RAILROAD GAZETTE

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Contributions.

Another Water-tube Locomotive Boiler.

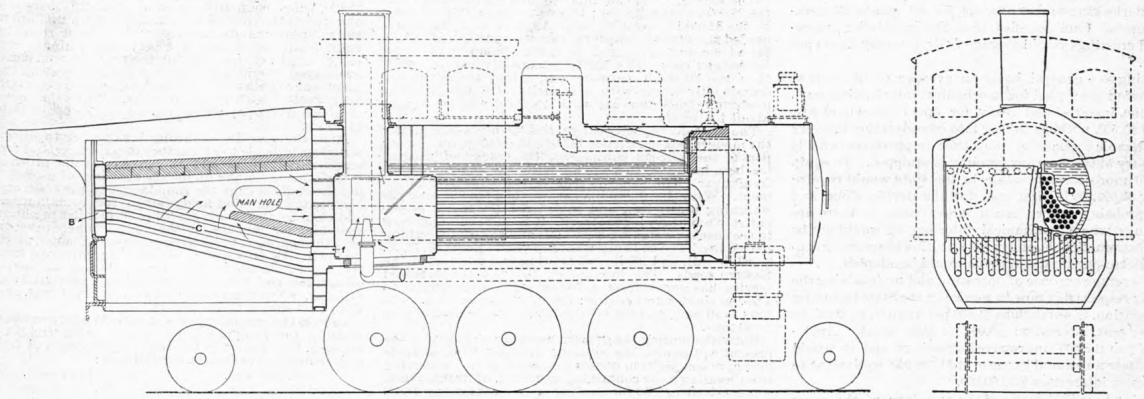
HARTFORD, Dec. 20, 1895.

TO THE EDITOR OF THE RAILROAD GAZETTE:

In your valuable paper of Nov. 1, I noticed a short article by Mr. C. M. Higginson, on the requirements of the locomotive boiler of the future which interested me, as about that time I was designing a locomotive boiler. In a later issue I saw a tendency to a change, as illustrated in C. B. & Q. engine No. 590 (*Railroad Gazette*, Dec. 6, p. 799) and in your issue of Dec. 13, the discussion at the meeting of the Western Railway Club would seem to indicate that we may look for marked changes and improvements in locomotive boilers in the near future.

Mr. Forsyth of the C. B. and Q. has shown a bold deviation in his water-tube firebox, illustrated in the same number, and I beg to submit a design which also has the object of a combination of the water-tube and flue boiler, and which differs materially from anything now in use.

The water-tube boiler has come to stay and the application of water tubes in steam generators is steadily increasing. What is sought in the boiler illustrated is a largely increased and more effective heating surface in the firebox, a longer flame way and a larger grate area, also the combustion of gases and smoke in the smoke arch, which in this case is located at the rear end of the boiler, near the firebox.



Christiansen's Design for a Water-Tube Boiler for Locomotives.

A brief explanation of the drawing may be desirable. The firebox consists simply of two waterlegs extending backward from each side of the boiler and connected across at the top of the rear end by a waterleg *B*, which receives the water tubes inserted in the boiler and in said rear waterleg in the manner of the Heine boiler or similarly. Two large flues 12 in. in diameter lead from the firebox to the front end of the boiler, and the usual 2-in. or 2½-in. tubes carry the products of combustion again toward the rear and into the smoke arch which is located there, and from said smoke arch in the usual manner, and impelled by the exhaust of the engine out through the stack.

A short tube *f*, inserted in the lower end of the firebox and connecting the firebox directly with the smoke arch, and admitting a jet of flame from the firebox directly into the smoke arch, aids the combustion of unconsumed gases and smoke before they enter the stack, and thus probably in a great measure the issue of smoke from the stack will be prevented.

JOHN CHRISTIANSEN, *M. E.*;
An old Master Mechanic.

Railroad Grade Crossings Under the Illinois Law.

Embodied in the annual report of the Railroad & Warehouse Commission of the State of Illinois for the year 1895, is a report by the consulting engineer of the Commission, Mr. Dwight C. Morgan. A particularly interesting part of his report is that in which he takes up the suject of the intersection of railroads at grade, giving information as to the workings of the several laws of the state. This he has done as the result of many inquiries from different parts of the country, and the summary seems to us of sufficient general interest to justify its pulication at considerable length in our columns.

