No. 758,529. PATENTED APR. 26, 1904.

H. GREY.

MANUFACTURE OF FLANGED METAL BARS OR BEAMS AND STRUCTURAL WORK.

APPLICATION FILED SEPT. 29, 1902.

NO MODEL. 3 SHEETS—SHEET 1.

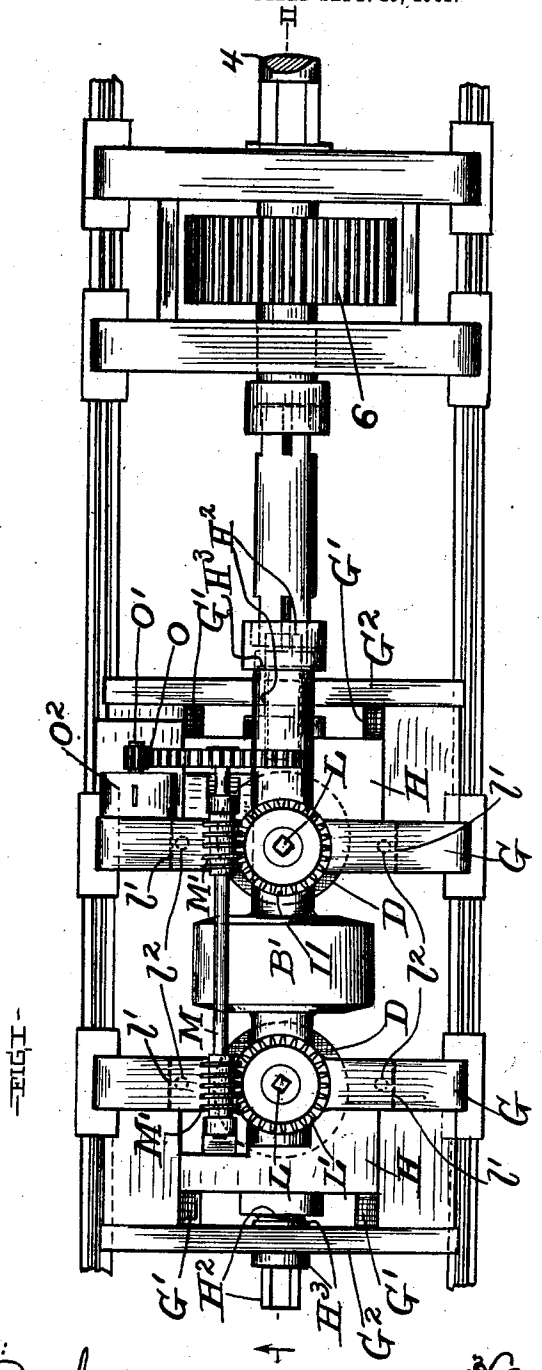

FIG. 1.

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Tilsa Schwartz.

