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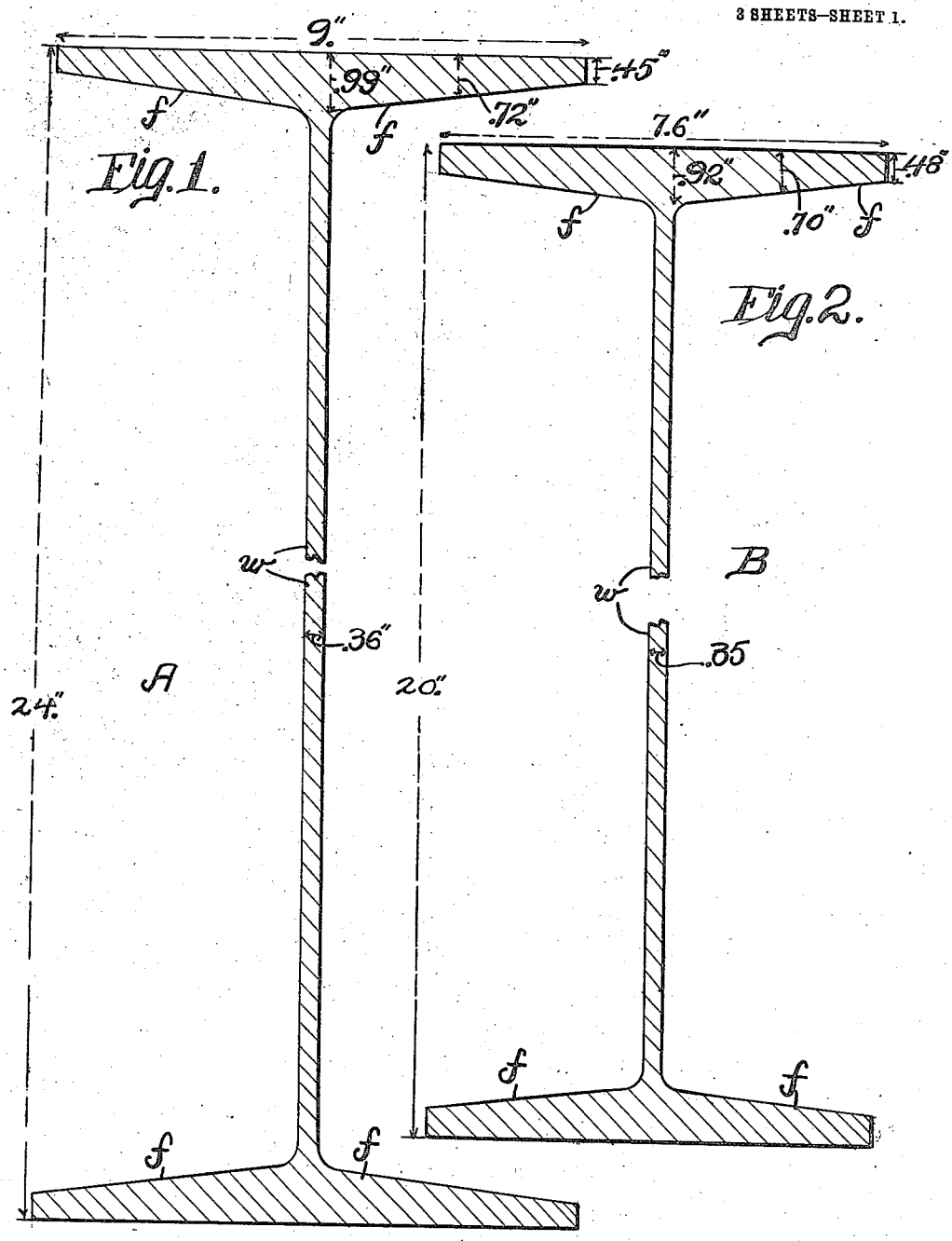
SOLID ROLLED METAL I-BEAM OF SIXTEEN INCHES AND UNDER TWENTY-FIVE INCHES IN HEIGHT.

APPLICATION FILED SEPT. 16, 1903.

1,013,651.

Patented Jan. 2, 1912.

