

March 9, 1965

T. A. FOX

3,172,313

STRIP ROLLING APPARATUS

Filed March 21, 1961

3 Sheets-Sheet 1

Fig. 1.

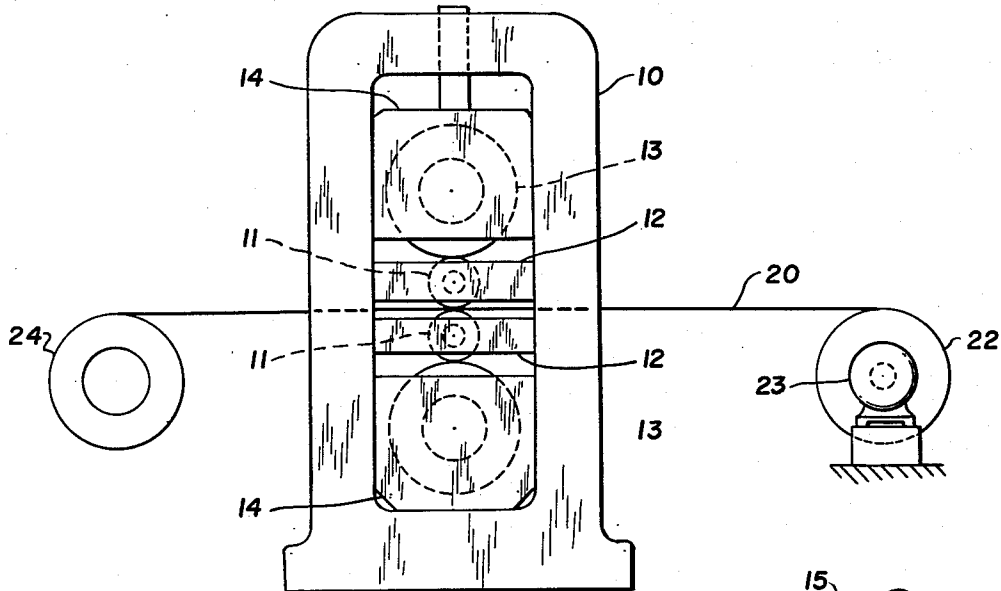
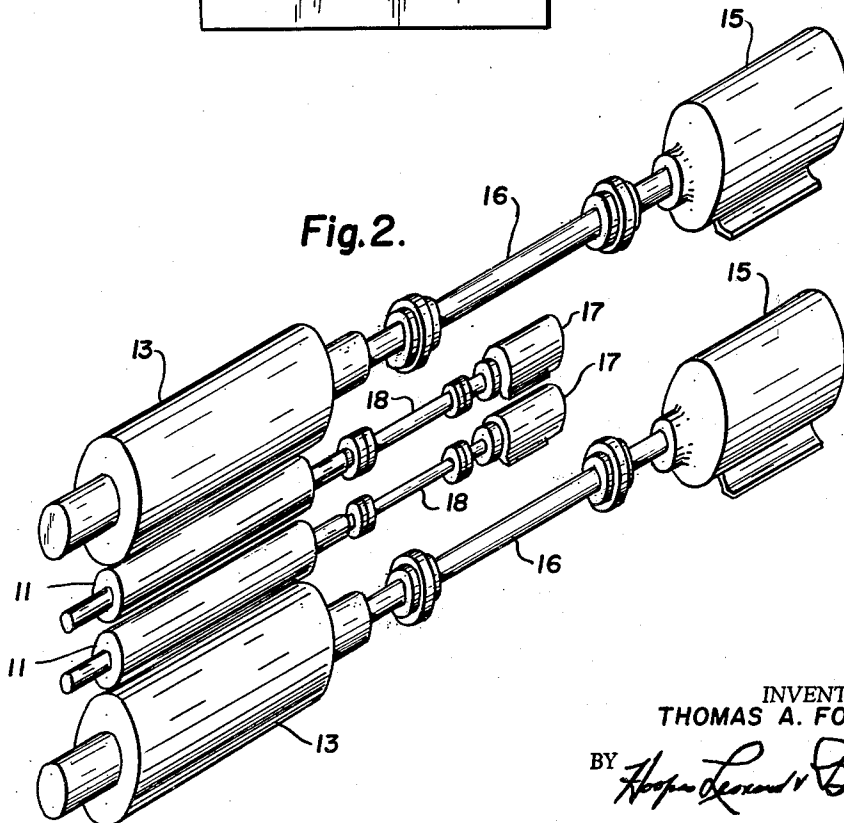


Fig. 2.