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Synnestvedt & Lechner
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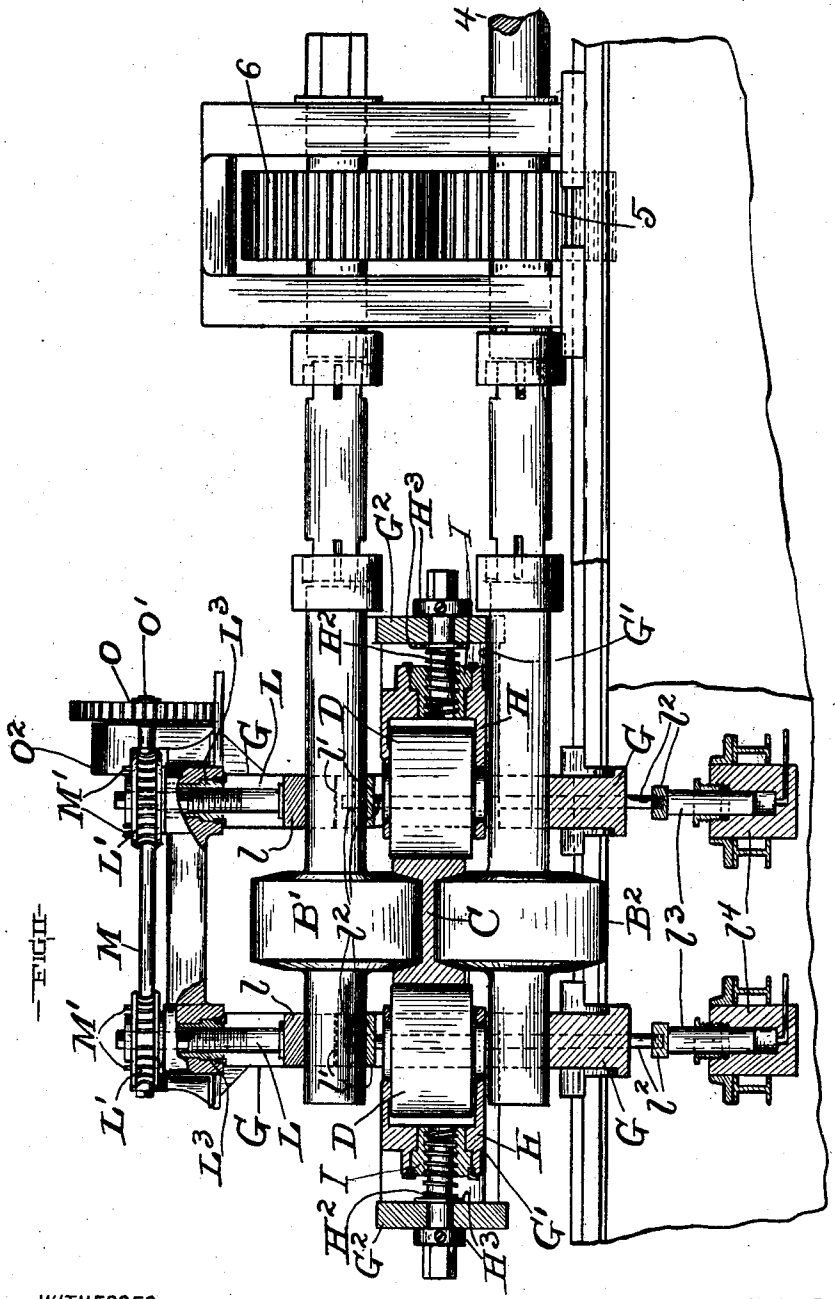
NO MODEL. 3 SHEETS—SHEET 2.



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NO MODEL. 3 SHEETS—SHEET 3.

FIG. X.

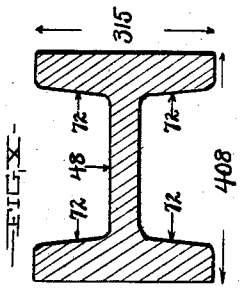


FIG. XI.

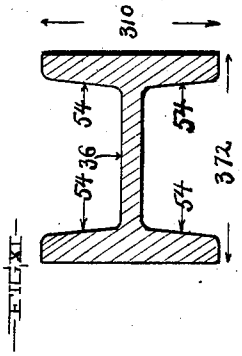


FIG. XII.

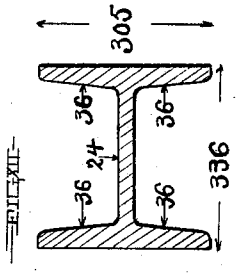


FIG. IV.

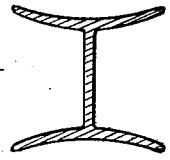


FIG. VIII.

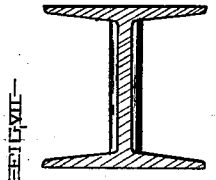


FIG. VIII.

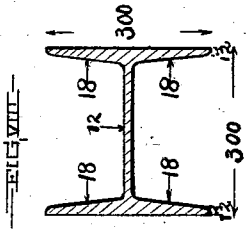


FIG. III.

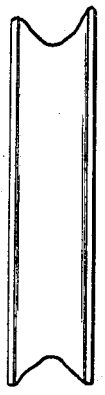


FIG. V.

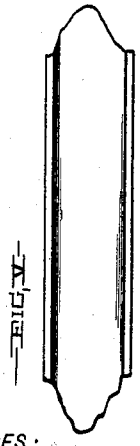


FIG. XI.

