AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

SEPTEMBER, 1896.

THE ALTOONA SHOPS OF THE PENNSYLVANIA RAILROAD.

III.

(*Continued from page* 169.)

The focus of Altoona is the Logan House, a hotel which was built soon after the shops were located there, and which is now in the center of the city on the north side of the railroad tracks, the great locomotive repair shops being on the south side and opposite to the hotel. The hotel is not shown in the plan of the shops, which was published in our June number.

For convenience of reference this plan is reprinted herewith, and the position of the hotel is indicated in the reprint. The erecting shop, No. 1, shown in the plan, is directly opposite to the hotel and first attracts attention. It was, we believe, the first shop of the kind in this country which was built with longitudinal tracks and overhead traveling cranes, and has been the subject of frequent study and much criticism by railroad men ever since it has been erected. The cranes were made in England and are carried in brick arches along the sides of the shop. These are large and cumbrous and exclude a good deal of light, and would not be repeated if the shops had to be rebuilt. In fact it is said that the cranes which were originally put into this shop are now too light for the beavy engines which must be handled, and plans are under consideration to replace the cranes with heavier ones, and substitute an iron supporting structure to carry them.

Erecting shop No. 2 forms a part of the same group of buildings and is similar to No. 1, and has three longitudinal tracks with a pair of overhead travelling cranes which were built in Altoona. They, too, are carried on brick arches, but these are arranged so as to light the shop better than No. 1 is lighted. The two side tracks each have a pit, while the centre one has not. The engines to be repaired are placed on the side tracks, and the middle one, as far as possible is kept clear. The space between the middle and side tracks is excavated and covered over. In these basements, as they may be called, the water and steam pipes for heating the building and testing boilers are located, In the No. 1 shop the pump and accumulator for the water pressure, are located under the floor. The boilers are all tested first by a cold water hydraulic test, and then with hot water and steam pressure. For both tests the water is conducted to the boilers by the system of pipes described, and in making the steam test the boilers are entirely filled with water, which is then heated, and expanded with steam from the steam pipes.

The space below the floor is also used for storing the parts of engines, which are brought in for repairs, and are dismantled. The woolen floor is removable which enables the parts to be easily deposited in the basements and taken out again when they are needed.

There is room for nine engines on each track and about 34 can be repaired and turned out each month in each shop, although the average is not as great as that number. The cranes are not very rapid in their movements and for that reason they are used for handling only the heaviest parts of the locomotives which are being repaired. As has often been explained, any engine can be lifted up bodily and transferred laterally over the middle track, and then moved longitudinally to any point in the shop, and again carried over to either side track and placed wherever it may be required. In this way, if for any reason it is desirable to give precedence to some engine, it can be taken up and placed in any desired position.

These shops and the appliances in them have now been in use for a good many years and although the relative merits of shops with longitudinal and transverse tracks is still a much-disputed question it would be hard to find any one about Altoona who would advocate the building of an erecting shop with transverse tracks and a transfer table, which is the usual plan adopted in this country.

The general arrangement of these shops may be commented on. The machine shop is a two-story building centrally located between the two erecting shops, with which it is connected by wings at the south end. At the north each of the three parallel shops abuts against a transverse building with tracks leading out to a transfer table. In this shop the cylinders, frames, trucks, etc., are assembled, and put together, preliminary to being taken into the erecting shops. Between the machine and erecting shops there are open spaces where wheels, castings, etc., are stored temporarily before being taken into the shop. West of the transfer-table is the wheel shop, smithy and boiler shops. The wheel shop is in a direct line with the machine shop, and all the buildings last referred to are connected with the transfer table and by that means material or partly finished work can be carried to any part of the machine or erecting shops. Still farther north is the wheel foundry and another larger foundry for general castings. The brass foundry and other smaller buildings are distributed as shown in the plan from which it will be seen that what may be called the co-relation of the shops is very convenient and that although the present arrangement of buildings has been the result of a process of evolution it has not been without a system which has evidently been carefully thought out. The location of the three round houses Nos. 1, 2 and 3 is shown and also that of the testing laboratory which is now famous the world over.

