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J. W. O'BRIEN
ROLLING MILL

3,425,249

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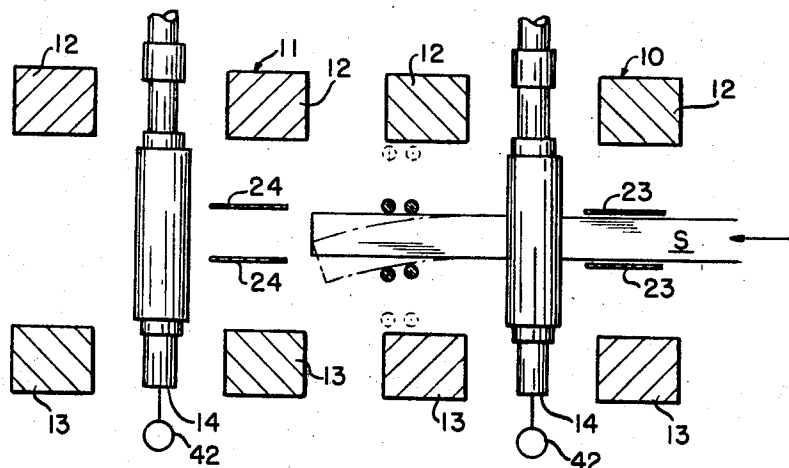


