

June 2, 1936.

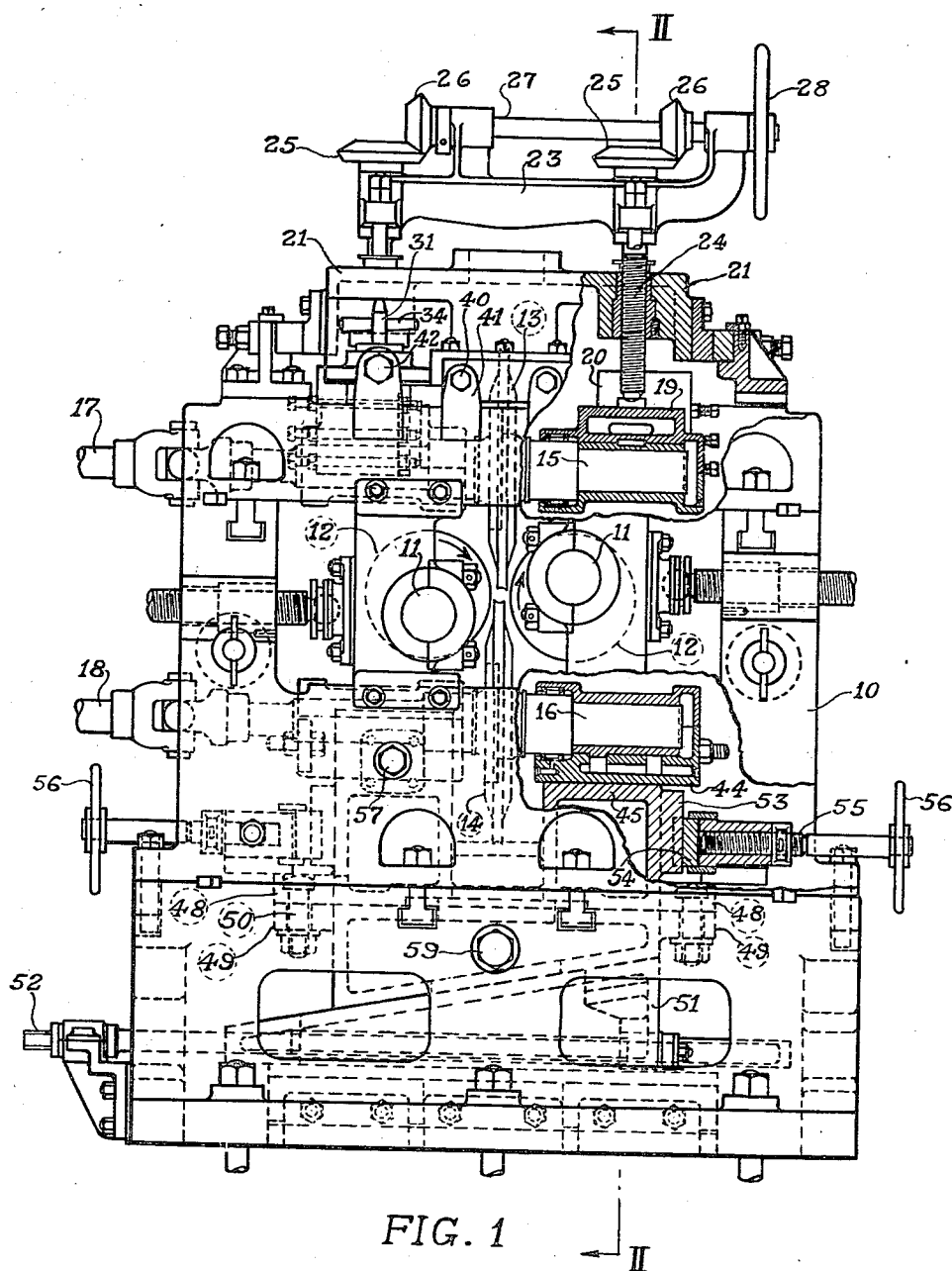
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2,042,832