At the time of our visit to the erecting shops all the engines in No. 1 it was noticed had Belpair boilers. The Pennsylvania Railroad has adopted this form of boiler more extensively than any other line in this country, and, apparently, have no present intention of abandoning it, but are applying it to all new engines which are built and to old ones which are rebuilt. It is true that some of the earlier boilers of this type, which were too small, have been removed and are now used in stationary service, but the number is constantly being increased and the type is adhered to, which indicates that it has been giving satisfaction. Some

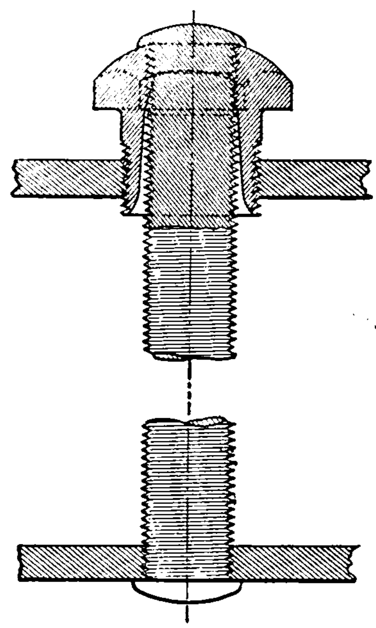
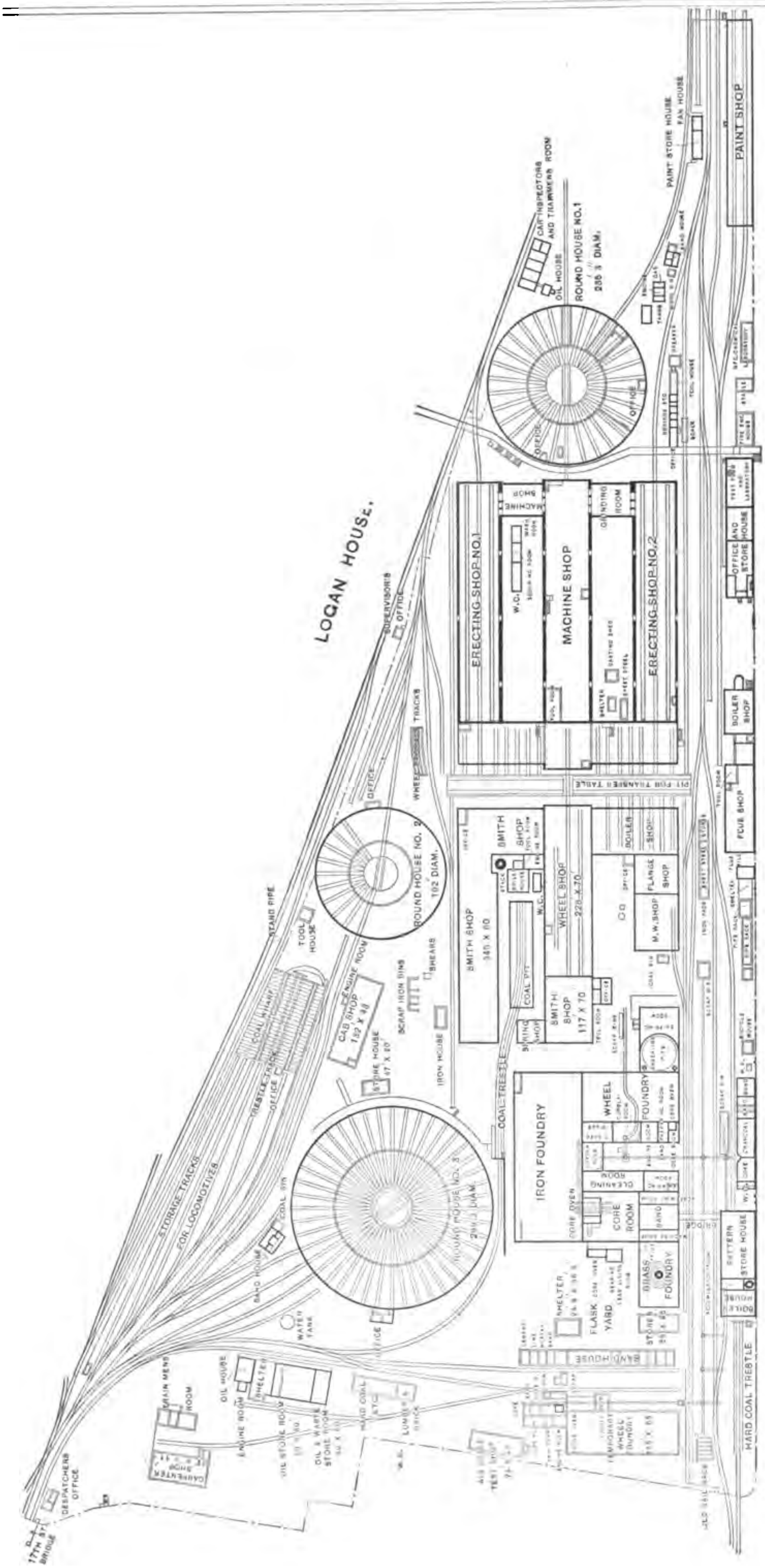