FIG. 1

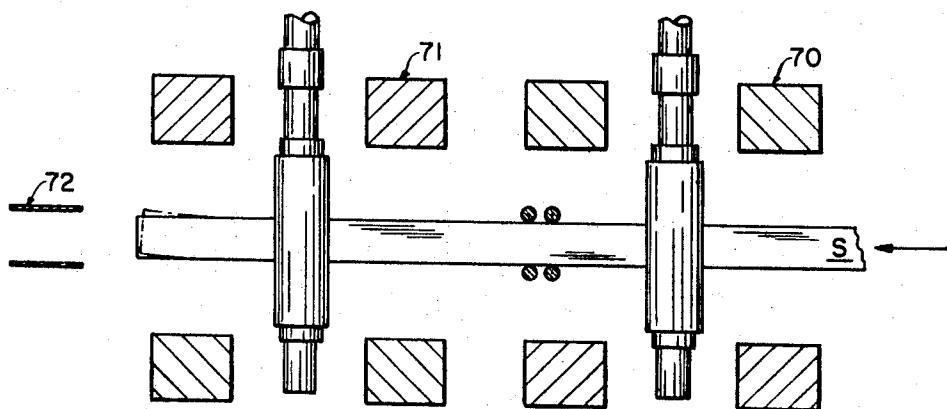


FIG. 6

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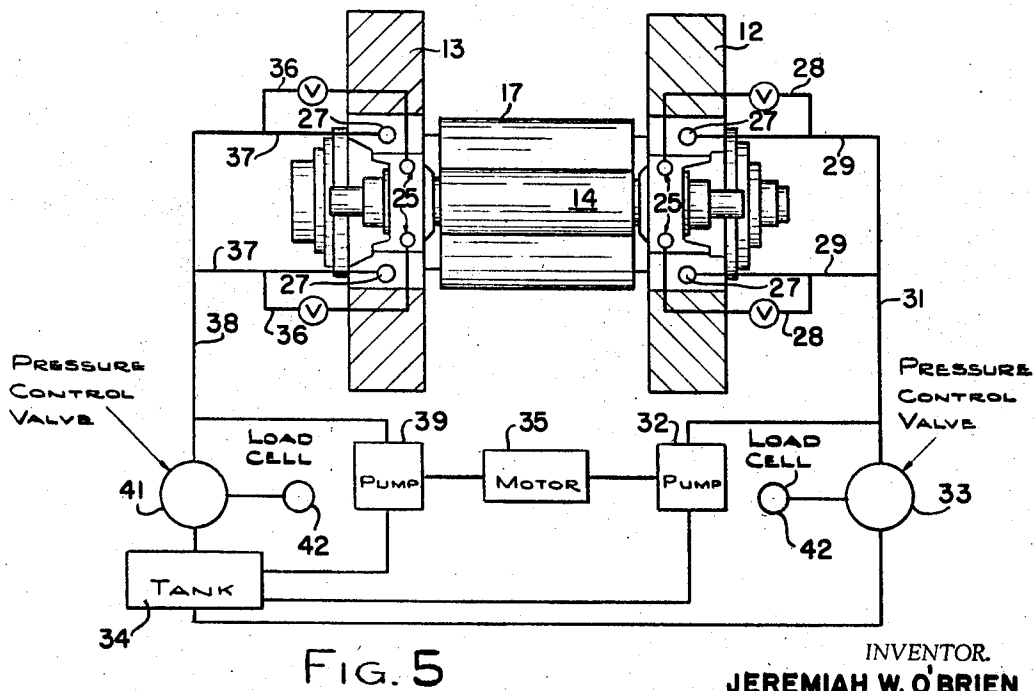
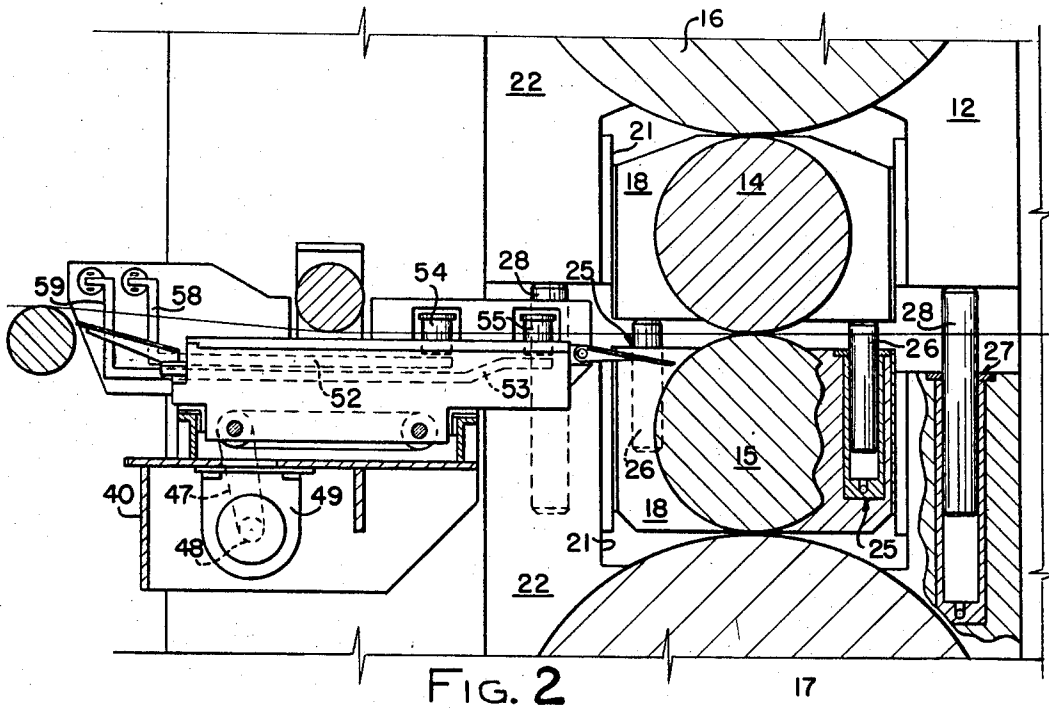
