ALIGNMENT MAINTENANCE FOR THE ROLLS OF ROLLING MILLS

March 30, 1937.

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Filed Jan. 11, 1932

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Fig. 1.

Fig. 2.

Fig. 3.

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Fig. 7.

Fig. 8.

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The present application is a continuation, in part, of my copending application Serial No. 437,536, filed March 20, 1930, and the invention hereof relates in general to roll bearings as used, for example, in the journaling of rolling mill rolls. In particular, the invention resides in a novel combination and arrangement of parts whereby bearings of this character are made effective to maintain the correct axial relations of the rolls or other rotating members which are journalled therein.

In rolling mill practice, it is well recognized that especially bad effects, both on the rolled product and on the rolling apparatus, are produced when the axes of a pair of cooperating reducing rolls become crossed, in consequence of any lateral displacement of either or both of said rolls from its normal operating position. In other words, it is of prime importance that the axis of each roll be maintained at right angles to the direction of travel of the stock passing between said rolls; otherwise the stock may emerge from said rolls in a deformed condition, with a tendency to twist, and furthermore, there will be stresses and strains of abnormal proportions set up in the rolling apparatus.

An immediate result of any disturbance of this desired normal right angle relation between roll axis and direction of stock travel is a strong tendency of the roll to move endwise, due, in the case of a stand of two-high rolls, to screwing action between roll surface and stock surface, and in the case of a stand of four-high or backed-up rolls, to screwing action between the surfaces of working and backing-up rolls. According to the present invention, such endwise tendency of a roll is made use of, in a highly advantageous manner, to correct at once the lateral displacement of the roll axis which gave rise to said endwise tendency, thus to restore automatically the desired right angle relation between roll axis and direction of stock travel. Other and further objects and advantages of the invention will be apparent from the following detailed description thereof, reference being had in this connection to the accompanying drawings, in which—

Fig. 1 is a view in end elevation of a two-high stand of rolls, to which my invention is applied.
Fig. 2 is a horizontal sectional view on the line 2—2 of Fig. 1.
Fig. 3 is a large scale fragmentary horizontal sectional view, illustrating the action of my invention in automatically restoring the alignment of a roll which has become crossed or laterally displaced.

Fig. 4 is a view in end elevation, showing the application of my invention to a stand of four-high or backed-up rolls.
Fig. 5 is a fragmentary large scale horizontal sectional view, similar to Fig. 3, illustrating the action of my invention in automatically restoring the alignment of one of the working rolls of Fig. 4.
Fig. 6 is a schematic view of the rolls of Fig. 4, showing the reactions thereon when the working rolls become crossed.
Fig. 7 is a view similar to Fig. 4, illustrating a different embodiment of the invention from that specifically shown by Figs. 4, 5 and 6.
Fig. 8 is a wiring diagram applicable to the embodiment of the invention shown by Fig. 7.

Like reference characters refer to like parts in the different figures.

Referring first to Figs. 1, 2 and 3, the numerals 1, 1 designate the two sides of a conventional two-high roll housing, each side having the usual window or opening 2 for the reception of bearing devices wherein are journalled the necks 3 and 4 of cooperating upper and lower reducing rolls 3a and 4a. The proper operation of said rolls is largely dependent upon maintenance of their axes in parallel and uncrossed relation; and my invention, as hereinbefore described, enables either or both of said rolls, in the event of such crossing, to restore itself or themselves automatically to the desired uncrossed relation where both roll axes stand at right angles to the direction of travel of the stock undergoing reduction. In the form of my invention shown by Figs. 1, 2 and 3, this automatic restoration is accomplished by a special construction of the bearing in which the necks 3 and 4 of said rolls are journalled.

