June 30, 1931. W. C. OBERG 1,812,246

METHOD OF MAKING FLANGED SHAPES

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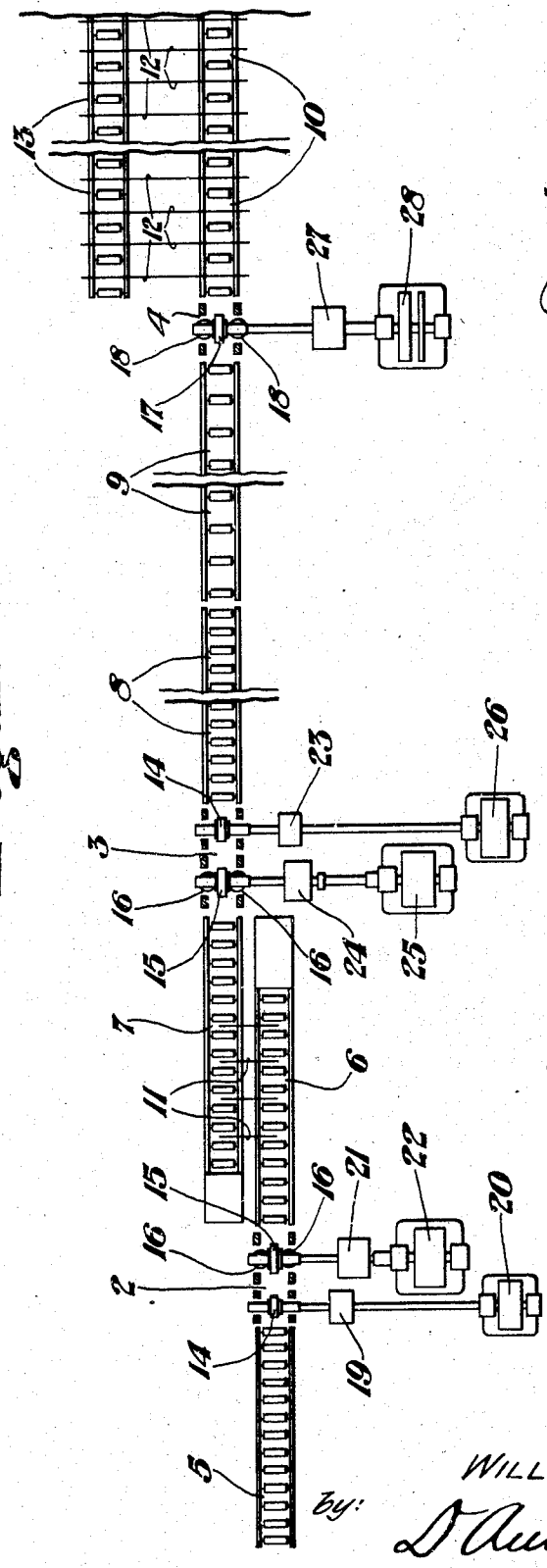


Fig. A.

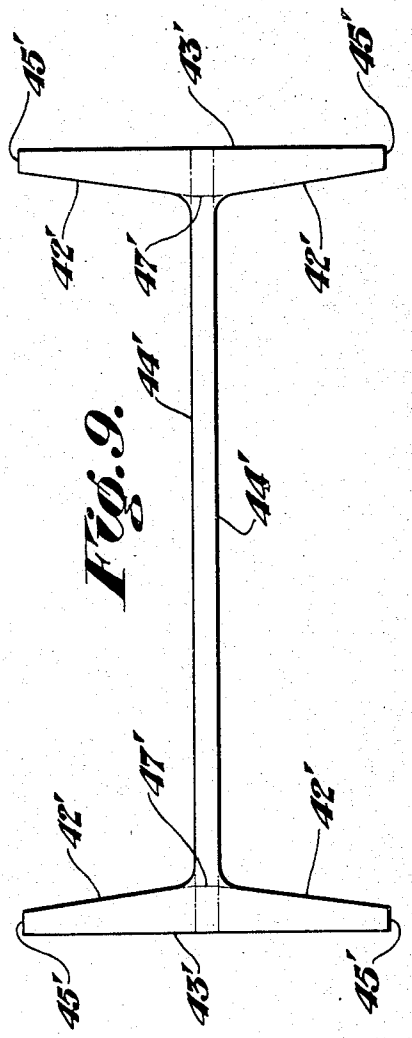


Fig. 9.

Inventor:
WILLIAM C. OBERG,
by: D'Anthony Usina
his Attorney.

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Fig. 2.

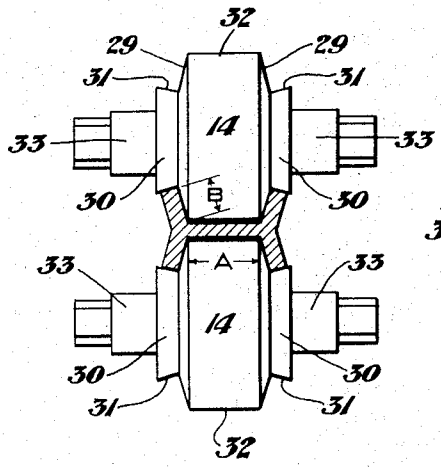


Fig. 3.

