length of these track sections. A peculiarity of the trouble is, however, that it disappears after the circuits have been in operation for a time and it is then possible to again extend the sections to their original length.

"The trouble is due to the enormously increased conductivity of the tie, due to the chloride of zinc solution. A tie thus treated has a resistance of approximately 8,232 ohms, and as the resistance between the rails varies inversely as the number of conductors between them, it is quite apparent that we can introduce enough ties in a section to reduce the resistance between the rails to such an extent that the current will leak across, and therefore fail to hold the relay. In a section 5,000 ft. in length there will be 4,166 of these ties, which would reduce the resistance between the rails to about 2 ohms, and with an initial potential of 1.2 volts on the track, there would be a loss of about .6 of an amp. in this length of track circuit, due exclusively to the treated ties, which together with other losses may easily cause trouble with the relays.

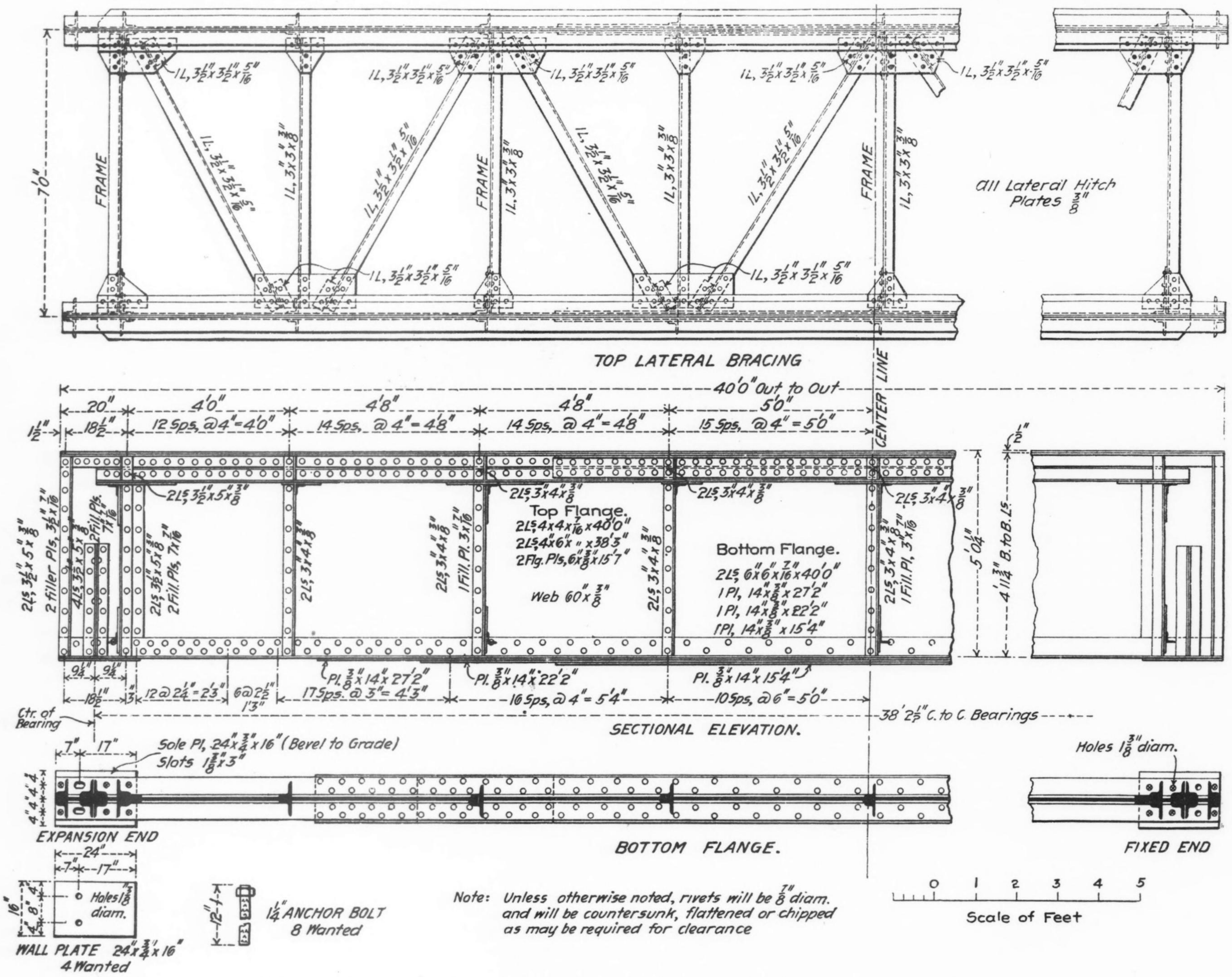
"By reducing the length of the sections we increase the resistance between the rails; but, as before stated, after the track sections have been working for some time the trouble disappears. The ties have lost part, at least, of their conductivity. This loss is due to the effect of the electric current passing through the tie, causing an electrolysis of the zinc solution ($ZnCl$, HO). The Cl is freed at the positive pole, which in this case is one of the iron spikes holding the rail to the tie. Zn is deposited at the other spike, the negative pole. The Cl enters into combination with the H in HO, forming HCl, or hydrochloric acid, and this attacks the iron of the spike, producing $FeCl$, or chloride of iron, which is deposited on the spike, or rather between the spike and the wood of the tie, in greenish-blue, hydrated crystals. This deposit of chloride of iron offers sufficient resistance to the weak track circuit to reduce the conductivity of the tie to such an extent that the track circuit section may be lengthened considerably without the trouble with the relay reappearing.

"It therefore appears as if it would be good practice when a track circuit is to be installed and a large number of these ties are in the track, that several cells of battery in series be put on the track for some considerable time before the signals are to be put into service, thus increasing the resistance between the rails, and permitting the use of track circuits of the ordinary length without danger of trouble. Care must be taken that the polarity of the rails is always maintained the same.

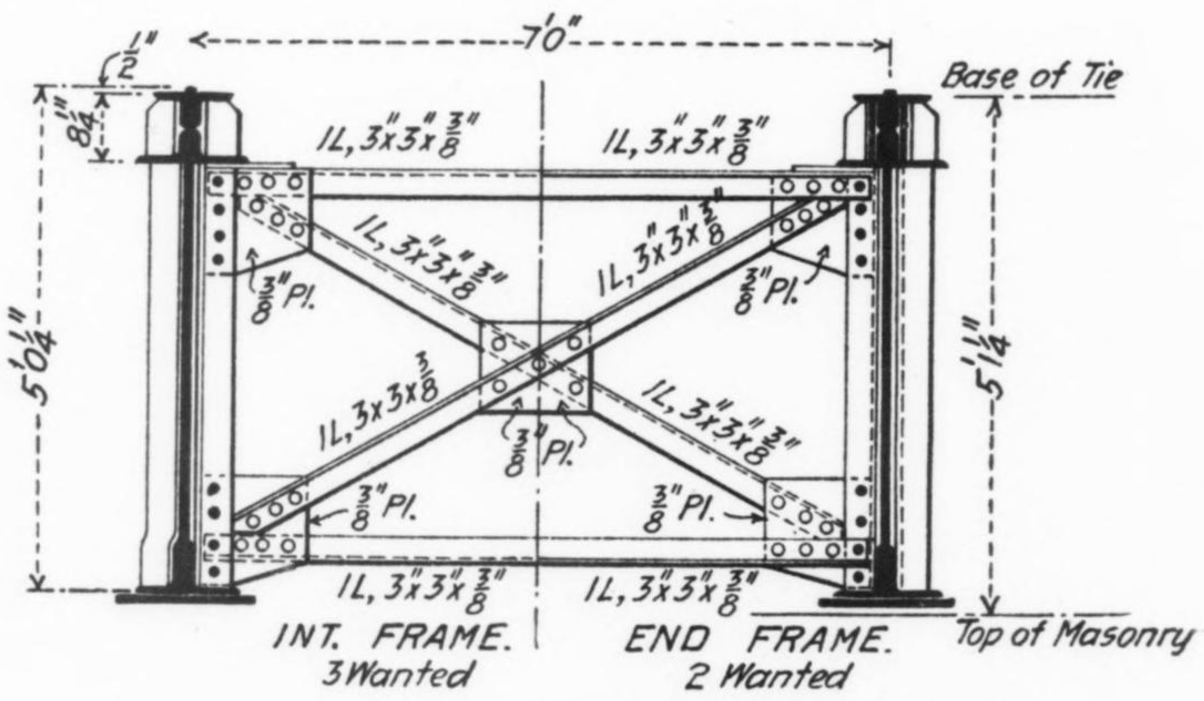
"On account of the great affinity of chlorine for water, ties treated in this manner will never become thoroughly dry. The trouble would therefore return if the spikes on the positive rail were renewed, as the crystals of $FeCl$ on the spike are necessary to successful working."

Standard Bridges on the Harriman Lines.

Last week we showed the plans for the 20-ft. I-beam girder bridge and 30-ft. plate girder bridge adopted as standard on the Harriman Lines together with the complete specifications covering all steel bridge work. The drawings in this issue are of the 40-ft. and 50-ft. plate girder spans. Some important differences will be noted in the distribution of metal in the flanges in the 30-ft. girder shown last week and the 40-ft. girder shown here. The depth of the 40-ft. girder has been increased 11½ in. to 4 ft. 11¾ in., and an additional bottom cover plate 15 ft. 4 in. long has been put on. Instead of a third top cover plate for increas-

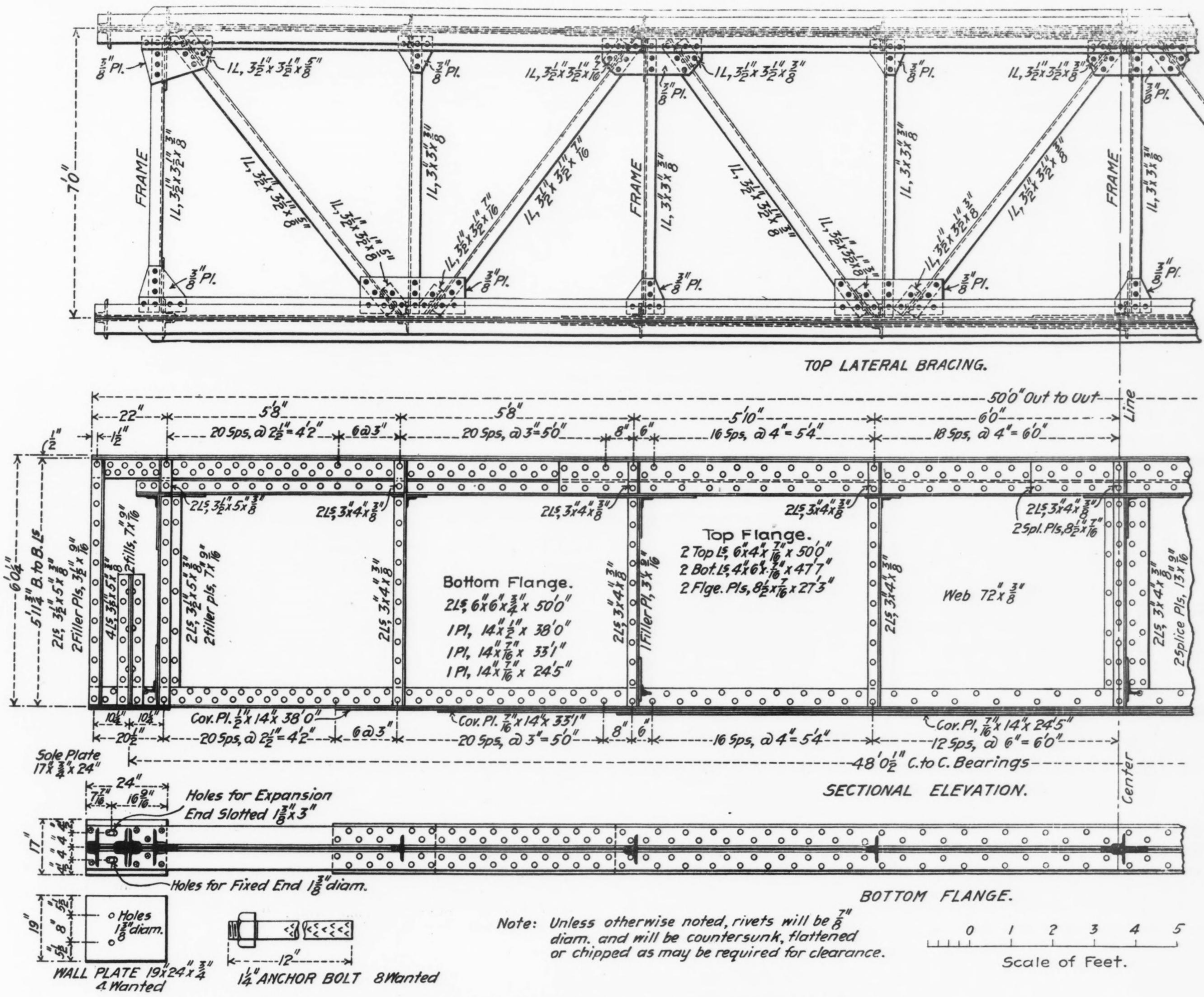


Details of Standard 40-ft. Deck Plate Girder Railroad Bridge, Harriman Lines.

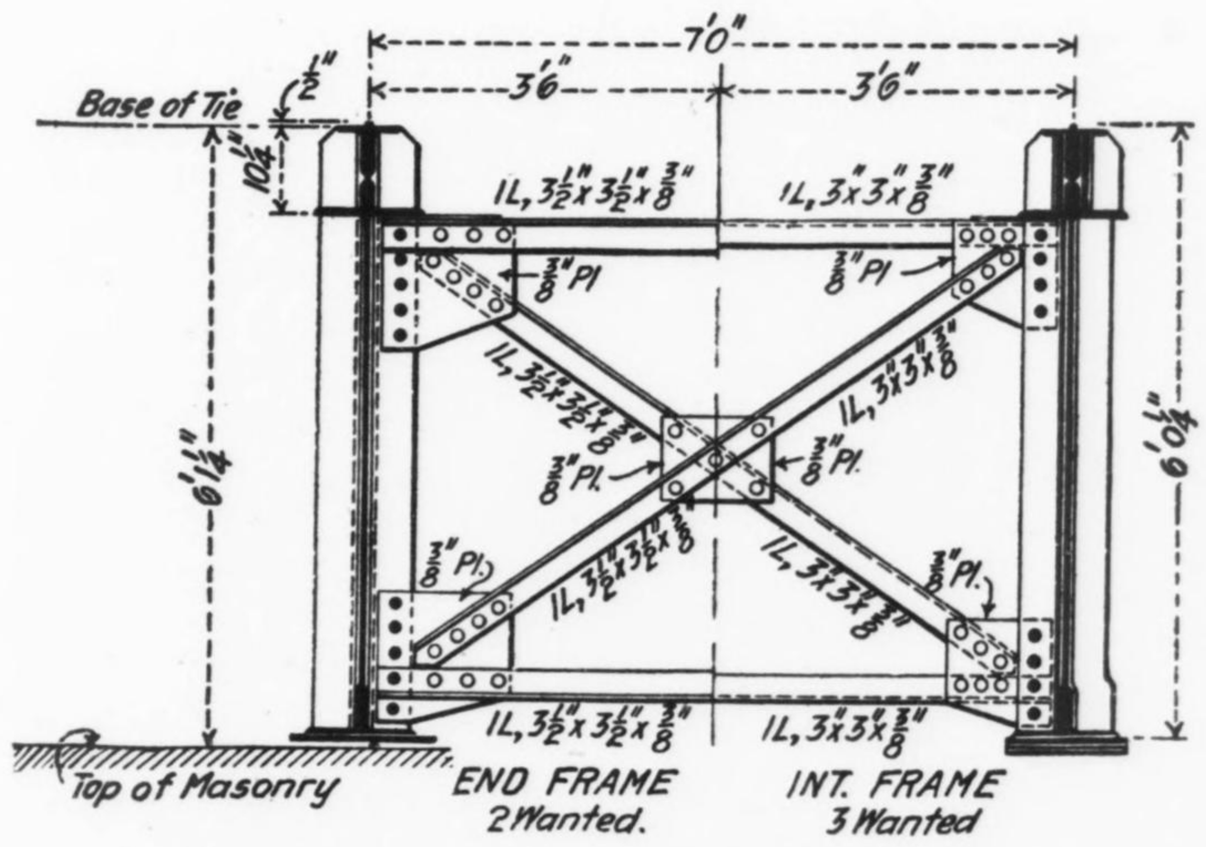


Details of Cross Frames, 40-ft. Girder.

ing the metal in the top flange, a 3-in. x 4-in. x ⅜-in. angle has been added inside and out, just below the top flange angle, and an 8-in. x ⅜-in. plate is riveted over the vertical legs of both angles. The top lateral bracing has been increased to include connections at each panel point and more vertical stiffening has been put in at the ends of the girders over the bearing plates. The estimated weight of one 40-ft. span is 23,800 lbs. The 50-ft. girder is 5 ft. 11¾ in. deep from out to out of flange angles, and is practically identical with the 40-ft. girder in the details. It weighs 34,300 lbs.



Details of Standard 50-ft. Plate Girder Railroad Bridge, Harriman Lines.



Details of Cross Frames for 50-ft. Girder.

Biennial Report, Wisconsin Railroads.

A limited number of copies bound in paper of the eleventh biennial report of the Railroad Commissioner of Wisconsin has been issued for the use of the Legislature now in session at Madison. The report is to be issued shortly bound in cloth. In the matter of form the report is a great improvement over former reports. It consists of 436 pages of matter clearly printed on good paper, and contains 16 full page photos of interlocking plants, engines, new stations, arches and bridges of various roads in the state. The mileage of line in the state is as follows:

June 30, 1901	6,762
June 30, 1902	*6,916
June 30, 1903	6,862
June 30, 1904	6,923

*Miles operated.

The northern part of Wisconsin is a lumbering district, and small railroad lines, and spurs and branches from the larger roads, are constructed into the timber and taken up and abandoned when the timber is exhausted. As the timber is being rapidly exhausted more of these lumber roads are now being removed than are built, so that the gross railroad mileage in the state is not increasing very rapidly.

The report points out that accidents resulting in personal injury within the state have increased greatly. There were 607 injuries to persons reported for the year ending June 30, 1900, of whom 228 were killed and 379 injured. For the year ending June 30, 1903, there were 1,156 injuries to persons, of whom 179 were killed and 977 injured. For the year ending June 30, 1904, there were 1,468 injuries to persons, of whom 190 were killed and 1,278 injured. Of the killed in 1904, seven were passengers, 63 employees, 97 trespassers and 23 "others." Of the injured, 213 were passengers, 966 employees, 67 trespassers and 38 "others."

The operating account of Wisconsin roads within the state since 1900 has been as follows:

Year ending Dec. 31:	1900.	1901.	1902.	1903.	1904.*
Gross earnings	$40,759,951	$43,577,576	$47,718,565	$49,513,379	$45,566,697
Operating expenses	26,824,409	27,786,298	31,463,897	31,405,275	......†
Net earnings	13,935,542	15,791,278	16,254,668	18,108,104	......†
Gross earnings per mile	6,208	6,444	6,900	7,099	6,684*
Net earnings per mile	2,123	2,335	2,350	2,594	......†

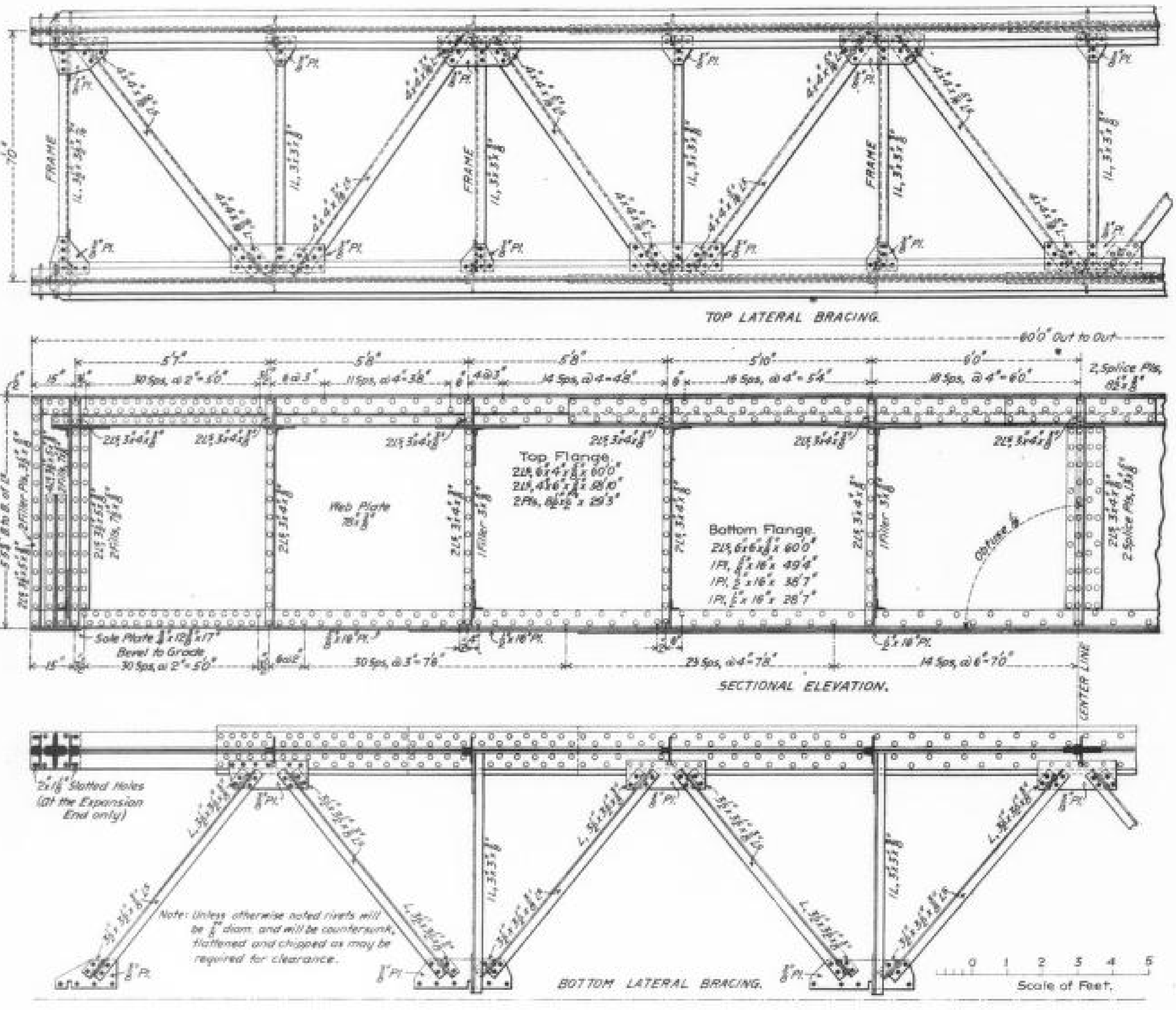
*Year ending June 30th, 1904.
†Not reported.

story, the air pressure was about 16 lbs. and no trouble with blows had been encountered since they had come into the heading some hours before. About 8 o'clock one of the men detected a small blow near the edge of the apron down on one side by the hissing sound of the escaping air. He and the other three men located and stopped the leak with sand bags kept in the heading for such emergencies and began work again. Another blow under the top of the apron opened shortly afterwards and before it could be stopped the water and mud began to come into the chamber. William Creegan, who was on the working platform under the roof, attempted to close the break with straw bags, but the rush of the escaping air drew him into the hole and out beyond the apron. The temporary plugging of the hole by his body allowed the air pressure to rise in the shield with sufficient force together with his own struggles to carry him up through the five feet or more of mud which covered the top of the tunnel. Once clear of the mud he was carried up through 15 ft. of water and lifted several feet in the air on the column of water forced up from the river by the escaping air. He retained consciousness during his journey upward and on striking the water again began to swim. When picked up by a boat which put out from the shore he was apparently uninjured and suffered from nothing but the shock. His companions in the heading were rescued by the men behind the shield who heard the sound like an explosion when the blow occurred. They were stunned by the sudden drop in the air pressure but not otherwise hurt. The temporary plugging of the hole by Creegan's body prevented the immediate rush of mud and water following the rush of escaping air and allowed the men back of the shield to get three men out of danger and close the lock in the shield before the compartment was flooded completely. No damage was done to the tunnel beyond filling the advance heading with mud and work will be resumed at once.

