July 14, 1942. F. P. DAHLSTROM 2,289,410

METHOD AND APPARATUS FOR CONTROLLING ALIGNMENT OF MILL ROLLS

Filed Feb. 21, 1938 3 Sheets-Sheet 1

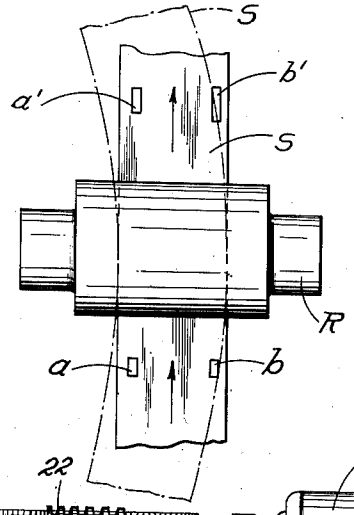


Fig. 1

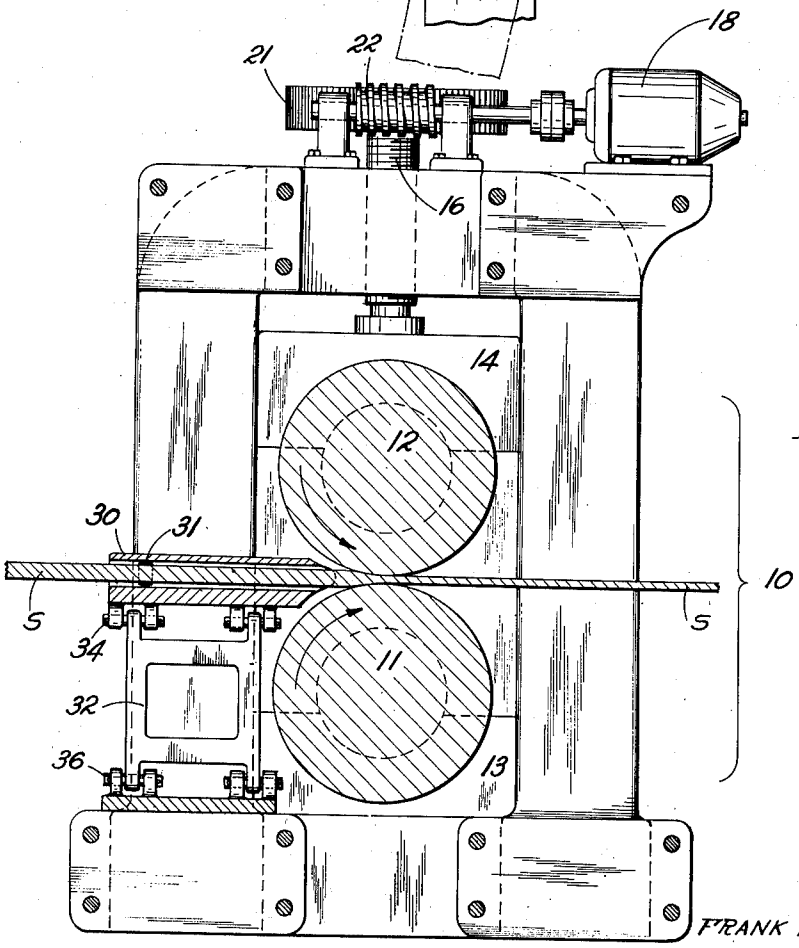


Fig. 2

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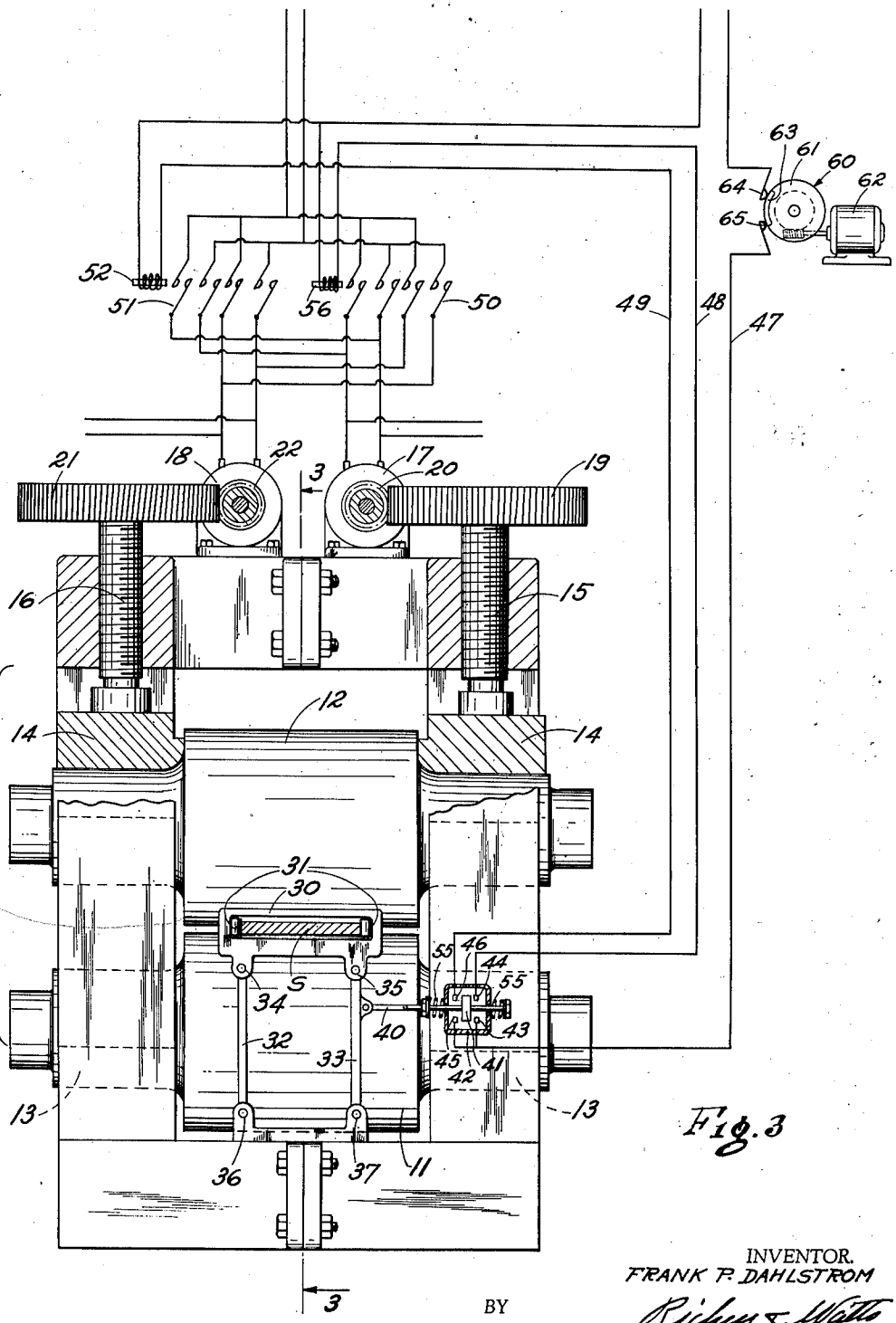


Fig. 3

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Fig. 5

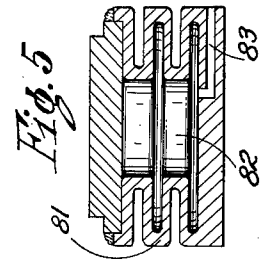


Fig. 6

Fig. 4

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UNITED STATES PATENT OFFICE

2,289,410

METHOD AND APPARATUS FOR CONTROLLING ALIGNMENT OF MILL ROLLS

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Application February 21, 1938, Serial No. 191,669

21 Claims. (Cl. 80—56)

This invention relates to the rolling of metal and more particularly to methods and apparatus for controlling the vertical axial alignment of the rolls of rolling mills, i. e., for controlling the space between the rolls.

The general objects of my invention are to improve the efficiency of the operation of rolling mills, to produce a more accurately rolled product of more nearly uniform thickness throughout the width of the material, and to provide a method and means for controlling the axial alignment of the mill rolls of rolling mills so as to subject the stock to substantially uniform reduction throughout and to insure the passage of the stock through substantially the center of the mill.

In the drawings, Figure 1 diagrammatically illustrates a phenomenon which occurs in the rolling of metal and other materials and which I employ to control automatically the axial alignment of the mill rolls; Figure 2 is an end elevation of a roll stand to which my invention has been applied, including a wiring diagram for a preferred type of control; Figure 3 is a sectional view of the roll stand of Figure 2, the section being taken along the line 3—3 of Figure 2; Figure 4 is an end elevation of a different embodiment of my invention illustrating the invention as applied to a temper pass mill; Figure 5 is a detail on an enlarged scale illustrating a fluid pressure bellows for maintaining uniform rolling pressures in the mill shown in Figure 4; and Figure 6 is a wiring diagram for a modified form of control for the apparatus shown in Figures 2 and 3.