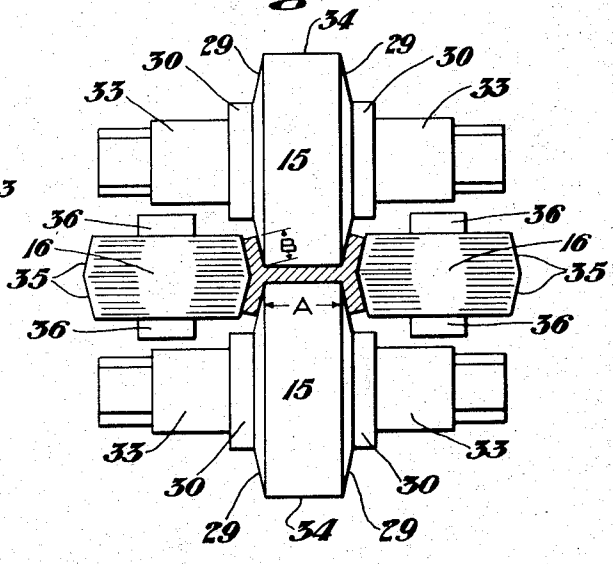
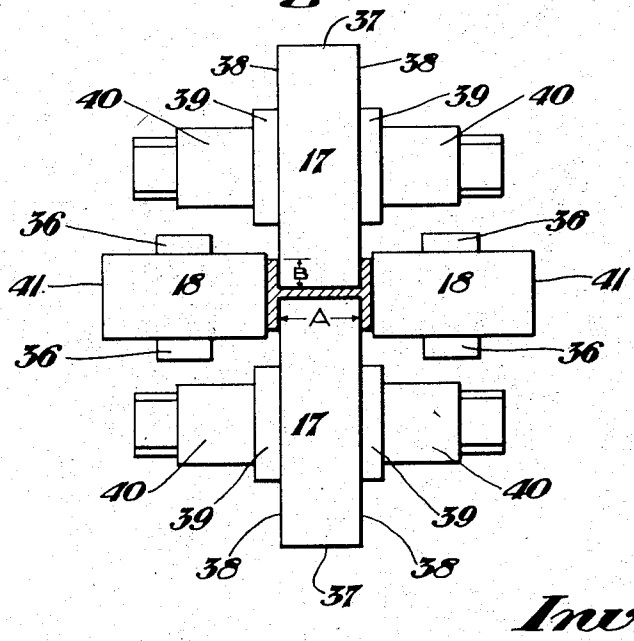


Fig. 4.



Inventor:
WILLIAM C. OBERG,
by: D. Anthony Usina
his Attorney.

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Fig. 5.

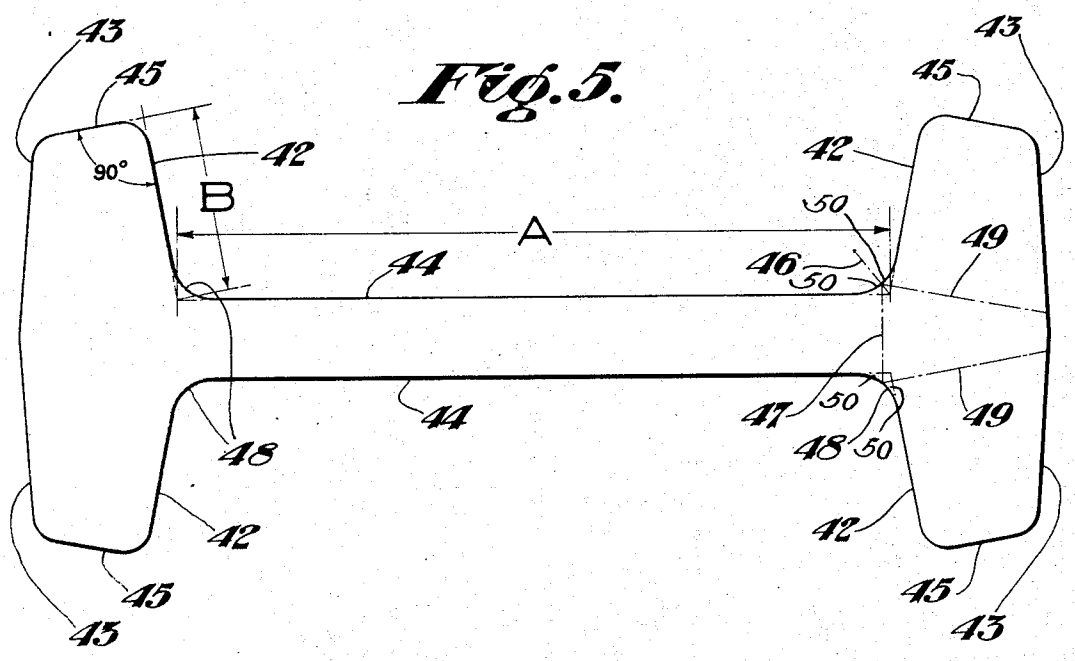
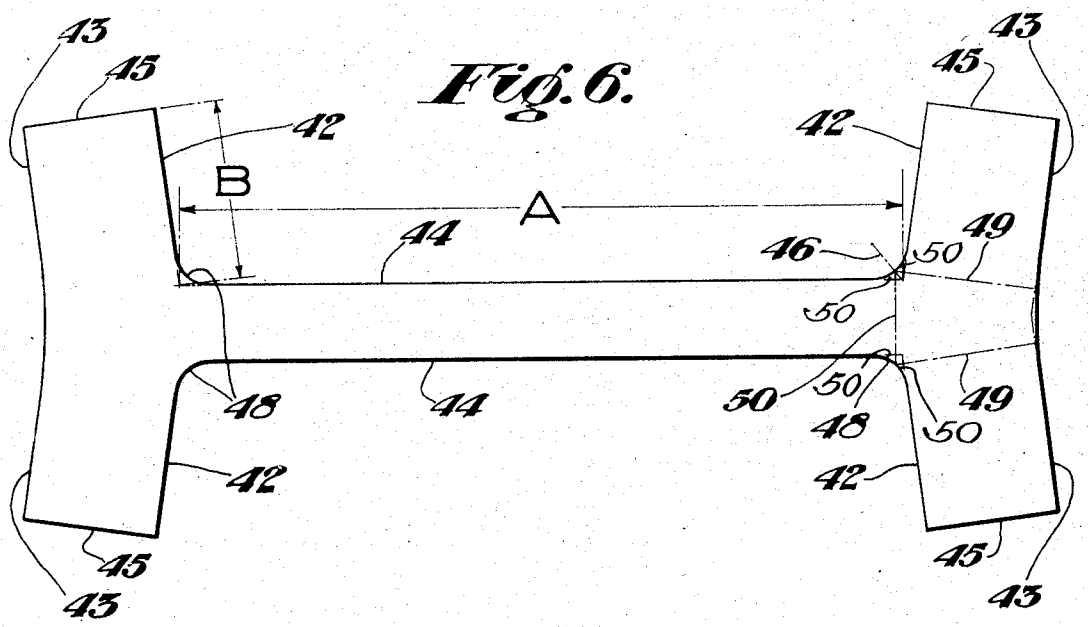


