

April 12, 1966

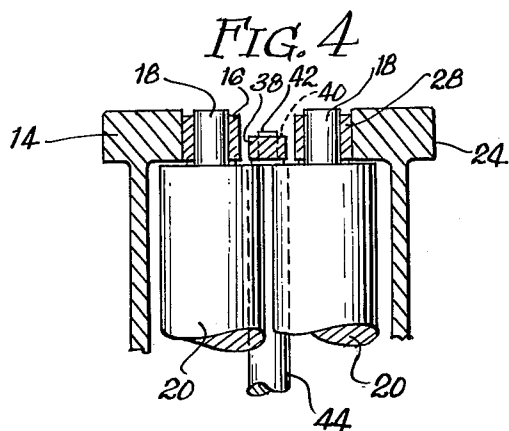
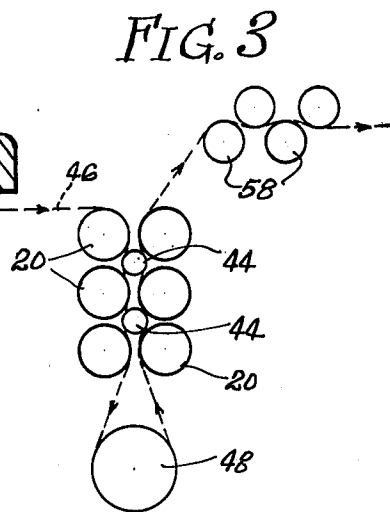
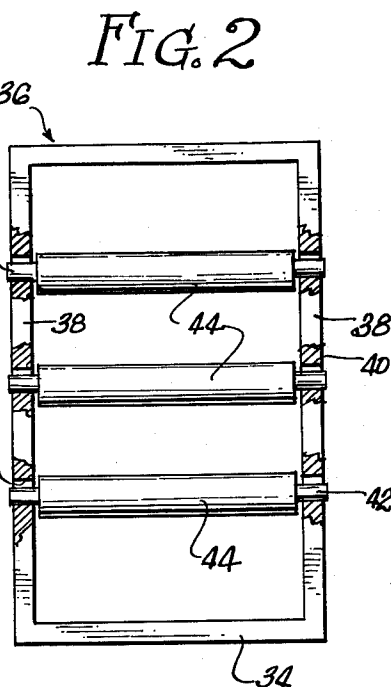
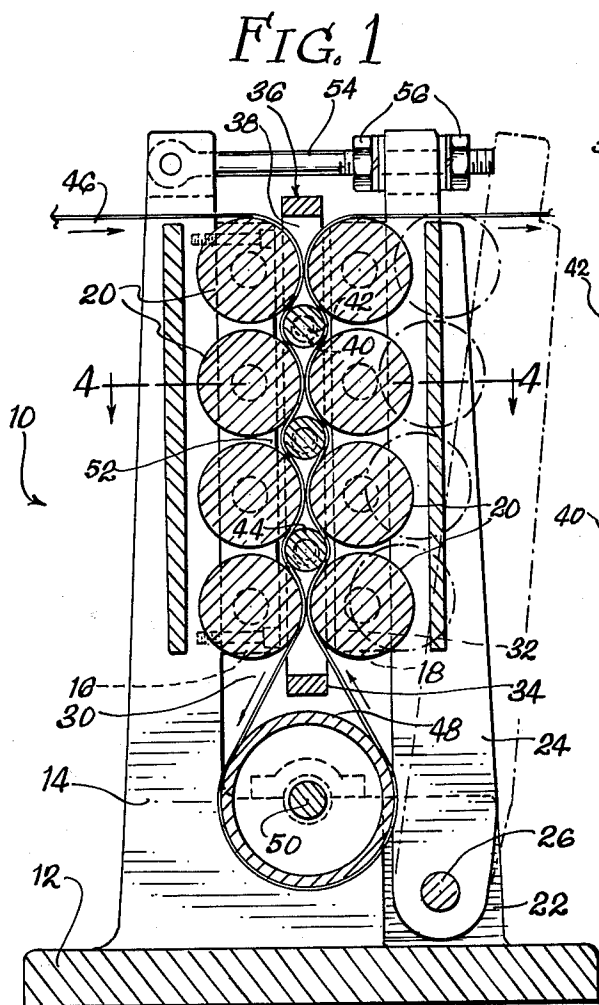
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3,245,244

