Dec. 20, 1938. C. M. MacCHESNEY 2,140,533

METHOD OF AND APPARATUS FOR STRAIGHTENING STEEL STRAPPING

Filed June 25, 1936 2 Sheets-Sheet 1

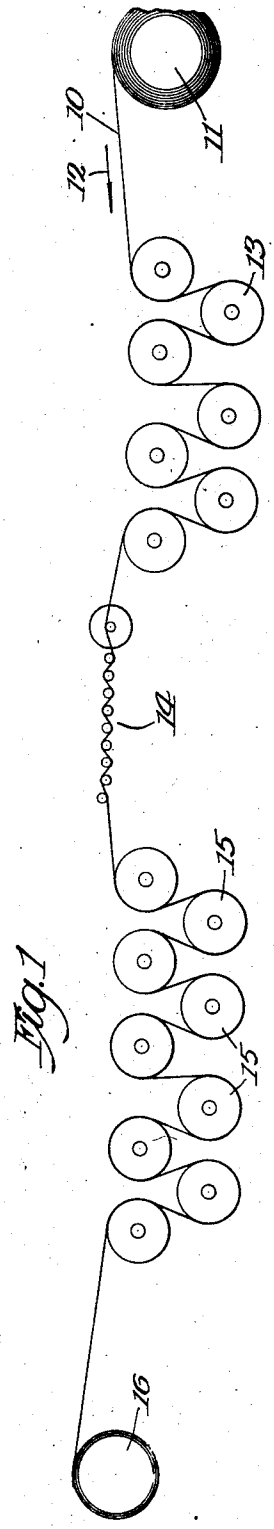


FIG. 1

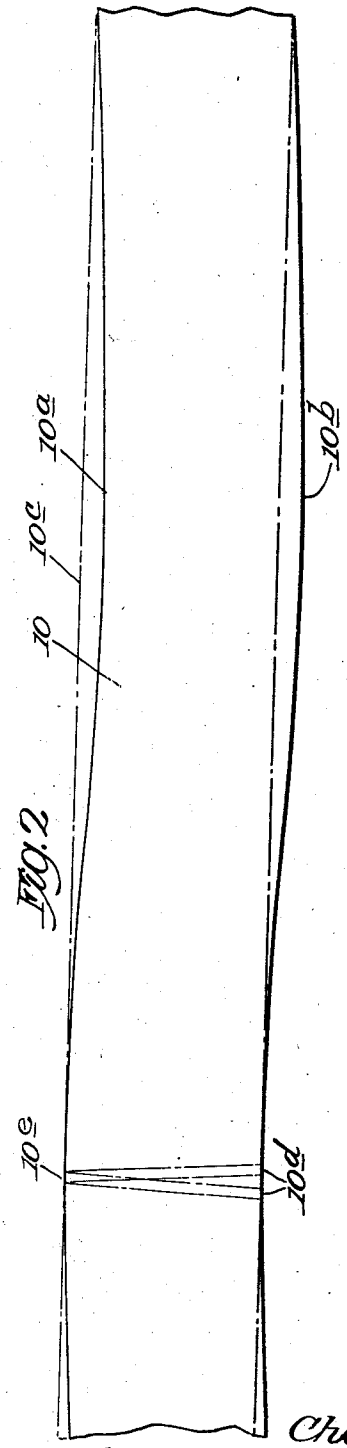


FIG. 2