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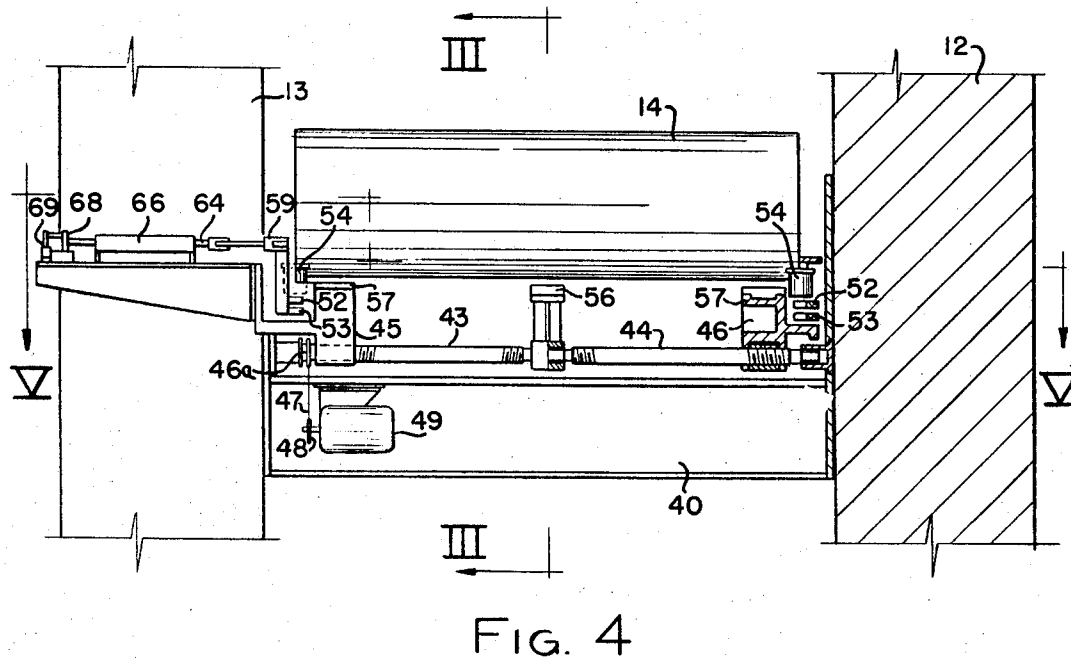
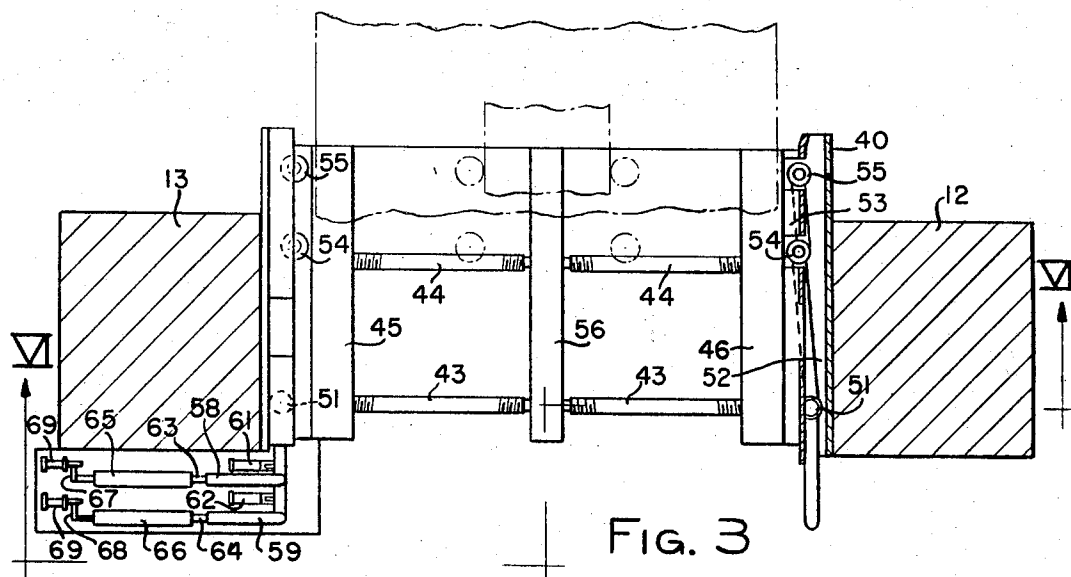
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3,425,249