MECHANISM FOR FLATTENING METAL STRIP

Filed Aug. 7, 1963

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

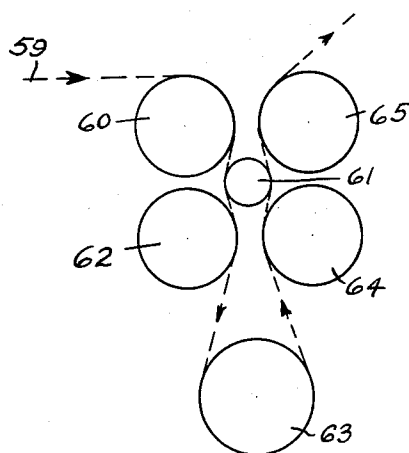
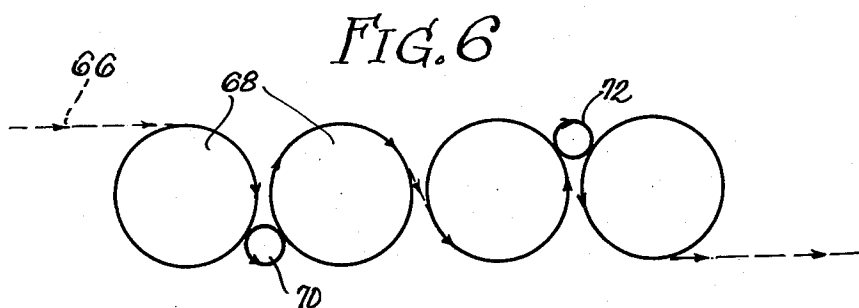


FIG. 5

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MECHANISM FOR FLATTENING METAL STRIP

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Filed Aug. 7, 1963, Ser. No. 300,488

14 Claims. (Cl. 72-163)

This invention relates to an improved apparatus for flattening metal strip. In particular, the invention is concerned with a unique mechanism which is peculiarly suitable for the flattening of extremely thin metal strip.

After completion of working operations in cold rolling mills, metals strips often exhibit an unsatisfactory flatness. Since a high degree of flatness is required for relatively thin metal strip which is to be used for the production of panels, boxes, cans, etc., procedures must be devised for removing waviness in the sheet.

It has been recognized that lack of flatness is demonstrated by edge or center waviness which can be attributed to dimensional inconsistencies across a given strip section. These inconsistencies arise during a rolling operation, wherein certain strip sections may be elongated to a greater extent than adjoining sections, and these dimensional differences result in poor flatness and undesirable internal stress patterns.

Many roller leveler devices have been provided which are capable of flattening strip above a certain thickness. In such roller levelers, the strip is exposed to alternative flexure between opposed sets of rollers arranged in a staggered relationship. By providing a sufficiently high degree of flexure, portions of the strip which are "shorter" than others will slightly elongate and, therefore, buckles, waves, etc., can be removed.

Roller leveler machines have been developed to a high degree of perfection for use with a relatively thick strip. However, for strips thinner than about 0.01 inch, extreme difficulties have been encountered. Such strips, especially in the work-hardened state, are almost impossible to flatten because the required plastic flexure cannot be accomplished in a conventional roller leveler. It is believed that the main difficulty with respect to such strip lies in the necessity for providing flexing rollers of sufficiently small diameter so that the ratio between strip thickness and roller diameter is of the order of 1:100 when the strip is about 0.01 inch thick or thinner, rollers of one inch diameter or less would be required. Such thin rollers have little inherent rigidity and they would bend excessively between backing elements in conventional leveler constructions, thus resulting in their sine-like deflection and consequent formation of streaks in the strip. Consequently, roller levelers of orthodox design cannot utilize rollers as thin as 0.2-0.5 inch in diameter and are, therefore, incapable of efficient flattening of strips about 0.005 inch thick or thinner. Indeed, the practical lower limit for work rolls in common levelers lies around one to 7/8 inch diameter.

It is an object of this invention to provide a completely unique mechanism for using in the flattening of metal strip.

It is a more particular object of this invention to provide a strip flattening apparatus which is particularly suitable for the handling of relatively thin strip.

It is a further object of this invention to provide a strip flattening apparatus which is capable of employing rollers having a diameter of one inch or less whereby effective flattening of strip having a thickness of .010 inch or less can be accomplished.

