Nov. 6, 1945. T. V. BUCKWALTER ET AL 2,388,249

ROLLING MILL

Filed March 12, 1940 3 Sheets-Sheet 1

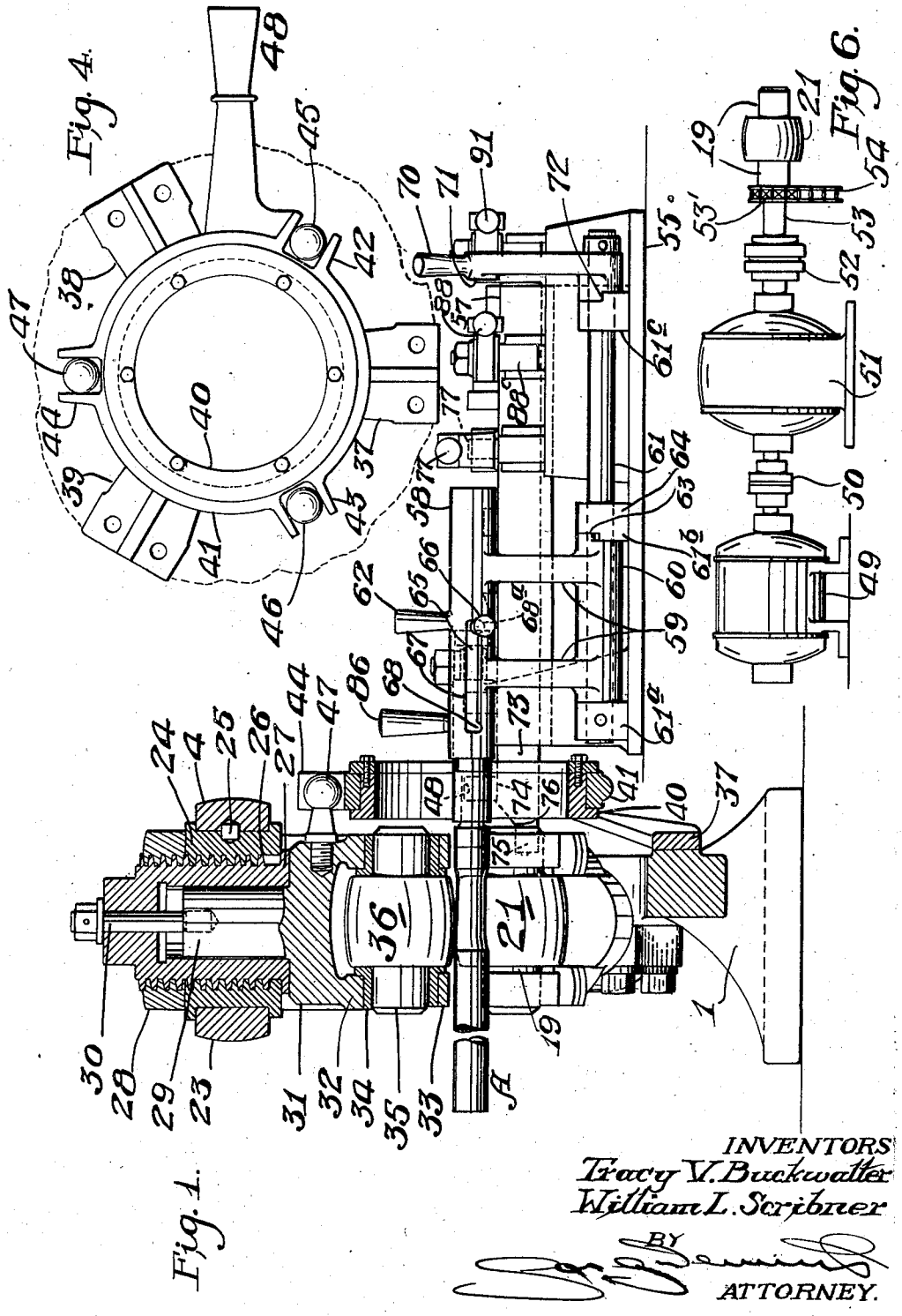


Fig. 1.

Fig. 4.

Fig. 6.

INVENTORS
Tracy V. Buckwalter
William L. Scribner
BY
ATTORNEY.

