Fire-box, water space,	front, 4½ ins.; sides, 4 ins. to 6½ ins.; back, 4 ins. to 5½ ins.
Fire-box, crown staying	Radial, 1⅛ ins. diam.
Fire-box, stay bolts	Ulster iron, 1 in. diam.
Tubes, material	Charcoal iron No. 11
Tubes, number of	413
Tubes, diameter	2¼ ins.
Tubes, length over tube sheets	18 ft. 6 ins.
Heating surface, tubes	4476.5 sq. ft.
Heating surface, fire-box	205.41 sq. ft.
Heating surface, total	4681.91 sq. ft.
Grate surface	59.47 sq. ft.
Ash pan, style	With air openings suitable for oil burning
Exhaust pipes	Single
Exhaust nozzles	5½ ins., 5¾ ins., 6 ins. diam.
Smoke stack, inside diameter	15⅝ ins.
Smoke stack, top above rail	15 ft. 6 ins.
Boiler supplied by,	2 injectors, Nathan Simplex No. 11 R. & L., outside of cab.

Tender.

Weight, empty	58,600 lbs.
Weight, loaded	134,900 lbs.
Wheels, number of	8
Wheels, diameter	33 ins.
Journals, diameter and length	5½ ins. by 10 ins.
Wheel base	20 ft. by 4 ins.
Tender frame	A., T. & S. F. standard steel channels
Water capacity	7,000 U. S. gals.
Oil tank capacity	2,250 gals.
Total wheel base of engine and tender	62 ft.

SALARIES OF MOTIVE POWER OFFICERS.

Because it reveals so many vital questions a recent remark by a prominent railroad president seems to us one of the most important which has come to our notice in a long time. In commenting upon the operation of the very heavy locomotives of to-day it was said that there is an increasing difficulty in securing the right sort of men to whom to entrust their handling. That there is any difficulty in finding men competent to operate the largest locomotives can only be the fault of the railroads, and this is a severe indictment of railroad managements in their treatment of their motive power problems generally. While this may not be a popular subject it should not be avoided.

In the six years ending with 1899 almost merciless retrenchment and strictest economy were necessary. Trains were cut down in number, runs were increased in length, the tonnage of freight trains increased, engines became larger and more was expected of train and engine men than ever before. During this time many records for economy were earned by operating officials, and altogether, of course, a great deal was accomplished in the line of improvement. The pooling system was generally introduced and annual average mileage increased. But a railroad officer says that he does not find many satisfactory men to run the big engines. Another says that in his entire lot of engineers, and he has a large number, he does not find many worthy of promotion. There must be a reason for these things if they are really true. If the men have been treated as they ought to be, and if the attitude of their employers toward them and their work has been what it should be, the question is a fundamental one and deeper than it appears.

There seems to be comparatively little inducement for engineers to put forth their best efforts, and this should not be lost sight of by those who are seeking records. When men were assigned to engines and took personal pride in their condition and appearance more engineers were promoted to higher positions and the inducements for good men to take up this work were greater. But now the tendency is toward making them mere machines to control other machines, and to this the pooling system contributes unless special care is put into its administration. In this case the engineer is used to introduce the real subject of this discussion.

With the concentration of power in large units and a tendency toward further increase in this direction the engineer should be improving. What inducement does he find in the condition of his immediate superiors? He sees a master mechanic in charge of 1,500 men, working under a salary of $2,000 a year, and another in charge of a division of a large system, which was formerly a whole railroad by itself, who draws $1,800 a year, and a mechanical engineer who is required to be a technical school graduate, having shop experience, at $1,000 a year. Worse than these is the case of the superintendent of motive power of a road of respectable size who for years has received a salary of but $3,000. It is to the everlasting credit of these men that their devotion and care of their work have enabled them to attain the splendid results which are seen on every hand.

These things may adjust themselves in time when they are appreciated and understood and there are signs of awakening as it becomes more and more apparent that the attractions of motive power life are not what they might be. A general uplift and improvement in the positions and encouragements of this entire department is necessary. We may learn something from England with reference to the motive power officer. There the chief locomotive officer is one of the best paid in the service, salaries being double and often more than double, those in this country and the positions are correspondingly important.

It is, furthermore, a poor reward for a faithful effort to permit a man in a subordinate position to strive for years to fit himself to succeed the head of his department only to find when the goal is reached that the salary of that position has shrunk, perhaps 25 per cent., when the opportunity came to take advantage of a new man. That this is the settled policy of one of the large roads is difficult to believe, but that this is the present practice of one of them is a fact. If a corporation actually desires to remain at a standstill as to improvements, the best way to indicate the policy is to discourage the officers and men, but of course no one intentionally establishes such a condition.

There is a well-grounded and growing belief that the commercial rating of brains of mechanical officers is too low, and that all is not done that might be done to attract to the railroad field the best mechanical skill. When a young division master mechanic can leave railroad for commercial work and step at once into a position financially equivalent to that of the general superintendent of the road he leaves, there is something wrong.

The best location of the office of the Superintendent of Motive Power, whether at the general office of the road or at the shops, is frequently a subject of discussion in visiting these offices, and it is a subject of considerable importance. A railroad officer should have his headquarters where he can best manage the affairs of his department. Some prefer to be near the principal shops, where they may easily keep in close touch with the problems continually arising in connection with repairs, and a great many are so located. There are equally strong arguments in favor of placing the general officers in intimate touch with each other, and this view appears to have the best support. In the past the importance of the functions of the head of this department in connection with repairs were relatively greater than they are now. Repairs are even more important since locomotives have become so big, but other functions have increased in importance to such an extent that this cannot now be said to constitute the chief care of the superintendent. With an efficient shop organization repair work may be even better managed if the chief is sufficiently removed to enable him to take general rather than direct supervision. The motive power superintendent to-day needs to be a business man and an engineer rather than an expert mechanic, although proficiency in mechanical work is, of course, highly desirable. He needs to be able to look above the shops to the broader principles of his work, in fact, to take a bird's-eye view of his department, and if he does this there is no danger of neglecting this branch. Furthermore, as his work affects all departments and is closely interwoven with them all he should be conveniently at hand for consultation. If he is at the shops, which are usually more or less distant from the general offices, he is not so likely to be consulted as often as he should be, with the result that often decisions in which he should have a part are made without him, and he must be heard afterward, and perhaps too late, if heard at all. This may put him in a very uncomfortable, as well as undignified position, which does not aid him in the administration of one of the most important departments of the road. It appears that those who favor placing him with or very near the other general offices have the stronger arguments. If the location of the shops interferes with this, the superintendent of motive power should be located in the general office headquarters.

Nowadays there are so many demands upon the runners of locomotives on fast trains that it is most important to provide in every possible way for the utmost economy of their attention. Schedules are growing faster and the service more severe in many ways. In inspecting a road recently equipped with an extensive application of automatic block signals, an apparent disregard of a vitally important factor was forced upon the attention, namely, that while there was no apparent desire to practice a crippling economy, comparatively few of the signals were located properly and many of them were so placed that they could be seen only when the approaching locomotive was almost upon them. This is not as it should be, and yet the serious character of the fault has probably escaped the notice of those who were responsible for the installation. On a crooked road, and this is a very crooked one, it is customary to use distant signals, working with the home signals where the latter must be located in the midst of sharp curves. This was done in this case, but as the distant signals were placed on the same masts with the home signals, they, to say the least, failed to correct the fault and remove the difficulty. The trouble is this: A signal which can be seen only from a certain point—as, for example, one located on a curve—fails in a large measure to fulfil its proper office as an aid to the engineer. If block signals must be placed on curves where they cannot be seen from a proper distance, they certainly should be provided with distant signals which are properly located. A properly located signal is one placed so that the enginemen can have as long a time as possible in which to take its indication and, in order to obtain their full value a great deal of care must be exercised in the location and sighting of signals. Those who are responsible for the discipline of the enginemen on the road in question should enter a vigorous protest against careless or hurried work in this important part of signal engineering. It would be advisable to insist upon having the locations determined by a committee upon which the locomotive department is represented. It would well repay motive power officers to thoroughly inform themselves as to the principles of signaling. They can easily acquire information sufficient to enable them to give valuable assistance in the planning of installations, and it is well worth their while to do so. The locomotive department suffers as much as, and perhaps more than, any other from an improperly located signal. A locomotive runner cannot do good work when he is obliged to spend a large part of his time watching for obscure signals, to say nothing of the danger of it.

RATE FIXING IN PIECEWORK.

In discussing the fundamentals of a bonus plan before the American Society of Mechanical Engineers, last December, Mr. Fred W. Taylor made the following pertinent observations, which have an important bearing on the establishment of all forms of piecework. He considered the rate-fixing department quite as important as the drawing room. "Fifty years ago," he said, "few engineering establishments had a drawing room, but it is now considered to be absolutely essential to the proper conduct of a manufacturing establishment, and it is safe to say that 30 years hence a rate-fixing department will be considered fully as essential to success as a drawing room. The objection that is usually made to this department is that it is an extra expense for which there is no return. But it must be remembered that the work which it does must be done somewhere. It is usually done in the shop on the spur of the moment by the man at the lathe or the foreman, who does not give it the proper consideration as to how the work is to be done. It stands to reason, then, that a man who devotes his whole time to the subject is better fitted to carry it on than a man who has it thrust upon him and must decide off-hand as to how he will do it. When a pump is to be built the men in the shop are not told to build a pump as it may please them, but the work is first designed and drawings are furnished. The same common sense principle will apply to rate-fixing and its attendant work of specifying the method of doing this work."

BOX CAR, 80,000 POUNDS CAPACITY.

American Railway Association Standard Dimensions.

Chesapeake & Ohio Railway.

These drawings illustrate a new box car with wooden sills and metal bolsters, built for the Chesapeake & Ohio, to drawings and specifications prepared under the direction of Mr. W. S. Morris, Superintendent of Motive Power. The inside dimensions are those adopted by the American Railway Association, and the design was prepared with a view of adapting underframes of steel, without materially disturbing the general features wherever such a substitution seems necessary. The most important dimensions are given in the following table:

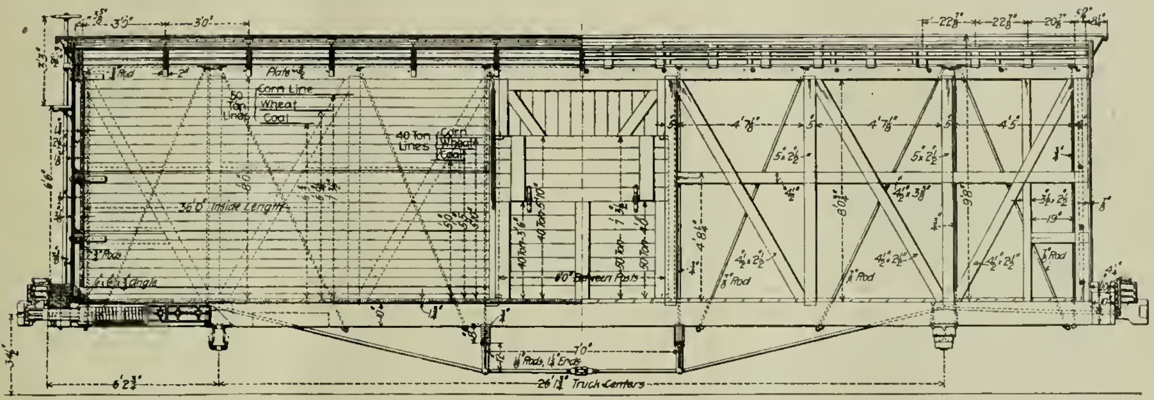
General Dimensions.

Length of framing over end sills	38 ft. 7¼ ins.
Length over siding	36 ft. 10¼ ins.
Length inside	36 ft.
Length over running boards	38 ft. 2¾ ins.
Width over side sills	9 ft. ¾ in.
Width over siding	9 ft. 2½ ins.
Width inside	8 ft. 6 ins.
Width of door opening	6 ft.
Height between sill and plate	8 ft. ¾ in.
Height from floor to under side of carline	8 ft.
Height from rail to top of running board	12 ft. 11¾ ins.
Height from rail to top of brake shaft	13 ft. 10¼ ins.
Height from rail to eaves (at center, cambered)	12 ft. 1⅛ ins.
Height from rail to eaves (before cambering)	12 ft. ¼ in.
Height from rail to center of coupler (after cambering)	2 ft. 10½ ins.
Height from rail to center of coupler (before cambering)	2 ft. 10⅞ ins.
Center to center of trucks	26 ft. 1¾ ins.
Center to center of tie beams	7 ft.

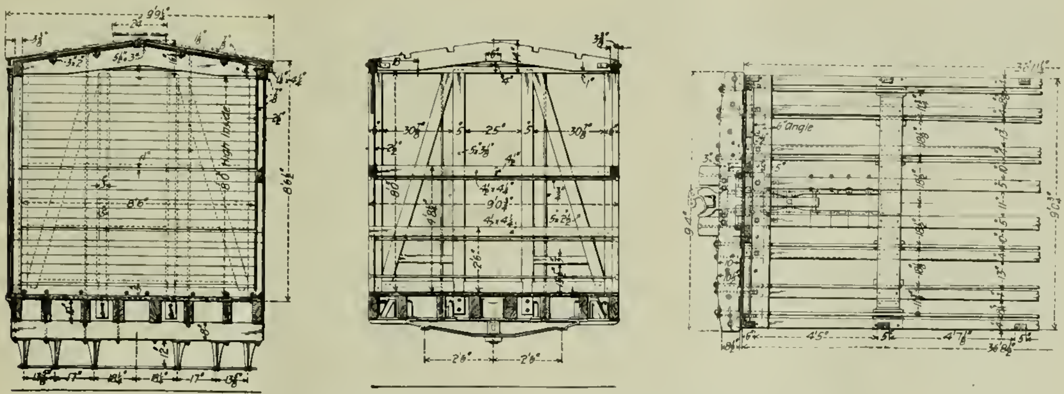
There seems to be a doubt as to just what the important minimum clearances of the country are, but this will probably be thoroughly settled before the M. C. B. Convention next summer. In the meantime cars will be built to bring the eaves as low as practicable. In this case the trucks have straight top "arch bars" and the coupler shank passes through the end sill.

The sills are as follows: Two side sills, 4 by 10 ins.; 2 center sills, 5 by 10 ins.; 2 intermediate sills, 4 by 10 ins., and end sills 10 by 14 ins., with end sill caps of 4¼ by 10½-in. oak. The drawings show the dimensions of the other important timbers.

A 4¼ by 10½-in. white oak end sill cap is placed on top of the end sill and the end sill is cut out for the coupler chafing iron. Inside of the end sill cap is a 6 by 6 by ¾-in. angle sill brace, 9 ft. ¾ in. long, bolted to the longitudinal sills and to end grain piece, which is beveled at the top. The couplers have 5 by 7-in. shanks, and the draft gear, which is the Miner, is secured between the center sills. The draft arms butt against a substantial bracket on the body bolster, which extends upward 8½ ins. between the center sills. Chicago grain doors and roofs are fitted to these cars. They have Westinghouse brakes and cast-steel bolsters and National hollow brake beams.



Half Longitudinal Section and Elevation



Sections and Partial Plan, Showing Underframing

Box Car, 80,000 Pounds Capacity—Chesapeake & Ohio Railway.

West Virginia University, Morgantown, W. Va., has received from the Baltimore & Ohio R. R. a gift of a 38-ton passenger locomotive of the 10-wheel type for experimental purposes. The locomotive has been placed in the new mechanical building, and will be mounted in a locomotive testing plant when the other equipment of the new laboratory is installed.

NEW LOCOMOTIVE SHOPS.

Central Railroad of New Jersey.

At Elizabethport, N. J.

A ground plan and details of the construction of the buildings of this plant were presented on page 340 of the 1901 volume of this journal. We now give a description of the equipment of the locomotive shops, which were built to maintain 450 locomotives. When the car shops are completed 8,000 coal cars, 8,000 other freight cars and 500 passenger cars will also be maintained here, and the present power house will serve for both departments.

Locomotive Shop.

This building is 150 by 700 ft. in size, and combines in three bays under one roof the erecting, machine and boiler shops. The erecting shop is 82 by 700 ft., with three longitudinal tracks and pits, arranged in three lengths, as shown in the plan. The pit nearest the machines is the shortest. This was done to avoid cutting up the floor for the entire length of the shop on all three tracks. Three lines of engines may be accommodated on the tracks and perhaps others on trestles between, the spacing of the tracks being 22 ft. from center to center. For vise work, very strong portable benches are used. They are not bolted down, and may be moved anywhere by the cranes. In dotted lines the main pipe tunnel is indicated in the plan. This extends the full length of the shop between the machine and erecting floors, with branches to the power house and blacksmith shop. The tunnels are 4 ft. wide and 5 ft. deep, of concrete construction.

The erecting shop is spanned by two 80-ft. 50- ton cranes, with 35-ft. clearance under the hooks. Two 35-ft. bays provide for the machinery. In the central bay all the heavier machinery is placed where it is served by a 10-ton and a 5-ton traveling crane. The lighter tools in the outer bay are served by hand cranes where these are necessary. A large monitor over the erecting floor and about half the areas of the two sides, of translucent fabric, furnishes natural light through the roof. The rest of the roof is of 3-in. yellow pine, covered with tarred gravel. The floor of this building begins with a 12-in. layer of cinders covered by 6 ins. of concrete, supporting 4 by 4-in. sleepers at 2-ft. centers, the spaces between which are filled with concrete, and these take flooring of 3 by 3-in. yellow pine.

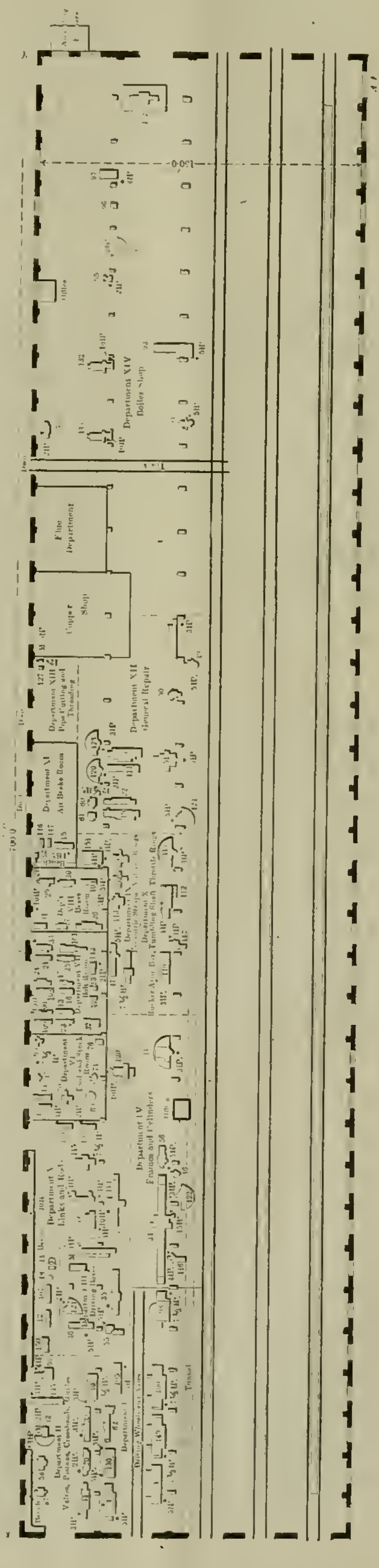
The machine tools are grouped in accordance with the work, with a view of economy in the transfer of material and parts. In the large plan drawing the motors are located and the sizes noted. An unusually large number of individual motors are used, and the number of group drives is correspondingly small. There are 18 group drives and about 70 individual motors, all on direct-current with rheostatic control. The "floating" tools have no foundations, they carry their own motors, and connections to the mains may be made at any desired location by plugs. About 5/8 of the motors are belted to the machines and the rest drive through rawhide pinions.

The boiler shop is equipped with oil furnaces, and a large annealing furnace outside of the building. The riveters are all operated by compressed air, the largest having a 16-ft. gap. A special 40-ton electric crane serves this riveter and provides 45 ft. clear space under the crane. The riveting tower covers a nearly square space at the end of the boiler shop, taking in two posts from the end wall and extending across the full width of the main machine bay.

The heating system uses exhaust or live steam, the fans taking air from the building and after passing it through the heaters delivers it to concrete tunnels under the floor. These extend along the outside walls, the discharge being through galvanized outlets 10 ft. from the floor and 20 ft. apart.

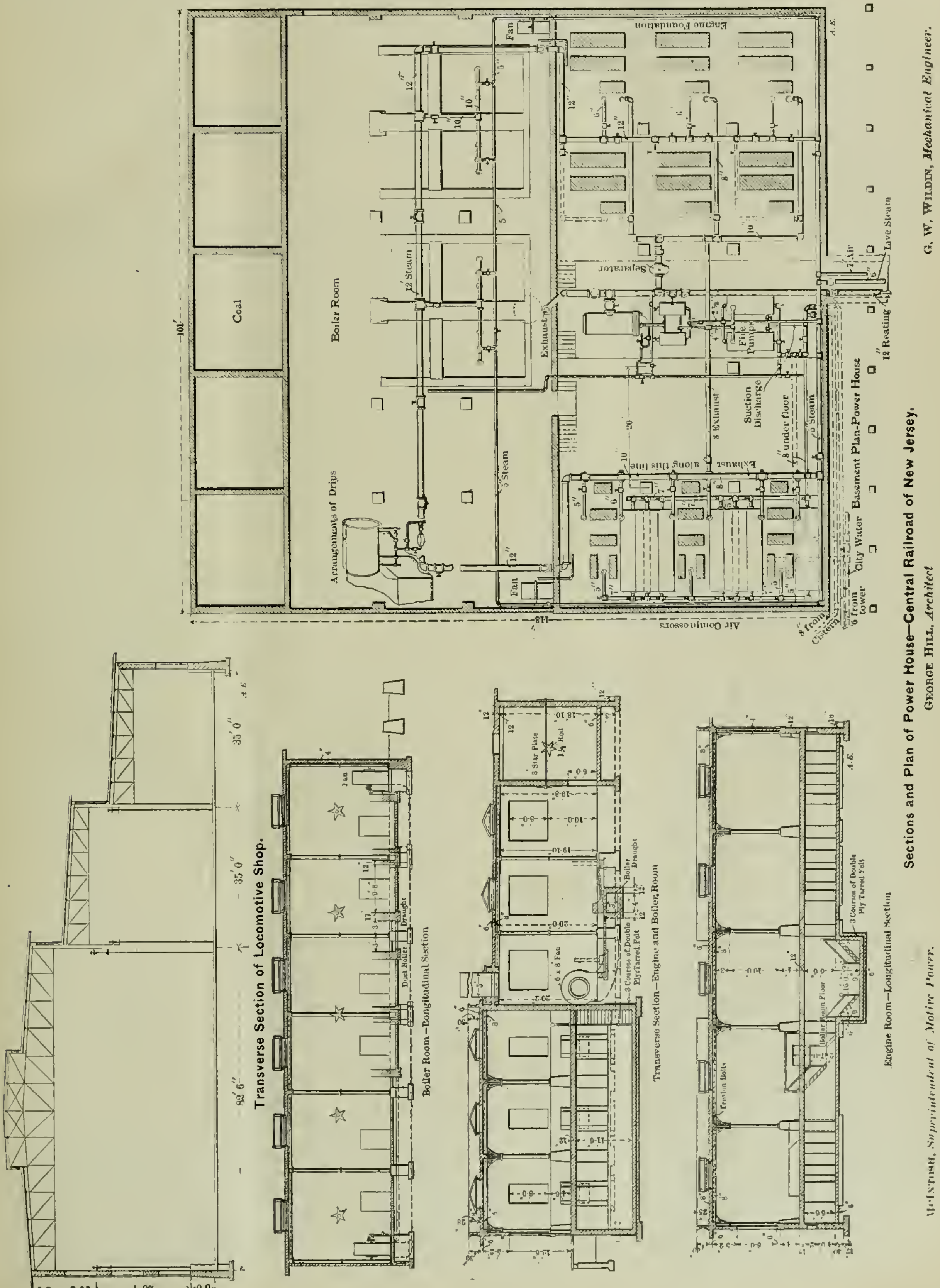
Power House.

This building is entirely of concrete, including the roof. The power equipment consists of three 100-kw. direct-current generators at 240 volts, with spare spaces for three more. The



Plan of Locomotive Shop.

Central Railroad of New Jersey—At Elizabethport, N. J.



Transverse Section of Locomotive Shop.

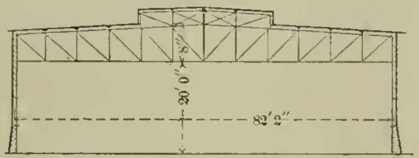
Sections and Plan of Power House—Central Railroad of New Jersey.

GEORGE HILL, *Architect*

G. W. WILDIN, *Mechanical Engineer.*

MCINTOSH, *Superintendent of Motive Power.*

generators are direct connected, of the Lundell-Sprague type, the generators being at a ratio of 30 per cent. of the power of the motors. No deduction is made for the crane or fan loads and the lighting load is figured separately. The engines are by Ball & Wood, with 16 by 16-in. cylinders, of 175 horse-power and running at 275 revolutions with a steam pressure of 100 lbs. Three engines are installed and spaces are provided for three more. They are placed on the fonndations at the right in the power house plan. The engines have frames which would normally be used with 18 by 18-in. cylinders, and other parts in proportion. This strength was provided to deal safely with the peak of the load if two cranes are used simultaneously in addition to the other loads, and to do this with a cut-off of ⅝ of the stroke of the engines. With this method



Transverse Section of Blacksmith Shop.

used to equalize the air pressure and save the expense of larger mains. There are three mains extending the whole length of the shop, and in addition a 2-in. main the full length of the middle pit.

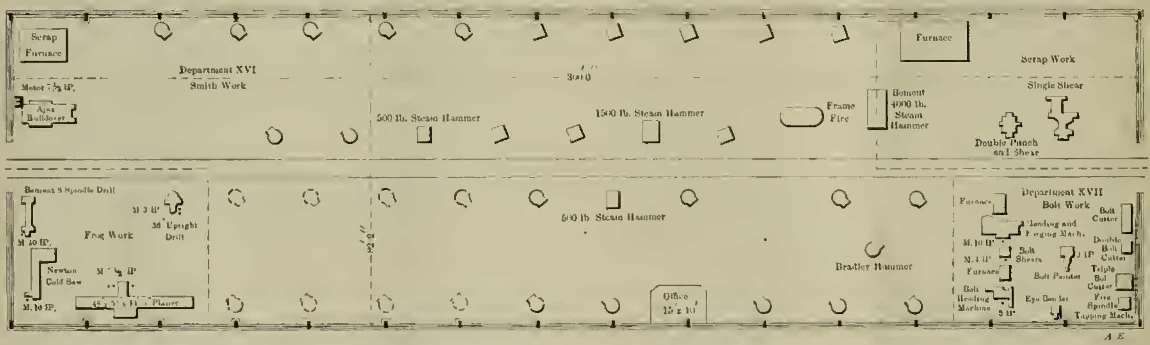
The cranes are given important duty in this plant, in fact, the machinery arrangement is hinged on getting everything to the cranes for movement to any desired part of the shop. Auxiliary hoists are provided, and the large cranes have a clearance of 35 ft. under the hooks, while the smaller ones have 25 ft.

Blacksmith Shop.

This building is 82 by 300 ft. in size, and has a reserve capacity for the car works, which must be provided for later. Its equipment is stated in the list of tools, and a glance at the floor plan shows that it includes a forge, a scrap, a bolt and a frog shop. A track runs through this shop lengthwise and connects with the yard through the transfer table. In the drawing two sizes of forges are indicated.

Other Features.

Transfer Table.—This table is 80 ft. wide, and the complete runway will be 800 ft. long. The speed will be 125 ft. per minute when fully loaded and 275 ft. when light. It will be used for the locomotive and car departments, and owing to



Blacksmith Shop—Central Railroad of New Jersey.

it is easy to increase the power of the engines by using larger cylinders.

There are two 500 h.-p. standard Babcock & Wilcox boilers, with space for one more. They are operated by forced draft on the closed ashpit system, with a sheet-iron stack 5 ft. in diameter and only 25 ft. high. The draft is supplied through an underground duct. Rice coal will be used. It will be dumped into bins of about 300 tons capacity at the end of the power house, discharging into the boiler room. A conveyor will handle the coal.

The switchboard has three generator panels, one for lighting and one for power circuits. Circuit breakers are provided for all circuits carrying 200 amperes or more, the others having fuses. The limit of circuit in the entire switchboard construction is 750 amperes per square inch of section, rolled copper being used exclusively for bus-bars and switches. A recording wattmeter is supplied to each generator.

The piping is arranged as indicated in the engravings of the power house, the boiler header being a 12-in. pipe running into the engine room on both sides. The exhaust is piped through a 4 by 6-ft. tunnel to the locomotive shop for heating, the main pipe being 12 ins. Through the tunnel there is also a 6-in. high-pressure pipe for boiler testing and steam hammers. In the basement of the power house the piping is supported on pipe stands and the wiring is attached to the ceiling, which leaves the floor of the engine room free from obstruction.

The two air compressors, made by the Ingersoll-Sergeant Company, have a combined capacity of 2,000 cu. ft. of free air per minute. They discharge into storage tanks, and are of the single stage type. Along the air pipe six 4 by 12-ft. tanks are

the plan of the plant, will be a vital feature of its operation. We do not know of a larger table than this. Its capacity is 200 tons and it is carried on 16 wheels on eight tracks laid on 18-in. concrete walls, which rest on concrete foundations 18 ins. thick and 5 ft. wide, with expanded metal in their bases. Power is supplied to two 25 h.-p. direct-current motors by a trolley at one end of the table. Locomotives and cars will be warped on and off of the table by winding drums.

Steel baskets, adapted for handling by the cranes, will be used for transportating, cleaning and storing the parts removed from engines. These may be placed bodily in the cleaning vat and the parts kept in them until wanted. For communication with the tool room a pneumatic tube service will be installed. Tools will be ordered by numbers and will be kept in good condition in the tool room. Expanded metal lockers for the men will be placed in convenient locations.

The machine tools were furnished by Messrs. Manning, Maxwell & Moore.

For convenience in reference they are listed in the various subdivisions of the shops as follows:

List of Machinery in Detail.

Department I.—Wheels and Axles.

No. 1, 72-in. tire lathe; No. 149, 90-in. wheel lathe; No. 100, 90-in. wheel lathe; No. 48, 8-ft. boring mill, with slotter; No. 4, Niles tire lathe; No. 130, quartering machine; No. 62, 84-in. wheel press; No. 10, 30-in. by 12-ft. lathe; No. 105, 42-in. by 14-ft. lathe.

Department II.—Valves, Pistons, Crossheads, Guides.

No. 67, No. 1 cotter drilling machine; No. 58, 8-in. slotter;

No. 42, 48-in. radical drill; No. 145, Brown & Sharpe surface grinder; No. 57, 14-in. slotter; No. 11, 24-in. by 16-ft. lathe; No. 20, 28-in. by 12-ft. lathe; No. 39, 24-in. by 24-in. by 8-ft. planer.

Department III.—Driving Boxes.

No. 36, 24-in. by 24-in. by 6-ft. planer; No. 121, 30-in. drill press; No. 65, small hydraulic press; No. 40, 24-in. crank planer; No. 55, 36-in. car-wheel borer; No. 35, 36-in. by 36-in. by 10-ft. Pond planer; No. 7, 36-in. by 16-ft. engine lathe.

Department IV.—Frames and Cylinders.

No. 34, 60-in. by 60-in. by 25-ft. Pond planer; No. 116, 24-in. crank planer; No. 122, 40-in. drill press; No. 46, 36-in. upright radial drill; No. 56, cylinder boring machine; No. 129, 24-in. slotter; No. 119, No. 3 Bickford radial drill.

Department V.—Links and Rods.

No. 150, 12-in. by 42-in. grinder; No. 12, 18-in. by 8-ft. lathe; No. 107, 18-in. by 8-ft. engine lathe; No. 48, 4-ft. spindle cotter drill; No. 44, 40-in. upright drill; No. 59, 16-in. traveling head shaper; No. 114, slab milling machine for boring; No. 115, vertical milling machine; No. 102, 36-in. turret lathe; No. 104, Gisholt turret lathe.

Department VI.—Tool and Stock Room.

No. 18, 14-in. by 5-ft. tool room lathe; No. 14, 18-in. by 8-ft. lathe; No. 47, 13-in. friction drill; No. 66, tool grinder; No. 70, No. 2 universal milling machine; No. 69, Cincinnati cutter and reamer grinder; No. 71, Washburn twist drill grinder; No. 76, nut facing machine.

Department VII.—Bolt Room.

No. 109, 18-in. by 8-ft. engine lathe; No. 106, 18-in. by 8-ft. engine lathe; No. 108, 18-in. by 8-ft. engine lathe; No. 24, 20-in. by 8-ft. lathe; No. 21, 20-in. by 10-ft. lathe; No. 33, No. 2 lathe; No. 23, 22-in. by 8-ft. lathe; No. 13, 18-in. by 8-ft. lathe; No. 16, 16-in. by 6-ft. lathe; No. 17, 16-in. by 6-ft. lathe; No. 25, 16-in. by 8-ft. lathe; No. 101, 2 by 24-in. flat turret lathe; No. 32, universal lathe; No. 77, bolt centering machine; No. 143, 1-in. triple Acme bolt cutter; No. 28, 16-in. by 4-ft. Fairbanks lathe.

Department VIII.—Brass Room.

No. 31, 16-in. by 6-ft. Monitor brass lathe; No. 29, No. 3 Monitor brass lathe; No. 27, 12-in. by 5-ft. universal speed lathe; No. 30, No. 3 Monitor brass lathe; No. 26, 24-in. by 12-ft. lathe; No. 103, 18-in. Fox lathe.

Department IX.—Eccentric Straps, Valves and Rings.

No. 37, 24-in. by 24-in. by 8-ft. planer; No. 118, 36-in. by 36-in. by 10-ft. planer; No. 113, 34-in. vertical boring mill; No. 52, 39-in. boring mill; No. 53, 39-in. boring mill.

Department X.—Rocker Arms, Boxes, Tumbling Shafts, Throttle Valves.

No. 110, 42-in. by 14-ft. engine lathe; No. 117, 24-in. crank planer; No. 112, horizontal boring machine; No. 41, No. 3 Bickford radial drill.

Department XI.—Air Brake Room.

No. 82, angle-cock grinding machine; No. 146, 20-in. wheel and lever feed drill; No. 147, 20-in. wheel and lever feed drill; No. 15, 18-in. by 8-ft. lathe.

Department XII.—General Repairs.

No. 61, 8-in. shaper; No. 60, 16-in. shaper; No. 19, 36-in. by 16-ft. lathe; No. 22, 25-in. by 14-ft. lathe; No. 120, 30-in. drill press; No. 123, 40-in. drill press; No. 111, 42-in. by 16-ft. engine lathe; No. 9, 30-in. by 14-ft. lathe; No. 51, 80-in. boring mill; No. 50, 48-in. drill press; No. 49, 48-in. drill press; No. 8, 33-in. by 18-ft. lathe; No. 124, 40-in. drill press.

Department XIII.—Pipe Cutting and Threading.

No. 127, pipe threading machine; No. 128, Curtis pipe threading machine.

Department XIV.—Boiler Shop.

No. 73, 1½-in. Acme single bolt cutter; No. 133, 54-in. throat single punch; No. 132, 54-in. throat single punch; No. 95, small punch; No. 43, 42-in. radial drill; No. 96, suspended drill; No. 97, flange punch; No. 94, double punch and shear; No. 93, 10-ft. boiler rolls; No. 142, 16-ft. pneumatic riveter.

This machine list includes six "floating" tools, so-called because they are intended for moving about by the cranes to meet special demands in any of the departments. These are 24-in. crank planers with 4-h.-p. motors and 40-in. drill presses with 3-h.-p. motors.

In the plan of the blacksmith, frog, scrap and bolt shops the machines are all indicated, rendering the numbering unnecessary. These machines are as follows: Ajax bulldozer, two 500-lb. steam hammers, one 1,500-lb. steam hammer, one Bradley hammer, one Bement 4,000-lb. steam hammer, Bement 8-spindle drill, Newton cold saw, 48 by 54-in. by 14-ft. frog planer, 36-in. upright drill, a single shear for scrap, a double shear, three bolt cutters, a 5-spindle tapping machine, an eye bender, bolt pointer, heading and forging machine, bolt shears and bolt-heading machine.

For the drawings and information concerning these shops we are indebted to Mr. Wm. McIntosh, Superintendent of Motive Power of the road, and to Mr. George Hill, Architect and Engineer, who designed and constructed the plant.

TESTS ON CENTER PLATES AND SIDE BEARINGS.

In discussing center plate friction before the Western Railway Club recently, the results of tests made by Mr. L. H. Turner, Superintendent of Motive Power of the Pittsburgh & Lake Erie, were quoted. The object was to determine the relative amounts of friction in a ball-bearing center plate and side bearing, as compared with flat plates and bearings now commonly used in freight car service. The ball-bearing plates and side bearings were made of malleable iron. In the truck center plate were four pockets, the center line of which was a circle 6 or 6½ ins. in diameter. The pockets were ¼ in. deep at the center and tapered out to nothing at the ends. In each pocket was a 2¼-in. steel ball. The body center plate had a continuous groove ¼ in. deep, the center line being a circle of the same diameter as that on which the pockets were spaced in the truck center plate. The truck side bearing contained a pocket 15 ins. long, ¼ in. deep in the center, and tapering to nothing at the ends. In each truck side bearing was a 2¼-in. steel ball. The body side bearing contained a groove similar to that of the body center plate.

This arrangement was applied to a 60,000-pound flat bottom gondola car in June, 1897. In the latter part of October, 1900, after having been in service practically 3½ years, this car was brought to the shops and the trucks were removed. A very close examination was made of the trucks, and it was impossible to see that any wear had taken place in the flanges of the wheels; they were apparently as good as the day the wheels were placed in service. During this service the car had made a mileage of 11,323 miles and carried 226,440 tons.

These results proving satisfactory, it was then determined to ascertain, if possible, what decrease in friction was due to this arrangement over that in the ordinary flat plates. A turntable, 7 ft. long, was constructed, and one end of this car loaded to its maximum capacity was run on to it. By means of a spring dynamometer it was easy to determine the number of pounds necessary to deflect the truck. The tests gave the following results:

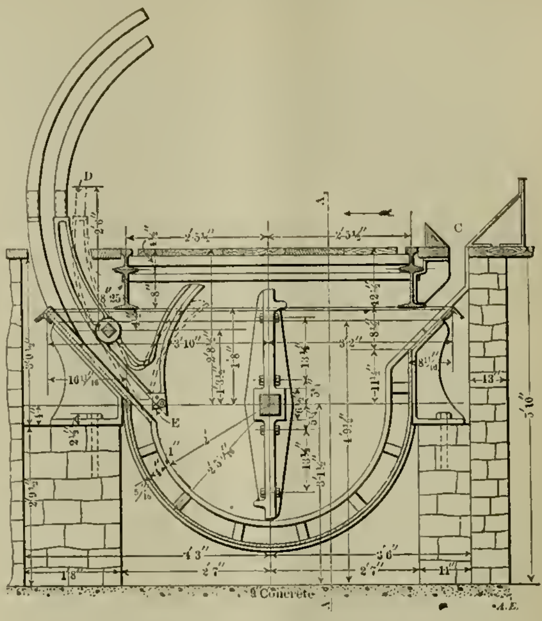
First Test.		
Plain center plates and side bearings, with ⅛-in. deflection of the body bolster resting on the truck side bearings. Pounds pull necessary to deflect the truck	800 lbs.	100%
Second Test.		
Plain center plates, without side bearings. Pounds pull to deflect the truck........	275 lbs.	34%
Third Test.		
Ball-bearing center plates, and side bearings with ⅛-in. deflection of body bolster resting on the truck side bearings. Pounds pull to deflect truck........	75 lbs.	9%
Fourth Test		
Ball-bearing center plates and without side bearings. Pounds pull to deflect truck........	75 lbs.	9%

Since this experiment was made a number of all-steel gondolas of 95,000 lbs. capacity have been equipped with these bearings, and the results will be looked for with interest.

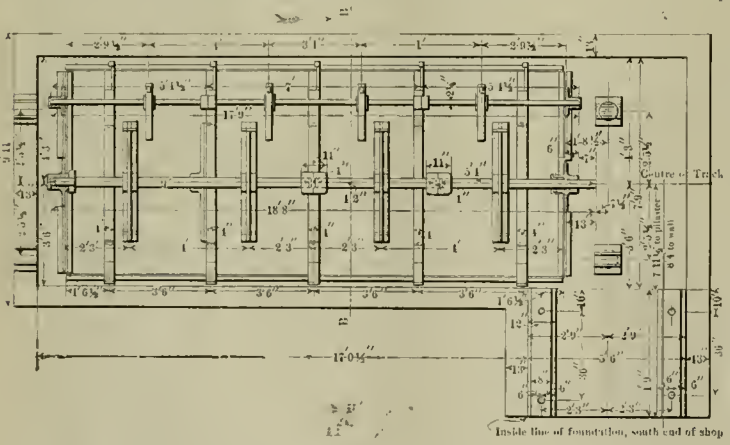
A NEW FLUE RATTLER.

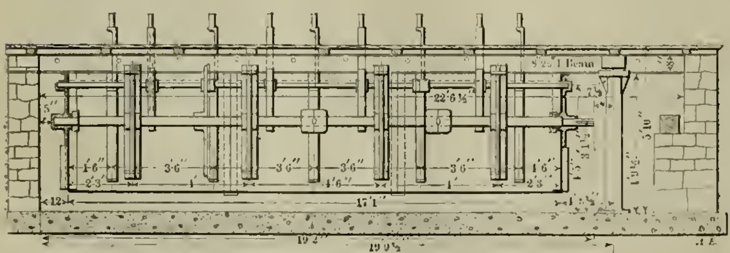
Chicago & Northwestern Railway.

At the West Chicago shops of the Chicago & Northwestern Railway the boiler plant is equipped with a novel flue rattler which is giving excellent results. A shell of 5/16-in. tank steel is supported by castings in a masonry pit, which has an extension at one end for the link belt driving mechanism. Inside of this half cylindrical shell are five 1 by 4-in. rings supported by the shell on thimbles. These rings receive the fall of the tubes as they are lifted and dropped by four revolving arms. The shell is filled with water, which renders the rattler dustless, and when covered over by a plate roof the operation is also noiseless. These are great advantages over the usual forms of flue rattlers. The car carrying the tubes to be cleaned is received on the track over the rattler, the mechanism being sufficiently depressed to receive two tracks on a level with the ground. By pushing the tubes off at the right-hand side of the car, as shown in the sectional view, the tubes fall into the rattler at C, and the operation of cleaning begins. The guides, D, are closed, as shown in the dotted position, while the work is being done. After three or four hours, during which the machine requires no attention, the guides, D, are turned on their pivots and an opening is made whereby the lower layer of tubes is carried out of the machine at the left-hand side. Pawls or latches, shown at E, hold the last tube, and the process of unloading the machine is completed by a few turns of the arms. By the curved arms the discharged tubes are loaded upon the car, except a few at the last, which are taken out of the guides by hand. By turning the guides through 180 degs. on the squared positions at D, the tubes may be discharged to another car on a second track at the left-hand side of the machine if desired. The machine holds 200 tubes, and at the present rate of working, about 6,000 tubes per month are cleaned while operating but two-thirds of the time. In addition to cleaning the outside of the tubes the soot is thoroughly removed from the inside, and the attendant also attends to all the testing of the tubes. A speed of about 10 revolutions per minute seems to be most satisfactory. Tubes of 1½ to 1¾ ins. in diameter may be put through this rattler. The wear from the tubes comes upon the rings already mentioned.



Section B-B Looking in Direction of Arrow.





Section A-A Looking in Direction of Arrow,

A New Flue Rattler Chicago & Northwestern Railway.

This machine was designed and patented by Mr. H. O. Westmark, draftsman in the motive power department of the Chicago & Northwestern Railway at Chicago. In the Chicago & Northwestern shops the tubes are lifted out of the rattler by the traveling crane, which is the most convenient method there, because the rattler is located inside the shop.

A pneumatic tube system for delivering parcels is in successful operation in Boston. From the main station at Essex street and Harrison avenue, in the retail store district, parcels are sent 1½ miles to the "Back Bay" station and one mile to the "South End." There are two lines of common cast-iron pipe 10-in. in diameter. These are not bored out, but the joints are carefully smoothed and laid like water pipe. The carriers run on five small wheels at each end which have stood service tests of more than 8,000 miles. With this construction no packing is required, and this is the greatest improvement embodied in this application. Very simple transmitters and receivers are used and a pressure of 2 lbs. per square inch is sufficient to give a speed of 30 miles per hour. Air power is supplied by a motor-driven 24 by 12 in. Rand compressor. From the description in "Engineering News" of December 5, 1901, this appears to be a distinct advance over previous pneumatic transmission methods.

TONNAGE RATING ON RAILWAYS.

Methods of the Canadian Pacific Railway.

Use of the Dynamometer Car.

By J. W. Harkom, M. Can. Soc. C. E.

Much attention has been given of late to the rating of locomotives by tonnage, with greater or less advantage. At the January meeting, 1901, of the New York Railway Club, Mr. Tait, of the Canadian Pacific Railway, read a paper on the subject and gave illustrations of the system established by him, which resulted most satisfactorily, increasing the average train loads and eliminating to a very great extent trouble by trains stalling, and also affording a basis for checking and comparing on an equivalent basis the performance on different divisions for the same and corresponding periods. This system has been thought by some to be elaborate and cumbersome, but when it is stated that no additional labor was found necessary and no extra delay was caused in preparing the trains for despatch from terminals, it will be seen that the advantages above mentioned were valuable aids to efficient service.

Rating Locomotives.—The system, as far as the car handling is concerned, was fully dealt with in the paper by Mr. Tait, but the classification of locomotives was not treated. In considering the advantages to be derived from a system of tonnage rating it was at once seen that a correct comparative rating of the locomotives must be first established. This was done first on a theoretical basis and loads set, the results causing further investigation to be determined upon and frequent practical tests were made, their results being compared with the theoretical power, which latter was calculated by the formula of the Master Mechanics' Association. Comparisons were made with the weight on driving wheels, with the result that while in various builds of locomotives of the same class the theoretical power was frequently at variance with practical results, the weight on drivers nearly always bore a constant relation to the results of the tests. These tests were made with a dynamometer car fitted with coiled springs, which repeated calibration showed to be extremely accurate, and the record, automatically made, showed speed and drawbar pull, together, affording a ready means of arriving at conclusions.

To any about to enter on work preliminary to establishing such a system, it is suggested that the locomotives be classified for freight service altogether by the power exerted on the drawbar behind the tender, leaving out entirely all calculations as to the work done by the locomotive to move itself, that being for practical purposes no advantage to the operating department. It will be conceded by everybody that the load a locomotive can haul is its measure of value to its owners, and the greatest load which it can steadily haul past a certain point at a defined speed is that measure.

In classifying the locomotives a piece of track embodying in its features those of the maximum grade and curvature should, if possible, be selected and the minimum speed at which the traffic is desired to be moved decided upon, and representatives of every class of locomotive should be tested there. Having done this, the dynamometer record of drawbar pull at the speed at which it is desired shall be the minimum when passing selected points will give the data for rating.

As a basis of comparison of power of locomotives, a unit of 1,000 lbs. pull on the drawbar at the minimum desired speed should be established, and it is suggested that, say on a 7, 10, 15 or 20-mile basis, a locomotive that will exert 1,000 lbs. on the drawbar shall be rated as of 5 per cent. capacity, so that 20,000 lbs. shall be 100 per cent., thus admitting all present classes of locomotives being rated with, say, 5 per cent. variation, and that is the basis on which they should be purchased and sold. There are many locomotives which can start a big train, but whose boiler capacity will not allow them to sustain the effort. Again, there are others which are cylindered altogether above the efficient work to be got by the weight on drivers with more or less efficient boilers.

The system of classifying by drawbar pull eliminates all arguments as to merits of this or that make or style. When it is remembered that whether the motive power be steam or electricity the tractive power is limited by the weight on drivers, but is also dependent on two other factors, viz.: Machinery power, varied by size of cylinders, driving wheels, etc., and boiler power to supply the machinery, and the weakest engine fixing the power, it must be clear that measurement by drawbar pull is the best basis for classification, it being capable of direct and definite determination. The result would then be shown in an index giving the numbers of all locomotives and their capacity, and the heading of haulage tables would correspond to the capacities of the various locomotives in service on the section for which table is compiled.

Fixing Loads.—Having fixed the relative capacities of locomotives, next comes the determination of loads on each district. The use of an ordinary profile to determine the load a locomotive should haul over any section is an unsatisfactory method, and the value of momentum of the train, which is sometimes calculated very elaborately, is under no method so clearly shown as by a dynamometer car recording drawbar pull and speed together, as by it, taking advantage of the momentum where practicable, the "virtual" grade is arrived at.

In reading these records marginal notes, made at the time the record is made, should be taken to avoid errors, as for instance, in case of a train passing over a sharply defined summit of a grade in, say, a rock cut, the locomotive having passed the summit will suddenly exert an increased and unnecessary power which will be recorded; therefore, the exact points of summits and bottoms of grades, also commencement and end of curves, should be carefully noted, in order that incorrect deductions may be avoided.

It is not advisable to depend on one trip over a section to fix a load, but after noting results with one load additions or reductions should be made on another train, the dynamometer recording whether the locomotive is exerting its proper power and the correct speed is maintained.

Equivalent System to Meet Varying Classes of Tonnage.—All the above is correct for any constant class of traffic where cars are of the same character and weight, and similarly loaded, but when trains are made up, as in the case on most railroads of varying classes of cars and freight, then there comes into prominence the necessity of some system which will afford a means of making up the trains so that the locomotives may in their several capacities be loaded fairly and give the best average results in time and fuel used on each trip.

To illustrate the difference in power required to move the same actual tonnage in similar cars with different classes of freight we will assume a train of 40 box cars weighing 30,000 lbs. each, loaded to their full capacity of 60,000 lbs. with grain, making a total weight of 1,800 tons, or 45 tons per car gross weight, which it is found is just the load a locomotive exerting its full power can take past a certain point at a defined speed. Then assume the same class and build of cars loaded with hay, the weight in each car being only 20,000 lbs., or 25 tons per car, gross weight. To get 1,800 tons actual weight of train will require 72 cars. These trains are of the same actual weight, yet it takes a practical railroad man no time to determine that the 72-car train is too heavy for the locomotive which can just haul the 40-car train under the conditions specified.

It is clear, therefore, that if the tonnage load is fixed by the heavily loaded cars the other train would stall and embarrass the traffic, or, if fixed by the tonnage that the lightly loaded car train can haul there would be a loss in case of the heavily loaded cars. To leave the loading to the discretion of employees or officials, whether trainmen or yardmasters, would result in confusion. Somewhat similar objections present themselves when trains are made up by cars instead of tonnage

Canadian Pacific Method.—There have been many attempts to arrive at a system by which trains may, under the varying conditions noted above, be made up to get the best results, but that which the Canadian Pacific Railway has adopted and styled the "Equivalent," is the one best adapted for universal use. The term Equivalent signifies that each train is made up of tonnage equal to a fixed schedule and the basis on which it is founded is that of the tonnage of cars loaded with two tons of freight to one ton of cars.

The next thing to note is that compared with a "two to one" car, an empty car pulls, per ton, much harder. Under certain conditions a ton of empties will pull 30 per cent. harder than a ton of "two to one" loads, and an empty car train of 1,800 tons would pull equal to 2,340 tons of such cars as the 40-car train of 1,800 tons above referred to.

It will be at once remarked, "But that 30 per cent. is not true for all conditions." That is quite true, but it is very peculiar how nearly 30 per cent. averages correctly on roads with grades between 0.5 and 1 per cent. Careful tests made go to show that on level track empty cars pull per ton as high as 70 per cent. harder than loaded of "two to one," while on grades as high as 1.67 per cent. the difference on straight track comes down to 16 per cent. But here comes again trouble, for there are few grades without curves, and these will generally be found very near the summit, and always are the hardest places to get a train past. On a 2° curve on 1.67 per cent. grade the increased power required per ton to move empties compared with "two to one" loads comes up to 22 per cent. It is the uncertainties which curvature and grades in their every-day occurrence infuse into theoretical calculations which makes the use of a dynamometer car the best method of determining a load for locomotives.

Many persons have noted that cars with pressed steel trucks pull harder than those of older construction. The writer found on 0.5 per cent. straight track empty cars with pressed steel trucks pulled 36 per cent. harder than the same cars loaded "two to one," while with ordinary cars under the same conditions the difference was 30 per cent. On 1 per cent. straight tracks the difference with ordinary cars was 26 per cent., and on 1 per cent with 3 degree reverse curve, 38 per cent. These instances are given to show how closely a 30 per cent. equivalent will average on grades between 0.5 per cent. and 1 per cent. under average conditions.

The Canadian Pacific Railway has lately put into force on various sections 10 per cent. and 20 per cent. equivalents to meet the varying conditions of grades, the result being satisfactory, the 20 per cent. having been used on grades of from 1 per cent. to, but not including 2 per cent. and the 10 per cent. equivalent on grades of 2 per cent. and over. Using different equivalents will offer no difficulty, as all that has to be done in making up trains is to use the desired chart, a specimen of which is contained in the Proceedings of the New York Railway Club of January, 1901.

The total quantity of coal taken in any given year from the mines of the whole world cannot be very accurately ascertained, but from the best available information, according to "Cassier's Magazine," it may be assumed to have been about 700,000,000 tons of 2,000 lbs. each for the year 1900, the last of the nineteenth century. Assuming that the combustion of 1 lb. of coal produces available energy equal to the work of one horse for one hour, and that a horse-power is equal to the power of seven men, it is found that this represents in energy the equivalent of 9,800,000,000,000 hours of work for one man, and allowing 10 hours to each day and 300 working days to the year, this is found to be equal to the work of 3,000 millions of men during one year. This is about double the entire population of the globe, and it follows that the utilization of the energy of combustion is equivalent to an increase of the working capacity of this population to the extent of an addition of two able-bodied men for every man, woman and child; and practically it amounts to much more than this, for these additional 3,000 million stalwart laborers make no demands upon the food products of the world; they need no clothing, no matter what the zone of their employment, and in faithfulness, loyalty, general docility and ease of management they are beyond compare.

INCREASING USE OF FUEL OIL, SOUTHERN PACIFIC RAILWAY.

Mr. Howard Stillman, Engineer of Tests of the Southern Pacific, outlined the use of oil on that road to a representative of the New York "Commercial" as follows:

The company has been gradually increasing its use of fuel oil for years. About the only new feature at present is the conversion of ferryboats on the bay of San Francisco from coal to oil burners. The Piedmont, which runs between San Francisco and Oakland, has used oil since November 1 with good results. The Solano, which ferries trains from Benecia to Port Costa, is being fitted for burning oil. As far back as 1885 oil was tried on this boat and it made a satisfactory fuel, but the oil used was a high distillate and costly, as compared with the present California fuel oils, which are not only cheap but perfectly safe.

The company has about eight ferryboats on the bay, and it is said that all will be converted into oil burners. There are about 170 locomotives on the Southern Pacific system using oil. Its use of oil for locomotives dates back half a dozen years and there has been a gradual increase of the number converted.

Recently the company bought five Baldwin engines with Vanderbilt fireboxes. They are in successful operation between Yuma and Los Angeles, burning oil. There are over 60 oil-burning engines running on Southern Pacific lines out of Los Angeles. None of the Sacramento locomotives are using oil. In the shops at Los Angeles, Tucson and West Oakland oil is being used in stationary boilers. In the Sacramento shops oil is used to a limited extent.

GRATE AREAS FOR LIGNITE.

In answer to a question concerning the burning of lignite in locomotive service, in a recent discussion before the New York Railroad Club, Mr. Vauclain, of the Baldwin Locomotive Works, made the following statement

The ratio of heating to grate surface for lignite coal depends somewhat on the analysis of the lignite itself. For the more inferior grades of lignite coal we like to have a ratio of not over 50 to 1, and preferably 40 to 1. 40 to 1 is a very desirable ratio of heating to grate surface for anthracite coal; but anthracite coal is entirely the opposite from lignite. Lignite is a free-burning fuel, very light and full of water, similar to green wood, and therefore, in addition to the excessive grate surface, it is necessary to provide excessive depth of furnace. For good bituminous coal, to get the very best results, we demonstrated several years ago, I think in 1892 or 1893, that the desired ratio of heating to grate surface was about 60 to 1, and in all the satisfactory locomotives for bituminous coals that we build the ratio of heating to grate surface is about that figure, unless it is found that in order to increase the weight of the locomotive we can increase the size of the boiler and get a much larger heating surface than is actually necessary for a locomotive of that sort, in which event the heating surface is allowed to run as high as 70 to 1. The "run-of-mine" coal is always harder to burn than the better class of coal, and for that purpose, when we know of locomotives that are to use that class of fuel we do not like to exceed a ratio of 1 to 60; whereas with the higher grade of bituminous 1 to 75 is quite permissible. For soft coal screenings or slack at the mines, we find that it is necessary to provide about all the grate we can get. That becomes a case of getting the most of a good thing that we can.

The German experiments upon high speeds upon the Prussian Military Railroad line have so far reached a maximum of 99.44 miles per hour with a line tension of 10,000 volts. This is believed to be the safe limit for the present track and it is to be reconstructed before pursuing the investigation further.

COMPOUND CONSOLIDATION PASSENGER LOCOMOTIVE.

Colorado Midland Railway.

Built by Baldwin Locomotive Works.

The chief interest in this locomotive is that it is of the consolidation type and used for passenger service on grades of 3 and 4 per cent. and curves of 16 degrees in the mountains of Colorado. These conditions required unusual tractive power and involved a large weight on driving wheels. Mr. Vauclain, of the Baldwin Locomotive Works, in explaining the reason for the inclination of the cylinders of this engine, said that the officers of the road wanted the cylinders sufficiently high to clear the "scenery" of the Rocky Mountains, which is "so unstable that it is likely to be found alongside the railroad tracks." The cylinders were placed in this way to clear any ordinary boulders which may roll down. Flanges are placed on all of the driving wheels. These engines have been fitted with the form of cylinder brake illustrated on page 12 of our January number in connection with the recent heavy oil burning locomotives for the Santa Fe.

This design clearly illustrates some of the difficulties to be contended with in typical Rocky Mountain railroading. These engines are used principally between Colorado Springs and Divide, a distance of twenty-seven miles; and between Arkansas Junction and Thomasville, a distance of thirty-six miles. The maximum grade between Colorado Springs and Divide is 211.2 feet rise in one mile, while the average for the whole distance is 109.9 feet to the mile, which average is reduced considerably by the small average of 25.8 between Colorado Springs and Colorado City, a distance of three miles. Between Manitou and Cascade Canon, the maximum grade, there is an average of 189 feet rise to the mile, with seven 16°, four 14°, and a great many curves of less degrees in a distance of 5.4 miles, including six tunnels in a distance of 3.4 miles.

The time of train No. 5, west-bound (which consists of a combination mail and smoker, two chair cars and a sleeper, weighing approximately 150 tons, not including passengers, baggage and mail, and a tourist sleeper added to this train one day a week, which increases the light weight tonnage to 195) between Manitou and Cascade, is 29 minutes. There are a few cases recorded where one of these engines made the time with six cars, the light weight of the train being approximately 230 tons. Train No. 4, east-bound, has need of the compounds between Thomasville and Ivanhoe, where a maximum grade of 158.4 feet and an average of 132.7 feet rise in a mile exists, including in this distance of 21.4 miles about thirty-eight 16° and twenty 14° curves, not counting those curves of greater radius. The time for this stretch is 1 hr. 23 minutes. The train usually consists of a baggage car, combination smoker and mail, chair car and a sleeper, all but the combination car having 6-wheel trucks. The light-weight of the train is about 166 tons, and once a week this tonnage is increased to 215 tons by the addition of a tourist sleeper. These engines have a rigid wheel base of 15 ft. 9 ins., and have all tires flanged, which experiment has met on this road with the most satisfactory results as to their easy curving qualities and minimum flange wear, due to the fact that four flanges instead of two, as is customary, take the thrust of the sharp curves.

The most important dimensions of this engine are given in the following table:

COMPOUND CONSOLIDATION PASSENGER LOCOMOTIVE.
Colorado Midland Railway.

Cylinders.	
Diameter	high pressure, 17 ins.; low pressure, 28 ins.
Stroke	30 ins.
Valve	Balanced piston
Boiler.	
Diameter	74 ins.
Thickness of sheets	3/4 in.
Working pressure	200 lbs.
Fuel	Soft coal
Firebox.	
Material	Steel
Length	120 1/8 ins.
Width	42 ins.

Compound Consolidation Passenger Locomotive—Colorado Midland Railway.

J. R. GROVES, *Superintendent of Machinery* BALDWIN LOCOMOTIVE WORKS, *Builders.*

Depth	front, 65 3/4 ins.; back, 61 ins.
Thickness of sheets, sides	5-16 in.
Thickness of sheets, back	3/8 in.
Thickness of sheets, crown	3/8 in.
Thickness of sheets, tube	1/2 in.
Tubes.	
Material	Iron
Number	337
Diameter	2 ins.
Length	14 ft.
Heating Surface.	
Firebox	172.2 sq. ft.
Tubes	2,453.7 sq. ft.
Total	2,625.9 sq. ft.
Grate area	35 sq. ft.
Driving Wheels.	
Diameter outside	60 ins.
Diameter of center	52 ins.
Journals	9 ins. by 11 ins.
Engine Truck Wheels.	
Diameter	30 ins.
Journals	6 ins. by 10 ins.
Wheel Base.	
Driving	15 ft. 9 ins.
Total, engine	24 ft. 4 ins.
Total, engine and tender	53 ft. 2 ins.
Weight.	
On drivers	157,500 lbs.
On truck	22,500 lbs.
Total, engine	180,000 lbs.
Total, engine and tender	300,000 lbs.
Tender.	
Diameter of wheels	33 ins.
Journals	5 1/2 ins. by 10 ins.
Tank capacity	6,000 gals.
Service.	
Passenger.	
Grades, 4 per cent. combined with curves of 16 degrees.	

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EDITORIAL ANNOUNCEMENTS.

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

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

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Mr. Edward E. Silk, who for two years has been connected with this journal as Associate Editor, concludes his connection with it with the appearance of this issue, to accept a promising appointment with the O. M. Edwards Company, of Syracuse, N. Y. The readers of this journal will join us in regretting his retirement from this field and in wishing him and his new associates long life and prosperity.

"I have seen the steam gauge point up 25 lbs. in four minutes," writes a correspondent who is using oil fuel extensively on locomotives. Such forcing is impossible with coal and for the sake of the boilers it is well that it should be impossible. In burning oil the fire needs constant attention, as is required by coal, and if the change of the running conditions such as the speed, reverse lever and throttle positions are immediately followed by corresponding changes in the oil valve there need be no great variation in the steam pressure. While the fireman is relieved of his laborious work on an oil burner it seems to be difficult to get most men to keep close watch of the fire. Because the fire can be so easily forced the men do not feel the necessity for keeping constant pressure, and to this cause may be laid the only difficulties which appear to be serious in oil burning. Cases are known indicating that in a crown bolt the center of the head is curiously affected by the heat and raising the question whether it cannot even be melted, the metal in the center of the head being too far from the water to keep its temperature down below the danger point. With careful regulation there is no difficulty, but most firemen are not careful, and occasionally neglect the fire, having to force it to catch up again.

This points to the desirability of building boilers for oil burning which are specially adapted to severe forcing. To meet this condition staybolts should be avoided, and this appears to indicate a specially favorable field for the corrugated cylindrical firebox, which avoids the necessity for staybolts. At least the statement recently made in these columns with reference to the desirability of designing boilers specially for oil burning seems to be justified.

THE WIDE FIREBOX FOR SOFT COAL.

There is no uncertainty or hesitation in the expression of opinion concerning the moderately wide fireboxes for soft coal by those who are using them. Locomotive improvements so universally satisfactory as this are very rare. More time will be required to show the effect of short and wide fireboxes on the breakage of staybolts, but even in this direction considerable improvement over the narrow firebox, confined between the frames, is expected. Staybolt breakages appear to be exceedingly frequent in some of the large passenger engines with narrow grates, built two and three years ago. It is probable that the short and wide fireboxes will do better than these. The best advantage of the wide firebox is its steaming qualities, and the present exigencies of service make this feature prominent.

"What steam pressure do you carry?" used to be a common question. It has given place to "What steam pressure have you got?" The large grates help in a remarkable way to answer the second question favorably. There are men who do not expect to build another narrow-firebox locomotive of the old type for road work, so confident do they feel. On the Buffalo, Rochester & Pittsburgh, Mr. Turner has found it necessary to define the condition which was described on so many delay reports by the entry "no steam." Having engines with normal pressures varying from 140 to over 200 lbs., it was necessary to establish the pressure at which stalling with the normal rating would probably occur. He placed the condition of "no steam" at 85 per cent. of the boiler pressure. This reflects the rigor of the present-day requirements in a way to indicate the importance of adequate boiler power. The tendency in boilers seems to be to make them still larger. With steam heat, air brakes, air sanders and bell ringers, air fans in the cars, water raised by air in sleeping cars, electric headlights and electric lights in cars, larger boilers were needed for the demand for "auxiliaries," and the gradually increasing weights of trains add another important requirement to be met. The boiler cannot be made too powerful in these days, and the wide firebox has come in a time when it was greatly needed.

It cannot be said, however, that the wide firebox gives no trouble or that it always insures abundant steam. On at least four prominent roads wide fireboxes have given considerable trouble in failures to steam freely and in a serious leakage of flues. After investigation it can be stated that these difficulties arise from a very definite and simple cause. They have occurred with locomotives having long and also with short flues. There must be something about the wider grate that is not fully understood.

With grates of 28 sq. ft. area thick fires were necessary in order to burn a sufficient amount of coal, and, of course, the strong draft necessary for thick fires required rather small nozzles, but holes in the fires of these engines are rare and if they occur the engine "dies" at once. When the grate area is increased to 40 or 50 sq. ft. the fire is thinner, and, naturally, the nozzles were somewhat enlarged. Thin fires offer less resistance to the air and a hole in a thin fire does not produce a sudden effect. A thin fire needs more careful firing than a thick one, and for a wide firebox the thinner the fire the better, providing the necessary amount of coal is burned. It is the opinion of those best able to judge that the leaky tubes and failures in steaming of wide firebox engines are generally caused by the admission of cold air through holes in the fires which often occur unnoticed, and generally in the corners of the fireboxes. As one mechanical officer put it, "Our wide firebox engines never fail in steam since the firemen learned the 'side step' which is necessary to get the coal into the back corners."

A large grate requires more careful firing than a small one, but when properly handled the work of the fireman is easier with the large grates, and it is fair to expect greater care.

HEAVY LOCOMOTIVES.

Editorial Correspondence.

Where Is the Present Tendency Leading and Is It Justified?

There never was a time in the history of the locomotive when so many radical and so important steps in progress have been taken as during the past few years, and it is natural that this should raise the question as to where it will lead. Recently rumors were heard of a new design for special mountain service of a monster locomotive of the decapod type, with 230,000 lbs. on the driving wheels, a total weight of 260,000 lbs. It may also be mentioned that a prominent superintendent of motive power has expressed a favorable opinion of 20-ft. tubes for a prairie type passenger locomotive having 84-in. drivers.

If these suggestions are worked out in practice, very little surprise will be felt at anything which may follow. This heavy engine has already been built, and the very proper question as to where this is leading is worthy of thoughtful attention. Are these enormously heavy engines justified? They are if there is work for them to do and if the design is conducted on a logical and consistent plan. In this case 4,681 sq. ft. of heating surface and corresponding cylinder power are employed. On mountain roads with long, heavy grades there is undoubtedly work for such machines to do. In view of the unquestioned tendency toward heavier engines for all classes of service and the doubt in many minds of the advisability of such a tendency, it is worth while to review the arguments advanced in favor of heavy engines.

For years the policy of the Lake Shore, with its level and straight road and very light engines, was held as an example of economical practice, but now this road is among the foremost in the new order of things and of the wisdom of the change there can be no doubt. Even short roads with but little over 100 miles for the longest run, are taking up heavy locomotives and comparatively level lines are building larger ones, showing that the practice is by no means confined to roads having heavy grades. There must be a reason for this. These engines must be reducing operating costs by increasing the weights of trains. They certainly do not represent a spasmodic movement.

A reduction in the cost of train and engine crew wages is the first saving to attract attention as a result of increased weight of trains. It is perfectly clear that the heavier the trains to haul a given tonnage the less will be the wages of the men required to operate them. The saving is instantly apparent, and it bears a direct relation to the weights of the trains. Double-heading is more economical than to run short trains, but both are comparatively expensive. Other savings which, while also increased in the same way, are not so apparent and are not evident at all on roads which have not yet adopted the ton-mile basis for locomotive statistics, and where separate accounts of passenger and freight expenses are not kept.

This problem may be examined with reference to the effect of heavier engines on the cost of repairs, wages of crew, lubrication and waste, terminal service and fuel. Larger engines are sure to increase the cost of repairs per engine mile, but they should, if properly loaded, reduce the cost per ton mile, because of the increased tonnage hauled. The hauling capacity may increase more rapidly than the cost of repairs, providing they are given the tonnage which they require. Wages of engine men, and also train crews, depend upon the number of trains, and any influence tending to reduce the number of trains to haul a given tonnage must effect a corresponding saving in both of these items. In busy times this is an important economy. The cost of lubrication and waste will be about the same for large as for small engines when based upon ton miles, because as the tonnage increases so also do the number of bearings, and generally also the steam pressure. In terminal service there will be no material increase in the wages of "dispatchers" and "hostlers," and while the bearing surfaces are larger the cost of wiping should not increase much. In the roundhouse, laborers' wages will increase per engine mile, but they should decrease when based on the ton mile, and a saving may be expected here.

As to the fuel item, generalizations based upon the data taken from isolated cases of very large engines are unsatisfactory. We prefer to take the results of a gradual increase in the weight of locomotives on any road, and from the tendency shown in such a case, a fair judgment as to the advantages of continuing the process may be formed. In our November issue was printed a table of data from the large engines on the Illinois Central, the December number recorded tests on the Michigan Central, and we have also another confirmation of the policy of increasing the weight of engines, tending to show the value of a gradual increase, as follows:

We have been permitted to examine the records of three classes of locomotives on one of the leading railroads and to make a comparison which, while it does not include a so-called heavy engine, is sufficient to establish the tendency of the decreased cost obtained by two steps toward heavier locomotives. This comparison includes a large number of 18 by 24 eight-wheel and 19 by 24 ten-wheel and 19 by 26-in. ten-wheel engines. The results are taken from the actual records of freight service, and are believed to be reliable. These engines are represented by their tonnage capacity under the same conditions of speeds and grades. In the following table the cost of terminal service includes the wages of wipers, laborers and dispatchers, and the item of train crew wages is based on a cost of 7 cents per train mile.

Comparison of Three Classes of Locomotives of Different Capacities, Showing the Advantages of the Heavier Engines in Freight Service.

	10-wheel. 19 x 26"	10-wheel. 19 x 24"	8-wheel. 18 x 24"
Weight of engine, lbs.	152,500	126,000	90,000
Weight on drivers, lbs.	118,400	102,700	57,700
Tonnage hauled, average for each	620	460	390
Terminal wages per 1,000 ton-miles, cents	1.96	2.28	2.69
Locomotive men, wages per 1,000 ton-miles, cents	10.38	13.21	14.97
Train crew wages per 1,000 ton-miles, cents	11.18	14.23	17.70
Oil and waste per 1,000 ton-miles, cents	0.52	0.52	0.52
Repairs and stores per 1,000 ton-miles, cents	6.23	7.11	7.61
Fuel per 1,000 ton-miles at $1.50	145.80	185.30	200.60
Summary, based on 1,000 ton-miles	$1.76	$2.23	$2.44

While these are not very heavy engines, the effect of increased capacity is perfectly clear, and it is fair to expect the relationship to continue with much greater increase of capacity. In these three classes of locomotives the consumption of coal per 100 ton miles has decreased in the order of 26.75, 24.71 and 19.44 lbs. in favor of the heavier engines, and from more recent returns a modified class of the ten-wheel engines having wide fireboxes, show the last figure to be reduced to 15.5 lbs. per 100 ton miles. This is taken to indicate that heavier engines are desirable, where they may be properly loaded, and that wide fireboxes and other improvements should be included in designing them. There is much to be gained in increased weight and power, to which still more gain may be added by other improvements. It may, perhaps, be found that the heavier the engine, the greater the advantages of such improvements as wide fireboxes, but there is nothing to be gained by increased weight which does not give increased power.

At present the development of the locomotive is further advanced than that of the track, the strength of the draft gear of cars, the strength of bridges, the length of side tracks, and it is also in advance of operating methods in loading heavy engines. In the proceedings of the Central Railway Club for

September last the experience of the Illinois Central with its two heavy engines was stated by Mr. A. W. Sullivan, assistant Vice-President of that road. In speaking of the two very large engines on that road, referred to in the record printed in our November number, he said:

They were simple engines with cylinders 23 x 30: they carried 210 lbs. of steam, had 82-in. boilers, long fireboxes, one a consolidation, the other a twelve-wheel type. We were quite interested to know what this size of engine could do in the way of ultimate pulling capacity, so the order was given to start with a train of 1,500 tons on a run out of Chicago of about fifty miles, in the middle of which was the ruling grade of that district, about 24 ft. to the mile; and each day it made the trip increasing the train load by 500 tons until the train got up to 3,500 tons, eighty-two loaded cars. There was no trouble in the engine handling the train; the trouble was to handle the engine.

This was about two years ago. We had two engineers and three firemen; that is, we had these men in reserve, and when we came to the heavy part of the hill the engine in its hardest pull made a mile and a half to a ton of coal and used up 5,000 gallons of water in running five miles. When it arrived at the station at the summit of the grade it had to cross over to the other track to let an important passenger train pass it, necessitating a short back-up movement to enter the cross-over track. In making this back and forward movement the train broke in two eight or nine different times, on one occasion shearing under the head and under the nut twelve 1-in. drawbar pocket bolts, so great was the power of the engine. Two hours and three-quarters was consumed in crossing over and getting back, and the train that it was intended to let by without causing any delay was delayed an hour and a half.

We came to the conclusion that it was quite possible to get one engine that was large enough to handle a bigger train than was practicable, as a transportation proposition, to move over the road.

These large engines have now been in service nearly two years. We give them each trains of 1,800 tons on portions of the road where mogul engines of 19 x 26-inch cylinders handle trains of 900 tons. Each of the big engines takes a double train. The total expense of moving 10,000 tons one mile with the big engines is $1.86, as against $2.02 with the mogul. By reducing the train to a tonnage that could be handled readily, we have been able to operate the large engines successfully, having them take their turn in the service just as it comes—one day with a heavy coal train, next day with a stock train or with a banana train, making speeds anywhere up to forty-five to fifty miles an hour, and do that without any trouble.

This may be taken as a condemnation of the heavy engines, and it will doubtless be so interpreted, but is it not really the best proof that the principle of great power is correct and that serious weakness exists in the other directions? An advantage of 10 per cent. in operating these large engines, even when underloaded, is important, and the weak factors thus exposed should be studied. Doubtless it would be wiser to come to the 150-ton engine more gradually, but there is good reason to believe that we shall come to it before long. Another fact drawn from the Illinois Central experience is the importance of using the utmost care in the design of the large engines to secure every possible advantage from the increase of weight. In locomotives and cars the most important work for the next few years will be in securing operating advantages from every possible pound of weight. The boiler of the locomotive should profit by every pound which can be saved in the other parts, and in the car the construction should be such as to make every pound of weight of the structure count toward carrying the load. There is much yet to be done in both of these fields, and the track, bridge and operating offices have their part to perform. We do not believe that the course toward heavier locomotives can be checked, and that the co-related factors should be treated with this fact in view. The desire to "go one better" than one's neighbors in the weight and power of locomotives is not profitable. This principle of heavy engines needs careful treatment, and if the problem is studied with the care it deserves the Illinois Central experiment will probably be found to mark an epoch in locomotive practice. It should be kept in mind that track and structures improve slowly. The advance of the locomotive must not be too rapid for its suroundings.

Further analysis of the performance of these large engines on the Illinois Central is presented in another column in this issue; also a description of the remarkable engines just completed for the Atchison, Topeka & Sauta Fe.

A DRAFTSMAN.

A young man, after working a few years in a drafting room, called at the editorial rooms of this journal to ask whether he was on the right track to success. He was told that he was and that some of the best railroad officers of the present time had spent a long time in this department. He went back to his table, determined to get out of the drafting room because of having shown his ability there. The next day brought the following letter, which we hope every draftsman will read:

"It seems to me to be a step in the right direction when one learns that there is no easy sailing, and makes up his mind to make an opportunity rather than wait for an opportunity to make him. I realize that it requires considerable determination and application to work ahead of oneself, preparing for something that may some time offer an opportunity or striving to gain knowledge that may be of value some time. The beginning is undoubtedly half the undertaking in any work, and difficulties apparently enormous at first, taken each in turn as they present themselves, should become simpler and finally be overcome."

We hold that there is no better place in which to gain experience than the drafting room. We also hold that a man who is a good draftsman and one who can organize and direct a drafting room properly has a combination of experience and qualities of the executive and the engineer which fit him for greater responsibilities. If this department is not appreciated, not only is a good opportunity lost by the management, but a number of promising, ambitious young men are discouraged and a great mistake is made. Drafting in railroad service is usually drudgery, but the men themselves may be to blame for this. They usually have it in their own hands to make its importance felt and to make the drafting room a good stage in progress from which they may graduate because of showing that they have a grasp on the important affairs with which they deal.

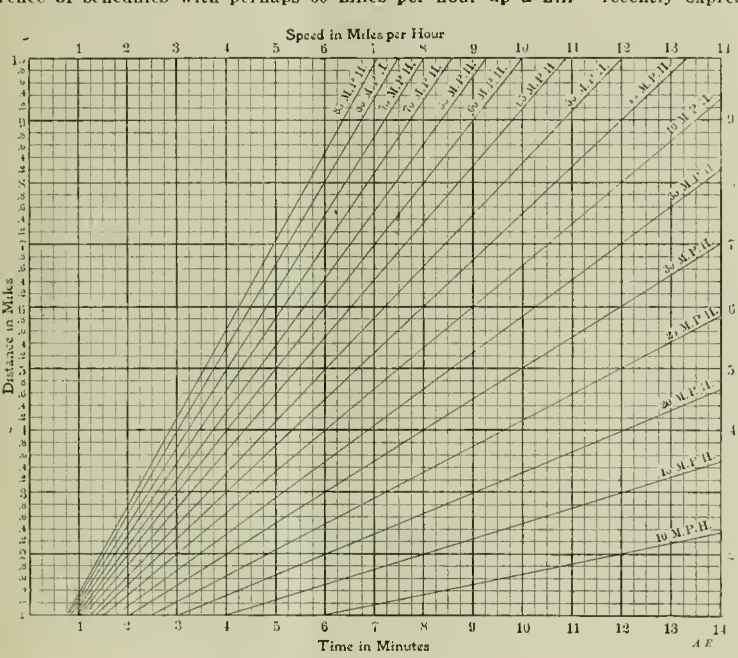
NEED OF INDUSTRIAL EDUCATION WITH REFERENCE TO THE MACHINE TRADE.

At the Baldwin Locomotive Works a new system of managing the apprentice problem has been inaugurated with a promising outlook. This plan was outlined on page 309 of our October number. In connection with apprentice training an educational system of some sort is necessary, and the views of Mr. Samuel M. Vauclain on this subject are recently expressed before the Engineers' Club of Philadelphia. In the course of his remarks Mr. Vauclain recommended that when our youth have left school and stand ready to enter upon their life's work, there should be a well-defined and improved system of indenture pursued by the owners of all industries to meet the various grades of boys seeking places. Those who have had less general education should be instructed in the shops for a longer term of service than those who have had a high school or collegiate training. He believed that the money now spent by the various trade schools should be devoted to a thorough teaching of mathematics and mechanical drawing, and perhaps chemistry and mechanics, while the shops of our nation could be organized into mechanical training schools already thoroughly equipped with teachers and machinery far more valuable than those now employed. He briefly described what is being done in this direction by the Baldwin Locomotive Works of Philadelphia, and pointed out that it would be better for every manufacturer to entrust his business to a competent stranger educated under his own roof than to an irresponsible and disinterested progeny.

A CONVENIENT TIME DIAGRAM.

The accompanying engraving, made from a diagram devised by Mr. W. R. Maurer, Chief Draftsman of the Motive Power Department of the Buffalo, Rochester & Pittsburgh Railway, will be found convenient in checking up time-tables and for various other purposes in connection with the time of trains. These limits of 14 minutes and 10 miles will cover nearly all ordinary time-tables. To ascertain the speed in miles per hour, find the intersection of the horizontal and vertical lines passing through the desired numbers.

If the speed of a train making 7.6 miles in 10¾ minutes is desired, it is found to be midway between the oblique lines at 40 and 45 miles per hour, or 42.5 miles per hour, which is near enough for practical purposes. When time-tables are made up, such a diagram would be a convenient check upon uniform speed, and its use would tend to prevent the frequent occurrence of schedules with perhaps 60 miles per hour up a hill



Convenient Time Diagram.

and perhaps 40 miles per hour down on the other side. A diagram of this sort may be easily made with any desired number of spaces and oblique lines.

A second historical locomotive has just been deposited with Purdue University by the Baltimore & Ohio Railroad, as a result of interest shown by Mr. J. N. Barr and Mr. F. D. Underwood, when with that road, and Mr. F. D. Casanave, the present General Superintendent of Motive Power. The engine belongs to what is known as the "camel-back" type and is designated by the initials B. & O., No. 173. This type of locomotive was originated some forty years ago by Mr. Ross Winans, one of the most eminent of the early locomotive designers and builders. Engine No. 173 is of the ten-wheel type, and has cylinders 19 by 22 ins.; driving wheels, 50 ins. in diameter; weight on drivers, 56,500 lbs., and a total weight of 77,100 lbs. The shell of its boiler is 48 ins. in diameter. It was built in 1863, and has been in regular service until withdrawn to be put in order for delivery to the University, after which it made the trip from Baltimore to Lafayette under its own steam in six days. This engine of thirty odd years ago presents many interesting features, the whole machine being, in fact, designed with great skill and ingenuity. The name "camel-back," as may be surmised, was given to the engine on account of the peculiar appearance produced by the large cab on the central part of the barrel, and of the rapidly receding back end, with its staircase and handrail on the steeply inclined firebox, all of which gave the engine a humped appearance.

DOUBLE HEADING.

The Weakness Which It Exposes.

If the water, crane service, coaling stations or side-track facilities of a road are not up to date and are inefficient, the fact is most noticeable in connection with "double-headed" trains. The delays thus caused may even overbalance the gains which are expected from the reduction of train-crew wages. Double heading is a test of the efficiency of operation of a road. Mr. A. W. Sullivan, of the Illinois Central, recently expressed his views on this subject before the Central Railroad Club as follows:

The question of running double-headers I hardly think is one that can be considered settled. There are more points to it than the mechanical conditions of the service. The test of the question is, next to its economy, the efficiency of the service. For instance, if a double-headed train will get a given number of loads over the road quicker, as well as with less expense, then I think it can be said to be good practice; and if that can be done generally, it may be said to be good established practice; but it is very doubtful if that point has been reached. For example, I know of an instance where two large engines were double-headed because the superintendent thought he could make a better showing by double-heading two large engines than he could by double-heading two small engines; and in the course of the trip they came to a coaling station where each engine had to have 12 tons of coal; and while they had made very good time over the road, it took them about two hours to get away from that coaling station; and similarly at water stations that are not equipped with large-sized standpipes, it takes a long time to get water. Then, in side tracking trains at meeting and passing points; it is not generally the case to find the sidings long enough to take one of those long trains, along with another train in the opposite direction; and it is hardly safe nowadays, on lines of dense traffic, to count on only one train having to take the siding at a passing or meeting point.

While, of course, the economy of the saving of one train crew in moving double-headed trains must, of necessity, be admitted, there are offsets to that economy in the delays on the road, the consequent overtime, the damage that is done to cars in "sawing" trains at a meeting point where the sidings are not long enough to clear the main line, the difficulty of handling trains over hilly portions of the road, the uncertainty of trains moving on orders to make meeting points on short time, and a variety of other conditions which are essential elements of the transportation service, and tend to diminish the benefits that come from the consolidation of transportation units into large train loads, and of reducing the number of men required to move them over the road.

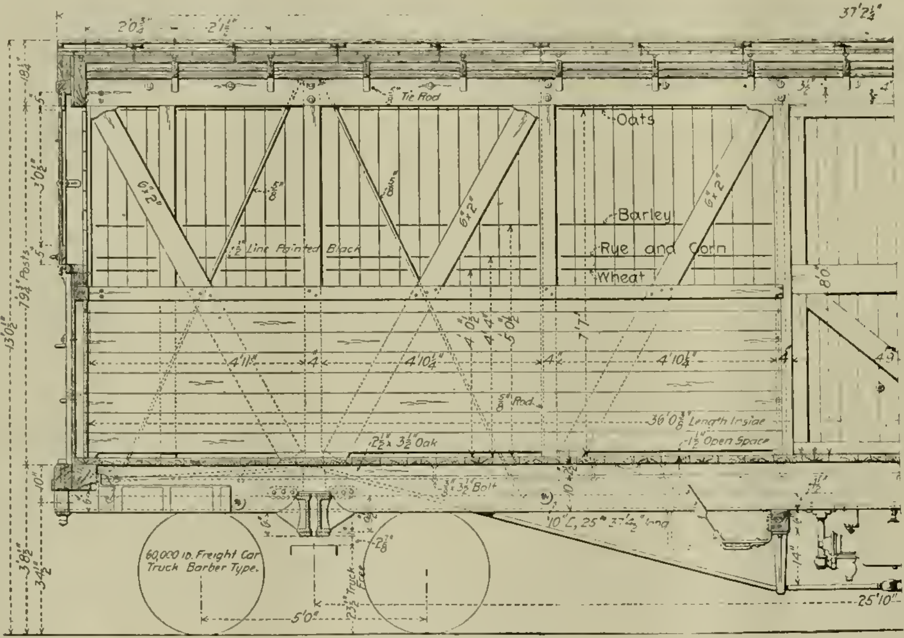
Mr. Sullivan's remarks also apply to heavy engines, and this may be accepted as an indication of the importance of putting roads into condition for handling larger trains. Double-heading and large locomotives demand better water, coaling and side-track facilities and stronger draft gear.

NEW CONSTRUCTION OF STEEL CENTER SILLS AND BOLSTERS.

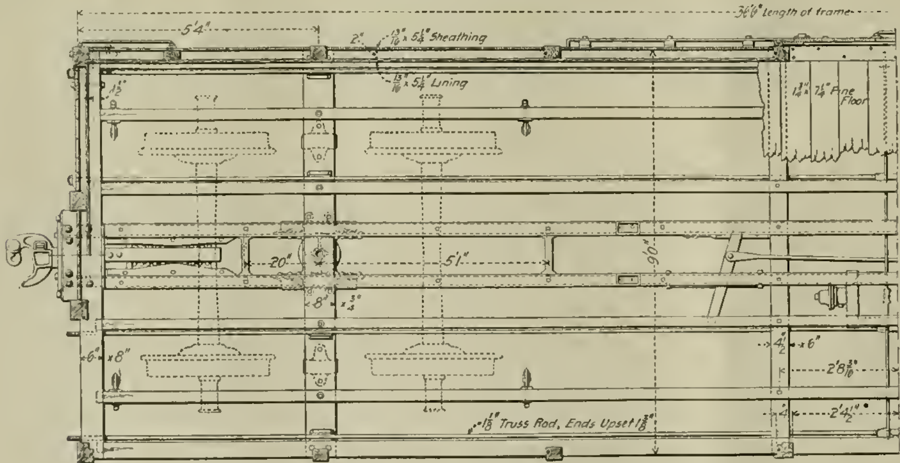
Chicago, Milwaukee & St. Paul Railway.

The Chicago, Milwaukee & St. Paul Railway has just turned out of its West Milwaukee shops a lot of new 60,000-lb. capacity wooden cars, the inside dimensions of which are in accordance with the recently adopted standard for 40-ton cars. These cars have continuous metal center sills and continuous metal body bolsters, the arrangement having been patented by Mr. J. J. Hennessey, Master Car Builder of the road.

The cuts herewith presented show that the arrangement employs two 10-in. 25-lb. channels for center sills, and the draft gear, in this case the Miner, is attached between the webs, which are placed 10⅞ ins. apart. The draft is central with the center sills and to meet this condition a novel arrangement of the body bolster was devised. The construction is easily understood by a glance at the sectional view at the bolster. A substantial spider casting is placed between the two members of the body bolster, and this casting has brackets or wings extending lengthwise of the car for 20 ins. under the center sills, and may be made longer if necessary. These brackets receive the entire load from the center sills, and when the spider casting and bolster are bolted together both members of the bolster are held firmly in place. The center plate is riveted to the lower member, while the upper member passes through the center sills at the neutral axis. These openings are reinforced by brackets riveted to the center sills. This prevents movement of the bolster along the center sills. The object of cutting the sills for the passage of the upper members of the bolster at the neutral axis was to avoid weakening them as beams.



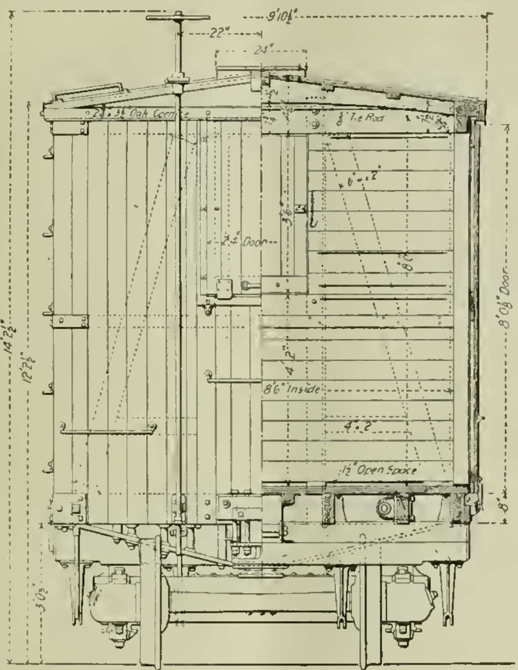
Half Side Elevation.



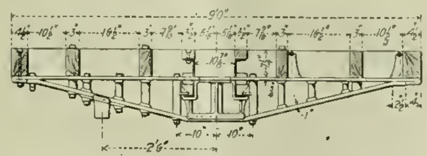
Half Plan, Showing Construction of Steel Center Sills and Bolsters.

New Construction of Steel Center Sills and Bolsters—Chicago, Milwaukee & St. Paul Railway.

This method gives continuous body bolsters and continuous center sills, a very desirable feature. It permits of dealing with the pulling and buffing stresses in straight lines and provides for this feature without the sacrifice of strength which results from dividing the bolsters at the center sills or the center sills at the bolsters, or cutting any of the sills at the bolsters. In case of a wreck the metal center sills may be as easily removed and replaced as in the usual construction of wooden cars, which is an unusual feature in the use of steel sills. This bolster is 9½ ins. deep between the upper and



End Elevation and Section.



Transverse Section of Underframing.

lower members. If necessary to use a higher truck this distance may be reduced to 7 ins. These steel center sills are standard commercial shapes and may be readily replaced if damaged in wrecks. It is obvious that they supply the functions of continuous draft attachments and also furnish a substantial backbone to the underframe. Cars constructed in this way have been in service some eight months and careful inspection shows them to be in excellent condition. Mr. Hennessey has devised an interesting and valuable combination. These cars are equipped with Barber trucks, furnished by the Standard Car Truck Company.

The Lehigh Valley Railroad, in a recent circular, gave the number of articles of various descriptions found during the year in the coaches of passenger trains on a certain railroad as 1,270. This does not include articles found on Pullman cars. Of these articles 288 were claimed and returned to owners, the balance of the number, 982, still remaining in the hands of the baggage department of the company, awaiting claimants. It is hard to explain the low percentage of calls made for such articles left on trains, unless it be that passengers, in the main, do not understand that such articles that are found and turned into the baggage departments of the various railroads are held there subject to orders of the owners.

COMPARING HEAVY AND LIGHT LOCOMOTIVES.

By Edward Grafstrom,

Mechanical Engineer, Atchison, Topeka & Santa Fe Railway.

The descriptions of the road tests on the Illinois Central Ry. (American Engineer, November, 1901, page 343), and on the Michigan Central Ry. (American Engineer, December, 1901, page 379), are valuable contributions to current railroad literature, and deserve more than passing notice from the student of railroad economies, whether he be a mechanical or an operating official.

Both the tests were made for the purpose of enabling the managements of the respective roads to determine the comparative value of heavy and light locomotives, but while the one presents the results in shape for use of the general manager, the other one appears to have been carried out to serve, primarily, the Superintendent of Motive Power. In other words, while one was made for the purpose of determining the economy of heavy versus light locomotives, the other one was apparently intended to determine the relative efficiency of two types of locomotives, different in weight as well as in construction. Although thus not of the same scope, they both seem to have given the parties interested the information wanted to decide between the purchase of light or heavy additional power. Supplemented by intimate knowledge of local conditions and limitations the results of either test are undoubtedly sufficient, but as these results have been published and may be taken into consideration for similar purposes by officials of other roads than those on which the tests were made, it becomes interesting to analyze the published reports, in order to understand them correctly.

The Illinois Central test was made with four engines, each one a fair representative of its class, but all of the old school of design: simple expansion, narrow firebox, D-valves (with one exception). The trains were taken as they came, fast or slow, full rating or not. Cars were set off or picked up along the line. The delays were frequent and irregular; sometimes an engine was held for two hours while its train was being weighed, car for car. In fact, the traffic demands were such that the test may be said to represent average service conditions, with scarcely any attempt to favor the engines.

The Michigan Central test, on the contrary, was made with a good representative of the old type of narrow firebox, single expansion engine, in contrast with a modern compound with a wide firebox, high pressure, and piston valves. The trains were selected in accord with the rating of each engine, and the engines were favored in every way, thus giving results that do not obtain under ordinary service conditions.

It is not surprising that the fuel consumption on the Illinois Central test engines was so much higher than that of the Michigan Central. The Illinois Central ten-wheeler (No. 35) and the Michigan Central mogul (No. 126) have the same size cylinders, yet the Illinois Central ten-wheeler burned 1,050 pounds of coal to the Michigan Central mogul's 816 pounds per 10,000 ton miles. The difference in the quality of the coal used by each company during the test is undoubtedly responsible for some of this, but the service conditions during the tests, nevertheless, account for the most of it.

Aside from the calorific value of the coal used, its commercial worth in different localities affects the net results of a comparative test more than the fluctuations in wages or any other items. In the Illinois Central test the coal appears to have cost $1.03 per ton delivered on the tender. If the price of coal had been twice as high (which is not unusual on a number of railroads), the total operating expenses per 10,000 ton miles for the locomotives in that test would have shown up as follows, other items remaining undisturbed:

	Cost at $1.03	Cost at $2.06
10-wheel	$1.93	$2.48
Mogul	2.02	2.60
Consolidation	1.86	2.48
12-wheel	1.87	2.50

From which it will be seen that in some localities the operating cost of the ten-wheel engine would be as economical as that of the heavy consolidation, and, furthermore, if the price of coal be still higher, the ten-wheel would actually become the more economical of the two.

There is still another important side of the question to consider, and that is the investor's or stockholder's. If we have, say, half a million dollars to invest in new locomotives, what size will give the best return for the money? Interest, taxes, and depreciations being the same for the total amount, whether light or heavy locomotives are bought, and taking the traffic conditions and topography of the Illinois Central for a basis, the proposition would appear as follows:

Suppose that $500,000 will procure 44 ten-wheelers of the No. 35 class at $11,363.63, or 31 twelve-wheelers of the No. 640 class at $16,129.03. Using the Illinois Central test data as a measure and assuming that all the engines of either class would make as many trips in the same length of time, we find that when each engine has made 10,000 miles, the 44 ten-wheelers would aggregate 473,598,972 ton-miles, while the 31 twelve-wheelers would foot up to 468,492,047 ton-miles. The total cost of hauling the tonnage with the ten-wheelers would be $91,400.82, at $1.93 per 10,000 ton-miles. With the twelve-wheelers the corresponding cost would be $87,627.44 at $1.87 per 10,000 ton-miles. Consequently more revenue would be had at a higher operating cost if the half million is invested in ten-wheelers, than if the twelve-wheelers had been chosen.

Again, if it was possible to buy only 42 ten-wheelers at a cost of $11,904.76, instead of 44 at $11,363.63, the result would have been a gross tonnage-mileage of 452,071,746, at a cost of $87,247.58 at $1.93 per 10,000 ton-miles. Thus with only 42 ten-wheelers both revenue and cost of hauling would be lower than with the twelve-wheelers. For easy comparison of these figures, the following table is given:

Number of Engines.	Type	Ton Miles.	Cost per 10,000 Ton-miles.
44	10-wheel	473,598,972	$91,400.82
31	12-wheel	468,492,047	87,627.44
42	10-wheel	452,071,746	87,247.58

It will thus be seen that the number of engines which a certain sum will buy, or, in other words, the cost of each engine, will play an important part in determining the size most suitable for certain conditions. Taking everything into consideration, the large engine is therefore not always economical in proportion to its size.

In stationary practice it is customary to so select power units that each engine can either run at its full capacity or not at all, and if this practice should be carried into railroad financiering it would be found that those engines which most frequently haul their full rating would prove the cheapest ones in the long run. This is another argument in favor of moderating the size of engines to suit the traffic demands, instead of blindly following the lead of other roads on which the heaviest engines built are none too large and always have their full trains waiting for them.

METAL CARLINES—PERE MARQUETTE RAILROAD.

The thickness of car roofs has not been specially important until the adoption of the standard inside dimensions of box cars by the American Railway Association made it difficult for some roads to keep within the demands, because of the height of the standard car at the eaves. Mr. B. Haskell, Superintendent Motive Power of the Pere Marquette, has devised a pressed steel carline which makes it possible to gain two inches at these points. These carlines are pressed out of 3/16-in. steel and 7 of them take the place of 11 or 12 wooden carlines in a 38-ft. car. Mr. Haskell describes a test in which 7½ tons of pig iron were evenly distributed over the running board of a car using this construction and allowed to remain for four hours, with a deflection of ⅜ in. After removing this load there was no permanent set. This method of construction shortens the posts, braces and siding, thereby saving in the cost of lumber and reducing the weight of a car about 200 lbs.

CORRESPONDENCE.

INCREASING SIZE OF LOCOMOTIVE DETAILS.

To the Editor:

Since reading the comments on the four-cylinder compound locomotive on page 319 of your issue of October last, I have done a lot of thinking about our modern locomotives of enormous weight and size. In passing through the shop yesterday I came across two high-priced machinists moving, by aid of a bar and roller, the main rods of one of our heavy consolidation engines, and was struck at once as never before with the great weight of these parts. You will criticize me for allowing high-priced men to do the work of laborers, but that is aside from the point I am making, which is that of the increasing size of locomotive details. They have grown during the past five years to an extent which I admit I did not, and I do not believe the majority of your readers, appreciate.

For the sake of comparison I send you two prints showing

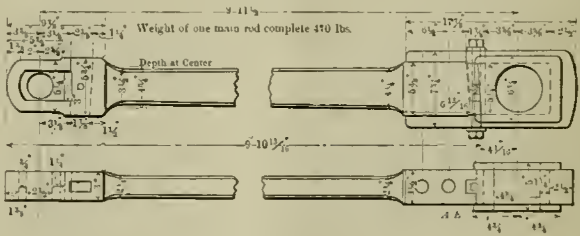


Fig. 1.

main rods. One is from a very heavy, recently built consolidation locomotive, and the other from a ten-wheel engine built in 1890. The former main rod weights 1,050 lbs., complete, and the latter 470 lbs. These rods are from the heaviest engines on our road at the times they were built, and they fairly represent the increased weight of these parts in our vicinity.

We are not having less, but more, trouble with engine failures than formerly, which goes to show that the progress of ten years which has brought out such heavy engines has not resulted in the relief which improved design should bring. There is no doubt but that engines are now loaded more nearly to their ultimate capacity than ever before. But this applies to the engines built ten years ago as well as to new ones, and it

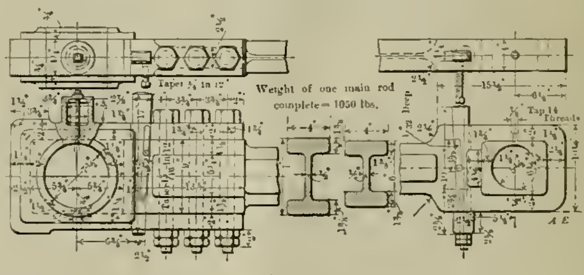


Fig. 2.

is a fact that the big engines of to-day break down oftener than those which have been in service for ten years.

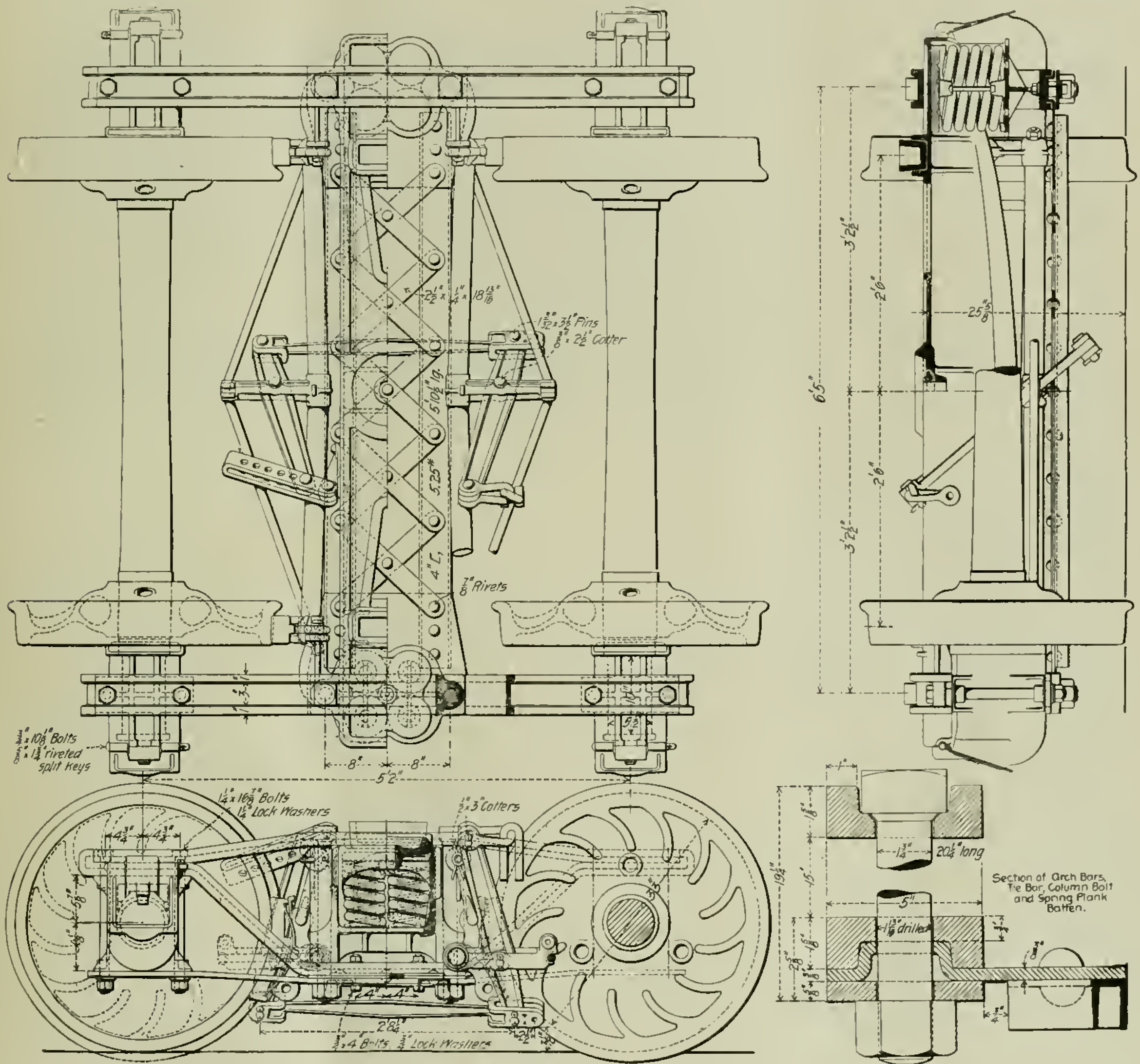
I believe that this means that the increase of running repairs will drive us into lighter loading of engines, or into designs which will make it possible to divide the work up among a greater number of parts. I have no doubt that the four-cylinder balanced compound with four main rods instead of two will help us out in this respect. The crank axle and the increased number of parts of this engine over the ordinary types of course means greater complication, but we must do something like this or else decrease the weight of trains. Ten years ago I had no difficulty to keep the number of "laid up for repairs" engines down to 7 per cent. I have hard work to keep the proportion below 10 per cent., as we are operating to-day. In this matter boiler work figures heavily, but the comparison of the rods represents the situation pretty clearly.

SUPERINTENDENT OF MACHINERY.

[Editor's Note.—These two main rods tell an important story. We present both of them in the accompanying engravings.]

A STEEL CHANNEL ARCH-BAR TRUCK FOR 50-TON CARS.

The accompanying engravings illustrate a steel truck designed by Mr. George I. King and adopted as a standard in the construction of steel cars of 50 tons capacity. Special attention is directed to the latticed spring plank with its embossed end battens fitting snugly into the lower arch-bar channels. This fit extends for a length of 20 ins. along the room available for brake beams, and avoids the difficulties which have been experienced with some of the patented beams for which there is insufficient space when the brake hangers are hung in the usual way. In this truck the side bearings have been located 60 ins. from center to center, and adjustable cast-iron fillers are placed in the side bearing pockets, with a view of adjusting the desired clearance between the body and truck side bearings by means of shims. This truck employs 5½ by 10-in. axles, malleable iron journal boxes, pressed steel



A Steel Channel Arch-Bar Truck for 50-Ton Cars.

bottom arch bar and is relied upon to keep both side frames of the truck in parallel alignment under all conditions of service, relieving the bolts of this duty. The channel-shaped arch bars offer the advantage of a maximum of strength with a minimum of dead weight, and they may now be obtained from two of the prominent steel companies. It should be noted that the brakes are hung from the cast-steel end castings of the truck and are thus rigidly hung from the truck frame and not from the bolsters. With this construction the brake shoes remain always at the same distance above the rail, which is not true of trucks in which they are hung from the bolsters. This arrangement gives a large amount of lids, special channel arch bars, cast-steel bolsters and end castings, malleable-iron brake levers and National Hollow Brake Beams.

In a recent extended trip by a representative of this journal among the motive power departments of the East and Middle West the chief topic of conversation was the introduction of piece work. It was not confined to car departments, but also included locomotive work. It was not spoken of altogether as a good move on the part of the road, for business reasons alone, but there seemed to be a general feeling favoring better relations with the men for mutual benefit.

TESTS NEEDED ON THE LENGTH OF BOILER TUBES.

The difficulties in the way of establishing definite ratios between the factors of locomotive construction are generally understood and are so thoroughly appreciated that comparatively little has ever been done in an experimental way to guide the designer. It is the difficulty rather than the lack of appreciation of the need that has led to the use of the "cut and try" method so generally in this practice, but there seems to be good reason to believe that a good deal might be accomplished by concerted and concentrated effort if it can be started. We would like to give emphasis to the following paragraph from one of the recent Master Mechanics' Association reports which appeared in connection with the subject of the most favorable lengths of boiler tubes:

"One of the unfortunate conditions under which this association works is that of being unable to make appropriations for carrying on scientific investigations of subjects of vital interest to all railroads. It is to be hoped that in time the powers controlling the railroad purse strings will undergo a change of heart and find that it will be to their interest to furnish a pro rata amount, sufficient to enable the Association to hire experts to conduct researches along important mechanical lines. Action of this kind would prove economical to the individual railroad, by relieving it of the expense incurred in making individual research, and by furnishing to all railroads a central source of authority to which they can turn for information, thereby making the American Railway Master Mechanics' Association a far stronger society in the eyes of the world. Let us hope that these conditions may come to pass. In the meantime some of our more ambitious members are investigating for themselves, or in many cases cutting and trying in order to obtain definite information along some of these lines, and each effort meeting with good results will be an encouragement to go a little further."

The particular subject referred to, boiler tubes, merits and really needs investigation. Radical oifferences of opinion are held by locomotive men as to the wisdom of the present tendency toward increasing the ratios of lengths to diameter and a thorough experimental investigation would give an answer which would be not only much quicker but more reliable than that derived from the slow process of "survival of the fittest." Furthermore, the concentration of expense of many practical experiments in actual construction into a series of carefully conducted tests would be economical in the end. It may also be said that when a new engine is built with long tubes there are likely to be other factors of the construction which tend to obscure the results from the special feature upon which information is most desired. The laboratory method renders it possible to confine the attention to the chief point at issue and eliminates the influence of other, perhaps disturbing factors. It seems very desirable to establish certain relationships between lengths and diameters of boiler tubes which would serve as a guide to future practice under present conditions. This is a difficult and expensive undertaking, but it cannot be done better than under the direction and control of the Master Mechanics' Association.

Up to the present time there are no records on this subject which apply to modern American locomotive practice, as it is generally admitted that Mr. Henry's experiments on the Paris, Lyons & Mediterranean Railway, recorded in the "Railroad and Engineering Journal" of August, 1890, were carried out on the lines of stationary rather than locomotive conditions and are, therefore, not to be relied upon now. In spite of this fact, these tests are continually quoted in support of short tubes, and they have, undoubtedly, had a strong influence on the construction of locomotive boilers, the world over, for the past ten years. Something new is needed as a safe guide in the future and it is to be hoped that the rather mild suggestion in the report referred to may eventually bear fruit.

EXHAUST AND DRAUGHT IN LOCOMOTIVES.

The International Railway Congress in 1899 considered this subject from elaborate reports by Mr. C. H. Quereau, Mr. B. O. Ekman and Mr. Ed. Sauvage. After detailed discussion the Congress adopted conclusions intended to cover practice all over the world, which were printed in the November number of the "Bulletin," of 1901, as follows:

1. No general rule to decide on the choice between a fixed and variable blast can be laid down. This choice should take into account whether the locomotive does uniform or irregular work, the profile of the lines run over, the loads drawn, the length of run between stops, the kind of fuel used, the cost of maintenance of the apparatus, and the care and skill of the staff.

2. The simple circular fixed blast and the variable blast fitted with two flap valves appear to satisfy most of the requirements met with in practice.

3. More complicated arrangements, such as the blast fitted with petticoat above it, the deflector plate fixed in the smokebox, the annular blast, either fixed or variable, the variable blast with sliding sleeve, by-pass for a portion of the steam, etc., may give good results, but do not as a rule appear to show any great superiority over the two simple forms mentioned above, provided that the latter are suitably arranged. Blast pipes are subject to rapid incrustation with dirt, which makes the maintenance of complex mechanism difficult; this incrustation is frequently unequal in the case of annular blasts.

4. The dimensions of the blast pipe and of the chimney and also the position of the blast pipe, may be determined by certain formulæ, but it is advisable to verify the results by actual experiments on each class of locomotive; practical tests alone form the real criterion.

5. When the blast opens into the upper portion of the smokebox, as is generally the case throughout Europe, it appears advisable not to raise the opening much above the upper row of tubes. When the blast opening is in the lower portion of the smokebox, it should be fitted with a petticoat. It does not appear that this arrangement, which, moreover, possesses some disadvantages, shows any great superiority over others. It is of great importance to provide a large and easy entry for the gases into the lower end of the chimney. There is a general tendency to somewhat increase the opening by making the upper portion of the chimney conical.

6. The length of smokebox may attain and even exceed 2 meters (6 ft. 6¾ ins.) without producing an unfavorable effect on the draught. Large smokeboxes may serve as a receptacle for cinders; the chimney should then be placed sufficiently far back; but it is advisable, when no deflector plate is used, to place the chimney sufficiently far from the tube plate to ensure equal distribution of the gases throughout the tubes. When it is not desired to catch the cinders in the smokebox, the length may be reduced to about 1.50 meter (4 ft. 11 ins.) in accordance with recent American practice.

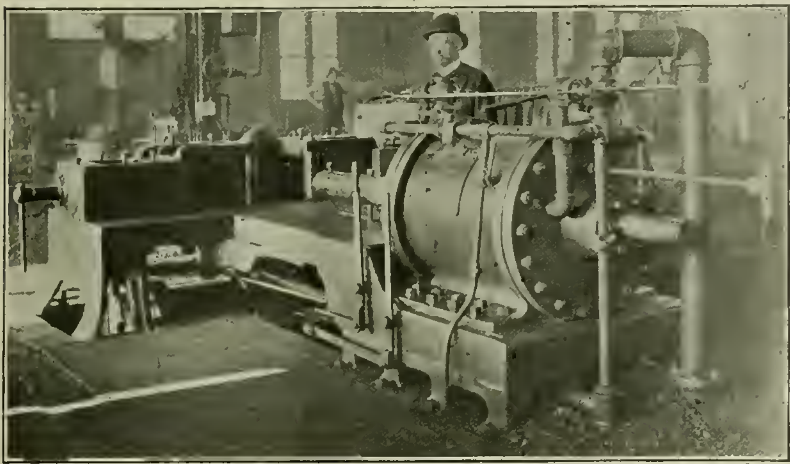
7. Spark arresting devices are rarely very efficient without impeding the draught. It is, therefore, advisable to use these appliances as little as possible, and to simplify them to as great an extent as the quality of the fuel and the character of the country run through may permit.

Of all apparatus intended to utilize the waste heat of the exhaust steam, the exhaust steam injector is the only one which is found frequently in use; this apparatus appears to ensure some small economy in fuel, and to result in easier steaming.

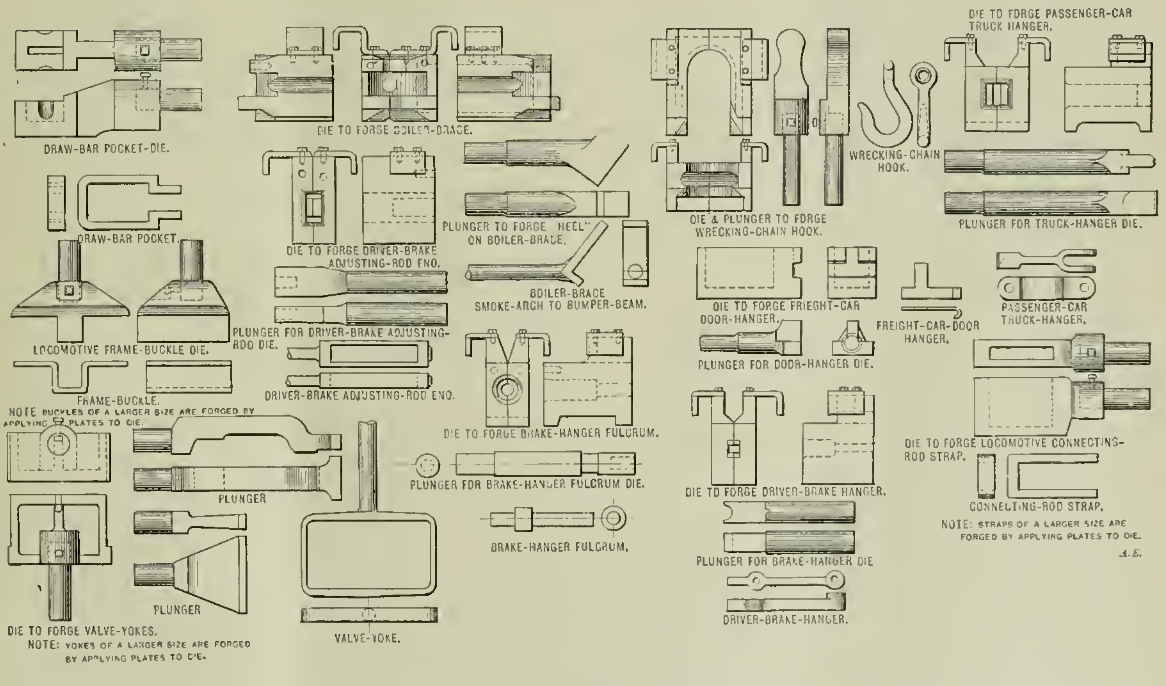
The Beaumont oil field now has 110 active wells, 27 new "gushers" having been added during the month of November. At that time the total tank capacity at that point amounted to 1,280,000 barrels.

PNEUMATIC FORGING MACHINES AND WHAT THEY WILL DO.

At the Burnside shops of the Illinois Central Railroad are being built six very powerful pneumatic forging machines of three different sizes, two of which weigh 15 tons each and have cylinders 24 by 31 ins., two 9 tons each with cylinders 20 by 26 ins., and two of 5 tons with cylinders 16 by 22 ins. They are



24 by 31 in. Pneumatic Forging Machine.



Some Dies Used and the Work Performed by Pneumatic Forging Machine—Illinois Central Railroad.

for use in the Burnside shops, and are similar to the two pneumatic forging machines already in use at that place.

The accompanying engraving of one of the largest of these tools shows a 24-in. air cylinder bolted to the top of the longer arm of the bed-plate and used to operate the plunger or male die. On each end of the two short arms of the frame is an adjustable die-block which has dovetailed and grooved connections with the bed-plate, and moves at right angles to that of the plunger. For such work as welding and the more complicated operations in forging there is a 24-in. auxiliary air cylinder under the machine, which operates one of these die-blocks as a pneumatic hammer for delivering lateral blows. The plunger piston and die-block piston can be operated either separately or in conjunction with each other. The air pressure used is 125 lbs. By opening and closing the lever valve over the main air cylinder a static pressure or a blow of 60,000 lbs. is delivered to the work, and in either case the force is controlled by opening and closing a cut-out cock in the line of piping. The working of one of these machines was fully described on page 289 of the September, 1900, issue of this journal.

The capacity of this tool is limited by the amount of iron that can be heated and brought to the dies. Four men, and a boy to operate the machine, can turn out 600 arch-bars a day of ten hours. To forge a valve yoke at a fire requires three men; a blacksmith, who receives $2.90 per day, and two helpers, each receiving $1.70 per day. In ten hours these men will turn out three valve-yokes, while with two men and a boy at the machine 30 valve yokes are finished in the same length of time. The man in charge of the machine gets $2 a day, his helper $1.60, and the boy who operates the machine, $1.10 a day. This gives, as the cost of labor for one valve-yoke, about 15¾ cents when finished in the machine, and $2.10 when finished by hand. To forge a strap for the side rod of a locomotive, which weighs 236 lbs., requires a blacksmith and three helpers working two hours. The blacksmith at $2.30, and the helpers at $1.70 each. By the use of the machine two men and a boy will forge a strap in 47 seconds. A few of the dies used and the work they perform are shown by drawings in the second engraving on page 59. All these forgings are made by two men and a boy. The construction of this machine permits of using very much smaller dies than any other machine doing the same class of work, and it takes fewer of them. For quite a large number of forgings the dies are always set, so that it only requires a plunger to do the work. In a number of cases the same plunger is used for different forgings. To make different sizes of the same forging for example, say, a strap for a locomotive side rod 5 or 6 ins. wide is wanted, and the plunger to be used has been made for a strap 4 or 4½ ins. wide. In this case the machine forges a liner around the plunger, and with different thicknesses of liners as many different sizes of straps can be forged. In making various sizes of valve-yokes the plunger is made for the smallest size and liners used in forging larger sizes. This machine requires no belting, gearing or lubrication. It will give repeated short, quick blows, when desired, without returning to the end of the stroke.

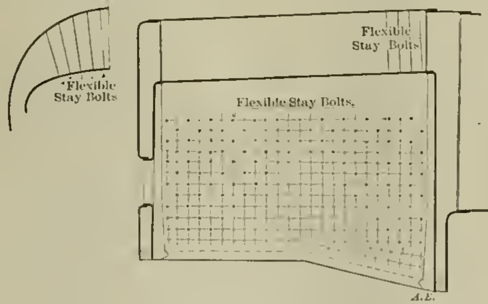
The great variety of work performed, ranges from the heaviest of forgings to the smallest S hook, and must be seen to appreciated.

Through the ease of changing dies, which for the majority of complicated operations simply lift in and out of the die-blocks, nearly all are accomplished in one heat, the time required to change dies in all cases ranging from 1 to 3 minutes. An inspection of this machine and its work indicates it to be a valuable labor saver. Not only does its work cover a wide range in each individual machine, but the machine itself may be built in a variety of forms for adaptation to the work of different departments of rolling stock construction. We are indebted to Mr. M. Kennedy, foreman of the Burnside blacksmith shop, for this information.

APPLICATION OF FLEXIBLE STAY BOLTS TO LOCOMOTIVE BOILERS.

Wabash Railroad.

While a great deal of attention has been given to the construction of stay bolts, with a view of providing for bending without danger of breaking, little has been recorded with reference to the location of these special stay bolts in boilers. In our December number, 1900, the ball and socket stay bolt de-



Application of Flexible Staybolts—Wabash Railroad.

signed by Mr. J. B. Barnes, of the Wabash Railroad, was described and illustrated. This is now called the "Acme Flexible Stay Bolt," and from the manufacturer, Mr. C. A. Thompson, of St. Louis, we have received a drawing showing its application to a recent lot of new locomotives built for that road by the Richmond Locomotive Works.

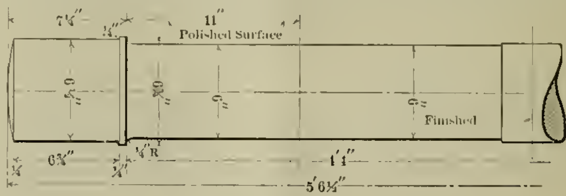
While there is no fixed rule for their location in the fireboxes, the practice of this road may be followed safely. About 100 of these flexible stays are distributed over each side sheet, as indicated in the sketch, their locations being governed by experience with the breakage of bolts of the usual form. In this case they are used in alternate spaces except in a central portion of A shape. In the back head about 36 are applied and in the front end of the crown sheet about 40, making nearly 280 in all. There are none in the throat sheet. At the front end of the crown sheet four transverse rows are put in, and these extend five rows each side of the center.

Mr. Barnes states that thus far he has not found a single broken stay bolt of this kind, and from the examination of side sheets when engines have come in for wheel and driving box work the sheets appear to be in much better condition than those having the old form of bolts exclusively. Mr. Thompson believes that the cracking of side sheets will be overcome by the use of these flexible stays. Those which have been in service for a year or more and have been removed for examination show the under side of the head to be worn bright and smooth as if they had been freshly turned and ground, but no scale has been found under the heads. This appears to demonstrate conclusively the flexibility of these bolts.

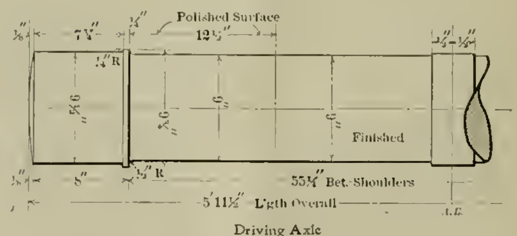
AXLES WITH ENLARGED WHEEL FITS.

Delaware & Hudson Company.

These drawings are presented as a reminder of good practice, for the application of enlarged wheel fits is not new. It is not as general, however, as the merits of the idea seem to warrant. When axles are made large in diameter where they are inaccessible for inspection the chances for unsuspected cracks are greatly reduced, and it is surprising that all driving



Engine Truck Axle



Driving Axle

Enlarged Wheel Fits for Locomotive Axles.

and engine truck axles are not made in this way. The same remark applies also to crank pins. During the past three years attention has been repeatedly directed in our columns to this principle, and another example is now added to the list. At the inside of the wheel fit a collar is left on the axle to aid in meeting the severe thrusts due to the shocks from suddenly entering curves. At the center of each axle a space is left rough in order to receive the record of the material, date of manufacture and application, which is stamped upon it. A driving and a truck axle are shown in the drawing. This is the standard practice of the Delaware & Hudson Company, and in time it will undoubtedly be in general use.

The Crane Company, of Chicago, in connection with its profit-sharing plan, inaugurated three years ago, distributed nearly $125,000 to its employees January 1. Five per cent. of the amount paid each employee in wages during the year 1901 was thus awarded without reference to the length of service.

A PARADOX IN CONNECTING ROD DESIGN.

By Geo. L. Summers, M. E.

The accompanying diagrams show in an interesting manner a peculiarity in the design of connecting rods; that is, by adding more metal to certain parts of the rod section the rod not only is not strengthened, but may even be made weaker.

A section of a main rod, of good design, with flanges ⅞ in. thick, is shown in Fig. 1. If the flanges be gradually thickened the rod will attain a maximum strength when the flanges are 19/16 ins. thick, and the strength will then decrease until the flanges come together in the center.

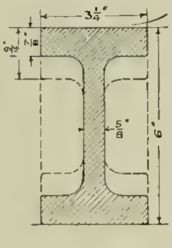


FIG. 1.

The curves reproduced in Fig. 2 show graphically:

That inside of certain limits the fiber stress as a long column may, for commercial purposes, be taken as the pressure divided by the area.

That if a strong enough rod cannot be obtained by adding a small amount to the inside of the flanges it is better to take a new section than to try to gain strength by making the flanges extremely thick.

The most economical point is reached where the depth of the flange equals about one-sixth of the total depth.

[Editor's Note.—This concise study of the design of locomotive connecting rods represents a portion of a commercial method of checking calculations, worked out by Mr. Summers. He has promised a thorough discussion of the design of connecting rods for a future issue.]

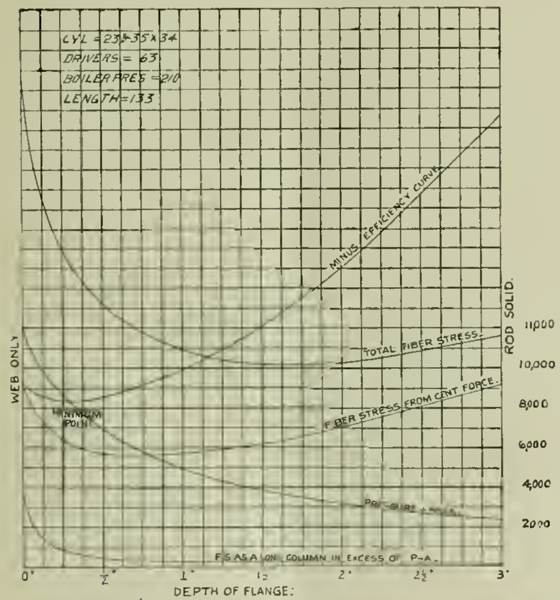


FIG. 2.

Mr. G. W. Kenney has been appointed superintendent motive power and rolling stock of the Rutland Railroad. Mr. J. J. Reed, formerly general foreman of the locomotive department of the D., L. & W. Railway at Scranton, Pa., has been appointed assistant superintendent motive power, and Mr. C. J. McMaster assistant superintendent rolling stock. The headquarters of all of these officers will be at Rutland, Vt.

PERSONALS.

Mr. R. P. Blake has been appointed mechanical engineer of the Northern Pacific, with headquarters at St. Paul, Minn.

Mr. M. R. Coutant, formerly mechanical engineer of the Wabash, has been appointed master mechanic of that road at Fort Wayne, Ind., to succeed Mr. G. S. McKee.

Mr. M. B. Hunt has been appointed mechanical engineer of the Erie, with headquarters at Susquehanna, to succeed Mr. T. H. Curtis.

Mr. J. J. Maguire has been appointed assistant purchasing agent of the Mexican Central Railway, to fill the position just now created. He will be located at No. 52 Broadway, New York.

Mr. John A. Orr has been appointed insurance inspector of the New York, New Haven & Hartford. He will inspect the insurance risks of the company, investigate fires affecting railroad property and act as adjuster for the railroad company.

Mr. George H. Goodell, who recently resigned as mechanical engineer of the Northern Pacific to enter the engineering department of the Pressed Steel Car Company, has been appointed chief engineer of the latter company. Mr. Goodell was for a number of years mechanical engineer of the Erie Railway.

Mr. W. A. Nettleton has been appointed assistant superintendent of machinery of the Atchison, Topeka & Santa Fe, with headquarters at Topeka, Kan. He was formerly superintendent of motive power of the Kansas City, Fort Scott & Memphis.

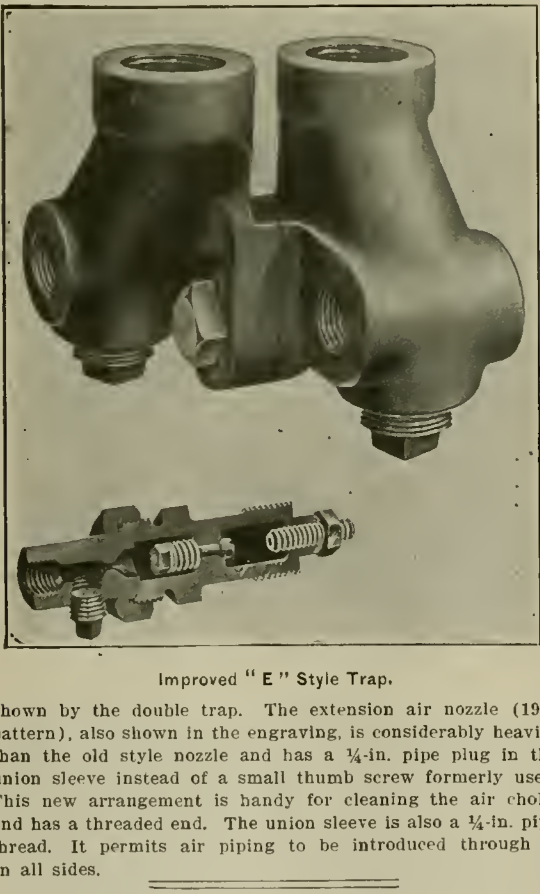
Mr. A. L. Humphrey, superintendent of motive power and car department of the Colorado & Southern, has been appointed superintendent of motive power of the Chicago & Alton, with headquarters at Bloomington, Ill., to succeed Mr. C. M. Mendenhall, resigned. Mr. Humphrey has been with the Colorado & Southern since July 1, 1900, and was formerly for nearly eight years in a similar position with the Colorado Midland.

ANGUS BROWN.

Angus Brown, Division Superintendent Motive Power of the New York Central at West Albany, was instantly killed by a train January 22, as he was going from his office to his home at noon. This shocking accident removes one of the most promising of the staff of the New York Central. He had been at West Albany less than a year, and in that time had won a position with superiors and subordinates which is given to but few men to attain, and the grief of all who knew him, especially those in immediate contact with him at Albany, is expressive of the highest honor and esteem and marked the influence of his quiet, unassuming, self-forgetful life. The writer was privileged to know him, and the sad duty of giving the news to his friends carries with it a melancholy pleasure in pointing to his high character, honesty of purpose, quiet and forceful way, which made him a power among men and brought him absolute trust and high regard from his officers. To these attributes were added an unusual ability and breadth of view. Such men are needed everywhere, and especially in charge of large bodies of men, where example is so important and where management is becoming increasingly difficult. He had a fine record of seventeen years on the Northern Pacific and was afterward Superintendent of Motive Power of the Wisconsin Central. As he was laid away one of the shop men said with tears, that he had never had such a superintendent.

IMPROVED "E" STYLE TRAP.

The accompanying engraving illustrates the improved "E" style trap of the American Locomotive Sander Company, which is a modification of the Leach D2 trap. This last mentioned trap has been found difficult to keep tight at feed-pipe unions, caused by the union nuts working loose, or pipes being of an irregular length. To correct these troubles the E trap is made in two parts, which are screwed separately on the ends of the feed pipes and then brought together and bolted. The bolt holes are oblong, which will allow for irregularities in pipe lengths. It may be applied in place of the D2 trap without any change in the pipe connections. The centers have been kept the same as with the old style. The triple trap is also furnished of a design to accomplish the same object as



Improved " E " Style Trap.

shown by the double trap. The extension air nozzle (1901 pattern), also shown in the engraving, is considerably heavier than the old style nozzle and has a ¼-in. pipe plug in the union sleeve instead of a small thumb screw formerly used. This new arrangement is handy for cleaning the air choke and has a threaded end. The union sleeve is also a ¼-in. pipe thread. It permits air piping to be introduced through it on all sides.

WATCHMAN'S IMPROVED TIME DETECTOR.

The Imhauser time detector in its improved form, as used in the United States Life Saving Service, and which was the only contrivance of its kind employed at the Pan-American Exposition, is a clock with chronometer adjustment and fully jeweled works. It is protected by a dust-proof cap and the outer edge is fitted with a safety knife blade lock attachment which cuts the dial every time the clock is opened or closed. There are 12 or 24 keys fitted, one to each station inside or outside the buildings. The watchman at arriving at a station inserts the key in the key-hole of his clock and turns it once to the right. This punches a figure on the dial at the exact time indicated by the clock. A single stamping spring made from the finest steel is used. It is attached to the cover and is completely independent of the watchman. The construction of the clock is such that tampering with it is out of the question. The highest award was given Imhauser & Co. for their exhibit at the Pan-American Exposition.

A BONUS SYSTEM.

Owing to the difficulty in our composing room, referred to in our January number, a number of articles were destroyed and could not be replaced in time for publication in that issue. Among these was the following reference to an important paper read before the American Society of Mechanical Engineers.

Unquestionably the most important subject brought before the society at this meeting was that introduced by Mr. H. L. Gantt in a paper entitled "A Bonus System of Rewarding Labor." In the paper and discussion chief prominence was given to the absolute necessity of establishing the base prices of systems of bonus, premium and piece work upon a correct basis. Mr. Gnatt carried this to a scientific point by the use of instruction cards for each piece of work. This gave the order of operations, the methods of placing the work in the machines, designated the tools to be used for each operation and the feeds and speeds for each. In fact, the cards reduced the process to a "rule of thumb," which was definite and complete. The effect was to reduce the cost of work to an astonishing extent and yet the men were happy. A bonus was earned by the men who carried out these instructions and completed the work in the specified time. The regular daily wage is paid if the bonus is not earned. This plan gives a bonus also to the foreman if the men make theirs, and the foreman's reward is greater if every man earns his bonus.

Premiums are paid, as was stated in the discussion, even to unskilled laborers for such work as shoveling and loading pig iron. Under the day work plan it cost nine cents per ton to load pig, and this was reduced to four cents, the wages going up from $1.25 to $1.85 for the work to accomplish this.

Two factors were considered absolutely essential to the success of any form of piece work: First, a correct basis of prices. Second, perfect and complete confidence on the part of the men that no change will be made in the rate until the introduction of new methods renders the old rate obsolete. While these have been pointed out again and again as the only possible foundation for success, the introduction of "piece work" continues with a strange disregard of these fundamentals.

Most organizations, such as railroads and manufacturing companies, grow from small beginnings, with a tendency toward the overlapping of functions and duties which involves unnecessary expense. One speaker described a study of his organization, employing 300 men, in which, by constructing a chart of the functions of officers and foremen, it was found that the lines crossed frequently. An hour's study of this chart showed where $3,600 could be saved annually by avoiding a few unnecessary duplications of work. The cost of these charts and that of the instruction cards, referred to, of course increased the general expense, but it was made clear that these functions, if performed at all, are usually done by men in the shop who are poorly qualified for them. It was better to intrust such things to specialists. This pointed clearly toward "rule of the thumb" methods in the work, but this was considered advantageous if intelligently carried out.

All of these suggestions came from large works, handling heavy pieces, such as heavy forgings, guns and crank shafts. The underlying principles, however, apply as well to smaller work and to all kinds of "piece work." This paper is suggestive even if too far advanced for most enterprises.

The locomotive industry of Austria comprises five different establishments, employing at present 5,200 workmen, viz.: The machine works at Florisdorf, with 1,300 men; the machine shops of the State Railway Company at Vienna, with 1,300 men; the locomotive works at Wienerneustadt, with 1,400 men; the Kraus Machine Factory at Vienna, with from 400 to 500 men; and the Bohemian-Moravian Locomotive Works at Prague, with 800 men. The total annual capacity of the five establishments is about 400 locomotives, and their annual earnings are between 20,000,000 and 25,000,000 crowns ($4,060,000 and $5,075,000).

BOOKS AND PAMPHLETS.

"Compressed Air: Its Production, Uses and Applications." By Gardner D. Hiscox, M. E. 820 pages, large octavo; 545 illustrations; cloth. Published by Norman W. Henley & Co., 132 Nassau street, New York, 1901. Price, $5.

This work assembles more tables, formulas and information concerning compressed air than have been gathered together before. It is a valuable treatise on the subject, and the large number of examples worked out to illustrate calculations constitute its most important feature. Many of the engravings record a state of the art in compressed air application which is constantly changing and will not long be up to date, but the treatment of principles will be valuable for a long time. The book treats of the thermodynamics of air, its compression, transmission, expansion, uses for power purposes, compressors, motors, air tools, sand blasts, air lift pumps, submarine work and refrigeration. It cannot be expected to give authoritative detailed information in so many items, but it is nevertheless the most complete work which has so far appeared on the subject.

"Metallurgy of Cast Iron." By Thomas D. West. Third Edition. Published by the Cleveland Printing & Publishing Company, Cleveland, Ohio, 1901. Price, $3.

The fact that this book is in its third edition speaks for its character. The author is well known for his systematic and persevering efforts to place foundry work above the plane of the time-honored methods, particularly as to the grading of iron by inspection. He stands for analysis of the pig, and has for years pursued the subject of the transverse testing of cast iron with a view of overcoming the wide variations in results which have in the past brought many men to believe that this form of test was not worth while, because its results were not reliable. In this direction Mr. West's efforts are crowned by the adoption of his ideas by the American Foundrymen's Association, and Chapter 70 contains a compilation of the tests of this association by which each grade of iron was found within twenty seconds by one ladle of iron, thus insuring the pouring of all bars of each grade at the same temperature. This result has never before been achieved in the pouring of test bars. Mr. West is thoroughly experienced as a foundryman, and gives the reader the benefit of his long experience and his opinions based thereon. He has studied blast furnace practice with a view of its application to the cupola, and he does not recommend anything which he has not tried and proved. He defines the effects of the various metalloids upon iron and treats in a thorough manner the principles of foundry work. A fair amount of attention is given to car wheels, and it is interesting to note his quotation of Mr. J. R. Whitney from the National Car and Locomotive Builder of May, 1889, on the expansion of iron in cooling. It is a valuable book for all who use or direct the use of cast iron.

"Dixon Automobile Graphites."—This little pamphlet presents the advantages of graphite for use on automobiles. The larger part of the pamphlet is devoted to testimonials from well-known men who have given the solid lubricant thorough tests.

The Electric Smelting & Aluminum Company, of Illinois, has begun equity proceedings to have Paul S. Reeves and S. K. Reeves, trading as Paul S. Reeves & Son, of Philadelphia, enjoined from making an alleged infringement of certain letters patent relating to improvements in manganese bronze, an alloy of commerce. This refers to the manufacture of manganese bronze, patents for which are controlled by the Ajax Metal Company, of Philadelphia.

Mr. W. H. Tew, formerly connected with the American Locomotive Company, Brooks Works, and later with the mechanical engineering department of the Chicago & Northwestern Railroad, has been appointed Managing Director of the newly organized German branch of the Standard Pneumatic Tool Company, with headquarters at Klosterstr, 13-15a, Berlin, Germany. This company is about to erect works at that place for the manufacture of "Little Giant" pneumatic tools and appliances for supplying the trade in Continental Europe.

The American Metal Hose Company, 40 Dearborn street, Chicago, have issued a catalogue of metal hose, their specialty being a double construction, the inside of which is copper and the outside of steel, made to stand rough use and high steam pressure. This hose has been adopted for use in the German navy and by the North German Lloyd Steamship Company. It is known as the Witzenmann system. The claims of this hose certainly warrant investigation by railroad officers with reference to its use for steam heating connections between cars and also for compressed air connections.

Exhaust Heads and Steam Traps.—The B. F. Sturtevant Company, of Boston, has issued a small catalogue, No. 119, illustrating and describing the Sturtevant exhaust head and steam trap. Tables of sizes and dimensions are included in the descriptions.

The Standard Pneumatic Tool Company has just issued a small pamphlet illustrating and describing their "Little Giant" pneumatic tools. The printing of the pamphlet is entirely in the German language, and it is for distribution among the trade in Germany.

The American Steam Gauge & Valve Manufacturing Company, Boston, Mass., report that their business for 1901 was largely in excess of the previous year, and the outlook for 1902 is more promising than at the same time last year. The demand in this country for their gauges and valves has not only increased, but their foreign business is crowding them. They also report that the sale of their Thompson indicator has steadily increased, until they feel there are now more Thompson indicators sold than all the other makes combined.

The Watson-Stillman Company, of New York, has just issued a new catalogue, No. 63, entitled "Hydraulic Valves and Fittings." In this catalogue only the most popular varieties of high pressure hydraulic valves and fittings are given. These include screw stem valves, plunger valves, balanced piston valves, balanced spindle, double valves, valves relating to accumulators and hydraulic check valves. This catalogue, like all others that have been issued by this company, is made up of separate sheets with the description and engraving of one machine on each sheet. These sheets are numbered and sent out separately on request. The complete catalogue can also be procured by those interested in this machine. Those applying by postal should give their position or the line of business.

"A Book for Club Women" is the title of a very attractive and pleasing pamphlet just issued by the advertising department of the Santa Fe Railway. The book is beautifully illustrated with views of verandas, courts, gardens and interior views of women's clubs. The text treats especially of home and club life, and of houses, gardens and domestic conditions, with a few words of information in the back of the book telling about the special excursion rates that will be in force during the National Convention of the Federation of Women's Clubs at Los Angeles, May 1 to 8, 1902. Any information regarding passenger rates, tickets, through car accommodations or other particulars can be had by addressing any of the passenger department agents of the Santa Fe Railway.

Mr. R. M. Dixon was elected Vice-President of the Safety Car Heating & Lighting Company and First Vice-President and Manager of the Pintsch Compressing Company at a meeting of the boards of directors of the above two companies on January 15, 1902. Mr. Dixon will have charge of the mechanical departments, embracing also adoption of all standards and experimental work, together with the construction and operation of the gas works. He will also have charge of the preparation of all applications for patents. The assistant engineers and superintendents of the gas works will report to him. In the absence of the president he will perform the duties assigned to the president by the by-laws of the companies.

At the same meeting Mr. D. W. Pye was elected Assistant to the President of the Safety Car Heating & Lighting Company and Second Vice-President of the Pintsch Compressing Company. Mr. Pye will have charge of the commercial interests of the companies and perform the duties of general purchasing agent. He will also perform such other duties as may be assigned him by the president.

"Record of Recent Construction, No. 30." This pamphlet of the Baldwin Locomotive Works contains an address upon compound locomotives, delivered by Mr. S. M. Vauclain last July. before officers and employees of the Union Pacific Railway, at Omaha. The address was illustrated by stereopticon views, and the pamphlet contains the most important of these, and a sliding valve diagram explaining the functions of the valves of the Vauclain system of compounding.

Sturtevant Dry Kilns.—This catalogue of 86 pages gives the essential principles of the Sturtevant hot-blast apparatus, together with information regarding the process of lumber drying and of the various designs of this company's dry kilns and apparatus. The engravings, which are of a high class of work, show only typical applications of the company's apparatus. In the back of the catalogue is a leaf forming pages 83 and 84, which is detachable and contains fourteen well-directed questions to be filled out and sent to the B. F. Sturtevant Company, Boston, Mass., by those wishing to have designs and estimates submitted on dry kilns.

With the rapid growth in the number of desirable winter resorts in the South there has also been a general development in the means of reaching these places, both by rail and water. To aid in selecting a resort at which to spend the winter the passenger department of the Lehigh Valley Railroad has issued a very attractively illustrated pamphlet giving the advantages, surroundings and facilities of the more important winter resorts in Florida, North Carolina, Virginia and New Jersey, together with routes by which they can be reached, the rates of fare and other useful information. All of these places are reached by the Lehigh Valley. A copy of this pamphlet can be procured by writing Mr. Chas. S. Lee, General Passenger Agent of the Lehigh Valley Railroad, 26 Cortland street, New York.

The J. A. Fay & Egan Company's new catalogue of standard wood-working machinery has been received. It is in keeping in every particular with the high standard of this company's machines. The J. A. Fay Company and the Egan Company have up to this time issued separate catalogues, but in this volume of 440 pages, of standard size, 9 x 12 ins., bound in heavy black cloth, the united efforts of the combined company (J. A. Fay & Egan Company) are shown in a complete line of new and improved machines. The contents of this book covers nearly everything in the wood-working line. The descriptions of the machines are clear and concise, and are illustrated by large woodcut engravings. The completeness of this catalogue, the interesting information and facts which it contains, makes it a reference book that every railroad or manufacturing company using wood-working machinery should possess. For additional information regarding this catalogue—Series L—address the department of advertising of the J. A. Fay & Egan Company, Cincinnati, Ohio.

EQUIPMENT AND MANUFACTURING NOTES.

CHICAGO PNEUMATIC TOOL COMPANY.

The organization of the Chicago Pneumatic Tool Company, of New Jersey, has been completed, and on December 31, 1901, took over the properties proposed; namely, the business and plants of the Chicago Pneumatic Tool Company, of Illinois, the Boyer Machine Company, of Detroit, Mich.; the Chisholm & Moore Crane Company, of Cleveland, Ohio; the Franklin Air Compressor Company, of Franklin, Pa., and the New Taite-Howard Pneumatic Tool Company, of London, England. The securities issued are $2,000,000 5 per cent. twenty-year gold bonds and $5,000,000 of common stock, there being only one kind of stock. There remains in the treasury, unissued, $500,000 of bonds and $2,500,000 of stock. The company starts with a working capital very largely in excess of one million dollars, of which more than 50 per cent. is in actual cash. It also starts with actual earnings by the constituent-companies, before this organization, at the rate of $700,000 per year, which, after paying fixed charges and sinking fund under the mortgage, leaves 11 per cent. earnings on the stock.

The directors of the company are as follows: Charles M. Schwab, President United States Steel Corporation; John A. Lynch, President National Bank of Republic, Chicago; John R. McGinley, capitalist and banker, Pittsburg, Pa.; James H. Eckels, President Commercial National Bank, Chicago; William B. Dickson, Assistant to President, United States Steel Corporation; Charles A. Miller, President Galena Oil Company; J. W. Duntley, President Chicago Pneumatic Tool Company; Joseph Boyer, President Boyer Machine Company, Detroit, Mich.; Edward Y. Moore, Vice-President Chisholm & Moore Manufacturing Company; Max Pam, Counsel; John Charles Taite, of Taite-Howard Company, of London, England; Charles Parker Whitcombe, of Taite-Howard Company, of London, England.

The Executive Committee is as follows: J. W. Duntley, Chairman; Charles M. Schwab, Max Pam.

The officers are: J. W. Duntley, President; W. O. Duntley, Vice-President; Edward Y. Moore, Second Vice-President; Ernest P. Wenger, Treasurer; H. R. Kent, Assistant Treasurer; Le Roy Beardsley, Secretary; S. G. Allen, Assistant Secretary; Joseph Boyer, Mechanical Engineer; A. J. Doughty, General Superintendent; Pam, Calhoun & Glennon, General Counsel.

The Executive Board has made the following appointments: W. O. Duntley, Vice-President and General Manager; C. E. Walker, Assistant General Maanger; Thomas Aldcorn, General Sales Agent; W. P. Pressinger, General Manager Air Compressor Department; Chas. Booth, Manager Chicago Office; S. G. Allen, Manager New York Office.

The West Virginia Central & Pittsburgh Railway has ordered 500 hopper cars of the Vanderbilt design, which was illustrated in our November number of 1901. These cars will be built by the Cambria Steel Company.

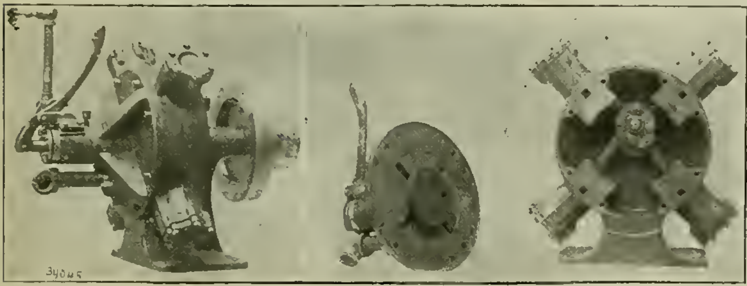
The Bullock Electric Mfg. Co. and the Wagner Electric Mfg. Co. have issued a card illustrating a single or multiphase motor direct-connected to a small centrifugal pump for apartment buildings where alternating current is the only available power. The pump delivers 25 gallons per minute, and will raise water 100 feet, if necessary. It is a compact unit, which will be exceedingly useful for auxiliary service in connection with large shop plants.

The O. M. Edwards Company, of Syracuse, N. Y., have secured the services of Mr. B. S. McClellan as traveling representative for the Edwards window fixtures, extension platform, trap door fixtures and other railway devices. Mr. McClellan is a practical railroad man, thoroughly familiar with current practice, and has a wide acquaintance from his connection with the New York Central as foreman of the passenger car shops at West Albany, and previous to that he held a similar position with the Illinois Central at New Orleans.

The general sales offices of the Pennsylvania Steel Company and the Maryland Steel Company have been moved to Philadelphia, located in the Girard Building. They will be represented by Mr. Howard F. Martin, General Manager of Sales of the Pennsylvania Steel Company. A local sales office will be retained at the Steelton plant for business in the vicinity of the works, and will be under the charge of Mr. Chas. W. Reinoehl, Sales Agent.

THE LEONARD HIGH-SPEED MULTIPLE-CYLINDER ENGINE.

The accompanying illustrations represent an improved steam or compressed air engine, designed to meet certain requirements where high speed and light powers are an advantage, as for detached machinery, pumps, dynamos and fans. It is also particularly adapted to launches and locomobiles, owing to its compactness and strength in design of frame, and because no working parts are exposed to gather dust and dirt.



Leonard High Speed Multiple Cylinder Engine for Light Powers.

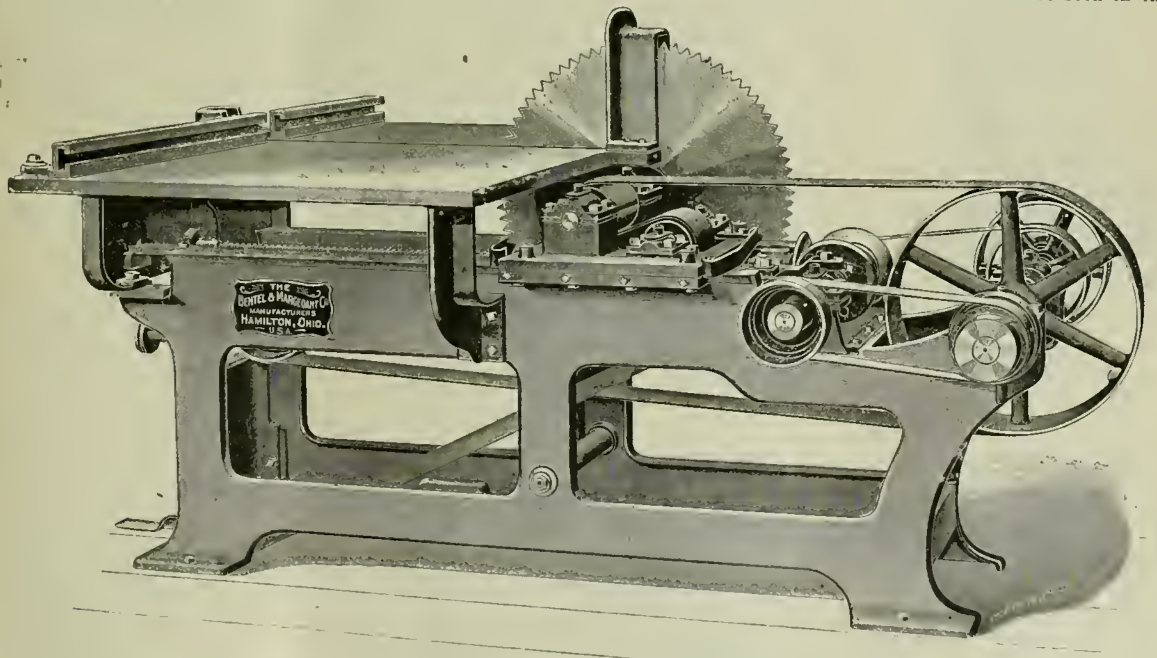
The most important feature of this engine is its simplicity, which will be apparent to all users of engines. There are very few parts, all of which are easy of access. There are only two places requiring packing. The first figure shows the complete engine as used for stationary purposes. It will be seen that the frame, cylinders and bearing are all cast in one piece. There are four single acting cylinders set at right angles to the crank shaft, which is made of one solid piece of steel. Four pistons with connecting rods are attached to an ingenious center bearing on the crank shaft, which runs in oil inside the frame casing. The engine is balanced, and, owing to the arrangement of cylinders the strain on the crank pin is nearly constant, as one cylinder is under pressure while the one at right angles is exhausting. The valve gear is of the rotary type, and very simple. It is operated by a disc as shown in the view with the valve casing removed. This valve is controlled by a lever having a ratchet stop, and by this arrangement the motion of the crank shaft can be reversed, the speed slowed down or stopped; also, by this same movement a variable cut off is obtained. This is a great advantage for use on launches or locomobiles, also for railroad and other shop use, as the engine is always under the control of the operator. The operation is as follows:

Steam is admitted to the side of the valve frame, passing through ports in the valve to the top of the cylinder and is exhausted back through the same valve to an exhaust chamber in the valve chamber, thence to the exhaust pipe. All wearing parts are bronze bushed and can easily be replaced. No attention is required to run the engine other than to keep the oil cups filled. There are no rods to key up, or knocking of moving parts inside the casing, as on most engines of this class, and an interesting feature is that the engine starts at once and at any point, either right or left, at the will of the operator. It is compact, strong, and light, compared with other small upright engines on the market. This engine is used with very satisfactory results in driving flexible shafts in locomotive and other similar work.

Further information may be had from Joseph E. Wise, The Bourse, Philadelphia, Pa.

HEAVY AUTOMATIC CUT-OFF SAW.

This machine is designed with a heavy central connected table or long extension roller table to be used for medium and heavy work of such dimensions as is required in car shops, shipyards and for heavy building material. It has a very heavy, well-braced frame 7 ft. 5 ins. long, which supports a table 5 ft. long by 3 ft. 4 ins. wide. As will be seen in the accompanying engraving the two halves of the table are strongly connected by a bridge over the saw, and each supplied with a section of fence to be placed either at the front

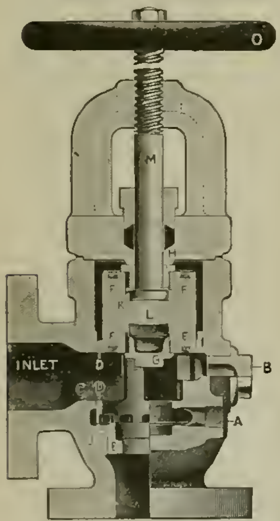


Heavy Automatic Railway Cut-Off Saw.
Bentel & Margedant Company.

or rear end of the table, as preferred. The machine is furnished with one saw 24 ins. in diameter, but saws up to 30 ins. in diameter can be used and will cut off material 27 x 6 ins. or 17 x 11 ins. The saw housing travels in dovetail slides and is provided with adjusting gibs for taking up wear and for lining up the saw. To allow the housing to move more freely and to do away with the swinging tension frame, the saw is driven by an improved endless belt which keeps the tension equal throughout the length of travel. The feeding of the saw housing is by means of a heavy lead screw which is made to rotate right or left through miter frictions which are thrown in and out of gear by a foot treadle. There are three rates of feed and a fast return feed. The saw can be started and stopped at any point in its travel and the speed of travel can be increased or diminished by the operator at will, through the medium of the foot treadle, which is under his direct control. On the countershaft, which is attached to the machine, are tight and loose pulleys 14 and 13 ins. in diameter, with 8¼-in. faces, of the Bentel & Margedant Company's patented construction. There has been specially designed, for the easy handling of heavy timbers, a long extension roller table. This is provided only by special order. The weight of this machine is about 42,000 pounds. Any information of a special nature regarding this cut-off saw machine No. 111 will be furnished upon application to the Bentel & Margedant Company, Hamilton, Ohio.

THE DURO BLOW-OFF VALVE.

The Lunkenheimer Company has just placed on the market a blow-off valve, made in three sizes, with flanges or screw ends and having a self-cleaning seat. This ingenious device consists of a plug which fits snugly in a separate and easily-removable bronze casing, which can be readily replaced when worn. Any accumulation of scale on the seat is prevented by a jet of steam blowing over the seat.

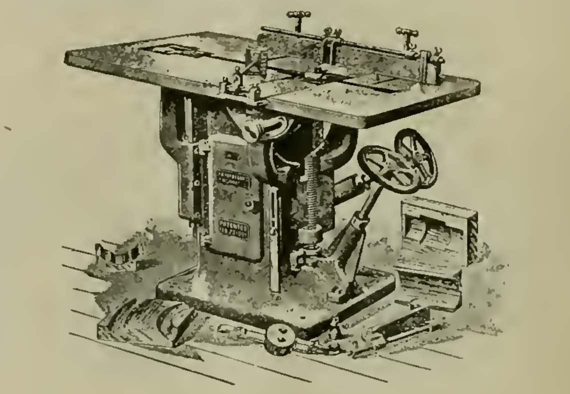


Sectional View of Duro Blow-Off Valve.

In the sectional view of this valve, shown in the accompanying engraving, it will be noticed there is a steam inlet, A, which connects with an annular passage, C. This inlet connects to the steam part of the boiler with a suitable valve interposed. The steam inlet A admits to C and J, and discharging from the latter, blows across the seat, cleaning off any scale or sediment that may have accumulated on it, so that the disc and seat bearing, when in contact, will be perfectly clean. The iron body of the valve has a brass casting, D, with a circular slot, J, cut into the side, at a point below the level of the seat, E. This casing is held in place in the body of the valve by the seat ring, E, both of which are removable at any time for repairs or replacement with new parts. In closing the valve the disc is screwed down, and the edge in passing the lower edge of the casing, D, cuts off a great deal of the flow of water and sediment. At the same time the valve in the steam pipe leading to the inlet, A, should be opened and the steam admitted to the annular space, C, from whence it passes through the slot J and blows off the entire surface of the seat, E. The disc on reaching the seat cuts off the flow of steam from the inlet, A, as well as the blow-off from the boiler. The valve in the piping leading to the inlet, A, can be left open at all times, as the disc of the blow-off valve would keep this outlet closed. The disc or plug is reversible, as it has two seating faces which can be changed at will, and thus increases considerably the durability and efficiency of the valve.

A NEW CORE-BOX MACHINE.

The accompanying engraving represents a new core-box machine which has been brought out by the J. A. Fay & Egan Company, and for which the makers claim great advantages in


New Core-Box Machine.

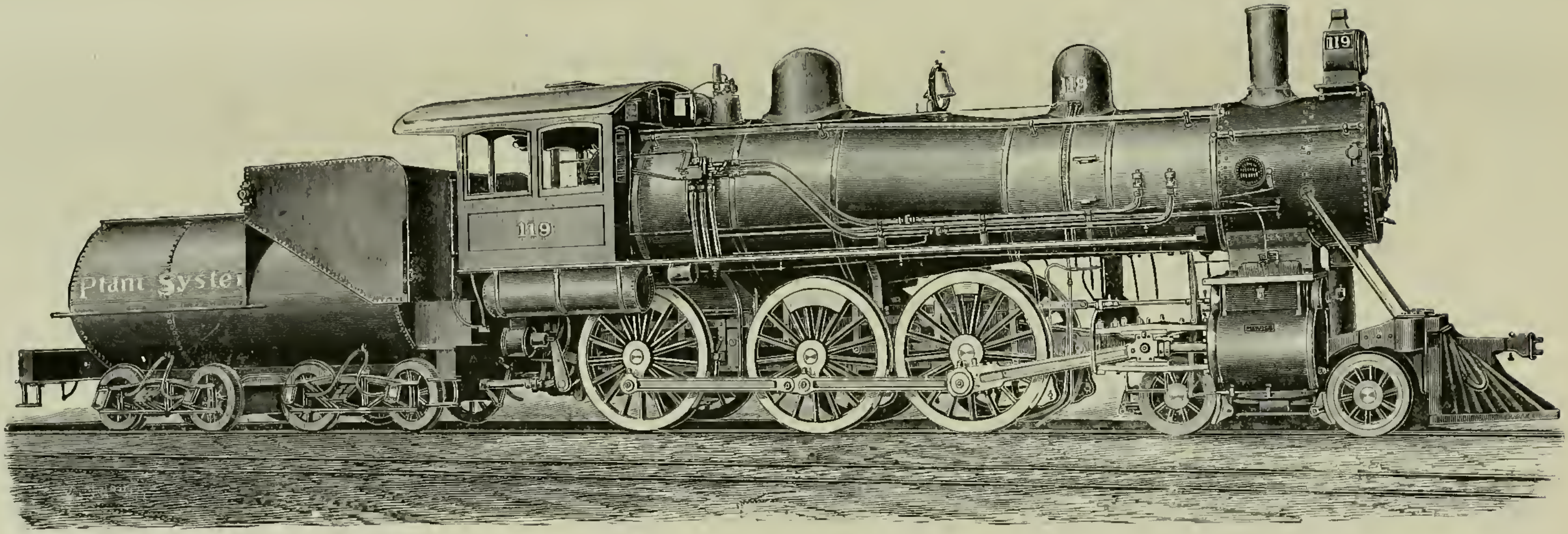
speed and accuracy for making all kinds of cored boxes and work that requires recessing and duplicating.

This machine will cut semi-circular core boxes of any length, and from 1 to 20 ins. in diameter; also semi-circular core boxes closed at the ends with recesses of different diameters, and with corners of any desired shape. On patterns with internal curves, such as the inside of staves, cores and cutting out the under side of bosses to fit on rounded patterns, the work can be produced very rapidly. For making large fillets on engine and pump frames, and similar patterns, it is a great saving over the old methods of working the curve. It is not necessary that clear lumber be used when making cuts on this machine, as the cutters are so constructed that they will cut knotty lumber either with or across the grain and give it a smooth surface. To produce correctly such core boxes as elbows, a radius attachment is used with the machine. The heads used can be set for different diameters and are so made and set that the bits are adjustable. By this arrangement a fewer number of heads need be used to accomplish a wide range of work. The address of the J. A. Fay & Eagan Company is 409 Front street, Cincinnati, O.

KNECHT FRICTION SENSITIVE DRILL.

The frictional sensitive drill press manufactured by Knecht Brothers, Cincinnati, Ohio, is so evidently satisfactory wherever it is used as to justify our directing attention to it again in these columns. Its chief characteristics are the speed control, friction drive and variable power adjustment. The engraving shows the construction of the machine. The slide guiding the friction roller is graduated for the proper speeds for drilling cast-iron, the sleeve passing through the spindle head is graduated for the depth of hole, and a collar may be fixed for drilling a number of holes to the same depth. The machine is very convenient, and those using them say that the saving of broken drills pays for the machine in a short time. Further information may be had by sending for Circular No. 4, to Knecht Brothers Company, Cincinnati, Ohio.


Knecht Friction Sensitive Drill.



Ten-Wheel Compound Passenger Locomotive—Plant System of Railways.

W. E. Symons, Superintendent of Motive Power.

Vauclain, Four Cylinder Balanced System, with Vanderbilt Boiler and Tender and Symons Steel Truck.

THE 20,000th LOCOMOTIVE BUILT BY THE BALDWIN LOCOMOTIVE WORKS,

Philadelphia, Pa., U. S. A.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

MARCH, 1902.

CONTENTS.

AMERICAN ENGINEER TESTS.

Locomotive Draft Appliances.

VI.

TESTS OF LOCOMOTIVE STACKS.

Report by Professor W. F. M. Goss, of Purdue University.

Section 1, Continued from Page 35.

4. The Variables.—The plan, as outlined, and as approved by you before the beginning of the work, involves a study of the effect produced upon the efficiency of the draft action by certain definite changes in the mechanism of the engine and in the conditions under which it is run. Factors which by the outline of the tests are subject to change are as follows:

a. Form of Stack.—With reference to this factor, two contours only were provided, one straight and one tapered, of the general form disclosed by Figs. 2 and 3, respectively. (See American Engineer, page 35, February number.)

b. Diameter of Stack.—Each form of stack was developed into a series of different diameters, the diameters being 9¾ ins., 11¾ ins., 13¾ ins. and 15¾ ins., respectively. The dimensions given apply to all portions of the straight stacks above the base, and to the least diameter of the tapered stacks. It is the understanding of the undersigned that the reasons which influenced Mr. Vaughan in the selection of the diameters chosen are to be found in the fact that they are in close agreement with the diameters used in the von Borries-Troske experiments.

c. Height of Stack.—Each of the eight stacks already described was made in five sections, the upper four sections each being 10 ins. in height. This provision makes it possible to employ either of the eight stacks in heights varying from 16½ ins. to 56½ ins.

d. Exhaust Nozzles.—It was not expected that the work should involve any investigation of exhaust pipes or nozzles, this phase of the draft appliance problem having been very thoroughly covered by the Committee of the Master Mechanics' Association, working under the inspiration and direction of Mr. Robert Quayle. It was assumed, however, that in order to get the maximum efficiency of each different diameter and height of stack it would be necessary to provide a variable height of nozzle. This was done in the manner indicated by Fig. 4. The nozzle shown, therefore, provides means for testing each stack with nozzles of different heights.

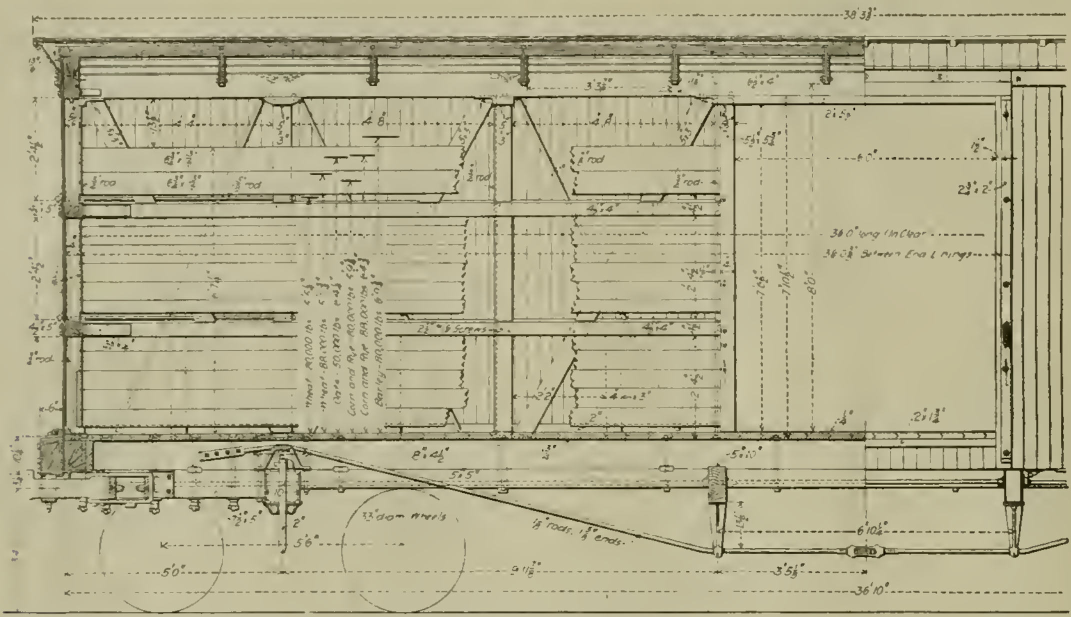
e. Power of the Locomotive.—In the early discussion of the matter, the question arose as to whether a combination of apparatus which would give the highest efficiency when the engine was worked at light power, would prove the most efficient under conditions of heavy power, and that there might be no question arising from this source it was determined to make tests under each combination of apparatus, with the engine running at three different rates of power. It was determined, also, that this could best be accomplished by running all tests under a constant steam pressure, a fixed cut-off, and a wide-open throttle, the desired variations of power being obtained by varying the speed. The conditions chosen were approximately as follows: Steam pressure 180 lbs., cut-off of 1-3 stroke, speeds for different power 20 miles, 30 miles and 40 miles, respectively; the power under these conditions being approximately 260, 370 and 475. The amount of steam generated by the boiler, and discharged from the exhaust tip, varies nearly in direct proportion to variations in power.

5. The Measure of Efficiency.—Following the practice of the Master Mechanics' Committee, the efficiency of each individual arrangement has been judged by the value of the ratio of the reduction of pressure in the smokebox to the back pressure in the steam passage between the cylinder and the exhaust pipe. Thus, calling the reduction of pressure in the smokebox "draft," and the pressure in the exhaust passage "back pressure," the efficiency is

$$\text{Efficiency} = \frac{\text{Draft}}{\text{Back pressure}}$$

This measure is based upon the assumption that the result, which is sought by use of draft appliances, is a reduction of pressure within the front end, and that the force necessary to be expended in securing such a result is represented by, or is a function of, the back pressure between the cylinder and the exhaust tip. Consequently, other things being equal, that arrangement of apparatus which will give the desired reduction of pressure in the front end for the least back pressure is the most efficient. To be entirely logical, both the draft and the back pressure should be expressed in units of the same value, though this is not necessary where results are for comparisons within themselves.

6. Methods.—It is well known that the draft, as measured by a reduction of pressure within the front end, is affected by conditions other than those which control the action of the steam jet. With the force of the jet remaining constant, the draft will vary with every change in furnace condition which serves in any way to affect the freedom with which the air is permitted to move through the grate and firebox. Thus, all other things remaining constant, the draft is reduced by opening the fire door, and increased by closing the ash-pan dampers. Similarly, a thin, clean fire, which offers but little resistance to the passage of air, results in light draft, while a thick, heavy fire, which impedes the movement of air at the grate, increases the draft. This being true, and since the draft is a factor in our accepted measure of efficiency, it follows that the observed efficiency of any given detail in the front-end arrangement will be affected by any variation of conditions at the grate. The present purpose is concerned entirely with the stack and the dependent mechanism within the front end, and that observations in connection with these need not be affected by complicating conditions elsewhere, it has been deemed essential to provide for constant conditions at the grate. As this could not be done in connection with solid fuels, the experimental engine was equipped for burn-



80,000 Lbs. Capacity Box Car.
New York Central & Hudson River Railroad.

ing oil, the air openings into the firebox being so arranged that they would at all times be of fixed dimensions; the degree of ease, therefore, with which air finds its way into the furnace is unaffected by the condition of fire. The fuel used was Lima oil. Acknowledgements are due Mr. C. W. Owston, representing the Standard Oil Company, for courtesies received in connection therewith.

In work previously carried on at Purdue the draft has been obtained by means of a U-tube connecting with a pipe extending into the smokebox just back of the diaphragm. Before undertaking an investigation so formal as that with which this report deals, it seemed best to consider whether such a location of the draft gauge gave a representative value for the reduction of pressure in the front-end, or whether the gauge itself might not be affected by conditions of running, independent of the normal pressure existing in the front-end. The question having been raised, it seemed best to make a preliminary survey of the front-end to determine what is the condition of pressure throughout every part, with the expectation of finally locating the draft-gauge at a point which could be accepted as satisfactory. The results of this investigation and the conclusions derived therefrom constitute the subject of another section of this report.

The steam pressure within the exhaust passage of the saddle has been determined by means of a U-tube filled with water or mercury, and checked by a Bristol pressure-recording gauge. As a further check on this reading, specially prepared indicators were attached to the right cylinder. These indicators were supplied with ten pound springs to permit the back-pressure line to be drawn at large scale, and adjusted in such a manner as to prevent injury to the indicator during the effective stroke of the piston.

7. Limiting Conditions.—The concluding portion of the preliminary work consisted in a study of the effect upon the experimental study, of limitations upon the height of stacks as disclosed by existing designs. For example, the limits which conditions of service place upon the height of the stack, necessarily limit the range affecting the relative position of all other parts within the front-end. It was thought that in the experimental work there would be no need to include conditions which could not under any circumstances be applied on the road. For this purpose information was sought from those having large boilers in service, concerning the dimensions of the several parts entering into the draft arrangement, including height of nozzles and of stacks. A study of data thus obtained has been made by Professor Forsyth, with conclusions which are presented in a succeeding section.

(To be continued.)

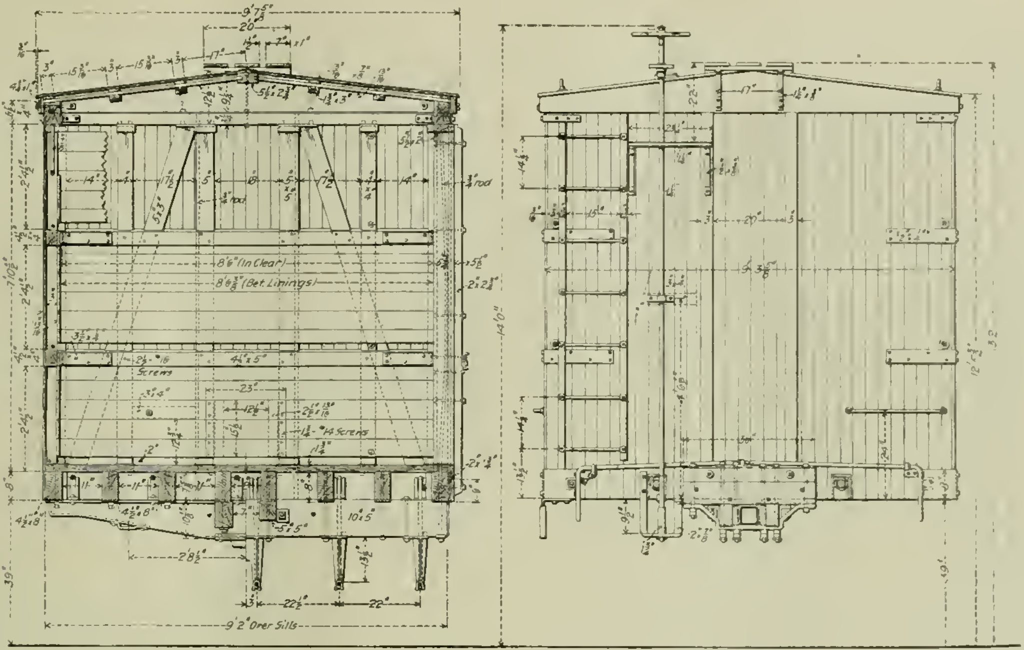
80,000-LB. CAPACITY BOX CAR.

New York Central & Hudson River Railroad.

Built to Standard Interior Dimensions.

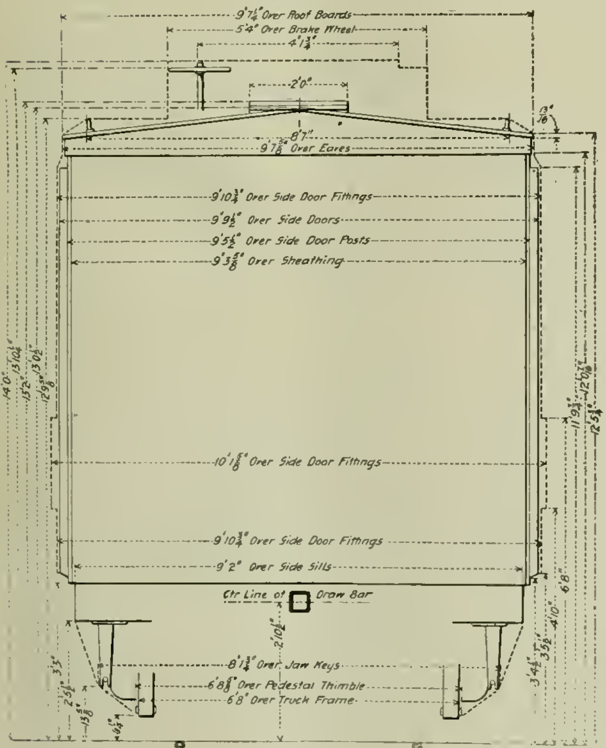
Through the courtesy of Mr. A. M. Waitt these engravings have been prepared to illustrate the new standard 36-ft. box car for this road, which is an interesting and important design in view of the fact that it covers the requirements of the standard inside dimensions and comes within the clearance limits of the Eastern roads, which are important in interchange of equipment. Furthermore, the construction is such as to avoid cutting the end sill for the shank of the coupler. This becomes important in the case of wooden underframes, although there is less objection, because of the weakening of the sills, when the underframes are of steel. This disposition of the coupler permits of retaining the usual height of the floor and the real difficulty is then transferred to the eaves, where close figuring is required to keep the width within the necessary limits. With this construction some care was required to secure sufficient room for a proper depth of the bolster. In this case the body bolster is 10⅛ ins. deep, which has been used satisfactorily under 40-ton cars, and either pressed steel or arch bar trucks may be used. These cars will have trucks of the former type.

Drawings for a car of this capacity had been completed when the standard interior dimensions were adopted by the American Railway Association, and after the announcement of the standard the dimensions were changed to those shown



80,000 Lbs. Capacity Box Car.

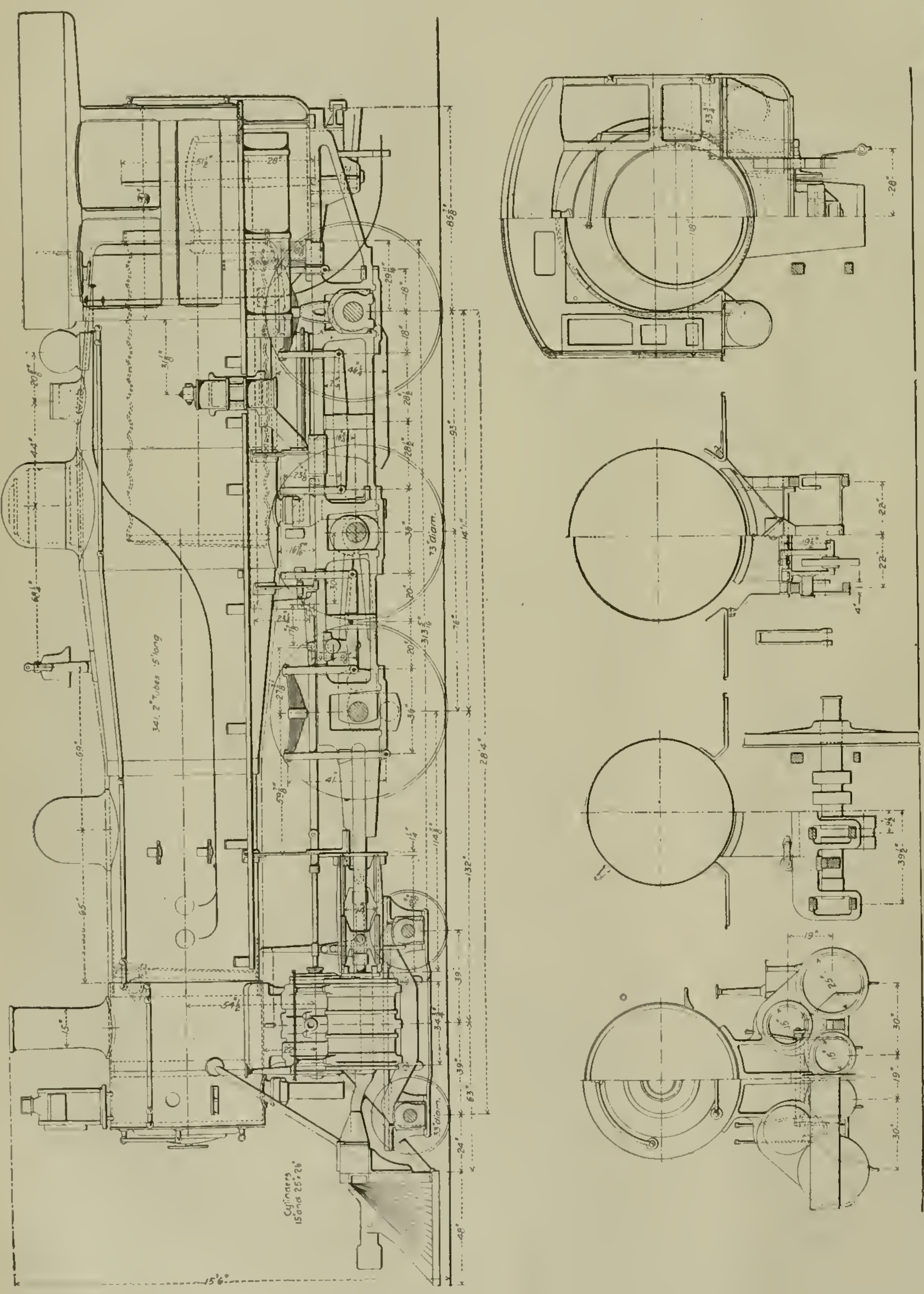
New York Central & Hudson River Railroad.



Clearance Diagram, 40-Ton Car.
New York Central & Hudson River Railroad.

in these engravings. These include a 6-ft. door opening, and the usual number of side posts was retained in order to avoid bringing the bracing too near to the vertical. It will be seen that the needle beams have been placed under the door posts to give them substantial support. All the posts and braces have cast-iron pockets at both ends, and instead of using tie rods between the plates the carlines and plates are connected by joint bolts.

The distance from the top of the rail to the upper face of the floor is 4 ft. ¾ in., which is but ¾ in. more than that recommended by the circular from the committee of the Master Car Builders' Association. At a height of 12 ft. 6¾ ins. above the rail the width of the New York Central car at the eaves is 9 ft. 7⅝ ins., or but ¼ in. more than the distance recommended by the committee. Otherwise the dimensions of the car meet the recommendations of the committee. While the slope of the roof is less than that of earlier cars on this road it has less pitch than that proposed by the committee, which was done in order to secure a minimum clearance of 20 ins. over the running boards of the cars for the home road. These cars have "Security" doors with no shields over the door rails. Only very thin metal shields could be used, and they were omitted entirely, the upper joint between the door and the car body being water tight without further protection. Winslow roofs and malleable iron draft arms are used. The engravings have been prepared with special care to illustrate the details of the construction. The clearance diagram indicates the cross-section of the car with the dimensions conveniently arranged for comparison with the clearance diagrams of other roads. It would be well for all roads to prepare these diagrams if they expect to interchange equipment with the Eastern lines with restricted clearances. We printed a similar cross-section for the New York, New Haven & Hartford on page 17 of the January number.



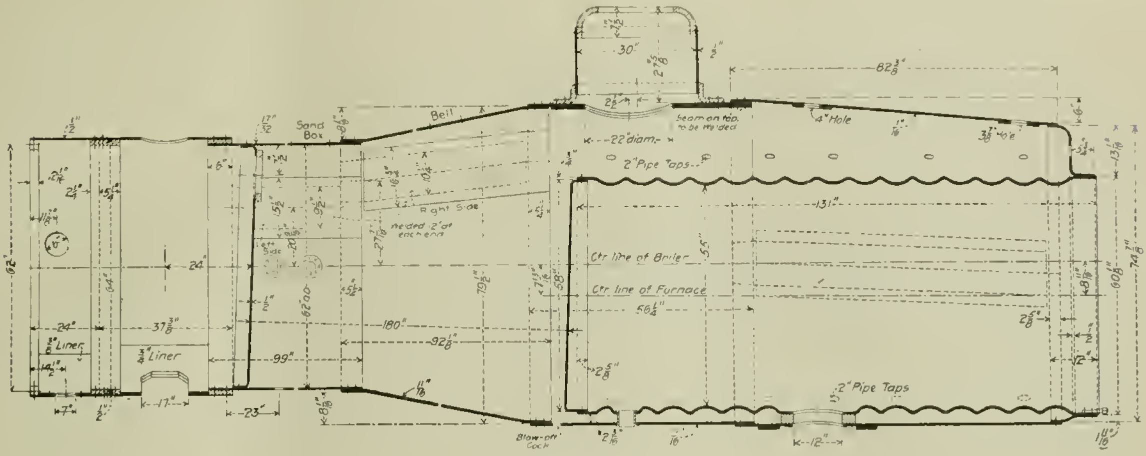
W. E. SYMONS, *Superintendent Motive Power.*

BALDWIN LOCOMOTIVE WORKS, *Builders.*

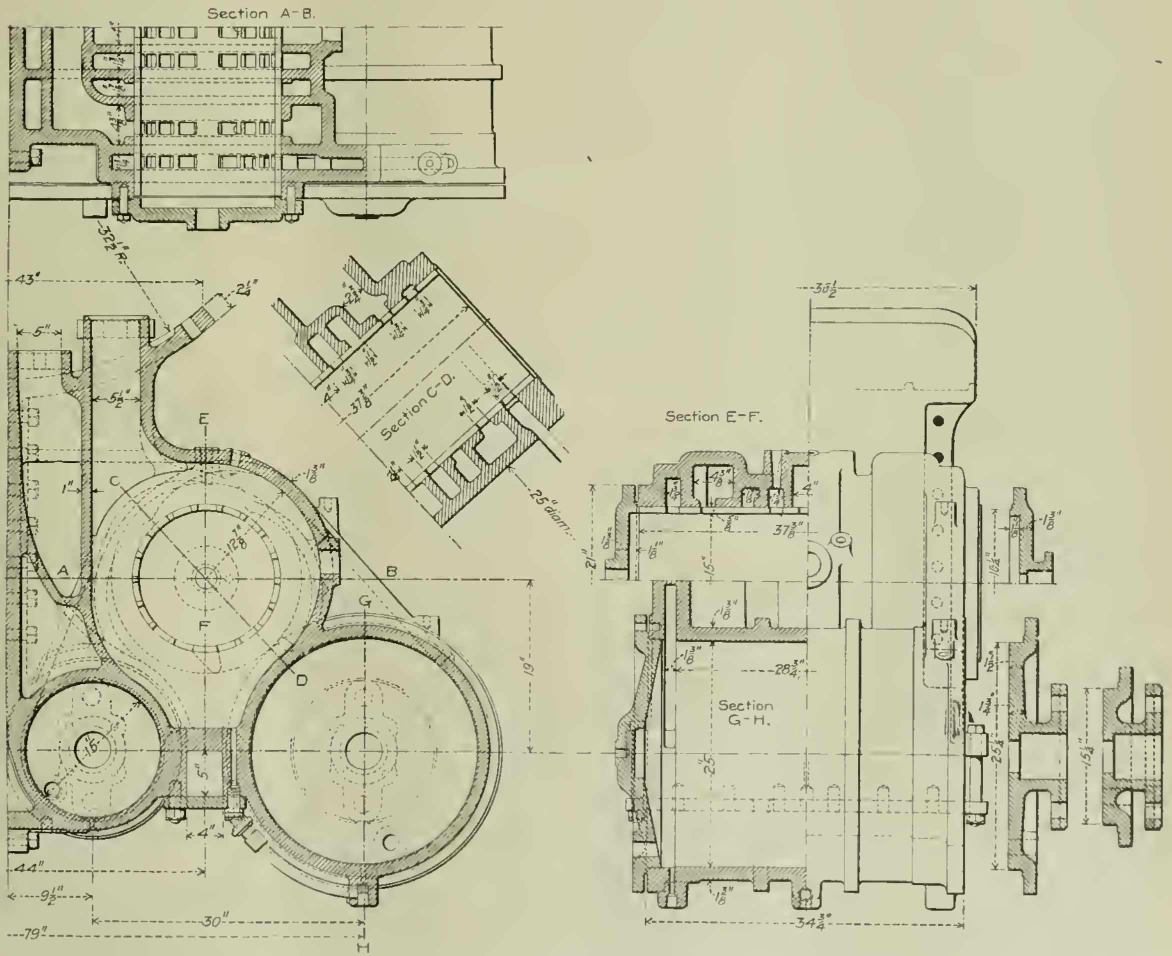
Compound Ten-Wheel Passenger Locomotive, Plant System of Railways.

Vauclain Four-Cylinder Balanced System, with Vanderbilt Boiler and Tender.

THE 20,000TH LOCOMOTIVE BUILT BY THE BALDWIN LOCOMOTIVE WORKS.



Vanderbilt Boiler.



Cylinders.

Compound Ten-Wheel Passenger Locomotive.—Plant System of Railways.

VAUCLAIN FOUR-CYLINDER BALANCED SYSTEM.

COMPOUND TEN-WHEEL PASSENGER LOCOMOTIVE.

Vauclain Four-Cylinder Balanced System.

Plant System of Railways

The 20,000th Locomotive Built by The Baldwin Locomotive Works.

With An Inset.

This locomotive combines the four-cylinder balanced construction recently patented by Mr. S. M. Vauclain, with the Vanderbilt boiler and tender. It also has the boltless cast-steel tender truck recently brought out by Mr. Symons, superintendent of motive power of the Plant System. It happens to be the 20,000th locomotive built by the Baldwin Locomotive Works in their 70 years of continuous operation. Editorial comment on this design will be found in another column of this issue.

The driving wheels are 73 ins. in diameter, and the connecting rods couple to the forward driving axle, which has cranks between the frames for the high-pressure connecting rods. The cylinders are 15 and 25 by 26 ins., and are arranged with their axes in the same plane and parallel. Above the cylinders is a 15-in. piston valve. A glance at the cylinder drawings will show the arrangement of drainage of the cylinders and steam passages for the water of condensation. A ⅜-in. pipe drains the exhaust cavity. All four crossheads are alike and of cast steel, with bronze shoes, each weighing but 181 lbs.; the connecting rods are very short. In order to permit of an approximately perfect balancing of the reciprocating parts the pistons are made hollow, the high pressure being of cast iron and the low pressure of malleable. Type metal is run into the high-pressure pistons in order to take care of the balance, and the result, as indicated in the table, is an excess weight of but 34¾ lbs., which is not balanced. All of the revolving weights are balanced. The piston rods are of the same size and also very light. Snap rings, with Peacock joints, are applied to the pistons, the piston rods having United States metallic packing. But one set of valve motion is required, and a motion bar, offset and guided, connects with the valve stem on each side. The cranks are at right angles and the pairs at 180°, and the details of the crank axle are shown in the drawing. It is of open-hearth steel, and seems to be an excellent piece of work. It is designed for a maximum fiber stress of 18,000 lbs. In order to make room for this axle the driving wheels were "dished" and the webs brush against the boxes. The valve travel is 5 ins., the outside lap for the high-pressure valves 1 in., that of the low-pressure valves ⅞ in., and the high-pressure valve has ¼ in., and the low-pressure ⅜ in. negative inside lap. The eccentric throw is 5½ ins. With this arrangement of cylinders a low truck cradle was required, because the center bearing is brought well down by the high-pressure cylinders. Relief valves are fitted to the heads of the low pressure, and the steam passages of the high-pressure cylinders. For a starting device a plug cock is used, which provides communication through a pipe between the ends of the high-pressure cylinder, by-passing the high-pressure valve. By placing the low-pressure connecting rods on the inside journals of the crank pins the fiber stresses on these pins are materially reduced.

In arranging the counterbalancing of this engine the following actual scale weights were taken:

	High-pressure. Pounds.	Low-pressure. Pounds.
Crosshead	181	181
Main rod, front end	120	130
Main rod, back end	244	280
Pistons	343¾	368½
Piston, crosshead and main rod	644¾	679½
		644¾
Difference		34¾

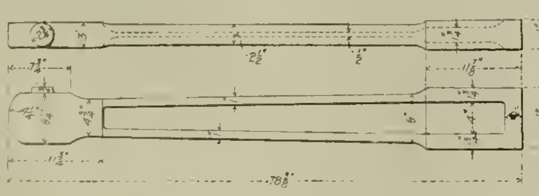
The difference might be reduced by using more type metal in the high-pressure piston, but it was not considered necessary to do so. This metal was employed because it is not expected to shrink and become loose in service.

Little need be said about the boiler and tender, as they have been described before. The firebox is 131 ins. long and 55 ins. in diameter, made by the Continental Iron Works, of Brooklyn. This provides for a grate area of 27 sq. ft., a brick bridge wall and a grate rocking in two sections. Mr. Symons's new tender truck is shown in one of the engravings. It is constructed of cast steel and put together with keys instead of bolts. There are no rivets or bolts, and the only nuts are those at the ends of the keys. This truck is believed to have a smaller number of parts than any heretofore devised. It requires some machine fitting, but the surfaces for this purpose are made small. The springs are short elliptics. An enlarged detail shows the construction of the keys and their bearings in the castings.

The following table presents the most important dimensions of the engine:

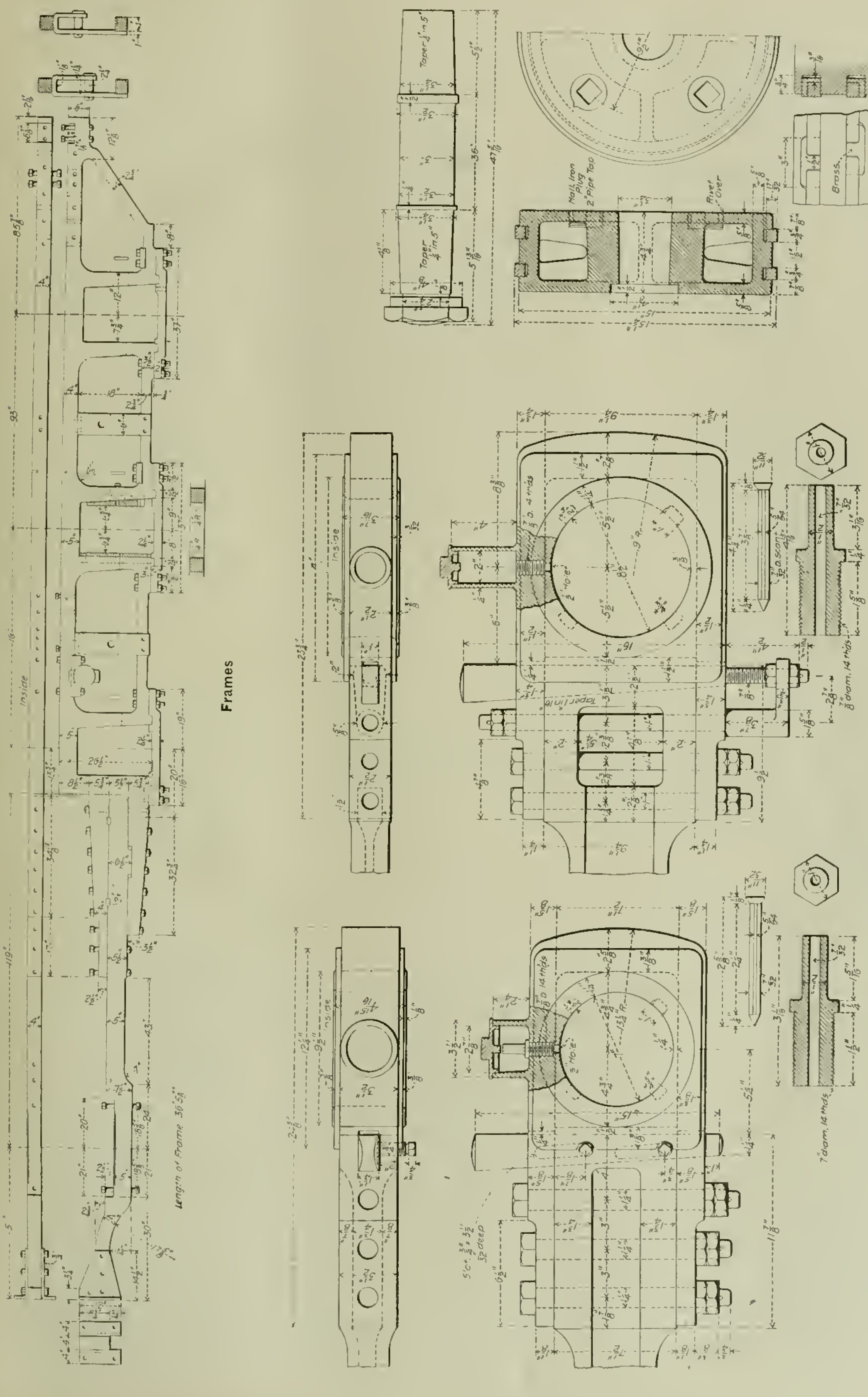
Four-Cylinder Balanced Compound Locomotive.
Plant System of Railways.

Gauge	4 ft. 8½ ins.
Fuel	Soft coal
Cylinders	15 and 25 by 26 ins.
Weight on drivers, estimated	114,000 lbs.
Weight on trucks, estimated	41,000 lbs.
Weight, total, of engine, estimated	155,000 lbs.
Wheel base, total of engine	28 ft. 4 ins.
Wheel base, driving	14 ft. 1 in.
Wheel base, engine and tender	56 ft. 0 in.
Height of stack above rail	15 ft. 6 ins.
Heating surface, firebox	128 sq. ft.
Heating surface, tubes	2,665 sq. ft.
Heating surface, total	2,793 sq. ft.
Grate area	2,725 sq. ft.
Wheels, leading truck, diameter	33 ins.
Wheels, driving, diameter	73 ins
Material of wheel centers	Cast steel
Journals, truck	5½ by 10 ins.
Journals, driving	8½ by 12 ins.
Main rods, center to center, high-pressure	83 ins.
Main rods, center to center, low-pressure	83 ins.
Valves, piston, diameter	15 ins.
Valve travel	5 ins.
Outside lap, high-pressure	1 in.
Outside lap, low-pressure	⅞ in.
Inside clearance, high-pressure	¼ in.
Inside clearance, low-pressure	⅜ in.
Lead in full gear, high-pressure	None
Lead in full gear, low-pressure	⅛ in.
Boiler	Vanderbilt
Boiler, diameter	Front, 67 ins.; back, 80¾ ins.
Boiler, pressure	200 lbs.
Boiler, thickness	17/32 in. and 11/16 in.
Boiler seams, longitudinal	Butt, sextuple riveted, welded ends
Firebox, length	131 ins.
Firebox, diameter	59½ ins.
Tubes, number	341
Tubes, diameter	2 ins.
Tubes, length	15 ft.
Tubes, material	Steel
Stack, diameter	15 ins.
Stack, material	Cast iron
Tender, type	Vanderbilt
Tender, trucks	Symons, boltless cast steel
Tender, wheels	33 ins.
Tender, journals	5 by 9 ins.
Tank, capacity for water	5,000 gals.
Tender, capacity for coal	9 tons



Low-Pressure Main Rod

High-Pressure Main Rod.



Frames

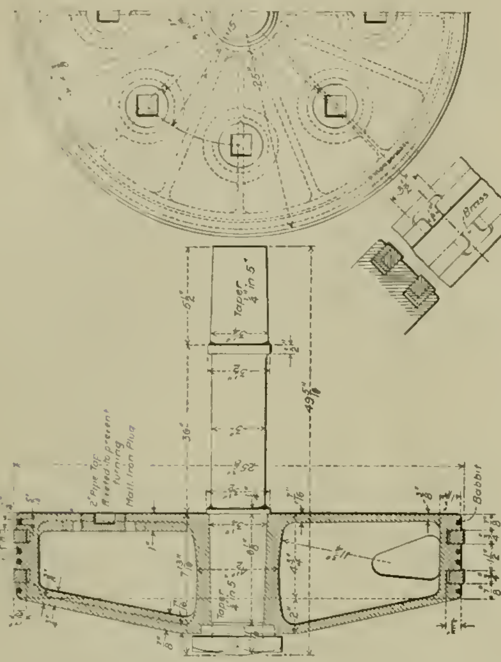
Main Rod Ends.

High-Pressure.

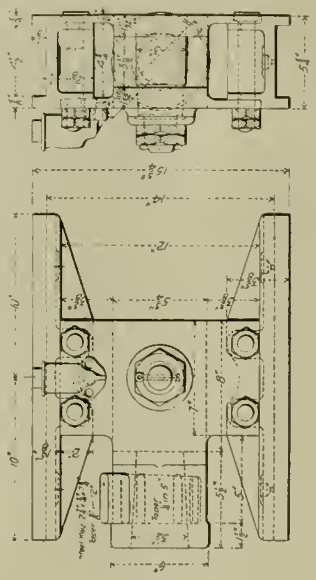
Low-Pressure.

High-Pressure Piston and Rod.

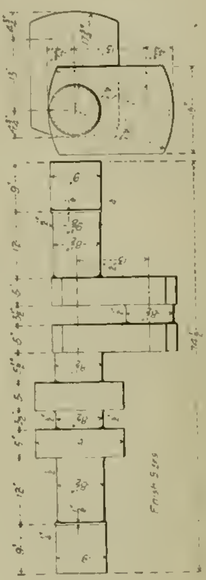
VAUCLAIN FOUR-CYLINDER BALANCED COMPOUND.—FOR THE PLANT SYSTEM OF RAILWAYS.



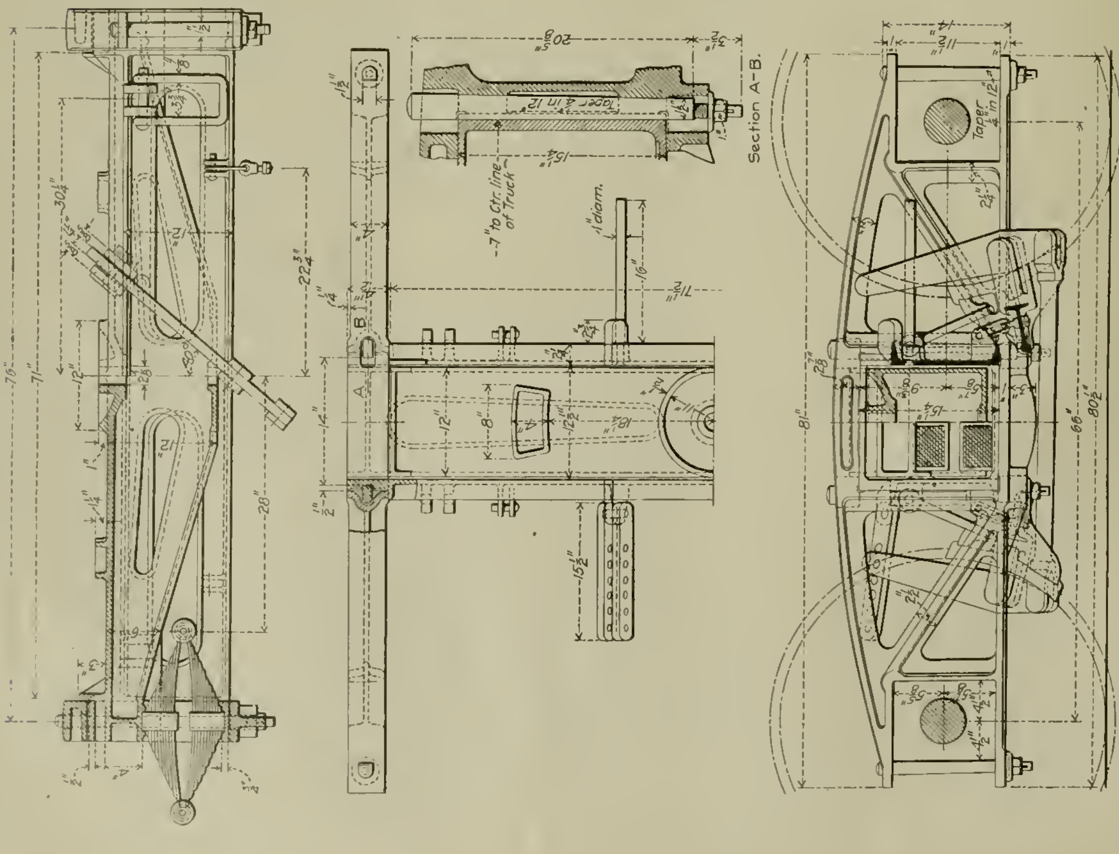
Low-Pressure Piston and Rod.



Crosshead.



Crank Axle.



Symons' Boltless Steel Truck.

VAUCLAIN FOUR-CYLINDER BALANCED COMPOUND.—PLANT SYSTEM OF RAILWAYS.

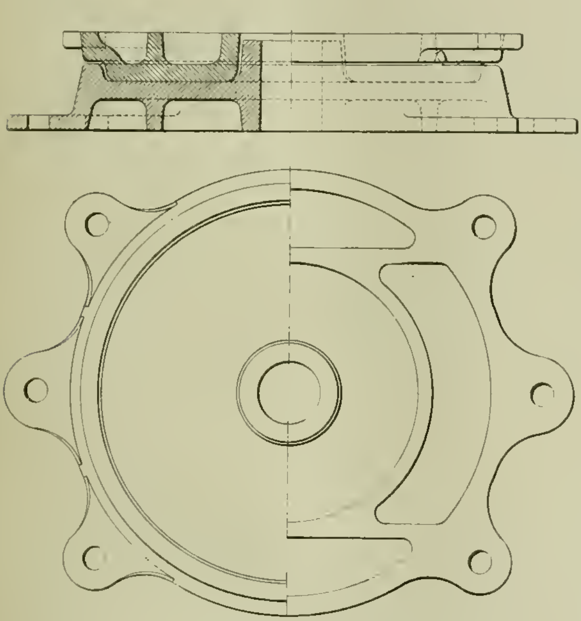
CAR CENTER PLATES.

By C. A. Seley, Mechanical Engineer, Norfolk & Western Railway.

The modern large capacity freight car requires special consideration in the design of many of its details, and the support upon the trucks, because of the greater weight transmitted has, of necessity, to be provided for in a very different structure than that which has performed satisfactory service in the smaller capacity cars.

Center plates have more to do than to merely transmit the weight of the car to the truck. The trucks of 40 and 50-ton cars weigh from 6,000 to 8,000 pounds each, and they must be pulled along by the center plates. They are generally arranged, and properly, so that the center pin does not come into play in this action. The pin should only be a safeguard, if it be even that, in case of a derailment of the trucks.

The retarding force of the brakes is applied to the trucks and in part is transmitted through the center plates to the body. There is generally some play in the plates, one upon the other, and much of the wear of the plates is due to the fore and aft play. In addition to this the movement of one plate upon the other, due to curvature of the trucks, amounts to something, although less than is generally supposed. The M. C. B. committee report on center plates in 1900 supports this. It is probable, however, if the plates are lubricated, that they will more freely respond to curvature and relieve the truck very considerably from the cornering stresses and also reduce wheel flange wear.



Center Plates of Cast Steel.

In view of the valuable information contained in the M. C. B. committee report and also in other literature on the subject, it is desired to present a few considerations with respect to a design of center plates for large capacity cars, and preferably with respect to those having metal sills or metal truck bolsters, or both.

In a design shown herewith one point to be noted is the double lock of the lower plate, the outer and inner rings both assisting in retaining the top plate in place. The outer ring is also designed to retain lubrication, and oil ways are provided whereby oil may be applied from a spout can. It will be noted, and perhaps criticized, that there is no center pin bearing in the top plate. This is purposely omitted. The inner ring of the lower plate extends up some distance, enough to retain the top plate under a considerable separation of the plates, due to a derailment. If the top plate goes high enough to get away from the outer ring it may mount upon the inner ring of the lower plate and bear against the center pin, which would then be in simple shear.

With center plates having but a shallow lock and a center pin bearing in both plates, the pin is quite sure to bend between the bearings in case of a derailment. In the present design, if the top plate goes higher than the top of the inner ring the pin may bend, but we have provided for ordinary contingencies, and center pins are of little value in controlling a derailed truck of a large modern car.

The bottom view of the bottom plate is shown in order to explain the ribbing under the bearing surface, which is similar in both plates. The straight ribs are intended to coincide with the webs of the truck bolster members and with the webs of the body center sills, or as near thereto as will give a maximum of support to the bases of the plates by interposing continuity of bearing between the car and truck. There are also semicircular ribs supporting the bearing surfaces about midway, and cross ribs may be introduced if thought necessary.

A study of the cross-sections leads one to believe that these forms will mold readily; that the section is uniform and so arranged as to produce straight castings; that the plates are about equally strong to resist deformation; the fastening lugs are so separated as not to influence an unequal shrinkage and consequent warping. The bearing area is ample, and considerable wear is allowed for before the center ring would have a bearing on the body bolster. They could be made in either cast steel or malleable iron, the former being preferable for very large capacity cars. To be fair to the reader, be it said that this is a proposed design, and not one actually in service at the time of writing.

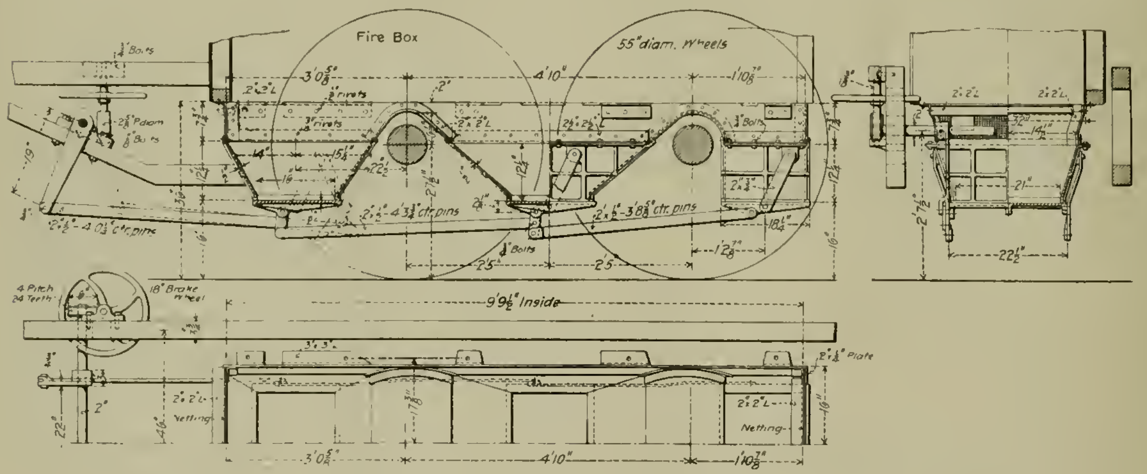
THE BOLSTER PROBLEM.

The bolster problem will probably ultimately be solved as an incident in the settlement of the more pressing draft gear question. Mr. R. P. Lamont's paper, read recently before the Western Railway Club, is summed up in his conclusion: Provide a reasonable space for the bolsters, also a reasonable proportion between length and depth and pay for enough metal, so that the stresses can be kept within safe limits. To provide this vertical space of 10 or more inches for the body bolster of flat-bottom cars simply involves the use of a low truck and a low truck bolster. There has been, however, a decided aversion to changing car construction for the benefit of the bolsters. A weak bolster settles down on the side bearings and so attracts little or no attention, while failures which put a car out of service demand consideration. Weak draft gear means a failure which cannot be ignored, as the weak bolster may be. Draft gear is, therefore, likely to be improved. Underhung draft gear of 20,000 to 40,000 lbs. capacity will transmit comparatively light shocks on the line of the sills by the coupler horn striking the end sill, but the fallacy of attaching high capacity draw gear beneath the sills has already been demonstrated in service, on a large scale. Experience has shown that draw gear should be placed on the neutral axis and between metal center sills. This does not necessarily mean an entire steel underframe, but this is doubtless the logical result. This location of draw gear means cutting or piercing the end sill, and that of necessity points to steel end sills. It seems hardly worth while to use steel center and end sills, and then make the remainder of the frame out of wood. The steel underframe would, therefore, seem to be the final form of car construction which will be used, and when used the bolster problem will be solved.

ASH PAN CONSTRUCTION FOR LOCOMOTIVES.

Great Northern Railway.

By the courtesy of Mr. Max Toltz, Mechanical Engineer of the Great Northern Railway, a drawing has been received illustrating an ash pan arrangement for which he has applied for a patent. The hoppers are of cast iron, bolted by means of angles to the upper section, which is also secured by angles to the mud ring. By means of swinging links pivoted at the sides of the three hoppers the flat cast-iron valves are supported so that they may be swung to the right, as seen in the engraving, to clear the openings, and when replaced they are brought up against their seats and held firmly so as to make tight joints with the hoppers. A small obstruction on one of the plates does not prevent the others from closing, because of the equalized connections. One of the valves is shown in its open position by dotted lines. In this case the valves are operated by a wheel, placed under the frames. This wheel turns a worm, as indicated in the drawing, and it is necessary for the fireman to be upon the ground when dumping the ashes, but the wheel may be placed in the cab if desired. In this construction the air admission is at the front and rear of the ash pan, through openings covered by wire netting. Much more attention is given to ash pans than was formerly thought necessary. They should be designed with a view of facilitating the cleaning of engines, and in order to avoid burning and warping the castings the joints should be tight enough to exclude air from the hot coals among the ashes.



Ash Pan Construction for Locomotives—Great Northern Railway.

WEAR OF JOURNALS.

The most economical axles are those under tenders, is the opinion of Mr. David Van Alstine, superintendent of motive power of the Chicago & Great Western. He explained, at a recent meeting of the Northwest Railway Club, from investigations he had made that the average life of tender axles for ½-in. wear in diameter was about 14 years, or perhaps 490,000 miles, and only 5 per cent. of these axles had been removed for worn collars. The large mileage they had made was probably due to the excellent care they received, and the average light loads they carried. With regard to engine truck axles the records were very incomplete, but they indicated that for ½-in. wear the average life appeared to be 7 years, or say 245,000 miles. This low average is accounted for by the use of babbitt bearings, and having usually smaller wheels they make more revolutions per mile and run at higher speed than the tender axles. The record of driving axles shows an average of 476,800 miles; this corresponds to about 13 years' service for ½-in. wear.

Driving axles have a tendency to wear taper and hollow. This uneven wear is, no doubt, due to an uneven distribution of dirt in the packing. Uneven wear, which concentrates the load on small areas, sufficient to exclude the oil, produces a hot box. A driving box which will distribute dirt uniformly along the journal, or better, exclude it altogether, is much to be desired.

Freight-car axles (4¼ x 8 ins.), show a life of 3.83 years for every 1/32-in. depth of wear, which brings them to about 30 years for ½-in. wear, which is the full life of the axle. Assuming that a freight car makes 25 miles per day, the life of the axle would be about 274,000 miles. This is not much more than half the mileage of passenger-car axles. The probable explanation is that freight axle boxes contain more dirt, and so wear the journals away quicker. The average for passenger-car axles of 4¼ x 8 ins. points to a life of 7 years, which probably equals 504,000 miles for ½-in. wear.

The conclusion which Mr. Van Alstine draws, is that the quality of the bearing metal and the packing need not be a source of much anxiety. The increase in the life of journals, and a decrease in the number of hot boxes, depend mainly on the exclusion of dirt.

In a recent discussion of the subject of repairs to all-steel cars, a committee of the Central Railway Club laid special stress on the protection of the metal by frequent painting. These cars should be painted inside and out at least once in eighteen months. It was found to take longer to clean the surfaces than to paint them, and the sand blast was recommended for this purpose. One speaker referred to the successful use of small pneumatic hammers with broad-faced flat chisels for cleaning the metallic surfaces of government vessels before painting. For steel car work the spray method of painting was recommended because it was of low cost, and also because the jet would reach points where were inaccessible to the brush. To reduce the cost of repairs and the present long delays to steel cars in the shop, proper special tools should be provided.

BRAKING POWER OF 100,000-LB. CARS.

The modern relation of revenue load to tare weight has introduced a new problem in brake service. Formerly, when cars weighed a considerable proportion of the gross weight hauled, the difference between the braking power of light and loaded cars was not so apparent. Nowadays, with heavily loaded cars of comparatively light individual weight, the brake problem has taken definite shape. Mr. H. H. Forney, general air-brake instructor of the Southern Pacific, speaking at a recent meeting of the Pacific Coast Railway Club, said: These cars must have sufficient braking power to be handled safely in any kind of service; the power must be sufficient to permit of their being handled safely on the ruling grade; the arrangement or adjustment of the braking power must be simple and strong, and must conform in a general way to the standard apparatus now in use; and this arrangement must not be a radical departure from standard practice.

Owing to the great difference between light and loaded cars, it will be necessary to have some form of brake equipment which will admit of exerting more power on a loaded car than on an empty one, and the braking percentage on a loaded car must be high enough to insure its holding itself. As Western mountain grades are not usually more than 2 per cent., the speaker thought that 30 per cent. of total load might be accepted as the minimum allowable braking power. The present maximum is 90 per cent. of the light weight. With the comparatively light weight of modern large capacity cars, the 30 per cent. minimum limit cannot be obtained. Large capacity cars are to-day being operated with a total braking percentage of from 17 to 21, and this means that other cars with excess braking power hold them.

Mr. Forney suggested, therefore, the application of a foundation rigging strong enough to withstand twice the strain now permissible, and also to equip these cars with two brake cylinders, so arranged that one cylinder would operate on an empty car at 75 per cent. of its light weight, and when loaded both cylinders would operate, thus giving 150 per cent. of light weight, but which would actually be about 35 per cent. of the total load. Each car in a train would then be an effective braking unit, able to hold itself without help from others.

TAR BURNERS AS AN AUXILIARY TO COAL ON LOCOMOTIVES.

Oil, or tar, is used as an auxiliary to coal fuel on express locomotives for the Eastern Railway of France. According to "Engineering" the boiler is of the Belpaire type, with ribbed Serve tubes; the firebox is fitted with a brick arch and with two tar burners. The engine is fitted with four steam cylinders, and is provided with a starting device for the direct admission of steam to the low-pressure cylinders. The two tar burners are placed on each side of the firebox door, and do not interfere with the ordinary working with coal; they are not intended to replace coal firing, but to increase when necessary the heat developed and the power of the locomotive on the steeper gradients. The burners are of the Vétillard and Scherding type; the tar is contained in a receiver on the tender, whence it is brought down to the ejector, a tap regulating the flow. The tar is supplied to the firebox by a steam jet. When necessary, live steam is delivered inside a serpentine pipe placed in the receiver to heat the tar and give it the required fluidity. Each ejector allows the burning of 220 lbs. of tar per hour under good conditions. The tar receiver is made to hold one ton of this special fuel.

WATER STATIONS.

The committee appointed to report to the Association of Railway Superintendents of Bridges and Buildings on water stations, upon the best material for foundations, tanks, substructures, connections, capacity, etc., presented a very interesting report. The committee sent out circular letters, in which twenty questions were asked. The reply from the Erie Railroad stated, among other things, that the height of the bottom of the tank above the rail, for that road, was 30 ft. In the matter of cost, the total was $2,704.26, of which $832.43 was the cost of a steel trestle, weighing about 30,270 lbs. A pine tub of 50,000 gals. capacity costs $275. In looking over the figures for the foundation, the most costly item is for Portland cement, which amounts to $63. Exclusive of labor the foundation appears to have cost $177.04. Masons' labor was $239.12, and carpenters' labor $186.91. The principal items in the plumbers' bill were, a 10-in. Mansfield standpipe, complete, $225; 10¾ tons of cast-iron pipe, $236.50, and plumbers' labor, $153.23. In the report from the Boston & Maine Railroad a 16 x 24-ft. water-tank foundation is quoted as costing $350. The tank, complete on the foundation, including fixtures for delivering water to engines, amounts to $1,200. The standard height on this road from bottom of tank to top of rail is 13 ft. 6 ins., but this is to be increased, probably to 14 ft. 6 ins.

ELECTRICITY AT THE NEW YORK NAVY YARD.

In rebuilding the machine shops of the New York Navy Yard, after the fire of 1899, the question of electric driving came up, and was finally decided by the introduction of the alternating current system. This system possesses advantages for transmission over considerable distances, transformers being used at the points of application. The new buildings include a machine shop 350 x 130 ft., an erecting shop 252 x 130 ft., and a boiler shop 300 x 96 ft., all being fireproof and equipped with modern tools. The generating plant consists of three sets with McIntosh-Seymour engines and Westinghouse alternators. The engines at 136 revolutions give 630 horse-power. The alternators have 25 periods per second, two-phase, at 220 volts pressure. The generators have a guaranteed efficiency of 94½ per cent. at full load, and 84 per cent. at quarter load. The motors range from 200 horse-power to 30 horse-power. The entire plant is designed in accordance with most advanced ideas. Standard apparatus is used throughout, making duplications or possible renewals very easy. The equipment of this plant in thoroughly modern style removes from the Government the reproach often merited, of being too conservative. Its good example in this case will be felt.

RICHMOND RAILROAD CLUB ORGANIZED.

A meeting was held on January 18, in Richmond, Va., which was largely attended by prominent railroad men of the city and state. The motive of this gathering was to organize the Richmond Railroad Club. The object of the club is similar to that of the existing railroad clubs, of which there are now twelve. Mr. W. S. Morris, Superintendent of Motive Power of the Chesapeake & Ohio Railway, was chosen president of the new club. Mr. C. S. Churchill was elected first vice-president; Mr. R. C. P. Sanderson, second vice-president, and Mr R. E. Smith, third vice-president. Mr. F. O. Robinson was elected secretary, and Mr. W. F. La Bonta accepted the treasurership.

One of the scholarships of the Master Mechanics' Association at Stevens Institute of Technology will be vacant in June, 1902, upon the graduation of one of the students. The scholarship confers the privilege of attending the entire course of four years at the Institute free of all tuition charges. It is open to sons of members or deceased members of the association, and particulars may be obtained from Mr. J. W. Taylor, secretary, 667 Rookery Building, Chicago.

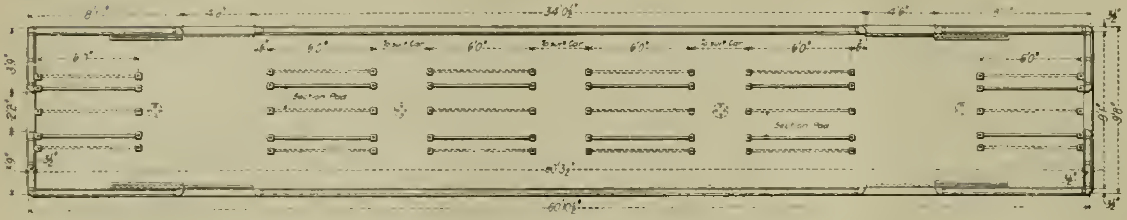
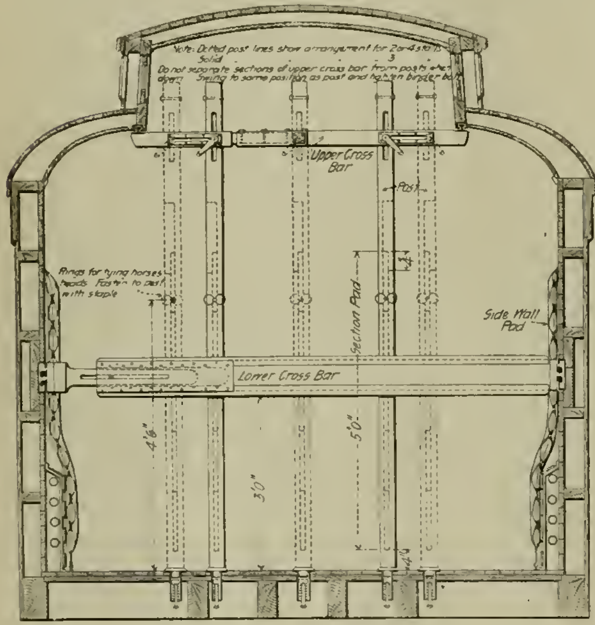


Fig. 1.



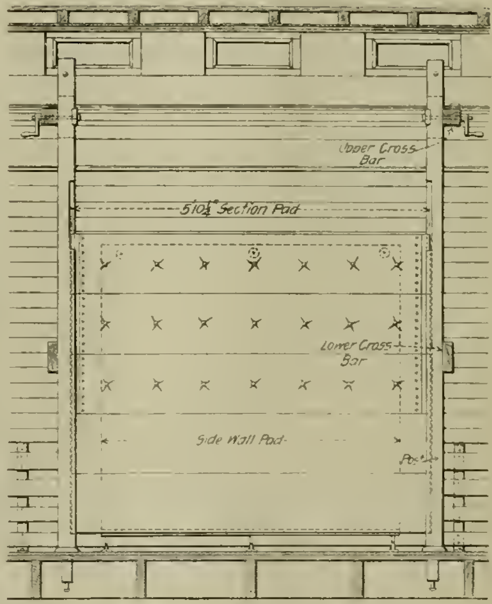


Fig. 2. Fig. 3.

Improved Equipment for Horses in Baggage Cars.
New York, New Haven & Hartford Railroad.

Fig. 4.
End View of One of the New Cars.

IMPROVED EQUIPMENT FOR HORSES IN BAGGAGE CARS.

New York, New Haven & Hartford Railroad.

These drawings and photographs, illustrating the latest practice of the New York, New Haven & Hartford in the transportation of horses, have been received from Mr. W. P. Appleyard, Master Car Builder of that road. They show the construction and application of a portable horse stall to baggage cars, the device being patented by Mr. J. P. Young, General Foreman of the car department.

This improvement seems to offer advantages over previous arrangements for this purpose. It furnishes means for the safe and comfortable transportation of horses without requiring the maintenance of distinct lines of car equipment for the purpose. The stalls may be applied to any class of baggage or express car used in passenger service, or they may also be put up in any style of box car. Once fitted to receive the stalls, a superior horse car is available, and the removal of the posts and stall divisions leaves the car perfectly free of all obstructions, and it is immediately available for its regular service. There is no nailing up of timbers of any character; the stalls may be applied or removed by two laborers in 15 minutes, and no tools are required. As the best of material is used, the stall equipment should last as long as the car. This stall has been adopted by the New York, New Haven & Hartford; the Erie; the Atchison, Topeka & Santa Fe, and the Southern Pacific Railways, and also by the Adams and the Wells-Fargo express companies.

In the illustrations, Fig. 1 is a plan showing the stalls arranged for four or three horses, across the width of the car, the solid lines indicating the arrangement for three horses. Fig. 2 is a cross-section showing the ends of the stalls and the breast boards. This view and Fig. 3 illustrate the details of the attachment whereby the use of tools is avoided. In the photograph, Fig. 4, the end of the car, with the wide door, is illustrated. The plank is made in sections, and is carried in slings under the car when not in use. The portable parts of the stall equipments are kept at different points on the line, thus permitting a car to be fitted up at short notice to give accommodation for 24 horses in a 60-ft. car, with sufficient additional room for attendants. The wide end door is used to accommodate carriages.

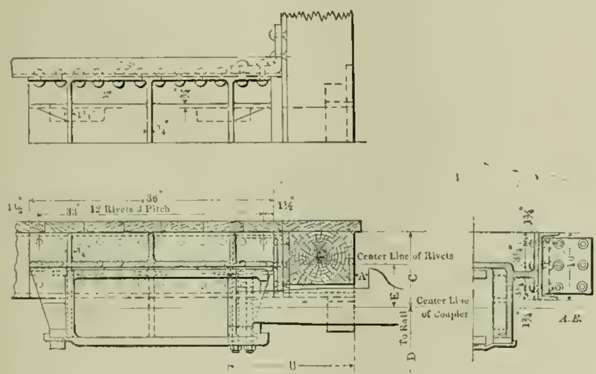
Other descriptions of horse-car equipment for using baggage or express cars, may be found in the American Engineer of the following dates: June, 1898, page 193; February, 1899, page 47, and October, 1900, page 310.

A NEW TENDER DRAFT CASTING FOR FRICTION DRAFT GEAR.

By Frank B. Kleinhans.

When the Westinghouse friction draft gear was placed on the market, a short time ago, it was thought that cast iron would be satisfactory for the draw castings, but since some of these have broken with only a few months' service, cast steel has in some cases been substituted. There is little, if any, difference in cost, for while cast steel is more expensive than cast iron, the design can be made lighter in steel, and this will about offset the increased cost.

The usual arrangement of these castings is to butt them against the bumper, and then having a flange to extend under



A Cast Steel Draft Casting for Locomotive Tenders.

the channels; bolts are placed through the flanges. In the first place, there is no reason for butting the casting against a bumper on one side and having nothing on the other, since the thrust on the draw bar is as great in one direction as in the other. And, secondly, a new pattern must be made for every variation in the thickness of the bumper, and for every change in the height of the coupler, and everyone knows that holes should not be drilled in the flanges of the channels, for they are over-hanging beams to support the load of the tender, and to take up the thrust of the draw bar.

In this design it is proposed to do away with three things: Butting the casting against the bumper, drilling holes in the flanges, and making new patterns. In order to do this the entire impact on the draw bar will be taken up by rivets, in the same way as the columns in the steel structural work are supported by rivets in the foundation plates.

In deciding upon the length of the casting to be used two things must be looked out for. In the first place a good substantial base must be provided, and, secondly, the casting must not interfere with the truck. Thirty-six inches gives a substantial base, and will very rarely interfere with the truck. By keeping the rivets 1½ inches from the edges, we have 33 inches over which to distribute the rivets. The sizes of the channels would be determined by the weight and capacity of the tender. A 10-inch channel of 30 lbs. per foot, ½-inch web and 8½-inch area would represent the average section, and for this section ¾-in. rivets would be used. Now as to the force acting on these rivets. It is known that a wrought-iron section equal to 12 inches will outlast any of the couplers on the market. Taking the working stress at 10,000 pounds per sq. in. we could have a draw bar impact of 12 × 10,000 or 120,000 pounds. This force acts in the line of the center of the draw bar. For direct tension, taking the shearing stress of the rivets at 10,000 pounds per sq. in., we would require

$$\frac{120{,}000}{10{,}000 \times .44} = 27 \text{ (rivets)}.$$

For eccentric loading, a sufficient number of rivets must be uniformly distributed over the 33 inches to be equal in strength to a key 33 inches long, and of sufficient width to carry the load. Referring to the engraving, the distance E from the center of gravity of the rivets to the center of the draw bar, is the arm of the eccentric load. We may take this at 8 inches, and, with the following notations,

W = draw-bar impact = 120,000 lbs., L = arm of the eccentric load = 8 ins., M = bending movement, Z = movement of resistance, S = the shearing stress on the rivets, b = breadth of the key, h = length of the key;

we have,

$$M = W \times L = SZ,$$

$$Z = \frac{WL}{S} = \frac{bh^2}{6},$$

$$b = \frac{Z \times 6}{h^2} = \frac{WL \times 6}{S \times h^2},$$

$$= \frac{120{,}000 \times 8 \times 6}{10{,}000 \times 1{,}089} = .52 \text{ inches.}$$

The number of ¾-in. rivets to be equal in strength to the key will be

$$\frac{.52 \times 33}{.44} = 39.$$

The total number of rivets required to withstand the load will be 27 + 39, or 66, but to be on the safe side, and to give a good spacing of the rivets, 32 have been placed on each side. There will also be a thrust, due to the eccentric load on the draw bar, which will tend to push the end of the channels vertically up or down, and this action will be about the center of the support of the beams. We may take the truck 4 feet from the rear end, the thrust will then be

$$\frac{120{,}000 \times 8}{48} = 20{,}000 \text{ pounds.}$$

This will easily be taken up by the corner plates, as shown. These plates will also help to stiffen the frame.

The two faces of the casting in contact with the channels will be faced off, and holes drilled 1-16-in. small. A sheet-iron template can then be made, and holes scribed off on the web of the channels. The holes can then be punched or drilled. The casting will then be held in place with a few bolts, holes reamed to size, and then riveted together. It will be seen that the pattern can easily be altered for various distances at C and D. The center can be raised or lowered and ribs altered to suit, the core box in any case remaining the same. A and B are fixed distances, hence for any variations in the bumpers the casting can be shifted to suit.

(Established 1832.)

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

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

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

The next vacancy in the two scholarships of the Master Mechanics' Association will occur next June upon the graduation of one of the students now enjoying this privilege. We take pleasure in mentioning this fact prominently. Mr. J. W. Taylor, secretary of the association, will furnish particulars with reference to eligibility of candidates.

At least three vitally important subjects in car construction are to come before the Master Car Builders' convention next summer. These are the standard box car, improved draft gear and side bearings and center plates. The third of these is perhaps the least in the minds of most of the members. It is not a mere matter of detail construction of the castings used for side bearings and center plates. If so it would be sufficient to design good castings. The real question involves the construction of trucks, bolsters and car underframes. The expected report offers an opportunity for settling several mooted questions, which involve large expenditures of money, and it is time that these should be definitely disposed of. The present situation as to side bearings and center plates is anything but satisfactory.

Within a short period four prominent motive power officers have been selected for important operating responsibilities, and the fact seems significant of changing conditions of railroad methods. For many years train service experience has been considered as the best preparation for the high administrative positions, and this has brought out many able men. Train service, civil engineering and other departments are not less important than formerly, but the present course of the greatest development is in the direction of motive power. At least here is where the greatest possibilities lie, and he who best understands the locomotive and its use is best able to make the maximum contribution to future improvement. Those methods which bring the best development of the locomotive and its operation are to be recognized and rewarded in the future, for purely business reasons. Methods of selecting motive power men must change, also their treatment and, what is more, something must be done to attract the necessary ability to this work. Wall Street will soon discover these facts and will learn that the day of the motive power officer who is merely a good mechanic is past, and that brains and business ability are required. Furthermore, it will become clear that mechanical men are very much like other men and are likely to go where they are appreciated. In fact, they are doing so.

Messrs. Delano, Potter, Morse and Marshall are able men who deserved advancement, but there is much more to be seen in these appointments than the mere recognition of ability. They are given higher positions because they fill them better than other men who were available. They have been successful mechanical officers and have shown their ability to organize and direct large departments in which the responsibilities are great and varied and where it is impossible to follow precedent or rule. The mechanical chief needs to be an organizer, a mechanical engineer, a manufacturer, a business man, a controller of labor and a thorough railroad man. For any individual one of these attributes men receive good compensation, but when they are all combined in a mechanical officer he is not properly recognized or paid.

If these appointments mean that superintendents of motive power may become recognized and properly compensated railroad officers, and that the owners of railroads are beginning to learn that this is good business policy, we are at the opening of a new dispensation which will prepare the way for great possibilities for the future. We are firm in the belief that the locomotive and its operation has only begun its development. It cannot develop until the shackles and manacles of opinion in which its department is held are removed, and they seem to be loosening.

A PROMISING LOCOMOTIVE.

In this issue the new passenger locomotive for the Plant System is described. This engine is the first to appear in this country under the responsibility of a railroad for a trial of the four-cylinder balanced-compound principle, which has been so successful abroad as to fairly represent the direction of locomotive development there. If the judgment of this journal is correct this design is the most important now before American railroad men. If the expectations of its sponsors are realized it will show that through the division of the work among four cylinders with separate connections and the balancing of the reciprocating weights, means are available for an increase of capacity which will move the approach of the limit of locomotive power far into the future. The foundation for these expectations has been repeatedly presented in these columns.

There seems to be but one drawback to this design—the crank axle. A great deal, therefore, depends upon the behavior of this important member. This axle was made of the best-known material by the manufacturers of the crank shafts of many of our fine war vessels, and it was made without specifications, entirely upon the honor of the makers to furnish the best that their experience and skill can produce. Aside from the crank axle the engine has no untried and unknown element, and our foreign readers, especially in France and on the Continent, will probably smile at our caution in this particular. Crank axles have a bad name here, but it should be remembered that the growth of the locomotive and the increased severity of its service since the days of the old, inside-connected engine have been accompanied by improvements in steel and its working. If this axle meets the requirements this engine seems sure to be the beginning of a new dispensation, the importance of which is not likely to be overestimated.

The eccentrics are on the second axle and a long connection to the valves is required. The engine has a relatively small grate area, and very short connecting rods. For a trial of the principle as a test of all there is in it these conditions might perhaps be improved upon, but these features are not believed to be, under the circumstances, vital in a trial of the running gear, which is the real feature at issue. Those who examine the details will not fail to be impressed in these days of huge and heavy parts with the remarkably light reciprocating parts and connections, and this is one of the reasons why this type of engine seems especially worthy of attention now. Crossheads weighing 181 lbs., and connecting rods weighing 364 lbs., seem almost like toys in comparison with usual present practice. It is true that the number of these parts is doubled, but it seems perfectly reasonable to divide the stresses when they become as large as they are to-day. It is but little less than brutal to place a direct stress of 99,000 lbs. on a single crank pin, as is done on certain large engines to-day.

As to balancing, it is interesting to know that the reciprocating weights may be provided for within 34¾ lbs. In contrast with this, on recent large freight engines there is not room enough in the main wheel for the weights which should be put into them. The smooth riding of a balanced engine, while important, is secondary to the gain in the increased weight which may be placed on driving wheels by this system.

It will be worth while to watch for the reports of experience from this engine.

THEORY OF COMPENSATION OF LABOR.

A significant sign of the times most clearly indicated in the ascendancy of American manufacturing is the general tendency, for business reasons, toward improvement in methods of paying for labor. The payment for labor actually performed, instead of paying for time occupied, is piece-work, though it goes by different names. Piece-work is not new, and little that is new remains to be said about it; but conditions have now been reached which never before existed, and piece-work now appears to be the point of the wedge which is opening railroad mechanical work to the adoption of business or manufacturing principles. Under this system railroad shops may be placed on the plane of the successful manufacturing establishments which have sent American locomotives and bridges all over the world. The system has been ready for a number of years, and now it appears that the railroads are ready for the system. At least some of them are, and it is important that the principles should be understood, because many blunders have been made, and there are doubtless more to come. In spite of mistakes, however, the movement is gathering momentum, which is sure to carry it on.

The principle involved is that of co-operation, every man becoming a contractor, in business for himself, and not placed in a class which does not provide proper distinction and recognition between different grades of ability. It is well known that the men resist it, but who would not under the conditions which have prevailed? In too many cases employers have put it into effect by bulletin notices. They have tried to create it at one stroke, and to show that this is not the way to succeed is the object of this discussion and of others to follow it. This movement must come by evolution, not revolution, or it will always fail. It must be introduced on a basis of confidence and continued on a basis of honesty. Everything must be open and frank in the dealings, and the men should have access to all the information they require to fully understand their situation.

Piecework and the development of home talent together seem to be the sum of the industrial problem. Piecework should be a part, and not the whole scheme of management. As to scope and possibilities, there seems to be no limit except in the ability of the officers in its administration.

"Preparedness is the secret of most successes in this world. Fate seldom makes league with the unequipped. Events come marching into every century, into every day, crying aloud for the nation or the man who is prepared."

This was never so true of anything as of this subject, and those who have not studied it for at least several years should not undertake to introduce it. A necessary part of the preparation begins with the management. The higher officers must be ready to see the men make large wages, and unless the management is stable, and the policy steady, it should be let alone. There is no place for quick record making in connection with piecework, and the time has come when he who attempts to meddle with piecework and cut prices by wholesale becomes responsible for results which will some time make him shudder. A newly appointed officer, imported from another road, should never attempt piecework, and when he really knows his men he should make but one move in about six months. That is to say, he should move carefully and slowly. The confidence of the workingmen of to-day is given only once, and it is too important to be trifled with. This confidence is the basis and foundation of success in the management of men, and the lack of it explains the deplorable industrial struggles of the past.

Piecework schedules of other roads are frequently asked for by those who are introducing the system. Until after one's own schedule is prepared, the knowledge of what others have done is useless, and even dangerous. Price fixing by copying the schedules of others will never do, because on most roads the prices among the different shops must vary, and so also will they vary on different machines in the same shop. Local conditions should fix the prices. A very careful study of these conditions should be made, and the men should be fully informed of what is being done, and they should be encouraged to study the problem with you. They should be given to understand in no uncertain way that your motto is absolute fairness; that both you and they will make mistakes, and that both must be always ready to correct them. A volume could be written on this subject alone.

A prominent lawyer once said that if he was pleading a jury case and should prepare an address to the jury in advance of hearing his opponent's case, he was sure to lose; but if he first heard all the other side had to say, and then addressed the jury in view of all of the facts, his case was usually won. Begin piecework by a lot of talking and a thorough acquaintance with the men. Get the leaders and the foremen interested. Then start it so that the men will ask for its extension. Never try it with a promise to give it up after a stated time if the men vote against it. Find a man who is in sympathy with the principle and has a standing with the men in experience, knowledge and integrity. Let him study conditions and take charge of the problem, but never try to say: "Go to! We will now have piecework!"

For successful administration on a large railroad system with many shops a competent general piecework expert is a necessity, and he, being one man out of a million, is difficult to find. This is the field, if there ever was one, for a specialist. He must be a man who can overcome prejudice, stir the manhood and inspire the honest purposes of the men. He must be prepared to meet them at every point, as one having experience and knowledge of their capabilities, as well as those of the machines. He must have sufficient authority and ample support, for his work is difficult and its scope is broad, covering every feature of shop practice, including the equipment itself. This man must have such command of the situation as to enable him to change rates which are wrong, and to do this with the consent of the men, by putting them on their honor. It has been found that the men will themselves sometimes suggest lowering prices which are too high, and this is the severest test of the administration of the system.

Careful records must be made of what each tool can do under given conditions, and what men can do, as a basis for payments. The prices must not be based upon less than the full capacity of the machines, and they must not be fixed for the expert man who can double the ordinary output. The price fixing requires study, experience, and the hearty co-operation of the men who do the work. It must be based on a good day-work system to start with.

Another chapter would be required to state the results of piecework. It may be summed up in increased output, decreased cost, contented men, new and better methods every day because of the use of the brains of the men. The men earn larger wages, and this tends to steadiness. They have no desire to leave the service. They buy houses and become factors in the community and become better citizens. In a piecework shop, properly managed, there are no "floaters," and changes come rarely, except when men die. By placing the responsibility, and requiring poor work to be replaced, the quality is improved by this system. With the actual cost of work as a basis, a valuable check on designs is available; and when it is shown that unnecessary "finish" on a certain piece costs 25 cents, the finish is left out. Piecework permits of a unification of practice in a number of shops because of the information it produces. It brings in the right kind of competition, based upon a comparison of costs of the same work of various shops. With it a superintendent is prepared to go to his manager with a request for a new wheel lathe, prepared to state that he can save its cost in 16 months; and what is more, he can prove his statement. This is far better than to ask for a new one "because the old one is worn out," and it brings into railroad work the principle which leads successful manufacturers to discard old and introduce new facilities—because they will pay.

When properly administered, piecework is the best friend of labor. It renders combinations of workmen for protection unnecessary by removing the cause of the combination, and the necessity for protection.

"It is a familiar fact that the unbelievers in piecework to-day become its ardent supporters to-morrow. The skepticism of honest men unfolds the truth, and becomes the conviction of the aftertime."

We acknowledge the assistance of Mr. J. F. Deems, Superintendent of Motive Power, and Mr. R. T. Shay, General Piecework Inspector, of the Chicago, Burlington & Quincy Railroad, in the preparation of this article.

The timber used in the construction of the new British Westinghouse plant comes from the United States, and it is said that some of the window frames were placed in the walls eight weeks after the order was filed in this country. The construction work is being done by 2,600 British workmen under the direction of seven American foremen and it will be completed within a year, whereas English builders wanted five years to complete it.

At the present time the total railroad mileage in the United States and Canada which is equipped with block signals is 3,347. "A year ago," says the "Railroad Gazette," "we published a detailed statement showing that block signals were used on less than 2,300 miles. The increase during the year has been nearly 50 per cent. There is enough new work now under construction or soon to be built, to make a total of over 4,000 miles, which is 65 per cent. more than the actual mileage in use at the close of the year 1900."

COMMUNICATIONS.

TREATMENT OF SPECIAL APPRENTICES IN THE SHOP.

To the Editor:

After reading your comment upon the fact that few college graduates are entering railroad work, I think that I can add another fact which is keeping young men from this particular line of work. I know from my own and from the experience of a great many of my friends that the treatment given to special apprentices in railway shops by the machinists and helpers is of the very worst kind. They seem to think that we are a detriment to their welfare, and accordingly are treated as such. This is more noticeable in the South and West, I find. I know of plans that have been carefully laid where parts of the engines and tools should fall on special apprentices, and had they been carried out might have been serious. They are cursed from 7 A. M. to 6 P. M., and then are made the subject of radical discussion at union meetings. It is not at all strange to me that this keeps a great many young men away from railroads, where low wages would not. A. A. G.

[Editor's Note.—Our correspondent is undoubtedly correct, but is this not one of the difficulties to be overcome by the special apprentices themselves?]

SALARIES OF MOTIVE POWER OFFICERS.

To the Editor:

Permit me to congratulate you on your plea for the adequate remuneration of motive power men (page 39, February 1902). I had never taken time to consider how shabby our treatment has really been. One of the cases you describe must be mine, as I am master mechanic of a division that was formerly "a whole railroad by itself," operating upwards of one hundred engines.

Not only do the engines, two shops, six round-houses, and the water service come under my jurisdiction, but the car shops and a dozen interchange points furnish diversion for my spare moments. Yet I probably have the easiest division, as far as legitimate work goes, of all on the system.

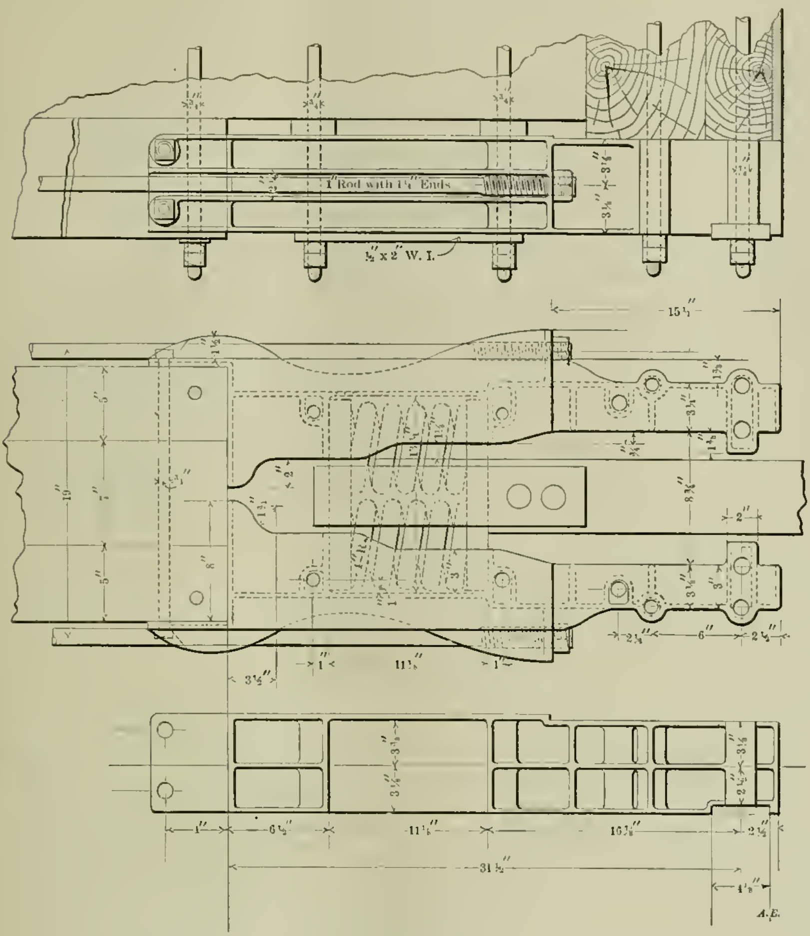
I started out some eighteen years ago with a high school education and a chance to watch the building of locomotives while I swept out the office and made the blue-prints. Eventually I lost some of the awe in which I held egg-shell paper and tracing cloth, and after having contracted "draftsman's hump," eradicated the same by use of the hammer-and-chisel. Meanwhile I had burnt a modicum of midnight oil in scraping a passing acquaintance with a few foreign and domestic celebrities, such as Reuleaux, Clark, Thurston and DuBois, so that, while I still look wise and say nothing when the youth with the sheepskin hurls quarternions at me, I do not recall that I ever determined the clearance of a piston-valve engine by pouring water into the steam port until it rose level with the bottom of the valve, or put ⅛ in. inside and ⅝ in. outside lap on an express engine.

I have held a variety of positions in machine shop, foundry, drafting-room and office, and have yet to receive the first request for my resignation every move I have made so far being for more experience or additional money; yet here, in charge of 400 men, and responsible for the expenditure of nearly one million dollars annually, my check is less than one per cent. of the pay-roll, and many a runner, responsible for one engine only, goes out of the pay car with more money than I do.

Yet such is the glamor of the business that not long ago I refused an offer to take charge of a machine shop employing less than 100 men on work that I am thoroughly familiar with, at a salary of double my amount and a chance to get an interest in the business.

Were my case peculiar, I should lay the scanty remuneration to my own lack of ability or other shortcomings, but I know dozens of men in the same fix. On this very road there is a young man, a better executive, with better training, and a brighter engineer than myself; he has almost twice the number of engines to operate under much more difficult conditions, yet his salary is no more than my own.

MASTER MECHANIC.



Needham's Malleable Iron Draft Attachment—Wabash Railroad.

NEEDHAM'S MALLEABLE IRON DRAFT ATTACHMENT

Wabash Railroad.

A drawing of a new malleable iron draft attachment, in use on the Wabash Railroad, has been received from Mr. C. S. Needham, General Foreman of the car department of that road. Its construction is clearly indicated in the engraving. This form of casting offers over 54 sq. ins. of buffing surface for each casting. It also offers means for binding the wooden timbers and filling blocks together and supplies a rear guide for the coupler yoke. Other objects of the designer were to provide large bearing areas for the followers, render the attachments easy to apply to old cars without trimming or fitting, to make each draft attachment in one piece with a minimum number of bolts and other parts, to take the standard couplers and yokes, and to provide an inexpensive and durable draft gear. Draft rods may be passed through the lugs and extended as far as the needle beams, or they may be extended the entire length of the car.

The idea of putting apprentices on three months' trial before allowing them to begin their term is suggested by a writer in the "American Machinist" who has evidently had a very unsatisfactory experience. To succeed in any work one needs to be adapted to it, and a period of probation would permit of selecting candidates who are worthy of the training.

LARGE BORING AND TURNING MILL.

William Sellers & Company, of Philadelphia, have designed and constructed for the Westinghouse Electric and Manufacturing Company a large boring and turning mill, which has several interesting features. The housings are so placed as to permit of work 28 ft. in diameter being swung. The crossrail has been designed with special reference to withstanding the powerful torsional stresses produced when the boring bars are extended for deep boring and turning. The housings are of rectangular section, the front and back edges being parallel and the crossrail is extended back to the rear face of the housings, where an additional pair of elevating screws and clamping shoes are provided. The crosshead bar measures 7 ft. 6 ins. from the front fact of the housings to the clamping point on the rear, while its depth is 40 ins. When this great beam, braced by internal diagonal webs, is secured to the front and back of the housings, it affords a degree of rigidity not hitherto obtained in this class of machine. In fact, when the crossrail is clamped up for work no connection would be needed between the upper ends of the housings as far as securing stiffness is concerned. The front of the crosshead is further stiffened by a curved beam over 43 ins. deep in the middle, and bolted to the top of the crossrail between suitable cast abutments.

Each saddle carries its own feeding mechanism, with change wheels for the speeds of the feed, and there are, within the crossrail, two shafts from which power may be taken. The saddles can be moved along the crossrail, or the bar be raised or lowered by rapid power traverse with great nicety. The operating levers are so interlocked that the rapid traverse cannot be thrown in for one saddle unless it is disengaged from the other, so that it is impossible for the operator on one head to move the opposite head accidentally. The great length of the crossrail makes it necessary to provide intermediate bearings, and ingenious drop hangers are provided, which move out of the way as the saddles travel along; when in action they hold the shafts effectively in closed bearings.

The pension system has been in operation on the Pennsylvania Railroad for about two years. A recently issued statement shows that there was an amount authorized to be paid to retired employees, aggregating during 1901 the sum of $292,290.20, and this, added to allowances paid during 1900, gives a total of $536,310.17. These disbursements are met by an annual appropriation of $300,000. Since the creation of the pension department, 1,574 employees have been retired and pensioned. Of these 217 died prior to December 31, 1901. Out of the total number who were retired 248 were in the 65 to 70-year class.

At a cost of between $15,000 and $20,000 the Boston & Maine management has again gratuitously supplied its employees with new uniforms.

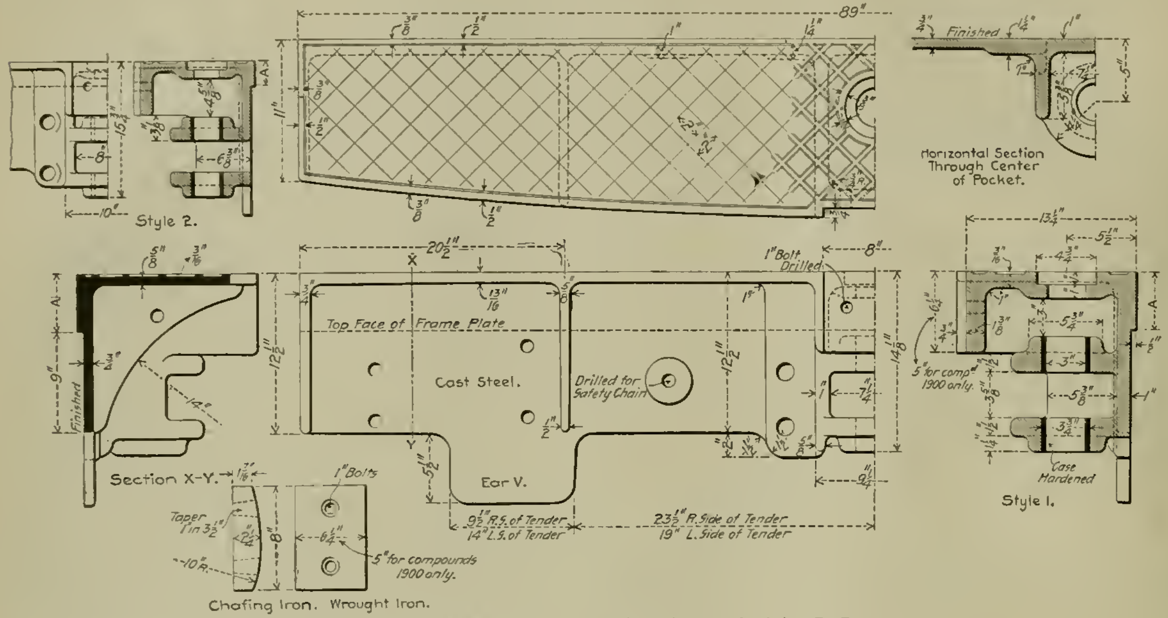


Fig. 1.—Cast Steel End Sills for Tenders—Boston & Maine R. R.

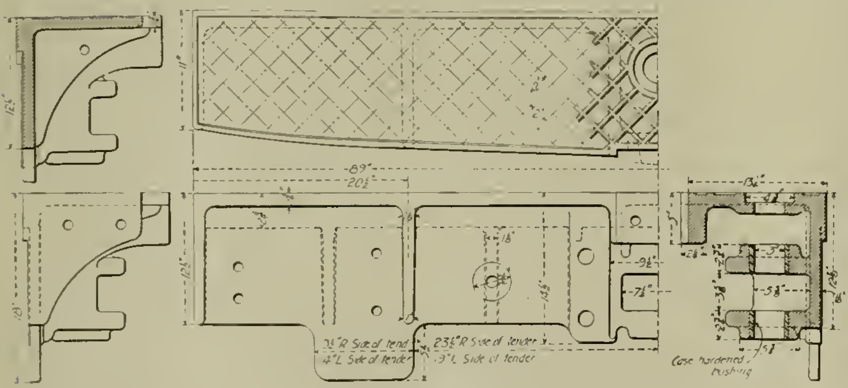


Fig. 2.—Cast Steel End Sills for Tenders.

CAST STEEL END SILLS FOR TENDERS.

Boston & Maine Railroad.

The difficulty in obtaining oak for the purpose has led to the use of cast steel end sills for tenders on the Boston & Maine, which are made in accordance with the drawing from which the accompanying engraving, Fig. 1, was prepared. Mr. Henry Bartlett, Superintendent of Motive Power of the road, has kindly furnished the information and states that the weight of the casting illustrated is 735 pounds when rough. The casting, Fig. 1, is secured to the tender frame by bolts and the features of the construction are plainly shown in the engraving. The plan permits of saving a number of parts and tends to increase the life of the frame. The draw head and chafing plate are embodied in the steel casting and the arrangement of the ends is favorable to a satisfactory step, which is not true of the ordinary thick oak end sill. The wear of the coupling pin is taken on case hardened bushings and as this is the only wear to be provided for the casting appears to be likely to outlast all other parts of the tender. These castings are applied to all new tenders.

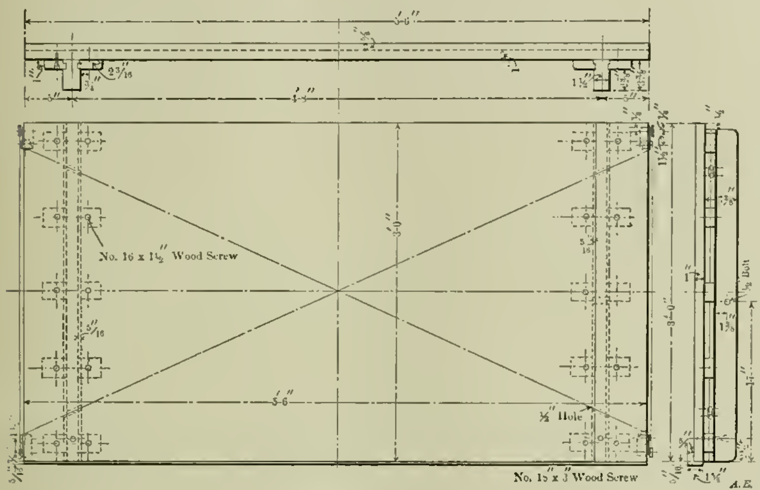
Fig. 1 gives the leading dimensions, those which are changed to suit various tenders are indicated by the letter "A." The ear "V" is used on 19-ft. tenders only. Style 1 is used on all but the latest 18-ft. switcher tender, designed this year and these end sills are fitted to all tenders having steel frames. Fig. 2 illustrates the experimental sill from which the present standard was developed. The first one weighed 1,090 lbs. when finished and it will be noted that the flanges and webs have been thinned to save weight.

Mr. Bartlett has had these end sills in service for over a year with entirely satisfactory results. Some of them have had rough usage in derailments, especially on switching engines, but they have passed through the ordeal successfully and none have been removed. From present indications it appears that only a serious collision will break them.

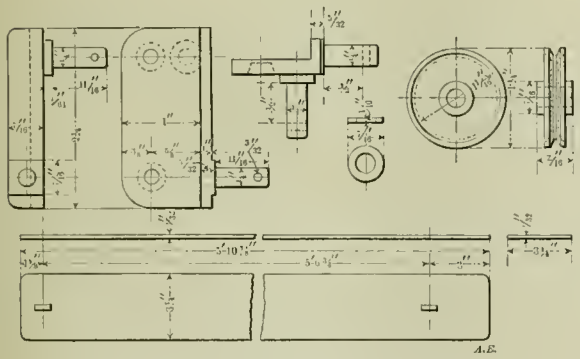
"To feel the pressure of work is a cause for thankfulness. The time when we are busiest is the time we are most likely to do our best. Often there comes the temptation to feel that, if we had more leisure, we could do more and better work, but experience usually shows that to be a mistake. The world recognizes this. It does not call on the men with most leisure when it wants an exceptional undertaking carried through. No employer in any walk of life looks among the ranks of those with plenty of time to spare when he would fill a position. He wants one who is already numbered among the busiest, who is demonstrating that he has a right to live by shouldering his full share of this world's activities, and whose powers are at their best through their exercise. To keep busy is to keep in training, and that is the secret of attainment as truly in the race of life as on the athletic field."

A CONVENIENT DRAWING BOARD.

The drawing board shown in the accompanying engraving is made of well-seasoned white pine, with strip battens and clamps of hardwood. It is provided with a wooden straight edge 3½ ins. wide by 5/32 ins. thick, extending the full length of the board. To operate the straight edge an ingenious device is used, whereby the straight edge is held parallel at all times to the top and bottom edges of the board. From the engraving it will be seen that two 1¼-in. pulleys are attached to a small bracket at each corner of the board, one pulley having its face parallel with the edge, while the face of the other pulley is parallel to the under surface of the board. A continuous cord is passed over these pulleys at each corner of the board and crossed on the under side at the center. By crossing the cord in this manner any change in tension that



A Convenient Drawing Board.


Details of Pulley Casting and Straight Edge.

might occur will affect both ends of the straight edge equally and keep it parallel. A heavy cloth is used to cover the board when not in use. One end of the cloth is fastened to the upper edge of the board and the other end to a wooden roller. When the cover is rolled up, it rests in three small curved supports, which are fastened to the upper edge of the board. A pedestal, 3 ft. 3¾ ins. high, supports the drawing board at each end, where it is pivoted and allowed to swing to any desired angle. Mr. H. K. Griffith, Chief Draftsman of the Southern Railway, who developed the design, has used them for several years to good advantage in the drafting room of that road in connection with a 2-ft. 6-in. by 5-ft. flat-top table, which is convenient in referring to blue prints, and for the keeping of drawing instruments and materials.

EXPERIMENTS ON SPIRAL SPRINGS.

By Chas. H. Benjamin, Cleveland, O.

And Roy A. French, Pittsburg, Pa.

A Paper Read Before the American Society of Mechanical Engineers.

Our text books and our technical journals contain discussions and formulas, but very few data from which constants can be obtained to use in the formulas. In the experiments to be described, an attempt has been made to determine the coefficient of torsional elasticity and the safe stress for different sizes of bar and different ratios of mean diameter of spring to diameter of bar.

The following notation will be used

P = loads in pounds. S = torsional stress in pounds per square inch. G = coefficient of torsional elasticity. D = mean diameter of spring in inches. d = diameter of bar in inches. H = height of spring in inches. L = length of bar in inches. x = deflection in inches with load P.

Then, by the usual formulas for tension and compression springs:

$$P = \frac{255D}{Sd^2} \text{ and } x = \frac{Gd}{LDS}.$$

The springs tested were all made of tempered steel and were open coil, or compression springs. The results shown in the table were in every case obtained by testing a number of springs made as nearly alike as possible, and using the average loads and deflections for computation.

Every spring was first closed solid, coil to coil, several times in a hydraulic press, to remove all permanent set; then placed in a Riehlé testing machine and tested for capacity and corresponding deflection.

