

AMERICAN SOCIETY OF CIVIL ENGINEERS.

INSTITUTED 1852.

TRANSACTIONS.

NOTE.—This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

601.

(Vol. XXVIII—June, 1893.)

FINAL REPORT OF THE COMMITTEE ON STANDARD RAIL SECTIONS.*

To the President and Members of the American Society of Civil Engineers :

Your Committee on Standard Rail Sections have the honor to submit the accompanying series of rail sections (Plates LVIII to LXX) and the following report as their final recommendation, and ask to be discharged.

Since the progress report of the Committee, which was presented and accepted at the Annual Meeting of the Society, January 21st, 1891, your Committee has held a number of meetings and conducted an extensive correspondence with many of the Chief Engineers of the railroad systems of the country.

The carefully prepared reports of the Committee of the Society on "The Proper Relation to each other of the Sections of Railway Wheels and Rails," and the papers and discussions of the Society, called forth by them, gave your Committee valuable data as the basis of their work. The first result of their deliberations was the preparation and discussion of several series of rail sections. As will be seen by reference to the progress report, there were originally considerable differences in the views of the several members. Correspondence, observation of the

* Presented at the Business Meeting of the Annual Convention, August 2d, 1893.

results obtained from rails in actual use, and discussion, have reconciled these differences so that your Committee are able to present a final report.

As the mileage of practically straight track so much exceeds that on curves, it seemed wisdom to select sections which would give the most satisfactory results on the greater percentage; if, at the same time, such service would extend to curved track, so much the better. We are satisfied that the sections recommended are the best for straight track, and that if the rails are properly laid they will do well on curves.

Our investigation developed that the greatest difference of opinion among the railroad engineers of the country as to rail sections was upon the proper radius for the top corners of the rail heads. In the correspondence which we present as an appendix to this report, it will be observed that this point is the most discussed. Most of these letters were received in reply to a final circular letter of inquiry, which was sent to the Chief Engineers of every railroad having 100 miles and over of track. Fifty-five replies were received, and of these we present those giving decided opinions.

In deciding upon a series of sections, your Committee have given consideration to the manufacturing details of rail making, while seeking designs whose forms would be best adapted to meet the various requirements of traffic.

To have a smooth track, it is absolutely necessary that the surface and line of the rails shall be without lumps and kinks. To obtain such rails it is of importance that the metal in the head and flange of the section should be as nearly balanced as economy will permit, thereby permitting the hot metal in the just-rolled rail to cool with the least internal strain, and thus, when cold, to be as nearly as possible straight in all directions, thus avoiding excessive "gagging" in the final cold straightening. The importance of this increases with the amount of metal in the section. We decided upon 42% of metal for the head, 21% for the web and 37% for the flange. The other constant factors are: top radius of head, 12 ins.; top-corner radius of head, $\frac{1}{16}$ in.; lower corner radius, $\frac{1}{16}$ in.; corners of flange, $\frac{1}{16}$ in.; side radius of web, 12 ins.; top and bottom radii of web, $\frac{1}{4}$ in.; angles of under side of head and top of flange, 13°.

As the grain or "fineness" of "hot-rolled" steel is governed by the work applied to it as its heat decreases, and as we are convinced

that the wearing qualities of rails largely depend on the closeness of the grain of the steel in their heads, we have sought to design heads which, so far as permitted by the other proportions of the sections, will be affected to the greatest extent by the pressure or work of the rolls.

One of the difficulties in rail manufacture is obtaining perfect flanges. The amount of metal being much less in the flange edges than elsewhere in the section, it cools more rapidly; hence, if the flange is both wide and thin, difficulty will be experienced in making it fill out to the full designed width, and also in preventing the development of flaws, which, if detected, will condemn the rail as first quality, but which may be so concealed as to escape detection, and exist as a constant menace to the safety of the rail. These considerations influenced us in designing our flange sections.

At the meeting of the Committee which was held in the Society's House on December 2d, 1892, all of the members present congratulated themselves upon the—to them—satisfactory progress of their labors, and separated, little thinking that before another meeting of the Committee could be held the hand of death would be laid upon one of the members of the Committee. H. Stanley Goodwin was not present at that meeting, official duties preventing at the last moment; but he telegraphed his views, and later wrote the Secretary of the Committee endorsing the Committee's proceedings. To know Mr. Goodwin was to respect him; to be thrown intimately with him was to yield the warmer tribute of friendship. Your Committee unite with all the members of the American Society of Civil Engineers in deploring the loss of so valued a member, and one who was so useful to his fellow men.

We have the honor to remain,

G. BOUSCAREN, *Chairman.*

FOSTER CROWELL.

VIRGIL G. BOGUE.

S. M. FELTON.

J. D. HAWKS.

E. T. D. MYERS.

SAMUEL REA.

THOS. RODD.

A. M. WELLINGTON.

F. M. WILDER.

ROBERT W. HUNT, *Secretary.*

I concur in the foregoing report in all respects except one, the width of the heads. If the same wheels are to run over all rails, the portion of the rail which comes in contact with the wheel should always be of the same form. Taking the 80-lb. rail with its 2½-in. head as standard, the same width of head should be maintained for all sections likely to be used. The slight reduction in width of head proposed for the 60-lb. and intermediate sections is comparatively unobjectionable, and I consented to approve the whole report if the same rate of variation had been maintained for the larger sections; the variation in width would then not exceed $\frac{1}{4}$ in. or $\frac{1}{8}$ in. from the mean. The present large variation of $\frac{1}{4}$ in. from the mean to the maximum section is too great, and I cannot accept this portion of the report. I present the sections herewith appended, Plates LXXVI to LXXIX.

GEORGE S. MORISON.

APPENDIX.

NORTHERN PACIFIC RAILROAD COMPANY,

CHICAGO, ILL., November 30th, 1892.

I have forwarded this morning, by Adams Express, a roll containing tracings of 103 sections of 66-lb. rail in track on our line between Logan and Butte, Mont. I also enclose a report on this matter from E. H. M. Henry, Principal Assistant Engineer, dated November 15th.

J. W. KENDRICK,

Chief Engineer.

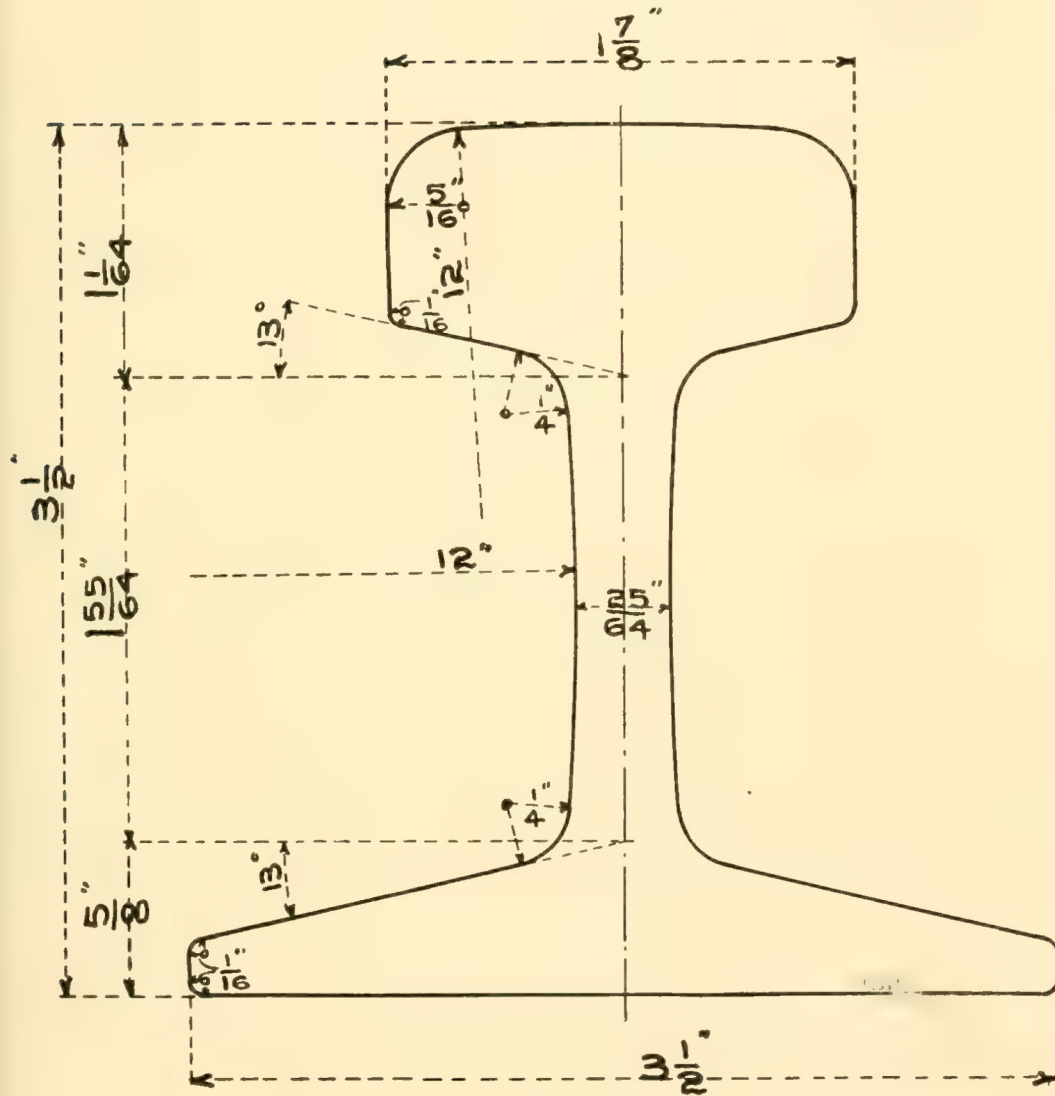
TACOMA, WASH., November 15th, 1892.

J. W. KENDRICK, Esq.,

Chief Engineer.

DEAR SIR, —I send you herewith tracings of 103 rail sections taken on the Logan to Butte Division of the Northern Pacific Railroad. It is very hard to deduce any general conclusions from the rail sections contained in the sheets. The wear seems to be variable without appreciable cause, the rails laid on light curves showing, in many cases, much greater wear than those on sharper curves, and *vice versa*. The notes show the original line has been lost, and the curves, almost without exception, have altered radii from those laid out. Mr. Relf has shown the actual radius of the curve at the point where the section is taken, which has probably been computed from the ordinate. Mr. Relf's note, on the last sheet of the sections, gives the ordinary speed of trains at from 10 to 15 miles per hour. This is obviously intended for the ascending rate, and he has omitted to take into account the fact

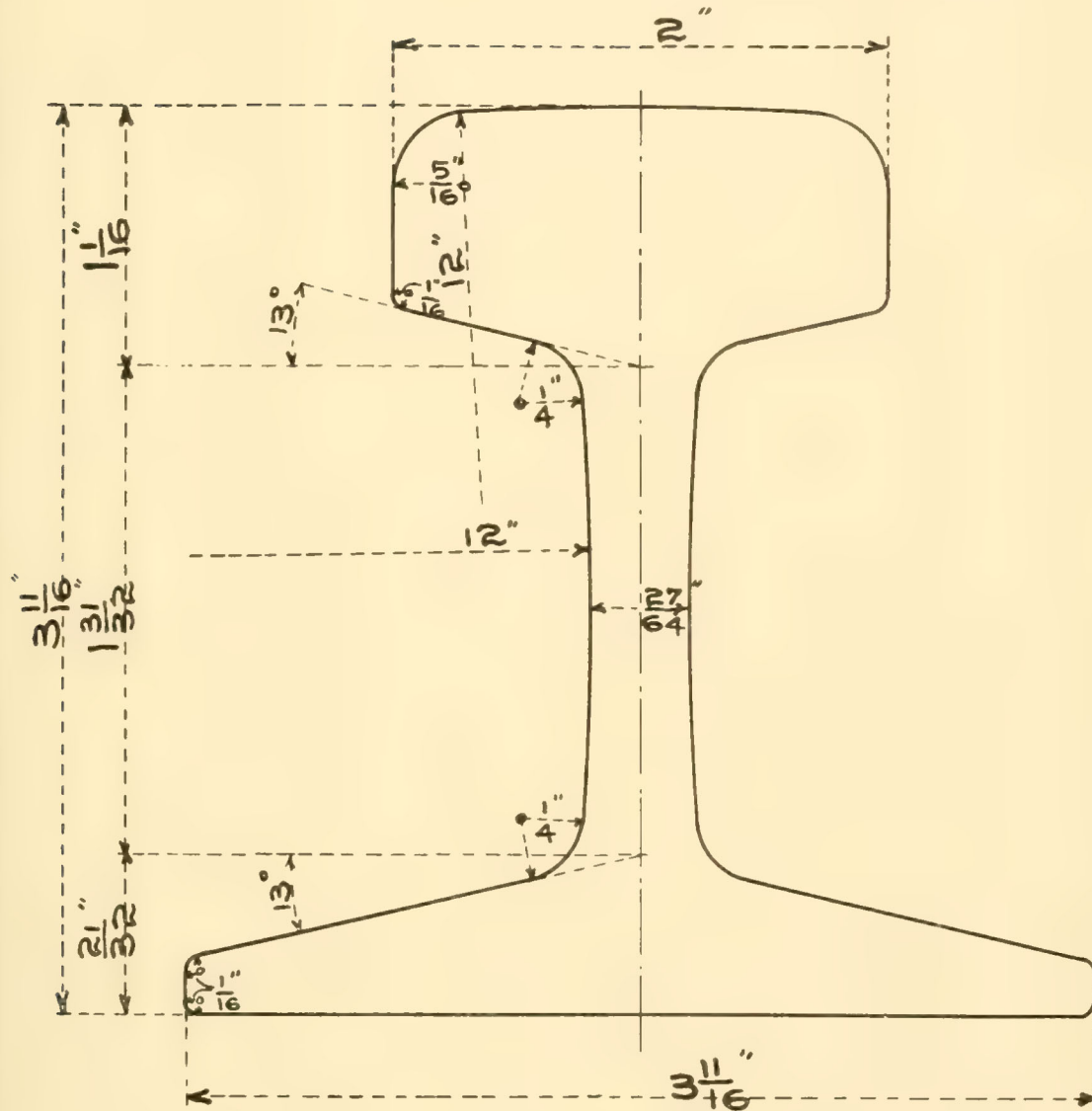
PLATE LVIII.
 TRANS. AM. SOC. CIV. ENGRS.
 VOL. XXVIII, No. 601.
 REPORT ON STANDARD RAIL SECTIONS.



