ROLLING MILL FOR ROLLING BUSHES AND THE LIKE

FIG. 3

INVENTORS
WOLFGANG BACKE
OTTO ULRYCH

by
McElwain & Fren
ATTORNEYS
ROLLING MILL FOR ROLLING BUSHES AND THE LIKE

Wolfgang Backé, Aachen, and Otto Ulrych, Dortmund-Horode, Germany, assignors to Rheinstahl Wagner Werkzeugmaschinenfabrik m.b.H., Dortmund, Germany

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ABSTRACT OF THE DISCLOSURE

A mill for rolling annular workpieces, such as bushes and the like, whose axial lengths are large relative to their diameters, has two superposed relatively adjustable horizontally centered rolls supported on opposite ends, with the larger diameter upper roll being driven and the smaller diameter lower roll being axially displaceable. Respective bearings rotatably support each end of each roll, and a drive is connected to one end of the upper roll. A support frame is closed above and beneath the rolls and encloses the bearings. The bearing at the drive end of the upper roll is fixedly mounted in the frame, and a displaceable bearing block on the frame engages the top and sides of the bearing at the other end of the upper roll and is vertically adjustable. A carriage is mounted on the frame for adjustment relative to the upper roll and carries the bearings at the ends of the lower roll.

BACKGROUND OF THE INVENTION

Rolling mills for annular workpieces normally have two working rolls which can be adjusted relatively to each other, usually one of these rolls being driven. In the most common design, the orientation of the roll axes is vertical. The larger diameter or disk roll is driven, and is mounted in stationary position, usually in an overhung arrangement. The smaller diameter roll, or roll mandrel, can be adjusted relative to the disk roll, and is supported, during the rolling operation, at its free end by means of a counter holder which can be either folded down or lifted for the purpose of insertion or removal of the workpiece.

Rolling mills of this type are not particularly suitable for the economical rolling of thin-walled workpieces whose axial lengths are large relative to their diameters, such as, for example, bushes and the like. On the one hand, the roll bearings, for the forces appearing in annular workpieces whose axial lengths are large relative to their diameters, and which have low wall thicknesses, are not stiff enough, so that the rolled annular workpieces deviate considerably from the ideal cylindrical jacket form. Therefore, they require excessive machining allowances for metal removal. On the other hand, the necessity of lifting the workpiece over the roll mandrel, during loading and unloading of the rolling mill, makes automation of the change of workpieces, which is necessary for optimum profitability, difficult.

For rolling annular workpieces, there are also known, rolling mills, wherein the disk roll is supported at both ends, the upper bearing being arranged in a stand or in a C-shaped structure of the rolling mill frame. Such a rolling mill is shown, for example, in U.S. Pat. No. 2,307,191. This arrangement, in which the upper bearing is exposed to high bending stress, increases the rigidity of the roll bearing only insignificantly. However, it makes changing of the disk roll much more difficult. If bushes and similar objects with a different outer contour have to be produced, the changing of the rolls requires a long down time with the corresponding production loss.

SUMMARY OF THE INVENTION

For the bilateral support of the roll mandrel, there have been used arrangements wherein the roll mandrel is loosened from one bearing for changing the workpieces and is displaced axially, as shown, for example, in U.S. Patent No. 2,776,585. The manipulation of the workpieces thus is facilitated. In this case, too, stands or C-shaped structures are required for the second support of the roll mandrel. These stands or structures are subject to considerable bending stresses, with resultant deformations, particularly when bushes or other objects having a large or great axial length are to be pulled.

It has also been suggested, for example, in French Pat. No. 1,159,355, to use, for rolling of annular workpieces, a vertical rolling mill with horizontal roll axes, and wherein both rolls are supported on opposite ends and the roll mandrel can be displaced axially for changing the workpieces. In this arrangement, both rolls are driven and feed and removal of the workpieces are effected over inclined conveyor troughs which require a stationary arrangement of the lower roll mandrel and adjustment of the top disk roll. Such adjustment necessitates the provision of a drive shaft for the top disk roll, which drive shaft is driven from a stationarily mounted motor. This further complicates and increases the cost of the construction which is already costly because of the drive of both rolls. The aforementioned considerations apply to the rigidity of the roll support, so that this rolling mill does not offer any better prerequisites for the rolling of bushes and the like than do the other known constructions.