To illustrate, take for an example, group No. 1 in the table. This group consisted of 15 springs, 9.25 ins. outside diameter and 17.25 ins. free height before closing. The steel used was 1.3125 ins. in diameter and 150 ins. long before the ends were tapered. These springs were placed in the press one at a time and closed coil to coil twice under the full capacity of the press, 75,000 lbs. The pressure was then removed, and upon measuring they were found to average 15.25 ins. in height, showing a set of 2 ins. They were then closed twice more, but took no further set. A spring closed solid with 100 per cent. overload should take all its permanent set with two closings.

The springs were then placed in the testing machine and the load and total deflection measured. The average load necessary to close them was found to be 10,900 lbs., and the corresponding deflection was 7.0625 ins. When taken from this machine the free height was again measured, but they had taken no more set.

For substitution in the formulas we then have:

$$P = 10.900.$$
$$d = 1.3125.$$
$$D = 9.25 - d = 7.9375.$$
$$x = 7.0625.$$
$$L = 150.$$

Substituting and solving for S and G:

S = 97,500 = the torsional stress in pounds per square inch when the spring is closed coil to coil, and G = 12,500,000, the coefficient of elasticity. Dividing the mean diameter of the spring by the diameter of the bar gives a ratio which will be called R, in this case equal to 6.05. Dividing the permanent

RESULTS OF TESTS OF A NUMBER OF SPRINGS.

Group	Number of springs. N	Outside diam. O	Mean diam. D	Diam. of bar. d	Ratio D/d R	Length of bar L	Height before closing. H	Height after closing. H'	Perman't set = H — H'. S	Height when closed H"	Total action = H' — H". x	Ratio s/x Y	Load to close spring. P	Coefficient of torsional elasticity. G	Torsional or shearing stress S
1	15	9.25	7.9375	1.3125	6.05	150	17.25	15.25	2	8.8175	6.432	.311	10,900	12,500,000	97,500
2	20	6.625	5.375	1.25	4.3	80	7.125	7	.125	5.9375	1.062	.117	6,375	14,400,000	44,700
3	12	6	4.75	1.25	3.8	67	7.875	7.5	.375	5.875	1.625	.23	16 600	16,150,000	103,000
4	6	5.25	4.125	1.125	3.67	89	10.75	10.125	.625	7.625	2.5	.25	13,800	13,400,000	102,000
5	20	4.75	3.625	1.125	3.23	75	9.875	9.375	.5	7.25	2.125	.235	17,000	12,500,000	110,000
6	40	7.75	6.625	1.125	5.9	100	7.875	7.625	.25	5.5	2.125	.117	4,850	15,800,000	57,500
7	36	5	3.9375	1.0625	3.7	61	7.5	6.9375	.562	5.375	1.567	.36	12,000	14,400,000	100,000
8	64	5.5	4.4375	1.0625	4.18	101	11.125	10.6875	.437	7.625	3.062	.142	12,000	15,100,000	113,000
9	24	4.375	3.3125	1.0625	3.1	48	6.5	6.125	.375	5	1.125	.333	14,800	13,700,000	104,000
10	6	6	5	1	5	84	8.625	8.125	.5	5.625	2.5	.2	8,000	17,100,000	102,000
11	20	4.5	3.5	1	3.5	79	9.875	9.4375	.437	7.25	2.187	.201	12,500	11,100,000	111,800
12	16	4.25	3.25	1	3.25	49	6.5	6.125	.375	4.875	1.25	.3	13 100	13,800,000	109,000
13	36	4.75	3.75	1	3.75	37	4.5	4.125	.375	3.25	.875	.43	12,000	18,100,000	114,400
14	35	4.187	3.25	.9375	3.48	50	6.5	6	.5	4.75	1.25	.40	10,500	11,700,000	106,000
15	800	4.5	3.625	.875	4.15	57	6.375	6	.375	4.4375	1.562	.24	6,250	13,100,000	86,500
16	8	3.75	2.875	.875	3.28	41	5.375	5	.375	4.125	1.875	.43	10,800	18,100,000	118,000
17	24	4	3.125	.875	3.58	60	7.375	7	.375	5.4375	1.562	.24	8 650	13,900,000	103,000
18	40	4	3.125	.875	3.58	51	6.5	6	.5	4.625	1.375	.364	12,000	18,900,000	143,000
19	24	3.375	2.625	.75	3.5	62	7.25	7	.25	5.655	1.345	.186	5,250	13,500,000	83,500
20	8	5.75	5	75	6.67	172	17.625	16	1.625	8.4375	7.562	.212	2,850	13,100,000	86,500
21	8	4.5	3.75	.75	5	84	8.5	8	.5	5.5	2.5	.20	4,000	15,200,000	91,000
22	12	3.5	2.75	.75	3.67	53	6.375	6	.375	4.625	1.375	.273	6 950	16,200,000	115,000
23	4	4	3.25	.75	4.33	41.5	5.75	4.6875	1.0625	3.0625	1.625	.655	6,500	15,400,000	127,000
24	24	3.5	2.875	.625	4.6	68	7.375	7	.375	4.6875	2.312	.162	3,250	13,600,000	97,500
25	100	3.25	2.625	.625	4.2	37.5	4.375	4	.375	2.8125	1.187	.316	4,225	15,500,000	116,500
26	100	3.25	2.625	.625	4.2	43	4.75	4.5625	.187	3.375	1.187	158	4,000	16,700,000	109,500
27	200	3.5	3	.5	6	108	9.75	9.625	.125	5.8125	3.812	.032	1,250	12,900,000	76,500

set by the working deflection gives another ratio, which will be called Y. In this case, Y = .283.

In a similar manner were calculated all the results given in the table.

Additional notation used in table:

N = number of springs in group.
O = outside diameter in inches.
H = height before closing in inches.
H' = free height in inches after producing set.
H" = height in inches when closed solid.
s = H — H' = permanent set in inches.
x = H' — H" = total action in inches.

The value given for G in most hand books is 12,000,000. The larger values shown in the tables are doubtless due to the higher grade of steel used. The variation in values of G is probably due to differences in temper, although in some cases the chemical constituents of the steel may have varied slightly. The average value is found to be 14,700,000, which may be written 14,500,000 for convenience.

The proper stress is a more difficult thing to determine. A wide range of stresses was used in the springs experimented with. In each case the stress was that believed to be the best for the conditions under which the spring must work.

In some few cases, as in No. 18, it was necessary to use an abnormally high value to meet the conditions. This necessitated a special grade of steel, and great care in manufacture. Such a spring is not safe when subjected to sudden and heavy loads, or to rapid vibrations, as it would soon break under such treatment; if merely subjected to normal stress, it would last for years.

It will be noticed, by comparing columns S, Y and R of the table, that Y varies with both S and R for the same diameter of bar; that is, if R is constant, S and Y increase together, and if S is constant, R and Y increase together. There are some exceptions to this rule noted, but it is believed to be generally correct. This being true, a spring with its mean diameter small, as compared with size of bar, will allow a higher stress with less proportionate set than one of a larger mean diameter. An excessive set means injury to the material, and liability of failure.

Springs of a small diameter may safely be subjected to a higher stress than those of a larger diameter, the size of bar being the same. The safe variation of S and R cannot yet be stated.

There is an important limit which should be here mentioned. Springs having too small a diameter as compared with size of bar are subjected to so much internal stress in coiling as to weaken the steel. A spring, to give good service, should never have R less than 3.

The size of bar has much to do with the safe value of S; the probable explanation is this: A large bar has to be heated to a higher temperature in working it, and in high carbon steel this may cause deterioration; when tempered, the bath does not affect it so uniformly, as may be seen by examining the fracture of a large bar.

The above facts must always be taken into consideration in designing a spring, whatever the grade of steel used. A safe value of S can be determined only by one having an accurate knowledge of the physical characteristics of the steel, the proportions of the spring, and the conditions of use.

For a good grade of steel the following values of S have been found safe under ordinary conditions of service, the value of G being taken as 14,500,000.

For bars below ⅜-in. diameter:

R = 3 S = 112,000
R = 8 S = 85,000

For bars 7/16 to ¾ in. in diameter:

R = 3 S = 110,000
R = 8 S = 80,000

For bars from 13/16 to 1¼ ins. in diameter:

R = 3 S = 105,000
R = 8 S = 75,000

For bars over 1¼ ins. in diameter a stress of more than 100,000 should be used. Where a spring is subjected to sudden shocks a smaller value of S is necessary.

As has been noted, the springs referred to in this paper were all compression springs. Experience has shown that in close coil or extension springs the value of G is the same, but that the safe value of S is only about two-thirds that for a compression spring of the same dimensions.

Mr. Andrew Carnegie has recently given $100,000 to the Stevens Institute of Technology, as an endowment for the engineering laboratory. This laboratory was built by money donated by Mr. Carnegie. It cost $65,000. Not long ago Mr. Henry Morton, president of Stevens, invited Mr. Carnegie to the dedication of the new laboratory, and the latter expressed himself as surprised that a school of technical training could be so complete and practical as this one is; the favorable impression made by this visit is, no doubt, responsible for the endowment gift. The yearly interest will just about meet the running expenses.

Experiments in making coke from western coals are being conducted at the works of the Illinois Steel Company in Chicago. While no definite results have been announced, we are informed that the outlook is promising. If successful, this will become a most important factor in steel making, which will tend toward a movement of the steel making center toward the West.

PERSONALS.

Mr. W. H. Marshall, who has been superintendent of motive power of the Lake Shore & Michigan Southern for the past two years, has been promoted to the position of general superintendent, to succeed Mr. A. H. Smith. This seems to be another turning point in Mr. Marshall's interesting career, and another and greater advancement for which he is admirably prepared. He began as an apprentice at the Rhode Island Locomotive Works, and is a general superintendent at the age of 37 years. After completing his apprenticeship he entered the drafting room and soon became chief draftsman. After this he went to New York as a consulting mechanical engineer, and in January, 1888, went to Chicago as editor of the "Railway Review." Three years later he became editor of the "Railway Master Mechanic," and in 1896 edited the American Engineer and Railroad Journal. His first distinctive railroad experience began in June, 1897, when he was appointed assistant superintendent of motive power of the Chicago & Northwestern. Two years later he was called to the Lake Shore as superintendent of motive power, where his work has placed his name among those of the ablest motive power officers of the country. The class "J" prairie type, passenger locomotive, which he designed (see American Engineer, March, 1901), is sufficient of itself to give him such recognition. His experience and his thorough knowledge of motive power problems is an excellent preparation for operating responsibilities, and the appointment is exceedingly important, because it may be accepted as an indication of an appreciation of the real position of motive power in the operation of a railroad. Mr. Marshall's success seems to be due to a combination of honesty, personal ability, breadth of view, a recognition of the importance of the development of subordinates and a thorough knowledge of the problems which have confronted him. He has a thorough technical education which he obtained himself by individual study, and we have departed from our usual custom in announcing appointments, because Mr. Marshall's career should be brought before young men who have had far better advantages.

Mr. H. F. Ball has been promoted from the position of mechanical engineer to that of superintendent motive power of the Lake Shore & Michigan Southern Railway, to succeed Mr. W. H. Marshall. Mr. Ball began his railroad work as an apprentice in the Pennsylvania shops at Altoona in 1884. In 1888 he entered the drafting room there, and in 1890 became chief draftsman of the car department of the Lake Shore & Michigan Southern. In 1892 he took charge of the car shops at Cleveland as general foreman. In 1894 he became general car inspector and was appointed mechanical engineer in 1899. He comes to the responsibilities of the motive power department with an excellent preparation and with the important advantage of a thorough knowledge of the road. Appointments to such important offices are so seldom made from the subordinate positions as to cause comment. The appointment seems to be as wise as it is pleasing.

The New York Central announces the following appointments in its motive power department: Mr. G. H. Haselton is appointed division superintendent motive power at West Albany, succeeding Mr. Angus Brown, deceased; Mr. John Howard is appointed division superintendent motive power at Depew, succeeding Mr. G. H. Haselton, promoted; Mr. E. A. Walton, master mechanic river division, is appointed division superintendent motive power at Corning, succeeding Mr. John Howard, promoted. Of these, Mr. Walton's rise has been the most rapid. He entered the service of this road as general foreman at Oswego in 1899 and was made master mechanic of the river division a year ago.

Mr. John R. Slack, for some time assistant superintendent of motive power of the Delaware & Hudson, has been appointed superintendent of motive power. He was educated at Columbia College and later at the Stevens Institute of Technology. He began railroad work in 1886 as an apprentice in the New York Central shops. Four years later he became locomotive inspector and mechanical engineer. In 1899 he became assistant superintendent of motive power of the Delaware & Hudson, from which position he has been promoted.

Mr. G. R. Henderson, superintendent of motive power of the Atkinson, Topeka & Santa Fe, has appointed Mr. F. N. Risteen mechanical superintendent of the Eastern Grand Division, with headquarters at Topeka. Mr. C. M. Taylor has been appointed mechanical superintendent of the Western Grand Division, with headquarters at La Junta, Colorado. Mr. James Collinson having resigned as general master mechanic, the position has been abolished. The division master mechanics report to the mechanical superintendent of their respective grand divisions.

Important changes on the New York Central and the Lake Shore have called Mr. W. C. Brown to New York as third vice-president of the New York Central, where he will have charge of the transportation, engineering, mechanical and purchasing departments, but he retains the position of vice-president of the Lake Shore. Mr. P. S. Blodgett returns to the Lake Shore as general manager, and is succeeded as general superintendent in New York by Mr. A. H. Smith, formerly general superintendent of the Lake Shore. Mr. W. H. Marshall succeeds Mr. Smith as general superintendent of the Lake Shore, as noted elsewhere, and Mr. H. F. Ball, formerly mechanical engineer, succeeds Mr. Marshall as superintendent of motive power.

Mr. F. H. Stark, formerly master car builder of the Cleveland, Lorain & Wheeling, has been appointed general foreman of the car department of the Baltimore & Ohio, at Baltimore, Md. This change has been necessitated by the purchase of the C. L. & W. Ry. by the Baltimore & Ohio Railroad. Mr. Stark was formerly with the Lake Shore; Cincinnati, Hamilton & Dayton; Consolidated Rolling Stock Company; Wheeling & Lake Erie, and the C. L. & W. railways.

Mr. Thomas Paxton has been appointed superintendent of motive power of the Colorado & Southern, with headquarters at Denver, Col. He succeeds Mr. A. L. Humphrey, resigned. Mr. Paxton leaves the Gulf, Colorado & Santa Fe, with which road he has been connected since March, 1901, holding the position of master mechanic. He was for three years master mechanic of the Chicago Division of the A., T. & S. F., and for seven years he was master mechanic of the middle division. Mr. Paxton's connection with the Santa Fe system dates from April, 1884.

Mr. Willard A. Smith, president of the "Railway and Engineering Review," of Chicago, has been appointed chief of the Department of Transportation at the St. Louis Exposition, commemorating the Louisana Purchase. Mr. Smith contributed to the success of the World's Fair at Chicago, the Pan-American Exposition at Buffalo in similar capacities, and had charge of the American engineering and transportation exhibits at the recent Paris Exposition. He will continue in the active management of the "Railway and Engineering Review."

From the Chicago & Northwestern Railway we learn that Mr. A. B. Quimby has been appointed master mechanic of the Northern Iowa Division, with headquarters at Eagle Grove, Iowa, also that Mr. E. H. Wade has been appointed assistant master mechanic of the Wisconsin and Northern Wisconsin Divisions, with headquarters at Fond du Lac, Wis., to succeed A. B. Quimby, promoted.

Mr. Harry Ashton has been appointed master mechanic of the Moncton locomotive shops of the Intercolonial Railway of Canada.

Mr. Spencer Otis has been appointed Western representative of the American Locomotive Company, with office in the Fisher Building, Chicago. Mr. Otis was formerly the acting representative of the Rhode Island Locomotive Works.

Mr. J. F. Deems has resigned as superintendent of motive power of the "Burlington" to become general superintendent of the American Locomotive Company at Schenectady. This step removes from railroad service one of the very ablest motive power officers and one the service can ill afford to lose. In our judgment Mr. Deems has no superior in the management of men in the motive power department, and this change should make managing officers thoughtful. That which renders Mr. Deems valuable to his new employers is precisely that which makes him valuable to the railroads—the ability to conduct his department on a business basis. His success lies in his knowledge of men and his fair and considerate treatment of them. His personality and influence reach beyond the work of the men, touch their attitude toward their employers and even go into their homes. He has introduced piecework on the "Burlington" and made it a success under unusually difficult conditions. Nothing more than this need be said of his methods. Mr. Deems has always been a student, though not a graduate of a technical school. He began on this road as a machinist at Beardstown, Ill., and has been advanced very rapidly. We heartily congratulate the American Locomotive Company upon securing his services, and cannot forbear saying that the railroads have only themselves to blame when they lose such men. Motive power positions should be such that they will attract and hold the best men to be found.

Mr. F. H. Clark has been promoted from the position of mechanical engineer of the Chicago, Burlington & Quincy to that of superintendent of motive power, to succeed Mr. J. F. Deems. Mr. Clark was educated as a mechanical engineer and was for a number of years associated with the late David L. Barnes in consulting engineering work in Chicago. About seven years ago he entered the service of the "Burlington" at Aurora as chief draftsman of the motive power department, and succeeded Mr. William Forsyth as mechanical engineer. Mr. Clark has held that position until now. This promotion, following so closely that of Mr. Ball, on the Lake Shore, indicates an appreciation of the importance of mechanical engineering in connection with railroads, and is an encouraging recognition of the office of the mechanical engineer. We cannot avoid observing in connection with this appointment that the entire organization of the road must necessarily be strengthened by a promotion of this kind. Mr. Clark is well prepared for his new responsibilities and it is a pleasure to record his appointment. It is high honor to succeed such men as Messrs. Rhodes, Delano and Deems, and one of which Mr. Clark is thoroughly worthy.

Chicago ranks fourth among the principal ports of the world, in the tonnage of arrivals and clearances, with 14,186,100 tons. London, New York and Hamburg stand above it. So far as the United States is concerned Chicago leads all ports except New York. It handles more than three times the tonnage of Boston, almost four times the tonnage of Philadelphia and more than four times that of Baltimore. In the thirty years since 1870 the tonnage has more than quadrupled, but it is nevertheless a fact that the annual total of arrivals and clearances has decreased by nearly 8,000, due to the increase in the size of the vessels. Fewer boats are used than formerly, but they carry much more.

TESTS OF BEAUMONT (TEXAS) OIL.

Oil from the Beaumont district of Texas was recently tested by Prof. J. C. Denton, of Stevens Institute of Technology, for Mr. H. M. McDonald, of New York. The tests were made in New York City in comparison with coal, under a return tubular boiler 6 ft. in diameter by 18 ft. long, having 1,900 sq. ft. of heating surface. The burner used was devised by Mr. T. H. Williams, and is illustrated by the accompanying engraving. From the tests the following conclusions were drawn:

For a range of from 112 to 220 horse-power the total evaporation from and at 212° per pound of oil varied from 15.71 to 15.29 lbs. of dry steam, and the burner consumption varied from 3.1 to 4.8 per cent. of the boiler output, so that the net evaporation ranged from 14.74 to 15.16 lbs. of water per pound of oil.

The combustion of the oil by the burner was practically

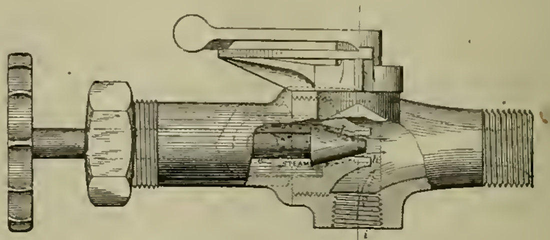


Fig 1.—Horizontal Section of Williams Burner.

perfect, since by the evidence of the heat balance the heat accounted for by the steam production, the hot gases flowing to the chimney, and a reasonable allowance for radiation represent about 98 per cent. of the total heat of combustion of the oil when burned in oxygen in a calorimeter.

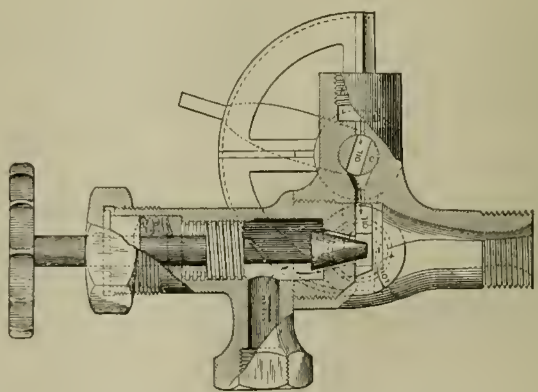


Fig. 2.—Vertical Section of Burner.

The boiler utilized about 78 per cent. of the heat of the fuel, which represents the best average boiler practice, and the percentage of steam consumed by the burners is a minimum for steam-jet burners. An excess of cold air probably caused a loss of evaporation for the smaller horse-power, but for the 189 and 220 horse-power tests there was no excess of the air necessary for complete combustion. Consequently for the two higher horse-powers the net evaporation of 14.8 pounds of water per pound of oil may be considered to represent the best economy that is to be expected from the use of the oil as a fuel with steam-jet burners.

The evaporation from and at 212° per pound of coal was 9.17 and 8.94 lbs. of water for 93 and 119 horse-power. The coal afforded 11.6 per cent. of ash, and 14,680 B. T. U. per pound of combustible when burned in oxygen in a calorimeter, which represents an excellent No. 1 buckwheat.

The comparative fuel costs of coal and oil for the particular conditions of the ice factory where the tests were conducted are therefore as follows: (A) For producing the horse-power required by the factory, or one horse-power per about 20 sq. ft. of heating surface, with the moisture and ash as found:

1.	Moisture in coal, per cent	6.2
2.	Ash, per cent	16.2
3.	Weight of oil per gallon, lbs	7.66
4.	Weight of oil per barrel of 42 U. S. gallons, lbs	322
5.	Evap'n per pound of wet coal from and at 212 deg., lbs	9.17
6.	Net evap'n per lb. of oil from and at 212 deg., lbs	1.51
7.	Ratio of oil to coal $\frac{15.1}{9.17}$ =	1.65
8.	Number of barrels of oil equivalent to 2,240 lbs. of coal	4.23
9.	Price of coal per 2,240-lb. ton, without cartage and cost of ash removal	$3.00

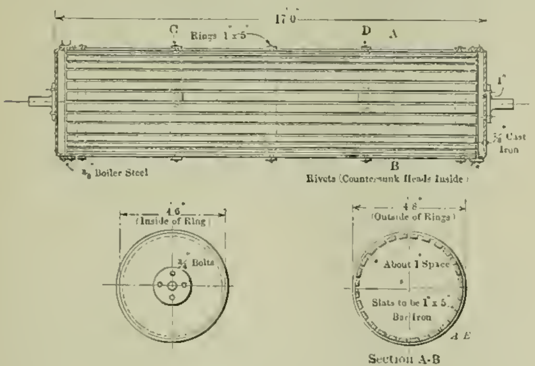
(B) For producing horse-power upon the commonly guaranteed basis of 1 horse-power per 10 sq. ft. of heating surface, and with an average percentage of moisture and ash in the coal:

10.	Equivalent price of oil per barrel of 42 U. S. gallons	$0.71
1.	Moisture in coal, per cent	3
2.	Ash, per cent	17
3.	Evap'n per lb. of wet coal from and at 212 deg., lbs	8.75
4.	Net evap'n per lb. of oil from and at 212 deg., lbs	14.8
5.	Ratio of oil to coal $\frac{14.8}{8.75}$ =	1.69
6.	Number of barrels of oil equivalent to 2,240 lbs. of coal	4.12
7.	Price of coal per 2,240-lb. ton, without cartage and cost of ash removal	$3.00
8.	Equivalent price of oil per barrel of 42 U. S. gallons	$0.73

The oil was tested, chemically, from samples from each barrel as it was delivered, with the following results from the mixture:

Specific gravity		0.920	
Flash point		142°	F.
Burning point		181°	F.
Cold test		— 6°	F.
Calorific value per pound by oxygen calorimeter		19,060	B. T. U.
Chemical Composition	Carbon	84.60	per cent.
	Hydrogen	10.90	"
	Sulphur	1.63	"
	Nitrogen	0.00	"
	Oxygen	2.87	"

Good Pittsburg coal contains as much as 1.7 per cent. of sulphur without damaging the boilers. With as much as 2.6 per cent. of sulphur this oil will give about as much as the



A Tube Rattler Made of Slats.

coal for equal horse-powers, but this proportion is considerably greater than is actually contained in this oil. Good Indiana coal contains as much as 3.5 per cent. of sulphur, which would be equivalent to 6.9 per cent. of sulphur in oil. This coal gives no trouble from the sulphur, which is sufficient ground for the claim that the oil will cause no deterioration from this source. In coal, sulphur causes clinker, but in oil there is no equivalent effect.

Oil has a great advantage in saving labor, because one man can tend 30 oil burners of 100 boiler horse-power each. With plants of 500 horse-power and over, a saving will be effected in the labor item. Under average conditions of coal and wages this will amount to about 15 cents per ton of coal for powers in excess of 500 horse-power, and in addition to this there is a saving in handling ashes and coal. Oil will be cheaper in labor charges than coal used in stokers, for plants of over 1,000 horse-power. The ash charge is about 10 cents per ton of coal used. In furnace repairs, this report gives oil the advantage of 2 cents per ton of coal used.

PLATE FOR LAYING OFF DUNBAR PACKING.

A convenient device for saving time in laying off Dunbar packing rings, devised by Mr. George Wales, is in use at the West Burlington shops of the Chicago, Burlington & Quincy Railway. It is in the form of a cast-iron plate 1 in. thick and 21 ins. in diameter, with circles scribed upon it for the various sizes of pistons. The plate is drilled with ¼-in. holes

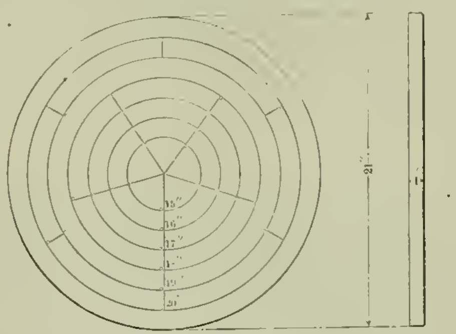


Plate for Dunbar Packing.

⅞ in. deep at intervals along the circles, and to these holes pins are fitted to hold the packing. A small metal T-square is used to mark the packing. The diameters of packing rings provided for range from 15 to 20 ins., inclusive, and the bore of each ring, to which the pins are set, is ⅝ in. less in diameter for each. The manner of using the plate will be apparent from the sketch. With this device a man can lay off 125 rings in an hour, as compared with 7 rings an hour with dividers.

A TUBE RATTLER MADE OF SLATS.

An improved rattler for locomotive tubes, whereby the disagreeable dust and noise from this necessary part of every locomotive shop equipment is avoided, was illustrated on page 46 of our February number. Our attention has been called by Mr. Wagstaff, general boiler inspector of the New York Central, to a simple and effective construction, which is illustrated in the accompanying engraving. This rattler has two cast-iron heads, 4 ft. 8 ins. in diameter, connected by slats of 1 by 5-in. iron with intermediate support from three 1 by 5-in. rings, to which the slats are riveted. Mr. Wagstaff says that a rattler of this form was constructed by the Chicago & Northwestern some time ago, and was replaced by Mr. Westmark's device when the new boiler shop at Chicago was equipped. This one of slat construction may also be used under water, but it would be advisable to make a larger opening than that provided by the removal of one of the bars extending from ring C to ring D. Whether used under water or not this open rattler allows the dirt to fall away from the tubes and greatly facilitates and improves the work.

THE DEVELOPMENT OF PASSENGER CARS.

Passenger car construction is now undergoing an interesting development which is likely soon to bring out comparisons which should exert an important effect upon future practice, particularly on steam roads. Cars for suburban service on these roads are increasing in weight to an extent which in one extreme case requires a locomotive with 140,000 lbs. on the driving wheels for a train of six or seven coaches. These coaches have six-wheel trucks and weigh not less than 84,000 lbs. each, not far from half the weight being in the trucks. It is held that heavy equipment is required to meet the demand for smooth riding and for the comfort of the passengers. The development which this represents is along the lines followed in the long-distance fast-train service, and it means very heavy cars. Undoubtedly the practice of the Pullman Company in sleeping car construction is an influence in this direction.

Another and entirely different development is that of the equipment of suburban electric roads, where it is necessary to provide much heavier and more capacious cars than have ever before been used in other than steam road equipment. Naturally this advance was based on the old horse car, which was made larger, heavier and stronger for the new power. This equipment, with relatively short and light cars, admirably answers the requirements of large cities, but for longer distances and interurban service greater capacity, more power, and greater strength were required. At the present time cars for such work have reached a length of 60 ft. They are light in the body and also the trucks. They often run on fast schedules which closely resemble those of the steam roads, and from a careful consideration of these facts we raise the question whether this is not the better line of development of the two. It is apparent that electric roads have met the ideas of the public in suburban transportation methods better than the steam roads, and this is not alone due to the favorable character of the power. In fact, in order to compete with parallel electric lines, steam roads need to take several leaves out of the electric book.

In this connection two types of cars recently built by the J. G. Brill Company, of Philadelphia, are interesting. The first is a 34-ft. car for the Utica Belt Line. This car is 34 ft. 4 ins. long by 8 ft. wide, with platforms 4 ft. 8½ ins. in length from the panel over the dasher, making a total length of 43 ft. 9 ins. The trucks are the Brill No. 27, with a wheel base of 6 ft., which have been illustrated in this journal. The sills of the car are lined with ½ by 12-in. steel plates, and the ends are fitted with angle-iron bumpers. The windows are protected by three iron rods at the corners and the sash cannot only be raised and lowered as in steam car construction, but may be slid up out of the way in the roof. This style of construction, which is known as the Brill patented semi-convertible car, does not convey with the actual operation of the windows all the advantages which it possesses. Owing to the fact that the windows when open are raised into the roof the necessity for framing in the inside walls a pocket for the reception of the sash is entirely eliminated. As a consequence, while the exterior width of the car is preserved, the interior width is increased by 7¼ ins., to the comfort of the passengers, and providing an increase in the width of the aisle. The Brill semi-convertible feature therefore provides in a narrower car practically the same room as in the standard steam railroad coaches of to-day.

The seats have corner handles ,and straps are omitted. At

Large Electric Car for Utica Belt Line—J. G. Brill Co.

Trailer Car for New York, New Haven & Hartford Railroad.
Providence, Warren & Bristol Line.

the front end of the car is a partition enclosing four tr nsverse types of its class. And we are informed by the Brill Company that fully 80 per cent. of their present orders for inter urban cars cover the same character of car that we have explained above—that is, the Brill patented semi-convertible car. The hoods are of plain clam-shell pattern, and the monitor deck is light. It is designed to meet all of the conditions of modern interurban electric service. Its weight is 42,565 lbs., complete with trucks and four motor equipments. The trucks, with motors, weigh 12,000 lbs. each.

Another and entirely different construction is that of the cars for the New York, New Haven & Hartford, for use on the electric line between Providence, Warren, Bristol and Fall River. These cars are 31 ft. 6 ins. over the bodies, and 40 ft. over the buffers. They have 24 36-in. walkover seats, covered with imitation leather, without arm rests, and have adjustable foot rests. Externally the appearance is like that of steam cars, with straight sides and needle beams. They are carried high enough to require three steps. The entrances are at diagonally opposite corners. These cars are similar in most respects to those which carry motors, and are mounted much higher than would be required for most electric roads. With the exception of the vestibules, the interior style and finish are in accordance with the practice of the road. One of these, for the motorman, is glazed, and the other is ceiled up. This car is a combination of the practice of steam and street car practice, with modifications for electric service. Its weight is 35,500 lbs. with trucks, but without motors.

METAL HOSE.

The successful and economical conveyance of hydraulic or pneumatic power or destructive or dangerous liquids by the use of flexible steel and copper pipes is an art which has been little understood in this country. The American Metal Hose Company's hose product constitutes an apparently reliable and practically indestructible substitute for rubber hose, combining as it does, the durability of metal with the flexibility of rubber. Metal hose, in consequence of its construction and the material employed, is practically impervious to the influence of destructive fluids, and is therefore adapted to the conveyance of steam, compressed air, water, oils, acids, alkalies, benzine, gasoline, naphtha or gas. Heretofore metal hose has been known as flexible metallic tubing. This tubing is quite different from metal hose, in that the former consists of a single tube, which can only be satisfactorily used where it is not hauled, twisted or subjected to hard usage. It has, therefore, not come into extended use. This tubing has been made in England and France.

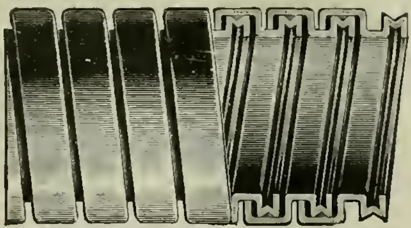


Fig. 1.—Single Metallic Hose.

The invention known as double metal hose is not an india rubber tube enclosed in metal. It is constructed of metallic tape, which is rolled up in the form of a spiral so that the edges overlap and fit tightly into each other, without detracting from its power of motion. As the tape is rolled up it forms a groove for the reception of a packing which is entirely enclosed in the metal as it rolls, and where it remains protected from internal or external wear and tear. This packing makes the hose perfectly tight, while the jointing produces a flexibility superior to rubber hose of equal dimensions. As the hose will not kink or crush, it delivers its full capacity and gives a larger opening than does rubber hose of equal external diameter. Couplings and connections being made from outside leave the internal diameter constant.

Metal hose is made according to several systems. In one of these the packing is of rubber and lies between the overlapping edges of the tape. This hose is only for light work where there is not much pressure. In another system, shown in one of these engravings, the packing is of asbestos. It does not lie between tne overlapping edges as in the first system, but is held firmly in a groove of the tape. A third method is the double hose, which is shown in the second illustration. It is made of two tubes, one within the other, and firmly fastened at the ends. The coils of the tubes are turned in opposite directions. The double coil prevents this form of hose from becoming untwisted, by careless handling or great strain, as may happen to the single coil hose. The double tube hose can be made, for special service, capable of withstanding a pressure of 3,000 lbs. per square inch. Its uses are varied. It can be used for conveying steam at any ordinary pressure. It is used for blowing flues, for rock drills, and is serviceable on railroads, in roundhouses, shops, mines, tunnels, etc. For conveying greasy liquids, which destroy rubber, this hose gives the best results, as its flexibility is increased by the lubricating quality of the liquid passing through it, and its life is consequently prolonged. This is known as the Witzenmann system.

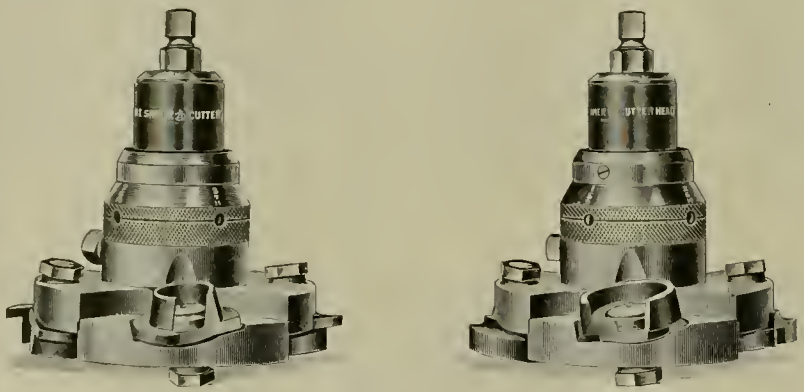
Fig. 2.—Double Metallic Hose.

Further information may be obtained from the American Metal Hose Company, 425 Dickey Building, Chicago, Ill.

Since the recent sad accident in the New York Central tunnel a number of signaling schemes for exhibiting lights in locomotive cabs have been brought to public attention and their inventors have been quoted as promising perfect protection from collisions by such apparatus. Inventors should have proper encouragement, but in this case they should be brought up quickly to the point of proving reliability in the apparatus which is to carry such heavy responsibilities. Suggestions of signal lights and audible signals in locomotive cabs and automatic safety stops for working air brakes are not new. They possess features which are desirable, but it will require years of successful operation to convince experienced signal officers that the locomotive, as it is operated today, can safely be made a part of a signaling system. Railroads have not proved their appreciation of signaling with existing devices by a degree of attention in maintenance which gives promise of the better care which such a device as an insulated truck under a locomotive tender will require, and until this has been done we are prepared to maintain, vigorously, the position that the locomotive should be kept free from these additional complications.

SHIMER CUTTER HEADS.

The cutter heads here illustrated are the latest improved form made by Samuel J. Shimer & Sons, of Milton, Pa. These cutters have been improved in many ways. Solid steel forgings are now used instead of bronze, for the heads. They are made with four, six or eight bits, each set placed in what has been found to be the best cutting position for speed and general efficiency. The cuts show the heads with four bits, and the latest form of expansion movement. So accurate is this feature of the device that by turning the adjusting ring until it snaps one notch, the cutters can be expanded or contracted the thickness of tissue paper. A quarter of a turn, or three notches, will change the size of tongue or groove 1/64th of an inch, and a full turn will change them 1/16th of an inch. The great advantages of this rapid method of adjustment will be readily apparent when it is remembered that any particular tool, set of bits or knives will not make the tongue and groove alike in all kinds of wood. The bits rest within conical duplex bit seats to line up their cutting edges to under-cut and overcut, with clearance for single tongue and groove flooring, ceiling, siding and wainscoting. Every part of the cutting edge of these bits is protected with clearance and a new cutting edge is brought full and sharp at each filing and setting of the bits. The cutter head is protected against injury, if the driving belt should break with the feed on, by reason of the concave bit seats which are provided; brass heads with flat seats, have often been injured by such an accident. The strength of the heads and this concave feature in the bit seats makes these tools practicably indestructible. The concave seat, with its duplex incline, includes another good feature. It is that the bit tapers both ways from its largest diameter, when the heaviest in-cut is made, and shaves away the chip from a dividing line, up and down, giving to these leading parts a diamond-shaped tool point. Another good feature is that the bits which cut the upper half of the tongue and groove are placed upon the lower section of the head, which carries the top adjusting screw and remains a fixture in line with the set of the cylinder. Further information may be had from the manufacturers.



The Shimer Cutter Heads with Four Bits and Expansion Device.

Impact tests on notched specimens are extremely effective in showing brittleness or lack of homogeneity in structural steels. A notched bar under impact tests yields in an entirely different way from an unnotched one. There is as yet no general agreement as to the best form and depth of the notch. These matters were discussed recently by the International Association for Testing Materials of Construction at Budapest. One method is to use test bars of .314 in. by .393 in., having a sawcut 1 mm. deep and rounded at the bottom; V notches were advocated by other members. There is a general consensus of opinion, however, that the height of the fall should be such as to cause rupture at one blow. In experiments conducted by M. Barba specimens 11.8 ins. by 1.18 in. were used, and were V-notched, the angle of the sides being 45 deg. It is important that the radius of the point of the V should not be greater than 1/125 in. In testing, the bars are gripped between jaws, the notch on the top being vertically over the edge of the lower jaw. The piece, 25 mm. long, projecting from the jaws, is then struck by a falling weight if 39.4 lbs., moving between guides. The weignt strikes .866 in. away from the center of the notch. The height of tne fall is adjusted by trial, so as to just insure fracture. These tests detect brittleness, as well as a lack of homogenity in a specimen. In order to avoid the time lost in the trial and error method for finding the proper height of fall, M. Tremont devised a machine in which the "tup," after breaking the bar, is received on springs which register the energy remaining in it. The height of the fall is purposely made too great, and the work done in breaking the bar is found by subtracting the remaining energy in the tup after fracture, from that in it at the moment of striking.

M. Barba found that annealing ordinary steel does little to correct a tendency to brittleness, but tempering does. Confirmation of this fact has been forthcoming in some experiments made on shafting steel used for French warships, by M. Godard, Ingenieur de la Marine at Indret. The height of fall needed for fracture with the annealed specimen was only 10 to 20 millimeters, while the tempered specimen did not break with a fall of 3.55 meters.

A simple and inexpensive method of waterproofing blue prints is given in "Mines and Minerals." It renders them completely impervious to water, and will be appreciated by those who have experienced the annoyance of having the prints discolored and blurred by rain, drippings or moisture in general. The waterproofing medium is refined paraffin, and may be applied as follows: Immerse in melted paraffin, until saturated, a number of pieces of an absorbent cloth a foot or more square, and when withdrawn and cooled they are ready for use at any time. To apply to a blue print, spread one of the saturated cloths on a smooth surface, place the dry print on it with a second waxed cloth on top, and iron with a moderately hot flatiron. The paper immediately absorbs paraffin until saturated, and becomes translucent and highly waterproofed.

THE EXCESSIVE TONNAGE EVIL.

"Heavy train tonnage," says Mr. G. W. Turner, in a recent issue of the "Railway and Engineering Review," "seems to have been adopted by a number of railway companies as the stepping stone toward economy." True economy, however, as the writer of the article proves, is not always obtained in that way.

It looks very well on paper to see trains run from terminal to terminal with maximum tonnage, but the reason it looks so well is that bad delays are not shown and a heavy engine repair bill, due to overloading, is altogether excluded from the statement, and even trains which make a very bad record are dropped out of sight so that the average may be kept up, on paper. In reality it is impossible to successfully handle "the limit heavy tonnage trains" without greater proportionate expense, and an almost inevitable freight blockade to follow. Shippers wonder why there is a car famine or a lack of power to move their goods promptly, especially where new equipment has been added.

The writer gives his experience of the effects of this train-tonnage craze on a certain trunk line upon which he was employed. He says: "We were doing an enormous freight business and were taxed to our utmost with the power we had, to keep the road from being blocked, when the mandate was issued to load trains to the very last notch. Protest was useless, and the result was a freight blockade. The powers above, believing this had been caused by shortage of power, gave us 25 new engines and a lot of new cars, but the situation did not improve, in fact it became worse. Had we been furnished with 250 engines, working under the heavy tonnage system, the road would still have been blocked. The management, however, went to the other extreme and ran ridiculously light trains in order to relieve the congestion.

"To satisfy ourselves, I persuaded my superintendent to try an experiment on the quiet. Our business was such that we were able to make an experiment. We took two new 20 x 26 engines of the same class; we put one on a drag freight train giving the limit, 60 loads; the other was put on a faster freight with 40 loads. This was done on a 125-mile district. A 90-day test was made, and from this a year's average performance was computed. The one hauling 60 loads took an average of 12 hours on the road. She was held at each terminal an average of five hours for flue work and other necessary repairs. In other words, she was 34 hours making a round trip. She lost 15 days for engine failures complete; 35 days held in for work; 21 days through the shop for general repairs. That left 294 working days, or 7,056 hours. Dividing this by 34, we found she had made 207 round trips and had hauled 24,840 loads. At $16 car revenue, she had earned $397,440.

"The other engine made the round trip in 20 hours; she lost 21 days for general repairs, one day for engine failure; was held in three days for work. She worked 240 days, or 8,160 hours, and had made 408 round trips, hauling 32,640 loads and earning $502,400. That is $104,960 better than the heavy tonnage engine. Looking at this test, fairly made over a division having 14 daily passenger trains and countless freight trains, the drag train did well to make the trip in 12 hours.

"It has been estimated that a box car kept moving will earn $3 per day. By reason of the slow time made by the heavy train nearly 8,000 cars were tied up, which, at the figure quoted, means a loss of $24,000 on a 125-mile district. Suppose the road was 2,500 miles long, it would show a loss of $480,000 on equipment, with untold losses on account of revenue being driven from the road. It would not take many of these drag trains to spoil the dividends. Still it is kept up."

One of the arguments against lighter tonnage trains is "Look at the cost of running more trains, with more trainmen to pay, etc." The answer to is the single item saved on equipment due to quick movement will more than offset this. The overtime paid on drags, repairs, etc., on a large system would soon build a railroad, and if heavy tonnage were made the exception and not the rule, handsome returns would be the result all round.

THE 20,000TH BALDWIN LOCOMOTIVE.

The Baldwin Locomotive Works celebrated their seventieth anniversary February 27, and the completion of the twenty-thousandth locomotive built by them. As the event occurred after this journal went to press we must be content to merely announce the fact at this time and give an account of the occasion later.

The history of these works is contemporaneous with that of steam railroads in this country. Mathias Baldwin, the founder of these works, was a jeweler, and about 1830 constructed a model of a locomotive for exhibition in Philadelphia. This led to an order from the Philadelphia, Germantown & Norristown Railroad for a locomotive to replace horses for car traction. His only guide with reference to the details was obtained by an inspection of an English locomotive ,then running on the Camden & Amboy Railroad. In 1832 the "Old Ironsides" was completed and put into service. Its cylinders were 9½ by 18-in., it had but four wheels, and weighed 5 tons. The boiler was 31 ins. in diameter, and had 72 copper tubes ½ in. in diameter and 7 ft. long. An interesting model of this historic engine may be seen at the Baldwin Locomotive Works, where it is carefully preserved.

In 1834 five locomotives were built, and in 1835 the works were moved to their present location. In 1835 fourteen engines were built; 40 were built in 1836. After some financial troubles the business began to develop on a firm basis in 1842, and these works after that date grew with the railroads.

The works as they stand to-day are very largely a result of the sagacity and skill of Mathias Baldwin, and they constitute a monument to his efforts. He died in 1866. The building of the first thousand locomotives at these works occupied thirty years, being concluded in 1861. Since that time 19,000 have been built, and the celebration of this achievement will be appropriate and impressive. It is interesting to study the character of this twenty-thousandth locomotive from the engravings which we publish in this issue. It is fitting that this particular engine should be of unusual interest, and if, (as we confidently expect it to do), it marks a turning point in locomotive practice in this country, this celebration of the Baldwin Locomotive Works will have a large place of its own in the history which is yet to be written.

A feature of the celebration was the assemblage of notable men, and we are of the opinion that this indicates a growing appreciation of the part which the locomotive is to play in future railroad development.

SPEED OF EXPRESS TRAINS.

By C. M. Muchnic.

Till quite recently American trains held the supremacy in speed over any other trains in the world. That our fastest trains are now only second in the line of fast trains will be evident from an examination of the tables below, published by the "Archiv für Eisenbahnwesen." These tables show the speeds of regular trains run in France, the United States, England and Germany during the summer season of 1900, giving the mileage between terminal stations, number of stops, hours consumed per trip and average speed of train per hour.

Comparing the two fastest trains, viz., the Paris-Bordeaux, with a stretch of 363.5 miles, and the New York to Buffalo express (Empire State), with a stretch of 439.9 miles, it will be seen that the former train, with an equal number of stops (4) covers the distance at an average speed of 56.5 miles per hour or 2.5 per hour faster than the Empire State Express at an average speed of 54.0 miles per hour. For short distances the fastest trains will be seen to be the Philadelphia & Reading and Pennsylvania expresses from Camden to Atlantic City. The former covers the distance of 59.3 miles in 53 minutes with no stops, at a speed of 67.2 miles per hour, and the latter covers the distance, 60.3 miles, including one stop, in 59 minutes, or at a speed of 61.4 miles per hour.

The American trains are heavier than the European, but it is also true that the American engines that haul these heavy fast passenger trains are from 25 to 40 per cent. more powerful than their European mates. Those who are accustomed to see the powerful American engines and have had occasion to observe the performance of those smaller French engines are led to do some thinking.

Two conditions seem to be essential in the fast passenger engine. First: as powerful a boiler as can safely be carried on the wheels, and second, the reduction to a minimum or total annihilation of the dynamic effect of the reciprocating weights. A study of these engines will show how much the designers of these French express engines have sought to meet those two conditions and how closely they have reached their solution.

To obtain the highest boiler efficiency with a minimum weight they have adopted the compound principle. Mr. de Glehn claims that any modern high-pressure locomotive boiler will be 25 per cent. more efficient or powerful when furnishing steam to compound cylinders than to simple expansion cylinders. The second condition is realized by arranging the compound cylinders and working of their respective pistons in such a manner that their reciprocating weights counterbalance each other, thus producing the balanced engine. It is because of these two conditions or features, noticed on almost all European express locomotives, that such high speeds, combined with an economical performance, have been attained.

SPEED OF EUROPEAN EXPRESS TRAINS.

Line.	Distance in miles.	Hours consumed per trip, stops included.	Number of stops.	Hours consumed per trip, stops deducted.	Av. speed per hour.
France.					
		h. m.		h. m.	
Paris, Erquelines	149.1	2.49	2	2.44	54.7
Paris, Mons	155.3	3.35	2	3.11	48.7
Paris, Amiens, Calais	185.2	3.30	0	3.30	53.0
Paris, Arras, Lille	153.5	3.00	3	2.52	53.7
Paris, Rouen, Havre	141.7	3.00	1	2.55	48.4
Paris, Tours, Poitiers, Bordeaux	363.5	6.42	4	6.25	56.5
Bordeaux, Hendaye	144.8	2.52	4	2.45	52.8
Tours, St. Nazaire	159.7	4.29	7	3.34	44.7
Bordeaux, Narbonne, Cerbere	318.1	8.15	8	7.10	44.1
Paris, Limoges, Toulouse	443.0	10.57	9	10.22	42.8
Paris, Nevers, Clermont	261.0	7.26	10	6.48	38.5
Paris, Dijon, Lyon	318.1	7.27	3	7.07	44.7
Paris, Macon, Geneve	389.0	10.14	7	9.38	40.3
Lyon, Marseilles	218.1	4.42	2	4.29	48.5
Paris, Belfort	275.3	6.08	4	5.48	47.2
Paris, Nancy, Avricourt	254.8	5.42	5	5.27	46.6
Paris, Frouard, Pagny	232.4	5.39	8	5.14	44.1
Paris, Reims, Mezieres	213.8	3.30	2	3.19	46.0
United States.					
New York, New Haven, Boston	232.4	5.00	3	4.49	48.4
New York, Albany, Buffalo	439.9	8.15	4	8.07	54.0
New York, Geneva, Buffalo	451.1	9.55	14	9.29	47.5
New York, Buffalo, Chicago	980.6	24.00	12	23.12	42.2
New York, Niagara Falls, Chicago	980.6	26.30	46	24.52	39.1
New York, Philadelphia, Chicago	913.5	24.00	16	23.07	39.7
N. York, Philadelphia, Washington	228.0	5.00	7	4.46	47.8
Chicago, Cleveland, Buffalo	540.0	12.55	15	12.19	44.1
Chicago, Detroit, Buffalo	523.2	13.40	19	13.04	41.0
Chicago, Baltimore, Washington	845.10	23.00	21	22.02	38.5
Chicago, San Francisco	2,420.3	69.30	39	67.21	36.0
Baltimore, Philadelphia	108.7	1.57	1	1.56	49.7
Baltimore, Cincinnati, St. Louis	934.6	28.35	41	27.01	34.8
Boston, Albany, Buffalo	49.9	13.00	9	12.17	40.4
Cleveland, St. Louis	548.1	13.45	22	13.07	41.6
Philadelphia, Atlantic City	60.0	1.00	1	.59	61.4
Camden, Atlantic City	59.0	.53	0	.53	67.2
England.					
London, Newcastle, Edinburgh	394.6	7.45	3	7.29	52.8
London, Leicester, Glasgow	425.0	9.05	6	8.40	49.1
London, Crewe, Holyhead	264.1	5.15	1	5.10	50.9
London, Bristol, Plymouth	247.3	5.18	2	5.00	49.7
London, Harwich	69.0	1.27	0	1.27	47.8
London, Dover	76.4	1.41	0	1.41	45.3
London, Southampton	78.9	1.45	0	1.45	45.4
Edinburgh, Aberdeen	130.5	3.17	5	3.08	41.6
Dublin, Cork, Queenstown	177.1	4.25	3	4.06	43.5
London, Crewe, Glasgow	402.0	8.00	4	7.48	51.6
Germany.					
Berlin, Hamburg	177.7	3.36	1	3.32	50.3
Altona, Kiel	65.2	1.37	1	1.35	41.0
Berlin, Stralsund	149.7	3.52	3	3.42	40.4
Berlin, Dirschau	264.7	6.26	5	6.09	42.9
Dirschau, Konigsberg, Eydtkuhnen	225.6	4.52	3	4.41	41.6
Berlin, Schneidemuhl, Thorn	238.0	5.34	4	5.18	44.7
Berlin, Breslau, Oderberg	316.9	7.27	6	7.07	44.7
Breslau, Dresden	165.3	4.22	7	4.04	40.4
Dresden, Leipzig	98.2	1.43	1	1.42	42.3
Berlin, Leipzig, Hof	209.4	5.02	2	4.54	42.9
Munich, Salsburg	95.1	2.17	0	2.17	41.6
Hamburg, Munster, Cologne	278.4	6.48	11	6.22	43.5
Berlin, Halle, Frankfort	374.4	8.50	10	8.24	41.0
Leipzig, Madgeburg, Hanover	165.3	4.27	5	3.54	42.3
Berlin, Stendhal, Hanover	160.9	3.42	2	3.37	44.7
Berlin, Madgeburg, Hanover	179.6	4.15	4	4.00	44.7
Hanover, Essen, Cologne	201.3	4.51	4	4.40	42.3
Berlin, Hildesheim, Cologne	357.9	9.21	14	8.46	41.0
Cologne, Bingerbruck, Frankfort	137.9	3.40	4	3.20	41.6
Cologne, Mayence, Carlsruhe, Bale	321.9	7.38	8	7.10	44.7
Frankfort, Carlsruhe, Bale	210.6	5.17	6	4.52	43.5
Luxemburg, Strasburg, Bale	208.8	6.00	13	5.33	41.0
Avricourt, Strasburg	109.4	2.49	2	2.39	41.0

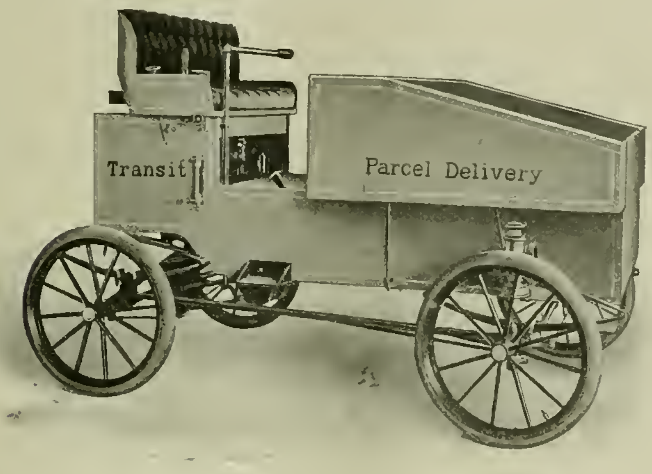
It is impossible to take diagrams from a steam turbine, therefore there can be no indicated power. A recent De Laval turbine test developed the fact that the theoretical and experimental values for steam consumption agreed within 1/10 of 1 per cent. The two turbines tested were each 100 horsepower. The pressure was 172 lbs. and saturated steam was used. For a run of 4½ hours, with a condenser pump, almost 18 pounds of steam were used per effective horse-power. Without the pump the consumption was 16.92 lbs. By making a deduction of 10 per cent., to reduce these results to those of highly efficient steam engines, it will be seen that the turbine is quite as efficient a machine as the reciprocating engine of the same power. The turbine is especially adapted for use with superheated steam, since there are no rubbing surfaces, no valves to keep tight, and no lubricants to become carbonized by heat. A test made at the Technical High Schoot at Dresden proved that an economy of 30 per cent. was effected by the use of steam superheated 336 deg. C. The high temperature of the exhaust steam makes it desirable for heating feed water.

There is, generally speaking, a sufficient traffic, properly conserved, to maintain fair returns upon all our railways. The service, especially in freight traffic, is so nearly uniform and there is such an increased identity of interest of each company as compared with its neighbor as to justify abandonment of the old idea of grasping everything in sight, and instead, a devotion primarily to the development of local and regular traffic and the making of the same effort to bring about, by concerted action, an equitable distribution of the more competitive traffic on broad lines, as between the several roads competing therefor, as was formerly expended in individual effort for purely selfish ends. Take as an illustration two great trunk lines. Eighty per cent. of the earnings of each are of the local or regular patronage character. How wise it would seem to be to establish an understanding for an equitable distribution of the 20 per cent., instead of an indiscriminate competition therefor which must, by the nature of things, draw into the demoralization a considerable part of the other business!—B. D. Caldwell, before New York Railroad Club.

We have been asked what differences exist between the fuel oils of the East and those of California. The Eastern oils are principally of hydrocarbons of the paraffin series, while those of California contain a greater proportion of hydrocarbons, having a greater percentage of carbon than those of the paraffin series. This large amount of carbon explains the reason for the principal value of California oils for fuel, because they are less adapted to refining for illuminating and other purposes. The California oils are productive of asphaltum, gas distillate, lubricating oil and naphtha, but their greatest value is for fuel.

A NEW MOTOR CAR.

This vehicle is worthy of the attention of our readers, especially because it was developed and built by a railroad man of wide experience, Mr. W. S. Rogers, who designed it with reference to the needs of railroad officers for inspection cars. The one now completed is for road use as an "automobile," but with the substitution of flanged wheels and a rigid front axle the same machine is to be used for inspection service, as the gauge is 4 ft. 8½ ins. The engraving shows the construction for distributing parcels on city streets. By the removal of the parcel box and substitution of a seat box tne carriage becomes a passenger vehicle. It was built at the Steamobile factory at Keene, N. H., and has been called the "Transit." It has been fitted with the Steamobile Company's special two-cylinder 6-h.p. engine, and steam is generated in a straight shell boiler with 428 ½-in. tubes, 13 ins. long. The fuel used is gasoline, which is stored in a tank of 12 gallons' capacity, while the water tank holds 36 gallons. The weight of the "Transit" is 1,400 lbs. in working order. It is mounted on four 28-in. wheels having 3-in. rubber tires, and its wheel base is 6 ft.



A Motor Car for Road Use and Railroad Inspection Service.

As a parcel delivery vehicle it is of very convenient form. The operator's seat is at the back, and is no higher than that of the present type of motor cars, and though the parcel receptacle is in front, it is low enough to afford the operator an unobstructed view of the road in front. Parcels and goods carried cannot fall out and are at all times under the eye of the man in charge. This parcel box can be removed and the vehicle turned into a passenger conveyance if desired. When this is done the parcel holder is replaced by a comfortably upholstered passengers' box, which will normally seat four persons, though five or more can ride pleasantly, at a pinch. The "horseless" feature of this carriage is emphasized by the fact that the entrance for the passengers is directly where the tail of the horse would ordinarily be. The passengers, though sitting with feet but 18 ins. from the ground, nevertheless have an excellent view of everything about them, and this without interfering in any way with the operator. The front position of the passengers protects them from annoyance from steam, gas fumes or dust.

This vehicle might be very useful in the service inaugurated by some of our leading railroads, and be employed in the conveyance of passengers from station to hotel or residence, and vice versa. It would make an ideal delivery wagon for hand baggage and small articles, in the same service.

Wire-wound cast-iron pipe.—M. Jacquemart, the managing director of the Société Metallurgique d'Aubrives et Villerupt, France, has introduced the system of winding steel wire, under pressure, round the extremities of the pipe and in grooves cast in the body of the pipe. The idea of shrinking iron bands onto cast-iron cylinders is very ancient, but the problem was to find some method which would cause the bands to follow exactly the shape of the parts to be enveloped, and exert an even pressure throughout. This is accomplished by the method of winding above referred to. In the manufacture of pipe all complicated machinery must be rejected, and it was therefore essential to provide a method of winding which, while being perfectly simple in its application, would secure perfect uniformity of tension in each wire wound round. M. Jacquemart started from the fact that a steel wire of uniform diameter has a constant resistance throughout its length. He devised a method by which the wire is passed through a drawplate, which reduces it to a certain fixed diameter. Winding at an equal and constant pressure is effected by revolving the pipe, the wire first passing through the drawplate above described under the desired amount of tension. Another important point is the bedding of the ends. This is effected by shaping the edges of the grooves so that the wire can be bedded into them, and thus be securely fixed; and for greater security molten tin is poured over every end. Asphalt is put on at high temperature, which penetrates the spaces between the coils and completely covers them. Experiments with these steel-bound pipes indicate that with them it is possible to avoid a burst with a large main. Their behavior under such conditions as sudden and instantaneous shocks shows that pipe of this type is proof against a burst, and that even when strained to the point of fracture the damaged parts remain in their original position. A cast-iron main of this type 78 in. in diameter has been laid by the water company of Paris.—The "Mechanical World."

Cylinder brakes of the Le Chatelier type receive renewed interest with the increasing weights of locomotives which are used in mountain service. Recently the Baldwin Locomotive Works have developed a new brake of this character, illustrated on page 12 of our January number, which has been extensively applied on the Atchison, Topeka & Santa Fe, the Colorado Midland and other roads having heavy grades. With these brakes as auxiliaries the engines are operated on a down grade with the driver brakes cut out, the reverse lever in full back motion and the brake resistance of the cylinders is regulated by a valve at the hand of the engineer, whereby he controls the amount of air which is pumped by the cylinders. Mr. Vauclain says: "It is surprising how uniformly one can bring a passenger train down those long grades without applying the brakes to the car wheels. The serious business of running passenger trains—also freight trains—on long steep grades is that the tires warm up, the brake shoes get red hot and cast-iron wheels sometimes burst, making the wear and tear on the wheel equipment very severe. But with this device and this locomotive, we were able to bring train after train down those grades without any assistance from the train brakes."

Mr. Charles B. Young has been appointed mechanical engineer of the Chicago, Burlington & Quincy Railroad to succeed Mr. F. H. Clark. Mr. Young has been chief draftsman of this department for a number of years, and succeeded Mr. Clark in that position.

RECKONING TONNAGE OF PASSENGER TRAINS.

On the Ton-Mile Basis.

In order to answer a recent inquiry concerning methods of figuring the tonnage of passenger cars, as to whether it is customary to use the actual weights of the cars, information was secured from four roads which may interest our readers.

On the first of these, when the ton-mile basis was first put into effect, blue prints were prepared for the car accountant's office, in which the ton mileage was computed. On these prints the different classes of passenger cars were grouped, each group containing the number of cars of the same class or of the same weight, the weight of the empty cars being given by weighing a few of each class. For example, one group contained the numbers of all the 12-wheel vestibuled chair cars weighing 40 tons. Another group contained all the 8-wheel vestibuled chair cars weighing 30 tons, and so on. The clerks of the accountant's office soon knew all of these numbers and it was necessary only occasionally to refer to the print. As the passenger cars went through the shops from time to time they were weighed, and in this way the actual weight of all of them was taken. This gave an opportunity to keep track of the increase of weight of any of the cars by adding vestibules or enlarging water reservoirs, and to keep the record up to date. It was found, however, that unless radical changes were made the original weights were quite close.

On another road the weight of the passengers and baggage is taken into account, on the assumption that each passenger and his baggage weighs a definite amount, say 180 lbs. Of the exact weight taken we are not sure, and the number of passengers is obtained from the reports of the conductors. These weights are added to the known weights of the cars.

A third road uses the scale weights of all the different classes of cars and adds to these two tons to each for passengers, while to the weights of baggage, mail and express cars five tons are added for their contents. A fourth road adds three tons to the scale weight of every passenger equipment car for passengers, baggage, mail and express, the varying weights being considered as averaging this amount.

VALUE OF TECHNICAL JOURNALS.

To those who watch the progress of men the importance of keeping thoroughly informed is clearly understood. The most successful men in all professions and occupations are usually those who closely follow the work of others as recorded in the technical papers of their special work. A letter recently received from an old subscriber, a blacksmith, contains a valuable suggestion to young men, no matter what their field, and it is printed in full for their benefit, as follows:

"For the past 28 years I have been foreman of the boiler and blacksmith shops of one of the leading railroads of this country, and, in leaving this work, it is only fair that I should say that the greatest assistance I received in my work was the information derived from the American Engineer and Railroad Journal, the American Machinist and other technical papers. I can truthfully say that the ambitious young man whose work lies along these lines cannot obtain greater assistance than the information contained in such journals, which, when properly utilized, will equip him to fill any position in his chosen work to which he may be called.

'Because of leaving the field in which I have so long worked, for another, entirely different, it is necessary for me to study the new subject in the same way, by aid of the best publications which are devoted to it. I therefore reluctantly cancel my subscription to your paper."

Mr. Clarence P. Day, 253 Broadway, New York, has inaugurated a unique service in connection with advertising. He acts as advertising counsellor, and from his intimate knowledge of the publishing business and thorough acquaintance wi. advertising methods is prepared to assist in securing the best results from a given expenditure. He stands for the better value of good advertisements in a few of the best papers as compared with small and passive cards in many, which are selected without the benefit of the discrimination which the expert only can use. The American Engineer endorses Mr. Day and his service, and urges advertisers to consult him.

While the mechanical departments of the American railroads are being crowded in the matter of capacity of locomotives, and with the present tendency will find it difficult to meet the requirements for power, it is clear that in the capacities of cars they are far ahead of the present abilities of the operating departments in the loading of the cars. The increase in capacity of the freight car has not been accompanied by a corresponding increase in the loads carried, and considerable improvement will be necessary before the increased cost of 40-ton above that of 30-ton cars will be earned. A competent authority places the actual loading of cars at not above 55 per cent. of their nominal capacity, considering the railroads of the country as a whole. It is only in grain, coal, ore or similar traffic that full loads are always insured, but by careful watching of the loading at local points, the average of miscellaneous freight will gradually be raised. There is now a great waste of equipment, and the benefits to be derived from increasing car loadings will be apparent at once. They will appear in decreased car mileage, decreased train mileage, switching cost, and in increased earning capacity of the entire road, because of the more profitable use of facilities. The present situation is not in the least an argument for smaller cars; it is the strongest argument for larger ones, because it shows the deficiencies in present methods of loading.

BOOKS AND PAMPHLETS.

"Power and Power Transmission." By E. W. Kerr, Assistant Professor of Mechanical Engineering, Agricultural and Mechanical College of Texas. 8vo, 356 pages; illustrated. Published by John Wiley & Sons, New York, 1902. Price, $2.00.

This book covers in a small space a large part of the subject of mechanical transmission of power, and it would be impossible to treat one out of a dozen of its most important topics properly in a work of its size. It is intended as an outline, an indication of principles, and as a course of study. The reviewer cannot help feeling that it will give a superficial view of machine design, steam power transmission, the steam engine and valve gear to those who do not enjoy the advantage of the author's explanations and research into the large question upon which he touches. The work is to be commended to those who are deprived from access to complete works on the various branches of the subject. The author states in the preface that it contains the subject matter of lectures delivered to students of the elementary principles of engineering, and its purpose was to direct the beginner along the proper course of study.

"Mill Building Construction." By H. C. Tyrrell, C. E. 40 pages, 6 by 9 ins., illustrated. Published by Engineering News Publishing Company, New York. 1901. Price, $1.

The earlier pages of this little book are devoted to discussion of the live and dead loads which must be provided for in the roof and floor systems of mill buildings. A diagram is given showing the weights of roof trusses for given spacing and working stresses. The floor construction is shown in several forms, including permanent concrete ground floors, fireproof floors and the slow-burning or factory type of floor. The details are not elaborate, but serve to suggest points of value for the designer. In general, it may be said that the details of construction for the framework, etc., appear to be borrowed from good practice. However, the book cannot be said to be more than a suggestion, and were there not such a dearth of literature in this now important field of structural engineering there would seem to be small justification for the issue of so meager a treatment of the subject. On the other hand, it is but fair to say that the author does not call his work a treatise, and it must be granted that the book is well worth the price asked for it.

"Water Tube Boilers." By Leslie S. Robertson, New York. 1901. D. Van Nostrand Company. 170 illustrations; 213 pages, Price, $3.

The author of this book is thoroughly competent to present the subject, and in this work has placed in available form five lectures delivered by him at University College, London. Bertin's "Marine Boiler," which was translated by him, is the best work on the subject, but it is costly. Mr. Robinson's book is less elaborate, but serves its purpose admirably. He evidently has access to information from the British Admiralty and also received assistance from boiler builders. The first chapter is a historical description of the best known types of water-tube boilers brought up to date. Next comes a treatment of the general principles of boiler construction, with particular reference to water-tube boilers. This is followed by a chapter on circulation of water and hot gases, presenting the Yarrow experiments. After describing the most important types of water-tube boilers and discussing their weights and space occupied, the author gives a fair statement of the advantages and disadvantages of the type. It is an excellent book, describing practice and presenting that which has been well tried, including such features as automatic feed-water regulators.

The Proceedings of the Thirty-Second Annual Convention of the Master Car and Locomotive Painters' Association have been issued. The book contains a verbatim report of the papers read and the discussions which followed. It contains a great deal of useful and practical information. It can be had on application to the secretary of the association, Mr. Robt. McKeon, Master Painter of the Erie Railroad at Kent, Ohio; or from the Industrial Press, 9-15 Murray street, New York. The price is one dollar. The book contains, with index, 150 pages, and is of the M. C. B. standard size.

The Proceedings of the Eleventh Annual Convention of the Association of Railroad Superintendents of Bridges and Buildings for 1901 have just been issued. The meetings were held at Atlanta, Ga., in October. The reports of committees were, Method of sinking foundations for bridge piers in depth of water of 20 ft. and under; Passenger platforms, best material, and cost of same; Best method of operating turn-tables by power; Auxiliary coaling stations, best design, capacity, and method of handling coal; Water stations, best material for foundations, tanks, substructure connections, capacity, etc.; Is it best for railroad companies to erect their own steel structures, or to let manufacturers erect them? The best and most convenient outfit cars for bridge gangs, and the number of men constituting a bridge gang. The proceedings were issued from the Rumford Press, Concord, N. H. Mr. S. F. Patterson, of the Boston & Maine, Concord, N. H., is the secretary of the association.

"Golf in California" is the title of a small magazine devoted to the interests of the game on the Pacific Coast. In the January issue are descriptions and interesting illustrations of the most noted links, country clubs and winter hotels in California. The pamphlet also gives diagrams of the different links. The last four pages of the pamphlet are devoted to information concerning the Santa Fe Railway and its daily trains from Chicago to San Francisco, Los Angeles and San Diego.

"Steel Plate Fans" is the subject of Catalogue No. 134, issued by the American Blower Company, of Detroit, Mich. There are about twenty-four half-tones, showing the fans full housed and three-quarter housed. Details of fan construction, journal boxes, general dimensions, with capacity of fans and useful information concerning them, is given. This catalogue also contains a price list. It will be sent to persons interested upon application. The New York office is at 141 Broadway.

The Pond Machine Tool Company, 136-138 Liberty street, New York, has sent us a very tastefully executed catalogue containing information regarding its latest line of heavy, powerful engine lathes. The half-tones are excellent, and the description accompanying each contains information concerning the tool shown, as well as giving the principal dimensions. Fourteen machines are catalogued, beginning with a 28-in. back-geared lathe, and presenting 36, 42 and 48-in. triple geared lathes, up to an 84-in. machine. A four-tool shafting attachment, which can be applied to the lathe carriage, is shown. This device has four tool slides, independently adjustable. The catalogue will be forwarded to persons interested.

H. M. Treadwell & Company, of 95 and 97 Liberty street, New York City, have issued a catalogue which illustrates the character of their car-building work. The rolling stock here set forth shows the style of work done from 1876 to the present time. The catalogue is arranged with a half-tone perspective view of a car on one page, with dimensions on the opposite page. The concluding half-tones show an 80,000-lb. capacity high-side wooden gondola, with side stakes made of structural steel, built for the Baker & Whiteley Coal Company; also a wooden 60,000-lb. hopper gondola, for the Philadelphia & Reading Railway, carried upon Fox steel trucks; and finally, a modern Union Tank Line car. Treadwell & Company solicit inquiries for prices and general information, and will supply the catalogue upon application.

Mr. R. T. Crane, president of the Crane Company, recently made an extensive investigation in regard to the utility of an academic education for young men who have to earn their own living, and who expect to pursue a commercial life. In this connection he sent out letters of inquiry to a large number of prominent business men throughout the country, as well as college presidents and graduates. The result of such investigation has now been published in pamphlet form for private distribution. Mr. Crane has published upward of fifty replies from persons prominent in college, railway and mercantile life. The pamphlet will be sent to anyone interested in the subject. It contains the opinions of some of the most successful business men of the country, and is valuable as well as interesting.

The Bradford Machine Tool Company, of Cincinnati, Ohio, has just issued a catalogue which contains descriptions of the various sizes and makes of the Bradford Lathe. After a brief general description, there follows, on alternate pages, cuts of lathes and the dimensions of their parts. The cuts are clear, and indicate the substantial construction of the tools which this company aims to maintain. About fifteen of these machines are here shown, including ordinary shop lathes; double back-geared lathes; coarse screw-cutting lathes; automatic power-feed turret lathes, and shafting lathes. The improved taper attachment given on page 23 appears to have considerable merit. The aim of the manufacturers is to give, in this catalogue, a concise view of the Bradford Lathe as it is made to-day by them, after over sixty years of successful manufacture.

The American Blower Company, of Detroit, Mich., has issued a neat catalogue, which gives information regarding the "A B C" hot-blast heater. The heater consists of a series of steam-fed vertical coils which, when boxed in, form a very effective building warming apparatus. Through this box a current of cool, fresh air is driven by means of a fan operated either by a pulley, or directly from a small engine. Above the heater coil is a passage for cold air, the supply of which is regulated by a damper, so that the hot air may be diluted with cool air as circumstances may direct. In any case, fresh air is supplied to the building which is to be warmed. The catalogue has many good half-tones, and gives information relative to size, construction and operation of the heaters.

Patent improved drop hammers is the subject of a catalogue sent out by the Billings & Spencer Company, of Hartford, Conn. Hammers of 1,000, 1,200 and 3,000 lbs. are illustrated, and the details of trip lever, latch, head construction, pulleys, board guard and foundations, follow, with separate illustrations and notes. A dissected hammer is illustrated, each part being numbered and named for facility in ordering. An improved trimming press is shown, and also two heating furnaces. Some handy tools for use in changing dies are manufactured by this firm. The catalogue, which will be sent to interested persons, shows on the three last pages an almost infinite variety of forgings of iron and steel which may be formed under the B. & S. drop hammers.

The Railway Appliance Company has issued a small folder, which they call "Now and Then." It points out the state of affairs which can occur when a freight train, hard pressed by the "Limited," and miles from everywhere on a dark night, breaks in two, and the crew has no spare knuckle to couple up with again. The Gilman-Brown emergency knuckle has been designed for just such cases. It is not exactly a knuckle; it is really a tool, and may be carried in the caboose. The "R. A." car mover is another useful device, particularly about a yard. Its operation is simplicity itself; the power which applies the leverage clamps the bar to the rail, and the greater the resistance the tighter the grip. The Railway Appliance Company, of 680 Old Colony Building, Chicago, will furnish further information concerning these devices.

EQUIPMENT AND MANUFACTURING NOTES.

Mr. Charles F. Pierce has been appointed to the commercial staff of the Goodwin Car Company, with office at 96 Fifth avenue, New York City.

At the Wilmington shops of the Pullman Palace Car Company the private car "Olympia" has been equipped for the use of Prince Henry of Prussia with the electric light system of the Consolidated Railway Electric Lighting and Equipment Company. The interior decorations are of bronze and mahogany, the upholstery is of blue plush, the tapestry is brown and the curtains of brown silk. This is one of the handsomest cars ever built in this country. It is lighted in every room by electricity and ventilated by electric fans.

We are informed that the Ball Bearing Company, Boston, Mass., well known as manufacturers of ball and roller bearings for all kinds of machine construction, have moved their factory to Philadelphia, where they will enjoy exceptional facilities for handling their large and increasing business in the most expeditious and convenient manner. The company ask our readers to note that in future all correspondence should be addressed the Ball Bearing Company, 2322 Market street, Philadelphia, Pa.

Mr. J. B. Wilson has been appointed manager of the new Canadian offices of the Standard Pneumatic Tool Company. The business of this company in Canada has of late been so encouraging that an office has been opened at 103 Union Station Arcade, Toronto, Ontario, where a full line of "Little Giant" pneumatic tools and appliances, repair parts and accessories will be carried. In future, it is the purpose of this firm to ship all machines for Canadian customers direct from the Toronto office, thereby saving purchasers the inconvenience of making out manifests and of paying duty. The Standard Pneumatic Tool Company's general offices and works are situated at Aurora, Ill.

The Structural Steel Car Company has been formed in Canton, Ohio, with a capital stock of $500,000, with the privilege of increasing it to $1,000,000, to build cars at that place. Mr. Ellwood C. Jackson, of Wilmington, Del., is president. He is a son of the late Job H. Jackson, and was for many years an officer of the Jackson & Sharp Company. The other officers are: H. A. Cavanah, vice-president; A. S. Griffin, secretary and treasurer; J. R. Reed, general manager; H. H. Woodcock, general superintendent, and R. H. Hornbrook, engineer. The company was formed to build structural steel cars. The plant occupies thirty acres in a favorable location, and will start next month with a daily capacity of about twenty-five cars.

The spirit of the times in the matter of consolidation has been shown in the recent consolidation of the various interests of the Chicago Pneumatic Tool Company, and the acquisition by it of two modern plants, viz.: the Chisholm & Moore Manufacturing Company (Pneumatic Cranes and Hoists) and the New York, Franklin Air Compressor Company. The crane department is running full time on orders in hand, and the outlook in this department promises the working of a double shift. The compressor department is also very busy. The company reports that since its reorganization, orders for compressors, pneumatic tools and appliances, including cranes and hoists, for the first half of January, equals the total December business of last year. This includes an order for 80 tools received from the Cramp Shipbuilding Company.

The Magnolia Metal Company has removed to a commodious office building and factory at 113-115 Bank street, New York City. The factory is fitted with the most modern appliances. The company produces "Magnolia," "Defender," "Mystic" and "Adament" metals, and all grades of babbitt, as well as solders and railroad brasses. With factories at New York, Stirling, N. J., Chicago and Montreal, the company possesses unusual facilities for filling orders promptly.

The Leighton & Howard Steel Company is the name of the new company formed by Messrs. Geo. B. Leighton and Clarence H. Howard, which has secured control of the Shickle, Harrison & Howard Iron Company. The latter concern was originally formed for the manufacture of cast-iron pipe and structural shapes, and the new up-to-date cast-steel plant at East St. Louis will be devoted entirely to the manufacture of cast-steel railway specialties, such as Ajax trucks, Player car and tender trucks, body and truck bolsters, Davis driving-wheel centers, Leeds reversible pilot couplers and other similar devices which were made by the old company. Mr. Clarence Howard will continue his activity in connection with the new company, of which he is vice-president and general manager.

There is probably no appliance so generally used in mechanical works as rubber hose, and none which requires more constant replacement, not only because rubber is limited as to endurance, but because of rough usage which is unavoidable, especially in a shop or roundhouse. Many attempts have been made to protect hose by various methods and the problem has been attractive to inventors. This subject has been attacked in a practical way abroad with apparently good results, and a particularly promising product is now being introduced into this country. The American Metal Hose Company, 425 Dickey Building, Chicago, offers a metal hose which they guarantee to be practically indestructible and absolutely tight. The hose is made entirely of metal, and it is stated that it is more flexible than rubber hose of equal dimensions and is of about the same weight. When this company first placed its product on the market many engineers thought it was impossible to make a steam tight hose entirely of metal which would have the flexibility of rubber. This seems to be successfully accomplished. This is clearly shown by the large number of orders they have received from concerns who are using double metal hose. In the list of users of this hose we find large manufacturing firms and well-known railroads. Pamphlets will be furnished upon application.

The Patent Title and Guarantee Company, Inc., of 150 Broadway, New York, have come forward with a novel plan for the protection of patentees against infringement. The company has drawn up a contract, in which it agrees to fight infringement suits brought against its patrons. It offers a system by which the poorest patentee is placed on an equality with a powerful trust or wealthy corporation in a legal struggle. It proposes to pay its contract holders, in the event of successful litigation, the amount of award of damages in full if not exceeding the amount of contract, and to pay from 50 to 90 per cent. of all damages awarded by the court in excess of the amount of contract if these damages are collected. The company charges 2 per cent. per annum on the amount of protection applied for by the patentee—that is, 2 per cent. on the amount of whatever a patentee may estimate the damage to him would be from infringement. It is a kind of protection intended to prevent patents being rendered practically useless through successful infringement or from being wrested from their holders owing to inability to enter into a costly legal defence. A number of prominent manufacturers and business firms are given as among this company's clients. Recently an important suit was won by the Patent Title and Guarantee Company, by which Mr. I. M. Landes was awarded royalties aggregating $50,000,000 on his patents covering metallic curbing. There are said to be 400,000 property-owners in the United States who have infringed the patents, and who will have to pay 50 cents royalty per lineal foot in consequence.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

APRIL, 1902.

CONTENTS.

AMERICAN ENGINEER TESTS.

Locomotive Draft Appliances.

VII.

Report by Professor Goss.

(Continued from Page 67.)

SECTION II.

Equipment for Burning Oil.

8. Storage Tank.—By the courtesy of the Indianapolis office of the Standard Oil Company a 90-barrel tank was loaned the University, into which the contents of a tank car could be unloaded. This tank was located at a convenient point outside of the laboratory, at a level which permitted oil from cars to be unloaded by gravity. Oil as needed by the burners was drawn from this tank by means of a pump, in a manner to be hereafter explained.

9. Delivery of Oil to Burners.—To secure satisfactory action in an oil burner it is necessary that oil be supplied at a pressure which can be maintained constant, the degree of pressure being at all times under the control of the fireman. In stationary work, burners have often been fed from an elevated tank, which is kept filled to an overflow by means of a suitable pump. In locomotive service the same result has been attained by having the oil carried in a closed tank, to which air is admitted under sufficient pressure to carry the oil to the burners. In the experiments under discussion neither of these plans were followed, but as a substitute for them there was employed an automatic feeding device, handled by the National Supply Company, of Chicago, whereby oil is supplied with great regularity at any desired pressure. The apparatus was deposited with the University through the courtesy of its builders, the Snow Steam Pump Company, of Buffalo. It is known as a No. 3 double fuel-oil system, and is illustrated by Fig. 5. It is applicable either to locomotive or to stationary service. Throughout the experiments it never failed to supply the burners with oil at the pressure for which it was set, said pressure being entirely under the control of the engineer. A detailed description of this apparatus by Mr. E. E. Reynolds, who, as instructor in charge, has been immediately concerned with its operation, is as follows:

10. The Fuel-oil Pressure System, as manufactured by the Snow Steam Pump Works, Buffalo, and as installed for feeding fuel oil to the burner of the locomotive, consists of the following essential parts:

(a) A pair of duplex steam pumps for drawing the oil from the tank and maintaining the desired pressure in the receiver from which the burners are supplied.

(b) A cylindrical receiver containing a filtering compartment and a heating coil, and fitted with air chamber, thermometer and pressure gauge.

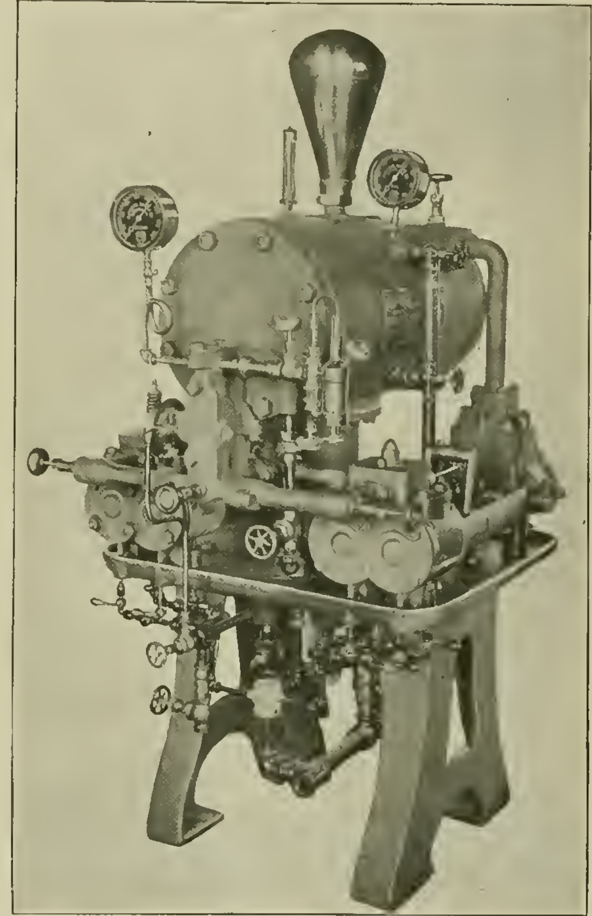


Fig. 5.

(c) A regulator or governor, actuated by the pressure in the receiver, and which automatically operates the pump so as to maintain the receiver pressure constant.

(d) An adjustable relief valve placed between the suction and the delivery sides of the pump, through which all oil in excess of requirements may pass, in case of accident, to the governor.

(e) A cast-iron base or frame, upon which the mechanism is securely mounted.

(f) The necessary piping, valves, etc., for steam, oil, water and drainage connections.

A view of the apparatus is shown by Fig. 5, and the detail drawings by Fig. 6. Only one of the pumps is operated at a time, the other being held in reserve in case of accident. The exhaust steam from the pump is conducted through the heating coil in the receiver and serves to warm the oil. Should the oil be thus heated to too high a temperature the heating coil can be cut out by means of a three-way plug and the exhaust thrown directly into the drain pipe. In case the oil is very cold, provision is made for sending live steam through the heating coil in such amounts as may be required.

The cylindrical receiver is kept about one-third full of water, the oil being pumped in on top of the water. Any water that may be pumped in with the oil is, therefore, separated by gravity in the receiver. The water-level is shown by a gauge glass on the side of the receiver, and any surplus accumulation of water may be drawn off at the bottom through the blow-off valve. The oil delivery pipe draws its supply from the top of the receiver.

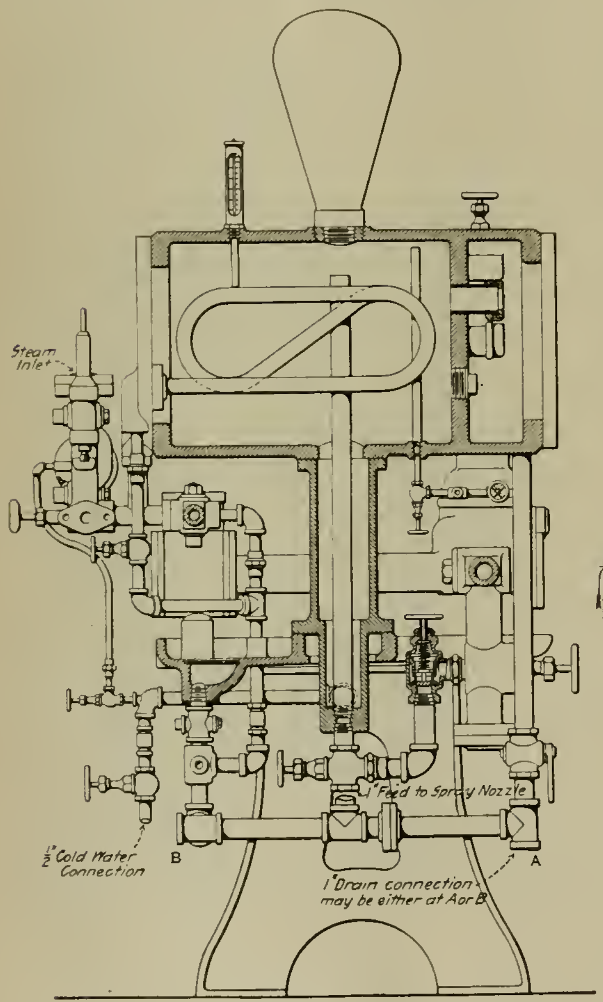


Fig. 6.

The governor consists of a cylindrical, partially balanced valve. The stem of this valve is attached to a copper diaphragm forming one side of a chamber which contains water, and which is in pipe communication with the receiver. The receiver pressure is thus transmitted to one side of the diaphragm, and is balanced by an adjustable spring and system of levers on the opposite side. By tightening the spring, the pressure required to close the governor valve is increased, and an increased pressure is, therefore, maintained in the receiver.

The relief valve is placed in a pipe which connects the oil delivery pipe to the suction pipe, and is a disc valve held upon its seat by a helical spring which may be compressed by a hand wheel.

The piping to this oil system is so arranged that steam from the University power plant can be used to operate the pump and spray the oil in starting up, and until the steam pressure in the locomotive boiler has become high enough to do this work. When this condition is reached, steam from the locomotive can be used.

11. Preparation of the Firebox.—In preparing the firebox for oil fuel, the grate bars were removed, the bottom of the ash pan strengthened, and fire brick applied, all as shown by

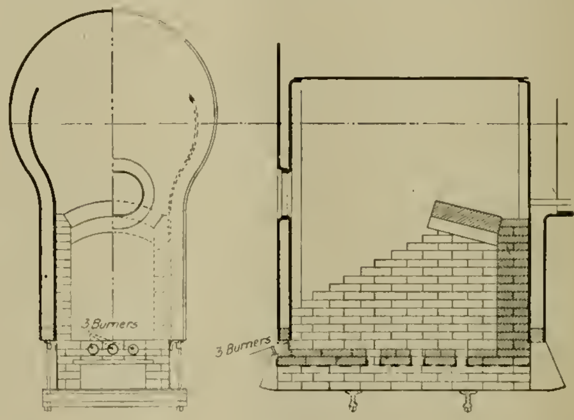


Fig. 7.

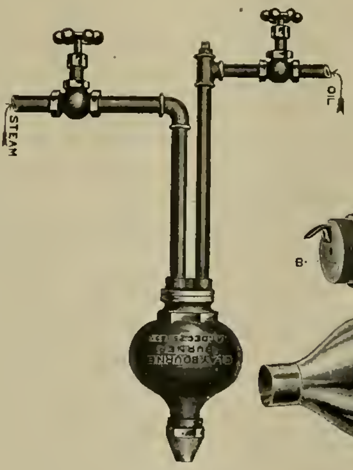


Fig. 8.

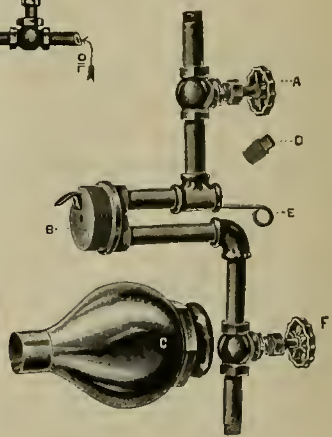


Fig. 9.

Fig. 7. In the design of this arrangement it was necessary to provide a furnace in which a good fire could be maintained and, also, one to which air would be admitted by openings of constant area. The necessity for maintaining the area of air openings constant has already been commented upon (paragraph 7). It arises from the fact that any change in the resistance to be overcome by air entering the furnace produces changes in the pressure within the smoke box, the observance of which constitutes an important factor in the present work.

The design shown was adopted after a considerable amount of preliminary experimentation. It was at first assumed that the maintenance of brick work in the bottom of the furnace would prove troublesome, and that the passage of air through portions of the bottom which were supposed to be closed, would be considerable and of varying amounts. To guard against this, the openings in the brick work were first made of liberal area, and the whole ash pan was enveloped in a light structure of galvanized iron having a single opening in the bottom. The use of this enveloping structure required all air on its way to the firebox to pass an opening in a metal plate, the area of which would, of course, be in no danger of undergoing changes as the test proceeded. After repeated trials and several changes in the extent and location of the air opening, the use of this air box was reluctantly abandoned, the conclusion being that the most liberal dimensions in such a structure were not sufficient to prevent its presence from producing an unfavorable effect upon the steadiness of the fire. In the arrangement finally adopted (Fig. 7), the bottom of the furnace is made up of two courses of fire brick well bonded. The air openings are narrow and extend the full breadth of the furnace, thus permitting the brick work which bounds them to be laid in masses which are comparatively large and strong. Each brick was dipped in fire clay as laid. The edges of the openings are bounded by angle iron. This construction, while possibly open to some criticism, seems nevertheless to be as secure as could readily be obtained. As a practical matter, it appeared throughout the test to serve well its intended purpose. In the beginning of the work, the ports for the admission of air were accurately measured, and as the work proceeded they were frequently verified, and, when necessary, they were corrected.

12. Size of the Air Opening.—In the preliminary discussion of the experiment by the railroad representatives and other gentlemen interested, it was suggested that the area of the air opening should be the same as that which was employed in the Von Borries-Troske tests. It is fair to presume that the purpose of this suggestion was to insure conditions of draft in combination with similar volumes of air, which would be comparable with those of the Von Borries-Troske tests. A moment's reflection will show that the conditions of service such as those under which the Purdue experiments were made, are altogether at variance with those surrounding the Von Borries-Troske tests. In the actual engine there is added to the resistance of any orifice which may be employed the resistance of the firebox and of the tubes, and if the same volume of air or gases are to reach the smoke box of the actual engine, the orifice at the ash pan must of necessity be larger than that which was employed in the Von Borries-Troske experiments. In general it may be said that as the number of the resistances to the passage of air, in its course from the atmosphere to the smoke box, increases, the area of the various openings along the way must be increased. To have made the results of the present tests strictly comparable with those of the Von Borries-Troske tests, effort should have been made, not to employ equal areas, but equal resistances to the movement of air into the smoke box. Difficulties in doing this are great, and consequently no serious effort has been made to duplicate the Von Borries-Troske tests in this respect.

The size of the openings actually employed were determined from the condition of the fire. The purpose of admitting air is to sustain combustion and the work proceeded on the assumption that as little air should be admitted as is consistent with satisfactory furnace conditions. It was assumed, also, that for the present purpose it would be sufficient to fix the area for one condition of running, since as the power of the engine was increased, and there was necessity for admitting larger quantities of air, the draft became greater and the movement of air through the fixed opening more rapid.

The area of the air ports finally settled upon amounted to 196 sq. ins. Under all but the heaviest conditions of running the discharge from the stack was colorless, but with this opening at the grate there was some smoke when the fire was very heavy.

13. Burners.—The oil burner was placed below and in contact with the mud-ring and inclined upward at an angle about as shown in Fig. 7. An attempt was first made to use the Booth burner, which has been described. (American Engineer, December, 1901, page 388.) A burner of this type with its accompanying heater was supplied through the courtesy of Mr. G. R. Henderson, superintendent motive power of the Atchison, Topeka & Santa Fe Railway. This burner discharges oil in the form of a broad stream, which falls upon and is atomized by a ribbon of steam beneath. Its capacity is enormous, and whenever the conditions were such as to permit the carrying of a heavy fire, its work was satisfactory. The proportions of the burner in question were evidently such as to adapt it for use upon a much larger engine than that which was employed in the experiments, and for this reason the performance of the burner under the conditions of the tests under consideration was not entirely satisfactory. For much of the work it was necessary to maintain a light fire. An attempt to do this with the Booth burner resulted in an unsteady flame, and after some experimenting it was thought best to discontinue the use of this form of burner. The abandonment of the Booth burner reflects no discredit upon this burner, the fact being that the apparatus in question was much more powerful in action than anything which we could use.

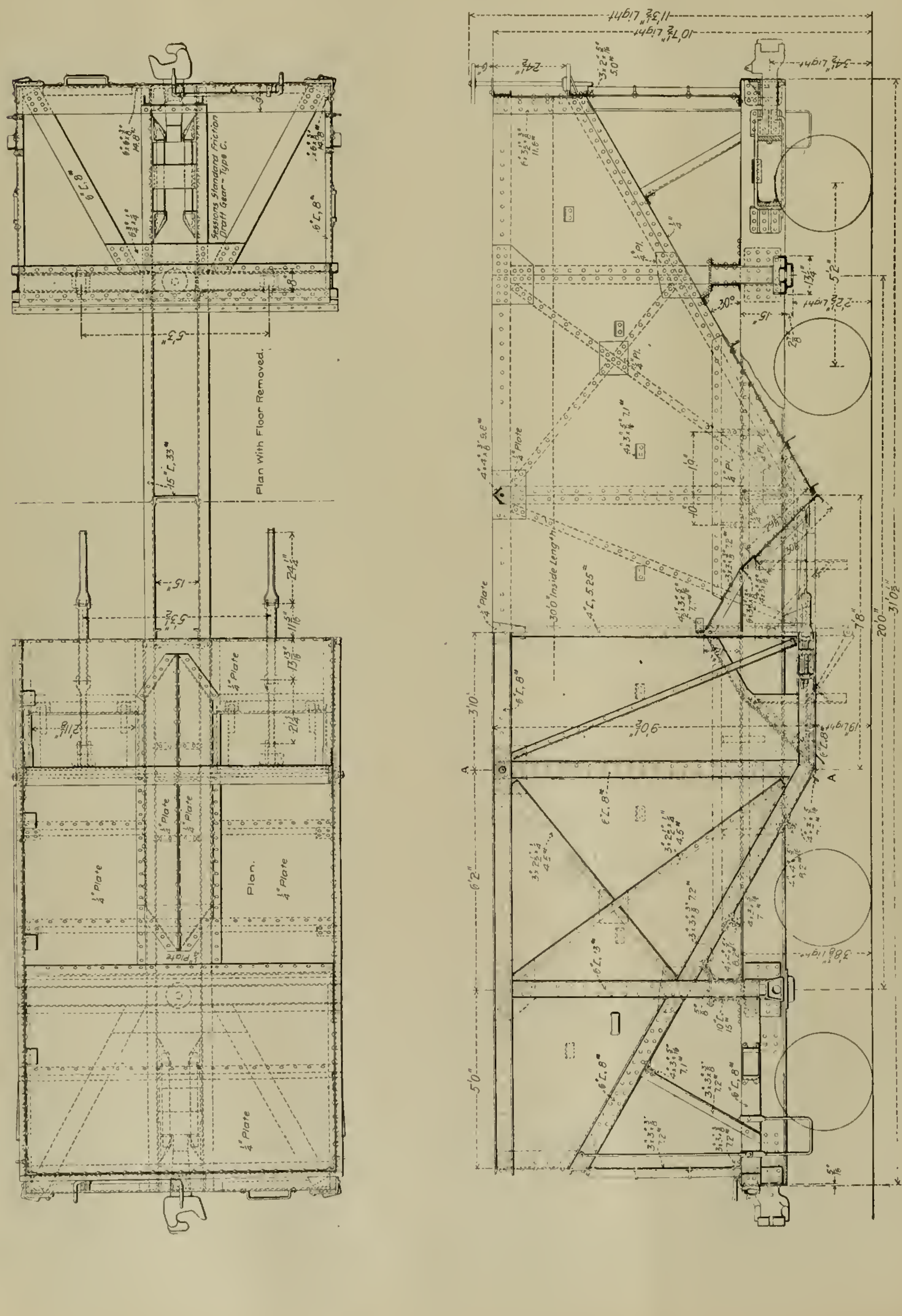
After the removal of the Booth burner, three burners of smaller capacity were substituted. These were supplied through the courtesy of the Claybourne Burner Company, of Chicago. They were so connected that either one, two or three could be employed, depending upon the amount of power required. The manner of their application is well shown by Fig. 7. The presence of the three burners gave an element of flexibility which, under the conditions of the laboratory, greatly contributed to ease in firing. Generally one burner was used in raising steam and for a light power, and two burners were found to suffice under almost all conditions of running.

The general form of the Claybourne burner is shown by Fig. 8. The oil and steam are intimately mixed in a spherical mixing chamber, the oil being fed from a pressure of about 25 lbs. or less through an orifice of about one-eighth of an inch in diameter. Fig. 9 shows the arrangement of the several parts. The oil stream is deflected by a shield above the orifice and is thus brought in contact with the jet of steam which emerges from the center of the fitting which closes the base of the burner.

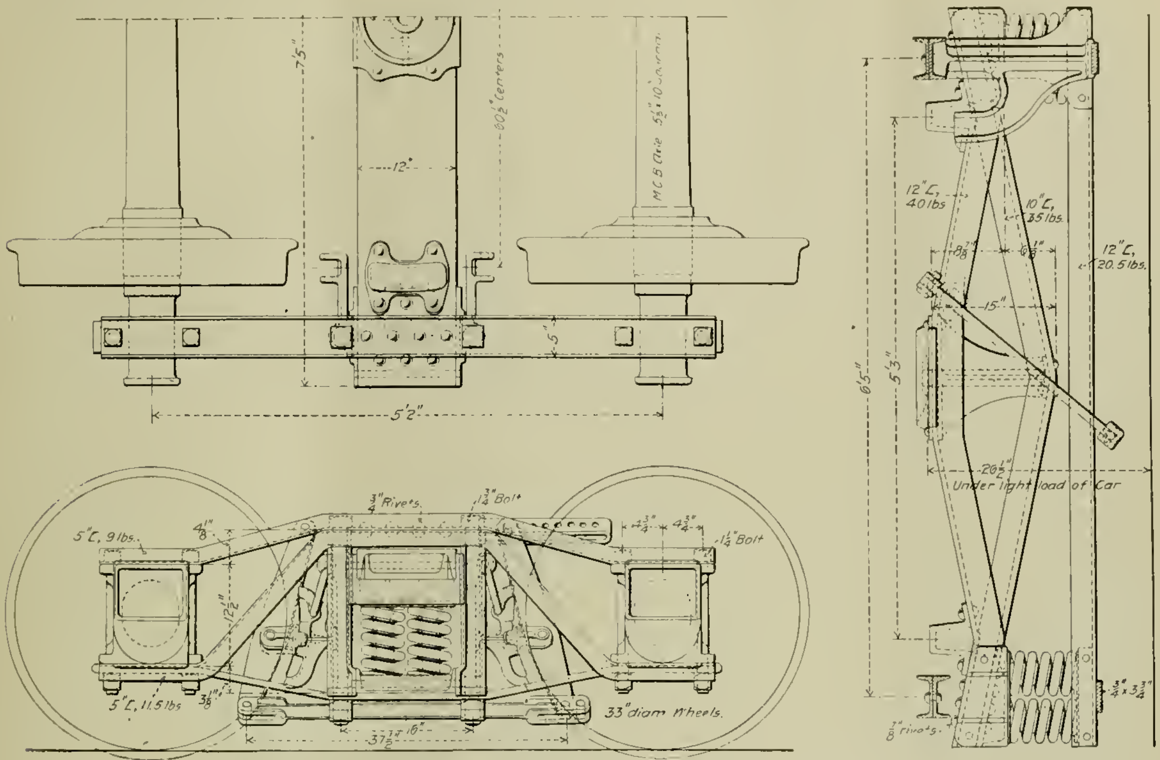
(To be continued.)

"By watching small items," says a writer in "Railway Machinery"; "considerable reduction in cost of operation may be accomplished." After surveying the record of the past year he prepared a system of handling work so as to have no superfluous men. Laborers were put on rough work and a piecework price determined, for those who left were not replaced. This made the laborers earn their own wages instead of the machinist earning it for them. A saving was effected by the systematic picking up of nuts, retapping those which could be used again, and scrapping the rest. Engines in for repairs were credited with scrap at prevailing prices, and a careful supervision was exercised to see that what could be worked up again was not scrapped, thus decreasing the demand for new material. The working up of templates, air appliances, and other methods of quickly and cheaply handling material were introduced. The net result of these reforms in "little things" gave an increase of 18 engines reported for service, and an actual total decrease in expenses over the previous year of $4,042. There were 18 more days worked, which, at an average of $114 per day, showed a net decrease of $6,094 for the same number of days.

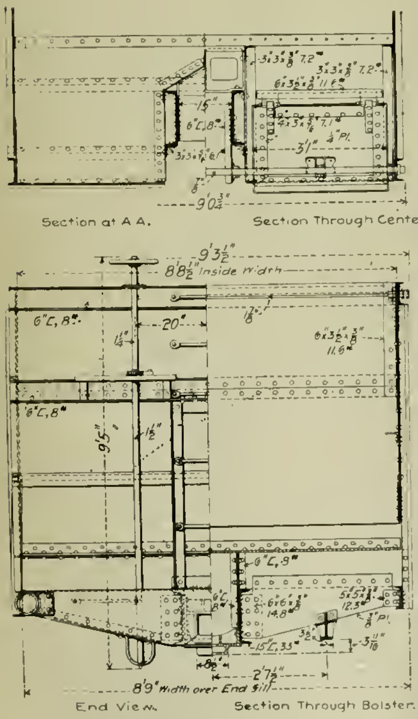
It is stated, on the authority of Mr. J. Kruttschnitt, of the Southern Pacific, that that road is likely to adopt fuel oil for all the locomotives of the entire line.



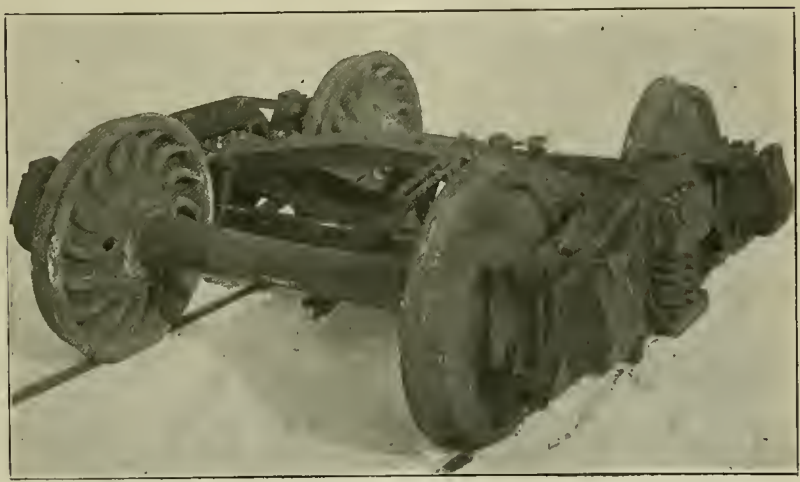
100,000 Pounds Capacity Hopper Coal Car—West Virginia Central & Pittsburg Railway. Designed by Cornelius Vanderbilt, M. E.



Vanderbilt Compression Arch Bar Truck.



Transverse Section and End View.



From a Photograph.

100,000 POUNDS CAPACITY HOPPER COAL CAR.

West Virginia Central & Pittsburgh Railway. Designed by Cornelius Vanderbilt, M. E.

VANDERBILT 50-TON HOPPER COAL CAR.

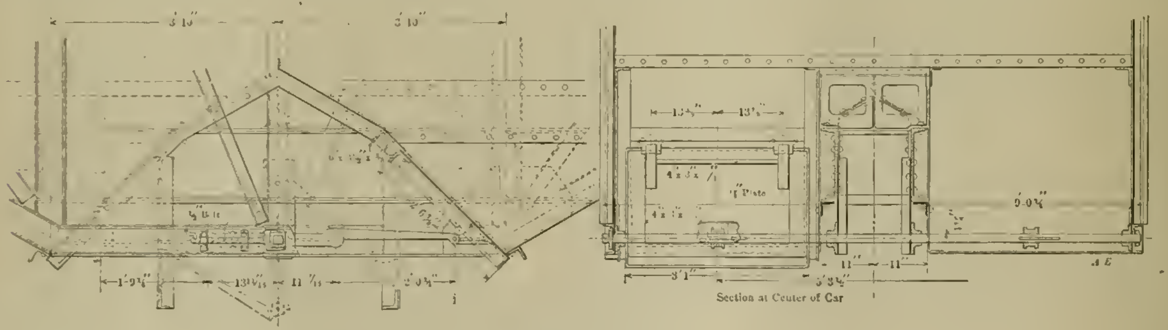
West Virginia Central & Pittsburgh Railway.

These drawings illustrate the construction of 800 steel hopper cars of 100,000 lbs. capacity, designed by Cornelius Vanderbilt, M. E., which are now being built for the West Virginia Central & Pittsburgh Railway. In our November number of last year, page 338, we illustrated the experimental car by Mr. Vanderbilt, and the present construction embodies the development of the ideas of the earlier design.

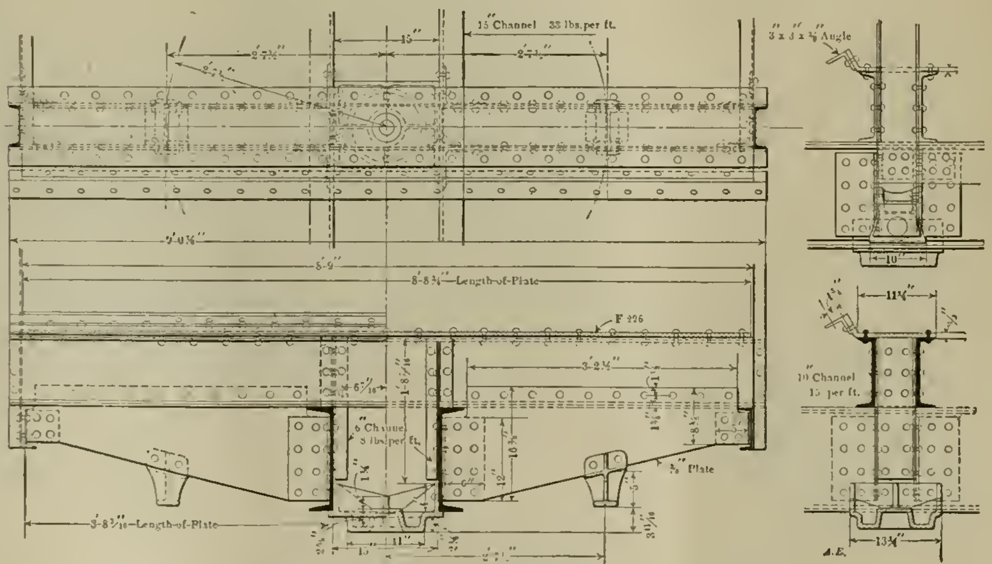
In the first cars, for the Lackawanna Iron & Steel Company, it was decided to employ small center sills in the form of 9-in. channels, 25 lbs. per ft., and these cars will be watched with interest on that account, if for no other reason. The present construction employs 15-in. channels of 33 lbs. per ft., and these center sills form the backbone of the car. Instead of channels for end sills this car employs 5-16-in. plates with a top flange 9 ins. wide, which acts as a gusset to strengthen the connections between the center sills and the diagonal end sill braces. Angles are riveted to the bottom of these plates. End sill braces extend from the end sill to the body bolsters, and are there secured to the car body supports as well as to the body bolsters. The car body supports are vertical posts at the ends of the bolsters. The body bolsters are two 10-in. channels, resting on top of the center sills and secured at their ends to the car body supports. Two ⅜-in. plates are riveted to the webs of these channels, extending the depth of the center sills and secured thereto by means of angles. To these bolster plates the body side bearings are secured by rivets. The end framing is further strengthened by angles

TABLE COMPARING LARGE CAPACITY CARS.

TYPE.	OWNER.	Light Wt., Lbs.	Load Limit,	Length, Inside, ft. in.	Width, Inside, ft. in.	Height, top of rail, top of side, ft. in.	Capacity, level full, cu. ft.	Capacity, 30° heap, cu. ft.	Capacity, lbs., coal level 52' cu. ft.	Capacity coal, 30° heap., at 52 lbs
Pressed Steel,	L. S. & M. S.	36,600	110,000	30 0¼	9 6	10 0	1,680	2,030	87,360	103,560
" "	Erie	36,300	110,000	30 0¼	9 6	10 0	1,680	2,030	87,360	103,560
" "	P. R. R.	39,600	110,000	31 6⅛	9 6	10 0	1,685	2,056	87,620	106,912
" "	L. V. R. R.	37,600	110,000	30 0¼	8 6	10 2½	1,738	2,088	90,376	108,576
Structural Steel,	L. S. & M. S.	38,300	110,000	32 0	9 0	11 7⅝	1,800	2,140	93,600	111,280
Vanderbilt,	Lackawanna, I. & S. Co.	37,000	120,000	30 0	9 0	11 3	1,822	2,136	94,744	111,072
Pressed Steel,	B. & O.	36,700	110,000	30 0¼	8 8½	10 7½	1,590	1,886	82,680	98,072
Structural Steel, Vanderbilt,	W. Va., C. & Pg.	36,500	120,000	30 0⅛	8 8½	10 7½	1,594	1,889	82,888	98,228



Hopper Door Mechanism.



Views of the Body Bolster.

THE VANDERBILT 50 TON HOPPER COAL CAR.

extending from the end sill braces to the under side of the car body. The corners of the body are securely held together by heavy angles instead of channels, as in the experimental car. For the corner bracing of the end sills 6-in. channels are used, extending from the end sill plates to plates resting on the top flanges of the center sills at the body bolsters. Instead of the diagonal floor supports of the earlier car this one has angles extending straight across the car body, the long legs of which extend downward. The body center plates are 10¾ ins. in diameter, and have a 13¼ in. bearing on truck center plates. The center sill cover plates, instead of being riveted to the top flanges of the center sills, are riveted to the plates which form the hopper sides. The following table gives the principal dimensions of the car:

VANDERBILT FIFTY-TON HOPPER CAR.

Light weight, estimated	36,500 lbs.
Maximum capacity	120,000 lbs.
Length inside of body	30 ft.
Width inside body	8ft. 8½ ins.
Length over all	31 ft. 10 ins.
Width over all	9 ft. 3⅞ ins.
Height over brake staff (light)	11 ft. 3½ ins.
Height over car body	10 ft. 7½ ins.
Height to bottom of hopper	1 ft. 7 ins.
Height to top of sills	3 ft. 8⅜ ins.
Maximum capacity, 30 deg. heap	1,889 cu. ft.
Capacity level full	1,594 cu. ft.
Capacity, coal at 52 lbs. per cu. ft.	98,228 lbs.

The truck is of the arch bar type, a combination of a recently patented diamond type using channel arch bars with Commonwealth Steel Company's end castings and Crone rocker side bearings. When the car is carrying its maximum load of 120,000 lbs. the bolster carries 72,000 lbs. The truck bolster has been patented by Mr. Vanderbilt. One of them was recently tested to 188,000 lbs.

Our engravings also illustrate Mr. Vanderbilt's arch bar truck with compression members, although the cars are not fitted with the truck which is shown in the engraving. The object of this design was to reduce weight in the trucks. Instead of being in tension the bottom arch bar is in compression. As a short strut, a channel is of greater value in compression than in tension.

These cars are equipped with the Sessions-Standard friction draft gear, type C, Tower couplers with 5 by 7 in. shanks, Vanderbilt structural brake beams, cast iron wheels, McCord journal boxes and lids, Corning insert brake shoes and steel castings from the Commonwealth Steel Company, of St. Louis. In the table on page 104 a comparison of the characteristics of a number of large capacity cars is given.

NEEDED IMPROVEMENTS IN THE DESIGN OF DRAFT GEAR.

By R. A. Smart.

Some discussion has recently been indulged in concerning the damaging effects to freight cars of the failure of couplers and draft gear to permit of proper curving. It has been pointed out that while the contour lines laid down by the M. C. B. coupler committee provided for a maximum angle of 14°, there are many couplers in service and on the market to-day which do not curve more than 2 or 3°. In such cases, when the angle of a curvature allowed is less than the normal amount, serious strains are set up in forcing the couplers to greater angles than they will naturally allow, which strains are thought to be responsible for a good deal of the damage to equipment, usually attributed to other sources.

It has further been shown that even with proper contour lines the present draft arrangement leads to serious trouble with cars of unequal length on simple curves, cars of equal length on reverse curves, or in cases where one car is on a tangent and the adjacent car is on a curve. In such cases the center lines of adjacent cars at the point of coupling may not coincide by an amount greater than the side play allowed the coupler, thus throwing serious transverse stresses on the draft rigging at various points.

While it is quite likely that from time to time some improvements in methods of manufacture will be introduced which will result in closer conformity to the M. C. B. lines, it is improbable that perfect lines and the consequent maximum angle of curvature originally provided for will ever be realized on all couplers sold. And even though this result should be attained, it seems that we are always going to have trouble with draft gear, unless some radical method is adopted in the gear itself which will take the matter squarely in hand and rationally provide for the difficulty.

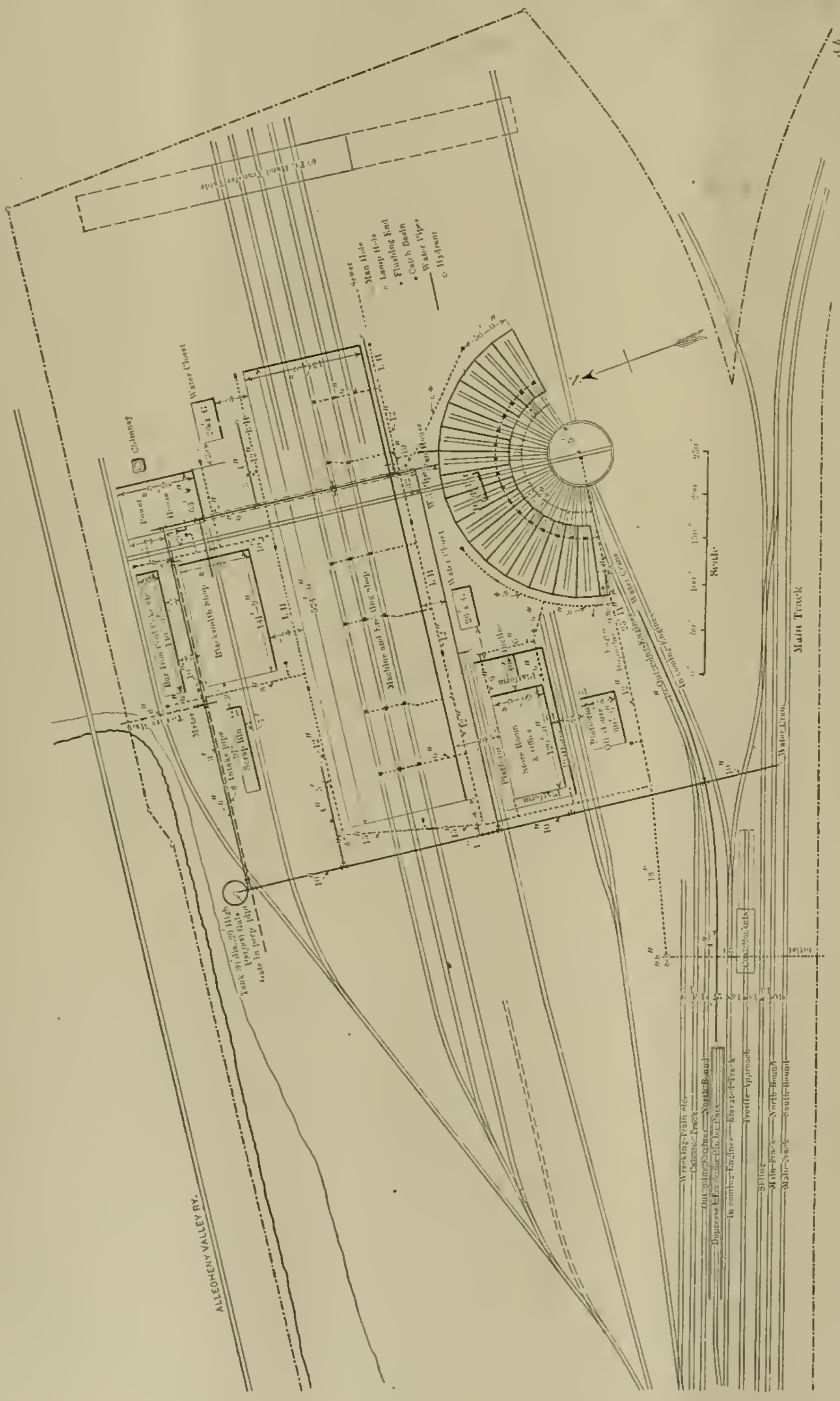
Opinions are not wanting from well-known authorities that the present design is adequate to meet all conditions. This seems very surprising, in view of the fact that evidences could be multiplied showing the damage inflicted, not only on couplers and draft gear themselves, but upon car bodies, truck frames and wheels. Many of these failures are attributed to other causes, such, for instance, as rough handling in the yards. The writer has, however, evidence that the real reason has in many instances been overlooked, and that the failure of couplers and draft rigging to curve properly is responsible for a great deal of damage.

It is well known that, in theory, the properly designed draft gear should be made to swing about the center of the truck, so that two adjacent coupler shanks will be in the same straight line. Why should not the actual design approximate somewhat to this ideal condition? Of course it will be urged that such a gear will be too complicated and costly to apply and maintain. If, however, the present design were charged with the full measure of responsibility for damage which is due it, there might appear good reason for some radical changes. A few years ago, no one would have predicted that complicated friction draft gears, such as are now being sold in large numbers, would ever be applied to freight cars. But there is now no question that for some classes of service they are a necessity. So it may be that a better general design of draft gear, although somewhat more expensive than the present form, would be economy in the end.

This subject has not received the attention which it merits, and it is one which is daily increasing in importance. It should be thoroughly discussed, with a view to either sustaining or disproving the charges preferred against the present design.

MARCONI'S LATEST ACHIEVEMENT.

In an article by Mr. Wilfrid Blaydes, appearing in the "Electrical World and Engineer," a fac-simile of the tape record of what may be called a "Marconigram" is shown. The tape was indented by an ordinary Morse registering machine on board the S.S. "Philadelphia," when 2,099 miles distant from the sending station. After overhauling and testing his plant at Poldhu, Cornwall, Mr. Marconi arranged the details concerning messages which were to be sent after him as he sailed westward to America. From the first no doubt of their success was entertained, and the inventor found he did not require specially sensitive adjustments. The messages were always received in the presence of independent witnesses, and the tape records were attested by the ship's officers. What Mr. Marconi has accomplished has been done with a purely temporary installation at Poldhu, as far as aerial capacity is concerned. The electrical energy which has sufficed to send legible signals over 2,099 miles is about one-tenth of the supply which Mr. Marconi will have available as soon as the work of tower erection in England is completed. The tests on the "Philadelphia" show the nicety of "tuning" which has been achieved with these instruments. The "Umbria," which followed the "Philadelphia" across the ocean one day later, failed to receive one of the signals which were certainly passing over her.



Locomotive Shops, Du Bois, Pa.—Buffalo, Rochester & Pittsburgh Ry.

C. E. TURNER, *Superintendent Motive Power.* R. H. SOULE, *Consulting Engineer.* J. M. FLOESCH, *Chief Engineer.*

NEW SHOPS AT DU BOIS, PENNSYLVANIA.

Buffalo, Rochester and Pittsburgh Railway.

Capacity, 200 Locomotives per Year.

These shops are specially interesting because the preliminaries and plans were drawn up by the motive power department of the B., R. & P. Ry., with the assistance of Mr. R. H. Soule, as consulting engineer, and Mr. William Forsyth, as mechanical engineer, although neither of these gentlemen followed them to completion.

The road is divided into the following principal operating divisions:

Divisions.	Miles.
Rochester to Ashford	94
Buffalo to Bradford	124
Bradford to Punxsutawney	104
Reynoldsville to Clearfield	38
Punxsutawney to Butler	62
Butler to Newcastle	40
Butler to Allegheny (over B. & O. tracks)	
Punxsutawney to Coalfields	40

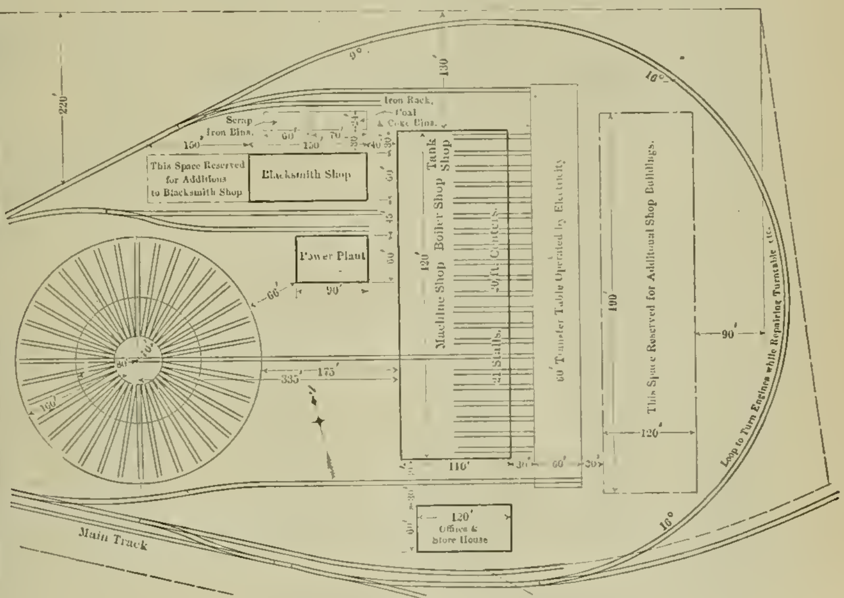
The shops were located at Rochester, with facilities for an average of only about five engines per month for heavy and light repairs: Bradford, with a capacity of about seven engines per month, for lighter repairs, and Du Bois, about 1.5 engines per month, light repairs. The total capacity was about 14 engines per month for heavy and light repairs, and the southern portion of the road, as shown in the sketch map, was seriously handicapped for lack of shop facilities. In all there were but 5 shop pits for heavy repairs. Whatever may be done for future improvement at the north end of the road the territory naturally divides into two portions at Clarion Junction, and the new shops at Du Bois were planned to completely maintain all engines assigned to the middle, Clearfield and Pittsburgh divisions, and to do all new firebox work for the Rochester and Buffalo divisions; the Rochester and Buffalo shops to continue to deal with light repairs on the Rochester and Buffalo divisions, up to and including tire turning and flue renewals. At Du Bois 32 acres were available for the shop plant and yard, the location being in the heart of the coal fields.

The total number of engines to be repaired at Du Bois each year was 147, out of a total of 209. Provisions for expansion for five years at 15 per year, or for 75 engines, were made, a total of 200 engines of which would be dependent upon the new shops, or 17 engines per month. With an allowance of 20 days for each engine in the shop, not including work which may have been done previously on the boiler in the boiler shop, each stall should turn out 1½ engines per month and 12 stalls would provide for 18 engines per month, which would be sufficient. The actual equipment at the present time includes:

4 Atlantic type	2.2 per cent.
8 American type	4.4 " "
4 Switch engines	2.2 " "
22 Ten-wheelers	12. " "
65 Moguls	13.6 " "
25 Consolidations	25.5 " "
55 Twelve-wheel	30.1 " "

The total is 183, and 20 additional engines are maintained by this road. The average weight is 130,000 pounds, and the average tractive power 25,000 pounds. There are now on order 10 twelve-wheel engines of 170,000 pounds, having 33,700 pounds tractive power, and 10 consolidation engines of 180,000 pounds and 41,100 pounds tractive power. It was assumed that about one-third as many boilers as engines would be under repair at one time, or 6 boilers, and the same was applied to tanks. For 12 engines at 45 ft., 6 boilers at 35 ft., and 6 tanks at 30 ft., 930 ft. of track room would be required. A two track shop would need to be 465 ft. long, and a three track shop 450 ft. It was decided to use a length of 524 ft. and a "longitudinal" track arrangement was decided upon, although a plan for a "transverse" track shop was made by the officers of the road for comparison of the two systems. An opportunity to compare the two systems seldom presents itself and both plans are presented here as a study.

Map of B., R. and P. Ry.



The Proposed Transverse Plan.

LOCOMOTIVE SHOPS AT DU BOIS, PA., BUFFALO, ROCHESTER AND PITTSBURGH RAILWAY.

The Transverse Plan.

This is termed the "old" plan. It was believed to furnish the best facilities for the least cost, and to provide for ample extensions. The distances from shop to shop were not believed to be materially affected by the track arrangement inside the erecting shop. In this plan all the buildings may be extended. Particular stress was laid on the short distance between the locomotives on the erection floor and the machine shop, this being considered more vital than any other distance. In fact, all the distances from the machine shop to various other departments were made low, and this is made clear in the tabular comparison which follows, although other transporting distances about the plant are somewhat greater in this plan than in the other. It is worthy of note that with the exception of the distance from the erection shop to the roundhouse, the distances from that shop are lower when expressed in a total than in the longitudinal plan. By moving the roundhouse nearer the other buildings these distances would have been much less.

The advocates of the old plan question the advisability of adding greatly to the length of shops, because of increasing the distances from the engines to the machines and upsetting the internal arrangements. This plan employs but one crane instead of two, but obviously two, one heavy and one light, could be used, and in either case a number of small post cranes for the machine shop are required. For convenience in crossing the shop the passages are frequent and parallel in this plan, which was considered exceedingly important. In a transverse shop the height of crane lift for the large crane is lower than in the other, because the engines are not lifted over each other. For this reason the erecting shop may be placed next to the wall of a shop, the central bay of which is higher than the side bays. And in any case the cranes may be carried on comparatively low runways.

The Longitudinal Plan.

The distance from shop to shop, measured from center to center, when taken as a whole, are less in the "new" plan, which was adopted by recommendation of Mr. Soule. All of the buildings may be extended. This plan does not depend upon the transfer table (and in fact the one shown may never be built). Every part of the yard space is available from some track. Engines may be brought directly to the shop and delivered directly therefrom, without the transfer table process. Two cranes are required to lift an engine, but they are also available for continuous use. The roof truss spacing is independent of the location of the engines and may be made to suit the roof independently of other considerations.

In this comparison of distances between the old and new plans all the measurements are taken between the centers of the spaces. It should be carefully studied in order to note the relative importance of the distances, because the totals do not in all cases tell the story.

The Adopted Plan.

The machine, boiler and tank shops are provided for in a building 134 x 524 ft. in size, the blacksmith shop is 80 x 141 ft., the power house 63 x 93 ft., the office and storehouse 60 x 120 ft., and in addition to these is a 30 x 60 ft. oil house, a 16 stall roundhouse and a 26 x 140 ft. coal, coke and bar iron storage. A straight track runs from the roundhouse across the entire shop space, with turntables for connection to the blacksmith shop and yard tracks. A straight tunnel for pipes and wires extends from the power house to the roundhouse and drains toward the roundhouse. The plant is lighted and driven by electricity. These and the special features of the buildings will be described and illustrated in detail in future issues of this journal.

We acknowledge the kind assistance of Mr. C. E. Turner, superintendent of motive power; Mr. F. D. Hyndman, master mechanic, and Mr. W. R. Maurer, chief draftsman of this department, in connection with this description.

B. R. & P. R. R. DU BOIS SHOPS.

Comparison of Distances, Old and New Plans.

	"Old" or Transverse Plan, feet.	"New" or Longitudinal Plan, feet.
From Roundhouse of Turntable to Machine shop	450	275
" " " " " Boiler shop	510	395
" " " " " Erecting shop	510	270
" " " " " Blacksmith shop	350	380
" " " " " Storehouse	530	295
Totals	2,350	1,610
From Machine Shop to Roundhouse	450	275
" " " " Boiler shop	240	430
" " " " Erecting shop	60	240
" " " " Blacksmith shop	310	260
" " " " Storehouse	210	410
Totals	1,270	1,605
From Boiler Shop to Roundhouse	510	395
" " " " Machine shop	240	430
" " " " Erecting shop	240	190
" " " " Blacksmith shop	200	240
" " " " Storehouse	440	140
Totals	1,630	1,395
From Erecting Shop to Roundhouse	510	270
" " " " Machine shop	360	240
" " " " Boiler shop	240	190
" " " " Blacksmith shop	220	120
" " " " Storehouse	220	200
Totals	1,250	1,020
From Blacksmith Shop to Roundhouse	350	370
" " " " Machine shop	310	250
" " " " Boiler shop	200	240
" " " " Erecting shop	220	125
" " " " Storehouse	480	300
Totals	1,560	1,285
From Storehouse to Roundhouse	530	290
" " " Machine shop	210	410
" " " Boiler shop	440	140
" " " Erecting shop	220	200
" " " Blacksmith shop	480	300
Totals	1,880	1,340

Summary of Total Distances.

From Roundhouse	2,350 feet.	1,610 feet.
" Machine shop	1,270 "	1,605 "
" Boiler shop	1,630 "	1,395 "
" Erecting shop	1,250 "	1,020 "
" Blacksmith shop	1,560 "	1,285 "
" Storehouse	1,880 "	1,340 "
Totals	9,940 "	8,255 "

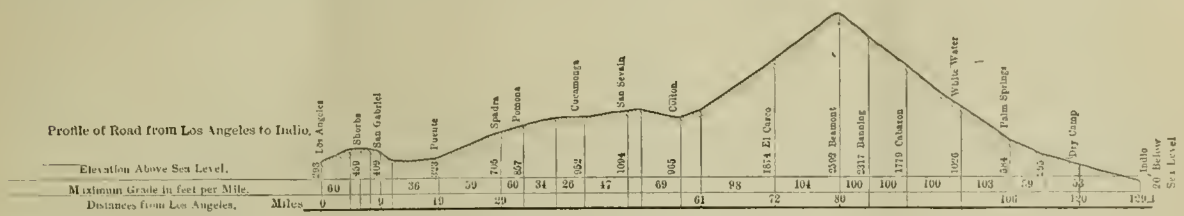
COMPARATIVE TESTS OF OIL BURNING LOCOMOTIVES, SOUTHERN PACIFIC RAILWAY.

Mr. H. J. Small, superintendent motive power of the Southern Pacific, has sent us an interesting account of tests made recently on that road with oil fuel on a Cooke simple engine and a Vauclain compound having a Vanderbilt firebox. These tests were very carefully made under the personal direction of Mr. H. Stillman, engineer of tests, and they represent the best practice in oil burning on locomotives. Engine No. 1723 is a Vauclain compound with a Vanderbilt firebox. Engine No. 1625 is a simple engine, with an ordinary firebox, built several years ago by the Cooke Locomotive Works. The tests covered two round trips with each engine between Los Angeles and Indio, under ordinary service conditions as is usual in such tests, and the conditions were as nearly alike as the traffic would allow. The profile of the road is given in the accompanying diagram.

The compound engine with the Vanderbilt boiler showed an advantage of 9.42 per cent. in equivalent evaporation, 17 per cent. in ton miles per gallon of oil and 7 per cent. in ton miles per gallon of water, these figures being based upon the totals and averages. Mr. Small states that the Vanderbilt style of boiler shows every evidence of proving to be a satisfactory one for oil burning, from the fact that there is an entire absence of seams, staybolts, or crown bolts in the furnace to be affected by the extreme heat generated, which in an ordinary firebox causes more or less trouble from leakage.

The Kern River fuel oil had the following characteristics:

Gravity	.969 or 14¼ Baume.
Flash point	240 deg. F.
Fire point	280 deg. F.
Commercial weight	8 lbs. per gal.



Profile of Southern Pacific, Los Angeles to Indio.

SERVICE TESTS, SIMPLE AND COMPOUND MOGUL LOCOMOTIVES ON LOS ANGELES DIVISION, JANUARY, 1902. OIL BURNING.

TWO ROUND TRIPS EACH ENGINE BETWEEN LOS ANGELES AND INDIO.

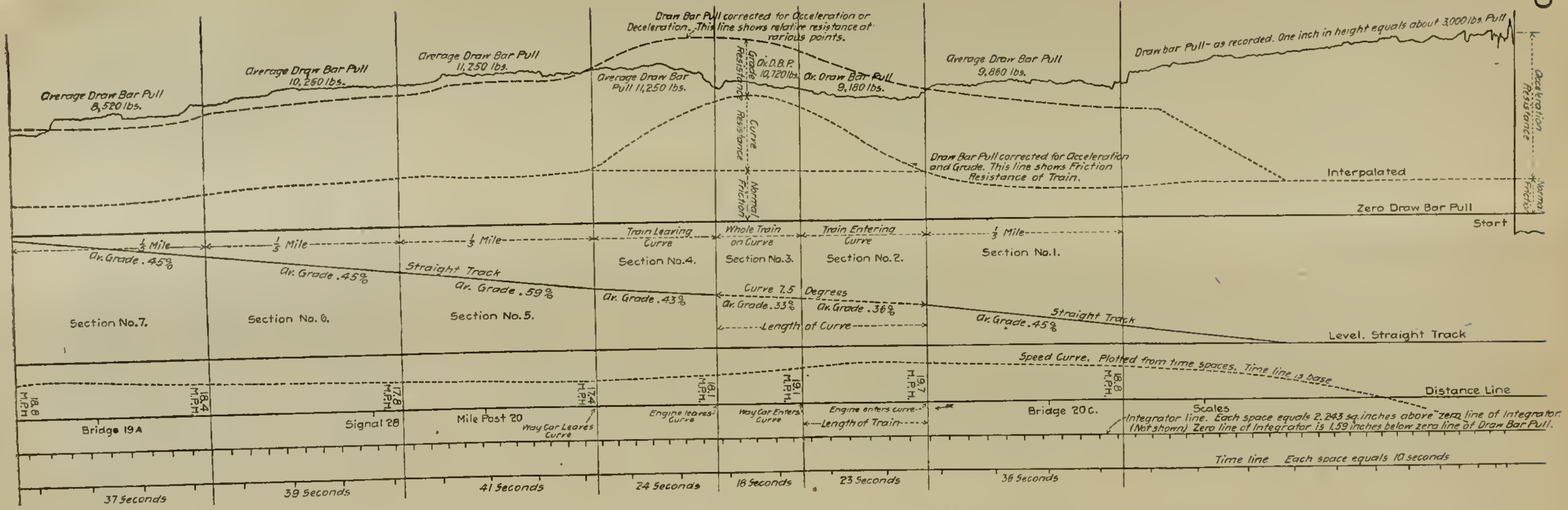
Number of test	1	2	3	4	Totals and Averages.	
Number and class of engine	1625	Class E. D.	1723	Class E. F.—1	1625 E. D.	1723 E. F.—1
Builder and kind of engine	Cooke.	Simple.	Baldwin.	Compound.	Simple.	Compound.
Size of cylinders	20 by 28		15½ and 26 by 28		20 by 28	15½ and 26 by 28
Location of test	Los Angeles to Indio.	Indio to Los Angeles.	Los Angeles to Indio.	Indio to Los Angeles.	Two round trips. between Los Angeles and Indio.	
Date of test	Jan. 21 & 23.	Jan. 22 & 24.	Jan. 14 & 16.	Jan. 15 & 17.		
Number of train, through freight	244	243 & ext. West.	244	243		
Kind of oil fuel		Kern	River District.			
Schedule time between terminals	19 hrs. 10 min.	20 hrs. 0 min.	19 hrs. 10 min.	20 hrs. 0 min.	39 hrs. 10 min.	39 hrs. 10 min.
Total time of test	18 hrs. 49 min.	22 hrs. 21 min.	19 hrs. 23 min.	20 hrs. 0 min.	41 hrs. 10 min.	39 hrs. 23 min.
Actual running time	13 hrs. 28 min.	14 hrs. 2 min.	13 hrs. 54 min.	14 hrs. 4 min.	27 hrs. 30 min.	27 hrs. 58 min.
Time lost during test (standing)	5 hrs. 21 min.	8 hrs. 19 min.	5 hrs. 29 min.	5 hrs. 55 min.	13 hrs. 40 min.	11 hrs. 24 min.
Mean running time between terminals, M. P. H.	19.3	18.5	18.7	18.5	18.9	18.6
Number of stops made	24	33	24	31	28.5	27.5
Maximum steam pressure (gauge)	188 lbs.	187 lbs.	199 lbs.	198 lbs.	188 lbs.	199 lbs.
Minimum steam pressure (gauge)	160 lbs.	135 lbs.	173 lbs.	167 lbs.	135 lbs.	167 lbs.
Average steam pressure (gauge)	178 lbs.	179 lbs.	188 lbs.	184 lbs.	178½ lbs.	186 lbs.
Maximum temperature of smoke box	800 degs. F.	763 degs. F.	675 degs. F.	700 degs. F.	800 degs. F.	700 degs. F.
Mean temperature of smoke box	665 degs. F.	658 degs. F.	619 degs. F.	625 degs. F.	662 degs. F.	622 degs. F.
Mean temperature of feed water	60 degs. F.	60 degs. F.	60 degs. F.	60 degs. F.	60 degs. F.	60 degs. F.
Gallons of water evaporated	25,732	30,286	24,979	29,150	26,018	54,129
Pounds of water evaporated	214,429	252,379	208,162	242,913	466,808	451,075
Gallons of oil burned	2,510	2,969	2,235	2,603	5,479	4,838
Pounds of oil burned	20,078	23,752	17,880	20,824	43,832	38,704
Pounds of water evaporated per pound of oil	10.68	10.62	11.642	11.66	10.65	11.654
Equivalent water evaporated from and at 212 degs. F.	12.921	12.825	14.087	14.12	12.885	14.101
Pounds of water evaporated per gallon of oil	85.44	84.96	93.136	93.28	85.20	93.232
Equivalent water evaporated from and at 212 degs. F.	110.54	102.26	112.70	112.92	105.080	112.81
Gallons of water evaporated per gallon of oil	10.25	10.20	11.176	11.198	10.226	11.188
Equivalent water evaporated from and at 212 degs. F.	12.40	12.34	13.523	13.550	12.37	13.537
Pounds of water evaporated per square foot heating surface per hour	5.39	5.34	4.64	5.19	5.36	4.92
Pounds of water evaporated per square foot, equivalent per hour	6.526	6.46	5.614	6.280	6.486	5.958
Engine miles run per 1,000 gallons oil	103.5	87.5	115.79	99.42	95.03	107.00
Engine miles run per 1,000 gal. water	10.06	8.54	10.37	8.878	9.24	9.562
Number of loaded cars in train (mean)	30.5	180	33.6	28.4	24.2	31
Number of empty cars in train (mean)	3	22.7	1.5	5.2	12.8	3.3
Total number of cars in train (mean)	33.5	40.7	35.1	33.6	37	34.3
Weight of train in M's (mean)	1,692	1,664	1,681	1,788	1,678	1,735
Weight of train in tons (mean)	846	832	840.5	894	839	867
Distance run, miles	258.8	258.8	258.8	258.8	517.6	517.6
Gross ton mileage	219,114	215,322	217,690	231,546	434,436	449,236
Ton miles per gallon of water	8.434	7.107	8.712	7.942	7.752	8.296
Ton miles per gallon of oil	87.34	72.49	97.40	88.946	79.31	92.849
Ton miles per pound of oil	10.92	9.06	12.18	11.118	9.79	11.606

In the accompanying table the data and results of the tests are given. The train weights do not include the engine and tender. Helper engine mileage is allowed for in the gross ton mileage. The water evaporation per square foot of heating surface per hour includes the total time of the tests. The form of oil burner used in the tests was the "Sheedy," with the Southern Pacific furnace and draft appliances.

The weight of the compound engine is 176,640 pounds, with 153,880 pounds on the drivers and 22,760 pounds on the trucks. The heating surface is 2,340 sq. ft., of which 177 sq. ft. are in the firebox. The firebox is 10 ft. 5 ins. long and 59 ins. in diameter over the corrugations. The tender carries 6,000 gals. of water and 3,000 gals. of oil.

The simple engine has 62 in. drivers, 2,114 sq. ft. of heating surface and weighs 126,000 lbs. on driving wheels. It is a lighter engine than the compound. As a result of these tests the Southern Pacific has ordered twenty more of these compounds with Vanderbilt boilers, making twenty-five in all.

The annual report of the Pennsylvania Railroad recognizes the necessity for the extension of the company's lines into New York, and the desirability of connecting directly with the Long Island Railroad. To do this, tunnels would have to be constructed, but the depth below the surface and the gradients which the topographical conditions would render necessary seemed to make operation by steam power impracticable. Electricity as a source of power is well adapted to the conditions. The greater part of the necessary property has been secured at reasonable prices. On account of the novel engineering involved, a commission was appointed to thoroughly study the whole subject and prepare plans. Colonel Chas. W. Raymond, U. S. Army, is chairman, assisted by Mr. Gustave Lindenthal, Mr. Wm. H. Brown, chief engineer of the Pennsylvania Railroad, Mr. Chas. M. Jacobs and Mr. Alfred Noble. This commission will have general control of the undertaking. Mr. Jacobs will have direct charge of the North River section, and the East River section will be under Mr. Noble's supervision. The study of the project has progressed far enough to prove its practicability, and the commission will have the choice of several plans.



Reproduction of the Dynamometer Car Record.

Curve Resistance Tests at West Alton, Mo., By Mr. Max Wickaorst, Engineer of Tests.—Chicago, Burlington & Quincy Railway,

Test number	9	10	11	12
Av. speed, miles per hr.	8.1	12.9	18.4	21.9
Number of cars	19	19	19	19
Weight of train, tons	635	635	635	635
Av. weight per car, tons	33.4	33.4	33.4	33.4
Temperature of air	81°	81°	82°	83°

Test 9

Section number	1	2	3	4	5	6	7	8
SPEED.								
Initial	8.4	9.1	6.9	5.9	6.4	8.4	8.3	8.0
Final	9.1	6.9	5.9	6.4	8.4	8.3	8.0	7.8
Average	8.8	8.0	6.4	6.2	7.4	8.4	8.2	7.9
DRAW-BAR PULL, POUNDS.								
Total, actual	8,600	8,080	14,420	13,760	10,900	8,760	7,730	8,620
Per ton: Actual	13.54	12.71	22.70	21.70	17.20	13.80	12.18	13.58
Cor. for accl.	12.76	17.11	24.64	21.08	15.20	13.91	12.50	13.77
Cor. for accl. + grade	3.76	9.90	17.94	12.48	3.40	4.91	3.50	2.37
Due to curve	.....	12.62	14.35	17.78	.....	.....	.....	.....
Per degree of curve	.....	1.68	1.91	2.37	.....	.....	.....	.....
Av. on str. & lev. tr'k	3.59							
Av. per deg. of curve	1.99							

Test 10

Section number	1	2	3	4	5	6	7	8
SPEED.								
Initial	13.1	13.3	12.5	11.6	11.7	12.6	13.0	13.0
Final	13.3	12.5	11.6	11.7	12.6	13.0	13.0	11.7
Average	13.2	12.9	12.0	11.7	12.2	12.8	13.0	12.3
DRAW-BAR PULL, POUNDS.								
Total, actual	8,450	8,140	11,920	13,120	11,100	8,880	7,610	7,830
Per ton: Actual	13.30	12.81	18.77	20.66	17.48	13.98	11.99	12.33
Cor. for accl.	12.96	14.89	21.80	20.44	16.07	13.31	11.99	14.40
Cor. for accl. + grade	3.96	7.69	15.20	11.84	4.27	4.31	2.99	3.00
Due to curve	.....	7.96	11.49	16.26	.....	.....	.....	.....
Per degree of curve	.....	1.06	1.53	2.16	.....	.....	.....	.....
Av. on str. & lev. tr'k	3.71							
Av. per deg. of curve	1.58							

Test 11

Section number	1	2	3	4	5	6	7	8
SPEED.								
Initial	18.8	19.7	19.1	18.1	17.4	17.8	18.4	18.8
Final	19.7	19.1	18.1	17.4	17.8	18.4	18.8	18.0
Average	19.3	19.4	18.6	17.7	17.6	18.1	18.6	18.4
DRAW-BAR PULL, POUNDS.								
Total, actual	9,860	9,180	10,720	11,250	11,250	10,260	8,620	7,700
Per ton: Actual	15.51	14.44	16.90	17.72	17.72	16.17	13.41	12.11
Cor. for accl.	13.23	16.81	21.94	20.38	16.83	14.77	12.43	13.98
Cor. for accl. + grade	4.23	9.61	15.34	11.78	5.03	5.77	3.43	2.58
Due to curve	.....	10.80	11.13	15.14	.....	.....	.....	.....
Per degree of curve	.....	1.44	1.48	2.02	.....	.....	.....	.....
Av. on str. & lev. tr'k	4.21							
Av. per deg. of curve	1.65							

Test 12

Section number	1	2	3	4	5	6	7	8
SPEED.								
Initial	22.0	22.6	22.2	20.8	20.4	20.8	21.8	22.6
Final	22.6	22.2	20.8	20.4	20.8	21.8	22.6	23.1
Average	22.3	22.4	21.5	20.6	20.6	21.3	22.2	22.8
DRAW-BAR PULL, POUNDS.								
Total, actual	9,580	9,300	10,360	10,350	10,460	10,360	10,020	9,320
Per ton: Actual	15.09	14.64	16.33	16.31	16.49	16.33	15.80	14.70
Cor. for accl.	13.38	16.56	25.43	17.96	15.39	13.65	13.52	13.28
Cor. for accl. + grade	4.38	9.36	18.83	9.36	3.59	4.65	4.52	1.88
Due to curve	.....	11.12	15.03	11.12	.....	.....	.....	.....
Per degree of curve	.....	1.48	2.04	1.48	.....	.....	.....	.....
Av. on str. & lev. tr'k	3.80							
Av. per deg. of curve	1.67							

ADDITIONAL DATA IN CURVE RESISTANCE TESTS.

Sec.	Location of middle of train. Initial.	Final.	Elevation of middle of train. Initial.	Final.	Dif.	Lth. ft.	% gr.	Grade res. per ton.
1	10,360.5	10,370.5	120.9	125.4	4.5	1,000	.45	9.0
2	10,370.5	10,377.5	125.4	127.9	2.5	700	.36	7.2
3	10,377.5	10,382.0	127.9	129.4	1.5	450	.33	6.6
4	10,382.0	10,389.0	129.4	132.4	3.0	700	.43	8.6
5	10,389.0	10,399.5	132.4	138.6	6.2	1,050	.59	11.8
6	10,399.5	10,409.5	138.6	143.1	4.5	1,000	.45	9.0
7	10,409.5	10,420.5	143.1	148.0	4.9	1,100	.45	9.0
8	10,420.5	10,430.5	148.0	153.7	5.7	1,000	.57	11.4

CURVE RESISTANCE TESTS AT WEST ALTON, MO.

St. Louis, Keokuk & Northwestern R. R.

Tests Made With Dynamometer Car on 7½ Degree Curve.

By Max H. Wickhorst, Engineer of Tests of C., B. & Q. Ry.

The tests described below were made at West Alton, Mo., primarily to determine the relative resistance of a train on straight track and curves at this point. The straight track, which is tangent to the curve, has a grade of about 5 per cent. and the curve is 7½°, with about 0.33 per cent. grade. The purpose of this article is to give results of curve resistance tests which were made with our dynamometer car, and which we have reduced to pounds per ton per degree of curve. The tests were made on the 10th of September, 1901, with a train of 19 cars, including the test car and the way car, or a total tonnage of 635 tons behind the engine. The cars were mostly gondolas loaded with coal, and a list of the cars, showing scale weights, is given below:

Cars Used in Tests Numbers 9, 10, 11 and 12; in Order Beginning at the Head End.

Number.	Initials.	Kind.	Weights— Empty.	—Weights Loaded.	Capacity.	Lading.
90,151	C., B. & Q.	Test.	38,300	38,300	......	......
26,069	L. & N.	Gond.	24,000	77,800	......	Coal
26,445	L. & N.	Gond.	24,400	78,000	50,000	Coal
28,819	L. & N.	Gond.	23,300	77,900	50,000	Coal
27,220	L. & N.	Gond.	21,100	68,300	40,000	Coal
26,732	L. & N.	Gond.	24,100	78,700	50,000	Coal
57,372	Southern	Gond.	29,600	93,000	60,000	Coal
33,845	L. & N.	Gond.	26,200	94,200	60,000	Coal
28,586	L. & N.	Gond.	19,800	62,400	40,000	Coal
1,650	L. E. & St. L.	Gond.	......	71,000	50,000	Coal
56,537	Southern	Gond.	22,300	68,500	40,000	Coal
26,748	L. & N.	Gond.	19,800	66,000	40,000	Coal
26,567	L. & N.	Gond.	20,300	65,300	40,000	Coal
20,630	C., B. & Q.	Box	23,800	64,900	40,000	Coal
18,749	C., B. &. Q.	Box	24,100	64,700	40,000	Coal
13,379	C., B. & Q.	Box	21,600	52,600	50,000	Coal
3,107	H. & St. Jo.	Box	22,400	63,200	40,000	Coal
11,979	C., B. & Q.	Box	22,900	55,800	40,000	D. pipe
162	StL.K&NW	Way	30,000	30,000	......	......
Total pounds				1,270,600		
Total tons				635.3		

Most of the trucks of the gondola cars were in a condition of poor repair, and the cars were down on their side bearings. Four tests were made with this train, starting from the main line of the West Alton yards and ending at Bellfontaine bridge.

The engine was fitted with a Boyer speed recorder, this being placed in the cab, and the engineer instructed to maintain uniform speed throughout each test. The object of having speed as near uniform as possible throughout any test was to avoid the necessity of making acceleration or retardation corrections. The speeds selected were 10, 15, 20 and 25 miles per hour, respectively. In the test car we obtained a record of the drawbar pull, time and distance. As regards drawbar pull, the test car is supplied with a hydraulic dynamometer which has a piston fitted to the cylinder, without packing rings, and in calibrating the dynamometer a dead-weight gauge tester was used. The time record was obtained by means of a pen connected with an electro-magnet and clock, so as to show automatically intervals of 10 seconds. As regards distance, record was made showing when the test car passed various points, such as mile posts, beginning of curves, end of curves, etc. For the purpose of working up the records we divided each one into eight sections, as shown on the sample record given herewith. Section No. 1 represents 1/5 mile north of the beginning of the curve, that is, from the point where the train strikes section No. 1 to the beginning of the curve, representing 1/5 mile of track. Section No. 2 represents a distance equal to the length of the train from the point where it enters the curve. Section No. 3 terminates where the train starts to leave the curve again for the straight track, and this section represents the portion of track where the whole train was on the curve. Section No. 4 represents the portion of track from where the head end of train leaves the curve to a distance south equal to the length of the train. Section No. 5 represents 1/5 mile south of this. Sections 6, 7 and 8 represent 1/5 mile consecutively.

After the tests were made, levels were run over this piece of track and the average grades of the various sections are also shown on the sample diagram. These averages are for a distance one-half the train length from the beginning of the section to one-half the train length from the end of the section. In working up the results we first determined the average total drawbar pull for each section, then calculated the drawbar pull per ton, actual. This was corrected for any acceleration or retardation there may have been in the section, using the formula:

$$R_a = 91.2 \frac{V}{S}$$

where R_a equals acceleration in pounds per ton, positive or negative. V equals the difference in velocity in miles per hour between beginning and end of the section. S equals seconds in going over the sections. These results then give the drawbar pull per ton for uniform speed.

Next we corrected this for grade by the formula:

$$R_g = 20\ G,$$

where R_g equals grade resistance in pounds per ton, and G equals grade in per cent.

The residual then gives frictional resistances, including curve resistance, if any. To determine the normal frictional resistance with the cars under consideration, we took the average of the results obtained on straight track. For the section where the whole train was on the curve, we subtracted the normal frictional resistance from the residual obtained above, which then gives the additional resistance due to the curve. As this was a 7½° curve, we divided the results by 7½ and got the curve resistance per degree. Where the train was entering or leaving the curve, we multiplied the results obtained as before, by 2, and thus got the curve resistance per ton per degree. The results of the four tests are shown in the table herewith, which gives the initial, final and average speed for each section of each test, and also gives the drawbar pull in pounds as follows:

Total actual, per ton actual, per ton corrected for acceleration, per ton corrected for acceleration and grade, per ton due to curve, per ton per degree of curve, per ton, average on straight and level track, per ton average per degree of curve.

Results of the four tests, showing the average frictional resistance reduced to straight and level track, and also resistance per degree of curve for the four tests, are given in the following table, expressed in pounds drawbar pull per ton:

Test No.	Friction, straight and level.	Curve resistance, per degree.
9	3.59	1.99
10	3.71	1.58
11	4.21	1.65
12	3.80	1.67
Average	3.83	1.72

It will be noticed that the average resistance per ton reduced to straight and level track we found to be 3.83 lbs. for these cars under the conditions at the time. The average weight of the cars was 33.4 tons per car and an average speed of about 15 miles per hour. The curve resistance we found to be 1.72 lbs. per ton per degree of curve on this 7½° curve. Curve resistance is usually taken as equal to 0.5 to 0.7 lb. per ton per degree of curve. The results of the West Alton tests give a high figure for curve resistance. I understand the Pennsylvania road made some tests of a similar nature, which also gave a figure for curve resistance considerably higher than that usually taken. This matter is of some importance, and we hope at some time to make further tests under various conditions.

A sample diagram is given herewith showing test No. 11, which may be of interest as showing the composition of train resistance at various points respectively. It also shows the nature of the records taken in the test car. These tests were made for Mr. Henry Miller, assistant superintendent of the St. Louis, Keokuk & Northwestern Railroad, at Hannibal, Mo., and I am indebted to him for the privilege of recording these results.

(Established 1832.)

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

Suburban service has not, as a rule, been considered sufficiently important to require special locomotives, and in most cases old and light road locomotives are used. Conditions are, however, changing, especially in large cities, where the competition of electric roads is felt and suburban service is in some cases the most difficult to manage of all passenger service. For this reason the new suburban locomotives of the New York Central seem exceedingly important. This road is not materially affected by electric road competition, but to handle heavy local trains on fast schedules out of New York City very powerful locomotives are required. This led to the design of the handsome engines illustrated in this issue. Not only are these engines heavy, they are powerful, with a heavy weight on driving wheels, large cylinder and boiler capacity, and ample grate area. Instead of a separate tender a good supply of coal and water is carried on the engine, and the disposition of it is admirable. Other roads are considering the construction of special suburban engines, and the drawings which we present will doubtless aid in the movement toward suitable locomotives for this important business. The factor most needed appears to be high accelerating power with ample boiler capacity, combined with a construction which permits of running in either direction. This design is certainly skilful, and it appears to be entirely successful. We cannot forbear the remark, however, that suburban cars are often much heavier than the actual necessities seem to demand, and the great weight of this engine suggests a study of the weight of suburban service cars.

Curve resistance has ordinarily been reckoned at about 0.5 to 0.7 lb. per ton. It has been stated to be as low as 0.43 lb., but Wellington proved fourteen years ago that it was far greater than these figures and that it depended upon the speed. In this issue are the results of recent tests on the "Burlington" by Mr. Max H. Wickhorst, engineer of tests of that road, which tend to confirm Wellington and show that under the conditions of an average speed of about 15 miles per hour the resistance on a 7.5° curve is two or three times as much as the generally accepted amount. Mr. Wickhorst finds it much greater than Wellington did at this speed. General deductions on these results should not be made, but it is safe to say that the effects of curvature are generally underestimated. Mr. Wickhorst expects to pursue this investigation further, and we hope to present his conclusions after trials on various curvatures and at various speeds in a future issue.

A great many malleable iron castings are now used in connection with rolled steel sections in car and truck construction and similar work. An important item in their design seems to have been rather generally overlooked. The malleable casting makers tell us that they could furnish castings more promptly and at a lower price in many cases if they were made with "chipping strips," which would reduce the areas of the surfaces requiring grinding for fitting against other surfaces, such as the flanges on webs of rolled steel shapes. Unless a large bearing area is required, narrow fitting strips are quite as satisfactory, and they require very much less time and labor in grinding than castings, the entire bearing surfaces of which must be ground to a fit. This becomes important in connection with an order for several thousand cars, and here is a chance for the drafting room to save quite a little expense.

Those who have used Vanderbilt boilers for oil burning have expressed very favorable opinions of their advantages with that fuel, because of their freedom from riveted seams in the region of greatest heat effect, but from the facts presented elsewhere in this issue, it appears that the conditions of combustion or of heat absorption must be better than in the case of fireboxes of the usual form. The results of the careful tests of Mr. Howard Stillman on the Southern Pacific, which, through the courtesy of Mr. H. J. Small, are published in this issue, indicate an unmistakable gain in evaporative effect. A compound locomotive would be expected to do more work, per gallon of oil, than a simple engine, but the figures show an important difference in the boiler performance as well. In "equivalent evaporation" the advantage of the Vanderbilt boiler was 9.42% in this case.

The Baldwin Locomotive Works recently celebrated the construction of their 20,000th locomotive, and the 70th year of continuous operation. It was a memorable occasion, and among the guests were many whose lives and abilities have been devoted exclusively to the development of transportation, and particularly the development of the locomotive, without which the present condition of this country would be an impossibility. We congratulate the Baldwin Locomotive Works. It is something to have built one locomotive; it is more to have built 20,000, and it is a truly great accomplishment to have built up an establishment with a capacity of 1,500 locomotives per year, and to do this with an organization, unique in its management of a force of 11,000 men. A system which erects a complete locomotive in 24 hours, and sends it out for delivery 48 hours after the boiler comes into the erecting shop, is worthy of admiration. The mantle of Matthias W. Baldwin has fallen upon the shoulders of able and skilful men.

COMMUNICATIONS.

TREATMENT OF SPECIAL APPRENTICES IN THE SHOP.

To the Editor:

As one who has been an observer of, as well as a workman among, special apprentices in railway shops, I wish to take exception, in a measure, at least, to the remarks of "A. A. G." in your March issue. I can answer the editor's note without hesitation; the difficulty is to be overcome by the special apprentices themselves. But granting, for the sake of argument, that "A. A. G." is correct in his statement, can you blame the machinists? Here we have 50, 100 or 300 men who, from positions as messenger, blue printer, water carrier, or what not, have gradually worked up through years of service until they have become full fledged machinists. To this trade they have adhered for years, perhaps for years drawn the same wages. Along come the technical graduates, sons of directors, friends and sons of officials, and expect to receive from the machinists that which is their stock in trade, viz., the full knowledge of the machinist, in half the time, without remunerating their teachers. Is this the manner a lawyer or physician deals out instruction and advice—gratis? But the machinists are, as a rule, willing to lend a helping hand, and in a few years they see all the special apprentices advancing by steady strides to positions above them. Is it any wonder that in a few cases an old and skilled machinist should look with envy upon one of these young men as he begins his course? But, on the other hand, I believe that the skilled machinists of our railway, locomotive and car shops are liberal-minded, whole-hearted men, who are only too glad to assist the special apprentice in every possible way. But you must not expect the machinists to do it all. The special apprentice has a part to fulfill.

If the special apprentice enters a shop with the idea that he "knows it all," and that the workers, the wage earners, are beneath him, he will not see the best of the men coming up, and on bended knee proffering their services. No. We do not want workmen who will bow in submission; it is unmanly. But the special apprentice who comes to the shop with the feeling that he has years of information to acquire, and that the men in the shops are the ones who possess that information, with a very little common "horse" sense will soon come to respect and honor those men, and will find them always ready to assist and impart information.

I know of cases of special apprentices in railroad shops who were afraid of soiling their hands and clothing, who always had some different method of doing work, who always knew how to do everything, and always had an opinion to express, and they found the shop conditions just about as intolerable as "A. A. G." They would be sent to the foundry to borrow the blast furnace, or to the pattern shop for a half-round square, or taken out on a bitter cold night to hunt the "Elbertritschel." These are facts, not fancies, and the special apprentice who "pursues the even tenor of his way," minding his own business striving to attain perfection, willing to perform whatever duties are imposed upon him, and following the rules of common courtesy with his associates, is sure to meet with success.

But the special apprentice must not be treated as a "little tin god" because he has had the advantage of a college training. He must be taught from the start that he is no better than the other workmen, and that only by "keeping everlastingly at it" can he hope to be advanced. He must be treated as other workmen are treated, and no advantages given or favoritism shown, and should not be advanced over practical men unless his ability warrants the advancement.

It may be the case that in some shops too much attention is shown the special apprentices, which would doubtless bring about the results mentioned by "A. A. G."

"ENGINEER."

To the Editor:

I wish to comment upon, and answer, through my personal experience, the question asked in your editorial note upon the treatment of special apprentices in shops on page 82 of your March number.

It has been asked, "Is not the workman's ill treatment of and wrong attitude towards the special apprentices to be overcome by the apprentices themselves?" I think that an answer in the affirmative is most decidedly the only one which can be made to this question.

I am at present a student in the mechanical engineering course at Cornell University, expecting to take my M. E. degree this spring, but I have served part of my time as special apprentice during the past two summer vacation months in the shops on a large road in the Middle West.

When I first entered the shop I found there a special apprentice who was very much disliked by the workmen, and I was naturally anxious to discover the cause of his unpopularity. Unwillingness to help men, an overbearing and haughty manner, and a tendency to disagree, are not points in favor with any workman. Especially is this so in the case of a man who comes into a shop under different conditions than his fellow workman. Some of these characteristics I quickly noted in the unpopular apprentice, trying at the same time to correct them in myself, and in a gentlemanly way to become one of the men.

Although I was looked upon unfavorably at first, because of the fact that I was a special apprentice, I did not suffer any ill treatment, and in less than a month I was on the same footing in the shop as any new workman. Moreover, the fact that I was a "special" had in a large measure been lost sight of by the men with whom I had to work.

After graduation I expect to return to these shops in order that I may serve my time out, and it is with the greatest pleasure that I look forward to the renewing of acquaintances and friendships with some of the men. I will say from personal experience that the average "special" is over-impressed with his own ability, knowledge and importance when he enters a shop, and a display of this quickly places him in disfavor. I firmly believe the best thing a special can do, upon entering a shop, is to keep his mouth closed and his eyes open, and to give information only when he is asked. He will thereby win the favor and good will of the shop men. It is, therefore, upon these grounds that I assert that a special apprentice must look to himself for his treatment by the men in the shop, and not rely upon the fact that he is a special apprentice, and is a little better than his fellow workmen.

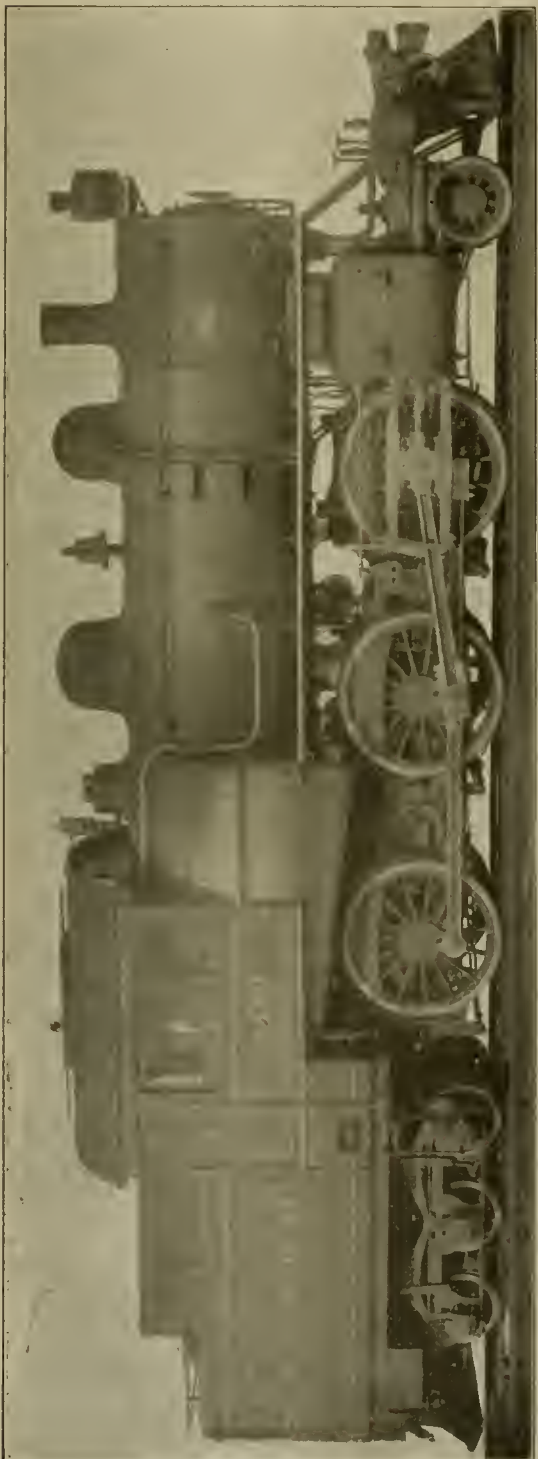
C. D. Y.

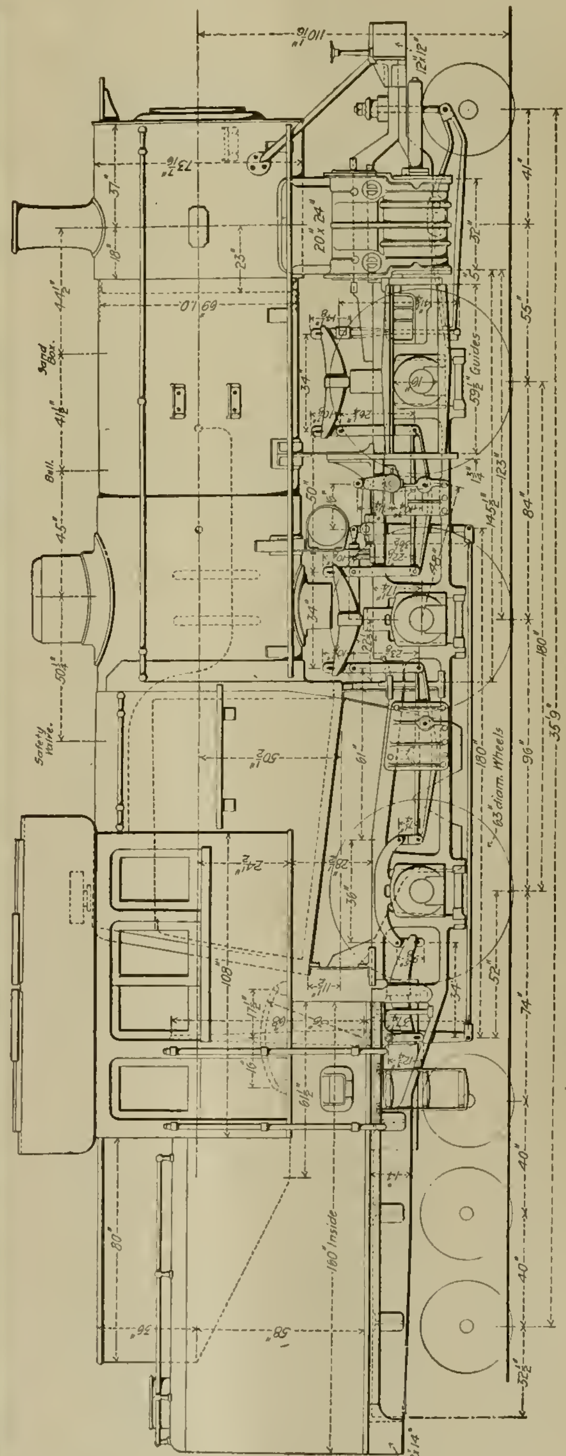
[Editor's Note.—To face and overcome opposition and prejudice is one of the most important accomplishments in the career of anyone. It is well that the special apprentice should be obliged to do this at the start, and that his way should not be unnaturally smoothed. To gain the confidence and respect of the shop is a necessity to advancement. Those who cannot do this should not continue, but try something else.]

The Atchison, Topeka & Santa Fé Railway has been experimenting with its new tandem-compound decapods (see American Engineer, February, 1902), on the three per cent. grade up the Cajon Pass in the Sierra Nevada Mountains. The load hauled by one of these engines is reported to be 703 tons, and the length of the grade six and one-half miles. This is believed to be the heaviest load ever taken over such a grade by one engine.

The kindling of fires in locomotives has been reduced to a very inexpensive item on the Chicago & Northwestern Railway by the employment of strips of refuse from the manufacture of oak barrel staves. A bundle of these, of the length of an ordinary barrel stave, costs about 2½ cents and is sufficient for kindling a fire. If there is need of haste another half bundle is added. This low cost is made possible by making use of convenient material which is accessible along the line of the road.

The "Railway and Engineering Review," of Chicago, published a notable special number March 15, devoted to the subject of maintenance of way, with a construction supplement. It was prepared for the annual convention of the American Railway Engineers and Maintenance of Way Association, an is the best of the special numbers of the papers prepared for that convention.

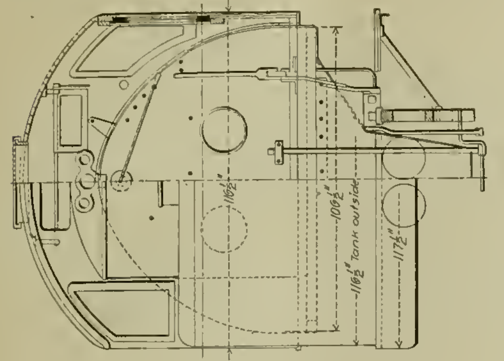


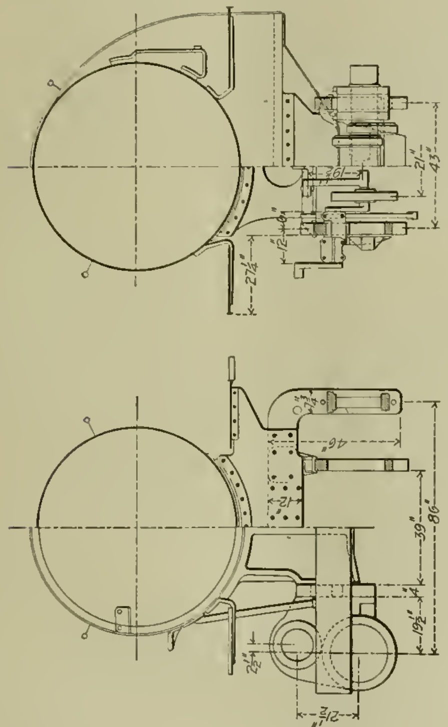


Heavy Suburban Locomotive—New York Central & Hudson River Railroad.

A. M. Waitt, *Superintendent of Motive Power and Rolling Stock.*

American Locomotive Company, Schenectady Works, *Builders.*





Transverse Sections.

HEAVY 6-COUPLED SUBURBAN LOCOMOTIVE.

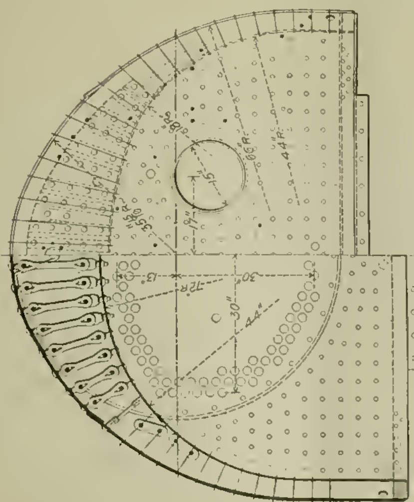
New York Central & Hudson River Railroad.

American Locomotive Company—Schenectady Works.

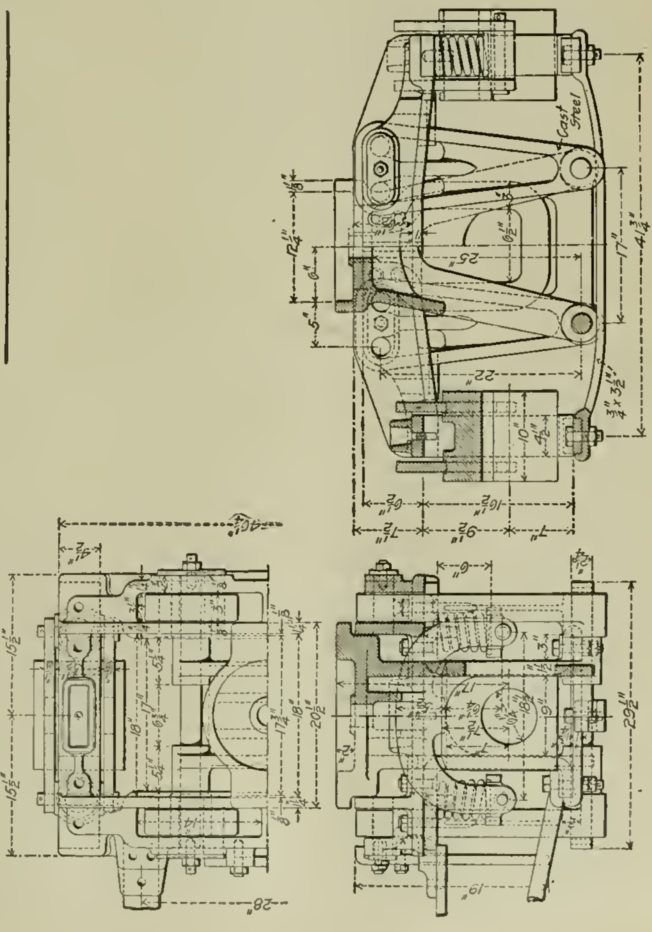
The fact that locomotives as powerful as this one are required to handle suburban trains, is impressive of the severity of present schedules. The heating surface of this engine is 2,437 sq. ft., while that of the largest 8-wheel engine on the Chicago & Northwestern is but 70 sq. ft. greater. This engine has a two-wheel leading truck, 63-in. drivers, a six-wheel truck under the tender, and 20 by 24 in. cylinders. The grate area is 62 sq. ft., and the fuel is anthracite coal.

For runs of about 75 miles large tender capacity is not required, but in the compact space 3,700 gals. of water and 5 tons of coal are carried. The engines are very powerful, and much heavier than any other suburban class ever constructed. In one section of a suburban run out of New York City, these engines cover 48.2 miles in 100 minutes, with 18 stops. On a complete run of 73 miles another train makes a speed of 25 miles per hour, with 32 stops, and including the stops. We cannot give the weights of these trains accurately, but the one first mentioned weighs about 212 tons, exclusive of the engine and the weight of the passengers. It is evident that such work requires exceptional starting power and large steam making capacity.

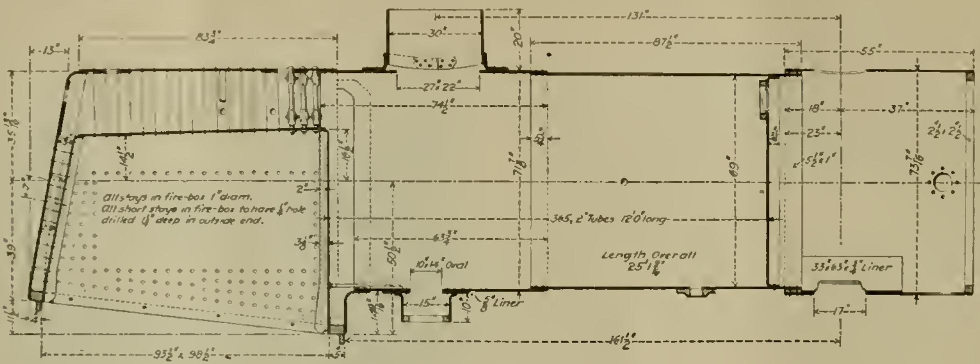
These engines have attracted a great deal of attention, and because they are unique they are illustrated in considerable detail. They are remarkably attractive in appearance, and are large engines, even among the big ones of the "Central



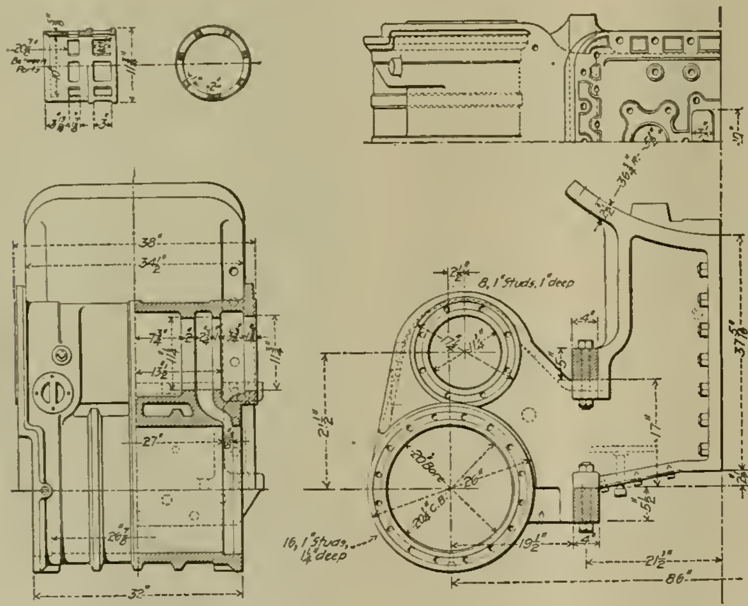
Section Through Firebox.



The Leading Truck.



Longitudinal ection of Boiler.



Cylinder and Valve Bushings.

Atlantic" type, which we have illustrated. Their accelerating power is great, and records taken from one of them show that they are capable of exerting a draw bar pull of 27,000 lbs. This required heavy frame construction with substantial fastenings back of the cylinders, which are indicated in the frame drawing. At the rear end the frames flatten out into slabs back of the cab. The frames are 40 ft. long. The equalizer system is continuous for each side of the engine from the rear driver to the pony truck. The boiler has a sloping back head. The mud ring is 5 in. wide in front and 4 in. wide on the sides and at the back end. The grate is 7 ft. 9½ ins. long by 8 ft. 2½ in. wide, and the curve of the side sheets rapidly increases the length of the staybolts above the lower rows. There are two fire doors. The principal dimensions of these interesting engines are given in the following table:

HEAVY SUBURBAN LOCOMOTIVE, NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

General Dimensions.

Gauge	4 ft. 8½ ins.
Fuel	Anthracite coal
Weight in working order	216,000 lbs.
Weight on drivers	128,000 lbs.
Wheel base, driving	15 ft. 0 in.
Wheel base, rigid	15 ft. 0 in.

Cylinders.

Diameter of cylinders	20 ins.
Stroke of piston	24 ins.
Horizontal thickness of piston	5 x 4¼ ins.
Diameter of piston rod	3½ ins.
Kind of piston packing	Cast iron
Kind of piston rod packing	United States

Valves.

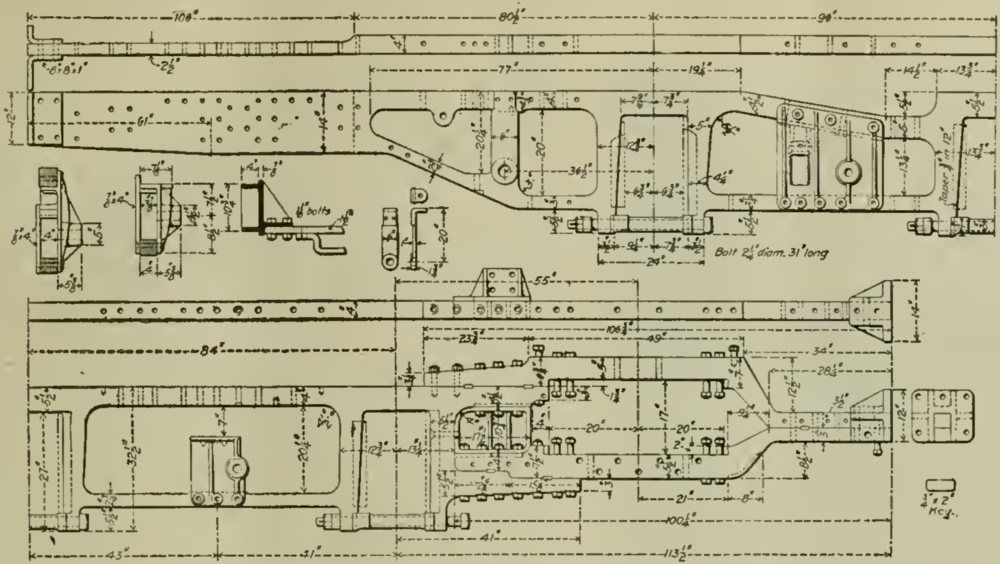
Kind of slide valves	Piston type
Greatest travel of slide valves	5½ ins.
Outside lap of slide valves	⅞ in.
Inside lap of slide valves	0 in.
Lead of valves in full-gear, line and line full stroke forward,	¼ in. lead at 6 ins. cut-off.
Kind of valve stem packing	United States

Wheels, Etc.

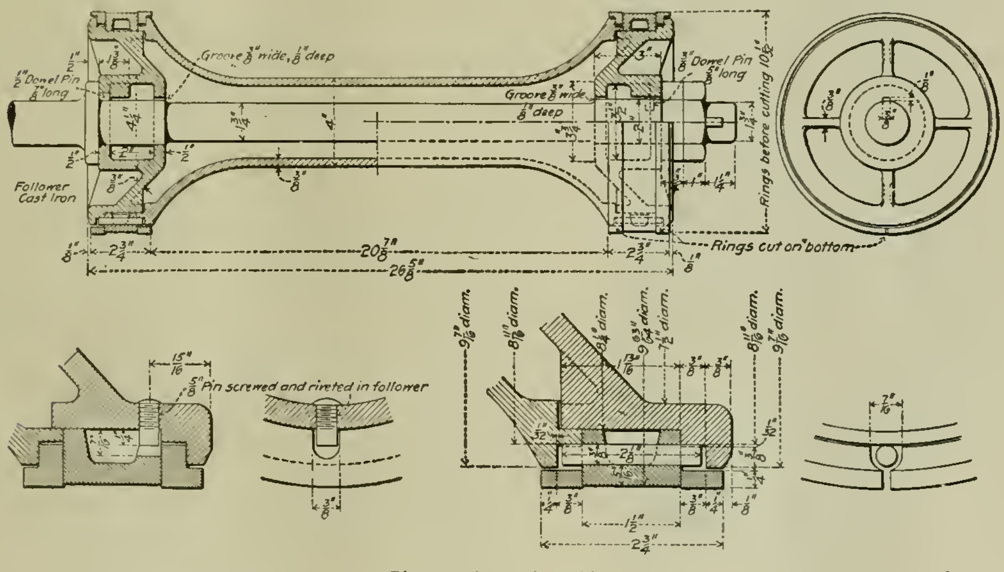
Diameter of driving wheels outside of tire	63 ins.
Material of driving wheel centers	Cast steel
Tire held by	Shrinkage and retaining rings
Driving box material	Cast steel
Diameter and length o. driving journals	9 ins. dia. x 12 ins.
Diameter and length of main crank pin journals, main, 6 ins. x 6½ ins.; main side, 7 ins. dia. x 5 ins.	
Diameter and length of side rod crank pin journals, front, 5 x 3¾ ins.; back, 5 ins. dia. x 3¾ ins.	
Engine truck, kind	2 wheel swing bolster
Engine truck, journals	6¼ ins. dia. x 10 ins.
Diameter of engine truck wheels	30 ins.
Kind of engine truck wheels, Krupp No. 3 cast iron spoke center, with 3⅛ in. tire.	

Boiler.

Style	straight, with wide firebox
Outside diameter of first ring	70 ins.
Working pressure	200 lbs.
Material of barrel and outside of firebox	Coatesville steel
Thickness of plates in barrel and outside of firebox, ½ in., 23-32 in., ⅝ in., ¾ in.	



Frames



Piston Valve and Packing

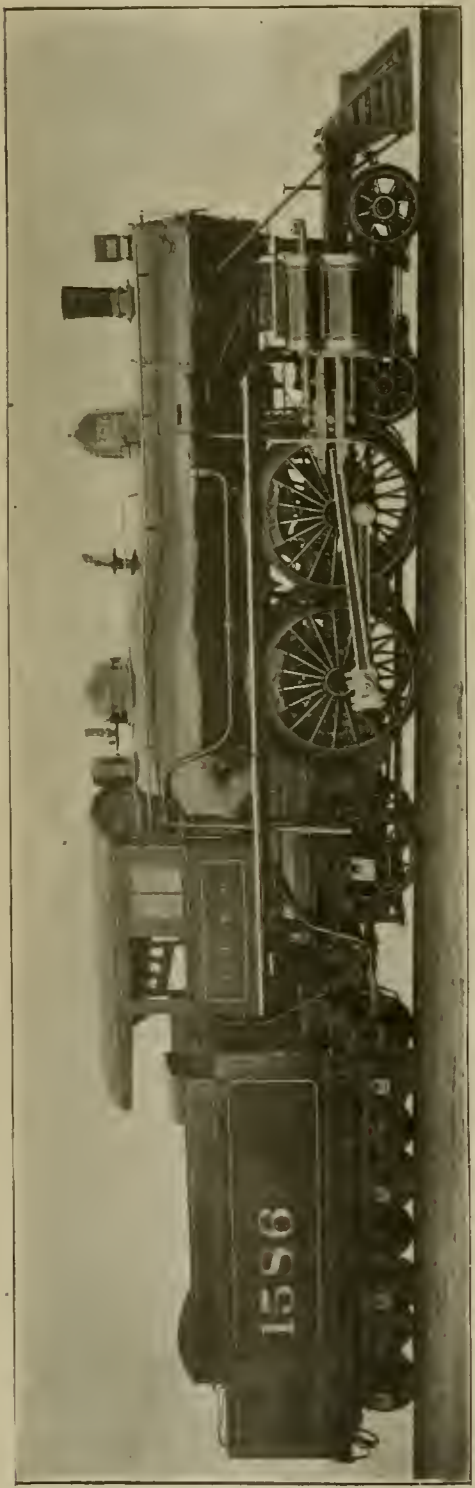
Horizontal seams, butt joint sextuple riveted, with welt strip inside and outside.
Circumferential seams ....Double riveted
Firebox, length ....93 ins.
Firebox, width ....97⅞ ins.
Firebox, depth ....front, 67 ins.; back, 53½ ins.
Firebox, material ....Carbon steel
Firebox plates, thickness, sides, 5-16 in.; back, ⅜ in.; crown, ⅜ in.; tube sheet, ½ in.
Firebox, water space..front, 5 ins.; sides, 4 ins.; back, 4 ins. and 5 ins.
Firebox, crown staying ....Radial, 1⅛ ins. dia.
Firebox, stay bolts ....Taylor iron, 1 in. dia.
Tubes, material ....Charcoal iron
Tubes, number of 365
Tubes, diameter ....2 ins.
Tubes, length over tube sheets ....12 ft. 0 in.
Heating surface, tubes ....2,2(?)5 sq. ft.
Heating surface, firebox ....162,000 sq. ft.
Heating surface, total ....2,437 sq. ft.
Grate surface ....62.07 sq. ft.
Grate, style ....Rocking, cast iron grate
Ash pan, style ....Hopper, dampers front and back
Exhaust pipes ....Single
Exhaust nozzles ....5 ins., 5¼ ins., 5¼ ins., dia.
Smoke stack, inside diameter ....14 ins.
Smoke stack, top above rail ....14 ft. 8 ins.
Boiler supplied by 2 monitor injectors, screw handled R. & L. inside of cab

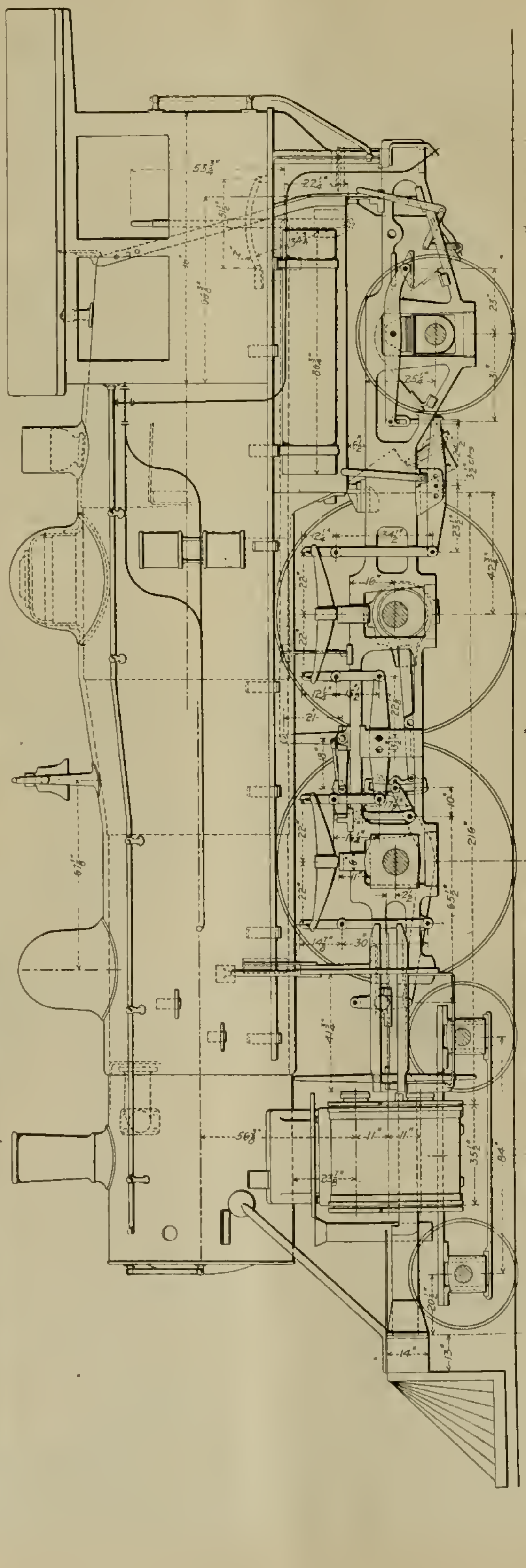
Tank and back end of engine.

Wheels, number of 6
Wheels, diameter ....30 ins.
Journals, diameter and length ....5 ins. dia. x 9 ins.
Rear truck, one 6-wheel center bearing, swing motion, with wrought iron side bars and iron cross beams.
Water capacity ....3,700 United States gallons
Coal capacity ....5 tons
Total wheel base of engine and tender ....35 ft. 9 ins.

The engine has the following special equipment: Three consolidated muffled safety valves; Westinghouse-American combined brakes; Westinghouse 9½ in. air pump and Westinghouse air signal; Leach D-2 double sand feed; Gould couplers; Star 6-in. chime whistle and Sansom bell ringer.

The American Brake Shoe and Foundry Company, with temporary offices at 26 Cortlandt street, New York, has assumed control of the following types of brake shoes: Sargent skeleton steel, the "Diamond S," the skeleton steel insert, the Lappin, Streeter, Corning and Ross-Mehan. Until further notice orders should be sent direct to the several combines.





Vauclain Compound Atlantic Type Passenger Locomotive, Chicago, Burlington & Quincy Railway.

F. H. Clark, *Superintendent Motive Power.*

Baldwin Locomotive Works, *Builders.*

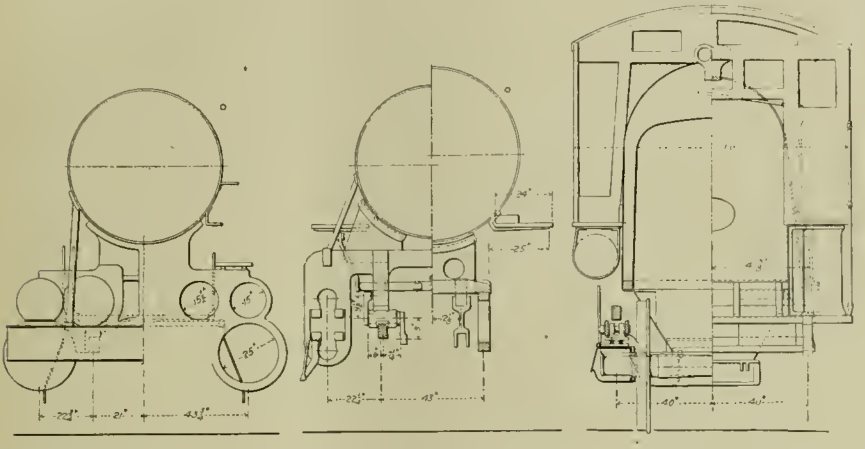
COMPOUND ATLANTIC TYPE PASSENGER LOCOMOTIVE.

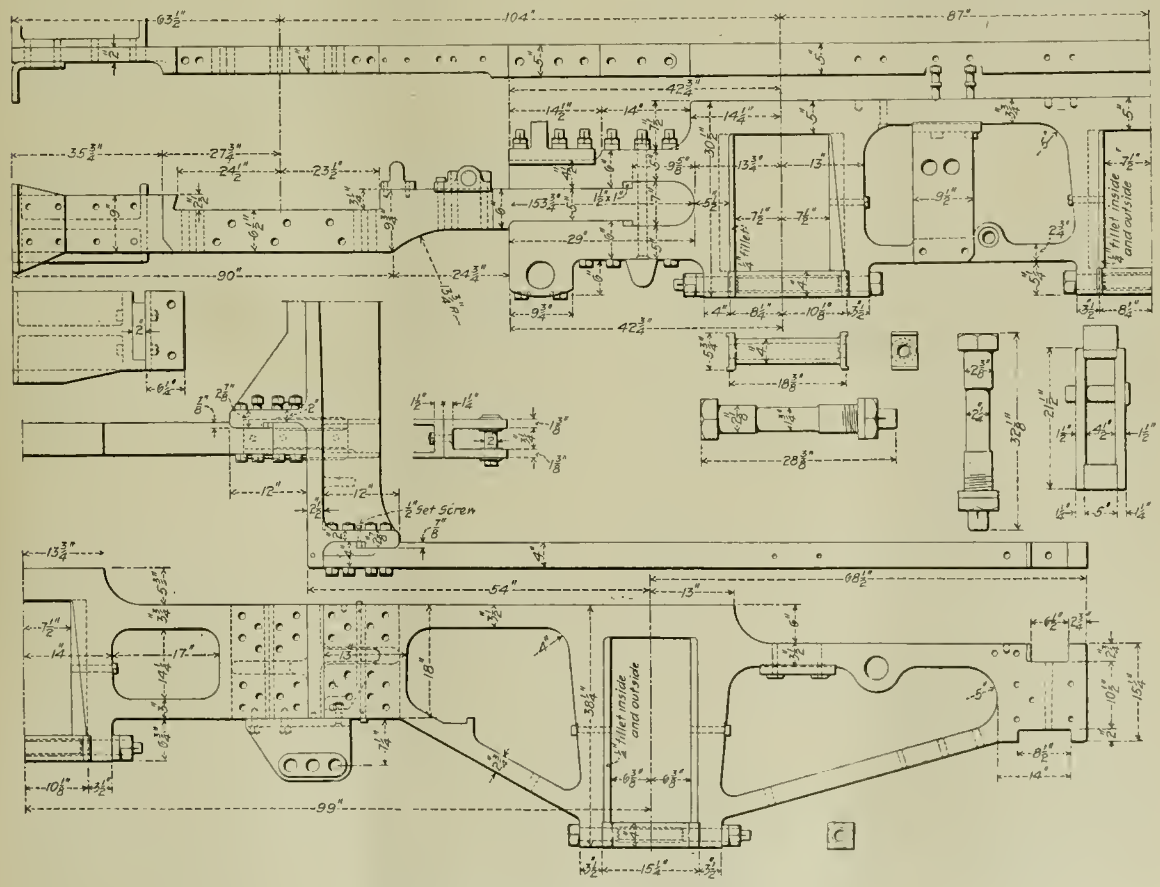
Chicago, Burlington & Quincy Railway.

For heavy passenger service the Chicago, Burlington & Quincy has received from the Baldwin Locomotive Works the first of a number of heavy, Atlantic type, Vauclain compounds with wide fireboxes, which are specially interesting because of the considerable increase of capacity above the design of the same type, with narrow fireboxes, by the same builders, which was illustrated on page 141 of our May number of 1899. The advance of three years is represented by the following table:

	1899.	1902.
Cylinder	13½ and 23 by 26 in.	15 and 25 by 26 in.
Heating surface	2,510 sq. ft.	2,990 sq. ft.
Grate area	33.6 sq. ft.	44.25 sq. ft.
Weight on drivers	85,850 lbs.	95,880 lbs.
Total weight	159,050 lbs.	183,080 lbs.

Besides having a wide firebox the present design has outside journals for the trailing wheels, and the trailing truck, which was developed by Mr. F. A. Delano for the first Prairie type engine (American Engineer, April, 1900, page 104), with modifications in the equalizer attachments. The trailer truck boxes have roller bearings, to take care of the side motion. This construction at the rear end necessitates an offset in the rear portions of the frames, which is illustrated in the frame drawing. A large steel casting is employed at the frame splice, an arrangement which seems to have given excellent service on this road. The grate area is not so large as to require a large angle of slope for the firebox sides; in fact, these are nearly vertical. The driving journals are 9½ by 12 ins.





Vauclain Compound Atlantic Type Passenger Locomotive.
CHICAGO, BURLINGTON & QUINCY RAILWAY.

The tractive power of these engines is 20,000 lbs. when operating compound, and 22,000 with live steam in the low pressure cylinders. They are equivalent to simple engines with 19-in. cylinders as compounds, and when starting can exert tractive power equivalent to 20-in. cylinders.

For comparison with other Atlantic type engines the following references to descriptions of this type may be consulted: American Engineer, October, 1900, page 304; February, 1901, page 37, and January, 1902, page 15. The chief dimensions of the design are given in the following table:

ATLANTIC TYPE COMPOUNDS, CHICAGO, BURLINGTON & QUINCY RAILWAY.

Gauge	4 ft. 8½ ins.
Cylinder	15 and 25 by 26 ins.
Valve	Balanced piston
Boiler, type	Wagon top
Boiler, diameter	64 ins.
Boiler, thickness of sheets	11-16 in. and ¾ in.
Boiler, working pressure	210 lbs.
Boiler, fuel	Soft coal
Boiler, staying	Radial
Firebox, material	Steel
Firebox	length, 96⅛ ins.; width, 66⅛ ins.
Firebox, depth	front, 70⅝ ins.; back, 68⅝ ins.
Firebox, thickness of sheets, sides, 7-16 in.; back, ⅜ in.; crown,	⅜ in.; tube, ½ in.
Firebox, water space	front, 4; sides, 4; back, 3
Tubes, material	Iron, wire gauge No. 11.
Tubes, number	330; diameter, 2; length, 16 ft. 6 ins.
Heating surface, firebox	155.5 sq. ft.
Heating surface, tubes	2,834.5 sq. ft.
Heating surface, total	2,990 sq. ft.
Heating surface, grate area	44.25 sq. ft.
Driving wheels, diameter outside	84¼ ins.
Driving wheels, diameter of center	78 ins.
Driving wheels, journals	9½ by 12 ins.
Engine truck wheels (front) diameter	37¼ in.
Engine truck, journals	6 x 10 ins.
Trailing wheels, diameter	54¼ ins.
Trailing wheels, journals	8 x 12 ins.
Wheel base, driving	7 ft. 3 ins.
Wheel base, rigid	7 ft. 3 ins.
Wheel base, total engine	27 ft. 8 ins.
Wheel base, total engine and tender	about 56 ft.
Weight, on driving wheels	95,880 lbs.
On truck	47,000 lbs.
On trailing wheels	40,200 lbs.
Total engine	183,080 lbs.
Tank, capacity	6,000 gal.
Tender, wheels	number, 8; diameter 37¼ ins.
Journals	5 x 9 ins.
Service	passenger

SIDE MOTION IN COUPLERS AND LATERAL MOTION IN TRUCKS.

In considering the necessities of the draft gear situation, increased capacity to care for the increasing severity of service is probably fully appreciated. Many well-directed efforts are being made to meet this requirement, and good, sound progress is the result. Capacity to receive heavy shocks in pulling and buffing is, however, not sufficient. These shocks, important as they are, by no means cover the whole punishment of draft gear. Much of the destruction due to rough handling of cars in yards will be overcome by stronger gear, but there is a direction in which draft gear may be too strong, that is, to say, too rigid. The necessity for sufficient side play of the coupler shanks for taking curves is unquestionably generally overlooked, especially by those who have discarded swing motion trucks, or their equivalent. An article in another column directs attention to this, and in addition to Mr. Smart's discussion it should be emphatically stated that if a tender is backed up to a 70-ft. car on a 19° curve the two couplers will not approach each other within about 6 ins. If the couplers in this case are coupled up this 6 ins. must be absorbed somewhere at the expense of severe strains if not "accident." It has been ascertained in a rough experiment that side stresses amounting to 57,000 lbs. may be set up in this way on passenger equipment. Of course, the length of cars has an important influence on these stresses, but even in relatively short freight cars they are undoubtedly sufficient to explain some of the destruction which is now going on and which may, for lack of means of knowing its amount, be wrongfully charged to rough handling. An important discussion of this question will be found in the Proceedings of the Western Railway Club for October, 1901. Whatever may be done with the coupler and draft gear to provide for or reduce these lateral stresses, it seems reasonable to believe that the equivalent of the side motion truck will afford greatly needed relief in this direction.

THE VALUE OF UP-TO-DATE TOOLS FOR RAILROAD WORK.

By M. K. Barnum, Master Mechanic, Union Pacific R. R.

A paper read before the Western Railroad Club.

The amount of money that is wasted every day by the lack of "up-to-date" tools is appreciated by very few railroad officials. Even many superintendents of machinery and master mechanics do not fully realize the saving that can be effected by replacing worn out and obsolete machines with others which are strictly "up-to-date" and fitted with all the latest improvements.

If an old machine can be replaced with a new one which will do enough more work or do the same work with enough less labor to represent a saving in money equal to 5 per cent. per annum on the investment it should be entitled to careful consideration, as this is the basis on which other railroad improvements are figured. How easy then, ought it to be for mechanical men to obtain approval on a requisition for a machine which will save from 10 per cent. to over 100 per cent. per annum on the investment.

A few actual examples of such savings may be needed to convince those who have not studied this question, or others who have not had the new machines to compare with old ones.

(1) In a railroad shop employing about 160 machinists there were no horizontal boring machines for such work as boring driving box brasses, rod brasses, rocker boxes, air pump cylinders, etc., and all such work had to be done in lathes, milling machines or drill presses.

After repeated conferences and much argument, accompanied by estimates of savings that would result, permission was obtained to order a No. 2½ horizontal boring and drilling machine with 4 in. bar and latest attachments. It has been in use about 18 months and shows earnings by money saved as follows:

Original cost of machine installed ready for work	$1,696.00
Average savings per year as compared with old manner of doing same work	900.00
Interest on investment	53 per cent.

It formerly required three hours to bore a driving box brass for a 9 x 12 in. journal in a milling machine and about four hours to do the same work with a lathe, whereas they are now bored in one hour in the horizontal boring machine. Rocker boxes ,tumbling-shaft boxes, etc., are done in one-half the time formerly used.

In boring air pump cylinders it was formerly necessary to take the pump apart and set and bore each cylinder separately, requiring from two to three hours each. In the new machine it is possible to bore all four cylinders of a New York pump at one setting, without taking them apart, and requires but an average of one hour for each cylinder. In addition to the saving in time, much greater accuracy is insured. It is very conservative to say that this machine does double the work of the old ones, thereby saving the wages of one machinist at $3.00 per day for 300 working days, or $900.00 per year.

(2) An old car wheel borer was replaced by a new, heavy 42-in. borer with hub-facing attachment, power crane for handling wheels, etc., which cost, installed, $1,710.90. This wheel borer saves the wages of one helper three hours a day and does more than double the work of the old machine, making a total of $2.45 per day, or $735.00 a year, which amounts to 42½ per cent. on the investment.

(3) A new heavy double head car-axle lathe, costing

$1,665.00 installed, turns out one-third more work than the old one on account of taking a heavier cut and heavier feed, thereby saving about $250.00 a year, or 15 per cent. on the principal.

A long list of such examples could be given to show the increased earning power of machine tools which are strictly up-to-date. Tools are not up-to-date when there is something else on the market which will do more work or do it at less cost of labor. They need not necessarily be worn out to be wasteful by comparison.

Most engine lathes of modern design have greater power, weight and strength to withstand heavier cuts and coarser feeds than those built 20 or 25 years ago, which enables the former to turn out from 20 to 30 per cent. more work. This represents savings equal to from 15 to 35 per cent. interest on the investment, varying with the cost of the lathe and the class of the work for which it is used.

Recent planers are built 30 to 50 per cent. heavier than they were 20 years ago, with greater power and quicker return, the latter running as high as 72 to 80 feet per minute as compared with 40 ft. or less for the older machines. They are also fitted with three or four tool heads, whereas the old planers had only one or two at most. This means an increase of 25 to 50 per cent. in the amount of work done, or earnings of 10 to 25 per cent. on the amount expended for the machine.

The various types of turret lathes for making bolts, studs and pins from bar iron are well adapted to locomotive work and will easily turn out twice or three times as much of this class of work as will an ordinary old style engine lathe. Such machines cost $1,600.00 to $1,800.00, and make a return of from 50 to 60 per cent. in savings. The large automatic turret lathes for turning piston heads, cylinder packing, bull rings, balanced valve rings, etc., will do double the amount of this work that an engine lathe will, and the same may be said of the latest boring and turning mills.

Many improvements have been made in drill presses, among which may be mentioned easier and quicker adjustments of both spindle and work, swiveling tables, tapping attachments, multiple spindle drills, variable speed countershafts, etc., all of which help to increase the output.

Milling machines are great time savers on certain classes of work which used to be done on slotters, shapers or planers, and are especially economical where a large number of duplicate parts are to be made. Every tool room ought to have at least one universal milling machine, and there are various jobs of locomotive work that can be done to great advantage on such machines. The percentage of saving to be obtained depends not only on the original cost and amount of additional work done, but also on the rate of pay and skill of the operator and the number of hours the machine is run. As a rule, improved small tools will therefore earn a larger rate of interest on the investment than larger and more expensive ones.

There are very few railroads to-day which have not more or less pneumatic drills, hammers, riveters, hoists, etc., and no argument should be necessary to demonstrate their earning capacity, but the value of air jacks for cars and locomotives is not so generally known. It formerly required about four hours for eight men with screw jacks to take a 10-wheel engine weighing 132,000 pounds off its drivers, at a cost of $5.14, and about one-half that time for four men to do the same work with hydraulic jacks, but using four pneumatic jacks, it is now regularly done by four men in one hour at a cost of 66 cents. However, to be strictly up-to-date an electric crane should be used and the time reduced to ten minutes.

A pneumatic ram was recently made at a cost of $168.55 for breaking staybolts to remove worn out fireboxes, which earns very large interest on the investment. It formerly cost $45.60 to cut out the crown bolts and staybolts of a 10-wheel locomotive with 9-ft. firebox, using three men, but with the pneumatic ram it is done by two men for $15.20, thereby saving $30.40 on each firebox. If only one firebox was removed each year this tool would earn 10 per cent. on the investment, but as this shop applies 30 new fireboxes a year the saving amounts to $912.00, or 541 per cent. per annum on the amount invested.

The improvements and radical departures during the past ten or fifteen years, from old practice in the manufacture of machine tools for metal working, have been much greater than in wood working machinery; but recent designs of planers, tenoners, moulding and mortising machines are much heavier and more powerful and will do from 25 to 50 per cent. more work than old machines.

The hollow chisel mortiser is an ingenious and very profitable tool for any shop, and the four and six spindle boring machines are great labor savers. Wood trimmers are most valuable additions to the equipment of cabinet or pattern shops, and the new pattern and corebox machines will easily earn 100 per cent. on their cost if used one hour a day.

In figuring the earnings of the "up-to-date" tools in the above example, only average results have been taken and not special cases of unusual savings. No credit has been allowed for the scrap value of old machinery thrown out, nor have we considered the saving in shop room due to the use of more efficient tools; and last, but not of least importance in railroad work, is the reduction in the number of days locomotives must be held out of service for repairs, which will follow the use of up-to-date machinery.

In a certain shop which makes general repairs to about 160 locomotives a year the average length of time required to put each engine through the shop was reduced from 34 days in 1898 to 30 days in 1900. This represents a saving of 640 days for one locomotive, which, at a rental value of $10.00 a day, gives $6,400.00. As this was done with the addition of only a few new machines in a shop full of old and worn out tools, many of which had been in service from 25 to 35 years, you can readily understand how much greater saving could be effected had the shop been fully equipped with up-to-date machinery.

THE METRIC SYSTEM—A PROTEST.

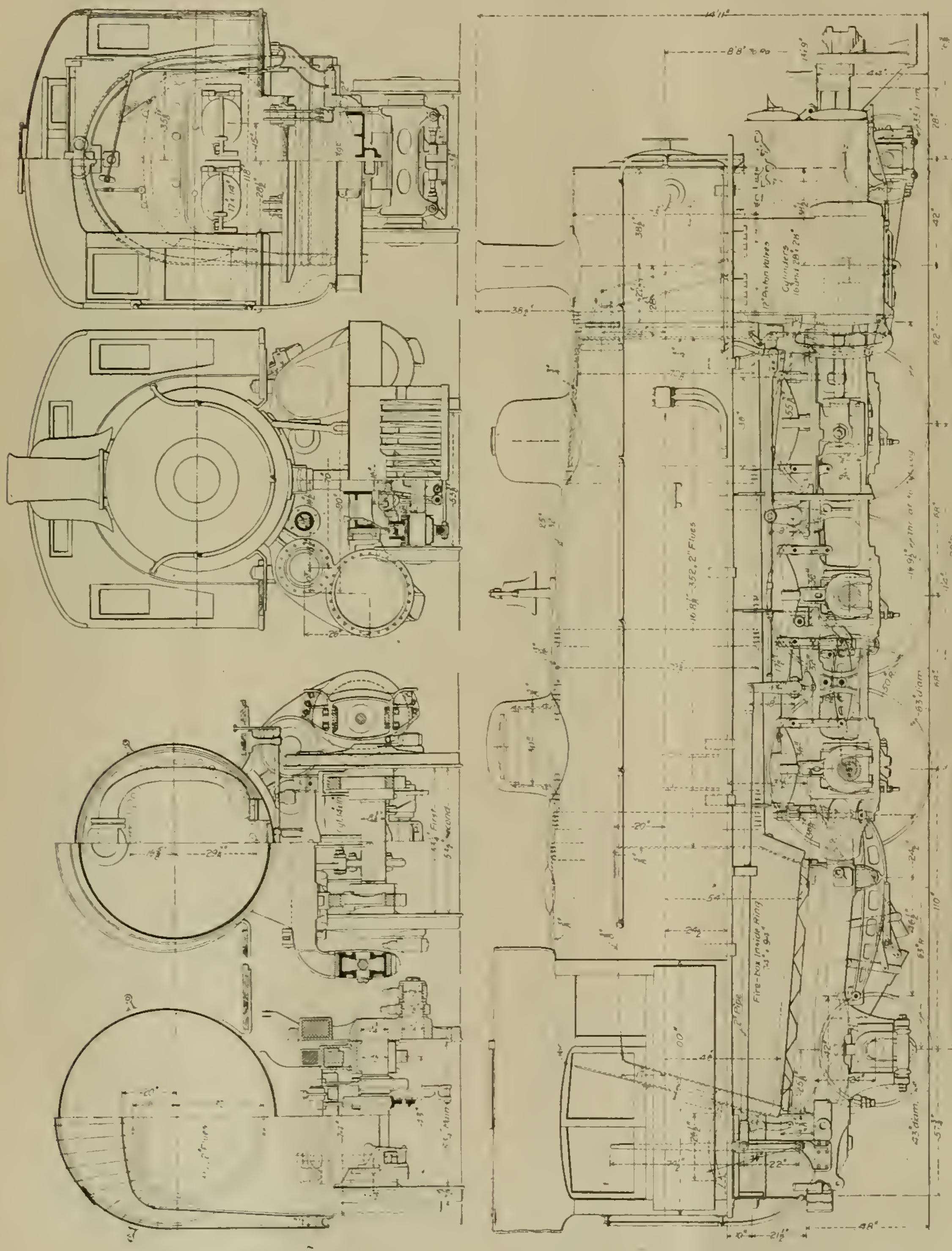
The executive committee of the American Society of Mechanical Engineers has issued, in the form of a circular letter to all members, the report of its committee on the metric system. The report is signed by Messrs. Coleman Sellers, Coleman Sellers, Jr., George M. Bond, J. E. Sweet and Charles T. Porter, and is strongly against the compulsory adoption of the metric system in this country. Members are earnestly urged to address their respective representatives in Congress and to protest against the pending legislation in that direction. It is pointed out that the metric or French system is now legal, and its use is optional, while, if the bill now before the House is passed it will be illegal to use in the United States pounds and tons, yards, feet and inches, and gallons, as measures.

EXPERIMENTS ON SPIRAL SPRINGS.

Typographical Error.

On page 85 of our March number a typographical error occurred which we regret exceedingly. In the paper by Messrs. Benjamin and French, near the middle of the second column on that page the formulæ should read:

$$P = \frac{Sd^3}{2.55D} \text{ and } x = \frac{LDS}{Gd}$$



"Lake Shore" Type Tandem Compound Freight Locomotive—Chicago Great Western Railway.

Mr. D. Van Alstine, *Superintendent Motive Power.*

American Locomotive Company, Brooks Works, *Builders.*

"Lake Shore" Type Tandem Compound Freight Locomotive—Chicago Great Western Railway.

"LAKE SHORE" TYPE TANDEM COMPOUND LOCOMOTIVE.

Chicago Great Western Railway.

For Freight Service.

These engines, built at the Brooks works of the American Locomotive Company, are very heavy examples of the "Lake Shore" or "Prairie" type, and are particularly interesting because of the use of tandem compound cylinders with a novel arrangement of the support of the guides, whereby the packing of the low pressure pistons may be reached quickly and conveniently. With the exception of the 10-wheel compounds built in 1900 for the Lehigh Valley, these engines are the heaviest of the six coupled type that we have in our record. They are heavier by 1,700 lbs. than the new Sante Fe prairie type engines (American Engineer, December, 1901, page 373), and the fact that they are tandem compounds, from the Brooks Works, renders them specially worthy of interest. These works had early experience with this type of compound, and have embodied their experience in this design.

Unlike the Lake Shore and Santa Fe engines, the main wheels of this design are the third pair, which gives a long main rod. With 63-in. drivers the wheel base is 29 ft. 2 ins. and the length of tubes but 16 ft. 9 ins. Thus the difficulties in connection with this type are greatly reduced by the size of the driving wheels. The center of the boiler is 8 ft. 8 ins. above the rail. As these engines are to be used in bad water districts the boiler design was considered with special care, the boiler being constructed in accordance with the views and experience of Mr. Van Alstine, who prefers good circulation and large water spaces to the maximum possible amount of heating surface. For this reason the tubes, which are 2 ins. in diameter, are spaced at 2 29-32-in. pitch. Four-in. water spaces are provided at the mud ring, which is of cast steel, and from a height of 12 ins. above the mud ring the length of the stay bolts increases to a length of 7 ins. at the crown. In making the mud ring of cast steel advantage was taken of the opportunity of using deep lugs at the ends for attaching the plates to support the back end of the boiler. These works are now making mud rings with cast steel ends welded to wrought sides.

Cast steel motion bars connect the links with the rockers, the attachments being made with forks with long bearings to give direct stresses. The links and rockers are of cast steel, and also the brake hanger brackets. The guide yokes have large cast steel brackets, similar to those of the Lake Shore engines. The leading truck has long three point hangers and coil springs with curved yokes, the trailing trucks being Player's patent, of the radial type.

In the side elevation and sectional views through the guides the ingenious curved steel castings for supporting the front ends of the guides may be seen. These arms carry the guides clear of attachment to the rear cylinder heads and permit of pulling these heads and the low pressure pistons back far enough to reach the packing rings with no difficulty. This is a bold construction, which is worked out in an attractive manner. If it does not develop structural weakness it offers the simplest and most convenient method of dealing with the chief difficulty in the tandem arrangement of cylinders. For packing the piston rods between the cylinders reversed vibrating cups are used. Enlarged wheel fits for crank pins and axles are a feature of this design. The main driving journals are 9½ by 12 ins., and the others 9 by 12 ins. In the spring rigging several adjustable ball spring hangers are used. These will be convenient in adjusting the spring rigging.

Twenty of these fine engines are now being built, with a larger number in prospect. Further references to the cylinders and other special features of these engines will be made in a future issue. The following table gives the chief dimensions:

"LAKE SHORE" TYPE TANDEM COMPOUND FREIGHT LOCOMOTIVE, CHICAGO GREAT WESTERN RAILWAY.

Gauge	4 ft. 8½ ins.
Kind of fuel to be used	Illinois and Iowa bituminous coal
Weight on leading wheels	28,400 lbs.
Weight on driving wheels	133,200 lbs.
Weight on trailing wheels	30,100 lbs.
Weight on total	191,700 lbs.
Weight on tender loaded	120,000 lbs.

General Dimensions.

Wheel base, total of engine	29 ft. 2 ins.
Wheel base, driving	11 ft. 4 ins.
Wheel base, total engine and tender	54 ft. 2¼ ins.
Length over all, engine	40 ft. 11 ins.
Length over all, total engine and tender	64 ft. 9 ins.
Height, center of boiler above rail	8 ft. 8 ins.
Height of stack above rail	14 ft. 11 ins.
Heating surface, firebox	179 sq. ft.
Heating surface, tubes	3,071 sq. ft.
Heating surface, total	3,250 sq. ft.
Grate, area	48.5 sq. ft.

Wheels and Journals.

Wheels, leading, number	4
Wheels, leading, diameter	36 ins.
Wheels, driving, number	6
Wheels, driving, diameter	63 ins.
Wheels, trailing, number	2
Wheels, trailing, diameter	42 ins.
Material of wheel center, Driving wheels, cast steel; trailing wheels, cast iron.	
Type of leading wheels	Standard
Type of trailing wheels	Improved radial axle
Journal, leading axles	6 x 12 ins.
Journal, leading axles, wheel fit	6 ins.
Journal, driving	9½ x 12 ins.
Journal driving axle wheel fit, 9¾ ins.; main, 9½ ins.; front and second	

Journal, trailing	7 x 12 ins.
Diameter trailing wheel fit	6⅞ ins.

Cylinders.

Cylinder, diameter high pressure	16 ins.
Cylinder, diameter low pressure	28 ins.
Cylinder, stroke	28 ins.
Piston rod diameter	4 ins.
Main rod, length center to center	11 ft. 0 in.
Steam ports, length	29.2 ins.; H. P. and L. P.
Steam ports, width	2 ins. H. P.; 2⅛ ins. L. P.
Exhaust ports, least area	100 sq. ins.
Bridge, width	3¼ ins. H. P., 2¾ ins. L. P.

Valves.

Valves, kind of	Improved piston valves
Valves, greatest travel	5¼ ins.
Valves, steam lap	H. P. inside 1 in., L. P. outside 1⅛ ins.
Valves, exhaust clearance	H. P. outside 0 in., L. P. inside ¼ in.
Lead, in full gear	H. P., 1-16 in.; L. P., 1-16 in.

Boiler.

Boiler, type of	Radial stayed wagon top.
Boiler, working pressure	200 lbs.
Boiler, thickness of material in shell	¾ in., 25-32 in., 13-16 in., ⅝ in., 9-16 in.
Boiler, thickness in tube sheet	¾ in.
Boiler, diameter of barrel front	70⅛ ins.
Boiler, diameter of barrel at throat	79⅝ ins.
Seams, kind of, horizontal	Butt sextuple
Seams, kind of, horizontal	Triple
Dome, diameter inside	30 ins.

Firebox.

Firebox, type	Wide
Firebox, length	96 ins.
Firebox, width	74 ins.
Firebox, depth, front	74 ins.
Firebox, depth, back	63 ins.
Firebox, material	Steel
Firebox, thickness of sheets, Crown, ⅜ in., tubes, ⅜ in., side,	⅜ in., back, ⅜ in.
Firebox	Brick arch on water tubes
Firebox, mud ring width	Front, 4 ins., sides, 4 ins., back, 4 ins.
Firebox, water space at top	Sides, 7 ins., back, 6 ins.
Grates, kind of	Rocking
Tubes, number of	352
Tubes, material	Charcoal iron
Tubes, outside	2 ins.
Tubes, thickness	11 B. W. G.
Tubes, length over tube sheets	16 ft. 8⅞ ins.

Smoke-box.

Smoke-box, diameter outside	73 ins.
Smoke-box, length from tube sheet	66½ ins.

Other Parts.

Exhaust nozzle, single or double	Single
Exhaust nozzle, variable or permanent	Permanent
Exhaust nozzle, diameter	5¾ ins.
Exhaust nozzle, distance of tip below center of boiler	2 ins.
Netting, wire or plate	Wire
Netting, size of mesh or perforations	2½ x 2½ ins.
Stack, straight or taper	Taper
Stack, least diameter taper	15 ins.
Stack, greatest diameter taper	17 ins.
Stack, height above smoke-box	3 ft. 2½ ins.

Tender.

Type	Eight wheel steel frame
Tank, type	Water bottom
Tank, capacity for water	6,000 gal.
Tank, capacity for coal	12 tons
Tank, material	Steel
Tank, thickness of sheets	¼ in.
Type of under frame	Steel channel
Type of trucks	B. W. all metal trucks
Type of springs	Elliptic
Diameter of wheels	33 ins.
Diameter and length of journals	5 ins. x 9 ins.
Distance between centers of journals	5 ft. 6 ins.
Diameter of wheel fit on axle	5⅝ ins.
Length of tender over bumper beams	22 ft. 1½ in.
Length of tank inside	20 ft. 6 ins.
Width of tank inside	9 ft. 10 ins.
Height of tank, not including collar	5 ft. ½ in.
Type of draw gear	Dayton

Special Equipment.

Brakes	American and Westinghouse
Pump	9½ ins.
Sight feed lubricator	Michigan
Safety valves	Ashton
Injectors	Hancock and Ohio
Springs	French

Mr. John P. Green, first vice-president of the Pennsylvania Railroad, said at the fifty-fifth annual meeting of the company that the business of the road had outgrown anything that could have been foreseen. It was now necessary to order about 19,000 cars and 260 locomotives. The car required to-day no longer costs from $500 to $600. Fifty-ton steel cars and cars with steel underframes are now required. These cost from $1,000 to $1,100. The style of engine which formerly cost from $8,000 to $9,000 must be replaced by machines which cost from $16,000 to $18,000. The company is thus brought face to face with an expenditure of $25,000,000 for additional equipment. The Pennsylvania Company recently approved of the issue of $50,000,000 3½ per cent. gold bonds, convertible into capital stock at $70. Of this amount $24,000,000 is to be used in buying engines, $[illegible]0,000,000 for real estate and the construction of the New York tunnel and terminal, and $5,000,000 for general corporate purposes. The bonds are to mature in ten years.

A NEW HIGH PRESSURE BALANCED SLIDE VALVE.

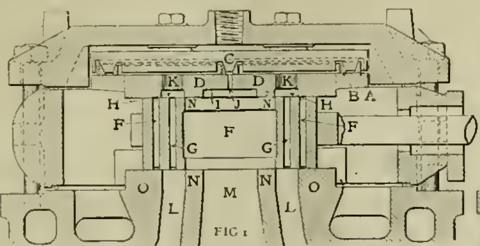
The purpose of this valve, which has just been developed by Mr. J. T. Wilson, president of the American Balance Slide Valve Company, is to furnish a slide valve which will work easily under pressures as great as 250 lbs., and it embodies other important features.

The imperfection in the balancing of the slide valve has been due to the fact that, at different points in its stroke, the pressure on its back varied. In this valve this has been overcome by varying the balanced area to suit the changed condition of the valve at the different points in its travel, thereby balancing the valve under its heaviest pressure, as well as its lightest, and thus maintaining a uniform frictional contact between the valve and its seats, which is just sufficient to form steam-tight joints.

The valve itself, which is very light, is the only moving part, and as the seat is so proportioned that, at the shortest cut-off, the valve travels to the edge of the seat, the valve and the seats should wear straight. The packing forming the balance for the valve is stationary and is, therefore, not subject to wear. This construction may be applied to inside as well as outside admission.

Fig. 1 is a cross sectional view of the valve and balancing arrangement in position in the steam chest; the valve in its central position on the seat. Fig. 2 is a longitudinal section. Fig. 3 is a broken face plan of the steam chest cover, with the cone plate in position on the cover, and half plan of balance plate over the cone plate. Fig. 4 shows the valve at beginning of admission. Fig. 5 shows the valve in the open position, and Fig. 6 shows it at the beginning of exhaust opening.

In Fig. 1 E is the valve. It is open clear through, and is alike on both faces. F and G are slots, or passages, through the valve to give free passage of steam from pocket H, in the balance plate, to the cylinder port, so arranged that communication is always maintained between pocket H and the cylinder port. D is the balance plate. Its face is a duplicate of the valve seat, and is set in direct alignment over the seat. The valve being alike on both faces, the back of the valve operates against the face of the balance plate in unison with the face of the valve against the valve seat. The back of the balance plate is a flat surface, against which the balancing packing forms a steam tight joint. The balance plate rests loosely on the valve, and is free to lift ⅛ in. It is held central by a self-adjusting, double taper, cast iron ring, the lugs on the cover being safety stops. A cone plate C is fastened to the steam chest cover. It contains three cones—the rings fitting these cones form the balance for the valve. The main ring A is the balancing ring. The two small rings B are beveled on the outside to withstand pressure from within, and these rings perform the change in the balanced area. By referring to Fig. 4 it will be noted that steam is being admitted to the cylinder port at one face of the valve and to the pocket port H, in the balance plate, by the other face of the valve. From the pocket H it passes through the passage K into the interior of one of the rings B, and counteracts the upward pressure of the steam in the port. At the same time it passes through passage F and the valve into the cylinder port, giving double admission to the cylinder. The interior of the small rings B are in communication with the cylinder ports at all times, there being no position of the valve that can cut this communi-



Cross Section of Valve, Balance Plate and Cone Plate in Position in the Steam Chest.

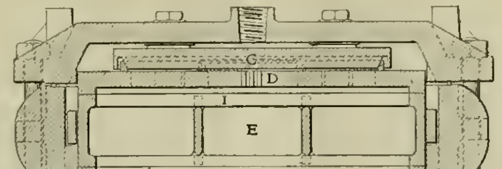
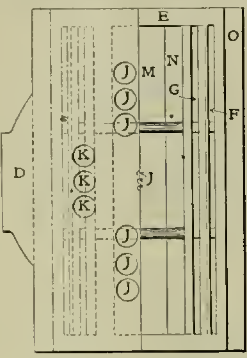
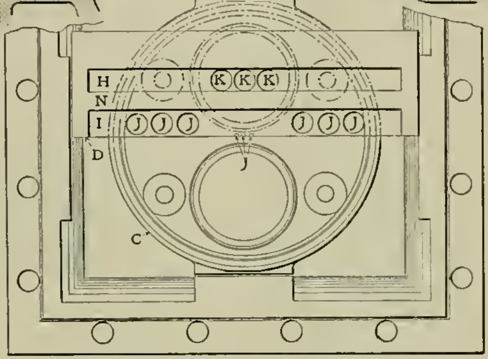


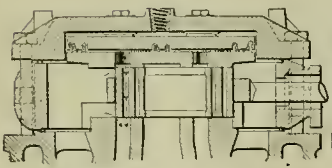
FIG. 2
Longitudinal Section through Valve and Balance in Chest



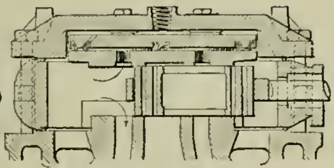
Plan of Valve on Valve Seat and Half Plan of Balnce Plate



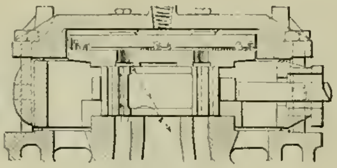
Plan of Steam Chest Cover (Face up) With Cone Plate and Balance Plate in Position.



Valve in Position of Opening, Showing Double Admission of Steam to Cylinder.
FIG. 4



Valve in Position of Wide Open.
FIG. 5



Valve in Position of Exhaust Opening, Showing Double Exhaust of Steam from Cylinder.
FIG. 6

A. E.

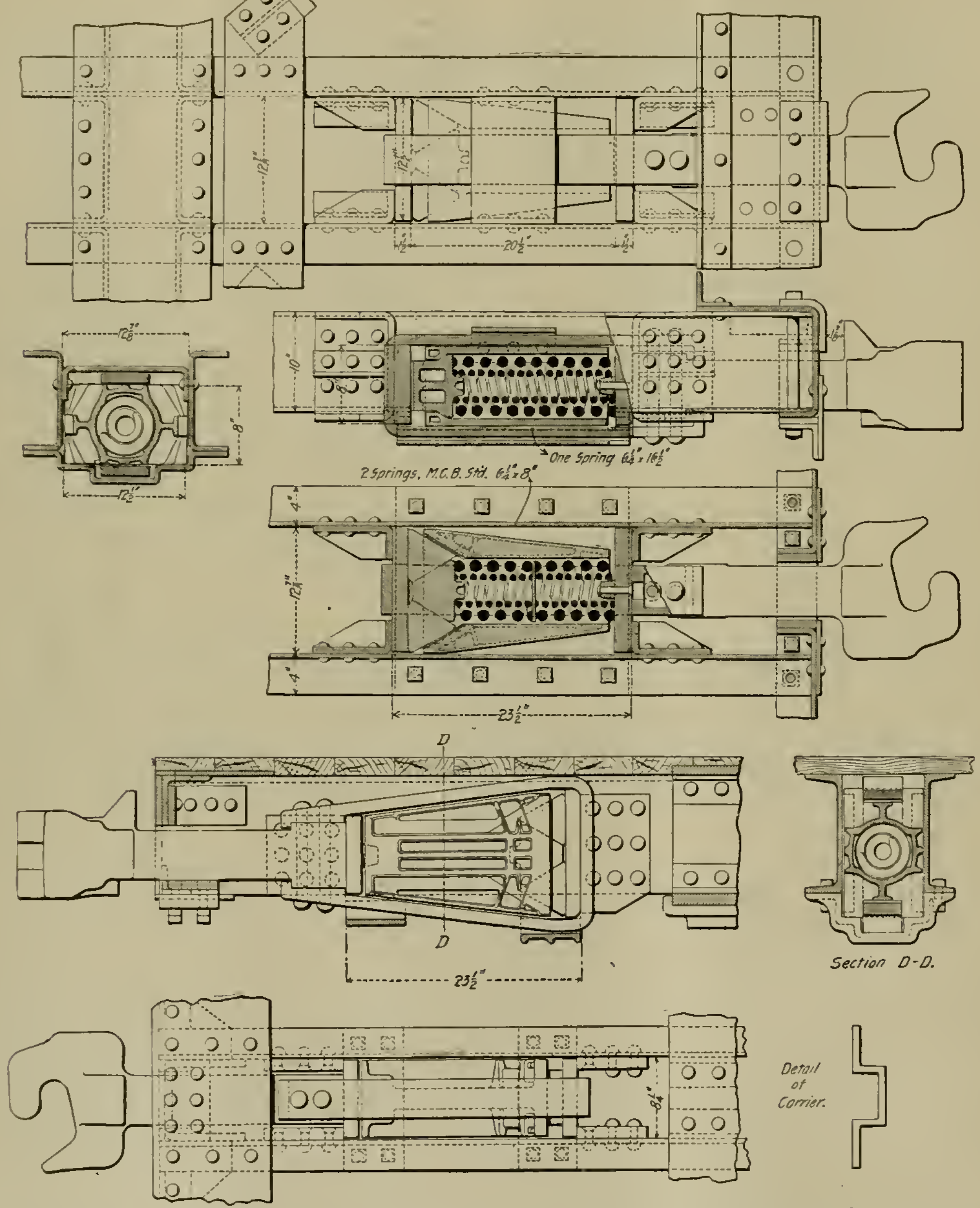
Wilson's New Balanced Slide Valve for High Pressures.

cation off. Therefore, whatever pressure is in the cylinder port is on both faces of that portion of the valve over the port, and is on the back of the balance plate in the interior of the ring B, which in area equals the area of the steam port, thereby neutralizing all pressures in the ports, and the valve is balanced regardless of the pressure in the steam port. In Fig. 5 the valve is shown over the seat on the right. This portion of the valve has pressure on both sides of it, and is, therefore, balanced. In order to correctly appreciate the perfection of balance in this valve we will again refer to Fig. 4, where we find an amount of the valve face equal to the area of the steam port, suddenly balanced by the admission of steam to the port and to the pocket port H. This virtually reduces the size of the valve from its size as shown in Fig. 1, when the whole valve face is on the seat. This reduction in the size of the valve (properly the frictional contact of the valve) is cared for by the reduction of balanced area in equal proportion, and it will be noticed now that the edge of the valve at the right is at the edge of the seat, and that further movement of the valve does not change the area of contact unless the bridge is over traveled more than one-third, which, in this valve, with double openings, is not necessary. In Fig. 6 we find the valve exhausting, and the steam passing out through the passage F at the same time as at the face of the valve, and thus securing the very valuable feature of double exhaust opening.

Valves of the same design are in heavy fast passenger service on the Lehigh Valley Railroad, giving excellent satisfaction. It is now being applied by other large roads, and new locomotives in several modified forms.

It is claimed that this valve is the nearest approach to a perfect balance that has been obtained, while retaining an automatic adjustment for wear, which feature can be considered indispensable for economical and efficient valve service. Other very valuable features are embodied in this design, and the whole combination seems simple and clear, and in service should show a marked improvement in efficiency and durability. Further information may be obtained from the American Balance Valve Company, Jersey Shore, Pa.

Derailments at interlocking plants were discussed at a recent meeting of the Railway Signaling Club in Chicago. The chief cause of such accidents is the usual absence of electric locking, which insures against mistakes of operators, whereby signals may be changed from "all clear" to "stop" indications, and the derails opened in the face of approaching trains. Electric locking prevents this, but the chief objection to it is the difficulty of maintaining electric locks at outlying crossings. A time lock on the home signal levers was suggested as a remedy by Mr. Charles Dunham, signal engineer of the Illinois Central. This device would prevent the operator from changing the signal until a certain time had elapsed after the signal is cleared, and as the same signal controls the opening of the derail, the lock would be a safeguard. The advantage of a time lock is in maintainance, and in this respect the device seems to be worthy of consideration. It can not be as great a protection, however, as a properly maintained electric lock.



The New Sessions Standard Friction Draft Gear for Narrow Sill Spacing.

THE NEW SESSIONS STANDARD FRICTION DRAFT GEAR.

As Applied to Vanderbilt Coal Cars.

This draft gear was illustrated on page 390 of our December number of last year. It is now being applied to the Vanderbilt coal cars for the West Virginia Central & Pittsburgh Railway illustrated in this issue), in an improved form, which is illustrated by these engravings. Without changing in any way the essentials of the device it has been redesigned so that it may be used between sills with a minimum distance apart of 8¼ ins.

This is accomplished by tapering the barrel, and when placed, as shown in the lower views, it will lie between sills with that spacing. When turned, as in the upper engraving, it requires 12⅞ ins., which is usual in steel car construction.

For special cases, therefore, by turning the gear on its edge it will go between sills which are arranged for the M. C. B. gear. When placed in this way the followers are short, and with 1½ in. followers the gear measures 23½ ins. over the followers. This improvement employs all of the features of the original construction, and the flexibility of arrangement is accomplished by changing the shape of the barrel and making the yoke conform to it. The flanges at the small end of the barrel are removed, and the metal is so disposed as to increase the strength. The only additional parts are chafing plates, placed between the barrel and the yoke. A large number of these gears have been sold, but the application to these cars is the first to be made on cars in actual service construction. Further information may be obtained from the Standard Coupler Company, 160 Broadway, New York.

THE WATER QUESTION.

I.

[Editor's Note.—This is the first of several articles prepared specially for the American Engineer by a well-known chemist and engineer who has made a thorough study of this subject.]

The constantly increasing severity of the duties imposed upon the locomotive renders it imperative that conditions for high performance be as perfect as possible. Water of the proper quality for steam raising purposes is a necessary adjunct to good performance.

The water question with railroads is subject to its own peculiar conditions, for a railroad must depend upon the country through which its lines run to obtain feed water. It cannot, as other steam users frequently do, use the fact of the presence of pure feed water as a deciding factor in locating, but must locate watering stations at fairly regular intervals, and where several sources of supply are at hand take that which is best, or, as it might usually be stated, that which is least bad. Owing then to the peculiar conditions of water service to which railroads are subject, we may at once dismiss the question of locating upon a good source of water supply, and must turn our attention to methods having in view the amelioration of objectionable conditions.

Errors of judgment are frequently made in considering the action of various waters in locomotive boilers, due to the fact that most locomotives use water from a number of water stations and a result obtained may not be from the last tank of water drawn, but from a previous one. For instance, suppose a tank of water is drawn at "A," and before this is entirely taken into the boiler a supply is taken from "B." After leaving "B" priming or foaming takes place, but it does not follow that the trouble is caused by water from "B"; it is in fact more than likely that the trouble is due to the concentration of soluble salts in the water from "A," although many engineers would blame the water from "B."

Incrustation or scale, which increases coal consumption and lowers the steaming capacity, is an accumulative evil, and in locomotive boilers is, as a rule, the result of the action of a number of waters.

Corrosion is due to the solvent action of the water or some substance held in solution thereby.

The first question which naturally arises is why does a certain water form incrustation or cause corrosion or foaming. Naturally the best method of finding this out is by careful chemical analysis, and opinion upon this analysis by a competent and, above all, a practical chemist. It is not sufficient that the superintendent of motive power be furnished simply with a string of figures attached to a list of long chemical names, but he should be informed also of the action of the various compounds and substances found in the water.

Chemical names and symbols are frequently confusing, and following are some of the common names of incrusting solids most frequently found and reported in an analysis of boiler feed water:

Chemical Names:	Common Names:
Carbonate of lime or calcium	Chalk, marble.
Carbonate of magnesia	Magnesia (boiler lagging).
Sulphate of lime	Plaster of Paris.
Sulphate of magnesia	Epsom salts.
Silica	Sand

Having then found the substances causing the trouble in the water proper steps must be taken to prevent their action, such as the prevention of the formation of scale or corrosion. Much confusion has resulted when chemical analyses are under consideration, due principally to the different methods adopted by chemists in calculating and reporting analyses. The question of the proper way to combine the various bases and acids found in water is still an open one. Some chemists report bases and acids separately, and simply state so many grains of lime and magnesia, so many grains of sulphuric acid, and so many of chlorine, thus shirking all responsibility and leaving to the one who receives the analysis the task of making the combination to suit himself. The matter of calculating a water analysis is of such importance that it would seem best that some concerted action should be taken by chemists, having in view the adoption of uniform practical methods.

Railroad chemists usually report analyses in grains per gallon. This method is perhaps intelligible to the chemist, but how many men not versed in chemistry know that one grain per gallon is one part in 58,418. "Pounds per thousand gallons" is grasped at once. Grains per gallon are converted into pounds per thousand gallons by dividing by seven. Thus a water containing fourteen grains per gallon of incrusting solids carries into the boiler two pounds of such solids in each thousand gallons of water used. The next subject to be treated is incrustation.

(To be continued.)

BRAKE SHOE TESTS.

Whether a brake shoe, which wears well, is an efficient train retarder, is the question with which Mr. W. H. Stocks, master mechanic of the Chicago, Rock Island & Pacific Railway, dealt in a paper read recently before the Western Railway Club. He tested two kinds of shoes, equipping one side of an engine with one type and the other side with the other. Two engines were so equipped. One shoe, designated "A," was of cast iron with two curved inserts of very hard white iron on the outer tread-bearing portion, and three similar inserts on the portion covering the wheel flange, the center portion over the limits of rail wear being cut away. The shoe designated "B" was cast iron, with four crucible cast-steel inserts arranged along the outer tread-bearing portion, and three disposed along the flange groove. The shoe was recessed over the limits of rail wear, and was heavily chilled on its beveled ends. The "B" shoe showed such superior wearing qualities that its frictional efficiency as a train retarding agent was seriously doubted. This led to further tests with dynamometer car attached. Two stops were made with each set of driving shoes at 40, and two at 65 miles per hour. The conclusions drawn were that from a frictional standpoint there was practically no difference between them. As regards durability, the "B" shoe had three and a half times the life of the "A" shoe. It was 12½ per cent. heavier, which slightly reduces its advantage, but at the same price per pound it must be more economical of the two. No accurate data exist as regards the tire-dressing qualities of the shoes, but the opinion of those concerned appears to be that the "B" shoe is in this also superior.

B. M. Jones & Co., representatives of Taylor Brothers & Co., of Leeds, England; Samuel Osborn & Co., of Sheffield, and other firms, have removed their Boston office to 159 Devonshire street.

Mr. John H. Allen has been appointed manager of the Chicago office of the Standard Railway Equipment Company, with headquarters in suite 707, Great Northern Building. He succeeds Mr. H. V. Kuhlman, who has resigned to engage in other business. Mr. Allen will direct the company's affairs in Chicago in the sale of Monarch Pneumatic tools and Murphy car roofs.

The manufacture of pinions for street railway motors by the pressing process has been accomplished in Brooklyn. The object is to secure toughness and durability superior to the usual cut gears. Dies are used, and pinions are pressed out of cylindrical billets by a 500-ton press. It is stated that by this process a high carbon, hard steel may be used. Thus far the process has been applied only to pinions.

PERSONALS.

Mr. H. H. Vaughan has been appointed Assistant Superintendent of Motive Power of the Lake Shore & Michigan Southern Railway. He succeeds Mr. H. F. Ball, formerly Mechanical Engineer, who has been promoted to the position of Superintendent of Motive Power. Mr. Vaughan thus occupies a new position on this road, and while he will act as Mechanical Engineer, the duties of the office fully justify the broader title. Mr. Vaughan was educated in a technical college in London, being an Englishman by birth. He entered railroad service in this country as a machinist on the Great Northern Railway in 1891, and soon became mechanical engineer under Mr. Pattee, at St. Paul. While in this position he designed and patented among other things, the engineer's brake valve, which was adopted by the New York Air Brake Company. In 1897 he was appointed Mechanical Engineer of the Philadelphia & Reading, and about two years later took charge of the manufacturing interests of the Q. & C. Company in Chicago, which was afterward absorbed by the Railroad Supply Company. In this capacity he has made a special study of pneumatic tools, and also has designed a number of machine tools and automatic machines. In all this work he has found time to write for the American Engineer, and his masterly analysis of the investigations on the subject of locomotive stacks and nozzles, published by us in connection with the American Engineer Tests on Locomotive Draft Appliances, is undoubtedly his most important work in this direction. He combines in an unusual degree, engineering knowledge, mechanical and investigating ability with a good business experience, and is one of the kind of men greatly needed by railroads. The Lake Shore is to be congratulated upon this important addition to its mechanical staff, and Mr. Vaughan is fortunate in having an opportunity to join that staff.

Mr. C. H. Hogan, master mechanic New York Central & Hudson River, of East Buffalo, N. Y., has been appointed master mechanic of the River division of the West Shore, with headquarters at New Durham, N. J., to succeed Mr. E. A. Walton, promoted, and Mr. J. O. Bradeen has been appointed master mechanic at East Buffalo, to succeed Mr. Hogan. Mr. W. J. McQueen has been appointed assistant master mechanic of the Hudson, Harlem and Putnam divisions of the New York Central, with headquarters at Mott Haven, N. Y.

Mr. George Gregg has been appointed master mechanic of the Chicago & Alton at Bloomington, Ill., to succeed Mr. V. B. Lang, who has resigned to become master mechanic of the Alabama Great Southern, with headquarters at Birmingham, Ala., succeeding Mr. W. N. Cox, resigned.

Mr. H. G. Hudson, master mechanic of the "Big Four" at Mount Carmel, has been transferred to the same position on the Michigan division, with headquarters at Wabash, Ind. He succeeds Mr. G. Wirt, who is transferred to Delaware, O., to succeed Mr. M. Rickert, resigned.

Mr. W. H. White has been appointed acting purchasing agent of the New York, New Haven & Hartford, with headquarters at New Haven. For twelve years he has been chief clerk of the department, and succeeds Mr. H. A. Bishop, resigned.

Mr. J. S. Goddard has been appointed chief draftsman of the Chicago, Burlington & Quincy to succeed Mr. C. B. Young, who was recently promoted to the position of mechanical engineer. Mr. Goddard is a graduate of the University of Michigan.

Mr. Tracy Lyon has been promoted from the position of general superintendent to that of assistant general manager of the Chicago Great Western. Mr. G. A. Goodell has been appointed general superintendent to succeed him.

Mr. F. A. Torrey has been appointed master mechanic of the Chicago, Burlington & Quincy at Creston, Ia., to succeed Mr. E. Jones, who has resigned.

Mr. David Patterson has been appointed division master mechanic of the Gulf, Colorado & Santa Fe at Raton, N. M., to succeed Mr. C. M. Taylor, promoted.

Mr. T. B. Purves, superintendent motive power of the Boston & Albany, after April 1 will transfer his headquarters from Springfield to Boston.

Mr. I. N. Funk has been appointed acting master mechanic of the "Burlington" at Ottumwa, Ia., to succeed Mr. F. A. Torrey, promoted.

THE 20,000TH BALDWIN LOCOMOTIVE.

The Baldwin Locomotive Works celebrated the building of their 20,000th locomotive, February 27, by a banquet at the Union League Club, Philadelphia. It was a notable occasion. The guests included many men whose achievements have made them famous. At the table of honor were the following: E. H. Harriman, William P. Henszey, George F. Baer, Alexander J. Cassatt, John H. Converse, Wayne MacVeagh, Stuyvesant Fish, Geo. Westinghouse, Jr., J. Harris Sanders, Joseph G. Darlington, Clement A. Griscom, Thomas Dolan, James M. Beck, Charles Smith, Edward Longstreth, William Sellers, John G. Johnson, Bishop Cyrus D. Foss, Col. Alex. K. McClure, Robert Adams, Jr., Capt. John P. Green, P. A. B. Widener, William L. Elkins, Frank A. Vanderlip, Edward Atkinson, Samuel H. Ashbridge, Charles A. Dickey, D. D., Samuel R. Callaway, George S. Webster, Joseph L. Caven, Robert C. Lippincott; and in all, the guests numbered 263. The banquet hall was beautifully decorated with flowers, and the arrangements were perfect. The speakers were:

George F. Baer, "Industries of Pennsylvania."
John P. Green, "The Pennsylvania Railroad."
Stuyvesant Fish, "Aristocracy and Democracy."
James M. Beck, "Unity of the Republic."
J. Harris Sanders, "American Development from an English Standpoint."

Throughout, the addresses were admirable, constituting a tribute to railroads, and particularly to the locomotive, for its part in the development of the country. No one attending this pleasant assemblage could fail to better appreciate the locomotive, or fail to be deeply impressed by the part taken by the Baldwin Locomotive Works in its development.

Mr. J. F. Deems, who has just retired from the position of superintendent of motive power on the Chicago, Burlington & Quincy Railroad, to become general superintendent of the American Locomotive Company's plant at Schenectady, N. Y., was recently tendered in Aurora a flattering testimonial from his former subordinates. The gift to Mr. Deems was a gold watch, Elgin make, of railroad pattern, but the significance of the presentation lay in the expression of genuine love and esteem which his parting with those who had worked under him evoked. The former superintendent of motive power was most deservedly popular, because of his ability to know his men, and with all the departmental routine and official intercourse, which is inseparable to the discharge of his duties, he had reached below the surface and had found the human side of those with whom he worked. As showing his personal sympathy, he said in his reply after the presentation: "If I have in any way made easier the rough pathways of life, if I have gained your friendship and confidence and respect, I feel that I have accomplished something in life, and am satisfied."

FIRE DOORS.

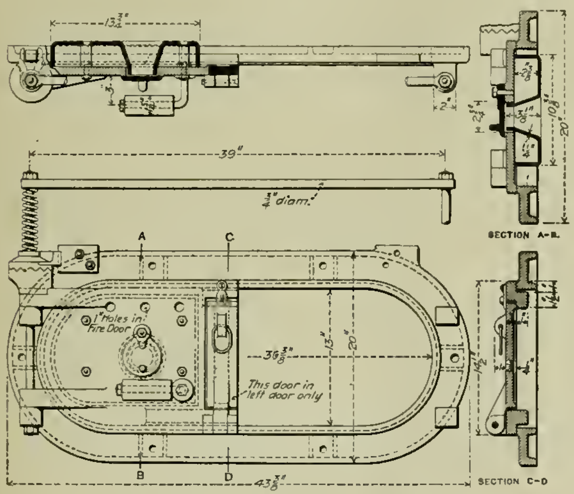
By G. S. Edmonds.

In one of the recent editions of a technical publication attention is pointedly called to the amount of experimentation and thought given the subject of steam distribution, as governed by cylinders and valve motion, of the locomotive, to the almost total neglect of its generation in the boiler.

The February number of the American Engineer makes the statement, "there must be something about the wide grate that is not fully understood."

This, as a basis for thought, has given rise to this communication, which, while non-affirmative, may be suggestive, and awaken discussion. If it should lead to the alleviation, or, better, eradication of some of the difficulties experienced, with consequent increase in efficiency, its purpose is attained.

A factor of importance with the boiler, but one too often receiving little consideration, is the fire door. If an examination be made of the recent designs governing wide firebox practice, it will be noted in the majority of cases that there are two openings, spaced some 25 to 45 ins. centers, dependent on the width of the grates. It is reasoned as advantageous compared with the single door, because more ready access is had to all parts of the grate surface for both cleaning and firing. With two doors there is less cooling action over the fire surface as a whole, with its consequent advantage as to steam when firing. One side may be taken care of at a time, hence liability of steam going back, when partially cleaning on road, is materially decreased. There are also other claims for two doors.



Locomotive Fire Door—D. & H. Co.

Realizing the direct bearing of that variable quantity, "personal element," on the efficiency, does it, with two doors to open and fire, located as above, decrease the manual energy expended, as compared with the single divided door, when the major portion of the fire can be readily controlled with either the right or left half?

As to cleaning, when partially so doing on the road, assume that the right section of the fire first receives attention. This door is opened, the fire shaken, dead spots repaired and recoaled. Meanwhile cold air has been entering. Follow its course, and it will be found that the action on the tube sheet is felt on an area the center of which lies relatively near the outer row of flues. The remaining portion of the sheet is kept at the same temperature as before, the left-hand division of the fire being as yet untouched. Does not this alternate cooling, unevenly distributed over the tubes by the double opening, have a greater detrimental effect than where, as is the case with the single door, its influence more nearly affects the sheet as a whole, radiating from its center? Furthermore, do not such conditions exist in a minor degree during the entire period of firing?

Experience teaches, more forcibly with hard coal, that during this period of road cleaning the steam drops back, possibly to a greater extent with the single door, inasmuch as work is done over a larger portion of the grate. To obviate this why not reduce the air inlet during this period to a minimum. This has been done by means of the door shown in this sketch, and is being experimentally tried on the road with which the writer is connected.

For the removal of dead spots and air holes (which, in passing, it may be noted, are often caused by rigid adherence to the accepted practice of 45, or thereabouts, per cent. of air opening in grates, rather than in accordance with the grade of fuel), as well as cleaning of the fire, the right-hand half of the door is opened, the rake inserted in the opening made by dropping down the small center door. The area for admission of air is in this manner reduced to some 10 by 2¾ ins., the importance of which is best known by the fireman, when the fire begins to die in spots on a grade, with a heavy freight, or fast passenger, a drop of steam meaning either stalling or loss of time.

Considering the end of the run, if the coal is poor (and few roads receive near relations of the cannel product) a slaggy accumulation is formed. With a single opening approximating 13 by 36 ins., is not the opportunity for readily removing this debris much better than with the two doors of 16 or 17 ins. diameter? Further, should not the deleterious effect on flues already noted be decreased, for the reason previously mentioned, viz., more equal distribution of cold air on the sheet, and less time during which the door is open for its admission?

PENSION SYSTEM, METROPOLITAN RAILWAY, NEW YORK.

Mr. H. H. Vreeland, president of the Metropolitan Street Railway of New York, has announced the plan of a pension system for that road, which will affect all employees whose annual wages do not exceed $1,200. The company has 15,000 employees.

This pension system provides for voluntary and involuntary retirement of all employees so included between the ages of sixty-five and seventy after twenty-five years' service in the Metropolitan Street Railway Company or any of its constituent companies. Employees benefited by the system will be of two classes.

First—All employees who have attained the age of seventy years, who have been continuously in such service for twenty-five years or more preceding such date of maturity, and

Second—All employees from sixty-five to sixty-nine years of age who have been twenty-five years or more in such service who, in the opinion of the trustees of the pension, have become physically disqualified.

All employees of seventy years will be considered to have attained a maximum age allowed for active service, and will be retired by age limit, while those whose ages range from sixty-five to sixty-nine may, upon examination, be retired under pension if found incapable. The pension allowance to such retired employees shall be upon the following basis:

(a) If service has been continuous for thirty-five years or more, 40 per cent. of the average annual wages for the ten previous years.

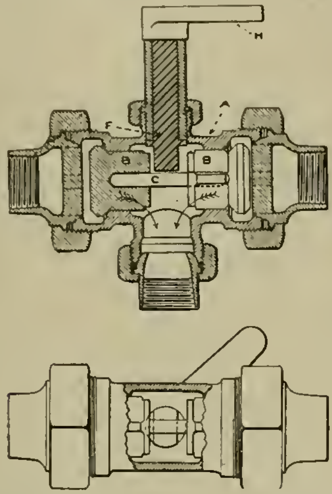
(b) If service has been continuous for thirty years, 30 per cent. of the average annual wages for the ten previous years.

(c) If service has been continuous for twenty-five years, 25 per cent. of the average annual wages for the ten previous years.

The fund from which payments will be made will be appropriated each year by the company, and employees will not be required to contribute to it.

LUNKENHEIMER AUTOMATIC LOCOMOTIVE CYLINDER COCK.

The new Lunkenheimer automatic cylinder cock for locomotives consists of a valve casing, A, which contains two wing valves, B B, which are connected together by a loose pin, C. The valves, B B, open and close alternately as steam is admitted or exhausted through the opposite ends of the cylinders, to which the inlets of the cock are connected. In this manner the device is in constant operation, relieving the cylinder of condensation.



Lunkenheimer Automatic Locomotive Cylinder Cock.

The stem, F, is operated from the cab by means of a lever. When the stem, F, is placed in its central position, both valves, B B, are held off their seats at the same time, and the water of condensation will be drawn off from both ends of the cylinder. The Lunkenheimer Company, of Cincinnati, Ohio, manufacture this device, and will be pleased to give full information concerning it to those interested.

LOCOMOTIVE CYLINDER CLEARANCE.

Referring to indicator cards published October, 1900, in the American Engineer and Railroad Journal, Mr. Ira C. Hubbell, in a paper before the Railway Club of Pittsburg, stated that the compression there shown was carried considerably above the initial pressure and that excessive back pressure was present, indicating that clearance had been reduced below the point justified by the valve movement, and the locomotive must, therefore, have been operated at a loss. The cylinder clearance in question was 5 per cent. He emphasized the importance of the effect of cylinder clearance upon the economy of the steam engine, locomotive, stationary or marine. In one card, taken at a speed of 75 miles per hour, with drivers turning 319 revolutions per minute at 5-in. cut-off, the lead is 9/32 in., and mean effective pressure, 46.34 lbs. He says the pre-admission was probably not less than 3 ins., and that fact calls for attention to avoid a very serious loss.

Since the first of this year the Atchison, Topeka & Santa Fe has ordered Pintsch lighting equipment for eighty-three cars. Previous to the placing of that order they had seventy-four of their passenger cars equipped with it, so that the total number now gas lighted on the road aggregates 157. The Pintsch Compressing Company are about to erect a Pintsch gas works at Point Richmond, where gas will be manufactured for the road, and a Pintsch supply station will also be established at Barstow, Cal., while a Pintsch gas works has just been completed at El Paso, Tex., where the Atchison cars on that division will be supplied.

The Bullock Electric Company, of Cincinnati, O., has issued a neat pocket calendar for 1902, with twelve illuminated pages, each containing the calendar for the month and the vignette of some master worker in the domain of physics. On the back of every page appears a brief account of the life and work of the twelve distinguished men selected. They are Benjamin Franklin, Michael Faraday, Sir Charles Wheatstone, Hermann Von Helmholtz, Lord Kelvin, Jas. Clerk Maxwell, Henry A. Rowland, Werner von Siemens, Elihu Thomson, John Hopkinson, Gisbert Kapp, and C. E. L. Brown. It is a happy grouping of representative English, American and German men of science.

EQUIPMENT AND MANUFACTURING NOTES.

Mr. C. H. Hogan, Master Mechanic of the Western Division of the New York Central, who was recently transferred to a similar position on the Mohawk Division, was recently presented with a silver set and handsome diamond as a token of the esteem of his recent subordinates. The gift represented $1,500, which was subscribed for the purpose. The gifts were made by the Webb C. Ball Company, of Cleveland.

The O. M. Edwards Company, of Syracuse, N. Y., have established an office and show room in Chicago, located at 501 Fisher Building, which will be in the charge of Mr. Edward E. Silk, as western manager. The increasing business of the company has made it necessary to open a western office, where a complete line of samples and models may be seen. Mr. Silk is well known to our readers as formerly associate editor of this journal.

The Clayton Air Compressor Works, Brooklyn, N. Y., are anxious to correct a statement which has gained currency in some quarters, to the effect that they had sold out and gone out of business. Nothing is farther from the truth. This combine has made no changes that will in any way alter their business relations with their various customers. With new capital they are enlarging their works, and expect to serve their patrons better than in the past, and to give them an advantage in prices on improved machinery and new designs. The New York office is at 120 Liberty street.

The Franklin Manufacturing Company, of which Mr. Chas. S. Miller is president, has acquired the exclusive right to sell the boiler lagging made by the Keasby & Mattison Company, of Ambler, Pa. The Franklin Company will handle this lagging in the United States, Canada, Mexico, South and Central America. It is composed of 85 per cent. pure carbonate of magnesia. The Franklin Company has made a careful, practical and scientific examination of the whole field and has determined that this sectional lagging is of the very highest quality. They have therefore great confidence in putting it upon the market.

The Sargent Company, of Chicago, which has heretofore been operating an open-hearth steel plant for the manufacture of draw-bars, knuckles, coupler parts for repair, and has been working a plant at Chicago Heights, Ill., for the manufacture of Tropenas steel castings and steel and iron brake shoes, has transferred the plant at Chicago Heights, with the business done there, to the American Brake Shoe and Foundry Company, which company will hereafter conduct the business of this department from its office at Chicago Heights. The Sargent Company will continue the operation of the open-hearth steel plant at Fifty-ninth street, Chicago, where its general offices will be located. The Sargent Company is having plans drawn for an extension to its plant which will approximately treble its capacity.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

MAY, 1902.

CONTENTS.

AMERICAN ENGINEER TESTS.

Locomotive Draft Appliances.

VIII.

Report by Professor Goss.

SECTION III.

Methods and Results of Preliminary Investigations.

13. The Preliminary Tests.—It has often been asked whether the draft, as observed from gauges attached to the front end of a locomotive, is in any way affected by changing the point of application of the gauge. The question arises from an appreciation of the intense activity which characterizes the circulation of gases through the front-end. It is evident that, from a theoretical point of view, differences of pressure must exist, for it is in response to these that the flow of the gases is maintained, but whether they are sufficient materially to influence the ordinary forms of draft gauges has, so far as the writer is aware, never been determined. It has not been known whether a gauge attached to the front-end at random can be depended upon to indicate the normal pressure within. The question having frequently been raised, it seemed best, before proceeding with the formal tests, the value of which necessarily depended upon the accuracy with which the draft is measured, to ascertain whether measurable differences of pressure exist, and to secure such information as will permit the selection of a satisfactory point of attachment for the draft gauge. Such an investigation was therefore undertaken under the joint direction of Professor Forsyth and Mr. Reynolds. The conclusions, based on results obtained, are to the effect that, excepting in the immediate vicinity of the exhaust jet, all portions of the front-end between the diaphragm and the front door are substantially at the same pressure. Unless instruments are to be employed having greater accuracy than the ordinary U-tube containing water, it is safe to make the connection for the draft gauge through the shell of the smoke-box at any point which may be most convenient. But connection should not be made behind the diaphragm, for here the pressure varies widely from that in other portions of the front-end. A detailed statement, covering the methods employed in this preliminary work and the results upon which the conclusion stated is based, will not be without interest, and is, therefore, embodied in the remaining paragraphs of this section.

