April 5, 1927. 1,623,273

N. C. RENDLEMAN

PROCESS OF ROLLING FLANGED BEAMS

Filed July 14, 1926 3 Sheets-Sheet 1

Fig. 2.

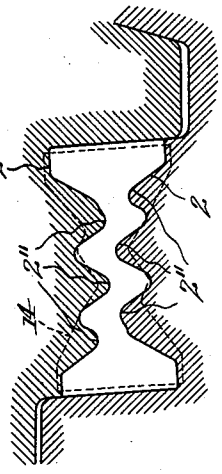


Fig. 4.

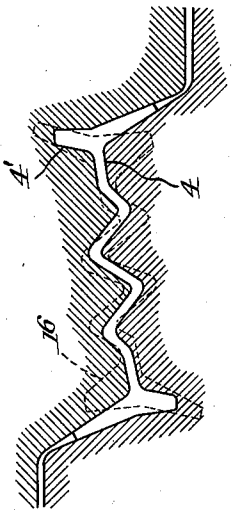


Fig. 1.

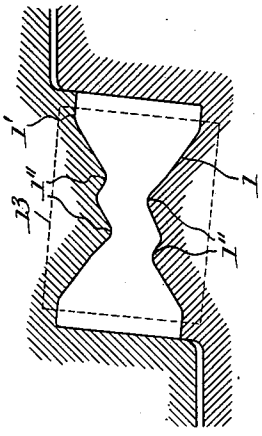
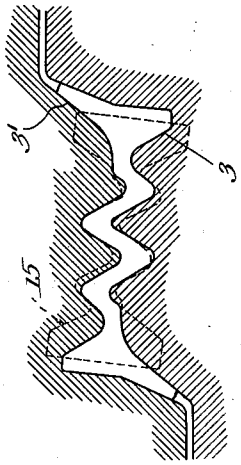


Fig. 3.



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Filed July 14. 1926 3 Sheets-Sheet 2

Fig. 6.

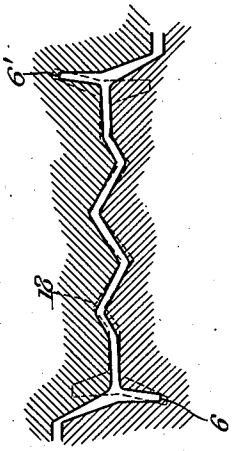


Fig. 8.

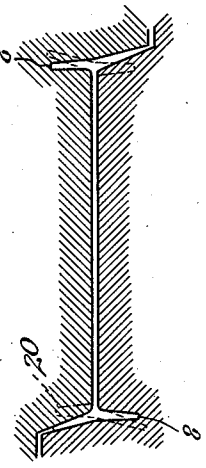


Fig. 9.

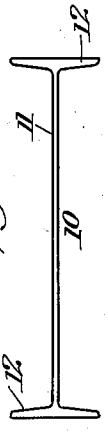


Fig. 5.

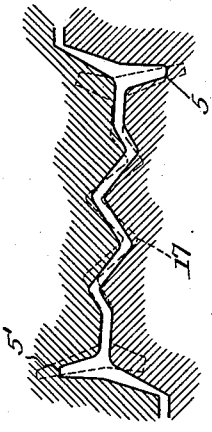
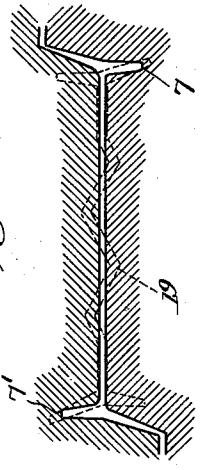


Fig. 7.