The generally level surface of the state, rendered the crossing of one railroad by another on the same level the simplest and in first cost the least expensive method. . . . Of the approximately 800 intersections of railroads in Illinois, but 54 of them have been disposed of by being constructed over or under the railroad crossed. The conditions affecting the 740 crossings established at grade are diversified, not only in the dangers attending the movement of trains over them, but in the complex arrangement of the tracks and the attending inconvenience to the railroad companies and to the public. Sixteenth street in the City of Chicago is cited as being so intricate in the arrangement of the tracks involved, that without extensive alterations it would be impossible to install appliances that would prove effective for the safe movement of trains.

. . . It became the general practice by the companies to stop their trains before proceeding over the tracks of another railroad. While this action reduced the liability to crossing accidents, yet it was not sufficiently effective in determining the rights of the respective companies, and there also existed an indefinite understanding as to what constituted a stop for the crossing. This embarrassment resulted in the enactment of a law, made effective July 1, 1872, entitled "An act to prevent injury to persons or property at railroad junctions or crossings." This law required all trains to come to a full stop at a distance of at least 200 ft. before entering upon said crossing or junction, and not more than 1,000 ft. from the same, and if practicable within said limits to stop in full view of said junction or crossing. . . . Oftentimes a difference of opinion existed between trainmen as to which of two trains was first entitled to pass over the crossing; the increase in the number of crossings established enhanced the dangers to trains, and it was found that the many crossings very seriously interfered with the prompt and efficient movement of trains. On one of the important railroad lines in the state extending from Chicago to East St. Louis, conformity to the law necessitated 28 stops exclusively for railroad crossings at grade. . . .

July 1, 1887, a law entitled, "An act in regard to the dangers incident to railroad crossing on the same level" became effective. This law while not affecting the provisions of the act of 1872 and the amendment of 1885, provided further, that upon the construction of signaling appliances at grade crossings of railroads, by which it is rendered safe for engines or trains to pass over such points, and which shall first be approved by the Railroad & Warehouse Commission, that it shall then be lawful to run such railroad crossing without stopping, any law to the contrary notwithstanding. It was further provided in this act, that the Railroad & Warehouse Commission shall have the power in case such interlocking shall by experience prove to be unsafe or impracticable to order the same discontinued.

It was upon this law that the matter of protecting grade crossings of railroads in Illinois first took definite form, the result being that in the four years' interval from July 1, 1887, to July 1, 1891, 25 railroad crossings were equipped.

This law not being mandatory, the protection of these crossings was entirely voluntary on the part of the railroad companies and therefore upon some satisfactory agreement between them as to the division of the cost of construction, maintenance and operation of the devices. Up to July 1, 1891, the crossings equipped with interlocking were confined to companies of sufficient financial ability to warrant them in the expenditures necessary to overcome the dangers and inconveniences, which were so apparent.

The advantages derived from the equipment of these crossings were so manifest that other companies sought to have crossings on their roads protected, but as there were always two or more companies whose lines were involved in the crossing, some of them did not feel justified in making the necessary expenditures. This, and in some instances an inability to agree as to the division of the items of expense involved, prevented their more extensive introduction. . . . Any crossing equipped without the consent of all parties interested, to share in the expense, had to be upon the basis of one company bearing a large part or all of the expense involved. This act did not provide for the protection of drawbridges, of which there are many in the state. . . .

The act of 1887 was amended May 28, 1891, to include protection for drawbridges, and also a separate bill was introduced to the legislature and passed in June of the same year entitled, "An act to protect persons and property at the junctions and crossings of railroads by providing a method to compel the protection of the same." This law, which became effective July 1, 1891, does not affect the provisions of the original or amended act of 1887, but confers such additional power on the Commission as is necessary for a determination of cases arising in connection with the protection of all crossings at grade.

The practical workings of the laws of 1887 and 1891 set forth three methods of procedure by which grade crossings may be equipped with interlocking devices:

1st. Under the act of 1887 the railroad companies are given opportunity to agree between themselves.