Fig. 1.—Flexible Staybolt.

trouble has been experienced with them in common with all other locomotive boilers from the breaking of stay-bolts. It was observed that more stay-bolts break in steel than in iron plates, and that the tighter the bolts are screwed into the plates the larger the number of breakages were. From this and other facts the inference was drawn that the rigidity of the bolts had much



PLAN OF LOCOMOTIVE REPAIR SHOPS, ALTOONA, PA.

to do with their failure. Mr. Joseph Nixon, the foreman of the boiler shops, was therefore led to design the form of attachment shown in Fig. 1, which permits of some degree of flexibility in the bolt, and also provides a more secure fastening. It consists of a nut with a tapered thread 1¼ inches in diameter which is screwed into the outside plate of the fire box. The hole on the inside of the nut is tapered, and "runs off to nothing" in the thread, which is cut in the outer end of the hole. The point of flexure of the bolt is thus distributed over some distance and is not concentrated at one point. The bolt is riveted over the outside of the nut, as is usual, and the inside end is screwed and riveted into the fire-box plate in the usual way. The nuts were first made of brass, but are now made of malleable iron. They were first applied to boilers in 1892, and they worked so satisfactorily that they have gradually been used more and more, and now orders have been given to apply them to all boilers which go through the shops. Thus far no bolts have been found broken which are fastened in this way. They are put in the upper rows which are most liable to break, and in some engines in all places where the nuts will not interfere with the attachments to the boilers. The drilling of the ends of stay bolts it has been found will not always reveal a fracture if it occurs, and it was partly for that reason and also to lessen the cost of repairs that this method of fastening bolts was designed by Mr. Nixon and adopted by the company.

A good many years ago the Pennsylvania Railroad had in its equipment a number of Winans Camel engines which some of our older readers will remember had fireboxes, the crown sheets and tops of which sloped downward and backward from the barrel of the boiler, and were stayed with ordinary stay-bolts. Later the Pennsylvania Railroad Company built some consolidation engines with similar fireboxes which have been known as Class I engines. It is said of the boilers of these engines that they are the cheapest to maintain of any on the road, as they are also the lightest boiler in proportion to their size of any in use. Having some interest in this we made inquiry and ascertained the weights of three classes of boilers: 1st, Class I, of the kind described; 2d, Class A, for anthracite coal, but having a wagon top and crown-bars, and Class R, a Belpaire boiler. The following table gives the weights of the boilers as they leave the boiler shops without flues, their heating surface and the weight per square foot of heating surface:

Class.	Weight of boiler.	Heating surface.	Weight per square foot of heating surface.
	Pounds.	Feet.	Pounds.
I	11,413	1,259.5	9.06
A	16,361	1,205.0	13.57
R	18,850	1,731.0	10.89

