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[45] **Feb. 27, 1973**

[54] **CLUSTER MILL WITH CANTILEVERED ROLLS**

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[73] Assignee: **Instytut Melaturgii Zelaza,** Gliwice, Poland

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[51] **Int. Cl.**..........................**B21b 29/00,** B21b 31/16

[58] **Field of Search**........72/237, 240, 241, 242, 243, 72/246, 247, 245

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Primary Examiner—Milton S. Mehr
Attorney—Irvin A. Lavine

[57] **ABSTRACT**

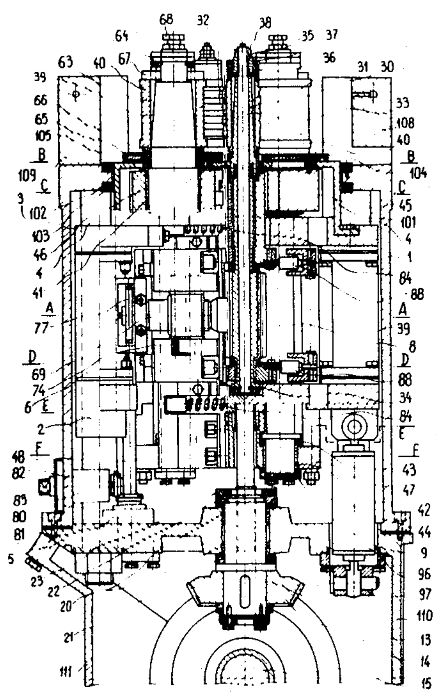
Cluster mill with cantilevered rolls designed mainly for rolling of workpieces comprises two cantilevered working rolls of small diameter and long body, and four cantilevered back-up rolls of relatively great diameter. Thanks to the small diameter of the working rolls a better elongation of the rolled metal is obtained, the whole rolling process being more economical.

A few passes, up to several dozens of passes may be cut on working surfaces of the working rolls, a great rigidity of said rolls being maintained, and thus metal workpieces may be precisely rolled.

The working rolls and back-up rolls are carried in a frame composed of plates and which are shiftable perpendicularly to the rolling line on columns. The working rolls are adjusted symetrically to the rolling line. A driving shaft sliding in a second driving shaft drives the working rolls through an assembly of gears, couplings being thereby eliminated. The drive from a common driving shaft may be transferred to the second driving shaft through bevel gears or through a frontal gear coupling or from an individual driving motor.

It is possible to combine a cluster mill with cantilevered rolls with every method of cluster mill setting, as hitherto known.