3 SHEETS—SHEET 1.



WITNESSES:

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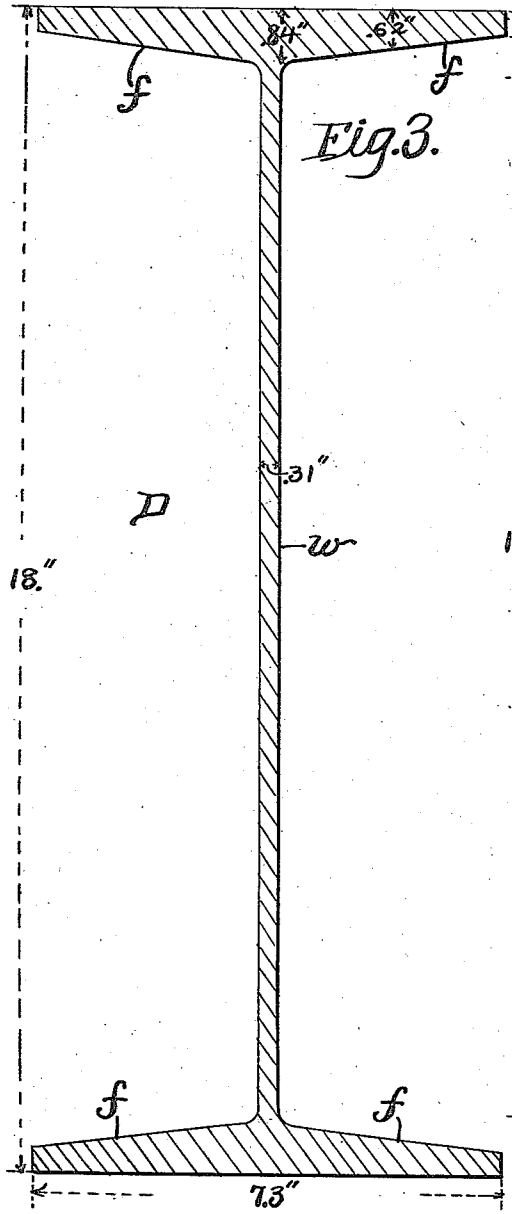


Fig. 3.

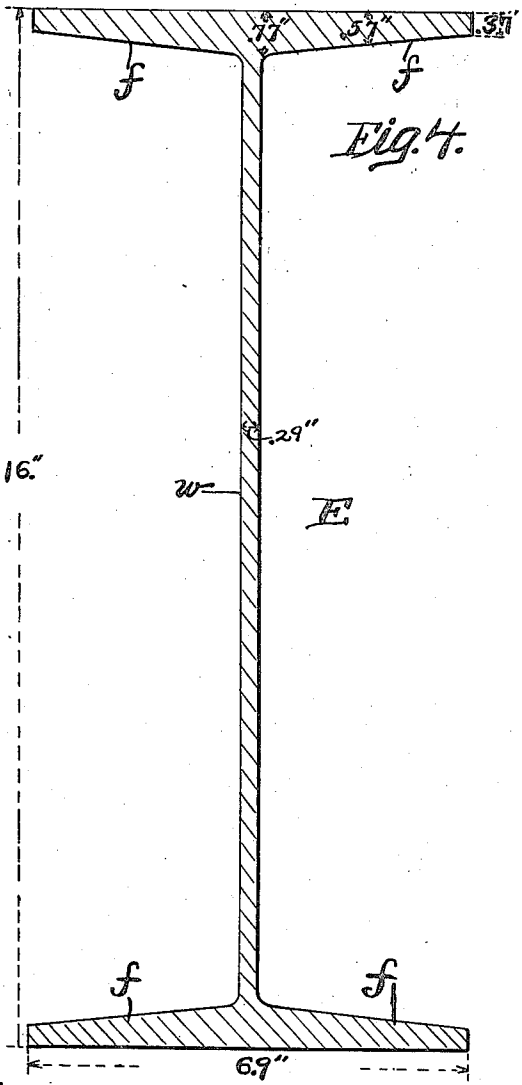


Fig. 4.

