

Oct. 20, 1970

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3,534,577

ROLLING MILLS FOR ROLLING METAL

Filed Nov. 6, 1967

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Fig. 1.

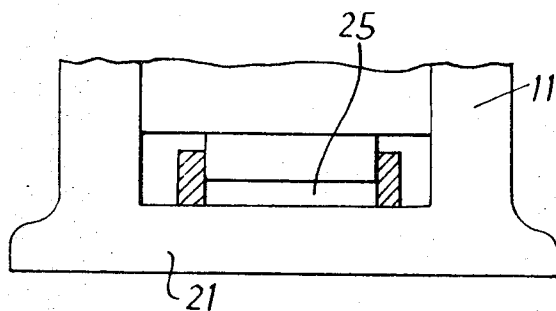
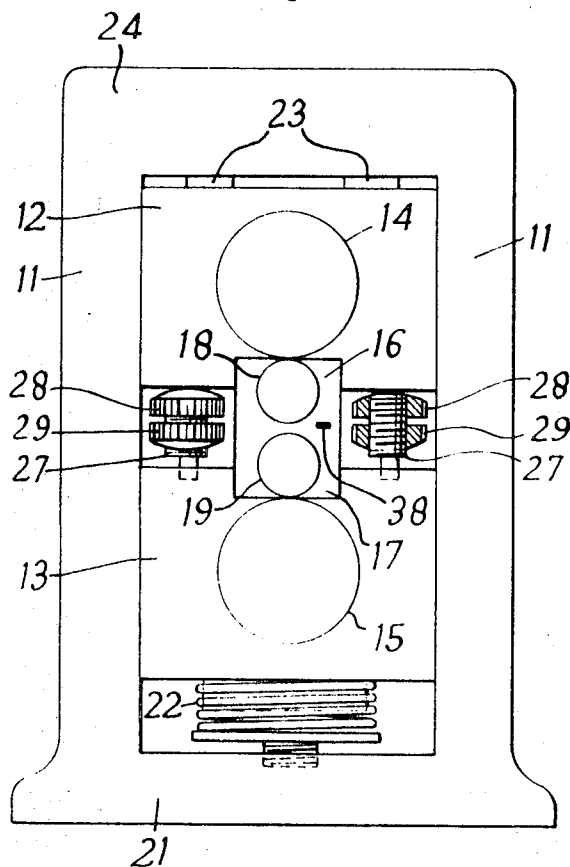


Fig. 2.

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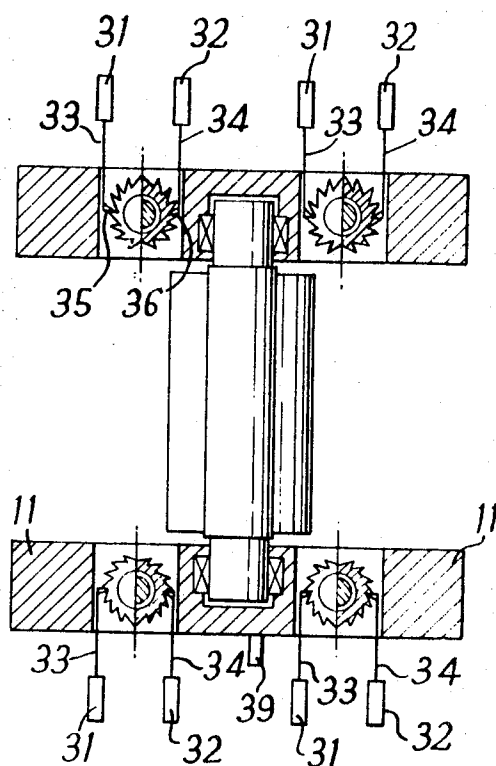
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Fig. 3.