Nov. 6, 1945. T. V. BUCKWALTER ET AL 2,388,249

ROLLING MILL

Filed March 12, 1940 3 Sheets-Sheet 2

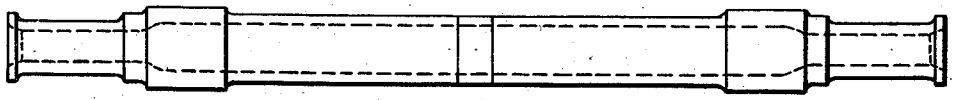
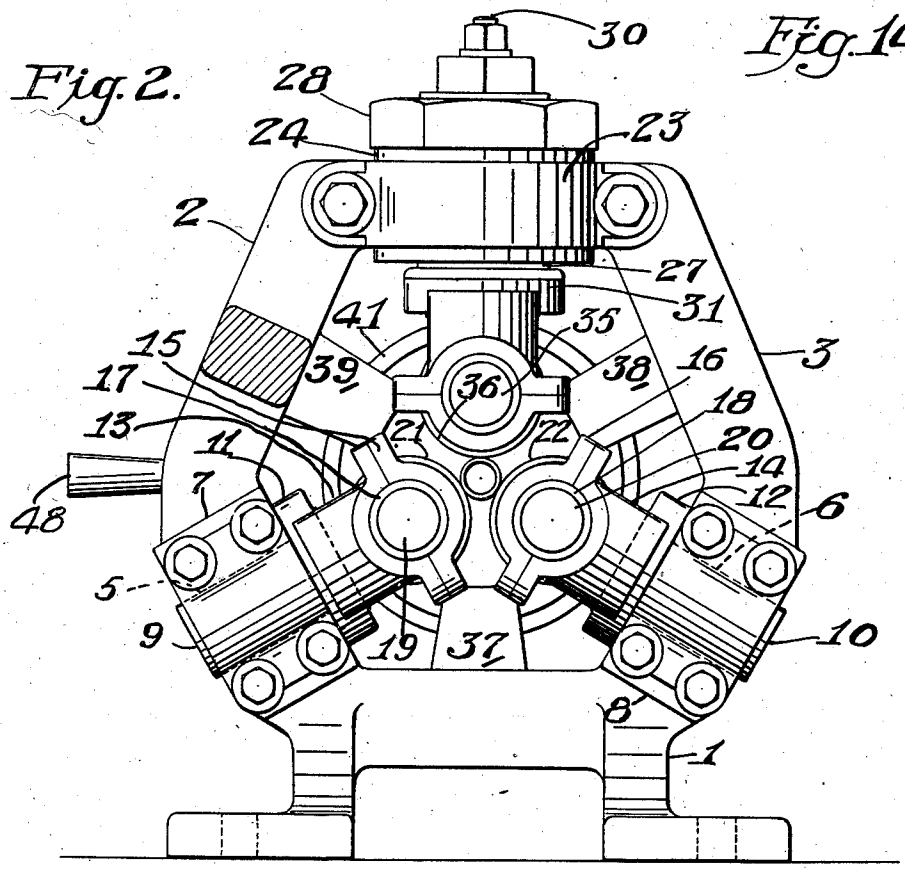


Fig. 14.

Fig. 2.



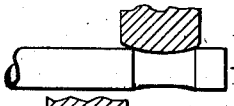


Fig. 8.

Fig. 10.

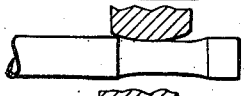


Fig. 9.

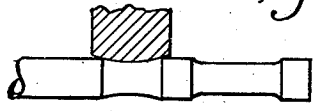


Fig. 11.

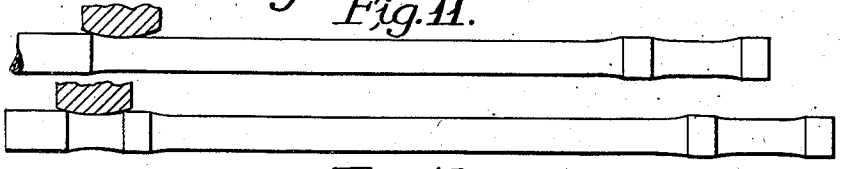


Fig. 12.

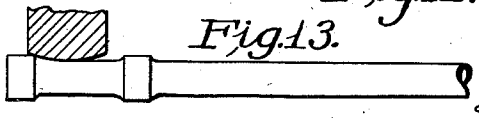


Fig. 13.