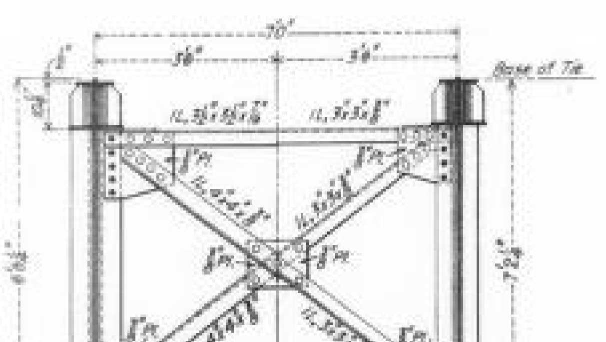
Standard Bridges on the Harriman Lines.*

The accompanying drawings show the standard 60-ft. deck plate girder for single-track which differs but slightly from the 50-ft. span shown last week. Bottom lateral bracing of 3½-in. x 3½-in. x ⅜-in. has been added, however, and cast-steel bed plates are put under the ends of the girders in place of a flat wall plate. The depth of the girders has been increased to 6 ft. 5¾ in., and heav-

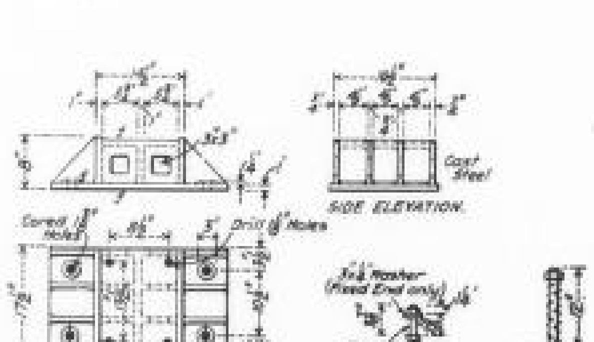
*Previous articles giving the general specifications for stone bridges and drawings of the standard 20, 30, 40 and 50-ft. plate girder spans on the Harriman Lines appeared in the *Railroad Gazette*, March 17 and 24.



General Drawing of Standard 60-ft. Deck Plate Girder Railroad Bridge, Harriman Lines.



Details of Cross Frames for 60-ft. Girder.



Details of Bed Plate for 60-ft. Girder.

ier flange angles and cover plates have been used in the flanges. The area of metal in the top flange is 35.78 sq. in., and in the bottom flange 42.47 sq. in. The estimated weight of one span is 47,500 lbs.

The Cost of Locomotive Operation.

IV.

With an Inset.

BY G. R. HENDERSON.

(*Continued from page 225.*)

FUEL.

Useful Work.—The items heretofore considered have been mostly connected with the waste of fuel, and were introduced to impress upon the reader the many difficulties to be overcome in order to observe strict economy. While these all have a great influence upon the cost of the service, it is a fact that only the proper amount of fuel is consumed in doing the work of the train that is required by the laws of nature—the balance is burned in an attempt to make up for leaks and other deficiencies in maintenance or operation of the engine; that is to say, that a given amount of work requires a definite quantity of heat, and no more can be utilized in performing the work, but is wasted in one or more of the various ways enumerated. It is therefore perfectly logical to determine the amount of fuel needed for doing useful work, and if the engine is in poor condition or improperly treated, an allowance should be made in estimating the total coal consumption. What this should be it is generally impossible to state, as there is no way of accurately estimating the effect of such circumstances. As tests are made under ordinary working conditions, we can assume that the values so obtained will cover a number of the defects which generally have to be contended with, but leaks and other severe drains upon the boiler should certainly not be included.

All work performed is the product of force and speed, and so the work done by a locomotive is represented by the drawbar pull or the tractive force, and the speed at which this force is maintained. If now we can determine the quantity of fuel required for any and all combinations of speed and pull within the capacity of the engine, we can also, by knowing the resistance offered by grades, curves, etc., find out the amount of coal needed on such grades, etc., in order to take the train at the required speed. From a study of some tests made by the author a few years ago, it has been found possible to elaborate a diagram for any particular locomotive whose general dimensions are known, which will give at once the fuel consumption per mile or per hour, the diagram being based upon theoretical as well as practical considerations, and giving values, it is believed, agreeing closely with actual conditions.

The construction of the diagram and the method of using it can, perhaps, be made most clear, by assuming a locomotive of certain proportions, and developing the study for this engine. We will consider a consolidation locomotive or 2-8-0 type having the following general dimensions:

Diameter of cylinders	21 ins.
Stroke of pistons	32 "
Diameter of drivers	56 "
Boiler pressure	200 lbs.
Grate area	40 sq. ft.
Heating surface	3,200 "
Weight of engine and tender	150 tons

The theoretical tractive force of such a locomotive will be

$$\text{T.T.F.} = \frac{P\ d^2\ s}{D} \ \ldots\ldots\ldots\ldots (2)$$

where P = Boiler pressure in pounds per sq. in.

d = Diameter of cylinder in inches.

s = Stroke of piston in inches.

D = Diameter of drivers in inches.

When we allow for drop in steam pressure and internal resistance, we find that the available tractive force at circumference of the drivers is only .8 of the theoretical tractive force or

$$\text{A.T.F.} = \frac{.8\ P\ d^2\ s}{D} \ \ldots\ldots\ldots (3)$$

for simple engines, when working at slow speeds with the reverse lever in the corner notch.

For the engine under consideration we therefore find as follows:

$$\text{T. T. F.} = \frac{200 \times 441 \times 32}{56} = 40{,}000 \text{ lbs. approx.}$$

As the speed of the locomotive increases, however, beyond the point where the boiler can supply the complete volume of the cylinders at each stroke, an earlier cut-off must be used and it is necessary to determine the effect of such a change. In order that this may occur at the maximum possible speed, the boiler must be worked to its full capacity, which is limited by its ability to burn fuel. From various tests it seems as if this limit might be considered as stated below, the quantities being expressed in pounds of coal per square foot of grate area per hour:

Bituminous coal	200 lbs.
Anthracite, large sizes	100 "
Anthracite, small sizes	60 "

We will assume that our engine is burning Pennsylvania or Virginia semi-bituminous coal, therefore the maximum combustion will be 40 × 200 = 8,000 lbs. coal per hour. We admit that this is a large amount to be handled by one man for any great length of time, but there is no doubt that it could be burnt if supplied. In order to determine the quantity of steam generated by this amount of fuel in the boiler which we have assumed, Fig. 1 is introduced. This has been compiled from various sources of information, and it is thought fairly represents the average practice in this country. In this figure, the ordinates give the maximum evaporation in pounds of water from and at 212 deg. Fahr. per square foot of heating surface per hour that can be expected under ordinary conditions, as stated above, the abscissae denoting the ratio of heating surface to grate area. For the engine in question this will be

$$\frac{3{,}200}{40} = 80,$$

and for semi-bituminous coal, curve "C," we find that with a ratio of 80, fifteen pounds of water from and at 212 deg. may be evaporated per hour from each square foot of heating surface, or for the boiler as a whole,

$$3{,}200 \times 15 = 48{,}000 \text{ lbs. per hour.}$$

The factor of evaporation from ordinary temperatures of feed water will be about 1.2, so that we shall have at boiler pressure

$$\frac{48{,}000}{1.2} = 40{,}000 \text{ lbs. per hour.}$$

The steam will be somewhat reduced in pressure at the cut-off point, however, and the table here given indicates the probable relation of this pressure to the boiler pressure, when the reverse lever is in the corner notch, and the throttle wide open.

Ratios of Cut-Off Pressure to Boiler Pressure.

Revolutions per min.	Starting.	50.	100.	150.	200.
Long ports	0.98	0.94	0.88	0.82	0.78
Short ports	.98	.92	.85	.77	.72
Medium ports	.98	.96	.86	.80	.75

By long ports is meant those in which the length of port in inches divided by the area of the cylinder in square inches is approximately .12, and by short ports, where this ratio is about .05. If we assume .90 for the ratio in the case in hand, we shall have

$$200 \times .90 = 180 \text{ lbs. at cut-off,}$$

which steam will weigh .432 lb. per cubic foot. The volume of a cylinder 21 in. in diameter and 32 in. long is 6.4 cu. ft., or for one revolution four times this amount, or 25.6 cu. ft. No allowance is made for clearance, as the cut-off, with lever in the corner, is usually about 90 or 92 per cent. of stroke. For each revolution, then, the steam consumption will be

$$25.6 \times .432 = 11.06 \text{ lbs.}$$

and

$$\frac{40{,}000}{60 \times 11.06} = 60 \text{ revolutions per minute}$$

as the maximum speed at which the boiler will furnish steam at full stroke. The speeds in miles per hour corresponding to the revolutions per minute for a 56-in. wheel are as follows:

5	10	15	20	25	30	35	40	miles per hour.
30	60	90	120	150	180	210	240	revs. per min.

Therefore it is plain at above 10 miles an hour the cut-off must be reduced, diminishing the available tractive force of the engine. A study of the variation in tractive force due to speed indicates that the method explained below gives a close approximation to actual results.

In Fig. 2 the ordinates represent the tractive force in pounds, and the abscissae the speed in miles per hour. As the maximum speed at full stroke was found to be 60 r.p.m., or 10 miles an hour, we find the intersection of this speed with the theoretical tractive force at "A." We therefore construct an equilateral hyperbola through this point, that is, a curve the product of whose ordinates will always have the same value, viz., 50,000 x 10 = 500,000. As we have seen, the available tractive force, however, cannot exceed 40,000 lbs. By drawing from the point "B" a tangent to the hyperbola, we then have a locus consisting of a straight line and a curve, and this locus gives us the maximum available tractive force (at circumference of the drivers) for which the boiler will supply the cylinders at any speed. But to do this, we must burn 8,000 lbs. of coal an hour, so that the locus BC also gives the combinations of speed and available tractive force which may be obtained by the combustion of 8,000 lbs. of coal an hour.

The rate of combustion per square foot of heating surface per hour is $\frac{8{,}000}{3{,}200} = 2.5$, and from Fig. 3 (curve C) we should expect 6 lbs. of water per pound of coal from and at 212 deg., or a total steam production of 8,000 x 6 = 48,000 lbs., which is the same as our first figure. If the rate of combustion be reduced, however, there will be more steam generated per pound of coal, as indicated by Fig. 3. For instance, if three-quarters the amount be consumed, or 6,000 lbs., the rate of combustion will be $\frac{6{,}000}{3{,}200} = 1.87$ lbs. per sq. ft. of heating surface, and from Fig. 3, the evaporation will be about 7 or 7 x 1.87 = 13.09 lbs. of water per sq. ft. of heating surface per hour, instead of 15 lbs. as before. This would supply the cylinders at full stroke for 15:13.09::10:8.7 miles an hour. From this, as a starting point, we construct a new hyperbola and tangent as before, which locus gives the combinations of speed and tractive force for 6,000 lbs. of coal an hour. In the figure the loci have been drawn for each thousand pounds per hour from 1,000 to 8,000.

If now we divide the quantities per hour by the speed, we obtain the fuel consumption per mile, and this is shown by the dotted lines. Thus with a tractive force of 20,000 lbs. and a speed of 15 miles an hour, we should expect an hourly consumption of 3,000 lbs., or 200 lbs. per mile. With a force imum capacity of the boiler). These critical cut-offs are indicated on the diagrams Figs. 8 and 9, with a cross mark, the values of the several factors being shown in the following table:

Nominal speed in r.p.m.	Cut-off in per cent.	Steam per I. H. P.-hour.	Maximum cylinder H. P.
40	69.0	36.2	715
80	44.5	25.1	1010
120	39.5	23.7	1120
160	36.5	23.2	1100

The cylinder horse-power given in the last column of the above table is what would be expected by indicator if tests had been run under the conditions of maximum power at the several speeds and cut-offs. It is now only necessary to reduce the cylinder horse-power to equivalent drawbar pull by means of the following equation, in which S is the speed in miles per hour and F is the corresponding average frictional drawbar pull (see Table 12):

$$\text{Drawbar pull} = \frac{\text{Horse power} \times 375}{S} - F$$

The drawbar pull at the several speeds, as determined from the above equation is given in the following table:

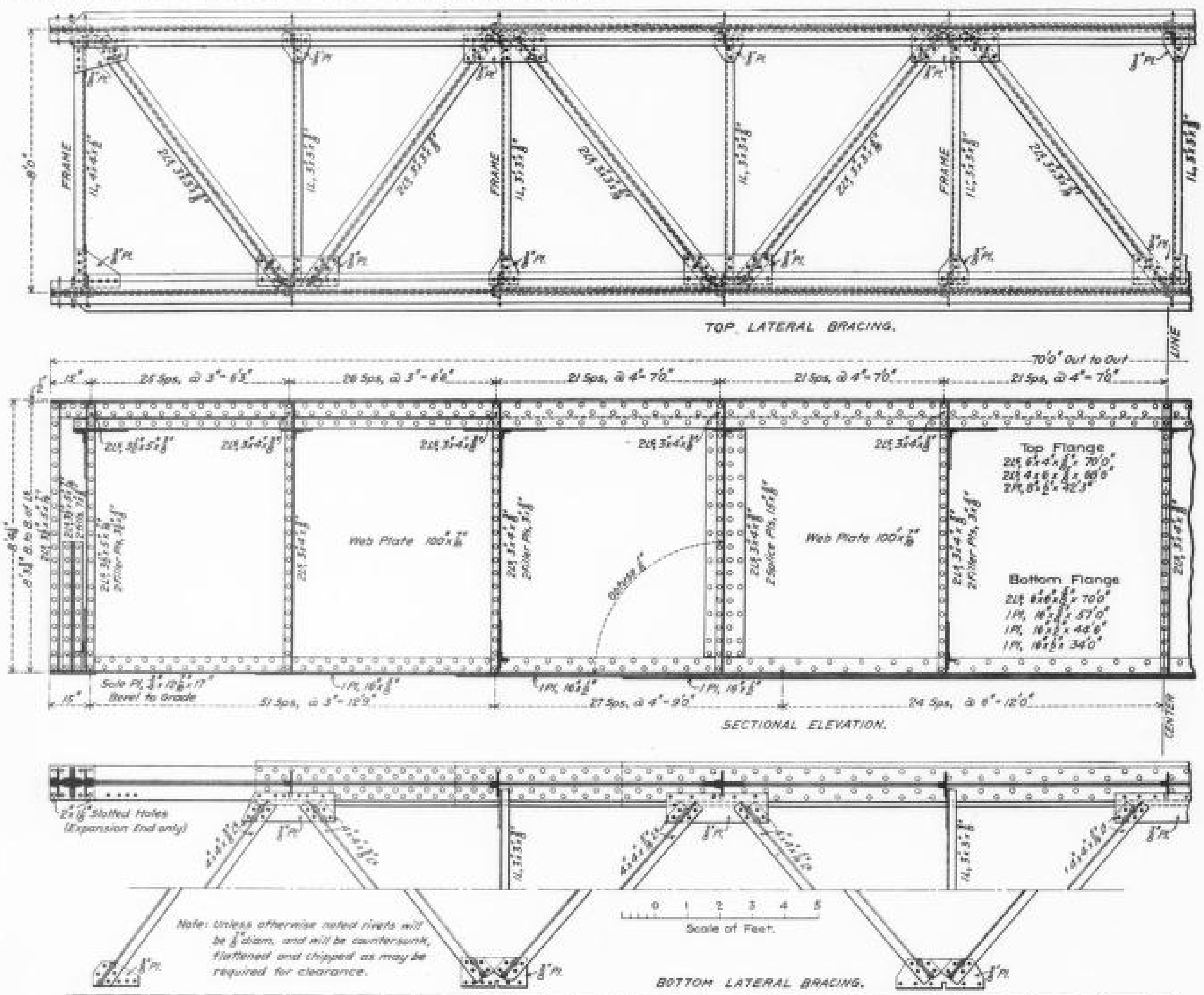
Speeds in r.p.m.	Maximum estimated drawbar pull, lbs.
40	35,706
80	24,903
120	17,554
160	12,346

The full line in the diagram, Fig. 10, shows graphically the results given in the above table. The lowest speed at which the full power of the boiler can be utilized is 30 r.p.m., this speed being determined by the intersection of the straight line of maximum tractive effort with the maximum power curve. The dotted lines on the diagram show the maximum and average drawbar pulls respectively, at the several speeds as actually recorded in the tests.

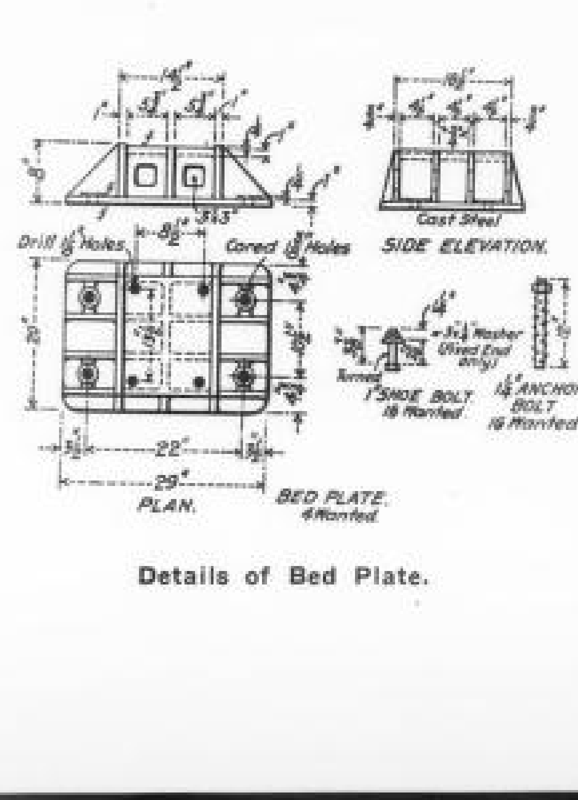
Standard Bridges on the Harriman Lines.*

The bridge shown in this issue is the standard 70-ft., deck plate girder, single-track span. It is 8 ft. 3¾ in. deep, back to back of flange angles, and weighs complete 68,000 lbs. In the 30, 40 and 50-ft. girders no camber was provided for, but in the 60-ft. girder shown last week, the two middle panels were given a camber by cutting the web plates at a slight obtuse angle. The third panels from each end in this girder are cut ⅛ in. obtuse to allow sufficient camber. The lateral and cross bracing is essentially the same as that shown last week for the 60-ft. girder. In the top flange of the 70-ft. girder there is a cross-sectional area of 34.94 sq. in. and in the bottom flange 42.85 sq. in.

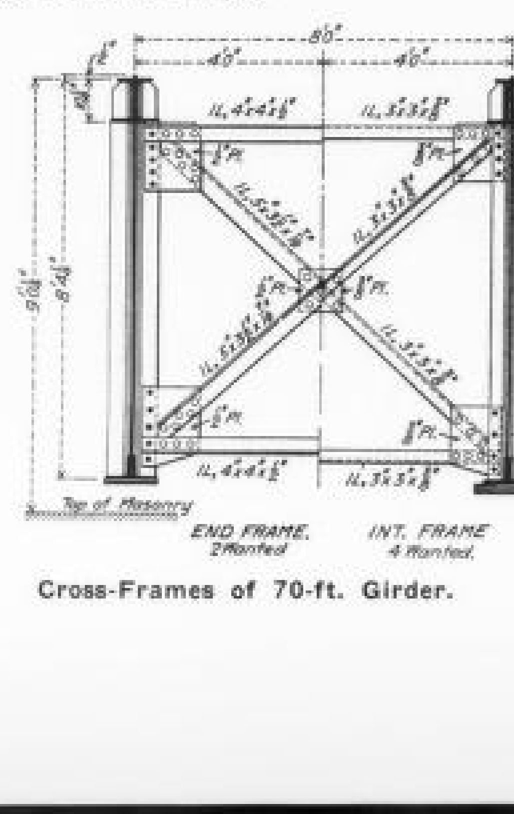
*Previous articles appeared in the *Railroad Gazette*, March 17, 24 and 31.



General Drawing of Standard 70-ft. Deck Plate Girder Railroad Bridge, Harriman Lines.



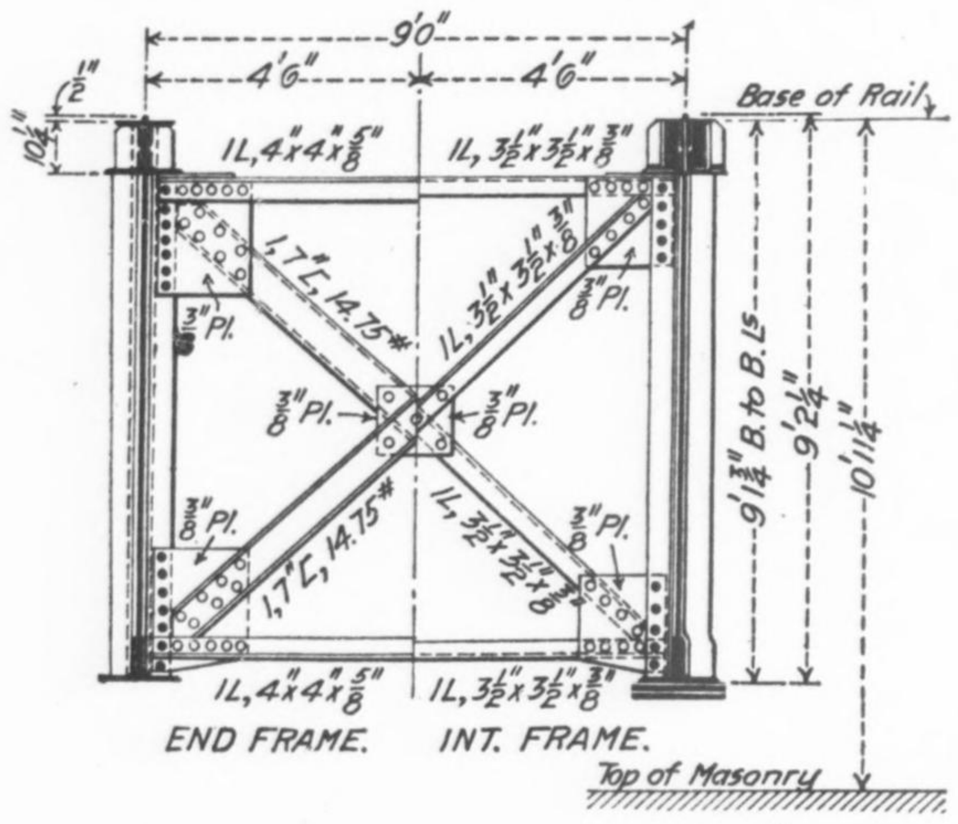
Details of Bed Plate.



