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SOLID ROLLED METAL EIGHT INCH I-BEAM.

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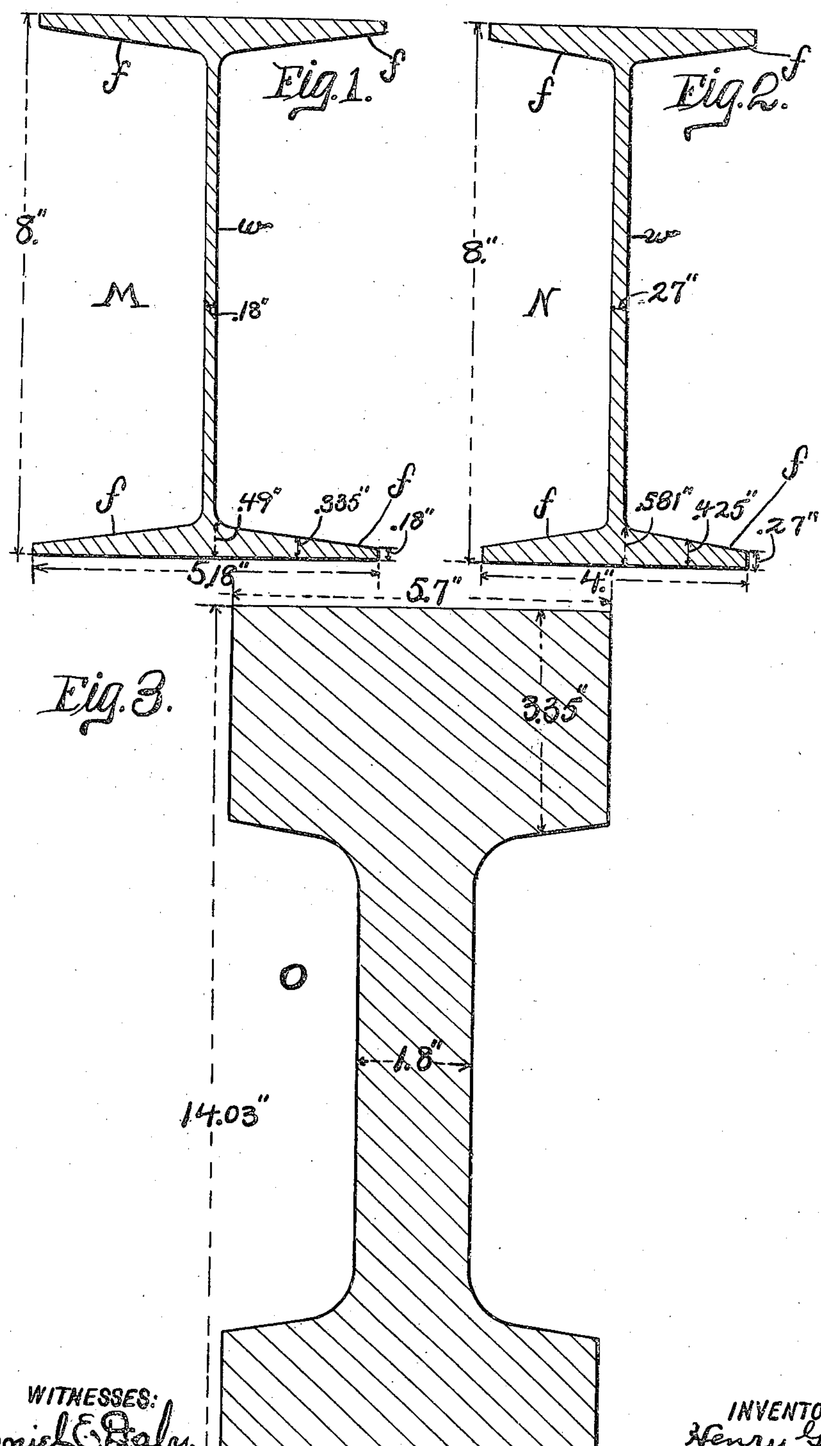
1,013,650. Patented Jan. 2, 1912.

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# UNITED STATES PATENT OFFICE.

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## SOLID ROLLED METAL EIGHT-INCH I-BEAM.

**1,013,650.** Specification of Letters Patent. **Patented Jan. 2, 1912.**

Application filed September 14, 1903. Serial No. 173,109.

*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 Eight-Inch I-Beams; 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 an improved solid rolled "eight-inch" I-beam.