14 Claims, 13 Drawing Figures



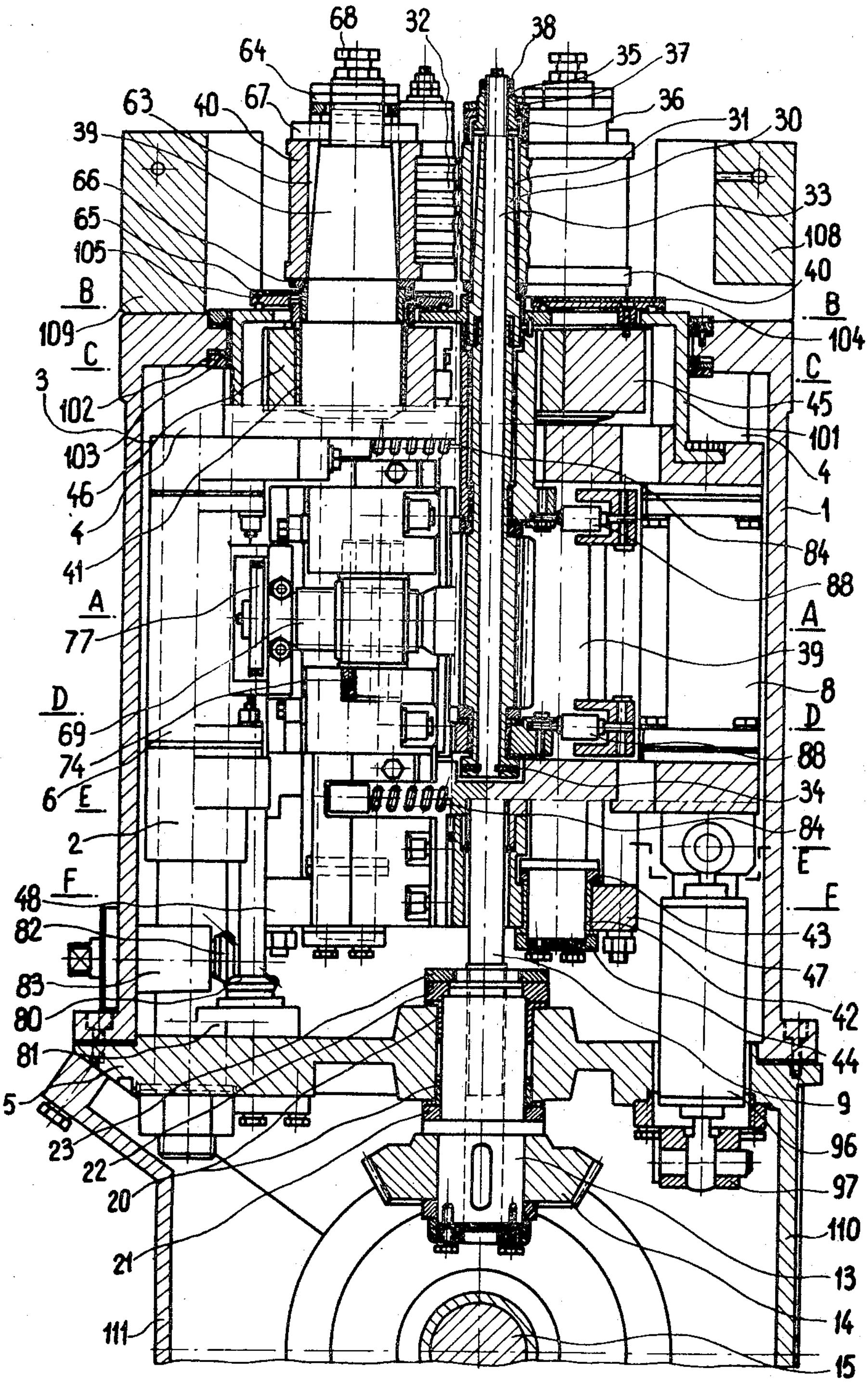

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Fig. 1

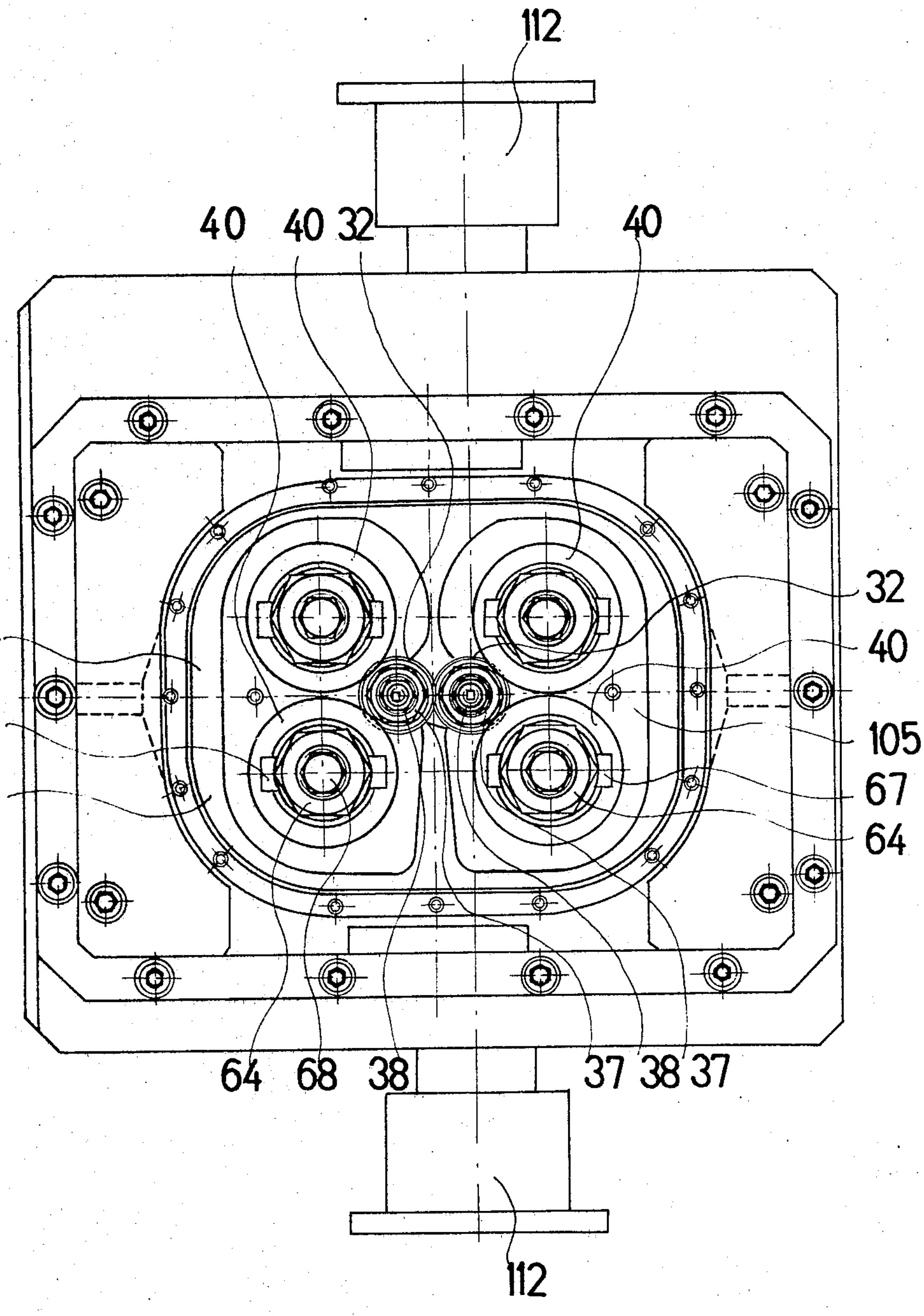
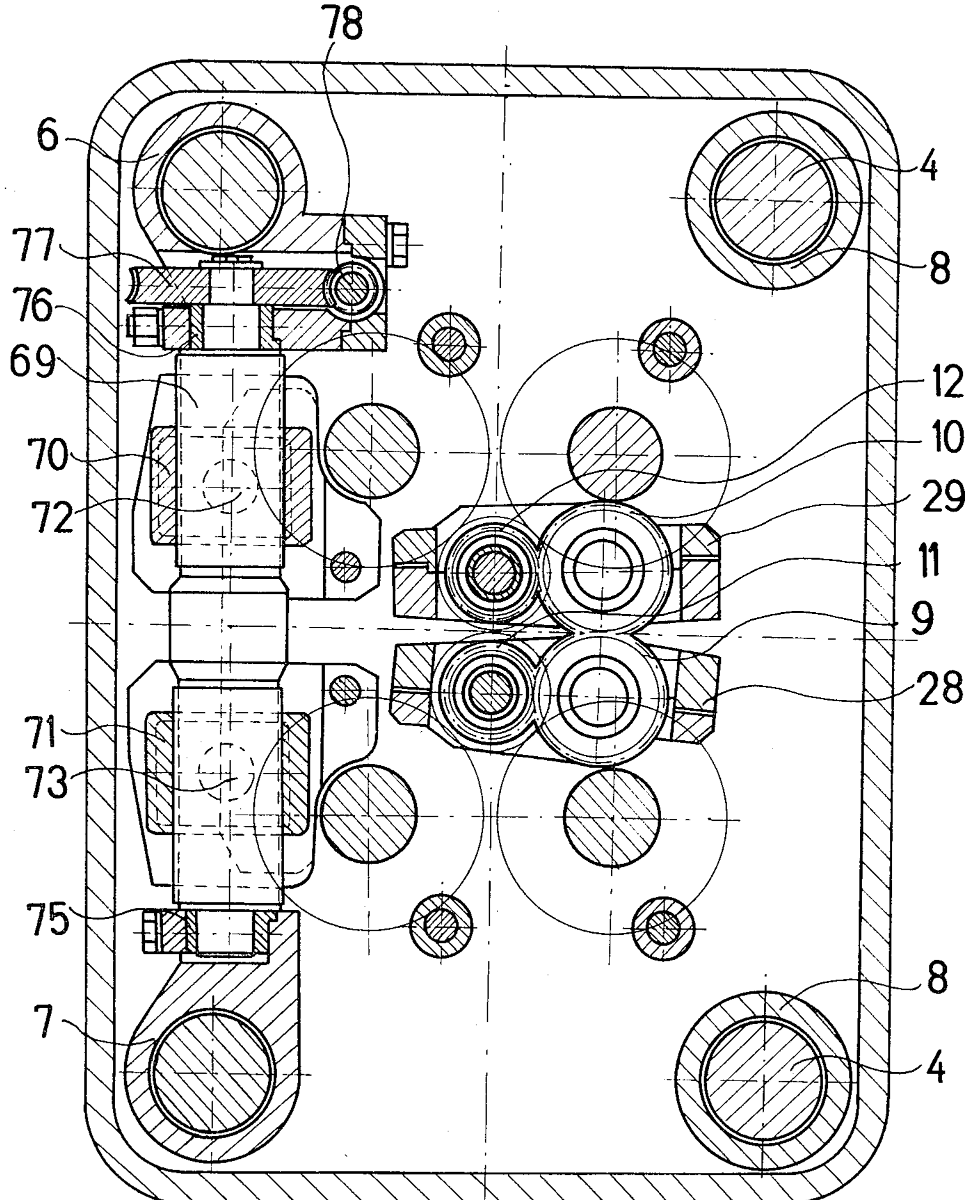


Fig. 2



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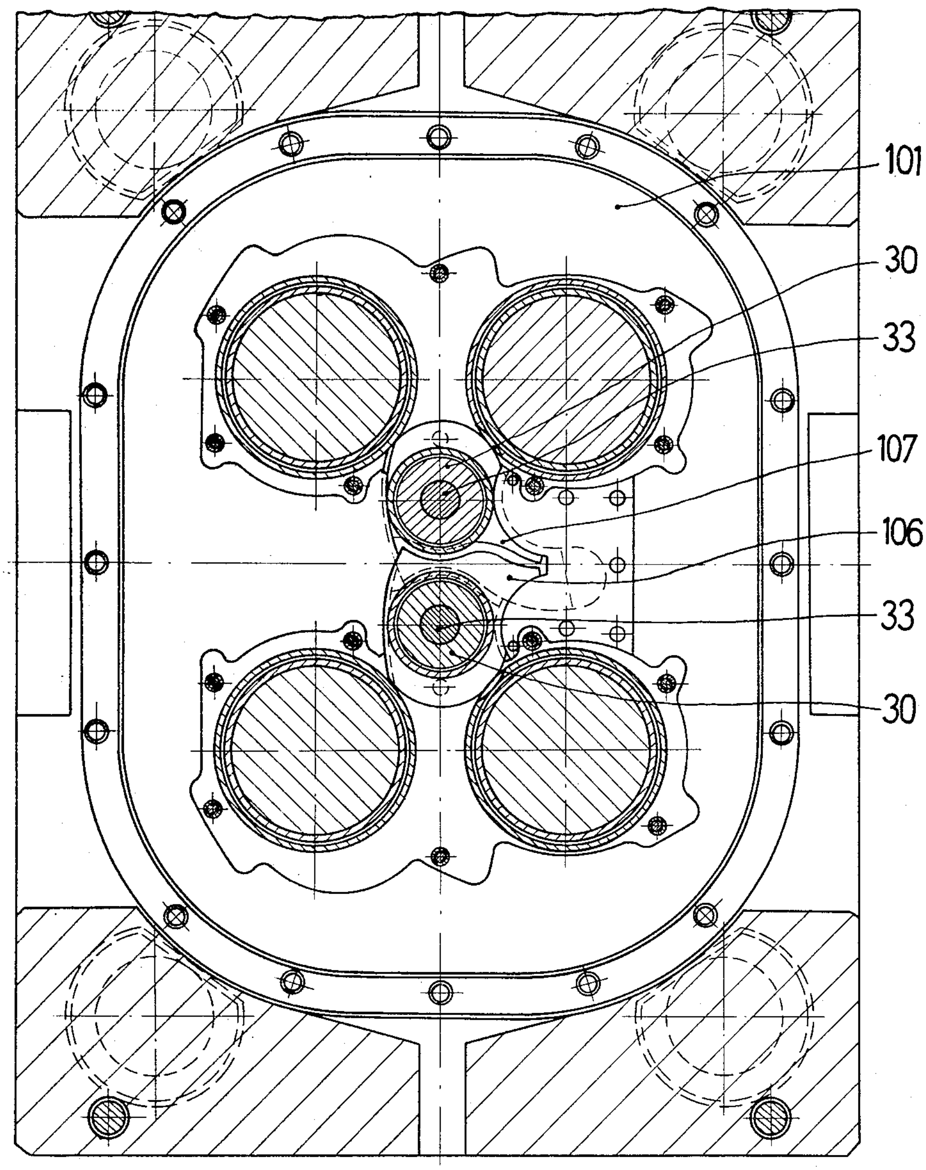

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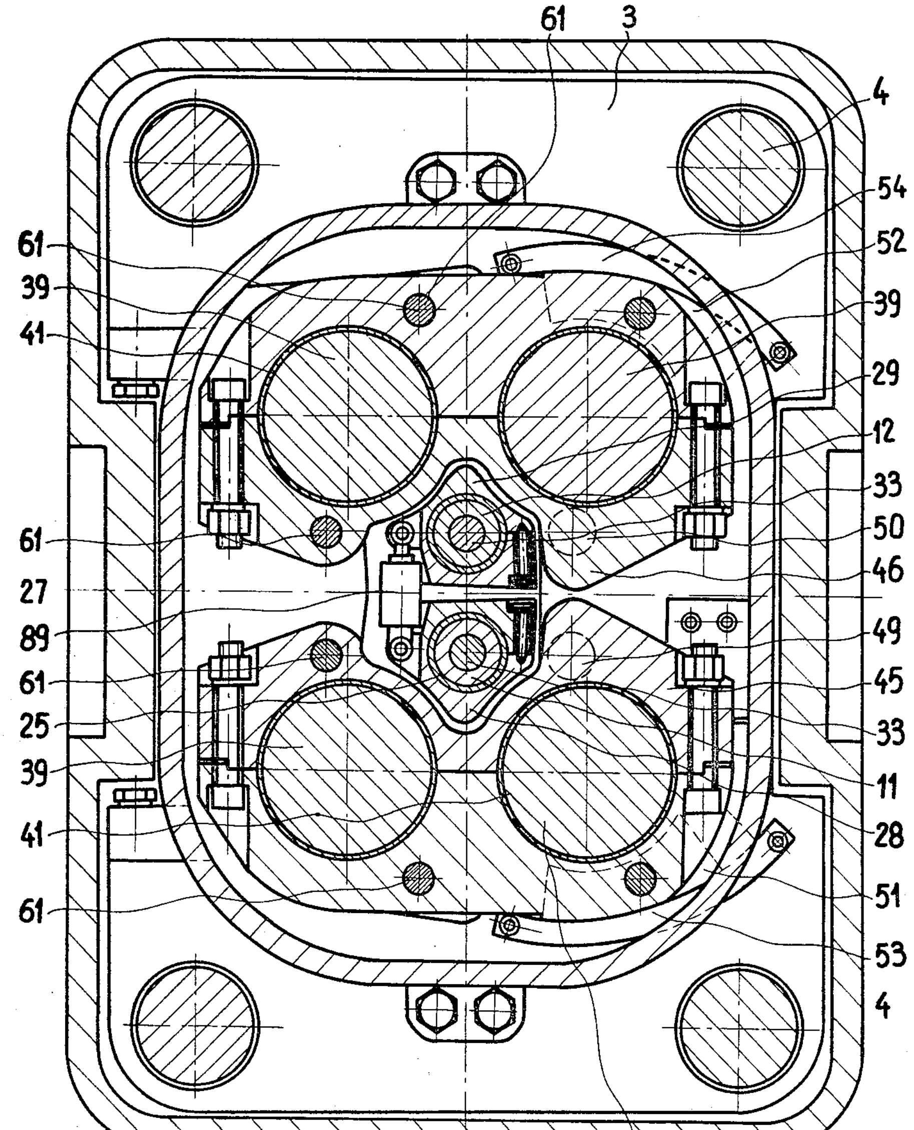
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Fig. 5