Cross-Frames of 70-ft. Girder.

Standard Bridges on the Harriman Lines.*

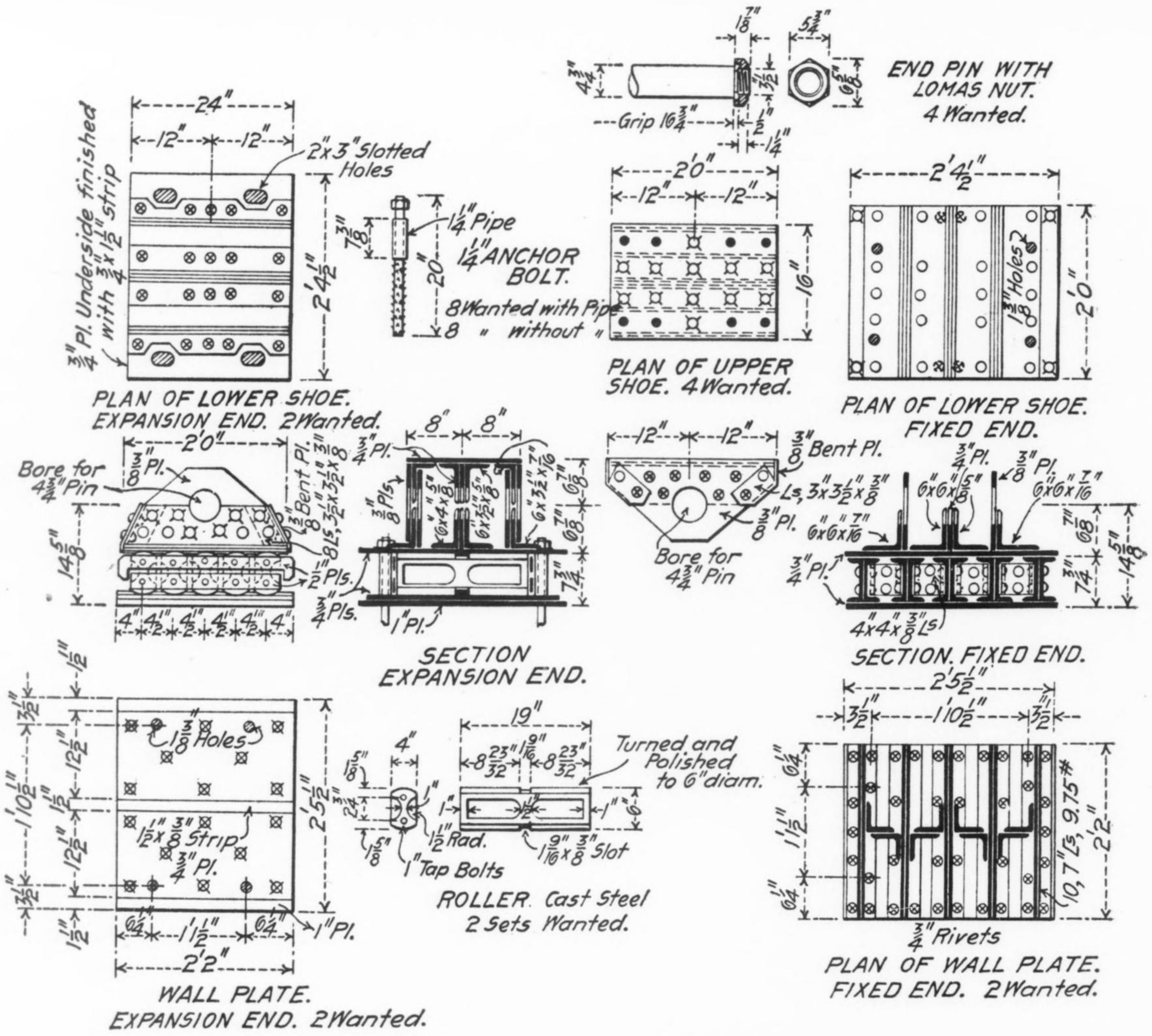
The drawings in this issue show the standard 90-ft. plate girder for the Harriman Lines. It differs from the 80-ft. girder shown last week only in the general dimensions, all the details being essentially the same. The web plate is made in six pieces and cambered



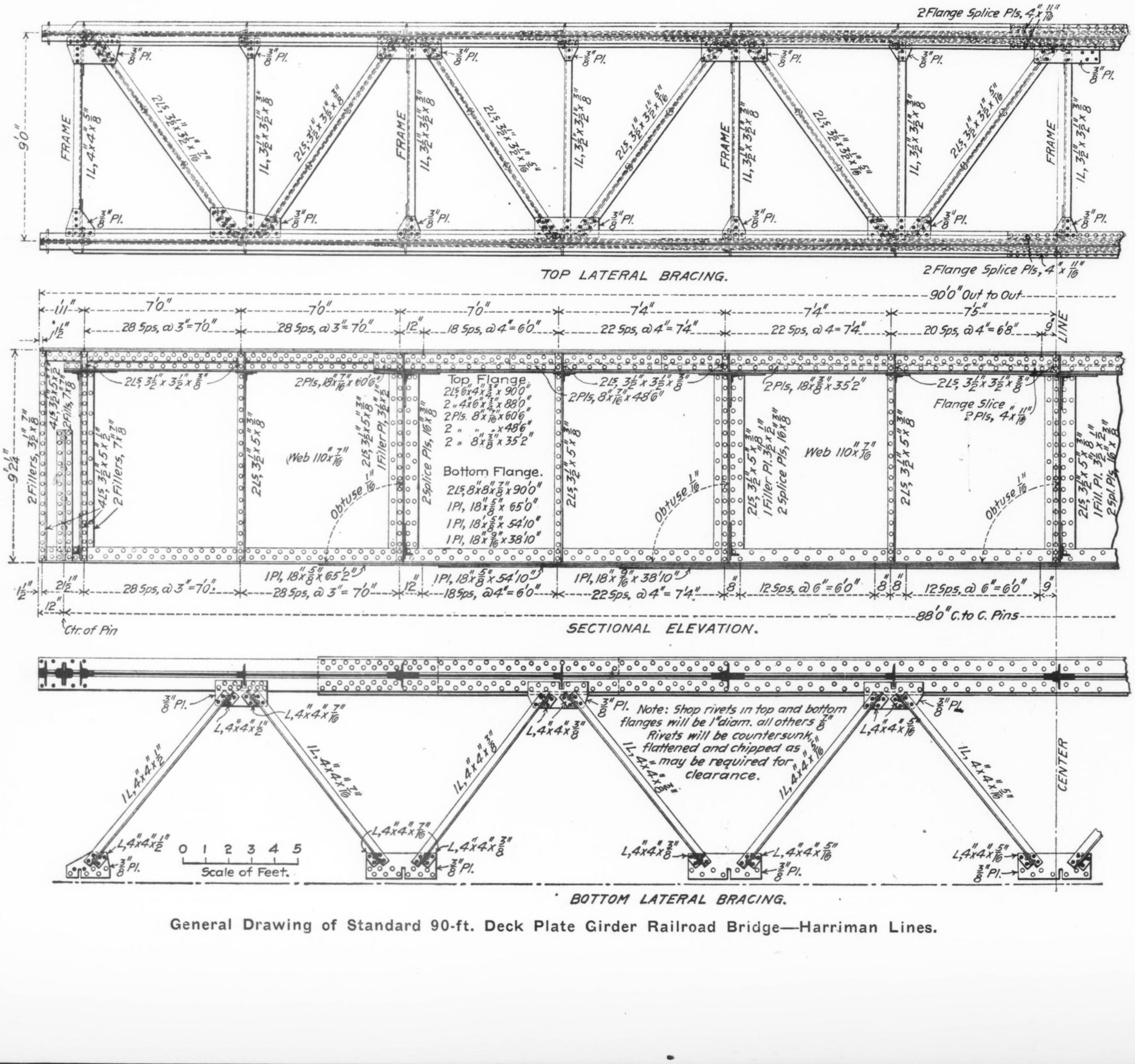
Cross Frames for 90-ft. Girder.

$^1/_{16}$ in. at each of the five splices. In this girder as well as in the 80-ft. girder channels have been substituted for angles in the end cross frame diagonals. The area of cross section in the top flange is 51.26 sq. in. and in the bottom flange 62.49 sq. in. One span complete weighs 113,200 lbs.

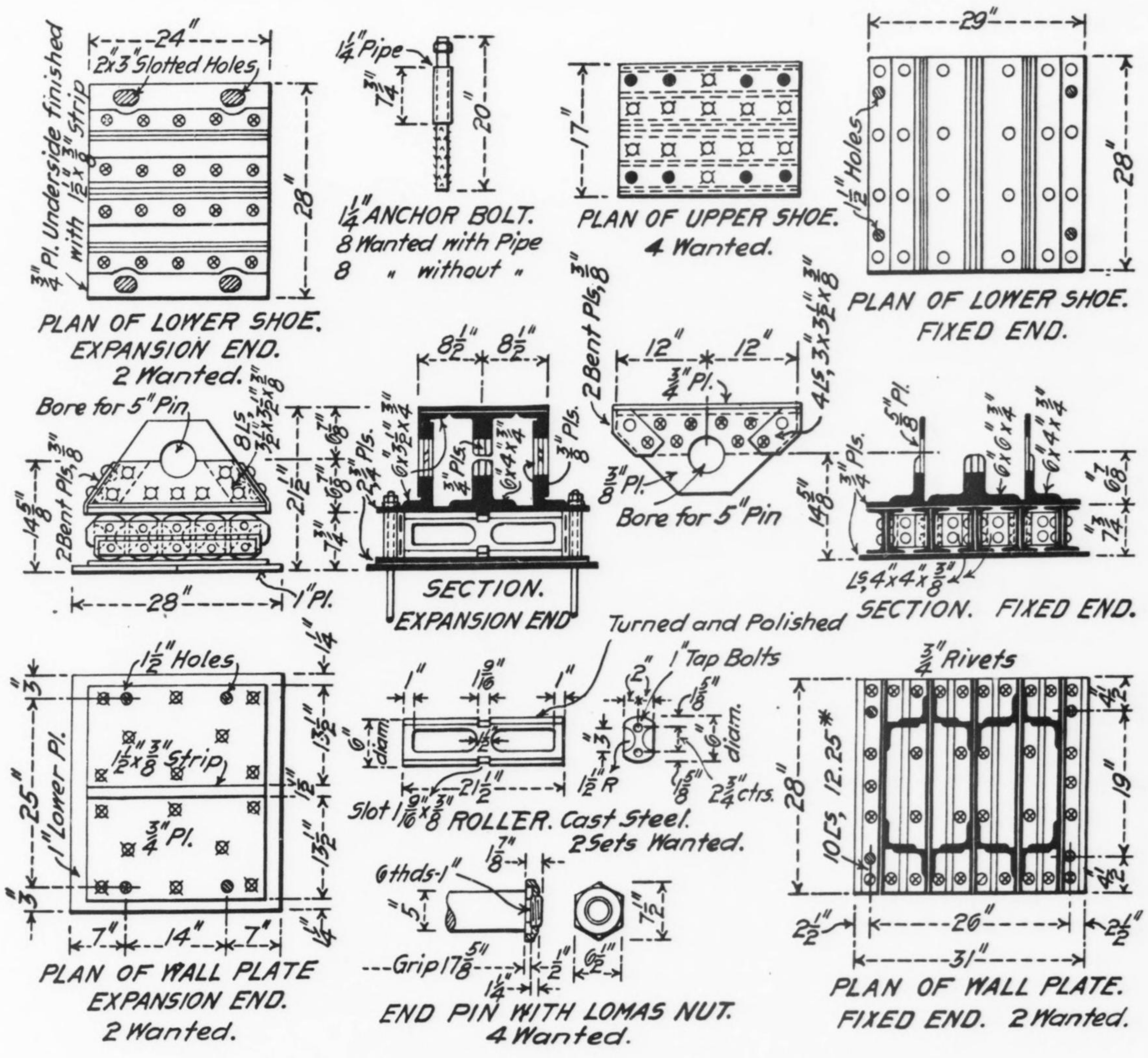
*Previous articles appeared in the *Railroad Gazette*, March 17, 24, 31 and April 7 and 14.



Details of Fixed and Expansion End Bearings.



General Drawing of Standard 90-ft. Deck Plate Girder Railroad Bridge—Harriman Lines.

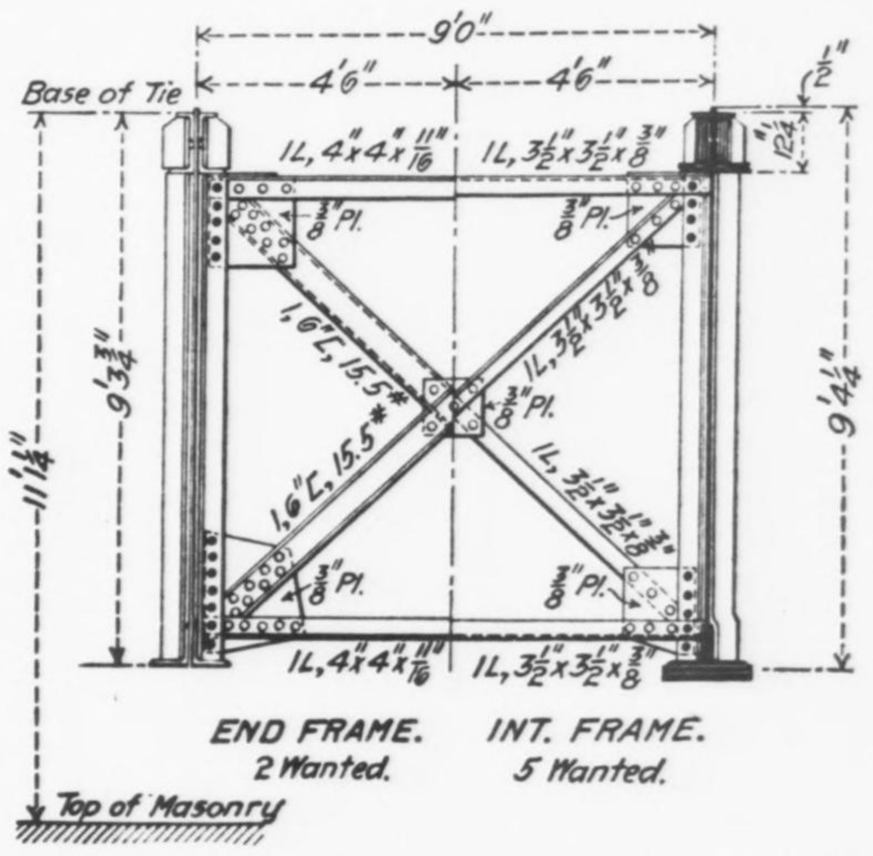


Details of Fixed and Expansion End Bearings for 100-ft. Girder.

Standard Bridges on the Harriman Lines.*

VII.

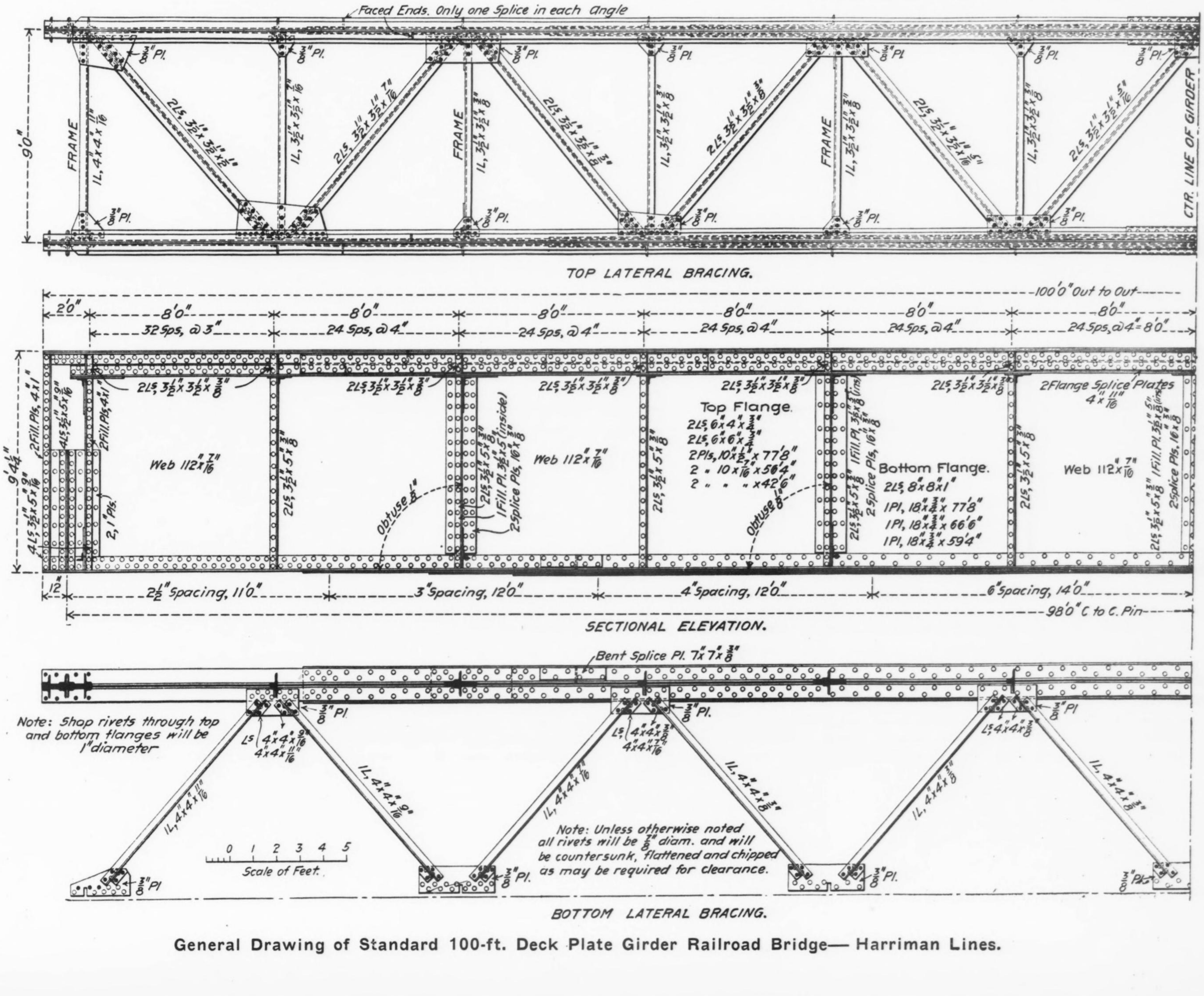
This week we show the Harriman Lines' standard 100-ft. plate girder which is next to the largest size in use. The depth has been increased only 2 in. over the 90-ft. span shown last week, the additional strength re-



Details of Cross Frames for 100-ft. Girder.

quired being supplied by a considerable increase in the amount of metal in the top and bottom flanges. A camber of ⅛ in. is put in the two end splices of the web plate, but the middle joint is cut with square edges. In the top flange the area of cross-section is 63.51 sq. in. and in the bottom flange 73.50 sq. in., as compared with 51.26 sq. in. and 62.49 sq. in. respectively in the 90-ft. girder. The weight of one span is 137,800 lbs.

*Previous articles appeared in the *Railroad Gazette*, March 17, 24, 31, April 7, 14 and 21.



General Drawing of Standard 100-ft. Deck Plate Girder Railroad Bridge— Harriman Lines.

and there are thousands of them who are not only adapted to the railroad service, but who are anxious to get into it, but do not know how to go about it—pass upon the qualifications of the applicant, and if he appeared to be a desirable man, look up his record, and if satisfactory and he could and did pass the physical examination, put him on a waiting list, and when new men were needed supply them from that list.

Plenty of clean-cut, nervy, ambitious young men, coming from respectable families, of good standing legally, adjacent to the railroad, would at the present rate of wages paid by the railroad companies, jump at the chance of getting into the service, and by securing them the companies would not only get a higher class of men, morally, mentally and physically, than they do now, but would also in a measure secure the good will and interest of their families. This frequently in local and state affairs could be used advantageously and at the same time would prevent the employing of such characters as those above mentioned. We all know that it is the careless, unfit men, those who neither know the rules nor care to learn them, who have no adaptability for the service, that get injured themselves and cause accidents that result in injury to others and loss and damage to property.

How much better it would be to be able to telephone or telegraph the officer whose duty it was to employ and furnish men that you want so many agents, telegraph operators, firemen, brakemen, or switchmen, and know you would get good men, instead of being obliged to hustle around and hire the first thing you can pick up and call him an agent, operator, brakeman, fireman, or switchman, and then hold your breath fearing every minute a telegram will come calling for the wrecking car and the coroner or the chief of police!

The adoption of such a plan would, of course, cost something and mean a lot of work for somebody to start and maintain it, but the cost would be nothing compared to the losses caused by the present method, and would, in the end, prove the best investment the railroad adopting it had ever made. It would demonstrate by results that it is as important to have good men as it is to have good engines, cars and roadway, and in a few years we would see a wonderful improvement in the class of men now engaged in the service.

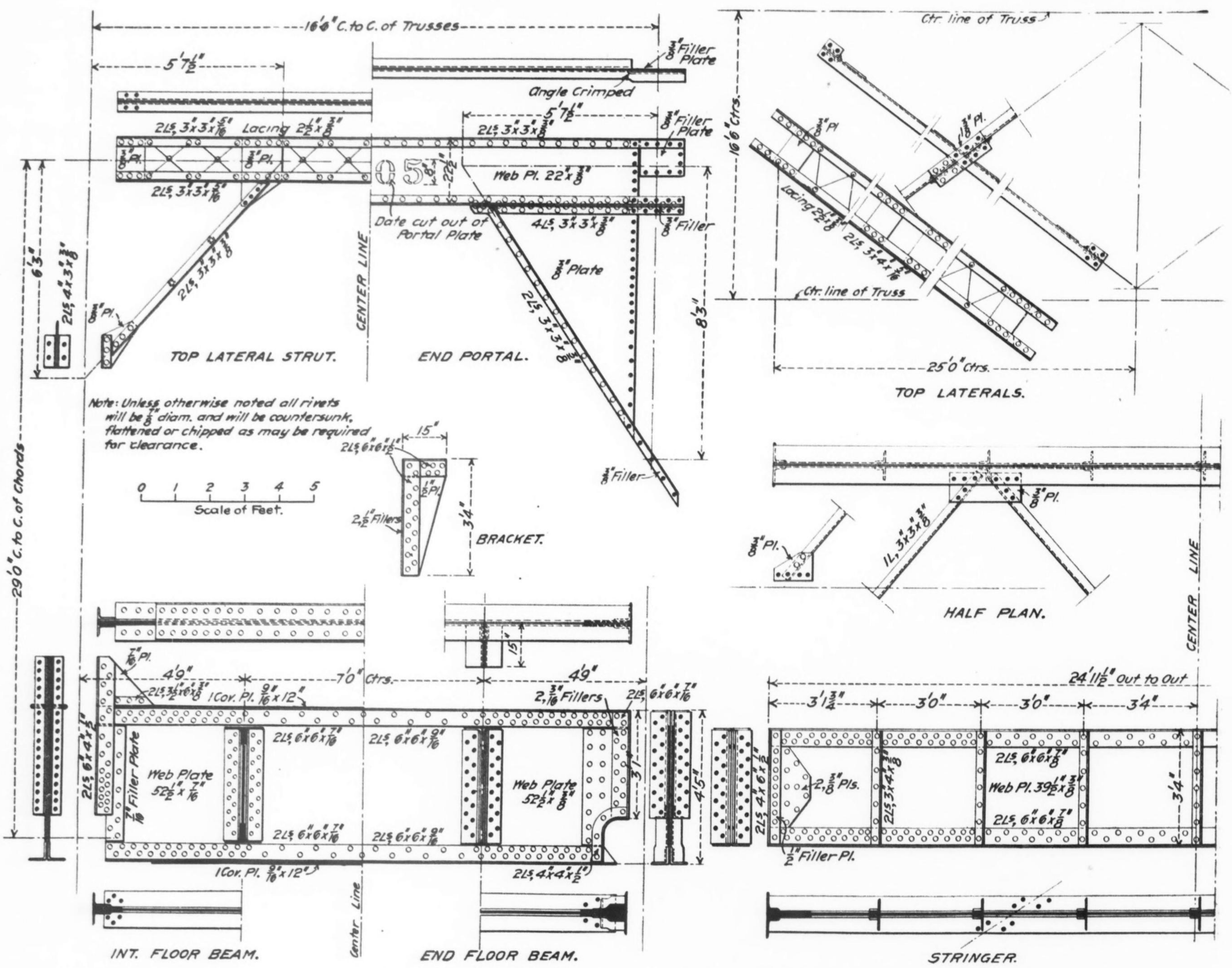
If, in addition to having a Bureau of Employment, we also had a school in which to instruct the new men, and the old ones too, for that matter, what the rules and their duties are, and how to perform them, the labors of the claim department and the losses of the companies would be cut in half.