2d. In case the railroad companies cannot agree either party may appeal to the Commission for its determination of all or any points that may be in contention.

3d. In case any railroad crossing is deemed by the Commission to be unsafe, authority is conferred on it to cite the railroad companies to appear before the Board and show cause why the crossing of their lines should not be protected by an interlocking device.

Of either of the three methods by which any interlocking case may have been determined and the crossing equipped the Commission in all instances exercises its authority; 1st, in the approval of the plan of the proposed devise, and 2d, upon completion, causing the same to be examined that compliance with the statutes may be had. . . .

Upon satisfactory evidence to the Commission that the law and its requirements have been complied with a permit or certificate of authority is issued to the railroad companies giving them the right to run the crossing under the following provisions:

1st. Said companies shall cause said device to be trequently inspected, and shall keep the same in first-class working order and in good repair, and shall provide for its efficient operation by a competent person or persons, so long as it shall be in use under this permit.

2d. Each engine and train shall be brought under control after passing distance signal, and shall proceed under control over said crossing. "Control," as here used, means speed of train must be governed by brake power at command, and in no case exceed the power of trainmen to readily stop train within safe distance should danger appear between distance signal and crossing or at crossing.

3d. No change shall be made in the location of said device or any of its parts, nor in the mechanical construction thereof, nor in the manner of operating the same, without the approval of the Commission; and, in case of any such change without such approval having first been obtained, the authority hereby conferred shall at once cease.

Under the foregoing laws there have been constructed by the railroad companies and placed in operation

throughout the State under the authority of the Commission 115 interlocking plants. In a number of instances three or more railroads cross in close proximity to each other, and to obtain the most practical and economical results the devices constructed at such points have been so arranged as to protect all crossings involved.

In this way, of the 115 plants installed, protection is afforded to 131 crossings. Ninety-nine plants have been constructed by agreement between the railroad companies. Sixteen cases have been appealed to the Commission for determination, several of which were subsequently agreed upon and dismissed by request of the petitioners. Three citations have been issued by the Commission, one of which was dismissed, one agreed upon, and one merged into a petition.

The necessity of equipping the crossing having been determined upon, the principal points of disagreement between the railroad companies, as affecting the division of the several items of expense, and which have been contended in the cases before the Commission, may be briefly set forth as follows:

1st. That the division of the expense should be in proportion to the number of main tracks of each road involved in the crossing.

2d. That the division of the expense should be in pro portion to the number of trains passing over the crossing on the respective roads.

3d. That the division of the expense should be in proportion to the number of levers in the machine reguired for each road.

4th. That each road should pay the expense of constructing the device in its own tracks, and the cost of operation and maintenance adjusted upon the basis of proportionate levers required for each road.

5th. The force of existing contracts or agreements between the companies as to the protection of the crossing and the division of expense.

These points, upon which issue has been taken, may have reference to the cost of construction, cost of maintenance or cost of operation, or all of them. The decisions of the Commission show that consideration has been given to each, but under the various conditions affecting the different crossings it has been impossible to adopt any unyielding principle of determination that could be used as a precedent in all cases.

There are approximately about 600 unprotected grade crossings yet in the state, but the complete applicability of the present laws to all crossings of this character and the evidence in hand as to contemplated work, indicate that many of them will be protected in the near future through the same spirit of united interest on the part of the railroad companies which has characterized the progress already made.

A number of times has the question been asked, "Why does not the Commission exercise its power to compel the protection of all railroad crossings at grade in the state?" To those who have given but little consideration to the subject, the extraordinary results of such an order are not apparent.

Of the plants now installed, the number of levers in the interlocking towers average, for all plants, 22 working levers. I am satisfied that the remaining unprotected crossings would average fully as many levers per plant.

Taking as a general basis an average of 22 levers at the present price paid for mechanical interlocking, each machine, installed and ready for operation, would cost about $5,500, without taking into consideration the very considerable expense of the other improvements made necessary at the time any crossing is equipped. To equip the 600 unprotected crossings in the state would require nearly $3,500,000 in first cost for the devices alone, and most probably a very much larger sum, as there are crossings where mechanical interlocking would not be the most practicable, and in substitution the more expensive electro-pneumatic systems would be adopted.