40 LBS.



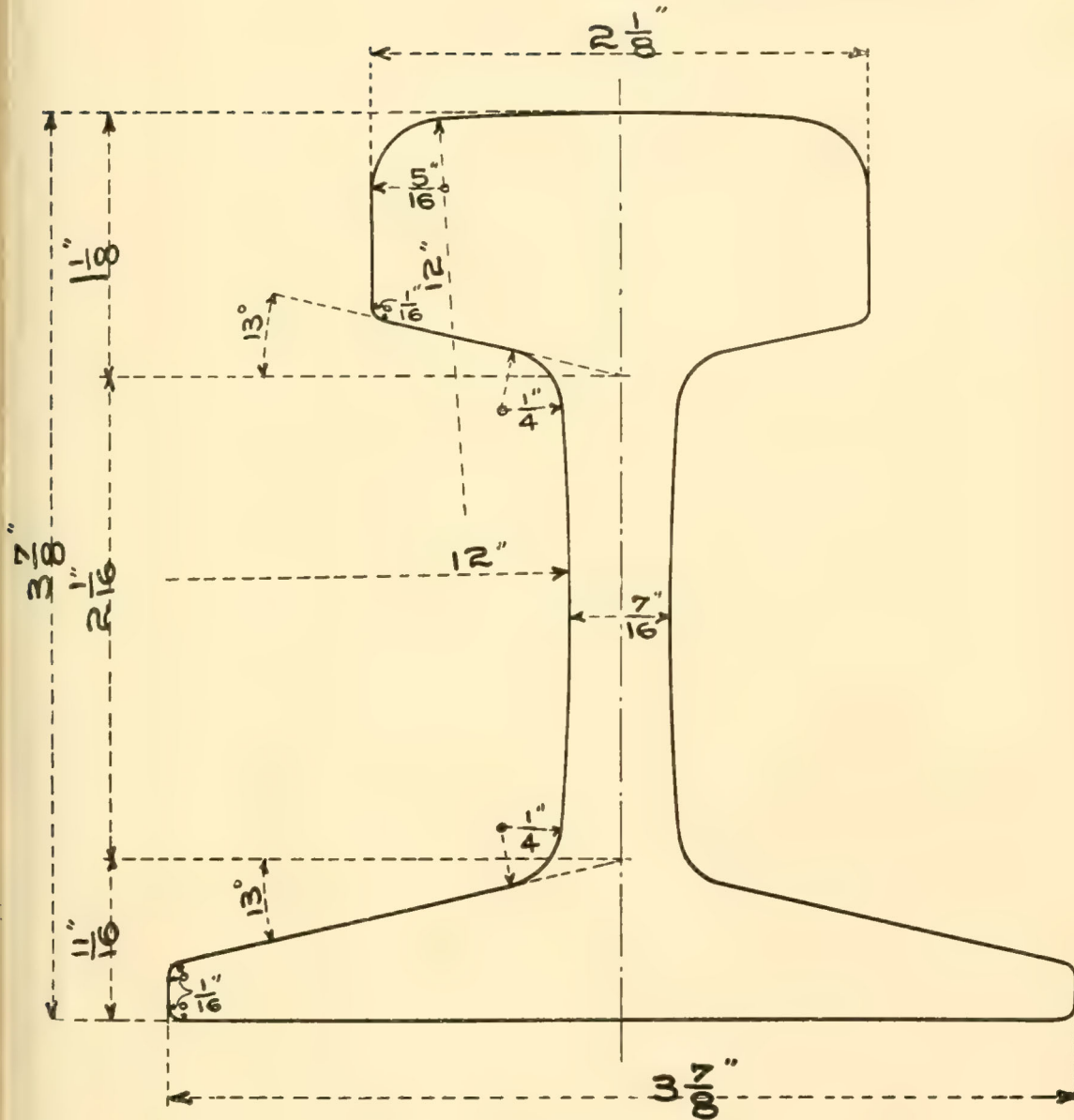
PLATE LIX.
 TRANS. AM. SOC. CIV. ENGRS.
 VOL. XXVIII, No. 601.
 REPORT ON STANDARD RAIL SECTIONS.



45 LBS.



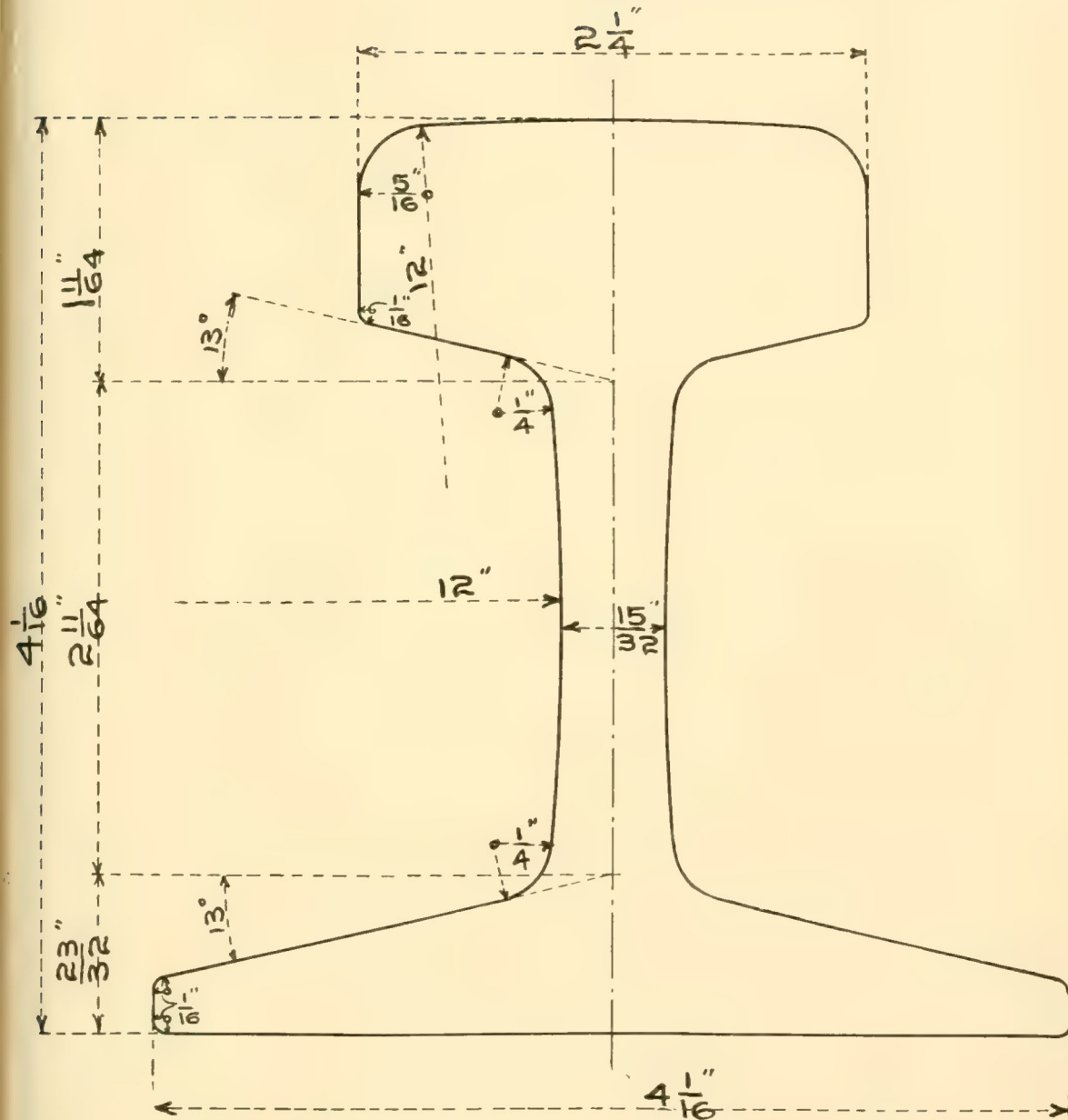
PLATE LX.
 TRANS. AM. SOC. CIV. ENGRS.
 VOL. XXVIII, No. 601.
 REPORT ON STANDARD RAIL SECTIONS.



50 LBS.



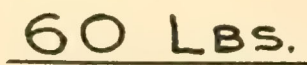
PLATE LXI.
 TRANS. AM. SOC. CIV. ENGRS.
 VOL. XXVIII, No. 601.
 REPORT ON STANDARD RAIL SECTIONS.



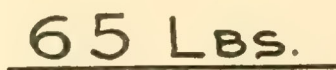
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REPORT ON STANDARD RAIL SECTIONS.

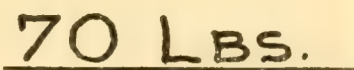








REPORT ON STANDARD RAIL SECTIONS.





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REPORT ON STANDARD RAIL SECTIONS.



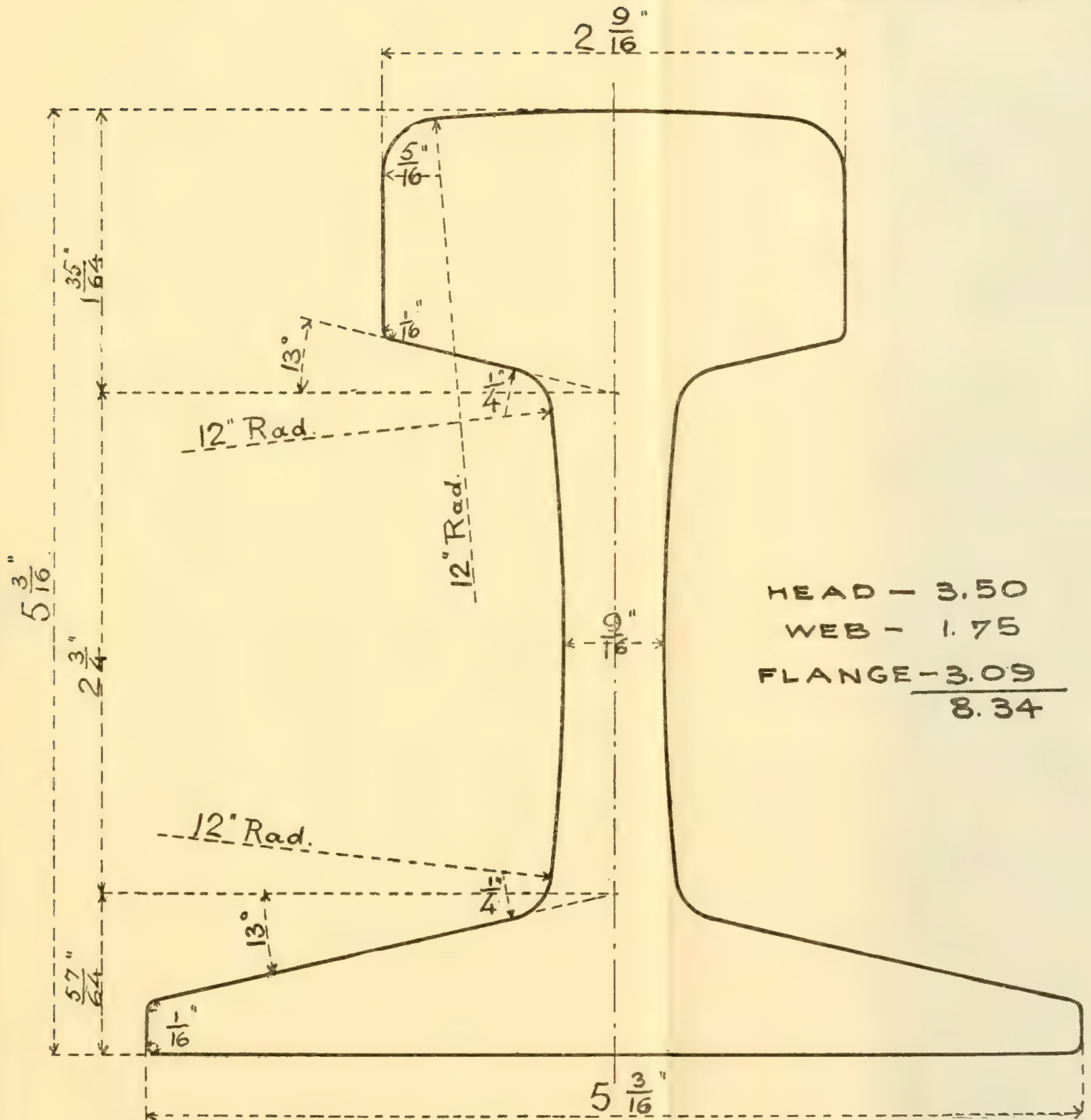
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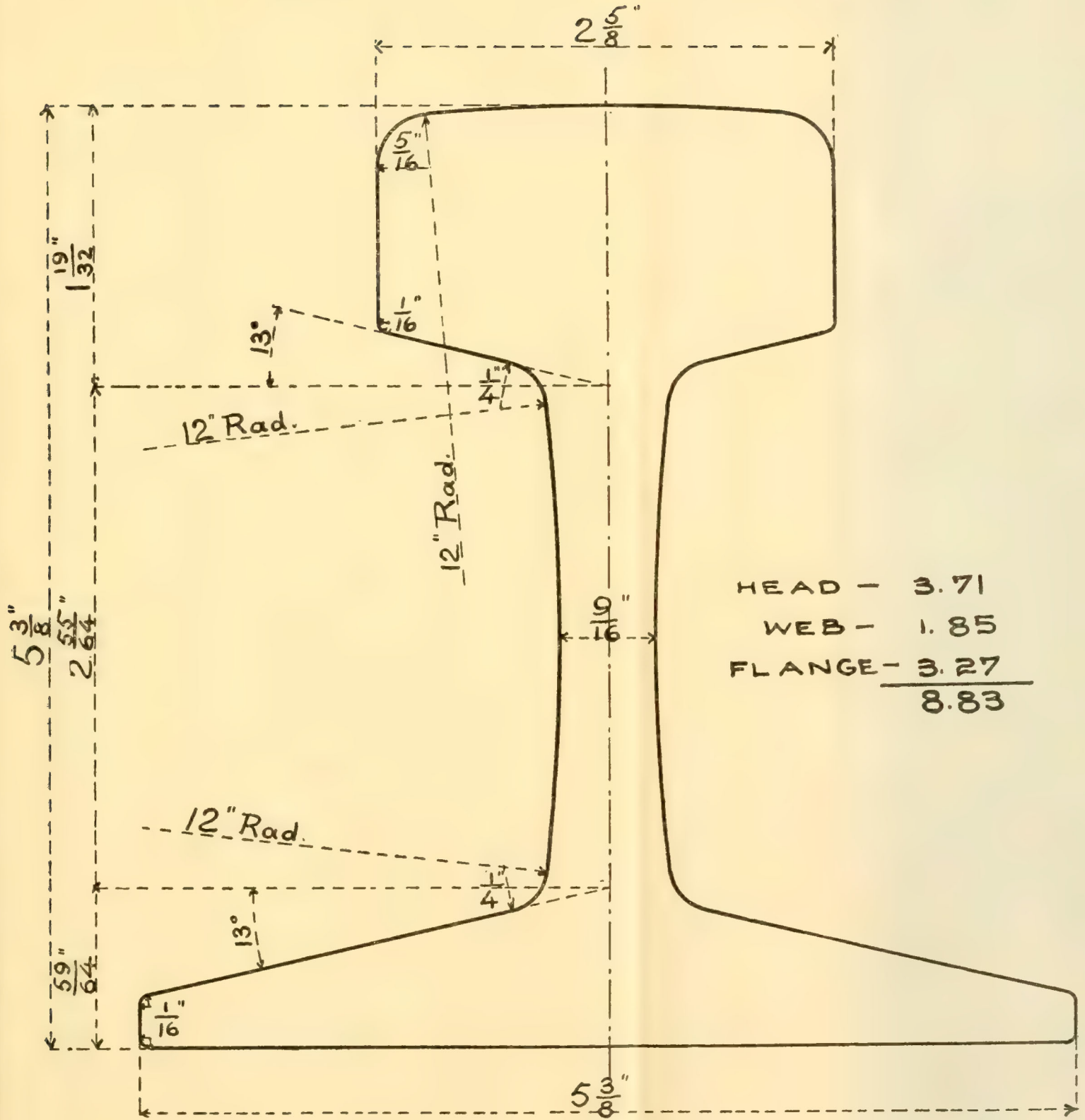
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80 LBS.





