

[54] VERTICAL MILL

[72] Inventor: Herbert Lemper, Pittsburgh, Pa.
 [73] Assignee: Mesta Machine Company, Pittsburgh, Pa.
 [22] Filed: June 1, 1970
 [21] Appl. No.: 42,077

[52] U.S. Cl. 72/239, 72/245, 72/249
 [51] Int. Cl. B21b 31/08
 [58] Field of Search 72/237, 238, 239, 240, 245,
 72/247, 249

[56] References Cited

UNITED STATES PATENTS

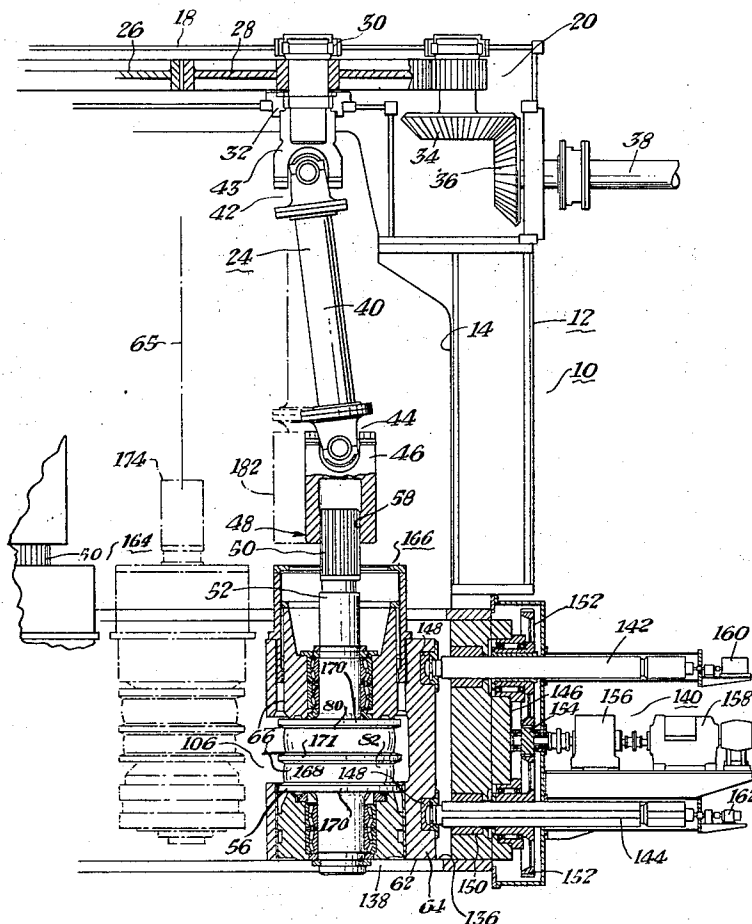
2,927,488	3/1960	Peterheit	72/238
2,011,686	8/1935	Mikaelson et al.	72/239
737,277	8/1903	Rowland	72/245

Primary Examiner—Charles W. Lanham
 Assistant Examiner—Michael J. Keenan
 Attorney—Don J. Smith

[57] ABSTRACT

I disclose a rolling mill comprising a housing, a pair of mill rolls rotatably mounted on said housing, means mounted on said housing for rotatably mounting each of said rolls, means for rotating each of said rolls including a drive spindle, means for moving each of said rolls axially, a detachable coupling for detachably coupling each of said spindles to the associated one of said rolls, each of said detachable couplings including inter-fitting and axially withdrawable keying components on the associated drive spindle and mill roll respectively, and said axial moving means being capable of moving each of said rolls through a distance at least sufficient to engage and to withdraw said inter-fitting keying members.

18 Claims, 7 Drawing Figures



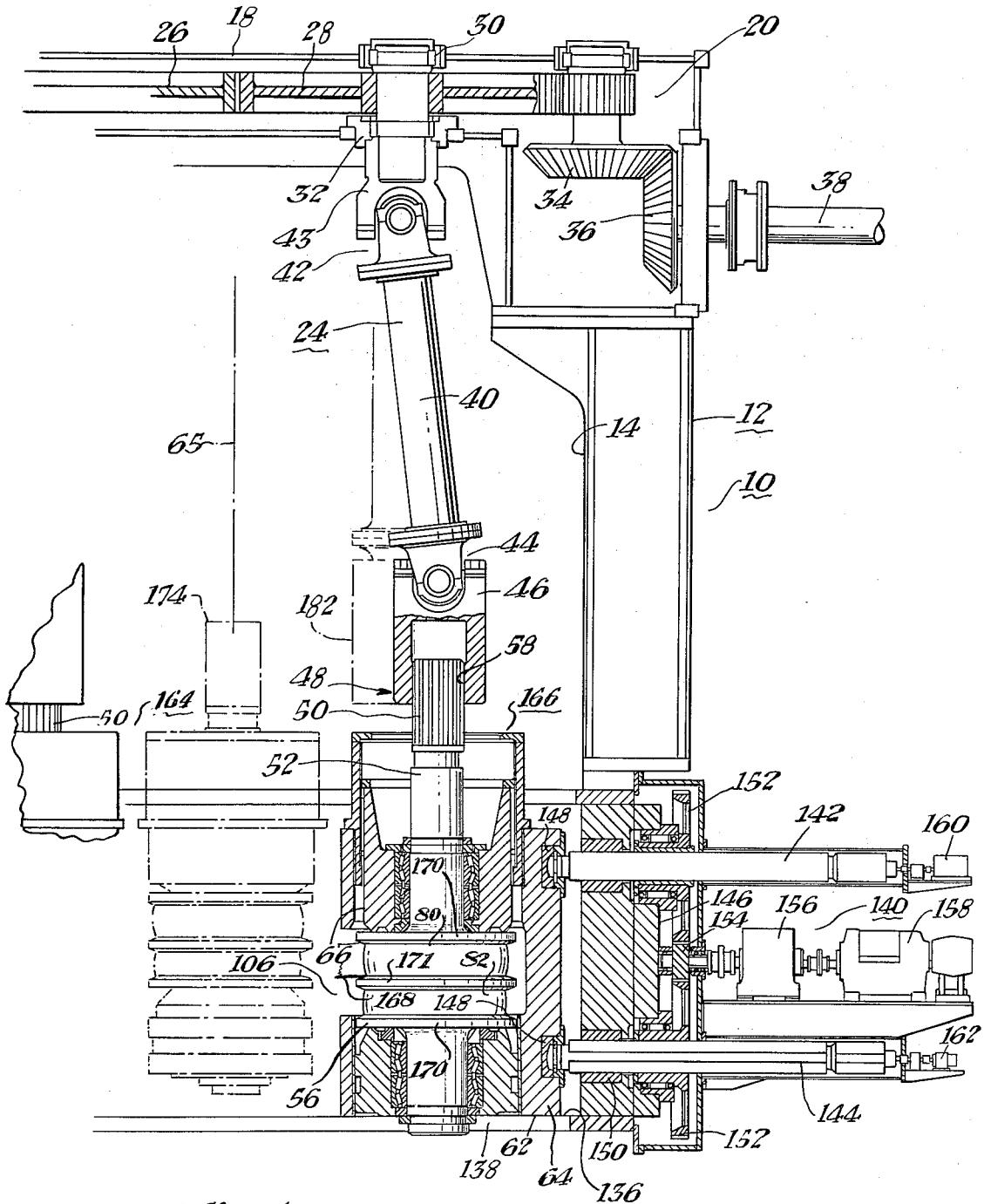


Fig. 1.