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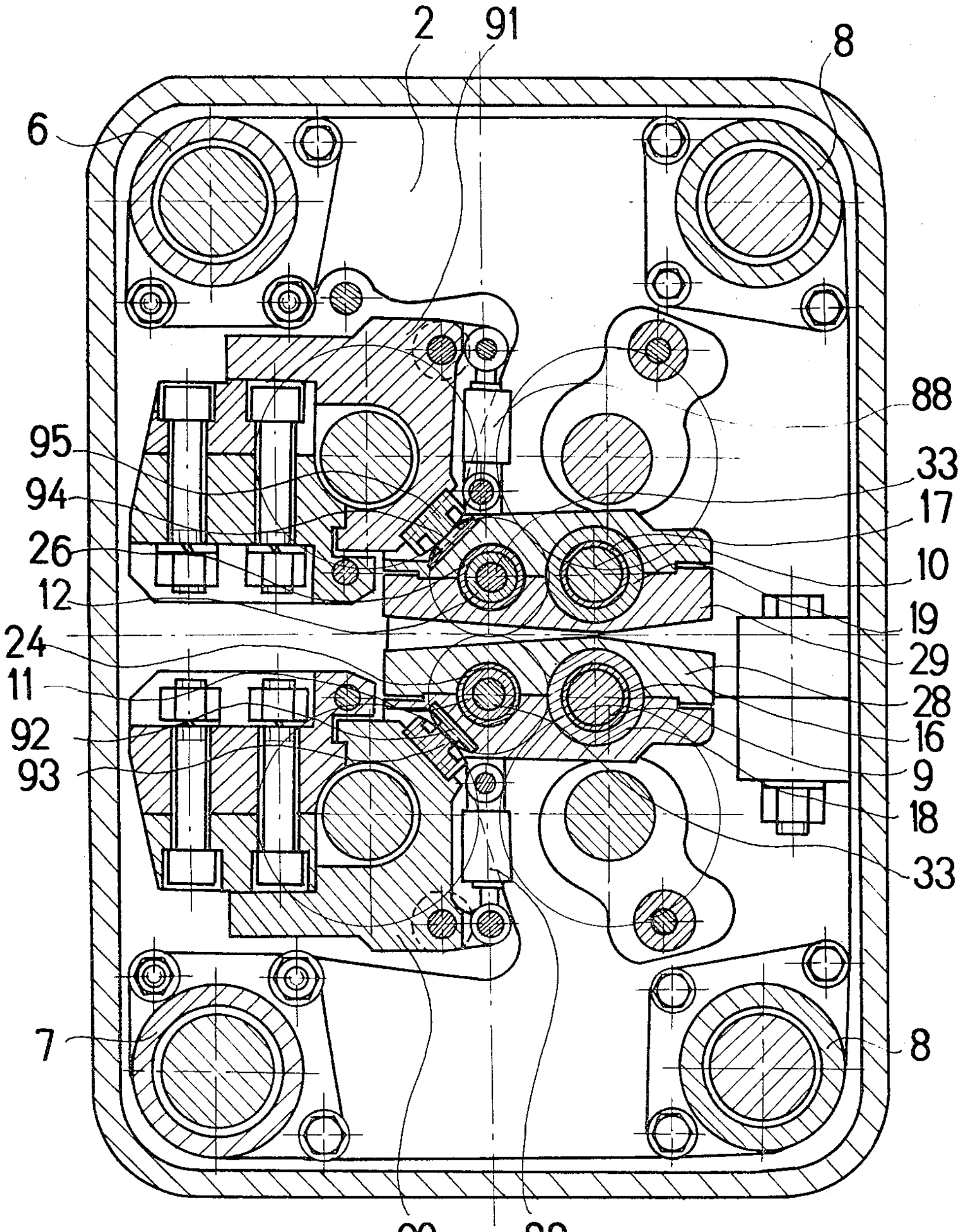