This invention relates to a rolling mill for rolling annular workpieces whose axial lengths are large relative to their diameters and, more particularly, to a novel and improved rolling mill for this purpose which is free of the disadvantages of known prior art rolling mills, used for this purpose, and which has a high productivity rate and is particularly adapted to automatic feeding and removal of the workpieces to be rolled.

The invention provides for the economical production of bushes and similar annular workpieces with a low capital expenditure. This is possible because of a bilateral support of the rolls and a rigid overall structure of the machine, so that even workpieces of great axial length can be rolled with minimum deviations in form and thus minimum machining allowances. Furthermore, replacement or changing of the disk roll, for rolling different workpiece forms, can be effected with a minimum expenditure of time and the changing of the workpieces can be automated using simple and safe means.

In accordance with the invention, the rolling mill includes two superposed and mutually adjustable rolls, which are supported on opposite ends and oriented horizontally. The larger diameter upper or disk roll can be driven, and the smaller diameter bottom roll, or roll mandrel, can be displaced in an axial direction. The rolling mill in accordance with the invention is characterized by a frame which is closed both above and below the rolls, and encloses the bearings at opposite ends of both rolls. The bearing on the driving end of the top roll is fixedly mounted, and the bearing block embraces the other bearing of the top roll engaging the top and both sides thereof, and this bearing block is vertically displaceable. A carriage supports the bearings of the bottom roll, and can be displaced relative to the top roll and adjusted relative to the latter.

Maximum accuracy in the rolling of the form of the annular workpieces is obtained when the top roll has imparted thereto an initial stress, in the unloaded state and through the displaceable bearing block, such that,
when the rolls are loaded by the rolling force, the bearing centers of both rolls lie on two parallel lines or, in other words, the axes of the two rolls are essentially parallel. In order to attain this, under varying operating conditions, the bearing block is made adjustable in its vertical position with respect to the bearing of the top roll, by means of a threaded adjusting means or the like. In order to provide for easy disassembly or changing of the top roll, despite a minimum distance between bearings resulting in maximum rigidity of the entire structure, the inside width, between the guides of the bearing block, is greater than the maximum diameter of the top roll. In order further to simplify changing of the rolls and to reduce the tooling costs, the top roll, in accordance with the invention and in a known manner, comprises an inner part carrying the bearing pin and an annular outer part secured on the inner part and connected non-rotatably therewith. For the purpose of providing for rolling of workpieces of different axial length under optimum conditions, by adapting the bearing spacing of the smaller diameter bottom roll to the axial length of the respective workpiece, the rolling surface of the outer part of the top roll consists of several annular parts. By this arrangement, the working surface of the top roll can be adapted easily to the axial length of the workpiece to be rolled, so that space is provided, during the rolling of annular workpieces having smaller axial lengths, to bring the replaceable bearing of the smaller diameter lower roll as close as possible to the workpiece, when an axially shorter lower roll mandrel is to be used.

For avoiding damage or fouling of the bearing surfaces during disassembly or changing of the outer part of the top roll, the outer part can be removed from the inner part over the bearing, remaining on the bearing pin, after disengagement of the bearing block upwardly from the bearing.

An object of the invention is to provide an improved rolling mill for rolling annular workpieces, such as bushes and the like, whose axial lengths are large relative to their diameters.

Another object of the invention is to provide such a rolling mill having two superposed relatively adjustable horizontally oriented rolls supported at opposite ends.

A further object of the invention is to provide such a rolling mill in which the larger diameter upper roll is driven and the smaller diameter lower roll is axially displaceable.

Another object of the invention is to provide such a rolling mill including respective bearings rotatably supporting each end of each roll, with a support frame closed above and beneath the rolls and enclosing the bearings.

A further object of the invention is to provide such a rolling mill including a drive connected to one end of the upper roll with the bearing at the drive end of the upper roll being fixedly mounted in the frame.

