

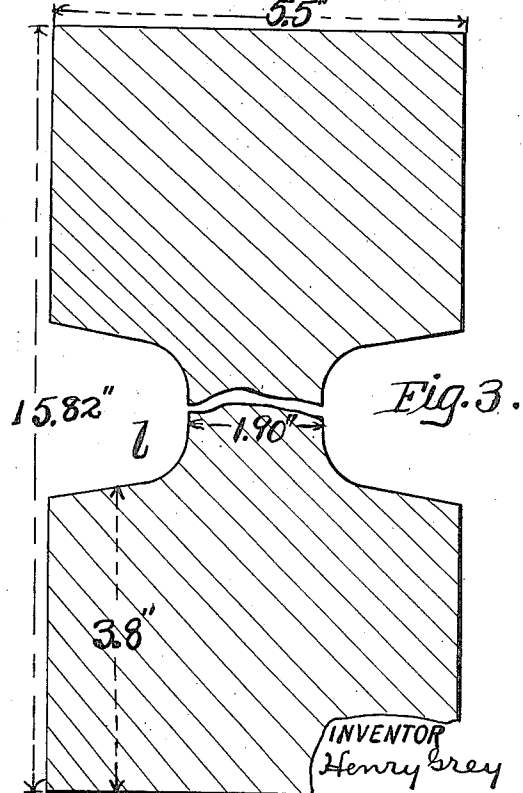
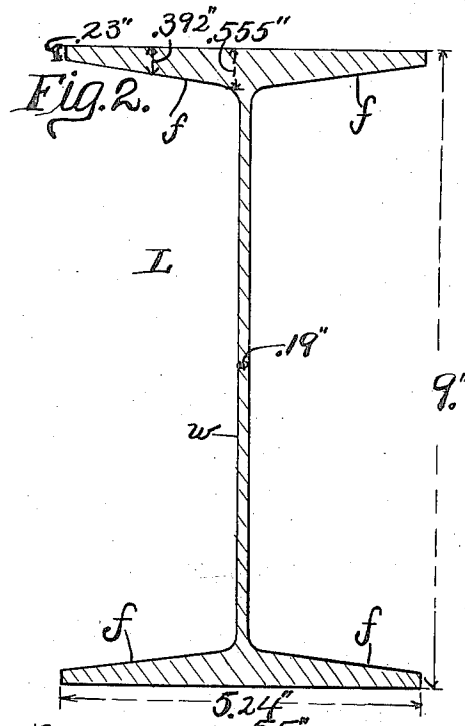
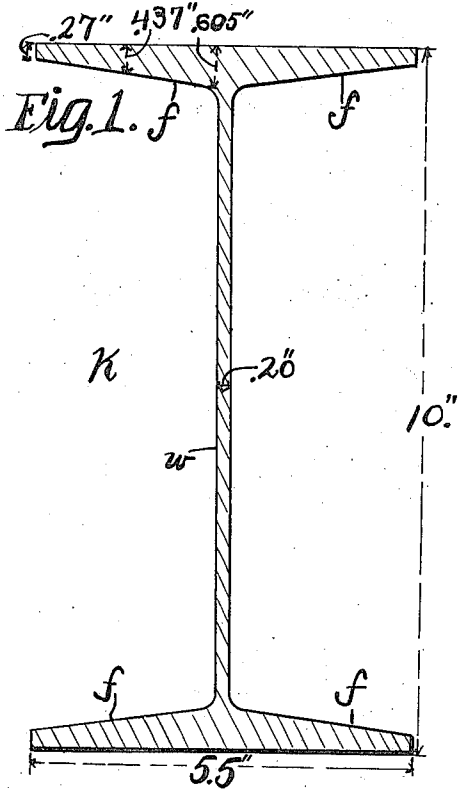
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SOLID ROLLED METAL I-BEAM OF NINE INCHES AND UNDER TWELVE INCHES IN HEIGHT.

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1,013,649.

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WITNESSES:

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UNITED STATES PATENT OFFICE.

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SOLID ROLLED METAL I-BEAM OF NINE INCHES AND UNDER TWELVE INCHES IN HEIGHT.

1,013,649.

Specification of Letters Patent.