INVENTORS
Tracy V. Buckwalter
William L. Scribner
BY
ATTORNEY.

Nov. 6, 1945. T. V. BUCKWALTER ET AL 2,388,249

ROLLING MILL

Filed March 12, 1940 3 Sheets-Sheet 3

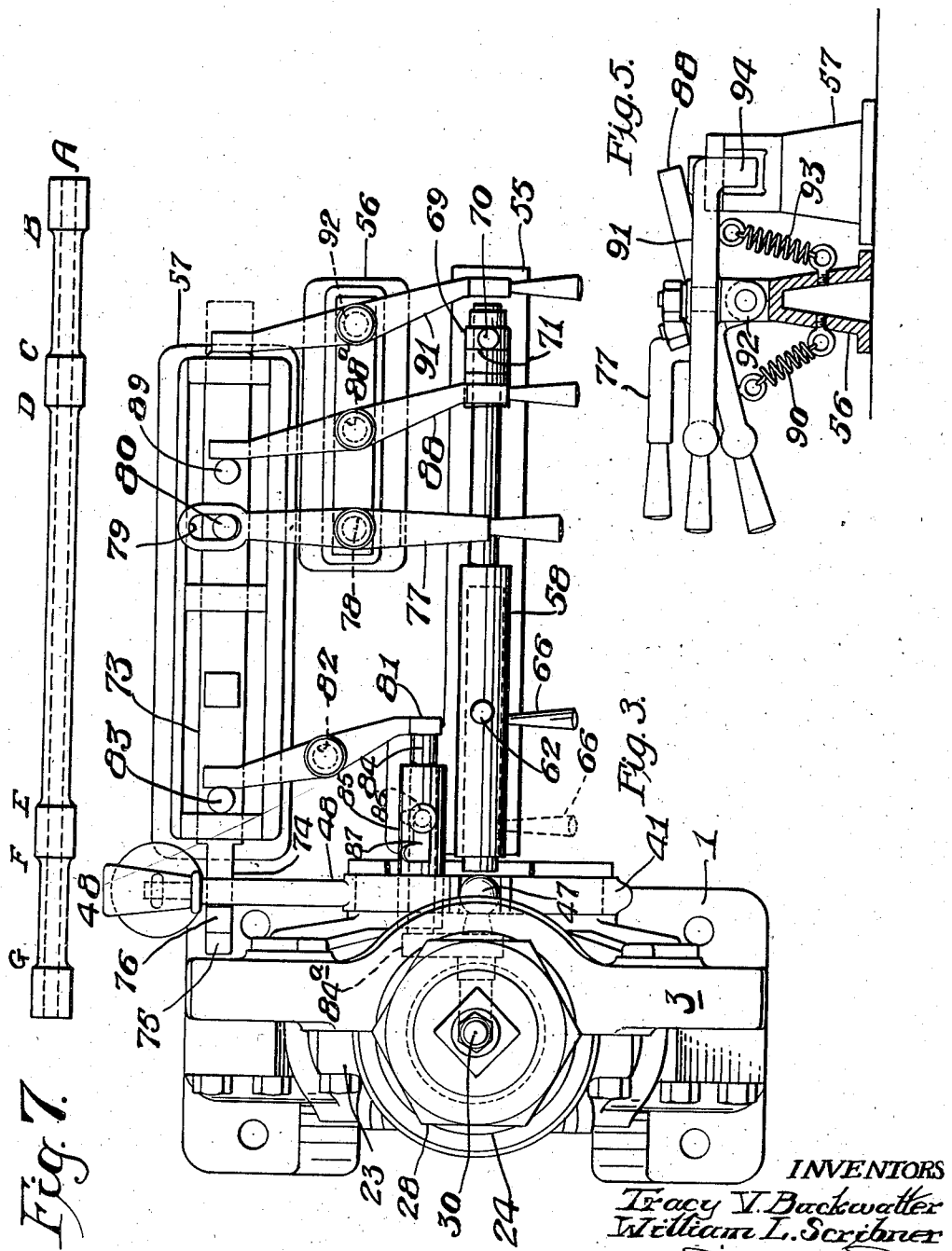


Fig. 7.

Fig. 5.

Fig. 3.

INVENTORS
Tracy V. Buckwalter
William L. Scribner
BY
ATTORNEY.