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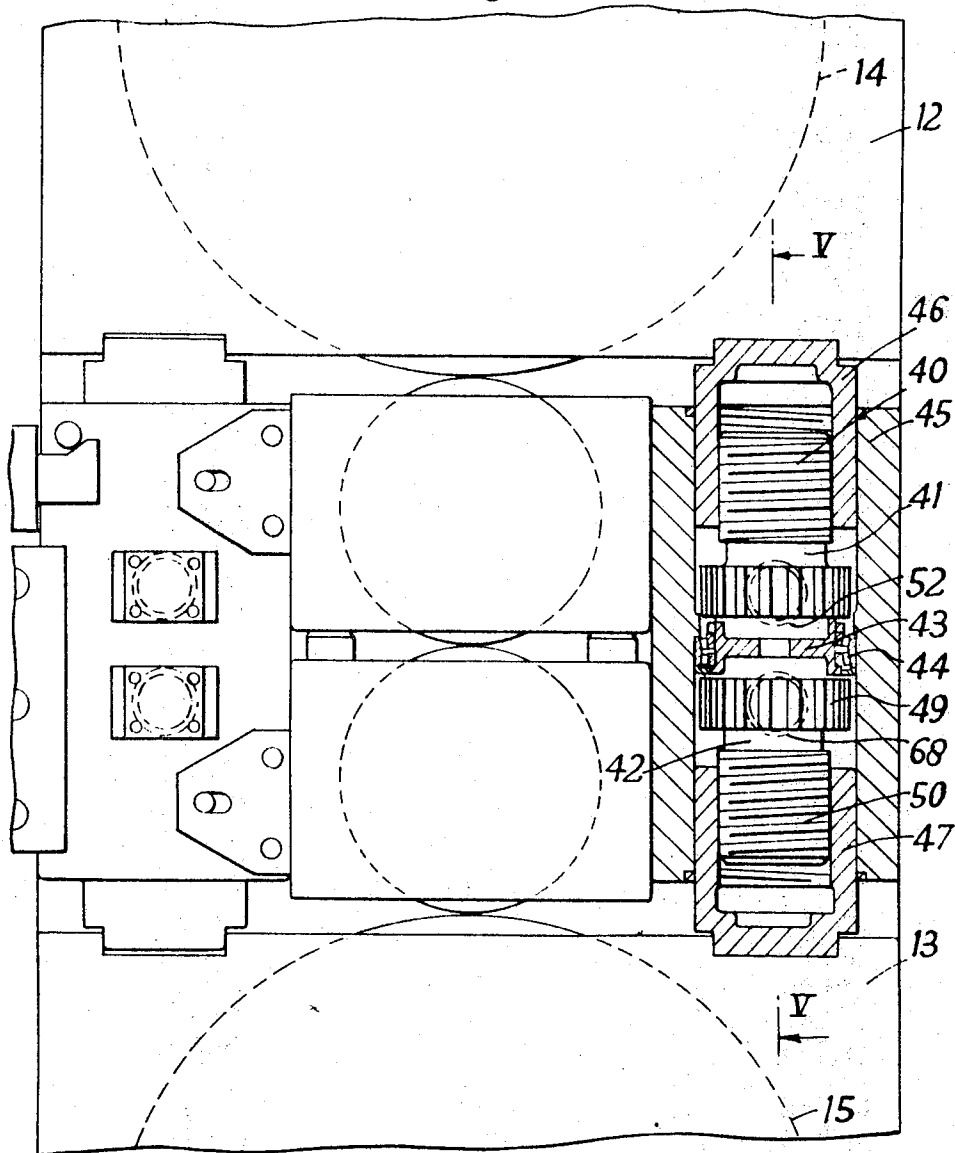
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Fig. 4.