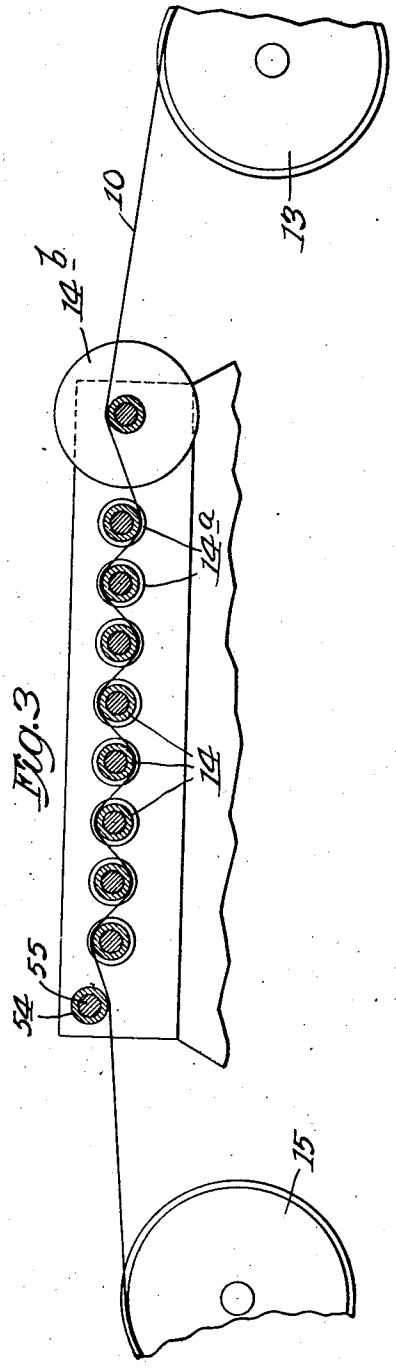


FIG. 3

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METHOD OF AND APPARATUS FOR STRAIGHTENING STEEL STRAPPING

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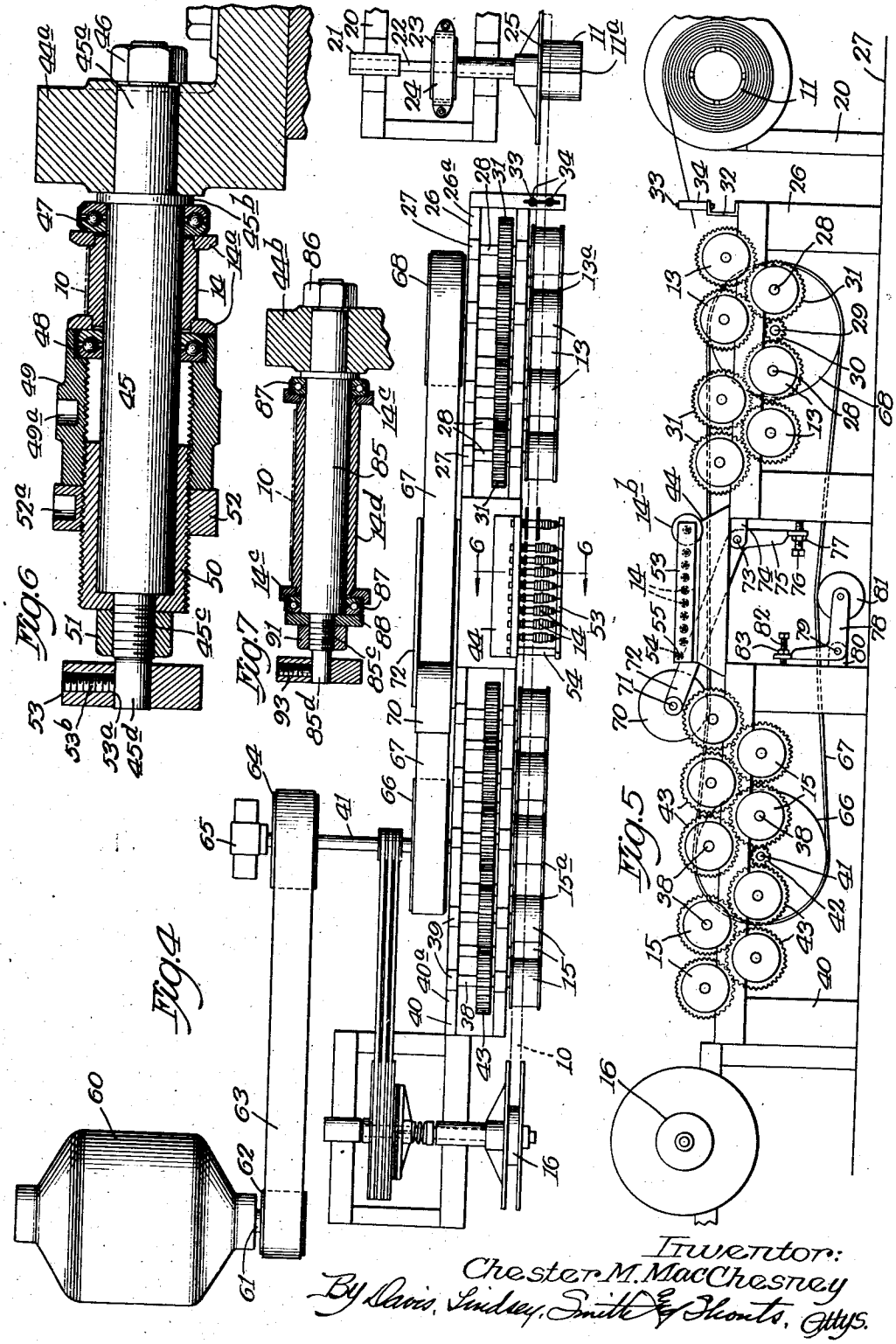