The bearing devices for the two rolls 3a and 4a are identical in construction, so that a description of one set of these bearing devices will suffice for both rolls. Any suitable means for supporting said bearing devices may be provided; for example, those for the upper roll may take the form of lugs 5, 5 projecting inwardly of the housing windows 2, 2, while the lower roll bearings may be supported for vertical adjustment by the usual wedge blocks 6,—it being understood that, in the operation of the rolls, the upper roll 3a is held to its work by the usual holding-down screws 7 carried by the housing cap 8 and effective against the bearings of said roll.

Referring now to Figs. 2 and 3, it is to be noted that each roll neck 3 or 4, as the case may be, is surrounded by a bearing member 9, here shown...
as made in two parts or halves, so as to allow the provision on the roll neck of a collar 10, the latter serving to prevent endwise displacement of said bearing member 9 and take up any wear on said neck. Any other means for preventing such endwise displacement may be employed without departing from my invention, and it is obvious that the latter is not in any way connected to the making of the bearing member 9. In two parts or halves, said member 9, as shown, has convex outer surfaces or sides 11, 11, the curvature of the latter intersecting the roll axis at right angles. For cooperation with each such convex surface 11, I provide a shoe 12, which has a corresponding inner concave surface in opposition to said convex surface; as shown in Fig. 1, the plane bottom edges or surfaces of these shoes 12, 12, like the corresponding bottom surfaces of the bearing members 9, are slidably supported on the bearing supports 5a, 5a, or 6z, as the case may be.

Each pair of shoes 12, 12 provides outside surfaces 13, 13 in parallel vertical planes disposed at an inclination to the vertical plane containing the axis of the associated roll 3a or 4a, thus to cooperate with the pair of oppositely acting wedges 14, 14 whose inner surfaces correspond with said parallel vertical planes, and whose outer surfaces bear against the opposite sides of the housing window 2. Each of said wedges 14, 14 is adjustably held in position by means of a screw 15 carried by a bracket or lug 16, attached in any suitable way to the housing 1. It will be understood, of course, that by means of said screws 15, 15, the wedges 14, 14 will be moved in or out, as the case may be, to establish initially a substantially exact parallelism of the axes of the two cooperating rolls 3a and 4a, so as to secure the desired right angle relation between said roll axes and the direction of travel of the stock between said rolls.

Let it be assumed, in the operation of reducing rolls journaled in the manner above described, that, from one cause or another, there occurs a disturbance of this desired right angle relation between the axis of either roll and the direction of travel of the stock. Such a condition is represented, in an exaggerated manner, by the broken axial line y-y in Figs. 2 and 3, and under these conditions, with the stock travelling in the direction of arrow A, at right angles to the normal line x-x of the roll axis, the reaction between said stock and the displaced roll will produce a screwing action of said roll toward the left, as represented by the arrow B. This left hand endwise movement of the roll, carrying with it the shoes 12, 12, produces, by a relatively short traverse of said shoes along the wedges 14, 14, a pronounced and immediate shifting of the roll axis from its displaced position y-y to a corrected position z-z, where it again stands at right angles to the direction A of stock travel. As soon as this endwise shifting action has re-established the desired right angled relation between roll axis and direction of stock travel, the screwing tendency is wholly eliminated; thus either roll in operation is capable of effecting by itself a restoration of its alignment, whenever its axis gets out of normal relation. In other words, the bearing construction is such that the roll in action is self-aligning; there can never occur any substantial skewing of a roll axis, or any substantial crossing of the axes of cooperating rolls, because the corrective action above described comes into play immediately upon the slightest disturbance of the normal right angle relation between roll axis and the direction of stock travel.