The weight of the Class I boiler included water grates, whereas the others did not. It will be seen that it weighs 1.83 pounds per square foot of heating surface less than a Belpaire boiler, and 4.51 pounds less than one with crown-bars. In a boiler with 2,000 square feet of heating surface there would, therefore, be a difference of more than 3,660 pounds in the weight of a Belpaire boiler, and one of the Class I type and over 9,000 pounds between a boiler of the latter type and one with a crown sheet supported by crownbars. The comparison is, perhaps, not quite fair, for the reason that the Belpaire boiler was designed to carry a higher pressure than the others were intended for, but, after allowing for this, the fact remains that boilers of the camel type are lighter than any other form in use, and are easier to maintain, not slight advantages. As the objection is sometimes made to them that they do not carry water well, we made special inquiries with reference to that point. The testimony relating to this point was a little conflicting regarding the class I boiler which was probably deficient in steam room. Men who ran camel engines, and still survive, say that they always carried water very well. They had, however, high domes which were very large in diameter, and located at the front of the boiler near the front tube-sheet. If the only difficulty with boilers of this kind is that of carrying water satisfactorily it would, therefore, seem that it is remediable. The figures indicate that the capacity of a boiler of this kind, of a given weight would be about 20 per cent, greater than one of the Belpaire type, and the difference would be still greater if the comparison was made with one having crownbars. These are certainly no small advantages.

It is a curious fact that in piecing out flues in different shops in the country there are a greater variety of methods in use than are employed in doing any other kind of work. At Altoona there is one of the best equipped and most convenient flue shops that we know of. It is a large, well lighted and ventilated building apart from the boiler shop and just south of it. The flues when they are brought in to be pieced are first put into a "rattler," and the scale is cleaned off. The rattlers used here are cylinders of about 30 inches diameter, which are formed by bolting long cast-iron bars of T section to circular discs or heads attached to a suitable shaft. One of these bars is removable, and the flues are put inside of the cylinder through the opening which is left when it is removed. Between the others there are open spaces or slots about ¾ inch wide. Formerly flues were rattled dry, but now the practice is to put them into the rattler with broken furnace slag and then conduct a stream of water, by a perforated pipe, which extends the whole length of the rattler—the water entering through the open spaces left between the bars. It is said that a given number of flues can be cleaned by the wet process in less than half the time than is possible if they are "rattled" dry.

After being cleaned the next step is to cut them off to the proper length, and scarf the ends of the flues externally, the piece to be welded on being scarfed internally. They are then driven together, heated in a coke fire and welded in a very simple machine, consisting in a revolving horizontal shaft which enters the inside of the flue. Another parallel shaft carries a roller, about 3 in. diameter and 2½ in. face, which can be raised and lowered in relation to what may be called the bearing shaft, and after the heated flue, which is to be welded; is placed in the latter, the roller is pressed down on the heated joint and the weld-ing is effected in a few seconds. The two shafts are geared and revolve together. The machines are made by J. Sadler, of New York.

After being pieced in this way, the flues are tested in a hydraulic tester. This is arranged so as to fill the tube with water taken from the water supply. At the same time the water flows into what was originally a pump cylinder of a Westinghouse brake pump, containing a piston. The water enters the cylinder below the piston and raises it up. When the flue and the cylinder are filled the water connection is closed, and compressed air is admitted above the piston in the cylinder. This is proportioned so as to give the requisite pressure in the flue, and the test is thus made almost instantly. After being tested the flues are swaged down at one end, which is ground to receive a copper ferrule. This is brazed to the tube, and is in turn also ground on its outside surface. It has been found that when tubes leak, that the leak is more likely to occur between the tube and the ferrule, and not between the ferrule and tube plate, and that the brazing prevents such leakage.

Another method of putting in flues has recently been tested. This consists in putting the ferrule into the hole in the tube sheet and rolling it before the tube is put in. Afterwards the tube is put in and rolled inside of the ferrule.

This shop has a capacity for handling about 11,000 flues per month, the average output being about 8,000. All the work is done by piecework, as is the case in most of the shops in Altoona, which system is popular with the men and is profitable to the company. The general verdict is that there is no practical difficulty in securing good work by careful inspection, and that it is no more trouble to inspect work under the piece system than it is to inspect the men when they work by the day and keep them up to their duties.