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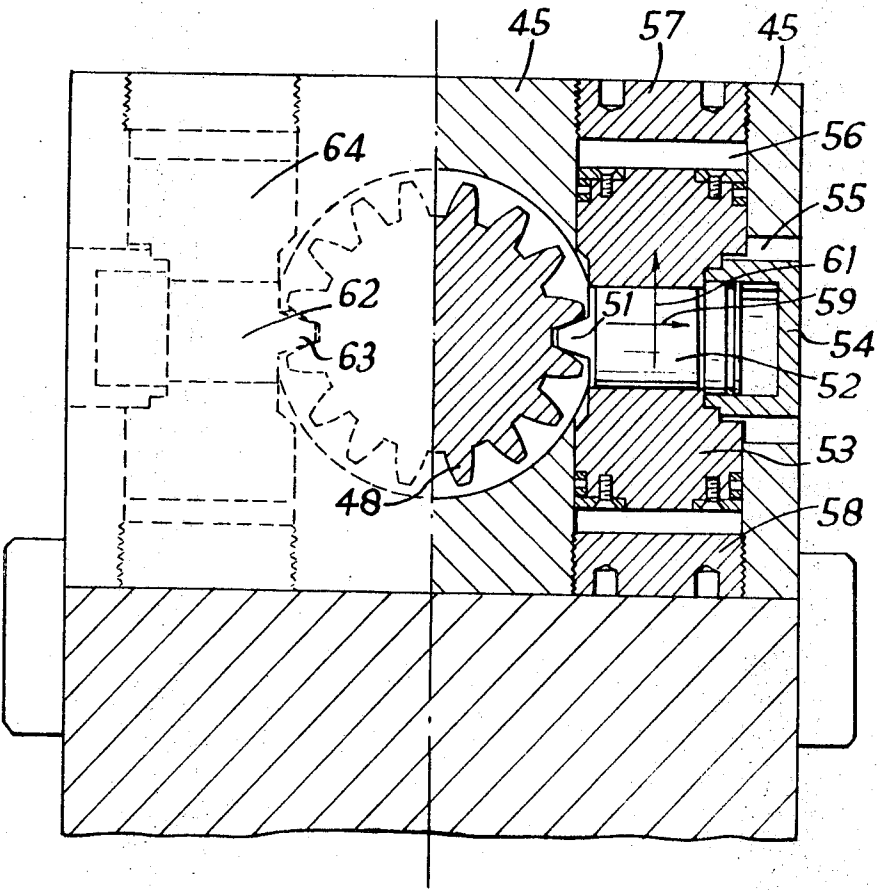
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Fig. 6.