14. Apparatus and Observations.—In investigating the conditions of pressure within the front-end, a considerable number of exploring tubes were employed. These were so fitted that their inner ends could be placed in certain specific positions within the front-end, their outer ends being meanwhile connected with U-tube gauges partially filled with water. The exploring tubes were of 1/4-in. pipe. That the pressure within the tubes might not be affected by the motion of the gases in which they were immersed, the inner end of each tube was filled with a plug, and new orifices were formed by drilling a series of holes through the wall of the tube, all as shown by Fig. 10.

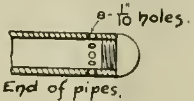


Fig. 10.

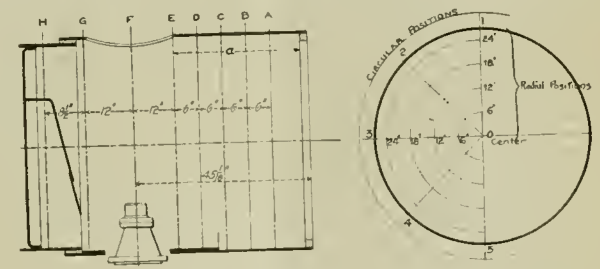


Fig. 11.

As a part of the preparation for the application of the exploring tubes, everything was removed from the front-end excepting the steam pipes, the exhaust pipe and nozzle and the diaphragm, leaving the entire space in front of the nozzle wholly unobstructed. The method followed in applying the exploring tubes to this portion of the front-end, hereafter to be referred to as space a (Fig. 11) may be described as follows: Three exploring pipes, No. 1, No. 2 and No. 3, Fig. 12, were securely fitted within a piece of 1 1/4-in. pipe, the latter serving as a jacket, by means of which the smaller pipes were handled. The front door of the smoke-box was then drilled and a fitting added, through which the 1 1/4-in. pipe might be moved in or out, or turned through any desired angle; graduations on the jacket pipe served to indicate the precise position of the tips of the exploring tubes. The inner end of one tube was thus located at the center of the boiler, that of

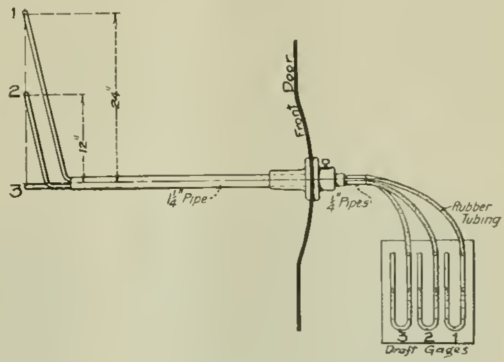


Fig. 12.

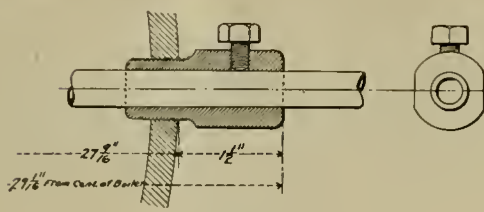
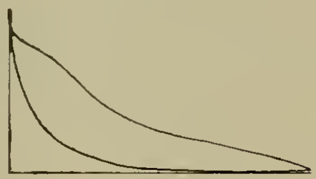
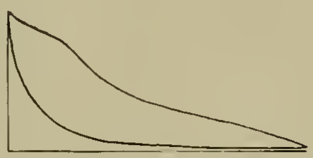


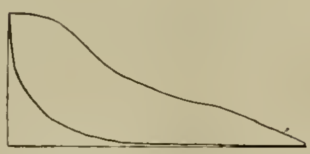
Fig. 13.



40 M. P. H.—194.4 R. P. M.—45.3 Lbs. M E. P.



30 M. P. H.—145.8 R. P. M.—52.3 Lbs. M. E. P.



20 M. P. H.—97.2 R. P. M.—65.9 Lbs. M. E. P.

Indicator Cards One-half Size.

Fig. 14.

another at a radius of 12 ins. from the center, and that of a third at a radius of 24 ins. from the center. Readings were taken on the cross sections A, B, C, D and E (Fig. 11), in the circular positions 1, 2, 3, 4 and 5, and the construction of the apparatus was such as to give readings for the radial positions of 0 in., 12 ins. and 24 ins. from the center. The results thus obtained for speeds of 20, 30 and 40 miles an hour are given in Table 1.

Simultaneously with those just described, observations were also made on Sections F, G and H (Fig. 11), Section F being in line with the exhaust pipe, Section G back of the exhaust pipe, but in front of the diaphragm, and Section H back of the diaphragm. The points within the several sections covered (Fig. 11) were: in Section F, positions 2 and 3; in Section G, position 2, and in Section H, positions 3 and 4. For each position of each section there was employed a separate exploring tube, sliding in a fitting similar to that shown by Fig. 13, each tube being graduated to give the location of the inner end, and having its outer end connected by rubber tubing to an individual draft gauge. Readings were obtained from each of these gauges for the radial positions of 6 ins., 12 ins., 18 ins. and 24 ins. Results thus obtained are presented in Table II.

During this preliminary work the locomotive was fitted with the sectional taper stack No. 4 D, and with exhaust pipe No. 1. (See Figs. 2-4, American Engineer, February, 1902, page 35.) The conditions of running were as follows:

Boiler pressure	180 pounds.
Reverse lever, notches from center forward	5
Revolutions per minute for 20-mile test	97.2
Revolutions per minute for 20-mile test	145.8
Revolutions per minute for 40-mile test	194.4

The power which was developed during the tests may be judged from the sample cards which are given as Fig. 14.

The conditions of running specified were maintained as nearly constant as possible for a period sufficiently long to allow the readings of all gauges to be taken. During this period the several exploring tubes were adjusted in rapid succession from one point to another, readings being secured for each position of each pipe. There were employed in this work several different observers, and it was found that five different readings from the thirty-five different points within the smoke-box could be taken in about twelve minutes' time. All work was several times repeated.

It would be too much to assume that under the conditions described there were no variations in conditions. As a matter of fact, there were slight fluctuations both in steam pressure and in speed, and the draft was undoubtedly affected by these changes. The fluctuations, however, were not greater than 2 per cent. in the case of speed, and were much less than this in the case of steam pressure. So that the variation in draft resulting, while doubtless noticeable, could not have been great.

15. Results of Preliminary Tests.—The average values of the draft, measured in inches of water, for each of the thirty-five different points embraced by the investigation, and for speeds of 20, 30 and 40 miles, are presented in Tables I. and II.

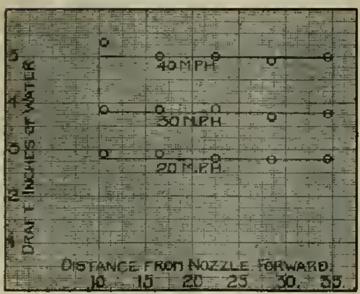


Fig 16.

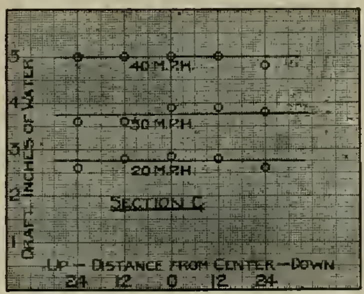


Fig. 17.

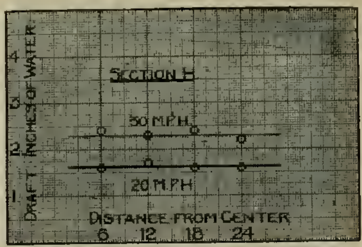


Fig. 18.

TABLE I. Draft io Inches of Water.

Readings in Space a.

Circular Position.	Section.	A.			B.			C.			D.			E.		
	No. of Pipe.	1.	2.	3.	1.	2.	3.	1.	2.	3.	1.	2.	3.	1.	2.	3.
1.	20 m.p.h.	2.6	2.7	2.9	2.6	2.9	2.9	2.6	2.8	2.8	2.6	3.0	2.8	2.7	2.8	2.8
	30 "	3.5	3.6	3.8	3.8	3.9	3.9	3.6	3.6	3.8	3.6	3.6	3.6	3.6	3.7	3.6
	40 "	5.3	5.3	5.4	5.2	5.3	5.2	5.0	5.0	5.0	4.9	5.0	5.0	5.0	5.0	5.0
2.	20 "	2.7	3.0	3.1	2.7	2.8	2.8	2.6	2.6	2.7	2.6	2.8	2.8	2.7	2.7	2.8
	30 "	3.7	3.7	3.8	3.7	3.7	3.9	3.7	3.7	3.8	3.5	3.5	3.5	3.5	3.6	3.7
	40 "	5.3	5.4	5.4	5.0	5.0	5.0	5.0	5.1	5.1	5.0	5.0	4.9	4.9	5.0	5.0
3.	20 "	2.7	3.0	2.9	2.9	2.9	2.9	2.8	2.9	2.8	2.6	2.7	2.8	2.7	2.7	2.7
	30 "	3.7	3.7	3.9	3.7	3.8	3.8	3.7	3.9	3.9	3.4	3.5	3.6	3.7	3.8	3.9
	40 "	5.2	5.3	5.3	4.8	4.8	4.9	5.1	5.1	5.1	4.8	4.9	4.9	4.9	5.0	5.0
4.	20 "	2.7	2.9	2.9	2.8	2.8	2.9	2.8	2.8	2.8	2.7	2.9	2.9	2.7	2.8	2.8
	30 "	3.8	3.9	3.9	3.8	3.8	3.9	3.9	3.9	3.9	3.7	3.8	4.0	3.6	3.7	3.9
	40 "	5.3	5.3	5.3	4.9	5.0	5.0	5.0	5.1	5.0	4.8	5.0	4.9	4.8	5.0	5.0
5.	20 "	2.9	2.8	2.8	2.7	2.9	3.0	2.6	2.8	2.8	2.6	2.7	2.7	2.6	2.7	2.8
	30 "	3.7	3.8	3.8	3.7	3.7	3.7	3.8	3.9	4.0	3.7	3.9	3.9			
	40 "	5.3	5.3	5.2	5.1	5.2	5.0	4.8	5.0	5.0	4.7	4.9	4.9	4.7	5.0	5.1

TABLE II. Draft in Inches of Water.

Readings in Sections F, G and H.

Section.	F.								G.				H.							
Circular Position.	2.				3.				2.				3.				4.			
Radial Position.	1.	2.	3.	4.	1.	2.	3.	4.	1.	2.	3.	4.	1.	2.	3.	4.	1.	2.	3.	4.
20 m.p.h.	3.4	2.7	2.8	2.7	2.8	2.8	1.7	2.7	2.7	2.8	2.5	2.5	1.6	1.7	1.6	1.6	1.6	1.8	1.7	1.8
30 "	4.7	4.1	3.6	3.6	4.7	4.0	3.8	3.5	3.4	3.6	3.5	3.4	2.4	2.3	2.4	2.2	2.3	2.4	2.4	2.4
40 "	5.0	5.0	4.8	4.7	5.1	5.0	4.8	4.7	5.0	4.4	4.7	4.8	3.0	2.5	2.5	2.7	2.8	3.1	2.8	3.2

A study of these data will show that for a given speed all points in front of the diaphragm have almost the same pressure. Variations recorded are generally not greater than 0.1 of an inch, which, under the vibrating conditions of the laboratory, is the limit of accuracy to which draft gauges can be read. Where differences are greater than 0.1 of an inch, they are probably due to accidental causes, since a careful study of them fails to disclose any law which can serve to explain them. A few comparisons will serve to show the general character of the results. For example, the values obtained for the several points between the exhaust pipe and the front door, along the axis of the smoke-box (center position, Sections A, B, C, D and E, Fig. 11), are presented in Fig. 15. With one exception, no point on the diagram varies from the assumed normal draft by more than 3 per cent. The one exception applies to that point in the smoke-box which is but 12 ins. distant from the center of the nozzle. With the low nozzle used, and with allowance for the spread of the jet, this point was not far removed from the edge of the stream of exhaust steam. Notwithstanding this fact, the diagram (Fig. 15) shows that for speeds of 20 and 30 miles the draft is normal at this point. It is only when the power of the engine is made to approach its maximum, as is the case when the speed is increased to 40 miles, that the condition of pressure at the point in question is influenced by the jet.

Again, a comparison of the pressure at several points along a vertical diameter of the smoke-box (Section C, radial positions 6 inches and 18 inches, and circular positions 1 and 5, Fig. 11), is presented by Fig. 16. In this diagram there is one value which departs from the normal value of the group to which it belongs by an amount equal to 0.2 of an inch. There are others showing variations as great as 0.15, the largest percentage difference for the whole diagram being approximately six. Other groups of results have been plotted, but those which are presented are typical of all. They justify the conclusion that while different points in the smoke-box show differences in pressure which are clearly distinguishable, the value of such differences is so slight that it does not seem necessary to take them into account in fixing the location of the draft gauge, except in so far as it indicates that the point of application should not be too near the steam jet. In accord with this view, it was decided that the permanent location of the draft gauge, in the case of the Purdue locomotive, to serve on all future work, might be on a horizontal diameter of the boiler in line with the nozzle at a point quite near the outer shell, or, stating the location more specifically by the aid of Fig. 11, in Section F, circular position 3, radial position 24.

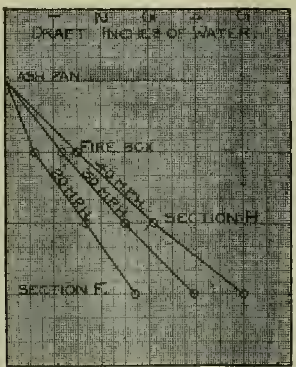


Fig.. 18

The preceding statement concerning the uniformity of pressure within the smoke-box applies to all that portion between the diaphragm, or baffle plate, and the front door. It does not apply to the space behind the diaphragm. In this space the draft is always less than in the main portion of the front-end. How much less will be seen by comparing the values presented in Table II., Sections F and G of the table being in front of the diaphragm and Section H behind the diaphragm. It is worthy of note that the pressure within the space behind the diaphragm is subject to the same degree of uniformity as other portions of the front-end, but as it is an intermediate point, it is evidently not well to employ it as a point of application for the draft gauge.

16. Distribution of Draft.—While the present investigation was designed to concern smoke-box conditions only, it will be of interest to note in what manner the difference of pressure between the smoke-box and the atmosphere is utilized in moving the stream of air and gases against the resistances set in their path. A study of this question was, therefore, made a part of the preliminary tests. The results show that approximately one-third of the total draft is required to move the air from the ashpan into the furnace, another third from the furnace through the tubes, and the remaining third from

the front tube-sheet under the diaphragm and into the main portion of the front-end. A concise statement of the facts is shown by Table III., and a graphical view is shown by Fig. 18.

TABLE III.

Percentage of Total Draft Required.

Speed M.P.H.	To draw air into fire-box.	To draw smoke and gases through flues.	To draw smoke and gases under diaphragm.
20	22.6	41.1	36.3
30	30.1	33.6	36.3
40	30.4	32.0	37.6

The degree of vacuum within the firebox was obtained by connecting a draft gauge with a hollow staybolt. The values for all other points were obtained by means already described. They appear in Tables I. and II.

The statement that the diaphragm offers as much resistance to the forward movement of the air as the tubes, and absorbs approximately one-third of the total draft effect, is too significant to be passed without further comment. It should be noted, therefore, that the adjustable portion of the diaphragm in question was raised to the highest point for which, in the design of the engine, provision had been made. The distance between the lower edge of the diaphragm and the bottom of the smoke-box was 14 inches, and the area of opening under the diaphragm amounted to 430 square inches, or about 83½ per cent. of the total tube area.

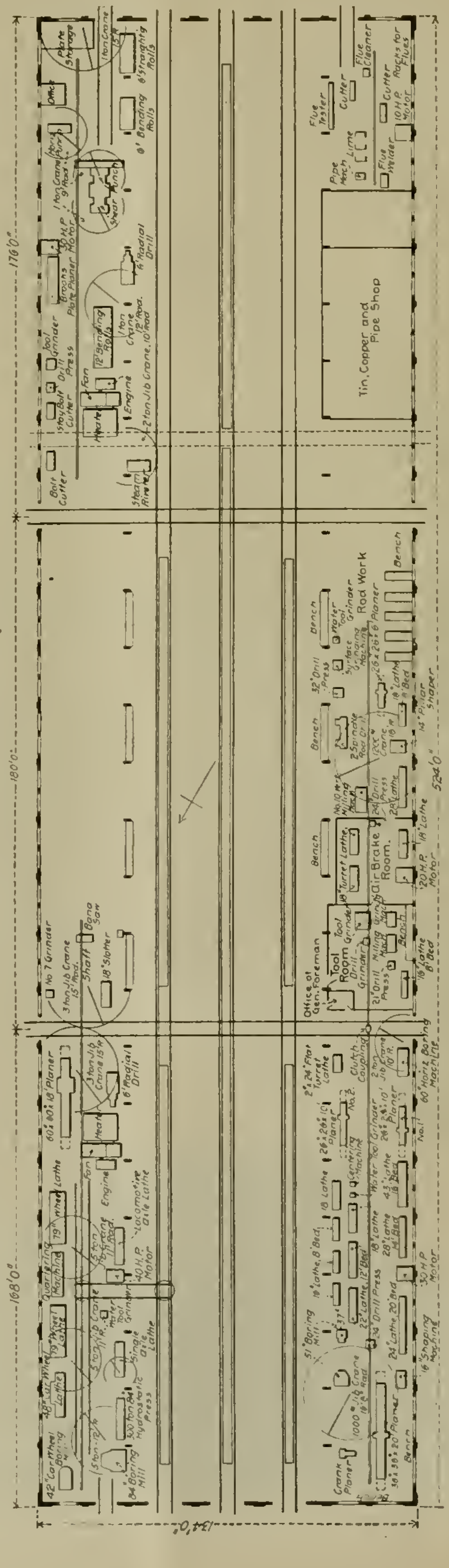
Typographical Errors.

In the February issue, page 35, the diameter of the exhaust tip of the Purdue engine is given as 4½ ins. It should have been 4¾ ins. Also, in the March issue, page 68, in referring to the practice of Purdue in selecting a location for the draft gauge, it was said, "In work previously carried on at Purdue the draft has been obtained by means of a U-tube connecting with a pipe extending into the smokebox just *back* of the diaphragm." It should have been, "In work previously done on *Schenectady No.* 2 the draft gauge has been connected with a pipe extending into the smokebox in *front* of the diaphragm."

(To be continued.)

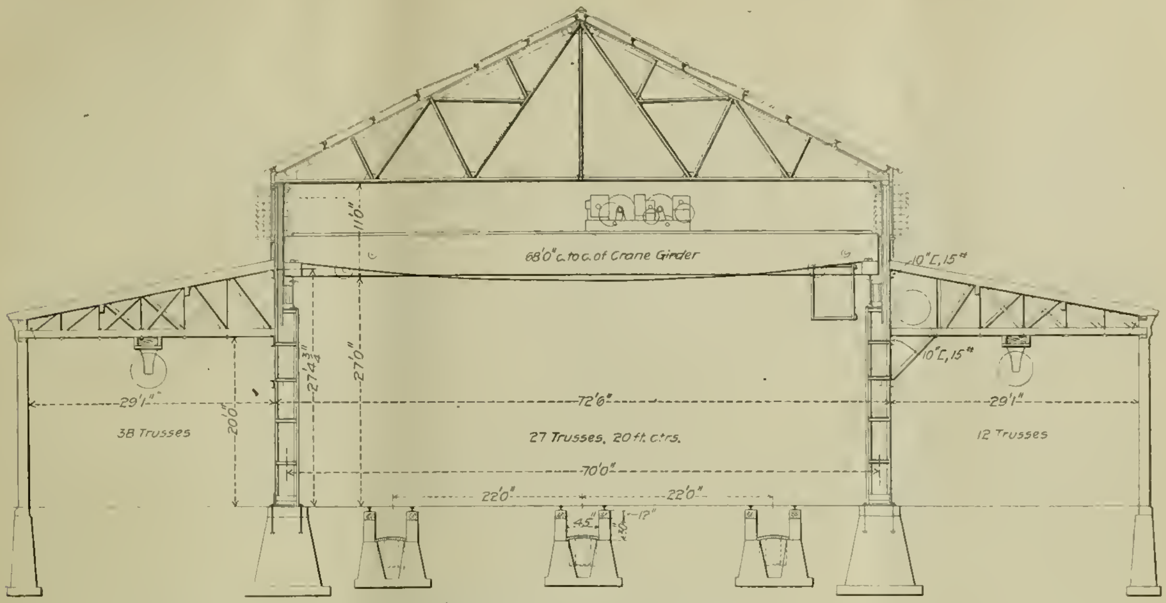
OIL FUEL AS A LABOR SAVER.

On many of the large engines now in use on our railways, hauling very heavy trains, over level divisions, the physical endurance of the fireman has been about reached, and with the return of the summer months his staying powers will be even more heavily taxed. In this connection the recent performance of S.S. "Murex," from Singapore to London, via Cape Horn, is of exceptional interest. This vessel made that long voyage with crude petroleum as fuel, and showed an estimated saving of about seven tons per day over Welsh coal, which is of good quality. The "Murex" made the voyage with three stokers instead of twenty-four. In locomotive practice such economy of labor is not possible, but the use of oil fuel would at least remove the necessity of supplying two firemen for one division, which some roads have found it desirable to provide. At sea, the economy of oil as fuel has also the advantage of reducing the space occupied for any given voyage, and this reduction provides more room for what is called on railways "revenue load." On land transportation, this economical advantage might possibly take the form of greater mileage made with one tender full of oil than could be made with coal; or the reduction of wear and tear on tenders by reason of the less weight carried for a single trip; together with the absence of the work of fire cleaning, and ashes to be handled at terminals. When the limit of physical endurance of the railroad fireman has been fully reached, oil as fuel, or the mechanical stoker, are the obvious solutions of the problem.



Floor Plan of Locomotive Erecting, Boiler and Machine Shop.

NEW SHOPS AT DU BOIS, PA.—BUFFALO, ROCHESTER & PITTSBURGH RAILWAY.



Section Through Erecting and Machine Shop.

NEW SHOPS AT DU BOIS, PENNSYLVANIA.

Buffalo, Rochester & Pittsburgh Railway.

Details of the Plant.

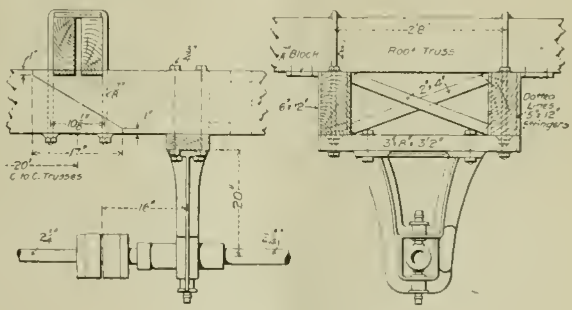
On page 107 of our April number will be found a description of the ground plan of these shops. The accompanying engravings illustrate the most important details, with particular reference to the locomotive shop, power house and roundhouse.

The buildings are of brick, with slate roofs. The roof trusses of the erecting-shop, power house and roundhouse are of steel, and those of the machine bays of wood, as shown in the cross-section of that shop. The blacksmith shop, store and oil houses have wooden roof trusses. Those of the blacksmith shop are of 80-ft. span and are spaced to 20-ft. centers, with 20-ft. clear head room. This building has a continuous ventilator, 9 ft. wide, on the roof.

The storehouse has two stories, with 10 ft. 10 ins. head room in each, and wooden roof trusses at 20-ft. centers. This building has a 4,000-lb. electric elevator. The first floor of the oil house has a clear head room of 12 ft. 10 ins. This floor is 4 ft. above the tracks. There is an 8-ft. basement. The building is divided into two sections by means of a 12-in. fire wall. One section is used as a distributing room, and contains shelving for the storing of portable equipment removed from engines. The other section is used for storing oil and waste. The basement contains the tanks. The oil flows from the large tanks to smaller tanks through a check valve, these smaller tanks then being emptied by air pressure. There is no pressure on the large tanks. In the room above are kept the waste and barreled oil.

The power house has brick walls 13 ins. thick, with 17-in. pilasters. It is divided by a 12-in. brick wall into two portions, the boiler room occupying 37 ft. and the engine room 54 ft. A basement under the engine room provides for the piping, pumps and electric cables, and this building is connected through the locomotive shop to the roundhouse by a 5 x 4-ft. 7-in. brick and concrete subway, which is drained to a sump at the roundhouse end. A plan of the blacksmith shop is shown, in which the equipment is indicated. It has down-draft forges connected under ground to the exhaust fan. It also has three forges 6 ft. in diameter, ten other forges and two heating furnaces. It has four jib cranes for general use, besides two 1-ton cranes at the punch and shears. Power is furnished by a 40-h.p. motor, belted to a single transverse line shaft. In this drawing the frog and switch shop is shown at the lower left-hand corner. A 50-lb. hammer and a 28-in. drill press are provided for the toolmakers. Flanging for the boiler shop will be done here by aid of a flanging clamp worked by compressed air. In this way the boiler shop is kept free from all but portable fires.

In the boiler room of the power house are four Stirling boilers of 200-h.p. each. Coal is received on a trestle beside the boiler room and is delivered through the wall by gravity. In the engine room are two 100-h.p. and one 200-h.p. Westinghouse engines and the air compressor. The pipe subway to the locomotive shop contains a 12-in. exhaust pipe, a 6-in. live steam main, a 4-in. hot water pipe, a 4-in. air pipe, 4-in. return piping and the electric cables. The piping plan is very compact. It includes a feed water heater of 1,000-h.p. capacity and the piping. With the exception of the drop at the power house into

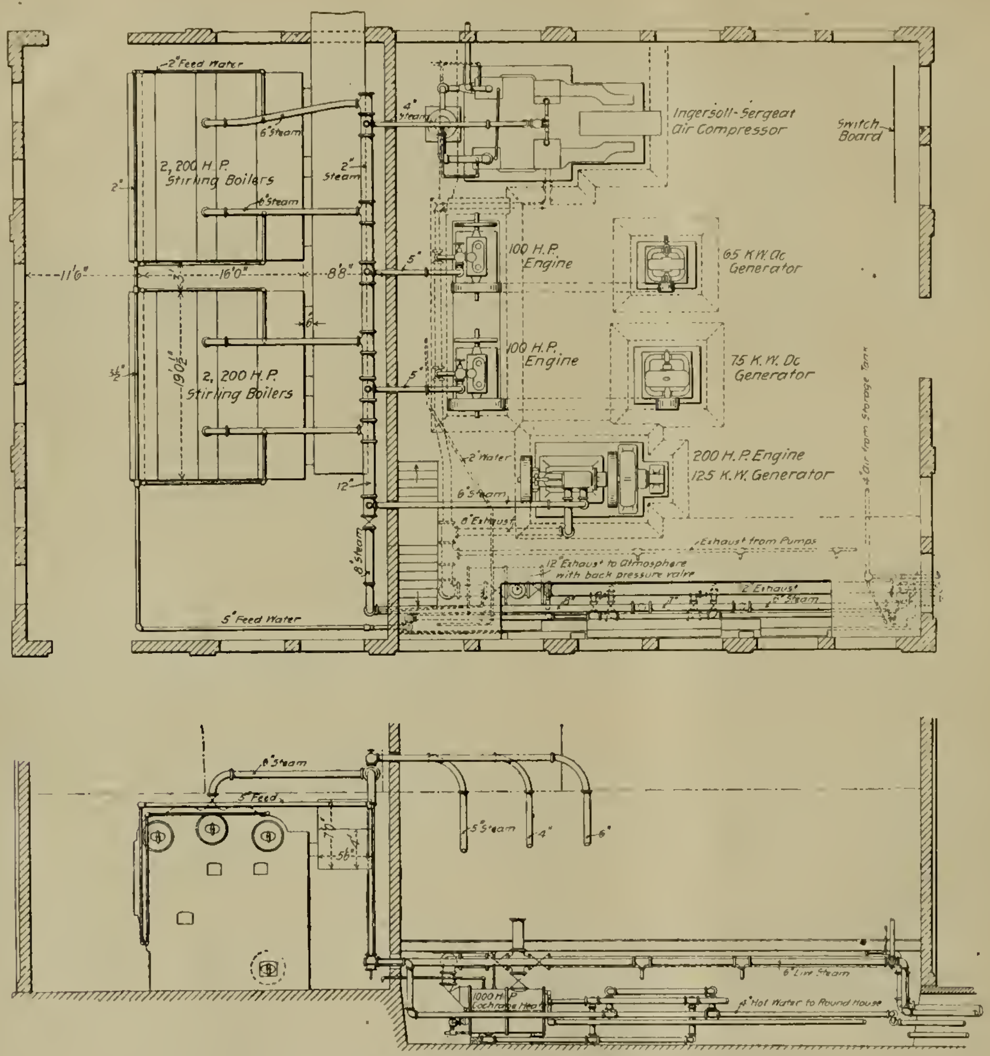


Attachment of Shafting.

the subway it is perfectly straight. It is fitted with Wainwright expansion joints.

For draft on the boiler a 120-ft. round brick stack is provided. It is constructed on a 14-ft. 6-in. square concrete foundation and has an outside diameter of 14 ft. 6 ins. at the base, tapering to 9 ft. 4 ins. at the top. The flue is 6 ft. 6 ins. in diameter. The batter of the outside is ¼ in. in 12 ins.

At present the roundhouse has 16 stalls. Its roof trusses



Plan of Power House, Du Bois Shops.—Buffalo, Rochester & Pittsburg Railway.

are of steel, with a 77-ft. span and no intermediate posts. In the plan the heating conduit is shown. It is under the floor and delivers hot air to the pits through drain tile conduits. Air is delivered at two points in each pit, and is so arranged that it will be discharged under the running gear of the engine as well as the tender. The building is lighted by eighty 16-c.p. incandescent lamps run in rows of six, each row controlled by a snap switch. In addition there are twenty-six wall receptacles for extension cords, to permit carrying lights under the engine, and doing away with the smoky torch. Hot and cold water are piped between the pits under the floor, steam and air being brought along the roof trusses.

The turntable, 70 ft. in diameter, is operated by a Westinghouse turntable "donkey," consisting of a series reversible 10-h.p. motor mounted within a cast-iron frame having a traction wheel which runs upon the rail of the turntable pit.. The roundhouse floor is of brick, and those of the erecting and machine shops are concrete.

In connection with the locomotive shop no statement was made last month with reference to the size of the boiler shop. This is now given in terms of proportion and, for convenience in comparison, the proportion in other well-known shops is included:

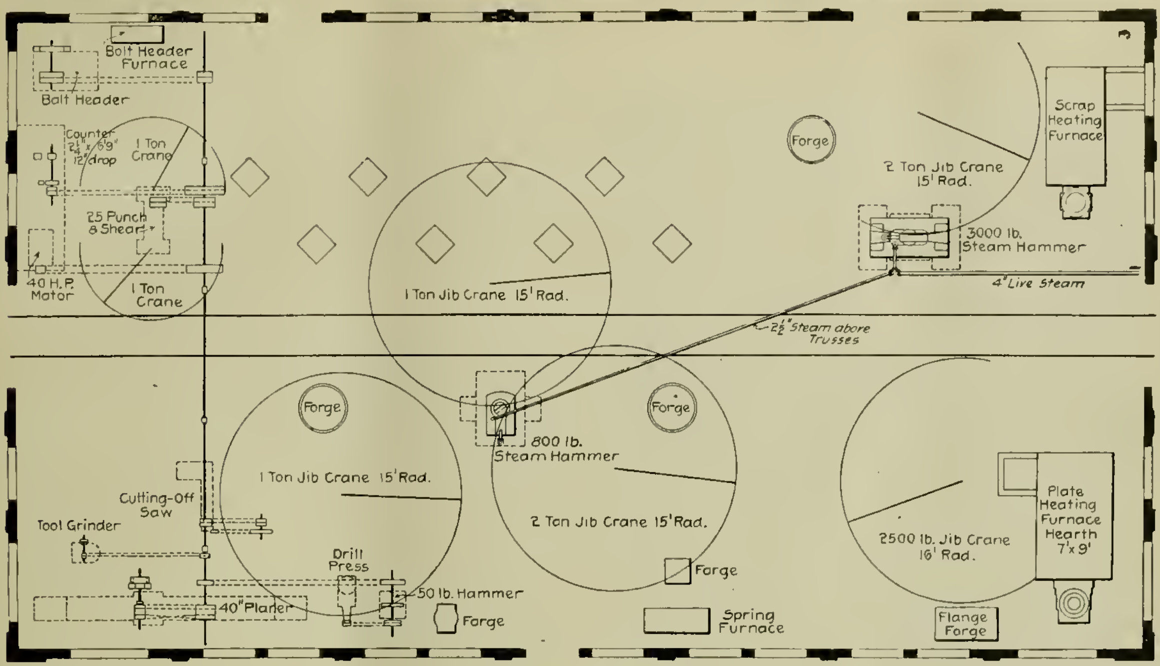
	Per cent. of Machine and erecting shop.	Total. Boiler shop.
Du Bois—170 ft. long	67	33
West Burlington—C., B. & Q.	78	22
Roanoke—Norfolk & Western	77	23
Concord—B. & M. R. R. (if full width)	74	26
Denver—Colorado & Southern	75	25
Oelwein	76	24

There are three tracks through the locomotive shop, the central having a pit its entire length, interrupted only by the pipe conduit, which extends across the shop to the roundhouse. At the south end the other two tracks, for a length of 170 ft., have no pits; they are used for boiler work. For delivery of material two standard gauge tracks cross the shop, dividing it into three nearly equal portions.

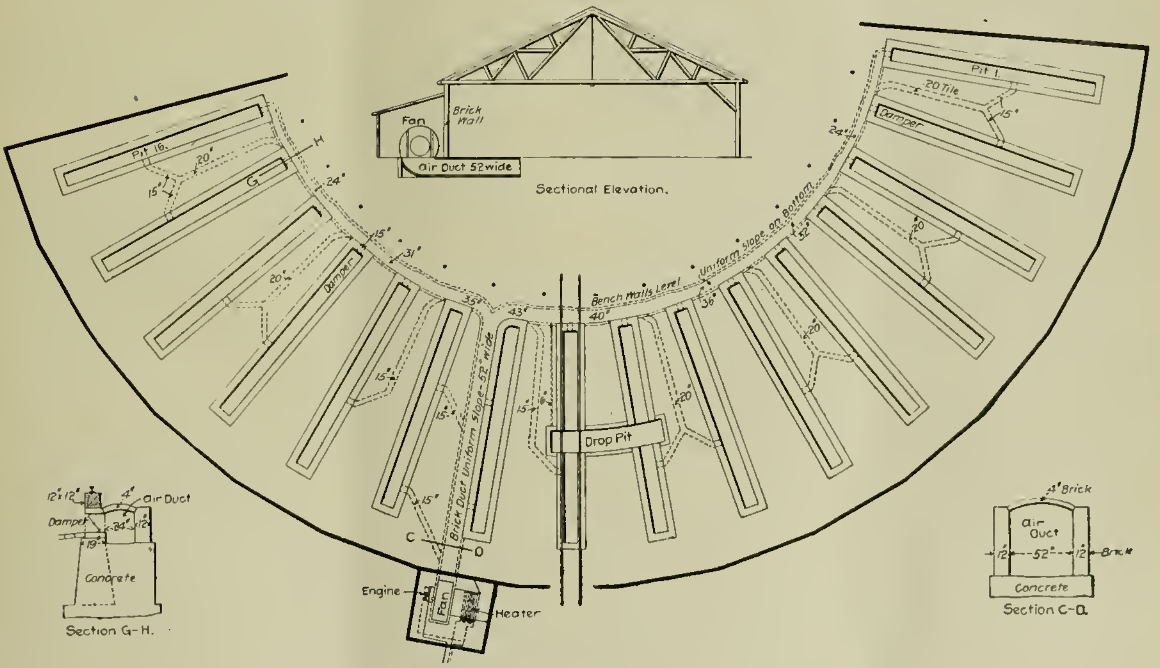
The machine shop is divided into two bays, having a number of small jib cranes. On the east side the central portion is now used for light woodwork, and may be used for increasing the machine shop capacity when required.

Natural lighting is provided through skylights at 20-ft. centers over the machine bays, and in the roof of the erecting shop is an 8-ft. continuous skylight on each side.

The heating of the locomotive shop is by the fan system with overhead conduits. It is worked ordinarily with exhaust steam and is piped for live steam also. It is guaranteed to



Plan of Blacksmith Shop.



Roundhouse.

DU BOIS SHOPS.—BUFFALO, ROCHESTER & PITTSBURGH RAILWAY.

heat the building to 65°, with an outside temperature of 15° below zero.

The lighting of the locomotive shop is by three rows of arc lamps, nine in each row, at 60-ft. centers. One of these is at the center of the building and the others are under the crane runways. Each machine and bench has one or more 16-candle incandescent lamps. There are two plug receptacles for extension cords on each of the columns, also in the center pit; approximately every 15 ft. there is a junction box containing a socket and plug receptacle.

The shop is driven on the group system with line shafts attached to the roof trusses of the machine bays. The detail of this attachment is shown in one of the engravings. The shafting stringers are put up without boring holes in the roof trusses, U bolts being used for the attachment. The line shafts are cold-rolled and are carried on Hyatt roller bearings, and a shaft 200 ft. long, without belts, could be turned by the hand.

Electrical Apparatus.

There are three generators in the power house. The 200-h.p. engine drives a 125-kw. direct-current 250-volt generator for power and day lighting. The night unit is a 75-kw. direct-current 250-volt generator driven by a 100-h.p. engine, and the yard and distant lighting is furnished by a 65-kw. alternating two-phase generator, giving 2,200 volts and 7,200 alternations. The yards are lighted for three miles by lamps placed 400 ft. apart. The outside arc lighting consists of three circuits of Manhattan alternating current series enclosed long-burning arc lamps of 25 lamps each, and one circuit to the Falls Creek station; this station is wired for incandescent lamps, and is fed through a Westinghouse transformer; this main circuit runs south, also connects through transformers to 104-volt secondary circuits, and furnishes lights for the Du Bois passenger station, freight station and Y. M. C. A. building, and the Du Bois car repair shops. Each of these outside arc circuits is connected in series with a Manhattan series alternating current voltage regulator. These regulators being automatic in their action, the going out or the short circuiting of a lamp or a group of lamps will make no appreciable difference to the balance of the circuit, as the excessive current is taken up in the regulator choke coils.

The engine room switchboard is of the Westinghouse type, of white Italian marble, 28 ft. long by 8 ft. high. The north panels of the board contain the apparatus to control the alternating current machine, and plunger switches of the Westinghouse pattern, one switch for each of the phases, each leg in each phase being fused on the back of the board. The fuses are the porcelain tubular enclosed type. The south panels contain the ammeters, voltmeters and main circuit switches for the motor circuits, and are fed from the 125-kw. generator through the basement. The center panels are for the 75-kw. machine and the lighting apparatus. The switchboard is wired on the back with two sets of bus-bars for the direct-current circuits, one set for the lighting and one set for the motors, and is so arranged that either machine may be operated on either lights or power, or both machines on either light or power. This makes the plant absolutely interchangeable, and is very desirable on account of its flexibility.

Five motors drive the machine shops. The largest, 40-h.p., drives the heavy tools, including the wheel work at the northeast end. A 30-h.p. motor drives the group at the northwest corner. The tool and air brake rooms and the rod work are driven by a 20-h.p. motor in the air brake room. A 10-h.p. motor drives the flue machinery, and on the opposite side of the shop the boiler machinery has a 30-h.p. motor. These motors are installed on platforms elevated about 5 ft. from the floor. A 40-h.p. motor in the blacksmith shop and another of 10-h.p. for the roundhouse turntable and a 7½-h.p. motor for the flue rattler complete this equipment.

The wiring for the lighting and motor circuits provides for growth of the plant, and has a 50 per cent. overload capacity. It is all underground in the main conduit and boxes leading from it. At the east side of the locomotive shop is the distributing box. It has three panels with three sets of feeders. One of the panels feeds the cranes. The center panel controls the 30 and 40-h.p. motors on the east side of the building, and the 7½-h.p. motor for the flue rattler. The third panel controls the arc and incandescent lighting for the east side of the building, feeding 10 branch circuits for incandescent lights. Each circuit has about 20 16-candle power 230-volt lamps. The arc circuits are controlled at this point by a single switch, and each arc lamp is controlled by a separate switch. The other panel board is placed on the west wall of the shop. In the blacksmith shop are three circuits for incandescent lamps and eight long burning arc lamps.

The electrical equipment was supplied by the Westinghouse Electric & Manufacturing Company. The cranes were supplied by Manning, Maxwell & Moore; the machine tools by the Niles-Bement-Pond Company, of New York, and the Hilles & Jones Company, of Wilmington, Del. The steel work of the buildings was furnished by the American Bridge Company; the brick work by Hiram Edgerton, of Rochester, N. Y.; the piping by Howe & Bassett, of Rochester, N. Y.; the electric wiring by Higgins-Almstead Co., of Rochester; the nineteen pneumatic and hand-operated jib cranes by the Whiting Foundry Equipment Co., of Chicago; the heating apparatus and forges by the Buffalo Forge Co. The tool and machinery list is presented in unusual detail as follows:

TOOL LIST.

WHEEL AND AXLE MACHINERY.

Two 79-in. Niles driving wheel lathes.
One Niles quartering machine.
One Schaffer 79-in. wheel press, 300-ton triple pump.
One Niles locomotive axle lathe, 13 ft. bed, with 2 carriages.
One Pond single axle lathe, 7 ft. 6 in. between centers.
One 48-in. Niles steel tired car wheel lathe.
One 42-in. Pond wheel borer, with automatic hub facer.

PLANERS.

One 24-in. Bement crank planer.
One Niles 36 in. x 36 in. x 20 ft. planer, 2 heads on cross rail.
Two Niles 26 in. x 26 in. x 16 ft. planers, 1 head on cross rail.
One Niles 26 in. x 26 in. x 6 ft. planer, 1 head on cross rail.
One 60 in. x 60 in. x 29 ft. 3 in. Niles planer, 2 heads on cross rail.
One Pittsburg Machine Tool Co. 40 in. x 16 ft. frog and switch planer.

LATHES.

One 44-in. Bement lathe.
One 24 in. x 20 ft. Niles standard engine lathe.
Three 18 in. x 10 ft. LeBlond engine lathes.
Four 16 in. x 8 ft. LeBlond engine lathes.
Two 18 in. x 6 ft. No. 2 American improved turret lathes.
One Jones & Lamson 2 in x 24 in. flat turret lathe.
Two 28 in. x 14 ft. 6 in. back geared Pond engine lathes.
Two 22 in. x 12 ft. Niles engine lathes.
One 16 in. x 8 ft. LeBlond engine lathe.

SLOTTERS.

One 18-in. Bement slotting machine.

SHAPERS.

One 16-in. Bement single traveling head shaper, 72-in. bed.
One 14-in. Pratt & Whitney pillar shaper.

MILLING MACHINES.

One Bement No. 10 vertical milling machine.
One No. 2 LeBlond universal milling machine.

BORING MACHINES.

One Niles No. 2½ horizontal boring and drilling machine.
One 84-in. Niles vertical boring and turning mill, 2 heads.
One 51-in. Niles vertical boring and turning mill, 2 heads.
One 37in. Niles vertical boring and turning mill, 2 heads.
One Bement No. 7 two-spindle connection rod drilling machine.

DRILL PRESSES.

One 32-in. Aurora drill press.
Two -8-in. Aurora drill presses.
Two 24-in. Aurora drill presses.
Two 6-ft. Pond radial drills.
One 21-in. Aurora drill press.

GRINDING MACHINES.

One No. 3 universal grinder. (Universal Machine Co.)
One Gisholt universal tool grinder for lathe and planer tools.
Four Whitney No. 2 water tool grinders, single wheel.
One No. 1 Washburn C twist drill grinder.
One Diamond No. 7 grinding machine for 20-in. wheels.
One Diamond surface grinder, with 28 in. x 64 in. table.
One Pratt & Whitney No. 1 centering machine.

BOLT AND PIPE MACHINERY.

Two No. 7 Jarecki pipe threading machines.
One Acme No. 1 ½-bolt header.
One Acme 2-in. double bolt cutter; Class A.

BOILER SHOP AND BLACKSMITH SHOP.

Two Hilles & Jones combined punches and shears. One 48-in. throat for 1-in. plate. One 25-in. throat for 1-in. plate.
One Hilles & Jones horizontal punch
One set No. 5 Hilles & Jones power bending rolls for ¾ plate 12 ft. wide.
One set No. 0 Hilles & Jones power bending rolls.
One set Hilles & Jones power plate straightening rolls.
One 18-ft. plate planer.
One Baird staybolt nipper, to cut 1¼-in. bolts.
One Allen 24-in. air riveting machine for 1-in. rivets.
One Bement steam riveting machine, 9-ft. stake, 36-in. cylinder, for 1-in. rivets.
One Bement 3,000-lb. double frame steam hammer.
One Bement 800-lb. single frame steam hammer.
One Scranton 50-lb. dead stroke hammer.
One Newton No. 2 combination power cutting off saw.
One Otto flue cleaner.
One Hartz flue welding machine.
One Ferguson flue welding furnace.
One pair 12-ft. flanging clamps, air operated.
One pair 9-ft. flanging clamps, hand operated.

One spring forming machine.
Two Acme tube rolling and cutting out machines.
One Clement 48-in. band saw.
One Greenlee Bros. No. 6-B heavy pattern single spindle radial vertical right hand boring machine.

POWER HOUSE.

Four 202-h.p. Stirling boilers.
One Westinghouse 14 and 24 by 14 compound engine.
Two Westinghouse 12 by 11 standard engines.
One Ingersoll & Sergeant air compressor, rated capacity 950 cubic ft.
One 1,000-h.p. cylindrical horizontal Cochrane feed water heater and receiver.
Two Worthington general service piston pumps, having steam cylinders 10-in. diameter by 10-in. stroke.
One Worthington packed plunger pump, having steam cylinders 16-in. diameter by 10-in. stroke, and brass mounted water cylinders 10¼-in. diameter by 10-in. stroke. Capacity, 42,000 gallons per hour.
Two Worthington 3 x 2 x 3 packed piston Class 3 pumps with metal valves.

ELECTRICAL APPARATUS.

One Westinghouse 125 k.w., 250-volt, 280 r.p.m. compound wound "engine type" generator.
One 75 k.w., 250-volt, 750 r.p.m. multipolar belt driven generator.
One 65 k.w., 2,200-volt, 7,200 alternations, 2 phase alternating current generator, operating at 900 r.p.m.
One 2½-h.p. direct current multipolar exciter, operating at 125 volts, 1,800 r.p.m.
Two 40-h.p., 220-volt, shunt wound multipolar motors, operating at 550 r.p.m.
Two 30-h.p., 220-volt, shunt wound multipolar motors, operating at 575 r.p.m.
One 20-h.p., 220-volt, shunt wound multipolar motor, operating at 600 r.p.m.
One 10-h.p., 220-volt, shunt wound multipolar motor, operating at 750 r.p.m.
One 7½-h.p., 220-volt, shunt wound multipolar motor, operating at 850 r.p.m.

CRANES.

Two "Shaw" 50-ton electric traveling cranes, each with 6-ton auxiliary hoist; span 68 ft. center to center of runways; top of runway 27 ft. above floor; speed, main hoist, 6 ft. per minute, loaded; auxiliary hoist, 60 ft. per minute, light; speed of trolley, 100 feet per minute, loaded; speed of bridge, 250 ft. per minute, light; line voltage at crane, 220 volts; length of runway, 521 ft. 2 in.

FAST RUNS ON THE PENNSYLVANIA.

From official sources we have obtained the following record of fast runs by special trains carrying President Cassatt from Philadelphia to Jersey City, March 23 and 24, 1902:

Miles.	Station.	Extra No. 804 Sunday, March 23, 1902.	Speed between stations. Miles per hour.	Extra No. 850, Monday, March 24, 1902.	Speed between stations. Miles per hour.
....	Broad Street	1.12 P. M.	....	12.19 P. M.	....
2.7	Mantua	....	29.5	....	32.4
5.4	Germantown Junc..	....	54.0	....	54.0
9.2	Frankford Junc....	....	57.0	....	65.1
13.2	Holmesburg Junc..	....	80.0	....	87.3
23.4	Bristol	....	68.0	....	74.2
33.7	Trenton	....	77.2	....	72.7
43.4	Princeton Junc....	....	72.7	....	83.1
49.4	Monmouth Junc...	....	90.0	....	72.0
57.5	Millstone Junc....	....	60.7	....	72.0
64.6	Metuchen	....	71.0	....	81.1
70.4	Perth Amboy Junc.	....	81.9	....	73.3
75.7	South Elizabeth...	....	85.0	....	67.0
79.4	Waverly	....	74.0	....	59.2
82.4	East Newark Junc.	....	45.0	....	48.0
89.4	Jersey City	2.32 P. M.	70.0	1.38 P. M.	60.0
		80 minutes.	Average speed per hour, 67.1 miles.	79 minutes.	Average speed per hour, 67.9 miles.

In connection with the recent celebration of the Baldwin Locomotive Works an interesting comparison was prepared to show the advance which has been made since 1870. At that time the average number of men per locomotive built in the year was 6.51. The average pay was $11.66 per week; the average tractive power per locomotive, 10,461 lbs.; the average horse-power per locomotive, at ten miles per hour (working full stroke), 279; the average horse-power represented by the work of one man per year, 42.85, and the average number of men employed in that year 1,822. In the year 1901, with much heavier and more powerful engines, the average pay per week, $13; average tractive power per engine, 26,965 lbs.; average horse-power at ten miles per hour, 719; average horse-power represented by one man, 106.51, and average total number of men employed 9,281. This is an increase of nearly 250 per cent. in the average horse-power represented by one man's work.

SUPERHEATED STEAM FOR LOCOMOTIVES.

Results of Trials on the Prussian State Railways.

The issues of the "Zeitschrift des Vereins Deutscher Ingenieuren" (Journal of the Association of German Engineers) for February 1 and 8 contain an interesting paper on the economies and advantages to be obtained by the use of highly superheated steam on locomotives. The paper is by Privy-Councillor Garbe, one of the Board of Managing Directors of the Prussian State Railways, and was read before the Berlin center of the Association of German Engineers. By title the paper is a report on the locomotives exhibited at Paris, but Herr Garbe found the locomotives with the Schmidt superheater so interesting that the greater part of his report is devoted to locomotives of this class.

The superheater consists of about 63 tubes 1.3 inches inside diameter, fitted round the inside of the smoke box wall. The steam to the cylinders passes through these tubes while the furnace gases pass round outside of them. The steam is delivered to the cylinders at a temperature of about 825 degrees F., that is, superheated 450 degrees F. at 170 pounds per square inch boiler pressure.

Four locomotives with this superheater are in use on the Prussian State Railways, and as a result of the economies they have shown twenty-five new engines now building are to be similarly equipped. The first engine equipped with the superheater has been in service for two years without any trouble developing in the superheater or in the cylinders. Herr Garbe reports that in October, 1901, this engine, which is of the American four-coupled type, was tested against two compound locomotives with the following favorable result:

	Per Train Mile. Water.	Per Train Mile. Coal.
Superheater No. 74..........................	206 lbs.	34.0 lbs.
Compound No. 73..........................	278 "	37.7 "
Compound No. 49..........................	278 "	38.2 "

These results are the averages from a trial of nine days' running express trains of an average total weight of 360 gross tons. The engine from which these figures were taken has cylinders 19⅜ x 23⅝ ins. and driving wheels 78 ins. in diameter. Herr Garbe's paper is profusely illustrated with indicator diagrams and he calls particular attention to the cards taken with partially closed and short cut off. It is in the ability of the locomotive with the superheater to run economically under such conditions, that Herr Garbe finds one great advantage of the superheater. The range of power which is economically available with superheated steam is so great, that Herr Garbe proposes to build his locomotives with large cylinders and to run them under ordinary conditions throttled down and with a short cut-off; the reserve cylinder power available will then be sufficient to render unnecessary the present practice of double heading trains on heavy divisions.

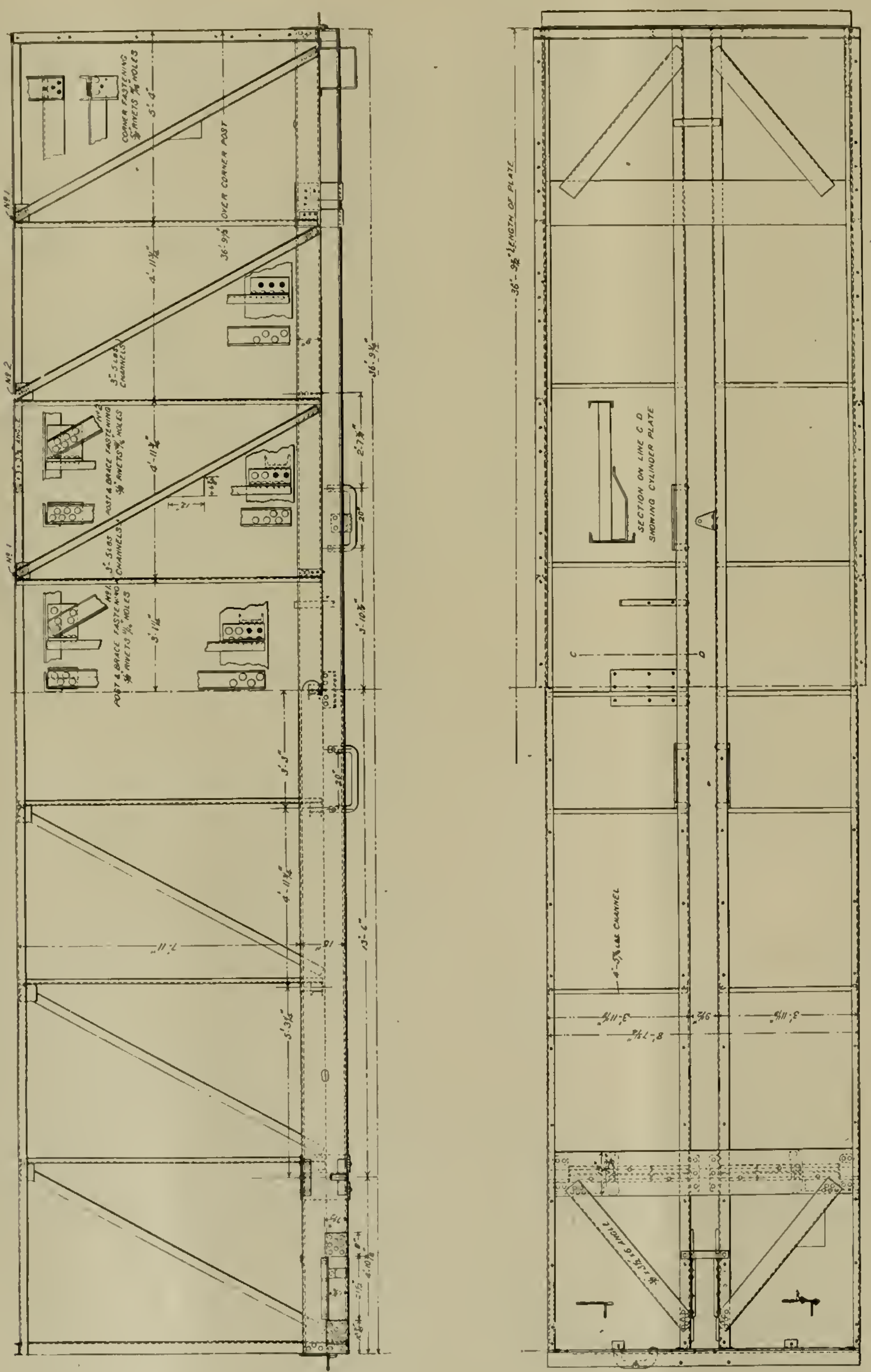
According to Herr Garbe's estimates the entire work on the Prussian State Railways can be handled with four classes of locomotives if these are fitted with superheaters. He has taken up the question with representatives of the four most prominent German locomotive builders, and in connection with them has determined the proportions of these four standard types. Drawings of these engines are given with the original paper. The engines proposed are the following:

Eight-wheeled American type for express service and ordinary passenger service, with cylinders 20½ x 23⅝ ins. and driving wheels 78 ins. in diameter.

Mogul type for heavy passenger and light freight service, with cylinders 20½ x 23⅝ ins. and driving wheels 61 ins. in diameter.

Eight-wheeled all coupled heavy freight locomotive, with cylinders 21⅝ x 23⅝ ins. and driving wheels 53⅛ inches in diameter.

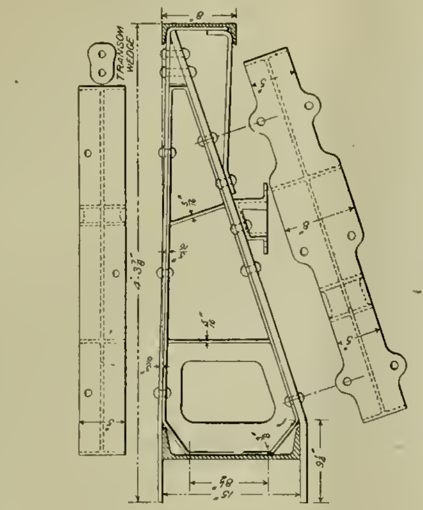
Mogul type tank engine for surburban service and short passenger runs, with cylinders 20½ x 23⅝ ins. and driving wheels 59 ins. in diameter. L. H. F.



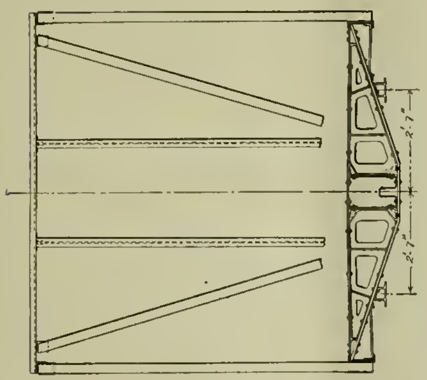
80,000 Pounds Capacity Steel Frame Box Car—Norfolk & Western Railway.

W. H. LEWIS, *Superintendent of Motive Power.* C. A. SELEY, *Mechanical Engineer.*

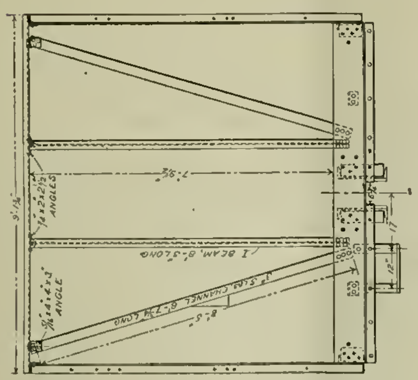
80,000 POUNDS CAPACITY STEEL FRAME BOX CAR—NORFOLK & WESTERN RAILWAY



Standard Body Bolster for 80,000 lbs. Capacity Car.



Body Bolster Connection to Steel Framing.



End Elevation of Steel Frame.

FORTY-TON STEEL FRAME BOX CARS.

Norfolk & Western Railway.

Following their interesting development of metal in their car construction, the Norfolk & Western has put into service the first of a lot of 100 forty-ton box-cars with steel upper and under frames, known as the "B. G." class. The accompanying drawings illustrate the frames which constitute the principal features of this car. The chief dimensions are as follows:

40-Ton Steel Frame Box Car.
Norfolk & Western Railway.

Weight, empty	38,000 lbs.
Light weight in per cent. of total loaded weight	32.2
Length inside	36 ft.
Length over side sills	36 ft. 9¾ ins.
Width inside	8 ft. 6 ins.
Height inside	7 ft. 6 ins.
Distance between center of trucks	27 ft.
Center sills	15 in., 33 lb. channels
Side sills	8 in., 11¼ lb. channels
Posts and braces	3 in., 5 lb. channels
Corner posts	3 in. x 4 in. x ⅜ in. angles
End posts	4 in., 7½ lb. I-beam
Side plates	3 in., x 3½ in. x 5-16 in. angles
End plates	4 in., 5¼ lb. channels
Underframe diagonals	6 in. x 3½ in. x ⅜ in. angles
Intermediate sill supports	4 in., 5¼ lb. channels
Center and side sill connections	4 in. x 4 in. x ½ in. angles
Bolster and sill connections	3 in. x 3 in. x ⅜ in. angles

A trussed side frame, built to aid in carrying the load, in which the diagonal bracing of the center panel for the door openings is omitted, will appear to bridge designers as a little out of the ordinary, but the service test of 100 cars will tell the story, we think, satisfactorily. Those who wish to study the stresses involved will be aided by the discussion by Mr. J. H. Lonie, which is printed in this issue. This frame was developed very carefully and the designer was mindful of the fact that wood must be used for many purposes, such as the attachment of the flooring, siding and roofing. The use of steel in the upper frame is justified by giving it some of the load and the design is simple, sensible and skilful. The drawings show the various members clearly; also the methods of attachment. They also illustrate the substantial I-beam end posts. While the body bolsters are almost exactly like those of Mr. Seley's earlier designs, the detail is illustrated again because it appears to be giving perfectly satisfactory service. The large filling castings are of malleable iron. The trucks are the Norfolk & Western standard for 40-ton cars. They have 10 in. I-beam truck bolsters and diamond side frames.

Readers who desire to refer to the earlier steel frame cars of this road will find the 40-ton gondola illustrated in the American Engineer, April, 1900, page 100, and the 50-ton hopper car on page 42 of February, 1901. Another in the series will soon be illustrated.

GRAPHICAL METHOD OF DETERMINING STRESSES IN CAR FRAMING.

By J. H. Lonie, Norfolk & Western Railway.

With the advent of cars built wholly or partly of steel, we no longer depend entirely on the underframing to carry the load, but carry part of it on the side framing. The stresses in the various members can, of course, be obtained analytically, but for preliminary designing the graphical method affords a rapid solution, of sufficient accuracy for all practical purposes.

In Figs. 1 and 2 is shown the application of this method to a steel frame box car of recent design. The first step is to lay out the center lines of the truss accurately to scale and to determine the amount and direction of the load which acts at each joint. A part of the load in each of the panels adjacent to the bolster will be carried directly to the bolster by the sills and will exert no influence on the stresses in the truss. It may, therefore, be ignored in the solution. In this particular case the members of the frame shown in dotted lines, Fig. 1, form no part of the truss proper and, for the sake of clearness, will be left out of consideration.

If we assume that, as is usually the case, the car is symmetrically loaded about the center of its length, it follows that $P = P_7$, $P_1 = P_6$, $P_2 = P_5$ and $P_3 = P_4$, P_1 and P_6 being the bolster reactions at the side sill $P_1 + P_6 = P + P_2 + P_3 + P_4 + P_5 + P_7$.

For convenience we may letter the truss as shown in Fig. 1. The members will then be designated by the letters of the spaces between which they lie. For example the diagonal marked x will be designated as J K.

The construction of the stress diagram is shown in Fig. 2. On a vertical line lay off, to any convenient scale, $AB = P_7$, $BC = P_6$, $CD = P_5$, $DE = P_4$, $EF = P_3$, $FG = P_2$, $GH = P_1$, and $HA = P$. It will be noticed that each load is laid off in the direction of its action. Through A draw a line, parallel to A I (Fig. 1), intersecting one through H, parallel to H I, at I: through I draw a line, parallel to I J, intersecting one through A, parallel to A J, at J; through J draw a line, parallel to J K, intersecting one through G, parallel to G K, at K; through K draw a line, parallel to K L, intersecting one through A, parallel to A L, at L; through L draw a line, parallel to L M, intersecting one through F, parallel to M F, at M; through M draw a line, parallel to M N, intersecting one through A, parallel to A N, at N. This completes the stress diagram as far as is necessary to obtain the stresses in the different members, since the stresses are the same in the corresponding members on the other side of the center line of the car. But it is well to complete the diagram as shown in dotted lines, continuing from N in the same manner as above. If the work is correctly done the closing line of the diagram, in this case T A, will pass through the starting point A. The lengths of the lines represent to scale the stresses in the corresponding members. For example, the length of the line J K represents to scale the stress in the diagonal J K.

From an inspection of the truss the character of the stresses in the different members, in this case, may be readily determined. For cases in which their character is not so apparent the following method may be used:

Cut the stress by a section about any joint, as Y, at which the direction of one force is known, and consider the truss as removed and the stresses in the cut bars as outside forces acting on the joint, as in Fig. 3. These forces are in equilibrium and the lines representing them in the stress diagram form a closed polygon. Their direction can, therefore, be obtained, when the direction of one force is known, by following around the polygon in the direction indicated by this force. From the stress diagram the force polygon for the joint Y is as shown in Fig. 4. From the truss it is readily seen that the action of the load P causes a tension in A J. The force in A J therefore acts toward the left. Following around the polygon in this direction we have the forces acting as follows:

A J to the left, A L to the left, L K downward, K J upward and to the right.

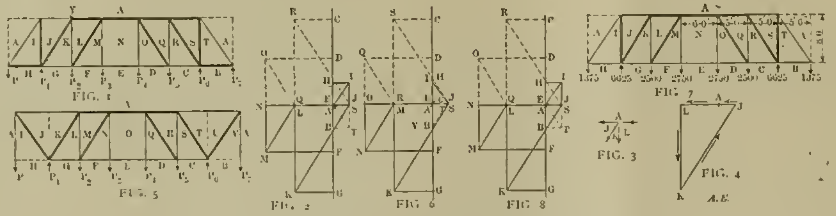
Putting arrows on the diagram of the joint to correspond with these directions, it is seen that A L and J K are in compression and that A J and K L are in tension. This method will apply to any case. In Fig. 1, members in tension are indicated by single lines, members in compression by double lines, and members which are under no stress, by dotted lines.

In Figs. 5 and 6 is shown the application of the method to the framing of a box car of usual design. It will be noticed that in this case the points H and I, J and K, B and V, and T and U coincide, showing that, as is to be expected, there is no stress in these members. The closing line of the stress diagram here is V A.

In all cases the side sill is under an additional stress to that shown above, due to carrying the floor load to the joints, and this should be separately calculated and added to that previously found.

It is believed that a study of the foregoing examples and method will enable anyone to solve all questions of car framing which will be met in usual practice.

For illustration the problem is worked out in two ways,



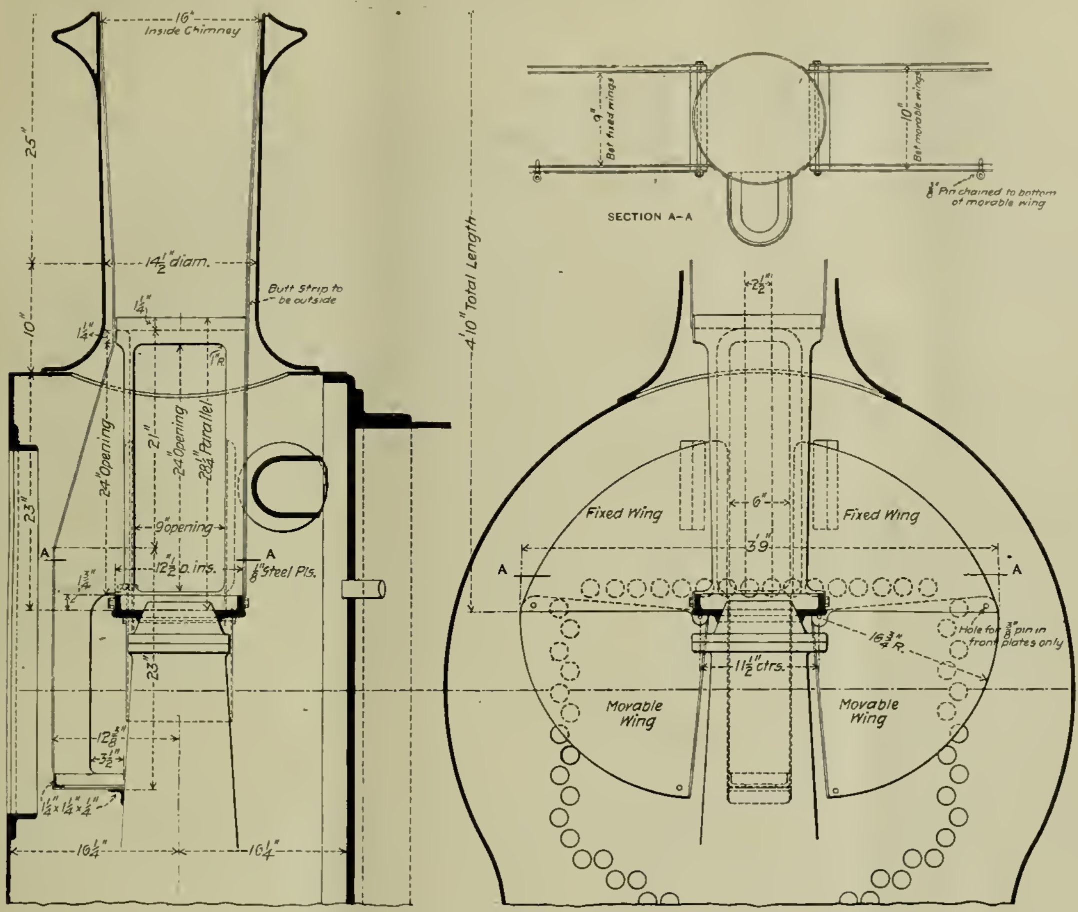
Graphical Determination of Stresses in Car Framing.

with an assumed load at 500 pounds per ft. on the side sills. The graphical method gives results agreeing closely with the analytical. As the stress diagram is constructed on the scale of 2,000 pounds per in., it will be seen that the degree of accuracy is a question of the scale used. Usually a scale at 1,000 pounds per in. is employed unless extreme accuracy is desired.

In the analytical method, Figs. 7 and 8, the length of O Q and R S is 9.433 and of T A, 9.70. A I is in tension $= 1{,}375 \times \frac{9.7}{8} =$ 1,667 lbs. H I is in compression tension in A J $= 1{,}375 \times \frac{5.5}{8} =$ 944 lbs. I J is in compression $= 1{,}375$ lbs. A L is in compression $=$ tension in K G $= 2{,}500 + 2{,}750 \times \frac{5}{8} =$ tension in A J $= 3{,}281 - 944 = 2{,}337$. J K is in compression $= 2{,}500 + 2{,}750 \times \frac{9.433}{8} =$ 6,190 lbs. K L is in tension $= 2{,}500 + 2{,}750 = 5{,}250$ lbs. A N is in compression $=$ tension in W E $=$ tension in M F $= 2{,}750 \times \frac{5}{8}$ $+$ compression in A L $= 1{,}720 + 2{,}337 = 4{,}057$ lbs. M N is in tension $= 2{,}750$ lbs.

From the diagram:

A I scales, 27/32 in. =	1,687 lbs.
H I = A J scales, 31/64 in. =	968 lbs.
I J scales, 11/16 in. =	1,375 lbs.
A L = K G scales, 1 3/16 in. =	2,375 lbs.
J K scales, 3 7/64 in. =	6,218 lbs.
K L scales, 2⅝ in. =	5,250 lbs.
A N = N E = M F scales, 2 3/64 in. =	4,093 lbs.
M N scales, 1 ⅜ in. =	2,750 lbs.



Drummond's Front End Arrangement for Locomotives.
London & South Western Railway.

DRUMMOND'S "FRONT END" ARRANGEMENT FOR LOCOMOTIVES.

London & South Western Railway.

Through the courtesy of Mr. Duggald Drummond, chief mechanical engineer of the London & South Western Railway, drawings of his new patent draft arrangement for locomotives have been received. It is attracting wide attention abroad because of its fuel saving and spark arresting qualities.

The purpose of the arrangement is to distribute the effect of the draft from the nozzle over a large area in the smoke box. The greatest suction of the smoke box gases is around the exhaust nozzle. Mr. Drummond has surrounded the nozzle with a cup having wings at the sides. These wings are in two portions, the lower portions being hinged to give access to the tubes. These wings are closed at the bottom, so that the gases are drawn from the sides of the smoke box over such an area as to allow them to escape freely from the smoke box into the stack. He says: "We find our engines work best with the fuel we use at the minimum water vacuum of 2½ ins. and the maximum of 3 ins. By this arrangement the blast is distributed over a large area without creating a violent current, as in the old system, which was without this arrangement. The fire in the firebox lies at perfect rest and gives as nearly as possible the most perfect combustion that can be obtained in an open furnace. To work this satisfactorily with low partial vacuum a comparatively thin fire is required. The amount of ash in the smoke box averages one pound for every hundredweight of coal consumed. Not only does the arrangement remove the risk of fire, but a saving is effected in the fuel consumption, averaging about 7 lbs. per mile."

From records of tests received from Mr. Drummond it appears that this device secures a saving of about 26 per cent. in the amount of fuel burned to do the same work as other engines in a "gang." If it stops spark throwing it is easy to see how such a saving is possible, because Prof. Goss has found spark losses to amount to 20 per cent. in narrow firebox engines.

In addition to the wings already referred to, the drawing shows a vertical pipe in front of the exhaust nozzle, a portion of the circumference of which is cut away. It opens into the stack and above the wings are other openings through the pipe, all of which are supposed to distribute the effect of the blast.

This arrangement is not used in connection with Mr. Drummond's firebox water tubes, these engines having only the ordinary brick arch. With Welsh coal containing slack there seems to be no spark throwing and the fire resembles a gas furnace, the effect of the blast being similar to that of a fan. From a study of the drawing there seems to be no other explanation to account for the satisfactory action other than that of "uniform distribution." Undoubtedly the best spark arrester is one which will permit the coal to stay on the grates and burn in the firebox. It seems to be worth while ascertaining whether these devices will work on large engines with the freedom of steaming obtained by Mr. Drummond. This subject is worthy of interested attention. It is clear that there is much to be learned about draft appliances.

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EDITORIAL ANNOUNCEMENTS.

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

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

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

Mr. C. W. Obert has been appointed associate editor of this journal, beginning his work with the June number. He has been connected with the staff of "Steam Engineering" as associate editor, and comes to us with technical preparation and experience in newspaper and railroad work.

In his report on the American Engineer Tests on Locomotive Draft Appliances, Professor Goss gives, in Section III., in this issue, some interesting and important information. He has found that for a given speed all points in front of the diaphragm have almost the same pressure, the variations recorded being generally less than 0.1 inch. These results justify the conclusion that while different points in the smoke-box show differences in pressure which are clearly distinguishable, the value of such differences is so slight that it does not seem necessary to take them into account in fixing the location of the draft gauge, except in so far as it indicates that the point of application should not be too near the steam jet.

Behind the diaphragm the draft is always less than in the main portion of the front end. The results show that approximately one-third of the total draft is required to move the air from the ashpan into the firebox, another third from the furnace through the tubes, and the remaining third from the front tube sheet under the diaphragm and into the main portion of the front end. A significant fact is that one-third of the draft effect is required to carry the gases past the deflector plate.

From the Sante Fe in its appointment of mechanical superintendents of several grand divisions of the road to have charge of the locomotive service outside of shop matters, comes a timely suggestion in connection with the specialization of responsibility. The time has come when large roads begin to find it necessary to specialize with reference to the important subdivisions, such as shop management and outside matters. Shop problems in large plants are becoming serious enough to require a "works manager" who does not divide his time between the shop, methods of firing, roundhouse service, the assignment of engineers and grievances of engineers and firemen. The shop is slighted if the proper amount of attention is given to these other matters and the roundhouse and road service on a large road are enough for another good man. The "master mechanic" must soon divide his duties on large roads, and the result cannot fail to be an improvement. It is becoming apparent that there will be a great demand for men who can operate large shops as the best manufacturing plants are operated, by shop superintendents. In fact, there is now a rather general search for good foremen, which is clearly indicated by correspondence from several directions. This is accompanied by applications from men who can take the responsibility of directing practice at roundhouses and look after the road service, with a view of obtaining uniform and improved practice. This appears to be a "sign of the times."

Roundhouse facilities for prompt work on locomotives between runs are being thoroughly overhauled on several roads. Attention is particularly directed to quick work in washing out boilers, and this requires large piping for blowing down the steam. It is inconvenient to allow steam to fill a roundhouse and the most approved method of blowing down is through an overhead pipe to which flexible connections to the steam dome may be made. This pipe may be led to a cistern and the steam used to heat water for filling boilers, or the steam may be blown into a cistern containing water blown down from the blow-off cocks of boilers, which is suitable for use again in boiler washing. Evidently the size of this pipe and its connections with the boilers is important. It must be a large pipe or the blowing down will cause a long delay. A 6-in. pipe, through the roundhouse over the engines, is not too large, and the blowing-down process may be accelerated by blowing part of the steam back through the injectors. In busy times every hour in the boiler washing counts, and it ought to be possible to thoroughly wash out a boiler in less than four hours. The question of damaging boilers by blowing down the steam pressure rapidly has been raised. It does not seem to be serious, however, because the stresses set up by a release of pressure are probably much less severe than those of rapidly raising the pressure in firing up. In the near future improvements in facilities for more prompt work in washing out may be expected.

Steel underframes for freight cars have usually been considered on the basis of durability. Irrespective of the cost of running repairs the decision in favor of steel underframes has usually been made because the increased cost of steel could be earned in the long life of the material. In some cases progressive men are lingering at the steel center sill, and even the steel draft sill stage, taking the view that with present relations between the prices of steel and wood, it will pay to renew two wooden frames reinforced in this way rather than pay the price of an all-steel underframe. This view is based on the opinion that the most important function of the steel frame is in connection with draft stresses and that steel center or continuous draft sills are sufficient, giving all that is necessary to add at present to the wooden frames.

Recent experience with large all-steel hopper cars in trains with wooden cars indicate that these sills are not sufficient, and that the steel underframe is necessary on a basis of strength as well as the durability of material. It is doubtful whether a composite structure, such as a car underframe, can be made satisfactory, because of the great severity of the stresses, chiefly from buffing blows.

It must be recognized that the shocks in yard work nowadays are equivalent to the mild collisions of a few years ago, and probably nothing short of a full-steel frame, using both center and side sills to meet these stresses, will suffice. If a steel "backbone" is provided to meet these conditions it must bear practically all of the blows, for the wood will not assist. Figures will, before long, be published indicating that the shocks of ordinary service conditions in coupling large capacity cars are beyond even the imagination of those who have given the subject most thought. Furthermore, the favorable location of the draft gear between the center sills and the satisfactory disposition of the body bolster problem must be credited to the all-steel frame.

Present conditions indicate that it is advisable to make underframes as strong as possible, having a proper regard to the weight of the structure. This is chiefly because the shocks received from other cars in the train are greater and of a more destructive character than those of carrying the load. With the increase in the number of large capacity cars the necessity for protecting all cars increases.

LOCOMOTIVE ERECTING SHOP ARRANGEMENT.

Seldom is such an opportunity offered to compare shop plans as is given by the discussion of the new locomotive shops of the Buffalo, Rochester & Pittsburgh, at Du Bois, which appeared in our April issue. From time to time the arguments in favor of the longitudinal and transverse arrangements of shop pits have been presented in this journal, and until recently the longitudinal shop seems to have had the stronger advocates. In fact, the Du Bois shops are constructed on this plan, and it has Mr. R. H. Soule's endorsement.

A new view of the subject is unquestionably gaining ground. Formerly it was considered necessary to use a transfer table in connection with the transverse track arrangement, but now two large shops are nearing completion in which the approach is by means of turntables, and the engines are to be handled inside the shops by cranes. It is not necessary to review the arguments for each arrangement here; this has already been done in this journal, but it seems advisable to direct attention to a vital feature of the transverse shop, which has not had sufficient consideration. This is the convenience in passing from the engines to the machine shop. This is not a matter of crossing the pits (in the case of the longitudinal shop) alone, but is a question of actual distances from the machines to the locomotives.

In this particular case it is an open question whether the accepted plan at Du Bois as to the arrangement of buildings, with reference to each other, could not have been worked out very nicely in connection with a transverse erecting shop and without the use of a transfer table. In other words, given equal facilities for extending the buildings and getting engines into and out of the shop, the advocates of the transverse plan will not consider the case at Du Bois a conclusive argument against their views.

This plant has received most careful study, and the comparison of distances given in connection with the description is worthy of considerable attention. It may not always be fair to compare the distances between departments from their centers, because these measurements do not necessarily show the distances through which the movements of heavy material must pass, but such a study in connection with a shop plan is very important, and it should be a part of the preparations for every new shop.

THE PASS QUESTION AND THE JUNE CONVENTIONS.

The pass agreement, put into effect this year, is likely to affect the work of the Master Mechanics and Master Car Building associations next month unfavorably. A number of roads, chiefly west of Buffalo, have signified their willingness to furnish transportation to members, but nearly all will find it necessary to pay fare east of Buffalo. Of course the progressive roads will urge their representatives to attend and will pay their expenses, but those needing the aid of the associations most may not be represented, because of this extra expense.

We publish a letter dated April 15, from Mr. G. W. Rhodes, Assistant General Superintendent of the Burlington & Missouri River, to the president of the Master Car Builders' Association, giving the views of one of the most faithful and influential members, as follows:

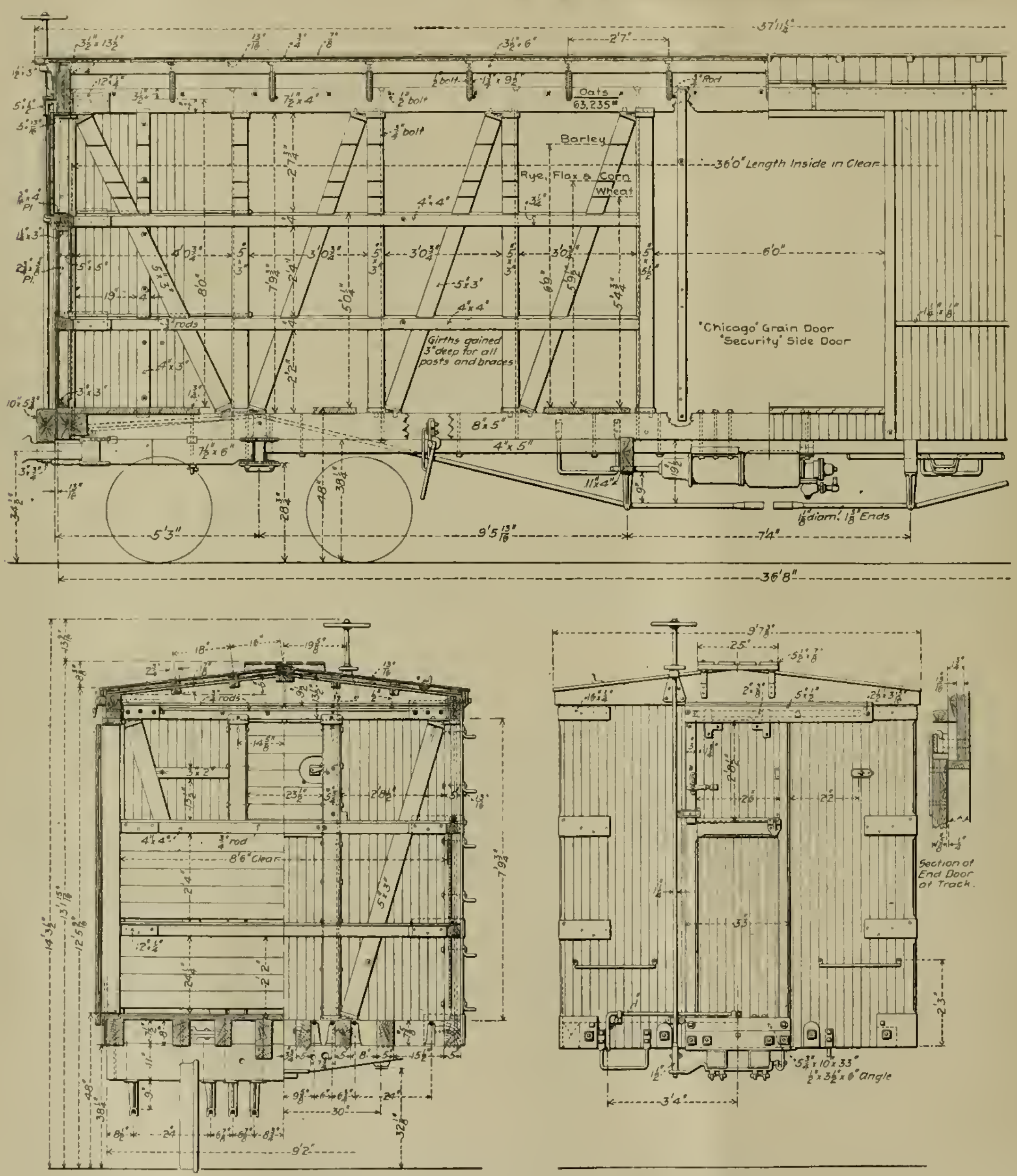
We understand the principal Eastern railroads have decided that they cannot consistently give the members of the M. C. B. Associaton and American Railway Master Mechanics' Association transportation to attend their annual conventions this year at Saratoga.

This, it seems to me, is very unfortunate. These two associations have done more, perhaps, than any other organization in this country to build up the high standard of car and locomotive construction that we now enjoy. Not only does our equipment compare favorably with that of any other country, but the Government has adopted some of our standards, in so far as safety appliances are concerned, and they now form part of the laws of the country.

When the executive committee of our two associations met and selected Saratoga for the place of meeting for the year 1902 they undoubtedly did so on the assumption that the same facilities for transportation would be given to members of the association and their families as has heretofore been given. Since this action was taken the Eastern roads have adopted new rules in regard to transportation, and it seems to me the executive committee, for the good of the association, ought to at once meet and reconsider their action. The gathering at Saratoga, under the present conditions, in the opinion of many of the M. C. B. members, will be a very tame and poorly attended affair. This would be entirely obviated if the executive committee would decide on selecting some Western point for the conventions. Either Chicago or St. Louis has ample hotel accommodations for all the people the associations can get together. The recent successful gathering of the American Railway Engineering and Maintenance of Way Association, held at the Auditorium Hotel, Chicago, has shown clearly that it is not necessary to go East for a successful convention. We have always felt that the Western members hardly got the attention that they ought to have in so frequently holding our annual conventions in the East. There never will be a better opportunity to give the Western members a little attention than now offers, and, voicing the opinion of a good many Western members, we would urge that the executive committees reconsider their action and select some Western town within the pass territory for the June conventions.

The above is not written with the idea of any criticism of the action the Eastern roads have taken on the pass situation. It is written solely in the interest of having a large and profitable gathering at the mechanical men's annual conventions. This would seem to be best served by holding the meeting at the extreme limits of the new pass territorial districts.

It is too late to change the meeting point this year, and it is doubtful whether anything would be gained by such a course. If these pass agreements do not permit of modification or exception for such a purpose, the railroads must pay the expenses of their representatives or they will suffer an irreparable loss. Now that the greatest operative problems are those of the mechanical departments, it is incomprehensible that anything should be allowed to threaten interference with good attendance, which always means the success of such gatherings.



80,000 Pounds Capacity Box Car—Illinois Central Railroad.

Built to Standard Measurements.

80,000 LBS. CAPACITY BOX CARS.

Illinois Central Railroad.

Built to New Standard Dimensions.

This car was designed to meet the American Railway Association standard inside dimensions, and 1,500 are to be built next summer by the Pullman Company. In determining upon the exterior dimensions, careful consideration was given to the recommendations of the committee of the Master Car Builders' Association, as stated on page 17 of our January issue of the current volume. The height of the car at the eaves, measured from the rail, is 12 ft. 5 9-16 ins., which is within the distance recommended. The height of the upper surface of the floor from the rail is 4 ft.; the width and height inside are 8 ft. 6 ins. and 8 ft. respectively; the width at the eaves is 9 ft. 7¾ ins., and the minor recommendations have also been considered. This construction provides for the coupler below the end sill, this member not being cut. There is a strong objection on the part of motive power officers to the cutting of the end sill for the coupler. In this case the end sill is turned on its thicker side and the floor maintained at a height of 4 ft. from the rail. The posts at the end doors are stiffened by plates, as shown in the end view and transverse sections. All the posts and braces are fitted to castings at the plates and sills, and the castings at the upper ends of the end door posts have substantial lips over the end plates to give additional strength at these points. These cars have Chicago roofs, Security doors and Chicago grain doors. Five hundred of them have Fox trucks and the remainder, 1,000, have Kindl trucks. We are indebted to Mr. Wm. Renshaw, superintendent of machinery of the Illinois Central, for the drawings.

THE WATER QUESTION.

II.

(Continued from page 127.)

Incrustation.

Let us take up first the matter of incrustation, which seems the most important. An analysis usually discloses the fact that scale is formed by the precipitation from the water, by means of heat and evaporation, of salts of lime and magnesia. Any method calculated to remove scale already formed should be dismissed at once. To attempt to take out scale after it is formed in the boiler is an effort directed against a result and not a cause. An attempt to remove old scale is merely an attempt to hide the marks of disease, the malady having run its course. It is obvious that any substance powerful enough to dissolve scale would have a tendency to dissolve the metal of the boiler. Many boiler compounds, intended for this purpose, contain ammonium chloride, which, under the heat of the boiler, gives off muriatic acid. That this is injurious to the boiler need not be stated. The treatment of water intended for steam raising purposes so as to prevent incrustation may be divided under the following heads:

Use of Blow Off Cock.—This is efficient only to a small degree, because blowing off can only get rid of matter in suspension or solution in the water, and has no effect upon scale fastened to sheets and flues. All matter in suspension or solution can be blown out of a boiler only by entirely emptying the boiler. The blow off cock is of great use where foaming is caused by the concentration of soluble salts, like sulphate of soda or common salt, in the boiler, enabling the engine man to dilute the concentrated solution with fresh water. Engineers hesitate to use the blow off, due to fear that a piece of loose scale may lodge in the valve and prevent its being closed. Instances of locomotives "dying" on the road from this cause are not uncommon.

Use of Internal Collecting Apparatus or Skimmers.—All water in the boiler must pass this device, which, when it acts, only affects the carbonates. The working condition of such apparatus can only be ascertained by examination inside the boiler.

Heating the Feed Water.—Practice has shown that open heaters are most effective for water purification, but they only affect incrusting solids to a limited extent. The drain upon a passenger locomotive for heating cars is already great. Exhaust steam is not available, being used in all classes of locomotives to produce draft, and the question of carrying an open heater upon a locomotive is open to obvious objection. Heaters are certainly of great value, but from the fact that there is hardly a stationary plant in the country using a heater which does not have scale in the boilers we must draw the conclusion that heaters do not accomplish what is claimed for them.

Filtration.—Some waters carry in solution but a small proportion of scale forming solids, but hold in suspension much mud and silt. For the treatment of such waters filtration is well adapted.

Distillation.—This method without doubt produces a pure water and leaves behind all solids, whether in solution or suspension. Two important points here require consideration. The first is the cost. Below are figures taken from actual experience upon the distillation of water from a common steam boiler:

COST OF DISTILLING 50,000 GALLONS OF WATER IN 10 HOURS.

Conditions:

Condensing water at 60 degrees F.
Boilers and condensers clean.
Coal on track at $1.50 per ton.
Labor ten hours per day at $1.50 per day.
Temperature of steam entering condensers 215 degrees F.
Temperature of distilled water leaving condensers 100 degrees F.
Condensers so arranged that distilled water runs by gravity into storage tank.
Pumping water over condensers 40 feet from ground, 1½ cents per thousand gallons.
Evaporative power of coal, 7.
Twenty gallons condensing water to condense one gallon of distilled water.

Cost:

Thirty tons of coal at $1.50 per ton		$45.00
Pumping 1,000,000 gallons condensing water at 1½ cents per thousand gallons		15.00
Unloading car, one day at $1.50		1.50
Firing, carrying away cinders (about 4 tons), and attendance on plant, 2 men at $1.50 a day		3.00
Interest on investment at six per cent., 5 250-H. P. boilers set and connected	$11,000.00	
Condensers	4,000.00	
Pumps and housing	3,000.00	
	$18,000	
Interest, six per cent., $1,080.		
Interest one day		2.96
Cost of 50,000 gallons		$67.46
Cost per 1,000 gallons		1.35

We have not taken into consideration the use of triple or quadruple effect evaporators, for which claims are made for the production of distilled water at a cost as low as 34 cents per thousand gallons, because machinery of this class is complicated and very expensive. We are informed that a plant to do duty as above described would cost in the neighborhood of $40,000. Aside from the fact that the cost of distilled water is almost, if not quite, prohibitive, we must not forget to consider that by the distillation of water scale is only transferred from the boiler of the locomotive to the boiler of the distilling apparatus. An objection which can, however, be overcome is that distilled water is too pure. It is a well-known fact that pure or distilled water is a solvent of iron. Stationary steam plants using condensing engines and returning condensed steam to the boilers find corrosion or pitting taking place unless a portion of undistilled or impure water is mixed with the returns from the condensers. A distilling plant could be placed between two stations where water could be obtained containing sufficient lime and magnesia to mix with the too pure distilled water and prevent its corrosive action.

Chemical Treatment.

The first thought which naturally occurs in studying this question is the use of some substance which will precipitate the offending material. This material is usually lime and magnesia. Substances having the property of producing precipitates of varying degrees of insolubility with lime and magnesia and other incrusting solids are numerous, and have been introduced by the thousands. The addition to the water in the boilers of any substance having in view the precipitation of the incrusting solids can, from the very nature of the thing, have but one result, namely, to add to the offending material already there. Indeed, if it were possible to remove scale-forming material by treatment within the boiler, it would not be desirable, since the boiler has neither room nor energy to spare for chemical or mechanical operations.

The chemistry of boiler compounds is correct, and has been for years well understood, but a remedy to be effective must be applied in a proper manner, at a seasonable time, and in the right place. Simply because a substance will, when put into hard water, precipitate lime and magnesia, is no reason why this substance should be put into the boiler. Quite the contrary. Heat, without chemicals, causes the precipitation in the boiler, and that is just the thing which is not desired.

Before proceeding to the consideration of the proper place in which to precipitate this offending material, it would be well to consider the substances available for this purpose their efficiency and economy.

The following tables give the amount of the various substances required to precipitate one pound of carbonate of lime, and also one pound of sulphate of lime, and the cost of so doing. Where possible, the figures are taken from the advertisements of persons selling these substances as boiler compounds or for the manufacture of boiler compounds. These substances, though few in number, are fair representations of the class of materials sold and used. It would be impossible to list all of them here. Such a list would require a large percentage of the nouns in the English language.

One pound of carbonate of lime requires for its precipitation:

		cents.
	.56 lbs of lime at .25 cent per pound	.14
or	2.18 " " tri-sodium phosphate at 4c. per pound	8.72
or	.80 " " caustic soda at 2c. per pound	1.60
or	3.15 " " barium hydrate at 2.50c. per pound	7.87
or	11.92 " " tannin extract, 27 per cent., at 2.75c. per pound	32.78
or	2.28 " " sugar at 5c. per pound	11.40

For the removal of sulphates and chlorides one pound of sulphate of lime requires for its precipitation:

		cents.
	.85 lbs. of soda ash at one cent per pound	.85
or	1.94 " " sal soda at .65c. per pound	1.26
or	1.53 " " barium chloride at 2c. per pound	3.06
or	8.76 " " tannin extract, 27 per cent., at 2.75c. per pound	24.09
or	1.68 " " sugar at 5c. per pound	8.40
or	1.60 " " sodium phosphate at 4c. per pound	6.40

An examination of the above tables shows conclusively that lime and soda are the most efficient, and, at the same time, fortunately, are the most economical substances for the removal of scale-forming material from water. They are also the most available, being obtainable at any time in the open market.

Returning to the question of the proper time and place in which to use these chemicals, it seems that but little philosophy is required to conclude that water is no exception to the rule that a thing must be purified before it is used and not afterwards. There are a number of good reasons why it would not be practical to attempt to purify water upon the engine. Most prominent among these reasons are the following:

The constantly increasing number of devices requiring the attention of the engine driver will make it seem best that an apparatus for the purification of water be in charge of some one whose duties are less numerous. The reason which, in our opinion, at once shuts out any apparatus intended for the purification of water upon the locomotive is that locomotives must use several different waters, and any efficient apparatus would necessarily have to be reset to treat varying waters and it is manifestly impossible to provide a mechanism with the guiding instinct to make these variations automatically and without human aid. Coupled with this are questions of space and weight, and the economy of a separate apparatus for each locomotive.

Owing to these facts it would seem that the most logical location for a softening or purifying plant would be at the source of supply. At such a point as this the apparatus would be in charge of the water pumper, or some similar employee, without extra cost for attendance. It is needless to say that such employees are not versed in chemistry, and the apparatus must be so simple that the pumper will have no difficulty in its operation.

Having then decided that the proper place or location of the purifying or softening plant is at the source of supply we must carefully consider the functions necessary to make this apparatus desirable, economical and, above all, efficient.

In the first place this apparatus should be easy of access. It should require no heat in the purification of the water. It should be easily cared for by one not skilled in chemistry. It should require but little time for attendance. It should not give rise to back pressure on the pumps, thus requiring extra steam for operating them. The machine should be continuous in its action. The apparatus should deliver water at such height that it will flow by gravity into the storage tank and not require repumping. It should be automatic, starting and stopping the feed of reagents with the starting and stopping of the flow of water. The apparatus should automatically treat varying quantities of water with varying quantities of material without resetting, and be as economical in the use of these materials as possible. Above all, the apparatus should be of such construction that the liability of freezing is reduced to a minimum. It should consist of as few parts as possible. It should be of such size that the water will take at least three hours to pass through it, so that the reaction may be completed before the water enters the storage tank. If possible the storage tank should be a part of the apparatus.

The use of lime and soda for softening water is called the Porter-Clark process, named for the discoverers. Attempts to use this process directly in the roadside storage tank by pumping into the main supply pipe solutions of lime and soda have resulted in failure, due to the difficulty of making pumps throw at all times the proper amounts of the reagents, and to trouble experienced in getting the precipitated matter to settle in the tank, where the water is agitated frequently by the outflow of water drawn for locomotives. The greatest difficulty, however, has been experienced with the sludge or mud resulting from the process, which generally amounts to 500 or 1,000 lbs. a day, this large amount of mud resulting in the necessity of very frequent cleaning of the tank. Apparatus, filling to a greater or less degree the requirements of an efficient water softener, are now upon the market, some of which are meeting with very gratifying success. An apparatus meeting the requirements as stated above should be all that is desired.

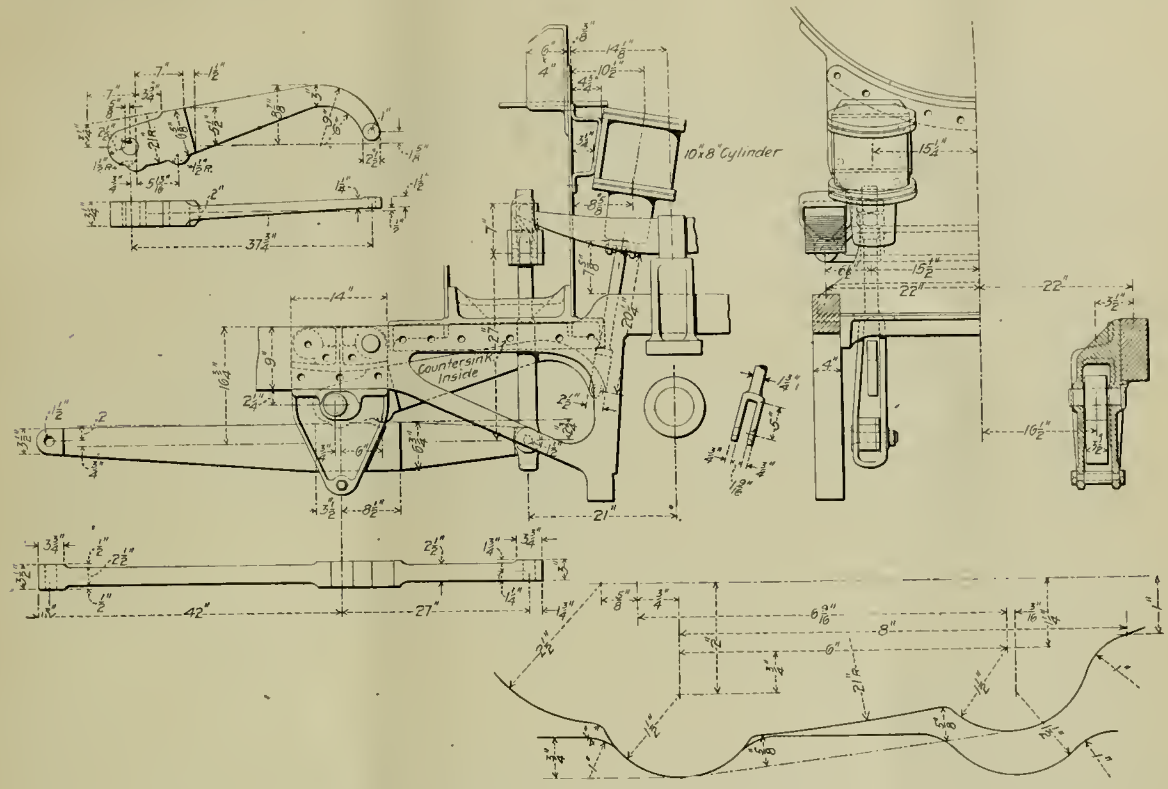
We have taken up here the treatment of waters for the removal of scale forming solids only. Corrosion and foaming are due to causes apart from scaling, and are subjects for further consideration.

AN IMPROVED SAND DRIER.

A drawing has been received from Mr. Charles Linstrom, mechanical engineer of the Chicago & Alton, showing the construction of an improved drier devised by him for drying locomotive sand. This improvement consists in the introduction of a coil of pipe in the drier of the usual form, by means of which the vapor from the wet sand finds a ready means of escape from the mass of the sand. In this construction the vapor, as it is driven out of the sand, passes through small holes in the bottom of the coiled pipe and escapes to the smoke flue or passes outside of the drier. If such a precaution is not taken the vapor may not be entirely driven off, which results in leaving portions of the sand wet so that they may clog the sand pipes, or it may accumulate a pressure which either dislodges the sand from the heater or bursts it. Furthermore, the retention of the moisture reduces the capacity of the apparatus. In this device the lower end of the pipe is closed with a cap, which may be removed to empty the pipe from possible collections of sand. In a comparison made at Bloomington Mr. Linstrom found the following results:

	Without coil.	With coil.
Sand dried, pounds	6,870	7,425
Coal used, pounds	346	320
Duration of comparison, hours	10	10
Increase of capacity, per cent	.....	8
Reduction of coal, per cent	.....	8

The Kansas City Belt Railway has recently received a large switching engine from the Baldwin Locomotive Works. It is intended to operate over $1\frac{1}{2}$ per cent. grades. Its total weight is about 185,000 lbs., and it is of the four-wheel-coupled type, with wheel base 15 ft. 4 ins. The leading and trailing wheels only have flanges. The cylinders are 21 x 32 ins. An inside admission piston valve, 10 ins. in diameter, is used. The steam pressure is 210 lbs. Driving-wheel diameter, 57 ins. This powerful engine exerts a tractive force of 44,190 lbs., the adhesive ratio under ordinary conditions being 4.1. The heating surface is 2,666 sq. ft., of which 220 is in the firebox, and the grate area amounts to 33.5 sq. ft. The tender is of the sloping back type, 4,000 gallons capacity, and is carried on two Player cast-steel trucks.



Locomotive Traction Increaser.
American Locomotive Company.

LOCOMOTIVE TRACTION INCREASER.

American Locomotive Company.

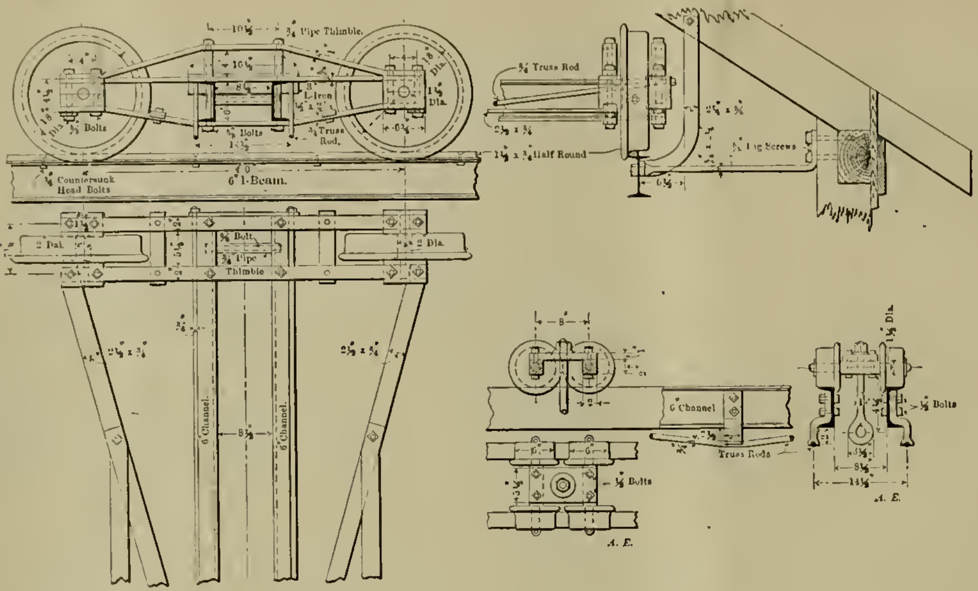
In order to temporarily increase the weights on the driving wheels for the sake of increasing the tractive weight of locomotives in starting trains, a number of different "traction increasers" have been devised by the locomotive building firms. On page 39 of our February number of last year the Schenectady design was illustrated in connection with the large passenger engines of the New York Central. On page 372 of the December number a design for applying the same principle to prairie type Baldwin locomotives for the Santa Fe was shown, and the present illustration was prepared to show the arrangement devised at the Brooks works of the American Locomotive Company for application to "Chautauqua" type engines recently built for the Pere Marquette.

These engines are similar in their general features to those of this type which we have illustrated, a typical example of which will be found in the April number of 1901, page 101. The traction increaser is applied to the trailer equalizers and is apparently of the simplest possible construction. It consists of a 10-in. air cylinder, a piston, piston rod and a lever whereby the equalizer fulcrum is moved a distance of 6 ins. by rolling the levers into their new positions under the pressure of air in the cylinders. The fulcrum lever is always in contact with the equalizer, and the location of the normal projection on the lever is such as to cause the weight of the engine to tend to raise the piston in the cylinder and keep the device in its normal position. A glance at the engravings will make this clear.

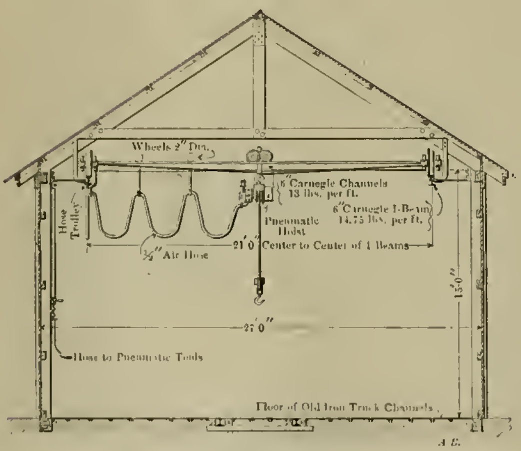
This particular case was worked out to increase the weight on drivers about 8,000 lbs., but this amount may be varied in different constructions as desired.

The Southern Pacific Company recently contracted for seventy-two steel tanks for the storage of fuel oil. About 50,000 barrels is to be the average capacity of each tank, and the entire storage capacity of this new equipment will equal 3,600,000 barrels. Thirteen tanks are now in use, ten west of El Paso and three east of that city. They hold altogether the contents of 650,000 barrels. When the new steel tanks are delivered, twenty-one will be placed on the lines between Los Angeles and San Francisco, Cal., and Ashland, Ore., thirteen between Los Angeles and Deming, and thirty-eight will be placed along the company's lines in Texas. This road has 125 oil-burning locomotives west of Ogden and El Paso, which is about one-third of the total number of engines in use. East of El Paso about eighty locomotives have been converted into oil burners.

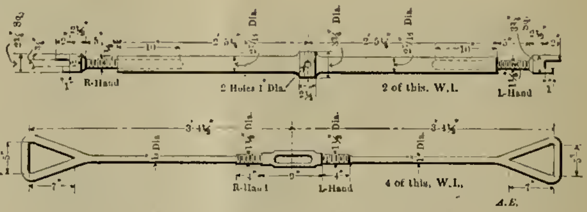
A long-rail experiment is being made on the Michigan Central Railroad. It consists in butting together perhaps seventeen 30-ft. rails without any allowance for expansion, with splices screwed up very tightly with machine-made bolts, thus securing practically a 500-ft. rail. At the ends of this long rail specially designed slip joints are used, where expansion is fully provided for. At Detroit, where a number of these composite long rails are being tried, the center is anchored by bedding several ties in a concrete foundation and slot-spiking the joint splices. At Saginaw, where more of these long rails are being tried, the anchoring of the center is accomplished by bedding a 15-ft. vertical rail in concrete in a hole excavated in the roadbed. The top of this anchor rail fits into a notch in the horizontal leg of a splice bar on the track rail. Mr. A. Torry, chief engineer, is conducting these experiments.



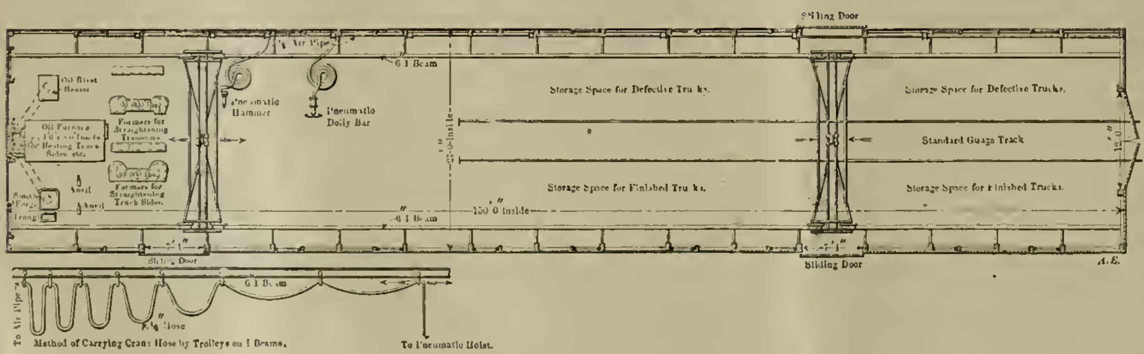
Details of Cranes for Handling Trucks.



Cross Section of Shop.

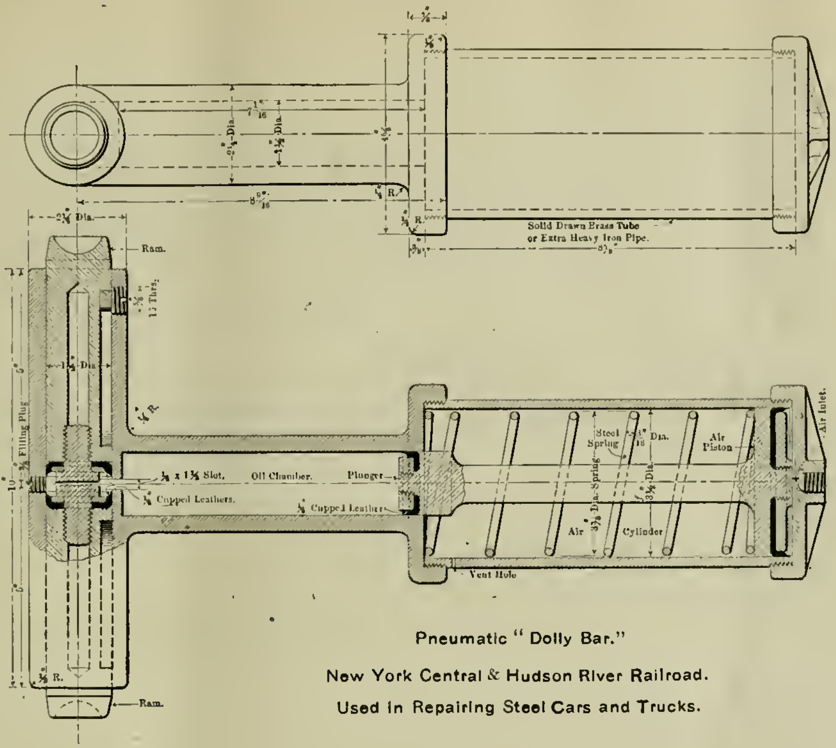


Push and Pull Jacks for Straightening Plates.



Shop for Repairing Steel Freight Trucks.

New York Central & Hudson River Railway.



Pneumatic "Dolly Bar."

New York Central & Hudson River Railroad.

Used in Repairing Steel Cars and Trucks.

SHOP FOR REPAIRING STEEL FREIGHT CAR TRUCKS.

New York Central & Hudson River Railroad.

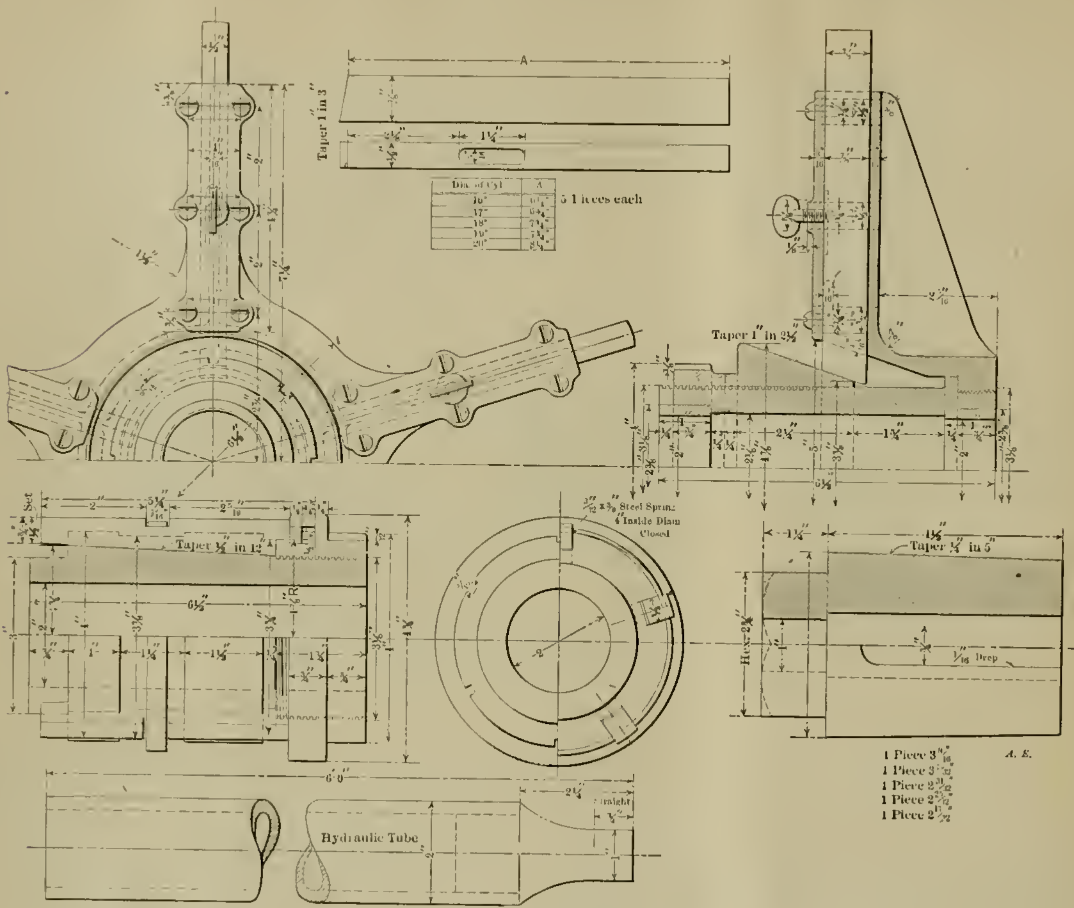
Steel freight trucks requiring repairs on the New York Central Railroad are all sent to East Buffalo, where a convenient shop has been equipped with special facilities for dealing with them. This shop is 150 ft. long by 27 ft. wide, and is equipped with two traveling cranes running the full length of the building, the cranes being fitted with pneumatic chain hoists, which permit of holding the trucks in any desired position for riveting. The present output of this shop is 60 trucks per month, at a cost of $2.65 for labor and $6.75 for material, or $9.40 per truck, including all labor and material from the arrival of the trucks until they are stored ready for use again. This cost has been reduced from an average of $26 per truck, the expense necessitated by tne previous method of sending the trucks to the builders for repair.

This shop is equipped with pneumatic drills and reamers, a hydraulic hand punch and a pneumatic hammer, for riveting. For bending plates and transoms pulling and pushing jacks are used. For riveting a pneumatic "dolly bar" is employed. It has a holding pressure of 1,000 lbs., and employs air pressure in the large cylinder, which forces oil into the small holding cylinders. These devices are illustrated in the engravings, which also show the construction of the travelers and the method of transmitting air pressure for hoisting. Cast iron formers are used for the side frames of the trucks, and the plan view of the shop shows the locations of the furnace, forge and rivet heater. The "dolly bar" has an extension piece to reach across a truck.

Nearly all the trucks repaired at this shop are damaged through unfair usage. Only about 2 per cent. are damaged otherwise. With more than 55,000 pressed steel trucks in service on this road, and the records cover three years, not one accident has occurred through a failure of one of them. Mr. F. A. Brazier, assistant superintendent of rolling stock of the road, is authority for this statement, and he also says that within the last two months 17 arch bar trucks have broken on that system, causing in some cases quite serious accidents. Of these 17 trucks, 13 had broken arch bars, and the other 4 were cases of broken column bolts.

We are indebted to Mr. A. M. Waitt, superintendent of motive power and rolling stock, for these drawings.

A snow plow with a "turntable attachment" has been put into service on the Delaware, Lackawanna & Western Railway. As illustrated in the "Railway Review," a turntable track about 5 ft. in diameter is built on the front truck. At or near the center of the plow, or rather at the balancing point, there is a bolster with a center bearing arranged to fit the truck, and six wheels, 8½ ins. in diameter, radially disposed, are located so that they will bear upon the turntable track. At the front are two cylinders, placed vertically, and operated by compressed air. The outer ends of the piston rods bear upon blocking placed upon the ties, and when air is admitted to the cylinders the front end of the plow is raised as upon air jacks. When in this position the front truck may be pushed back under the central bolster and the air released. The whole plow is then carried on the turntable truck, with the rear truck hanging clear of the rails. It is said that three men can then turn the plow around. Air is again used to take the weight of the front end, and this places the rear truck down on the rails and frees the turntable truck, which can be pushed forward to its normal position and the front of the plow lowered upon it. The advantages of this arrangement are obvious. The forward truck, when in turntable position, can be more easily oiled and examined than when closely housed under the nose of the plow. The plow can be turned at any point on the road, and is, by reason of its construction, even more satisfactory than a double-end plow. This form of plow obviates the necessity for an intermediate turntable or Y as far as snow plows are concerned.



The Aurora Guide Setting Bar.
Chicago, Burlington & Quincy Railway.

A CONVENIENT GUIDE SETTING BAR.

Chicago, Burlington & Quincy Railway.

In various shops of the Chicago, Burlington & Quincy the cost of lining up guides has been greatly reduced by the use of the device which is illustrated in the accompanying engraving. It is also in use at the Baldwin Locomotive Works and at the Pittsburgh works of the American Locomotive Company. It is called the "Aurora Guide Setting Bar," which would lead to the conclusion that it was devised at the Aurora shops of the "Burlington."

The guides are set by means of a crosshead plug carried on a bar 6 ft. long, which appears in the lower left hand corner of the engraving. It is held in line with the cylinder by two guides, one being in a spider fitting the bore of the cylinder and the other is in an expansible mandrel fitting the packing opening in the back cylinder head. The method of setting the arms of the spider with the taper bushings and use of the mandrel for the other support are made clear in the drawing. Five lengths of arms are provided for the spider and five plugs for the crosshead fit. The construction is ingenious. A complete bar costs about $90, and it reduces the cost of setting guides fully one-half, besides making a positively true alignment.

THE HEAVIEST LOCOMOTIVE IN GREAT BRITAIN.

The tendency in modern locomotive engineering practice is to provide boilers and fireboxes with maximum possible capacity in respect to steam generation. In dealing with this matter, effective heating surface plays a very important part. Mr. Chas. R. Rous-Marten, in a recent issue of "The Engineer," discusses some features of this modern tendency. Large and powerful boilers, however, are not all; it is, at the same time, necessary to develop the means by which the gain in boiler power can be practically utilized, and turned into effective haulage. The Great Western Railway of England has lately turned out, at its Swindon shops, what is said to be the heaviest engine in Great Britain. Mr. William Dean's new machines weigh, in working order, without tender, 69 tons. The boiler is 14 ft. 8 ins. long, with a Belpaire firebox, 9 ft. long. The total heating surface is 2,400 sq. ft. and the steam pressure is 200 lbs. per sq. in. The driving wheels are 80½ ins. in diameter, and the cylinders, placed outside, are 18 x 30 ins. These engines will have 121.5 lbs. tractive force for every pound of mean effective pressure, and about 50 tons of adhesive weight with which to utilize it. These engines, when compared with others in England, are found to be two tons heavier than Mr. W. Wordsell's North Eastern six-coupled type, and ten tons heavier than Mr. Aspinal's large engines on the Lancashire & Yorkshire.

COMMUNICATIONS.

TREATMENT OF SPECIAL APPRENTICES.

To the Editor:

I have read with considerable interest the communication signed "A. A. G." in your March issue, and must say that my personal experience has not contained any such disagreeable incidents as he mentions. In fact I have invariably received the most courteous treatment in various shops and am usually able to obtain considerable information and keep on the right side of the men. I have never heard of any deliberate attempts to injure special apprentices, but, on the contrary, have been warned whenever I have carelessly or ignorantly exposed myself. "A. A. G." should try another part of the country.

There is no doubt but that the wages paid to college men entering railroad work as special apprentices are very low and do not offer much inducement. In my humble opinion, however, the average college man who has not had any practical experience is of very little value to a railroad company until he has acquired that experience and realized that his college degree does not make him a superior being who should be paid for existing.

In general, I think that if a college man will forget his fancied superiority, he will be able to acquire a great deal of information concerning practical questions, and that he will also learn that it is not necessary to be a college graduate in order to be a gentleman.

Chicago, April 1, 1902. "Q."

[Editor's Note.—This view of compensation will be approved by all. Inducements to enter shops will not bring good results. The promising future before a successful mechanical railroad officer ought to be sufficient. Coddling does not make strong men.]

LOCOMOTIVE CINDERS AND SPARKS.

How cinders are made is an exceedingly interesting topic—a "hole" in the fire, friable coal, or light particles not cemented together with water, thrown into that strongly pulsating storm center of air and gas, flame and carbon, which is found in the locomotive firebox, when the engine is working hard; these are the conditions favorable to the formation of sparks and cinders. Prof. W. F. M. Goss, of Purdue University, discusses this whole subject most interestingly and instructively in a book just published, entitled "Locomotive Sparks." A series of careful experiments have been made at the university and on the road, and it is very likely that Prof. Goss' work will be at variance with many time-honored, but unverified, theories. The loss of fuel by cinders and sparks, when tabulated, forms interesting reading. In seven tests the ratio of total weights of cinders and sparks to weight of coal fired varied from .043 to .138, but when it comes to the heating value of this matter thrown from the stack or retained in the front end, we are told that under ordinary working conditions more than 13 per cent. of the fuel which passes the furnace door may completely pass the heating surface of the boiler unconsumed, and this figure may even go up to 20 per cent. if the rate of combustion is sufficiently increased. There is no doubt that the weight of cinders thrown from the stack is greatly in excess of that retained in the smokebox; in fact, modern practice aims at a self-cleaning front end. The book is full of interesting points, which are often not so much not known as overlooked, and it is satisfactory to see them duly placed in order. The conclusion concerning the distribution of sparks in a stack is shown graphically. They follow most readily those portions of the stream issuing from a stack which have the lowest velocity. One may see the same thing when watching the flow of water in a brook; leaves and small twigs will more often hug the shore, where friction along the banks decreases the velocity of water on each side.

In summarizing the results of tests made beside the track of the Lake Erie & Western Railroad, at a point about halfway up a steep grade, Prof. Goss says the greatest number of sparks fell at from 35 to 150 feet from the center of the track, the pans from 15 to 20 feet away usually caught fewest sparks, and no scorching of the cotton which lined the pans was in any case observed. It may be stated that the tests were made in April and May, when there is a certain amount of moisture in the air. Beyond 125 feet the sparks were of such a character as to preclude the possibility of causing fire. In March preceding the tests, when a light crust of snow covered the ground, it was possible to trace evidence of dust from passing engines 800 feet from the track. It might here be mentioned that the "output" of the stack contains a certain percentage of pure ash.

In the matter of "throwing fire," Prof. Goss gives tables showing the distance to which sparks and cinders may be blown when falling from different heights with winds of varying velocities, and also when projected vertically from the assumed height of the stack, 15 feet. In these tables the acceleration due to gravity is taken, as is usual in mathematical calculations, at 32.2 feet per second. This is the true acceleration if a body falls in vacuo. As a matter of fact, the sparks and cinders fall through, and are retarded in, the atmosphere, therefore, by a very ingenious series of laboratory experiments on falling cinders, a new and approximately correct value was worked out. As mathematicians would probably say, Prof. Goss' new "g" fits the locomotive cinder problem more closely than the theoretically correct value. This value is given as 22.72. Based upon this new factor, the two tables previously given are re-stated, and sparks and cinders travel further afield, but even with this allowance for slower falling, the cinders, under the calculated effect of wind, do not appear to go to any extraordinary distance. In fact, the largest individual specimens of cinders were found, in actual practice, within a distance of 100 feet from the track. This practically fixes the danger line, and further, the motion of the train itself may, and no doubt does, often modify or neutralize the action of the wind.

This study of the subject is of great value to those interested in the details of locomotive operation, or who love experimental science for its own sake, but counsellors-at-law, called upon to defend a railway company on the charge of having thrown sparks capable of starting a conflagration, will find much matter within the pages of this little book to lay before the judge and the "twelve good men and true." The book is published by John Wiley & Sons, 43 East Nineteenth street, New York. Price, $2.00.

APPROXIMATE FORMULA FOR THE WEIGHT OF WATER IN LOCOMOTIVE BOILERS.

The following formula will give approximately the weight of two gauges of hot water in a locomotive boiler:

Weight in lbs. $= (ad^2 - bt)\ l \div cfk$, where

$a = .0227$

$b = .0991$

$c = .653$ for narrow fireboxes, say 40 ins. wide.

$c = .706$ for wide fireboxes, say 75 ins. wide.

$c = .976$ for very wide fireboxes, say 100 ins. wide.

$d =$ the inside diameter in inches of first ring of straight boilers, or the average of the inside diameters of the smallest and largest courses of other types.

$t =$ the number of 2-in. tubes; for other sizes multiply the number by the square of the diameter divided by four.

$l =$ the length in inches of the tubes over the tube-sheets.

$f =$ the length in inches of the firebox, at the bottom, inside.

$k =$ the depth in inches of the firebox, at back.

This, as all other simple formulæ for finding weight of water in a boiler, is only approximate, and is not intended to take the place of a careful calculation based on the boiler drawing, but is a ready means of forming an opinion as to the weight of water from the specification before the drawings have been laid down.—George F. Summers, in the "Railroad Gazette."

METALLIC PACKING FAILURES.

A prominent superintendent of motive power is reported to have said that he thought the leakages through piston rod and valve stem packing were nearly as great in volume as the steam that went up the stack. This humorous exaggeration, however, serves to emphasize the fact, true of other things as well as steam, that small leaks will in the aggregate amount to very serious losses. In discussing the Master Mechanics' committee report, last year, on what is the most promising direction in which to effect a reduction in locomotive fuel consumption, Professor Goss, speaking of steam pumps, said that he had found leakage losses of steam to be, in some cases, 2 per cent. and in others 5 per cent., and this, he said, suggests the probability that the steam leaks from a locomotive, even in good condition, result in losses which are too great to be overlooked in any close analysis of the subject.

There is no doubt that it is through the packing of valve stems and piston rods that a good deal of locomotive steam leakage takes place, but like the comparison recently made between a car bolster failure and a drawgear failure, the former does not put the car out of service and is thus, in many instances, neglected. A packing failure is not as serious on the road as an airbrake failure, and does not compel attention in the same way. The packing failure is none the less serious, however, though the results are economic loss rather than operating delay. This may account for the fact that packing is often subjected to treatment which, bringing its natural result, would hardly be described by our M. C. B. friends as "failure under fair usage."

Some of the common causes of failure of packing may be that the babbitt rings are made entirely too hard. In the use of this form of packing, the principle of the "flow of metal" must be relied upon almost entirely to secure good results. Often, it is found, the vibrating cups are elliptical, and so bear unevenly upon the rings. In making repairs the ground ball joints may not be examined as carefully as they should be, and that brings us to the point of cost. In instituting piece work prices for such work, care should be taken not to produce conditions which in practice work out so that it is to the advantage of a workman simply to renew a set of rings, when leakage is reported, rather than to look for the real cause.

Sometimes leaks from cylinder heads, steam chest joints, relief valves, etc., if inaccurately reported by enginemen as packing troubles, may lead to much more being charged against this item of engine maintenance than should be. Injudicious cutting of packing rings, and bad workmanship, in the matter of repairs, may also run up a bill against the otherwise innocent packing, which a court of equity would in fairness be compelled to rule out. There have been packing failures noted on engines just turned out of the repair shop. Such failures have, in specific cases, been traced to the fact that piston or valve rods have been allowed to "knock about," so to speak, on the shop floor, while other work was in progress. It is, however, safe to say that manufacturers of metallic packing would be at all times most ready to instruct railroad employees as to the care of and the manufacture of repair parts.

One large road, remembering the days when the engineer did his own work, was recently reported as going back to the use of hemp packing, on account of trouble with metallic packing. Steam pressures are higher and temperatures higher in steam chests and cylinders nowadays, and the attempt had to be abandoned after a trial of a week.

A good quality of metallic packing, properly applied, should make at least 5,000 miles per set of rings, but here again the "fair usage" idea is essential. The rods must be finished perfectly true, preferably by grinding on a rigid machine, and they must be adequately lubricated. Furthermore, excessive wear must not be allowed to destroy the close fit necessary for the best results. It has been noticed in some instances that a road having trouble with one brand of metallic packing will apply another with very good results for a time, but eventually the second gives no better results than the first, owing, it is claimed, to want of due care and watchfulness.

A very great saving would probably be effected if metallic packing, when not bought directly from the manufacturer, was made in some one shop on the system. This would insure uniformity of quality and workmanship. With all such improvements it is, however, always necessary to educate those who make and those who use the shop product. It may be that, for a time at least, the services of a specialist in this line would produce good results. There is no mystery connected with the efficient maintenance of metallic packing. If it is not closely looked after it will not do its work properly, any more than will any other mechanical contrivance. At least, the packing should all be made at one point and distributed to the various storehouses.

Why is it that the same packing which runs for from two to five years on the shop engine will last perhaps only a week on a locomotive? Of course, dust and dirt have some bearing on this, but it does not explain such a difference. The solution of the difficulty is to either buy the repair parts from the manufacturers or appoint a specialist to have charge of the entire packing question, and one well prepared for his duties by studying the subject at the works of the manufacturers as well as on the road. If this matter is taken up systematically it ought to be easy to save $1,000 per month on a road having 1,000 locomotives. We have figures from actual service to substantiate this statement.

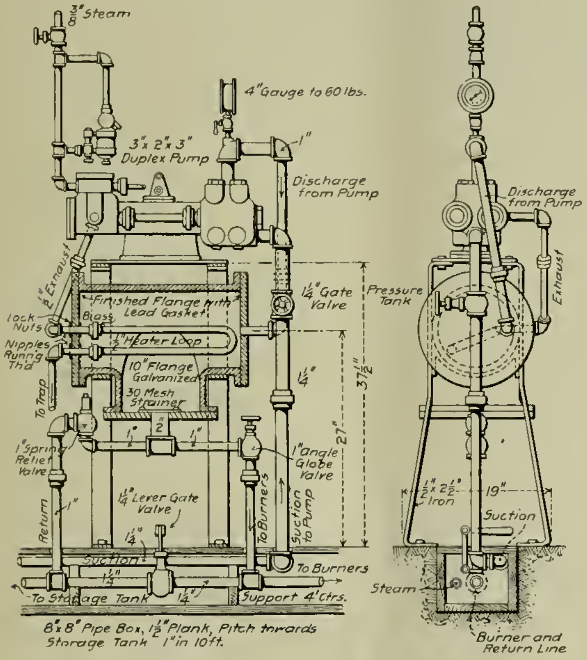
THE STEAM TURBINE.

The steam turbine, in gaining its position in modern engineering practice, is not so much an example of retrograde evolution, but is, what Darwin would have called a "reversion to original type," it being the oldest form of steam motor known. The advantages claimed for the type installed in the Hartford, Conn., power-house are that it occupies about half the space required by a reciprocating engine of equal capacity. Wear is minimized by its having only two bearings. It has a lower fuel consumption, and fewer parts requiring cleaning or repairs. Its first cost is less, and being coupled directly to the shaft, no power is lost in belting or gearing. In order to prevent vibration, running at the high speed it does, the bearings are made of a number of concentric rings of brass fitted loosely, one within the other, the annular spaces between them being filled with oil. This forms a sort of self-centering cushion which prevents vibration, and assists the shaft to seek its true center while running. This machine is extremely sensitive to the governor, which is of the ordinary ball type, and is adjustable so as to run within a variation of a fraction of 1 per cent., between full load and no load. The Hartford turbine with no load will run for 20 minutes after steam has been shut off. Increased economy in operation generally means greatly increased complexity of parts and a rise in some of the maintenance charges, but this is not true of the turbine. The generator to which this Hartford machine is coupled is rated as a 1,500 killowatt high speed alternator. The turbine is operated with 150 lbs. steam pressure, and running at 1,200 revolutions per minute, should develop about 2,000 h.p. of effective energy. It is interesting to reflect that if the steam turbine is found to be a practical and truly economical substitute for the reciprocating engine, it proves that a vast amount of study and work has been thrown away upon the reciprocating steam engine, which in its highest development is inferior to this more primitive type, in which steam passes directly through the mechanism, and thus, strangely enough, avoids everything for which the mechanical engineer has striven for a century.

A PUMPING SYSTEM FOR FUEL OIL BURNERS.

By William D. Hoffman.

The increasing use of oil as fuel has brought out improved methods of handling and storage. Where the oil must be distributed over considerable distances, the pumping system shown in the accompanying engraving, which was designed by the writer some years ago, has proven an efficient means of supply for any number of oil burners within the range of the pump. The 10-in. T acts as a reservoir for the oil under pressure, the upper part of the T being an air chamber. The openings are closed by blank flanges, and the joint made with a lead gasket. The exhaust from the pump is carried through the coil inside of the T, so as to heat the oil when necessary, and it may be noted that all fuel oil lines should be laid in a box with a steam heating pipe to secure the best results from the fuel when it reaches the burner. The oil is discharged from the reservoir through a 2-in. opening, which



A Pumping System for Fuel Oil Burners.

is reduced by means of a T to two 1-in. branches. One of these branches goes to the burner line, while the other furnishes a relief for surplus oil through the relief valve back to the storage tank. I consider this superior to relieving the surplus oil back into the suction. The burner line is connected to the return line to the storage tank through the lever gate valve shown below the center of the reservoir. Opening this lever gate valve drains the entire system, and also the burner line, back into the storage tanks. In case of accident the stoppage of all burners may be made instantaneous by opening the lever gate valve, and the oil is returned to the storage tanks through the return line. The pump may be set, as shown, on the frame which supports the reservoir, or in any convenient location near the reservoir. The relief valve may be set to open at any desired pressure indicated on the gauge. In cases where the burners are operated at intervals a pump governor operated by the pressure from the reservoir will prevent any decrease of the pressure on the oil. By removing the blank flanges on the T the interior is accessible. A galvanized T is best, as it prevents any leakage through sand holes in casting. This pumping system being made up of simple parts, it may be easily constructed at a low cost.

[Mr. Hoffman's address is 102 Purchase street, Boston, Mass.—Ed.]

VISION, COLOR-SENSE AND HEARING.

The important point in Dr. Charles H. Williams' paper on "Vision, Color-Sense and Hearing," recently read before the Western Railroad Club, is that a man may pass the colored-worsted test, and yet have defective color sense for colored lights at night. He showed that the lantern test, by reason of its different intensities of lights and its smoked glass lenses, approximates closely to actual service conditions. It can be made to show a light which, by size, can be made to represent a switch or signal light at short range or at a distance of 1,500 ft.

The reason why the lantern test is efficient is that it shows whether or not the central portion of the retina of the eye is affected. It is upon this central portion that the rays from a distant object are focused. When the colored object is large enough or when it is near the eye, its image may extend beyond the affected part of the retina and its color will be recognized. When the retinal image is small and falls entirely within the defective central area, the color is easily mistaken. This central defect is frequently found in the case of men who use tobacco to excess, especially when combined with alcohol.

Test cards on the market, for ascertaining acuteness of vision, were found to vary so much in size of letters, that special cards were prepared in accordance with rules laid down by Prof. Snellen. These cards are published by the Rand-Avery Supply Company, of Boston. An example was given of a man who had learned the smallest line of letters, and apparently read it easily. The examiner discovered the fraud by unexpectedly asking him to read the next larger line. The way to avoid such a difficulty is by having three cards printed, with a different arrangement of letters on each, for each of the given distances. Then if the letters on all three cards have been committed to memory, the subject for examination cannot tell which of the cards will be held up, and he cannot read them unless he can see them.

The hearing test requires that a man shall hear with one ear at a time, words spoken in an ordinary conversational tone at a distance of 20 ft., and be able to count the ticks of a ratchet acoumeter.

The use of glasses is to be permitted for reading train orders, but they are not otherwise to be worn on duty, except in the case of telegraph operators, station agents, section foremen and crossing flagmen. The paper contains the rules which are in force on the New York, New Haven & Hartford, with a discussion of each rule. These rules have been in use for three years.

Speaking of keeping hard times away, a Pullman official recently said that his company was working with its entire production for this year sold, and at the rate of one thousand freight cars and one hundred passenger cars per month. The company employed six thousand men, and the full capacity of the Pullman plant was now being tested. This unexampled prosperity was not the exclusive experience of the Pullman Company; all the big, leading industries of America are feeling it too, and as no trade breaks off suddenly, he thought that from forty to seventy-five per cent. of present prosperity would continue during 1903, and that would certainly keep hard times away for at least another complete year.

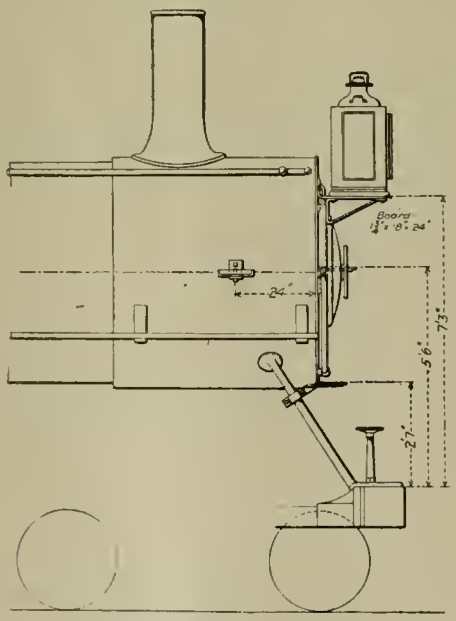
HOW TO KNOW STEEL.

I have often seen a machinist pick up a bar of metal covered with rust and dirt and wonder whether it was tool steel or machine steel. Now, there are a number of means of finding this out, but the emery wheel test, while not a particularly refined method (it will not tell you everything about a steel) is as quick and handy as any. To test a piece, touch it lightly against a dry emery wheel and observe the sparks as they strike the frame of the machine. A high-carbon steel gives a spark which apparently bursts into a brilliant star-like point of light when it strikes against anything. The spark from a low-carbon steel is, on the contrary, merely a dull, incandescent particle. All the air-hardening steels I have noticed give a very red spark. By the way, some air-hardening steels can be greatly improved by heating to a bright red and quenching in oil. In grinding after this care should be taken not to start the color.—American Machinist.

LOW LOCOMOTIVE HEADLIGHTS.

Chicago & Northwestern Railway.

Headlights are often placed on top of the smokeboxes of locomotives, where they are frequently subjected to high temperature, and with the gradual increase in the length of boilers they give a cramped appearance when placed close up to the stack. On several roads the location has been changed, with advantage in the condition of the headlight, and in the



Low Headlights on Smokebox Fronts.
Chicago & Northwestern Railway.

appearance of the engine. The headlights on the large engines on the Chicago & Northwestern have been changed in accordance with the accompanying sketch, which shows the construction of the brackets and the steps. This location brings the light down nearer to the rails, which is important in the case of large engines.

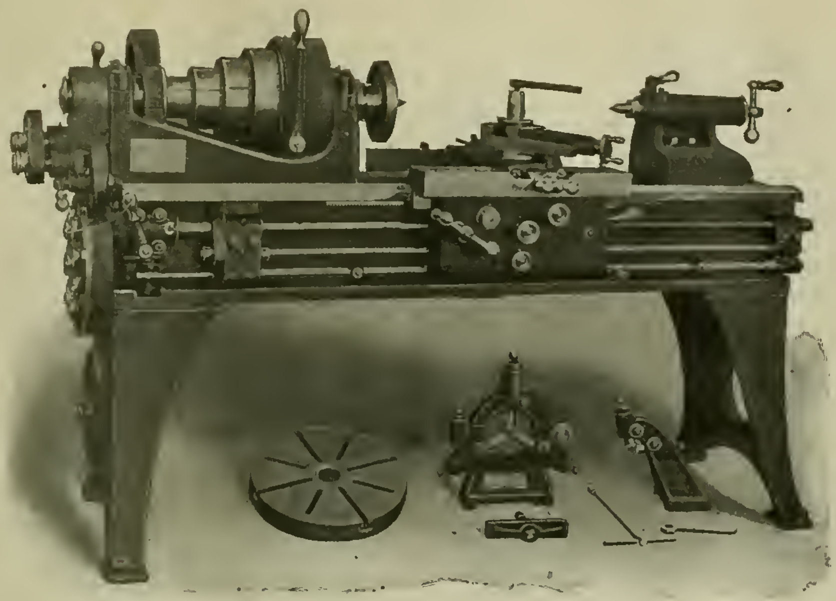
TEAM WORK IN COMMERCIAL ENGINEERING.

"The future lies in team work," said Mr. Charles Kirchhoff, in an address recently delivered to the students of Sibley College. This is true, as he points out, because "our industries are destined to be controlled more and more by larger units, the modern consolidations." In this most suggestive address on the Commercial Side of Engineering, the editor of the "Iron Age" lays down the principle that it is by the achievement of commercial results, rather than simply the attainment of technical excellence, that the work of the engineer must be judged, and though the engineer may not at first look with entire satisfaction on such an idea, it is, however, fair and equitable. It is true that a clever sale or a timely purchase made by the business manager of a large industry may make a spectacular appeal to the average stockholder, but a small, cost-reducing technical improvement made by the engineer is a saving which, though it may attract less outside attention, is not of merely passing value, but is a positive advantage for all time.

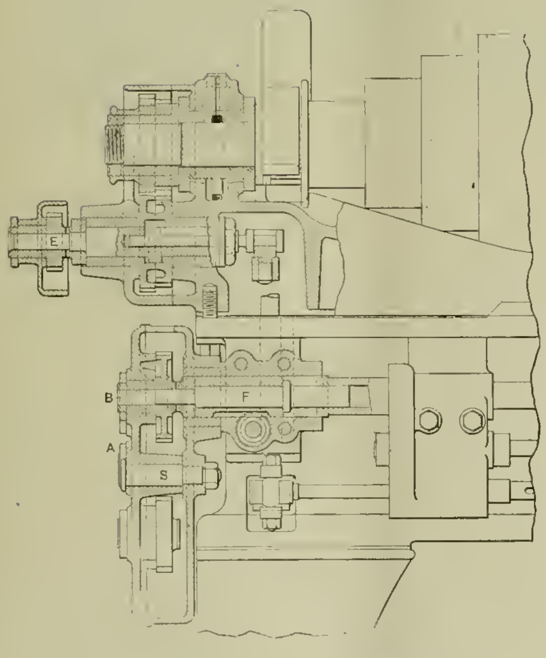
The system of the United States Steel Corporation is taken as an example. The object of that corporation, while it endeavors to eliminate competition outside, fosters competition and rivalry between its various plants. A committee is formed among the managers of special branches of steel making in the different works. Each committee meets to study costs, methods of comparison, etc., and a record of the conference is kept. This system broadens the views of those upon whom it operates, and its educational value is beyond question. Every special appliance, every minor manufacturing kink, once jealously guarded, is now the property of all. In fact, there is a constant interchange of all that is best, and a consequent weeding out of faulty or expensive methods. The practical standard of excellence is the average cost of the six best managed plants, and the others are expected to reduce their expenses, with due allowance for circumstances, to conform with this actually attainable cost. In some such way it is possible that good results could be obtained on railways, by the pitting of one division against another in friendly rivalry, but the essence and beauty of the steel corporation system is that the methods and the ideas, and we might almost say the appliances, of each are the common property of all. The system has in it, after all, less of the feeling of hostile competition, but more of the spirit of a team which is learning to play the game together.

In this country those who can afford the luxury have private cars, but English nobility has gone a step further in the case of the Duke of Sutherland, who has a whole train, which was built specially for him at the Wolverton Works of the London & North Western Railway. It contains a large saloon for dining, a private sitting room, berths, luggage spaces, kitchen, pantry and lavatories, the whole connected by a series of handsomely decorated vestibules and corridors. Viewed, even from the outside, the train presents a sufficiently striking appearance, with its dark green enameled panels, picked out with cream and gold. Internally the fittings are of the most elaborate description. The principal saloon has a figured lincrusta roof in white and gold, with side panelling to match. All of the couches and easy chairs are upholstered in green figured tapestry, and the friezes and window curtains are of rich green silk. Velvet pile carpets cover the floors of the principal compartments, and cork linoleum is fitted to the corridors, vestibules, kitchen and lavatories. Electric lighting is used throughout, and there are also electric bells in the attendants' compartments, and electric fans for hot weather. For heating in winter, stoves on the hot-water high-pressure system are provided.

Last year the Lake Shore increased its revenue freight 10 per cent.; mileage of loaded cars 7 per cent. The average load per train increased 16 per cent. and the mileage of freight trains decreased 5 per cent.



New Engine Lathe—Springfield Machine Tool Company.



Section Showing Change Gear Mechanism.

THE "IDEAL" ENGINE LATHE.

With Rapid Gear Changing Attachment.

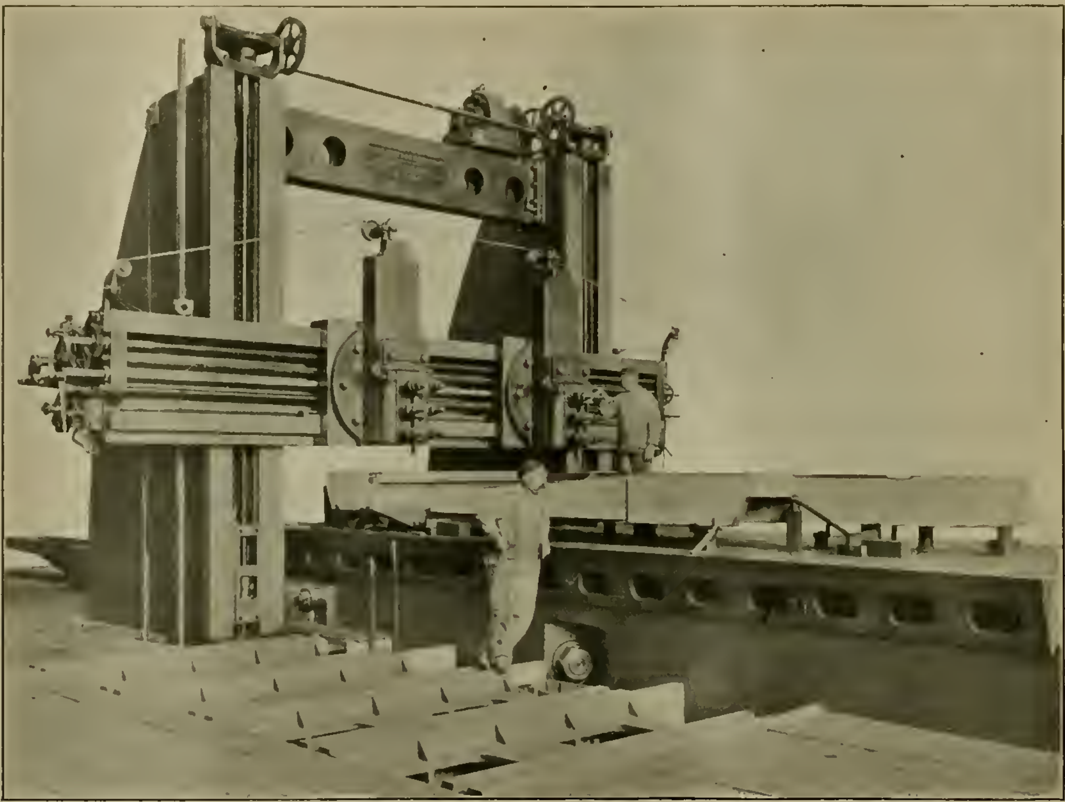
Among the interesting features of this new lathe, built by the Springfield Machine Tool Company, of Springfield, Ohio, is an attachment whereby any change gear may be substituted for any other driving the lead screw without unscrewing binding nuts or touching the gears.

The change gears are mounted in a gear box, shown at the left-hand side of the large engraving, the intermediate and head stock spindle gears being those ordinarily used. The cover of the gear box is rotated about a central stud, and the gears are carried on the inside of the cover, arranged in a circle concentric with the case, and this circle brings the change gears opposite the end of the lead screw by revolving the cover of the case. The small clutch, C, moves a telescopic extension of the lead screw and enters it into a hole in the change gear before the driving clutches between the change gear and the extension come into contact. This device takes the bearing of the change gear upon the extension for its support, and secures the change gear to the lead screw as firmly as if fastened by a nut. In order to change the gear, the cover is revolved until the desired gear is opposite the center of the lead screw extension, when the small clutch is thrown. All of the eight change gears are protected by the case except the top of the one which is in mesh with the intermediate gear.

To give a sufficient range of pitches, a set of three pairs of gears is provided in the headstock to vary the speed of the intermediate gear. These are housed in the gear cases shown at the extreme end of the headstock. These are clutched to their spindles by slipping them on until their clutches engage the spindles, which have clutches with their end sections reduced, as in the case of the lead screw shown at F in the sectional drawing. These gears furnish ratios of from 1 to 1, 2 to 1 and 4 to 1. The last two may be reversed and five speeds may be given to the fixed pinion driving the intermediate gear. The intermediate gear revolves on a fixed stud on a quadrant to which the handle is attached, and is removed from contact by raising the quadrant.

This lathe has a range of threads from 2 to 56 per inch, and a range of turning feeds from 8 to 224 turns per inch, and all the changes for any of these feeds or threads may be made while the lathe is running. The lathe has a reverse motion operated at the carriage, a friction geared head spindle and an automatic stop for screw cutting and turning.

The Magnus Metal Company have moved their New York office from 71 Broadway to 170 Broadway.



A Massive Planer—Capacity 12 by 10 Feet.
William Sellers & Co., Incorporated.

A 12 BY 10 FT. PLANER.

Designed and Built by Wm. Sellers & Co., Incorporated.

The illustration here presented shows an unusually massive and powerful planer, built for the Midvale Steel Co., of Philadelphia. It is designed to take the heaviest cuts on hard steel forgings and has a capacity between housings of 12 ft. and a height of 10 ft., with a table 10 ft. wide and 27 ft. long, having a working travel of 25 ft. There are two saddles on the crossrail and a vertical slide rest on each upright or housing.

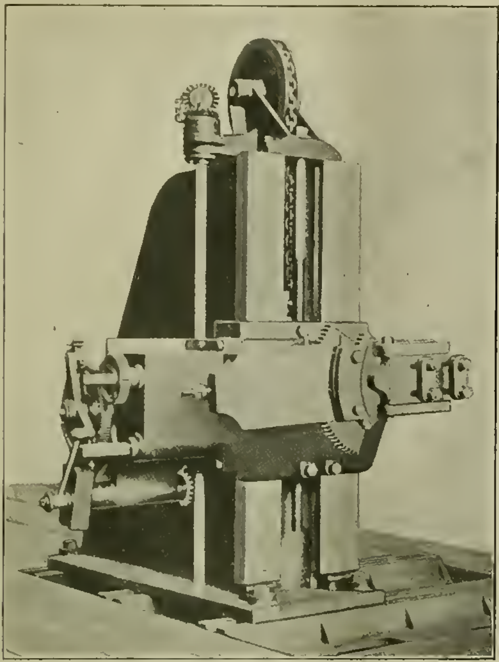
One peculiarity of this planer is that the feeds for each of the four tool holders are independent in direction and amount, each having its own feed motion and crank disc for regulating the amount of feed. To accomplish this, feeding mechanism is mounted on both ends of the crossrail, the two saddles being controlled from opposite ends. Each vertical slide rest carries likewise its own feeding mechanism and all are driven from a common source.

The bed, which is in two pieces, has a vertical depth of 4 ft. 4½ ins. and the ways on the table are flat, 16 ins. wide and 7 ft. from center to center. One bearing only is guided. The table is provided with a steel rack of 3-in. pitch, 18-in. face, operated by a bronze spiral pinion on a 9-in. diagonal shaft. This shaft is driven by a bevel wheel and pinion from a pair of friction clutches operated by a pneumatic cylinder. The action of the stops on the table admits air pressure through either end of the clutch shaft to the proper end of the clamping cylinder, thus causing the alternate engagement and disengagement of the driving and reversing clutches.

The receiving pulley on the machine is 48 x 12 ins. and power is transmitted from the pulley by suitable gearing to the clutches, the train to the forward motion clutch being provided with change gears to give a variety of cutting speeds, the speed of reverse remaining constant. It is thus possible to obtain with ease the best results on materials of all kinds, from soft cast iron to high carbon steel.

Air pressure is also employed to move the stops in the escapement train which operates the feed motions. It is thus seen that the table does no work in the act of reversing, except to move the small air valves which control the escapement and driving cylinders. The tool clamps on the crosshead are arranged to take tool bars 6 ins. square and the parts are so massive that it is necessary to provide means of handling them by power; two series motors are therefore mounted on the projecting ends of the crossrail, which is 42 ins. deep and nearly 23 ft. long, and by these motors the saddles on the crosshead and the slides on the saddles can be moved to any desired point at a rapid rate and with great accuracy. The crosshead itself is lifted by a 10-h.p. motor mounted on top of one of the housings, provided with an electric brake to prevent the load from running down. The vertical slide rests are counterbalanced, have power feed on the face of the upright and a power crossfeed which may be either horizontal or inclined through a wide angle above and below the horizontal.

The lubrication of the massive table is a matter of great importance in a machine of this kind, and it is here accomplished by a centrifugal pump forcing oil over the bearings under the table, the arrangement of oil grooves being such as to insure a thorough distribution over the entire surface. Catch troughs are arranged to extend beyond the furthest



Auxilary Upright for Large Sellers Planer.

overhang of the bed and the oil is led back through a strainer to the pump tank.

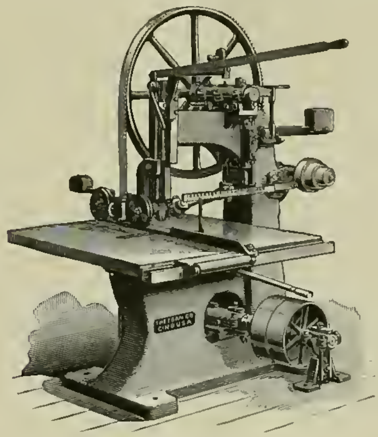
The housings are of box construction and measure 30 ins. wide on the face and 19½ ft. high, and nearly 10 ft. deep in the direction of the length of the bed. It is said that the method of driving is peculiarly successful, it being possible to stop and start the table by hand at will and to reverse promptly, so that the table may be used with a very short stroke.

The illustration does not show the vertical slide rests on the uprights, one being obscured by the intervening bed and table and the other having been removed for attachment to the auxiliary upright shown in a separate illustration. This upright is used in finishing work too wide to pass between the housings and is carried upon the floor plate shown in the illustration, power for feed being derived from the square shaft on the left hand housing for actuating the feed on the auxiliary upright.

The spraying machine saves time but uses more paint than the brush, was the general verdict of the Southern and Southwestern Railway Club, at a recent meeting where the question of relative cost was discussed. It was claimed that the sprayed car presented a rougher surface than the brush painted car, but if this is the case, it is offset by the fact that sprayed paint finds its way into places not reached by the brush, and the covering is fully as durable. A long nozzle was advocated, in order to prevent the operator inhaling a dangerous amount of spray. The weight of the machine is obviously a drawback, and causes loss of time by reason of the operator needing to rest occasionally. A truck carrying a supply reservoir has been found convenient, but trouble has been experienced by the eating out of the supply hose. According to one report, the advent of the machine had the effect of making the hand painters work faster. Opinion, on the whole, was about evenly divided as to the relative merits of the two systems. Further experience and more perfect construction of the machine, however, was thought likely to soon gain for it a permanent position in every railroad paint shop.

NEW SELF-FEED BAND RIP SAW.

The J. A. Fay & Egan Company, of Cincinnati, Ohio, have just put upon the market a patent self-feed band rip saw. The illustration shows that company's No. 1 size. It will rip wood from 1 to 10 inches thick with equal facility and without the blades being changed. All adjustments can be made easily, quickly and accurately. It is safer to operate than is a circular saw, as there is no danger of the stock being thrown back to strike the operator. The blade of the saw is very thin, and the small kerf removed in ripping is a point of excellence which cannot fail to be appreciated by users of fine lumber. The straining device used in connection with the knife edge balance insures, under ordinary circumstances, a perfect and uniform tension on the saw blade. This is an important feature, as it tends to prolong the life of the blade. The feed arrangement is very powerful. The feeding-in and feeding-out rolls are placed close together, so that short stock may be worked to advantage. Where flooring is made in large quantities a machine can be supplied with "live rolls"; these will return the material to the operator for another cut, thus saving much time and attention. The company, whose offices



A New Self-Feed Band Rip Saw.

are at 409-429 West Front street, Cincinnati, Ohio, will give further information, and on request will send free a new 450-page catalogue showing every machine made in the works.

Grinding, as a machine operation, has passed the experimental stage, and now takes its place as a recognized mechanical operation in railroad or other shops, and can be made to yield most economical results. For good cylindrical grinding, stable machines which will resist vibration and are capable of successfully dealing with a large stream of water, are necessary. For surface grinding where accuracy is not of much importance, grinders will be found in a great many cases much more economical than hand polishing, as one man can keep four or five machines in operation. The most striking example, however, is in cylindrical grinding. Work was recently done, says "Engineering," on a machine capable of finishing parts up to 18 ins. in diameter and up to 8 ft. long, carrying a 24-in. grinding wheel with 2-in. face. It is on record that a 4-in. shaft, 3 ft. long, can be finished in six minutes. The shaft was first rough-turned, with a 12-per-inch feed. It was left 0.01 in. above size at the bottom of the tool marks. Parts up to 7 ins. in diameter are rapidly finished, with a limit of variation of 0.001 in. With such facts before them, manufacturers and shop superintendents can hardly afford to overlook grinding as an important "cost reducer."

PERSONALS.

Mr. C. A. Goodnow has resigned as general superintendent of the Chicago, Milwaukee & St. Paul, to become general manager of the Chicago, Rock Island & Pacific.

Mr. A. O. Berry has been appointed mechanical engineer of the Boston & Albany, with headquarters in Boston. He is a graduate of Cornell University.

Mr. W. J. McQueen has been appointed master mechanic of the Hudson, Harlem and Putnam divisions of the New York Central to succeed Mr. S. W. Simonds, who has resigned.

Mr. John Purcell, master mechanic of the Santa Fe at Fort Madison, Iowa, has been promoted to the position of superintendent of the Topeka shops.

Mr. Charles Linstrom has resigned as mechanical engineer of the Chicago & Alton to accept the position of chief engineer of the Pressed Steel Car Company.

Mr. H. T. Herr has resigned as master mechanic of the Chicago Great Western at St. Paul to become master mechanic of the Santa Fe at Fort Madison, Iowa, to succeed Mr. John Purcell, promoted.

Mr. A. J. Cota has been transferred from the position of master mechanic of the Burlington at Beardstown, Ill., to succeed Mr. R. D. Smith as master mechanic at Chicago. Mr. Cota is succeeded at Beardstown by Mr. Taylor L. Smith.

Mr. G. R. Joughins, who recently resigned as mechanical superintendent of the Intercolonial, of Canada, has been appointed mechanical superintendent of the Pacific Coast lines of the Santa Fe at San Bernardino, Cal., succeeding Mr. G. W. Smith, resigned.

Mr. George Gibbs has been appointed the sixth member of the Pennsylvania Railroad Commission in connection with the terminal developments in New York City and on Long Island. Mr. Gibbs will have charge of the mechanical and electrical engineering problems, a work for which he is specially well fitted.

Mr. J. C. Whitridge has resigned from the editorial staff of the "Railroad Gazette," to accept the position of assistant to the general manager of the Buckeye Malleable Iron & Coupler Company, at Columbus, Ohio. Mr. Whitridge has been connected with the "Railroad Gazette" for the past six years as associate editor.

Mr. C. H. Quereau has resigned as assistant superintendent of motive power of the Denver & Rio Grande to accept the position of superintendent of shops of the New York Central at West Albany, where he will have charge of both locomotive and car shops. Mr. Quereau will be a valuable addition to the New York Central staff. He has had a good experience and thorough preparation for his new position.

Mr. W. E. Symons has resigned as superintendent of motive power of the Plant System of railways and will sail for France in a few days to make a study of recent locomotive practice there and in other continental countries. He has been at the head of the motive power department of the Plant System five years. Previous to that he represented the Galena Oil Company here and abroad, and for five years held the position of master mechanic of the Santa Fe at Raton, New Mexico, and at Argentine, Kansas.

Mr. R. D. Smith, who has for many years been identified with the motive power department of the Chicago, Burlington & Quincy, has been appointed superintendent of motive power of the Burlington & Missouri River. Mr. Smith was born in New York City in 1854, educated at Albany, N. Y., and entered railroad service in 1872 on the Albany & Susquehanna as a machinist apprentice. He served as machinist, fireman and locomotive engineer on the Kansas City, St. Joseph & Council Bluffs until he went to the Burlington as foreman in the Aurora shops in 1881. In 1885 he went to Chicago as general foreman of car and locomotive repairs and in 1888 was made master mechanic at Chicago, which position he has held to date.

Mr. Charles A. Seley has resigned as mechanical engineer of the Norfolk & Western, to accept a position with the same title on the Chicago, Rock Island & Pacific. He was born in Wapella, Ill., in 1856, and was educated in the schools of Peoria, Ill., and St. Paul, Minn. Prior to 1885 he had twelve years' shop experience, drawing office and engineering work, and in that year was appointed a member of the State Board of Boiler Inspectors of Minnesota, serving two years. After this he entered the service of the St. Paul & Duluth in the drawing office, and next had charge of the Great Northern drawing office for four years. In 1892 he resigned, and spent two years in the machinery business as mechanical engineer. In 1895 he took charge of the drawing office of the Chicago Great Western, serving four years, and went to the Norfolk & Western as mechanical engineer in 1899. This position he now leaves to take up his work with the Rock Island. Mr. Seley is a self-educated mechanical engineer, who has outstripped many men who have enjoyed superior advantages. He has made an enviable reputation as an intelligent, careful designer and painstaking, reliable investigator, qualities which are needed in every motive power department.

The annex to the Mutual Life Insurance Building in New York is in several respects the most remarkable structure in the world. The engineering work done is worthy of special mention. The cellar floor is 55 ft. below the sidewalk and 35 ft. below the line of standing water. The foundations rest on bed rock 100 ft. below the surface of the ground. Above the sidewalk the annex is eight stories high on Cedar street, while its towers are sixteen stories high in Liberty street. The building at 32 Liberty street, one wall of which had to be underpinned, is the highest building ever so treated. The work was rendered more difficult, as the ground floor was filled with safes and vaults of a safe deposit company, and a settlement of one-sixteenth of an inch would have stopped the working of the locks. The filling of the spaces between the caissons with red clay was ingeniously performed. It was done by sinking a 3-in. pipe between the caissons by means of a water jet, dropping cores of clay into the pipe, and forcing the clay out by dropping a heavy steel bar upon it, the pipe having been drawn up the depth of the clay core.

In Great Britain the question of "standards" was recently taken up by the Engineering Standards Committee. The question took the form of a discussion as to whether it was desirable to standardize locomotives, and, if so, should it be the standardization of general design or of the component parts only. Standardization was unanimously affirmed as a principle, though it was shown that the standardization of general design would not be of benefit to the English lines, but would be of great importance to the Indian and Colonial railways, and that this standardization would effect an enormous saving of time and money. The question of standard specifications, defining the quality of the materials used in locomotive construction, was also discussed.

BOOKS AND PAMPHLETS.

"The Engineering Index for Five Years, 1896-1900." Edited by Henry Harrison Suplee. Large octavo, 1,030 pages. New York and London: "The Engineering Magazine." 1901. $7.50.

"Next to knowing a thing comes the faculty of knowing where to look for it, and, indeed, it is a question as to which form of knowledge should take precedence." This quotation from the preface of this work represents its place in the working equipment of an engineer. In it are 40,000 entries concerning important articles from 200 periodicals devoted to engineering and manufacturing. These are selected with discriminating care and are entered with sufficient information to indicate the character and scope of the articles. The arrangement is alphabetical, as to "catch words," and a careful test of the cross indexing shows it to be conscientiously carried out. It is a great work for a great purpose. It renders available the enormous volume of periodical literature with a scope vastly beyond the possibilities of the widest reader. It is a directory to much which an engineer never sees and has not time to read, as well as to that which has come to his attention. The reviewer considers this the most important book of the time to the engineer, contractor, attorney and student. This is not a time for technical books. Progress is far too rapid for any record other than that of periodical publications. This index virtually collects the periodical literature of five years into one convenient book, the pages of which may be consulted on the shelves of any good engineering library. This is the third volume of the Engineering Index, which was undertaken originally by Professor Johnson. It is enlarged and improved in every way, and is particularly rich in entries from foreign publications, in railroad subjects and particularly with reference to locomotives. Mr. Suplee and the "Engineering Magazine" should have every encouragement to continue this valuable service.

"Velocity Diagrams: Their Construction and Their Uses." By Chas. W. MacCord, A. M., Sc. D., Professor of Mechanical Drawing, Stevens Institute of Technology. 8vo., 116 pp., 83 illustrations. John Wiley & Sons, 43 East Nineteenth street, New York. Price, $1.50.

This treatise is in effect an abstract of a series of lectures given to the author's classes. It explains the principles of the more common and convenient graphic processes of determining at any given instant the direction and velocity of the motion of a point, whether the motion be constant or variable. Extensive use is made of the Reuleaux method of instantaneous centers, and some very interesting results are obtained by the use of Roberval's method of drawing a tangent to a curve. The treatment is clear and concise. Graphical methods are employed with simple mathematical proofs which permit anyone who may be interested in the subject to study the various problems without the aid of an instructor.

"Railway Management and Operation."—Mr. A. W. Sullivan, assistant second vice-president of the Illinois Central Railroad, recently delivered an address before the students of the College of Commerce and Administration, in the University of Chicago, in which he set forth what a railroad really is, and explained the method of its management and operation. This address has now been issued in pamphlet form for distribution. The definition of the various departments, with the scope of each, occupies the opening pages, together with a statement of the duties o. the officers. The whole harmonious inter-relationship of each of the parts in the organization of a modern railway is dealt with in detail. Mr. Sullivan gives a bird's eye view of railway management and operation which is most useful to a young man entering the service. One learns from such a comprehensive picture many of the details which men, closely occupied in departmental routine, never gain outside of the department in which they are themselves employed.

Some quaint reminiscences of the London & North Western Railway appear in a paper recently read by Mr. C. E. Stretton at the Railway Club of that road. It appears that this railway was formed by the union of the London & Birmingham, the Grand Junction, and the Manchester & Birmingham lines. The cause which brought them together was principally the erection of the Birmingham viaduct. Seeing their danger, being narrow gauge lines themselves, they united to keep the 7-foot gauge lines south and west of Birmingham. At that time the London & North Western had 257 locomotives, and was and is the largest joint stock railway corporation in the world. In December, 1846, it was possible for a passenger to leave Euston by the Scotch express at 10 A. M. and arrive at Carlisle at 9.55 P. M., but be had to continue his journey to Edinburgh by stage coaches.

A handsome souvenir mailing card, containing 8 half-tones, showing as many steel structures of great strength and pleasing architectural effect, has been issued by the Joseph Dixon Crucible Company, of Jersey City, N. J. It will be sent to any address on request, and is expected to be of interest to constructing engineers, architects and others. The Dixon Silica-Graphite Paint used to protect this metal construction from rust, has been used extensively in this country, and also in Mexico, Australia, China, Japan, the West Indies and the Philippine Islands. It has proved its protective and wearing qualities in all climates.

The U. & W. Piston Air Drill is illustrated in the catalogue of the Columbus Pneumatic Tool Company. This pneumatic tool is designed for "close work," or where holes have to be drilled where the room to get at them is limited. It is made entirely of steel, with frame and cylinders of high grade bronze. It is a slow speed tool, and so is not likely to burn the drills. It is stated that with 100 lbs. air pressure the No. 2 size will drill a 2-in. hole in steel at the rate of 1 in. in 4 minutes. The tool weighs 25 lbs., and has roller bearings throughout, with one exception, and is consequently economical with oil. The catalogue shows in 8 half tones the variety of tight places in which it can be successfully and economically operated. The address of the company is 123 Liberty street, New York, or Columbus, Ohio. The catalogue will be furnished on application.

In the Jones National Fence Company's catalogue concerning "up-to-date" metallic sheeting and fireproof material, which has just come to hand, we find a form of construction which might be applicable to station platforms or shop floors. It is described as the "flat arch showing carrying rods and metallic netting on wood construction." The floor, in this method, is carried on longitudinal wooden stringers or joists of ample size. Upon these stringers the metallic netting and carrying rods are placed, with the under side protected by plaster. Upon the upper side of this netting a substantial layer of concrete is placed, almost as deep as the wooden stringers themselves. Resting upon the concrete is the floor proper, which may be composed of wood, tile or cement, of any depth required. This form of construction has every appearance of being solid, and thoroughly fireproof. A catalogue will be sent to those interested by addressing the Jones National Fence Company, of Columbus, Ohio.

The B. F. Sturtevant Company, Boston, Mass., give some interesting and surprising figures in a neat little pocket publication, "Bulletin 46, on Mechanical Draft, What It Is and What It Does." We are told that when that company remodeled its works at Jamaica Plain, a new location was chosen for the boiler plant, and a chimney was not built. Instead, a Sturtevant, engine-driven, induced system fan with water-cooled bearings, was installed above the battery of boilers, thus occupying no floor space. The engine for operating the fan is automatically controlled by the steam pressure of the boilers, and there is practically no smoke. Fuel of a cheaper grade was consequently used, and the saving on fuel in a year was greater than the first cost of the mechanical draft plant; and the cost of the apparatus for producing this induced draft was less than half what it would have taken to build a chimney. The power was increased 103 per cent. above the rating, with an evaporation of 10.75 lbs. of water from and at 212° F. per pound of coal. The Sturtevant Company will forward the bulletin to applicants.

Steel car design on the Norfolk & Western has been pursued systematically and effectively. In this issue a 40-ton steel frame box car is added to the number of successful designs. Of its success there seems to be no doubt, and these cars constitute a series, all worked out by the motive power department of the road. This is a record to be proud of.

FALLS HOLLOW STAYBOLT.

The Engineering Department of McGill University, Montreal, Canada, has recently made a test of Falls Hollow Staybolt iron at the request of the Falls Hollow Staybolt Company, of Cuyahoga Falls, Ohio. The result of the test showed the ultimate strength of the iron to be 49,300 lbs.; the yield point, 32,000 lbs.; an elongation of 31.20 per cent. was observed, with a reduction of area of 45.7 per cent. Concerning these stays, Prof. J. W. Shepherd, of the University of Chicago, says: "A proper distribution of hollow staybolts, in a properly drafted locomotive, burning bituminous coal, will undoubtedly lessen the black smoke and be economical as far as fuel is concerned, because of the better mixing of the oxygen of the air with some of the volatile gases of the coal, which would otherwise partly or wholly escape combustion."

THE NEW ASHTON BLOW-OFF VALVE.

This blow-off valve, recently perfected and placed on the market by the Ashton Valve Company, of Boston, has met with a reception which confirms the claims made for it. Its special features are ease of operation in both opening and closing, and a straight passageway free from obstruction when the valve is opened. Instead of depending upon the boiler pressure to keep it tight, this valve is made with a split plug, which is expanded to make a tight joint by the final movement in closing. In opening, the first movement releases the wedge and loosens the plug. It then opens, without friction against the seat. In fact, the pressure carries the valve away from the seat. At the bottom of the casing is a removable plug, for the removal of anything which may collect in the casing. This valve is claimed to be perfectly tight when closed, and it is said to be very durable.

EQUIPMENT AND MANUFACTURING NOTES.

The Railroad Supply Company, and the Q. & C. Company, will operate separately after July 1, as they did before the union of interests was effected in January, 1901.

Mr. J. D. Hurley, formerly vice-president and general manager of the Standard Pneumatic Tool Company, has been appointed manager of the Chicago Pneumatic Tool Company, with headquarters in Chicago.

Mr. E. N. Hurley, formerly president of the Standard Pneumatic Tool Company, now a director in the Chicago Pneumatic Tool Company, has sailed for London to meet the president, J. W. Duntley, and complete arrangements for the purchase of the International Pneumatic Tool Company, of London. Messrs. C. E. Walker and C. Booth are also in Europe in the interest of the Chicago company. The popularity of pnuematic tools abroad is indicated in an order recently received for 150 pneumatic tools from a single European concern.

The newly organized Standard Steel Car Company, of which Mr. John M. Hansen, late chief engineer of the Pressed Steel Car Company, is president, will be located in Butler, Pa. Contracts for buildings and machinery have been let. The United States Steel Corporation will deliver 30,000 tons of steel to the car company this fall, when the work of car building will begin. It is reported that the company has orders for steel cars amounting to about $2,000,000. Mr. A. R. Fraser is vice-president and treasurer, Mr. Gearhart is general manager, and Mr. Peter F. McCool is works manager.

The American Brake Shoe & Foundry Company announces the appointment of Mr. Joseph D. Gallagher as second vice-president, and Mr. Joseph B. Terbell as general sales manager. Mr. Gallagher was formerly president of the Lappin Brake Shoe Company, and Mr. Terbell was president of the Corning Brake Shoe Company.

The Grand Trunk Railway has recently contracted with the Safety Car Heating and Lighting Company for the equipping of 50 additional cars on their line with the Pintsch system of lighting. The Pintsch gas works at Moncton, N. B., which have been in the course of construction for the past two months, is now completed, and gas is being made there for use in the cars of the Intercolonial Railway.

Col. John T. Dickinson, who has heretofore represented the Consolidated Railway Electric Lighting and Equipment Company in Chicago, has been transferred to New York as general agent, with headquarters at the general offices of the company, 100 Broadway, and Mr. George W. Carhart has succeeded Colonel Dickinson as general agent of the company in Chicago and the West.

The Structural Steel Car Company's plant, which is now under construction at Canton, Ohio, is favorably located and is extensive, with provisions for future expansion. The principal buildings for the steel car plant are a main shop, 506 by 78 ft.; power house, 50 by 110 ft.; blacksmith shop, 50 by 75 ft., and office building, 50 by 40 ft., of two stories. The plant is on several lines of large railroads, which will make it convenient for repair work, for which the facilities are ample. The ground for the wooden car department is already staked off. The steel foundry will occupy 400 by 100 ft., with two lean-tos and other supplementary buildings. The officers of the company are: Ellwood C. Jackson, president; H. A. Cavuah, vice-president; A. S. Griffin, secretary and treasurer; J. R. Reed, general manager; W. H. Woodcock, general superintendent, and R. H. Hornbrook, engineer.

A train of cars 300 miles long represents the output in cars, to March, 1902, of the Pressed Steel Car Company of Pittsburgh. To be more exact, these car works had by March 27 turned out over 60,000 cars. The shops are pushed to their fullest extent, and in addition to the daily delivery of over 100 cars, a large number of trucks, bolsters, center plates and other pressed steel specialties for wooden and steel cars are manufactured. The steel cars built at Pittsburgh have practically revolutionized modern methods of freight transportation; the pressed steel car is much lighter in proportion to carrying capacity than the old style wooden cars used prior to 1897. In other words their tare weight is low and revenue load high, so that for any given gross tonnage less dead weight has to be hauled than was possible before the advent of the steel car.

William Imhauser, widely known as a manufacturer and inventor of watchman's time detectors, died at his home on Long Island, March 28. Mr. Imhauser was 77 years old, and was a native of Germany, where he introduced watchman's time detectors. He came to the United States in 1867 and started in business for himself as a manufacturer of time detectors in 1869. Later he obtained a number of patents on notable improvements in these instruments. Mr. Imhauser was the recipient of many medals of award from expositions for his work in this line, his time detectors receiving medals from the Centennial Exposition, the American Institute, the Cotton Exposition at Atlanta, in '81, the Exposition for Railway Appliances at Chicago, in '83, the Pan-American Exposition, last year, and many others. Mr. Imhauser was active in business until about five years ago, when his bad health caused him to retire. The business, which is known as E. Imhauser & Co., is conducted by his wife, Mrs. Elise Imhauser, and his son-in-law, George M. Still, and will be continued by them without change.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

JUNE, 1902.

CONTENTS.

THE STANDARD BOX CAR.

By A. W. Sullivan,

Assistant Second Vice-President Illinois Central Railroad,

President American Railway Association.

At a meeting of the American Railway Association, held in New York, September 5, 1901, the following resolutions were adopted:

"Resolved, That the dimensions of the standard box car be 36 feet in length, 8 feet 6 inches in width and 8 feet in height, all inside dimensions; cross section, 68 square feet; capacity, 2,448 cubic feet. The side-door opening to be 6 feet in width.

"Resolved, That no box cars of larger dimensions than those prescribed for the standard car shall be hereafter constructed, and that all owners and builders of cars be officially notified of the adoption of this resolution.

"Resolved, That the Master Car Builders' Association be requested to consider and adopt the required external dimensions for the standard box car, based upon the interior dimensions, as prescribed by the American Railway Association."

The diagrams of the American Railway Association showing the measurements of the standard box car provide that the length and the width are to be neat measurements between the interior lining of the ends and of the sides of the car, and that the measurement of height shall be from the surface of the floor to the under side of the carline; the purpose being that all the interior measurements of the car shall conform exactly to the dimensions specified.

In 1901 there were in existence 680,000 box cars of the following different lengths:

28 to 30 feet long	85,000 box cars
30 to 33 feet long	110,000 box cars
34 feet long	386,000 box cars
36 feet long	71,000 box cars
Over 36 feet long	28,000 box cars

In the important work of revising the minimum carload weights to conform to the standard box car, which has become the unit for the establishment of such minimums, the classification committees have experienced difficulty in grouping the box cars now in existence, because of the great variation in the actual lengths of the cars, which are found to vary, not only by all the inches of the scale, but also by many fractions of an inch from their nominal lengths. To overcome this difficulty, the American Railway Association, at its meeting April 23, 1902, adopted the following resolution:

"Resolved, That six inches above any given length shall be rated as even length in feet of whatever length it may approximate. Lengths of over six inches shall take the minimum of the next greater length; thus, a length of 38 feet 6 inches shall be rated as a 38-foot car; one of a fraction over 38 feet 6 inches as a 39-foot car."

This provision for grouping the cars of various lengths has application specifically to the cars now in existence, and is not intended to apply to cars hereafter built under specifications for the standard box car.

It is, therefore, within the province of the Master Car Builders' Association, in its function of determining the external dimensions of the standard box car conformably to the internal dimensions fixed by the American Railway Association, to establish standards of dimensions of the constructive parts of the car which shall result in a car that will be standard in respect to all its parts.

It is rarely that such an opportunity is presented of crystallizing a constructive problem into such definite shape, and it is to be hoped that the Master Car Builders' Association will not fail to definitely fix the dimensions allotted to all parts of the standard car so that not only will the exact size of the car be guaranteed, but that the parts may be interchangeable throughout the country, and the railroads reap the fruit of their action in the benefits that will come from the facility with which repairs may be made in the quickest time and at the least expense to any portion of a car in any part of the country.

Delaware, Lackawanna & Western Railroad Company,

Office of President.

I most heartily favor the proposition that the Master Car Builders Association take up, consider and establish standard exterior dimensions for 40-ton box cars to correspond with the American Railway Association standard interior dimensions.

To my mind, it hardly admits of discussion that the more the freight car equipment used by all railroads in this country can be reduced to standard sizes and the parts used in their construction universally standardized, the greater the economy possible in the repair and maintenance of cars on all railroads in this country. Great progress has already been made in this direction, but no one familiar with the matter can for a moment claim that everything has been done to this end that is reasonably possible.

It is most difficult to arrive at any accurate idea of the large additional expense occasioned to the different railroad companies of the country by reason of each company having such a large variety of cars of its own, and the necessity of carrying in stock so many different patterns of the same parts of freight cars. The delay in repairs to freight cars on every road is very much greater by reason of this fact, and when it comes to repairing equipment of other roads, the delay therein owing to the repairing line having to wait until it can get the material from the owner of the car, is infinitely greater and involves the loss of equipment, and expenses in handling the damaged cars, together with furnishing side-track facilities to store them on, must aggregate large sums every year.

To my mind, it is certainly advisable to standardize the entire construction of 40-ton cars, with the possible exception of the roofs, doors, draft gear, bolsters and trucks, and with a body of mechanical men in charge of the work, such as the M. C. B. Association can furnish, there should certainly be no difficulty in getting a standard car which would be recognized as such and be equal, if not superior, to any that can be designed by any single car builder in this country.

I certainly trust that the influence of your journal will be exercised to the fullest extent in favor of this movement.

W. H. TRUESDALE,
President.

Illinois Central Railroad,

Office of Second Vice-President.

With regard to the advisability of extending the standardization to include the actual construction of box cars, I would say that I think this is a step in the right direction.

The interior of the standard box car having been given fixed dimensions, it is possible to establish external dimensions, and in so doing there should be a standardization of all parts of which the car is constructed, to the extent at least of fixing the limit of dimensions where such dimensions will affect adjoining parts or the size of the car as a whole.

These standards of detail should include as nearly as possible every part of the car, so that the lumber, the castings and the forgings may become commercial standards of which the dealers would be willing to carry in stock an ample supply for current requirements, and of which the stock carried by railways could be applied not alone to the repairs of their own cars, but as well to the equipment of any other line.

The saving in the working stock of material that would be effected by the substitution of a limited number of standard parts in wood and metal for the endless variation in form and dimensions of the parts now used for the same purposes would in itself be a strong recommendation for the establishment of standards in the details of construction. A further reason, however, would lie in the refinement and perfection of proportion and design that could be given to the different parts of the car as the result of general experience in its use. The attitude of every observer would be alike, and the knowledge of the weaknesses and defects gained by actual use of the standard car in different parts of the country would quickly crystallize opinion as to the merits or demerits of any question of improvement that might arise, with the result that in a comparatively short time the proportions of the parts could be perfected.

The stability given to the demand for material by having standard specifications would enable dealers to carry large quantities of material in stock in anticipation of orders, and would lessen the cost of production, to the advantage of the railways, in enabling them to obtain quickly the material required of standard quality and at reduced cost.

These are a few ideas that occur to me in connection with this matter. J. T. HARAHAN,
Second Vice-President.

Grand Trunk Railway System,

Office of Third Vice-President.

This company is heartily in accord with any movement that tends to standardize railroad work, and we see no reason why it is not perfectly feasible to construct the 40-ton box cars under discussion so that standard lengths of lumber can be utilized in their construction with minimum waste, and it might be possible for the committee, which is to report on this very important subject, to take the strong points of car construction of the railways of the country, and combine them in a new specification, so as to have a box car that will meet all conditions and be of maximum strength, produced at a reasonable cost, and be free of the many specialties (the best of which might be decided upon and adopted as standard), thus reducing the stock of material at railroad shops, but at all times making it possible for material to be carried by the different companies to insure immediate repairs being made to damaged cars.

We feel that this standardization could be extended to the entire car, to the great benefit of all concerned, and would be glad to see a move made in this direction.

Taking one item in car construction, viz., that of drawbars, the railways could be saved a great burden, so far as expense and stock is concerned, if a standard drawbar could be adopted embracing the strong points of many of the bars now in existence, and eliminating the weak points in many of them, which have been made necessary in order to prevent infringement upon other patents.

This latter suggestion could not, of course, be accomplished by the committee, i. e., designing of a new drawbar, and is referred to merely as one of the many items in car construction where standardization would benefit the railways, in the same manner as the standards adopted by the Westinghouse Company. FRANK W. MORSE,
Third Vice-President.

The Lake Shore and Michigan Southern Railway.

Office of the General Superintendent.

I am very much in favor of standardizing the actual construction of box cars, and believe this is an opportune time for the Master Car Builders' Association to undertake the task. It has been suggested many times in the past, but as there was very little prospect of an agreement upon the inside and outside dimensions of such cars the task of standardizing the details appeared to be a hopeless one. Now, however, the situation is changed materially, in that we have standard inside dimensions, and at the convention of the association this year the outside dimensions that will be recommended by the committee of the association will doubtless be adopted. If the association will now adopt a standard design for the entire car it will be a step in the right direction. From the work the association has done in the past we know that the design adopted will be a good one, and while it may not be followed by all railroads, it will undoubtedly be followed by a great many, and will ultimately effect a great saving in the standardization of materials entering into the repairs of cars. Uniform sizes for the lumber used in repairs and standard patterns for numerous castings will not only reduce the stock of materials that must be maintained by each railroad for the repair of foreign cars, but will save excessive delays in the making of these repairs and increase the mileage of the equipment. The purchasing agent will also find his task materially lightened if the sizes of lumber which he must buy are materially reduced in number.

I see no good reason why a standard car should not be adopted in practically all of its details. No railroad builds its box cars to-day for service on its own lines alone. They become scattered all over the country, and there are no conditions which must be met in building the equipment for one road that are not also imposed upon those designing and building the equipment for another.

W. H. MARSHALL,
General Superintendent.

Southern Pacific Company,

Pacific System.

Respecting the matter of standardizing details of car construction, I would say that this is a consummation which I have long wished for, and I believe the time is approaching when favorable action on the part of mechanical officials of the American railroads will be made possible.

I believe the motive power officials of this country should each be willing to concede minor points and work together for the introduction of standard details of freight car construction. Such action will greatly reduce the cost of repairs, as well as the cost to railways of carrying material for repairs of cars belonging to foreign lines, as well as for cars owned by railway companies themselves.

I see no reason whatever why standard sizes of sills, plates, carlines, purlines, girts, posts, braces, sheathing, lining and roofing cannot be adopted. The only reason why they are not now of uniform dimensions is probably due to some whim of the individual heads of mechanical departments. Certainly 3-in. siding is as good in every way as 3¼-in. siding, and I see no reason why one-sixteenth or one-eighth of an inch difference should be made in siding or lining, as is now often the case.

Flooring should be also be made of standard sections, so that when it is necessary to make repairs a better and quicker job could be done than at present, where we are obliged to get out sizes and sections to suit the car under repair; or, if material slightly differing from dimensions is used, we are under the necessity of applying repair cards and defect cards for wrong material, with the prospect of future bills from the line owning the car. I do not think there would be any difference of opinion as to the proper strength of material employed, and when that is determined the rest should be easy of accomplishment.

Considerable work in this line has recently been accomplished by the motive power officers of a group of important railway systems under the same control, for which standard cars for the various freight services are being agreed on, together with nearly all details of construction. Nor can I see any good reason why we should not go even further than adopting standard dimensions of wood details. There is no reason why standards governing dimensions of a truck, body bolster, arch bars, oil boxes and draft gears could not also be adopted. I am aware that the standardizing of draft gears, and also trucks, would involve a great deal of discussion, but probably no more so than did the standardizing of journal bearings and oil boxes.

There is no question but that the standardizing of material used in freight equipment would result in a large decrease of cost of car maintenance, and certainly a great saving in time of foreign cars held in repair yards awaiting receipt of material which may have been ordered from the owning road.

From the above you may infer that I am heartily in favor of any movement tending to standardize details of freight equipment. H. J. SMALL,
Superintendent of Motive Power.

Pere Marquette Railroad Company,

General Manager's Office.

It seems to me that the adoption of standard construction for box cars will have the same beneficial results as came from the adoption of standard sections for rails. I do not have enough technical mechanical ability to suggest any rule on which the construction should be laid down, but now that the inside dimensions have been determined and the experience of a few months has shown that the business of the country can be handled with these inside dimensions, the outside dimensions should follow without great difficulty, and the standardizing of such parts as can be handled in this way would result in great economy of material and time.

S. T. CRAPO,
General Manager.

Buffalo, Rochester & Pittsburgh Railway Company,

President's Office.

I think it very desirable that a standard construction for box cars for all roads should be adopted. There are a good many things, however, in the way of this, some roads being willing to pay for a higher standard and better construction than others. A great many roads use the cheapest of everything, while others use the best, as in our case, and our cars, as a rule, cost considerably more than the cars of other companies. If a high standard could be agreed upon by all roads, then I think a box car standard could be carried out which would be very desirable. ARTHUR G. YATES,
President.

Fort Worth & Denver City Railway Company,

Office of General Superintendent.

Relative to standardizing box cars in this country, I think that it is the proper thing to do. It will, undoubtedly, cheapen the cost of construction, simplify repairs and make it possible to interchange parts. Inasmuch as at the present time cars go from one section of the country to the other, it cannot be truthfully said that there is any necessity for box cars of various designs and construction to meet the requirements of the different sections of the country. The thing to do is to agree on what would be the best all-round car, settle on that, so far as dimensions are concerned; railroads and builders should lend their energies toward getting the very best construction, and make it standard in all that the name implies.

W. R. SCOTT,
General Superintendent.

Erie Railroad Company.

Office of the President.

The adoption of standard dimensions for all freight car equipment is a proposition that should receive the support of all roads whose interchange of equipment with other companies is of any considerable volume. So far as this company is concerned, it will be pleased to co-operate with others to that end. F. D. UNDERWOOD,
President.

Burlington, Cedar Rapids & Northern Railway,

Office of the President.

There is no doubt in my mind but what, if standard construction of box cars could be adopted, it would result in a great saving, not only in construction, but in the maintenance of the box cars of the country, and I trust that the efforts in that direction may be entirely successful. C. J. IVES,
President.

Chicago, Rock Island & Pacific Railway Company,

Office of the General Manager.

This company is committed to the American Railway Association standard for box cars, and is constructing most of its equipment on those lines. Personally, I think it is desirable, and a step in the right direction. C. A. GOODNOW,
General Manager.

Chicago & Eastern Illinois Railroad Company,

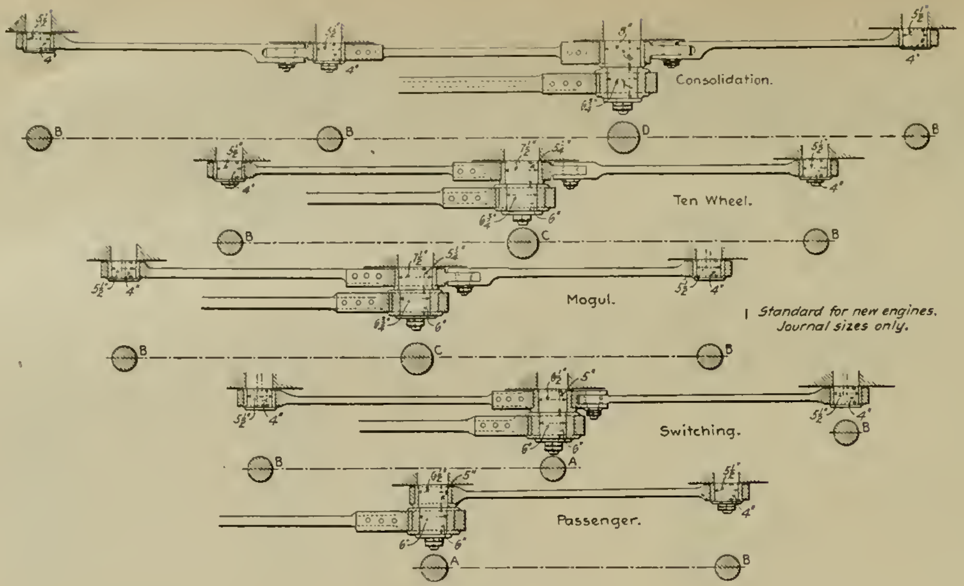
President's Office.

Railroads of the country at large would be benefited by adopting standards where it is possible to do so. The reasons for doing this are obvious. I see no reason why standards for box car construction should not be adopted, as you suggest.

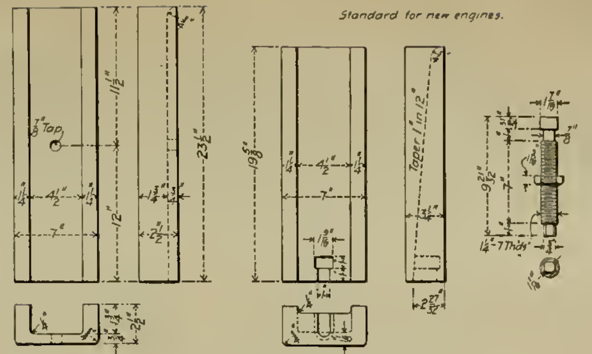
M. J. CARPENTER,
President.

Progress in the application of air brakes to engines and freight cars, up to January 1, 1902, was reported by the American Railway Association at its recent meeting as follows:

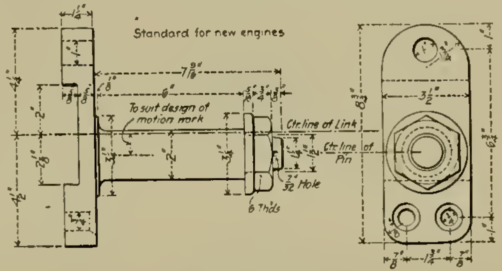
Number of members reporting	147
Freight cars in service	1,436,057
Fitted with air-brakes (76½ per cent.)	1,099,099
Engines in service	36,817
Equipped with power brakes (99.1 per cent.)	36,508
New freight cars under contract or construction to be fitted with air brakes	73,465
New engines to be equipped with power brakes	2,175



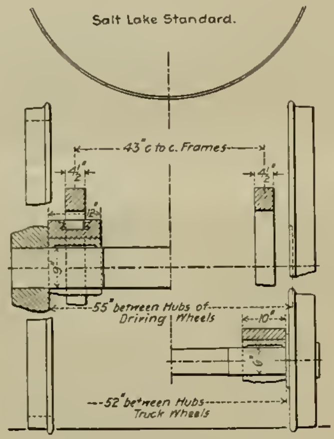
Crank Pins.



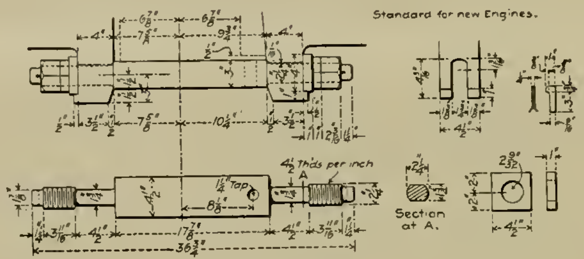
Shoe and Wedge—Wedge Bolt.



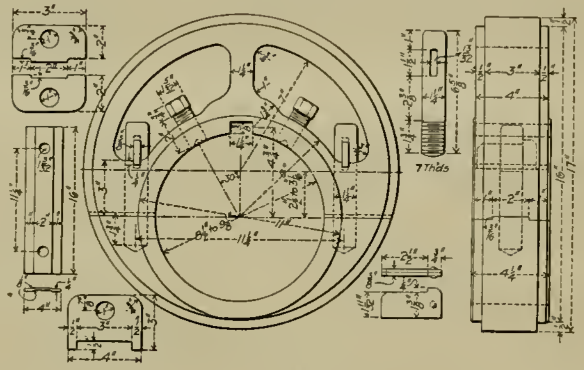
Link Saddle Pin.



General Dimensions of Engines.



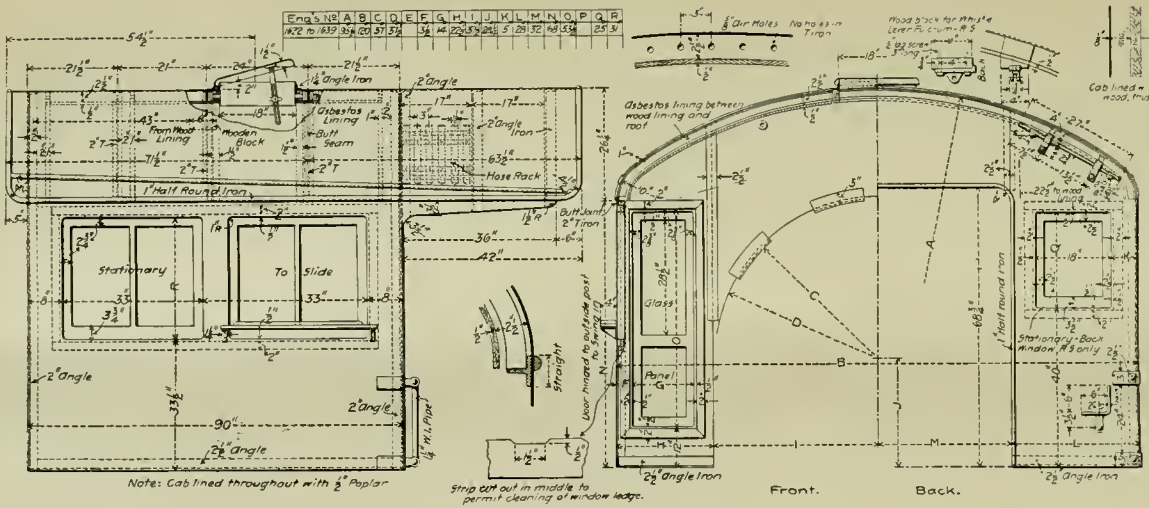
Pedestal Binder.



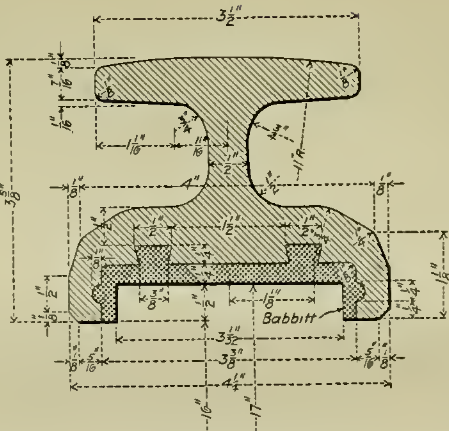
Eccentric.

STANDARDS FOR LOCOMOTIVES AND CARS—"THE HARRIMAN LINES."

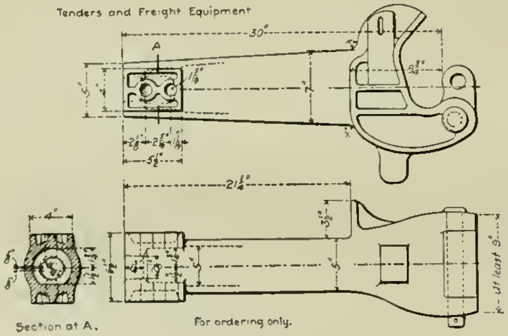
Union Pacific, Southern Pacific, Oregon Short Line, Oregon Railroad & Navigation Company, Chicago & Alton.



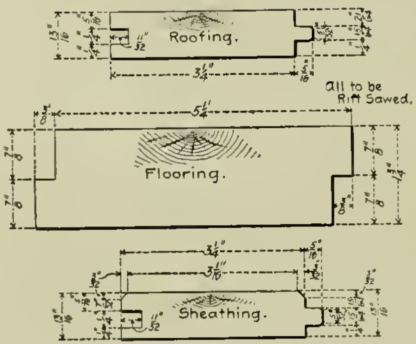
Cab–Sheet Metal, Lined with Wood.



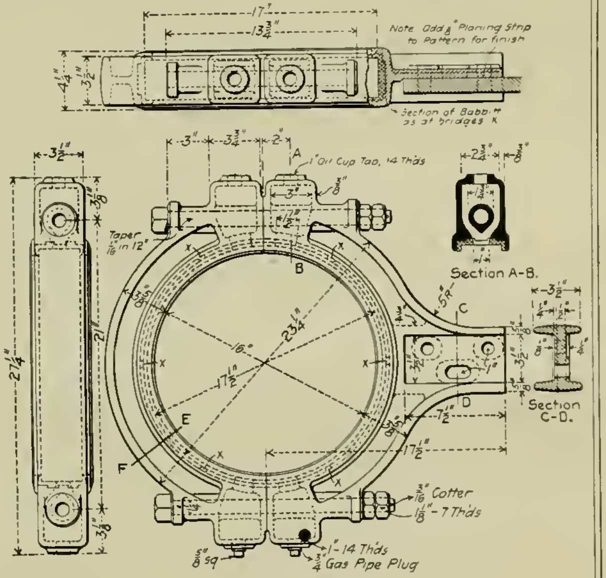
Section E–F.
See engraving below.



M. C. B. Coupler–5 by 7-in. Shank



Roofing, Flooring and Sheathing



Eccentric Strap

STANDARDS FOR LOCOMOTIVES AND CARS–THE "HARRIMAN LINES."

Union Pacific, Southern Pacific, Oregon Short Line, Oregon Railroad & Navigation Company, Chicago & Alton.

STANDARDS FOR LOCOMOTIVES AND CARS

For "Harriman Lines,"

Union Pacific, Southern Pacific, Oregon Short Line, Oregon Railroad and Navigation Company, and Chicago & Alton.

These railroads, which are associated under one ownership, last July inaugurated a policy in the construction of new rolling stock which appears to be an epoch-making improvement. A centralized authority at once suggested the advisability of adopting uniform practice in the construction of new equipment, so that when locomotives, as well as cars, are interchanged among the lines, there will be no delay or embarrassment in making repairs. The advantage of such a plan from a business—the stockholder's—point of view need no elaboration, for it is clear enough that purchases upon one set of requirements for five roads may be made upon most favorable terms, and a relatively small repair stock will suffice.

Last year the motive power officers of these roads, acting together, planned the broad scheme, the scope of which is outlined here. Such a work is really never completed, but remarkable progress has already been made toward the standardizing of all of the details of cars and of the wearing parts of locomotives which may require repairs at shops of other than those of the road to which the engines are assigned. In the cars, everything except the knuckle-end of the coupler will eventually be standardized. In locomotives, the plan will be carried out with reference to all parts except the design of boilers. This applies only to new equipment, but it is obvious that many of the standard details will be used in repair work wherever they will fit.

Mr. S. Higgins, superintendent of motive power of the Union Pacific, has generously supplied specifications, drawings and books of standards, showing what has been done up to date. These include specifications for material, which all of the purchasing agents will use. Each of the superintendents of motive power has a book of car and another of locomotive standards, in which additions will be made, and as the work proceeds drawings are made to correspond. A sample page from the locomotive book is as follows:

Description.	Drawing.	Reference.
W		
Weights on drivers, pounds............		
Desired on one pair, 45,000............		
Maximum limit, 50,000..................		
On two pairs, 90,000...................		
On three pairs, 135,000................		
On four pairs, 180,000.................		
Wheels, engine truck, all road engines to have steel tires.....................		

This sample page shows the starting point with reference to the locomotive standards. Cylinders are designed to keep the ratio of adhesion to tractive power between 4.25 and 4.75, the sizes of cylinders being 19, 20 and 21 ins. in diameter for simple engines, and 14 and 24, 15½ and 26, and 17 and 28 ins. for compounds, the stroke to be made to suit the service and grades. All simple engines will have steam ports 18 ins. long. All cabs will be made of steel, 90 ins. long and 120 ins. wide. Crank pins will be made of one size for each type of locomotive indicated on the drawing.

The selections from the standard drawings already adopted serve to indicate the thoroughness of this work and the lines which are being followed. The ideas and experience of all the officers concerned are obtained at meetings held for the purpose, and while no one road dominates, the details are placed in charge of Mr. Higgins, who is ably assisted by Mr. F. N. Hibbits, mechanical engineer of the Union Pacific.

This interesting and inspiring subject will be placed before the readers of this journal in greater detail next fall. It is to be hoped that this example will attract the attention of other lines having official organizations which will permit of such sensible and altogether economical practice. No more important mechanical policy has ever been introduced upon American railroads. A great opportunity is lost if concentration of ownership of railroads is not followed by a plan in mechanical matters which will eliminate the expensive and unbusinesslike practice of the present, which is due to the different whims and crotchets of several motive power superintendents who are all in the service of the same set of stockholders. There can be no reason why two lines owned by the same people and running over similar profiles between the same terminal cities should not be almost exactly alike. There is no reason why a locomotive which is safe to haul a freight or passenger train into Omaha from the east is not as safe and serviceable to haul it out of the same city to the west. There is no reason why a steel underframe for a box car should not be equally satisfactory for a stock car. Arguments may be multiplied indefinitely to bring out the advantages of standardizing.

The standardizing of equipment is one of the most important questions before the railroads of this country to-day, and other pointed references to the principle will be found in this issue.

PROFESSIONAL SPIRIT IN RAILROAD SERVICE.

By F. A. Delano, General Manager Chicago, Burlington & Quincy Railway.

Editor's Note.—This article was written in response to a special request for the author's views as to the prospects of railroad service for educated young men.

I am frequently asked by young men, or by fathers or friends of young men, what the prospects are for a young man in the railroad business, with special reference to those with pretty fair education who wish to make railroad work their profession.

I have heard it argued that railroad work was not a profession any more than any branch of trade or commerce, but whether this is so or not, I think it is obvious to anyone that a man may go into "railroading" with a professional spirit quite as much as a man may take up art or literature, medicine or law. A profession requires of a man that he should go into the work with heart and soul, and with the desire and intention of doing something worth doing; or, as Ruskin puts it in regard to art, somewhat as follows: A man who devotes himself to art must do it "for art's sake alone," not for the love of gain or prestige or glory, but for the sake of doing something worth doing. Doubtless there are a few men who go into railroading every year with this end in view, and I believe it is obvious that, as the number of men who do so increases, the standard of railroad work will improve.

It may be asked what this notion of railroading has to do with success as a railroad man or the wise operation of the railroad property. To answer this question, I am disposed to go back to the first principles of what every man's aims may properly be. In the words of the Declaration of Independence, every man has "the right to life, liberty, and the pursuit of happiness." The greatest measure of life and liberty comes to those who are thoroughly in earnest about what they are trying to accomplish, to whom work is not a drudgery or daily routine; and we all know that happiness is not measured by position or salary.

It would be a mistake for any man to encourage another to enter railroad work, quite as much as it would be a mistake to encourage him to enter any other profession. The desire to give one's life to any profession must spring from the man himself, and not be forced upon him; but there is much in railroad work which, in the vastness of the field and diversified and absorbing interests, equals that of any other profession.

Let me enumerate a few of the problems which confront the student of railroad questions of to-day, and let me say that

A TABULAR COMPARISON OF NOTABLE

ARRANGED WITH RESPECT

PASSENGER

Type—Drivers	4-Coupled	6-Coupled	4-Coupled	4-Coupled	4-Coupled	4-Coupled	4-Coupled	4-Coupled	6-Coupled	6-Coupled	6-Coupled
Type—Classification	Atlantic	10-wheel	Atlantic	N. West. Atlantic	Cha't'q'a. Atlantic	Atlantic	Cha't'q'a. Atlantic	Atlantic	10-wheel	10-wheel	10-wheel
Name of railroad	Atlantic City	Plant System	Wabash	C. & N. W.	B. C. R. & N.	Canadian Pacific	C., R. I. & P.	C. R. R. of N. J.	Great Northern	Illinois Central	L. S. & M. S.
Number or road class	P1-b	119	......	D	77	......	1301	......	150	64	I-1
Builder	Baldwin	Baldwin	Baldwin	Schenectady	Brooks	Can. Pac. Ry. Co.	Brooks	Baldwin	Brooks	Baldwin	Brooks
Simple or compound	Vauclain Compound	4-cyl. bal. Compound	Simple	Simple	Simple	Vauclain Compound	Simple	Vauclain Compound	Simple	Simple	Simple
When built	1898	1902	1898	1900	1900	1899	1901	1899	1898	1901	1899
Weight, engine, total, lbs.	150,400	155,000	157,900	158,000	158,600	162,000	162,000	163,510	166,580	167,000	171,800
Weight, on drivers, lbs.	72,500	114,000	83,450	91,000	88,000	82,000	87,000	87,865	130,000	137,040	133,000
Weight, on leading truck, lbs.	41,900	41,000	36,600	33,000	35,600	41,000	38,000	41,295	36,580	30,840	38,800
Weight, on trailing truck, lbs.	36,000	......	37,850	34,000	35,000	39,000	37,000	34,350	......	......	......
Weight of tender (loaded), lbs.	100,000	......	92,680	43,200 (empty)	112,000	105,000	110,000	100,900	96,000	116,120	112,000
Wheel base, driving, ft. and ins.	7, 3	14, 1	7, 0	7, 0	6, 9	7, 3	7, 0	7, 3	14, 6	13, 6	16, 6
Wheel base, total, engine, ft. and ins.	26, 7	28, 4	24, 5¾	26, 9	27, 0	25, 11¼	28, 8	26, 7	25, 4	24, 4	27, 4
Wheel base, total, engine & tender, ft. & ins.	51, 2½	56, 0	49, 3½	54, 8¾	52, 4¾	53, 0¾	53, 7	53, 2	53, 7¼	53, 3	55, 2¼
Driving wheels, diameter, inches	84½	73	73	80	75	84	78½	84¼	63	63	80
Cylinders, diameter, inches	13 & 22	15 & 25	19	20	19½	13½ & 23	20¼	14 & 24	20	20	20
Cylinders, stroke, inches	26	26	26	26	26	26	26	26	30	28	28
Heating surface, firebox, sq. ft.	134	128	200	170.70	155.8	170	189	136	189	135	223
Heating surface, arch tubes, sq. ft.	......	......	......	28.27	17	......	......	43	......	......	......
Heating surface, tubes, sq. ft.	1,645	2,665	2,223.27	2,816.91	2,396	2,231	2,617	2,478	2,196.6	2,362.5	2,694
Heating surface, total, sq. ft.	1,827	2,793	2,436.16	3,015.88	2,568.8	2,401	2,806	2,657	2,385.6	2,497.5	2,917
Firebox, length, inches	114	131	101½	102⅛	90¼	110	108	114	123	94	121
Firebox, width, inches	96	59½	42½	65¼	74	42⅝	74	96	41	63½	41
Grate area, sq. ft.	86	27.25	29.92	46.27	46.38	32.25	54.0	76	32.6	33	36.60
Boiler, smallest diameter of, inches	58¾	67	62¼	68⅝	64	60¾	66	64	70	68	66
Boiler, height of center above rail, ft. & ins.	8, 9¼	......	......	9, 1½	9, 2½	8, 10½	9, 7¼	9, 0⅛	8, 9⅝	......	9, 2
Tubes, number and diameter in inches	278, 1¾	341, 2	300, 2	338, 2	306, 2	284, 2	322, 2	318, 2	303, 2¼	350, 2	345, 2
Tubes, length, ft. and ins.	13, 0	15, 0	14, 3	16, 0	15, 1	15, 0	15, 7¾	15, 0	13, 10¼	13, 0	15, 0¼
Steam pressure, lbs. per sq. in.	200	200	200	200	200	210	210	200	210	180	210
Type of boiler	Wootten	Vanderbilt	Extended Wagon top	Straight	Belpaire	Belpaire	Wagon top	Wootten	Player Belpaire	Vanderbilt	Extended Wagon top
Fuel	Anthra. Coal	Bitum. Coal	Bitum. Coal	Bitum. Coal	Bitum. Coal	Bitum. Coal	Bitum. Coal	Buckwheat Ant. Coal	Bitum. Coal	Bitum. Coal	Bitum. Coal
Reference in American Engineer and Railroad Journal	Oct., 1898 P. 341	Mar., 1902 P. 72	......	Aug., 1900 P. 237	Dec., 1900 P. 375	......	Apr., 1901 P. 101	......	Oct., 1898 P. 326	June, 1901 P. 205	Nov., 189 P. 343

FREIGHT L

Type—Drivers	8-Coupled	8-Coupled	6-Coupled	8-Coupled	8-Coupled	8-Coupled	6-Coupled	8-Coupled	8-Coupled	8-Coupled	8-Coupled
Type—Classification	Consolidation	Consolidation	Prairie	Consolidation (with trailer)	Consolidation	Mastodon	Prairie	Mastodon	Consolidation	Consolidation	Consolidation
Name of railroad	L. S. & M. S.	D. & H.	C., B. & Q.	Mex. Cent.	R. G. W.	C. & E. I	Chicago Gr. West.	Southern Pac.	N. Y. C. & H. R.	P. R. R.	Lehigh Val.
Number or road class	B-1	349	R-2	207	300	145	264	2026	G-2	H-6a	10-E-17-V 56-28
Builder	Brooks	Schenectady	Baldwin	Brooks	Richmond	Pittsburg	Amer. L. Co.	Schenectady	Schenectady	Pa. R. R. Co.	Baldwin
When built	1900	1899	1901	1897	1900	1899	1902	1898	1901	1899	1899
Simple or compound	Simple	Simple	Vauclain Compound	Simple	Simple	2-Cylinder Compound	Tandem Compound	2-Cylinder Compound	2-Cylinder Compound	Simple	Vauclain Compound
Weight, engine—total, lbs.	174,000	176,000	176,192	193,450	183,000	185,950	191,700	192,000	192,000	193,500	195,000
Weight on drivers, lbs.	154,000	157,500	132,838	145,200	166,400	146,950	133,200	155,000	166,000	173,900	171,000
Weight on leading truck, lbs.	20,000	18,500	17,034	23,450	16,600	39,000	28,400	37,000	26,000	20,500	24,000
Weight on trailing truck, lbs.	....	....	26,320	24,800	....	....	30,100	....	....	....	....
Weight on tender (loaded), lbs.	124,500	102,150	116,600	93,300	106,000	100,000	120,000	39,650 (empty)	108,500	134,700	121,000
Wheel-base, driving, ft. and ins.	17, 4	17, 8	12,1	15, 0	16, 8	15, 6	11, 4	15, 6	19, 0	16, 6½	16, 3
Wheel-base, engine, ft. and ins.	25, 6	24, 5	28, 0	23, 5	24, 11	26, 2	29, 2	26, 5	25, 11	24, 9	25, 5
Wheel-base, total engine & tender, ft. & ins.	55, 4¼	51, 1¾	54, 5½	50, 9¼	52, 11	54, 6½	54, 2½	53, 6½	53, 10	58, 1½	52, 6⅝
Diameter of drivers, inches	62	50	64	56	56	54	63	55	63	56	62
Cylinders diameter, inches	21	22	16 & 27	21	22	21½ & 33	16 & 28	23 & 35	23 & 35	22	17 & 28
Cylinders, stroke, inches	30	28	24	26	28	30	28	32	34	28	30
Heating surface, firebox, sq. ft.	199	225.53	151.1	224	206	197	179	206.5	155.4	166.5	177.7
Heating surface, arch tubes, sq. ft.	22.3	86.75	22.5	....	....	....	....	....	27.09	....	....
Heating surface, tubes, sq. ft.	2,653	3,036.26	2,733.0	2,175	2,667	2,044.8	3,071	2,819.3	3,298.08	2,675.9	2,809.6
Heating surface, total, sq. ft.	2,874.3	3,348.54	2,906.6	2,399	2,873	2,241.8	3,250	3,025.85	3,480.57	2,842.4	2,987.3
Firebox, length, inches	120¼	120	84	120	122	126	96	120	96	107	118
Firebox, width, inches	40¼	108	72	37¾	41 1-16	41	74	42	75⅜	66	96
Grate area, sq. ft.	33.5	90.19	42	31	34.7	35.8	48.5	35	50.32	49.1	76.33
Boiler, smallest diameter of, inches	68¾	74	65¼	74	74	64	70⅛	72	70⅝	69½	66
Boiler, height of center above rail, ft. & ins.	9, 4⅛	8, 7	8, 0	9, 1	8, 7	8, 7	8, 8	....	9, 7	9, 2	8, 10¼
Tubes, number and diameter in inches	340, 2	417, 2	272, 2¼	374 2	318, 2¼	288, 2	352, 2	332, 2¼	396, 2	373, 2	358, 2
Tubes, length, ft. and ins.	15, 0⅛	14, 0	17, 1 11-16	11, 1 5-16	14, 2⅞	13, 6	16, 8⅞	14, 6	16, 0	13, 8½	15, 1
Steam pressure, lbs. per sq. in.	200	180	200	180	190	200	200	200	210	205	200
Type of boiler	Wagon top	Wide Firebox	Wide Firebox	Belpaire	Extended Wagon top	Extended Wagon top	Wagon top	Extended Wagon top	Wide Firebox	Belpaire Wide Firebox	Wide Firebox
Fuel	Bitum. Coal	Anthra. Coal	Bitum. Coal	Wood and Bitum. Coal	Bitum. Coal	Bitum. Coal	Bitum. Coal	Bitum. Coal	Bitum. Coal	Bitum. Coal	Anthra Coal
Reference in American Engineer and Railroad Journal	Feb., 1900 P. 37	Dec., 1899 P. 398	May, 1901 P. 135	Nov., 1897 P. 371	Sept., 1900 P. 283	Mar 1900 P. 84	Apr., 1902 P. 123	Jan., 1899 P. 26	Mar., 1901 P. 83	June, 1899 P. 177	Apr., 189 P. 110

NOTE—These figures have been verified by the railroad officials in charge.

EXAMPLES OF RECENT LOCOMOTIVES.

'O TOTAL WEIGHTS.

OMOTIVES.

Coupled ba't'q'a. tlantic	6-Coupled Prairie	6-Coupled 10-wheel	6-Coupled 10-wheel	4-Coupled Central Atlantic	4-Coupled Atlantic	6-Coupled 10-wheel	4-Coupled Atlantic	6-Coupled 10-wheel	4-Coupled Atlantic	6-Coupled 10-wheel	4-Coupled Cha't'q'a. Atlantic	6-Coupled 10-wheel	6-Coupled Prairie	6-Coupled Special Suburban
. R. & P.	L. S. & M. S.	N.Y. C. & H. R.	A., T. & S. F.	N. Y. C. & H. R.	P. R. R.	D., L. & W.	C., M. & St. P.	Northern Pacific	C., B. & Q.	Union Pacific	C. R. R. of N. J.	Lehigh Valley	A., T. & S. F.	N.Y. C. & H. R.
162	J	F-3	T-14-B	I-2980	E-2	1005	A-2	S-2	1586	1820	590	10-D-17-W 66-28	P-14-A	1410
Amer. L. Co.	Brooks	Schenectady	Baldwin	Schenectady	P. R. R. Co.	Brooks	Baldwin	Schenectady	Baldwin	Baldwin	Amer. L. Co.	Baldwin	Baldwin	Amer. L. Co.
Simple	Simple	Simple	Vauclain Compound	Simple	Simple	Simple	Vauclain Compound	2-cylinder Compound	Vauclain Compound	Vauclain Compound	Simple	Vauclain Compound	Vauclain Compound	Simple
1902	1901	1900	1901	1901	1901	1900	1901	1900	1902	1901	1901	1900	1901	1902
73,000	174,500	175,000	175,000	176,000	176,600	179,000	181,535	182,500	183,080	184,240	191,000	194,758	210,800	216,000
9,000	130,000	134,200	135,000	94,800	109,033	137,000	100,335	141,000	95,880	142,440	99,400	141,348	143,600	128,000
0,000	21,500	40,800	40,000	42,600	36,650	42,000	45,100	41,500	47,000	41,800	48,000	53,410	29,700	......
4,000	23,000	......	......	38,600	30,917	......	36,100	......	40,200	......	43,600	......	37,500	......
20,000	124,500	112,000	110,000	112,000	90,000	106,000	120,000	42,700 (empty)	......	......	124,000	96,500	112,600	......
8, 0	14, 0	14, 11	14, 6	7, 0	7, 5	14, 0	7, 3	14, 10	7, 3	14, 6	7, 8	13, 0	13, 8	15, 0
20, 2	31, 10	26, 0	26, 7	27, 3	30, 9½	25, 3	27, 11½	25, 10½	27, 8	26, 9	29, 10	25, 3½	32, 2	35, 9
.....	57, 3¼	52, 11½	56, 6¾	53, 0	60, 11 3-16	50, 10¼	57, 5½	53, 7	56, 0	54, 0	53, 8	52, 6⅞	57, 8¾	35, 9
72	80	75	69	79	80	69⅝	84	63	84¼	72	85	72	79	63
20¼	20½	20	15½ & 26	21	20½	20	15 & 25	22 & 34	15 & 25	15½ & 26	20½	17 & 28	17 & 28	20
26	28	28	28	26	26	28	28	30	26	28	26	26	28	24
202.3	169.3	185.64	182	180	166	180	207	208.7	155.5	186	174	171.71	195	162
.....	20.7	......	......	27.09	......	......	......	28.95	......	......	......	......	......	......
,805.6	3,172	2,729.6	2,811	3,298.08	2,474	2,520	3,008	2,771.2	2,834.5	2,825	2,793	2,536.59	3,543	2,275
,007.9	3,362	2,915.24	2,993	3,505.17	2,640	2,700	3,215	3,008.85	2,990	3,011	2,967	2,708.3	3,738	2,437
108	84⅛	108⅛	133½	96⅛	72	97	102	120 3-16	96⅛	118 3-16	123	114	108	93
74	83¼	40¾	59	75⅝	111	127	65⅞	41	66⅛	39⅛	97	89⅞	71¼	97⅞
54.43	48.6	30.3	......	50.32	55.5	82.2	46.76	34.22	44.25	32	82	71.25	53.5	62.07
70⅛	66	66	66	72	65	72⅛	66	70	64	66	68	64	70	70
), 7½	9, 2	8, 10⅝	9, 2	9, 3	9, 3 5-16	9, 6	9, 5½	8, 9	......	......	9, 8½	9, 2	9, 4	9, 2 1-16
336, 2	285, 2¼	366, 2	360, 2	396, 2	315, 2	350, 2	350, 2	376, 2	330, 2	350, 2	325,2	325,2	318, 2¼	365, 2
6, 0¼	19, 0	14, 10	15, 0	16, 0	15, 0	13, 10¼	16, 6	14, 2	16, 6	15,6	16, 6¼	15, 0	19, 0	12, 0
220	200	200	200	200	205	210	200	200	210	200	210	200	200	200
raight de box	Wide box Wagon top	Extended Wagon top	Vanderbilt	Wide box	Straight Wide box	Wagon top	Extended Wagon top	Extended Wagon top	Extended Wagon top	Extended Wagon top	Wagon top	Wide box	Straight top	Straight Wide box
itum. Coal	Bitum. Coal	Bitum. Coal	Crude Petrol.	Bitum. Coal	Bit. & Ant. Coal	Fine Ant. Coal	Bitum. Coal	Bitum. Coal	Bitum. Coal	Bitum. Coal	Fine Ant. Coal	Anthra. Coal	Bitum. Coal	Anthra. Coal
., 1902	Mar., 1901	Aug., 1899	Dec., 1901	Feb., 1901	June, 1902	Sep., 1900	Oct., 1901	......	Apr., 1902	Feb., 1901	Jan., 1902	Oct., 1900	Dec., 1901	Apr., 1902
P. 29	P. 69	P. 255	P. 374	P. 35	P. 188	P. 272	P. 313	......	P. 119	P. 54	P. 15	P. 312	P. 373	P. 115

OMOTIVES.

Coupled onsoli- lation	10-Coupled Decapod	8-Coupled Consolidation	8-Coupled Consolidation	8-Coupled Mastodon	8-Coupled Consolidation	10-Coupled Decapod	8-Coupled Mastodon	8-Coupled Consolidation	8-Coupled Mastodon	8-Coupled Consolidation	8-Coupled Consolidation	8-Coupled Consolidation	10-Coupled Decapod	10-Coupled Decapod
orthern Pac.	Erie R. R.	A., T. & S. F.	Ill. Central	D., L. & W.	Northern Pac.	M., St. P. & S. S. M.	Great Northern	A., T. & S. F.	Ill. Central	Lehigh Val	Union	B. & L. E.	A., T. & S. F.	A., T. & S. F.
Y-2	J-1	836	639	808	Y-3	600	100	824	640	10-E-18-W 49-30	95	150	989	940
Amer. L. Co.	Baldwin	Amer. L. Co.	Rogers	Brooks	Amer. L. Co.	Baldwin	Brooks	Baldwin	Brooks	Baldwin	Pittsburg	Pittsburg	Amer. L. Co.	Baldwin
1901	....	1902	1899	1899	1901	1900	1898	1902	1899	1898	1898	1900	1902	1902
Tandem Compound	Vauclain Compound	Tandem Compound	Simple	Simple	Tandem Compound	Vauclain Compound	Simple	Vauclain Compound	Simple	Vauclain Compound	Simple	Simple	Tandem Compound	Tandem Compound
98,000	200,550	201,000	203,000	205,000	209,500	210,000	212,750	214,600	221,450	225,082	230,000	250,300	259,800	267,800
75,000	173,700	176,000	184,800	166,000	185,500	185,100	172,000	191,400	181,400	202,232	208,000	225,200	232,000	237,800
23,000	26,850	25,000	18,200	39,000	24,000	24,900	40,750	23,200	40,050	22,850	22,000	25,100	27,800	30,000
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
47,000 (empty)	90,100	46,400 (empty)	147,600	106,600	47,000 (empty)	124,550	96,000	110,000	147,600	121,000	104,000	141,100	134,900	....
17, 0	18, 10	15, 4	16, 3	15, 0	15, 0	19, 4	15, 10	15, 4	15, 9	15, 0	15, 7	15, 7	20, 0	20, 4
26, 2	27, 3	24, 1	24, 5	25, 9	23, 8	28, 0	26, 8	24, 6	26, 6	23, 10	24, 0	24, 4	28, 11	29, 10
3, 10½	53, 5½	....	56, 10½	50, 4¼	52, 4½	58, 3	53, 11	54, 2¾	60, 2½	55, 0½	54, 9½	57, 11¾	62, 0	59, 6
63	50	57	57	54	55	55	55	57	57	55	54	54	57	57
15 & 28	16 & 27	18 & 28	23	21	15 & 28	17 & 28	21	17 & 28	23	18 & 30	23	24	17½ & 30	19 & 32
34	28	32	30	32	34	32	34	32	30	30	32	32	32	32
155.64	185	178	221	218	173	201	235	165	263	215	205	241	205.4	210.3
26.43	....	....	....	....	22.9	....	....	....	....	....	....	....	....	23.9
3,231.9	2,228	2,787	2,982	2,950	3,450.4	2,799	2,730	4,031	3,237	3,890.6	3,116.5	3,564	4,476.5	5,155.8
3,414.	2,470	2,965	3,203	3,168	3,646.3	3,000	2,965	4,266	3,500	4,105.6	3,321.5	3,805	4,681.9	5,390.
00 1-16	131½	101⅛	132	123	100 1-16	132	123	84	132	120	120	132	108 1-16	108
75¼	98⅛	71¼	42	97	75¼	41	39¾	28-diam. (3-cy'n'd'l) oil br. only	41¼	108	40½	40¼	79¼	78
52.29	89.0	50	38.5	82.4	52.3	37.5	34		37.5	90	33.5	36.8	59.5	58.5
66½	76	68	79¾	83⅞	74¾	68	78	74	80⅛	80	80	84	78¾	78¾
9, 5	8, 0	....	9, 2	9, 2½	9, 3¼	8, 11	9, 5	9, 2	9, 8	8, 7¾	9, 3⅜	9, 11¾	....	....
388, 2	354, 2	355, 2	417, 2	410, 2	442, 2	344, 2	376, 2¼	652, 1¾	424, 2	511, 2	355, 2¼	406, 2¼	413, 2¼	463, 2¼
16, 0	12, 0¼	15, 0	13, 8	13, 10¼	15, 0	15, 7	13, 10⅜	13, 7	14, 8⅜	14, 7¾	15, 0	15, 0	18, 8	19, 0
210	180	210	210	200	210	215	210	210	210	200	200	220	225	225
Wide Firebox	Wide Firebox	Extended Wagon top Wide Firebox	Belpaire	Conical Con. Wagon top	Wide Firebox	Extended Wagon top	Belpaire Wagon Top	Extended Wagon top	Belpaire	Wootten	Straight	Straight	Extended Wagon top Wide Firebox	Extended Wagon top Wide Box
Bitum. Coal	....	Bitum. Coal	Bitum. Coal	Fine Ant. Coal	Bitum. Coal	Bitum. Coal	Bitum. Coal	Crude Petroleum	Bitum. Coal	Anthra. Coal	Bitum. Coal	Bitum. Coal	Crude oil and Bitum. Coal.	Bitum. Coal
pt., 1901	....	June, 1902	Jan., 1900	Nov., 1899	....	Oct., 1900	Jan., 1898	Jan., 1902	Oct., 1899	Dec., 1898	Nov., 1898	July, 1900	Feb., 1902	June, 1902
P. 271	....	P. 179	P. 13	P. 365	....	P. 319	P. 1	P. 10	P. 315	P. 395	P. 365	P. 214	P. 38	P. 192

even slight progress along any one of these lines is a worthy achievement for one man:

(1) The development of organization; (2) better co-operation between various co-ordinate departments of a large, complex organization; (3) harmonizing conflicting interests in the relations of railway officers and employees, and between the railway and the public; (4) the economic principles underlying the making of rates; (5) the principles of railway location; (6) the practical limits of expenditure in the reduction of grades and curves; (7) the more thorough combustion of coal and the more complete use of the products of combustion in locomotive and stationary boilers; (8) the more economical use of steam in the locomotive engine; (9) economies in shop management and locomotive and car maintenance; (10) water purification, timber preservation, and many more which might be mentioned.

A young man entering the railway service with such aims as I have outlined, and endowed with a fair amount of courage and persistence, patience and common sense, is certainly quite as sure to make a "success" in the sense of doing something worth doing and of satisfying himself, as in any profession. Large combinations of capital in railroad, as in any other business, have not by any means destroyed a young man's chances. New problems of great importance have been introduced. The work of organization so as to centralize authority, yet place on each part of the machine its proper burden, is very difficult to accomplish. The operation of a large railway, like the operation of any large consolidation of widely-scattered manufacturing plants, or the operation of a large machine consisting of many pulleys or gear wheels for transmitting power, involves serious losses in friction and in the doing of useless work. How to diminish this friction and useless work to a minimum, and do the greatest amount of effective work for the power utilized, is a great problem.

Furthermore, a man entering the railroad service with the object of making it his profession must put to one side any idea of listening to the siren voice of those who seek to tempt him away. Granted that many a doctor, lawyer or minister has had an opportunity to quit his profession and to take up some other pursuit, if he does so his career in the profession he has followed ends; and it is equally true with many of the young men who enter railroad work. The temptation of a little more pay to enter the manufacturing field frequently tempts them away, and they give up the chance of becoming something in the railroad profession.

THE OVERLOADING OF LOCOMOTIVES.

By G. R. Henderson, Superintendent of Motive Power,

Atchison, Topeka & Santa Fe Railway.

The matter of tonnage rating of locomotives is frequently overdone to such an extent that not only is a greatly reduced mileage obtained from the power, but traffic is delayed on account of the slow movement of trains, thus blocking other and more important traffic. The writer remembers an incident on a certain road where a locomotive was calculated to take a load of 610 tons up a 2 per cent. grade, and instructions were issued from the transportation department to give it 850 tons. This load, of course, pulled the engine backward down the mountain. The load was then reduced to 650 tons, when the result was that the trains crawled up the mountain at a speed of about four miles per hour. After working this way for several months, the officers of the operating department, thinking that they had beaten the motive power department in the rating, the loads were reduced to 610 tons, and we understand it has been operated with this load for the last two years. This enabled the trains to climb the mountain with about double the speed and make more trips in a day than with 650 tons, showing that a small margin of 40 tons will make a great difference in the operation of a locomotive on a heavy grade.

Referring to another case which happened within the writer's recent experience: This locomotive, with 52,000 pounds tractive force, was figured to draw 1,100 tons up a grade 124 miles long, with numerous 95 ft. grades in it. When the rating was made 1,150 tons, it was found practically impossible to ascend this grade without doubling at some points and greatly delaying the train. With 1,100 tons the trip was made readily, at a much better speed, showing that in this case a small difference of 50 tons was also accountable for the practical success or failure of this engine.

On a 3 per cent. grade, my calculations showed 600 tons to be the proper rating, yet 700 tons were occasionally applied, with the result that critical points had to be doubled, the engine was very slippery, and delays in handling trains ensued, whereas with 600 tons the engine went up at a good speed, and kept the traffic moving in good shape. Some people would think it incredible that a small difference of 40 or 50 tons would make such a difference to a large engine; but if tonnage rating is correctly figured (and it is a small matter to figure rating on heavy grades), there will be little difficulty in maintaining a proper train movement and getting good results from the power.

Another cause which influences this greatly is the fact that there may often be discrepancies and errors in the profile of the section. It recently came to the writer's knowledge that certain engines were not beginning to pull their tonnage on a certain grade. This grade was stated to be 1.40 per cent. The rating figured for the engines in question was 1,350 tons. It was stated, however, that they found it necessary to reduce the tonnage to about 1,150 tons. This, of course, called for an investigation, and, upon going thoroughly into the matter, it was found that, while the profile showed maximum grades of 1.40 per cent., as a matter of fact there were occasionally stretches of road where the grade ran as high as 1.65, which called for a rating of 1,200 tons. The engine was able to handle this tonnage nicely upon making a trial, and this again demonstrated the necessity for close observation and careful analysis of the various details which go to make up the record in an engine test.

If an engine will not pull a certain tonnage, there may be two or three things about the engine to be looked for.

First—It may be impossible to maintain steam.

Second—Even if steam is maintained, the proper work may not be gotten out of the cylinders.

Third—Internal friction may be such as to greatly reduce the effective drawbar pull. These facts may be determined by means of a steam engine indicator and the dynamometer car, and if the engine is then exerting the calculated drawbar pull, there is no reason why it should be considered as failing in its duty. The fault evidently lies with an incorrect profile or some unusual condition of train friction.

MEETINGS OF DEPARTMENT SUBORDINATES.

By Robert Quayle.

Superintendent of Motive Power, Chicago & Northwestern Railway.

The office of superintendent of motive power is largely executive. It calls upon him and his assistants, including the master mechanics and others, to devise ways and means that will enable him to render the best possible service to the patrons of the railway he serves, and at the same time obtain the best results for the least expense.

It is not possible for one man to be able to grasp the situation in detail on a large railway. There is much information that he must necessarily depend upon his subordinates for; hence the reason that his official associates in the work should be educated thoroughly in the policies to be pursued by the head of the department; and they should by such education work harmoniously toward the successful attainment of the policies adopted. In adopting such policies, I have considered it wise and beneficial to have them discussed thoroughly by the master mechanics of the railway; hence the reason for the adoption of what we term a local master mechanics' association.

At these meetings, which are held about eight times a year, we discuss important questions and problems pertaining to cost of operation, the improvement of the condition, the betterment of the service, the adoption of standards, the abandonment of expensive methods of doing work, and the introduction of cheaper and at the same time more effective methods of accomplishing the same or better things.

It goes without saying that when ten or a dozen men belonging to one department get together, and they know what subjects are to be discussed at the next meeting thirty days in advance, they begin to prepare themselves, and get such data as will be of value and as will show that they are on the alert and are looking for the successful accomplishment of the subject to be discussed. And this preparation necessary for the discussion of these topics makes them more capable, more efficient, and better all-round men. Every man has a justifiable pride in himself to do just as much as the other fellow can do. We are not all born with the same attainments. Some have larger executive ability than others. One man is a genius, and his forte is particularly adapted to shop practice, devising schemes and "shop kinks" that will enable the company to do its work more quickly and more cheaply in the shops. Another man may not have this mechanical genius, but he may have the ability to foresee things and to forestall trouble, and the ability to have other men in his employ think that he is the best fellow in the world and whatever he does or says is right, and the men are loyal to him and to his interests, and therefore to the company's interests. Thus he is able to marshal his forces and hold them in line and get whatever is right out of them.

There is another class of men able to formulate ways and means for accomplishing certain ends, and they have not the ability to execute and to see that the other men put into execution the schemes that they have devised.

When, however, we get these men all together, and one gives his opinion on his best line of thought, and another on the line of his genius, and another on the line of his great executive ability, and another one on the fact that he is able to compel the other men to execute and to do what he has formulated—each of these men, while listening to the others, gets the best (more or less) of each of the others' spirit, and he sees where he lacks; and therefore, by their association and working together, each man improves himself, and is thereby better fitted, and is made a better all-round man for the work he has to accomplish.

Now, as to the results of this kind of organization:

First, it brings all the heads of the various divisions into close relationship with the head of the department. The head of the department must be liberal and broad in his views. He must not, however, sacrifice any of the company's interests or any of his personality in order to accomplish this. It is not necessary. It is good policy to take a vote on subjects, and allow the majority vote to carry; provided, of course, that the head of the department understands that it will not be in conflict with any policy of the road. When the master mechanics realize that their vote is a factor in the management of the motive power department, it at once not only touches their pride, but causes them to realize that they are not mere machines, but that they at once have become a part of the management of the motive power department, and that therefore they must consider the questions from every standpoint, and be able to vote intelligently, so as to make no mistakes. The other factor is that when these men go back to their respective divisions, and they have become a party to some new method, and it is introduced, it at once commands their attention and their best efforts to make that which they have fathered win.

These meetings promote harmony between the master mechanics, and thus strengthen our entire organization. We arrive at a clearer understanding concerning our methods, and thus save a good deal of time and clerical work. It at once makes a uniform practice in our work, as well as a uniform method of handling our men from one end of the system to the other. It not only introduces, but maintains standards in our shop work, which are of incalculable value to the railroad company. Standards reduce the number of parts carried in stock; they reduce the number of drawings in the drawing office, and in every way are most desirable, as well as economical.

While perhaps it cannot be said that by these practices we maintain a standard of men, we can say that it does raise the standard of our men, and causes each man at the head of the various branches of the mechanical department to pin his standard just a little higher each year. He fixes some ideal in his mind, and he works constantly to maintain that high standard which he has placed before himself as the result of these meetings. It in a manner prevents men from getting into ruts. While it is true that associations or organizations will sometimes get into ruts, it is certainly a fact that where ten or twelve men are assembled together to determine the best practices and the best methods of all kinds to be used, they are much less liable to get into ruts than would a single individual. Therefore, in a word, the railroad company which they serve gets the benefit of the exchange of ideas—the benefit of what a dozen men say as to the best practices on all the other roads they come in touch with, as well as the literature they read, and the pointers they get from each member of the association.

By having a personal discussion of the cost of the amount of coal used per 100 ton miles, the cost of oil, the cost of engine repairs, and the cost and extent of engine failures and their prevention, we at once get to the heart of these subjects, and each man profits by the experience of the others, and this enables him to cull out the poor and select the good, and thereby improve materially the conditions on his division.

TACT IN RAILROAD SERVICE.

By A. M. Waitt,

Superintendent of Motive Power and Rolling Stock, New York Central & Hudson River Railroad.

The fundamental elements of a successful business career have been illustrated by a well-proportioned four-legged chair. Although, by great care, the chair may be made to support its occupant, after a fashion, with one leg missing, yet a successful and complete support is furnished only by the entire four. These supports to a successful career are: Education, Practical Experience, Business Ability and Tact.

Much has been said and written about the first three of these essentials, but less has been said about the last. To be sure a tactful person naturally exercises this attribute without making it noticeable; in fact this feature comprises one of its essential elements.

If we seek a dictionary definition we find it described as "fine perception, a fine sense of how to avoid giving offense, ability to do or say what is best for the intended effect."

A little consideration of these definitions will at once show the importance of such an element in the fully successful business career.

Life is full of hills, which must either be climbed, tunneled or gone around. It has many sharp edges to be passed without getting badly hurt. It has numerous obstacles to success and happiness to be overcome and yet avoid serious falls. The man who has this gift is the one who can surmount or pass these obstructions unscathed. Without tact, even though possessing a complete outfit of education, experience and business ability, a man will constantly make mistakes through haste, conceit or excessive enthusiasm. These will leave him on the level of the many who do not possess that fineness of discernment and action which gives employers or others in higher authority the confidence to place him in positions where he must cope with the larger general problems, patrons, business solicitors and the general public. These positions require freedom from errors in judgment, or if errors are made they require the ability to minimize their effect.

One essential element of tact is kindness, which always puts one's self in the other's place before passing judgment. This faculty must be in constant action on many occasions, hence it must be well and carefully cultivated. It is not by any means merely an inheritance. It may be developed and strengthened. The tactful person never says an unpleasant thing in a manner to unnecessarily wound the feelings of another. He sugar-coats all bitter pills, and does not tear out an obnoxious growth, but removes it with the surgeon's skill, and then dresses the wound for rapid healing without leaving a scar. He knows, not only when and what to do and say, but equally well when and what not to do or say. One never knows what changes life may have in store. Friends are always blessings, and enemies are always a source of sorrow and annoyance. We should so treat all with whom we come in contact that, whether we can comply with their wishes or not, they still remain our friends and we retain their respect and good will.

When it is necessary to discipline a subordinate it should be done in such a way that he will feel that he has been fairly and honorably treated, and that the discipline was merited. The officer should always praise a good action or faithful effort. He should notice, greet and encourage his subordinates and yet maintain firm discipline and proper dignity. The officer should so act that they will consider him fair, just and reasonable, and will see that he has their best interests at heart. This includes such treatment as to encourage them to do their very best for the interests of their superior and employers. Such a course will enable the officer to make every subordinate feel that the "boss wants, if possible, to find a better position for every faithful man, and that he knows pretty well what every man is doing. It will enable the head of the department to carry out this principle, which is essential to a strong organization. Strong language, sarcasm or angry words between officers and men will never be used under such conditions. Practice proves that "you can catch more flies with molasses than with vinegar."

Tact is equally necessary in the dealings between the subordinates and superior officers. It will make one careful never to exaggerate reports, either verbal or written. The truthful man will say all the good things possible of others, and not mention or magnify the evil. The subordinate should have freedom, with respect, but not familiarity. When asked for an opinion, it should be given frankly, with the reasons upon which it is based, but opinions should not be urged or pushed if they are not wanted. No word or act should be thought of that may be construed or interpreted as disloyal.

This subject also includes the relations between the officers and supply men. They should always be given a fair hearing and pleasant greeting. Ways may be found for denying a request, for business reasons, without the use of hasty or unkind words. A man who has been "turned down" may yet go away feeling that, even if he cannot secure his object, he is welcomed as a friend or as a visitor.

Our good friends, the supply men, will also permit the suggestion that one soliciting business needs to discern when a railroad officer is busy or perplexed, and this will lead him to be brief or to simply pay his respects and call again at a more propitious time. The wise solicitor will not take undue advantage of those whose offices are conveniently near, to annoy them with too frequent calls, such as regular semi-monthly visits, for frequently such persistency injures rather than helps one's cause. It is always distasteful to bear a competitor "run down" or to hear a "tale of woe," such as is often poured into the ears of a patient railroad man. Tact in both the railroad man and supply man will enable each to so act toward the other that if their positions should ever be reversed each would still be glad to see the other at reasonable times.

On the whole, tact is a wonderfully valuable and necessary feature in enabling one to make his success complete. There is far too little appreciation of the need of its cultivation. Those who do develop it, and use it most, other things being equal, are, as a rule, the most successful, the most highly esteemed and the most truly trusted in matters of great importance.

As a suggestion in the education and preparation of young men for a business or professional career, it seems not amiss to hint that no greater help can be given than by making the necessity of this attribute prominent.

COKE AS LOCOMOTIVE FUEL.

By Henry Bartlett,

Superintendent Motive Power, Boston & Maine Railroad.

After nearly three years' experience, the Boston & Maine Railroad stands as ready to approve the use of coke as a locomotive fuel as at the time your previous article was published on the matter, in your October issue of 1899. The situation has changed somewhat in regard to it, as the consumption has been increased to 160,000 tons annually, and 150 locomotives are using it. It forms at the present time one-sixth of the fuel supply of this road. The above facts would answer alone, perhaps, for the satisfaction it is giving, were not some further information regarding it interesting.

Cast-iron finger grates are now used in all the coke-burning engines, but these have been slightly changed to give more air-space (50 per cent.), which, with the steam jet under them, results in lessening the formation of clinkers. The use of coke is now confined entirely to local passenger and shifting service, and has been discontinued entirely on through passenger service. The reason for the latter was that it was found on long, heavy runs that a deposit formed on the tubes, which, toward the end of the run, partly closed them up and materially affected the steaming qualities of the engine. This deposit was difficult to remove while the engine was working, but was easily taken out when the firebox cooled down. In runs up to 75 miles in length no difficulty is experienced.

No injurious effects are found in any way to the boilers or fireboxes from the use of coke, with the exception of a more rapid deterioration of the pipes, nettings, etc., in the smokeboxes, due to the action of the gases. The same gas also attacks metal superstructures with which it comes in contact, such as bridges and station roofs, but to a lesser degree. To the surprise of all concerned, coke is found to be rather severe on the tenders, the sharp, cutting edges of the fuel rapidly wearing the tank-sheets where it comes into contact with them.

As to the capacity of coke compared with coal, recent experiments show that it appears to correspond closely to that of anthracite coal of similar size and to be about 80 per cent of the capacity of the best coals, such as Pocahontas, Cumberland, New River, etc. By capacity is meant the ability to evaporate steam with a given grate area and draft pressure, irrespective of economy.

The advantages of coke are considered to far outweigh its disadvantages. Under the conditions it is received, it is without doubt one of the most satisfactory fuels for locomotive use, and its appreciation by the traveling public is noticeable in many ways.

VOLUNTARY LOYAL SUPPORT FROM SUBORDINATES.*

By J. F. Deems,

General Superintendent, American Locomotive Company, Schenectady Works.

"How is it that men can be brought into the frame of mind which makes them a part of the company instead of being mere servants."

Your interrogatory certainly touches the question of paramount importance to railroads, as well as many manufacturing concerns to-day, and while I regret my inability to answer your query in anything like the manner its importance deserves, I will venture a few suggestions, based on a good many years' experience in "being handled," as well as in "handling" men.

There can be little doubt that the question of leadership, or the successful management of a large body of men, is largely a question of the personality of the leader, but it would seem that this personality or individuality might be, to a considerable extent, moulded by a careful study of certain basic principles, or cardinal rules concerning the question, and after all that great rule of rules, "Do unto others as you would they should do unto you," is the frame of the entire structure.

It is a question of simple justice; of the proper understanding and application of the broad principles of Right between man and man. No, this is not quite all; there must be a feeling of kinship, a practical recognition and constant exemplification of the universal brotherhood of man; there must be something in common. Oh, but says some one, this will be subversive of all authority; this will be a sacrifice of official dignity. There is no authority worthy the name, except that which secures voluntary service; there is no official dignity except that which is based on the love and respect of the subordinate for the superior, and if the railroads could to-day measure in dollars and cents the exact cost of this so-called "authority" or "official dignity," they would probably find it a liability of much greater magnitude than they now realize.

Again, let men know they are appreciated; impress them with the idea that the success or failure of the company depends largely upon their efforts; this is merely a plain, simple truth. Why should it be withheld?

Then, again, it is probably safe to say that nine out of every ten—yes, ninety-nine out of every hundred—men will work willingly and cheerfully for a less compensation if they are made to feel they are appreciated. This is not suggesting a reduction of salaries, but merely the plain statement of a simple truth. Too much still remains of the old idea that work is a curse, a punishment, instead of being the only real pleasure of life. "There is no pleasure but in resting from work, except resting in work, which is rapture beyond the dreams of sainthood," is a thought it might be well for many men in positions of responsibility to remember, and try and make the work of their subordinates as restful as possible by imbuing their minds with this idea, rather than trying to impress upon them the "official dignity" idea.

"Treat any race, or section of a race, well, and you will improve it. You give it a higher opinion of itself and make it ambitious."

Now, let it be understood that I am advocating no maudlin sentimentalism, no paternalism, nor anything savoring of charity; far from it. It is not these things that men want; but they do believe they are entitled to, and should have recognized, the idea that men are men, and not machines. Let us place the question where it belongs, on a purely commercial basis, and I insist that the methods outlined are those that are attended with the best results for both sides.

The poorest paid and hardest worked men on most railroads are the clerks, and yet their loyalty can be depended on at almost all times, and why? Because they are in closer contact with the heads of departments; because there is that feeling of confidence and mutuality growing out of free and somewhat intimate daily intercourse.

In times of trouble you seldom think of a foreman being disloyal, although he may not be as well paid as some of his subordinates, who are willing to strike on the slightest pretext.

Now, the contention is, that the more nearly the rank and file can be brought into the same influences that surround the foreman or clerks, the more advantageous it will be to the company; and let me suggest here, don't be surprised if many of the efforts to attain this end fail, as it must be borne in mind that we railroad officials have dwelt so long in the high altitude of "official dignity," and left the lower strata, where the rank and file live, so completely to the chronic malcontent, that it will be no easy task to re-educate both sides and get them on a normal basis. But just so sure as these lessons are not learned and advantage taken of them, just so sure is it that the United States will surrender her supremacy as a manufacturing country to a more receptive people, which will be to the detriment of both sides.

Doubtless a multitude of "ifs" and "buts" will be on hand to meet these suggestions, all of which have been indulged in for generations by England, while her lack of receptivity was gradually but surely undermining her supremacy as a manufacturing and commercial nation. Shall history repeat itself in the case of the United States? is a question worth considering.

* Written by Mr. Deems by special request while he was at the head of the motive power department of the Chicago, Burlington & Quincy Railway.—Editor.

REPRESENTATION BY TONNAGE IN THE M. C. B. ASSOCIATION.

By R. P. C. Sanderson, Superintendent Motive Power, Seaboard Air Line.

Among the topical discussions at the last Master Car Builders' Association Convention was the proposal that the voting power of the representative membership be in proportion to the rated tonnage capacity of the cars owned, instead of in proportion to the number of cars owned. The subject was ably presented by Mr. Lentz, of the Lehigh Valley, but the members were evidently not ready to discuss so radical an innovation, and there was no discussion on the subject beyond a motion by Mr. Rhodes to refer the matter to the executive committee for such action as they chose to take. Doubtless the matter will not rest there, but will probably be taken up in many quarters, and whether finally a change in the method of representative voting is made or not it should be well discussed, and it is with this in view that the following notes on the subject are presented.

The main underlying principle from which the suggestion has sprung is that the cost of the modern large capacity cars is so much greater than that of the older 40,000-lb. capacity cars and smaller ones yet, that roads which are destroying old cars and replacing them with new ones of large capacity properly feel that their representative power in the association is being unfairly affected thereby. As an illustration, let us assume that some railroad had, five years ago, 15,000 old 40,000-lb. and 30,000-lb. capacity coal cars, with a total tonnage capacity of, say, 270,000 tons. Let us assume that on account of the heavy cost of maintainance of these old cars in modern heavy service, and to reap the benefit from handling coal in large units, instead of small ones, they decide to buy 10,000 new cars of 80,000 lbs. capacity, spreading the purchase over some years, and retiring the old cars during the same time. At the end of that time they would have increased their tonnage capacity to 400,000 tons from 270,000 tons, largely added to the capital invested in rolling stock, and yet have only ten votes in the association instead of fifteen. Is this right?

As the money invested in the equipment is the principal consideration, it does not look fair, nor is the tonnage basis for representation likely to be any fairer; rather the other way, perhaps. A capacity of 60,000 lbs. is generally considered as large as is practicable, on account of refrigeration, weight, etc., for refrigerator cars. For interchange box cars, a 36-ft. car of 80,000 lbs. capacity will be the general standard for some years to come. Furniture cars are not frequently built of more than 60,000 lbs. capacity, while for hopper cars and gondola cars 100,000 lbs. capacity is already almost a standard. And yet the 15-ton refrigerators cost nearly, if not quite, as much as the 50-ton coal, hopper or gondolas. The 30-ton furniture monstrosity costs as much or more than the 40-ton box car. All of them will cost more than a 50-ton flat car. These differences are going to remain, and would seem to the writer to place a road having a large, expensive equipment of refrigerators, box and furniture cars, at a disadvantage when voting, as compared with a road having less money invested in an equal tonnage capacity of coal cars and lumber flats.

Practically no cars are being built, or will be built, of less than 60,000 lbs. capacity from now on. The old light capacity cars are destroying themselves almost faster than the railroads can stand it, even in prosperous times. Many roads have been forced to take their old cars out of main line service and tear them down as fast as earnings would permit, the expense accounts being charged for replacement, so that a few years will largely wipe out the old car and the possible unfairness due to its having an equal voting value with a modern 50-ton car. This can, therefore, be considered a temporary condition, after the passage of which all the roads will be on an equal footing again; and it is believed that the difference in capacities between refrigerators, furniture cars and coal cars, or ore cars, will be a permanent one, so that unfairness due to a tonnage basis of voting would stay by us.

As the capital invested should be proportionately represented, regardless of the number or capacity or style of car, why not make the voting power proportional to the M. C. B. valuation, new, for cars of all kinds, settling reasonably fair values on such cars in considerable use as are not now included in the M. C. B. price list? Why not have one vote for every $500,000 invested in cars, on the M. C. B. valuation basis?

Before closing the subject for the present, there is another phase of it that should receive attention. It has been contended that cabooses, work train cars, derricks, and cars in freight service that never go off the owners' lines, should not be included in the voting basis, as they are not in interchange service. As far as the cabooses, work train cars, derricks and ditchers are concerned, this objection is a good one; but the total number on any road is so few that there would not be any material difference in the vote if they should all be cut out. But as to coal cars, ore cars, lumber cars, etc., that are often built to run specially between certain points on the owners' roads, these should be included in the vote, for while they are not in interchange service at first, they begin to drift there eventually, due to changes in traffic contracts and conditions. History has proved repeatedly that when cars are built for special service, and have proved themselves economical, the money saved by them is a strong inducement to arrange conditions and facilities so that they can be used in other service, and they soon are found in interchange service. Besides, the M. C. B. standards are used on these cars, the same as others, and should they not be represented when voting for standards of the association?

If, therefore, it is desired to make any change in the voting basis, for the reasons above set forth, the writer would urge that the representative vote should be on the basis of the money invested in freight cars used in revenue freight service, on M. C. B. valuation of cost when new.

DEPARTMENT CONFERENCES.

By T. S. Lloyd,

Superintendent Motive Power and Machinery,

Delaware, Lackawana & Western Railroad.

In the modern organization of the motive power department of a railroad it is essential that the head of the department be in the closest touch with his subordinates. The duties of the executive are becoming more complex on account of new forces being employed and devices hitherto unknown introduced into locomotive performance and shop practice almost daily. Matters of discipline and organization are becoming more intricate, due principally to powerful outside influences, which have manifested themselves to a marked degree, especially in the past two years.

The executive of to-day requires more than technical ability to successfully handle the situation. He must possess other qualifications less easy of estimation than technical proficiency. To correctly appraise the value of a man as a leader of men, and his probable behavior in case of an emergency, frequent personal contact is necessary. It is important that the head of the mechanical department have the master mechanics, mechanical engineer and shop superintendents meet at least once a month; the meetings to be held preferably at the different shops in rotation, when topics, one or more, previously announced for discussion are minutely considered. Interest will be stimulated by the researches of the various officers along these particular lines and opportunity afforded to take up special features of the different shops where the meetings are held. Careful consideration should be given to the opinion of each and criticism freely rendered without offense being taken. Each member should clearly understand that he is an important unit and will voluntarily consider himself as authorized to assist by suggestion and otherwise in the introduction and perpetuation of improvements. Soliciting and obtaining views of the subordinate officers at such conferences also enables the chief of the department to determine the capability and peculiarity of each member of his staff. It enables the latter to absorb from each other and from the chief, modern suggestions, difficult, if not impossible, to obtain in any other manner. It is educational and elevates the personnel, and is worthy of adoption rather than continuing in a primitive way, such as when we never had general conferences or endeavored to obtain in any manner from subordinates valuable features relative to mechanical matters, the adoption of progressive standards and important data pertaining to the economical maintenance of equipment. Such a method discourages the assistant and loss of individuality results. Unless perfect unity and complete harmony prevail the organization is chaotic and necessarily disappointing, regardless of the mechanical ability of the head of the department.

Periodical meetings of the master mechanics and their foremen should be introduced into the individual organization at each shop, the foreman to be requested to suggest plans whereby the production from his department can be hastened and, if possible, cheapened. It familiarizes each foreman with the conditions and requirements of all departments, and methods can be adopted to facilitate the movement of work in such as are backward. The most valuable information can thus be obtained, enabling the master mechanic to be conversant with minute details in every department and to promptly adjust irregularities, if any exist. A feeling of unity and co-operation is produced and a vigorous effort should be manifested by the individual to extend it to the rank and file.

The organization of this scheme is incomplete unless great care is exercised in the selection of a chief clerk or secretary in whom the head of the department has implicit confidence.

He should be of comprehensive mind, familiar with all clerical matters pertaining to the office, and specially trained in the important duty of relieving the executive of trivial routine work. He should be an apt student in mechanical and executive propositions, and having almost constant opportunity for interview should acquire the necessary proficiency to act and execute intelligently, should occasion demand it. He should, when possible, attend the monthly meetings, keeping data of the principal proceedings, such as results of tests conducted and the adoption of progressive ideas in general. By his attendance at the meetings he is familiar with matters discussed and adopted, and his position places him at an advantage where deviation from established practice and methods introduced is quickly observed and brought to the attention of the executive. Unless the chief is so relieved, matters of great importance may escape attention until of such magnitude that they are difficult and expensive to correct.

RATIONAL DESIGN OF LOCOMOTIVE BOILERS.

By D. Van Alstine, Superintendent Motive Power, Chicago Great Western Railway.

The size of a locomotive boiler has an important bearing on the ability of the locomotive to make time, on the consumption of fuel and on the cost of maintenance. The larger the boiler, the more freely the engine will steam when forced to its maximum horse power, the more economical it will be on fuel as compared with a smaller boiler forced to the same horse power, and the lower will be the cost of boiler maintenance because of having to generate less steam per square foot of heating surface. If the maximum tractive power of an engine be referred to its heating surface, and a ratio of 10 to 1 be taken as none too high for an efficient, economical and reliable boiler using western water and coal, then it will be found impossible to get more than three-fourths of the total weight of the engine on the drivers, with weights ordinarily allowed per wheel. The remaining one-fourth will have to be carried on the forward trucks, and perhaps upon trailers also.

The expense of hauling dead weight on engine trucks and trailers need not be a matter of concern, so long as all the weight possible has been put into greater heating surface in the boiler. The value of heating surface is not measured by the maximum number of square feet it is possible to crowd into a boiler, but by the maximum number of properly disposed square feet it is possible to get in.

Good circulation is essential not only to free steaming, but also to reliability and freedom from leaking and cracking. Freedom from leaking and cracking means reduced cost of maintenance. Good circulation is obtained by wide water spaces around the firebox, wide spacing of flues and freedom from sharp bends that impede the flow of the water.

Practically all cases of cracking and leaking are traceable to overheating. Overheating may be due to the collection of scale or to sediment, or to restricted circulation, which prevents water from replacing steam as rapidly as it is generated, or to forcing the boiler beyond its reliable capacity. Water purification, washing out and blowing off, take care of the first cause of overheating, liberal water spaces the second, and ample heating surface the third.

The fuel economy due to ample boiler capacity is probably as great as that due to compound cylinders, and is likely to be more uniform, since the boiler efficiency is only impaire by the gradual accumulation of scale, while the engine efficiency is constantly reduced by blowing piston and cylinder packing and defective valve motion.

It is my opinion that the length of flues and the method of securing them in the flue sheet have little to do with "leaky flues," but that the spacing of flues, length and depth of the firebox and the width of water spaces around the firebox are mainly responsible.

It would seem that with an average evaporation of from 10 or 12 lbs. of water per square foot of heating surface per hour, which must be largely exceeded at the firebox, the flow of steam upward in the water legs must be so great that there is not much downward flow of water, so that the water that gets into the water legs must come from the front through the space between the flue sheet and outer shell. The increased length and decreased depth of fireboxes which are placed on top of the frames, as compared with the old deep and short fireboxes, has increased the demand for water in the water legs and decreased the space through which it is assumed to flow. The head creating this flow has not increased, hence the circulation is not as good, and overheated side sheets result. I have seen in boilers of recent construction the side water spaces so contracted that the rivet heads in seams joining the flue sheet to side sheets and the wagon top to the throat sheet and barrel were only 1½ ins. apart, and they must offer a very material obstruction to the flow of water into the water leg.

The moderately wide fireboxes, such as are used in Prairie type engines, are a decided step in the right direction, not only because of the larger grate area, but because their greater width admits of reducing the length, the firebox side sheets are flat and the water space can be made wide for free circulation.