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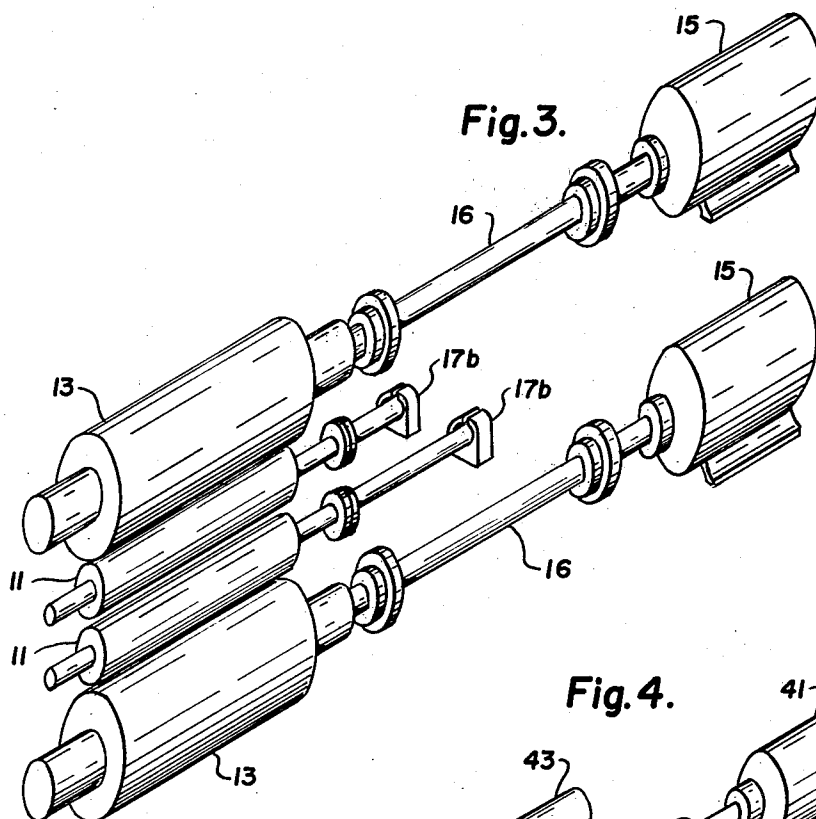
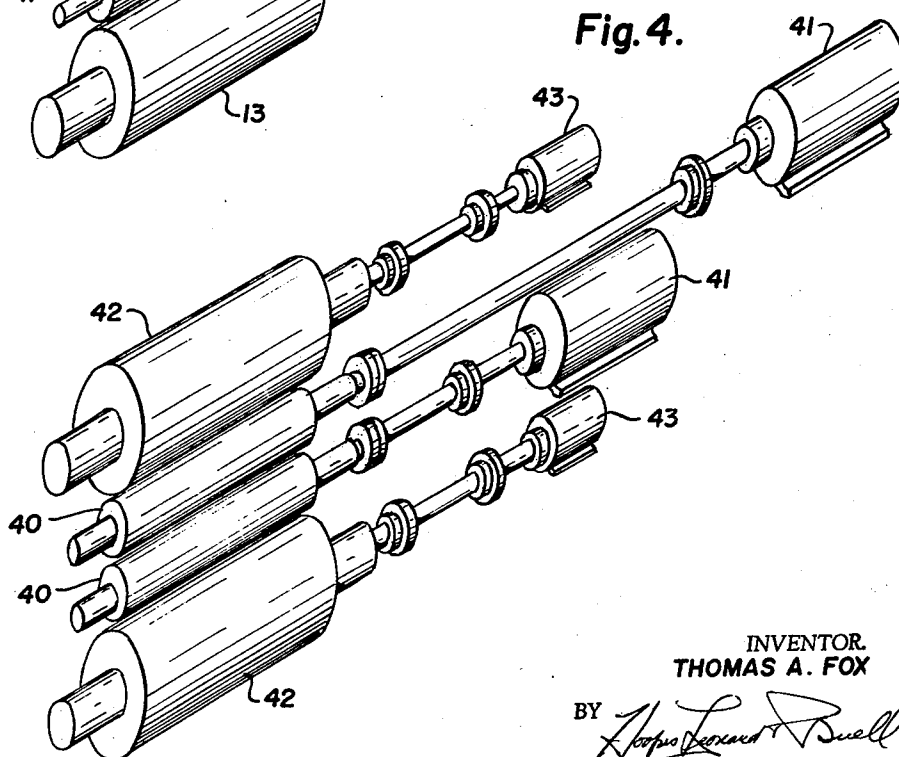
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3 Sheets-Sheet 2



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3 Sheets-Sheet 3

Fig. 6.