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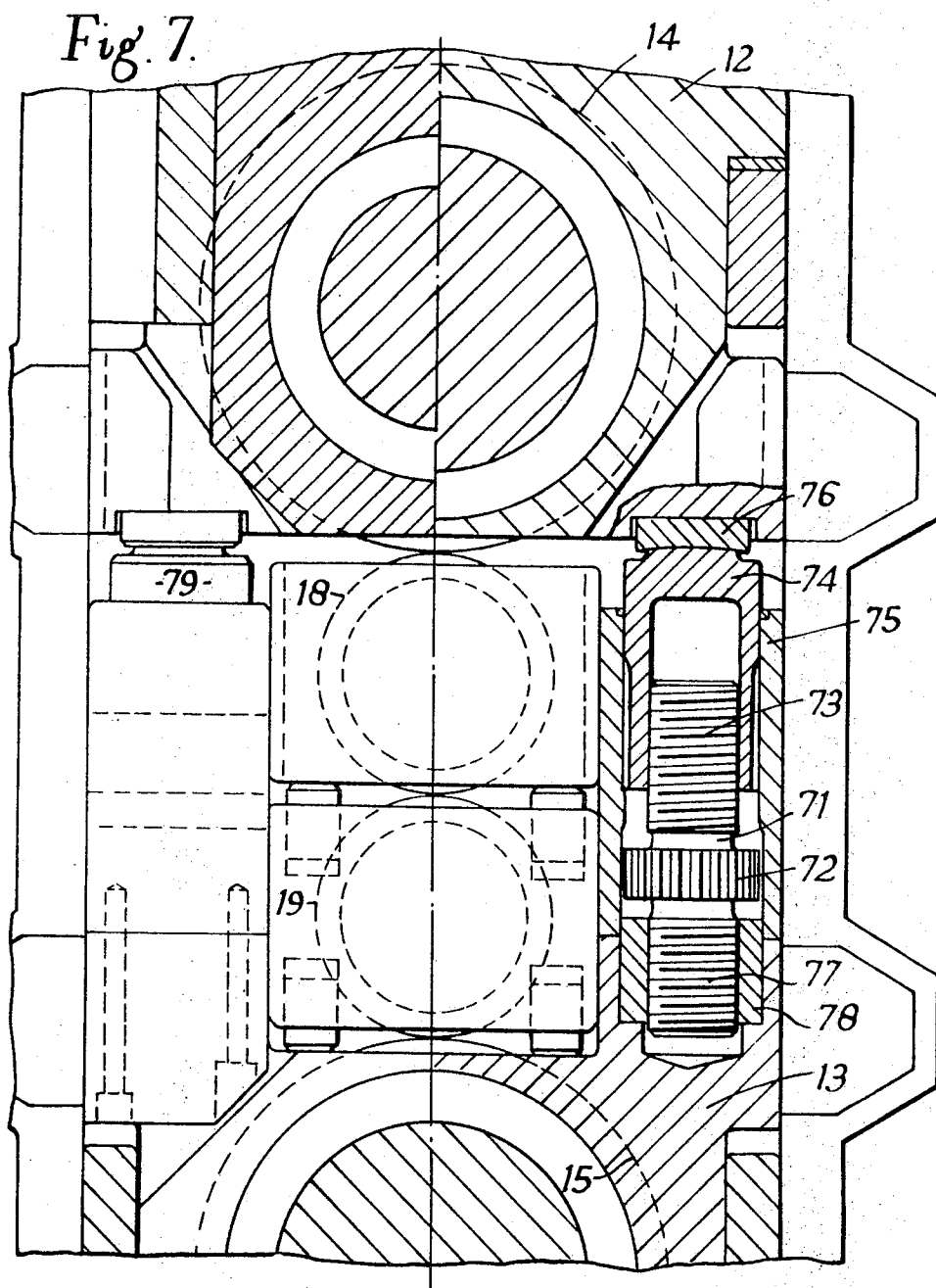
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ROLLING MILLS FOR ROLLING METAL

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Int. Cl. B21b 31/32

U.S. Cl. 72—245

10 Claims

ABSTRACT OF THE DISCLOSURE

The roll gap of a rolling mill is adjustable by mechanical screw-type jacks located between upper and lower vertically slidable roll-carrying chocks thereof or between the mill housing and chocks carrying one of the rolls. The screw adjusting means of each jack is drivably connected between two oppositely-acting, one-way transmissions to two power-driven actuating members respectively. Each time a selected actuating member is operated, it imparts to the screw adjusting means of the corresponding jack a predetermined angular movement in the required direction and thereby produces a corresponding predetermined lengthening or shortening of the jack.

This invention relates to prestressed, constant-gap rolling mills and is concerned with improved means for adjusting the roll gap in rolling mills in which the working rolls and the back-up rolls, if provided, are carried by vertically adjustable chocks.

The invention has for its object to provide a roll-gap-adjusting means which is of simple construction, is reliable in operation and enables an operator without difficulty to increase or decrease the roll gap by known predetermined amounts, or to adjust the roll gap automatically in order to maintain constant gauge or a predetermined pattern of gauge.

With this object in view, there is provided a rolling mill in which upper and lower working rolls and associated upper and lower back-up rolls (if provided) are carried by chocks mounted for vertical sliding movement in a mill housing and in which roll-gap-adjusting means are arranged respectively on each side of the mill, either between the chocks of the upper and lower working rolls or those of the associated back-up-rolls (if provided) or between the upper chocks and the top of the mill housing or between the lower chocks and the bottom of the mill housing, wherein the said roll-gap-adjusting means comprises mechanical, screw-type jacks and power-driven actuating means associated respectively with said jacks and operable at will either to shorten or lengthen the associated jack by rotating a screw-threaded component of said jack in one direction or the other respectively, the arrangement being such that each operation of said actuating means will cause said component to rotate through a predetermined angle so as to produce a predetermined lengthening or shortening of said jack.