METHOD AND APPARATUS FOR CROSS ROLLING TUBES

Filed Sept. 2, 1932

4 Sheets-Sheet 1



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METHOD AND APPARATUS FOR CROSS ROLLING TUBES

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4 Sheets-Sheet 2

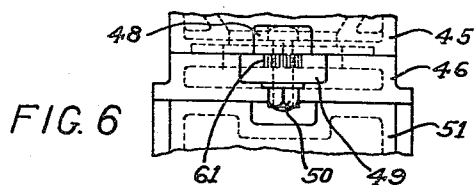


FIG. 6

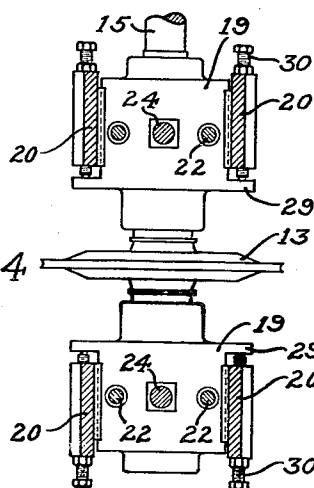


FIG. 4

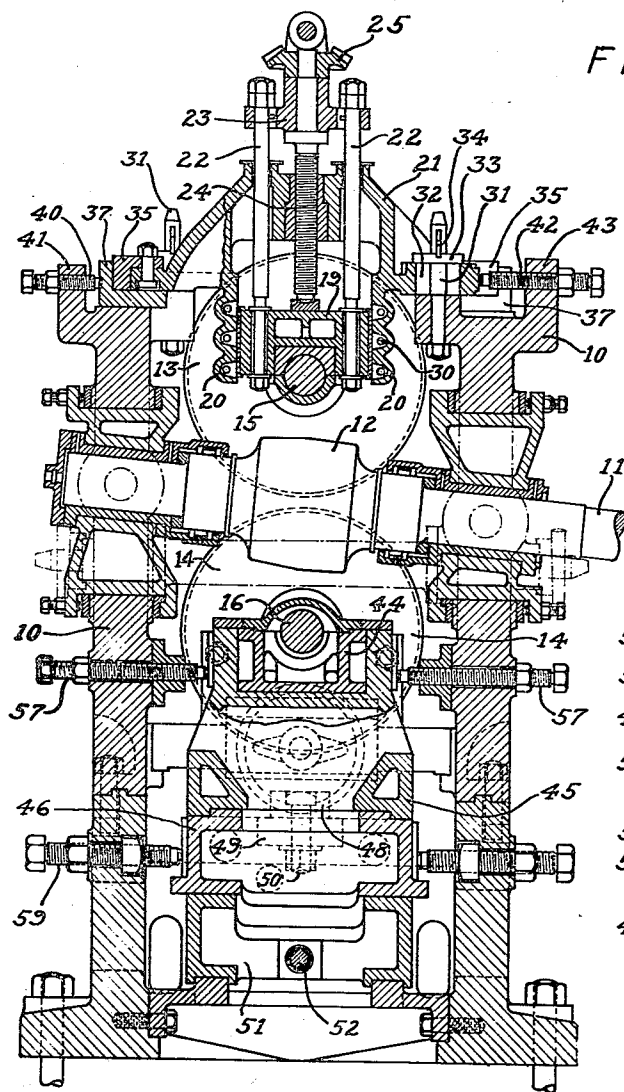


FIG. 2

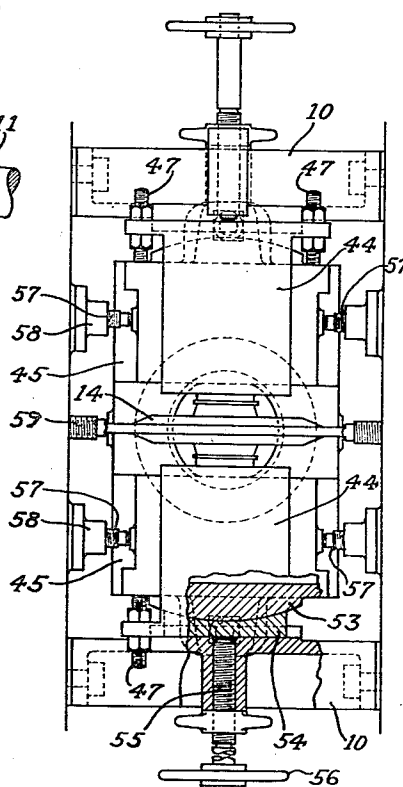


FIG. 5