Fig. 6.



Inventor:
WILLIAM C. OBERG.
by: D. Anthony Usina
his Attorney.

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METHOD OF MAKING FLANGED SHAPES

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Fig. 7.

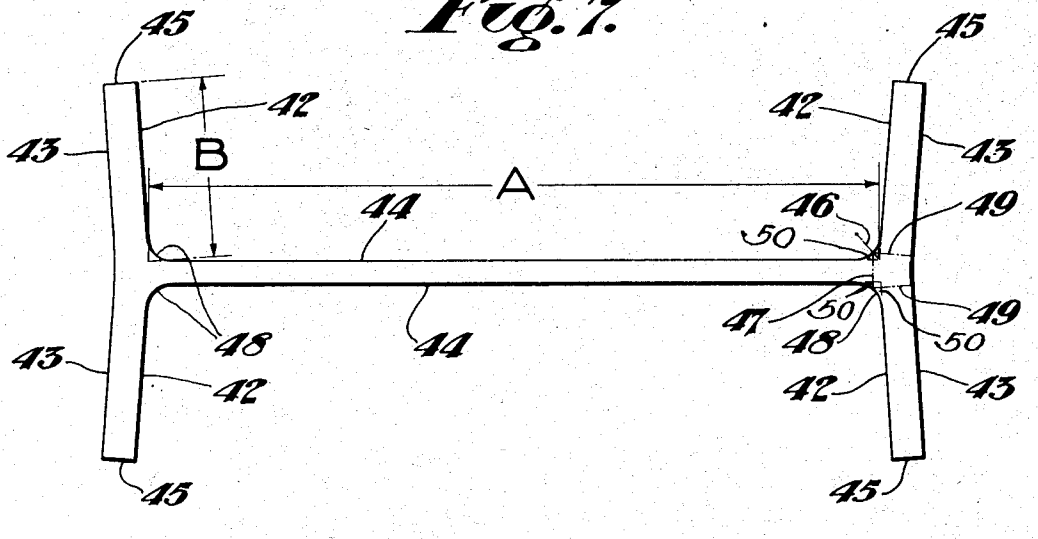
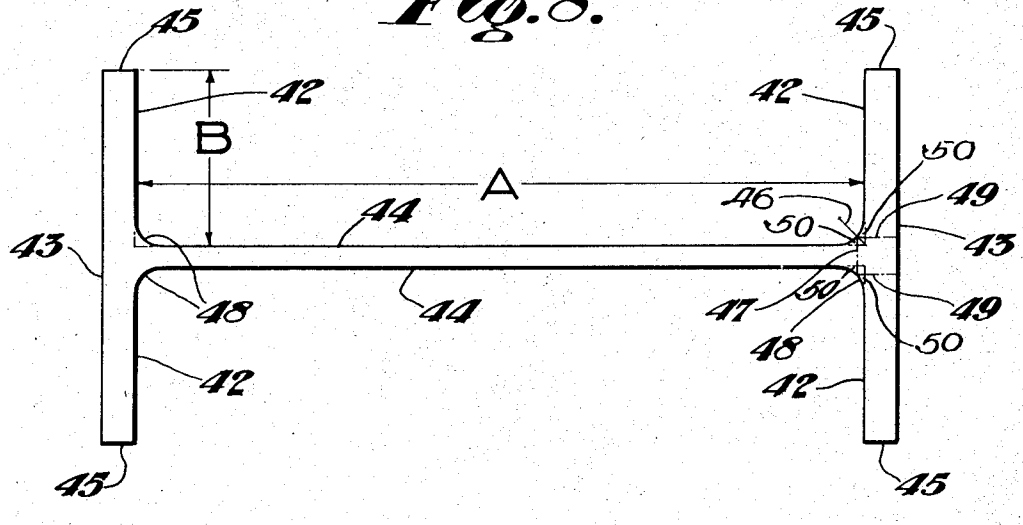


Fig. 8.



Inventor:
WILLIAM C. OBERG,
by: D. Anthony Usina
his Attorney.

Patented June 30, 1931 1,812,246

UNITED STATES PATENT OFFICE

WILLIAM C. OBERG, OF MUNHALL, PENNSYLVANIA

METHOD OF MAKING FLANGED SHAPES

Application filed December 27, 1928. Serial No. 328,813.

This invention relates to methods of making flanged structural shapes. Although adapted for use in making standard structural shapes having comparatively narrow flanges with sloping inner flange surfaces, the invention more particularly relates to rolling wide flange H and I-beams and girder beams of the types used extensively in the framework of modern high buildings, and in constructing bridges, towers and similar structures. The method is peculiarly well adapted for use in rolling wide flange H-beams, I-beams and girder beams having flanges with parallel side surfaces in a wide variety of sizes and weights.

