United States Patent [19]

Franek et al.

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[54] **TREATING STRIP METAL**

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** **72/205,** 72/163, 72/241

[51] **Int. Cl.** **B21b 39/08**

[58] **Field of Search** 72/205, 160, 164, 163, 72/241, 366

[56] **References Cited**

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[57] **ABSTRACT**

Substantial longitudinal uniformity of the distance between the longitudinal edges of strip metal is obtained by moving the strip lengthwise under tension and subjecting it to multiple bowing in directions substantially at right angles to the longitudinal axis of the strip by passing the strip between at least three straight work rolls and partly around two opposed rolls of four freely rotatable back-up rolls of substantially equal diameters which are large as compared with the diameters of the work rolls, the work rolls being freely rotatable between the back-up rolls and constrained against axial movement. The work roll first engaged by the strip has a diameter less than that of the work roll last engaged and the diameter of the intermediate work roll is less than that of the first and last engaged work rolls.

9 Claims, 5 Drawing Figures

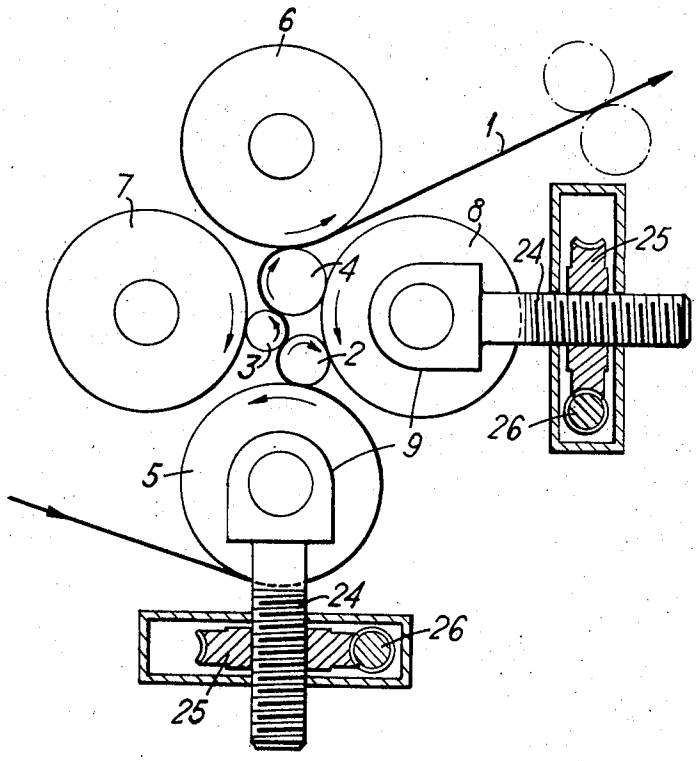
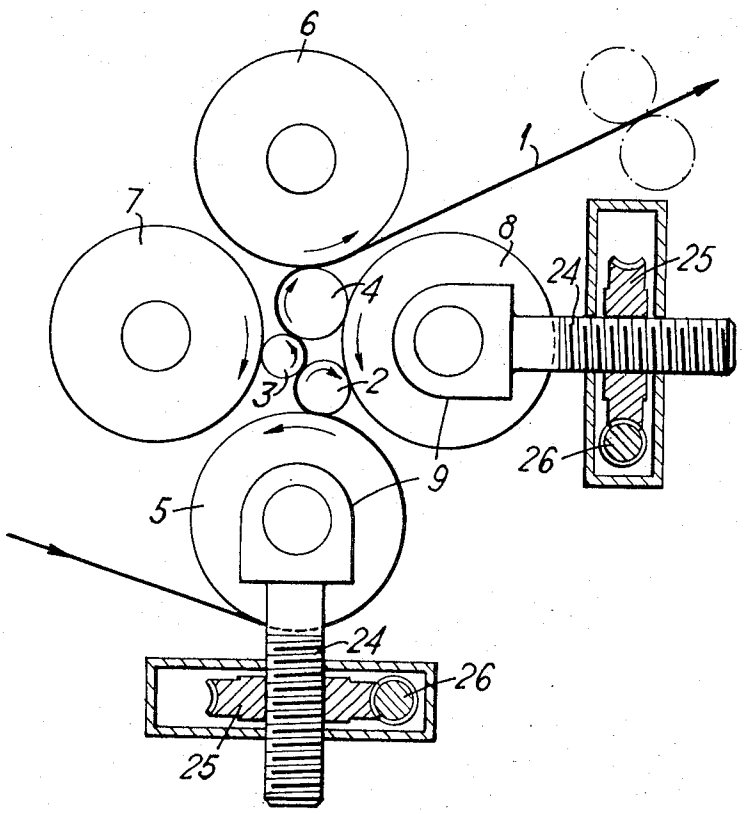