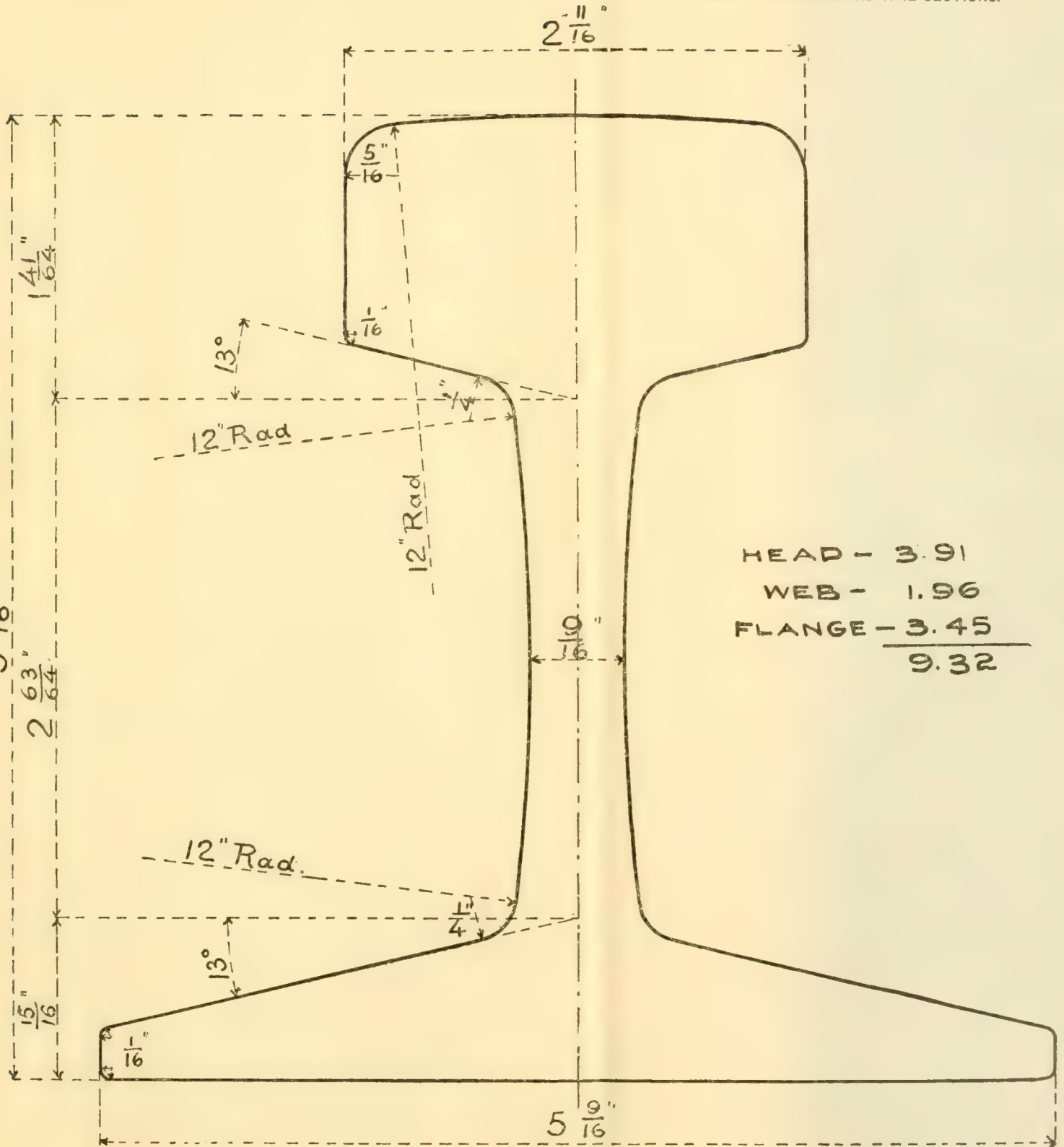




HEAD -	3.71
WEB -	1.85
FLANGE -	3.27
	<u>8.83</u>

90 lbs.

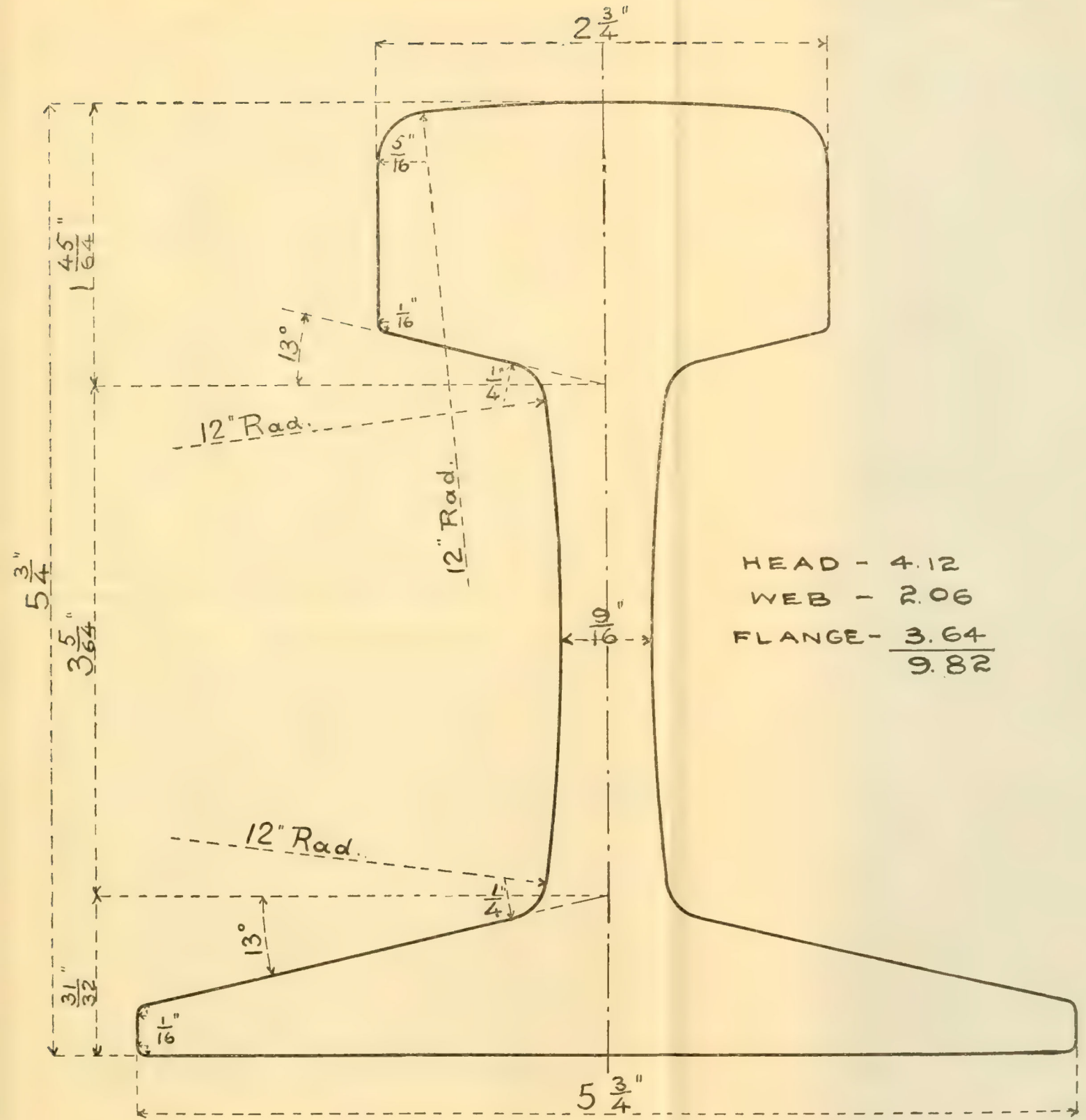




HEAD -	3.91
WEB -	1.96
FLANGE -	3.45
	9.32

95 lbs.





100 lbs.

that the rate on the descent is very much greater. I think the correct method is to put up the curves for a speed very little in excess of that used by the ascending trains, and to hold down the speed on descending trains by strict orders, and, by proper supervision, to see that these orders are carried out. Apparently, the effect of elevating the outer rail too much would be in the direction of decreasing train resistance, as the centrifugal force would not then overbalance the tendency for the flanges to seek the lower rail, due to the effect of gravity. In practice, however, I am convinced that this does not occur, and that the train resistance is actually increased. The car floors are no longer balanced, and an unequal proportion of the weight falls on the lower trucks, preventing them from conforming properly to the curve. This is especially noticeable when a train traverses a reversing curve. The trucks must then swing through a considerable arc in changing from the radial position they have assumed on one curve to a radial position on the opposing curve; and as this shifting is done under very unfavorable conditions, the weight being thrown upon one side instead of balanced at the center, it seems to cause considerable extra train resistance. Calculating this resistance by the decrease in train speed, in one case, I found it to be equivalent to an additional rise of 1.1 ft. in the length of the two curves. By a reversing curve I do not mean, of course, curves without a reversing tangent, but curves close enough together so that the train will be on both curves at the same time. In the particular case in point, I feel convinced that a large amount of the rail wear is owing to the undue elevation used.

It makes it still more difficult to generalize from the sections given, as it is not at all certain that the indicated rail wear is due to the existing conditions, as the causes which lead to the excessive wear may have disappeared with the re-adjustment of track. In many cases the sections show an apparent wear on the inner face of the low rail. In some cases this is palpably wrong, and in others may have been due to a deficient original section. Where the characteristic deformation or change of section exists that is caused by the metal flowing under the wheel tread, it is certainly wrong, as any flange wear, if it existed, would prevent the appearance of bulging or swelling, which is especially noticeable in sections Nos. 44, 72, 78, 94 and 96. In section 34 it is possible that insufficient gauge may account for some of the apparent wear on the inner face of the low rail. As you will note, the gauge at this point is 4 ft. 8 $\frac{3}{4}$ ins.—should be 4 ft. 9 $\frac{1}{2}$ ins. Insufficient gauge will, in all probability, account for wear of this character in similar sections to the above when it is taken into account that the gauge has probably, in a great number of cases, been too tight when originally laid, although the gauge does not now show it, on account of the track spreading and also the great amount of rail wear.