Referring now to the drawings, Figure 1 is a diagrammatic plan showing a preferred relative arrangement of roll trains for use in rolling shapes by my improved method.

Figure 2 is an elevation showing the relative arrangement of the rolls of the two-high reversing stands of edging rolls of the rolling mill plant of Figure 1.

Figure 3 is an elevation showing the relative arrangement of the positively driven horizontal rolls and the frictionally driven vertical rolls of the reversing universal roll stands of the roughing and intermediate roll trains shown in Figure 1.

Figure 4 is an elevation, similar to that of Figure 3, showing the construction and relative arrangement of the positively driven horizontal rolls and frictionally driven vertical rolls of the universal finishing roll train of Figure 1.

Figure 5 is a plan showing the profile of a preferred form of shaped bloom as rolled for use in making shapes by the method forming my invention, and illustrating the novel feature forming part of my invention, as applied in determining the relative areas of the flange, web and neutral metal of the shaped bloom.

Figure 6 is a plan showing a profile of the rolled shape after the initial reduction of the bloom in the roughing roll train, and showing the method of determining the relative areas of the flange, web and neutral metal in the partly rolled shape.

Figure 7 is a plan, similar to that of Figure 6, showing the profile of the rolled shape after completion of the rolling operation in the intermediate roll train, and the way of determining the areas of the flange, web and neutral metal in the shape,

Figure 8 is a plan, like those of Figures 6 and 7, showing the profile of the finished shape as completed by the finishing roll train and the method of determining the flange, web and neutral areas of the shape.

Figure 9 is a plan showing the profile of a shape and illustrating the method ordinarily used heretofore in determining the flange, web and neutral areas of shapes rolled in universal mills.

In the accompanying drawings, the numeral 2 designates the roughing roll train of Figure 1, in which shaped blooms (or shaped ingots) having flange and web portions are rolled in the first series of back and forth shape reducing or forming passes. The intermediate roll train 3, in a second series of back and forth passes, further reduces the partly rolled shapes received from the roughing roll train 2 and on the discharge side of the intermediate train 3 is a finishing roll train 4 in which the flanges of the shape are straightened and a surface finish is imparted to the shape.

Roller feed tables 5 and 6 are employed in handling the materials while being rolled in the roughing train 2 and similar feed tables 7 and 8 handle the materials in rolling them in the intermediate train 3.

Feed tables 9 and 10 serve to handle the materials in rolling them in the finishing train 4. The feed tables 6 and 7, which are offset so as to be side-by-side, as shown in Figure 1, have a series of skids 11 on which

the materials being rolled are transferred sidewise from the table 6 to the table 7.

Skids 12, alongside the feed table 10, provide means on which the rolled materials, when finished, are moved sidewise from the table 10 to a feed table 13 which delivers the rolled shapes to a saw or to straightening machines or storage beds, or other place of disposal.

The roughing roll train 2 of Figure 1 comprises the positively driven horizontal edging rolls 14, 14 that are alike and form the edging roll stand, and the positively driven horizontal rolls 15, 15 and frictionally driven vertical or side rolls 16, 16 that form the universal roll stand.

The intermediate roll train 3 of Figure 1 is of the same construction as the roughing train 2 and likewise has a pair of positively driven rolls 14, 14 forming the edging roll stands and a universal stand formed of positively driven horizontal rolls 15, 15 and frictionally driven vertical rolls 16, 16.

By reference to Figure 1 it will be seen that the stand of edging rolls 14, 14 and universal stand of rolls 15, 15 and 16, 16 forming the roughing roll train are in tandem and are close enough to simultaneously roll on different parts in the length of a shape being rolled, and that the stand of universal rolls 15, 15 and 16, 16 and the stand of edging rolls 14, 14 in the intermediate roll train are similarly located in respect to each other.

It also will be noted that the edging rolls 14, 14 of the roughing train are on the entering side of the roughing train 2 and the edging rolls 14, 14 of the intermediate train 3 are on the delivery side of the intermediate roll train 9.

The universal finishing roll train 4 comprises positively driven horizontal rolls 17, 17 and frictionally driven vertical rolls 18, 18, this roll train not having a stand of edging rolls and the rolls 17 and 18 all having truly cylindrical peripheries.

The vertical rolls 16, 16 of the roughing and the intermediate roll trains 2 and 3 and vertical rolls 18, 18 of the finishing train 4 are frictionally driven by contact with the outer surfaces of the flange portions of the shapes being rolled.

The edging rolls 14, 14 of the roughing roll train 2 are positively driven through pinions 19 by the variable speed, reversing electric motor 20, and the horizontal rolls 15, 15 of the universal stand are similarly driven through pinions 21 by another variable speed, reversing motor 22. The horizontal edging rolls 14, 14 and horizontal rolls 15, 15 of the universal stand forming the intermediate roll train 3 are similarly driven through their respective sets of pinions 23, 24 by variable speed, reversing motors 25 and 26 (see Figure 1).

The horizontal rolls 17, 17 of the finishing roll train 4 are driven through suitable pinions 27 by a variable speed motor 28.

It, of course, will be understood that suitable means are provided for adjusting the horizontal edging rolls 14, 14 of each stand toward and away from each other in a vertical direction, and that similar means will be provided for adjusting each pair of horizontal rolls 15, 15, vertically and each pair of vertical rolls 16, 16 horizontally in the roughing train 2 and also in the intermediate train 3.

The adjustments, which are made after each reducing pass to which the shape is subjected, may be made by hand but ordinarily the rolls of the roughing train 2 and intermediate train 3 will be adjusted by power means, and preferably automatically operating power adjusting means.