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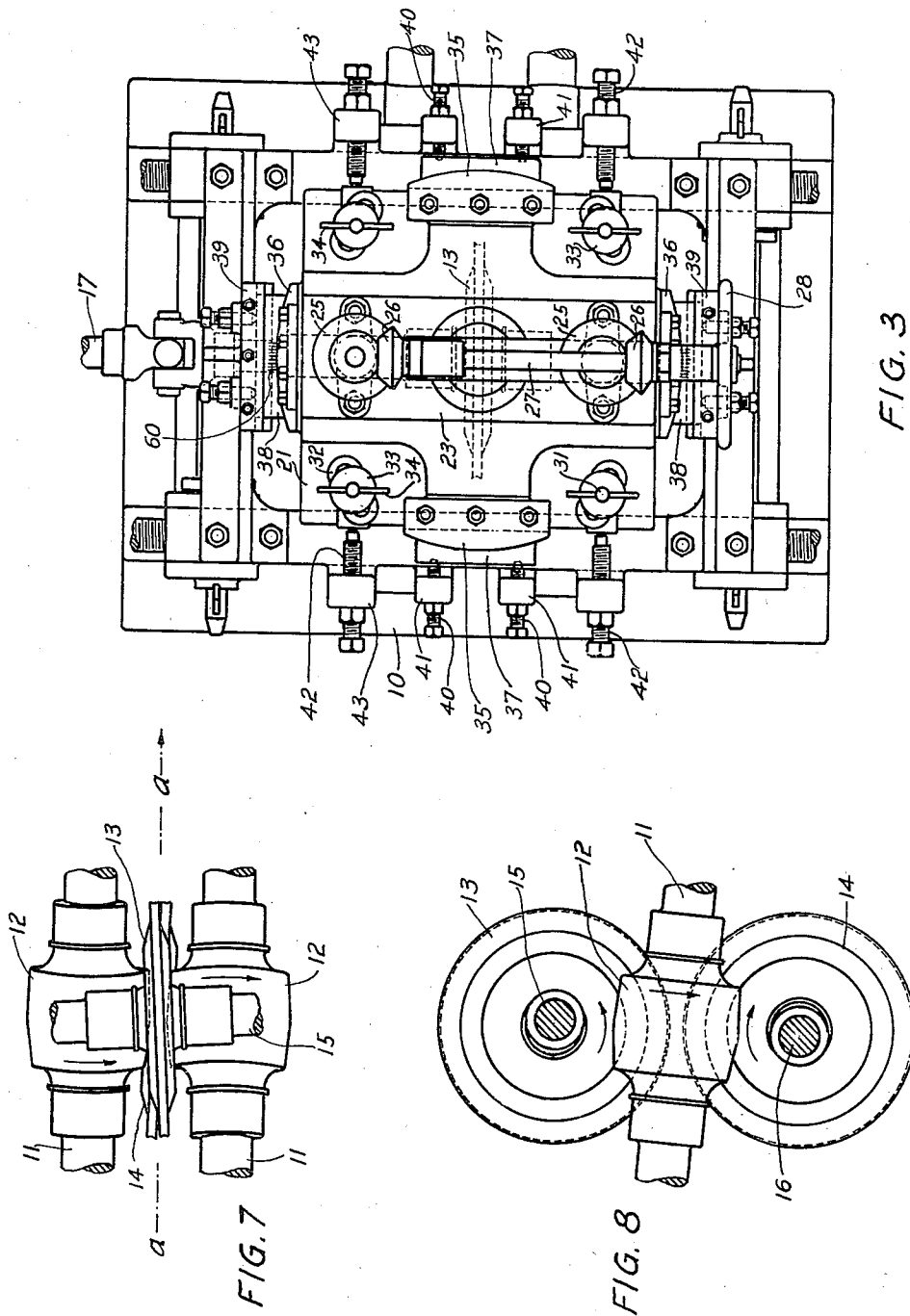
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METHOD AND APPARATUS FOR CROSS ROLLING TUBES

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4 Sheets-Sheet 3



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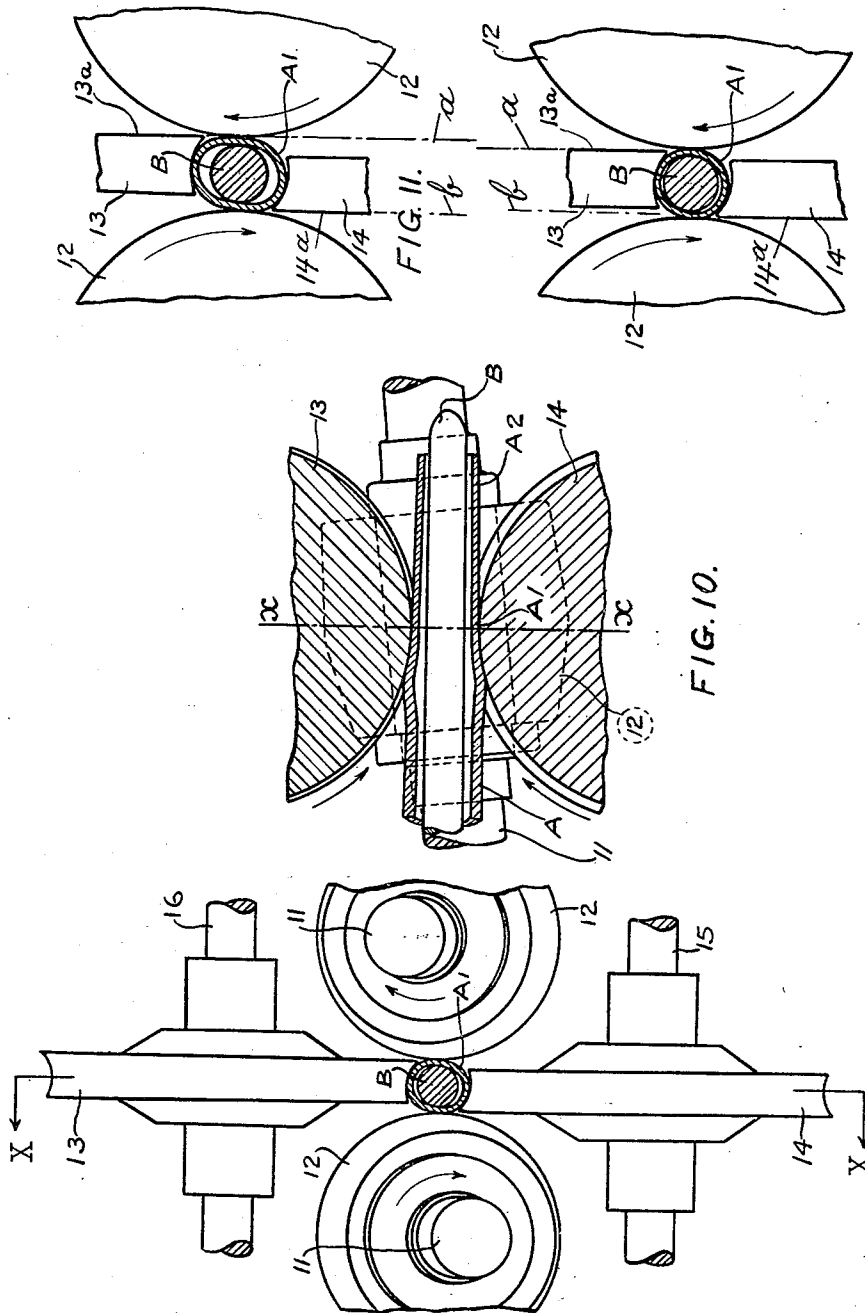
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METHOD AND APPARATUS FOR CROSS ROLLING TUBES