FIG. 4

FIG. 5

FIG. 6

FIG. 7

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METHOD OF AND APPARATUS FOR STRAIGHTENING STEEL STRAPPING

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Application June 25, 1936, Serial No. 87,140

9 Claims. (Cl. 153—54)

This invention relates to improvements in methods of and apparatus for straightening strip metal and the like and its purpose is to provide improved means by which elongated metal strips may be straightened and flattened. Strip steel, such as that employed in binding boxes, bales and the like, and for various other purposes, is rolled in long continuous strips and it is frequently found that when it comes out of the mill it has a lateral curvature or a multiplicity of lateral curvatures in its own plane, called "camber", which interferes with the winding of the strip in a coil and prevents its use for most purposes. It has heretofore been necessary to scrap a great deal of this imperfect strip metal and quantities of this material are frequently returned by customers because of defects in this respect. The present invention involves the discovery that this lateral curvature in strip steel and the like may be removed by an improved process of bending and stretching the material while it is under tension with the result that the metal on the side of the strip which is shorter is stretched and elongated so that the opposite edges of the strip are restored to their desired parallel relationship. This improved process is preferably carried on by moving the elongated metal strip while under tension through a plurality of rolls which are arranged to cause the strip to follow a staggered or zigzag path and which are preferably provided with means for preventing the lateral shifting of the metal strip longitudinally of the rolls so that, as the strip is bent back and forth between the rolls, the shorter portions thereof are elongated and the metal strip emerges from the rolls in a flat condition with parallel edges so that it may be wound in a coil and used for all purposes for which such strip metal is ordinarily employed. The apparatus of the present invention comprises two series of driven friction rolls located at the opposite ends of a series of straightening rolls about which the metal strip passes in zigzag fashion and which are comparatively small in diameter, so that the elongated metal strip is bent sharply back and forth as it passes between these rolls under tension, which is created preferably by driving one series of friction rolls slightly faster than the other series of friction rolls, or employing friction rolls in one series which differ slightly in diameter from those of the other. The elongated metal strip which is to be straightened is initially wound upon a reel and is progressively unwound therefrom as it is drawn through the friction rolls and straightening rolls after which the straightened strip is rewound upon another reel in readiness for distribution to the customer. Other objects of the invention relate to various features of construction and arrangement and to details of the method of straightening which will appear more fully hereinafter.

The nature of the invention will be understood from the following specification taken with the accompanying drawings, in which one example of the improved method is disclosed in connection with one form of apparatus adapted for use in practicing the invention. In the drawings,

Fig. 1 shows a somewhat diagrammatic side elevation of the improved apparatus which is employed in the straightening process of the present invention;

Fig. 2 shows an enlarged top plan view of a short length of strip steel or the like which has a lateral curvature of the type which is adapted to be corrected by the use of the present invention;

Fig. 3 shows an enlarged vertical section through the straightening rolls which are embodied in the apparatus illustrated in Fig. 1 and showing portions of adjacent friction rolls;

Fig. 4 shows a top plan view of one form of apparatus embodying the features illustrated in Fig. 1;

Fig. 5 shows a side elevation of the apparatus illustrated in Fig. 4;

Fig. 6 shows an enlarged detail section on the line 6—6 of Fig. 4; and

Fig. 7 is a sectional view similar to that of Fig. 6 showing a modified form of straightening roll adapted for use in straightening metal strips of considerable width.