As the adjustments necessary in the finishing train are infrequent and as the construction of this train is much lighter than the others, a hand operated roll adjusting mechanism preferably will be used for the universal rolls of the finishing train 4.

The body of the edging rolls 14 is cylindrical and has frusto-conical ends 29, 29 with an edging collar 30 on each end. The frusto-conical edging surfaces 31 of the collars 30 which engage with and "edge" the toes of the flange portions of the shapes in the rolling operations extend outwardly at an angle of 90 degrees to the surface of the frusto-conical ends 29 of the roll body. The length A of the cylindrical body of the edging rolls 14 corresponds to the length A of the web of the shapes rolled, and the distance B along the surface of the frusto-conical ends 29 from the frusto-conical edging surface 31 of the collars 30 and the point of intersection of the frusto-conical surfaces 29 with the periphery 32 of the roll body corresponds to the length B of each flange portion of the shape being rolled. The roll necks 33 by which the rolls 14 are supported by suitable bearings in the roll housings extend outwardly from the sides of the collars 30.

The horizontal rolls 15, 15 of the universal stands of the roughing train 2 and intermediate roll train 3 also have a cylindrical body and frusto-conical ends 29, 29 with collars 30 on the ends of the roll body and roll necks 33, 33 projecting outwardly from the collars 30 in these rolls, also the length A of the roll body at its periphery 34 being equal to the length A of the web portion of the shape being rolled.

The collars 30 of the rolls 15 do not have a frusto-conical edging surface like the edging surface 31 on the collars 30 of the edging rolls 14 and are of a diameter small enough to not contact with the toes of the flange portions of the shapes. The periphery of the vertical side rolls 16, 16 of the universal stands in the roughing and intermediate

trains 2 and 3 has an oppositely tapering peripheral surface 35, the large diameter of these rolls being at the middle of their length and tapering in opposite directions. The angle of the taper, when shapes with flange portions having parallel side surfaces are being rolled, is the same as that of the frusto-conical ends 29 of the horizontal roll bodies 14.

The vertical rolls 16 are mounted on roller bearings which, in turn, are mounted on pins or shafts 36 by which the vertical side rolls are supported in horizontally adjustable carriers.

The horizontal rolls 17, 17 of the universal finishing roll train 4 have bodies of a length A the same as the length of the web portions A of the finished shape, the peripheries 37 of these rolls being cylindrical and having parallel end surfaces 38, 38 with cylindrical collars 39, 39 on the ends of the body and necks 40, 40 projecting from the collars 39. The collars 39 also are of such small diameter as to not contact with the toes of the flanges of the shapes in finishing the shapes.

The vertical rolls 18, 18 of this roll train 4 also have cylindrical peripheries 41 of uniform diameter throughout their length and are mounted in carriers, not shown, in the same way as the vertical rolls of the roughing train 2 and intermediate train 3.

The exact dimensions of the finished shape will be known beforehand when preparing for rolling a shape of any given size by the method forming this invention.

The area of the flange, web and neutral metal in the finished shape will be determined. The area ratio and thickness ratio of the flange and web portions also will be determined by dividing the total area of the flange portions by the area of the web portion, and by dividing the flange thickness by the web thickness.

Although any of several known methods may be used in determining the area of neutral metal in the shape (i. e. that portion of the metal that is neither flange nor web metal) preferably this will be done by the novel method forming part of my invention and as is to be described, because of the improved results obtained in the shape rolling operations in elongating the flange and web portions uniformly and in this way avoiding internal stresses in the finished shapes.

The areas and transverse dimensions of the shaped bloom from which the shape is to be rolled also will be determined, due attention being paid to the proportion of metal in its flange, web and neutral portions, and the area ratios of the flange and web portions being made the same or substantially the same as those of the finished shape. The profile of the shaped bloom may vary considerably.

The amount of reduction to be given the bloom in shaping it in the initial pass of the roughing train 2 will be decided.

In the initial pass the length A of the web portion and length B of the flange portions will be established and these lengths will be preserved thereafter, in the succeeding rolling passes. The length B of the flange portions will be increased somewhat when rolled in the universal stands of the roughing and intermediate trains but will be restored by the rolls of the edging rolls in each reducing pass or as often as required.

That is to say, the flange may not need edging after each pass in the universal roll stands of the roughing roll trains 2 or those of the intermediate roll train 3, and the toes of the flanges will only be edged often enough to maintain the established flange length.

The contour of the flange, as well as the length of the web and each flange portion, will be fixed in the initial passes given the bloom in the roughing train 2, collars 30, 30 on the edging rolls 14, 14 fixing and maintaining the length B of the flange portions and the length of the body of the horizontal rolls 15, 15 fixing the length A of the web. The horizontal rolls 15, 15 and vertical rolls 16, 16 in the universal stand of the roughing train 2 shape the flange portions and simultaneously reduce the thickness of the flange and web portions.

It will be noted that in the initial pass or passes given the shape in the roughing train, the side surfaces of the opposite flange portions on each end of the web portion are shaped to extend upwardly and outwardly at a slight angle to a plane at right angles to the plane of the surfaces of the web.

This angular relation of the side surfaces of the flange portions is thereafter maintained in the rolling passes given the shape in the roughing train 2 and the intermediate train 3.

The area and thickness ratios and the length of the flange portions and web portions of the shape to be rolled, the number of passes required to roll the shape as produced in the initial pass of the roughing train 2 to the finished shape as produced by the finishing train 4, will be determined so as to reduce the shape in the smallest number of passes that is found to be practicable.

The area and thickness ratios will be kept constant in determining the thickness to be given the flange and web portions in each reducing pass. The results of these determinations will be tabulated and in this way the roll designer and the mill operatives will have a chart that informs them how the shape of given size and weight is to be rolled from the preformed bloom that is to be used.