These and other objects of this invention will appear hereinafter and for purposes of illustration, but not of limitation, specific embodiments of this invention are shown in the accompanying drawings in which:

FIGURE 1 is a vertical elevational view, partly in

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section, of one suitable mechanism for accomplishing the objects of this invention;

FIGURE 2 is an elevational view of the flexing rolls and supporting frame use in the construction of FIGURE 1;

FIGURE 3 is a diagrammatic view illustrating the travel of strip to be flattened with the construction of FIGURE 1;

FIGURE 4 is an enlarged fragmentary sectional view taken about the line 4-4 of FIGURE 1;

FIGURE 5 is a diagrammatic view of an alternative form of the invention; and,

FIGURE 6 is a diagrammatic view of a still further alternative form of the invention.

The apparatus of this invention includes a stand which is adapted to carry a plurality of work rolls of relatively large diameter arranged to rotate about their fixed axes. Means are also associated with the apparatus which are capable of supporting flexing rolls, and the strip to be flattened is carried in contact with the work rolls and flexing rolls. It must be emphasized that both the flexing rolls and the work rolls partake in flexing of the strip; however, the different terms are used to provide a means for distinguishing between the different sets of rolls used in the systems of this invention.

An important feature of this invention provides for a floating arrangement of the flexing rolls whereby neither the ends of the rolls nor their bodies are supported for rotation about a fixed axis. To the contrary, the flexing rolls which characterize the apparatus of this invention are held in position by means which uniformly support them along their length whereby bending or deflection of these rolls will not take place during the strip flattening operation. With this arrangement, rolls having a diameter of about one inch or less can be employed for flattening metal strip even where the strip is relatively wide.

In accordance with one form of this invention, the strip to be flattened is adapted to pass while under tension in contact with the flexing rolls on both sides thereof whereby the strip itself acts as the means which prevents deflection of the flexing rolls. The arrangement provided by this invention enables firm holding of the flexing rolls in position whereby the desired flexure in the strip can be uniformly accomplished and whereby the danger of distortion of the flexing rolls is substantially eliminated.

In a distinct form of the instant invention, the strip to be flattened is alternatively passed over large work rolls and over flexing rolls. The work rolls and flexing rolls are arranged in staggered relationship, and although the flexing rolls do not actually contact the work rolls, deflection of the flexing rolls is eliminated as a result of the rigidity of the work rolls and due to the support of the strip itself. Specifically, the strip to be flattened is at all times passing between the flexing rolls and work rolls in accordance with this form of this invention; however, the strip which moves under tension constantly presses against the flexing rolls whereby they are urged in a manner such that back-up support is provided by the work rolls.

The accompanying drawings illustrate specific structures which are characterized by the features of this invention. FIGURE 1 illustrates a structure 10 including a base 12 having a first upstanding post 14 integrally associated therewith. This post 14 includes bearing members 16 whereby the ends 18 of work rolls 20 can be rotatably carried by this post. The post 14 also includes projections 22 which pivotally carry a roll supporting platen 24. This platen pivots about the pin 26 and also includes bearing member 28 for carrying the ends 18 of a second set of rolls 20. Whereas the work rolls are shown end-journalled to explain the principle of the dis-

closed systems, it is obvious that in wide units, a conventional backing structure may be employed with respect to these work rolls.

An intermediate section 30 of the post 14 defines a recess 32 which receives the lower end 34 of a frame 36. The sides 38 of this frame define openings 40 which are adapted to receive the ends 42 of flexing rolls 44. It will be noted that the openings 40 are oversize whereby vertical displacement of the ends 42 can be accomplished.

The strip 46 which is to be flattened is guided through the apparatus whereby the strip will pass over the uppermost left-hand work roll 20 and then downwardly along a path defined between the flexing rolls 44 and the left-hand bank of work rolls. A large idler roll 48 is provided at the bottom of the apparatus and is rotatably supported on shaft 50. The strip 46 changes direction when passing over this idler roll and then passes upwardly between the right-hand set of work rolls 20 and the flexing rolls 44.

The frame member 36 is adapted to be seated in the stand whereby each of the rolls 44 can float within the generally diamond shaped spaces 52 defined between the opposed adjacent rolls 20. It will be appreciated that with this arrangement, the rolls 44 will actually rest on the surfaces of the strip 46 and the ends 42 of these rolls will not contact the frame. Accordingly, bending stresses will not be set up in the rolls and deflection thereof will be avoided.

