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METHOD OF SINKING TUBES

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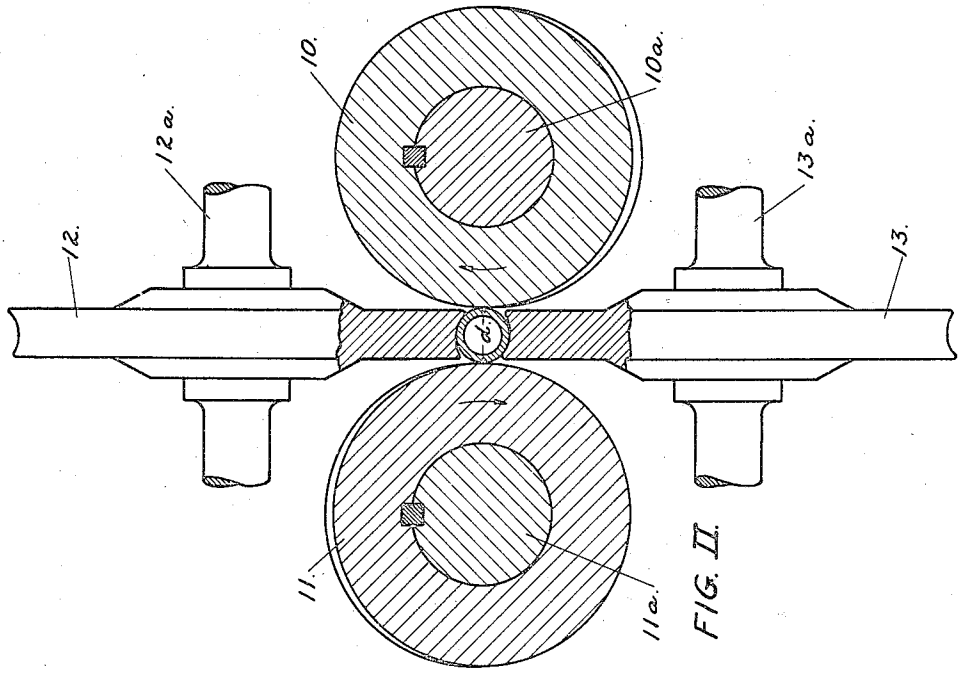


FIG. II.

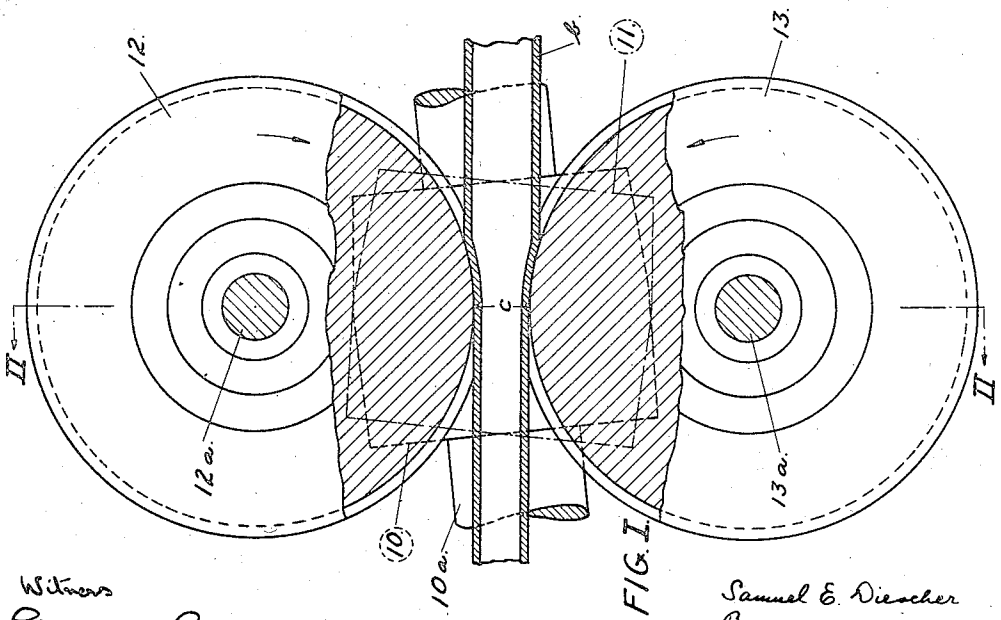


FIG. I.

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1,934,844

METHOD OF SINKING TUBES

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Application August 6, 1932. Serial No. 627,718

4 Claims. (Cl. 80—62)

My invention pertains to methods of "sinking" tubes, that is to say performing upon tubes the operation of reducing their external and internal diameter by the application of exterior pressure in a direction which is, broadly speaking, radial of the tube.