The data that is tabulated as a preliminary to rolling the shaped bloom of Figure 6 into the rolled shape of Figure 8 and obtained as

described herein, is tabulated below, the areas being in square inches and linear dimensions in inches and fractions thereof—

	Total flange area	Total web area	Total neutral area	Total area	Flange thickness	Web thickness	Area ratio	Thickness ratio
Shaped bloom	139. 12	80. 80	33. 66	253. 58	Av. 5. 20	3	1. 72	1. 73
Roughing roll train pass No.								
No. 1	136. 06	78. 82	30. 67	245. 55	5. 18	2. 88	1. 72	1. 80
No. 2	126. 64	73. 40	25. 90	225. 94	4. 82	2. 68	1. 72	1. 80
No. 3	114. 86	66. 57	23. 11	204. 54	4. 37	2. 43	1. 72	1. 80
No. 4	103. 09	59. 76	19. 44	182. 29	3. 92	2. 18	1. 72	1. 80
No. 5	91. 32	52. 95	15. 96	160. 23	3. 47	1. 93	1. 72	1. 80
No. 6	79. 52	46. 15	12. 86	138. 53	3. 02	1. 68	1. 72	1. 80
No. 7	67. 72	39. 34	9. 96	117. 02	2. 57	1. 43	1. 72	1. 80
No. 8	58. 25	33. 89	7. 75	99. 92	2. 21	1. 23	1. 72	1. 80
No. 9	50. 49	29. 26	6. 42	86. 17	1. 91	1. 06	1. 72	1. 80
Intermediate roll train pass No.								
No. 10	43. 90	25. 58	5. 49	74. 97	1. 67	. 92	1. 72	1. 82
No. 11	38. 92	22. 55	4. 92	66. 39	1. 47	. 81	1. 72	1. 82
No. 12	35. 56	20. 63	4. 62	60. 81	1. 35	. 74	1. 72	1. 82
No. 13	33. 45	19. 53	4. 43	57. 41	1. 27	. 70	1. 72	1. 82
No. 14	32. 67	18. 98	4. 34	55. 99	1. 24	. 68	1. 72	1. 82
Finishing roll train pass No.								
No. 15	31. 88	18. 60	3. 86	54. 34	1. 222	. 67	1. 72	1. 82

In determining the proportions of the total area to be defined as the flange, web and neutral portions of the metal in the shape by the steps forming part of my improved method, a greater amount of the metal is considered to be neutral metal, insofar as I am aware, than in any of the methods used heretofore.

One old method of determining these areas is illustrated in Figure 9. As there shown, the lines 44′, 44′ defining the web thickness are extended to the lines 43′, 43′ indicating the outer surfaces of the flanges. The lines 42′ defining the inner surfaces of the flange portions are then connected at the point of intersection with the lines 44′, 44′ by lines 47′, 47′. The area of each flange portion is that included between the lines 42′, 43′ 44′ and the line 45′. The metal in the fillets is disregarded. The area enclosed by the lines 44′, 44′ and 47′, 47′ is the web area and the area at each end of the web portion that is defined by the lines 44′, 44′ and 43′, 47′ forms the neutral metal at each end of the web.

In accordance with my invention, the flange, web and neutral portions are determined and their areas are defined as follows—

A profile drawing of the finished shape like that shown in Figure 8 will be drawn exactly to scale. The lines 42 indicating the inner surfaces of the flanges and the lines 44 that indicate the surfaces of the web will be extended until they intersect.

Radial lines 46 will then be drawn from the centers from which the curved lines of the fillets 48 are struck to the points of intersection of the lines 42, 44. This is the same as bisecting the fillets. A line 47, which will be at right angles to the surfaces 44 of the web of the shape, is then drawn between the points where the radial lines 46 bisect the curved lines 48. The lines 49, 49 then will be drawn from the points where the radial lines 46 bisect the curved lines 48 to intersect the lines 43 which define the outer surfaces of the flanges, the lines 49 extending at right angles to the plane of the inner surfaces 42 of the flange portions.

In this way of determining the portions of the metal in the shape that are to be considered as flange, web and neutral metal, the flange areas are defined by the lines 42, 43, 45 and adjacent line 49, the web portion by the lines 44, 44, 47 and 47 and the neutral portions by the lines 43, 49, 49 and 47. The small portions 50 of the metal in the fillets are not considered to be part of the flange and web metal, respectively.

By comparison of Figure 8 with Figure 9, it will be seen that in accordance with my improved method, not only is a larger proportion of the total metal considered as neutral metal but also that the metal of the fillets is not disregarded, as is the case in the old method, illustrated in Figure 9.

The area of the flange, web and neutral portions, as laid out in Figure 8, may be calculated from the measurements of the profile but ordinarily will be obtained by means of a planimeter. The area ratio and also the thickness ratio of the flange and web portions are then readily obtained (by dividing the total flange area by the web area, and by dividing the flange thickness by the web thickness), the length A of the web and length B of each flange portion of the shape having been known when making the profile of Figure 8.

A profile drawing of the shaped bloom, as rolled from an ingot (or an ingot shaped in casting) will then be made. Ordinarily, a number of sizes of shapes and number of weights of each size of shape will be rolled from each shaped bloom (or shaped ingot) of a given size and profile. The area ratio of the flange, web and neutral portions of the shaped bloom will be made the same or approximately the same as these ratios in the finished shape and in calculating these ratios, the area ratio of the flange, web and neutral portions of the shaped blooms, such as that of Figure 5, will be defined and determined in the same way as has been described in connection with the finished shape of Figure 8.