The invention will now be described by way of example with reference to the accompanying drawings, in which:

FIG. 1 is a diagrammatic vertical section taken in a plane at right angles to the roll axes and close to one of the housings of a rolling mill provided with one form of the roll-gap-adjusting means according to this invention,

FIG. 2 is a fragmentary diagrammatic vertical section similar to that of FIG. 1 illustrating an alternative form of pre-stressing means,

FIG. 3 is a diagrammatic horizontal section illustrating details of the roll-gap-adjusting means,

FIG. 4 is a vertical section through one of the roll chock housings of a rolling mill having another form of roll-

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gap-adjusting means, the section being taken in a plane normal to the roll axes.

FIG. 5 is a view partly in elevation and partly in section on the line V—V in FIG. 4 illustrating details of the roll-gap-adjusting means according to FIG. 4,

FIG. 6 is a horizontal section on the line VI—VI in FIG. 5, and

FIG. 7 is a vertical section corresponding to FIG. 4 but showing yet another form of roll-gap-adjusting means.

FIG. 1 shows one of the two housings for the roll chocks which carry the work rolls and back-up rolls of a 4-high rolling mill. In the vertical members 11 of this housing there are mounted for vertical sliding movement chocks 12, 13, for the top and bottom back-up rolls 14, 15 and chocks 16, 17 for upper and lower work rolls 18, 19. A prestressing load is applied between the back-up chock 13 and the bottom part 21 of the mill housing means of a spring 22 which is adjustable to vary the pre-stressing load which is measured by load cells 23 located between the top back-up chock 12 and the top part 24 of the housing.

The other housing of the rolling mill, the vertical members 11' of which can be seen in FIG. 3, is generally similar to the housing shown in FIG. 1.

FIG. 2 illustrates an alternative arrangement in which the pre-stressing load is applied by a hydraulic or pneumatic cylinder 25. In order to keep the pre-stressing pressure constant, the pressure in the cylinder 25 may be controlled by a servo-hydraulic valve which is responsive to signals received from the load cells 25 via an electrical amplifier (not shown).

In alternative arrangements (not illustrated), the pre-stressing spring 22 or cylinder 25 is arranged between the top back-up chock 12 and the top part 24 of the housing and the load cells 23 are arranged between the bottom back-up chock 13 and the bottom part 21 of the housing.

Rolling mill having the features so far described are already known. The arrangement illustrated in the drawings differ however, from known rolling mills in the construction and arrangement of the means described below for adjusting the roll gap.

Between the upper and lower back-up chocks 12, 13 in each of the two housings there is arranged a pair of screw jacks, having screw-threaded spindles 27 with square-section projections on their lower ends which projections are engaged in closed-end, square-section recesses in the top part of the bottom back-up chock 13. Screwed on the screw-threaded spindles 27 of the jacks are double ratchet wheels, each of which has an upper part 28 with ratchet teeth inclined one way and a lower part 29 with ratchet teeth inclined the opposite way.

The tops of the double ratchet wheels bear against the bottom surface of the upper back-up chocks 12.

Associated with each jack is a pair of hydraulically or pneumatically-operated cylinders 31, 32. Pistons (not shown) in these cylinders are connected by their piston rods 33, 34 to pawl drives indicated diagrammatically at 35, 36 in FIG. 3. Each pawl drive 35 has a pawl which cooperates with the upper part 28 of the corresponding double ratchet wheel and each pawl drive 36 has a pawl which cooperates with the lower part 29 of the same double ratchet wheel. During each working stroke of any of the piston rods 33, the pawl of the corresponding pawl drive 35 coacts with the upper part 28 of the associated ratchet wheel to rotate the latter in one direction through a distance corresponding to the distance between two adjoining ratchet teeth. Similarly, during each working stroke of any of the piston rods 34, the pawl of the corresponding pawl drive 36 co-acts with the lower part 29 of the associated ratchet wheel to rotate the latter in the opposite direction through a like distance.