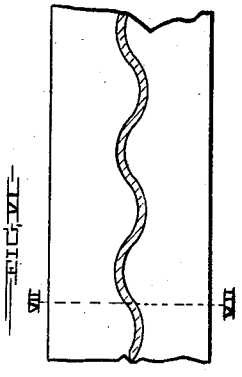
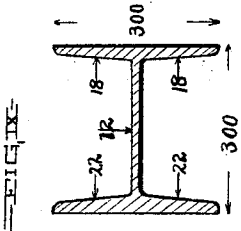


FIG. IX.



WITNESSES:

Daniel E Daly

Telsa Schwartz

INVENTOR

Henry Grey

BY

Synnestvedt & Lechner

ATTORNEYS

No. 758,529. Patented April 26, 1904.

UNITED STATES PATENT OFFICE.

HENRY GREY, OF NEW YORK, N. Y., ASSIGNOR TO AMERICAN UNIVERSAL MILL COMPANY, OF NEW YORK, N. Y., A CORPORATION OF WEST VIRGINIA.

MANUFACTURE OF FLANGED METAL BARS OR BEAMS AND STRUCTURAL WORK.

SPECIFICATION forming part of Letters Patent No. 758,529, dated April 26, 1904.

Application filed September 29, 1902. Serial No. 125,316. (No model.)

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, in the county of New York and State of New York, have invented certain new and useful Improvements in the Manufacture of Flanged Metal Bars or Beams and Structural Work Generally; 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.

My invention relates to improvements in the manufacture of a steel or iron beam, girder, bar, or other structural piece or section having a head or flange or heads or flanges, and pertains more especially to improvements in producing an I-beam or bar or section having a web between two heads or flanges and rolled in a mill, which comprises, first, two horizontal rolls arranged in the same vertical plane and transversely of and next to the path of the blank to be operated upon in position to operate upon the upper side and lower side, respectively, of the web of the blank, and upon the inner sides of the flanges or heads of the blank, with one of the said rolls, and preferably the top roll, adjustable vertically toward and from the other roll, and, second, two vertical or upright side rolls arranged in the aforesaid vertical plane and next to and in position to operate upon the outer sides of the heads or flanges of the blank and adjustable apart.

In the manufacture of a flanged bar or beam, and more especially in making a product having very broad flanges, it is very desirable that the elongation of the flanges be made at an equal rate with the elongation of the web. Otherwise latent strains are developed by the undue reduction and elongation of one part of the product, causing either a stretching action or fracture in the flanges or buckling in the web, and thus creating strains and faults or imperfections that materially reduce or impair the value of the product.

The object of this invention is to effect such a distribution of the metal in the reduction of the blank during each successive pass of the blank or work through the mill that both the web and the flanges or heads, whether the latter are even or not, shall be elongated at the same rate and escape the undue strains which result in imperfections formed in the finished product when the several parts of the blank or work, web, and heads or flanges have not had the proper proportionate reduction during each and every pass made by the work through the mill. With this object in view in a mill of the character indicated I provide a blank with web and flanges, the thickness of the web of which bears the same relation to the mean thickness of each of the flanges that these respective dimensions bear to each other in the finished beam. Preparatory to each passage of the blank or work through the mill the top web-reducing roll is moved inwardly, so as to reduce the space between itself and the bottom roll a distance which bears to the distance which each flange-reducing side roll is shifted inwardly, or approximately, the ratio which the thickness of the web of the finished bar, beam, or product bears to the thickness of the finished flange or head whose outer side was rolled by the said side roll. In other words, I shift each of the side rolls during a readjustment of all of the adjustable rolls preparatory to each pass of the blank or work through the mill inwardly or toward each other a distance which bears to the distance which the top roll is lowered the same or approximately the same ratio which the mean thickness of the heads or flanges of the finished product bears to the thickness of the web of the said product, so that the creation of undue strains during the reduction of the blank or work is impossible. The aforesaid adjustment insures an even elongation of all of the parts of the section or product in process of manufacture. If the flange or flanges operated upon by one of the side rolls differ in thickness from the flange or flanges operated upon by the other side roll, the two side rolls are obviously not shifted the same distance during their adjustment; but the distance which each side roll is shifted

inwardly always bears to the distance which the top roll is lowered the same or approximately same ratio which the mean thickness of the finished flange whose outer side was rolled by the said side roll bears to the thickness of the web of the finished product.