The extent to which boilers give trouble depends on local conditions surrounding their use, but my observation is that the character of the trouble is the same, and the difference is in degree only. The remedy lies in more rational design.

MODERN CAR DESIGN.

By C. A. Seley, Mechanical Engineer Chicago, Rock Island & Pacific Railway. Formerly of the Norfolk & Western Railway.

The subject of modern car design is not now adequately covered by any standard literature on the subject. By this it is not meant that the railway press has not diligently and faithfully recorded all advances and illustrated the new designs that have been proposed or adopted in American railway practice. Indeed it is only by a close study of the current periodicals which cover the ground of railway practice that one can become thoroughly informed in the state of the art.

It is not intended in this brief article to do more than to touch upon the general principles which seem to be of prime importance in this line of engineering. The subject is one of greatest importance to railway managements, and not until late years has it demanded the intelligent and painstaking efforts of designers who could appreciate the problems in all their bearings.

The money represented in freight car equipment of the average railroad is probably close to three times the amount invested in freight locomotives. This would be a financial reason justifying the expense of time, talent and care in preparation of designs and specifications of cars. These designs should represent cars of highest ratio of paying load to dead weight. This is not only a financial but a transportation question as well, producing the largest returns in revenue with an economy in motive power, train service expense, sidings and car storage facilities.

The designs should also include the use of materials in construction that are now available, such as malleable and steel castings, standard forms of rolled plates, shapes and bars of steel and pressed forms of various kinds, that are standard with manufacturers. Such practice adds a third reason, that of economy of maintenance, to those of finance and operation.

The most successful car designer is one who views the subject from many sides. The bridge engineer needs to study the methods of the car inspector and repairer and the facilities of the repair track before undertaking car designing. Cars have been built that are beautiful examples of the bridge builder's art, but they do not appeal to the men in any department of a railroad that has actual contact with them. Neither is it true that a man ignorant of the mathematics of the bridge builder can most successfully use the bridge builder's forms of construction and materials in car construction. It is the composite individual who knows what to use and what to cut loose from; who fully appreciates how far a new construction of new materials and new details can be handled with a reasonable modification of maintenance facilities, and who can make headway against the prejudice of those who would thwart progress when he clearly sees an economic advantage in construction or material.

This is the era of heavy tonnage trains and large capacity cars. The giant strides of the Pressed Steel Car Company and the influence of their designs toward decreasing dead weight, and the consequent increase in the percentage of revenue freight carried, mark an epoch in the history of car building.

One would be unwise to say that the fifty-ton car is the limit, although there are signs that we cannot go much further on present lines. Take, for instance, a fifty-ton car, and if a 10 per cent. excess load is allowed, the total live load is 110,000 pounds. Add to this 40,000 pounds for dead weight, and the total for eight wheels to carry is 150,000 pounds, or 18,750 pounds per wheel. There are not many engine drivers as heavily loaded as that, yet we expect a common cast-iron chilled wheel to perform this service.

The engine which may be called the standard freight engine of the Norfolk & Western Railway is a 21 x 30-in. consolidation, whose eight wheels carry 150,000 pounds, the same weight per wheel as those under many fifty-ton cars. It is quite true that many fifty-ton cars do not weigh 40,000 pounds, but they do not weigh so much less as to materially affect the argument. For coal carrying, the weights of various designs of fifty-ton cars runs from 35,000 to 40,000 pounds, and it is believed that the lighter weights than these are of designs that may need strengthening and reinforcing sooner than is desirable. There are ore and other cars for concentrated lading of fifty tons which require less cubical capacity, and therefore can be made of lighter weight than the above figures. Efforts have been made by some to obtain a light weight by making light trucks, but these are almost uniformly unsuccessful.

Now, what are the probabilities in the design of a fifty-ton car? Say it shall carry 110,000 pounds as a maximum, and that the percentage of revenue freight shall be 75. This means that the light weight shall not exceed 36,666 pounds and that the ratio of dead to live load is 33 1-3 per cent. If the trucks are to weigh 15,000 pounds it will leave 21,666 pounds for the body. It is believed that this is feasible, but not in a wooden car; the frame, at least, must be of steel, the castings of malleable, and all members carefully calculated.

In view of the many difficulties in the design and operation of fifty-ton cars, the necessity for strengthening bridges and permanent way of many railroads not now adapted for such wheel loads, and the safer load for the ordinary cast-iron wheel, the prediction is ventured that the forty-ton car will be very generally adopted in the next few years. It is feasible to build forty-ton capacity hoppers or gondolas to carry 88,000 pounds, with a ratio of dead and live weight of 37 per cent., which means 73 per cent. revenue load, or 2 per cent. less than is stated for an ideal fifty-ton car.

I have never been able to understand the necessity for a forty-ton capacity box car, except for the grain-carrying roads, and the advent of fifty-ton capacity cars is a still greater puzzle. I bow, however, to the superior wisdom of the traffic departments, who not only seem to want them, but also succeed in getting them, and stand ready to make any capacity desired.

Owing to the weight of the superstructure, the average design of forty-ton capacity box cars will not carry over 70 per cent. of revenue freight, as a well designed car and trucks to carry 88,000 pounds will weigh in the neighborhood of 37,000 pounds, new. It is possible to reduce this weight somewhat, as has been done in many cases, but they look very much like 60,000-pound boxes on 80,000-pound trucks, and doubtless will do very well in mixed service, as of all cars the box car is most generally loaded below its capacity.

The use of steel in car construction has brought about many changes in the theories of designers. Formerly there was little or no thought of carrying the load except by the under framing. The sides of the car were merely thought of as necessary to retain the load, and the utilization of the sides of gondolas and hoppers, for a through, uninterrupted truss was not taken advantage of until recently.

Indeed, it has been proposed in some designs to transfer most of the weight of the lading between the bolsters to the sides and thence to the outer ends of the bolsters, but it is believed that this is not desirable. The value of center sills for other offices than carrying is lost sight of. With the heavy tonnage trains and great tractive power now employed, it is believed to be necessary and advisable to use heavy center sills and draft gear connections. It has also been proposed to use such heavy center sills that it will be safe to bracket out from them and thereby carry most of the load, but it is not known that this has been employed to any extent, and it would probably make a very heavy car. In steel there are a number of suitable sections of rolled shapes or pressed or built-up sections which may be employed for sills.

In wood construction the center sills may very profitably be heavily reinforced on the under side between the bolsters, so as to minimize the bad effect of underhung draft gear in transmitting heavy buffing stresses. It is also believed to be good practice to truss all sills except the side sills of wooden cars, but that this may be successfully practiced there should be good body bolsters and needle beams, and the side framing should be well designed, in order to support the sides between the bolsters and needle beams. Proper attention is not paid in all cases in locating the truss rods so that, for an equally distributed load, the rods will be uniformly loaded.

The history of the development of the composite cars of the Norfolk & Western is instructive, overthrowing as it does the old theory that the carrying strength of the car must be provided in the under framing. In 1899 this road built 1,000 fifty-ton hopper cars with steel under frames and wooden hoppers. These cars carry 110,000 pounds, and weigh on an average 39,600 pounds after nearly three years' service. This is a ratio of dead weight to paying load of 36 per cent., or a revenue freight load of 73.53 per cent. The following year there were built 500 flat-bottom drop-door gondolas, which were 33 feet long, 8 feet 9½ inches wide, with sides 4 feet 6 inches high. Average coal would load these cars to 88,000 pounds, but as much of the coal handled by the Norfolk & Western exceeds the common average weight of 52 pounds per cubic foot, giving an overload, the cars were stencilled 85,000 pounds, and their average weight is 32,500 pounds. With the customary excess lading, the ratio of dead weight is 34.8 per cent, revenue load 74.2 per cent. Comparing, then, these two cars, it will be seen that, although the latter is of a lighter capacity, it represents a gain of carrying capacity in proportion to the dead weight. This was brought about to some extent by making a steel truss for the side frames. The lining and flooring of the car are of wood. I believe this design of car was the first employing the construction described to be made in any quantity in this or any other country. The car was a complete success from the beginning, and although a radical departure in car construction, no defects have become apparent, and this year the Norfolk & Western are adding to their equipment by purchase and building 2,500 more of these cars, to be made in accordance with the original design. These cars were illustrated in this journal in June, 1899, page 187, and April, 1900, page 100.

The success of these cars proves that it is not necessary to provide the carrying strength entirely in the underframing. They have heavy center sills to withstand the heavy pulling and buffing strains incident to heavy tonnage train service. The sides, while light, are immensely strong vertically, and reasonably so laterally; in fact, were it not necessary to secure lateral strength we could use much lighter members for the side trusses. It is not necessary for me to go into details of the construction of these cars. Last year (1901) it became necessary to add to the road equipment of fifty-ton hopper-cars, and instead of duplicating the four-sill design of 1899, a new design, employing a steel truss side, was made and 900 cars were built (American Engineer, February, 1901, page 43), which at once demonstrated their superiority over the former design by reason of lighter weight and at the same time being stiffer and stauncher in many respects. These cars now stencil 38,000 pounds on the average, which represents a gain in lighter weight of 1,600 pounds less than their predecessors. Their weight represents a dead weight ratio to live load of 34.5 per cent. and a revenue carrying capacity of 74.3 per cent. These cars have heavy center sills, carrying approximately 55 per cent. of the load, while 45 per cent. is carried by the truss sides to the bolster ends. No defects have appeared in this design, and the road is preparing to build 750 more of them in the near future, on the same identical lines of framing. There is also an order for 750 forty-ton hoppers of a similar design, modified for that capacity.

The Norfolk & Western also built some steel frame box cars of forty tons capacity, American Engineer, May, 1902, page 141. This is a new, untried design, and therefore to some extent experimental. They have steel under, side and end frames, up to and including the plates, with the usual wooden flooring, lining, sheathing and roofing. Steel in box car construction is not as interesting as in hoppers and gondolas or flat cars. Much wood must be used for nailing strips for securing lining, sheathing and floor.

I am of the belief that steel in car construction has come to stay; that while education and experience are necessary in all departments of railways to handle these cars; in design, in operation, in wrecking and repairing, yet the American railways are too progressive to neglect an opportunity to use a most valuable material and to lead the world in car construction.

SHOULD RAILROADS DESIGN THEIR OWN LOCOMOTIVES?

By F. F. Gaines.

Mechanical Engineer Lehigh Valley Railroad.

The answer depends largely upon whether or not the railroads have competent mechanical staffs. There are very few roads that either do not have such a staff or at least admit their utility. A discussion of their value is, however, a separate question. Assuming that the majority of railroad companies have a mechanical department, it would seem that they should design their own locomotives, for several reasons. In answering the question in this manner it is not to be inferred that the experience and ideas of the builders are to be ignored, but rather that they are to be consulted on all sides of the question. After such conference and mutual agreement on the leading points of the design the drawings should then be made by the railroad company.

The type of engine and leading dimensions being agreed upon by buyer and builder, it might seem as if the details were of such small importance that the builders could do just as well, or better, than the railroad company; but in the present status of the art it is the care and attention to details that insure an engine of satisfactory and economical design. The builders, while having better facilities for designing, as good, or a better corps of engineers, lack to a large extent the experience and knowledge derived from observation of engines in service and in handling repairs. On the other hand, the mechanical department of a railroad has, or should have, men who are familiar with the conditions at repair shops and the handling of work, as well as knowledge from experience gained by riding on engines, that is to say, service conditions.

Not so very long ago it was customary to purchase engines for general use on all parts of a road, and under these conditions the engines of the same size and class on different roads differed but little. To-day the conditions of service, not only for individual roads, but different divisions of the same road, demand modifications to produce the best results. Under these circumstances it is natural to expect that the mechanical department of the railroad is better prepared, from a close study of all conditions, to meet and provide for these conditions than the builders.

Many roads absorb the output of local mines for fuel, the fuel requiring for suitable combustion special arrangements of grates and amounts of grate area and heating surface. On some roads, where heavy traffic is provided for by extra tracks, low wheeled engines at moderate speeds may prove very satisfactory, while neighboring roads in the same territory may have such traffic conditions that the use of low wheeled engines incapable of high speed would be out of the question.

Some of the reasons why the road should be better posted than the builder on general design having been given, let us look at the details a little. The putting together of a new engine is an entirely different matter from partially taking it apart. The builder puts it together once when building, and the railroad takes more or less of it apart many times. In putting it together the first time, the builder has the opportunity of assembling it in that order which is most convenient; while in repairing, the part that has to be renewed the most frequently is often the most inaccessible; and in many instances the work has to be handled without the accessories of the builder, such as electric cranes, etc. Lack of repair shop experience on the part of the builder is accountable for many detail designs, which if more attention had been given to the question of repairs would have saved time, money and profanity in the shops.

Service conditions frequently require radical modifications to parts that theoretically have a high factor of safety, yet as a matter of fact are proving by their failure that an experience factor is necessary. Some engines turned out by one of the builders recently had side rods that gave a very high factor of safety, but there was no particular spot where on some of the lot the rods had not broken. Another builder saved weight by steel wheel centers of approved design, but service conditions ruled them out by bending and breaking the spokes and crushing the tread between spokes. In another case the main frames of a lot of engines were carried under the cylinders, the builders dropped the cylinders on the frames and the boilers on the cylinders. When in course of time a broken cylinder had to be replaced, it was found that reversing the process was expensive and required considerable time. This could have been avoided if separate front frames had been used. The same engines had piston valves, and to remove them for new packing rings required a drop pit to eliminate the engine truck from the proposition. I have in mind one more instance of a detail design by builders that would have been modified if repair work had been more familiar to them. The furnace bearers, both front and back, were fastened to the outside sheets of the firebox and covered several rows of staybolts, a broken staybolt requiring the removal of a furnace bearer; the pitting between the sheets will also eventually require patching the boiler.

Lack of knowledge of service conditions is likely to result in a bad cab arrangement. There is no investment that will pay a larger dividend than time taken to carefully locate all accessories in the cab so as to require the minimum attention and effort of the engineer to operate and adjust.

Beginning with the cab itself, it should be as cool as possible in summer, and warm in winter. To protect the feet of the men from the cold; reverse lever openings, cracks in the floor and pipe openings several sizes too large should be covered. Lagging the back head of a large boiler cuts down the temperature several degrees in hot weather and relieves the fireman to that extent, besides saving fuel that would otherwise be lost by radiation. The location of the engineer's brake valve so that he can readily reach and apply it while leaning out of the window contributes to an easy stop at the right place. The location of both injectors in the cab prevents injector failures, as an engineer on a fast line in bad weather does not like to crawl out on the running board to inquire too closely into the whys and wherefores of a sulky injector. Gauge lamps situated so as to illumine lubricators and gauge cocks so that they can readily be seen saves the engineer lighting a torch, or picking up a lantern, at a time when his attention should be diverted as little as possible. Gauge cocks located in the front part of the cab allow escaping steam to be driven toward the engineer, making it difficult for him to see, while it is blown away from him if they are placed in the rear. Provision for the engineer getting at machinery easily for oiling saves time at station stops; as does also a manhole on the tank of such size as to be reached by the crane without stopping the engine on a chalk mark. In order to provide sufficient water capacity many tanks for large engines have a water space under the firing floor. This makes a solid foundation for the fireman to stand on, but unless covered with wood will result in a large fuel loss, as coal intended for the furnace is thrown out between the tank and engine when the fireman slips on the smooth surface. On some of the big engines, with this style of tank, where every scoopful counts, it is discouraging to the fireman when, instead of getting a shovel of coal, his scoop strikes a rivet and flies up. The rivets could be countersunk, but they are not always. It is a great assistance to a fireman to have a design of tank that will deliver all the coal to him at a point not too far distant from the fire door, as it greatly decreases his work. This can be accomplished by sloping the sides of the coal space so that there are no flat surfaces, and it becomes self-clearing. The focus of all the slopes should be as near the firing floor as possible. Aprons arranged to prevent coal working out at the sides between the engine and tender, and to catch and hold the coal that by accident misses the door, have on some classes of engines been known to save a ton of coal in a round trip.

Engines designed with the repair shop constantly in mind save the extra trouble and cost of such designing the first time the engine goes in for light repairs. In fact it is justifiable to go farther and increase the first cost within reasonable limits, if by so doing the difference in the design will admit of more rapid and economical overhauling. Water impurities affect a boiler in as many different ways as there are kinds of water, and frequently require special designing to counteract them. Heavy curvature calls for ample provision against flange and hub wear and a design that will permit of rapid and cheap renewal of worn parts. On some consolidations built for a crooked road cut flanges on the front drivers became serious for a time. By shortening the radius bar several inches and setting in the tire on the front and back pairs of wheels the trouble was almost entirely disposed of.

The foregoing are some of the details frequently overlooked by builders to a certain extent; more so of late years, since the tax on the builders has become greater on account of the unprecedented demand by the roads for more power. One of the most valuable guides in designing comes from the record of failures on existing engines. Many roads have a system whereby all broken parts are reported by blue print sketches, the location of fracture and size of the part being marked on an undimensioned print. When these reports show by their frequency that a certain part of a certain class of engines requires strengthening, steps are taken to do this in a satisfactory manner. This experience gives the motive power officials an idea of practical proportions, and often furnishes coefficients for otherwise rational formulæ. This experience is from the nature of things, to a large extent, denied the builder; who would undoubtedly be very glad to have the information and also to profit by it. These reasons do not in any manner reflect on the credit of the builder, or his sincere desire to produce the very best machine that brains and money can produce; they do, however, indicate why the mechanical officers of a road are, or should be, better prepared to do their own designing.

LOCOMOTIVE TRACTION INCREASERS.

By Edward Grafstrom,

Mechanical Engineer, Atchison, Topeka & Santa Fe Railway.

Necessity is the mother of invention. History tells us that fifty-two years ago Mr. Baldwin took a contract to build two locomotives guaranteed to do certain work, and, finding that he would not come out even in his calculations, he resorted to the traction increaser. The Baldwin Locomotive Works thus became the birthplace of this device. But history also relates that these two engines were failures from an operating point of view, and that this traction increasing encumbrance was soon removed, even at the sacrifice of tractive force.

As time went on and railroads grew the traffic requirements for more powerful locomotives became prevalent. The true relation between boiler capacity and cylinder force not having been thoroughly studied, locomotive cylinders soon outgrew the boilers, and thirty years after its inception Baldwin's old remedy was dug up as a means of correcting over-cylindered locomotives. The crop of traction increasers which then sprang into existence was tried with such varying success that in 1886 the Master Mechanics' Association appointed a committee to investigate the merits of the different devices used up to that time. When this committee reported, the opinion prevailed that the proper function of the traction increaser was that for which it was originally created, namely, to supply additional adhesive weight to over-cylindered engines, but that its sphere of usefulness did not extend to new and well-designed engines, and that the best traction increaser was an ample boiler, together with the sandbox. Henceforth boilers commenced to grow in proportions, and pneumatic sanding arrangements were brought out, until nothing more in either of these lines could be desired.

But history repeats itself. With the advent of the compound locomotive an increased cylinder force has been put within reach of the engineman which surpasses the established relations between the factors that make up the tractive force. The boilers of modern locomotives are as large as space and weight permit, and the compound cylinders are proportionate when used as such. But the augmented cylinder force, when these engines are worked simple, requires an increased weight which would be superfluous and cumbersome while working compound. This condition has again turned constructors' eyes to the traction increaser.

The Santa Fe is at present experimenting with two distinct styles of traction increasers and four styles of compounding, all of which are already familiar to the readers of The American Engineer. The compound systems do not come within the scope of this article, but the experience of that railroad with the two styles of traction increasers is pertinent to the subject at hand.

One of these types of traction increasers now in use on locomotives recently put into service on the Atchison, Topeka & Santa Fe is similar in principle to one described in a previous number of this journal. It is operated by steam from the locomotive boiler and works on the principle of changing the fulcrums for the equalizers. So far it has only been used for transferring weight from the front truck to the driving wheels to the extent of increasing the adhesive weight by 7,000 pounds. Its application takes place rather suddenly, partaking of the nature of a jerk; the front end of the engine raises about two inches, the frame coming down close to the boxes in the rear, while the driving springs become cocked to one side.

The other traction increaser receives its motive force from the Westinghouse air supply, with which it is connected through the intermission of a special auxiliary reservoir. Its application is so gradual that it is not noticed on the engine. On the Prairie type of engines, upon which it has been installed, it operates both on the front and trailing trucks, relieving both of a load aggregating about 15,000 pounds.

The weight on the driving wheels of these engines is normally 140,000 pounds. When the traction increaser is applied this is raised to 155,000 pounds. The engines have a tractive force of 34,000 pounds when running compound. This gives a coefficient of adhesion of 23 per cent. when the engine is not using the traction increaser. If the engine is operated in simple working, the tractive force becomes 38,000 pounds and the necessary coefficient of adhesion would then be 27 per cent., which is higher than can be counted on with the best sanding apparatus. By the aid of the traction increaser, however, this coefficient is reduced to about 24 per cent., thus bringing it down to normal conditions. From which will be seen that the new field of usefulness of the traction increaser is principally to regulate the adhesion when compound engines are operated in simple working.

The Santa Fe traction increasers are connected up so that they are put into action automatically when the reverse lever is dropped down into the corners, either in forward or backward motion.

The ideal conditions would be, however, to have the traction increaser apply automatically only when the engine is operated as simple and when the lever is in the positions named.

The principal difficulty with the traction increaser on the Santa Fe is that the enginemen are unable to tell whether it is operative and effective or not. One engineer who runs a regularly assigned engine was asked one day how he liked the device. "It is fine," he replied. "I don't often have to use sand when starting, and the engine walks right off with any kind of a train." In looking over the engine it was found that the traction increaser had been cut out for several trips on account of a leaky operating valve without the engineer's knowledge, but he still clung to his belief that the traction increaser had done the work. The trouble is that with a powerful engine the engineman cannot tell whether or not it is the normal weight of the engine or the traction increaser that gives the adhesion, and if the traction increaser is out of order, he has no means of telling it, unless it is entirely "dead." The inspectors in the roundhouse are equally helpless, for many traction increasers require the jar of the engine, while running, to get them started. This does not mean that traction increasers cannot be made as reliable as the air-brakes, for instance, but that they are still in a stage of evolution, although it is their third appearance before the American railroad world.

LARGE MODERN LOCOMOTIVES—REPAIRS AND LOADING.

By William McIntosh,

Superintendent of Motive Power, Central Railroad of New Jersey.

At the April meeting of the New York Railroad Club, Mr. J. N. Barr laid strong emphasis on the necessity that everyone connected with the care and management of modern large locomotives should pay close attention to their inspection and repairs. These suggestions were pertinent and timely, but he did not go far enough; the importance of this should also be understood by the management, and the fact should be brought to its attention that the change from the capacity of the old power to that of the new is not going to prove all clear gain, and that comparisons with the cost of maintenance of the old equipment are not only manifestly misleading and unfair to the motive-power department, but, if pressed too hard, are liable to produce disastrous results in attempts to meet such comparisons. Consider the matter on an avoirdupois basis: The new equipment is double the weight of the old—it is bought and paid for on that basis—and the weight and cost of repair parts is bound to maintain the same ratio. That to handle these parts requires double the force admits of no argument, whether this force be applied in the form of brawn and muscle or through the medium of machinery; they both cost money. More coal and water are required to fill the tank and boiler, and more sand to fill the sandbox; it will take longer to clean or build fires in a firebox with 80 square feet of grate surface than it will one with 25 square feet; it will take longer to wash out the boiler, longer to fill it up, more time to get up steam, more power to turn the table, and so on through the list; yet motive-power departments are gravely asked to explain why the cost of handling and maintaining motive power should be greater than it was a few years ago. Some unsatisfactory records have been shown up for large power under such pressure, combined with pooling, and without the thorough organization required to keep it in order.

Operating officials naturally look for immediate returns from the new equipment, and on a basis of the increase in tractive power, overlooking the fact that much of it is of new design and not yet fully developed; that the evolution process must continue through the all-convincing method of actual trial, and that the men who are to operate these monsters have to learn their trade over again and develop the skill necessary to handle a 3,000-ton train in place of one of 1,200 tons. The engine-handling forces and repair men at terminals must familiarize themselves with the new equipment before they can handle it and turn it out promptly.

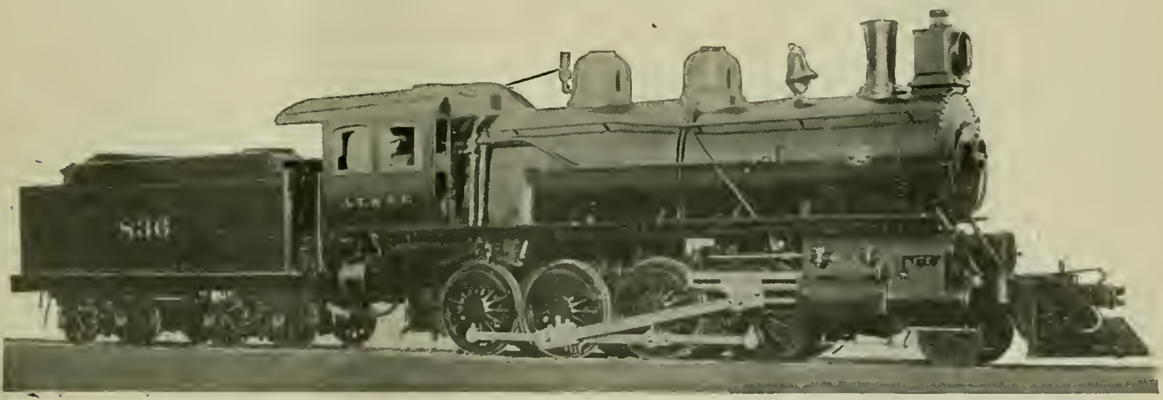
Modern engines exerting a 40,000-lb. pull at the drawbar under 200 lbs. steam pressure are veritable battering-rams, and, if neglected, will soon be damaged far beyond the cost required to keep up the running repairs, and a liberal allowance toward keeping up such repairs will pay big interest in the absence of loose frames, broken brasses and the many other demoralizing conditions developing from neglect or false economy in this respect.

It is perhaps not necessary that forces be doubled, but a liberal policy in this connection will reduce the indirect loss due to inefficient motive power, and when the results are measured by tonnage moved—the only equitable basis to work from—good returns from the investment will be apparent.

A word more regarding overloading in some cases. Engines can be loaded beyond the economical basis; for instance, when the hours on the road from this cause are extended beyond good practice a general loss is bound to follow. In the first place, there is but a narrow margin between a train load that the engine has capacity to handle with ease and the few additional cars that overload it. Under first-mentioned conditions there will be a cheerful and united effort on the part of engine and train crews to keep moving, and there will be, as the mariner says, "clear sailing," but when the tonnage taxes the capacity of the locomotive the crews become weary and disheartened from the long hours on the road and the train movements become sluggish. A daily loss of the use of power amounting to 25 per cent. might thus be easily explained, which would hardly be compensated for by the two or three per cent. of lading that constituted the overload. The efficiency of the crews would be greatly lowered under such a system, assuming that, like the locomotives, they were on the road 25 per cent. beyond normal practice. An additional force, to that extent, would be required, while the overtime paid for the extra hours on duty could easily absorb the gain from the small portion of the tonnage constituting the overload.

The greatest economy with modern equipment and the best all-around results must come from a tonnage well within the capacity of the locomotive and the movement made as near continuous as possible. Toward this end it is not unlikely that track tanks and water scoops will become the rule instead of the exception, and that tonnage trains will be moved with the regularity of passenger trains in the near future. Certainly the proposition is a tenable one, and will appeal from a business standpoint—compare it, for instance, with a factory. The greatest output is obtained in a factory with machinery speeded up to the economical limit, and then run continuously. The same is true of train movements; the ideal results would follow from starting a full-tonnage train and running it to destination at a uniform rate of speed without stopping. Every stop involves not only the time standing, but the time lost in bringing the train to a stand and getting it under way again, besides the wear and tear and liability of pulling out drawbars and breaking knuckles—an indeterminate though not inconsiderable amount.

If tonnage trains could be moved along at an average of ten miles per hour it might be considered satisfactory to all concerned, and it would seem that this movement could be obtained under a thorough organization, especially on double track roads, and under conditions following the lowering of grades and introduction of heavier rolling stock. This continuous movement must be looked to for rounding out the greatest economy of transportation.



Tandem Compound Consolidation Freight Locomotive—Atchison, Topeka & Santa Fe Railway

G. R. HENDERSON, *Superintendent Motive Power.* AMERICAN LOCOMOTIVE COMPANY, *Builders*

TANDEM COMPOUND CONSOLIDATION FREIGHT LOCOMOTIVE.

Atchison, Topeka & Santa Fe Railway.

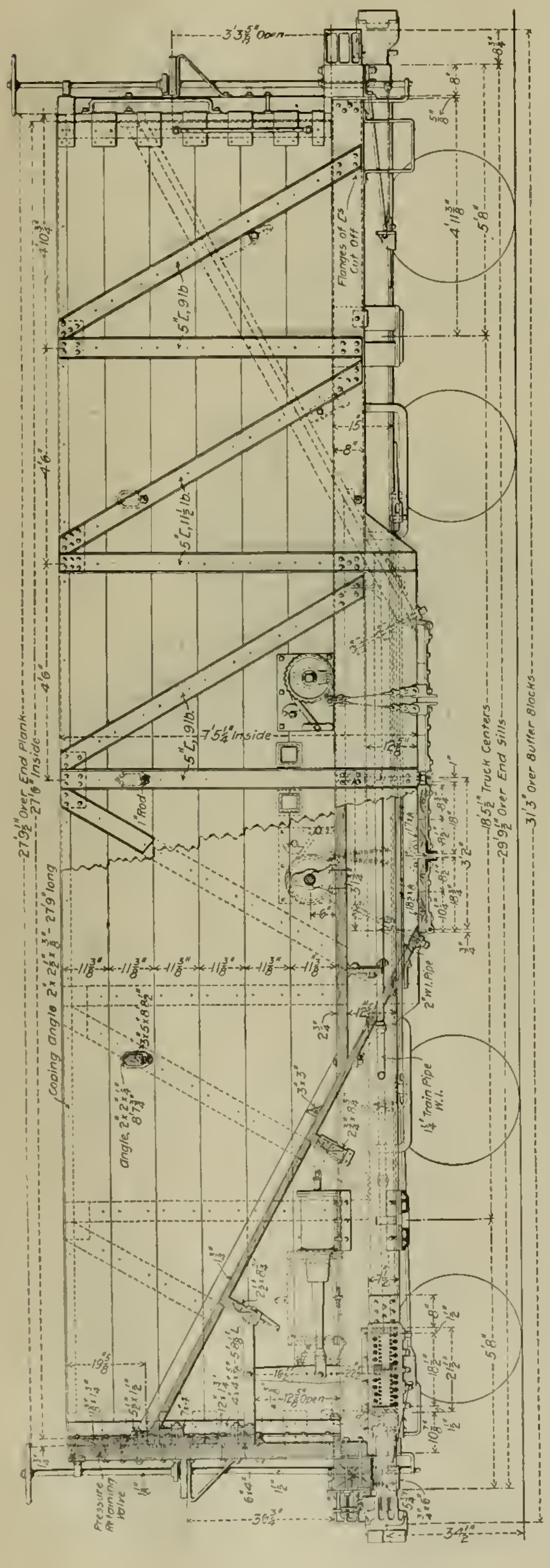
Elsewhere in this issue the enormous decapod tandem compound for this road is illustrated, and on page 38 of our February number is a description of another very powerful freight engine. These are specially heavy engines for special service. The accompanying engraving illustrates a much lighter freight engine of the consolidation type, which has just gone into ordinary road service, with promise of being very satisfactory.

On the division between Dodge City, Kan., and La Junta, Col., 202 miles, the usual rating of the freight engines is 1,800 tons. The average grade is 8 1-3 ft. per mile, found by dividing the total rise by the mileage. In one place there is a 34.3 ft. grade 35 miles long. On a test with a bad rail one of these engines hauled 68 loaded cars, or 2,426 tons, over this division in 24 hours 50 minutes, with 8 hours 27 minutes dead time, part of which was due to doubling the heaviest grade and the rest to interference from passenger trains. The actual running time was 16 hours 23 minutes, or an average speed of 12.4 miles per hour. The total amount of coal burned was 31 tons, and the coal per 100 ton miles was 12.7 lbs. Two days later another of these engines hauled 2,305 tons over the same division, with a good rail, without doubling. The tractive power, compound working, is 40,000 lbs. The following table presents a description of these engines.

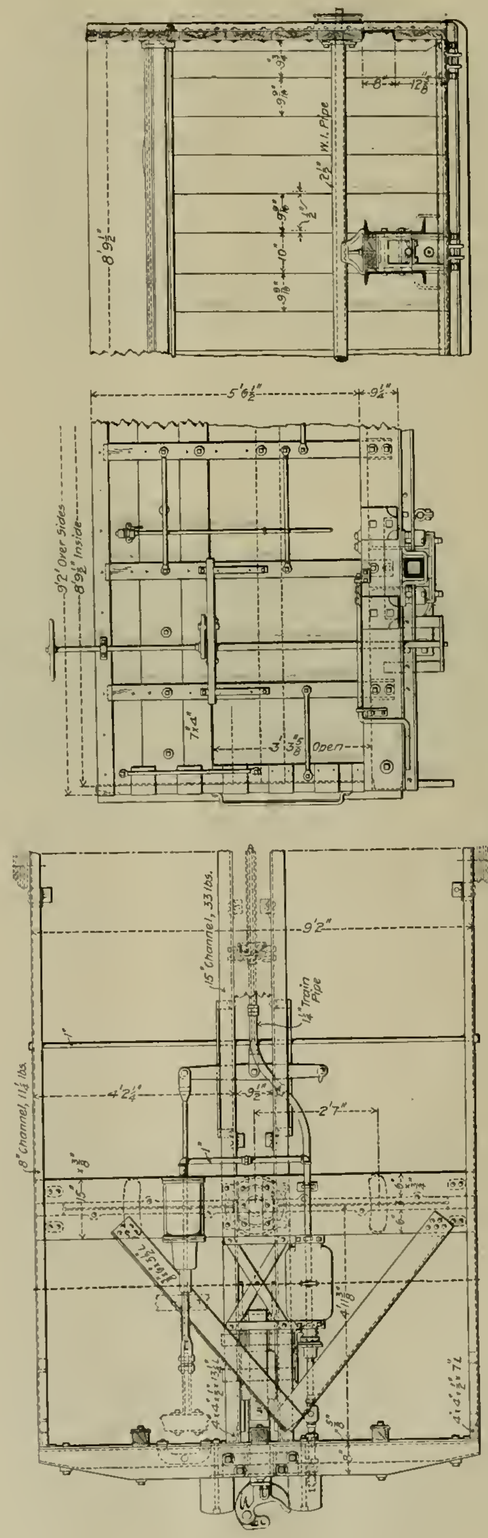
TANDEM COMPOUND CONSOLIDATION LOCOMOTIVE, ATCHISON, TOPEKA & SANTA FE.

Gauge	4 ft. 8½ ins.
Fuel	Bituminous coal
Weight in working order	201,000 lbs.
Weight on drivers	176,000 lbs.
Wheel base, driving	15 ft. 4 ins.
Wheel base, rigid	15 ft. 4 ins.
Wheel base, total	24 ft. 1 in.
Cylinders.	
Diameter of cylinders	16 ins. and 28 ins.
Stroke of piston	32 ins.
Horizontal thickness of piston	5½ ins.
Diameter of piston rod	4 ins.
Kind of piston packing	Plain rings
Tractive force, working compound	40,000 lbs.
Valves.	
Kind steam chest valve	Piston type
Greatest travel of valves	6 ins.
Steam lap of valves	⅞ in.
Exhaust clearance	L.P. ¼ in., H.P. line and line
Lead of valves in full gear	Line and line
Wheels, Etc.	
Diameter of driving wheels outside tire	57 ins.
Material of driving wheel centers	Cast steel
Driving box material	Main, cast steel; others, cast iron
Diameter and length of driving journals	9½ x 12 main, 9 x 12 F. & B. & Int.
Diameter and length of main crank pin journals	6¾ x 6¾
Diameter and length of side rod crank pin journals	F. & B. 4½ x 4; Int. 5½ x 4½
Engine truck kind	2-wheel swing bolster
Engine truck journals	6½ x 10½
Diameter of engine truck wheels	31¼
Boiler.	
Style	Extended wagon top with wide firebox
Outside diameter of first ring	68 ins.
Working pressure	210 lbs.
Thickness of plate in barrel and outside firebox	11-16, ¾, 25-32, 9-16, & ½
Firebox, length	101½ ins.
Firebox, width	71¼ ins.
Firebox, depth	62½ ins. back, 71¾ ins. front
Firebox material	Lukens steel
Firebox plates, thickness	Crown, sides and back ⅝ in., tube ½ in.
Firebox water space	Front 4½ ins., back 4 ins., sides 4 ins.
Firebox crown staying	Radial, 1½ ins. diameter

(Table concluded on page 181.)



Half Section and Side Elevation



Partial Frame Plan, End View and Section.

40 TON COMPOSITE HOPPER CAR—NORFOLK & WESTERN RAILWAY.

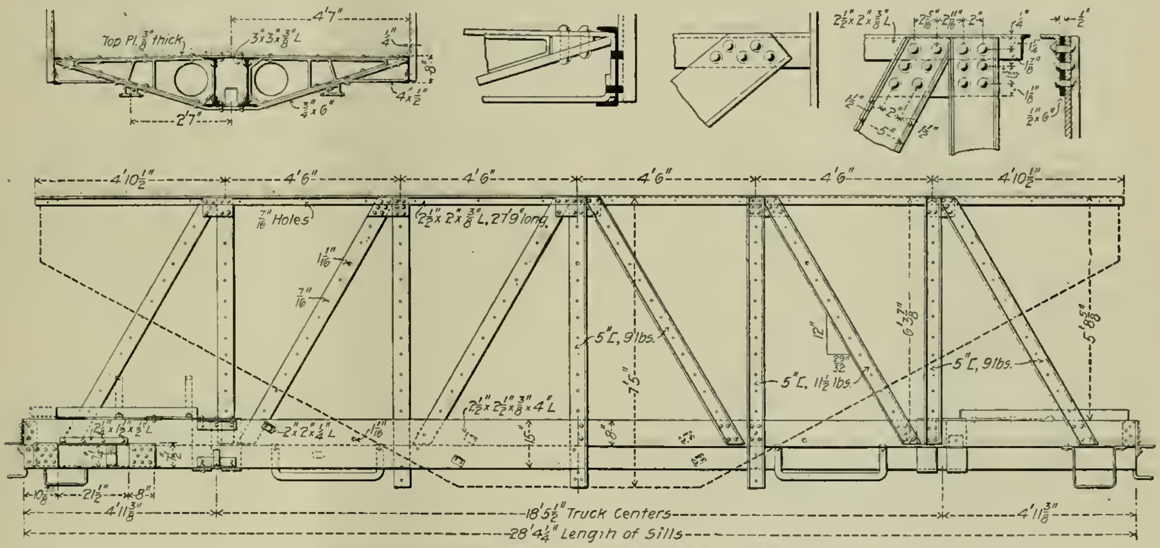
Firebox staybolts	Taylor iron, 1 in. diameter
Tubes, number of	355
Tubes, diameter	2 ins. O. D.
Tubes, length over tube sheet	15 ft. 0 ins.
Fire brick	Supported on arch tubes
Heating surface, tubes	2,787 sq. ft.
Heating surface, firebox	178 sq. ft.
Heating surface, total	2,965 sq. ft.
Grate surface	50 sq. ft.
Exhaust pipe	Single
Exhaust nozzles	5¼ ins., 5½ ins., 5¾ ins.
Smoke stack, inside diameter	15⅝ ins. to 18⅝ ins.
Smoke stack, top above rail	15 ft. 4 ins.
Boiler supplied by	2 Simplex No. 10 injectors

Tender.

Weight empty	46,400 lbs.
Wheels, number of	8
Wheels, diameter of	34¼ ins.
Journals, diameter and length	5 ins. x 9 ins.
Wheel base	17 ft. 6 ins.
Tender frame	A., T. & S. F. steel channel
Water capacity	6,000 gallons
Total wheel base of engine and tender	53 ft. 9½ ins.

the 40-ton flat-bottom gondolas of this road. One of the detail drawings shows the malleable-iron filling castings for the bolsters, with ⅜ by 15-in. top plates, and two ¾ by 6-in. bottom plates. As far as possible, this road has followed the policy of using the same details for a number of classes of cars, such as those already mentioned, also drop doors and air-brake details. These cars have the large flat-bottom center plate illustrated on page 75 of the issue of March, 1902.

This series of cars is unique in connection with steel construction. They are all successful, and all were developed on this road by Mr. C. A. Seley, formerly mechanical engineer, under the direction of Mr. W. H. Lewis, superintendent of motive power. They have demonstrated the advisability of utilizing the side frames for carrying a part of the load, and have also shown that composite construction is advisable where



40-Ton Composite Hopper Car—Norfolk & Western Railway

40-TON COMPOSITE HOPPER CARS.

Norfolk & Western Railway.

The Norfolk & Western has recently ordered 6,000 cars of various types, most of which are of the composite designs which we have illustrated. A noteworthy fact concerning the order for two of the classes is that after two years' service there is no change in the designs, not even a rivet. This confirms our opinion that these are remarkable designs, which are worthy of adaptation by other roads.

The new 40-ton hopper cars are intended for traffic for which the 50-ton car is too large. They are similar to the 500 cars built by this company in 1900 and illustrated in this journal in February, 1901, page 42, except that the new ones have one less pair of drop doors, the sides are 6 ins. lower and the center panel is omitted to cut down the capacity. The general dimensions are as follows:

Length over buffers	31 ft. 3 ins.
Length over end sills	29 ft. 9½ ins.
Length over body	27 ft. 9½ ins.
Length inside	27 ft. 6 ins.
Width over sides	9 ft. 2 ins.
Width inside	8 ft. 9½ ins.
Height over hopper	7 ft. 5 ins.
Estimated weight, new	34,500 lbs.

The center sills are 15 in. 33-lb. channels; the side sills, 8 in. 11¼-lb. channels, and the side posts and bracket, 5-in. channels, connected at their upper ends by gusset plates and also attaching to a heavy angle forming the top chord of the truss. This angle also serves as a coping for the wooden lining. The body bolsters and trucks are the same as those of lumber is as cheap as along this road. Descriptions of the earlier designs may be found in this journal as follows: Fifty-ton steel underframe hopper, June, 1899, page 187; 40-ton flat bottom, steel frame gondola, April, 1900, page 100; 50-ton steel frame hopper, February, 1901, page 42, and the 40-ton steel frame box car, May, 1902, page 140. Mr. Seley's article elsewhere in this issue presents a discussion of his views of the steel car question.

Mr. W. S. Morris has resigned as superintendent of motive power of the Chesapeake & Ohio, to succeed Mr. J. N. Barr as mechanical superintendent of the Erie. Mr. Morris is 45 years of age, and has spent 28 years in railroad service, beginning as an apprentice on the Housatonic Railroad. He was president of the Master Mechanics' Association last year. He has filled important positions on the Wabash, Missouri Pacific and other roads, and nine years ago was appointed to the position which he now leaves. He is sure to succeed in his new work, and he seems to be just the man to take up the work of Mr. Barr, which is enough to say of his ability. It will be a pleasure to everyone to know that preferment has come to Mr. Morris, even to those to whom his relations as head of the motive power department of the Chesapeake & Ohio have endeared him. It is safe to say that the most humble shop or repair track man will deeply regret his change. Mr. Morris is one to secure the "voluntary loyal support" of the rank and file, of which Mr. Deems writes in this issue. This journal congratulates Mr. Morris and the Erie Railroad.

(Established 1832.)

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EDITORIAL ANNOUNCEMENTS.

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

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

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

A great deal is crowded into this issue, and it is hoped that the reader will give some thought to the broad ground which is covered. Motive-power men are engaged upon problems which have not heretofore been considered important, but are full of promise for the future.

In the variety of subjects discussed in this issue by well-known railroad officers even the casual reader must be impressed with the strong reflection of the opinion that the human element is to be exceedingly important in the progress of the immediate future. In all lines of industrial development it is becoming more and more difficult to find men who are properly prepared to meet the demands of constantly increasing responsibilities. Mr. Deems indicates that leaders must make a study of men. Mr. Delano suggests to educated young men that they should look upon railroad work as a profession. Messrs. Quayle and Lloyd indicate methods for getting men together for a complete study and understanding of their common problem. Important as the other subjects are, those relating to men, their encouragement and inspiration, appear to be the ones which require most careful and thoughtful attention.

THE STANDARD CAR.

Last October the American Railway Association adopted standard interior dimensions of 40-ton box cars and requested the Master Car Builders' Association to determine the corresponding exterior dimensions. A committee will report these dimensions at Saratoga this month.

The standard interior dimensions dispose of the traffic department difficulty by arranging the minimum rates in a way which will discourage the construction of other than cars of standard size, but the purpose of the American Railway Association was broader and deeper than this. The intention was to clear the way for actual standards in construction, so that standard timbers may be used in a standard design. It is important that the members of the Master Car Builders' Association should know this fact and that they should understand that the demand for standard construction has come from the managing officers. If this is understood the subject will undoubtedly be placed in the hands of a committee at the approaching convention, and as the use of steel, as well as wood, must be considered, its work will be difficult and interesting, as well as important.

In this issue will be found the opinions of influential railroad officers on this subject, and also an account of the exceedingly interesting action of the Union Pacific and other Harriman lines in the matter of standards. For business reasons standardizing seems to be the question of the time. There seems to be no danger of overdoing it, and the men who have made it possible may be depended upon to provide for future progress and to proceed carefully.

In connection with the length of the standard car, it is important that Mr. Sullivan's reference to the variation in length, in his article on page 163 of this issue, should be understood. This does not apply to new cars. Mr. Sullivan's statement should be carefully read by all who will have to do with this subject at Saratoga. It contains a clear and complete expression of what is expected of the Master Car Builders' Association. Not only must a standard car be adopted, but it must be safeguarded in a way which will permit of no trifling with the dimensions which have been adopted as standard.

"PER DIEM" HAS COME.

It now appears impossible for the present vicious and dishonest system of the payment for the use of "foreign" cars on a mileage basis to last or return after July 1, 1902. "Per diem" has been adopted by an official vote of 86 to 7, and this vote has just been confirmed by the signatures of the voters. It is to be tried for one year, but there can be no doubt of its permanency.

Next to the train rules, this is the most important work of the American Railway Association. Its effects cannot now be foreseen or appreciated. A careful study of the report of the committee on car service, through which this result was attained, compels admiration for its definite, clever expression and for the ability and foresight of its framers. It met with a determined but unavailing opposition, as we understand it, from those who desired to continue to pay dividends from the use of other people's property, for which proper compensation is not given under the present system.

The new system will place the car owner in control of his property and he will receive the per diem rate (20 cents, and $1.00 after 30 days) for every day his car is off his own lines. He may waive this on occasion if he chooses, and in the case of repairs his pay stops from the time special repair material is ordered until it is received by the road on which the car may be held for repairs. Thus the material will be hurried and also the repairs. In fact, "acceleration" all round seems to be the chief promise of the system. Foreign cars form a relatively small proportion of the cars in use by most roads, but the movement of these cannot be quickened without a corresponding effect upon home equipment. In Russia the average daily mileage of cars, under the per diem system, is about 80. In this country on some roads it is now as low as 18.

Such a reform is always difficult, and often the difficulties are proportional to the benefits. There are the best of reasons for congratulations upon the results and for high praise for those who have carried the movement forward. There is now no obstacle to the adoption of the standard car, and the Master Car Builders' Association will not fail to see this and act in the part of the work which is now at hand.

AMERICAN ENGINEER TESTS.

Locomotive Draft Appliances.

IX.

Report by Professor Goss.

SECTION IV.

A STUDY OF LIMITING CONDITIONS.

17. Purpose.—In choosing heights and diameters of stacks to be experimented upon, it was thought wise to have a complete understanding of the form and dimensions of a considerable number of stacks in use on modern engines. In the matter of height of stack, for example, it was thought not necessary to employ experimental stacks which should greatly exceed the limits which are fixed by conditions of service. To supply materials for such a study there was published in the American Engineer a request for information concerning front-end and stack arrangements, as applied to engines having a diameter of front-end greater than 64 ins. In a few cases, also, requests for information were transmitted by mail. All responses to these requests were in the end delivered to Professor William Forsyth, by whom they were studied, and whose report on the subject is presented in paragraphs 18 to 28, inclusive.

PROFESSOR FORSYTH'S REPORT.

18. The Sizes of the Locomotives Examined.—The size of the locomotive, so far as it affects the proportions of the stack, is best indicated by the diameter of the smoke-box and the size of the cylinders. Data covering these details, together with the proportion of stacks and height of nozzle for a number of representative modern locomotives, are given in Table IV. The diameters of smoke-boxes vary from 64 ins. to 84 ins., and the size of cylinders from 18 x 26 ins. to 23 x 30 ins., and for the high pressure cylinder of compound engines to 23 x 32 ins.

The locomotive at Purdue, upon which the experiments were made, has a smoke-box 55⅛ ins. in diameter, and the cylinders are 16 x 24 ins.

19. The Diameter and Shape of Modern Stacks.—While a few straight stacks are still used, the prevailing practice is to make the top diameter about 2 ins. larger than that at the choke. The minimum diameter of stack seems to bear no definite relation to the size of the cylinders or of the boiler. The stack having 14 ins. minimum diameter is used on the largest passenger engines having 75-in. smoke-boxes and 20 x 28-in. cylinders. Practice for passenger service allows a minimum diameter of 14 ins., and for freight 16 ins., the largest diameter at choke being 20 ins. This is an isolated case. The maximum diameter for all others is 17 ins. at the choke.

20. The Height of Choke from Top of Smoke Arch.—For this dimension the figures of the principal roads and locomotive works range from 3 ins. to 14 ins., while quite a large number of them, representing very good practice in locomotive design, use a height of about 7 ins. Two or three of the largest roads appear to use the same patterns for smokestacks for both passenger and freight service, for large engines having smoke-boxes 67 to 71 ins., and where the limit of height is reached the pattern is simply cut off at the top. With smoke-boxes above 80-ins. the choke is only 3 to 4½ ins. from the top of the smoke-box.

21. Height of Stack Above Smoke-Box.—The height of the center line of boiler above the top of the rail for large engines is now 9 ft. or more, and with a smoke-box 6 ft. in diameter its top is 12 ft. above the rail. For a maximum clearance line of 15 ft., which is as high as most roads can use, there remains only a distance of 3 ft. for height of stack above the smoke-box; for engines having smoke-boxes above 66 ins. in diameter the height of stack above the smoke arch is simply governed by this road limit, and it thus varies from 26½ to 39 ins. These stacks of 26½ to 36 ins. seem short, and the fact appears to be acknowledged, for all the roads use petticoat pipes of one form or another, which perhaps constitute in effect the equivalent of a stack inside of the smoke-box.

22. Inside Stacks.—On a number of roads there is found a gradual extension of the stack into the smoke-box, and while in some cases it has only reached the rudimentary stage of 4 ins., in others the stack extends down as far as 32½ ins. below the top of the smoke-box and within 5 ins. of the center line of the boiler. This form of stack is made 16 ins. in diameter at the lower end, straight within the smoke-box and

TABLE IV.

Proportion of Modern Locomotive Stacks and Nozzles.

Road or Locomotive Works.	Diameter of Smokebox. Inches.	Cylinders. Inches.	Top of Nozzle — Below Center of Boiler. Inches.	Top of Nozzle — Below Choke of Stack. Inches.	Top of Nozzle — Minimum and Maximum Diameter Inches.	Stack — Height above Smokebox. Inches.	Stack — Choke above Smokebox. Inches.	Stack — Top above Center of Boiler Inches.
Bessemer and L. E.	84	24 x 32	3	48	16 -17	39	3	81
Pennsylvania Railroad	70	20½ x 26	15	53½	16 -18¾	35½	3½	70½
	73	20 x 28	20	88½	20 -21	35½	7	72
	73	22 x 28	17	60½	17 -18	40	7	71¾
	74	20 x 28	17	61	17 -18	34¾	7	77
New York Central	75	21 x 26	11	60½	14 -15½	27½	12	85
	70	20 x 28	9	47½	16½-16½	36¾	3½	72
	73	23 x 35 / 32	3½	52	14 -15½	26½	12	63
	70	20 x 28	13	62	16 -18½	39	14	74
Lake Shore (same stack)	69	20 x 28	4	45½	15 -16⅞	34½	7	89
	67	20½ x 28	3¼	43¾	15 -16⅞	34½	7	68
	71	21 x 30	5	47½	15 -16⅞	31¾	7	88¼
Chicago & Northwestern	71	20 x 28	5½	55	14 -16½	38	14	71½
	69	21 x 26	5½	54	14 -16½	38	14	70½
Brooke	71	21 x 26	6½	54½	16 -18½	31	12½	88½
	71	21 x 30	5	47½	15 -16⅞	32	7	67½
	85	23 x 30	7	54	15¼-18	31	4½	..
Schenectady	70¾	20 x 28	1¼	50½	14 -16½	34	14	69 3-10
	75⅛	21 x 26	10⅞	58	14 -16½	27½	10	65 1-16
	73½	21 x 26	5⅝	47¾	16 -17	31½	5	68⅛
	70¼	20 x 28	9⅛	48¼	16 -18½	33½	14	68⅝
Pittsburgh	64¼	18 x 26	3	47⅛	15 -18	45	12	77⅛
	68½	20 x 26	5⅛	45⅞	17 -17½	42	6½	76¼
	73	21 x 28	3⅛	45¾	15 -16	39	12	75½

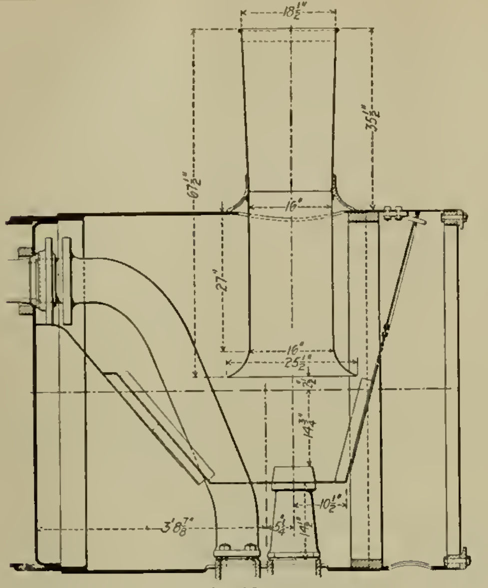


Fig. 19.

tapering outside to 18¾ ins. at the top for passenger engines, and for freight it is 20 ins. as a minimum and 21 ins. as a maximum.

The bottom of the stack is flared, trumpet shape, to a radius of 6 ins. This form of stack has been shown by Mr. J. Snowden Bell in his paper on "Locomotive Front-Ends," read before the Western Railway Club, September, 1899, page 25, and illustrated by Fig. 19 accompanying. Where these inside stacks are used an extremely low nozzle is also employed, so that the distance from top of the nozzle to the minimum diameter of the stack is 32 ins., and the total height of stack, from choke to top, is as much as 56 ins. for passenger and 62 ins. for freight locomotives. It will be seen, therefore, that some benefits must have been derived from the use of long stacks, since, in the case of engines which allow but short lengths outside, the stack has been extended inside until the effective height of stack has been increased to 62 ins. These long inside stacks having been adopted as standard by one of the largest roads, for all modern equipment, the tendency appears to be for other roads to follow this practice, and, as above stated, the drawings which have been reviewed indicate that quite a number of roads are gradually going through the same experimental stages as a preliminary to the process of extending their stacks down into the smoke-box. Where the inside stack is employed all the gases must be drawn down to a point near the center line of the boiler before they can enter the stack, and such an arrangement of baffle plates is required as will direct the gases down toward the center of the boiler, and thence upward through the stack, with danger of producing eddies which would injuriously affect the efficiency of the draft action.

It would seem that the inside stack opens up an entirely new field for discussion and experiment, and that while it constitutes a subject that cannot be gone into fully at this time, its successful operation indicates that it may be an efficient method of correcting the difficulties which are encountered when an attempt is made to use a short outside stack. Further experimental work in this connection will need to be directed towards the proper arrangement of the baffle plates and the proper height of the exhaust nozzle with respect to the choke of the stack, which now becomes located near the center line of the boiler instead of being above the top of the smoke-box. The self-cleaning quality of the front-end, possessed under some combinations of stacks and nozzles, is worthy of careful attention.

(To be Continued).

SUGGESTIONS CONCERNING LOCOMOTIVE ERECTING SHOPS.

By C. H. Quereau, Superintendent of Shops, New York Central & Hudson River Railroad, West Albany, N. Y.

The following remarks are presented not as a studied essay, but merely with a view to stimulating study and investigation. Assume, for consideration, a modern erecting shop, equipped with traveling cranes of ample power; under the conditions attendant upon such an equipment is it good practice to have the locomotives stripped and unwheeled on the pits where they are to be repaired, as is the usual practice? There are several reasons why it is better and more economical to have this work done on a special stripping pit.

If the stripping pit is properly located, there will be practically no more work put on the transfer table, or other means used in getting the locomotives into the erecting shop, by first delivering them to this stripping pit and then to the erecting shop tracks, than in placing them at once on the tracks where they are to receive their repairs. If the locomotives are stripped on the repair tracks, it is usual to have one or more gangs of men assigned to this special work who, when not doing this work, assist in the erecting shop; the pit foremen naturally, and almost inevitably, give considerable attention to the work of stripping, taking them away from the oversight of the erecting, while the delivery of the parts which are to go to the machine, boiler and blacksmith shops falls to the men employed on the erecting floor.

If the stripping of all locomotives, including the unwheeling, were done on one pit, there would naturally be a foreman in charge of the work, with a gang of laborers, receiving the minimum scale of wages, and this foreman and his men would soon become experts. In all probability the work would be done more cheaply and quickly under these circumstances than if done on each pit, as it seems more than probable that the work would be done more promptly by a foreman solely in charge of all this work than if under the charge of foremen who do this work at intervals, infrequently, and whose chief duty, concern and responsibility is to supervise repairs on a number of tracks. It seems reasonable to assume there would be less handling of blocking and similar material about the shop, and the floor could certainly be kept clean and tidy much more easily and at less expense if the blocking, waste and grease from journal boxes, dust and dirt from ash pans, fireboxes and front ends, etc., which cannot be entirely cleaned outside the shop, are confined to one pit, even if this special pit is not partitioned off from the rest of the shop.

It may be urged that, while the stripping is under the charge of the shop or gang foremen, there will be less liability of taking down parts which do not require removal either from their condition or from the nature of the repairs. This argument assumes that the shop or gang foreman, or both, should be the judges as to what work should be done on an engine; it would seem, however, that the better system would be to place this responsibility on the general foreman, who should determine by inspection what work is necessary and notify the erecting shop and stripping foremen. This should certainly be the system if piecework is employed. One of the most potent factors in the commercial development, reduced costs of manufacture and general betterment of the conditions of both employees and employers during the last hundred years has been the specialization of tools and workmen. This, of itself, appears to be a sufficient argument for the use of a special stripping pit.

It quite frequently happens that a locomotive requires very heavy repairs, such as a new boiler or firebox, new cylinders, or has a broken frame; under these circumstances it will probably be admitted that the stripping-pit system has quite an advantage over the other, because not only will the work of stripping and distributing of the parts be done more economically, but the erecting pits will not be idle while this work is beng done. It may be urged that this stripping-pit system would reduce the number of available erecting pits, and that this would be considered a serious objection to the plan; on the other hand, I am very strongly impressed that railroads, as a rule, spend considerably more money in building larger erecting shops than is necessary or advisable, and that appreciably larger dividends would be returned by the same money invested in locomotive repair shops, if the erecting shop capacity be considerably reduced and the money so saved devoted to machine, blacksmith and boiler shops and tools. Railroads get from one to two locomotives a month from each pit of their erecting shops, scarcely averaging one and a half—in all probability this output could be doubled.

Assume for the present that, with proper management, each pit of the erecting floor would turn out three locomotives a month instead of half that number, and that the money so saved is spent in betterments in the other shops. It is evident at once that the dividend-earning power of the money invested in the erecting shop, not considering the cranes and other equally valuable tools, is doubled; that the efficiency of the cranes is increased because of the shorter distances to be traveled; that the distance over which materials must be handled in the erecting shop is divided by two; that the money saved in the erecting shop building and spent in other shops will increase their capacity, and that there will be a saving in the ground devoted to erecting shop purposes. The greatest gain, however, will come from the fact that locomotives will average but ten instead of twenty days in the shop, and their earning capacities are increased to that extent, or that the number of locomotives necessary and the capital invested in them may be reduced proportionally.

Too often it is taken for granted that the capacity of a locomotive repair shop is limited by the number of pits in the erecting shop, and its size is thus proportioned to the number of locomotives to be taken care of, on the basis of an average number to be turned out by each pit per month, this average being usually assumed as about one and a half. A little consideration, however, will show that any number of men, from one to a dozen, can work to advantage on one pit, and even as many as twenty in emergencies, while one man can get the maximum product from a machine shop tool, two from a blacksmith's forge and anvil, and from one to three from each boiler shop tool. It therefore seems evident that the capacity of a locomotive repair shop is determined, within considerably wider limits than is usually assumed or indicated by current practice, by the capacity of the facilities outside the erecting shop, and that a reduction of the size of the usual erecting floor, with a corresponding increase in the facilities of the other shops, will increase the capacity of the plant as a whole, thereby increasing the earning power of the capital invested.

The usual capacity of a railroad erecting-shop pit is very frequently doubled by locomotive builders, and it is not unusual for them to more than double it. It is probably true that a repair shop erecting floor cannot equal the capacity of a manufacturing erecting floor having the same facilities and number of pits, because it is very difficult, if not impossible, to reduce the time lost in waiting for repaired parts to the extent which is possible when manufactured parts are used. I am, however, fully persuaded that a large part of the lost time in railroad erecting shops could be saved by introducing manufacturers' methods, and that two of the most potent factors in reaching this very desirable result are a smaller erecting shop floor and a pit devoted to stripping the locomotives.

The Santa Fe is reported to be using fuel oil for locomotives at the rate of 118,000 barrels per month and extending it to the lines east and north in California. The consumption on the Southern Pacific is stated to be 50,000 barrels per month. In a short time this fuel will be used exclusively on these roads in that State..

OIL FUEL FOR LOCOMOTIVES.

Hoosac Tunnel.

Boston & Maine Railroad.

The application of oil fuel to the Hoosac Tunnel helping locomotives by the Boston & Maine Railroad is a result of the necessity of keeping the tunnel clear of the smoke from the coal-burning engines.

The ventilating system in the tunnel is somewhat experimental in nature, and consists of a large fan, located in a central shaft rising from the middle of the tunnel upward 1,028 ft. to the top of the mountain, which fan may be operated to exhaust or force, but the success of this system depends greatly on the conditions of the weather and wind for its efficiency. As a rule, only one-half of the tunnel from one portal to the central shaft can be kept clear, even under the most favorable conditions, while the other half would remain contaminated. The heavy freight traffic passing through the tunnel, together with the necessity of double-heading between North Adams and the East Portal, owing to the grades of 26 ft. to the mile each way in the tunnel, has overtaxed the ventilating system and made it impossible to maintain the tunnel free from smoke. The tunnel A B is 4¾ miles long, and the prevailing grades from the Vermont line eastward may be seen from the accompanying profile of the road.

It was decided to fit up four of these helpers to burn petroleum oil (three of which are now at work and the fourth is being equipped in the shop), in which service it was necessary to provide:

1. Simplicity of arrangement, and duplication of all parts to which an accident might occur to stop the train.

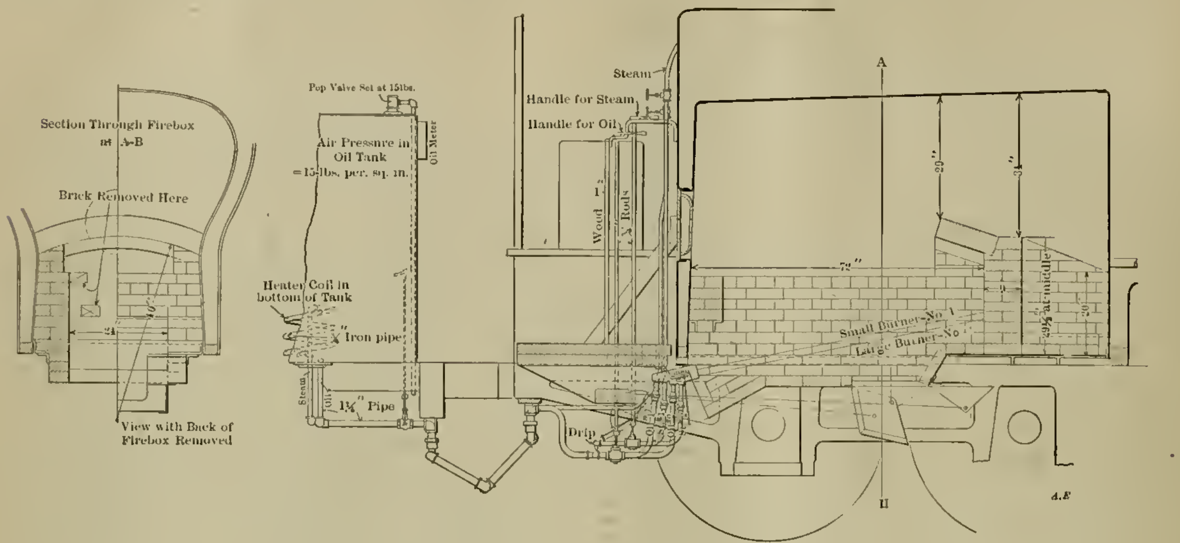
2. Complete combustion of the fuel, leaving no smoke odor or gas.

3. Ability both to raise steam quickly and to hold steam under light fire for long periods.

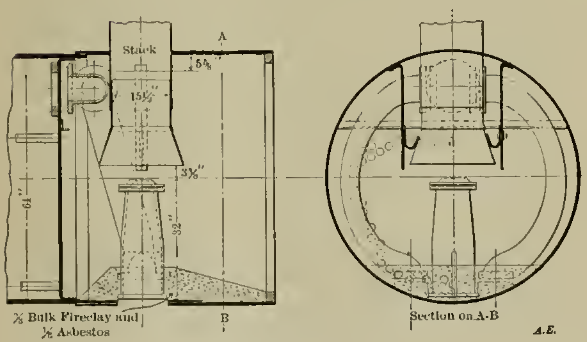
The most important change in the engines was that in the firebox arrangement. The drawing of the firebox shows the arrangement of the burner and the firebrick arch. As may be seen, the burner enters the firebox just beneath the rear water-leg and is inclined upward at an angle of 15 degrees, so as to direct the flame under the arch. The ashpan is replaced by a special pan which is bolted to the lower ring of the water-leg, and supports the firebrick lining and arch, as well as the dampers. The firebrick is laid up in alternate courses of headers and stretchers, although in front a single course of stretchers may be used, except in the center wall, which braces the arch to the tube-sheet. At the back end of the box a tie-wall is built in, resting on angle irons, to stay the side walls. The damper is arranged so that it may be entirely closed for holding steam with a light fire.

The burner is of ingenious construction, consisting of two burners in one, a narrow one on top and a wide one below. Both are flat, or slot, burners, with the steam arranged below that for the oil so as to blow through the stream of oil. A burner of this type, with properly proportioned steam slot and opening for the atomized spray, as the one shown, is capable of efficiently burning 150 gallons of oil per hour. A large air opening is provided near the burner to admit air for initial combustion, while the damper at the rear of the box furnishes what more is necessary. This burner has given good satisfaction, having never become stopped up. With the small burner it is possible to adjust the fire very low for the purpose of holding steam during long waits or delays, while with both burners a capacity far beyond any possible requirement is available.

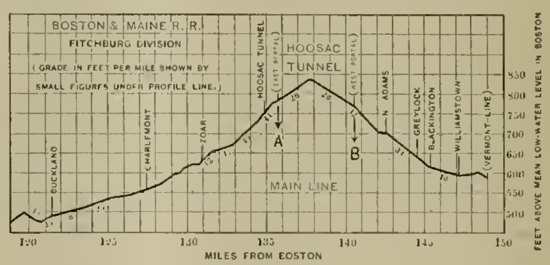
The arrangement of the steam and oil piping for the burner is very simple. Oil is fed directly from the tender tank to the burners through throttle valves, and the steam is likewise controlled by throttle valves, all of which valves have their



Firebox Setting for Oil Fuel–Boston & Maine Railroad.



Smokebox Arrangement for Oil Fuel.



Profile at the Tunnel.

OIL FUEL FOR LOCOMOTIVES IN HOOSAC TUNNEL–BOSTON & MAINE RAILROAD.

handles located conveniently in the cab. The piping is, as shown, conveniently fitted with brass unions to facilitate taking the burner down, and bends are used in place of fittings wherever possible. A steam connection is run to the tender through a reducing valve to supply the tank heater, and another steam connection is arranged outside the cab to supply the steam oil-pump at the storage station when filling the tender tank, as will be described in a later issue.

Very little change has been made in the front-end arrangement in these engines except that all nettings and diaphragms were removed. The lower flaring edge of the petticoat pipe is 3⅜ inches above the exhaust nozzle and its upper end is 5⅝ inches below the bottom of the stack, as shown in the front-end sectional view.

It is stated that no repairs have been found necessary by the change in fuel, whereas since the change the work of three coal-burning helper engines has been done by two oil burners, and no hostler service is required at all. Steam is raised from cold water in the boiler in 40 minutes after starting the burner, and 200 pounds is indicated at the gauge in 50 minutes more. A pressure of 10 or 15 pounds will start the burners and in firing up this pressure is obtained from another engine. In one case one of the engines which had been without fire for 15 hours showed 150 pounds of steam at the gauge in 40 minutes after the burner was started. The efficiency of combustion in the oil burners is shown remarkably well in the accompanying engraving, which shows oil burner No. 1068 helping a freight train up the grade into the tunnel. The oil engine shows no smoke from the stack.

Mr. Henry Bartlett, superintendent of motive power of this road, furnished these interesting drawings. We are also indebted to Mr. W. D. Houman, the engineer in charge of the work during its installation, for valuable assistance. Descriptions of the oil storage, oil meter and further discussion of the firebox setting and the burner will be reserved for another article.

Tests will be made to compare oil and coal fuel in the same service and the results will be given in these columns.

The following is quoted from the official instructions issued to cover the operation of coal-burning engines used in connection with these helpers:

Helping engines equipped to burn oil fuel have been provided to help trains in both directions through the Hoosac Tunnel, and will work between Williamstown and East Portal, under the direction of the assistant superintendent of the western section.

The object is to reduce the amount of smoke and gas generated by coal-burning locomotives while in the Hoosac Tunnel. In all cases, except those of emergency, firemen must see that their fires are bright and clean and that they have full steam pressure before entering the tunnel. The use of green coal must be entirely avoided, except as above, while passing

Showing Contrast Between Fuel Oil and Coal. Both Engines Are Working Hard Up Grade Entering Tunnel. This Is a Fair Representation of the Results as to Smokelessness of Oil.

through the tunnel. With the present tonnage of freight trains, it is expected that the oil-burning helpers will be able to help the road engine sufficiently to enable it, when entering the tunnel with fire in proper condition and steam of proper pressure, to take the balance of the tonnage through without using fresh coal.

Suitable arrangements will be made at North Adams to hold eastbound trains on the sidings east of the station in the event of any delay in entering the tunnel, in order that firemen may have an opportunity to get their fires bright and in proper condition before entering the tunnel.

Fatalities among conductors, brakemen, switchmen, flagmen and watchmen in coupling accidents, in the year ending June 30, 1901, have, according to the Interstate Commerce Commission, decreased about 35 per cent. from the figures of the previous year. The number injured decreased about 52 per cent. These figures represent 70 per cent. of the mileage of the country, and the reduction of accidents seems to be due to the progress in safety appliances.

The adoption of a standard cipher code for all departments of railroad work was suggested at the recent meeting of the American Railway Association, with a view of reducing the number of words in telegraphic correspondence. It was placed in the hands of a special committee for report at the next meeting.

F. A. Krupp, of Essen, has been awarded the Bessemer Medal of the Iron and Steel Institute. The late Mr. A. Krupp began business as a workman at the crucible. He developed his enterprise himself, serving as steel worker, bookkeeper, manager, salesman and all, and became the owner of the largest steel and iron establishment in the world. His son ably extended the business, and now employs twice as many workmen as his father did. He is at present the sole proprietor of works employing 47,000 men.

The Q & C Company, manufacturers of railway specialties, machinery and pneumatic tools, will operate in their own name, with C. F. Quincy as president, commencing June 1, with offices in the Western Union Building, Chicago, and 114 Liberty street, New York. The general sales department will be located at the shops at Chicago Heights, Ill.

PERSONALS.

Mr. M. S. Monroe has been appointed master mechanic of the Macon, Dublin & Savannah Railroad, with headquarters at Macon, Ga.

Mr. H. A. Furgusson has been promoted to the position of assistant superintendent of motive power of the Chicago Great Western from that of general foreman at Oelwein, Ia.

Mr. W. D. Robb has been made superintendent of motive power of the Grand Trunk, with office at Montreal. His title has been acting superintendent of motive power.

Mr. F. W. Cox has been appointed master mechanic of the Chicago, Milwaukee & St. Paul at West Milwaukee, Wis., having been transferred from a similar position at Sioux City, Ia.

Mr. J. W. Luttrell has resigned as master mechanic of the Illinois Central at Burnside to succeed Mr. J. O. Pattee as superintendent of motive power of the Missouri Pacific, with headquarters at St. Louis, Mo.

Mr. J. H. Vought has been promoted from the position of master mechanic to that of assistant superintendent of motive power of the Lehigh Valley, with headquarters at Bethlehem, Pa.

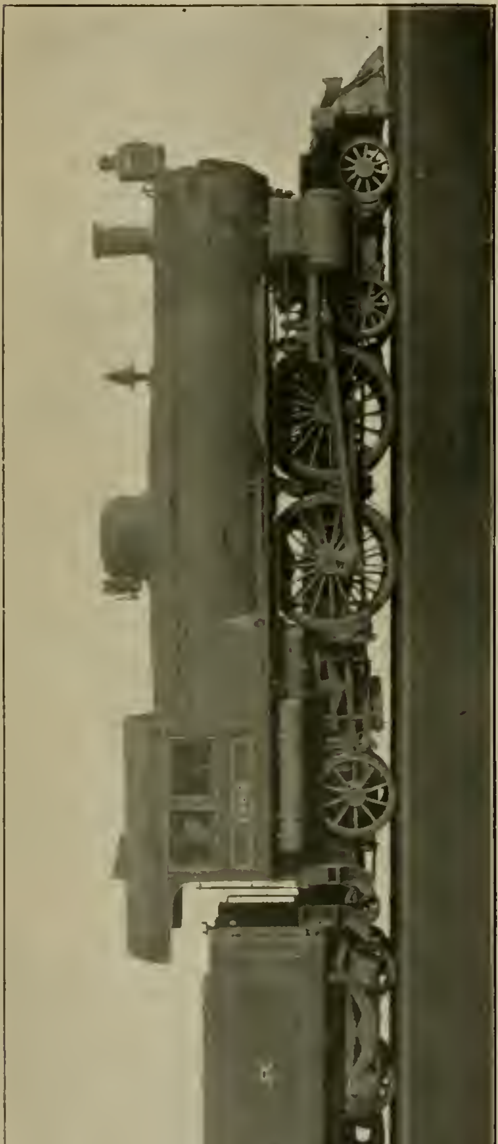
Mr. J. N. Barr has resigned as mechanical superintendent of the Erie to become general superintendent of the Chicago, Milwaukee & St. Paul Railway, and thus another leading motive power officer is called to greater operating responsibilities.

Mr. J. A. Pilcher has been appointed mechanical engineer of the Norfolk & Western, to succeed Mr. C. A. Seley. Mr. Pilcher was formerly connected with the road when Mr. George R. Henderson held this position, and has for a number of years been one of the leading designing draughtsmen at the Baldwin Locomotive Works.

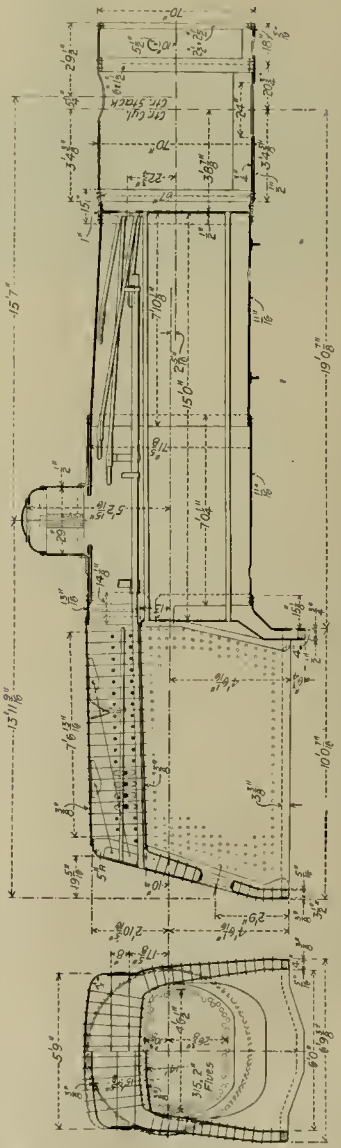
Mr. W. E. Symons, formerly of the Plant System, has been appointed mechanical superintendent of the Gulf, Colorado & Santa Fe, with headquarters at Cleburne, Tex. He expected to take a rest and study locomotive progress for several months in Europe, but the demand for his services would not permit. His new position places him in charge of the Santa Fe lines in Texas, one of the most important districts of the road. He thus returns to the Southwest, where much of his success and reputation have been earned.

Mr. Clement F. Street, member A. S. M. E., has resigned as manager of the railroad department of the Dayton Malleable Iron Company to join the staff of the Wellman-Seaver-Morgan Engineering Company, of Cleveland. Mr. Street has had a wide experience with engineering firms and railroads, and is best known in his work as editor of the "Railway Review," of Chicago. He was a member of the World's Transportation Commission, and in that capacity spent two years in studying transportation methods in all parts of the world. Being thoroughly informed in the engineering requirement of railroads he will be a valuable addition to the staff of the company which he now joins.

Mr. A. N. Spencer, second vice-president of the J. A. Fay & Egan Company, of 409 to 429 West Front street, Cincinnati, O., will represent that company at the Saratoga convention and have charge of their exhibit. This firm has made a specialty of the development of heavy woodworking tools for car construction, and their experience enables them to give valuable assistance in connection with the modernizing of woodworking departments.

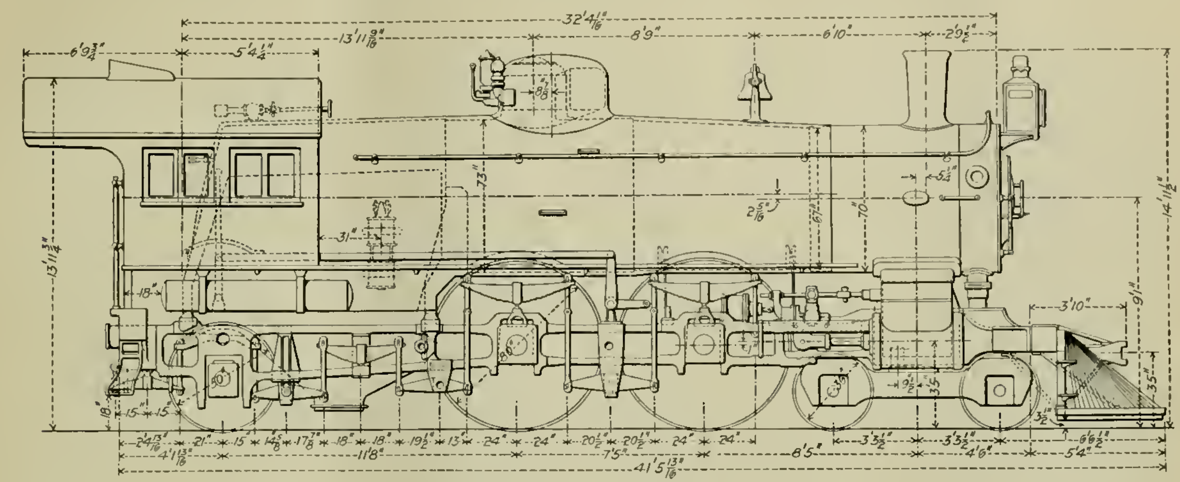


Atlantic Type Fast Passenger Locomotive—Pennsylvania Railroad.
Class E 2

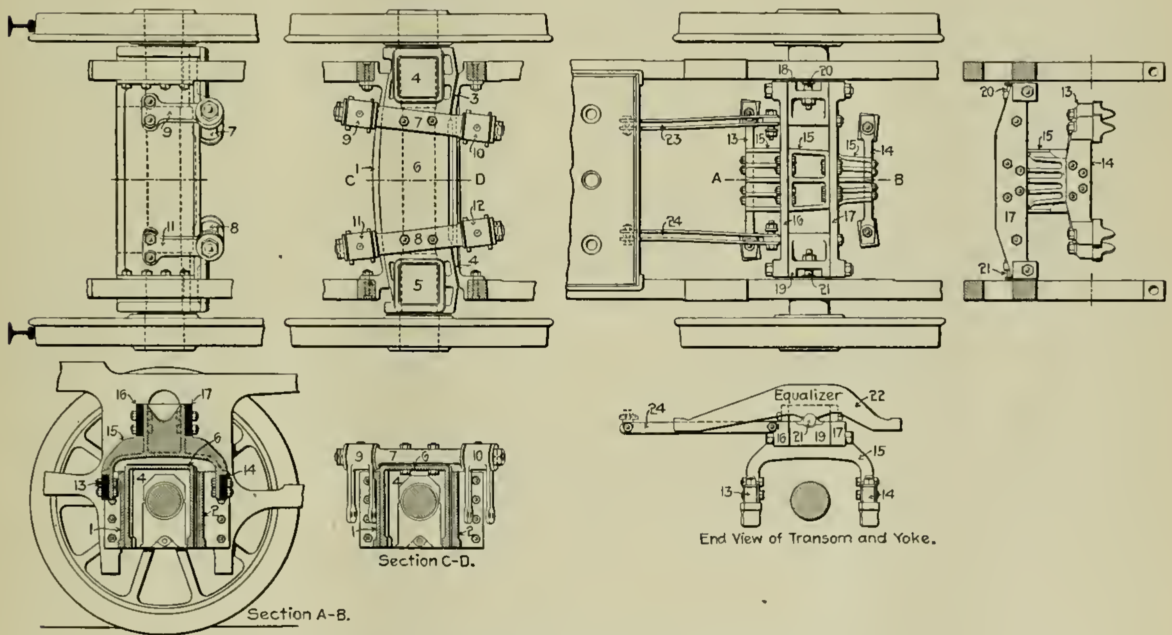


Boiler of Class E 3a Fast Passenger Locomotive.

ATLANTIC TYPE FAST PASSENCER LOCOMOTIVE—PENNSYLVANIA RAILROAD



Elevation Diagram of Class E 2 Passenger Locomotive.



Detail Construction of the Trailing Truck.

Atlantic Type Fast Passenger Locomotive, Pennsylvania Railroad.

ATLANTIC TYPE FAST PASSENGER LOCOMOTIVE.

Pennsylvania Railroad.

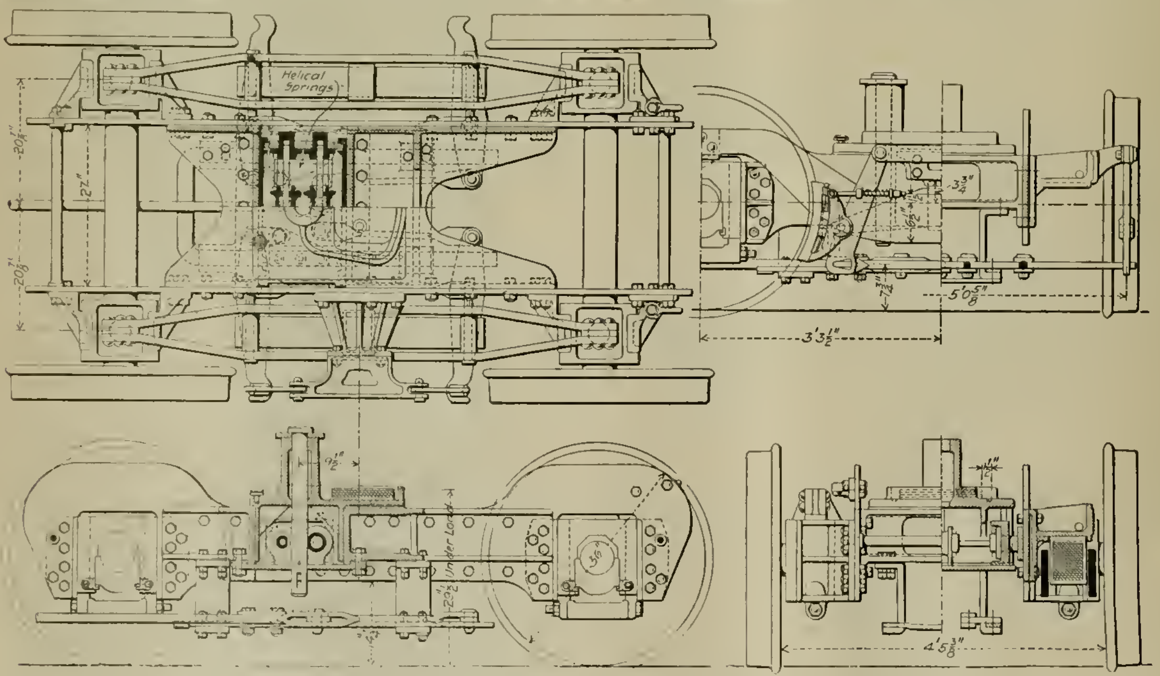
Class E2.

In our June number of 1900 will be found a description of the original Atlantic type or Class E1 engine of this road, which had a grate 102 x 96 ins., a Belpaire firebox and combustion chamber. The wide firebox made it necessary to place the cab over the barrel of the boiler, and thus separated the enginemen. This is a remarkable engine, and is one of the best examples of design in detail which has ever been produced. It is also one of the most important on this road, as a predecessor of the later passenger engines with the same wheel arrangement but different boilers and sizes of cylinders. This series cannot fail to compel the admiration of those who have seen the engines.

Class E2.—This class has been running about two years. It has many of the details of the E1, but the narrower grate permits of placing the cab in the usual position, which is considered very important. The wheel base was lengthened, the combustion chamber omitted, the tubes were made ¼ in. larger and lengthened, the heating surface and also the weight were increased. The weight on driving wheels was increased from 101,550 lbs. to 109,033 lbs. The E2 boiler has a round top, a departure which was considered an experiment. In the E3 design, the next step in advance, the cylinders were increased to 22 x 26 ins., and the boiler also had a round top. It is understood that the larger cylinders were adopted for special road conditions on the Pittsburg division, where these engines are used. The next step, the E3a, will return to the Belpaire firebox top, but retain the 72-in. grate

ATLANTIC TYPE LOCOMOTIVES, PENNSYLVANIA RAILROAD.

Character of service		Passenger		
Type of wheel arrangement		Atlantic		
Classification	E1	E2	E3	E3a
Diameter of drivers, in inches	80	80	80	80
Size of driving axle journals, in inches	9¼ x 8½ x 13	9½ x 13	9½ x 13	9½ x 13
Driving wheel base	7 ft. 5 ins.	7 ft. 5 ins.	7 ft. 6 ins.	7 ft. 6 ins.
Total wheel base of engine	26 ft. 6½ ins.	30 ft. 9½ ins.	30 ft. 9½ ins.	30 ft. 9½ ins.
Total wheel base of engine and tender	50 ft. 5 ins.	60 ft. 1 13-16 ins.	60 ft. 1 13-16 ins.	60 ft. 1 13-16 ins.
Number of wheels in engine truck	4	4	4	4
Diameter of wheels in engine truck	36 ins.	36 ins.	36 ins.	36 ins.
Size of engine truck axle journals	5½ x 10	5½ x 10	5½ x 10	5½ x 10
Spread of cylinders	85½ ins.	85½ ins.	86½ ins.	86½ ins.
Size of cylinders, in inches	20½ x 26	20½ x 26	22 x 26	22 x 26
Steam ports, in inches	1½ x 20	1½ x 20	1½ x 20	1½ x 20
Exhaust ports, in inches	3 x 20	3 x 20	3 x 20	3 x 20
Travel of valve, in inches	7	7	7	7
Lap of valve, in inches	1½	1½	1½	1½
Type of boiler	Belpaire	Round top	Round top	Belpaire
Minimum internal diameter of boiler	65⅞	65	65	65
Number of tubes	353	315	316	315
Outside diameter of tubes	1¾	2	2	2
Length of tubes between sheets	156 ins.	180 ins.	180 ins.	180 ins.
Fire area through tubes, square feet	4.33	5.26	5.26	5.26
Size of firebox, inside	102 x 96	72 x 111	72 x 111	72 x 111
Grate area, square feet	68	55.5	55.5	55.5
External heating surface of tubes	2102.4	2474.0	2474.0	2474.0
Heating surface of firebox, square feet	218	166	166	166
Heating surface, total, square feet	2,320.4	2,640	2,640	2,640
Steam pressure	185	205	205	205
Number of wheels under tender	6	8	8	8
Diameter of tender wheels	42	36	36	36
Tender axle journals, size	5 x 9	5½ x 10	5½ x 10	5½ x 10
Weight of engine empty, in pounds	154,700	157,033	158,000	158,000
Weight in working order, front truck	38,125	36,650	37,000	37,000
Weight in working order, first pair drivers	50,250	53,800	54,000	54,000
Weight in working order, second pair drivers	51,300	55,233	55,500	55,500
Weight on trailing wheels	33,775	30,917	31,000	31,000
Weight of engine in working order	173,450	176,600	177,500	177,500
Weight of tender loaded	90,000			
Ratio heating surface to grate area	34.2	47.66	47.56	47.56
Ratio tube heating surface to firebox heating surface	9.6	14.9	14.9	14.9
Tractive power per pound M. E. P.	136.6	136.6	136.6	136.6
Tractive power per pound M. E. P. at 4-5 boiler pressure	20.220	22,400	22,400	22,400
Trailing wheels, diameter	56 ins.	50 ins.	50 ins.	50 ins.
Trailing axle journal, size of	7 x 11¾	7 x 11¾	7 x 11¾	7 x 11¾



Leading Truck of Atlantic Type Passenger Locomotive, Pennsylvania Railroad.

of the E2. The E3 designs are heavier and more powerful than the earlier ones, with 109,500 lbs. on the driving wheels, which is the greatest weight in our record of Atlantic type engines. For convenience in comparison, the characteristics of the four designs referred to have been tabulated in this description.

While the E2 engine is not a standard, it marks an important step in that direction and is worthy of record, because of its remarkable success in handling fast and heavy passenger trains. This class has done specially noteworthy service on the line between Camden and Atlantic City, where the conditions are particularly severe.

As stated, the E2 boiler is of the radial stayed type. This road has long favored the Belpaire firebox, because of its direct staying with straight line stresses, and experience in this case leads to a return to it because it is believed to better provide for the expansion stresses. The running gear is generally the same as that of the E1, except as to the leading and trailer trucks and the spring rigging, which is modified at the back end because of the new trailer trucks.

In the boilers of recent engines on this road, special care is taken to secure free passage of water at the throat into the water space around the firebox. The water space at the throat widens rapidly above the vertical portions of the sheets, and this should greatly improve the circulation. Methods of supporting the fireboxes to the frames have also been most carefully studied in order to provide for wear and to take care of the stresses without subjecting the firebox plates to bending. The boiler support used in these engines is known as the Tate boiler clamp.

The main rod of this engine is similar to that of Class E1, and represents the most recent development in this direction. The end of the rod is forked, and is provided with a gib bolt, which prevents the forks from spreading. This bolt slopes on the forward side to fit the slope of the taper key, and it is made of D section. A U-shaped block or liner fits in the forks and bears against the liner of the brass on one side and against the key on the other side. In this way about 4 ins. of metal resists the stresses which may be produced by water in the cylinder. If shearing does occur, the rod end can still be taken down. This construction was adopted because it is lighter and stronger than a strap.

Leading Truck.—This truck has side plates, terminating at their ends in palms, to which the journal box guides are bolted. The transoms are of cast iron, with long flanges bolted to the side frames. Between the transoms is a saddle, moving laterally, the saddle containing a spring box to secure the centering movement. Upon the top of the saddle is the centerpin, which is placed to bring the center of rotation 9½ ins. back of the center of support, a plan which was developed in connection with the E1 engine, but in this case side motion is also provided. This centering of the truck gives equal weight on all the wheels, but gives to the leading wheels a larger leverage in guiding. A pocket contains the lubricant, and the wear is received upon liners which are adjustable. This truck is equipped with air-brakes.

Radial Trailing Truck.—When the wheel-base of the E1 engine was increased, it became necessary to design a new radial trailer truck, and this was worked out to secure the centering action by gravity, instead of by a spring. This construction gives about 3½ ins. side motion each way from the center. Between the engine frames are placed two guide-plates, 1 and 2, having curved faces of suitable radius. The rear guide is curved throughout its whole length, but the forward guide has its curved faces, 3 and 4, located near the ends only. Between these are placed the truck journal boxes, 4 and 5, which are integral with the connecting piece, 6, curved in plan and in the form of an inverted trough. On the top of the connecting piece between the boxes are rigidly bolted the axles, 7 and 8, which are journaled at their ends for the purpose of carrying the inverted T-shaped hangers, 9-10 and 11-12. These axles are placed radially to the curves of the guiding faces, and each is fitted at its lower end with two pins connecting the legs of the hangers. Upon these pins rest the transoms, 13 and 14, which at their ends are fitted with special bearing blocks so shaped that a tooth-formed projection fits between the two pins at the lower end of the hangers, thereby permitting the axle wheels and boxes, with the parts fastened to them, to move laterally without danger of the transoms slipping out of the hangers. Resting upon these transoms and fastened to them is the yoke, 15. Resting upon the latter and fastened to it are the transoms, 16 and 17. These transoms are of a length nearly equal to the distance between the engine frames, but are not attached in any way to the latter. Spacing blocks, 18 and 19, are bolted to these transoms at the ends. These blocks carry at their outer ends bearing pins, 20 and 21, upon which the equalizers rest. One only of these, 22, is shown. To prevent any tendency of the long transoms to rotate, they are tied by two sets of links, 23 and 24, to the foot-plate, permitting them, however, to rise and fall to whatever extent is demanded by the equalizing system.

DECAPOD TANDEM COMPOUND FREIGHT LOCOMOTIVE.

Atchison, Topeka & Santa Fe Railway.

The Most Powerful Locomotive in the World.

A locomotive with 62,500 lbs. tractive power, 5,390 square feet of heating surface, and a total weight of 267,800 lbs., has just been delivered by the Baldwin Locomotive Works to the Atchison, Topeka & Santa Fe Railway. It is the largest and most powerful locomotive in the world, and has set a mark so high that it seems improbable that it will be surpassed for some time to come. A glance at the photograph, the height of the stack and the location of the whistle, conveys an impression of its enormous size.

It has the largest cylinders ever applied to a four-cylinder engine, and the boiler is the largest ever constructed. An idea of the size of the details is had from the equalizer of the pony trucks, which is 13 ins. deep at the center. The main crank-pin is 8¼ x 8½ ins. The crossheads are of the Laird pattern, with 4 x 9-in. (top) and 6¼ x 5-in. (bottom) guides. The pistons are of cast iron, with babbitt rings. One of the most interesting features is the cylinder and valve construction. The high-pressure cylinder is secured to the front of the low-pressure, and the connection between the steam chests is made in the form of a packed gland or slip joint, which is easily separated and requires no close machine fitting. For convenience in handling the high-pressure cylinder, a small crane is permanently mounted on the side of the smoke-box, the cylinder being lifted by a ring located over its center of gravity. Only one joint needs to be ground in, and access may be had to the low-pressure pistons without taking the guides down. A special form of piston-rod packing made by the United States Metallic Packing Company is used between the two cylinders. It takes care of vertical and lateral movements of the rod. Instead of crossing the ports of the high-pressure cylinder, the valve for that cylinder is double-ported, as shown in the engraving.

In simple working this engine is equivalent to one with 25.44-in. simple cylinders, and as a compound, to one with 24¼-in. cylinders. The cylinder power is calculated to be sufficient to slip the wheels with a boiler pressure of 200 lbs. All of the tires except the third pair are flanged. The first and fifth pairs of driving tires are set at a distance of 53⅛ ins. apart, the others being 53⅜ ins. The Le Chateller water brake, as well as the Westinghouse, is applied to this engine, as its service is to be on the heaviest mountain grades on this road. We regret that space is not available in this issue for comment upon other interesting features of this remarkable design. Its place among heavy locomotives may be seen in the table published in the insert with this issue. The principal dimensions of the engine are as follows:

DECAPOD TANDEM COMPOUND FREIGHT LOCOMOTIVE.

Atchison, Topeka & Santa Fe Railway.

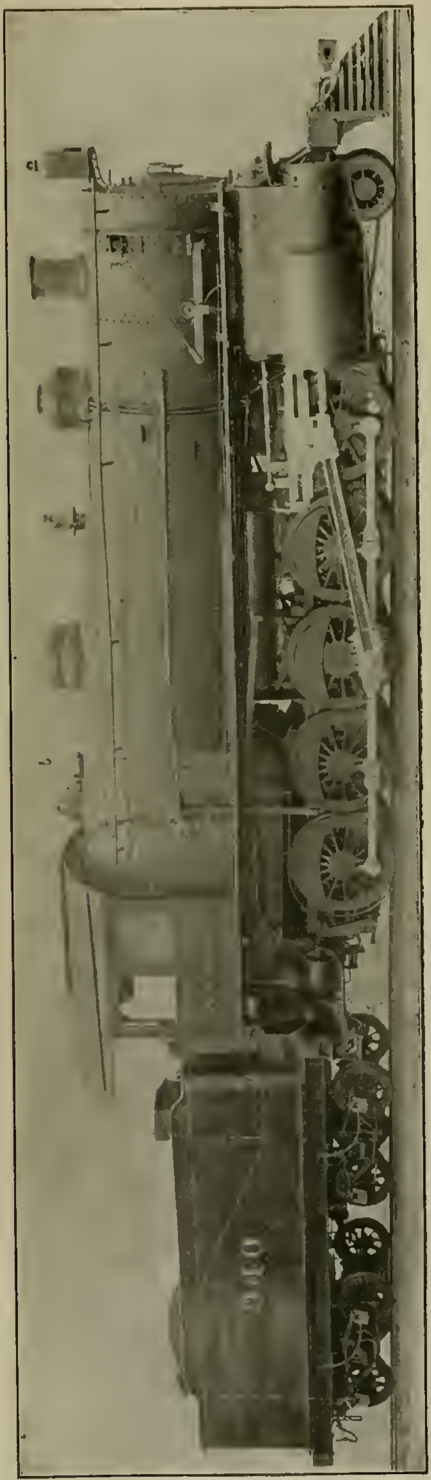
Gauge	4 ft. 8½ ins.
Fuel	Soft coal
Weight in working order	267,800 lbs.
Weight on driving wheels	237,800 lbs.
Weight on leading truck	30,000 lbs.
Wheel base, driving	20 ft. 4 ins.
Wheel base, rigid	20 ft. 4 ins.
Wheel base, total of engine	29 ft. 10 ins.
Wheel base, total, engine and tender	59 ft. 6 ins.

Cylinders.

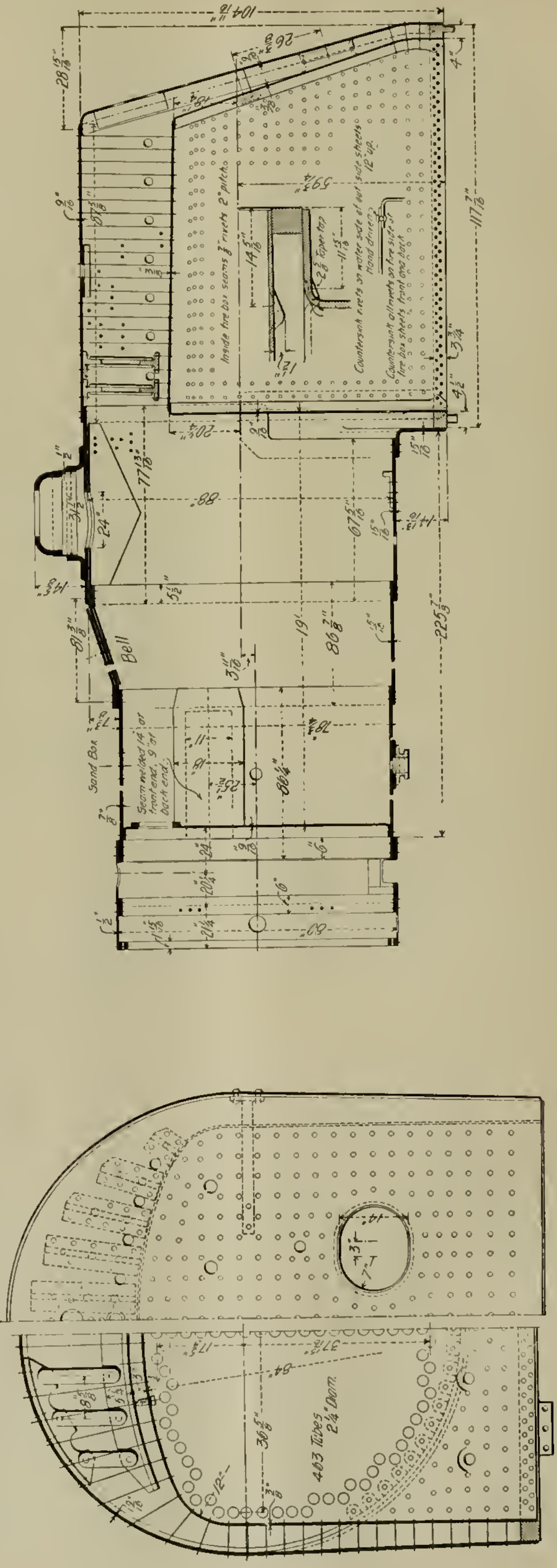
Type	Tandem compound
Diameters of cylinders	19 and 32 ins.
Stroke of pistons	32 ins.

Valves.

Type of	Piston
Diameter	13 ins.
Travel of valves	6 ins.
Outside lap	H.P. ⅞ in., L.P. ¾ in.
Inside lap (negative)	H.P ¼ in., L.P. ⅜ in.
Lead of valves	L.P. ⅛ in.
Throw of eccentrics	6 ins.
Steam ports, length	29¾ ins.
Steam ports, width	H.P. 1⅝ ins., L.P. 1¾ ins.
Bridges	H.P. 2¼ ins., L.P. 2⅝ ins.
Exhaust ports, length	29¾ ins.
Exhaust port, width	8¾ ins.

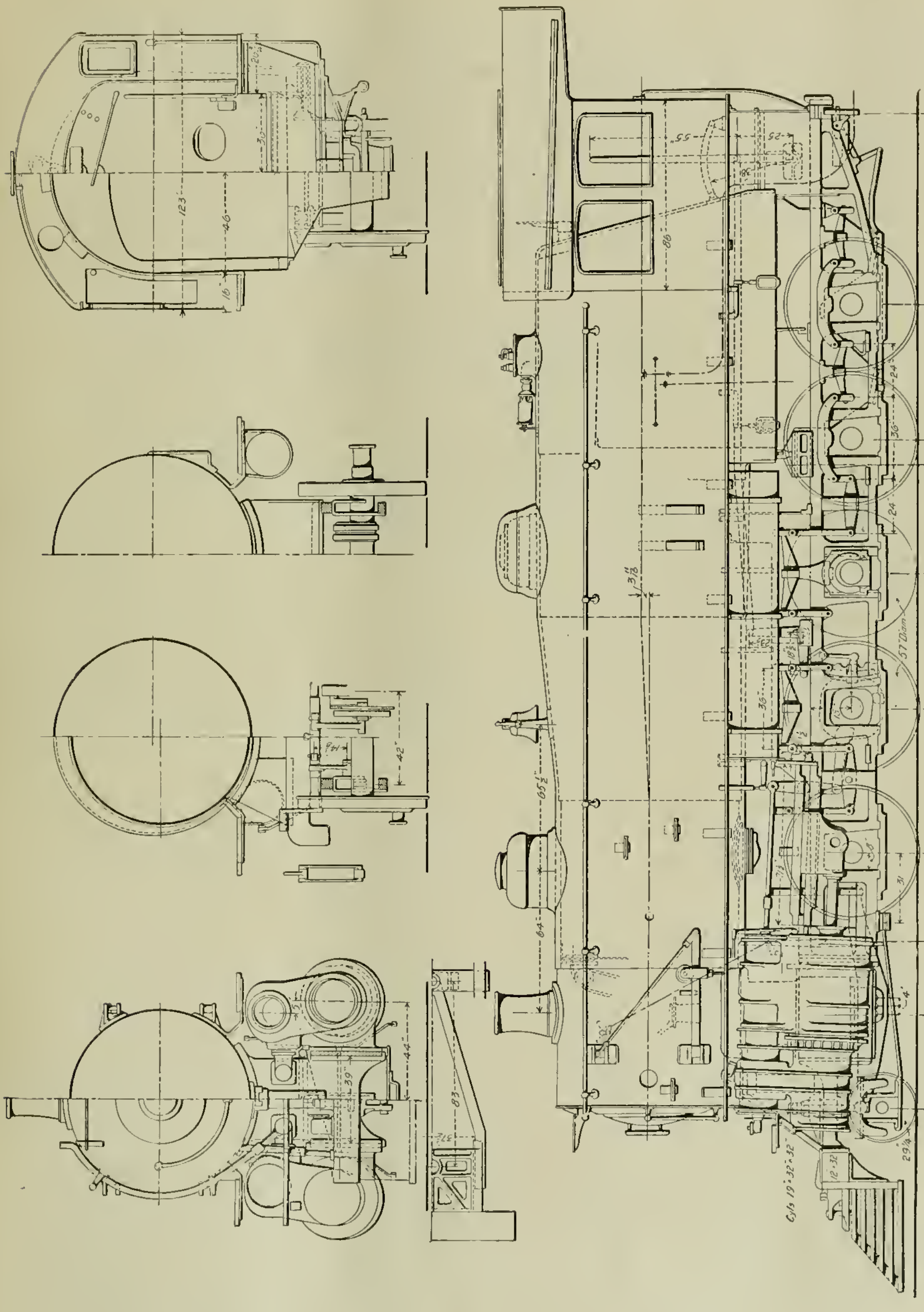


The Heaviest and Most Powerful Locomotive in the World.



Decapod Tandem Compound Freight Locomotive—Atchison, Topeka & Santa Fe Railway.

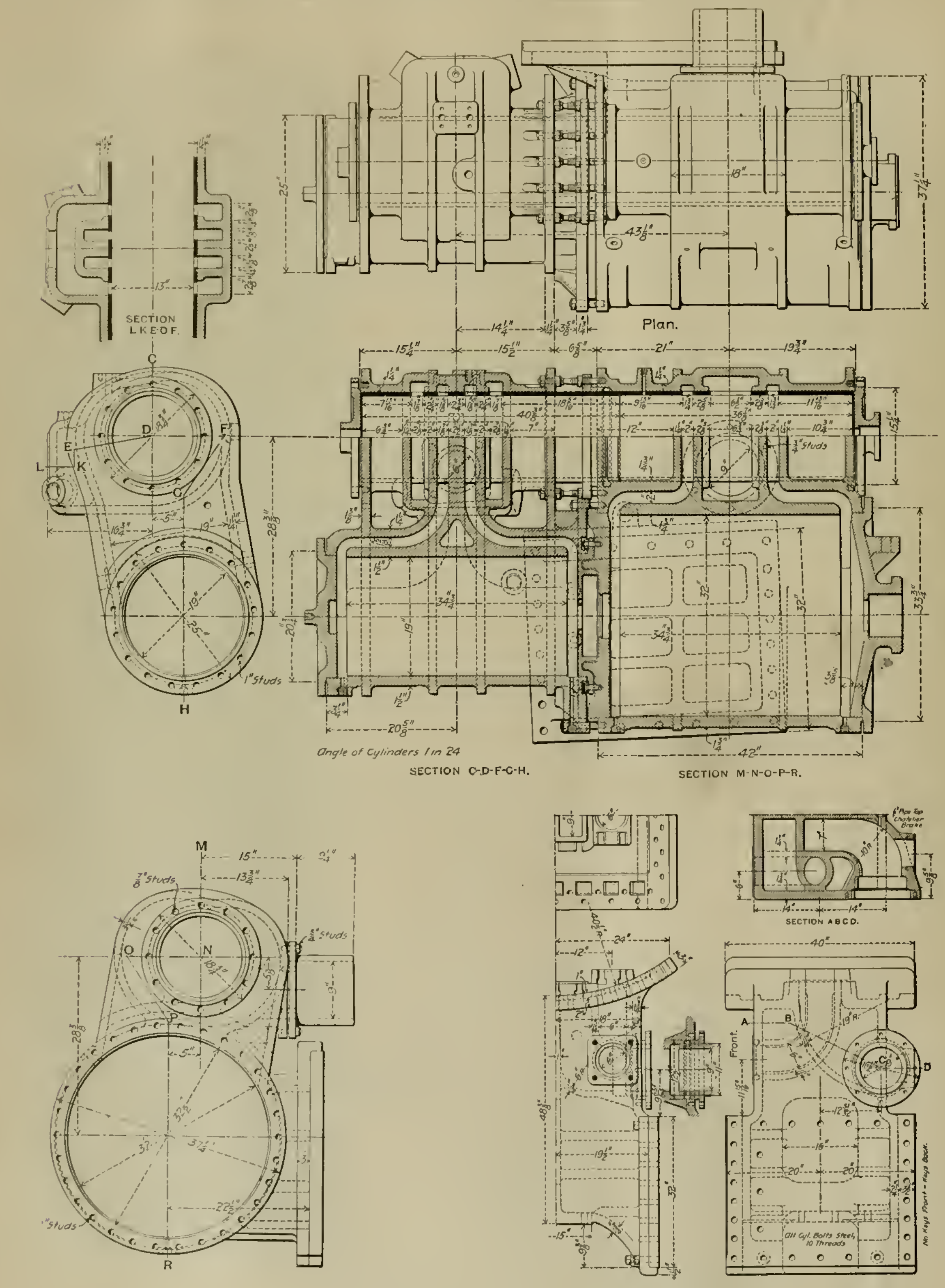
G. R. HENDERSON, *Superintendent Motive Power.* BALDWIN LOCOMOTIVE WORKS, *Builders.*



Decapod Tandem Compound Freight Locomotive—Atchison, Topeka & Santa Fe Railway.

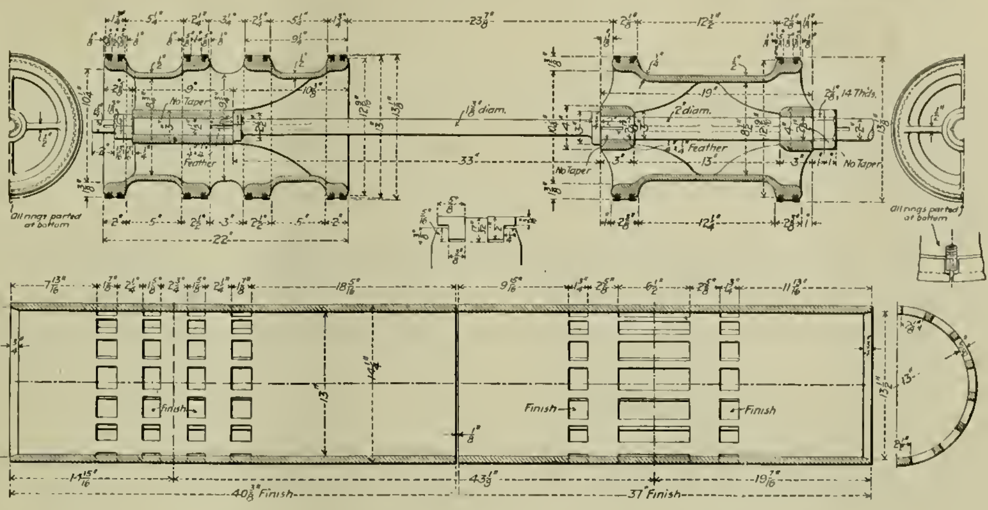
G. R. HENDERSON, *Superintendent Motive Power.*

BALDWIN LOCOMOTIVE WORKS, *Builders.*



Decapod Tandem Compound Freight Locomotive, Atchison, Topeka & Santa Fe.

Cylinders and Steam Chests.



Decapod Tandem Compound Freight Locomotive—A. T. & S. F. Ry.

Valves and Valve Bushings

Wheels, Etc.	
Driving, diameter outside	57 ins.
Driving wheels, centers	50 ins.
Truck wheels, centers	29¼ ins.
Driving journals, main	11 x 12 ins.
Driving journals, others	10 x 12 ins.
Truck, type	Swing motion
Truck, wheels	Steel tired
Truck journals	6½ x 10½ ins.
Crank pins, main	8¼ x 8½ ins.
Crank pins, others than main	5 x 4½ ins.
Boiler.	
Type	Wagon top
Steam pressure	225 lbs.
Diameter	78¾ ins.
Thickness of sheets	⅞ and 15-16 in.
Type of staying	Radial
Number of fire doors	2
Firebox, length	108 ins.
Firebox, width	78 ins.
Firebox, depth	Front 80 ins., back 78 ins.
Staybolts	1 in. Ulster iron
Crown sheet, thickness	⅜ in.
Tube sheet, thickness	9-16 in.
Side sheets, thickness	⅜ in.
Back sheet, thickness	⅜ in.
Water space	Front 4½ ins., back and sides 4 ins.
Tubes, number	463
Tubes, diameter	2¼ ins.
Tubes, length	19 ft.
Heating surface, tubes	5,155.8 sq. ft.
Heating surface, firebox	210.3 sq. ft.
Heating surface, arch tubes	23.9 sq. ft.
Heating surface, total	5,390.0 sq. ft.
Grate area	58.5 sq. ft.
Smoke stack above rail	15 ft. 6 ins.
Center of boiler above rail	9 ft. 10 ins.
Tender.	
Type	8-wheel
Frame	10-in. steel channels
Trucks	Plunger cast steel, diamond frames
Capacity for water	7,000 gals.
Capacity for coal	1[illegible] tons
Wheels	34¼ ins., steel tired
Journals	5 x 9 ins.
Journal boxes	McCord

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

(Chemistry Applied to Railroads—Second Series.)

XXVIII.

(Disinfection of Passenger Cars.)

By C. B. Dudley, Chemist, and M. E. McDonnell, Bacteriologist, of the Pennsylvania Railroad Company.

It will hardly be denied that the subject of the disinfection of passenger cars, stations, waiting rooms and dwellings of employees is one of very great importance to railroads. As knowledge increases, we seem to be learning that there is very much more liability of disease being contracted from occupancy or contact with locations that have been contaminated by persons suffering with certain diseases than was formerly believed, and although the absolute limits of the danger as applied to passenger cars and waiting rooms have not been completely demonstrated by positive experiment as yet, it is still evident that in the case of some diseases, such as smallpox, no one feels satisfied to enter a place so contaminated until the same has been disinfected. And if, as seems probable, it shall be demonstrated by further experiment that there is danger of contracting diphtheria, scarlet fever, tuberculosis, pneumonia, etc., from the occupancy of places contaminated by persons suffering with any of those diseases, it is evident that some efficient means of disinfecting large places, such as passenger cars, waiting rooms, etc., is a very great desideratum. The ordinary fumigation with sulphur, and the treating of infected material with steam for disinfection, are surrounded with some difficulties. The effect of the sulphur gases on metals and on upholstery is very disastrous, and while steam is thoroughly efficient, in order to use it, it is necessary to have large closed spaces into which materials can be placed. Accordingly, when, a few years ago, it was announced that formaldehyde gas apparently successfully met all the requirements of a thoroughly efficient gaseous disinfectant, there was quite a feeling of relief among sanitarians and boards of health, and in many cases railroads began to supply themselves with the necessary apparatus with which to use this new disinfectant.

As time has progressed, however, some disappointment has been experienced in regard to the behavior of formaldehyde. Some boards of health, even at the present time, do not regard formaldehyde as of any value, while positive experiments, made by scientific experts in some cases, have resulted in disappointment. Furthermore, there does not seem to be general agreement as to the conditions under which formaldehyde is efficient as a disinfectant. Some authorities claim, and at first we think it was generally taught, that the gas, in order to be efficient, should be as dry as possible. Others claim that their apparatus gives the proper amount of moisture; while still others specify a certain amount of water to be vaporized per unit of space to be disinfected. Also, the question as to what effect the temperature has on the action of the gas seems to be in doubt. Some authorities think that the gas is absolutely inactive below 45 degrees Fahrenheit, and that it is much more active at higher temperatures than even as low as this point.

In view of this state of affairs, some two years ago experiments were begun in connection with the Chemical and Bacteriological Laboratory of the Pennsylvania Railroad Company, to see, if possible, under what conditions formaldehyde gas did produce disinfection. The questions which we asked ourselves were:

First—Is it essential that the gas should be as dry as possible in order to be efficient?

Second—If not, what influence does moisture have on disinfection?

Third—If moisture is found to be favorable to disinfection, how much moisture is essential?

Fourth—What influence does temperature have on the action of formaldehyde gas as a disinfectant?

Fifth—Are there any other conditions than moisture and temperature that have an influence on the action of formaldehyde gas as a disinfectant?

It is, perhaps, fair to say that it was hardly possible at the beginning of our studies to plan out the investigation as methodically as the questions above given seem to indicate, as the whole field was to us very largely unknown, and we had to feel our way. The above resumé is simply given for convenience in setting forth the results of our studies.

The first point which we tried to settle by experiment was the effect of the presence or absence of moisture on the efficiency of disinfection by means of formaldehyde. Before giving in detail the method of experimentation and the results on this point, it may, perhaps, be wise to spend a few moments with the question of moisture in the air. It is well known that moisture is always present in the air to a greater or less extent, and that the amount of moisture that the air can contain is largely a function of the temperature. Barometric pressure has an influence, but this need not be considered, so far as our experiments are concerned. A few rather elementary figures may not be amiss. When the air is saturated with moisture at a temperature of 40 deg. F. each cubic foot of it contains about 2.80 grains of water; at 50 deg. the amount of water is 4 grains; at 60 deg., 5.70 grains; at 70 deg., 8 grains; at 80 deg., 11 grains, and so on. But it rarely happens that the air is saturated with moisture. The usual condition of the air is a good deal below saturation. The amount of moisture in the air varies with different parts of the country and at different seasons of the year. The usual method of stating the condition of the air as regards its moisture content, or as is commonly said, its "humidity," is by means of a percentage figure. For example, if we say the humidity of the air is 70 per cent., we mean that the air contains 70 per cent. of the moisture that it can contain at the temperature; or, in other words, if the air contains 2.80 grains of water per cubic foot, and the temperature happens to be 50 deg. F., it is evident, since the air can contain 4 grains of water per cubic foot at 50 deg., that the moisture in the air is 70 per cent., that is, 2.80 grains are 70 per cent. of 4 grains, and so on for any other temperature.

One point further should be made clear, namely, there is no necessary relation between the humidity expressed in percentages and the number of grains of water per cubic foot in the air. For example, when the humidity is 70 per cent. and the temperature as above stated is 50 deg., there are 2.80 grains of water per cubic foot in the air. When the humidity is 70 per cent. and the temperature is 70 deg., there are 5.60 grains of moisture per cubic foot in the air; or again, when the humidity is 70 per cent. and the temperature is 80 deg., there are 7.70 grains of water per cubic foot in the air. It will be noted, a little later, that if our experiments are to be trusted, the absolute amount of moisture, that is, grains per cubic foot, has no relation to the efficiency of disinfection by means of formaldehyde. On the other hand, the humidity or percentage of moisture that the air can contain at the temperature has a very important influence on the efficiency of disinfection by means of formaldehyde gas.

Returning now to our experiments. A year ago last winter all the time that could be devoted to this subject was taken up in our bacteriological laboratory with experimental work on this subject. A tight alcohol barrel had the glue soaked out of it, the head taken out and the barrel thoroughly dried. The inside was then coated with paraffine wax, in order to render it impervious to moisture, and the head replaced. The barrel was placed horizontally and an opening made in one of the heads, which was closed by a tight door, and an auger hole (closed with a rubber cork when desired) bored in the head, to enable us to introduce the gas. Along one side of the barrel holes were bored, sufficiently large so that they could be stopped with rubber corks, each cork carrying a half inch or more diameter glass tube, which was closed at the outer end and open at the inner one toward the barrel. This glass tube was divided into two compartments by a little shelf. There were a number of these holes. The object of this glass tube was to carry the test objects which were to be exposed to the action of the gas. The barrel was also fitted with two holes, which were stopped with rubber corks carrying dry and wet bulb thermometers, the wet bulb thermometer being normally removed and a tight cork put in its place, the object of the arrangement being to enable us to determine the amount of moisture in the air. These thermometers read to tenths of a degree, were carefully compared and believed to be fairly accurate. The test objects consisted of the *bacillus coli communis* and *staphylococcus pyogenes aureus*. These test objects were prepared in the proper culture media, and were exposed both on platinum foil and plush, each cork, with its glass tube and shelf arrangement, giving us sufficient space to have both kinds of test objects, both on platinum foil and plush, exposed at one time. In order to dry the air inside the barrel, air which had been passed through chloride of calcium and concentrated oil of vitriol, was sucked through the barrel through proper apertures. We succeeded in getting the moisture out of the air in this way down to a humidity of 18 per cent., the temperature of the room and of course the air in the barrel being from 70 to 90 deg. F. This dry condition of the air being obtained, test objects were introduced into the proper apertures, as above described, and allowed to remain for an hour, until they should come to the condition of dryness which corresponded to the condition of the air in the barrel. Then the proper amount of formaldehyde was introduced by boiling it off from formalin solution, or by the use of para-form decomposed with a little borax water, as will be described later. The amount of formaldehyde gas was varied. In some experiments the amount used was the amount contained in 150 cubic centimeters of 40 per cent. formaldehyde solution per thousand cubic feet of space, but this amount was increased two, three and fourfold in various experiments. The moisture was then measured by means of the dry and wet bulb thermometers, and the gas allowed to act. The test objects were removed at the end of 15 minutes, 30 minutes, 2 hours, 4 hours, 6 hours and 23 hours, and tested for growth. It should be mentioned that the introduction of the formaldehyde always increased the moisture. Also the introduction of the wet bulb thermometer for the time necessary to make the measurements increased the moisture. Both these operations increased the humidity from 15 to 20 per cent., depending on temperatures. It should also be stated that "controls," as they are called, namely, some of the test material which had not been exposed to the gas, was always tested in exactly the same way as that which had been exposed to the gas, to be sure that we were experimenting with live material. It would hardly be possible in a paper of this kind to give the details of all the experiments, as they would occupy too much space. It is perhaps sufficient to say that, although the experiments as above described with dry air were repeated several times, the amount of moisture being always below 45 per cent., we never succeeded in any case in sterilizing test objects as long as the moisture remained at or below that low figure. Even the 23-hour exposure, with the moisture below 45 per cent., in no case ever gave us sterilization.

This point being pretty thoroughly established in our minds, we began to increase the amount of moisture. Depending on the amount that we desired to have present, the moisture was obtained by bubbling air through water, and sucking this air through the barrel, until the desired condition was obtained, or in some cases, in the form of steam from a flask boiled for the purpose, both before the gas was introduced, along with the gas, and after the gas was introduced. The latter procedure, namely, the steam, was employed when we desired to get pretty near to saturation. In this way experiments were made with 50, 55, 60, 70, and so on, per cent. humidity. In brief, our experiments in the alcohol barrel may be summed up as follows: With the moisture in the air below 45 per cent. of the amount that it can contain at the temperature, we never got sterilization, as already stated. With the moisture in the air up to 65 and 70 per cent. and above, we never failed to get sterilization. Between these two points the results were more or less erratic. Sometimes an occasional object would be sterilized, and sometimes none. It should be mentioned that as the amount of moisture increased the time of exposure necessary to produce sterilization seemed to diminish. Indeed, when the moisture in the air approached saturation the test objects withdrawn 15 minutes after the gas was all in, were completely sterile, and this experiment was repeated a number of times.

It will be noted that our experiments do not seem to confirm the idea that dry formaldehyde gas is efficient, but that, on the contrary, certain fairly definite percentages of moisture in the air are essential in order that the gas may do its work. This conclusion, reached over a year ago, was so contrary to what we had been taught that we were quite skeptical of our results, and did not at the time make any use of them, other than to talk the matter over with bacteriologists, whenever we could get a chance. We felt that the matter was of so much importance that hasty conclusions should certainly be avoided, and that it would be desirable to make experiments on a car, or other larger enclosed space, than our alcohol barrel. Accordingly, the matter was held in abeyance until the advent of cold weather again, since in the summer and fall of the year the amount of moisture in the air is quite large, and it is difficult to make a car tight enough to maintain dry or moist air in it, and we were therefore quite dependent on the outside conditions for our condition of moisture. Before, however, leaving the alcohol barrel, we should mention that a piece of plush, corresponding in size to the amount in a passenger car, was introduced into the alcohol barrel, to see what effect this would have on the moisture in the air. It was found to have a very marked effect. Plush being hygroscopic in its nature, with plush present it was necessary to add a good deal more moisture in order to have the proper percentage show on the dry and wet bulb thermometers than was the case with no such hygroscopic substance present. This point will be referred to later.

In our experiments on a passenger car, which have occupied most of the time during the past winter, we had in mind:

First—To demonstrate whether our conclusions in regard to moisture as obtained from the alcohol barrel were correct as applied to a car.

Second—What is the effect of temperature on formaldehyde disinfection?

Third—Whether any other conditions would manifest themselves in the course of our experiments that would have a bearing on the problem.

An ordinary passenger coach was accordingly chosen, the ventilators closed on the outside with hoods of canvas, the doors, windows and deck sash likewise closed, and dry and wet bulb thermometers on a proper stand were set inside one of the doors, where they could be easily read. In the experiments on the passenger car for convenience only the *bacillus coli communis* was used, and test objects, both on plush, on foil and on filter paper, were employed, as before. The test objects were distributed throughout the car, some in the basket racks, some on the window sills, some on the seats, some on the floor and some in the closets. Twenty-four test objects in all were used with each experiment, and the ordinary controls were made as before. The test objects were always put in place and allowed to stand an hour, before the gas was introduced, and then an hour after the gas was introduced, in order to allow it to act. The gas was boiled off from formalin, always adding a little borax to the formalin, as suggested by Novy, it being found under these conditions that high temperature and pressure are not essential in order to decompose para-formaldehyde. Usually on the car the amount used was about 0.40 of a quart for each thousand cubic feet of space in the car. The gas was introduced through the keyhole, in the opposite end of the car from where the dry and wet bulb thermometers were placed.

It will be readily understood that by warming the air in the car it was easy to get low humidity. The temperature outside varied from 20 to 40 deg. F., and as the amount of moisture possible in the air at these temperatures is less than 3 grains per cubic foot, after heating the inside of the car to 80 degrees, which was often done, the percentage of moisture in the air was readily obtained as low as 22, 25 and 28 per cent., and if the temperature was made a little higher even lower figures could be obtained. A number of experiments were made on a car in this way with the air in the car containing moisture below 40 to 45 per cent. In no case did we succeed under these conditions in getting sterilization; in other words, we absolutely confirmed on the car our experiments with the alcohol barrel. In all perhaps six or eight tests were made with low moisture in the air in a car.

On attempting to increase the amount of moisture in the air we ran across very serious difficulties, owing to the diffusion. It will be understood that a car not being perfectly tight, there being crevices around the windows and underneath the doors, and also around the ventilators more or less, the attempt to maintain a high condition of moisture in such a space was found to be more than we could accomplish, especially in view of the hygroscopic nature of the plush and window curtains. Accordingly at this point we took up the question of the influence of temperature. It will be readily understood that if the temperature is ignored it would be easy to maintain almost any percentage of moisture desired in a car. For example, if the temperature outside was 40 deg. F. and the humidity was 70 per cent., it would require only a few grains of water per cubic foot inside the car to bring the moisture up to saturation if desired. Without going into all the details of all the experiments it may perhaps be sufficient to say that the experiments on the car, ignoring temperature and at high moisture, demonstrated two things, if our experiments are to be trusted: First, we never failed to get disinfection with the moisture above 70 per cent. Second, temperature within the limits of our experiments has no perceptible influence on the action of formaldehyde gas. In other words, even at as low as 25 deg. F. we get complete sterilization of the test objects, provided the amount of moisture was sufficiently high.

It may not be amiss to repeat that our experiments on the car seemed to indicate, first, that with low humidity, up to as high as 45 per cent., we did not get disinfection, irrespective of the amount of gas used. With high humidity, 70 per cent. or above, we never failed to get disinfection. Between these two points the results were more or less erratic and variable. Also temperature at least as low as 32 deg. F., and perhaps safely as low as 25 deg. F., does not retard or prevent disinfection by means of formaldehyde gas, provided a sufficient amount of moisture is present in the air.

One or two interesting points developed in the course of our experiments on the car: First, on a windy day the test objects on the side of the car toward the wind sometimes failed to disinfect, even though the amount of moisture and other conditions were what they should be. This is apparently due to the fact that, as has been stated once or twice, a car not being tight there is more or less air movement in the car, and the gas was probably carried away from that side of the car. Second, when experimenting in a doubtful region of humidity, namely, from 40 to 65 per cent. of moisture in the air, on one or two occasions we got sterilization on the floor and seat of the closet, while we did not get it in other parts of the car. This apparently is explained by the fact that the asphalt floor of the closet was considerably colder than the point at which the moisture was measured in the car, which would have the influence of increasing the percentage of moisture in the air, as already explained. Third, some experiments were made on the car to determine how well the formaldehyde gas penetrates such material, as may occur, as for example, dry sputum. These experiments were not quite as satisfactory as we would like, and we do not feel that this point is completely covered. We could not experiment with the sputum of tuberculosis, as the resources of our laboratory do not involve cultures in living animals. Accordingly the cultures we had already experimented with were mixed with healthy sputum, dried down, and then exposed in the regular way. We always got sterilization of these test objects, provided the amount of moisture was sufficient, but the controls were not satisfactory, indicating perhaps that the *bacillus coli communis* does not flourish in a culture medium containing considerable healthy sputum, or that the drying was detrimental. The point, therefore, of the penetration of the gas into dried sputum is not quite satisfactorily settled by our experiments.

This is the place perhaps to mention that thus far we have made no experiments on a Pullman car, with its wealth of upholstery. So far as our experiments, however, have gone we are clearly of the opinion that it will take a very much larger amount of moisture, introduced in some way, in order to get sterilization in a Pullman car than with an ordinary passenger coach, provided, of course, the air does not happen to have the proper amount of moisture in it when the experiment is made.

A few words on how to get the moisture in the air may not be amiss. We tried two different methods; one was by boiling in a large amount of moisture along with the gas or preceding the gas. This method is not to be recommended, we think, as the heat which goes in with the steam raises the temperature of the car and makes the maintenance of the percentage of moisture more difficult, the tendency of the air inside and outside the car to intermingle through the crevices being increased by difference in temperature. The other method consisted in sprinkling the floor. This has the two fold advantage of supplying the moisture required and at the same time lowering the temperature in the car and making it easier to maintain the humidity nearer saturation. It seems fairly probable that possibly spraying through the keyhole for those places into which it is not desirable to enter may be a thoroughly efficient means of getting the moisture, and indeed there are some indications that spraying may be the best means of all of obtaining the moisture in the space to be disinfected.

Another point which should be mentioned is that there may be some difficulties connected with getting rid of the gas after the space has been sterilized. Our usual procedure has been to open the doors and windows and allow the car to ventilate itself, but we have always found that when a car is heated after such a procedure sufficient material remains in the car to cause some difficulty. This difficulty diminishes if the car is heated up to 70 or 80 deg. F. and then ventilated, and then heated up a second time and thoroughly ventilated. A third heating shows very little odor. This procedure we commonly employed between experiments, so as not to have anything carried over from one test to another, but it is obvious that if cars are disinfected in the summer, and do not completely lose the effects of the disinfection before winter, there may be some trouble. The use of ammonia gas to overcome this difficulty did not prove entirely satisfactory. The point remains for further study, with the expectation on our part that two or three times heating up to a pretty high temperature and ventilating between will probably make cars quite satisfactory to use.

It might perhaps be fairly stated that it is the intention to prepare definite instructions in printed form, embodying the results or our studies on the subject, to be used by the employees of the railroad company who do this work of disinfection. This has not yet been done, but will receive attention as soon as possible.

In view of the work that has been done on this subject, which has been summarized above, we are inclined to think we are warranted in trusting the following conclusions:

First—That in order to get efficient disinfection it is essential to have the air of the space to be disinfected contain at least 70 per cent. of the moisture that it can contain at the temperature.

Second—That we are fairly safe in ignoring temperature in the matter of disinfection with formaldehyde down to as low, at least, as 32 deg. F.

Third—That it would be desirable not to attempt to sterilize artificially heated rooms or spaces on account of the difficulty of maintaining the proper amount of moisture in the air.

Fourth—That a hygrodeik or some means of determining the amount of moisture in the air is an essential to every sterilizing outfit.

Fifth—That the necessary moisture can probably, in almost all cases, be satisfactorily obtained by sprinkling the floors. In cases where it is not desirable to enter the space on account of fear of infection the moisture can be sprayed in through the keyhole in the door.

Sixth—Since formalin, the usual commercial form of obtaining the material, is cheap, it is probably better to use an excess than to try to diminish the amount to the smallest figure which will give success, and that it would be desirable to charge the apparatus with not less than 0.40 of a quart of formalin for each thousand cubic feet of space to be disinfected.

Seventh—That if a small amount of borax is added to the formalin solution it is not essential to use high temperatures and pressure in the generator.

Eighth—It is probable that it would be unwise to attempt to disinfect a coach or a room on the windy side of a building when high winds are blowing.

Ninth—That it is probably good practice after the moisture is introduced to allow twenty minutes or half an hour to elapse before the gas is introduced, in order to have the moisture disseminate itself, and that after the gas is introduced, provided sufficient moisture is present, an hour is abundant for the action of the gas. Of course all the windows and doors should then be opened, to give thorough ventilation.

It is simple justice to say that in the planning and carrying out the large number of experiments epitomized above the chances for consultation with and the suggestions of Mr. F. N. Pease, principal assistant chemist of the Pennsylvania Railroad Company, have been of very great value.

THE SUPERINTENDENT OF MOTIVE POWER AND THE STOREKEEPER.

By G. F. Slaughter,

General Storekeeper, Chicago & Northwestern Railway.

It is usually conceded that the store and motive power departments in railway work are closely related. In times of financial prosperity, as at present, this is especially true. Business activity brings added responsibility to both. For instance, at such times locomotives are usually overworked, and material with which to repair them is difficult to procure, though planned for far in advance of actual requirement. Hence there must be hearty co-operation; first, between the superintendent of motive power and the general storekeeper; second, between the master mechanic at the division shop and the local storekeeper.

To achieve the best results, the two departments should be interdependent, though in no sense under one head; for one branch of the service requires mechanical instinct, the other that of the merchant. The mechanical department creates, while the store department supplies the demand.

To be of proper assistance, the storekeeper must possess a fair knowledge of the locomotives on the division where he is employed. Usually there are many classes, and he must know of what these consist. This is not sufficient, and he must seek further information from the detail drawings secured from the mechanical office. Some parts of locomotives last much longer than others, and it is his business to know just what these parts are, to prevent a shortage of that for which there is a demand, or an overstock of useless material; otherwise his motive-power friend will soon discover that he has everything in stock except the particular part desired.

To secure appropriations for shop improvements, such as machinery, etc., the mechanical department is usually required by the management to assume the obligation of cutting down the cost of output. Before attempting to cut it down, however, the cost must be known. For this purpose simple intelligent cost-accounting is required. When, as on some railways, the storekeeper is entrusted with this, he is of far greater value to the mechanical department. He must furnish the cost of all output, impartially, upon its completion, exhibiting the rate of compensation, the time consumed, kind and quantity of material and labor used. Then only can the mechanical department distinguish between labor wisely and unwisely expended, and compare the ability of their men, whether foremen or mechanics. The following examples show how such information may be presented:

Example "A"

Cost of manufacturing ten freight whistles on lot No. 3583, dated March 3, 1902, in M. P. & M. Department. Completed April 21, 1902. Shops, April 22, 1902. No. 1914, M. P. & M. file No. 983.

		$	
5 feet tubing, 33¾ lbs.	at c.		
10 castings No. 910, 35 lbs.	"		
8 feet 1 in. soft steel, 20 lbs.	"		
10 castings No. 764, 9 lbs.	"		
10 rivets, ⅜ x 1¾, ½ in.	"		
10 cotters, ⅛ x 1	"		
10 whistle castings, 239 lbs.	"		
	Exp.	—	—
Labor			
Machine Shop.	Hours. Rate. Total.		
Check 1367 at			
" 1381 "			
" 1376 "			
" 1374 "			
" 1386 "			
" 1366 "			
	Superintendence	—	—
	Total		
Credit			
10 lbs. brass scrap at		—	—
	Total cost	==	=

Remarks.

April cost $....per each.
March cost $.... " "
February cost $.... " "
January cost $.... " "

Approved:

.... Supt. M. P. & M.

.... General Storekeeper.

Example "A" is for the manufacturing of ten locomotive whistles. Aside from the material, with its cost, is shown the labor performed in each shop; also, the men who performed it, identifying them by check numbers. In Example "B," aside from the opening details, you will observe the quantity

Example "B"

Cost of manufacturing 28,533 lbs. engine bearings (solid) on lot No. ...., dated ...., in Brass Foundry Department. During .... March, 1902. No. ....

Quantity.	Items.	Price.	Amount
Pounds	molassea	at c. gal.	
"	flour	" cwt.	
"	sand	" ton	
"	charcoal	" cwt.	
"	egg coal	" ton	
Nos.	crucibles	" Hd. Nos.	
Pounds	copper	" lb.	
"	coke	" ton	
"	tin	" lb.	
		Exp.	
Labor			
Superintendence			
	Total cost		— —

Remarks. March cost.... c. per pound.
February " .... " " "
January " .... " " "
December " .... " " "
November " .... " " "
October " .... " " "

Approved:

....

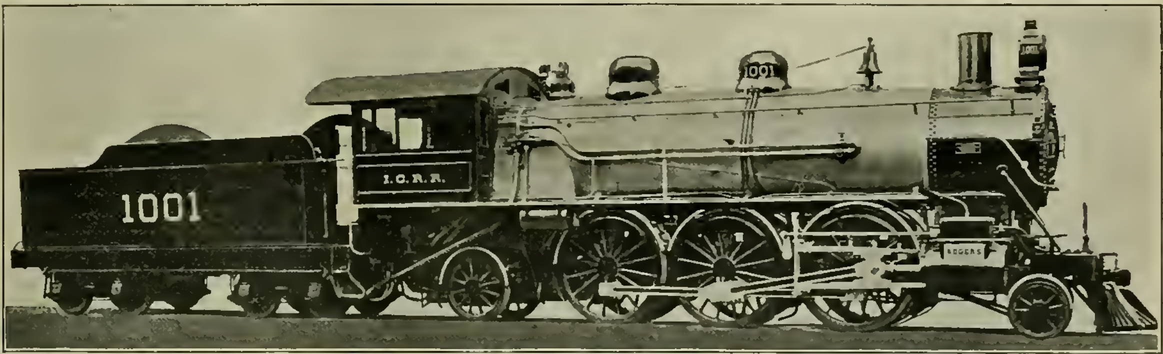
Supt. M. P. & M. General Storekeeper.

PRAIRIE TYPE PASSENGER LOCOMOTIVE.

Illinois Central Railroad.

This handsome prairie type engine is one of a lot of twenty now building for the Illinois Central by the Rogers Locomotive Works.

This road has a large number of ten-wheel passenger engines and is now receiving the Atlantic and prairie type wide-firebox engines for the first time, the intention being to make long time tests of the performances of the three types from which to determine future practice. Among the features of this prairie type engine is a forced lubrication of the driving boxes from the cab through pipes which appear in the engraving. The trailing truck has a pair of yokes for each box, and from these yokes the load is applied to the boxes through initial stability links or "three-point" hangers. In the following table the chief characteristics of the engine are summarized:



Prairie Type Passenger Locomotive—Illinois Central Railroad.

WM. RENSHAW, *Superintendent Machinery.* ROGERS LOCOMOTIVE WORKS, *Builders.*

and kind of material used; finally, the division of labor and the finished product, with the usual charge for superintendence; giving the total cost compared to that of previous months.

To the inquiring mind such statements suggest improved methods and, where practicable, the substitution of cheaper materials, and often less expensive labor. A catalogue of locomotive castings, alphabetically arranged, and containing a numerical index of the patterns, affords a ready reference for the store and motive power departments. Such a book is of inestimable value, difficult to compile at the start, but hard to dispense with after once inaugurated.

Now, to enable the storekeeper to provide material for repairs in due season, the mechanical department must keep him advised as far in advance as possible as to just what classes of locomotives are expected to be shopped, and the nature of their repairs. For example, a certain locomotive will need a pair of cylinders, another a firebox, while a third will need general repairs. The material for such repairs must be on hand far enough in advance to complete all necessary machine work with as little delay as possible after the locomotives enter the repair shop. A locomotive unemployed represents idle capital.

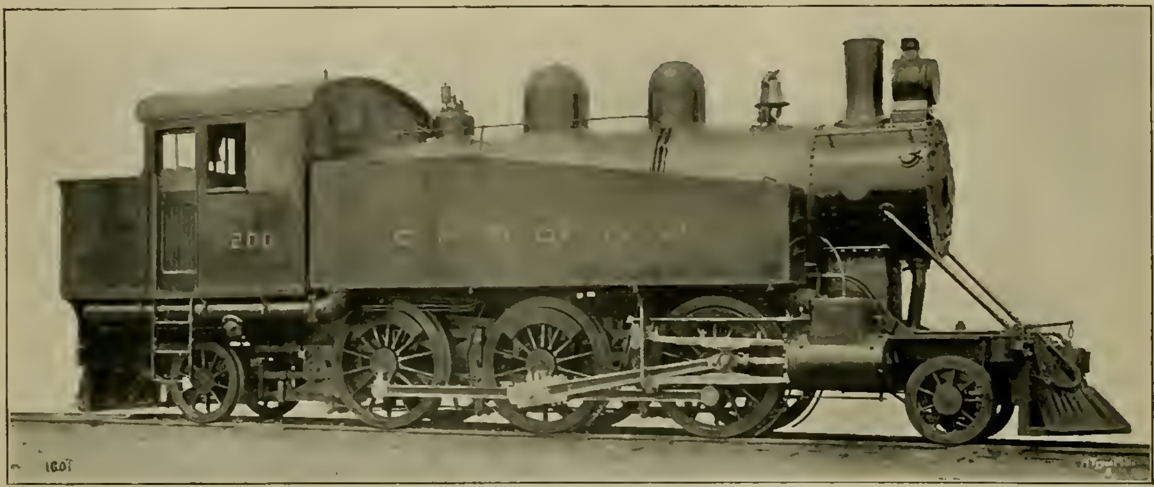
To obtain material and finish without delay the many items essential to a locomotive requires forethought, constant effort, and eternal vigilance in both departments. While we rely on human agencies errors will occur, both excusable and inexcusable; but even errors are not without good, since the alert, profiting by past experience, rarely make the same mistake twice.

The J. S. Toppan Company, 77 Jackson boulevard, Chicago, has brought out a new car seal, which seems to be an excellent device. It is made of a single piece of tin, and is applied without tools of any kind.

Gauge	4 ft. 8½ ins.
Cylinders	20 x 28 ins.
Driving wheels, diameter	75 ins.
Driving wheel base	13 ft. 6 ins.
Total wheel base of engine	30 ft. 9 ins.
Weight on drivers	144,000 lbs.
Weight on truck	22,000 lbs.
Weight on trailers	37,000 lbs.
Weight, total	203,000 lbs.
Boiler, diameter	68 ins.
Heating surface, tubes	3,333 sq. ft.
Heating surface, firebox	201 sq. ft.
Heating surface, total	3,534 sq ft.
Grate area	51 sq. ft.
Boiler pressure	200 lbs.
Tubes	335
Tubes, size outside	2 ins.
Tubes, length	19 ft.
Firebox, length	102 ins.
Firebox, width	72 ins.
Driving axle journals	9½ x 12 ins.
Engine truck wheels	33 ins.
Trailing wheels, diameter	48 ins.
Tender, water capacity	7,000 gals.
Tender, coal capacity	15 tons
Tender journals	5½ x 10 ins.

The Bentel & Margedant Company, of Hamilton, O., manufacturers of woodworking machinery, have issued a handsome catalogue of 250 pages, 9 x 12 inches in size, devoted to illustrations of their product. It is bound in cloth and is a thoroughly admirable catalogue. Heavy book enamel paper contributes to bringing the engravings out well.

The "Pocket List" has won its suit and the Supreme Court of the District of Columbia has decided the injunction case in favor of that publication, allowing it to continue its distribution through the mails at the rate for second-class mail matter. This is the first injunction case brought to determine the power of the postmaster general to charge the higher rate under the new departmental regulation. It is an important victory.



Six-Coupled Suburban Locomotive—Central Railroad of New Jersey.

WM. MCINTOSH, *Superintendent of Motive Power.* BALDWIN LOCOMOTIVE WORKS, *Builders.*

SIX-COUPLED SUBURBAN LOCOMOTIVE.

Central Railroad of New Jersey.

A suburban locomotive, with the prairie type of wheel arrangement, has just been built by the Baldwin Locomotive Works for the Central Railroad of New Jersey to suit the conditions of suburban traffic on that road. This is another instance indicating the necessity for special engines for work requiring high accelerating power, which is one of the conditions making suburban schedules particularly severe. More of this type will be built if the results of experience are satisfactory.

This engine is much lighter than that of the New York Central, illustrated in April, page 114. It has side tanks, which are filled through pipes from the rear, and the weight is carried on 10 wheels instead of 14, as in the case of the New York Central engine. The following table gives a summary of the principal characteristics of the design:

SIX-COUPLED SUBURBAN LOCOMOTIVE,

CENTRAL RAILROAD OF NEW JERSEY.

Number to be built	10
Gauge	4 ft. 8½ ins.
Cylinders	18 x 26 ins.
Valves	Balanced, slide
Boiler, type	Straight
Boiler, diameter	60 ins.
Boiler, pressure	200 lbs.
Fuel	Hard coal
Staying	Radial
Firebox, length	109 ins.
Firebox, width	72 ins.
Firebox, depth, front	55¼ ins.
Firebox, depth, back	44¾ ins.
Firebox, sheets	⅜ in.
Tube sheets	½ in.
Boiler sheets	⅝ in.
Water spaces	Front 3½ ins., others 3 ins.
Tubes, number	249
Tubes, size	2 ins.
Tubes, length	13 ft.
Heating surface, firebox	137.4 sq. ft.
Heating surface, tubes	1,684 sq. ft.
Heating surface, total	1,821.4 sq. ft.
Grate area	54.5 sq. ft
Driving wheels, diameter	63 ins.
Driving journals	8½ x 12 ins.
Truck wheels, front	36 ins.
Truck journals, front	7 x 12 ins.
Trailer wheels	42 ins.
Trailer journals	7 x 12 ins.
Wheel base, driving	14 ft.
Wheel base, total	31 ft. 8 ins.
Weight on drivers (estimated with half supply of water and coal)	108,000 lbs.
Weight, total (estimated with half supply of water and coal)	165,000 lbs.
Tanks, capacity for water	3,000 gals.
Tractive power	22,700 lbs.

The Pittsburg Blue Print Company, Park Building, Pittsburgh, Pa., have received orders aggregating 50,000 yards of "Rapid" printing blue print paper during the month of May.

The Handy Car Equipment Company, Old Colony Building, Chicago, has taken over the sale of the American Dust Guard, manufactured and formerly sold by the American Dust Guard Company, of Columbus, Ohio.

The Boston Belting Company, Boston, Mass., are now prepared to weave their "Universal" cotton jacket over any kind of rubber hose. The cotton jacket consists of a heavy seamless fabric which they weave directly over the rubber hose, thus greatly increasing its strength and wearing qualities. It is claimed that it will not unwind if a single strand is cut, that it prevents kinking of the hose, and when painted it is waterproof.

Mr. J. W. Duntley, president of the Chicago Pneumatic Tool Company, has just returned from a trip through Europe. While there he secured orders for an aggregate of 2,700 "Boyer" and "Little Giant" pneumatic tools, as well as for 25 "Franklin" air compressors, for early delivery. Mr. Duntley states that Europeans now realize the absolute necessity of using labor-saving tools to reduce the cost of manufacture and counteract the influence of the "American invasion" (which is causing widespread alarm in commercial circles) and enable them to compete for the markets of the world. The remarkable increase in the sales of pneumatic tools in foreign countries recently may be attributed, in a measure, to the cause above mentioned and also to the fact that the opposition to pneumatic tools by workmen, on account of their labor-saving qualities, has been overcome.

The Ajax Metal Company, Philadelphia, Pa., announce that they have recently acquired additional ground adjoining their present plant and will erect a building, 100 x 175 feet, for the refining of all kinds of brass scrap, under patents granted their Mr. G. H. Clamer for a process of eliminating zinc, iron, manganese, aluminum and other impurities. They will be in position also to work the ores, such as copper matte and galena, direct from the mines. They expect, under these patents, to be able to produce a metal for bearings which will cost considerably less than the market prices ruling to-day. It was the manufacture of Ajax plastic bronze that led Mr. Clamer to recognize the feasibility of his process for eliminating all impurities from metals. It is expected that the additional plant will be ready for operation in September.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

JULY, 1902.

CONTENTS.

MASTER CAR BUILDERS' ASSOCIATION.

THIRTY-SIXTH ANNUAL CONVENTION.

Saratoga, N. Y., June, 1902.

The convention was called to order at 10 A. M., June 18, at Saratoga Springs, by President J. J. Hennessey, the attendance being unusually large. After the opening prayer by the Rev. H. M. Gesner, the Hon. Adelbert P. Knapp, president of the village, welcomed the association for the ninth convention at Saratoga. Mr. A. M. Waitt responded in his usual happy manner. The address of President Hennessey was an admirable statement of the purposes and objects of the association, the interchange rules being given the highest place in his estimate of its work. But 19 disputes had been submitted to the Arbitration Committee during the year, this being an excellent exhibit of the smooth operation of the rules. Construction, repairs and especially uniformity in construction constituted the most important field for the immediate future. Progress should be the rule. A closer adherence to the established standards was urged upon the members. Attention was directed to the necessity for considering the increasing rigor of service in the construction of cars throughout. The increase of capacity had been accompanied by greater demands for strength throughout. The address was thoughtful and suggestive. It did not include a review of past history or prophesy for the future, but constituted a concise presentation of the work in hand. It was an admirable, practical appeal for good, effective work, and was well received.

The report of the secretary showed the total membership at present to be as follows: Active, 275; representative, 190; associate, 8, and life, 18; a total of 491. The number of cars represented had increased to 1,630,016, an increase of 124,394 during the year. The funds on hand, in the treasury, amounted to $9,165.85, all bills being paid. The dues were reduced from $4 to $3 per vote per year, because of the large amount of money in the treasury.

Under the head of new business proposed changes in the constitution were considered. These related to the admission of honorary members, the names of candidates to come before the Executive Committee. A suggestion of a change in the constitution was offered, to extend the eligibility of active membership to mechanical engineers. This will be acted upon next year. A committee was appointed to consider the suggestions made by the president in his address.

Report of Committee on Standards.

But two changes in standards were proposed. The first was to strengthen the wedge-stop lugs on the outer end of the box for 5 x 9-in. journals, and the second provided for stenciling letters "A" and "B" on the ends of cars to indicate the end which carries the brake staff, for convenience of inspectors.

A number of changes in recommended practice were brought up in the report, all of which were adopted.

Topical Discussions.

"Advisability of Using Metal Center Sills in Wooden Car Construction."—Opened by R. P. C. Sanderson.

The speaker considered it a mistake to use a combination of steel and wood in underframes. Deflection, as well as carrying capacity, must be considered. Steel sills will deflect under their share of the load, and wooden sills, even if cambered, will give way, while the steel sills must take more than their share of the load, leading to breakage of the steel. He preferred entire steel underframes. The steel bolster was not objectionable, as it is a whole unit by itself, but steel and iron mixed brought up the question of uniform deflection, which could not exist with this construction. Mr. Streicher supported this view, citing the case of the sandwich bolster, in which shrinkage as well as deflection had given serious trouble. There was no question between steel and wood. Great strength was needed to meet the stresses of impact, and the implication was that entire underframes should be of steel. Mr. L. T. Canfield agreed with the previous speakers. A steel construction was needed to withstand buffing stresses. If steel is added to wooden underframes it should be placed below the wooden sills to take care of the draft gear stresses. Mr. Sanderson believed that a strong steel column should be provided to take the buffing shocks, which were far greater and more destructive than the pulling stresses. Enough metal should be provided to take advantage of the backbone of the car necessarily provided for vertical stresses to also carry the others. Mr. J. E. Simons was opposed to any combination of wood and steel. Moisture and decay were sure to occur at the contact surfaces. Bolting was sure to wear loose in the wood, subjecting the metal to undue stress. The time had come for all steel underframes. Mr. Hayward thought that the rapid extension of the use of steel cars meant that the time for combination of steel and wood was past.

"Meters for Stopping Leaks in Car Work Expenses."—Opened by G. W. Rhodes.

Municipal water service was used as an illustration of the wastes of water which had led to the use of meters to stop the unnecessary consumption. Railroad supplies were not metered. Headlights were left lighted unnecessarily because there was no check upon it. Pintsch gas was often left lighted when not needed. Better accounts would reveal these leaks. In freight car lubrication reductions of from 12 to 4 cents per 1,000 miles had been proved to be possible on a road of 4,000 miles, when accounts were kept, and a saving of $8,000 per year effected. The association was urged to watch these meters of consumption. This was evidently a suggestive subject to many members. Mr. Sanderson recommended the recording of statistics in the form of diagrams, which, by the slope of the line, would indicate the tendency of the figures. A busy man could see at a glance whether the line sloped upward or downward without studying long tables of figures. The discussion was lively, and it brought out not only a marked interest in improvements, but a general testimony of efforts to meet commercial practice. This was revealed after a criticism by Professor Hibbard to the effect that railroad shops were generally far behind contract establishments in methods and facilities for shop work, railroad machinery being usually driven not above one-fourth of its capacity. Mr. T. H. Symington considered competent foremen as the best meters. Good mechanical meters cannot be had except for good prices. This applied equally well to the human meters.

Report of Committee on Triple Valve Tests.

Before taking up this subject Mr. W. E. Sharp directed attention to the effect of using triple valves in repairs which did not correspond to the leverages of the brake gear, and suggested that the rules should provide for the use of triples which would give the proper braking capacity. Triples should be replaced by those of the same make.

No triples had been submitted to the committee for test during the year.

In answer to a question, Mr. R. D. Smith stated that the Burlington & Missouri River had experimented with a triple valve (the Hibbard) which was constructed so as to provide different braking power for loaded and empty cars. Seven of these valves were tried and the results were sufficiently satisfactory to justify ordering 30 more. From the verbal report of the committee and the discussion it was evident that an adjustment of braking power between loaded and empty cars is needed, because of the great weight of large capacity cars and their loads. Mr. Herr, representing the Westinghouse Air Brake Company, was called on, and stated that that company was working on the problem of varying braking power and the improvement of methods of braking trains on long mountain grades, and would be ready with the devices when they are needed.

Laboratory Tests of Brake Shoes.

This report contained a recommendation of a series of road tests of brake shoes to check the results of the laboratory tests by actual service. The subject was referred to the Executive Committee for action.

Tests of M. C. B. Couplers.

This committee had been hampered in its work because of the use of the Altoona testing machine for the Draft Gear Committee.

In discussing necessary improvements in couplers the committee believed it wise to consider abandoning the link pin holes in the near future, as soon as satisfactory devices are secured for handling cars around short curves. As a result of tests made on the dimensions suggested last year, the committee realized that stronger lugs and greater strength through the pin hole were necessary. This involved modifications of contour which could be made very gradually.

To sum up, the committee believed that a head 11 ins. or 12 ins. deep, with a 9-in. or 10-in. face for a solid knuckle, the contour of which should be changed to admit the use of a 1¾-in. pin, would meet all the requirements of the heaviest service, but another year's experience with these heavier types is necessary before any definite recommendations can be given.

The construction of a testing machine for couplers and axles for the association at Purdue University was recommended, the university having offered facilities for its erection and maintenance.

This report reflected the opinion generally expressed throughout the convention, that it was necessary to provide in every possible way for the rough handling resulting from the increased weight of cars and trains. The Baltimore & Ohio, according to Mr. Stark, had for two years used knuckles without the link slot, and thus far had not found difficulties at all commensurable with the increased life of the knuckles. The committee had virtually recommended discarding the slot. Mr. Appleyard, of the committee, believed that the time had arrived to discontinue its use, as 29½ per cent. of the breakages were due to this slot and the pin hole. Mr. Waitt wished to see these omitted from the standard drawings, and made a motion with a view of leading to the purchase of knuckles without the slot and pin hole for trial during the year, the subject to be brought up as a change of standard next year if the experience is satisfactory. Carried. Mr. Waitt moved the acceptance of the offer of Purdue University with reference to testing machine. Carried.

At this point the convention was addressed by Chairman E. A. Moseley, of the Interstate Commerce Commission, his remarks being chiefly concerned with the pending bill with reference to safety appliances. If the location of hand holds and grab irons were transferred from recommended practice to the standard of the M. C. B. Association no legislation would be necessary. As a result of the safety appliance law the fatal accidents in coupling cars had been reduced one-quarter between the years 1893 and 1901, while the number of men employed was increased 12,000 during that time.

Cleaning Triple Valves.

In discussing this report Mr. F. M. Nellis, representing the Air Brakemen's Association, was called upon and offered valuable suggestions from the standpoint of the air brake inspectors. This led to the appointment of a committee to consider the suggestions in connection with the report for consideration at a later session. This was a rather unusual proceeding, but the plan was generally approved.

Interchange Rules.

This part of the proceedings was dispatched quickly and smoothly, considering the difficulties. The systematic method of securing suggestions from the railroad clubs, referring these to the Arbitration Committee and then to the association, is admirable and effective. There were no radical changes, except those made necessary by the recent adoption of the per diem system.

Maintenance of Steel Cars.

There was no printed report of this committee. Mr. Lewis stated the reason to be that experience with steel cars did not yet supply the information necessary for a report. There are about 70,000 cars in service, or one-tenth of 1 per cent. of the total car equipment in service, not enough to require provision of systematic methods for repairs. Prior to 1898 we had no steel cars to speak of. In 1897 the principal steel car manufacturer, the Schoen Company, turned out 501 cars. In 1898 they built 2,931; in 1899, 9,624; in 1900, 16,671, and in 1901, 24,590. The total number by this concern and its successor, the Pressed Steel Car Company, up to June 1 of this year, was 63,872 cars. No new tools or facilities or skilled labor had been found necessary. The time will come, however, when special facilities will be required. Mr. Stark (B. & O.) spoke of experience in repairs to 12,000 steel cars. Men worked in gangs of four and the work was specially favorable to piece work, which will soon be introduced. Mr. McIntosh said that among 1,000 steel cars on the Central Railroad of New Jersey, thus far the necessity for repairs was limited to wrecks, but the time would come when special shop facilities, with cranes, would be required.

Standard Axles.

Mr. Nelson considered the drop test the most important factor in the testing of axles. With reference to deflection under the drop he was led to believe stiffness in axles a desirable feature. Segregation in axles is guarded against by cutting off about 25 per cent. of the top of the ingots. Out of 65,000 axles made to the Pennsylvania specifications only two broke under test. It is understood that one axle is selected to represent 100 axles in the test. This report was submitted to letter ballot.

Draft Gear.

Mr. Quereau doubted the value of drop tests in comparing draft gear. The committee stated in their report that the yoke rivets were sheared in the tests because of the light weight striking at higher velocity. The drop weight did not at all represent the action of cars coming together. A drop weight of 1,640 lbs. dropping, as in the test of 30 ft., was moving at about 30 miles per hour. A car of 20 times this weight acted differently on draft gear. Friction gears were designed for cars. They operated best when allowed appreciable time to act, as in trains. The speaker also called attention to the effect of the preliminary spring in the friction gears. The recoil of these tests was really only a measure of the action of the preliminary spring. The recoil was very different in service with cars. These matters had not been mentioned by the committee. Mr. Chamberlain disavowed the intention of criticising the committee, but virtually discredited the report because so little information was given as to the construction of the gears tested, and no assurance, except in a single case, that of the Miner, that the construction was such as is usually furnished for service. The applause indicated that he was supported by the members. Mr. Sanderson defended the drop test, on the basis of its satisfactory use in connection with axles. Mr. Quereau agreed that the drop test might be very satisfactory in comparing materials and construction, but too much importance could be given to these tests in drawing conclusions requiring comparisons. Mr. Waitt commended the work of the committee, which had brought the subject forward, as a beginning of improvement. This led to a motion to continue the committee and commend their work.

Side Bearings and Center Plates.

This committee wished the report to be considered as one of progress, and suggested continuing the subject for definite recommendation next year. This was provided for.

Cast Iron Wheels.

Mr. G. L. Fowler had recently inquired into the reported difficulties with breakage of cast iron wheels. He found that there was little trouble on level roads. Cracks lengthwise of the tread had occurred frequently, and this was overcome by increasing the thickness of the metal. Recently a new form of transverse cracks had appeared. By experiment these cracks had been produced by the thermal test, which would seem to indicate that they occur in service as a result of the heating by the brakes. The speaker believed that cast iron wheels had now developed, in both design and material, to such a point as to lead to complete confidence in them for use under heavy cars. The committee was continued.

Outside Dimensions of Box Cars.

Mr. Appleyard presented this report. Mr. Quereau commented upon the importance of co-operation in connection with such important improvements as the standard car. This association had now an opportunity to carry out a great work in connection with, and under the direction of, the American Railway Association. He directed attention to the fact that the report omitted recommendations with reference to the outside length of the car. The committee had demurred with reference to the size of the door opening. Mr. Quereau clearly brought before the association the facts that the width of the door is established and that the association is expected to provide for the standard size of the door and to establish the outside length. Mr. Waitt showed that it had taken ten years to establish the standard inside dimensions. It was wise to accept the report as one of progress and take up the work more completely, rather than to take hasty action now. The committee was continued.

The Committee on Standard Pipe Unions was continued.

A verbal report of the Committee on the Revision of the Car Builders' Dictionary was made, and the members were urged to co-operate with the *Railroad Gazette*, the publishers, in this work.

Mr. Canfield presented, as a topical subject, a comprehensive and interesting review of the state of the art in car lighting. He compared the costs of the various systems, and we shall print an abstract of his paper. This being an important subject it will be reported upon by a committee next year.

The election of officers resulted as follows: President, J. W. Marden; vice-presidents, F. W. Brazier, W. P. Appleyard, Joseph Buker; treasurer, John Kirby; secretary, J. W. Taylor; executive members, L. T. Canfield, H. F. Ball and S. F. Prince.

Adjourned.

MASTER MECHANICS' ASSOCIATION.

THIRTY-FIFTH ANNUAL CONVENTION.

The convention was called to order by President Waitt and opened with prayer by the Rev. T. F. Chambers, which was followed by an address of welcome by Mr. Knapp, president of the village of Saratoga. President Waitt's address was one of the ablest, most comprehensive and suggestive of possibilities of improvement of the motive power department that has ever been delivered before the association. He said in part:

"The past year has been one of uninterrupted progress and prosperity in all lines of business, so much so that the railroads of the country have been taxed to their utmost capacity to care for the enormously increased traffic, and our newspapers have been continually compelled to chronicle a car and motive power famine.

"Statistics compiled for the year 1901 showed the total output of the eight principal locomotive building plants of this country as 3,384. This was the largest output on record, and is 7 3-10 per cent. more than in 1900. For the year ending June 1, 1902, the record of locomotive building has exceeded even the year 1901. The reports of five locomotive manufacturing companies indicate an output of 3,638, which is a total result beyond what has ever before been reached. Of the locomotives about 540 were for passenger service, 2,380 for freight service, and the balance for switching and miscellaneous uses. Eighty per cent. were for use of bituminous coal; 10 per cent. for anthracite, and the balance, 10 per cent., for oil or other fuels. Of the bituminous coal burning standard gauge engines, about 50 per cent. were constructed with so-called wide fireboxes, extending beyond the outside of frames. During the past year about 30 per cent. of the total of passenger and freight engines built by the two largest locomotive manufacturing companies were of the compound type. The heaviest engine built during the past year weighed, not including the tender, 267,800 lbs., 237,800 lbs. of which were on the driving wheels. This was a locomotive of the decapod type, built for heavy service on the Atchison, Topeka & Santa Fe Railway.

"The past five years have shown a wonderful development in the main features of locomotive design and construction. No longer ago than 1897, passenger engines with 2,200 ft. of heating surface, and freight engines with 2,900 ft., were spoken of as marvels of progress, and comment was made at that time of the fact that boiler pressures were being raised to above 150 lbs., and might possibly reach 180 lbs. on simple locomotives. The past year engines have been constructed for passenger service with over 3,500 ft. of heating surface, and freight engines with 5,390 ft. Most of the simple engines constructed carry 200 lbs. pressure, and some have been designed for 225 lbs. At the present time it seems to be a conceded fact that with 200 lbs. pressure the economical limit for simple engines has been reached, and that for higher pressure the compounding feature is necessary for economy in fuel consumption.

"During the past two years the limitations of the two-cylinder compound engine have been reached and passed. The required dimensions for the low pressure cylinders for two-cylinder type on the heavy engines of recent construction exceed the possible clearance limits for side tracks and switch stands, and the space between the necessary location of the center of cylinder and top of rail. In the present state of the art two alternatives seemed to be presented, namely, the tandem or the four-cylinder compounds, both of which types have enthusiastic adherents and ardent opponents.

"All efforts of the executive officers of our railroads have the object in view of increasing the difference between the cost of operation and the revenue received for handling traffic. To my mind there are several lines of action for advantageous consideration in which the motive power department officials can materially assist in bringing about a decrease in operating expenses and an increase in efficiency of operation.

"Prominent among these I would name 'System and Organization' in department work. The past two or three years has done much toward bringing many lines having independent organizations into more close business relations than heretofore. This has been brought about by consolidations, leasing, purchase, or as a result of the merging or a 'community of intrests.' The result of such moves is to bring about a more uniform general policy; to give better service to the public; to standardize methods and equipment, and to reduce friction.

"In many cases this has given to executive and operating officers a more extensive jurisdiction and larger duties, and has imposed burdens upon them that call for the establishing of a carefully worked out system and thorough organization for conducting the business delegated to them, if the desired results are to be obtained. Success, in small matters, may be possible without the necessity for inaugurating system, as in such matters an officer may be able to divide his time and presence so as to come in personal contact with much of the detail, but in large affairs, embracing much territory and many men, an executive officer cannot go much into detail, or be in frequent personal contact with but few points.

"In handling large business propositions the executive officer must, in order to be successful, inaugurate a thorough system, and he must gather about him an organization of efficient helpers. These subordinates must be of such a character that they can each be relied upon to carry out the part of the systematized work delegated to them, and present to their chief in command such summaries of results as will keep him thoroughly posted as to the work accomplished. These reports should be of such a character as to enable the chief to quickly locate weak points in either the system or the organized force for carrying out the system, so that such weak points can be strengthened by personal contact. Scattered efforts are most often futile. Concentration is needed for success in large matters.

"Any system, to be successful, must clearly define duties and the measure of responsibility, so that if a failure occurs there will be no doubt as to who is to be looked to for an explanation, and who is responsible. Lack of a good system, or absence of a reliable organization, cause many executive officers to carry burdens and worries which could be readily avoided. Better results could be more rapidly obtained with the expenditure of a little more money for efficient subordinates, enabling the chief to take more time for planning and systematizing the work, and less for the detail that could be done just as readily by assistants.

"In 'Good Shop Practice and Methods' is another source of money saving for railroads. There should be a sufficient number of foremen to properly supervise the quantity and quality of work. The average grade of mechanics, in many of our railroad shops, is considerably below the standard in general manufacturing lines. Although the work is generally more steady and continuous the year round, yet on account of the average pay being less it is found that at certain times of the year, manufacturing shops, outside, can hold out better temporary inducements, and the men are willing to take chances of being able to return to the railroad shops when the outside business is dull. It is almost always the better class of men that leave. As a result of the poor average grade of mechanics, much work is spoiled or poorly fitted, requiring more work in setting up, and giving poor results in service. Much poor work from poor mechanics has to go to the scrap pile. Some way of inducing the better grade of mechanics to seek railroad shop service, and to remain in such service, is desirable. It is noticeable that in shops using the piecework system, if it has been introduced in a fair and liberal spirit, the best grade of men remain in service, and the poorer ones leave voluntarily. Piecework is a boon alike to the shop superintendent and to the good mechanic, as it gives the mechanic a much higher net pay per month, and relieves the foreman from having to rush the men in order to get the proper quantity of work turned out.

"In introducing piecework it must be done with absolute fairness, and in a manner to show the mechanic that if he maintains a fair output, he is guaranteed the equivalent of his day rate of pay, and is given the privilege of greatly increasing his wages by means of an increased output, and will not be curtailed because he puts in unusual efforts, and draws high monthly pay. A piecework basis should be made clearly advantageous to the mechanic, while retaining part of the benefit for the company. A price should be carefully established, and it should be understood that when it is established it will stand for three, or, better, six months, before revision, unless some material change is made in the tools or facilities for getting out the work. In revisions of prices an equal division may properly be made between the mechanic and the company.

"Above all, straightforwardness and fairness, by all concerned, is necessary to success in introducing a piecework system, or any new system affecting relations between the employer and employees.

"Much can be done in reducing loss in operation by furnishing good, modern tools, and keeping them in good condition. Experiments with higher grades of tool steel will, in many shops, enable the speed of running the machines to be doubled, or greatly increased, thereby giving much larger output. Greatly improved results can be obtained by giving attention to proper grinding of tools, and proper setting in the tool post.

"Care in the selection and purchasing of good material, under carefully prepared specifications, will reduce to a minimum the loss from poor material, and will increase the wear of the parts made.

"As has been frequently stated, the cost of coal consumption is the largest single item of expense that the motive power department has to deal with. In order to handle this question to the best advantage, it is necessary to make a careful study of the production and treatment of the coal in detail from the mine to the tender. On many large systems the work of an A1 man, as a specialist, devoting his time to a study of the quality of coal and its handling, would, without doubt, effect a saving of from 5 to 10 per cent.

"It is a known fact that the size of locomotives of recent design is such that the limit has almost been reached for the capacity of a single fireman to properly fire the engines. If any further increase in the size of the firebox is contemplated, it may be necessary to install an automatic method of stoking. In many of the engines put in service during the last three years an automatic stoker would, undoubtedly, be the means of considerable economies in the burning of coal.

"In 1896 a committee from this association made a report on front end arrangements for locomotives, which has been taken by many of the railroads as a standard for practice for a number of years. The development of the enormous proportions of engines to-day has so changed the conditions of operation that it is evident, from experiments made by some of the prominent members of the association, that the old rules of practice are not applicable to present conditions. The management of the American Engineer and Railroad Journal, seeing that such a condition existed, and that it did not seem feasible at the time for this association to enter into a somewhat expensive series of locomotive tests, have at their own expense and risk arranged for a careful series of tests being made at Purdue University, to determine for modern front end practice what the fundamental governing rules for draft appliances should be to enable the best and most economical results to be obtained. I desire to commend this work to this association, and bespeak their hearty co-operation, and the financial co-operation of the roads which are represented here."

The report of the secretary showed a total membership of 712, with an increase of 21 active members during the past year. The treasurer's report showed a balance of $2,784 in the treasury.

COMMITTEE REPORTS.

Ton Mile Statistics.

The object of this report was to suggest methods of reporting ton mile statistics and recommend them to the American Railway Association and the American Railway Acounting Officers, the time being ripe for reforming statistics on the rational basis of the ton mile. There was thought to be no opposition to this basis, the question being to fix the method. The report covered only general principles and recommended a series of resolutions, printed elsewhere in this issue. These resolutions were adopted unanimously with too little discussion, and they will be brought before the American Railway Association. The committee was continued to report on details of statistics.

Cost of Running Trains at High Speeds.

Professor Goss said: "It seems to me that if the consideration of this question be narrowed to the locomotive and made simply one of determining how much fuel is required to do work at different speeds, that we are reasonably safe in depending on the results presented by Mr. Delano in the report of last year, which are confirmed by those presented this year by Mr. McIntosh. Assuming the locomotive to be well adapted to the service required of it, if we base comparisons upon time, we shall find that the increase of power, and consequently the increase of fuel, is practically proportional to increase of speed. If we base comparisons upon distance traversed we shall find that the coal required is practically the same for high speed as for low speed; this statement applying within such limits of speed as are now common."

Electric Driving for Shops.

(A paper by C. A. Seley, mechanical engineer, C., R. I. & P. Ry.)

This paper described the application of electricity to the shops of the Norfolk & Western at Roanoke. It is an old shop, recently extended, and the problem was therefore a special one. The author did not favor individual driving in the average railroad shop. Mr. Fowler brought up the question of the economy of the electric drive, which was but a small factor in comparison with the convenience and flexibility of electric driving. In one shop referred to the saving in labor was six times that obtained by the electric drive itself. Mr. Wright (Pittsburgh & Lake Erie) stated that in the new shops at McKees Rocks individual driving was adopted because of the advantage of better speed control. The steps on cone pulleys gave too large changes in speed. With direct driven machines and a wide variation of speeds the adjustment can be made accurately, as well as easily. This would permit also a saving of power. Mr. Seley favored direct current. Mr. T. R. Brown, works manager of the Westinghouse Air Brake Company, briefly described the alternating current system used in that plant. The operation and reliability of these motors had been most satisfactory. Mr. L. R. Pomeroy (General Electric Company) contrasted the problems of a change in an old shop and the equipment of a new one. In an old shop there must naturally be as few changes as possible, the shafting being already in place. He believed that even in the case cited in the paper individual motors would gradually be introduced because of their convenience. He also spoke of the effect of the individual method on the construction of buildings. Without shafting a lighter roof sufficed. He brought out the effect of the power factor on the capacity of generators. Mr. Van Alstine thought there was a lack of definite information concerning the cost of operation of various systems, and suggested the appointment of a committee to present the subject next year. Mr. McIntosh spoke of the new shops of the Central Railroad of New Jersey, where both individual and group driving is employed. Individual driving was a great convenience. Machine builders had yet much to learn with reference to the attachment of motors to machines. Mr. Seley showed that each plant and its conditions must be studied by itself for the best application of electricity. Convenience of transmission of material and parts far overshadowed the small saving made possible by motors. Small tools, he thought, could best be grouped and large tools individually driven by relatively large motors. At Roanoke the standard motor was one of 20 h.p. He had found a lack of information concerning the power required to drive various tools and believed in using a test motor under such conditions as were described in the paper. The discussion was disappointing and was evidently not prepared for in advance.

Topical Discussion.

"Is the Master Mechanics' Association Standard Front End Arrangement Best Adapted to the Modern Locomotive Having Wide Firebox, Increased Length of Flues and Larger Grate Area."—Opened by Mr. John Player.

The speaker called attention to the general use of the Master Mechanics' arrangement. He had found it advisable in large engines to increase the usual distance between the flue sheet and exhaust pipe. The adjustable diaphragm plate gave best results when placed back of the exhaust pipe. The Bell front end was strongly commended as better than the one already referred to.

Professor Goss stated that he thought that changes made back of the front end would probably not affect the arrangement of the front end itself. He directed attention to the diaphragm plate as an obstruction to the draft and raised the question whether it cannot be omitted, as is done in foreign practice. This subject was mentioned in his report on the American Engineer Tests, on page 134 of our May issue. Mr. Quereau believed that the coming front end arrangement would not include a diaphragm, but data not now available would be needed in order to accomplish this.

Mr. Player desired to see a committee appointed to further investigate the proper dimensions for a standard front end, and this led Mr. Quereau to direct attention to the American Engineer Tests, which had been already referred to by President Waitt in his address, and to offer a resolution authorizing the Executive Committee of the association to assist in the work. This was carried by unanimous vote.

Up to Date Roundhouses.

In the absence of the chairman, Mr. Quayle, this subject was introduced by Mr. Van Alstine. Mr. Quereau did not approve of using but one ash pit at a roundhouse. In order to run engines around others, two pits were needed. Drop pits, he believed, should cover at least three tracks. Sand house construction should be such as to avoid the necessity for shoveling. He emphasized the importance of the organization of the roundhouse force; this was more important than the details of construction or their arrangement. Mr. Gaines raised the questions of the fire risk of wooden smoke jacks and the destruction of the abrasive effect of sand dried by a stove because of driving out the water of crystallization by overheating. Mr. Robb (Grand Trunk) thought it necessary to "burn" sand in order to thoroughly dry it. Professor Hibbard emphasized the necessity of securing the maximum amount of daylight in roundhouses. This had been neglected. Mr. Forney suggested using the largest possible window area and carrying the glass as high toward the roof as possible.

Improvements in Boiler Design and Proportions of Heating and Grate Surface.

Mr. Gaines, who prepared this report for the committee, presented the subject. This was a discussion by technical men and is exceedingly important in the design of locomotives. Professor Goss approved the report. He desired to see the term "cylinder horse power" substituted for "indicated horse power," unless actual power measured by the indicator is meant. Mr. Vaughan objected to changing the ratio established by the committee of 1897, which gave the relation between the heating surface and cylinder volume. The committee recommended a new ratio in comparing engines. This practically defeated the object of the committee to establish new methods of comparing engines. Mr. Forney asked whether it was possible to get too much heating surface. If not, he asked why it would not be good practice to use as much heating surface as possible. The discussion was closed without action on the recommended comparisons.

"A Typical Shop for 300 Locomotives." (A paper by Mr. L. R. Pomeroy.)

This admirable and suggestive study of present problems in shop practice should lead to others on this subject. Mr. Van Alstine criticised the crane equipment suggested by the author. He considered the crane over the machines the most useful one in the shop in point of actual time in service. Costs of shop work needed more attention. Detailed costs of parts, such as staybolt accounts, were valuable. When a new tool is applied its effect should be known. Mr. Seley directed attention to the advantages of the longitudinal shops. The objection to the transfer table (for an erecting shop) was not so much a matter of obstruction and snow and ice as to the investment required for a tool seldom used. He was not sure that he would use a 60-ton crane when one of lighter capacity would suffice. Mr. McIntosh defended the transfer table.

Standard Specifications of Locomotive Axles.

Mr. Gaines did not find the suggestions of the committee satisfactory with reference to specifications. It was too expensive to sacrifice entire axles for test. This might be overcome by using an extension of an axle or a "witness piece" for the purpose. Hammer or forging press work should bear some relation to the volume of the metal worked. The subject was continued, and representatives of the locomotive building companies will be added to the committee, with authority to co-operate with the American Society for Testing Materials.

"Helping Engines and Their Performance." (A paper by F. F. Gaines.)

Mr. Quereau stated that the paper showed only the credit side of double heading. Professor Hibbard commended the report specially, because of the recommendations as to designing helping engines, and referred to the article by the author in the June number of the AMERICAN ENGINEER. Mr. Whyte stated that while large drivers were theoretically desirable for hill service, experience on the road was unquestionably favorable to small drivers.

Standard Pipe Unions.

This report was substantially the same as that presented to the M. C. B. Association. The committee was continued and instructed to work with the committee of the other association.

"Modern Water Supply Stations." (A paper by F. M. Whyte.)

This is an exceedingly well prepared and comprehensive paper, which cannot fail to bring to this subject the attention it deserves. It is an admirable record of the subject and was received with applause. Mr. Gaines and Mr. Vaughan complimented the paper highly, for its value as a record and its satisfactory arrangement. Mr. Vaughan had made experiments which showed that the formula given by Prof. I. P. Church, in his article on page 376, volume 75, of the AMERICAN ENGINEER, was correct. There was very little discussion, as is usual in the case of such papers.

TOPICAL DISCUSSIONS.

"Piston Valves."—Opened by Mr. F. H. Clark.

With an experience with piston valves, dating from 1895, and now having about 150 engines fitted with them, he spoke in high terms of their value. There was, however, room for improvement. Mr. Muchnic referred to the necessity for relief valves, because of the inability of the piston valve to relieve an accumulation of water. This required careful design of relief valves. Leakage of piston valves was mentioned by several speakers as requiring watching. Mr. Gaines spoke of a new balanced slide valve (the Wilson) which is being tried on the Lehigh Valley. It offered all the advantages of the piston valve, and he considered it a step in advance in valve construction. There was an indication of a tendency to question the supremacy of the piston valve.

"Does the Extension of the Smokestack Into the Smokebox Materially Assist in the Steaming of the Engine."—Introduced by Professor Goss.

The speaker stated that his information on this subject was secured in the American Engineer Tests. The results tended to show the importance of high stacks. The stack may be lengthened by extension into the smokebox, and this meant using lower nozzles. The space between the nozzle and the end of the extension might be made 10 ins., and this permitted the use of stacks of considerable length. The extension inside was thought to be as valuable as that outside. By the inside stack the desired length might be obtained, and this permitted a lowering of the center of draft effect, which may result in an adjustment which will make it possible to get along without the diaphragm plate. By the use of the inside stack the efficiency was held up. Mr. Gaines confirmed Professor Goss as to the effect of the inside stack, and also had found it possible by its use to materially reduce the size of the diaphragm.

"Flexible Staybolts."—Opened by Mr. T. A. Lawes.

The cost of flexible staybolts in repairs was much less than of the usual form, as far as the application to which he referred had gone. Mr. West reported very favorable figures for breakages in wide firebox engines. The fireboxes referred to were very wide. He thought the design of the firebox was responsible for much of the breakage. In some boilers of this type, in 12 years of service, bolts longer than 9 ins. had not broken. Mr. Gaines and Mr. Player supported Mr. West. Mr. Player strongly favored wider water spaces. Mr. Miller spoke very favorably of flexible bolts. Mr. Lawes strongly advocated the use of flexible staybolts for engines already built.

The election of officers resulted as follows:

President, G. W. West; vice-presidents, W. H. Lewis, P. H. Peck and H. F. Ball; treasurer, Angus Sinclair; secretary, J. W. Taylor.

Purdue University has now in process of erection a temporary building for the accommodation of its collection of historic locomotives. The building is 60 by 64 ft., and contains four tracks, three of which are already occupied by locomotives. The list includes the "James Tolman," an engine of English design; the Baltimore & Ohio engine No. 173, known as a Hayes Ten-Wheel "Camel," and a 16 by 24 in. American type engine from the Chicago & Northwestern Railroad. It is understood that the university very much desires to obtain an inside-connected engine which it can add to its collection.

A cement for pipe joints that is said to be as good in a faced or rough flange joint as red-lead putty, at one-tenth the cost, consists of a mixture of ordinary pine tar and dry oxide of iron. At a recent meeting in Columbus of the Ohio Gas Light Association its use was recommended by Mr. George Light, who stated that it does not harden as soon as red lead, and is very adhesive under pressure.—Engineering Record.

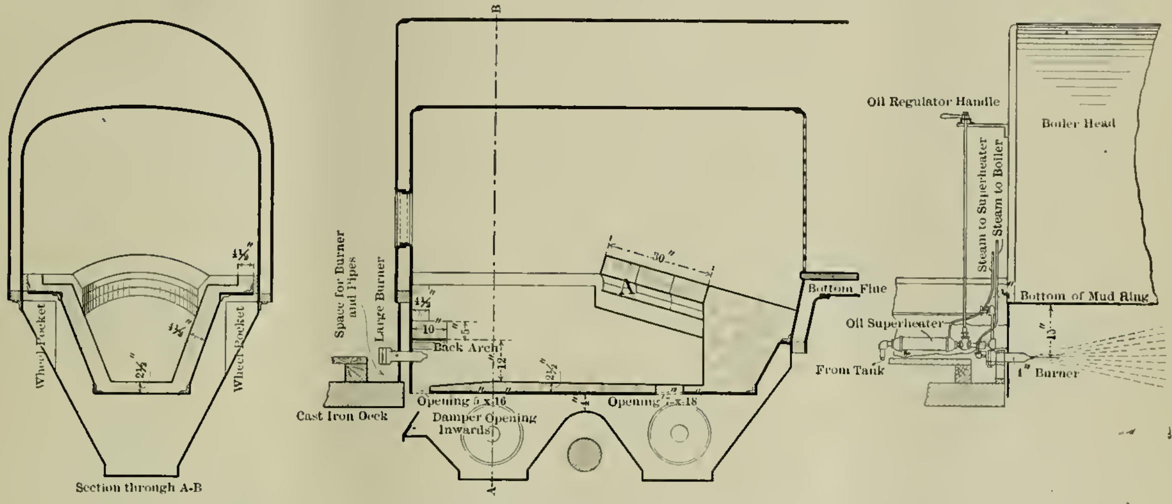
THE USE OF OIL FUEL ON THE SOUTHERN PACIFIC.

By P. Sheedy, Master Mechanic, Southern Pacific Railway.

The success of the use of fuel oil on locomotives in the Southwest cannot better be attested than by the increasing introduction of oil burning upon the locomotives of the Southern Pacific Railway system. The company has at present nearly 250 locomotives equipped for oil burning, and the results of this fuel have so far been quite satisfactory; indeed, so satisfactory has it proved that standard designs of burners, piping proper. Also, some air is admitted through the burner itself, as may be seen from the sectional view.

The standard front-end arrangement, which is shown in section and front elevation, contributes greatly to the even distribution of the hot gases in the tubes. As may be seen, the tip of the nozzle is located half-way between the top and bottom flues, and the flaring edge of the petticoat pipe is 1 in. above it. The top of the petticoat pipe is 4½ ins. below the top of the smoke arch.

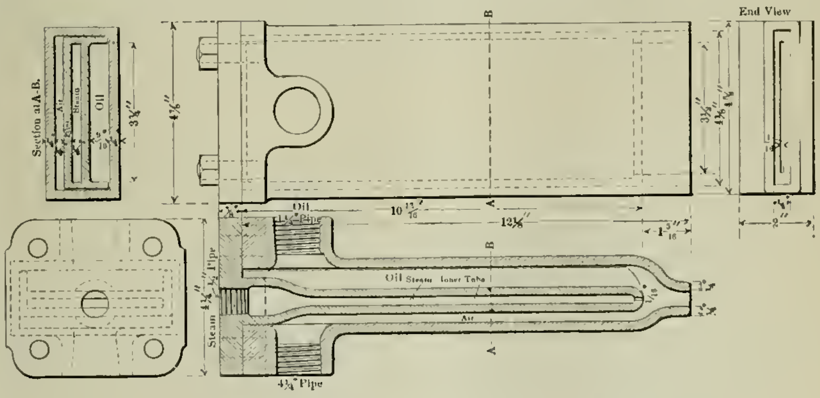
The Sheedy-Carrick burner, which was some time ago adopted as standard by the Southern Pacific system, is the one



Firebox Setting for Fuel Oil—Southern Pacific Railway

connections, bricking and arch arrangements, front-end arrangements, etc., have been originated and adopted by the management.

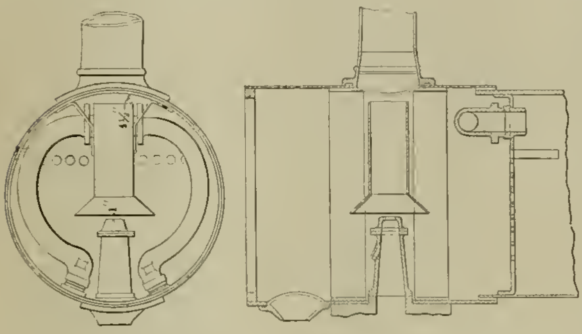
The accompanying drawings show the arrangement of the burner and piping connections, the front-end arrangement and the details of the burner, of the class D-Z engines recently equipped at the Southern Pacific shops at Los Angeles, Cal., to burn fuel oil. These engines, of which a number were recently received from the Baldwin Locomotive Works are Vauclain compounds, built for heavy passenger service, having boilers of the wide firebox type, carrying a working pressure of 200 lbs. per sq. in. As may be seen in the sectional views of the firebox, there is an inside pan arrangement, constructed inside the ash pan proper, to support the brick lining and arch. This inside pan, which is made from ⅜-inch boiler steel, is well stayed and substantially made, and is suspended from the studs that formerly held the side bars for the coal grates. This method of supporting the arch places the burner and brickwork so low that almost the entire heating surface of the firebox is exposed to the hot gases, the only surface covered being where the brickwork is extended up to protect the rivets in the mud ring. The burner is located 15 ins. below the mud ring, and directs its spray under the arch, A, from whence the flame spreads back and distributes itself very evenly through the firebox and tubes. The admission of air is regulated by a damper in the back end, and winker dampers on each side of the two hoppers in the bottom of the ash pan



Sheedy-Carrick Oil Burner.—Southern Pacific Railroad.

in use. It operates by induction and gravity combined, and consequently does not require pressure in the oil tank to bring the fuel oil to it. The drawing of the burner shows its construction diagrammatically and in section. The oil enters from above, flows out and down over the orifice, or slit, from which the steam issues, where it is atomized and blown into the firebox. Air is also permitted to flow through the burner through the lower passage by induction. The details of the burner are clearly shown in the drawing, which indicates the construction whereby the inner, or steam, tube may be easily removed from the burner casing. The arrangement of the oil and steam piping connections is shown in the boiler head view, which shows also the oil superheater connected in the oil delivery near the burner.

Engines equipped with this burner arrangement burn a steady, smooth flame, free from disagreeable explosions, or the drumming so common to oil-burning locomotives not properly equipped. They steam splendidly, and with ordinary care on the part of the fireman will not show a trace of smoke. The burner shown in the diagram is of ample size to handle the firebox of a class D-Z engine, or, in fact, any larger size of firebox. This view shows, of course, an arrangement for



Front End Arrangement—Oil Fuel on Southern Pacific Railway

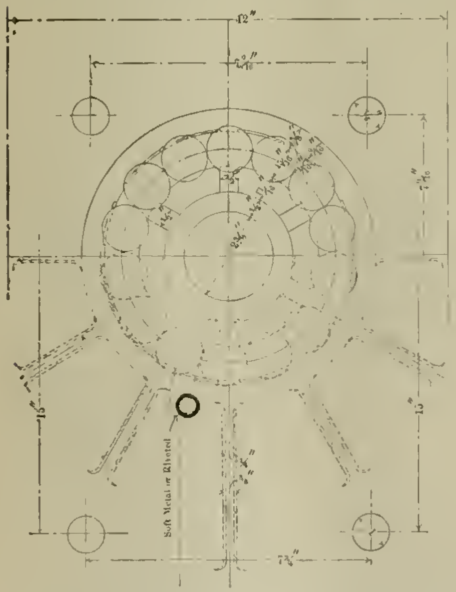
one particular class of engine, but all kinds of engines have been equipped on this road for oil burning, from the smallest narrow-gauge motors to the largest engines with Wootten fireboxes. Also, some of the locomotives equipped with Vanderbilt boilers are burning crude oil, and have given very good satisfaction up to date.

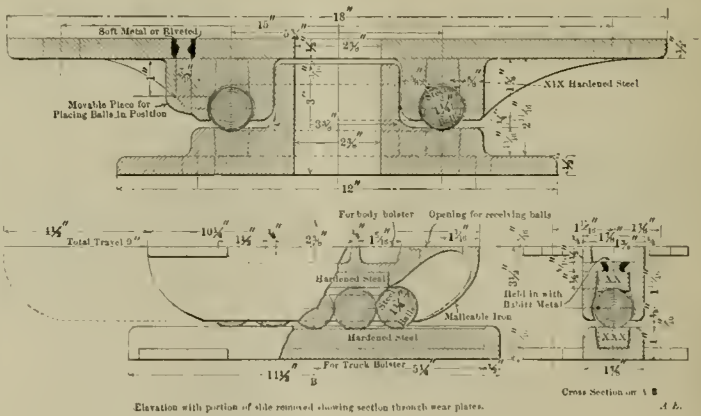
A symposium on the locomotive piston valve, published in the special convention issue of the *Railway and Engineering Review*, is the most complete and satisfactory treatment of the subject available anywhere. It includes the construction of the valve, the form of packing rings and the advantages derived from the perfect balancing which this valve permits. The discussion includes reports of experience and statements of preference in design and construction from a numoer of well known motive power officials, bringing the subject up to date in an admirable way.

THE NORWOOD SIDE BEARINGS AND CENTER PLATES.

The Norwood ball side bearings and center plates developed from a desire to provide means whereby trucks should be made to curve easily in order to avoid accidents due to the resistance in curving and the severe wear of wheel flanges, which is unavoidable with ordinary construction. The advent of the large capacity car increased and added to the difficulties which formerly existed, and the time has come to consider devices of this kind as necessities. Many railroad officers are ready to apply so-called "frictionless" side bearings and centerplates when they are sure of having found trustworthy devices.

Mr. Norwood selected ball bearings as the simplest and most satisfactory solution of the problem. To avoid accumulations of dirt it was necessary to suspend the balls in such a way as to insure its escape from the bearings. Simplicity was the next desirable feature. It was also necessary to avoid springs or other centering devices. These bearings, both center plate and side bearings, have been developed into the construction shown by these engravings, in which there are no bolts or nuts and no loose parts except the balls. The balls are 1¼ ins. in diameter, of the best tool steel, ground and hardened. They have been tested in bearings with loads of 25 tons per ball without signs of failure, and they should wear a long time. Special low carbon steel, case-hardened to a depth of from 1-16 to ⅛ in., is used for the ball races, and these are cheap and easily renewed in case of wear. The castings are simple and the metal is favorably placed. In order to resist





Norwood Side Bearings and Center Plates.

lateral motion, and avoid the difficulty from the wear which it would cause, the ball race grooves are deep, giving arcs of bearing surface amounting to about one-third of the circumference of the balls. This also distributes the load on the balls; they will last much longer than if loaded on points only, as they would be if the races were flat or V-shaped. The resistance to lateral motion is considered one of the advantages of balls over rollers.

The side bearing is shaped to return the balls so that they will be kept in a central position by gravity. They are introduced into the casting through a hole at one end, which is fitted with a cover riveted in, and the ball race of the upper bearing is held in place by a projection which is sealed with melted babbitt or lead. This fastening bears no strain, and merely holds the race from dropping out. The lower race is forced to a level bearing by hydraulic pressure. With five balls 9 ins. of motion is obtained, with an upper race only 4¾ ins. long, two of the balls always being out of service, with a space at each end of the bearing into which they may travel.

This construction permits of using a small number of balls. For heavy tenders, ten balls are provided, in two parallel races, the seat for the lower race being curved in section, to be sure that both sets of balls come to a bearing.

The center plate employs the principle of the side bearing, the balls being introduced through a hole which is closed by a loose piece secured by a lead seal. To guard against lateral displacement, the races are grooved and the lower casting projects into the center of the upper one, as in the center plates described by Mr. C. A. Seley in our March number, page 75. Double ball races have been applied to the center plates also, but these are unnecessary, except under the heaviest special equipment. These bearings may be made to fit any bolster, and for such service as the standard Pullman trucks special designs are made. This company has also completed cast-steel body and truck bolsters, each cast in one piece, including the cast portions of the bearings. It is an attractive design, which was exhibited at Saratoga.

A recent test to show the power required to turn the plates with increasing pressures under as nearly service conditions as possible, showed the following results:

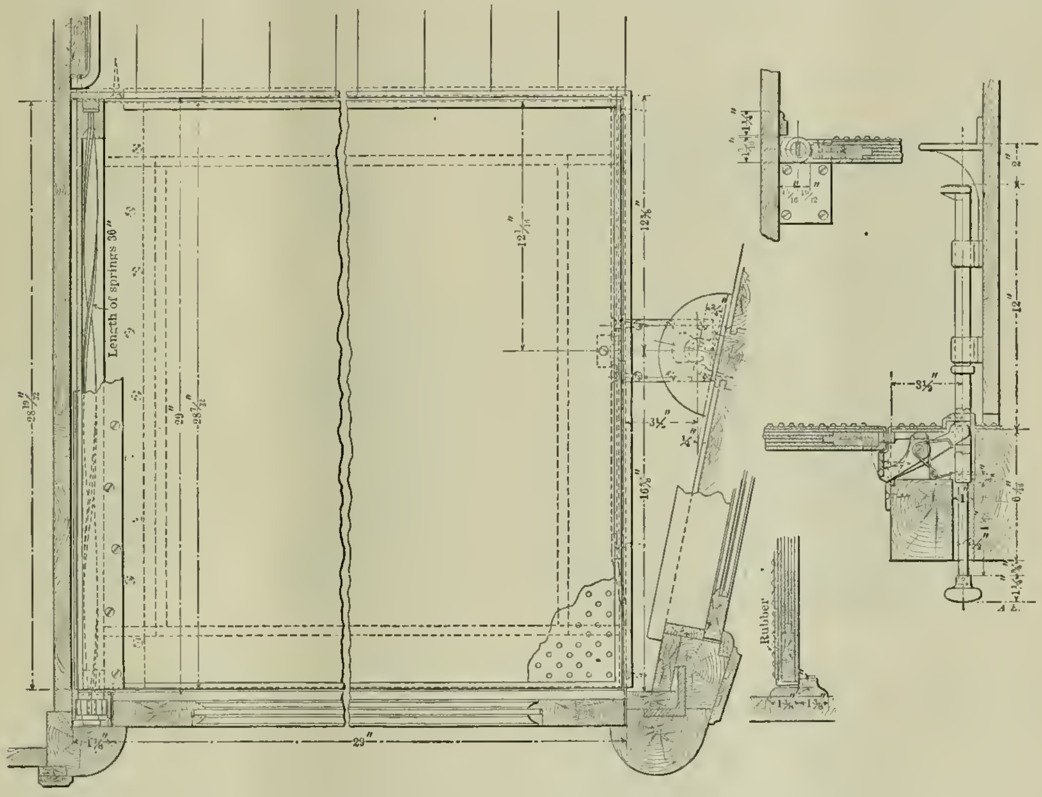
Load in Pounds on Center Plates.	Pounds Applied to 35 inch Lever from Center Pin.
10,000	10 to 20
20,000	10 to 30
30,000	20 to 35
40,000	20 to 59
50,000	30 to 50
60,000	40 to 60
67,000	60 to 75
70,000	70 to 90

This test of ball-bearing center plates was made by the Baltimore Ball Bearing Company under a Riehle upright press, using a lever 35 ins. long from the center of the center pin to show the power exerted by the flange of the wheel to turn center plates under a 100,000-lb. car.

The subject of friction-reducing side bearings and center plates has been so thoroughly dealt with in this journal as to render a review of the arguments unnecessary, but it may be said here that one is incomplete without the other, and both should be applied. These bearings are manufactured by the Baltimore Ball Bearing Company, Calvert Building, Baltimore, Md., from whom further information may be had.

THE EDWARDS EXTENSION PLATFORM TRAP DOOR.

Because vestibules have become a necessary accompaniment of modern passenger equipment, the trap doors which must be used with them, and must be opened often, have become important items of construction. An ingenious arrangement has been developed by the O. M. Edwards Company, of Syracuse, N. Y., and is now in use on many of the leading railroads. It has proven itself an inexpensive and successful device.



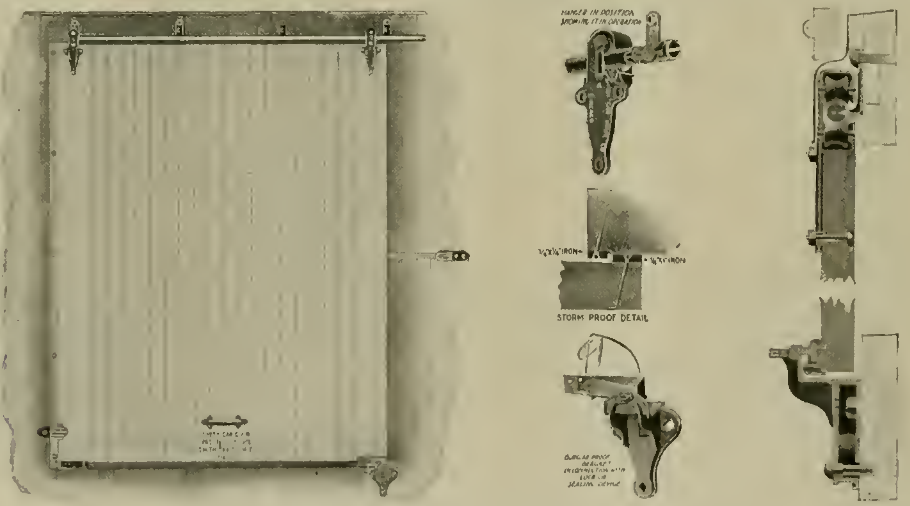
The Edwards Extension Platform Trap Door.

As shown in the engraving a hinge extends the entire width of the door, through which passes a torsional spring, consisting simply of two flat steel bars. This spring is fastened at one end in the hinge and at the other end in a ratchet wheel located in a bracket, which is fastened in the corner post of the car. By means of this ratchet wheel the torsion in the spring may be regulated to open the door automatically to a full open position or to a semi-open position, as desired.

The door is operated by means of a foot lever pin, located in the front end of the vestibule, and protected by the usual signal step, which is fastened in the end of the vestibule. By pressing down on this pin with the foot, the lock bolt is withdrawn from the keeper in the door and allows the door to open automatically. As soon as the lock bolt is fully withdrawn, the lever, which is shown in the sectional view of the platform and door, is brought up against the under side of the door, and should the door stick, forces it past that point where it cannot be bound by the platform. This lever does away with the usual handhold in the door, which has been found objectionable by some railroads, as it is a receptacle for water and dirt. If desired, the door can also be operated from the outside of the car by a short pull-rod, which is screwed into the lower end of the foot operating pin, and projects through the end sill of the platform just far enough to allow the knob on the end of the pull-rod to be handled easily in opening the door.

THE SMITH CAR DOOR.

As shown by this engraving, the Smith car door, which is controlled by the Jones Car Door Company, of Chicago, has a number of interesting features. The track is steel tubing of 14 gauge and 1 5-16 ins. in diameter. It has a 3/8-in. slot in the back, permitting of using supports having two knobs 1 1/2 ins. apart. These render unnecessary the usual furring strips. Each hanger has two rollers, one above and the other below the track. These hold the door to the track, and it cannot fall off after being hung. The use of loose axle wheels is also an advantage. At the lower right-hand corner of the door is a combined lock and sealing device, with a burglar-proof bracket. It is burglar proof because the lag screws are covered and the carriage bolts cannot be turned by their heads, which are outside. A storm-proof detail is added in the form of a 3/4 by 1/4-in. iron strip on the door post and a 3/4 by 1-in. strip on the back of the door. The strip on the door bears on the rub iron on the car, and when the door is closed the two vertical strips make a storm-proof joint. An 8-in. steel hood covers the rail and the upper joint of the door. The engraving illustrates the construction of the door. Further information may be had from the Jones Car Door Company, 234 La Salle street, Chicago.



The Smith Car Door and Fixtures.

We are pleased to learn that the University of Wisconsin will again conduct their Summer School for Apprentices and Artisans this summer, from June 30 until August 8. This school is intended primarily to give to stationary engineers, superintendents of power stations, machinists and apprentices in various trades such mathematical, laboratory and shop instruction as would be found of most practical value to them and which could be imparted in the limited time of six weeks. Any person over 16 years of age, speaking the English language and having a fair knowledge of arithmetic, will be admitted. The school has a faculty of ten, composed of the regular professors and instructors from the faculty of the College of Engineering of the university. Correspondence school students will find the opportunities for laboratory and shop work offered here particularly helpful.

The courses of instruction are: The use of Formulæ; Mechanical Drawing; Steam Engineering; Applied Electricity; Transmission of Power; Strength of Materials and Shop-work in Carpentry, Forging and Machine Tools. The tuition fee has been placed at the moderate sum of $15 for all courses for the term, in addition to which 5 cents per hour is charged for all time spent in the laboratories at practical work.

The school was started last year as an experiment and has proved eminently successful, as has been shown by personal indorsements of those who took the courses. This school is not self-supporting, as the fees pay but a small portion of the expenses; the remainder is paid out of the general university funds.

GROWTH OF THE PINTSCH LIGHT SYSTEM.

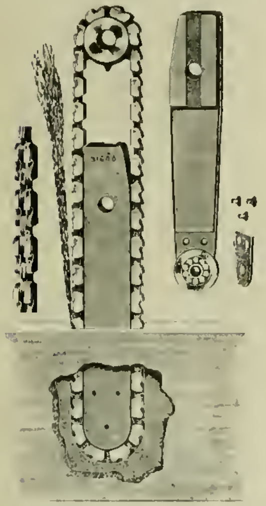
An interesting statement has been issued by the Safety Car Heating & Lighting Company, showing the remarkable increase in the use of the Pintsch light system during the past twelve months, as well as giving the total number of cars, locomotives, buoys and beacons equipped with this system throughout the world. Upon reference to the table, we find that there are at present in the United States and Canada 18,663 cars equipped with the Pintsch system, while in the territory controlled by the American company there are sixty-six Pintsch gas manufacturing plants in operation. The statement complete to May, 1902, appears below:

	Cars.	Locomotives.	Gas Works.	Buoys and Beacons.
Germany	40,156	4,786	71	124
Denmark	45		3	21
England	18,859	18	87	272
France	6,741	....	27	240
Holland	3,487	5	10	86
Italy	1,528	....	5	15
Switzerland	380	2	1	....
Austria	4,218	....	10	1
Russia	3,041	112	13	13
Sweden	679	43	4	2
Servia	216	....	....	....
Bulgaria	98	....	1	....
Turkey	114	....	...	....
Egypt	42	....	3	118
Canada	166	....	3	65
Brazil	974	31	1	33
Argentine	1,096	....	10	2
Chili	46	....	2	....
India	9,584	....	16	....
Australia	2,053	....	13	38
United States	18,497	....	63	172
Japan	100	....	2	4
China	.....	....	1	15
Mexico	81	....	1	....
Total	112,191	4,997	347	1,211
Increase for the year	6,527	525	11	49

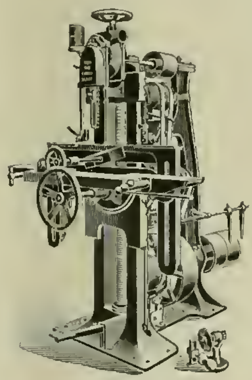
CHAIN SAW MORTISER.

The chain saw mortising machine shown herewith, which is made by the New Britain Machine Company, New Britain, Conn., is a distinct advance in the field of woodworking machinery. As shown in detail view of the chain mechanism, mortising is done by a sprocket chain, each link of which carries a sharpened cutting tooth so formed as to carry out its own chip. This chain is driven by a sprocket wheel arranged in the head of the machine and in the cutting portion of its travel slides down around the grooved guide bar, having the roller bearing guide wheel at the bottom. Chips are carried away by a rotary fan on the sprocket shaft on the head.

This arrangement permits a very gradual, even cutting action, as with the ordinary chain speed of 1,500 ft. per minute, 40,000 cutting teeth are presented to the work in that time; likewise for the same reason very rapid work may be done, as high as 120 door stiles mortised per hour being possible with



Details of Chain Mechanism.



Chain Saw Mortiser.

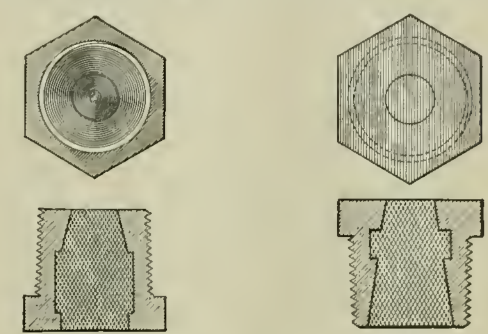
this machine. The range of sizes of mortise possible with one setting of the work is from ¼ x 1½ ins. up to 1 x 13 ins., and any depth up to 6½ ins., greater sizes being of course possible by readjusting the work. It is claimed to work equally well in all kinds of wood, hard or knotty, including the "fattest" Georgia pine. Taper mortises may also be cut by providing special taper chain-guide bars, and the table may be tilted for angle mortises.

This machine is furnished in two sizes, each for heavy and light work, in the form of an adjustable gang mortiser, and also with a special hollow chisel attachment for very deep mortises and special work. The New Britain Machine Company will be pleased to furnish information regarding these machines to anyone interested.

The passenger department of the Boston & Maine Railroad has issued the first of a new series of folders describing picturesque New England. By means of maps, routes, rates and lists of hotels and boarding houses a complete trip may be planned and accommodations secured in advance. The territory covered is unsurpassed; it includes the White Mountains, Mount Desert, the Adirondacks, Catskills, Montreal, Quebec, the beautiful lake regions and the beaches of New England. All this is covered in a single large folder, which is admirably arranged. The folder cannot be carefully examined without stimulating a desire to visit all of the attractions which it describes. It is a directory to all of the summer resorts of New England.

APPROVED FUSIBLE PLUGS.

The United States Treasury Department recently took action, in view of a disastrous boiler explosion at Philadelphia last fall, to enforce Section 4,436 of the United States Revised Statutes regarding specifications for fusible plugs for boilers, and have issued a circular specifying that all fusible plugs shall be filled only with pure Banca tin and stamped with the name of the maker, and requiring an affidavit setting forth this fact to be filed with the local boiler inspector wherever the plug is used. The Lunkenheimer



Company, Cincinnati, O., have for some time manufactured fusible plugs fully complying with these specifications, and have recently made an affidavit before the United States Steamboat Inspection Service to that effect. The accompanying illustrations show sections and plan views of both the inside and the outside types of the plugs which they make.

PERSONALS.

Mr. J. W. Storey has been appointed chief draftsman of the mechanical department of the "Q. and C." Railway, at Ludlow, Ky.

Mr. W. C. Ennis has been appointed master mechanic of the Pennsylvania Division of the Delaware & Hudson Company, to succeed Mr. Robert Rennie, who recently resigned.

Mr. S. Higgins has resigned as superintendent of motive power of the Union Pacific, and has been appointed superintendent of motive power of the Southern Railway, to succeed Mr. W. H. Thomas, who has recently resigned.

Mr. W. R. McKeen, Jr., has been appointed to succeed Mr. S. Higgins as superintendent of motive power of the Union Pacific. He is a graduate of Rose Polytechnic Institute, and began his railroad service as a special apprentice, and in 1893 was appointed master mechanic on the Union Pacific at North Platte, Neb., having held this position until now.

Herr A. Von Borries, one of the best and most favorably known locomotive authorities, who has for years held the position of Regierungs und Baurath, Prussian State Railroads, has been appointed to a professorship in the Imperial High School at Berlin, where he will have charge of the subject of railroad equipment. A great deal of scientific work of most valuable character may be expected from his connection with this school, and it is not too much to say that instruction and investigation concerning locomotive subjects could not be placed in better or more competent hands.

The Pennsylvania Steel Company will have its Northwestern office in the Western Union Building, Chicago, after July 1. It will be in charge of Mr. Clifford J. Ellis, sales agent, and Mr. Robert E. Belknapp, assistant sales agent.

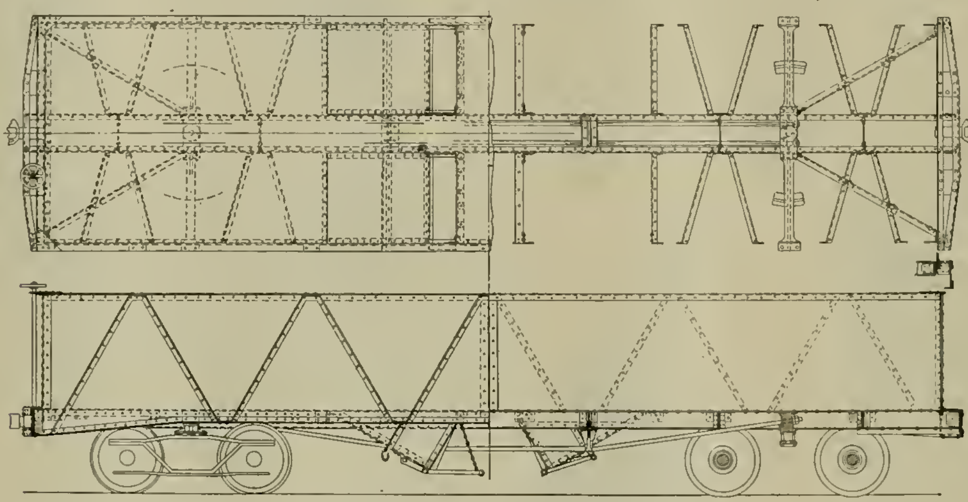
40-TON HOPPER GONDOLA.

Structural Steel Car Company.

The Woodcock steel hopper car of structural steel shapes and plates, which was illustrated in our April number, 1901, was the predecessor of a series of designs which the Structural Steel Car Company, Canton, Ohio, is prepared to build.

The chief feature of the construction of the car shown by this engraving is in the use of the sides of the car to assist in carrying the load. They are plate girders, with diagonal stiffeners of rolled angles at the sides themselves and also the ends and top. At the end sills the sides are brought down to meet the reverse angles and T-bars which form the connection between the end plates and sills. The end sills are built up of angles and plates, and the center sills are trussed channels, with corner bracing of angles, as shown in the floor framing plan. The effect of this is to give the car a stiff backbone, almost equivalent to a box girder. At frequent intervals the center sills are braced by plates, and betwen the bolsters are four floor stiffening members, besides two sets of diagonal braces of angles, the arrangement of the floor supports being intended to secure the maximum possible amount of support with a minimum quantity of material, angles being used for this purpose. The hopper door frames are of channels.

This car has a capacity of 1,600 cubic feet, and its estimated weight is 32,000 lbs. The length is 38 ft., width, 9 ft. 3 ins.; height, from rail, 8 ft.



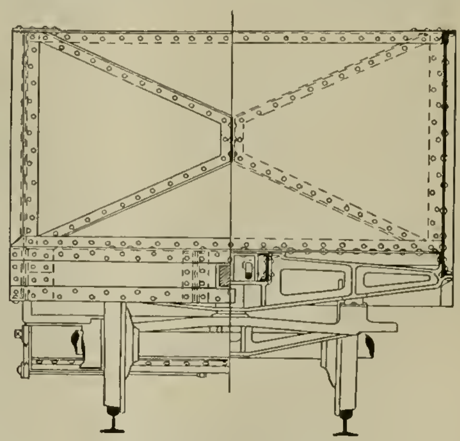
Structural Steel Hopper Gondola Car.

The Structural Steel Car Company is now operating its plant at Canton, Ohio, and is ready to build cars, underframes, trucks, bolsters and brake beams, either to its own designs or to those of the purchaser. Rolled steel of standard shapes is used at these works. The location of the plant is favorable for receipt of material and shipment of product, being on the line of the Wheeling & Lake Erie, and the Pittsburgh, Fort Wayne & Chicago railroads. Forty acres of level land were available for the plant, and nearly two miles of storage and repair tracks have been laid down.

The machine and erecting shop is 507 by 80 ft., in a single span, with steel frame and walls of brick and hollow tile. This shop is served by a Pawling & Harnischfeger electric crane, running its full length and extending outside a distance of 150 ft. for the unloading of material from cars and transportation into the shop. Two longitudinal tracks run through the shop, and the car bodies are built on trestles between them. They are handled by the crane when ready for painting and shipping. The shop has a capacity of 50 cars per day, with provision for doubling this output.

The machinery includes plate rolls, a 110-hole multiple punch, with a space of 118 ins. between the housings; two quick-acting double punches, a double-ended punch, coping machines, bending machines for bolsters and sills, all of these machines being the product of the Cleveland Punch & Shear Company. A Scully rotary shear is used to cut the plates. In the truck department is a Watson & Stillman hydraulic press and a Grant axle lathe. All of these machines are driven by Westinghouse alternating-current motors, the wiring being under ground.

The power house is 175 by 50 ft., and is equipped with two Corliss 500 horse-power engines, driving two Westinghouse generators and their exciters, supplying light and power to the entire plant. For supplying air for hammers, drills and reamers in the erecting shop, two Laidlaw-Dunn-Gordon 150 horse-power compressors have been installed in the power house. Steam is supplied by two batteries of vertical water tube boilers, and the power plant also includes fire and feed pumps and feed water heaters.



Half Section and End View.

The forge shop, 75 by 50 ft., contains a 1,000-lb. Bement & Miles drop hammer, an Ajax bulldozer, a set of Ajax brake lever rolls, two Acme forging machines, an Acme bolt and rivet machine and an Acme threading machine. This shop also has four open fire smith forges and three furnaces for use of natural gas or oil fuel. These are for use with the forging machines.

Both arc and incandescent lighting are used, including 50 2,000-candle-power arc lamps. Artesian wells furnish the water supply. For oil, paints and other supplies, storehouses are provided at convenient locations. For the planning of this excellent plant the company did not find it necessary to call for any assistance to its own engineers, who are men of wide experience.

Electric lighting of cars deriving power from the axle has made material progress, in the opinions of railroad men, during the past year. At the Saratoga Convention the private Pullman car "Columbia," used by Prince Henry of Prussia, on his recent American tour, was exhibited. This car is equipped with electric lights and fans on the system of the Consolidated Railway Electric Lighting & Equipment Company, of 100 Broadway, New York, the car being part of the special equipment of the Pullman Company. It has two large and five small staterooms, an observation and dining room and kitchen. The system is the same in principle as that of the Columbian Electric Car Lighting Company, which has been illustrated in this journal, but under the management of the new company the details have been greatly improved, and a high degree of reliability secured. The Atchison, Topeka & Santa Fe, after a test of 100 new equipments for an entire year, has bought the apparatus outright and taken over its maintenance. We are informed that a private Pullman car recently completed a tour of 98 days in the West and in Mexico without a single failure of any kind in the lighting apparatus. In all this time it received no attention from anyone except the colored porter. It is stated that this system is being applied to all new Pullman equipment. This company either sells the equipment outright or it will be installed and maintained by them at a fixed annual rental. The maximum power required is estimated at about 1½ h.p. per car, or 9 h.p. for a six-car train. Under the management of the present company, of which Mr. John N. Abbott, J. L. Watson and Col. John T. Dickenson are the principal officers, the extension of the system has been rapid, and it has a promising future. In a paper before the Master Car Builders' Association, Mr. L. T. Canfield, of the D., L. & W. R. R., in speaking of electric car lighting, said: "The third, or axle-lighting system, which in my mind is the best system in use to-day, on account of allowing of the free movement of cars, consists of a dynamo or generator driven by a pulley on the axle of the car and the storage battery working in combination with the dynamo, the dynamo charging the battery when the car is running, and the lights not burning, and working in series with the same when the lights are burning."

The Western Manufacturing Company, Springfield, O., had an interesting exhibit of their Champion lathe and planer tools and expanding mandrels at the Saratoga Convention. This company is foremost in the field of tool holders for the economical use of self-hardening steel, their holders having among other advantages the particular advantage of a support directly under the point of the cutter. Tool holders were exhibited of the straight and offset types, and for diamond-point, inside, cutting-off and threading cutters. Also a spring-threading holder, a special planer-tool holder, a boring-tool attachment and a set of expanding mandrels were shown. The expanding mandrel consists of a taper arbor and a flexible slotted sleeve fitting upon it, and is used by driving the taper arbor through the sleeve when the sleeve is within the hole in the work, and thus expanding same into contact.

In the patent case in which the Pressed Steel Car Company asked for an injunction restraining John M. Hansen, president of the Standard Steel Car Company, from disposing of six patents and applications for patents, Judge Buffington has handed down a decision which allows Mr. Hansen to make any assignment of these patents and applications which he chooses, subject to the final decision of the court.

The Illinois Central has 1,000 miles of telephone lines and is rapidly extending them. At the recent meeting of the Telegraph Superintendents the telephone seemed to have made important progress.

CORRESPONDENCE.

PROFESSIONAL SPIRIT IN RAILROAD SERVICE.

To the Editor:

I may venture to say that to the majority of the readers of the American Engineer who read Mr. Delano's article in the June number on "Professional Spirit in Railroad Service" Mr. Delano must seem somewhat of an idealist, and that if our railroad companies are to await the more thorough awakening and development of this spirit because of the reasons set forth by Mr. Delano they may wait "forever and a day."

Early in his article Mr. Delano quotes Ruskin's saying that "a man who devotes himself to art must do it for art's sake alone." This is doubtless a very high and noble sentiment, but the artist must live, and his desire is, like that of other mortals, "to live as well as he can." The professional requirement "that a man should enter into his work with heart and soul, and with the desire and intention of doing something worth doing," I think is now commonly prevalent among the "younger blood" of the railroad employees. But I maintain that the first thought behind all this is, and never can be anything else, than self advancement. The mere pleasure in the performance "of the thing worth doing" and consequent approval of the employer, are very large factors in the incentive, but human nature would not be human nature if the individual benefit to accrue was not uppermost in the mind of the doer. If railroad companies do not see fit to value and reward service as highly as do operators in the manufacturing field, surely the young man who has entered railroad service may be forgiven for "listening to the siren voice of those who seek to tempt him away." Business is business, and ability attained by study and experience is a marketable product, and open to the highest bidder of good standing.

The railroad field is a most attractive one, yet it would seem that the "professional spirit" could be better fostered by means more substantial than by an appeal to the sentiment. The manufacturer does not look for sentiment as an incentive to his employees to render valuable service. Why, then, should the railroad company? It seems to me that the only man who would be likely to accept Mr. Delano's views without qualification is the man who finds it entirely unnecessary "to work for his living."

There are many who quit railroad service for other reasons than the mere allurement of increased salary in other directions. I have in mind a young man, at one time in railroad service, who promised to be one of the brightest and most valuable in his profession. He was full of the "professional spirit." He came to his position well equipped and full of enthusiasm. He found things in the department of which he was given charge in a state of chaos. He worked hard and faithfully for over two years, obtained the respect, admiration, loyalty and liking of the entire corps of his subordinates, both sub-department heads and rank and file, and good results brimmed over. The management, however, at the end of this time failed to appreciate these good results, and the young man's resignation was voluntary. He retired to the manufacturing field, disgusted with railroad service. In the employ of one of the largest manufacturing concerns of this country, he is now, one year after leaving railroad service, in receipt of almost three times his salary as a railroad employee. This instance is but one of many, and is brought forward to show how blind the management of many railroad companies are to the real interests of the company, and if they would create and foster the "professional spirit" they must wake up to an appreciation of it. A. H. WESTON.

100 Broadway, New York.

An interesting and instructive exhibit of electric driving of machine tools, by the Bullock Electric Manufacturing Company, attracted interested attention at the Saratoga Conventions. The multiple voltage system of this company was shown as applied to a 28-in. Lodge & Shipley lathe by a motor mounted on top of the headstock, gear connected. This ran at 200 revolutions per minute and a speed range of the spindle of from 1 to 400 revolutions per minute in 26 steps was obtained by the multiple voltage system. The controller was mounted on the front of the base, below the headstock, and operated by a handle on the slide rest. Speeds intermediate between those obtained from the different voltages were secured by resistances. A motor-generator set and a single panel switchboard completed the installation.

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EDITORIAL ANNOUNCEMENTS.

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

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

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Two very important papers were read at the recent convention of the American Institute of Electrical Engineers, held at Great Barrington, Mass., one regarding electric traction for the New York Central Railroad, by B. J. Arnold, and the other a joint paper relating to comparative acceleration tests of steam locomotives and electric cars, by B. J. Arnold and W. B. Potter. The first paper is an abstract of the report made by Mr. Arnold to the management of the New York Central, proposing plans for the electrical operation of the section of the road within the city. As a result of tests Mr. Arnold has recommended a combined electric system of third rail for the main line section of the road and overhead conductor construction for the yard (similar to the overhead system which the B. & O. R. R. recently discarded for the safety third rail system), and the entire system is to be operated by direct current, there not being sufficient time to make necessary tests upon possible alternating current systems. Mr. Arnold's calculations indicate the probability of a slightly lower cost of operation by electric than by steam locomotion, due consideration being had for the extra expenses and maintenance of the power station, transmission system, etc. The second paper, in determining data by short-haul tests, reveals the fact that the electric cars, owing to their more even starting torque, utilize to better advantage the weight on their drivers, and are able to maintain their accelerating rate much longer than steam locomotives. Another point was brought out, which is usually lost sight of, that the energy per seat mile, or per passenger mile, is much less with the electric car, on account of the seating capacity of the locomotive. Further reference to these important papers will be made in a later issue.

MASTER MECHANICS' CONVENTION.

The American Engineer Tests received an unexpected and pleasing indorsement in the address of President Waitt, which is referred to elsewhere. It is exceedingly gratifying to have this recognition. Later in the convention the resolution offered by Mr. Quereau again brought the tests before the association, and the Executive Committee was instructed to assist in the work. This action is thoroughly appreciated, and we thank the association for its endorsement. The investigation of the subject of stacks has progressed to the stage of analysis of the data and it is too early to plan for the next step, but the field is almost infinite. Thus far the entire expense has been borne by this journal, and the plan has worked well, but the character of the subject and the desirability of the active co-operation of the railroads will render assistance very acceptable in extending the investigation. We desire to again acknowledge the help of Mr. Vaughan, the Lake Shore Railroad, the Railroad Committee, and especially Professor Goss and Purdue University, for the efforts which have advanced the work to such a point as to justify the statement that the results will throw valuable light upon the designing of front ends. In a topical discussion referred to in another column, Professor Goss briefly stated the conclusions which are justified at present and the completion of the report promises to be as valuable as it is interesting.

The presidential address by Mr. A. M. Waitt should be read carefully by all officials who are in charge of subordinates. In dealing with motive power subjects he included the vital elements of organization and the principles of management involving the treatment of men. His expressions were not whispered, but clearly spoken. There can be no doubt that human nature is to be considered in the future operation of railroads as it has not been in the past. Mr. Waitt has set a difficult pace for future presidential addresses.

The association cannot have too many papers like that of Mr. Seley, describing the application of electric driving to a railroad shop. New shop problems are much simpler than those involved in refitting old plants. As many old shops are to be equipped, the questions discussed by Mr. Seley are exceedingly important. The present state of opinion and knowledge of electric driving and its rapid development and improvement render it necessary that the association should pursue the plan which is so well started.

Shop papers are specially appropriate just now, when so many roads are building or considering shops. Mr. Pomeroy suggested a plan for a new shop which might well have been a description of an actual plant. The discussion was disappointing, and the opportunity for a general exchange of opinions as to the arrangement of tracks was lost. This leads to a conclusion which is justified by the entire convention, namely, that the discussions throughout were of little value. Discussions should not be less valuable than the reports or papers themselves, but these did not in any case add much to the information of the members. This was evidently due to lack of preparation, which is explained by the delay in getting out the advance papers. It would be well to adopt a rule excluding papers from presentation unless they are ready for distribution at least a month before the convention. Carefully prepared discussion is absolutely essential to the life of the association.

A short time ago a building which would house locomotives, and a turntable, sufficed for a roundhouse. Now a roundhouse is but one part of a locomotive terminal, the efficiency of which largely governs the efficiency of the motive power department. This was made clear by the roundhouse report. This paper furnishes strong arguments for liberal treatment of this problem. A roundhouse plan necessarily involves a large appropriation, and nothing which can contribute to quick service in caring for locomotives should be omitted. Chief engineers who were asked to contribute information to the committee had asked to have copies of the report sent to them, thus indicating interest in the requirements of the motive power departments.

Mr. Whyte's paper on water service is the best record of this equipment that has appeared. It covered practically the whole field of water service, and the treatment of water scoops and track tanks is specially valuable. It is a good plan to include record papers in the proceedings, in order that these volumes may reflect progress in a form convenient for record. This paper will stand for the present state of the art.

It was noticeable that a number of large roads had no representatives at the conventions. Others had several. One road sent two draftsmen and seven other representatives. Presumably this road will profit by this liberality. The discussions in the meetings themselves form but a small part of the value of the conventions. Much is to be gained by the extension of acquaintance and the exchange of opinions as well as in studying the exhibits. Why is it not a good plan for each road to send a representative and require him to report the conventions to the management?

The exhibits this year were specially interesting, machine tools being more prominent than in previous years. These received a great deal of interested attention, indicating a marked interest in the subject among the members.

MASTER CAR BUILDERS' CONVENTION.

The convention is generally considered one of the most successful ever held by the association. Perfect weather, good attendance and worthy subjects combined to produce good work and healthy progress was indicated.

The standard car was advanced by an important step, though a final decision as to standard exterior dimensions was not reached. It will not be surprising if the constructive dimensions should occupy the attention of this association for a year or two, in view of the fact that it has taken ten years or so to obtain standard interior dimensions. The M. C. B. Association undoubtedly will soon come to appreciate that this movement has been prepared for them and that they are expected to finish this important work. When they realize this the adoption of standards will probably proceed along the lines of the other work for which this association has made so high a name.

As usual, the topical discussions stimulated the thought of the members and brought many of them to their feet who would respond more slowly in the other discussions. The experience of the last few years indicated the value of these informal discussions as a method of assisting in the selection of subjects for formal reports for the coming year. The topical subjects this year were specially well selected, carefully presented and ably discussed.

The draft gear report furnished another example of the great importance of securing actual service conditions in comparisons between various devices or constructions used in cars. Tests of draft gear must be made on cars or under car conditions in order to secure the information wanted. A drop test gives high velocity to a relatively small weight and not a low velocity to a great weight, as occurs in service operation of trains. A candle may be fired from a rifle through a board because it has no time to flatten out under such a high velocity. Drop tests may bring out comparisons of strength of material, but they will not show the best draft gear, because they do not give the resistances time to act as they are intended to act. Furthermore, the recoil cannot be measured under a drop weight, because a 1,640-lb. weight will rebound more than a 135,000-lb. car. The drop test really obscures, or at least entirely changes, the action of the preliminary spring of a friction gear.

Steel cars have had a remarkable infancy. The discussion revealed the fact that in 1897 the Schoen Pressed Steel Car Company, the principal builders of steel cars, turned out 501 cars. In 1898 they built 2,931; in 1899, 9,624; in 1900, 16,671, and in 1901, 24,590. The total number of steel cars built by this company and its successor, the Pressed Steel Car Company, up to June, 1902, was 63,872 cars, and the total number, including those of other builders, is about 70,000. Thus far, however, this association has not given its official opinion with reference to methods of construction. At this convention it was suggested that a committee take up the design of 80,000 and 100,000-lb. cars and metal underframing for gondola, box and flat cars.

An interesting discussion, introduced by Mr. Sanderson, upon the advisability of using metal center sills in wooden car construction, developed strong opinions on two principles in car construction. The first is that steel and wood cannot be combined in the same structure without danger of failure, because of the difference in deflection of the members of each material, and because of deterioration resulting from moisture between the surfaces of metal and wood. The old time flitch plate, or sandwich, bolster was an example of failure cited to support this opinion. It was held that if steel is used in connection with wood the steel should be placed under the wood and under the frame, as in the case of draft sills. The second principle concerns the necessity for increased strength to meet the enormous buffing strains of present conditions. Speakers with the most extensive experience with steel cars maintained that the time had come to use all steel underframes, because they are needed on a score of strength. In other words, in their opinion, the time for wooden underframes has passed.

Improvements in cast iron wheels, both in material and design, have apparently led to the conclusion that this wheel, which has contributed so extensively to the success and progress of railroads in this country, is worthy of confidence.

With the increasing capacity of cars and the weights of cars and loads it has been long apparent that a device is needed which would make it possible to adjust the braking power so that it will not be the same for a car when empty and loaded. A topical discussion revealed the fact that the Burlington & Missouri River Railroad is now experimenting with a new triple valve which by a hand adjustment changed the braking power. Seven of these were tried and 30 more are to be put into service. More experience is required before a report can be made as to its value, but it seems promising. Other ways have been devised to accomplish the same object, for example, the application of two cylinders of different diameters, with a cock to control them. Years ago devices were suggested for the automatic control of the braking power, making the braking power a function of the load. It is apparent that this is to be a question for development in the near future. Some special provision must soon be made to improve methods of handling large capacity cars, fully loaded, when descending heavy mountain grades. There seems to be no objection to devices, such as cocks, which may be manipulated by trainmen, whereby empty cars may be given the usual precentage, and fully loaded cars may be given an increase of brake power. It will probably not be advisable to provide any intermediate adjustment from an empty to a loaded car, because of the additional complications involved.

Mr. G. W. Rhodes always brings up some important question at these conventions, and it is usually a reminder of some principle which has escaped attention of less observing and studious men. This time he presented a brief discussion entitled "Meters for Stopping Leaks in Car Work Expenses." This is referred to elsewhere in this issue, and his remarks will be printed in full next month. One effect was to lead several speakers to compare the cost of work in contract and railroad shops. Members were not quiet under the charge of securing but one-fourth of the full capacity of their shop machinery, and rose to defend themselves. Without doubt excellent progress has been made in recent years in the effort to put railroad shops upon the contract shop, or commercial, basis. This is, in fact, one of the promising movements of the time. While such defense will look well in the proceedings of this convention, the fact remains that railroad shops are woefully behind the commercial shops, not only in their use of their machinery, but in their methods of operating it. It is idle to argue that railroads are now doing their shop work as cheaply as it is done by commercial plants. There may be exceptions in cases of roads with special equipment for building cars, but railroads should not deceive themselves as to the facts regarding their shop work as a whole. This journal will soon undertake to treat this subject systematically, for there is no doubt that the commercializing of railroad shop practice offers not only an opportunity for progressive mechanical men, but it is positively necessary that greater progress should be made in this direction.

Purdue University already is custodian of the air brake testing rack of the M. C. B. Association, also the brake shoe testing machine. It was decided at this convention to add a new drop testing machine for testing couplers and axles to this equipment, by agreement with the University. The machine will be constructed, probably, at the expense of the association, the University to provide the foundation, maintenance and insurance. This will bring all of the testing equipment of the association together in one place, where it will be permanently cared for and where assistance and observers are always available for experimental work. The school is to be congratulated upon its policy of securing this equipment, which ties it closely to progress in railroad work, and the association is equally fortunate in having its apparatus in such competent and responsible hands.

Among the exhibits this year draft gears were more prominent and numerous than ever before. This seems significant of the tendency toward improvement in this direction.

The convenience of the fuel-oil flue-welding furnace of the Railway Materials Company of Chicago was demonstrated at the recent conventions at Saratoga. This company exhibited a furnace in operation, the blast being furnished by a motor-driven blower. With one of these furnaces a temperature for welding is obtained for 10 hours on a consumption of 25 gals. of oil. The capacity of the furnace is limited only by the ability of the man handling the flues. A fair continuous rate is 65 2-in. flues welded per hour, and 100 may be done if necessary. One hundred 2-in. flues are scarfed and put together ready for welding in an hour, and the same number of safe ends in 15 minutes. Three hundred and forty-six flues have been put through the shops in six hours by one man and a helper. This furnace has been introduced on 40 railroads in one year.

A compact 40-foot air-compressor, belt-driven by a 7-h.p. Foos gasoline engine, was exhibited at the Saratoga Convention by the Rand Drill Company. The compressor is their "Imperial No. 11," with 6 by 6-in. cylinders, and the ratio of speed is 310 revolutions of the engine to 200 of the compressor. The exhibit also included a similar compressor belted to a 7.5-h.p. motor, a compound 360-foot "Type 10" compressor, with 9 by 12-in. steam and 9 and 14 by 12-in. air cylinders, and an 8 by 8-in. "Imperial" belt-driven compressor.

The Kindl Car Truck Company, of Chicago, exhibited models of Kindl and Cloud trucks at the Saratoga Conventions, and a great deal of attention was given to the Kindl truck with rollers for side motion. It is becoming evident that side motion is desired by those who are anxious about the failure of cast-iron wheels. This company has recently acquired the Cloud truck, and is now prepared to supply it in either the plate or trussed form.

The Soule Dust Guard Company, 113 Devonshire street, Boston, exhibited their rawhide-lined dust guards at the Saratoga Convention. This guard is made of wood and is lined with a narrow ring of rawhide secured in a recess on one side. The construction is such as to bring the wear upon the rawhide lining.

SPRING MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The forty-fifth meeting of the American Society of Mechanical Engineers was held in Boston, Mass., from May 27 to May 30, opening with a Tuesday evening meeting in Huntington Hall in the Rogers Building of the Massachusetts Institute of Technology, and closing with the Friday morning meeting in Pierce Hall at Harvard University. It was one of the best attended conventions ever held by the society, over 800 members and guests being in attendance.

The opening meeting consisted of an address of welcome by President Pritchett, of the Institute of Technology, followed by an address by President Kimball, of the Boston Society of Civil Engineers, which were responded to by Senior Vice-President Dodge, in the absence of President Reynolds. Under the head of new business, Mr. Fred J. Miller offered a resolution providing a letter ballot of the members upon proposed amendments to the rules, which was accepted to be voted upon, under the rules, at the fall meeting at New York. Mr. Henry R. Towne then presented a resolution calling for the appointment by the acting president of a nominating committee to nominate a committee to revise the rules, etc., and report to the society in time for the result to be mailed to the members before the next annual meeting, which was also agreed to.

The important matter of the proposed increase of membership dues then came up for consideration. As will be remembered from our account of the last December meeting, in our January issue, there was great surprise when it was learned that the society was over $13,000 in debt, and as a result of which the council of the society instigated a thorough investigation of the financial affairs, instead of favoring the increase of dues. A few weeks before the late meeting a 24-page pamphlet report of the investigations of the council was distributed to the members, giving in considerable detail the financial status of the society, with recommendations for the future, which may be summed up as follows: An investigation of the society's accounts by an expert accountant revealed them to be correct, showing that at the close of the last fiscal year the society had a floating debt of over $15,000, and that during that year the income had exceeded the expenditures by only about $200. It was also revealed that in the 22 years of the society's existence there had been accumulated a surplus of over $73,000, but that at present there is no surplus at all to meet an emergency and no means whatever of reducing the mortgage of $33,000, which still remains on the society's house and library. Certain unimportant economies were recommended and inaugurated by the council, but for a conclusion of the report the council again advocated an increase of dues, but this time to $20 per year.

In consideration of this report Mr. Fred J. Miller, of the finance committee, presented a careful statement respecting the present condition of the society, which, judging from the hearty applause with which it was received, expressed the sentiment of a large majority of the members present. He called attention to the fact that there had been accumulated during the past 22 years a surplus of over $73,000, which if accumulated uniformly in that time would mean an annual saving of about $3,300. That entire surplus has now disappeared, and, as it is replaced by a large deficit, it is wise to consider the reasons for it and whether the increased expenditure is wise or necessary. In regard to the character of the published volumes and the quality of the papers printed by the society and the improvement of them, he was of the opinion that, while an improvement in the practical usefulness of the papers presented is very desirable, it is doubtful if such improvement can be secured by mere expenditure of money alone, and suggested that possibly different methods might bring about such an improvement. He took exception to the final conclusions of the council that it would be advisable to raise the dues, stating that there is a prevalent and perhaps growing conviction among the members that the society will never be able to do all that it should do, nor to develop the degree of usefulness which it should, or might, develop, until it has a secretary who is not only efficient and business-like, but who can devote his entire time to the affairs of the society, having no other interests which he may consider paramount. With the cost of operation of the society's house of over $3,700 per annum, he considers the maintenance of this house an expensive luxury, especially when the interest actually paid out on the mortgage indebtedness upon it is considered in addition to the figure just mentioned; while admitting that the advantages of the society's owning its own house are of great weight, still he questions if these advantages are not being very dearly paid for, especially when it is considered that the house has become totally inadequate for its chief purpose. Mr. Jesse M. Smith thought there should be no curtailing of expenses that would in any way interfere with the usefulness of the society. He favored a free distribution of the papers, in advance of the meetings, to all members of the society, as had been done previously, until withdrawn as a measure of economy. Mr. Harrison Emerson thought organizing talent, so important for engineers to possess, to be very poorly represented by the management of the society, and that it was, in his opinion, after considerable study on the matter, possible to effect an economy of at least $10,000 per year without in any way interfering with the efficiency and usefulness of the society. He thought considerable saving might be effected in the printing, and stated that 25 per cent. of the society's income was entirely too large a proportion to be expended in salaries.

The paper on "Electricity in Cotton Mills" is one from which much may be learned with reference to the electric driving of machine tools in machine shops, as well as the question of the central power station for generating the current; much valuable information was presented with reference to the alternating current drive from the standpoint of efficiency. Professor Benjamin referred to some tests that he had made, in which it was proved that there was nothing to be gained in efficiency over the shafting method of distribution, while Mr. S. M. Vauclain stated that the introduction of electric driving in the Baldwin Locomotive Works had resulted in an economy of floor space amounting to 40 per cent., simply because the machinery could be placed to the best advantage without regard to means of receiving power.

This meeting was one of the best attended and in some ways the most remarkable convention ever held by the society, but it is to be regretted that in general the value of the papers presented was not in keeping. The large attendance was no doubt due to the many attractions in Boston and vicinity, which were greatly enjoyed by the members on the several excursions tendered them. The notable feature of this convention seems, however, to be the "housecleaning" which has been begun, and which will be continued, as a result of the investigation of the society's financial affairs and management; it seems to be the general opinion of the members that the usefulness of the society can only be increased when work is done and conditions secured which money cannot buy, and that in consequence the expenses should be lightened rather than increased.

It is to be regretted that none of the papers presented at this meeting are of sufficient interest to our readers to warrant their publication in full in our columns. We can only feel that this is the result of a lack of appreciation of the importance of the many problems still to be solved in the transportation field. Much valuable work can be done by the society in connection with the many purely mechanical problems in both steam railway practice and interurban electric railway practice, and this not by an increase of membership dues, but by an arousal of interest among both officers and members.

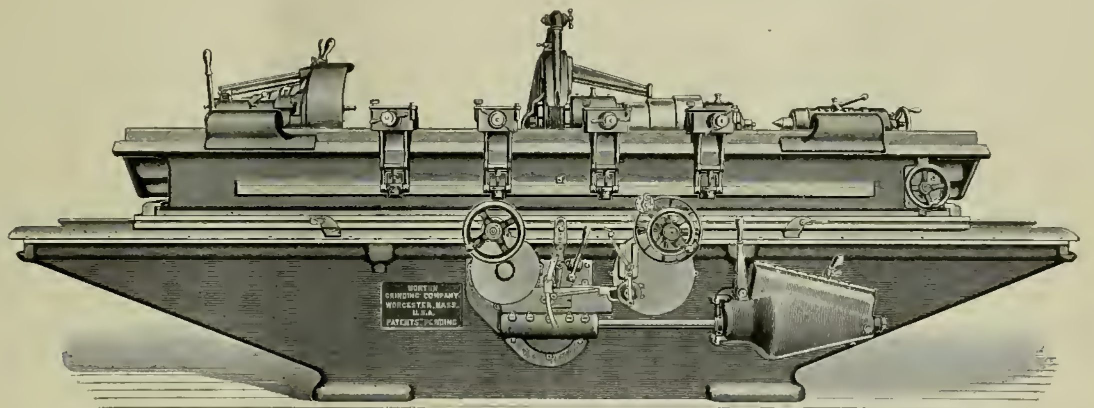
NORTON HEAVY GRINDING MACHINE.

The demand for the Norton grinding machine has steadily increased since it was brought out, only a short time ago, and it has become an established standard in a majority of the large shops. The accompanying illustration is a view of the 18 by 96-in. heavy plain grinder. As may be seen, all adjustments are controlled from the front side, there being sixteen changes of table speed, eight changes of work speed and six changes of wheel speed, all independent of each other. Among the features of this machine is the extra heavy swivel table of triangular section, with a peculiar arrangement of ways for the head and foot stocks, which gives especial stability.

It has long since been demonstrated that grinding is an economy, and not an expense; this machine has demonstrated its ability to do the accurate sizing of cylindrical work, in place of the "finishing" or "sizing" cut usually made with the lathe. Its massive proportions enable it to remove stock in large quantities, so as to allow of very crude turning in the lathe. This very materially reduces the cost of the lathe work and gives round and smooth work at a total cost much less than by the old lathe and file method. For example: A Rice & Sargeant engine exhaust valve 26½ ins. long by 5½ ins. in diameter was turned and ground complete to limit of 0.002 in. in 42 minutes. Another valve, 12 ins. in diameter by 60 ins. long, weighing 827 lbs., was ground to a limit of 0.002 in., removing 0.025 in. from the diameter, in 1 hour 15 minutes. Crucible steel lathe spindles 50 ins. long, with nine diameters, the largest bearing being 5½ ins., were rough turned from the forgings and ground to a 0.005-in. limit complete, ready to use, in five hours.

A locomotive piston rod in repair work may be ground in 30 minutes, and the material which would be cut away by a lathe-tool may be saved, and the rod is left perfectly round and smooth. This work is known to take two hours in many railroad shops with the usual methods. In finishing new piston rods a single roughing cut is taken, leaving 1-32 in. for grinding. Car axles constitute a large field on railroads for grinding, and several up-to-date roads are preparing to grind all their axles. We shall take this subject up systematically in the near future.

The Norton Grinding Company, Worcester, Mass., are building a new machine shop at Barbers Crossing, where their heavy plain grinding machines will in the future be manufactured, instead of at the shops of the Norton Emery Wheel Company, as heretofore. The new shop is located near the plant of the Norton Emery Wheel Company, and will have all modern conveniences, including an electric traveling crane capable of handling the heaviest work in the shop.



Norton Heavy Grinding Machine.

The "Twentieth Century" trains, which went into service on the New York Central and Lake Shore Railroads on June 15, 1902, making the run of 980 miles between New York and Chicago in twenty hours, are equipped with the "Axle Light" system of electric lights and fans of the Consolidated Railway Electric Lighting and Equipment Company, 100 Broadway, New York.

THE GOLD CAR HEATING & LIGHTING COMPANY.

The Gold Car Heating & Lighting Company, which has just been incorporated under the laws of the State of New York, with a capital of one million dollars ($1,000,000), has purchased outright the entire business of the Gold Car Heating Company, of New York, Chicago and London, and also the entire business of the Gold Street Car Heating Company.

It takes possession on July 1, 1902, of all of the property of both of these companies, and in addition to nearly 100 patents already owned by them, has acquired a number of new and valuable patents covering electrical apparatus.

The business of the Gold companies has increased enormously during the past five years, and now extends all over the world, wherever railway cars are operated by steam or electricity.

The Gold companies have a larger number of unfilled contracts on their books just now than ever before in the history of their business. At the present time they are engaged in equipping new cars or locomotives being built for the following railroads:

New York Central, Lake Shore & Michigan Southern, Jersey Central, Delaware, Lackawanna & Western, Lehigh Valley, Norfolk & Western, Philadelphia & Reading, New York, Ontario & Western, Chesapeake & Ohio, Southern, Atlantic Coast Line, Plant System, Alabama Great Southern, Waycross Air Line, Cincinnati Southern, Nashville, Chattanooga & St. Louis, Louisville & Nashville, Northern Pacific, Minneapolis, St. Paul & Sault Ste. Marie, Chicago, Burlington & Quincy, Missouri Pacific, Texas & Pacific, Denver & Rio Grande, Union Pacific, New Orleans & Northeastern, Pittsburgh & Lake Erie and others.

The foreign business of the company is larger now than ever before, over 2,000 sets of car-heating apparatus being under construction for shipment abroad within the next three months. Among the large electric heater contracts recently received is one from the Louisville Railway Company for over 300 sets of car-heating apparatus, and orders from the Jersey street railways for about 100 equipments, as well as from the Boston & Maine, New York, New Haven & Hartford, Massachusetts Electric Companies and South Side Elevated Railroad of Chicago. A contract has recently been closed with the Metropolitan Street Railway of New York for electric heating apparatus which will be a departure from anything of this character heretofore undertaken.

In addition to all of the work now under way, the Gold companies have already equipped nearly 40,000 cars and locomotives on about 500 railroads all over the world. The capital of the Gold Car Heating & Lighting Company, which takes over all of this business, is $1,000,000, and has been more than fully paid. There are no bonds on the new company, and there is no preferred stock. Its capital is represented by 10,000 shares of common stock of the par value of $100 each, fully paid and non-assessable, and the company has no other liabilities whatever. The net value of the property taken over by the new company is $1,000,000.

Mr. Edward E. Gold, of New York City, has been elected president of the new company, and made chairman of the executive committee. All of the stockholders of the old companies will be numbered among the stockholders of the new company, the plan having received the unanimous approval and consent of every shareholder in all of the properties purchased. The main office of the new company will be at Frankfort and Cliff streets, New York City.

The new 20-hour trains of the Pennsylvania and New York Central systems between New York and Chicago have been successfully inaugurated. The shortening of the time makes it possible for a busy man to save almost a complete business day in this journey, for 5 hours are practically a day in these times of business stress. The schedules are as follows:

New York Central—Leave New York, 2.45 P. M., Eastern time; arrive Chicago (by the Lake Shore), 9.45 A. M., Central time; returning, leave Chicago, 12.30 P. M.; arrive New York, 9.30 A. M.

Pennsylvania—Leave New York (Twenty-third street), 1.55 P. M.; Philadelphia, 4 P. M.; Harrisburg, 6.05; Altoona, 8.45, Pittsburgh, 11.20; Chicago, 8.55 A. M.; eastbound, leave Chicago at noon; arrive at New York, 9 A. M.

There has been no difficulty in making the time, and for long distance service these trains lead the world. If present expectations are realized this service will be permanent.

BOOKS AND PAMPHLETS.

The J. G. Brill Co., Philadelphia, Pa., have recently issued a very attractive descriptive pamphlet and folder regarding the Brill No. 27 perfectly equalized steam and electric passenger truck. In its latest form this truck is built up with solid forged side frames, which insures the maximum rigidity and squareness, and its characteristic features of three sets of springs supporting in series between the frame and the truck bolster and the link spring-suspended equalizing bars provide a perfectly equalized and cushioned bearing of the load. This truck is claimed not to cant or tilt under brake action, and on account of its very wide link suspension base to carry the car more steadily around curves than the usual standard truck. These and its other advantages render it adaptable to steam railroads, as well as to elevated and electric roads. The catalogue is illustrated with engravings showing the truck and its details, together with two views of its application to elevated road and to electric road practice.

A very artistic little booklet was gotten out by the Niles-Bement-Pond Company, New York, for distribution at the Crystal Palace Exposition in England. It comprises a series of engravings illustrating representative tools of their production, including heavy engine lathes, both standard and motor-driven, planers, slotters, boring mills, etc., and special railroad tools, such as special driving-wheel and car-wheel lathes, axle lathes, car-wheel boring machines and wheel presses.

Also a beautifully illustrated new steam-hammer catalogue was recently issued by the Bement, Miles & Co. branch of this company, in which the various types of hammers built by that branch are illustrated and described. It includes single-frame, double-frame, open-frame and double-frame steel tilting hammers, and drop hammers of both the belt-driven and steam types. The hammers are described as to rating, valve and valve-gear, testing, etc., with instructions for erecting. It is to be noted that this company rates their steam hammers according to the actual weights of the falling parts; thus, a 1,100-lb. hammer means one whose ram, piston and top die, together, weigh 1,100 lbs.

A beautifully illustrated brochure, entitled "A Colorado Summer," has recently been issued by the passenger department of the Santa Fe, illustrating and describing the principal resorts on their entire system, including the Colorado Midland, the Denver & Rio Grande and the Colorado & Southern. It is very artistically gotten up, and enticingly describes the many pleasures of the Colorado region and the West.

An interesting folder has been received from the Soule Rawhide-Lined Dust Guard Company, Boston, Mass., in which the necessity of care and protection of journal boxes from dust and grit is set forth. It is stated that as many as 50,000 of their dust guards are ordered per annum by individual railroads for repair shops.

The "Major" Coupler is illustrated and described in a pamphlet received from the Buckeye Malleable Iron & Coupler Company, Columbus, Ohio. The reputation and high standing of this company would justify attention to any announcement they may make, but when they issue a description of a coupler designed to secure the advantage of the full capacity of the M. C. B. coupler shank our readers are urged to give it the attention it deserves. Ten minutes suffices to read this pamphlet and learn how the new coupler is made to secure a positive lock set in the head, a knuckle opener, a construction which relieves the knuckle pin of stress and gives large bearing areas and wearing surfaces, provides deep sections of metal where strength is needed and without adding to the number of parts of the old-time M. C. B. type couplers. The pamphlet is well printed and well illustrated. It represents the result of experience, combined with a desire to meet the conditions of increasing severity in the handling of cars.

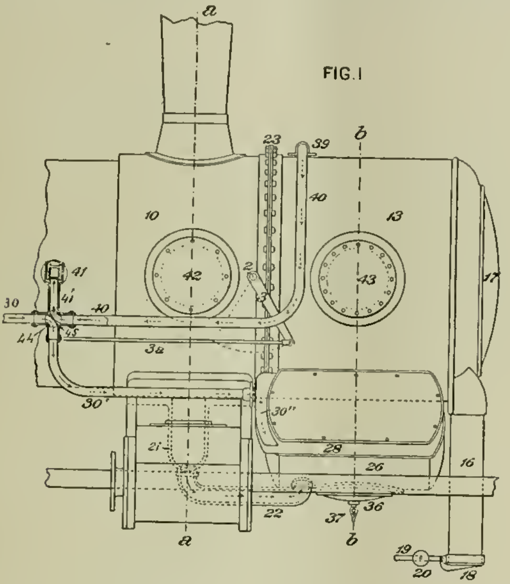
A profusely illustrated catalogue has been received descriptive of the Century belt conveyors and conveying machinery, manufactured by the Jeffrey Manufacturing Company, Columbus, O., in which different types of apparatus are shown for conveying all manner of material, from ores, sand, refuse, gravel, coal, ashes, etc., to packages, rolls of cloth, bags of grain, etc. The endless belt conveyors are made to run flat, or troughing to carry material combined with liquids. Also bucket conveyors, endless wooden apron and pan conveyors, are shown, together with crushers and sizing screens for coal, rock and other materials.

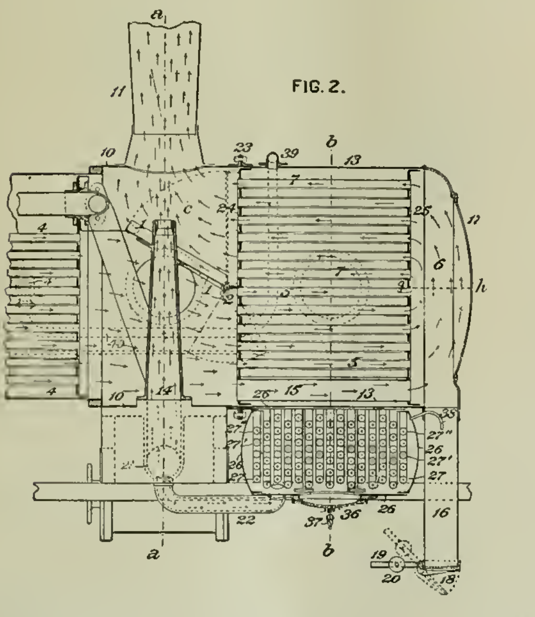
FEED-WATER HEATER FOR LOCOMOTIVES.

By M. N. Forney.*

To convert one pound of water of zero temperature into steam at 200 lbs. pressure requires 1,231.7 units of heat; a unit being the amount required to raise 1 lb. of water 1 deg. If the average temperature of water in a locomotive tender is 60 deg., then 1,231.7—60 = 1,171.7 units of heat must be imparted to it to convert it into steam of the pressure named. One per cent. of that will be 11.71 units, so that if each pound of feed water is increased that many—or, say 12—deg. in temperature, by waste heat, before it enters the boiler, it will be equivalent to a saving of 1 per cent. of the fuel required to convert it into steam. This is true theoretically, and has often been proved practically.

Assuming the average pressure of the exhaust steam to be 10 lbs., its temperature will be 240 deg. If it and the feed water are brought into such relations to each other that the heat of the steam can be communicated to the water, the latter will be heated up to





the temperature of the steam. What is required to do this in a heater is plenty of time and sufficient heating surface. If, then, the feed water is thus raised from a temperature of 60 deg. to 240 deg.—or increased 180 deg.—it would result in a saving of 15 per cent. of heat, and consequently of that proportion of fuel.

*501 Fifth avenue, New York.

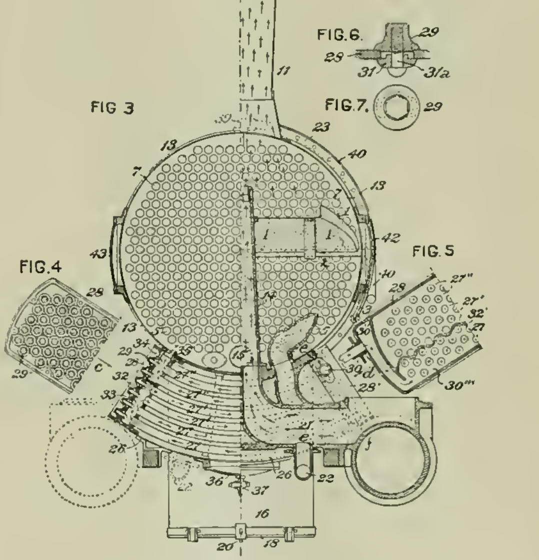
But the temperature of the waste gases in the smoke-box of a locomotive when it is working steam varies from about 400 deg. to 1,200 deg. If we heat the feed water first by the exhaust steam and next by the waste gases, then, if the feed water is raised to 300 deg. or increased 240 deg. in temperature, the saving would be 20 per cent.; if to 360 deg., 25 per cent., and to 420 deg., 30 per cent. Of course, if the water was heated to the latter temperature, in a separate heater, part of it would be changed into steam before it entered the boiler, because the sensible temperature of steam of 200 lbs. pressure is only 388 deg.

Fig. 1 represents a side view and Fig. 2 a longitudinal section of the front end of a locomotive boiler and smoke-box, with an exhaust and fire-heater: 13 is the fire-heater, which is bolted to the front end of the smoke-box by angle-iron flanges 23, and 26 is the exhaust-heater, located below the fire-heater. Fig. 3 shows two vertical half-transverse sections, the right-hand half taken on the line *a a* of Figs. 1 and 2, looking forward, and the left-hand half on the line *b b*, looking in the same direction.

The exhaust-heater, 26, consists of a crescent-shaped vessel made to conform to the contour of the cylindrical fire-heater, 13, above it. The outside shells of both are made of boiler plates, excepting the ends, 28 28' of the exhaust heater, which consist of cellular castings having double plates with water spaces between them. It is provided with a series of bent tubes, 27 27' 27", Fig. 3, which are connected to the inner plates of its heads. The spaces between the plates are divided by partitions, one of which, 32, is shown to the left side of Fig. 3, and another, 32', is represented by the serpentine lines in Fig. 5, which is a half-sectional view of one of the heads of the heater, drawn on the line *c f* of Fig. 3 and looking in the direction of the dart *d*.

The tubes are bent to correspond to the form of the heater and to permit them to be expanded and contracted by changes of temperature.

The feed water is conducted from the pump or injector to this heater by the pipe 30, shown in Fig. 1, and also on the right side of Fig. 3 and in Fig. 5. The direction of the flow of water is indi-



cated by the arrows in the pipe 30 and 30', Figs. 1 and 5. From the latter figure it will be seen that the water passes from the pipe 30' to the chamber 30" and downward to 30'" and thence into the tubes 27. In order to indicate in the end view of the tubes, in Fig. 5, the direction of the flow of the water an × mark is used to show that the flow is from the observer and a — mark that it is toward him. From the two figures last referred to it will be understood that the water enters the lower series of tubes 27 27—which are represented by dotted lines on the right side of Fig. 3—and flows through them to the chamber 33, on the left, as indicated by the arrows. There the current is reversed and flows back toward the right, through the tubes 27' 27', to a chamber at the right-hand and adjacent to 28', where the current is again reversed and the water flows back through the tubes 27" 27" to the chamber 34, from which it is conducted to the fire-heater 13 above by the passage 35.

Exhaust steam is conducted from the exhaust pipes 21, of the cylinders, to the exhaust heater by two pipes, 22 22, shown in Figs. 1, 2 and 3. The bent heating tubes, 27, 27' and 27" are thus surrounded and exposed to exhaust steam while the engine is working. The heating tubes being exposed to this steam, some of its heat is transmitted to the water inside of them. As the water must flow to and fro through them three times, it is exposed for a considerable time to the heat of the exhaust steam by which they are surrounded.

The exhaust-heater represented in the engraving has 88 tubes 2 ins. in diameter, and their average length is 50 ins., so that they have nearly 200 square feet of heating surface.

It is a well-known fact that the effect of heating many kinds of water is to cause it to deposit its impurities as soon as it gets hot. With such water the result would be that the heating tubes would soon become filled with solid deposit unless they were periodically cleaned. To facilitate this, each of the tubes of the exhaust-heater has a hand hole and cover, 29, Figs. 3 and 4*, opposite to its end. One of these is shown on an enlarged scale in Figs. 6 and 7. By unscrewing these covers, access may be had to each tube from the outside of the locomotive, and they may be cleaned from end to end by using a flexible scraper, or any tube may be caulked or removed through the hand-hole opposite its end and a new tube put in its place.