It is my belief, derived from experience, that excessive and unusual rail wear occurring locally is almost invariably due to insufficient gauge. Variations in the temper of the steel may sometimes cause the same effect; but rail wear due to this cause may be usually detected, as the effect upon contiguous rails is not uniform.

While the results obtained have not been conclusive, or very satisfactory in many respects, I think it may be definitely stated that nothing has been found to cause any change of opinion regarding the propriety of using the sharp-cornered rails; in fact it is obvious from the sections that if the corners had been larger in the beginning, the rate of rail wear would have been accelerated, which is shown to some degree in the sections on the last sheet.

I note Mr. Hunt asks for information in regard to sharp wheel flanges, and particularly whether such flanges have been found on both wheels on the same axle. I feel that I am able to shed some light on this subject, and I do not remember ever having seen it noted in any of the various discussions regarding the proper rail section. I wish to assert my belief that a large part of the excessive wear observed on both wheels and rails on new track is due to the chisel action of the sharp-cornered rail at the joint cutting the flanges of the wheels, and scoring them in such a manner that their reaction upon the rail is in turn equally destructive. In support of this I will point out the results obtained during the construction of some of our new lines. You will remember that at the time the Butte line was constructed we were much annoyed by the extraordinary flange wear on the engine drivers. The wear was abnormal and occurred on both wheels on the same axle alike. The principal wear was on the forward and rear driving wheels, the intermediate wheels, even if flanged, showing but very little wear. This might be expected, as the flanges on the intermediate wheels would rarely come in contact with the rail.

This phenomenon bothered me greatly, and I made a large number of examinations with a view to determining the cause. During several track inspections I noted that the amount of new filings or chips of metal along the track were especially noticeable, indicating that the wear of the flanges and rails was excessive. This line of worn metal was continuous along the outside rail of every curve. The amount of filings was increased at the joint, some joints showing much more wear than others. It was noticeable that the filings increased in amount wherever the alignment between the ends of the adjacent rails was not perfect. Also, that where the expansion was insufficient, in addition to the alignment not being perfect, that the amount was increased. Where the expansion was too great, even a considerable offset did not produce similar results, as in the other cases. An inspection of the engine drivers showed that they were not worn smooth and bright as in ordinary practice, but were extremely rough,

being scored or cut in very perceptible curves. The shape of these curves was that of a modified cycloid, showing the characteristic loop at the beginning of the reverse curve. This led to the conclusion that the extraordinary rate of wear was unquestionably due to the effect of the sharp corner at the end of the rail, which acted precisely as a sharp cutting tool in every case where there was not a perfect alignment. This perfect alignment it is practically impossible to secure in curving rails for very sharp curves, for obvious reasons. Acting upon this theory, I predicted that the excessive wear would disappear in time and become no longer noticeable, which has since proven true, and my theory has been demonstrated to be correct in a number of other cases.

While this wear went on in the same manner in the case of rails laid on the main line it was not so noticeable, as the number of wheels that passed over the ground was very much greater, and the percentage of mileage run over the new steel was an insignificant proportion of the whole. In the case of our construction engines on the track laid entirely with new steel the result was different, as the mileage run was entirely upon new steel. The wear of the flanges due to this cause was not confined to the wheels alone; the engine flanges, being roughly scored, in turn wore the rails, and there was consequently, first, the action of the rail ends on the engine flanges, and second, the reaction of the roughened flanges against the rail throughout its length between the joints.

Yours truly,

E. H. MCHENRY,
Principal Assistant Engineer.

PENNSYLVANIA LINES WEST OF PITTSBURGH.
PITTSBURGH, PA., November 3d, 1892.

In answer to your inquiry, I have no personal experience with rails with sharp top corners to their heads. The Pennsylvania Railroad pattern, as is well known, has large top-corner radius.

My personal opinion is that a sharper top-corner radius than we use is desirable. I have not expressed this, so far as I can recollect, in reply to the questions of the former committee, of which I was a member, but I have expressed it in other ways when this subject has come up, both in my official capacity and as a member of the Society.

Yours truly,

THOMAS RODD,
Chief Engineer.

The section shown in Fig. 1, Plate I, is the new pattern used by the Northern Pacific and the Chicago, Burlington and Quincy lines.

PITTSBURGH, PA., September 13th, 1892.

In response to your communication of September 1st, 1892, I beg to refer you to Vol. 21, pages 154 and 247, of the *Transactions* of the Society for my sentiments on the question under consideration by your committee, from which I have no reason to deviate at this time.

You know the rail sections in use on our lines in 1889, when I gave expression of my views in the contributions to the discussions above referred to; and you know also the changes made in the sections since that time. I almost feel that you will agree with me that our progress towards the "ideal" is rather slow.

Very sincerely yours,

M. J. BECKER.

BURLINGTON & MISSOURI RAILROAD IN NEB.,

C., B. & Q. SYSTEM,

LINCOLN, NEB., September 23d, 1892.

Answering your circular-letter of the 1st. We laid about 100 miles of this sharp-cornered rail on our Deadwood line, where curvature runs up as high as 16". We found that the sharp corner of this steel, both on curves and on straight lines, wore off and assumed a shape with a large radius and flaring side, conforming somewhat to the shape of the flange of the wheel. We found that after the rail was worn, which had been in the track now a little over two years, that we could increase our train load by about one-seventh. We also found that wear on our car wheels was very materially diminished after the rail was worn to the shape above described.

We have a good many miles of this same sharp-cornered rail on other lines where grades are very light and curvature very slight, but have not yet been able to see the ill effects of the sharp corners and straight sides; but the test on the Deadwood line is conclusive that the section is wrong entirely (Fig. 1, Plate LXXI).

Yours truly,

I. S. P. WEEKS.

NORFOLK AND WESTERN RAILROAD CO.,

ROANOKE, VA., October 12th, 1892.

In answer to your first question I beg to advise that on this road we have not had very direct experience in the use of rails having what is now designated sharp top corners to their heads. The sections of rails used on this road prior to June of this year have had the radius of the head and the top corners of head of such dimensions as may be best classified as medium. The standard rail section for the main line and extensions of this road, from 1886 until June, 1892, has been Pennsylvania Steel Company's Section No. 2, or corresponding sections

of other mills. (All these sections are shown in Figs. 2, 3 and 4, Plate LXXI.) The radius of top of heads in these rails is either 10 or 11 ins., and the top corner radii are either $\frac{1}{3}\frac{1}{2}$ or $\frac{1}{3}\frac{1}{2}$ in. This 67-lb. rail was put in our main line between the years 1886 and 1892, displacing 60-lb. rail and 56-lb. rail, which rail has been transferred for use on sidings, short branches, etc. Figs. 5 to 12, inclusive, Plates LXXI and LXXII, show the various sections of rail in use on the main line of this road prior to its displacement by the 67-lb. rail. You will note the radius of top of the head is generally either 10 or 13 ins., and that the upper corner radii of the head are $\frac{1}{16}$ in., the same as in the 67-lb. rail.

Our experience on this road, where we have on the main line from Norfolk to Bristol numerous curves varying from 4 to 8°, and where we have on other divisions of the road some curves as high as 12°, has been that rails of the forms shown have been cut quite badly on these curves by the wheel flanges. From a very careful study into this matter by our officials early this year we came to the conclusion that any new section for a heavy rail should have vertical sides and a sharper top corner radius. Further, that the width of the head should be somewhat wider in proportion than that of the 67-lb. rail heretofore used. In June, 1892, it was decided to use on those portions of our main line subject to the heaviest traffic 85-lb. rail, and the section shown in Fig. 13, Plate LXXII, was adopted by us as standard. This is the section previously adopted by the Baltimore and Ohio Railroad. You will note that this section has a top radius of head of 12 ins., and radius of top corners of $\frac{1}{4}$ in., and has vertical sides. This section, therefore, represents the views of the officials of this road as to the best form of rail to withstand the wear to which it is subjected. We think the sharp top-corner radius and the vertical sides postpone to a comparatively late day the subjection of the rail to the grinding wear of the flanges of wheels on the outerrail of curves; or wear at any other point where from the inequalities of the wheels or irregularities in the construction of the trucks the flanges of the wheels have a tendency to bear hard against the sides of the rails.

* * * * *

I have only to add to this that in the case where a rail on the outside of a curve has been worn down on the side, so that the section corresponds practically with the flange of the wheels, then the wear, both on the rail and on the wheel, produced by the grinding action of the wheel must be extremely rapid. This is certainly an argument for rails with comparatively short top corners and for rails having vertical sides.

I trust the above answers give you the necessary information.

Yours truly,

CHAS. S. CHURCHILL,

Engineer Maintenance of Way.

MICHIGAN CENTRAL RAILROAD COMPANY,

DETROIT, MICH., September 15, 1892.

The Michigan Central, with which I am connected, has during the last four years laid 40 000 tons of 80-lb. rail with the $\frac{1}{4}$ -in. top-corner radius (Fig. 14, Plate LXXII). It is giving perfect satisfaction as far as the corner radius is concerned, and I see no reason why the top-corner radius should be any larger than $\frac{1}{4}$ in. I have put down a few experimental rails having perfectly square top corners and flat tops, and find that carrying out the idea to such an excess will show no bad results.

Yours truly,

J. D. HAWKS,

Chief Engineer.

BOSTON AND MAINE RAILROAD,

BOSTON, MASS., November 7th, 1892.

The 75-lb. steel rail (Fig. 15, Plate LXXII) we are now laying has what you would call "sharp top-corners."

Of course our engines, having previously run on round-top rails, have drivers more or less worn, and the new rails wear more on the outside than on the center: there will always be a tendency that way. but, taking everything into account, I think the flat-top, sharp-cornered rail is the best. One of the principal reasons for their use is that we shall have less hollow drivers.

Yours truly,

H. BISSELL,

Chief Engineer.

NEW YORK, LAKE ERIE AND WESTERN RAILROAD COMPANY,

NEW YORK, September 13th, 1892.

Below please find my answer to the question asked in your circular of the 1st inst. about steel rail sections.

My experience with such rails as are referred to has extended over a period of three years, and has been entirely satisfactory. The radius used in the corner of the heads of these rails is $\frac{1}{4}$ in. (Fig. 16, Plate LXXII).

I have put down about 40 000 tons and have heard no complaint about sharp wheel flanges.

Respectfully yours,

CHAS. W. BUCHHOLZ,

Civil Engineer.

THE DULUTH AND IRON RANGE RAILROAD COMPANY.

DULUTH, MINN., September 19th, 1892.

The opinion has been with me one of gradual growth, from the beveled to the straight (vertical) sides of the ball, from the $\frac{1}{4}$ -in. radius at top corner in a 56 to 60-lb. rail to the $\frac{1}{4}$ -in. radius in the 80-lb. rail

we are now using in renewals (Fig. 14, Plate LXXII). Of these latter we have put down about 4 500 tons, Michigan Central pattern.

From the information at hand a noticeable decrease of sharp flanges in our car-wheels can be attested, and corroborative testimony is found in the condition of the rail heads on the gauge side; dull, almost rusty in the 80-lb. rail; bright, silvery on the corner and side of the 60-lb. rail with the large radius of the corner. Just what proportion of this may be due to the increased resistance offered by the wider, flatter head of the 80-lb. rail to the lateral variations in the path of the wheels I am not able to indicate; but there is less nosing of individual cars on the 80-lb. than on the 60-lb. rail; and I am of opinion that there is also a perceptible difference between rails of equal weights (60-lb.) in favor of the straighter side and small top-corner radius.

You are aware that our business is that of hauling iron ore between Ely and Two Harbors; the alignment consists of 80% tangents and 20% curvatures (6° max. curves); the equipment consists of consolidated engines 104 000 lbs. on 14-ft. wheel base; ore cars 24½ ft. center to center of couplings; average weight loaded, 75 000 to 76 000 lbs., all provided with Westinghouse automatic brakes.

Nosing is a local term, and describes the path of the individual ore cars relative to the left and right rails in a zigzagging course. It obtains, no matter how perfect the track may be, and is due largely to the position of the load between the trucks in a concentrated form, and is a very destructive agency to track and bridges.

Yours truly,

K. AUGST,
Chief Engineer.

LONG ISLAND RAILROAD COMPANY,
LONG ISLAND CITY, N. Y., September 19th, 1892.

DEAR SIR,—In reply to yours of the 1st inst I beg to state that my experience with rails has been almost entirely with the P. R. R. and the P. & R. R. standard forms, and from this experience of 13 years I have been induced to adopt as a standard for this railroad a rail having 12-in. radius for top of head, with radius of top corners of ¼ in.

I have laid this spring on this railroad 5 000 tons of the above-mentioned sharp top-cornered rails.

Yours truly,

P. D. FORD,
Chief Engineer.

CHICAGO, ROCK ISLAND AND PACIFIC RAILWAY COMPANY,
DAVENPORT, September 13th, 1892.

DEAR SIR,—In reply to yours of the 1st on the subject of rail sections, I would say: This company has not gone into the rail question

scientifically. Some years ago we adopted the Lehigh Valley (Goodwin) pattern of 70-lb. rail, and can only say that it is doing good service. Whether another shape of rail would have done better service. I do not know.

Yours truly,

A. KIMBALL,
Assistant to President.

ATCHISON, TOPEKA AND SANTA FÉ RAILROAD COMPANY.
TOPEKA, KANS., October 3d, 1892.

DEAR SIR,—I have never had any experience with rails of this class (with sharp top-corners). I hand you herewith a print (Fig. 17, Plate LXXIII) showing the general form of all sections which are now in use on the Santa Fé line, from which you will see that all have $\frac{3}{4}$ in. radius of corner. Our 66-lb. section has been in use about a year and a half and has so far given very good results.