In the rolling of any flat strip or sheet material, it is obviously desirable to produce a product of uniform thickness throughout the width of the strip or sheet. It is also desirable to roll material at a high rate of speed for the sake of economy of operation. In modern strip mills such as are used in the manufacture of strips and sheets of ferrous material, the material is reduced to the desired gauge by being passed continuously through a series of roll stands, each of which effects part of the desired reduction in thickness. In ordinary continuous mills, a high degree of skill on the part of the operator is required to produce strips or sheets that are uniform in thickness throughout their widths and constant adjustment of the mill rolls is necessary in order to attain this end. If a greater percentage of reduction is taken at one side of the strip than at the other, the elongation at that side is correspondingly greater and the strip tends to curve or camber. This causes the strip to move axially of the mill rolls as it passes through the roll stand and makes it difficult properly to coil the strip material.

This phenomenon is illustrated diagrammatically in Figure 1, which shows a top view of a strip S passing between mill rolls R in the direction indicated by the arrow. Assuming for example that a greater percentage of reduction is being taken at the right-hand end of the mill than at the left, then each particle of material passing between the rolls on the right-hand edge of the strip will be elongated to a greater extent than the particles at the left-hand edge of the strip. That is, the element *b*, which is shown as being equal in length to element *a* on the feed side of the mill, will be elongated to a greater extent than the element *a* in passing through the mill rolls. The elongation is illustrated in greatly exaggerated form at *b'* and *a'*. Because of the greater elongation of the strip on the right-hand side of the mill, the tendency is to slow up the speed of entrance of the material to the mill and speed up the delivery from the mill on the right-hand side with respect to the entry and delivery speeds on the left-hand side. The material therefore tends to curve or camber as shown in the dot and dash lines, and the stock passing through the mill tends to move from the center of the mill to the left as shown in the drawings.

While in practice differences in reduction taken on the left-hand and right-hand side of the mill may be very small, nevertheless, since the mill operates continuously on a long strip and at high speed the effect is cumulative and unless corrected, would soon cause the strip to move considerably to the left even to the extent that the edges of the strip would engage the stationary guides, which are often used, or the supports for the rolls, which would damage the strip. This effect can be caused either by the rolls being positioned closer together at one end than at the other or by minute variations in thickness in the material entering the mill. At present excessively high tensions are employed in some mills in order to minimize this effect. Also, the mill operator corrects the axial alignment of the mill rolls by means of the screw-downs in order to take care of the situation, but of course the strip material must move an appreciable distance to one side or the other, or become noticeably cambered, before the operator can detect the improper operation and correct the roll setting accordingly.

According to my invention high strip tension

can be eliminated and the operation of the screw-downs controlled automatically to insure a uniform percentage of reduction and uniform elongation across the strip, thus to insure the production of strips or sheets free from camber and of substantially uniform thickness throughout. To control the alignment, I utilize the difference between the amounts of elongation taking place at opposite sides of the mill to control the setting of rolls and I preferably make use of the movement of the strip from one side of the mill to the other to actuate the control mechanism, as this movement is such a sensitive indicator of the unequal percentage of reduction taking place on opposite sides of the mill that it can be used to correct the setting even though the differences in reduction between one side of the mill and the other are so small as to be hardly measurable.

A simple and convenient apparatus for carrying out my method of controlling the alignment of the rolls is illustrated in Figures 2 and 3 in which a conventional two-high mill is indicated generally at 10. This mill may comprise a lower roll 11 and an upper roll 12 suitably supported by roll neck bearings 13 and 14, respectively, mounted in the frame of the mill, the position of the upper roll being controlled by conventional screw-down mechanisms consisting of screws 15 and 16 mounted on opposite sides of the roll stand and driven by reversible motors 17 and 18, respectively, through the worm wheels and worms 19 and 20, and 21 and 22, respectively.