The pre-stressing force exerted by the pre-stressing

spring 22 or cylinder 25 holds the upper and lower back-up chocks 12, 13 tightly against the upper and lower ends respectively of the jacks.

Accurate control of the gauge is obtained, as in known rolling mills, by adjusting the tension of the springs 22 (FIG. 1) or the pressure of the fluid medium in the cylinders 25 (FIG. 2).

The jacks are used for coarse adjustment or for further adjustment after the limit of adjustment by means of the springs or cylinders has been reached, but can also be used for the control of the gage.

All the jacks may be adjusted simultaneously and equally in the same direction. The jacks on one housing can, however, be adjusted independently of those on the other housing, e.g. to eliminate a tendency for the rolled strip to "track."

An advantage of the arrangement of jacks described above is that each working stroke of any given working cylinder 31 or 32 will produce a predetermined movement of one of the work rolls relatively to the other, e.g. a movement of two thousandths of an inch.

Direct measurement of gauge can be effected either with the aid of pneumatic or magnetic gap detectors 38 (FIG. 1) located between the work roll chocks 16, 17 or with the aid of contact type or contactless gauges such as 39 (FIG. 3) outside the roll bite of the mill.

The load cells 23 or load cells (not shown) between the chocks provide an indirect measurement of gauge, the latter being calculated from the roll load measured by such cells.

Such measurements can also be used to control automatically the operation of the pressure cylinders 31, 32 to maintain constant gauge or any desired pattern of gauge.

In the embodiment of the invention illustrated in FIGS. 4 to 6, the pawl-and-ratchet operated jacks of the embodiment according to FIGS. 1 to 3 are replaced by jacks operated by rack-and-pinion gears in which means are provided for disengaging each rack from the corresponding pinion during the return stroke.

Each of the jacks has two separate spindles 41, 42 disposed vertically in end-to-end adjustment with a thrust ring 43 between them as shown in FIGS. 4 and 5. The thrust ring 43 is rotatably mounted by means of a double-row, tapered roller thrust bearing 44 in a guide block 45 mounted for vertical sliding movement in guides (not shown) in one of the vertical members of the mill housing. The upper end part of the upper spindle 41 is screw-threaded at 40 for engagement with an interior screw-thread in a thrust member 46 which is mounted for axial sliding movement in a bore in the guide block 45 and bears against the chock 12. Similarly, the lower end part of the lower spindle 42 is screw-threaded at 50 for engagement with an interior screw-thread in a thrust member 47 which is likewise axially slidable in the guide block 45 and bears against the chock 13. On the end portions of the spindles 41 and 42 adjacent the thrust ring are formed pinions 48 and 49 respectively. A rack tooth 51 on the piston 52 is arranged to cooperate with the pinion 48. As shown in FIG. 5 the piston 52 is mounted for movement towards and away from the pinion 48 in a hydraulic cylinder formed partly by a horizontal transverse bore in a piston 53 and partly by a cylinder head 34 carried by said piston 53 and arranged to move therewith in a horizontal slot 55 in the housing 45. The piston 53 is movable in a horizontal bore 56 in the guide block 45 between two stop members 57, 58 screwed into opposite ends respectively of the bore 56. The piston 52 is movable by the application thereto of hydraulic pressure in the direction of the arrow 59 or in the opposite direction as and when required. Similarly, the piston 53 is movable by the application of hydraulic pressure in the direction of the arrow 61 or in the opposite direction as and when required.

