Jan. 11, 1938. J. M. O'MALLEY 2,105,258

METHOD OF AND APPARATUS FOR ROLLING ROUNDS

Filed Nov. 27, 1933 5 Sheets-Sheet 1

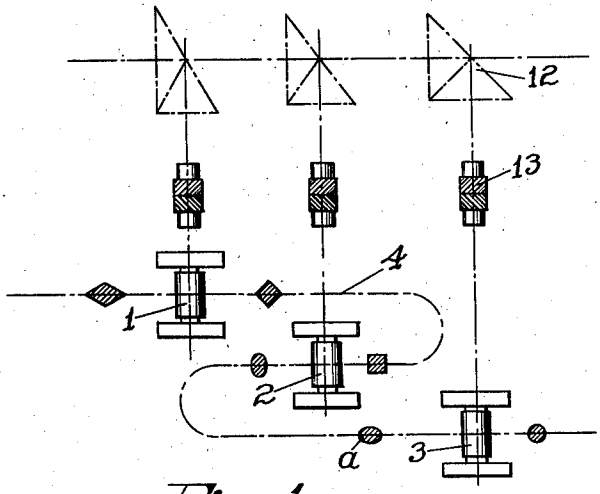

Fig. 1

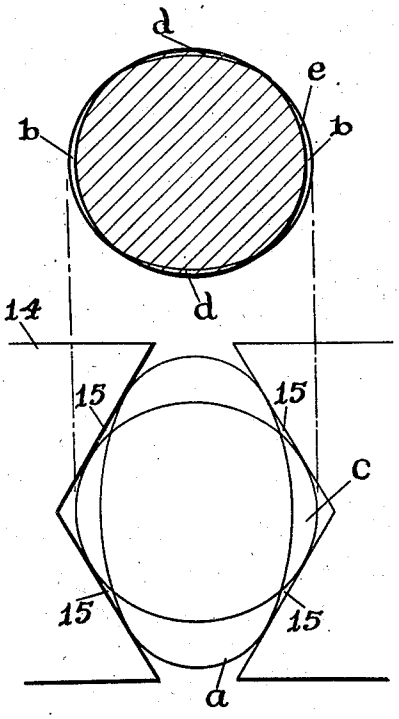

Fig. 2

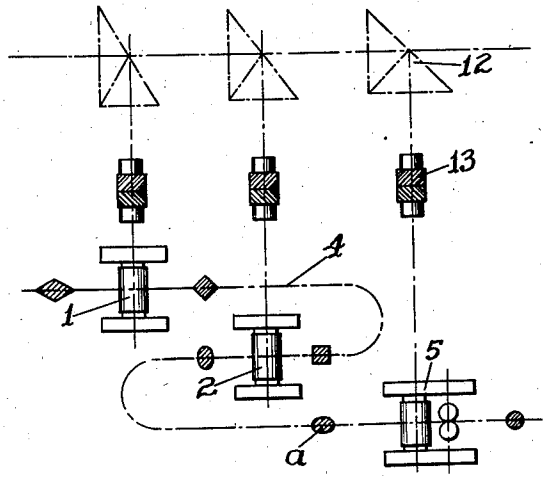

Fig. 1a

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METHOD OF AND APPARATUS FOR ROLLING ROUNDS

Filed Nov. 27, 1933 5 Sheets-Sheet 2

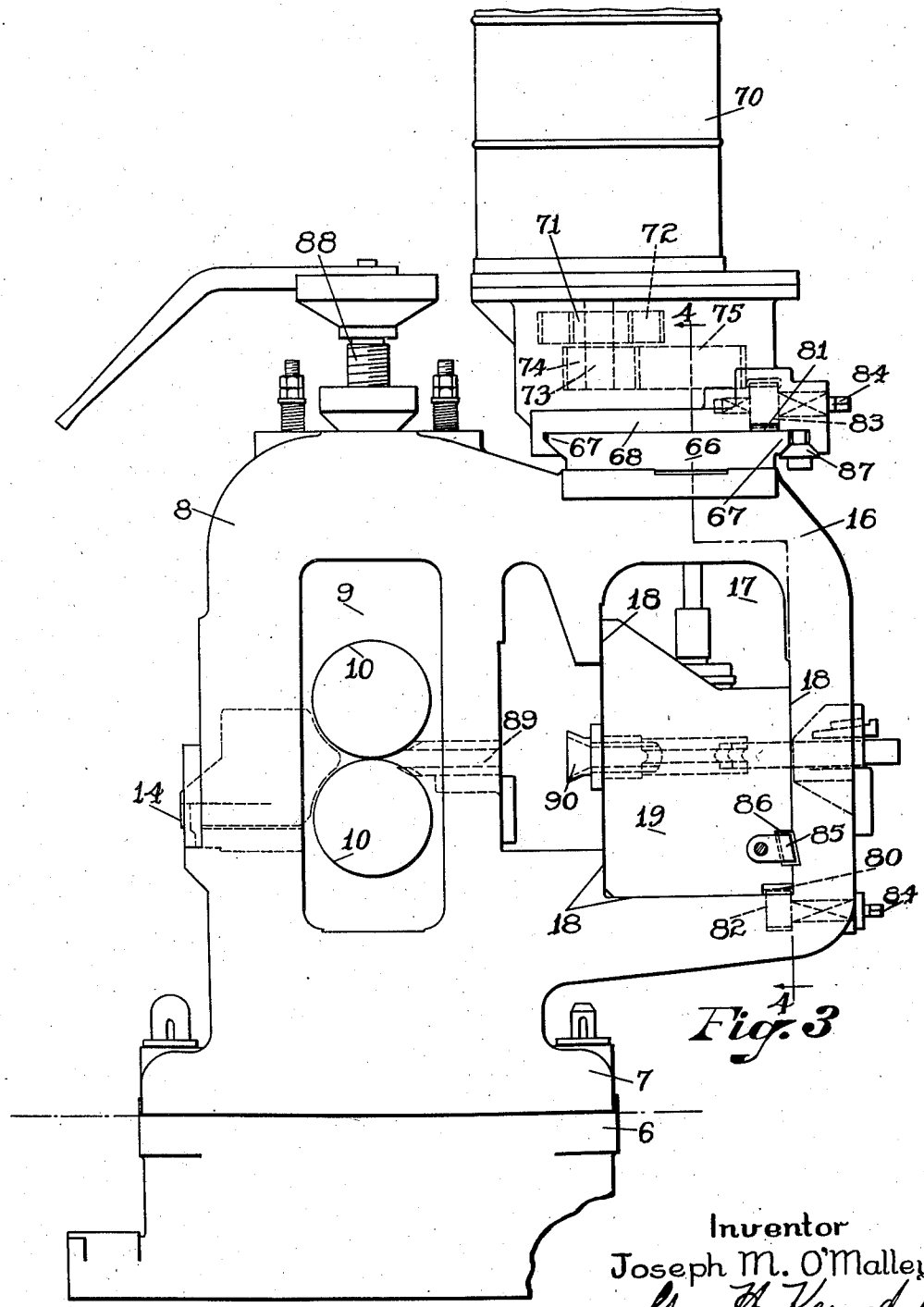

Fig. 3

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METHOD OF AND APPARATUS FOR ROLLING ROUNDS

Filed Nov. 27, 1933 5 Sheets-Sheet 3

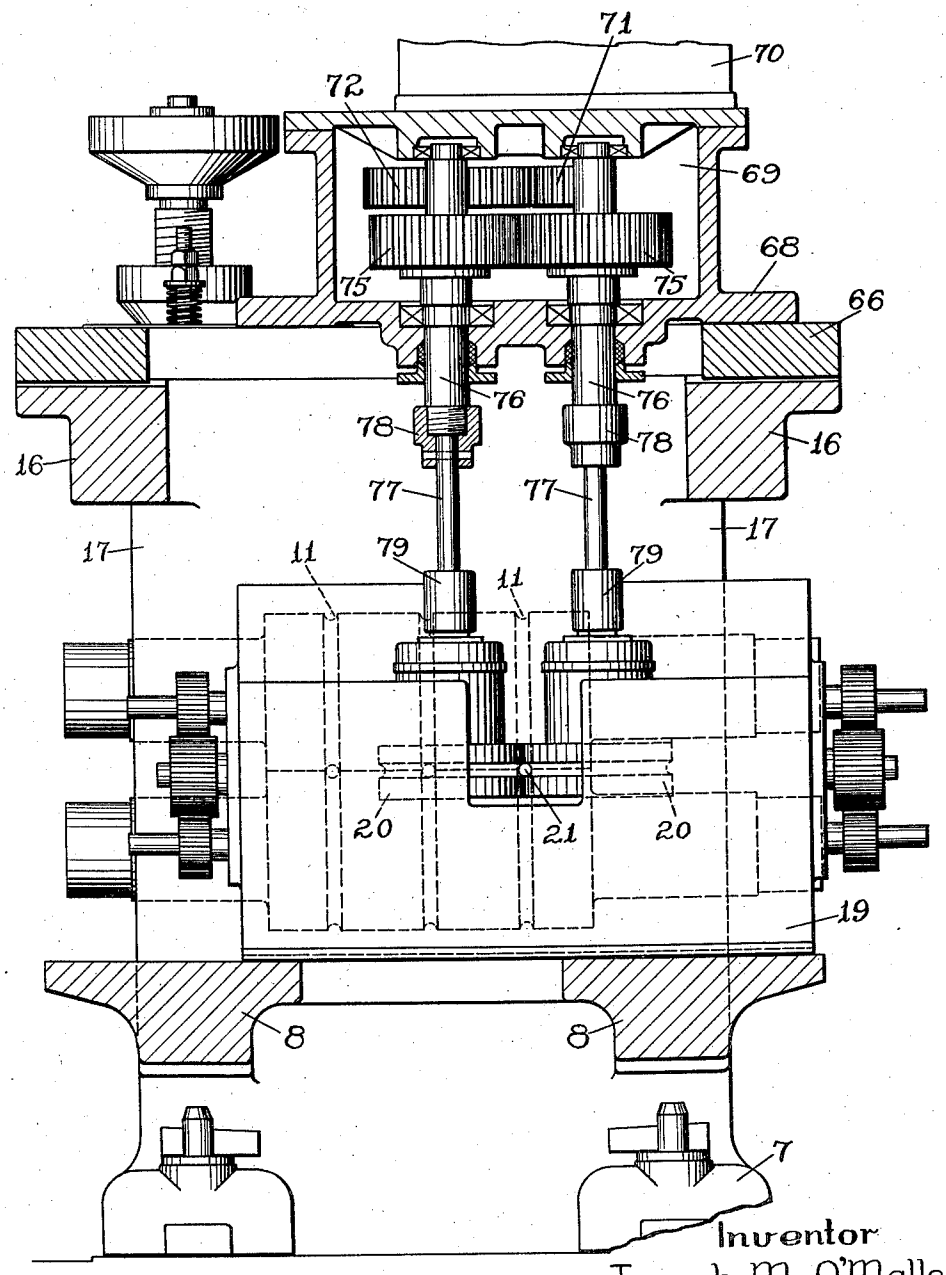

Fig. 4

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METHOD OF AND APPARATUS FOR ROLLING ROUNDS

Filed Nov. 27, 1933 5 Sheets-Sheet 4

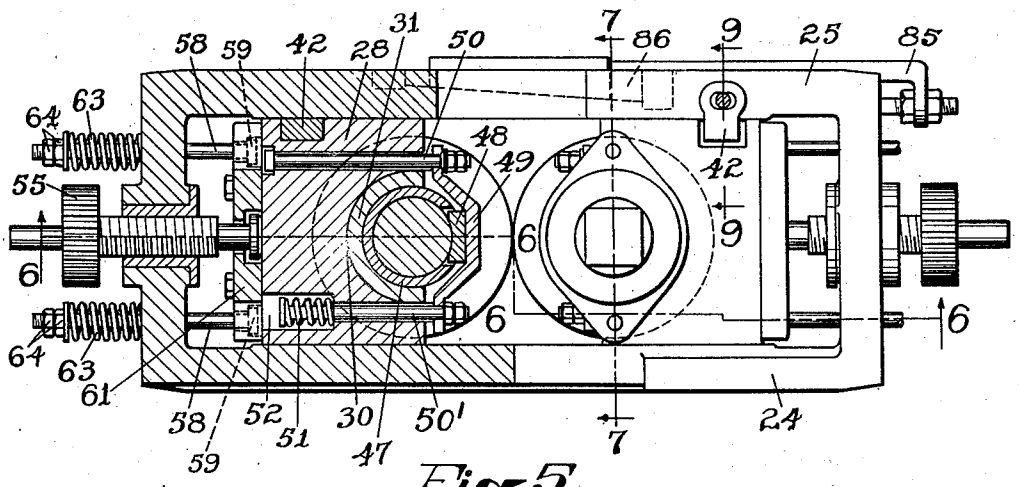

Fig. 5

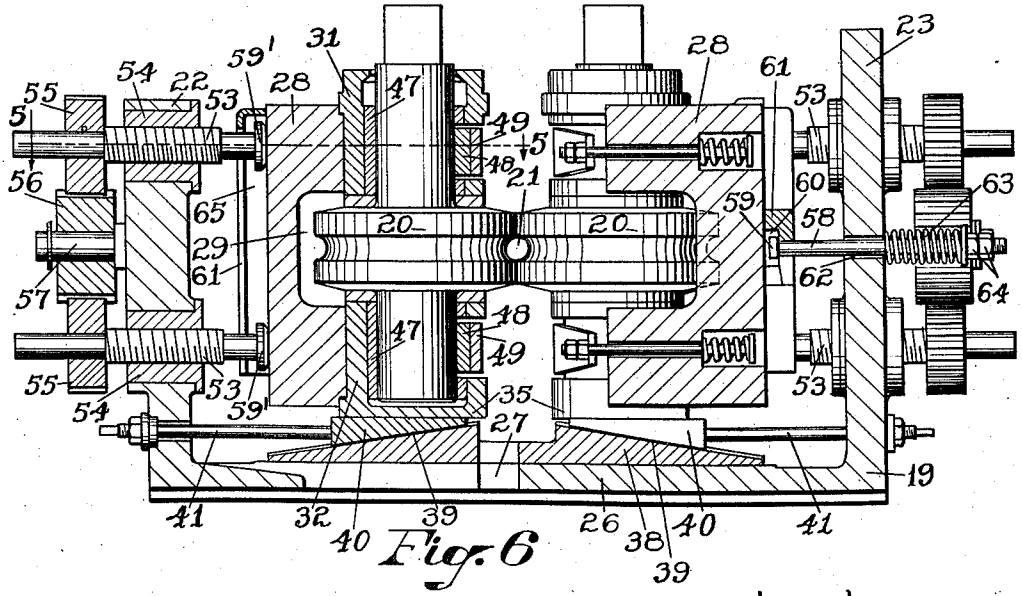

Fig. 6

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METHOD OF AND APPARATUS FOR ROLLING ROUNDS

Filed Nov. 27, 1933 5 Sheets-Sheet 5

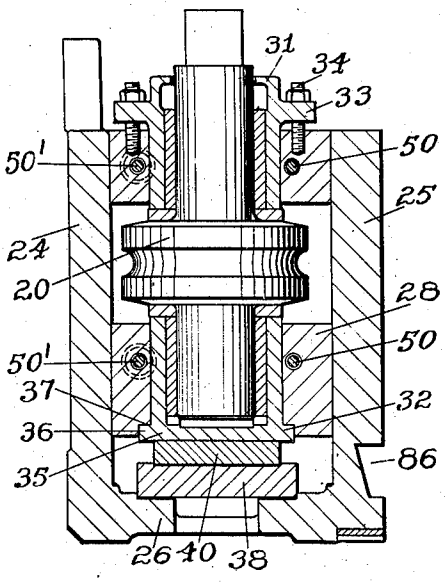

Fig. 1

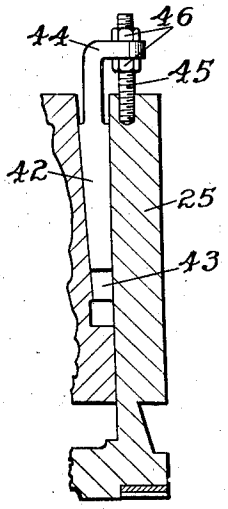

Fig. 9

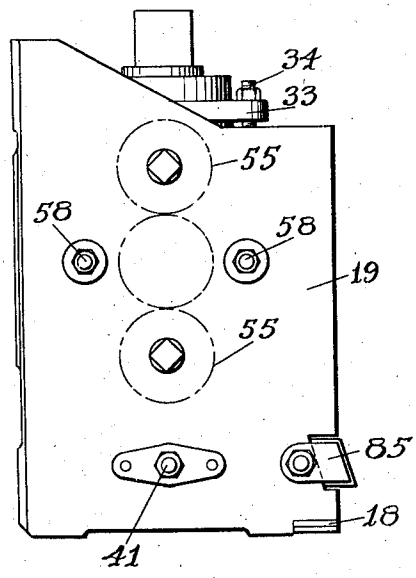

Fig. 8

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2,105,258

UNITED STATES PATENT OFFICE