To control the motors 17 and 18 and the screw downs 15 and 16 automatically to maintain the running position of the stock in the center of the roll pass and to insure that the roll stand will take a substantially uniform percentage reduction throughout the width of the material, I preferably employ the mechanism illustrated at the entry side of the roll stand and disposed as shown in the drawings directly in front of the roll pass and the lower roll 11. This mechanism preferably comprises a guide box 30 having a rectangular opening therethrough through which the strip S is passed before it enters the bite of the rolls. The guide box is arranged to closely engage the edges of the strip and, if desired, may be provided with anti-friction rollers 31 which bear against the edges of the strip. The box is mounted upon parallel links 32 and 33 which are pivotally connected to the guide box at their upper end as at 34 and 35 and are pivotally mounted on the base of the mill as at 36 and 37, respectively. The guide box is thus free to move sideways as the strip moves from side to side as it passes through the rolls. The slot or opening in the guide box is of sufficient thickness and the links 32 and 33 are long enough so that the up and down movement of the guide box as it moves from side to side will not cause the upper or lower surfaces of the slot to engage the rapidly moving strip.

The movement of the guide box from side to side is employed to control the screw-down motors 17 and 18, this control being accomplished through a horizontally extending link 40 which is pivotally connected to the link 33 and suitably guided in a horizontal position. The link carries a contact member 41 disposed within the switch box 42 and adapted upon movement of the strip to the right to close the circuit between contacts 43 and 44, and upon movement of the strip to the left to close the circuit between contacts 45 and 46. The contacts 43 and 45 are connected to the conductor 47 of the screw-down motor control circuit, while contacts 44 and 46 are connected to the conductors 48 and 49, respectively. The circuit of which these conductors are a part control the magnetic reversing switches indicated diagrammatically at 50 and 51, which in turn control the power supply for the screw-down motors 17 and 18. Thus assuming that the condition illustrated in Figure 1 of the drawings should occur, the strip tends to move to the left and then the guide box 30 will move to the left pulling the link 40 to the left and closing the circuit between contacts 45 and 46 and conductors 47 and 49. The closing of this circuit results in the energization of the solenoid 52 closing the magnetic switch 51 and energizing the screw-down motors so as to operate the motor 17 to release the screw 15 and simultaneously operating the motor 18 in a direction to screw down the screw 16. The condition described, as noted above, was caused by the fact that a greater percentage of elongation was taking place on the right-hand side of the strip than on the left, and obviously the operation of the motors will change the vertical axial alignment of the upper roll 12 with respect to the lower roll 11, so as to correct the unequal amount of reduction and to straighten out the strip. As soon as the screw-downs have operated sufficient distances to correct the operation of the mill, the strip will move back to the center of the roll pass, the guide being centered by engagement with the strip and also by centering springs 55 so that the contact 41 is moved away from the contacts 45 and 46, thus deenergizing the magnetic switch 51 and stopping the screw-down motors 17 and 18. If, on the other hand, the strip should move toward the right as shown in the drawings, the contactor 41 would close the circuit between the contacts 43 and 44, thus energizing the solenoid 56 and closing the switch 50 to cause the screw-down to operate in the opposite direction to increase the percentage of reduction taken on the right-hand side of the mill and decrease the percentage of reduction on the left-hand side of the mill.

In order to prevent operation of the screw-down motors 17 and 18 from over-correcting and "hunting," I preferably include in the motor control circuit the mechanism indicated generally at 60 in Figure 2, which comprises a rotating contact member 61 preferably driven at a constant speed by a small motor such as a clock motor 62 and having a conducting segment 63 which intermittently engages the contacts 64 and 65. By this means, the screw-down motors are operated intermittently for short periods of time when the circuit between contacts 43 and 44 or 45 and 46, as the case may be, are closed, thereby varying the rolling pressure by increments. Thus the strip is given time to move back toward the center of the mill rolls after each operation of the screw-down motors so that, for example, if a single operation is sufficient to correct the misalignment no further operations of the motors will occur. Thus, overcorrecting is eliminated. Of course the speed of the rotating contacting member 61 may be varied and the length of the contact 63 may be adjusted so that the motors will be operated for the desired periods of time, depending upon the conditions of operation of the mill. Generally speaking, it requires only a very slight operation of the screw-downs to correct the operation of the

mill, the roll neck bearings being moved distances on the order of a fraction of a thousandth of an inch.

In Figures 4 and 5 of the drawings, I have somewhat diagrammatically shown a modified form of my invention adapted particularly to temper pass mills or skin pass mills as they are variously called. The function of the mills of this sort is to effect a definite average percentage of reduction across the width of the strip to cold work the material to impart a certain degree of hardness thereto. In mills of this type, it is desirable to apply a certain definite pressure to the upper rolls and to maintain this pressure substantially constant regardless of small variations in thickness of the material entering the mill, so that the same pressure will be applied to the material and substantially the same percentage of reduction effected.