In the accompanying drawings, Figure I is a top plan of a portion of a rolling-mill suitable for use in carrying out my improved process. Fig. II is an elevation, largely in section, on line II II, Fig. I, looking in the direction indicated by the arrow. Fig. III is a side view of an imperfect beam or bar having unduly-elongated flanges. Fig. IV is a cross-section of an imperfect bar or beam having bent flanges. Fig. V is a side view of an imperfect beam or bar having an unduly elongated web. Fig. VI is a side view, in longitudinal section, of an imperfect bar or beam having a web which is buckled up. Fig. VII is a cross-section on line VII VII, Fig. VI. Fig. VIII is a cross-section of a perfect bar or beam having flanges which correspond in thickness. Fig. IX is a cross-section of a perfect beam or bar having flanges which differ in thickness. Figs. X, XI, and XII are cross-sections illustrating different phases of a blank or work from which the product illustrated in Fig. VIII results.

A rolling-mill suitable for use in making an I-beam or flanged bar by my improved process is illustrated in Figs. I and II and comprises an upper horizontal roll B′, a lower horizontal roll B^2, and two vertical side rolls D and D, arranged at opposite ends, respectively, of the said horizontal rolls and centrally between the axes of the said horizontal rolls. The roll B′ is arranged next above and transversely of the upper side of the path of the blank or work in position to operate upon the upper side of the web of the blank or work and upon the inner sides of the work's flanges or heads above the web. The roll B^2 is arranged next below and transversely of the path of the work in position to operate upon the lower side of the web and upon the inner sides of the heads or flanges below the web. The two side rolls D and D are arranged at opposite sides, respectively, of the path of the blank or work in position to operate upon the outer side of the adjacent flange or head of the work.

The blank or work C is shown in position in Fig. II.

The rolls B′ and B^2 are practically of the same diameter and rotated in opposite directions, respectively, and the blank or work is given as many passes through the mill as are required to complete the rolling or shaping of the work, and the blank is of course suitably heated preparatory to its introduction into the mill and fed with its web arranged horizontally.

An engine-shaft 4 (see Fig. II) is operatively provided with a gear 5, which is operatively connected in any suitable manner with a neck or trunnion of the bottom web-reducing roll B^2. The gear 5 meshes with a diametrically-corresponding gear 6, which is operatively connected in any approved manner with the adjacent trunnion of the top web-reducing roll B′.

The bottom roll B^2 is suitably supported from the two housings G and G, which are arranged a suitable distance apart at opposite sides, respectively, of and a suitable distance from the path of the blank or work.

The top web-reducing roll B′ is adjustable vertically, and the side rolls D D are adjustable apart. It is obvious that the said rolls B′ D D are at the commencement of the operation of the mill set as required for the first pass of the heated blank.

The adjustment of the rolls B′ D D relative to the path of the blank or work is effected simultaneously, and the side rolls D D in adjusting them apart simultaneously with the adjustment of the top roll are moved to effect the adjustments hereinbefore indicated.

One of the objects of shifting the side rolls during their adjustment toward each other a greater distance than the distance which the space between the horizontal rolls is shortened during the adjustment of the horizontal rolls is to reduce the flanges at the edges proportionately faster than the web in order to make up for the much slower rate of delivery at the points of the horizontal rolls from which the edges of the flanges are delivered as compared with the rate of delivery at those parts of the horizontal rolls at which the web is delivered and to avoid long crop ends and torn or cracked flange edges; but, furthermore, I have found after much costly experimenting that when the web and each flange of the blank are so relatively and simultaneously reduced during each work-reducing pass of the blank the extent to which the mean thickness of each flange is reduced during the said pass shall not only exceed the extent to which the thickness of the web is reduced during the said pass, but shall bear to the extent to which the thickness of the web is reduced during the said pass the same or approximately same ratio which the said flange when finished and as it appears in the finished product bears to the thickness of the web of the said product the liability of the presence of any imperfections, latent, as well as visible, in the finished product is reduced to a mimimum, and the product is uniform in strength throughout the flanges and web. More especially is my process invaluable in rolling a blank into a finished bar or beam whose web has a thickness of not more than two-thirds of the mean thickness of any flange of the product. For instance, for a product having a web which has a thickness of twelve millimeters and flanges having, respectively, a mean thickness of eighteen milli-

meters, as shown in Fig. VIII, each side roll D during each relative readjustment of the rolls of the mill employed in rolling the said product would by my improved process be shifted inwardly fifty per cent. farther than the distance which the space between the horizontal rolls would be shortened during the approach of the top horizontal roll toward the bottom horizontal roll.