INVENTOR
 BY Herbert Lempert
Paul, Blau & Zassenheim
 HIS ATTORNEYS

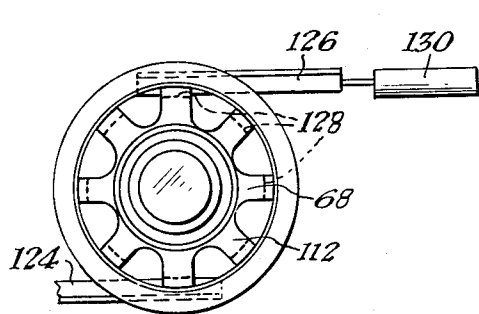


Fig. 3.

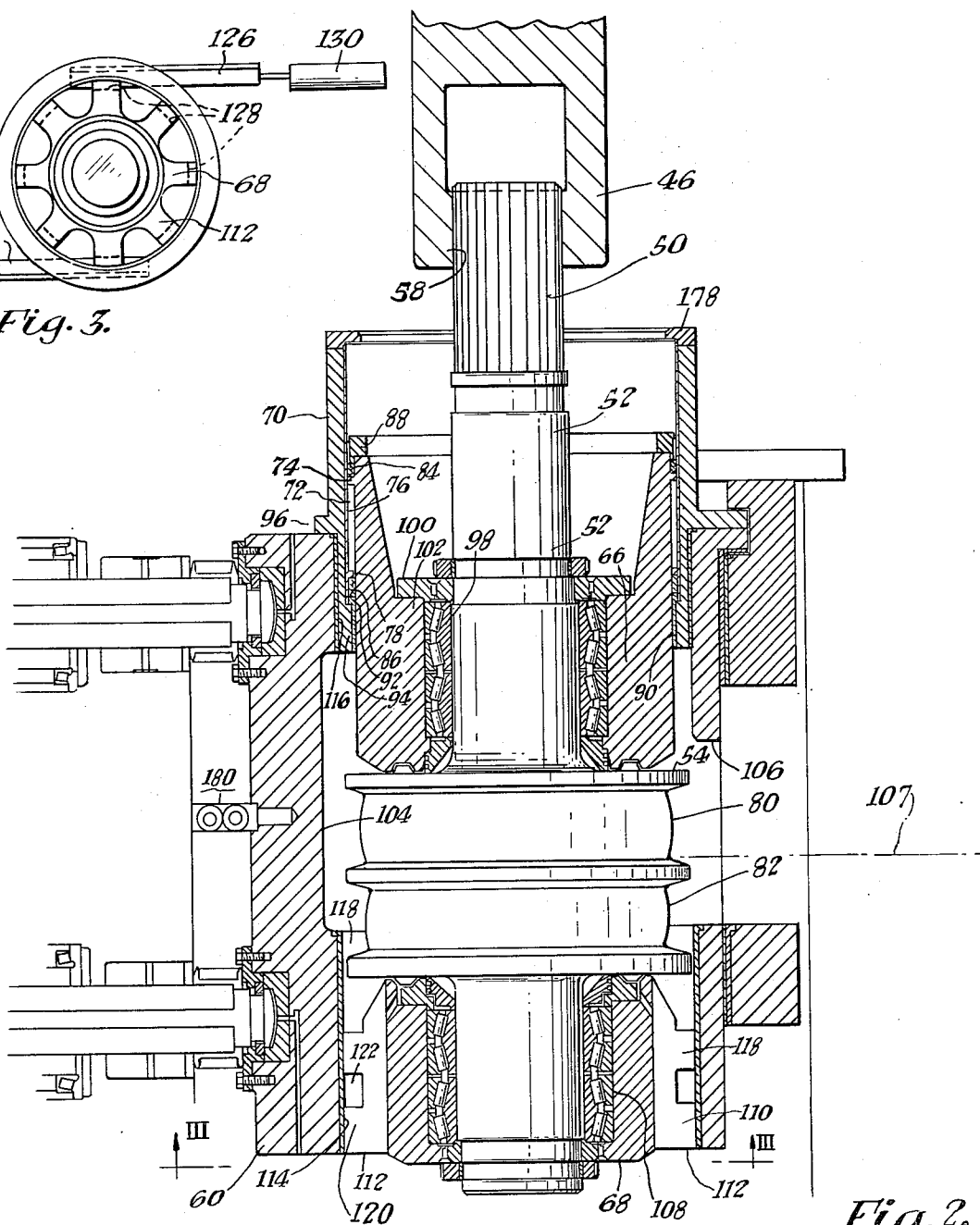


Fig. 2.

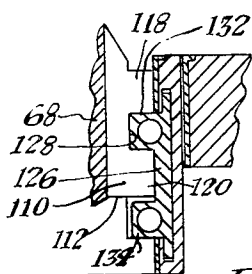
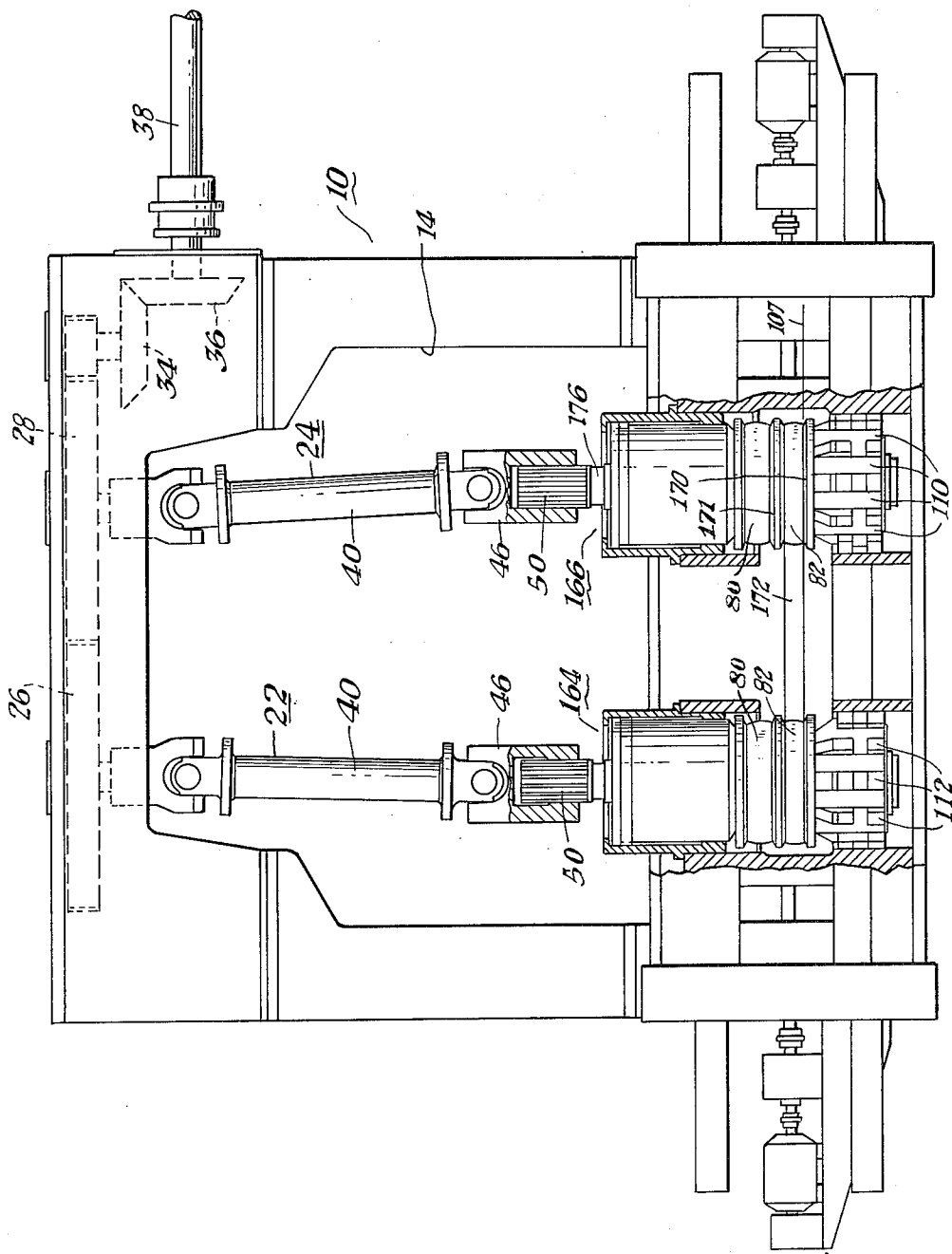