The fire-heater 13, shown in Figs. 1 and 3, consists of two series of heating-tubes, 5 5 and 7 7, Fig. 2, inclosed in a cylindrical shell which is attached to the front of the smoke-box. This shell has suitable heads, 24 and 25, to which the heating-tubes 5 5 and 7 7

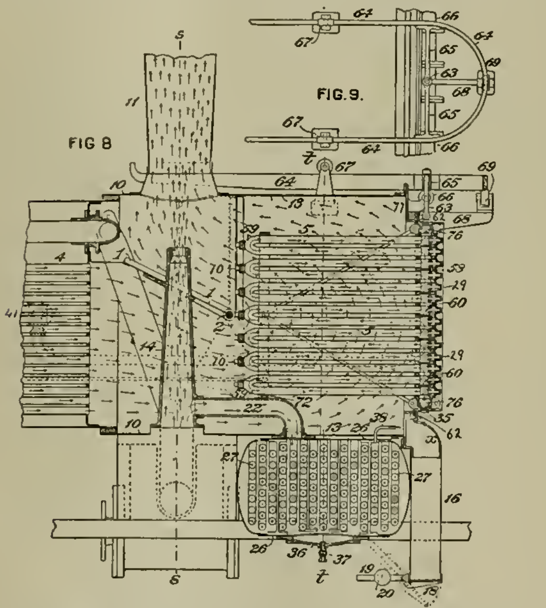


FIG 8 FIG. 9.

are connected, and it contains the water to be heated, which surrounds the tubes. The waste gases from the boiler before they escape out of the chimney are caused to circulate through these heater-tubes by means of a partition or diaphragm in the smoke-box, provided with a door or valve, 1 1, by which the lower portion of the smoke-box may be separated from the upper part *c* and—as indicated by the arrows—the products of combustion are thereby conducted from the boiler tubes 4 4 through the lower portion of the smoke-box to the lower tubes 5 5 of the heater, and through them to a chamber, 6, in front of it, and then back through the upper tubes, 7 7, to the top chamber *c* of the smoke-box and thence to the chimney 11. The door 1 1 is attached to a transverse shaft, 2, which can be turned by a lever, 3, Figs. 1 and 2, on the outside of the smoke-box, and a rod, 3a, which connects the lever with the cab, thus raising the door into the position represented by the dotted lines at 24 in Fig. 2. Communication is thus opened from the lower chamber of the smoke-box to the upper one, and the chimney, so that the smoke and waste gases can then pass directly from the boiler tubes 4 4 to the smoke-box and out of the chimney.

The heater represented has 412 2¼-in. tubes 3 ft. 8 ins. long, and has 890 sq. ft. of heating surface. The temperatures in the smoke-box, when a locomotive is working under steam, vary from about 400 to 1,200 deg. With that amount of heating surface and such temperatures, a very large amount of heat would doubtless be transmitted to the feed water—how much cannot, of course, be determined, excepting by actual test, but, as already pointed out, these figures indicate not only the possibility, but the probability, of a saving of a very large percentage of fuel, and, in places where bad water is used, a very material saving in the cost of boiler repairs, by arresting the solid constituents of the water and depositing them in the heaters, and thus excluding them from the boiler.

When a feed-water heater is used the consumption of steam by an injector is a matter of much importance. It is a fact established by careful experiments that with a steam pressure of 200 lbs. it takes about 10 per cent. of all the steam generated by a boiler to operate the injector; or, in other words, it takes 1 lb. of steam to put 10 lbs. of water into a boiler. It is true that a considerable quantity of the heat of this steam is imparted to the water and is returned to the boiler, so that it is not wasted, but a pump operated by steam working expansively will require only about one-tenth or one-twelfth as much steam as an injector to force a given quantity of water into a boiler. The pump, however, will not heat the water, but if a boiler is fed with a pump and the feed water is heated by exhaust steam or the waste gases, then clearly there is a saving of about 9 per cent. of all the steam generated, because the pump takes only about one-tenth as much steam to work it as an injector does, and if the feed water from the pump is heated it may be delivered into the boiler at the same temperature as it is by an injector.

To get the full advantage of heating feed water, it is, therefore, essential to feed with a pump, and not with an injector, excepting when the engine is standing still or in emergencies. It is, therefore, proposed, in using the feed-water heater here described, to feed the boiler in regular service with a pump having a variable stroke, so that the quantity of water fed can be accurately regulated to the amount of work done.

The centers of the tubes are placed directly opposite those of the boiler tubes 4, and in order to make it possible to remove any of the latter without disturbance to the heater, the heater tubes are made of sufficient internal diameter so that the boiler tubes will pass through them, and the latter can thus be removed through the former and new ones substituted.

By the construction herein described a large amount of heating surface is provided in the fire-heater. The water is then admitted to or near its lower portion, and escapes through the nozzle 39 at its top and is conducted by a pipe, 40, to the check-valve 41, Figs. 1 and 2, and thence to the boiler. The fire-heater is, therefore, entirely filled with water, which is in contact with its heating surfaces for a period of time equal to that required for the consumption of a volume of water in the boiler equal to the contents of the heater.

No netting is shown in the smoke-box, but should it be needed it could be placed in the supplementary smoke-box, 6, as indicated at *g h*, and also below the door 1 1 in the smoke-box.

To provide for the contingency of the failure of the heater by the bursting or collapse of a tube or pipe, or other cause, and to prevent the engine from being disabled thereby, the feed pipes are connected to a four-way valve or cock, 44, Fig. 1. The feed pipe 30 is connected with the pump or injector; 30′ is a continuation of the feed pipe, and is connected to the exhaust-heater; 40 is a delivery pipe, and connects the fire-heater with the valve 44, and 41′ connects it with the check valve 41. The valve 44 is provided with a plug, 45,

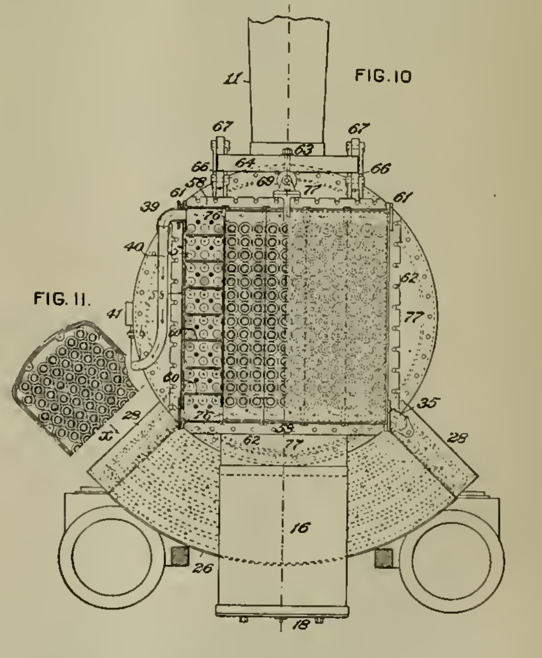


FIG. 10 FIG. 11.

which, when the heater is in condition to work, is set in the position in which it is represented. The feed-water can then flow, as indicated by the arrows, from the pump or injector through the pipe 30 and the passage in the valve 44 to the pipe 30′, and thence to the exhaust-heater; the course through that has already been explained. After passing through it, it enters the fire-heater, as described, and escapes at its top through a connection, 39, and the pipe 40 to the valve 44, and through the passage shown to the check valve 41, and thence to the boiler. In case of the failure of any part of the heater, so that it would be necessary to shut off the water from it, the plug 45 of the valve 44 would be turned into the position represented by dotted lines. The water would then flow from the pump through the pipe 30 and the passage in the valve directly to the check valve and boiler, and the pipes 30′ and 40 would be shut off from it. At the same time the door 1 1 in the smoke-box would be opened, so that the smoke and gases would escape direct up the chimney, and thus would not pass through the fire-heater tubes. By these means the engine would not be disabled

*Fig. 4 is a half view of the end of the heater, looking at it in the direction indicated by the dart *c*.

by the failure of the heater, and, in fact, if it was important to do so, the position of the plug of the valve 44 could be changed and the door in the smoke-box be opened without stopping the engine.

In many places water must be used which contains ingredients which form a hard deposit, and which can only be removed by having free access to the surfaces on which the incrustation is deposited. The provisions for giving access to the tubes of the exhaust-heater have been described, but if the tubes of the fire-heater should become incrusted with hard deposit, it would be impossible to remove it except by taking out the tubes. To provide for this contingency, the fire-heater shown in Figs. 8-11 was designed. It consists of longitudinal horizontal water tubes, so disposed that they can be removed from the smoke-box whenever it may be desirable to do so to clean or repair them. The exhaust-heater 26 has curved tubes, and, being substantially similar to that shown in Figs. 1 to 5, need not be again described. The tubes 5 of the fire-heater, Fig. 8, are placed horizontally and set longitudinally in the extended smoke-box 13, to the front of which a number of cast-iron sectional headers, 58, are bolted. These are made with double plates and a water space between them, and are of a width sufficient to take three, or may be made to take any other number of vertical rows of heating tubes. The tubes are attached to the inner plates of the headers in pairs, and the adjoining back ends of each pair of tubes are connected together by a U connection, 59. Between the two tubes of each pair a division, 60, is formed in the headers. These divisions are shown in Fig. 8 and also in Fig. 10, in which one header, 58, is represented in transverse section. The feed water is conducted from the exhaust-heater to the fire-heater through the openings and pipe 35, Figs. 8 and 10. The different headers have water passages, 76 76, Fig. 10, at their upper and lower ends, connecting those which adjoin each other. The water when it enters through the pipe 35 (see Fig. 10) can flow from one header to the other (as indicated by the dotted arrows on the left of 35) and into the lowermost of the tubes 5 (see Fig. 8), and backward through them to the U bends, 59, by which these tubes are connected to those next above them, and then forward through the second row of tubes to the next compartment in the header above the lowermost one, as indicated by the arrows in the figure. The water can then again flow backward through the third row of tubes from the bottom and forward through the fourth row to the header, and so on until it reaches the top row and the top of the headers. It then flows in the direction indicated by the dotted arrows in Fig. 10, above the top row of tubes, then out through the nozzle 39, and is conducted by the pipe 40 to the check valve 41 (shown in Figs. 8 and 10), and thence to the boiler.

In order to give access to the inside of the bends 59, plugs 70 are screwed into their back ends. By unscrewing these any scale or deposit which may accumulate in the bends may be removed.

In order to be able to handle the heater conveniently, the headers and tubes connected to them are suspended by a bolt, 63, attached to the top of the system of headers upon a species of crane, 64, a partial plan of which is shown by Fig. 9.

The weight of the heater, which will be about 10,000 pounds, may be urged as an objection to it. With mogul and consolidation engines this must be carried on the pony truck in front, and it may in some cases be essential to increase the size of the axles and other parts of the truck to carry this extra weight, but in new engines there will be no difficulty in distributing the weight and proportioning the parts satisfactorily.

From the preceding description it will be seen that this heater has the following advantages:

1. An ample amount—over 1,000 square feet—of heating surface.

2. The insides of all the water tubes are accessible and can be thoroughly cleaned, caulked or be replaced from the outside of the locomotive.

3. They are all entirely free to expand and contract, thus relieving them and the parts to which they are attached from strains and consequent deterioration and corrosion.

4. The fire-heater shown in Fig. 8 can be readily removed from the smoke-box and be cleaned externally or repaired.

5. If any part of the heater should fail the water and waste gases can be shut off from it, and the water fed direct into the boiler, and the waste gases be conducted to the chimney, so that the engine will not be disabled by the failure of the heater.

6. The only care which will be required to operate the heater will be to remove the sediment and incrustation from the tubes.

The cost of the heater has not yet been ascertained, but if it will lessen the consumption of coal from 25 to 30 per cent., increase the capacity of the boiler in like proportion, arrest the solid constituents of the water before they enter the boiler, and consequently materially reduce the cost of boiler repairs, and keep the engine in service a greater proportion of the time, these advantages should be some indication of its value to railroad companies.

The Dayton Draft Gear, manufactured by the Dayton Malleable Iron Company, of Dayton, Ohio, is the subject of a 24-page pamphlet just issued. It discusses the origin and design of the gear, the construction and tests at Purdue University, and illustrates seven different arrangements of the elements as used by well-known railroads. These are illustrated by half-tone engravings on one page and corresponding line drawings upon the opposite page, the engravings being excellent. One of the tests recorded indicates that the gear, after sustaining a loan of 250,000 pounds for a period of 12 hours, was still in condition for service. The catalogue gives the information wanted concerning this gear by railroad officers.

MASTER CAR BUILDERS' ASSOCIATION.

THIRTY-SIXTH ANNUAL CONVENTION.

Abstracts of Reports.

OUTSIDE DIMENSIONS OF BOX CARS.

Committee—C. A. Schroyer, G. W. Rhodes, W. P. Appleyard, Joseph Buker, J. N. Barr.

At the meeting of the American Railway Association, held April 24, 1901, the following principle regarding the construction of box cars was approved:

"That the essential elements of the standard box car require that the height and width be as great as are permitted by the physical limitations of the important railroad clearances and the present established height of loading platforms; that the length be determined by economy in construction, maintenance and operation and the requirements of economical storage."

At the convention of the same association, held in St. Louis on October 23, 1901, in pursuance of the above principle a Committee on Standard Dimensions of Box Cars submitted a report in which the following resolution was offered for adoption:

"Resolved, That the dimensions of the standard box car be 36 ft. in length, 8 ft. 6 ins. in width, and 8 ft. in height, all inside dimensions. Cross section, 68 square feet, capacity 2,448 cubic feet. The side-door opening to be 6 ft. in width."

On a vote by the roads the above resolution was adopted, there being but one dissenting vote. The cross-section and longitudinal measurements are the dimensions between lining, the vertical measurements being from top of floor to under side of carline. During the discussion of the above report the following resolution was adopted:

"Resolved, That the Master Car Builders' Association be requested to consider and adopt the required external dimensions for the standard box car, based upon the interior dimensions as prescribed by the American Railway Association."

Upon receipt of advice from the American Railway Association to the above effect, the president of this association appointed the above mentioned committee to consider and report at this convention such external dimensions as would meet the requirements of a car with the inside measurements agreed upon.

The above is a brief outline of the facts leading up to the formation of your committee.

Believing the essential elements of the box car to be as stated in the principles enunciated above, your committee carefully considered the physical limitations of clearances, etc., of the railroads of the country, bearing in mind the further limitations prescribed for inside dimensions by the American Railway Association, and submitted to the members of this association certain outside dimensions, as follows:

For a box car set on trucks used as standard, where the height from top of rail to top of floor is 4 feet:

	Feet.	Inches.
Height, top of rail to upper edge of eaves........	12	6¾
Width at eaves, at above height, maximum.......	9	7⅝

For a box car set on low trucks, where the height from top of rail to top of floor is 3 ft. 6 ins.:

	Feet.	Inches.
Height, top of rail to upper edge of eaves........	12	¾
Width at eaves, at above height, maximum.......	9	10

The members of the association were asked to state whether or not they approved of the above dimensions; if not, wherein they should be modified to meet existing conditions. From the replies to this circular it was found that the exterior dimensions given above were satisfactory to a majority of the roads, but on certain trunk lines there were clearance limits which would not permit cars set on low trucks (3 ft. 6 ins.), of the cross section given (9 ft. 10 ins.), at the height of 12 ft. ¾ in., to pass.

To meet these conditions your committee has decided to modify its original recommendation in this respect, and would suggest 9 ft. 7 ins. as the maximum width at eaves at a height of 12 ft. ¾ in., and for the sake of uniformity would also change its original recommendation as regards the width at eaves of cars set on trucks, with 4 feet in height to top of floor, from 9 ft. 7⅝ ins. to 9 ft. 7 ins., thus giving a standard width for cars of either height.

In the determination of the above figures the following dimensions have been used:

VERTICAL DIMENSIONS.

For a box car set on high trucks (4 ft. to top of floor):

	Feet.	Inches.
Height, top of rail to upper edge of eaves............	12	6¾
DETAILS.		
Top of rail to upper face of floor....................	4	0
Upper face of floor to under edge of carline...........	8	0
Width of carline at end where secured to plate........	0	3 13-16
Thickness of rafter to which metallic roof is applied...	0	1⅜
Thickness of purline to which roof boards are secured..	0	1⅛
Thickness of roof boards..........................	0	13-16
	12	7⅛
Less pitch of roof from inside edge of plate to outside edge of eaves..............................	0	⅜
Total	12	6¾

CROSS SECTION.

	Feet.	Inches.
Width at eaves, at above height maximum	9	7
DETAILS.		
Width between lining	8	6
Thickness of lining	0	1⅝
Thickness of siding	0	1⅝
Thickness of posts and braces	0	6
Air space between fascia boards	0	1
Thickness of fascia boards	0	1⅝
Projection on each side for roof, 9-16 in	0	1⅛
Total width	9	7

VERTICAL DIMENSIONS.

For a box car set on low trucks (3 ft. 6 ins. to top of floor) :

	Feet.	Inches.
Height, top of rail to upper edge of eaves	12	¾
DETAILS.		
Top of rail to upper face of floor	3	6
Upper face of floor to under side of carline	8	0
Width of carline at end where secured to plate	0	3 13-16
Thickness of rafter to which metallic roof is applied	0	1¾
Thickness of purline to which roof boards are secured	0	1⅛
Thickness of roof boards	0	13-16
	12	1⅛
Less pitch of roof from inside edge of plate to outside edge of eaves	0	⅜
Total height	12	¾

CROSS SECTION.

	Feet.	Inches.
Width at eaves, at above height maximum	9	7
DETAILS.		
Width between lining	8	6
Thickness of lining	0	1⅝
Thickness of siding	0	1⅝
Thickness of posts and braces	0	6
Air space between fascia boards	0	1
Thickness of fascia boards	0	1⅝
Projection on each side for roof, 9-16 in	0	1⅛
Total width	9	7

In determining height from top of rail to upper face of floor of 4 ft., the following dimensions were used:

	Feet.	Inches.
Rail line to center line of drawbar	2	10½
One-half of drawbar stem	0	2½
Clearance between drawbar stem and under side of sill	0	¼
Thickness of sill	0	9
Thickness of floor	0	1¾
Total	4	0

Where the height from top of rail to upper face of floor is 3 ft. 6 ins., the following dimensions were used:

	Feet.	Inches.
Rail line to center line of drawbar	2	10½
One-half of drawbar stem	0	3
Width of sill above gain for drawbar, the floor to be rabbeted into sill	0	4½
Total	3	6

The inside measurements having been established by the American Railway Association, and the outside dimensions being confined to the limiting clearances of the leading trunk lines, the committee has carefully considered the various forms of framing which have been submitted to it, in order that the best possible construction may be had between these limitations, and it submits for your consideration what it believes to be a substantial box-car framing, which will carry the loads required and make a strong car in every particular.

Your committee would recommend that on all cars built to these dimensions the words and letters "Standard, 12 ft. 6¾ ins. by 9 ft. 7 ins." be stenciled in letters not less than three inches in height on the end fascia boards.

Your committee would also recommend that the dimensions for inside measurements of box cars, as prescribed by the American Railway Association, be adopted as the standard of this association.

SIDE DOOR.

The American Railway Association has recommended that the side-door opening for the above car be 6 ft.

Your committee finds that there is much objection from the mechanical standpoint to the 6 ft. width of door opening, for the following reasons:

1. It weakens the framing of the car, both on the sill and plate lines.

2. The increased size in the width and height of the side door makes it extremely difficult to construct a door which will remain straight and prevent binding on the sides of the car, which has always been found to be very objectionable and destructive to both siding and door, because of the indifferent manner in which our doors are manipulated at the freight houses.

3. On the grain-carrying roads it would necessitate the use of a grain door so heavy and large that it would be impracticable for one man to handle it: additional complications would be entailed in its construction, and it would necessitate carrying in stock additional thicknesses of lumber in such sizes as not to be readily obtainable.

Your committee, while it has recommended for adoption as standard external dimensions which it believes adequate for strength for cars of the inside dimensions adopted by the American Railway Association, and has presented for your consideration certain details of car framing to meet these external dimensions, does not recommend these latter details for adoption. It believes that the time is now here for the adoption by this association of a standard box-car framing, and it would recommend that a committee be appointed to propose for adoption as standard, at our next convention, a system of framing for box cars with inside and outside dimensions as above.

A brief summary of the recommendations herein mentioned is as follows:

1. That the inside dimensions of box cars as approved by the American Railway Association, namely, 36 ft. long, 8 ft. 6 ins. wide and 8 ft. high, be submitted to letter ballot for adoption as standard:

2. For box cars on high trucks (4 ft. to top of floor) :

	Feet.	Inches.
Height, top or rail to upper edge of eaves	12	6¾
Width at eaves, at above height, maximum	9	7

be submitted to letter ballot for adoption as standard.

3. For box cars on low trucks (3 ft. 6 ins.) :

	Feet.	Inches.
Height, top of rail to upper edge of eaves	12	¾
Width at eaves, at above height, maximum	9	7

be submitted to letter ballot for adoption as standard.

4. That the words and letters "Standard, 12 ft. 6¾ ins. by 9 ft. 7 ins." be stenciled in 3-inch letters on the end fascia boards on all cars built to these dimensions.

5. That a committee be appointed to report at the next convention a detailed form of framing for box cars, for adoption as standard.

DRAFT GEAR.

Committee—E. D. Bronner, G. F. Wilson, Mord. Roberts, W. W. Kiesel, Jr., T. A. Lawes, C. M. Mendenhall, J. F. Deems, Wm. Forsyth.

At the convention of 1900 a Committee on Draft Gear was appointed, with instructions to report on the requirements of modern draft gear to meet modern conditions, spring capacity, sizes and strength of parts, excluding drawbar, prepare methods of attaching to sills of cars and submit recommendations and drawings covering principles.

At the convention of 1901 a preliminary report was made, outlining in a general way its proposed plan of action. The committee was continued, with instructions to carry its plan into operation.

Pursuant to these instructions, at a meeting of the committee, held in Chicago, October 8, 1901, a preliminary plan of tests was proposed, and it was decided to request the draft gear makers and those of our members interested in this work to meet the committee at a session to be held at the Auditorium Hotel, Chicago, on Wednesday, November 20, 1901, at 10 o'clock A. M., to discuss this proposed plan of tests. The object of this meeting was to bring out criticisms and suggestions, to the end that the tests as determined and agreed upon beforehand would be satisfactory to all concerned.

The Pennsylvania R. R., through Mr. W. W. Atterbury, General Superintendent Motive Power, kindly gave the association the use of its drop testing machine at Altoona, Pa., for drop test purposes. Likewise Purdue University, through Prof. W. F. M. Goss, gave the association the use of its 300,000-pound capacity tensile testing machine, at Lafayette, Ind., for tensile and compression tests.

Quite a number of the draft gear manufacturers met with the committee on the date named, and after a free discussion of the preliminary plan of tests, the following plan was agreed upon:

Nature of Tests.

First—Tests under the standard M. C. B. drop testing machine.

Second—Tests in a 300,000-pound capacity tensile testing machine.

These tests are expected to show the efficiency of the different riggings and their relative standing under shocks and under steady pulls.

Testing Apparatus.

The drop testing machine used to be the one at Altoona, Pa., owned by the Pennsylvania Railroad and built according to M. C. B. standards, and shown in the Proceedings of the Association. The limit of this machine is a drop of 40 ft., and the weight is 1,640 pounds.

The tensile and compression testing apparatus used to be the Riehle screw machine at Purdue University, Lafayette, Ind. It has a capacity of 300,000 pounds, and it is fitted with an automatic beam of such dimensions as to allow tensile and compression tests to be made on specimens 8 ft. long and less, and permits of any length of draft rigging which can be used on a car.

Specifications for Mounting Draft Rigging for Tensile and Compression Tests.

Manufacturers will be required to furnish two draft riggings complete, already fitted to sills to suit the tensile testing machine at Purdue University. One rigging will be used for pulling and one for compression test. The riggings may be attached to either 10-in. steel I-beams or 5 x 9-in. oak timbers, the spread varying from 9 to 23 ins. for the steel and 9 to 18 ins. for the wood construction. In addition to the draft rigging, manufacturers will only be required to furnish the I-beams or oak timbers properly fitted, as shown by detail drawings, and the cast-steel dummy couplers. The eye bolts, pins, crossbar, rods and caps will be used in all the tests and be furnished by the committee.

Drop Tests.

One sample of each kind of rigging, approved by the committee and properly mounted, will be required for the drop tests. For drop test purposes, draft riggings will be divided into two classes, as follows:

Class I., underhung draft rigging for cars with wood or metal draft sills where the draft attachments are not blocked between the body bolsters.

Class II., draft riggings placed between the center sills, and also cars where underhung draft attachments are well blocked to the body bolsters and well blocked between the body bolsters.

It is anticipated that different results will be obtained from the testing of these two classes of riggings. Riggings included in Class I. will first be tested as applied to cars. If the fastenings begin to fail, then blocking will be put in between the attachments and the anvil and the draft attachments will be tested to destruction. If necessary, Class II. riggings will be blocked in the same manner.

If any part fails in the test, that part may be replaced once, provided it is thought desirable by the committee.

In testing under the drop, the test will begin with a drop of 1 ft., and the height of drop will be increased by intervals of 1 ft., one blow each, until the rigging is destroyed. A tup of 1,640 lbs. weight will be used, striking the face of the dummy coupler. When parts are replaced, the test will be carried on from the point where the test was discontinued on account of the broken part.

Tensile and Compression Tests.

Two samples of each kind of draft rigging, approved by the committee and properly mounted, will be required for these tests. One rigging will be tested in tension and the other in compression. These tests will be carried to the capacity of the machine, 300,000 lbs., provided the riggings do not previously fail. Curves will be obtained, showing the relation between the load and the movement of the coupler. The load will be removed at frequent intervals before the draft rigging is injured, so as to ascertain its condition and its behavior on release of load. The points at which any failures occur will be noted in detail. If any part fails in the test, that part may be replaced at once, if it is thought desirable by the committee.

The following definitions of terms were adopted for use in connection with the work of the committee:

Draft Rigging.—A general term, implying the whole combination of draft attachments and coupler attachments.

Draft Attachment. — The parts of the draft rigging attached to center sills of the car, including sill plates, carrying irons, etc.

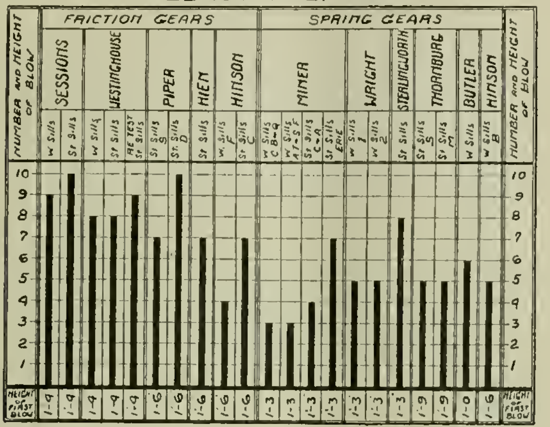
Coupler Attachments. — The parts of the draft rigging attached to the coupler and included within the yoke, such as the yoke, springs and followers, or their substitutes.

In accordance with the arrangements had at this meeting, ten draft gear manufacturers submitted designs for testing, the understanding being that each manufacturer should be permitted to witness only the test of his own device, the details of the tests to be presented in full to this convention. Your committee has, therefore, thought it advisable to give in detail the result of tests, which it is hoped will prove of interest.

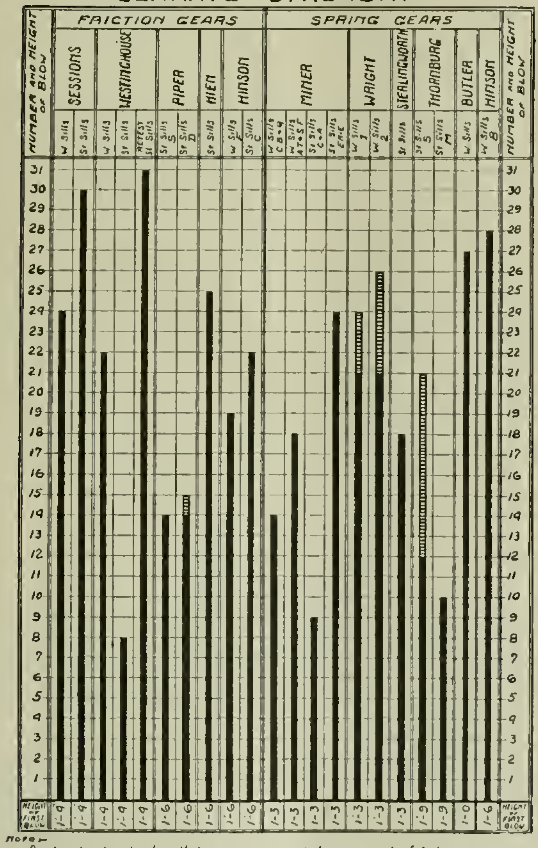
On account of the extent of the tests, the large number of gears tested and reported on and the amount of work required to put the results in shape, it has not been possible at this time to do anything more than present the facts as shown by the tests. The committee, therefore, has not attempted to draw any conclusions from the tests or to make any comparisons of the various gears.

Your committee is of the opinion that, in order to fully carry out the instructions given by the association as to the nature of a final

— ELASTIC LIMIT —

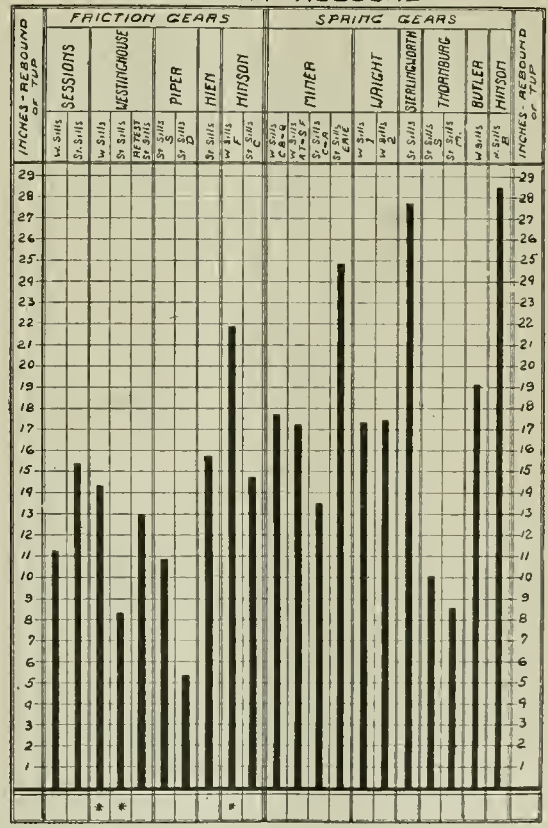


— ULTIMATE STRENGTH —



Note — Section lined parts show that test was carried beyond point of failure

— MAXIMUM REBOUND —



* Rebound still increasing when gear failed

Diagrams Showing Results of Tests on Draft Gear.

report on the subject of draft gear, that a series of road tests is necessary, whereby a record can be kept for a given period of the repairs necessary to the draft gear itself and to the other parts of the car independent of each other; also that a record be kept of the car mileage and tons hauled during that period, and it would recommend that a committee be appointed to carry these tests to a conclusion. It would then be possible to design a draft gear in conformity to the original instructions given the committee by the association.

STANDARD METHODS OF CLEANING AIR BRAKES.

Committee—C. H. Quereau, F. H. Scheffer, W. E. Symons.

After carefully considering the matter we have decided that there cannot well be standard methods of cleaning air brakes because of the varying conditions and facilities, any more than there can be standard methods of doing any other work. Dimensions and designs can be made standard, but we believe it will be best only to recommend standard practice for methods of cleaning air brakes. With this understanding the following is offered:

The brake cylinder and its parts need not be removed from the car for cleaning. First, secure the piston rod firmly to the cylinder head, then, after removing the cylinder head, piston rod, piston head and release spring, scrape off all deposits of gum and dirt with a narrow putty knife and place the removed parts in kerosene or other light oil, leaving them there until the inside of the cylinder is thoroughly cleaned. Particular attention should be paid to cleaning the leakage groove and the brake cylinder tube. Then clean the parts which have been soaking, removing the packing leather and expanding ring for proper inspection and cleaning. When the expanding ring is free its ends should be from 1¼ to 1½ ins. apart. In all cases the follower nuts should be drawn up snugly before replacing the piston head and the inside of the cylinder and the packing leather evenly coated with a suitable grease or vaseline. No sharp tool should be used in getting the packing leather into the cylinder. After the piston is in place and before the cylinder head is fastened on, the piston rod should be moved in all directions about 3 ins. from the center line of the cylinder, in order to be certain that the expanding ring is not out of place. The cylinder should be stenciled with the date of cleaning, using white lead, and if on a foreign car, a repair card should be attached, as provided by the rules. The bolts or nuts holding the cylinder and reservoir to the car should be tightened.

The triple valve should be removed from the car for cleaning in the shop, to be replaced by a triple in good condition. It should be dismantled and all the parts, except those with rubber seats, immersed in kerosene to soften the accumulated oil and gum. No metal tool should be used to remove gum or dirt or loosen the piston packing ring in its groove, as the almost inevitable result will be damage to some vital part of the triple. Particular pains should be taken in cleaning the feed groove not to enlarge it. Rags, or better still, chamois skins, should be used rather than waste, as the latter invariably leaves lint on the parts on which it is used. Great care must be used in removing the emergency valve seat, as this is frequently found bruised and distorted in triples which have been cleaned. The working parts should be carefully examined to know they are in good order. Particular attention should be given the triple piston packing ring, the ends of which should not be more than 1-64 in. apart when the piston is in its bush, and should be a neat fit in its groove and the triple piston bushing. The bushing should be true and without more than a barely perceptible shoulder in it. The graduating stem nut should be cleaned of dirt and rust, the graduating stem work freely in its nut, and the graduating spring be of standard dimensions. The slide valve, triple piston packing ring and bushing should be lubricated with a very few drops of signal oil, but the emergency piston, valve and check should not be oiled.

Should the triple piston packing ring need to be removed or the bushing require truing, we strongly recommend that this work be done by the manufacturers. We are thoroughly convinced that the average workman cannot, at least does not, do work of this kind satisfactorily, and that by far the largest proportion of the attempts to economize in this way result in inefficient air brakes and slid flat wheels.

Usually sufficient attention is not paid to the condition of the emergency parts of the triple, as shown by their condition; the emergency valve seat is found distorted, the stem bent, the rubber seat imperfect and the check valve not properly fitting in a number of cases. These facts account for a large number of slid flat wheels.

The cylinder cap gasket and check valve case gasket should be carefully examined and cleaned by using a cloth. They should not be scraped with a metal tool. Judging an examination of a number of triples, these gaskets should be renewed more frequently than they are.

Before assembling the parts after cleaning, the casings and body of the triple should be thoroughly cleaned out with a blast of compressed air.

In replacing the emergency parts the greatest care should be exercised not to injure any of them when tightening the cap screws.

When replacing the triple on the auxiliary reservoir the gasket should be fitted to the triple instead of the reservoir.

Testing Triples.

After cleaning and repairing it is essential that triples be tested and come within required limits, if a reasonable efficiency of the air brakes is to be maintained.

Test No. 1.—The tightness of the slide valve, the emergency and check valves and all points should be determined by painting with soap suds.

Test No. 2.—Maintaining a pressure of 90 pounds in the train pipe, the auxiliary pressure should reach 70 pounds in not less than 45 seconds or more than 60 seconds, as provided in test No. 9 of the M. C. B. Air Brake Tests.

Test No. 3.—To test repaired triples for release, charge the auxiliary to 70 pounds pressure and make a full service reduction of 20 pounds, or until the auxiliary and cylinder pressure are equal. Place the special cut-out cock in such position that pressure must pass through the 3-64-in. port, and turn main reservoir pressure of 90 pounds into the train pipe. If the triple does not release under these conditions it should be condemned.

Test No. 4.—The triple piston packing ring should be tested for leakage by blocking the piston in the graduating position, maintaining the train pipe pressure at 70 pounds. Under these conditions the pressure in the auxiliary reservoir should not increase faster than 15 pounds per minute.

[Editor's Note.—The report concludes with schedules of prices for labor in cleaning and repairing.]

CAST-IRON WHEELS.

Committee—J. N. Barr, William Garstang, J. J. Hennessey, D. F. Crawford, William Apps.

Owing to circumstances beyond control, the committee was not able to get satisfactory information on the subject. This is particularly the case with reference to the wheels for cars of heavy capacity, which have been coming into vogue for the last two years; in fact, it is believed that the information on this subject is, so far, quite indefinite and fragmentary, and that insufficient experience with cars of this character does not permit of any very definite statements.

The practice for weights of wheels under 100,000-lb. capacity cars varies from a minimum of 630 lbs. to a maximum of 750 lbs. As there seems to be a great discrepancy in this respect, the committee considers the matter of sufficient importance to recommend the continuance of the committee for the coming year, to pay direct attention to the developments which may arise in this direction. This is especially important in view of the fact that some roads have considered the matter so seriously as to go, to a certain extent, into the use of steel wheels.

The question of recommending minimum weights of wheels for different classes of cars, so that at interchange points, if the wheels do not meet these figures, the cars may be refused, is one which is very difficult to deal with. If one railroad company, in order to avoid undue weight of wheels, goes to the expense of using high-priced material, it would be an injustice to it to put it on the same footing as in the case of the use of wheels of miscellaneous and undefined mixture of metal, and these railroads would be put in an undesirable situation by making a high maximum. By making a low maximum weight, that is not safe for some metals frequently used in wheels, it would leave railroad companies without proper protection.

The committee is inclined to think that the majority of railroad companies are necessarily compelled to go to the weight of wheels which gives satisfactory service on their own line, and believes that if a rule were made to prevent putting wheels of less than a given weight on certain capacity foreign cars, that the interchange requirements would be as closely met as it is practicable to do at the present time.

The committee believes that this is one of the most important matters before the association; that with the development and manufacture of larger capacity cars the circumstances are shifting rapidly, and the committee recommends that the subject should be continued for another year.

In conclusion, your committee would recommend that a careful record be kept by the members for the purpose of furnishing information to this association of all cases of breakage of wheels, giving the following information:

1. Weight of wheel. 2. Capacity of car. 3. Character of breakage. 4. Track circumstances, as far as the grade is concerned; that is, whether the breakage occurred on a grade or near the terminus of a grade of a given length. If any grades are found specially troublesome, a plan showing profile and curvature would be especially valuable.

The terms descriptive of breakages should conform, as far as possible, with the terms adopted by this association.

CODE OF RULES FOR EXAMINATION OF CAR INSPECTORS.

Committee—G. W. Rhodes, M. K. Barnham, Chas. Waughop.

In determining the proper age for inspectors we have had to bear in mind that vision and hearing, so important for men in this line of railroad work, begin to fail at 40 years of age. Glasses then become necessary, and glasses are not always successfully used in outdoor active work in all kinds of weather by car inspectors.

It has also been thought wise to map out a line of work that seems most desirable for the schooling of inspectors. The committee recommends:

One year at oiling cars.
Two years at car repairing.
Age limit for new men, 30 years.
Age limit for promoted men, 40 years.
Vision, 20-20 in one eye and not less than 20-40 in the other, without glasses.

Method of Testing.—Acuity of Vision.—The test card should be hung in a good light and the party to be examined should, if possible, be seated with his back to the window. Each eye should be examined separately, using, for the purpose of excluding one eye, a folded handkerchief. The lowest line that can be read should be determined by exposing only one letter at a time through a hole cut in a strip of cardboard. In making out the report in each case, the visual acuity of each eye should be denoted by a fraction of which the numerator represents the number of feet at which the applicant is seated from the card, while the denominator represents the number of feet at which the lowest line which he can read should be read. Thus, if at 20 ft. he reads the line marked 20 ft., his vision—20-20 or 1, which is the normal standard. If at the same distance he can only read the line marked 70 ft., his vision—20-70. If at 20 ft. he reads the 15-ft. line, the vision—20-15, or more than normal. If a room 20 ft. long cannot be used, a testing distance of 15 or 10 ft. should be employed, in which case normal vision would be represented by a 15-15 or 10-10 respectively, and lower grades of vision by such fractions as 15-20, 10-70 and so on.

Field of Vision.—Test should be made by having the applicant and examiner stand about 3 ft. apart, each with one eye shut, looking each other steadily in the eye. The examiner should then bring his hand in from the edge of the field toward the center of the space, between them, until the applicant sees it coming. This should be done from different directions, up, down, and from each side. The applicant should see the hand coming about as soon as the examiner does. If not, this should be noted on the report.

Hearing.—Test should be made in a quiet room. First, the examiner should hold the watch opposite the ear to be examined not less than 48 ins. distant, then gradually approach the ear until the applicant hears the tick, the stop being used to satisfy the examiner that the applicant is not deceiving. The distance at which the applicant hears the watch should be noted in inches. The normal ear should hear the tick of the watch at 48 ins. Then the hearing power will be denoted by a fraction whose numerator represents the number of inches at which the watch is heard. Thus, if he hears the watch at 48 ins. his hearing—48-48, or normal. If he hears it at only 10 ins. distant his hearing—10-48, and so on.

Color.—The committee does not think it essential that inspectors should be rejected on account of imperfect color sense. It is, however, believed that inspectors should be tested as to their color sense so that they, as well as their employer, may know their condition in this respect.

Educational.—The applicant should be able to write a legible hand in English, and also to read manuscript matter as well as printed matter.

Car Knowledge.—The inspectors should be able to name each part of the cars in general use, in preference using M. C. B. dictionary terms.

M. C. B. Rules.—Inspectors must pass a satisfactory examination on M. C. B. Rules, answering 75 per cent. of the questions submitted. (Sample questions conclude the report.)

STANDARD AXLES AND SPECIFICATIONS FOR SAME.

Committee—E. D. Nelson, Wm. Garstang, Jas. Coleman.

The present M. C. B. specifications for axles have been in force since 1896, and therefore the oldest axles made according to these specifications are not more than six years old. The practical results, judged by the service these axles have given, lead your committee to believe that no serious errors have been made in either the design or the character of the steel specified. It is too soon, however, to speak positively on these questions, because an axle somewhat low, with proper dimensions, or of material somewhat inferior to what it should be, does not break as soon as it is put in service, but fails eventually, due to the constant reversals of strain in service, and this must be repeated many thousands of times in order to result in failure. It is not thought that six years of service is sufficient to determine whether an axle of given design and material has proved successful.

Furthermore, a very large proportion of the axles made since 1896 are much less than six years old, and consequently it would not be reasonable to look for failure unless there was some serious defect in the design or material. The next two or three years will probably furnish some reliable data in connection with the axles designed according to these specifications that may be withdrawn, having worn out in service.

As to the possibility of making limiting weights and dimensions for axles, your committee does not feel that this is necessary. The dimensions adopted for different portions of the axle should be followed as closely as it is possible to do in practice, and by introducing the question of the limit of weight it simply becomes a disturbing factor.

Further, cases have come to the attention of your committee where axles bought on specifications requiring minimum weights have been found less in diameter at certain portions of the axle than required by the present M. C. B. drawings, and this, as is readily seen, will result in the axle being overstrained in that portion where it is less than the proper diameter.

In general, your committee feels that the present specifications should stand for another year at least, and until some definite information can be obtained which would lead to modifications.

The committee on axles, reporting to the convention of 1901, recommended that the wheel seats of M. C. B. axles should be changed in order to allow more material for refitting wheels to the following dimensions:

Axle "A"...........5⅛ ins.	Axle "C"...........6½ ins.
Axle "B"...........5¾ ins.	Axle "D"...........7 ins.

And in addition that the center of axle "B" be made 4¾ ins.

These recommendations were submitted to letter ballot, which closed September 14, 1901, the result of which was that the recommendations were adopted by the association. When the drawings of these axles appeared in the proceedings of 1901, however, changes were made in the diameter of the tapered portion of the axle where it joins the fillet next to the rough collar. The diameter at this point should be approximately the same as that of the wheel seat when turned down to its limit, although somewhat less. It was also found that the diameter of the rough collar was insufficient from a practical standpoint, in order to have this collar fulfill the functions for which it was designed.

After consulting a number of axle manufacturers, it appears necessary to have the diameter for the rough collar about ⅜ in. greater than the finished wheel seat. The usual practice in the forge shop, when axles are smooth-forged, is to make the diameter of the rough collar and wheel seat the same, allowing ¼ in. on the diameter for finishing, and, therefore, in this case the rough collar would be ¼ in. greater in diameter than the finished wheel seat. When the wheel seat is rough turned by the manufacturer, the diameter of the rough collar and the wheel seat are forged the same, but are made from ⅜ in. to 7-16 in. greater than the finished wheel seat. This allows ¼ in. to be taken off in rough turning, and still leaves ⅛ in. on the diameter of the wheel seat for finishing when wheels are fitted on the axles.

Your committee submits with this report drawings of the M. C. B. axles A, B, C and D, showing the changes which they think necessary as referred to above, all of which is respectfully submitted.

LABORATORY TESTS OF BRAKE SHOES.

Committee—J. E. Simons, Geo. Gibbs, L. T. Canfield.

The committee report presented at the association meeting of 1901 was rather exhaustive and covered the question of tests so thoroughly that there was nothing for this committee to do except to ascertain as far as possible what efforts were being made by the members of the association to adopt the coefficient of friction as recommended by the committee and later adopted as standard by this association.

Your committee therefore made inquiry by circular as to whether any of the members desired it to test the shoes being used, and the replies received from that inquiry would indicate that a very large percentage of the members are using shoes that were tested by our predecessors, and as the results obtained are satisfactory in nearly all instances, the necessity of another test so soon after the adoption of the coefficient of friction as standard, was evidently considered as premature, and consequently no tests were made.

In connection with the Circular of Inquiry, the committee deemed it advisable to ascertain, if possible, the result of the continuous application of brakes on grade. From the replies received, the indications are that the results in some cases are disastrous to the wheels, causing overheating and checking of the tread, eventually forming comby spots and circumferential cracks in or adjacent to the throat, and surface cracks across the tread normal to the flange.

It has not been definitely determined, however, that the long-continued application of the brake is the real cause of this, but the fact that these conditions exist on roads having long, steep grades, more prominent than on roads having light grades, would make it appear that there is room for further investigation along the lines of the effect of temperature, and that some effort should be made to obtain more knowledge in regard to the friction of brake shoes and its effect upon cast-iron wheels under heavily loaded cars by continuous application of the brakes.

Your committee is of the opinion that steps should be taken wherever possible by members of the association, to check the results obtained by the Committee on Laboratory Tests of Brake Shoes, by making practical tests in actual service of shoes having the frictional qualities of the recommended standard.

If members will in this way co-operate with the committee, it seems probable that additional facts of value will be obtained for the use of the association.

SUBJECTS FOR INVESTIGATION AND REPORT NEXT YEAR.

Committee—C. A. Schroyer, F. W. Brazier, A. E. Mitchell.

1. To submit drawing of a proposed standard steam coupling with outlet same size as steam pipes; (a) to suggest a proper distance from center of car and from top of platform; (b) to consider the best system of admission valves, and other matters pertaining to train line pipes and steam hose.
2. To submit drawing for a uniform shape of brass and wedge, and report upon the extent to which variations now exist from standard.
3. To consider and report upon a proper method of handling condensation in air brake equipment and best means of preventing ice forming in train line and hose connections.
4. To consider and report upon the use of collarless journals. What have been the results? Do they create more hot boxes? What is a safe limit to allow them to run?
5. To consider the difficulties existing because of variations in shapes and sizes of M. C. B. journal box wedges; best methods to obtain uniformity.
6. To propose a standard for signal lamp brackets and sockets, and location for same on end of passenger cars.
7. To submit drawing of proposed standard pedestal and oil box for passenger cars with axles having 5 and 9 journals.

STANDARD PIPE UNIONS.

Committee—B. Haskell, W. H. Lewis, Thomas Fildes.

Originally there was a committee appointed by this Association, the American Railway Master Mechanics' Association and the American Society of Mechanical Engineers, to consider the subjects of (1) Square Bolt Heads and Nuts, (2) Standard Pipe Threads, and (3) Standard Pipe Unions. In order to facilitate the work and have each subject given proper attention, the subjects were divided between the three associations, the Master Car Builders' Association taking charge of the first subject, the American Railway Master Mechanics' Association the second subject, and the American Society of Mechanical Engineers the third subject.

The subjects assigned to the Master Car Builders' Association and the American Railway Master Mechanics' Association have already been reported upon to both associations and standards have been adopted in both associations as a result of the investigations of the committee.

The committee of the American Society of Mechanical Engineers, after considerable unavoidable delay, was finally organized, and after a careful consideration and study of the designs of all makers of unions, the committee has completed a design of commercial sizes of malleable pipe unions for wrought iron pipe from ⅛ in. to 4 ins., inclusive.

After the convention of 1901 the executive committee of this association requested Mr. E. M. Herr to present to this convention an individual paper on some agreeable subject, to which he acquiesced, suggesting that inasmuch as the committee of the American Society of Mechanical Engineers (of which he was chairman) had submitted its report on standard pipe unions, it would perhaps be timely to bring the subject to the attention of this association and also the American Railway Master Mechanics' Association, and at his request the former committees were revived to receive the report. Your committee has received from Mr. Herr a copy of the report to the American Society of Mechanical Engineers, and it is appended hereto as the principal part of its report. The matter has been carefully considered and your committee recommends that pipe unions ⅛ in. to 4 ins., inclusive, of the dimensions given in Table B, be referred to letter ballot for adoption as a standard of this association.

The following is taken from the report to the American Society of Mechanical Engineers by a committee of which Mr. Herr was chairman:

Gentlemen:—Your committee, appointed to consider the subject of securing uniformity in the threads of coupling unions for pipe, in joint conference with similar committees of the American Railway Master Mechanics' Association, and the Master Car Builders' Association, beg leave to report as follows:

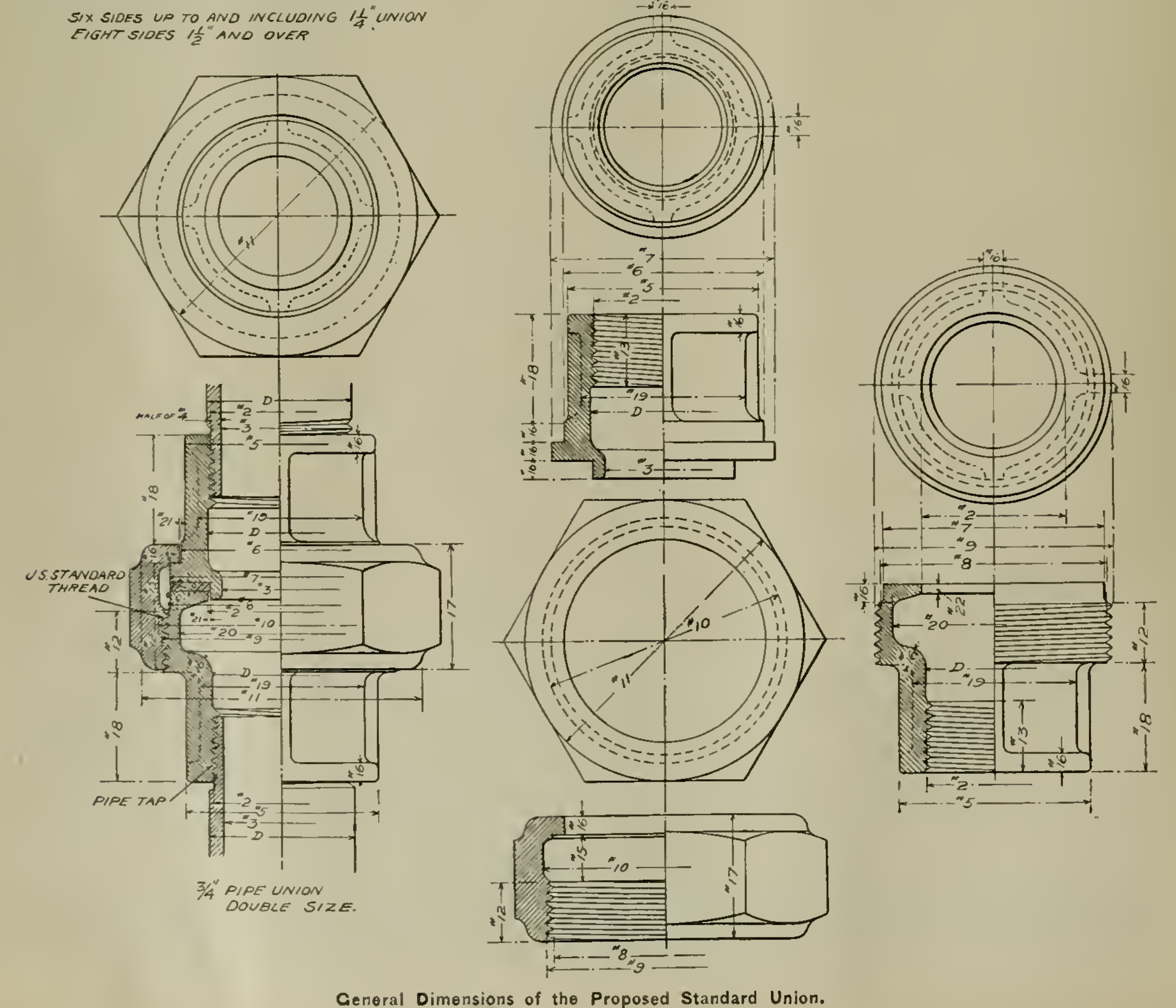
It was found that the committees of these associations were also considering two other matters, namely, Uniform Pipe Threads, and Standard Square Heads for Bolts; and desired your committee to proceed with the active consideration of the subject of Uniformity in the Threads of Coupling Unions for Pipe.

A careful examination of the dimensions of the threads in the unions made by each of the principal manufacturers of these fittings showed that there was absolutely no two alike and, further, that the other dimensions of the unions were so affected by the dimensions of the threads in the coupling nut that any successful attempt at uniformity in the threads must necessarily carry with it uniformity in so many of the other dimensions of the union itself that it would be necessary for this committee to take up not only the dimensions of the threads but of the entire coupling union.

A careful study of the design of all makes of unions, now commonly used, was then made for all sizes of pipe from ⅛ in. to 4 ins., inclusive. This investigation showed that no make of unions was sufficiently free from defects when critically examined in all sizes to warrant its adoption as a standard, even had it been considered desirable to do so; and your committee then decided to undertake the complete design of commercial sizes of malleable pipe unions for wrought iron pipe from ⅛ in. to 4 ins., inclusive, which we could indorse as a consistent design and submit as a proposed standard union. While this somewhat broadens the scope of your committee's work, it seemed the only practicable way to comply with our instructions.

The details of the design were worked out under the personal direction of Mr. Vogt, of the committee, who has prepared the data, drawings, and tables of dimensions accompanying this report, as follows:

Plate A shows a ¾-in. union, with all dimensions numbered for reference to the accompanying Table B.



General Dimensions of the Proposed Standard Union.

Table B. DIMENSIONS FOR PROPOSED STANDARD PIPE UNIONS.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
⅛ in...	.375	.270	.105	.59	.63	.78	.80	.85	.89	1.05	.26	¼	27	.2225	.08	.5625	½	.59	.615	.006	.05
¼ in...	.496	.364	.132	.76	.80	.96	.98	1.05	1.09	1.29	.33	5-16	18	.2625	.10	.6925	9-16	.76	.76	.006	.06
⅜ in...	.630	.494	.136	.90	.95	1.11	1.13	1.20	1.24	1.45	.34	⅜	18	.2825	.11	.7325	⅝	.90	.905	.006	.07
½ in...	.783	.623	.160	1.16	1.21	1.38	1.40	1.49	1.54	1.78	.40	7-16	14	.3025	.12	.8225	11-16	1.03	1.20	.006	.08
¾ in...	.992	.824	.168	1.38	1.43	1.61	1.63	1.72	1.77	2.02	.42	½	14	.3225	.13	.8725	¾	1.24	1.43	.007	.09
1 in...	1.246	1.048	.198	1.74	1.79	1.98	2.01	2.13	2.19	2.49	.49	9-16	11	.3625	.15	1.0025	13-16	1.565	1.76	.007	.10
1¼ in...	1.592	1.380	.212	2.12	2.18	2.37	2.40	2.52	2.58	2.90	.53	.6	11	.3825	.16	1.0725	.9	1.91	2.15	.007	.11
1½ in...	1.831	1.610	.221	2.40	2.46	2.66	2.69	2.81	2.87	3.20	.55	.7	11	.4025	.17	1.1225	1.0	2.18	2.40	.007	.13
2 in...	2.306	2.067	.239	2.89	2.95	3.16	3.19	3.31	3.38	3.74	.60	.8	11	.4225	.18	1.2025	1.1	2.66	2.90	.008	.14
2½ in...	2.775	2.468	.307	3.39	3.45	3.67	3.70	3.86	3.93	4.39	.77	.9	8	.5225	.23	1.5225	1.2	3.16	3.41	.008	.16
3 in...	3.401	3.067	.334	4.07	4.13	4.36	4.40	4.56	4.63	5.13	.84	1.0	8	.5625	.25	1.6525	1.3	3.81	4.08	.008	.18
3½ in...	3.901	3.548	.353	4.61	4.68	4.91	4.95	5.11	5.19	5.72	.88	1.1	8	.6025	.27	1.7525	1.4	4.31	4.63	.008	.20
4 in...	4.4	4.026	.374	5.15	5.22	5.47	5.51	5.67	5.75	6.31	.94	1.2	8	.6225	.28	1.8425	1.5	4.81	5.19	.008	.22

DESCRIPTION ACCOMPANYING TABLE OF MALLEABLE PIPE UNIONS.

NUMBERS AT THE HEAD OF THE COLUMNS ABOVE ARE THOSE GIVEN IN THE DIMENSION LINES ON PLATE A.

Column No. 1 in table represents the nominal diameter of pipe.

Column No. 2 represents diameter of pipe at one-half the height of full thread nearest solid section of pipe.

Column No. 3 represents the internal diameter of the pipe.

Column No. 4 represents the difference between Columns Nos. 2 and 3, and is equal to twice the thickness of metal in pipe, measured from inside line to one-half the height of thread, as specified before.

Column No. 5 represents the outside diameter of end of pipe union, and is taken as *No. 2 plus twice No. 4* plus an arbitrary increment.

Column No. 6 is equal to No. 5 plus an increment varying from .04 to .07 of an inch. This increment was allowed for the purpose of being able to slip the nut over swivel end of union.

Column No. 7 is No. 6 plus an amount varying between .15 and .25. This lip created is considerably in excess of what exists on present pipe unions, for the reason that we find the surface between the lip and the corresponding part of nut is often damaged, and the bearing surface, when the full strength of the man is used on the wrench, is sufficient. We assume that a man would pull about 30 pounds on a wrench, with a possibility of using less force on pipes of small diameters. For that reason we made a variation in the width of lip, which lip, theoretically, would be uniform for all sizes of pipe. The nut itself has been strengthened to prevent the lip from deflecting upward.

Column No. 8 is No. 7 plus an increment varying from .02 to .04 of an inch.

Column No. 9 is No. 8 plus twice the height of the thread.

Column No. 10 is No. 9 plus an increment varying between .04 and .08 of an inch.

Column No. 11 is No. 10 plus one and one-half times No. 4.

Column No. 12 is two and one-half times No. 4, and was figured especially for bearing surface, so that the thread would not wear away too rapidly when the nut is occasionally removed.

Column No. 13 has been assumed arbitrarily, but in all cases is greater than the length of full thread on standard pipe.

Column No. 14 represents the number of threads per inch in length of nut. This thread, we believe, should be United States standard form and not sharp thread.

Column No. 15 is taken arbitrarily, but is based on the probable requirements of manufacturers for tapping out the nut.

Column No. 16 is three-fourths of No. 4.

Column No. 17 represents the full height of nut, and is equal to No. 12 plus No. 15, plus No. 16.

Column No. 18 is the amount of projection outside of nut.

Column No. 19 is No. 2 plus No. 4, plus an arbitrary increment.

Column No. 20 is No. 7 less No. 16, with slight modifications.

Column No. 21 represents the clearance at several points, as indicated on print.

Column No. 22 is assumed arbitrarily.

Table B gives the dimensions of all sizes of unions from ⅛ in. to 4 ins., the figures at top of column referring to corresponding dimensions on Plate A. The description accompanying Table B explains this table, and where any radical departure is made from present practice, it is explained and the reasons given briefly.

It will be noted that all sizes from ½ in. to 4 ins. have the pipe and swivel ends paneled where the pipe wrench engages. This paneling is not put upon the smaller sizes on account of the increase in size of the nut and dependent parts necessitated by putting the ribs on the ends, nor is it considered at all necessary on these sizes.

The mark (S) on the side of the nut is suggested for a designating mark which could be secured by this society if it is deemed wise to pursue such a course. The committee recommends that this be copyrighted and the standard unions thus designated.

(Abstracts to be concluded.)

MASTER MECHANICS' ASSOCIATION.

THIRTY-FIFTH ANNUAL CONVENTION.

Abstracts of Reports.

HELPING ENGINES.

A Paper by F. F. Gaines,
Mechanical Engineer, Lehigh Valley Railroad.

The economy of using a helper under any given condition is determined by the total cost of transportation with and without the helper, of one ton, or some multiple of this unit, over the division. The conditions may be such as to require no calculation to demonstrate their economy. Or again, they may be such that only a very careful analysis of all conditions and factors is necessary to determine whether or not their use will be advantageous.

The leading factors in such a problem are: The volume of traffic; ruling grades, their length and rise; the time in which the traffic must be moved, due to competing lines; and the economical train length and tonnage, considered in connection with other divisions. The combinations of the variations of these factors furnish an almost infinite number of conditions. Each condition requires separate study and treatment, and excludes from consideration any general law applicable to all. The economy of using a helper, and its tractive power, if desirable to use one, is generally indicated by the average volume of traffic.

Each of the leading factors is subject to many modifications in connection with varying profiles. A few of the more common grade conditions are:

1. A comparatively level division, with the exception of a ruling grade of comparatively short length. 2. An undulating division, with heavy grades, and ruling grade only slightly in excess. 3. An undulating division, with a comparatively short, heavy ruling grade. 4. A division with a ruling grade of great length.

Assuming that the above conditions obtain in the direction of greatest volume of traffic, it is obvious that we may have the same or entirely different conditions of grade in the opposite directions. One of two conditions, as regards the size of train, may exist in a general way. In connection with other divisions, it may be desirable to have trains of a certain tonnage, for reasons that will be dealt with later; or, for various reasons, the largest train that can be handled by one engine is much less than can be handled satisfactorily by one train crew. Some of the conditions that might result in the latter are: Average size of recently built power, owned; limiting weight of engines, due to bridges, rail, tunnel and other clearances; or, a standard road engine of insufficient power on the heavy grades. Where the economical tonnage, as regards handling by the train crew, or a standard train cannot be handled by the leading engine under the four general grade conditions, it would seem from a theoretical standpoint to call for a helping engine or engines.

The general conditions referred to divide into two general subclasses: First, where the length of grade is such that the helping engines are required only for a part of the division; and, second, where the helping engines are required for the whole division, or the greatest part of it. Cases one and three come under the first subdivision, and cases two and four under the second. Under some circumstances, case three may come under both; that is, double heading over the division, with a helper in addition on the heavy grade.

Where a helper is used only for a part of a division, and the helper is of the same power as the road engine, the tonnage handled over the division is doubled per train; the cost per ton-mile for fuel, wages of engineers and firemen, etc., is lessened in some cases, while the wages of one train crew have been saved in one direction, and if the road engines can handle the tonnage in the opposite direction alone, the wages of a train crew over a division and return have been saved. The light mileage of the helper is offset by the underloading of the two road engines that are necessary to handle the same tonnage without a helper, after passing over the ruling grade.

Where double heading in one or both directions over a division, with leader and helper of the same power, the wages of the second train crew are saved. Where the return tonnage can be handled by the leading engines, there is an additional economy, due to the difference in expense of the light mileage of helper, and the underloaded second engine that would otherwise be necessary.

In general, where a helper, either over a division or part of it, of equal or greater power than the leader, can be used in connection with normal loading, the economy is real and substantial. As the proportion of power to be furnished by a helper decreases, a point is reached where the economy curve changes direction and becomes negative.

There are certain conditions where the volume of traffic is light, and a certain number of trains are to be run, irrespective of their size, which make it more economical to have engines of sufficient power to handle the necessary trains under the grade conditions.

When the volume of traffic becomes so great that to handle the trains requires a more powerful engine than can be run, owing to the physical limitations of the right of way, from a theoretical standpoint a pusher or double heading becomes desirable.

On a trunk line, handling a large volume of through freight between its termini, it would seem that the maximum train that could be handled on the level, the limitations being due to length of train that can be handled with safety, should be its standard train. The size of the standard train may be further limited by the speed, as in fast freights, the lengths of sidings or physical limitations of the right of way, such as bridges, rail, ballast, etc., prohibiting the use of a sufficiently powerful engine. Whatever the limiting factors, a standard train becomes desirable. With it yard work, delays and wear and tear due to shifting are eliminated at each division terminal it must pass from origin to destination. It will readily be seen that the time saved, where a train is brought in by one crew to a division terminal, and immediately taken out by another without shifting, is considerable. The expense of maintenance is also considerably decreased by such an arrangement, as it is safe to say that out of the total cost of repairs to rolling stock more than 50 per cent. of the cause is due to shifting in yards. Under a standard train system, it is desirable to have the leading engine of sufficient power to handle the train at the desired speed over the level, or comparatively level, divisions. The power of helping engines on the grades may then vary from a very small to a very large engine. Where no such system is in vogue, and each division handles its traffic to best advantage, independent of the size of train that may be delivered to it, or that it may turn over, the problem is simplified, in that it depends solely on the profiles of the different divisions, and each division can be treated separately.

From the record of a six months' performance of a number of engines of the same class on the Wilkesbarre mountain grade of the Wyoming Division of the L. V. R. R., the percentage of cost of the more important items, constituting the total direct cost per ton-mile, was found to be as follows:

	Per Cent.
Water supply	0.346
Waste and other supplies	1.167
All oils (lubricating and illuminating)	1.259
Roundhouse men (hostlers, wipers, etc.)	2.478
Interest and depreciation	12.315
Repairs	16.188
Fuel	16.366
Wages of engineers and firemen	21.386
Wages of train crew (exclusive of engine crew)	28.495
Total	100.000

It is apparent that with another engine of the same class as helper the tonnage would be doubled, the cost per ton-mile of all items remaining the same, with the exception of the wages of train crew, which would be decreased 50 per cent. As the cost of this item per ton-mile would be reduced by 50 per cent., and as it is about 28 per cent. of the total cost, the saving would be 14 per cent. on the double tonuage, or 28 per cent. It is also evident that an engine of less power would effect a less saving, and one of greater power a greater saving. These figures would vary under different conditions, but they indicate approximately the proportions of the different items constituting the total direct cost, and show that the direct economy is largely due to cutting down the cost of wages of train crew per ton-mile. There is also an indeterminate saving where helpers are used, due to the fewer number of trains. Where the volume of traffic is great, and must be handled on a single track, or at least two tracks, in connection with a number of passenger trains, the indirect saving is no inconsiderable item. In some cases a large volume of traffic may originate at or near the foot of a heavy grade; under these conditions it is sometimes advisable to make up the trains at the summit, and handle the tonnage on the grade entirely by helpers, or all except the amount in some cases handled by the road engine when on the way to the summit to take out a train. Obviously, the more powerful the helpers, the greater the economy until the limiting size of engine is reached.

There are three leading factors which largely determine the limiting size:

1. Weight that can be carried by rail and bridges.
2. Clearances, such as overhead bridges, tunnels, etc.
3. Construction of rolling stock.

There is also a point reached where the coal consumption per hour becomes so great that one or more additional firemen are necessary. Until such time as all cars have very much stronger underframes and draft gear than the average car of the present day, an engine with a tractive power of about 50,000 lbs. would seem to be near the economical limit.

An ordinary road engine, unless specially designed for such service, should not be used as the second engine in double heading, as, in addition to its own power, the frames and draft gear have to transmit the power of the leading engine. Conversely, an engine that is to be used for double heading or pushing should be designed with the service intended for it in view. As on heavy grades the maximum power is exerted at slow speeds, all parts should be extra strong, such as frames, rods, axles, crank pins, etc. The wearing parts should have liberal bearing surfaces, and provision for ample lubrication. Tenders of large coal and water capacity should be provided so as to cut out all or as many stops as possible on grade, as the time lost and damages to cars in starting are considerable. Where the grade is comparatively long it is doubtful economy to use a small diameter of driving wheel, on account of the greater power. It would seem a better policy to use a size of wheel that would allow the light engine to make good time down the grade without heating bearings or shaking the machinery to pieces, and to provide for the necessary power in the steam pressure and the size of cylinders.

No class of service makes heavier demands on power than helping service, and time spent in careful design so as to produce satisfactory results will be amply repaid by the decreased maintenance charge. In designing, special care should be given to accessibility, both on the road and in repairs. Helping engines are frequently located where they can only receive roundhouse repairs between general overhaulings, so that the desirability of a design to which running repairs can be made cheaply and quickly is very essential.

PRESENT IMPROVEMENTS IN BOILER DESIGN AND BEST PROPORTIONS OF HEATING AND GRATE SURFACES, FOR DIFFERENT KINDS OF COAL.

Committee—George W. West, T. W. Demarest, H. D. Taylor, John Player.

Your committee, after a preliminary study of the subject, decided that it was more comprehensive and of greater scope than its limited time would allow to take up and treat thoroughly. For this reason it was decided to deal with that portion of it that concerns heating and grate surface. The remaining portion, dealing with improvements in design, is of sufficient magnitude to form an independent paper. As such a paper would be valuable, the committee recommends that it be considered as a subject for the next convention and a new committee appointed to investigate and report on it.

Knowing from past experience that it is difficult to obtain from the members full and prompt replies to a circular of inquiry, the data for this paper was obtained from the technical press. It consists of the engines illustrated by the different railroad papers during the years 1900, 1901, and the first four months of 1902. As only new types of engines, representing the most advanced ideas of buyer and builder, are so treated, it will be seen that the data is reliable, full, and covers the most recent practice. In addition to the engines obtained in this manner, a few engines with boilers and fireboxes for burning anthracite coal, the performances of which are known by the committee, have been added.

The ratios given by the committee, in its report to the association at the convention of 1897, do not cover the recent increase in grate surface, and the basis of comparison of the previous ratios determined for the association contains only one factor—the working force. This factor alone, without considering speed, with which the problem is so intimately connected, is of very little real value for accurately determining the correct proportions of a boiler. If, however, we combine the working force with the speed or rate of working, we then have the power. As the boiler must furnish a certain amount of power, or an amount of energy sufficient to perform a certain amount of work in a given time, it becomes apparent at once that the real basis from which the amount of heating surface should be computed is the maximum power, and that the total heating surface of any boiler is the product of a constant times the maximum power demanded by the service. If we take for the unit of power a horse-power, the formula for heating surface becomes of the following form:

Total heating surface = (constant) × maximum horse-power.

The formula for horse-power is:

$$\text{H. P.} = \frac{P\ L\ A\ N}{33000} \qquad (1.)$$

Where P = The mean effective pressure or Pm;
L = The length of stroke (feet) or S/12;
A = The area of cylinder, or $\frac{1}{4}\pi d^2$;
and N = The number of strokes or 2 × revolutions per minute for one side, or 4 × (R. P. M.) as a total.

$$\text{Also (R. P. M.)} = \frac{\text{Miles per hour} \times 5280}{60 \times \text{circumference of drivers (feet)}},$$

where the circumference of drivers $= \pi$ D/12.

Substituting the above values of the factors in equation (1), it becomes:

$$\text{H. P.} = \frac{Pm \times S/12 \times \frac{1}{4}\pi d^2 \times 4\ (\text{M. P. H.}) \times 5280}{33000 \times 60 \times \pi\ D/12};$$

$$\text{simplifying:}\quad \text{H. P.} = \frac{Pm\ d^2\ S \times (\text{M. P. H.})}{375 \times D} \qquad (2.)$$

The English rule for the maximum sustained speed of an engine is:

10 × diameter of drivers (in feet) = M. P. H.;

but for the sake of simplicity, if we take the maximum sustained speed as equal to as many M. P. H. as there are inches in the diameter of the drivers, we have for the sustained speed:

M. P. H. = D, and equation (2) becomes:

$$\text{H. P.} = \frac{Pm\ d^2\ S}{375} \qquad (3.)$$

Where the M. P. H. equals the diameter of drivers in inches, the revolutions per minute become constant, or R. P. M. = 336. The Baldwin Locomotive Works show, in their handbook (page 27), that for 336 revolutions per minute the mean effective pressure is 30 per cent. of the initial pressure, and that the initial pressure is about 76 per cent. of the boiler pressure. This makes the mean effective pressure

$$Pm = .3 \times .76 \times (\text{boiler pressure})$$
$$= .228 \text{ or } 23\ \% \times (\text{boiler pressure}—P).$$

Substituting this value for Pm in (3) we have:

$$\text{H. P.} = \frac{.23\ P\ d^2\ S}{375} = \frac{P\ d^2\ S}{1630},$$

where P = Boiler pressure;
d^2 = (diameter of cylinder in inches)²;
and S = Stroke (in inches).

The above, while applying to simple engines, does not apply to compounds, nor is there any available data to show the average mean effective pressure of a compound at high speeds. If, however, we equate the gross tractive power of a compound engine to the gross tractive power of a similar simple engine, and then solve for cylinder diameter, we have the size of a simple cylinder having

SUMMARY OF RESULTS OBTAINED.

Kind of Engine.		Simple Passenger	Compound Passenger	Simple Freight	Compound Freight.
Total Heating Surface. / Max. Ind. Horse-power or number of feet of Heating Surface per I. H. P.	Maximum	2 39	2.58	2.30	2.15
	Mean.	2.00	2.13	1.71	1.80
	Minimum.....	1 72	1.70	1.48	1.58
Total Heating Surface. / Grate Area or number of feet of Heating Surface per square foot of Grate Area	Very free-burning bituminous...............	65 to 90	75 to 95	70 to 85	65 to 85
	Average bituminous coal	50 " 65	60 " 75	45 " 70	50 " 65
	Slow-burning bituminous or mixture of anthracite and bituminous	40 " 50	35 " 60	35 " 45	45 " 50
	Slack bituminous, mixtures of anthracite and bituminous, and free-burning anthracite..............................	35 " 40	30 " 35	30 " 35	40 " 45
	Very low grade bituminous, lignite, mixtures of anthracite and bituminous and slow-burning anthracite................	28 " 35	24 " 30	25 " 30	30 " 40
Tube Heating Surface. / Fire-Box Heating Surface or number of square feet of Tube Heating Surface per square foot of Fire-Box Heating Surface...	Maximum	16.67	18.56	18.50	17.56
	Mean............	13.42	13.42	12.75	13.58
	Minimum	10.25	10.09	9.04	11.50
Total Weight of Engine. / Max. Ind Horse-power or weight (in lbs.) per I. H. P..	Maximum	145 00	165.00	142.50	127.50
	Mean........	127.00	135.00	115.50	113.25
	Minimum............	108.00	111.00	101.25	102.25

the same power as the compound. This was done for the compound engines, and the size of the equivalent simple cylinders is shown on the data sheets. It is admitted that this method is open to criticism, yet as the results are to be used for comparative purposes, it provides, in the absence of more authentic information, a basis for comparison, and indicates limits which may be of service in future designing. As the horse-power formula has as its basis the results of a large number of indicator cards, it might be appropriate to speak of horse-power determined in that manner as "indicated horse-power" (I. H. P.), and it will be so referred to in this report.

The important relations in boiler design are those between the power and the total heating surface, and between the total heating surface and the grate area. These relations for the engines in question have been determined, and also some additional ratios that are of no special value, except as of interest in making comparisons. These ratios were all tabulated on data sheets, and the relations in all cases determined graphically. The maximum, mean and minimum ratios of total heating surface to maximum I. H. P. were determined for the various examples as follows: Using as ordinates and abscissæ the values of these two factors, a point was determined graphically upon a diagram for each engine under consideration. A line drawn approximately through the middle of these points is an average or mean location of all points. If in the equation of a straight line, $y = ax + b$, we substitute the ordinate and abscissa of any point on the line, we have an equation where, if any other ordinate be known, its abscissa can be determined. After locating the mean line, the extreme lines representing the maximum and minimum limits were drawn and their equations determined. All ratios have been determined separately for

(*a*) Simple passenger engines,
(*b*) Compound passenger engines,
(*c*) Simple freight engines, and
(*d*) Compound freight engines.

Where the ratios deal with grate areas, these divisions have been further subdivided so as to cover both anthracite and bituminous coal. The number of engines constituting the data from which the grate-area proportions for anthracite coal were determined is small —in one case only three engines. Each engine, however, represents a class in which there are a large number of individual engines, and it is known that their performance is satisfactory.

RESULTS:

For the ratio $\frac{\text{Total heating surface}}{\text{Max. Ind. horse power}}$, we have:

Kind of Engines........	Simple Passenger.	Compound Passenger.	Simple Freight.	Compound Freight.
Maximum ratio — square feet of heating surface per horse power.......	2.39	2.58	2.30	2.15
Mean ratio—square feet of heating surface per I. H. P...............	2.00	2.13	1.71	1.80
Minimum ratio — square feet of heating surface per I. H. P.	1.72	1.70	1.48	1.58

The compound passenger engines show the greatest variation between extremes, and the compound freights the least, while the compound engines have in each service a higher mean ratio than the simple engines.

For the ratios $\frac{\text{Total heating surface}}{\text{Grate area}}$, we have:

Kind of Fuel............	Bituminous Coal.			
Kind of Engines........	Simple Passenger.	Compound Passenger.	Simple Freight.	Compound Freight.
$\frac{T\ H\ S}{G\ A}$, or square feet of heating surface per square foot of grate—				
Maximum ratio	90.50	94.50	87.00	87.50
Mean ratio	66.67	75.00	71.50	66.67
Minimum ratio	51.50	62.91	47.00	51.25

Kind of Fuel............	Anthracite Coal.			
Kind of Engines........	Simple Passenger.	Compound Passenger.	Simple Freight.	Compound Freight.
$\frac{T\ H\ S}{G\ A}$, or square feet of heating surface per square foot of grate—				
Maximum ratio	40.38	35.38	37.38	45.63
Mean ratio	33.50	32.75	31.63	39.25
Minimum ratio	27.75	23.63	27.88	30.63

In the above table, under bituminous coal, the ratios found cover grate areas for burning nearly all grades of this coal. The maximum ratio is probably only suitable for extremely free burning qualities, and should not be exceeded. The mean ratio is probably suitable for the average quality of bituminous fuel, while the minimum limit is suitable for the poorer qualities. While division is made between anthracite and bituminous coal on the diagrams and tables, in reality no such division exists, the maximum ratios under the latter head being suitable for slack bituminous coal, and in fact one lot of engines plotted under this head burns bituminous coal. The higher ratios under anthracite coal are really only suitable for low grades of bituminous coals or a mixture of ordinary bituminous coal with fine anthracite. The mean ratios under anthracite are suitable for good lump anthracite, and mixtures of bituminous and fine anthracite, while the minimum ratios are none too small for ordinary lump anthracite, mixture of fine anthracite and bituminous, and fine anthracite alone It is not possible to define absolutely the necessary amounts of grate surface for the varying qualities of fuel that are in use, but the ratios show limiting practices and to a certain extent should be useful, as indicating for average bituminous and anthracite coal the proportions used in most recent constructions.

The ratio between the tube heating surface and the firebox heating surface was also derived. This ratio is of no particular value, as the grate area controls it to a large extent, but may prove of interest, as the graphical analysis shows the relation between them to follow a fairly defined law. The ratios as derived are:

Kind of Engine	Simple Passenger.	Compound Passenger.	Simple Freight.	Compound Freight.
Maximum ratio — square feet of tube heating surface per square foot of firebox heating surface.	16.67	18.56	18.50	17.56
Mean ratio—square feet of tube heating surface per square foot of firebox heating surface....	13.42	13.42	12.75	13.58
Minimum ratio — square feet of tube heating surface per square foot of firebox heating surface.	10.25	10.09	9.04	11.50

The relations between power and weight, which are to a certain extent an index to the probable weight of a new engine after the power has been decided, were also determined as follows:

Kind of Engine	Simple Passenger.	Compound Passenger.	Simple Freight.	Compound Freight.
Maximum ratio — weight in lbs. per I. H. P.....	145.0	165.0	142.5	127.50
Mean ratio — weight in lbs. per I. H. P........	127.0	135.0	115.5	113.25
Minimum ratio—weight in lbs. per I. H. P.......	108.0	111.0	101.25	102.25

A summarizing table of all ratios derived will be found below, including in the second part the interpretation of the grate area in relation to the fuel as outlined heretofore.

The committee recommends, in connection with this report, that the association adopt as a standard:

(1) For comparisons of heating surface, the relation between the indicated horse-power and total heating surface, the formula for I. H. P. being:

$$\text{I. H. P.} = \frac{P\,d^2\,S}{1630}$$

Where P = Boiler pressure.
d^2 = (Diameter of cylinder in inches)^2.
S = Stroke in inches.

(2) For comparisons of weight, the relation between the indicated horse-power and the total weight of engine.

In case of the adoption of these methods by the association, it is further recommended that the secretary of the association be instructed to communicate with the technical press and request their co-operation in the use of these methods of comparison.

ELECTRIC DRIVING FOR SHOPS.

An Individual Paper by C. A. Seley.

This mode of transmission of power has, since the committee report on this subject presented to this association in 1900, undergone considerable development, and shows such advances and new opportunities that it may be interesting to know what were the consideration and ruling factors in the design of one specific example of installation. We cannot, as a rule, have new shops to lay out exactly to meet our economic needs in railway equipment building and repair work, but have to build on and add to an old establishment until often the original plan is lost. Transmission of material and movement of partially completed and of finished product are of much greater importance than transmission of power, and this is too often lost sight of in railway shop arrangement. In many lines of manufacturing which employ metal and woodworking tools the most successful managers are those who have kept up with the latest developments of modern tools, automatic machinery, electric cranes, pneumatic hoists and tools, and other means of multiplying production, and, above all, economy of handling.

Electric driving is of special value in old establishments that have outgrown their original plan, or those which could be enlarged or rearranged in reference to economic movement of material, provided a satisfactory solution of the power problem was offered. In many old shops additions have been put on and line-shafts unduly lengthened, an engine put in here and a boiler there. The cost of these auxiliaries is not so great, but if we look into the cost of daily maintenance, the extra attendance, the handling of fuel when distributed to a number of points, handling of ashes, the low efficiency of small isolated plants, the general waste of supplies when drawn for a number of plants scattered here and there, and carefully analyze the cost of each of these items, it will often be found that the fuel charge is by no means the greater portion of the cost.

An example of an old shop very largely added to, and employing auxiliary steam and power in several departments, is the Roanoke shops of the Norfolk & Western Railway Company. These shops were built in the early 80's, on a liberal scale, and fortunately were laid out so that additions consistent with the general plan could be made. By June, 1901, the work required at Roanoke had developed to an amount that important additional buildings were planned, necessitating also a general revision of the power transmission which should also check the waste due to the several plants. An unfortunate delay in the delivery of some of the machinery has, however, hindered the construction and starting up of the plant, so that some data is not available at the time of writing.

In order to give an idea of the size of the Roanoke shops, it may be stated that they take care of the medium and heavy repairs of nearly 500 locomotives, mainly of the consolidation type, build complete one 21 by 30 consolidation engine per month, and of cars about 1,000 per year, and also the freight repair work of 1,600 freight cars per month, the entire passenger equipment, heavy repairs and considerable building of new passenger equipment, miscellaneous road work, switches, water station and coal pier work, etc., of a 1,600-mile road, including all foundry work for same. The general plan of the shops is shown in the accompanying engraving.

There were two principal power plants, one in the machine shop, which furnished power to a number of shops, and one in the planing mill, whose boilers furnished steam for various purposes. Besides these, there were five auxiliary plants of boilers or engines, or both, making a sum total of 880 nominal horse-power of boilers and 775 nominal horse-power of engines for shop power, heating and lighting, the latter service extending beyond the shop's inclosure and furnishing all night and some day lighting for lighting the general offices, hotel, depots and yards.

Thus a varied, scattered power service had been built up, and to take its place the new plan must take into consideration the concentration so far as possible into a central power station of such an amount of power as would do away with all auxiliaries, and the change had to be made without interference with the operation of the shops or lighting plant. A careful study of the situation developed the following plan: To provide a new boiler plant capable of developing steam for all power needed, except only such as could easily and with certainty be furnished from refuse from the planing mill with practically no extra cost of handling, the object being to thus utilize a means of burning refuse.

In such an electric installation the center of electrical distribution is an important point to find, and the generating plant should be placed near thereto. In shop plants this is not always the ruling factor, as it may pay to use a little more copper and place the plant where other considerations are of more importance. In this case the utilization of a large brick stack of sufficient capacity and the location of an elevated trestle for directly dumping hopper cars of coal indicated the location of the new boiler house, which was planned for the immediate installation of 600 nominal horse-power of boilers and reserve for 400 horse-power additional. These boilers are in 200 horse-power units, it being believed that smaller units do not give a like economy and that it would not be wise to have less than a two-thirds capacity to fall back on in case of the failure of any one boiler. The boilers have been installed and connected to the old system of steam piping, and have been operating for some months in a very satisfactory manner, and a considerable economy of fuel and maintenance has been secured thereby.

The direct-current system of electric transmission of power and lighting was adopted, using two-wire, 220-volt current for motors and three-wire system for lights. This was determined upon after visiting a large number of plants. Instead of preparing a set of specifications requiring a definite arrangement of the electrical machinery, it was thought best to issue an invitation to the electrical companies to tender on such forms of apparatus as in their opinion would best suit our needs, these needs being fully set forth for their information. The instructions relative to the general lay-out read as follows: "There are to be three generators, each direct driven by a compound, non-condensing engine. Inasmuch as two voltages are desired, namely, 110-volt, three-wire system for lighting, and 220 volts for power circuits, the arrangement and design of these generators may be proposed in more than one form, to permit delivery of current from the switchboard of either power or lighting voltage from any combination of the generators." A schedule of the power and lights probably required was then given, covering the twenty-four hours. The instructions then proceed: "All generators must be of the latest and most improved type. They must be guaranteed by their makers to develop the electrical energy specified, and the guarantee should state the electrical efficiency and also the limit of heating with the rated load."

The system of shop lighting had been a series, constant-current, double-carbon, open-arc lamp system for general illumination, and 110-volt incandescent lamp system on alternating circuits. The new system puts the power and lights on the same current, using more than one unit for generating, and thereby lessening the probability of a breakdown affecting the continuity of service. Direct-current machinery was chosen on account of its applicability to all the classes of service required, and for three principal reasons: First, for use in crane service, as being best adapted to that work; second, by reason of the slower speeds of direct-current motors, so that they are more readily belted direct to line shafts and machines without the use of intermediate countershafting; third, although alternating-current motors are very enticing, on account of their simplicity and ease of repair, they are, however, far more expensive per horse-power than direct-current motors, and great care has to be taken in wiring for the alternating-current systems to avoid trouble and losses from induction and cross currents. No trouble of this kind is experienced with the direct current if care is taken to properly proportion the wires for their load and the ordinary precautions in regard to insulation are followed.

The accompanying plan of the work shows that the power station is by no means the center of distribution, the greatest radius being about 2,000 ft., and it required a 700,000 c. m. (.84-in. diameter) cable to transmit the power necessary at the mill. The investment in such a cable, however, was far less than it would have been to install the power house at an intermediate point so as to reduce this radius and the weight of the copper required.

The bidders were requested to fulfill the following conditions in their tenders on the switchboard: "The switchboard to be of marble, provided with one ammeter and one voltmeter for each generator; two recording wattmeters (one for each side of the three-wire circuits; one recording wattmeter for power circuits. To have also automatic cut-outs for guarding against overloads; lightning arresters, and the necessary fuses. Triple bus-bars are to be provided for light circuits and double bars for power circuits, and suitable switches are to be provided to throw the current from any generator to either the lighting or power circuits, and in addition to these there should be a main switch for throwing the two sets of bus-bars together. Contractors are requested to furnish a design of switchboard embodying these features, and in addition such feeder panels and switches as seem necessary to operate the plant, taking into consideration the plan of the works and the distribution of power and lights as stated.

"It is desired that the switchboard be of neat design, with all instruments, switches and other attachments first class in every respect. It is desired to incur no unnecessary expense in elaboration, but to provide every facility for convenient operation, safety and accurate electrical measurements and records. The wiring between the generators and switchboards to be of heavy copper, braided, rubber-covered cable run below the floor in conduits."

A complete plan of the works and yards and the probable amounts of light and power for each location were furnished bidders upon which to base their recommendations and proposals. The system finally adopted comprised three generators, one 75-k.w. and two of 160 k.w each, the smaller unit being approximately 100 horse-power and the larger ones something over 200 horse-power each, so that it may be seen that by combinations of the generators, 100, 200, 300, 400 or 500 horse-power may be transmitted to the board. This is believed to be good steam engineering, as it affords an opportunity to work the engines closely within their most economical range of steam using. The three-wire system of lighting generally requires two 40-volt generators, to be worked in series, but in this plant, for considerations of simplicity, first cost and general convenience, and for the further reason that the plant is primarily a power plant, the generators were arranged with a view to all these considerations to operate direct to the board at 220 volts, which is also the proper voltage for the outside wires of the three-wire system. The means of maintaining proper current balance between the two sides of the three-wire lighting system was then provided for by using a motor-generator balancer set of 10-k.w. capacity, which machine has its controlling switches on a panel of the switchboard and in a simple manner maintains the balance of the two sides, correcting any inequality of current due to one side being more heavily loaded than the other. Care having been taken in the distribution of the lights on the circuits, the balancer has little to do, and is a simple and effective device.

General inside illumination is provided for by the use of 110-volt inclosed arc lamps on the incandescent lamp circuit, having opalescent single globes and sheet-iron shades painted white. This style of arc lamp is believed to be best suited for shop lighting, as against the use of double-glass globes with no shades, as the shades distribute downward a portion of the light that would be otherwise wasted upward and do not interfere with the lateral distribution of the light.

The question how far individual motor driving should be considered for machines is an interesting one, but it is the belief of the writer that it is not necessary or advisable to consider anything but group driving in the average railroad shop. There is one shop, for instance, that has been considerably exploited by the consulting electrical engineer who laid it out, which is a shining example of the extreme in individual motor-driving, there being 94 machines, excluding cranes, turntables, etc., driven by 68 motors; the machine shop shows 42 machines driven by 29 motors. The motors are of varying sizes, and the arrangement is such that if another machine were to be put in, a motor for it would be required. In the Norfolk & Western machine shop there are 133 machines, which will be group-driven by six motors, aggregating not over 100 horse-power. A machine may be added to any group without seriously overloading the motor, and, as there are several groups, we may add a number of machines without change of motors. The additional load would be shown only at the switchboard, but by reason of the group system it would add but a small amount to any one motor.

The reasoning in favor of group-driving of railway shop machinery is as follows: One machine requiring one horse-power may be taken as a unit; individually motor-driven, this machine would require a one horse-power motor attached to operate it, no matter how much or little it runs, and average machine tools are idle or running light at least half the time, for work or tool adjustment, while two or three such tools grouped would not require their full multiple of the unit power. The full value of grouped driving will be reached, first, when the number of machines in the group will enable the use of a motor of sufficient size for a near approach to good electrical efficiency, which is not possible with small motors; and, second, when the number of machines is such that their proportions of idle time may be so distributed over them as to be practically continuous and effect a proportionate reduction in the power needed in the motor. For example, if one unit takes one horse-power and is idle one-half the time, two such units can be driven by a one horse-power motor, provided the machines are run alternately, but if both are operated together the motor will be subjected to 100 per cent. overload. If we take 10 such units, however, and use a five horse-power motor, the chances are about even that the motor will be driven to its rating, and they are infinitely small as to its ever getting 100 per cent. overload. There is no argument against individual motor driving in case the machines to be driven are large enough, or their isolation is necessary to facilitate movement of material, but we are considering average railway shop machinery, and in most cases old machinery already group-driven from shafting.

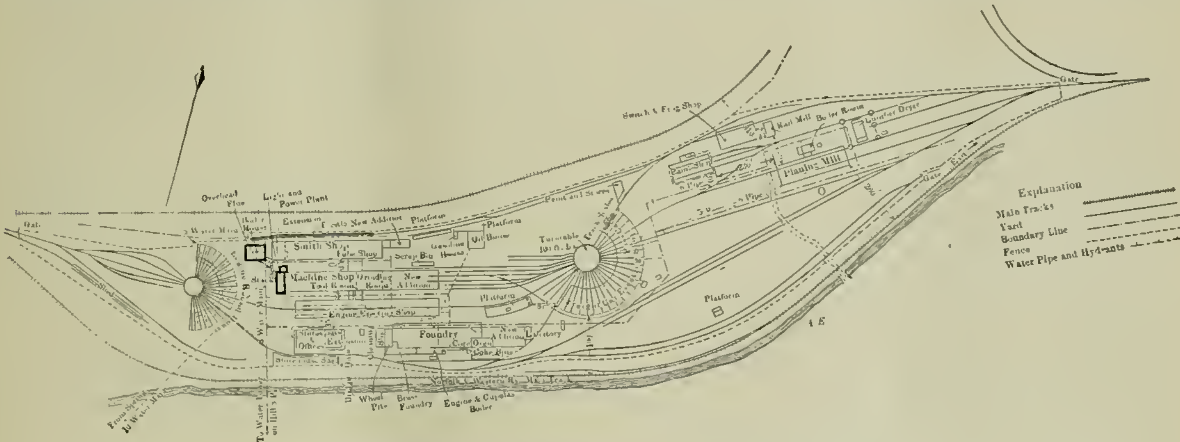
The extremist in electric driving does not like to use shafting, but as against an almost 100 per cent. increase of total motor capacity required, the low electrical efficiency of small motors and also the high cost per horse-power for small motors, as compared with those of moderate size and power, a reasonable length of shafting will in the end prove the best investment for our class of work. In a wood-planing mill the case is somewhat different. The power required is so much greater for heavy planers, and other continuously operated machines, that individual driving may be attempted, but even here it may profitably be limited. Saws, shapers, jointers, mortisers, tenoners, band saws, borers, all intermittently operated machines, can be successfully grouped and driven with a fraction of the power required for individual driving.

The mill was driven with a large engine. An indicator test showed the average power required, including all friction, to be 160 horse-power, although for short intervals it ran a little over 200 horse-power. It was believed that, by the elimination of the engine friction, the heavy transmission belts, and certain unused lengths of shafting, that 125 horse-power of motors would operate the mill, but it was decided that it would be wise, however, to overrun the calculated power at the heavy end of the shop somewhat and 140 horse-power of motors were ordered.

Other departments that are to be motor-driven in groups are the smith shop, bolt and forging machinery; the forge blowers, together with the flue-shop machinery; the bolt and nut-cutting machinery, together with the smith shop punching and shearing machinery; boiler-shop machinery; the foundry rattlers, grinders and drilling machinery in two groups, and the foundry cupola blowers are also to be driven with a motor with rheostatic control for varying the speed according to the need for blast. In all, twenty-three motors were ordered, as follows: Three 7-5 horse-power, five 10 horse-power, three 15 horse-power, ten 20 horse-power, one 30 horse-power, one 35 horse-power, aggregating 382.5 horse-power. It will be noted that the 20 horse-power motor is ordered in a larger quantity than any other size, it being intended that this should be the standard motor, so far as possible. All motors are of the regular commercial type, standard with the manufacturers.

The above described motors are in all cases to be belted direct to line shafting, instead of directly attached on the end of line shafting, as at the General Electric Company's shops at Schenectady. Back-geared motors directly attached were not used, as the gearing is very noisy, and this plant does not employ strictly standard motors. At the Baldwin Locomotive Works, where both individual and grouped driving are very extensively used, belts are used to the greatest possible extent, and in many cases with such short belt centers as to be surprising that good results could be obtained. It was explained that this method was very satisfactory, and that after a belt was taken up a few times in most cases it would run thereafter almost indefinitely, and, if it did fail, its replacement was much easier, cheaper and speedier than to repair broken gearing.

On the other hand, many shops employ gear connections be-



Ground Plan of Roanoke Shops.—Norfolk & Western Railway.

tween their motors and machines, especially the modern heavy machinery, much of which is now built to be directly driven. Where the gearing can be covered and protected it may do very well, but wear is inevitable and gear breakages are expensive and at times exceedingly inconvenient. There is a very desirable flexibility in a belt connection, and if there should be a failure of the motor an extra one can be readily installed if standard types are employed. Some of the electrical companies have developed systems of multiple voltage, which, in connection with double or triple gearing, give a large range of adjustment of cutting speed of tools individually driven, enabling maximum output after proper speed has been determined by experiment. These systems involve the use of considerable gearing, additional wiring and a generating set arranged with reference to the number of the voltages desired. Some of our friends who have installed multiple voltage may be able to enlighten us as to its advantages, but, as the writer does not favor individual driving as a rule, multiple voltage was not considered in connection with the plant under discussion.

(*Abstracts to be concluded.*)

The Handy Car Equipment Company has, in addition to its other specialties, secured control of a patented swinging pilot coupler, to be known as the Handy Horizontally Swinging Pilot Coupler. The office of the company is in the Old Colony Building, Chicago.

EXHIBITORS AT THE SARATOGA CONVENTION.

American Balance Valve Company, Jersey Shore, Pa. American balanced slide valves.
American Brake Shoe & Foundry Company, New York and Chicago. Railway brake shoes and miscellaneous iron and steel castings.
American Locomotive Co., New York. Locomotives.
American Steel Foundry Company, St. Louis, Mo. Models of steel trucks and bolsters.
American Watchman's Time Detector Company, The, New York, N. Y.
Ashton Valve Company, Boston, Mass.
Aurora Metal Company, Aurora, Ill.
Ajax Metal Company, Philadelphia, Pa.
Alexander Car Replacer Manufacturing Company, Scranton, Pa.
American Locomotive Sander Company, Philadelphia, Pa.
Baker Manufacturing Company, Pittsburg, Pa.
Baltimore Ball Bearing Company, Baltimore, Md. Norwood ball-bearing center and side bearings.
Boston Belting Company, The. Samples of air brake, steam and water hose.
Brill Company, J. G., Philadelphia, Pa. Car trucks.
Buckeye Malleable Iron & Coupler Company, Columbus, O. The Major automatic coupler.
Bullock Electric Manufacturing Company, Cincinnati, O., 28-in. Lodge & Shipley lathes driven by type "N" Bullock motor. Speed controlled by Bullock multiple voltage system.
Chicago Pneumatic Tool Company, Chicago, Ill. Full line of pneumatic hammers and drills and other pneumatic tools.
Chicago Railway Equipment Company, Chicago, Ill. National Hollow, Kewanee, Diamond and Central brake, Sterlingworth, Monarch solid and "Ninety-Six" Automatic Frictionless Side Bearings, and a specially adapted brake beam for high-speed brake service.
Commonwealth Steel Company, St. Louis, Mo. Models of trucks and bolsters.
Consolidated Car Heating Company, Albany, N. Y. Steam heating apparatus, steam couplers, steam traps, etc.
Consolidated Railway Electric Lighting & Equipment Company, New York, N. Y. Electric car-lighting apparatus and fixtures. The private Pullman car "Columbia," used by Prince Henry on his recent tour in the United States, equipped with Consolidated "Axle Light" system of electric lights and fans.
Crane Company, The, Chicago, Ill. The new Crane locomotive muffler pop safety valve, gun metal globe and angle valves and blow-off valves for high steam pressure.
Crosby Steam Gage & Valve Company, Boston, Mass.
Curtain Supply Company, Chicago, Ill.
Damascus Brake Beam Company, St. Louis, Mo.
Damascus Bronze Company, Pittsburg, Pa.
Davis Pressed Steel Company, Wilmington, Del. Davis solid truss brake beams.
Dayton Malleable Iron Company, Dayton, O. Dayton draft gear, Dayton patent car door fastener, lubricating center plate.
Joseph Dixon Crucible Company, Jersey City, N. J. Preservative paints.
Drake & Wiers, Cleveland, O. Car roofs and universal drafting machine.
Economy Car Heating Company, Portland, Me.
Edwards Company, The O. M., Syracuse, N. Y. Window models showing four designs of windows comprising recent improvements, four models of extension platform trap doors for wide vestibules and open platforms for railway coaches.
Edwards Railroad Electric Light Company, Cincinnati, O. Half section model of electric headlight.
Excelsior Car Roof Company, St. Louis, Mo.
Falls Hollow Staybolt Company, Cuyahoga Falls, O.
Fay & Egan Company, J. A., Cincinnati, O.
General Electric Company, Schenectady, N. Y. Eight horse-power motor driving a 48-in. portable Newton slotter; two Chapman valves.
Gold Car Heating Company, New York and Chicago. Car heating apparatus, duplex coil system and straight steam operated under steam; also various parts of apparatus shown separately.
Goodrich, B. F., Company, Akron, O. Rubber hose, packing, belting, locomotive tender hose, rubber tiling.
Gould Car Coupler Company, New York, N. Y. Showing passenger and freight slack adjuster, improved M. C. B. journal boxes, improved malleable draft rigging for freight equipment, with spring buffer blocks; improved M. C. B. coupler for 100,000-lb. car and improved locomotive tender coupler for heavy equipment.
Hammett, H. G., Troy, N. Y. Richardson and Allen Richardson balanced slide valves, oil cups, "Sansom" bell ringer, link grinders, etc.
Handy Car Equipment Company, Chicago, Ill. Full size Snow locomotive and car replacers, American Dust Guards, Handy horizontally swinging pilot couplers.
Jones Car Door Company, Chicago, Ill. Jones and Smith car doors.
Keystone Drop Forge Works, Philadelphia, Pa.
Kindl Car Truck Company, Chicago. Models of Kindl trucks, Cloud trucks, Woods pedestal roller swinging-motion truck.
Manning, Maxwell & Moore, New York. Inspirators, check valves, steam valves and strainers for locomotives.
McCord & Co., Chicago and New York. McCord journal box, McCord spring dampener, McKim gasket and Torrey anti-friction metal.
McConway & Torley Company, Pittsburg, Pa. Steel and malleable-iron couplers for freight and tenders of the Kelso and Janney patterns.
Merritt & Co., Philadelphia, Pa. Expanded metal lockers for shops, offices, roundhouses, etc.
Michigan Lubricator Company, Detroit, Mich. Lubricator and oil cups.
Nathan Manufacturing Company, New York. Injectors and lubricators.
National Car Coupler Company, Chicago, Ill. National steel platform and buffer for passenger cars, National freight car coupler, Hinson friction draft gear, and the Hinson drawbar attachment.
National Malleable Castings Company, Cleveland, O. Tower coupler.
Norton Grinding Company, Worcester, Mass.
Philadelphia Pneumatic Tool Company, Philadelphia, Pa.
Piper Friction Draft Gear Company, Cleveland, O. Draft gear.
John N. Poage Manufacturing Company, Cincinnati, O. Car showing the Williams grain door.
Railway Appliances Company, Chicago. Ajax canvas vestibuled diaphragms, auxiliary couplers and Gilman-Brown emergency knuckles.
The Railway Materials Company, Chicago, Ill. Flue-welding furnace in operation and the Ferguson portable heater.
Rand Drill Company, New York. Rand compressors—one style of Type 10 and three styles of Type 11. Plain belt-driven electric motor-driven and gasoline engine.
Republic Railway Appliance Company, St. Louis, Mo. Friction draft gear and dust guard.
Safety Car Heating & Lighting Company, New York, N. Y. A handsome exhibit of car lighting and heating apparatus, ornamental deck lamps, bracket lamps, gas ranges for private cars and buoy lantern.
Sellers, William & Co., Philadelphia, Pa.
Scullin-Gallagher Company, St. Louis, Mo. Miscellaneous steel castings.
Simplex Railway Appliance Company, Chicago. Simplex bolsters for 80,000-lb. capacity cars, also for 60,000-lb. cars. Susemihl frictionless roller side bearing.
Soule Raw Hide Lined Dust Guard, Boston, Mass.
Standard Car Truck Company, Chicago, Ill.
Standard Coupler Company, New York. Standard steel platforms, Sessions' standard friction draft gear, Standard couplers.
Sterlingworth Company, Easton, Pa.
St. Louis Car Company, St. Louis, Mo. Journal bearings.
Symington, T. H., & Co., Baltimore, Md. Journal boxes and dust guards.
J. S. Toppan Company, Chicago, Ill. The Kennicott water softening apparatus, Martin steam and air specialties and car-door seal and Miller grain door.
C. Vanderbilt, New York. One 12,000-gal. capacity all-steel tank car, built by the American Steel Foundry Company, St. Louis, and equipped with their trucks and truck bolsters; the Vanderbilt brake beam and a 100,000-lb. capacity steel hopper car equipped with the Vanderbilt cast-steel bolster, made by the Commonwealth Steel Company, St. Louis.
Western Railway Equipment Company, St. Louis.
The Westinghouse Air Brake Company, Pittsburgh, Pa. The American Brake Company, St. Louis, Mo.; Westinghouse Automatic Air & Steam Coupler Company, St. Louis, Mo. Triple valve-testing rack, two quarter-size four-wheel car models equipped with Westinghouse air brake, freight and passenger; Westinghouse friction draft gear, freight and passenger application; Westinghouse automatic air and steam coupler, freight and passenger; American automatic slack adjuster, freight and passenger; Westinghouse high-speed reducing valve.
G. S. Wood & Co., Chicago.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

AUGUST, 1902.

CONTENTS.

OIL FUEL FOR LOCOMOTIVES.

Hoosac Tunnel,

Boston & Maine Railroad.

(For previous article see page 185.)

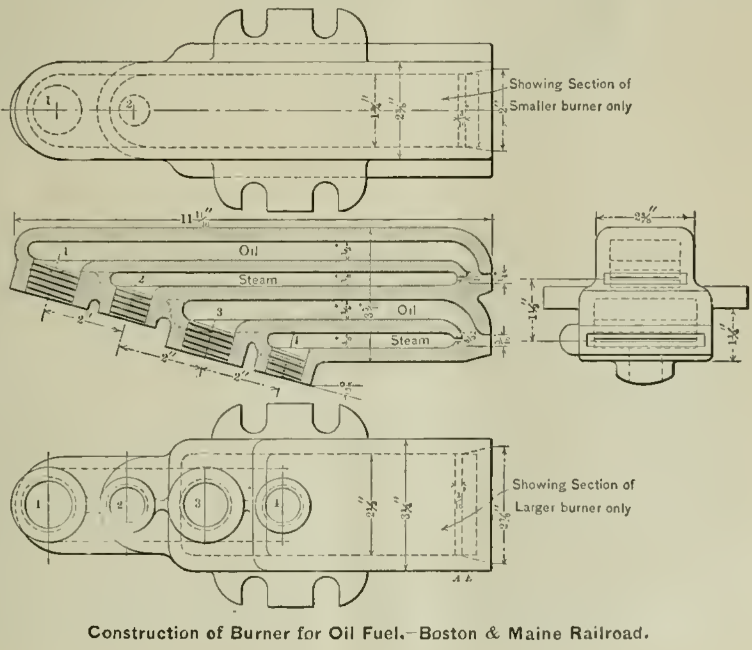
In the June issue lack of space prevented us from referring in detail to the interesting oil burner in use upon the Hoosac Tunnel helper locomotives in connection with the descriptive article. This burner is shown in detail in the accompanying drawing. It consists of two separate burners of different sizes, arranged in a single casting, the smaller one above and the larger one below. The slot type of burner is used instead of the nozzle type, as having been found more suitable for burning large quantities of oil and for forcing. It is of extremely simple construction, but is not troubled by stopping up. The variable service of the helper engines led to the design of the double burner, with one burner large enough to meet the demand of the heaviest loads and the other small enough to burn steadily with the least possible amount of steam and oil when the engine is waiting for service; the smaller burner was, however, found large enough to be capable of sufficient forcing to carry a train load in an extreme case of accident to the other burner.

In the latest design of this burner it has been changed so that the upper small burner is reversed from the arrangement shown in this sectional view, in order to place the steam passage above the oil passage. This causes the steam jet to blow from the surface of the oil as it feeds up from the oil passage, thus insuring a steady feed and no trouble from gasification of the thin layer of oil in the oil passage, and consequent breaking of the fire, as with the former arrangement when the valve is cut down for a low fire. The burner is set in the firebox 2 ins. below the firebox ring and 2 ins. above the brick in the pan, permitting an opening for air around the burner, which is desirable for keeping up combustion before the flame strikes the arch.

Mr. W. D. Hoffman, the engineer in charge of installation, is of the opinion that there is no benefit to be derived from an admission of air through the burner itself, as the volume of air that could be passed through the necessarily small opening in a burner would be of no consequence as compared with the large amount necessary for combustion. When admitted outside and around the burner, the harder the burner is forced the more air will be drawn in to support combustion in the flame before it reaches the arch, where the necessary larger volume of air is admitted through the damper. The burner is inclined upward at an angle of 15 degrees, so that the flame will strike about the middle of the arch wall, and then rebound toward the top of the firebox.

In operation, the greater the amount of steam used the greater the amount of oil burned, so that the fireman is called upon to use as much judgment here as with coal burning. In starting one of these burners, after first blowing out to clear of water, the steam valve is opened, so as to blow slightly from the burner, and then oil is turned on until the combined blast is ignited by the hot brick arch, or by a small fire of burning waste, if the firebox is cold; then both the oil and steam are regulated until the proper fire is obtained. In changing the fire, the steam is always opened up before the oil in increasing it, and in shutting down the oil is cut off first.

The throttling valves used in the steam and oil supply pipes are plug valves, in which the holes in the plugs are enlarged at their ends by tapering grooves cut in the circumference of the plug, so as to permit more gradual adjustment of the flow; these have been found more satisfactory than either globe or needle valves. The stems of the valves extend up through the floor of the cab to handles within easy reach of the fireman, and thus indicate by their position the opening of the valve. The blower connection is left in place, but is used only in case



Construction of Burner for Oil Fuel.—Boston & Maine Railroad.

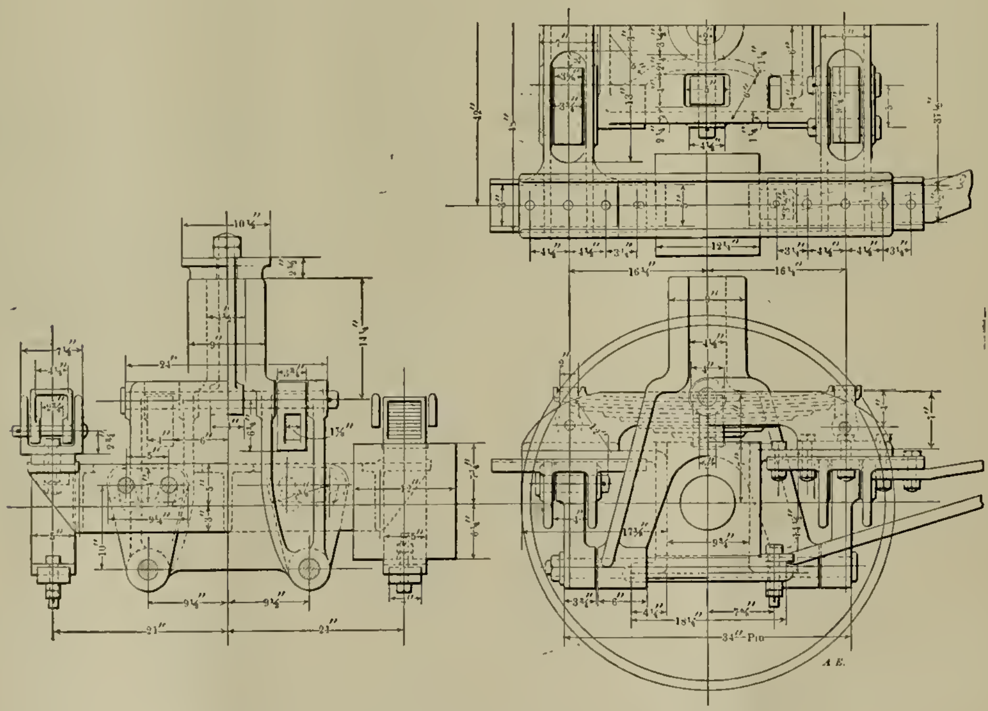
of very sudden stoppage of the engine, as the air pump exhaust is not sufficient to furnish draft.

The success of oil burning on these engines is interesting, in view of the peculiarly severe service to which they are subjected; they are in service for the entire twenty-four hours, having two crews, and are called upon at very irregular intervals and on very short notice. Also in the tunnel the fireman has to judge his fire entirely by its appearance, as it is impossible for him to see the stack. But they require no hostler service, no ash pit cleaning, no repairs to front end diaphragm and netting, and repairs do not appear to be increased by the oil burning. By closing the dampers the engine may be left for four or five hours without fire, and then be gotten ready for service in a very few minutes; in one instance one of the oil-burning engines, after having stood 15 hours without fire, showed 150 pounds' pressure at the gauge in just 40 minutes after the fire was started, and in another instance steam was raised to 150 pounds pressure from cold water in the boiler in 90 minutes after starting burner. When the engine is cold, the burner is started with steam from another engine, the blast being ignited by throwing a handful of oily waste in the firebox in front of the burner and lighting it with a torch.

In the tunnel the fireman can easily tell whether the fire is burning properly, or is smoky, by looking through the peep hole in the firebox door. After reaching the top of the grade at the middle of the tunnel the large burner is shut off and the small one started with a low fire for the remainder of the run, which is down grade.

It may be added that there is no possibility of damage to property along the line by sparks with the oil burners. In standing idle for some time, with a low fire, a coating of soot is liable to form in the tubes, but the soot is easily removed while the engine is working hard by simply throwing a small handful of sand into the firebox, which under the action of the strong draft effectually scours the tube surfaces clean. It is the opinion of Mr. Hoffman that no soot forms when the engine is working hard, but that with a light fire the hot gases are partially condensed by the cooling action of the large tube surface before combustion is complete. The change in the condition of the tunnel resulting from the use of oil fuel on the helper engines is very apparent, even with only two of them in service; in the opinions of employees that have been on that section of the road for several years, the tunnel has never been so clear as since the oil burners have been in operation.

The engines, 1072, 1073 and 1075, are Vauclain compound consolidations, with 15 and 25 by 24-in. cylinders, while the 1068 differs only in that it is a simple consolidation, with 20 by 24-in. cylinders. All are similar in principal dimensions, having total weight, with tender, of 225,000 pounds, weight on drivers of 121,000 pounds, and heating surface of 1,856 square feet.



Leading Truck, Prairie Type Locomotive.—A. T. & S. F. Railway.

Ton-miles are necessary to know what use superintendents are getting out of their power and out of their cars, what use the road as a whole is getting out of its plant, how far it is balancing its traffic, whether the fault of decline in net earnings lies with the traffic department or the operating department, and finally whether the service or commodity which the railroad is offering in the public market is declining in value more rapidly than the cost of producing it. These are the conditions on which the entire value of the property must ultimately rest, regardless of what may be its book capitalization. —J. Shirley Eaton, in *Railroad Gazette.*

TRUCKS AND FRAMES—PRAIRIE TYPE PASSENGER LOCOMOTIVES.

Atchison, Topeka & Santa Fe Railway.

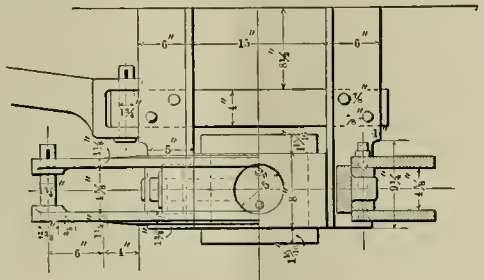
A general description of the very heavy prairie type passenger locomotives built last year by the Baldwin Locomotive Works for the Santa Fe, was published in this journal in December, 1901. Additional drawings of the interesting leading and trailing trucks and the frame construction have been received.

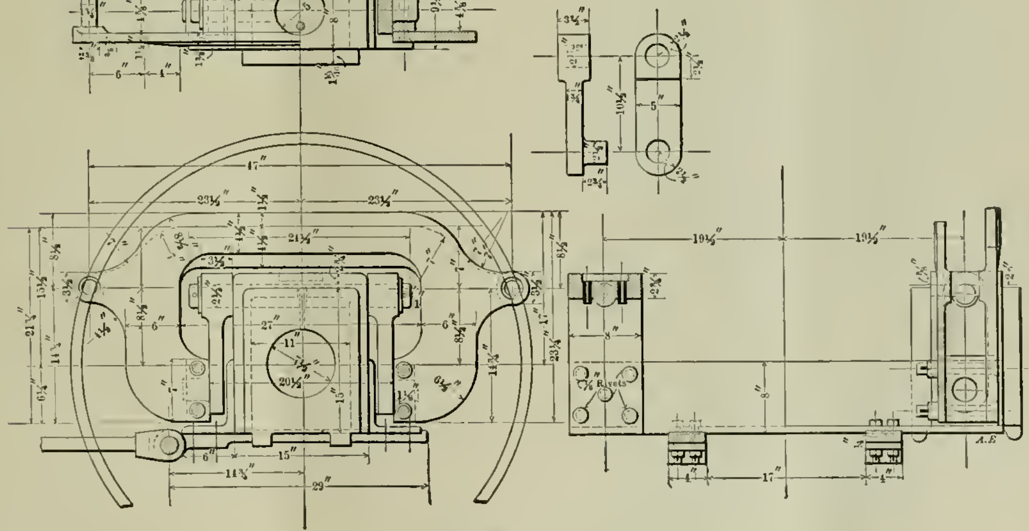
This design required a low front truck, and in accordance with suggestions from Mr. Henderson a combination using three-point hangers and leaf springs was effected in such a way as to keep the springs out of the way of other parts. In fact, the spaces occupied by the springs, which are flat, could not be used for any other purpose, as a glance at the drawing will indicate. This arrangement includes two equalizers, one at each side of the truck center. When the truck turns on a curve one of the equalizer hangers swings forward and the other swings back. The pin forming the bearings for the hangers is in double shear, because of the form of the casting. This arrangement is compact, and it seems to include all the features usually desired in trucks of this type.

To accommodate the trailer truck, which is also of the radius bar type, and to provide for the large amount of motion required by so long a wheel base the frame jaws are unusually far apart, as shown in the frame drawing. The truck drawing shows the method of suspension, and the attachment of the springs may be seen in the elevation view of the engine on page 372 of the December number of last year. The lower ends of the swing links terminate in trunnions, with bearing blocks between the ends of the equalizer plates.

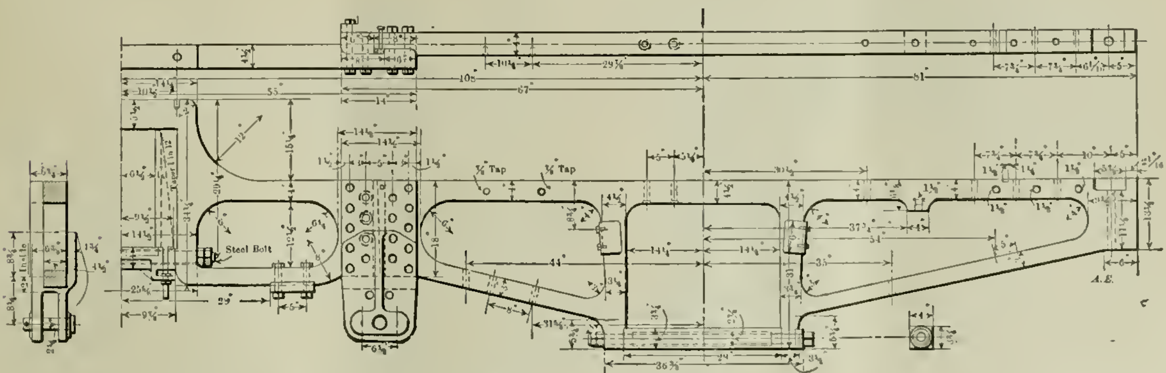
Because of the large size of the engine and the construction of the frames in three parts with two splices, the rear part of the frame drawing is shown. The rear end of the front rail terminates in a palm, which is secured by two compression keys in addition to the bolts. Another splice, with compression keys, is used to secure the rear platform at a point where the frames are 18 ins. deep.

We are indebted to the Baldwin Locomotive Works for these drawings, and to Mr. G. R. Henderson for information concerning the details. It is understood that this trailing truck has been patented by Mr. Kenneth Rushton, of the Baldwin Locomotive Works.



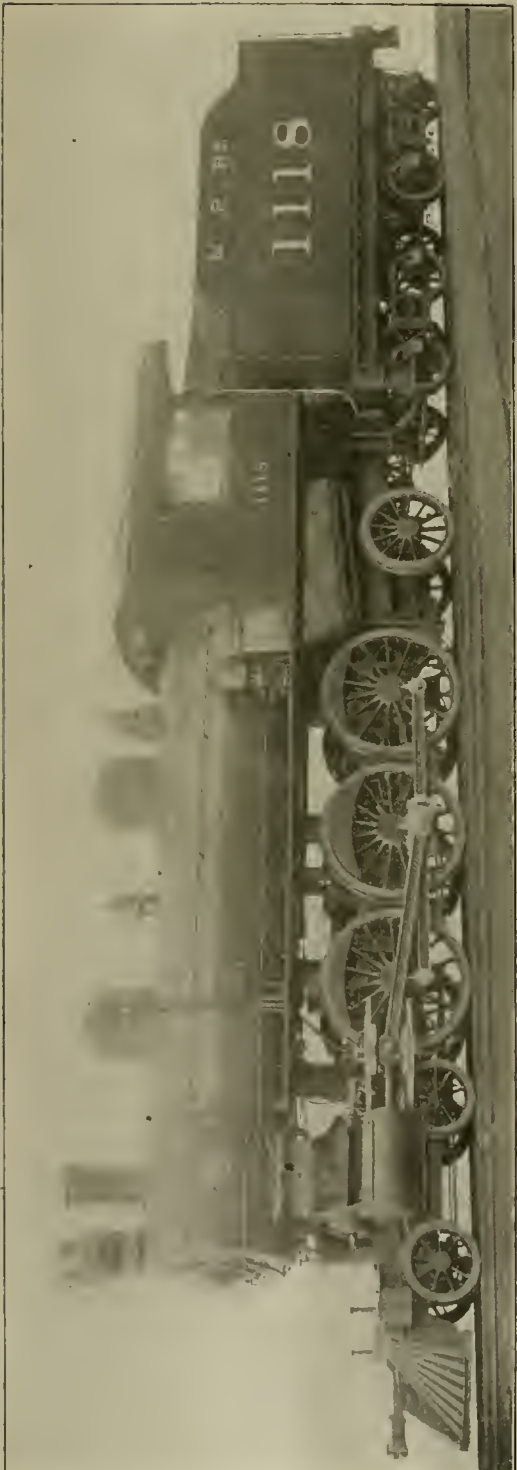


Trailing Truck.



Rear Section of Frames.

Trucks and Frames, Prairie Type Locomotives.—Atchison, Topeka & Santa Fe Railway.



Six Coupled Passenger Locomotive.—Missouri Pacific Railway.
Built at the Brooks Works of the American Locomotive Company.

NEW SIX-COUPLED PASSENGER LOCOMOTIVE.

Chesapeake & Ohio Railway.

Missouri Pacific Railway.

This type of wheel arrangement, while not entirely new, was devised to meet new conditions. Under the Whyte classification it is the 4-6-2 type and was decided upon because of the necessity of large tractive power combined with large heating surface and grate area. This required six-coupled wheels for both designs, also wide fireboxes. For heavy grades large boiler capacity was needed, and this required wide grates. Naturally one would turn to the 2-6-2 or Prairie type for such work as the Chesapeake & Ohio and the Missouri Pacific have to do, but because of the crooked roads and fast running which always occurs on mountain lines four-wheel leading trucks were decided upon as being safer than two-wheel trucks, although there is a difference of opinion upon the relative safety of the two. The Chesapeake & Ohio engines were designed under the direction of Mr. W. S. Morris when superintendent of motive power of this road, and the Missouri Pacific design was made in accordance with the views of Mr. J. O. Pattee, formerly of that road.

The Chesapeake & Ohio engines, built at Schenectady, weigh 187,000 lbs. in working order, with 131,000 lbs. on drivers. They have 22 x 28-in. cylinders, 72-in. driving wheels, 3.533 sq. ft. of heating surface and 47 sq. ft. of grate area. The tractive power is 32,000 lbs. These engines have tubes 19 ft. 6 ins. long.

The Missouri Pacific engines, built at the Brooks Works, weigh 173,000 lbs. in working order, with 120,000 lbs. on drivers. They have 20 x 26-in. cylinders, 69-in. driving wheels, 2,952.5 sq. ft. of heating surface and 42.4 sq. ft. of grate area. The tractive power is 25,600 lbs. These engines have tubes 18 ft. 6 ins. long.

It will thus be seen that the Chesapeake & Ohio design is much heavier and more powerful than the other. In fact there are but three passenger engines noted in our record, printed in June, heavier than this design. In 1892 the Chicago, Milwaukee & St. Paul applied trailing wheels to a 10-wheel engine, probably in order to overcome some defect in the distribution of weight, but this type is now designed purposely for certain definite conditions. The photograph shows one of the Missouri Pacific engines. In a later issue further illustrations of both designs will be presented, and attention will be directed to a number of interesting details. The general dimensions of the Missouri Pacific design, of which ten have been built, are as follows:

SIX-COUPLED PASSENGER LOCOMOTIVE. MISSOURI PACIFIC RAILWAY.

Description.

Gauge	4 ft. 8½ ins
Kind of fuel to be used	Bituminous coal
Weight on leading wheels	31,000 lbs.
Weight on driving wheels	120,000 lbs.
Weight on trailing wheels	22,000 lbs.
Weight, total	173,000 lbs.
Weight, tender, loaded	110,000 lbs.

General Dimensions.

Wheel base, total, of engine	30 ft. 5 ins.
Wheel base, driving	12 ft. 4 ins.
Wheel base, total, engine and tender	55 ft. 1½ ins.
Length over all, engine	44 ft. 8¾ ins.
Length over all, total, engine and tender	67 ft. 9½ ins.
Height, center of boiler above rail	9 ft. 6 ins.
Height, stack above rail	15 ft. 4½ ins.
Heating surface, firebox	152 sq. ft
Heating surface, water tubes	22 sq. ft.
Heating surface, tubes	2,778.5 sq. ft.
Heating surface, total	2,952.5 sq. ft.
Grate Area	42.4 sq. ft.

Wheels and Journals.

Wheels, leading, number	4
Wheels, leading, diameter	33 ins.
Wheels, driving, number	6
Wheels, driving, diameter	69 ins.
Wheeels, trailing, number	2
Wheels, trailing, diameter	49 ins.
Material of wheel centers	Steel
Type of trailing wheels	Improved radial
Journal leading axles	5½ ins. x 12 ins.
Journal leading axles, wheel fit	5½ ins.

Journal, driving	9 ins. x 12 ins.
Journal, driving, axle wheel fit	8⅞ ins.
Journal, trailing, axle wheel fit	7 ins. x 14 ins.
Journal, trailing, axle wheel fit	7½ ins.

Cylinders.

Cylinder, diameter	20 ins.
Cylinder, stroke	26 ins.
Piston rod, diameter	3⅝ ins.
Main rod, length center to center	111 ins.
Steam ports, length	25½ ins.
Steam ports, width	1⅞ ins.
Exhaust ports, least area	65 sq. ins.
Bridge, width	3 ins.

Valves.

Valves, kind of	Improved piston
Valves, greatest travel	5 5-16 ins.
Valves, steam lap (inside)	1⅛ in.
Valves, exhaust clearance, outside	0
Lead in full gear	0

Boiler.

Boiler, type of	Radial stayed wagon top
Boiler, working pressure	200 lbs.
Boiler, material in barrel	Steel
Boiler, thickness of material in shell	21-32 in., 11-16 in., 9-16 ins, ½ in.
Boiler, thickness in tube sheet	¾ in.
Boiler, diameter of barrel, front	64 3-16 ins.
Boiler, diameter of barrel at throat	69¾ ins.
Seams, kind of horizontal	Sextuple
Seams, kind of circumferential	Triple
Crown sheet stayed with	Radial stays
Dome, diameter inside	30 ins.

Firebox.

Firebox, type	Wide
Firebox, length	78 ins.
Firebox, width	80 ins.
Firebox, depth, front	77 7-16 ins.
Firebox, depth, back	63 ins.
Firebox, material	Steel
Firebox, thickness of sheet	Crown ⅜ in.; tube ⅝ in.; sides ⅜ in.
Firebox, brick arch	On water tubes
Firebox, mud ring, width	3½ ins. back; 3½ ins. sides; 4 ins. front
Firebox, water space at top	6 ins. back; 6 ins. sides; 6 ins. front
Firebox, grates, kind of	Rocking
Tubes, number of	256
Tubes, material	Charcoal iron
Tubes, outside	2¼ ins.
Tubes, thickness	No. 11 B. W. G.
Tubes, length over tube sheets	18 ft. 6½ ins.

Smoke Box.

Smoke box, diameter, outside	67 ins.
Smoke box, length from tube sheet	69 ins.
Exhaust nozzle, single or double	Single
Exhaust nozzle, variable or permanent	Permanent
Exhaust nozzle, diameter	5 ins., 5⅛ ins., 5¼ ins.
Exhaust nozzle, distance of tip below center of boiler	3½ ins.
Netting, wire or plate	Wire
Netting, size of mesh or perforation	2½ x 2½
Stack, straight or taper	Taper
Stack, least diameter, taper	15 ins.
Stack, greatest diameter, taper	17 ins.
Stack, height above smoke box	37 ins.

Tender.

Type	8-wheel steel frame
Tank, type	Water bottom
Tank, capacity for water	5,000 gals.
Tank, capacity for coal	10 tons
Tank, material	Steel
Tank, thickness of sheets	¼ in.
Type of under frame	Steel channel
Type of trucks	All metal
Type of springs	Double elliptic
Diameter of wheels	33 ins.
Diameter and length of journals	5 ins. x 9 ins.
Distance betweeen centers of journals	5 ft. 1 in.
Diameter of wheel fit on axle	6⅝ ins.
Diameter of center of axle	5⅝ ins.
Length of tender over bumper beam	21 ft. 1½ in.
Length of tank inside	19 ft. 6 ins.
Width of tank inside	9 ft. 10 ins.
Height of tank not including collar	5 ft. 1¼ in.
Type of draw gear	M. C. B. coupler

Link pin holes and link slots in M. C. B. couplers have been maintained because of the difficulty of handling cars around very short curves, as in mill yards and upon floats where the water level varies greatly. It is certainly unfortunate that a little inconvenience at a few such points has made it necessary for these weakening elements to be retained generally. The Coupler Committee this year reported an inspection of 400 knuckles of various makes, taken at random from a scrap pile: Of the failures, 37½ per cent. were due to the link pin holes, and 21 per cent. to the link slot, while 12 and 29½ per cent. were due to the tail and knuckle pin hole respectively. The action of the association, after the discussion, which amounted to official approval of omitting the hole and slot, was wise, and in view of the figures of the committee, a great saving of knuckles and consequent break-in-twos may be expected, as a result of such omissions..

A TWENTIETH CENTURY RUN.

133.9 Miles at 69.3 Miles Per Hour.

A continuous run of 133.9 miles in 116 minutes, at the rate of 69.3 miles per hour as an average speed over the entire distance, is truly a "pretty fair run." This was done by the Twentieth Century Limited on the Lake Shore with train No. 25, leaving New York at 2.45 P. M., July 11, leaving Buffalo at 10.50 P. M. of the same day.

On this occasion the Lake Shore had a bad freight wreck near Brocton, N. Y., a short time before the westbound "Limited" was due, completely blocking both tracks. Reference to the tabulated record shows that the train was first delayed at Farnham, and was further blocked at several other points, and did not finally get clear until after leaving Brocton, where the wreck was passed. From there the track was clear and the fast time was made in a remarkable effort to make up the lost time.

This train makes a regular station stop of three minutes at Erie. Another stop is made at Collinwood to change engines, and it is necessary to slow down through Cleveland yard on account of new track work. A regular stop is made at Cleveland, one at Toledo, one at Elkhart, where on the morning in question a dining car was added. There are also two suburban stops in Chicago and several slow-downs for crossings. The following figures were furnished from the official records, and while the times recorded between stations should not be considered as absolutely accurate, the time over each division may be so considered. The weight of the train back of the tender was about 250 tons.

Transcript of run of Train 25, "Twentieth Century Limited," leaving Buffalo July 11, 1902. Eastern Division, 176 miles. Class "J" engine 652, Engineer J. L. Baldwin. Four cars—One composite buffet and baggage, two sleepers, one observation.

Station.	Miles.		Time Passed.	
Buffalo			10.50	On time
B. C. Crossing	2		10.57	
Athol Springs	12		11.06	
Lake View	4		11.12	
Angola	8		11.18	
Farnham	5	A 11.21	D 12.33	Blocked by wreck
Silver Creek	6	A 12.42	D 12.57	Blocked by wreck
Waites Crossing	4		1.02	
Dunkirk	5	A 1.15	D 1.30	Block
Van Buren	4		1.39	
Brocton	5	A 2.12	D 2.14	Passing wreck
Westfield	8		2.24	
Ripley	8		2.34	
North East	8		2.41	
Harbor Creek	7		2.47	
Erie	4	A 2.59	D 3.02	
Dock Junction	2.3		3.07	
Swanville	4.2		3.13	
Girard	7		3.19	
Springfield	4.8		3.23	
Conneaut	7.5		3.28	
Kingsville	7.5		3.35	
Ashtabula	5.7		3.41	
Geneva	9.3		3.50	
Madison	5.4		3.56	
Perry	5.3		4.00	
Painesville	5.5		4.05	
Mentor	6.3		4.10	
Willoughby	4.3		4.15	
Wickliffe	4.2		4.18	
Nottingham	4.7		4.21	
Collinwood	2	A 4.24	D 4.27	Changing engines

Three stops for wreck, one stop for block—176 miles in 227 minutes = 46.5 miles per hour.

Collinwood to Toledo, 115½ miles. Class "F" engine 146, Engineer Jos. Polite, 18 ins. x 24 ins., 10-wheel, 68-in. drivers, 190 lbs. steam, 88,000 lbs. on drivers.

	Station.	Miles.	Time Passed.
Left	Collinwood		4.27 A. M.
Arrived	Cleveland	7.5	4.39
Left	Cleveland		4.41
	West Park	5.9	4.53
	Berea	6.4	4.59
	Olmstead Falls	2.1	5.01
	Shawville	6.2	5.08
	Elyria	4.5	5.11
	North Amherst	0.4	5.18
	Brownhelm	4.4	5.22
	Vermillion	3.2	5.24
	Ceylon	7.5	5.30
	Huron	4.0	5.35
	Sandusky	8.9	5.45
	Venice	2.9	5.47
	Danbury	4.9	5.51
	Gypsum	2.1	
	Port Clinton	3.0	5.55
	La Carne	6.1	6.02
	Oak Harbor	5.5	6.08

Rocky Ridge	3.5	6.11
Graytown	2.3	6.13
Martin	4.6	6.17
Millbury	4.8	6.21
Rockwell Junction	5.0	6.26
Toledo	3.0	6.30

115½ miles in 121 minutes = 57.2 miles per hour.

Air Line Division, Toledo to Elkhart. Class "I" engine 606, 20 x 28 ins., 10-wheeler, 80-in. diameter, 200 lbs. steam, 133,000 lbs. on drivers. Four cars. Engineer J. H. Caulkins.

Station.	Miles.		Time Passed.	
Toledo			6.32	
West Tower	2.6		6.38	
Holland	7.2		6.44	
Swanton	9.3		6.61	
Delta	6.7		6.56	
Wauseon	7.8		7.03	
Pettisville	4.5		7.07	
Archbald	4.		7.10	
Stryker	6.		7.14	
Bryan	7.3		7.20	
Melbern	6.		7.25	
Edgerton	5.1		7.29	
Butler	6.9		7.35	
Waterloo	7.6		7.42	
Corunna	6.7		7.47	
Kendallville	6.		7.63	
Brimfield	7.		7.59	
Wawaka	4.4		8.02	
Ligonier	6.5		8.06	
Millersburg	7.		8.12	
Goshen	7.7		8.18	
East Yard, Elkhart	10.3		8.27	
Elkhart	.4	A 8.28	D 8.33	Changing engines

133.9 miles in 116 minutes = 69.3 miles per hour.

Western Division, Elkhart to Chicago, 101.1 miles. Class "I" engine 607, 20 x 28 ins, 10-wheel, 80-in. drivers, 200 lbs. steam, 133,000 lbs. on drivers. Five cars, diner added at Elkhart. Engineer J. R. Valance.

Station.	Miles.		Time Passed.
Elkhart			D 8.33
Osceola	6.54		8.40
Mishawaka	6.68		8.46
South Bend	3.98		8.49
I. I. & I. Crossing	1.		8.51
Warren	6.96		8.57
Terrecoupee	4.74		9.02
New Carlisle	1.70		9.03
Rolling Prairie	6.30		9.10
L. E. & W. Crossing	6.05		9.16
LaPorte	1.		9.17
Durham	6.38		9.23
Otis	3.54		9.27
Burdick	3.64		9.31
Chesterton	4.09		9.35
Dune Park	5.65		9.40
Millers	5.80		9.46
Pine	6.86		9.51
Brinson	3.67		9.54
Whiting	2.49		9.56
One Hundredth Street	3.54		10.00
South Chicago	1.11		10.01
Grand Crossing	3.21	A 10.05	10.06
Englewood	2.39	A 10.09	D 10.10
Chicago	6.65		A 10.21

Two suburban stops—101.1 miles in 106 minutes = 57.2 miles per hour.

The fastest running was made on the Air Line Division, from Toledo to Elkhart, the conditions being specially favorable over that division. The following is a summary of the four division runs:

Eastern Division.

176 miles in 227 minutes, 46.5 m. p. h., deducting three stops for wreck and one for block signal.

Cleveland Division.

115.5 miles in 121 minutes, 57.2 m. p. h.

One stop at Collinwood and one at Cleveland.

Air Line Division.

133.9 miles in 116 minutes, 69.3 m. p. h.

No intermediate stops.

Western Division.

101.1 miles in 106 minutes, 57.2 m. p. h.

Two suburban stops in Chicago.

Whole distance 526.5 miles in 570 minutes, 55.4 miles per hour.

The Eastern Division locomotive was the "Class J," Prairie type, illustrated in this journal in March, 1901. The one making the phenomenal run on the Air Line Division was one of the 10-wheel type, designed by Mr. W. H. Marshall, now general superintendent of the road, and built in 1899 at the Brooks Locomotive Works. A description will be found on page 343 of our November number 1899. This is a narrow firebox engine, and it is noteworthy that its record was so much better than that of the new Prairie type. The engines, however, were not selected for this emergency, and probably the conditions were not favorable to this particular Prairie type engine. The run on the Western Division was also made with one of the earlier 10-wheel engines. The section from Collinwood to Toledo was covered by a Class F 10-wheel engine, with 88,000 lbs. on drivers and 68 in. wheels. The record reflects great credit to the motive power department of this road.

In the famous run of October 24, 1895, over this road from Chicago to Buffalo the average speed was 65.07 m. p. h. over the entire distance, with special preparation. In the run recorded here, however, the train was a regular one, and it appears to indicate the possibility of faster regular long distance trains than have ever before been attempted.

FLEXIBLE AND COMMON STAYBOLTS COMPARED.

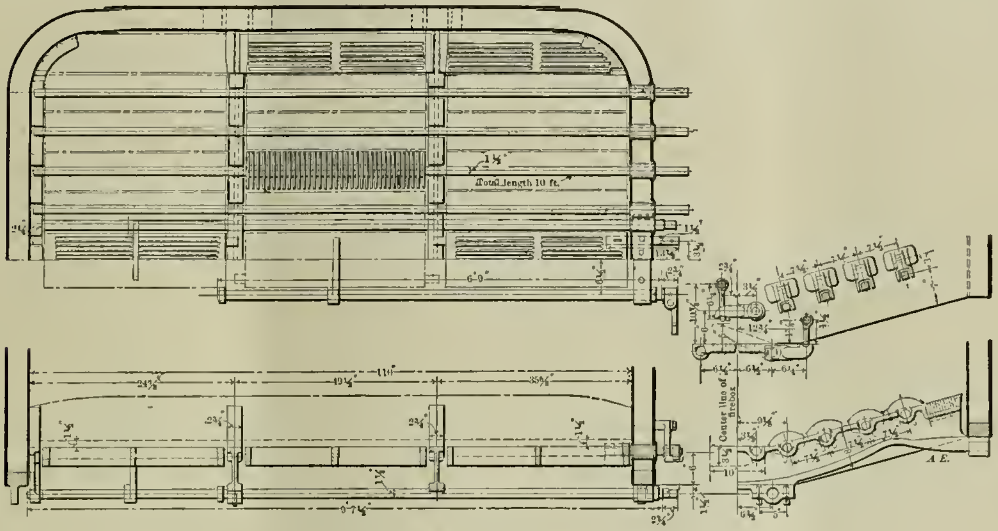
There can be no doubt of the success of "flexible" staybolts. Where they are tried experimentally their use continues and the number of roads using them seems to be increasing. Comparative figures of cost between the usual form and ball-and-socket-headed bolts are rare and difficult to obtain, because the service of the engines, the shape of the fireboxes and the locations of the flexible stays influence the results. It appears to be proven that ball-and-socket-headed staybolts do not break, and if they relieve apprehension of exploding boilers and tend to increase the life of side sheets, considerable increased first cost is justified. Judging, however, from the figures quoted by Mr. T. A. Lawes, superintendent of motive power of the Chicago & Eastern Illinois Railroad, at Saratoga in June, the actual expense of application of a large number of flexible stays is returned by the saving in repair expense. Mr. Lawes has kindly supplied a copy of his remarks, which are as follows:

"The cost of renewing 105 staybolts, in lots of six at a time, in one year on a certain engine carrying 200 pounds of steam was $113.40. This includes taking down and putting up the parts of the engine which were in the way of the boiler makers; it also includes the cost of blowing off the engine, letting water out of boiler and filling same, and cost of the water. The cost of the same number of flexible staybolts, put in all at one time, when the engine was in the shop for repairs, was $94.50, no charge being made for stripping, as flexible staybolts were applied when new sheets were put in. From this it appears that the cost of flexible staybolts for the first year's service is $18.90 less than the same number of common staybolts. Now, if the same number of common staybolts were to break the second year, we would save $113.40. However, since the side sheets of our engines carrying 200 pounds of steam last but two years, flexible staybolts are renewed with the side sheets, except that the brass sleeves and caps are used again with the new staybolts. So far as first cost is concerned, flexible staybolts are cheaper than common staybolts when common staybolts are renewed in the roundhouse in lots of six at a time..

"The great advantage in the use of flexible staybolts is that the service of the engine is increased, since they do not break and engines are not held for renewals of bolts. It is our rule to take out staybolts where six adjacent staybolts are broken. The loss of service of our engines in one year under this rule, taking out 105 staybolts and renewing them, amounts to twelve days. In addition to labor and material this period also includes the time it takes to blow off steam, letting out water and cooling off boiler, so that men can work in it; also filling up the boiler, but not getting up steam. It may be of interest to state that the greatest number of flexible staybolts we have used in one engine is 430; the least is 140. We have 27 engines equipped with these bolts—in all 5,280 flexible staybolts in use.

"We use the flexible staybolt invented by Wehrenfennig, chief engineer of material of the Northeastern Railway of of the railways of India, and still further improved by the Pennsylvania Railroad. No doubt you are all familiar with this flexible staybolt, as it is used in great numbers by that company. The patents on this type of flexible staybolts have long since run out and they can be used by any one without royalty."

Readers will find a description of the Wehrenfennig staybolt in the October, 1900, number of this journal, page 320.

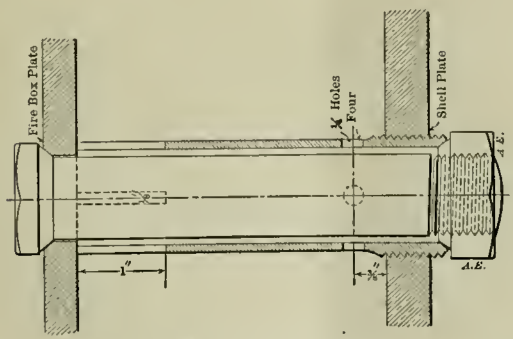


Firebox Arrangement with Long Radius Corners.

FLEXIBLE STAYBOLTS AND LARGE RADIUS FIREBOX CORNERS FOR PREVENTING BREAKAGES.

Philadelphia & Reading Railway.

Mr. S. F. Prince, Jr., superintendent of motive power and rolling equipment of the Philadelphia & Reading, has given the subject of staybolts special attention. The accompanying engravings illustrate a form of staybolt designed and patented by him and also a method of constructing fireboxes with corners of large radius. Both have been applied to locomotives, but not to the same engine.



Flexible Staybolt with Ball Joints.

This staybolt forms a ball joint in a spherical seat in the firebox sheet and a similar joint is made between the nut at the other end and a tube which surrounds the staybolt. This tube bears against the firebox sheet and is threaded into the outer sheet. It serves as a spacer for the sheets and when the nut at the outer end is brought up at the proper tension the bearing of the nut tends to spread the threaded end of the tube and increase its tightness in the sheet. It is not intended that the inner end of the tube shall have a perfect bearing at the inside sheet; in fact, circulation of water around the staybolt is provided for by the slots and by four ¼ in. holes near the other end of the tube. An engine fitted with these staybolts ran for 19 months before coming to the shop for general repairs, and the service of the bolts was eminently satisfactory with none broken. These bolts do not appear to require hammer inspection, as any failure will indicate itself, and as they are in tension only, they may be made of ordinary iron and give satisfactory results.

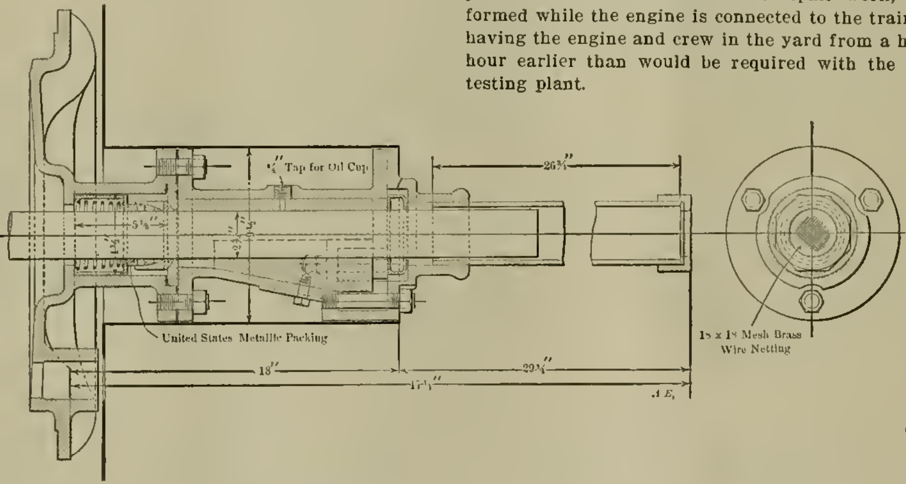
The large radius for the corners of fireboxes seems to be equally promising. Its primary object was to secure construction which would permit of making the corners absolutely tight and incidentally to ascertain the effect upon staybolt breakage. It is a matter of observation that vertical boilers with cylindrical fireboxes seldom break their staybolts. Except after very long service it is seldom if ever necessary to renew staybolts in cylindrical fireboxes, and it was thought advisable to ascertain the effect of the large corners on locomotives. This construction has been in use on a locomotive for over a year. When overhauled for general repairs no broken bolts were found. This engine has a wide firebox and there was no difficulty in using a radius of 12 ins. for the inside sheets. Incidentally this drawing illustrates the construction of the grates and their slope toward the center of the firebox.

One of the best long distance runs ever made by the Pennsylvania Railroad, says the Pittsburgh *Post*, took place July 7 with train No. 11, the St. Louis fast mail. The Pittsburgh division, from Altoona to Pittsburgh, a distance of 117 miles, was covered in 125 minutes, including a delay of 19 minutes, the train consisting of three cars hauled by one of the new E-2 type engines. The train left Altoona 13 minutes late and lost 19 minutes more by unavoidable delays en route, but still arrived at the Union Station in Pittsburgh on time. This is remarkable running, as the Pittsburgh division is the most difficult section of the Pennsylvania's main line.

ADJUSTABLE BEARING FOR EXTENDED PISTON RODS.

Difficulties in taking up the wear of bushings for extended piston rods have led many to discard the practice of using the rods. Mr. V. Z. Caracristi, chief draughtsman of the Intercolonial Railway of Canada, has sent drawings of an arrangement devised by him while connected with the Chicago & Alton and used on locomotives of that road. The piston rod has metallic packing at the front cylinder head. The weight of the rod rests upon an adjustable bearing, which may be secured in the desired position on the inclined plane of the sleeve shown in the drawing. A casing of pipe is used to protect the rod.

The object of the design was to provide means for adjustment without taking off the cylinder head and to avoid the inconvenience of pushing out the bushing with hydraulic pressure. With an easily operated adjusting device, which may be changed in the roundhouse, the rods may be kept up to their proper position instead of wearing perhaps 5-16 in. before being touched, which renders the extension rod valueless. By the use of the metallic packing the cylinder clearance is not increased by the volume of the pipe. This device has been in service about six months, and appears to be giving good results.



Adjustable Bearing for Extended Piston Rods.

Work is now well under way upon the foundations of the new shops of the Great Northern at St. Paul, Minn., and it is expected that the machine shop will be ready for the heavy machinery within a few months. The machine shop is to be 600 x 450 ft., and the boiler and blacksmith shop, which is also well under way, will be 430 x 230 ft. A power plant is to be built, occupying a brick building of 105 x 100 ft., which will supply compressed air and electric current for power, and also furnish electric lighting. We understand that the buildings alone will cost about $1,000,000.

A steam railroad 40 miles long, the Cincinnati, Georgetown & Portsmouth Railway, is soon to be converted from steam to electric traction. The system to be used is the combined system of alternating current for the transmission and rotary convertors for direct current distribution to the line. The Westinghouse Electric and Manufacturing Company is furnishing two 600-kilowatt alternating-current generators and a number of 300-kilowatt rotary convertors to the Tennis Railway Equipment Company, who have the contract for the change.

YARD TESTING PLANTS.

Mr. H. F. Ball, Superintendent Motive Power of the Lake Shore & Michigan Southern, presented the following, in a discussion before the M. C. B. Association, on "Yard Testing and Charging Plants:"

"Is there any economy in fitting up yards with air pipes for the purpose of testing and charging train pipes before the engine is connected to its train? The answer to this question depends entirely on the character of the yard and the trains involved and the method of handling same.

"As a general proposition, all division terminal yards should have air pipes, also yards at large interchange points, and the installation of the air plant will not only be found necessary but economical. At terminals where trains are made up the air brake equipment should be inspected and tested. This procedure involves more or less repair work, which, if performed while the engine is connected to the train, would mean having the engine and crew in the yard from a half hour to an hour earlier than would be required with the use of a yard testing plant.

"The average time required for inspecting, testing and repairing air brakes per train at one of our terminals for a period covering 100 trains was 42 minutes. As some of the trains were made up at times on two tracks, due to yard conditions, a much greater length of time would have been required if the road engine had been used in place of the yard plant.

"From this it will appear that for yards where trains are made up of cars received from connecting lines and local points or where through trains are switched and filled out there is economy in having a testing plant.

"At intermediate division terminals, it is a question whether any advantage would be gained in connecting up the yard plant to through trains which go through solid and which have passed through a regular inspection at the terminal.

"About seven minutes are consumed from the time the road engine is coupled onto the train until it is ready to leave, providing the train is left charged. If the outgoing engine is at hand it would appear that no time would be gained by connecting to the yard plant. The train having previously been inspected, tested and repaired, very little work should be required.

"As a matter of fact very few trains pass through a division terminal yard without requiring some changes in their make-up, and such being the case the yard testing plant will be found necessary and economical in being able to minimize the time required for the air brake work.

"On the road with which the speaker is connected under present conditions very few if any trains are run solid from terminal to terminal. A fast through train may leave Buffalo for Chicago filled out with Cleveland cars. At Cleveland cars are put in to replace those taken out, and this may be repeated at each division terminal. So in order to reduce the time at division terminals the cars awaiting the trains should be tested and put in good shape before the arrival of the train in which they are to be placed.

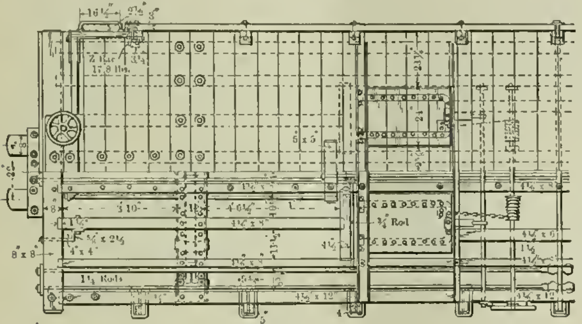
"At points where no yard testing plant is in operation about 20 minutes is required for changing and trying the air after changing engines.

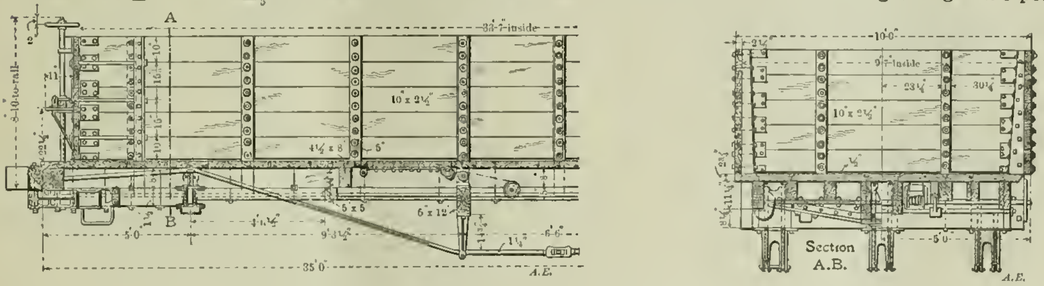
"This time could, no doubt, be reduced in many cases by supplementing the work of charging the train by connecting to the yard plants."

METHOD OF INCREASING CAPACITY OF 40-TON GONDOLA CARS.

Pittsburgh Coal Company.

Mr. J. E. Simons, superintendent of rolling stock and machinery of the Pittsburgh Coal Company, has kindly sent us drawings of coal cars recently constructed for that road, embodying an ingenious method of increasing the cubical capacity without adding materially to the dead weight. At the brake end the side planks are cut off at the first stake and are set in a sufficient distance to accommodate the hand holds without projecting beyond the outer faces of the rest of the siding. At the first stake a joint is made by means of a vertical 5-in. Z-bar and the rest of the siding is secured to the outside faces of the stakes, as is clearly indicated in the drawings. In this way the width of the car is made 6 ins. greater all along except at the brake end. These cars have sides 50½ ins. high. Mr. Simons says that some difficulty has already been experienced because of overloading, some of the loads put on at the mines being from 90,000 to 94,000 lbs. of bituminous coal, the nominal capacity being 40 tons. This car measures 10 ft. in width outside the box. Those of the Hocking Valley Railway illustrated in our January, 1900, issue, page 5, having the siding outside of the stakes, measure 9 ft. 8½ ins. outside.





Increasing Capacity of 40-Ton Gondola Cars.—Pittsburg Coal Co.

There were 800 applicants for admission to the Massachusetts Institute of Technology at the June examination this year and but 400 vacancies.

CAR LIGHTING BY ACETYLENE AND ELECTRICITY.

Progress and the state of the art of car lighting was reviewed by Mr. L. T. Canfield, master car builder of the Delaware, Lackawanna & Western, before the M. C. B. Association at Saratoga. His remarks on acetylene and electric lighting are interesting, and are reprinted in part below:

"The introduction of the Pintsch light advanced the efficiency of car lighting to such an extent that there is not the same chance for improvement over the Pintsch as there was between the oil lamp and the Pintsch. However, the desire of the successful railroad manager and owner to make their passenger cars as comfortable and as pleasant as they possibly can for their patrons, forces them to be on the lookout for any improvements that are not so marked. The success of the passenger business depends to a very great extent upon the car equipment. * * * "

With reference to acetylene, Mr. Canfield said:

"We have several different systems of furnishing acetylene gas for car lighting, some of which generate the gas from a generator applied to each car, others have a generating plant similar to the Pintsch gas plants where the gas is generated and compressed to as high as 300 pounds pressure per square inch. A method of storing acetylene gas was discovered by two French inventors, who found that one volume of acetone under ordinary temperature and pressure dissolved 25 volumes of acetylene and under 12 atmospheres of pressure would dissolve 300 volumes of acetylene. Acetylene is very explosive under compression, and was prohibited in England under the Explosive Act in 1873, but under the provisions of said act, it being shown that reservoirs packed with porous brick, acetone and acetylene were not explosive or possessed of explosive properties, the Secretary of State exempted it from being deemed an explosive April 10, 1891.

"In the reservoir for storing this gas the porous bricks, or asbestos, which is sometimes used, is simply for the prevention of explosion. The acetone is for the storing of gas in large quantities in small space, and these two do not enter into the quality or efficiency of the light. The bricks are first made of a mixture of clay and powdered charcoal. The baking of them burns out the charcoal, leaving a porous brick, with which the storage reservoirs are packed. If these bricks were pressed solid closing up the openings made by the burning out of the charcoal, the solid substance would take up 20 per cent. of the space within the reservoir. Forty-three per cent. of the reservoir would be filled with acetone, leaving 37 per cent. of the space for expansion. A reservoir 20 ins. in diameter by 10 ins. long filled as stated above, charged with acetylene gas at 165 pounds pressure per square inch was placed upon a car on the Delaware, Lackawanna & Western having four lamps with three burners each and one lamp with one burner. This gas burned a total of 260 consecutive hours, remaining in service from March 4, 1902, to May 12 of the same year, without recharging. The fact of being able to run the car so long without recharging makes this a very desirable light.

"I have had experience with none of the systems that have a generator on each car, and from what I can learn of it, I am very much in favor of the system where the gas is generated at a stationary plant, then stored in reservoirs on the cars. There is another system used largely in the Northwest, where the porous brick and acetone is not used, but a large number of reservoirs are used. I am advised that a car with two or three reservoirs has been known to furnish light for cars in a snow blockade for as long as 12 days. To overcome the explosive feature, this system uses fusible seams in tanks and all high pressure pipes under the car are of fusible material, which will fuse at or below 500 degrees. I have had no experience with this system."

In discussing the various electric systems the speaker stated that the axle lighting system was, in his opinion, the best in use. He described the regulators, but did not consider the device he had seen entirely satisfactory. Continuing, he said:

"In operating the axle lighting system, it is necessary to handle same with a great deal of care. The batteries, for instance, must be charged immediately after they are set up, as the plates will rapidly deteriorate if they are left standing uncharged in the diluted sulphuric acid which is used. Again, you must not charge or discharge same too fast for fear of buckling the plates, and when a new battery is placed in service, it is necessary to charge and discharge it several times. If the battery is overcharged or charged or discharged too fast, it has the effect of sulphating the plates, which increases the internal resistance of the battery and also uses up these plates, and destroys the battery much sooner than in ordinary use. I will not attempt to give a detailed description or try to explain the actual working of the electrical apparatus of these two different systems, as it would take up too much time and as in a general way they resemble each other, but will point out a few of the faults showing what we have to contend with in trying to keep the lights burning when required. The dynamo does not become operative until the train has reached a certain speed, about 12 miles per hour, called the critical speed. In suburban service, for instance, if from any cause the batteries are run down, that is, nearly all of the stored electricity in them is used, you will not get the benefit of the dynamo in recharging them or helping to supply the light until the critical speed is reached, and in many cases about or before the time this speed is attained it is necessary to slow down the train for the next stop. Therefore you are not generating any electricity, but your lights are burning all the time and using it continually from the storage battery, consequently you are going deeper and deeper into trouble, on account of the lights growing dimmer and sometimes going out when the train is standing still, or is running below the critical speed. At this time of the year we naturally have very little trouble, but in the winter time, when the days are short, and it is necessary to use the light for a longer period of time, it is different. On through service you will not, of course, have this particular trouble to contend with, but in the operating of this kind of light the belts occasionally jump off of the pulleys or break, the battery becomes defective, the regulators get out of order, the fuse burns out, there is a short circuit, a wire is broken, the armature burns out, the armature shaft breaks, the dynamo runs hot, the commutator is out of order, or something in the system gives out or goes wrong, and the lights become dim or go out altogether; then we are in trouble. At the present stage of electric lighting in railway service it is absolutely necessary to have an auxiliary light at hand to fall back on. I am sure many of us who have had experience with this light would be perfectly satisfied to do away with it on account of the trouble it has caused— but this is an age of progress and there is no doubt but that there will continually be improvements made in electric car lighting. When it is so perfected that it will not require an expense greatly in excess of that necessary to maintain the gas lamp of to-day I am sure it will come into general use. One point I wish to call your attention to is the fact that the dynamo should be hung to the bottom of the car where it would receive the benefits of both elliptic and equalizer springs to relieve it of all the shocks possible. Another thing, a long belt is desirable in preference to a short one on account of allowing the dynamo to adjust itself to the lateral motion of the axle; but it is absolutely necessary to have the perfect belt cover so as to increase the life of the belt.

"I will conclude by reading a statement comparing the cost to our company of each kind of light for one month."

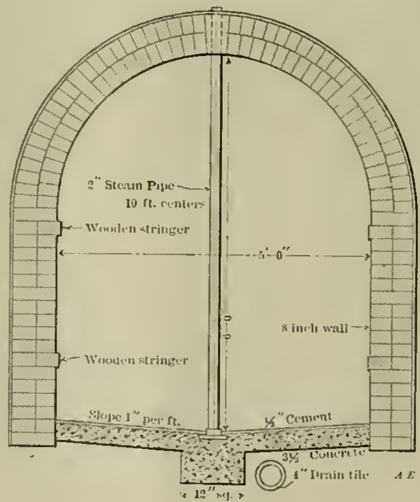
FIRST-CLASS CARS.

Kind of Light.	No. of Lights.	Average Mileage.	Cost per car.	Cost per flame.	Kind of Service.
Oil	6	12,710	$2.40	$0.40	Through
Electric Lights	17	2,092	8.81	.52	Suburban
Electric Lights	36	12,710	37.31	1.04	Through
Electric Lights	25	1,560	7.57	.30	Suburban
Pintsch Gas	20	12,710	5.73	.29	Through
Pintsch Gas	16	2,092	2.45	.15	Suburban

TUNNEL FOR PIPING AND ELECTRIC CABLES.

Iowa State College.

A tunnel 460 ft. long, 5 ft. wide, and 6 ft. high at the center, has been constructed at the Iowa State College at Ames, Iowa, to connect the new Engineering Hall with the central power station. The top is a circular arch of 2 ft. 6 in. radius, both top and sides being of brick, with a ½-in. outside covering of



Piping and Wiring Tunnel.—Iowa State College.

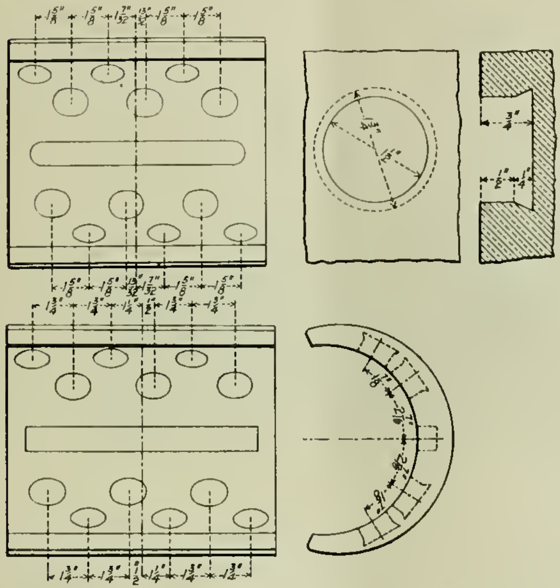
cement and a ½-in. floor of cement on 3½ ins. of concrete. At 10-ft. centers columns of 2-in. pipe are placed along the center of the tunnel, with 12-in. square concrete supports, 9 ins. thick, below the floor of the tunnel. These, passing up through the roof, serve to support brackets forming one end of the carriers for the steam pipes. A 4-in. tile drain extends under the floor of the tunnel.

The heavy pipes will be supported on rollers turning on pieces of 1-in. shafting carried on brackets clamped to the iron columns and to 2 x 4 wooden stringers built into the tunnel walls, as shown in the engraving. This permits of supporting the pipes at any desired grade. The smaller pipes will be supported by ordinary hangers on chains to the shafting already referred to. The portion of the side of the tunnel not occupied by the steam pipes will be used for electric cables and telephone wires. At intervals of 20 ft. the tunnel will be lighted by incandescent lamps. The cost of the tunnel was $3,300, or about $7 per foot. The drawing of the cross section was furnished by Prof. G. W. Bissell, who is in charge of the Mechanical Engineering Department of the college.

SOFT METAL SPOTS IN DRIVING BOXES.

Chicago & Northwestern Railway.

In order to overcome the difficulties due to the heating of locomotive driving boxes, which have become serious because of large locomotive mileage, Mr. Quayle, of the Chicago & Northwestern, has introduced plugs of soft metal in the driving box brasses. These are poured into cavities in the brasses located as indicated in the sketch, and made of such form as to secure them from falling out. These plugs are 80 per cent.



Driving Boxes with Spots of Soft Metal.

lead and 20 per cent. antimony. Bearings of this kind appear to wear the journal somewhat more rapidly than the usual form, but among 950 locomotives the number of hot driving boxes has been reduced to an average of about 26 per month. The holes are "staggered" in such a way as to make the soft metal cover the full length of the journal as it revolves. Two sizes of driving box brasses are shown in the sketch. It is understood that this change has been made general practice on this road with satisfactory results.

A very valuable general instruction car has recently been put into service by the Atchison Topeka & Santa Fe system. A 20-car train air brake equipment, with accessories, and a 6-car train signal equipment are provided, and besides these there is also an up-to-date special equipment, including an "Axle-Light" dynamo and car light controlling apparatus, a Pyle electric headlight equipment, an acetylene gas headlight apparatus, a small model of Vauclain compound cylinders and valve motion, a Nathan cylinder lubricator, a simplex injector and a Crosby muffled safety valve. The car itself is fitted with a Westinghouse friction draft gear and a slack adjuster. The instructor is Mr. J. B. McDonald.

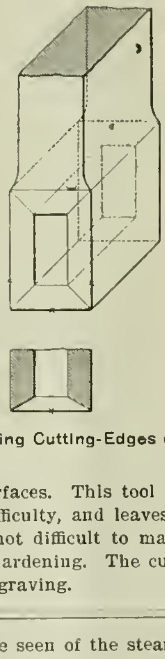
The remarkably fast run of the "Twentieth Century Limited" on the Lake Shore, recorded elsewhere in this issue, suggests the possibility of regular 16-hour trains between New York and Chicago. A speed of 69 miles per hour for 133 miles beats the best record we have for such a distance.

COPPER FIRE-BOX STAYS.

In a paper recently read by Mr. F. W. Webb, Chief Mechanical Engineer of the London & North-Western, before the Institution of Civil Engineers, the superiority of the copper firebox stay over the copper-alloy stay for use with copper plates was shown by the author's experience upon his four-cylinder compound passenger engines. These engines, of which there are 40 of the earlier class, are the hardest worked on the system, the average speed being 50 miles per hour, and many running on a 158-mile run without a stop, but with a total mileage of 5,622,064 miles the stays renewed were only one per 844 miles (the stays being 1 1-16-in. copper and the boiler pressure 200 lbs. per square inch). The 10 latest engines of this type are making a still better showing. Of the several different alloys of copper with zinc, tin and aluminum that had been tried there had been no improvement over the copper, except perhaps the 9-per cent. zinc alloy; in tests of the alloys the aluminum alloy had been found non-homogeneous, varying greatly in structure from small to large crystals. Riveting over the stay in the copper plate was found by sectioning such a joint to expand the hole and injure the plate, thus making the joint imperfect, so that Mr. Webb concludes that the stay, whatever the material, should be softer than the plate for a good joint.

A TOOL FOR PLANING TIN.

Ordinary planer tools will "run" while cutting tin unless the chip is very light. At the Baldwin Locomotive Works a new tool of the form shown in this engraving was developed for use on locomotive crossheads, which are now generally fitted



Showing Cutting-Edges of Tool.

with tin bearing surfaces. This tool takes a very large chip without the least difficulty, and leaves a good surface. It is easily ground, and not difficult to make. It is made hollow to avoid trouble in hardening. The cutting edges are marked by crosses in the engraving.

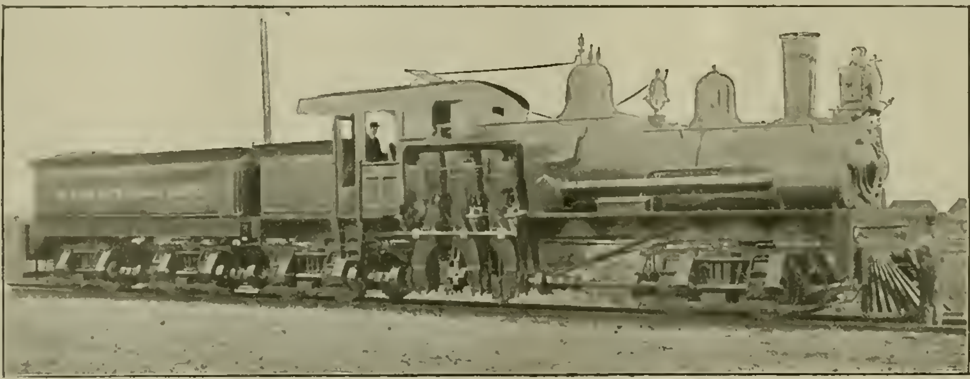
"From what I have seen of the steam turbine, I see a great future before it, and the reciprocating engine has got to look out for itself. Here you have something that you can place almost upon the floor, no matter what its size is. You do not require any particular foundation; the vibration is almost nothing; the room taken is very small, and the economy is about equal to the maximum of other forms of engines now and is likely to be increased."—F. W. Dean, before New England Railroad Club.

A LARGE SHAY-PATENT LOCOMOTIVE.

The El Paso & Rock Island Route.

Heaviest Geared Locomotive Ever Built.

The accompanying engraving is an illustration of a new Shay-patent geared locomotive recently delivered by the Lima Locomotive and Machine Company, Lima, Ohio, to the El Paso & Rock Island Route, which comprises the El Paso & Rock Island, the El Paso & Northeastern, and the Alamogorda & Sacramento Mountain roads, and extends from El Paso, Tex., to Santa Rosa, New Mexico. The road traverses a very mountainous country and has an excessive number of sharp curves and heavy gradients, to which the geared locomotive alone is universally adaptable. This locomotive is, in addition to being the heaviest geared locomotive ever built, the heaviest on drivers of any type of locomotive whatever. This is, of course, due to the fact that all of its 16 wheels under both boiler and tender are driving wheels, being driven by the 3-cylinder vertical engine at the side through shafting with universal and slip expansion joints. The total weight (on drivers) is 291,000 lbs., while the greatest weight on drivers of any other locomotive is 237,800 lbs., as exemplified in the decapod tandem-compound locomotive recently built for the Atchison, Topeka & Santa Fe Railroad, and illustrated in our June issue, page 192.



Heaviest Geared Locomotive Ever Built.—El Paso & Rock Island Route.

This locomotive is intended for operation on the division of the road laid with 60-lb. rail, extending from Alamogordo, New Mexico, to Cox Canon, a distance of 31 miles, having a total rise between terminals of nearly 6,000 ft., and grades ranging from 3 per cent. to a little over 6½ per cent. There is a stretch of 4.5 to 5.2 per cent. grade for a distance of about 8 miles, including ½ mile of 6 to 6½ per cent. grade, coupled with heavy curves.

A train of 27 cars, each weighing about 16,000 lbs., and a caboose weighing about 12,000 lbs., making total train weight with engine of 362 tons, was hauled over the 6 to 6½ per cent. grade. This haulage is equivalent to 715 tons total weight on level, or 575 tons net train weight on a 3 per cent. grade.

The most important dimensions of this engine are as follows:

SHAY GEARED FREIGHT LOCOMOTIVE.
EL PASO & ROCK ISLAND ROUTE.

Gauge of road	4 ft. 8½ ins.
Fuel used	Soft coal
Weight on drivers in working order	291,000 lbs.
Weight, total, in working order	291,000 lbs.
Weight of tender empty	62,500 lbs.

General Dimensions:

Total wheel base, engine and tender	54 ft. 4 ins.
Total length engine (boiler frame)	44 ft. 5 ins.
Total length engine and tender	71 ft. 9 ins.
Height, center of boiler above rail	7 ft. 7 ins.
Height, top of smokestack above rail	14 ft. 6½ ins.
Height, extreme, over pop valve	14 ft. 10 ins.
Heating surface, tubes	1,837 sq. ft.
Heating surface, firebox	156 sq. ft.
Heating surface, total	1,993 sq. ft.
Grate area	36 sq. ft.
Total tractive force with effective pressure equal to 85 per cent. of boiler pressure	47,000 lbs.

Wheels, Gears, Etc.:

Number of trucks	4
Rigid wheel base of trucks	58 ins.
Number of driving wheels	16
Diameter of driving wheels	40 ins.
Number of teeth in gear rims	41
Number of teeth in pinions	20
Pitch of teeth	2¼ ins.
Face of teeth	7 ins.
Material of gears	Cast steel

Cylinders:

Cylinders, number	3
Cylinders, diameter	15 ins.
Cylinders, stroke	17 ins.
Cylinders, cubic contents of, total	6.9 cu. ft.
Crank shaft, material	Forged steel
Cranks	Set 120 degs. apart

Valves:

Valves, kind	Lima balanced
Valve travel	3¼ ins.
Outside lap	9-16 in.
Inside clearance	1-16 in.
Lead in full gear	1-32 in.
Steam ports	1⅛ x 12 ins.
Exhaust ports	2¼ x 12 ins.
Bridge	15-16 in.

Boiler:

Type	Extended wagon top
Working pressure of boiler	190 lbs.
Diameter barrel at smallest ring	60 ins.
Diameter of dome	30 ins.
Dome connection to boiler—Pressed steel flange 1⅛ ins. thick, with reinforcing plate inside	
Thickness of barrel plate	⅝ and ¾ in.
Thickness of tube sheet	½ in.
Horizontal seams—Butt joint, inside and outside welt, sextuple riveted	
Circumferential seams	Double riveted

Front End:

Smoke box, diameter	63 ins.
Smoke box, length ahead of tube sheet	62 ins.
Exhaust nozzle, single	Permanent
Exhaust nozzle, diameter	5 ins.
Exhaust nozzle above center of boiler	6 ins.
Smokestack	Taper
Smokestack, least diameter	19 ins.
Wire netting	No. 12 gauge 3½ ins. mesh.

Firebox:

Type	Sloping; radial stay
Length inside	96 ins.
Width inside	54 ins.
Depth at front above grates	60 ins.
Depth at rear above grates	55½ ins.
Thickness sheets, crown	⅜ in.
Thickness sides and door sheet	5-16 ins.
Diameter of crown stays	1⅛ ins.
Diameter stay bolts	1 in.
Water space, front	4 ins.
Water space, sides	3 to 5 ins.
Water space, rear	3 to 4 ins.
Grates, kind of	Rocking
Tubes, number	270
Tubes, outside diameter	2 ins.
Tubes, thickness	No. 12 gauge
Tubes, length over tube sheet	13 ft.

Tender:

Water capacity of tank	6,000 gals.
Coal capacity, coal bunk	9 tons

Special Equipment:

Brakes, engine	Le Chatelier and steam
Brakes, train	Westinghouse air
Sanders	Leach
Injectors	two No. 8 Friedman, non-lifting
Lubricator	Michigan triple sight feed
Blow-off cock	Johnstone
Stay bolts	Johnstone flexible
Pop valves	Crosby
Draw heads	Tower couplers
Lagging	Magnesia

Concrete factory construction was severely tested at Bayoune, N. J., last April, in a fire at the Pacific Coast Borax Company's plant. The fire started from the bursting of an oil main, and was hot enough to fuse cast iron from the machinery and copper from the dynamos and motors. The entire contents of the building were destroyed, but the building, which cost $100,000, was damaged only to the extent of $1,000, a remarkable demonstration of the value of concrete construction. All foundations, footings, walls and columns were of concrete, with twisted, square steel rods imbedded in it. According to an interesting account of the fire in the *Iron Age*, the floors were of 6-in. concrete slabs, supported by 4½ by 21 in. concrete beams, 24 ft. long and spaced 3 ft. apart. The columns are square, of concrete, 17, 19 and 21 ins. respectively. The walls are 16 ins. thick, with 10-in. hollow spaces in the center. The floors were subjected to loads of as much as 1,360 lbs. per sq. ft. under the conditions of continuous service, with various concentrated loads, such as grinding mills, requiring 35 h. p. to operate. In the fire the concrete stood without damage, except from falling tanks from the roof. There was no damage or distortion to any of the walls or columns or injury to the floors, except from the falling tanks. This is a remarkable demonstration of the fire-resisting qualities of concrete.

The possibility of saving $30 per day by the use of a crane over car repair tracks was suggested by Mr. L. H. Turner before the M. C. B. Association in discussing improved facilities for repairing steel cars. A 10-ton crane serving tracks holding 80 cars and having a 90-ft. span would cost $23,000, an investment at 6 per cent. of $3.78 per day. Adding the wages of the operator and two helpers the crane would cost $10 per day. It would not only lift cars or heavy parts, but also transport wheels, truck frames and other heavy material. Mr. Turner estimates the cost of equivalent work done by hand at $40 per day. This saving amounts to $9,000 per year, and the crane would pay for itself and cut off the interest charge in less than three years, and would also reduce the lost time of the cars in the shops. An alert manager of a commercial shop would not hesitate a moment to make an investment of this kind.

The Borsig Locomotive Works, Berlin, Germany, celebrated, on June 21, the achievement of completing their 5,000th locomotive. The festival was attended by many eminent people, and also a workman was present who was in the employ of August Borsig, founder of the works, in 1837, and who is still in the service of the company. The Borsig works were established in the earliest days of railroading in Germany by August Borsig, a self-educated mechanic of great executive ability, and are now being conducted by two of his sons.

The Berlin Military Railroad are about to resume their experiments to determine the maximum possible train speeds, which were interrupted by improvements necessary to their track. Siemens & Halske have recently completed an electric locomotive for them, built to the designs of Chief Engineer Reichel, which it is expected will maintain a higher speed than the previous maximum of 99 miles per hour. This locomotive will take current from the trolley wires at a potential of 10,000 volts without transformation.

CORRESPONDENCE.

VOLUNTARY, LOYAL SUPPORT FROM SUBORDINATES.

To the Editor:

Of all the articles I have read for months, I must say that the one by J. F. Deems in the June number has more real value than anything I have come across. It is characteristic of the man, I believe, though I have met him but once. Many of the contributors of articles would do well to keep out of print for a month and study this one until digested, then apply it. For, in spite of all their pet theories, this man has made a success by considering the rank and file as well as his subordinate officers. His shops turned out work while many others were practically turning out nothing. In these days of trouble, agitation and education, this is the doctrine that counts. Keep up the good work. Such articles are the kind to have in your journal.

R.

TREATMENT OF THE SPECIAL APPRENTICE.

A special apprentice's complaint concerning his uncomfortable treatment by his shop mates was printed on page 82 of our March number of the current volume. This has resulted in a surprising correspondence from young technical graduates in all parts of the country. Most of these young men take a very sensible view, and expect to make their way with the shop men by gaining their confidence through merit. The following letter expresses the ideas of a young man who is likely to succeed:

A special apprentice, on entering a shop, at once finds himself an object of interest and possibly suspicion, and will find a little tact and a great deal of hard work necessary to gain the good will and respect of his associates. He must do his work cheerfully, and do his share of it. He must have a good word for everyone, and be always ready to lend a hand. Above all, he must realize that he is there to learn, and not to teach, and the best way to know a thing and learn how to do a thing is to do it. If he is careful about these matters, he will find the men good natured, good hearted and always willing and glad to help him, and if it should ever be his good fortune to be placed in charge of a shop he will understand the men better, and never regret, but be proud of, the time spent among them.

F. E. S.

Mr. Walter D. Crosman has resigned as Western representative of the Gold Car Heating Company to become sales manager of the railway department of the Western Roofing and Supply Company, with headquarters at 195 Lake street, Chicago. He will be prepared to supply roofings, linings, and coverings, including 85 per cent. magnesia locomotive lagging; also roofing and insulating materials for cars and all kinds of railroad buildings, pipe coverings, cold water paint and asphalt paint for boiler fronts. Mr. Crosman, from his many years of editorial experience on the *Railway Review* and *Railway Master Mechanic*, has an unusually extensive and valuable acquaintance, and is an important acquisition to the staff of this company.

The twentieth annual convention of the Road Masters and Maintenance of Way Association will be held in Milwaukee September 9, 10 and 11, 1902. The headquarters will be the Plankinton House. Arrangements have been made for an exhibition of articles that will be of interest to the Road Masters and Maintenance of Way Association. There will be ample room for models and devices that are not cumbersome. It is doubtful whether heavy articles can be exhibited to advantage. The convention held a year ago was very successful, and the indications point to a similar condition this year, as Milwaukee is a very popular place. All exhibits should be in Milwaukee not later than Monday morning, September 8, at which time allotments of space will be made by Mr. J. Alexander Brown, secretary and treasurer of the Road and Track Supply Association.

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EDITORIAL ANNOUNCEMENTS.

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

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

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

FRICTION DRAFT GEAR.

That progress in locomotive construction, leading up to the enormous weight and power of the present, has not been met by a corresponding increase in the strength of cars is generally admitted. Very little is known of the actual stresses produced by these heavy locomotives, but no less an authority than a committee of the Western Railway Club, of which Mr. W. H. Marshall was chairman, stated that an engine coupling to its train gives stresses ranging from 65,000 to 142,000 lbs.; a switch engine coupling to a dynamometer car standing alone gives 103,000 lbs.; a switch engine coupling to a train of loaded cars may give a stress of 199,000 lbs., and 30 loaded cars moving at 6½ miles an hour coupling to 10 loaded cars with brakes set produced a shock of 376,490 lbs. The committee reports another astonishing case. A loaded 60,000-lb. furniture car was standing on the track and the dynamometer car (the special test car of the Westinghouse Air Brake Company) struck it at a speed of 13½ miles an hour. The apparatus in the car recorded 381,704 lbs., which was its limit. What the actual shock was cannot be told.

This committee was appointed to study the stresses in draft gear in connection with the consideration of the draft gear question. From its report we have a fearlessly expressed opinion with the force of unprejudiced judgment of railroad officers who have themselves conducted the experiments. Our readers should procure the report from this committee and make it a subject of thorough study. The following forcible expression shows the opinion of this committee, and considering its source it is the most important declaration thus far made in connection with the subject:

"From the general results of the tests it is believed that the tensile stresses in draft gears with careful handling will frequently reach 50,000 lbs., with ordinary handling 80,000 lbs., and with decidedly rough handling fully 100,000 lbs., while the buffing stresses can be placed at 100,000, 150,000 and from 200,000 to 300,000 lbs. respectively. In extreme cases the buffing stresses will go considerably above the last named figure. It will undoubtedly require more extensive tests to determine whether these figures need modification, but it is evident that the tests give us a more definite idea of the stresses which draft gears and sills must stand than we have been able to obtain heretofore. Continued investigation along these lines should finally result in a sufficient amount of information to permit of a more exact method in the designing of draft gears.

"We think the figures show the necessity of something better and more effective than the spring draft gear so commonly used. It would be reasonable, in view of the above figures, to require draft gears and underframes to be capable of withstanding tensile stresses of 150,000 lbs., and buffing stresses of 500,000 lbs., and it is evident that the present spring resistance is inadequate. Whatever one may think of the details of the various friction draft gears, it must be evident that in the character and amount of resistance they are superior to the spring gears."

A RAILROAD OFFICER'S CORRESPONDENCE.

In railroad service there is scarcely anything more important to a successful career than the ability to write clearly. The character of a railroad officer's correspondence very largely determines his success, because it is such a vital element in the transaction of his business. Two classes of correspondence are worthy of special attention—that which contains instructions to subordinates and that which goes before the superior officers in the form of reports and recommendations.

In his recent paper before the Western Railway Club, Mr. F. M. Whyte, of the New York Central, said that one of the greatest difficulties in railroad work is to get instructions to the man who does the work. For example, consider the importance of getting orders to train and engine crews, and the correct understanding of the orders. There is also much difficulty in getting back from the man who does the work suitable reports of the results of what he has done. When something out of the ordinary is to be done, the correspondence becomes at once voluminous or the service is put out of order, unless, indeed, the instructions are given by one who has the time to consider carefully the peculiar conditions at each place, and the peculiarities of the men who are being dealt with. A moment's consideration shows how important is the ability to instruct clearly.

One reason for the remarkable development and rapid rise from the ranks of some of the best railroad officers of the day, and one reason why this service is so well supplied with able men, is the fact that they have grown up with their correspondence, and have been obliged to depend upon their ability to state facts clearly in connection with their every-day work. Correspondence in itself is a developer of character and ability, perhaps because it stimulates clear thinking and a judicial method of weighing the importance of things.

In the matter of recommendations, he who states his case clearly and fortifies every point strongly, is likely to be allowed to try that which he recommends. We go so far as to say that the railroad man, whether he is an officer or not, who treats his correspondence with his superiors as if it was some time to be printed and constitute his record for a basis of promotion, will find his advancement rapid.

It was recently the privilege of the writer to watch the effect of a little care in the preparation of a recommendation.

It was made by a young man who had studied his subject thoroughly and wanted to try a radical departure in shop practice which involved a large expenditure. He was quite willing to become responsible for results. His argument was clear, ample, convincing and concise, and it brought consent in the following words: "There must be something in this. You may try it." This same plan, however, had been repeatedly offered before by this young man's predecesors, and had been rejected.

Evidently there is a close relation between a clear, convincing method of expression and success.

APPRENTICESHIP.

Every practicable suggestion made in connection with the apprenticeship problem brings such a response as to indicate a general feeling that it has been somewbat neglected. It is one in which every industry is interested and is a national questiou. If all of the trades are to be left to "handy men" who have no education and no outlook beyond the present day, the future will bring problems which will be full of difficulty. Anything which may be said or done to bring this fact before the mechanical world should be brought forward immediately, in order to awaken to action all who can be brought to appreciate it.

An officer of one of our best-known machinery building companies has written this journal, urging the publication of the descriptions of good apprentice systems, mentioning that of the Baldwin Locomotive Works (American Engineer, October, 1901, pages 309 and 319), as being specially worthy of record. This gentleman has made a careful research throughout this country into apprenticeship methods, and says that in many instances he finds "shocking conditions." Before learning of the Baldwin plan he had thought his own system the best in use, but now has acknowledged gracefully a superior. This is high praise for the Baldwin system, because the company with which our correspondent is connected has an unequaled reputation for its excellent work and its workmen.

Our correspondent says: "The whole trouble in any of these systems is in carrying them out in the spirit and letter of the way in which they are started. It is hard to keep an apprentice system up to a high standard. If it were not for our apprentices I hardly know how this establishment could be carried on and kept up to the standard of workmanship set by the company many years ago. It is growing harder and barder every day, and without the apprentices trained in our works I think the task would be well-nigh hopeless."

Those who treat the apprentice problem as our correspondent has done have a grievance against those who do not. He says: "We seem to be furnishing help from our drawing room and from our shops to people who appear so indifferent to the work that they do not train men themselves and even take them from us, greatly to our discomfort."

Without doubt the reason for neglecting apprenticesbip is that its operation is slow. It requires a look into the future to appreciate its advantages, and men are too often so busy making a record this year that they forget the better record which may be made in a number of years by aid of a thorough apprentice system. One of the greatest needs on railroads to-day is the development of home talent, and apprenticeship is a good starting point.

There is an evident need of elasticity in establishing tonnage rating for locomotives, lest zeal in the direction of the maximum possible weight of trains shall lead to overloading and delay. Mr. Henderson gave a much-needed word of warning against this in his article on page 168 of the June number of this journal. It is well to figure the tonnage rating carefully as a starting point, but the best of judgment and knowledge of the operation of the locomotives is required in loading them so that they will haul the heaviest possible loads without danger of laying out traffic by slow movements or by doubling. Among the factors to be considered is the condition of the boilers and the condition of each engine with reference to steam-making. Foaming often seriously affects the amount of freight which a locomotive will haul, and in general it may be said that the cylinder power does not by any means indicate the capacity to get trains over long grades, simply because, for one of several good reasons, the boiler may not furnish the necessary steam. One effect of recent advances in the loading of locomotives is to throw light upon the insufficient boiler power of the practice of from five to ten years ago. The incapacity of boilers is indicated by the fact that recent tests on a large road show a temperature of smoke-box gases of over 1,200 degrees F. in a large number of cases, while with larger boilers of more recent engines the temperature is but 600 degrees. It would seem to be worth while to place the responsibility for the loading of engines in the hands of men who fully understand the factors which enter into efficient rating, and who are qualified to have an influence in future locomotive designs.

PERSONALS.

Mr. Charles M. Muchnic, mechanical engineer of the Wisconsin Central, has resigned to accept the same position on the Denver & Rio Grande.

Mr. George W. Rink has been appointed chief draughtsman of the motive power department of the Central Railroad of New Jersey, to succeed Mr. W. E. Denton, recently resigned.

Mr. Charles H. Kenison, of Portland, Me., has retired, at his own request, from the office of master car builder of the Maine Central Railroad, after a long term of faithful service, and the car department has been placed under the jurisdiction of Mr. Philip M. Hammett, the superintendent of motive power.

Mr. George S. Hodgins has joined the editorial staff of *Railway and Locomotive Engineering.* He was formerly one of the editors of the *Railroad Digest*, and gained his practical experience in the shop and drawing office of the Canadian Pacific and other important railways. The American Engineer wishes him the best of success in his new work.

Mr. W. B. Leach, formerly general foreman of the New England division of the New York, New Haven & Hartford Railroad, has been appointed master mechanic of the Albany division of the Boston & Albany. Mr. Leach is a comparatively young man, 32 years of age, having entered the employ of the Boston & Albany as machinist in 1890, upon the completion of his apprenticeship.

It is with regret that we learn of the accidental death of Prof. J. B. Johnson, dean of the College of Engineering of the University of Wisconsin, on June 23, by falling under the wheels of a wagon loaded with household goods being driven to his summer home near Fennville, Mich. Professor Johnson, who was 52 years of age, was for many years professor of civil engineering at Washington University, St. Louis, Mo., and was prominently connected with a great many government tests of timber and other materials. Two years ago he was appointed dean of the College of Engineering at the University of Wisconsin, which position he filled up to the time of his death. He was a member of the American Society of Civil Engineers and the Western Society of Engineers, and through his able contributions to engineering literature and the number of text-books of which he was author he came to be regarded as a leading authority on engineering.

EXPANDED-METAL LOCKERS.

The accompanying illustrations are views of the improved expanded-metal lockers manufactured by Merritt & Co., 1024-8 Ridge avenue, Philadelphia, Pa. The time has come when the provision of a suitable place for employees in shops to leave their belongings while at work is one of the important features of shop equipment. Wooden closets and chests no longer fulfill the requirements of progressive shops, either as to neatness aud sanitary qualifications, or in regard to fireproof construction. Wooden lockers are a positive fire risk, especially in view of the liability of oily waste being left in them by the workmen. Furthermore, wooden lockers are dirty and become foul through lack of ventilation, and will breed vermin unless unusual care is taken to prevent it.

The Merritt locker is constructed entirely of metal, of angle iron framing, with the expanded metal webbing in the sides, top and bottom. The expanded metal webbing is formed from high grade sheet steel, which is cut and opened in one operation into diamond-shaped meshes of suitable sizes. Thus there are no joints or connections, each side being formed of a single sheet, and the web cannot be pried open and entered like woven wire.


Expanded-Metal Lockers.


A Modern Locker Room.

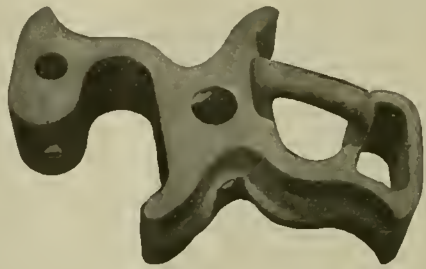
The neatness, compactness and entire divisibility of these lockers are well illustrated in the accompanying view of a locker room equipped with Merritt lockers. The cleanliness and sanitary advantages resulting particularly from the perfect ventilation are evident with this arrangement. Also it tends to promote cleanliness among the employees, and practically prohibits the hiding of tools, "pints of whiskey," etc., in the lockers, as is so usual with wooden lockera. The neatness of this system of lockers was strongly evidenced In an illustration of the washroom of the Norwalk Iron Worka Co., which was presented in a paper on Locomotive Shops, by Mr. L. R. Pomeroy, before the recent Saratoga Convention of the Master Mechanics' Association. The lockers were shown arranged around the edge of the washroom—a most accessible arrangement.

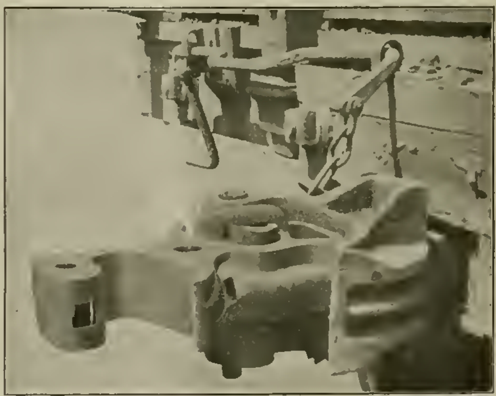
The reduction of repairs with metal lockers is not to be overlooked, as in a certain case with wooden cupboards for 2,500 to 2,800 employees it requires the entire services of one carpenter to keep them in repair. The Merritt metal lockera are strongly advocated by many leading railroads and industrial establishments, and are very highly endorsed by the Fire Underwriters' Association.

The Standard Steel Car Company is equipping its new plant for electric driving throughout. A recent purchase from the Westinghouse Electric and Manufacturing Company comprises two 375-kilowatt alternating-current generators, one 400-kilowatt direct-current generator, and a 300 kilowatt rotary converter for use as a connecting link between the two. This company has purchased also about fifty induction motors, which will be used largely for direct connection to machine tools.

AN AUXILIARY COUPLING FOR AUTOMATIC COUPLERS.

The accompanying engravings illustrate a new auxiliary coupling for automatic couplers, that has recently been brought out by the Railway Appliances Company, No. 675 Old Colony Building, Chicago, Ill. This coupler is adapted for both pushing and pulling on curves too sharp for operation of the M. C. B. standard coupler, and is exciting interest amongst railroad men, due not only to the approaching abolition of the link slot and pin hole, but also to the investigation which has been carried on for some time by the Interstate Commerce Commission regarding the methods used by the railroad companies for handling cars on very sharp curves, such as occur at many factory sidings. At present such sidings are operated with link and pin between the couplers, or by means of coupling bars. This is bad enough as it is, but with the approaching abandonment of the link slots and pin holes it will be necessary to push cars around such curves with a push-pole and haul them out with a chain or rope, which plan is practically prohibited by the fact that pushing is very liable to damage the release rigging, and increase repairs at a point where the greatest number of defects are now developed; also by the danger of throwing cars off centers, as well as the increase of time necessary to set cars.

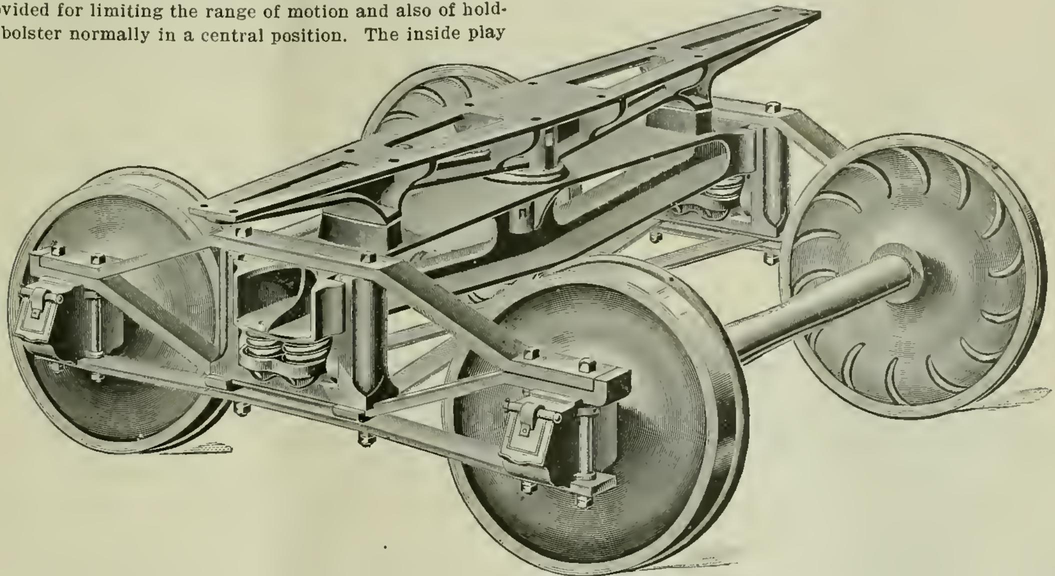

The Auxiliary Coupling.


In Place upon the Knuckle of an Automatic Coupler.

After considerable experimenting and study this auxiliary coupling was brought out, patent applied for May 13, 1902. It is cast from open-hearth steel in a single piece and weighs no more than the average knuckle. When a curve is reached on which draw-bars pass, it is taken from the caboose or engine and hung on either one of the couplers, the opposing knuckle being open; the cars are then backed together, and coupling takes place automatically. The cars can then be hauled to a straight track, and the auxiliary removed or left in position. Two of the largest switching roads in Chicago are using this device and it is on test on many others, its great advantage being that it is automatic and does not require the presence of a switchman between the cars. The lower engraving shows the auxiliary in place upon an automatic coupler, the looped portion at one end supporting it upon the knuckle of the coupler.

THE COMMONWEALTH STEEL TRUCK.

The accompanying engraving is an illustration of the new truck manufactnred by the Commonwealth Steel Company, St. Louis, Mo. In this truck side motion of the truck and body bolsters, whioh is so necessary for the safety of wheel flanges in the large capacity cars, has been provided for, but means are also provided for limiting the range of motion and also of holding the bolster normally in a central position. The inside play



The Commonwealth Swing Motion Steel Truck.

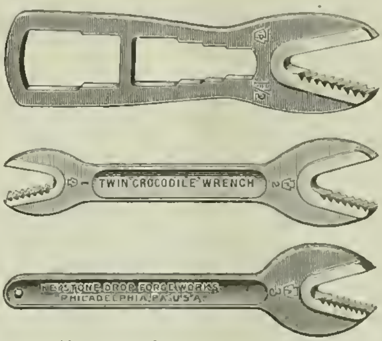
of the bolster is secured by use of a swing spring seat suspended by two links from inside the vertical columns of the side frames, the links being supported by lugs cast integral with the columns. The truck bolster, the ends of which rest on the springs supported by the swing seats, is provided with vertical cast flanges, which limit the side play by their contact with the columns, and the swing spring seat support is also provided with flanges which come into contact with the bottom arch bar, permitting the same amount of lateral or swing movement as the bolster; and as both limiting stops come into contact at the same time, one near the top and the other at the bottom of the side frame, there is no tendency to overturn the side frame. As the links hang normally in a vertical central position it is evident that any side deflection will tend to raise the bolster a small amount, resistance to which will tend to keep the car returned to normal position.

From the method of supporting the spring seat it is free to swing and will therefore always remain parallel to the spring bearing face of the bolster, so that the load will be uniformly sustained and no tendency exerted to cant or cramp the springs. As the faces of the bolster are always horizontal, the pressure on the springs will always be vertical in direction regardless of the amount of side swing. This form of construction lends itself readily to the use of sufficient metal to secure an ample factor of safety in the suspension parts. However, if breakage of a link or lug should occur, the result will be simply a transformation to a non-swinging truck and there would not be enough drop of the bolster to produce injury from running.

The cast steel truck bolster, which is patented, is notable for its great strength with the light weight and absence of rivets and bolts. The design is varied somewhat in the different capacity cars, a deeper web being used in those intended for heavier loads. The body bolster is of similar construction, also made of cast steel, and is light in weight for its strength.

KEYSTONE "CROCODILE" WRENCHES.

"Crocodile" wrenches, as every man with shop experience knows, are most convenient tools for many purposes, particularly in locomotive and car work. The difficulty has been to get good ones. The Keystone Drop Forge Works, of Philadelphia, who make the "Keystone" connecting link and other drop forgings so largely used on the car equipment of leading railroads, are making excellent wrenches, bearing their well-known trade mark, which is found only on good product, this company

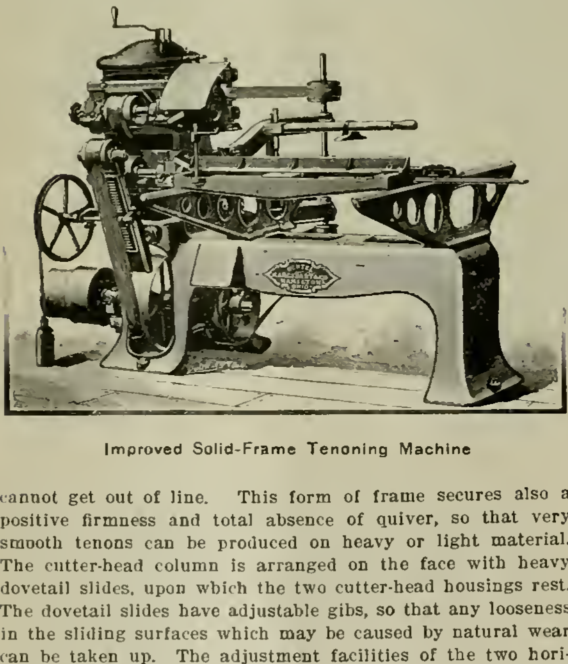


Keystone Crocodile Wrenches.

not being willing to jeopardize the high esteem in which it is held by anything but the best material and workmanship. Wrenches made of steel in which the carbon and other ingredients are not uniformly distributed are not satisfactory because the teeth are too hard or too soft in spots and will crush or flake off. All of the wrenches of these manufacturers are of a special grade of pipe wrench steel such as is used in the famous "Stillson" wrenches. The handles are designed with a flute and are set so that the fingers readily grip the wrench with a good broad surface on the edge for the hand. All sizes are drop forged from the solid bar without welds or inserted jaws. These cost no more than those of inferior quality. The connecting links made by this firm are so satisfactory as to justify confidence in other products of their works. The accompanying illustrations show three forms of "Crocodile" wrenches. A representative of this journal has made a careful investigation of this product. The address of the Keystone Drop Forge Works is Twentieth and Clearfield streets, Germantown Junction, Philadelphia.

SOLID-FRAME TENONING MACHINE.

The accompanying engraving is a view of the improved solid-frame tenoning machine, with roller carriage tables, manufactured by the Bentel & Margedant Company, Hamilton, Ohio. This tenoner is adapted for both heavy and light work, cutting single-length tenons up to 3½ ins. in length, and double-length tenons up to 6½ ins. in length. The machine frame is cast with the cutter-head column and table brackets in one single piece, so that the sliding table and cutter-heads retain under all circumstances their relative adjustment and



Improved Solid-Frame Tenoning Machine

cannot get out of line. This form of frame secures also a positive firmness and total absence of quiver, so that very smooth tenons can be produced on heavy or light material. The cutter-head column is arranged on the face with heavy dovetail slides, upon which the two cutter-head housings rest. The dovetail slides have adjustable gibs, so that any looseness in the sliding surfaces which may be caused by natural wear can be taken up. The adjustment facilities of the two horizontal housings on the column are as follows: Both housings can be raised and lowered, each one independent, or both can be raised and lowered together, keeping the adjustment or relative setting of the two unchanged while raising or lowering. The upper housing is provided also with horizontal slideways, so that it can be moved sideways or horizontally for adjusting of shoulder or oversetting the shoulders. The vertical adjustment is made by the crank shown on top of the machine, and the movement of a single housing or of both housings together requires only the throwing of a small lever in or out of gear, while turning the crank. Also, attention is called to the sliding or carriage table, which is arranged with roller and "V" slides for easy and accurate movement. This will be highly appreciated by all who use such machines, as also the fact that the slides are of such length as to permit the cutting of tenons 24 ins. wide and 3½ ins. long with single heads, or 24 ins. wide and 6½ ins. long with double cutter-heads, or 8 ins. long and 24 ins. wide by cutting twice. The cope cutter-heads are attached to the housings of the horizontal cutter-heads by means of slides, permitting them to be moved either with the horizontal heads or independent of them, both vertically and laterally, for adjustment in coping. They are driven by a counter-shaft attached vertically, placed at a considerable distance from the heads in order to run long belts, and in such a position that the driving belts retain the necessary tension in all positions. The table is provided with a gauge of all lengths, and with an adjustable fence for either square or angular tenons, and has a convenient lever for holding the material down.

The various systems of car lighting were compared by Mr. Canfield at the Saratoga convention, and the result of the discussion was to place this among the subjects for investigation and report next year. Elsewhere in this issue will be found an abstract of Mr. Canfield's remarks, including comparative figures of cost of various systems on the Lackawanna. By reference to the table, which, for convenience, is repeated here, the costs may be studied. If these figures represent comparable lighting service, and it is assumed that they do, Pintsch gas on their suburban cars costs only five cents per month more than oil in their through car service, and electric lighting costs about seven times as much as gas on through cars. As the cost is an important factor in such comparisons, it is well that the whole subject should come before the M. C. B. Association. The figures are as follows:

First-Class Cars.

Kind of Light.	No. of Lights.	Average Mileage.	Cost per Car.	Cost per Flame.	Kind of Service.
Oil	6	12,710	$2.40	$0.40	Through
Electric lights	17	2,092	8.81	.52	Suburban
Electric lights	36	12,710	37.31	1.04	Through
Electric lights	25	1,560	7.57	.30	Suburbau
Pintsch gas	20	12,710	5.73	.29	Through
Pintsch gas	16	2,092	2.45	.15	Suburban

The Chicago Pneumatic Tool Company, Chicago, Ill., has, through its counsel, John R. Bennett, of New York City, commenced suit in the U. S. Circuit Court against the Philadelphia Pneumatic Tool Company and others, for an injunction to enjoin the Philadelphia company from further manufacture and sale of pneumatic tools. It is alleged that the patent regarding which the suit has been brought has been sustained by the U. S. Courts, and that the tools now being manufactured by the Philadelphia company are precisely the same as those against which the courts have already granted injunctions. Injunctions have been granted against several infringing manufacturers, the last having been against the Standard Pneumatic Tool Company, of Chicago, which resulted in that company conveying its plants and business to the Chicago Pneumatic Tool Company in settlement. Under its patents, the Chicago Pneumatic Tool Company claims the exclusive right to all pneumatic tools now on the market.

The Haydon & Derby Manufacturing Company, 85 Liberty street, New York City, are advised that the Metropolitan 1898 injector, model "O," has been adopted by the Philippine Insular Government as the standard on their Class "A" cruisers, fifteen of which have been thus fitted, as a result of a contract secured by F. W. Horn & Co., Yokohama, Japan, agents for the Haydon & Derby Manufacturing Company at that point, after careful and exhaustive tests made with a view of selecting devices which had the greatest merit. The adoption of the Metropolitan injectors under such conditions endorses their superiority.

The Steubenville and Wheeling Traction Company has just purchased two 500-kilowatt Westinghouse railway generators, to be used in the operation of an electric railroad running from Steubenville, Ohio, to Wheeling, W. Va., and also a line from Wellsburg to Wheeling.

In an order for 500 cars recently placed at the Middletown Car Works by the Norfolk & Western Railway the brake-beams specified are the Damascus brake-beam, manufactured by the Damascus Brake Beam Company, St. Louis, Mo.

DETERMINATION OF THE POWER REQUIRED TO OPERATE THE TRAINS OF THE NEW YORK CENTRAL & HUDSON RIVER RAILROAD AND THE RELATIVE COST OF OPERATION BY STEAM AND ELECTRICITY.*

By Bion J. Arnold.

In August, 1901, the writer was commissioned by the New York Central Railroad Company to study the conditions governing the operation of its trains between Mott Haven Junction and Grand Central Station, and to report upon the feasibility of operating them by electricity. This division consists of 5.3 miles of four-track road forming the trunk line, or main artery over which the trains from the three divisions of the New York Central and the main line of the New York, New Haven & Hartford Railroads enter the city of New York. For 2.58 miles from Mott Haven Junction the tracks are carried on an elevated stone and steel structure; then for 2.04 miles through a tunnel underneath the street, emerging into an open cut .68 of a mile long, then terminating at the Grand Central Station in an intricate stub-end yard, having about eight miles of switching tracks. Over this division are made nearly 600 train movements per day, as almost all trains entering the yard or station must be returned to Mott Haven Junction, owing to lack of sufficient storage tracks at the Grand Central terminus.

Soon after taking up the work it became evident, on account of the number and weights of the trains to be handled and the numerous variable elements entering into the operating system, which would not adapt themselves conveniently to formulæ, that the most practical and satisfactory way of ascertaining the power required to propel the trains was to measure, by means of a dynamometer car, the "draw-bar pull" of a sufficient number of trains of various weights, to determine the average power required per train and from this compute the general load diagram.

A dynamometer car known as "Test Car No. 17," owned jointly by the Illinois Central Railway Company and the University of Illinois, was secured, and men thoroughly skilled in its use were employed to operate it. This car was coupled between the locomotive and the train in each case, and operated on trains running over the different divisions of the road, so that not less than four runs, two or more in each division, were made for each class of train. Since the trains of all divisions, including those of the New York, New Haven & Hartford Railroad, run over the New York Central tracks between Mott Haven Junction and Grand Central Station, the records of the New York Central trains for this division will apply to trains of equal weight on the New York, New Haven & Hartford road, and were so considered in the calculations.

(This dynamometer car was illustrated and described in detail in our August, 1900, issue, page 239.)

Dynamometer records were taken on eight different classes of trains which are in daily operation over some of the divisions of the road. In each record was recorded graphically the following:

(1) The "draw-bar pull" of train.
(2) The speed of the train, and—
(3) The profile of the road, at the bottom, and the alignment, at the top of each record, so that it is possible to calculate by formulæ the theoretical horse power required to haul the train under the conditions of each case, and after equating for grade and curvature, to check the result by the curves.

The records did not include the power required to propel the locomotive, nor the head end resistance offered to it by the air, and also when the dynamometer car was running backward, the power to propel it was not represented in the record and its weight should not be taken into consideration as a part of the train. These factors were taken into account when determining the final load diagram.

*Abstract of paper read before the June convention of the American Institute of Electrical Engineers at Great Barrington, Mass.

Method of Obtaining Horse Power at Draw-Bar From Dynamometer Records.

This was obtained in general in the following manner: From actual dynamometer car tests the average draw-bar pull of the various trains over the various runs was determined, proper allowance made for increased train weight due to motor equipment, and finally a reduction of the draw-bar pull thus obtained to horse power, and eventually to kilowatts. Owing to the fact that the maximum speeds on this division seldom exceed 35 miles per hour and that the trains were never less than three cars in length—often reaching eleven cars in length—no correction was made for head end air resistance.

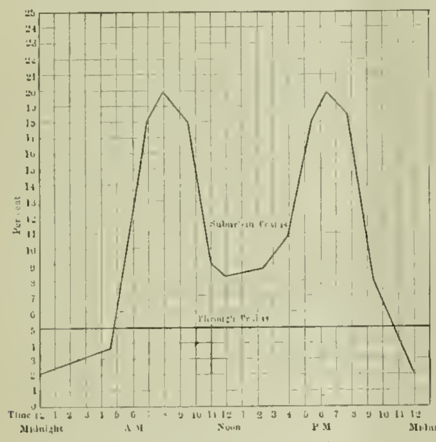
The successive steps were as follows:

(1.)—In order to determine the average draw-bar pull for any given period, the entire area under the dynamometer pen record was found by a planimeter and divided by the length of base of the interval from start to stop, the result being the average height of the dynamometer records between stops. This average height when multiplied by the constant of the instrument, represents the average draw-bar pull between these stops.

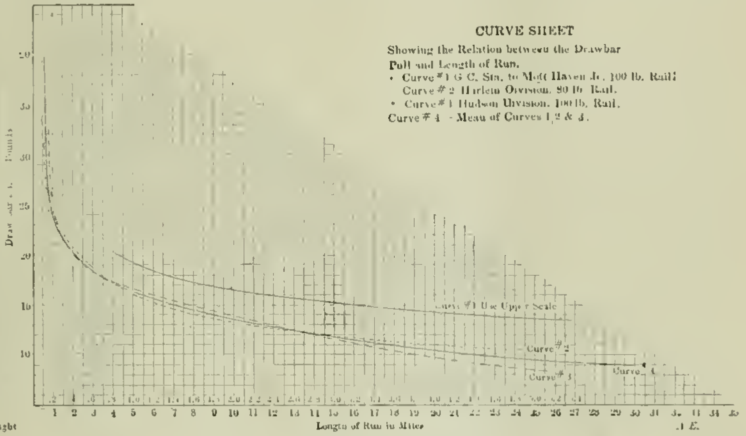
(2.)—From passenger records taken during dynamometer tests, the curve, shown herewith, was plotted, showing the ratio of the weight of the live load to the light weight of the train.

(3.)—Dividing the average pull in pounds by the total weight of the train, the average pounds per ton draw-bar pull over the run under consideration, was obtained.

The average pounds per ton draw-bar pull (not tractive effort) for various lengths of run over the Mott Haven Division are shown in Curve 1, of the accompanying curve sheet. Curves 2 and 3 show these values for longer runs, as obtained on the Harlem and Hudson Divisions respectively, and Curve 4, which is the mean of Curves 1, 2 and 3, shows very roughly what may be expected to obtain as the average value of the "pounds per ton" draw-bar pull under ordinary steam railroad conditions, on a level and comparatively straight track, with various weights and length of train (three to ten cars, 100 to 400 tons), and at an average speed of about 30 miles per hour.



Ratio of Weight of Live Load to Light Weight of Train.



Draw-Bar Pull in Pounds per Ton of Train Weight—not tractive effort.

(4.)—(A graphical method of obtaining the speed in miles per hour between any two stations when the time of run between these two stations is given, was next set forth.)

(5.)—The weight of every train arriving or leaving the Grand Central Station on a given day was obtained, and its average speed between stops determined from the above curves. Knowing, therefore, the average draw-bar pull in pounds required to haul a train, and the average speed at which this draw-bar pull was exerted, the horse power at the draw-bar becomes:

$$\text{H.P.} = \text{foot pounds per minute} / 33{,}000$$
$$= \text{draw-bar pull} \times \text{miles per hour} \times 5{,}280 / 33{,}000 \times 60$$
$$= \text{draw-bar pull} \times \text{miles per hour} / 375.$$

(This formula was also presented graphically, from which, knowing the draw-bar pull and speed, the horse power or kilowatts corresponding thereto could be determined.)

Method of Obtaining Daily Load Diagram.

From a careful examination of the weights of all locomotives now in service on this division, it was found that properly powered electric locomotives having a total weight of 65 tons each, all of which would be available for tractive effort, could satisfactorily perform the service of existing steam locomotives. To each train horse power curve, therefore, is added the horse power required to propel a 65-ton locomotive.

This horse power was obtained in the same manner as that required to haul the train and was plotted seperately on the train sheets; evidently, the friction of an electric locomotive in pounds per ton is greater than an equivalent weight of train, but this difference was considered in selecting the proper locomotive efficiency. The sum of the instantaneous values of these individual curves was then plotted. The mean height of this curve was plotted on each sheet, and represents the average horse power required to propel all schedule trains and locomotives during the six hours covered by the sheet.

This average horse power when converted into kilowatts by means of the following formula:

$$k.w. = h.p \times 746 / 70\% \times 1{,}000$$

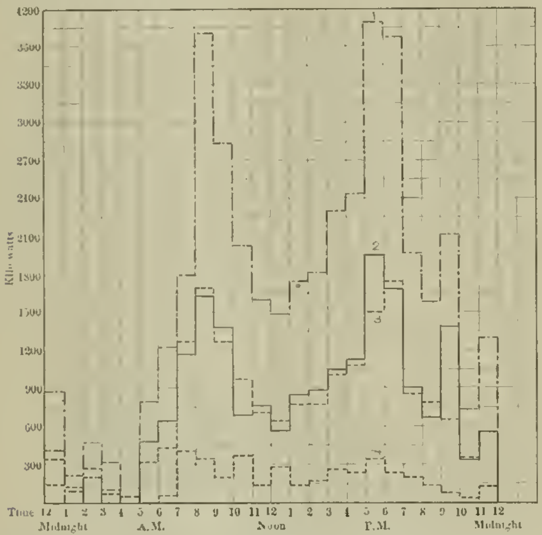
where 1,000 watts = 1 k.w.
746 watts = 1 electrical h.p.
and 70% = efficiency of locomotives

gives the average kilowatt input required at contact shoes of electric locomotives for the period covered by each sheet.

Another curve shown represented the mean average kilowatt input at contact shoes throughout a period of 24 hours, under the same conditions, and the demands of the switching and shop train service were found.

The sum of these curves when plotted as a curve therefore represented the average daily kilowatt input required at the contact shoes of the locomotives for all service.

Curve 1, of the accompanying plate of total load curves, is a condensed load diagram of the entire service, showing the hourly variation of the different classes of service, as deduced from the curves previously determined.



Condensed Load Diagram of the Entire Service, Showing Hourly Variations.

From the curves of average inputs which were determined from the curves, on these sheets, it is seen that the daily average input required would be at the rate of 1,800 kilowatts and, therefore, the total annual input required at the contact shoes of the locomotives, for propulsion alone, would be (1,800 × 24 × 365) = 15,768,000 k.w. hours. From the total number of tons hauled yearly over this division, including passenger, shop trains and switching service, the ton-miles per year were found to be 250,285,710. Hence, the electrical energy required to haul a ton one mile over this division under the existing conditions would be:

$$\frac{15{,}768{,}000.000}{250{,}285{,}710} = 63 \text{ watt hours per ton-mile.}$$

With this figure as a basis and the load factor as determined from the load diagram, the problem of determining the best method of producing, distributing and applying the power was considered.

Choice of System.

While it is the writer's opinion that the alternating current railway motor will yet prove to be the most efficient, all things considered, for long distance railway work, it has not yet, in his opinion, demonstrated its ability to start under load as efficiently or to accelerate a train as rapidly as the direct current motor. The line under immediate consideration was short, the trains numerous and rapid acceleration desirable, all of which are conditions favorable to the direct current motor.

Furthermore, direct current motors with their necessary auxiliaries have become fairly well standardized, and it is the only class of electric railway apparatus available from the manufacturers of the United States without involving experimental work and large development expense.

In view of these facts and the probable necessity for rapid construction, the writer refrained from advising anything of an experimental nature and, therefore, recommended the direct current system in combination with the third rail for the main line, and overhead construction for the yards, all of which have demonstrated fully their ability to meet the conditions imposed by railway operation so far as motive power is concerned, although there has not yet been an electric installation on any existing terminal that is as complex, or into which anywhere near the number of heavy trains enter as on this section of road.

Had the length of road under consideration been considerably greater, and had it been thought possible to secure sufficient time to conduct experiments or invite demonstrations by manufacturers of alternating current motor equipment, this class of apparatus would have been more seriously considered.

Discussions and Analysis of Plans and Estimates.

In the preparation of estimates, twelve distinct plans of generation and distribution were considered and the results tabulated as shown in the accompanying table. All the estimates were computed upon the same basis so far as cost of fuel, labor and losses in transmission were concerned. The different headings in the table here shown are deduced from another table not here published, the columns of which were as follows:

Column A.—Total Cost of Entire Installation.—Erected complete, consisting of power house, transmission circuits, feeders, substations, track construction chargeable to electrical equipment, overhead construction and electrical locomotives.

Column B.—Total Operating Expenses per Annum.—Including wages in power house and sub-stations and on rolling stock, together with all coal, oil, water, waste, repairs, etc.

Column C.—Fixed Charges per Annum.—Including interest at 4 per cent. on total investment, and taxes at 2 per cent. on buildings, sites, machinery and electrical locomotives.

Column D.—Total Expense per Annum.—Made up of Column B plus Column C.

Column E.—Operating Expenses per Annum at Power House.—Including coal, water, oil, waste, etc., and repairs and wages.

Column F.—Operating Expenses per Annum at Contact Shoe.—Including coal, water, oil, waste, etc., and repairs and wages in power house; oil, waste, repairs and wages in sub-stations; and repairs (labor and material) on transmission lines.

Column G.—Total Expense per Annum Exclusive of Rolling Stock.—Including operating expenses per annum at contact shoe (as in preceding Column F) plus fixed charges as follows: interest at 4 per cent. on total investment (less cost of electric locomotives) and taxes at 2 per cent. on buildings, sites and machinery.

Column I.—Total Locomotive Miles per Annum.—Determined from information furnished through the Operating Department.

The explanation of the columns in the table is as follows:

Column H represents the operating expenses per k.w. hour at power house switchboard. Column M represents the operating expenses per k.w. hour at contact shoe. Column N represents the total cost per k.w. hour delivered to motor terminals, exclusive of fixed and operating charges on electric locomotives. The cost per k.w. hour at motor terminals differs from the cost per k.w. hour at the contact shoe only when batteries are carried on the locomotives, in which event the cost per k.w. hour at the motor terminals is increased over the cost per k.w. hour at the contact shoe by the cost of energy lost in the batteries. Column J represents the operating expenses per electric locomotive mile. The values in this column are directly comparable with values now obtained in the present steam locomotive service, except that the operating expenses for steam locomotives as shown by the performance sheets of the Motive Power Department do not include any charge for water. From the best information available, the cost for water for the present service on this division is about .987 cents per locomotive mile, which amount added to the present cost as shown on the locomotive performance sheets, gives an amount which should be compared with the values in Column J. Column K represents the fixed charges per electric locomotive mile, and is here tabulated merely as a step in obtaining. Column L (which is Column J plus Column K) represents the total cost per electric locomotive mile.

Plans 4 and 5 bring out quite clearly the difference in the cost of operation between two sub-stations and one, both plans permitting the location of the power station on the river front.

The difference in favor of Plan 5 is entirely due to the saving in labor of one sub-station.

Plans 6, 7 and 8 were studied with the object of ascertaining whether the purchase, instead of the generation of power, would offer a satisfactory solution of the problem.

The purchase of both D. C. and A. C. energy was considered on the lowest basis that it was thought possible for any existing company to furnish it, and it was found that the D. C. energy would cost the railroad company one-half cent more per k.w. hour than the A. C. energy, in consequence of the interest, depreciation, maintenance, etc., of the transmission lines, rotary converters and other sub-station apparatus which would have to be furnished by the energy producing company.

Owing to the more or less complex system of overhead or third-rail yard construction made necessary by the nature of the case, and the advantages to be obtained by their elimination in the substitution of locomotives which could, for switching service, be self-contained, though normally supplied with energy from the working conductors, a study was made of electric locomotives carrying batteries.

The results of these studies made under several different assumptions are shown under Plans 9, 10 and 11. From Columns L and N it is evident that whatever may be gained by the elimination of the overhead construction is largely offset by the additional cost of operation, although it will be observed that the cost per locomotive mile of Plan 9 compares favorably with the cost of Plan 12.

Plan 12 differed only from Plan 5 in a slight reduction in the capacity of the converting apparatus in the power house and substations and the substitution therefor of two storage batteries (one located in or near the power house and one in the sub-station), each of such capacity that it, together with only a portion of the main station and sub-station machinery, would be capable of taking over the entire load of the line for a short period of time in cases of emergency.

The additional first cost and the slight increase in annual expense (as compared with Plan 5) represented by a reserve station capacity of this nature, was thought to be of secondary importance only, in view of the increased reliability of operation thereby obtained. The increased cost of operation in this plan over that of Plan 5 is due to the fact that the battery maintenance was figured at 10 per cent. per annum, which is considerable higher than is

TABLE 1.

Plan.	CHARACTER OF STATIONS, ETC.	H = Column E / Total k.w. hours at power-house switchboard.	M = Column F / Total k.w. hours at contact shoe, annually.	N = Column G / Total k.w. hours at motor terminals, annually.	J = Column B / Column I	K = Column C / Column I	L = (Column J + Column K)
1.	Direct current power station at center of line and contiguous to tracks. 600 volt working conductor, no batteries	.447c	.60c	1.06c	14.02c	6.58c	20.60c
2.	Same as No. 1, with batteries in power house	.472	.66	1.137	14.65	6.71	21.36
3.	Same as No. 1, with battery sub-station near Grand Central Station and Mott Haven Junction	.475	.668	1.20	14.7	7.25	21.95
4.	Alternating current power station on river front near center of line, with rotary converter sub-stations near each end of line. 11,000 volt A. C. and 600 volt D. C.	.572	.715	1.287	15.2	7.58	22.78
5.	Combined D. C. and A. C. power station at Harlem River near one end of line and one rotary converter sub-station near the other end of line. 11,000 volt A. C., 600 volt D. C., no batteries	.570	.666	1.19	14.7	7.18	21.88
6.	Direct current feeders from Manhattan Railway sub-station located near center of line. Transmission from sub-station to working conductor. 600 volts D. C. energy to be purchased	2.5	2.650	2.748	34.64	2.89	37.53
7.	Rotary converter sub-station at center of line. A. C. energy to be purchased from Manhattan Sub-station and transmitted at 11,000 volts. Energy to cost ½ cent less per k.w. hour than D. C. energy delivered	2.5	2.336	2.508	31.50	4.23	35.73
8.	Two rotary converter sub-stations, one near each end of line. A. C. current to be purchased from Manhattan sub-station near center of line	2.1	2.336	2.504	31.50	3.93	35.43
9.	Combined A. C. and D. C. power station near Harlem River at end of line. One sub-station near other end, and batteries carried on locomotives charged from working conductor	.519	.629	1.122	16.58	7.76	24.34
10.	One rotary converter sub-station near center of line. A. C. current purchased from Manhattan sub-station No. 7, batteries on locomotives charged from working conductor	2.12	2.4	2.502	34.40	4.08	38.48
11.	Direct current feeders from Manhattan sub-station No. 7, near center of line. Batteries on locomotives charged from working conductors	2.5	2.738	2.742	37.81	2.51	40.32
12.	Combined A. C. and D. C. power station at Harlem River near outer end of line. One sub-station near other end. Batteries in power station and sub-station. A. C. transmission 11,000 volts, D. C. conductors 600 volts	.55	.775	1.335	15.80	7.83	23.63

Table of Estimates on Plans for Proposed Electrical Equipment of the N. Y. C. & H. R. R. R. Between Grand Central Station and Mott Haven Junction.

ordinarily assumed, and will probably be considered excessive by some.

A battery of this kind would not only serve as a reserve, but would prove of considerable value as a regulator of potential along the line, and in addition it would, notwithstanding its inherent losses, tend to reduce the power house operating costs by taking up the excessive load fluctuations of the system and permitting the load upon the engines to be maintained at or near their most efficient working capacity.

It was considered of the utmost importance in an installation of this magnitude that the number of interruptions of power supply be reduced to a minimum, that no device which could increase the safety and reliability of the plant should be omitted, and that the probability of future extensions of the electrical system should be considered. As best fulfilling the above conditions, therefore, Plan 12 was the one specifically recommended for adoption.

Operating Expenses.

A careful compilation of all the expenses entering into the operation of the present steam service was made, and the following comparative table (Table 2) of relative costs is believed to be correct, assuming that the present locomotives running between Mott Haven Junction and Grand Central Station should be abandoned and the service now performed by them duplicated by electric locomotives operated in accordance with Plan 12. It is assumed that the electric locomotives will be operated by the same class of men as those who now operate the steam locomotives, and that they would receive the same rate of pay that they now receive.

This condition is not favorable to electric traction, as it is not ordinarily necessary to have two men to operate an electric motor, but in the writer's judgment it is not advisable to operate a service of this class under such exacting conditions without two men on each locomotive.

If the motor car system should be adopted, as it probably would be were the electrical equipment extended beyond Mott Haven Junction, or if the forward guard or brakeman were allowed to take the place of the second man while passing through the tunnel and yards, a saving equivalent to his wages could thereby be effected.

With two men of the same skill as at present employed on the locomotives, the figures are as follows:

TABLE 2.

	Steam	Electricity
Operating expenses per locomotive mile exclusive of fixed charges, but including water, labor, cost of cleaning and repairing tunnel, and all other expenses of locomotive operation	23.05	15.80
Fixed charges per locomotive mile assuming that it now requires 40 locomotives to perform the present service and that 33 electric locomotives could perform the same service	1.13	7.83
Total in cents	24.18	23.63

From these figures it appears that while there would be a slight annual saving in operating expenses in favor of electricity, it is not sufficient to warrant its adoption on the grounds of economy alone, although its adoption can be justified on other grounds.

In connection with the investigation, a series of comparative acceleration tests of steam locomotives and electrical equipment were made at Schenectady, the results of which are set forth in another paper prepared by Mr. W. B. Potter and the writer. (This will appear in a later issue.—Editor.)

"A Treatise on Roofing" is the title of a 24-page pamphlet issued by the American Insulating Material Manufacturing Company, of St. Louis, Mo. It contains a discussion of roofing, its requirements, manufacture and application, which should be read by all who are concerned in the application or maintenance of roofs on buildings or cars. This company presents facts from its extensive experience. The pamphlet includes descriptions of Sawyer's plastic and flexible car roofing which will especially interest our readers. The address of the company in St. Louis is 213 North Third street.

The American Blower Co., Detroit, Mich., have recently issued a catalogue descriptive of their disc ventilating fans and also a dry kiln catalogue. In the fan catalogue their steel plate disc fans are illustrated in all types, belt-driven and direct-connected steam engine and electric motor driven, adaptable for all kinds of drying, ventilating and other blowing service. The dry kiln catalogue illustrates their "moist-air" and blower dry kilns, together with the special apparatus and fittings necessary. Special lumber trucks are shown for use in the kilns, and also a simple return steam trap of their manufacture is shown for returning condensation from heater coils to the boiler.

The Baldwin Locomotive Works pamphlet, "Record of Recent Construction," No. 35, is devoted to rear truck locomotives. The origin of the use of trailing trucks is explained by text and engravings illustrating the wide firebox locomotives which required them. Examples of the "single" of the Philadelphia & Reading, the Atlantic types of the Chicago, Milwaukee & St. Paul, the Prairie types of the Burlington, and the Mikado type of the Bismarck, Washburn & Great Falls are illustrated by half-tones, with tables of dimensions. The pamphlet closes with an illustrated description of the Rushton trailing truck, which has been applied to a number of recent Baldwin engines.

MASTER MECHANICS' ASSOCIATION REPORTS.

(Concluded from July.)

UP-TO-DATE ROUNDHOUSES.

Committee—Robert Quayle, D. Van Alstine, V. B. Lang, G. M. Basford.

[Editor's Note.—This report is divided into four papers presented by the committee from its individual members. Mr. Quayle discussed the plans of terminals recently constructed, Mr. Van Alstine presented an ideal plan for a locomotive terminal, Mr. Basford presented a large number of details of recently constructed roundhouses and facilities connected with them, and Mr. Lang discussed the operation of roundhouses. Selections from the first three are presented here. From Mr. Basford's paper the portion on ventilation is reproduced.]

Plans of Terminals.

I submit for your consideration, first, a plan of roundhouse terminals at Clinton, Iowa, on the Chicago & Northwestern Railway. This plan I submit for the reason that it is flexible, and one, two, three, four or more roundhouses may be set in line. This part of the road points east and west, and it is the opinion of the writer that the roundhouses ought to be set parallel with the tracks.

At Clinton, Iowa, two divisions terminate. The Galena division, which runs from Chicago westward to Clinton, 138 miles, and the Iowa division, which runs eastward from Boone to Clinton, 202 miles. These are the lengths of both passenger and freight divisions.

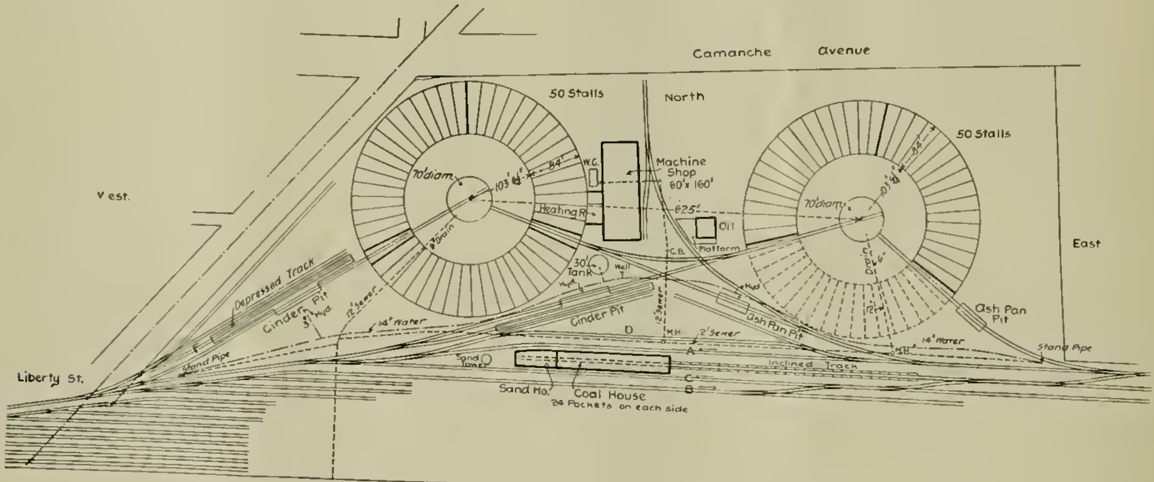
At a busy terminal, where there are from 200 to 350 locomotives to be handled a day, it is very necessary that engines should have track facilities that will enable them to be moved easily from the roundhouse up into the freight yard to be coupled on to the trains without any interruption by an opposing movement of locomotives. It is also necessary to have an additional track that will enable the locomotive to come from the freight yard up and into the engine house without being detained by opposing engines. This not only holds true for freight locomotives, but also for passenger locomotives.

I will first call your attention to the movement of passenger locomotives from the passenger depot, and I do this because on some roads they use a better quality of coal for their important passenger engines than they do on their freight engines; consequently, they have the coal better taken care of, broken up and placed on the tender in better condition, and for this reason it is necessary to have one side of the coal house given over to passenger coal, and hence it is necessary to have a track on the side of the coal house over which the passenger coal is to be delivered to locomotives set aside for passenger locomotives, and on this plan the northbound track, marked "A," is known as the track for the movement of passenger locomotives. The depot being to the east of the roundhouse, the engines cut off from their trains and come up through the yard westbound until they enter upon track "A," on which they pass up to the coal chute and take coal, and immediately at the west end of the coal chutes is the sand tower from which they take sand. They then pass on down to the standpipe and take water, and then move to the switch, which gives them a clear way over their cinder pits and into their respective roundhouses, whether they be Galena or Iowa division engines.

Your attention is next called to the passenger locomotives leaving the house and going up to the depot to be ready to couple on to train after its arrival. If the passenger engine is in the west roundhouse, which belongs to the Iowa division, it will pass out of the roundhouse on the track to the east of the roundhouse, and will pass over what is termed the ash-pan pit, and if the ash-pan needs cleaning it will be cleaned out, and the engine will pass onward down toward the depot, connecting with track "A," where they have access to a standpipe, and can fill their tanks with water at that point, if necessary.

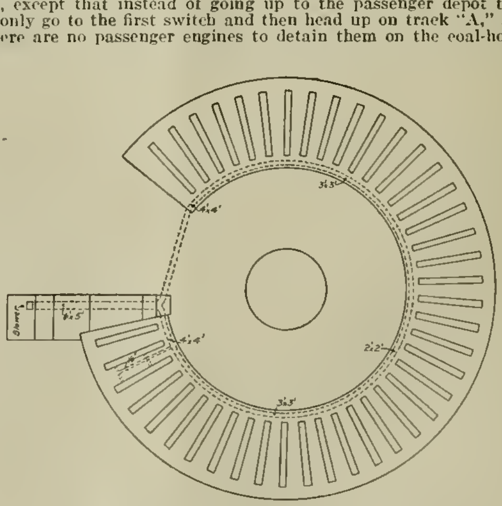
When passenger engines go out from the east roundhouse they go down to the eastbound track and take water at the same penstock, and on eastward to the depot.

Now, we will follow the freight engines from the point of giving up their freight trains to their arrival in engine house. First, be it understood, that the freight yard in this plan is to the west of the roundhouse, and all east and westbound trains terminate in the same freight yard, and as it is located west of the roundhouse, they all have to come eastward past the coal chute on track "B," and then cross over to coaling track, "C," where they will take coal and pass westward to the switch, and go into either east or west engine house in the same manner as described above for passenger engines.



The Clinton, Iowa, Roundhouses.—Chicago & Northwestern.

The freight engines will come out of each of the east and west houses in the same manner as shown above for passenger locomotives, except that instead of going up to the passenger depot they will only go to the first switch and then head up on track "A," and if there are no passenger engines to detain them on the coal-house track, "A," they will pass on said track up into the freight yard. But, should there be passenger engines taking coal at the coal house on track "A," they will take track "D," which we will call the runaround track.



Plan of Roundhouse with Reference to Vent.

This plan could be extended indefinitely, so far as relates to number of roundhouses. Would also call attention to the fact that this plan calls for a depressed track, of which the writer is in favor, as his experience during some severe winter weather has caused him to discount very materially the use of pneumatic hoists for such purposes. Would recommend that we should always have pits long enough to at least clinker two engines at a time.

The Ideal Roundhouse.

The ideal roundhouse is one which handles engines with the least possible delay at the lowest possible cost. It provides in-bound tracks of sufficient length to store a large number of engines, on which are located coal chutes, sandhouse and cinder pits.

The coal chutes consist of 40 or 50-ton pockets on scales, into which hopper-bottom cars may be unloaded. The track above the pockets is reached by a 4 per cent. or 5 per cent. grade. At one end of the coal chute are the sand pockets, which are filled from cars, same as the coal pockets. After the sand is dried it is stored in elevated pockets, from which it is drawn into sand boxes. The cinder pits are 150 ft. long, and depressed track about 8 ft. below bottom of cinder pits, to allow of cheap loading of cinders into cinder cars. There should also be short cinder pits in out-bound tracks for cleaning ash pans of out-bound engines, and cleaning fires of switch engines.

Standpipes should furnish water to engines on in-bound and out-bound tracks. The turntable is 70 ft. long and operated by power. The roundhouse is 80 ft. long in the clear, with doors 12 ft. wide and 16 ft. high.

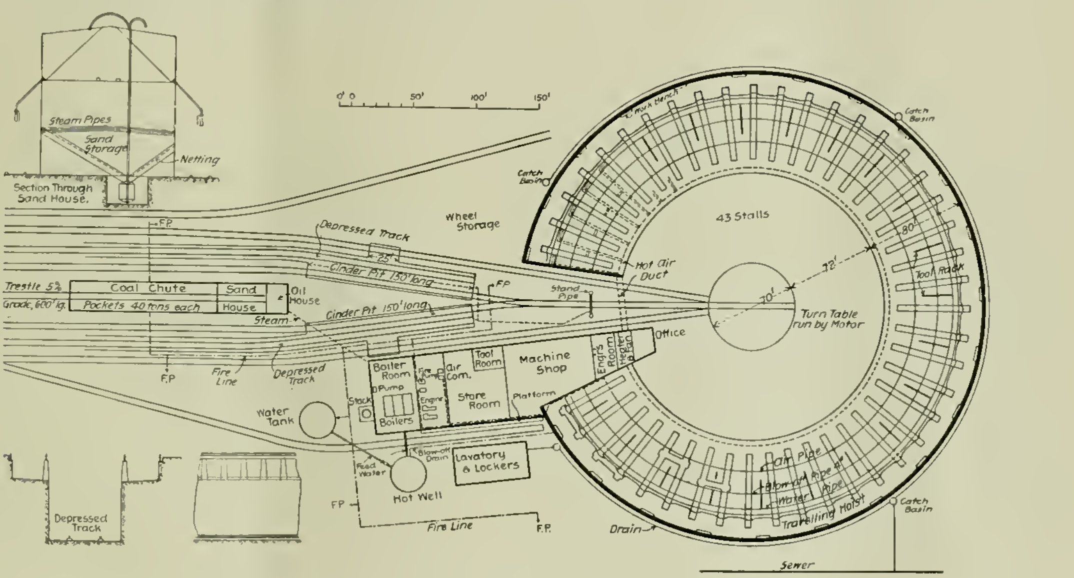
It is heated by hot air from heater and fan, which passes around the house through an underground duct on the inside circle, and is

Heating and Ventilating.

Nearly all roundhouses of recent construction are equipped with fan systems, these being considered as furnishing the ideal method of heating. For small houses, steam pipes in the pits seem to be the most economical. In the plans accompanying this report are a number of different arrangements of conduits from the fans, most of them underground. The conduits may then be of brick and concrete, and are permanent. When underground, they are also entirely out of the way and do not obstruct the light. Various methods are employed to distribute the hot air to the pits, the chief point of interest being the methods of delivering the air under the engines and tenders for the purpose of quickly melting snow and ice. These require no comment, but it is evident that the plans are not of equal merit in this respect. The roundhouse pits of the Jersey Central at Elizabethport are fitted with elbows to direct the air to the machinery. These, when pushed into the bushings in the walls, automatically open the delivery dampers.

For good ventilation, the volume of air required from the fan is much greater than is required to pass through the fan for heating alone. A good rule is to require the air to be renewed every eight or ten minutes. Practice in heating and ventilating is not by any means uniform, and an attempt has been made to secure information which shall be a guide to good practice.

The variable factors are: Volume of house per stall, outside temperature range, character of exposure, use of live or exhaust steam, location of fanhouse, space available for fan and amount of heated air to be returned to the fan. In a roundhouse the air



An Ideal Locomotive Terminal.

distributed to pits through underground pipes. The air to be heated is not taken from inside the roundhouse. A hot well, into which is drained all the exhaust steam from the plant, as well as steam from engines blown off, furnishes hot water for washing out and filling up, and for stationary boilers. The power-house boilers are arranged to burn front end sparks where the price of coal makes it profitable.

The engine room is provided with engine, dynamos, washout pumps, fire pump and air compressors. The machine shop is provided with lathes, bolt cutter, drill press, shaper, grindstone, planer, screw press, blacksmith forge and anvil. The store room contains all necessary supplies, except oil, and a tool room for small tools. The engineer's room is located close to the roundhouse foreman's office, and contains bulletin boards and desk. The roundhouse foreman's office is centrally located. The lavatory is provided with wash basins, shower baths, closets and lockers for engineers, firemen and roundhouse men. The oil house should be conveniently located for taking oil cans to and from engines.

In the roundhouse are tool racks between pits for pinch bars, wrenches and heavy tools, work benches on outer wall supported by brackets, drop pits for engine truck and driving wheels, an overhead track for lifting smokestacks, smokebox fronts, steam pipes, steam chests, pistons, cylinder heads, crossheads, etc., electric lights, electric and air motors for cylinder boring, etc. The overhead track has trolleys and chain hoists. The drop pits have hydraulic jacks on carriages for raising, lowering and moving wheels. The rodman is provided with a work bench on wheels. A wheel storage yard is conveniently located for getting wheels into and out of the roundhouse. If fuel oil is used for fire kindling a 6,000-gallon storage tank, underground, is located so that it can be filled from a tank car, and oil easily pumped from it for use in the roundhouse.

should not be returned to the fan. The form of roof affects the heating. An average of about 33,000 cubic feet of space per stall seems to represent usual construction. About 2,000 cubic feet of air delivered per minute per stall gives good results. The committee found one case in which 800 cubic feet per minute seemed to be ample. A range of from 125 to 150 deg. F. seems to be satisfactory for the delivery temperature. To estimate approximately the amount of steam in pounds per minute required for the heater, multiply the total volume of air supplied per minute by the number of degrees to which it is heated, divided by the constant 55.

In order to secure definite figures, one of the leading firms of engineers, making a specialty of heating and ventilation, was asked to submit suggestions based upon the roundhouse shown in Mr. Van Alstine's portion of this report, the conditions being those of the climate of Chicago, the minimum outside temperature being 20 deg. below zero, the inside temperature to be 70 deg. and the range of temperature of the hot air to be from 125 to 150 deg. This information is as follows:

Number of stalls	42
Approximate cubical contents per stall	34,700 cubic feet
Air supply per stall per minute	2,000 cubic feet
Total air supply	84,000 cubic feet
Temperature air supply	140° F
Size of fan	11 ft
Speed of fan	150 r.p.m.
Size of engine	11 x 14
Lineal feet in heater	8,500 to 9,500

"These figures are subject to some change, depending, first, upon the character of the exposure, the probable minimum outside temperature, variable steam pressure, and the amount of hot air returned to the fan. You can readily see that unless we were given a specific case and knew all of the conditions pertaining thereto, it is quite impossible to figure closely.

"We enclose herewith a sketch in which is shown in dotted line a suggested system of underground conduit for this roundhouse. We have shown also the approximate size of this conduit. If the fact that it is arranged to run under the radial tracks is a disadvantage, it could, of course, be placed near the outer wall. The proportions of this sketch are probably wrong, because the blueprint enclosed is not scaled. The dimensions thereon are evidently not intended to be perfectly accurate.

"Assuming the cubical contents per stall about 34,000 cubic feet, and, assuming the temperature of delivery 125 deg., a careful computation, taking into account only the heat loss from walls, roof and windows, and making no allowance for the opening of doors and other accidental ventilation, we find that it will be necessary to supply 1,200 cubic feet of air per minute per stall to maintain an inside temperature of 70 deg., with an outside temperature minus 20 deg. In order, therefore, to safely provide for accidental ventilation, the air supply should not be less than 2,000 cubic feet. This will serve to show that an air supply of 800 cubic feet would hardly be large enough unless there were unusually favorable conditions to be met."

To secure the best conditions of ventilation and heating, it seems wise to consult the leading firms dealing in this apparatus and provide a liberal appropriation for the equipment, and to secure a fan capacity far greater than sufficient to maintain a comfortable temperature at all times, then to drive this fan hard enough to secure good ventilation through the smokejacks and roof ventilators.

MODERN WATER SUPPLY STATIONS FOR LOCOMOTIVES.

From a paper by F. M. Whyte, before the Master Mechanics Association.

Editor's Note.—This paper is a record of current practice, and cannot fairly be presented in abstract. Selections are reproduced and the reader referred to the original, which is the most complete discussion of this subject available. The chapters on track tanks and water scoops are specially valuable. The illustrations are numerous, and comparatively few of them have been published before.

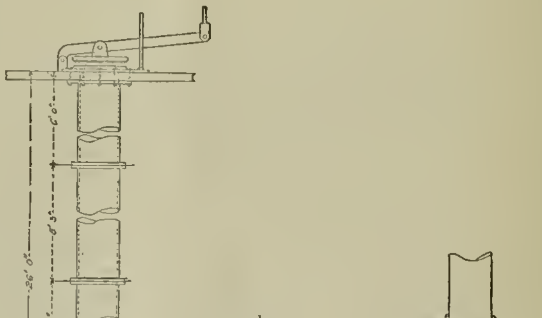
Quite generally the pumping plant for a locomotive water station is so small that only the simplest arrangements are provided; the number of boilers is seldom greater than one or two, and because one man can attend this number and the services of one man are needed, labor-saving devices are not needed in the average steam plant. The boiler house is built as substantial as circumstances allow; it is located so that fuel can be taken to it conveniently and refuse taken from it. When the conditions allow, the boiler and pump are placed in the same building.

The exhaust from the steam pump should be connected to the suction pipe at some distance from the pump, the steam being directed toward the pump where the steam enters the suction. This **arrangement** will assist the suction, reduce the back pressure on the steam end of the pump, and raise the temperature of the water, all of which are desirable results. Those who have used the arrangement give caution that care must be exercised to keep the exhaust pipes free from leaks.

The internal-combustion engine, in the form of gas or gasoline engine, is being used more and more for providing power for pumping, and there are conditions which can be fulfilled very nicely with this kind of power. Where the work is intermittent, or can be made so, and the attendant is employed to advantage elsewhere when not attending the pumps, these engines have been used with much satisfaction. The gas engine or gasoline engine pumphouse should be thoroughly ventilated at all times. It is the general practice to use gasoline in these engines, but quite recently it has been found that hydro-carbon, a by-product of the Pintsch gas plants, can be used in these engines, and when this hydro-carbon is available there may be a material reduction in the cost of operating the engine. If a road is supplying its own engines from its own gas plants a very convenient way for handling the liquid is to provide metal casks of a capacity of about 50 gallons; or a sufficient number of tank cars may be provided, the cars to be sent out over the line and stopped wherever a supply of oil is needed, the oil tank at the pump house filled, and the tank car moved on to the next station. These engines may be handled in such a way as to be extremely economical from the standpoint of labor costs; they can be so arranged that the only labor shall be that of starting the engine, it being cut off automatically when the water tank is filled. The labor cost, then, is such as is necessary to provide sufficient attention to start the engine before the tank is emptied.

Compressed air gives a very convenient means of raising water from deep-driven wells, because the operating machinery is all above ground and the pipes, if they are found out of order, are easily and quickly replaced. Another condition which justifies the use of compressed air is the necessity of using a number of wells to provide the necessary quantity of water, allowing the water from the various wells to flow either to the place where needed, or to flow to the suction of force pumps. The air-lift will not deliver the water horizontally to any great distance, so that when the lift, or well, is at a greater distance than 40 ft. from the place where the water is to be used it is necessary to raise the water perpendicularly at the well to such a height that it will be delivered by gravitation to the place desired, or to provide other means for the horizontal delivery. This means of pumping can be used to advantage also when it is desired to locate the pumping machinery at some distance from the well. This condition may arise when it is difficult to get the machinery or the fuel for operating it, sufficiently close to the well; or when it is possible, by locating the machinery at some some distance from the well, to keep the attendant busy at other work, when his services are not required all the time for pumping water. Also compressed air may be available for other service at the place where required, and in the use of it for raising water a considerable economy may be shown.

Information concerning the proper proportioning of air lifts has been the result of experience obtained by those who are engaged in making air compressors and in designing air lifts, and the formulæ which have been deduced from experience are treasured highly and are not available for publication. The general practice is, however, to make the relation of the submersion to the lift from 4 to 3, to 3 to 2. This is the "working" submergence as distinguished from the height at which the water stands in the well before pumping is begun; generally the water level in the well falls as soon as pumping is begun. If a lower percentage of submergence is used the cost of operation is increased. The weight of the column of water above the air inlet is readily calculated, and this will equal the pressure at which the air must be delivered to the point where the air and water are mixed. The starting pressure will be greater than the working pressure. The working pressure, divided by the atmospheric pressure at the altitude of the well, will give a quotient which, if unity is added, will give the number of volumes of free air required. The capacity of the well may be calculated by allowing 15 gallons per sq. in. of cross section of pipe per minute, or by taking the rate of flow in the discharge pipe at 5 ft. per second. For heights of from 15 to 50 ft. there will be required 2 or 3 cu. ft. of air at atmospheric pressure per cu. ft. of water delivered; for heights of from 50 to 100 ft. it is considered best to provide three to four cu. ft. of free air at atmospheric



Ideal Piping Arrangement for Water Cranes.

Suggested by Mr. Whyte.

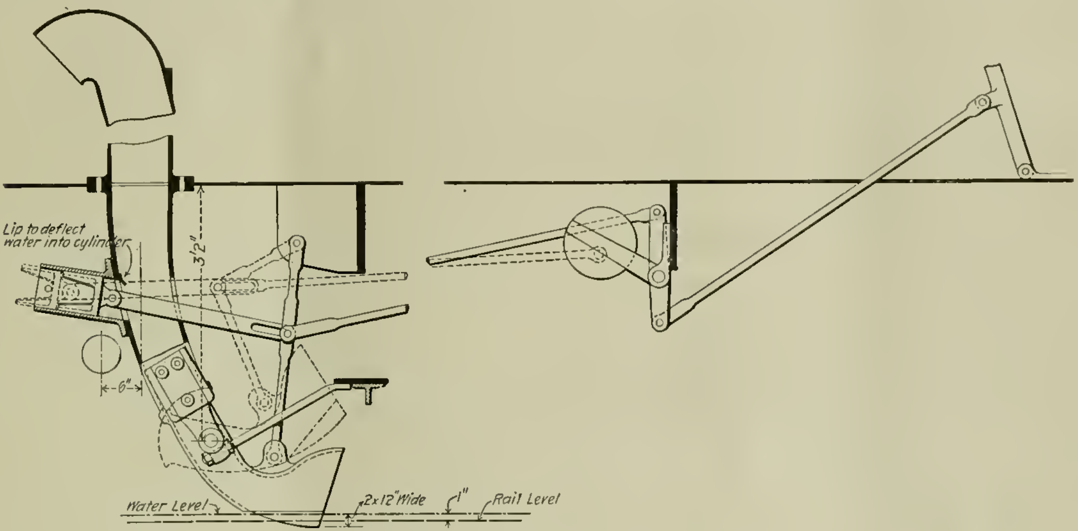
pressure for each cu. ft. of water delivered. The efficiency of this system of pumping is about 50 per cent. maximum, and may be as low as 15 to 20 per cent.

Water Cranes.—Cranes are necessary where the reservoir tank cannot be located conveniently for delivery direct to the locomotive tank. The water for the crane is generally supplied from a reservoir tank. The present rush of both passenger and freight business makes necessary the saving of every minute possible, and more attention is being given to means for delivering quickly the water to the locomotive tank; with the object of delivering the water as promptly as possible, the pipe from the reservoir tank to standpipe is made larger in diameter than was commonly the practice; the crane, or standpipe, is made larger; and the valve is made with a more direct passage for the water. In fact, a serious study is being made of the friction of water in pipes, valves and bends, and as a result some previous designs are being revised or discarded. It will be appropriate to give here the results of some tests made by Mr. T. W. Snow. A 90-degree bend of a radius equal to one and one-half times the diameter of the pipe, for pipes 8 to 14 ins. in diameter, offers a resistance to the flow of water equal to that of 100 ft. of straight pipe; a 12-in. pipe, 300 ft. long and having three bends of 90 degrees each, the head being 24 ft., gave a flow of 4,000 gallons a minute; under the same conditions, except that the length of the pipe was 900 ft., the flow was 3,200 gallons a minute. With an improved standpipe, the flow under conditions similar to the first instance given above was increased to 5,000 gallons a minute. These data will impress the necessity of having direct passages. Of course, there are various designs of cranes and each is given peculiarities which are held out as inducements to prospective buyers, but it is impossible to refer to them here; there are some things, however, which are considered essential features, and some of these may be mentioned. The pipe connecting the reservoir and tank and the crane should be larger than the crane; one size larger seems to be in accordance with improved practice, and the change in diameter is made just outside of the crane pit, or as close to the valve as possible. Some device should be provided to protect the pipe and the valve against shock due to sudden closing of the valve. The valve passages should be made as direct as possible, so that the resistance to the flow of water may be the minimum; this should be considered in connection with the 90-degree bend, which must be made in changing direction from the horizontal delivery pipe to the vertical standpipe. It should be possible for a person to operate the crane while standing on the ground, and also while standing on top of a tender. The standpipe, for cold climates, should be drained automatically when the controlling valve is closed. The arm should have considerable motion in a vertical plane, so that there will be some adjustment possible to accommodate for locomotive tenders of different heights, and to clear the better the coal board and the ends of cars. It should be positively locked in the position parallel to the track, so that it cannot be blown by the wind, or placed accidentally into the position to foul trains. Drainage must be provided for the crane pit. For proper security a gate valve should be placed inside of the crane valve, and there should be another valve near the reservoir tank.

Track Tanks.—Track tanks are made 6 ins. or 7 ins. deep and 18 ins. to 20 ins. wide; they are placed central between the rails of a track, and the top of the tank, or, more particularly, the level of the water in the trough, must bear a fixed relation to the top of the rail. The tanks are of various lengths; some are 1,200 ft. long, others 1,400 ft. long, and others are 1,600 ft. long, and the Lake Shore & Michigan Southern is making them 2,500 ft. long where there is room. The length is determined by the maximum amount of water which is to be delivered into one locomotive tank, or the track tanks are made of sufficient length that the tanks of two locomotives coupled together can be filled with water; this is to provide for "double-heading"; the scoop of the leading locomotive is dropped at the approach to the track tank, and the scoop of the other locomotive is dropped when the middle of the track tank is reached. It is necessary to make the tanks level, but it is not necessary to locate them on tangents; the Philadelphia & Reading has a tank on a curve of 2 degrees; some of the railways in England do not hesitate to locate track tanks on curves.

A slope is provided at each end of the track tank so that if it happens that the scoop is not raised before the end of the tank is reached the scoop will ride up on the incline and be raised over the end of the trough. The scoop is arranged, usually, so that when raised as high as the top of the track tank it will be raised higher than the top of the rail, even though the operator fails to do his part. Also, an incline is provided sometimes for the approach to the tank at each end, so that if the scoop is dropped too soon it will ride the incline into the trough. The slope usually provided is too abrupt; in England an easier slope is provided. Of course, it happens sometimes, when the raising of the scoop is dependent upon human energy, the raising is neglected or some of the machinery is out of order, and the end of the track tank is torn out; this difficulty is not particularly serious, but it is annoying; to facilitate repairs the lower end of the scoop is made in such a way as to be easily renewable, and the end of the track tank may be made of a piece of plank bolted to the tank. If the slope is 20 ft. or 25 ft. long the tank will be injured less frequently.

Track tanks are not storage tanks; they must be refilled after each passage of a scoop through them. Track tanks are supplied from reservoir tanks usually, and the size of pipe through which water is delivered to the track tank will be determined by the minimum length of time allowed to fill the track tank, and by the location of the inlets to the track tank. The gravity head to produce flow in the tank is not great; therefore, in order to increase the rate of flow, the distance through which the water must flow in the tank should be as short as the demands require and circumstances will allow. The rate of flow in the tank cannot be assisted by pressure, but it can be assisted by velocity if the stream is directed into the tank properly. For instance, if the inlet is in the end of the tank and the water is directed lengthwise of the tank, then the water may be forced into the tank at considerable velocity, and so reduce the time of flow to the opposite end of the tank; on the other hand, if the water is admitted vertically through the bottom of the tank, the water must be run in slowly enough to prevent overflowing the sides. The bottom inlet may be used and the water be admitted at a considerable velocity by placing a deflector at the inlet, so that a part of the water will be directed toward one end of the tank and the remainder be directed toward the other end. The bottom inlet is the usual one, and this is covered with a grating to keep out heavy, solid substance. Disregarding any possible velocity head, the location of the inlet, or inlets, for most rapid filling will be understood readily from the following explanation: If the tank is 1,600 ft. long and 7 ins. deep, and the one inlet located at one end, the gravity head is, of course, 7 ins. in 1,600 ft., and frequently this is overcome by a strong wind blowing in a direction opposite to the flow; if the inlet is placed at the middle of the length, the gravity head is 7 ins. in 800 ft.; with two inlets each should be placed at a distance from each end of the tank equal to one-quarter the length of the tank. If there is to be only one inlet for each tank, and this one located at the end of the tank, the approach end should be preferred. If the water is to be kept from freezing by circulating it through the tanks and through injectors or other heater, the relative locations of inlets and outlets will be such that there will be no "short circuiting" of the heated water, and therefore no "dead ends" in the tanks. The general practice in America is to control the flow of water into the tanks by means of a valve operated by the attendant at the pump house. Immediately after a scoop has been run through the tank the attendant opens the valve through which is controlled the flow of water into that tank, and he closes the valve again when the tank is filled. Sometimes an annunciator is placed in the pump house to give warning when the tank is filled, and sometimes the attendant must go to the tank and see when it is full. At other times the attendant opens the valve a certain amount and leaves it open for a certain length of time, and then closes the valve. All of these uncertain conditions make possible, between engine crews and pump attendants,



Balanced Water Scoop.—Great Northern Railway, England.

Designed by H. A. Ivatt, *Locomotive Superintendent.*

The Lip Diverts Water into the Cylinder, the Pressure of which Aids in Lifting the Scoop in Fast Running.

disputes concerning the amount of water in tanks at various times. A more positive, automatic arrangement is used in England, the controlling valve being operated by means of a large float, the float being in a tank of water which is connected to the track tank by an equalizing pipe.

STANDARD SPECIFICATIONS FOR LOCOMOTIVE DRIVING AND TRUCK AXLES.

Committee—A. E. Mitchell, S. Higgins, W. S. Morris, L. R. Pomeroy.

Your committee selected to report on the subject of "Standard Specifications for Locomotive Driving and Truck Axles," when notified of their appointment, promptly organized for work, and in addition to sending out the usual circular, commenced a systematic canvass of the whole subject. The information gathered was duly tabulated and arranged for a final meeting of the committee to determine upon the report to be presented. In this connection the valuable work of the International Association for Testing Materials, in formulating Standard Specifications for Axles and Steel Forgings, was brought to the attention of the committee, and it was thought that the proposed specifications, as drawn up by the American section of the International Association, were, in the main, so comprehensive and satisfactory that, with slight modifications, they would be acceptable to the association.

On this account it was decided to report progress, and to ask the association to authorize the committee, and invest them with the necessary power to co-operate with the International Bureau of Tests, with a view of having such changes incorporated in the proposed specifications as would make them acceptable to the association, and to report to the next regular meeting of the association.

A TYPICAL SHOP TO SERVE A ROAD OR DIVISION EQUIPPED WITH 300 LOCOMOTIVES.

A Paper by L. R. Pomeroy, General Electric Co.

The items of expense entering into the cost of operation, for which the motive power department is more or less responsible, represent about 30 to 35 per cent. of the total operating expenses, of which labor comprises 12½ per cent., fuel and lubrication 12.7 per cent., and repairs 8.8 per cent. These items show the very narrow field or range in economies in which the motive power officer must confine his efforts in seeking to effect economies in his department. As the question of repairs represents nearly one-third of the items for which he is more or less accountable, the shop problem becomes quite important and worthy of careful attention.

Division of labor is to-day recognized as an essential characteristic of manufacturing. It has been found that in no other way can production be made so rapid and so economical in material and labor. To produce a manufactured article, a number of processes are required, each different from the other, in appliances used and in the character of skill required of its working force, but all co-operating to the same end—the production of a single, complete, marketable article. In designing a manufacturing plant, it follows that this differentiation of appliances and manual skill must be recognized if the best use is to be made of the appliances and of the men. The railway shop plant is a kind of manufacturing plant, and the same principles which apply to the successful operation of other manufacturing plants apply to its operation.