In Fig. 2 of the drawings, there is illustrated a portion of an elongated section of strip steel 10 or the like which has a lateral curvature or camber, first in one lateral direction and then in the other, as shown by the relative positions of the edges 10^a and 10^b of the strip with reference to the lines 10^c which represent the edges of the strip if it were straight with its lateral edges parallel to each other. In practice, these lateral curvatures, in the plane of the strip, may succeed each other in quick succession or they may appear only at intervals with long stretches of straight strapping between them, or they may be continuous in the same direction from end to end of the coil. In either event, this lateral curvature causes the metal strip to wind in irregular fashion upon a reel and it has been found that if elongated strip metal of this character be moved while under longitudinal tension in a zigzag path through a

series of idler rolls, the metal in passing through these rolls will stretch along those side portions thereof which are shorter, provided the strip be restrained against lateral movement between the rolls, and, by this process of stretching, the successive shorter side portions of the strip are elongated until they are of the same length as the respective opposite longer portions, so that the strip is gradually put into a condition where the side edges are parallel as shown at 10c. In Fig. 2, this stretching is illustrated as occurring at the points 10d on the shorter side of the strip and as diminishing gradually toward the opposite portion 10e of the strip which is initially longer. This progressively increasing stretch of the strip toward its shorter side results in a sufficient elongation at the point 10d to bring about a parallel relationship of the opposite edges and a graduated stretching of intermediate parts so that these intermediate parts are in flat condition when the strip emerges from the straightening rolls.

The apparatus for practicing the method of the present invention is illustrated diagrammatically in Fig. 1, where the elongated metal strip 10 of steel or the like is shown as being withdrawn from a reel 11 and moved in the direction of the arrow 12 by means of a series of driven friction rolls 13 which are comparatively large in diameter and which are arranged in zig-zag fashion so that the strip is compelled to follow an irregular path in passing through this series of rolls, thereby obtaining a large area of contact between the strip and the surface of each roll. The strip 10 then passes in zig-zag fashion through a series of parallel straightening rolls 14 which are comparatively small in diameter and which operate as idler rolls arranged with their axes in one plane, so that the metal strip is bent back and forth between these rolls as it passes through them, being preferably restrained against lateral movement as it passes between these rolls. The strip 10 then passes through or around a series of friction rolls 15 which are power driven and which pull the strip under tension through the straightening rolls 14. Upon emerging from the rolls 15, the strip 10 is wound upon a reel 16, which maintains the strip under sufficient tension in the process of winding to hold it in contact with the friction rolls 15. The friction rolls 15 are preferably slightly larger in diameter than the rolls 13 if the rolls of the two series are driven at the same angular speed, or the rolls 15 are driven slightly faster than the rolls 13, so that the peripheral speeds of the rolls 15 are greater than the peripheral speeds of the rolls 13, which creates a substantial tension in a longitudinal direction in the strip 10 as it passes through the intervening idler rolls 14. Some slippage is provided in the driving mechanism of the friction rolls so that the tension created in the strip 10 is not sufficient to elongate the strip generally throughout its width and the result is that as the strip passes through the rolls 14, the tension therein is sufficient to stretch the shorter edges of the strip until these shorter edges are of the same length as the opposite longer edge portions. A brake is applied to the supply reel 11 to prevent the metal strip from being withdrawn therefrom too rapidly, thereby maintaining it in close contact with the rolls 13, and the driving mechanism which is connected to the winding reel 16 is provided with a friction clutch which is adapted to slip when required so that if the reel 16 be driven at a greater speed than the friction rolls 15, as is the preferred practice, the friction clutch may slip and at the same time maintain the strip sufficiently taut between the rolls 15 and the reel 16 to bring about a tight winding of the strip in the coil and at the same time keep the strip in close contact with the surfaces of the rolls 15.