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Filed July 14, 1926 3 Sheets-Sheet 3

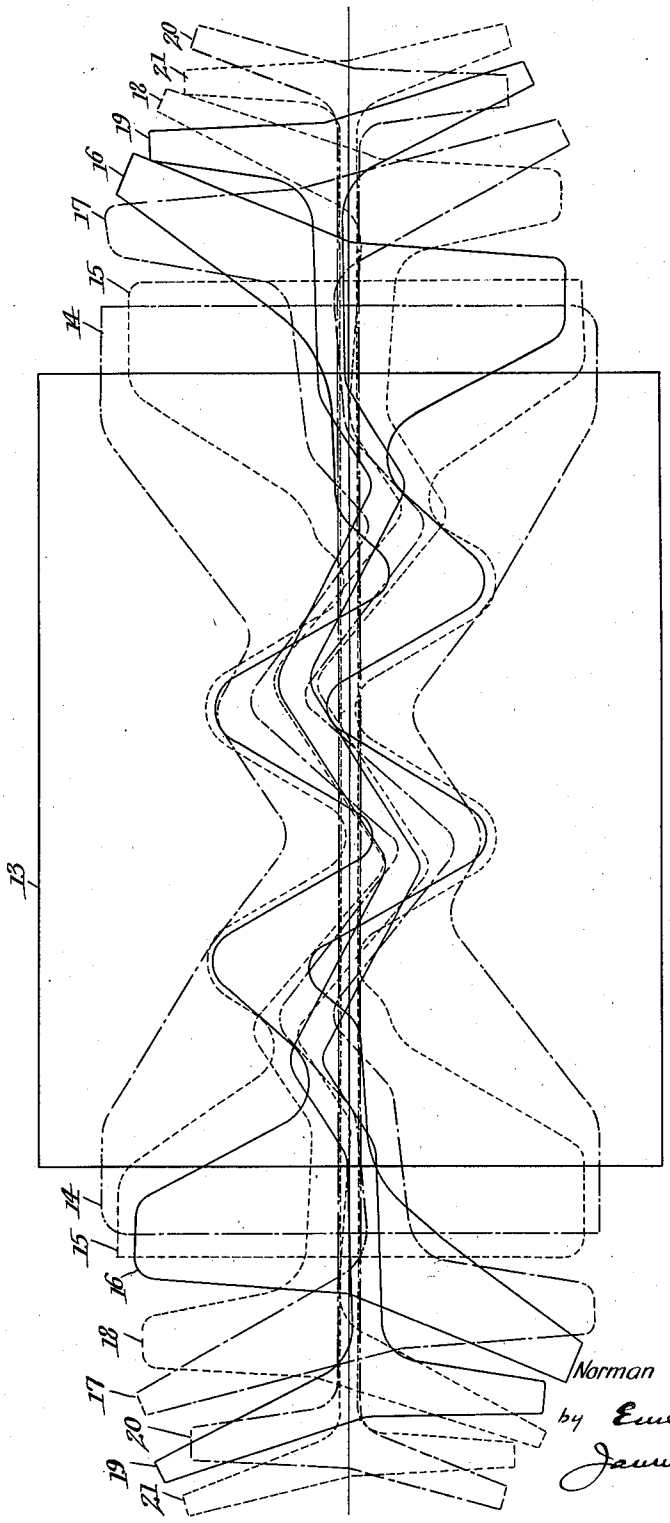


Fig. 10.

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UNITED STATES PATENT OFFICE.

NORMAN C. RENDLEMAN, OF DORMONT, PENNSYLVANIA.

PROCESS OF ROLLING FLANGED BEAMS.

Application filed July 14, 1926. Serial No. 122,373.

This invention aims to improve processes of metal rolling, and is an improvement on those described and claimed in my prior applications filed March 15, 1913, Serial No. 625,342, for manufacture of flanged beams, and July 2, 1925, Serial No. 40,861, for manufacture of flanged beams having thin webs.

It is particularly applicable to rolling flanged structural members and beams having thin webs, such as I-beams and channels, of light weight and greater depth in proportion to weight than it has heretofore been considered practicable to produce or than could be readily produced by rolling processes heretofore commonly used.

A further aim of the invention is to improve metal rolling processes whereby the necessary changes in cross-sectional shape from the billet to the finished shape may be secured in a minimum period of time and with a minimum reduction in cross-sectional area, thus enabling thin sections to be completed at one heat.