Fig. 2A.

INVENTOR
Herbert Lempert
BY
Paul, Ober & Ziesenheim
HIS ATTORNEYS



INVENTOR
Herbert Lemper
BY
Small, Elms & Fahrenheim
HIS ATTORNEYS

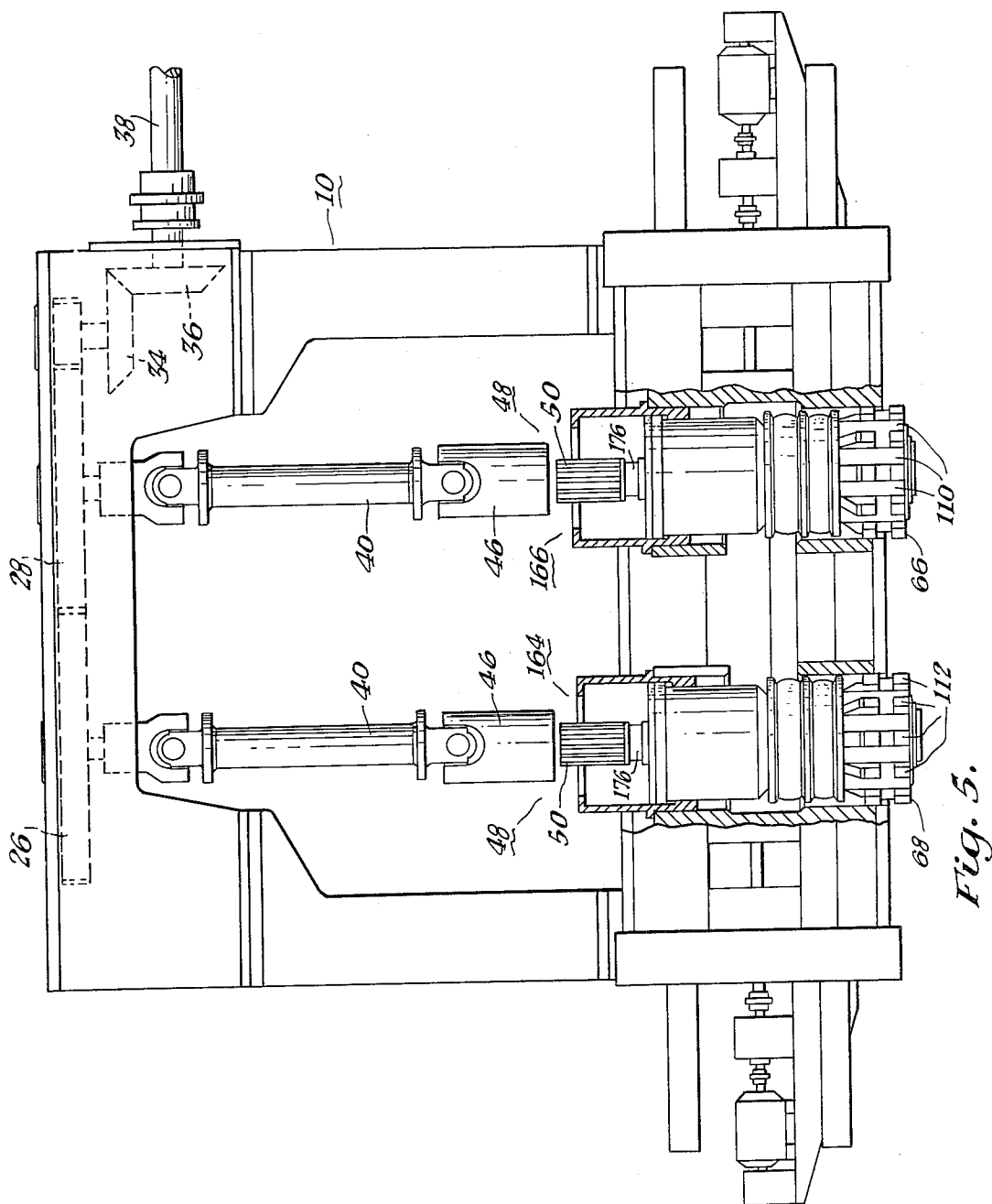
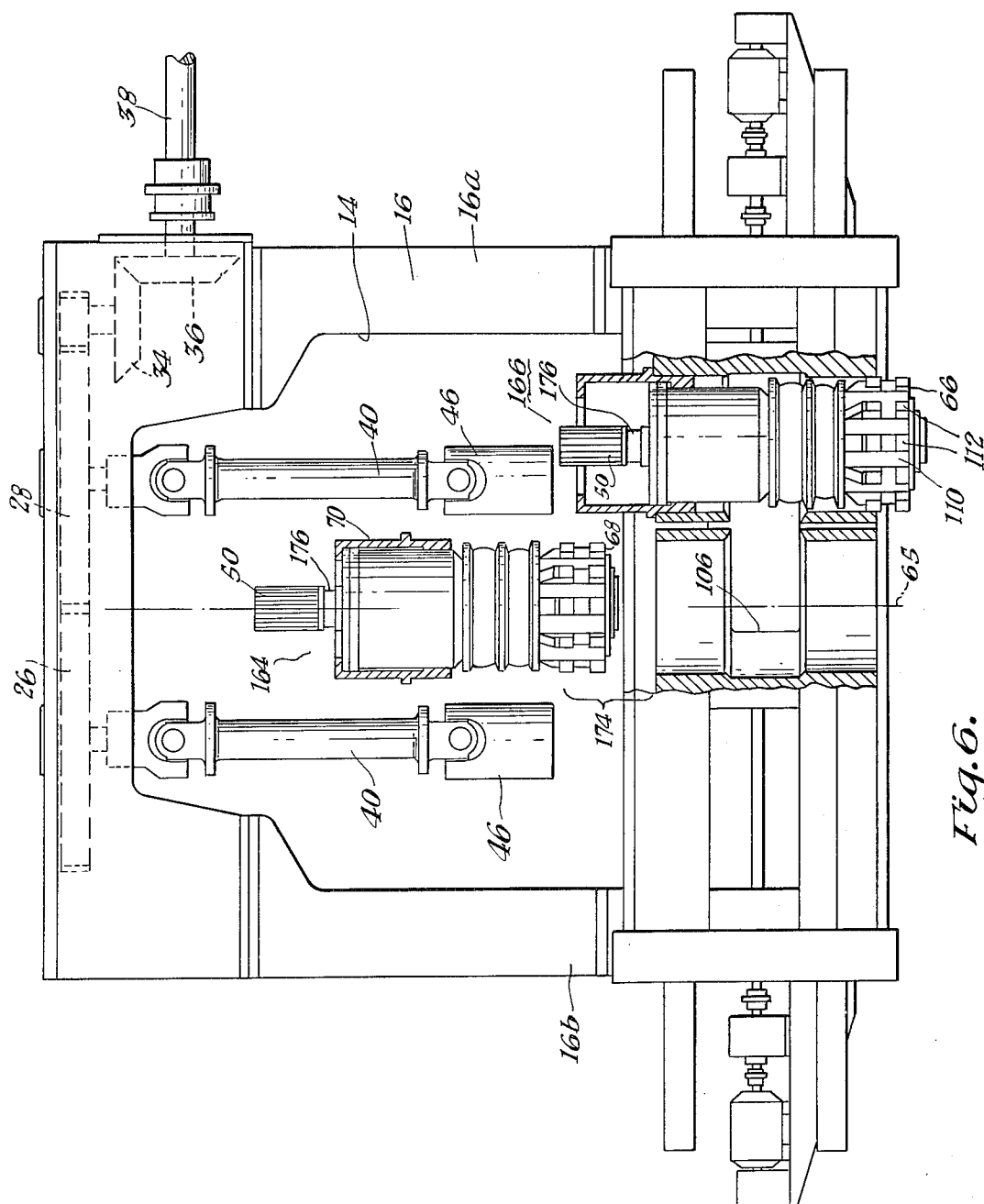