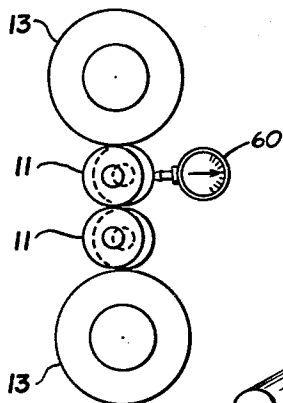


Fig. 5.

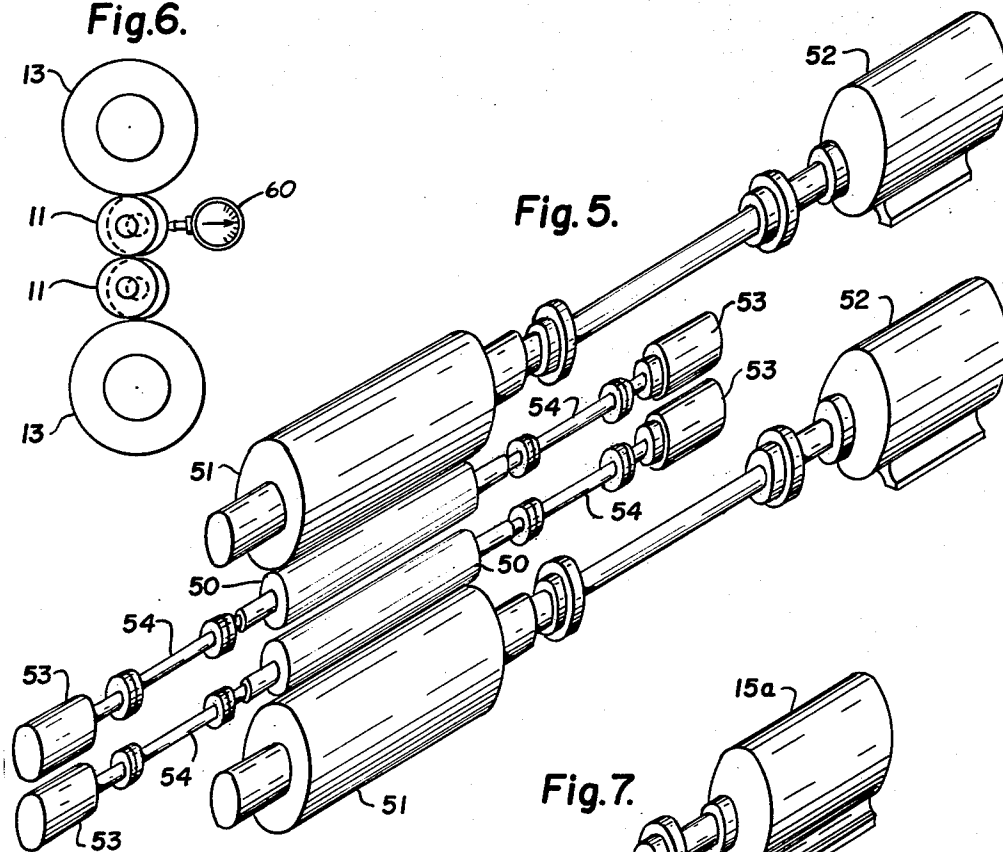
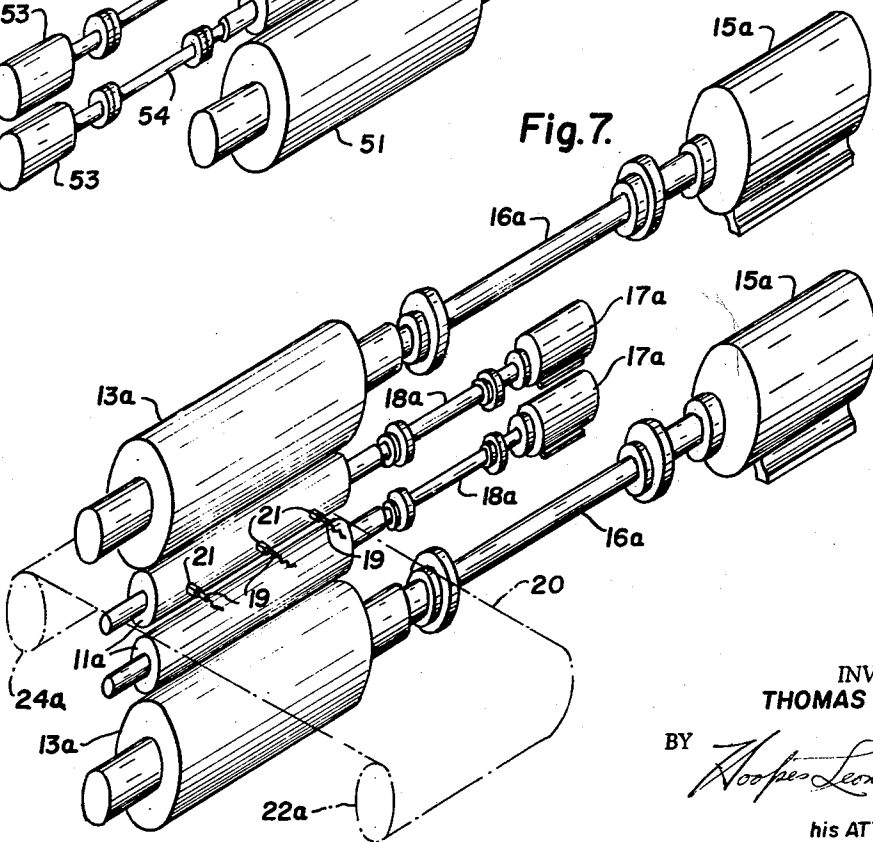