Yours truly,

JAMES DUN,
Chief Engineer.

GRAND TRUNK RAILWAY OF CANADA.
MONTREAL, October 11th, 1892.

I may say that, generally, for many years we have adopted a series of "Holley" patterns of which a section is shown in Fig. 18, Plate LXXIII, and that our experience is satisfactory.

Yours truly,

E. P. HANNAFORD,
Chief Engineer.

COLORADO MIDLAND RAILWAY COMPANY.
COLORADO SPRINGS, Colo., September 27th, 1892.

I am inclined to favor very strongly the use of a rail, shaped approximately like the standard D. and R. G. rail, a section of which I send you (Fig. 19, Plate LXXIII), as there can be no question the rail will stand much longer wear on a curve than the Colorado Midland 65-lb. rail (Fig. 20), before it would assume the shape of a worn piece of the C. M. rail.

The web of the D. and R. G. rail, which is $\frac{7}{16}$ in. thick, seems light for a 65-lb. rail, but a two-year test in the track would indicate that it is strong enough to endure the strain to which it is exposed.

Yours very truly,

B. H. BRYANT,
Chief Engineer.

NEW YORK CENTRAL AND HUDSON RIVER RAILROAD COMPANY.

NEW YORK, October 4th, 1892.

With regard to the use of sharp top-corner rails on this road I would say that with the close of the present season there will be very nearly 100 000 tons of rails of 80-lbs. weight per lineal yard laid in the main passenger tracks of this road, between New York and Buffalo; part of which is what we term "old model" 80-lb. rail, which has a height of 5 ins., radius of top, 12 ins.; and radius of top corners, $\frac{5}{16}$ in. Since the first of this year this model has been slightly revised. The new model 80-lb. rail has a height of $5\frac{1}{8}$ ins., top radius of 14 ins. and corner radii of $\frac{1}{4}$ in. Last spring we relaid track No. 1 at West Albany with the old model 80-lb. rail. Some two months ago track No. 2, at the same point, was laid with the new model rail. A late examination of these rails shows that at the present time they are wearing excellently well, seem to fit the template of the wheel perfectly, and to fit over the entire head of the rail, but, if anything, better on the new model rail with the $\frac{1}{4}$ -in. corners and flat top than on the old model. Mr. P. H. Dudley has kindly furnished me with the results of his late examinations on some other roads; and as the information is, I think, valuable, and may not possibly reach you in any other way, I will herein give you a brief note of the same: The B. and A. R. R. has laid 17 000 tons of 95-lb. rail, with a head 3 ins. in width, 14 ins. top radius, and $\frac{5}{16}$ in. corner radii. These rails on curves of 4 and $4\frac{1}{2}$ °, and on gradients of 52 to 85 ft. per mile, after 15 months service, show a wheel flange contact on their inner sides of from $\frac{3}{8}$ to $\frac{1}{2}$ in. in depth, which is reported as being less than one-half the similar wear on 72-lb. rail with $2\frac{1}{4}$ in. width of head and $\frac{1}{3}\frac{1}{2}$ in. corner radii—both weights of rail having about the same angle of side inclination. On the 95-lb. rail it was observed that there was very little flow of metal on the inside of the lower rails on curves. The R. W. and O. Div. of this road last year laid 11 000 tons of 70-lb. rail with $\frac{1}{4}$ -in. corner radii. These rails are reported as wearing very well. The A. and St. L. R. R. has laid 24 000 tons of 75-lb. rail, and 2 000 tons of 60-lb. rail, all with $\frac{1}{4}$ -in. corner radii. The Central Railroad of Vermont has laid 2 700 tons of 75-lb. rail of the same model as the preceding. The Buffalo, Rochester and Pittsburgh has laid 3 000 tons of our new model 80-lb. rail. The N. Y. and N. E. R. R. has laid 10 000 tons of rail with corner radii of $\frac{5}{16}$ in. From general observation on many lines, Mr. Dudley states to me that he has arrived at the conclusion that $\frac{5}{16}$ in. seems to be the best radius of heads of $2\frac{3}{4}$ to 3 ins. width, and $\frac{1}{4}$ -in. radius for heads under $2\frac{3}{4}$ ins. width. He also states that under certain conditions there will always be, to some extent, "flow" on the inner edges, but that it is of much less serious amount than that resulting from larger corner radii, which seems to permit a flow of metal from the top of the head to the corners

under the very heavy service of modern locomotives and "30-ton" car-loads.

Yours truly,

WALTER KATTÉ,
Chief Engineer.

LOUISVILLE AND NASHVILLE RAILROAD COMPANY.

September 21st, 1892.

The Louisville and Nashville Railroad Company received and laid during the calendar year 1890, 10 388 tons of 70-lb. rails; during 1891, 11 345 tons of the same section; and will lay during the present calendar year 12 000 tons, most of which has already been placed in track; making a total of 33 733 tons.

The ball of this rail (Fig. 21, Plate LXXIII) has a 12-in. top radius, with top corners $\frac{1}{4}$ -in. radius, and vertical sides.

The rails laid in 1890 did not show satisfactory results, which was partially due to excessive wear of the corners, on account of the wheels being grooved for the old narrower headed rails, thus causing excessive weight on the outer edges of the ball of the new rails; and partially due to defective material in the rails, which showed extraordinary softness in spite of the fact that the carbon averaged over $\frac{4.0}{100}$ of 1 per cent.

The 70-lb. rails received in 1891 and 1892 have given much better results, doubtless due to the fact that the grooves in the wheels have gradually worn to fit the new rail section, and also to the better quality of material in the rails.

I anticipate no further trouble on the score of the change in section.

Our Superintendent of Machinery has watched closely the effect of the sharp corners of the new rails on wheel flanges. At first he was of opinion that these sharp corners had a marked effect on the leading wheels of locomotives, and he reported sharp flanges on both wheels of the leading axle in the engine trucks, but seldom found a like condition of affairs to exist on the flanges of wheels of car trucks. More recent observations have led to the conclusion that the sharp flanges caused by the $\frac{1}{4}$ -in. radius of top corner of ball of rail is not of serious moment.

I feel satisfied that when a similar section is generally adopted all objections to it will disappear, and better results will be obtained than could be had from the old section with larger top-corner radius.

Yours truly,

R. MONTFORT,
Chief Engineer.

NOTE.—The following communication was received from Mr. Montfort at a subsequent date.

LOUISVILLE AND NASHVILLE RAILROAD CO.

DEAR SIR,—I hand you herewith a map and profile of Baker's Hill Grade on the Henderson Division of the Louisville and Nashville Rail-

road (Plate LXXV), which was laid with our 70-lb. section of rail (Fig. 24, Plate LXXIV) during the years 1890-92.

You will notice that the grade is very steep—4%, or 211 ft. per mile. It extends for about 8 000 ft. The alignment of track is also very crooked ; 11° 20' curves reversing into 12° curves.

There are, I believe, few such grades operated with ordinary locomotives. At Baker's Grade two consolidation engines are in constant service, helping trains up and down the hill.

I am informed by our Mechanical Department that they have been unable to detect that the wear on flanges of wheels has increased appreciably since the round-cornered 58½-lb. (Fig. 25, Plate LXXIV) and 68-lb. rails were replaced by the sharp-cornered 70-lb. rails. This would seem to show conclusively that the sharp corner is not detrimental to the flanges of locomotive wheels.

Very sincerely yours,

R. MONTFORT,

Chief Engineer.

BUFFALO, ROCHESTER AND PITTSBURGH RAILWAY COMPANY,

ROCHESTER, N. Y., September 24th, 1892.

We have been using sharp top-cornered steel rails on our road, and have laid some 5 000 tons of them ; we find that they are a great improvement over the old and round-cornered sections. The radius of our 70-lb. rail is $\frac{5}{16}$ in., and of our 80-lb. rail, $\frac{1}{4}$ in.

Truly yours,

WILLIAM E. HOYT,

Chief Engineer.

BOSTON AND ALBANY RAILROAD COMPANY,

SPRINGFIELD, September 12th, 1892.

In answer to yours of September 1st, I will say that our 72-lb. rail, of which we have some 150 miles, has a radius $\frac{1}{3}\frac{1}{2}$ in., and has given good service.

Yours truly,

W. H. RUSSELL.

FALL BROOK RAILWAY COMPANY.

CORNING, N. Y., September 12th, 1892.

This company has not used rail sections with sharp top corners to their heads until this year, having previously used the 76-lb. standard L. V. R. R. section with $\frac{2}{8}$ -in. radius for top corners. This section has not given entire satisfaction, owing principally to its poor lasting qualities, particularly on curves ; the outside rail wearing away very much on the gauge side and the inside rail wearing un-

equally in spots along its top, giving it a wavy appearance and causing low spots along the length of the rails as well as at the joints. We came to the conclusion that the softness of the head of this section was owing principally to its large percentage of metal, and therefore in January of this year adopted a 75-lb. rail section (Fig. 22, Plate LXXIII), which was designed almost exactly after the standard adopted by the American Society of Civil Engineers. We have laid this year about 2 000 tons of this 75-lb. section, but it has been in the track too short a time for observations to be of value.

Yours truly,

S. T. HOYT, Jr.,

Engineer F. B. Ry. Co.

MANITOBA AND NORTH WESTERN RAILWAY COMPANY, OF CANADA,
PORTAGE LA PRAIRIE, MAN., September 29th, 1892.

In reply to your circular-letter of 1st inst., I beg to say that my experience with steel rails has been entirely with those with top corners having a radius of $\frac{1}{2}$ in. I inclose a blue print of the section in use on this road, of which we have 232 miles laid in track, equal to 20 416 tons.

I have had immediate charge of track during the past 18 years laid with rails of this section, and find when properly made and track kept in good order that they have given every satisfaction, both as regards wear of rail and of wheel flange.

I have no reason to recommend a change from our section for a 56-lb. rail.

Yours truly,

GEORGE H. WEBSTER,

Engineer.

FLINT AND PÈRE MARQUETTE RAILROAD,
SAGINAW, MICH., September 15th, 1892.

Our standard rail which gives much satisfaction has a radius of $\frac{5}{16}$ in. at the upper corner, $\frac{3}{16}$ in. at the lower corner, and is $\frac{1}{8}$ in. wider at the lower than at the top corner of the head; the radius of the top is 14 ins. and this we find wears very much as rolled; we have some 13 500 tons of this 67-lb. rail.

Very truly yours,

GEORGE M. BROWN.

FLORIDA CENTRAL AND PENINSULAR RAILROAD COMPANY,
JACKSONVILLE, FLA., September 15th, 1892.

Of all that we have tried I like our standard best 58-lb. rail, top-corner radius, $\frac{7}{16}$ in.

My idea of a perfect rail has always been that they should be rolled rights and lefts, the outside top corner rounded only enough to take

off the sharp corner, the inside top-corner radius to be from $\frac{1}{16}$ to $\frac{9}{16}$ in., and inside of head to be $\frac{1}{16}$ in. out of vertical, the fullness being at the bottom of the rail.

Yours truly,

BLAIR BURWELL, Jr.,
Chief Engineer.

THE NEW YORK, CHICAGO AND ST. LOUIS RAILROAD COMPANY.

CLEVELAND, O., September 16th, 1892.

We have been using for the last three years a 65-lb. rail, radius of top, 12 ins.; radius of top corner, $\frac{5}{16}$ in.; angle of side of head, 4° ; radius of bottom corner of head, $\frac{1}{16}$ in.; height of rail, $4\frac{1}{2}$ ins.; width of base, $4\frac{1}{4}$ ins.; width of head, $2\frac{7}{8}$ ins.

So far this section has given better satisfaction than any we have used.

We have in track at present 5 100 tons of the 65-lb. rail with section as given above.

Yours truly,

G. W. VAUGHN,
Division Engineer.

EVANSVILLE AND TERRE HAUTE RAILROAD COMPANY,

EVANSVILLE, IND., September 14th, 1892.

The rail we have used on both the Peoria, Decatur and Evansville and Evansville and Terre Haute roads since I have been connected with the system has for its surface radius 15 ins. and for the top corners $\frac{5}{16}$ in., the lower corner $\frac{3}{16}$ in. with an angle of 7° perpendicular deflection from the lower corner to the top corner.

This form has given me the best satisfaction and I believe for general use is near to what the standard should be. I am not in favor of extreme sharp corners nor perpendicular sides on the ball of the rail, from the fact that the fillet and shape of flanges in engine drivers or car wheels must eventually cut away the top part and wear the top corner of the rail down to a radius of at least $\frac{3}{16}$ in. This being true, I do not believe there would be anything gained in making rails with corners having a smaller radius than $\frac{3}{16}$ in. and a deflection of at least 4° perpendicular.

It is very desirable, of course, to secure as much rail surface as is possible, and while the rail is new a flat top will give what is desired, but it would certainly be depreciated very soon, as no wheel can be made without having sufficient fillet to insure its strength, for if the fillet was entirely taken out you would be continually having broken flanges.

Yours truly,

T. A. ALLEN,
Chief Engineer.

FITCHBURG RAILROAD COMPANY,

FITCHBURG, MASS., September 16th, 1892.

I send you herewith two blue prints showing rails lately used by the Fitchburg Railroad Company. The 1891 pattern which we are now using has $\frac{3}{8}$ -in. top-corner radius, which is the shortest we have.

All the rails laid between 1882 and 1891 have had a large corner radius, most of them about like the 76-lb. $4\frac{1}{2}$ -in. high section, a blue print of which is enclosed. We have now in the track 7737 tons of the $4\frac{1}{2}$ -in. high 76-lb., with $\frac{3}{8}$ -in. corner radius, and I do not know of any trouble arising from sharp flanges which could have been caused by this rail. I have noticed that on the old 76-lb. section the wheel flanges cut much faster into the rails on the outside of curves, than on the new 76-lb. section. Both these sections were rolled at the South Scranton Works, and the material is presumably the same. If I were to design a new rail for our use, I think I should use $\frac{1}{4}$ -in. corner radius and straight sides. I have never expressed an opinion on this subject to your committee.