The system of piece work has been very generally adopted in all the shops, even in round house repairs, and in such work as washing windows with the result of a great reduction in cost. The system is generally liked by officers and men and it would be difficult to induce the authorties at Altoona to return to the days work system after the experience they have had. It is said that the piece work system saves 65 per cent. on the cost of labor. There were of course at first many difficulties in introducing this method, one of the chief of which was, the making of a scale of prices, which took three years to perfect, and which now requires amendment at times. Besides the advantages named work is done quicker and can be hurried more than is possible when men are working by the day. In this way more work can be done with a given equipment than is possible with the old method. The inspection is done by the foreman or a special person appointed for that duty. It is upon the inspection that the success of the system of piece work is dependent. It is said that but little trouble is experienced from bad work.

One of the most interesting places in Altoona is the testing department and laboratory, which has acquired a world wide reputation. It occupies a three-story building 40 by 72 feet, located on the south side of the ground owned by the company. The chemical laboratory, under the charge of Dr. C. B. Dudley, occupies the whole of the third story and about half of the second. The first floor is devoted to the department of physical tests, under the charge of Mr. A. W. Gibbs.

The chemical laboratory is very fully equipped with every requisite for analyzing the great variety of materials which are bought and used in the operation of a great road like the Pennsylvania. The purchase of material by this company amount to many millions annually, and cover a great variety of substances. These include metals of different kinds, such as iron, steel, copper, brass, lead, zinc, etc., paints, oils, soaps, petroleum products of various kinds, caustic soda, blue vitrol, sal ammoniac, disinfectants, mineral wool, magnesia, boiler coverings, India rubber, etc., etc. The aim of those who conduct the laboratory is first to establish a standard of qualities which the material that is bought should possess, and then make specifications of these qualities by which they are bought, and to which they must conform. This alone has required an immense amount of investigation, study and research. At present about thirty-five specifications of this kind have been formulated, and all the materials to which these refer are bought to conform thereto. When the material is delivered samples are sent to the testing department, properly labeled, and designated by the number of the requisition under which it was ordered, and none of the material can be used, excepting in emergencies, until the samples have been inspected and analyzed to ascertain whether they comply with the specifications. As soon as the analyses are made reports thereon are sent to the superintendent of the motive power department, and the holders of the materials are duly notified whether it does or does not comply with the requirements. If it does it is accepted and used, if not the parties who supplied it are notified and it is returned to them. Some of the materials are subjected to both chemical analysis, and to physical tests before being accepted. The ascertainment of the qualities and characteristics, which all these different materials should have of course, implies as has been said an immense amount of special knowledge, and these which have been prepared were evolved as the result of the work of this unique department of the Pennsylvania railroad during the many years of its existence and are the results of much labor, research and experience. The great variety of materials which are bought by and are sold to railroad companies are, of course, subject to all kinds of deterioration, adulteration and falsification. Sometimes this arises from the ignorance of dealers or manufacturers; in others it is more culpable. It is the business of the testing department to ascertain whether the materials bought have the qualities required. There are, of course, some things which require only to be inspected, and not tested, and for that reason inspectors are employed, but these belong chiefly to the physical test department, and are sent wherever their services are required. That a private individual firm or a great company will be liable to be cheated if it does not know what kind of materials are supplied to it, or if its knowledge of what it gets is supplied only in a very casual, desultory and unsystematic way, would hardly appear to require any proof. The Pennsylvania Railroad Company has organized its test department in a thoroughly systematic manner to do what every prudent business man does when he buys anything. The magnitude of the transactions of the railroad company of course requires that the organization and scope of this department should correspond thereto in order to accomplish its purpose. In another article a fuller detailed description will be given of the work which has been and constantly is being done, with some reports of the results which have been accomplished thereby.

(To be Continued.)

Communications.

Sensational Tests of Car Weeels.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

The interesting account on page 92 of your June issue of certain "thermal tests" of car wheels, made at Altoona, is calculated to excite alarm and to weaken confidence in cast-iron car wheels.