Fig. 7.



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STRIP ROLLING APPARATUS

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15 Claims. (Cl. 80-38)

This invention relates to strip rolling apparatus and particularly to apparatus for cold rolling strip and sheet.

It is now a well recognized fact that metal strip or sheet can most effectively be rolled by the use of small work rolls backed up by one or more back-up rolls of large diameter. This is so because of the considerable variation in the amount of work involved in moving the rolls depending upon the working arc of the roll.

The use of small diameter work rolls introduces many problems, among which are deflection both vertically and laterally. Vertical deflection is taken care of by the use of massive back-up rolls having diameters many times greater than the diameter of the work rolls. Lateral deflection on the other hand has proven difficult to overcome. Wadsworth Patent 2,160,767 attempts to overcome this problem by a complex arrangement of small rolls in a cluster, backed up by a larger work roll. This is an expensive arrangement requiring a complex drive mechanism. Dahlstrom Patent 2,601,792, shows still another approach to this problem. Dahlstrom provides a work roll backed up by a driven back-up roll and a driven take up reel receiving the strip. A member movable in response to deflection of the work roll operates a controller which increases or decreases the power on the drive to the take-up reel and the back-up roll so as to add increased pull on the strip or increased speed of the roll depending upon direction of deflection of the roll. This mechanism is complicated by the need to correlate two different drive motor speeds and has never to my knowledge proved to be entirely satisfactory.

I have invented a strip rolling apparatus which overcomes these problems of lateral deflection. I provide a strip rolling apparatus having a pair of small diameter work rolls for metal reduction, a large diameter back-up roll for each work roll, driving means connected to one pair of said work rolls or said back-up rolls, and variable load means acting on the undriven pair of said work rolls and back-up rolls to provide a load variation in one direction or the other on the driven rolls. The variable load means may act as an additive or subtractive load on the main driving force of reduction. The resultant of such variable load means on the undriven roll is to cause the axis of each work roll to move from one side to the other of the vertical axis of the back-up rolls or to a position directly on such vertical axis dependent upon the forces of rolling and the force exerted by the variable load means. Preferably the variable load means is a hydraulic or electric motor or a brake. In a preferred form of my invention I provide a sensing means in contact with the work roll adapted to signal a change in contour from a null position to a control means for the variable load means. The variable load means may alternatively be manually operated. The sensing means may be in the form of load cells, the Sheffield air gauge, a movable rheostat arm, or may be actuated through variations of load on the drive means.