As shown in the drawings, a mill of this type may comprise upper and lower rolls **71** and **72**, the upper roll being provided with screw-down mechanisms **73** and **74** operated by reversible motors **75** and **76**, the mechanism being similar to that previously described. In accordance with my invention, however, the screw-downs instead of acting directly on the roll neck bearings **77** and **78**, respectively, act through the bellows **79** and **80** which, as shown in Figure 6, have corrugated side walls **81** and a central opening **82** which may be supplied with fluid under pressure through the passageway **83**.

In operation the bellows may be filled with a fluid such as oil under pressure to apply a definite pressure to the roll neck bearings, the screw-downs being employed principally for initial adjustment of the rolls for the gage material being rolled. The pressure may be supplied to the bellows **79** and **80** through fluid conduits **84** and **85**, respectively, and to allow for the expansion and compression of the fluid, i. e., to increase the "elasticity" of the fluid system thereby to render the total rolling pressure substantially constant regardless of small variations in thickness thereby securing uniform "cold working" of the material, lengths of pipe **86** and **87** may be connected to the conduits **84** and **85**. Pressure gages **88** and **89** may be connected to the pipes, the sum of the reading of the pressure gages being a measure of the total pressure applied to the mill rolls. The necessary initial pressure may be built up in the conduits and pipes by the screw down mechanisms or by any convenient pump illustrated diagrammatically at **90**.

To control the alignment of the mill rolls, thereby to secure equal reduction and elongation of the material and prevent sideways movement of the material as it travels through the roll pass, I employ a guide member **91** which is similar to the guide **30** previously described and which actuates through the link **92** a potentiometer rheostat indicated at **93**. The rheostat **93** is supplied with a direct current through the conductors **94** and **95** and is arranged to control the field current of a Ward-Leonard type generator **96**, the generator being driven by any suitable motor **97**. The output of the Ward-Leonard generator is delivered to the armature of the direct current motor **98** which in turn is employed to drive through suitable transmission mechanism **99** a gear or other suitable pump **100** interposed between the conduits **84** and **85**.

The operation is as follows: Assuming the condition shown in Figure 1 to obtain, the guide **91** and link **92** will move to the left as shown in the drawings, moving the contactor **101** of the rheostat to the left and causing a current to flow in the direction of the arrows in the conductors **102** and **103** leading from the rheostat to the Ward-Leonard generator. The intensity of the current and thus the output of the generator is increased as the guide is moved farther to the left. The generator thus operates the pump motor in a direction to drive the pump gears in the direction shown by the arrows on the pump, thus reducing the fluid pressure in bellows **80** and increasing the fluid pressure in bellows **79** although the total pressure applied to the mill rolls remains substantially constant. By this operation, the percentage of reduction taken on the left of the strip will be increased as compared with that taken to the right and the strip will be caused to return to the center of the mill rolls. If the strip should travel to the right, the operation is similar except that the flow of current through the conductors **102** and **103** to the field **96** of the Ward-Leonard generator is reversed, the generator becomes of opposite polarity and the pump motor is operated in the opposite direction thus driving the pump to reduce the pressure in bellows **79** and increasing the pressure in bellows **80**.

It is to be noted that in this modification of my invention all likelihood of hunting is eliminated, for by reason of the use of the potentiometer rheostat **93** and the Ward-Leonard control system, the speed of the pump driving motor **98** is proportional to the displacement of the strip from center. Thus the restoring force applied to the strip gradually increases as the strip moves farther to one side or the other and is gradually reduced as the strip returns to center. While the fluid pressures in the bellows **79** and **80** may be substantial, depending upon their area and the design of the mill, nevertheless the pump is not required to do any excessive amount of work inasmuch as the differences in pressure in the two bellows and those on opposite sides of the pump will never reach excessive magnitudes. I prefer to employ a gear pump as illustrated in the drawings, as this type of pump is particularly suited to my purpose because of the slip in the pump which may be five to ten percent of the capacity of the pump. Because of the slip, the pressures in the two bellows will gradually equalize whenever the motor **98** is stopped and differences in pressures will be built up gradually in proportion to the speed of the motor, which as noted above varies with the displacement of the strip from center.