The apparatus, as illustrated more in detail in Figs. 3 to 7, inclusive, comprises a frame 20 having mounted thereon bearings 21 in which is journaled a shaft 22. This shaft is provided with a brake drum 23 engaged by a friction brake strap 24 and the projecting end of the shaft has secured thereon the reel 11 on which the metal strip to be straightened is wound. This drum 11 has a disk 25 at one side thereof and its periphery is slotted as shown at 11a for engagement by the inner end of the strip. As the strip is unwound from this drum, the brake 23—24 prevents the drum from unwinding too freely and the brake strap is capable of adjustment for the purpose of regulating the resistance which is interposed to the unwinding of the strip. The friction drums 13, about which the strip 10 passes in advance of the straightening rolls 14, are carried by a frame 26 which is mounted on the floor or base 27 by which the frame 20 is carried. This frame 26 comprises longitudinal frame members 26a carrying bearings 27 in which are journaled a plurality of transverse shafts 28 on the projecting ends of which the friction rolls 13 are secured. These rolls are of sufficient width to accommodate any width of strip metal to be straightened and they are provided at their edges with flanges 13a to retain the metal strip in position thereon. The shafts 28 are so positioned that the rolls 13 have an irregular zigzag arrangement so that the metal strip 10 follows a corresponding sinuous course in passing through these rolls and is compelled to contact with a considerable portion of the surface of each roll. The shafts 28 are driven from a parallel shaft 29 which is journaled in bearings secured to the under sides of the frame members 26a and this shaft carries a pinion 30 which meshes with two gears 31 fixed on two of the shafts 28. These two gears mesh with other gears 31 fixed on the other shafts 28, as shown in Fig. 5, so that when the shaft 29 is driven as hereinafter described, all of the shafts 28 are driven in the proper directions to advance the strip 10 through these rolls when the apparatus is in operation. The end of the frame 26 carries a transverse member 32 which is provided with a slot 32a in its upper flange for engagement by a pair of pins 33 which extend vertically and have rollers 34 mounted thereon. These rollers 34 are positioned on opposite sides of the strip 10 and are adapted to maintain the strip in proper alignment with the straightening rolls 14 as the strip moves through the apparatus. The pins 33 are adapted to be clamped in the desired adjusted position to accommodate strips of various widths.

The rolls 15 are fixed on the ends of a plurality of shafts 38 which are journaled in bearings 39 carried by the longitudinal frame members 40a of another frame 40 which is carried by the base 27. The rolls 15 are provided with flanges 15a to retain the strip 10 in position thereon and they are arranged in zigzag fashion like the rolls 13 so that the strip 10 coacts with a considerable portion of the periphery of each roll. The shafts 38 are driven by a shaft 41 which has a pinion 42 secured thereon and arranged to mesh with two of the gears 43 which are secured on two of the shafts 38. Other gears 43 are secured upon the other shafts 38 and these gears intermesh with