In the foregoing general statement I have set out certain objects, advantages and purposes of my invention. Other objects, purposes and advantages of my invention will be apparent from a consideration of the following description and the accompanying drawings in which:

FIGURE 1 is a vertical side elevational view of a 4 high rolling mill in accordance with my invention;

FIGURE 2 is a diagrammatic view of a rolling mill arrangement according to a preferred embodiment of my invention;

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FIGURE 3 is a diagrammatic view of a rolling mill arrangement according to a second embodiment of my invention;

FIGURE 4 is a diagrammatic view of a rolling mill arrangement according to a third embodiment;

FIGURE 5 is a diagrammatic view of a rolling mill arrangement according to a fourth embodiment of my invention;

FIGURE 6 is a vertical section of the mill of FIGURES 1 and 2 showing in exaggerated scale the horizontal deflections which may take place in work rolls and indicator means for showing the same; and

FIGURE 7 is a schematic illustration of the embodiment of FIGURE 1 with a control system in schematic form.

Referring to the drawings I have illustrated a mill housing 10 of generally conventional design. Mounted in housing 10 are a pair of work rolls 11, journaled in bearing chocks 12 in usual manner, and backed up by back-up rolls 13 as is the case in most 4 high mills. The back-up rolls 13 are journaled in chocks 14 in the housing 10 and are driven by drive motors 15 through couplings 16 of usual design.

The work rolls 11 are provided with drive motors 17 and couplings 18 to the roll necks. The work roll axes are in the same vertical plane as the back-up roll axes so that any lateral bowing movement will carry a portion of the work roll out of this plane and the contact of the work roll and back-up roll will tend to be in an arcuate shape, up one side of the back-up roll or the other. The effect of this lateral displacement is readily detected by visual observation or by conventional detecting or sensing means measuring thickness variations of the strip or actual deflection of the work rolls 11.

A take up reel drum 22 of usual design is used to take up the finished strip. This reel is driven by a conversion motor drive 23. Similarly a conventional pay out reel 24 is provided on the feed side of the mill. This reel 24 may be provided with a drive or brake in conventional manner.

In the form illustrated in FIGURE 2 I have not shown any detecting or sensing means. The operation of this device is as follows. The strip passing from pay out reel 24 through work rolls 11 onto take up reel 22 is reduced by the action of the work rolls which are frictionally driven through the back-up rolls 13. If the work roll is laterally displaced to the left viewing FIGURE 2, the operator energizes drive motors 17 to rotate the work rolls 11 in a direction opposite to the frictional drive of the back-up rolls. In FIGURE 2 the back-up rolls could be rotating in clockwise direction and urging the work rolls in the counter clockwise direction. With lateral displacement to the left of FIGURE 2, the drive motors 17 would urge the work rolls in clockwise direction tending to carry them back beneath the back-up rolls.

If the rolls 11 are laterally displaced to the left then motors 17 would be energized to drive the rolls in counter-clockwise direction.

In the embodiment of FIGURE 7 I have illustrated the same drive arrangement as FIGURE 2 but with automatic controls. Load cells 19 are mounted above the strip pass line 20 with feeler arms 21 in contact with the face of the work roll. The load cells are arranged to give a signal in one direction or the other depending upon the direction of lateral displacement of the work rolls 11. Motors 17 are energized to rotate in one direction or the other depending upon the displacement of rolls 11. The load cells may be used to operate the motors 17 through any of the well-known amplifier and motor controller circuits, such as for example as are illustrated in Polakowski Patent No. 3,018,676 and in various technical publications.

This circuitry is well known and will not be described in specific detail here.

The operation of the device of FIGURE 7 is as follows. The strip passing from pay out reel 24a through between work rolls 11a onto take-up reel 22a is reduced by the action of the work rolls which are frictionally driven through the back-up rolls 13a. If the work roll is laterally displaced to the left, viewing FIGURE 7, the feeler arms 21 will move and energize the load cells 19 which will energize drive motors 17a to rotate the work rolls in a direction opposite to the frictional drive of the back-up rolls. In this example with the strip moving toward the right in FIGURE 7 the back-up rolls would be rotating in the clockwise direction and urging the work rolls to rotate in counter-clockwise direction. With lateral displacement to the left, as predicated in this example, the drive motor 17a would urge the work rolls in the clockwise direction tending to carry them back beneath the back-up rolls. This sensing arrangement may be used with any of the embodiments of the invention illustrated and described in this application.

If on the other hand the take-up reel is exerting a greater pressure on the work rolls and urging them into a bow toward the right then the work roll drive would cause them to increase their rotation in the counter-clockwise rotation thus supplementing the back-up roll frictional drive.