Fig. 1.



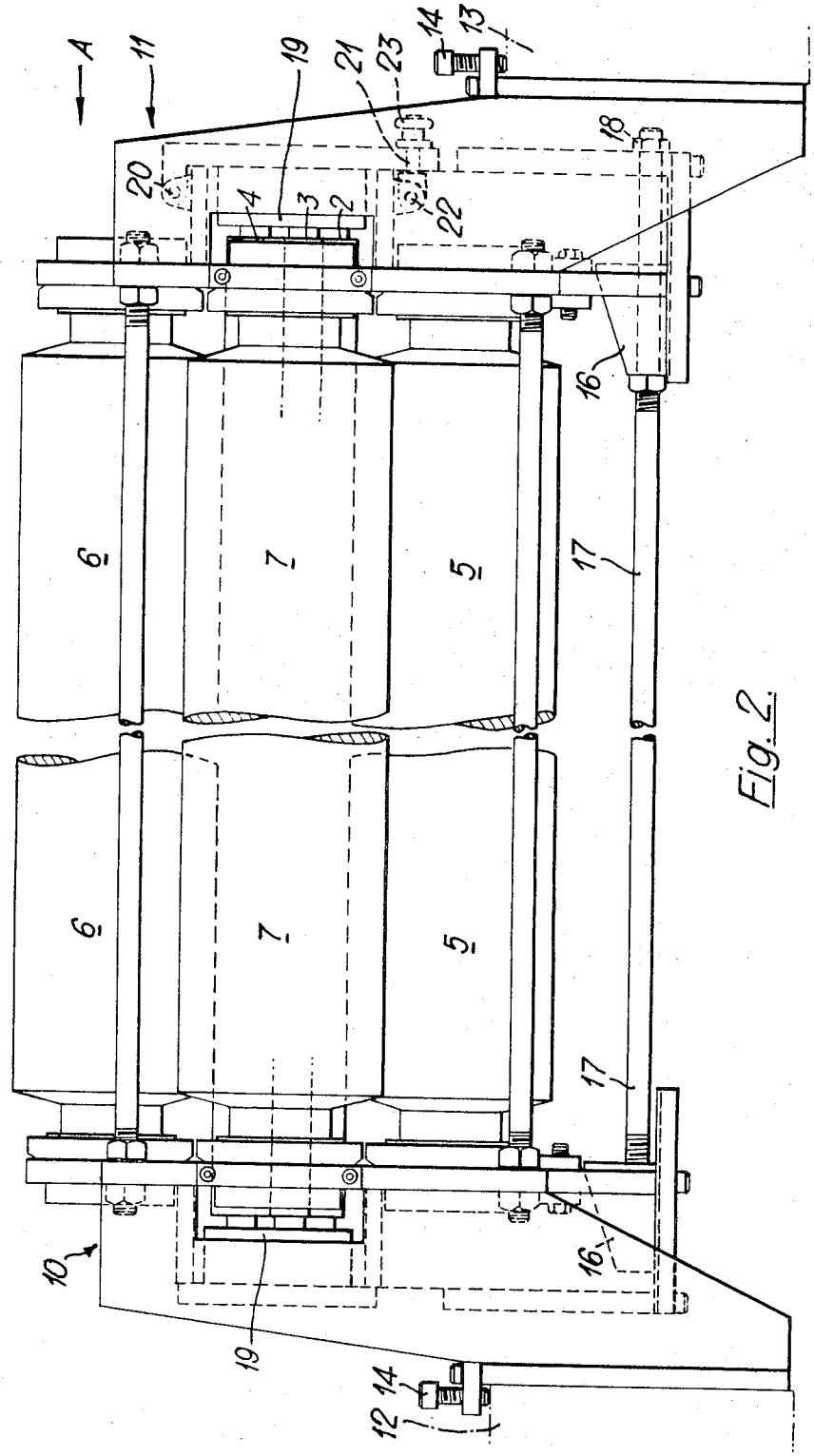


Fig. 2