ROLLING MILL

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39,689/64

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8 Claims

ABSTRACT OF THE DISCLOSURE

A rolling mill wherein there is provided means for compressing at least, in part, certain components of the mill on either side of the rolls thereby to cause differential pressure to be exerted along the width of the strip so as to cause the workpiece to be guided as it issues from the mill and/or rolled so as to reduce or remove the camber in the workpiece. The compression of the mill parts on either side is effected by rapidly operating fluid piston cylinder assemblies arranged between the chocks on either side of the rolling mill pass line. In the strip guiding mode rollers are arranged on the opposite sides of the strip after it passes through the mill, either of which is contacted on lateral displacement of the strip from a given reference point which displacement effects through an electrical hydraulic control system operation of either one of the compression piston cylinder assemblies.

This invention relates to an apparatus for use in processing elongated strip-like material and, more particularly, is addressed to an apparatus for feeding and guiding such material as it passes into, through and out of a rolling mill or similar apparatus.

In order to better understand the utility of the present invention reference will be made to three areas in the production of metallic strip and plate which, previous to the present invention, have involved serious problems relative to the rolling thereof.

The first area has reference to the tandem reduction cold mill, wherein the strip is passed through a number of rolling mill stands for progressively reducing the thickness thereof. Because of the increase it has on the production rate of the mill, it is highly desirable to feed the leading end of the strip through the mills at the highest possible rate of speed. At the entry side of each mill and adjacent to the roll bite there is usually provided guides in the mill which confine the edges of the strip from moving in a transverse direction. These guides also may comprise means for directing and urging the strip into the bite once the leading end thereof has passed into the guide. The ability to pass rapidly the leading end of the strip through the mill depends to a great extent on whether or not the leading end of the strip is relatively straight, that is to say, whether or not it is uncambered. On many occasions the leading ends of the strips have a cambered condition, either by reason of their shape when brought to the cold mill or as a result of the rolling action of a previous stand of the mill. In any event the camber makes it extremely difficult, if not impossible, to feed the strip through the mill at a rapid rate of speed since such a cambered strip requires manual assistance.

Turning now to a second area where strip feeding and guiding becomes important in the production of a strip

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by a rolling mill process, reference is made to the operation of a finishing train of a hot strip mill where there is provided at the exit end and closely adjacent the last stand, a side trimming shear. In this arrangement, as an adjunct of rolling wherein the strip is traveling at high speed, the strip is side trimmed immediately after it issues from the last stand of the finishing train. Past practice has demonstrated that it is extremely difficult to side trim the strip because the strip has a tendency to wander transversely of its path of travel.

The third area involves the operation of a plate mill. It frequently occurs in the reduction of plate by a reversing mill that due to the inherent characteristics of the plate and the peculiarities of the mill, a camber is formed in the leading and trailing ends of the plate. While this camber does not generally create a guiding problem as in the previous two cases, it is necessary in order to finally perfect the plate to a desired marketable condition to remove the camber from the plate. This is usually done by auxiliary straightening machines which not only are quite expensive, but require additional time and labor. It will be noted that such plates are reduced while in a plastic hot condition; whereas, the straightening usually takes place when the plates are relatively cold, if not absolutely cold.

The present invention is addressed, in part, to an improved rolling mill or other material processing apparatus, wherein by its employment a camber in material can be removed or lessened; therefore, making it possible to rapidly feed and/or straighten the material during its processing or wherein the wandering of the material can be controlled.

One object of the present invention is to provide in connection with strip-like material processing apparatus means for varying the elastic compression or expansion of certain members of one side of the means as opposed to like members on the other side, thereby the load transversely of the material can be differentially regulated to effect guiding and/or removing or lessening of the camber of the strip-like material. The elastic compression or expansion can be accomplished by a number of different means, such as, roll balance cylinders, roll bending cylinders, hydraulic roll adjusting cylinders or special cylinders provided for this purpose.

It is another object of the invention to provide means, in combination with a rolling mill, for determining the existence of a camber or lateral movement of the strip, in combination with means for varying the elastic stretch or compression of certain components of a mill so as to differentially control the rolling pressure transversely of the strip as it is being rolled by the mill.

A still further object of the invention has reference to the employment of conventional roll balance cylinder assemblies of a rolling mill, whereby the pressure on balance cylinder assemblies on the opposite sides of the mill will be controlled to differentially change the elastic characteristics of the components of the mill on opposite sides thereof to vary the transverse rolling pressure in a manner to remove or lessen the camber from a strip or plate and/or cause the strip to move transversely in order to maintain it in a proper path of travel.

It is another object of the present invention to provide in a 4-high rolling mill means for controlling the pressures of the balance cylinder assemblies for either or both of the work rolls and backup rolls on both sides of the mill to differentially effect the elastic character-

istics of certain elements on the opposite sides of the mill for the reasons above mentioned.

A still further object of the present invention relates to providing a means for determining the presence of a camber or lateral movement of the strip or plate, comprising one or more strip-engaging members which, when displaced, will operate a control valve, the valve being connected to the balance cylinder assemblies of the rolling mill operating them to differentially change the elastic characteristics of certain components of the mill to effect a differential application of rolling pressure.

In the preferred form of the present invention there is provided, in connection with the balance cylinder assemblies for the work rolls and backup rolls on each side of a 4-high mill, means for controlling the pressures in at least one of these assemblies on one side of the mill so as to vary the elastic expansion and/or compression of the components on one side of the mill as opposed to the other, such as the chocks and housings, whereby a differential pressure will be imposed upon the strip being processed, means located in the path of the strip or plate for detecting the existence of a camber that the strip or plate has moved relative to a desired path, and means for connecting the detecting means to the means for controlling the pressures in the balance cylinder assemblies.