Standard Bridges on the Harriman Lines.*

The previous series of articles showed the standard designs of plate girder bridges for short spans from 30 ft. to 100 ft., and included the complete specifications for steel bridges. The accompanying drawings show the shortest of the riveted through truss bridges, which are used for spans from 100 to 150 ft., including 110, 125, and 140-ft. spans. They are designed for the same loading as the plate girder bridges and are to carry a single track.

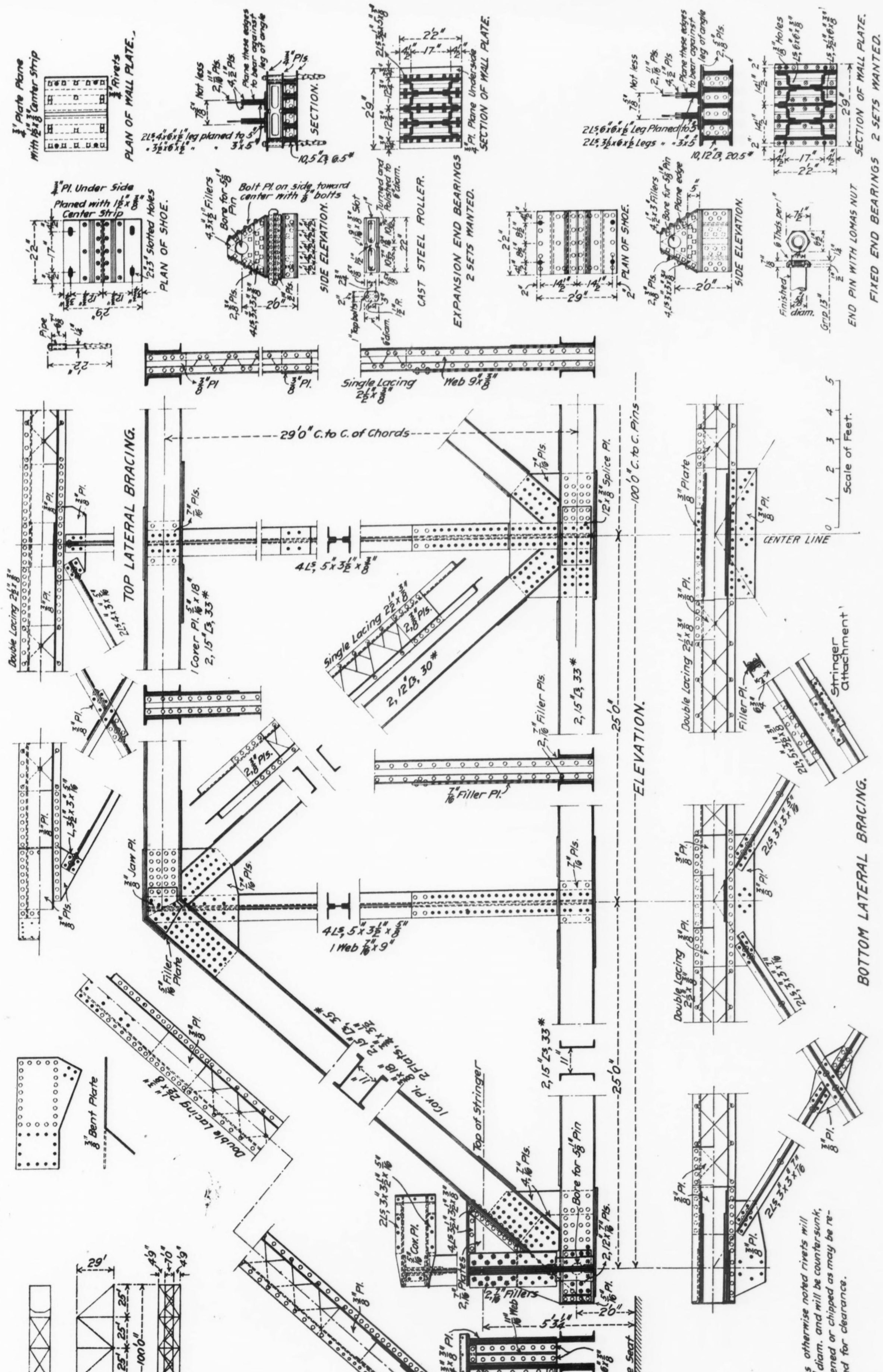
The panels are of uniform length, 25 ft., and the distance from center of bottom chord to center of top chord is 29 ft. The top and bottom chords are made up of 15-in. 33-lb. channels placed back to back, a 5-16-in. cover plate being used on the top chord and double latticing on the bottom chord. For the end diagonals a ⅜-in. x 18-in. cover plate, two 15-in. 35-lb. channels and two flats, ¾ in. x 3½ in. are used. The vertical members at the panel points are I-beam posts made up of four 5-in. x 3½-in. x ⅜-in. angles and a web plate 7-16 in. x 9 in., while the intermediate diagonals are two channels tied with single lacing. For the top lateral bracing double angles are used for the diagonals and laced struts for the transverse braces. Between the bottom chords diagonal angle braces only are used.

The floor system consists of deep floor beams at each panel point riveted to the posts and a pair of stringers 40 in. deep between each floor beam. The ties are notched over the top flanges of the stringers in the usual way. At the ends of the bridge the end floor



Details of Floor System and Portal Bracing for 100-ft. Riveted Through Truss—Common Standard, Harriman Lines.

*Previous articles appeared in the *Railroad Gazette*, Mar. 17, 24, 31, April 7, 14, 21 and 28.



Details of Side Trusses and End Bearings for 100-ft. Riveted Through Truss Bridge—Common Standard, Harriman Lines.

beams are riveted to the bearing plates which are built up inside the channels forming the bottom chord and the bearing pins pass through the bottom chord and bearing plates. The end bearings, both fixed and movable, are the same as those used for the plate girder bridges. The weight of a span complete is 165,000 lbs.

Electric Tramways and the Carriage of Goods in Great Britain.*

BY ALFRED H. GIBBINGS,
M. Inst. E. E., A. M. Inst. C. E.

Within a period of less than seven years, the development of electric traction in Great Britain has been marvelously rapid. The rate at which Parliament has granted concessions for private enterprise, and the eagerness with which the municipal and local authorities have pressed forward in this matter, has been abnormal in comparison with the progress of any other undertaking of a similar class, not excepting electric lighting.

In 1897, the writer, in conjunction with the city surveyor of Bradford, drew up the first municipal electric tramway specification, and on July 29, 1898, the working of the first ten miles of municipally-owned electric tramways was successfully inaugurated. Prior to this the only electric lines of any considerable extent were those of the Bristol Tramways and Carriage Co., which commenced running electrically in October, 1895, and the Dublin United Tramways Co., which were opened in May, 1896.

At the present time there are no less than 153 electric tramways and light railways in the United Kingdom, with nearly 2,000 route miles in operation. Many of these are in groups, physically connected up and maintaining an interchange of traffic, and hence the possibility arises of conveying goods as well as passengers over these lines. Every Electric Tramway and Light Railway Order contains a schedule of the articles allowed to be carried and the maximum rates and charges for the conveyance of almost all classes of goods, animals and things which include such heavy pieces as boilers, stone, machinery, etc., of which any single piece may weigh over eight tons. In fact, such facilities are granted for the carriage of goods on electric tramway systems, that it is impossible to forecast the extent of the probable development in this direction in the immediate future.

It will be apparent therefore, that the very short time which has elapsed since the introduction of electric traction, has precluded any very striking progress on the "goods" side of these undertakings; indeed, in some cases, it has not been possible to meet adequately the demand of "passengers." On the other hand, however, it has been found that on many of the interurban and rural tramways, the traffic receipts from passengers have not been, and are not likely to be, sufficient to meet expenditure owing to the high initial cost of construction. The problem of goods traffic is thus, at the outset, confronted with two difficulties of an entirely opposite character. On the one hand the town systems are already overcrowded with cars and are earning enormous profits; on the other hand the urban and rural systems are handicapped by unremunerative capital and are limited in their scope and extent. It is true that this is only one aspect of the subject, but typical of many other difficulties which present themselves, and are the first and most important requiring solution, and it is clear that some compromise must ultimately be arrived at.

There will be no need to enumerate those towns which are fortunately situated in having good dividend-earning undertakings, but some instances of the opposite class may be cited here in order to indicate clearly the necessity which exists for them to use all their available powers in order to increase their earning capacity. The following tabulation shows the loss sustained in operation on a passenger traffic basis.

Loss on Electric Tramway Undertakings.

Names.	Commencement of electric running.	Length of line open, miles.	Deficit for 1904.
Aberdeen	1899	25	No profit.
Birkenhead	1901	23	No profit.
Blackburn	1899	24	£5,138.
Brighton	1901	13	£4,779
Burnley	1901	19	No profit.
Burton-on-Trent	1903	8	No profit.
Darwen	1900	6	£1,485
Farnworth	1902	7	£1,780
Halifax	1898	44	No profit.
Huddersfield	1901	35	£4,911
Ipswich	1903	12	£1,920
Lancaster	1903	3	£2,833
Leicester	Horse trams.	16	£1,330
Lowestoft	1903	6	£226
Northampton	Horse trams.	9	£392
Oldham	1902	28	£7,826
Reading	1903	13	£543
Rochdale	1902	5	£4,037
Rotherham	1903	9	£17
Southport	1900	19	£341
Warrington	1902	9	£783
Wolverhampton	1902	13	£2,366
Great Yarmouth	1902	5	£215

The position in which these undertakings find themselves is indeed unfortunate. Before commencement of operation it was almost impossible to tell with any degree of accuracy what the number of passengers per car mile would be, and hence the nature of these promotions has been highly speculative. When once this figure has been ascertained it is in most cases almost invariable from year to year and so, unlike most other business ventures, the tramway is absolutely circumscribed in its development. So far, however, we have been referring to passenger traffic alone. There remains yet one solitary hope to admit of these concerns being placed on a sound financial footing. That hope is in the carriage of goods.

Attention was first called to the potentialities of a goods traffic on electric tramway systems by passing the Light Railways Act, in 1896, which to all intents and purposes has in almost every instance been used to obtain electric tramway powers instead of applying under the Tramways Act, 1870. The Light Railways Act was passed with the special object of facilitating the transport of goods, but more particularly agricultural produce, from country districts to railway centers, canals, towns, etc. It has not yet fulfilled the object of its existence, but indirectly, through the construction of a large number of interurban tramways and light railways, it may ultimately do so.

In 1900—1901, the writer was interested in the development of the South Lancashire Tramways, which serve an area full of promise for the most successful growth of goods traffic, a careful canvass showing an enormous amount of road conveyance of a wide variety of goods. Papers by the writer were read on the subject before the British Association in September, 1901, and the Liverpool Engineering Society in January, 1902. The compilation of these papers necessitated enquiry into all sorts of conditions, pro and con, which exist in this country; into many similar cases on the continent and in the United States, where more progress has been made, and the discussions which arose at the reading of the papers brought out many novel and striking features. Several of these will be referred to further on in this article.

The next step has been a practical application of the powers which hitherto have lain dormant. It consists in the inauguration of a local parcels service on several systems, on some of which it has been very completely and extensively organized.

The undertakings which have made this attempt are: Manchester Corporation, Bradford Corporation, Dublin United Tramways Co., Ltd., Dundee Corporation, Edinburgh and District Tramways Co., Ltd., Huddersfield Corporation, Bury Corporation, Gravesend and Northfleet Electric Tramways, Ltd., Ipswich Corporation, Reading Corporation, Potteries Electric Traction Co., Halifax Corporation and the London United Tramways Co.

A full description of most of these schemes has appeared in the technical press, but it is not the intention here to describe or enlarge upon the details of a parcels service. It will suffice to remark that the Manchester Corporation has designed a special goods or parcels van, which runs between the passenger car services throughout the day. The van is almost identical with the type which has been used for many years by the Pittsburg Express Company, Pittsburg, Pa. It is a clear indication that the business will not be allowed to rest within the limits of parcel conveyance, but that when some of the more obstructive difficulties have been overcome, the carriage of goods will commence in earnest.

Beyond the movement in connection with parcels, very little has yet been done towards inaugurating a comprehensive goods service. The Huddersfield Tramway Department are carrying coals over their lines, and in 1901, the South Lancashire Tramways Co., appointed a goods traffic manager, but gave up the idea through want of capital.

At the annual meeting of the Potteries Electric Traction Co., on April 11, this year, the chairman, Mr. G. F. M. Cornwallis-West, said:

"There had been an increase again in the parcels traffic, the number of parcels carried being 209,633, and the receipts had increased correspondingly. Other tramway undertakings, both municipal and otherwise, had taken up this important subject, and the Potteries Company had been the model in many instances upon which these systems had worked. It was to be hoped that in the near future it would be possible for these concerns to form some sort of combination whereby they could act as each other's agents in the districts they serve, and so enormously increase the volume of business, and thus reap the profits now obtained by intermediaries. The carriage of heavier goods was receiving the directors' attention, and application had been made to the local authorities with reference to the construction of sidings to facilitate such traffic, but so far unsuccessfully."

This undertaking is one of the large group of tramways associated with the British Electric Traction Co., and it may be assumed therefore that the foregoing speech indicates that the British Electric Traction Co. attach considerable importance to the goods traffic problem.

In enumerating the difficulties of inaugurating a goods service on electric tramways, no regard need be given to such objections as may be classed as æsthetic, constructive, or purely traffic troubles. These are simple and weigh but little in comparison with those of a more obstructive and real nature. Indeed, there are some which must be removed, notwithstanding the facilities and powers already conferred by the Acts and Orders, before any business can be done.

In the first place even the carriage of parcels has met with strong local opposition in Manchester, and has involved the corporation of Manchester in serious litigation on a question, the decision of which will be awaited with great interest.

When the scheme was proposed, it met with determined opposi-

*Reprinted from the July number of the *Engineering Review*.

sicians and gave a judgment of $15,000, which was paid by the company. Some months afterwards plaintiff was seen in the back yard of his house chasing stray chickens off his premises.

Another case was that of injury to an engineer in East Texas in a collision. The usual claim, "spinal-nervous injury," was made, which was supported by the usual medical testimony. The jury awarded him $8,000 and very soon after the money was paid he actively engaged in business, and has ever since enjoyed good health.

A freight conductor who was injured in East Texas in 1902 claimed to have sustained an injury to his nervous system, and received in involuntary settlement $1,850. The following year he was again injured and his nervous system was again deranged; he also alleged that his hearing was greatly impaired. In support of these claims he furnished certificates of several physicians. The company paid him $2,300 and a few months after this he entered the service of another company in the eastern part of the state as conductor of a construction train.

In the spring of 1904 this same man entered the service of a railroad company in the northern part of the state as switchman, and was again injured, this time claiming that the handhold on a freight car had pulled loose, allowing him to fall to the ground, striking his back, with result that his nervous system was again shattered.

An investigation of his former history showed that some four years before he had sued a railroad company for damages for injuries sustained by reason of a fall from a freight car on account of alleged defective hand-hold. The injuries complained of in the petition were "shattering of the nervous system and loss of manhood." The company settled with him and his attorneys for $800 and he left the service. In view of this fact the last company refused to make any payment for the injuries received, and a suit was instituted. The suit was continued several times, and it was ascertained that while the suit was pending he engaged in the railroad service at another point in the state, and his nervous system was again ruined, and his manhood again lost in another hand-hold accident, this being the third accident of that character in which the nervous system of this unfortunate man had been wrecked.

Another case was that of a passenger who claimed that in the spring of 1903 he was injured by slipping on a banana peel which had been carelessly left in one of the coaches, the result of which was injury to the "spine." This claim was declined by the company and a suit was instituted. Investigation of the claimant's history showed that some three years before he had a suit against another railroad for injuries alleged to have been received in a collision. The jury awarded a verdict of $2,500. While the motion for a new trial was pending the plaintiff, believing himself secure from observation, abandoned the use of his crutches, and was seen running to catch a train at the station not far from the place where the suit was pending. When these facts were brought to the attention of the court a new trial was granted.

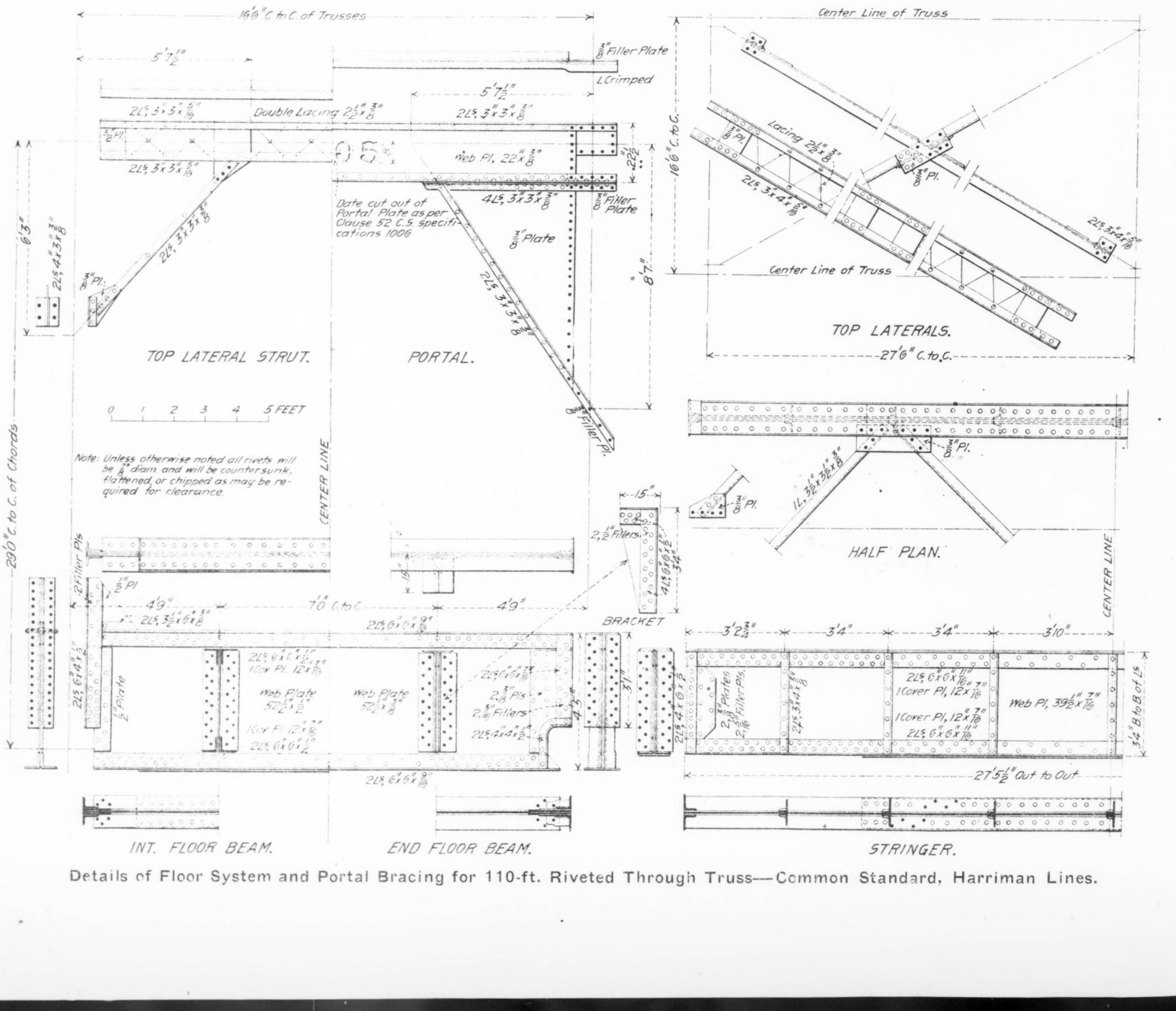
While the banana suit was pending the plaintiff moved into a remote part of the state and went into hiding. He was traced and found hard at work as a fireman at a cotton gin, his duties requiring the exercise of all his muscular powers. It was also found that after the banana peel accident he had made application to an insurance company and represented to it that he was in good health, a statement which was corroborated by the examining physician of the insurance company. The testimony of witnesses to these facts was procured, and upon seeing the depositions on file the suit was dismissed.

I will mention but one other case which, although like most of the others, is rather remarkable in one respect: The sufferer in this instance was a brakeman who claimed to have been injured in a derailment on one of the lines leading out of Houston. The usual claim of injury to the "spine" and nervous system was made, also inability to perform manual labor—all of which was supported by medical evidence. The company paid in settlement $4,500 after suit had been instituted. Within three months from the payment of the money this physical wreck took the first prize in a cattle roping contest held in one of the cities in North Texas. I believe that the record shows that he roped, threw and tied a steer in 27.5 seconds.