Fig. 5.

INVENTOR
Herbert Lempert
BY
Ernest A. Shale & Frenkenheim
HIS ATTORNEYS



INVENTOR
 BY *Herbert Lempert*
Paul, Blank & Frenken
 HIS ATTORNEYS

VERTICAL MILL

The present invention relates to a vertical mill, and more particularly to an edging mill in which the vertical rolls each can be provided with a plurality of passes. The invention is particularly concerned with a vertical edger for employment in conjunction with hot strip mills.

The invention will be described primarily in conjunction with a vertical edging mill, although it will be apparent from this description that the invention can be readily adapted for the axial adjustment of rolls in other types of mills.

It is desirable to provide a vertical edging mill which is capable of extremely high reduction in order to obtain a larger variety of band widths from the same slab width. Efficiencies of primary slab producing equipment can be considerably increased, if only the wider slabs and fewer sizes thereof need be produced. Naturally, continuous slab casting machines operate more efficiently when producing the widest slabs, as slab width is directly proportional to productivity. A vertical edging mill, with multiple roll passes, operates most efficiently when capable of extremely high reductions in conformance with those of a typical high lift slabbing mill. Differing slab thicknesses, of course, require differing passes in the vertical edging mill.

Throughout the description of the invention, and in the appended drawings, a vertical edging mill is presented, wherein the rolls are provided with two passes conforming to the predominant product thicknesses of present day slabbing mills. It will be understood of course that the invention can be readily applied to vertical edging mills and the like wherein the rolls are provided with a different number of passes. In general the use of multiple pass rolls in a vertical edging mill has resulted in reduction in down time in comparison with the more conventional single pass mills. Single pass mills are exemplified in the U. S. Pats. to Burkhart U.S. Pat. No. 2,535,898, Norlindh U.S. Pat. No. 2,676,502; O'Brien U.S. Pat. No. 3,292,406; and O'Brien U.S. Pat. No. 3,383,897. Certain features of the invention are, however, advantageously applicable to single pass vertical mills.

A first major problem, which has existed in the past in connection with vertical edging mills, is the difficulty coupled with the considerable labor and time involved in roll changing operations. Although the use of multiple pass rolls can reduce the number of required roll changes, provisions must be made nevertheless for roll changing for maintenance purposes or when unusual sizes or thickness are encountered. In the past, there have been three procedures for changing the rolls in this type of mill:

a. to remove the rolls by lifting them in pairs from the housing, for example as set forth in the U.S. Pat. to Hill et al. U.S. Pat. No. 2,583,844; (b) to remove the rolls together with the inter-housing where such a mill construction is being employed for example as in the U. S. Pat. to Lobkowitz U.S. Pat. No. 2,870,664 and Norlindh U.S. Pat. No. 2,676,502; and (c) in certain mills to remove the entire mill and replace it by a duplicate mill. While the extent of lost production time experienced in changing of the rolls differs in each of these procedures, even the most efficient of these operations involves an appreciable loss in production time. Production losses may be mitigated to some extent in the turret mill construction disclosed in the U.S. Pat. to O'Brien U.S. Pat. No. 3,292,406; however, the size and complexity of the O'Brien mill militates against its use in many applicational situations.

As the complexity of the mill design is a large factor in its maintenance, many of the known mill designs are disadvantaged in this respect. A high level of maintenance further increases the down time of a given mill, with attendant loss of production not only of the mill itself but of associated rolling mill equipment.

In those vertical mills, such as exemplified in the aforementioned Hill et al., Norlindh, and O'Brien patents, removal of the rolls as a unit usually entails a time-consuming withdrawal of additional components of the mills, such as inboard housings or the like. In these and similar mills, variously encountered were the problems of additional weight, withdrawal of

the rolls through the top of the mill and driving the rolls from the bottom, space limitations entailed thereby, use of a complex arrangement of inner and outer housings. Further, it was frequently necessary to decouple universal joints between the drive spindles and the rolls or to remove portions of the drive spindles with the rolls as in the Hill et al. arrangement.

A second major problem in previous vertical mills, has been the difficulty and the complexity of mechanism usually provided for the vertical adjustment of the rolls. Even in mills having a more simplified roll pass design or where the passes are all of the same size, the mills are provided with vertical roll adjustments so that each roll pass can be positioned to receive a workpiece along a fixed pass line.