Fig. 6

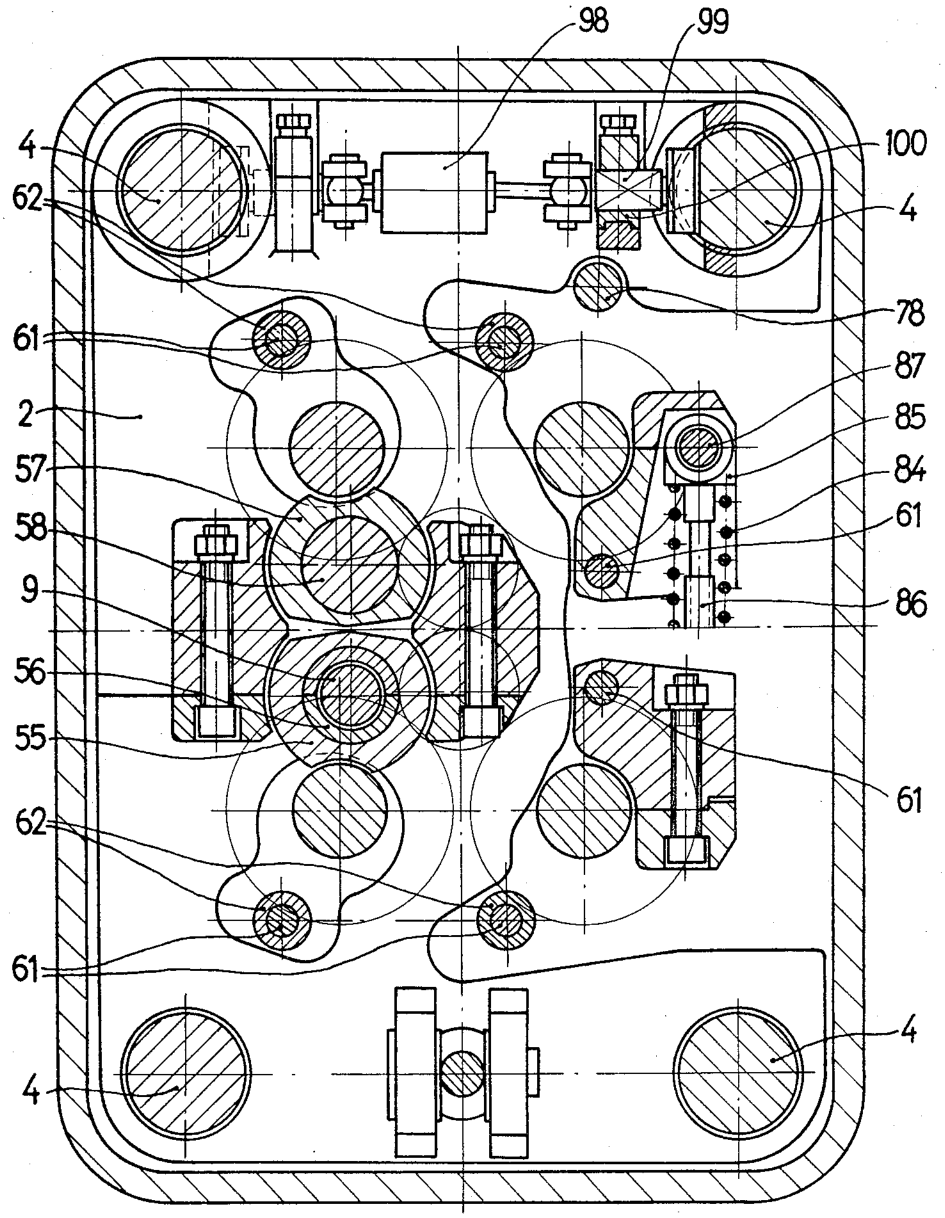

Fig. 7

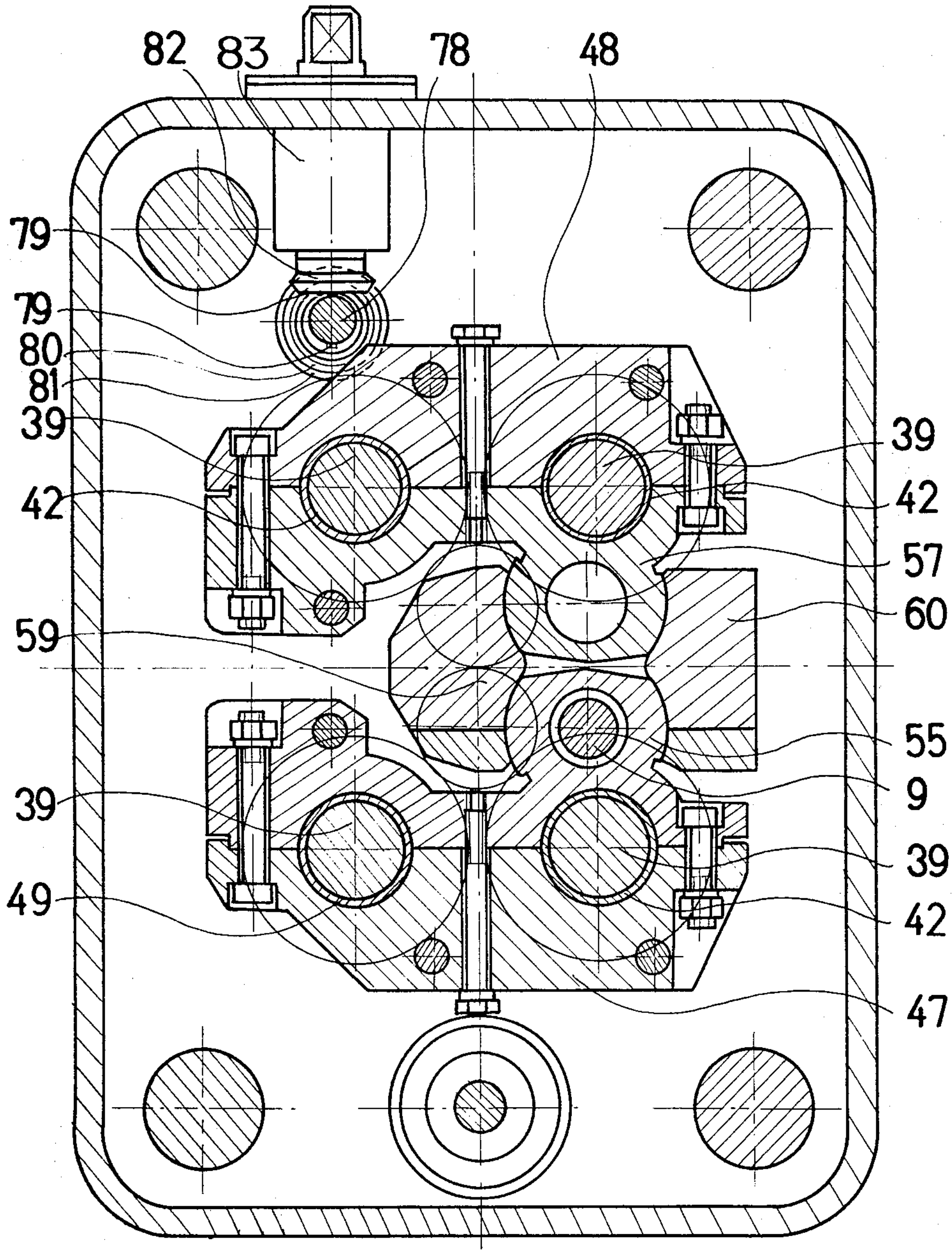

Fig. 8

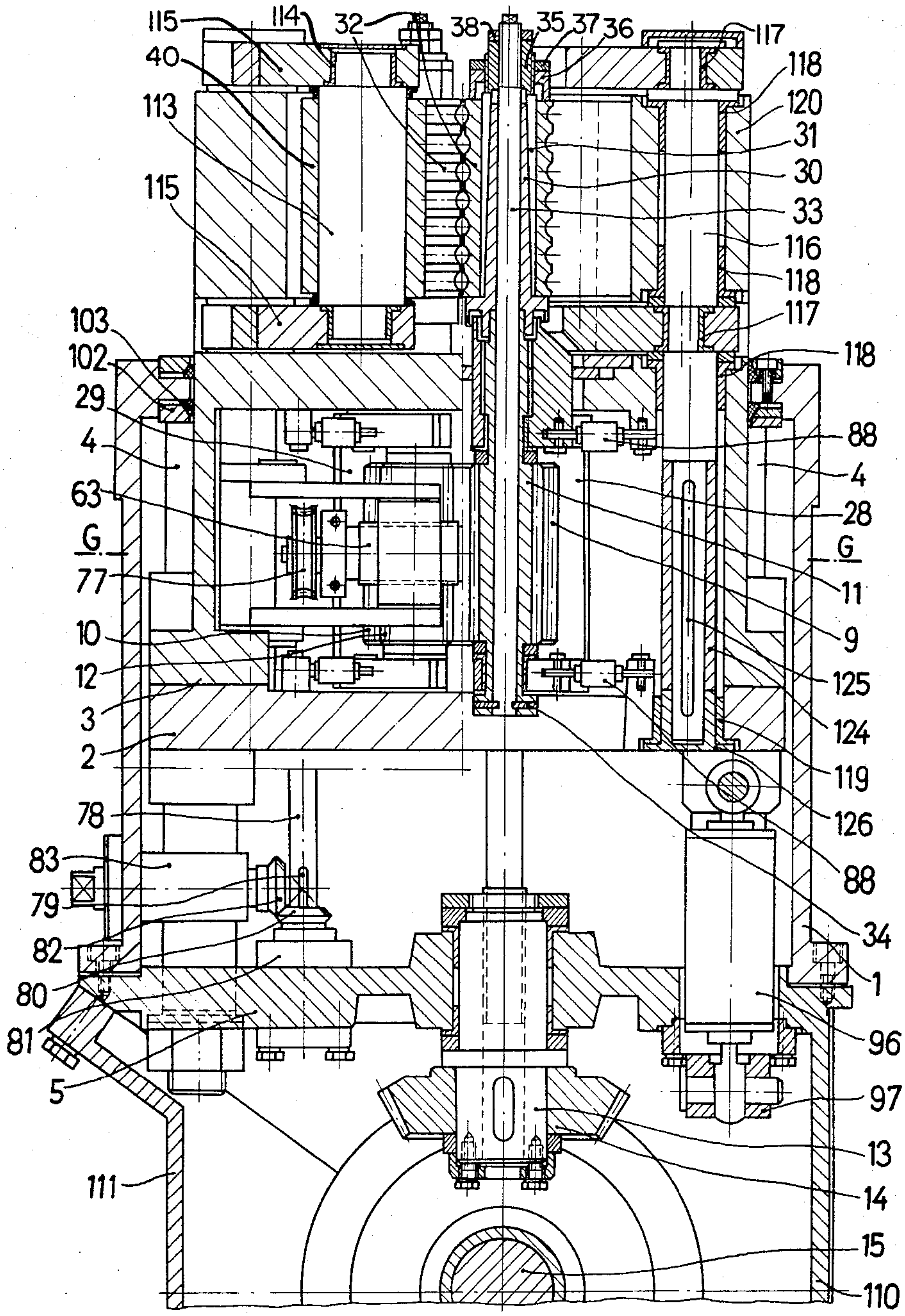
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Fig. 9