Further aims and advantages of the invention appear hereinafter in connection with the illustrative mode of practicing the invention shown in the accompanying drawings, wherein—

Figs. 1 to 8, inclusive, are vertical longitudinal sections through the bights of alining portions of the rolls of successive stands in a continuous mill;

Fig. 9 is an end view showing the outline or shape of the cross-section of the finished beam chosen for illustrating the process; and

Fig. 10 is a diagram showing the comparative shapes of the illustrative billet and blank at successive stages of the process.

In the rolling of very thin sections time is an important factor as the rolling must be completed before the termperature of the metal becomes too low. My invention enables light, thin sections to be produced at much higher rolling speed than heretofore and hence shortens the time required to the limit within which the rolling may be completed at one heat. The invention is preferably put into operation in a so-called "continuous mill", that is, one having the successive passes arranged in series in a straight line following the direction of movement of the billet or blank by providing a series of stands of two high rolls through which the billet or blank travels continuously in one direction, being engaged by two or more stands of rolls simultaneously and its speed of movement increasing as its cross-sectional area is reduced in the successive passes, the rolls being geared together or driven by motors the speed of which may be controlled to suit the speed of travel of the billet or blank as it enters each set of rolls.

For purposes of description the invention is illustrated in a suitable mode for the production of a twelve inch I-beam 10 (see Fig. 9) having a weight of about ten pounds per linear foot and of such cross-sectional shape that the thickness of the web 11 is about 1½% of the depth, and the width of the flange 12 is about 25% to 30% of the depth.

Such a beam may advantageously be rolled from an approximately square billet whose longest side is preferably about one-half the depth of the beam (see Figs. 1 and 10). In the example selected for illustration the billet 13 is about 6⅜″ by 5″ and weighs a little over one hundred pounds per foot, necessitating a reduction in cross-section and consequent elongation of about ten to one. This billet is much smaller in height and width than the blooms or billets required for producing flanged beams of the same depth by any rolling methods in use prior to my invention on which this process is an improvement (see Figs. 5 and 6 of my application Ser. No. 625,342) and hence can be rolled to finished dimensions in less time than has heretofore been possible with larger billets, and while the metal is at rolling heat.

Another advantage of my process is that the smaller billet required has sufficient length to be readily handled in the heating furnaces and on the rolling mill tables; whereas the considerably larger billets or blooms required for producing the I-beam by the "groove" process of rolling, and the equally large beam blank required for producing the I-beam by rolling in a universal mill, which were the only commercially practicable means heretofore available for rolling flanged beams, are either too short to be readily handled in the furnaces and on the tables in the first passes or else they produce too long a finished product to be completed within the time available while the metal is at a rolling heat.

In the first pass (see Fig. 1) the roll grooves 1, 1′, are similar and are provided with two laterally displaced wedge shaped

working collars 1″ to channel the billet 13 (shown in dotted lines in Fig. 1) on both sides near its mid-line and separate the edges so as to spread the blanks 20% to 30% in width, measured along the zig-zag center-line, and thin its thickness at the middle 60% to 80%, preferably with a minimum reduction in cross-sectional area. The resulting blank 14 (see Figs. 2 and 10) is rolled through a second pass having roll grooves 2, 2′, provided with three laterally displaced wedge shaped collars to spread the middle portion of the blank and form a web having lengthwise bends therein of a zig-zag cross-sectional shape, calculated to thin the middle portion 30% to 60% and to spread the flanged edges and expand the blank 40% to 50% more in width (measured along the zig-zag center line) with a minimum reduction in cross-sectional area. This rapid deformation is made possible by permitting a considerable portion of the displaced metal to flow laterally into the roll grooves between the flanges, as shown in Fig. 2, the increase in the width of the web portion thus produced being accommodated by bending it along four longitudinal lines to form two ribs or corrugations on each face, as shown in Figs. 2 and 10.