A brake arrangement, such as a generator, or any other known form of retarding device might be used where it is desired to control only lateral deflection to the left caused by the frictional force of the back-up rolls. Such an arrangement is shown in FIGURE 3 where a brake 17b is substituted for motor 17 of FIGURE 2.

In FIGURE 4 I have illustrated another form of my invention in which the work rolls 40 are driven by main drive motors 41 and the back-up rolls 42 are provided with retarding motors 43 capable of retarding or driving the back-up rolls to cause the driven work rolls to be returned to their normal unbowed position.

In the embodiment of FIGURE 4 the driven rotation of work rolls 40 in counter-clockwise direction by motors 41 will cause them to bow to the left while frictionally rotating back-up rolls 42 in the clockwise direction. If the counter-clockwise rotation is applied to the back-up rolls 42 by motors 43, the work rolls 40 will be forced to return to their normal or null position.

A braking arrangement similar to that of FIGURE 3 could be substituted for the retarding motors 43 on back-up rolls 42.

In FIGURE 5 I have illustrated still another embodiment in which work rolls 50 are backed up by back-up rolls 51 driven by motors 52. Each end of each work roll 50 is connected to a drive motor 53 through a drive shaft 54. The operation of this arrangement is identical with that of FIGURE 2, however, the use of motors 53 on each end of the work rolls produces greater uniformity of action on small diameter work rolls.

In the FIGURE 6 I have illustrated in exaggerated form the bowing of work rolls 11 to the right and an indicator dial 60 indicating the extent of the bowing. An operator viewing the reading on dial 60 can actuate motors or brakes on the appropriate rolls to cause the rolls to return to proper position, either in the vertical plan of the back-up roll axes or some selected deviation therefrom to give a selected action on the strip contour. This application is related to applicant's copending application Serial No. 122,939.

While I have illustrated and described certain present preferred embodiments of my invention it will be understood that this invention may be otherwise embodied within the scope of the following claims.

I claim:

1. In apparatus for rolling strip material, a multiple high stand of rolls comprising a pair of small diameter work rolls adapted to provide a working pass for said

strip material and a large diameter back-up roll for each work roll forming another pair of rolls, driving means connected to one pair of said rolls for imparting driven rotation thereto, and variable load means acting directly on the undriven pair of said rolls to cause the work rolls to remain in vertical alignment with the back-up roll axes.

2. In apparatus for rolling strip material, a multiple high stand of rolls comprising a pair of small diameter work rolls adapted to provide a working pass for said strip material and a large diameter back-up roll for each work roll forming another pair of rolls, driving means connected to one pair of said rolls for imparting driven rotation thereto, and second drive means acting on the other pair of said rolls independently of and selectively at different speeds from the driving means for the said one pair of rolls to cause the work rolls to remain in vertical alignment with the back-up roll axes.

3. In apparatus for rolling strip material, a multiple high stand of rolls comprising a pair of small diameter work rolls adapted to provide a working pass for said strip material and a large diameter back-up roll for each work roll forming another pair of rolls, driving means connected to one pair of said rolls for imparting driven rotation thereto, and brake means acting on the undriven pair of said rolls to cause the work rolls to remain in vertical alignment with the back-up roll axes.

4. In apparatus for rolling strip material, a 4-high stand of rolls comprising a pair of small diameter work rolls adapted to provide a working pass for said strip material and a large diameter back-up roll for each work roll, driving means connected to said back-up rolls for imparting driven rotation thereto, sensing means in contact with the work rolls signaling a change in contour from a null position, and power means actuated by said sensing means acting on the undriven pair of work rolls to cause them to return to their null position.

5. In apparatus for rolling strip material, a 4-high stand of rolls comprising a pair of small diameter work rolls adapted to provide a working pass for said strip material and a large diameter back-up roll for each work roll forming another pair of rolls, driving means connected to said back-up rolls for imparting driven rotation thereto, sensing means in contact with the work rolls signaling a change in contour from a null position, and drive means actuated by said sensing means acting on the other pair of said work rolls to drive them in a direction opposite a force causing them to bow whereby to cause them to return to their null position.