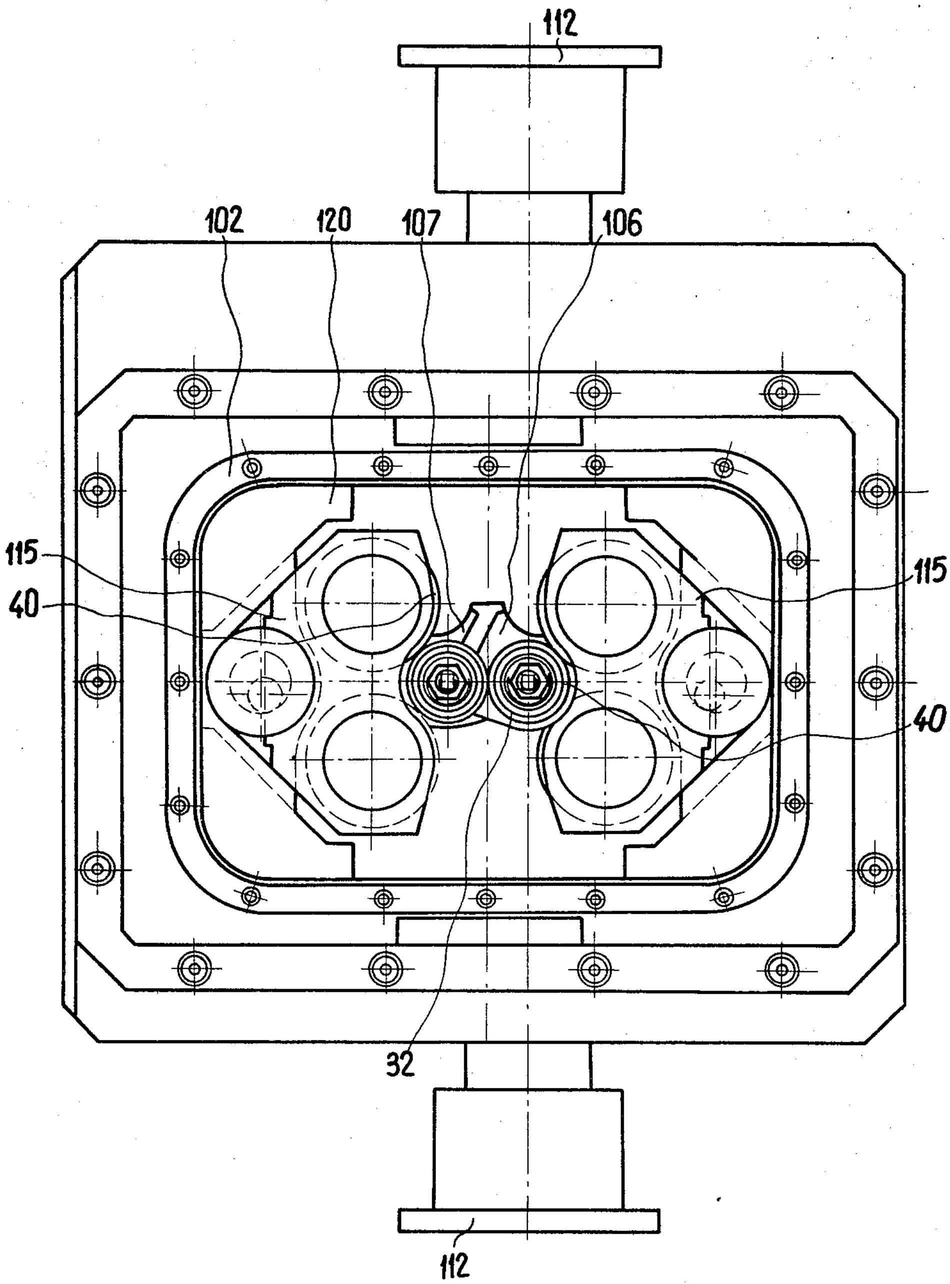

Fig. 10

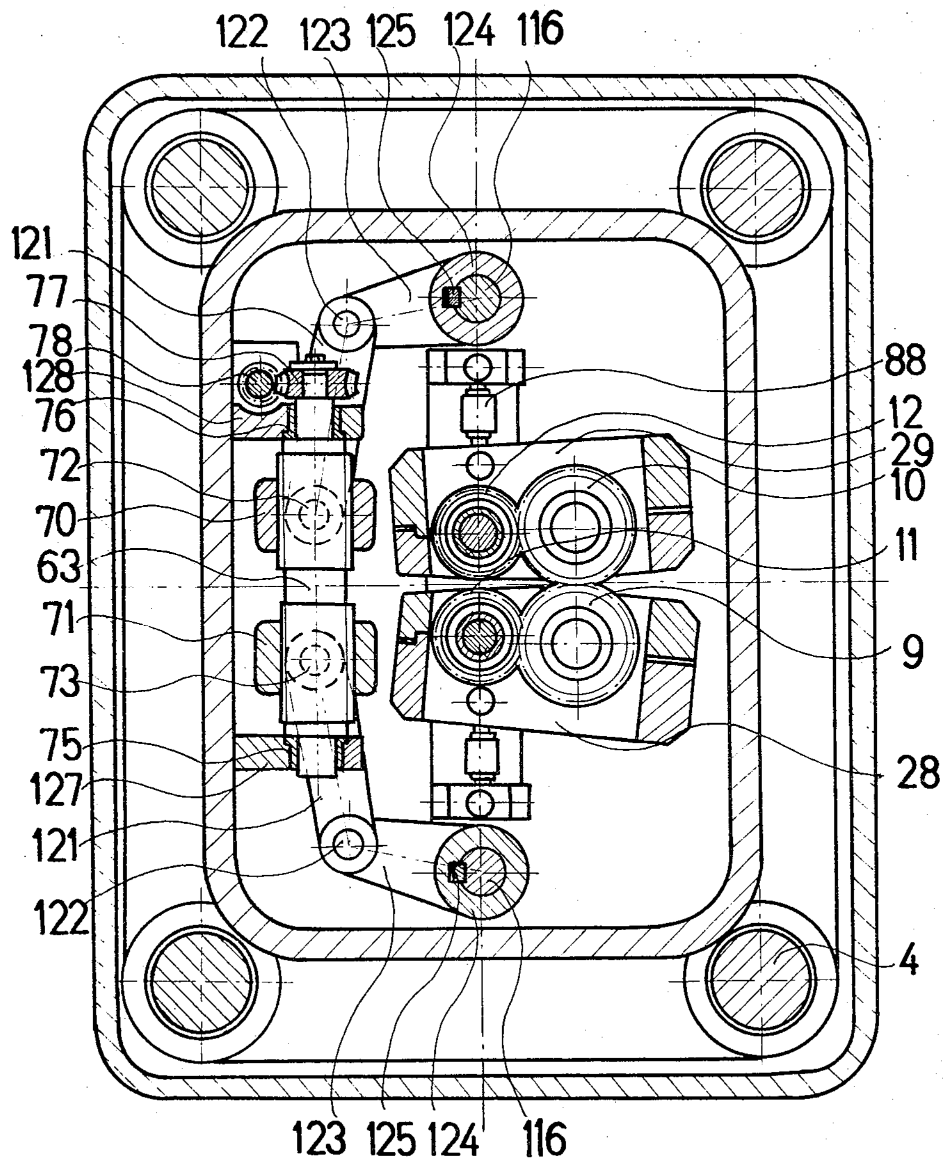
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Fig. 11

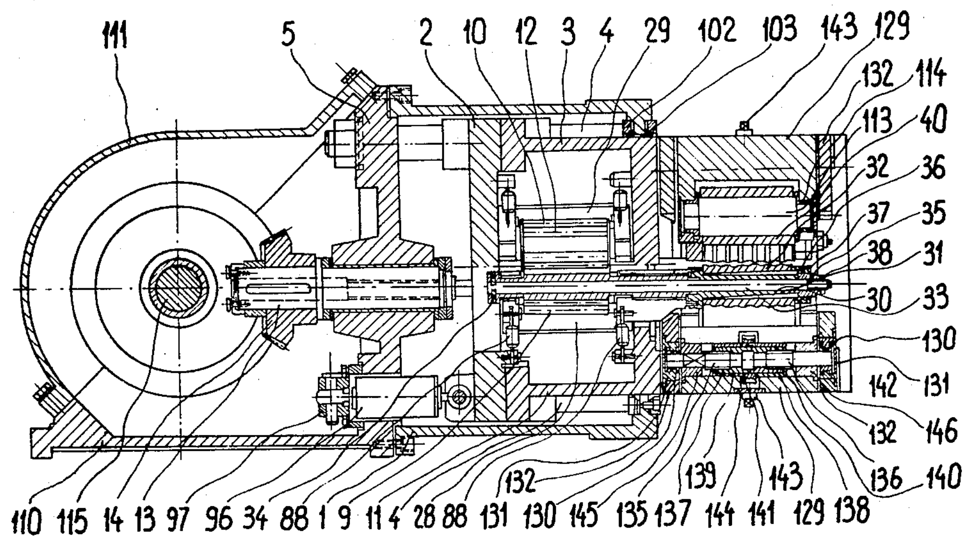
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Fig. 12

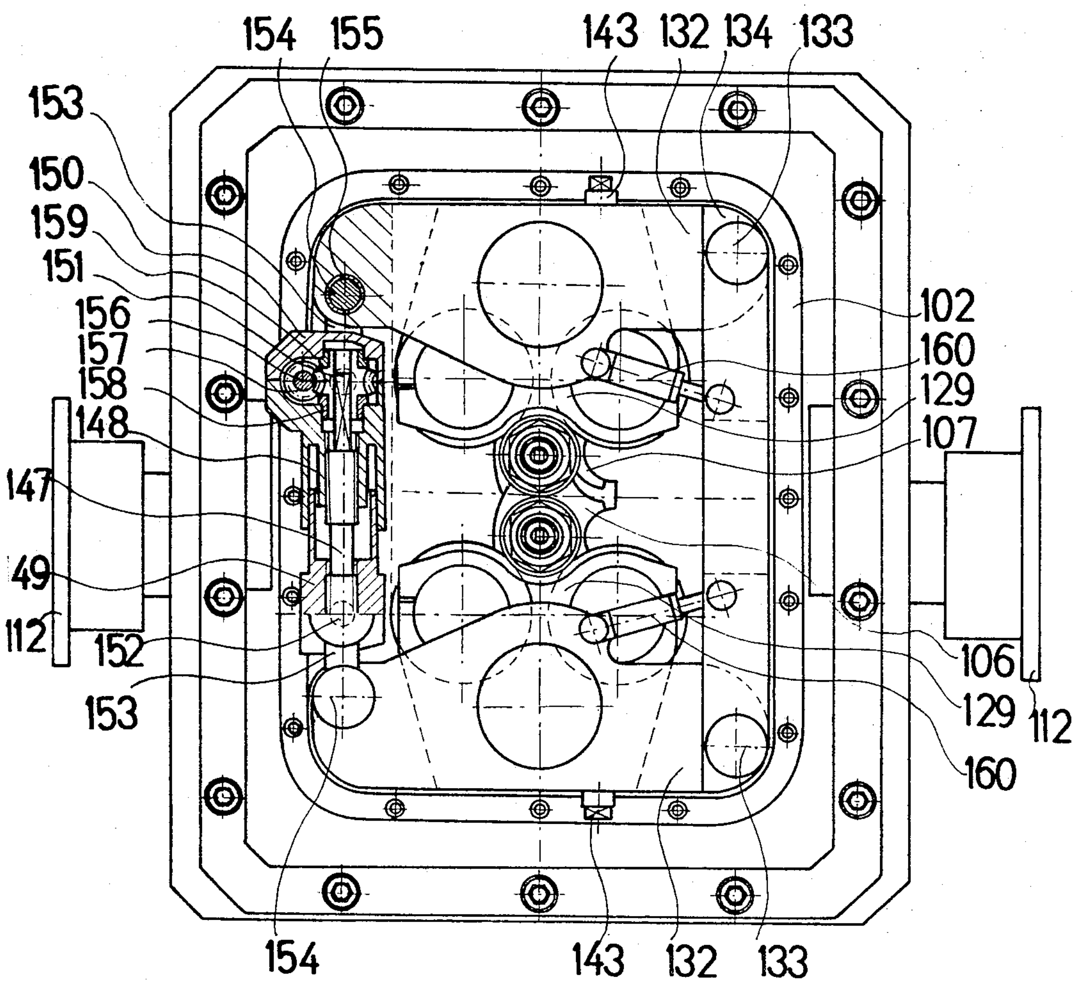
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Fig 13

CLUSTER MILL WITH CANTILEVERED ROLLS

There are known roll supports or roll stands, particularly for strip rolling mills, provided with two working rolls and four back-up rolls, but either the back-up rolls or both the working rolls and back-up rolls are journaled on side necks of these rolls, and so are cantilevered.

Such mounting makes access to the working rolls and to the guides of the rolls difficult and renders impossible their correct and rapid adjustment, which in turn causes some irregularities in the rolling process.

There are also known roll supports with two cantilevered work rolls, in which one or two of the work rolls are driven. In driving two working rolls the stands have no possibility of being moved in a direction transverse to the rolling line.

In these stands the whole driving gear of the rolls and of their adjustment is located inside the housing fastened to a base plate.

These stands have, however, a number of disadvantages, namely: the possibility of using only one or at most two grooves in the working rolls due to a roll bend that increases by the third power with increases in the length of the roll barrel; the impossibility of using cantilevered back-up rolls with large diameters, to limit the amount of bend which increases under the pressure of the stock being rolled in the mill; the necessity of frequent shut-downs of the rolling mill, due to rapid wear of the grooves, especially in finishing stands.

An object of this invention is to provide for the rolling of metals, mainly rods, on cantilevered working rolls of small diameter with practical elimination of bending of the working rolls even for a great length of working roll surface, on which a number of grooves, depending on need, are made, with the capability of moving the rolls in a direction transverse to the rolling line.

This object has been achieved by a construction of a cluster mill with cantilevered rolls, which have two working rolls and four back-up rolls with diameters greater than those of the working rolls.

The driven working rolls are mounted in bearings in two end plates, while the back-up rolls are journaled outside these plates.

These plates are joined together by means of connecting members so that they form a rigid frame which can be shifted perpendicularly to the rolling line on columns located inside the mill.