Owing to the thickness of the slabs accommodated by a typical vertical mill, a considerable vertical adjustment must be provided in this type of mill, particularly where multi-pass rolls are employed. Prior vertical adjustments, such as those set forth in the aforementioned patents, involve considerable numbers of mechanical linkages such as jack screws or the like and a complex array of inner and outer housings. Not only is removal of the rolls and one or more of the housings as a unit necessitated, but considerable time is involved in making the adjustment, particularly when moving the rolls from one pass to another. In many cases, the vertical adjustment is accomplished by mechanism positioned at the top or the bottom of the mill resulting in additional space requirements and complexity of construction. The vertical adjustment usually is employed in one manner or another during the roll changing procedure, and the roll changing operation is unduly delayed thereby.

I overcome these disadvantages of the prior art by providing a vertical rolling mill or the like in which each of the rolls can be removed individually through a window in the mill housing, without entailing decoupling of a universal joint between the rolls and the drive spindles. In particular, I provide a quick-attach coupling, the components of which are formed on each of the juxtaposed roll necks and on the spindle ends respectively but apart from the universal joints. The quick-attach couplings are coupled and decoupled in a unique manner, by a predetermined operational variation of the unique vertical adjustment and pass selection means provided by my invention. By providing for removal of the rolls through the housing window and by a quick decoupling thereof with the aid of my novel vertical adjustment means, I have considerably reduced the spatial requirements of the mill but at the same time have likewise reduced the time and labor consumed in the roll changing operation.

My novel vertical adjustment means permits the rolls to be quickly raised or lowered to select a given roll pass and adjustably to position each roll pass with respect to a predetermined pass line of the workpiece. In furtherance of this purpose, each roll is housed within a sleeve therefor, a portion of which is arranged as a hydraulic cylinder containing a closely fitted plunger. One of the roll neck bearings, for example, the upper bearing, is housed within the plunger. Hydraulic pressure is applied to the cylinder portion to raise or lower the roll assemblies. Cooperating with the aforementioned vertical adjustments and with the detachable couplings, as the occasion arises, are lateral adjustment means for each roll assembly. The lateral adjustment means engage the roll assembly shells for positioning each roll assembly with respect to the desired width of workpiece during operation of the mill and for individually positioning each roll assembly preparatory to decoupling and withdrawal thereof during the roll changing procedure.

The other or lower bearing housing of each roll assembly is provided with a segmented circular keyway which provides drainage for the inevitable scale and water. Lock means are provided on each roll assembly shell to cooperate in a unique manner with the segmented keyway for locking each roll assembly in a selected roll pass position with reference to the pass line structure of the mill.

I accomplish these desirable results by providing a rolling mill comprising a housing, a pair of mill rolls rotatably mounted on said housing, means mounted on said housing for rotatably mounting each of said rolls, means for rotating each of said rolls including a drive spindle, means for moving each of said rolls axially, a detachable coupling for detachably coupling each of said spindles to the associated one of said rolls, each of said detachable couplings including inter-fitting and axially withdrawable keying components on the associated drive spindle and mill roll respectively, and said axial moving means being capable of moving each of said rolls through a distance at least sufficient to engage and to withdraw said inter-fitting keying members.

I also desirably provide a rolling mill comprising a housing, a pair of multiple pass mill rolls rotatably mounted on said housing, means for axially displacing each of said rolls to align a selected one of the roll passes thereof with a predetermined workpiece pass line, a supporting shell for each of said mill rolls mounted on said housing and closely and rotatably receiving the associated roll, said axial displacing means including cooperating cylinder plunger members on said shells and on said rolls, and means for rotatably mounting each of said plunger members on the associated mill roll for axial displacement therewith, said plungers and said cylinders respectively enclosing a hydraulic fluid spaced therebetween for axially moving said plungers relative to said cylinder members.

I also desirably provide a rolling mill comprising a housing, a pair of mill rolls rotatably mounted on said housing, a supporting shell for each of said rolls slidably mounted on said housing, each of said shells closely and rotatably receiving an associated one of said mill rolls, means coupled to each of said shells and the associated mill roll for axially displacing said mill rolls, and lateral moving means coupled to said shells and to said housing for moving said shells transversely of said rolls.

During the foregoing discussion, various objects, features, and advantages of the invention have been set forth. These and other objects, features and advantages of the invention together with structural details thereof will be elaborated upon during the forthcoming description of certain presently preferred embodiments of the invention and presently preferred methods of practicing the same.

In the accompanying drawings I have shown certain presently preferred embodiments of the invention and have illustrated certain presently preferred methods of practicing the same, wherein:

FIG. 1 is a vertically sectioned partial view of one arrangement of my invention, illustrated here in conjunction with a vertical edging mill;

FIG. 2 is an enlarged sectional view of one of the roll assemblies and associated components of the apparatus as shown in FIG. 1;

FIG. 2A is a similar but partial, sectional view of the roll assembly of FIG. 2 taken along a rotated plane;

FIG. 3 is a cross-sectional view of the apparatus as shown in FIG. 2 and taken along reference line III—III thereof;

FIG. 4 is an elevational view, partially sectioned, of the mill structure of FIG. 1 and illustrating operational utilization of a lower roll pass of each mill roll;

FIG. 5 is a similar view showing the decoupled positions of the roll assemblies; and

FIG. 6 is a similar view representing steps in a roll changing procedure.

With primary reference to FIGS. 1 and 2 of the drawings, an exemplary vertical mill structure 10 incorporating my invention includes a housing 12 having a window opening 14 in an upper side wall thereof. The housing 12 includes a pair of standards 16 and an overhead supporting structure 18 mounted on the standards 16. The supporting structure 18 in this example serves as a casing for a gearing train 20 or other suitable transmission for a pair of drive spindles 22, 24 (FIG. 4) which are rotatably suspended from the supporting structure 18. In an exemplary arrangement, the gearing train 20 includes a pair of enmeshed spur or helical gears 26, 28, each of which is

rotatably mounted on sleeve and thrust bearings 30, 32, respectively. Each drive spindle 22, or 24 is centrally secured to the associated gear 26 or 28 for rotation therewith. The transmission or gearing train 20 further includes a double ended pinion and bevel gear 34 rotatably mounted in idler fashion on the supporting structure 18 and an input bevel gear 36 likewise mounted on the supporting structure 18. An input drive shaft 38 is coupled to the input gear 36 for rotation therewith and to a suitable prime mover (not shown) for the mill 10.

Each drive spindle 22 or 24 includes an intermediate spindle section 40 connected at its ends to universal joints 42, 44 respectively. The upper joint 42 includes a coupling component 43 secured to the associated output gear 26 or 28 for rotation therewith, while the lower joint 44 includes a cooperating component 46 of a detachable roll coupling denoted generally by reference character 48.