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4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

2,042,832

METHOD AND APPARATUS FOR
CROSS-ROLLING TUBES

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Application September 2, 1932, Serial No. 631,511

10 Claims. (Cl. 80—62)

My invention relates to apparatus for cross-rolling tubular and cylindrical work-pieces,—as, for instance, in piercing work-pieces, elongating and reducing wall thickness of tubular work-pieces, reducing the diameter of tubes, straightening tubes, etc., by the action of cross-rolls (which term, throughout this application, is intended to include broadly members which act rotatively and helically to apply pressure, for one purpose or another, to work-pieces introduced between them).

In apparatus of this character, when constructed in accordance with certain earlier inventions I have made, a pair of discs (or, in some cases, a single disc) is employed. The peripheries of these discs engage the work-piece between the cross-rolls. The discs are positively rotated, in the direction of the longitudinal progression of the work-piece, at a speed in excess of that of such longitudinal progression, with the result that the frictional resistance of the discs to the rotating movement of the work-piece (which, of course, in its helical movement, rotates as well as progresses longitudinally) is reduced in a manner that has been explained in prior patents which I have obtained.

It is an object of the present invention to provide a cross-rolling apparatus, embodying discs of the aforementioned character, by means of which frictional resistance of the discs to the rotating movement of the work-piece can be reduced to a greater extent, with a given speed of rotation of the discs, than has heretofore been possible. Another object is to provide such an apparatus in which the operation of the discs will be improved, and made more efficient and convenient for varying settings and characteristics of the work-piece and the cross-rolls. Other and further objects of the invention, and special advantages secured thereby, will appear from the following specification and the claims annexed thereto.

A cross-roll mill constructed in accordance with my invention is described, by way of example, in the following specification, and shown in the accompanying drawings. The mill thus selected for description and illustration is one suitable for the elongation and reduction of wall thickness of tubular blanks, and, as shown, employs two discs. The invention can, however, be embodied in other constructions of cross-roll mill than that shown, and, of course, can be embodied in cross-roll mills having purposes other than that of elongating and reducing wall thickness of tubular blanks, and a single disc

may, in certain circumstances, be employed in place of a plurality of discs, all within the scope of my invention, as defined in the appended claims.

In the drawings:

Fig. 1 is a front elevation of the mill, portions being broken away to display interior parts;

Fig. 2 is a sectional side elevation taken on the line II—II of Fig. 1;

Fig. 3 is a plan of the mill;

Fig. 4 is a detail sectional plan showing the means for laterally adjusting the upper disc;

Fig. 5 is a plan of the lower disc and its associated parts;

Fig. 6 is a detail fragmentary view showing the means for indicating the extent of angular adjustment of the lower disc;

Figs. 7 and 8 are a schematic plan and side view, respectively, showing the discs as disposed in planes inclined with respect to the line of longitudinal movement of the work-piece, such inclination being exaggerated for purposes of clearness of illustration;

Fig. 9 is an enlarged end view of the cross-rolls and discs, looking in the direction of the feed of the work-piece through the mill, and showing such work-piece, and the mandrel, therein;

Fig. 10 is a section taken on the line X—X of Fig. 9; and

Figs. 11 and 12 are schematic views illustrating different transverse positions occupied by the discs.

The mill comprises a stand 10 in which are mounted, on suitably driven shafts 11, the cross-rolls 12, the same being adjustable to approach or recede from each other in the well known manner. Upper and lower discs 13 and 14 are mounted on shafts 15 and 16 so as to engage the work-piece intermediate the cross-rolls, the disc shafts being driven, through universal joints 17 and 18 respectively, in such direction that their peripheral movement at the points of their engagement with the work-piece is in the same direction, broadly, as the longitudinal movement of the work-piece.