The aforesaid features, as well as others, of the present invention will be more clearly appreciated from the following description when read in light of the accompanying drawings of which:

FIGURE 1 is a schematic plan view of a 2-stand tandem rolling mill, diagrammatically illustrating in exaggerated form a cambered strip passing through the first stand in relation to the entry guides of the second succeeding stand,

FIGURE 2 represents an enlarged front elevational view of one of the stands of the rolling mill illustrated in FIGURE 1,

FIGURE 3 is a plan view of a portion of FIGURE 2 showing more clearly the camber or strip wandering, detecting device,

FIGURE 4 is a side elevational view of the mill shown in FIGURE 3, particular emphasis being placed on the detecting device,

FIGURE 5 is a schematic arrangement of the hydraulic circuit for the work roll and backup roll balance cylinder assemblies illustrated in FIGURE 2, and

FIGURE 6 is a schematic arrangement of a part of the finishing train of a hot strip mill showing a camber strip passing from the last stand thereof and also showing a side trimming shear at the exit side of the mill.

With reference first to FIGURE 1 there is shown the first two stands 10 and 11 of a tandem cold reduction mill, the number of stands may range from two to six. The stands comprise symmetrical housing posts 12 and 13 which receive a pair of working rolls 14 and 15 (one roll of each stand only being shown), the rolls being supported in the usual manner by backup rolls 16 and 17, which are only shown in FIGURES 2 and 5. As FIGURE 2 shows, the ends of the work rolls are received in the bearing chock assemblies 18, the chocks themselves being slidably mounted in openings 21 formed in the bearing chocks 22 provided for the backup rolls 16 and 17. The upper backup roll 16 is adjusted by the mill screws, not shown, in accordance with the usual practice as exemplified by U.S. Patents Nos. 2,292,535 issued to C. M. MacChesney on August 11, 1942, and 1,935,091 issued to L. Iversen on November 14, 1933. As to the other components of the mills, it is believed that the reference of the above mill parts will be sufficient to completely understand the present invention and, consequently, no description will be given the other components of the mill. It will be noted that, not only are the housing posts 12 and 13 identical, but the components that are associated with each housing post are identi-

cal so that the mill stands constitute identical assemblies on either side of the path of the strip and, thus, each side will have substantially identical compression characteristics.

With reference to the path of the strip, FIGURE 1 shows the strip S moving in the direction indicated by the arrow passing through the first stand 10 and issuing from the first stand, but not yet entering into the second stand 11. As FIGURE 1 shows, at the exit side of the stand 10, the strip is illustrated with a camber shown in outline form to an exaggerated extent. The full line portion of the strip at the exit side of the stand 10 portrays the desired position of the strip. FIGURE 1 also illustrates, diagrammatically, that there is provided for each stand 10 and 11 entry guides 23 and 24, respectively; the opposed guiding member of the guides 23 and 24 having been adjusted to receive the strip S. However, unless the camber is corrected the strip will interfere with the guide 24, thereby preventing its feeding of the strip through the stand 11.

FIGURE 1 also serves to illustrate the arrangement provided for detecting the existence of a camber in the leading end of the strip. The illustrated form of this device, which will be more fully described hereinafter, consists of two pairs of spaced-apart strip edge-engaging rollers which are adjustable transversely and adapted to be brought into position so as to fall within the path of travel of the edges of the strip and on the experiencing of a camber are adapted to be individually deflected in different degrees out of this position.

With reference again to the chocks 18 and 22 of the work and backup rolls and in referring to FIGURE 2, it will be noted that in the lower work roll chock 18 a pair of piston cylinder assemblies 25 is provided, the pistons 26 of which are adapted to engage the lower surface of the upper work roll chock 18. A similar construction is provided in the upper portions of the backup roll chocks where there is provided piston cylinder assemblies 27 having pistons 28 that project and engage the lower surface of legs formed in the upper backup chocks 22. These cylinder assemblies will be recognized as following the teaching of common mill designs. The piston cylinder assemblies are single-acting assemblies and, as shown in FIGURE 2, in connection with the piston cylinder assemblies shown in section, they are provided with ports at the lower portion of the cylinders.