Figs. 4, 5 and 6 show the invention in an environment which emphasizes its usefulness, namely, in connection with cooperating working rolls 17 and 18, of relatively small diameter, which, in a manner well known in the art, are "backed-up" by larger rolls 19 and 20, respectively, the latter being relied upon to provide the necessary resistance to the heavy pressures and strains incident to the passage of the stock between the rolls 17 and 18. Said working rolls 17 and 18, being of relatively small diameter, are susceptible, even more than ordinary-size rolls, of becoming crossed in operation. Referring to Fig. 4, the roll housing 21, whose windows at opposite sides receive the necks or gudgeons of both the working and the backing-up rolls, provides at each side a suitable supporting means, as shown at 22, for bearing 23 of the upper backing-up roll 19. From said supporting means 22 may be suspended, as shown at 24, another supporting means 25 on which the bearing devices 17 are carried. Any suitable supporting means, as for instance, a member 26 supported on the lugs 27, 27 of the housing 21, may be provided for the bearing devices of the lower working roll 18. These bearing devices for the upper and lower working rolls 17 and 18 are substantially identical in construction with the bearing devices shown in Figs. 1, 2 and 3 for the stand of two-high rolls 3a, 4a, and are here indicated by the same reference numerals with the addition of the prefix "v", viz., by the reference numerals 9' to 16' inclusive.

Although the bearing devices of working rolls 17 and 18 are substantially identical in construction with those of rolls 3a and 4a, their arrangement must be somewhat different in order to give effect to the influence on said rolls 17 and 18 of the backing-up rolls 19 and 20. The diagrams of Fig. 6 illustrates the situation that arises when, from one cause or another, the axis of the upper working roll 17 becomes crossed with relation to the axis of the lower working roll 18, or skewed, as shown in exaggerated form at y, y, with relation to the direction of stock travel (arrow A'). When the upper working roll 17 is skewed as shown in Fig. 6, the stock has a tendency to shift laterally toward the right hand end of said roll. This tendency produces a certain reaction of the roll 17 to the left, but this reaction will always be considerably less than the reaction toward the right that is effective on said roll 17, due to the fact that said roll 17 is rotating in frictional contact with and in skewed relation to the upper backing-up roll 19. The latter, having a substantially rigid and immovable mounting in the housing and being made of hard material, exercises on the working roll 17 an effect that predominates over the effect exercised by the stock, since said stock is plastic or semi-plastic and is subject to deformation; in consequence, the major reaction of the upper working roll 17, under the conditions assumed, is toward the right, and for this reason, the wedges 14', 14' of the bearing devices require an opposite hand arrangement from that shown in Figs. 1, 2 and 3 in order to obtain automatic correction of the axial displacement of the working roll or rolls.

A modification of my invention, shown in Figs. 7 and 8, utilizes in a somewhat different manner the endwise tendency of a crossed or displaced
roll to produce the corrective action by which the normal position of the roll axis is restored. Referring to Fig. 7, the working rolls 17', 18' and the backing-up rolls 19', 20' are arranged in the usual manner in a housing 21', with their necks received in the windows or openings of the upper sides of said housing. The necks of the working rolls 17' and 18' are encircled and supported as shown in Fig. 7, by bearing shoes 28, 29, and it is apparent that only by constant adjustment of these bearing shoes can the rolls 17' and 18' be kept from being crossed, or laterally displaced in any direction.

As shown in Fig. 7, each bearing shoe 28 (there being two for each working roll, one at either end) is movable in or out by a screw 29, which is turnable in the side of the housing 21' to produce lateral movement of the shoe. Each screw 29 is connected by suitable gearing 30 to a reversible driving motor 31, the latter being operable, as hereinafter described, to move its associated bearing shoe 28 inwardly or outwardly, as the case may be, for the positioning and maintenance of the rolls 17' and 18' in non-crossed relation.