each other in such a manner that the shafts 38 are all driven in the proper directions when the shaft 41 is actuated as hereinafter described. The straightening rolls 14 are carried by an intermediate frame 44 which is in the form of a heavy angle bar having its ends resting upon and secured to the frames 26 and 40, as shown in Fig. 5. The frame 44 has an upwardly extending flange 44a, shown in Fig. 6, in which are secured the inner reduced ends 45a of a series of stationary spindles or axles 45 upon which the straightening rolls 14 revolve. These spindles have enlarged collars 45b which coact with the outer faces of the frame members 44 and their inner threaded extremities are engaged by nuts 46 by which the spindles are clamped securely in position on the frame. Each roll 14 is in the form of a cylindrical sleeve adapted to revolve about the body portion of one of the spindles 45 and it has secured to the ends thereof a pair of annular flanges or collars 14a which are adapted to engage the lateral edges of the strip 10 to hold the strip against lateral movement as it passes through these straightening rolls. A ball bearing unit 47 is mounted on each spindle 45 between the roller 14 and the adjacent collar 45b and another similar ball bearing unit 48 engages the flange 14a carried by the other end of the roller and is located within the inner end of an adjusting member 49. This adjusting member 49 is internally threaded for engagement with an externally threaded cap member or sleeve 50 which is secured on the outer portion of the spindle 45 and which has an aperture in its end engaged by the threaded reduced portion 45c of the spindle. A nut 51 engages this threaded portion 45c to hold the cap member 50 in fixed position on the spindle. The adjusting member 49 is provided on its outer side with recesses 49a which may be engaged by a wrench for adjusting the member to the proper position to secure the ball bearing units 47 and 48 and the intermediate roller 14 against endwise movement on the spindle. The adjusting member 49 is secured in adjusted position by a locking member 52 which is internally threaded to engage the member 50 and which is provided externally with recesses 52a for engagement by a wrench. The outer ends of the spindles 45 are reduced in diameter as shown at 45d and these parts are arranged to fit apertures 53a formed in a bar 53 which extends along the outer ends of the spindles. This bar is secured at its ends to the ends of two or more of the spindles 45 by set screws 53b and at the end adjacent the rolls 15, it serves with the frame member 44 to support a roller 54 mounted upon a rod 55 which extends between the parts 44a and 53. This roller 54 located above the metal strip 10 imparts a reverse bend to the metal so that it has no tendency to remain coiled in one direction after passing through the rolls 15 or after being removed from the reel 16. The roll 14 which is located nearest to the friction rolls 13 is provided with end flanges or collars 14b which are considerably larger in diameter than the flanges 14a carried by the other rolls 14 so that the strip 10 is properly guided in its passage to the roll 14 from the rolls 13. The flanges 14a at each end of each roll 14 should be in absolute alignment, as nearly as practicable, with the flanges 14a at the same end of each of the other rolls 14.

The apparatus described above is driven by an electric motor 60 which has a shaft 61 provided with a relatively fixed pulley 62. A belt 63 passes over this pulley and over another pulley 64 which is secured upon the projecting extension of the shaft 41 previously described. The adjacent end of this shaft is journaled in a bearing block 65 and a pulley 66 is secured on the shaft adjacent to the frame 40. A belt 67 passes around the pulley 66 and around another pulley 68 which is secured upon the shaft 29 referred to above. In this way, the power derived from the motor 60 is utilized to drive both of the shafts 29 and 41 which operate the friction rolls 13 and 15, respectively. Since the rolls 15 are slightly larger in diameter than the rolls 13, for example, a few thousandths of an inch, the rolls 15 tend to pull the strip 10 through the straightening rolls 14 at a greater speed than that with which the strip is supplied to the rolls 14 by the rolls 13, and in order to retain the desired degree of tension in the strip 10, while it is in engagement with the rolls 14, by this method, without unduly stretching or breaking the strip, some slippage of the belt 67 on the pulleys 66 and 68 is permitted during the operation of the machine. In order to regulate this slippage for the purpose of maintaining the desired tension in the strip, means are provided for adjusting the tension of the belt 67. These means include a roller 70 which revolves on a pivot pin 71 carried by the free ends of a pair of arms 72 having their lower ends pivoted on a shaft 73 carried by a bracket 74 projecting from the frame 26. The shaft 73 has secured thereon a downwardly extending arm 75 which is apertured at its lower end for engagement by a stud 76 having its inner end threaded into a hole in the adjacent frame member. A nut 77 threaded on the stud 76 is adapted to engage the outer face of the arm 75 to limit the outward movement of this arm and the corresponding upward movement of the roll 70. As a further means of regulating the tension of the belt 67, a bell crank lever 78 is pivoted at 79 on a bracket 80 carried by a frame 40 and one arm of this bell crank lever is bifurcated to receive a roller 81 which is rotatably mounted therein and adapted to engage the under side of the lower stretch of the belt. The upstanding arm of the bell crank lever 78 is apertured for engagement by a stud 82 which is threaded into the adjacent vertical member of the frame 40. A nut 83 threadedly engages the stud 82 to limit the outward swing of the upper arm of the lever 78 and thereby limit the downward movement of the roller 81 which coacts with the belt. By regulating the extreme positions of the rollers 70 and 81, the slippage of the belt 67 may be regulated as desired.