In referring now to the hydraulic control for providing a differential pressure for the piston cylinder assemblies on the opposite side of the mill, reference is made to FIGURE 5. It will be first appreciated that the elastic stress necessary to accomplish the aforesaid objective could be obtained in a given case by employing only the balance cylinder assemblies of the backup roll, whereas in either cases both the work roll balance cylinder assemblies and the backup balance cylinder assemblies on one side of the mill could be employed in unison. The latter arrangement is the one selected to illustrate the present invention. As FIGURE 5 illustrates, the pair of work roll balance cylinder assemblies 27 associated with the housing posts 12 are connected by lines 28 and 29, respectively, to a common line 31 that is connected to a pump 32 and a solenoid control pressure valve 33. The pump and control valve are, in turn, connected to a tank 34, the pump being driven by a motor 35.

A similar arrangement is provided for the work roll balance cylinder assemblies 25 and backup cylinder assemblies 27 associated with the housing posts 13. In this connection the work roll balance cylinder assemblies and the backup balance cylinder assemblies are connected by lines 36 and 37, respectively, to a common line 38 which is connected to a pump 39 and a solenoid control pressure valve 41. In this case, also, the pressure control valve and pump are connected into the tank 34 and the pump is driven by the motor 35, the motor therefor serving to drive both of the pumps 32 and 39. The pressure control

valves 33 and 41 are operated by load cells 42 provided in each mill and which are shown diagrammatically in both FIGURES 1 and 5.

It will be appreciated that in operation the pressure control valves 33 and 41 will be set to deliver to the balance piston cylinder assemblies the pressure normally employed to balance the rolls. Once the strip enters the first stand 10 its load cell 42 will initiate the operation of the camber detecting mechanism, which prior to the signal from the load cell 42 remains inoperative. On the experience of a cambered strip either one or the other of the control valves 33 and 41, depending in which direction the camber extends, will be operated to increase the pressure on one side of the stand 10 as opposed to the other. This will elastically stretch the components on the one side of the stand, such as the chocks and mill posts, to cause a differential pressure to be imposed upon the strip which, as previously explained, will cause the strip to elongate more on one side than on the other; thereby causing the cambered portion of the strip to assume the proper path of travel before it enters the entry guides of the succeeding stand. As the strip enters the stand 11, its load cell 42 of this stand will render the camber deflecting mechanism inoperative and the hydraulic system will return to the roll balance pressure.

With reference now to the camber detecting device, reference is made particularly to FIGURES 2, 3 and 4 where there is shown a platform 40 which extends between the posts 12 and 13 to which the ends are rigidly secured. The platform beneath the pass line of the strip rotatably supports a pair of chained, connected spaced-apart shafts 43 and 44, the shafts having two portions with opposite hand threads which portions are received by frames 45 and 46. At the left-hand side of the assembly, as one views FIGURES 2 and 4, a sprocket 46a is provided on one of the shafts 43 and 44 for receiving a chain 47, the other end of the chain is secured to a sprocket 48 which is mounted on the shaft of a gear reducer-motor assembly 49. In this manner the frames 45 and 46 are traversed over the shafts 43 and 44 and moved in opposite directions.

In describing, in particular, one of the frames, it carries a vertical trunnion 51 which, in turn, carries two overlapping arms 52 and 53 that extend in the direction towards the stand 10 and on the end adjacent thereto there is rotatably mounted, spaced-apart, vertically arranged strip edge-engaging rollers 54 and 55. As FIGURES 3 and 4 illustrate, immediately below the pass line of the strip and centrally located relative to the ends thereof, there is provided a support 56 which cooperates with supporting surfaces 57 mounted on the top of the frames 45 and 46 which support the strip as it passes from the mill stand 10 to the mill stand 11. As FIGURE 3 illustrates, the rollers 54 and 55 are so arranged with respect to the supporting surfaces 57 of the frames 45 and 46 that in the event the strip supported by the supporting surfaces 57 move transversely or, because of a camber, project over the supporting surface towards the mill posts 12 and 13, the edge of the strip will engage one or the other, or both, of the rollers 54 and 55 and cause a displacement of one or both of the arms 52 and 53, which, as noted, are pivotally secured to the common trunnion 51. If desired the deflector such as the rollers 54 and 55 can be so spaced apart that they will produce an independent signal, wherein when the second rollers are being displaced no signal will be produced by the first rollers and vice versa.

The arms 52 and 53 actually constitute bell crank assemblies at one end of each of which there are connected links 58 and 59. Also connected to the arms 52 and 53 are separate spring assemblies 61 and 62 which urge the arms 52 and 53 in a direction to move the rollers 54 and 55 in a direction toward the edge of the strip. The springs 61 and 62 urge the arms 52 and 53 against a stop that positions the rollers 54 and 55. Connected to the links 58 and 59, there are provided rods 63 and 64

that pass through guides 65 and 66, the other ends of the rods protrude out of the guides to which there is secured brackets 67 and 68. The two lengths of the portions of the arms 52 and 53 bear a two-to-one ratio so that the brackets 67 and 68 will move only one half of the displacement of the rollers 54 and 55.