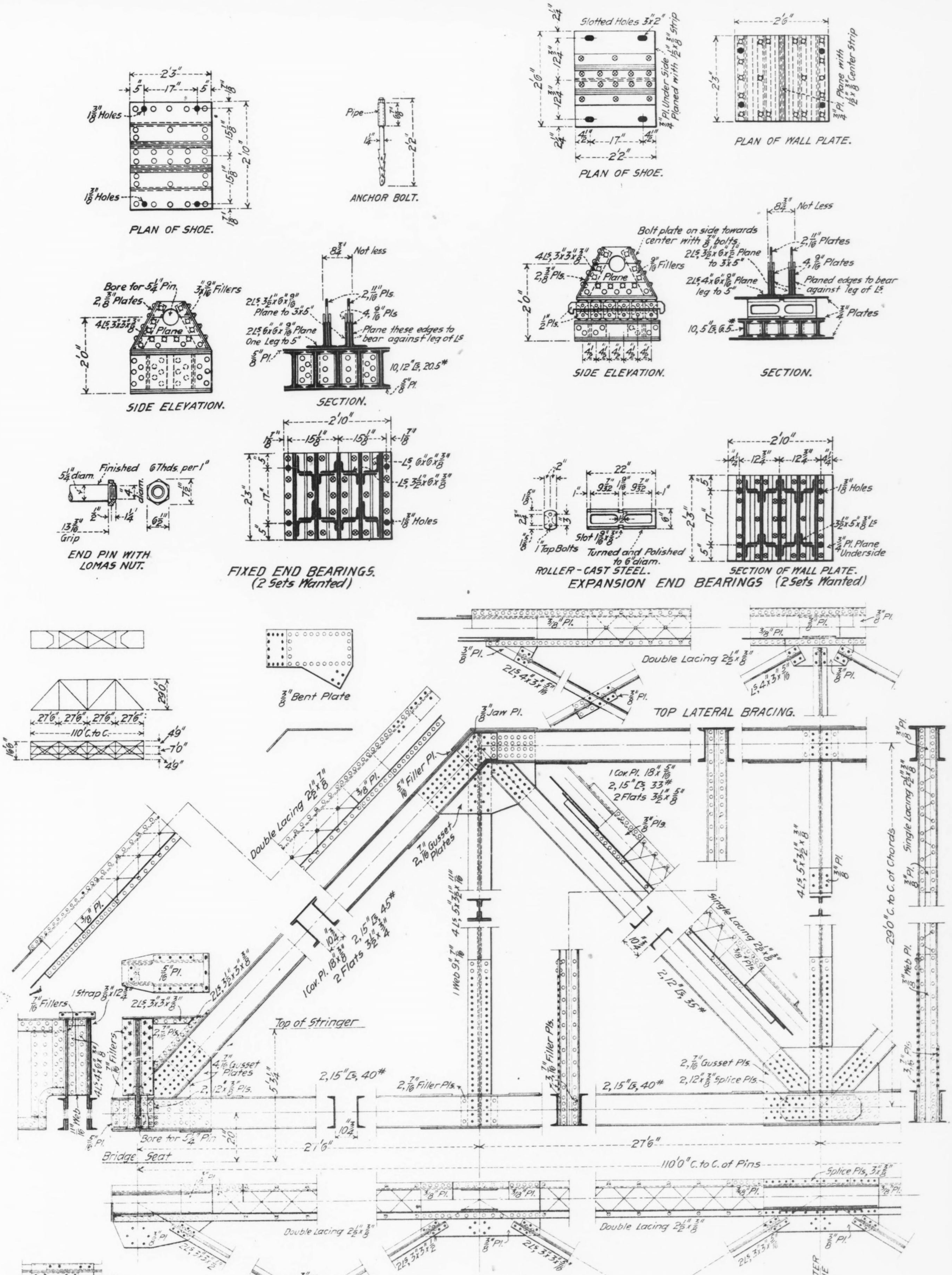
Standard Bridges on the Harriman Lines.*

The accompanying drawings show all the details of the common standard 110-ft. through riveted truss bridges used by the Harriman Lines. They are essentially similar in all respects to the 100-ft. span shown July 28, and an extended description is not necessary. The estimated weight of one span complete is 185,000 lbs.

*Previous articles appeared in the *Railroad Gazette*, March 17, 24, 31, April 7, 14, 21, 28, and July 28.



Details of Floor System and Portal Bracing for 110-ft. Riveted Through Truss—Common Standard, Harriman Lines.



Details of Side Trusses and End Bearings for 110-ft. Riveted Through Truss—Common Standard, Harriman Lines.

Ball freight which have been delayed. This form is also used by yardmasters in reporting the forwarding of such cars, delayed by any cause, when not sent out in the proper train. The passing report, form 101, is used only by agents or yardmasters at a small number of important stations, and is a progress report for the information of the superintendent of car service. The final report, form 103, is used by all agents in reporting arrival of cars at destination.

It is provided that local merchandise traveling as Red Ball freight shall be red balled to the last district terminal reached before distribution begins, after which the car travels on local trains. These cars are handled on form 1,173. Less than carload shipments may be waybilled on Red Ball freight waybill form 1,171 or 1,172, but no symbol letters and numbers must be used on such waybill. It is specially provided that Red Ball freight must be handled only on trains designated or covered by special instructions, and that all Red Ball freight must be bunched as far as possible at district terminals for movement in such trains; these trains to be filled out with Green Ball freight. Cars containing freight other than the commodities given in the book of instructions must not be billed on the special classified waybills without permission from the office of the superintendent of car service. The diversion of all loaded cars in transit is handled through the office of the freight claim agent, and whenever a car is diverted the agent making the diversion shall notify the freight claim agent jointly with the superintendent of car service, by wire, giving new consignee, destination and routing. The general monthly report of the movement of this freight is shown on form 108, in abbreviated form.

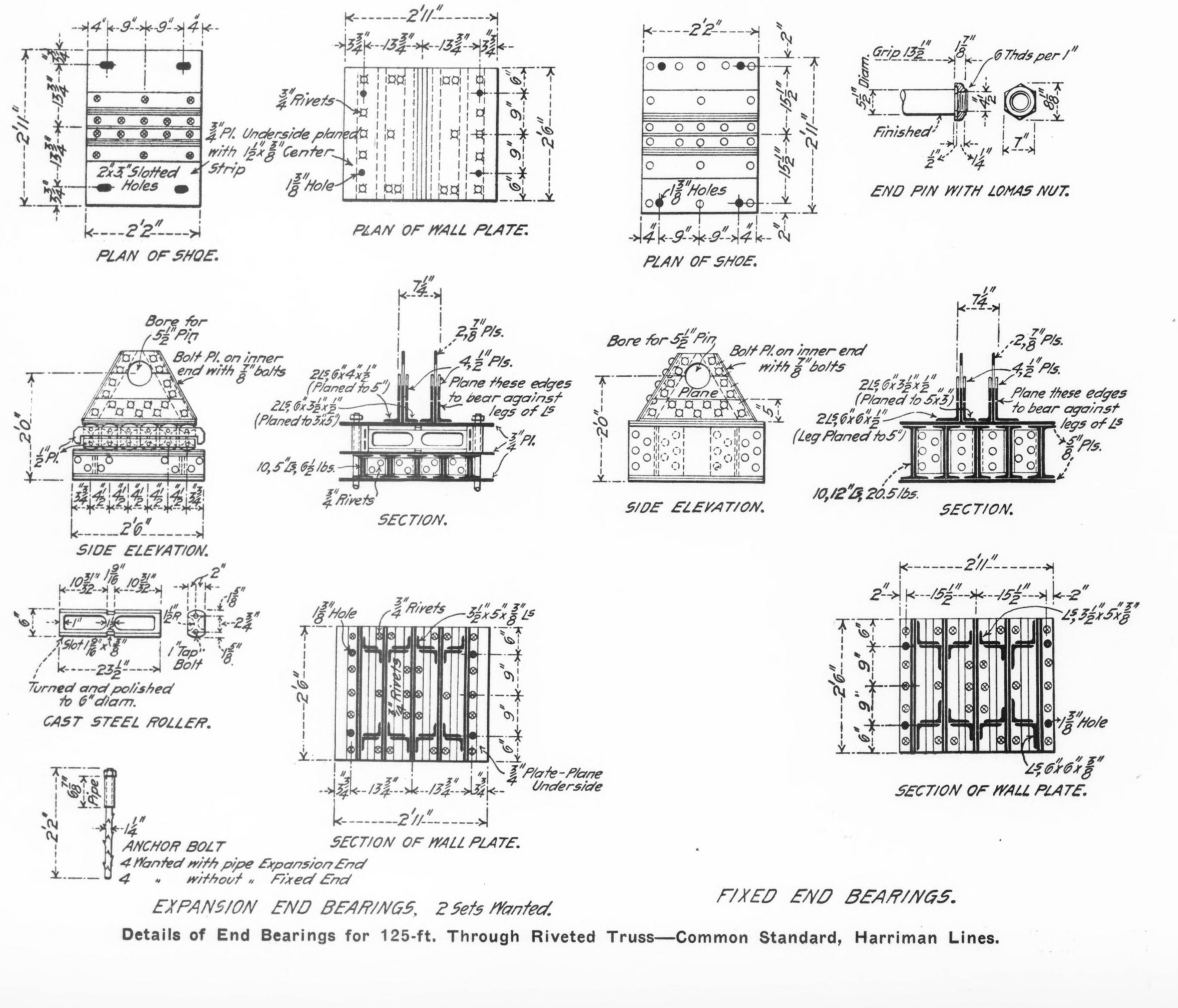
The Air-Brake Law.

The Interstate Commerce Commission, acting under the authority vested in it by the law of March 2, 1903, proposes to make a change in the requirement that there shall be a certain percentage of air-braked cars in all trains, increasing the minimum beyond the present 50 per cent., provided it shall prove reasonable and practicable to do so. As a preparatory measure, the Commission has called upon the railroads to report to it before October 1 the average percentage of air-braked cars used in [freight] trains during the past six months. The law empowers the commission, "to more fully carry into effect the objects" of the law, from time to time, after full hearing, to increase the minimum percentage of cars which must have power brakes in use. It is held that sufficient time has now elapsed to permit the railroads to make any necessary preparations. In the preamble of the present notice it is said that "it has been brought to the attention of the Commission that dangerous conditions frequently arise from the buckling of trains under emergency applications of air on trains insufficiently air-braked," and that it now seems practicable to increase the aforesaid minimum percentage without serious inconvenience to the carriers. After the required information has been received, a day for a hearing will be appointed. The roads are to report also the number of freight cars in use and the number equipped with air-brakes; and they must also send a statement of any instructions which have been issued respecting the use of air.

Standard Bridges on the Harriman Lines.*

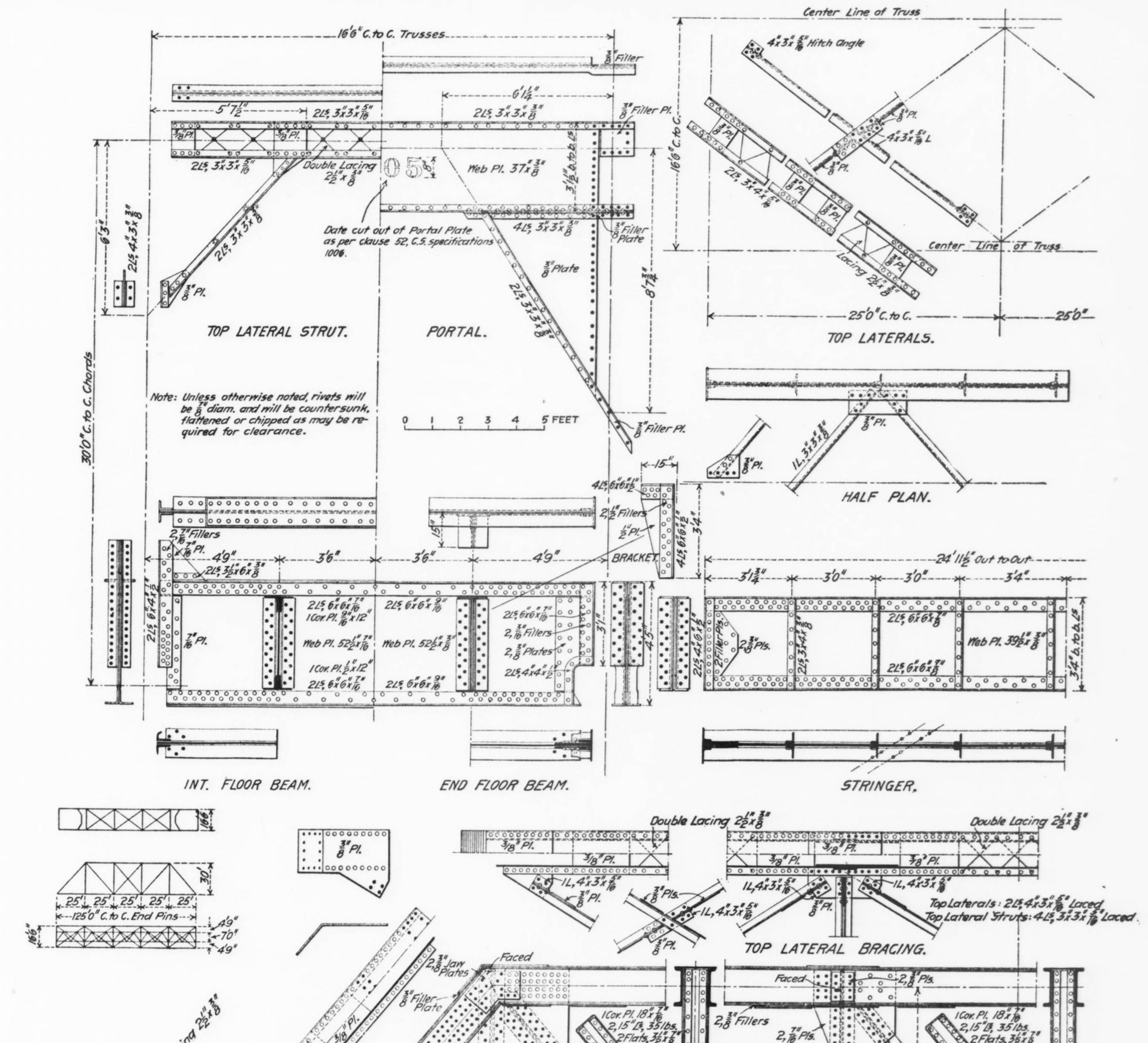
The drawings herewith show the Harriman Lines' standard 125-ft. riveted through truss bridge. It differs in some essential details from the 100-ft. and 110-ft. spans previously shown, notably in the introduction of a fifth panel and in the design of the diagonals. In the intermediate panels of the 125-ft. span the diagonals are fabricated with an I-section from four 6-in. x 3½-in. x ½-in. angles and a 9½ x ½-in. web plate instead of two 12-in. channels with single lacing as in the shorter spans. Double diagonals are used in the middle panel, built up of four angles 4 in. x 3 in. x ⅜ in. laced to approximate an I-section. The top and bottom chords are exactly the same as for the shorter spans, as is also the lateral bracing both top and bottom. The end bearings are correspondingly heavier and stronger, but in the details of the design no changes have been made. The estimated weight of one span complete is 220,000 lbs.

*Previous articles appeared in the *Railroad Gazette* March 17, 24, 31, April 7, 14, 21, 28, July 28, and Aug. 11.



EXPANSION END BEARINGS. 2 Sets Wanted. FIXED END BEARINGS.

Details of End Bearings for 125-ft. Through Riveted Truss—Common Standard, Harriman Lines.



Details of Trusses and Floor System of 125-ft. Through Riveted Truss—Common Standard, Harriman Lines.

Reports on the Mentor Disaster.

Coroner Siegelstein, of Cuyahoga County, on August 16 rendered a verdict in connection with the wrecking of the Twentieth Century Limited at Mentor, Ohio, on the night of June 21, in which 19 lives were lost. The Coroner holds that Walter F. Minor, the telegraph operator at Mentor, opened the switch which caused the accident. The verdict, in part, is as follows:

"I find that the switch was opened by Walter F. Minor, the night telegraph operator in charge of the station. I reach this finding by deduction; i.e., after having read over the notes on the testimony taken at the Painesville inquest, which I attended, and the testimony taken at my own inquest, I find that the time (according to observations taken by this office), from which the headlight of the Twentieth Century Limited train is seen approaching from the station platform at Mentor until it reaches the switch, is a maximum of 31 seconds. During this brief period of time, if Mr. Minor did not throw the switch on that night, and another person did, then that person must have appeared at the switch from some unknown place, unlocked the lock with a key, removed the lock, taken the coupling pin out, turned the switch, put the coupling pin in place again, placed the lock in the hole of the coupling pin, locked the lock and disappeared—a physical impossibility in my opinion. In the 500 folios of typewritten testimony taken at my inquest there appears not one word tending to show the presence of anyone but Minor, who was in charge of the station that night, in the immediate vicinity of the station or the switch, immediately preceding the wreck or afterward.

"Hence I can only come to the conclusion, which is reinforced by other points of the evidence, that Walter F. Minor opened the switch, but whether he did so of his own volition or by telegraphic orders of a superior officer I am not prepared to say."

State Railroad Commissioner J. C. Morris on August 17 made a report from which we take the following essential paragraphs:

"The derailment took place about 70 ft. east of the frog. The main track was found to be in good condition and the switch points, stand, bridle rods and all attachments were found in good working order and neither main track nor switch showed any signs of having recently received any repairs, which proved at once that neither the physical condition of the main track nor of the switch was in any degree responsible for the accident.

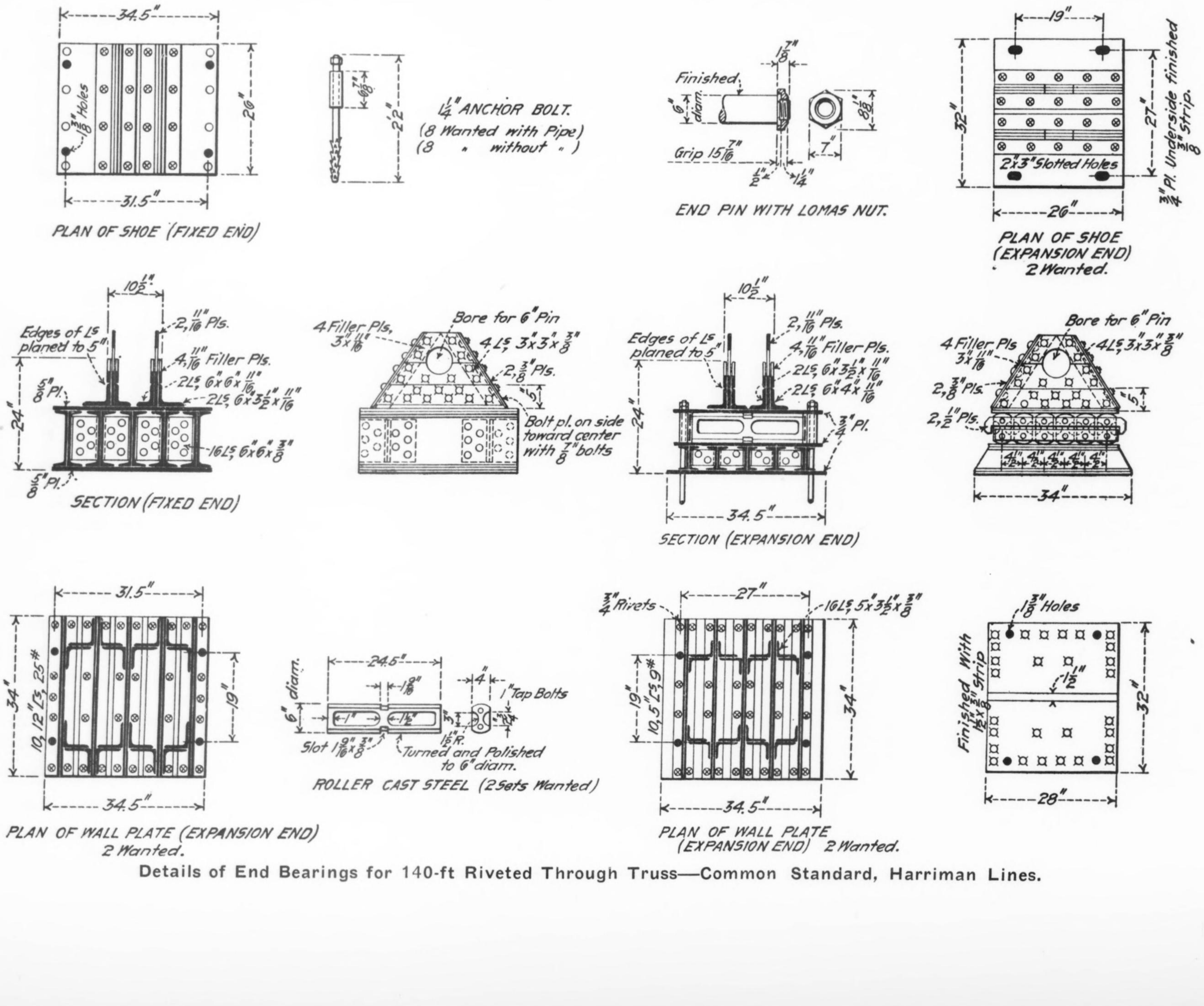
"An examination of the operator's train report showed that no trains passed Mentor in either direction between the passing of train No. 10, eastbound, at 8.31 p.m., which did not stop, and the arrival or No. 26, the wrecked train. A further examination of the operators' train reports at Wickliff and Willoughby, telegraph points immediately west of Mentor, and the original train sheet kept by the train despatcher at Buffalo, confirms this and shows no discrepancies in the records in any manner. A number of persons were interviewed and their statements, together with the testimony as given by the operators, train despatchers and train crews before the Coroner of Lake County, corroborate the official train sheet in the despatcher's office at Buffalo. The only eastbound train between Collinwood and Mentor was freight train 5919, which was passed by No. 26 on the four track portion of the road about nine miles west of Mentor, 5,919 running on track number 4 and No. 26 on track number 3. Owing to the distance from Mentor to the point where No. 26 passed 5,919, and the fact that there are two telegraph offices, one at Willoughby and the other at Wickliff, between these points, would indicate the improbability of the switch [at Mentor] being opened for the purpose of permitting 5919 to clear the main track for No. 26. I find that the switch was in the position of "open" and had been placed and locked in that position by some person in possession of a switch key."

Commissioner Morris then recommends distant signals for facing point signals, and the use of easier curves at the entrances to passing tracks. He says nothing as to who misplaced the switch except that the coroners and the railroad company have put forth every effort to discover the one responsible.