How to best subserve his own particular conditions is then the thing which the motive power officer has to consider. The factors which enter into this problem are many, but we think they may be gathered under the following heads:

1. Convenience of location in respect to the accommodation of the system as a whole;

2. Convenience of location with respect to centers of supply of material and labor, and

3. Advantages of location in respect to cost of land, buildings, taxes, etc.

Defects in shop design, causing inconvenient handling of material or movement of workmen, are permanent and cannot be removed. From the time the raw material is taken in hand until it is erected in the finished locomotive, its movement should be directed to the end. Shops, therefore, should be so laid out that the proper sequence of operations can be followed so as to minimize labor and lessen cost of operation.

Some general considerations governing the erection and design of new shops, as laid down by a Western manufacturer, are pertinent in this connection, and are as follows:

First. The most suitable manufacturing building is a ground-floor surface, protected from the weather and direct rays of the sun, without interfering with the light.

Second. A plant started on a scale however small should be capable of indefinite extension without expense in altering or in any way interfering with previous construction.

Third. Land enough should be secured in the first instance to avoid the future necessity of removal and abandonment of a plant at a loss, owing to lack of room.

Fourth. With land at $2,000 per acre, or less than 5 cents per square foot, it is cheaper to use land for one-story buildings than to save land by building more than one story.

Fifth. It is cheapest to support machinery directly on the ground. There is no vibration, no danger of heavily loaded floors falling when buildings are old, nor of upper floor loads falling upon the lower in case of fire.

Perhaps it is not too much to claim that all are quite agreed that the arrangement of erecting shops with longitudinal tracks, when provided with conveniently appointed cranes, is superior to the old form of transverse track arrangement with the accompanying transfer table and the numerous doors opening thereon, even if a traveling crane is provided.

Recently, however, several shops have been designed on the transverse or across-track plan, dispensing with the transfer table and attendant side doors for each pit. (Sketch plans, made from published cuts, illustrating this latter form, were shown, including a plan and section of the erecting, machine and boiler shops of the L. S. & M. S. Railway, at Collingwood, Ohio, a section through the erecting and machine shops of the P. & L. E. Railway, at McKee's Rocks, Pa., and a plan and section of the erecting and machine shops of the P. & R. Railway, at Reading, Pa. Also two designs on this order were shown, one by Mr. M. N. Forney, and the other by the late Howard Frye for the West Shore Road.

The design shown in the accompanying drawing is presented to show the author's idea of the typical shop designed to comply with the conditions indicated at the head of the paper. The erecting, machine and boiler shops are practically under one roof, compact, and arranged to facilitate the handling of material, reducing to a minimum the distance to be traversed by both men and material.

The longitudinal tracks in the erecting shop side are arranged to provide 25 ft. between centers, enabling, when necessary and desirable, the placing of engines between the tracks, thereby adding to the normal capacity of the shop; the capacity rating of the erecting shop, however, is based on the track capacity only.

As noted on plan, the erecting shop is nominally 400 ft. long, with a track capacity of 24 locomotives, allowing ample space at either end of shop and for a definite passageway between the head and rear ends of all engines standing on the tracks.

The cranes in erecting shop are in two units of 60 tons each, the combined capacity, when working in unison, enabling the handling of the heaviest type of locomotive in use at the present time.

As the cranes will not be utilized for lifting engines more than 10 to 15 per cent. of the time, two cranes are available for general use, when not employed in lifting and traversing engines, and both cranes are provided with rapid auxiliary hoists.

The boiler shop being a continuation or extension of the erecting and machine shops, one of the erecting shop cranes is available for use in the boiler department, when desired, while the other can be usefully employed in facilitating the erecting of engines, and yet both can be brought directly into service in either place, as the dictates of necessity or utility require.

The engines enter from the right, preferably by means of the center track, are lifted off their wheels and carried to any convenient or desired location. The wheels are then taken to the storage tracks provided, adjacent to the wheel and axle department, and receive attention in due course.

The machine shop side is divided into two bays; the one on the outside for the lighter tools served by light traveling air hoists locally arranged, as the tools and departments naturally determine; while in the other, nearest the erecting tracks, are grouped the heavy tools. This latter bay is provided with two cranes of 10 and 5 tons capacity, respectively. These cranes are provided with rapid hoists and serve all the tools in this bay, traversing the full length of the building and also available in the boiler end, serving the tools of this department and running clear into the riveting tower.

The question of tracks, both standard and industrial, should be considered and provided when necessary.

Steam and water pipes should also be provided, running the entire length of the shop; also electric cables with numerous taps for portable lamps.

While no arrangement for lighting is shown on plans, yet the scheme comprehends an adequate electric lighting system, with the necessary generator for same.

Compressed air mains to run lengthwise of the shop, and branch pipes attached to each post to run down to a point near the floor are shown. Numerous storage tanks located at convenient points should be provided to insure a steady and uniform pressure.

Tools.

The electric motor has taken its place as one of the everyday, hard-working, steady-going, reliable pieces of apparatus that is to be counted on and used with the same freedom that a pulley or a block and tackle would be applied in its appropriate place in the construction of a modern industrial plant.

Electric transmission places no restriction on the location of the machines, and each shop may be planned with a view of handling its product with least waste of labor and with greater convenience of access to the tools.

In order to insure the greatest amount of service from shop tools, a careful calibration and a predetermined rating of each is a *sine qua non.*

When the tools are carefully rated, and the best commercial speeds, as to feeds and cuts, covering the range of the tools, with reference to the material and product desired, definitely determined, a more uniform output from similar machines and the maximum output from all the tools is assured.

A plate giving this information attached to each tool places this information before the operator, so that no uncertainty as to which speed or cut to use to perform a given operation is possible.

The question of the limitations of life of a given tool is a subject often discussed, and the following extracts from the technical press are directly to the point:

Tools are not up to date when there is something else on the market which will do more work or do it at less cost for labor.

They need not necessarily be worn out to be wasteful by comparison.

In England the decision was to keep the old machinery turning over as long as it could be made to do its work. With us the decision was to make scrap of it as soon as a newer machine could be found which would produce sufficient increase of product to pay the required interest on the investment. And be it observed, the fundamental conditions were more favorable to frequent renewals in England than here, for until recently rates of interest have been uniformly lower there than here, while the cost of machinery there has called for a smaller outlay for a given equipment. In our rolling mills and steel works it is, we believe, a conclusion at which engineers have arrived that provision must be made for renewing them *in toto* every 10 years, and, in point of fact, we not long ago saw a rolling mill (by which term we now mean a set of rolls with its attached engine and appurtenances) which was in process of demolition and on its way to the cupola. That mill, we were told, had been built but five years before, to be, as it then was, a strictly modern and up-to-date mill, but the progress of improvement had made its demolition a necessary measure of economy.

This incident illustrates the American view of such matters. Not all American works have been so managed, but those that have not have been crowded to the wall by those that have. And it may be predicted with entire confidence that the process that has been at work between individual establishments will also operate between nations. It is a matter of easy proof—in fact, it is almost self-evident—that the American practice leads to the best use of capital, as well as labor, and that it must survive.

The English idea seems to be to regard a machine, once bought, as a permanent investment, or at any rate as one which is to be extinguished only by the operation of a suitable depreciation charge applied year by year.

Electrical Equipment.

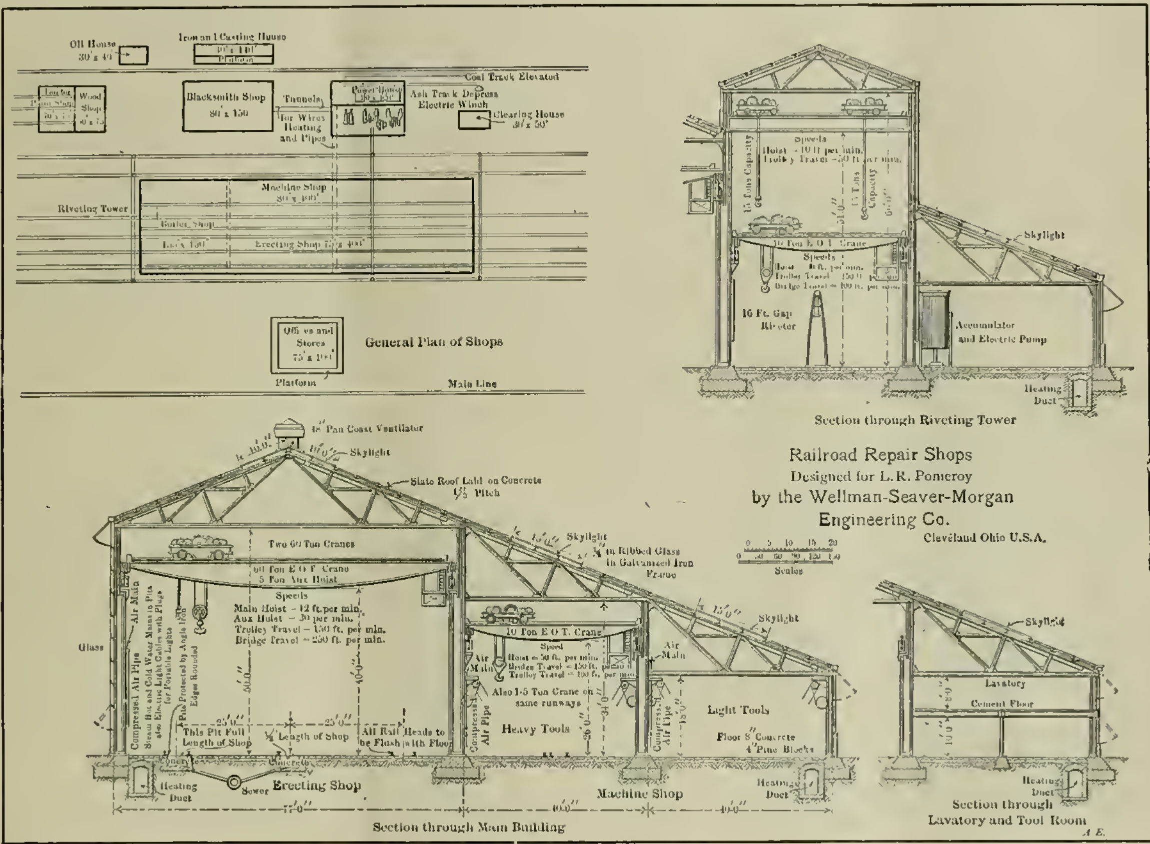
While the question of the individual location and arrangement of the tools has received careful attention, and we had at first contemplated showing this on an enlarged ground plan, we finally concluded to omit it, as such an arrangement is more or less determined by local conditions and circumstances.

At the present state of the art, keeping in mind rational and economical conditions, also being governed by conservative, rather than radical considerations, we would advise a judicious combination of the group and individual methods of driving.

Generally speaking, tools requiring more than five horse-power should be provided with individual motors, although there is no hard and fast rule for this, as the location of the tool with more or less reference to the work performed, the average running period, whether the work is constant or intermittent, and how much variable speed is a factor, are the governing features.

It is the writer's practice to make a careful study of each individual case, determine the space and distance to be covered, and arrange what seems best under the circumstances.

In numerous cases the work through the shop has been studied by means of templates of the governing sizes and pieces, drawn to scale, and these, worked over the plans, keeping in mind various combinations, exceptions and alternatives, have been of great assistance in determining the best location and groupings of the tools. Such groupings and arrangement has been the basis upon which the motor selection, type of drive or the method of applying same, has been determined.



Plan and Elevation of Typical Shop.

Power House.

The equipment of the power house to completely cover the scope of the foregoing plans, necessary power for tools, steam for smith shop and heating, etc., is as follows:

Two 400-H. P. and one 200 H. P. boilers, making a total of 1,000 H. P. Ordinarily, the two 400 H. P. units will drive the shop and the third unit can be used as a square; the light or summer load can be handled by one of the 400 H. P. units.

An air compressor capable of compressing 1,000 cu. ft. of free air per minute.

One 200 k. w. generator coupled directly to a 300 H. P. cross-compound engine.

One 150 k. w. generator coupled directly to a 225 H. P. tandem compound engine.

One 75 k. w. generator coupled directly to a 125 H. P. tandem compound engine.

This latter unit, besides taking care of the lighting, will handle sufficient power load to carry such departments as require to work overtime when the balance of the shop is shut down.

In summation:

2 400-H.-P. Boiler units	800-H.-P.
1 200-H.-P. Boiler unit	200-H.-P.
Total	1,000-H.-P.

1 200 K.-W. or 300-H.-P. engine	
1 150 K.-W. or 225-H.-P. engine	
1 75 K.-W. or 125-H.-P. engine	
Total	650-H.-P.

Suitable switchboard should be provided. Ample capacity of boiler feed and fire pumps should be provided, as also feed-water heaters and economizers.

Power tunnels are shown leading from power house to the machine and smith shops to carry all steam, water and air pipes, and provision is made for all electric cables and feed wires.

The absolute command of draft for the generation of the required quantity of steam, utilization of heat from flue gases made by improved forms of economizers, the ease of making ample provisions for large future capacity, and the low first cost of installation, as compared with the chimney, will commend the mechanical induced draft system in the construction of the modern power plant. With mechanical draft the labor of the fireman is much reduced, a cooler fire-room possible, with steadier steam and less labor in handling fires.

The heating of the machine and erecting shop, store house and office building should be by means of exhaust steam to stacks or coils, and the heated air circulated by means of fan blowers.

The various fan loads would be as follows:

Machine shop, 4-25-H.-P. motors		100-H.-V.
Wood shop		10-H.-P.
Storehouse and office 2-10-H.-P.		20-H.-P.
Total for heating		130-H.-P.
Blowers for smith shop	25-H.-P.	
Exhaust fan for smith shop	25-H.-P.	
Exhaust fan for wood shop	10-H.-P.	
	60-H.-P.	60-H.-P.
Total fan load		190-H.-P.

Costs.

One of the most valuable fields of investigation for a shop foreman is that of cost of doing work on or by means of different machine tools, which are used in doing the work which he is required to supervise. One may say "that goes without saying," but in my experience, when you pin a foreman down as to the cost of different things you get very different replies. Some men, when you ask the cost of doing a certain piece of work—manufacturing, for instance, certain details of a locomotive—would give you the cost of the man's wages who runs the machine that manufactures this, taking the number of hours that he has to have the piece in the machine; another man will add to that the cost of the material that goes to make up the piece, but this is by no means the total cost of the manufactured part; in fact, it in general is rather a small percentage of the total cost. I recently had some investigations of this sort made in one of our shops, and I was rather surprised to find how much of the actual cost of manufacturing a certain article or doing a certain job of repair work was in the cost of moving the materials and appliances which are used to enable the man to do the job, and putting them away, in the grinding of tools, and of the incidental time that is taken up in manufacture. I had and am having this looked up in different shops, and as an example of what is being done in this direction, I will cite a case of boring cylinders, which is familiar to all railroad men. I have in my hand the statement of cost of boring cylinders of certain engines. I will simply read the data of the cost of this, with a view of showing the method which should be employed in arriving at the cost of doing this kind of work and of analyzing it, so that the different items of expense which enter into the total cost may be known and intelligent action taken upon them:

Boring Cylinders, Engine 298.

Right cylinder, before boring 16⅛ ins.; after boring, 16¼ ins.
Left cylinder, before boring, 16⅛ ins.; after boring, 16 9-32 ins.

	Hrs.	Mins.	Rate.	Amt.
Getting in boring bar	0	30	$1.90	$0.095
Putting bar in cylinder	0	45	1.90	.15
Putting up flex. shaft	1	0	1.90	.19
Rope broke and repaired	0	30	1.90	.095
Roughing in cut	0	35	1.90	.11
Finishing cut	0	30	1.90	.095
Counterboring back end	0	30	1.90	.095
Counterboring front end	0	15	1.90	.05
Repairing and grinding tools	0	30	1.90	.095
Changing bar	1	15	1.90	.24
Roughing cut	0	35	1.90	.11
Finishing cut	0	30	1.90	.095
Counterboring back	0	35	1.90	0.11
Counterboring front	0	15	1.90	.06
Taking down bar	0	20	1.90	.67
Helper on job	3	35	1.90	.67
	12	10		$2.31

In order that ways and means for the reduction in cost of work may be intelligently effected, we must first determine what the work is actually costing under existing conditions; by being armed with this information we may argue from facts, and the force of our statements will be much greater.

The storehouse, besides serving the useful function involved in its name, can be made still more valuable as the basis of an adequate and comprehensive cost-keeping plan, by using it as the "clearing-house" of the system.

The following in regard to the railway master mechanic was quoted:

"A successful master mechanic must be two-sided. He must not only keep the machinery under his charge in proper order, but he must discipline, direct and control the animated human machine that operates the inanimate tools or engines. He should, therefore, be a good mechanic as well as a good leader of men. He should be familiar with tools, and should understand theoretically and practically the locomotive and other steam engines, as well as the laws of combustion. He cannot ignore gas and petroleum motors. He should cultivate the habit of critically analyzing operating results shown in statements issued from his own and the accounting office. He should be a student of current technical literature. He should attend the meetings of technical societies, and under no circumstances should he fail to study their proceedings. He should cultivate a spirit of relentless self-criticism; should never be quite satisfied with what he has accomplished, and should determine to excel all others engaged in his particular line of work. To be a good leader of men, he should cultivate perfect patience, forbearance and self-control, remembering that no man ever controlled others who did not start by controlling himself. He should be even-tempered, or, if not born so, should not let any one discover it. He should be strictly just, granting cheerfully everything due his employees, while jealously guarding his employer's interests, curbing his generosity in spending funds intrusted to him. A man so qualified should make a successful master mechanic, but would not long remain one in the present day of keen competition in all branches of railroad service."—*J. Kruttschnitt, Pacific Coast Railway Club.*

SUBJECTS FOR 1903.

Committee—A. E. Manchester, Howard Stillman, Alfred Lovell.

1. A committee to be appointed and continued until after the 1904 meeting of the International Railway Congress, said committee to work in conjunction with the American Society of Mechanical Engineers, the American Institute of Mining Engineers and the International Association for Testing Material, in preparing standard specifications for locomotive forgings, and to report progress and results of their investigations to this association in 1903, and each successive year until their work is completed and the committee discharged.

2. What is the most satisfactory practice for setting flues in the firebox end of a locomotive boiler, and what is the best style and form of tool for setting and repairing same?

3. What is the best arrangement of drawbar and buffer attachment for use between engine and tender; what should be the form and relative strength of drawbar to the tractive power of an engine, and what offset in the bar is permissible?

4. What is the best kind of light in the locomotive headlight for economy per unit of light, and what standard constitutes sufficient light for the purpose?

5. Strength versus Size of Locomotive Boilers.—What will produce the greatest economy for a given weight of boiler—high pressure and boiler built strong enough to sustain same, or lower pressure with increased heating surface?

6. If the committee that now has question No. 4 for this year does not cover this point, I would suggest that the committee be continued, or a new one appointed, to determine what shall be the relative grate and heating surface for different kinds of fuel as applied to compound two or four-cylinder locomotives.

7. What is the best practice for painting locomotives and tenders, cost, durability and appearance all being considered, especially bringing out any economical appliances which have been utilized to assist in this work.

TON-MILE STATISTICS.

Committee—H. J. Small, C. H. Quereau, G. R. Henderson, G. L. Fowler.

When this committee was first appointed, to report to the convention of 1899, the title of its subject was: "Advantages of the Ton-Mile Basis for Motive Power Statistics." By some method of evolution the subject title has been changed to "Ton-Mile Statistics," and perhaps properly so, for the reason that the convention of 1899 accepted the ton-mile basis by passing the following resolution:

"*Resolved*, That it is the sense of this association that the ton-mile basis for motive power statistics is the most practical and encourages economical methods of operating, and that it is desirable that the heads of motive power departments urge its adoption on their managements."

This, so far as the association is concerned, practically disposed of the question as to the *advantage* of the ton-mile basis, and the adoption of the ton-mile basis in some form within the past few years by several large railway systems has proven the wisdom of the action taken by this association, and we think there are few, if any, members of this association who will now oppose the ton-mile basis as being the best basis for motive power statistics.

Further investigation of this matter by your committee, under the subject title of "Ton-Mile Statistics," develops complex questions and conflicting opinions as to what the statistics should include.

It has been thought wise to confine the present report to discussion of the general principles involved, in the belief that with these settled, the details can be worked out to better advantage afterward, and numerous chances of confusion and an unnecessarily prolonged discussion be avoided.

It may seem out of place that an association of motive power officers should venture and discuss opinions concerning operating department statistics, but in view of the fact that this association was among the first to discuss the question of statistics on the ton-mile basis, and has constantly urged their use, that this basis is not as generally used for operating as for motive power statistics, that we are convinced that its general use for the operating department would result as beneficially as experience has shown it has for the motive power department, and that the use of the same basis for both departments will further result in economies in the statistical department we venture our opinions and suggestions.

In considering this subject, we should view it in the light of what the statistics should include to best promote and suggest motive power economies; should statistics include all classes of service, as passenger, freight, switching and work train? In computing ton-mileage should weight of locomotive, tender and caboose be included? Should statistics be segregated to show main line and branches separately? Should passenger and freight business be divided into fast and local?

While your committee is not in harmony on all these points it is deemed advisable to present an argument covering all the questions and request action thereon by the association.

[Editor's Note.—This argument is exhaustive. The conclusions, as summed up in resolutions offered, are given as follows:]

Acting under authority given it at the convention of 1901, your committee corresponded with the American Railway Association and the American Railway Accounting Officers, and learns that, while both of these associations have committees on mileage statistics at work, nothing definite has been decided upon as regards ton-mile statistics, and it is the belief of your committee that any action taken by this association at this time would receive the careful consideration of the above associations. The statistician of the Interstate Commerce Commission also expressed interest and promise of co-operation.

The following resolutions embody the general principles on which your committee requests the action of the association, with a view to presenting the results of such action to the American Railway Association for its approval:

"*Resolved*, That it is the sense of this association that conclusions based on a comparison of the statistics of one railroad with another may easily prove incorrect, should be given less weight than they usually are, are just only when the accompanying conditions are fairly well known and their influence can be determined with some degree of accuracy; that a comparison of the statistics of a division or a system with those of the same territory for a previous corresponding period very largely eliminates these uncertainties and makes conclusions based on such a comparison much more reliable."

To make the record complete, we include the following, passed unanimously in June, 1901:

"*Resolved*, That it is the sense of this association that the ton-mileage of the locomotive is a just credit to the motive power department for statistical purposes."

We would amend this by inserting the words "and caboose" after the word "locomotive."

"*Resolved*, That the ton-mile is the best practical basis now available for motive power and operating statistics by which to judge the efficiency of locomotive and train service.

"*Resolved*, That actual tonnage should be used in computing ton-mile statistics for comparison with those of other roads, but for comparison with the previous records of the same system or division the use of adjusted tonnage is advisable.

"*Resolved*, That the statistics of passenger, freight, work train and switching services should be on the ton-mile basis, each service in a separate group, and passenger and freight service should be each further grouped under 'Through' and 'Local.'

"*Resolved*, That the statistics of branch lines and main lines should be kept separately.

"*Resolved*, That the credit of ton-mileage for locomotives in switching service should be proportional to their tractive power.

"*Resolved*, That the ton-mileage of trains using more than one locomotive should be divided among the locomotives attached to these trains in proportion to their tractive power and for the distance over which the helping locomotives are used.

"*Resolved*, That the tonnage of the locomotive should be its weight in working order, plus the light weight of the tender and half its capacity of coal and water."

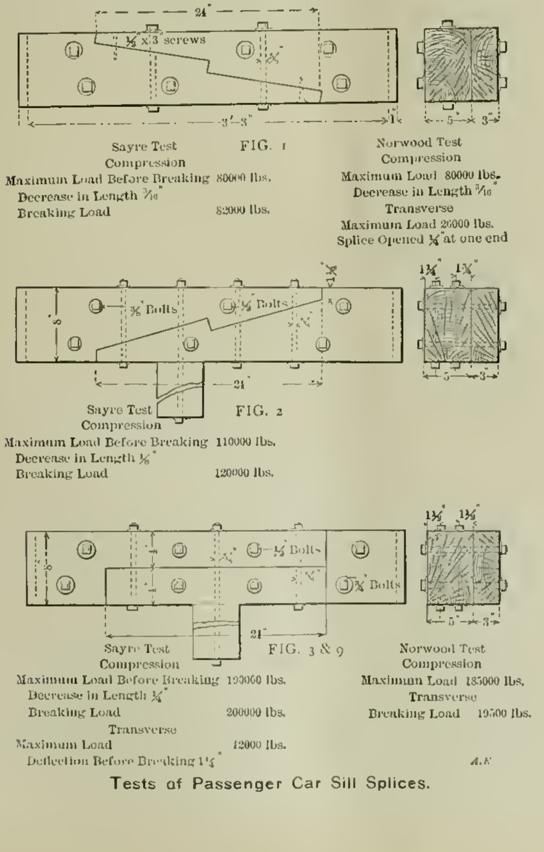
MASTER CAR BUILDERS' ASSOCIATION REPORTS.

(Concluded from July.)

SPLICING PASSENGER CAR SILLS.

Committee—J. S. Lentz, Mord Roberts, T. W. Adams.

Your committee having received drawings of various forms of splices, and considering the subject of sufficient interest and value, determined to make a test of the various types most generally used and that could be tested with the facilities at hand. All tests were made in wheel presses. The first series were made at Sayre, Pa., under the direction of Mr. J. Hawthorne, master mechanic, and the second set at Norwood Central, Mass., by Mr. T. W. Adams. The result of the two series of tests show that the lock splice, as commonly used, is not as strong under compression and it would appear not as strong under transverse loading as the step splice, and very little stronger than some of the other forms of splices. It would seem to the committee that if the splice is properly located over a needle bearing, so as to eliminate vertical strains, the step splice is much superior. It is also apparent that this form, besides being stronger than the lock splice, can be applied at less cost, especially in the repairing of cars. Two forms of splices are shown, Figs. 1 and 2, known as the Pullman standard, a practice most generally followed for splicing intermediate and side sills, and Fig. 3, the step splice, which stood the most satisfactory tests, and which is recommended for all sills. Your committee is of the opinion that under these existing conditions both of these forms should be submitted to letter ballot, as recommended practice, and in the event of neither receiving the required two-thirds vote on the first ballot, the one receiving the largest number of votes be again submitted to ballot.



Tests of Passenger Car Sill Splices.

TESTS OF M. C. B. COUPLERS.

Committee—R. N. Durborow, W. P. Appleyard, Joseph Buker, W. S. Morris, F. H. Stark.

Editor's Note.—This standing committee had not been able to make tests because the committee on draft gear required the use of the Altoona testing machine. This led to a recommendation that the association should build a new machine at Purdue University. The committee also recommended improvements in the contour and worn coupler gauges. The suggestions with reference to strengthening couplers themselves are reproduced as follows:

Your committee is sure, and the opinion seems to be very general, that the abandonment of the link-pin holes and link slots would be the greatest improvement to the automatic coupler that could be made at the present time, but there still seems to be some objection to making this change until some supplementary device is found which will be entirely satisfactory and adequate for handling cars around short curves in mill yards and at warehouses, as well as on and off floats where the water level varies greatly. Your committee has experimented with several devices for handling cars around short curves, which are partially successful, but which cannot be said to meet all the requirements of the service, and on this account we feel compelled to give up recommending the change at this time. From an inspection of 400 knuckles of various different kinds, taken at random from a scrap pile, it was found that 37½ per cent. of the failures were due to the link-pin holes and 21 per cent. to the link slot, while 12 per cent. and 29½ per cent. of the failures were due to the tail and to the knuckle-pin hole, respectively, which plainly shows how great a saving would be effected by the use of the solid knuckle. It also shows that there is a great weakness at the knuckle-pin hole, where the trouble will be much harder to remedy. It seems unfortunate that a little extra inconvenience at these local points should outweigh in importance the very great advantage and saving to be gained all over the country.

Your committee has made some few tests of the head presented last year for experiment, which suggest first of all that it is impracticable to use a 1⅝-in. pin in a head 8 ins. between lugs. For these tests a type of coupler was used in which the end of the tail of the knuckle, fitting squarely against the head, showed, after the specification test, that the pin had been relieved of considerable punishment. Even in this type of coupler the 1⅝-in. pins in the three tests made were bent ¼ in., ¼ in. and 3-16 in., while in two of them the knuckle wold not open after three blows at 5 ft. and two blows at 10 ft. This shows plainly that the longer pins will bend in the holes unless they have large enough section to give them the required stiffness. A striking test of a coupler of the same type and same distance between lugs, but with 3-in. lugs instead of 2½-in. and a 1¾-in. knuckle pin showed a perfectly straight pin after the test, and the knuckle and locking devices remained operative until the seventh extra blow at 10 ft., which broke the knuckle through the knuckle-pin hole, and the pin then only showed a scant 1-16-in. bend. From this it seems that a knuckle with an 8-in. hub can hardly be recommended with the present contour, from the fact that the 1⅝-in. pin bends too much, while the 1¾-in. pin increases the present weakness through the knuckle-pin hole and at the lugs of the bar. The 13-in. face for the knuckle, as suggested last year, does not seem advisable, since one 10 ins. deep proves to be stronger through this part than through the hub. In view of the fact that we hope very soon to be able to abandon the link-pin holes and link slots, which will make this the strongest part of the knuckle, and transfer almost the entire breakage to the knuckle-pin hole, it seems that this extra depth is not the direction toward which we should be working. We would rather look for some way to get a bar with stronger lugs as well as a knuckle much heavier and stronger through the knuckle-pin hole, where even now, with the 1⅝-in. pin, the percentage of breakage is very great. To do this would mean a change in contour, which might be done so gradually that little difficulty would be experienced. Your committee realizes that this is a serious proposition, which will have to be faced sooner or later, in order to get the additional strength in the lugs of the bar, and in the pin, as well as in the knuckle; at all of which places the failures are becoming very serious. Your committee thinks that increased strength of lugs will be better obtained by an increase in section rather than in depth, which may also be said of the knuckle at the pin hole. Another feature of the experimental head presented last year is the increase of 1 in. in the distance from back of horn to inside face of knuckle. Some types of couplers may need this for strength or for providing more room inside for knuckle and locking devices, while other types do not need it. As your committee does not know of any reason why this distance should be maintained exactly the same, knowing well that it cannot be less than it is now or much greater on account of the extra weight of metal unnecessarily involved, it is recommended that a little latitude be allowed to the discretion of the makers, and that this measurement be not specified.

To sum up, your committee believes that a head 11 ins. or 12 ins. deep, with a 9-in. or 10-in. face for a solid knuckle, the contour of which should be changed to admit the use of a 1¾-in. pin, would meet all the requirements of the heaviest service, but thinks that another year's experience with these heavier types is necessary before any definite recommendations can be given.

Five comparative pulling tests have been made with the increased butt riveted up in different combinations, as per drawing herewith (not reproduced—Editor), the approximate results of which are also shown. From these results it appears that the strength of the lips with two rivets is very much in excess of any direct drawbar pull ever found in service. Whether a third rivet is needed to give extra stiffness or to stand excessive shocks, only experiment can determine, which also will be necessary to prove the advantage of the short rivet method over the old one. From the pulling tests very little information on this subject could be gained, except that after test 2 the rivets were all much looser than after test 3, so your committee does not recommend a change until more information can be obtained from service conditions, which could be best had by using the two methods at the different ends of the same cars. A little more experience with these butts will also give more information concerning the comparative facility with which the work can be done. In the old method your committee suggests that the rivets be inserted from the opposite sides of the yoke, which results in having one hole well filled on each side. It is also suggested that the fillets at the lips of the yoke always be kept smaller than the radius of the corners of the butts.

SIDE BEARINGS AND CENTER PLATES.

Committee—B. Haskell, H. M. Pfleger, W. H. Marshall, J. W. Luttrell, T. W. Demarest.

Your committee on Side Bearings and Center Plates was continued from last year, with instructions to report on (1) a design of center plate, with a view to adopting dimensions for standards or recommended practice; (2) the location of side bearings; (3) uniform relation between center plate and side bearing; (4) the merits of anti-friction side bearings for relieving the center plate from part of the load; (5) will the use of anti-friction side bearings diminish the resistance between the wheels and rails.

Center Plates.

Your committee has endeavored to obtain data which would enable it to present for your consideration a form of center plate for adoption as standard. Under the direction of Mr. T. W. Demarest, Superintendent of Motive Power, P. C. C. & St. L. R'y, a series of tests has been conducted of different forms of center plates and side bearings, and the results, as far as they have been completed, are given herein.

The object of the test with center plates was twofold; first, to ascertain the best metal for center plates; second, to define, if possible, the best shape. In making the test, two male center plates were bolted on the opposite sides of one end of a lever, each male center plate in turn engaging in a female center plate; the entire construction being forced together by a hydraulic press, from which were obtained total pressures ranging from 15.3 tons to 40.8 tons. The end of the lever in turn was moved through an arc by means of an air cylinder; an indicator and reducing motion being attached, in order to ascertain the amount of work done in turning the male plates in the female plates under the different pressures obtained.

The result of these tests is shown in detail, both graphically and in statement form, on data sheets Nos. 1 to 8, inclusive, and statement sheet No. 9 attached; two sets of sample cards are also shown. The tests for side bearing friction were made in practically a similar manner, with the exception that the lever was pivoted at a point which would correspond to the average distance of side bearings from king bolt.

In order to ascertain, if possible, the best material for center plates, a number of plates were made as per plate "A," of three different materials: cast iron, malleable iron and cast steel. We were unable to obtain pressed steel plates of equivalent area or shape. The area, generally, of the plates was 100 square inches.

Test No. 1 of this series was made with the castings as they were received from the manufacturers, with no dressing or cleaning whatever. The cast steel, which gave the highest resistance, was extremely rough, had thick scale, fused patches on the surfaces, lumpy fillets, fins around the core holes, etc. The cast iron was not much better, and as a consequence the friction is close to the steel. The malleable plates were very smooth, clean castings, and gave a very much lower resistance. The results of this test show the difference in friction or resistance due to the varying smoothness of the surface.

Test No. 2 of this series was made by grinding the surfaces with an emery wheel, and chipping off fins and lumps in the fillets. This attention is assumed to be about as much dressing as it would be practicable to give the plates in actual practice. The scale was not removed, the casting simply being made smooth. In this test the resistance of the cast-iron and malleable-iron plates varies very little, if any, from the resistance obtained in the first test. The resistance of the cast-steel plates, however, has fallen most materially. The large drop in resistance of the steel plate was thought to be due to the crumbling of the thick, porous scale into a powder, which acted as a lubricant. This view was sustained by the fact that in the next test, with this same plate lubricated, there was but little further drop in the friction, the powdered scale in the latter instance preventing good lubrication.

In test No. 3 the same plates were taken as in previous tests and lubricated. The results of the lubrication are shown very conclusively in the very great drop in resistance.

In order to ascertain, if possible, if the low friction of the cast steel in test No. 2 was due to the powdering of the scale, the cast-steel plates were put in a lathe and the scale turned off and surfaces made smooth. They were again tested and the resistance was found to be lower than before the scale was removed from the surface. The effect of lubrication in test No. 2 practically eliminates the effect of the metal, as the plates of the different materials, when lubricated, have practically the same resistance.

The object of the second series of tests was to determine the effect of the shape of the contact surfaces. Having found the effect of rough castings in the first series of tests, all plates were smoothed and fitted. All plates were made of the same metal, cast iron, and all except that designed by Mr. Klohs, for the Master Car Builders' committee, had 100 square inches area of contact surfaces; the latter plate had 76 square inches. The results from test of flat plate in series No. 1 were taken for comparison with the curved and spherical plates in series No. 2, and it was expected that the flat plate would have the lowest friction on account of the tendency of the inclined surfaces of the other plates to wedge together. The results obtained from the tests do not at all confirm the theory. They do not show the superiority of the flat plate, and they do show an abnormally low friction for the plate designed by Mr. Klohs. The curves, as on general data sheets Nos. 4 and 5, show very plainly, as in the first series of tests, the good effect of lubrication, and indicate that when well lubricated the shape of the plate does not materially affect the resistance. The tests with the lubricant do show, however, that the resistance of the flat plate is lower than the spherical plate "X" and curved plate "B," and about the same as the Klohs plate. We can see nothing in the contour of the Klohs plate which would tend to produce lower resistance than we have obtained from the spherical plate "X." The unsuspected results are due, we believe, to the condition of the surfaces of the plates. The flat plate required but little grinding and fitting to give it a good bearing. The spherical and curved plates, however, fit badly in the rough, and required hard grinding, filings, etc., to bring them to a reasonable fit. The final condition of the surfaces was, therefore, very much better with the spherical and curved plates than with the flat plate.

Further tests in this series were made with special plates, namely, a small experimental plate "C" with flat surfaces, designed to be used without a center pin, and having a face only 4 ins. in diameter, with the idea that it might be possible to use such a plate in conjunction with a roller or other low friction side bearing to assist in maintaining the balance of the car. It was desired to have this plate chilled, as only a very hard surface could stand the heavy pressures. The plates were received soft from the foundry, however. The friction of this plate is very low, but cut badly both when dry and when lubricated, the cutting in both instances taking place in the center of the plate. The second special plate tested in series 3, as shown on data sheet No. 6, was the ball-bearing center plate used by the P. & L. E. R. R. This plate gave the lowest resistance recorded under the conditions. The balls lie in pockets, which, in length, are about twice the diameter of the ball, and enough larger in width than the diameter to allow the ball to roll freely. The bottoms of these pockets curve upwards at the ends, so that the ball begins to roll up hill as soon as it leaves the central position, and as the slope of the pocket is curved, the resistance of the plate to revolution increases as the ball rolls up the slope. The cards taken in this test (samples of which are attached) show a gradually ascending line to a point where the ball seems to lock and stop rolling; the top plate then slides on the balls. The starting and final resistance is shown in tables and on curves for each pressure.

All tests, both of center plates and side bearings, show the desirability of thorough lubrication, the castings to be smooth, but scale allowed to remain on. A thick grease, furnished by the Galena Oil Company for the purpose, was used for lubrication. It is impossible to say how long the grease would last in service. The ball plates and roller side bearings gave very good results, although the ball center plate was badly cut in the upper groove by locking of balls in the pockets. Further, with the larger plates, that is, all plates with the exception of small flat plate "C," no cases of cutting, even under the pressures used, were experienced when there was a good bearing over the entire surface.

It will be noted in the statements that the resistance of the plate to turning is reduced to the wheel flange. We regret that our tests have not been comprehensive enough to permit us to make definite recommendations as to minimum contact area of plates under definite loads, the shape of the plate, or the material from which it should be made. The machine used was rather crude and it is being redesigned with the idea of carrying these tests to a conclusion.

Anti-Friction Side Bearings.

The fourth and fifth subjects assigned to your committee relate to anti-friction side bearings, and are as follows:

The merits of anti-friction side bearings for relieving the center plate from part of the load.

Will the use of anti-friction side bearings diminish the resistance between the wheels and rails?

For the committee to determine these qualifications it would be necessary to conduct a series of tests extending over a period of years. This was thought unnecessary at the present time. A circular was therefore addressed to each member asking his co-operation to the extent of furnishing to the committee the result of such tests as had been made, and which was available. Of the members replying those giving opinions or furnishing data control about one-fifth of the car equipment represented in the association.

The following results of tests of side bearings were submitted by members in answer to the circular of the committee, and are given below as bearing on the general subject: (The other replies are omitted.—Editor.)

Pittsburg & Lake Erie R. R. Co.

On June 1, 1897, one 60,000-pound capacity gondola car was equipped. The construction consisted of four steel balls 2¼ ins. in diameter, between two malleable-iron center plates, the lower plate having four grooves equally spaced, 4 ins. long, ¼ in. deep at the center, running out to nothing at the end. Lengthwise the grooves conformed to the radius of the bearing surface of the center plate. The upper plate had a groove ¼ in. deep, corresponding to the diameter of the balls and extending all the way around. The side bearings had each one steel ball of same diameter as those used in center plates; each bearing had a groove 15 ins. long, same diameter as the ball, straight on the bottom, but curved to proper radius. Balls were protected by deep flanges on each bearing, the top passing down over the outside of the lower. The ends of the flange on upper bearing were cut so as to permit of the greatest curvature of truck.

After the car had been in service three years, proving clearly that the device was entirely practicable, a careful test was made to establish its value in the way of reducing flange and rail wear on sharp curves. A turntable 7 ft. long was made so as to determine, by the use of a dynamometer, the actual power required to displace a truck 2 ins. at the end, or 4 ins. in its length, equaling a 154 degree curve. The appended report is the result of the trial:

First Test.

Flat center plate and side bearing, with ⅛ in. deflection of body bolster resting on side bearing:

	Resistance Pounds.	Resistance Per Cent.
Required to start truck	800	100
Required to displace truck 2 ins............	1,100	100

Second Test.

Flat center plate, without side bearing:

	Resistance Pounds.	Resistance Per Cent.
Required to start truck....................	275	34
Required to displace truck 2 ins............	525	48

Third Test.

Hartman ball-bearing center plate and side bearing, with ⅛ in. deflection of body bolster resting on side bearing:

	Resistance Pounds.	Resistance Per Cent.
Required to start truck	75	9
Required to displace truck 2 ins............	450	40

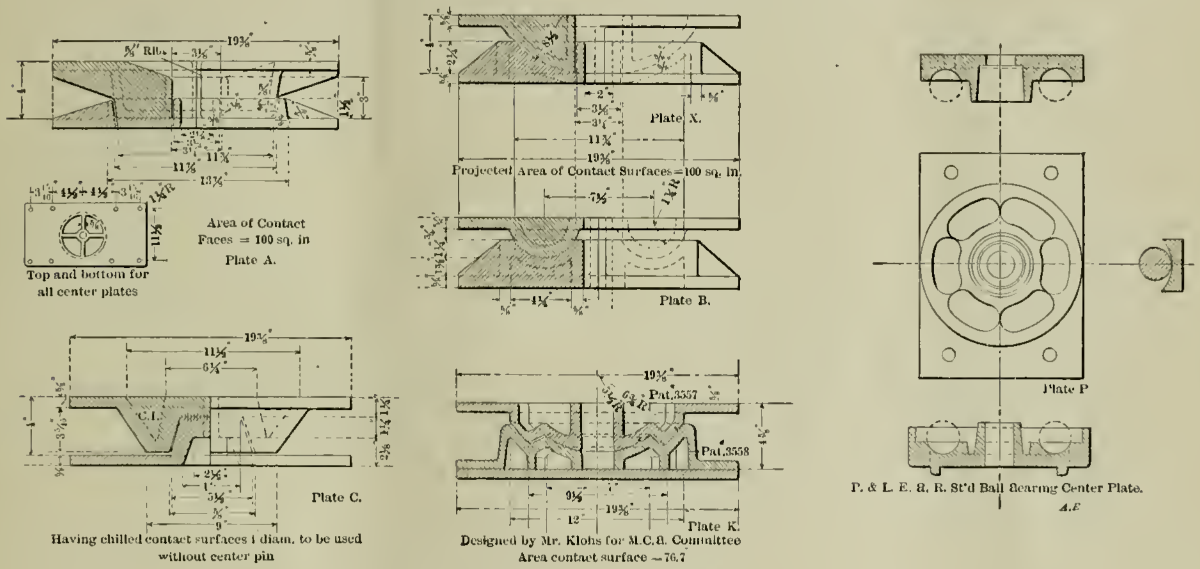
Fourth Test.

Hartman ball-bearing center plate, without side bearing:

	Resistance Pounds.	Resistance Per Cent.
Required to start truck	75	9
Required to displace truck 2 ins............	325	29

This report, to our mind, clearly indicates two things, namely: We should have a frictionless side bearing to assist cars around curves with high outside elevation, but on straight and level track the load should be carried on the center plate, and by all means on a ball bearing. The most valuable feature in the center plate in question is the dish in the grooves in the bottom plate, which answers two purposes, one being to keep the balls properly spaced and the other the tendency to straighten the truck quickly after leaving a curve, this being explained by the fact that the slning of the truck on a curve forces the balls up the inclined plane of the grooves, and as soon as straight track is reached they naturally gravitate back to their proper position.

For your information we append a report of the service of the car in question:



Side Bearings and Center Plates.

Car built	April, 1896
Equipped with Hartman appliance	June, 1897
Miles run from June, 1897, to date	11,323
Approximated loaded mileage	7,548
Capacity of car	60,000
Tons carried one mile	226,440

Wheels show no flange wear up to date.

The perfect condition of the wheel flanges demonstrates its value, not only as increasing the life of the wheel, but reducing train resistance.

Duluth & Iron Range R. R. Co.

Service of Automatic Frictionless Side Bearings. Effect Upon Flange Wear.

Year.	Wheels Removed. All Defects.		Removed for Sharp Flanges.	Per-centage.
1899	998		254	25.5
1900	2,248*		463‡	20.6
1901	1,815†		322	17.7
1902 (Jan. & Feb.)	372		24‡	
	6	Approximate for year	6	
	2,232		144 approximate.	06.0‡

*An unusual condition affected this year's record. Over 60 per cent. of the removals, after deducting the wheels taken out for sharp flanges, were removed for flattened wheels in service.

†The automatic frictionless side bearings were in service all this year and affecting flange wear.

‡No removals for sharp flanges on cars with roller bearings.

Not considering the 200 cars built by the Illinois Car and Equipment Company, in 1899, there were 512 ore, flat, box and logging cars equipped with automatic frictionless side bearings in 1899 and 1900. Exact dates of applications of the side bearings to 278 ore cars, 38 box cars and 70 flat cars (386 cars in all) in 1899 and 1900 are known, and also the dates of six applications to ore cars in 1901.

The wheel records show that for the year of 1900, after the automatic frictionless side bearings had been just applied, but had not been in service long enough to have appreciable effect upon the wheel flange wear, 463 wheels were removed from box, ore, flat and logging cars for sharp flanges. During 1901, when the bearings were in service on 512 old cars of these classes, and materially affecting the flange wear, only 322 wheels were removed for worn flanges; a reduction of 30 per cent., notwithstanding that the wheels were an average of four years old when bearings were applied, that the car mileage had been increased, that train hauls had become greater, and that the equipment was one year older.

The indications are that the flange wear of 1902 will be decreased in even greater proportion, as the effect of the side bearings on the service in general approaches its limit.

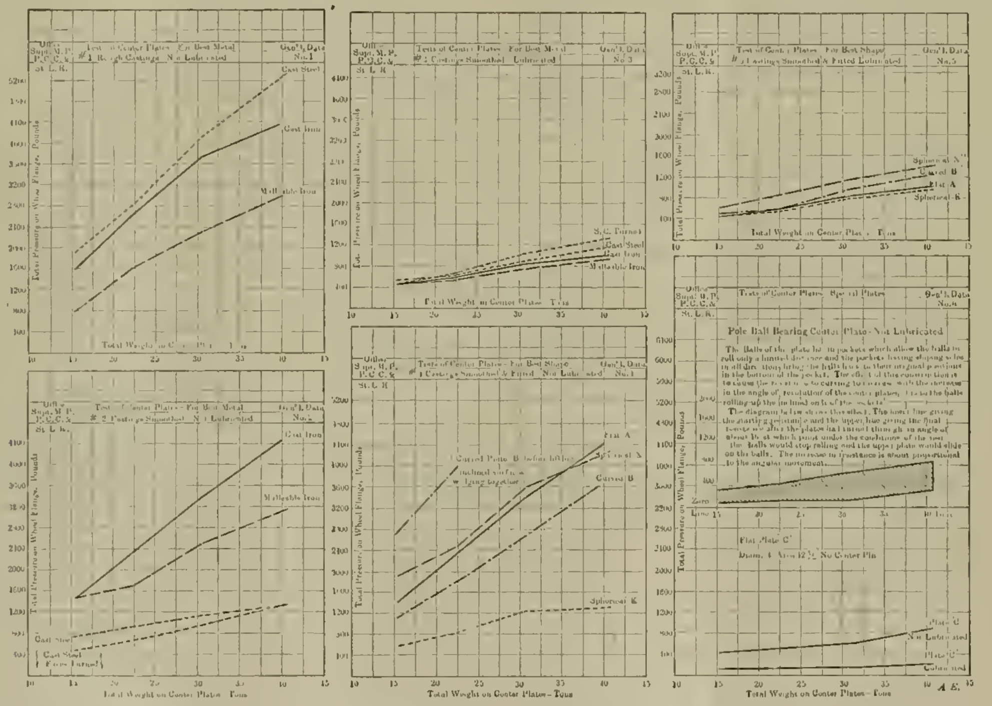
The service of 52 ore cars equipped with the roller bearings was compared to that of 52 cars with plain side bearings (the car numbers selected at random) for 1900.

While no wheels whatever were removed from the 52 cars with the roller bearings, 17 wheels were taken from the cars with plain bearings for having the flanges worn. By comparing 300 ore and flat cars with the automatic frictionless side bearings with 300 cars with plain bearings for 1901, it was found that while 101 wheels were removed for sharp flanges from the cars having plain side bearings, only 16 wheels were removed for having the flanges worn, from those cars equipped with the automatic frictionless side bearings.

The question of the effect of the automatic frictionless side bearings on flange wear alone is presented, because the wear of the wheel flanges can be easily and definitely ascertained, but while the other economies and advantages are equally apparent, they cannot be so accurately determined. It will be readily appreciated, however, that this reduction in flange wear shown means an equivalent reduction in rail wear, and a proportionate decrease in the draft of trains, and consequently a reduction in the cost of transportation. Again, the capacity and the life of the car bolsters are increased, and the cost of truck repairs considerably lessened.

Conclusions.

Taking up the divisions of this subject, as outlined at the beginning of this report, (1) a design of center plate, your committee presents the results of tests already made, which show the necessity for further tests in order to determine conclusively what should be the minimum area of contact of plates under definite loads, the shape of plate and kind of material. Owing to lack of time and the necessity for redesigning the machine, in order to complete the tests, your committee would ask to be continued another year, in order that it may complete its work.



Tests.—Side Bearings and Centre Plates.

Attention is called to the reduction in flange resistance by lubrication, the lubricant being a thick grease.

As already stated, the second and third divisions of this subject, namely (2) location of side bearings and (3) the relation between side bearings and center plates, are so closely allied to the first, that your committee has nothing definite to recommend in this connection at the present time. The replies received to the circular of inquiry from eighteen members show a variation in distance, center to center, of side bearings and center plates, from 24 ins. to 32½ ins.

The height of center plates varies from 2½ ins. to 7 ins.

As to the (4) merits of anti-friction side bearings for relieving the center plate from part of the load, from the replies received from the members it would seem that opinion is about equally divided. Your committee is of the opinion, however, that with a center plate of proper design and material, and a truck and body bolster of sufficient strength, the load can and should be carried on but one bearing point, namely, the center plate.

As for the fifth subject, resistance between wheels and rails, it is the opinion of your committee, and this opinion is substantiated almost unanimously by the replies received from the members, that the use of anti-friction side bearings will diminish this resistance.

Attention is further called to the fact that when side bearings are in contact the pressure against wheel flanges is greater than with center plates alone in contact.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

SEPTEMBER, 1902.

CONTENTS.

FRENCH FOUR-CYLINDER COMPOUND LOCOMOTIVES

Opinions Based Upon Experience.

EDITOR'S NOTE.—The remarkable results which have been obtained in France with four-cylinder compound locomotives have greatly impressed a number of American locomotive men who have investigated them. In response to requests for the facts of experience, statements have been obtained from two of the highest authorities on the subject—Mr. A. G. de Glehn, of the Société Alsacienne de Constructions Mécaniques, and Mr. A. Herdner, assistant locomotive and carriage superintendent of the Southern Railroad, in France.

These gentlemen treat the subject in a way which suggests the probability of successful application of the four-cylinder balanced principle in American practice. The position of THE AMERICAN ENGINEER on this subject is well known. The principle seems worthy of a thorough trial in this country. Mr. de Glehn's article is presented below, and Mr. Herdner's will follow in a later number.

THE DE GLEHN FOUR-CYLINDER COMPOUND.

By A. G. de Glehn.

As four-cylinder compound locomotives on the divided and balanced principle, which I introduced many years ago (in 1885), have steadily increased in favor, and seem now in a fair way to be tried in America and in England, I may perhaps be allowed to send you the following remarks on the subject:

The advantages of the four cylinders appear to be now generally admitted, but the two separate sets of valve-gear are still objected to in some cases, and this on the score of complication. This bugbear of complication is responsible for a good deal of confused thinking. Why! almost all mechanical progress has been by and with increased complication! A planing machine is more complicated than a hammer, chisel and file, and a Corliss engine than an ordinary engine with a single slide valve driven by an eccentric; and yet we do use planers and Corliss engines and much other complicated machinery, and are very glad indeed to have them.

When I introduced the four-cylinder compounds, the word "complication" was, of course, used to kill the new engine. What? Four cylinders! How complicated! Well, the four cylinders seem to have proved their right to existence, in spite of the complication, and now people say: "Four cylinders are all very well; but two separate sets of valve-gear—that is too much of a good thing; that is far too complicated."

What does this mean? Why, merely that the results attained have seemed to justify the complication of the four cylinders, but that there is yet hesitation in some minds (principally in the minds of those who have never tried such engines) as to whether the complication of the two separate sets of valve-gear has sufficient advantages to justify its existence. In America you seem to have decided offhand and without trial that this complication is unnecessary, and have (see an article in your paper of some time since) called the separate gears the unnecessary "fringes" that adorn French locomotive design, whereas severely practical America will have none of such vanities. Now, I wish to explain why we have adopted separate distributions and the intercepting valve allowing of a direct exhaust for the high-pressure cylinders, for, whatever our taste may be in dress, we do not care more about unnecessary fringes in locomotives than you do. We introduced these complications with a very definite idea of what we wished to attain thereby, and the experience of many years, with the very large number of express engines on all the French main lines, has so far really convinced those responsible for the working of the engines that the results attained have justified the increased first cost and the very slight additional cost of and trouble in oiling. These last are the only real objections that can be urged against the two sets of valve-gear.

I may here at once state that one of the first arguments used against my new type of engine was that the cost for repairs would greatly exceed that for a simple engine. From the first I declared that this would not be the case, and experience has proved me to have been right, and it is not difficult to understand how this should be the case. A locomotive is a very hard-worked machine, and we give all its parts and, indeed, can give them, but relatively very small wearing surfaces in proportion to the work to be done, which is for many reasons, but principally because we are hampered for room, being limited in *width*, while it is just in the direction of width that lies what we want for our wearing surfaces (pins, axles, etc.), namely, length of bearing. We can give diameter, but we are limited in length. Now, by dividing the engine and the valve-gears we have doubled the number of parts, thereby halving the work each part has to do, and at the same time, owing to the peculiar location of the cylinders, we have more *room*, for the high-pressure cylinders drive one axle and the low-pressure cylinders another. This dividing of the total work over a larger number of smaller and lighter parts, and the being able to give them at the same time proportionately larger wearing surfaces, has had a very marked effect on the wear of the parts themselves, and the better division of the strain over the frames has much contributed to the general favorable result.

As regards the crank-axles—a very important question, as they are costly and were constantly breaking in the two-cylinder engines—I asked myself why they broke, with the obvious answer—*because they have too much to do.* As it was not possible, for many reasons, to do much with advantage in the way of increased dimensions, all that remained to be done was to give them less to do. The work that a crank-axle has to do is of a very complex nature, but what greatly contributes to their breakage are the side blows of the wheel-flanges against the rails, acting with a powerful leverage against the cranks in engines with large wheel-diameters. This kind of stress and fatigue could not be reduced. All, therefore, that remained to be done was to reduce the work coming from the cylinders by giving the crank-axle only half of it to do. The result has been a very largely increased mileage for the crank-axles. Such are the principal reasons that explain the fact that the cost for repairs has not increased with the number of parts.

As regards the valve-gears, it may be objected that when using piston valves the gears have so little resistance to overcome that the available wearing surfaces for an ordinary gear are largely sufficient. As I shall recur later to the subject of piston valves, I may leave this objection unanswered for the moment. I think, then, that my assertion is justified that the objections to the two separate gears may be, as I have said before, confined to the increased first cost and the very slightly increased cost of and trouble involved in oiling.

It remains to be shown what are our gains, and then to try and decide whether, as the French say, "the game is worth the candle."

First.—With a very high piston speed it is of the utmost importance that the steam should pass from the boiler to the exhaust with as direct and straight a course as possible, having on its way as few and as slight changes of section as possible. The most cursory examination of the design of my four-cylinder compounds will show that this flow is freer and less obstructed than in the case of a four-cylinder engine with one piston valve on each side to determine the steam distribution for the two cylinders on that side; for this the necessary grid-iron openings in valves and bushings are largely responsible.

Second.—A single valve and casing determining in quick succession the distribution of high-pressure (high-temperature) steam and low-pressure (low-temperature) steam is, as Hirn long ago showed, by no means conducive to economy and a thing to be carefully avoided wherever possible.

Third—Piston valves are notoriously more difficult to keep steam-tight than flat valves. They may, without much reduction of economy, be used for the high-pressure cylinders in an engine having flat valves for the low-pressure cylinders, as is so often done in marine practice; but in locomotive work the difficulty is further increased by the need of having either compressible segments for the piston valves, which answers to the lifting of D valves, or relief valves on the cylinders, or both, with the notorious loss of steam by leakage and the additional cost of keeping them in order. A really satisfactory piston valve may yet be found, but it can hardly be maintained that it has yet been found. If steam-tight, it is as difficult to move as an ordinary D valve, and if not really tight, it is a great waster of steam. In the four-cylinder engines with separate gears and four flat valves there is remarkably little wear, the high-pressure valves being partially relieved by the receiver pressure and the low-pressure valves being only under low-pressure steam. For a large number of engines on the Western of France lines the mileage of the valves for ordinary engines is 40,000 miles, and for four-cylinder compounds, 185,000 miles.

Fourth.—The work required from a locomotive is extremely variable, and the separate gears for the high and low-pressure engines enables you to adapt yourself to the varying conditions. The drivers soon find out this for themselves (though, of course, instructions are given them), and on starting put all four cylinders in full gear by the usual handwheel, as in an ordinary engine, and soon after, by the release of a simple trigger arrangement, with the same handwheel, notch back the high-pressure gear so as to have an earlier cut-off in the high than in the low-pressure cylinders. The relative cut-off can thus be regulated to suit the various conditions with the same ease as when, in an ordinary engine, you vary the absolute cut-off. With these engines an interesting demonstration can be made of the importance of the relative cut-off. Put both gears forward so as to cut off at 40 per cent. in high and low-pressure cylinders, and after a time you will, with a given train, be running steadily, say, at 55 miles per hour. Notch up the low-pressure gear to a cut-off of 50 per cent., and notch back the high-pressure gear to 35 per cent., and the speed will rise steadily to 62 miles per hour. Fast running down hill will require a slightly different adjustment, and so on. I well know, of course, that by making a higher ratio between the diameters of the high and low-pressure cylinders the disadvantage of not being able to vary the relative cut-off diminishes, but these very large dimensions for the low-pressure cylinders have other disadvantages, and are not always convenient.

Coming now to the intercepting valve by which the exhaust from the high-pressure cylinders can be diverted from the receiver to the exhaust pipe, I may remark that the arrangement enables you to obtain an exceptionallly rapid start, as, by simultaneously introducing steam (at reduced pressure) to the large cylinders the start is effected by what answers to two engines (four cranks), one high and the other low pressure. This intercepting valve enables you to run the engine with the high-pressure cylinders alone or the low-pressure cylinders alone, in case of accident to either pair; it also enables you when starting on a bank to exert an exceptional pull. None, I think, will undervalue the marked superiority of these four-cylinder compounds over ordinary engines in their rapidity and certainty in starting and getting up speed.

Now, is it possible to figure out the exact value of the advantages claimed, so as to see how they count in comparison with the disadvantages of the increased number of parts? It would perhaps be possible under one set of circumstances and for one line or country, but then the comparison might not hold equally good for other and different circumstances. I maintain, however, that the disadvantages are limited to an increased first cost of some $400 for an engine costing $18,000, and to the very little increase of oil necessary for oiling one more set of valve-gear. As to the exact value of the advantages set forth, opinions may differ; but it can hardly be said that they are unimportant.

My experience—and the engines are by no means in an experimental stage—is that if you want to get all you can out of an engine—maximum rapidity and certainty in starting, greatest power for a minimum of weight, maximum smoothness of running at high speeds, maximum adaptability to varying circumstances (I have said but little on the important point of balancing, as I take it the advantages of this system are fully recognized as regards this capital feature in powerful engines)—you can get these, as far as our present knowledge goes, best by a four-cylinder compound, with the high-pressure cylinders outside, toward the middle of the engine, and driving one axle, and the low-pressure cylinders between the frames and the smokebox, and driving the crank-axle, and with separate gears for high and low-pressure cylinders, and an intercepting valve.

I have seen the drawings of the four-cylinder engine lately built by the Baldwin Locomotive Works, and regret to see that the system should first be tried in America simultaneously with an experimental boiler. It is always difficult to draw correct conclusions under such circumstances. I may add that the crank-pin bearing is so narrow as to be sure to give trouble from heating. Further, low-pressure cylinders are much better placed *inside* the frames, and this on account not only of the better protection against condensation, but also that they thus allow of better balancing.

You will notice that I have so far said nothing about fuel economy, and purposely so. Though an important factor, its importance has in many cases been exaggerated, and I, for my part, have never advised the adoption of compound locomotives on the ground of fuel economy alone. What has made the success of this type of engine has been the number of advantages obtained by the use of four cylinders arranged in the particular way I have advocated. For an express engine weighing in working order over sixty-five tons, to haul in regular every-day work 370 tons behind the tender from Paris to Calais, 184 miles, in three hours and ten minutes, with one stop at Amiens, on a coal consumption of 38½ pounds per mile, must, I think, be allowed to be pretty good work. The line is by no means smooth or level, there being between Paris and Amiens a 15-mile hill of one in two hundred; then another of 23 miles of one in three hundred, and also between Amiens and Calais four hills of one in one hundred and twenty-five, one of them seven miles long. Under such conditions the engine maintains a steady speed of 56 miles per hour on the hills of one in two hundred, indicating up to 1,500 horse-power, and the maximum speed is never allowed to exceed 75 miles per hour.

To conclude: I by no means wish to imply that it may not be possible to find some better system of engine for hauling heavy trains at high speeds on a small fuel consumption without having to use a heavy engine (for we are limited to 16½ to 17 tons per axle), but in the present state of our knowledge it would seem that the particular system of which I am speaking is the best so far. This contention is perhaps justified by the steadily increasing adoption of the four-cylinder balanced compound locomotive, as shown by the fact that there are now some 1,500 engines of this type running on the continent of Europe.

BEARING SURFACE OF CRANK PINS AND CROSS-HEAD PINS.

By F. K. Caswell.

In designing locomotive crank pins and cross-head pins, the maximum bending moment is first found and the pin made of sufficient diameter to keep the fiber stress within the proper limits. The length of the bearing, however, is governed by the area required to give a certain pressure per square inch on the projected area of the journal.

With the quality of oil usually furnished by railroads, the pressure per square inch of projected area should not exceed from 1,600 to 1,700 lbs. on crank pins or 4,800 lbs. on cross-head pins. To facilitate the work of checking the projected areas, the accompanying diagram has been prepared, and is used as follows:

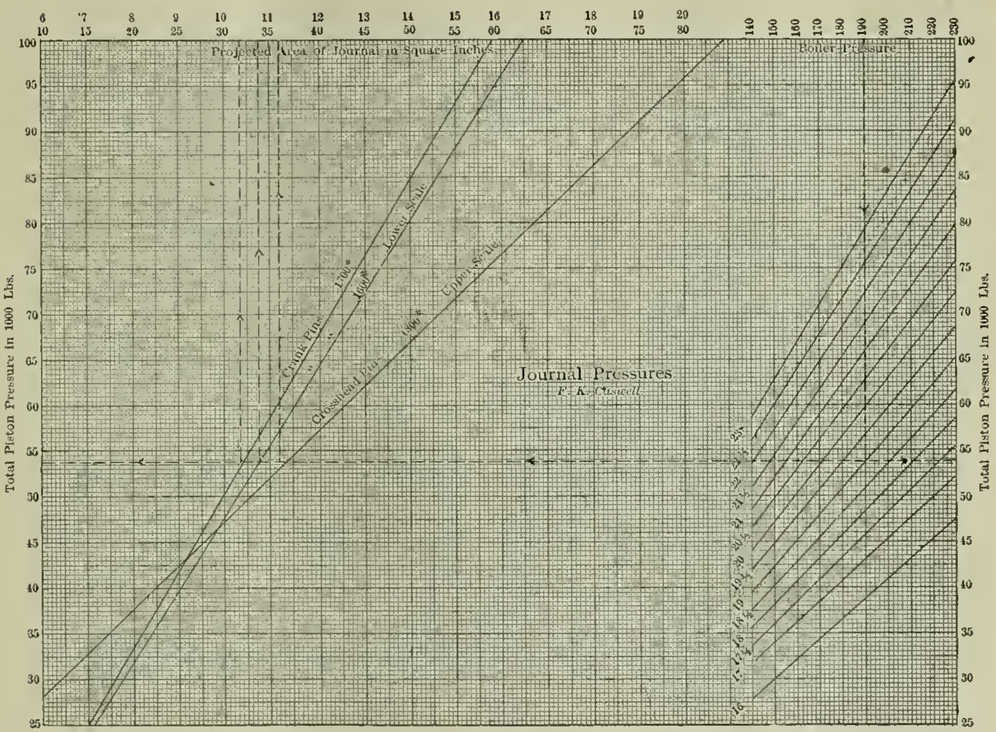
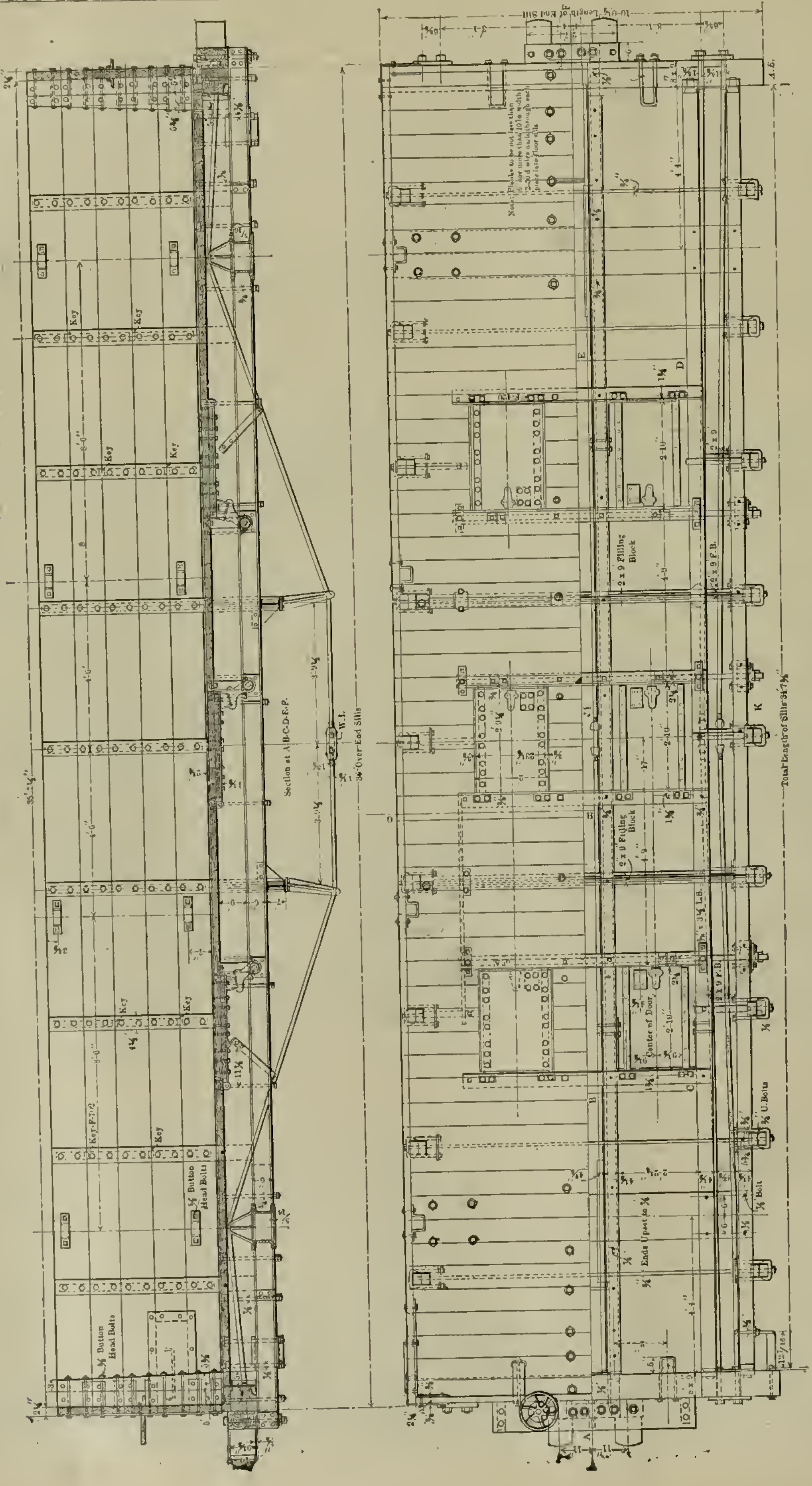


Diagram for the Determination of Bearing Surfaces for Crank Pins and Cross-Head Pins.

Starting at the upper right-hand corner of the chart with any given boiler pressure, as for example, 190 lbs., follow the line of pressure downward until it intersects the diagonal of cylinder diameter, which in the case of a 19-in. cylinder, would give a total piston pressure of about 53,600 lbs. The latter being read on the scale at the right or left-hand side of the chart.

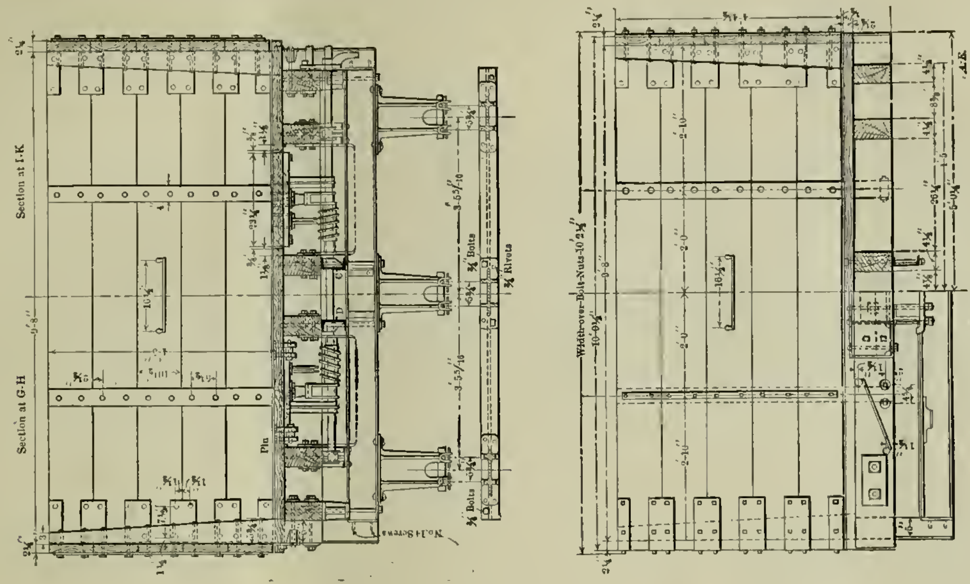
Follow the horizontal line of total piston pressure until it intersects the diagonal for the desired maximum pressure per square inch of projected area, and then, vertically above that intersection, read the minimum projected area allowable with the given pressure per square inch.

The use of this diagram in connection with a similar one for finding a maximum fiber stress has been found to save considerable time where many calculations of this kind have to be made.

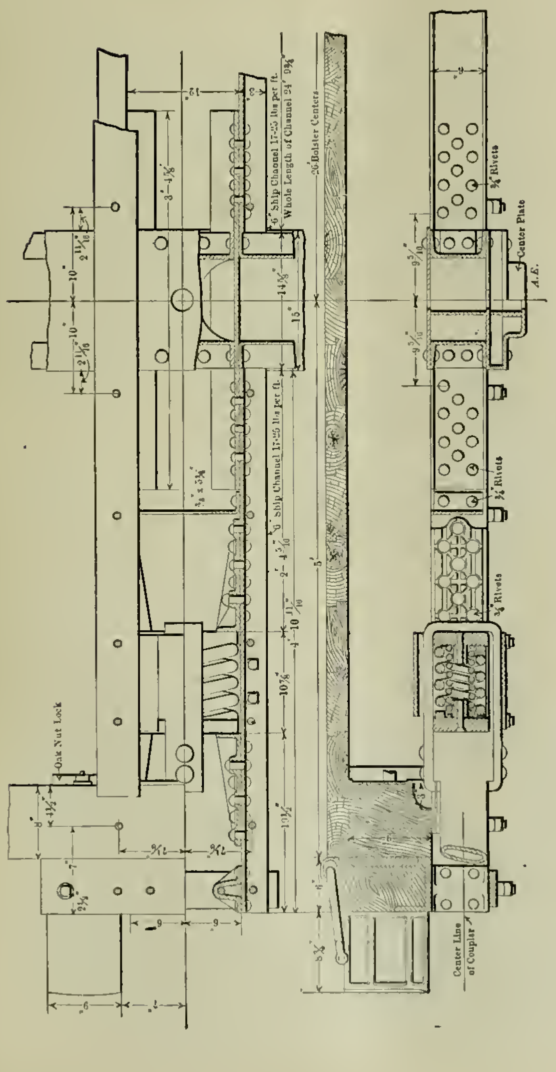


90,000 Pounds Capacity Gondola Car with Steel Draft Frame and Roller Side Bearings.—Lake Shore & Michigan Southern Railway.

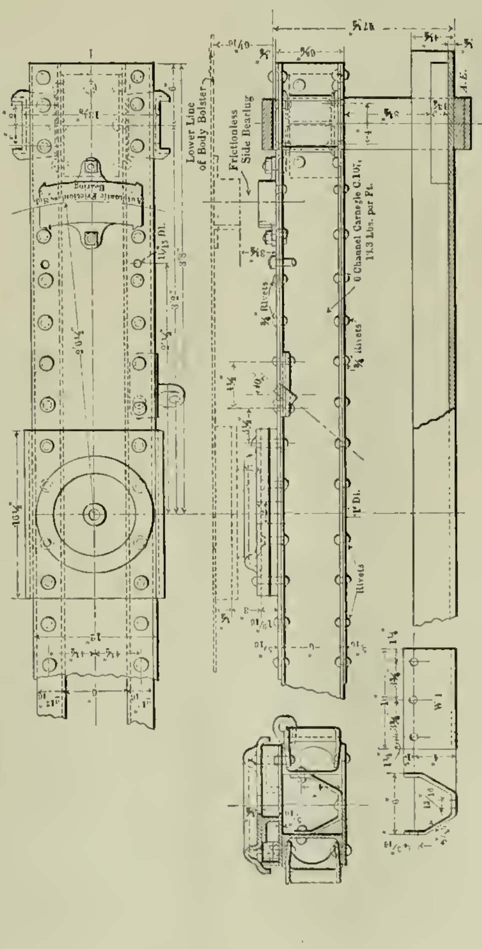
H. F. BALL, *Superintendent of Motive Power.*



Cross-Sections of Car.



Draft Gear, Showing Attachment to Steel Draft Sills.



Truck Bolster.

90,000 Pounds Capacity Gondola Car.—Lake Shore & Michigan Southern Railway.

H. F. BALL, *Superintendent of Motive Power.*

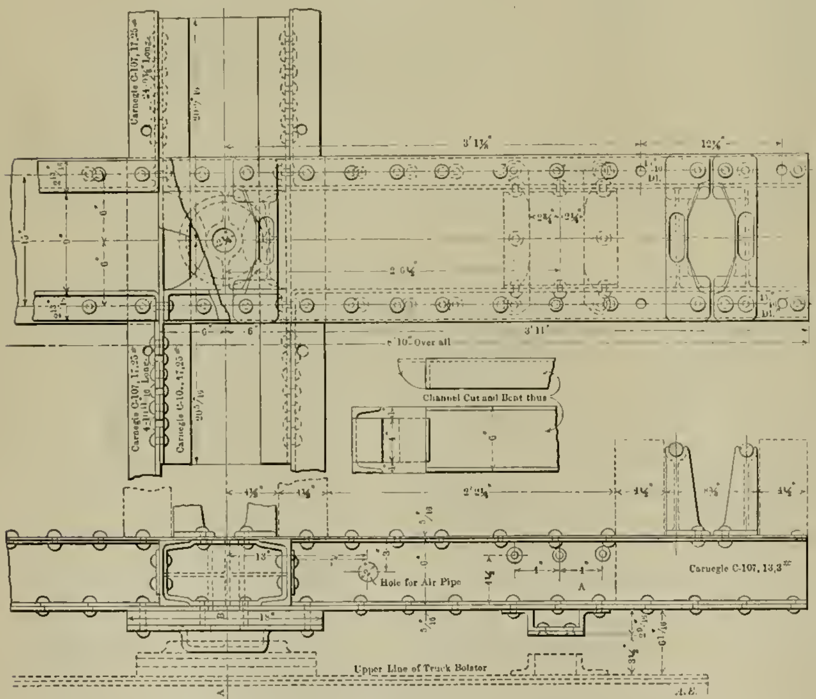
90,000-POUNDS CAPACITY GONDOLA CAR.

Lake Shore & Michigan Southern Railway.

Steel Draft Frame and Roller Side Bearings.

The chief interest in this car lies in the use of roller side bearings arranged to permanently carry 88 per cent. of the load. It has very light body and truck bolsters and a steel draft frame. The six drop doors were provided to meet the needs of shippers and to save the cutting of the floors in unloading. Thus far only one of these cars has been built.

Aside from the question of side bearings provision for the eccentricity of the draft and buffing stresses in the usual construction led to the employment of the steel draft sills, which are 6-in. channels, continuous between the bolsters. The drawings of the draft gear and body bolsters illustrate the arrangement of these parts with reference to the steel draft sills. The body bolsters are built up of two 6-in. channels with top and bottom cover plates, suitably braced at the center plates. They are very light, and this illustrates the advantage of placing the side bearings in contact. The truck bolsters are also very light, being built of two 6-in. channels with cover plates. Seven inch I-beams are used for cross-tie timbers.



Body Bolster.

90,000 Pounds Capacity Gondola Car.—Lake Shore & Michigan Southern Railway.

In order to build the car as wide as clearances would permit the grab irons are set in at the ends. One 10-in. plank in the siding is cut out and the handle is secured to a plate placed on the inside of the opening. The car will hold 90,000 lbs. of coal and is designed for a 10 per cent. overload. The trucks are the diamond type with 5 x 9-in. journals. The roller side bearings used are the well-known product of the Chicago Railway Equipment Company. This car has Southern pine sills, side planks and floor; if Norway pine had been used, as was intended, the weight would have been from 1,500 to 2,000 lbs. less. The weight and its distribution is as follows:

Weight of body, light	36,700 lbs.
Weight of lading	99,000 lbs.
Weight, total	135,700 lbs.
Deduct weight of trucks	13,200 lbs.
Weight of car and load	122,500 lbs.
Weight carried on side bearings	107,800 lbs.
Weight carried on center plate	14,700 lbs.
Weight of body bolsters, each	900 lbs.
Weight of truck bolsters, each	570 lbs.

We are indebted to Mr. H. F. Ball, Superintendent of Motive Power of this road, for the drawings of this interesting car.

ELECTRIC CAR LIGHTING IN GERMANY.

Electric lighting for railway cars is meeting with considerable favor in Germany. Many experiments and continued tests have been made by the Prussian railway engineers on the different systems of electric car lighting, namely, sets of storage battery on each car charged, either at intervals at permanent charging stations, or intermittently by axle-driven dynamos on each car, and also direct lighting by current furnished from a single dynamo permanently located on the train. The individual axle-driven dynamo and storage-battery unit on each car, which is, theoretically, the ideal system, owing to the independence of location of the car as well as its length of run, has been discarded, owing to three defects thought to overrule its advantages, namely (1) increase of the already very heavy load on the locomotive, owing to the power taken from the axles; (2) large space occupied and dead weight added by dynamo, regulating-apparatus and accumulators, and (3) jarring and grinding noise of the gears and dynamos which annoy the passengers.

The use of storage battery units charged from permanent charging stations has, in spite of its advantages, been ruled out by the necessarily great weight of batteries large enough for long runs, and also by the delays involved in charging. As a result, the Prussian State railway administration finally settled on the direct system of lighting from a single generator, which system has, however, been modified in that the steam-driven dynamo is located upon the locomotive, under the control of the engineer, and also auxiliary or regulating storage batteries are placed on each car of the train, thus rendering each car of the train practically an independent lighting system, its lights being ensured a constant supply of current from its own accumulators, which accumulators are kept charged by the dynamo on the locomotive. It is stated that this combination meets more perfectly than either of the others the requirements of simple, economical and efficient construction, maintenance and attendance in regular service. The first practical tests of this system were so thoroughly satisfactory that other trains are now being equipped, and it is thought that a satisfactory system has been found.

ECONOMY DERIVED FROM REHEATING COMPRESSED AIR.

Tests Performed by W. G. Edmondson and E. L. Walker, Students in the Railway Engineering Department of Cornell University.

It was the object of the experimenters in these tests to ascertain the exact gain derived from reheating compressed air used in small motors, with the idea also that some such method as this could be advantageously put into application in connection with the use of compressed air in railroad shops, mines, etc., where compressed air is extensively used.

A small 2 h.p. vertical engine with a shaft governor was used as the motor. The compressed air coming from the compressor was first passed through a meter, and then before being admitted to the engine was passed through a reheater. The arrangement of the apparatus is plainly illustrated in the accompanying diagram. The amount of air used in each run was recorded by the meter, which was furnished for the test by the Equitable Meter Company, of Pittsburgh. The meter was especially designed to withstand high pressures. The air passed through the meter at the temperature of the atmosphere. The meter was calibrated for the pressures used in the experiments, before and after the runs were made, and the meter readings were then corrected from this calibration. The results therefore show accurately the amount of air used in each case.

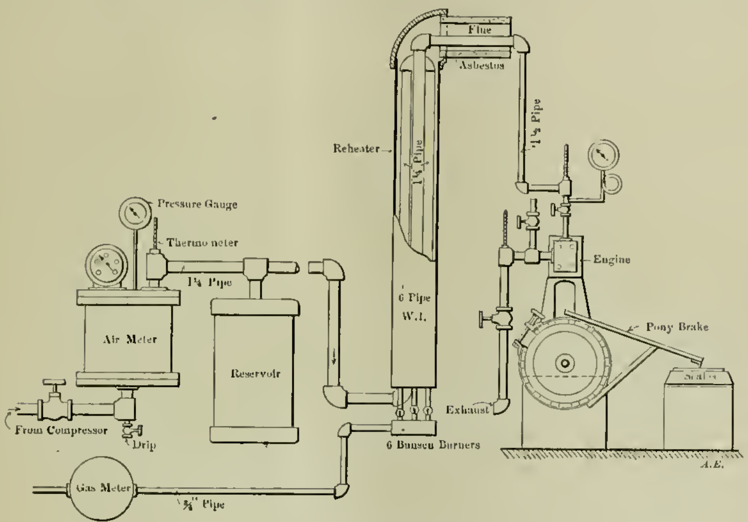


Fig. 1.

General Arrangement of Apparatus Used in Tests with Reheated Compressed Air.

The reheater was constructed out of pipe. It consisted of a coil of three lengths of 1¼ in. wrought iron pipe, which was surrounded by an outer casing of 6-in. pipe. This casing was also covered with an asbestos non-conducting covering, which prevented the escape of heat. The construction of this reheater is indicated in the diagram. Gas was used as the fuel, and was burned in a burner placed at the base of the reheater. Gas was selected as the fuel on account of the ease with which the supply of heat could be governed. A gas meter recorded the amount of gas used in each run so that the amount of heat supplied to the reheater could be easily computed when the heat value per cubic foot and the number of cubic feet of gas supplied per hour were known. The engine was equipped with a prony brake, and an indicator was attached to the cylinder, which enabled both the D.H.P (brake-horse-power) and the I.H.P. (indicated-horse-power) to be computed. In every case the temperature of the air was taken at the meter, and again after it had passed through the reheater, at a point as near to its entrance to the engine as possible.

In conducting the experiments three series of runs were taken as follows:

Series I.—In which six runs were made, all at about 57 lbs. gauge pressure, while the temperature of the air entering the engine was varied from 60 deg. F. to 401 deg. F.

Series II.—In which five runs were made, all at about 82 lbs. gauge pressure, while the temperature of the air entering the engine was varied from 60 deg. F. to 395 deg. F.

Series III.—In which two runs were made, at about 77 lbs. gauge pressure, and the temperature of the entering air 42 deg. F. and 266 deg. F. respectively.

The average results from each "run" were then taken from the log of each run and are shown on the general result sheets, one of which is reproduced. The tests were performed during the month of April, 1902, in the Mechanical Laboratory of Sibley College, Cornell University.

The term "cubic feet of free air" is used to represent the volume of air at standard conditions, which are taken in this case to be at a pressure of 14.7 lbs. absolute, and at a temperature of 60 deg. F.

Results and Conclusions.

The net gain in economy obtained with the lower pressure was 38.4 per cent., while with the higher pressure it was but 31.7 per cent. under the same conditions. In other words, we get a reduction of from 31 to 38 per cent. in the cost of the production of compressed air for a plant by reheating the air from 60 to 400 deg. F. before using it.

The curves in Fig. 4 illustrate how the economy is raised by increasing the temperature. It is seen that the increase in economy is gradually lessened after the temperature reaches about 300 deg. F. By continuing the curve it would indicate that the point would soon be reached where an increase in the temperature would not cause any further increase in economy, this point being reached at about 450 deg. F.

The results obtained in these experiments afford a very interesting comparison of the effects produced by different degrees of reheating, as well as by the use of different working pressures. Of the three different series of runs taken, the one employing the lowest pressure (56 lbs.) seemed to give the most efficient results.

It was not considered advisable with our engine to raise the temperature of the entering air much above 400 deg. F., on account of the bad effect it would have on the packing in the valve rod and piston rod glands, and also on the lubricant; however, a much higher temperature could have been attained with the reheater used.

Although the economy derived from the application of heat to the air may result from the increased volume, yet we are led to believe that the high results obtained are due partly to other changes of condition in the working of the engine, resulting from the higher temperatures. By reheating the air the engine is relieved from the difficulties due to freezing of the moisture in the exhaust passages and the choking up of the valve.

It was noticed that as the temperature of the air was raised while the pressure remained constant, the speed of the engine was increased, the cut-off was made shorter, and in general the operation of the engine was rendered much more smooth.

The results obtained from the tests appear to be approximately those which are indicated theoretically with the same conditions, and prove conclusively the many advantages to be gained by reheating, which was the object of this investigation.

For instance, it is seen that the reduction in the air consumption of a small motor is in almost direct proportion to the increase in temperature. By referring to the curves in Fig. 2 it is seen that the decrease in consumption of air is in almost direct proportion to the increase in temperature, until the higher temperatures are reached, when the decrease becomes more gradual, and finally ceases when the temperature is raised above the limit of practicability.

In Series I., which employed a pressure of about 56 lbs., it is seen that a saving of 44.6 per cent. of the air used cold was effected by reheating it from the temperature of 59 deg. F. to 401 deg. F. With Series II. and III., in which higher pressures were used, the gain was not quite as much on account of the lower efficiencies which always accompany higher pressures with compressed air. As shown by item No. 44, on the Table of Results, the results obtained by applying heat in this manner to compressed air, are from 8 to 18 times more important than would be obtained if the same amount of heat were expended under the boiler back of the compressor.

The results obtained in these experiments may be represented clearly by means of a simple proportion. Referring to the results obtained in Series I., we find that the maximum gain in air saved with the highest temperature is 44 per cent. of the amount of cold air required to produce the same amount of power.

Let us assume that 300 lbs. of compressed air at 60 lbs. pressure are required to produce 1 h.p. per hour at 60 deg. F. Then if we reheat this air to 400 deg. F. we effect a saving of 44 per cent., and we will then require but (100—44) = 56 lbs., per h. p. hr. At this rate if we take 100 lbs. of cold air and reheat it to the above temperature the increase in the power produced will be:

56 : 100 :: 100 : x.

Whence x = 178.6;

which indicates that the power derived from the same weight of air would be increased about 78 per cent. by reheating it from 60 deg. F. to 400 deg. F. In other words, a compressor which is able to supply 100 h.p. at the motor with cold air could be made to supply 178 h.p by the use of reheaters.

As the increase in volume obtained by raising the temperature of the air from this amount is only 65.3 per cent. it will be observed that the increased saving must be due partly to the more favorable conditions that the heated air provides for the engine to operate under.

The percentages of gain given in the results refer to the brake horse power, and the increased mechanical efficiency caused by the use of heated air must have a considerable effect upon the results. The increase in mechanical efficiency is shown by the curves in Fig. 3.

Thus three important points are secured by the use of a reheater, viz.:

1. Absence of freezing;
2. Reduced cost of plant throughout; and
3. Great increase in permanent economy.

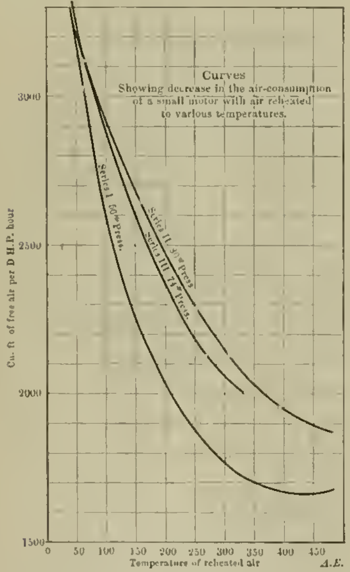


Fig. 2.

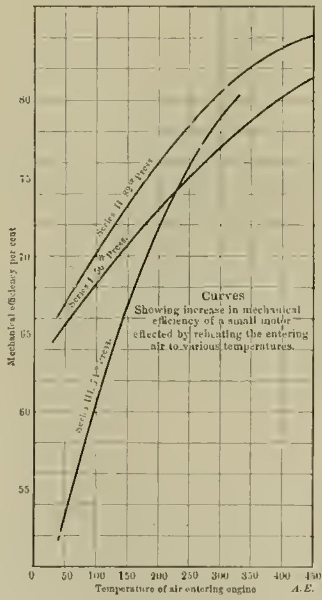


Fig. 3.

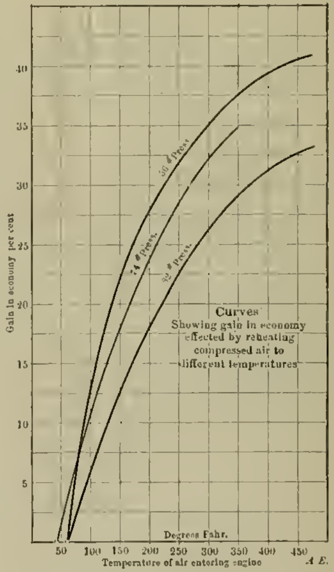


Fig. 4.

Tests with Reheated Compressed Air.

GENERAL RESULTS.—SERIES 1.

1. Number of run	1	2	3	4	5	6
2. Length of run, hours	1	1	1	1	1	1
3. Barometer	29.41	28.97	28.89	28.89	29.0	29.32
4. Gauge pressure at meter (corrected)	57.6	55	55.4	57.8	53.7	58.7
5. Gauge pressure at engine	55	53	53.8	56	57	57.0
6. Temperature at meter	51.2	86.8	86.3	79.1	91.5	74.3
7. Temperature at engine	59	176.5	256	306	348	401
8. Temperature of exhaust air	7	87.6	147	177	198	236
9. Temperature of room	48	79	83	78	76	70
10. Temperature of flue in heater	..	220	309	352	..	421
11. Cubic feet of air per hour from meter	371	319.5	300	270	248.5	234
12. Cubic feet of air per hour corrected from calibration of meter	377	323.4	303.4	274.4	252.6	238
13. Cubic feet of air per hour at standard conditions	1,877	1,445	1,367	1,295	1,204	1,150
14. Increase in temp. of air by heating	..	89.7	169.7	226.9	266.5	326.7
15. Corresponding increase in vol., per cent.	..	16.4	31.0	42.0	49.4	61.1
16. Weight of air supplied per hour, lbs	143.5	110.4	104.4	99.0	92.2	87.5
17. B. T. Us. absorbed by air per hour	2,659	2,350	4,210	5,340	5,840	6,820
18. Cubic feet of gas per hour from meter	..	9.5	16.5	22.2	..	28.8
19. Cubic feet of gas per hour, actual	..	8.7	15.7	21.4	..	28
20. B. T. Us. contained in 1 cu. foot of gas	530	530	530	530	530	530
21. B. T. Us. supplied to heater per hour	..	4,615	8,320	11,350	..	14,840
22. Efficiency of reheater	..	51.0	50.6	47.1	..	45.9
23. Average cut off head and crank, per ct.	56	36.5	35	32.2	29.4	28
24. Average ratio of expansion	1.79	2.74	2.96	3.11	3.40	3.57
25. Range of temperature of air in engine	52	88.9	109	129	150	165
26. Revolutions per minute	330.5	368	374	378.9	381.5	357.5
27. Brake load, lbs	5	5	5	5	5	5
28. D. H. P.	.629	.693	.7175	.7235	.727	.682
29. I. H. P.	.909	.975	.945	.956	.910	.860
30. Mechanical efficiency, per cent	69.2	71	75.9	75.6	79.9	79.3

31. Cu. feet free air used per D. H. P. hour..	3,080	2,085	1,901	1,790	1,658	1,688
32. Cu feet free air used per I. H. P. hour..	2,650	1,480	1,440	1,355	1,330	1,338
33 Cu. ft. free air used per D. H. P. per min.	50.5	34.75	31.75	29.86	27.7	28.15
34. Pounds of air used per D. H. P. hour.. .	228	159.3	145.5	137	127	128.9
35. Cu. ft. of free air saved per D. H. P. hr..	..	945	1,129	1,240	1,372	1,352
36. Gain in air saved, per cent....	0	31.2	37.25	40.9	45 25	44.6
37. Equivalent H. P. from heater per hour..	0	.196	.258	.296	.329	.304
38. Percentage of power from heater	0	31.2	32.25	40.3	45.25	44.6
39. Heat equivalent of work done per hour (I. H. P.)..............................	2,315	2,485	2,450	2,436	2,320	2,190
40. Work done per pound of air, adiabatic expansion (n = 1.408), B. T. U....	9,170	5,130	5,000	4,690	4,600	4,630
41. Efficiency of the fluid, per cent	25.3	48.5	49.0	51.8	50.4	47.2
42. Thermal cost of air saved per O. H. P. hour. B. T. U..............................	..	6,670	11,600	15,700	..	21,800
43. Thermal cost of equivalent amount of air from compressor B. T. U	..	131,500	157,000	172,500	191,500	183,500
44. Ratio: Cost of air by compressing / Cost of air by heating	..	19.7	13.5	11.0	..	8.62
45. Thermal cost of air from compressor in B. T. Us. per D. H. P. hour.............	415,000	292,000	264,200	249,000	231,000	234,000
46. Total thermal cost of air used per D. H. P. hour	415,000	298,670	275,800	264,700	..	255,800
47. Gain in economy, per cent.	..	28.1	31.2	36.3	..	38 4

A modern boiler shop is far different from its congener of half a century ago, in that, for one thing, the methods of construction have been greatly simplified and improved tools are in more general use. These last have also reduced costs so much that an old-timer revisiting the shop would stare in amazement at what is now possible. It is not generally known that a boiler of forty horse-power can be made and shipped in about eight hours. That is to say, if an order is put in by 7 o'clock in the morning it can be on its way to its destination by 3 o'clock of the same day, ready for steam when set. This boiler will be taken from the flat sheets, rolled to dimensions, all rivets driven, tubes set and rolled, and the work made water and steam tight within the time named; but it will be of the return-tubular type, where no smith work or flanging is required. This is quick work, and I know of one shop where it is done; doubtless there are others.—Egbert P. Watson, in *Engineering Magazine.*

The New York, New Haven & Hartford Railroad is having two very large steel car floats built by the Fore River Ship and Engine Company at its yard on Quincy Point, Boston harbor. Each barge is to have three tracks, with room on them for setting 23 50-ton cars at one time. Steel construction was adopted in preference to wood because of the protection against accident which it affords.

OIL-STORAGE STATION.

Hoosac Tunnel.

Boston & Maine Railroad.

In the June and July issues detailed descriptions appeared of the equipment of the Hoosac tunnel helper engines, on the Boston & Maine Railroad, for oil burning, including drawings of the firebox arrangement and details of the burner. Results comparing oil and coal will be presented upon the conclusion of tests which will soon be made.

The oil-storage station is located in an isolated spot near the east portal of the tunnel, and consists of a masonry vault built for the storage tanks below the ground-level, in order to prevent spreading of the oil in case of accident or leak in the tanks. The accompanying engraving shows the exterior of the storage station, together with one of the oil-burning engines in position alongside the standpipe for taking oil. The station contains three cylindrical tanks, 30 ft. long by 10 ft. diameter, each of a capacity of 17,000 gallons, making a total capacity of 51,000 gallons, which is sufficient to supply four of the helper engines for about two weeks, working day and night.

View of Station Showing Oil Burner Engine in Position Alongside Standpipe for Taking Oil.
Oil Storage Station—Boston & Maine Railroad.

The piping is so arranged that the three tanks may be used as a unit or separately, as desired, so that different grades of oil may be kept in storage without danger of mixing. The tanks are filled through the "storage line" of 4-in. pipe from the two inlets shown at A and B in the accompanying diagram of the station, piping and standpipe, which inlets are alongside the tracks upon which the tank-cars stand to be emptied; so that two tank-cars may be unloaded simultaneously. The flow of the oil to the various tanks is controlled by the valves C, D and E, the handles of which extend outside the building. At the bottom of the pit there is an "equalizing line" opening through the valves F, G and H, to the various tanks, so that they may be connected together as one and their levels equalized, or kept separate. At the track end of the pit there is a "suction line" of 4-in. pipe, by which oil may be pumped from any one of the tanks desired by means of the controlling valves K, L and M, also conveniently arranged with their handles outside the building.

One of the principal features involved in the design of this station is the arrangement whereby no constant attendant is required, which is secured by an ingenious arrangement of a steam pump so connected as to force the oil from the storage tanks through the standpipe into a tender tank by steam temporarily furnished through a hose connection from the locomotive being filled. As shown in the engraving, the storage station is located on a level lower than that of the track, so that the storage tanks are filled by gravity, and the pump is needed only in supplying the locomotives.

The pump, which is a low-service duplex pump, is located in the small pumproom shown adjoining the station on the west and near the track, and pumps from the "suction line" into the standpipe connection, having a capacity of about 1,000 gallons of oil in five to ten minutes. The steam taken from the locomotives to run the pump is reduced to a pressure of about 30 lbs. by a reducing valve before entering the pump, and there is an arrangement of exhaust piping so that the exhaust steam may be used to heat the oil in any one of the storage tanks, or in tank-cars to be unloaded by means of heater coils. There is also a connection for heating the oil by live steam direct from locomotives. The oil-delivery pipe from the pump is fitted with a relief valve, which is arranged to divert the flow from the standpipe back into the storage tanks by excess pressure when the valve is closed at the nozzle of the standpipe. The walls of the station are of brick and concrete, and the roof, which is of timber, graveled, is surmounted by a small tower with louvres for ventilation, and a door for entrance into the station. Alongside of this tower is a gauge-board with pointers for indicating the height of oil in any one of the storage tanks.

Storage Tanks.

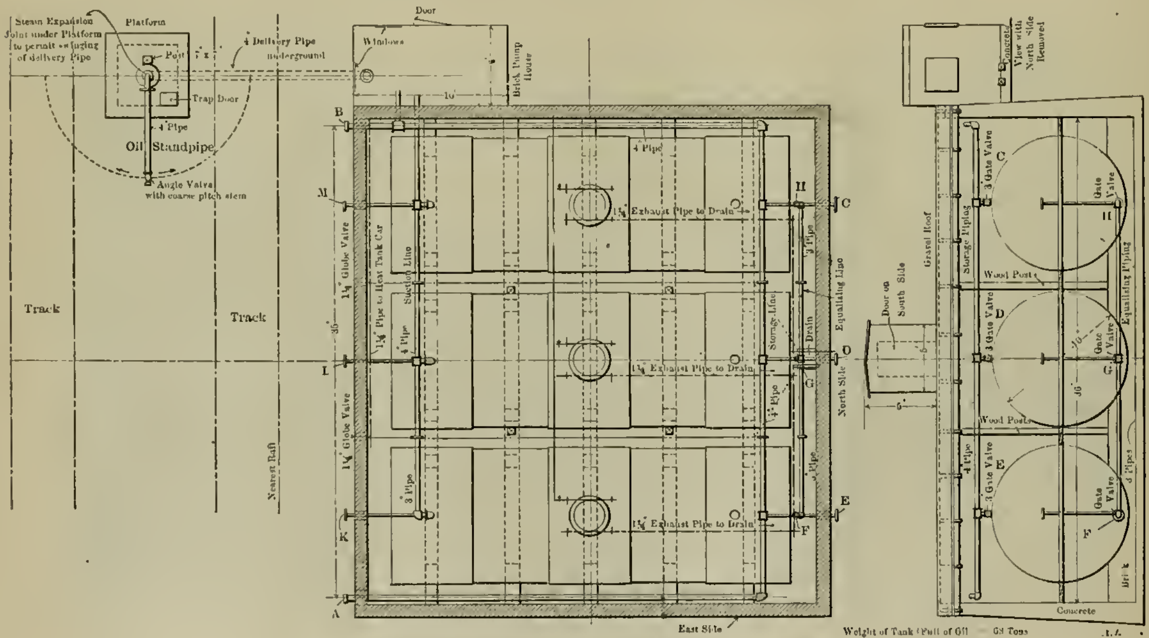
The storage tanks, one of which is shown herewith in side and end sections, has an interesting arrangement of heater coils, of which there are two in each tank, so that they may be easily removed. Each coil, which is of parallel piping, with close return bends, lies on the bottom of the tank, and has a chain attached running up to the manhole; then, by merely uncoupling the unions UU, which connect the ends of the coil to the pump and exhaust, the coils may be pulled out through the manhole without emptying or otherwise disturbing the tank. The oil suction pipe enters the tank through an enlarged flanged opening of sufficient size to permit it to be removed, together with the foot-valve at its lower end. A float is arranged in each tank to actuate its gauge-pointer on the roof, and each tank has a vent-pipe consisting of a hooded pipe running 10 ft. above the top of the tank. At the right of the plan of the tank is shown a corner of the storage station in section, giving the arrangement of the pump exhaust connection to the heating coils, and also the by-pass for running live steam into the heating coils.

Standpipe.

The standpipe, shown at the left of the locomotive in the engraving, is located between two tracks, so that tender tanks may be filled on either track. It is very simply constructed of standard pipe and fittings, with an ordinary steam expansion joint at the lower end, under the platform, to permit of the necessary swiveling of the delivery pipe, and having an angle globe valve with a coarse pitch stem at the end of the delivery pipe. The standpipe is supported by a 7 by 7-in. hardwood post, against which it is pivoted so as to swing freely. The end of the delivery pipe terminates in a funnel and strainer for conducting oil to the tender tanks, and an air-check is placed in the delivery pipe near the valve to permit the oil to drop back when the pump is stopped. This arrangement essentially precludes any danger of fire, as the oil is at all times below the level of the tracks, and as the station pit or building is large enough to hold all the oil from the tanks if they should all burst, and with this form of standpipe there is no drip of oil and not even any odor from it.

Tender Tank.

The tender tanks are rectangular closed tanks of 1,050 gallons capacity, shaped to fit into the coal space of the tender, and well braced internally to withstand an air pressure of 15 lbs. The filling hole is in the middle of the manhole at the rear end of the tank, and is covered by an air-tight lid, which may be quickly removed by simply loosening a hand-bolt, as

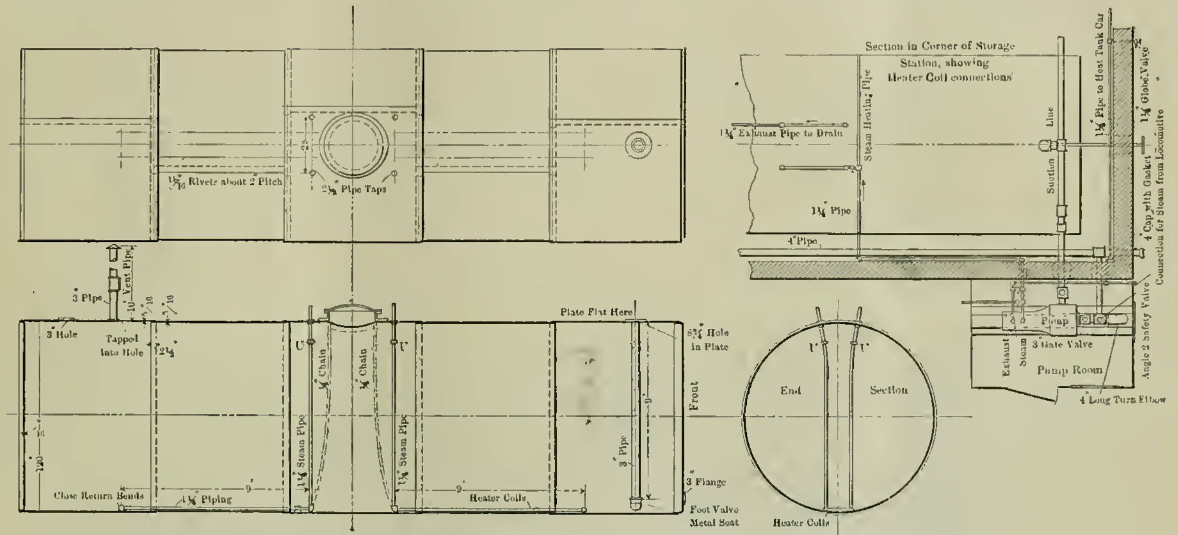


Arrangement of Tanks in Oil Storage Station, Showing Piping and Connections—Boston & Maine Railroad.

shown in the accompanying detail sketch. The burners may be fed by gravity alone, but a more uniform flow is secured by carrying an air pressure of 8 to 10 lbs. within the oil-tank, which pressure is obtained through a reducing valve from the brake-reservoir. There is a steam-heating coil in the tank near the outlet to the burner delivery pipe, in which steam is circulated at 10 lbs. pressure. The burner delivery projects 1½ ins. up into the tank above the bottom to prevent dirt from entering, and is provided with a lever gate-valve, with its handle projecting up through the tender floor, for cutting off any flow to the burner when the engine is laid up.

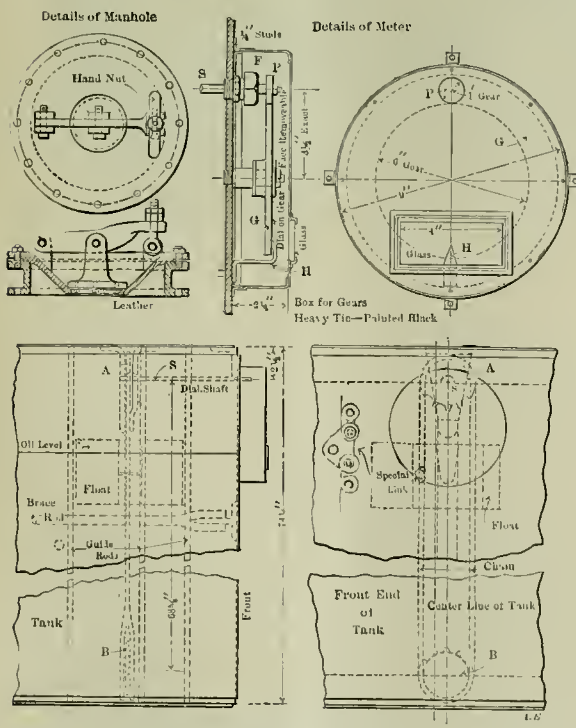
Oil Gauge or Meter.

In the determination of the amount of oil in the tank, the unsatisfactory methods of wasting air pressure in inserting a rod into the tank, or of the breakable glass gauge for indicating the oil level, are avoided by an ingenious oil meter operated by a float within the tank. This meter, which is shown in the accompanying detail view, consists of a dial which is revolved by the rising and falling of a float in the oil, as shown in the view of the front end of the tank. The float, which is guided in its movements by guide rods, is fastened to an endless sprocket chain by means of a special



Construction of Tanks and Arrangement of Heater Coil Connections.

link, so that as it moves it carries with it the chain and thus revolves its supporting sprocket wheels. The upper sprocket A is keyed onto the dial-shaft S, which extends through the air-tight stuffing-box F, out into the meter outside the tank, and has keyed onto its outer end the pinion P. This pinion meshes with the larger gear G in such a ratio that for a total rise or fall of the float the gear G moves through one revolution, and upon the outer face of the gear there is a dial so graduated that each division represents one barrel of oil (50 gallons), so that by means of the stationary pointer H the amount of oil in the tank at any time is indicated. The lower sprocket wheel B is supported by a framework supported from the top of the tank, so that in case of a bulging of the tank due to the air pressure the chain will not be unduly tightened.



Details of Locomotive Tank Manhole and Filling Hole, and of Tank Oil Meter or Gauge.
Boston & Maine Railroad.

Reports from Russia give a very unfavorable account of twenty-four locomotives built for the Central Russian Railway by the Charkoff Locomotive Works. Their speed is unsatisfactory, being only eighteen miles per hour on a maximum under conditions for which fifty miles was expected. This is said to have led to the decision to buy foreign locomotives in the future, American locomotives being in high favor. With reference to this decision Mr. John H. Converse, of the Baldwin Locomotive Works, is quoted as saying: "Our establishment has been building locomotives for Russia for the last thirty years, and we have shipped no less than 419 engines of various patterns, equipped with all of the most effective and modern appliances known to the trade. The total amount of money received by our firm from Russia for these constructions is between six million and seven million dollars, and that country has always been among our best patrons."

TANDEM COMPOUND CONSOLIDATION FREIGHT LOCOMOTIVES.

Erie Railroad.

The accompanying engraving illustrates the tandem compound consolidation freight locomotives recently delivered to the Erie Railroad by the Cooke Works of the American Locomotive Company. This locomotive corresponds in wheel and cylinder arrangement to the new tandem-compound consolidation freight locomotive for the A., T. & S. F. Ry., which was illustrated on page 179 of our June issue, although the Erie engine is heavier and differs further in having a modified Wooten boiler. The heating surfaces of these two engines are, however, practically the same, that of the Erie engine, 2983 sq. ft., being only 18 sq. ft. the larger, but the tractive force of the Erie engine is considerably the greater, being 45,900 lbs., or 5,900 lbs. greater.

Among other notable features of this locomotive, attention may be called to the hand rails at the front and on the outside of the right-hand running board, and also to the arrangement of the air tanks over the fire-box, and behind the cab, two tanks, 20 1-2 by 84 ins., being located on either side of the bell and pop-valve connection. The steam using auxiliaries in the cab are connected to a special fountain, which is fed directly from the dome in front of the cab, thus ensuring dry steam.

The principal dimensions of this engine are given in the following table:

Tandem-Compound Consolidation Locomotive.
Erie Railroad.

Gauge	4 ft. 8½ ins.
Fuel to be used	Fine anthracite coal
Weight of engine in working order, total	209,000 lbs.
Weight on drivers	185,500 lbs.
Weight on truck	23,500 lbs.
Weight of tender, loaded	120,000 lbs.
Wheel base, driving	15 ft. 6 ins.
Wheel base, total, of engine	24 ft. 3 ins.
Wheel base of engine and tender	51 ft. 11 ins.

Cylinders.

Diameter	16 ins.
Stroke of piston	30 ins.
Slide valve, pattern	Piston type
Travel of valve	6 ins.
Steam ports, width	1⅞ ins.
Steam ports, length	30½ ins.
Exhaust ports	2⅛ ins. x 28½ ins.
Lap of valve high and low pressure, outside lap	⅞ in.
Inside lap, high pressure, line and line; low pressure, ¼-in. clearnce.	

Wheels, Etc.

Diameter of driving wheels outside of tire	56 ins.
Driving wheel centers, material:	Main of cast steel; first, second and fourth, cast iron
Driving wheel centers, diameter	50 ins.
Engine truck wheels, diameter	30 ins.
Engine truck wheels, kind:	Standard cast-iron center, steel-tired, with retaining rings
Driving axle journals, diameter:	Main, 10 ins.; first, second and fourth, 9 ins.
Driving axle journals, length:	Main, 12 ins.; first, second and fourth, 12 ins.
Engine truck axle journals, diameter	6 ins. x 10 ins.

Boiler.

Boiler type	Straight top, wide firebox, radial stayed
Boiler working pressure	220 lbs.
Boiler, horizontal seams	Sextuple riveted
Boiler diameter, first course, outside	70½ ins.
Boiler, thickness of shell	9-16--¾ ins.
Boiler firebox, length	114⅛ ins.
Boiler firebox, width	96¼ ins.
Boiler, style of grate	Drop front and back, six sections rock bar
Tubes, number	369
Tubes, diameter	2 ins.
Tubes, length	14 ft. 6 ins.
Heating surface, firebox	199 sq. ft.
Heating surface, tubes	2,784 sq. ft.
Heating surface, total	2,983 sq. ft.
Grate surface	76.27 sq. ft.
Exhaust pipe	Single, high
Smokebox	Extended
Height, center of boiler from rail	9 ft. 5 ins.
Height, top of stack from rail	15 ft. 6¼ ins.
Brake	Westinghouse-American

Tandem Compound Consolidation Freight Locomotive—Erie Railroad.

W. S. MORRIS, *Mechanical Superintendent.* *Built by* THE AMERICAN LOCOMOTIVE COMPANY, COOKE WORKS.

Tender.

Frame	12-in. steel channel
Truck, style	Barber
Truck, wheel kind	Chilled cast iron
Truck, wheel, diameter	33 ins.
Truck, axle journal, diemeter and length	5 x 9 ins.
Tank, water capacity	6,000 gallons
Coal capacity	10 tons

The Atchison, Topeka & Santa Fe Railway system has succeeded in reducing the dust nuisance on the arid section of its main line from Seligman, Ariz., to Hesperia, Cal., a distance of 360 miles, by liberally sprinkling the track with crude oil. The spraying will be repeated until the ballast is thoroughly saturated. The result thus far is very satisfactory; it is now possible to ride out on a back platform while the train is making sixty miles an hour and be practically free from the annoyance of dust. Also, the Santa Fe engines in California use crude oil for fuel and are cinderless. Thus the absence of both dust and cinders makes railroad traveling in that almost rainless country a matter of enjoyment instead of the reverse, and the rides down the Yampai and Hualapai valleys are no longer disagreeable.

CORRESPONDENCE.

THE CARE OF BLUE PRINTS IN THE SHOP.

To the Editor:

"A place for everything and everything in its place" finds practical application to a great extent in and about locomotive and car repair shops, as far as small tools, supplies, etc., are considered, but seems to have stopped, in a great many cases, just short of the drawings or blue prints used.

In a great many instances we find the prints kept in some sort of a case or file, and such a case in each shop or department, but no check or system is employed to tell the whereabouts of prints, everybody helping themselves. Again, in some others, we find all prints intended to be kept at one place—say the general foreman's office—but with no good system of keeping track of them. In either case, if a print cannot be found in the case or file, a search must be made, which always runs into minutes and generally a whole hour, depending, of course, on the size of the shop and the location of the cases. A moment's thought should convince any man in charge of a shop that a great deal of time is lost in this hunting for prints, and that it will never stop till some efficient means are employed to care for and to locate the prints.

Collections of blue prints are libraries of information, and should be treated as such. They should be catalogued and their whereabouts known at all times. There are two systems—one in which all prints are kept at one place, and the other in which each shop or department has cases for its own prints, depending, of course, upon the size of the shops, the number of prints, and the location of the buildings; but before any one system is adopted a thorough investigation should be made and the advantages and disadvantages of each carefully considered.

In the moderate-sized shop, where the various buildings are conveniently located with respect to each other, the first method should be used, as a rule, as it insures all prints being kept together and looked after by one person, thus insuring uniformity at the least expense. Right here the question may be asked, "How about the time spent in going from some shop to the office after a print every time one is wanted?" Of course, some time is consumed in doing this, but if several prints, say those likely to be used during a few days or even a week, be taken to the shop and all of them charged up to that shop, only one trip is taken, and the office knows just where to find them all. If this method is resorted to, too many prints should not be issued to one shop at one time, as the more prints there are in the shop the harder it is to keep track of them. Where the various shops are large and widely scattered, and the number of prints large, the second system would undoubtedly prove the better, as it would lessen the time spent in getting prints from a central point.

Where a system is adopted, uniformity in methods of cataloguing and of caring for prints should be insisted upon. In cataloguing a lot of prints, the fitness of the card catalogue cannot be questioned, as it is perfectly elastic and handy, easy to keep up, and a time-saver when compared with any book catalogue that can be devised. Prints should be indexed, or catalogued on the cards. *by the name of the detail, by the print number*, and *by the case number;* that is, there should be three separate catalogues or indexes. In indexing by the name of the detail, the cards should be in alphabetical order; thus, for cylinders, cocks, etc., we have cards under "C," axles under "A," etc. The cards of this catalogue should contain spaces for the class of engine or car to which the detail belongs, for the case or file number, for the print number, and finally spaces for the date the print was received and the date canceled. In indexing by print number, the cards should contain spaces for the print number, for the case or file number, and for the name or title of the print. This catalogue, running by numbers, will be found to be the most convenient, as print references are generally given by the number of print. In indexing by case or file number, the cards should contain spaces for the case number, for the print number, and for the name or title of the print or detail. The latter space is not absolutely necessary, since the print-number catalogue contains the name, but it will be found to be convenient, its utility coming into play when prints are lost or taken from the case without being checked, since by referring to the print-number catalogue we find the name of the print missing and are thus enabled in most cases to locate it.

To handle prints conveniently and preserve them, they should be mounted on cardboard or light sheet iron, and protected from grease and dirt by a good coating of varnish or shellac. On the backs of these boards numbers should be stenciled in large figures of such a color as will contrast with the card. These numbers should also be protected with shellac.

When necessary to remount prints, or to use discarded mounting cards for new prints, it will be found most convenient and economical to remove the old prints by holding the card over a hot fire, such as a coppersmith uses, and allowing the print to burn off. This will in no way injure the card, provided the fire is hot enough.

Like everything else, a blue-print case must be taken care of in order to be efficient and serve its purpose. A little time spent now and then looking it over to see that all prints in use about the shop are checked and that all are in prime condition will prevent bother and waste of time sooner or later. It is good practice to have all prints collected from the various shops once a week and brought into the office case; this materially lessens the liability of their becoming lost. N. C. HURST.

West Burlington, Iowa.

Yankee methods and British workmen are still performing feats that startle the British public, who have hardly had time to close their mouths from wondering at the records made in bricklaying at the British Westinghouse Co.'s works at Manchester when they are called upon to admire the huge chimney stack of the generating station of the Mersey Railroad Co. at Liverpool. Commenced about Christmas time, the stack, which is about 250 ft. in height, has been completed already and stands as a record-breaker so far as expedition in building is concerned. The work has been carried out by the British Westinghouse Co., who have the contract for converting the Mersey railway tunnel from steam to electric traction, and the work has been done by British labor under the direction of Messrs. J. Stewart & Co., famous for record-breaking time in the construction of the Manchester works, the Galveston docks, and the renowned grain elevator "Kalumet K."

The case which was brought against the Michigan Malleable Iron Company, of Detroit, Mich., in the United States District Court at Detroit by Canda Bros., New York, for alleged infringement of certain claims of their letters patent, No. 460426, has been decided by Judge Swan in favor of the defendant. The infringement charged was in the manufacture of draft apparatus by the Michigan Malleable Iron Company, under contract with the Thornburgh Coupler Attachments Company, Limited, of Detroit, the designs being covered by letters patent, No. 588722, granted William Thornburgh on August 24, 1897. The case was vigorously defended, and the victory gained fully sustains the validity of the Thornburgh patents.

The Traveling Engineers' Association will hold their tenth annual convention at Chicago, Ill., commencing September 9, 1902, at 9 A. M., with headquarters at the Stratford Hotel, corner of Jackson and Michigan Boulevards. Accommodations at the hotel, which is on the European plan, may be secured in advance, and also half-fare arrangements have been secured with the Pullman Company for members of the association and their families attending. It is announced also that the office of the secretary of the association, Mr. W. O. Thompson, will hereafter be at No. 7 Manning Square, Albany, N. Y., instead of at Elkhart, Ind., as formerly.

The total number of cars built in the United States in the year 1900, according to a recently issued bulletin of the Census Bureau, was 145,440. Of this number 118,504 were built by the contracting companies, the rest being built by the railroads. The cars were divided into classes as follows: Built by contract—Freight cars, 116,590; passenger cars, 979; street cars, 935; the railroads themselves built 26,543 freight cars and 390 passenger cars in their own shops.

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EDITORIAL ANNOUNCEMENTS.

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

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

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THE LOCOMOTIVE—A THOUGHT FOR THE FUTURE.

The locomotive does not usually advance by radical changes; at least, the permanent improvements usually come very gradually, and result from careful study to meet special conditions. It is an interesting fact that in this country there have been comparatively few departures from perfectly simple construction, and advancement has followed the direction of increased size, weight and power. For five years this progress has been so rapid as to justify the criticism of rivalry in efforts to outdo previous weight and power.

Power is wanted, and the greatest success lies in securing the highest possible power and sustaining it for long pulls. This, however, has been sought in a way which has been characterized as "brutality and not engineering." The experience of the French railways in the development of the De Glehn engines suggests a possible line of improvement in this country, which appears attractive in view of the statements and opinions presented by M. de Glehn on another page of this issue (page 265). We have no counterpart of the French trains, considering the weight and speed which these engines pull, and it is doubtful whether our engines of equal weight and heating surface can equal their performances.

Additional complication is not desirable. A locomotive made all in one piece would be the natural finality of the present tendency here, but this is, of course, absurd; yet the fear of complication is equally absurd—the air-brake has proved that. Complication in a locomotive is, however, a question by itself, but M. de Glehn speaks plainly on this point from years of experience.

The adoption of French practice is not the object of this discussion. It is perfectly clear that we can learn much from French locomotive practice, and it is equally clear that the locomotive should soon have the benefit of the development in the matter of steam engineering which has led to such great improvements in marine and stationary engines. It would probably be an excellent investment for one of our American railroads to borrow one of the French four-cylinder engines and ascertain positively what it can do under our conditions. It is not adapted to them, but a practical experimental study of its design and construction would undoubtedly lead to an improved American locomotive with greater power per unit of weight than can be produced by our present methods. This, however, is but one of the possible advantages. The fundamental features of this French design, properly applied to our conditions and developed as our present designs have been developed, would produce power, capacity and economy of operation, which seem to be beyond the reach of our present methods.

Complication may, after all, be found to be a cheap price for greater capacity. This is worth finding out.

REHEATING COMPRESSED AIR.

It is generally understood that a saving results from reheating compressed air before its use in motors, but the figures presented elsewhere in this issue, page 271, by Messrs. Edmondson and Walker, indicate that the real importance of reheating is not appreciated. If it were, the principle would be more generally employed by the larger users of compressed air.

The experiments described show a maximum gain, by reheating, of 44 per cent. in the amount of air required to produce a given amount of power, and that a compressor which is able to supply 100 h.p. at the motors with cold air may be made to supply 178 h.p. by the use of reheaters. This means that many compressors, which are now overloaded and are running too fast, may be made more effective, and the day of replacement by larger machines put off, by installing reheaters. A reduction of 30 to 40 per cent. in cost of production of compressed air by reheating it from 60 to 400 deg. F. just before using is thoroughly worth while, especially when the simplicity of the reheating is considered.

The contractors constructing the new Rapid Transit Subway in New York, who are using compressed air very extensively, appreciate reheating and employ it very effectively. On one of the sections, where reheaters are used, the heaters are of cast iron, made all in one piece cored out, in the form of stoves with small grates for the fires. These are placed near the air drills and are left out of doors and unprotected. The expense of the fire and its attendance is insignificant in consideration of the great gain in power.

The above-mentioned paper is presented in a way to give the results at a glance to busy readers. The comparisons are presented in curves, in which not only the figures of comparison are given, but also the probable limits to the practical economy of reheating are indicated. The heater used was capable of producing much higher temperatures of air delivered, but about 450 deg. seemed to be the highest temperature for satisfactory use in the small engine employed. It is important to notice that the speed of the engine increased with reheating of the air; also that the engine ran more smoothly and the cut-off was shortened. That is to say, the increase of volume of the air is not by any means the only saving due to reheating. The action is somewhat similar to that of superheating for a steam engine. There is, of course, no freezing of the exhaust with reheated air.

Plants may be installed at reduced cost throughout and the economy of operation is increased permanently by using reheaters. This is most effectively stated by the authors when they point to the fact that the results obtained by applying heat in this manner to compressed air are from 8 to 18 times more important than would be the same amount of heat expended under the boiler which drives the compressor.

The extent to which the draw-bar pull behind the engine may be carried during braking retardations due to lack of braking power on the engine's wheels was exhibited during the tests by B. J. Arnold in preparing his report concerning electric motive power on the New York Central. The following is quoted from his report:

"It appears that the braking effort per ton is not as high on certain types of locomotives as it is on coaches. This is due to the fact that not always are all the wheels of the locomotive braked, and those that are braked cannot be set to the skidding point with a fully loaded tender, for if they were they would then skid with a lightly loaded tender. Hence the draw-bar pull during retardation is often as great, or even greater, than it is during acceleration. An instance of this was noticed where the maximum draw-bar pull due to the braking effort of the train on the locomotive was 11,950 lbs., while the maximum draw-bar pull exerted in starting the train was 9,945 lbs. That is to say, in that particular run, during the period over which an possible retardation was desired, the draw-bar pull, instead of being zero, was 20 per cent. greater than that available for acceleration. In one record of a stop these figures became respectively 15,675 lbs., 9,899 lbs. and 60 per cent."

The facts thus revealed by the dynamometer car should call attention to this too easily overlooked matter of braking all wheels of locomotives.

The balanced locomotive in which there is not the least suspicion of the hammer blow upon the rail; the locomotive that, with four cranks set at the four quadrants of a circle, will give a non-racking, uniform rotative force approximating to the uniform rotative force of the electric motor, practically giving a higher coefficient of friction between wheel and rail, and giving that even pulling power which, in addition to the long cut-off of the compound, is going to handle the cars so much easier, not having to back an engine to take up the slack in a long freight train and then jerk it ahead to get it into motion, and incidentally jerk out a drawbar or two—this is the locomotive which is believed to be at the commencement of a new era in transportation in this country; a new era for the overworked rail, joint, tie and ballast, for the bridge, and for the locomotive repair shop.—Prof. H. Wade Hibbard on four-cylinder balanced compound locomotives, in a discussion on "Maximum Trains; Their Relation to Track, Motive Power and Traffic," before the New York Railroad Club, April 17, 1902.

It's a sign of inefficiency not to be able to get others to help us do our work. There are many men who cannot get others to take portions of their responsibilities. They cannot hand over the less important details in order that they themselves may devote more energy to the more important ones. A well-known and successful railroad officer has said that there is a limit to what one man can do, but no limit to what he can get others to do for him. "Blessed is that man who has found somebody to do his work." A man may furnish the inspiration for himself and others, but not often do we find a man who has the inspiration and is able alone to fulfill it in works.

The practice of using flanges on all driving wheels of locomotives is probably more general than most people think. It was recently stated before the Rocky Mountain Railway Club that since the year 1875 the Baldwin works alone have built 1,029 locomotives with flanges on all driving-wheel tires. Of these nearly 300 were of the consolidation type. These figures do not include the current year.

PERSONALS.

Mr. A. H. Thomas has resigned his position as mechanical engineer of the Chicago, Milwaukee & St. Paul Railway to accept a similar one on the Baltimore & Ohio.

Mr. S. K. Dickerson, division master mechanic of the Lake Shore & Michigan Southern at Cleveland, has recently been transferred to their new shops at Collinwood, Ohio.

Mr. R. S. Wickersham, formerly in charge of tonnage rating on the Santa Fe system at Topeka, has been appointed assistant engineer of tests of the Coast lines of the system, at San Bernardino, Cal., vice H. B. Gregg, resigned.

Mr. N. L. Rand has been appointed master mechanic, with office at Moncton, N. B., of the division of the Intercolonial Railway of Canada, extending from Moncton to Halifax and St. John, including the Moncton and Truro terminals.

Mr. R. Atkinson has resigned his position as superintendent of rolling stock of the Canadian Pacific Railway to become master mechanic of the Philadelphia & Reading, in charge of the new locomotive shops and roundhouses at Reading, Pa.

Mr. George W. Hepburn, of the Chesapeake & Ohio, has been promoted from his former position of assistant master mechanic of the Cincinnati division, at Covington, to that of master mechanic of the Kentucky division, at Lexington, Ky.

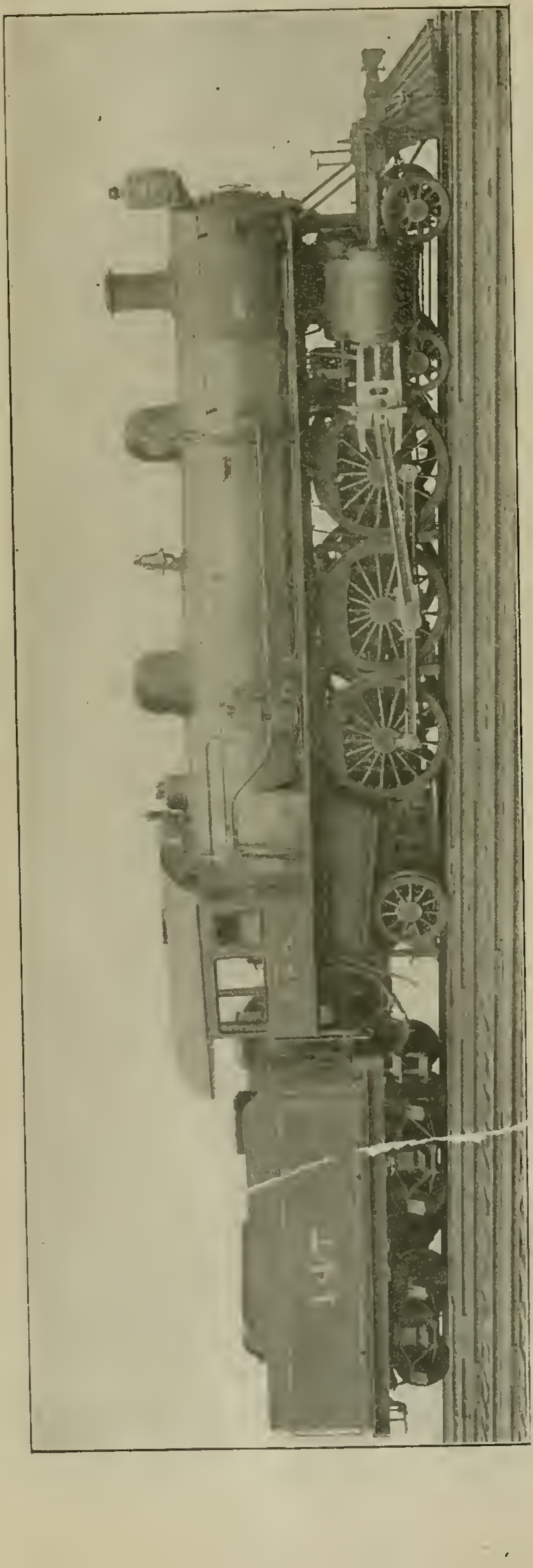
Mr. W. A. Nettleton has resigned his position of assistant superintendent of motive power of the Atchison, Topeka & Santa Fe, in order to devote his entire time to his private affairs. Mr. Nettleton was formerly for many years superintendent of motive power and machinery of the Kansas City, Fort Scott & Memphis Railroad.

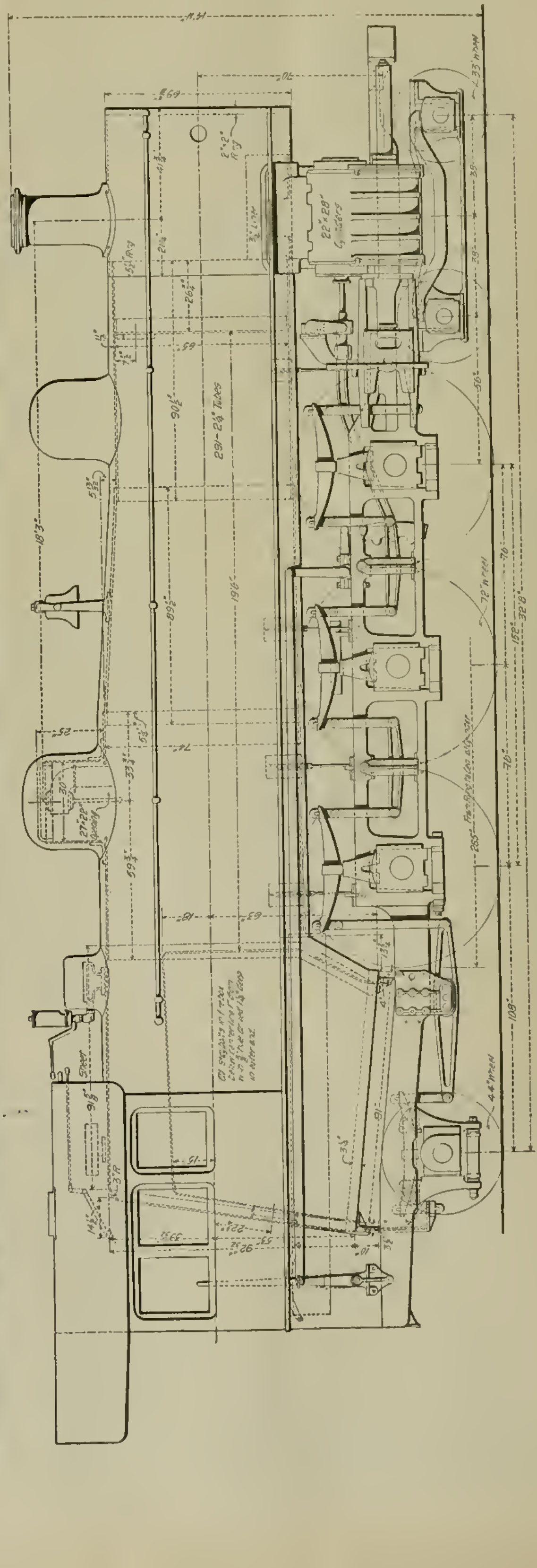
Mr. J. E. Simons has resigned his position as superintendent of rolling stock and machinery of the Pittsburgh Coal Company to accept the position of general manager of the Hunt Foundry and Machine Company, of Pittsburgh, which is a reorganization of the Hunt Air-Brake Company.

Mr. W. L. Kellogg has been appointed master mechanic of the Missouri Pacific at Fort Scott, Kan., to fill the vacancy made by the resignation of Mr. C. A. Sanders. Mr. Kellogg was formerly foreman of engines of the St. Louis, Iron Mountain & Southern at Little Rock, and previous to that traveling engineer on the C. St. P. M. & O.

Mr. A. E. Mitchell has resigned his position as assistant superintendent of motive power of the Chicago, Milwaukee & St. Paul to become superintendent of motive power of the Northern Pacific at St. Paul, Minn., succeeding Mr. Alfred Lovell. Mr. Mitchell was for many years superintendent of motive power on the Erie Railroad.

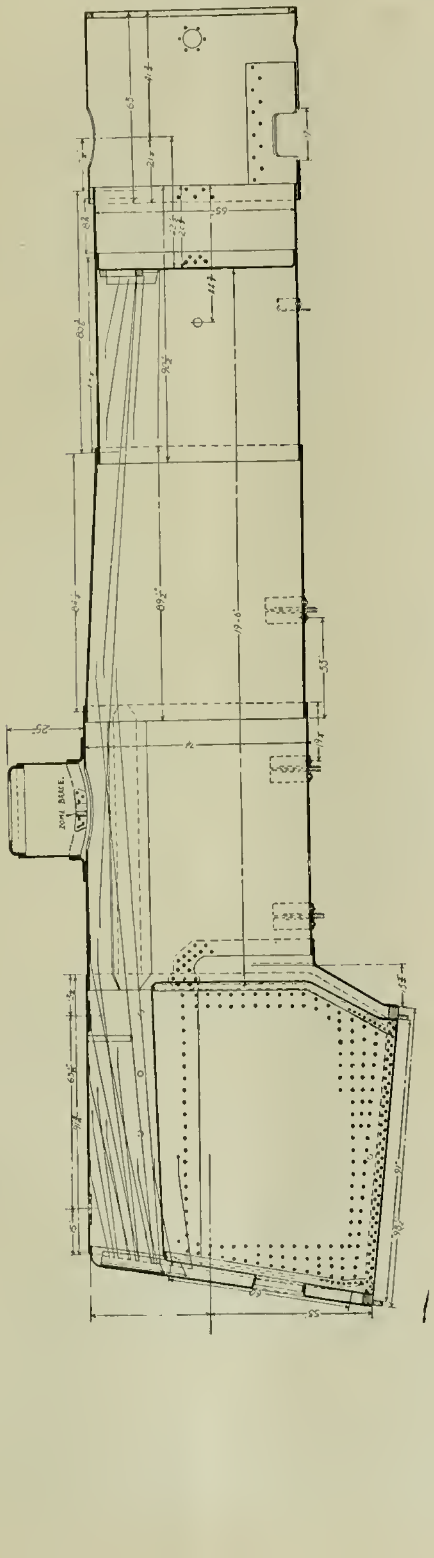
Mr. Fred Mertsheimer, formerly superintendent of motive power and machinery of the Kansas City Southern, has been appointed superintendent of machinery of the Denver & Rio Grande, at Denver, Col., to fill the vacancy made by the resignation of Mr. Henry Schlacks. Mr. Mertsheimer has been connected with both the Union Pacific and the Kansas City, Pittsburgh & Gulf Railroad in various mechanical capacities, having held the position of general superintendent of the latter road until three years ago, when he was made superintendent of motive power and machinery.





Six-Coupled Passenger Locomotive.—Chesapeake & Ohio Railway.

American Locomotive Company, Schenectady Works, *Builders*.



Longitudinal Section of Boiler.—C. & O. Locomotive.

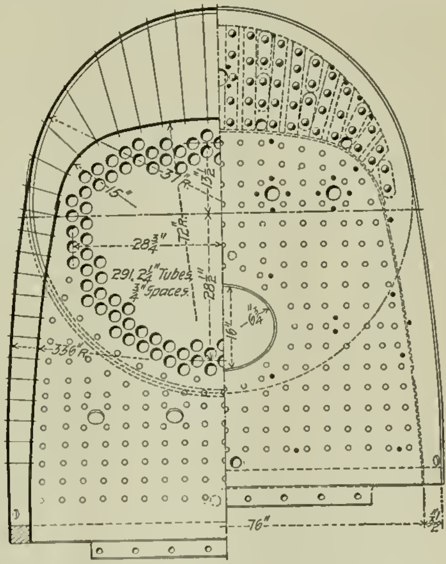
NEW SIX-COUPLED PASSENGER LOCOMOTIVES.

Chesapeake & Ohio Railway.

Missouri Pacific Railway.

In the August number, page 236, a description of two new passenger locomotives of the 4-6-2 type of wheel arrangement for the Chesapeake & Ohio and the Missouri Pacific Railways was begun. General plans are here given of these two engines in the accompanying engravings, and comparisons between the two may be made by aid of the drawings and additional information. There are but three passenger locomotives in the record issued with our June number heavier in total weight than the Chesapeake & Ohio engine, and but one, the Santa Fe Prairie type, with a larger heating surface. In length of flues, 19 ft. 6 ins., this engine leads the list. This length was undoubtedly due to the wheel arrangement and large driving wheels rather than to a desire to exceed previous practice in this particular. However, recent experience with 19-ft. tubes has thus far been satisfactory. These long tubes are 2¼ ins. in diameter. It is interesting to know that the opinion seems to be growing in favor of 2-in. tubes for these great lengths. The smaller tubes are believed to be more easily kept tight. With six-coupled passenger engines with large drivers and wide fireboxes the tube question is important and is worthy of intelligent investigation.

These designs were both made by the American Locomotive Company, that of the Chesapeake & Ohio at the Schenectady,

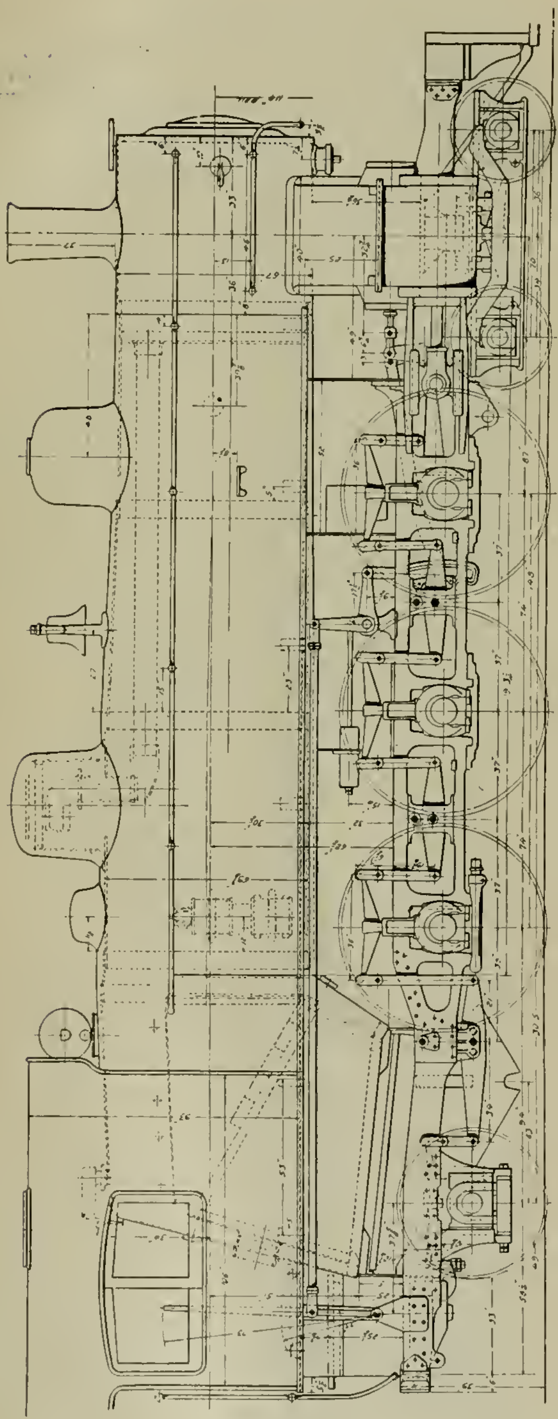


Cross Section Through Fire-Box.—C. & O. Locomotive.

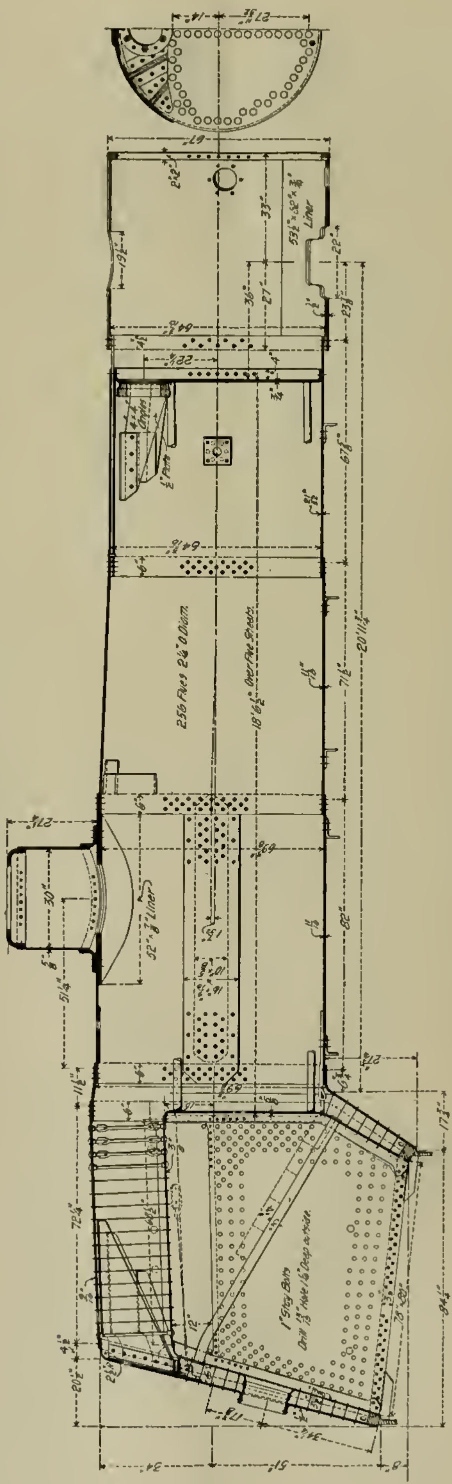
and the Missouri Pacific at the Brooks works. A few comparisons of ratios may be interesting:

	C. & O.	Mo. Pac.
Total weight to heating surface	52.9	58.6
Total weight to weight on drivers	1.427	1.441
Heating surface to grate area	75.1	70.2
Tractive power	32,000 lbs.	25,600 lbs.

Cast steel is used extensively in both designs. Both have inside admission piston valves with direct motion, the details being worked out differently, as appears in the engravings. The trailing trucks are entirely different, that of the Brooks design being Player's radial type, and that of the Schenectady a pedestal truck. The Brooks engine has cast steel hooks for the spring hangers and a novel cast steel, adjustable pedestal binder for the rear driving axle pedestals. This pedestal tie or binder, which is Mr. John Player's patent, is illustrated by



Side Elevation.

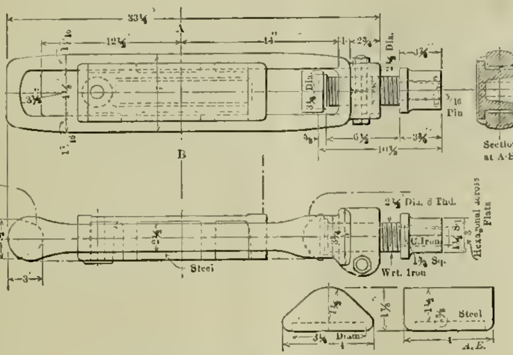


Longitudinal Section of Boiler.

Six-Coupled Passenger Locomotive.—Missouri Pacific Railway.

AMERICAN LOCOMOTIVE COMPANY, BROOKS WORKS, *Builders*.

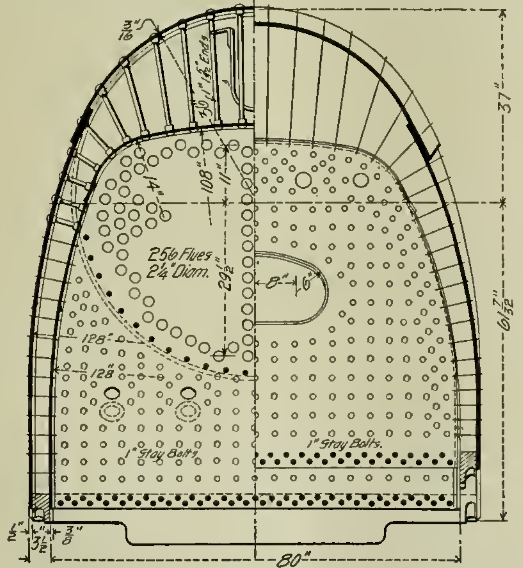
a drawing reproduced herewith, which clearly shows its construction. It is provided with a clamping screw at one end, the other portion of the binder being held and clamped together with bolts to prevent the screws from turning. The end of the binder screw is provided with a cast-iron protecting nut to prevent the corners from being worn off. The spacing block between the pedestal jaws is made of cast iron,



Cast Steel Adjustable Pedestal Binder, Missouri Pacific Locomotive.

and is provided with square wedge bolts. It may be noted that this spacing block is cored to secure extreme lightness. This engine also has Player's new arrangement of the ash pan, with swinging doors hung on compensating links. The frames of both designs have single bar front sections and the fireboxes of both are supported on plates. Other features are made clear by the engravings.

The dimensions of the Missouri Pacific design were printed last month. Those of the Chesapeake & Ohio are as follows:



Cross Section Through Firebox.—Missouri Pacific Locomotives.

Heavy Six-Coupled Passenger Locomotive, 4-6-2 Type.
Chesapeake & Ohio Railway.
Description.

Gauge	4 ft. 9 ins.
Fuel	Bituminous coal
Weight in working order	187,000 lbs.
Weight on drivers	131,000 lbs.
Wheel base, driving	12 ft. 8 ins.
Wheel base, rigid	12 ft. 8 ins.
Wheel base, total, engine	32 ft. 8 ins.
Wheel base, total, engine and tender	60 ft. 0 ins.

Wheels and Journals.

Diameter of driving wheels outside of tire	72 ins.
Material of driving wheels, centers	Cast steel
Tire held by	Shrinkage
Driving box material	Cast steel
Diameter and length of main crank pin journals	7¼ ins. diameter x 4¾
Diameter and length of side rod crank pin journals	5 ins. diameter x 4½
Diameter and length of main side journals	7 ins. diameter x 6½
Diameter and length of driving journals	9 ins. diameter x 12
Engine truck, kind	4-wheel swing bolster
Engine truck, journals	6 ins. diameter x 12
Diameter of engine truck wheels	33 ins.
Kind of engine truck wheels	Steel tired

Cylinders.

Diameter of cylinders	22 ins.
Stroke of piston	28 ins.
Horizontal thickness of piston	5¼ ins.
Diameter of piston rod	3½ ins.
Kind of piston packing	Cast iron rings
Kind of piston rod packing	Metallic

Valves.

Kind of slide valves	Piston type
Greatest travel of slide valves	6 ins.
Outside lap of slide valves	1 in.
Inside clearance valves	⅛ in.
Lead of valves in full gear	Line and line
Kind of valve stem packing	Metallic

Boiler.

Style	Extended wagon top, wide firebox
Outside diameter of first ring	66 ins.
Working pressure	200 lbs.
Material of barrel and outside of firebox	Steel
Thickness of plates in barrel and outside of firebox	11-16 in., ¾ in., ½ in., 23-32 in.
Firebox, length	90 ins.
Firebox, width	75 ins.
Firebox, plates, thickness	Sides ⅜ in., back ⅜ in., crown ⅜ in., tube sheet ½ in.
Firebox, water space	Front 4 and 5 ins., sides 3½ and 5½ ins., back 3½ and 4½ ins.
Firebox, crown staying	Radial stays
Firebox, staybolts	Iron
Tubes, material	Charcoal iron No. 12
Tubes, number of	291
Tubes, diameter	2¼ ins.
Tubes, length over tube sheets	19 ft. 6 ins.
Fire brick, supported on	Water tubes
Heating surface, tubes	3,328.28 sq. ft.
Heating surface, water tubes	23. sq. ft.
Heating surface, firebox	182. sq. ft.
Heating surface, total	3,533.28 sq. ft.
Grate surface	47.02 sq. ft.
Exhaust pipes	Single high
Exhaust nozzles	5¼ ins., 5½ ins. and 5¾ ins. diameter
Smokestack, inside diameter	18 ins.
Smokestack, top above rail	14 ft. 11 ins.

Tender.

Wheels, number of	8
Wheels, diameter	36 ins.
Journals, diameter and length	5 ins. diameter x 9 ins.
Wheel base	16 ft. 8 ins.
Tender frame	10-in. steel channels
Tender trucks	Schenectady Works standard with C. & O. box and center plate
Water capacity	6,000 U. S. gallons
Coal capacity	8 (2,000 lbs.) tons

Petroleum briquettes are being successfully introduced in France. These briquettes are composed mainly of petroleum, crude or refined, and they possess all the advantages of coal and of oil, without the inconveniences of either. They weigh half as much as coal, and leave only 2 or 3 per cent. of residue. They do not melt or run. When stored do not absorb moisture and will keep indefinitely. They will not explode, and are not liable to spontaneous combustion. The method of manufacture is simple; petroleum is placed in one tank and the necessary chemicals in another. Both are allowed to flow into a mixing apparatus, where chemical combination takes place. The product is then pressed to the desired shape, and is ready for use. As this mode of procedure is simple, the plant necessary is very inexpensive. The use of this chemical combination as binder and enricher solves the difficulty encountered in making coal dust or sawdust briquettes. The relative advantage of coal and briquettes may be stated thus: If a boat takes 2,000 tons of coal to steam a certain number of miles, it would require only 1,000 tons of petroleum briquettes to cover the same distance, and steam would have been raised in much less time. These briquettes can be used for any kind of domestic or industrial work. They burn with a very white flame, without smell or smoke, and are convenient and easy to handle. The briquettes are likely to be adopted by the French government, as a cheap and efficient fuel. It is estimated that they would cost about $1.54 for 220 lbs., or, in other words, $14 per ton of 2 000 lbs.

TRACTIVE-POWER FORMULAE.

By George F. Summers, M. E.

It is evident that a simple tractive-power formula will not exactly fit any two engines, for every locomotive has its peculiarities, and not only does each builder have his own ideas about the design, but the general engineering practice is changing from year to year. Where possible, it would seem best to take indicator cards from each class of engines from which to figure the hauling capacity of similar locomotives; and it is for the purpose of basing one engine upon experience with another that the following approximate formulæ are arranged.

The symbols used in this discussion are:

T = the maximum indicated tractive power. That is, the force or pull of a locomotive, at slow speed, on a straight, level track, including the force necessary to overcome the friction of the moving parts as well as that necessary to propel the engine, tender and train. To take out of the tractive power the effect of the internal friction, multiply T by 92 per cent. This figure is taken from Mr. G. R. Henderson's paper on page 205, Master Mechanics' proceedings, 1901. The force to propel the locomotive and tender may be found from tables or other sources, and is not taken up in this article. The remainder is the force at the tender coupler available to pull a train.

C = diameter in inches of low-pressure cylinder.

c = diameter in inches of high-pressure cylinder, or in simple engines of either cylinder.

s = stroke in inches.

D = diameter in inches of driving wheels when new.

H = equals pressure in pounds on piston of low-pressure cylinder, and is equal to the product of the difference between the cylinder area and the average piston-rod area, multiplied by the mean effective pressure for the low-pressure cylinder.

h = pressure in pounds on piston of high-pressure cylinder, or in simple engines of either cylinder.

b = boiler-working pressure in pounds per square inch.

k = the percentage to multiply into the boiler pressure to obtain the mean effective pressure in simple engines, or the sum of one high mean effective pressure and one low mean effective pressure in compound engines.

M = mean effective pressure in pounds per square inch in low-pressure cylinder.

m = mean effective pressure in pounds per square inch in high-pressure cylinder, or in simple engines the mean effective pressure of either cylinder.

For simple engines:

$$T = \frac{kbc^2s}{D};\quad k = \frac{1.27324\ h}{c^2b};\ \ldots\ldots\ldots\ldots (1)$$

log. 1.27324 = .104910, if T is based on card Fig. 1; k = .85905, log. k = — 1.934020.

For two-cylinder compound engines with receiver:

$$T = \frac{kbc^2C^2s}{(c^2 + C^2)\ D};\quad k = \frac{1.27324\ h\ (c^2 + C^2)}{bc^2C^2};\ \ldots (2)$$

If T is based on card Fig. 2; k = .87914, log. k = — 1.944057.

For four-cylinder compound engines without receiver:

$$T = \frac{kbc^2C^2s\left(\dfrac{1}{\dfrac{h}{H}C^2 + c^2} + \dfrac{1}{\dfrac{H}{h}c^2 + C^2}\right)}{D};\ \ldots\ldots (3)$$

FIG. 1.

Simple engine.
C. & N. W. eng. No. 1017.
20 x 26-in. cyl.; 80-in. drivers;
3¼-in. piston rod not extended.
Boiler pressure, 163.
19 miles per hour.
m. e. p., 141.9.

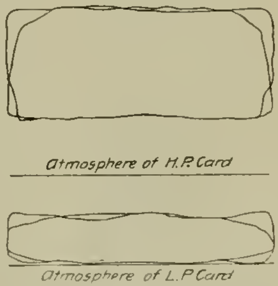


FIG. 2.

2-cylinder compound engine working compound.
Northern Pacific engine No. 170.
22-in. and 34 x 26-in. cyls.; 63-in. drivers; 3¾-in. rods, with 2¾-in. extensions.
Boiler pressure, 204.
10.8 miles per hour.
m. e. p.: h. p. cyl. = 129.13; l. p. cyl., = 53.5.

FIG. 2a.

The same card as Fig. 2, the lengths being reduced to the ratio of the cylinder volumes. The areas of this diagram are proportional to the work done in the cylinders.

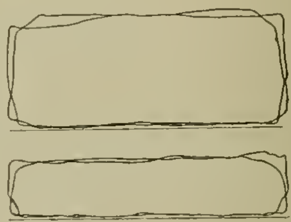


FIG. 3.

2-cylinder compound engine working simple.
Northern Pacific engine.
23-in. and 3 x 30-in. cylinders; 55-in. drivers.
Boiler pressure, 200.
3.3 miles per hour.
m. e. p.: h. p. cyl. = 128.88; l. p. cyl. = 69.0.

Tractive Power Formulae.

$$k = \frac{1.27324\ (h + H)}{bc^2C^2\left(\dfrac{1}{\dfrac{h}{H}C^2 + c^2} + \dfrac{1}{\dfrac{H}{h}c^2 + C^2}\right)};\ \ldots\ldots (3)$$

If T is based on card Fig. 3;

$$k = .87323,\ \log.\ k = -\ 1.941131$$

$$\frac{h}{H} = .75172,\ \log.\ \frac{h}{H} = -\ 1.876057$$

$$\frac{H}{h} = 1.3303,\ \log.\ \frac{H}{h} = .123943$$

For two-cylinder compound engines working simple; consider them as simple engines, with both cylinders the size of the high-pressure cylinder.

For four-cylinder compound engines working simple; consider them as two simple engines, each with two cylinders the size of the high-pressure cylinders.

The formula for simple engines is computed as follows: In equation (3)

make H = h,

and C = c,

then $T = \dfrac{kbc^2s}{D}$, the required formula.

The formula for two-cylinder engines is computed as follows:

For simplicity it is assumed that the work done in the high-pressure cylinder ie equal to that done in the low-pressure cylinder.

Then in equation (3)

H = h; and observing that there are two cylinders instead of four,

$$T = \frac{kbc^2C^2s}{D\ (c^2 + C^2)}, \text{ the required formula.}$$

The formula for four-cylinder engines is computed as follows:

For simplicity it is assumed that the sum of the mean effective pressures is proportional to the boiler pressure, M + m = kb, and that the proportion of work done in each cylinder is the same as in the base engine.

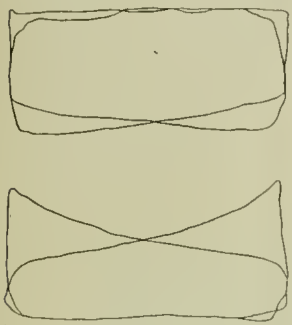


FIG. 4.
Tandem compound engine working compound.
H. p. spring, 100; l. p. spring, 50.
Northern Pacific eng. No. 17.
15-in. and 28 x 34-in. cyl.; 55-in. drivers; 3¾-in. and 3-in. rod not extended.
Boiler pressure, 205.
5.9 miles per hour.
m. e. p.: h. p., 132.2; l. p., 50.2.

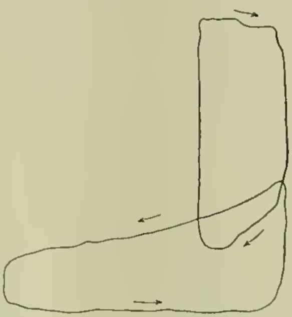


FIG. 4a.
The same card as Fig. 4, the lengths being reduced to the ratio of the cylinder volumes.

$$\frac{m}{M}\frac{c^2}{C^2} = \frac{h}{H},\ m = \frac{MC^2h}{c^2H},\ M + \frac{MC^2h}{c^2H} = kb,$$

$$M = \frac{kbc^2}{\frac{h}{H}C^2 + c^2},\quad m = \frac{kbC^2}{\frac{H}{h}c^2 + C^2}$$

work = force multiplied by distance, therefore force = work divided by distance.

$$\text{Tractive force} = \frac{\text{work done in cylinders}}{\text{distance traveled by engine}}.$$

For one revolution

$$T = \frac{2 \times m \times c^2 \times \frac{\pi}{4} \times 2 \times s + 2 \times M \times C^2 \times \frac{\pi}{4} \times 2 \times s}{\pi D}$$

$$= \frac{kbc^2C^2s\left(\frac{1}{\frac{h}{H}C^2 + c^2} + \frac{1}{\frac{H}{h}c^2 + C^2}\right)}{D}, \text{ the required formula.}$$

"The White Mountains as Viewed From the Summit of Mt. Washington" is the title of an interesting map recently issued by the Boston & Maine Railroad to instruct its patrons concerning the topography of New England. It is finished in several different colors, with a printed list showing the names of each mountain peak, as well as also the numerous ravines and valleys. This map is an instructive work and is something entirely original. It will be mailed to any address by the general passenger department of the Boston & Maine Railroad, Boston, Mass., upon receipt of 6 cents in stamps.

BOOKS.

"Logarithmic Tables of the Measures of Length." Logarithms of lengths, from 0 to 50 feet, advancing by intervals of one-sixteenth of an inch. By Thomas W. Marshall. Published by The Engineering News Publishing Company, New York, 1902. Price, $2.

These tables are apparently intended for the use of draftsmen and computers in structural work mainly. The book is well arranged and of good typography. The two pages open at any place cover one entire foot, the logarithms being given for every sixteenth of an inch. The book is bound in leather, in pocketbook form, and has an introduction clearly explaining the use of the tables.

"Handbook for Street Railway Engineers." A book of tables and formulæ covering the principal electrical and mechanical problems to be met in street railway work. By H. B. Andrews, C. E., Boston, Mass. Bound in morocco, size 3 x 5 ins., 202 pages and 41 figures. Published by John Wiley & Sons, 43 East Nineteenth street, New York, 1902. Price, $1.25.

This little work is intended to present in very compact form the tables and formulæ needed for the problems most likely to be met in practice by street railway engineers. The author, during his long connection with the Boston Elevated Railway Company, has computed and tabulated much of the information given, and the remainder has been compiled from various reliable sources. Information regarding the following subjects, and others, is furnished: Mensuration, trigonometrical formulæ, circular curves, compound transition curves, plain curves, bending moments, strength of materials, data for estimates, aluminum for electrical conductors, the storage battery, relative percentages of expenditures to gross receipts for street railways in Massachusetts. We can recommend this work to those desirous of having at hand a collection of information that will be of the most practical value in every-day work.

American Standard Specifications for Steel. By A. L. Colby, South Bethlehem, Pa. Price $1.10.

Mr. Colby's admirable little book opens with a short introduction in which he briefly traces the history and objects of the movement to standardize specifications for steel. He says that, at first, though these specifications, drawn up by the Association of American Steel Manufacturers, were regarded somewhat by the technical press as "manufacturer's standards," they nevertheless steadily grew in favor among consumers. The work in the main consists of a critical review of these specifications, and the author sets forth the reasons which influenced the committee in reaching its various conclusions. Mr. Colby took an active part in the work of standardization and knows his subject thoroughly. Restrictions as to the details of the manufacture were excluded, because the committee held it to be generally outside the province of the engineer to specify details of metallurgical processes, when afforded facilities for fully testing the finished product. That is practically what many of our railroad cast-iron car wheel makers are saying to superintendents of motive power. In an appendix are given nine standard specifications, which include steel castings, axles, forgings, tires, rails, splice bars, structural steel for buildings, structural steel for bridges and ships, and open hearth boiler plate and rivet steel.

"Theory of Steel Concrete Arches, and of Vaulted Structures," William Cain, M. Am. Soc. C. E. Second edition. Thoroughly revised. Van Nostrand Science Series, No. 42; pp. 182. Price, 50 cents.

In this volume Prof. Cain describes a graphical method for examining the strength of the following structures, viz.: Arches of variable section under vertical loads, culverts and tunnel arches, groined and cloistered arches, and domes of masonry. In particular he discusses thoroughly the method of investigating a concrete-steel arch. Eddy's graphical treatment is followed. The theory of the action of concrete-steel which Prof. Cain uses is not new, but is based on the idea proposed by Prof. Johnson and others, of considering the re-enforcement replaced by an equivalent area of concrete. The usual arch formula is then applied to the graphical results to find the maximum stresses normal to the assumed sections. Prof. Cain also proves that the temperature stresses in a concrete-steel arch are not negligible, as many engineers contend. The book will be very useful to the draughtsman or architect who needs a compact method to determine the stresses in such arched structures, whether of concrete-steel or masonry. The style is clear, the directions are explicit. To the trained engineer it presents nothing new, but may prove valuable for reference.

NEW AIR-BRAKE INSTRUCTION CAR.

New York Central & Hudson River Railroad.

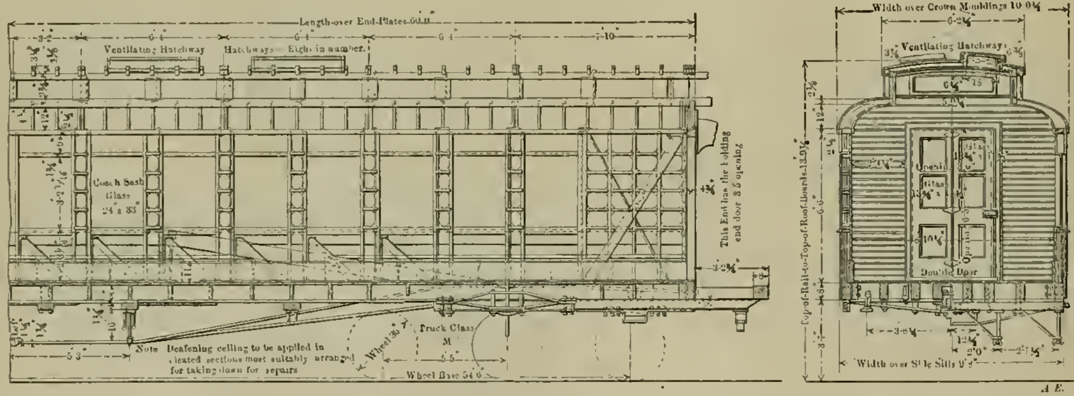
A new air-brake instruction car, involving some interesting new features, has recently been placed in commission by the New York Central. A novel method of ventilation has been introduced on this car for use while classes are in progress, and also a new departure has been made in the method of driving the air-compressor.

The construction of the car is clearly shown in the accompanying side and end sectional elevation views, which also indicate the general dimensions. The method of ventilation mentioned consists of a series of eight ventilating hatchways arranged in pairs along the roof of the car, as shown, which may be opened up during classes. These hatchways give openings of 4 ft. 1¼ ins. long by 1 ft. 6 ins. wide, and are arranged with hinged covers which may be locked shut or open. The hatchway-covers, as well as the roof, are covered with heavy duck canvas embedded in white lead.

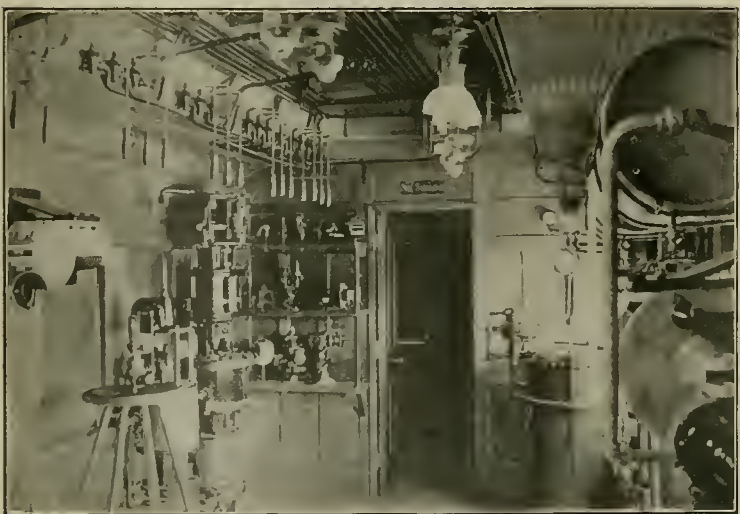
Another convenient improvement in the construction of this car is the double door in the forward end, as shown in the end elevation views. The two doors are hinged together at the middle, and, in opening, double back upon each other, giving thus a total opening of 3 ft. 6 ins. by 6 ft. 5 ins. The flooring of the car is double, consisting of an upper floor 1⅛ ins. thick and a ⅞-in. floor beneath, laid at an angle of 45 degrees.

The car is divided off into three compartments, one at each end and a large one at the middle. The large central compartment, which is 31 ft. long, is devoted to the air-brake instruction equipment, air signal apparatus, models, etc. The forward compartment contains the air-compressor, a work-bench, etc., while the compartment at the opposite end of the car (not shown) contains an office and sleeping compartments for the officials in charge of the car. A desk 24 by 48 ins. is provided, together with a book-case, chairs, etc., on one side, and on the other is a standard upper and lower berth and a closet containing a clothes-press and washbasin.

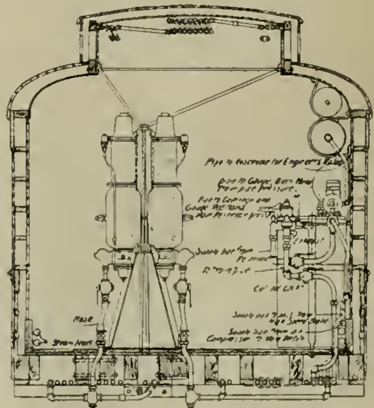
The instruction compartment is provided with a 20-car-train air-brake equipment, the brake cylinders being arranged as shown in the floor plan of the car. The 20 brake cylinders are supported in a framework, which is thoroughly braced, as shown in the elevation views. The various air-brake devices usually carried on locomotives and tenders are secured to the left side of the car at the rear of the central portion. The



Part Side and End Elevation View of Car.



Interior View of Car Looking Toward Office.



Cross Section of Car Through Central Compartment.

New Air Brake Instruction Car.—New York Central & Hudson River Railroad.

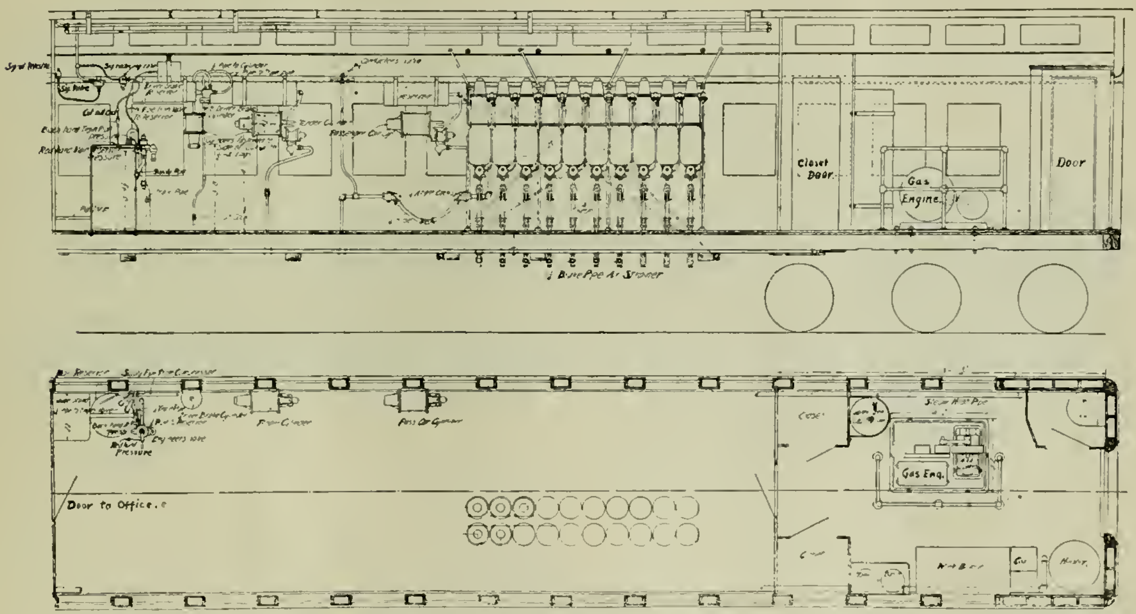
bank of train-line piping is carried under the frame of the car and tightly clamped to the sills to prevent rattling, the cut-out cocks being operated by a key through openings in the floor over the valve stems.

The air signal instruction apparatus consists of a 15-car-train equipment, together with the requisite signal-train-line piping, for illustrating the different handling necessary in signaling from the rear end of a long passenger train as compared with that at the front end. A portion of the signal train-line—the first nine cars—is run along the lower side of the deck between the ventilating hatchways and the remainder is placed outside above the deck windows, as is clearly shown in the interior view of the car. This interior view also shows the location of the signal discharge valves on the right-hand side of the car, as well as the location of the engineer's air-brake valve above the main reservoir at the left side, and the triple valve, governor, brake-cylinder and pump sectional models in the corner opposite.

A very commendable innovation has been introduced in the gasoline engine for such purposes is that a licensed engineer will not be required in attendance in cities having boiler-inspection laws, as with the boiler and steam compressor.

NEWEST TYPE OF SCHMIDT SUPERHEATED STEAM MOTOR.

After many experiments, Mr. J. E. Christoph, Niesky, Lausitz, has succeeded in successfully constructing a Schmidt motor with a double-acting high-pressure cylinder. The engine is tandem compound; diameters of cylinders, 12 and 19½ ins., respectively; stroke, 28 ins.; revolutions per minute, 120. The boiler pressure is ten atmospheres, and the steam is superheated to a temperature of 350 degrees C. The engine is fitted with an apparatus which allows an admission of highly superheated steam for 20 per cent. of the stroke; as soon as the admission becomes greater than 20 per cent., a regulator opens a second valve, which admits saturated steam. The



Partial Longitudinal Section and Plan.

Air Brake Instruction Car.—New York Central & Hudson River Railroad.

method of driving the air-compressor by a gasoline engine, which not only frees the car from the heat, dust and other unpleasant features of the steam boiler, but also renders unnecessary the services of an attendant for the boiler. The gas engine-compressor set is situated in the forward compartment, toward the middle of the floor, for ease of access to all portions of the engine and compressor. The compressor, which is belt-driven from the gasoline engine, has a capacity equal to an 8-in. Westinghouse pump. Cooling water for the cylinder jacket of the engine is supplied from the 98-gallon tank adjacent, and the compressor set is surrounded by a pipe guard-frame. The compressor is 6 by 6 in. and the engine 5 h p.

This is probably the first use of a gasoline engine for driving an air-compressor in such service as this; but why is this not an ideal motive power for such work? It is true that gas engines give trouble when not adjusted properly with respect to the proportion of air and gasoline in the explosive mixture, to the time of the ignition, etc., but the many advantages of cleanliness and independence of operation are too great to be overlooked. An incidental result, also, from the use of the

quantity of saturated steam admitted is greater according as the admission period becomes greater, this arrangement allowing the superheated steam motor to be made double acting.

The engine is installed at the paper works of Mr. F. Erfurt, Straupitz, and an engine economy of 11¼ lbs. of steam per horse-power hour was guaranteed by the maker. Two trials, each lasting eight hours, were carried out. In the principal trial the engine developed 147.75 indicated horse power, the steam consumption was 10.2 lbs. per indicated horse-power hour, and the boiler efficiency was 54 per cent. The temperature of saturated steam corresponding to the pressure was 183 degrees C., the temperature of the steam as it left the superheater was 402 degrees, temperature at admission to the high-pressure cylinder, 339 degrees. The temperature of the gases on the way to the superheater was 615 degrees, after leaving the superheater and economizer it was 176 degrees, while the temperature in the chimney was 131 degrees.

The apparently low boiler efficiency is attributed to the probable leakage of coal air to the flues through the brickwork. —Foreign Abstracts, Institution of Civil Engineers.

GRAPHICAL METHOD OF FINDING LIMIT DIAMETERS FOR CAR AND TENDER AXLES.

R. B. Kendig, Chief Draughtsman, L. S. & M. S. Ry.

The method of analysis devised by an M. C. B. Association Committee of 1896, for arriving at the limit diameter of, or the safe working load which may be applied to, car or tender axles in connection with the design of an axle for an 80,000-lb. capacity car, is conclusive enough to be looked upon as authoritative. Equation 10 of this committee's report, page 152, M. C. B. Proceedings, 1896, for finding the bending moment at any point on the axle between the wheels, can be simplified considerably, as will be shown, without detracting from its accuracy when applied to the usual conditions of practice.

For convenient reference formula 10 is quoted:

$$\text{“Bending moment, } M = \frac{Wb}{2} - \frac{Hh}{m}(X - b) + \frac{Hh_1x}{L} + Hh_2 + \left(\frac{W}{2} - \frac{Hh}{m}\right) h_2 \tan a,\text{”}$$

in which

W = The total vertical pressure on the axle, including allowance of 26 per cent additional for vertical oscillation;

H = The horizontal force caused by curves, switches and wind pressure;

b = Height of center of gravity of car above top of rail;

h_1 = Height of center of gravity of car above center of axle;

h_2 = Height of center of axle above top of rail;

L = Length of axle between points where load is assumed applied;

m = Distance between centers of rails;

h = Distance from center of rail to point where load is assumed to act;

a = Angle that wheel tread makes with horizontal, and

x = Any distance between hubs measured from point where load is assumed applied, to point where bending moment is required.

When we consider the application of this formula in connection with the combination of a standard gauge track, 33-inch wheels and a car having its center of gravity with load six feet above the rail, we have left but three variables, viz.: W, L and X; for we can assume H = .4 W; h = 72 inches; h_1 = 55.5 inches; h_2 = 16.5 inches; m = 59 inches; b = ½ (L — M); tan a = .026. We can now substitute this new value for "b" in the terms in which it is given, and write:

$\frac{WL - Wm}{4}$ instead of $\frac{Wb}{2}$, and

$\frac{2\,Hhx - HhL + Hhm}{2m}$ instead of

$\frac{Hh}{m}(x - b)$;

then by giving numerical values to the symbols representing the quantities assumed as above, we have:

$$M = .25WL - 14.75W - .4881\ WX - 14.4W + .2441\ WL + \frac{22.2\ WX}{L} + 6.6W + .005166W; \ldots\ldots (1)$$

$$\text{reducing: } M = .4941\ WL + \frac{22.2WX}{L} - .4881\ WX - 22.545\ W; \ldots\ldots (2)$$

and further, including 26 per cent. for vertical oscillation:

$$M = W\left(.6226L + \frac{27.97X}{L} - .615X - 28.41\right) \ldots\ldots (3)$$

The bending moment at the center of the axle, "X," becomes .5 L; then we have:

$$M = .3151\ WL - 14.425\ W \ldots\ldots (4)$$

Now, if we assume the hub located the same as with the M. C. B. wheel; that is, 48½ inches face to face of hub, X becomes $\frac{L - 48.5}{2}$ and the moment at the wheel seat becomes:

$$M = .3151\ WL + .489\ W - \frac{678.27W}{L} \ldots\ldots (5)$$

Equations (4) and (5) have been substituted for M in the formula, $d = \sqrt[3]{\frac{M}{.0982f}}$, in which "d" is the diameter and "f" the fibre stress per square inch, the latter being taken at 22,000 lbs., and the results plotted as shown in the accompanying diagram, showing diameter curves for values of W ranging from 10,000 to 45,000 lbs., and values of L ranging from 76 inches to 80 inches, inclusive. In the same manner the bending moment for the journal is substituted in the equation for diameter, the fibre stress being assumed at 10,000 lbs. per square inch. The bending moment is here simply M = .5WJ,

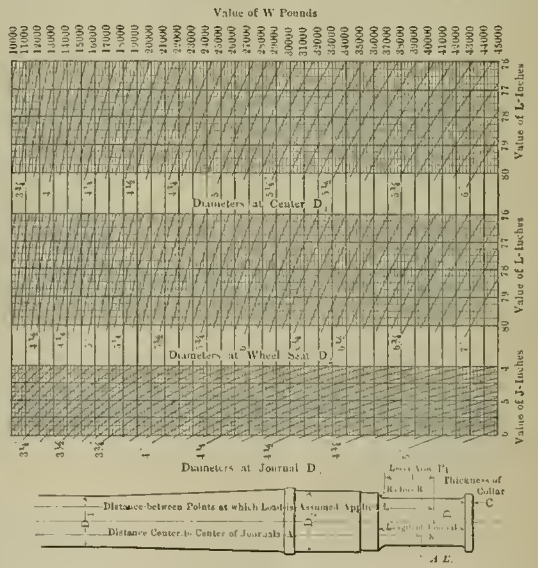


Diagram for Determination of Limit Diameters of Car and Tender Axles.

NOTE—This diagram was accidentally made too small. It will be reproduced in our next number.—EDITORS.

and results are plotted for a range between 4 inches and 6 inches for J.

The factor, L, is found in the manner described by Mr. E. D. Nelson, in a communication to the M. C. B. Association in 1901, viz.:

$$L = A + 2C + R + ½\text{ inch};$$

$$\text{and also } J = \frac{L + K - A - 2R}{2}.$$

The horizontal lines at the upper part of the diagram represent values of "L," and those in the lower group values of "J;" the vertical lines represent the total load, "W," on one axle, and the groups of curved lines represent the diameters at center D_1, at wheel seat D_2, and at journal D_3, respectively, for corresponding values of W and L, and W and J.

As a convenient example showing the application of the diagram, let us take the M. C. B. 5 x 9 inch axle, in which A = 76 inches, C = ¾ inches, R = ¾ inches, and K = 9 inches; then L = 76 + 1½ + ¾ + ½ = 78¾ inches, and J = $\frac{78¾ + 9 - 76 - 1½}{2}$ = 5⅛ inches.

Now, with given axle load of 32,000 lbs., let it be required the proper diameters for the axle: For the diameter at Center D_1, follow down the horizontal line representing value of L = 78¾ inches to the vertical line representing the value of W = 32,000 lbs., and the curve, 5⅝ inches, next above their intersection, is the required diameter. In the same manner D_2, the diameter at the wheel seat, is found to be 6 5-16 inches, and by following down the horizontal line representing the value of J = 5⅛ inches to the vertical line representing 32,000 lbs., we find the diameter at journal to be 4⅜ inches. The curves are plotted by increments of 1-16 inch, but values may be interpolated closer if desired, as those selected in this way will not vary by more than .02 inch either way from results obtained by calculation.

If it is required to apply this chart to a case where wheels are spaced more than 48½ inches between hub faces, the diameter results, as determined by use of the diagram, should be read closely, and the difference between the wheel-seat diameter and diameter at center noted. Then for a new location of the hub face it is a simple question of proportion, as the center diameter D_1 and the wheel-seat diameter D_2 are plotted as though spaced 24¼ inches apart, and the wheel-seat diameter increases in a direct proportion to the increase of the distance of the hub from the center, D_1.

The 1902 report of the Board of Railroad Commissioners of the Commonwealth of Massachusetts, with the returns of 1901, has been received. The intereseting fact is revealed that there are over 1,900 miles of street-railway line in that State, which is only 200 miles less than the total mileage of main and branch lines of the steam railroads in Massachusetts.

Mr. Philip T. Lonergan has resigned as division superintendent of motive power of the New York Central to become superintendent of motive power of the Rutland Railroad.

Mr. A. Lovell has resigned as superintendent of motive power of the Northern Pacific, and will succeed Mr. W. A. Nettleton as assistant superintendent of motive power of the Santa Fe. Mr. A. E. Mitchell, of the C. M. & St. P. Ry., succeeds Mr. Lovell on the Northern Pacific.

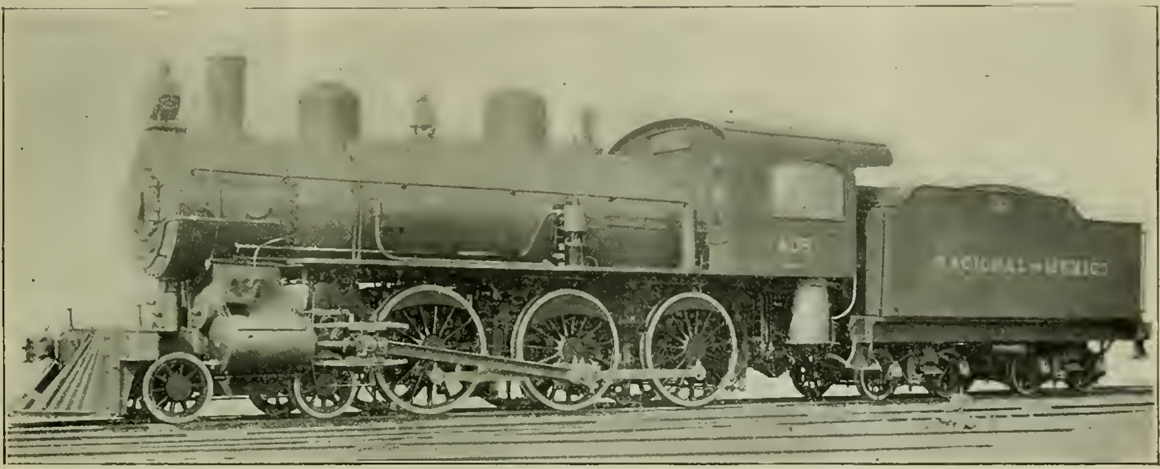
Mr. John Mackenzie has resigned as superintendent of motive power of the Nickel Plate and is succeeded by Mr. W. L. Gilmore.

Mr. J. M. Robb has resigned as master mechanic of the Virginia & Southwestern Railway to accept the position of superintendent of motive power of the Canadian Northern, with headquarters at Winnipeg. Mr. Robb is succeeded upon the Virginia & Southwestern by Mr. John B. Camden.

TEN-WHEEL PASSENGER LOCOMOTIVE.

Mexican National Railway.

The photograph reproduced herewith illustrates one of ten interesting ten-wheel locomotives recently built for passenger service on the Mexican National Railway by the Brooks works of the American Locomotive Company. This is a distinctly American locomotive, with details thoroughly modern, including piston valves, an acetylene headlight, etc. The heating surface is large, being 2,754 sq. ft., and the maximum tractive power of the engine is 28,000 lbs., which, with the adhesive weight of 133,000 lbs., will ensure the maximum drawbar pull under the average condition of rails without the use of sand. A notable feature of this locomotive is the size of the tender, which has a capacity of 7,000 gallons of water and 12 tons of coal. This would seem to be about the limit of size for passenger service.



New Ten-Wheel Passenger Locomotive—Mexican National Railway.

The following table will present the principal dimensions of this locomotive:

Ten-Wheel Passenger Engine.
Mexican National Railway.

Gauge	4 ft. 8½ ins.
Fuel to be used	Bituminous coal
Weight, total	172,000 lbs.
Weight in driving wheels	133,000 lbs.
Weight on leading wheels	39,000 lbs.
Weight, tender loaded	140,000 lbs.
General Dimensions.	
Wheel base, driving	14 ft. 6 ins.
Wheel base, total, of engine	25 ft. 7 ins.
Wheel base, total, engine and tender	56 ft. 3½ ins.
Length over all, engine	39 ft. 4 ins.
Length over all, total, engine and tender	66 ft. 3 ins.
Height, center of boiler above rail	8 ft. 9 ins.
Height, stack above rail	14 ft. 11½ ins.
Heating surface, firebox	177 sq. ft.
Heating surface, arch tubes	23 sq. ft.
Heating surface, tubes	2,553.7 sq. ft.
Heating surface, total	2,753.7 sq. ft.
Grate area	35.15 sq. ft.
Wheels and Journals.	
Wheels, leading, diameter of	33½ ins.
Wheels, driving, diameter of	68 ins.
Wheel centers, material of	Driving wheels, cast steel
Wheel centers, material of	Engine truck wheels, cast iron, spoke center
Journal, leading axles	5½ ins. x 12 ins.
Journal, driving axles	9 ins. x 12 ins.
Cylinders.	
Diameter of cylinders	20 ins.
Stroke of piston	28 ins.
Piston rod, diameter	3¾ ins.
Tractive force	28,000 lbs.
Valves.	
Valves, kind of	Improved piston
Valves, greatest travel	5 15-32 ins.
Valves, steam lap (inside)	1⅛ in.
Valves, exhaust clearance (outside)	0
Lead in full gear	1-16 in.
Steam ports, length	25½ ins.
Steam ports, width	1⅞ in.

Exhaust ports, least area	65 sq. ins.
Bridge, width	2 ins.
Boiler.	
Boiler, type of	Extended wagon top, radial stayed
Boiler, working pressure	200 lbs.
Boiler, material in barrel	Steel
Boiler, thickness of material in shell	9-16 in., 5/8 in., 1/2 in., 11-16 in.
Boiler, thickness in tube sheet	3/4 in.
Boiler, diameter of barrel front	67 7/8 ins.
Boiler, diameter of barrel at throat	75 1/2 ins.
Seams, kind of horizontal	Sextuple
Seams, kind of circumferential	Double
Firebox.	
Firebox, length	124 ins.
Firebox, width	42 ins.
Firebox, depth, front	77 ins.
Firebox, depth, back	60 ins.
Firebox, thickness, sheets	Crown 3/8 in., tube 5/8 in., side 3/8 in.
Tubes, number of	348
Tubes, material	Charcoal iron
Tubes, diameter outside	2 ins.
Tubes, thickness	12 B. W. G.
Tubes, length over tube sheets	14 ft. 1 5-16 ins.
Smokebox, length from tube sheet	64 1/2 ins.
Exhaust nozzle	Single, not variable; 5 3/4 ins. diameter
Tender.	
Tank, type	Gravity water bottom
Tank, capacity for water	7,000 gallons
Tank, capacity for coal	12 tons
Tank, material	Steel
Type of under frame	Steel channel
Type of trucks	American basic steel bolsters
Diameter of wheels	33 1/2 ins.
Diameter and length of journals	5 1/2 x 10 ins.

COMPARATIVE ACCELERATION TESTS WITH A STEAM LOCOMOTIVE AND ELECTRIC MOTOR CARS.

By B. J. Arnold and W. B. Potter.

In connection with the preparation of a report [the report appearing on page 251 of our August issue.—Ed.] on the use of electricity for the propulsion of trains of the New York Central Railroad in the tunnel entrance and terminal in New York City, an invitation was extended by the General Electric Company to Mr. W. J. Wilgus, chief engineer of the railroad company, to use its experimental track and apparatus at Schenectady, and a series of tests were accordingly carried out, principally for the purpose of determining a comparison between steam and electric traction on short-haul suburban passenger service. The short curves in the connecting tracks prevented the General Electric Company's track from being used for the steam locomotive tests, so that the steam tests were made on the New York Central main-line tracks west of Schenectady.

(The steam locomotive used in these tests was the very heavy 6-coupled suburban locomotive which was recently built for the New York Central from the specifications of Mr. A. M. Waite, superintendent of motive power and rolling stock, by the Schenectady Locomotive Works, and which was illustrated and described on page 115 of our April, 1902, issue.) This locomotive was designed specially for the rapid acceleration work required in suburban service, being provided with large grate area and heating surface and a very large proportion of weight on its driving wheels.

Electric Train Used in the Comparative Acceleration Tests.—(The two forward cars are the motor cars.)

The two electric motor cars used for the electrical tests were similar in form, 54 feet over all, each weighing about 35 tons including the electrical equipment, which consisted of four General Electric 55 motors and type M control. All axles being equipped with motors, the two cars together gave approximately the same weight upon the drivers as the steam locomotive. The acceleration was, therefore, directly comparable for trains of equal net weight, and, to secure this comparison, the same trail cars, arranged in the same order, were used in both the steam and electric tests. In the steam-runs the drawbar pull, speed and time were recorded by the Illinois Central dynamometer car, and the same car was used with the electric motor cars to determine the relation between the current input in amperes and the drawbar pull.

The order of the tests, both steam and electric, was as follows: A train of six cars, including five standard New York Central passenger coaches and the dynamometer car, was started and run over a mile of track, acceleration being made as rapidly as possible. These runs were repeated, dropping off one car at a time, until only the dynamometer car remained. Automatic records were kept of the drawbar pull, speed, time, distance, and the strength and direction of the wind. The condition of rail and temperature was also noted. The same runs were repeated, using the two electric motor cars in place of the steam locomotive, additional records being kept of voltage, ampere and wattmeter readings. The wattmeter was not carried on the car, but was placed stationary at the point of feeding the third rail, thus avoiding any inaccuracy due to jarring. The voltage leads of the watt-

* Abstract of a paper read before the June convention of the American Institute of Electrical Engineers at Great Barrington, Mass.

It is undoubtedly the desire of every one of our readers to occasionally, if not frequently, purchase books upon engineering and scientific subjects, but the selection of the most suitable book from those offered by the publishers is most difficult if one is not able to see the books personally. It has been truly said that "titles of books are very misleading," as they are so in many cases, as one finds upon ordering a book without seeing it in advance. An innovation is offered in this line, however, by the Derry-Collard Company, recently formed with offices at No. 256 Broadway, New York. This company proposes to make selections of books, to the best of their judgment, for those stating to them their wants and desires with respect to the purchase of books, and will forward the book selected to the purchaser for examination, whereupon he may pay for same if it is suitable, or return it if it is not just what is wanted. Any book published will be procured, and will be sent to anyone without any references and without any extra charge for the service. This proposition appears to be a boon to those desiring to purchase technical books, and we feel sure that the best of selections will be made owing to the technical ability incorporated in the officers of the company.

Mr. F. J. Kraemer has been appointed master mechanic of the Wyoming division of the Burlington & Missouri River, with headquarters at Alliance, Neb., to succeed Mr. J. P. Reardon. Mr. A. B. Pirie has been made master mechanic of the Southern division, with headquarters at Wymore, Neb., to succeed Mr. Kraemer. Mr. W. F. Ackerman succeeds Mr. Pirie as master mechanic of the Havelock shops. Mr. C. S. Bricker succeeds Mr. Pirie as piecework inspector.

meter were connected to the extreme end of the third rail and track, thus receiving at all times the exact voltage at the train, so that the energy delivered to the motor cars represented the net input and did not include losses in the feeder system.

The Electric Runs.—Electric Motor Cars Nos. 4 and 5.

The electric runs were made upon the General Electric experimental track against a head wind of 15 m. p. h. The rail was dry, the temperature 8 degrees C., and the grade practically level. In the middle of the run there was a curve having a minimum radius of 875 feet, equivalent to about a 6½-degree curve, the effect of which may be assumed as approximately equivalent to the 1 per cent. up grade met on the steam runs.

No. of run.	Character of load.	Weight of load, tons.	Total weight train, tons.	Maximum speed.	Average speed.	Watt hours per ton mile. From volt amperes.	Watt hours per ton mile. From watt-meter.
1	... 6 Trailers	157.	228.5	36.4	27.2	75.9	79.4
3	... 5 Trailers	130.	201.5	37.9	28.6	78.4	82.0
5	... 4 Trailers	104.	175.5	39.1	29.8	84.3	86.9
7	... 3 Trailers	77.	148.5	41.0	30.6	81.7	93.4
9	... 2 Trailers	47.	118.5	42.8	32.0	98.5	99.4
11	... 1 Trailer	23.	94.5	44.7	33.1	115.0	114.0
13	...No Trailer	...	71.5	46.7	34.6	132.3	129.0

One of the General Electric Co.'s Motor Cars—Used in the Comparative Acceleration Tests.

[This view shows also the Improved Type of Protected Third Rail and Contact Shoe, used on the General Electric Co.'s Test Railroad.]

The Steam Runs.—New York Central Steam Locomotive No. 1407.

All steam locomotive runs were made upon the New York Central main-line track west of Schenectady, against an up grade of 1 per cent. and a head wind of 15 m. p. h. The temperature was 4 degrees C., and the rail wet with a very light falling snow.

No. of run.	Character of load.	Weight of load, tons.	Total weight of train, tons.	Maximum speed, m.p.h.	Average speed, m.p.h.
2	.... 6 Trailers	157.	264.	30.0	28.2
4	.... 5 Trailers	130.	237.	41.3	28.1
6	.... 4 Trailers	104.	211.	40.9	27.4
8	.... 3 Trailers	77.	184.	45.7	27.3
10	.... 2 Trailers	47.	154.	48.0	30.1
12	.... 1 Trailer	23.	130.	50.9	33.0

Although this locomotive was especially built for suburban, or acceleration, work, and was provided with a large firebox, giving it facilities for rapid steaming, the pressure dropped from 200 lbs. to less than 185 lbs. during the first part of acceleration. In starting, the throttle was opened wide and steam used full stroke, the engine being hooked up as acceleration proceeded. Although the steam locomotive was able to give a maximum tractive effort at starting equal to that obtained electrically, this high tractive effort was not maintained, but immediately fell off with increased speed, even with the most expert handling. Even though the electric runs had the advantage of dryer rails than the steam runs, the driving wheels were not slipped in either instance.

(The results of these runs have been represented graphically, as shown in the accompanying engravings. In each run the drawbar pull, the speed, and, in the electric runs, the voltage and amperes per train, have been plotted with respect to the number of seconds after the start, and for ease of comparison the curves for corresponding steam and electric runs have been superimposed, as shown, Steam Run No. 2, upon Electric Run No. 1, etc. In this way direct comparisons of the steam and the electric service may be made.)

As the acceleration curves produced by the steam locomotive and electric motor cars have different shapes, and as in the two tests there was about the same weight upon the drivers, it is interesting to note how well this driver weight was utilized. This is shown by the following tables giving the speed reached in ten, twenty and thirty seconds with equal trailing load for both electric and steam trains.

Miles Per Hour Attained in 10 Seconds.						
Number of trailers	1	2	3	4	5	6
Motor cars No. 4 and 5..........	22.5	20.7	17.3	14.4	12.6	11.
Locomotive No. 1407............	14.	13.	12.5	12.	10.	9.7
Miles Per Hour Attained in 20 Seconds.						
Number of trailers	1	2	3	4	5	6
Motor cars No. 4 and 5..........	34.	32.3	29.4	27.4	24.5	21.2
Locomotive No. 1407............	25.	21.2	21.5	19.5	18.	16.3
Miles Per Hour Attained in 30 Seconds.						
Number of trailers	1	2	3	4	5	6
Motor cars No. 4 and 5..........	38.2	36.4	34.2	32.	30.3	28.1
Locomotive No. 1407............	31.7	26.2	27.	24.7	23.2	20.8

An inspection of the above tables and diagrams brings out clearly the fact that the electric motors can during acceleration more effectively utilize the weight upon their drivers than a steam locomotive. As rapid acceleration is especially important when stops are a mile or so apart, the electric motor has an advantage in being able to cover the same distance in the same time with less energy expended and at less maximum speed than with the steam locomotive, owing to its being able to maintain its maximum accelerating rate for a longer period.

The average speed given in both steam and electric tables is the average speed of the train while it is in motion, and does not include time of any stop at the end of the run. Starting from rest, the power was kept full on to the three-quarter mile post, where the power was shut off and the brakes applied in such a manner as to bring the train to rest as near the mile post as practicable. In the tests the steam train ran from 5 to 15 per cent. over a mile before the train was brought to rest, and the electric trains from 2 to 4 per cent.; but even with the longer distance, the average speed of the steam runs only approaches that attained in the electric runs made over a shorter distance. A comparison of the two sets of runs on the basis of average speed is therefore not quite fair to the electric motor car, as its average speed would have been considerably higher if the length of the run had been the same as that made with the steam locomotive. An inspection of the tables will show, however, that even with the shorter distance run the electric motor cars were able to make higher average speeds than the steam locomotive over its longer distance, and these higher average speeds were obtained also with a lesser maximum speed.

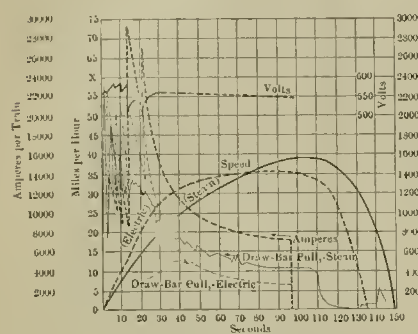
The maximum speed of a train making a given run in a given time serves as an indication of its energy consumption. A train, therefore, which is so handled as to make a given run in a given time, with lowest maximum speed, will consume less energy for the run. The electric runs tabulated all show a lower maximum speed and a higher average speed than those runs made with the steam locomotive, and the energy consumption of the electric runs should therefore be less for the same service performed than with the steam locomotive.

The motors of an electrically equipped train may be placed upon the trucks of ordinary passenger coaches, each carrying its full complement of passengers, and thus lessen the gross weight of each train by elimination of the locomotive; also, in reality, the true measure of comparison between steam and electrically propelled trains should be the energy per seat mile rather than per ton mile, as the latter is based upon the total train weight, and includes a considerable proportion of dead weight embodied in locomotive and tender. The weight of the electric motors is much less than the weight of a steam locomotive capable of performing the same service, as the latter, in addition to its tender, must be heavy enough upon its drivers to provide a drawbar pull sufficient to accelerate the train.

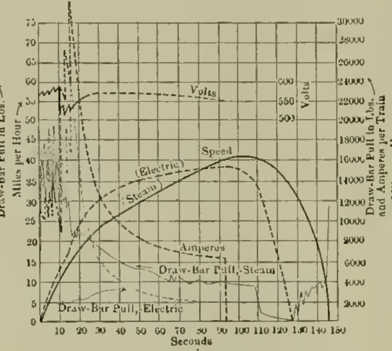
As an illustration, the following table has been prepared from these tests, showing the number of cars in the train, the number of passengers carried (each car seating 64 people), and the energy, which for convenience we have given in watt hours, required per passenger, for both steam and electric runs.

Efficiency of Electric Runs.

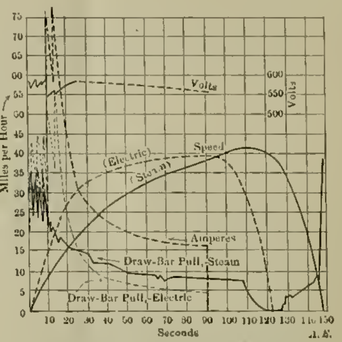
Trailers.	Average m.p.h.	Watt hours per ton mile, Output.	Input.	Efficiency of run.
6	27.2	59.1	79.8	74. %
5	28.6	61.0	82.0	74.3%
4	29.8	63.8	84.9	75.3%
3	30.6	68.0	90.2	75.3%
2	32.	69.6	99.6	69.9%
1	33.1	75.3	112.8	66.7%
0	34.6	79.8	130.0	61.5%



Electric Run No. 1 and Steam Run No. 2.



Electric Run No. 3 and Steam Run No. 4.

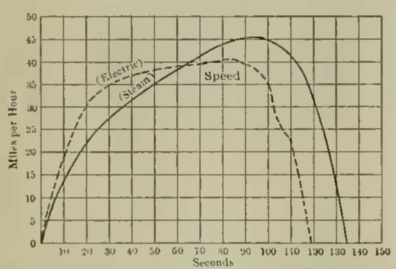


Electric Run No. 5 and Steam Run No. 6.

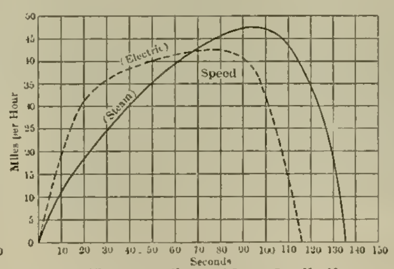
Electric..........6 Trail Cars.	
Weight	157 tons
Weight, including motor cars	228.5 tons
Power on	4,170 ft.
Distance run	5,380 ft.
Watt-hours per ton mile	79.4
Steam..........6 Trail Cars.	
Weight	157 tons
Weight, including locomotive	264 tons
Power on	4,035 ft.
Distance run	6,150 ft.

Electric..........5 Trail Cars.	
Weight	130 tons
Weight, including motor cars	201.5 tons
Power on	4,170 ft.
Distance run	5,380 ft.
Watt-hours per ton mile	82
Steam..........5 Trail Cars.	
Weight	130 tons
Weight, including locomotive	237 tons
Power on	4,270 ft.
Distance run	6,050 ft.

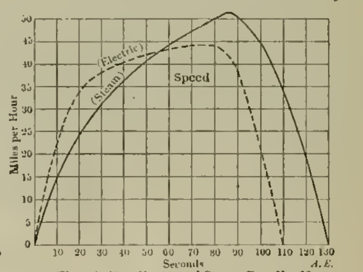
Electric..........4 Trail Cars.	
Weight	104 tons
Weight, including motor cars	175.5 tons
Power on	4,135 ft.
Distance run	5,380 ft.
Watt-hours per ton mile	86.9
Steam..........4 Trail Cars.	
Weight	104 tons
Weight, including locomotive	211 tons
Power on	4,490 ft.
Distance run	5,943 ft.



Electric Run No. 7 and Steam Run No. 8.



Electric Run No. 9 and Steam Run No. 10.



Electric Run No. 11 and Steam Run No. 12.

Electric..........3 Trail Cars.	
Weight	77 tons
Weight, including motor cars	148.5 tons
Power on	1,470 ft.
Distance run	5,370 ft.
Watt-hours per ton mile	93.4
Steam..........3 Trail Cars.	
Weight	77 tons
Weight, including locomotive	184 tons
Power on	4,520 ft.
Distance run	5,930 ft.

Electric..........2 Trail Cars.	
Weight	47 tons
Weight, including motor cars	118.5 tons
Power on	4,100 ft.
Distance run	5,490 ft.
Watt-hours per ton mile	99.4
Steam..........2 Trail Cars.	
Weight	47 tons
Weight, including locomotive	154 tons
Power on	4,455 ft.
Distance run	5,927 ft.

Electric..........1 Trail Car.	
Weight	23 tons
Weight, including motor cars	94.5 tons
Power on	4,060 ft.
Distance run	5,350 ft.
Watt-hours per ton mile	114
Steam..........1 Trail Car.	
Weight	23 tons
Weight, including locomotive	130 tons
Power on	4,460 ft.
Distance run	6,260 ft.

Net Energy Per Passenger Carried.

Number of Cars.	Number of Passengers.	Watt Hours per Passenger Steam.	Electricity.
6	384	43.9	29.7
5	320	52.2	32.1
4	256	57.5	33.5
3	192	77.4	37.5
2	128	103.0	45.2
1	64	187.8	45.2

This table is based upon the actual net energy delivered to the wheels of the train, and does not include the losses inherent to any system of operation. The results tabulated may, therefore, be considered as fundamental, and typical of the two systems of operation—the steam locomotive and the electric motor car.

The following table gives the efficiencies for the seven electric runs, the efficiency being the ratio between net energy output to the wheels and total volt ampere input:

An accurate comparison of the relative efficiency or coal consumption of steam and electric power for similar service would require an extensive series of tests with indicator and dynamometer on the performance of the steam locomotive. But as a matter of interest we have secured an approximate comparison from a single test by weighing the coal and water taken by steam locomotive No. 1407 for a period of 24 hours, covering four trips between North White Plains and Grand Central Station, a distance of 24.75 miles, on the Harlem division of the New York Central. The trips occupied about 4 hours, the yard movements about 1 hour, and the locomotive was idle for 19 hours. The following is a detailed record:

North White Plains to Grand Central Station.

Time.	Number of Cars.	Number of Stops.	Total Weight.	Weight of Cars.	Effective H.P. Hours.
63.5 min.	3	21	204 tons	97 tons	129
Lay-over................6 hours.					

Grand Central Station to North White Plains.

Time.	Number of Cars.	Number of Stops.	Total Weight.	Weight of Cars.	Effective H.P. Hours.
66.25 min.	5	17	278 tons	171 tons	255

Lay-over.............. 12 hours.

North White Plains to Grand Central Station.

Time.	Number of Cars.	Number of Stops.	Total Weight.	Weight of Cars.	Effective H.P. Hours.
60.3 min.	7	13	387 tons	280 tons	231

Lay-over...............¾ hours.

Grand Central Station to North White Plains.

Time.	Number of Cars.	Number of Stops.	Total Weight.	Weight of Cars.	Effective H.P. Hours.
59.75 min.	4	20	256 tons	149 tons	246

Lay-over...............1¼ hours.
Total effective H.P. hours hauling coaches 861
Coal consumed .... 13,412 lbs.
Coal per effective H.P. hour .... 15.6 lbs.

The effective H. P. hours given above is the energy required for movements of the cars only, exclusive of the locomotive, and was determined from the drawbar pull taken by dynamometer car in previous tests over the same route. The coal consumption covers all coal burned during the period of 24 hours, not only for movement of cars, but also movement in the yard and the banking of fires during lay-overs.

The effective H. P. hours to move the cars serves as the basis of comparison with electric service, the coal consumed by the locomotive for whatever purpose being properly chargeable to the net work done by the locomotive during the period.

The efficiency of an electrical system, as an average under variable load, may reasonably be assumed as follows:

	Efficiency, Per Cent.
Engine	.90
Alternator	.92
High potential transmission	.98
Transformers	.97
Converters	.92
Third rail	.95
Motors, including control	.75
Resultant efficiency	51.33

This percentage of effective horse-power output of motors to indicated horse power of engine will vary somewhat, depending on the load factor. As an even figure, we will assume an efficiency of 50 per cent. Coal consumption per indicated horse-power hour, from actual records of electric power stations, is in some cases less than 2 lbs., the average being about 2½ lbs. At the latter figure, the coal per effective horse-power hour output of electric motors would be 5 lbs. Assuming the head-end air resistance as 10 per cent., and as the electrical equipment would increase the weight of the cars about 20 per cent., the actual comparison of coal consumption would be approximately in the ratio of 6.6 for electric and 15.6 for steam.

Assuming that coal for a power station can be purchased for 80 per cent. of the cost per ton of that used in the locomotives, and that the cost of coal for electrical power is about one-third of the total cost, including maintenance and interest on investment, it is probable that the actual gross cost of electrical power would closely approximate the coal consumption of a steam locomotive in this class of service, the maintenance of the electrical equipment and attendance required being, however, considerably in favor of the electric power.

LEAKS IN CAR WORK EXPENSES.

Mr. G. W. Rhodes opened a discussion of the possible opportunities of the savings in connection with car work (at Saratoga in June) by comparing railroad methods with the use of meters by municipal water companies to stop the waste of water. Continuing, he said:

"A railroad company furnishes all its supplies without meters, and the wastes that consequently occur are simply enormous. Let me cite a few cases that may be seen almost any day. What justifies a railroad company in allowing its locomotives to run with their headlights lit at 1 or 2 o'clock in the afternoon? Go to any union depot on a bright sunny day at 2 and 3 o'clock in the afternoon and it is not unsual to find headlights lit. Why? Simply because there is no meter. We would not allow such a waste at home because we would have to pay for the oil. On a railroad, where oil is obtained simply by asking for it, it is a quite sufficient excuse to say the train does not stop when it begins to get dark, or else that we are traveling in a windy country, and, therefore, cannot light the headlight out of doors. Such an argument goes with the average railroad man, although it is equally well known that by folding and dropping a lighted discarded train order down the chimney of the headlight the lamp can be lit in the strongest gale of wind.

"Take again the matter of lights in coaches. At our homes nobody thinks of lighting lamps an hour or two before it is dark, but there is hardly a railroad that does not have its lights lit while the sun is still shining. Recently in going east from Chicago the Pintsch gas was turned up in the sleeper in which I sat while in the depot, which was all right, as the depot was dark. As soon as we got out of town the sun was shining brightly, but the 24 burners in the car were all allowed to remain burning turned on full. No one would have thought of such extravagance anywhere excepting on a railroad. No check was kept on the gas consumed and no one at the end of the month was any wiser whether much or little was used. Many other cases might be cited if time permitted.

"The remedy for this and similar wastes is a more general use of meters; the only meter that is practicable on a railroad is railroad accounts. We have not a great deal of information as to just what the various departments of a railroad ought to cost. Some railroad men are better informed on these matters than others, and know by looking over the meters, or accounts, whether improvements can be made or not. Let us consider for a moment the question of car oil. A few years ago it was considered remarkably cheap with oil costing 20 cents per gallon to lubricate freight car equipment for 8 cents per 1,000 miles. The railroad official to-day who does not keep his cost of freight car oil down to an average of 4 to 6 cents per 1,000 miles is laying himself open to a great deal of criticism. A reduction in freight car lubrication, with oil at 20 cents per gallon, from 12 cents per 1,000 miles to 4 cents per 1,000 miles on a railroad of 4,000 miles extent, is the equivalent of a saving of $8,000 per year, a figure that is well worth the expense of an intelligent meter.

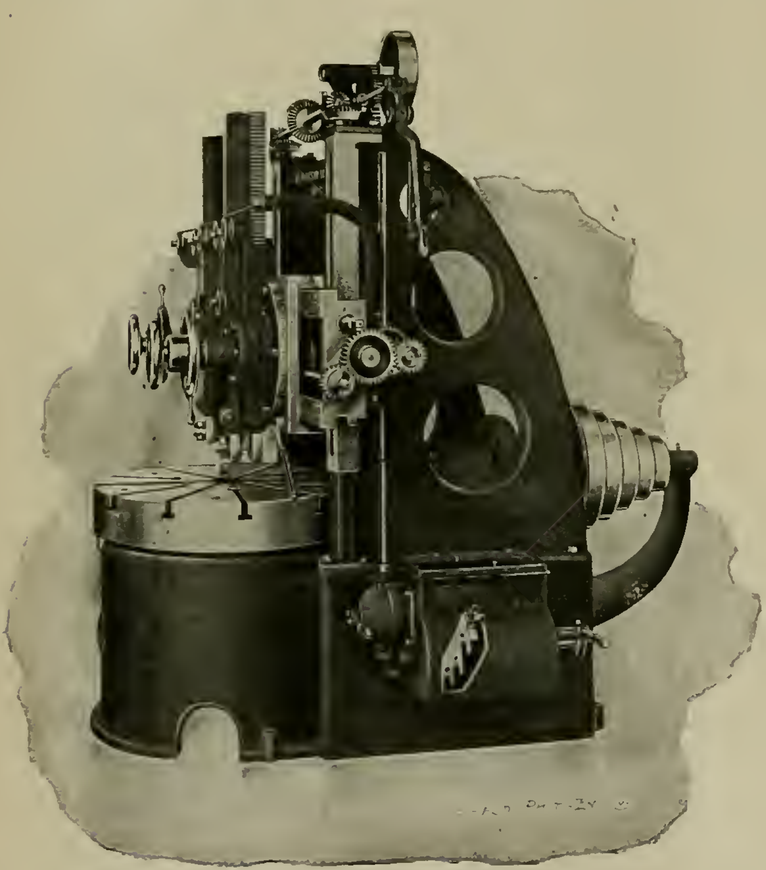
"The substitute for meters in railroad work then is carefully compiled accounts. I well know that operating men are too busy to be in full touch with the many accounts on a railroad, but we have able help in this matter in the auditing department, and I would urge car men and machine shop men to keep in close touch with the auditing department. Get them interested in showing how our meters read. They have charge of a most important department, and it is available to all of us if we will use it. The most successful railroad of to-day is the one that can operate cheaper than its neighbor. This is what has given this country its commanding commercial position among nations. Through our economical methods of production and of transporting we are able to invade the markets of every continent throughout the world. I therefore urge the members of our association to be untiring in watching the meters of their department and stop some of the wastes that even at the present time are so glaringly prominent on many of our best railroads."

The M. C. B. coupler, in spite of its faults, will stand as a remarkable piece of work of the Master Car Builders' Association. Up to the present it has stood tests of service which could not have been foreseen by those who made it standard, and it has stood well. Its general use brings a serious difficulty, however, as it becomes evident that greater strength is now needed, and at the recent convention the Committee on Coupler Tests suggested a change in the contour to permit of the use of 1¾-inch knuckle pins, this change to be made very gradually, to avoid interference of contours, which would defeat the very object of the standard contour. The history of the M. C. B. coupler as to contours and the lack of conscientious following of the standard lines by the manufacturers does not inspire confidence in this method of securing the necessary additional strength. It is not at all likely that hasty action will be taken in this direction, and before anything is done a better way out of the difficulty may be found. Such a way has already been brought to the attention of this journal and it will be put before the readers in a short time.

A NEW BORING AND TURNING MILL

The trend of progress in machine-shop methods has brought the boring mill into nearly as great importance as the lathe. The large number of operations that can be made on a boring mill to far greater advantage than in the lathe, both for boring and for turning, should bring the boring mill into much more extensive use in railroad shops.

The accompanying engraving is an illustration of an improved type of boring mill recently brought out by the Bausch Machine Tool Company, Springfield, Mass., which embodies many important new features, adding greatly to its economic value as a machine tool. One of the most important features of this tool is the addition of positive-drive feeding mechanisms, of which there is an independent mechanism for each of the two heads of the machine, thus rendering different rates of feed possible for the tool in each head. These gear mechanisms, one of which is shown located at the lower right-hand side of the machine, are adaptations of the well-known Hendey-Norton variable-speed gearing device, which consists of a cone of gears of differing sizes and a gear movable upon a splined shaft and capable of being thrown into mesh with any gear of the cone. Power for the feeds is delivered through vertical splined shafts, which engage with feed gears on the cross-rail. By this means fifteen changes of feed at the heads, ranging from 1-64 to 9-16 in., for vertical, and from 1-64 to ⅞ in., for horizontal, per revolution of the table are possible, and may be made almost instantly and without stopping the work. This method of changing the feeds has great advantages over the belt and cone-pulley method, even in view of the fact that the gear-drive will not spare the tool as the slipping of a belt will in a belt-drive.



The New Bausch Boring Mill.

The back gears of this machine are arranged to be thrown in or out by means of a lever, thus avoiding the use of the lock-nut, another unquestionable saving of time. The cross-rail is arranged to be rapidly raised and lowered by power controlled by the lever shown at the top of the frame, and the heads, besides being operated and adjusted independently, are provided with split nut arrangements permitting them to be moved back and forth very rapidly for quick adjusting to the work.

The table may be removed and replaced by either an independent or universal chuck, all being interchangeable. The main spindle bearing is very large and long, and is provided with a self-oiling device. These mills may be changed over for direct motor-driving by simply removing the cone pulley and bearing, and connecting up in their place on the bed a suitable electric motor.

Among some of the machining operations to which the boring and turning mill is particularly adaptable may be mentioned: Turning, facing and boring all special, irregularly shaped castings, which are very difficult to chuck in a lathe, such as gate-valve castings, large, rectangular-shaped castings, cylinder heads, etc.; also, large, thin rings may be easily handled, and special operations may often be expediently handled, such as boring a casting with a tool in one head and facing or turning another part of the casting with the other head. No trouble is experienced with the boring mill if the work is entirely out of balance, as there is with the lathe.

The development of the alcohol industry in Germany is fostered by the government, because of the lack of petroleum deposits in that country. Denaturized alcohol, suitable for industrial purposes, is free from tax, whereas the alcohol for drinking is highly taxed. The result has been a great increase in the product from potatoes and other cheap sources. It has led to a development of the alcohol engine, which is important as well as interesting.

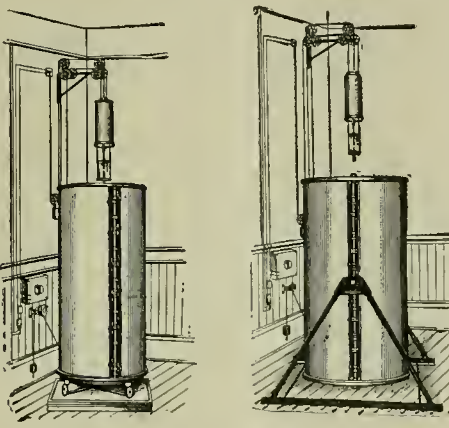
Mr. A. G. Wells has recently been appointed general manager of the Coast lines of the Santa Fe system, with headquarters at Los Angeles, Cal. He has made the following appointments: F. J. Shepard, general superintendent of the Coast lines; R. B. Burns, chief engineer, and G. R. Jougins, mechanical superintendent.

Mr. W. E. Cavey and Mr. C. F. Richardson have recently been appointed to the positions of general road foremen of engines of the Baltimore & Ohio, with their headquarters at Baltimore.

Mr. Allan Bourn, of the New York Central & Hudson River Railroad, has resigned his position as purchasing agent, which position he has held since 1891, when he came from the Michigan Central.

AN ELECTRIC LIGHT BLUE-PRINT MACHINE.

Blue-printing has been rendered entirely independent of rainy, cloudy and dark days by the electric light blue-print machine. The cylindrical electrical copier, two views of which are shown in the accompanying illustrations, permits blue-printing to be done at night as easily as in bright sunlight. It consists essentially of a cylinder of plate glass, made in halves longitudinally, and an electric arc lamp with means for lowering it down through inside the cylinder. The tracing and sensitized paper are wrapped, facing inward, around the outside of the cylinder and held in place by stout canvas covers. The lamp is then released and descends slowly through the cylinder at a speed regulated by a pendulum and escapement, the escapement being driven by the lamp-supporting cord, which wraps around a drum connected to the escapement wheel. The lamp needs to go down but once for an exposure, and on reaching the bottom is quickly withdrawn by winding up the cable.



The Pittsburgh Electric Light Blue-Print Machine.

The speed of the lamp's movement, and hence the time of the exposure, is adjusted to suit different brands of paper by properly setting the pendulum uob on its rod and thus altering the length of the pendulum. The upright at one of the joints in the glass cylinder carries some horizontal flat steel springs, to the ends of which vertical strips of wood are attached, which act as clamps to hold the first edge of the tracing and sensitized paper. The sheets of canvas are attached to the same upright under the springs. To the free edges of the canvas are attached, by tension springs, a number of hooks which hook over a metal rod on the upright at the opposite joint in the glass—shown at the front side in these views. The spring hooks insure an even pressure everywhere and give the best possible conditions for securing perfect contact.

To save walking around the machine, one form of the copier, shown in the left-hand accompanying view, is placed on rollers, so that it may be easily revolved. A cast-iron floor-plate is provided, a spindle in the center of which keeps the machine in position on the base. In the other form—the tilting type shown in the right-hand cut—the glass cylinder is arranged to tilt down to a horizontal position, and is specially adapted for small prints. The machines are made in various sizes, accommodating tracings from 30 x 42 ins. in the smallest to 42 x 84 ins. in the largest. Each tracing occupies but one-half of the cylinder, so that two prints may be made at once.

It is, of course, obvious that by the present plan the strength of the light and consequently the printing are precisely equal and uniform on all parts of the tracing, and as the light is close to the surface its action is rapid, two prints 42 x 60 ins. being made in from $2\frac{1}{2}$ to 3 minutes.

These machines are made in all the sizes and with arc lamps adapted for any circuit, by the Pittsburg Blue Print Company, No. 1505 Park Building, Pittsburg, Pa.

EQUIPMENT AND MANUFACTURING NOTES.

The Standard Roller Bearing Company, Philadelphia, Pa., have recently made two important acquisitions—first, in the purchase of the entire business, patents and good will of the Grant Roller Bearing Company, Springfield, Ohio, and, second, in the later purchase of the Roller Bearing and Equipment Company, Keene, N. H. The Standard company is now prepared to fill all orders for roller and anti-friction bearings as made by these concerns, and will move the machinery of the acquired businesses to their factory at Philadelphia. This gives the Standard company a very large control over the roller-bearing field, both in equipment and because of the large number of patents now owned by them.

The Standard Roller Bearing Company some time ago found their present facilities inadequate to meet the growing demand for their product, and purchased a large and valuable piece of trackage property near the center of the city, about ten minutes' ride from the City Hall, on the main line of the Pennsylvauia Railroad, where they will build a large factory for the better accommodation of their acquired interests. The new plant is advantageously situated, and is intended to be a model one in every resnect. It will be 200 ft. long and from 100 to 150 ft. wide. The principal buildings will consist of two factories 200 ft. long and 60 ft. wide, of the most improved design and construction. Work has already been started and will be continued, to eventually cover the entire property of about two and one-half acres within a short time. The Ball Bearing Company, recently removed from Boston, will occupy a portion of the new plant. The rapid growth of the Standard Roller Bearing Company is worthy of notice, as it is a remarkable development within so short a time. Credit is due to the merit of the company's product, which includes ball, roller and all kinds of anti-friction bearings for machine construction.

The exhibition of ship-riveting with pneumatic tools which the Chicago Pneumatic Tool Company has been making in Glasgow, Scotland, is proving highly successful. Mr. E. Guennell, for many years superintendent of the Chicago Shipbuilding Company at South Chicago, Ill., is in charge, further assisted by two expert riveters from the Chicago shipyards, and he reports most favorable progress and great iuterest on the part of the shipbuilders on the Clyde. They are just waking up to the imperative necessity of the use of pneumatic tools in that work to enable them to compete with American shipbuilders, and it is anticipated that practically all of the yards on the Clyde will very shortly be equipped with pneumatic tools. The Chicago company is injecting American methods into its European business, having recently sent Mr. F. D. Johnson, manager of its New York office, to push business there, and has also sent Mr. George H. Hayes to take charge of the mechanical work in its London works. The recent absorption of the International Pneumatic Tool Company, of London, gives the Chicago Pneumatic Tool Company control of the pneumatic tool trade throughout Europe. It will now consolidate the factory of the International Pneumatic Tool Company with its plant already started in London. The company has been compelled to operate two of its factories in America extra time, working at night, and this addition to its London plant will give it a much-needed increase in manufacturing facilities.

The Chicago, Rock Island & Pacific Railway has contracted with the Consolidated Railway Electric Lighting and Equipment Company, of 100 Broadway, New York, for the equipment, with its "Axle Light" system of electric lights and fans, of all the cars now being built by the Pullman company to be used in the new limited trains that go into service November 1 between Chicago and San Francisco via the Rock Island and Southern Pacific. The "Axle Light" system of electric car lighting of this company is now in use on the twenty-hour trains of the New York Central and Lake Shore, and Pennsylvania Limited, and also on the finest trains of the Atchison, Grand Trunk, Chicago Great Western, Missouri Pacific and St. Louis & San Francisco, on the dining-cars of other leading railway lines, and also on all private Pullman cars.

The Ashcroft Manufacturing Company, 85 Liberty street, New York, report that the Tabor steam-engine indicator has been adopted by the Philippine Insular Government as their standard on Class "A" cruisers, fifteen of which have been supplied with these indicators. The selection of the Tabor indicator, after the most careful and exhaustive tests, endorses the claims of the manufacturers that it is recognized as standard in all parts of the world.

The contracts for the new plant of the Cleveland Pneumatic Tool Company have been let, and it will soon be completed and ready for operation. The plant will be equipped with the most modern machinery and appliances for turning out work very rapidly. This company has recently opened offices at 411 Park Building, Pittsburgh, Pa., and at 34 Lemoine street, Montreal, Canada.

The New Britain Machine Company, New Britain, Conn., are sending out a folder descriptive of the hand saw accessories of their manufacture. In it are illustrated and described a self-acting vise for use in filing band saws, an "equal-blow" setting band saw blades and the Pineo band saw guide. The "equal-blow" setting machine involves some interesting features worth mentioning. This machine is a device for setting the teeth of band saws by giving a graduated hammer blow on an adjoining right and left hand tooth at the same instant, the blows being, of course, equal and oppositely directed. The saw is held in a self-adjusting vise, allowing for uneven thicknesses of blades, due to brazing, variations of gauge, etc., and the blows are delivered by two hammers, actuated by the same spring, which are pulled back and released for the blow by a crank and cam arrangement. After each blow the vise is automatically released and the blade pulled along the distance of two teeth for the next blow, by a ratchet and detent mechanism. In this way the action is continuous and an entire band saw blade may be set throughout its length in a very short time by merely turning the crank actuating the cam. The machine is built very solidly with a one-piece heavy frame, and is intended for service.

The officials of the Louisville & Nashville Railroad are making plans for the entire reconstruction of the shops at South Louisville, Ky. The plans are very extensive, calling for an expenditure of over $2,500,000, and include a complete system of electrical transmission of power throughout. When the new shops are completed the ground occupied by the old shops will be utilized for an extension of freight yards at that point. It is expected that work on the new shops will be begun this fall, the details being in charge of Mr. T. H. Curtis, mechanical engineer of the road.

The Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio, announce a great increase in trade in their staybolt iron, both hollow and solid, which is giving the best of satisfaction to all users. The great security attaching to the use of their hollow staybolts, which give automatic warning of breaks, is especially emphasized, and it is claimed that a much more efficient and reliable staybolt is secured with the hollow bolt than with the solid bolt having the weakening "tell-tale" holes bored in the ends.

BOOKS AND PAMPHLETS.

The Crane Co., Chicago, Ill., have recently published a 1902 edition of their general catalogue. It is a large 362-page cloth-bound volume, illustrating and listing their entire line of standard, medium and low-pressure valves and fittings and steam engineers' specialties and supplies. It is beautifully executed typographically, and is profusely illustrated by excellent engravings. The Crane Co. has also issued a special catalogue of 95 pages illustrating in an equally tasty manner their extra heavy valves, fittings and pipe work for working pressures up to 250 pounds. In connection with this catalogue they particularly call attention to the fact that the dimensions of their extra heavy valves and flanged fittings have been changed in several particulars from the standards given in previous catalogues, so that in ordering valves and fittings to fit old standard dimensions it is now necessary to specify "old dimensions."

A bulletin has recently been issued by the Consolidated Railway Electric Lighting and Equipment Company, 100 Broadway, New York City, descriptive of their "axle-light" system of supplying electric lights and fans for railway cars. The system is thoroughly illustrated and described, both as to general principle and as to operative details. Considerable attention is given to a description in detail of their interesting regulator, by means of which the axle-driven dynamo does not furnish current to the lighting system or storage batteries until the car has reached a sufficiently high speed to generate the proper voltage. When the speed of the car diminishes, the dynamo is automatically cut out of circuit, and the lighting system is supplied by the storage batteries.

We are pleased to learn that the publishers of the Monthly Official Railway List (sometimes called "the Red List") of Chicago, have won their suit before the Supreme Court of the District of Columbia against the Postmaster-General of the United States. to compel him to reinstate their publication under the second-class mail rates. The court issued a mandamus on the Post Office Department, but the department intimated its purpose to appeal the case, ask to have the appeal act as a supersedeas and continue to oblige the publishers to pay third-class rates until final decision in the highest courts. The department finally receded from the position taken, entered the list again as mail matter of the second class and ordered the excess postage heretofore paid to be refunded.

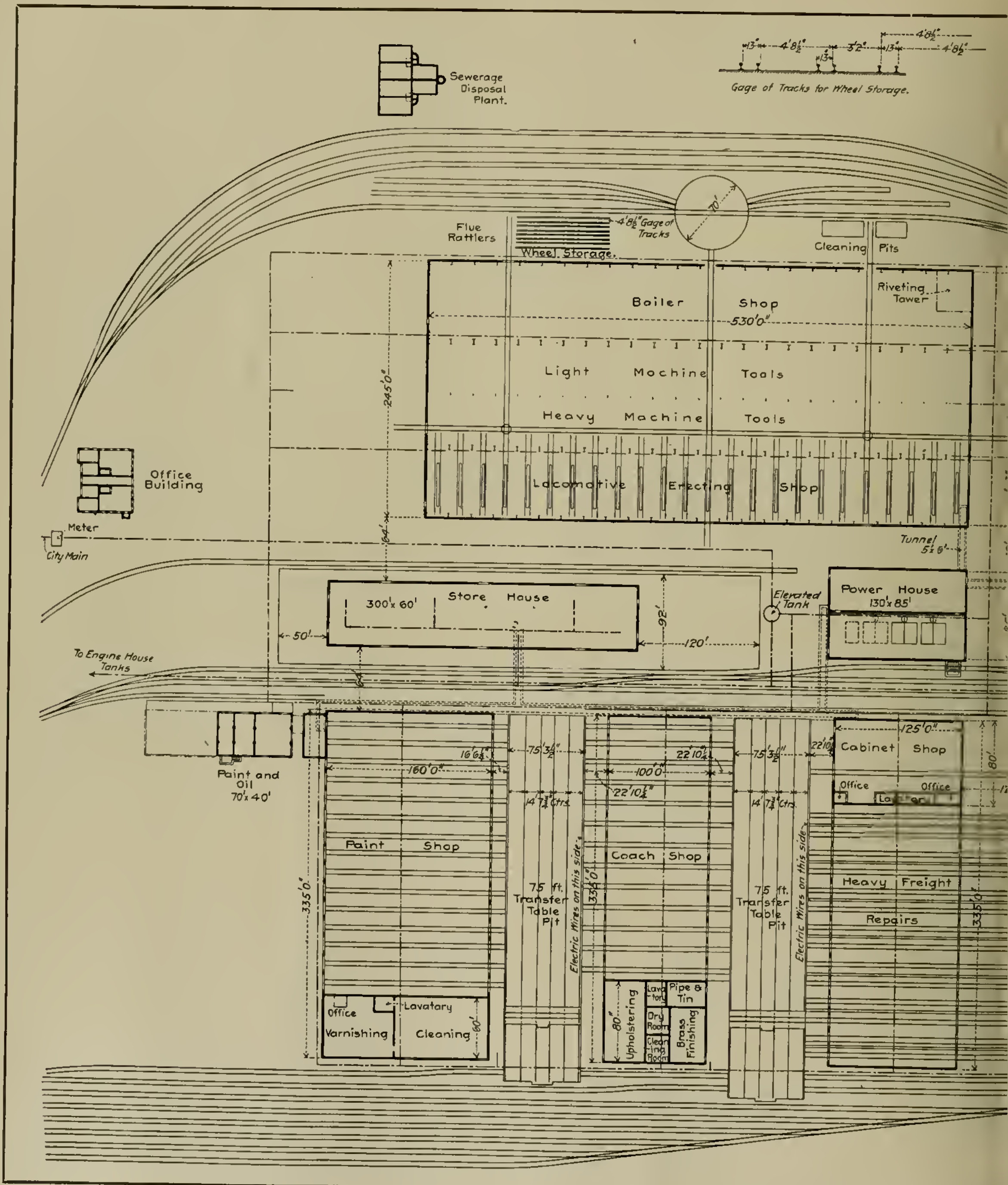
"Soft Water," Railroad Edition.—This is the title of a catalogue recently issued by the J. S. Toppan Company, No. 77 Jackson Boulevard, Chicago, Ill., descriptive of the water-softening process and apparatus manufactured by the Kennicott Water Softener Company, Chicago, Ill. The advantages of soft water for locomotive use are set forth and the process used described. Several important installations of the Kennicott water-softener are illustrated, and results of the process given as determined by analyses. In the latest patented form the Kennicott softener has the lime-saturator inside the settling tank, which will serve to effectually prevent it from freezing in the coldest weather.

Catalogue "A" of the Riehlé Bros. Testing Machine Company, Philadelphia, Pa., has recently been received. This catalogue illustrates and describes all the vertical screw-power testing machines, hydraulic testing machines, and also some special testing machines, made by this company. For the other testing machines made by this company separate catalogues have been issued, as follows: Catalogue "B," wire-testing machinery; "C," chain-testing machines; "D," foundry testers; "E," spring testers; "F," hydraulic pumps and accessories; "G," cement-testing machines, and "H," marble molding and countersinking machines.

The Boston Belting Company, Boston, Mass., have issued a folder descriptive of fire hose for mill and factory protection. Rubber-lined, cotton-covered hose is supplied for this purpose, and also unlined linen hose for use where it must be kept hung up in dry places. This company also furnishes all couplings, pipes, reels, spanners, connections and other accessories necessary for such installations, as well as all kinds of mechanical rubber goods of every description.

"The Railway Equipper" is the name of a new monthly bulletin issued by the M. Mitshkun Company, 925 Chamber of Commerce Building, Detroit, Mich., devoted to the interests of contractors and to the buying and selling of locomotives, cars, steam shovels, rails, etc. It will be sent free upon application.

No more entertaining evening can be spent by visitors to New York than at one of the Proctor theaters. A variety of entertainment is offered at the Proctor playhouses, including, as is their custom, vaudeville acts between the acts of the regular play. One feature, the "kalatechnoscope," which is included in every performance at all the Proctor theaters, will be of interest to railroad men, from the continuous moving views of railway trains in motion, or views taken from trains in motion, which are nearly always shown.

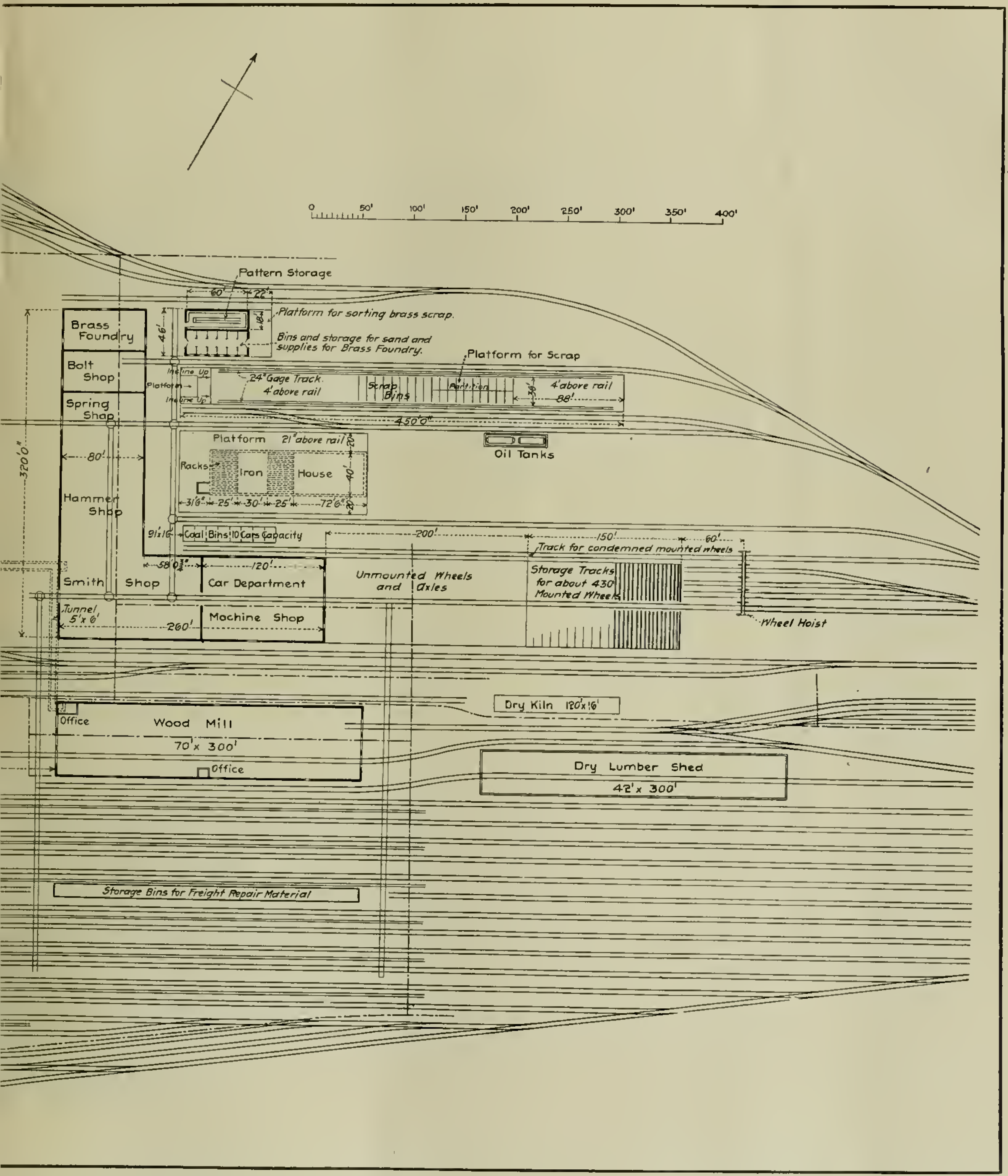


LOCOMOTIVE A

Collinwood, Ohio — Lake Shor

H. F. Ball, *Superintendent Motive Power.*
H. H. Vaughan, *Assistant Superintendent Motive Power.*

W. H. Marshall, *Genera*



ND CAR SHOPS.

& Michigan Southern Railway.

Superintendent.

E. A. Handy, *Chief Engineer.*
A. Lucius, *Consulting Engineer.*

AMERICAN ENGINEER AND RAILROAD JOURNAL.

OCTOBER, 1902.

CONTENTS.

AMERICAN ENGINEER TESTS.

LOCOMOTIVE DRAFT APPLIANCES.

X.

Report by Professor Goss.

SECTION IV. (Continued from Page 184.)

Editor's Note.—At this point it seems appropriate to introduce a letter from Herr Von Borries because of the importance of his opinions, which are based upon a thorough knowledge of both American and foreign practice. His reference to high back pressure in American locomotives should be considered in connection with the statement on page 303 of our October number of last year: "On some of these cards the back pressure is from 20 per cent. to 25 per cent. of the mean effective pressure. In other words, from 16 to 20 per cent. of the total power developed by the engine is employed in creating the draft necessary for combustion." It should be mentioned that in the particular case referred to here, the locomotive had a smaller nozzle than was required, but the illustration fairly represents conditions which are prevalent in large high speed passenger locomotives.

To the Editor:

In Professor Goss' report, Article VIII., on his most interesting preliminary trials of locomotive draft appliances, I find on page 134 of the May number of your valuable paper the statement for the distribution of the draft, according to which some one-third of it is required to overcome the resistance given by the diaphragm plate. From this statement it seems to me that the draft in American locomotives, which generally use that plate, must be some 50 per cent. higher than in European locomotives, which do not use this plate. Consequently the back pressure on the pistons must be higher in a similar measure, causing a higher consumption of coal for accomplishing the same work.

I believe it would be well to extend the trials on draft, also to include the question whether the diaphragm plate is really necessary.

Here we do not use it, but give the blast pipe such a position that the fire burns equally over the whole grate and the gases are distributed equally over the tubes. In our former trials we found that lowering the blast pipe caused more draft through the lower tubes and the back part of the grate, while raising it gave the contrary effect. Therefore there is one position which causes equal draft, and we always try to find it out practically for new types of engines. Generally the formulas I gave as a result of our trials for the dimensions of the stack and blast pipe have proved sufficient. Sometimes small corrections have been found economical.

A. VON BORRIES.

Hanover, Germany, May 24, 1902.

A STUDY OF LIMITING CONDITIONS.

CONTINUATION OF REPORT.

(See June number, page 184.)

23. Height of Choke Above Top of Nozzle.—This distance, as shown by the drawings reviewed, is quite variable for the same size of engine on different roads, and seems to follow no law. It is 45 ins. for 64-in. boxes; 50 ins. for 68-in. boxes, and 52 ins. for boxes 72, 76 and 80 ins. in diameter.

24. Conclusions as to Stacks.—The diameter at the choke of 14 ins. is used to a considerable extent for the largest modern passenger engines, and 16 ins. at the choke and 18 ins. at the top represent average practice for freight engines. The diameter of the stack at the smoke-box joint is as small as 17½ and as large as 24 ins. The average diameter, therefore, may be taken as 22 ins. While there is no uniformity in practice relative to the height of the choke from the top of the smoke-box, the prevailing practice is represented by a height of 14 ins., though this height is reduced to from 3 or 4 ins. when smoke-boxes are above 80 ins. in diameter. The height of the stack above the smoke-box is governed largely by the height of the boiler from the rail, but it averages 36 ins. The height of the choke above the top of the nozzle averages from 45 to 52 ins., for smoke-boxes from 64 to 80 ins. in diameter.

25. Nozzles.—The diameter of nozzles cannot be definitely fixed by reference to other proportions, but the aim is to make them as large as consistent with good steaming. The exhaust base and single nozzle, similar to the proportions recommended by the committee of the Master Mechanics' Association in 1896, seem to be generally used to-day. On one of the principal roads the choke is in the cylinder saddle instead of its usual position in the exhaust base. This is used with a high saddle, where the distance from the center of the cylinder to the bottom of the smoke-box is 2 ft. 9 ins. and the top of the partition of the choke is 6 ins. below the exhaust base joint on the saddle. The choke itself is 10 ins. below the smoke-box. In this construction the exhaust base is like a straight open pipe without a partition, and the total height of the base and the nozzle above the saddle is 20 ins. in smoke-boxes 72 to 74 ins. in diameter.

26. The Height of Nozzle is usually given as the total height of base and tip above the bottom of the smoke-box. It is evident that this dimension can have little significance if its relations to other dimensions are important and are to be considered. For example, a nozzle 24 ins. high would have its tip 3 ins. below the center of the 55-in. smoke-box of the Purdue locomotive, 11 ins. below the center of boiler on a 68-in. smoke-box, and 18 ins. below the center of the boiler in an 84-in. smoke-box. (See Fig. 20.) In the first case the tip would be 32 ins. below the stack base; in the second case, 44 ins., and in the third case, 60 ins. All these different relations are for an

exhaust nozzle 24 ins. high, and for this reason it is thought that the position of the tip in the smoke-box, with relation to other draft fixtures, would be more definitely fixed if expressed in inches below the center line of the boiler.

27. Average Height of Nozzle.—If the smoke-boxes are arranged in groups varying by intervals of 4 ins. in diameter, from 64 to 80 ins., and the average distance of top of nozzle

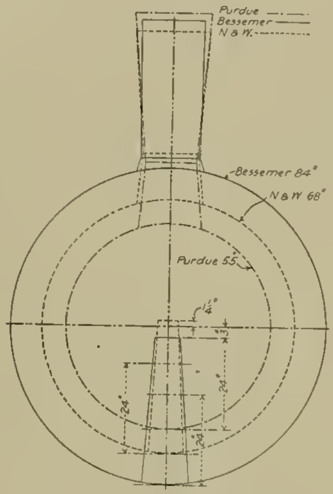


Fig. 20.

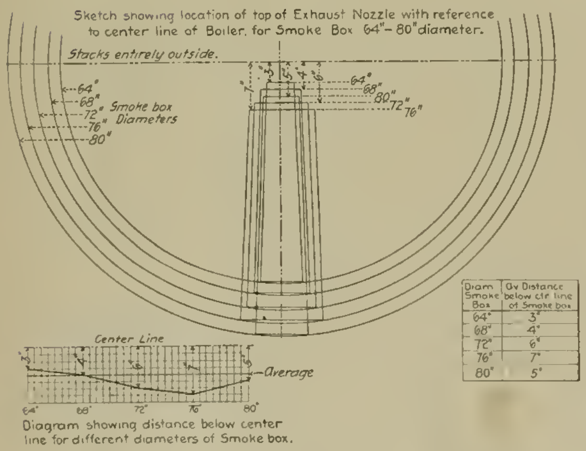


Fig. 21.

below center line is obtained for each group, the showing will be about as follows:

Diameter of Smoke Box.	Average Distance of Top Below Center Line of Smoke Box
64 ins.	3 ins.
68 ins.	4 ins.
72 ins.	6 ins.
76 ins.	7 ins.
80 ins.	5 ins.

These relations are also well shown by Fig. 21, in which the diameters of the smoke-box and height of the nozzle are drawn to scale. It will be seen that the range of heights of nozzles for smoke-boxes of various diameters on large boilers is small, and the distance below the center line varies from 3 to 7 ins. This distance increases with the diameter until the 80-in. smoke-box is reached, when the height is 5 ins. below the center. All this suggests that a height of nozzle 3 to 5 ins. below the center line can be used successfully on boilers having smoke-boxes 64 to 80 ins. in diameter, and it is quite probable that a height of 4 ins. below the center would answer for all of them.

It may be said, therefore, that for modern locomotive boilers of from 64 to 80 ins. in diameter, having the stack entirely outside the smoke-box, the top of nozzle is very nearly 4 ins. below the center line of the boiler. As already mentioned in connection with inside stacks, the nozzles with such designs are much below the center of the boiler. The examples, the drawings for which have been reviewed, are similar to those shown in Fig. 19, with inside stacks on boilers from 70 to 74 ins. in diameter; the distance from the center of the boiler to the top of the nozzle is 15 ins., 20 ins. for passenger engines, and 17 ins. for freight engines.

28. Conclusions as to Nozzles.—The diameter of the nozzle is not considered within the scope of this investigation.

The height of nozzle is best shown by its relation to the center line of the boiler, and when so measured the variation for smoke-boxes of widely different diameters is found to be small, it being 3 ins. for 64-in. boxes and 5 ins. for 80-in. boxes, and it is safe to conclude that good practice is well represented by a distance of 4 ins. below the center of the boiler in smoke-boxes from 60 to 80 ins. in diameter.

The relation of the top of the nozzle to the choke of the stack has been considered under paragraph 22, but we may repeat that the range appears to be from 45 to 52 ins. for smoke-boxes from 64 to 80 ins. in diameter.

(End of Professor Forsyth's report. The report by Professor Goss is to be continued.)

The importance of strong cars is emphasized by the railroad commissioners of Michigan, in their annual report for 1901, in the following words: "A practice that cannot go into disuse too rapidly is that of operating light passenger coaches of insufficient strength. The loss of life in time of collision or other accident wherein the car strain is a factor is notably less when strong cars are used and equally prominently greater when weak cars are used. Good railroad management discovered this long ago, and I am glad to state that it is my belief that an ambition begets all railroads to as soon as possible operate only the strongest, heaviest and best possible cars." Unquestionably, strength and safety should be considered as the first rule of car construction. It is believed to be possible, however, to increase the strength of cars and decrease the risk of crushing in collisions, and at the same time actually reduce the weight by the use of steel floor structures and steel platforms.

The Aurora, Elgin & Chicago Electric Railway, running between Chicago, Wheaton, Aurora and Elgin, Ill., begun operation August 25, running passenger trains to connect with the Metropolitan Elevated Railway in Chicago. Trains are run at 30-minute intervals and at speeds averaging 45 miles per hour, including stops. By this service important suburban districts and outlying towns will have the advantage of frequent trains, rapid transit and an ideal method of distribution over the loop tracks and connections in the city of Chicago. This is the sort of competition the steam roads need to watch.

The present high prices for scrap are specially favorable to railroads having a large number of small capacity cars to tear down. The "per diem" agreement seems to have brought a lot of small cars home on many roads, and it is reported that within a month about 15,000 cars will be scrapped in Chicago alone, which will yield about 100,000 tons of scrap iron and steel.

The steam yacht Arrow in a trial trip last month on the Hudson River made a mile at the rate of 39.13 knots, or 45 miles, per hour, using 4,000 horse-power. The steam pressure was from 350 to 400 lbs., and the engines made from 540 to 600 revolutions. The length of the boat is 130 ft.

NEW LOCOMOTIVE AND CAR SHOPS.

Collinwood, Ohio.

Lake Shore & Michigan Southern Railway.

With an Inset.

I.

These interesting shops are now going into service, and through the courtesy of the officers of the road they will be described in a series of articles in this journal. The plan throughout originated with the motive-power department, and the construction has been carried out with the hearty co-operation of the engineering department. The underlying idea was to meet the business problems involved, in a plant which is ample for present needs and provides for extension to meet the increased demands of many years. The plant is thoroughly modern and business-like, but it does not involve expense which is not justified by operating results.

The work was begun and nearly completed under the direction of Mr. W. H. Marshall while he occupied the position of superintendent of motive power. He was ably assisted by Mr. H. F. Ball, the present superintendent of motive power, and by Mr. H. H. Vaughan, the present assistant superintendent of motive power. The buildings and preparation of the grounds were under the charge of Mr. E. A. Handy, chief engineer, and the details of the buildings were worked out by Mr. Albert Lucius, of New York, consulting engineer.

Location and Capacity.

This road has shops at Elkhart, Ind., and required another with modern facilities near the eastern end of the line, where the business is very much heavier. A central location would be desired if the business was uniform, but naturally in this case the location was selected toward the eastern end. Furthermore, the main line is divided into four divisions, and the Elkhart shops are easily reached by all locomotives on the two divisions immediately east of Chicago. By placing the new shops at Collinwood (near Cleveland) all main-line engines east of Toledo are easily accessible to these shops, so that with the present arrangement all main-line engines pass a main shop in the course of every round trip.

At the present time about 350 locomotives per year will come to Collinwood for heavy and light repairs, the ultimate capacity of the present facilities being 450 per year. With the present output of 350 locomotives, 29 will pass through the shops per month. These shops will take care of two-thirds of the locomotive work for the entire system. The shops at Elkhart, while old, are still serviceable and can easily maintain the power on the two western main-line divisions and all the Michigan branches. Many of the heavier engines for the entire road requiring extensive work will go to Collinwood to take advantage of the crane and other facilities. The excellent machine equipment at Collinwood will also permit of making all stock locomotive repair material, which is required in quantities, at that point.

Car Shops.

The car-department buildings are now being erected, the foundations being nearly completed. These will take care of the entire passenger-car equipment of the Lake Shore system. This involves an important business principle in concentration, as every passenger car on the system is put through the shops for either partial or complete overhauling once every year. It is intended that the entire equipment shall be dealt with in nine months of each year, releasing the passenger equipment entirely for the three summer months when traffic is heaviest. About 500 passenger cars will be maintained here, but facilities will be furnished for handling 550 in nine months, to be called upon when needed. During the season of light work, or when, for any reason, the shops are not working to their full capacity, it is intended to build whatever baggage or mail cars may be needed.

Collinwood is also to be important as a freight-car repair point. The present freight repair shops at Ashtabula, Englewood and Toledo will be maintained, the only change being a large increase of the Cleveland facilities at Collinwood. The same principle that applies to locomotive repair work will be introduced into the car work, as to making stock for repair material at Collinwood. This shop will be the most important freight-repair plant on the road, but there will be no effort made to concentrate these repairs there.

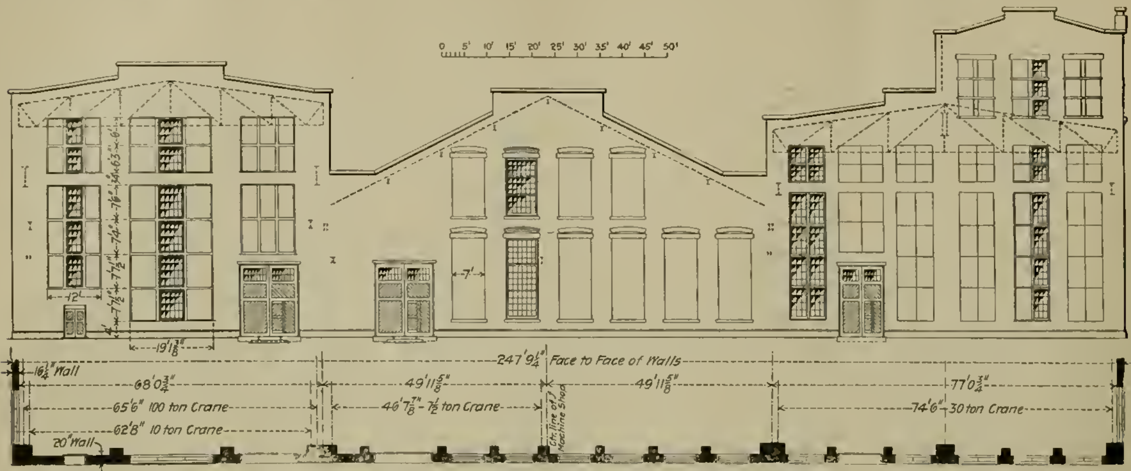
General Description.

With the main line at the south and private property on the north, the plot was limited in width, and the general plan in the inset accompanying, shows how well the space is used. With the power-house and storehouse at the center, the buildings are grouped in a way which gives ample space between them, good passageways, and convenient means for transporting material. The distances for moving the material are direct and short, considering the size of the plant. Too much cannot be said of the storehouse location and facilities. The large raised platform, 92 ft. by 120 ft., at its eastern end, is a feature. The power-house is the heart of the lay-out. The combination of brass foundry, bolt shop, spring shop, smith shop and car-department machine shop in an L-shaped building placed between the storage yard, scrap-bins, wheel storage and the main locomotive shop, and within easy reach of the car shops, is very convenient and compact. Everything will move in straight lines throughout the plant, and this includes the lumber and all other material. The blacksmith shop is east of the locomotive shop, with a through track for heavy material, which extends also through the storage space. The north end of the blacksmith shop is the hammer department, with forges down on each side, while the south end has the bulldozers, forging machines and their furnaces. The car-department machine shop will handle car-wheels, axles and necessary machine work on car forgings, which are delivered there direct from the blacksmith shop, and the bolt shop concentrates all of this work for the entire plant. Lumber for car work is brought in from the east end of the yard, and passes through the lumber kiln and lumber shed to the wood mill, and from there to the car-repair shops over the track westward from the mill.

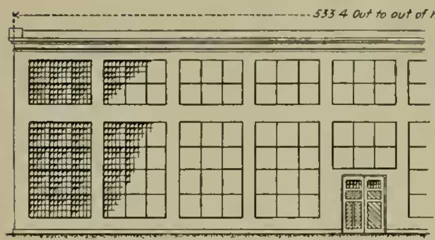
Locomotive Shops.

The locomotive shop is a noble building, 530 by 245 ft., combining all of the locomotive work under one roof, with plenty of cranes, unusual natural lighting, general convenience, and a single system of heating for the whole. This building is impressive in its generous width and the general substantial character of its construction. Heavier steelwork and masonry are seldom seen in buildings of this character, and it may be expected to remain an up-to-date building for many years. Daylight lighting is better than in any other railroad shop. In this respect it closely resembles the shops of the New York Navy Yard and the machine shop of the Chicago Shipbuilding Company. There are 24 pits at 22-ft. centers in the erecting shop. At the north of this shop is a 70-ft. turntable. There is no transfer table for handling locomotives.

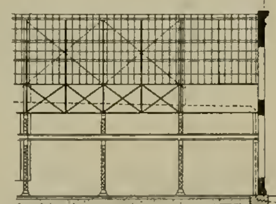
By adopting the transverse track, locomotives are handled by a single crane, which was preferred to the other plan requiring two large cranes. Furthermore, the plan adopted was considered more convenient. The officers of the road believe, however, that where good crane service is provided the arguments for and against transverse or longitudinal tracks are not as strong as they would be where crane service is limited or entirely absent. In deciding upon the width of the various bays, the erecting shop was made wide enough to give plenty of room for the longest engines and the pit tracks were made long enough to give storage room for the wheels, extending part of their length into the machine-shop bays. By doing this the span of the large crane for handling engines was



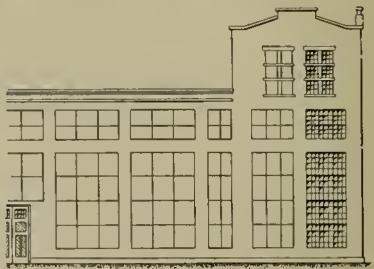
East End of Erecting, Machine and Boiler Shops.



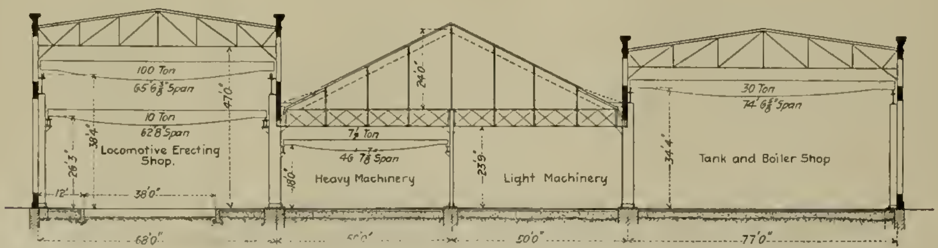
Part Elevation of Engine Shop.



Part Section Through Center of Machine Shop.



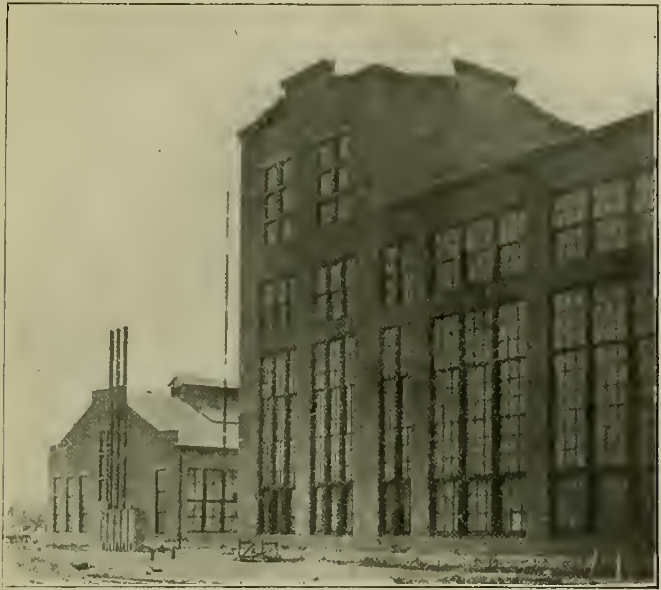
Part Elevation of East Corner of Tender Shop.



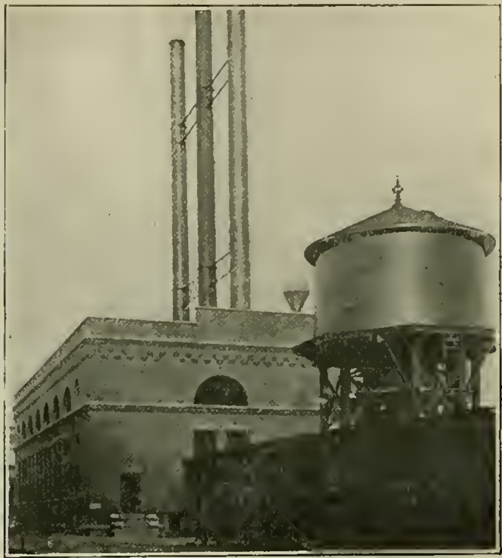
Section of Erecting, Machine and Boiler Shops.

West End of Boiler, Machine and Erecting Shops.

Locomotive and Car Shops, Collinwood, Ohio.—Lake Shore & Michigan Southern Railway



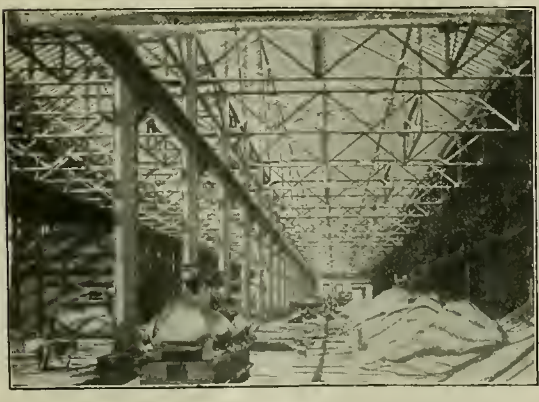
Northeast Corner of Boiler Shop, Showing Riveting Tower.