The general object of this invention is to produce an improved solid rolled steel or iron I-beam having a height of eight inches and capable of safely carrying on any span whose length in feet is equal or somewhat 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 "eight-inch" I-beam 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 "eight-inch" I-beams which are capable of safely carrying, on spans of at least one foot for every inch in height of the beam, an evenly distributed safe load equal in amount to that carried by any heretofore made solid rolled I-beam of the same height, with ten per cent less weight of material.

Another object is not only the production of a solid rolled "eight-inch" I-beam which shall, by reason of an advantageous distribution of material in its web and flanges, be able to carry safely, on all spans included within the above-mentioned limitation, a larger load to the unit of weight in the said beam than can be carried by any heretofore produced solid rolled I-beam of the same height, but which is free from imperfections, latent as well as visible, and has a web of considerably less thickness than the thickness of the web of the heretofore made solid rolled I-beams of the same height and also considerably less in thickness relative to the mean thickness of the flanges than the webs of the said beams of the prior state of the art, and has a width which, measured straight across the outer sides of adjacent oppositely projecting flanges of the beam, is considerably greater relative to the mean thickness of the flanges of the beam than the width of any solid rolled "eight-inch" I-beam of the prior state of the art.

With these objects in view, this invention consists more especially in the production of a solid rolled "eight-inch" I-beam having such width relative to the mean thickness of the flanges, with the mean thickness of each flange and the thickness of the web bearing such proportion to each other, that the coefficient of strength in the said beam, per unit of weight of one pound, for a fiber stress of sixteen thousand (16,000) pounds per square inch, exceeds ten hundred and sixty pounds (1060 lbs.) for every inch of height of the beam.

In the accompanying drawings, Figure 1 is a cross-sectional view of a solid rolled "eight-inch" I-beam embodying my invention. Fig. 2 is a cross-sectional view of the solid rolled "eight-inch" standard I-beam of the prior state of the art. Fig. 3 is a cross-sectional view of a rough beam or blank suitable for use in the manufacture of my improved solid rolled "eight-inch" I-beam illustrated in Fig. 1.

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

M, in Fig. 1, designates a solid rolled I-beam embodying my invention and having a height of eight inches, as already indicated,—that is, measuring eight inches (8″) between the outer sides of the flanges formed at one and the same side of the web of the beam. The beam M has a width of five inches and eighteen hundreths of an inch (5.18″),—that is, measures five inches and eighteen hundredths of an inch (5.18″) between the longitudinal edges of adjacent oppositely projecting flanges of the beam. The said width is over fifteen times the mean thickness of the flanges of the beam. The thickness of each flange *f* of the beam M is forty-nine hundredths of an inch (.49″) at the root of the flange and eighteen hundredths of an inch (.18″) at the longitudinal edge of the flange, so that the mean thickness of each flange of the said beam is three hundred and thirty-five thousandths of an inch (.335″) and approximately only fourteen hundredths less than twice the thickness of the web $w$ of the beam, and hence almost or approximately again as thick as the said web whose thickness is eighteen hundredths of an inch (.18″). The taper of the inner sides of the flanges of the beam M is obviously twelve and one-half (12.5) per cent. The weight of the beam M, per running foot, is sixteen pounds and two-tenths of a pound (16.2 lbs.). The coefficient of strength of the beam M, for a fiber stress of sixteen thousand pounds (16,000 lbs.) per square inch, is one hundred and fifty-one thousand, two hundred pounds (151,200 lbs.), and the coefficient of strength for the unit of one pound, in the said beam, is therefore, nine thousand, three hundred and thirty-three pounds (9,333 lbs.), the quotient obtained by dividing 151,200 lbs. by the number of pounds (16.2) per running foot in the beam, and the quotient, obtained by dividing the coefficient of strength for the unit of one pound (9,333 lbs.) by the number of inches that the beam is high (8) is eleven hundred and sixty-six pounds (1166 lbs.) which is the coefficient of strength, in the beam M, per unit of one pound, for every inch of the height of the beam, and a load which, when evenly distributed, the said beam can safely carry per pound of a span for which the said beam is designed, instead of ten hundred and fifty-four pounds (1054 lbs.) which is the greatest load which any heretofore made solid rolled beam of the same height can safely carry, per pound of material, on a corresponding span.