Patented Nov. 6, 1945 2,388,249

UNITED STATES PATENT OFFICE

2,388,249

ROLLING MILL

Tracy V. Buckwalter, Massillon, and William L. Scribner, Canton, Ohio, assignors to The Timken Roller Bearing Company, Canton, Ohio, a corporation of Ohio

Application March 12, 1940, Serial No. 323,520

12 Claims. (Cl. 80—22)

Our invention is an improved rolling mill for rolling substantially cylindrical work stock, such as tubes or bars, to reduce and elongate spaced sections of lengths of stock at a single heat to render them suitable for special uses, such, for example, as the manufacture of automobile front axles as set out in the patent of T. V. Buckwalter, No. 2,227,436, dated January 7, 1941, or the manufacture of railway car axles requiring a section of large diameter to receive the wheel hub at one end of the journal bearing and a flanged or enlarged section at the opposite end of the journal bearing.

In its preferred embodiment, our improved rolling mill comprises a series of working rolls arranged about the horizontal center line of the mill along which the work stock progresses during treatment. The working surfaces of the rolls are substantially spheroidal or barrel shaped; their contour being generated by the rotation of an arc about an axis of rotation. The rolls are journalled in mountings journalled in the mill frame and turning on axes normal to the axes of rotation of the respective rolls mounted therein. The projections of the axes of the respective mountings intersect at a point preferably in the horizontal center line of the mill.

One or more of the working rolls are rotated on their axes of rotation from a suitable source of power so as to rotate a length of cylindrical work stock placed between the rolls and the pressure applied thereto may be varied by moving the mounting of one or more rolls longitudinally along the axis of such mounting or mountings. When the axes of all the working rolls are parallel with the axis of the work, or with the horizontal center line of the mill, the pressure is exerted radially of the stock, and the spheroidal shape of the rolls will result in the formation in the stock of a channel connected with an unrolled section by a curved shoulder. When, however, the roll-mountings are turned on their axes, in the same direction and to the same extent, so that the axes of rotation of the rolls are diagonal to the center line of the mill, the diagonal pressure then exerted on the stock simultaneously squeezes the stock and imparts a forward creeping motion thereto. Consequently the channel is widened, the stock elongated, and the work advanced until the roll mountings are again turned on their axes so that the axes of rotation of the rolls lie parallel with the mill's center line.

The straightening of the rolls, after a desired length of stock has been rolled, is preferably effected automatically under the control of the advance of the rolled stock without interrupting the rotation of the working rolls which make an annular curved shoulder at the end of the reduced section. The positioning of the stock for starting the several rolling operations may be conveniently gauged by suitable stops movable into and out of the path of movement of the work.

The characteristic features and advantages of our improvements will more fully appear from the following description and the accompanying drawings of an illustrative embodiment thereof.

In the drawings, Fig. 1 is a part sectional side elevation of a rolling mill embodying our invention; Fig. 2 is a front end elevation thereof to which the stock is fed; Fig. 3 is a top plan view thereof; Fig. 4 is a fragmentary rear end elevation of the skew ring; Fig. 5 is a fragmentary end elevation of the skew ring operating means; Fig. 6 is a diagrammatic side elevation of mechanism for driving one or more of the mill rollers; Fig. 7 is a longitudinal view of an axle blank after rolling by our improved mill and according to our method; Fig. 8 is a fragmentary diagrammatic view illustrating the beginning of the first of a series of rolling operations in making the axle blank shown in Fig. 7; Fig. 9 is a fragmentary diagrammatic view illustrating the completion of the first rolling operation; Fig. 10 is a fragmentary diagrammatic view illustrating the beginning of a second rolling operation spaced axially from the initially rolled section of the work; Fig. 11 is a fragmentary diagrammatic view illustrating the finishing of the second rolling operation; Fig. 12 is a fragmentary diagrammatic view illustrating the beginning of a third rolling operation on a section of the work spaced from the second rolled section; Fig. 13 is a fragmentary diagrammatic view illustrating the completion of the third rolling operation; and Fig. 14 is a longitudinal view of a modified form of axle suitable for use as a railway car axle.

In the embodiment of our invention illustrated in the drawings, our improved rolling mill has an integral main frame comprising a base 1, standards or cheeks 2 and 3 and a cross-head 4 connecting the upper ends of the standards or cheeks 2 and 3.