In this frame two pinion gears are mounted at a fixed distance from one another, one being a driving pinion gear formed with a splined shaft, through which it is connected with the main driving shaft located in the rear plate.

These pinion gears mesh with pinion gears of the lower and upper working rolls, whereby the pinion gears of the working rolls do not mesh with each other.

The pinion gears of the working rolls connected rigidly with the working rolls are mounted in frames that permit their rotary movement to provide for adjustment of the working rolls.

Inside the frame is also located a screw mechanism with left-hand and right-hand threads for working roll adjustment, whose drive is effected by a worm gear and a pair of bevel gears.

For moving the rolls into a required position the roll stand is provided with a drive cylinder mounted in the lower part of the stand at the side of the main drive, located in the rear plate or side plate of the frame, and is used for rough displacement.

Further, on the side plate of the frame, on the drive side, the roll stand is provided with a mechanism consisting also of the driving cylinder and locks, used for precise displacement of the rolls in a direction transverse to the rolling line.

The movable frame together with the bearings of the working rolls and the back-up rolls, the aforementioned set of gears, screw mechanism for adjusting the gap between the rolls and the mechanism for displacement of the working rolls, for protection against harmful external conditions, are located inside the mill housing.

To the side surface of the movable frame on the side of the rolls there is fixed a shield sealed to the housing. Thus, during displacement of the frame, all parts located inside the mill housing are protected. For the protection of parts provided inside the mill housing during adjustment of the rolls, the mill is provided with sealing plates and two sealing inserts.

The cluster mill with cantilevered rolls in one embodiment of the invention, with a view of increasing the rigidity of the cantilevered working rolls, is provided with back-up rolls journaled on both sides in bearings carried in pivotal plates located outside the side plate of the frame, which is movable on columns.

For adjustment of the pivotal plates the roll stand is provided with eccentric shafts mounted in end plates of the movable frame and, for driving the eccentric shafts a screw mechanism is provided.

The cluster mill, in another embodiment of the invention, in order to further increase the rigidity of the cantilevered working rolls, is provided with pivotal plates mounted in rockers, which for moving to and from one another have: two screws with left-hand and right-hand threads, nuts, ties, bolts and bolts with sleeves; for a rapid replacement of back-up rolls it is provided with shafts protruding from pivotal plates with a mechanism for effecting their relative movement.

The constructions of the cluster mill with cantilevered rolls, according to the invention, do not have the disadvantages of roll stands used heretofore. On the contrary, they have a number of important advantages, the main one of which is the capability of using small diameter working rolls which enables the stock being rolled to be intensively lengthened.

The second essential advantage of the constructions disclosed herein is the capability of employing working rolls with long barrels, on which grooves can be cut, depending on needs and pass dimensions.

A further advantage is that the roll stand has no connecting members for driving the working rolls, whereby, in adjusting the working rolls gap, the gearing characteristic is not subject to any changes.

Another advantage of the constructions discussed above is the possibility of exact displacement and setting into the required position of the working rolls, on which grooves are cut.

The invention will be explained in detail in connection with the accompanying drawings in which:

FIG. 1 is a view vertical cross-sectional of the roll support in a cluster mill;

FIG. 2 is an end elevation of the working rolls;

FIG. 3 is a sectional view taken along line A—A of FIG. 1;

FIG. 4 is a sectional view of the roll stand taken along the line B—B of FIG. 1;

FIG. 5 is a sectional view of roll support taken along the line C—C of FIG. 1;

FIG. 6 is a sectional view of the roll support taken along the line D—D of FIG. 1;

FIG. 7 is a sectional view of the roll support taken along the line E—E of FIG. 1;

FIG. 8 is the sectional view of the roll support taken along the line F—F of FIG. 1;

FIG. 9 is a view in side elevation of an alternate embodiment of roll support;

FIG. 10 is an end elevation of the working rolls of the embodiment of the roll stand of FIG. 9;

FIG. 11 is a sectional view of the embodiment of roll stand of FIG. 9 taken along line G—G thereof;

FIG. 12 is a view in side elevation of a third embodiment of a roll stand;

FIG. 13 shows another embodiment of a roll stand in side elevation taken from the side of the working rolls with parts in section to show a portion of a screw mechanism for adjustment of the gap between rolls.

As shown in FIG. 1, the cluster mill with cantilevered rolls comprises the housing 1 of the roll support stand and two shiftable plates 2,3, mounted on four columns 4, see also FIG. 5.

The columns 4 are fixed in the housing 1 and the rear plate 5. The columns 4 fulfill at the same time the function of connecting the housing 1 and the rear plate 5. The plates 2 and 3 are joined together by means of connecting members 6,7,8 and relative connecting screws, as shown in FIGS. 1,3.

Between the plates 2 and 3, as shown in FIG. 3 a set of pinion gears 9,10,11, 12 is mounted. The pinion gear 9 is provided at its rear end with a splined shaft, through which it is connected with the main driving shaft 13.

On the main driving shaft 13, as shown in FIGS. 1,9, and 12, a bevel gear 14 is mounted so that a number of roll stands may be driven from a common shaft 15, or a coupling may be provided, when the roll stands are each driven individually from a separate motor.

The driven pinion gear 9 as shown in FIG. 3 meshes with pinion gear 10. The pinion gear 9 is journaled in bearings 16 and pinion gear 10 is journaled in bearings 17 also mounted in the holes of bosses 18 and 19 protruding from plates 2 and 5, as shown in FIG. 6.

The main driving shaft 13 is mounted in bearings 20 located in the rear plate 5. The axial forces acting on the main driving shaft 13 are resisted by thrust rings 21 and 22, fixed on this shaft, the ring 22 being secured by a nut 23, as shown in FIGS. 1,9, and 12.

The axes of intermediate pinion gears 9 and 10 simultaneously, determine the axes of rotation of the set of rolls. Thereby, the intermediate axis of the pinion gear 9 is the lower fixed axis of rotation, while the axis of the intermediate pinion gear 10 is the upper fixed axis of rotation.

The intermediate pinion gear 10 meshes with the pinion gear 11, transmitting drive to the lower working roll. The drive for the upper working roll is provided by intermediate pinion gear 10 with meshing direct pinion gear 12.

The pinion gear 11 is journaled in bearings 26 and 27, as shown in FIGS. 5 and 6. The bearings 24 and 25 are mounted in chock 28, while the bearings 26 and 27 are mounted in the chock 29.

The chocks 28 and 29 are mounted for rotary movement through any desired angle to permit adjustment of the working rolls about fixed upper and lower axes of rotation. Thereby, the frame 28 may make a rotary movement about the axis of boss 18 and chock 29 may have similar rotary movement about boss 19, which extend from plates 2 and 3, as shown in FIG. 6.

The direct pinion gears 11 and 12 are toothed shafts. As shown in FIG. 1, at their front ends, the pinion gear 11 and the pinion gear 12 are provided with notches for connection with bevel sleeves 30, on which beveled clamping sleeves 31 are set, which clamp and fix in suitable position the lower and upper working rolls 32.

For proper linking between the multi-spline connection of direct pinion gears 11 and 12 with bevel sleeves 30, the roll stand is provided with tie rods 33.

The tie rods 33 are fixed at their inner ends in the direct pinion gears 11 and 12 by means of plates 34, while their outer ends are threaded, and nuts 35 are screwed onto them, to press the bevel sleeves 30 onto the splined ends of direct pinion gears 11,12.

On the external diameters of nuts 35 a thread is cut for screwing on the pressure sleeves 36 which fix in a determined position the working rolls 32. To lock the nuts 35 against unscrewing, the lock nuts 38 are screwed on ties 33.

The supporting shafts 39 of back-up rolls 40 are mounted from the work side in bearings 41, and on the drive side in bearings 42. The axial forces acting on supporting shafts 39 are absorbed by thrust rings 43,44, mounted on these shafts.

The bearings 41 of supporting shafts 39 for the lower back-up rolls are mounted in the lower chock 45, see FIGS. 1 and 5 while the bearings 41 of supporting shafts 39 for the upper back-up rolls are mounted in the upper bearing chock 46.

As shown in FIGS. 1 and 6, the bearings 42 of supporting shafts 39 for the lower back-up rolls are mounted in the rear lower bearing chock 47, and the bearings 42 of supporting shafts 39 for upper back-up rolls are mounted in the rear upper bearing chock 48.

In order to carry out a rotary movement about the fixed axes of rotation at the required angle for adjustment of the gap between the rolls, the front lower check 45 is provided with a pin 49 and the front upper bearing housing 46 is provided with a pin 50, as shown in FIG. 5. The pins 49 and 50 are mounted in bores in the plate 3.

In order to reduce the load on pins 49 and 50 and to increase the rigidity of the bearing chocks 45 and 46, both are provided with bosses 51 and 52.

To obviate rapid wear between the plate 3 and the bosses 51 and 52 inserts 53 and 54 are provided, as shown in FIG. 5.

As shown in FIGS. 7 and 8, to enable pivotal rotary movement of the rear lower bearing chock 47 about the fixed lower axis to provide the required adjustment of the rolls, the chock 47 is provided with a boss 55 in which a bore is made for insertion therein of the pin 56 protruding from the plate 2.

Similarly, for pivotal rotary movement of the rear upper bearing chock **48** about the fixed upper axis to provide for adjustment of the rolls, the chock **48** has a boss **57**, in which also a bore is made to insert therein the pin **58**, protruding from the plate **2**, as shown in FIG. 7.

To increase the rigidity of this arrangement the rear parts of bosses **55** and **57** are made as circular segments, which penetrate the bosses **59** and **60**, protruding from plate **2**, as shown in FIG. 8.

To additionally increase the rigidity the front lower bearing chock **45** and the rear lower bearing chock **47**, these chocks are connected by means of tie bolts **61** and fixing sleeves **62**.

Also to increase the rigidity of the front upper bearing chocks **46** and the rear upper bearing chocks **48**; these chocks are connected by means of tie bolts **61** and fixing sleeves **62**.

The front parts of the supporting shafts **39**, FIG. 1, are tapered and expansion sleeves **63**, fixing the position of back-up rolls **40** are mounted on these tapered front parts. The expansion bevel sleeves **65** are mounted on the bevel ends of shafts **39** are secured by means of nuts **64**.