2,105,258

METHOD OF AND APPARATUS FOR ROLLING ROUNDS

Joseph M. O'Malley, Worcester, Mass., assignor to Morgan Construction Company, Worcester, Mass., a corporation of Massachusetts

Application November 27, 1933, Serial No. 699,823

12 Claims. (Cl. 80—36)

The present invention contemplates improvements upon the process and apparatus of Edwards Patent No. 1,193,001, of August 1, 1916, in the precision rolling of metal bars of circular cross section, known as "rounds".

In the arrangement proposed by said Edwards patent, the usual final and finishing roll stands of a mill for the rolling of rounds are supplemented by an additional sizing unit, providing both vertical and horizontal rolls, the same being arranged to receive the slightly-oversize round at a considerable distance from the mill. Such an arrangement, besides being wasteful of space, is extremely costly from the stand point of the extra equipment needed for the driving of the two sets of precision of sizing rolls; furthermore, since the stock approaches these added final finishing and sizing rolls with a section that is approximately round, there can be no adequate positional control of said stock section, to prevent it from turning on its axis in its approach to and passage through such added stands of rolls.

The present invention overcomes all of these disadvantages. It provides for the precision sizing and finishing of the stock by means of associated horizontal and vertical rolls that are contained in a roll housing adapted to replace, as an entirety, the usual last stand of finishing rolls of the mill; thus the precision sizing apparatus, instead of being an appendage of the mill, becomes actually a part of the mill, being so constructed and located that the existing driving devices and connections for the usual final roll stand of the mill are readily applicable for the driving of its contained horizontal rolls. To the latter the stock, of the usual flat oval or elliptical section produced by the last-but-one of the regular mill roll stands, is delivered through appropriate side guides which effectually resist the strong tendency of such section to "turn down"; by the close cooperative action of the horizontal and vertical rolls, as hereinafter described, the stock emerging from this precision sizing unit that replaces the last usual or regular roll stand of the mill, acquires an accuracy and uniformity of section not heretofore obtainable with continuous high speed rolling.

My invention further provides a novel and highly advantageous mounting for the vertical rolls and their driving instrumentalities, by which to facilitate their adjustment in and, when desired, their removal from the housing of the precision sizing unit. Other and further objects and advantages of the invention will more fully appear from the following detailed description thereof, taken in connection with the accompanying drawings, in which—

Fig. 1 is a diagrammatic plan view of a conventional arrangement of rolling mill apparatus for the production of rounds.

Fig. 1*a* is a view similar to Fig. 1, but showing the replacement of the final finishing roll stand by the precision sizing unit of my invention.

Fig. 2 is a diagrammatic representation of the successive changes in cross section which the stock undergoes in the precision sizing unit of the invention.

Fig. 3 is a view in side elevation of said precision sizing unit.

Fig. 4 is a transverse sectional view on the line 4—4 of Fig. 3.

Fig. 5 is a top plan view, partly in section, on the line 5—5 of Fig. 6, showing the vertical roll assembly.

Fig. 6 is a vertical section on the line 6—6 of Fig. 5.

Fig. 7 is a vertical section on the line 7—7 of Fig. 5.

Fig. 8 is an end view of said vertical roll assembly.