N, in Fig. 2, represents a standard solid rolled "eight-inch" I-beam of the prior state of the art. The beam N weighs eighteen pounds (18 lbs.) per running foot. The thickness of each flange of the beam N is somewhat over fifty-eight hundredths of an inch (.58″) at the root of the flange and twenty-seven hundredths of an inch (27″) at the longitudinal edge of the flange, so that the said flange has a mean thickness of four hundred and twenty-five thousandths of an inch (.425″). The web of the beam N has a thickness of twenty-seven hundredths of an inch (.27″). Hence each flange of the beam N has a mean thickness of approximately one and fifty-seven-hundredths (1.57) times the thickness of the web. The coefficient of strength in the beam N, for a fiber stress of sixteen thousand (16,000) pounds, per square inch, is one hundred and fifty-one thousand, seven hundred (151,700) pounds, and obviously the coefficient of strength for the unit of one pound, in the said beam, is eight thousand, four hundred and twenty-seven (8,427) pounds, or ten hundred and fifty-four (1054) pounds for every inch of height of the beam. The beam N has a width of four inches (4″) or fifty per cent. of the height of the beam. That is, the said beam measures four inches (4″) straight across the outer sides of adjacent oppositely projecting flanges of the beam. The width of the beam N is obviously less than ten times the mean thickness of the flanges of the beam, and the taper of the inner sides of the said flanges is sixteen (16) per cent.

O, in Fig. 3, represents a cross-sectionally I-shaped blank especially suited for use in the production of my improved solid rolled "eight-inch" I-beam illustrated in Fig. 1. The blank O measures in height somewhat over fourteen inches (14″) and has a width of,—that is, measures straight across the outer sides of adjacent oppositely projecting flanges,—five inches and seven-tenths of an inch (5.7″). The mean thickness of each flange of the blank O is three inches and thirty-five hundredths of an inch (3.35″) and the thickness of the web of the blank is one inch and eight-tenths of an inch (1.8″), and hence the mean thickness of the said flange is approximately one and eighty-six-hundredths (1.86) times or nearly twice as thick as the web of the blank. It will be observed, therefore, that the mean thickness of each flange of the blank O 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 M, Fig. 1, to which the said blank is to be reduced, bears to the thickness of the web of the beam.

The improved I-beam, illustrated in Fig. 1, can be readily made by providing and suitably heating the cross-sectionally I-shaped blank shown in Fig. 3, in which blank, as already indicated, the thickness of the web and the mean thickness of each flange bear to each other the same or substantially the same proportion which the mean thickness of the said flange and the thickness of the web are to bear to each other in the I-beam to which the said blank is to be reduced, and then rolling the flanges and web simultaneously in a rolling-mill and thereby reducing the mean thickness of each flange and the thickness of the web 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.

I would remark that my 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 a solid rolled "eight-inch" I-beam, and that my improved solid rolled "eight-inch" I-beam has no more material in its web than actually needed, and obviously considerably less material than the solid rolled I-beam of the same height in the prior state of the art.

In attempting to design an I-beam the result is always a compromise between an ideal that exists in the mind of the theorist and the practical possibility that can be attained in the manufacture of the beam. 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 the 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 of gravity of section, from top to 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. I would remark, also, that to make a solid rolled "eight-inch" I-beam, which shall be equally strong to resist bending under a load and avoid buckling of the web, for a certain length of span hereinbefore mentioned, is the object I aim at in producing my improved solid rolled "eight-inch" I-beam hereinbefore described; that a consideration of the possibility to commercially produce and my study of what is most desirable in a solid rolled "eight-inch" I-beam, have resulted in my inventing such a proportion, in a solid rolled "eight-inch" I-beam, between the thickness of the web and the mean thickness of the flanges, and between the mean thickness of the flanges and the width of the flanges, as to produce my improved solid rolled "eight-inch" I-beam, which when used as a girder or joist, is, with ten per cent. less material in it, equal in load-carrying capacity to the solid rolled "eight-inch" I-beam of the prior state of the art.

What I claim is:—

1. As a new article of manufacture, a solid rolled I-beam eight inches or over in height and the ratio of the width of the flanges to the thickness of the web is not less than twenty-two.

2. As a new article of manufacture, a solid rolled I-beam, the height of which is eight inches or over, and the ratio of the width of the flanges to the thickness of the web is not less than twenty two, the said width of flanges being substantially 5.18 inches and the said thickness of web being substantially .18 of an inch.

3. As a new article of manufacture, a solid rolled I-beam the width of the flanges of which is not less than fifteen (15) 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,
Victor C. Lynch.