The cheeks 2 and 3 contain respectively boxes 5 and 6 having caps 7 and 8 bolted thereto and forming therewith cylindrical seats for journals 9 and 10 having axes converging toward a center in the horizontal center line of the mill. The journals have flanged heads 11 and 12 which bear against the ends of the boxes and have pairs of yoke-like arms 13 and 14 at the ends thereof. Caps 15 and 16 are bolted to the arms 13 and 14 and have concave inner faces complementary to the concave outer faces of the arms 13 and 14 to form cradles or pillows for the brasses 17 and 18 which provide bearings for pairs of end trunnions 19 and 20 of working rolls 21 and 22.

The axes of the rolls 21 and 22 extend substantially parallel with the horizontal center line of the mill and transversely to the axes of the

journals 9 and 10. The surfaces of the rolls 21 and 22 are preferably barrel-shaped or spheroidal, viz., the surface contours thereof are generated by the revolution of a circular arc about the axis of each pair of cylindrical trunnions 19 and 20 so that the round periphery of the body of each roll is convexed axially thereof.

The head 4 has bolted thereto a cap 23 and complementary concave surfaces of the cross-head and cap form a pillow-block for the internally threaded fixed nut or flanged box 24 which is held against rotation within the pillow-block by dowels 25. The nut 24 has screwed therein an externally threaded bushing 26 having a flange 27 on its lower end and a lock nut 28 on the portion thereof projecting above the nut 24.

A stem 29 is rotatably secured in the bushing 26 by the bolt 30 and has a flanged head 31 provided with a pair of arms 32 at the ends thereof. The top surface of the head 31 is engaged by the bushing flange 27 and the arms 32 have concave lower faces complementary to the concave upper faces of caps 33 bolted to the arms 32. These complementary faces form seats for the boxes or brasses 34 in which are journalled the cylindrical trunnions 35 of a spheroidal or barrel-shaped roller 36 similar to the rollers 21 and 22. By loosening the bolt 30 and the lock-nut 28, the bushing 26 may be rotated to raise or lower the mounting of the roller 36 without turning the stem 29 so as to vary the clearance between the rolls and permit free movement of the stock between the rolls or the application of any desired pressure to the stock.

Brackets 37, 38 and 39 are bolted to and project inwardly from the main frame and support a track 40 containing a cylindrical peripheral groove in which is seated a cylindrical ring 41. The ring 41 has three sets of ears projecting from the periphery thereof and forming equidistant sockets 42, 43 and 44 in which are housed the spherical ends of bolts 45, 46 and 47 screwed respectively into the inner ends of the heads 11, 12 and 31. The ring has a weighted lever arm 48 projecting radially therefrom by which it is biased on the track so as to tend to turn the heads 11, 12 and 31 about their axes and skew the axes of the rolls 21, 22 and 36 respectively to the horizontal center line of the mill.

One or more of the rolls 21, 22 and 36 may be rotated in any suitable manner, as for instance through the driving mechanism illustrated diagrammatically in Fig. 6, and comprising an electric motor 49 which is connected, through a flexible coupling 50, with a speed change box 51 which is connected through a universal joint 52 with a shaft 53. The shaft 53 may be connected through any suitable coupling with an outer trunnion 19 of one of the rollers, as, for instance, the roller 21. The shaft 53 may be connected by a suitable sprocket wheel 53′ and sprocket chain 54 with a suitable sprocket or sprockets, not shown, fixed to the outer ends of the trunnions of one or more of the other two rolls. Preferably, only the two lower rolls are positively driven where the upper mill roll is vertically adjustable, as in the example hereinbefore described.

When the rolls are rotated with their axes parallel to the horizontal center line of the mill, the work remains stationary axially in the position to which it has been adjusted by any suitable means, but when the rolls have been skewed by means of the mechanism above described so that their axes lie diagonally to the horizontal center line of the mill the rotation of the rolls feeds the work through the mill. To provide means for controlling the position and for feeding of the work, there may be provided positioning and controlling mechanisms mounted on sub-frames 55, 56 and 57 behind the mill.

The stop gauges for positioning the work at the beginning of a rolling operation may comprise a housing 58 carried on arms 59 of a sleeve 60, the latter being sleeved on a shaft 61 fixed in bearings 61*a*, 61*b* and 61*c* adjustably fixed to the frame 55. The housing 58 may be rocked by means of the handle 62 into and out of alignment with the work stock A emitted from the rolls along the horizontal center line of the mill. The oscillations of the housing are limited by the engagement of shoulders 63 of the sleeve 60 with steps of a bearing 61*b*. A longitudinally movable bolt or slide 65 is housed in the housing 58 and may be advanced or retracted by means of the handle 66 projecting through a slot 67 in the housing 58. The lower edge of the slot 67 may be provided with notches such as 68 and 68*a* in which the shank of the handle 66 may be seated to prevent inadvertent movement of the bolt 65.