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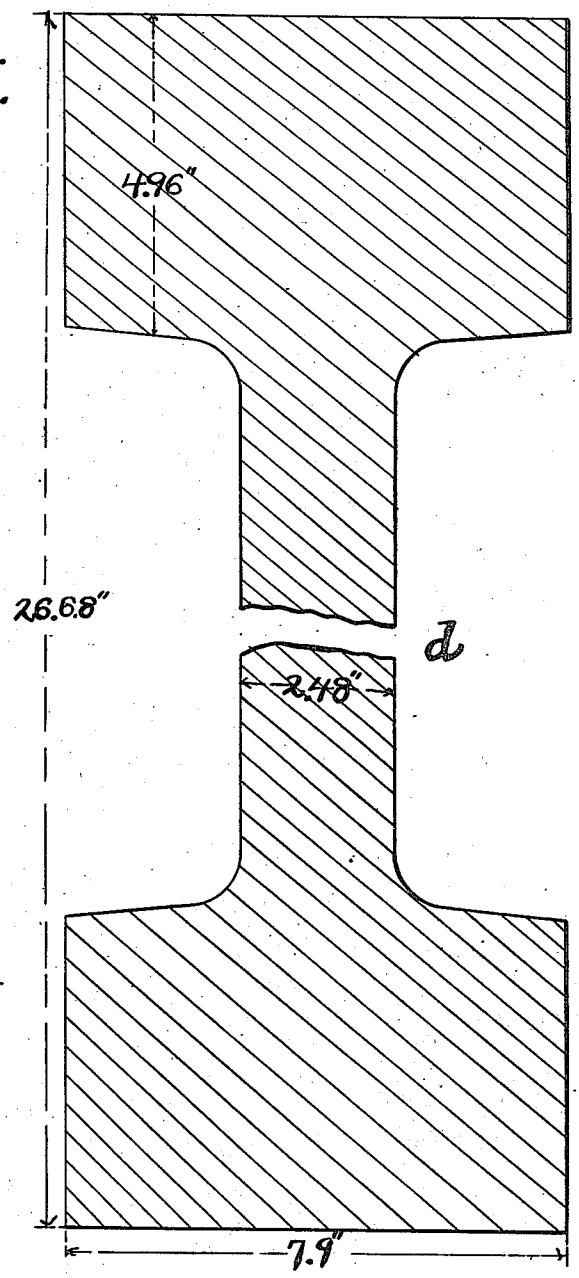
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3 SHEETS—SHEET 3.

Fig. 5.



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UNITED STATES PATENT OFFICE.

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SOLID ROLLED METAL I-BEAM OF SIXTEEN INCHES AND UNDER TWENTY-FIVE INCHES IN HEIGHT.

1,013,651. Specification of Letters Patent. Patented Jan. 2, 1912.

Application filed September 16, 1903. Serial No. 173,413.

To all whom it may concern:

Be it known that I, HENRY GREY, a citizen of the United States of America, residing at New York city, in the county of New York and State of New York, have invented certain new and useful Improvements in Solid Rolled Metal I-Beams of Sixteen Inches and Under Twenty-five Inches in Height; and I hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it pertains to make and use the same.

This invention relates to improvements in solid rolled metal I-beams having a height of from sixteen to twenty-four inches inclusive.

The general object of this invention is to produce improved solid rolled steel or iron I-beams having a height of at least sixteen and under twenty-five inches, and capable of safely carrying, on any span whose length in feet is equal to or exceeds the height of the beam in inches, for a given unit of material, a greater load than has heretofore been carried. In other words this invention has in view the production of a solid rolled metal I-beam having a height within the above-mentioned range, which shall, by reason of an advantageous distribution of material in its web and flanges, be able to safely carry, on all spans included within the above-mentioned limitation, a larger load to the unit of weight in the said beam than has heretofore been carried by any heretofore produced solid rolled I-beam of the same height.

The object of this invention, more specifically stated, is to produce solid rolled metal I-beams of at least sixteen inches and under twenty-five inches in height and capable of safely carrying, on spans of one or about one foot for every inch in height of the beam, an evenly distributed safe load equal in amount to that carried by heretofore made solid rolled I-beams of the same height, with ten per cent. less weight of material.

Another object is not only the production of a solid rolled I-beam having the height within the range hereinbefore indicated, which shall, by reason of an advantageous distribution of material in its web and flanges, be able to safely carry, on all spans included within the above-mentioned limitation, a larger load to the unit of weight in the said beam than has heretofore been carried by any heretofore produced solid rolled I-beam of the same height, but which has a web of considerably less thickness than the thickness of the webs of heretofore made solid rolled I-beams of the same height and about one-half or approximately one-half the mean thickness of the flanges of the beam, and has a width, measured straight across the outer sides of adjacent oppositely projecting flanges of the beam, considerably greater, relative to the mean thickness of the flanges of the beam, than the width of heretofore produced solid rolled I-beams of the same height.

With these objects in view, this invention consists more especially in the production of solid rolled I-beams ranging in height from sixteen to twenty-four inches inclusive, which have such dimensions cross-sectionally and have the mean thickness of the flanges and the thickness of the web in such relative proportion that the quotient, obtained by dividing the coefficient of strength in any beam having a height within the said range, per unit of weight of one pound, for a fiber stress of sixteen thousand (16,000) pounds per square inch, is considerably over one thousand (1,000) pounds.