The rolls are connected for the electrical connections by which the motors 31, 31 are operated for the adjustment of the bearing shoes 28, 29, to produce automatically a correction of the positions of the working rolls 17', 18' as soon as any lateral displacement of either of said working rolls occurs. Shown in said diagram, each roll 17', 18', at the end thereof, carries a suitable conductor 32, the latter being disposed normally in an intermediate non-contacting position between two sets of contacts 33, 33 and 34, 34. When a roll 17' or 18' gets out of alignment, the endwise movement of the same in one direction or the other, produced, as above described, by reaction between said roll and the associated backing-up roll, carries the conductor 32 into bridging relation either with the pair of contacts 33, 33 or with the pair of contacts 34, 34, and this action is followed of inducting the operation of the corresponding motor 31, in such a direction as to screw the bearing shoe 28 either inwardly or outwardly, as the case may be, until the correct position of the roll is restored. With such restoration of position, which eliminates any endwise tendency of either roll, the conductors 32, 32 resume their normal non-contacting positions, intermediate the sets of contacts 33, 33 and 34, 34, thereby to discontinue the motor operation until the parallelism is again disturbed; in effect, the conductors 32, 32 have more or less a floating action between the opposite sets of contacts while the working rolls are in operation, the motors 31, 31 thereby being brought intermittently into operation in whichever direction is necessary to substantially maintain the axial parallelism of the rolls 17' and 18' at all times.

The electrical connections to accomplish these results are shown in Fig. 8, and inasmuch as they are identical for the two rolls 17' and 18', it will be sufficient to describe the same with reference to one of said rolls and the associated motor 31. When the roll 17', by reason of the screwing action produced by skewing of its axis, shifts to the left and causes the conductor 32 to bridge the contacts 33, 33, the current from a suitable source of electrical supply, made available by the closure of a switch 35, flows in a closed circuit consisting of the operating coil 36 of a contactor or relay device E, said circuit being closed by the bridging of said contacts 33, 33. The energization of coil 36 produces, in the well known manner, a right hand movement of the movable member of relay E, thereby to close the normally-open pairs of cooperating contacts 37, 37' and 38, 38; this establishes, in parallel with the circuit containing the coil 36, a closed circuit containing the motor 31, the latter thereupon operating in such direction as, for example, to screw the bearing shoe 28 inwardly, so as to shift the roll 17' far enough to restore its position, and thereby overcome the endwise tendency that originally carried the conductor 32 into engagement with the contacts 33, 33. As a result of this action, the endwise tendency of said roll is reversed, and the effect of this is to draw the conductor 32 away from the contacts 33, 33, whereupon the circuit containing the relay coil 36 is broken; with the coil 36 thus deenergized, the movable member of the relay returns to its normal position, breaking the circuit of motor 31 that had previously been completed through the contacts 37, 37' and 38, 38', and thereby discontinuing the action of said motor in shifting the bearing shoe 28.

Should the adjusting action above described cause the roll to move too far to the right, or should a screwing action produce a roll farther to the right by crossed axes set up a right hand, instead of a left hand endwise tendency, then the conductor 32 will bridge the contacts 34, 34, under these circumstances, a circuit containing the operating coil 39 of a contactor or relay device F will be established. The energization of coil 39 produces, in the well known manner, the movement of the movable member of said relay device F, to bring together the normally-open pairs of contacts 40, 40' and 41, 41', as a result of which a parallel circuit containing the motor 31 is established in which the current flows in the opposite direction from that which prevails when the relay E is made operative. This causes the motor 31 to operate in the reverse direction from that above described, whereby the bearing shoe 28 is screwed outwardly far enough to allow the roll axis to have its position restored. In this way, the endwise movement of a roll in either direction, as produced by a screwing action when the normal right angle relation between roll axis and direction of stock travel is disturbed, is made use of to set in operation immediately the necessary corrective forces,—with the result that the roll is kept substantially in proper position all the time it is operating. This automatic adjustment is likewise applicable to the other roll 18' by means of contactor or relay devices G and 31, the former corresponding to the relay device E and the latter corresponding to the relay device F.

It is to be noted that the last-described embodiment of my invention not only maintains the axial parallelism of the rolls, but also prevents or overcomes any material disturbance of the normal endwise relationship between the rolls,—this last being of particular advantage, for example, in the rolling of strip and like material. In such rolling, the wear occasioned by the passage of the stock produces a slight groove of the width of the stock in the surface of the roll, and because of this, mill schedules are usually arranged so that the widest strip is rolled first, and thereafter successively narrower strips are rolled,—the final procedure, before any wider strip is rolled, being to regrind the roll so as to avoid any marking of the product from its overlap of either edge of the shallow groove.