The resulting zig-zag shape blank 15 (see Figs. 3 and 10) may if preferred be successively rolled through one or more passes having similar but wider and shallower grooves with shallower longitudinal ribs or corrugations, until its width is over 95% of the depth of the finished beam and its thickness at the edges of the flanges and through the web is such that the areas of these portions exceed those of the flanges and web of the finished beam in similar proportions. In the illustrative case in the first pass the billet is spread from a 5″ by 6⅜″ rectangle to a width of 7⅜″ (about 15% increase in width) and is reduced in thickness at the middle to 1″ (a reduction of about 80%), and in the second pass the center line width is increased to 11½″ (about 15%) and the thickness is reduced to ⅝″ (about 45%), the total spreading in the two passes being about 85% and the reduction in thickness of the web being about 87½% of the original dimensions of the billet. By rolling the billet in this manner it is easier to complete the rolling of the beam in one heat because of the saving in time by the reduction in the number of passes thereby permitted.

The invention is not restricted to any particular number of passes for this widening and reducing operation, as this will necessarily be affected by the results aimed at in different cases and will depend on the condition of rolling and the products desired.

In the illustrative case, the passes succeeding the second pass (see Figs. 3 to 8) are designed to work on the diagonally opposite flanges of the blank to thin them in sets of two in alternation, at the same time separating them somewhat and reducing and widening the web to increase the depth and reduce the weight of the beam. For example, in the third pass the roll grooves 3, 3′, are designed to work the top right and bottom left hand flanges and the fourth pass has roll grooves 4, 4′, designed to work the unworked flanges in the third pass. The grooves are slightly tilted as a whole away from the working flange on each roll so as to equalize the side thrust, this tilt being greater in the earlier passes. The angle of the bends between the zig-zag portions of the web becomes less acute as the beam is widened in successive passes.

The diagonally opposite arrangement of working grooves and tilt of the principal axial plane of the blank and grooves so as to be disposed at an inclination to the axis of rotation of the rolls, permits the blank to free itself more readily from the grooves, and thus relieves the guides and strippers. This arrangement is particularly advantageous in the rolling of double flanged shapes (such as I-beams) having thin flanges, for it tends to avoid stripping the flanges from the web at high rolling speeds.

The following stands of rolls (see Figs. 5 to 8, inclusive) may be of any suitable type for reducing the blank to the desired shape for finishing, but preferably are similar to the third and fourth. As illustrated, the roll passes are intended for a continuous mill, and the roll grooves 5, 5′ and 6, 6′ are shaped so as to work upon diagonally opposite flanges of the blank in an advantageous manner to thin and separate them, the reduction in area of the flanges and web in each pass being proportional. In addition to the widening due to flattening out the zig-zag portions of the web, part of the metal of the upper right and lower left flanges of the blank 17 (as seen in Fig. 5) is displaced sidewise by the grooves 5, 5′ of the fifth pass and this increases the depth of the blank 18 therein formed; and a similar sidewise displacement of part of the metal of the opposite flanges is caused by the grooves 6, 6′ of the following pass (6th) which still further increases the depth of the blank 19 formed therein.

Similarly, the roll grooves 7, 7′ and 8, 8′ of the seventh and eighth passes, the latter of which are shown as having plain web reducing faces, may advantageously be designed to work in succession upon the pairs of diagonally opposite flanges of the blank, at the same time separating them somewhat and reducing the web in proportion to the reduction of the flanges, the grooves 7, 7′ operating on one pair of flanges to produce

the blank 20 and the grooves 8, 8′ operating upon the other pair of flanges to produce the blank 21 (see Figs. 7, 8 and 10).

Rolling the flanges in alternation in this manner puts less strain upon the adjacent ends of the web and hence contributes to the rolling of light sections having a thin web and thin flanges, and therefore is desirable, although not essential, to obtaining all the advantages of my invention.