6. In apparatus for rolling strip material, a 4-high stand of rolls comprising a pair of small diameter work rolls adapted to provide a working pass for said strip material and a large diameter back-up roll for each work roll forming another pair of rolls, driving means connected to and said back-up rolls for imparting driven rotation thereto, sensing means in contact with the work rolls signaling a change in contour from a null position, and brake means actuated by said sensing means acting on the other pair of said work rolls to retard their rotation when bowing of said work rolls in the lateral direction occurs whereby to cause them to return to their null position.

7. In apparatus for rolling strip material, a 4-high stand of rolls comprising a pair of small diameter work rolls adapted to provide a working pass for said strip material and a large diameter back-up roll for each work roll forming another pair of rolls, driving means connected to said pair of said work rolls for imparting driven rotation thereto, sensing means in contact with the work rolls signaling a change in contour from a null position, and drive means actuated by said sensing means acting on the other pair of back-up rolls to cause them to rotate in opposition to the work rolls whereby to cause said work rolls to return to their null position.

8. In apparatus for rolling strip material, a 4-high stand of rolls comprising a pair of small diameter work

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rolls adapted to provide a working pass for said strip material and a large diameter back-up roll for each work roll, driving means connected to said pair of work rolls for imparting rotation thereto, sensing means in contact with the work rolls signaling a change in contour from a null position, and brake means acting on the undriven back-up rolls to cause them to resist rotation of the work rolls whereby to return said work rolls to their null position.

9. In apparatus for rolling strip material, a 4-high stand of rolls comprising a pair of small diameter work rolls adapted to provide a working pass for said strip material and a large diameter back-up roll for each work roll, driving means connected to one pair of said rolls for imparting driven rotation thereto, sensing means adjacent the work rolls signaling a change in contour from a null position, and power means actuated by said sensing means acting on the undriven pair of said rolls to cause the work rolls to return to their null position.

10. In apparatus for rolling strip material, a 4-high stand of rolls comprising a pair of small diameter work rolls adapted to provide a working pass for said strip material and a large diameter back-up roll for each work roll forming another pair of rolls, driving means connected to one pair of said rolls for imparting driven rotation thereto, sensing means adjacent the work rolls signaling a change in contour from a null position, and drive means actuated by said sensing means acting on the other pair of said rolls to cause the work rolls to return to their null position.

11. In apparatus for rolling strip material, a 4-high stand of rolls comprising a pair of small diameter work rolls adapted to provide a working pass for said strip material and a large diameter back-up roll for each work roll, driving means connected to one pair of said rolls for imparting driven rotation thereto, sensing means adjacent the work rolls signaling a change in contour from a null position, and brake means actuated by said sensing means acting on the undriven pair of said rolls to cause the work rolls to return to their null position.

12. In apparatus for rolling strip material, a 4-high stand of rolls comprising a pair of small diameter work rolls adapted to provide a working pass for said strip material and a large diameter back-up roll for each work roll, driving means connected to said back-up rolls for imparting driven rotation thereto, sensing means in contact with the work rolls signaling a change in contour from a null position, and power means actuated by said sensing means acting on each end of the undriven pair

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of work rolls to cause them to return to their null position.

13. In apparatus for rolling strip material, a 4-high stand of rolls comprising a pair of small diameter work rolls adapted to provide a working pass for said strip material and a large diameter back-up roll for each work roll forming another pair of rolls, driving means connected to said back-up rolls for imparting driven rotation thereto, sensing means in contact with the work rolls signaling a change in contour from a null position, and drive means actuated by said sensing means acting on each end of the other pair of said work rolls to drive them in a direction opposite a force causing them to bow whereby to cause them to return to their null position.

14. In apparatus for rolling strip material, a 4-high stand of rolls comprising a pair of small diameter work rolls adapted to provide a working pass for said strip material and a large diameter back-up roll for each work roll, driving means connected to said back-up rolls for imparting driven rotation thereto, sensing means in contact with the work rolls signaling a change in contour from a null position, and brake means actuated by said sensing means acting on each end of the undriven pair of said work rolls to retard their rotation when bowing of said work rolls in the lateral direction occurs whereby to cause them to return to their null position.

15. In apparatus for rolling strip material, a 4-high stand of rolls comprising a pair of small diameter work rolls adapted to provide a working pass for said strip material and a large diameter back-up roll for each work roll forming another pair of rolls, driving means connected to said pair of back-up rolls for imparting driven rotation thereto, sensing means in contact with the work rolls signaling a change in contour from a null position, and drive means actuated by said sensing means independently acting on each end of the other pair to cause them to rotate in opposition to the work rolls whereby to cause said work rolls to return to their null position.

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