Fig. 3.

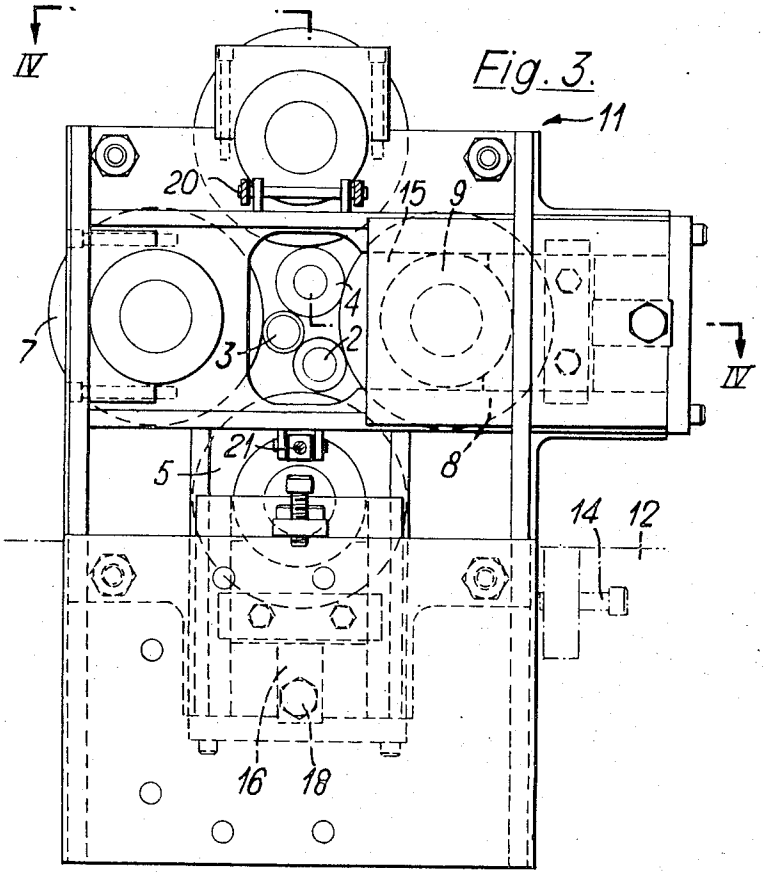


Fig. 4.