Fig. 9 is a fragmentary sectional view on the line 9—9 of Fig. 5.

Like reference characters refer to like parts in the different figures.

In Fig. 1 is shown a succession of horizontal stands of rolls 1, 2 and 3, the same representing diagrammatically the finishing end of a conventional mill for the production of rounds; the broken line 4 indicates the path of the stock, and the stock sections, as well as the relative positions of said sections, both at the entrance to and the emergence from the several roll stand passes, are indicated by the several cross sectional representations on opposite sides of said passes. In the similar diagram of Fig. 1*a*, the conventional final finishing roll stand 3 of Fig. 1 has been replaced, according to my invention, by a special precision sizing unit, designated as a whole by the numeral 5, and embodying cooperating stands of horizontal and vertical rolls; the preferred construction of this unit 5 is as follows:—

Referring first to Figs. 3 and 4, the numeral 6 represents the usual bed plate to which, in the conventional mill arrangement shown by Fig. 1, would be fastened the housing of the final finishing stand 3 of said mill. To facilitate attachment to this bed plate, the base 7 of the housing for unit 5 is preferably of an appropriate size and form to fit said bed plate, as shown in Fig. 3. The opposite housing sides 8, 8, rising vertically

from base 7, provide the usual windows 9, 9, wherein are received and retained any suitable bearings, not shown, for a pair of horizontal rolls 10, 10, extending transversely of the housing and each having a plurality of pass grooves 11, 11, as is customary with horizontal rolls used in the production of rounds. It is to be understood that no departure from known or conventional rolling mill practice is required in respect of the mounting, retention, and adjustment of the rolls 10, 10 in the housing windows 9, 9; consequently the drawing, in the interests of simplicity, omits any showing of the roll bearings and their adjusting and retaining devices.

The rolls 10, 10 are so located within the housing that they aline substantially with the driving connections, indicated at 12, 13 in Fig. 1, that are provided for the last roll stand 3 of the ordinary finishing mill; in other words, the existing driving connections for the stand of rolls replaced by my special precision sizing unit are applicable to the drive of the horizontal rolls of said unit. Furthermore, it is to be noted by a comparison of Figs. 1 and 1a that no changes are contemplated in the arrangement or operation of the preceding roll stands 1 and 2,—the same or similar pass contours being employed in these preceding roll stands to produce ultimately the usual oval or elliptical stock section *a* that in both cases is delivered upright to the final finishing rolling operation, being maintained in such upright position by the usual receiving guide 14, Fig. 3, which, as more clearly shown in the diagram of Fig. 2, provides appropriate contact surfaces 15, 15 for effectually resisting the strong tendency of the oval to "turn down".

These guide surfaces 15, 15 very definitely fix and control the position of the stock section in its movement through the pass provided by a pair of cooperating grooves 11 in the horizontal rolls 10, 10, which pass, as hereinafter more particularly described, is deliberately made "full" or oversize on the horizontal diameter of the section. Furthermore, these guide surfaces 15, 15 exert the same, or nearly the same, positional control on the stock in its passage between the pair of vertical rolls also provided by the precision sizing unit of my invention,—which vertical rolls with their appurtenant driving and adjusting devices will now be described in detail.

As best shown in Fig. 3, each housing side 8 provides a forward extension 16 overhanging its base 7, and in such extensions 16, 16 are provided the matching openings or windows 17, 17. Extending transversely of the housing and fitted in the windows 17, 17, for sliding movement on the surfaces 18, 18 thereof, is an elongated box or supplementary housing 19, containing the pair of vertical rolls 20, 20. Said box or supplementary housing 19 contains and supports the complete vertical roll assembly which, as a unit, is capable of being withdrawn by horizontal endwise movement from the windows 17, 17 for purposes of replacement or repair, and which, as hereinafter described, is subject to adjustment of position in said windows, transversely of the sizing unit 5, for the purpose of alining the vertical roll pass 21 with any selected pair of pass grooves 11 in the horizontal rolls 10, 10.

The box or supplementary housing 19 provides end walls 22 and 23, side walls 24 and 25, and a bottom 26, the latter having an aperture 27 for the escape of the water and scale from the rolling operation. Within said box, and making a snug sliding fit with the side walls 24 and 25 thereof, are a pair of oppositely facing yoke-shaped blocks 28, 28, each associated with a vertical roll 20 and recessed, as shown at 29, to accommodate the barrel portion of said roll. The portions of each block that lie, respectively, above and below its recess 29 are appropriately concaved, as shown at 30 in Fig. 5, to receive, respectively, an upper roll neck bearing 31 and a lower roll neck bearing 32. Each upper bearing 31, as shown in Fig. 7, has lugs 33 for the passage of bolts 34 that secure the bearing to the block 28.

Each lower bearing 32 incorporates a bottom or step portion 35, against which rests the end of the lower roll neck, and from which extends a flange 36 that is received by a suitable recess 37 in the bottom surface of block 28. The bottom 26 of the auxiliary housing or box 19 has secured thereto a plate 38 which provides the oppositely inclined surfaces 39, 39, whereon wedges 40, 40 are arranged to be adjusted in or out, as by means of their threaded rods 41, 41 projecting from the end walls 22 and 23 of the supplementary housing. These wedges 40, 40 underlie the step portions 35, 35 of the lower bearings and through them support the blocks 28, 28.