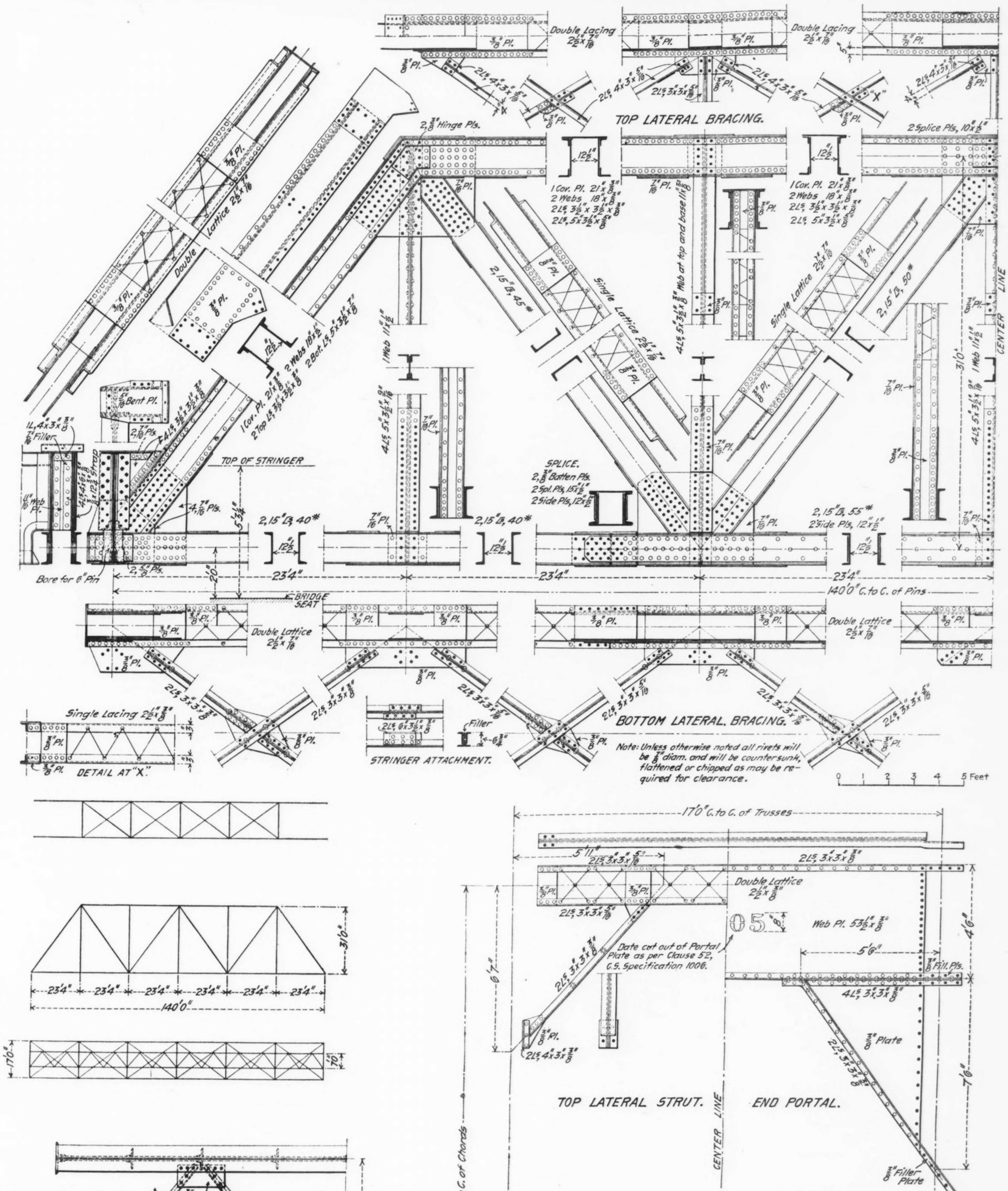
Standard Bridges on the Harriman Lines.*

The 140-ft. riveted through truss bridge shown this week again has some differences in the details of the various members over any of the shorter spans previously shown. The number of panels has been increased to six with single diagonals in each panel. These are made up of two 15-in. channels, 45 lbs. and 50 lbs. per ft., with single lattice across the top flanges. The top chord is built up of a cover plate 21 in. x 3/8 in.; two webs 18 in. x 3/8 in., spaced 12½ in. apart; two top flange angles 3½ x 3½ in. x 3/8 in., and two bottom flange angles 5½ in. x 3½ in. x 5/8 in. The end diagonals are fabricated in a similar manner but of heavier sections. For the bottom chord two 15-in. 40-lb. channels with ½-in. side plates are used as in the 125-ft. span. The estimated weight of one span complete is 273,000 lbs.

*Previous articles appeared in the *Railroad Gazette* March 17, 24, 31, April 7, 14, 21, 28, July 28, August 11 and 18.



Details of End Bearings for 140-ft Riveted Through Truss—Common Standard, Harriman Lines.



Details of Side Trusses and Floor Framing of 140-ft. Riveted Through Span—Common Standard, Harriman Lines.

months' notice of his intention to do so, and is thereupon entitled to receive from the fund an annual allowance for the rest of his life. It is stipulated that for every year of service in the department he shall receive one-sixtieth part of his annual rate of pay, but in no case shall the total yearly allowance exceed two-thirds of such annual rate of pay. It is also provided that the board may extend the provisions of the superannuation to cases where the contributor's service is not less than 35 years but does not amount to 40 years. A contributor who retires with the consent or by the direction of the Minister on the ground of being physically unfit for further duty is entitled on his retirement to receive an allowance for the rest of his life as stipulated above. It is provided that if any contributor voluntarily retires from the service of the department before becoming entitled to a retiring allowance under the act, or if his services are dispensed with from any cause other than misconduct, he shall be entitled to a refund of the whole amount actually contributed by him to the fund, but without interest, together with any compensation to which he is entitled under the Government Railways act of 1887. Contributors dismissed or those whose services are otherwise dispensed with from misconduct are likewise entitled to a refund of the entire amount which they have actually contributed, computed without interest. In the event of the death of a contributor before retirement his legal representative receives the entire amount paid in without interest, in the same manner as with one who voluntarily retires prior to the expiration of his time. But if such contributor dies leaving a wife or children who survive him, then in place of such payment to his legal personal representative it is provided that there be paid to or for the benefit of the widow during her widowhood the annual sum of £18, with an additional sum of 5s. a week for each child until the child is 14 years old. These annual payments are to be made at the discretion of the board, but in no cases shall payments be at longer intervals than four weeks. The widow has the option, however, of receiving in a lump sum in place of this allowance such portion of the amount of contributions actually paid by the contributor to the fund and of the compensation to which the contributor was entitled under the provisions of the Government Railways Act as the board may determine.

If at any time the pay of a contributor is temporarily stopped by the department on the ground of ill health he is allowed to continue to contribute to the fund and his rights to the benefits provided are not affected by the stoppage. With regard to determining the annual rate of pay as mentioned in the previous paragraph, it is provided that this rate shall be taken as the rate the contributor was receiving at the time of his retirement, unless within the previous five years he had served in a lower grade. In that case, the average rate during the seven years next preceding his retirement is taken. But where a contributor's pay is temporarily reduced, or where through age or infirmity he is transferred to a subordinate position to that which he previously occupied, his retiring allowance is computed on the maximum rate of pay he received before such reduction or transfer.

At times when the fund is unable to meet the charges upon it, the board is instructed to set forth the fact to the Colonial Treasurer, stating the deficiency and the causes, and the Treasurer is authorized to make good the deficit without further authority. Retiring allowances and other money granted under the Act cannot be assigned or in any way alienated from the grantee and these grants are not subject to the Bankruptcy Act of 1892.

A servant girl riding in a third-class compartment in Hungary carried with her three gallons of alcohol in a demijohn which by some accident broke, so that the alcohol ran over the floor and also into the adjacent compartment. There a countryman touched it with a lighted match "just for fun," to see if it would burn. It did burn, and so did the car and the next one, and the poor girl and two other passengers.

Automatic Block Signals on the Erie.

The Hall Signal Company has taken an order from the Erie Railroad for equipping with automatic electric motor semaphore block signals its line from Bergen, N. J., two miles from the Jersey City terminal, westward to Middletown, N. Y., 66 miles. The contract covers 175 miles of track. There will be 82 single-arm and 33 two-arm signals. In blocks more than one mile long, the distant signals will be on separate posts, but between Bergen and Suffern the blocks are shorter and distant and home signals will be on the same post. The lengths of the blocks vary from three-fourths of a mile to 1¾ miles. This is the first important installation of automatic signals which has been made by the Erie, and the new signals will, for most of the distance, displace controlled manual block signals. The automatic block signals are to be worked by storage batteries charged by wire lines from generating stations at Rutherford, Ridgewood Junction, Suffern, Oxford and Middletown. A portion of this line is four-track, and on this portion bracket posts will be used. Parts of the line close to the eastern terminus have been four-tracked for many years, and the present signals are on bridges; these bridges will be retained. The Sykes lock and block apparatus, which is to be displaced, has been in use about 18 years, and much of it had reached the age at which it would soon need to be renewed.

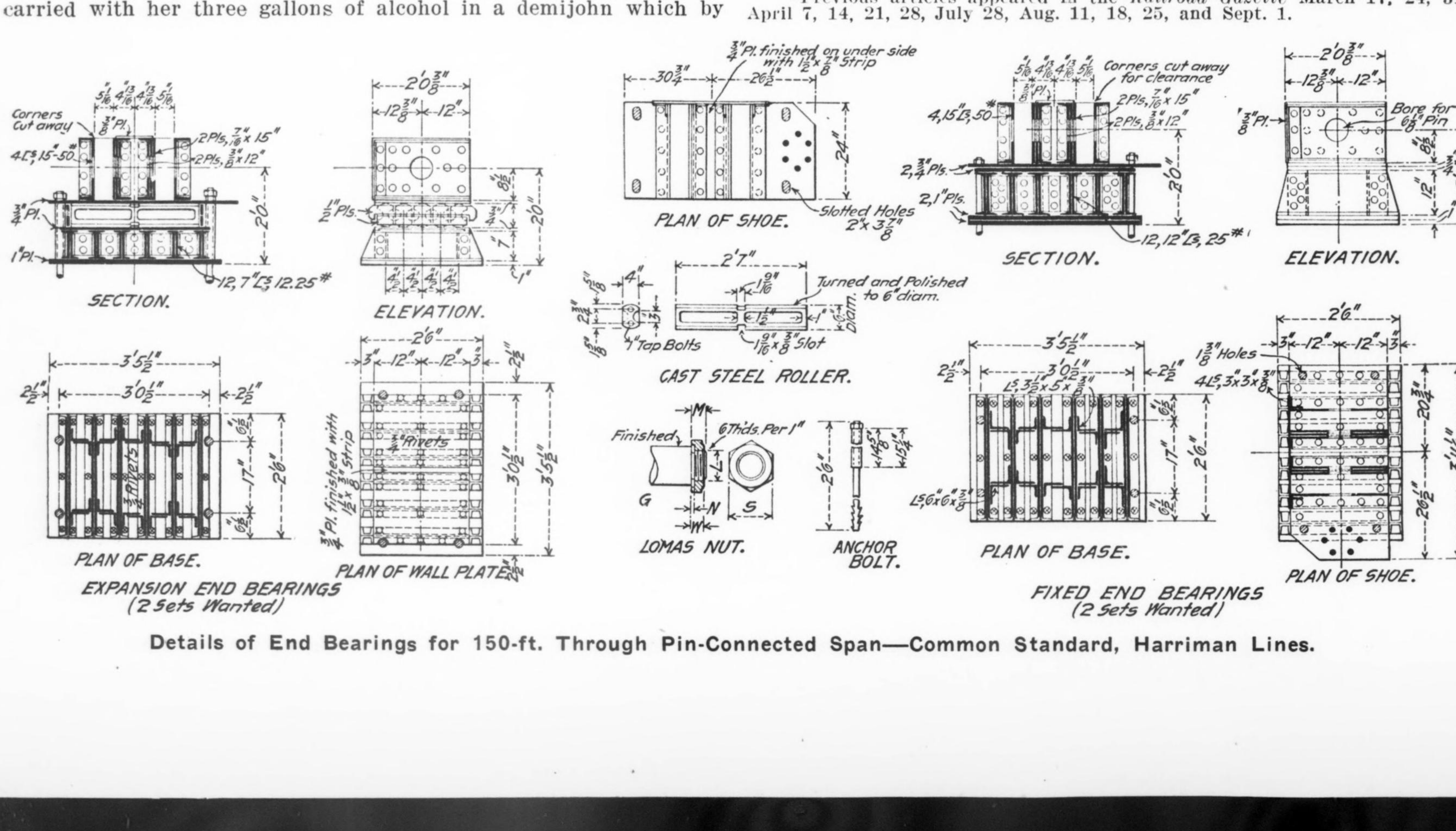
The five charging stations have each a 500 volt, three k.w. direct current generator operated by a gasolene engine. The charging lines will be No. 10 hard drawn copper wire. The contract also calls for 95 electro-mechanical slots for existing signals and 27 highway crossing bells.

The Hall company has also closed contracts recently with the Chicago & Alton, the Union Pacific and the Alabama Great Southern.

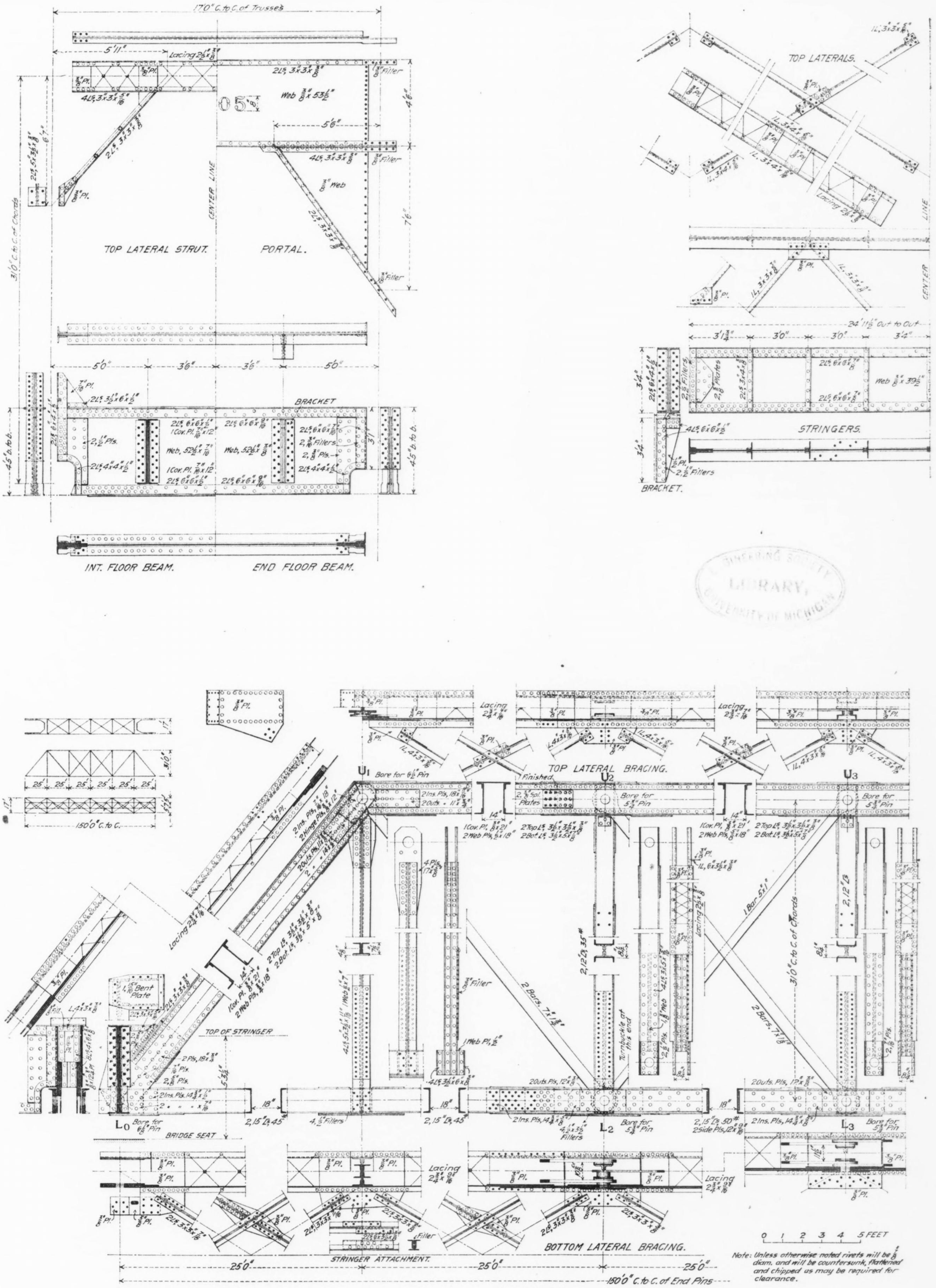
Standard Bridges on the Harriman Lines.*

The 150-ft. span through pin-connected truss bridge illustrated this week is the first of the Harriman Lines standard designs shown for this type of bridge. There are six panels, the two center panels have double diagonals, one of which consists of two bars 7 in. x 1⅛ in. and the other of a single bar 5 in. x 1 in. The intermediate panels have single diagonals each 7 in. x ¾ in. The top chord is built up of a cover plate 21 in. x ⅜ in.; two webs 18 in. x ½ in. spaced 14 in. apart; two top flange angles 3½ in. x 3½ in. x ⅜ in., and two bottom flange angles 3½ in. x 5 in. x ⅞ in. The end diagonals are fabricated in a similar manner to those shown in the 150-ft. riveted through truss bridge which was illustrated last week, the only difference being the distance between and in the thickness of the web plates, which are spaced 14 in. apart instead of 13 in. and are ¾ in. in thickness instead of ⅝ in. The bottom chord is made up of two 15-in. 45-lb. channels and two 12-in. x $^9/_{16}$-in. side plates. The estimated weight of one span complete is 304,000 lbs. as against 311,000 lbs. for the 150-ft. riveted through truss span shown last week.

*Previous articles appeared in the *Railroad Gazette* March 17, 24, 31, April 7, 14, 21, 28, July 28, Aug. 11, 18, 25, and Sept. 1.



Details of End Bearings for 150-ft. Through Pin-Connected Span—Common Standard, Harriman Lines.



Details of Trusses and Floor of 150-ft. Through Pin-Connected Span—Common Standard, Harriman Lines.

passengers carried during the year and average fare for each passenger carried. In addition to this a classified list of employees is given, with the average hours worked per day for each class and the average number of hours constituting a day's work.

A summary of the data given in the tables show that there are 25 separate electric railways now being operated in Michigan, having 1,158 miles of single track. This would equal two lines from the Straits of Mackinaw to the southern line of the state and two lines across the state at its widest point, a wonderful development in the few years since the use of electricity as a motive power.

The capital stock of these electric roads is given at $34,075,000, of which $1,600,000 is reported as preferred stock. The actual value of the roads with their equipments will approximate $45,000,000. Last year 18 of these lines spent $1,682,718 for permanent improvements, 10 of them extending their lines to the extent of over 62 miles.

During the year 151,001,029 passengers were carried on these lines, the sum of $6,581,275 being received for passenger traffic alone. The average rate of fare for all passengers carried being .04⅓ each. During this same period the receipts from freight traffic were $229,612, and $99,314 was received from other sources, making the total receipts of the 25 lines $6,910,201. The receipts of the electric roads in the state for one year equals the entire expense of the state government for the same period.

The combined lines operate 1,494 cars, of which 1,352 are for passenger traffic. Many of these cars are of the most elegant modern construction, especially those used on the interurban lines. In furthering the conveniences of travel 17 of the lines give universal transfers, the lines that do not, being the ones operating outside the cities, or where the lines are continuous so that a transfer is not needed. On five of these lines transfer tickets are given where one transfer has already been made. The usual price charged for a single ticket is five cents, and on most of the interurban or county lines tickets are sold at the rate of one and one-half cents per mile, but almost every line has different conditions in selling tickets, such as "six for 25 cents," "50 for $1.50," "less per round trip," "school children tickets," "laborers" tickets at certain hours," "party tickets," etc.

At the time the canvass was made the lines were employing in the aggregate 5,144 people who were paid an average daily wage of $1.89, ranging from $4.16 for a division superintendent to $1.12 for the most common laborer. Among the classified employees the wages of a large per cent. are computed by the hour, none of the classifications averaging more than 11 hours per day, the average of the entire canvass being slightly above 10 hours for each day. The statistics show that approximately 50 per cent. of the receipts of the electric lines in Michigan is paid for the labor they employ.

In 1895 Michigan had but few electric lines outside the principal cities, a partial canvass made that year showed many of the lines on the verge of bankruptcy. The aggregate capital stock of all the companies was less than $8,000,000. They operated 400 miles of track, much of which was in very poor condition. The annual receipts of all the companies were reported at $2,231,468, while their indebtedness approximated $11,000,000. At that time 1,865 employees were canvassed, 75 per cent. of this number were conductors and motormen. Although this large per cent. were of the better paid employees, the canvass showed that the average per diem received by all employees was only $1.69. The canvass of that year also showed that over 13 per cent. of the employees were compelled to lose more or less time.

Standard Bridges on the Harriman Lines.*

The 160-ft. span through pin-connected truss bridge shown this week differs but little in regard to details of its various members over the 150-ft. span bridge shown last week. The number of panels and the method of bracing remains the same, but the diagonals are slightly heavier. The top chord is similar in every respect excepting that the cover plate is ⅜ in. x 24 in. instead of ⅜ in. x 21 in., and the web plates are 20 in. x ⅜ in. instead of 18 in. x ½ in. The spacing of the web plates remains the same, 14 in. The bottom chord is made up of two 15-in. 55-lb. channels and two 12-in. x ⅝-in. side plates. The end diagonals are fabricated in a similar manner to those used in the shorter span, the only difference being in the width of the cover and web plates. The end bearings are also practically the same as those for the 150-ft. span, excepting that a few of these parts have been made a trifle heavier. The estimated weight of one span is 348,000 lbs.