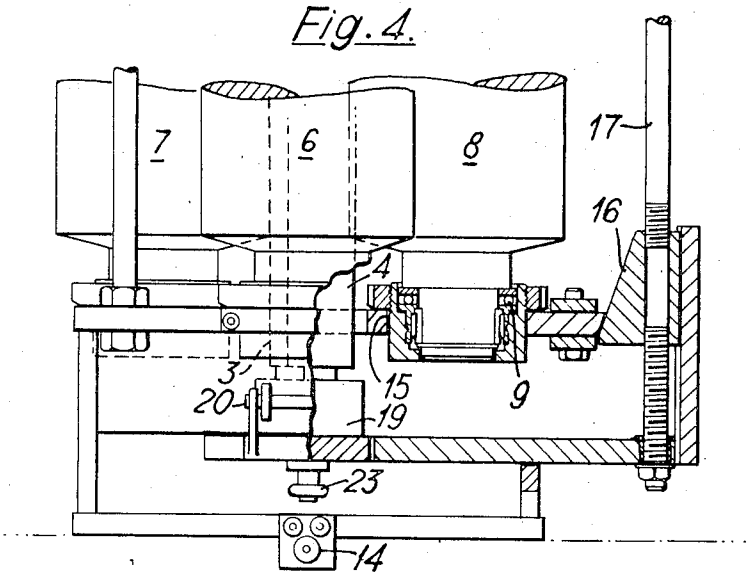
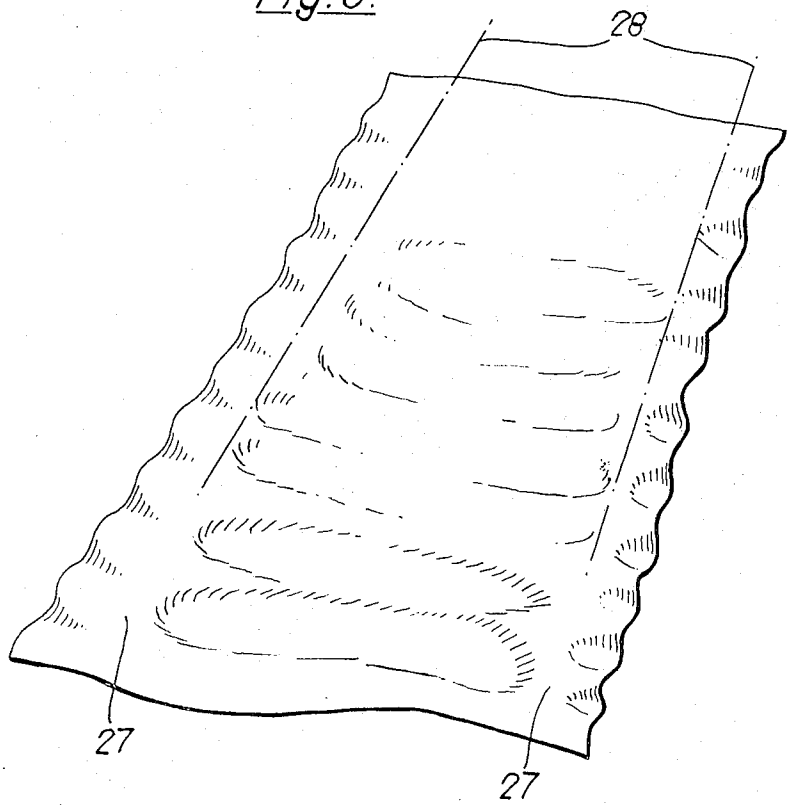


Fig. 5.



TREATING STRIP METAL

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to improvements in treating strip metal, either ferrous or non-ferrous, for example blackplate, tin-plate or aluminium, which is normally cold-rolled to predetermined thicknesses which may be of the order of 0.005 inch to 0.015 inch and in widths of 20 inches to 80 inches.

2. Description of the Prior Art

Unless the rolling parameters are ideal the strip produced may be of unacceptable shape mainly due to defective flatness. As will later be described with reference to the drawings, there are a number of defects which may occur such as edge unevenness, blisters, herring-bone patterning, and short edges with full centre, this latter being often referred to as "canoeing." While the strip defects may not matter in respect of some uses which the strip metal may be put it is, for other uses, such as can making, most desirable that the defects be eliminated as far as possible to provide sheet material with little or no visible variations from a flat condition of the strip. It is a main object of the present invention to provide a method of and an apparatus for treating strip metal longitudinally to ensure across the width of the strip, and over a given span of strip, a substantial uniformity of the distance between the longitudinal edges of the strip and of the centre area thereof.