A stop lever 69 has its hub sleeved on the shaft 61 and may be rocked by means of a handle 70 to move its stop face 71 into or out of alignment with the path of work A traveling along the horizontal center line of the mill. The throw of the lever 69 is limited by the engagement of shoulders 72 with steps on the bearing 61*c*.

When the housing 58 is rocked upward so that the bolt 65 is aligned with the horizontal center line of the machine, the front face of such bolt provides a gauge for the positioning of the work A in either of two positions, determined by the location of the handle 66, and when the housing 58 is rocked downward and the lever 69 is rocked upward the stop face 71 provides a third gauge for positioning work A along the horizontal center line of the mill.

The skew controlling mechanism comprises a slide 73 slidable rectilineally in a slideway of the sub-frame 57. An extension on the inner end of the slide 73 forms an upper rest 74 and a lower rest 75 for the weighted arm 48; these rests being connected by the inclined surface 76. When the arm 48 rests on the upper rest 74, the ring 41 is positioned to straighten the rolls, and when the arm 48 rests on the lower rest 75, the ring 41 is positioned to skew the rolls.

The slide 73 is manually reciprocable, to lower or elevate the arm 48, by a lever 77 which is fulcrumed on a fixed bearing 78 of the frame 56 and has at the end thereof an elongated slot 79 for the pin 80 of the slide 73.

The slide 73 is automatically movable inward, to raise the arm 48 and straighten the rolls, by a lever 81 fulcrumed on a fixed bearing 82 on a bracket of the sub-frame 57. The work end of the lever 81 is adapted to engage and thrust a stud 83 on the slide 73 and the power end of the lever 81 is operable by a bolt or cylindrical slide 84 which is longitudinally movable in a cylindrical slideway 85 of the sub-frame 55.

The bolt 84 may be manually manipulated by a handle 86 projecting through a notched slot 87 in the housing. A crank arm 84*a* is fixed to the inner end of the bolt 84 and the extremity of the crank arm may be turned arcuately through the handle 86 and bolt 84 into and out of alignment with the center line of the machine and the work A moving along such line. When the crank arm is aligned with the work, the advance of the latter retracts the bolt 84

and rocks the lever 81 to shift the slide 73 and raise the arm 48.

The slide 73 is similarly operable by a lever 88 fulcrumed on a swinging bearing 88a of the sub-frame 56. The work end of this lever is normally biased by a spring 90 above the plane of the stud 89 of the slide 73, with the power end of the lever below the center line of the mill. When the power end of the lever 88 is rocked upward into the path of an advancing piece of work, the continued advance of the work rocks the lever 88 horizontally into engagement with the stud 89 to thrust the slide 73 into roll-straightening position.

The slide 73 is further operable by a lever 91 fulcrumed on a swinging bearing 92 of the sub-frame 56. This lever is normally biased by a spring 93 so that its depending end 94 lies in the plane of the slide 73. Consequently when advancing work strikes the power end of this lever, which lies normally in the center line of the mill, the slide 73 is engaged by the end 94 and shifted to roll-straightening position. This lever may be rocked downward against the action of the spring 93 to clear the work and the slide.

In initiating the treatment of a length of tubing containing a conforming arbor or mandrel, to form an axle such as shown in Fig. 7, for instance, the arm 84a is rocked out of, and the housing 58 is rocked into, alignment with the center line of the mill. The bolt 65 is advanced toward the rollers and the handle 66 is latched in the notch 68. The slide 73 is in its forward position, so that the arm 48 rests on the upper-seat 74 and the axes of the rolls 21, 22 and 36 are substantially parallel with the center line of the mill. The roll 36 is elevated to permit the passage of the work or tube A between the rolls into abutting relation to the end of the bolt 65. This leaves a section from B to the end of the tube A extending beyond the working surfaces of the rolls.