In Figure 6 of the drawings I have shown a modified form of control adapted particularly for use in conjunction with rolling mill and screw-down apparatus illustrated in Figures 2 and 3. In this modification I employ a photo-electric cell control mechanism instead of the movable guide mechanism illustrated in Figures 2 and 3. The photo-electric cell control may preferably comprise two photo-sensitive tubes **110** and **111** suitably mounted in brackets **112** and **113** above the path of the strip S and on either side thereof, the brackets being positioned in advance of the mill and preferably being adjustable so that the apparatus can be used with different widths of strips. These brackets also serve as supports for light sources including incandescent lamps **114** and **115** and lenses **116** and **117** which are adapted to direct beams of light toward the photo-electric cells **110** and **111**, as indicated by the dotted lines in the drawings. The

brackets 112 and 113 are positioned so that when the strip is in the center of the mill rolls, the edges of the strip obstruct the path of light between the light source and the photo cells. Upon movement of the strip to either side, however, one or the other of the photo-electric cells will be energized by light falling thereon. The current generated by the photo cells 110 and 111 is amplified by suitable vacuum tube amplifiers 120 and 121, respectively, and the amplified current is employed to control the solenoids 52 and 56 which function to close the screw-down motor control switches in the manner described and by means of the circuits disclosed on Figures 2 and 3. Thus assuming as before that the strip tends to move to the left, then the strip will no longer prevent light from the bulb 115 from falling on the photo-electric cell 111. The light falling on the cell causes a weak current to flow therethrough which is amplified by the vacuum tube amplifier 121 and employed to energize the solenoid 52, thereby closing the magnet switch 51 and energizing the screw-down motors so as to operate the motor 17 to release the screw 15 and simultaneously operating the motor 18 in a direction to screw down the screw 16 (see Figure 2).

Conversely, movement of the strip to the right will throw the photo-electric cell 110, amplifier 120 and solenoid 56, and close the magnetic switch 50, thus resulting in the operation of the screw-down motors in the opposite direction.

As in connection with the modification shown in Figure 2, I prefer to employ a circuit interrupter to prevent over-correcting and hunting. In this instance, the circuit interrupter may comprise rotating contact members 61*a* and 61*b* in the circuits from amplifiers 120 and 121, respectively, the members having conducting segments 63*a* and 63*b* which are engaged by contacts 64*a*, 64*b*, 65*a* and 65*b*. Both members 61*a* and 61*b* may be driven synchronously by the motor 62*a*. The operation of the device is the same as described in connection with Figure 2.

From the foregoing description of preferred forms of my invention it will be evident that I have provided simple and effective method and means for controlling the screw-downs of rolling mills to insure equal percentages of reduction being taken across the width of the strip being operated upon, and equal elongation of the stock, thus preventing the occurrence of curves and cambers in the strip. As my apparatus is controlled by differences in elongation, preferably as reflected by the side-ways movement of the strip as it passes through the rolls, it will be evident that it is extremely sensitive as the effect of any error is cumulative so that even an extremely minute difference in reduction and elongation will soon cause the mechanism for correcting the error to be actuated.

My apparatus is simple in construction and operation and can be installed in existing mills of various types without necessitating great changes in the structure of the mills. The apparatus results in an improved product and lowered operating cost.

In the foregoing specification, I have described only preferred forms of my invention. It will be obvious to those skilled in the art that various changes in the method and apparatus described and illustrated may be made without departing from the spirit and scope of my invention. While the invention has been described with particular reference to strip mills of the type employed in connection with ferrous materials, it will be obvious that my invention can be employed and will be useful in the rolling of various other types of materials. Therefore it is to be understood that my patent is not limited by the foregoing description or in any manner other than by the scope of the appended claims.

I claim:

1. In a rolling mill, a roll adapted to reduce stock, and means controlled by the movement of the stock transversely of the mill for varying the rolling pressure at one end of said roll with respect to the rolling pressure at the other end thereof while maintaining the total rolling pressure substantially constant.

2. In a rolling mill, a housing, a roll adapted to reduce stock supported by said housing, and screw-down means controlled independently of dimensional changes in said housing by the movement of the stock transversely of the mill for increasing the rolling pressure at one end of said roll while simultaneously decreasing the rolling pressure at the other end thereof.

3. In a roll stand, a housing, a reducing roll supported thereby and adapted to act upon stock passing through the stand, screw-down mechanisms for said roll carried by said housing, means independent of dimensional changes in said housing and controlled by differences in the amount of elongation of the stock taking place at one side of the stand and the amount of elongation of the stock taking place at the other side of the stand for actuating said screw-down mechanisms to increase the rolling pressure at one side of the stock and simultaneously to reduce the rolling pressure at the other side of the stock to substantially equalize the amounts of elongation taking place at each side of the stock, and means for periodically interrupting the operation of said screw-down mechanisms.