SUMMARY

The invention provides a method of and apparatus for ensuring that throughout the length of a strip of metal there is substantial uniformity of the distance between the longitudinal edges of the strip across the width thereof. This is done by moving the strip lengthwise under tension and subjecting it to multiple bowing in directions substantially at right angles to the longitudinal axis of the strip by passing the strip between at least three straight work rolls which are constrained against axial movement and which are supported for free rotation between four freely rotatable back-up rolls. The diameters of the back-up rolls are substantially equal and are large as compared with those of the work rolls the diameters of which are such that the diameter of the work roll first engaged by the strip is less than that of the work roll last engaged and that of the intermediate work roll or rolls is or are less than that of the first and last work rolls.

Two adjacent back-up rolls may be supported by frame members to be rotatable about fixed axes and the other two may be supported for movement towards and away from the work rolls and have adjusting devices operable to effect such movements.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 diagrammatically illustrates apparatus according to the invention,

FIG. 2 is a broken elevation of the apparatus,

FIG. 3 is an end view looking in the direction of arrow A, FIG. 2,

FIG. 4 is a section on line IV–IV, FIG. 3, and

FIG. 5 is a diagrammatic representation of a portion of a metal strip to be treated by the apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, longitudinal tension is applied to a strip 1 of rolled metal, for example tin-plate, by moving the strip lengthwise through a sinuous path defined by at least three freely rotatable work rolls 2, 3, 4 adjacent ones 2, 3 and 3, 4 of which co-operate to engage the strip passing therebetween. The work rolls 2, 3, 4 have strip-engaging surfaces which are so finished as not to impart roughness to the strip and are, as described below, constrained against axial movement and are supported between four freely rotatable back-up rolls 5, 6, 7, and 8 of substantially equal diameters which are large as compared with those of the work rolls. The diameter of the last work roll 4 engaged by the strip is greater than that of the first work roll 2 engaged by the strip and the diameter of the intermediate work roll 3, or of each intermediate work roll if more than one is used, is less than that of the first and last work rolls 2 and 4. In a preferred embodiment of the invention the diameter of each back-up roll is 6 inches, that of the first work roll 2 is 1½ inches, that of the second work roll 3 is 1 inch, and that of the last work roll 4 is 2¼ inches. It will be understood, however, that the diameters of the rolls are controlled by a number of factors such as the thickness of the strip to be treated, the yield stress of the strip, and the geometry of the apparatus itself which requires that the diameter of the intermediate roll or rolls 3 has or have the smallest diameter. If desired, as indicated above, a number of work rolls greater than three may be used.

The strip 1 may be drawn into the apparatus directly from a strip rolling apparatus of any kind, for example an apparatus of the kind described in British Pat. Specification No. 1,087,097, or by draw rolls DR, indicated in phantom in FIG. 1, from a coil, not shown, as in apparatus arranged to cut-up strip fed from a coil, or the apparatus may be used in conjunction with other forms of apparatus for working or handling long lengths of thin strip metal during lengthwise movement thereof under tension.

The length of each of the rolls 2 to 8 is greater than the maximum width of a strip 1 to be treated and all of the rolls are freely rotatable about their respective axes. Thus as the strip is pulled through the rolls the work rolls 2, 3 and 4, being supported only by the back-up rolls 5, 6, 7 and 8 and spaced by the strip 1, are free to find their own positions in a vertical plane relative to each other and to the back-up rolls, thus effecting multiple bowing of the strip in directions substantially at right angles to the longitudinal axis of the strip. As the result of this treatment it is found that "canoeing" is to all intents and purposes not present in the strip issuing from between rolls 4 and 6.

By pulling the strip through a set of rolls as just described there would tend to be a permanent curvature left in the strip. To avoid this the diameter of the work roll 4 is important. Each work roll introduces a curvature into the strip in opposite directions, but the combination of the diameters of the last work roll 4 and the back-up roll 6 produces perfectly flat strips without residual curvature.