On the other side of the pinion 48, there is provided

a hydraulic piston 62 carrying a tooth 63 and mounted in a further hydraulic piston 64, the pistons 62 and 64 being constructed and arranged similarly to the pistons 52 and 53. Each pair of pistons 52, 53 and 62, 64 is arranged to be operated independently of the other pair. When the pistons 52, 53 are set in operation they perform the following cycle of operations. First, the piston 52 is moved in the direction opposite to that of the arrow 59 to engage the tooth 51 with the pinion 48. The piston 53 then advances in the direction of the arrow 61 through a distance such that the pinion 48 is rotated anti-clockwise (as seen in FIG. 5) through an angular distance corresponding to the circular pitch from one tooth of the pinion 48 to the next tooth thereof. At the end of this advance movement of the piston 53, the piston 52 is withdrawn in the direction of the arrow 59 to disengage the tooth 51 from the pinion 48. The piston 53 then returns to its original position, after which both pistons 52 and 53 remain at rest until they are operated again.

The pistons 62, 64, when set in operation, perform a similar cycle of operations to rotate the pinion 48 through the same angular distance, but in a clockwise direction (as seen in FIG. 5).

The pinion 49 is arranged to be rotated likewise in one direction by a tooth 67 operated by pistons 68, 69 corresponding respectively to the tooth 51 and the pistons 52, 53 and in the opposite direction by a tooth and pistons (not shown) corresponding respectively to the tooth 63 and the pistons 62, 64.

In the embodiment of the invention illustrated in FIGS. 4 to 6, the screw-thread 40 on the spindle 41 is right-handed and has a 9.6 mm. pitch, while the screw-thread 50 on the spindle 42, which is also right-handed, has a 10 mm. pitch. Consequently, a fine adjustment of the roll gap is obtainable by rotating both spindles 41 and 42 simultaneously in the same direction, a coarse adjustment is obtainable by rotating only one of these two spindles and a very coarse adjustment is obtainable by rotating both spindles simultaneously in opposite directions respectively.

FIG. 7 illustrates a variant of the embodiment according to FIGS. 4 to 6, in which each of the jacks has only one spindle 71 and one pinion 72. The pinion 72 is rotatable clockwise or anti-clockwise as required by two racks (not shown) on two opposite sides thereof respectively, these racks being similar in construction and operation to those already described with reference to FIG. 6.

The spindle 71 has its upper end part screw-threaded at 73 for engagement with an interior screw-thread in a hollow cylindrical thrust member 74 which is slidable, but not rotatable, in a guide member 75 rigidly supported on the lower chock 13. The upper end of the thrust member 74 has a convex part-spherical thrust surface which bears against a complementary concave lower surface of an insert 76 secured in a recess in the lower end of the upper chock 12. The lower end part of the spindle 71 is screw-threaded at 77 for engagement with an interior screw-thread in a sleeve 78 fitted in a recess in the upper end of the chock 13. The screw-threads 73, 77 on both end parts of the spindle 71 are right-handed but of different pitches.

A similar jack, the hollow cylindrical thrust member 79 of which is visible in FIG. 7, is provided on the opposite side of the upper and lower work rolls 18, 19.

The variant illustrated in FIG. 7, while it does not provide for both fine and coarse adjustment of the roll gap, has the advantage of being simpler and cheaper than the construction illustrated in FIGS. 4 and 5.

While the jacks in the embodiment illustrated in the drawings are arranged between the upper and lower back-up chocks, they could of course be arranged between the upper and lower work roll chocks.

Alternatively, the jacks could be arranged between the upper chocks or lower chocks and the upper or lower

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parts respectively of the mill housing, in which case the spring or cylinder would be between the back-up chocks.

I claim:

1. A rolling mill comprising;

a pair of mill housings,

upper and lower rolls rotatably carried by bearings

supported respectively by said mill housings,

chocks arranged for vertical sliding movement in said mill housings to vary the roll gap between adjacent working surfaces of said upper and lower rolls, each chock having mounted thereon a bearing for a corresponding end of one of said rolls, and

roll-gap-adjusting means for adjusting and fixing the size of said roll gap,

said roll-gap-adjusting means including at least two screw-type jacks arranged with one of their ends acting against the chocks carrying at least one of said rolls and each having a driving member rotatable in one direction for extending said jack and in the opposite direction for shortening the same, and power-driven actuators having fixed strokes drivably connected to each of said jacks

each of said actuators being selectively operable to impart rotation to the driving member of the associated jack through a fixed predetermined angle in one direction and through a fixed predetermined angle in the opposite direction.