By joint inward or outward adjustment of the wedges 40, 40, both blocks 28, 28, together with the vertical rolls 20, 20 and their bearings, can be either raised or lowered, as desired, to aline the vertical roll pass 21 with the pass of the horizontal rolls 10, 10. Furthermore, either wedge 40 may be moved in or out as required, for raising or lowering its associated block 28 and roll 20, to position the pass grooves of the two rolls 20, 20 at exactly the same level. When the desired vertical adjustments of the rolls 20, 20 have been obtained, the blocks 28, 28 are rigidly fixed and held in their adjusted positions by means of vertically disposed wedges 42, 42 that are received in wedge-shaped slots 43 of each block, and bear against the side wall 25 of box 19. Each wedge 42 has a lateral extension 44 through which passes a bolt 45 projecting upwardly from said side wall 25. By means of nuts 46 on said bolt, the wedge 42 can be vertically adjusted to provide the desired cooperation with the horizontal wedge 40 in fixing and holding the associated block 28 and roll 20 in any desired position of vertical adjustment.

Each roll neck bearing 31, 32 is preferably equipped with a liner 47 of suitable material, such as micarta,—the liner encircling the neck of the roll, but being broken away at an intermediate portion in its length to permit the neck to be contacted by a yieldingly-held shoe 48, the purpose of these shoes (two for each roll) being to seat the roll in its bearings 31, 32 and to prevent any radial displacement of roll or bearings, relative to block 28, such as might occur when the stock undergoing reduction is initially entered in the pass 21. To this end, each shoe 48 is held against its associated roll neck by a yoke or strap 49, the ends of the same being adjustably secured to the block 28 by rods 50 and 50', the latter being held yieldingly to its work by a spring 51 disposed in a recess 52 of the block. In this way, each vertical roll 20 is held firmly but yieldingly against the seat provided by its bearings 31, 32, in consequence of which the entrance of stock to the pass 21 may be effected without undue shock or strain on the apparatus.

For holding the rolls 20, 20 to their work, and maintaining the rolling pressure, the two blocks 28, 28 are each acted upon by a pair of thrust

screws 53, 53, that work in suitably threaded bushings 54, 54 carried by the end walls 22 and 23 of the auxiliary housing 19. To insure uniform motion of these thrust screws, in applying pressure to the associated block, each screw carries a gear 55, and each pair of gears 55 is in mesh with an operating pinion 56, journalled on a stud 57 projecting from the end wall 22 or 23. To prevent any play between each block 28 and its pressure screws 53, 53, a pair of rods 58, 58, having their heads 59, 59 received by a slot 60 of bracket 61 on the outer end of each block 28, project outwardly through holes 62 in the end walls 22 and 23 and are encircled by compression spring 63, 63, acting against nuts 64, 64 on the ends of said rods. Said springs 63, 63 maintain at all times the contact between blocks 28, 28 and the heads 59', 59' of their pressure screws 53, 53,—said heads 59', 59' being received in a slot 65 also provided by bracket 61, so that when the pressure screws 53, 53 are retracted, the associated block 28 will have a following movement. By means of these head-receiving slots 60 and 65, the previously-described vertical adjustments of both blocks 28, 28 can be carried out, without effect on the functions of the rods 58, 58 and the pressure screws 53, 53.

Above their windows 17, 17, the housing side extensions 16, 16 support a horizontal transverse plate or frame 66, Figs. 3 and 4, the edges of which provide ways or guides for a slide 68. Said slide 68 provides a gear inclosure 69, and on its upper portion supports an electric motor 70 of suitable type, as hereinafter referred to, for the drive of the vertical rolls 20, 20. The shaft of motor 70, at its lower end within the inclosure 69, carries a pinion 71, which is in mesh with a gear 72 carried by a countershaft 73 suitably journalled in said inclosure. The countershaft 73 also carries a smaller gear 74 which meshes with and drives one of a pair of companion equal-size intermeshing gears 75, 75, these latter being secured to a pair of shafts 76, 76, journalled in and projecting through the bottom of slide 68, and substantially concentric with the pair of vertical rolls 20, 20. Spindles 77, 77, each having suitable couplings 78, 79 with the shafts 76, 76 and with the upper necks of rolls 20, 20, serve to transmit to said rolls 20, 20 the rotation of shafts 76, 76 obtained, through the gearing above described, from driving motor 70. The couplings 79, 79 are of a suitable telescopic form well known in the art to permit, when desired, the previously-described vertical adjustment of either or both of the vertical rolls 20, 20.