Another object of the invention is to provide a displaceable bearing block on the frame and engaging the top and sides of the bearing at the other end of the upper roll.

A further object of the invention is to provide a carriage mounted on the frame for displacement relative to the upper roll and carrying the bearings at the ends of the lower roll.

A further object of the invention is to provide means for adjusting this carriage relative to the upper roll.

Yet another object of the invention is to provide such a rolling mill in which the upper roll has a rolling surface which is adjustable as to axial extent, and which is formed on an outer annular part which can be removed over an associated bearing.

For an understanding of the principles of the invention, reference is made to the following description of a typical embodiment thereof as illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a vertical sectional view through the rolling mill taken along the line A-B of FIG. 2;

FIG. 2 is a vertical sectional view through the rolling mill taken along the line C-D of FIG. 1;

FIG. 3 is a partial vertical sectional view, on an enlarged scale, of the rolling mill and taken along the line G-H of FIG. 1; and

FIG. 4 is a horizontal sectional view of the rolling mill taken along the line E-F of FIG. 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, the larger diameter of top roll 1, which is referred to as the disk roll, and the smaller diameter bottom roll 2, which is referred to as the roll mandrel, are supported at opposite ends in bearings, and these bearings are enclosed by the machine frame 3. Bearing pin 4 of top roll 1 is connected with the drive (not shown) for the rolling mill, and is mounted in a bearing bush 6 which is rigidly connected with machine frame 3. Bearing pin 4 is arranged to rotate with roll 1, and is rotatable in anti-friction bearings or the like in bearing bush 6, while being restrained against axial displacement relative to bearing bush 6. The other bearing pin 6 of top roll 1 is rotatably mounted in a bearing bush 7, while being fixed against axial displacement therein, and bearing bush 7 is embraced on its top and on both sides by a bearing block 8. Bearing bush 7 is secured against rotation and axial displacement relative to bearing block 8 by suitable means, which have not been specifically illustrated, for example by a pin or the like.

A guide rod 12 is secured to bearing block 8, and comprises a tubular intermediate portion and two end pieces. Guide rod 12 is guided in a guide sleeve 13 secured in machine frame 8. Bearing block 8 is adjustable in height by means of a nut 14 threadedly engaged with a thread on guide rod 12, this nut bearing, in the lowermost illustrated position of bearing block 8, on the upper end face of guide sleeve 13. By means of a lock nut 15, which can be screwed onto the upper end of guide sleeve 13, bearing block 8 can be rigidly braced, relative to machine frames 3, through guide rod 12, nut 14 and guide sleeve 13, so as to be able to absorb upwardly directed force components.

Top roll 1 comprises an inner part having the bearing pins 4 and 6, a sleeve 16, rings 17 and 18 and a flange 19. Sleeve 16 can be secured on the inner part and connected therewith by suitable means, which have not been shown, such as adjusting springs and screws, so as to be secured against rotation and axial displacement relative to the inner part. The inner diameter of sleeve 16 is greater than the outer diameter of bearing bush 7. Rings 17 and 18, whose outer circumferential surfaces form the rolling surface of top roll 1, are centered on sleeve 16 by suitable means which have not been shown, such as adjusting springs and the like, and are connected non-rotatably with sleeve 16 and secured against axial displacement relative thereto by a collar on sleeve 16 and a flange 19, which is connected with this collar by suitable bolts or screws (not shown). The maximum diameter of rings 17 and 18 is smaller than the inside width of recess 9 of machine frame 3, which recess is exposed when bearing block 8 is displaced upwardly.

Below top roll 1, there is a roll carriage 20 having guide ribs 21, 22, 23 and 24 engageable with guide faces of the machine frame, as best seen in FIG. 4. Carriage 20 may be displaced vertically of machine frame 3 by hydraulic actuators including cylinders 25 and 26, secured on machine frame 3, and respective piston rods 27 and 28, connected to roll carriage 20. The smaller diameter bottom roll 2 is journalled at the upper part of roll carriage 20. Roll 2 has one conical end 29 engaged in a flange.
bushing 31 which is secured in bearing bush 32 against rotation and axial displacement. Bush 32 is rotatably mounted in a bearing block 35 by means of anti-friction bearings 33 and 34, and is secured against axial displacement relative to bearing block 35. The conical end 30 at the opposite end of roll 2 is seated in a flanged bushing 36 and has a threaded extension threaded into bushing 36. Roll 2 is secured against rotation and axial displacement in a bearing bush 37 which is rotatably mounted in a bearing block 40 by means of anti-friction bearings 38 and 39 designed for absorbing both longitudinal and transverse forces.