The other component of each detachable coupling 48 comprises a splined end portion 50 of the adjacent roll neck 52 of the associated roll 54 or 56. In this arrangement, a limited length 58 of each spindle coupling component or sleeve 46 is similarly grooved for keying engagement with the splined end portion 50. The respective lengths of the sleeve 46 and the cooperating splined end portion 50 are such as to afford the desired total axial adjustment of the associated roll 54 or 56 while yet permitting decoupling of the detachable couplings 48 upon further axial movement of the rolls, in the manner described below. Naturally, I contemplate other keying arrangements in substitution of the splined, roll neck end portions 50 and of the complementary internally grooved sleeves 46. Further, reversals of the detachable coupling components 46-50 are contemplated such that the sleeves 46, for example, can be formed on the roll necks 52 and the splined end portions 50 on the universal joints 44.

As shown in FIGS. 1 and 2 each roll 54 or 56 is suspendible within a shell 60 or 62, with the shells being allochirally disposed as evident from FIG. 1. The thickened portions 64 of the allochiral shells 60, 62 are, therefore, disposed oppositely of one another and outwardly relative to center line 65 of the mill 10. The thickened portions 64 provide areas of engagement with the lateral shell adjustment means 140 described below.

A removable roll assembly including each roll 54 or 56 is comprised in this example with upper and lower bearing chocks 66, 68 respectively. The upper bearing chock 66 has an external surface shaped as a plunger for closely fitted insertion into a suspending cylinder 70, whereby the roll assembly is suspended within the associated shell 60 or 62. The cylinder 70 is shaped, in this case, for removable insertion into the upper portion of the supporting shell 60 or 62.

For movement of the roll assembly axially of the supporting cylinder 70 and shell 60 or 62, a space 72 for hydraulic fluid or the like is reserved between each cylinder 70 and the associated upper bearing chock 66 by means of circumferential ridges 74, 76 formed respectively on the bearing chock 66 and cylinder liner 76 (FIG. 2). The ridges 74 are axially separated to allow a sufficient stroke of the plunger 66 and axial movement of the roll 54 or 56 to select the appropriate roll pass 80 or 82 of each roll, for decoupling of the detachable coupling 48 of each roll assembly, and for other desired axial adjustment of the roll assembly. Although two roll passes 80, 82 are illustrated on each roll 54 or 56, obviously a different number can be employed depending upon a specific application of the invention.

A suitable hydraulic circuit (not shown) or the like is coupled to the cylinder 70 in communication with the annular spaces 72 for actuation of the plungers 66. In vertical mill structures, such as in the vertical mill 10, the cylinders 70 and plungers 66 can be single-acting with downward movement of the plungers being effectuated by gravity. For application of the axial adjustment means of the invention to horizontal mill rolls (not shown), double-acting plungers (not shown) and suitable hydraulic circuitry can be substituted.

Each plunger 66 is sealed to the inner wall surfaces of the cylinder 70, i.e. in this case to the cylinder liner 72, by spaced chevron seals 84, 86 or the like. The upper chevron seal 84 can be confined between the plunger ridge 74 and end ring 88. The lower chevron seal 86 is confined between the cylinder liner ridge 78 and a lower or auxiliary cylinder liner 90 which is provided with a thickened end portion or lip 92 for positioning engagement with an inwardly extending shoulder 94 formed adjacent the lower end of the cylinder 70.

As noted above, the cylinder 70 of each roll 54 or 56 is removably supported on the associated roll shell 60 or 62 - in this case by means of an outwardly and circumferentially extending ridge 96. The roll 54 or 56 proper is in turn suspended by engagement of its upper roll neck 52 with a conventional mill roll bearing 98, a supporting flange 100 of which is bolted at an inward supporting shoulder 102 of the associated plunger and bearing chock 66.

A midportion 104 of each roll assembly shell 60 or 62 is internally enlarged at 104 to afford adequate clearance for radially flung cooling water, scale, and the like during the rolling operation. A pass opening 106 is provided in each shell 60 or 62 generally opposite from the enlargement 104 to provide access to the selected roll pass 80 or 82 through the corresponding shell 60 or 62. Desirably the shell openings 106 extend sufficiently above and below a predetermined workpiece pass line 107 to permit vertical adjustment of the pass line structure or adjustment of the mill rolls 54, 56 relative to a given pass line such as the pass line 107.

The lower roll chock 68 of each roll assembly similarly supports a conventional mill roll bearing 108. Each lower bearing chock 68 is further provided with a series of axial grooves 110 (FIGS. 2 and 3) for drainage purposes. For this purpose, each of the axial grooves 110 communicate with the enlarged portion 104 and adjacent areas of the associated shell 60 or 62. The axial grooves 110 define a plurality of radial projections 112, as better shown in FIG. 3, the outer extremities of which are closely fitted within a lower shell liner 114. A similar liner 116 is provided in the upper portion of each shell 60 or 62 to closely receive the inserted portion of the associated suspending cylinder 70. In consequence, each roll 54 or 56 is closely fitted within its associated shell 60 or 62 such that a careful horizontal positioning of either shell provides a precise lateral adjustment of the associated roll 54 or 56.

Each radial projection 112 includes a pair of locking lugs 118, 120 and an intervening notch 122 at its outward edge. Together, the radial projections define a pair of axially spaced segmented ring structures including respectively the locking lugs 118, 120 as better shown in FIGS. 3 and 4. The locking lugs 118, 120 and intervening notch 122 of each radial projection cooperate with a pair of diametrically apposed bar locks 124, 126 which are slidably mounted in keyways 128 extending transversely through the lower portion of each roll assembly shell 60 or 62. An actuating cylinder 130 is mounted on the associated roll assembly shell 60 or 62 for insertion and withdrawal of the bar locks 124, 126. In FIG. 2A, the bar lock 126 has been rotated 90° about the shell 60 for purposes of illustration.

Each bar lock 124 or 126 is provided with a pair of locking ridges 132, 134 each of which can be closely fitted into the notches 122 of the lower bearing chocks 68. The ridges 132, 134 of each bar lock 124 or 126 are spaced apart a distance X which is desirably equivalent to the distance X' (FIG. 2) separating the roll passes 80, 82. It follows, of course, that the bar locks 124, 126 can be provided with a different number of locking ridges depending upon the number of roll passes provided in a given applicative utilization of the invention.

By suitably manipulating the lock cylinders 130 to the withdrawn positions of the bar locks 124, 126 the rolls 54, 56 can be axially adjusted by actuation of the cylinders 70 and plungers 66 to position either one of the roll passes 80, 82 properly at the pass line 107. For use of the lower roll passes 82, the locking ridges 132, 134 straddle the lower locking lugs 120 of two or more of the radial projections 112, as shown in

FIG. 2. On the other hand, when the rolls 54, 56 are axially adjusted to bring the upper roll passes 80 to the pass line 107, the locking ridges 132, 134 then straddle the upper locking lugs 118 of such radial projections. In the first instance, i.e. when the lower roll passes 82 are utilized the upper locking ridges 132 of the bar locks 124, 126 are closely fitted into the notches 122 of such radial projections. When the upper roll passes 80 are utilized, the lower locking ridges 134 are so interfitted, as shown in FIG. 1. Withdrawal of the bar locks 124, 126, of course, permits either roll assembly, including the roll 54 or 56, the associated suspending cylinder 70, plunger and upper bearing chock 66, and lower bearing chock 68 to be withdrawn from the shell 60 or 62 respectively. The withdrawal procedure is described in detail below.