The illustrated construction provides a threaded member 54 adapted to be attached to the portion 24 by means of nuts 56. With this arrangement, the portion 24 can be pivoted clear of the apparatus to facilitate threading of the strip 46. This threading operation should be accomplished by moving this portion 24 to the dotted line position shown in FIGURE 1 bringing the strip around the roll 48 and then upwardly over the top right-hand roll 20. The portion 24 can then be clamped in place and the strip can be passed to finishing leveling step comprising rolls 58 shown in FIGURE 3.

The strip is to be drawn through the apparatus while maintained under tension. The tension applied to the strip must be at least sufficient to provide pressure against the flexing rolls whereby the floating arrangement will be achieved. In order to accomplish this pressure, drag means may be applied to the play-out reels, pinch rolls may be used at intermediate points, and tension take-up reels may be provided. It will be obvious that various combinations of conventional means for holding strip under tension can be suitably employed in the systems of this invention.

In the form of the invention shown in FIGURE 5, the sheet 59 is fed over the inner peripheral portion of a first roll 60. The sheet is then subjected to bending over the side surface of intermediate flexing roll 61. Thereafter, the sheet is bent about the inner peripheral portion of roll 62, this roll comprising the second roll in a pair of work rolls constituting the rolls 60 and 62.

A roll 63 is provided whereby the direction of movement of the sheet can be reversed. The sheet is then fed back over rolls 64, 61 and 65. The rolls 64 and 65 comprise a pair of rolls which, with the first mentioned pair of rolls, form a cluster of four rolls similar to the clusters heretofore described.

In the embodiment shown in FIGURE 6, the strip 66 is first passed over work roll 68, around the flexing roll 70, then around the next two work rolls into contact with flexing roll 72. The flexing rolls 70 and 72 are provided alternately above and below the rolls 68. It will be appreciated however, that these work rolls provide the necessary back-up for the flexing rolls whereby deflection can be avoided. A floating mounting for the flexing rolls is also contemplated with respect to the embodiment shown in FIGURE 6.

It will be understood when considering any of the above embodiments that the number of work and flexing

rolls and their sizes can vary considerably in accordance with the concepts of this invention. With respect to the embodiment shown in FIGURES 1 through 4, it will be noted that each of the flexing rolls actually provides for two separate operations. Accordingly, a substantial space saving feature characterizes this embodiment of the invention.

The concepts of the instant invention are contemplated for use with metal strips even where such strips are not considered extremely thin. In such cases, the support features described herein will eliminate to some degree the necessity for using roll manufacturing procedures designed to eliminate a tendency toward bending. Furthermore, in cases where extremely wide strip, even of substantial thickness, is to be flattened, the concepts of this invention have considerable value since the rolls in levelers of this nature tend to deflect even though they are of relatively great diameter. Although the instant invention is not intended to be limited to a particular formula, it has been determined that the maximum diameter of a small roll that can be accommodated in the spaces 52, when the work rolls are in their most closely spaced arrangement, is about equal to $r(\sqrt{2}-1)$ where r is equal to the radius of the work rolls. It will be understood that where larger spaces are defined between the work rolls, then larger flexing rolls can be included in the spaces. Similarly, rolls smaller than the maximum suggested by the above relationship can be suitably employed.

It will be understood that various changes and modifications can be made in the structures described above which provide the characteristics of this invention without departing from the spirit thereof particularly as defined in the following claims.

What is claimed is:

1. An apparatus for flattening metal strip comprising a stand, a plurality of work rolls mounted for rotational movement in said stand, said rolls being arranged in at least two, spaced-apart, opposed rows, an open space defined between each set of adjacent rows, a strip flexing roll fitted within each such space, each flexing roll being mounted for floating movement within said space, and means for transporting said strip through said apparatus whereby the strip is carried in contact with one row of said work rolls and in contact with said flexing rolls, said strip being thereafter returned to pass into contact with the other row of said work rolls and in contact with said flexing rolls whereby the flexing rolls are held in position substantially completely through engagement with said strip.

2. An apparatus in accordance with claim 1 wherein said flexing rolls are not more than about one inch in diameter and are substantially smaller than said work rolls.

3. An apparatus for flattening metal strip comprising a stand, a plurality of work rolls mounted for rotational movement in said stand, said rolls being arranged in at least two, spaced-apart, opposed rows, the rolls in each of said rows being arranged with their axes in parallel relationship and being co-planar whereby a generally diamond shaped open space is defined between each set of adjacent rolls, a strip flexing roll fitted within each such space, each flexing roll being mounted for floating movement within said space and means for transporting said strip through said apparatus whereby the strip is carried through said spaces first in contact with one row of said work rolls and in contact with said flexing rolls, and is thereafter returned through said space to pass in contact with the other row of said work rolls and in contact with said flexing rolls whereby the flexing rolls are supported substantially completely through engagement with said strip.