The roll 36 is gradually fed downward by turning the bushing 26 and power is applied to the rolls 21 and 22 to rotate the rolls and therethrough rotate the work and upper roll. When an axially arcuately-concave channel of desired depth has been rolled (Fig. 8), the housing 58 is rocked out of alignment with the work and the bolt 84 is shifted to align the extremity of the arm 84a with the end of the work A. The lever 77 is rocked to shift the slide 73 outward so that the weighted lever 48 slides down the incline 76 onto the lower rest 75, thereby turning the ring 41 and skewing the rolls 21, 22 and 36 so that the rolling pressure of their spheroidal surfaces is applied diagonally of the axis of the work, which is thereby fed through the mill and the channel elongated (Fig. 9), until the movement of the bolt 84 by the work A rocks the lever 81 sufficiently to move the slide 73 into roll-straightening position. The straightened rolls and work continue to revolve to form an annular concave shoulder at the position C.

The arm 84a is then swung out of alignment with the work by rocking the bolt 84 and the bolt 65 is retracted until the handle 66 lies at the rear end of its slot 65. The housing 58 is then rocked into alignment with the work. The top roll 36 is raised and the work A advanced into abutment with the stop formed by the end of the bolt 65. The roll 36 is again fed downward, and the rolls begin rolling an arcuately concave annular channel having a shoulder at the position D spaced from the shoulder at the position C. The depth of the channel rolled at D may be greater, less or the same as the depth of the channel from B to C. When the channel is of desired depth, the housing 58 is rocked out of alignment with the work and the lever 77 is rocked to move the slide 73 into roll-skewing position.

The work A is again fed forward by the diagonal rolling pressure of the rolls until the end of the tube A abuts against the lever 88, which is manually lifted into the plane of the work and is rocked by the latter to shift the slide 73 into roll-straightening position (Fig. 11) and form a curved annular shoulder at E.

The lever 88 is then depressed, the lever 69 is rocked inward, the roll 36 is elevated and the work is advanced into abutment with the stop 71. The roll 36 is then fed downward to cause the rolls to roll a channel with a shoulder at F, and, when this channel is of desired depth, the lever 77 is rocked to skew the rolls. The work is thereupon caused to creep forward by the diagonal pressure of the spheroidal surfaces of the rolls until the forward end of the work rocks the lever 91 and moves the slide 73 into roll-straightening position, thereby causing the rolls to roll a curved annular shoulder at G. The roll 36 is then raised and the lever 91 is rocked in a vertical plane to permit removal of the work, which has an unrolled section between the shoulder at G and the end of the tube.

The unrolled sections of the tube may be fabricated as in said Patent No. 2,227,436.

By suitable adjustments of the stops, skewing mechanism and the descent of the roller 36, a tube may be rolled on our mill by the general method above described to form an axle blank such as shown in Fig. 14 having unrolled end sections flared outwardly and intermediate unrolled sections suitable for wheel hub seats.

Many other uses for our improved apparatus will suggest themselves to those skilled in the art.

While it is preferable that the feeding of the stock to effect the elongation of the rolled channels be effected by skewing the rolls, it is possible to advance the work through the rolls by applying pressure lengthwise of the work while the spheroidal rolls are in their straight position and to thereby elongate the rolled channels without skewing the rolls.

Having described our invention, we claim:

1. A rolling mill comprising a frame, a plurality of roll-mountings journalled in said frame and having axes normal to the work axis of the mill and converging toward a common point, a working roll having a working portion and journals journalled in each of said mountings and having an axis of rotation transverse to the axis of its mounting, the axis of each mounting being between the extremities of the working portion of the roll journalled in such mounting, and rotatable means connected with the respective mountings by spherically headed bolts extending substantially parallel to the axes of rotation of said rolls for turning them upon their respective axes transverse thereto.

2. A rolling mill comprising a frame, a series of roll-mountings each having a journal journalled in said frame and each journal having an axis intersecting, when produced, the produced axis of another mounting, a working roll having end journals journalled in each mounting on opposite sides of the journal thereof and having an

axis of rotation transverse to the axis of its mounting, a rotatable ring, and couplings extending substantially parallel with said axes of rotation and connecting said ring with the respective mountings to turn them on their respective axes.

3. A rolling mill comprising a frame, a series of roll-mountings having journals journalled in said frame and having axes radiating from a common center, each of said mountings having arms projecting laterally from its journal, a working roll journalled in the arms of each of said mountings and having an axis of rotation transverse to the axis of its mounting and an axially convexed working periphery, and means for moving one of said mountings longitudinally of the axis thereof and including an externally threaded sleeve concentric with said last named axis, said sleeve housing a portion of said mounting and bearing against a surface thereof adjacent to said arms.