The operation of the cross-rolls and discs will be understood from Figs. 9 and 10. In these figures, a tubular work-piece is shown as being elongated, the portion A thereof designating the untreated part, having its original shape, the portion A¹ designating the part which is, at the moment, in the throat of the roll pass, and the portion A² thereof designating the part which has been elongated to produce the tube. B design-

nates the mandrel upon which the work-piece is
 elongated. It will be noted from Fig. 9 that the
 part A¹ of the work-piece which is in the pass of
 the cross-rolls, assumes a non-circular shape,
 shown as oval, the extent of the "ovality" being
 determined by the distance between the periph-
 eries of the discs 13 and 14,—it being understood
 that the tube is brought into final circular form
 by the surfaces of the cross-rolls as the tube
 emerges therefrom. As the tendency of the metal
 is to bulge into a more pronounced oval than is
 actually permitted it will be seen that the pres-
 sure between the work-piece and the discs is
 great. The same considerable pressure between
 the discs and the work-piece occurs in all uses
 of such discs, whether for elongating and reduc-
 ing wall thickness or otherwise, and occasions
 important friction problems.

Since the work-piece moves helically, the fric-
 tional resistance between it and an object en-
 gaging it may be regarded as exerted in two di-
 rections,—viz., in a direction circumferential
 of the work-piece, and in a direction longitudinal
 of the work-piece. The frictional resistance in
 a circumferential direction is an important ob-
 stacle to successful operation, and is greatly less-
 ened, or may theoretically be obviated entirely,
 by rotating the discs, in the direction of longi-
 tudinal movement of the work-piece, at a speed
 greater than that of the longitudinal movement
 of the work-piece. The theoretical formula for
 such obviation of the frictional resistance to
 rotation requires that the peripheral speed of the
 discs be equal to approximately one-half the speed
 of rotation of the work-piece divided by the sine
 of the average angle of the helix of movement
 of the work-piece through the cross-rolls. How-
 ever, to obtain a desired degree of reduction of
 the frictional resistance of the discs against ro-
 tation of the work-piece, it would sometimes be-
 come necessary, in previous constructions of
 cross-roll mills employing such discs, to rotate
 the discs so rapidly that their friction longi-
 tudinally of the work-piece, though taking effect
 in a forward direction, would have disadvanta-
 geous results.

By the apparatus of the present invention, I
 am enabled to reduce the frictional resistance ex-
 erted by the discs, at any given peripheral speed
 thereof, against the rotative movement of the
 work-piece, thereby being able to obtain a given
 reduction of such frictional resistance with a less
 peripheral speed of the discs than would other-
 wise be necessary. In obtaining this result, the
 cross-rolling apparatus of my present invention is
 constructed in such manner that the discs can
 be inclined with respect to the line of longi-
 tudinal movement of the work-piece, as illus-
 trated in Figs. 7 and 8. When so inclined,—in
 such a direction that the planes of the guide
 discs approach parallelism with the helix of move-
 ment of the work-piece, as distinguished from
 receding from such parallelism,—the frictional
 resistance exerted by the discs against rotative
 movement of the work-piece is decreased and the
 peripheral speed of the guide discs need not,
 therefore, be so great as would otherwise be nec-
 essary in order to obtain a desired result.

In cross-roll mills employing discs of the char-
 acter herein referred to, it will often be desirable
 to change the distance separating the discs, or,
 if only one disc is used, to change the distance
 between the periphery of the disc and the axis
 of the pass, or line of pass, between the cross-

rolls. For example, supposing a tubular work-
 piece to have been elongated, to produce a tube
 of a certain diameter and wall thickness, at a
 given setting of the cross-rolls and guide discs,—
 it would be necessary to separate the discs more
 widely if it were desired to obtain, with the
 same mandrel and the same setting of the cross-
 rolls, a tube of the same wall thickness but
 greater diameter. Similar occasions for vary-
 ing the distance separating the discs occur in
 other uses of cross-roll mills employing such
 discs.

To permit the varying separation of the discs
 above referred to, the apparatus according to my
 present invention is made so that the discs can
 be shifted both towards and away from each other
 and also in a transverse direction, and the discs
 are made so as to engage the work-piece chiefly
 to one side of a plane passing centrally through
 the space between the cross-rolls. Since each
 disc thus engages the work-piece on an area more
 close to one of the cross-rolls than to the other,
 the opposite side of the disc need not approach
 its adjacent cross-rolls as closely as does the side
 at which the engagement takes place, or, in other
 words, the disc can be of reduced thickness and of
 smaller diameter at the side thereof remote from
 the side at which the engagement with the work-
 piece chiefly occurs, as shown particularly in
 Figs. 9, 11 and 12. This reduces the necessary
 total thickness of the discs and permits them
 to be shifted towards each other without com-
 ing into engagement with the surfaces of the
 cross-rolls, the distance between which latter nar-
 rows, of course, as the axis of the pass is neared.
 The engagement of each disc with the work is
 predominantly on the side of the work-piece near-
 est to that cross roll, of the two, which is caus-
 ing the metal to move towards the disc, or, in
 other words, is rotating towards the disc, and
 by the apparatus of my present invention the discs
 can be placed in close proximity with the cross-
 rolls at the sides of the discs where they thus
 engage. This avoids spaces, between the edges
 of the discs and the surfaces of the cross-rolls,
 into which the metal might tend to flow to the
 detriment or destruction of the product.