West End of Power House.

Construction View of Erecting Shop.

Exterior Construction View of Machine Shop.



Interior Construction View of Machine Shop.

Interior View of Boiler Shop.

Locomotive and Car Shops, Collinwood, Ohio.—Lake Shore & Michigan Southern Railway.

shortened, making the erecting bay a convenient and economical width and enabling the wheels to be handled by the cranes in both the erecting and machine shops without further transfer. The width of the boiler shop was determined with reference to the handling of boilers and tenders, leaving sufficient space along one side for the necessary machine tools. The machine shop was made very much wider in proportion to the rest of the plant than is usual in railroad shops, because the erecting floors do not limit the output of the plant. This limit is usually the machine space, and by making it large in proportion to the erecting floor more engines may be dealt with per year on each track than could be handled otherwise. The amount of work which can be obtained from one track on the erecting floor is dependent upon the number of men employed in that work, and the output is flexible, whereas if the machine space is not large enough to begin with it is impossible to overcome the difficulty. This machine shop is large, and it may be made larger if necessary by providing for the driving wheels in some other location.

The first impression given by the location of the toilet facilities in the main shop and the smith shop is unfavorable, but this soon changes to approval. With perfect protection to the health of the men there is no valid objection to placing them within the buildings, and this location renders it unnecessary for any but laborers in handling material to leave the shop upon any pretext.

Locomotives enter the shop over the turntable at the north side of the building. They are taken south into the erecting shop and distributed among the pits by the large crane. This shop will be illustrated and described in detail in another article. The steam pipes, air and water pipes are placed in large underground tunnels connecting the various buildings and centering at the power-house. At the northwest corner of the grounds is a sewage disposal plant, which was made necessary by the local conditions. At the extreme west end is an attractive office building for the master mechanic and master car builder and their clerical forces, the chemist and engineer of tests, shop drafting room and chemical laboratory. This building is near the road and the entrance to the grounds. It is well adapted in size, arrangement and lighting for its purpose, and is more comfortable than many of the quarters provided for general officers, but is not expensive or elaborate.

Extension of Plant.

This plan provides for extension in any direction. The locomotive shop may be extended west, the storehouse west, the paint shop by additional buildings south of the paint and oil storehouse. East of the blacksmith shop building is a brass-foundry storehouse and pattern shop. South of this is a scrap platform 450 ft. long, partly divided into bins, so that scrap may be handled, after sorting, by cars, or it may be moved west to the small platform to go to the smith or bolt shop. South of the scrap platform is an iron house, in which all iron is stored for the smith and bolt shops. Finished forgings and brasses will be stored at this point. South of the iron house are coal and coke bins for the smith shop. The tracks north of the locomotive shop are for storage of locomotives awaiting repairs, and on this side of the shop are the cleaning pits and flue rattlers; also storage tracks for wheels. Storage for about 430 mounted wheels is provided east of the car-department machine shop.

Buildings.

The buildings, except the storehouse, have very little wood about them. The steelwork is very heavy. In the locomotive shop there are 2,150 tons of steel, the building being approximately 60 ft. high by 530 ft. long and 250 ft. wide, with posts 52½ ft. high. This building, being very long, has brick ends for two reasons—to give bulkhead bracing and to dispose of the problem of expansion.

The blacksmith shop also has heavy steelwork, and a load of 10 tons may be hung to the roof trusses at any point. In locating a large hammer a load about 50 per cent. in excess of this was placed upon the middle of one of the trusses.

The walls are ample, as indicated in the drawings, and so also are the foundations, which are of concrete made in the proportions of 3 parts of sand and 5 of stone to 1 of cement. A base course of 18-in. stone starts the walls above the foundations around the entire locomotive-shop building, except at the ends, and this is cut out for the steel posts. At the ends this course is 23½ ins. thick. The end walls are 20 ins. thick to the top of the first tier of windows, and 16 ins. thick above that to the top. The rich red color of the brick is an attractive feature of the buildings.

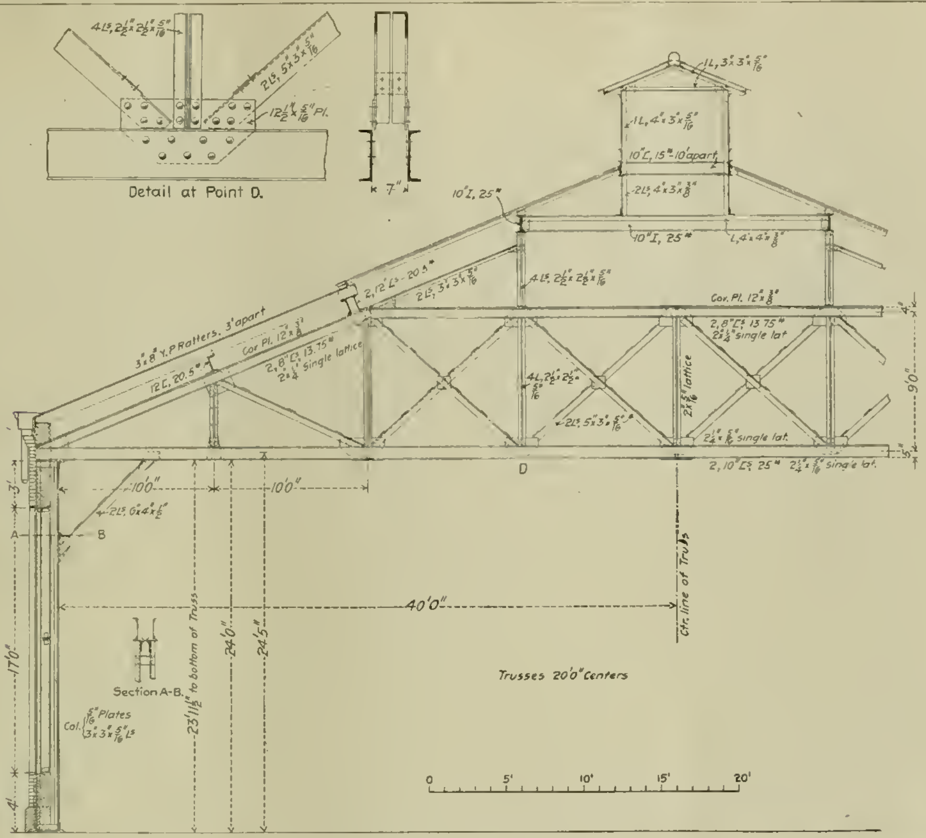
The steel frame of the locomotive shop is specially interesting. That of the erecting shop is so rigid that in standing upon the roof or on any member of the framing when a locomotive is lifted by the cranes, no indication of the load is given. The main steel frame consists of two rows of posts placed in each of the main walls of the erecting and boiler shops and one row of posts on the center line of the machine shop. The posts are braced in pairs, forming fixed sections, braced and riveted, alternating with unbraced sections, to provide for local expansion. The posts in the outside walls are very interesting, and will be illustrated in our next article. They carry the girders for the cranes and the roof trusses only. Those in the inner walls carry the additional load of the machine-shop roof and the walls above that roof, with their proportion of the weight of the shafting. The posts at the center of the machine shop carry their portion of the load of the roof, which is of glass, that of a small traveling crane and their part of the shafting. The steelwork of the main window sections and of the doors in the outer walls is framed in and fastened to the posts. The roof trusses are also braced in pairs, forming fixed sections, alternating with unbraced sections, all fixed sections being riveted up rigidly, while the unbraced sections are carried on seats and shelves and connected by fishplates with holes sufficiently large for local expansion. The roof over the light-machine shop is subdivided by secondary girders into sections of 11-ft. span to carry the line and countershafting.

The floor of the locomotive shop has a top surface of tongued and grooved maple 6 ins. wide, dressed, 1 in. thick, laid on 3-in. yellow pine plank, varying from 8 to 12 ins. in width, supported on 6 by 4-in. nailing strips spaced at 2-ft. centers. These strips are graded to the level of the under side of the floor, which corresponds to the top of the timber covering of the hot-air ducts, which are under the floor. To permit of such grading, a space of 1 in. is provided between the top of the asphalt binder and the bottom of the nailing strips. Sand is used for grading. The entire floor of the main building is filled with clean gravel, packed and rolled. This is covered with a 4-in. layer of asphalt binder made of small-sized broken stone mixed hot with hot asphalt and tar binder mixture, of one gallon to every cubic foot of stone. No water can come from underneath to rot the floor.

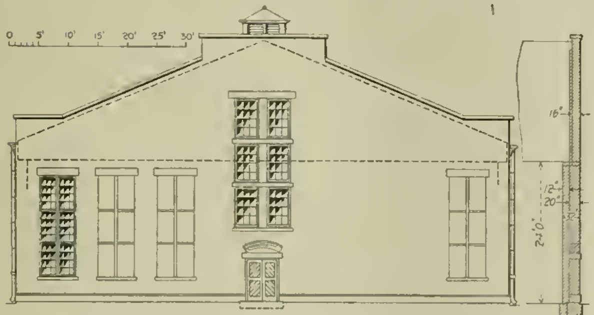
The roof joists carrying the roof boards of the boiler shop, riveting tower, erecting shop, and the sides of the machine-shop roof, below the skylights, are of 3 by 8-in. yellow pine, seven of them being employed in each 22-ft. panel. Upon these, tongued and grooved 1-in. hemlock boards are laid. The roofs are covered with asphalt laid in five-ply roofing felt. The pitch of the erecting and boiler-shop and riveting-tower roofs is 1¾ ins. per foot, while that of the machine shop is 6 ins. Over the felt is a layer of crushed roofing gravel.

Over the machine shop is a skylight 80 by 530 ft., of ⅜-in. ribbed glass, 22 ins. wide and 6 ft. long, making 22 panels, which are supported on the steel frame. These sections correspond with the fixed and expansion sections of the steel frame of the building. The windows have steel frames and wooden sash, with the lower sash movable, and all lower sashes are protected by wire netting.

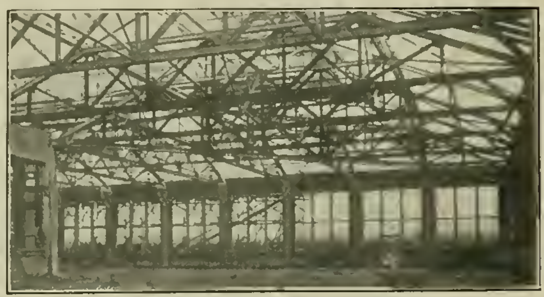
Inside drainage is provided for the roofs, with the main leaders secured to the roof trusses. This construction will



Smith Shop Building—Frame Construction.

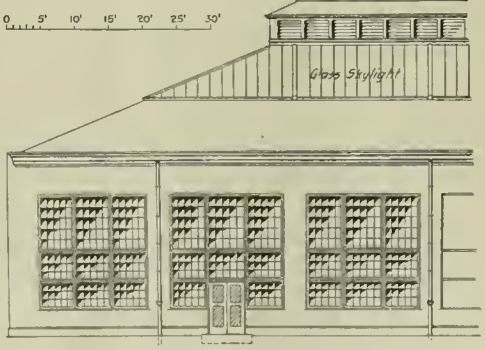


Smith Shop—End and Section.



Smith Shop—Showing Corner.

Office Building.



Smith Shop—Exterior.

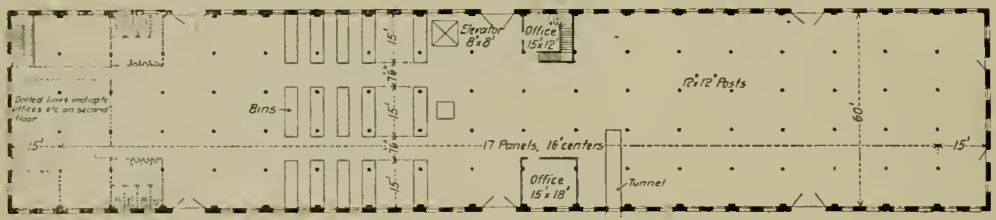
Locomotive and Car Shops, Collinwood, Ohio—Lake Shore & Michigan Southern Railway.

Storehouse—End and Partial Side Views.

prevent all trouble from freezing. The details of one of the roof gutters will he illustrated next month.

Storehouse.

The storehouse is a 60 by 300-ft. brick building of three stories, with floors of heavy wood construction. An extensive platform, 4 ft. high, surrounds the building, and is reached by tracks on both sides. This building has a 5,000-lb. electric elevator, delivering material to all floors. Instead of placing the storehouse in the charge of any particular department, in this case the storekeeper reports to the general manager and serves all departments. The stationery stock for the entire road forms an important item of this department.



Storehouse—First Floor Plan.

FLOOR AREAS OF SHOP BUILDINGS.

LOCOMOTIVE DEPARTMENT.

Erecting shop (530 x 68) =	36,040 sq. ft.
Machine shop (530 x 100) =	53,000 sq. ft.
Boiler and tank shop (530 x 77) =	40,810 sq. ft.
Total locomotive shops (530 x 245) =	129,850 sq. ft.
Blacksmith shop, including spring, hammer and smith shops (300 x 80) =	24,000 sq. ft.
Bolt shop (40 x 80) =	3,200 sq. ft.
Brass foundry (40 x 80) =	3,200 sq. ft.
Total locomotive department shops =	160,250 sq. ft.

PERCENTAGE OF TOTAL LOCOMOTIVE DEPARTMENT SHOPS (160,250 sq. ft.)

Erecting shop	22.5
Machine shop	33.0
Boiler and tank shop	25.5
Brass foundry, bolt and total blacksmith shops	19.0
	100.0

RELATION TO ERECTING FLOOR AREA, IN PER CENT.:

Machine shop	1.47
Boiler and tank shop	1.13
Brass foundry, bolt and total blacksmith shops	.84

CAR DEPARTMENT.

Coach shop, total (335 x 100) =	33,500 sq. ft.
Cabinet shop (125 x 80) =	10,000 sq. ft.
Paint shop, total (335 x 160) =	53,600 sq. ft.
Total passenger shops =	97,100 sq. ft.
Machine shop, car (120 x 80) =	9,600 sq. ft.
Freight repair shop (255 x 125) =	31,875 sq. ft.
Wood mill (300 x 70) =	21,000 sq. ft.
Upholstering, pipe and tin, and brass finishing sections of coach shop (100 x 80) =	8,000 sq. ft.
Cleaning and varnishing sections of paint shop (160 x 60) =	9,600 sq. ft.
Paint and oil building (70 x 40) =	2,800 sq. ft.

PERCENTAGE OF TOTAL PASSENGER CAR SHOPS (97,100 sq. ft.)

Coach shop	34.5
Paint shop	55.2
Cabinet shop	10.3
	100.0

Upholstering, pipe and tin, and brass finishing section = 23.8 per cent. of total coach shop.

Cleaning and varnishing section = 17.9 per cent. of total paint shop.

AREAS, GENERAL:

Storehouse, per floor (300 x 60) =	18,000 sq. ft.
Storehouse, total for three stories =	54,000 sq. ft.
Storehouse platform (470 x 92, over all) =	25,240 sq. ft.
Power house (130 x 85) =	11,050 sq. ft.

WINDOW AREAS, LOCOMOTIVE SHOP BUILDING:

Total area of wall, boiler shop side of building =	23,260 sq. ft.
Area of glass, boiler shop side of building =	14,470 sq. ft.
Ratio of window area to area of wall =	62.2 per cent.
Total area of wall, erecting shop side of building =	27,740 sq. ft.
Area of glass, erecting shop side of building =	17,280 sq. ft.
Ratio of window area to area of wall =	62.3 per cent.
Total exterior area of entire building, exclusive of ends =	211,260 sq. ft.
Total area of window glass in entire building, exclusive of ends =	82,570 sq. ft.
Ratio of total area of window glass to total exterior area of building, exclusive of ends =	39 per cent.

DISTANCES OF TRAVEL BETWEEN CENTERS OF SHOP DEPARTMENTS:

LOCOMOTIVE DEPARTMENT:

Erecting shop to machine shop =	85 ft.
Erecting shop to boiler and tank shop =	175 ft.
Erecting shop to blacksmith shop =	590 ft.
Erecting shop to storehouse =	340 ft.
Totals =	1,190 ft.
Machine shop to erecting shop =	85 ft.
Machine shop to boiler and tank shop =	90 ft.
Machine shop to blacksmith shop =	570 ft.
Machine shop to storehouse =	425 ft.
Totals =	1,170 ft.
Boiler and tank shop to erecting shop =	175 ft.
Boiler and tank shop to machine shop =	90 ft.
Boiler and tank shop to blacksmith shop =	620 ft.
Boiler and tank shop to storehouse =	515 ft.
Totals =	1,440 ft.
Blacksmith shop to erecting shop =	590 ft.
Blacksmith shop to machine shop =	570 ft.
Blacksmith shop to boiler and tank shop =	660 ft.
Blacksmith shop to storehouse =	800 ft.
Totals =	2,620 ft.
Storehouse to erecting shop =	340 ft.
Storehouse to machine shop =	425 ft.
Storehouse to boiler and tank shop =	515 ft.
Storehouse to blacksmith shop =	800 ft.
Totals =	2,080 ft.

CAR DEPARTMENT:

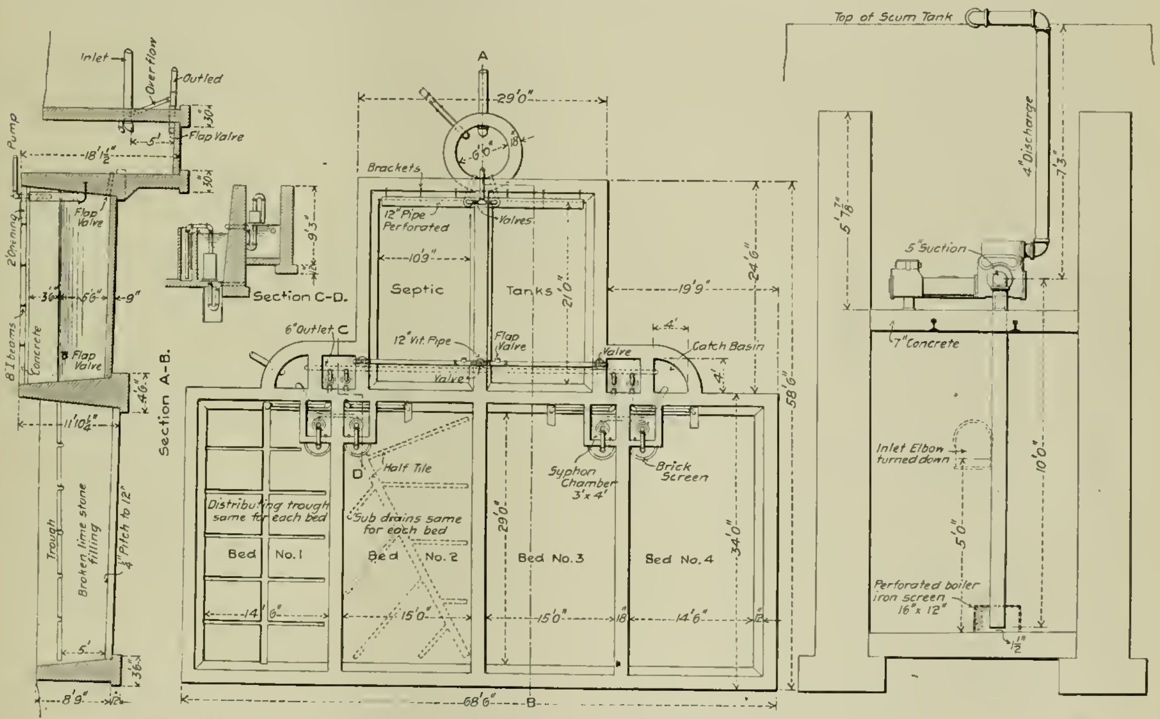
Freight repair shop to wood mill =	500 ft.
Freight repair shop to blacksmith shop =	590 ft.
Freight repair shop to car machine shop =	690 ft.
Freight repair shop to storage mounted wheel =	1,025 ft.
Freight repair shop to storehouse =	705 ft.
Freight repair shop to freight repair material storage =	355 ft.
Totals =	3,865 ft.
Coach shop to wood mill =	690 ft.
Coach shop to cabinet shop =	360 ft.
Coach shop to blacksmith shop =	780 ft.
Coach shop to car machine shop =	880 ft.
Coach shop to mounted wheel storage =	1,210 ft.
Coach shop to storehouse =	430 ft.
Coach shop to paint shop =	240 ft.
Totals =	4,590 ft.
Wood mill to freight repair shop =	500 ft.
Wood mill to coach shop =	690 ft.
Wood mill to cabinet shop =	360 ft.
Wood mill to dry lumber shed =	460 ft.
Wood mill to dry kiln =	380 ft.
Totals =	2,390 ft.

Drainage System.

Particular attention has been paid to the sanitary equipment of the Collinwood shops, thus necessitating a complete sewer system and means of sewage disposal. Lake Erie, which is the natural drainage for Collinwood, is lined at this point with beautiful summer residences, owing to which specially enacted legislation prohibits the discharge into it of sewage or other refuse liable to pollute the shore or cause unpleasant odors. For this reason a bacterial sewage disposal plant of a capacity of 40,000 gallons per day was decided upon and installed, which purifies the sewage and then discharges it to the lake.

The details of this disposal plant are presented in the accompanying drawing, which shows it in plan and sectional elevation, and also a sectional elevation of the receiving basin. The sewage from the shop sewer system flows into the receiving basin or circular section adjoining the septic tanks, which basin is provided with an overflow outlet and direct outlet for prevent agitation of the liquid and consequent interruption of the bacterial process. This process involves no "treatment" of the water. It merely offers an opportunity for the bacteria to act and purify it.

The liquid stands in the septic tank where the desired bacterial process of purification begins, the usual scum forming with the attendant reduction of foul matter in the sewage by the bacteria. Either one of the septic tanks, which have a reserve capacity 50 per cent. greater than will now be needed, may be used, valves being provided for all possible connections and flow. As the level of the liquid rises in the septic tanks it flows into one of the two catchbasins at the sides, which catchbasins are provided with automatic siphons for emptying their contents out into the contact beds, Nos. 1-4, when the level rises to a certain height. Each catchbasin has two siphons, each delivering into one of the two adjacent contact beds through a multi-ported trough for preventing rush of liquid and agitation.



Plan and Sectional Elevation of Plant.

Section Through Receiving Basin.

Sewage Disposal Plant.

use in emergency only. The location of the plant did not permit of placing the various tanks at different levels for gravity flow from one to another, so the sewage is pumped from the catchbasin up into the septic tanks upon a higher level, from whence it flows by gravity into the contact beds beyond. For the pumping a duplex pump, operated by compressed air, is used, a float in the basin controlling the air-admission and operation of the pump. An air-driven pump, rather than an electrically-driven pump, was used, owing to the greater reliability expected from the former, as well as the probability of a more constant supply of air than of electricity; also the susceptibility of an electric motor to dampness, as would be inevitable in this work, counted against its use. The delivery from the pump, which branches through valves for feeding into either septic tank, is enlarged from 4 ins. in diameter to 12 ins. for a length at the end, which length of 12-in. pipe is perforated, to cause a quiet flow, to

The contact beds are filled with broken limestone, clean and free from dirt to prevent clogging, in contact with which the sewage stands for some time, to carry out to the best advantage the bacterial action started in the septic tanks. A medium size of broken stone is used for the filling, having 40 per cent. voids in the interstices. From the contact beds the sewage drains out, through open-jointed half tile on the bottom of the bed, to outlet catchbasins, which are also provided with automatic siphons intermittently delivering out into the lake. By the time the sewage is flushed out of the contact beds it is sufficiently purified so that there is absolutely no odor and almost no color; it is, in fact, almost pure enough for domestic use, showing that the process is carried further than is really necessary. One of the most important features of this plant is its entirely automatic action, the pump and siphons working automatically, which renders only occasional attendance necessary.

NEW ALTERNATING-CURRENT SYSTEM FOR THE OPERATION OF ELECTRIC RAILWAYS.

A particularly interesting announcement has recently been made by the Westinghouse Electric and Manufacturing Co. in regard to the equipment of an important new interurban electric railway, which they have contracted to furnish. The rather startling statement is made that they are to equip the new 40-mile Washington, Baltimore & Annapolis Electric Railway with single-phase alternating-current apparatus throughout! It is claimed that a system of single-phase alternating-current operation has been devised which avoids the limitations inherent in polyphase induction motors, as also, of course, the disadvantages of the extra conductors necessary in polyphase systems, although very little definite information regarding the details of the system have as yet been given out.

It is safe to say that such a system as this is what street-railway engineers have been looking for ever since the existence of electric railway systems. The hitherto absolute necessity of feeding direct current to the car-motors has proved to be the greatest drawback to modern street-railway development. In the usual method of operating electric railways direct current is fed to the trolley line for the car motors, the current being usually generated as direct current for city lines and districts of heavy traffic; but for long-distance interurban roads the great cost of the copper in feeders is entirely prohibitive to direct-current distribution, so that alternating current is generated at high pressure and transmitted to numerous sub-stations, where it is transformed by means of transformers and rotary converters to direct current at the usual railway voltage—from 500 to 650 volts. The rotary converter sub-station has, however, always been an undesirable feature on account of the cost of the building and apparatus and the attendance required. In Europe the polyphase system using induction motors has been used to some extent, but it involves the use of two or three overhead wires, and, moreover, the characteristics of the induction motor in regard to its starting power and average efficiency in railway service are not good. Other systems which have been proposed involve the use of single-phase synchronous alternating motors upon the cars driving generators which, in turn, supply power to the motors on the axles. This, however, involves the placing of a sub-station upon the car itself, and so cannot be considered a great improvement over the ordinary alternating-current direct-current system.

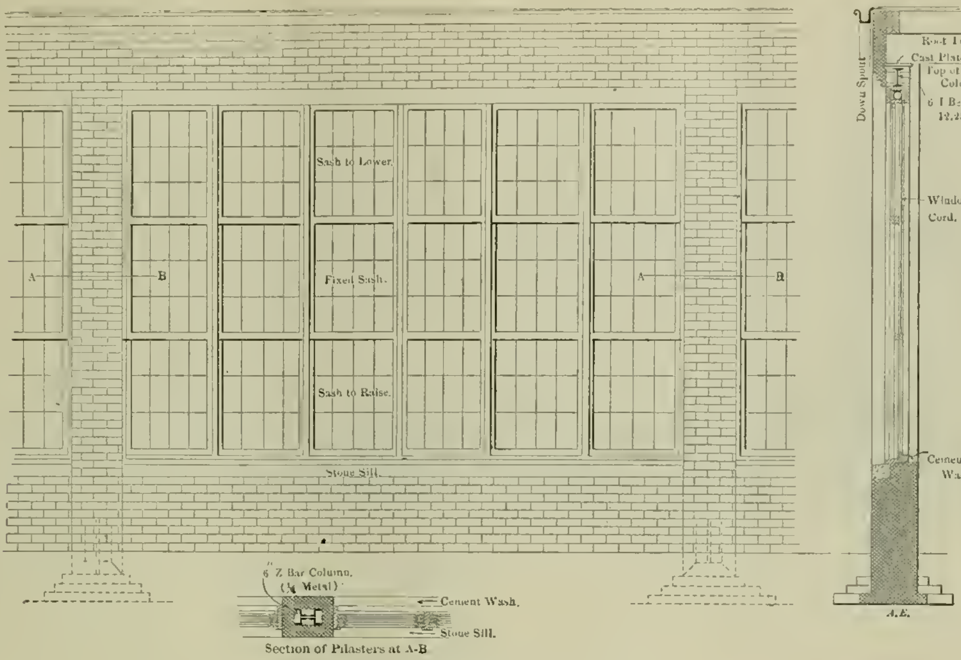
Single-phase alternating current will be generated for this road in a main power-house located at Hyattsville by three 1,500-kilowatt single-phase Westinghouse generators, delivering current at 15,000 volts, and driven by cross-compound Hamilton-Corliss engines. Current will be distributed from the power-house at 15,000 volts to transformer stations located at suitable intervals along the line. These transformer stations will contain stationary alternating-current transformers only, with the necessary switches and fuses, but no moving machinery, thus not requiring the presence of an attendant. From these sub-stations current will be fed to the single trolley-wire line at 1,000 volts, the pressure of 1,000 volts which has been adopted not, however, being a necessary part of the system, as a much higher voltage could have been used if it had been deemed advisable.

The cars will probably be 60 feet in length, weighing about 50 tons each, and will be equipped with trucks designed for high speed. Each car is to be equipped with four motors, each of 100 horse-power, with which it is expected a normal speed of 40 to 45 miles can be attained and a speed of 60 miles when necessary. The motor, which is the novel part of the equipment and the key to the entire system, is a variable-speed motor having characteristics adapted to railway service and in all respects equal to the present direct-current railway motor. It has been developed and tested in severe service during the last few years by the Westinghouse Electric and Manufacturing Company, under the supervision of their assistant chief engineer, Mr. B. G. Lamme.

Although no definite information has been received from the Westinghouse Company regarding this interesting installation, it has been elsewhere learned that the system to be used is that of using series-wound motors of the direct-current type, adapted to alternating current by completely laminated magnetic circuits, including laminated field cores and pole pieces, together with other modifications necessary in the windings. It has long been known that direct-current motors thus adapted will run successfully on alternating current, but heretofore great difficulty has been encountered with sparking at the commutator, as well as low starting torque and low efficiency. It is said that this Westinghouse motor has largely overcome these difficulties, the sparking being greatly diminished and the power factor rendered high. If such is the case, and starting accelerations prove to be as satisfactory as with existing direct-current systems, the new system will undoubtedly meet with great favor. Several minor difficulties have yet to be encountered however, one of which, the large inductive drop in voltage sure to result from passing the return alternating current through the circuit of iron formed by the rails, bids fair to give considerable difficulty.

"It may not be out of place here to refer to what appears to have been an oversight in planning the water-supply systems of the railroads in America, at least. It seems sometimes that the idea has been that a water tank or column in sight is as good as one at hand, and as a result locomotives are delayed near water stations until other locomotives are supplied with water. Large switching yards are provided with one or two cranes, usually near a short ashpit, and several times a day a line of locomotives may be seen near the water station, the crews awaiting their turns. There must be done just so much work, and just so much water must be used to do it, and it is cheaper to deliver the water in pipes to the locomotives than to run the locomotives to the water stations, if the stations are not conveniently located. With the cranes conveniently located in a switching yard, the locomotive tanks need not be of extreme capacity, and it is expensive to switch water backward and forward. The saving in cost of pipe and cranes is a false economy."—F. M. Whyte, in his paper before the Master Mechanics' Association.

In discussing the cost of mechanical and hand stoking in *Engineering Magazine*, Mr. W. W. Christie says: "A full day's work for an able fireman is the shoveling of not more than 10 tons of coal in 12 hours, or about sufficient for 450 boiler horse power. If the same man is required to handle coal into hoppers for mechanical stokers, he could take care of two units of 500 horse power each, while if the coal was fed into the hoppers automatically he could take care of four such units, or 2,000 horse power. The cost of labor would thus be reduced in the proportion of 450 to 2,000, or about three-fourths, one man being able to do the work formerly requiring four. The time required for cleaning a fire under a mechaniaclly fired boiler is also said to be less than one-tenth that needed for similar work with hand-fired furnaces. * * * Apart from considerations of economy and of smoke prevention, the introduction of the mechanical stoker is to be advocated for the reason that it supersedes one of the most fatiguing and difficult kinds of work which has been undertaken by human effort. Even in land installations the work of firing boilers is hard and dirty, while on shipboard it has long been considered the heaviest and most exhausting work which can be performed. Of all labor-saving machinery, that which relieves human beings from the stoking of boilers should be welcomed, even if no commercial advantages should result."



Improved Natural Lighting for Round-houses.

INCREASED LIGHT FOR ROUND-HOUSES.

Method of Wall Construction Permitting Larger Window Area.

By T. A. Lawes, Superintendent of Motive Power and Machinery, Chicago & Eastern Illinois Railroad.

At the last meeting of the American Railway Master Mechanics' Association, Mr. Forney said: "In past years I have had occasion to travel through the country and visit railroad shops in many places and it seems as if the designers of railroad shops always took the greatest pains to exclude daylight."

This criticism cannot be controverted. The writer has visited a number of shops on important roads, and has observed that all are poorly lighted. Railroad shops are in this important particular behind manufacturing shops. The Chicago Ship Building Company's machine shops at South Chicago, Ill., are models for imitation; with the exception of the monitor roof the sides and roof of their shop are of steel and glass, and, paradoxical as it may seem, the light inside of the shop is better than it is outside—due, no doubt, to reflection and the use of machinery painted white. This shop is a splendid example of what may be done to furnish adequate lighting. The erecting shop of the steam engineering buildings at the United States Navy Yard in New York City is also a fine example of a well lighted building.

The round-house is the shop building that should be designed with greatest possible window area. In busy times it is the most important shop, since it is then used as a repair-shop for the running repairs of engines, as well as for housing them also. Round-houses are as a rule miserably provided with light; each section usually has in the outside walls two windows, narrow and of small dimensions, and a few small windows above the doors in the inner circle. Work in the round-house must always be done promptly, but the mechanics are handicapped at the outset in being obliged to work with lamps in broad day light.

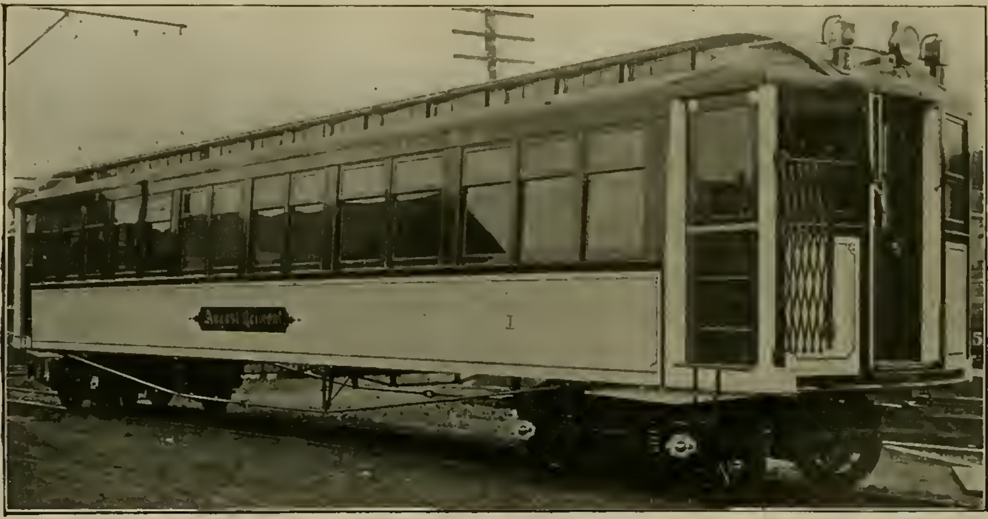
The accompanying view shows the outer wall of a proposed round-house, with a window arrangement which will increase the light entering 350 per cent. beyond that of our present round-houses. The roof trusses rest upon "Z"-bar built-up columns, which are enclosed, for fire-proofing, by brick-work. The bricks, however, carry none of the weight of the roof. The brickwork above the windows, and between pilasters, is carried by 6-in. I-beams, supported by the Z-bar columns. The roof and upper brickwork are wholly supported by the Z-bar columns, and the 6-in. I-beams serve only to tie the Z-bar columns together and to carry the small amount of brickwork above the windows. The top window sash is balanced by the lower sash, which affords in warm weather an excellent ventilation—far beyond anything now in use.

This drawing is furnished to show how the increased lighting may be accomplished; the stock excuse has been, when more window area was required, that the upper part of the brick wall between the pilasters would be weakened, but the plan submitted here will render such excuses void.

ECONOMY OF STEAM TURBINES.

Superheated steam gives excellent results in steam turbines. Tests made by Messrs. Dean & Main on a 300 h. p. De Laval turbine at Trenton, N. J., showed that at full load, about 350 h. p., the steam consumption with saturated steam was 15.17 lbs. per h. p. With steam superheated 84 degs. F., the consumption was reduced to 13.94 lbs., a saving of 8.8 per cent. These figures are based on brake horse-power. A recent number of *Engineering Record* presented the results in full.

A noteworthy installation of turbines will soon be made in the equipment of the power house of the Cleveland, Elyria & Western Electric Railway. Two Westinghouse turbines will be direct connected to two 1,000-kw. 2-pole generators running at 1,500 revolutions per minute, furnishing alternating current at 400 volts and 25 cycles per second. The steam pressure will be 150 lbs. and the superheating will be 200 degs. The turbines will exhaust into condensers and a performance of 10.8 lbs. of steam per horse-power-hour is guaranteed. At one-half load the consumption is not to increase more than 15 per cent. These turbines, described in a recent number of *Engineering Magazine*, are novel in that the steam expands in two chambers successively, with a reheater between them. By using these engines the space available in the power house can be made to yield 5,000 kw., as against 2,000 for reciprocating engines.



Car for the Interborough Rapid Transit Railway, New York City.

CARS FOR THE INTERBOROUGH RAPID TRANSIT RAILWAY, NEW YORK CITY.

Mr. George Gibbs, Consulting Engineer for the Interborough Rapid Transit Company, New York City, has employed a novel and interesting method of deciding upon the minor details of the construction of the standard cars of that road. The structure of the subway determined the length and cross section of the cars and the high speeds in a double and four track tunnel necessitated vestibules. These features being established, two sample cars have been built by the Wason Manufacturing Company, Springfield, Mass. They are fitted up with various fixtures and interior arrangements, both having automatic couplers, continuous platforms, platform buffers and electric heaters. These cars are to be completely equipped electrically as well as otherwise, and will be run upon the Long Island Railroad, which has a portion of its line equipped with the third rail. Every feature will be thoroughly tested before the equipment is ordered, and experience with these sample cars will enable the officers to contract for the entire equipment and make it standard without changes.

These engravings show side, end and interior views of one of the cars. It will be noticed that the sides have an inward slope from the window seats to the roof. This was necessary in order to secure the maximum space for the passengers, and yet come within the limiting curve clearances; otherwise the appearance and arrangements closely resemble those of elevated equipment, except that there is everywhere evidence of stronger construction. The following comparison is interesting:

Comparisons of Car Dimensions.

	Interborough.	Manhattan.
Length over platforms	50 feet 1 inch	47 feet 1 inch.
Length over car body	42 " 7 inches.	39 " 10 inches.
Length center of bolsters	36 " 0 "	33 " 2 "
Width over window stools	8 " 11¾ "	8 " 9 "
Width over sheathing	8 " 9¾ "	8 " 7 "
Width over deck eaves moulding	8 " 5 "	8 " 9½ "
Height top of rail, center draw-bar	2 " 5 "	2 " 5 "
Height top of rail to under sills	3 " 1⅛ "	3 " 3¼ "
Height top of rail over platform	3 " 8 "	3 " 9 "
Height top of rail over roof	12 " 0 "	12 " 10½ "

There are four longitudinal sills of composite construction. The centre sills are 5-in. I beams, sandwiched between two 3 x 5 in. timbers, and the side sills are 6-in. steel channels, to which an outside strip of 3¾ x 7 ins., and an inside strip 3¼ x 6 in. are fitted. The sills extend through the platforms, terminating in steel castings, to which the platform end sills are secured. The sills are braced by centre cross trussing between the needle beams. The platform end sills are 6-in. channels, fitted with ¼-in. steel, anti-telescoping plates extending 15 ins. toward the rear and the full width of the platform below the sills. The side framing of the car bodies is white ash, doubly braced and heavily trussed.

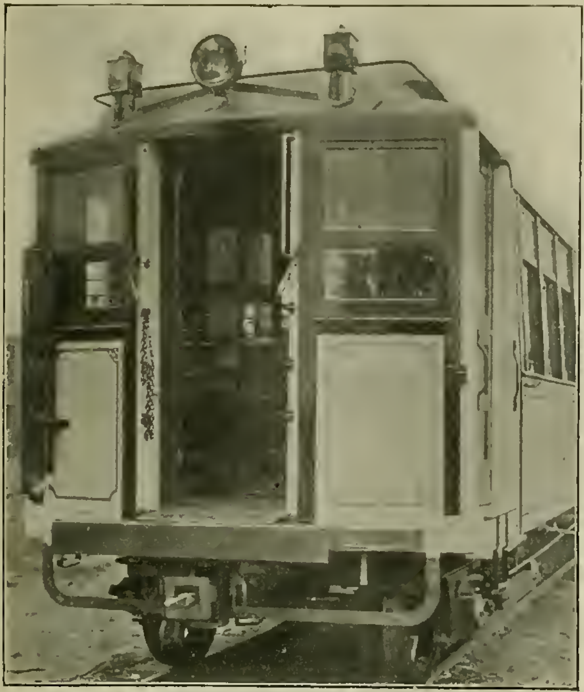
The platform posts are composite, with steel bars sandwiched between substantial white ash posts at the corners and centre of the vestibule platform. These posts are bolted to the steel longitudinal sills, also to the anti-telescoping plate below the floor, and to the hood reinforcement, which is a heavy steel angle reaching in one piece from plate to plate and extending back 6 ft. into the car body on each side. In case of an accident in which one platform rises above the other, 8 sq. ins. of metal must be sheared off before other damage can be done.

The car illustrated has vestibule doors of the Gibbs type, supported from above, and sliding into pockets in the side framing without taking up room required for the passengers. The other car is fitted with the Gold, Pitt, Duner and Gibbs doors, for the purpose of making a comparison of their relative merits. The end vestibule door is arranged so that it may close up the passage between the centre vestibule posts or it may form a closed compartment on the vestibule for the motorman. The end view shows the levers for operating the Gibbs doors.

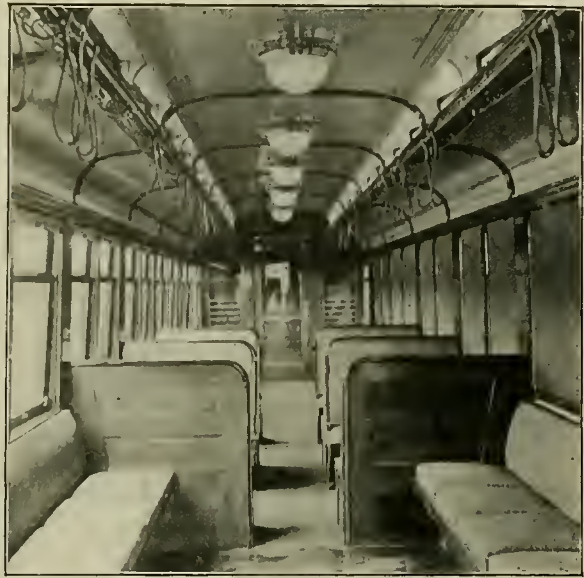
Both cars have double floors, with fire-felt sandwiched between the layers. In order to secure absolute protection against fire from the wiring, a lining of ¼-in. "transite" board is secured as a lining underneath the sills and bridging. In this way the wiring is kept away from all wood; furthermore, the motor circuits do not enter the cars at all, and the fuses and blow-outs will be enclosed in fireproof boxes in the motorman's compartment outside of the car. In this there is a lesson for all designers of electric equipment.

One car has the ordinary clerestory roof and the other the half empire form, with light-colored ceiling. One has cluster lights on the upper deck ceiling, and the other has single incandescent lamps on the upper and side deck ceilings. In one car the lower windows are stationary and the upper ones raise; this arrangement will undoubtedly be adopted, though the size of the glass may be changed. The floor covering presents a problem. Cocoa mats, linoleum and maple strips are being considered. For sanitary reasons the maple strips are likely to be adopted, and the spaces under the seats will probably be boxed in as shown in the car illustrated.

New difficulties in the way of reverse curves preclude the



End View, Showing Platform.



Interior View.

use of the ordinary platform of either the Pullman or Standard types. With a view of meeting this problem a new experimental continuous platform buffer has been developed for these cars by the Standard Coupler Company, and the end view shows one of them. This will be tried in service, and whether adopted or not, is exceedingly interesting. The long plate buffer shown in the engraving is carried on the drawbar, and moves laterally with it, the weight being carried on the flange of an angle curved to fit the under side of the platform end sill.

The electrical equipment, including the trucks, has not yet been decided upon, but it is understood that each motor car will have two motors of 200 h. p. each, and that each local train of five cars will have three motor cars. In the express trains, five out of eight cars will be motor cars. When the decisions with reference to the details have been made, and the working drawings completed, the construction will be placed on record in this journal.

RELIABILITY OF GAS ENGINES.

Confidence in the gas engine for important service is increasing to an extent which will surprise those who have been accustomed to consider it an unreliable and uncertain motor. The reason for this feeling is to be traced to the claims of manufacturers to the effect that such engines do not require expert attention. If this was ever true of the smaller sizes it certainly does not apply to larger ones, and it is found necessary, as in the case of all classes of machinery, to give them suitable attention. It is well known that a 65 horse-power Westinghouse gas engine was run continuously for 128 days at the works of the Consolidated Gas Company in New York some time ago, the only stoppages in all this time aggregating 34 hours.

According to an interesting article in "Engineering News," an extensive installation of large gas engines is now under way in Philadelphia in connection with the fire service in the business district of that city, where the requirements are unusually exacting. The plant will contain ten 280 horse-power, 18 by 22-inch Westinghouse 3-cylinder single acting gas engines, though but seven will be at present installed. These engines will be direct connected by gearing to 1,200 gallons, triplex, double action piston pumps working against a pressure of 300 pounds per square inch, and discharging into a 20-inch main. Two 125 horse-power 13 by 14-inch Westinghouse 3-cylinder gas engines, will also form part of this equipment and will be geared to smaller pumps through friction clutches. These engines will also supply the electric igniters and drive air compressors to furnish air under pressure to start the larger engines.

The gas engine was selected for this work because of the following requirements, which it fulfills better than any other form of power: Readiness for full duty load within a period of one minute from the time of the alarm signal, absolute continuity of operation, high economy of floor space, economy of fuel, simplicity of construction and care and rapidity of repairs. For intermittent service this power is specially well adapted because it is not necessary to maintain steam pressure always in readiness for use and when the engines stop the fuel expense stops altogether. A better tribute to the gas engine as a reliable motor could hardly be imagined. Such an installation will doubtless be well supplied with spare parts for the engines, and this will dispose of the question of repairs very satisfactorily.

The use of liquid fuel on board ship has been unsuccessful to a considerable extent on account of the rapid burning out of some part of the furnace of boiler. This may have been due to the use of burners or atomizers too large for the purpose. In one case where a single large burner was used, the combustion was by no means completed in the firebox, but continued through the boiler flues and on into the base of the smoke stack. The heat generated in the smoke stack was so great as to burn out its lower ring. In the first vessel launched by the New York Shipbuilding Company, oil burners were installed in small units, five small burners being used in each furnace. They are set well out in front of the boiler in order to leave plenty of space for combustion in the firebox.—Engineering Record.

STEEL RAILS: SPECIFICATIONS.

By Robert Job, Chemist of the Philadelphia & Reading Railway Company.

Freedom from fracture and slow wear or distortion under heavy traffic are essential qualities in a satisfactory rail, and call for both strength and ductility in the steel, and these, in turn, are regulated partly by composition and partly by method of manufacture. Safety is dependent largely upon freedom from brittleness, and such condition is proved by ability to withstand the drop test. Slowness of wear, on the other hand, is not to any great extent indicated by the result of the drop test.

It is well known that, in general, with a given composition, strength and ductility and service durability in a given piece of steel increase inversely with the size of the granular structure, and that fine granular form is secured by thorough working of the steel down to the critical point. From this it might be thought that a rail finished at a rather high temperature, say at a bright yellow color, and therefore having a relatively coarse granular structure, would be fractured by the drop of 2,000 lbs. falling twenty or twenty-five feet. We have found, however, after investigating a large number of rails, that coarse structure in itself does not result in fracture under the drop, provided that the steel is sound and solid. At first thought it would appear that all steel which does not contain piping or similar defects is solid, but upon examination after polishing and etching, numerous small cavities and also particles of slag and oxide may be found, and it is these which break up the continuity of the steel and generally cause failure due to brittleness. Unsound condition of this character may be due to overheating and burning, whereby thin films of oxides are formed in the steel, rendering it exceedingly fragile, or it may be caused by overblowing or by failure properly to settle. In any case, it is unquestioned proof of defective manufacture, and can be guarded against at the mill by proper practice. Steel of this type shows a marked falling-off from the standard in both tensile strength and ductility, and in service tends to fracture in the track upon exposure to sudden changes in temperature.

Rails which, though having coarse structure, still pass the drop test, obviously have greater strength and toughness, and this has been found due to comparative freedom from the unsoundness mentioned above, and in rails of a given composition we have never found a case where steel which passed the drop test contained any appreciable proportion of this enclosed foreign matter and gas, especially near the surface.

Unfortunately, it is a matter of universal experience that these solid but coarse-grained rails give relatively poor service, wearing far more rapidly and having far greater liability to fracture than other rails of the same composition which also pass the drop test, but which have a relatively fine granular form. The question thus brought before every consumer is how to distinguish in a definite, practical manner between the two forms of structure and compel adherence by the mill to the finer form. The microscope, of course, shows the condition and tells the story at a glance, but this can hardly be used at the mill by an inspector whose time is well occupied in other ways, and a simpler method is therefore essential.

As stated above, fine granular form is merely an index of the method of treatment of the steel, and shows that thorough working has continued well down toward the critical point. Fine structure might, of course, be obtained by annealing the rail after letting it cool below the critical point, but this practice is not ordinarily followed.

It is a matter of common knowledge that metals expand as the temperature increases, and several years ago Mr. William R. Webster suggested that this property might be utilized in a practical manner by specifying that a rail of given length at the ordinary temperature should not exceed a definite length when cut by the hot saws immediately after the last pass of the rolls. It was found, however, that this procedure might not result in fine granular form throughout the rail, since the steel might be run at a high temperature through all the passes except the last, and there be held while cooling—and crystallizing—until at a temperature low enough to meet the shrinkage requirement, then receiving a reduction in the last pass too slight to work the steel to the center of the rail, and thus merely breaking up the coarse-grained structure near the surface, but having little or no effect upon that beneath. What is needed is, obviously, to complete the rolling in the shortest time practicable after reaching the point at which the rolls do not work the steel clear to its center, and with such practice to stipulate that the length between the hot saws shall not exceed a certain definite amount. The duty of the inspector is thus to see that rapid rolling and sawing are maintained and to see that the specified distance between the hot saws is not exceeded.

Under the old system which produced rapid-wearing, coarse-grained rails, the saws were spaced at about 7½ ins. in excess of the 30-ft. length, to allow for shrinkage in cooling to the normal temperature. Better practice, which produced better wearing rails, reduced this to 6¼ ins., and it is found perfectly possible to-day at the modern mill to keep within a 5¾-in. limit, with our rapid rolling requirement, a practice which prevents possibility of coarse granular structure. In our specifications we place our maximum at 6 ins., in order to avoid controversy, but we find it practicable, as stated above, to keep well within this figure.

From the foregoing it is evident that to secure a safe, durable rail, the drop test is essential, and also that there must be careful oversight of the process of manufacture.

A good deal of discussion has arisen as to the number of drop tests which are necessary to ensure thorough safety. The best practice, as we consider it, is to make a drop test upon one rail built from each heat, and in case of failure to take two more butts from other ingots in the same heat, the rail from the top of an ingot being taken in each case, and the result of the majority determining the acceptance or rejection of the heat. In some cases, where the condition of the steel is seriously defective, a series of heats may fail entirely, excepting, perhaps, a single one, and in such a case we retain the right to test another butt from that heat. In case of failure then, a third butt is tested, and decides the disposition of the heat.

Objection has been made that this test of every heat would delay the rolling and block the output of the mill, but in tests of many thousands of tons of rails under this practice we have never had the least difficulty in keeping well ahead of the work and in avoiding delay.

In process of manufacture it will be noted that no mention has been made as to whether the direct process or the use of reheated blooms is desired. Under the usual mill practice there can be no question but that the former will give the more satisfactory results, owing to the difficulty in maintaining the reheating furnace at a suitable temperature and in finishing with rapid rolling at the temperature specified. At the same time, there is no inherent reason why the reheating process should not meet the requirements, and if this can be effected by careful arrangement and method we feel that the product should be as satisfactory as that produced by direct rolling, provided, of course, that the reduction of the bloom after the reheating furnace is sufficient to work the steel thoroughly to the center.

Up to this point we have practically ignored the matter of composition, not because it is unessential, but because steel of the very best composition may be completely ruined by failure to observe correct rolling methods. Instance after instance has come under our observation of service failure of rails the composition of which has been within perfectly satisfactory limits. The whole difficulty in each case was found to be a result of faulty mill methods. Present loads and speeds demand a high degree of stiffness in the rails, and this necessitates a fairly high proportion of carbon, and our regular practice for 90-lb. rails averages about 0.58 per cent. carbon, which, with the other elements, and with mill practice as specified, results in a strong, tough and fairly fine-grained rail, which seldom fails under a drop test of 2,000 lbs. falling 23 ft., the butt being 3 ft. between the supports.

In the matter of cropping, we have preferred not to specify a definite amount or proportion, but to work out the practice found desirable at each mill.

In length, the old standard of 30-ft. lengths is temporarily retained, though different lengths are ordered as desired. We are confident, however, that before long the practice of the mills will have changed materially, and that a standard of at least 45-ft. lengths will be adopted generally by the railroads.

In drawing up specifications we have taken those of the American Society for Testing Materials as a basis, raising its standard to that proved most desirable by our service results.

PHILADELPHIA & READING RAILWAY COMPANY.

SPECIFICATIONS FOR STEEL RAILS.

1—a.—The entire process of manufacture and testing shall be in accordance with the best standard practice and it is especially desired that thorough working of the steel in the rolls shall not cease until the temperature is as near as practicable to the recalescent point, or to about a low red heat.

b.—The temperature of the ingot or bloom shall be such that with rapid rolling and without holding before or in the finishing passes or subsequently and without artificial cooling after leaving the last pass the distance between hot saws shall not exceed 30 ft. 6 ins. for a 30-ft. rail, or a proportionate distance for other lengths.

c.—The amount of cropping shall be sufficient to ensure freedom from piping and injurious segregation.

d.—Ingots shall be kept in a vertical position in soaking pits.

e.—Bled ingots shall not be used.

2—Rails of various weights per yard specified below shall conform to the following limits in chemical composition:

	60 to 69	70 to 79	80 to 89	90 to 100
Carbon	.40—.50	.43 to .53	.46—.56	.53—.63
Phosphorus shall not exceed.....	.10	.10	.10	.10
Silicon shall not exceed	.20	.20	.20	.20
Manganese	.70—1.00	.75—1.05	.80—1.10	.80—1.20

3—Drop Test.

One rail butt, at least 4 ft. long and not exceeding 6 ft., shall be taken from the top of an ingot from each blow and placed on skids to cool, and the blow number stamped upon it. When cool it shall be placed either head or base upwards, or upon the side, on solid iron or steel supports, 3 ft. between centers, and shall be subjected to the following impact test under a free falling weight, as specified in Section 4.

Weight of Rail. Lbs. per yard.	Height of Drop.
Up to and including 70 lbs.	18 ft.
All heavier than 70 lbs.	23 ft.

If any rail break when subjected to the drop test two additional tests will be made upon other rails selected by the Inspector from the same blow and if either of these fail, all the rails of the blow represented will be rejected; but if both the additional test pieces meet the requirements, all the rails of that blow will be accepted. If desired by the Inspector, two rail butts may be taken from each blow for the drop test, and if either of these fail, a third shall be selected by him, and fracture of the third will cause rejection of all rails of that blow.

4—Drop Test Machine.

The drop testing machine shall have a tup of 2,000 lbs. weight, the striking face of which shall have radius of not more than 5 ins., and the test rail shall be placed upon solid supports as specified. The anvil block shall weigh at least 20,000 lbs., and the supports shall be a part of, or firmly secured to, the anvil.

If the drop test machine differs in any respect from the above standard, inspection shall be made by this company, and rolling shall not be begun until approval has been given.

5—The manufacturer shall furnish the Inspector daily with carbon and manganese determinations of each blow, and a complete average chemical analysis of the blows of each day and night turn, the drillings being taken from small test ingots.

6—Section.

Unless otherwise specified, the section of rail shall be the American Standard specified by the American Society of Civil Engineers, and shall conform as accurately as possible to the template furnished by the Railway Company, consistent with paragraph No. 9 relative to specified weight. A variation in height of 1-64 in. less, and 1-32 in. more than that specified will be permitted. A perfect fit of the splice bars shall, however, be maintained at all times.

7—The rails must be smooth on the heads and bases free from all mechanical flaws, seams, and injurious defects, and must be sawed square at the ends, and entirely free from swells in the center of the head or on top of the flanges of the base.

The burrs made by the saws shall be filed and chipped off carefully, particularly under the head and top of flange, to insure a proper fit of the splice bars.

8—Cold Straightening.

The rails must be straight in all directions, as to both surface and line, without twists, waves or kinks, particular attention being given to having the ends without kinks or drops.

Rails shall be straightened while cold, and shall be absolutely free from "gag" marks.

The distance apart of the supports in straightening press must be suitable for the stiffness and section of the rail.

9—Weight.

The weight of rails shall be maintained as nearly as possible after complying with paragraph No. 6 to that specified in contract. A variation of one-half of one per cent. for an entire order will be allowed. Rails shall be accepted and paid for according to actual weight.

10—Length.

The standard lengths of rails shall be 30 ft. Ten per cent. of an entire order will be accepted in shorter lengths varying by even feet down to 24 ft.

A variation of ¼ in. in length from that specified will be allowed.

11—Drilling.

Drilling for bolts shall be in strict conformity with the blue prints attached or the dimensions given herewith and all holes must be accurate in every respect, and finished without burrs.

12—The name of the maker and the month and year of manufacture shall be rolled in raised letters on the side of the web, and the number of the blow shall be stamped distinctly thereupon in at least two places not subsequently covered by the splice plates. The rail from the top of each ingot shall also be stamped "A," the second rail "B," the third rail "C," the fourth rail "D," and the fifth rail "E."

13—Inspectors of this Company shall have free entry to the works of the manufacturer at all times when a contract is being filled.

All tests and inspections shall be made at the place of manufacture prior to shipment, but the Inspector may obtain drillings from test ingots, and subsequent analysis must conform to the limits specified.

14—No. 2 rails in amount not exceeding that specified in contract will be accepted.

Rails which possess any physical defect or for any other cause are not suitable for first quality, but which have no injurious defects, shall be considered as No. 2 Rails, and shall be painted red on the ends. Rails rejected under the drop test will not be accepted as No. 2 Rails.

15—Rails must be handled during manufacture and loading in such manner as not to bruise the flanges or cause other injury.

16—All rails which fail in service owing to defective manufacture or to improper handling at the mill, must be replaced free of cost.

The Atchison, Topeka & Santa Fe has recently purchased a large tract, embracing about 1,500 acres, in the Kern River petroleum districts. This road is satisfied that crude petroleum is to be the fuel of the Pacific coast, and purchased the entire possessions of the Petroleum Development Company, of California, which will give a fuel supply for the Santa Fe lines from San Francisco to Seligman, Arizona—832 miles—for an indefinite period.

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EDITORIAL ANNOUNCEMENTS.

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

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

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THE COLLINWOOD SHOPS.

Railroad shops in which there is so much to commend and so little to criticise have seldom, if ever, been built before. The first view of the exterior of this plant is impressive of size, solidity and convenience. Further examination confirms this impression and reveals a remarkable combination of factors selected with one purpose and admirably arranged to serve it—the business principle of maintaining locomotives and cars upon a commercial basis. It is a sensible, business-like shop plant, containing no fads or experiments, and represents a judicious expenditure of a large sum. It is safe to say that as a plant it will long stand a monument to the business sagacity and engineering ability of the men who created it and as an example of unreserved co-operation of officers of different departments who must come together in problems of this character. The thoroughness with which the details were worked out by the officers of the road and the consulting engineer surpasses anything of the kind we have ever seen. It is a pleasure to describe an exceptional result so harmoniously attained, and sufficient space will be given to place the plant on record in a worthy manner.

HEAT TREATMENT OF STEEL.

Steel rails which would satisfy specified chemical and physical requirements and meet the approval of inspectors as to finish and section, were formerly accepted as entirely satisfactory in spite of the fact that every one knew that the use of larger sections was not accompanied by satisfactory wear. In fact, some of the light rails of twenty years ago have given better wear than heavier ones of quite recent date. In this issue is printed an important contribution on the subject, which has a bearing on many steel products other than rails. Mr. Job has made a painstaking study of steel rails with the aid of the microscope, combined with careful observation of mill practice, a study of chemical analysis, physical tests and records of service. He gives an important place to chemical and physical requirements, but goes much further and controls the treatment of the steel in finishing. Mr. Job's work confirms that of the best known investigators in this field, and his opinions are presented with confidence. Attention should be directed also to the factor of heat treatment in other steel products.

In steel forgings of all kinds the treatment while hot unquestionably affects the results, and is as important as in connection with rails. Those who are engaged in drafting specifications of steel of any kind, which is worked at high temperatures, should give most careful consideration to this article.

THE SHOP AS A SCHOOL.

When young technical school graduates are about to enter practical work they are often wisely told that they should consider their period of studying as only beginning. They are also often told that the shop is a school in which to complete their education. It is a school in the broadest sense and, to those who succeed, all life is a period of continuous study and instruction. But the attitude of the young man entering practical work toward that work may be vitally influenced by his understanding of the kind of school he is to attend. With the hope of offering a valuable suggestion, a comparison will be drawn between two imaginary young men, who are supposed to have been graduated from the same technical school and to have begun a career in the motive power department of the same railroad. Both are bright earnest young men, ambitious and sensible and both are naturally in a hurry to "get on in the world."

No. 1 has corresponded with the superintendent of motive power and is accepted as a special apprentice. An attractive course of three years is offered him and he knows that he will be moved about at more or less regular intervals and cover the work of the entire department in that time. He begins work and does very well. He learns a great deal and covers a wide range of work in three years. He has a good general view of the motive power problem at the end of the time and is ready to apply what he knows. The shop has been to him a school of instruction and he ought to be prepared for a position of responsibility if he has profited by the opportunity he has had. During this time he has been known all over the shop as a man from whom much is expected and he has been given special privileges because of his education. But if he is of the right sort he will have gained the confidence of the men and the officers and he should have a good general idea of how the department should be managed.

No. 2 is also accepted as a special apprentice, but after thoughtful consideration makes up his mind to make an independent start. The roundhouse seems to offer the best opportunity for experience and he goes to the foreman and asks for a job. On being questioned the young man cannot tell what he can do. He is put into the boiler washing gang. He does not like this work, but he gets some good ideas and valuable experience. In connection with this work he occasionally helps on boiler and other repairs and gradually obtains a view of the whole roundhouse and its importance. He sees a way to improve the method of handling the boiler washing and asks for an opportunity to try it. He is soon in charge of the boiler washing gang and his experience as an executive begins. From emergency work in the roundhouse, the next step is to the erecting shop, and he goes to the general foreman and again asks for a job, this time as a helper. The men in the gang and the foreman are prejudiced against him and haze him. This bothers him until he determines to win their friendship. In a short time he has it, and the hazing is replaced by respect and friendliness, which, when accorded by shop men, is a valuable possession. He boards with the men, eats at their table and really lives among them. He not only understands their work, but knows their surroundings and understands them thoroughly, because he is one of them. Soon the gang foreman turns one of the other helpers over to this young man and the management of men begins again. In less than a year this student is the leading man in the gang and next becomes a gang boss. After making a success of this position he sacrifices it to enter the machine shop as a machine hand and is given a set of eccentric straps to bore. This happens to be an emergency and the foreman takes advantage of the young man to discourage him. The eccentric straps are bored, however, and are right, though the method is clumsy. He had no help or instruction in this, but gets on infinitely better without, because he is obliged to get the results and it is necessary to win the confidence of this shop also or he cannot stay in it. He remains here until he is offered the position of assistant foreman. After handling this well he leaves the shop and learns to fire a locomotive in the regular way. He is firing in freight service at the end of three years and is holding his own in the pool.

The question is: Which of these young men, of equal ability and equal mental and physical skill, is more likely to be selected as foreman of an important roundhouse or master mechanic of a small division? Both of them considered the shop as a school, but their points of view were entirely different. The shop is modified to receive the first, and to a certain extent the officers of the road did homage to his education. His view of the shop is not the view taken by the men. There is an important element of the knowledge of men, to which the so-called "practical men," who fill so many important positions to-day, owe their success, which he cannot obtain. He may, perhaps, get along without it, but the lack of it is a handicap. On the other hand the second considers the shop as a plain shop. It is an organization in which he is to find his place at once. His position depends upon himself alone and he is obliged to make his way from the very beginning.

The following question is left to the reader: Which of these young men is better qualified to meet the emergencies of railroad service, where experience, knowledge and steady-headedness are so vitally necessary, and which of them is probably the better able to understand the difficulties and to meet them, including the management of men?

COMPARISON OF LOCOMOTIVES.

Locomotive development has reached a stage requiring frequent comparisons of the principal factors. This is particularly necessary in getting up new designs and in making any sort of study of the factors going to make up the capacity for sustained power.

There is no lack of methods or bases for comparison. In 1897 Mr. Henderson suggested the ratio between heating surface and cylinder volume as a good basis, and at the recent convention Mr. Gaines proposed the ratio of heating surface to horse-power, and Mr. Waitt suggested the relation between the heating surface and the weight on drivers. Each of these has its advocates and each has been criticised. It is natural that those who use any particular method of comparison should employ it in their estimate of the value of each new design as it appears. But while each method may have its good points, a uniform method is desirable in order that those who are most intereste‿ in the subject may, so to speak, talk in the same language. It is not so necessary to have the best method of comparison as it is to secure uniformity.

Mr. Fry presents a new method in his article in this issue, and it has strong claims for attention, as it embraces all of the necessary factors, and its terms include none which are taken or calculated specially for the purpose of comparison. He introduces the steam pressure, cylinder power, driving-wheel diameter and heating surface in a single ratio, involving the tractive power, size of driving wheels and heating surface, all of which are prominent factors in any consideration of a locomotive design.

This matter is attracting interested attention and is the subject of considerable correspondence among the younger locomotive men. It is hoped that the discussion will lead to a careful consideration of the whole question by the Master Mechanics' Association and the adoption of a uniform plan to be generally used. Such a course may be expected to result in a considerable improvement in the American locomotive, for it would unquestionably lead to more frequent comparison and a better knowledge of the problem of securing the maximum possible amount of sustained capacity, and this is what is wanted.

THE RELATION BETWEEN HEATING SURFACE AND CYLINDER POWER.

A Measure for the Steaming Capacity of Locomotives.

By Lawford H. Fry.

The proper relation of boiler capacity to cylinder power is of such vital importance in locomotive design that it is remarkable that there is no generally accepted standard for its measurement. A number of different ratios have been proposed as a basis of measurement, but none has been universally adopted. The purpose of the present paper is to advocate the use of a method which will be shown to be extremely simple and at the same time perfectly accurate. It will be shown that the steaming capacity of a locomotive is inversely proportional to the quantity obtained by dividing the maximum cylinder tractive effort by the total heating surface area, and multiplying the result by the driving-wheel diameter. In this article the steaming capacity factor thus obtained will be referred to as "BD," so that

$$BD = \frac{\text{max. cylinder tractive effort}}{\text{total heating surface}} \times \text{driving-wheel diameter.}$$

In comparison with other quantities and ratios which have been suggested for the same purpose, BD has the advantage of being determined by the least possible amount of calculation, and in this calculation only such quantities are used as are required for other purposes in an investigation of the locomotive. Various systems for measuring the relation between boiler capacity and cylinder power have been suggested before the Master Mechanics' Association, the more important being:

1. That suggested by Mr. George R. Henderson and endorsed by the Association in 1897. In this the ratio of heating surface to cylinder volume is taken as a measure of the steaming capacity. This gives accurate results in the comparison of locomotives having the same working pressure, but if two engines have 19 x 26-in. cylinders, and one is worked at 180 and the other at 200 pounds boiler pressure, with the same cut-off and speed, the engine with the higher pressure will develop about 11 per cent. more power, and should therefore have a correspondingly greater boiler capacity. This method also requires the calculation of, or the use of, a table of cylinder volumes, which is unnecessary in the determination of BD.

2. That suggested by Mr. A. M. Waitt before the Association this year of the ratio of weight on driving wheels to heating surface. Figures can be obtained on this basis to give the proper relation between heating surface

and adhesive weight for a given service; but as the heating surface utilizes the adhesive weight through the medium of the cylinders, it appears more logical to determine separately the proper relation between boilers and cylinders, and between cylinders and adhesive weight. The use of this method would also be complicated by the introduction of traction increasers.

3. That suggested by Mr. Gaines in his paper before the Association this year, of determining the ratio of heating surface to maximum horse-power (at as many miles per hour as the driving-wheel diameter has inches). This ratio is a proper measure of the steaming capacity of the locomotive, but to find it one must calculate the cylinder horse-power at the above speed (336 revolutions per minute), which is a quantity not otherwise valuable, as unless designed for very high speed the boiler will not be capable of maintaining full cylinder power at this speed.

In finding the factor BD the only preliminary calculation is the determination of the maximum tractive effort at slow speed, a quantity which is always required in any examination of a locomotive. And further, the algebraic analysis given below shows that BD is an accurate measure of the steaming capacity, and that it is adaptable to all conditions of service. It will be shown that

$$BD = \frac{2370\ h}{c\ r}$$

where h measures the maximum rate of evaporation,

c is the length of cut-off in per cent. of stroke,

r is the number of revolutions per minute;

so that for any given conditions of service the proper value of BD—that is, the proper relation between boiler capacity and cylinder power—may be determined.

BD is *inversely* proportional to the steaming power of the locomotive, so that to develop full cylinder power at high speeds a locomotive must show a low value of BD, while a high value of BD indicates a low steaming capacity. These conclusions, arrived at from theoretical premises, are well sustained by figures from actual practice, as may be seen from the accompanying tables. These represent figures obtained from 79 locomotives constructed in the last three years. The figures have not been selected to produce a special result, but are from locomotives which appear to represent modern American practice. The dimensions are taken from the technical papers for the years 1900, 1901 and 1902, and from the "Records ot Recent Construction of the Baldwin Locomotive Works."

Table I.

Type.	Number of Locomotives.	Values of BD. Min.	Max.	Mean.
Prairie	3	541	594	570
Atlantic	14	566	741	648
American	8	624	829	712
Ten-wheeler	25	646	900	753
Mogul	5	731	805	772
Consolidation	24	685	946	8 6

Table II.

Service.	Number of Locomotives.	Mean Value BD.
High Speed	25	635
Medium Speed	25	753
Low Speed	29	809

In Table I. the locomotives have been grouped in accordance with their wheel arrangement, and it will be noticed that the general tendency is for BD to show a low value for locomotives designed for high-speed service, and a high value for low-speed service. In Table II. the grouping has been made more general, the locomotives being classed together according to the service for which they are suitable. The Prairie, Atlantic and American type engines are placed together as high-speed engines, the Moguls and Consolidations make up the low-speed class, while the Ten-wheelers hold a medium position. In the averages thus obtained the relation of BD to the class of service is well marked. In round numbers BD averages 650 for the high-speed engines and 800 for the low-speed engines. The ten-wheel engines give intermediate values, with an average of about 750. As a matter of interest the detail figures for the Prairie and Atlantic type engines are given below:

	Type and Road.	Cylinders in Inches.	Drivers in Inches.	Boiler Pressure	Heating Surface	BD
	Prairie Type:					
1.	Illinois Central	20 x28	75	200	3,534	541
2.	Chicago, Burlington & Quincy	20 x24	64	200	2,888	568
3.	Lake Shore	20½x28	80	200	3,362	594
	Atlantic Type:					
4.	New York Central	21 x26	79	200	3,505	556
5	Buffalo, Rochester & Pittsburgh	19½x26	72	200	2,950	572
6.	Chicago Northwestern	20 x26	80	200	3,016	590
7.	Illinois Central	20 x28	79	200	3,192	596
8.	Long Island	19½x26	76	200	2,658	633
9.	Burlington, Cedar Rapids	19½x26	75	200	2,569	655
10.	Wabash	19 x26	73	200	2,436	657
11.	Central of New Jersey	20½x26	85	210	2 967	658
12.	Buffalo, Rochester & Pittsburg	20¼x26	72	220	3,008	665
13.	Paris, Lyons & Mediterranean	17¼x26	84¼	213	2,095	666
14.	Chicago, Rock Island	20¼x26	78½	210	2,806	676
15.	Central of New Jersey	20½x26	85	210	2,967	679
16.	Pennsylvania (E2	20½x26	80	205	2,640	723
17.	Pennsylvania (E1	20½x26	80	185	2,320	741

It would be of considerable interest and advantage if the technical papers were to make it a rule, when describing locomotives, to give the ratio of adhesive weight to maximum tractive effort, of maximum tractive effort to heating surface, of heating surface to grate area, and also the quantity BD. In the course of the investigation leading to the present paper it has been found advantageous to express these ratios as quotients, as shown below. The figures in this example are taken from a consolidation engine.

$$\frac{\text{Adhesive weight}}{\text{Tractive effort}} \cdots\cdots \frac{168{,}000}{41{,}100} = 4.08 \cdots\cdots\cdots\cdots (A)$$

$$\frac{\text{Tractive effort}}{\text{Heating surface}} \cdots\cdots \frac{41{,}100}{2{,}844} = 14.45 \cdots\cdots\cdots\cdots (B)$$

$$\frac{\text{Heating surface}}{\text{Grate area}} \cdots\cdots \frac{2{,}844}{49.1} = 58.00 \cdots\cdots\cdots\cdots (C)$$

By multiplying the quotient B by the driving-wheel diameter D, the quantity BD is obtained. It has been found convenient to designate the three quotients respectively by the letters A, B and C. The application of these letters is easily remembered if it is noticed that the first quotient determines the ratio of Adhesion, the second the Boiler capacity, while the third relates to the Combustion.

Slide Rule Method for Finding the Quotients.—By the use of a slide rule the quotients are very quickly and easily determined. In the case given above the cursor is set to the tractive effort (41,000) on the fixed scale, and the slide is set so that the adhesive weight (168,000) is read under the cursor; then the reading on the slide above the end of the fixed scale gives A = 4.08. Keeping the cursor at the same setting, the slide is moved to bring the heating surface (2,844) under the cursor; then the reading on the fixed scale under the end of the slide gives the quotient B = 14.45, and the reading on the fixed scale under the driving wheel diameter (56) gives BD = 810. Another setting of the rule in the ordinary way gives the quotient C.

Determination of the Relation of BD to the Steaming Capacity.—The steaming capacity of a locomotive performing a certain service may be measured by determining the maximum possible steam production of the boiler and dividing it by the actual steam consumption for the service. The quotient thus obtained (hereafter referred to as Q), is obviously a direct measure of the capacity of the locomotive. If Q is large, the engine has considerable margin of reserve steaming power; if Q is equal to unity, the service is the maximum the engine can maintain; while if Q is less than one, the service is heavier than the engine can continuously maintain. Now it can be shown that Q is inversely proportional to the quantity BD. The following symbols will be used:

B = maximum tractive power divided by heating surface.

h = pounds of water evaporated per hour per square foot of heating surface, working at maximum power.

c = percentage of stroke at which cut-off takes place.

D = driving-wheel diameter in inches.
d = cylinder diameter in inches.
L = factor to allow for losses and consumption of steam not accounted for directly in the cylinders.
P = boiler pressure in pounds per square inch.
Q = water evaporated per hour by boiler divided by water consumed per hour by cylinders.
r = number of revolutions per minute.
S = heating surface in square feet.
s = stroke of piston in inches.
v = specific volume of steam at gauge pressure P.

The amount of water consumed by the cylinders and also the amount which can be evaporated by the boiler is then determined by the following calculation:

Cylinder Consumption:

0.7854 d^2sc cubic inches of steam per *stroke*.
3.1416 d^2sc cubic inches of steam per *revolution*.
3.1416 d^2scr cubic inches of steam per *minute*.
188.5 d^2scr cubic inches of steam per *hour*.

$188.5\ d^2s\dfrac{cr}{v}$ cubic inches of *water* per hour.

$6.786\ d^2s\dfrac{cr}{v}$ *pounds* of water per hour effectively consumed, or, taking account of losses by condensation, etc.

$6.786\ \dfrac{Ld^2scr}{v}$ pounds of water *consumed* per hour total.

Boiler Evaporation:

b = maximum number of pounds of water which can be evaporated per square foot of total heating surface per hour.
S = total heating surface in square feet.
bS = pounds of water is the maximum *evaporation* per hour.

$$\text{Hence, } Q = \frac{bSv}{6.786Ldscr}$$

$$\text{But, } B = \frac{0.85\ Pd^2s}{SD}$$

$$\text{Therefore, } BD = \frac{0.85\ Pd^2s}{S}$$

$$\text{And } QBD = \frac{0.85bPv}{6.786Lcr}$$

$$\text{Therefore, } QBD = \frac{bPv}{8Lcr}$$

Now Pv is for all practical purposes a constant for boiler pressures between 150 and 220 pounds per square inch, and if the mean value of 26,000 be taken for Pv in all cases, the error will in no case exceed 2 per cent., and for pressures in the neighborhood o. 180 lbs., will be very much less. Inserting this value for Pv, the above equation becomes:

$$QBD = \frac{3250b}{Lcr} \qquad (1)$$

Now, applying this expression to two locomotives of similar design but of different dimensions working under similar conditions of cut-off and speed:

The cylinders, etc., being of equal efficiency, L will be the same in both cases.

The boilers having the same proportionate evaporative power, b will be the same in both cases.

Consequently, the cut-off and speed being the same in both cases, the right hand side of equation (1) will be the same for both engines and the values of Q will be to each other inversely as the respective values of BD. That engine showing the higher value of BD, will have the lower value of Q, and the smaller reserve of steaming power. The lower value of BD will correspond to the greater steaming capacity.

In the case of a locomotive working at maximum power, so that the steam consumption is equal to the maximum steam production, Q is equal to one and

$$BD = \frac{3250b}{Lcr} \qquad (2)$$

The importance of this equation will be recognized. The quantity BD is not only shown to be a proper measure of the steaming capacity, but a simple expression is obtained determining the proper relation between heating surface and cylinder capacity for given conditions of service.

If L, the proportion of steam used and wasted to steam usefully consumed, is known, and b the evaporative power of one square foot of heating surface, these values are inserted in equation (2), and c and r are given the values corresponding to maximum service determining the required value of BD. Under ordinary conditions it will be safe to put L = 1.10, assuming that 10 per cent. more water passes the injectors than is usefully consumed in the cylinders. This value being inserted, equation (2) takes the form:

$$BD = \frac{2950b}{cr} \qquad (3)$$

In using this expression it must be noted that b is the number of pounds of water evaporated from feed water temperature to the temperature of the working pressure; hence, if the evaporative capacity of the boiler is to be expressed in pounds of water evaporated from and at 212 degrees, the constant factor 2950 must be divided by 1.2, making the expression:

$$BD = \frac{2460b}{cr} \qquad (4)$$

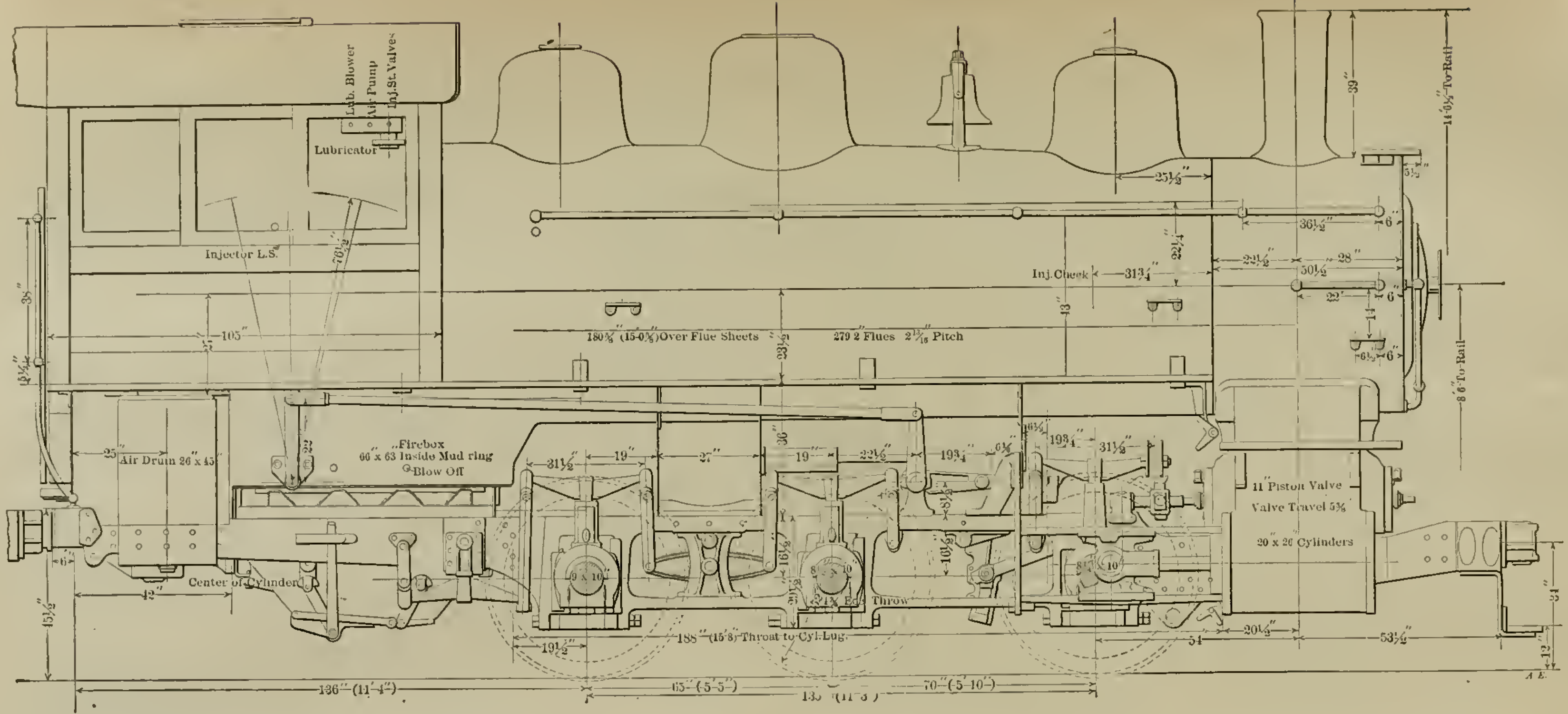
This expression is adapted for the calculation of the absolute value of BD for given conditions, but probably the widest and hence the most valuable use of the quantity BD will be in the making of comparisons.

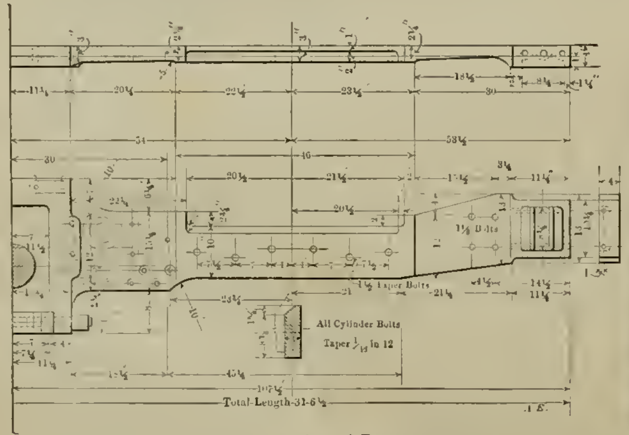
LOCOMOTIVE AND CAR SCRAP.

Locomotive and car scrap was the subject of a paper by Mr. T. A. Lawes before the Western Railway Club in September. The saving in the reclaiming of old bolts was shown to be $80 per month, in straightening old knuckles $96.60 per month, and by cleaning and using brass skimmings, instead of selling them, $125 per month. The corresponding investment has amounted to $700 in labor and material, and the saving represents a road having 140 locomotives and 11,000 cars. The conclusions of the author are as follows:

Scrap-bin floors should be on level with floors of box cars. The work of assorting scrap should be under the supervision of a man who has had experience in car repairs, that good material may be picked out and set aside for future use. Shears for cutting bolts, bolt-straightening machine and a bench with vise should be installed. The foreman of blacksmith shop should make several visits each day to scrap bins, inspect contents of same, and have set aside such material as he knows can be used to advantage. Good judgment must be used in regard to the working over of scrap materials; sometimes it costs more in the end than new material.

It would appear from tests and experiments (made by the author) that it is useless to ream a hole in a flue sheet which is less than 1-16 in. out of round, provided it is cylindrical, but if there is over 1-32 in. difference between the diameters at the two sides of the sheet, that the hole needs reaming, even although it is round. I do not claim that attention to these two points will stop the trouble from leaky flues, but I know that by watching them carefully, and reaming the holes at the proper time, our trouble will be reduced and, I believe, without any decrease in the life of the flue sheet.—S. W. Miller, in a paper read before the Western Railway Club.





Front Portion of Frames.

Six-Coupled Switching Locomotive with Piston Valves and Wide Firebox—Lake Shore & Michigan Southern Railway.

H. F. BALL, *Superintendent Motive Power.*

AMERICAN LOCOMOTIVE CO., BROOKS WORKS, *Builders.*

SIX-COUPLED SWITCHING LOCOMOTIVE.

Lake Shore & Michigan Southern Railway.

These locomotives, built at the Brooks Works of the American Locomotive Company, were designed for heavy yard service with a view of meeting the exacting conditions of such work and reducing shop repairs to the minimum. They give a drawbar pull of 30,600 lbs. and are rated at 84 per cent. This road rates all locomotives with reference to hauling capacity, the heaviest consolidation type, Class B, illustrated in February, 1900, page 37, being rated at 100 per cent. This method of rating shows at a glance the standing of every type of locomotive with reference to its power, making the weakness and inefficiency of obsolete equipment stand out boldly. These engines have piston valves with inside admission and direct motion. The frames, which are of cast steel, are in one solid piece from end to end, and the portions under the cylinder are 3 x 10 ins. in section. The firebox is 62¼ by 72⅝ ins. in size. As shown in the line drawing, the spring rigging is within the frames. Another feature which will contribute to their usefulness is the hopper ash pan. This will reduce the time on the ash pits materially. We are informed that the engines are exceedingly satisfactory in service. These engines have very short front ends, without cinder pockets, the extension front being only about 6 ins. long in front of the cylinder saddle.

Six-Coupled Switching Locomotive with Piston Valves and Narrow Firebox.

Lake Shore & Michigan Southern Railway.

Note.—This design represents locomotives built at the Pittsburg Works last year. The one shown on the opposite page is the latest of this type on this road. The description applies to the Brooks design.

Six-Wheeled Switching Locomotive—Lake Shore & Michigan Southern Railway.

General Dimensions.

Gauge	4 ft. 8½ ins.
Fuel	Bituminous coal
Weight in working order	139,000 lbs.
Weight on drivers	139,000 lbs.
Weight engine and tender in working order	227,000 lbs.
Wheel base, driving	11 ft. 3 ins.
Wheel base, total, engine and tender	43 ft. 2¾ ins.

Cylinders.

Diameter of cylinders	20 ins.
Stroke of piston	26 ins.
Diameter of piston rod	3⅝ ins.
Size of steam ports	2¼ ins. by 25.5 ins.
Size of exhaust ports	55 ins. square
Kind of valves	Piston

Wheels, Etc.

Diameter of driving wheels outside of tire	52 ins.
Material of driving wheel, centers	Cast steel
Thickness of tire	4 ins.
Tire held by	Shrinkage
Driving box material	Cast steel
Diameter and length of driving journals	8¼ and 9 ins. diameter by 10 ins.
Diameter and length of main crank pin journals	5½ ins. diameter by 6 ins.
Diameter and length of side rod crank pin journals	Main pin 6⅝ ins. diameter by 5 ins., F. S. B. 4½ ins. by 4¼ ins.

Boiler.

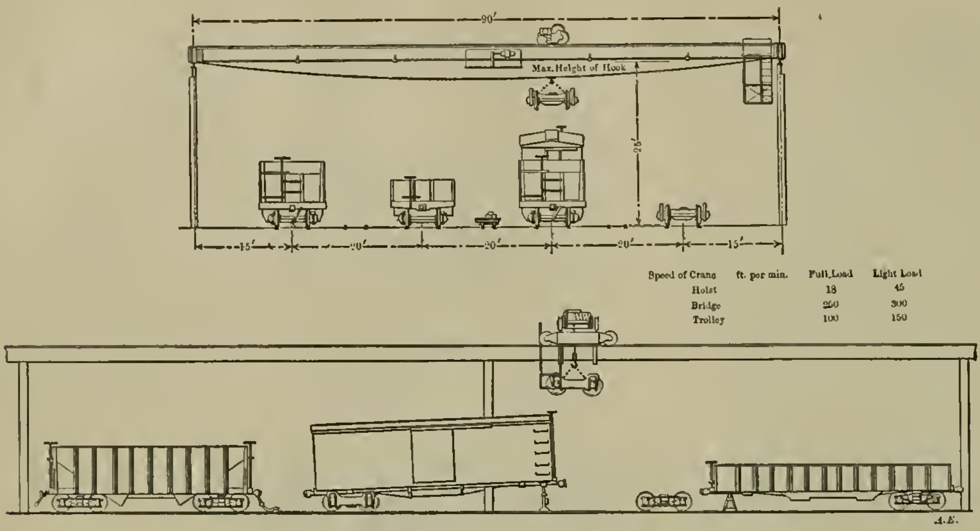
Style	Radial stay
Outside diameter of first ring	64½ ins.
Working pressure	180 lbs.
Material of barrel and outside of firebox	Steel
Thickness of plates in barrel and outside of firebox	⅝ and 8½ ins.
Firebox, length	66 ins.
Firebox, width	63 ins.
Firebox, depth	Front, 67 ins.; back, 64½ ins.
Firebox, material	Steel
Firebox plates, thickness	Sides, ⅜; back, ⅜; crown, ⅜; tube sheet, ½
Firebox, water space	Front, 4; sides, 3½; back, 3½
Tubes, number	279
Tubes, diameter	2 ins.
Tubes, length over tube sheets	5 ft. 0⅝ in.
Fire brick, supported on	Water tubes
Heating surface, tubes	2,185.63 sq. ft.
Heating surface, water tubes	20.74 sq. ft.
Heating surface, firebox	123.51 sq. ft.
Heating surface, total	2,329.88 sq. ft.
Grate surface	28.2 sq. ft.
Ash pan, style	Hopper
Exhaust nozzles	4⅞ and 5⅛ ins diameter
Smoke stack, inside diameter	15 and 17½ ins.
Smoke stack, top above rail	14 ft. 6½ ins.

Tender.

Style	Sloping back
Weight, empty	36,350 lbs.
Wheels, diameter	33 ins.
Journals, diameter and length	4¼ ins. diameter by 8 ins.
Wheel base	17 ft. 0 in.
Tender frame	Channel steel
Water capacity	4 000 U. S. gallons
Coal capacity	8 tons

Lithographed margin lines and titles for drawings are used in the mechanical engineer's department on the Lehigh Valley. Mr. Gaines has sent a tracing and letter describing the method. When a large number of sheets are lithographed at one time, and the tracing cloth is furnished in rolls, the average cost of cutting the cloth and lithographing the margins and general title is less than two cents per sheet. The average cost of doing the work by hand is about eight cents per sheet, and is not as uniform and regular as when lithographed. In lithographing these tracings, the trimming and margin lines, holes for punching and general titles may be put on as desired, and the tracing sheet is ready for the draftsman, who proceeds with the drawing without delaying to lay out the sheet. He completes the title and fills in the date when the drawing is finished.

Gas engines using blast furnace gas will be installed to furnish the blast for four new furnaces now building by the Lackawanna Steel Company at Stony Point, near Buffalo. This power has long been used in Europe, but this is its first appearance in this country for this purpose.



Speed of Crane	ft. per min.	Full Load	Light Load
Hoist		18	45
Bridge		250	300
Trolley		100	150

Repair Facilities for Steel Cars.—A Suggestion by L. H. Turner.

REPAIR FACILITIES FOR STEEL CARS.

A topical discussion on "Modern Requirements and Facilities for Repair Tracks as Influenced by High Capacity Cars," at the recent M. C. B. convention, was opened by Mr. L. H. Turner, as follows:

"It is probable that all that can be said upon this subject is already thoroughly understood and appreciated. However, the introduction of heavy capacity cars has made it necessary to provide additional facilities to repair tracks, and these facilities have not been provided to compare with the necessity. Generally speaking, the improvements of this class of work are the last to be considered, but the opportunities for improved methods and money saving are just as great there as in the repair shop. The time has passed when any railroad company that attempts to maintain from seven to ten thousand cars at any one shop can afford to get along without electric cranes, compressed air and other modern conveniences.

"Tracks for heavy repairs with a capacity of 80 cars, allowing 50 ft. to each car, can be equipped with a 10-ton crane, 90-ft. span, at a cost of $23,000, or an investment at 6 per cent. of $3.78 per day. This crane, with an operator accompanied by two men, can raise and lower all cars, transport wheels, truck frames and the various kinds of material that has to be moved from place to place, at a cost not to exceed $10 per day. On the majority of shop tracks handling this number of cars, the cost of doing by hand that which can be done with the crane, will reach at least $40.

"Compressed air is another very important factor in quick and economical repairs to cars, and is simply indispensable where steel cars are to be handled. Natural gas in connection with compressed air is another valuable adjunct in straightening parts of all steel cars, or those with steel underframing. Pneumatic riveters, drills and paint spraying machines are all made necessary by the heavy capacity cars, and in many instances are equally as valuable in handling the lighter types.

"This blue print shows the plan of a repair yard that is thought to be one where work can be done quickly and cheaply. Each car can be reached by the narrow gauge track, which is very convenient for handling the lighter material and scrap.

"The cost of freight car maintenance is continually increasing, due to the increased size of equipment, scarcity of help, advance in wages and cost of material, and can only be kept down by providing all means that tend to reduce the number employed and get the greatest possible output from each man. This not only makes itself felt upon the pay rolls, but reduces the time the car is out of service, which is another source of revenue."

An interesting article appeared in a recent number of *Popular Mechanics*, illustrating the 4,200-ft. aerial wire-rope tramway which the A. Leschen & Sons Rope Company, of St. Louis, Mo., built for the American Gold Mining Company, at Ouray, Colo. The line is 4,200 ft. long, extending from the works of the company, in the valley, up 2,100 ft. to the mouth of the mine. Any other mode of communication is impossible. The line consists of two stationary sustaining cables securely anchored at each end. The loaded buckets run on a rope 1⅛ in. in diameter, while the empties return on a 1-in. rope. The buckets are propelled by an endless steel wire rope ¾ in. in diameter, passing around an 8-ft. sheave at both terminals of the line, the one at the mine having a number of grips which clamp the rope tightly and afford the means to control the speed of the tramway when in operation; to this wheel are attached the brake-bands for stopping the tramway. The buckets are attached and detached automatically to and from the traction cable by means of patent clips, button-shaped, which are attached permanently to the cable. At the lower terminal of the line the tramway starts out a single span 2,100 ft. in length without any means of support between, which is the most remarkable feature of this tramway. The A. Leschen & Sons Rope Company are now building a tramway of this type at Encampment, Wyo., 16 miles long, which will be the longest tramway in the world.

Semaphore signals for two or more routes on the Chicago, Milwaukee & St. Paul Railway are now made in accordance with a new standard. The arm at the top of the pole governs high speed or main line movements. The arm for diverging or low speed movement is smaller and is placed 17 ft. below the main line arm. When the main line signal is "cleared" the red light of the lower arm is covered and engineers of high speed trains do not run against red lights, which mean nothing to them. The lower arm is placed 10 ft. above the rail.

NIGHT LIGHTING OF ROUNDHOUSES.

A new method of lighting the spaces between the locomotives in roundhouses has been tried on the Boston & Maine and is to be generally adopted on that road. A 16-candle power incandescent lamp with a silvered parabolic mirror, like those used on street cars, is mounted on the outer wall with its light directed between the engines and pointing toward the turntable. These lights are protected by air-tight boxes with glass fronts, and each has an independent switch to control the lamp without opening the box. The lighting is said to be much more satisfactory than that obtained by pendant lamps, even if two or three of these are used and hung from the roof in the usual way. The extra cost of the mirror is soon made good by the saving in the number of lamps required. Of course portable lamps for use under the locomotives must be provided in either case.

Superheated steam is employed by the Boston Elevated Railway in a new 4,500 h. p. compound engine recently put in by the Westinghouse Machine Company through Westinghouse, Church, Kerr & Co. The Babcock & Wilcox Company supplied the superheaters.

We are pleased to note that the Chicago & Alton Railway has established an employment bureau, the purpose of which is to recruit employes from among the people living along the line of the Alton road. Citizens living in towns upon and adjacent to the line of the Alton Railway are met by members of the bureau for the purpose of getting in touch with young men of good habits and high character who wish to become employes. Students in telegraph offices, clerks for the various departments, operators, brakemen, firemen, etc., are recruited from those whose records are kept by the bureau, the selections being made, after the mental and physical examinations forming a part of the Alton's requirements for employment have been passed, from those best suited and qualified.

If anyone is skeptical as to the necessity for examinations for vision, color sense and hearing, the experience of one of the large roads running out of Chicago should be convincing. On this road, says Dr. C. H. Williams, in a recent paper before the Western Railway Club, during the period from June 1, 1889, to November 30, 1901, there were rejected from among those applying for work, 1,888 men who could not pass the test for acuteness of vision, and 441 who were defective in their color perception to a dangerous amount. These figures mean, not only that the effectiveness of the operating force on this road was increased by the elimination of defective men, but also that other roads were getting more than their share of such persons; for many men rejected on one road find ready employment on another where no such tests are made. The figures also show that defects of acuteness of vision are much more numerous than those of color sense.

Two very unusual examples of rapid cutting were recently made at the Bethlehem Steel Company, with Taylor-White steel tools, which well illustrate the phenomenal qualities of that steel. In one instance a cut 1 3-16 in. deep was taken on a nickel-steel electric power house shaft mounted in a 90-in. lathe and revolving for a cutting speed of 25 ft. per minute, the rate of feed being 3-16 in. per revolution. In the other, a nickel-steel crank shaft for a protected cruiser was machined in a 50-in. slotter by a cut 1⅛ in. deep and a feed of 1-16 in. per stroke, the cutting speed being 18 ft. per minute. The former case corresponds to a removal of 66.78 cu. in. of metal per minute, or 2.318 cubic feet per hour. The great capacity of such rapid cutting can be better appreciated when it is considered that the rate mentioned corresponds to the removal of 1134.9 lbs. of steel per hour, or of 5.67 tons per day of 10 hours steady cutting.

It would appear from the following figures from the *Electrical Review* that electric lighting has little to fear from the competition of acetylene lighting: A ton of calcium carbide, which will generate 10,000 cubic feet of acetylene gas, requires 4,500 kilowatt-hours of electrical energy for its manufacture, and, in burning, this amount of acetylene gas will give out 250,000 candle-hours of light. But the same amount of electrical energy would, if used in incandescent lamps, produce 1,440,000 candle-hours, if used in the new Nernst electric glow lamps about twice as many, or nearly 5,000,000 candle-hours if used in open-arc lamps.

The rivets through the keel of the seven-masted schooner "Thomas W. Lawson," which was launched from the Fore River shipyards a short time ago, were nearly 5 ins. in length by 1¼ ins. in diameter. It was not possible to upset these properly with an ordinary yoke, one arm of which served as the anvil to resist the blows of the pneumatic hammer carried by the other arm. To have made the anvil heavy enough to accomplish the purpose would have produced a tool extremely awkward and difficult to handle in the cramped quarters underneath the keel. The difficulty was overcome by doing away entirely with the anvil and substituting a second pneumatic hammer. The two hammers, one on the end of each arm of the yoke, worked perfectly and there was no further trouble in making the rivets fill the holes completely. The strokes of the hammers were so exceedingly rapid that it apparently made no difference whether they approached synchronism or not.—*Iron Age.*

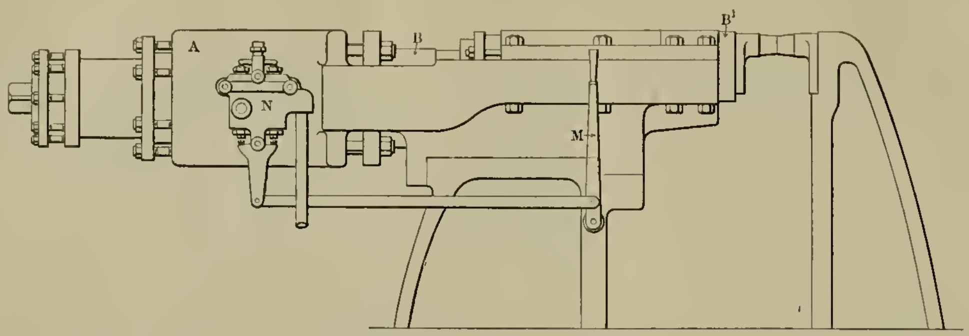
In a recent address before the Richmond (Va.) lodge of the National Association of Steam Engineers, Mr. Charles H. Garlick, national past president of the association, brought out the admirable position maintained by that society in the policy to which it holds. His remarks produced a profound impression, particularly the portion quoted below:

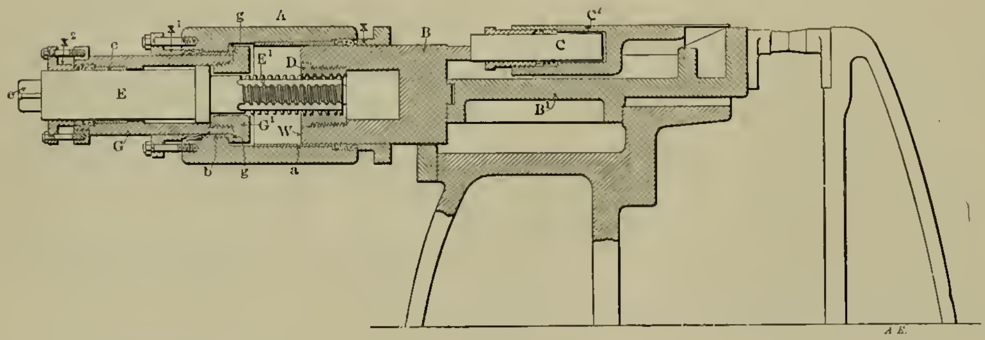
"The National Association stands out unique and alone as being the only large body of wage-earners in the world that does not resort to force and intimidation to accomplish its ends. It has 376 main and subordinate associations, located in every State and Territory in the Union with the exception of three. Its purpose is to educate the engineers in the art and science of steam engineering. The meeting-rooms are like schoolrooms, in which those that are better versed in engineering educate the less fortunate members of the society."

Mr. Garlick further stated that "the engineers who realized that coal, oil and other supplies cost money, and who, by their superior knowledge, could develop a horse-power with the least possible expense, were men who were to-day filling the best paid positions."

The maintenance of the policy of education in this great order of wage-earners for the accomplishment of their aims is the explanation of its great success. It is truly a noble and commendable policy. How often, in the trade unions and labor orders, incompetent old men are seen holding positions by virtue of priority only and thus keeping back better educated, progressive young men, whereas ability and education *should* govern.

A new burner has been perfected by the Safety Car Heating and Lighting Company. It is called the hexagon tip. Through its use the illumination afforded by a standard Pintsch lamp can be increased by about 40 per cent., while the additional consumption of gas amounts to less than 10 per cent. The tip is applicable to any standard four-flame Pintsch lamp—of which there are 140,000 in use—and it is fair to presume that the railroads will introduce this new tip as rapidly as it becomes necessary to replace the old ones now in service. One large railroad system in the East has already had many of its lamps fitted with the new burners, and all tips hereafter ordered by that company will be of the new type.





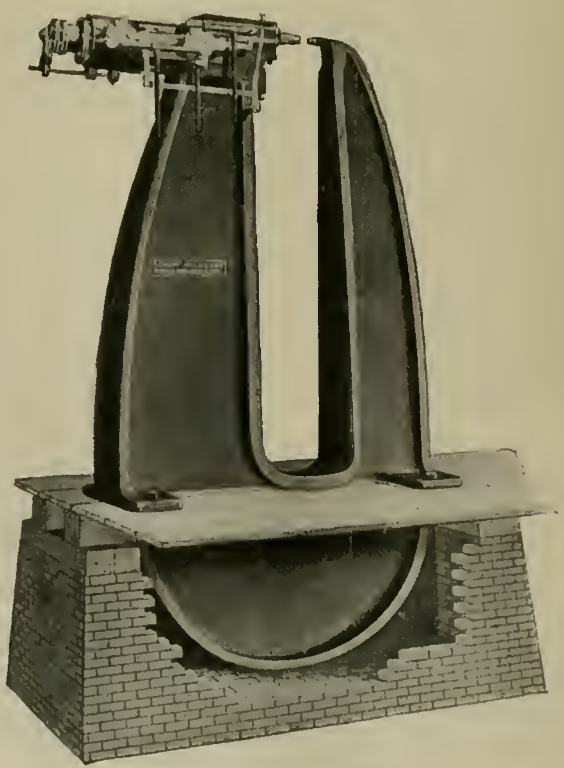
TRIPLE-PRESSURE RIVETER.

With Outside Packing.

Bement, Miles & Co.

These engravings represent an interesting new development which every railroad officer in charge of shop equipment should investigate. They show a 124-in., 75-ton machine, with cylinder and frames separate and of steel. All of the packings are of hemp and all are outside of the cylinder—a most important feature, which we believe has not before been accomplished in this kind of machine. They may be renewed without dismantling the machine. Furthermore, three pressures, 25, 50 and 75 tons, are obtained with one valve and one accumulator pressure, and these pressures are all applied in a straight line to the rivet and close to the dies. There are very few water joints. The photograph shows also the valve for operating the crane. The reader will find the construction of this machine very interesting. It is remarkably simple.

To facilitate the description the sectional view is lettered. The cylinder A and the guideways for the riveting slide B1 form part of the frame. The cylinder A has a bushing a and a stuffing-box x, through which the plunger B extends. C1 is a return cylinder, with a plunger C bearing against the plunger B. The cylinder A is open at the rear end and terminates in an inwardly projecting flange, which holds in place the bushing h, which is packed by the stuffing-box x1. An auxiliary tubular piston, or sleeve, G, extends into the rear end of the cylinder and carries the head G1 at its inner end. In the interior of the tubular piston G is an annular rib, having back of it the bushing c and stuffing-box x2, through which the piston E extends. This piston has a head, forming a shoulder, and also a threaded stem E1 extending beyond the head. The threads are interrupted like those of the breech of a gun. The opposite end of the piston E is squared, so that it may be turned through a partial revolution by a



Showing Riveter Complete.

wrench. The main plunger B is hollow, and carries the bushing D with an interrupted thread corresponding with that of the extension of the plunger E. The three pressures are obtained by the main and the two auxiliary plungers, which are locked or unlocked, separately or together, with the main plunger by means of the stem with the interrupted thread.

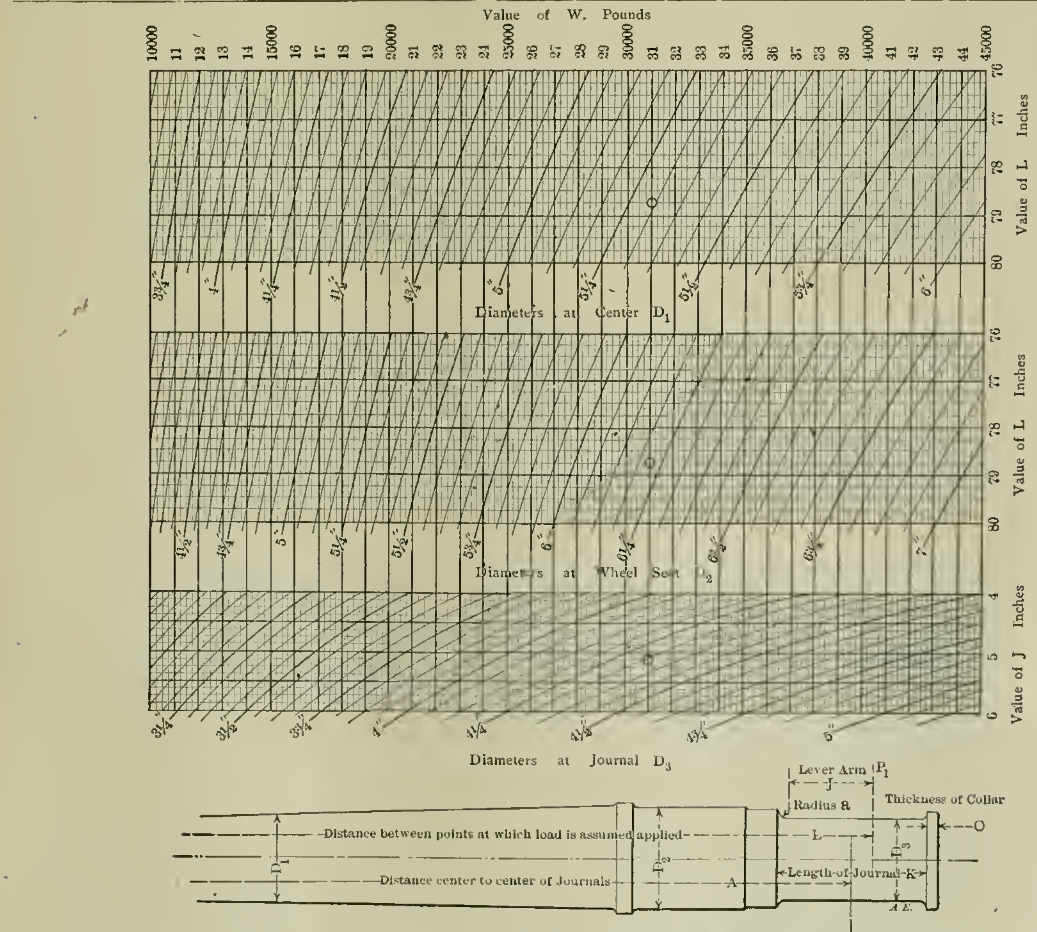
To secure the full pressure, the threaded stem is unlocked from the nut, and the pressure on the whole area of the main plunger is available. By turning the piston E when it is at the forward end of its stroke, and when the main plunger is in its forward position, as shown in the sectional engraving, the threaded stem E1 will engage the threads of the nut D, coupling it to the plunger B. This will reduce the effective area of the main plunger by the counter pressure on the piston E, and reduce the riveting pressure in this case to 50 tons. If the plunger B is moved into contact with the head G1 and the threads engaged, the pistons G and E will both move forward with the plunger B, and the force available at the dies will be only that due to the pressure against the annular surface g of the rear face of the head G1 of the hollow piston G. This gives the lighter pressure, or 25 tons, in this particular machine. One poppet valve gives the entire control.

These machines are made in three sizes, as follows:

Pressure in tons.	Gaps in inches.			
20—50—75	100	124	144	....
33—66—100	....	124	144	204
42—84—125	....	....	144	204

One of these machines of the 17-ft. gap size has been installed at the Chicago shops of the Chicago & Northwestern Railway. Others have been furnished the Baldwin Locomotive Works, Brooks Locomotive Works, Union Pacific Railway, Lake Shore & Michigan Southern Railway (for the new Collinwood shops), and also a number of other boiler shops. The machine at Collinwood will have a 17-ft. gap. Additional information will be supplied by Bement, Miles & Co., Philadelphia, Pa.

It is undoubtedly the desire of every one of our readers to occasionally, if not frequently, purchase books upon engineering and scientific subjects, but the selection of the most suitable book from those offered by the publishers is most difficult if one is not able to see the books personally. It has been truly said that "titles of books are very misleading," as they are so in many cases, as one finds upon ordering a book without seeing it in advance. An innovation is offered in this line, however, by the Derry-Collard Company, recently formed, with offices at No. 256 Broadway, New York. This company proposes to make selections of books, to the best of their judgment, for those stating to them their wants and desires with respect to the purchase of books, and will forward the book selected to the purchaser for examination, whereupon he may pay for same if it is suitable, or return it if it is not just what is wanted. Any book published will be procured, and will be sent to anyone without any references and without any extra charge for the service. This proposition appears to be a boon to those desiring to purchase technical books, and we feel sure that the best of selections will be made, owing to the technical ability incorporated in the officers of the company.



Graphical Method of Finding Limit Diameters for Car and Tender Axles—By R. B. Kendig.

Note.—This engraving is reproduced from that on page 288 to a larger scale.

THE TRACTIVE FORCE OF LOCOMOTIVES.

By Edward L. Coster, A. M. Am. Soc. M. E.

The major portion of the following article, by Mr. Coster, is a compilation from the paper entitled, "Practical Tonnage Rating," presented at the 1901 convention of the Master Mechanics' Association, by Mr. George R. Henderson, S. of M. P., of the Atchison, Topeka & Santa Fe Railway, and from information supplied in the course of private correspondence with Mr. Henderson and others. It is believed that this article will prove of interest to our readers.—Editor.

The tractive force referred to in this paper is that which is available at the circumference of the driving-wheels, and will be designated by the symbol T. It is determined as follows:

At slow speeds—5 to 8 miles an hour—with the reverse lever in the corner notch and a cut-off of about 90 per cent. of the stroke, cylinder pressures will be obtained approximately as follows:

Initial pressure = .95 boiler pressure.
Mean effective pressure = .91 initial pressure.
Mean effective pressure = .86 boiler pressure.
Allowing 8 per cent. for internal friction = .92 M. E. P.
Mean available pressure = .80 boiler pressure.

This allows for the friction of pistons, valves, eccentrics, etc., but not for the resistance to motion which must be considered with the train. (For a treatment of train resistance, refer to "Momentum and Acceleration," by Mr. F. J. Cole, American Engineeer, June, 1901, page 167.) For the maximum available tractive force we have for single-expansion engines:

$$T = \frac{p \times .7854\, d^2 \times 4s}{3.1416\, D} = \frac{p\, d^2\, s}{D} \quad \text{..................} \quad (1),$$

where p = mean available pressure in pounds per square inch;
d = diameter of cylinder in inches;
s = stroke in inches,
and D = diameter of driving-wheels in inches.

We can also write:

$$T = \frac{.8\, P\, d^2\, s}{D} \quad \text{..................} \quad (2),$$

where P = working boiler pressure in pounds per square inch.

For two-cylinder compounds, when operating compound:

$$T = \frac{.8\, P\, d_1^2\, s}{D\,(r+1)} \quad \text{..................} \quad (3),$$

where d_1 = diameter of low-pressure cylinder in inches, and

$$r = \text{ratio of cylinder volumes} = \frac{d_1^2}{d_h^2}.$$

For two-cylinder compounds when operating simple:

$$T = \frac{.8\, P\, d_h^2\, s}{D} \quad \text{..................} \quad (4),$$

where d_h = diameter of high-pressure cylinder in inches. (This, of course, assumes the adhesion of the engine to be sufficient to allow it to develop this tractive force without slipping.)

Formula (3) is based on the operation of the low-pressure cylinder alone, merely assuming that the high-pressure cylinder will have the same total effective piston pressure, and therefore perform the same work as the low-pressure cylinder. Thus formula (3) is really derived directly from formula (2), by substituting the low-pressure cylinder diameter and introducing the divisor, r + 1, which, when divided into "p," gives what might be called the intermediate receiver pressure necessary to maintain equally the work in both cylinders when they bear to each other the ratio "r."

Thus, if we consider a two-cylinder compound locomotive having a cylinder ratio of 1 to 2, (r = 2), it is evident that it will require twice as much mean effective pressure in the high-pressure as in the low-pressure cylinder in order to equalize the work between them. With 210 pounds boiler pressure we would, neglecting losses, require 70 pounds initial pressure in the low-pressure cylinder, and 210 pounds initial pressure in the high-pressure cylinder, since the latter pressure is opposed by the 70 pounds back pressure offered by the receiver pressure (which is also the low-pressure initial pressure), thus leaving 210—70 = 140 pounds effective pressure. Hence, to obtain the proper theoretical low-pressure initial pressure, we have $\frac{210}{3} = 70$ pounds; or $\frac{210}{2+1} = \frac{P}{r+1}$; from which it follows that the actual initial pressure $= \frac{.95\,P}{r+1}$; the mean effective pressure $= \frac{.91 \times .95\,P}{r+1} = \frac{.86\,P}{r+1}$; and deducting 8 per cent. for internal friction, the mean available pressure in the low-pressure cylinder $= \frac{.8\,P}{r+1}$; and similarly for all pressures and cylinder ratios.

$$\text{Consequently, } T = \frac{\frac{.8\,P}{r+1} \times .7854\, d_1^2 \times 4\, s}{3.1416\, D} = \frac{.8\,P\,d_1^2\,s}{D\,(r+1)};$$

as given in formula (3).

The converse of the foregoing will also be true, namely: the diameter of the low-pressure cylinder can be calculated from equation (3) when the ratio between the cylinder volumes has been determined. Thus, since $T = \frac{.8\,P\,d_1^2\,s}{D\,(r+1)}$, $T\,D\,(r+1) = .8\,P\,d_1^2\,s$; whence $d_1^2 = \frac{T\,D\,(r+1)}{.8\,P\,s}$, and

$$d_1 = \sqrt{\frac{T\,D\,(r+1)}{.8\,P\,s}} \quad \text{..................} \quad (3a)$$

On page 22 of the 1899 edition of the catalogue of the Brooks Locomotive works it is recommended that "the ratio between high-pressure and low-pressure cylinder volumes for two-cylinder compounds be 1 to 2.25, and for four cylinder compounds 1 to 3.5, these being the most desirable ratios at the prevailing pressures."

The larger standard cylinders of Vauclain compound engines (classes $\frac{16}{30}$ to $\frac{30}{64}$, inclusive) have ratios varying from 1 to 2.68, to 1 to 2.94; the average ratio being 1 to 2.8. In designing these cylinders the aim has been to obtain ratios of as nearly 1 to 3 as equal cylinder work, and the use of convenient measurements, would permit.

In their latest design of four-cylinder balanced compound "Atlantic type" express locomotive, for the Northern Railway of France, MM. Du Bousquet and De Glehn have adopted a cylinder ratio of 1 to 2.71, which is found to give a higher thermal efficiency than the ratio of 1 to 2.42, employed in the earlier De Glehn compounds on this road.

For an analysis of the considerations governing the selection of cylinder ratios for compound locomotives, reference may be had to pages 72 to 79 of "Compound Locomotives," by Prof. A. T. Woods and D. L. Barnes.

Four-cylinder compounds will give values as follows:

$$\text{When operating compound: } T = \frac{1.6\,P\,d_1^2\,s}{D\,(r+1)} \quad \text{..........} \quad (5),$$

$$\text{and when operating simple: } T = \frac{1.6\,P\,d_h^2\,s}{D} \quad \text{............} \quad (6)$$

In the case of four-cylinder compounds, if we assume an equality of the work performed in all of the cylinders, it is only necessary to multiply formula (3) by 2, since we have double the number of cylinders. This is the explanation of the factor 1.6, which appears in the numerator. Thus,

$$T = \frac{\frac{.8P}{r+1} \times .7854\, d_l^2 \times 4s \times 2}{3.1416D} = \frac{1.6\, P d_l^2 s}{D(r+1)}, \text{ as given above}$$

Conversely, since $T = \frac{1.6Pd_l^2 s}{D(r+1)}$, $TD\,(r+1) = 1.6Pd_l^2 s$,

$$\text{whence } d_l^2 = \frac{TD\,(r+1)}{1.6Ps}, \text{ and } d_l = \sqrt{\frac{TD\,(r+1)}{1.6Ps}} \quad \ldots.(5a)$$

It should be observed that if equal work is not done in all of the cylinders the foregoing formulae will not be strictly true. (Equal division of work between the high and low-pressure cylinders of a tandem compound is not essential, as an inequality will not tend to produce transverse twisting of the driving axle, as in a two-cylinder compound, nor vertical tilting of the cross-head, as in a Vauclain compound.)

From the foregoing it will be readily observed that the mean effective pressure does not stand by itself in these formulæ, because, if we desired to work on mean effective pressure we would substitute .86 for .8 in formulæ (2), (3) and (4), and 1.72 for 1.6 in formulae (5) and (6). We should then have what might be termed the "indicated tractive force," from which we would be obliged to deduct the engine friction in order to get the net power of the locomotives.

In regard to the tractive force of compound engines working simple, it is assumed that the operation of the high-pressure cylinder is the same as in single-expansion engines, and that the pressure of the live steam admitted to the low-pressure cylinder is reduced sufficiently to produce a cylinder work equal to that of the high-pressure cylinder. Hence formulae (4) and (6); these are, however, strictly applicable only to locomotives provided with intercepting valves, and a direct exhaust from the high-pressure cylinder to the atmosphere.

For Vauclain compound engines, the Baldwin Locomotive Works give the following formulae:

When operating compound,

$$T = \frac{.66P \times .7854 d_h^2 \times 4s}{3.1416D} + \frac{.25P \times .7854 d_l^2 \times 4s}{3.1416D} = \frac{.66Pd_h^2 s}{D} + \frac{.25Pd_l^2 s}{D} = \frac{Ps\,(.66d_h^2 + .25d_l^2)}{D} \quad \ldots\ldots\ldots\ldots(7);$$

and when operating with live steam in the low pressure cylinder,

$$T = \frac{.56Pd_h^2 s}{D} + \frac{.34Pd_l^2 s}{D} = \frac{Ps\,(.56d_h^2 + .34d_l^2)}{D} \quad \ldots\ldots\ldots\ldots\ldots(8).$$

In formula (7) it is assumed that the maximum mean forward pressure on the high-pressure piston = .91P, and that the mean back pressure (which is also the low-pressure mean available pressure) = .25 P. Hence, the high-pressure mean available pressure = (.91—.25) P = .66P; as given above.

In formula (8) it is assumed that the opening of the starting-valve and the consequent passage of live steam from the admission to the exhaust end of the high-pressure cylinder, reduces the mean forward pressure on the high-pressure piston from .91P (as in 7) to .90P, and increases the mean back-pressure, or low pressure mean available pressure, from .25P to .34P. Hence, the high-pressure mean available pressure becomes (.90—.34) P = 0.56P.

As the result of a number of tonnage rating tests and indicator cards, Mr. F. F. Gaines, mechanical engineer of the Lehigh Valley Railroad, has adopted for the maximum available tractive force of Vauclain locomotives during compound operation, the formula:

$$T = \frac{.71\, P\, d_h^2\, s}{D} + \frac{.265\, P\, d_l^2\, s}{D} = \frac{P\, s\,(.71\, d_h^2 + .265\, d_l^2)}{D} \quad \ldots\ldots\ldots(9),$$

in which the friction of the engine and all internal losses have been deducted, and the result obtained by the use of these figures Mr. Gaines recommends as available drawbar pull on straight, level track, at slow speed. By substituting the proper values for the maximum mean available pressures, formulæ (7) and (8) can, of course, be employed for tandem engines, and are also rendered applicable to cross-compounds by introducing 2 into each divisor.

While variations in these figures may sometimes be expected, they will in general represent safe deductions at the slow speeds mentioned above. As the speed of a locomotive is increased the value of T will evidently be reduced, the boiler being usually inadequate to maintain full pressure with the reverse-lever in the corner at a speed exceeding five to eight miles per hour.

In the absence of reliable information as to the average mean effective pressures obtained in compound locomotives when at high speeds, the available tractive force of these engines under such conditions may be approximately determined in the following manner:

In his discussion of Mr. Henderson's paper, Prof. W. F. M. Goss said that for the Purdue locomotive Schenectady No. 2 "the loss due to the machine friction of the engine is constant for all speeds." (Proceedings Am. Ry. M. M. Assoc., 1901, page 214.) Assuming this to be true for all locomotives, and taking this loss as equivalent, as before, to a reduction of 8 per cent. of the mean effective pressure, we have, after allowing for engine friction, .92 M. E. P., as given above.

Let it be required to find the tractive force of a given two-cylinder compound locomotive when at a translational velocity corresponding to a piston speed of, say, 700 feet per minute. Referring to the diagram, Fig. 1, given by Mr. F. J. Cole in the AMERICAN ENGINEER for June, 1900; page 176, we find that at this piston speed the mean effective pressure of a simple engine = .5 P. Hence, allowing 8 per cent. for internal friction, we have mean available pressure = .92 × .5 P = .46 P; and substituting this value for .8 P in formula (3), we obtain

$$T = \frac{.46Pd_l^2 s}{D\,(r+1)}.$$

Had the above hypothetical case been that of a four-cylinder compound, then, substituting 2 (.92 × .5) P = .92 P for 1.6 P in formula (5), we have

$$T = \frac{.92\, P\, d_l^2 s}{D\,(r+1)}; \text{ and similarly for other piston velocities.}$$

The available tractive force of a two-cylinder compound locomotive when the piston speed is 700 ft. per minute, can also be approximately determined as follows:

Equating formulæ (2) and (3), and solving for d, we have

$$\frac{.8Pd^2 s}{D} = \frac{.8Pd_l^2 s}{D(r+1)}; \text{ whence } d = \sqrt{\frac{d_l^2}{r+1}} = \text{ the diameter of}$$

the equivalent simple cylinders. Substituting this value for d in formula (2), and taking the mean available pressure = .46P, as before, we obtain $T = \frac{.46Pd^2 s}{D}$.

Similarly, for a four-cylinder compound, equating formulae (2) and (5), we have $\frac{.8Pd^2 s}{D} = \frac{1.6\, Pd_l^2 s}{D\,(r+1)}$, whence $d = \sqrt{\frac{2d_l^2}{r+1}}$;

or, equating formulae (2) and (7), we obtain:

$$\frac{.8Pd^2 s}{D} = \frac{Ps\,(.66d_h^2 + .25d_l^2)}{D}, \text{ whence } d = \sqrt{\frac{.66d_h^2 + .25d_l^2}{.8}} = \text{ the}$$

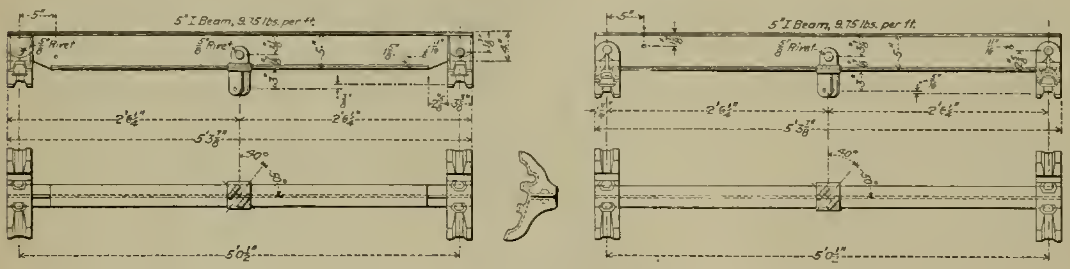
diameter of the equivalent simple cylinders. Substituting this value for d in formula (2), and taking the mean available pressure = .46P, we have $T = \frac{.46Pd^2 s}{D}$; and likewise for other piston speeds.

While the foregoing analysis is approximately correct, it should be observed that as compound locomotives consume less steam and operate with a later cut-off than similar single-expansion engines performing the same work, the reduction in mean effective pressure accompanying a given increase of piston speed is probably not so great in compound as in simple engines; hence at high speeds, the actual tractive force of the former will probably be somewhat in excess of that given by the above formulæ. For tonnage rating purposes, this discrepancy constitutes an error on the side of safety.

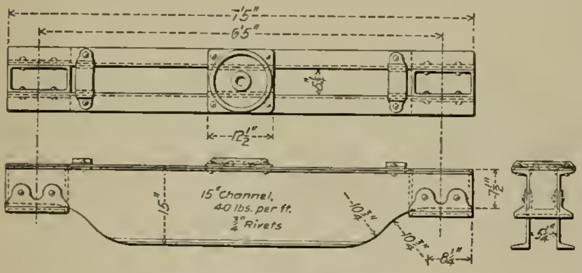
VANDERBILT TRUCK BOLSTER AND BRAKE BEAM.

This truck bolster is built up of 15-in. 40-lb. channels placed 5¼ ins. apart, with the lower portions of their ends cut away to fit into cast steel spring seats. They are secured together also by the side bearings and center plate. The spring seats are made in box form to fit between the channels and with exterior brackets, so that the rivets pass through three thicknesses of metal and hold the structure together, but without being subjected to strain from the load. This construction is used under cars of 100,000 lbs. capacity. It forms a beam of virtually uniform strength.

The brake beam is illustrated in two forms, both being constructed of 5-in., 9¾-lb. I-beams. In one both the flanges are continuous to the ends and the brake heads are fitted over one of the flanges and riveted to the web. In the other form one of the flanges is cut away at both ends and the heads are fitted to the T-shaped ends of the beam. This construction



The Vanderbilt Brake Beams.



The Vanderbilt Truck Bolster.

permits of slipping the brake lever fulcrum along to the end of the beam, where it may be slipped off without removing the brake heads. These brake beams are manufactured by the Buffalo Brake Beam Company, 100 Broadway, New York. The bolster and brake beams were designed and patented by Mr. Cornelius Vanderbilt.

NEW TRANSPORT FACILITIES FOR WESTERN ONTARIO.

An arrangement has lately been made between the Pere Marquette and the Lake Erie & Detroit River Railway companies which will doubtless prove of vast importance to western Ontario. The Pere Marquette company has secured the right to run trains over the Lake Erie & Detroit River tracks from Port Sarnia, Ont., to Rondeau and Port Stanley, Ont., where connections are made with the car ferry to Conneaut, Ohio, thus making a short cut from the upper peninsula of Michigan to the Bessemer & Lake Erie road, and to the Eastern States. Supplying, as it does, nearly all the soft coal for western Ontario from the Ohio and Pennsylvania fields, this ferry is already of considerable importance, but it is expected this new arrangement will make the ferry system across Lake Erie a line of general traffic, adapted for passengers as well as freight. There is now but one ferry running across Lake Erie between Conneaut and Port Stanley, having a capacity of twenty-six to twenty-eight loaded cars, and makes twelve round trips per week; but it is proposed to add several steamers of equal or greater capacity, sufficient to meet all the demands of the new line. The distance from Port Sarnia to Conneaut, Ohio, is about 150 miles, half by land and half by water.

WATER TUBE BOILERS IN MARINE PRACTICE.

The following quotation from the report of the committee appointed by the lords commissioners of the British Admiralty to consider certain questions respecting modern types of boilers for naval purposes may be of interest to our readers:

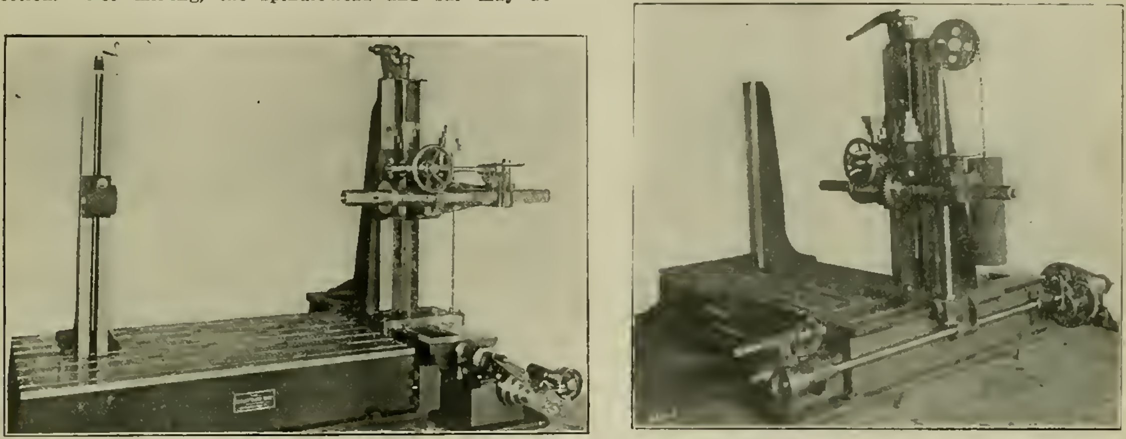
"In the course of their investigations the committee have watched the Babcock & Wilcox boilers fitted in the steamship 'Martello' of the Wilson line, employed in the Atlantic trade between Hull, Boston and New York, and copies of the reports of their inspections have from time to time been forwarded to their lordships. These inspections have taken place at the end of every round voyage for fourteen months, and the committee's opinion is that these boilers have stood the test of usage in the mercantile marine extremely well. The vessel has run about 91,000 miles since the boilers were put in, and has usually been less than a week in port at either end; the only repairs required have been those of the ordinary upkeep of any boiler, such as fire-bars, brickwork, etc., and only six tubes have required renewal. This opinion is strengthened by the inspections of boilers of the same type fitted in the 'Numidian,' the 'Buenos Ayrean' and the 'Turret Cape.' In the case of the last-named vessel the boilers have been in use seven years, and cannot have been as well looked after as they would have been in the navy, and their condition when examined recently was satisfactory. The committee have also examined and tested boilers of the same type in H. M. S. 'Sheldrake,' and find that, although they have been in use for four years, their condition is good and they have given little trouble.

"From the information which has been brought to the notice of the committee, it appears that water tube boilers are being very little used in large ships belonging to the mercantile marine, and that their use in such ships is increasing very slowly. In the British mercantile marine the only type of water tube boiler installed in ocean-going vessels is the Babcock & Wilcox, in some ships of the Wilson and the Petersen-Tate lines, and in three ships of the Allan line; in these last, however, only one water tube boiler is fitted in each vessel, to assist the original cylindrical boilers. In the United States mercantile marine Babcock & Wilcox boilers are used to a small extent, principally in the ships plying on the Great Lakes, and in the American navy many Babcock & Wilcox boilers are in use."

It is interesting to note that throughout their investigations, which lasted over a period of nearly two years, the committee were only able to examine into the merits of one type of water tube boiler successfully operating in the merchant marine, and, as will be seen by the foregoing, this was the Babcock & Wilcox.

FRANKLIN HORIZONTAL FLOOR-BORING, MILLING AND DRILLING MACHINE.

This new machine, designed and built by the Franklin Machine Works, Incorporated, Philadelphia, Pa., possesses a number of valuable features. While it conforms in general principles to more expensive and larger machines, it is capable of doing the boring and a large amount of the milling heretofore necessarily done on a long milling machine. It covers a specially large variety and wide range of work, being adapted to all kinds of boring, tapping, reaming, and various kinds of milling. It has a spindle of hammered crucible steel, 3 ins. in diameter, fed through a gun-metal sleeve, and has a No. 5 Morse taper hole in the end of the spindle, with a hole for a pin to secure boring bars, facing heads, etc., in position. The column carrying the spindle-head has an automatic feed of 42 ins. in either direction, the spindle-head has 30 ins. of vertical movement, and the spindle feeds 24 ins. in either direction. The feeds are arranged to be driven by power in any direction. For milling, the spindle-head and bar may be clamped in position. The wide range of work which it will do is sufficient recommendation for this machine. It will bore and face cylinders as large as 24 ins. in diameter, and will drill and tap holes as small as ⅜-in. It will mill long castings, cut keyways in long, heavy shafts, and yet occupies a small space in relation to the size of the work done. With a rotary facing-head it will do work ordinarily done on rotary planers. Many jobs formerly requiring the use of a heavy boring machine, where the work required raising and lowering to the bar, can be successfully done on this machine with the least possible amount of effort. The gearing throughout is very powerful and all of steel. Ten changes of speed are obtained from the driving-cone, which has five steps, and there are eight changes of feed for each step of the driving-cone. The platen is a strong, heavy, well-ribbed casting, and is provided with a plain or compound table, or both, if desired. This machine has been designed to meet a definite need, and it is very well received by the users of machine tools, who are becoming more and more discriminating in the selection of machinery every year. Further particulars may be obtained from the Franklin Machine Works, 1231 Callowhill street, Philadelphia, Pa.



Horizontal Floor Boring and Milling Machine.
Franklin Machine Works, Philadelphia, Pa.

Scale in gas-engine cylinder jackets in which hard water has been used can be effectually removed by filling the jacket with commercial muriatic acid, according to Mr. C. W. Andrews, Hamilton, O., at a recent meeting in Columbus of the Ohio Gas Light Association. It is allowed to stand in the jacket until the decomposition of the scale, with the attendant evolution of carbonic acid gas, is completed. One application has generally been found sufficient, if the scale is light.—Engineering Record.

A LARGE ELECTRIC RAILWAY SYSTEM.

One of our largest interurban electric railways is the Hudson Valley Railway Company, which is a consolidation of the Stillwater & Mechanicsville, the Greenwich & Schuylerville, the Glens Falls, Sandy Hill & Fort Edward, and the Warren County railroads, and the Saratoga Traction Company. The company has now in operation over one hundred miles of electric road, running north from Albany and Troy to Saratoga, Lake George, and the Adirondacks. At the present time power for operating the system is derived from independent power stations located at Stillwater, Saratoga, Middle Falls, Glens Falls, and Caldwell, but, ultimately, power for operating the entire system will be developed on the Hudson River near Waterford.

For the operation of the road in the meantime, until this Hudson River power station can be completed, an interesting and somewhat unusual method will be made use of. The company has increased the capacity of the direct-current power station at Glens Falls, and also of the Caldwell station, by installing additional generators. In the power station at Glens Falls there will be installed a 250-kilowatt three-phase rotary converter, transforming from direct current to alternating current, with voltage-raising transformers. Power will thence be transmitted by a three-phase 11,000-volt transmission line to Caldwell, where lowering transformers and a second 250-kilowatt rotary converter, operating alternating current to direct current, will be installed to supplement the generating power of that station. At the company's power station in Saratoga there is to be installed a 400-horse-power engine and a 250-kilowatt, 2,200-volt, alternating-current generator, with raising transformers, from which power will be transmitted by a three-phase, 11,000-volt transmission line to a sub-station at Round Lake to supply power to the recently completed Saratoga division of the system.

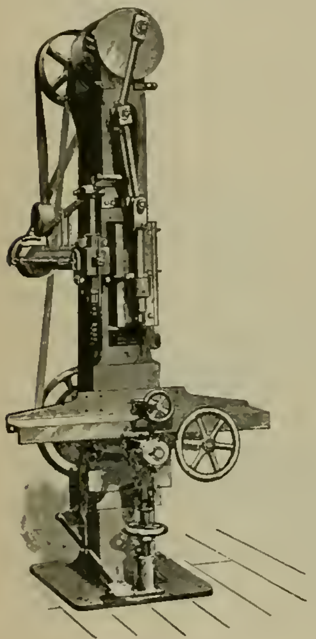
After the alternating-current generating plant is installed next year on the Hudson River near Waterford, the generating and sub-station apparatus now in use will be displaced by eight 300-kilowatt rotary converters, delivering direct current at 600 volts to the lines, and supplied by the main Hudson River power-house. The electrical apparatus for the temporary installations and for the permanent equipment of the sub-stations is to be furnished by the Westinghouse Electric and Manufacturing Company.

The importation of foreign scrap iron and steel is one of the features of the present unusual conditions of the metal market in this country, indicating the enormous demand for metals.

GRADUATED STROKE MORTISING AND BORING MACHINE.

In our August issue was illustrated an improved tenoning machine manufactured by the Bentel & Margedant Company, Hamilton, Ohio. The accompanying engraving illustrates the hydrostatic graduated stroke mortising and boring machine, also made by this company, upon which several important improvements have been added.

A characteristic feature of this machine is the very strong construction, enabling it to work on heavy car and bridge work with hard wood as well as soft; also the ingenious stroke-graduating mechanism for gradually advancing the reciprocating chisel into the work. The old process of lowering the reciprocating chisel by gradually depressing a foot-treadle as the cutting proceeds is here obviated by a hydraulic mechanism which is set in action by merely depressing the foot-treadle at the base of the machine and holding it down. A liquid in a cylinder resists the reciprocating blows of the chisel, the gradual settling of the piston in the cylinder permitting the gradual lowering of the chisel into the work. This cylinder is shown in the illustration at the base of the machine, at the rear.



This arrangement merely necessitates the raising of the operator's toe to give the treadle a one-half-inch movement, and also it effectually prevents breakages of chisels from irregular feeding, as the chisel bar is lowered uniformly and smoothly. The steel crank-shaft is seated in very long bearings, and the chisel bar is of improved design. The boring attachment is driven from the main shaft, and is controlled with tight and loose pulleys by a belt-shifting handle. The working table is raised and lowered by a heavy screw, centrally located, and provided with a long sleeve-nut. This machine is furnished with a series of chisels ranging from $\frac{3}{8}$ to $1\frac{1}{2}$ ins. in width, and the boring attachment will bore holes up to 6 ins. in depth. The table is 44 by 8 ins., and will receive material 18 ins. thick.

A relief association has been in operation on the Pennsylvania Railroad for a number of years, and it has recently been extended to the Grand Rapids & Indiana. Its funds are created by voluntary contributions at uniform rates, graded with reference to the rates of wages. The railroad company acts as trustee, and is responsible for the fund, paying any deficiency which may be required.

The amount of benefit in case of disability or death is graded in accordance with the class of service of the member and the amount of his dues. During eleven months of last year the employees of the Grand Rapids & Indiana received, on account of sickness, $2,507.20; accident, $1,684, and death, $4,500, making a total of $8,691.20 paid to employees of that company alone. Aside from the financial benefit derived from an association of this nature, it tends to bring the employees into more friendly relations with the company.

PERSONALS.

Mr. W. F. Kiesel, Jr., has been appointed assistant mechanical engineer of the Pennsylvaia Railroad to succeed Mr. A. W. Gibbs.

Mr. Benjamin Welch, master car builder of the Southern Pacific, has retired after a continuous service of 39 years. He has not been in active charge of the department for about two years.

Mr. H. E. Smith has resigned as chemist of the Chicago, Milwaukee & St. Paul to accept the position of chemist and engineer of tests of the Lake Shore & Michigan Southern, with headquarters at Collinwood, Ohio.

Mr. J. F. DeVoy, formerly chief draftsman of the motive power department of the Chicago, Milwaukee & St. Paul Railway, has been promoted to the position of mechanical engineer, to succeed Mr. A. H. Thomas.

Mr. A. R. Breckenridge has been appointed master mechanic of the Des Moines, Iowa Falls & Northern Railway, with office at Iowa Falls, Ia. He was formerly for 15 years foreman of the machine shop of the Illinois Central at Waterloo, Ia.

Mr. Frank G. Benjamin has been transferred to the position of master mechanic of the Iowa division of the Chicago & Northwestern, with headquarters at Chicago. This is a promotion from a similar position on the Madison division.

Mr. H. T. Bentley has been promoted to the position of assistant superintendent of motive power and machinery of the Chicago & Northwestern from that of master mechanic of that road at Clinton, Iowa. His headquarters are at Chicago.

Mr. John McGie, master mechanic of the Central Railroad of New Jersey, has resigned to accept the position of general master mechanic of the Choctaw, Oklahoma & Gulf Railroad. Mr. McGie was formerly general master mechanic of the Montana Central.

Mr. A. W. Gibbs, assistant mechanical engineer of the Pennsylvania Railroad, has been selected to succeed Mr. A. Kearney as superintendent of motive power of the Philadelphia, Wilmington & Baltimore, with headquarters at Broad Street Station, Philadelphia.

Peter E. Garrison, master mechanic of the Fonda, Johnstown & Gloversville Railroad, died August 22. He entered railroad service in 1868 in the shops of the New York, Lake Erie & Western at Port Jervis. In 1898 he was appointed to the position which he filled until his death.

Mr. B. D. Lockwood has been appointed mechanical engineer of the Wisconsin Central, with headquarters at Milwaukee. He has been chief draftsman of the motive power department of the Cleveland, Cincinnati, Chicago & St. Louis and has been connected with that road for a number of years.

Mr. Alexander Kearney has resigned as superintendent of motive power of the Philadelphia, Wilmington & Baltimore to accept the appointment of superintendent of motive power of the lines of the Baltimore & Ohio west of the Ohio River. He succeeds Mr. W. S. Haines and will have his headquarters in Pittsburgh.

BOOKS AND PAMPHLETS.

Universal Dictionary of Railway Officials, 1902. Compiled from official sources under the direction of S. Richardson Blundstone, Editor of the Railway Engineer. Representative for the United States: E. A. Simmons. 1333 Broadway, Brooklyn, N. Y.

Each new edition of this indispensable directory has been an improvement upon the previous one, the eighth being no exception, and 16 pages have been added this year. The length of each road, a statement of the equipment and the names of the officers are given under the name of the road, and names are readily found by aid of a finding list.

"The Railway Transition Spiral." By Arthur N. Talbot, C. E., M. Am. Soc. C. E., and Professor of Municipal and Sanitary Engineering, University of Illinois. Third edition, revised and extended. Published by The Engineering News Publishing Company, New York, 1901. Price, $1.50.

This "Transition Spiral" is among the best of the easement curves in use, and has met with much favor since it was first published in *The Technograph* in 1890. The book discusses in a simple way the proper length of spiral, in the determination of which speed forms an element. It derives in simple form the necessary formulæ for this spiral, and for further convenience, tables are added which show, for spirals of various chord lengths, the deflection angles, degree of curve, the co-ordinates at chord points, as also the total angle turned. These tables cover chord lengths of 200, 150, 125, 100, 80, 60, 50, 40, 30, 20 and 10 ft., thus making the transition spiral quite flexible. Other tables are also added for street railway use. The text further explains methods of use both for new curves and for realignment of old curves. The book is of convenient size for the pocket.

"Record of Recent Construction, No. 36," is the title of an interesting pamphlet recently gotten out by the Baldwin Locomotive Works, of Philadelphia, which shows representative examples of the new types of engines resultant from the rapid development of recent years. A great variety of engines, both simple and compound and of all wheel arrangements, are illustrated and described by tables of principal dimensions, the text being duplicated in French. The frontispiece is a night view of Prince Henry's special train standing in the Milwaukee station of the C., M. & St. P. R. R., the engine of the train being an Atlantic Vauclain compound.

The Santa Fé Railway has issued a folder, "Summer Outings in California," which deserves special mention. It is compact and attractive, with map and specially well-selected, fine pictures. The descriptions of the different California resorts are so very well written that the reader has a strong impulse to pack up and start directly. The only difficulty would be to choose a locality, since so many attractive places are described: Avalon, on the beautiful isle of Santa Catalina, lying in the Pacific eighteen miles from shore; Coronado, with its "Tent City" on the beach; the Yosemite Valley; the Sierras, with their wealth of trees—these are only a few of the many beautiful places inviting the summer tourist. Santa Barbara, Santa Monica, Mount Lowe, Long Beach, Sequoia National Park, Mount Whitney, Monterey, are among the attractive names, and even San Francisco itself, with its many beautiful surroundings, is highly praised as a summer resort. The author, whose name does not appear, has handled the subject admirably.

The Franklin Machine Works, Philadelphia, have issued a new catalogue of their machine tools which should be in the hands of all users of boring, milling, drilling and cold saw machinery. This pamphlet illustrates a tool-room boring machine for work formerly done on an engine lathe or an expensive and heavy boring machine; a horizontal floor boring, milling and drilling machine for a large variety of work; a similar machine for heavier work; a plain milling machine for work requiring power and strength of design; larger machines, Nos. 2 and 3, of this description; a bar saw cutting-off machine, with a 15-inch saw; another with a 21-in. saw, with a capacity for 5-in. squares; a heavier machine, with 30-in. saw for 8-in. squares; a universal cold saw, with a pivoted work-table; a steel foundry saw, with a 40-in. saw blade for 13-in. round heads; a new pattern steel foundry saw, for smaller work; a crank-shaft saw, and two new automatic saw-sharpening machines, which will sharpen saws from 12 to 72 ins. in diameter. This machinery has all been designed and developed by this company, and is offered with the confidence of extensive experience. The pamphlet is well illustrated, and presents definite information in compact form.

"Tour of the President to the Northwest." The Pennsylvania Railroad has issued a handsomely printed pamphlet giving in detail the itinerary of the tour of the President to the Northwest, including the stations at which he intended to stop, the times of arrival and departure of trains, a table of distances, list of members of the party and a well engraved map of the United States and Central America. Its style is admirable and its character unique.

An ingenious card device, for displaying the colors of Dixon's Silica-Graphite Paint in such manner as will permit of an exact idea of each color, is being issued by the Joseph Dixon Crucible Company. The color chart carries with it suggestions as to the class of construction that can be protected with this paint, also instructions as to best methods of applying protective paint. The new color chart can be secured by request to the Joseph Dixon Crucible Company, Jersey City, N. J.

The Safety Car Heating and Lighting Company, 160 Broadway, New York, have issued a very handsome pamphlet illustrating designs of Pintsch lamps which includes a number of new ones. Four new designs, appearing on pages 10, 11, 13 and 21 are exceedingly attractive and artistic. Such efforts to combine art with utility in railroad cars are commendable and it may be said that this company has not followed but led in the application of tasteful, handsome ornamentation to railroad cars. The lamps are numbered and each has an entire page to itself, being illustrated by an excellent engraving. The list includes gas, electric and combination lamps in a large variety. Twenty-nine varieties are presented.

"Electric Locomotives for Surface Haulage." An 80-page pamphlet has been issued by the Baldwin Locomotive Works and the Westinghouse Electric and Manufacturing Company, illustrating electric locomotives specially designed to meet certain particular requirements and showing the adaptability of this power for industrial purposes. One of them is a 13-ton locomotive for the Atlantic Coast Lumber Company, giving drawbar pull of 4,500 lbs. at a speed of 6 miles per hour; another is a 5-ton, 20-in. gauge locomotive for the Maryland Steel Company, at Sparrow's Point, Md.; several mining locomotives are shown, and others in use in various large manufacturing establishments, including one operated by storage batteries. This catalogue seems to indicate a tendency toward extending the electric motor service of manufacturing plants to the yards to avoid the difficulties with repairs to steam locomotives. The pamphlet is standard size and very attractive.

The Springfield Gas and Gasoline Engines, built by the Springfield Gas Engine Company, Springfield, Ohio, are described and illustrated in a 32-page pamphlet just received. Their engine was first brought out eleven years ago and it has made an excellent record. Since the first "Type A" was developed in 1891, improvements have been made by a systematic plan and the builders are prepared to meet present needs with engines which have proved satisfactory in design and operation. The valves are three in number, of the poppet type, and accessible because of being mounted on removable casings. These have gas tight joints and are independent of other operating parts. The valves are flat and have flat seats. Electric ignition is used, and both the igniter and the governor are well designed with large parts, all accessible. The igniter has but one spring and that a spiral, removed from the heat of the cylinder. The governor is of the "hit and miss" type which secures the same amount of gas for each charge and proportions the consumption to the varying load. All parts of the governor are large and instead of a revolving weight their construction employs a reciprocating weight at the end of a bell crank which is carried on a sliding bar, which forms part of the valve motion. This weight lags behind the motion of the slide, when the speed becomes too high and causes the igniter to miss. To aid in starting, the cylinder is relieved of a part of the compression by a device which opens the exhaust valve, allowing only enough of the pressure to escape to permit of starting easily. An air starter is supplied with engines of 25 h. p. and upward. This company builds either gas or gasoline engines and is prepared to meet the wants of engine users with thoroughly tried devices and construction. Simplicity is their most prominent feature as brought out by this pamphlet.

EQUIPMENT AND MANUFACTURING NOTES.

Mr. T. H. Symington, president of the T. H. Symington Company, has found it necessary to give his entire time to the business of this company and give up his connection with the Gold Car Heating Company. He states that he is prepared to furnish journal boxes and dust guards for all classes of equipment in grey or malleable iron and in any quantities.

The Detroit Graphite Company has received a large order for Superior Graphite Paint from Manila, P. I., and another from San Juan, Porto Rico. The increase in business requires continued service of men putting up new machinery and the plant is working regularly overtime.

The Kennicott Water Softener Company has found it necessary, because of increased business among the railroads, to take into their own hands the management of sales, and they have withdrawn their agency from the J. S. Toppan Company and placed this important service in the care of Mr. William R. Toppan, who will have charge of the railroad department at 406 Great Northern Building, 77 Jackson Boulevard, Chicago.

Mr. George Gould's private car Atlanta, now being completed at the car works at St. Charles, Mo., and which, it is stated, will be a veritable rolling palace, costing $150,000, is being equipped with the Consolidated "Axle Light" system of electric lights and fans.

Mr. T. F. DeGarmo has been appointed eastern representative of the Falls Hollow Staybolt Company, with headquarters at 3116 Clifford street, Philadelphia, Pa. With a good experience in the railway supply business and an unusually wide acquaintance. Mr. DeGarmo will be a very valuable addition to the staff of this company.

The Pennsylvania Railroad has placed an order for 250 locomotives with the Baldwin Locomotive Works. These will be for freight service and are to be delivered by the middle of next year. This is the largest single order for locomotives ever placed in this country, and it is reported that the road will soon order not less than 15,000 steel freight cars.

For operating their turntables at the new Denver roundhouse, the Colorado & Southern have ordered two Leonard high-speed multiple cylinder engines of 15 horse-power each, from the Leonard Engine Company, of Philadelphia, Pa. This admirable engine was illustrated in the American Engineer, February, 1902, page 65. At Denver they are operated by compressed air.

A new burner for Pintsch gas lamps has recently been perfected by the Safety Car Heating and Lighting Company. It is called the hexagon tip, and through its use the illumination afforded by a standard Pintsch lamp can be increased by 40 per cent., while the additional consumption of gas amounts to not more than 10 per cent. This tip is applicable to any standard 4-flame Pintsch lamp, and it is probable that the railroads will introduce it as rapidly as it becomes necessary to replace the old ones now in service. One large railroad system in the east has already a great many of their lamps fitted with the new burners and all tips hereafter ordered by that company will be of the new type.

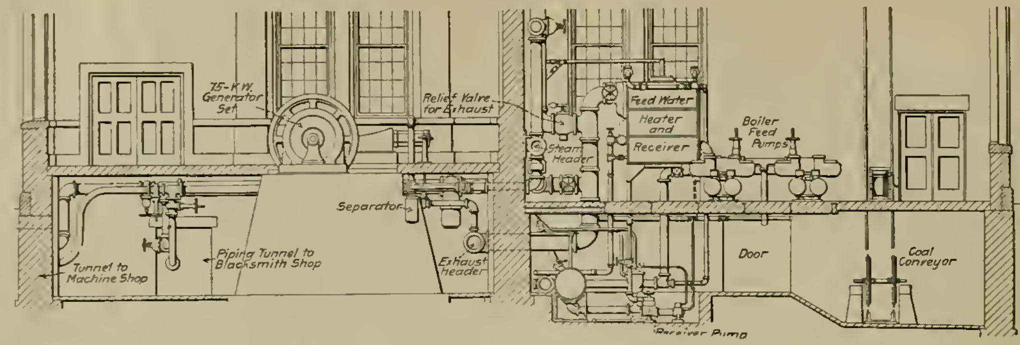
When firemen looked after the cleaning and varnishing of locomotive front ends, the attention of mechanical officers was not directed as it is now to the necessity for providing a durable paint for this purpose. On some roads the firemen have been relieved from this work and it is necessary to hire men especially to attend to it. The expense to a road having 1,000 locomotives may easily run up to $8,000 or $10,000 per year. The difficulty is to find paint which will stand the heat of the smokebox and prevent the rusty and burnt appearance which is so common. Readers will be glad to know of the experience of those who have used "Endura Enamel" for this purpose. It is presented in a little pamphlet issued by the Endura Company, 92 Griswold street, Detroit, Mich., and will be sent to anyone asking for it. This paint is said to meet the requirements for smokeboxes admirably.

One requisite to the safety and continued service of an elevator is a cable that will not break. Those who desire a good rope which will run a long time and relieve them from anxiety should investigate Leschen's Flattened Strand, made by the A. Leschen & Sons Rope Company, 920 North First street, St. Louis, Mo. This company has issued a neat little pamphlet entitled "Song of the Elevator," directing attention to their rope and its durability.

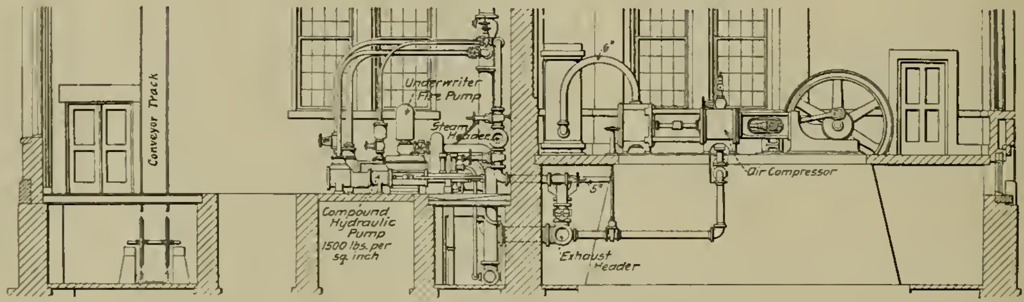
The Chicago Pneumatic Tool Company, air-compressor department, reports that its plant, at Franklin, Pa., is operating day and night. Among recent sales of importance are two large compound compressors for the New York Central & Hudson River Railroad Company's Jersey Shore shops; two large compressors for the Readville shops of the New York, New Haven & Hartford Railroad; a compound compressor of 2,000 cubic feet capacity per minute for the Lake Shore & Michigan Southern's Collinwood shops, being a duplicate of the first compressor installed; a 1,000-ft. compound compressor for the St. Louis, Iron Mountain & Southern Railroad, and one of the same capacity for the new shops of the C., C., C. & St. L. Railway. They have also secured an order from the Government for the installation of a 1,000-ft. compound compressor at the Norfolk navy yard. Other sales include five large straight-line compressors to the American Lime and Stone Company, Tyrone, Pa.; a 1,000-ft. compound compressor to the Mobile & Ohio Railroad for their shops at Mobile, Ala., and one of 500 cubic feet capacity to the Louisville & Nashville Railroad.

The Southern Pacific Railway Company, in conjunction with the Rock Island, has adopted the Consolidated "Axle Light" system of electric lights and fans for electrically lighting and ventilating all the new cars to constitute the Golden Gate Limited, which goes into service between Chicago and California on November 1. This is the same system of electric car lighting that is used on the Twentieth Century Limited of the New York Central and Lake Shore, the Pennsylvania Limited and on the best trains of other leading railway lines, as well as on all private Pullman cars. One of the advantages of the "Axle Light" system is that each car carries its own lighting apparatus, making its own electricity as it moves, with the power taken from the revolving car axle and storing up sufficient electricity in batteries underneath the car to keep it illuminated while stationary, so that, no matter if the car should be detached from the main train and sent to some other point, it is always electrically lighted.

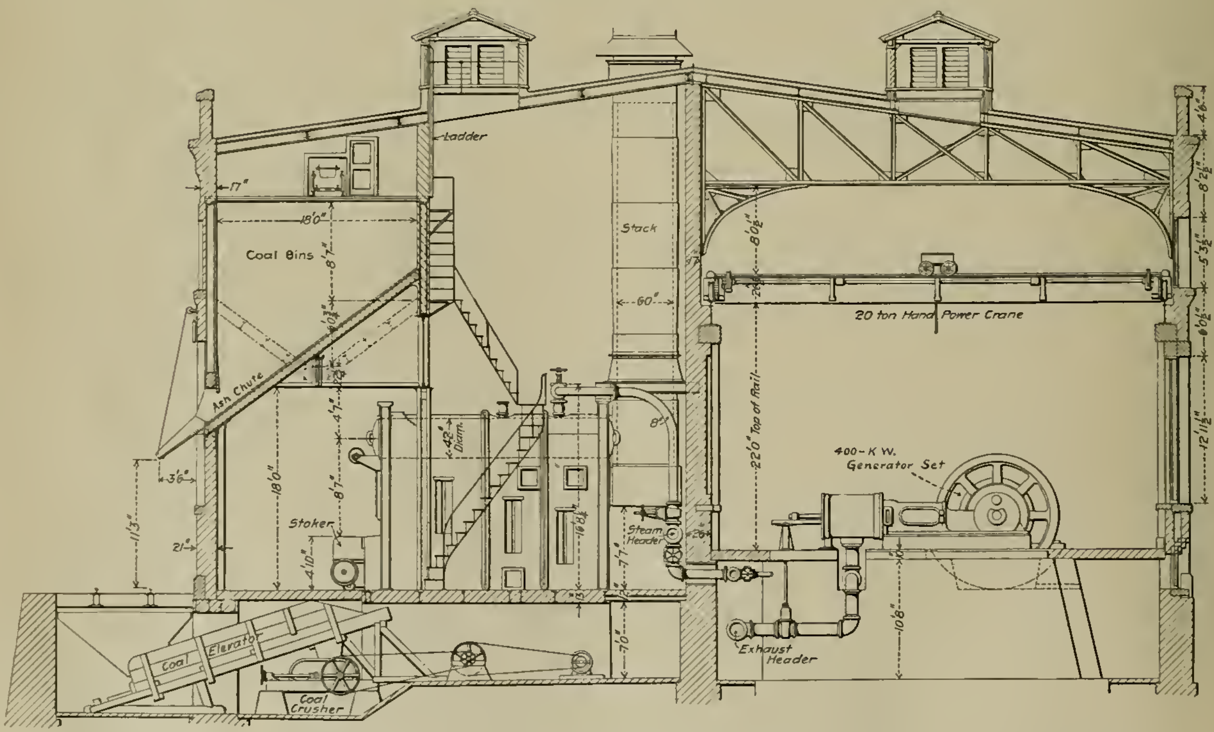
Mr. J. W. Duntley, president of the Chicago Pneumatic Tool Company, has just returned from a five weeks' trip to Europe, and talks entertainingly of the business situation there. His company now owns the New Taite Howard Pneumatic Tool Company and the International Pneumatic Tool Company, of England, having recently taken over the latter company, and having reorganized these under the name of the Consolidated Pneumatic Tool Company. The Chicago Pneumatic Tool Company owns all the stock of the three English companies; the Consolidated Company being capitalized for £300,000, with Mr. A. W. Macnochie, a member of the British Parliament, as Chairman of the Board. They operate factories in London and in Chippenham, Wiltshire, England, for the partial production of the pneumatic tools in Europe. The Chicago Pneumatic Tool Company expect to arrange to duplicate their Detroit plant in Scotland for the production of tools required in the shipbuilding work in that country. The exhibition before the Ship Builders' Federation in Glasgow, which has recently been concluded, was highly successful, and the pneumatic tools have practically been adopted for all the shipbuilding work in the Scotland yards. The American workmen making the exhibit of pneumatic tools in shipbuilding are now in Germany, and from there will go to France for the purpose of making other exhibits. While in France Mr. Duntley took an order for 130 pneumatic riveters for one of the largest French ship yards. As an evidence of the growth of the pneumatic tool business of this company, Mr. Duntley cites the fact that their sales in 1895 amounted to $8,000, while in the current year they will amount to $3,000,000. The Chicago Pneumatic Tool Company now operates four of their own factories in the United States and have two factories under contract manufacturing their pneumatic tools, and are operating their pneumatic tool plant at Detroit and their air compressor plant at Franklin day and night, to supply the increased demand for their product.



Section B-B, Looking East — East End of Plant.



Section A-A, Looking West — West End of Plant.

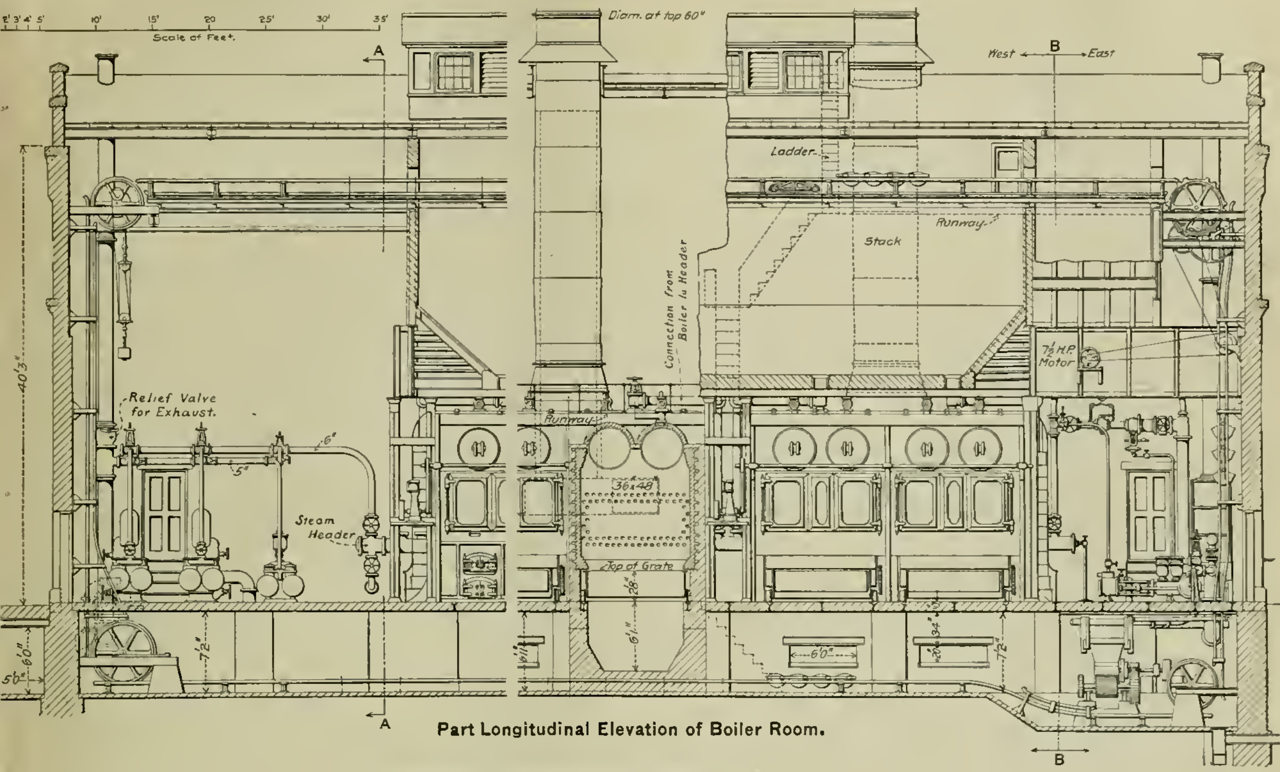


Section B-B, Looking West — Elevation of Boiler and Engine Room.

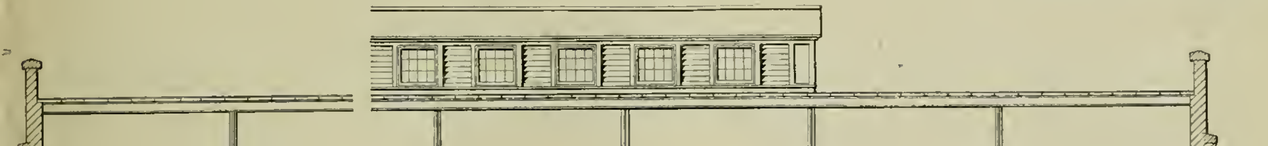
CENTRAL P

NEW LOCOMOTIVE AND CAR

LAKE SHORE & MIC



Part Longitudinal Elevation of Boiler Room.



Part Longitudinal Elevation of Engine Room.

WER PLANT.

HOPS AT COLLINWOOD, OHIO.

AN SOUTHERN RAILWAY.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

NOVEMBER, 1902.

CONTENTS.

AMERICAN ENGINEER TESTS.

LOCOMOTIVE DRAFT APPLIANCES.

XI.

Report by Professor W. F. M. Goss.

SECTION V.

The Tests.

(*Continued from Page* 298.)

29. A Résumé.—This report has already extended itself over a considerable course. In the four sections which have preceded, there have been presented a general discussion of the stack problem and a description of the special equipment employed in carrying out the present investigation. Descriptions have also been given of the preliminary experiment in using oil as fuel, the difficulties encountered in controlling perfectly the conditions at the grate, and of an elaborate experimental study of the draft conditions within the front-end, designed to disclose the correct point of attachment for the draft gauge. To these descriptions from the laboratory there have been added the results of a carefully conducted research by Professor Forsyth, concerning the limiting dimensions applying to stack design, as presented in a large number of examples drawn from modern practice. These preliminaries having been disposed of, it remains now to describe briefly the process of running the tests, and to present the results, and the conclusions which may be drawn therefrom.

30. The Tests.—The original outline contemplated observations concerning stack performance under a steam pressure of 180 lbs., a cut-off of approximately one-third stroke, and at speeds of 20, 30 and 40 miles an hour. The considerations leading to the choice of these conditions have already been set forth in paragraph 4. As the test proceeded, it seemed best in the case of certain of the series to include speeds of 50 and 60 miles, and, also, to add a new series for which the cut-off was varied while the speed remained constant at 40 miles an hour. A summarized statement of all conditions covered is as follows:

Variable Speed Series.

Constants.	Variables.
Boiler pressure, 180. Throttle wide open. Cut-off, per cent. of stroke, 23.8.	Speeds, 20, 30, 40, 50 and 60 m. p. h.

Variable Cut-Off Series.

Constants.	Variables.
Boiler pressure 180. Throttle wide open. Speed, 40 miles per hr. 194 revolutions per min.	Cut-off, per cent. of stroke, 19, 23.8, 26.9 and 35.

With the exception of certain conditions which could be omitted without interfering with the value of a series, tests were run under each condition specified above, for each of 40 different stacks, and these again were repeated for from two to seven different heights of exhaust pipes. To these conditions must also be added others applying to an inside or sliding stack, the results of which will be separately considered. The tests as actually made involved 1,032 distinct tests, for each of which the locomotive was brought under specific conditions of running, and for each of which a considerable series of observations were made of permanent record. Besides these recorded tests there have been many other trial or rejected tests.

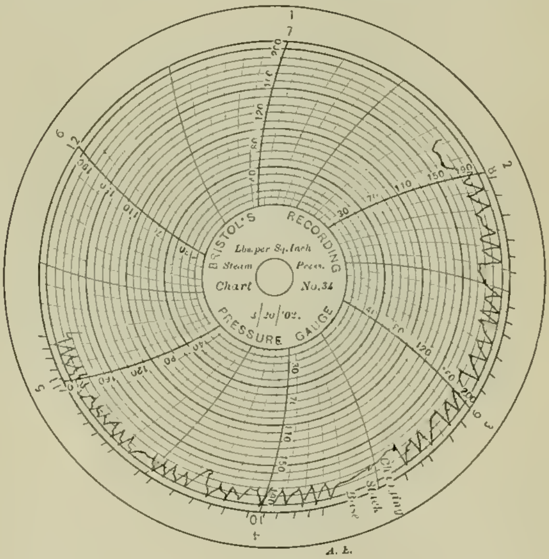


FIG. 22.

31. The Running of the Tests.—In anticipation of a series of tests, the engine was warmed by preliminary running. It was then started for a test, and after the throttle and reverse-lever had been brought to their desired positions, the speed of the engine was made to vary by changing its load. When the speed and the steam pressure were both that which were required, the signal was given and observations were taken. The engine was then stopped and such changes in stack or nozzle were made as were necessary for the next set of observations, after which the process above described was repeated. In this manner a day's work consisted in a succession of short runs with intervals between to allow the change of equipment.

32. Observations.—As a check on results, it was planned to have each condition observed simultaneously by two different observers, each using independent instruments. In the work-

ing out of this plan, it was found convenient to make the observations from one set of instruments the permanent record, and to hold the other set as checks upon the first.

The speed was determined from the dial of a Boyer speed recorder, the indications of which were checked repeatedly during each day's run by a comparison with the record of a registering counter. The readings of the registering counter were taken during a one-minute interval immediately following the signal.

The boiler pressure which, when all observations were taken, was intended to be 180, was observed by means of a gauge in the cab, checked by the indications of a Bristol recording gauge. While the record of the gauges is to be regarded only as a check upon more accurate observations, and thus intended merely to detect any gross error on the part of the observer, a typical chart (Fig. 22) will not be without interest. Each rise and fall of the steam pressure curve represents a test. When the locomotive was started the pressure was usually high. By varying the load a constant speed could be maintained while the pressure was allowed slowly to fall. When the finger of the gauge in the cab had reached 180, the signal for observations was given. The diagram indicates the rapidity with which the work was advanced. The marks outside the margin of the chart were made to indicate the hour when the several signals were given.

The back-pressure was observed by means of a U-tube filled with mercury, calibrated to read in pounds per square inch, and also by a low pressure Bristol recording gauge, both gauges being connected with the exhaust port of the cylinder saddle. Here again the Bristol gauge record is to be regarded merely as a check. A typical chart covering the same interval as that representing boiler-pressure chart is presented as Fig. 23. In general, the high points on the curve represent conditions of tests, but in this diagram, as in others, reference lines appear on the margin. A comparison of the gauge records will show that the record points in Fig. 23 represent hours for which the steam pressure (Fig. 22) was 180 lbs.

For a considerable portion of the work it was sought to further check the back-pressure record by means of an indicator fitted with a 10-lb. spring, having a stop to prevent too great a movement of the piston, and attached to the cylinder in the usual manner. It was not expected that values thus obtained would be the same as those obtained from gauges attached to the exhaust port, but rather that some relation would be found to exist between them, which would be helpful as an additional check. Experience soon disclosed, however, that the value of this record was insufficient to warrant the continued use of the indicator. The exhaust line, as recorded by use of a light spring, is a generous curve, the form of which varied considerably under different conditions of speed. For this reason no useful result could be obtained by always measuring the pressure at the same point in the stroke, and when this plan of procedure was abandoned, and when due regard had been given to the effect of inertia in the indicator, it was difficult to determine from the card what was the least back-pressure. The significance of this statement will appear from Fig. 24, which presents three back-pressure cards taken under identical conditions except as to speed. Finally as to back-pressure, it should be noted that this factor is the most troublesome of all those which were sought to be obtained. The difficulty grows out of the narrow range in the pressures to be measured, and also from the possibility of water of condensation collecting in the gauge pipes. While many precautions were taken to secure accuracy in this particular, it must be admitted that from an experimental point of view, these values are the least satisfactory of all those which were taken.

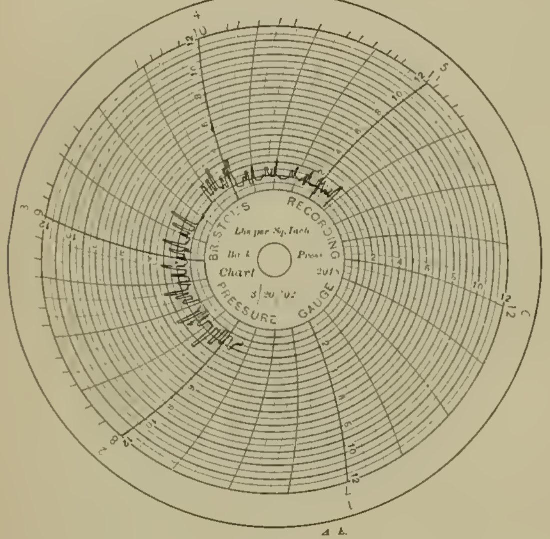


FIG. 23.

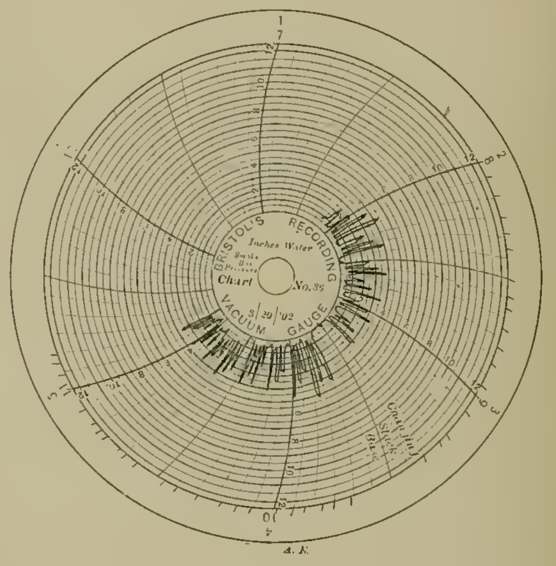


FIG. 25.

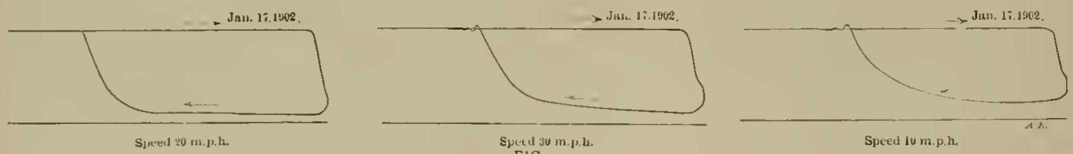


FIG. 24

The draft was determined by means of a U-tube gauge filled with water, checked by the indications of a Bristol recording gauge. The chart from the recording gauge covering the same intervals of time as those from other gauges presented, is given as Fig. 25.

It should be added for the benefit of those who may desire to study the records of the several recording gauges that all tests represented were at the same speed and cut-off. The same exhaust nozzle (No. 1) was used; the only changes were in respect to height and diameter of stack. Keeping this statement in mind, a glance at Fig. 25 will be sufficient to show that very considerable differences in draft may result from changes in stack proportion.

Normal indicator diagrams were obtained from one side of the engine for a sufficient number of tests to perfectly define the power developed by the engine under each condition of running. Copies of these will be found presented with the data.

TWO-CYLINDER COMPOUND SWITCHING LOCOMOTIVE.

New York, New Haven & Hartford Railroad.

The accompanying engraving is an illustration of a six-coupled, two-cylinder-compound locomotive, designed especially for heavy yard work, that has recently been built by the American Locomotive Company at their Rhode Island Works, for the New York, New Haven & Hartford Railroad. The Rhode

Two-Cylinder Compound Switching Locomotive.

New York, New Haven & Hartford Railroad.

John Henney, *Superintendent of Motive Power.* American Locomotive Company, Rhode Island Works, *Builders.*

Island's system of two-cylinder compounding has been applied, and the steam pressure to be carried is 215 lbs. per sq. in. Considerable interest is excited in this engine, on account of the unusually high working pressure that it is to carry, as well as also on account of the fact that the compound principle has not been very extensively used in yard service. The boiler is straight-top with radial stays and has a rather large heating surface for yard work. The design throughout gives evidence of generous proportions intended for heavy yard service, the maximum draw-bar pull capable of being exerted being 30,700 lbs. The principal dimensions of this interesting locomotive are given below:

Six-Coupled Two-Cylinder-Compound Switching Locomotive.
New York, New Haven & Hartford Railroad.

General Dimensions.

Gauge	4 ft. 8½ ins.
Fuel	Anthracite coal or coke
Weight in working order	135,800 lbs.
Weight on drivers	135,800 lbs.
Weight engine and tender in working order	219,000 lbs.
Wheel base, driving	11 ft. 6 ins.
Wheel base, total	11 ft. 6 ins.
Wheel base, total, engine and tender	42 ft. 3½ ins.

Cylinders.

Diameter of cylinders	H. P., 20½ ins.; L. P., 31 ins.
Stroke of piston	26 ins.
Diameter of piston rod	3½ ins.
Kind of piston packing	Cast-iron spring rings
Kind of piston-rod packing	Metallic

Wheels.

Diameter of driving wheels outside of tire	51 ins.
Material of driving wheel, centers	Main, cast steel; front and back, cast iron
Tires, held by	Shrinkage; thickness, 3½ ins.
Driving-box material	Cast steel
Diameter and length of driving journals	9 ins. diameter x 12 ins.
Diameter and length of main crank-pin journals	6 ins. diameter x 5½ ins.
Diameter and length of side-rod crank-pin journals	Front and back, 5 ins. diameter x 3½ ins.; int., 6¾ x 4½

Boiler.

Style	Straight (extended front end)
Outside diameter of first ring	62⅝ ins.
Working pressure	215 lbs.
Material of barrel and of firebox	Carbon steel
Firebox, length	102⅛ ins.
Firebox, width	39¼ ins.
Firebox, depth	Front, 61¾ ins.; back, 64¾ ins.
Firebox plates, thickness	Sides, back and crown, ⅜ in.; tube sheet, ½ in.
Firebox, water space	4 ins.; front and sides, 3½ ins.
Firebox, crown staying	Radial, 1⅛ in. diameter
Firebox, stay bolts	1 in. diameter
Tubes, material and gauge	Charcoal iron, No. 11, B. W. G.
Tubes, number	236
Tubes, diameter	2 ins., O. D.
Tubes, length over tube sheets	11 ft. 6 ins.
Fire brick, supported on	Lugs
Heating surface, tubes	1,416 sq. ft.
Heating surface, firebox	144 sq. ft.
Heating surface, total	1,560 sq. ft.
Grate surface	28 sq. ft.
Grate, style	Shaking grate without water tubes

Tender.

Style	Tank with sloping top
Weight, empty	37,880 lbs.
Wheel base	17 ft.
Tender frame	10-in. channels (steel)
Tender trucks	Fox pressed steel
Water capacity	4,000 U. S. gals.
Coal capacity	Anthracite coal, 6 tons

WAGES ON FRENCH RAILROADS.

France is not a place for high wages for railroad employees. Consul-General J. K. Gowdy, writing from Paris, says that an ordinary porter receives $21.55 a month, a head porter $25.33, a pointsman from $25.77 to $28.06, and a plate layer $18.50. The driver of a locomotive earns on an average $36 per month, and his "rewards" for saving coal, etc., usually amount to $14. Stokers receive about $25 per month, with $5.50 as extras. A foreman in the workshops earns as much as $48.50 per month, an ordinary workman $19.30, and an apprentice $14. Of 71,273 men working on the principal railroads 56 per cent. receive from $16.59 to $26.05 per month, and 84 per cent. get from $13.70 to $31.84 per month. The men work, on an average, 28½ days per month, and from 7 to 12 hours a day. Nearly 15 per cent. of the men are lodged.

In England long distance runs without stops are common. On the London & Northwestern two remarkable runs have been made. A special train run in connection with the trial trip of a new steamship recently made a run of 299 miles without a stop, and the new Viceroy of Ireland was carried from London to Holyhead, a distance of 262 miles, without an intermediate stop.

NEW LOCOMOTIVE AND CAR SHOPS.

Collinwood, Ohio.

Lake Shore & Michigan Southern Railway.

II.

Power House.

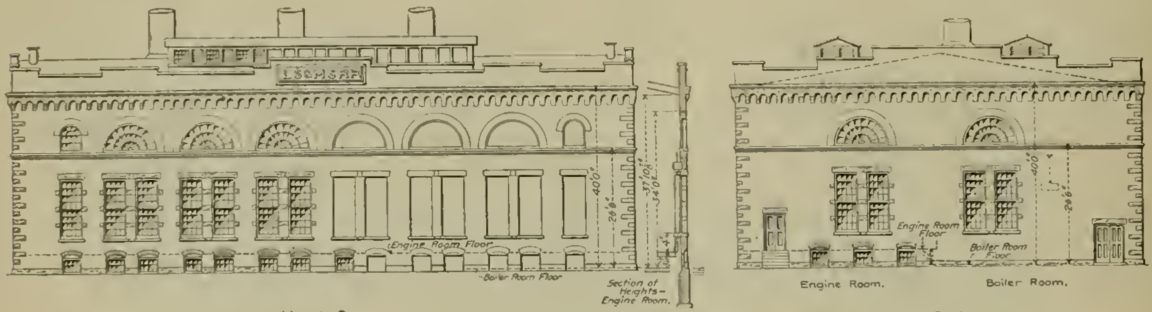
One of the most important features of modern railroad shops is the power plant and its equipment; the practice in modern shops is tending almost universally toward the concentration of all power generation into one building and electrical distribution from that one point to the points of power consumption. The advantages of this method of power distribution have been made use of in the new Collinwood shops of the Lake Shore & Michigan Southern Railroad to an extent and degree of completeness far surpassing that usually found in shops for railroad or other work. A power generating plant capable of furnishing all the power to be needed in the entire shops, both for motors and for electric lighting, has been installed at a point on the shop grounds very close to the theoretical center of distribution with respect to the consumption of power, from which point electric current is delivered to the various buildings through conductors located in underground tunnels. The state of development exemplified in this plant, not only with respect to the details of the steam and electrical machinery, but also to the character of the building itself, is not excelled by that of any other plant of its kind.

Building.

The building for the power house has many notable features, it being of very solid and durable construction and presenting by its exterior appearance the general impression of strength and substantial construction so noticeable in the machine-shop buildings. This building is also built up of steel and brick, with liberal provision of windows for daylight lighting, as may be seen by reference to the accompanying side and end elevations of the building. The design of this structure gives evidence also of an effort to embody a pleasing exterior appearance, this building and the office building being, in fact, the only structures in connection with the shops upon which an effort was made for ornamentation.

The foundations of the building are of concrete, 39 and 42 ins. thick, the mixture being one part of Atlas Portland cement to eight parts of gravel and fine broken stone. The basement walls vary from 31 to 38 ins. in thickness, the partition wall between the boiler and engine room basements being the thickest. The outside surfaces of the basement walls are covered with a heavy coat of asphalt put on hot for waterproofing, while the inside surfaces are smoothed off with a coating of strong cement mortar. The floors of the two basements, which are 8 ft. 3 ins. below the yard level, are of an asphalt binder mixture 5 ins. thick composed of ¾-in. broken stone and gravel mixed with hot asphalt in the proportion of 1 gal. of the liquid to 1 cu. ft. of the heated stone. This was well rammed in while hot and then dressed over to a correct surface with a ½-in. layer of asphalt. The surfaces of the floors are graded to the corners, where catch-basins are located for draining, being connected with 8-in. cast-iron sewer pipes; these sewer pipes have Y-connections, from which branches are led out through the basement floor for connection with the headers from the roof.

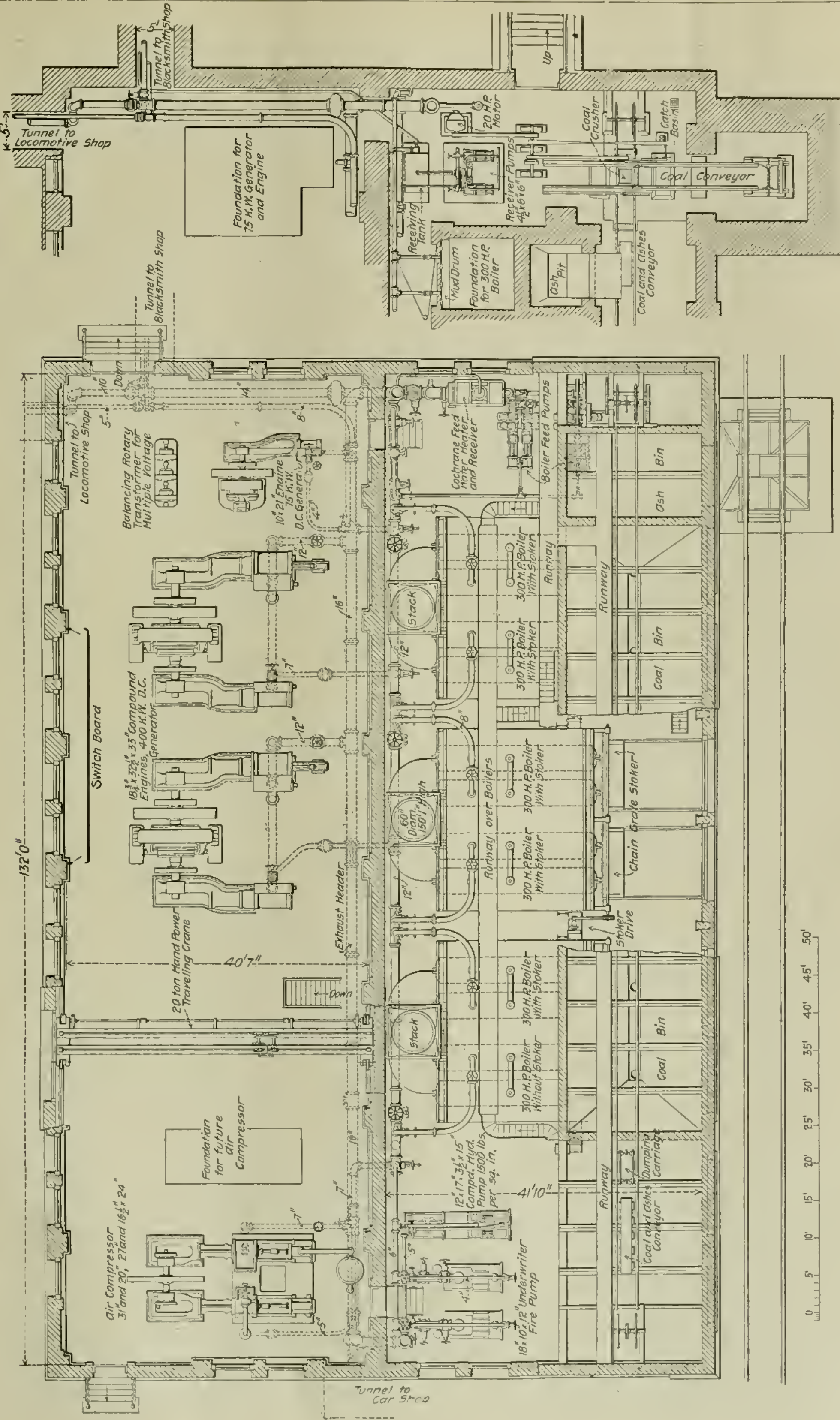
The walls of the engine and boiler rooms are all 21 ins. in thickness, with the exception of the partition wall and the north wall of the engine room, which are 26 inches thick. The inner sides of the engine-room walls are finished with a 12-in. baseboard of dark Tenuessee marble, above which, and up to a distance of 10¾ ft., was plastered a coat of cement mortar composed of two parts of cement to three parts of sand. The window sills are also of marble. All the posts of the steel framework of the building between the windows are filled with concrete and faced over with brick, the thickness of the wall being increased at those points to 34 ins. in the engine room and to 54 ins. in the boiler room, on account of the enlarged posts there supporting the great weight of the elevated coal bunkers. The steel posts are set on steel wedges, ½ in. thick, and when adjusted were cast in with a joint of clean Portland cement. All of the steel work that is covered with cement or mortar was first painted with a coating of hot asphalt of such a consistency as to dry thick and glossy; where it is left exposed it was first painted with red lead mixed in pure linseed oil and afterwards with a color.



North Side. West End.

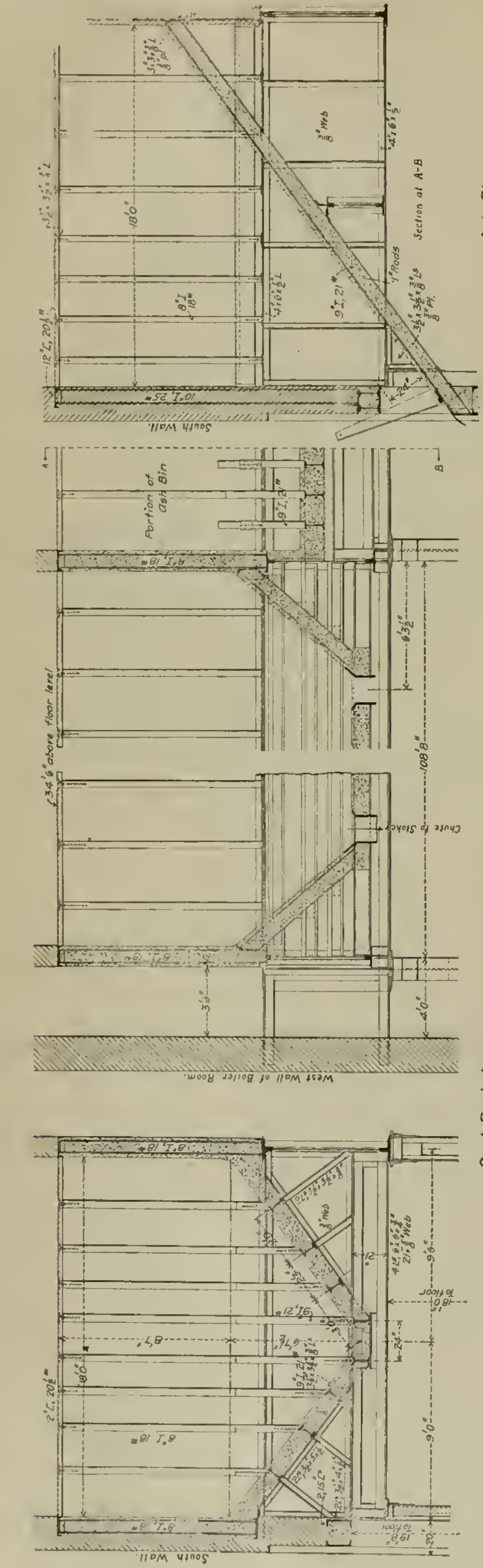
Exterior Elevations of Power House.

The roof is undoubtedly the most remarkable feature of the power-house building. The objectionable features of wooden or other roofs of a combustible nature, as well as the injurious effects of dripping condensation from all-metal roofs in winter have here been entirely obviated by the construction of a hollow-tile roof. Four-inch T-shaped bars were laid inverted upon the steel roof frame as purlins and then filled in with 4-in. terra-cotta tiles set in cement mortar, thus forming a solid tile roof. Gutters were then formed with mortar by filling in with it and troweling it smoothly up against the parapet walls, and so grading as to shed water into the leaders to the sewer. The roof was smoothed over completely with cement mortar to fill up all cracks, and the entire lower surface of the roof was plastered over flush with the lower sides of the T-iron purlins. Upon the top of the tile filling five courses of the best roofing felt were laid, each course being bedded in hot asphalt and each strip of felt overlapping its neighbor by one-fifth of its width. All the courses are laid in an unbroken layer in the gutter up against the parapet wall, each being cemented up under a joint in the parapet capping. A course of screened gravel laid in a thick layer of hot asphalt above the felt completes the roof. The rain leaders are connected to the roof through copper flashings 30 ins. square, set into the tile and overlapped by the roofing felt; these flashings lead down through copper-wire screens to 4-in. wrought-iron rain



Plan of Power Plant, Showing Arrangement of Apparatus.

Central Power Plant at Collinwood Shops — Lake Shore & Michigan Southern Railway.



Ash Bin.

Coal Pockets.

Sectional Elevation Views of Coal Pockets and Ash Bin, Showing Details of Construction.

headers, which are located inside the building to insure immunity from freezing and flooding in cold weather. This mode of roof construction leaves little to be desired in the matter of absolute protection to the most delicate of machinery.

Another remarkable feature of the building, indicating the substantial character of its construction, is the design of coal storage pockets and ash bin, which are of steel and concrete, built permanently into the upper portion of the boiler room, as shown in the elevation views in the supplement. The coal pockets are supported upon 21-in. built-up plate girders, 18 ft. 6 in. long, which span across from steel posts set in the south wall of the boiler room to similar steel posts located between the boiler settings. Upon these girders rest special triangular-shaped plates arranged to support the sloping portions of the base of the bin, which are built up of 9-in., 18-lb. I-beams laid longitudinally and filled in between with concrete. The ends of the trough-shaped bottom of the bunkers are also built in slanting from the edge of the stoker feed-holes up to the end walls with a similar concrete-filled construction of 9-in. I-beams fitted in with specially shaped fittings to the longitudinal I-beams, as shown, preventing accumulations of coal at the ends. The side and end walls of the pockets are built up of 8-in., 18-lb. I-beams with the solid concrete filling between them. The ash bin is similar in construction to that of the pockets, with the exception of being smaller and differently shaped; the slope of its base is all in one direction at an angle of 45 degrees toward the south wall of the building, the lower end of the base ending in a chute running through the wall, with a 24-in. clearance. The chute ends outside in a lip hinged to the wall and counter-weighted to swing up and down; when raised up, the lip acts as a door to close the chute, and when down as a trough delivering to car. The construction of the bins is very clearly illustrated in the accompanying detail drawing.

Equipment.

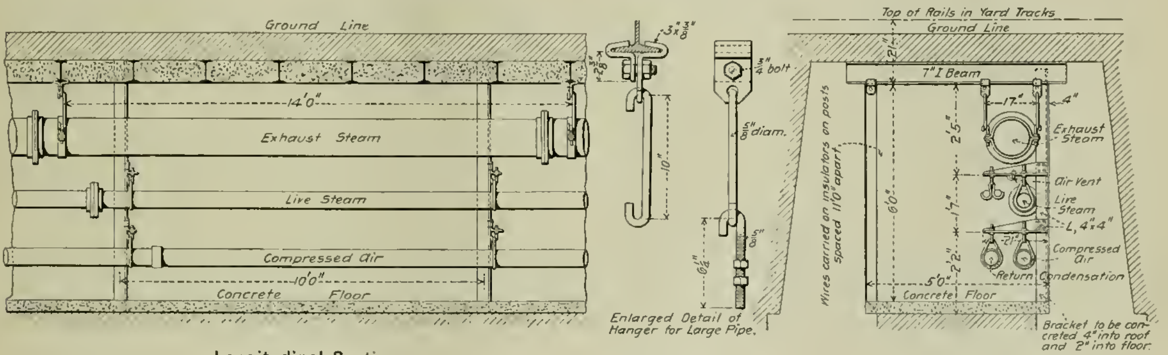
The equipment of the power plant, both mechanical and electrical, is fully in keeping with the character of the building in which it is housed, not only with respect to the thoroughly high-grade character of the apparatus, but also to the extreme completeness of detail manifested in the installation. The general design gives evidence of the expenditure of great care here, as well as throughout the shops, in the selection of apparatus and the planning of details for the best results and reliability in operation.

A very noticeable feature of the power plant is the complete automatic system of handling the fuel, no manual handling of coal being necessary from car to the stokers, thus reducing to a minimum the labor necessary in the boiler room. Coal is delivered to the power house by dumping direct from the car into a pit located outside the southeast corner of the boiler room, underneath the side-track alongside the building, through which it enters the conveyor system. This pit contains a receiving hopper of ¼-in. steel plate, which receives the coal dumped down and directs it into a short auxiliary apron-feed conveyor, running northward, carrying it to the crusher and main conveyor within the boiler-room basement. The apron-feed conveyor discharges the coal into a hopper feeding into the coal crusher, which breaks it up, if necessary, to the size required for the stokers; after leaving the crusher the coal drops into another hopper below, from which it is fed into the main bucket conveyor system for delivery to the coal pockets above.

The apron-feed conveyor feeds into the crusher's hopper in regular quantities, avoiding clogging or overloading the crusher. The crusher is of a very heavy pattern, 24 x 24 ins. in size, with a solid tooth roll. Both the crusher and the apron-feed conveyor are run by a 22 horse-power electric motor made by the Milwaukee Electric Company. The main conveyor is of the pivoted-bucket type, consisting of malleable iron buckets, 18 x 24 ins. in size, pivoted to two strands of 24-in.-pitch chain, which is fitted with self-oiling flanged rollers for running on the conveyor track. The buckets have overlapping ends, thus forming a continuous trough, which does not open up anywhere in transit except when on vertical section of conveyor track or when passing the dumping carriage, and thus does not require a feeder hopper. The dumper carriage is a tripping mechanism arranged below the conveyor track over the coal pockets, which will dump the buckets as they pass it. It may be placed in any location over the pockets for dumping and filling up at that section, its position being adjustable from the boiler room floor. This main conveyor also will take care of the ashes from the furnaces. Ash pits of bowl-shape are located in the boiler foundations below the stokers from which the ashes may be scraped out into the conveyor passing in front, and then by adjusting the dumper carriage properly they are dumped into the ash bin above, ready to be loaded into cars outside. The main bucket conveyor is operated by a 7½ horse-power electric motor, also furnished by the Milwaukee Electric Company, through a special set of equalizing gears transmitting an even motion. The conveyor travels on a track of 16-lb. T-rails. The entire conveyor system, and also the coal crusher, were supplied by the Link-Belt Engineering Company, Philadelphia, Pa.

for the lining of the surfaces exposed to the fire, exclusive of the flue.

To five of the six boilers, the Mansfield travelling chain-grate stoker has been applied, which was also furnished by the Aultman & Taylor Machinery Company. The Mansfield stoker consists of a wide band, or chain, made up of short link-like sections of grate bars pivoted after the fashion of a sprocket chain, which band travels around two drums in the fire-box, being so driven that the upper side moves backward from the boiler front toward the arch. Coal is fed evenly on to the moving chain as it recedes by a feeding hopper outside the front, which hopper is supplied directly by the coal chutes leading from the coal pockets above. The coal burns as it travels with the grate, the speed of travel being so adjusted that when rear drum is passed the coal is entirely consumed, leaving ashes only to be dumped off at the end—this entirely obviates cleaning fires. The stokers are driven by small vertical steam engines geared to drive the drums very slowly through ratchet mechanisms. It may be mentioned that steam engines were considered preferable to electric motors for this service inasmuch as they may be run when getting up steam or at any time steam is on, and are not dependent upon the dynamos running. The entire chain-grate mechanisms are mounted in frames with wheels running on tracks em-



Longitudinal Section. Cross Section.

Sections of the Piping and Wiring Tunnel, Showing Arrangement of Pipes and Details of Flexible Pipe Hanger.

Boilers and Stokers.

Steam for the plant is furnished by six 300-h. p. sectional water-tube boilers of the Caball horizontal type, installed by the Aultman & Taylor Machinery Co., Mansfield, Ohio, in batteries of two each as indicated in the plan view of the power house on page 333. These boilers are of the inclined-tube type, consisting of 16 sections of tubes, each containing nine 4-inch tubes, 18 ft. long, expanded into vertical headers at both front and rear, and two steam and water drums, each 42 ins. in diameter and 20 ft. 2 ins. long, located horizontally in the tops of the settings and connected to the tube headers at each end by special fittings. The tube headers at the rear end of the inclined tubes are connected at their lower ends, the lowest point, to a mud drum.

The total heating surface of each boiler is 6,040 sq. ft., and its grate area, 67.66 sq. ft., making thus 89.2 sq. ft. of heating surface per sq. ft. of grate area, a very high ratio for stationary boilers. Each boiler is equipped with two 4-in. safety valves, set to 150 lbs. per sq. in., and has an 8-in. steam-outlet connection running from the nozzle to the main steam header with large radius bends and no elbows. The Reliance safety water column, made by the Reliance Gauge Column Co., Cleveland, Ohio, has been applied to each boiler, embracing safety-self-closing gage-glass valves and an automatic low-water whistle alarm. The space occupied by each boiler, measured over the setting, is 20 ft. 2 ins. in length, 24 ft. 2 ins. in width and 16 ft. 8 ins. in height to top of nozzle. Each boiler required 26,500 common red bricks for the masonry in the setting, not including the foundation, and 8,670 fire-bricks

bedded in the boiler room floor so that the stokers may be easily withdrawn from the boiler settings for inspection or repairs. The arrangement of the grate links in the grate chain, or band, which is 8 ft. 4¾ ins. in width, is clearly shown in the illustration of the boiler fronts on page 337, as well as also a coal chute from the pockets above to a stoker hopper. One boiler is fitted with fire doors and stationary grates, instead of a stoker, in order to burn shavings and refuse from the wood mill and cabinet shop which will be delivered to the boiler room by a shavings exhaust system. Each battery of boilers has a separate steel stack, 60 ins. in diameter and 150 ft. 1 in. high, natural chimney draft by individual stacks having been considered preferable to forced or induced draft systems.

Boiler Auxiliaries.

The boilers are fed by two outside-end-packed duplex boiler-feed pumps which were furnished by the Snyder-Hughes Co., Cleveland, O. These pumps, which have cylinders 12 ins. and 7 ins. by 12 ins. stroke, are of the pot valve type and have capacity each to feed 1,800 h. p. of boilers. They are connected to take water from either the feed-water heater or the water supply, and are controlled by Foster pump governors, which render their action automatic, the feed being controlled entirely at the feed valve on the boiler. The feed water is passed through a Cochrane exhaust-steam feed water heater and purifier of the "open" type, which delivers it free from oil and at a temperature of from 2 to 5 degrees of that of the steam entering. Large depositing surface is provided in this heater for the water to have the greatest possible opportunity to deposit all impurities that the temperature of the exhaust will precipitate. The depositing trays are 25 by 18 ins., 20 in number, and the space for filtering material is 48 by 48 ins. by 49 ins. deep. The floor space required is 78 by 53 ins. The effect of the contact of the exhaust steam with the water in the heater is its partial condensation and consequent partial reduction of back pressure in the exhaust system and also a considerable quantity of condensed steam reclaimed. Cold water is automatically fed into the heater as fast only as it is required to supplement that condensed from the steam. This heater was supplied by the Harrison Safety Boiler Works, Philadelphia.

At the west end of the boiler room are installed two 18 x 10 x 12-inch stroke Barr Underwriter type duplex fire pumps, which were furnished by Dravo, Doyle & Co., Cleveland, O. These pumps have a capacity of delivering 1,000 gals. per minute and are adapted to fully meet the underwriters' requirements for constant priming, quick starting, etc. Adjoining the fire pumps is a compound duplex hydraulic pressure pump furnished by the Henry R. Worthington Company, New York. The cylinders of this pump are 12 and 17 by 3½ ins., with a 15-in. stroke, and the piping connections are as follows: Live steam, 2½ ins.; exhaust steam, 3½ ins.; hydraulic suction, 2½ ins., and delivery, 2 ins. This pump will, with 150 lbs. steam pressure, deliver up to 80 gals. per minute against a head of 1,500 lbs. pressure.

Engines.

The engine equipment of the plant will consist of one 150 horse-power simple engine, two 650 horse-power cross-compound engines, all direct-connected to engine-type multipolar dynamos, and two compound air compressors; at present, however, the 150 horse-power engine, one 650 horse-power engine and one compressor only are installed, the others to be placed later. The engines are the well-known automatic cut-off shaft governor type, manufactured by the Buckeye Engine Company, Salem, O. The simple engine has a 10 x 21-inch cylinder, and the compound has cylinders 18¾ and 32½ x 33 ins. The compound engine runs, with the rated steam pressure of 150 lbs. per square inch, at a speed of 135 revolutions per minute, and is guaranteed to regulate within 2 per cent. above or below that speed. Its rated power is 650 horse-power, but it has a range of economical working from 520 to 750 horse power, its ultimate capacity being 860 horse power. The size of the steam-admission pipe is 8 ins. and the exhaust 12 ins. This engine is guaranteed not to consume more than 19½ lbs. of dry steam per horse-power hour at its rated full load. The 150 horse-power engine is intended for the night lighting load, periods of light load, or any time when load is too low to be economical for the compound engine.

The air compressor is of the direct-connected fly-wheel type, with compound steam and compound air cylinders and separate intercooler, furnished by the Franklin Plant of the Chicago Pneumatic Tool Co. It has steam cylinders 20 and 31 x 24 ins. and air cylinders 16½ and 27 x 24 ins., the capacity being 1,500 cu. ft. of free air delivered per minute at a speed of 100 revolutions per minute. It delivers at a pressure of 100 lbs. per square inch with 80 lbs. steam pressure. The air inlet and discharge valves are of the poppet type, while the steam valve motion is the Meyer adjustable cut-off system. The fly-wheel is 120 ins. in diameter, with an 8-in. face. The intercooler is of the multitubular water-cooled type, and the heated water from it is used for boiler feeding if there is not a surplus of water in the heater, in which case it is discharged through a safety valve to the sewer.

Piping.

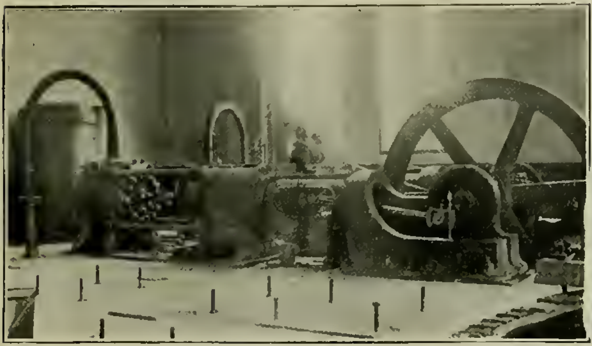
That the piping for a plant of this size and importance is of equal, if not greater, importance than the apparatus itself, has been manifested by the careful attention that has been paid to this detail. Often far too little attention is paid to the piping in the best of stationary plants. The general arrangement of the piping systems, steam, exhaust, etc., is apparent by reference to the plan of the plant on page 333, or to the elevation views in the supplement, but an idea of the grade of construction may best be had from the following quotations from the piping specifications: All high-pressure steam pipe lines above 2½ ins. diameter to have flange fittings and all 6-in. pipe and over to have flanges of rolled steel; all 8-in. pipe and smaller to be full-weight wrought iron, according to the standards of A. M. Byers & Co., of Pittsburg, and larger pipes, including 12-in., to be full-weight standards of the National Tube Works Company; all valves for 2-in. pipe and smaller to be solid brass gate valves with inside screws, except where used for throttling valves, when globe valves will be used; all valves for 2½-in. pipe and over to be iron body, outside screw and yoke, and rising spindle; 8-in. valves and over to have by-pass valves; boiler-feed pipes to be "extra strong" wrought-iron, with screwed joints and rolled steel flanges; blow-off pipes from boiler to be "extra strong" and equipped with asbestos-packed valves; water supply system to be best quality cast-iron pipe, to withstand 150 lbs. pressure; hydraulic-pressure line, which runs to accumulator in boiler shop and to blacksmith shop, where it is flanged for possible future use, to be "double extra strong" wrought-iron pipe, and to have flange fittings; all pipe lines 4 ins. in diameter and above to have flange unions every 50 ft. The contractor for the piping installation is the Best Manufacturing Company, Pittsburg, Pa.

The water-supply pipe is connected to the elevated tanks, situated to the west of the power house, for reserve supply, and also a connection is made to this tank from the city water supply for supply in emergency. Check valves are located in the delivery from the tank to the hydrant mains in the yards, so that when fire-pump pressure is on water will not back up into tank.

In the steam-piping system there is a 12-in. main steam header, to which all the boilers feed through Guland non-return angle valves and 8-in. double-bend W. I pipes. This header runs the length of the building behind the boilers and just above the level of the engine-room floor, and is divided up into sections by gate valves to enable different parts to be cut out. Steam connections are taken off the header as follows: A 6-in. pipe to each fire pump and to the hydraulic-pressure pump; a 7-in. pipe to the air compressor; a 7-in. pipe to the 650 horse-power engine, and a 4-in. to the 150 horse-power engine; an 8-in. pipe to the locomotive and blacksmith shops for various uses. Also a 3-in. connection to the heating system, to the boiler-feed pumps, and to two 4½ x 6 x 6-in. Snyder-Hughes receiving pumps in the basement used in connection with the heating system returns. The exhaust steam from all the engines and pumps is received by a 16-in. exhaust header running the length of the building in the engine-room basement, which header is connected to the heating system and to the feed-water heater, with also a Kieley back-pressure valve at each end, admitting exhaust to atmosphere through two exhaust heads on the roof in case of back pressure in the system. Condensation from the high-pressure steam pipes, separators, etc., are returned to the boilers by a No. 3 Holly return-system, cylinder cock drains being discharged into the exhaust pipe and all low-pressure drains into the receiving tank in basement.

Dynamos.

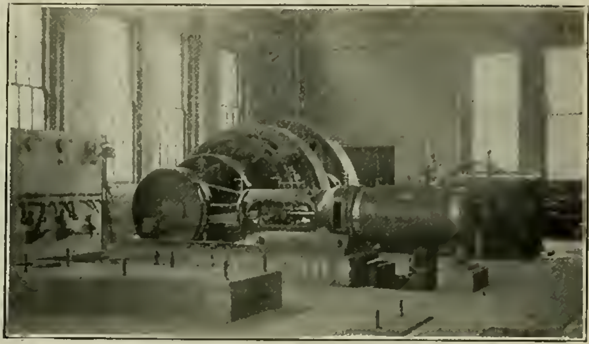
The dynamos are compound-wound multipolar slow-speed engine-type generators, mounted directly by pressure fit onto the engine shafts, and were built by the Crocker-Wheeler Company, Ampere, N. J. The dynamo connected to the 150 horse-power engine is of 75 kilowatts, and the one to the 650 horse-power engine of 400-kilowatt capacity, both being over-compounded about 4 per cent. so as to rise in voltage from the no-load normal of 240 volts to 250 volts at full load. The 400-kilowatt machine, which runs at a speed of 130 revolutions per minute, has 12 poles, and has a commutator 60 ins. in diameter with a 16-in. face. The current output at full load is 1,666 amperes, the entire range of load from no-load to full load being



Air Compressor, C-S-C Type.

With Compound Steam and Compound Air Cylinders, and Inter-cooler.

(Foundation in foreground for compressor to be installed.)



400-K.W. Multipolar Dynamo

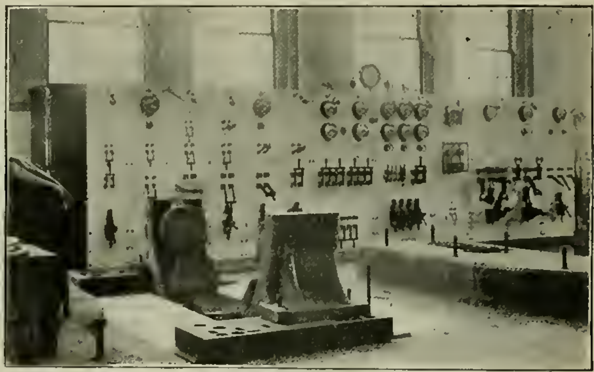
Direct-Connected to Cross-Compound Engine.

(Foundation in foreground for additional unit to be installed.)

75-K.W. Multipolar Dynamo

Direct-Connected to Simple Automatic Cut-Off Engine.

Balancing Rotary Transformer for Multiple Voltage in Foreground.



Twelve Panel Switchboard.

With Special Multiple-Voltage Panels.

(Foundation and base-frame in foreground for additional generator unit to be installed.)

Feed-Water Heater and Purifier, and Boiler Feed Pumps,

Bucket Coal and Ashes Conveyor to the Right.

View in Boiler Room,

Showing Boiler Fronts, Chain-Grate Stokers, and Coal Chute to Stoker Hopper from Pockets Above.

Central Power Plant.

Collinwood Shops — Lake Shore & Michigan Southern Railway.

delivered free from sparking without adjusting the brushes, and even momentary overloads as high as 75 per cent. (2,916 amperes) being possible without injurious sparking. The guaranteed efficiencies of the 400-kilowatt dynamo are: 93 per cent. at 25 per cent. overload, 93.75 per cent. at full load, 93.5 per cent. at three-quarters load, 92.5 per cent. at half load and 89 per cent. at one-quarter load.

The general electrical distribution system is a two-wire system operating at 240 volts, but in addition to this there is also a four-wire multiple voltage system for use in obtaining tapped off of any one of the three machines, or off of either two of them combined, giving with a main voltage six available voltages, ranging as follows: 40 volts, 80 volts, 120 volts, 160 volts, 200 volts and 240 volts; and with the 30-kilowatt capacity in each machine, 60 kilowatts is available at any one of the intermediate voltages. This capacity is, of course, very low, compared with the total capacity of motors installed in the shops using the multiple voltage, but it is totally improbable that all, or even that a very large number, of tools will be run at the same time off of the same pair of wires of the

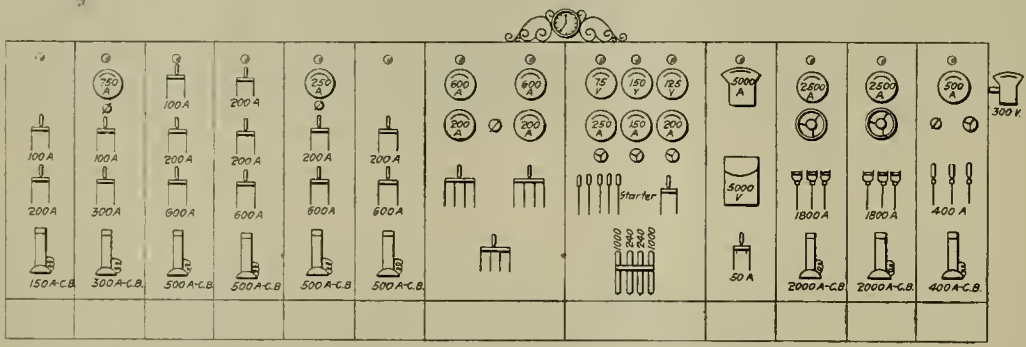


Diagram of Switchboard, Front Side.

Showing Arrangement and Capacities of Instruments.

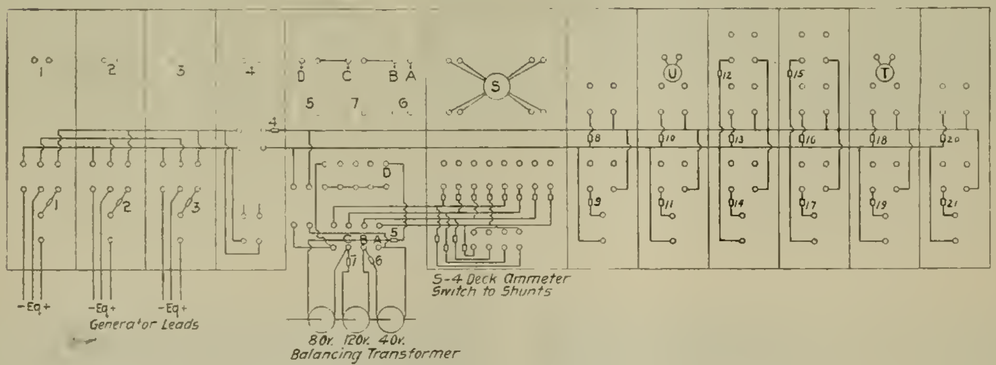


Diagram of Rear of Switchboard, Showing Arrangement of Wiring Connections.

Central Power Plant.

Collinwood Shops. — Lake Shore & Michigan Southern Railway.

variable speeds at the motors of the motor-driven machine tools in the machine shop. The Crocker-Wheeler Company's multiple-voltage system of speed control was adopted, and, for producing the intermediate voltages without rheostatic losses, a triplicate balancing rotary transformer is used, consisting of three size 25-D Crocker-Wheeler motors mounted on a common base, and with armatures on one shaft, as shown in the illustration of the 75-kilowatt dynamo on page 337. The three armatures are wound for 80, 120 and 40 volts respectively, and each machine has a capacity of about 30 kilowatts. The connections of the armatures of this transformer are shown in the diagram of wiring of the switchboard on this page, the three armatures being practically connected in series across the main circuit from the generators, and, running as a motor-dynamo, transform and deliver currents at the above-named voltages at their terminals; thus current may be multiple-voltage system; when there are loads across different branches of this four-wire system they will, of course, tend to balance each other and thus relieve the rotary transformer in the power plant, the function of the rotary transformer being merely to balance up whenever the load is unequally divided between the main leads of the system.

Switchboard.

The switchboard is a beautiful 12-panel board of 2-in. white Italian marble, as shown in the illustration on page 337. The panels are all of a uniform height of 6 ft. 6 ins. and have small 12-in. baseboard panels underneath them next to the floor. The arrangement of the panels, from right to left, is as follows: Three generator panels, each 24 ins. wide; one total output panel, 24 ins. wide; one transformer panel and one multiple-voltage panel, each 3 ft. 6 ins. wide, and six feeder panels, each 21 ins. wide. The first generator panel, at the right, contains a 400-ampere single-pole circuit breaker, three 400-ampere single-pole main knife switches, a 500-ampere ammeter, a field rheostat, and also a six-point voltmeter switch for connecting the main swinging-bracket voltmeter to any desired circuit at will. The other two generator panels each contain a 2,000-ampere single-pole circuit breaker, three 1,800-ampere single-pole main knife switches, a field rheostat and a 2,500-ampere ammeter. The total output panel contains a 5,000-ampere ammeter, to indicate the total output of the plant, a 5,000-ampere Thompson recording wattmeter, to record the total output, and at the bottom a 50-ampere double-pole knife switch controlling the lighting circuits of the power house. The transformer panel contains three voltmeters and three double-reading ammeters, as indicated on the switchboard diagram, page 338, for indicating the voltages and loads on the three branches of the multiple-voltage system, three field rheostats for the balancer machines, and a five-pole starting switch for starting up the balancer. At the base of the board is a four-pole, four-coil, four-arm overload and no-voltage circuit-breaker, of which all four of the latches are mechanically connected so that an overload in any one of the four legs trips all the breakers. The two outside arms of this circuit breaker are each of 1,000 amperes capacity, normal rating, and the two inside arms of 240 amperes capacity; this difference in capacity between the outside and inside arms of the circuit is partly because of the balancing of the motors among themselves on the multiple-voltage system so that the intermediate wires may be less in size than the outside wires, and partly because a portion of the power is supplied directly to motors which run at constant speed on the full voltage and so never make use of the intermediate wires.

The remaining seven panels of the board to the left are essentially feeder panels. The first is the multiple-voltage panel, having three four-pole main multiple-voltage feeder switches and four ammeters, two of 600 amperes and two of 200 amperes capacity. Two of the four-pole switches have outside blades of 600 amperes and inside blades of 200 amperes capacity, while the other has two arms of 400 and two of 100 amperes capacity respectively. A special four-deck three-point ammeter switch is provided on this board, by means of which all four of the ammeters may simultaneously be thrown onto any one of the three four-wire feeder circuits. The six remaining feeder panels contain 14 switches, of sizes indicated on the switchboard diagram, which control the entire distribution for light and power on the general two-wire 240-volt system, and two of the panels have ammeters with the necessary multi-point ammeter switches for connecting them to any of the feeder circuits. The six lower switches on these six panels control power circuits delivering current to the various shops, cranes, transfer tables, etc., and it is in these circuits that the circuit breakers at the bases of the panels are connected; four of these circuit breakers are of 500 amperes, and the other two of 300 and 150 amperes capacity.

The circuit breakers are all of the laminated edgewise type I-T-E circuit breakers manufactured by the Cutter Company, Philadelphia, and all are placed at the lower edge of the board. The ammeters and voltmeters are all the well-known Weston station-type instruments, the main bracket voltmeter and the total-output ammeter being of the illuminated-dial type, while all the others are of the round-pattern switchboard type. The switches for the board are calculated to carry not over 1,000 amperes and not to exceed 50 amperes per square inch of contact area in the clips at full load. All nuts on the switches have a clamping surface of 1 sq. in. per 150 amperes capacity. These proportions permit overloads up to 25 per cent. without injury. The bus bars behind the switchboard are of pure copper ¼ or ⅜ in. thick, with ¼-in. spaces opening between sections, and are calculated on the basis of 800 amperes carrying capacity per square inch of cross-section and with not over 150 amperes to pass per square inch of contact area. The bus bars extend the entire length of board, as shown in the wiring diagram of rear of board. All the switches are protected by D. & W. inclosed fuses mounted on separate panels at the back of the main panel, which are easily accessible. The duplicate numbers on the generator panels indicate the positions of the ammeter shunts and of the terminals of the ammeters to which they are connected; on the feeder panels the numbers indicate the shunts which may be connected by means of the ammeter switches, the power feeders to the 750-ampere ammeter and the lighting feeders to the 250-ampere ammeter. The switchboard frame is surmounted by a large clock set in ornamental framework, and each panel is separately lighted by incandescent lamp brackets. The entire switchboard, with its equipment, was furnished and installed by the Western Electric Company, Chicago.

Crane.

The engine-room crane is a 20-ton hand-power traveling crane, with 40 ft. 8 ins. span, furnished by the Browning Engineering Company, Cleveland. The main hoist of the crane has a speed of from ¾ ft. per minute at full load to 2 ft. per minute at no load; the trolley will travel from 12 ft. per minute at full load to 18 ft. per minute at no load, while the bridge travels from 8 ft. per minute at full load to 10 ft. per minute at no load. The crane is built up of I-beams, with channel top and flange stiffeners. The main hoisting mechanism is a 16-ton triplex chain block hung on the trolley and driven by a hand chain. The trolley is also traversed by a hand chain. The crane is carried upon 45-lb. steel rails mounted upon girders resting upon stone cappings set into the side walls above the window line.

MANUFACTURE OF ELECTRO-STEEL IN SWEDEN.

The problem of smelting steel by electricity has for a long time attracted the attention of inventors, but recent experiments in Sweden have given very interesting and promising results. Early in 1900, an electric furnace was built at Gysinge, by Mr. Benedicks, for the manufacture of steel without the use of electrodes, and after a few experiments an ingot of steel was produced which was found to be of excellent quality. The problem was not, however, solved economically; for, with the dynamo of 78 kilowatts capacity used, not more than 575 lbs. of steel were obtained in twenty-four hours, and in the furnace there was not room for more than 176 lbs. A larger furnace was completed in November, 1900, and proved to be a great improvement.

Engineer F. A. Kjellin said that the steel produced is of superior quality and characterized by strength, density, uniformity, toughness, and the ease with which it can be worked in cold, unhardened condition, even when containing a very high percentage of carbon. Compared with other steel, it also has less tendency to crack or warp when hardened.

The reason why this steel in certain qualities differs from other steel, especially in its softness when unhardened, is considered to be its freedom from gases. The manufacture of special steel, with nickel, chrome, manganese, or wolfram, will, of course, not meet with any difficulties. The chrome steel and wolfram steel produced at Gysinge has proved to be excellent for lathe tools. When used for permanent magnets, the Gysinge wolfram steel has been found to give stronger magnets than other wolfram steel and has not warped in the hardening.

From estimates made, it has been ascertained that the furnace used at Gysinge, which is simple in construction and easily managed, has prospects of competing, as to cost of operation, with the furnaces heretofore used for fusion of steel, especially as it yields steel of a better quality. If it proves commercially successful this method of smelting steel will become of great importance in the United States on account of the large supply of good ores and available water power.

LOCOMOTIVES USING SUPERHEATED STEAM.

By G. Lentz,
Civil Engineer, Dusseldorf, Germany.

About ten years ago Mr. Wilhelm Schmidt, C. E., of Wilhelmshohe, near Cassel, Germany, began the employment of superheated steam in steam engines of all kinds, and several years ago applied it to locomotives. We now have some hundreds of stationary engines in Germany working with superheated steam, giving excellent results in economy of coal and water.

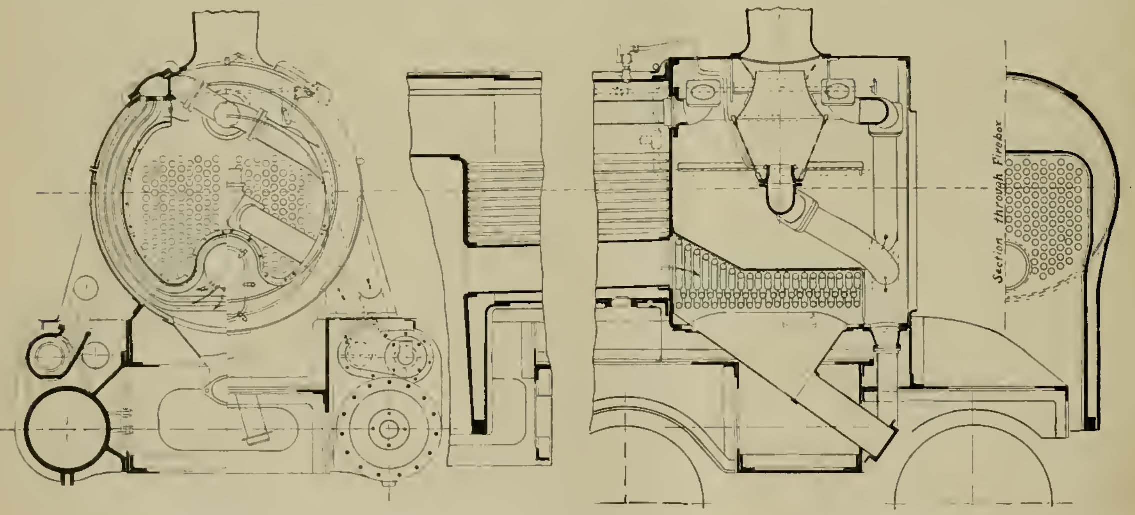
It is astonishing that it took so many years to get to a point where the advantages of dry steam are understood. But in former years it was impossible to use superheated steam in cylinders because of a lack of suitable lubricating materials and apparatus. It was customary to use animal or vegetable oils and fats which were not adopted to resist the high temperatures. They decomposed at 400 deg. F. and interfered with satisfactory operation of the engines. By using mineral oils with points of inflammation above 700 or 800 deg. F. this trouble was overcome and steam superheated to 600 deg. may now be used without difficulty. With a low degree of superheating, to 450 or 500 deg., a saving of 15 to 20 per cent. in cost is effected.

The rapid destruction of stuffing-box packing by burning constituted another drawback, as these packings mostly consisted of vegetable materials which could not resist the high temperatures of superheated steam. However, since the universal introduction of metallic packing there has been no trouble of this kind, and asbestos packings give good results with very high temperatures in engines not having metallic packing.

Another important reason for the want of success in the earlier efforts to use superheated steam consisted in the lack of suitable superheating apparatus; the superheaters required too large a space and gave insufficient degrees of superheating. All of these disadvantages acted together to balance the well known advantages of superheating and hindered its practical introduction until Mr. Schmidt solved all of the difficulties with perseverance, and he is now busy with the introduction of his system for locomotives. In Germany we have now some dozens of locomotives in service with it and some are also in course of construction in other countries.

A superheated steam locomotive was exhibited at Paris in 1900 by the locomotive works of Borsig, Berlin-Tegel, and in the current year one is exhibited at the Dusseldorf Exposition by the Hohenzollern Dusseldorf-Grafenburg. This engine has been in service for some months and has given excellent results.

In order to properly understand the value of superheating steam it is necessary to make clear the principal difference between superheated and saturated steam. Saturated steam is produced directly from water and no heat can be taken from it without the condensation of a part of it. Superheated steam is, on the contrary, a gas from which a part of the heat may be taken without transforming any part of the steam into water by condensation. For instance, saturated steam of 200 lbs. pressure has a temperature of 387 deg. F. If it loses 175 deg. its pressure becomes zero lb., but if steam of 200 lbs. pressure is superheated to 600 deg. and it loses 175 deg., its pressure remains at 200 lbs. and 38 deg. of superheat also remains. If, however, it loses these 38 deg. also, the steam becomes plainly saturated and any further loss of temperature is accompanied by a condensation and loss of pressure. In using saturated steam a part of this is lost in the form of heat transmitted to the steam piping and by condensation in the cylinders. This condensed steam not only gives no work, but it has a damaging effect in the cylinders. In the use of superheated steam the unavoidable losses in the piping and cylinders are taken from the superheating. The steam remains not only free from condensation, but it will be still superheated to a certain degree, so that the steam retains its full pressure during the stroke of the piston.



Section through Smokebox. Longitudinal Section.

The Schmidt Locomotive Superheater.

These advantages of superheated steam are seen to better effect if it is considered that the expression "saturated steam" is generally only a theoretical one, as steam boilers always produce a mixture of steam with more or less water. This in the superheater is first changed into the saturated steam and afterward into superheated steam. The principal differences between wet and superheated steam are as follows: The steam from the boiler enters the piping in the wet state, is partially condensed here and enters the cylinders, where a further condensation takes place. It therefore acts on the piston at reduced pressure after it has lost part of its force by condensation. These losses often amount to more than 20 per cent. Superheated steam merely loses a part of its superheated temperature. A further advantage in superheating consists in the enlargement of the volume of the steam without increasing the pressure. In superheating from 180 deg. F. the increase of volume is about 25 per cent., so that 1 lb. of steam at 85 lbs. pressure which has a volume of 27.5 gallons in the saturated state becomes 35 gallons when superheated. The influence of the steam passages and clearances at the ends of the piston stroke will be, as a matter of course, diminished in proportion to this increase of volume. This increase of volume has a great influence on the excellent results gained by superheating, which is important in large works, in the reduction in the number of boilers; in a locomotive its effect is to reduce the necessary amount of heating surface. The gain by superheating in the matter of fuel consumption averages about 20 per cent., which corresponds to a reduction of the number of boilers or amount of heating surface required from 5 to 4. A boiler with superheated steam may be worked much harder than one without it, because the disadvantages of carrying water over with the steam under forced working are overcome by superheating. For this reason three boilers with superheaters are fully sufficient where four hard worked boilers are necessary without it. This is equivalent to a 25 per cent. reduction in heating surface. With normal working the proportion of reduction of the boilers is very often equal to 3 to 2, or 33 per cent. This point is very important with reference to the cost of plant, as often the expense for superheaters in a new plant is covered by the reduced cost of boilers and buildings. The steam piping may also be reduced in diameter on account of the greater fluidity of superheated steam.

For the arrangement of superheaters the following are points of importance and should be given careful consideration:

1. The superheater must be able to superheat the steam without difficulty to 600 deg., and even more.

2. In order to facilitate its arrangement it must occupy little space, so that the maximum heating surface may be concentrated into the minimum space.

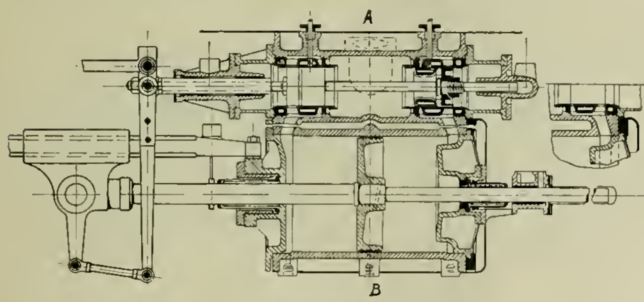
3. It must have sufficient material to be independent of changes in temperature during the process of combustion. The superheater must act like an accumulation during the time when fresh coal is put on the grate.

4. It must be so constructed as to be applicable to different kinds of boilers.

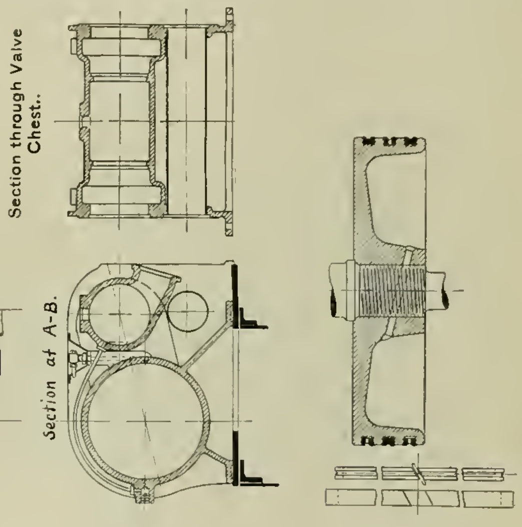
5. It must be absolutely safe in service and very durable in order to avoid annoying interruptions of service for repairs.

Mr. Garbe, of Berlin, general locomotive superintendent of the Prussian State Railways, was the first railway engineer to fully appreciate the value of Mr. Schmidt's system of superheating, and he was the first to plan its application to locomotives for different services. The locomotive exhibited at Paris was an express engine with 4-coupled wheels and a 4-wheel truck, after the type of the Prussian standard express engines, and it worked in regular service. A lot of these engines will presently go into service. The engine exhibited at Dusseldorf is a passenger and freight engine with 6-coupled wheels, for mountainous roads, heavy trains, sharp curves and high speeds. This engine has been in constant service for several months and has produced 1,200 horse power running at 56 miles per hour. The superheater is placed in the smokebox, according to Schmidt's patent. In order to run easily through sharp curves the leading and front coupled axles are combined in a 4-wheeled truck, according to Krauss' patent. The superheating is carried to 600 deg. in a system of tubes in the smokebox. Practical service has proved that the heat produced from the coal consumed was greater and the consumption of water less than in ordinary locomotives. The cylinders have piston valves with central admission, and they are lubricated by a central pump. The engine has the Schliefer air brake, a patent smoke consumer, steam heat attachment for cars, Pintsch lighting, a speed indicator and air sand blast. Its chief dimensions are:

Cylinder	20½ by 24¾ in.
Driving wheels	61 in.
Leading wheels	39¾ in.
Wheel-base, fixed	78¾ in.
Wheel-base, total	252 in.
Heating surface, firebox	126 sq. ft.
Grate surface	24 sq. ft.
Heating surface, total	1499 sq. ft.
Heating surface, superheater	365 sq. ft.



Longitudinal Section.



Cross Section.

Piston and Rings.

Cylinder of Locomotives Using Schmidt's Superheater.

Steam pressure	170 lbs.
Weight on drivers	99,200 lbs.
Weight in working order	129,190 lbs.
Wheel-base of tender	130 in.
Tender tank capacity	2,750 gals.
Tender coal capacity	11,000 lbs.
Tender weight in service	75,500 lbs.

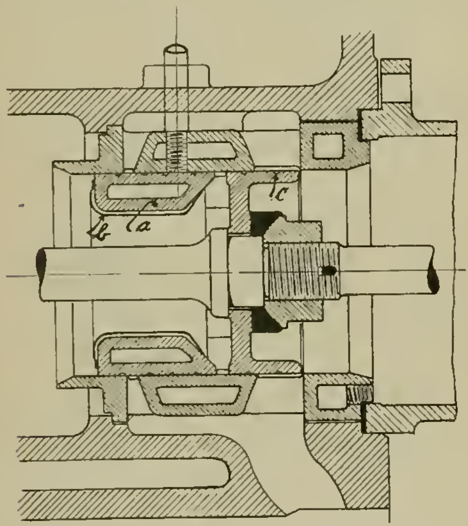
For the superheater a flue of usually 11 or 12 ins. in diameter is placed in the bottom of the boiler barrel between the tube plates, leading a great quantity of the firebox combustion gases to the smokebox, surrounding the tubes of the superheater in the smokebox.

At the present time we have a great variety of wet steam locomotives on the Prussian lines, and relay (double-header) engines are necessary and are very costly in service. It is therefore of the greatest importance to have engines of greater power for high speed as well as in freight service. By using superheated steam the variety of locomotives may be greatly reduced and all engines may have two equal cylinders and not four compound. The reason that no superheating compound engines have been tried is that the complication necessary in reheating the steam after it has worked in the high pressure cylinder, as in stationary practice, would be prohibitive.

In locomotives the superheater generally consists of 60 or 70 tubes of 1¼ to 1⅜ ins. inside and 1½ to 1⅝ outside diameter, bent to conform to the smokebox sides so that they form three concentric rings. These tubes are rolled and tightened into two long steam chambers, one at the right and the other at the left of the stack opening. The inner surface of the superheater corresponds to the shape of the outermost rings of tubes and rises to the right and left hand sides in the smokebox, to the top of the exhaust nozzle, and the whole superheater is enclosed in a cast iron box which is closed at the top by narrow valves which may be operated from the cab.

The right hand steam chamber is divided in the middle by a partition. In the rear half the wet steam enters and passes through the rear ten three-fold rings and enters, dried and partially superheated, into the left hand steam chamber which has no partition. From here the dried steam returns through the three-fold rows of tubes of the superheater to the front portion of the right hand steam chamber and passes through the steam pipes to the valve chests well superheated.

The gases diverted into the large flue to the arched space in the smokebox flow, by induced draft, through the superheater valves because of the vacuum produced by the blast acting through the stack. The stream of hot gases around the superheating tubes is proportioned to the work done by the locomotive and is nearly stopped when the throttle is closed. This



Longitudinal Section of Schmidt Piston Valve.

stream may also be regulated by means of the superheater valves. The shape of the superheater walls is such that they cannot easily accumulate too much heat and become red hot. For the protection of the superheater the blower arrangement is combined with the regulation of the valves so that the valves are closed when the blower is working.

The loss of temperature of the combustion gases from entering the boiler flue to the entrance to the chimney is about 1,450 deg., which is sufficient to heat the wet steam, during a long run of the engine, from 310 to 560 deg. According to measurements of temperature in the superheater the mean temperature was 1,230 deg., the temperature of the exit gases being 600 deg.

The lower rows of the superheater tubes are placed so far apart that the ashes entering through the large flue drop into the ash pit placed below the smokebox, and experience shows that the spaces between the superheater tubes are not blocked up. If, on the other hand, the tubes are placed too far apart, the space for the combustion gases becomes too large, the hot gases are too much thinned and give too low a superheating effect. The loose plates in the sides of the superheater box permit the inspection of the superheating tubes. From time to time the accumulated soot upon the superheater tubes is blown off by a steam jet, operated from the cab. The whole arrangement of the superheater requires but little enlargement of the diameter of the smokebox. The second ashpit is for the ashes drawn through the boiler tubes into the smokebox, and these are from time to time wet down by a steam jet.

The cylinders of the locomotives are as simple as the superheater. The piston valves with central admission give a natural balance of pressure and avoid subjecting stuffing boxes of the valve chest to high pressure. The valves of these engines can be moved easily by hand under full boiler pressure and the link motion parts can be made much lighter than usual and give long life in service. The stuffing boxes designed by Mr. Schmidt have proved their durability at the highest speeds. The working of the piston rod is cool and nearly frictionless, because of the flexibility of the packing and the tightening devices which are placed very far out and made of a lead-antimony composition. The cylinder piston is of the old Swedish type, with three light piston rings, ½ by ¾ in. in section, which do not carry the weight of the piston, but are pressed against the cylinder walls by the steam. Each ring has in the middle a light groove into which some small radial holes lead from the outside to the inside, so that when the piston is in its end position steam presses the end ring together and enters into the space beneath the ring and tightens the middle ring against the cylinder walls. It has been proved on an engine, which had been in regular service for some time, that this actually takes place.

After trying different piston valves Mr. Schmidt found the one here illustrated to be the best. The ring, a, is heated by the entering superheated steam and expands a little. The valve is protected against the heat of the steam by a clothing, b, of thin steel plate. In addition the piston valve is cooled on the outside by six small grooves, c.

In a nine days' run of two passenger trains over a distance of 104 miles and back in which the trains had a total weight of 794,000 lbs., a comparison was made between 8-wheel passenger engines with 4 wheels coupled, of the same type and weight; two of them were compound engines with ordinary steam and one was a simple engine with superheated steam. The engines with ordinary steam used from 37.82 to 38.24 lbs. of coal and 27.8 gallons of water per train mile. The engine with the superheater used 34.13 lbs. of coal and 20.61 gallons of water. The compound engines, therefore, averaged 11.5 per cent. more coal and more than 30 per cent. more water for the same work done. Furthermore, it is to be remembered that the engine with the superheater was built two years ago and did not represent the best experience up to date. This engine showed marked success and ran very quietly and easily at speeds of 70 miles an hour with driving wheels 78 ins. in diameter.

The following summary presents the advantages in the use of superheated steam:

1. With the superheater it is possible to greatly increase the power of an engine, without enlarging the boiler, and avoid using double-headers.

2. Both for the lightest service, running an engine over the road light, and the heaviest service, which exhausts the capacity of the boiler, the consumption of fuel and water of a 2-cylinder simple engine with superheater will be less than that of a 2 or 4-cylinder compound with saturated steam.

3. In using saturated steam the number of types of locomotives required is always great, but it may be considerably reduced by using superheaters and the details made more uniform, reducing the cost of the engines and the cost of maintenance.

4. Superheaters render it possible to reduce boiler pressures to 140 lbs.

5. Short tank engines, which are very convenient in service, can be used much more generally.

6. By increasing the productivity of the boiler by overcoming the condensation of steam and through the greater fluidity of superheated steam it is easy to design simple locomotives for the highest possible speeds.

Altogether the superheated steam locomotive represents great progress in simplicity, durability and economy of the locomotive engine.

NEW SIX-COUPLED FREIGHT LOCOMOTIVES.

Prairie or 2-6-2 Type.

Chicago, Burlington & Quincy Railway.

This is the third design of this type on this road. The first put into service, early in the year 1900, were relatively light locomotives, with small heating surface (1,958 sq. ft.) and 19 by 24-in. cylinders. They had wide fireboxes, with 42 sq. ft. area of grate, and were the pioneers in the general movement toward wider fireboxes for soft coal. These engines were illustrated in this journal in April and July, 1900. They had outside journals for the trailing wheels, and the frames were offset to provide for this feature. This frame construction has been used also on the 2-6-2 type shown on page 135 of the April issue, 1901, and the 2-4-2 type passenger enginea illustrated in April, 1902, and it has given excellent results in service. This experience led to the use of the same features in a new design of the 2-6-2 type for freight service, which is illustrated by this photograph. The original "Class R" gives a tractive effort of 21,860 lbs., and the new "Class R3" gives 28,300 lbs., which represents the comparative capacities of the two designs. This represents an increase of almost 30 per cent. in tractive power and an increase of over 50 per cent. in heating surface. The following ratios of Class R3 may be interesting:

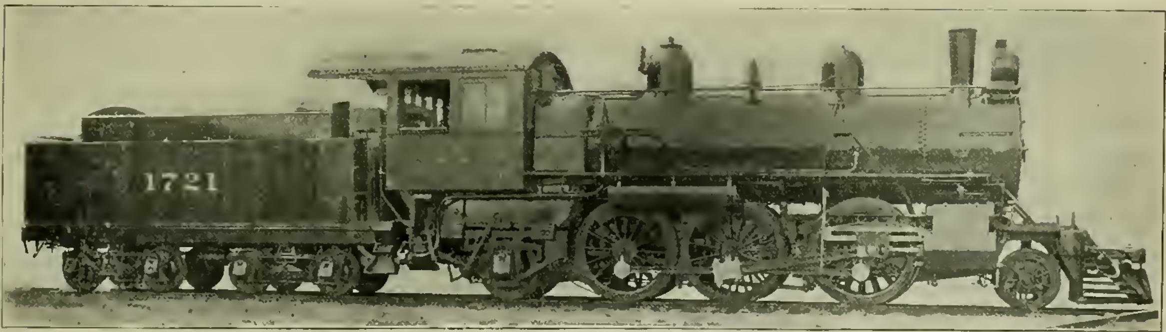
Ratio heating surface to cylinder volume, 294.
Ratio of tractive weight to heating surface, 43.9.
Ratio of tractive weight to tractive effort, 4.75.
Ratio of tractive effort to heating surface, 9.24.
Ratio of heating surface to grate area, 72.8.

The ratio of tractive effort to heating surface, multiplied by the driving-wheel diameter, is 638, which is remarkable for a freight engine.

This design is similar in appearance to the earlier ones. The same form of Belpaire firebox, with nearly vertical side-sheets, is retained, and the details are arranged to suit the much larger and more powerful locomotive. The trailing truck boxes are like those of the passenger engine referred to, with the equalizers over instead of under the journals. The drawings present no other important changes. The following table gives the leading dimensions:

Six Coupled Freight Locomotive.
Prairie, or 2—6—2 Type.
Chicago, Burlington & Quiacy Railway.

Gauge	4 ft. 8½ ins.
Cylinder	21 ins by 26 ins.
Valve	Balanced piston
Boiler, type	Belpaire straight
Diameter	65¼ ins.
Thickness of sheets	11-16 in.
Working pressure	200 lbs.
Fuel	Soft coal
Staying	Vertical
Firebox, material	Steel
Length	84 ins., width 72 ins.
Depth	Front 66¼ ins , back 63¼ ins.
Thickness of sheets	Sides ⅜ in., back ⅜ in., crown ⅜ in., tube ½ in.
Water spac	Front 5 ins., sides 4 ins., back 4 ins.
Tubes, material	Iron, wire gauge No. 11
Number 272	Diameter 2¼ ins., length 18 ft. 3 11-16 ins.
Heating surface, firebox	141.1 sq. ft.
Tubes	2919.4 sq. ft.
Total	3060.5 sq. ft.
Grate area	42 sq. ft.
Driving w eels, diameter outside	69 ins.
Diameter of center	62 ins.
Journals	9 ins. by 10 ins.
Engine truck wheels front, diameter	37¼ ins.
Journals	5½ ins. by 9½ ins.
Trailing wheels, diameter	42½ ins.
Journals	7½ ins. by 10½ ins.
Wheel base, driving	13 ft 0 ins.
Rigid	13 ft. 0 ins.
Total engine	28 ft. 3 ins.
Weight, on driving wheels	134,550 lbs.
On truck, ront	18,150 lbs.
On trailing wheels	29,220 lbs.
Total engine	181,920 lbs.
Total engine and tender, about	297,000 lbs.
Tank, capacity	6,000 gals.
Tender, wheels No. 8, diameter	33 ins.
Journals	5 ins. by 9 ins.



Six-Coupled Freight Locomotive, 2-6-2 Type. — Chicago, Burlington & Quincy Railway.

F. H CLARK, *Superintendent of Motive Power.* BALDWIN LOCOMOTIVE WORKS, *Builders.*

NEW QUARTERS FOR THE NEW YORK RAILROAD CLUB.

At the meeting of the New York Railroad Club, held October 16, President Vreeland, as chairman of the special committee on new quarters, reported the very thorough search his committee had made for a suitable meeting place. The only location recommended was in Carnegie Hall, which, however, was not obtainable on the club's regular meeting night. Having thoroughly considered the matter in all its phases, the executive committee of the club recommended to the membership that the regular meeting night be changed in order to secure permanent and adequate facilities, which recommendation was approved by unanimous vote and the club will hereafter meet on the third Friday of each month, except June, July, and August, at Carnegie Hall, No. 154 West Fifty-seventh Street, New York City.

The paper of the evening at the above-mentioned meeting was: "Railway Freight Claims," presented by Mr. R. L. Calkins, freight claim agent New York Central & Hudson River Railroad. The paper was very interestingly presented and elicited an instructive discussion on the subjects of car seals, defective freight equipment, handling of freight, etc.

A superintendent of motive power, in a recent communication upon the subject of college men in railroad work, says: "It seems to me that too many young men are being developed along the line of locomotive work exclusively. I think that this is a mistake and that there is a big field opening up in car-department work. It has been my aim in bringing up special apprentices to give them a pretty thorough training in car-department work, and I wish you would advocate this practice in The American Engineer."

(Established 1832.)

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EDITORIAL ANNOUNCEMENTS.

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

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

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

POWER PLANT AT THE COLLINWOOD SHOPS.

In another part of this issue we print a second installment of the description of the new shops of the Lake Shore & Michigan Southern at Collinwood, Ohio, taking up in considerable detail the building and equipment of the central power plant. It is not often that a power plant is to be met which involves the commendable completeness and thoroughness of detail that is evidenced in this plant, whether it be a railroad-shop power plant, or a commercial power or lighting plant. Considerable care appears to have been taken in the distribution of expenditures, in order to incorporate in the plant the great advantage not only of economy, but also of reliability and uninterrupted operation. No better evidence of this is to be had than in the mode of construction of the roof—roofs in power houses have always been a source of trouble; wooden roofs and others of a combustible nature have entailed very serious fire risks, while all metal roofs have given no end of trouble from dripping condensation in winter, but the solid hollow-tile roof at the Collinwood power house will remove both of these objections entirely. This method of roof construction is one that has for a long time been considered the best by the majority of power plant builders but has been reluctantly applied owing to its somewhat higher cost; we are pleased to see this and many other features insuring freedom from trouble introduced at Collinwood with a firm reliance on their eventual economy.

THE SHOP AS A SCHOOL.

The article on this subject in the October number of this journal was written for the purpose of setting railroad officers to thinking about methods of introducing "educated" young men to the service. The correspondence developed by it reflects the importance of the subject. Selected letters are printed in this issue and they should be read and thoughtfully studied by officers, young men and by educators who have so much influence over the young graduates.

No comment is required upon these opinions, but a summary of the most important suggestions seems desirable.

"All depends upon the man," say nearly all the correspondents. A young man's success must always depend largely upon himself, but everyone knows the importance of his point of view in starting. In this connection one says that it is a bad plan to select a number of young men to be educated for official positions. This course is a handicap to a young man.

Special privileges to college men seem to most of these correspondents undesirable and even harmful to the young men themselves, and unfair to other young men who cannot go to college. One of the letters—which is not printed—expresses the opinion that the college men, after serving special apprenticeships, invariably must rely upon the practical men to keep them out of difficulties, and the writer of the letter believes it "most unfair to discourage the practical men by putting impractical men over them." We are asked not to print this letter, and regret the request, because it would be sure to stir up a lively discussion, and it could not fail to set still more people to thinking.

Several others are unwilling to have their names appear, and one of them gives as a reason the fact that he is ashamed to say what he believes and have the readers discover that his apprentice system is "so different."

The development of self-reliance, responsibility, the ability to direct the efforts of others and the ability to meet emergencies form the burden of the remaining suggestions received in this correspondence. There is no patent method of bringing young men up in railroad work, and no one way will fit all, but if this discussion leads even a few motive power officers to see that more time and attention must be given to the training of young men, our purpose is accomplished.

SUPERHEATERS FOR LOCOMOTIVES.

Schmidt's development of superheating in Germany has been watched with interested attention for ten years. In stationary practice he has apparently overcome the difficulties, not only in superheating, but in the use of superheated steam, and for several years has given his attention to the locomotive with promise of equal success. Mr. Lentz, who has for many years been prominently interested in the development of the locomotive in Germany, has prepared for our readers a statement of the present situation of superheating in that country with particular reference to its application to locomotives. Being on the ground, he is in position to know the facts and is believed to be an impartial observer. According to his review of superheating, this principle offers advantages which promise great things for the locomotive and which, if the necessary additional complications of construction are to be overcome as easily as he states, will put the advantages of the compound system into the background.

Superheating has already made a good start in stationary practice in this country, and locomotive men here are not blind to its possibilities. Undoubtedly the subject will be thoroughly investigated and exploited in this country. Superheating should have the best attention in order to ascertain its adaptability to our conditions. It promises to increase the power of locomotives, to improve economy, to provide a method of doing this with a reduction of steam pressures; furthermore, it is applicable to boilers already in use, and it will permit of increasing the effectiveness of relatively small heating surfaces, rendering comparatively small boilers sufficiently productive to make it pay to continue them in service. Superheating disposes of the effect of cylinder condensation which is exceedingly important in locomotive operation, more so than in any other class of steam engines. If boiler pressures can be reduced, through superheating, the item of boiler repairs and the saving of trouble with stay-bolts becomes not the least important of its advantages.

What needs to be demonstrated is the practicability of the principle in connection with our conditions of operation. Because it works well in Germany it does not follow that with our methods of pushing locomotives to their utmost service, it will be equally satisfactory here. Just what it will do here is worth knowing, and this will undoubtedly be known before long.

The superheater as described by Herr Lentz does not seem likely to meet American requirements. Such contortions of tubes filling a large part of the smokebox does not appear attractive, but there must be a better construction which will find favor here. German experience justifies any American railroad in a plan for a trial of the principle, and we should be grateful to the Germans for their admirable pioneer work in this field. They offer us a system shown to be practically successful and complete.

BRIQUETTES FOR FUEL IN GERMANY.

One of the branches of German industry which deserves the attention of Americans by reason of their economy in the recovery or utilization of some raw material which exists unused in our country is the manufacture of briquettes from brown coal, peat, and the dust and waste of coal mines. Briquettes form the principal domestic fuel of Berlin and other cities and districts in Germany; they are used for locomotive and other steam firing, and are employed for heating in various processes of manufacture. For all these uses they have three tangible advantages: They are clean and convenient to handle; they light easily and quickly, and burn with a clear, intense flame; they make practically no smoke.

The average selling price of the briquettes in large quantities was for last year $3.16 per ton, as against $2.92 per ton for the year previous. Of the 1,566,385 tons sold last year, 749,208 tons were taken by the German railways, 124,380 tons were sold to retailers, 497,136 tons were sold to factories and works of various kinds, and 149,089 tons, or 9.8 per cent., were used by German merchant steamers and the navy, or exported.

The briquettes are to a large extent made from coal screenings, which require a matrix or binder of some plastic, inflammable material, and for this purpose mineral pitch is used, which costs on an average about $10.25 per ton, delivered.

The general use of briquettes for domestic fuel in a large, densely built city, as well as for generating steam in a number of electric generating plants and factories, has a decided and beneficial influence in reducing the smoke, which in most American cities has become a persistent and oppressive nuisance. Berlin, although a busy manufacturing city, ranks as one of the cleanest and best kept in Europe. One of the first things usually noticed by American and English travelers visiting the German capital for the first time is the absence of that cloud of dusty smoke that overhangs so many towns and cities in our country. The reason for this lies in the preponderant use of coke and briquettes, which are practically smokeless.

An amusing example of British opinion of "Yankee methods" appears in the editorial paragraph from our English contemporary, *Electricity*, which is quoted herewith:

"The question of right of way through the atmosphere has just been fought out in the United States between two rival telephone companies, to wit, the North Western Telephone Company and the Twin City Telephone Company, both of Minneapolis, Minn. The former was the plaintiff, and alleged interference with its business through the proximity of the defendant company's overhead wires; the judge held that the plaintiff company, being the first in the field, had the exclusive right of way through the atmosphere between the top crossarm on its poles and a point 20 ft. above the ground level. The Twin City Company has therefore been ordered to remove its wires at intersecting points, and also from such positions as are parallel to the plaintiff company's lines on the same side of the street. *Keen business men, these Yanks; they not only want to buy up the earth, but also yearn for a considerable vested interest in the very air we breathe.*"

The changes of fifty years in machine shop practice are scarcely appreciated by the majority to-day. In a reminiscent article in *Engineering Magazine* the veteran Egbert P. Watson presents the difficulties of the days of hand work. Speaking of skilled hand work he says: "Much heavy work that should have been done on a lathe—fly-wheels and heavy gears of large diameter, for example—was done by hand on the floor for want of a tool that would swing it; and there are many modern machinists who would not care to tackle a fly-wheel 25 ft. in diameter, in six sections, chip and file all the rim joints and the arm joints where they enter the central hub, drill the bolt holes in the rim flanges, so that every part of the structure and every bolt would be iron to iron and the wheel run true on its shaft when completed, without the use of a single machine tool. Yet this is what our forebears had to do, and they did it—in the course of time."

THE RELATION BETWEEN HEATING SURFACE AND CYLINDER POWER—A CORRECTION.

We regret a typographical error in the above article appearing in our October issue; the first formula on page 314 should have read: $BD = \frac{2460\ b}{cr}$, it being identical with the last formula, No. 4, on page 315.

PERSONALS.

Mr. J. E. Muhlfeld has resigned as superintendent of motive power of the Intercolonial Railway of Canada to join the staff of the Baltimore & Ohio.

Mr. George D. Brooke, master mechanic and master car builder of the Iowa Central, has accepted the position of superintendent of machinery of the Minneapolis & St. Louis, with headquarters in Minneapolis, Minn.

Mr. B. D. Lockwood has been appointed chief draftsman of the motive power department of the Louisville & Nashville at Louisville, Ky., instead of taking the position of mechanical engineer of the Wisconsin Central, as stated last month.

Mr. T. S. Reilly has been appointed master mechanic of the southwestern division of the St. Louis & San Francisco Railway. This is a promotion from the position of road foreman of equipment, and Mr. Reilly succeeds Mr. L. H. Waugh, resigned. His headquarters are at Sapulpa, Indian Territory.

Mr. J. J. Sullivan has been appointed master mechanic of the Louisville & Nashville Railroad at New Decatur, Ala. Mr. A. Beckert retains his title, general master mechanic, with general supervision over these shops and over the Nashville and Decatur division, the South & North Alabama and Birmingham Mineral Railroads, with headquarters at Decatur.

CORRESPONDENCE.

THE SHOP AS A SCHOOL.

The following letters, addressed to the editor, were written in response to the editorial bearing this caption in the October number of this journal. These letters should be carefully read by everyone interested in young men who are taking up railroad work as a profession:

From Superintendents of Motive Power.

In answering the question propounded in your editorial entitled "The Shop as a School," in your October number, my opinion is that student No. 2 has the superior training and is much better qualified than No. 1, and for reasons which you very clearly define. Intercourse with the employees, and especially those engaged in shops, enables the observer to obtain knowledge of the individual peculiarities of the men; this important qualification is absolutely essential for subsequent work of progressive character, and it must be obtained in this exacting age. Your article is an important one and very nicely prepared; modern history certainly indorses my opinion, and yours also. I believe, that student No. 2 is better prepared to anticipate and intelligently answer the complex problems daily arising than his less fortunate brother No. 1.

T. S. LLOYD,
Superintendent Motive Power,
Delaware, Lackawanna & Western Railroad.

From my experience with technical graduates I am of the opinion that the subject of your article, "The Shop as a School," is very important. I should say that course No. 2 is decidedly the better one for a technical graduate to pursue because his ability to progress in it will prove his appreciation of the necessity for his becoming more than a mechanic, or his failure will cause him to drop out entirely.

I am opposed to the title "special apprentice" and to paying educated beginners higher wages than others, because it sets them apart in a class by themselves at a time when it is not known whether or not such distinction will ever be justified and also at a time when this distinction can do them the most injury.

I believe that the practice of starting technical graduates in roundhouses as helpers instead of in shops as special apprentices will produce better results in a given time, and I find that they are better satisfied as a rule to start in roundhouses.

The gaining of sufficient knowledge and experience to fill positions of responsibility in railroad mechanical work is a slow and not very well paid process, and the sooner a man undertakes the hardest of it and makes up his mind that he is going to stick to it for the love of it, or give it up altogether, the better for himself and his employer.

DAVID VAN ALSTINE,
Superintendent Motive Power,
Chicago Great Western Railway.

I have read the article, "The Shop as a School," and in a general way am of the opinion that fully as much depends on the character, energy, inclination and aptitude of the person as upon the conditions under which he works. Under either circumstance he would have opportunities for studying general shop conditions and learn the habits and characteristics of shop employees in addition to the trade.

The selection of a man for foreman is usually made with reference to his ability to handle men and see that they perform their full duty, together with the man's knowledge of what this duty consists of and how to perform it.

From the examples you mention it is my opinion that case No. 2 will make the better foreman.

W. RENSHAW,
Superintendent of Machinery,
Illinois Central Railroad.

You are asking a very important question of the motive-power officers of this country, and you have taken two young men supposedly of equal educational preparation, and it is also understood that they are equal in ambition and in mental capacity so far as that is possible.

Now as to No. 1: You have described his work in a manner that to say the least is mild, and he simply accepts an attractive course covering a period of three years, in which he gets a good general view of motive-power problems, and in the end he gains the confidence of the men and the officers and knows something about how the department should be managed.

In the case of No. 2 it is an entirely different problem that the young man is up against, and the way you have put it in the article will cause every motive power man and every foreman of a shop to at once say, without giving the matter a deep thought, that No. 2 is the better man, because of the fact that you have painted him in such a way as to make him overcome a great many difficulties. He overcomes prejudice and surroundings, and everything else, and he wins out in every case.