By mounting the entire driving mechanism for the rolls 20, 20 on the slide 68, which is capable of being moved in parallel relation to the movement of the box or auxiliary housing 19, it is possible at all times to maintain the axial alinement of the drive shafts 76, 76 and the rolls 20, 20. That is to say, any transverse adjustment of the auxiliary housing 19, for alining the pass 21 with a selected groove in the horizontal rolls 10, 10, is accompanied by an equal transverse movement of the slide 68. To secure such movements, the auxiliary housing 19, along one of its edges, is provided with a rack 80, and a similar rack 81 is provided on the plate 66. Pinions 82 and 83 in mesh, respectively, with the racks 80 and 81 are so arranged that the squared ends 84, 84 of their shafts project outwardly to receive wrenches, or the like, by which to turn said pinions simultaneously in the same direction, for imparting the desired equal transverse motions to the auxiliary housing 19 and to the slide 68. When these desired adjustments have been made, the two parts are then securely fixed and held in their adjusted positions,—the housing 19 by the action of a suitable wedge 85 which is received in a horizontal slot 86, formed partly in wall 25 and partly in window 17, and the slide 68 by means of any suitable clamping device 87.

The above-described precision sizing unit 5 (replacing the usual last-finishing roll stand 3 of a conventional mill for rolling rounds), receives from the immediately-preceding roll stands of said mill the same oval stock section *a* as would ordinarily be received by said roll stand 3,—and there is the same provision, i. e. the receiving guide 14, for presenting said oval section in upright position to the horizontal rolls 10, 10 of said sizing unit 5. However, the pass grooves 11, 11 of these horizontal rolls, instead of providing, like the roll stand 3, an exactly round pass, provide instead a pass which is deliberately made slightly "full", or oversize, as shown exaggeratedly at *b*, *b*, Fig. 2, along the parting of said rolls 10, 10, thus to produce a slightly oval section *c*, whose horizontal axis is longer than its vertical axis by perhaps eight or nine thousandths of an inch in a one inch piece of stock. In this slightly oval section *c*, the vertical axis (a dimension always under the control of the operator by the usual expedient of adjusting the holding-down screws 88 of the upper horizontal roll 10) may be the same as the desired diameter of the finished round, or may be very slightly under such desired diameter, as indicate at *d*, *d*, Fig. 2, in order to make allowance for any slight spread in this connection, resulting from the action on the stock of the vertical rolls 20, 20.

A delivery guide 89, adjacent the rolls 10, 10, and a receiving guide 90, adjacent the rolls 20, 20, are preferably provided in the unit 5 for guiding the slightly oval stock section *c* in its passage to the last-named rolls,—these guides, however, being tubular or funnel-shaped and exercising practically no dominance on the position of the stock section, which latter, being so nearly round, is not susceptible to the exercise of such dominance by any engaging guide surfaces. However, the vertical rolls 20, 20 are so close to the horizontal rolls 10, 10 in the precision sizing unit 5 of my invention that the necessary positional dominance to keep the stock from turning on its longitudinal axis in passing from the rolls 10, 10 to the rolls 20, 20, is amply furnished by the surfaces 15, 15 of guide 14,—thus insuring the presentation of the stock section *c* to the vertical rolls 20, 20 in such position that the major axis of the oval remains horizontal and, therefore, has directly exercised thereon, in pass 21, the substantially uniform rolling pressure that corrects this oversize dimension of the stock section. At the same time, any undersize condition on the other axis of stock section *c* is automatically corrected by the spread factor which, in this case, is effective along the parting of the vertical rolls 20, 20 to eliminate the slightly flattened portions *d*, *d*. In this way, the stock in its passage, by the action thereon of the cooperating passes provided by the two sets of rolls 10, 10 and 20, 20, is given the accurately dimensioned and exactly round section shown at *e* in Fig. 2.

It is to be noted that only a small amount of the work of reduction is imposed on the vertical rolls 20, 20. Consequently, the motor 70 for driving these rolls may be of very small capacity. This motor is preferably one that has a drooping characteristic,—that is the vertical rolls would

be driven when empty at a slightly higher speed than the delivery speed of the horizontal rolls; but upon entry of the stock into the vertical rolls, this over-compounded motor would drop in speed to correspond to such delivery speed from the horizontal rolls. Because of the small amount of power delivered by motor 70 to rolls 20, 20, the pull of such rolls on the stock is very light, thus avoiding any possibility of deformation of the stock by tension thereon.

The provision of the vertical rolls in a removable supplementary housing, as above described, permits said rolls to be assembled in their entirety and properly positioned and adjusted before the assembly is mounted in the main housing. Furthermore, the separate drive mechanism for such vertical rolls, and its adjustability in the main housing, permits said rolls to be alined selectively with any one of the plurality of passes provided by the horizontal rolls,—the drive mechanism being readily adjustable to conform to the selected position of the rolls 20, 20.

I claim:

1. Apparatus for the rolling of precision rounds, from stock which is presented in substantially oval cross-sectional shape to the final rolling operation, said apparatus comprising horizontal reducing rolls providing a pass which is slightly "full" horizontally, a restraining guide in advance of said horizontal rolls to maintain the oval section upright in its presentation to said pass, and vertical rolls providing another pass immediately adjacent said first pass, to which other pass the stock is delivered by said first pass with no restraint other than that provided by said guide which presents it to the first pass.

2. In the production of precision "rounds" by finish rolling and sizing in a pair of alined, substantially round, closely adjacent reducing passes substantially at right angles to each other, the improvement which consists in presenting the stock to such pair of passes with its section in elliptical form, and holding the stock from turning on its axis, during such finish rolling and sizing, by guide engagement only with such elliptical section.