In the accompanying drawings, Figures 1, 2, 3 and 4 are cross-sectional views of solid rolled I-beams embodying my invention and having a height of twenty-four inches, twenty inches, eighteen inches and sixteen inches respectively. Fig. 5 is a cross-sectional view of a blank suitable for use in the production of the "eighteen-inch" beam illustrated in Fig. 3.

Referring to the drawings, *w* represents the web, and *f*, the flanges of the beams.

A designates the solid rolled I-beam illustrated in Fig. 1. The beam A has a height of twenty-four inches, as already indicated,—that is, measures twenty-four inches (24″) between the outer sides of the flanges formed at one and the same side of the web of the beam. The beam A has a width of nine inches (9″),—that is, measures nine inches (9″) between the longitudinal edges of adjacent oppositely projecting flanges *f* of the beam. The thickness of each flange *f* of the beam A is ninety-nine hundredths of

an inch (.99″) at the root of the flange and forty-five hundredths of an inch (.45″) at the longitudinal edge of the flange, and hence the mean thickness of the said flange is seventy-two hundredths of an inch (.72″) and twice the thickness of the web *w* of the beam, which last-mentioned thickness is thirty-six hundredths of an inch (.36″). The taper of the inner sides of the flanges of the beam A is, therefore, twelve and one-half (12.5) per cent. It will be observed, also that the width of the beam A is about twelve times the mean thickness of the flanges of the beam. The weight of the beam A, per running foot, is seventy-two pounds (72 lbs.). The coefficient of strength in the beam A, for a fiber stress of sixteen thousand pounds (16,000 lbs.), per square inch, is one million, eight hundred and sixty-three thousand, two hundred pounds (1,863,200 lbs.), and the coefficient of strength, for a unit of one pound, in the said beam, is, therefore, twenty-five thousand, eight hundred and seventy-seven pounds (25,877 lbs.), the quotient obtained by dividing 1,863,200 lbs. by 72, the number of pounds per running foot in the beam. The coefficient of strength for the unit of one pound (25,877 lbs.) divided by the number of inches that the beam is high (24) gives a quotient of ten hundred and seventy-eight pounds (1078 lbs.) which is the coefficient of strength in the beam A, per unit of one pound, for every inch of the height of the beam, and a load which the beam A can safely carry, per pound, on a span hereinbefore stated, instead of nine-hundred and sixty-seven pounds (967 lbs.) which is the greatest load which any heretofore made solid rolled I-beam of the same height can safely carry, per pound of material, on a corresponding span.

B, in Fig. 2, represents a solid rolled I-beam which has a height of twenty inches, as already indicated,—that is, measures twenty inches (20″) between the outer sides of the flanges formed at one and the same side of the web of the beam. The beam B has a width of seven inches and six-tenths of an inch (7.6″),—that is, measures seven inches and six-tenths of an inch (7.6″) between the longitudinal edges of adjacent oppositely projecting flanges *f* of the beam. The thickness of each flange *f* of the beam B is ninety-two hundredths of an inch (.92″) at the root of the flange and forty-eight hundredths of an inch (.48″) at the longitudinal edge of the flange, and hence the mean thickness of the said flange is seventy hundredths of an inch (.70″) and twice the thickness of the web *w* of the beam which last-mentioned thickness is thirty-five hundredths of an inch (.35″). The taper of the inner sides of the flanges of the beam B is obviously twelve and one-half (12.5) per cent. It will be observed, also, that the width of the beam B is about eleven times the mean thickness of the flanges. The weight of the beam B, per running foot, is fifty-eight pounds (58 lbs.). The coefficient of strength in the beam B, for a fiber stress of sixteen thousand pounds (16,000 lbs.) per square inch, is one million, two hundred and fifty-six thousand, five hundred pounds (1,256,500 lbs.), and the coefficient of strength, for the unit of one pound, in the said beam, is therefore, twenty-one thousand, six hundred and sixty-three pounds (21,663 lbs.), the quotient obtained by dividing 1,256,500 lbs. by 58, the number of pounds per running foot in the beam. The coefficient of strength for the unit of one pound, (21,663 lbs.) divided by the number of inches that the beam is high (24) gives a quotient of ten hundred and eighty-three pounds (1083 lbs.) which the beam B can safely carry per pound on a span hereinbefore mentioned instead of nine hundred and sixty pounds (960 lbs.) which is the greatest load which any heretofore made solid rolled I-beam of the same height can safely carry, per pound of material, on a corresponding span.