4. An apparatus in accordance with claim 3 wherein said flexing rolls are not more than about one inch in

diameter and are substantially smaller than said work rolls.

5. An apparatus in accordance with claim 4 wherein said flexing rolls are mounted in a frame member, said flexing rolls having end portions adapted to be received in openings defined in said frame member, said openings being oversized to permit floating association of said flexing rolls with respect to said frame member and whereby said flexing rolls are adapted to be supported by said frame member when said strip is removed from said apparatus.

6. An apparatus in accordance with claim 5 wherein the stand portion supporting one row of said work rolls is pivotally connected to the stand whereby this stand portion and the associated work rolls can be moved away from said apparatus to facilitate threading of the strip into said apparatus and adjustment thereof.

7. An apparatus in accordance with claim 3 wherein said rows of rolls are arranged vertically with the entry and exit end for said strip being located at the top of the apparatus, an idler roll at the bottom of the apparatus around which said strip passes when changing direction, and drive means adjacent said exit end for pulling said strip through said apparatus.

8. An apparatus for flattening metal strip comprising a stand, a plurality of work rolls mounted in adjacent pairs for rotational movement in said stand, a strip flexing roll fitted within the spaces defined between each pair of work rolls with the flexing roll associated with one pair of work rolls being mounted on one side of said work rolls and the flexing roll associated with an adjacent pair of work rolls being mounted on the other side of said work roll, each flexing roll being mounted for floating movement within said space, means for transporting said strip through said apparatus whereby the strip passes between each flexing roll and the adjacent work rolls, said flexing rolls being held in a floating position within said space by means of forces applied to their surfaces by said strip.

9. An apparatus in accordance with claim 8 wherein said strip is maintained under tension as it is passed through said apparatus.

10. An apparatus in accordance with claim 8 wherein said work rolls are arranged with their axes parallel and disposed in a horizontal plane with said flexing rolls engaging said work rolls and being pressed against said work rolls by reason of the force exerted by said strip.

11. An apparatus in accordance with claim 10 wherein the forces exerted by said strip urge said flexing rolls into the space defined between adjacent work rolls.

12. A method of leveling sheet metal which comprises feeding the sheet into a space defined by a cluster of four rolls and an intermediate roll in said space, said four rolls being fixedly arranged in pairs of work rolls on either side or opposite sides of said intermediate roll, the method including the following successive steps

- (1) feeding the sheet under tension into said space and bending it in one direction over the inner peripheral

eral portion of a first roll of the first pair of work rolls;

- (2) bending the sheet in the opposite direction about one side surface of said intermediate roll;

- (3) bending the sheet in said one direction about the inner peripheral portion of the second roll of the first pair of work rolls;

- (4) looping the sheet to reverse the direction of movement of its leading end portion;

- (5) feeding the sheet back to said space and bending it about the inner peripheral surface of the second roll of the second pair of work rolls in a direction opposite to that of the bending about the second roll in said first pair;

- (6) bending the sheet about the opposite side surface of said intermediate roll in a direction opposite to the previous bend on said intermediate roll; and

- (7) thereafter bending the sheet about the inner peripheral surface of the first roll of the second pair of work rolls, the direction then being opposite to that of the bend about the first roll of the first pair of work rolls.

13. The method of leveling sheet metal which comprises feeding the sheet into a space defined by a cluster of four work rolls and about the opposite sides of an intermediate floating roll, and maintaining a tension on said sheet during said feeding whereby said intermediate roll is drawn toward the inner peripheral surfaces of a pair of work rolls to press the sheet against such surfaces and thereby back up said intermediate roll.

14. In the method of leveling metal sheet stock which comprises feeding the sheet continuously into a space defined by a first group of work rolls and a second group of work rolls with a floating roll between each pair of work rolls in the first and second group of work rolls and in the space between said group of work rolls, the method comprising the steps of feeding the sheet under tension into the space between the two groups of work rolls for passage in one direction between the floating roll and the adjacent pair of rolls in the first group of work rolls and then in the opposite direction between the floating roll and the adjacent pair of rolls in the second group of work rolls whereby the sheet is flexed in one direction during passage between the first group of work rolls and the floating roll and in the opposite direction during passage between the second group of work rolls and the floating roll and whereby the floating roll is supported on its opposite sides by said sheet.

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