The shape of the guide discs, and the manner
 of differently positioning them, will be readily
 understood from Figs. 11 and 12. Fig. 11 shows
 the cross-rolls 12 as set, with respect to the man-
 drel B, for producing an elongated tube of a given
 wall thickness. The diameter of the elongated
 tube for any setting of the cross-rolls will be
 controlled by the position of the discs 13, 14,
 which are shown as widely separated, so as to
 produce a tube of relatively large diameter. The
 separation of the discs is somewhat exaggerated,
 however, in the figure, for ease of comparison
 with Fig. 12. It will be noted from the arrows
 showing the direction of revolution that the
 cross roll on the right is causing the metal to
 move towards the upper disc, that such disc en-
 gages the work-piece on an area nearer to that
 cross-roll than to the cross-roll on the left, and
 that the right-hand edge 13a, of the disc is dis-
 posed in close proximity with the adjacent cross-
 roll, so that the disc immediately intercepts and
 deflects the metal as it moves from the cross-roll.
 The left-hand side of the disc is so situated as to
 leave considerable clearance between it and the
 cross-roll on the left. This provides room for
 the disc to be moved further in towards the axis
 of the pass, and for the disc to be moved to the

left (so as to avoid contact of its right-hand edge 13a with the adjacent cross-roll when the disc is thus moved further in towards the axis of the pass), without the right-hand side of the disc coming into contact with the surface of the adjacent cross-roll. Figure 12 shows the same setting of the cross-rolls with respect to the mandrel B, giving a tube of the same wall-thickness as before. However, the discs are placed more closely together, to produce a tube of smaller diameter. To bring the discs into the closer position, they are moved so as to approach each other, and also transversely, as is indicated by the dotted lines *a* continuing the edge 13a of the disc 13 in the two figures, and the dotted lines *b* continuing the edge 14a of the disc 14.

In Fig. 10, the discs are shown as placed centrally of the length of the pass,—that is, so that the line *x* joining the closest points on their peripheries intersects a line joining the closest points on the surfaces of the cross-rolls. Varying circumstances of operation may require that the discs be thus positioned with respect to the length of the pass, or that they be positioned to a greater or less extent on either the entry or the exit side of the center of the pass.

The constructional details of that form of my apparatus which has been herein selected for description and illustration, by which the foregoing results are obtained, are as follows:

The shaft 15 of the upper disc, 13, is carried by bearing blocks 19 (Figs. 1, 2 and 4) which are mounted to slide in guide hangers 20 depending from a support cap 21 mounted on the top of the stand 10. The bearing blocks are sustained vertically by suspension rods 22 connected with the blocks at their lower ends and mounted at their upper ends in a bridge member 23 disposed above the cap 21. The bridge member is supported upon collars close to the upper ends of screws 24, the lower ends of these screws engaging against the tops of the bearing blocks. The adjustment of the parts is such that the suspension rods hold the bearing blocks in close engagement with the ends of the screws 24, it being understood that the screws 24 resist the upward pressure of the disc shaft 15 during the operation of the disc. Upon the upper ends of the screws are mounted bevel pinions 25 with which mesh other bevel pinions, 26, mounted upon a shaft 27 supported in bearings carried by the bridge member. The shaft 27 can be rotated by means of a handwheel 28, thereby to effect an adjustment of the screws 24. By such adjustment any desired vertical position of the disc 13 can be obtained, the upward pressure, imparted to such disc in the operation of the mill, being resisted by the screws 24.

The bearing blocks 19 are provided with flanges 29 adapted to be engaged by horizontal screws 30 threaded into the guide hangers 20; so that the position of the disc, transversely of the cross-rolls, can be adjusted by loosening the screws 30 on one side of the disc, and correspondingly tightening such screws on the other side of the disc.

The support cap 21 rests upon the top of the stand 10, and is secured in any position of adjustment thereon by means of bolts 31 passing through clearance slots 32 in the cap and carrying washers 33 adapted to be held down, in firm engagement with the support cap, by means of wedges 34. The support cap has secured thereto a pair of guide blocks 35 disposed at the front and rear thereof respectively, and a second pair

of guide blocks 36 disposed at the sides thereof, the outer faces of all these guide blocks being shaped to the arcs of concentric circles described about the center of the cap. The guide blocks 35 are engaged by bearing blocks 37 curved to conform therewith and slidably mounted upon the top of the stand 10. The guide blocks 36 are likewise engaged by bearing blocks 38, these bearing blocks being mounted to slide longitudinally in guides 39 carried by the stand 10. Adjusting screws 40, carried by lugs 41 extending upward from the stand, engage the bearing blocks 37, and adjusting screws 42, threaded in lugs 43 extending upward from the stand, engage the support cap 21. From this it will be seen that, upon loosening of the wedges 34, the support cap 21, and the disc which it carries, is adjustable both in the way of rotation about a vertical axis and in the way of movement in a direction longitudinal of the cross-rolls. As to the former, if the bearing blocks 37 are held stationary, the support cap can be turned about a vertical axis by tightening certain of the screws 42 and loosening others. As to the latter, the support cap can be moved bodily lengthwise of the cross-rolls by tightening the screws 40 and 42 on one side of the machine and loosening the corresponding screws on the other side of the machine.