D, in Fig. 3, designates a solid rolled I-beam embodying my invention, and having a height of eighteen inches, as already indicated,—that is, measuring eighteen inches (18″) between the outer sides of the flanges formed at one and the same side of the web of the beam. The beam D has a width of seven inches and three-tenths of an inch (7.3″),—that is, measures seven inches and three-tenths of an inch (7.3″) between the longitudinal edges of adjacent oppositely projecting flanges *f* of the beam. The thickness of each flange *f* of the beam D is eighty-four hundredths of an inch (.84″) at the root of the flange and forty hundredths of an inch (.40″) at the longitudinal edge of the flange, so that the mean thickness of the said flange is sixty-two hundredths of an inch (.62″) and twice the thickness of the web *w* of the beam, which last-mentioned thickness is thirty-one hundredths of an inch (.31″). The taper of the inner sides of the flanges of the beam D is obviously twelve and one-half (12.5) per cent. It will be observed, also, that the width of the beam D is over eleven times the mean thickness of the flanges of the beam. The weight of the beam D, per running foot, is forty-eight and one-half pounds (48.5 lbs.). The coefficient of strength in the beam D, for a fiber stress of sixteen thousand pounds (16,000 lbs.) per square inch, is nine hundred and fifty-two thousand, three hundred pounds (952,300 lbs.), and the coefficient of strength, for the unit of one pound, in the said beam, is therefore, nineteen thousand, six hundred and thirty-five pounds (19,635 lbs.), the quotient

obtained by dividing 952,300 lbs. by 48.5, the number of pounds per running foot in the beam. The coefficient of strength for the unit of one pound, (19,635 lbs.) divided by the number of inches that the beam is high (18) gives a quotient of ten hundred and ninety pounds. (1090 lbs.), which the beam D can safely carry, per pound, on a span within the limitation hereinbefore stated, instead of nine hundred and fifty-three pounds (953 lbs.) which is the greatest load which any heretofore made solid rolled I-beam of the same height can safely carry, per pound of material, on a corresponding span.

E, in Fig. 4, designates a solid rolled I-beam embodying my invention and having a height of sixteen inches, as already indicated,—that is, measuring sixteen inches (16″) between the outer sides of the flanges formed at one and the same side of the web of the beam. The beam E has a width of six inches and nine-tenths of an inch (6.9″),—that is, measures six inches and nine-tenths of an inch (6.9″) between the longitudinal edges of adjacent oppositely projecting flanges *f* of the beam. The thickness of each flange *f* of the beam E is seventy-seven hundredths of an inch (.77″) at the root of the flange and thirty-seven hundredths of an inch (.37″) at the longitudinal edge of the flange, so that the mean thickness of each flange of the said beam is fifty-seven hundredths of an inch (.57″) and approximately twice the thickness of the web *w* of the beam, which last-mentioned thickness is twenty-nine hundredths of an inch (.29″). The taper of the inner sides of the flange of the beam E is obviously twelve and one-half (12.5) per cent. It will be observed, also, that the width of the beam E is about twelve times the mean thickness of the flanges of the said beam. The weight of the beam E, per running foot, is forty pounds (40 lbs.). The coefficient of strength of the beam E, for a fiber stress of sixteen thousand pounds (16,000 lbs.) per square inch, is seven hundred and twenty-seven thousand, seven hundred pounds (727,700 lbs.), and the coefficient of strength, for the unit of one pound, in the said beam, is, therefore, eighteen thousand, one hundred and ninety-three pounds (18,193 lbs.), the quotient obtained by dividing 727,700 lbs. by 40, the number of pounds per running foot in the beam, and the coefficient of strength for the unit of one pound, (18,193 lbs.) divided by the number of inches that the beam is high (16) gives a quotient of eleven hundred and thirty-seven pounds (1137 lbs.) which is the coefficient of strength, in the beam B, per unit of one pound, for every inch of the height of the beam, and a load which the beam E can safely carry per pound on a span for which the said beam is adapted. I would here remark, however, that a "sixteen-inch" solid rolled I-beam is not made at present in America.