Yours truly,

A. S. CHEEVER,

Chief Engineer.

WESTERN NEW YORK AND PENNSYLVANIA RAILROAD COMPANY,

BUFFALO, N. Y., September 23d, 1892.

We have no "sharp top-cornered rail sections" on our lines.

Our "standard section" is Pennsylvania Steel Company's No. 2. or C. P. & Co.'s section old No. 35, present No. 50; all practically the same as Cambria section No. 55, 67 lbs. per yard.

Our experience with this section has been satisfactory so far.

Very truly yours,

R. D. McCREARY,

Chief Engineer.

TOLEDO, ST. LOUIS AND KANSAS CITY RAILROAD COMPANY,

TOLEDO, O., November 23d, 1892.

In the use of rails with $\frac{1}{4}$ -in. top-corner radius, I have found that the inside top corners of such rails on curves wore away very rapidly, and, in doing so, made many sharp wheel flanges, especially on those with steel tires. After these corners had worn down to about $\frac{1}{8}$ -in. radius, the wear became less rapid on both rails and wheel flanges. In such cases, the sharp corner is of short duration, and its wearing away is accompanied by corresponding wear on wheel flanges. My experience with such rails, and with rails with $\frac{3}{8}$ -in. top-corner radius, has led me to the conclusion that the former are not desirable for roads having in their alignment many sharp curves.

I have put down about 12 000 tons of rail with $\frac{1}{4}$ -in. top-corner radius.

A. L. MILLS,

Chief Engineer.

September 26th, 1892.

Answering your letter of the 1st of September, my experience in the use of rails with sharp top corners is limited to the section recommended by the Society some time ago, of which we have purchased and laid down this year 1 500 tons, 75 lbs., steel, $4\frac{1}{4}$ ins. high; radius top corners, $\frac{1}{4}$ in.; breadth of head, $2\frac{9}{16}$ ins. Since it was laid I have noted the process of wearing very closely, and especially for evidences of contact between the wheel flanges and the inside vertical face of the rail head, but so far the closest scrutiny fails to discover any evidence of it. The wheels tread squarely on the top face of the rail and not their flanges on the corner or side or vertical face as they do on rails having large round top-corner, and inclined side faces. In that particular, and in fact all others, the section now promises the best results, and I believe the sharp top corner of $\frac{1}{4}$ in. to be a decided advantage over a large radius. The locomotive engineers think they can make better speed over this rail, and that it is due to a better traction on account of its broad face. While that is true I think there is far greater benefit derived from the flange clearance of the side face of the rail head, because the effect of that contact continuously is like an applied brake to retard the train's movement.

Yours truly,

T. H. PERRY,

Chief Engineer L. E. & W. R. R.

THE LAKE SHORE AND MICHIGAN SOUTHERN RAILWAY COMPANY,
CLEVELAND, O., September 16th, 1892.

Replying to yours of 1st instant, I enclose blue print of the 65 and 70-lb. rail sections which we have been using since 1889.*

So far as the wear of the rail is concerned, these sections have proven satisfactory.

The amount of rail of these sections laid from 1889-92, inclusive, is as follows:

Year.	Tons, 65-lb.	Tons, 70-lb.	Total.
1889	13 022	2 015	15 037
1890	16 475	2 538	19 013
1891	21 494	2 498	23 992
1892	22 465	4 501	26 966
	73 456	11 552	85 008

Yours truly,

E. A. HANDY,

Chief Engineer.

* These sections show radius of upper corner, $\frac{5}{16}$ in. Radius of head, 12 ins. Inclination of sides of head, 4° .

THE PENNSYLVANIA RAILROAD COMPANY,

PHILADELPHIA, June 4th, 1891.

E. T. D. MYERS, Esq.,

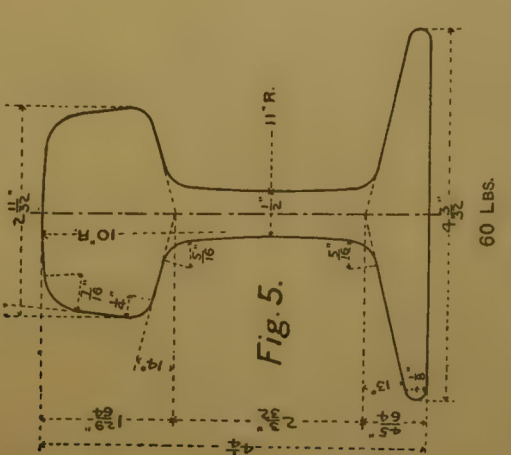
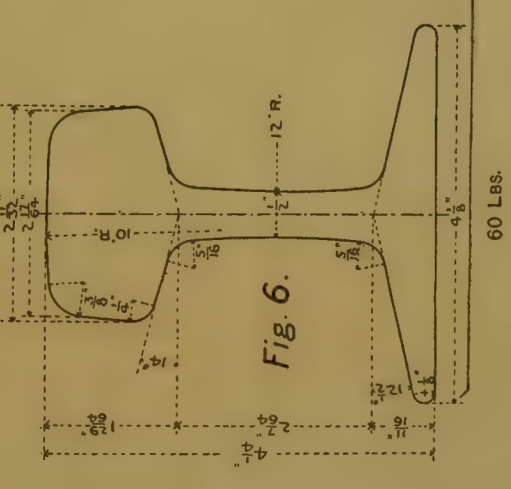
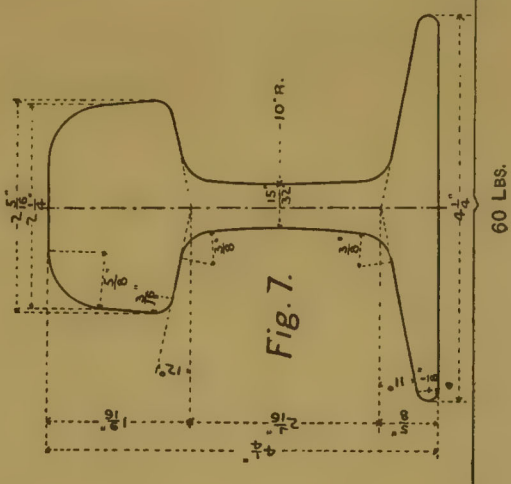
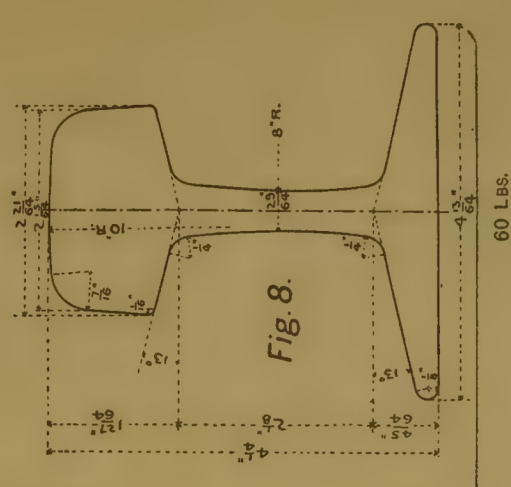
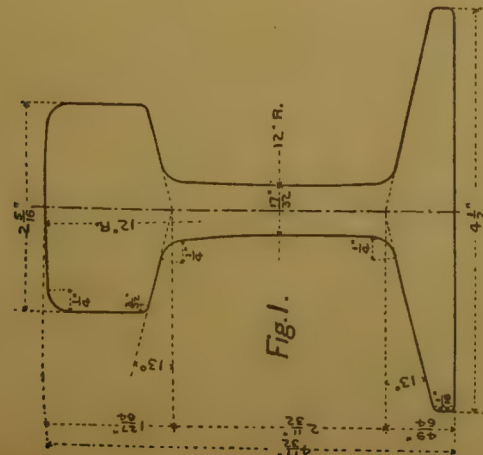
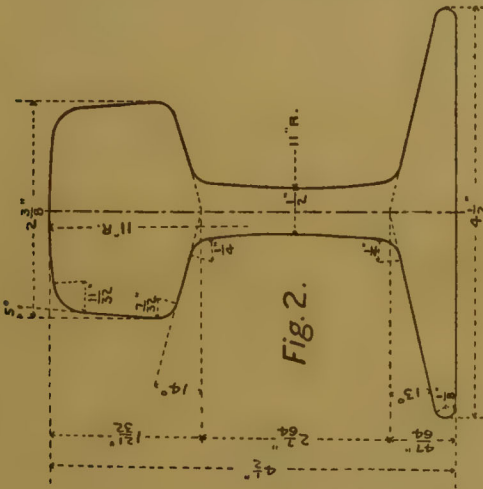
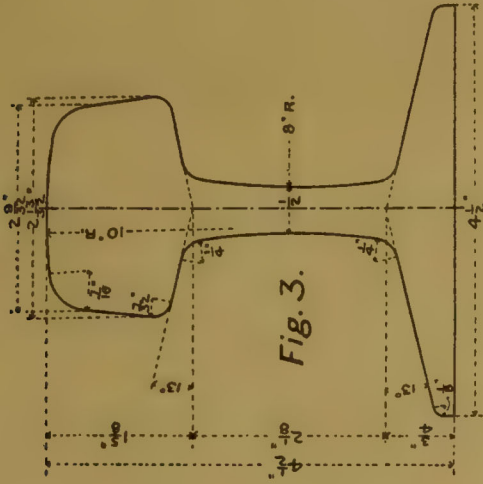
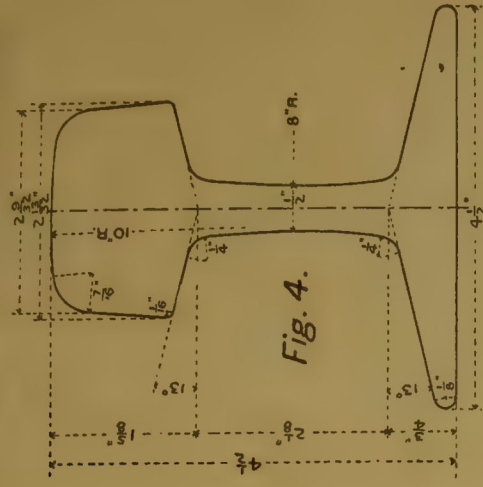
Genl. Supt. R. F. & P. R. R. Co., Richmond, Va.

DEAR SIR,—In answer to yours of the 3d instant, the $\frac{7}{16}$ -in. radius on the corner of our 85-lb. rail was placed there as a compromise between the Engineer Department and the Motive Power Department. The Motive Power Department always insisted on a $\frac{5}{8}$ -in. radius, while we would very much prefer to have only $\frac{1}{4}$ -in. radius. My own preference is, however, a $\frac{1}{4}$ -in. radius on the upper corner, and vertical sides, but I was overruled and adopted the 85-lb. section as a compromise. I think it is the best section that we have ever had, and I take pleasure in sending you a lithograph of it (Fig. 23, Plate LXXIII).

Respectfully,

WM. H. BROWN,

Chief Engineer.