The cross-sectional area and shape of the blank produced by the widening and reducing operations may be controlled to suit the desired finished beam so that the beam may be readily completed by a final finishing pass through a universal mill of well known construction, or by any other well known rolling mill methods of finishing such beams. Although not essential to the successful practice of the invention, it is desirable from the standpoint of cost that the various operations be performed at such speed that the billet may be broken down into a blank and rolled to the finished shape of the beam in one heat.

My inventions are the first, so far as I am aware, that enable a thin web light weight beam to be completed at one heat, thus making it practicable to produce such beams at a price that permits them to be sold in competition with wood joists and so-called metal lumber.

My inventions have the further advantage, applicable to the production of all sizes and shapes of beams and girders, channels and other rolled sections, of utilizing a narrower billet for wide and deep shapes than has heretofore been found practical, thereby not only reducing the rolling cost by lessening the reduction in area required, but also permitting the use of longer billets and thus expediting the heating and saving furnace space as well as facilitating handling in the earlier rolling operations.

It is obvious that the invention described herein is not restricted to any particular shapes or dimensions of rolled beams and structural members, nor to the use of all the steps described above in the illustrative process.

Having described an illustrative mode of practicing my invention, without limiting myself thereto, what I claim and desire to secure by Letters Patent is as follows:

1. The process of rolling flanged beams which comprises repeated grooving passes operating first upon the portion of the blank intermediate its edges to form a longitudinally corrugated web with thick edge portions, and progressively flattening out the corrugations and reducing their thickness to thin the web and spread it laterally and at the same time work the metal in the edge portions into the progressively widening web portion.

2. The process of rolling flanged beams which comprises repeated grooving passes operating first upon the portion of the blank intermediate its edges to form a longitudinally corrugated web with thicker edges, and progressively and simultaneously flattening out the corrugations and bending the edges outwardly and reducing their thickness to thin the web and spread it laterally.

3. The process of rolling flanged beams which comprises repeated grooving passes operating first upon the portion of the blank intermediate its edges to form a longitudinally corrugated web with thicker edges, and progressively flattening out the corrugations and reducing their thickness to thin the web and spread it laterally, the center line lengths of the corrugations being increased slightly and the edges thinned but not substantially narrowed in successive passes.

4. The process of rolling flanged beams which comprises repeated grooving passes operating first upon the portion of the blank intermediate its edges to form a longitudinally corrugated web with thick edge portions, and progressively flattening out the corrugations and reducing their thickness to thin the web and spread it laterally and at the same time work the metal in the edge portions into the progressively widening web portion, the center line lengths of the corrugations being increased slightly in successive passes.

5. The process of rolling flanged beams which comprises repeated grooving passes operating first upon the portion of the blank intermediate its edges to form a longitudinally corrugated web with flanges at its edges, and progressively flattening out the corrugations to spread the web laterally.

6. The process of rolling flanged beams which comprises repeated grooving passes operating first upon the portion of the blank intermediate its edges to form a longitudinally corrugated web with flanges at its edges, and progressively flattening out the corrugations to spread the web laterally, the center line lengths of the corrugations being increased slightly in successive passes.

7. The process of rolling flanged beams which comprises a series of passes through grooved rolls having collars for deeply corrugating the middle region of the billet or blank and separating the thicker margins, followed by a series of passes through grooved rolls for progressively thinning and flattening the corrugated middle portion to form a web and simultaneously reducing and separating the margins to form flanges.

8. The process of rolling flanged beams which comprises a series of passes through grooved rolls having collars for deeply corrugating the middle region of the billet

or blank and separating the thicker margins, followed by a series of passes through grooved rolls for progressively thinning and flattening the corrugated middle portion to form a web and simultaneously reducing and separating the margins to form flanges, the successive passes being grooved deeply on alternately opposite sides of each edge, and the ungrooved side of each edge being sloped off outwardly to bend and spread the corresponding marginal portion or flange sufficiently to enter the deep grooves of the succeeding pass.

In testimony whereof, I have signed my name to this specification.

NORMAN C. RENDLEMAN.