The average expense of operating and maintaining the devices respectively now in service in the State including depreciation, is as much as $1,800 per annum, equivalent to 5 per cent. interest on $36,000 for each plant. Applying this to the 600 unprotected crossings and it would necessitate an annual expense of $1,100,000, equivalent to 5 per cent. interest on $22,000,000.

It being true that many of the crossings of the more prosperous roads are at this time equipped, the burden of the expense would fall largely upon those companies least able to bear it. While there are compensating features to be derived from the protection of many of the crossings by interlocking devices, yet there are some instances where appliances of this character would not benefit in proportion to the current expense involved.

However, the chief function of the interlocking laws as laid down in the opinions of the Commission, is the protection of the public, and with this end in view, an exercise of authority from time to time as the exigencies demand, will doubtless be made, but at the present time the progressive policy of the railroad companies and the results already obtained through their voluntary action in equipping crossings, would not seem to justify serious consideration of such a comprehensive order as that suggested.

The question naturally arises—Is the continuance of all railroad crossings at grade and their equipment with signaling appliances, a complete and ultimate solution to the problem? In many cases it is, by reason of the local conditions existing and which are impossible of remedy except by very large and unjustifiable expenditures, and again there are many crossings at grade where it is entirely impracticable to alter the conditions. On the other hand, a considerable number of the grade crossings of railroads in Illinois present local conditions favorable to an alteration in the grades of the lines . . .

Of the crossings established at grade throughout the state, and for which protection has been provided, without exception preference has been given to interlocking devices rather than to reconstruct the roads and effect an overhead and underneath intersection. This is also true in the building of new lines in which the crossing of an established road at grade, and its protection by interlocking has been insisted upon by the junior road mainly through the motive of reducing the first cost of construction. In a measure this condition may be overcome in the discretion of the Commission through the power conferred on it by the act of 1889, entitled "An act in relation to the crossing of one railway by another and to prevent danger to life and property from grade crossings.".

This law provides that, in the event of a failure of the railroad companies to agree as to the place and manner in which a new road proposes to cross an established line, either party may appeal to the Commission for its determination of the case. It is believed that under the force of this enactment together with the benefit of past experience, greater weight in the future will be given to the question of overhead and underneath crossing of railroads.

As an illustration take the case of a simple crossing of two lines at grade, in which the local conditions render it practicable to alter the grades with a view of establishing one line above the other. The two propositions involved may be briefly set forth as follows:

1. Continue the intersection of the lines at grade, and equip the crossing with interlocking at an expense of at least $2,000 in first cost, and incur an annual expenditure for an indefinite period of years in its operation and maintenance, equivalent to 5 per cent. interest on $30,000 or

2. Expend from $10,000 to $25,000 in first cost to avoid not only the crossing of the lines at grade, but also substantially all subsequent expense except that which is necessary to the maintenance of the roadway in common with other parts of the lines. . . .

Satisfactory progress in the protection of grade crossings has been made during the past year; 14 new devices have been constructed and six plants built prior to this year have been remodeled and enlarged. Plans have been submitted and approved for the protection of 15 additional crossings, most of which are now in process of construction.

Locomotive Service.*

BY J. H. M'CONNELL, SUPERINTENDENT OF MOTIVE POWER, UNION PACIFIC SYSTEM.

Twenty-five years ago a large portion of the freight and passenger traffic in the United States was handled with 16 × 24-in. cylinder engines. On a few roads with heavy grades 45-ton 10-wheel engines and 50-ton consolidation engines were used. The maximum load in a freight car was 20,000 lbs., and to prevent loading cars beyond that limit a charge of double first-class was added to the excess. With an increase of freight traffic came the 28,000-lb capacity car; this was very shortly followed by the 32,000-lb. capacity car. As new equipment was needed the 40,000-lb. capacity car was introduced, which for a time was considered as having reached the limit for freight cars. The 50,000-lb. capacity car followed, then the 60,000-lb. capacity car, while to-day we see occasionally a car with a capacity of 80,000 lbs. The modern refrigerator car with its load and ice weighs about 100,000 lbs.