60 LBS.

60 LBS.

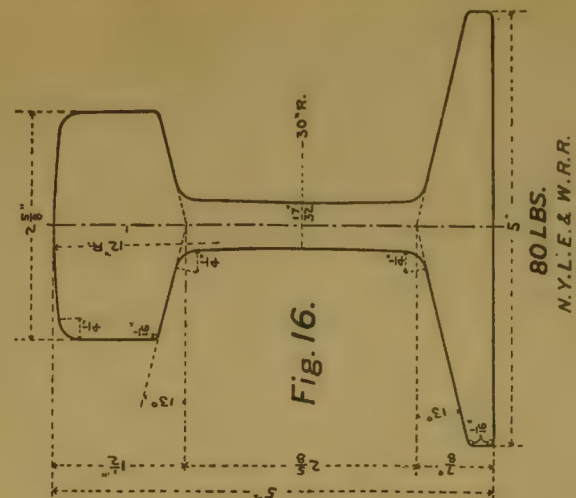
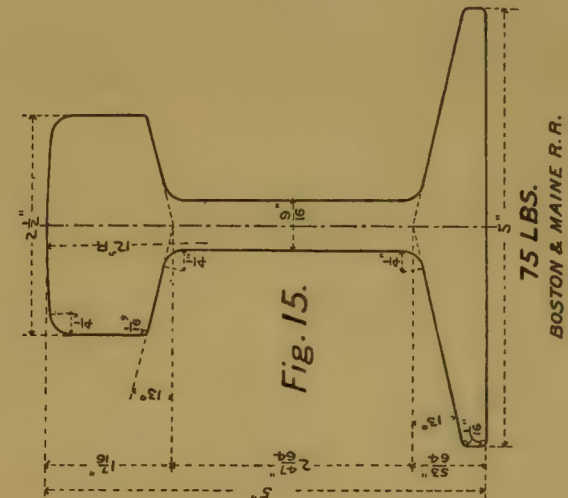
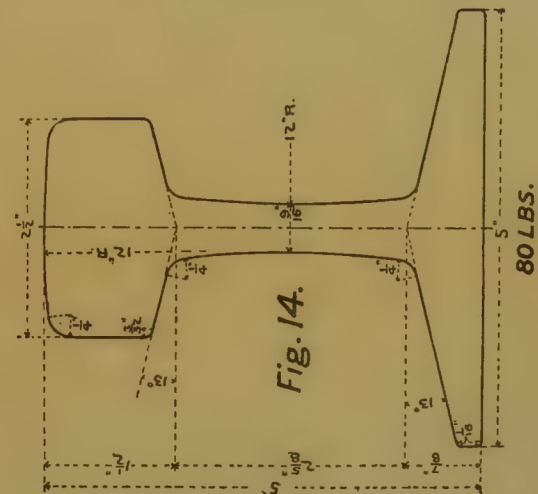
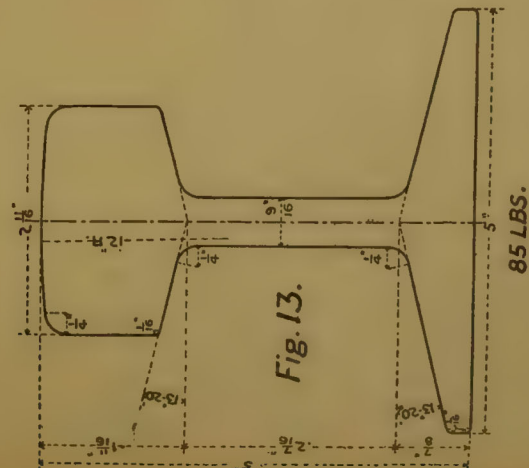
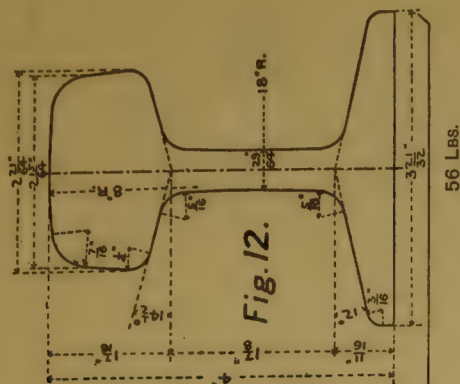
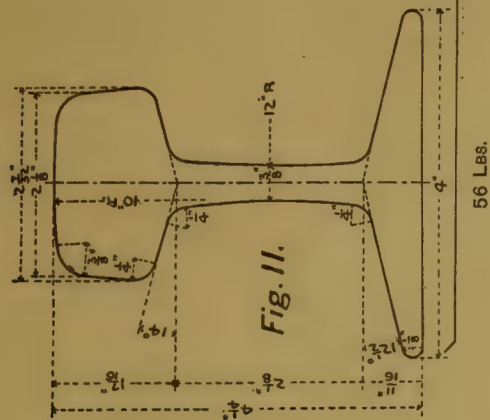
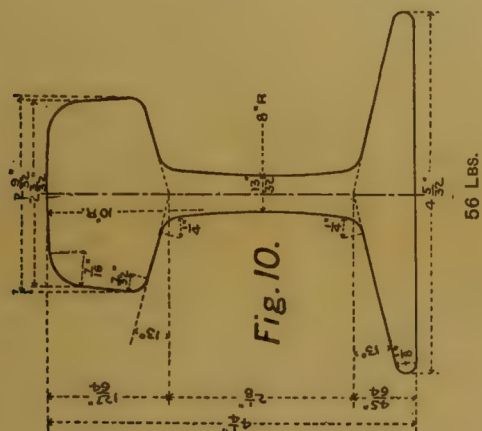
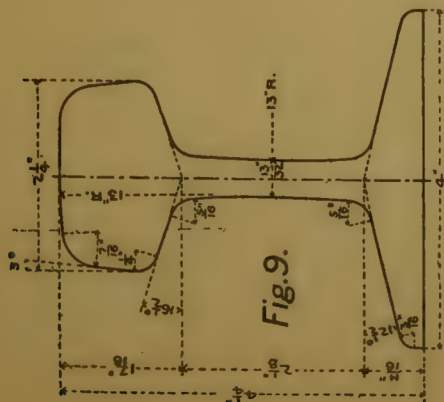
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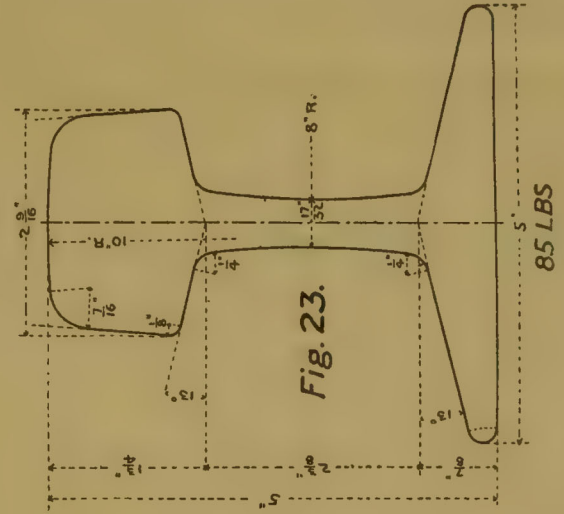
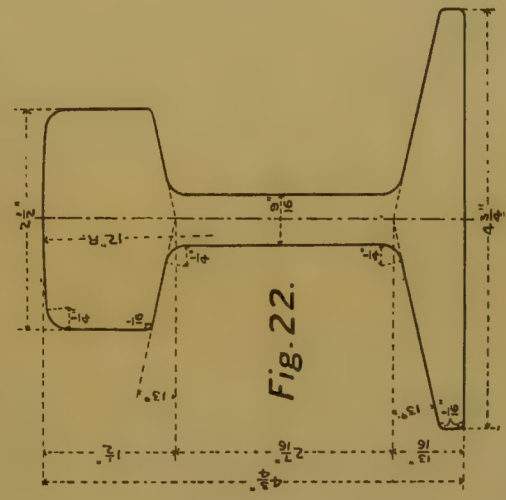
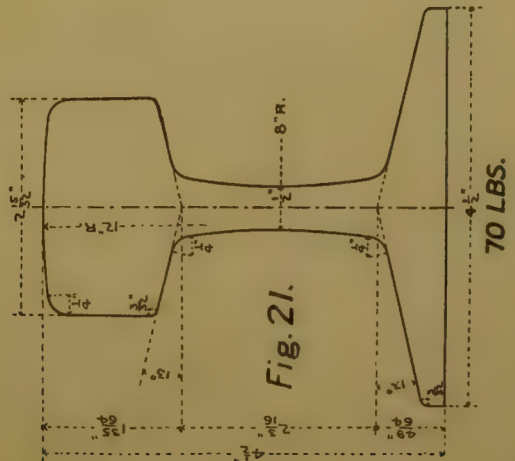
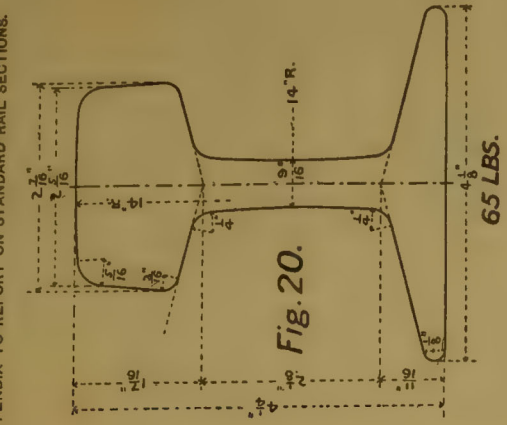
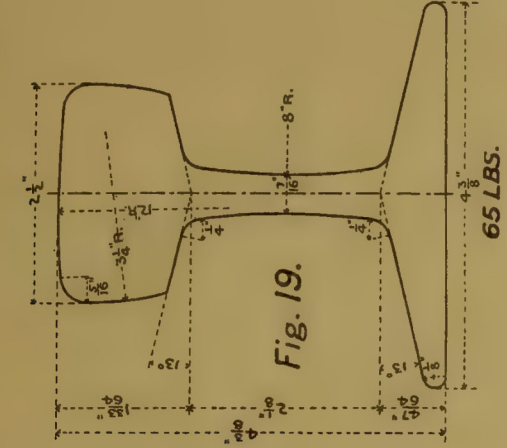
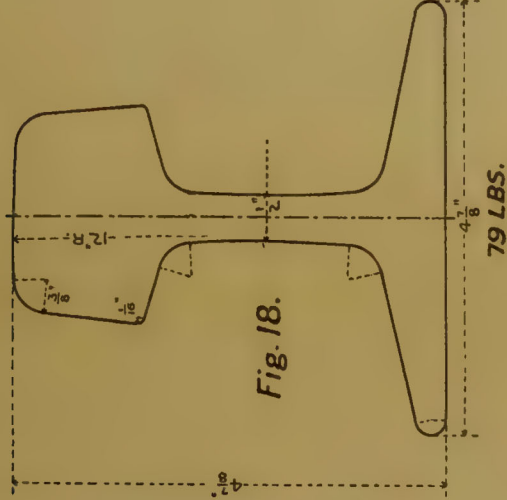
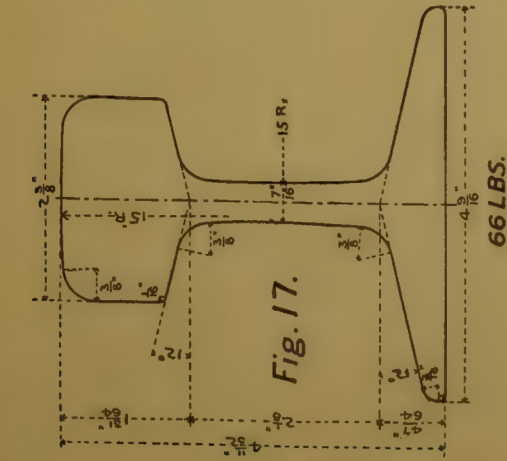
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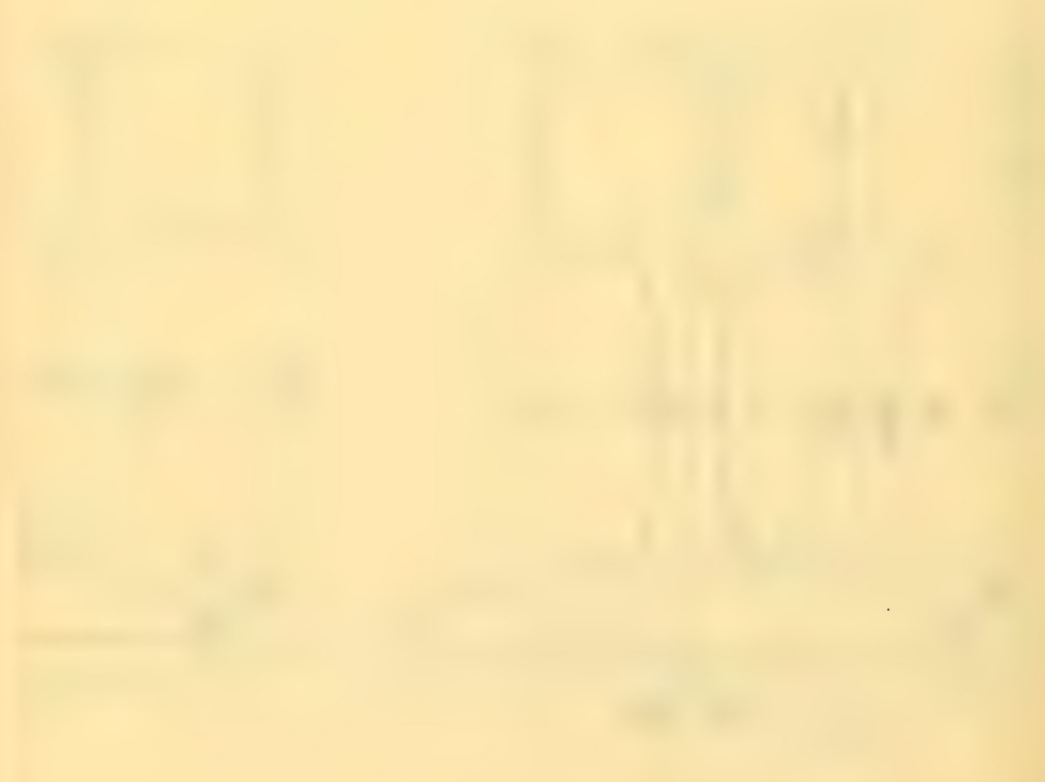
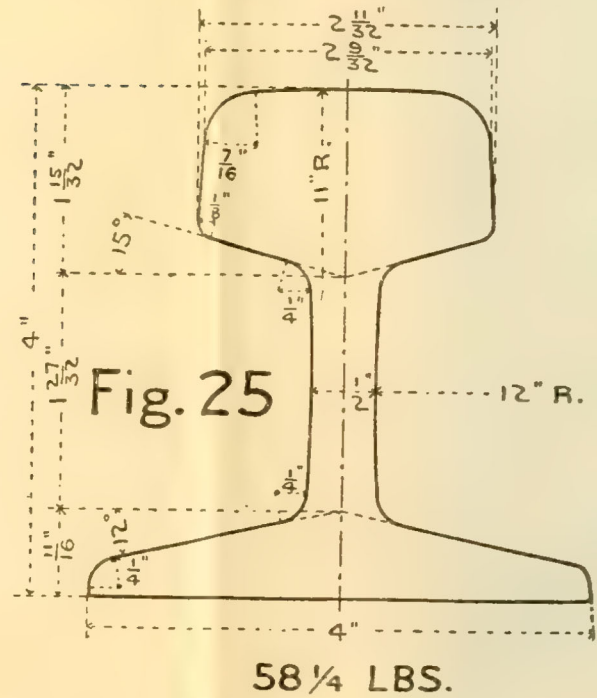
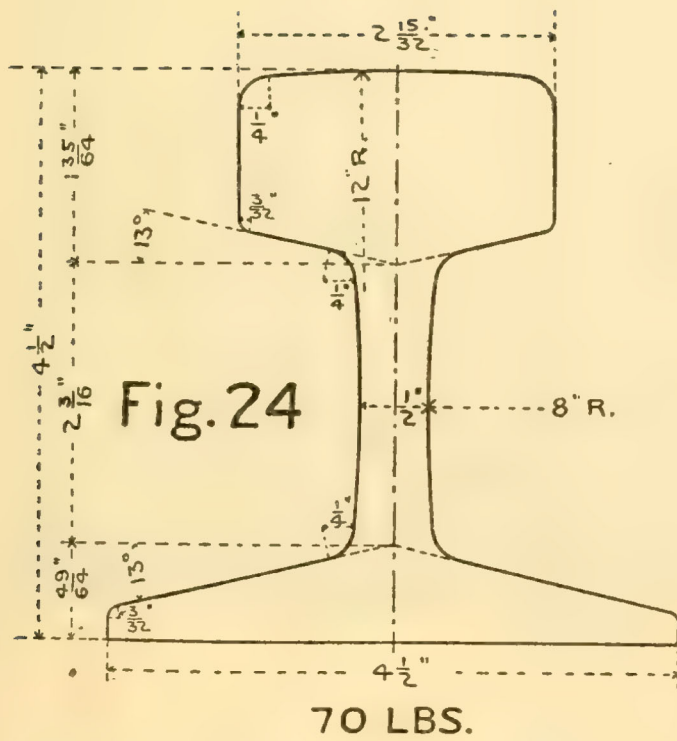
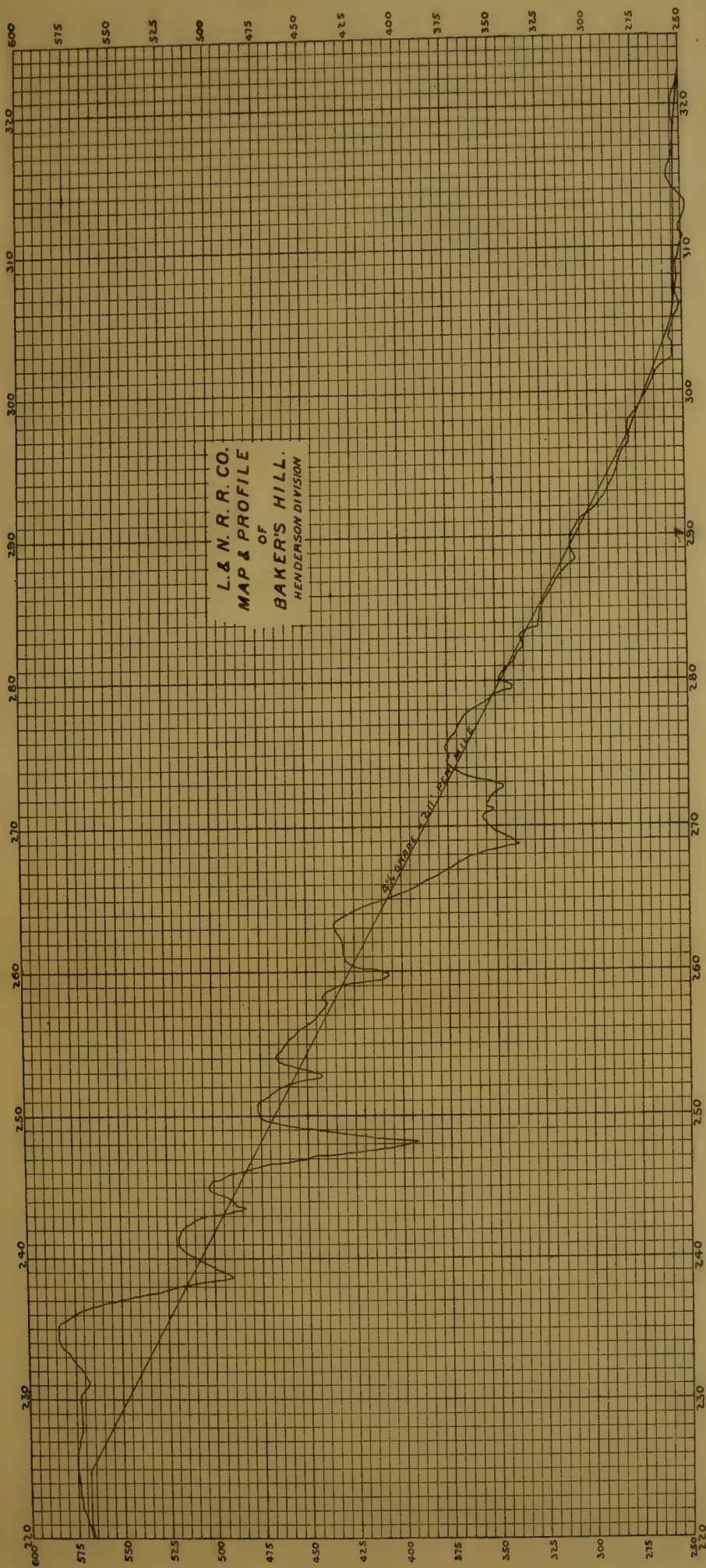