Each housing G near its lower end, adjacent to the adjacent trunnion of the bottom reducing-roll B^2, is provided with brackets G', which form a slideway for and support the slide H, which carries one of the side rolls D. Both slides H H are adjustable toward or from each other, and the two rolls D D are therefore adjustable apart. Each slide H is operatively connected at its central portion with a screw H^2, which is arranged parallel with the travel of the said slide and engages a correspondingly-threaded nut I, rigidly secured to the slide.

Each slide-operating screw H^2 extends from the connected slide H outwardly through a beam or bar G^2, which is secured to the housing which supports the said slide. Two collars H^3 and H^3, which are fixed or formed upon the screw at opposite sides, respectively, of the said bar or beam G^2, prevent endwise movement of the screw during the rotation of the screw.

It is obvious that each slide H and the roll D, supported thereby, are adjusted toward or from the path of the blank or work according as the connected screw H^2 is turned in the one direction or the other. The screws H^2 are manipulated in adjusting the slides H apart by wrenches, wheels, or levers to be applied to the outer ends of the said screws; but the screw-turning mechanisms forming no part of the subject-matter of this application and being well known in the art are not illustrated and described in this application.

Two upright screws L L engage correspondingly-threaded nuts L^3, fixed or formed in the tops of the housings G G, as shown in Fig. II. Saddles l are interposed between the lower ends of said screws and the trunnions of the top roll B', which trunnions have bearing in boxes l', which rest upon vertically-movable frames or structures l^2, engaged and held in the desired adjustment by the pistons l^3 of hydraulic cylinders l^4, and thereby supporting the roll at the desired elevation controlled by the screws L.

The mechanism employed for rotating the screws L is shown to be as follows: Upon the upper end or portion of each screw L is operatively mounted a worm-wheel L', which meshes with a worm M', formed upon a suitably-supported horizontally-arranged shaft M, which is arranged at the top of and above the housings G. The upper ends of the screws L are angular in cross-section and extend through corresponding holes in the central portions of the engaging wheels L', so that the said screws can move endwise without interrupting operative connection between them and the said wheels. The shaft M is suitably driven in the one direction or the other, according as the screws L, and consequently the top roll B', are to be elevated or lowered. The shaft M is intergeared at one end, as at o, with the shaft o' of an engine or motor o^2, which is only diagrammatically shown. Mechanisms suitable for operating screws and for regulating the endwise movement of the screws during their rotation are not claimed in this application, and therefore need not be further illustrated or described in this application.

Bottom and top guides (not shown) and side guides (not shown) for preventing displacement of the blank or work during the passes of the latter through the mill should be provided; but such guides form no part of the present invention and are not shown in this application being illustrated and described in United States Letters Patent No. 632,181, granted to me October 24, 1899.

It is obvious that, as already indicated, the top web-reducing roll B' and with it the flange-reducing side rolls D D are set relative to the path of the heated blank preparatory to the first pass of the blank through the mill, as required, to form the largest work-receiving passage between the rolls during the reduction of the said blank, and the said passage is rendered smaller preparatory to each successive pass of the work and the rolls after the work has had its finishing pass are again adjusted to enlarge the work-receiving passage between them, as required, for another blank.

It will be observed that preparatory to the first pass of the heated blank through the mill in carrying out my improved process the top roll B' is so set relative to the bottom roll B^2 and the side rolls D D are adjusted apart such a distance relative to the top and bottom rolls that the distance between the top roll and the bottom roll bears to the mean distance between each side roll and the opposing flange-reducing surface of the top and bottom rolls the same or approximately same ratio which the thickness of the web of the finished beam or product bears to the mean thickness of the finished flange whose outer side was rolled by the said side roll.

In making a beam or bar having flanges corresponding in thickness, as illustrated in Figs. VIII, X, XI, and XII, the side rolls D D are correspondingly adjusted relative to the opposing flange-reducing surfaces of the top and bottom rolls B' B^2. In making a beam or bar having flanges differing in thickness, as shown in Fig. IX, the adjustments of the side rolls relative to the opposing flange-reducing surfaces of the top and bottom rolls would differ. In every case, however, after the adjustable rolls have been properly set for the first pass of the heated blank through the mill ea

side roll preparatory to each and every subsequent pass of the blank or work through the mill is shifted inwardly a distance which bears to the distance which the top roll B′ is lowered the same or approximately same ratio which the mean thickness of the finished flange whose outer side was rolled by the said side roll bears to the thickness of the web of the finished beam or product.