Each of the roll assembly shells 60, 62 are slidably mounted for lateral movement upon a ledge structure 136 mounted in this example at the lower ends of the housing standards 16. The ledge structure 136 in addition defines an opening 138 through which the lower end portions of the roll assemblies project during decoupling and removal of the roll assemblies (FIGS. 5 and 6) as described below. Each roll shell 60 or 62 and the contained roll assembly is stabilized on the ledge structure 136 and displaced therealong as required by lateral adjustment means denoted generally by reference numeral 140.

As illustrated, the lateral adjustment means 140 includes a pair of jack screws 142, 144 which are advanced and withdrawn through a lower supporting block 146 of each housing standard 16. The inward ends of each pair of screws 142, 144 are rotatably coupled adjacent the upper and lower ends respectively of the associated roll assembly shell 60 or 62 at the thickened portions thereof. The screws 142, 144 of each lateral adjustment 140 are heavily constructed, together with their rotatable connections 148 with the associated roll assembly shell 60 or 62 and with their threaded mountings 150 on the housing supports 146, such that the screws 142, 144 provide adequate back up for the shells 60, 62 during the rolling operation.

Each pair of screws 142, 144 are advanced and withdrawn in parallel by a pair of spur gears 152 or the like, keyingly and respectively engaged with the screws 142, 144. The gears 152 are rotated by pinion 154 driven through speed reducer 156 by a suitable prime mover such as an electric motor 158. As each pair of screws 142, 144 is advanced and withdrawn simultaneously, one of the screws for example the screw 142 can be provided with a cam limit switch 160 and the other screw with a selsyn arrangement 162 for positional indication.

In operation, with initial reference to FIGS. 1 and 2, the roll assemblies 164, 166 have been vertically and laterally adjusted to receive an incoming slab 168 between upper roll passes 80 of the rolls 54, 56. The axial adjustment means including the cylinder 70 and the plunger 66 of each roll assembly has lowered, for this purpose, each roll assembly 164, 166 such that the upper roll passes 80 are aligned with pass line 107 and with shell pass openings 106. The lateral adjustment means 140 for each shell 60 or 62 is actuated to provide the required separation between the roll passes 80 for the anticipated reduction to be imparted to the slab 168. For at least the larger reductions, the roll passes 80 and 82 desirably are provided with collars 170 and 171 respectively. The roll passes can be crowned (as shown in the drawing in exaggerated form) to compensate for rolling distortions in conformance with conventional practices in this respect.

The roll assemblies 164, 166 are lowered by ejecting hydraulic fluid which is forced from the annular spaces 72 between the cylinders 70 and the plungers 66 by the weight of the roll assemblies. This permits the keyed coupling component 46, 50 of each roll assembly coupling 48 to be withdrawn axially while maintaining the keyed engagement as shown in FIG. 1. In particular the grooved areas 58 of the coupling sleeves 46 are maintained in full contact with the adjacent portion of the lowered splines 50 of the rolls 54, 56.

Referring to FIG. 4, the vertical adjustment means of the mill 10 have been actuated to raise the roll assemblies 164, 166 such that the lower roll passes 82 are now aligned with the pass line 107. The incoming slab 172 is thereby accommodated between the lower roll passes 82 of the rolls 54, 56. In this case the slab 172 is thinner than the slab 168, although this relationship obviously can be reversed. To align the roll passes 82, as aforesaid, with the pass line 107, the bar locks 124, 126 (FIG. 3) are withdrawn and hydraulic fluid is forced into the annular space 72 to raise the plungers 66 and associated roll assemblies 164, 166 to their positions as shown in FIG. 4. When the roll assemblies are properly and vertically aligned with the pass line 107 shell pass openings 106, the bar locks 124, 126 are replaced to maintain the vertical positioning of the roll assemblies 164, 166 during the rolling operation. At this position of each of the roll assemblies, it will be observed that their splined roll neck sections 50 have been substantially fully inserted into the sleeves 46 of the detachable roll couplings 48. As mentioned previously, the lateral adjustment means 140 for each roll assembly and its supporting shell 60 or 62 have been positioned to define the required reduction of the slab 172 as shown in FIG. 4.

The transmission 20 (FIG. 1) is then actuated to impart rotation and counter-rotation to the drive spindles 40 and roll assemblies 164, 166 respectively.

With reference to FIGS. 5 and 6 of the drawings, when it is desired to remove one or both roll assemblies 164, 166 the associated bar locks 124, 126 of the shell 60 and/or 62 are withdrawn and hydraulic fluid is expelled from the cylinders 70 to permit lowering of the plunger 66 to their lowermost positions (FIG. 5). At these positions, the splined end portions 50 are completely withdrawn from the sleeve components 46 of the detachable couplings 48.

Desirably when withdrawing the interfitting members 46, 50 forming the coupling 48, the associated roll assembly 164 or 166 and supporting shell 60 or 62 are first moved to a position of axial alignment, by operation of the associated lateral adjustment means 140 as denoted by chain outline 182 of the spindle coupling 24 (FIG. 1). By thus aligning the drive spindle 22 or 24 with the roll assembly 164 or 166 respectively, the absence of canting forces between the interfitting coupling members 46, 50 is assured. In consequence, withdrawal of the roll neck portions 50 by gravity is facilitated, when the axial displacement means including the cylinders 70 and plungers 66 are suitably actuated (FIG. 5).

One of the roll assemblies, for example the roll assembly 166 (FIG. 6) is then withdrawn laterally to the limit of its horizontal adjustment by its associated lateral adjustment means 140 to a position adjacent housing standard 16a. The other roll assembly 164 is moved laterally in the opposite direction by its lateral adjustment means 140 until the shell and roll assembly are aligned substantially with the center line 65 of the mill 10, and denoted by chain outline 174 thereof in FIG. 1. The roll assemblies 164, 166 are retained in their lowermost positions within their associated shells 60, 62 by their plungers 66 and a residuum of hydraulic fluid within the cylinders 70. At these positions (FIG. 5 and 6) the bar locks 124, 126 are, of course, withdrawn.

To permit grasping of the roll assembly 164 or 166 with a C-clamp, or porter bar, a journal or the like is formed on the upper roll neck 52 of each roll assembly and preferably immediately below the splined end portion 50 thereof. To permit a ready engagement between a C-clamp or porter bar (not shown) and the roll neck journal 176, the associated plunger 66 and cylinder 70 are actuated, at the center line position 174, such that the journal 176 clears the top side of the cylinder end ring 178 of the cylinder 70.

A hydraulic pull back mechanism 180 (FIG. 2) can be coupled to each standard support 146 and the adjacent roll assembly shell 60 or 62 to aid in withdrawing the shell 60 or 62 toward the standard support 146 and away from the mill center line 65. The hydraulic pull back mechanisms 180 are useful in the illustrated arrangements as the rotative connec-

tions 148 between the lateral adjustment screws 142, 144 and the associated shell 60 or 62 are designed primarily for exerting compressive forces upon the shell.