The very fact that this young man is painted in that manner will prejudice the minds of men in his favor, and that is an injustice to the first one. In other words, you have shown up what a bright fellow No. 2 is, and you don't show up that No. 1 is bright at all. No. 1 comes into the shop and starts in on the lathes. He goes to the foreman of the machine shop and he says: "I have been working on this lathe for a month and I know of a better way to do this work, and by the manufacture of some special tool I can accomplish more work and do it more cheaply than is being done by the present method." He begins to show that he is using his technical education to the advantage of the officers of the shops. The officer sees that he is a good man. He takes him away from there and puts him in another place, and true to his worth he makes other suggestions to get out of certain ruts that they have been in, and he again gains the confidence of these men, and the prejudice of the men that he is associated with is against him, but in a short time he gains their confidence, and he wins out and is placed over in another department, where by his educational facility and mechanical ingenuity, or, if you please, the simple word "fitness," he has made another victory, and has increased the output of the work very materially from what it ever had been before.

Now if you take No. 1 and carry it out on this line to its conclusion, you will place him in the same possible light before the reader that you have No. 2, and then it will be for the reader of the paper to write an article to your paper answering which of these two men is the better qualified to meet the emergencies.

Suppose there are two candidates on the platform to-day for nomination for President of the United States. Senator Depew gets up with all his oratory and sways the multitude that is before him, and every delegate feasts upon every word that he says and enjoys everything that he says, and before Senator Depew is through his candidate for the nomination, in the minds of his hearers, is the greatest man on earth.

No. 2 is likened unto another man who is candidate for the election, and "your humble servant" gets up and makes the nominating speech, and it falls so flat upon the hearers that his candidate is no good. He is dead before the first ballot is cast.

So I think in this case that the description, while it is all right, is in favor of No. 2, and No. 1 is dead before the paper is read through.

R. QUAYLE,
Superintendent Motive Power,
Chicago & Northwestern Railway.

I have carefully read your article entitled "The Shop as a School" and I know you would like me to start in and cut it wide open, but that I cannot do because I agree with most all that is said.

I believe that in taking the case of the two technical graduates and starting them out on a railroad, as you have done, one as a special apprentice and the other as an ordinary man looking for a "job," is a specially good one, and it is going to have a good effect on young men who are looking for this sort of work.

In the first place, let me state, that it seems to me the second man has made a remarkable record in three years' time. For a man to go into a shop, or rather enter railroad work, on an equal basis with everyone else, and do what the second man is assumed to have done, is entirely out of the ordinary run of things; in fact, to make this record it is almost imperative that his employer should regard him as a sort of special apprentice. However, assuming that he has gone through all of this work and has done it creditably, there does not appear to be much doubt but that he is the more valuable man of the two. He has covered almost the same ground as the special apprentice, and he has covered it more thoroughly. I say he has covered it more thoroughly because to be a gang boss—also an assistant foreman of the machine shop—he must be thoroughly familiar with the work required in both capacities.

A special apprentice will hardly be in one department long enough to acquire this familiarity; but more than this, the second man has had the handling of the men which the special apprentice has not had, and this is of inestimable value to him. If he has been successful in this he has learned how to handle men to the best advantage, and has also made them his friends. True, he may not know as much about the ways of doing the work in the boiler shop, the blacksmith shop or the car works, as the special apprentice, but he will have some little idea at least of these things. The special apprentice will not be master of any one of these crafts. Neither of these two men hope to become dependent on their skill as a blacksmith or a machinist, but they do hope to direct the efforts of skilled men, and the one who does it most successfully will be the most valuable man. At the end of three years the special apprentice has had no experience in directing the efforts of others, while the other man has had this experience, and had been successful in it. I believe on this account that at the end of three years the second man is the more valuable one. This does not necessarily say, however, that he will continue to be so. The special apprentice may in the long run prove himself better in an executive position.

Let me say again that it is my belief that it would require a man of extraordinary ability to do in three years what the second man did, without being favored, and that under ordinary circumstances would not be done.

I have thought about this matter a great deal in the last few years, and it has been my privilege to have assisted quite a few college men to better positions, and I have never been sorry for having done it. I write this as one who did not have the advantage of a college education.

From what I have written you will judge that I have never been able to decide definitely which is the best way to start out, but I am inclined to favor the second method. However, after all is said about either course, it often seems to me that it finally simmers down to the old proposition—*it depends upon the man.* In this same connection, permit me to say that if it had never been my privilege to have talked with you on this subject, I can read between the lines that you also favor the second man.

One point in the article that strikes me as being especially good hard sense, and something that a young man can follow up and get the best results from, is that in which you say, "He boards with the men, eats at their table, and really lives among them." That is the real meat in the cocoanut. The trouble with most of these young fellows who start out as special apprentices is that in nearly every case they want different surroundings than those of the men with whom they are daily associated. They do not learn how the workingman lives, what are his pleasures, and what pleases and displeases him, and until they learn that they do not know how to handle him, and that is the reason of so many failures of special apprentices.

R. D. SMITH,
Superintendent Motive Power,
Burlington & Missouri River Railroad.

The editorial in the October number of your journal is well calculated to bring forth some excellent suggestions and criticisms from various men who are well qualified to handle questions of this kind. In my opinion, No. 2 will be the best qualified man for roundhouse foreman or master mechanic after having gone through the experience outlined, although you have pictured the most adverse conditions for him. The special apprentice, as a rule, receives special consideration and favors, and this, in many instances, prevents him from acquiring valuable information and experience that he would necessarily have to acquire were he working his way on his own merits. He therefore falls just that much short of a complete or finished education from a practical standpoint, and no matter how polished or finished he may be from a purely educational standpoint, if he is still lacking in the necessary practical experience it will develop itself in various ways when he assumes the more responsible positions. This will be particularly noticeable should his lines be cast with new roads where there is lack of sufficient power to move the business, sufficient shop facilities to maintain the equipment, and the man in charge is daily thrown on his own resources, so to speak, and compelled to work out and solve problems in surmounting difficulties that could not ordinarily be overcome by a man who had not a thorough practical training.

In my wide range of experience I have been a fairly close observer of conditions and results, and I personally know of some roads to-day which have hundreds of thousands of dollars invested in motive power and equipment, much of which is poorly designed, on account of lack of a technical education on the part of the designer; while, on the other hand, there are some striking instances of heavy losses being sustained on account of lack of the necessary practical experience of the individual in charge. There is a happy medium between the two extremes, and it seems to me that the best man for a railroad company is one who has the widest range of knowledge of things in general.

There are many men who would not be qualified to superintend the motive-power department of a railroad, no matter if they spent ten or fifteen years in college and a corresponding amount for tuition; while, on the other hand, there are many practical men who are not qualified to advance beyond a shop-foremanship. Every dollar earned for a railroad company is earned by its locomotives, and a man to superintend the motive-power department should be a railroad man in the broadest sense of the word—well up on transportation matters, and with a thorough knowledge of human nature; a good executive officer, as there are intricate problems in connection with the labor question nowadays which, if not handled properly by the head of the motive-power department, will seriously affect the earning power of the property.

The experience outlined for young man No. 2 will produce a man closely in touch with his fellow-men and in many instances fit him for handling men, organizing shops, and securing the greatest possible degree of loyalty to be obtained, not only from the shop men but the road men. The man who has not had this experience either stands aloof from the men or they stand aloof from him, and while it may not be apparent to all, it can easily be seen by those who, from experience, are competent to judge, that the lack of a cheerful response to duty on the part of the different employees of the department, if measured in dollars and cents, would make quite a difference in the cash balance of the annual report.

W. E. SYMONS,
Mechanical Superintendent,
Gulf, Colorado & Santa Fé Railway.

From Mechanical Engineers.

You ask a vitally important question in your editorial in the October number of The American Engineer. You raise the question whether we are encouraging technical-school graduates to enter railroad service in the best way, and I must say the problem has never presented itself in this way to me before. I will not attempt to answer you, except to say that I had not realized the weakness of the special-apprenticeship system with reference to the lack of executive responsibility. The fact is that a boy is too old to "begin" after he has completed a three-years' apprenticeship course on top of his college years. He needs to get at once into contact with responsibility, and that is what makes men. It all depends upon the man, after all is said, but I believe the college professors ought to use their influence toward leading graduates to see the importance of executive experience at an early point in their careers. They all want to be mechanical engineers, when foremen are most needed.

A. B. C.

The subject which is considered in the article entitled "The Shop as a Schoool" is an interesting and an important one, but because it is treated hypothetically it is very easy to find more than one side to it. It would be interesting to watch the progress of boy No. 2 transposed to the position of boy No. 1, and to see how soon he would gain the position of the man who started him in the school or gain a similar position elsewhere. I think that boy No. 2 is an exceptional one and would make an exceptional record under any conditions.

My understanding of the article is that boy No. 1 carries around on him, probably unwittingly, a placard on which the men read, in large letters, "I Am the Coming It," and so that they may have in after years the pleasure of telling how they "rubbed it into It" when "It" was an apprentice, they all "take a shy" at the placarded apprentice. If some course can be pursued which will not result in the printing and the attaching of the placard, such a course is to be preferred.

It may be possible at the present time to select each year a number of boys, tell them that they are to be trained for official positions, and to actually develop them to such a degree that any and every one of them can be put into some official position which they will fill satisfactorily in accordance with present enlightenment; but the theory is not a correct one, and it will be proven wrong as the demands become more exacting. At the age at which an apprentice, or a beginner, must be employed it is impossible for the employer, or the boy either, to know whether he will develop an aptitude for the business. Some of the boys will not so develop, and therefore the employer must start a greater number of boys than he can expect to use ultimately, and some way must be provided for either side to terminate the arrangement when either side is satisfied that it cannot be concluded to advantage. This explains, also, the difference between boy No. 1 and boy No. 2 of the article. Boy No. 1 is told what is in prospect for him; therefore, if some of the work is distasteful to him, he gets over it as easily as possible, knowing that there is a predetermined time for a change, and that ultimately something must "be done" for him. Boy No. 2 knows that he must learn before he is advanced, and therefore sets himself about learning and working out his own station. If he finds that his rating is not sufficiently high to give him advancement, and he decides that he is at fault, and not the rating, he will probably find some other calling in which his rating will correspond with his own ideas. He will prosper accordingly, and no agreements will be broken.

No doubt boy No. 2 will prove to be the more valuable, but inasmuch as he is wise beyond his years, he will not seek employment where boy No. 1 is exhibiting his placard.

F. M. WHYTE,
Mechanical Engineer,
New York Central & Hudson River Railroad.

You make out a very plain case for No. 2, who shows an individuality which will conquer circumstances, and with equal opportunities he will beat No. 1 on account of his mental equipment, which he has reinforced by practical experience. Nine times out of ten the practical man will beat a purely theoretical man because his theory so frequently falls short of covering all of the conditions. He who combines theory with practice is the better man, and your No. 2 has schooled himself in management, which No. 1 has failed to do.

I have very little respect for a college man as such, and I have all respect for the advantages of a college education possessed by one who can take advantage of it. A college man coming to a railroad expects to have, in time, an advanced position. As a matter of fact, however, he is no better prepared for the detail of railroad work than any other stranger. In my opinion, it is necessary that the rules for apprentices should not be modified for a college man, but during his term of apprenticeship he should be given special work to do under the direction of the master mechanic, fitting him to take such an advanced position as the superintendent of motive power has in mind when taking special apprentices. It must be borne in mind that unless it is intended to fill such positions with college men, it would be no use to take them in unless they accept the opportunities of apprenticeship with absolutely no modification. I rather incline toward regular apprenticeship for technical-school graduates.

College education does not fit a man for an advanced position, but it will assist him very greatly if he has it in his make-up to handle men and matters which an uneducated man could perhaps do better by virtue of natural aptitude. In these things success is a matter of natural leadership, education or no education. I know of several mechanical engineers of railroads who have obtained marked success and are not college graduates. I also know college graduates who have entered railroad work and by going through regular courses of apprenticeship have fitted themselves by hard work to take advanced positions, and in these cases education has been very helpful.

There is no hard-and-fast rule in this matter. Everything depends upon the individual. I should be inclined to say to the man who is applying for special apprenticeship by virtue of his education that we have no special courses, and that if he wishes to enter upon a regular apprenticeship, all opportunities which we may have for special work will be given him, and he will then be left to work out his own salvation. If he proves to be an exceptionally good man, and by combination of his college education and his training he becomes a leader, he may confidently expect consideration when there are openings for advanced positions; in fact, we are all the time looking for such men.

S. A. C.

From a Master Car Builder.

I consider this article very important at this time, and I believe the subject is one which will be read with great interest. In answer to the question as to which of the two young men would be the more liable to succeed, I believe that No. 2 would have very much the better of No. 1, both from point of knowledge of detail and from the fact that he would have a first-class opportunity to demonstrate whether or not he would be capable as an executive.

It might be well at this time to sound a note of warning in regard to the special privileges allowed special apprentices. If we carry this matter too far, it will have a tendency to discourage the regular apprentices in the shops, who, if properly encouraged, will take up a correspondence course and acquire the necessary technical education. A great many good, practical men are leaving railroads that allow the special apprentice favors, on account of the fact that they have got the idea into their heads that no one but a college graduate will be promoted. This is a very serious matter, and steps should be taken to give everybody to understand that push and ability and close application to business will win, no matter whether a man has received his education in a college, common school, or by home study.

LE GRAND PARISH,
Master Car Builder,
Lake Shore & Michigan Southern Railway.

From Two Friends of Many Young Men.

I have gone very carefully over the article in your October number, and believe it covers the ground quite fully, but, after all, when we come to study this question of technical education of young men, I cannot but feel more and more each year that we know very little as yet about "education."

Mr. Schwab started on a grocery wagon to become president of a billion-dollar steel trust. Mr. Carnegie started in a cotton mill and graduated through the office of a telegraph operator to become one of the greatest organizers the world has ever known. Mr. Pullman started as an ordinary carpenter and died leaving as a monument one of the greatest enterprises in existence to-day. James A. Garfield started on the tow-path of a canal and became President of the United States. M. Witte, present Minister of Finance of Russia, and one of the greatest national financiers in the world, began as a railroad clerk.

Andrew Carnegie, in making answer to the following question propounded by a reporter some time ago—"What is the one great essential to success for a young man?"—said, "To be born poor." Ouida has said: "Poverty is the north wind that lashes men into Vikings": "Adversity is young ambition's ladder."

After all, may it not be a fact that in the Divine plan there may be a specification that the best education is to have to battle with adversity early in life? All of Christ's teachings would point to this, and is it not possible that in the great economy of nature this rule must apply as a sort of leveling process? Otherwise, the chasm between those who are able to get an "education," as we usually apply the term, and those who cannot do so, would grow wider and wider, and the result would certainly be most lamentable. You know someone has said:

"If life were a thing that money could buy,
The rich they would live and the poor they would die;
But God in His goodness hath ordered it so
That the rich and the poor they together must go."

I wonder, after all, if this same rule might not apply to some aspects of our struggle here on earth.

I, of course, realize that in some quarters this doctrine is quite unpopular; possibly it is wrong, but these are thoughts that constantly occur to me, and when I come to study, page by page, the great book of events transpiring around us, I cannot always refrain from thinking that possibly we do not yet know just the proper definition of the word "education," or rather that we attach altogether too much importance to the stilted process we now term "getting an education."

C. D. E.

I have read with much interest your article, and think you have put the situation confronting graduates about to enter shop work just right. After all, he must choose for himself, and success will continue to depend on the combination of technical knowledge, energy and ability to understand and make friends of those with whom he is associated in his daily work. I think the chances of success are about even between No. 1 and No. 2; the latter, however, more likely to receive recognition first.

N. W. SAMPLE,
Baldwin Locomotive Works.

From College Professors.

I have read the article, "The Shop as a School," appearing in the October issue of The American Engineer and Railroad Journal. The shop is never a school; it is simply a shop. In a well-managed and well-equipped technical school a young man can learn more in one year about machine-tool processes and the materials of engineering than he can in any shop in three years while working as a special apprentice. In a technical school he cannot learn how to handle men; he can never know how to handle men successfully unless he has been one of the men. He must think as they think. He can never handle men anyway unless he has some traits of character which make him sympathetic, tactful, and firm. Either one of the young men referred to in the above article will be successful if he is persistent and has work thrust on him that makes him feel responsibility. If wisely looked after, the first man will eventually make the better master mechanic. The second man may make more rapid progress at first, but that would depend more upon fortunate circumstances than upon the ability of the man.

L. P. BRECKENRIDGE,
University of Illinois.

The ground you cover is very familiar, but I have never seen a better illustration than this of the principles involved. I would suggest, however, that the fundamental difference between them is that No. 2 is a *man;* No. 1 may be, but more by good luck than good management. Colleges may educate to almost any extent, but it is only when they educate a *man* that much good is done.

A noted New York financier said that he had spent $50,000 on the education of his son, and yet he could not earn his living.

I know a man who did not spend $50 on the education of his three sons, and yet they are handsomely educated and can earn a living for quite a number besides themselves.

It is singular, but I have just answered a letter of a young man asking for advice. He was graduated last year, and has just started in a machine shop at the bottom. He is dissatisfied, saying there is no room to rise, and yet he tells me of a young man who went to the same shop four years ago and is now roundhouse foreman. This latter man was like the No. 2 of your article, and will be a man who will be of some use in the world.

There is no royal road to learning, nor is there to usefulness. Those who are useful, from kings down, or up, as the case may be, obtain that capacity for usefulness by hard knocks, persistent and untiring effort. I am sending your article to the young man who is asking for advice; he needs the article right now.

I am one of those professors who do not believe that their duty ceases when the lecture-room door closes, and in consequence am constantly running across those who would find the easy road, the paths which No. 1 trod, and urging them to take the path of your No. 2. I believe the difference is not so much in what the two know, but in that far nobler trait of character—manly self-reliance. No. 1 relies on his "pull," and how many there are who spend their lives complaining that they have no "pull" and therefore cannot succeed! Every man has all the "pull" in himself that he needs, but most men are too lazy to use it. They want someone else to pull them. This takes us back to the same old principle which involves all crime and misery—we try to avoid the punishment meted out to us through Adam—"In the sweat of thy brow thou shalt eat bread all the days of thy life."

I would that there were much more published along the lines of your article.

L. S. RANDOLPH,
Professor of Mechanical Engineering,
Virginia Polytechnic Institute,
Blacksburg, Va.

From a Promoted Apprentice.

I have enjoyed reading the article entitled "The Shop as a School," and feel that you have stated the situation very well; but I think that a young man fresh from a university would consider his a most strenuous life if he put aside his recently acquired learning and went to work on his own responsibility in a roundhouse washing gang. The special-apprentice course is all right as far as it goes, but a college man should not forget his college ideas and feel that he is no better than anyone else, and he should begin where his practical knowledge allows him to begin. The comparisons you have made are excellent, and the questions raised will be the cause of setting many young men thinking.

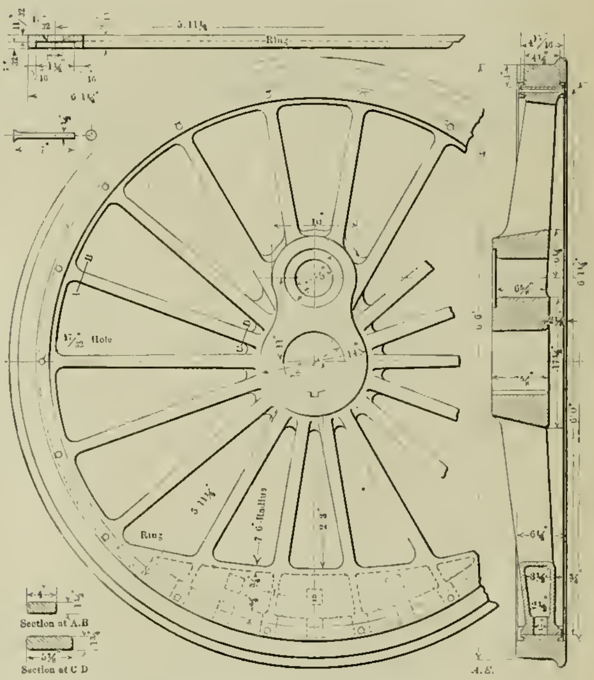
C. C. H.

CAST-STEEL DRIVING WHEELS.

Made Without Cutting the Rims.

Philadelphia & Reading Railway.

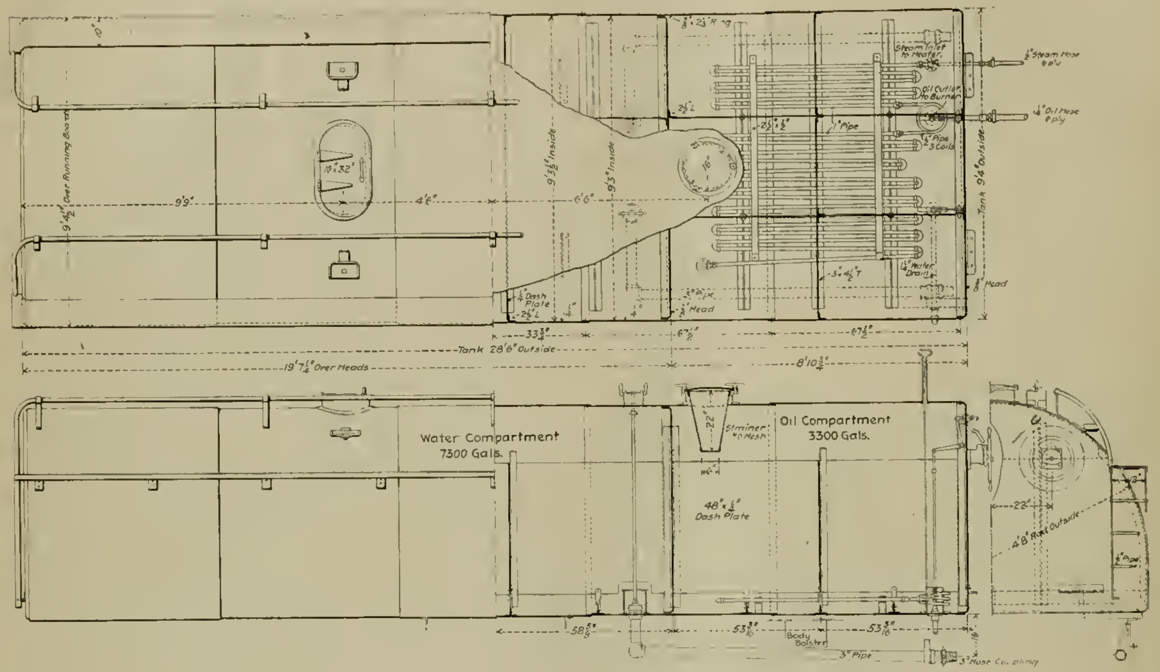
An interesting design of cast-steel driving wheels, brought out by Mr. S. F. Prince, Jr., superintendent of motive power and rolling equipment of the Philadelphia & Reading Railway, is illustrated by this drawing. With a view of overcoming the breakage of cast-steel wheel centers because of shrinkage stresses, Mr. Prince designed this pattern to be cast solid; that is, without cutting the rims. The draught is all in one direction, and the molder's work is simple. There was at first considerable hesitation on the part of the foundrymen



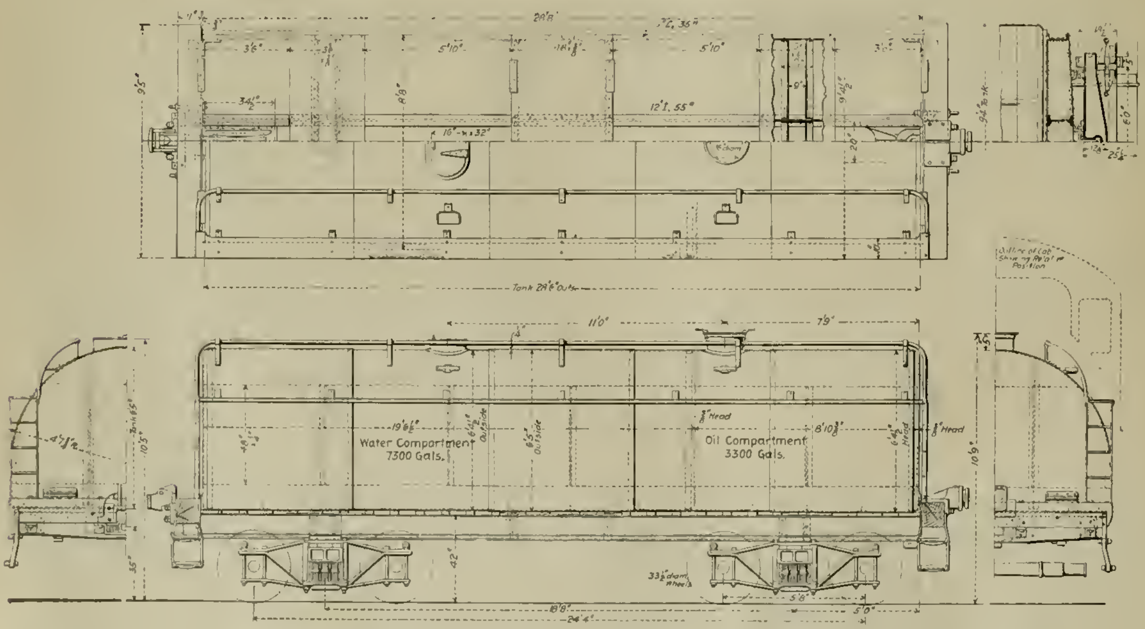
Cast-Steel Driving Wheel with Uncut Rims.—Philadelphia & Reading Railway.

to undertake the casting because of well-known difficulties with the shrinkage of the castings in the mold. Mr. Prince met this by suggesting the use of sawdust between the spokes in the mold to offer an elastic resistance to the shrinkage of the spokes. The yielding of the mold seems to meet the requirements, and wheels cast in this way are now undergoing experimental service. The construction of the wheel is clearly indicated in the engraving.

If nearly an hour is required for testing and making running repairs on the air brakes of a freight train which is made up and ready to go, and the engine must be coupled to its train for this purpose, it is easy to see an opportunity to materially increase the effectiveness of locomotive equipment in busy times by installing yard testing plants in order to save the time of the locomotives. Mr. H. F. Ball made this claim in a discussion at Saratoga in June. His conclusion was that it would pay to install these plants at all important points where trains are made up, or where cars are added, as at junction or division points.



Part Sectional Plan and Elevation of Tank, Showing Arrangement of Heater Coil



Plan and Elevations of Tender, Showing Details of Trucks, Frames, Etc.

Tender and Tender Tank for Oil-Burning Locomotives — Southern Pacific Railway.

TENDER AND TENDER-TANK FOR OIL-BURNING LOCOMOTIVES.

Southern Pacific Railway.

The use of fuel oil on the locomotives of the Southern Pacific has become sufficiently permanent and extensive to warrant the design of tenders specially adapted to the purpose of carrying oil and water. Heretofore an oil tank has usually been placed in the coal space of an ordinary tender and perhaps extended into the water space. In this case the whole tank is made semi-circular in section and divided by a partition into two sections, one for oil holding 3,300 gallons at the front of the tender and the other at the rear end for water, holding 7,300 gallons. The construction of the tanks and the tender frame is so clearly shown in the engravings on the opposite page as to render an extended description unnecessary.

At the front end of the oil tank is a coil of pipe by which the oil is heated by steam, and this coil has a loop surrounding the outlet for the purpose of facilitating the flow of oil through the valve. The valve is operated by means of a bell crank and lever at the front end of the tank. By making an attachment between this lever and the cab of the engine by means of a chain the oil valve is sure to be turned off in case the tender separates from the engine. The drawings show a strainer under the manhole through which the oil is passed into the tank.

The tenders are mounted on diamond trucks and the tender frames are of steel. The center sills are 12-in. I-beams placed 20 ins. between centers, and the side sills are 10-in. channels. The sills are tied together at the bolsters and also at the center. They are braced at the center by means of two pressed channels and also by a flat plate 48 ins. wide. These tenders are equipped with the Miner twin spring draft rigging placed between the center sills. The bolsters are built of top and bottom plates with stiffening filling pieces of pressed steel plate between them. These extend between the center and side sills and at the center a steel casting receives the center plate. The cast steel truck bolsters were furnished by the Leighton & Howard Steel Company.

SIDE PLAY REQUIRED IN CAR COUPLERS.

End Sill Clearance on Curves and Length of Safety Chains.

By Theo. H. Curtis, Mechanical Engineer, Louisville & Nashville Railroad.

Draw-bars should have sufficient side play to allow their cars to pass from a curve to straight track and return and from curve to reverse curve, without causing any binding or cramping in the side guards or in the coupler heads.

The M. C. B. contour lines permit side play to the extent of an angle of fourteen degrees between the center lines of draw-bar shanks when knuckles are locked. This angle is all that is required in most cases, when both cars are alike in wheel base, over-hang of draft rigging, etc., and both on the same curve. The angle between center lines of draw-bars, however great, does not relieve the necessity of side play for draw-bars in cars passing from straight track to a curve and vice versa, or from curve to reverse curve.

When two cars are on the straight line their draw-bars are pulling on a line directly over the middle of the track, and when the first car enters a curve, the center of face of its draw-bar at the rear leaves the middle of the track and passes toward the outside of the curve, while the center of face of draw-bar on car yet on a straight line is directly over the center of the track.

The side movement of the draw-bars in their relation to each other will be compensated for by the side play, if any, or, if bars are rigidly held; by springing both draft riggings, taking up all loose joints, etc., by pulling the car transversely of track, taking up all side play in journals, by throwing one pair of trucks to the inside of track and the other to the outside, making curving resistance very high. When all side play is taken up and still more is required some part of the draft rigging must give way, or the car is derailed.

The maximum side play required for any draw-bar can be determined without calculation, if the car in question can be placed on the sharpest curve over which it is to pass, as follows: Place the car on the curve central with the track; lay off center line of track under the draw-bar; move center of draw-bar face sidewise until same is exactly over center line of track. If every car has side play enough to permit draw-bar to come over center line of track there will be no binding, as each draw-bar needs to come only half way.

Several formulas are given below which cover general combinations of like cars in different relation to each other. For other combinations it is suggested that the formulas be used for computing each car and the respective angles they bear to each other; that a drawing be made showing the angles and the side play be measured from the drawing. The accompanying engravings represent such drawings—Fig. 1 showing two cars in a regular curve, and Fig. 2 two cars on reverse curves. Fig. 3 is a plan view of the draw-bars. Each figure has letters of reference, which letters are explained below:

a. Distance from face to draw-bar to line, f, in feet;
b. Distance from end sill to line, f, in feet;
c. Distance from center of truck to line, f, in feet;
w. Distance from center of car to end of end sill, in inches;
f. Line from center of curve to center of car between trucks;
g. Line from center of curve to center of truck;
h. Line from center of curve to face of draw-bar;
k. Distance from face of draw-bar to end sill, in inches;
l. Distance from outside corner of end sill to line, h, in inches;
m. Distance from inside corner of end sill to line, h, in inches;
n. Distance from face of side guards to pivot point, in inches;
p. Side play required at each side of draw-bar at face of side guard, in inches;
o. Distance from center line of car on curve to center line of track, in line h, in inches;
z. Distance from face of draw-bar to pivot, in inches;
x. Center line of car;
R. Radius of curve, in feet;
D. Degree of curve;
S. Angle between lines, f and h;
T. Angle between lines, f and g;
U. Angle between center lines of like cars on same degree curve;
V. Angle between center line of car and center line of draw-bar;
W. Angle between center lines of draw-bars.

EXAMPLE.

Assume a car 38 feet long, 26 feet between truck centers. 10 feet wide. 18 inch face of draw-bar to end sill; a = 20.5 feet; b = 19 feet; k = 18 inches; c = 13 feet; w = 60 inches; R = 193.2 feet; D = 30 degrees; z = 42 inches; n = 30 inches.

COMPUTATION OF RADIUS OF CURVE, DEGREE BEING GIVEN.

$\frac{5730}{D}$ = R. nearly. (This formula is close enough for practical purposes.)

For correct radius of curve see Engineering Tables for radii.

COMPUTATION OF ANGLE T:

$$\frac{c}{R} = \text{sin. } T; \quad \frac{c}{R} = \frac{13}{193.2} = \text{sin. } = 0.06728 = 3° \; 51'.$$

COMPUTATION OF ANGLE S:

$$\frac{a}{R \cos. T} = \text{Tan. S} = \frac{20.5}{193.2 \times .99774} = 0.10634 = 6^\circ\ 4'.$$

COMPUTATION OF DISTANCE l:

$$\left\{ (k \cot. S) + w \right\} \text{Sin. S} = l.$$

$$\left\{ (18 \times 9.409) + 60 \right\} \times 0.10569 = 24.2 \text{ ins.}$$

COMPUTATION OF DISTANCE m:

$$\left\{ (k \cot. S) - w \right\} \text{Sin. S} = m;$$

$$\left\{ (18 \times 9.409) - 60 \right\} \times 0.10569 = 11.52 \text{ ins.}$$

COMPUTATION OF DISTANCE o:

cars are both on the same curve. The maximum side play is not required when both cars are on the same regular curve, but only when they are on reverse curves.

COMPUTATION OF ANGLE V, for two like cars, one on curve and the other on straight track:

For the angle V, for the car on straight track—

$$\frac{\left\{ o - (z \text{ Sin. S}) \right\} .5}{(z \cos. S)} = \text{Tan. V.}$$

$$\frac{\left\{ 7.725 - (42 \quad .10569) \right\} .5}{(42 \quad .9944)} = .03927 = 2^\circ : 15'.$$

For the angle V, for the car on curve—

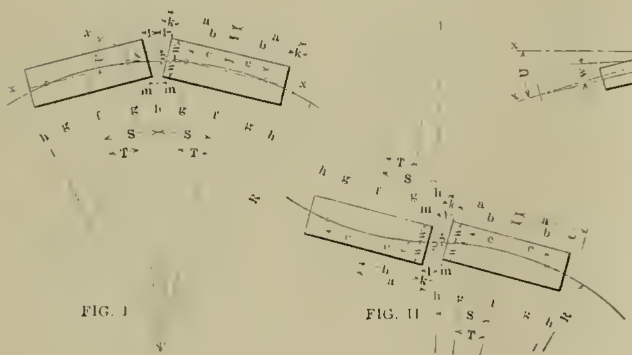


FIG. I FIG. II

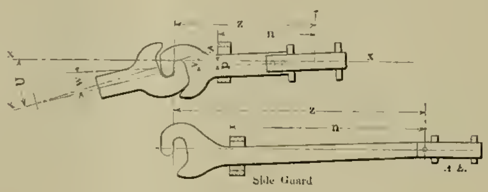


FIG. III.

Side Play Required in Car Couplers.

$$12 \left[\left\{ R\ (\text{Sec. S} - 1) \right\} - \left\{ R\ (1 - \cos. T)\ \text{Sec. S.} \right\} \right] = o$$

$$12 \left[\left\{ 193.2\ (1.0056 - 1) \right\} - \left\{ 193.2\ (1 - .99774)\ 1.0056 \right\} \right]$$

$$12 \left[\left\{ 193.2\ .0056 \right\} - \left\{ 193.2\ .00226 \quad 1.0056 \right\} \right]$$

$$12 \left[1.0819 - .43913 \right] = 7.725 \text{ ins.}$$

COMPUTATION OF ANGLE V, on reverse curves of same degree:

$$\frac{\left\{ o - (z \text{ Sin S}) \right\}}{(z \cos. S)} = \text{tan.} + S = V; \quad \frac{\left\{ 7.725 - (42 \times .10569) \right\}}{(42 \times .9944)} =$$

$$.0787 = 4^\circ\ 30' + 6^\circ\ 4' = 10^\circ\ 34'.$$

COMPUTATION OF ANGLE V., when coupler is held in side guards:

$$\frac{p}{n} = \text{tan. V.} = \frac{5.5}{30} = .18338 = 10^\circ\ 34.'$$

COMPUTATION OF SIDE PLAY, P:

$$N \times \text{Tan. V} = P.$$

$$30 \times .18338 = 5.5 \text{ ins.}$$

COMPUTATION OF ANGLE U, for two like cars on regular curve of same degree:

$$U = 2 \times S.$$

COMPUTATION OF ANGLE W, for two like cars on regular curve of same degree with draw-bars rigid in side guards:

$$W = 2 \times S;$$

with draw-bars having play in side guards:

$$W = 2\ (S - V).$$

When the angle W is greater than twice the angle S (2S), no side play is required for the draw-bars, while the two like

$$\frac{\left\{ o - (z \text{ Sin. S}) \right\} .5}{(z \cos. S)} = \text{Tan.} + S = V.$$

$$\frac{\left\{ 7.725 - (42\ .10569) \right\} .5}{(42. \quad .9944)} = .03927 = 2^\circ : 15' + 6^\circ : 4' = 8^\circ : 19'$$

Two M. C. B. draw-bars should couple at about 11 degrees for angle W; this allows for roughness of the castings with respect to the contour lines. The M. C. B. contour lines will allow an angle of 14 degrees for W.

For locomotive tenders the lengths (a) and (k) must be taken to suit tender on each end. For locomotives of the four or six-coupled type, the length (c) will be one-half the distance between centers of outside driving wheels. For locomotives having eight-coupled driving wheels and those having engine trucks or rear trailing wheels, the calculator must determine what pairs of wheels regulate the movement of the engine and take distance (c) accordingly.

COMPUTATION OF STRAIGHT LENGTH OF SAFETY CHAINS:

a. = Distance, in feet, from center of car to face of draw-bar when latter is pulled out to its extreme position;

b. = Distance, in feet, from center of car to inside bearing of first link in chain.

w. = Distance, in inches, from the center line of car to the center of the safety chain.

Use formula for computing distance (l) between the corner of the end sill and the line (h) on the outside of the curve, by substituting length, a, b and w, as given above. The distance, l, obtained from the computation is the distance, in inches, from the safety-chain fixed bearing to the line h. Twice l is the straight length of both safety chains when hooked together.

ELECTRICALLY OPERATED TURNTABLES.

The problem of operating turntables by power has recently received considerable attention in the columns of the railway engineering press. This subject is concisely stated in the following extract from a committee report of recent date to the Association of Railway Superintendents of Bridges and Buildings:

"The question of obtaining suitable power to facilitate the turning of locomotives by some motive power was brought to the front by the decided increase in the weight of locomotives during the last few years. The weight of locomotives used on some of the railroads to-day is such that they cannot be economically turned by hand, not only on account of requiring too many men to do the work, but the question of turning locomotives quickly at junctions and busy terminal points is a vital factor in considering the question as to what power to adopt to turn locomotives and other rolling stock, both promptly and economically. . . . On some of the eastern railroads locomotives weighing 175 tons, including the tender, are operated; such locomotives cannot, according to actual experience, be turned economically by hand, especially in the winter time." (The Atchison, Topeka & Santa Fe has an engine weighing 200 tons with the tender.)

A steam "donkey" or single-wheel locomotive is occasionally used for this purpose, attached to one end of the turntable and running on the same circular rail as the wheels of the turntable. The equipment usually consists of an upright boiler, a small steam engine and the inevitable coal bin. The entire arrangement is very inefficient, since economy is not an attribute of the type of boiler and engine which must be employed. It is necessary to continually supply coal and to remove ashes in small quantities and, in some communities, a licensed engineer is required by law. The suggestion has been made that steam might be conducted from a neighboring boiler plant, underground and up through the center of the turntable to a pivotal joint, thence to the "donkey" engine. Considerable difficulty would obviously be experienced due to condensation and this method cannot be recommended. Owing to the inherent disadvantaages of the steam "donkey," its use will never become general.

The electric motor possesses qualifications peculiarly valuable for work of this nature. A large number of turntables have been electrically equipped during the last few years and their successful operation leaves very little to be desired. A typical turntable equipment consists of a small railway motor with ordinary gearing, together with a rheostatic controller and a circuit breaker, usually mounted on a single-wheel truck.

The railway type of motor is especially adapted for this purpose, as it is completely enclosed and thoroughly water and dust-proof. The conditions of frequent starting and acceleration and large momentary overloads, correspond very closely to street railway work, where the series-wound direct-current motor is absolutely indispensable. In any case the motor must be designed and constructed to withstand rough usage, amounting often to positive abuse. The motor is usually provided with feet, as shown in Fig. 1, and in place of the car axle, an intermediate shaft is substituted, so that the armature of the motor drives the traction wheel through double reduction gearing. If there is sufficient space, it is well to follow street railway practice still further and enclose both gear reductions in gear cases, filled with oil. At this point it may be well to state that if the only available source of power is a multiphase alternator, an induction motor may be successfully employed. The motor should be designed for speed variation, with definite wound armature, collector rings and external resistances. A large turntable equipped with a three-phase variable speed induction motor has been in successful service for several months, readily handling the heaviest engines. Whichever type of motor is used, the armature shaft is usually extended at the end opposite the pinion, to accommodate a band brake. The brake should be normally applied by a weight or spring and released by a foot lever, or better still, by a shunt wound solenoid magnet (Fig. 1) connected so that the brake is automatically applied whenever the controller handle is in the "off" position. If this arrangement is used, a separate device for locking the turntable in position is unnecessary.

The controller is similar to the familiar street railway device, except that instead of using a separate reversing lever, the handle moves in either direction from a central "off" point. The few resistances required are also of the same form as used in street car equipments. The circuit breaker serves the double purpose of a switch and a protection for the motor, preventing any possibility of disastrous "short circuits" or injurious overloads. The electrical turntable possesses the following important advantages:

Simplicity of parts, low cost of maintenance and operation, can be operated by an unskilled attendant, rapid acceleration up to comparatively high speeds, large reserve capacity for momentary overloads, perfect speed control, consumption of power only when in actual service.

As intimated in the introductory paragraph, the time element is an extremely important consideration. With manual operation it is difficult to attain more than one-third of the speed of the electrical equipment. This is due to the rapid acceleration of the electric motor, the high turning speed and the ability to bring the turntable quickly to rest. At a certain busy terminal, the roundhouse was recently rebuilt with provision for twice the number of locomotives accommodated by the original structure. The superintendent stated emphatically that this very desirable concentration of locomotives was rendered possible only by operating the turntable electrically.

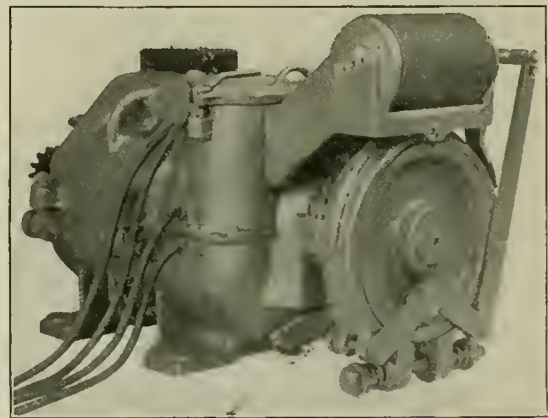


FIG. 1.

The power for operating the turntable may be obtained from the direct current power circuit (125, 250 or 500 volts) of the machine shop, or may be purchased at a nominal meter rate from a local illuminating or power company. The use of electric power has become so general that the conditions are very exceptional where a separate generator would be required for operating the turntable.

Where a large number of engines must be handled expeditiously, a regular turntable operator should be employed and a cab provided for his protection, as illustrated in Figs. 2 and 3. There are many cases, however, where it is feasible for the locomotive fireman to operate the turntable, in which event the controller may be located at the center of the table at one side, and a cab is not an absolute necessity. The details of the construction of the "donkey" with a cab are clearly shown in the illustrations. It will be noted that provision is made for sanding the rail in both directions. It is recommended that the mechanical features of the "donkey" be designed and constructed in the railroad shops wherever possible, the only apparatus to be purchased outside being the electrical equipment.

The turntable illustrated in Fig 4 is an excellent design and embodies some novel features. The table proper is hung on a heavy cradle, which turns on a train of small wheels, following the usual draw-bridge practice. The cradle contains an electric motor with a vertical armature shaft, at the lower end of which a pinion engages with the teeth of a large stationary gear. The motor is an adaptation of the well-known GE-800 railway motor, and is located between the girders of the table.

There seems to be some misapprehension regarding the amount of power required to operate an ordinary turntable, due perhaps to the arbitrary basis on which motors of the railway type are rated. In lists of electrically operated turntables, the capacities of some of the motors are specified to be from 7 to 10 h.-p., while in the case of a turntable equipped with a railway motor, the capacity may be given at 20 h.-p. The difference lies, not in the capacity of the motors, but in the methods by which they are rated. The capacity of an electric motor is determined by the heating in the armature windings. On the ordinary basis a 10 h.-p. motor will operate at that load continuously, without a dangerous rise in the temperature of the windings. Street railway work, however, is so extremely intermittent that a continuous rating is irrelevant and an arbitrary basis of rating has been established. A 20 h.-p. motor, railway rating, will develop 20 h.-p. continuously for one hour, with a rise in temperature not exceeding 167 degrees F. If the load were continued steadily at that figure, the motor would burn in a few hours. A motor rated in accordance with this arbitrary method will operate intermittently at its full rating, and continuously at about one-third of its rating—i. e., a 20 h.-p. motor of the railway type will develop about 7 h.-p. continuously. It does not follow, however, that a 7 h.-p. motor, continuous rating, will develop 20 h.-p. intermittently, and it is therefore evident that a motor of the railway type is more suitable for turntable operation. The actual power required to turn a sixty-foot table, carrying an engine weighing 200,000 pounds, at the rate of one revolution in forty seconds varied, in one case from 8 to 12 h.-p., depending upon the position of the engine. At starting and during acceleration, however, the load on the motor was considerably greater. In this particular case the minimum power seemed to be required when the engine was slightly out of balance, the weight being divided between the center bearing and the wheels at one end of the turntable. In general, the statement may be made that, with electrically operated turntables, no time need be wasted in balancing the locomotives.

There are three practicable methods of conducting the current to the motor on the turntable, as follows:

1. By collector rings and brushes at the center of the turn-

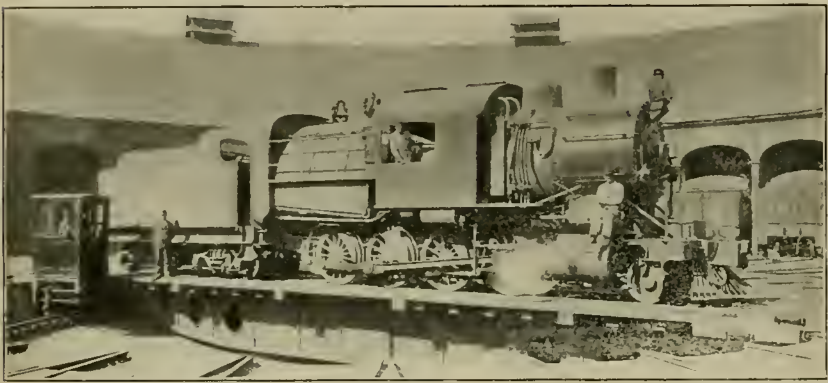


FIG. 2.

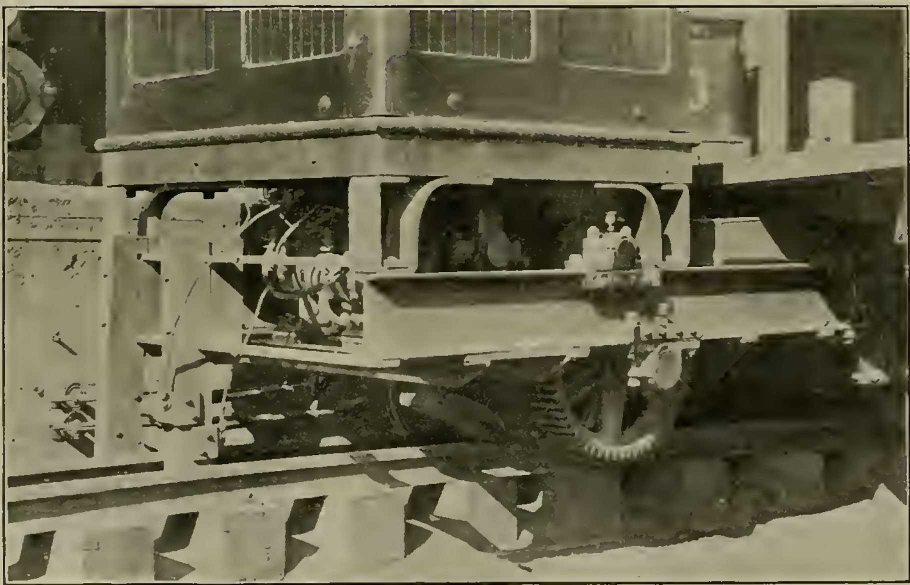


FIG. 3.

Electrically Operated Turntables.

table. 2. By trolley wires placed on the walls of the pit. 3. By an overhead device with collector rings and brushes.

The first method is by far the best, provided the design of the table permits its use. The wires from the power house are led underground and up through the center-casting to stationary collector rings. Attached to the turntable are brushes which collect the current from the stationary rings and maintain a perfect circuit, independent of the position of the turntable. This arrangement is the most simple and the least liable to give trouble. Many turntables, however, are built with center pivots cast solid, in which event the device described above cannot be employed. For a turntable of this description, the second method, illustrated in Fig. 3, is suggested. Two trolley wires, in chords of 6 or 8 ft., are

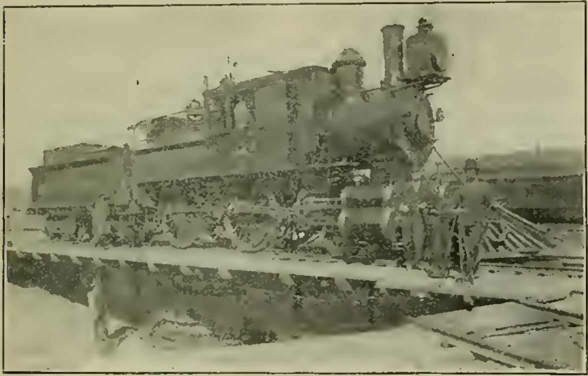


FIG. 4.

placed around the wall of the pit, supported by trolley hangers of the "toggle" type, ordinarily used in electric mine haulage. Short trolley poles are flexibly attached to the "donkey," so as to allow a horizontal movement on account of the variation in the trolley wires and a vertical movement to accommodate the tilting of the table. This scheme is simple and inexpensive and in practice has operated in a very satisfactory manner.

In some places, on account of the possibility of the pit being flooded, neither of the arrangements described above is practicable and it becomes necessary to collect the current from above the turntable. A very ingenious arrangement for this purpose has been used on a turntable at Long Island City, where the pit occasionally fills with sea water. A structure is erected at the center of the turntable and supports, directly above the pivotal point, a device embodying collector rings and brushes. Referring to Fig. 5, the case consists simply of a short piece of 8-in. steam pipe, with a regular steam cap, screwed on at each end. A bearing is provided at the top and a stuffing box at the bottom to accommodate a piece of 1-in. gas pipe, turned smooth on the outside. Attached to the gas pipe, which revolves with the table, is a hard wood insulating block with two copper rings, from which wires are led down through the pipe to the controller below. Two spring fingers, or brushes, are attached at diametrically opposite points to the inside of the iron case, which is held stationary by guy or feeder wires running to the roof of the roundhouse. The brushes are connected with the power circuit and maintain a constant connection with the collector rings. The case is filled with oil, which serves the double purpose of lubrication and insulation. The oil is an essential feature, as otherwise the insulation and contacts would be ruined by the gases and steam from the locomotives.

The cost of a turntable "donkey," similar to that shown in Fig. 2, amounts to approximately $1,000 as follows:

Single-wheel truck	$350
Electrical equipment	500
Installation, including contact arrangement	150
	$1,000

The cost of turning a locomotive by electric power depends upon the number of engines handled per day and upon the cost of the power. On one particular table, which handles 300 locomotives per day, the cost of the power is very much less than the cost of *hauling the coal* to the steam "donkey" previously employed. The following data, obtained from this installation may be of interest:

	Actual cost.	Cost at 4c. per kw. hr.	Cost at 6c. per kw. hr.
Cost of power per locomotive	$.0013	$.0034	$.0051
Cost of attendance	.0100	.0100	.0100
Total cost per locomotive	$.0113	$.0134	$.0151

The figures in the first column are an average covering six months and represent the actual cost, in this case, where the power was secured from the machine shop power plant and charged at the rate of 1.34 cents per kw. hour. The figures in the second and third columns are derived from the first column and represent the cost on the basis of rates at which power can ordinarily be purchased. From the figures above the extravagance of turning locomotives by hand is very apparent. It is by no means, however, entirely a question of expense. At an important junction or terminal, the expeditious handling of the locomotives is imperative and the advantages in this respect would usually outweigh the economy in dollars and cents.

From every standpoint turntables at busy terminals should be operated by power. The cost of power is less than that of

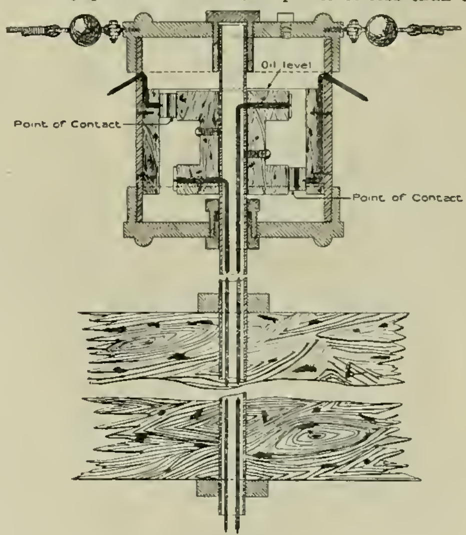


FIG. 5.

manual labor, and what is more important one man may always be depended upon to be on hand when a number of men cannot, and the saving of time is often far more important than the saving of cost of the work. Furthermore, in the winter a little snow may cause resistance to the turning of a table that is not to be overcome by even a large gang of men, whereas, a powerful motor will not be inconvenienced by it. With the present stress in locomotive service every minute counts and every important turntable should be driven by power. This principle is now accepted by progressive railroad officers.

The development of the alcohol industry in Germany is fostered by the government, because of the lack of petroleum deposits in that country. Denaturised alcohol, suitable for industrial purposes, is free from tax, whereas the alcohol for drinking is highly taxed. The result has been a great increase in the product from potatoes and other cheap sources. It has led to a development of the alcohol engine, which is important as well as interesting.

AUTOMATIC GREASE LUBRICATOR.

For Locomotive Driving and Truck Journals.

Delaware, Lackawanna & Western Railroad.

One of the most annoying and troublesome difficulties of railroad operation, and at the same time one of the most mysterious, is the occurrence of hot boxes. They are often produced by well known causes, and perhaps oftener by causes which are not known or understood. The latter are apparently not to be guarded against by usual methods. It is reasonable to suppose that a properly lubricated journal will not heat and that when one does heat it is because the surfaces for some reason become dry. Locomotive driving boxes present a difficult problem in this respect and in spite of all that has been done to avoid it they often give trouble and sometimes with serious results. Many devices have been tried for relief and yet hot journals continue. There seems to be no sure way of lubricating driving boxes with oil to insure freedom from heating.

If grease can be substituted for oil in this case, applied at the bottom of the journal, with no openings at the top of the bearing, there is reason to hope that relief may be found. Several months ago a trial of grease in this way was brought to our attention and it is, at least in the writer's experience, entirely new, although the lubrication of crank pins and other pins by grease is not at all unusual and is generally successful. We are permitted to place before our readers interesting facts concerning the development and operation of a new grease lubricator on the Delaware, Lackawanna & Western Railroad which is worthy of careful attention and investigation. The successful lubrication of the driving and truck journals of a passenger locomotive, promising 50,000 miles with one packing, at a cost of 4.3 cents per 1,000 miles, with an entire absence of hot journals, is an exceedingly important development, which has been brought about on this road under the direction of Mr. A. G. Elvin, Master Mechanic at Scranton.

Fourteen locomotives are now equipped with it, including some of the heaviest freight engines on the road, as well as passenger engines on the fastest and heaviest trains, making regularly 290 miles per day. Three of these passenger engines have been running with it since April last and in no case has there been the least trouble from hot boxes; furthermore, there has been no drop-pit work on any of these engines. Engine 977, in the accompanying record, has had an average of 9 lbs. 8 ozs. of grease applied to each box and, according to the consumption up to date, the packing should run 50,000 miles with enough left for a margin of 10,000 miles, which is the amount provided for safety to give the inspectors time to report for repacking.

The enginemen do not oil the boxes, except the shoes and wedges, and this means an important saving in time. It is the custom on many roads to pack the boxes daily and sometimes at each end of the run, in order to guard against the possibility of heating. This seems to be rendered entirely unnecessary by the plan described and the driving and truck boxes remain untouched.

Fig. 1 illustrates the lubricator applied to a driving box. Fig. 2 shows a block of grease with a follower plate under it ready to apply to an auxiliary cellar which is made of No. 16 steel with a perforated top formed to fit the journal. The follower plate is loose enough to slide easily in the auxiliary cellar and a spring urges it against the block of grease, toward the journal. The grease is fed through the perforations and comes into direct contact with the journal, maintaining at all times a generous film of grease between the perforated top and the journal. Fig. 3 is an end view of a cellar with the auxiliary cellar and grease in place. A small indicator wire protruding through the bottom of the cellar shows the position of the follower and the amount of grease in the box. When the indicator wire is flush with the bottom of the box there yet remains ¾ in. of grease at the shallowest part which, according to the records already made, should be sufficient for 10,000 miles for a passenger and 6,000 miles for a freight locomotive. In either case it is sufficient for at least a month's service after the indicator has passed out of sight. Fig. 4 shows the first experimental auxiliary cellar which was made of wood and lined with tin. It had a gauze netting on the top, next to the journal. The photograph was taken after 30,000 miles of service, in which 4 lbs. 11 ozs. of grease were consumed out of this box. Fig. 5 is the auxiliary cellar.

In using oil and waste, in the usual way, it is necessary to maintain a close fit between the cellar and the journal, in order to keep the packing in place and prevent the wasting of oil. After the engine makes considerable mileage and the brass is worn an opening occurs both in front and in the rear of the cellar, allowing waste to protrude. In many cases this catches fire from the ashpan sparks, especially on wide firebox engines, and a hot box is sure to result. With this grease device the

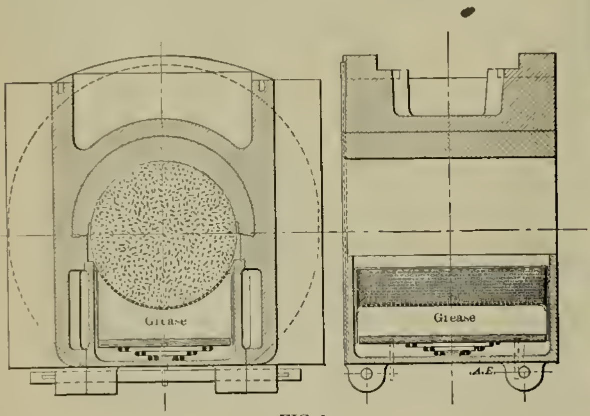


FIG. 1.


FIG. 3.

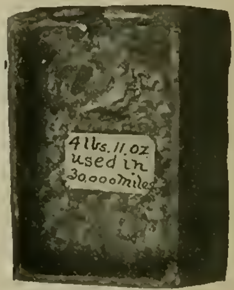


FIG. 4.

FIG. 2.


FIG. 5.

Automatic Grease Lubricator.

cellar need not fit the journal, as the auxiliary cellar is always kept against the journal by the spring. Mr. Elvin states that the engines mentioned have never given a moment of anxiety or a bit of trouble to the enginemen or roundhouse forces with reference to hot boxes since the beginning of the use of the grease. To determine the matter of wear the diameters of the journals were measured and the wear shown to be very slight considering the mileage made. This is indicated in the records below.

Statements of the records of mileage and the cost of the grease lubrication per 1,000 miles are appended. The comparison with oil is based upon the former allowance for these engines and does not take into account the oil which was ordinarily used in the roundhouse and often amounted to a relatively large item of cost. The records are as follows:

MILEAGE RECORD.

Engine. 991.	Date Applied.	Weight When Applied. lbs.	oz.	Am't Used Renew. oz.	Weight, Sept. 7th. lbs.	oz.	Miles Made.	Amount Used. oz.	Amount Used Per 1,000 Miles. oz.
Right rear	4-17-02	9	8	..	4	6	36421	82	2 1-3
Left rear	4-17-02	9	10	..	4	5	36421	85	2 1-3
Right main	4-21-02	10	..	6	4	8	35102	86	2 1-4
Left main	4-21-02	9	14	2	5	..	35102	80	2 1-3

COST RECORD.

Engine 991.	Cost of grease	$.04-3-10	per 1,000 miles.
Engine 991.	Cost of oil	.58	per 1,000 miles.
	Saved.	.53-7-10	per 1,000 miles.
Engine 977.	Cost of grease	.04-8-10	per 1,000 miles.
Engine 977.	Cost of oil	.58	per 1,000 miles.
	Saved.	.53-2-10	per 1,000 miles.
Engine 870.	Cost of grease	.10	per 1,000 miles.
Engine 870.	Cost of oil	.84	per 1,000 miles.
	Saved.	.74	per 1,000 miles.

Passenger Engines.

Eight-wheel, 20 x 26-in cylinders, diameter of driving wheels 68 ins., 185 lbs. pressure, weight on drivers 93,000 lbs.

Engine 870.

Consolidation engine, 21 x 26-in. cylinders, diameter of driving wheel 56 ins., 200 lbs. pressure, weight on drivers 162,000 lbs.

RECORD OF ENGINE NO. 870.

Engine. 870.	Date Applied.	Weight, When Applied. lbs.	oz.	Am't Used Renew. oz.	Weight, Sept. 7th. lbs.	oz.	Miles Made.	Amount Used. oz.	Amount Used Per 1,000 Miles. oz.
Right 1	4-13-02	8	2	3	6	10	12305	24	2
Right 2	4-13-02	10	2	..	7	12	12305	38	3 1-6
Right 3	4-13-02	8	..	..	6	7	12305	25	2
Right 4	4-13-02	10	2	..	8	7	12305	29	2 1-2
Left 1	4-13-02	9	..	..	7	9	12305	23	2
Left 2	4-13-02	10	8	8	8	11	12305	29	2 1-2
Left 3	4-13-02	8	8	..	6	14	12305	26	2 1-6
Left 4	4-13-02	8	8	4	6	11	12305	29	2 1-2
Truck right	4-13-02	2	15	..	1	11	12305	20	1 2-3
Truck left	4-13-02	2	14	2	1	8	12305	22	1 5-6

Diameter of right second journal March 23d, 8 5-16-in.
Diameter of right second journal September 7th, 8 19-64-in.
Diameter of left second journal April 13th, 8 7-16-in. } No wear.
Diameter of left second journal September 7th, 8 7-16-in. }
Diameter of engine truck journals April 13th, 6 in.
Wear up to September 7th, less than 1-64-in.

Note.—The amount of grease shown as used for renewal is due to changes in the gauze from the small mesh to the larger mesh.

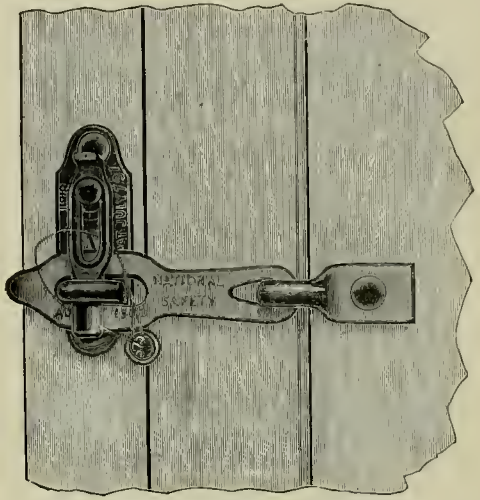
RECORD OF ENGINE NO. 977.

Engine 977.	Date Applied.	Weight When Applied. lbs.	oz.	Am't Used Renew. oz.	Weight September 7th. lbs.	oz.	Miles Made.	Amount Used. lbs.	oz.	Amount Used per 1000 Miles. oz.
Right rear	4-12 02	9	8	8	4	..	31326	5	8	2 3-5
Left rear	4-12-02	9	9	4	4	2	31326	5	6	2 2-3
Left main	4-21-02	9	8	..	4	13	31326	4	11	2 1-2
Right main	4-21-02	9	6	..	4	12	30376	4	10	2 1-2

Note.—Right back and left rear boxes changed from wood to steel box, necessitating adding eight ounces and four ounces of grease.

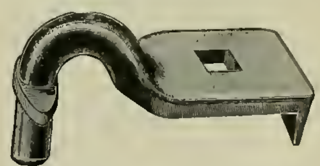
THE NATIONAL SAFETY CAR-DOOR FASTENER.

This door fastener, which is furnished complete in three pieces, has been improved and is believed to be proof against the well known practice of thieves who can pry the staple of the ordinary fastening, remove the lock and enter the car. With the ordinary hasp and staple the lock may be replaced



National Safety Car-Door Fastener.

and the door shows no indication of having been opened. With this new device, however, the door staple has a lip, as indicated in the engraving, and is secured by a bolt so that it cannot be removed. The hasp has been modified to adapt it to the new staple, but in other respects the fastening is identical with the well known National fastening and possesses all of the features of that device. The sealing pin is riveted to the staple plate and these parts go out as one piece. The riveting of the seal-



Sealing Pin and Door Staple of the National Fastener.

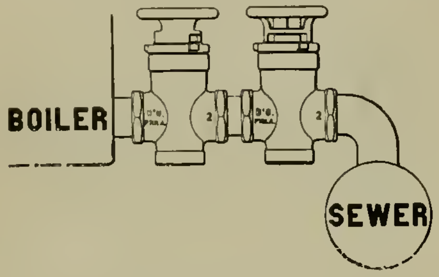
ing pin overcomes the difficulty of losing the pin and there are no chains or other loose parts to this fastener. Further information may be obtained from the National Malleable Castings Company, Cleveland, Ohio.

The Garvin Machine Company, New York, have recently issued subdivision catalogue No. 3, illustrating and describing their vertical milling machines, including their profiling machines and also their duplex milling machines. The Garvin company have adopted a very commendable practice in this respect, in that they are now informing their customers of their product by means of subdivided catalogues the various sections of which are brought up to date and issued at periodical intervals. In this way they are much better able to keep in touch with progress and give the trade prompt information regarding their improved, modernized machines. The machines described in this catalogue embrace the latest and most valuable improvements that are of advantage for those particular lines of work; yet greater improvements and further changes will be made upon them with the light of experience, and when made a new catalogue of that subdivision will be issued with respect to the latest improvements.

THE BORDO BLOW-OFF VALVE.

The Bordo valves are primarily intended to be used as blow-off valves for boilers. In this service they have proved very satisfactory and efficient. They have also given excellent service as blow-off valves on water columns and as stop valves between check valves and the boiler and between the water column and the boiler.

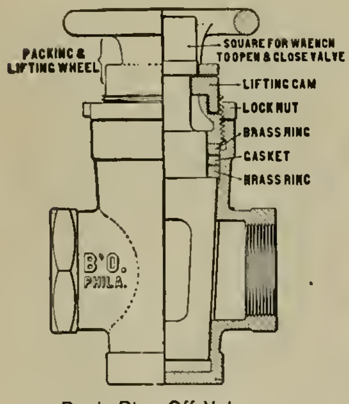
These valves are operated by means of a wrench on the square plug at the top in the hollow of the hand wheel. The hand wheel is fast to the packing gland, which when adjusted is permanently secured by a lock nut. Upon turning the hand wheel to the left the plug is lifted so that it may be easily



Duplicate Method of Connecting Bordo Blow-Off Valve to Stationary Boiler.

turned at any time. When the lock nut is turned up to the under face of the wheel a lifting cam, which couples the packing gland to the plug, may be pulled out and the gland is then free to be removed in order to repack the plug.

The accompanying part sectional engraving illustrates a straightway blow-off valve. This valve has a heavy shank, the outside diameter of which is the outside diameter of the next larger size pipe than that of the nominal dimension of the valve and discharge, thus insuring ample strength. When fitted to stationary boilers a desirable form of attachment is to



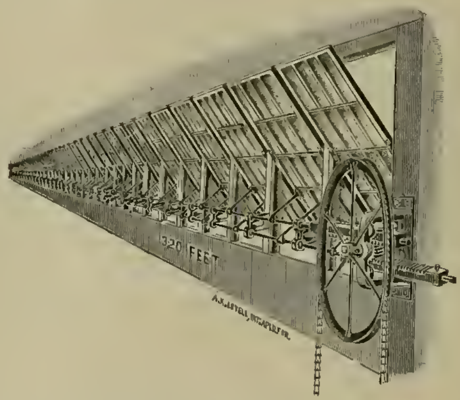
Bordo Blow-Off Valve.

place two of these valves in tandem in the blow-off pipe, as shown in the upper engraving. The valve next to the boiler is kept open except when the operating valve next to the sewer is to be packed. A special form of this blow-off valve, having a right-angle turn similar to that of an ordinary angle valve, is also made especially for locomotive use, the details of the gasket arrangement, lifting-cam, etc., remaining the same, however, as in the other form. Further information may be had from Mr. L. J. Bordo, 911 Filbert street, Philadelphia.

THE LOVELL WINDOW OPERATING DEVICE.

With the development of railroad shops into the large buildings of the present time mechanical devices for opening and closing windows are not only desirable from a labor saving standpoint but they are absolutely necessary in order to insure the prompt closing of the windows in case of storm. This becomes especially important in a building as large as 200 by 740 ft., a size which has been attained in railroad shop construction.

The devices illustrated were developed to meet this need, and one of the engravings shows a section of 320 ft. of sash operated

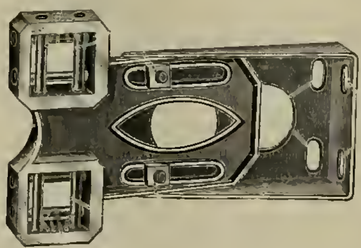


Lovell Window Operating Device.

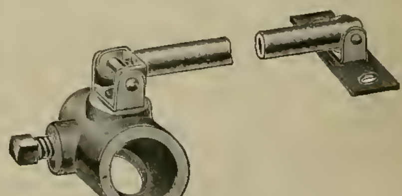
Showing Installation Controlling 320 Feet of Window Sash.

from one station. This has recently been applied in a foundry in Bridgeport, Conn., and in other large buildings in the East and West. The apparatus is strong and durable and is made upon the Lovell patents by the G. Drouve Company, Bridgeport, Conn.

The engravings show the complete fixtures for operating a line of windows, with the sash partially open. A chain driving



Bracket Receiving Side Thrust of Rods.



Toggle Connection to Window Sash

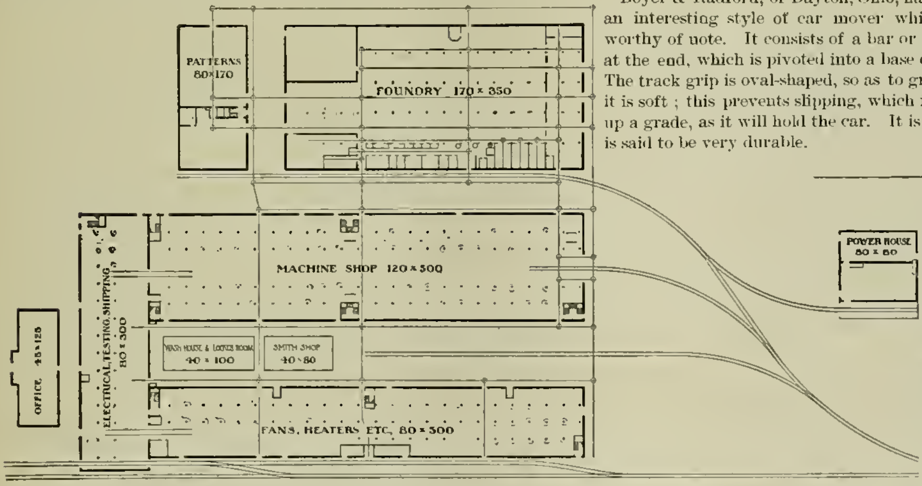
Lovell Window Operating Device.

the large wheel operates two racks, by means of a pinion between them. These racks are continued along the line of windows in the form of rods and open or shut the windows by means of toggle connections, one of which appears in the detail view. The rods move in opposite directions. The other detail illustrates one of the adjustable brackets with roller guides or bearings to carry the rods and take the thrust in opening and closing the windows. The manufacturers have brought to bear upon these devices their long experience as manufacturers and erectors of skylights and sheet metal work.

MANUFACTURING PLANT OF THE B. F. STURTEVANT COMPANY.

The new works of the B. F. Sturtevant Company, which are now nearing completion at Hyde Park, Mass., present an excellent example of carefully selected location and design for a modern manufacturing plant. The original plant at Jamaica Plain was limited in its opportunity for growth, and its capacity has long been strained to the utmost; the fire which occurred last year forced an immediate change, and the new site was selected after careful consideration of all the factors of supply of raw materials and skilled labor, and also as to shipping facilities. The new site at Hyde Park, which is only six miles from the old plant, contains 20 acres of land and has a frontage of 1,300 ft. on the freight yard of the New York, New Haven & Hartford Railroad. One side of the lot is bounded by a stream furnishing a plentiful water supply, and the adjacent shore is at a level 10 ft. below that of the yard and buildings, thus providing sufficient space for dumping waste material for years to come.

Careful consideration was given to the size and character of the buildings as to the requirements of the individual departments. Plans were made with the idea of providing a total floor space slightly more than double that of the old plant, and as conditions did not favor a group of one-story buildings, and also as simple calculations showed the actual cost of power expended in a single year for lifting the entire product of the works through a distance of 20 ft. figured only a little over a dollar, the company determined upon the building of multi-storied buildings. The arrangement of the buildings was determined by considerations of the provision for future growth.



New Plant of the B. F. Sturtevant Co.

This arrangement, illustrated in the accompanying plan, provides for a group of buildings parallel to the railroad tracks, with accommodation for switch tracks between buildings and their entrance at the ends of the building, and an abundant opportunity for growth by extensions in length.

The latest development of all-steel and concrete construction with large window areas did not appear to meet the requirements of comfort to workmen, convenience in attaching machines on hangers, etc., so that the type of building selected is composite in its character, consisting of steel interior columns and main steel girders, with heavy brick walls, wood timbered floor and plank roofs. In the case of the one-story foundry, the roof is supported by steel trusses; in the other buildings open timbering with wooden columns in the upper floor is employed. The main floor in the machine shop is of tar concrete, with spruce and maple flooring. The upper floors are carried upon wooden beams spanning the spaces between the steel girders, which follow a unit system of 20 ft. on centers through the building. All roofs are of 3-in. plank, with tar and gravel top.

For power it was decided that the entire plant shall be electrically driven from a central power house, the engines to run condensing, and the exhaust steam from the engines to be utilized for heating, with supplementary supply of live steam admitted at reduced pressure as required.

The equipment of this plant will involve many interesting features as to the product of the Sturtevant Co. Beginning with the power plant, Sturtevant mechanical draft apparatus, instead of natural draft, will be used. The buildings will be heated by a Sturtevant hot-air system, the shafting and individual machines driven by motors of the same make, the refuse from the wood-working machinery, the dust from the cleaning room of the foundry, and the removal of smoke from the smith shop will be accomplished by Sturtevant exhaust fans, while Sturtevant blowers will be used for brass and iron foundry, forge-shop blast and the like, and Sturtevant steam traps will be employed upon the steam driers. The engines and generators in the power plant will also be of Sturtevant make.

EQUIPMENT AND MANUFACTURING NOTES.

The Russell Car and Snow-Plow Company are building new shops at Ridgway, Pa., where they will in the future manufacture the well-known Russell snow plows and flanges, and special freight and miscellaneous cars, instead of at Boston as formerly.

Boyer & Radford, of Dayton, Ohio, have recently placed on the market an interesting style of car mover which involves several advantages worthy of note. It consists of a bar or lever of solid tool steel, hardened at the end, which is pivoted into a base or track grip of malleable iron. The track grip is oval-shaped, so as to grip the rail on the corners, where it is soft; this prevents slipping, which is of advantage in moving cars up a grade, as it will hold the car. It is well-built and is powerful, and is said to be very durable.

The Chicago Pneumatic Tool Company report that on account of the large amount of business they are receiving from the Southwest they have been obliged to again place a representative in that district, having located their Mr. W. C. Walker in St. Louis, with headquarters at 325 Lincoln Trust Building, which arrangement will facilitate handling the volume of business received from that territory.

The Barber truck, sold by the Standard Car Truck Company, Chicago, is to be used under the following new equipment: Seven hundred and fifty 50-ton hopper cars for the Norfolk & Western Railway, now building at their plant at Roanoke, Va.; 1,000 gondola cars for the Erie Railway, to be built by the Standard Steel Car Company, of Pittsburgh, for January 1, 1903, delivery; 1,300 cars for the Chicago, Milwaukee & St. Paul Railway, now being built by them at their West Milwaukee car works; 75 30-ton box and flat cars for the Duluth & Iron Range Railway, to be built by the Western Steel Car and Foundry Company for November delivery; 1,000 30-ton flats and 500 30-ton box cars for the Canadian Pacific Railway, to be built by car plants in Canada; and 2,500 cars for the Central Railroad Company of New Jersey.

Mr. B. F. Pilson, general contracting agent of the Ajax Metal Company, has removed from Richmond, Va., to Washington, D. C., where his headquarters will be in the Sun Building.

BOOKS AND PAMPHLETS.

Proceedings of the Western Railway Club. For the club year 1901-1902.

This volume comes as an annual reminder of the sensible and dignified policy of this organization in placing in the hands of every member a bound volume of the proceedings of the year. This seems preferable to the use of the funds for less permanent and profitable purposes. This plan, furthermore, influences the character of the work of the club, because its papers and discussions are known to be part of a permanent record. It should be adopted by the other clubs. These volumes are uniform with the Master Mechanics' and Master Car Builders' proceedings as to form and size, and are close to them in value and importance.

Materials of Machines. By Albert W. Smith, Professor of Mechanical Engineering, Leland Stanford University; 142 pages; illustrated. John Wiley & Sons, 43 East Nineteenth street, New York. Price $1.00.

As stated in the preface, "This book is the result of an effort to bring together concisely the information necessary to him who has to select materials for machine parts." It has five chapters and an index, the subjects being as follows: Outline of the metallurgy of iron and steel, testing, stress-strain diagrams, wrought-iron and steel and alloys. Too much can hardly be said in praise of this little book. It gives the information needed in using materials in designing machines, and is compact and concise. The engineer will read it with advantage and it is an excellent text book for the student.

American Railway Master Mechanics' Association. Proceedings of the Thirty-fifth Annual Convention, 1902. Published by the association. Edited by the secretary, J. W. Taylor, Rookery Building, Chicago.

This volume is the best issued by this association in a number of years. The subjects of the papers are important and interesting, and the engravings throughout the book are the best to be found in all of the volumes issued. In addition to the rules, records of resolutions and standards, the book contains a number of valuable papers and reports. Among these the following are specially worthy of mention: A paper on "Electric Driving for Shops," by C. A. Seley; a report upon "Up-to-Date Roundhouses," a report upon "Present Improvements in Boiler Design and Best Proportions of Heating and Grate Surfaces for Different Kinds of Coal"; a paper on "A Typical Shop to Serve a Road Having 300 Locomotives," by L. R. Pomeroy, and a paper on "Modern Water-Supply Stations for Locomotives," by F. M. Whyte. The volume has 453 pages and an index. The activity of the secretary in getting out these annual volumes is noteworthy. To produce such a satisfactory work of such a character in nine weeks after the close of the convention is a task worthy of praise and appreciation.

The Lunkenheimer Company, Cincinnati, Ohio, have issued a revised edition of their 1898 catalogue involving several changes of list prices. This catalogue illustrates and describes, as is probably well known, brass and iron valves of all types, injectors, whistles, lubricators, oil and grease cups and steam specialties. The Lunkenheimer Company report that great interest is being taken in their "Duro" boiler blow-off valve which was recently placed upon the market; this valve is so built that no scale or sediment can lodge on its seat, and will prove very durable.

"Twenty-fifth Anniversary of the Compound Locomotive." An interesting pamphlet bearing this title has been received from the author, Mr. A. Mallett, of Paris, commemorating the twenty-fifth birthday of the compound locomotive. Mr. Mallett was the first to place the compound in practical form, his first engine having been put into service on the Bayonne & Biarritz Railway, June 2, 1877. This engine was of the two-cylinder type. In twenty-five years the number in use has become nearly 15,000, of which about two-thirds are of the two-cylinder type. Of this number, more than 500 of the author's articulated, four-cylinder type have been successfully placed in service. The address of Mr. A. Mallett is 30 Avenue Trudaine, Paris, France.

Mr. W. F. DeGarmo, Eastern representative of the Falls Hollow Staybolt Company, has changed his headquarters from 3116 Clifford street, Philadelphia, to 60 West Ninety-third street, New York.

The Robert Aitchison Perforated Metal Company, Chicago, Ill., have issued a pamphlet on perforated metals, showing the various general types of perforations made by them in all kinds of sheet metal and for all purposes Over 600 varieties are standard with this company, while any special size or shape of perforation may be had from them.

A catalogue of "Metropolitan" Injectors has recently been received from the Hayden & Derby Mfg. Company, 85-89 Liberty street, New York. The Metropolitan, Automatic, "1898" and double tube types of injectors, as well as ejectors and jet apparatus, are illustrated and described. Also considerable information is given regarding their operation.

"Packing Sense" is the title of a pamphlet that has been gotten out by the United States Metallic Packing Company, Philadelphia, Pa., intended for those who are now using United States metallic packing. It is a very well-written, concise statement of the principle and details of this packing and sets forth many points to be looked after for the best results with it. The company desires that all persons interested in the care and maintenance of their packing shall have a copy, and will send same on request.

"Three Electric Cars of the Most Advanced Type" is the title of a beautifully designed and illustrated circular recently issued by the J. G. Brill Company, Philadelphia, Pa. The three patented cars made by this company, covering practically the whole field of electric passenger service, are very fully illustrated and described—first, their "semi-convertible" car; second, their "convertible" car, and then their "Narragansett" style open summer car. The "convertible" car made by this company should be received very favorably by the street-railway companies, as it combines in a most convenient manner the advantages of both the open and the closed cars, and thus, if used exclusively, would reduce the rolling equipment of a road by nearly one-half.

An illustrated descriptive pamphlet of great interest has recently been issued by the Rand Drill Company, New York, entitled: "New York Rapid Transit Tunnel." It is a large 55-page, 9x11 inch book, beautifully illustrated with views of all sections of the tunnel showing the various processes of construction, together with the progress up to date. In the construction of this important tunnel a great deal of rock was met and had to be cut through, and for this purpose numerous large air compressor plants were installed and are still in operation furnishing compressed air for the thousands of rock drills used—all the compressor plants, as well as the rock drills, being furnished by the Rand Drill Company. The enormity of this wonderful undertaking is comprehensively set forth by the beautiful half and full page half-tones with which the pamphlet is profusely illustrated; this tunnel easily distances any undertaking of its kind ever made, and the work done by the Rand Drill Company's apparatus is certainly a credit to them.

Destruction of property by fire is universally dreaded, and yet it constitutes one of those ever-present dangers which often lead to neglect of the most ordinary precautions. Attention should be given to the fire-protection equipment of shops so that it will be known to be always in first-class condition; but one must be impressed with the neglect of this important precaution in visiting railroad shops. It is not so among the mills and factories of New England and elsewhere under the jurisdiction of the Associated Factory Mutual Insurance Companies and the National Fire Protection Association. Such plants are obliged to equip with fire hose which fully meets the requirements of these organizations. A circular has just been received from the Boston Belting Company which directs attention to this important subject and illustrates the American Underwriters' cotton and linen fire hose. The cotton hose is for outside use on portable reels and on yard hydrants. It is made in 50-ft. lengths, of woven material, lined with rubber. The linen hose is for inside use in cases requiring the hose to be hung up in warm rooms or corridors. It is light, compact and convenient, and is made in any desired length. Both of these brands are made to conform with the requirements of the two companies referred to, and both are accepted and recommended by them. The address of the Boston Belting Company is 256 Devonshire street, Boston, Mass.

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AMERICAN ENGINEER TESTS.

LOCOMOTIVE DRAFT APPLIANCES.

XII.

Report by Professor W. F. M. Goss.

SECTION V.

(*Continued from Page* 331.)

33. Stacks and Exhaust Pipes.—Photographs giving a general impression of the form and character of the stacks and exhaust pipes chiefly experimented upon, have already been presented as Figs. 2, 3 and 4. A more complete definition of the sectional stacks especially designed for the experiments is shown by Fig. 26. The experimental stacks were of four different diameters, each diameter having a base of more or less taper. This base constituted the shortest length of stack employed. Increased length was obtained by the addition of 10-in. sections.

The notations in Fig. 26 are the same as are employed in connection with the presentation and all discussion of data. A No. 7 stack is a straight stack 15¾ ins. in diameter. A No. 7-A stack is a stack 26½ ins. long, while a No. 7-D stack is a stack 56½ ins. long. Similarly, a No. 8-A is a taper stack 15½ ins. in diameter at the choke and 26½ ins. long. A comprehensive definition of the stack terms used in connection with the data is presented as Table V.

TABLE V.
Stack Dimensions.

1 Designation.	2 Form.	3 Smallest Diameter, Inches.	4 Total Height, Inches.	5 Distance from Center Line of Boiler to Top of Stack.
Base No. 1		9¾	16½	45 1-16
1-A	Straight	9¾	26½	55 1-16
1-B	Straight	9¾	36½	65 1-16
1-C	Straight	9¾	46½	75 1-16
1-D	Straight	9¾	56½	85 1-16
2-A	Taper	9¾	26½	55 1-16
2-B	Taper	9¾	36½	65 1-16
2-C	Taper	9¾	46½	75 1-16
2-D	Taper	9¾	56½	85 1-16
Base No. 2		11¾	16½	45 1-16
3-A	Straight	11¾	26½	55 1-16
3-B	Straight	11¾	36½	65 1-16
3-C	Straight	11¾	46½	75 1-16
3-D	Straight	11¾	56½	85 1-16
4-A	Taper	11¾	26½	55 1-16
4-B	Taper	11¾	36½	65 1-16
4-C	Taper	11¾	46½	75 1-16
4-D	Taper	11¾	56½	85 1-16
Base No. 3		13¾	16½	45 1-16
5-A	Straight	13¾	26½	55 1-16
5-B	Straight	13¾	36½	65 1-16
5-C	Straight	13¾	46½	75 1-16
5-D	Straight	13¾	56½	85 1-16
6-A	Taper	13¾	26½	55 1-16
6-B	Taper	13¾	36½	65 1-16
6-C	Taper	13¾	46½	75 1-16
6-D	Taper	13¾	56½	85 1-16
Base No. 4		15¾	16½	45 1-16
7-A	Straight	15¾	26½	55 1-16
7-B	Straight	15¾	36½	65 1-16
7-C	Straight	15¾	46½	75 1-16
7-D	Straight	15¾	56½	85 1-16
8-A	Taper	15¾	26½	55 1-16
8-B	Taper	15¾	36½	65 1-16
8-C	Taper	15¾	46½	75 1-16
8-D	Taper	15¾	56½	85 1-16
Normal	Taper	14	48	75 9-16
Sliding	Straight	13¾	26½ to 56½	56 1-16 to 85 1-16

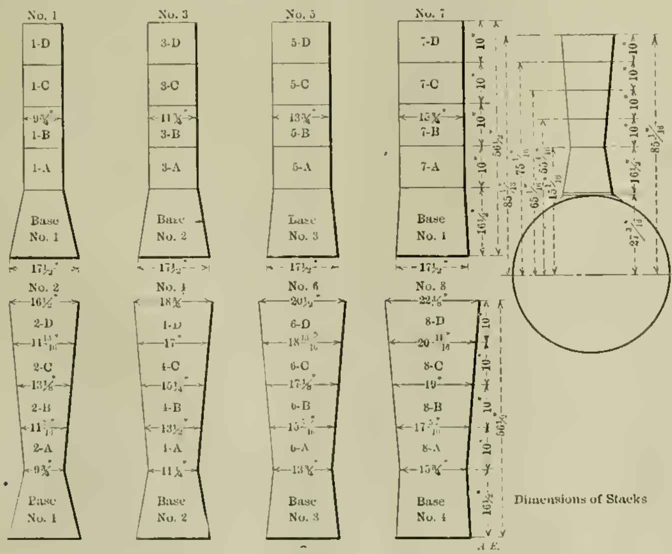


FIG. 26.

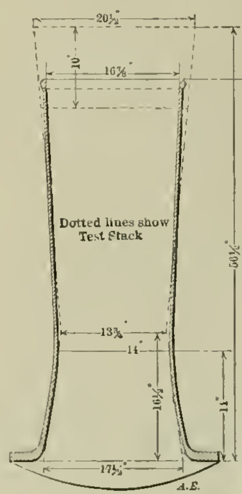


FIG. 27

The normal stack, which was supplied by the builders of locomotive Schenectady No. 2, with the engine, was subjected to the same tests as the sectional stacks. Its dimensions, compared with those of the 6-D and 6-E stack, with which its form most nearly agrees, is shown by Fig. 27.

The experimental exhaust pipes and nozzles, with the reference numbers which are always employed therewith are shown

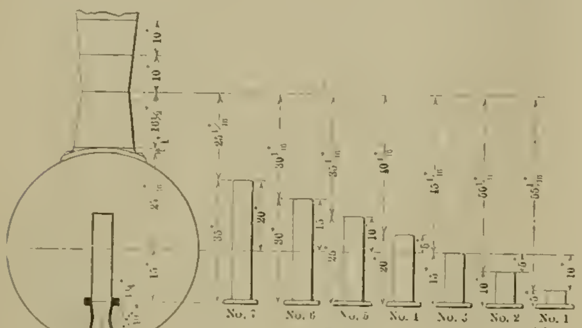


FIG. 28.

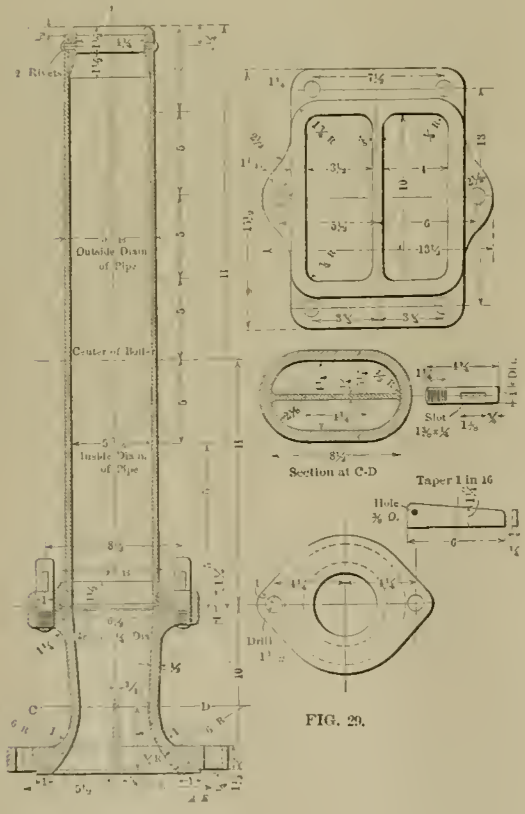


FIG. 29.

by Fig. 28. Thus, No. 1 pipe or nozzle is 5 ins. high upon a 10-in. base, while nozzle No. 7 is 35 ins. high upon a 10-in. base. While these will hereafter be referred to as nozzles, they really combine in one design a pipe and nozzle, as will be seen by the drawing representing their construction, Fig. 29. All nozzles were used upon the same base which, as shown, was 10 ins. in height.

34. Results.—While an array of figures presents few attractions for the average reader, the significance of the present work is such that it seems wise to include in this report, for future reference, as well as for the benefit of the present-day student of stack design, a complete record of the data obtained. Following this will be found such summarized statements of the facts disclosed as will serve those who have little time in which to follow an elaborate array of details.

The results, representing more than a thousand distinct tests for each of which the locomotive was at least once started, brought with great precision to a specified condition of running, and stopped again, are for convenience arranged in eight tables, numbered from VI. to XIII. inclusively, which follow.

(To be continued.)

PIECEWORK IN A LOCOMOTIVE ERECTING SHOP.

Suggestions Based Upon Successful Experience.

By J. Komo.

Strange as it may seem at this late day, many mechanical railroad men argue that piecework cannot be successfully introduced into a locomotive erecting shop on account of the many complications arising daily. They are honest in their opinions and these should be given due consideration, but when they once seriously undertake to solve the problem they will ask themselves the question, Why they did not do this before? Here are a few quotations by a well-known author which it may be well for us to study when preparing to put an erecting shop or any other department on a piecework basis:

"Before we change our action we have to change our ideas of the things toward which we act; our idea of the thing directs our action toward it. If our idea of the thing is right, our action toward it will be right; if our idea of the thing is wrong, our action toward it will be wrong. It is a rule to which there is no exception. There is only one way by which we can acquire knowledge of anything, and that is to first get an imperfect idea of it, then a more perfect one, and so on until our idea of it is complete."

Before starting piecework in the locomotive erecting shop the shop should be carefully systematized, and, where possible, work assigned to certain men. This is now done in many day-work shops, and has proved to be a good way of handling the erecting shop work. Shoes and wedges should be considered as one job; guides, steam chests, pistons, boring out cylinders and all that pertains to this class of work should be another; fitting cylinders, chipping cylinder saddles, and everything that pertains to this class of work should be another; cab work and framing should be another, and replacing drivers and trucks and everything that pertains to it should be another, and so on. Certain men should be assigned to general work—meaning jobs that cannot be consistently grouped. As far as practicable, stripping should be done by the men who are to replace the work, as they will then know the conditions the work is in when it came down, and will be better able to order parts for renewal, and will take more interest in doing the work if they know they are to replace it. Many other subdivisions of the work may be made when in the foreman's judgment it is wise. It is understood that men to have special jobs will look after them all the time on every engine that goes through the shop and not wait to be told by the gang boss or foreman. The foreman, of course, will have the same control of the shop that he always had, and will indicate the engines he wants first and call attention to anything that pertains to the work, but as long as affairs run along to his liking and smoothly, probably he will not say anything to the men from one end of the week to the other. Special men soon learn to watch the work with as much interest as the foreman, because the faster the work moves along the more money they make.

There should be a piecework inspector in a shop where there are 40 or more men employed. If there are a smaller number than this, one piecework inspector will handle the entire machine shop, machines and erecting, too. The piecework inspector in the erecting shop should be a practical, first-class machinist and thoroughly competent to pass on work, and a man who is absolutely reliable and absolutely fair. He should, as far as practicable, see every job that he pays for, and if it is not satisfactory he should try to readjust it with the men who did the work, and when he cannot do this he should call the foreman's attention to it, as he is in no way to interfere with the duties of the foreman.

If the shop is systematized as outlined, a careful record should be made of the time it takes to perform the different operations, and when enough information has been secured to warrant it, this should be carefully analyzed by the foreman, gang boss and piecework inspector. Each operation must be studied very carefully from a commercial standpoint; those in charge of piecework should figure what they would pay for the work if they owned the road, remembering that there are clearly two sides to the question, and that the men have rights as well as the company. In case of doubt on any job it would be well to do the work over again and take the record a second time.

It will not do to base piecework prices on the record of an exceptionally fast man or on work done under forced effort, as when this man works on piecework he is expected to largely increase his earnings. Neither will it do to base the piecework price on the slowest man, as that would be unfair to the company. Experience will soon determine just where to draw the line in these cases. If the men can be made to feel that their interests and those of the company are the same and if they can be consulted to make these prices, a great deal of trouble is avoided.

Care should be used to specify just what is intended to be done for a given price, leaving no room for doubt. This will at first be very difficult, but in time one will be enabled to cover this point very clearly. The officers should insist on first-class work and make the prices high enough, so that the men can do it as it ought to be done, because poor work is expensive at any price.

If an erecting shop is properly handled on a piecework basis it is one of the most satisfactory departments in a large railroad shop, both for the company and the men. It means increased output and decreased cost for the company, and better wages for the men and more agreeable positions. Many little squalls will come up in starting the department—some things will be unfair to the company and some to the men—but time and patience and the desire to do the right thing on both sides, and a clear understanding that this is the desire, will soon straighten matters out.

A few sample pages of a locomotive erecting shop schedule which has been in successful use for several years will form the subject of another article on this subject.

LIQUID FUEL.

Burners Which Do Not Atomize.

[Editor's Note.—The writer of this article has had wide experience in the use of oil as fuel for heating and welding burners and has been very successful.]

Fuel oil has long been recognized as a fuel that possesses many advantages over coal. It contains more heat-producing power than an equal weight of any other material that exists in large quantities, and containing no ashes, every portion may be burned to produce heat.

There is no doubt that the unsatisfactory results obtained by many who have used a liquid fuel has retarded its use, mainly owing to the fact that it has been proved to them that they were not getting the heat-producing efficiency from the fuel that it is supposed to be capable of giving.

Several hundred patents have been issued in this field in the past few years, and invariably the patentee has aimed to produce a burner that would atomize the fuel—in other words, one that would break the oil up into minute particles, so that when brought into combustion with the necessary oxygen it would be evenly distributed and minute enough to form the necessary chemical combination for perfect combustion.

Failures of this class of burners have been frequent, due in many cases to the fact that the combustion does not take place until the vapor or mixture is a considerable distance from the burner. In other cases, failure has resulted from relying upon the temperature of the furnace to obtain perfect combustion.

Fuel oil contains from 19,000 to 22,000 B. T. U. per lb., and from the best practice we find it necessary to supply this fuel with from 20 to 24 lbs. of air. It must be supplied in such proportion as will result in a bringing together of the right proportion of the gases at the right time to obtain the desired result—perfect combustion. If this is accomplished, we have a fuel that whereas its theoretical efficiency over coal is only 45 per cent., yet has a calorific energy more than 60 per cent. greater than bituminous coal. In the cases where it has been attempted to burn a liquid fuel by atomizing and burning it in the chamber in which the work has to be done, either heating material or raising steam, the results have shown a woeful difference between the efficiency obtained and the supposed efficiency of the fuel. This is due, no doubt, to the hydrocarbons passing off without giving up the heat units contained therein.

Many attempts have been made to obtain the full efficiency by having the oil undergo a preliminary treatment to convert it into a gas or vapor before trying to burn it. The failures of these gas generators have been common, and have done much to retard the use of oil in shops. Among the many types of oil burning devices placed on the market during the past few years, there is one system of oil furnaces that has many new features, inasmuch as the oil is not atomized, but is simply brought into combustion with a quantity of oxygen or fan blast. Partial combustion takes place, and the hydrocarbons burn on their way up a vertical combustion chamber; on reaching the top they come into combination with a further supply of air. The fuel is now in a state of perfect combustion; the oil and air supply, which are independent and under the control of the operator, can be regulated to a nicety. The manufacturers of these furnaces claim to obtain perfect combustion, as they have a number of welding heat furnaces in use for such work as welding tubes, small forging, etc., etc., in which the material has to be handled very rapidly, and in a perfect heat. Presumably they must have an improved system of combustion.

Liquid fuel, like other innovations, is a subject that requires thought, time and experience to perfect its use, and it is not only necessary to provide for a perfect combustion, but the furnace must be designed on correct principles, so that the greatest use may be made of the heat, and the number of important economies over coal or coke will not be fully realized until such properly designed oil furnaces are in use. It will then be found that by far the greatest economy will not be through a reduction in the cost of fuel, which should be from 25 to 50 per cent., depending upon the cost of oil, but in the increased output made possible by the use of this fuel. Its capacity for doing work should range all the way from 50 to 300 per cent. more than coal or coke, which means a big reduction in shop cost.

This increase in output is made possible by the perfect and easy regulation obtained with oil. The time of the men is wholly given to their work, and not to tending their fires. The uniform heat and absence of oxidation of the metal insures that each piece is heated in a perfect manner, and no material is lost through faulty heat treatment. No fuel is required when the furnace is not doing useful work. There is a further advantage in that no labor is required for bringing fuel to and removing ashes from the furnace, which is necessary in the use of coal or coke. Oil also contains little or no sulphur or phosphorus to attack the metal heated, and with the perfect combustion that should be made possible by the use of oil fuel, the metal is not injured in any way by being heated. Especially for such work as welding, the perfect combustion and absolutely clean fire made possible by the use of a liquid fuel, should certainly bring this fuel to the front for shop purposes. It should be remembered that the output of a blacksmith shop is not the capacity of the forging machines, but rather the capacity of the furnaces to supply the material in such a condition that it may be handled rapidly.

Two-Cylinder Compound Ten-Wheel Locomotive.—Canadian Pacific Railway.

E. A. WILLIAMS, *Supt. of Rolling Stock.* AMERICAN LOCOMOTIVE CO., SCHENECTADY WORKS, *Builders.*

TWO-CYLINDER COMPOUND LOCOMOTIVES.

Canadian Pacific Railway.

4-6-0 Type.

Double-Ported Piston Valve on Low-Pressure Cylinder.

This is the most recent development of the two-cylinder compound for passenger service. It employs piston valves with outside admission and the usual form of valve motion, and has a double-ported valve for the low-pressure cylinder. This valve was developed at the Schenectady works of the American Locomotive Company several years ago, and was recently applied also to a two-cylinder compound on the Chicago & Eastern Illinois. Its purpose is to provide double admission and double exhaust ports to the low-pressure cylinder, to secure easy entrance and exit for the steam, and also to secure a perfectly balanced valve for this cylinder. The construction of the valves and the cylinders is made clear by the engravings. This valve should enable the engine to run at high speed, and if there is any foundation for the claim that this type is handicapped in speed, this design ought to overcome it. Thus far there has been no attempt on the Canadian Pacific to determine this point. To reduce the braking effect of the low-pressure piston in drifting, the low-pressure cylinder is fitted with two large, automatic, by-pass valves, which appear in the photograph. The American Locomotive Company and the mechanical officials of the Canadian Pacific are apparently of the opinion that the two-cylinder compound has not yet reached the limit of its development.

Two-cylinder compounds are not, as a rule, handsome, but this is an exception. The Canadian Pacific tender and cab, with curved outlines, together with the piston valves, make a really attractive combination. The following table of dimensions will be convenient for reference:

Two Cylinder Compound Passenger Locomotive.

4—6—0 Type.

Canadian Pacific Railway.

General Demensions.

Gauge	4 ft., 8½ in.
Fuel	Bituminous coal
Weight in working order	168,000 lbs.
Weight on drivers	124,000 lbs.
Wheel base, driving	14 ft., 10 in.
Wheel base, rigid	14 ft., 10 in.
Wheel base, total	25 ft., 11 in.

Cylinders.

Diam. of cylinders	22 in. and 35 in.
Stroke of piston	26 in.
Horizontal thickness of piston	H. P., 5¾ ; L. P., 4⅛ in.
Diam. of piston rod	3¾ in.
Kind of piston packing	Cast-iron rings
Kind of rod packing	Metallic

Valves.

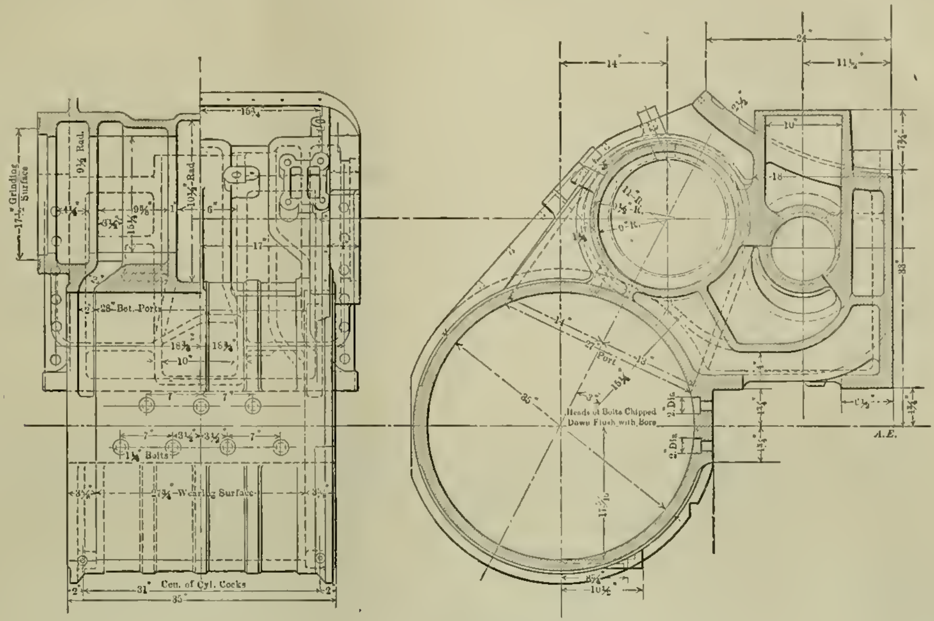
Kind of slide valves	Piston type
Greatest travel of slide valves	6 in.
Outside lap of slide valves	H. P. 1¼ ; L. P., 1 in.
Inside lap clearance	H. P., ¼ ; L. P., ⅜ in
Lead of valves in full gear	Line and line
Kind of valve stem packing	Metallic

Wheels, etc.

Diam. driving wheels outside of tire	69 in.
Material of driving wheels, centers	cast steel
Tire held by	Shrinkage
Driving box material	Cast steel
Diam. and length of driving journals	9 in. diam. × 12 in.
Diam. and length of main crank pin journals	7 in. diam. × 6½ in.
Diam. and length of side rod crank pin journals, main side	7½ in. × 4 ¾ in.; F. & B. 5 in. dia. × 4½ in.
Engine truck, kind	4-wheel swing bolster
Engine truck journals	6 in. dia. × 10 in.
Diam. of engine truck wheels	30 in
Kind of engine truck wheels	Steel tired ; cast-iron spoke center

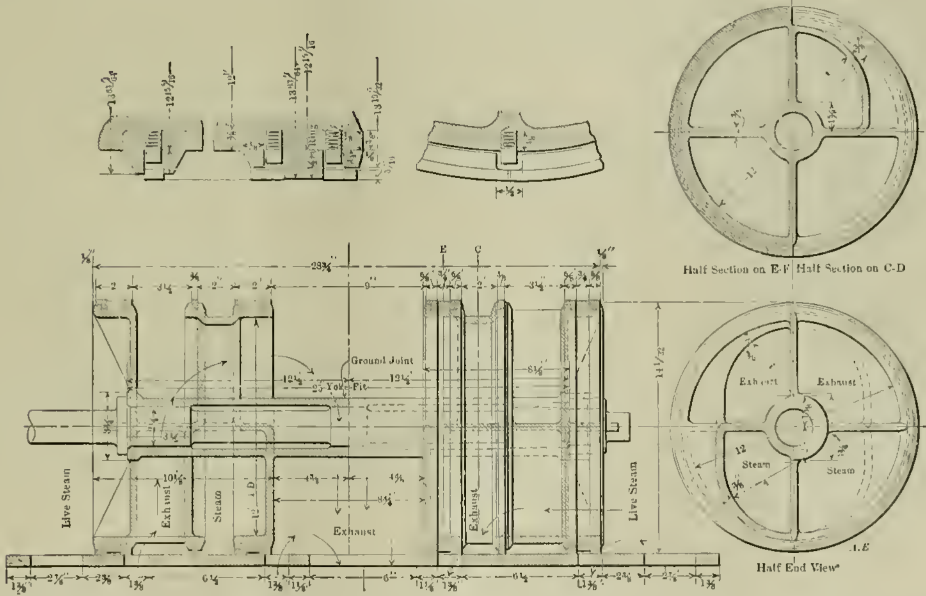
Boiler.

Style	Wagon top
Outside diam. of first ring	62½ in.
Working pressure	210 lbs.
Material of barrel and outside of fire box	Steel
Thickness of plates in barrel and outside of fire box	½ and ¾ in.
Fire box, length	108 in
Fire box, width	41 in.
Fire box, depth	F. 76½ ins., B. 64½ ins.
Fire box, material	Steel
Fire box, plates, thickness	sides, ⅜ in.; back, ⅜ in ; crown, ⅜ in.; tube sheet, ½ in.
Fire box, water space	front, 4½ and 5 ins.; sides, 3½ and 4 ins.; back, 3½ and 4½ ins.
Fire box, crown staying, radial	1⅛ ins. diameter
Fire box, stay bolts, iron	1 in. diameter
Tubes, number of	312



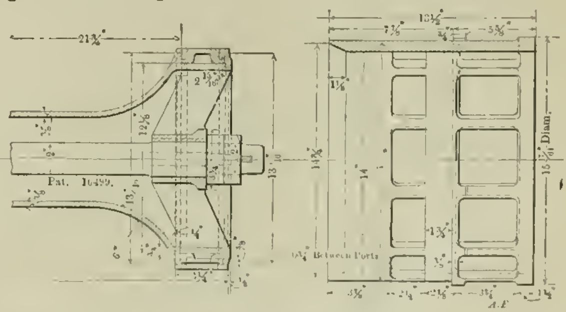
Part Section of Valve Chest. Cross Section.

Low Pressure Cylinder.



Low Pressure Valve Shown Against Its Bushing.

Tubes, diameter	2 ins.
Tubes, length over tube sheets	14 ft. 0 in.
Heating surface, tubes	2273.3 sq. ft.
Heating surface, fire box	171.96 sq. ft.
Heating surface, total	2445.26 sq. ft.
Grate surface	30.71 sq. ft.
Exhaust pipes	Single
Exhaust nozzles	5¼ ins., 5½ ins., 5¾ ins. diameter
Smoke stack, inside diameter	16½ ins. by 14¼ ins.
Smoke stack, top above rail	14 ft. 5¾ ins.
Tender.	
Weight, empty	50,500 lbs.
Wheels, diameter	40 ins.
Journals, diameter and length	5½ ins. diameter by 10 ins.
Wheel base	17 ft. 4½ ins.
Tender frame	10-in. steel channels
Water capacity	5,000 imp. U. S. gallons
Coal capacity	7½ tons
Total wheel base of engine and tender	54 ft. 6 ins.



High Pressure Valve and Bushing.

Two-Cylinder Compound Ten-wheel Locomotive.—Canadian Pacific Railway.

NEW LOCOMOTIVE AND CAR SHOPS.

Collinwood, Ohio.

Lake Shore & Michigan Southern Railway.

III.

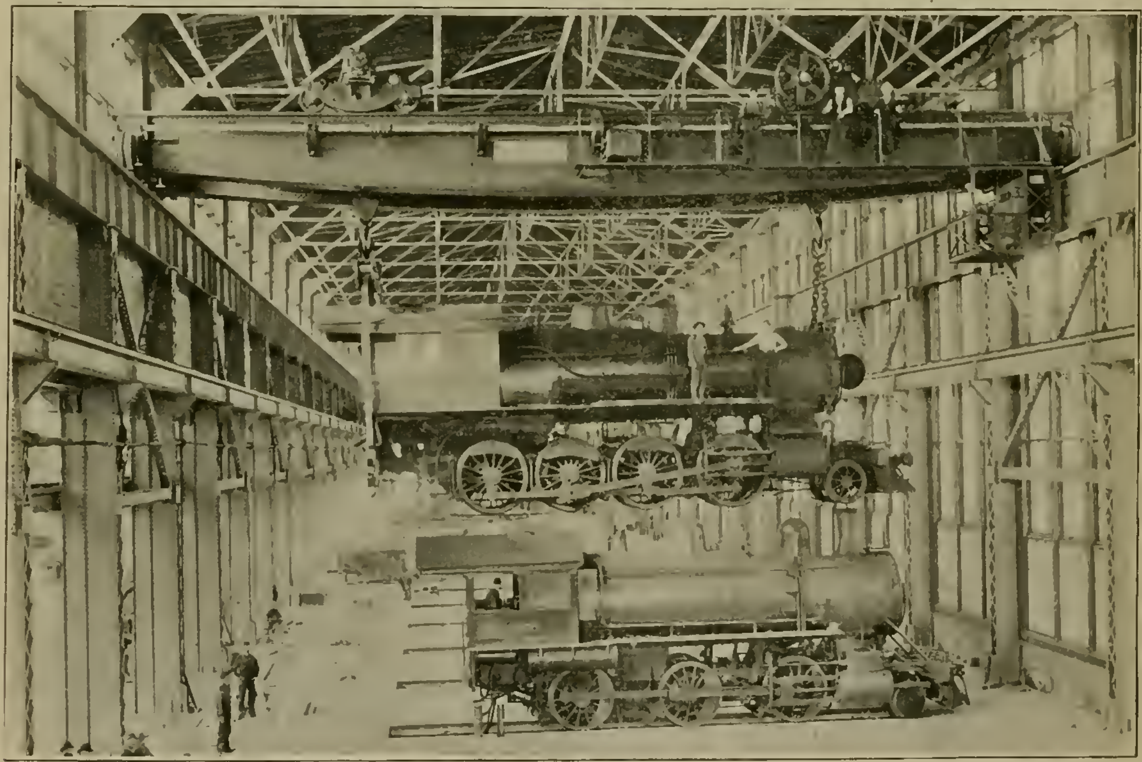
The Locomotive Shop Building.

On pages 300 and 301 of our October issue exterior views and a section of the locomotive shops of the Collinwood plant of the Lake Shore & Michigan Southern Railway were presented, together with interior and exterior construction views. In this number additional details of interest are shown with regard both to the side framing and to the roof construction, and also the equipment of the building. The framing supports are substantial steel piers placed on ample foundations of stone; they are designed of plates and angles in such a way as to support the roof and the crane girders independently, and also provide for the window framing. In the detail views on page 367 the dimensions and construction of the piers are clearly shown. These were designed with reference to simplifying the construction by using 23 units exactly alike in the outside wall of the erecting shop and making the units of the other walls so that they also could be alike along the entire length of the building.

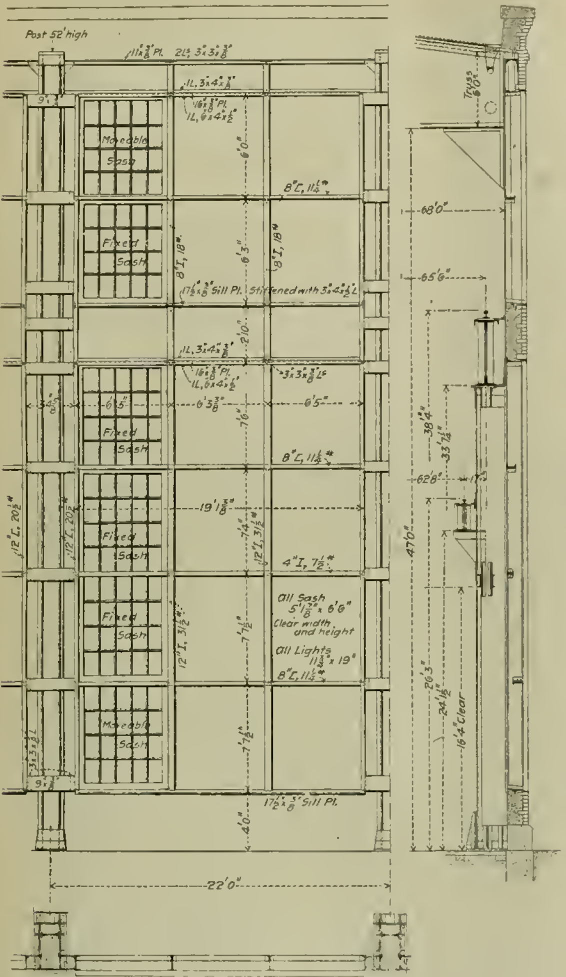
In the outside walls there are two intermediates between the main piers, with 12-in. mullions for the windows. The glass of the windows begins 4 ft. from the bottom of the wall, and there are about 30 ft. of glass here and then 3 ft. of brick wall, surmounted by 12 ft. 6 ins. more of glass. The support of this intermediate brick wall and the one in the division wall on the opposite side of the erecting shop is shown in one of the detail engravings, and the large proportion of glass in this building relative to the wall area was stated in the table on page 304 of the October number. The large side window areas are 19 x 30 ft. each in the lower sections and 19 x 12 ft. each above, these being repeated the entire length of the building. The windows in the top of the division wall between the erecting and machine shops, above the intermediate section of brick, are 19 x 12 ft. each, repeated the entire length, as on the opposite side. The details of construction of both the side framing and the windows of the erecting shop are very clearly shown in the interior view below and on page 367.

The steel work is provided with bracing in alternate bays, with expansion bays between, like a trestle. At the end of the boiler shop is a 30 x 35-ft. riveting tower, carried on a special roof truss extending across the building, and on a box girder reaching the length of two bays longitudinally. In the entire building the steel work was erected independently of the brick work. In the detail drawing of the steel columns the particular care in arranging the size to exactly take the brick facing is made evident, as is also the method of filling the columns with concrete, which is of a mixture of one part of cement to eight parts of combined sand and gravel.

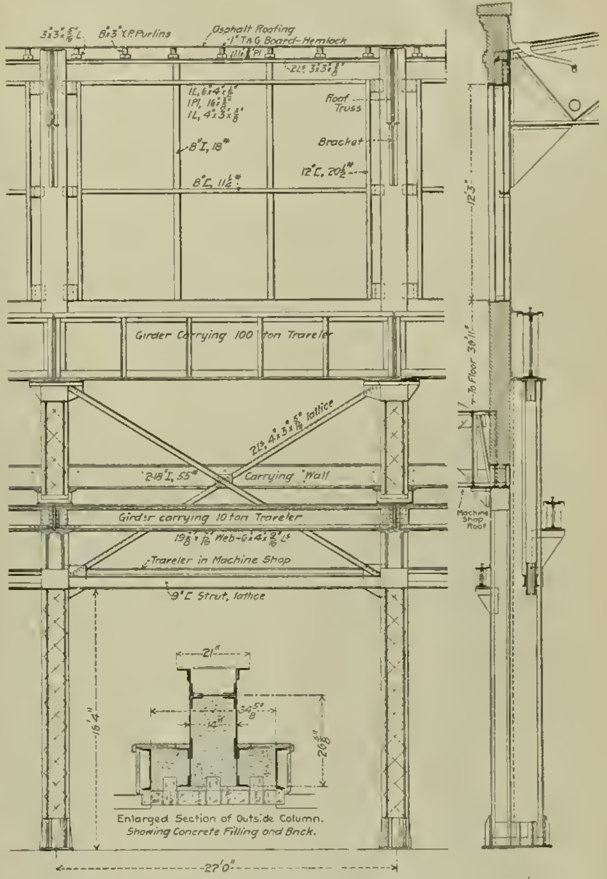
Another detail view, on page 369, illustrates the roof drainage with inside rain conductors. The angle made by the edge of the roof with the wall has a ridge at each end and at alternate panels; leaders are placed at the first, third, fifth, etc., panels, terminating in gutter boxes. As may be seen, the gutter boxes are 10-in. boxes made of 16-oz. copper with flash-



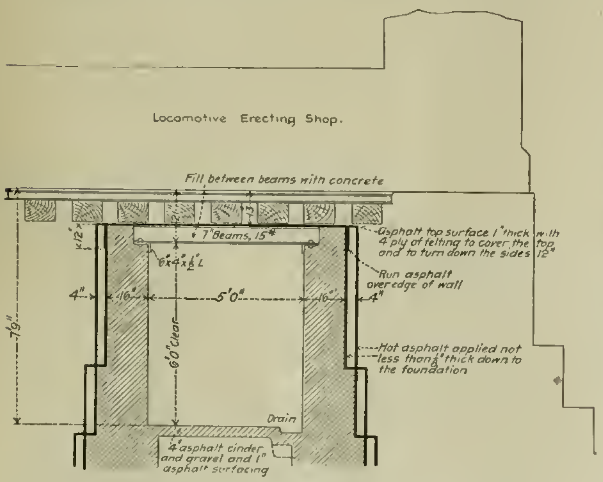
View of 80-ton Locomotive Lifted by Crane in Erecting Shop.
Collinwood Shops. — Lake Shore & Michigan Southern Railway.



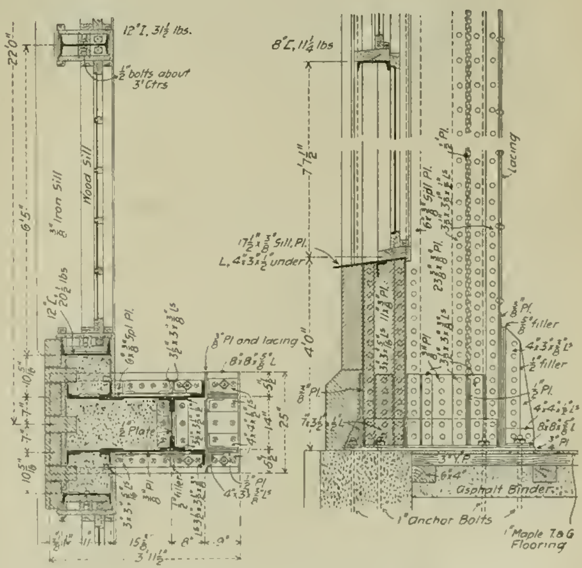
Details of Framing Unit, South Side of Erecting Shop, Showing Arrangement of Window Framing.



Details of Framing Unit, North Side of Erecting Shop, Showing Method of Supporting Intermediate Brick Wall



Cross-Section of Piping and Wiring Tunnel Where It Enters Locomotive Shop.



Detail Drawings of Steel Columns Indicating Concrete Filling and Method of Arranging Brick Facing.

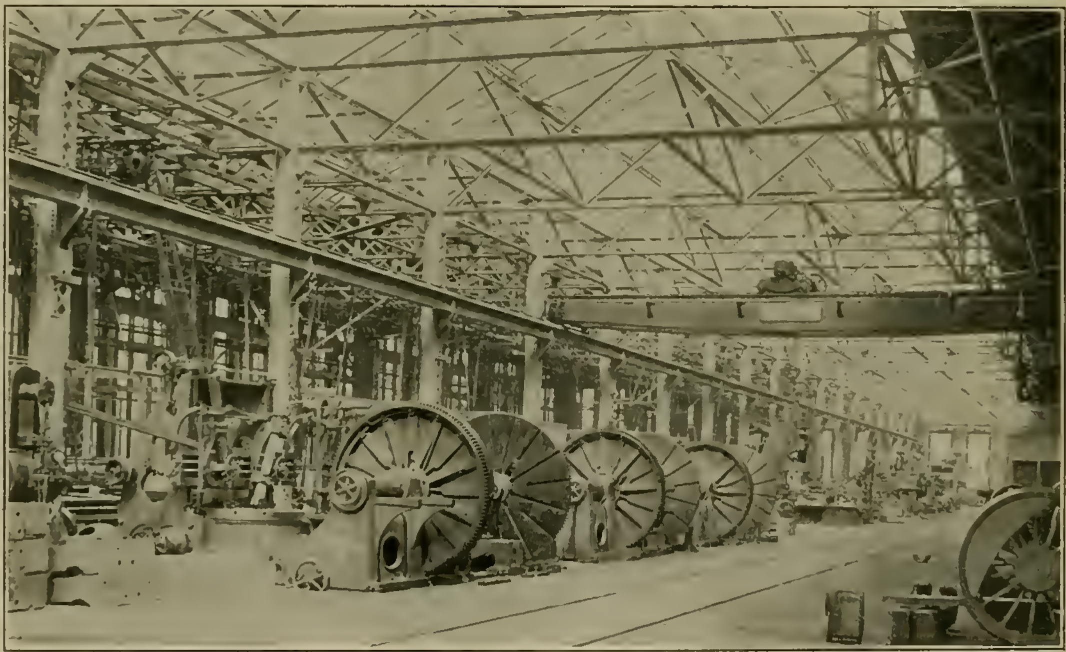
Collinwood Shops. — Lake Shore & Michigan Southern Railway.

ings extending 18 ins. on each side of the opening in the roof and underneath the roofing felt. Each box is provided with a copper wire screen to prevent entrance of gravel or obstructions into the leaders, to which they are connected by large tapering copper pipes leading down with easy bends into a 4-in. nipple screwed into the tee in the main leader of 4-in. W. I. pipe. This arrangement of inside drainage entirely obviates the difficulties usually met with the freezing of rain headers in winter.

Floor Plan.

On pages 370 and 371 are engravings of the floor plan of the locomotive repair shop showing the arrangement of machinery in the machine and boiler shop sections. Immediately to the north of the middle longitudinal track is the heavy tool section of the machine shop, which is served by a 7½-ton Niles crane with a span of 46 ft. 7⅞ ins., while the other half of the machine shop to the north adjoining the boiler shop is the light machinery section. The latter section of the shop is not provided with a large long span crane, being left with free overhead space to provide for the use of countershafting for the group-driven machine tools with the exception of three short 17 and 18 ft. span cranes, each with limited travel, serving a few groups of machines only; in this bay the tool rooms are located, as well as also the lavatory and locker compartments, which partially project into the boiler shop. This floor plan illustrates better than is otherwise possible the real advantages of the proximity of the heavy tool section to the erecting shop—the distance from the center of the erecting shop to the center of the heavy tool section is only 59 ft. and the large driving-wheel lathes, the frame slotters and the frame planer are all located toward the erecting-shop side of the bay. The commendable feature of the arrangement of this shop is the concentration of all the locomotive work under one roof; also the fact of having no pits to cross, and that of the engines remaining always in the same place until completed, are advantages of no little importance, and furthermore, the single erecting-shop crane, as used in this arrangement, is more convenient for handling the locomotives than the two required by the longitudinal arrangement.

It was contended by the officers of this road that the machine and erecting shop of a locomotive repair shop should be almost as wide for a small number of engines as for a large number, but that in shops of the magnitude of these a great deal of outside work is likely to be taken in for other departments, so that they must necessarily be larger if it is desired to avoid duplication of special machinery at other points of the system. In carrying out this commendable idea, it is interesting to note that the erecting shop was made 68 ft. wide and each bay of the machine shop 50 ft. wide, making the total shop, exclusive of the boiler and tank shop, 168 ft. wide; this is of interest in comparison with other notable railroad shops—the width of the erecting and machine shop of the Oelwein shops of the Chicago Great Western Railway is 90 ft. only, and that of the Hannibal shops of the Chicago, Burlington & Quincy Railroad is 98 ft.

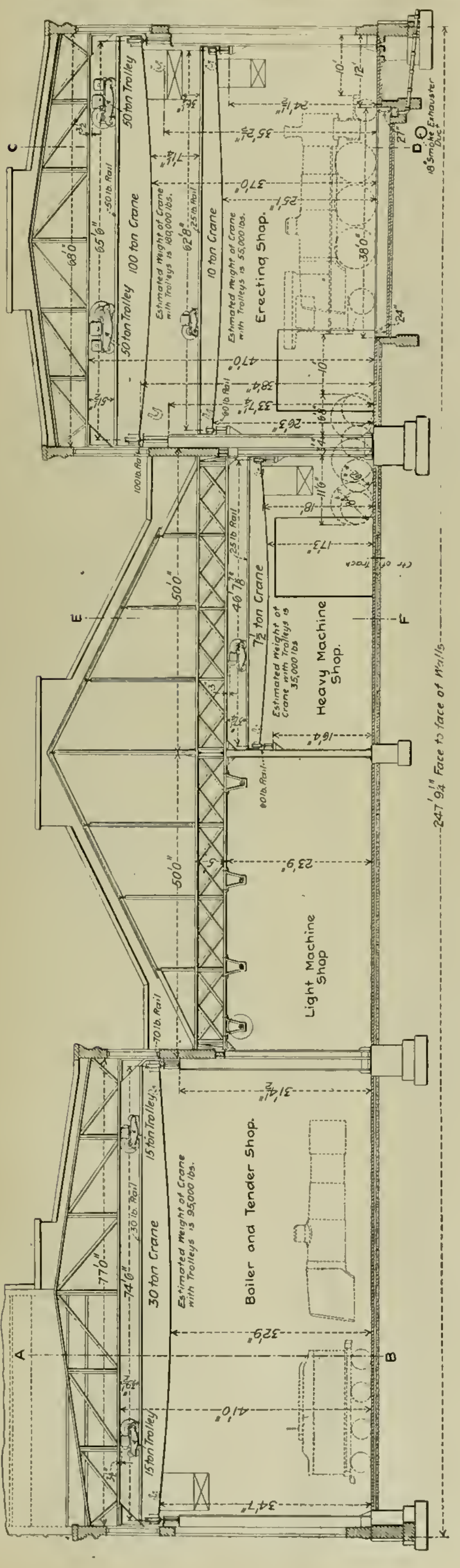


General View in Machine Shop, Heavy Tool Section.
(84-Inch Niles Driving Wheel Lathes in Foreground.)
Collinwood Shops.—Lake Shore & Michigan Southern Railway

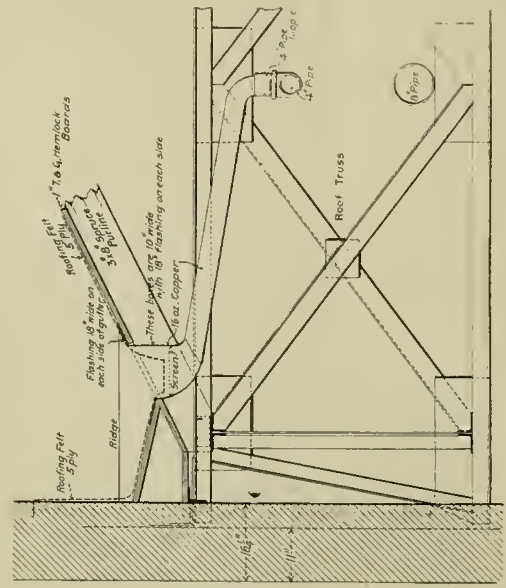
Heating and Ventilating System.

The heating and ventilating systems of the shop buildings are all hot-air fan blower systems delivering air through conduits under the floor. No return system is provided, as the fans are located within their respective buildings and take their air from within.

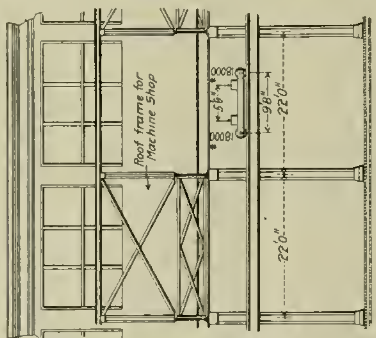
There are two of the direct-connected fan units in the locomotive shop building, one located near the center of the west half and the other near the center of the east half of the building, and each unit forces air into four delivery conduits leading toward the edges of its half of the building. The outlet openings are of galvanized iron pipe, 24 ins. in diameter, with two 17-in. openings for those along the edges of the building and 22 ins. for those by the center columns in the machinery section, and are all provided with dampers for shutting off the flow of air. The diagram indicates fully the arrangement and



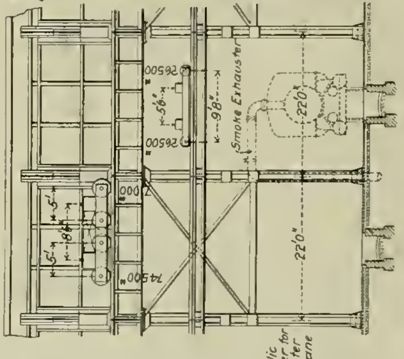
Cross Section Through Boiler, Machine and Erecting Shops, Showing Arrangement of Cranes and of Shafting Supports.



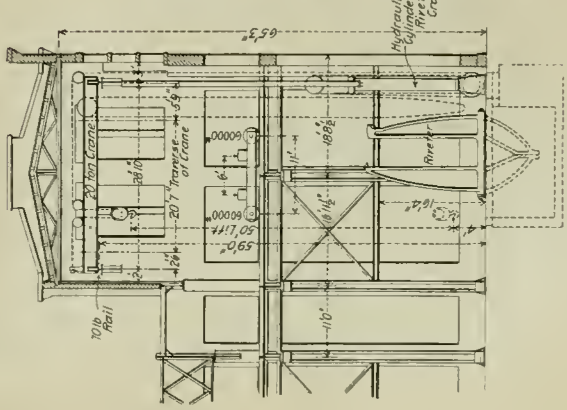
Detail of Roof Connections for Inside Drainage.



Section in Machine Shop, To Show Roof Framing.

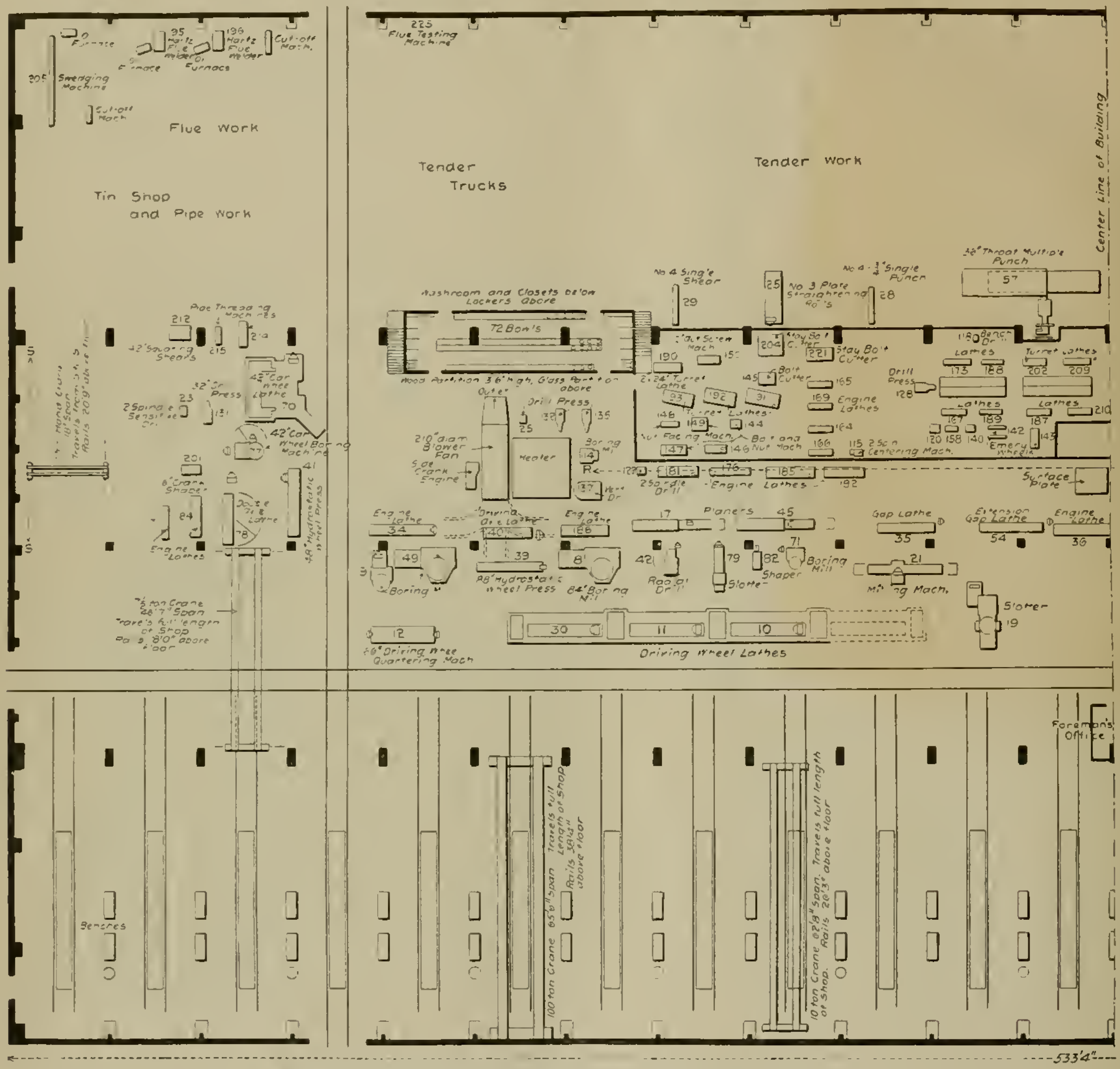


Section in Erecting Shop, To Show Framing Units.

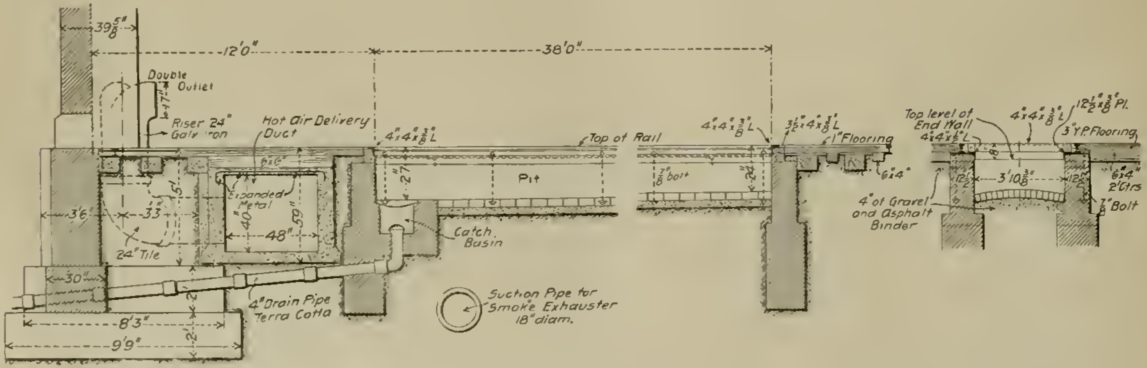


Section through Riveting Tower

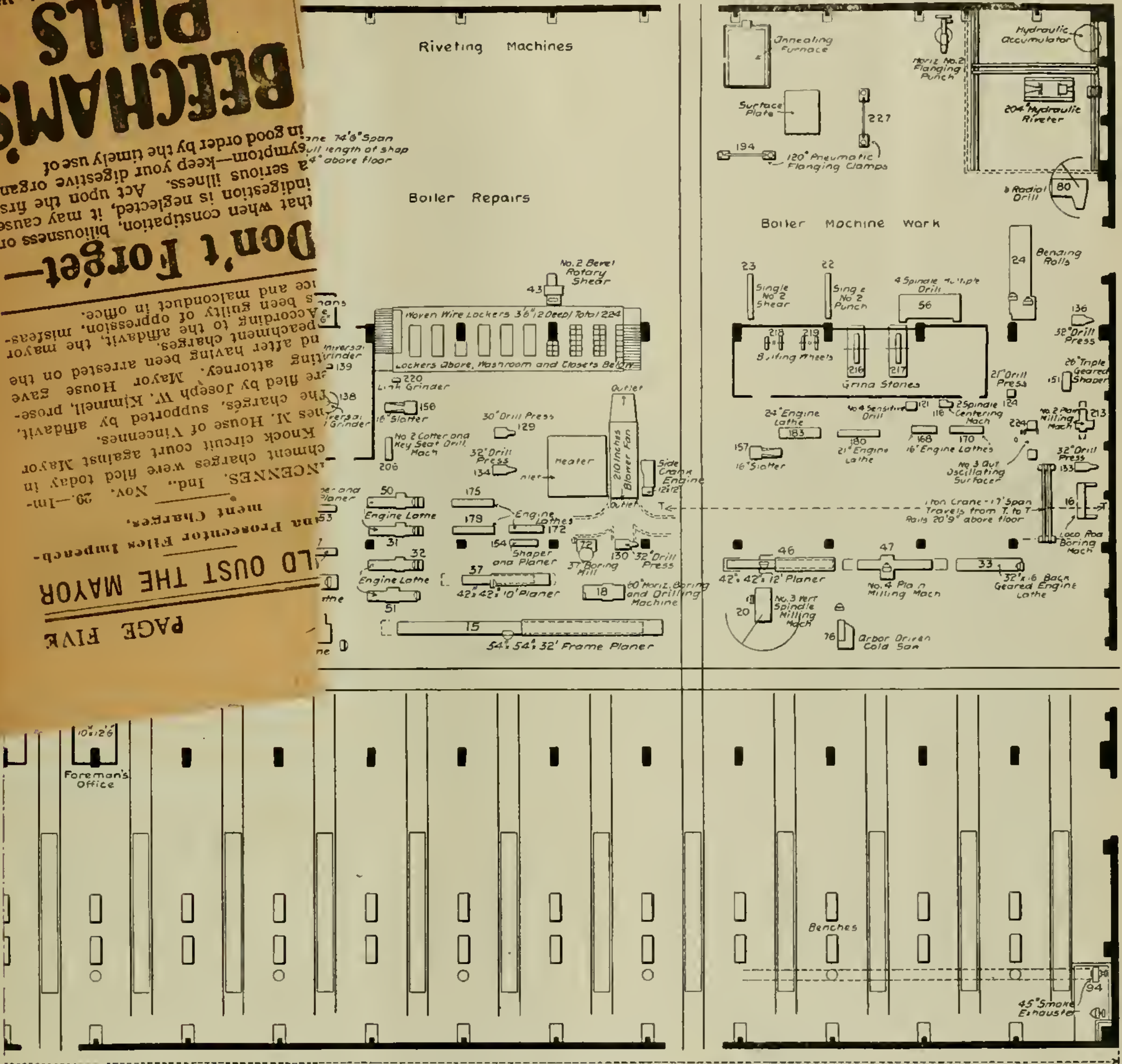
Collinwood Shops.—Lake Shore & Michigan Southern Railway.



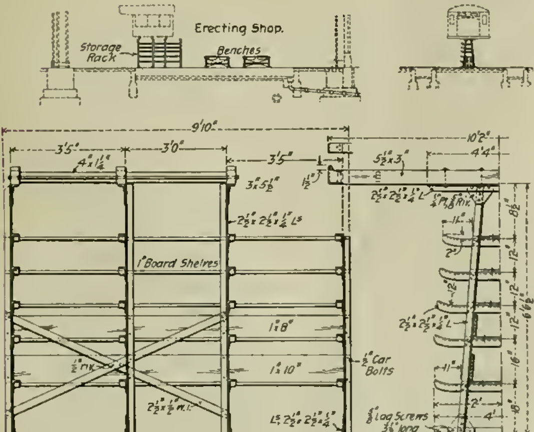
Floor Plan of Locomotive Shops, Showing Arrangement of Machinery.
(The other half of this plan is on opposite side.)



Detail of Engine Pits in Erecting Shop Construction of Hot Air Ducts and Outlet Connections Indicated Near South Wall.
Collinwood Shops. — Lake Shore & Michigan Southern Railway.



Floor Plan of Locomotive Shops, Showing Arrangement of Machinery.
The other half of this plan is on opposite page.)



Details of Racks between Pits in Erecting Shop.

View of the 148-inch Blower Fan in Machine Shop
Lavatory Compartment at Left.

Collinwood Shops. — Lake Shore & Michigan Southern Railway.

general dimensions of the branch conduits, while the photograph of the erecting shop and cranes below shows at the right a group of the double-outlet openings along the wall of the building.

The conduits are of concrete construction for the larger sections, the top walls being 2½ ins. thick, reinforced and stayed by a core of expanded metal; where tracks cross the flues the walls are thickened for about 10 ft. In the construction the tops of the flues were depressed so that the plank coverings of the floors do not rest on them. The smaller flues and outlet openings are of circular terra-cotta tile, which lead to the floor openings over which are the galvanized discharge pipes.

The fans are each of the three-quarter-housed-pattern steel plate type, with wheels 143 ins. in diameter and 72½ ins. wide, and each fan is direct-driven by a 12 by 12 in. 40 horse-power horizontal sidecrank engine running at 110 r. p. m. Each heater has 20 sections of pipe coils, each 7 ft. by 8 ft. by 10 ins., and each connected individually to the steam supply through a valve, permitting cutting in or out; in this way the temperature of the air delivered may be adjusted at will. Each section has mounted two rows of 1-in. pipe, the combined capacity of the two heaters being 25,320 ft. of 1-in. pipe. The system is guaranteed to maintain the temperature of the building constant at 60 deg. F. during the coldest weather. The engines, fans and heaters were all furnished by the Buffalo Forge Company, Buffalo, N. Y.

Along the entire length of the erecting shop under the outer ends of the pits is an 18-in. smoke-exhauster duct, with 18-in. branches to floor openings between alternate pits. To these the stacks of locomotives are connected by removable sections of galvanized pipes; in firing up the smoke is exhausted through a motor-driven fan at the east end of the building.

Piping Systems.

The question of accessibility was solved by the construction of piping tunnels from the basement of the power-house to the various shop buildings, a section of the one leading to the locomotive shop having been illustrated on page 335 of our preceding November issue. Its construction of concrete, with suitable waterproofing, renders it perfectly dry and clean and thus suitable for electric conductors; a detail drawing on page 367 shows this construction by a section where it enters the locomotive shop building. The entire exterior surface is thoroughly waterproofed by a coating of asphalt applied while hot to a thickness of ¼ in., and the top is covered by roofing felt laid four-ply, each layer in hot asphalt, and turned down 12 ins. over the sides. The concrete top of the tunnel is reinforced and stayed by 15-lb. 7-in. I-beams spaced 24 ins. between centers. High-pressure steam is used in the locomotive shop building for driving the ventilating blower fans, its use for that purpose having been thought preferable to an electric motor drive solely for the reason that with the steam engine its exhaust is available for very economically supplying the heater coils for the hot-air system. The high-pressure steam line consists of 5-in. wrought-iron pipe with screwed flange connections, suspended by swinging loops from brackets in the tunnel, and enters the engines through Cochrane steam separators of the vertical type located just above the engines.

The exhaust pipe leading to the power-house is an 8-in. pipe with screwed flanged connections and supported by the special swinging-link hanger supports that were illustrated upon page 335 of our November issue. This pipe may be used for conveying the exhaust from the blower engines back to the power-house if so desired, but will more probably be used for supplementing the steam supply to the heater coils by bringing over the exhaust from the engines and pumps in the power-house and from the steam hammers in the smith shop. This pipe connects to the large exhaust header in the power-house basement through an oil separator for preventing as much oil from entering the pipe line as possible. Also, a live steam connection is made to the exhaust system in the power-house for supplementing the combined exhausts in supplying the heater coils if found necessary in the coldest winter weather; the live steam is arranged to be admitted through two reducing

General View of Erecting Shop, Showing 10-Ton and 100-Ton Cranes.
(Air Delivery Outlets Appearing on Floor at Right.)

Locomotive Shops.—Lake Shore & Michigan Southern Railway.

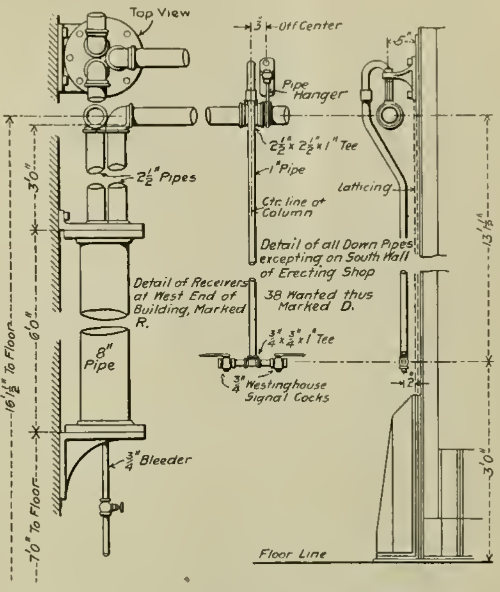
valves, the first reducing down to 40 lbs. and the second down to the exhaust line pressure.

The method of calculating the sizes of steam pipes required between the power-house and locomotive shop is interesting. The high-pressure steam line was calculated from the full-load steam consumption of the blower engines as stated by the makers, allowing a drop of pressure of 25 lbs. between the power-house and engine, and the exhaust pipe was calculated for the maximum flow from power-house necessary, as stated by the makers of the heater, to supply the heater coils under the worst conditions, after deducting, of course, that supplied from the exhaust of the engine itself. The formula used is as follows:

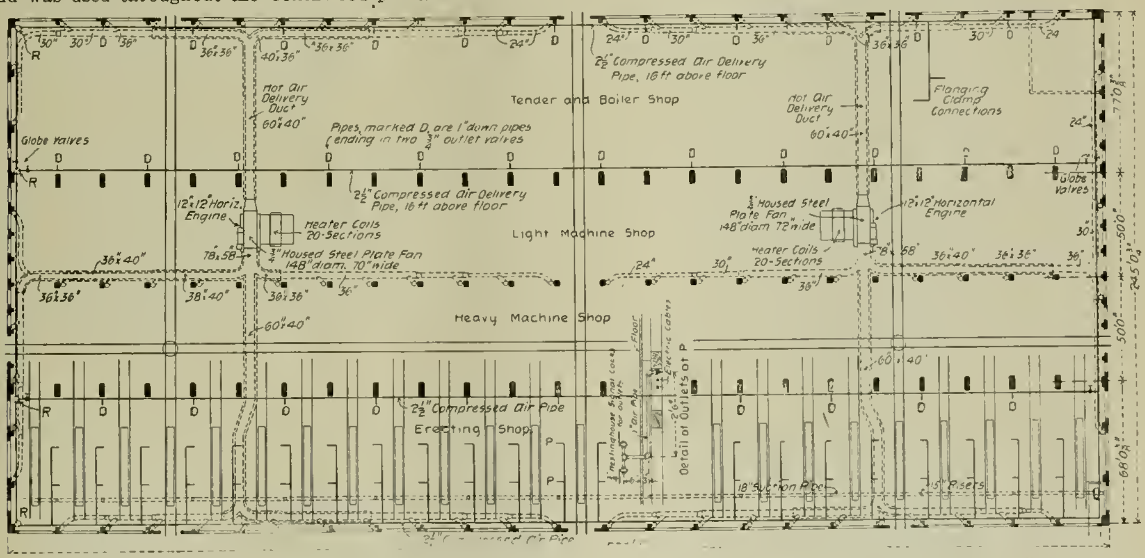
$$W = 87 \sqrt{\frac{w\ (p' - p'')\ d^5}{L\left(1 + \frac{3.6}{d}\right)}}$$

where W = Weight of steam flowing in pounds per minute;
w = Weight of steam per cubic foot at pressure, p';
p' = Pressure in pounds per square inch at entrance to pipe;
p'' = Pressure in pounds per square inch at delivery end of pipe;
d = Diameter of pipe in inches; and
L = Length of pipe in feet.

This formula has been found to give very satisfactory results and was used throughout the Collinwood plant.



Details of Reservoirs and Down Pipe Connections for Outlets in Compressed Air Piping.



Floor Plan of Locomotive Shops, Indicating Arrangement of Hot Air Ducts and Outlets, and also Compressed Air Piping, Collinwood Shops.—Lake Shore & Michigan Southern Railway.

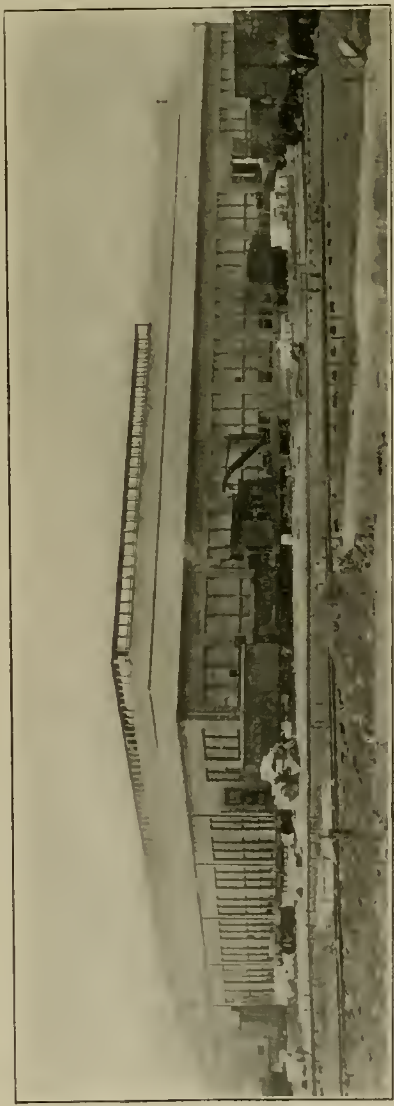
Compressed air is delivered to the locomotive shop through a 4-in. pipe with screwed flange connections which is suspended by swinging loop supports from the brackets in the tunnel. At the entrance to the building it is led up to connect with the 2½-in. distribution pipes which extend, at a distance of 16 ft. above the floor, entirely around the outside wall and along the two lines of main posts separating the main sections of the building, as shown in the diagram above. A detail of the outlet under one of the benches is also shown on the above diagram. Air reservoirs are located in the distribution piping at the junction of the pipe across the west end of the building, with each of four mains leading lengthwise. The valves and all the fittings for the piping were furnished by the Crane Co., Chicago, Ill., the well-known manufacturers of high-grade steam supplies; all 2-in. valves and smaller are brass valves, and those larger than 2 ins. are of iron body, brass trimmed.

Lavatories and Closets.

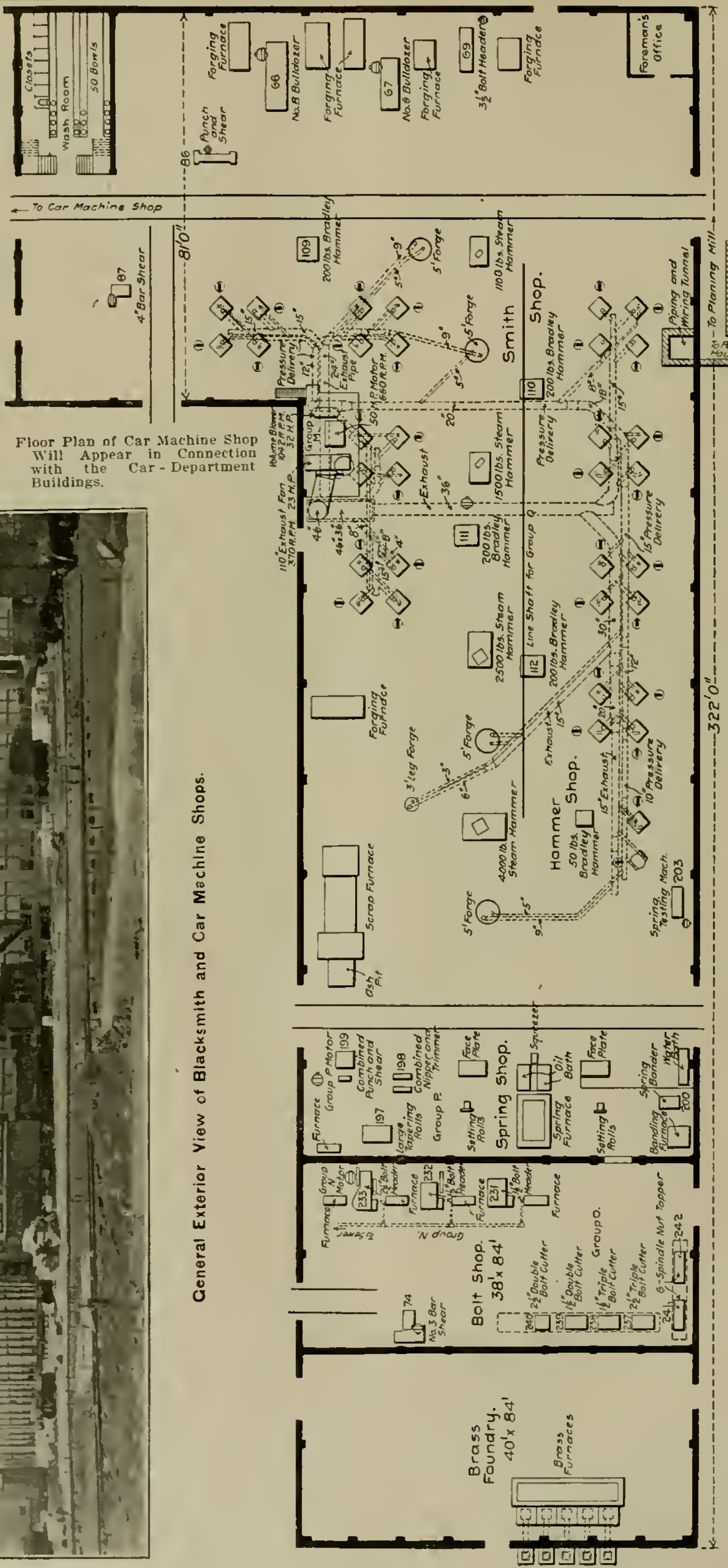
The lavatories and closets, as well as the employees' lockers, are provided for by two small two-story buildings or compartments, 15 by 56 ft., within the main building located upon the division line between the machine and boiler shops, one near the west center and the other near the east center of the building. The lower story of the compartment, which is 3½ ft. above the floor of the shop, contains four rows of wash basins, 72 bowls, in the central portion, and in each end are four water closets and a bank of urinals. Cleanliness and the best sanitary conditions are provided for by a slate floor and the best open plumbing. Hot water is supplied from the power house by a pair of circulating pipes keeping it always hot. A pair of stairs at each end of the compartment leads up to the upper floor, 8 ft. above the lower one, upon which are located 11 rows of lockers of the expanded metal type, furnished by Merritt & Co., Philadelphia; the lockers are 3 ft. 6 ins. high, each, and are arranged in tiers, two high, one above the other, there being in all 224 lockers in each compartment. A partial view of these compartments is shown at the rear of the blower fan in the view on page 371.

Handling of Work.

Storage tracks are located north of the boiler shop for skeletons of locomotives which have had their boilers removed for the application of new fireboxes, and also for locomotives and tenders, and the engine and tender truck wheel storage tracks are there also. Engines enter into and come out of the shop by means of an electrically operated turntable located north of boiler shop and midway between its ends.



General Exterior View of Blacksmith and Car Machine Shops.



Floor Plan of Car Machine Shop Will Appear in Connection with the Car-Department Buildings.

Floor Plan of Brass Foundry, Bolt and Spring Shops and Blacksmith Shop, showing Arrangement of Machinery.

Collinwood Shops. — Lake Shore & Michigan Southern Railway.

Tenders are disconnected from their locomotives outside of shop, and by means of the pony engine the locomotive is put on turntable and then into the shop. No stripping is done on center or entering track; the engine, immediately after entering, is lifted by the large crane and set on a shop pit designated in advance for this particular engine.

The "stripping" gang then takes it in hand and before the cranes are lowered the pedestal caps, spring rigging, braces, etc. (that are necessary for the removal of drivers and trucks), are taken down; then the engine is raised and the driving wheels rolled out (without removal of rods, except back-end and main ones) toward the back of the engine and engine truck rolled out forward.

"Baskets" of steel, holding all the parts of one small locomotive, or one-half those of a large one, are placed nearby, so that the work destined to go to the cleaning vats may be immediately placed in them and the whole thing handled with the crane to a truck; then it is taken to the vats outside, where another crane places the baskets containing the material in the cleaning liquid, and with the cover put on the whole thing is ready to steam. After steaming, the basket is removed and the perforated bottom drains out all the liquid, after which the material has only to be washed off with a convenient water hose and it is ready for distribution to the different departments.

One gang handles all the rods; another the pistons and crossheads; another the rockers, reverse shaft, links, reverse lever, throttle levers, etc.; another the driving boxes, eccentrics and straps; another steam pipes; another the boiler mountings; another the air brakes, etc. The distribution of the material is, of course, made to these different gangs.

When the work for any engine that is assigned to any gang has been completed it is sent at once to its corresponding engine in the erecting shop and placed on the racks provided for it; in this way the erecting department knows that what material is not on hand is not completed. The machinery for doing the particular work assigned to each gang is in all cases located conveniently for that gang.

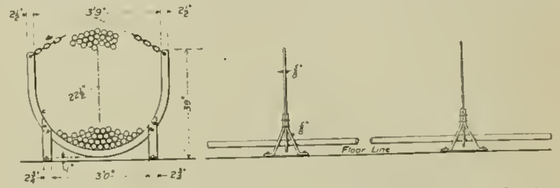
It may here be stated that renewals of small parts are furnished from storehouse stock, and no attempt is made to manufacture small articles for each engine individually. Rather they are drawn on "shop orders" from stock as needed, both for outlying points and for use at the central shops. In all cases the same men duplicate their work, and each individual does the same work over and over, so that it is done expeditiously and cheaply. For instance, one man does all valve setting; just as few as possible fit all driving boxes; still others fit up shoes and wedges, etc.

There is one general foreman; one foreman having general charge of all boiler work, with assistants as needed; one shop foreman in the machine shop, with an asistant; a rod-gang foreman; a motion-gang foreman; a piston-gang foreman; a wheel-gang foreman; one shop foreman, with assistant; a bolt-room foreman; a brass-room foreman; a tool-room foreman; one smith-shop foreman, with assistant in spring shop and bolt shop; one carpenter foreman; one copper-shop foreman, and one shop foreman in erecting shop, with six pit foremen. Pit foremen have just such regular men as are needed to do odd work. The steam-pipe gang goes from one engine to another, as scheduled; boiler-mounting gang does the same, as also the other gangs, these different gangs always doing their individual work, and while at work on any pit are directly under the supervision of the pit foreman having charge of that particular engine. The pit foremen are responsible to the erecting-shop foreman for good and economical work.

Engines are scheduled out the day they go into the shop, and if for any reason a delay should be foreseen, the individual who has charge of the department that may cause it is expected to report it in advance so that the general foreman may see to it that this particular part of the work is hurried along if possible.

Engines are fired up and "tested" before being lifted over onto the main track, and are immediately taken in charge by the trial engineer (who reports to general foreman) and moved out of shop. No trouble whatever is experienced from the fact that there is only one track for incoming and outgoing engines, as there is no delay whatever on this track, it taking but about ten minutes to take off an engine coming into the shop, and they are ready to move immediately on going out.

Flues are handled by the cranes in racks holding a complete set for each engine, both to and from the engines. The construction of the flue racks is shown by the accompanying sketch. The northwest corner of the shop is used for flue work. Outside of this shop there is one flue rattler for clean-



Crane Rack for Handling a Complete Set of Flues from an Engine.

ing flues, which will take one full set of flues in and out, all without handling. After rattling, the flues are taken in the shop to the flue fires, where each flue is heated, cut off and swaged in one heat, ready for application to its boiler.

Locomotives that are in the shop for fireboxes have the skeleton set on special trucks and are run outside while the firebox is being applied. All the work of the machinery is, of course, then being taken care of at the same time without taking up any pit room with the frames, cylinders, etc.

All heavy work can be handled from one shop to another by cranes and trucks. Each column in the erecting shop is provided with a portable crane so that one person can easily handle driving boxes in fitting them.

The storage location for the driving wheels is immediately behind each engine, so that when the eccentrics and straps and driving boxes have been fitted the wheels are in position to be rolled under the engine without extra handling.

Blacksmith Shop.

This building is in the shape of a letter L with a width of 80 ft. One wing contains the brass foundry, the bolt shop, spring hammer and smith shop and the car department machine shop fills the other wing; the latter will be described later in connection with the car department buildings which are not yet completed. This arrangement and the admirable location of the building permits of using the entire blacksmith shop equipment for both departments.

In the ground plan of this building the location of the forges and other equipment are shown and these will be included in the machinery list which is to appear next month. This shop is well lighted by numerous high windows and by skylights, shown in the photograph. The building is convenient to the iron racks, scrap bins and coal storage. The fires are arranged in groups of four, with a hydrant and coal supply for each group and each is convenient to a steam and a belted hammer as indicated in the plan. At the north end of this shop is a complete equipment of spring machinery. In the bolt shop there are five Furguson oil furnaces, there are three more in the spring shop and five in the blacksmith shop. In all there are 21 oil furnaces of this make in the plant. The furnaces and the oil distribution system will be described in another article.

Blast for the forges is supplied by blowers made by the Buffalo Forge Co., in the blacksmith, bolt, and spring shops. The forges are of the down draft type, finished by the same concern. The blower and exhauster for the forges are placed on an elevated platform at the corner of the shop and the ducts are under the floor where they are entirely out of the way. A 20 h. p. motor drives four Bradley 200 lbs. "Compact" hammer and one 50 lbs. hammer of the same make, in the blacksmith shop and in addition 4,000 lbs., 2,500 lbs., 1,500 lbs., and 1,100 lbs. steam hammers are arranged in a line along the center of the shop. The drawing is so complete as to render further comment on this shop unnecessary.

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EDITORIAL ANNOUNCEMENTS.

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

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

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PIECEWORK—A NECESSARY PRECAUTION.

In the movement toward commercializing railroad shop practice the payment for work done rather than for time expended is the foundation for improvement. This is nothing more nor less than piecework, the underlying principle of which has placed American industrial enterprises on their present successful basis. Piecework seems to be the only solution of the problem presented by the ever increasing demands of labor, because it seems to be impossible for corporations to raise wages much further without some corresponding increase in productivity. Paying for work done seems to meet this problem in a broad and fair way, for it gives a man an opportunity to benefit by his own efforts to increase his output, and the output of the machinery under his charge. That railroads must introduce piecework is generally admitted by those who are active in improving the motive power departments upon the plan of increased output at reduced cost.

It seems necessary, however, to again sound a warning against the method of introducing this system which has, it may be said, invariably led to failure and confusion. It cannot be successfully introduced without careful preliminary investigation and preparation. It should then be placed before the men in such a light as to lead them to desire it. The bulletin board notice to the effect that this system will go into effect for entire departments on a certain date is the wrong way. Placing the problem in the hands of a competent, trained, experienced piecework expert, who will study the local conditions and move only as rapidly as he is sure of his ground, is the right way, and to make his success possible and permanent thorough confidence in this individual on the part of the men is absolutely essential. Next to this must come an absolute and unswerving support of the principle of piecework from the management and no corporation is ready for this movement until these preliminaries are correctly arranged.

Price fixing is the difficult problem in starting piecework as the prices must be correct or they will need to be changed and the changing has been the cause of so many failures in the past. This work requires a special and peculiar experience and men are greatly in demand who have the necessary qualifications. Fortunately they are increasing in numbers but not fast enough to meet the requirements. At the present stage of this question it would seem advisable to provide for the training of men for this work. They need to understand men, to be fully informed as to the capabilities of men, the capacities of machines, the merits of tool steel and the possibilities of the removal of material with respect to feeds and speeds. The acquirement of such qualifications requires time and it is not to be admitted that railroad officers will neglect to make this preparation.

FRENCH FOUR-CYLINDER COMPOUNDS.

A gentleman whose name is known widely in the locomotive world happened to call at the editorial rooms of this journal when the proofs of Mr. Herdner's article (in this issue) came from the composing room. After reading it carefully and examining the drawings, he said:

"I wish to congratulate you upon obtaining so splendid an article for your paper. I believe it to be the most valuable addition to the contemporary literature on the compound locomotive."

Our desire is not to induce the reader to swallow French practice "whole," but to lead to a study of the high development of the compound locomotive which has been reached in France.

Mr. Herdner has something interesting to say about the crank axle, and he also disposes of the question of complication. But a French view of complication will hardly find a hearty response in this country. The proper way to look at this question is whether American locomotives are complicated enough. Is it not possible to simplify construction to a degree which imposes stresses on a small number of parts, which they cannot withstand because they cannot be made large enough? Has not this been done in this country, and is there not a lesson to be learned through the increasing frequency of frame and cylinder breakages?

It is to be hoped that someone will try the De Glehn principle or an Americanized application of its fundamental features.

PRIZE PAPERS FOR A RAILWAY CLUB.

The prizes offered by the Pacific Coast Railway Club for papers pertaining to the construction, equipment, maintenance and management of steam railways should flood the office of the secretary with literature. The writer of this paragraph was for a time secretary of a railway club, and knows how difficult it is to secure good papers from the members. This should not be so, and it would not be if young men in railroad service could be brought to understand the value to themselves which a well-considered discussion of an important subject will bring. There is nothing more sure and more satisfying than the result of a good paper before a railroad club, and officers should encourage their subordinates to work in their clubs as a duty. No one knows so well how he stands on a subject with which he may be familiar as he does after having written something about it which is to be read and criticised. The mere writing of the paper helps the young man to understand himself and, what is not less important, it helps others to understand him. Ability alone does not guarantee success. Acquaintance and reputation must accompany it, and how many of the well-known officers of mechanical and engineering departments of to-day owe their success to what they have written! The Pacific Coast Railway Club offers money prizes, but these are really insignificant in comparison with the prizes which are everywhere awaiting young men who have the knowledge and the energy to prepare papers for technical organizations and articles for the technical press. It is to be hoped that this club's effort will be successful. The papers must be from members of some railway club and they must be in the hands of the secretary, Mr. C. C. Borton, 1213 Twelfth street, Oakland, Cal., on or before January 1, 1903. The first prize is $100, the second $75, the third $50 and the fourth $25. The action of the club is commendable, but it is surprising that it should be necessary.

WHAT MOTIVE POWER OFFICERS ARE THINKING ABOUT.

Editorial Correspondence.

The most engrossing subject just now is the demand for locomotives. This concerns the East, West, North and South, and the condition is unprecedented. On one of the roads in the Northwest 48 locomotives sufficed for one of the heavy grain-carrying divisions last year. This year 147 will not handle the business, and 1,800 cars are now waiting on side-tracks. The locomotive builders, in spite of greatly increased productive capacity, are coming to the relief but tardily, because the traffic is enormous.

At such a time every factor tending to increase mileage is of vital importance. Every possibility of reducing the dead time of locomotives is considered, and these efforts have brought the subject of water purification into a prominence which it never before occupied. One general manager stated that this is now the most serious operating problem in bad-water districts because of the effects of the loss of time in boiler washing and boiler repairs. He also said: "The purification of feed-water is the most interesting and far-reaching problem concerning motive power departments to-day. Not on the score of economy alone, but because engines cannot be spared to wash or tinker boilers."

At present no road has enough purifying plants to represent the possibilities of purification. If but one of several water stations on a division is equipped with a plant its effects on boiler repairs will not appear to advantage, because the treated water is mixed in the tender with untreated water. Only when entire divisions are equipped can comparisons be made.

On one of the large Western roads having both good and bad water districts the following conditions represent the serious character of the water difficulty: On a good-water division engines 12 years old are still running with their original fireboxes, and the life of fireboxes averages more than 10 years. Flues give a mileage of 150,000, and after a little caulking are good for about as much more. In a bad-water district new half side sheets are necessary every year and new fireboxes every two years, the average condition requiring new half side sheets every two years and new fireboxes every four years. Flue mileage varies greatly, and in accordance with conditions which are sometimes puzzling. In bad-water districts they seldom last on this road for more than 55,000 miles before it is necessary to renew half of them. Frequently all the flues are taken out short of this mileage. These figures concern the cost of repairs. The necessity for washing boilers is perhaps more important. On the road referred to, all boilers are expected to be washed out every 10 days, but in the bad-water territory this is done for every 400 miles run. The actual time required is about five or six hours, but the boilers necessarily suffer under such practice, as they cannot be cooled down for washing as they ought to be in less than about 12 hours. Here is the strong argument for water purification, and among men who are doing their utmost to move freight this needs no elaboration. It would pay to spend a large amount to get water which would permit of renewing flues only twice in 10 years; not because of the flues alone, but because of reducing the dead time of the equipment. On the road mentioned, the mileage per engine failure averages 5,000 on the bad-water divisions and 16,000 on those having good water. Out of 450 engine failures for one month, 145 were due to leaky flues and fireboxes caused by bad water. In all of these cases engines of the same classes, using the same coal and making almost the same ton-mileage, were selected.

On another road, reaching far into the West, a worse condition was found. On a 200-mile division the boilers are washed out every round trip and the fireboxes of 12 new passenger engines are ruined in six months. Due to the water, each of these engines spends about two months out of every year in the shops, not considering the repairs to flues in the roundhouse. In this case flues are renewed four times a year. At one point a water is found which merits a monument. It has the following remarkable characteristics:

	Grains per Gallon.
Calcium Sulphate	26.04
Calcium Chloride	104.36
Sodium Chloride	249.13
Other Deviltry	7.47
Incrusting Solids	135.67
Non Incrusting Solids	251.43
Total Solids	387.00

Its by-products would be very valuable. Is there any reason why such water should not foam or scale boilers? In 1,000 gallons of it there are 19.38 lbs. of incrusting solids. Of course such water is not used. Better water is hauled 37 miles up a 1 per cent. grade at a cost of 30 cents per 1,000 gallons for use at this point. This water traffic requires the constant service of one engine and twenty tank cars to supply 100,000 gallons per day. Such water cannot be purified in any way except by distillation. This serves to indicate the character of the water problem.

On one division of this road 1½ tons of incrusting solids are taken into locomotive boilers every day at only three of the water stations.

The present pressure for power emphasizes the effect of forcing boilers. This is shown specially in flue and firebox mileage, and on one road visited by our representative it was found that freight engines and passenger engines also required more roundhouse work than ever before. This has led to experiments in improving circulation by reducing the number of flues and increasing the spaces between them. An effort is being made on that road to ascertain whether the loss in heating surface will not be more than made up in the improved circulation. In this case 1-in. spaces between the flues are provided. Mr. Van Alstine directed attention to this in his article upon rational boiler design in the June number of the current volume of this journal. Others are becoming interested in this subject, and there seems to be a tendency toward reducing heating surface somewhat in bad-water districts for the sake of reducing boiler repairs.

Remarkable feeds and speeds of lathe work at large manufacturing establishments have been frequently recorded of late. They are beginning to be found also in railroad shops. In one place our representative found a coach-wheel lathe turning the tires of 33-in. wheels at the rate of six pairs per day. The roughing cut was 3/8 in. deep and 1/8 in. feed, the chips coming off a brilliant purple color with no water. This was done on a Niles lathe that had seen hard service for nine years. The tool steel was a new brand and the job was done on piece-work.

In another shop a new high-grade tool steel was recently tried on a 58-in. Latrobe tire 5½ in. wide. The machine was a new 84-in. Niles lathe, and the tool finished the tire without grinding, the cut being ½ in. deep and the feed 1-16 in. at a speed of 31 ft. 4 ins. per minute. With ordinary tool steel a 56-in. tire was turned at 11 ft. per minute, the cut being ½ in. deep and the feed 1-32 in. This tool required grinding after cutting a distance of 2 ins. across the tire. At this point the tool of special steel was again put in at ½-in. cut and ⅛-in. feed. It ran at a speed of 31 ft. 4 ins. per minute and soon stalled the lathe. The lathe was in a group driven by a 25 h.p. motor, and when the other machines were cut out the motor, a Crocker-Wheeler, supposed to be capable of sustaining an over-load of 100 per cent., was again stalled. This lathe is to be equipped, as it ought to have been originally, with a 35 h. p. direct-connected motor.

In the same shop a test was made with the same steel in a boring mill. The tire was bored at a speed of 27 ft. per minute, the cut being ¼ in. and the feed 3-32 in. A tool of ordinary self-hardening steel took a 5-16-in. cut with a 1-32-in. feed at a speed of 12 ft. per minute, the tool giving out after cutting 1¼ ins. through the tire. Six and seven hours were required for boring a pair of tires with ordinary steel as against four hours for a pair of the same size with the special tool steel. Less time would be required with the new steel if the machine was rigid enough to stand up to the work.

In still another shop the line shafting has been speeded up 21 per cent. since last year. Planers for general work are driven at 28 ft. per minute, the shafting for the group-driven machines running at 170 revolutions per minute. In this shop 33-in. coach wheels are turned in an old lathe at the rate of three pairs per day. When ⅜ in. of material is to come off the first cut is ¼ in. and ¼ in. feed at 35 ft. per minute and the finishing cut is ⅛ in. with ¼ in. feed and the speed 40 ft. per minute.

On the boring mill the time for boring out a 79-in. tire was stated to be one hour, the cut and feed being ⅛ in. and the speed 57 ft. per minute. This time is said to include that for setting the tire in the machine.

In the wheel lathe tires are turned at 35 ft. per minute with ¼ in. cut and ¼-in. feed.

In another shop a record of 50 lbs. of steel per tire per hour was reported for a wheel lathe and one of the new brands of tool steel.

These records were taken from verbal statements. They represent wide differences in practice, but they serve to reflect increased attention to the commercial aspect of railroad shop practice, and they indicate the advantages of motor driving.

Speaking of piece-work brings up an interesting fact concerning machine tools. There is nothing like it to bring out the deficiencies in tools and tool steel. Piece-work generally means heavy cuts and fast feeds. A man running a fine new lathe was asked how he liked it. He replied: "It would do very well a few years back, but it's not a piece-work tool." His answer was confirmed by the chattering of the lathe. This is one of the best reflections of the effect of piece-work. It is also a hint to the tool builders. They will have a brisk race to keep up with the rapid advances now being made in tool steel. New, high-grade tool steel was found in a number of railroad shops visited. It should be found in all of them. The era of heavier machines, heavy cuts and rapid feeds has really begun on railroads. This is very noticeable.

In discussing machine-tool progress, a well-known motive power official said: "We are really past the stage of shop practice which permits of leaving the shop problems in the hands of a general foreman reporting to a master mechanic who must of necessity be away looking after road work half of his time. We must have shop superintendents with full authority who are qualified to hold equivalent positions in commercial establishments. To secure such men higher salaries must be paid. The time has passed for the $1,500-a-year general foreman to have the responsibility of repairs to 500 locomotives per year and the building of new engines. A commercial superintendent can save his salary over and over in the cost of the work, and it is absurd to pay the foreman less than only fair workmen receive in contract shops. We now have men who are worth $1,500 a year, but we need $3,000 men, and we must have them to get the engines out."

Every new shop has electric power, and the variety of opinions expressed in the distribution plans is noteworthy. This applies not alone to the electric systems themselves, but to the methods of attachment of motors to tools. Motive power men complain that they can get very little help from either the machine-tool builders or the electrical people. The tool builders give but little assistance with regard to the ranges of speeds which must be provided. In one case constant speed motors, cone drives and short belts from the motors to counter-shafts were recommended, thus throwing away a large portion of the advantage of motor driving as to ranges of speeds. On the other hand, the electrical people, in this case, recommended ranges so wide as to involve unreasonable expenditure in installation. The railroad officer had to decide for himself, and he was fortunately well able to do so. This is not as it should be. Motor driving of tools is yet in its infancy, but it is time to put practice in better shape. An electric driving installation is expensive, and inasmuch as its chief advantage is in the convenience of operation, some substantial progress should begin immediately.

Increased efforts to better provide for cleaning and repairing air brakes are noticeable, but on many roads little attention is given them. A large road, having 35,000 cars, employs 14 men to systematically and completely repair the brakes of 900 cars per week. The triples and brake cylinders are cleaned, the train pipes and hose overhauled, new gaskets put in and a test made. At this rate the entire equipment will be overhauled in less time than a year if it all gets to the shops. This work is necessary, as leaky train pipes are becoming a serious menace, as well as a source of expense and annoyance. Cases of the application of brakes by leakage are known to exist. The locomotive men are up in arms because of the demands for larger air pumps. Where trains are long it is not unusual to find two pumps on an engine, and two large ones are actually needed.

It seems strange that the old discarded "straight-air" brake should again be taken up and vigorously recommended, but this is done. It is being introduced in a new way, however, and for a new purpose. It is applied to locomotives and tenders of passenger, freight and switch engines, the number of roads where it was found being so large as to indicate the probability of a general introduction of the practice. "Straight air" is applied to the engine and tender in a way which does not at all interfere with the automatic brake. The "straight air" enables the engineer to apply and release the locomotive brakes as gradually as he pleases, and by its use he can "bunch" the cars together before applying the train brake and he can hold the slack of the train when releasing the automatic brakes in a long train. At low speeds it is dangerous to release the automatic brake without "bunching" the train from the engine. It insures the fullest braking power on the driving wheels. At water-tank stops its value in passenger service is noteworthy, and on mountain grades it is an important safeguard as a good and efficient retainer while the train reservoirs are being recharged. Used on switch engines, it stops the use of the reverse lever for making quick stops. Those who are using "straight air" speak enthusiastically of it as the greatest recent improvement in the air brake. It is being introduced pretty generally through the West.

(To be continued)

TWO NEW VANDERBILT CARS.

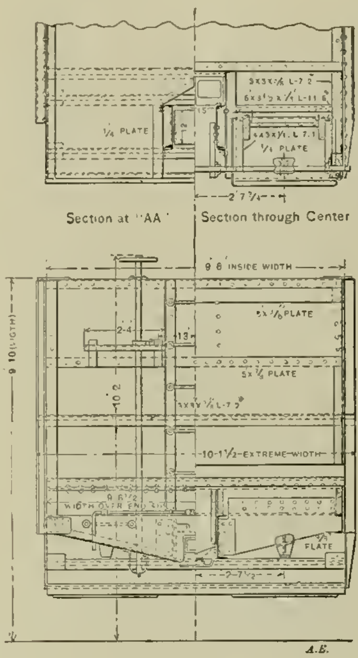
80,000 Pounds, Hopper Type.

Two new designs for structural steel cars of 80,000 lbs. capacity have been completed by Mr. Cornelius Vanderbilt. One is for limestone and the other for coal, the essentials being the same in both and the differences being in the detail construction. Both are of commercial shapes and plates and both employ Mr. Vanderbilt's patented method of construction.

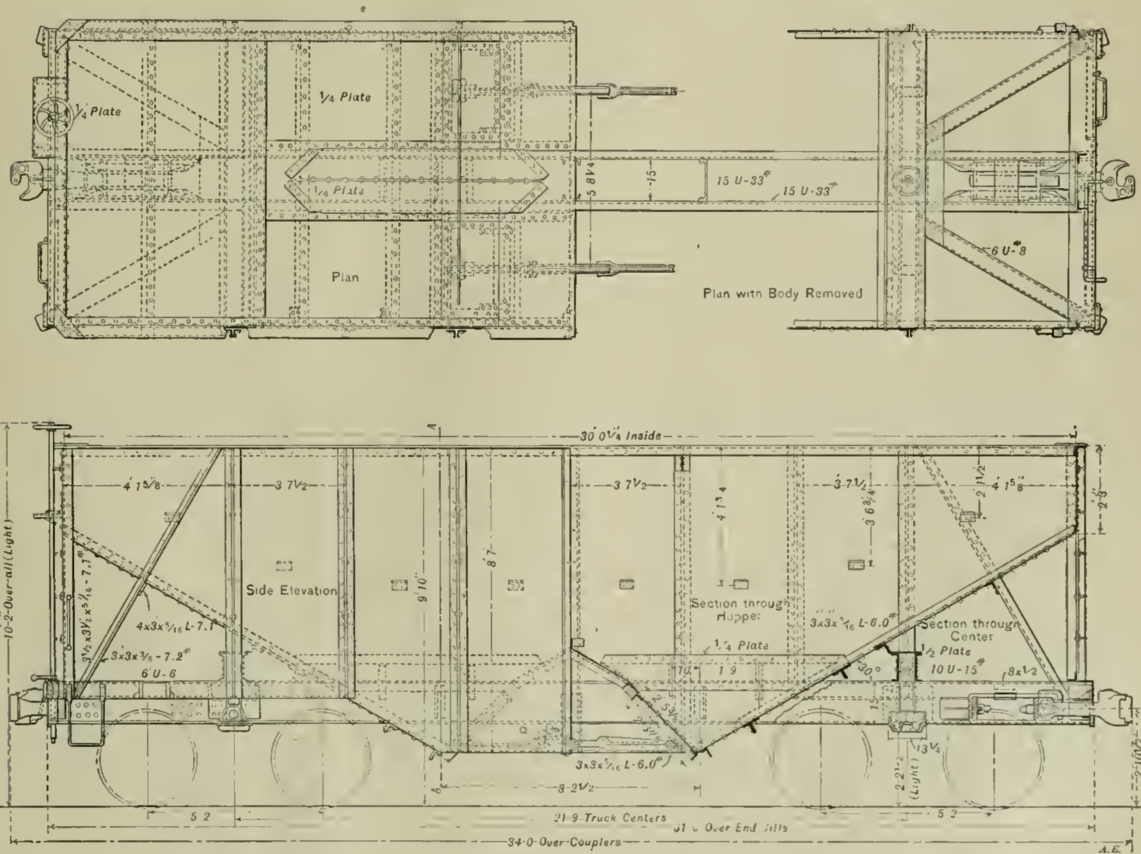
The coal car has the following dimensions:

Length inside car	30 ft. ¼ in.
Length over end sill	31 ft. 6 ins.
Length over couplers	34 ft.
Truck centers	21 ft. 9 ins.
Width inside car	9 ft. 6 ins.
Width over body	10 ft. 1½ ins.
Width over end sill	9 ft. 6½ ins.
Height, top of rail to top of brake-shaft	10 ft. 2 ins.
Height, top of rail to top of sides	9 ft. 10 ins.
Height, top of rail to bottom of hopper	1 ft. 3 ins.
Height, top of rail to center of coupler	2 ft. 10½ ins.
Height, top of rail to top of end sill	3 ft. 8 11-16 ins.
Height of sides	8 ft. 7 ins.
Capacity, level full, 1,569 cu. ft.	81,600 lbs.
Capacity, heaped 30 per cent., 1,864 cu. ft.	97,000 lbs.

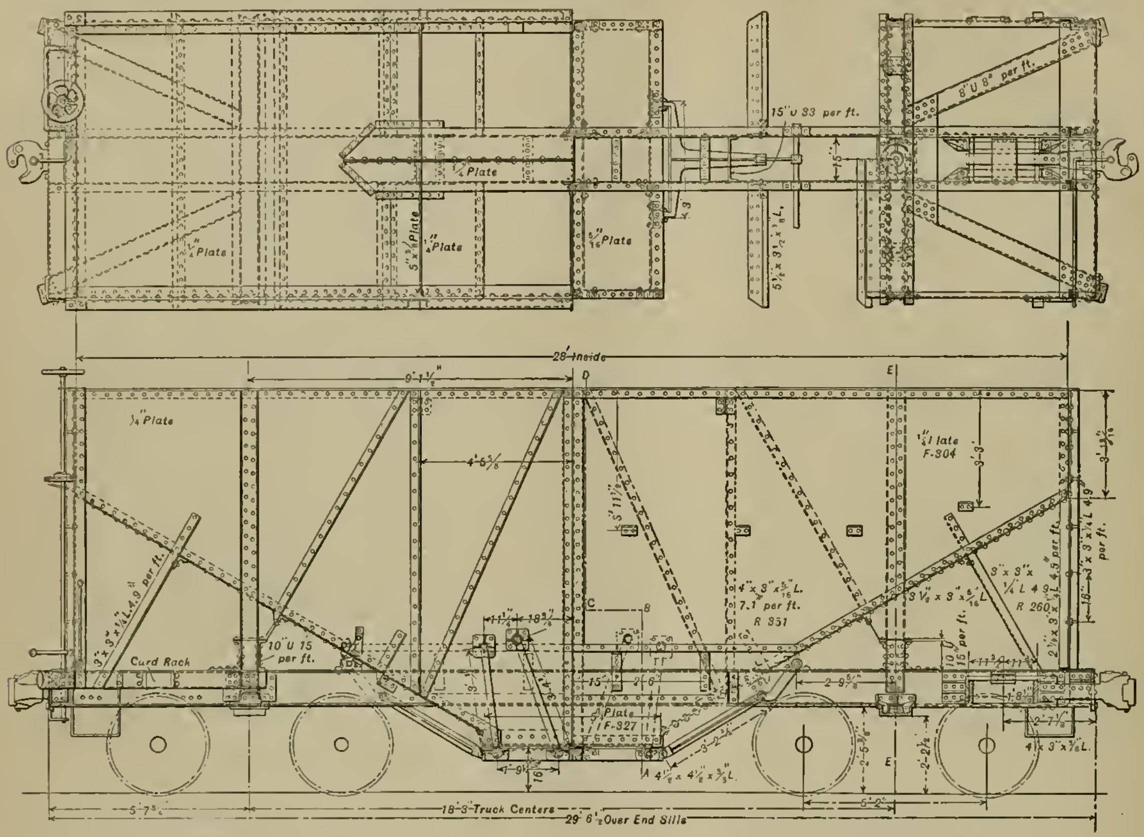
The coal car has the usual form of hopper doors with the door-operating mechanism between them, but the side plates extend down to the level of the lower angles of the hoppers, where they are cut parallel with the rail at a distance of 15 ins. from the rail. This construction gives a very deep side in the form of a plate girder. There are no side sills extending the full length of the car, but this car has short side sills at the ends, extending from the corner posts to the sloping floor plates, terminating at the ends of the first panels inside of the body bolsters. These are of 6-in. channels with the flanges facing toward the center sills. The side plates come down over them at the body bolsters. This construction



Transverse Section and End View.



80,000 Pounds Capacity Hopper Coal Car. – Designed by Cornelius Vanderbilt, M. E.

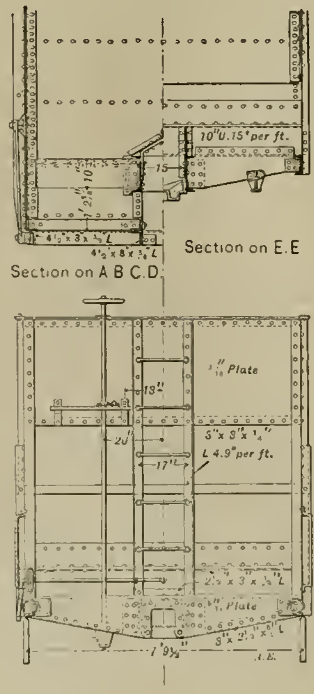


80,000 Pounds Capacity Hopper Car for Limestone.—Designed by Cornelius Vanderbilt, M. E.

is very much stronger in its support of the corner posts against push pole or cornering stresses than either of the earlier Vanderbilt hopper cars which were illustrated in this journal in November, 1901, page 338, and April, 1902, page 102.

The hopper form of cars is favorable to a good body bolster construction. These bolsters are 10-in. channels resting on top of the 15-in. center sills and covered by ½-in. cover plates, which are extended and bent to form floor supports for the hoppers. The bolsters are further stiffened and connected to the center sills by large ⅜-in. bracket plates, which are also secured to the short side sills by angles and to the inside faces of the bolster channels by rivets.

In this car the brace angles for the side plates are all vertical except at the end panels. As in the earlier designs, the panel spacing brings vertical members at the ends of the bolsters to serve to transmit the load of the plate girders directly to the bolsters. The omission of the diagonal braces of the side plates does not sacrifice strength, and it lessens the expense of construction, and also the weight. In this design the floor plates are not flanged, as in the earlier construction, to rivet them to the side shannels. In this case the channels are replaced by angles.

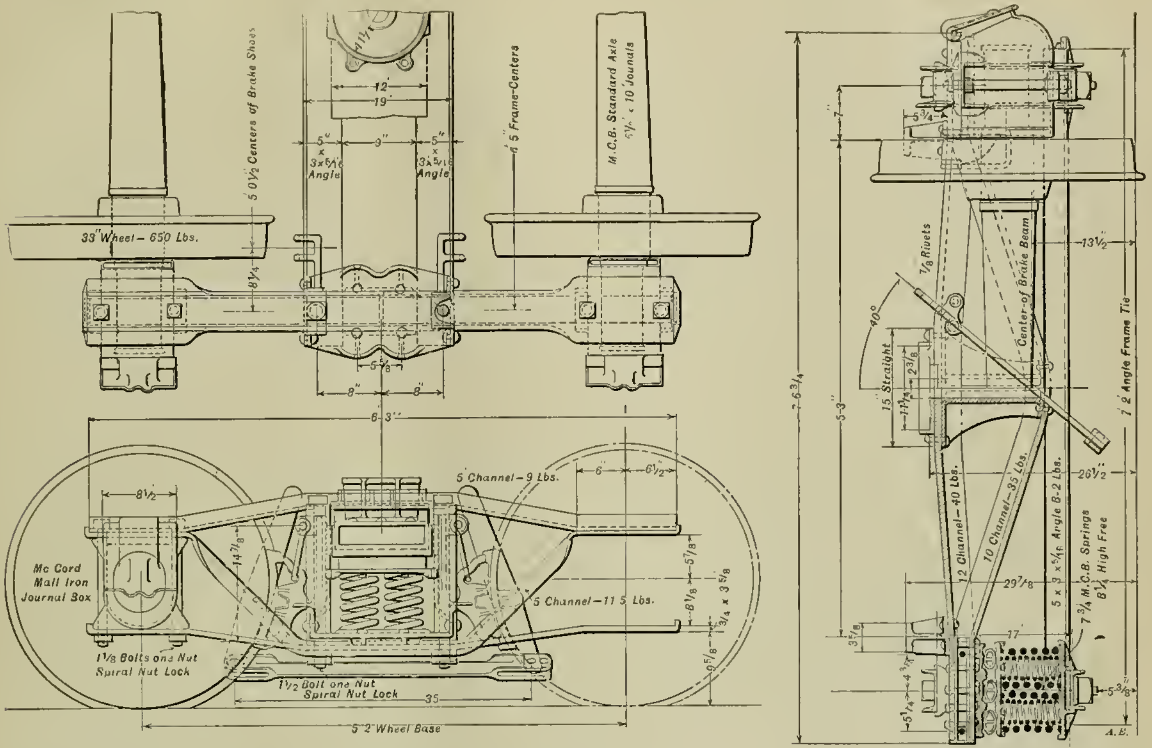


Transverse Section and End View.

The limestone car differs from the coal car in the center sills, which are 12-in. channels. It differs also in the length of the short side sills, which extend only to the bolsters, in the bracing of the sides and the absence of the wedge-shaped construction of the floor at the center of the car. In this design the load comes directly upon horizontal doors at the bottom of the single large hopper, and these doors swing bodily on link hangers. They are not hinged.

The body bolster construction is similar to the other Vanderbilt hopper cars and the vertical side-stiffening members at the bolsters are in this case 6-in. channels secured to the ends of the bolsters and transmitting the load from the side plate girders to the bolsters. The depth of the sides at the center of this car is 10 ft., and the bottom of the side plates comes down to a distance of 16¼ ins. from the rail.

These cars are designed to use the truck recently patented by Mr. Vanderhilt, which is used under 800 hopper cars built by him for the West Virginia Central, already referred to. The principal feature of this truck is the flattening of the flanges of the arch bar channels over the journal boxes. The engravings show a built-up truck bolster, but the latest design employs a cast steel bolster of the same general form. The top arch bar is a 5-in. 9-lb. channel, and the tension member is an 11½-lb. channel. The steel end casting combines the spring seat, brake-hanger fulcrums and arch-bar columns in a single casting.



Vanderbilt Channel Arch Bar Truck.

SELF-CLEANING LOCOMOTIVE "FRONT ENDS."

In a locomotive with ordinary extension front end the cinders accumulate very rapidly until a certain amount has been caught, and then the rest pass out and the front end becomes self-cleaning. Mr. Frank Slater, of the Chicago & Northwestern Railway, in a paper read before the Western Railway Club, November meeting, illustrated two methods of arranging the extension front end to make it self-cleaning. He strongly recommended such practice.

In the discussion Mr. J. Snowden Bell made some plain and forcible statements with reference to the long smokebox which should be carefully considered. He said, in part:

"The absolute fallacy of the 'spark-retaining' theory, upon which the claims of advantage of the extension front are chiefly based, has been so long ago and so fully demonstrated in railroad service that it is difficult to understand how anything other than prejudice or mere force of habit keeps the extension front out of the scrap-pile. It is too obvious to need argument that after an engine having a supposed 'spark-retaining' extension front has run a few miles and banked up a small quantity of cinders at the front of the extension, the cinders are thrown out during the remainder of the run, and, as stated by Mr. Slater, 'over a greater portion of the division the engine is being operated with what might be termed a self-cleaning front end' and the engine 'soon converts itself into a self-cleaner.'

"To sacrifice the positive advantages of freer steaming and reduction of back pressure due to the employment of a larger nozzle, which are attainable with a short front, for the doubtful one of transporting a small quantity of cinders to a terminal in an extension front, does not appear to be either good policy or good practice. That all the area of netting which is necessary can be located in a short front has been conclusively demonstrated on numerous roads, as has also been the absolute uselessness of the cinder hopper, an additional nuisance developed by the extension craze. I am sure a length of 28 ins. from center of exhaust to front will be ample for the purpose, and will give better steaming than with a greater length of front.

"Turning to actual practice, in which 'nothing succeeds like success,' we find the short self-cleaning front end to be adopted in what I believe to be the best and most intelligently designed locomotives in existence, viz., Mr. Marshall's 2—6—2 type of heavy fast passenger engines on the Lake Shore road. In these engines the distance from center of exhaust to front is only 30 ins., and in the latest design of six-wheel shifters, with wide firebox, on that road, this distance is 28 ins. No cinder-hopper is used or needed on either of these types, and the exhaust nozzles of the 2—6—2 engines are, I believe, 5¾ ins. Their steaming qualities are admittedly of the best, and if any engines with 'spark-retaining' extension fronts equal them in this regard, or surpass them as to cleanliness and freedom from fire-throwing, the evidence to that effect has yet to be produced.'

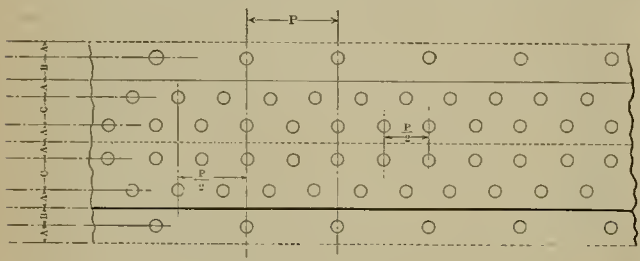
The Pittsburgh Spring and Steel Company have purchased the Fifty-third street plant of the Pressed Steel Car Company in Pittsburgh, consisting of five acres of land with suitable buildings, and will be prepared to execute orders January 1, 1903. The plant will be equipped with the best of facilities and equipment and will have a greater capacity than the works of the A. French Spring Company. In addition this new company expects to equip for the rolling of their own steel. The capital is $500,000. Mr. D. C. Noble, formerly secretary and treasurer of the A. French Spring Company, is president.

TABLE OF SEXTUPLE RIVETED SEAMS.

For Locomotive Boilers.

The accompanying diagram and table, in use in the drawing room of the mechanical engineer's department of the Lehigh Valley Railroad, will be found very convenient in laying out locomotive boilers. It saves a large amount of figuring, which is usually resorted to in order to obtain the right pitch of rivets in these seams.

The primary object was to get absolutely tight seams. In the thicker plates the efficiency of the seams has to a degree been made subservient to tightness and the saving of weight has been carried as far as is consistent with good practice. The form in which this information is put speaks for itself,



Prefer that Original Diameter of Hole allow for 1/8 inch Reaming.

Plate	Rivet	A	B	C	D	E	Max Pitch P	Max Pitch Eff. %	Min Pitch P	Min Pitch Eff. %
1/2	3/4	1 1/4	1 3/4	2 5/8	7/16	1/2	7	8[illegible].04	6 1/2	85.11
9/16	1	1 3/8	1 3/4	2 3/4	7/16	1/2	7 1/4	84.00	6 3/4	83.36
5/8	1 1/16	1 1/2	1 3/4	2 3/4	1/2	9/16	7 1/2	82.99	7	82.56
11/16	1 1/8	1 1/2	1 3/4	2 7/8	9/16	5/8	7 3/4	82.[illegible]	7 1/4	81.72
3/4	1 1/4	1 3/4	1 3/4	3	5/8	11/16	7 3/4	[illegible]	7 1/2	82.38
13/16	1 1/4	1 3/4	1 3/4	3	11/16	3/4	8	81.55	7 3/4	80.28
7/8	1 1/4	1 3/4	1 3/4	3	3/4	13/16	8 1/4	80.00	7 5/8	79.59

A. E.

Holes 1/16 inch Larger than Diameter of Rivet

Table for Sextuple Riveted Seams for Locomotive Boilers.

and it will be invaluable to the draftsman in making boiler drawings. Mr. Gaines, of the Lehigh valley, informs us that this diagram was devised by Mr. W. H. Mussey when he was connected with the drawing room of that road.

AN IDEAL VARIABLE-SPEED ELECTRIC MOTOR.

An unlooked-for development of the problem of electric drives for machine tools was announced in a recent lecture before the Central Railway Club at Buffalo, delivered by Mr. L. R. Pomeroy, special representative of the railroad department of the General Electric Co. In his remarks relating to variable speed motors he advocated for the direct current type, motors having provision for speed variation by changes in field strength, by means of variable resistances in the field circuit, as being the most satisfactory. This method of speed control has long been judged impracticable on account of the very serious sparking at the brushes, but it was announced that a special motor has been developed by the General Electric Co., which avoids this difficulty by means of its small armature reaction. On account of the constant potential across its armature at all times it will maintain a constant speed under changes of load and thus avoid the great objection to motors using the rheostatic control. This method of field control is economical on account of the fact that the total current used in the field coils of a motor is not more than 5 per cent. of the armature current at full load so varying it can have but little effect on the total current. This method also permits a wide range of speeds with a large number of steps and the size of controller required is much smaller. A 10 h. p. motor of this type, running on a 250-volt 2-wire system, has a range of speed of from 350 to 700 r. p. m.

In view of the great importance of the development of this form of motor speed control—so long given up as impracticable—as well as also the admirable treatment of the subject of electric drives in Mr. Pomeroy's paper, further consideration will be given to his paper in our next issue.

PERSONALS.

Mr. G. W. Crownover has been promoted from the position of general foreman of the Illinois Central at Waterloo, Iowa, to that of master mechanic at Freeport, Ill. He succeeds the late E. O. Dana.

Mr. B. F. Flory has been appointed mechanical engineer of the Lehigh Valley Railroad to succeed Mr. F. F. Gaines, recently promoted to the position of master mechanic of the Wyoming division.

Mr. J. J. Reid has resigned as assistant superintendent of motive power of the Rutland Railroad to accept the position of general machinery and locomotive inspector of the Northern Pacific, with headquarters at St. Paul.

Mr. W. L. Harrison has resigned the position of superintendent of shops of the Central Railroad of New Jersey to accept that of master mechanic of the Choctaw, Oklahoma & Gulf Railroad, with headquarters at Little Rock, Ark.

Mr. F. F. Gaines, formerly mechanical engineer of the Lehigh Valley Railroad, has been appointed to the position of master mechanic of that road at Wilkesbarre, Pa., vice Mr. E. T. James, who has been transferred to Buffalo in place of Mr. G. W. Seidel, resigned. Mr. Gaines has held the position of mechanical engineer since April, 1897, and has done excellent work in the motive-power department of the road and in connection with important committees of the Master Mechanics' Association. He was educated at Cornell University.

P. S. Blodgett, general manager of the Lake Shore & Michigan Southern, died October 27 at his home in Cleveland, at the age of 59 years. He was a native of New Hampshire and began his railroad service as a clerk on this road at Adrian, Mich., and never had any other employer until he was called to New York in June of last year as general superintendent. Last February he returned to the Lake Shore as general manager. Mr. Blodgett was a remarkable man, quiet in manner, and had an energy and force which did much to put the Lake Shore into its present high position. His subordinates did their best to assist him because they loved him. They could not help doing so, because of his personality. Had he been less modest and retiring in disposition, he would have been more prominent before the public, for his natural ability and sagacity were unusual. But his life was, for a railroad officer, a quiet one with reference to the public. It was a privilege to meet him and an honor to know him. The influence of his character and his methods will long remain as a priceless tradition of the Lake Shore road.

THE COMPOUND LOCOMOTIVE AND ITS DEVELOPMENT IN FRANCE.

BY A. HERDNER.

Assistant Chief Engineer of Motive Power and Rolling Stock, Southern (Midi) Railways of France.

Editor's Note.—The translation of this paper is by Mr. Charles M. Muchnic, Mechanical Engineer of the Denver & Rio Grande Railway.

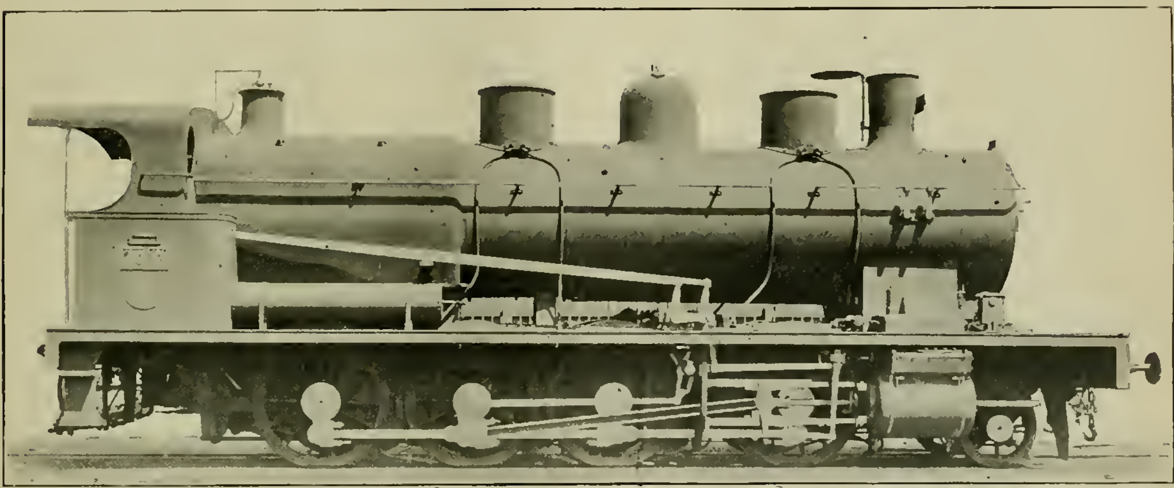
The compound locomotive may be considered, from several points of view, as a French production. It was, indeed, for a French railroad that the first locomotive of this type was built at Creusot (Schneider & Company, Creusot, France) in 1876, after the designs prepared by Mr. Mallet. The principle even upon which the superior economy of multiple expansion is based—that is to say, the absence of adiabatic losses in the cylinder walls—was proclaimed and demonstrated experimentally by two French scientists, Reech and Hirn. Finally, the compound locomotives that are in actual service to-day on French railroads are justly considered among the most perfected. It is not, however, to be inferred that the compound locomotive has made its entire evolution in France and has gone through all the stages of its development there. Like many another inventor, or initiator, Mr. Mallet was not a prophet in his native land. His example was first followed in foreign countries, especially in Russia, by Messrs. Borodine and Urquhart, then in England by Messrs. Webb and Worsdell. But it was in Germany, thanks to the persevering efforts of Mr. Von Borries, that the use of double expansion has been developed most rapidly, and it can be said that the Hanover division of the Prussian state railways became, beginning with the year 1880, one of the principal scenes of the contest that then ensued between the old and the modern systems of steam expansion—a struggle from which the compound locomotive came out triumphantly, as is acknowledged to-day.

At first the compound made little progress, but later it was used more and more. At the end of the year 1890, ten years after the trial by Mr. Von Borries, Germany possessed not less than 430 compound locomotives. At the same time the seven trunk lines of France had only 32, of which 23 were tandem eight-wheel connected compounds of the Woolff system, belonging to the Northern Railways of France. The other 9 were experimental locomotives which were never reproduced except in one or two cases.

It was not until 1892, after the success of the two high speed locomotives, Nos. 2121 and 2122 of the Northern Railways of France, the latter of which figured at the World's Fair in Chicago, as well as the locomotives C-11 and C-12 of the Paris, Lyons and Mediterranean Railways, that the ideas and tendencies toward double expansion have been definitely settled and that the French railway companies have entered resolutely the field so brilliantly opened by two of them.

On the first of January, 1902, ten years after the Northern Railway locomotives Nos. 2121 and 2122 were put into service, the number of compound locomotives in actual service on the seven principal railroads of France were 1,128 and of the following types:—

Two locomotives, having two main driving axles not coupled, one engine having four cylinders, the other three cylinders; 405 locomotives having two main driving axles coupled and four cylinders; 540 locomotives having three coupled axles, of which sixteen are two-cylinder compound; 1 three-cylinder and the remainder four-cylinder compounds; 18_ locomotives having four coupled axles, of which twenty-three are tandem compounds and the remainder four cylinder divided compounds.



Eight Coupled 4-Cylinder Compound Freight Locomotive.—Southern Railway of France.

Detail drawings of this engine will appear in a later number.

While Germany created none but two-cylinder compounds, and Mr. Webb remained true to his three-cylinder type, France, on the contrary, has adopted rather promptly the principle of compounding four cylinders, whose application has since become general, and which has enabled French railways to increase the speed and load of trains,—especially of express trains—to a point till then unknown. Indeed, of the 32 compound locomotives that the seven principal railroads possessed at the end of the year 1890, 29 were of the four-cylinder type, two others had three cylinders, one of the Webb system having a single low-pressure cylinder, and the other of the Sauvage system, having a single high-pressure cylinder. As to the two-cylinder compound type, then so flourishing in Germany, and which type otherwise continued to give satisfaction on the small railroad from Bayonne to Biarritz, it was represented in France, on suburban or secondary railroads, by but one engine. It was a locomotive of the French State Railways, having six coupled wheels, transformed into compound in 1888, and which was, moreover, again rebuilt to its original construction a few years later. Two other two-cylinder compound locomotives, built in 1892 for experimental purposes by the Eastern Railways of France, did not seem to have more success, and only in 1900 do we see a French railway, the Southern, after very encouraging tests, apply the two-compound cylinders to a lot of fourteen locomotives.

It would perhaps be difficult to evince the motives, apparently complex, for which this type of compound has been so unfavorably received in France. The epithet "limping" which occasionally is disdainfully applied to this type, seems to indicate that the reproach applies above all to the dissymmetric, or, in other words, to the inequality of work and forces developed on the two sides of this type of locomotive. The equality of work is beyond doubt desirable, and it is quite evident that it can very nearly be realized for a certain position of the reverse lever and for a certain speed, but it cannot have the same degree of equality for a different admission with a different speed, and especially so when the valve motions of both cylinders are interdependent, which is the general practice. Nevertheless it seems that the probable inconveniences caused by the lack of symmetry have been singularly exaggerated; the importance of these inconveniences is quite limited, since no locomotive, even of simple expansion, is rigorously exempt from them. In fact, a difference from the equality of work on either side of the engine of 20 per cent., and even of 25 per cent., for the most various positions of the reverse lever and speed, and which difference can be reduced to 5 per cent. or 10 per cent. when in the ordinary working gear and speed, cannot produce in practice any detrimental consequences.

Regarding the starting of the two-cylinder compound from a state of rest, which is one of the serious inefficiencies of this type of compound, it seems that the Mallet locomotive has been more severely dealt with than the old simple expansion locomotive. When these latter engines, for certain positions of the cranks, refuse to move the train without first "backing up," no one finds fault with it; this has, so to say, become a matter of course. But when a two-cylinder compound must "back up" to get slack in order to start a heavy train from a state of rest, many a person is still disposed to see in that an inherent defect of this compound system. It is true that the two-cylinder compound necessitates the use of a special apparatus —the intercepting valve—in order to start from a state of rest, and which is unnecessary in the simple engine. But it is also true that, thanks to the intercepting or starting valve, the compound picks up a train fully as well, and often better, than the simple engine. Although Mr. Mallet has given a very complete solution to this problem at the very beginning, there is indeed no apparatus that exercised more the ingenuity of the inventors than the intercepting or starting valve, and from the numerous designs proposed it is not difficult to find one of a very simple construction that will enable the compound locomotive to start more smartly than the similar simple engine, irrespective of the position of the cranks of the former. Such, indeed, is the case of the starting valve I have applied to the locomotives built by the Southern railways and which apparatus consist simply of a small valve, by the operation of which the engineer is enabled to admit live steam into the low pressure cylinder through an opening made in the middle of the cylinder wall and of about 2 sq. ins. area; the displacement of the same valve admits live steam through an opening of about 1.66 sq. ins. into the receiver.

More serious are the criticisms made in regard to the large dimensions requisite for the low pressure cylinder. It is true that the designer is often confronted with the difficulty of locating it, of giving ample section for admission and exhaust passages, and finally to counterbalance properly the excess weight of the low pressure piston. Also the two-cylinder compound arrangement is not the solution that suits best the powerful locomotives demanded to-day for the movement of trains on railroads having a heavy traffic. But it is essential to remark that all of the above objections disappear when it concerns the design of compound locomotives of moderate tractive power; that is, of locomotives that do not demand an evaporation of more than 11,000 to 13,200 lbs. of steam per hour, and which can therefore be made within the normal proportions of locomotive boiler construction in France, with a grate area not exceeding about 22 sq. ft.

There is then a class of locomotives, and quite an important one, for which the compounding of two cylinders constitute not only a very plausible solution, but one which is yet the simplest and the most advantageous. We must neither forget that of all compound locomotives it is the two-cylinder compound that offers the least surface for steam condensation, that it is still the two-cylinder compound that yields the best performance in effective work, and finally it is on the two-cylinder compound that the repairs are the least difficult, because, all things being equal, the dismantling of its parts is much easier. I will say further, the absence of the two-cylinder compound in the motive power equipment of the different French railways represents even to-day, in my estimation, a void to be regretted.

The custom is indeed not to create any new types of locomotives for the main lines until the traffic, having become more intense, justifies the employment of more powerful machines. The secondary or branch lines are very seldom operated by locomotives specially built for that service; most often they make use of the locomotives that have become insufficient for the roads of the first order. It is therefore beyond doubt that had the French railway companies adopted the two-cylinder compound, as has been done in foreign countries, all the locomotives built during the period of 1880 to 1890 and even to 1892 after rather old designs, the motive power of the secondary line would have been to-day, if not absolutely modern, at least far more economical than the motive power they are using to-day, and will naturally have to use yet for some years to come.

Certain railway companies have thought it not yet too late to remedy this deficiency, and it was for this reason that the Southern Railway was led to transform into two-cylinder compounds fourteen locomotives of the Mogul type, of which mention was made above. Other locomotives are being redesigned with a view of applying the two-compound cylinders as soon as those engines get back to the shop for general repairs; for a certain number of old engines this transformation will be quite advantageous. Finally, if we are correctly informed, other roads are doing work in the same direction.

The two-cylinder compound having thus been re-established and the value that it has apparently acquired in the present railroad operation having thus been defined, it is evident, as we have already remarked, that the more and more powerful locomotives that are being put into service on lines of intense traffic cannot be compounded according to the same formula, but four cylinders are absolutely indispensable.

While all two-cylinder compounds belong to the same type, differing from each other only in the design of the intercepting valve—i. e., of an organ of relatively secondary importance—the four-cylinder compounds can be of very different types. These different types may be classified according to their most essential parts and construction into three principal classes, which are characterized as follows:

1st. Having two main crack pins and two valve motions.

2nd. Having four main crank pins and two valve motions.

3rd. Having four main crank pins and four valve motions.

The first comprises the locomotive type well known as the "Vauclain," the type with concentric cylinders and also those of the tandem compound types.

The second class comprises the six-wheel coupled engine recently built by the Baldwin Locomotive Works for the Plant System of Railways as well as the design of the "Atlantic" type engine prepared by Mr. Muchnic for the Wisconsin Central Railway, drawings of which the author has kindly sent to me. (See American Engineer and Railroad Journal, January, 1902, page 24.) To the same class belong the three locomotives exhibited at the Paris Exposition (Parc de Vincennes) in 1900, by Mr. Webb, by Mr. Von Borries and by the Meridional Railway of Italy. This last locomotive, however, presents that important particularity in contradistinction to the types above cited, that both high pressure cylinders have one common valve and both low pressure cylinders have one common valve.

Finally the third class comprises the different types of locomotives that are in service on most of the French railroads and were created by Mr. de Glenn or constructed on the same principles, the express locomotive built by the Chemnitz works for the state roads of Saxony and exhibited in 1900 at the Paris Exposition; the locomotive types designed by the Paris, Lyons and Mediterranean Railways; the locomotives of the Saint Gothard Railway, the one of Central Switzerland and finally the swivel truck locomotives of Mr. Mallet. The de Glenn locomotives as well as the one of the state roads of Saxony are provided with two lifting shafts operated independently, on those of the Paris, Lyons and Mediterranean the two lifting shafts are interdependent and those of the Saint Gothard, of the Central of Switzerland and of Mr. Mallet are provided like all the locomotives of the first two classes with a single lifting

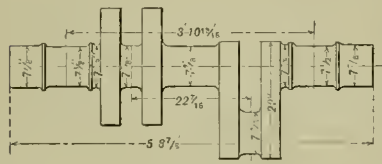


Fig. 1.

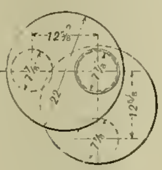


Fig. 2.

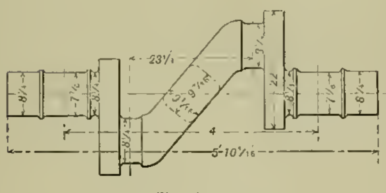


Fig. 3.

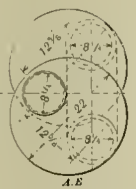


Fig. 4.

shaft. It will also be interesting to note that the four main cranks that characterize the third class of locomotives are on two different main driving axles, whereas on the locomotives of the second category, excepting the one of Mr. Muehnic, who equally employs two distinct main driving axles, the four cranks are always on one driving axle.

The locomotives of the first class present the advantage of lesser complications, and in this respect they approach very nearly the two-cylinder compound engine, but like the latter they are not adaptable for large increase in power. The power developed by the cylinders is being increased more and more, and so long as it is being persisted on to divide these forces on but two cranks it will be necessary to make use of engine transmission parts of much larger proportions, which are more difficult to handle. The masses subjected to a reciprocative motion can be counterbalanced in but a very imperfect manner, and the fatigue of the engine frames is being increased in direct proportion to the forces developed by the cylinders. It is, therefore, very essential to-day to consider future to make place for the locomotives with four main four-cylinder locomotives of the first class are for the above reason, in our estimation, destined to be abandoned in the future to make place for the locomotives with four main cranks which, by a better division of the total forces, permit of lighter engine parts, and in virtue of the possibility of setting the cranks at 180 degrees from each other permit of a much better equilibration of the reciprocating masses and exert a lesser strain not only on the engine frames but also to the permanent roadway on which they run.

It is true that excepting the Mallet type, whose arrangement responds to special conditions, the use of four cranks necessitates absolutely a crank axle—that is to say, a costly forging subject to cracks, and may, in case of failure, increase materially the cost of engine repairs.

The American locomotive builders have always shown themselves very little disposed to adopt the crank axle, and we can quite well understand their hesitation, having found ourselves in an analogous position but a few years ago. Indeed, until 1890 the Northern and Western Railways of France were the only roads that made use of inside connected cylinders for their high speed locomotives. The other roads have shown themselves more reserved. On the Southern particularly, to which the writer belongs, the crank axle was absolutely banished from locomotive construction, and when three years later, in consequence of the constant increase in weight of our express trains, we were led to put in service 14 four-cylinder compound locomotives similar to those of the Northern Railways of France, we were naturally very much concerned as to what service the crank axles, driven by the low pressure cylinder pistons, would render in practice. Those axles were of the Worsdell type with circular plates and are represented by Figs. 1 and 2.

The successive appearance of cracks on three of the axles after a mileage of 37,500, 58,000 and 133,000 miles respectively, seemed to justify the fears we had conceived in that respect, and yet a much longer experience leads us to-day to believe those fears to have been exaggerated. Of the fourteen crank axles put in service in 1894 and 1896 there remain eleven totally free of any fracture or crack, and their mileage varies from 212,100 to 293,900 miles.

In the more recent four and six-wheel connected locomotives the Worsdell axle has been replaced by the Z shape axle, as shown in Figs. 3 and 4. The design of this axle is obtained from the Worsdell axle by substituting in place of the two inner circular disks and the portion of the axle between by a rectangular bar connecting the two journals. Sixty-three of these axles have been put in service between the years 1896 and 1901, inclusive, and none of them have shown the slightest trace of a possible fracture, the oldest of these axles having already made a mileage of 206,200 to 242,000 miles. These results lead us to believe the axle of the Z shape is more advantageous than the one with the two circular plates, and indeed we give it preference to the former design, except when the central portion of the axle has got to be utilized for carrying the eccentrics, as is the case in our new consolidation type engine, about which I shall say a few words at the end of this article. At any rate, this manner of viewing this question will be still strengthened with longer experience.

One more remark we deem necessary to make on the subject of crank axles. When the cost of repairs and maintenance of locomotives is evaluated, it is the custom to proportion the same to the unit of the distance covered, without in any way considering the work performed; as the latter can vary from one to double for the different types of engines, and oftentimes in a ratio still greater, the comparison is necessarily unfavorable to modern locomotives, and so much more so as the power of the locomotives is increased. We do not doubt at all that if the same costs are proportioned to the units of the mechanical work performed—that is, the horse power—the comparison of these costs will generally bring out the advantage in favor of the more powerful locomotives, in spite of the crank axle that we were led to put in to obtain that very increase in power.

The four cranks thus combined can be arranged on one or two main driving axles. In the first instance the four cylinders are generally placed side by side in one transversal plane, while in the second case one pair of cylinders is placed most often to the rear of the other. It seems to us that the second arrangement affords a better distribution of the parts of the engine, accentuates the effects due to the angularity of the main rods and causes a lesser strain to both the crank axle and the coupling rods. It also permits of a more direct path for the steam from the throttle valve to the exhaust.

We have noted above the essential advantage obtained by the use of four main crank pins with respect to the balancing of the reciprocating weights. It appears, however, that this advantage has never before been appreciated in France as much as it is to-day. This, no doubt, results from the fact that the power exacted from the early four-cylinder compound locomotives was relatively quite moderate. The Northern Railways of France has even renounced, for its first four-cylinder compound express locomotive, the very advantages obtained by doubling the number of cranks, since the two main driving axles were made entirely independent of each other. The rotative masses of each high and low pressure cylinder mechanism were then counterbalanced for each wheel separately, as though it concerned an engine of the "single driver type," and in accordance with the formula then used by the Northern Railways, one-third of the total weight of the reciprocating parts was added to the rotative masses balanced.

All the four-cylinder compound locomotives of the eight-wheel type for fast passenger service on the Northern Railways built after were counterbalanced in the above manner, although both driving axles were connected by coupling rods, which it was thought at the time were likely to be removed after the first trials; so that in principle at least the reciprocating parts were very nearly counterbalanced by each other on one hand, and on the other hand the excess of counterbalance carried in the wheels—that is, the additional one-third of the weight of the reciprocating parts—were balanced by each other also. In reality the high and low pressure cranks on each side were not keyed at an angle of 180; to facilitate the starting of the engine they were set at an angle of 162 degrees, and under these conditions careful calculations have led to the adoption of different counterbalance weights for the two wheels on one axle. To avoid such complications it has been decided to give each pair of wheels the same counterbalance weight equal to the arithmetical mean of the two weights calculated and their center lines arranged to coincide with the bisector of the angle formed by the direction of the two calculated counterbalance center lines of the two wheels.

The locomotives of the Nos. 1751 to 1784 series of the Southern Railways were more powerful and heavier than the first locomotives of the Northern Railways, were counterbalanced in the above manner, but it was found in actual service that at the maximum allowable speeds the stresses on the rail were excessive. It was then decided to take into consideration the partial auto-balance of the H. P. and L. P. reciprocating parts obtained by the relative position of the cranks at an angle of 162 degrees and not to enter into the calculations of the horizontal balance, but the resultant of the forces of inertia developed by the reciprocating weights and which are in opposite directions. As this resultant is very small it was possible to obtain a complete horizontal balance, but only in the line of motion of recoil and without considering the "transversal" disturbing forces. The same solution was applied to six-wheel coupled locomotives first adopted by the Southern Railways in 1896. In each case the excess counterbalance due to the reciprocating weights was divided equally in all wheels, which allowed us to reduce the periodic overloads on the rails to a minimum—that is, to reduce to a minimum what is commonly termed the "hammer blow."

When the Northern Railways of France, in 1897, adopted the same type of locomotive a similar method of counterbalancing was applied. However, according to old erroneous ideas, only one-third of the resultant of the inertia forces developed by the reciprocating weights of both H. P. and L. P. cylinders on one side was counterbalanced, but this resultant was balanced in the ordinary way—that is, by adding counterbalance weights directed at once against the longitudinal motion of recoil as well as against the transversal disturbing forces, and this additional weight was uniformly distributed in all wheels.

The Paris, Lyons and Mediterranean Railways, which also found it at first advantageous not to key the H. P. and L. P. cranks on its four-cylinder compound locomotives exactly opposite each other, and which have even made use of the relative positions of the cranks quite different from the 180-degree angle, have not thought necessary to balance wholly or even partially the reciprocating weights on its first six and eight-wheel coupled locomotives. Its compound locomotives for fast passenger service have never had more than a vertical balance.

At the present it appears that the advantages derived from the relative position of the four cranks, as originally adopted, and which are quite disputable, have been renounced everywhere in France. In the more recent locomotives these cranks are set at 180 degrees on each side of the engine and the balancing method generally adopted is a vertical balance, pure and simple.

In the same proportion as the locomotives constructed will become more powerful and heavier, this rational solution will become more necessary. And, indeed, to indicate the measure of resistance of a given roadbed and the limit of fatigue to which it is subject, we have always contented ourselves to give the maximum static load per axle without considering the periodic stresses to which the rail is subjected, due to the centrifugal force of the excess (or horizontal component) counterbalanced weights, and which practically are added to the static load. It is evident that a given road, for example, on which a static maximum load per axle of 16 tons is authorized, but which actually is able to sustain loads that may vary at certain intervals from 13 tons to 19 tons (without even considering the influence of the angularity of the main rods and the play in the springs) will be fully apt to support a load more or less constant of 18 tons and above. The use of a propelling mechanism that allows, at the highest speeds, of a vertical equilibrium pure and simple, presents that incontestable and important advantage that it permits the increase of power and consequently the weight of the locomotive without the necessary increase in the number of axles; to increase even its adhesive weight without increasing the number of coupled axles, and therefore, in many instances, to increase the traffic capacity of a given line without increasing necessarily the main elements of the permanent road.

The above considerations have led the Paris-Orleans Railways Company to increase the static load on rail under each driving axle to 41,800 lbs. in its new express locomotives of the "Atlantic" type that are now under construction, and which, of course, will have but the vertical equilibrium.

(To be continued.)

One result of the prolonged strike of the anthracite miners may be a material lessening of the Canadian demand for anthracite coal in the future. The regular shipments of anthracite this summer from Pennsylvania to the Dominion were entirely withheld, owing to the strike, but the shortage has served as a great impetus to the manufacture of peat briquettes for fuel. Several manufacturers have machines for pressing and briquetting the peat, which removes 50 per cent. of the natural moisture, after which they are dried for use. A plant near Toronto, three miles from a railroad, sells its product at the works for $3.25 a ton, and at Toronto for $4.25, and is running night and day to fill orders. Canada's peat bogs are almost inexhaustible. This is something worth looking up in this country.

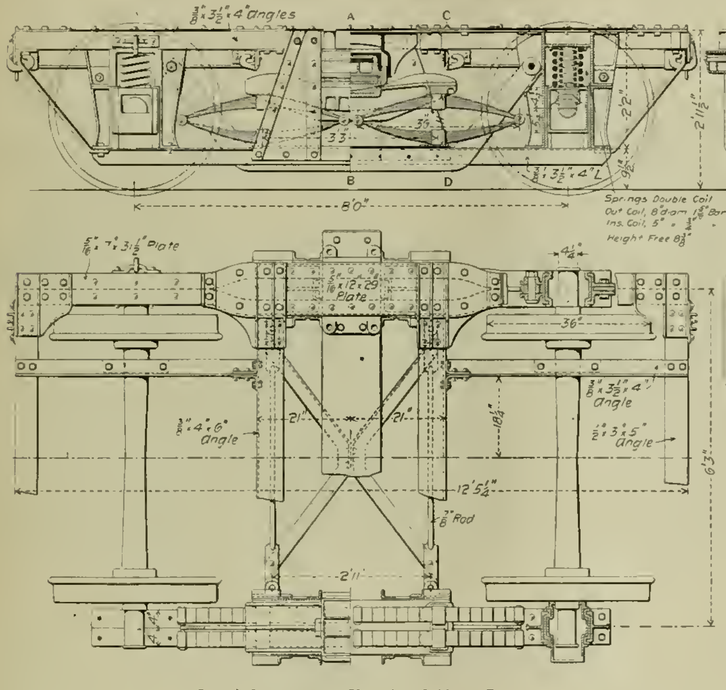
The 16-in. rifle recently completed at Watervliet Arsenal is being transported by water to the Sandy Hook proving grounds. It weighs 130 tons and the cost of moving will be $5,400.

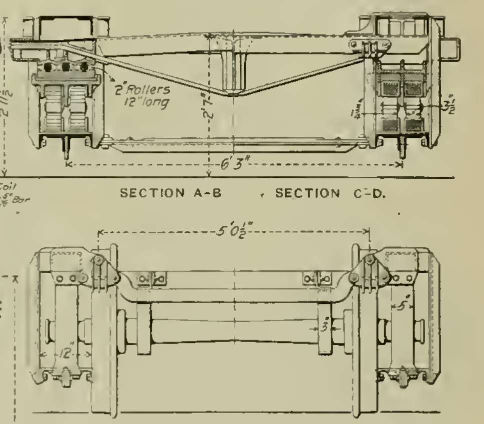
Draftsmen desiring positions should read the advertisement of the Municipal Civil Service Commission of the city of New York on page XXV. of this issue.

THE BARBER STEEL PASSENGER TRUCK.

Standard Car Truck Company.

This truck has been developed by Mr. J. C. Barber, of the Standard Car Truck Company, and it is now undergoing trial under a passenger car with promise of satisfactory results. It is an interesting design and does not follow wooden construction in any particular. Every part is of metal and it represents an effort not merely to substitute metal for wood, but to actually improve the riding qualities and durability of present practice. The truck shown by the accompanying drawing employs 4½ x 8 in. journals and standard M. C. B. boxes. The boxes are carried in columns protected from wear by shoes, and the outer columns are hinged so that wheels may be taken out, without raising the car, after the brace at the end of the frame is removed. The construction of the truck is such as to transmit all of the loads in a vertical direction by centralizing all the stresses in a vertical plane and transmitting them to the center of the journals. The load from the bolster is transmitted through a casting to a shoe upon rollers resting upon a steel seat. This seat rests upon the center of a strongly ribbed equalizer, the ends of which rest upon the centers of two pairs of elliptic springs. These springs rest upon a channel, which in turn is carried by a truss hung to the inner journal box columns by means of 1½-in. steel pins. This truss passes between the lower flanges of two angles which are secured to the under face of the channel, forming the seat for the elliptic springs. A glance at the sectional view shows the manner of transmitting the stresses to the center of the journals. Over the journal boxes are double-coil springs, the outer spring being 8 ins. in diameter and of 1 5-16-in. bar, while the inner coil is 5 ins. in diameter and of ¾-in. bar. The free height is 8⅝ in. The side frames of the truck are of 4 x 3½ x ⅜ in. angles. They are spread at the center and riveted to a cover plate 5-16 x 12 ins. x 29 ins. long. The bottom tie-bar is a ⅜ x 3½ x 4 in. angle. The transoms are ⅜ x 4 x 6 in. angles, with crosstie bracing for the said frames and lattice bracing of angles. The brakes may be hung either inside or outside of the wheels. The side frames have additional bracing in the form of angles and plates, on both sides of the ends of the bolsters. The side bearings are ingeniously arranged to straddle the side frames, and transmit the load which may come upon them to the truck bolster, where it will be received centrally upon the journals. Examination of the engraving will bring out additional interesting features of this construction, among which the removable shoes for the journal-box columns should be noted. The care with which this truck has been developed, and the experience of the designer, warrant the expectation that it will be entirely successful. A truck which will carry a car as smoothly as the present heavy passenger trucks and at the same time weigh very much less than they do seems to be greatly needed. The developments of experience with Mr. Barber's design will be watched with the greatest interest. The offices of the Standard Car Truck Company are in the Old Colony Building, Chicago.





Steel Passenger Truck of New Design.
Standard Car Truck Co.

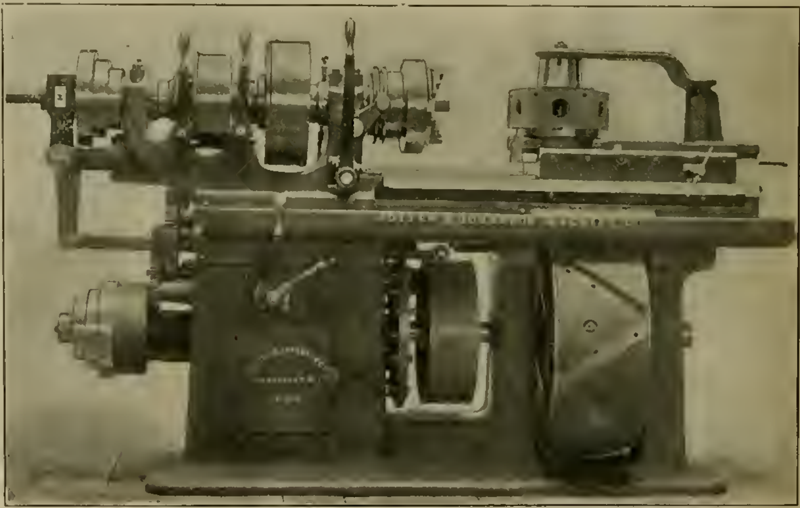
A NEW AUTOMATIC CHUCKING MACHINE.

The accompanying illustration is a view of a new design of automatic chucking machine, involving several interesting new features, which has recently been brought out by the Potter & Johnston Machine Company, Pawtucket, R. I. It is available for the automatic machining of a great variety of pieces of various shapes ranging in size up to 10 ins. diameter and 6 ins. in length, in cast iron, steel or brass, and in shops where large quantities of work of this nature are required, including bushings, collars, gear blanks, valve-motion pins and the like, it can be made a most profitable producer. It is adapted to a large class of work which most turret lathes cannot handle.

The machine shown in the engraving has a belt-driven, speed-changing head and is fitted with an automatic lever chuck. The turret is five-sided, with 2½-in. holes in each face, and the turret slide is operated by the large cam drum shown below the right end of the bed, the power for which drum is taken from the spindle and delivered through gearing to a large gear located near the periphery of the drum. This form of drive provides a direct application of power to the drum and tends to prevent strains on the bearings. The standard set of cams furnished on the drum provides the necessary advancing and withdrawal motions for the machining of all ordinary pieces up to 6 ins. in length and requires no adjustment within that range, and they are so adjusted as to cause the turret to withdraw, revolve and advance at a speed of forty times that of the feeding speed.

One of the most valuable features of this machine is the automatic lever chuck. This chuck is arranged for the opening and closing of its jaws while in motion by means of the vertical lever at its rear, and by its use pieces which can be handled with one hand may be chucked or removed without stopping the machine. In this way the machine may be kept running constantly with very little attention from the operator; one man could run from four to eight such machines at the same time, according to the nature of the work being done, or a single one of these machines could very easily be run in conjunction with a lathe or other machine tool. A heavy scroll chuck is also furnished with the machine for gripping extra heavy or eccentrically shaped pieces. The different speeds for the particular type of machine here shown are obtained through the jaw clutches on the spindle, which clutches are operated automatically.

There is also furnished with the machine a cross-slide, which may be arranged to operate automatically at any time with the turret, by means of the cam drum beneath the middle of the bed, and also an automatic back-facing attachment, which is an invaluable attachment for some classes of work. The cross-slide tool blocks have a travel of $4\frac{1}{2}$ ins. in either direction and have screw adjustments on the slide. The back-facing attachment enables the hubs of gears, pulleys, etc., to be finished on both ends, and other similar work to be done, at one setting, which would otherwise require two settings in the machine. A pair of universal turning and facing tools which is also furnished is of additional advantage to the equipment, and will take care of all the ordinary facing work within the machine's range, up to 10 ins. in diameter.



The New Potter & Johnston Automatic Chucking Machine.

These machines are made with three styles of heads, viz.: With geared automatic speed-changing heads, with belt-driven automatic speed-changing head, and with plain heads. With the geared head the spindle is driven through either one of two trains of gears, each train having four changes of speed, making eight changes in all; with the belt-driven head four changes of speed are available, and with the plain head a four-step cone pulley for belt drive is used. This new machine is characterized throughout by its liberal dimensions and strength of construction, as well as by the ample bearing surfaces and the plentiful supply of power which are so necessary for heavy cuts in rapid machining.

The rapidity with which pieces may be chucked in this machine, as well as the reduction to one-half of the time required for certain operations with the back-facing attachment are very strong arguments for the use of this machine where pieces within its range are required to be machined in large numbers; if it is possible to run it in conjunction with an engine lathe or turret lathe the greatly increased product may be obtained without material increase of the cost of labor entailed.

CORRESPONDENCE.

THE SHOP AS A SCHOOL.

(NOTE.—We are in receipt upon going to press of several additional letters relating to this subject which will appear in the following issue.—ED.)

To the Editor:

In the October number of your paper I was pleased to see what I consider a very timely editorial upon the training of young technical graduates for positions as foremen, master mechanics, etc. The technically educated man has been having his innings for the past few years and, rightly or wrongly, has been considered better qualified to hold the better railroad positions than the man who has grown up through the shops without a diploma. But now a change of opinion seems to be steadily gaining ground, and it is time for us to ask the reason, for, everything else being equal, the man with the higher education ought to be the better man.

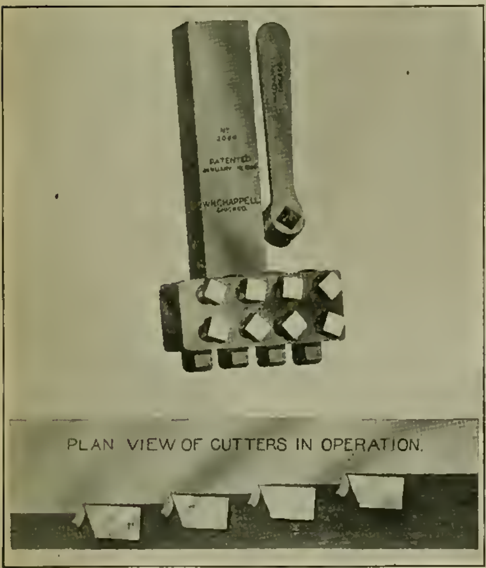
From my experience in the training of young men, I believe the editorial referred to tells the whole story. Too many young men get their shop experience after the fashion of No. 1. Not realizing that their education has just begun when they leave college, they go into a shop with the idea that they have but little more to learn, and to a superficial education they add a superficial shop experience. Such a man will talk most fluently about the pitch of gears and the figuring of the counter weight of a driving wheel, but what will he know about washing out boilers, adjusting the front end of an engine to make it steam, or the intelligent instruction of an engineer or fireman regarding the proper handling of an engine? He may be able to worry through it all after a fashion, but it will be but poor fashion at best. There are a thousand and one obstacles to be met and overcome in the shops, the roundhouses and "on the road" that can be learned in but one way—by actual experience, as did your example, young man No. 2; for no book contains the information; and when it depends upon a man with the limited training of your example—No. 1—to say what shall be done, he has to do one of two things—depend upon some one who has had the experience, or let the wheels stand still while he gains the knowledge for himself.

Such a man usually has a hobby for reports, and will have his office full of clerks comparing percentages that are worthless as regards utility, and making out statements that are never read. This is because his college training predominates and everything must be in black and white to be understood. While such a superintendent of motive power will be examining his reports, one with the training of No. 2 will be watching his shops and roundhouses, looking for opportunities to get more engines into service, and to get more and better service out of them when they are there. He won't be dependent upon tabulated statements for his knowledge of the condition of his power at the beginning of a hard winter's work; he will know from his own personal observation; for from his own experience when growing up in the business, and from his own knowledge of men he will have learned that it takes more than figures and a voluminous correspondence to run his department economically and well.

While in conversation with the manager of a large road a short time ago this question was brought up: He had a superintendent of motive power who was a great student and office man. There were reports to cover everything that took place on the road, and everybody had to make them out, from the man who hoed the ash pan to the master mechanic; and when the manager asked for the reason of a roundhouse delay or an engine "laying down" on the road he got a most elaborate report, a compilation of everybody's statement, but one that meant little, and was always too late to be of any use. That manager wanted results, not reports, and is now looking for a practical man.

What our railroads need at the head of the mechanical departments are men who not only know how to make and repair locomotives, but who can keep them turning at the roundhouses; see that they are properly cared for and gotten over the road; men who can go to either shops or roundhouses, fire cleaning track or coal dock, and talk intelligently with all classes of workmen, instruct them how to do their work and help them out of their little troubles; who can turn the tabulating work over to the comptroller, where it belongs, and devote their time to preventing the detentions and break-downs so that lengthy reports will not be necessary; men of executive ability and good horse sense. Such a man your No. 2 example should make; a man that any school and road would be proud of; a man who is sadly in the minority to-day.

SUPERINTENDENT.



Chappel's Gang Tool.

CHAPPEL'S OBLIQUE GANG TOOL.

This tool is used in shapers and planers, and gives in each stroke of the machine a series of independent and simultaneously successive cuts of the full depth required, the result being that a wide surface may be planed at each stroke of the machine. It is, in fact, much wider than would be possible with a single cutter with equivalent cutting edge. In the engraving the arrangement of the tool is clearly indicated. Each cutter-bar has an individual orifice and individual set-screws to hold it in position. The series of cutters has an oblique arrangement with relation to the line of motion, each cut being slightly in advance of the next succeeding one, each stroke being equal to four of a single-pointed tool.

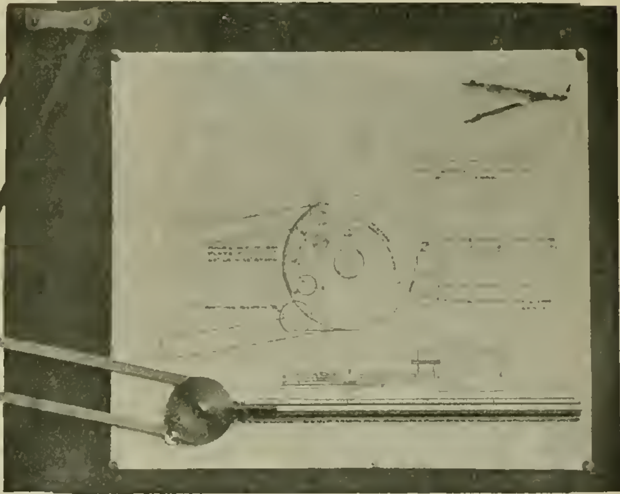
It is intended for roughing cuts on cast iron and brass, and will not work satisfactorily on wrought iron or steel. It is guaranteed to take a roughing cut over 14 sq. ft. of surface per hour and to stand a cut on cast iron or brass 1/4 in. deep with 1/4-in. feed. This tool has proved in actual service to save twice the amount paid per hour to the machinist using it as compared with a single-pointed tool. If 1-16-in. feed be used, the rear on fourth cutter will act alone. With 1/8-in. feed cutters three and four will cut; with 3-16-in. feed, the last three will cut, and with 1/4-in. feed all four cutters will come into use.

A large number of the best known machinery firms in the country are using this tool, and it should be used in every railroad shop. Further information may be obtained from the Edward Smith Company, Buhl Block, Detroit, Mich. This company informs us that the Chappel patent is being infringed and that the infringers will be prosecuted. All tools made under this patent bear the imprint of the W. H. Chappel manufacture.

A RAPID SKETCHING DEVICE.

Since prehistoric times there has been almost no improvement in the instruments used by mechanical draughtsmen. Herewith is illustrated a real improvement which appears to be admirably adapted to aid the draughtsman and assist in the mechanical part of his labors.

This device is exceedingly ingenious and very convenient, making it possible to produce a sketch or small drawing as accurately as may be desired, using simply a triangular scale, with which, by aid of the device, horizontal or vertical lines may always be drawn without attention on the part of the operator. This scale may be moved about as if nothing were attached to it. The device is intended as an aid to managers, superintendents, chief draughtsmen, and all who have occasion to make small drawings or sketches quickly.

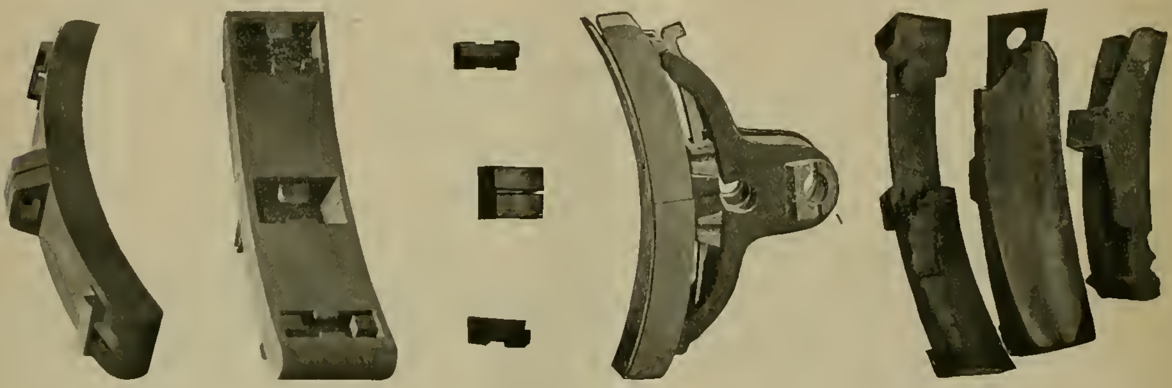


The Rapid Sketching Device Applied to a Drawing Board.

The device consists of a scale attached to a protractor, which is supported from an anchor-plate from the upper left-hand corner of the board by means of the linkage shown in the engraving. The scale has a free motion of 90 deg. between two stops. One stop gives the horizontal line and the other stop the vertical. The two stops are fastened to a protractor and may be turned to any angle, permitting the scale to come against a stop at the desired angle, and also to one at right angles to it. The lower part of the protractor always lies in the same direction, no matter where it is moved about the board, and hence, when the protractor is once set at any desired angle, the scale will give parallel lines anywhere on the drawing. This is accomplished by the two parallelograms, which act like a parallel ruler. The protractor may be clamped at any angle by the thumb-screw, and a spring stop is provided for the 0, 30, 45, 60 and 90-deg. points, and is operated by merely raising it and allowing it to drop into the hole for the desired angle. The scale is used exactly the same as if it had no attachment, and either a flat or triangular scale may be applied. The scales are "chucked," and may be turned to use any face. The triangular scale is preferred because of the variety of the graduations, while the flat scale offers the advantage of giving a better ruling edge. Scales of any graduation will be furnished, and those with white celluloid edges are specially recommended. The vital point in this construction is in the joints. From personal investigation the writer can say that these joints are beautifully made. They are hardened and ground, and, with such light service, should last a lifetime. The stop pins are made conical to compensate for wear. This is, as the name indicates, a device for rapid work, and we should say that not only every chief draughtsman and engineer but every individual draughtsman should supply himself with one of them. The manufacturers are the Universal Drafting Machine Company, Blackstone Building, Cleveland, Ohio. This company also make a draughting machine which was exhibited at the Saratoga convention last June and has been adopted in a number of well-appointed draughting-rooms. The writer believes this to be an excellent device, and it is time the draughtsman received some consideration in the matter of equipment for his arduous work. There has been no satisfactory improvement in draughting appliances which has come to our notice which deserves to be compared with this in importance. As to accuracy of operation, it is sufficient to say that we are informed of a recent test of a 36-in. scale on one of the Universal draughting machines in which the inaccuracy due to the joint was 0.0002 of an inch.

THE INTERLOCKING BRAKE SHOE.

The special feature of this brake shoe is its construction in two parts, permitting its attachment to the M. C. B. brake head and provision for the attachment to its base of shoes which have previously been worn down to their limit. By fitting the brake head at four points instead of three, the construction is safer and permits of self adjustment against the wheel to overcome the effect of an improperly hung brake beam. These shoes seem to wear very evenly, and, unlike ordinary shoes, which wear more rapidly at one end when the beam is badly hung. In the wearing face of the shoe, sockets are made whereby the lugs on a worn shoe may be secured and the old shoe worn entirely through, leaving only the lugs themselves as a loss. These weigh but a few ounces. The photographs illustrate the construction. One road having these shoes in use for three years has had no brake-shoe scrap during that time except from the makes of shoes on foreign cars. These shoes are made in two parts, each with lugs at the center and ends. These take the key in the usual way. When the first shoe is about two-thirds worn out it is removed from the head and placed upon the face of a new shoe, which is then keyed in position and the wear continued until the old shoe is gone and the new one two-thirds worn out. The back of the old shoe fits the face of the new one. Plain-faced shoes are provided for the initial application and for use on foreign cars equipped with shoes of other types. In contrast with this shoe, the usual form is generally scrapped at from one-half to one-third its weight. Instead of having a clearance of one-eighth inch between the lug of the shoe and the brake head at one end, this shoe fits the head at both ends and is not subjected to the heavy transverse strain which breaks many shoes, especially when they are worn thin. In this case the strain is placed on the brake head, where it properly belongs. The claim is made that in spite of the fact that this shoe is in two parts, it will involve the handling of a smaller number of pieces than with the ordinary shoe. On one road where it has been used exclusively for three years a saving of one-half is reported. Any desired material will be used. They may be made with chilled inserts or without, and of special mixtures or of gray iron. Further information may be obtained from the Manufacturers' Railway Supply Company, No. 203 Fisher Building, Chicago.



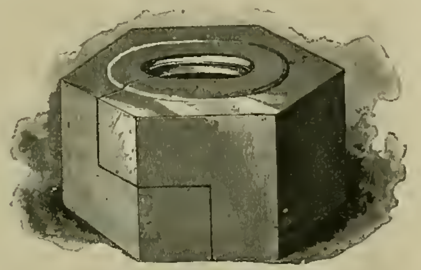
New. Worn. Worn Steel-Back Shoe.

The Interlocking Brake Shoe.

ELASTIC SELF-LOCKING STEEL NUT.

This elastic nut is made from a blank cut from a flat bar of steel. The ends are notched so that when the blank is rolled into the form of a ring and pressed in a hexagon die, it forms a perfect nut with a split on one side which opens slightly as the nut is turned on with a wrench. This split is zig-zag in form and it does not interfere with any of the functions of the nut. The nut is tapped slightly smaller than the bolt so that when put on with a wrench it is distended slightly and the split side opens about one one-hundred and twenty-eighth of an inch. This develops a constant grip on the bolt, which holds it from working loose. When made in this way, the grain of the nut is at right angles to that of the bolt, and it is always stronger than the bolt on which it is placed. The elastic opening permits the nut to be applied and removed repeatedly over rusted or battered threads, which would prevent the use of ordinary nuts. This nut is made in sizes from ⅜ to

1¼ ins. They are tapped to fit the regular U. S. Standard bolt of corresponding sizes. The elastic nut has been thoroughly tested for several years and has been found satisfactory on cars, locomotives, machinery, rail splices and for other purposes. When used in any of these services, but one nut is employed, and in car trucks a great saving is thereby effected.



Elastic Self-Locking Steel Nut

A representative of this journal has seen copies of letters showing satisfactory service where nut-locks or other types have failed. Further information may be obtained from the National Elastic Nut Company, Russell avenue and Superior street, Milwaukee, Wisconsin.

The output of the Pressed Steel Car Company in October surpassed all former records. In that month 3,000 cars were built, averaging 111 cars per day for 27 working days. This company has built 22,402 cars this year, requiring 350,000 tons of steel, not including material for numerous frames, trucks and bolsters.

BOOKS AND PAMPHLETS.

Master Car Builders' Association. Proceedings of the Convention of June, 1902. Edited by Mr. J. W. Taylor, secretary, No. 667 Rookery Building, Chicago, Ill.

This volume is of particular interest this year on account of the great importance of the subjects reported upon and the discussions regarding them, which are recorded in full. One of the most important subjects handled was the report by the committee on outside dimensions of box cars, and also important reports were made on the tests of side bearings and center plates, and on the tests of various draft gears. The Proceedings this year contains 560 pages and 54 folded plates regarding standards and recommended practices of the association. The book is well illustrated, and is bound in the usual style of binding. Credit is reflected upon the secretary for its early issue.

Poor's Manual of the Railroads of the United States. Thirty-fifth Annual Volume, 1902. Octavo, 1,640 pages, with tables, maps, and indexes. New York: H. V. & H. W. Poor, 68 William street. London: Effingham Wilson.

The fact that the stupendous work of compiling the statistics of the railroads of the United States for a year can be completed before the end of the following year comes as an annual surprise. This volume contains complete reports, representing 191,946 out of a total of 198,787 miles. It shows an increase of 4,453 miles during the year, and gives traffic statistics of 194,512 miles of road. The great value of the statistics lies in their completeness and in the special figures for each separate road, and the fact of their prompt appearance. These reports are the most valuable of their kind in the world, and while the Government statistics, prepared by the Interstate Commerce Commission have a value of their own, they give little information with reference to the individual companies. Poor's Manual, on the other hand, presents the organization, results of operation, history and financial position of every individual road in the country. Not only steam but street roads are given, the latter occupying a continually increasing share of space in the annual volumes. Canadian railroads are included; also miscellaneous corporations. The work includes tables of dividends paid by railroad and other corporations, a ready-reference bond list of leading steam roads, statements of annual meetings and transfer agencies, a list of railroads merged into other lines, statements of State and municipal indebtedness, a directory of railroad officials, and indexes of the contents. The manual not only holds its own but increases in value every year because of its continual extension. It is really a manual of the most important industry of the world, and has long been indispensable to those having financial interests in railroads.

"Oil-Burning Locomotives."—This is the subject of the Record of Recent Construction No. 37, published by the Baldwin Locomotive Works. Beginning with the discovery of oil, the use of liquid fuel in steam-raising is briefly traced and its earliest application to locomotives is considered. Following this is a liberal abstract from Dr. C. B. Dudley's published statements in this connection, in which a comparison of oil and coal as to relative cost is prominent. The advantages of oil over coal are considered, and the concluding pages describe, by aid of engravings, the successful practice of the Baldwin Locomotive Works in their experience in equipping 250 locomotives for oil-burning. This pamphlet is an important contribution on this subject, and should be filed for reference in the library of every motive-power officer.

Pintsch System of Car and Buoy Lighting.—The Safety Car Heating and Lighting Company has issued a tasteful and attractive pamphlet of 40 pages illustrating "an established and successful system" of lighting. It contains excellent half-tones of 59 plants for the manufacture of Pintsch gas, distributed from Maine to California and Mexico. The text presents the facts concerning this system and its development, and the impression received is that the Pintsch system is a product of study, experiment and practical experience of many years and that it may be regarded with confidence as a satisfactory system. No one can examine this fine pamphlet without being impressed with the solidity of the system and its large extent. The use of Pintsch gas in buoys as an aid to difficult navigation also receives attention.

The Jeffrey Manufacturing Company, Columbus, Ohio, have issued a new catalogue of elevating, conveying and power-transmission machinery. This is catalogue No. 72, a pamphlet of 372 pages, illustrating, from photographs of machinery in actual use, the product of this company, showing how it may be adapted to almost every known industry. Those interested in coal or ash conveyors, wire-rope transmission, electric locomotives and sprocket-chain devices of all kinds, should procure a copy of this catalogue.

Pratt & Whitney, Hartford, Conn., have recently issued a new catalogue descriptive of their new model of profiling machines. They have recently brought out this new model, involving a great many very valuable improvements over their previous types, the main feature of the change being a new principle of drive for the spindle. The drive is now through a pair of 45-degree spiral gears located within the head, but not in any way interfering with the traversing motion of the spindle. The result of this change is a greatly simplified and more efficient machine, its size being reduced nearly one-half for the same capacity. Other valuable improvements are also incorporated, notable among which are split or divided gears for the head traverse and table cross-feed motions, whereby all lost motion may be absolutely eliminated.

The Chicago Pneumatic Tool Company have recently issued a beautifully illustrated 72-page catalogue of the air-compressors manufactured at their Franklin (Pa.) plant. It contains new illustrations of all the latest types of compressors and a very complete illustrated description of the chief features of their design; also, all necessary data pertaining to standard styles of compressors, an article on the uses of compressed air, and much valuable information relative to the proper installation of compressed-air equipment and tables not usually printed in similar publications, are given. Although designed primarily for the operation of pneumatic tools in shop and field riveting, drilling, chipping, hoisting, etc., and possessing features particularly desirable for such duty, these compressors are also suitable for all of the customary employments of compressed-air power.

This company has also issued a pneumatic hoist catalogue, describing and illustrating their new line of the pneumatic hoists formerly manufactured by the Chisholm & Moore Manufacturing Company. Either one of these catalogues will be mailed free to anyone interested.

AD-EL-ITE PAINT PRODUCTS.

Something which will remove paint and varnish quickly and satisfactorily has long been sought for, and from what is said of a material called "Ad-el-ite," manufactured by the Adams & Elting Company, of Chicago, it seems that the right thing has been found. This is in a liquid and semi-paste form. It is said to remove varnish and paint very quickly, and there are apparently no disadvantages connected with its use. For example, it contains no water, alkali or acid; has no objectionable odor; does not injure the hands, and does not soften glue nor raise the grain of veneers or woods. It is said to be free from all injurious effects, and is in demand for refinishing cars, yachts, carriages, furniture, and cabinetwork of all kinds. One gallon will entirely remove from 200 to 300 sq. ft. of surface.

The same manufacturers produce "Ad-el-ite" enamels and wood finishers' supplies. They also manufacture a car cleaner which contains no potash in any form, and is both a varnish-preserver and cleaner.

Attention has been called repeatedly in these columns to the importance of using better material for painting the front ends or smokeboxes of locomotives. This concern manufactures "Ad-el-ite Black" for locomotive front ends, and they are prepared to send an expert to show its merits and economy by making a practical demonstration. The address of the Adams & Elting Company is 155 Washington Boulevard, Chicago, Ill. This company has had a long and satisfactory experience in the manufacture of wood finishers' supplies and paint specialties.

Illustrated Sectional Catalogue, No. 141, of the American Blower Company, Detroit, Mich., has been received, descriptive of blowers. Steel pressure blowers, volume blowers and fan blowers are illustrated and described together with necessary auxiliary apparatus. Also, this company has issued a brochure illustrating the "A. B. C. Co. at Home," in which all departments of their large factory are interestingly set forth.

The scrap pile is not attractive in any sense, but it contains lessons which are most important. Sooner or later it includes the best as well as the worst of everything used on a railroad, and an occasional hour spent in examining the truths which it tells as nothing else can tell, is time well employed. This idea is not original at all, but it is brought to mind by a leaflet just received from the Boston Belting Company, bearing a photograph of a pile of discarded air-brake hose, suggesting an examination of the scrap pile to show the brand of hose that lasts the longest.

The Franklin Machine Works, Inc., Philadelphia, Pa., have issued a catalogue illustrating and describing the machine tools of their manufacture. Their improved types of horizontal floor boring, milling and drilling machines, which were illustrated and described on page 325 of the October issue of this magazine, and their plain milling machines, are well illustrated and set forth. This company also makes a specialty of cold saw cutting-off machines, the catalogue illustrating three sizes of bar saws, universal cold saws, steel foundry saws, and crank-shaft saws as well as improved automatic sharpening machines for these cold saws.

MANUFACTURING NOTES.

An order was placed November 7 by the American Car and Foundry Company for 20,000 1⅜-in. Bartley nut locks, manufactured by the American Bolt and Nut Fastener Company, 306 Frick Building, Pittsburgh, Pa.

The Kindl Car Truck Company have opened an office at 425 Austell Building, Atlanta, Ga., where their interests will be looked after by Mr. P. H. Wilhelm as Southern agent.

The Holland Company has recently been incorporated in Illinois with offices at 77 Jackson Boulevard. The officers are Mr. Alex Holland, president; Mr. J. C. Martin, Jr., vice-president, and E. B. Pickhardt, secretary and treasurer. These gentlemen have been associated with well known railroad supply concerns. They are now manufacturing the Sharp journal box, the Martin flexible steam coupling and other railroad equipment devices.

The smokestacks of the Fall River Line steamer Priscilla, of the New York, New Haven & Hartford Railroad, and the stack of the Pennsylvania Railroad grain elevator, New York harbor, are protected by Dixon's silicon-graphite paint. This and other information is noted in a leaflet issued by the Joseph Dixon Crucible Company, Jersey City, N. J., including a statement that this paint has been continuously used for nearly 40 years by many of the largest steamship, smelting and manufacturing companies in different parts of the world.

Notwithstanding the fact that the Otto Gas Engine Works, Philadelphia, added 12,000 sq. ft. of floor space to their plant less than two years ago, their increasing business is again crowding them, and the last available bit of ground in the block covered by the works is having a building 45 ft. by 100 ft. erected upon it. The demand for large units makes necessary these increased facilities, and the new building will be equipped with the largest and latest types of machine tools. The tools are ordered, and the new shop should be running inside of six weeks.

The Pittsburgh Filter Manufacturing Company, Empire Building, Pittsburgh, Pa., state that they have had an unusually busy year installing waterworks filters and water-softening plants. In a recent letter they mention having constructed the largest water-softening plant in the world, having a capacity of 2,500,000 gallons, for the Tennessee Coal, Iron and Railway Company, Birmingham, Ala. They have also furnished six plants ranging from 500 to 7,500 horse-power in capacity and seven plants ranging from 600,000 to 2,000,000 daily capacity for various manufacturers and waterworks.

The Chicago Pneumatic Tool Company reports a very large increase in sales during the past few weeks, and all of its factories are working night and day in an endeavor to fill the orders which are pouring in. Especially is this the case in the air-compressor department at Franklin, Pa., which is being pushed to its utmost capacity. Mr. J. W. Duntley, president, is still continuing his business trip on the Continent, and his route is announced by the cables continually being received by the Chicago office containing large orders for pneumatic tools, annealing machines, rivet forges, etc. His return is not definitely announced, although he will probably leave Europe in the very near future.

The Gold Car Heating and Lighting Company is to be congratulated upon securing the services of Mr. Charles L. Gateley. Mr. Gateley has had a wide experience, and possesses a large acquaintance among railroad men, which will be particularly valuable in the work in which he is now engaged. He is a graduate of Stevens Institute of Technology, and began his railroad experience in the West in connection with the Missouri Pacific Railroad. His experience has brought him into close contact with car construction and particularly with heating and lighting problems, in which he is specially well versed. Mr. Gateley is also congratulated upon his connection with such a firm as the Gold Car Heating and Lighting Company.

H. K. Porter Company, Pittsburgh, builders of light locomotives, report very active business conditions. They have just completed two 24-in. gauge compressed air mine locomotives for a large lead company in Missouri; also a heavy compressed air locomotive for the mines of the Keystone Coal and Coke Company, of Pennsylvania, and additional air locomotives are now building for the McCormick Harvesting Machine Company, to be used at the Chicago works. Another order is being filled for the Central Coal and Iron Company, Alabama. Contracts have recently been closed for similar machines, including the equipment of the Dominion Iron and Steel Company, Sidney, Cape Breton. The shops are now engaged in building a number of steam mine locomotives for West Virginia and Pennsylvania, also a number of logging locomotives for the West and South. Lately there has been an unusual demand for this machinery for steel works and contractors, for switching locomotives, and the books show a large number of orders for export to Mexico, the West Indies, Japan and South America.