A little reflection will, I think, convince those who are familiar with the manufacture and use of car wheels that this test is entirely unlike any conceivable conditions, even of severest service. Prolonged action of brakes cannot approximate such a condition, although car wheels are frequently observed to be *very much hotter*, when examined at the bottom of a long descending grade, than your account shows sufficed to crack the test wheels, without any evidence of cracking in plate or brackets.

Pouring an annular lake of molten iron around the rim of a car wheel does not, at all, imitate the condition which obtains when brakes are suddenly and continuously applied, therefore no proper deductions can be drawn therefrom; though the *prima facie* reason why one wheel cracked under such a test and another did not, would appear to be that the cracked wheel had a deeper chilled tread and would, therefore, have proved a more serviceable wheel for the purpose for which it was designed, viz., to show good mileage in actual service.

Some years ago the wheels made at Altoona were cast by what was then called the "sand-flange process," and wheels cast in this way would, presumably, resist this extraordinary "thermal test" better than similar wheels cast in a chill not provided with the sand flange.

In 1881, when I last visited the Altoona shops, the sand-flange power process had been in daily use for more than five years and it would no doubt be equally applicable to contracting chills which are now generally used.

This process is simply providing a groove about ⅝ inches wide, ⅝ inches deep in the flange portion of a chill; this groove is filled with sand, properly packed to preserved the shape of the flange and an annular chamber about ⅛ inch wide and ⅛ inch deep with a few vent holes to carry off the steam generated in the sand rammed in the groove, while casting the wheel.

The practical effect of this arrangement was to decrease the chill of the flange of the wheel, without affecting the depth of chill on the tread. This difference would probably be sufficient to prevent the occurrence of a crack through the flange, which would, of course, immediately cause a crack in the brackets, followed by a crack through the plate.

I do not know whether the Altoona wheel was cast in this manner, or whether it was deficient in chill, but I regard the test as a sensational and misleading one, representing impossible conditions and likely to cause unnecessary alarm unless properly understood.

Not having been connected with car-wheel manufacture since 1887, I feel free to criticize this test. C.

[Our correspondent's observation that "the *prima facie* reason why one wheel cracked under such a test, and another did not, would appear to be that the cracked wheel had a deeper chilled tread," it is to be feared is a mere hypothesis, and may or may not be true, but is valueless as a basis for drawing any reliable deduction. Whether the wheels which were broken were or were not cast with a sand flange we are not able to say, neither do we know whether that method of casting "would probably be sufficient to prevent the occurrence of a crack through the flange." In cases like this it is well to keep in mind the maxim "that things which are not quite sure are very uncertain." Nor is it quite clear why the test referred to should be regarded as "sensational." That car wheels break when their rims are suddenly heated to comparatively low temperatures is surely a fact of importance in view of the experience, which is not uncommon, of more or less mysterious breakages of wheels in service, attended at times with loss of life or limb, and always by loss of property. It would or should be more sensational if such a fact did not receive very serious consideration by those who are interested with the responsibility of carrying us safely when we travel on railroads.—EDITOR.]

Indicator Rigging for Locomotives.

EDITOR AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL:

There is a mistake in the latter part of the article in your June issue on the Indicator Rigging used on the Pennsylvania Railroad, where it is stated that the rigging illustrated is the development of one used by Professor Goss, whereas it is the development of one first used and illustrated by Mr. Dean or George Strong.

I send you with this letter prints showing the general arrangement and details of our latest rigging, which is a modification of that used by Professor Goss. It was made for use on our new mogul compounds, as the pantograph rigging was not adapted to the increased stroke and higher steam chests of the compounds. The pantograph rigging is an accurate one and has been used at speeds over 80 miles per hour, but service has shown it to possess two disadvantages:

First. The workmanship has to be very excellent to prevent lost motion.

Second. It is too flexible laterally, and the side tremors set up are communicated to the motion rod, and thence to the indicator drum.

The motion shown in the blue prints sent you is an equally accurate and much simpler one, and, as will be noticed, uses several parts of the pantograph motion.

Trial shows that it wears better and is not subject to the same vibration as the other motion, but has not the same range of vertical adjustment. It has provision for taking up the wear where necessary, and the steam-chest bearing for the motion rod is much