The shaft 16 of the lower disc (Figs. 2, 5 and 6) is carried by bearing blocks 44 mounted for longitudinal sliding movement in a head 45 which is mounted to rotate, about a vertical axis, upon a support table 46. Stud bolts 47 extend from the head 45 and pass through flanges with which the bearing blocks are provided, so that by adjustment of the nuts upon these stud bolts the bearing blocks can be moved longitudinally in the head, so as to give an adjustment of the disc, transversely of the cross-rolls, which corresponds with the adjustment of the upper disc by means of the screws 30. Lugs 48 (Fig. 6) on the head are disposed above corresponding slotted lugs, 49, on the table, 46, and bolts 50 passing through such lugs are provided for locking the head in any angular position to which it may be adjusted relatively to the table.

The support table 46 rests upon a wedge member 51 which is guided, for longitudinal movement, in the stand 10 and is adapted to be moved lengthwise by means of a screw shaft 52. The head 45 is provided with guide portions or members 53 (Figs. 1 and 5), the outer faces of which are shaped to arcs having their centers in the axis about which the head is adjustable. These guide portions are engaged by correspondingly shaped guide blocks 54 mounted in the stand 10 for longitudinal movement with respect thereto and engaged by screws 55 adapted to be operated by hand-wheels 56. It will be seen that the blocks 54 guide the head 45 vertically, regardless of any adjustment of the said head either around its axis, or in a direction longitudinal of the cross-rolls, and, further, that these blocks support the head firmly against any tendency of the same to cant which may result from such lateral forces as may be applied to the disc during the operation of the mill. Lengthwise adjustment of the wedge 51, therefore, results solely in an adjustment of the vertical position of the lower disc, corresponding to that which is obtained in the case of the upper disc by the adjustment of the screws 24.

To rock the head 45 about its axis, screws 57 threaded into bosses 58 carried by the stand 10

are provided. These screws engage the head (Fig. 5), and by loosening certain of them and tightening others the head can be adjusted about its axis and locked in its adjusted position. For
 5 adjusting the lower disc longitudinally of the cross-rolls, screws 59, threaded into the stand 10 and engaging the table 46, are provided. By tightening the screw 59 and screws 57 at one side of the stand and loosening the corresponding
 10 screws at the other side of the stand, the table 46, and the head 45 carried thereby, can be adjusted in one direction or another lengthwise of the cross-rolls.

By means of the screws 42, adapted to move
 15 the cap 21 about its axis, and the screws 57 adapted to move the head 45 about its axis, the upper and lower discs can be moved about vertical axes so as to occupy positions which are inclined with respect to the plane (indicated by
 20 the line *a-a*, Fig. 7) bisecting the space between the cross-rolls. By thus inclining the discs, in the direction in which their planes approach towards parallelism with the helix of movement of the work-piece, the greatest reduction
 25 of frictional resistance of the discs to rotation of the work-piece, for any given peripheral speed of the discs, is obtained, or, conversely, the required peripheral speed of the discs is minimized for any given reduction of the frictional resistance of the discs to rotation of the
 30 work-piece.

Means are provided for indicating the extent of the inclination of the discs, such means consisting of index marks 60 (Fig. 3) upon one of
 35 the guide blocks 38, for the upper disc, and index marks 61 (Fig. 6) upon one of the lugs 49, for the lower disc. The amount of the inclination will vary in accordance with the conditions incident to the work being done and will, in any
 40 case, generally be subject to limitations connected with the space available between the cross-rolls. A comparatively small inclination (for instance, about 2°) has markedly advantageous effects, especially where the angle of the
 45 feed helix of the work-piece is also small. The inclination is shown in Fig. 7 as somewhat greater than it would usually be in practice, this being for clearness of illustration.

By means of the screws 24 and the wedge 51, respectively, the discs may be made to approach
 50 or recede from each other, and by means of the screws 30 and the nuts on the studs 47, respectively, the discs may be moved transversely of the cross-rolls. This permits the changing of
 55 the positions of the discs, with respect to distance from the longitudinal center of the pass in the manner that has been described above with reference to Figs. 11 and 12.

The position of the discs, longitudinally of the pass, can be changed by manipulating the screws
 60 40, for the upper disc, and the screws 59 for the lower disc, thereby permitting the discs to be set either at the narrowest part of the pass or at various positions on the entrance or exit side of
 65 such narrowest part.

I claim:

1. In a cross-rolling mill, a frame, a pair of cross-rolls rotatably supported thereby, a disc
 70 between the cross-rolls positioned to have its periphery engage a workpiece as it passes through the working pass of the cross-rolls, means borne by said frame for supporting said disc with its axis of rotation more nearly transverse than
 75 longitudinal of the line of pass through the cross rolls, said disc-supporting means being rotatable

about an axis substantially perpendicular to said line of pass and lying in the plane of rotation of the disc whereby to variably incline said disc with respect to said line of pass, and means for rotating said disc at a peripheral speed materially in excess of the longitudinal progression of a workpiece effected by the cross-rolls.