For attaching the back-up rolls **40** on supporting shafts **39**, fixing sleeves **65** and **66** and pressure plates **67** pressed on by screws **68** are utilized.

For adjustment of the gaps between working rolls **32**, as shown FIGS. 1 and 3, the rolling mill is provided with screw **69**, with right-hand and left-hand threads. The screw **69** is screwed into a nut **70** having a right-hande thread and into a nut **71** having a left-hand thread.

The nut **70** has pins **72** protruding therefrom, while the nut **71** has similar pins **73**. The pins **72** and **73** of the nuts **70** and **71** enter into the bores of guides **74**. FIG. 1, which cooperate with nut **70** and are mounted shiftably in the front upper bearing chock **46** and the rear upper bearing chock **48**.

Also, the guides **74** cooperating with nut **71** are mounted shiftably in the front lower bearing chock **45** and the rear lower bearing chock **47**.

The screw **69** is located in bearings **75** and **76**. The screw **69** may be rotated by means of a worm gear system consisting of worm wheel **77** and worm shaft **78**. The worm shaft **78** which has in its rear part splines **79** FIG. 8, which can be displaced inside the bevel gear **80**.

The bevel gear **80** is journaled in a bearing chock fixed to the rear plate **5**, and meshes with bevel gear **82** which journaled in a bearing chock **83** fixed to the housing of the roll stand **1**.

To eliminate play between cooperating parts of the adjustment mechanism of the rolls and for prestressing, the roll stand is provided with springs **84** as shown in FIGS. 1 and 7.

The springs **84** are located in guideways **85** and **86** which are pivotally mounted by means of bolts **87** in the front lower bearing housing **45** and the front upper bearing housing **46**, and the rear lower bearing housing **47** and the rear upper bearing housing **48**.

In order to exert a suitable preliminary pressure to the lower working roll **32** from the lower back-up rolls **40** and to the upper working roll **32** from the upper back-up rolls **40** the roll stand is provided with driving cylinders **88** and **89**, FIGS. 1, 5 and 6.

The driving cylinders **88** are located between plates **2** and **3** and fixed to the frame **28** and to cantilevered lower plates **90**, as well as to the frame **29** and to the cantilevered upper plates **91**, as shown in FIG. 6.

The cantilevered lower plates **90** are fastened by means of screws, one to the front lower bearing housing **45**, the other to the rear lower bearing housing **47**.

Also, the cantilevered upper plates **91** are fastened by means of screws to the front upper bearing housing **46** and to the rear upper bearing housing **48**.

To protect the rolls against excessive preliminary pressure, stops **92** are built in the frame **28**, and further in the cantilevered lower plates **90** stops **93** are provided. Stops **94** and **95** are provided in the upper frame **29**, and in the cantilevered upper plates **91**, respectively.

The driving cylinder **89** is fixed at one end to the frame **28**, and with the other end to the frame **29**, as shown in FIG. 5.

For rough positioning of rolls in their axial movement together with plates **2** and **3** and mechanisms built on plates and between plates, the roll stand has the driving cylinder **96**, shown in FIG. 1, which is fastened at one end to the plate **2** and at the other end to a mounting **97** joined with the rear plate **5** by means of screws.

For precise positioning of rolls into the required position, the roll stand is provided with driving cylinder **98**, FIG. 7, which is fastened to two catch mechanisms **99** situated in guideways **100**.

In order to protect all mechanisms contained within the housing of the roll stand **1** while moving the rolls in a direction perpendicular to the line of rolling against noxious external conditions, to the plate **3** from the roll side a shield **101**, FIGS. 1 and 4, sealed by means of rings **102** and packings **103**, is fastened.

Also, for the purpose of protection against external influences on all mechanisms within the housing of the stand **1** during adjustment of rolls, the roll stand is provided with sealing plates **104** and **105** and sealing inserts, the lower sealing insert **106** and the upper sealing insert **107**, as shown in FIGS. 4,10,13. On the side of rolls, the roll stand has a lower shield **108** and an upper shield **109**.

When a common drive is applied for a plurality of stands, as shown in the embodiments in FIGS. 1,9,12, the roll stand is provided with lower housing **110** and upper housing **111** for mounting a common driving shaft **15** and shielding the bevel gears.

The roll stand is equipped with couplings **112**, FIG. 2, secured to the ends of shaft **15**.

In the embodiment of the roll stand, as shown in FIGS. 9,10,11, the shafts **113** of back-up rolls **40** are journaled in bearings **114** located in pivotal plates **115** as shown in FIGS. 9 and 10.

The pivotal plates **115** are mounted on eccentric shafts **116** journalled in bearings **117**. The eccentric shafts **116** are journaled in bearings **118** and **119**. The bearings **118** are mounted in plate **3** and the boss **120** protruding from plate **3**, while the bearings **119** are mounted in plate **2**.

For adjustment of the gap between working rolls **32**, like in the embodiment shown in FIGS. 1,3, the rolling mill is provided with screw **63**, which screw has a right-hand and left-hand thread.

The screw **63** is screwed into nut **70** having the right-hand thread, and into nut **71** having the left-hand thread. The nut **70** has pins **72** projecting therefrom, and the nut **71** has similar pins **73**. The pins **72** and **73** of nuts **70** and **71** enter into bores of tie bolts **121**.

The tie bolts **121** are connected in an articulated manner through bolts **122** with arms **123** protruding from sleeve **124**. The sleeves **124** are connected with eccentric shafts **116** by means of splines **125**. The sleeves **124** are fixed on eccentric shafts **116** by means of flanged sleeves **126**.

The screw **63** is seated in bearings **75** and **76**. The shell **75** is located in mounting **127**, while the bearing **76** is located in mounting **128**. The mountings **127** and **128** are fastened to the plate **3**.

For exerting a suitable initial pressure between the working roll **32** and the lower back-up rolls **40** and between the upper working roll **32** to the upper back-up rolls **40**, the roll stand is provided with driving cylinders **88**. The driving cylinders **88** are mounted between plates **2** and **3** and fixed to the plates **2** and **3** and frames **28**,**29**.

In order to protect all mechanisms contained inside the housing of the stand **1** from harmful external influences, while the rolls are moved in a direction transverse of the rolling line, the plate **3** is sealed by means of rings **102** and packings **103**.

Also, to protect the mechanisms contained inside the housing of the stand **1** from harmful external influences during adjustment of the gap between rolls, the roll stand is provided with lower sealing insert **106** and upper sealing insert **107**.

In the further embodiment of the roll support or stand, as shown in FIGS. **12**,**13**, the shafts **113** of back-up rolls **40** are journaled in bearings **114** mounted in pivotal plates **129**. The pivotal plates **129** are journalled in bearings **130** inserted in chocks **131** which are mounted on rockers **132**.

The rockers **132** are mounted in articulated manner on bolts **133** located in the boss **134** protruding from the plate **3**.

For mounting the pivotal plates **129** the rolling mill is provided with shafts **135** and **136**. The shaft **135** has one end cut with a right-hand thread, and the other end provided with a tapered pin. The shaft **136** has one end cut with a left-hand thread and the other end is provided with a tapered pin.

The shaft **135** is screwed into a nut **137** which has a right-hand thread. The shaft **136** is screwed into a nut **138** having the left-hand thread.

The nuts **137** and **138** are mounted and fixed in sleeves **139** and **140**, which are connected with worm wheel **141** through the groove **142**, and the worm wheel **141** meshes with the worm **143** located in a mounting **144**.

The shifts **135** and **136** have guideways **145** and **146**. For adjustment of the gap between the working rolls the rolling mill in the embodiment shown in FIGS. **12**,**13** is provided with screws **147** which have right-hand and left-hand threads.

The screws **147** are screwed into nuts **148** having a right-hand thread, and nuts **149** having a left-hand thread.

The nuts **148** have covers **150**, with pins **151** protruding therefrom. Also, from the nuts **149** protrude pins **152**. The pins **151** and **152** penetrate bores of tie bolts **153** connected in an articulated manner with rockers **132** across pins **154**.

The pins **154** are fixed in sleeves **155**. The screws **147** are rotated by means of worm gearing, consisting of worm wheels **156** and worm shaft **157**.

The worm wheels **156** are journalled in bearings **158** and **159**, the bearings **158** being secured to nuts **148**, and bearings **159** to covers **150**.

The worm shaft **157**, in order to be rotated, is provided with a square pin at its front end protruding outside the nut **148** and cover **150**.

For balancing the shafts **114** of back-up rolls **40** of pivotal plates **129** and rockers **132** and for continuous elimination of play between screw **147** and nuts **148** and **149**, the roll stand is provided with driving cylinders **160** fastened in articulated manner to the boss **134** of the front plate **3** and to rockers **132**, as shown in FIG. **13**.

The shifting of rolls in a direction perpendicular to the rolling line in a required position is effected by operating the driving cylinder **96** to perform a rough displacement, and by operating the driving cylinder **98** for precise shifting of rolls which causes the spring catches **99** to engage precisely cut notches on columns **4** and locate the rolls in the required position.

Prior to consequent displacement of rolls into the required position and before operating the driving cylinder **96**, performing a rough adjustment, the spring catches **99** are first loosened by the driving cylinder **98** to effect the return movement.

After completing the rough displacement by means of the driving cylinder **96**, the driving cylinder **98** is again actuated.

The working rolls **32** are adjusted in a symmetrical manner in relation to the rolling line, with the result that the theoretical rolling line remains constant independently of the size of gap between the working rolls **32**.

The adjustment of back up rolls is effected by driving a shaft with notched bevel gear **82** which causes the rotation of the bevel gear **80** which is in mesh with it.

The bevel gear **80** drives the worm shaft **78** and permits a drive transmission of drive independently of the adjustment of working rolls **32**.

The worm shaft **78** drives the worm wheel **77** fixed on screw **69**. The rotary movement of screw **69** causes through nuts **70** and **71** and guides **74** the upper bearing chock **46** together with the upper bearing chock **45** and the rear lower bearing chock **47**, depending on the direction of rotation of bevel gear **82**.