Preferably, although not necessarily, the end surfaces 45 at the toes of each flange portion of the bloom will extend at right angles to the sloping inner surface of the flange portion, as shown in Figure 5. But when found

necessary or desirable the end surface 45 may be parallel with the side surfaces of the web 44.

The number of rolling passes necessary to reduce the bloom of Figure 5 to the finished shape of Figure 8 and percentage of reduction to be given in each pass will be decided, the number of passes and amount of reduction varying in making shapes of different sizes and weights.

Knowing the number of reducing passes and percentage in reduction to be given the shaped bloom in each bloom shaping pass, a profile drawing will be made of the shape to which the bloom is reduced in the first pass in the roughing roll train 2, the area ratio and the thickness ratio being the same as these ratios in the finished shape. In the first reducing pass in the roughing roll train, the length A of the web portion and length B of each web portion of the shape will be made the same or as nearly the same as in the finished shape as is within practical working limits and, within such limits, will be maintained throughout the subsequent reducing passes.

In determining the transverse dimensions and determining the thickness of the flange and web portions and area ratio to be given the shape in the first pass in the roughing train the web and flange length and the thickness ratio will be made the same as those of the flange and web portions of the finished shape. The same procedure is then followed in laying out the profile drawings for each of the subsequent rolling passes and, except for size, will be the same as is shown in Figures 6 and 7, the profile of the finishing pass in the finishing roll train 2 being the same as for the finished shape shown in Figure 8.

The rolling operations involved in reducing the bloom of Figure 5 into the finished shape of Figure 9 will now be described. The bloom, heated to a rolling temperature, is moved lengthwise into the roughing roll train 2, being first engaged by the rolls 14, 14 of the edging roll stand and then by the rolls 15, 15 and 16, 16 of the universal stand of the roll train 2.

Being in tandem and closely adjacent, the edging and universal roll stands will be reducing the metal at different parts of its length simultaneously. In this initial pass in the roughing train the bloom will be elongated and will be shaped and reduced transversely to the profile shown in Figure 6. The roughing roll train will then be reversed and the rolls in each stand will be relatively adjusted to give the partly rolled shape a further reduction in area and transverse dimensions. The partly rolled shape is then again passed through the roughing roll train.

In this pass the edging rolls will be adjusted into position to restore the length of the flange portions, if and when the flange length B has been increased to such an extent by the action of the vertical side rolls of the universal stand as to require the flange portions to be edged or reduced in length.

The shape is then given successive back and forth passes in the roughing train 2, being elongated and further reduced in flange and web thickness and area in each pass, while preserving the length of the flange and web portions of the shape. Generally nine to fifteen passes will be given the shape in the roughing train in rolling the bloom of Figure 5 to the finished shape of Figure 9.

Obviously, the number of passes may be varied to meet existing conditions in any particular shape rolling operation.

The partly rolled shape passes from the roughing train to the intermediate roll train 3 for further rolling in the way which has been described, and in this roll train is generally given from three to nine passes. In each of these passes the thickness and area of the flange and web portions is reduced in accordance with the table set forth above, so as to maintain the established area and thickness ratio and to elongate the flange and web portions, as nearly as practicable, to an equal extent. The edging rolls of the intermediate roll stand will, of course, be used to maintain the flange width in rolling the shape in the intermediate stand.

The shape will be rolled to substantially its finished size in the intermediate stand 3 although the angular relation of the flange portions relative to the web portion remains as substantially formed in the roughing train. Care will be taken to have the edging rolls of the intermediate train 3 act on and edge the flange portions so as to finish them to length in the final pass given the shape in the intermediate roll train.

The shape then passes from the intermediate train 3 to the finishing train 4 in which it is given a single finishing pass. In this pass the angularly extending flange portions are bent to their normal position, or position in which the side surfaces of the flanges extend at right angles to the side surfaces of the web of the shape. At the same time the flange and web portions are reduced slightly in area and thickness and are given their finished thickness. The finished shape is then carried away and the rolling operations are repeated with another shaped bloom.

The many advantages of my improved method will be readily appreciated by those skilled in the art. By proportioning the web, flange and neutral metal portions of the shapes in accordance with my invention, the desired equal elongation of the web and flange portions of the shapes is facilitated and made more nearly uniform than is possible with ordinary methods. Making the shaped blooms as shown and described further increases the improved results obtained

by my novel method of determining the area and thickness ratios of the shape being rolled in each of the shape reducing passes. By rolling the shapes in the manner disclosed, the flange lengths are made uniform and the manufacture of shapes of uniform thickness and having parallel flange surfaces without danger of overfills and fins on the edges of the flanges is readily carried out.

Modifications in the steps of the method forming this invention may be made without departure from my invention, as defined in the appended claims. The shaped bloom may differ in profile and the way of determining the flange, web and neutral metal portions in the successive passes may be varied and other changes may be made.

I claim:

1. The method of rolling flanged shapes which consists in reducing a shaped bloom having flange and web portions in a series of successive rolling passes, initially reducing the flange and web portions to the length, area ratio and thickness ratio of the completed shape and thereafter maintaining the finished length and the area and thickness ratios in the flange and web portions in the later rolling passes in reducing the shape to final form.

2. The method of rolling flanged shapes which consists in reducing a shaped bloom having flange and web portions in a series of successive rolling passes, initially shaping the flange portions to have parallel side surfaces and reducing the flange and web portions to the length, area ratio and thickness ratio of the completed shape and thereafter maintaining the finished length and the area and thickness ratios in the flange and web portions in the latter rolling passes in reducing the shape to final form.