4. In a rolling mill, a pair of reducing rolls adapted to act on stock passing through the mill, a frame, separate screw-down mechanisms carried by said frame at each end of one of said rolls for controlling the rolling pressure exerted upon the stock by said roll, and means independent of dimensional changes in said frame and operated by transverse movement of the stock with respect to said mill for simultaneously operating said screw-downs to increase the rolling pressure at one end of said roll and to decrease the rolling pressure at the other end of said roll.

5. In a rolling mill, a pair of reducing rolls adapted to act on stock passing through the mill, a frame, separate screw-down mechanisms carried by said frame at each end of one of said rolls for controlling the rolling pressure exerted upon the stock by said roll, and means independent of dimensional changes in said frame and operated by transverse movement of the stock from the center of said roll toward one end thereof for simultaneously operating said screw-downs to increase the rolling pressure at the end of said roll toward which the stock is moving, and to decrease the rolling pressure at the other end of said roll.

6. In a rolling mill, a pair of reducing rolls adapted to act on stock passing through the mill, separate screw-down mechanisms at each end of one of said rolls for controlling the rolling pressure exerted upon the stock by said roll, electric motors for operating said screw-downs and switch means operated by transverse movement of the stock with respect to said mill for closing electric circuits to said motors to simultaneously operate said screw-downs to increase the rolling

pressure at one end of said roll while decreasing the rolling pressure at the other end of said roll.

7. In a rolling mill, a pair of reducing rolls adapted to act on stock passing through the mill, separate screw-down mechanisms at each end of one of said rolls for controlling the rolling pressure exerted upon the stock by said roll, electric motors for operating said screw-downs, and a guide engaging the edges of the stock entering said mill and movable with the stock transversely of the mill, and switch means operated by movement of said guide for closing electric circuits to said motors to simultaneously operate said screw-downs to increase the rolling pressure at one end of said roll while decreasing the rolling pressure at the other end of said roll.

8. In a rolling mill, a pair of reducing rolls adapted to act on stock passing through the mill, separate screw-down mechanisms at each end of one of said rolls for controlling the rolling pressure exerted upon the stock by said roll, electric motors for operating said screw-downs, photoelectric means controlled by transverse motion of the stock for closing electric circuits to said motors to simultaneously operate said screw-downs to increase the rolling pressure at one end of said roll while decreasing the rolling pressure at the other end of said roll.

9. In a strip mill having a pair of reducing rolls adapted to act on strip passing through the mill, separate screw-down mechanisms at each end of one of said rolls for controlling the rolling pressure exerted upon the strip by said roll, and electric motors for operating said screw-downs, means for maintaining the path of a strip through the mill substantially in the center of the mill rolls, said means comprising a guide member engaging the edges of strip before it enters the mill, said guide member being movable transversely of the mill with the strip, and switch means operated by movement of said guide from the center toward one side of the mill for closing electric circuits to said motors to simultaneously operate said screw-downs to increase the rolling pressure at the side of the mill toward which the guide has moved while decreasing the rolling pressure at the other side of said mill.

10. In a rolling mill, a pair of reducing rolls adapted to act on stock passing through the mill, separate means at each end of one of said rolls for controlling the rolling pressure exerted upon the stock by said roll, electric motor means for operating said pressure controlling means, switch means operated by transverse movement of the stock with respect to said mill for closing electric circuits to said electric motor means to simultaneously operate said pressure controlling means to increase the rolling pressure at one end of said roll while decreasing the rolling pressure at the other end of said roll, and a circuit interrupter in the circuit including said switch means for causing said electric motor means to operate intermittently.

11. In a rolling mill, a pair of reducing rolls adapted to act on stock passing through the mill, separate screw-down mechanisms at each end of one of said rolls for controlling the rolling pressure exerted upon the stock by said roll, electric motors for operating said screw-downs, switch means operated by transverse movement of the stock with respect to said mill for closing electric circuits to said motors to simultaneously operate said screw-downs to increase the rolling pressure at one end of said roll while decreasing the rolling pressure at the other end of said roll, and a circuit interrupter in the circuit including said switch means for causing said motors to operate intermittently.

12. The method of controlling the alignment of the rolls of a roll stand to insure substantially equal elongation of the stock passing through the stand across the width of the stock, which comprises varying the pressure applied to the ends of one of the rolls of the stand by means controlled by variation between the elongation of the stock taking place at opposite sides of the stand while maintaining the total pressure applied to the roll substantially constant.