3. Apparatus for the precision rolling of "rounds", comprising, in combination, a finish rolling and sizing unit composed of two pairs of reducing rolls having alined, substantially round passes in immediate juxtaposition and substantially at right angles to each other, a preceding stand of rolls which presents the stock to said unit with a cross section of elliptical form, and a receiving guide associated with said unit, and operating on said elliptical section as the sole means to prevent the stock, in its passage through said unit, from turning on its axis.

4. Apparatus for the precision rolling of "rounds", comprising, in combination, a finish rolling and sizing unit composed of two pairs of reducing rolls having alined, substantially round passes in immediate juxtaposition and substantially at right angles to each other, a preceding stand of rolls which presents the stock to said unit with a cross section of elliptical form, a receiving guide associated with said unit, and operating on said elliptical section as the sole means to prevent the stock, in its passage through said unit, from turning on its axis, said finish rolling and sizing unit being provided as a replacement for the usual last horizontal roll stand of the mill, and having one pair of its reducing rolls associated with the driving connections for such replaced horizontal roll stand, and the other pair of said reducing rolls of said unit having an independent driving means carried by said unit and adjustable in unison with said last-mentioned rolls.

5. Apparatus for the precision rolling of "rounds", comprising, in combination, a finish rolling and sizing unit composed of two pairs of reducing rolls having alined, substantially round passes in immediate juxtaposition and substantially at right angles to each other, a preceding stand of rolls which presents the stock to said unit with a cross section of elliptical form, a receiving guide associated with said unit, and operating on said elliptical section as the sole means to prevent the stock, in its passage through said unit, from turning on its axis, said finish rolling and sizing unit having a main housing which is adapted to replace the roll housing of the usual last stand of horizontal rolls of a finishing mill, and having one pair of its reducing rolls associated with the driving connections for such replaced horizontal stand, an auxiliary housing adjustably and removably mounted in said main housing, the other pair of reducing rolls of said unit being mounted in said auxiliary housing, and having driving means carried by said unit and adjustable with said rolls.

6. The herein described method of rolling precision "rounds", which consists in imparting to the stock, by conventional finishing mill rolling, a pronounced elliptical cross section, subjecting such elliptical cross section to finish rolling and sizing in a pair of alined, substantially round closely adjacent reducing passes having their axes substantially at right angles, while restraining said stock from axial turning movement in both of said passes solely by engagement with said elliptical section as it enters the first of said passes.

7. In apparatus for the precision rolling of rounds, the combination with a main housing and a pair of horizontal rolls therein, of a supplementary housing mounted in said main housing, a pair of vertical rolls carried by said supplementary housing, wedge means for vertically adjusting each vertical roll in said supplementary housing, and means associated with each vertical roll, independently of the other roll of the pair, for effecting its lateral adjustment, lengthwise of said housing, in both directions.

8. In apparatus for the precision rolling of rounds, the combination with a main housing and a pair of horizontal rolls therein, of a supplementary housing mounted in said main housing and bodily withdrawable endwise therefrom, a pair of vertical rolls carried within said supplementary housing, driving devices for said vertical rolls mounted as a unit on said main housing, and detachable from said vertical rolls to permit said bodily withdrawal of the supplementary housing and its contained vertical rolls, and means operable on said supplementary housing and on said roll driving device unit for effecting their horizontal adjustments simultaneously and in unison.

9. The method of producing precision "rounds" comprising the steps of rolling the stock into a pronounced elliptical cross-section, applying rolling pressure to opposite sides of the stock in the direction of the major axis of the pronounced elliptical cross-section and thereby rolling the stock into a cross-section which is very slightly elliptical with its major axis at right angles to the major axis of the pronounced elliptical cross-section, applying rolling pressure to opposite

sides of the stock in the direction of the major axis of the slightly elliptical cross-section and thereby rolling the stock into a circular cross-section, and preventing rotation of the stock about its axis by guiding the pronounced elliptical cross-section.

10. Apparatus for the precision rolling of "rounds" comprising a final roll pass shaped to deliver stock with a circular cross-section, a semi-final roll pass immediately adjacent to the final pass and shaped to deliver stock with a cross-section which is very slightly elliptical, means to deliver stock to the semi-final pass with a pronounced elliptical cross-section, and a receiving guide immediately adjacent to the semi-final pass and arranged to prevent rotation of the stock about its axis.

11. Apparatus for the precision rolling of "rounds" comprising a pair of vertical rolls forming a final pass and shaped to deliver stock with a circular cross-section, a pair of horizontal rolls forming a semi-final pass immediately adjacent to the final pass and shaped to deliver stock with a cross-section which is very slightly elliptical, the major axis being horizontal, means to deliver stock to the semi-final pass with a pronounced elliptical cross-section, the major axis being vertical, and a receiving guide immediately adjacent to the semi-final pass and arranged to prevent rotation of the stock about its axis.

12. The method of producing precision "rounds" which consists in initially rolling the stock to a pronounced elliptical cross-section, subjecting the so-rolled stock to two closely-contiguous rolling operations which impart thereto, first, a slightly elliptical cross-section, and then a round cross-section, and, during said last-mentioned rolling operations, preventing rotation of the stock about its axis by guiding action on the pronounced elliptical cross-section thereof.

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