3. The method of rolling flanged shapes which consists in reducing a shaped bloom having flange and web portions in a series of successive rolling passes, initially shaping the side surfaces of the flange portions to incline outwardly at an angle to the normal position thereof in the finished shape and reducing the flange and web portions to the length, area ratio and thickness ratio of the completed shape, and thereafter maintaining the angular relation of the flange portions and the finished length, area and thickness ratios of the flange and web portions in the later rolling passes and bending the angularly inclined flange portions to normal position in the final finishing pass in completing the rolling operations.

4. The method of rolling flanged shapes which consists in reducing a bloom having flange and web portions in a series of successive rolling passes, initially shaping the side surfaces of the flange portions to incline outwardly at an angle to the normal position thereof in the finished shape, and reducing the flange and web portions to the length, area ratio and thickness ratio of the completed shape, and thereafter maintaining the angular relation of the flanged portions, the finished length, area and thickness ratios of the flange and web portions in the later rolling passes and bending the angularly inclined flange portions to normal position in the final finishing pass of the rolling operations.

5. The method of rolling flanged shapes which consists in reducing a bloom having flange and web portions in a series of successive rolling passes, initially shaping the flange portions to have parallel outwardly inclined side surfaces and reducing the flange and web portions to length, area ratio and thickness ratio of the completed shape, and thereafter maintaining the angular relation of the flange portions and the finished length, area and thickness ratios of the flange and web portions in the later rolling passes, and bending the angularly inclined flange portions to normal position in the final finishing pass in completing the rolling operations.

6. The method of rolling flanged shapes which consists in forming a bloom having web and flange portions with flaring inner surfaces on the flange portions, making the area of the web portion which lies between the side surfaces thereof and lines at right angles to said side surfaces that bisect the fillets connecting the web and inner flange surfaces and the area of the flange portions which lie between the side and end surfaces of the flange portions and a line at right angles to the flaring inner surfaces of the flange portions that bisect said fillets in the same proportion to each other as the areas of the same portions of the finished shape and rolling a shape therefrom in a series of successive reducing passes, and maintaining the established area ratio of the web and flange portions in rolling the shape in said later reducing passes.

7. The method of rolling flanged shapes which consists in forming a bloom having web and flange portions with flaring inner surfaces on the flange portions and with end surfaces on the flange portions approximately at right angles to the flaring inner flange surfaces, making the area of the web portion which lies between the side surfaces thereof and lines at right angles to said side surfaces that bisect the fillets connecting the web and inner flange surfaces and the area of the flange portions which lie between the side and end surfaces of the flange portions and a line at right angles to the flaring inner surfaces of the flange portions that bisect said fillets in the same proportion to each other as the areas of the same portions of the finished shape and rolling a shape therefrom in a series of successive reducing

passes, and maintaining the established area ratio of the web and flange portions in rolling the shape in said later reducing passes.

8. The method of rolling flanged shapes which consists in forming a bloom having web and flange portions, with tapering, oppositely inclined side surfaces on the flange portions, making the area of the web portion which lies between the side surfaces thereof and lines at right angles to said side surfaces that bisect the fillets connecting the web and inner flange surfaces and the area of the flange portions which lie between the side and end surfaces of the flange portions and a line at right angles to the flaring inner surfaces of the flange portions that bisect said fillets in the same proportion to each other as the areas of the same portions of the finished shape and rolling a shape therefrom, in a series of successive reducing passes and maintaining the established area ratio of the web and flange portions in said later reducing passes.

9. The method of rolling flanged shapes which consists in initially rolling a shape having web and flange portions with parallel, outwardly inclined side surfaces and edge surfaces on the flange portions at right angles to said side surfaces of said flange portions, making the area of the web portion which lies within the rectangle formed by the side surfaces thereof and lines at right angles to said side surfaces that bisect the fillets of the shape at the ends of the web portion and the area of the flange portions which lie in the rectangle formed by the side and end surfaces thereof and lines at right angles to the inner surfaces of the flange portions that bisect said fillets, in the same proportion to each other as the same portions of the finished shape, and then further rolling the shape, maintaining such area ratio of the inclined flange portions and web portions in the further rolling operations and bending the outwardly inclined flange portions into normal position in the final rolling pass.

10. The method of rolling flanged shapes which consists in initially rolling a shape having web and flange portions with parallel, outwardly inclined side surfaces and edge surfaces at right angles to said side surfaces on the flange portions, making the thicknesses of the web and flange portions in the same proportion to each other as in the finished shape, making the area of the web portion which lies within the rectangle formed by the side surfaces thereof and lines at right angles to said side surfaces that bisect the fillets of the shape at the ends of the web portion, and the area of the flange portions which lie in the rectangle formed by the side and end surfaces thereof and lines at right angles to the inner surfaces of the flange portions that bisect said fillets, in the same proportion to each other as the same portions of the finished shape, and then further rolling the shape and maintaining such thickness ratio and area ratio of the web and flange portions in the further rolling operations and bending the outwardly inclined flange portions into normal position in the final rolling pass.

11. The method of rolling flanged shapes which consists in forming a bloom having web and flange portions, with flaring inner surfaces on the flange portions and with end surfaces approximately at right angles to the flaring inner flange surfaces, making the area of the web portion which lies between the side surfaces thereof and lines at right angles to said side surfaces that bisect the fillets connecting the web and inner flange surfaces and the area of the flange portions which lie between the side and end surfaces of the flange portions and a line at right angles to the flaring inner surfaces of the flange portions that bisect said fillets in the same proportion to each other as the areas of the same portions of the finished shape and rolling a shape therefrom in a series of successive reducing passes, making the thickness of the web and flange portions proportional to the same portions of the finished shape in the initial shape rolling operations and maintaining the established area ratio and thickness ratio in the successive reducing passes.

In testimony whereof, I have hereunto set my hand.

WILLIAM C. OBERG.