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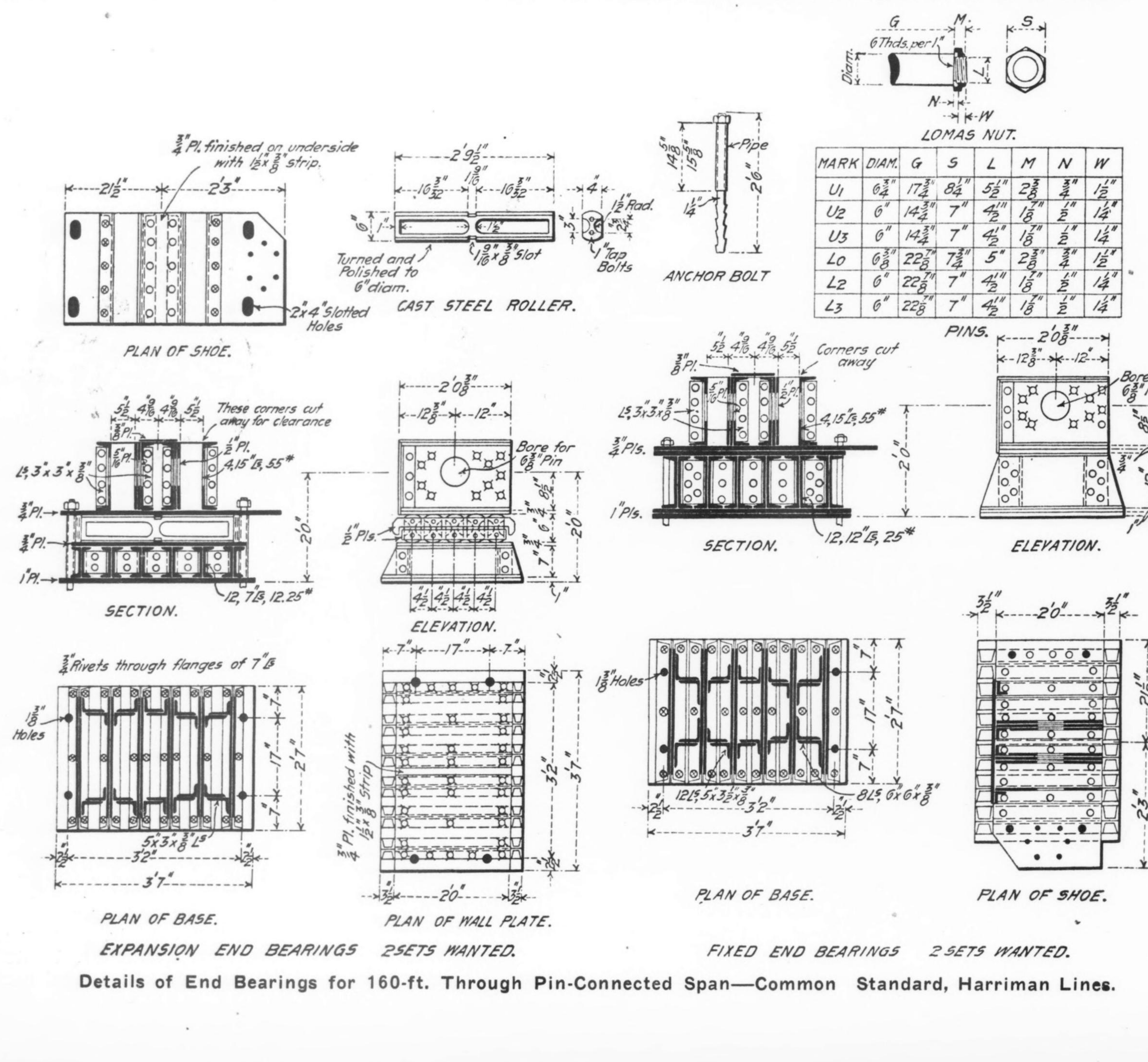
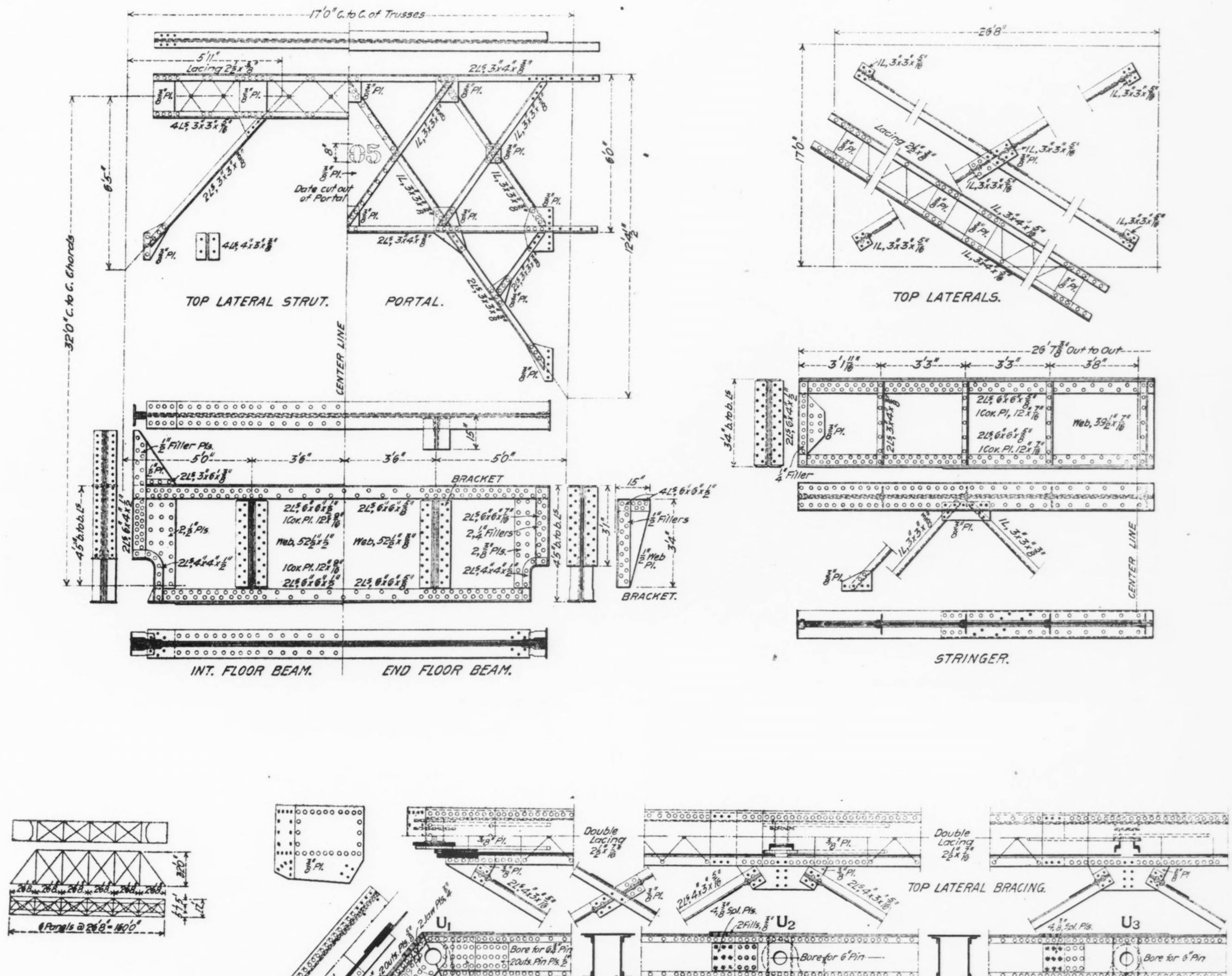


MARK	DIAM.	G	S	L	M	N	W
U1	6¾"	17¾"	8¼"	5½"	2⅜	¾"	1½"
U2	6"	14¾"	7"	4½"	1⅞"	½"	1¼"
U3	6"	14¾"	7"	4½"	1⅞"	½"	1¼"
L0	6⅜"	22⅞"	7¾"	5"	2⅜"	¾"	1½"
L2	6"	22⅞"	7"	4½"	1⅞"	½"	1¼"
L3	6"	22⅞"	7"	4½"	1⅞"	½"	1¼"

Details of End Bearings for 160-ft. Through Pin-Connected Span—Common Standard, Harriman Lines.



Details of Trusses and Floor System of 160-ft. Through Pin-Connected Span—Common Standard, Harriman Lines.

10 tons, and which averages 40 per cent. of this during its entire working period, we should expect the repairs to cost $(n F + 1) = .4 \times 10 + 1 = 5$ cents per mile.

In text, this formula might be easily remembered as one cent per ton of tractive force per mile plus one cent per engine-mile.

Mr. Virgil Bogue suggests a formula in which the cost of repairs and stores would be equal to .1728 times the tons on drivers, corrected by the proportion of average load to full load. With the general proportions of locomotives wherein the weight on drivers is 4 or 5 times the tractive force, the cost by this rule would be somewhat less than by ours, when the engine was fully loaded; however, as he uses higher percentages for the average power exerted by the engine, the two methods produce results not very far apart.

The most difficult part of the proceeding is to fix upon the value of n in formula 14, but as the rule itself is intended only to give an approximate idea of what the cost of repairs will be, it is not necessary to go to too much refinement. Moreover, as pointed out, the cost will vary greatly when the water or labor conditions are very different, for all of which due allowance should be made as heretofore pointed out. The most useful purpose of the rule is evidently to permit us to calculate the difference in total operating costs, for engines of various sizes over the same division, when we desire to know the relative cost of handling traffic by means of large or small locomotives. In this case, any extra flue or firebox work would probably be a nearly constant addition per mile for either locomotive, so that the difference in cost would be generally unaffected. As stated previously, costs of both material and labor vary so enormously throughout the country, or during a single year, that aboslute values for totals cannot be expected, but fortunately, if our rules are logically deduced, the difference of costs for various methods of operation in the same district can be determined with sufficient accuracy to enable us to find the cheapest speed, loading, etc., for the territory in which we are interested.

The increase in cost of locomotive maintenance and operation due to the larger sizes of the machine now in use is often commented upon as comparing unfavorably with the reduced cost of transportation charges. There is little logic, however, in such criticism. From our analysis, we have seen that it is natural to expect greater fuel and maintenance costs when the engine is enlarged. More work unquestionably requires more fuel, and heavier locomotives will certainly cost more for repairs than lighter ones. We cannot hope, therefore, to greatly increase the size of the power, and obtain large reductions in the cost per ton-mile on these two very important accounts: the cost is sure to be nearly in proportion to the work accomplished by the locomotive, which means that the fuel and repairs per ton-mile in the same service will not vary greatly, although there should be some gain in favor of the larger engines.

But with transportation charges this is entirely different. Outside of the switching and yard work, a long train requires little if any more labor or men than a short one, particularly since the general introduction of automatic brakes, and this fact alone is sufficient to cause a very considerable reduction in the cost of engine and train crews per ton-mile; thus the transportation accounts benefit at the expense of the maintenance charges, and instead of criticisms, the fact that the total cost of transportation is reduced, reflects credit upon the practice of increasing the power of the locomotives, which alone is responsible for the economical results obtained.

(To be continued.)

Standard Bridges on the Harriman Lines.*

The accompanying drawings show all the details of the common standard 180 ft. span through pin-connected truss bridges used by the Harriman lines. The details are essentially similar in all respects to the 160-ft. span shown Sept. 15, and an extended description is not necessary. The principal difference in the 180-ft. span is that it is made up of seven panels whereas the 160-ft. span has but six panels. The end diagonals and the top and bottom chords are fabricated in a similar manner to those used in the shorter span but are made of slightly heavier material. The end bearings are also of practically the same design as those used for the 160-ft. span. The estimated weight of the 180-ft. span which is shown is 417,000 lbs. against 348,000 lbs. of the 160-ft. span which was shown last week.

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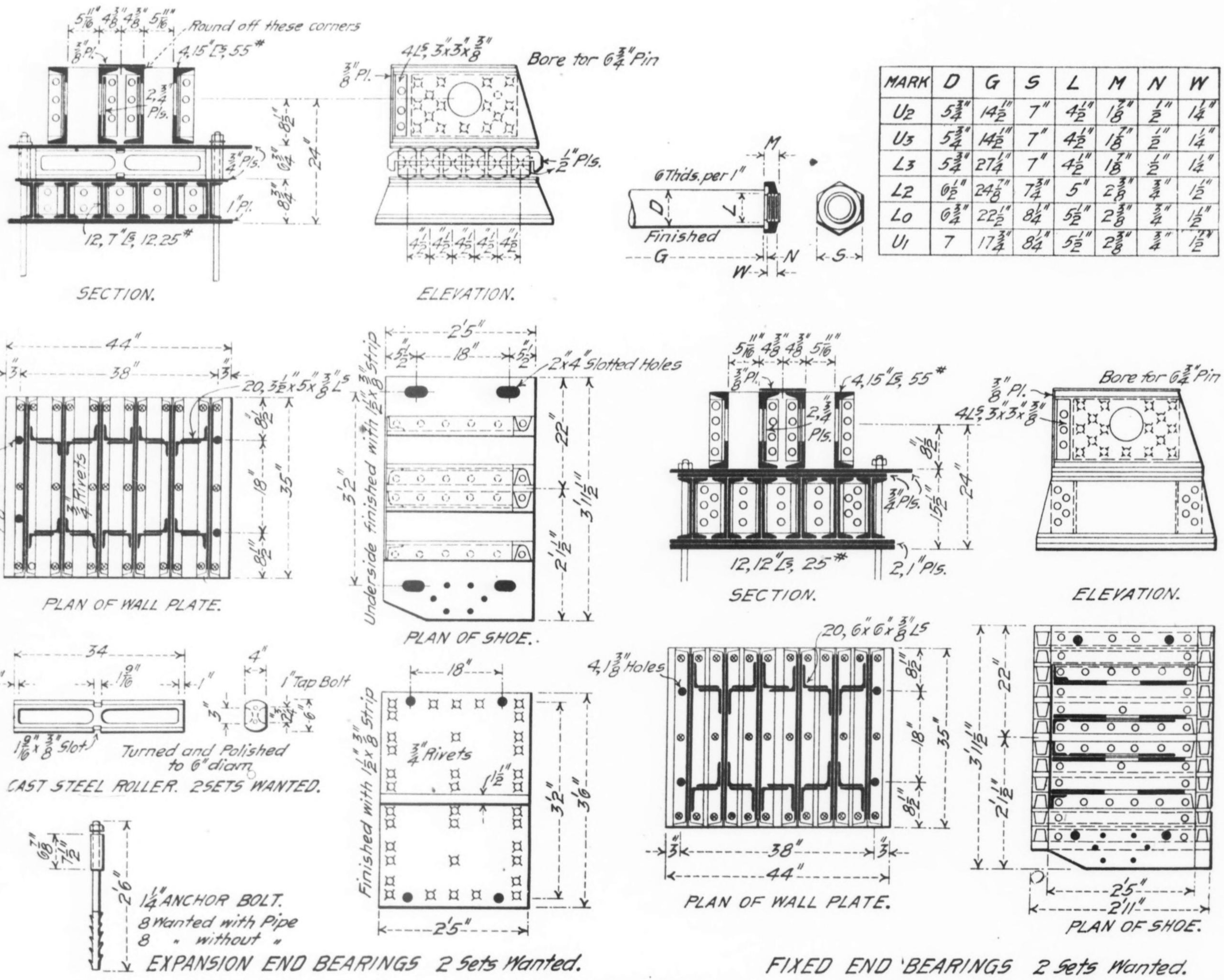
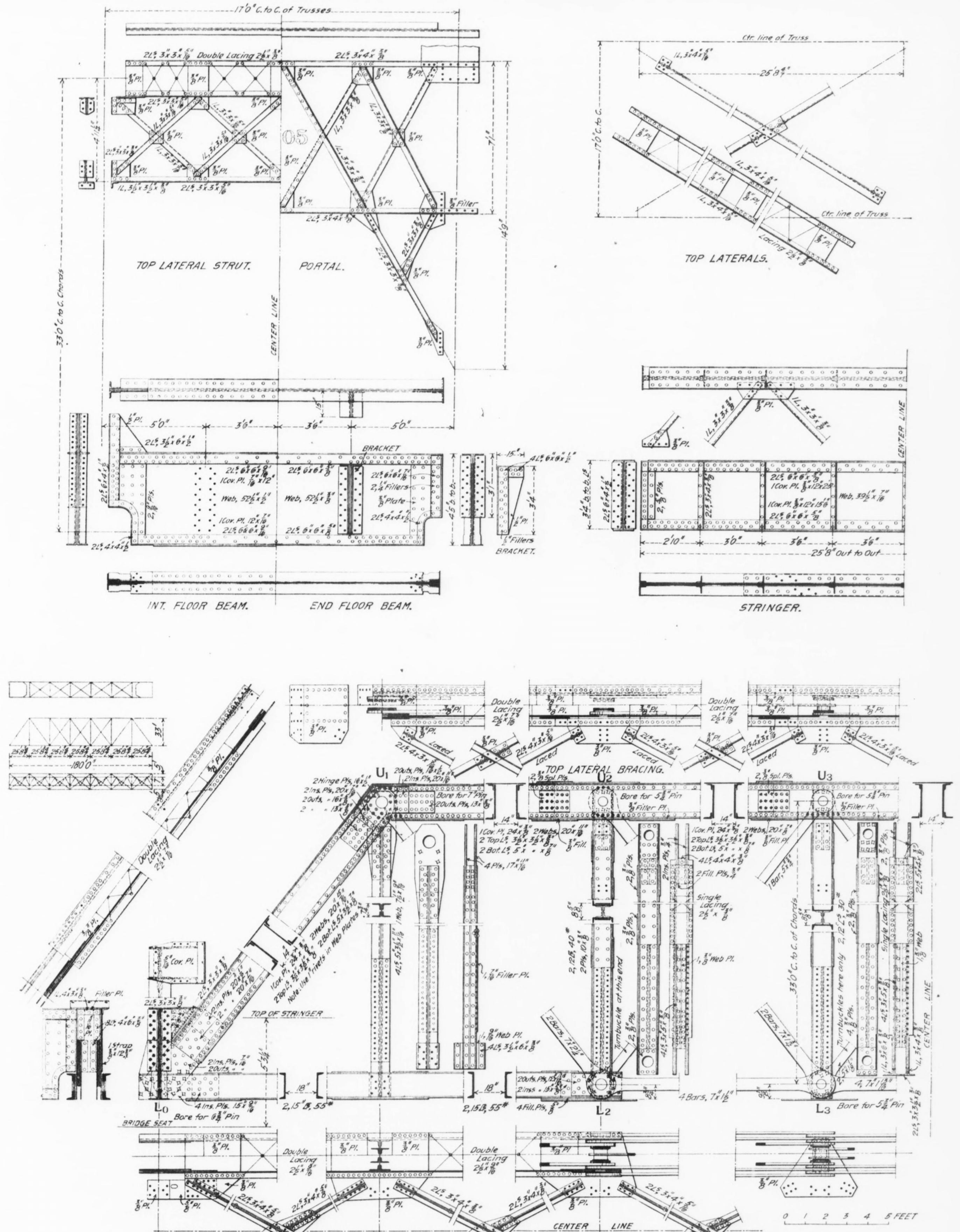


MARK	D	G	S	L	M	N	W
U2	5¾"	14½"	7"	4½"	1⅞"	½"	1¼"
U3	5¾"	14½"	7"	4½"	1⅞"	½"	1¼"
L3	5¾"	27¼"	7"	4½"	1⅞"	½"	1¼"
L2	6½"	24⅞"	7¾"	5"	2⅜"	¾"	1½"
L0	6¾"	22½"	8¼"	5½"	2⅜"	¾"	1½"
U1	7	17¾"	8¼"	5½"	2⅜"	¾"	1½"

Details of End Bearings for 180-ft. Through Pin-Connected Span—Common Standard, Harriman Lines.



Details of Trusses and Floor System of 180-ft. Through Pin-Connected Span—Common Standard, Harriman Lines.

ber of old engines every year, it, of course, being ascertained that there are a large number that are worn out or antiquated and of questionable service value. When the scrap engines are so reported each month, an arbitrary amount, in one case known to the author, of $17,000 an engine, is charged to the repair account and credited to a replacement fund. It is evident that such an amount as that named above is far in excess of the original cost of the engines which it is used to replace, and if the number scrapped each year be large and the average mileage small, the charges against the repair account may easily reach 2 or 3 cents per mile over and above the normal or actual cost of repairs. There is no criticism intended of the wisdom of such a policy, as it is doubtless the proper one to adopt, and many roads are burdened with a large number of "antiquated freaks" which are worth more as scrap than as motive power, but the importance of the method of replacing locomotives to the cost of repairs must not be overlooked, and it should always be considered in making comparisons of one road with another.

Very often it is not stated in the reports whether replacement figures are included in the repair charges or not, and this fact shows the uselessness of compiling large quantities of statistics when the method of computing them is not known, nor is it even at all likely that they have been worked up on the same basis. While 20 years has been referred to as the probable limit of useful life of a locomotive, it, of course, should be more a question of service than of years. On very few roads will the average annual mileage of all the locomotives exceed 50,000, although some engines may make 8,000 or 10,000 miles a month. The author remembers when engine 1,001 made two round trips a day on the Pennsylvania Railroad between Harrisburg and Altoona, as an experiment, and kept this up for a number of months. This amounted to 15,000 miles a month. Very frequently schedules are so arranged that a round trip of 150 miles, and in some cases 200 miles each way, can be covered every 24 hours in passenger service. This would correspond to 9,000 or 12,000 miles a month, as the case might be. Under such conditions we should expect these engines to wear out twice or three times as fast as the average for all the engines, and although they would have to be replaced that much sooner, the cost of such renewals, distributed over the mileage performed, would be no greater per mile run. Fifty thousand miles a year for 20 years would make a total of 1,000,000 miles, and if some engines ran 9,000 miles a month, they would reach this figure in about 10 years. The road could just as well afford to replace them then, as to wait 20 years at one-half the annual mileage, and better, because if such service were obtained from all the engines, it is evident that only one-half as many would be needed to operate the road, and only one-half as much capital would be tied up in equipment of this kind. The author believes in wearing locomotives out as fast as possible. By this he does not mean wearing them out by improper treatment or careless maintenance, but by the legitimate work of hauling trains. The faster they can be worn out the sooner they will be replaced with modern machines, and the strides made in the power and type of locomotives in the last few years have been such that an engine only 10 years old is of comparatively little use, except for branch service. It is very much better, if it be possible to so operate the road, to have, say, 50 engines which must be replaced in 10 years, than to have 100 stay in service for 20 years. This is what is meant by wearing them out as fast as possible, so as to reap the benefits of new and improved power.

But there is still another phase to the question which can best be illustrated by an actual case. An important line, having a number of 1 and 1¼ per cent. grades, was operated with power so light that only short trains could be hauled, or of respectable length by double heading. An analysis was made of the freight train movement for a calendar year, and it was found that if 20 new engines of larger size were purchased the saving in engine crew and train crew mileage in one year would be sufficient to pay the cost of the 20 new locomotives. It was no doubt good policy to make the substitution, and as the line in question was part of a large system, the lighter engines thus replaced could be used or other portions with easier gradients, but the difference between the price of the new engines and the credit received from the old ones would constitute a very large addition to the repair account, unless the difference were charged as a betterment to capital account, where it really belonged. Some roads like the Pennsylvania are continually improving the property and adding to its initial value out of the profits, all of which is sound business, but if these betterments are charged to repair accounts, as they often are, it is absolutely useless to compare operating expenses between different roads or different periods.

Apropos of this discussion a number of new and powerful passenger engines were put on a part of one of our western systems, displacing lighter engines, which were sent to other territories. These being replacements were naturally charged to the repair account. The first year that they were in service, each locomotive saved $5,000 by reducing the number of sections and double headers. This saving naturally accrued to the credit of the transportation department, as it was principally in train crew wages, but motive power costs had risen by the charges made against maintenance to provide for the purchase of the engines.

There are still other times when renewals are required, that is, when from collisions or wrecks the locomotives are either destroyed or so badly damaged that it will not pay to repair them. Such incidents throw heavy charges into repair accounts.

Rebuilding of locomotives, such as the application of larger boilers, cylinders or wheels, constitute what may be termed extraordinary repairs, and will greatly increase the cost, unless specifically treated. Even the application of driver or truck brakes, if introduced very generally for a year or so, will add quite a perceptible figure to the repair account. Where statements are regularly prepared and are used for comparisons it is advisable and proper to state whether wreck repairs, extraordinary repairs and renewal fund charges are included in the regular repair expenses, and if so, what they amount to, otherwise the comparisons of one year with another are valueless. As an example of how the repair figures may be affected by such charges, a large western road for one month had a *real* locomotive repair account of $90,000. During the same month there were charged to repairs and credited to the replacement fund $35,000, or 40 per cent.! Another road included $6,300 of wreck repairs in a total of $48,000, so that the wreck damage cost one-eighth of the total repairs for the month.

Under these conditions it is evidently impossible to make any general estimates which are likely to conform to the ordinarily published statements of the cost of repairs, as so much depends upon the policy pursued. It is no doubt fair to allow an ordinary amount, such as one cent a mile for renewals, but it would be out of the question to attempt to carry wholesale purchases of heavier power by any arbitrary figure that might be assigned without knowing the detailed operations and methods followed.

(To be continued.)

Cross-Tie Record of the Santa Fe.

E. O. Faulkner, Manager of the Tie and Timber Department of the Atchison, Topeka & Santa Fe, has prepared his regular semi-annual statement, for the first six months of 1905, of the tie insertions for the period mentioned and the removals for the entire period over which records have been kept. The figures for removals are given by divisions and by years, the reasons for removal being noted and the average life of the ties computed in each case. The following tables are made up from the information contained in the statement.

TIES REMOVED.

	Treated			Untreated			Av. life of treated
	Rotten.	Other causes.	Total.	Rotten.	Other causes.	Total.	ties, yrs.
Eastern Grand Division.							
Illinois Div.	748	19	767	58,181	190	58,371	5.5
Missouri Div.	3,840	219	4,059	52,936	200	53,136	5.0
Kansas iCty Div...	513	1	514	9,067	.....	9,067	5.9
Eastern Div.	1,830	561	2,391	79,589	1,869	81,458	5.9
Middle Div.	11,936	209	12,145	110,054	902	110,956	6.8
So. Kansas Div. ..	6,174	1,571	7,745	131,900	6,700	138,600	6.2
Okalhoma Div.* ..	15,557	35	15,592	54,657	.....	54,657	7.2
Western Grand Division.							
Western Div.	12,716	374	13,090	78,197	1,748	79,945	10.9
Pan Handle Div...	3,015	347	3,362	88,029	1,176	89,205	6.7
Colorado Div.	8,893	188	9,081	17,815	504	18,319	10.9
New Mexico Div...	40,183	2,156	42,339	9,401	866	10,267	10.9
Rio Grande Div...	33,589	743	34,332	8,922	831	9,753	15.1

*Including Eastern Oklahoma Ry.