13. The method of controlling the screw-down mechanism of a rolling mill having a frame and independently operable screw-down mechanisms carried by said frame and interposed between said frame and the bearings at each end of at least one of the rolls, which comprises automatically operating one of said screw mechanisms in a direction to increase the rolling pressure and simultaneously operating the other of said screw down mechanisms in a direction to reduce the rolling pressure in response to transverse movement of the stock in one direction, and reversing the operation of both of said screw-down mechanisms in response to transverse movement of the stock in the opposite direction, said screw-down mechanisms being operated independently of dimensional changes in said frame.

14. The method of controlling the rolling pressure applied to stock as it is passed through a rolling mill, which comprises automatically varying the rolling pressure applied to the stock at one edge thereof with respect to the pressure applied at the other edge thereof in response to movement of the stock transversely of the mill while maintaining the total rolling pressure applied to the stock substantially constant.

15. In a rolling mill, a roll adapted to reduce stock, and fluid pressure means controlled by the movement of the stock transversely of the mill for varying the rolling pressure at one end of said roll with respect to the rolling pressure at the other end thereof, while maintaining the total rolling pressure substantially constant.

16. In a rolling mill, a roll adapted to reduce stock, bearings for said roll at each end thereof and fluid pressure means acting on said bearings for controlling the rolling pressure exerted by said roll, said fluid pressure means including a pump operable to increase the fluid pressure, and thereby to increase the rolling pressure at one end of said roll with respect to the pressure at the other end of said roll while maintaining the total rolling pressure substantially constant.

17. In a rolling mill, a roll adapted to reduce stock, bearings and screw-down mechanisms for said roll at each end thereof, expansible chambers containing a fluid under pressure interposed between each of said screw down mechanisms and the adjacent bearing whereby the pressure exerted by said roll may be varied by varying the preessure of the fluid with said expansible chambers, a fluid connection between said expansible chambers, a pump in said fluid connection adapted to increase the fluid pressure in one of said chambers with respect to the fluid pressure in the other chamber while maintaining the sum of said fluid pressures substantially constant.

18. In a rolling mill, a roll adapted to reduce stock, bearings and screw-down mechanisms for said roll at each end thereof, expansible cham-

bers containing a substantially incompressible fluid under pressure interposed between each of said screw-down mechanisms and the adjacent bearing whereby the pressure exerted by said roll may be varied by varying the pressure of the fluid with said expansible chambers, means associated with each of said chambers for increasing the elasticity of the fluid system, and means actuated by transverse movement of material being rolled for varying the fluid pressure in said expansible chambers.

19. In a rolling mill, a roll adapted to reduce stock, bearings and screw-down mechanisms for said roll at each end thereof, expansible chambers containing a fluid under pressure interposed between each of said screw-down mechanisms and the adjacent bearing whereby the pressure exerted by said roll may be varied by varying the pressure of the fluid within said expansible chambers, and means actuated by transverse movement of material being rolled for varying the fluid pressure in said expansible chambers.

20. In a rolling mill, a roll adapted to reduce stock, bearings and screw-down mechanisms for said roll at each end thereof, expansible chambers containing a substantially imcompressible fluid under pressure interposed between each of said screw-down mechanisms and the adjacent bearing whereby the pressure exerted by said roll may be varied by varying the pressure of the fluid with said expansible chambers, a fluid connection between said expansible chambers, a pump in said fluid connection adapted to increase the fluid pressure in one of said chambers with respect to the fluid pressure in the other chamber while maintaining the sum of said fluid pressures substantially constant, power means for operating said pump and means actuated by transverse movement of material being rolled for controlling said power means.

21. In a rolling mill, a roll adapted to reduce stock, bearings and screw-down mechanisms for said roll at each end thereof, expansible chambers containing a substantially incompressible fluid under pressure interposed between each of said screw-down mechanisms and the adjacent bearing whereby the pressure exerted by said roll may be varied by varying the pressure of the fluid with said expansible chambers, means associated with each of said chambers for increasing the elasticity of the fluid system, a fluid connection between said expansible chambers, a pump in said fluid connection adapted to increase the fluid pressure in one of said chambers with respect to the fluid pressure in the other chamber while maintaining the sum of said fluid pressures substantially constant, power means for operating said pump and means actuated by transverse movement of material being rolled for controlling said power means.

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