Such overlap and consequent marking of the product, which comes from permitting a roll in
operation to shift endwise, does not take place to any appreciable degree with the arrangement disclosed in Figs. 7 and 8, because the electrical contacts tend always to maintain each roll in an endwise position that is substantially fixed. Any deflection from parallelism that produces momentarily an endwise movement is automatically responded to immediately by a motor action that, in laterally adjusting the roll bearings, also sets up, as above described, an opposite endwise movement of the roll, so that the latter at once resumes its correct position, both laterally and endwise. Thus in rolling strip or the like with the arrangements shown in Figs. 7 and 8, the product will not be marked by the edge of the shallow groove that is worn in either working roll.

From the foregoing, it is apparent that by the present invention there is provided an extremely effective arrangement for maintaining the alignment of the rolls of rolling mills. Upon the occurrence of any condition resulting in a disturbance of the normal right angle relation of a roll axis to the direction of stock travel, the arrangement of the present invention automatically functions in response to endwise movement of the roll, due to a screwing action of the stock thereon, to forcibly restore the roll axis to its normal position. In thus utilizing endwise movement of a roll, the present invention distinguishes from the roll aligning means disclosed in the copending application of Jerome P. George, Serial No. 452,797, filed March 3, 1939, wherein lateral displacement of a roll is depended upon to set in operation the means for restoring a roll axis to its normal condition.

I claim:

1. In a rolling mill, a reducing roll, a bearing for said roll, said bearing permitting endwise movement of said roll in response to a screwing action thereon when the roll axis undergoes displacement from its normal right angle relation to the direction of stock travel, and means responsive to movement of said roll axis to forcibly restore the roll axis to its normal position by pressure exerted on the bearing against the roll, said bearing being adapted for operativity upon displacement of the roll axis to the direction of stock travel, and means responsive to the operative condition of said contact device associated with said roll and made operative when said roll is displaced from its normal right angle relation to the direction of stock travel, and means responsive to the operative condition of said contact device, as a result of such endwise roll movement, for restoring the normal right angle relation of the roll to the direction of stock travel.

2. In a rolling mill, a reducing roll, a bearing for said roll, a backing-up roll therefor, a bearing for said backing-up roll, said bearing being adapted to follow endwise movement of the backing-up roll, a bearing for the backing-up roll, and means responsive to movement of said roll axis to forcibly restore the roll axis to its normal position by pressure exerted on the bearing against the roll, said bearing being adapted for operativity upon displacement of the roll axis to the direction of stock travel, and means responsive to the operative condition of said contact device associated with said roll and made operative when said roll is displaced from its normal right angle relation to the direction of stock travel, and means responsive to the operative condition of said contact device, as a result of such endwise roll movement, for restoring the normal right angle relation of the roll to the direction of stock travel, and means responsive to the operative condition of said contact device, as a result of such endwise roll movement, for restoring the normal right angle relation of the roll to the direction of stock travel.
tact device, as a result of such endwise roll movement, to exert a force for shifting said bearing, laterally, just enough to restore the normal right angle relation of the roll axis to the direction of stock travel.

11. In a rolling mill, a pair of cooperating rolls normally working with their axes in parallelism, normally inoperative contact devices associated and made operative by endwise movements of said rolls resulting from crossing of the roll axes, and means brought into action by the operative condition of said contact devices, as a result of such endwise roll movements, for restoring said rolls to a condition of axial parallelism.

12. In a rolling mill, a reducing roll adapted to operate normally with its axis at right angles to the direction of stock travel, a motor normally maintained inoperative, motor operating means set in action by endwise movement of said roll in response to screwing action of the stock thereon when the roll axis undergoes displacement from its normal right angle relation to the direction of stock travel, and means for shifting the roll by said motor under the control of said motor operating means until the roll axis resumes its normal position.