In FIGS. 2 to 4 it is assumed that the apparatus is used in conjunction with the strip rolling apparatus described in the above-mentioned British Pat. Specification No. 1,087,097 and is associated with the output

end of the strip rolling apparatus. The back-up rolls 4 to 8 are freely rotatable in ball bearings 9, FIG. 4, carried by frame members 10, 11, FIG. 2, supported between frame members 12, 13, shown in phantom, FIG. 2, of the strip rolling machine. Adjusting screws 14 permit adjustment of the apparatus relative to the strip rolling apparatus.

As can be seen from FIG. 1, the back-up rolls 5, 6 and the rolls 7, 8 are respectively aligned with and are opposite to each other. The back-up rolls 6, 7 are freely rotatable about fixed axes; but for the purposes of threading strip 1 through the apparatus, and of adjustment, the bearings 9 for rolls 5 and 9 are slidable in slots 15, FIG. 4, formed in the frame members 10, 11 and are associated with adjusting devices for effecting movement of the rolls 5 and 8 towards and away from the work rolls 2, 3, 4 and the back-up rolls 6, 7. As shown in FIGS. 2 to 4 the adjusting devices comprise wedge members 16 carried by rods 17. The rods 17 extend axially between the frame members 10, 11 and one end of each rod is screw-threaded so that by rotation of a nut 18 the rod 17 can be moved axially thus moving the wedge members 16 towards or away from the bearings 9 associated therewith. On slackening the nuts 18 the bearings can be manually drawn after the wedge members; and when returning the rolls 5, 8 to the working positions thereof this is effected by engagement of the wedge members 16 with the bearing 9.

In FIG. 1 there is diagrammatically illustrated an alternative form of back-up roll adjusting device which comprises an extension 24 of the bearing 9 which is screw-threaded and has mounted thereon a worm-wheel 25 rotatable by a worm 26 which can, in turn, be rotated manually by any suitable means, not shown. With this form of adjusting device movements of the bearing 9 in both directions is effected positively by rotation of worm 26.

The endwise constraint of the work rolls 2, 3, 4 is effected by flat plates 19 each of which is hinged at 20, as shown on the right-hand side of FIG. 2, to a frame member 10 or 11. A screw 21 is pivoted at 22 to the frame member and is provided with a wing nut 23. The screw 21 is movable into and out of a slot, not shown, formed in the plate 19; and the screw 21 and nut 23 serve to retain and lock the plate 19 in the adjusted roll-engaging position thereof.

FIG. 5 diagrammatically illustrates a portion of strip metal to be treated by the apparatus described above. As can be seen from FIG. 5 the strip has wavy longitudinal edges and adjacent to these edges localities 27 which are known as short centre localities which sometimes meet in the centre of the strip to form what is known as "a short centre." If the strip is trimmed along the lines 28 the resulting longitudinal edges would be what are known as "tight" or "short" and the centre portion of the strip would be what is known as "long."

As described above, the strip metal is treated while subjected to tension and it is found that the local tension combined with the tensile stresses induces by bending the strip by means of the work-rolls results in permanent extension of the shorter transverse localities of the strip. If the strip is perfectly uniform in the longitudinal direction, the tension and the bending stresses are not sufficiently great to impart any extension to the strip. Accordingly, it may be said that the apparatus is capable of extending only the shorter transverse localities of the strip.

The primary purpose of apparatus according to the invention is to correct the shape of rolled strip metal by removing short edges or short centre localities 27, FIG. 5, of the strip, and this necessitates that the work rolls be maintained as nearly straight as is possible. To this end it may sometimes be desirable to provide the backup rolls with a slight camber which results in the increased diameter at the centres of the back-up rolls not to allow any deflection of the work rolls.

The apparatus described above with reference to the drawings is self-contained and inexpensive to produce and can be readily accommodated in a relatively narrow space between frame members at the output end of a rolling mill. Further, the apparatus produces flat strip by the use of lower tension than has hitherto been possible. Whereas hitherto it has been usual to apply tension of the order of 100 to 600 lb/inch width it has been found possible when using apparatus according to the invention to apply a tension of not more than 60 lb/inch width.