Ties Inserted.

Eastern Grand Division.	Treated.	Untreated.	Total.
Illinois Division	111,894	111	112,005
Missouri Division	72,048	1,605	73,653
Kansas City Division	29,093	.....	29,093
Eastern Division	110,002	830	110,832
Middle Division	124,041	219	124,260
Southern Kansas Division	190,219	.....	190,219
Oklahoma Division	70,891	.....	70,891
Total	708,188	2,765	710,953
Western Grand Division.			
Western Division	111,090	1,095	112,185
Pan Handle Division	95,197	.....	95,197
Colorado Division	32,958	.....	32,958
New Mexico Division	45,386	44,312	89,698
Rio Grande Division	52,983	394	53,377
Total	337,614	45,801	383,415

Standard Bridges on the Harriman Lines.*

The 200-ft., pin-connected span shown this week is the longest of the standard designs for the Harriman Lines. The principal differences in its design over the 180-ft. span shown September 22, are in the substitution of a partly curved top chord for the straight top chord of the Pratt truss and in the fabrication of the verticals. The details of the end bearings have also been changed somewhat

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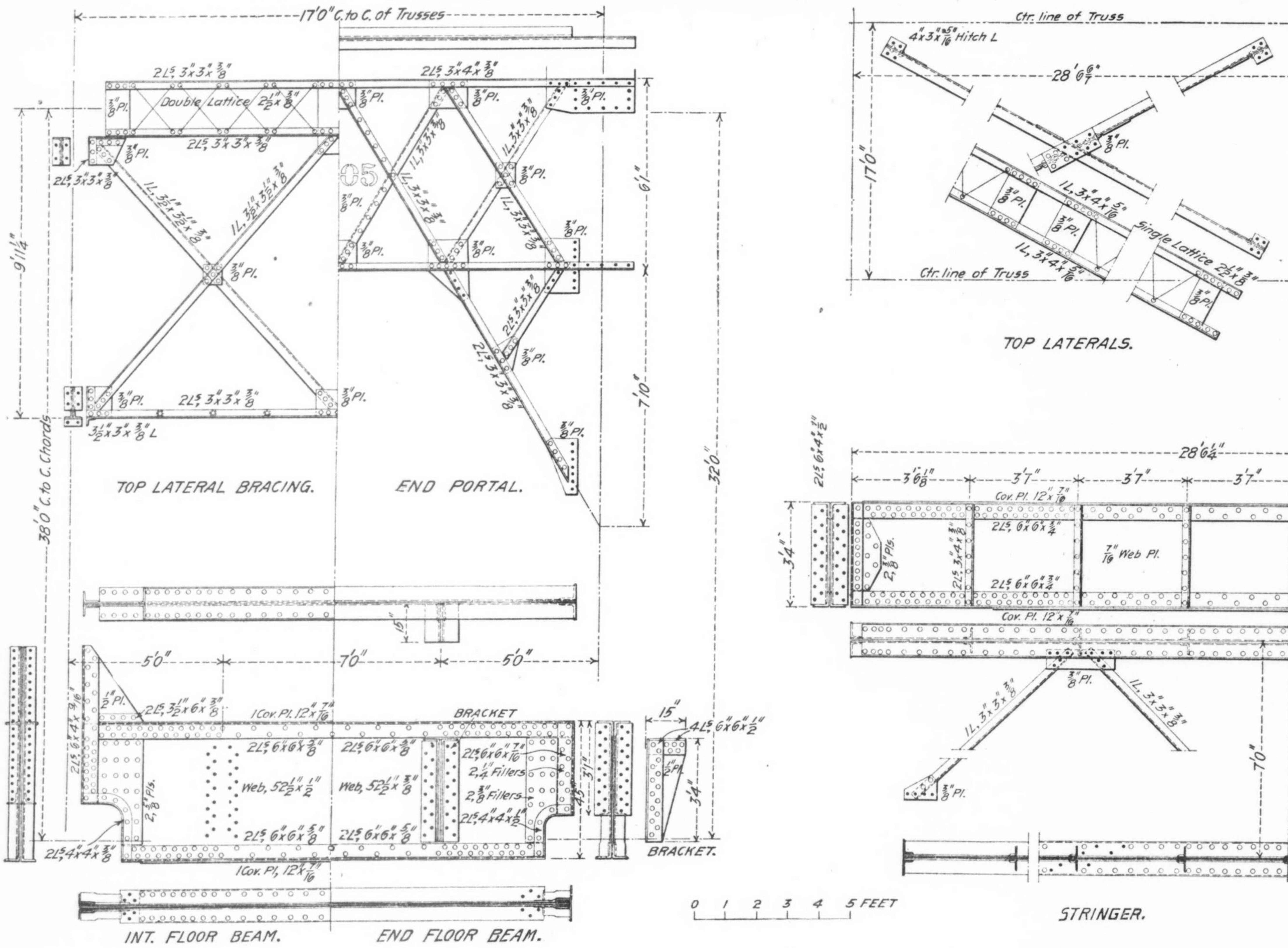
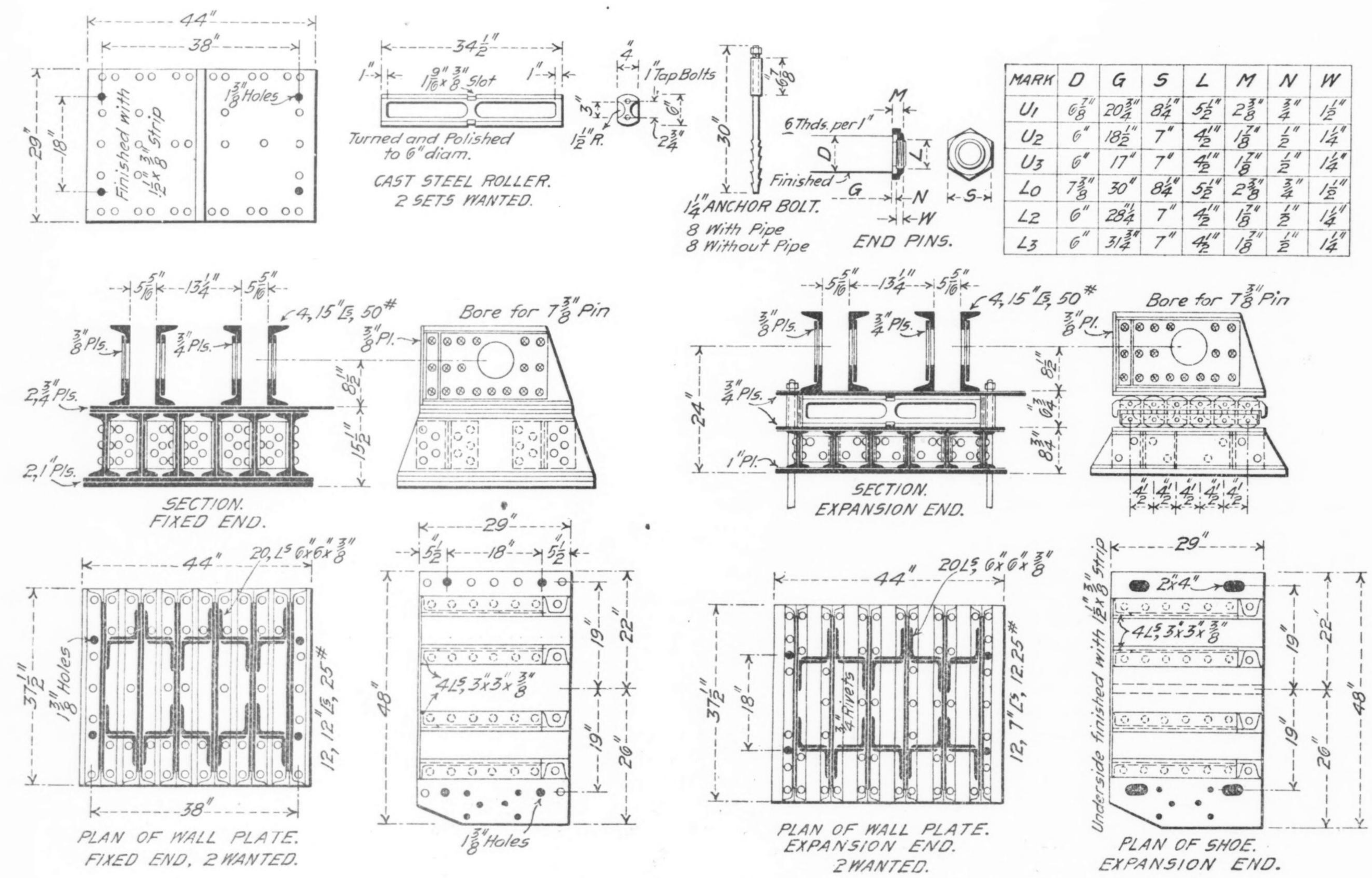
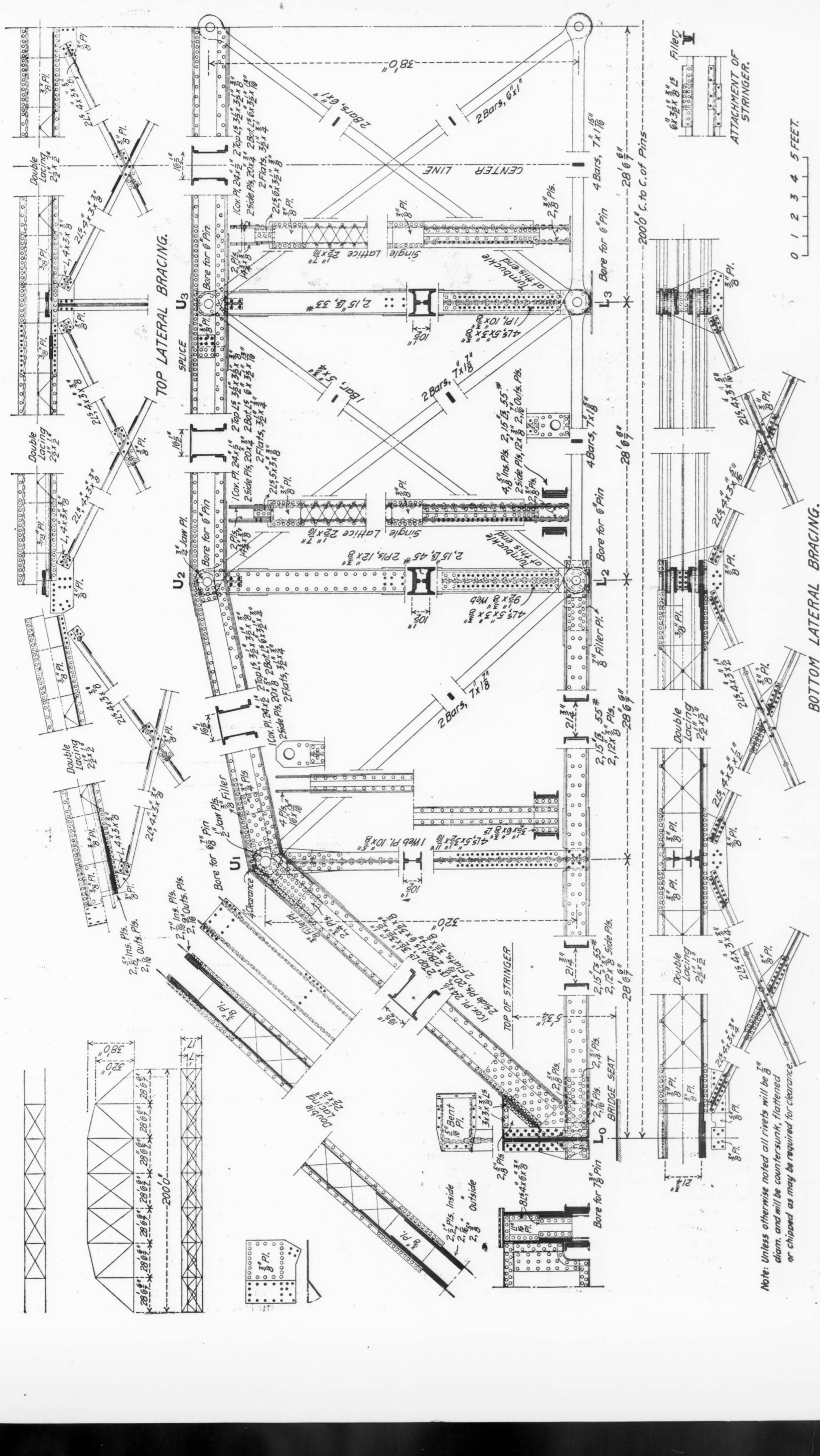


Details of Floor and Lateral Bracing of 200-ft. Pin-Connected Through Truss—Common Standard, Harriman Lines.



MARK	D	G	S	L	M	N	W
U_1	$6\frac{7}{8}$"	$20\frac{3}{4}$"	$8\frac{1}{4}$"	$5\frac{1}{2}$"	$2\frac{3}{8}$"	$\frac{3}{4}$"	$1\frac{1}{2}$"
U_2	6"	$18\frac{1}{2}$"	7"	$4\frac{1}{2}$"	$1\frac{7}{8}$"	$\frac{1}{2}$"	$1\frac{1}{4}$"
U_3	6"	17"	7"	$4\frac{1}{2}$"	$1\frac{7}{8}$"	$\frac{1}{2}$"	$1\frac{1}{4}$"
L_0	$7\frac{3}{8}$"	30"	$8\frac{1}{4}$"	$5\frac{1}{2}$"	$2\frac{3}{8}$"	$\frac{3}{4}$"	$1\frac{1}{2}$"
L_2	6"	$28\frac{1}{4}$"	7"	$4\frac{1}{2}$"	$1\frac{7}{8}$"	$\frac{1}{2}$"	$1\frac{1}{4}$"
L_3	6"	$31\frac{3}{4}$"	7"	$4\frac{1}{2}$"	$1\frac{7}{8}$"	$\frac{1}{2}$"	$1\frac{1}{4}$"

Details of End Bearings for 200-ft. Pin-Connected Through Truss—Common Standard Harriman Lines.



Note: Unless otherwise noted all rivets will be 7/8" diam. and will be countersunk, flattened or chipped as may be required for clearance.

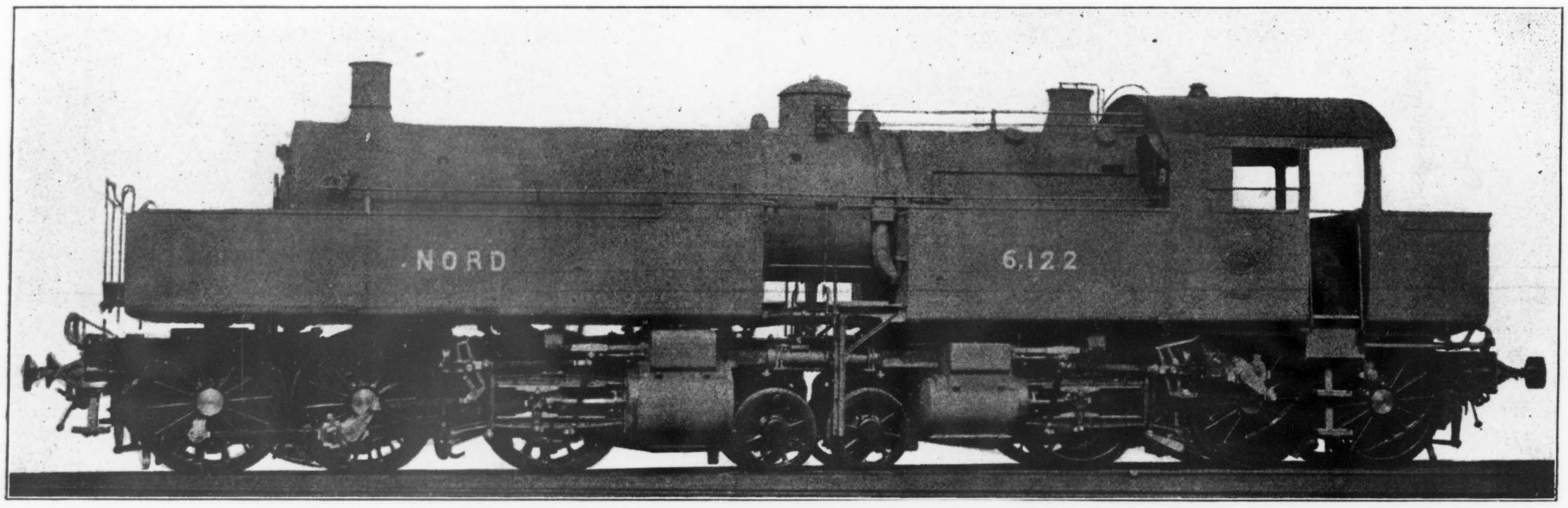
Details of Trusses for 200-ft. Pin-Connected Through Span—Common Standard, Harriman Lines.

to allow for the wider packing in the bottom chord of the truss. The top lateral struts have been made deeper but of no heavier material. The estimated weight of the span is 485,000 lbs.

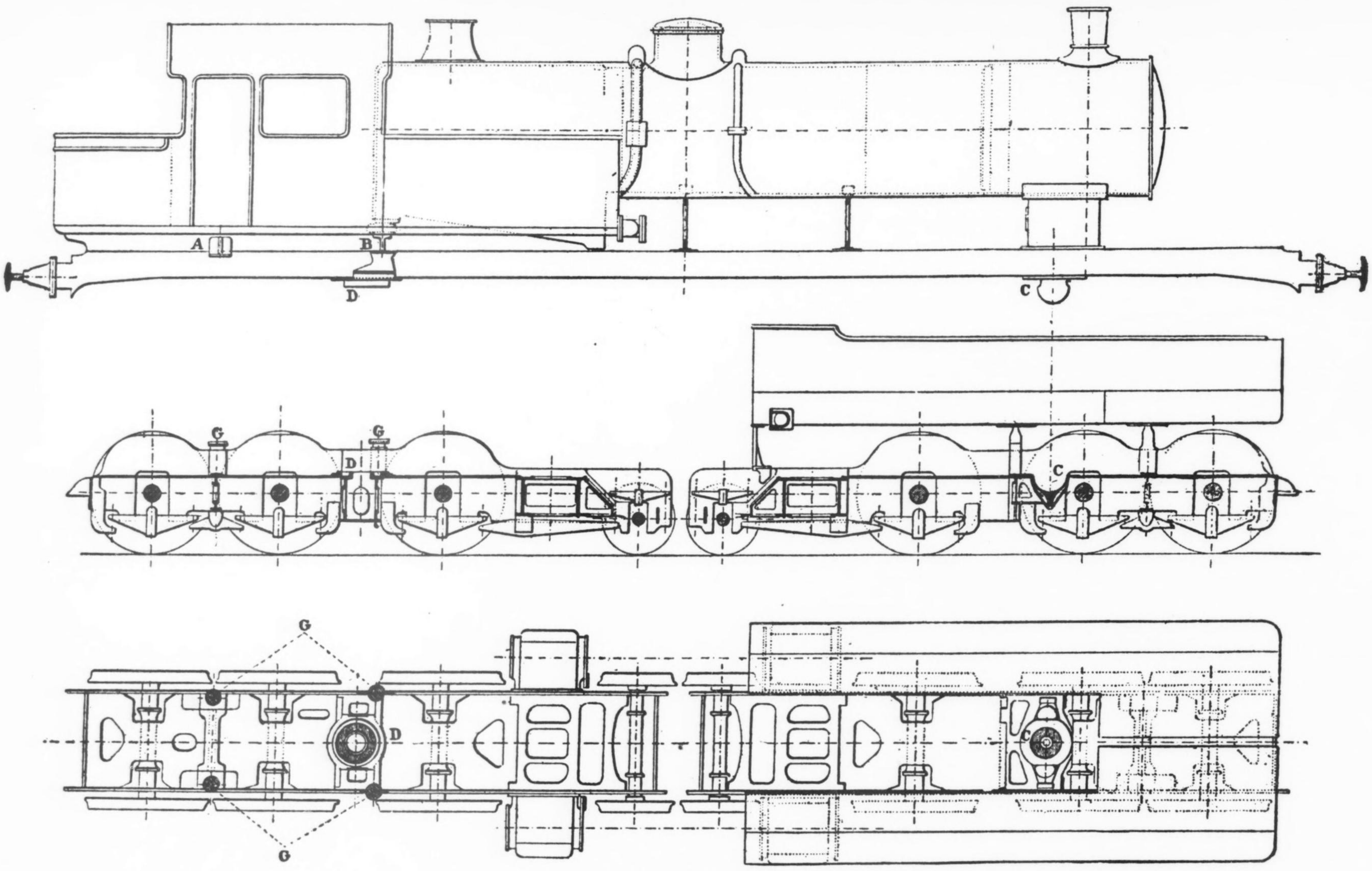
This article completes the series. For long crossings, skew bridges and at other places where the standard designs cannot be used special designs are, of course, worked out but the eight lengths of plate girders from 20-ft. to 100-ft. span, the five lengths of riveted through trusses from 100-ft. to 150-ft. span and the four longer pin-connected trusses from 150-ft. to 200-ft. span provide for a very large proportion of the steel bridge work which is required for railroads. These designs are the result of careful study on the part of the large number of competent engineers on the Harriman Lines and they embody the best modern practice in bridge construction. The drawings which have been shown give sufficient details of the material and dimensions to enable any engineer to utilize them as a basis of comparison for calculating new work of similar size or even as a complete general working drawing from which the shop drawings could be readily made. The young engineer will find them well worth careful study. We wish to again acknowledge our indebtedness to Mr. John D. Isaacs, Assistant Engineer of Maintenance of Way of the Southern Pacific, from whom the drawings were obtained.

Sixteen-Wheel Double Tank Locomotive for the Northern Railway of France.

The Northern Railway of France had a locomotive at the recent Exposition at Liege, Belgium, that is a notable departure from the practice of the road. At first sight it appears to be a modification of the Mallet type, or a combination of two 2-6-0 or mogul locomotives whose frames have been brought together head on, and the two then supplied with a boiler of extraordinary length. The immediate reason for the production of this machine is to be found in the importance of the coal traffic, and the grades over which it is hauled.



Sixteen-Wheel Compound Bogie Locomotive—Northern Railway of France.



Elevation of Superstructure, Longitudinal Elevation and Plan of Bogies for the Sixteen-Wheel Compound Bogie Locomotive Northern Railway of France.

This traffic has been increasing ever since 1857, when it was handled by 0-8-4 engines weighing 136,000 lbs., including the tender, of which 85,800 lbs. were on the drivers. In 1897 some 4-6-0 or 10-wheelers were built, of which the total weight of engine was 135,800 lbs., with 95,500 lbs. upon the drivers. The traffic originates in the north and is sent out over two routes. On one the curves are of long radius and the grades light (0.6 per cent.); on the second there are grades of 1.2 per cent. The trains on the latter, running by way of Valenciennes, weighed 950 tons and were handled by compound locomotives. But when they reach Valenciennes or