13. In a rolling mill, a reducing roll adapted to operate normally with its axis at right angles to the direction of stock travel, a reversible motor normally maintained inoperative, motor operating means set in action by endwise movement of said roll, in one direction or the other, in response to screwing action of the stock thereon when the axis of said roll undergoes displacement, in one direction or the other, from its normal right angle relation to the direction of stock travel, and means for restoring by said motor operation the normal position of said roll.

14. In a rolling mill, a pair of reducing rolls adapted to operate with their axes in parallelism, bearings for said rolls, a normally inactive motor, contact making and breaking devices responsive to endwise movement of either roll in response to screwing action of the stock thereon when the axes of said rolls become cross for initiating action of said motor, and means for transmitting to a bearing of one of said rolls the action of said motor, to restore the roll axes to a condition of parallelism.

15. In a rolling mill, a reducing roll, bearings for said roll permitting endwise movement of said roll in response to a screwing action thereon, when the roll axis undergoes displacement from its normal right angle relation to the direction of stock travel, and means for utilizing such endwise roll movement to develop a corrective force applied to a roll bearing to restore the roll axis to its normal right angle relation to the direction of stock travel.

16. In a rolling mill, a working roll, a backing-up roll therefor, bearings for said working roll permitting endwise movement of said roll, when the latter on account of being in skewed relation to the backing-up roll tends to screw endwise, and means for utilizing such endwise roll movement to develop a corrective force applied to a working roll bearing to restore the working roll axis to its normal unskewed relation with respect to the axis of the backing-up roll.

17. In a rolling mill, a reducing roll, bearings for said roll permitting endwise movement thereof, and means for utilizing endwise roll movement, in either direction along the roll axis, to develop a lateral pressure on a roll bearing opposite to the direction of roll displacement initially responsible for such endwise roll movement, as a result of screwing action on the roll, whenever its axis shifts from its normal right angle relation to the direction of stock travel.

18. In a rolling mill, a working roll, a backing-up roll therefor, bearings for said working roll permitting endwise movement of said roll, when the latter on account of being in skewed relation to the backing-up roll tends to screw endwise, and means for utilizing endwise working roll movement, in either direction along the roll axis to develop a lateral pressure on a roll bearing opposite to the direction of roll displacement initially responsible for such endwise roll movement, said lateral pressure continuing until the working roll axis is restored to its normal unskewed relation with respect to the axis of the backing-up roll.

19. In a rolling mill, a reducing roll, a bearing for said roll adapted to follow endwise movement thereof, and means cooperating with said bearing for converting any endwise roll movement into lateral movement of the bearing opposite to the direction of roll displacement initially responsible for such endwise roll movement, whenever the roll axis undergoes displacement from its normal right angle relation to the direction of stock travel.

20. In a rolling mill, a reducing roll, bearings for said roll adapted to follow endwise movement thereof, and means cooperating with said bearings for converting any endwise roll movement, in either direction along the roll axis, into lateral movement of each bearing opposite to the direction of roll displacement initially responsible for such endwise roll movement, whenever the roll axis undergoes displacement from its normal right angle relation to the direction of stock travel.

21. In a rolling mill, a working roll, a backing-up roll therefor, the axes of said rolls being normally in parallel relation, bearings for said working roll adapted to follow endwise movement of said roll, and means cooperating with said bearing, when the working roll on account of being in skewed relation with the backing-up roll tends to screw endwise, for converting such endwise roll movement into a pressure acting laterally on the backing-up roll bearing to restore the working roll axis to its normal unskewed relation with respect to the axis of the backing-up roll.