The relative rotary movement of these bearing chocks about the upper fixed axis of rotation and lower fixed axis of rotation, causes the shafts **39** with back-up rolls mounted on their ends to make the same movement.

The working rolls are pressed onto the back-up rolls **40** by means of the driving cylinders **88**,**89** and frames **28**,**29** and cantilevered plates **90**,**91**. Thus, a rotary movement about fixed axes of rotation performed by back-up rolls **40** involves the same movement of working rolls **32**.

A reduction or increasing of the distance between the axes of the working rolls **32** is effected by suitable rotation of the shaft with notched bevel wheel **82**.

The drive of cluster mill with cantilevered rolls, depending on requirements, is transmitted either from the driving shaft 15 across the bevel wheel 14 on the main driving shaft 13, as shown in FIGS. 1,9,12 or by the intermediary of a clutch mounted on the main driving shaft 15, when for driving the roll stand an individual driving motor or a spur gear with driving shaft protruding to enable the drive of roll stand is used.

The torque from the main driving shaft 13 is transmitted to the splined shaft of the intermediate pinion gear 9 which is driven independently from the position of the working rolls in a direction perpendicular to the rolling line, since the spline shaft of the intermediate pinion gear 9 can be displaced inside the main driving shaft 13 but remains in mesh with the shaft, as shown in FIGS. 1,9,12.

The intermediate pinion gear 9 meshes with the other intermediate pinion gear 10 separating thus the drive on the lower working roll 32 and the upper working roll 32.

The drive of the lower working roll 32 is affected through direct pinion gear 11. On the other hand, the drive of the upper working roll 32 is effected by the direct pinion gear 12.

Thus, in adjustment of a required distance between axes of working rolls, the direct pinion gears 11 and 12 driving the working rolls 32, are travelling about pitch diameters of the intermediate pinion gears 9 and 10, without alteration of the gearing characteristic.

Changing of one of the working rolls 32 is effected by partially removing the nut 38, removing the nut 37 and press sleeves 36 and partial removal of the nut 36 thus enabling the loosening of clamping sleeves 31.

After loosening the clamping sleeves 31 the working rolls 32 can be readily removed. The refitting of working rolls 32 is effected in the same way, but in reverse sequence.

Changing of back-up rolls is effected by partial removal of adjusting screws 68, removing clamping plates 67 and partial removal of the nuts 64 and loosening the clamping tapered sleeves 63, then the back-up roll 40 can easily be removed. The refitting of the back-up rolls is carried out in the same way but in reverse sequence.

The setting of the gap between the working rolls 32 in the embodiment shown in FIGS. 1,10,11, is effected by rotating the bevel gear 82.

The bevel gear 80 drives the worm shaft 78 mounted slidably therein. The splines 79 of the worm shaft 78 ensure a transmission of the torque independently of the adjustment of the working rolls 32.

The worm shaft 78 drives the worm wheel 77 fixed on screw 63. Rotation of the screw 63 causes rotation of the eccentric shaft 116 through nuts 70 and 71, tie bolts 121, arms 123, sleeves 124 and splines 125.

In turn, the revolution of eccentric shafts 116 causes appropriate movement of the pivotal plates 115, in which the back-up rolls 40 are mounted.

The movement of back-up rolls 40 depends on the direction of rotation of the shaft with notched bevel gear 82.

The working rolls 32 are pressed into the back-up rolls 40 by means of driving cylinders 88 and frames 28 and 29.

Thus, by an inward and outward movement of back-up rolls 40 a simultaneous movement of working rolls 32 is effected. The direction of this movement depends on the direction of rotation of the shaft with notched bevel gear 82.

The adjustment of the working rolls 32 in the embodiment of the roll stand shown in FIGS. 12,13, is carried out by rotating the worm shaft 157, which causes the revolution of worm wheels 156.

The rotary movement of screws 147 causes through nuts 148,149, tie bolts 153, rockers 132, the appropriate movement of the pivotal plates 129, in which the back-up rolls are mounted. The inward and outward movement of back-up rolls 40 depends on the direction of rotation of the worm shaft 157.

To enable rapid change of back-up rolls 40 in the roll stand in the embodiment shown in FIGS. 12,13, in pivotal plates 129 worm wheels 141 are mounted, the worm wheels being rotated by worms 143.

The worm wheels 141 transmit the torque on nuts 137 and 138, which causes a displacement of the shafts 135, 136. Depending on the direction of rotation of the worms 143, the shafts 135 and 136 move to cause the removal of tapered pins of these shafts from bearings 130 or move in the other direction whereupon the tapered pins of shafts 135 and 136 penetrate bearings 130 and are clamped therein.

The above described cluster mills according to the present invention are capable of rolling metals, preferably rods and bars with cantilevered working rolls of small diameter with practical elimination of roll bending even with a considerable length of the working roll barrel, on which a number of pass grooves, depending on the requirements, are cut, whereby the capability is provided for moving the rolls in a direction transverse to the rolling line.

The above cluster mills according to the present invention do not have disadvantages of roll stands used hitherto. On the contrary, they show a number of important advantages, the main of which is the possibility of using working rolls of small diameter limiting spread and enlarging elongation.

Another advantage is the capability of employing long working roll barrels, on which grooves can be cut, depending on requirements such as pass dimensions.

A further advantage consists in the fact that the roll stand has no connecting members for driving the working rolls, whereby, in setting up the working rolls, the gearing characteristic is not subject to any alteration.

Another advantage is the capability of exact displacement of the working rolls on which grooves are cut and setting these rolls into the required position.

We claim:

1. A cluster mill for rolling metal stock comprising:

a housing having a transverse fixed plate therein;

a first movable plate in spaced relation to said fixed plate and generally parallel thereto, and a second movable plate between said first movable plate and said fixed plate, and spaced from and parallel to said plates;

means in said housing transverse to said fixed plate having said movable plates in sliding relation thereto for guiding said movable plates;

means connecting said movable plates to each other;

a pair of adjacent working rolls on the side of the first movable plate remote from said second movable plate;

backup rolls in juxtaposition with said working rolls on the side of the first movable plate remote from said second movable plate;

means extending through said first movable plate for supporting said rolls in cantilever manner;

means between said movable plates for driving said working rolls, and

means between said movable plates for adjusting said working rolls.

2. The cluster mill of claim 1, wherein said means for driving said working rolls comprises a first chock and a second chock, means for pivotally mounting said chocks on a said movable plate, a first intermediate pinion gear passing through said last mentioned movable plate with the axis thereof coincident with the pivotal axis of the said first chock and a second intermediate pinion gear having its axis coincident with the pivotal axis of said second chock, said intermediate pinion gears being in mesh, a first direct pinion gear carried by said first chock and in mesh with said first intermediate pinion gear and a second direct pinion gear carried by said second chock and in mesh with said second intermediate pinion gear, and means for axially connecting each said direct pinion gear with a said working roll.

3. The cluster mill of claim 2, wherein there are an upper working roll and a pair of upper back up rolls and a lower working roll and a pair of lower back up rolls, said means for supporting said back up rolls comprising shafts and first and second chock means for supporting said upper and lower back up rolls respectively, and means pivotally supporting each said chock means for movement on an axis coincident with a said axis.

4. The cluster mill of claim 1, and further comprising means for moving said movable plates relative to said fixed plate and in the direction of the axes of said rolls.

5. The cluster mill of claim 4, wherein said last mentioned means comprises means for effecting a rough adjustment and means for effecting a fine adjustment.

6. The cluster mill of claim 5, said rough adjustment means comprising cylinder means extending in the direction of the roll axes.

7. The cluster mill of claim 5, said fine adjusting means comprising cylinder means extending transverse to the roll axis direction and means operatively connecting said last mentioned cylinder means to a said plate and said movable plate guide means.

8. The cluster mill of claim 1, and further comprising sealing means between said housing and said supporting means and carried by said first movable plate.

9. A cluster mill for rolling metal stock comprising:

a housing having a transverse fixed plate therein;

a second plate generally parallel to said first plate and spaced therefrom, and mounted for transverse movement;

first and second working rolls in juxtaposition on the side of said second plate remote from said fixed plate;

means for supporting said working rolls extending through said second plate;

means between said plates for driving and adjusting said working rolls;

a pair of back up rolls in juxtaposition with each said working roll;

a pair of spaced plates supporting each pair of back up rolls;

means for pivotally supporting each said pair of back up roll supporting plates, on said second plate;

and means for moving said pairs of back up roll supporting plates and the back up rolls supported thereby to and from each other.

10. The cluster mill of claim 9, wherein said pivotal supporting means comprises a shaft for each pair of supporting plates journalled in said second plate and said last mentioned means comprising eccentric portions of said shaft to which a pair of said supporting plates are journalled, and means for rotating said shafts.

11. The cluster mill of claim 9, wherein said means for supporting and moving said back up roll supporting plates comprises rocker means for each pair of plates, means for pivotally supporting each said rocker means from said second plate, means for pivotally connecting each said pair of plates to a said rocker means, said means for moving said pairs of supporting plates comprising means for moving said rocker means.

12. The cluster mill of claim 11, wherein said last mentioned means comprises a pair of tie bolts each connected to a said rocker means, and nut and screw means connected to said tie bolts and having a worm wheel meshing with a worm shaft.

13. The cluster mill of claim 11, wherein said means for pivotally connecting each said pair of plates to a said rocker means comprises multi-part shaft means carried by said pair of plates having the parts thereof axially movable and normally extending into said rocker means, and means for moving said multi-part shaft means axially to decrease the length thereof to a length no greater than the spacing of said pair of plates, whereby to permit withdrawal of said multi-part shaft means from said rocker means.

14. A cluster mill for wolling metal stock comprising:

a housing;

a pair of working rolls;

means for rotatably supporting said working rolls from said housing;

back up roll means in juxtaposition with each said working roll;

means for supporting said back up roll means comprising a pair of spaced plates having a back up roll journalled therein;

a second pair of spaced plates outwardly of said pair of supporting plates;

multi-part shaft means pivotally connecting said supporting plates to said second pair of plates, and means for disconnecting said supporting plates and said pair of plates comprising means for moving said shaft means axially.

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