I would here remark that in practice when the inward adjustment of each side roll D preparatory to each successive pass of the blank or work through the mill bears to the inward adjustment of the top roll B′ preparatory to the said pass a ratio much greater than the mean thickness of the finished flange whose outer side was rolled by the said side roll bears to the thickness of the web of the finished beam or product there is not only considerable difficulty in obtaining an absolute width and regularity in width of the flanges on account of the undue spread of the same, but the flanges are unduly elongated, and the undue elongation of the flanges beyond the web, as shown in Fig. III, drags on the web, and thus creates strains where the flanges adjoin the web, and consequently reduces the strength of the finished beam or product and at the same time increases the amount of scrap. These objectionable results under the imperfect condition of affairs mentioned indicate also an undue spread of the metal, because the reduction of the flanges, which are reduced faster than the web, is retarded by the slower reduction of the web, and the metal, being compressed between the side rolls D and the flange-reducing surfaces of the top and bottom rolls B′ B^2 and being prevented more or less from properly elongating, escapes where and how it can—namely, widthwise of the flanges. If, then, supplementary rolls (not shown) for regulating the width of the flanges by only operating on the edges of the flanges are employed, said supplementary rolls having more work than the work for which they are intended will bend the flanges laterally and outwardly, as shown in Fig. IV, when the blank or work is getting cold, thin, or nearly finished rather than reduce the flanges in width. Obviously when the work having said bent flanges passes between the main rolls B′ B^2 D D the flanges are straightened; but the flanges are then left too wide, and the resulting product is irregular, which materially affects the salability and value of the product. If, on the other hand, the distance which each side roll D is shifted inwardly preparatory to each pass of the blank or work through the mill bears to the distance which the top roll B′ is lowered, a ratio materially less than the mean thickness of the finished flange whose outer side was rolled by the said roll bears to the thickness of the web of the finished beam or product, then the flanges will be narrow or of abnormal dimensions and the web will be unduly elongated, so as to form scrap, as shown in an exaggerated form in Fig. V. An undue elongation of the web has a stretching or dragging action upon the flanges, and consequently results in fracturing the flanges at their edges and sets up latent strains in the material where the web adjoins the flanges, and if the beam or product which is being made is of the broad-flanged type, so that the lengthening of the web is unable to drag the flanges, the web is largely prevented from stretching out at the ends, and the web instead of unduly elongating and forming tongues at the ends of the product, as shown in exaggerated form in Fig. V, buckles up, as shown in Figs. VI and VII, sometimes along the whole length of the product, and thereby destroys its market value, and the resulting imperfect product is entirely scrap instead of a perfect and valuable product.

The imperfections or faults exaggeratively shown in Figs. III, IV, V, VI, and VII are only illustrated to more clearly show the action of different great straining forces operating during the rolling process, so as to render evident that if the unequal straining forces are not great enough to render visible to the naked eye the presence of such unequal and latent strains still they must be present if during an inward readjustment of the rolls B′ D D between successive passes of the work the distance traveled by each side roll D bears to the distance traveled by the top wall B′ a materially greater or less ratio than the mean thickness of the finished flange rolled by the said side roll bears to the thickness of the web of the finished beam or product and being present greatly reduce the strength of the finished product.

By my improved process, involving, as already indicated, the shifting of the adjustable web-reducing roll inwardly during a readjustment of the said roll and of the flange-reducing roll arranged to operate upon the outer side of the flange whose inner side is to be operated upon by the said web-reducing roll a distance which bears to the distance of travel of the roll arranged to operate upon the outer side of the said flange the same or approximately same ratio as the thickness of the web of the finished beam or product bears to the mean thickness of the aforesaid flange in the finished product, the different parts of the blank or work during the reduction of the same are equally elongated, and undue strains are avoided, and consequently the resulting product has the maximum strength and value.