The improved solid rolled I-beams hereinbefore described and illustrated in the accompanying drawings can be successfully produced by providing a suitably heated rough beam or blank I-shaped in cross-section and having such dimensions cross-sectionally that the mean thickness of each flange of the blank is twice or approximately twice the thickness of the web of the blank with the thickness of the said web and the mean thickness of the said flange corresponding or approximately corresponding, in their proportion to each other, with the proportion which the mean thickness of the said flange and the thickness of the said web shall bear to each other in the beam to which the blank is to be reduced, and then rolling the flanges and web simultaneously and thereby reducing the mean thickness of each flange and the thickness of the web substantially in the proportion which the mean thickness of the said flange and the thickness of the web bear to each other in the blank. This method of reducing the said blank is invaluable to avoid imperfections, latent as well as visible, in any portion of the resulting product. As an example, *d*, in Fig. 5, represents a cross-sectionally I-shaped blank especially suitable for use in the production of the improved solid rolled "eighteen-inch" I-beam D illustrated in Fig. 3. The blank *d* has a height of twenty-six inches and sixty-eight hundredths of an inch (26.68″),—that is, measures twenty-six inches and sixty-eight hundredths of an inch (26.68″) between the outer sides of the flanges at one and the same side of the web of the blank. The blank *d* has a width of seven inches and nine-tenths of an inch (7.9″),—that is, measures seven inches and nine-tenths of an inch (7.9″) straight across the outer sides of adjacent oppositely projecting flanges of the blank. The mean thickness of each flange of the blank *d* is four inches and ninety-six hundredths of an inch (4.96″), and the thickness of the web of the blank is two inches and forty-eight hundredths of an inch (2.48″), and hence the mean thickness of the said flange is twice the thickness of the web of the blank. It will be observed, therefore, that the mean thickness of each flange of the blank *d* bears, to the thickness of the web of the blank, the same or approximately the same ratio which the mean thickness of the said flange, when finished and as it is to exist in the beam D, Fig. 3, to which the blank is to be reduced, bears to the thickness of the web of the said beam.

The invention which constitutes the subject-matter of this application is the result

of an exhaustive study of the ways and means best adapted to most economically and advantageously distribute the material used in the manufacture of I-beams ranging in height from sixteen to twenty-four inches.

My improved I-beams have no more material in their web than actually needed but obviously considerably less material than solid rolled I-beams of the same height heretofore made.

Solid rolled I-beams made prior to my invention have too much material in close proximity to the neutral axis. The moment of inertia of an I-beam, when the latter is to be used as a joist or girder, is calculated by the well known formula, viz.—

$$I = \tfrac{1}{12} \text{ of } \left[bd^3 - \frac{1}{4^r}(h^4 - l^4) \right].$$

In the said formula, I stands for the moment of inertia, with the neutral axis perpendicular to the web at the center; b, for the width of the beam; d, for the height of beam; h, for the distance between the flanges at one and the same side of the web at the longitudinal edges of the said flanges; l, for the distance between the roots of the flanges at one and the same side of the web;

$$r = \frac{h - l}{b - t},$$

and t stands for the thickness of the web. From the said moment of inertia a coefficient for any given fiber stress is calculated for determining the evenly distributed load that the beam will safely carry. The said formula shows the coefficient equal to

$$\frac{8 \times \text{fiber strain} \times I}{\text{span in inches} \times n}$$

and n stands for the distance of center gravity of section, from top or bottom, in inches, and twelve inches (12″) is used for the span; thus the coefficient obtained is for one foot and this, in general parlance, is called the coefficient. If the safe load, uniformly distributed, is required for any definite span, the coefficient is divided by the number of feet in that span, and the quotient obtained is the safe load for that given span.

What I claim is:—

1. As a new article of manufacture, a solid rolled I-beam not less than sixteen inches in height, the width of the flanges of which is not less than twenty times greater than the thickness of the web thereof.

2. As a new article of manufacture, a solid rolled I-beam the height of which is not less than sixteen inches but under twenty-five inches, the ratio of the width of the flanges to the thickness of the web being not less than twenty.

3. As a new article of manufacture, a solid rolled I-beam, the height of which is substantially twenty inches, and the width of the flanges of which is substantially 7.6 inches, and the thickness of the web of which is substantially .35 inch.

4. As a new article of manufacture, a solid rolled steel I-beam, the height of which exceeds 16 inches, the width of the flanges of which is substantially 7.6 inches, the mean thickness of the flanges of which is substantially .70 of an inch, and the thickness of the web of which is substantially .35 of an inch.

5. As a new article of manufacture a solid rolled I-beam the width of the flanges of which is not less than twelve (12) times greater than the mean thickness of said flanges.

In testimony whereof, I sign the foregoing specification, in the presence of two witnesses.

HENRY GREY.

Witnesses:
C. H. Dorer,
G. M. Hayes.