With the apparatus described above, metal strips 10 of varying widths may be straightened by reason of the fact that any particular set of rolls 14 may be interchanged with other rolls of different lengths by removing the bar 53 and the parts 49, 50, 51 and 52 and replacing the rolls 14 by other rolls of different length. When straightening a metal strip 10 which is comparatively narrow and heavy, it is desirable to use rolls 14 having aligning flanges 14a which are spaced apart a distance substantially equal to the width of the strip, so that the strip is firmly held against lateral movement as it passes through the rolls 14 and is compelled to engage these rolls with its short edge only and is thus caused to elongate or stretch at those places where one side is shorter than the other, instead of shifting endwise of the rolls 14, which would be the natural tendency of the strip if it were not restrained. The use of rolls 14 having flanges 14a which are spaced precisely in this manner is recommended for the straightening of metal strapping or other metal strips of any gauge where the width is comparatively narrow, but it

has been found that the method of the present invention is capable of being used satisfactorily to straighten strip metal of considerable width without positively restraining the strip against lateral movement by flanges located at the ends of the straightening rolls, and there is illustrated in Fig. 7 a modified form of straightening roll which may be employed when operating upon metal strips of considerable width. In this view, the member 44*b* corresponds to the upstanding portion 44*a* of the frame member previously described and it has mounted therein a series of spindles 85 which correspond in form and method of mounting to the spindles 45 previously described, being secured in place within the frame member 44*b* by nuts 86. The rolls 14*d* which are mounted to revolve on the spindles 85 are comparatively long to accommodate a strip 10*a* of substantial width and although the rolls 14*d* are provided at their ends with flanges 14*c*, these flanges are not so spaced as to engage the edges of the strip 10*a* and metal strips having a considerable range of width may be rolled with one series of rollers 14*d*. The flanges 14*c* carried by the rolls 14*d* are engaged at their ends by ball bearing units 87 and a collar 88 is secured upon the threaded portion 85*c* at the outer end of each spindle to hold the adjacent ball bearing unit in position. The threaded portions 85*c* of these spindles are engaged by nuts 91 and the outer reduced ends 85*d* of these spindles engage a bar 93 which corresponds to the bar 53 described above.

Although one form of the improved apparatus has been shown and described, with a modification of the construction and mounting of the straightening rolls, it will be understood that the improved apparatus and the method of straightening may be modified without departing from the scope of the appended claims. In the claims, the term "metal strip" is to be understood as having the meaning given to it in the steel industry, where it is used to define a normally flat metal strip produced by a rolling process and where it is distinguished from wire, whether the wire be of round or other cross section.

I claim:

1. The method of removing lateral curvature from an elongated metal strip which consists in running the strip endwise along a zigzag path, restraining the strip against lateral movement as it travels along said path and thereby maintaining its edges substantially in parallel frames, and maintaining the strip under sufficient tension to stretch the shorter side portions thereof as it travels along said path.

2. The combination in apparatus for removing lateral curvature from an elongated metal strip, of a set of straightening rolls through which the strip is adapted to travel in a sinuous path, means for maintaining the edges of said strip substantially in parallel planes as it travels through said rolls, and means for moving the strip through said rolls and maintaining it under tension to stretch the shorter side portions thereof.

3. The combination in apparatus for removing lateral curvature from an elongated metal strip, of a set of straightening rolls through which the strip is adapted to travel in a sinuous path, means for maintaining the lateral edges of said strip substantially in parallel planes as it travels along said path, a power driven winding reel for winding said strip after it has passed through said straightening rolls, a supply reel from which the strip to be straightened is unwound, two series of friction rolls, each series of friction rolls being engaged by said strip between one of said reels and said straightening rolls, and power means for driving each series of friction rolls, the friction rolls in advance of said straightening rolls being adapted to move said strip at a lesser speed than the friction rolls which follow said straightening rolls, whereby sufficient tension is maintained in said strip to stretch the shorter side partions thereof.