Bearing block 40 is designed as a carriage which can be displaced in the longitudinal or axial direction of bottom roll 2 on guides 41 and 42 of roll carriage 20, as best seen in FIG. 4. Such displacement can be effected by a yoke 43, fixedly connected with bearing block 40, and on which act the piston rods 44 and 45 associated with respective cylinders 46 and 47 secured on roll carriage 20, the pistons and cylinders serving as hydraulic actuators.

A centering arm 48 is pivotally mounted in the upper part of machine frame 3, as best seen in FIG. 2, and its free end rotatably supports a centering roller 49. Pivotal movement of centering arm 48 is effected by a hydraulic actuator 50, mounting the finished workpieces and means for disconnection of the feed, which is effected by a scanning roller 54 when the desired diameter of the annular workpiece has been attained.

The method of operation of the invention will now be described with reference to the several elements of the rolling mill occupying the positions represented in the drawings. By supplying pressure fluid to hydraulic cylinders 46 and 47, yoke 43 and, with this yoke, bearing block 40 are displaced to the right as viewed in FIGS. 1 and 4. During such displacement, bottom roll 2, which has its conical end 30 threaded with flange bushing 36, is displaced so that its conical end 29 is disengaged from its seat in the flanged bushing 31. This exposes the space opposite rings 17 and 18 of top roll 1. Through feeding device 51, an annular workpiece blank 52 is brought into a position in which its axis is substantially aligned with the axis of bottom roll 2. By supplying pressure fluid in the opposite direction to hydraulic cylinders 46 and 47, bearing block 40, and with this bearing block bottom roll 2, is displaced again to the left until conical end 29 of bottom roll 2 again bears on the corresponding bearing surface of flanged bushing 31. During this movement, bottom roll 2 penetrates through the opening in workpiece blank 52.

Top roll 1 is then rotated by its drive and roll carriage 20 is pushed upwardly by supply of pressure fluid to hydraulic cylinders 25 and 26. As soon as contact is attained between top roll 1, workpiece blank 52 and bottom roll 2, workpiece blank 52 and bottom roll 2 are set into rotation. With continuous upward displacement of roll carriage 20, workpiece blank 52 is rolled to the finished bush-shaped ring with a reduction of the wall thickness and an increase in diameter. By supplying hydraulic fluid to actuator 50, centering arm 50 is shifted so that centering arm 50 is the outer edge of the annular workpiece 52 being rolled and, with a corresponding increase of the diameter of the workpiece, effects a steady and centric run of workpiece 52 with a corresponding retraction of centering roller 49.

Due to the bilateral support of both rolls 1 and 2, and to the position frame of the number of all the bearings, a very rigid support of both top roll 1 and bottom roll 2 is attained. The adjustment of bearing block 8, as shown to a larger scale in FIG. 3, can be affected by means of nut 14, in a manner such that equivalent supporting conditions exist for both bearings of top roll 1 when these are under load by the rolling forces, and deviation of parallelism between the axis of the two rolls can be avoided even with forces of large magnitude. Consequently, it is possible to roll annular workpieces which have a large axial dimension, such as bushes, very accurately, that is, with minimum deviation from the ideal cylindrical jacket form.

During rolling, scanning roll 54 bears on the outer surface of the annular workpiece 52 and, with increasing outside diameter of the workpiece, roller 54 is correspondingly retracted and effects emission of a disconnect signal when the desired size of the flange is obtained and retained. This disconnect signal stops further advance of roll carriage 20, so that a further reduction of the spacing between top roll 1 and bottom roll 2 can no longer occur. After a few more revolutions of the annular workpiece, for the purpose of equalization, and which do not effect a further reduction of the wall thickness or a further increase of the diameter of the workpiece, bearing block 40 is again displaced to the right by proper supplying of pressure fluid to hydraulic cylinders 46 and 47. Bottom roll 2 thus releases the finished workpiece which has been formed, after which the finished workpiece is removed from the rolling mill by the discharge device 53. Roll carriage 20 and centering arm 45 are again moved into the illustrated starting position, and a new cycle can start.