2. A rolling mill as claimed in claim 1, wherein the said upper rolls include a working roll and a back-up roll,

the said lower rolls include a working roll and a back-up roll

the said chocks include chocks for the bearings of said upper and lower rolls and

each of the jacks have one of its ends acting against a chock carrying the bearing for one end of the upper back-up roll and its other end bearing against a chock carrying the bearing for the corresponding end of the lower back-up roll.

3. A rolling mill as claimed in claim 1, wherein each power-driven actuator comprises:

two power cylinders operable one-at-a-time and each having a fixed working stroke and two one-way drives connected respectively between said two power cylinders on the one hand and the driving member of the corresponding jack on the other hand and arranged for transmitting rotation in opposite directions respectively to the driving member of the associated jack,

each of said power cylinders being arranged, when operated, to transmit to the corresponding one-way drive a predetermined movement whereby the driving member of the jack is rotated through a predetermined angle in the direction determined by the power cylinder selected for operation.

4. A rolling mill as claimed in claim 3, wherein each one way drive consists of a pawl-and-ratchet gear.

5. A rolling mill as claimed in claim 4, wherein each power cylinder has a working stroke of a predetermined fixed length such that each operation of said power cylinder will cause the driving member of the associated jack to be rotated through an angular distance equal to that between two consecutive teeth of the pawl-and-ratchet gear.

6. A rolling mill as claimed in claim 5, wherein the driving member of each jack is constituted by a nut having a thrust surface at one of its ends acting against a chock of one of the back-up rolls and each jack is also provided with a screw-threaded spindle having

the said nut screwed on one end thereof and its other

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end axially and rotatably fixed with respect to the corresponding chock of the other back-up roll

and wherein

the two one-way drives are constituted by

two pawls each of which is arranged to perform one working stroke and one return stroke each time that the corresponding power cylinder is operated and

two rings of ratchet teeth cooperating respectively with the said two pawls

the ratchet teeth of each of said two rings being inclined in the opposite direction to those of the other.

7. A rolling mill as claimed in claim 3, wherein each one-way drive is constituted by a rack-and-pinion gear, comprising:

a pinion rigid with the driving member of the corresponding jack and

a rack having a single tooth movable transversely thereof into and out of engagement with said pinion said rack being arranged to perform a working stroke followed by a return stroke each time the corresponding power-driven actuator is operated

and wherein a power cylinder is arranged to move said tooth into and hold it in engagement with said pinion during the working stroke of the corresponding power-driven actuator and to withdraw said tooth and hold it disengaged from said pinion during the return stroke thereof.

8. A rolling mill as claimed in claim 7, wherein the two power cylinders of each actuator are operatively connected to two racks engaging the same pinion on two opposite sides thereof respectively.

9. A rolling mill as claimed in claim 8, wherein the driving member of each jack:

is constituted by a spindle having screw-threaded upper and lower end parts of like hand the pinion is located between said upper and lower end parts and

the jack is also provided at its upper and lower ends with thrust members formed with screw threaded bores in which are engaged the said screw-threaded upper and lower end parts of said spindle.

10. A rolling mill as claimed in claim 3,

wherein each jack comprises:

two driving members constituted respectively by two axially aligned spindles arranged one above the other and

a thrust bearing arranged between the proximate ends of said two spindles

the said two spindles having portions at their other ends formed with screw-threads of different pitch

wherein each jack also comprises upper and lower thrust members formed with screw-threaded bores in which the screw-threaded end portions of the two spindles are respectively engaged and

wherein each spindle

is selectively rotatable in each of two opposite directions by a corresponding power driven actuator.

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