PLATE LXXIV.
 TRANS. AM. SOC. CIV. ENGRS.
 VOL. XXVIII, No. 601.
 MONTFORT ON STANDARD RAIL SECTIONS.



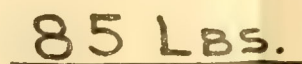




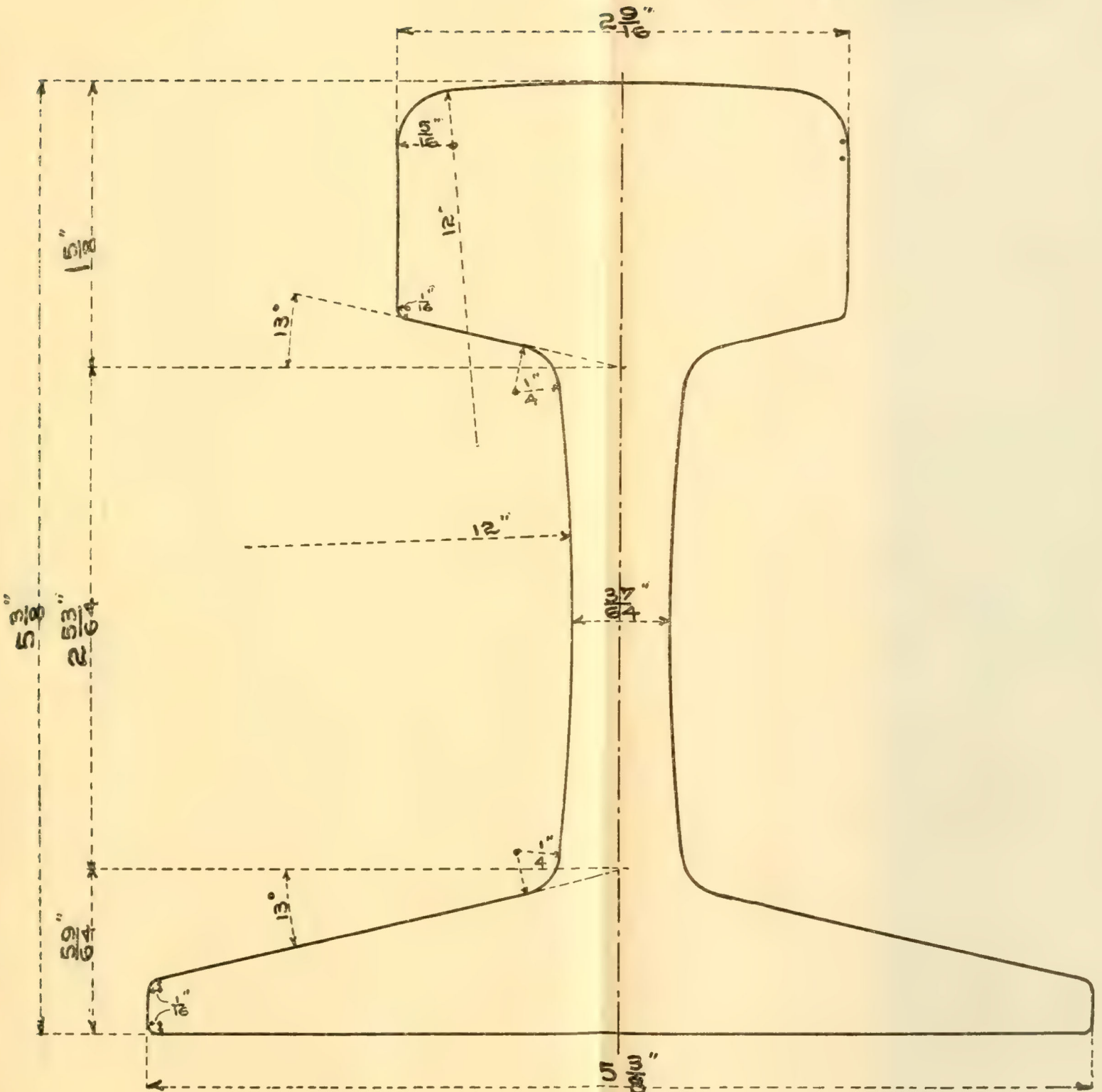
NOTE.
 THE ARROW POINTS WHICH INDICATES THAT THE RAIL EMBRACED BETWEEN
 THE FIRST HALF OF THE YEAR 1892,
 THAT IT WAS MADE BY THE CAMBRIA IRON CO. & WEIGHS 70 LBS. PER YARD.
 1889? INDICATES RAIL LAID IN THE SECOND HALF OF THE YEAR 1889.
 E.T. INDICATES RAIL MADE BY THE EDGAR THOMPSON STEEL CO.
 P.B. " " " " PITTSBURGH BESSEMER STEEL CO.



PLATE LXXVI.
TRANS. AM. SOC. CIV. ENGRS.
VOL. XXVIII, No. 601.

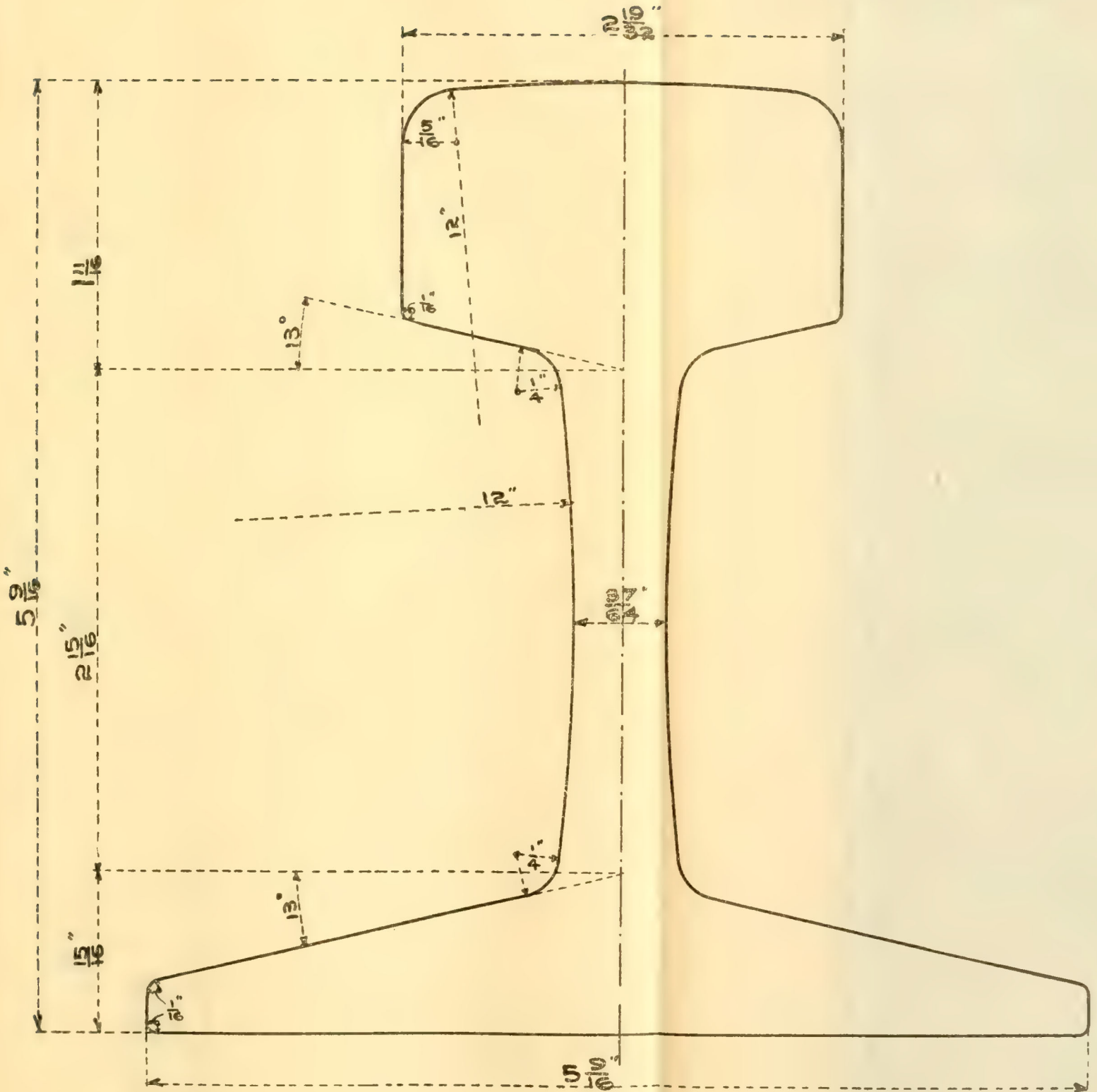






90 LBS.

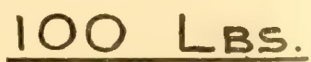




95 LBS.



Fig. 100





100 001