We claim:

1. A method of treating strip metal to ensure throughout the length of the strip substantial longitudinal uniformity of the distance between the longitudinal edges of the strip across the width thereof; said method comprising moving the strip lengthwise under tension and subjecting it to multiple bowing in directions substantially at right angles to the longitudinal axis of the strip by passing the strip between at least three straight work rolls including a first engaged work roll, a last engaged work roll and at least one intermediate work roll having strip-engaging surfaces; and partly round two opposed rolls of at least four freely rotatable back-up rolls having substantially equal diameters, which diameters are large as compared with the diameters of the work rolls; supporting the work rolls for free rotation between the back-up rolls, constraining the work rolls against axial movement, selecting the diameter of the first engaged work roll to be less than that of the last engaged work roll, and selecting the diameter of each intermediate work roll to be less than that of the first and last engaged work rolls.

2. Apparatus for treating strip metal to ensure throughout the length of the strip substantial longitudinal uniformity of the distance between the longitudinal edges of the strip across the width thereof, said apparatus comprising means to move the strip lengthwise under tension, at least three freely rotatable work rolls including a first engaged work roll, a last engaged work roll and at least one intermediate work roll having strip-engaging surfaces; at least four back-up rolls between which the work rolls are rotatable, said back-up rolls having substantially equal diameters which are large as compared with the diameter of the work rolls; frame members supporting the back-up rolls for free rotation, and means engageable with opposite ends of the work rolls to constrain the work rolls against axial movement, two opposed ones of the back-up rolls co-operating with the work rolls to subject the strip to multiple bowing in directions substantially at right angles to the longitudinal axis of the strip, and the diameters of the work rolls being so selected that the diameter of the first engaged work roll is less than that of the last engaged work roll and the diameter of each intermediate work roll is less than that of the first and last engaged work rolls.

3. Apparatus according to claim 2, wherein two adjacent ones of said back-up rolls are supported by the frame members to be rotatable about fixed axes, and the other two back-up rolls are supported by the frame members for movement towards and away from the work rolls and have associated therewith adjusting devices operable to effect said movement.

4. Apparatus according to claim 2, wherein said means engaging ends of the work rolls comprises a flat plate hinged to a frame member and locking means operable to retain the plate in an adjusted roll end-engaging position thereof.

5. Apparatus according to claim 3, wherein said means engaging ends of the work roll comprises a flat plate hinged ta frame member and locking means operable to retain the plate in an adjusted roll end-engaging position thereof.

6. Apparatus for treating stirp metal to ensure throughout the length of the strip substantial longitudinal uniformity of the distance between longitudinal edges of the strip across the width thereof, said apparatus comprising means to move the strip lengthwise under tension, at least three freely rotatable work rolls and at least four back-up rolls between which the work rolls are rotatable, said back-up rolls having substantially equal diameters which are large as compared with the diameters of the work rolls, means supporting the back-up rolls for free rotation, two opposed ones of the back-up rolls cooperating with the work rolls to subject a strip to multiple bowing in direction substantially at right angles to the longitudinal axis of a strip being treated, and the diameters of the work rolls being so selected that the diameter of the first engaged work roll is less than that of the last engaged work roll and the diameter of each intermediate work roll is less than that of the first and last engaged work rolls, and the path of a strip relative to the work rolls being in contact with each of the work rolls less than 180°.

7. The apparatus of claim 6 wherein one of said two opposed back-up rolls cooperates with said first engaged work roll and the other of said two opposed back-up rolls cooperates with said last engaged work roll.

8. The apparatus of claim 6 wherein two other opposed ones of said back-up rolls engage said work rolls remote from the path of a strip between the work rolls.

9. The apparatus of claim 6 wherein two other opposed ones of said back-up rolls engage said work rolls remote from the path of a strip between the work rolls, one of said two other opposed back-up rolls engaging both said first engaged work roll and said second engaged work roll, and the other of said two other opposed back-up rolls engaging at least said intermediate work roll and urging said intermediate work roll generally between said first and last engaged work rolls.

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