22. In a rolling mill, a working roll, a backing-up roll therefor, the axes of said rolls being normally in parallel relation, bearings for said working roll adapted to follow endwise movement of the roll, in either direction along its axis, and means cooperating with said bearings, when the working roll on account of being in skewed relation to the backing-up roll tends to screw endwise, for converting such endwise roll movement into pressures acting laterally on the working roll bearings to restore the working roll axis to its normal unskewed relation with respect to the axis of the backing-up roll.

23. In a rolling mill, a reducing roll, a bearing for said roll adapted to follow endwise movement of the roll and providing parallel guide surfaces inclined with respect to the roll axis, and a mounting for said roll bearing providing guide surfaces in engagement with the guide surfaces on said bearing, for converting endwise movement of the roll in response to a screwing action thereon, such as when the roll axis undergoes displacement from its normal right angle to the direction of stock travel, into a reaction between said guide surfaces which
shifts the roll, laterally, until the normal right angle relation of the roll axis to the direction of stock travel is restored.

24. In a rolling mill, a reducing roll, bearings for said roll adapted to follow endwise movement of the roll and providing guide surfaces oppositely inclined with respect to the roll axis, and mountings for said bearings providing guide surfaces in engagement with the guide surfaces of said bearings, for converting endwise movement of the roll in response to screwing action of the stock thereon, when the roll axis undergoes displacement from its normal right angle relation to the direction of stock travel, into reactions between the engaged guide surfaces which shift the roll, laterally, until the normal right angle relation of the roll axis to the direction of stock travel is restored.

25. In a rolling mill, a working roll and a backing-up roll adapted to normally operate with their axes in parallelism, a bearing for said working roll adapted to move endwise with said roll and providing parallel guide surfaces inclined with respect to the roll axis, and a mounting for said roll bearing providing guide surfaces in engagement with the guide surfaces on said bearing, for converting endwise movement of said roll, when the latter by crossing of its axis with the backing-up roll axis is subjected to a screwing action, into a reaction between said engaged guide surfaces which exerts a lateral force on said working roll bearing to shift the same just enough to restore said roll axes to their normal condition of parallelism.

26. In a rolling mill, a pair of reducing rolls adapted normally to operate with their axes in parallelism, bearings for each of said rolls adapted to move endwise therewith and each providing parallel guide surfaces inclined with respect to the roll axes, and mountings for said bearings providing guide surfaces in engagement with said guide surfaces on said bearings, for converting endwise movement of either roll, when the latter by crossing of the roll axes is subjected to screwing action from the stock passing between them, into a reaction between said engaged guide surfaces which shifts the corresponding roll bearings laterally, just enough to restore said roll axes to a condition of parallelism.

27. In rolling mills, the provision of means for automatically rendering effective the axially acting forces that are produced when the axes of cooperating rolls become crossed, in order to adjust said axes into a common plane, comprising supporting means for one of said rolls that permits said roll to move endwise under the influence of such forces, and means responsive to such endwise roll movement for laterally adjusting said supporting means to a position in which the axis of said roll is cut by said common plane.

28. In a rolling mill or the like, the provision of means for automatically rendering effective the axially acting forces that are produced when the axes of cooperating rolls become crossed, in order to adjust said axes into a common plane, comprising supporting means for one of said rolls that permits said roll to move endwise under the influence of such forces, and means responsive to such endwise roll movement for laterally adjusting said supporting means to a position in which the axis of said roll is cut by said common plane.

29. In rolling mills and the like, the provision of means for automatically rendering effective the axially acting forces that are produced when the axes of cooperating rolls become crossed, in order to adjust said axes into a common plane, comprising supporting means for one of said rolls that permits said roll to move endwise under the influence of such forces, and means responsive to such endwise roll movement for laterally adjusting said supporting means to a position in which the axis of said roll is cut by said common plane.

30. In a rolling mill or the like, a plurality of cooperating rolls, at least one of which, in response to operation of same in crossed relationship to an adjacent roll, is free to move endwise, and means for converting such endwise roll movement into a lateral adjusting movement of said roll, thereby to shift said roll into uncrossed relationship to said adjacent roll.