The 20,000-lb. capacity car carried 300 bushels of grain; the modern box-car carries 1,000 bushels of grain. Every part of the railroad equipment, the track and bridges, has been increased to keep up with the advance in the freight car. The same is true of the passenger equipment. With the 20,000-lb. car we had the sleeping-car weighing 60,000 lbs., and considered by many people entirely too heavy for the track. It is quite common now to see coaches weighing 80,000 lbs. and sleepers weighing 100,000 lbs. The 56-lb rail was followed by the 60, 67, 70, 75, 80, 90-lb. rail, and 100-lb. rail is being laid on some of the Eastern roads. The locomotive, to meet the increased service, has grown from a 30-ton eight-wheel engine to a 60-ton eight-wheel engine; the 10-wheel engine from 45 tons to 70 tons, and the consolidation engine from 50 tons to 80 tons.

Notwithstanding the greater carrying capacity of the present equipment, the constant decrease in rates made by active competition causes less revenue to be derived from hauling a car containing 60,000 lbs. of freight than was received in 1870 for hauling a car containing 20,000 lbs. of freight. From 1870 to 1880 there was a decrease in amount of revenue per ton per mile of 48 per cent.; between 1880 and 1894 a further decrease of 50 per cent. Comparing the rate per ton per mile earned in 1870 with 1894, there has been a decrease of 74 per cent. The revenue derived from hauling a car containing 60,000 lbs. of freight in 1894 was 22 per cent. less than that obtained from hauling a car containing 20,000 lbs. of freight in 1870. The train expense is greater, the general expense is greater, and the entire cost of operating a railroad is greater than in 1870. A railroad of any importance that shows operating expenses less than 65 per cent. of earnings is accused of failing to maintain the property. The ratio of operating expenses to earnings of six railroads running into Chicago shows the following percentages: 65.86 per cent., 68.37 per cent., 72.80 per cent., 62.35 per cent., 57 per cent., 74.59 per cent.

Work Done by Locomotives.—The question is often asked if the modern locomotive moves as much tonnage in proportion as the smaller engine did 25 years ago. Old engineers frequently remark that the engines of to day do not do the work in proportion to their size that the smaller ones did 25 years ago. Facts show that we are getting better work with the modern engine. Every condition is more favorable to the modern engine; we have greater weight on driving wheels, larger heating surface and increased steam pressure. Some records show a consolidation engine built in 1870 to have had 20 × 24 in. cylinders, a total weight of engine of 100,000 lbs., with 85,000 lbs. on driving wheels, 1,500 ft. heating surface in the boiler, and 140 lbs. steam. A consolidation engine built in 1895 shows a great difference in everything except the cylinders, which are the same. The total weight of engine now is 150,000 lbs., weight on drivers 137,000 lbs., heating surface in boiler 2,200 ft., steam pressure 180 lbs. The engine of 1870 hauled 24 loads weighing 528 tons, while the 1895 engine hauled a train of 35 loads weighing 1,120 tons over the same division. The increase in passenger service is almost as marked. Twenty-five years ago with a time schedule of 22 miles an hour it would have been considered an impossibility to make an engine haul 10 cars on a schedule of 40 miles an hour, yet it is now done every day, and these engines maintain a speed of 55 miles per hour between stations with 10 cars. Have we reached the limit with the modern engine, and have we determined how much a locomotive can be made to earn for the company?

Tonnage Rates.—The question should only be considered from one standpoint, that is, how much can we make the engine earn? To accomplish this, that is, make it earn all it can, the idea must be given up that an engine should run from 75,000 to 100,000 miles before it is taken in the shop. When freight engines are kept in service until they have made that mileage the company is not getting the revenue the engines could earn. An engine in freight service should haul every ton of freight it is capable of doing regardless of cost for repairs and fuel. When the performance is considered on a mileage basis, or with reference to how cheap it can be run and how many miles it will make between general repairs, there will be frequent complaints made by the mechanical department of over-loading, and an effort will be made to have the train reduced in order to favor the engine so there can be a better average made on repairs and coal. After four years' experience with tonnage rating on grades ranging from 40 to 96 ft. to the mile, it has resulted in a general increase in average number of cars per train. Where 22 loads was a train over some of the heavy grades, by the tonnage system frequently 26 cars are hauled with the same engine that hauled 22 cars for a full train. In another case where 28 cars was a full train, a tonnage rating has increased the train to 35 loads with the same engine. It was supposed that 28 loads was a full train, and trainmen were of the opinion that the engine could not pull 35 loads, but after several tests it was demonstrated that the engine was capable of doing this, and no further trouble was experienced in hauling a train of 1,100 tons.