4. The combination in apparatus for removing lateral curvature from an elongated metal strip, of a set of straightening rolls through which the strip is adapted to travel in a sinuous path, a power driven winding reel for winding said strip after it has passed through said straightening rolls, a supply reel from which the strip to be straightened is unwound, two series of friction rolls, each series of friction rolls being engaged by said strip between one of said reels and said straightening rolls, the friction rolls in advance of said straightening rolls being adapted to move said strip at a lesser speed than the friction rolls which follow said straightening rolls, and means for interconnecting the driving means of said two series of friction rolls to permit a predetermined slippage in the driving connection of one series of friction rolls whereby said strip is maintained at a predetermined tension as it passes through said straightening rolls.

5. The combination in apparatus for removing lateral curvature from an elongated metal strip, of a set of straightening rolls through which the strip is adapted to travel in a sinuous path, a power driven winding reel for winding said strip after it has passed through said straightening rolls, a supply reel from which the strip to be straightened is unwound, two series of friction rolls, each series of friction rolls being engaged by said strip between one of said reels and said straightening rolls, the friction rolls of one series tending to move said strip at a greater speed than the rolls of the other series, a pair of shafts each adapted to drive one series of friction rolls, power means for operating one of said shafts, a pair of pulleys each mounted on a separate one of said shafts, a belt extending around said pulleys, and adjustable means engaging said belt for regulating the slippage of said pulleys.

6. The combination in apparatus for removing lateral curvature from an elongated metal strip, of a set of straightening rolls through which the strip is adapted to travel in a sinuous path, a power driven winding reel for winding said strip after it has passed through said straightening rolls, a supply reel from which the strip to be straightened is unwound by said first-named reel, two series of friction rolls, each series being engaged by said strip between one of said reels and said straightening rolls, said strip being adapted to follow a zigzag path through each of said series of friction rolls, one series of friction rolls being of such diameter that they tend to move said strip at a greater speed than the rolls of the other series when driven at the same angular speed, a pair of shafts each adapted to drive one series of friction rolls, power means for operating one of said shafts, a pair of pulleys each mounted on a separate one of said shafts, a belt extending around said pulleys, and adjustable means engaging said belt for regulating the slippage of said pulleys.

7. The combination in apparatus for straightening an elongated metal strip, of a series of straightening rolls through which the strip is

adapted to travel along a sinuous path in engagement with successive rolls, a frame, a spindle carried by said frame for each of said rolls, each of said rolls being removably mounted in one of said spindles and having side flanges spaced apart to conform to the width of the strip to be straightened, fastening means for securing each of said rolls on each spindle and permitting each roll to be replaced by other rolls of different width, said fastening means for each roll comprising an external threaded cap member mounted on said spindle, a sleeve threaded on said cap member and adapted to retain the adjacent roll against endwise movement, and a nut threadedly engaging said cap member for securing said sleeve in adjusted position.

8. The method of removing camber from an elongated metal strip which comprises the steps of running the strip endwise in a sinuous path with the shorter edges only of the strip in contact with means determining the form of said path, restraining said strip against lateral movement during its travel, and maintaining the strip under sufficient tension to effect a progressive stretching of the metal between its shorter and longer edges whereby the opposite edge portions of the strip assume the same length and become parallel with each other.

9. The combination in apparatus for removing lateral curvature from an elongated metal strip, of a set of straightening rolls through which the strip is adapted to travel in a sinuous path, means for maintaining the edges of said strip substantially in parallel planes as it travels along said path, a power driven winding reel for moving said strip through said straightening rolls, a supply reel from which the strip to be straightened is unwound, a series of friction rolls engaged by said strip between each of said reels and said straightening rolls, and means for driving said friction rolls in such a manner that sufficient tension is maintained in said strip to stretch the shorter side portions thereof.

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