The flanged beam or bar shown in Fig. VIII and made by my improved process as carried out in the mill illustrated in Figs. I and II has flanges which correspond in thickness, and if, as indicated, the said product has a web twelve millimeters thick and each of its flanges has a mean thickness of eighteen millimeters the ratio of the travel of each side roll D to

the travel of the top roll B′ in readjusting the said rolls inwardly between successive passes of the blank or work through the mill during the manufacture of the said product corresponds to eighteen to twelve. Figs. X, XI, and XII show the blank during the reduction of the same to form the product illustrated in Fig. VIII and the ratios of the mean thickness of the flanges to the thickness of the web are represented by seventy-two to forty-eight, fifty-four to thirty-six, and thirty-six to twenty-four, respectively.

In the flanged bar or beam shown in Fig. IX one of the flanges has a mean thickness of eighteen millimeters, whereas the other flange of the product has a mean thickness of twenty-two millimeters. In this case during the inward readjustment of the rolls B′ and D D between successive passes of the blank or work through the mill during the manufacture of the said product the ratio of the distance traveled by the side roll D, arranged to operate upon the thinner flange to the distance traveled by the top roll B, is represented by eighteen to twelve, whereas the other side roll D, arranged to operate upon the thicker flange, is shifted a distance which bears to the distance which the top roll B′ is shifted the ratio of twenty-two to twelve. It will therefore be observed that by my invention the distance which each side roll D is shifted inwardly during the inward readjustment of the adjustable rolls between successive passes of the blank or work through the mill bears to the distance which the space between the web-reducing rolls B′ and B^2 is shortened the same or approximately same ratio as the mean thickness of the flange rolled by the said roll D bears to the thickness of the web after each pass of the blank or work through the mill. It will be observed also that in rolling a bar or beam having flanges differing in thickness the side roll D, employed in operating upon the thicker flange, is during an inward readjustment of the adjustable rolls between successive passes of the blank or work through the mill shifted a distance greater than the distance which the side roll D, employed to operate upon the thinner flange, is shifted.

I would have it understood that my invention broadly embraces the production of a flanged bar or beam having a web and flanges by forming in any approved manner a blank having a web and flanges and rolling the flanges and web simultaneously on opposite sides, and thereby reducing the mean thickness of each flange and the thickness of the web substantially in the proportion which the thickness of the said flange and the thickness of the web bear to each other in the blank.

What I claim is—

1. The improved process of making shapes of the class described which consists in taking a blank the thickness of the web of which bears substantially the same relation to the mean thickness of each of the flanges thereof as these respective dimensions bear to each other in the finished shape, subjecting said blank to a series of rolling operations and maintaining during said operations the aforesaid relation between the web and flanges.

2. The improved process of making shapes of the class described which consists in taking a blank the thickness of the web of which bears substantially the same relation to the mean thickness of each of the flanges thereof as these respective dimensions bear to each other in the finished shape, subjecting said blank to a series of rolling operations and maintaining during said operations the aforesaid relation between the web and flanges and also maintaining the width of the flanges substantially the same from pass to pass.

3. An improvement in the art of making a flanged bar or beam, consisting in providing a blank having a web between flanges, with the ratio which the mean thickness of each flange bears to the thickness of the web corresponding or approximately corresponding with the ratio which the mean thickness of the said flange, when finished and as it is to exist in the bar or beam to which the said blank is to be reduced, bears to the thickness of the web of the said product, and successively passing the blank between rolls arranged to operate upon opposite sides respectively of the web and upon the inner sides of the flanges and simultaneously between rolls arranged to operate upon the outer sides of the flanges; relatively readjusting the last-mentioned rolls and the first-mentioned rolls between successive passes of the blank to reduce the passage-forming space between the rolls, and, during the said readjustment, inwardly shifting each roll employed in operating upon the outer side of a flange a distance which bears, to the distance which the space between the web-reducing rolls is shortened, the same or approximately the same ratio which the mean thickness of the flange in the finished product bears to the thickness of the web of the said product.

4. The process of rolling a flanged bar or beam, having a web and flanges, consisting in forming a blank having a web and flanges, and rolling the flanges and web simultaneously on opposite sides and thereby reducing the mean thickness of each flange and the thickness of the web substantially in the proportion which the thickness of the said flange and the thickness of the web bear to each other in the blank.

In testimony whereof I sign the foregoing specification, in the presence of two witnesses, this 6th day of September, 1902, at Cleveland, Ohio.

HENRY GREY.

Witnesses:
C. H. Dorer,
Telsa Schwartz.