The brackets 67 and 68 form part of pneumatic-hydraulic controller 69 which may follow the teaching of several available commercial units. One such device is manufactured by General Precision Company of Chicago, Ill., and illustrated in its Bulletin EG 84, copyright 1959. These devices basically comprise an air jet detecting nozzle which is associated with the movable brackets 67 and 68 thereby detecting the extent and direction of displacement of these brackets. Connected to the sensing nozzle is a regulator comprising a diaphragm sensitive to the output of the sensing nozzle which controls a jet of air played against a distributor and through which means there is controlled the fluid being fed to control the control valves 33 and 41.

It will be appreciated that while a mechanical, hydraulic control detecting device has been provided many other arrangements can be substituted with equal success.

A brief description of the operation of the aforesaid arrangement of the present invention will now be given. With reference to FIGURE 1, as a strip S passes through the stand 10, it will cause the load cell 42 to initiate operation of the camber detecting mechanism. Should the strip have a camber as illustrated in the figure, it will be noted that one or both of the camber detecting rollers 54 and 55 on one side of the mill will be displaced. The displacement of the rollers will cause a displacement of the respective arms 52 and 53, thereby either or both of the brackets 67 and 68 will be displaced a proportional amount, which movement will be detected by the sensing nozzle of the pneumatic control system 69. The pneumatic hydraulic control 69 will then determine the amount of displacement of the rollers and operate either of the pressure control valves 33 or 41 to send fluid to the piston cylinder assemblies of the balance cylinder assemblies associated with one side of the stand 10 of the mill to elastically stretch the components of one side of the mill. The pressure delivered to the assembly may range from 1700 p.s.i. to 4500 p.s.i. When this occurs, the strip passing through the work rolls 14 and 15 will be differentially elongated on the side opposite the direction of the camber so as to tend to straighten the cambered portion of the strip in a manner diagrammatically illustrated in FIGURE 1. This will allow the strip to be fed into the side guards 24 of the succeeding stand 11. Once the strip has entered the stand 11, its load cell 42 will render the camber detecting mechanism inoperative and return the hydraulic pressure in balance cylinders to the roll balance pressure.

FIGURE 6 shows a second embodiment of the present invention wherein the invention is addressed to the objectional tendency of the strip waving back and forth as it passes through a mill. As previously indicated, FIGURE 6 is addressed to a finishing train of a hot strip mill where there is provided in tandem arrangement the last stands 70 and 71. At the exit side of the last stand 71, there is provided a side trimming shear 72 for shearing the marginal edges of the strips as an adjunct of the rolling mill operation. Between the stands 70 and 71 there are provided two pairs of strip-engaging rollers which are constructed similarly to the arrangements shown in FIGURES 2, 3 and 4 which detect any travel of the strips out of the preferred path of travel. Should the strip wander, the balance cylinder assemblies of either or both of the stands 70 and 71 can be operated as previously was explained in connection with the arrangement shown in FIGURE 1 to control the transverse travel of the strip and maintain it in its preferred line of travel.

It will also be appreciated, as previously mentioned, that the present invention can just as well be utilized in connection with the operation of a plate mill wherein instead

of operating the balance cylinder assembly of the mill to correct for a camber incident to the feeding of the strip, the balance cylinder assemblies can be operated to roll out the camber of the plate thereby alleviating or reducing the need for subsequent straightening thereof. It will also be appreciated that while the present invention has been explained in relationship to a rolling mill, other strip-processing apparatus, such as paper and rubber calendars, can utilize the features of the invention.