After the roll assembly 164 has been grasped and supported by the aforementioned C-clamp or porter bar, the hydraulic connections (not shown) to its cylinder 70 are disconnected and the roll assembly is raised to the position thereof as shown in FIG. 6. Such withdrawal separates the cylinder 70 and the lower bearing chock 68 of the roll assembly 164 from their close fitting engagements with the upper and lower shell liners 116, 114 respectively, and leaves the shell in place at the aforementioned center line position (FIG. 6). The shells 60, 62 therefore remain connected to their respective lateral adjustment means 140 throughout the roll changing procedure.

There is no necessity for disconnecting either lateral adjustment means 140. From its raised position in FIG. 6, the roll assembly 164 is then withdrawn through the housing window 14.

To replace the roll assembly 164 the aforescribed withdrawal procedure is reversed. The remaining roll assembly 166 is withdrawn in a similar manner. The roll assembly shell 60, preferably after a new or replacement roll assembly 164 is reinserted, is withdrawn from the center line position to its opposite limit of lateral movement adjacent the housing standard 16b. The other roll assembly shell 62 and roll assembly 166 are then moved to the aforementioned center line position 174 and the withdrawal procedure described above with reference to the roll assembly 164 is repeated. In order to permit the aforementioned lateral movements of the roll assembly housing 60, 62 to their respective center line positions, 174, the bottom opening 138 of the illustrated mill housing 12 extends preferably and substantially across the width of the bottom of the mill housing.

From the foregoing it will be apparent that novel and efficient forms of VERTICAL MILL have been described herein. While I have shown and described certain presently preferred embodiments of the invention and have illustrated presently preferred methods of practicing the same it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously embodied and practiced within the spirit and scope of the invention.

I claim:

1. A rolling mill comprising a housing, a pair of mill rolls rotatably mounted on said housing, means mounted on said housing for rotatably mounting each of said rolls, means for rotating each of said rolls including a drive spindle, means for moving each of said rolls independently and axially, a detachable coupling for detachably coupling each of said spindles to the associated one of said rolls, each of said detachable couplings including interfitting and axially withdrawable keying components on the associated drive spindle and mill roll respectively, said components being shaped such that relative movement therebetween through a predetermined axial distance uncouples said components, and said axial moving means being disposed for moving each of said rolls at least through said predetermined distance to engage and to withdraw the roll keying components relative to the spindle keying components.

2. The combination according to claim 1 wherein said drive spindles are rotatably mounted on said housing, and transmission means are likewise mounted on said housing for rotating said drive spindles and said rolls in relatively opposite directions.

3. The combination according to claim 1 wherein the interfitting components of each of said detachable couplings are shaped directly and respectively on a roll neck of the associated roll and on a universal joint member of the associated spindle.

4. The combination according to claim 3 wherein said rolls are disposed vertically, said drive spindles are rotatably mounted and suspended from a top portion of said housing, and the interfitting coupling components of said rolls are so shaped on end portions of upper roll necks of said rolls respectively.

5. The combination according to claim 1 wherein each of said rolls is provided with multiple passes, and each of said axial adjustment means are further disposed to move the associated roll independently to align a selected roll pass with a predetermined workpiece pass line structure.

6. A rolling mill comprising a housing, a pair of mill rolls rotatably mounted on said housing, means for axially and independently displacing each of said rolls to align such roll with a predetermined workpiece pass line structure, a supporting shell for each of said mill rolls mounted on said housing and closely and rotatably receiving the associated roll, said axially displacing means including cooperating cylinders and plungers on said shells and on said rolls, and means for rotatably mounting each of said plunger members on the associated mill roll for axial displacement therewith, said plungers being disposed for axial movement relative to said cylinders respectively, each of said plungers and the associated one of said cylinders respectively enclosing a hydraulic fluid space therebetween for axially and independently moving said plungers and said rolls relative to said cylinder members.

7. The combination according to claim 6 including a pair of drive spindles for said mill rolls, a detachable coupling for drivingly engaging each of said spindles to the associated mill roll, each of said detachable couplings including inter-fitting and axially withdrawable keying components on the associated spindle and mill roll respectively, said cylinder and said plunger members being shaped for axially displacing said rolls a sufficient distance to withdraw said inter-fitting members and thereby to decouple said rolls from said spindles.

8. The combination according to claim 7 wherein each of said rolls are multiple-pass rolls, and including a pair of axially displaced bearing and bearing chocks for each of said mill rolls, one bearing chock of each roll being configured as said plunger for engaging the associated shell cylinder member, the other bearing chock of each roll slidably engaging the associated supporting shell, and locking means for each roll cooperatively mounted on the associated shell and said other bearing chock for locking the roll in axial positions relative to the shell and corresponding to respective positions of alignment of said roll passes with said workpiece pass line structure.

9. The combination according to claim 8 including means coupled to each of said shells for moving said shells and said mill rolls in the lateral direction thereof.

10. The combination according to claim 6 wherein said cylinder members are detachably mounted on said supporting shells for removal therefrom with said mill rolls respectively.

11. The combination according to claim 9 wherein pull back cylinders are coupled respectively to said shells for aiding the action of said lateral adjustment means in at least one

direction of said lateral movement.

12. A rolling mill comprising a housing, a pair of mill rolls rotatably mounted on said housing, a supporting shell for each of said rolls movably and independently mounted on said housing, each of said shells closely and rotatably receiving an associated one of said mill rolls, means coupled to each of said shells and to the associated mill roll for axially and independently displacing the associated one of said mill rolls, and lateral moving means coupled to each of said shells and to said housing for moving said shells and the associated rolls transversely of said housing to facilitate independent removal of said rolls.

13. The combination according to claim 12 including a pair of drive spindles for said mill rolls, a slip coupling for coupling each of said spindles to an associated one of said mill rolls, said slip coupling including axially disengageable components on said spindles and on said rolls respectively, said axial displacement means being capable of axially displacing said mill rolls a sufficient distance to disengage said coupling members.

14. The combination according to claim 12 including said housing having a window opening, said laterally moving means being capable of moving said shells individually to positions of alignment with said window opening, and said axial displacement means being capable of protruding a portion of said mill roll from said shell for engagement by external lifting means for removing said mill rolls from said housing through said window opening.

15. The combination according to claim 12 including means for vertically mounting said shells and said mill rolls on said housing, drive mechanism for mill rolls mounted on a top supporting structure of said housing, detachable couplings for connecting said drive mechanism to upper roll neck portions of said mill rolls, and means for removing said rolls individually through a housing window in an upper sidewall portion of said housing.

16. The combination according to claim 12 including a multiple pass arrangement formed on each of said mill rolls, and said axial displacement means being capable of moving said mill rolls axially to positions of alignment of a selected one of said roll passes with a predetermined workpiece pass line and with pass openings in said shells respectively.

17. The combination according to claim 12 wherein said axial displacing means each include a casing surrounding at least a portion of the associated roll and removably seated on the associated one of said shells.

18. The combination according to claim 17 wherein said axially displacing means each further includes a piston and cylinder arrangement formed on each casing and the associated roll.

* * * * *

55

60

65

70

75