When the rolling surfaces of rings 17 and 18 are worn out, or when annular workpieces with a profiled outer contour are to be rolled, lock nut 15 is loosened. Guide rod 12 and, with this rod, bearing block 8, can be moved upwardly by means of a crane or any other suitable device and locked in the upper position by suitable means, which, for example, can be a pin engaging a slot on one of the workrolls. When the outer diameter of the workpiece is increased, the flange, together with rings 17 and 18, is removed from sleeve 16 over bearing bush 7 outwardly through recess 9 of machine frame 3. After the installation of new, or differently shaped, rings 17 and 18, flange 19 is again connected with sleeve 16, bearing block 8 and guide rod 12 are lowered, and lock nut 15 is retightened. The rolling mill is thus again relay for work. In the same manner, sleeve 16 of top roll 1 can be disassembled over bearing bush 7 and replaced, if necessary.

If narrower workpieces are to be rolled, for example, those having a smaller axial width of ring 17, only ring 18 is disassembled in the above described manner, and flange 19 is used to secure ring 17 against axial displacement by means of correspondingly shorter screws or bolts. Bottom roll 2 is disconnected by threading the thread extension of its conical end 30 out of flanged bushing 36 and replacing bottom roll 2 by a bottom roll having a correspondingly axially shorter cylindrical portion. After feeding of the narrower annular workpiece 32, conical end 29 of the axially shorter bottom roll is made to bear on the corresponding bearing surface of flanged bushing 31. For this purpose, bearing block 40 must be displaced to the left relative to the illustrated position by means of the hydraulic actuators including the cylinders 46 and 47.

Due to this measure, it is possible to obtain optimum supporting conditions with a minimum axial spacing of the bearings, even during the rolling of the narrow workpieces, for the initial stage of rolling, workpiece 52 must be kept at the smallest diameter as possible for a minimum material loss during punching of annular workpiece blank 52. With respect to top roll 1, whose inner part having the bearing pins 4 and 6 can be dimensioned appropriately without difficulty, maintenance of the original bearing spacing offers the advantages for the precision of the workpiece to be rolled.

The easy changing of top roll 1, and the easy exchang-
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6. In a rolling mill for rolling annular workpieces, the improvement claimed in claim 3, in which said top roll comprises an inner part having bearing pins engaged in respective bearings at the opposite ends of said top roll; and an annular outer part secured to said inner part and rotatable therewith.

7. In a rolling mill for rolling annular workpieces, the improvement claimed in claim 6, in which the rolling surface of said outer part comprises plural annular parts.

8. In a rolling mill for rolling annular workpieces, the improvement claimed in claim 6, in which said outer part has an inner diameter sufficiently large that, after displacement of said bearing block sufficiently from said bearing at the other end of said upper roll, said outer part can be removed axially over said bearing at the other end of said upper roll.

9. In a rolling mill for rolling annular workpieces, the improvement claimed in claim 1, in which the bearing at one end of said lower roll includes a first bearing bushing having a conical recess receiving a conical first end of said lower roll; the bearing at the opposite end of said lower roll including a second bearing bushing having a conical recess receiving a second conical end of said lower roll and internally threaded for engagement with an externally threaded extension of said second conical end of said lower roll.

10. In a rolling mill for rolling annular workpieces, the improvement claimed in claim 9, in which said bearing having said second bearing bushing is mounted in a bearing block; horizontally extending guide means mounting said bearing block for displacement laterally of said frame; and hydraulic actuator means connected to said bearing block and to said frame and operable to effect such lateral displacement.

11. In a rolling mill for rolling annular workpieces, the improvement claimed in claim 3, including actuator means engaged between said carriage and said frame; and operable to adjust said carriage relative to said upper roll.

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