In accordance with the provisions of the patent statutes, I have explained the principle and operation of my invention and have illustrated and described what I consider to represent the best embodiment thereof. However, I desire to have it understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

I claim:

1. In a rolling mill or a like apparatus including a housing,

a pair of processing rolls for engaging material passed therebetween,

bearing chock assemblies for rotatably supporting the ends of the rolls and received in said housing,

the bearing chock assemblies of each roll making up opposed pairs of bearing chock assemblies,

adjustable means arranged to resist separation of at least one of said rolls from the other and for holding its bearing chock assemblies associated therewith and, hence, said one roll in a selected rolling position during rolling,

the construction of said bearing chock assemblies and housing on each side of said mill being such that variations in the elastic compression of the bearing chock assemblies and housing on either side of said mill results in a change in the rolling positions of said rolls,

separate rapid responsive fluid force exerting means associated with each opposed pair of bearing chock assemblies for urging apart said opposed pairs of bearing chock assemblies and having the capacity to cause selective and differential elastic compression of at least said two pairs of opposed bearing chock assemblies so as to vary differentially along the width of the material the contact pressure exerted on the material by the rolls and means for selectively operating said separate force exerting means.

2. In a rolling mill or the like apparatus according to claim 1 including means for detecting the fact that the material has deviated from a prescribed path as it passes through the mill,

means associated with said detecting means for initiating operation of said force exerting means to cause the contact pressure exerted by the opposite ends of the rolls to vary and correct for any deviation of the material.

3. In a rolling mill or the like apparatus according to claim 2 wherein said detecting means includes two pair of spaced-apart material edge-engaging elements,

each pair of elements being arranged on opposite sides of the material and engageable by the material in the event of its deviation in the direction toward one of the pair of elements,

said elements being connected to a control which is operated on displacement of said elements by the material,

said control associated with said means for operating said force exerting means.

4. In a rolling mill or the like apparatus according to claim 2 wherein said rolling mill comprises a multi-stand mill including material entry guides for each of the stands of the mill,

said detecting means being located between a pair of said stands and before the entry guides of the latter of said pair of stands, whereby upon operation of

said force exerting means the material will be guided into the entry guides of said latter stand.

5. In a rolling mill or the like apparatus according to claim 2 wherein the said rolling mill comprises a plate mill, and wherein the force exerting means is effective to remove or lessen any longitudinal curvature in the material as it passes from the mill,

said detecting means being located at the exit side of said plate mill.

6. In a rolling mill or the like apparatus according to claim 2 wherein the rolling mill includes a shear for severing a longitudinal portion from the material as it leaves the mill,

said detecting means arranged on the entry side of said mill and said force exerting means being effective to correct for any of the material deviation from a prescribed path relative to the shear.

7. In a rolling mill including a housing, a pair of work rolls including chocks at their ends, a pair of backup rolls for supporting each work roll, including chocks at their ends,

piston cylinder assemblies arranged between the work roll chocks for urging their chocks apart,

piston cylinder assemblies arranged between the backup roll chocks for urging their chocks apart,

means for supplying fluid under pressure to said piston cylinder assemblies and for furnishing selectively a roll balance pressure which is employed during normal rolling and a material guiding pressure which is employed to correct for deviation of the material from a prescribed path,

a material deviating detecting means associated with a control to initiate operation thereof on a deviation of the material from the prescribed path to operate the piston cylinder assemblies on one side of the mill under the material guiding pressure to compress the components on one side of the mill to differentially vary the contact pressure exerted by the opposite ends of the work rolls on the material.

8. In a rolling mill having first and second tandemly arranged stands for rolling rapidly moving metallic strip and having strip edge guiding means arranged between said stands for guiding the leading end of a strip passing from the first stand to the second stand;

each stand including a housing, cooperative pairs of rolling mill rolls arranged in each housing for engaging material passed therebetween, bearing chock assemblies for rotatably supporting the ends of the rolls in said housings,

at least the bearing chock assemblies of the rolls of the first stand making up opposed pairs of bearing chock assemblies,

said first stand including adjustable means arranged to resist separation of at least one of said rolls thereof and for holding the bearing chock assemblies associated therewith and, hence, said one roll in a selected position during rolling,

the construction of said bearing chock assemblies and housing on each side of said mill of said first stand being such that variations in the elastic compression of the bearing chock assemblies and housing on either side of said first stand results in a change in the rolling positions of said rolls,

separate rapid responsive fluid force exerting means associated with each opposed pair of bearing chock assemblies of said first stand for urging apart said opposed pairs of bearing chock assemblies and having the capacity to cause selective and differential elastic compression of said two pairs of opposed bearing chock assemblies to selectively move either end of said one roll out of the selective rolling position to cause a guiding influence on the strip as it passes to the guiding means and to the second stand, means for selectively operating said separate force exerting means, and

means for interrupting the differential elastic compression of said opposed bearing chock assemblies whereby the end of said one roll will be caused again to assume said selected rolling position.

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U.S. Cl. X.R.

72—250, 17