2. In a cross-rolling mill, a frame, a pair of cross-rolls rotatably supported thereby, a pair of discs between the cross-rolls positioned to have
 10 their peripheries engage the opposite sides of a workpiece as it passes through the working pass of the cross-rolls, means borne by said frame for independently supporting each of said discs with its axis of rotation more nearly transverse than
 15 longitudinal of the line of pass through the cross-rolls and with said axes inclined to each other, said disc-supporting means being rotatable about axes substantially perpendicular to said line of pass and lying in the planes of rotation of the
 20 discs whereby to variably incline said discs with respect to said line of pass and to each other, and means for rotating said discs at peripheral speeds materially in excess of the longitudinal progression of a workpiece effected by the cross-
 25 rolls.

3. In a cross-rolling mill, a frame, a pair of cross-rolls rotatably supported thereby, a disc between the cross-rolls positioned to have its periphery engage a work-piece as it passes through
 30 the working pass of the cross-rolls, means borne by said frame for supporting said disc in a plane substantially parallel with the line of pass through the cross-rolls and with the periphery of the disc nearer to the cross-roll which rotates
 35 a workpiece towards the disc than to the other cross-roll, means for rotating said disc at a peripheral speed materially in excess of the longitudinal progression of a workpiece effected by the cross-rolls, and means for adjusting said disc-
 40 supporting means toward and from said line of pass and also transversely thereof.

4. In a cross-rolling mill, a frame, a pair of cross-rolls rotatably supported thereby, a pair of discs between the cross-rolls positioned to have
 45 their peripheries engage the opposite sides of a workpiece as it passes through the working pass of the cross-rolls, means borne by said frame for independently supporting said discs in planes substantially parallel with the line of pass through
 50 the cross-rolls and with the periphery of each disc nearer to the cross-roll which rotates the workpiece towards the disc than to the other cross-roll, means for rotating said discs at peripheral speeds materially in excess of the longitudinal progression of a workpiece effected by the cross-rolls, and means for adjusting said disc-
 55 supporting means toward and from said line of pass and also transversely thereof.

5. In a cross-rolling mill, a frame, a pair of cross-rolls rotatably supported thereby, a disc arranged between said cross-rolls with its periphery disposed to engage a work-piece as it passes through the working pass of the cross-rolls, means borne by said frame supporting said
 60 disc for rotation in a plane substantially parallel with the line of pass between the cross-rolls, means for rotating said disc, and means for canting the disc relative to said plane of rotation about an axis perpendicular to the line of pass.
 70

6. In a cross-rolling mill, a frame, a pair of cross-rolls rotatably supported thereby, a pair of discs arranged between said cross-rolls with their peripheries disposed to engage the opposite sides
 75

of a work-piece as it passes through the working pass of the cross-rolls, means borne by said frame supporting each disc for rotation in a plane substantially parallel with the line of pass between the cross-rolls, means for rotating said discs, and means for canting said discs relative to said plane and relative to each other about an axis perpendicular to the line of pass.

7. A cross-rolling mill comprising a supporting frame, cross rolls mounted for lateral adjustment in said frame, a pair of driven guide discs disposed for operation between said cross rolls and about axes extending substantially transversely of the axes of said cross rolls, shafts for supporting said guide discs, hangers adjustable toward and from the pass-line of the mill for supporting said shafts, frames mounted for both angular and sidewise movement on said supporting frame for supporting said hangers, means for adjusting said hangers in said hanger-supporting frames toward and from the pass-line of the mill, means for adjusting said hanger-supporting frames sidewise, means for angularly adjusting said hanger-supporting frames, and means for locking said hanger-supporting frames in a selected position.

8. The method of treating work-pieces in a cross-rolling mill, comprising subjecting a work-piece to the action of a pair of opposed cross rolls positioned to impart a helical movement to the work-piece, and applying to the work-piece in the pass zone of the cross rolls the resisting pressure of a guide member engaging the work-piece and moving, at a speed materially in excess of the speed of longitudinal progression of the

work-piece through the cross rolls, in a direction which is generally that of such longitudinal progression but inclined from the line of such progression toward parallelism with the feed helix of the work-piece.

9. In a cross-rolling mill for the manufacture of seamless tubular articles, the combination of a pair of oppositely rotating cross-rolls, and a pair of guide discs positioned between the cross-rolls on the opposite sides of the pass line through them and rotatable in the direction of travel of a blank through the mill, each guide disc being of greater diameter at its side adjacent to that one of said cross-rolls whose working face is rotating towards it than it is at its other side, and each guide disc being provided with a peripheral concave curved surface between its said different diameter sides.

10. In a cross rolling mill, a frame, a pair of cross rolls rotatably supported thereby, a disc between the cross rolls positioned to have its periphery engage a work-piece as it passes through the working pass of the cross-rolls, means borne by said frame for supporting said disc in a plane substantially parallel with the line of pass through the cross rolls, means for adjusting said disc transversely of said line of pass, means for adjusting said disc toward and from the line of pass, means for adjusting the disc axially of the line of pass and means for rotating said disc at peripheral speeds in excess of the longitudinal progression of a workpiece effected by the cross-rolls.

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