4. A rolling mill having means including working rolls having axes movable into positions parallel with or diagonal to the work axis, said rolls automatically feeding work through said mill along the work axis when the axes of the working rolls are diagonal to the work axis, roll-skewing mechanism for skewing or straightening the axes of said rolls relatively to the work axis, an actuator in the path of and operable by work passing through said mill for actuating said mechanism and therethrough moving said rolls into positions with their axes parallel with the work axis for checking the feed of said work without interrupting the action of the rolls on the work, and driving means for rotating one of the rolls to roll the work.

5. A rolling mill comprising a series of working rolls each having an axis of rotation substantially parallel to the direction of movement of work between them, a mounting for each roll having a turning axis normal to the axis of rotation of its roll, roll-skewing mechanism for turning said mountings to skew the rolls and thereby advance work in the direction aforesaid, and an actuator in the path of and operable by work so advanced to rotate said mechanism and turn said mountings.

6. A rolling mill comprising a series of working rolls having axes of rotation and movable about axes transverse to their respective axes of rotation, roll-skewing mechanism for turning said rolls on the axes second named to positions with their axes of rotation either parallel to or diagonal to the work axis, said rolls in said parallel position halting the axial movement of work acted on by said rolls without interrupting the rotation of said rolls on their axes first named, and said rolls in said diagonal position feeding work through the mill, and a series of members engaged in sequence by work advanced by said rolls when in said diagonal position, said members being operatively connected with said roll-skewing mechanism to turn said rolls to said parallel position and halt the advance of the work.

7. A rolling mill having a series of working rolls having axes of rotation and movable about axes transverse to their respective axes of rotation, and means for turning said rolls about said axes second named and including a rotatable ring flexibly connected with the respective rolls, a slide controlling the movements of said ring, and a rocking device in the path of and movable by work emitted from said mill for moving said slide.

8. A rolling mill comprising a series of working rolls having axes of rotation and movable about axes transverse to their axes of rotation respectively, a series of stops movable into and out of the path of work emitted from the mill, and means including a series of devices movable into and out of the path of work emitted from the mill for controlling the turning thereof about said axes second named.

9. A rolling mill comprising a series of working rolls having parallel axes and disposed about a center line, at least one of said rolls having a circular periphery axially convexed; and mounting means for moving said last named roll toward and from said center line and including a yoke encircling the opposite ends of said roll and a shank between said ends, an exteriorly threaded rotatable sleeve surrounding and concentric with said shank and bearing against said yoke and an interiorly threaded nut supporting said sleeve.

10. A rolling mill comprising a series of working rolls having their axes substantially parallel to one another; mountings for said rolls having journals turnable about axes disposed substantially radially to the axis of work acted on by said rolls; and mechanism for moving one of said mountings toward and from the axis of the work and including a fixed threaded nut, a housing threaded in said nut and encircling the journal of said last named mounting, a lock nut threaded on said housing and engaging said first nut, and a stem suspended from said housing and supporting said mounting.

11. A rolling mill comprising a frame, a series of roller mountings having journals journalled in said frame and bearings on opposite sides of said journals, working rolls having journals journalled in said mounting bearings and working portions between said bearings, said working portions being axially convexed, and skewing mechanism for turning said roller mountings about the axes of their journals to feed or stop the feed of work along the working axis of said mill by the working portions of said rolls, said skewing mechanism including a ring rotatable about an axis concentric with the working axis of said mill, couplings between said ring and said mountings, and an actuator in the path of work passed through said mill and ring for effecting the turning of said ring.

12. A rolling mill comprising a frame, a series of roller mountings having journals journalled in said frame and bearings on opposite sides of said journals, working rolls having journals journalled in said mounting bearings and working portions between said bearings, said working portions being axially convexed, and skewing mechanism for turning said roller mountings about the axes of their journals to feed or stop the feed of work along the working axis of said mill by the working portions of said rolls, said skewing mechanism including a ring rotatable about an axis concentric with the working axis of said mill, couplings between said ring and said mountings, and a plurality of actuators axially spaced along the path of work passing through said mill to periodically skew and straighten said rolls during the passage of work between them.

TRACY V. BUCKWALTER.
WILLIAM L. SCRIBNER.