When we consider the service of a locomotive from the standpoint of what it can earn, and not what it costs per mile to run it, we will then begin to increase the number of freight cars per train and arrive at the question affecting the revenue of the company, and that is the cost of hauling a loaded car per mile or cost of hauling a ton of freight one mile. There are very few roads in the west on which the train haul could not be increased on some of the districts. An increase of one car, containing 20 tons of freight, in each train will increase the earnings of a locomotive in one year $7,200, and the only additional expense would be 90 tons of coal. Taking the average of a locomotive at 3,000 miles per month, or 36,000 miles per year, we have the revenue of 20 tons of freight hauled the same mileage at one cent per ton per mile or 20 cents per mile per car. There has been no increase in the wages of the engineer, fireman or trainmen, or for repairs. The only extra expense has been five pounds of coal per car mile. Taking the average tonnage per car for the year on six Western roads, which is 11.44 tons per car, the locomotive can earn on this basis $4,118.40 per year for the company more than it did before. By keeping the engine in first-class condition at all times, I believe every locomotive in freight service on our Western roads can be made to earn at least $4,000 more for the company, per year, than at present; and the expense will not be increased except for fuel at the average rate of five pounds of coal per car mile.

Reports of Performance and Cost.—The monthly statements of locomotive performances sent out by railroads, when compared, show a wide difference in cost, and unless the conditions of making them up are known the comparisons are unsatisfactory. Some roads allow engines only actual mileage between terminals, regardless of length of time making the trip. Should the train be delayed several hours by switching or meeting trains, no mileage is allowed. In helping service the engine is only credited with actual mileage. While the crew will receive a day's pay the engine may make but 30 miles in 12 hours.

It is the practice of a number of roads to allow constructive mileage to all engines in passenger and freight service. Some roads add 10 per cent. to the mileage, as it is claimed to make up for the coal and oil used in taking the engines from the roundhouse to the train and in leaving the train and being put in the roundhouse. In addition to this they are allowed 10 miles per hour for switching or layouts on the road. Where overtime is paid the engineer, the engine is given mileage to make up for it. By this system of watering mileage a locomotive report is made to show a good average on coal and oil and low cost for repairs and a large individual engine mileage, when the actual cost is 10 to 15 per cent. greater than that shown by the report.

Taking the annual reports of some Western roads, considering the freight engine mileage with freight car mileage, they show the following percentages of freight engine mileage to freight car mileage:

4.06 per cent.	4.24 per cent.
4.76 "	5.35 "
4.37 "	5.32 "

The combined mileage of passenger and freight trains compared with the engine mileage in same service shows following percentages of engine to car mileage:

8.78 per cent.	7.76 per cent.
7.57 "	11.29 "
7.44 "	6.48 "

The following gives number of cars per train when figured on same basis for all the roads:

18.80	20.09
18.66	17.73
23.60	24.66
22.86	

There is no uniformity in rating trains. One road rates two empties as one load, others three empties two loads, and others five empties three loads. A train of 10 loads and 20 empties under these systems would be called respectively, 20 loads, 22 loads and 24 loads. But the showing on paper would convey the impression that one road was hauling a greater number of cars per train than another, when there is a probability that the road showing the smaller train was moving the same tonnage.

Following this matter still further, the average tonnage for a loaded car for the year on the five roads shows:

12.87 tons.	14.40 tons.
9.09 "	12.26 "
9.84 "	

With such a variation in the manner of allowing mileage and rating trains, no satisfactory comparison can be made, and until all roads show the cost of moving a

* A paper read before the Western Railway Club.

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