31. In a rolling mill or the like, a plurality of cooperating rolls, at least one of which, in response to operation of same in crossed relationship to an adjacent roll, is free to move endwise, a bearing for said roll, adapted to take part of the latter's endwise movement, and a mounting for said bearing wherein the latter is slidably, said mounting providing guide surfaces for said bearing at an angle to the line of such endwise movement, whereby to shift said bearing laterally prior to said roll coming into uncrossed relationship to said adjacent roll.

32. In a rolling mill or the like, a plurality of cooperating rolls, at least one of which, in response to operation of same in crossed relationship to an adjacent roll, is free to move endwise, a bearing for said roll, adapted to take part of the latter's endwise movement, and a mounting for said bearing wherein the latter is slidably, said mounting providing guide surfaces for said bearing at an angle to the line of such endwise movement, whereby to shift said bearing laterally prior to said roll coming into uncrossed relationship to said adjacent roll.

33. In a rolling mill or the like, a pair of cooperating rolls, bearings for said rolls, one of said rolls, in response to screwing action set up by the crossing of the axes of said rolls, being permitted to move endwise, and means associated with a bearing of one of said rolls for converting such endwise roll movement into a lateral adjustment of said bearing, thereby to move the roll associated with said bearing into substantially uncrossed axial relationship to the other roll.

34. The combination with a rolling mill roll, of means permitting endwise movement of said roll in response to screwing action set up by operation of said roll in crossed relationship to an adjacent roll, and means responsive to such endwise motion for laterally shifting one of said rolls to restore automatically the normal uncrossed relationship of said rolls.

35. The combination with a rolling mill roll, of means permitting endwise movement of said roll in response to screwing action set up by operation of said roll in crossed relationship to an adjacent roll, and means for utilizing such endwise motion to produce a lateral adjustment of one of said rolls, which restores the uncrossed relationship of said roll.

36. Apparatus for canceling the axial forces set up in rolling mill operation by crossing the axes of adjacent cooperating rolls, to restore said axes to a common vertical plane, comprising a
roll bearing adapted to move in response to such forces, and a support for said bearing that permits such movement but imposes on said roll a lateral component, thereby, through lateral movement of said bearing, to shift laterally the associated roll until its axis reoccupies said common vertical plane.

37. The combination with a pair of cooperating rolls, of means permitting endwise movement of one of said rolls in response to axial forces set up by the crossing of the axes of said rolls, and means responsive to such endwise movement for laterally moving one of said rolls to restore the normal uncrossed relationship of said pair of rolls.

38. In a rolling mill, a pair of cooperating rolls, one of said rolls being subject to axial forces set up by operation of same in crossed relation to the other of said rolls, and means brought into operation by said axial forces for laterally shifting one of said rolls to restore automatically the normal uncrossed relationship of said pair of rolls.

39. In a rolling mill, a pair of rolls, a mounting for one of said rolls permitting the latter to yield to axial forces set up by its operation in crossed relationship to the other roll, and means for procuring, in response to such yield, a lateral adjustment of one of said rolls to restore the normal uncrossed relationship of said pair of rolls.

40. In a rolling mill, the combination with a pair of adjacent cooperating rolls, one arranged to respond to axial forces set up by operation of said rolls in crossed relationship, of means set in operation by such response of said roll to said axial forces for laterally adjusting one of said rolls to restore the normal uncrossed relationship of said pair of rolls.

41. Apparatus for causing the axial forces set up in rolling mill operation by crossing of the axes of adjacent cooperating rolls to restore said axes to a common vertical plane, comprising a support for one of said rolls, said support being constrained to partake of axial movement produced by such forces on its associated roll, and guiding means for said support making lateral contact therewith on parallel surfaces that are inclined to said common vertical plane, thereby to obtain a lateral adjustment of said support in a direction to restore the axis of said roll to said common vertical plane.

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