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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 Nine Inches and Under Twelve 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 I-beams measuring over eight inches and under twelve inches in height.

The general object of this invention is to produce improved solid rolled steel or iron I-beams not less than nine inches in height and less than twelve inches, and capable of safely carrying on any span whose length in feet is equal 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 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.

The object of this invention, more specifically stated, is to produce solid rolled I-beams not less than nine inches and under twelve inches in height, which are capable of safely carrying, on all 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 any 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 a 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 limita-

tion, a larger load to the unit of weight in the said beam than can be carried by any heretofore produced solid rolled I-beams 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 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 over twelve times the mean thickness of the flanges of the beam.

With these objects in view, this invention consists more especially in the production of solid rolled I-beams having a height over eight inches and under twelve inches, and 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 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, exceeds ten hundred and eighty pounds (1080 lbs.) for every inch of height of the beam.

In the accompanying drawings, Figures 1 and 2 are cross-sectional views of solid rolled I-beams embodying my invention and having a height of ten inches and nine inches respectively. Fig. 3 is a cross-sectional view of a rough beam or blank suitable for use in the manufacture of the solid rolled "nine-inch" beam shown in Fig. 2. Portions are broken away in Fig. 3 to reduce the size of the drawing.

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

K designates the solid rolled I-beam illustrated in Fig. 1. The beam K has a height of ten inches, as already indicated,—that is, measures ten inches (10") between the outer sides of the flanges formed at one and the same side of the web of the beam. The beam K has a width of five and one-half inches (5.5"),—that is, measures five and one-half inches (5.5") between the longitudinal edges of adjacent oppositely projecting flanges *f* of the beam. The thickness of

each flange f of the beam K is six hundred and five thousandths of an inch (.605") at the root of the flange and twenty-seven hundredths of an inch (.27") at the longitudinal edge of the flange, so that the mean thickness of each flange of the said beam is somewhat over four hundred and thirty-seven thousandths of an inch (.437") and somewhat over two and eighteen-hundredths (2.18) times or about two and two-tenths (2.2) times the thickness of the web of the beam, which last-mentioned thickness is twenty hundredths of an inch (.20"). The taper of the inner sides of the flanges of the beam K is, therefore, twelve and one-half (12.5) per cent. It will be observed, also, that the width of the beam K is somewhat over twelve and one-half times the mean thickness of the flanges. The weight of the beam K, per running foot, is twenty-two and one-half pounds (22.5 lbs.). The coefficient of strength in the beam K, for a fiber stress of sixteen thousand pounds (16,000 lbs.) per square inch, is two hundred and sixty thousand, three hundred pounds (260,300 lbs.), and the coefficient of strength, for the unit of one pound, in the said beam, is, therefore, eleven thousand, five hundred and sixty-eight pounds (11,568 lbs.), and the quotient obtained by dividing 260,300 lbs. by the number of pounds (22.5) per running foot in the beam. The quotient obtained by dividing the coefficient of strength for the unit of one pound (11,568 lbs.), by the number of inches that the beam is high (10), is eleven hundred and fifty-six pounds (1156 lbs.) which is the coefficient of strength, in the beam K, per unit of one pound, for every inch of the height of the beam, and a load which, when evenly distributed, the beam K can safely carry, per pound, on a span within the hereinbefore mentioned limitation, instead of ten hundred and forty-two pounds (1042 lbs.) which is the greatest load which any heretofore made solid rolled beam of the same height can safely carry, per unit of weight, on a corresponding span.

L, in Fig. 2, designates a solid rolled I-beam embodying my invention, and having a height of nine inches, as already indicated,—that is, measuring nine inches (9") between the outer sides of the flanges formed at one and the same side of the web of the beam. The beam L has a width of five inches and twenty-four hundredths of an inch (5.24"),—that is, measures five inches and twenty-four hundredths of an inch (5.24") between the longitudinal edges of adjacent oppositely projecting flanges f of the beam. The thickness of each flange f of the beam L is five hundred and fifty-five thousandths of an inch (.555") at the root of the flange and twenty-three hundredths of an inch (.23") at the longitudinal edge of the flange, so that the mean thickness of

each flange of the said beam is approximately thirty-nine hundredths of an inch (.39") and about twice the thickness of the web w of the beam, which last-mentioned thickness is nineteen hundredths of an inch (.19"). The taper of the inner sides of the flanges of the beam L is obviously twelve and one-half (12.5) per cent. It will be observed, also, that the width of the beam L is over thirteen times the mean thickness of the flanges of the beam. The weight of the beam L, per running foot, is eighteen pounds and nine-tenths of a pound (18.9 lbs.). The coefficient of strength in the beam L for a fiber stress of sixteen thousand pounds (16,000 lbs.), per square inch, is two hundred and one thousand (201,000) pounds, and the coefficient of strength, for the unit of one pound, in the said beam, is therefore, ten thousand, six hundred and thirty-four pounds (10,634 lbs.), the quotient obtained by dividing 201,000 lbs. by the number of pounds (18.9), per running foot in the beam, and the quotient, obtained by dividing the coefficient of strength for the unit of one pound (10,634 lbs.) by the number of inches that the beam is high (9), is eleven hundred and eighty-one pounds (1181 lbs.) which is the coefficient of strength, in the beam L, per unit of one pound, for every inch of the height of the beam, and a load which, when evenly distributed, the beam L can safely carry, per pound, on a span for which the said beam is designed, instead of ten hundred and sixty-three pounds (1063 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.

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 and configuration cross-sectionally that the thickness of the web of the blank and the mean thickness of each flange of the blank correspond or approximately correspond, in their proportion to each other, with the proportion which the mean thickness of the said flange and 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 1, in Fig. 3, represents a

cross-sectionally I-shaped blank especially suitable for use in the production of the improved solid rolled "nine-inch" I-beam L illustrated in Fig. 2. The blank l measures, in height, fifteen inches and eighty-two hundredths of an inch (15.82"),—that is, measures fifteen inches and eighty-two hundredths of an inch (15.82") between the outer sides of the flanges at one end and the same side of the web of the blank. The blank l has a width of five and one-half inches (5.5"),—that is, measures five and one-half inches (5.5") straight across the outer sides of adjacent oppositely projecting flanges of the blank. The mean thickness of each flange of the blank l is three inches and eight-tenths of an inch (3.8"), and the thickness of the web of the blank is one inch and nine-tenths of an inch (1.9"), 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 l 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 formed and as it is to exist in the beam L, Fig. 2, to which the said blank is to be reduced, bears to the thickness of the web of the said beam.

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 the solid rolled I-beams of a height of eight and under twelve inches, and that my improved beams have no more material in their webs than actually needed, but obviously considerably less material than solid rolled 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.—

$$I = \frac{1}{12} \text{ of } \left[b d^3 - \frac{1}{4} (h^4 - l^4) \right]$$

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;

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

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 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 I-beam having a height of eight inches, nine inches or ten inches, 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 I-beams hereinbefore described; that a consideration of the possibility to commercially produce any given I-beam, and my study of what is most desirable in solid rolled I-beams having a height of eight and under twelve inches, have resulted in my inventing such a proportion, in the said beams, 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 enable me to produce solid rolled I-beams having a height not less than nine inches, which, when used as girders or joists, are, with ten per cent. less material in them, equal in load-carrying capacity to the solid rolled I-beams of the same height in the prior state of the art.

What I claim is:—

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

2. As a new article of manufacture, a solid rolled I-beam the width of the flanges of which is substantially five and one-half inches ($5\frac{1}{2}$) and the mean thickness of which flanges is substantially one-twelfth ($\frac{1}{12}$) of their width.

3. As a new article of manufacture, a solid rolled I-beam the height of which is over nine inches but under twelve inches, the ratio of the width of the flanges to the thickness of the web being not under twenty-two.

4. As a new article of manufacture, a solid rolled I-beam, the height of which is not less than nine inches, and the width of

the flanges of which is substantially 5.5 inches, and the thickness of the web of which is .2 of an inch.

5 As a new article of manufacture, a solid rolled steel I-beam, the height of which is not less than nine inches, the width of the flanges of which is substantially 5.5 inches, the thickness of the web of which is substantially .2 of an inch, and mean thickness

of the flanges of which is substantially .437 10 of an inch.

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

HENRY GREY.

Witnesses:

C. H. DORER,
G. M. HAYES.