In a common method of sinking tubes a series of pairs of grooved rolls are employed, the rolls constituting each pair being opposed and set with their axes parallel and at right angles to the direction of movement of the tubes so that there is enclosed between them a space which is of a generally circular character, though not often absolutely circular. The circumference of this space is less than that of the tube entering the particular pair of rolls, so that the tube is compressed by the rolls and its external and internal diameters are reduced. The shaping of the grooves of the rolls is such that the space between each pair is less than that between the preceding pair of the series, the result being that the tube, in passing through the successive pairs, is progressively reduced until the desired external diameter is reached. The successive pairs of rolls are disposed so that the axes of the rolls of any pair extend at an angle to the axes of the rolls of the next pair, usually at right angles. The rolls are disposed in this manner with the intention that any deformation of the tube, by one pair of rolls, in or about the plane between such rolls will be corrected by a succeeding pair of rolls, the plane between which will be at an angle to the plane between the first pair. As far as exterior shape is concerned, the results obtained, in this respect, are reasonably satisfactory, though shaping rolls, succeeding the train of reducing rolls, are usually required to bring the sunk tube to a final exterior shape as nearly circular as possible.

The foregoing method of sinking tubes has many drawbacks, the majority, and perhaps all, of which occur also in the practice of other sinking methods. The following are some of these drawbacks.

First.—In order to obtain a given reduction of external diameter, the tube must be passed through a relatively large number of reducing rolls, followed by shaping rolls. These are expensive to maintain, especially as wear of the roll-faces can not be taken up by adjustments, it being necessary to regrind the rolls when they become materially worn.

Second.—The wear on the grooved roll-faces is heavy. This is largely because only in its pitch plane (a plane intermediate the bottom and the top of the groove) does any roll move at a peripheral speed equal to the longitudinal speed of the tube. The portions of the grooved surfaces of each roll from the pitch plane to the top of the groove move faster, and the portions from the pitch plane to the bottom of the groove move slower, than the tube. The result is a relative sliding movement, between the rolls and the tube, which causes rapid wear of the rolls. As has been said, such wear cannot be taken up by adjustment.

Third.—Even though the finished tube be circular outside,—a result in itself difficult to obtain by the method under consideration,—it is not circular inside. This is because any one pair of reducing rolls compresses and deforms the metal of the tube in or about a plane passing between the rolls, thickening the walls of the tube to a greater extent in or about this plane than elsewhere. When the tube passes through a succeeding pair of rolls, the plane between which is at an angle to the plane between the preceding pair, any exterior protuberance produced by the first pair of rolls is compressed into line with the remainder of the surface of the tube, but, because of the wall having been thickened in that region, only at the expense of a corresponding interior protuberance. The result, therefore, is that the finished tube has a number of small interior longitudinal thickenings, causing, under heavy reductions, the bore of the tube to tend to assume a rectangular shape. In order to lessen this disadvantage, and also the disadvantage arising from the relative sliding movement between the rolls and the tube, it has been proposed to employ, instead of the pairs of reducing rolls, what are known as "quarto" rolls, that is to say groups of four rolls embracing the tube. But the resulting machinery is exceedingly complex, and, in any case, the troubles are only reduced, not eliminated.

Fourth.—Since the tube is being operated upon by a number of pairs of reducing rolls simultaneously as it passes through the sinking mill and is somewhat reduced and elongated by each pair, the various pairs of rolls should be driven at correspondingly different relative speeds. It is practically impossible to drive the rolls at exactly the right relative speeds. Therefore, since longitudinal compression of the tube between successive pairs of rolls would be undesirable, it has been the practice to set the relative speed of the rolls so that the tube is under some tension between the successive pairs of rolls. This results in a stretching of the tube, and such stretching of the tube results in the finished tube having a portion at

each end which is of greater wall thickness than the main body of the tube, due to the fact that the leading end portion and the trailing end portion of the tube are not stretched as much during their passage from one to another of the pairs of rolls as is the main body of the tube. In many instances these thicker ends of the tube must be cut off, with a resulting considerable waste of material and labor.

It is the object of my invention to provide a method of sinking tubes which will avoid the above-mentioned and other drawbacks which have characterized, not only the common method of sinking above-referred to, but such other sinking methods as have come under my observance; which will permit tubes to be sunk rapidly, sometimes by a single pass through the rolls and always with much fewer passes than have heretofore been necessary; which will permit, for its practice, the use of apparatus capable of operating on and/or producing tubes of a variety of diameters merely by adjustments of such apparatus; and the practice of which will produce a tube that is truly circular, both within and without, and is of uniform thickness from one end to the other.

I obtain the above object by applying to the tube to be sunk the pressure of cross-rolls (which term, as used herein, is intended to include other rotating pressure members adapted to rotate the tube about its axis), such as are used in the piercing of billets and the elongating of tubular blanks, and at the same time confining the tube between the cross-rolls by surfaces moving in the direction of the longitudinal movement of the tube.

In piercing billets and in reducing wall thickness of and elongating tubular blanks, a mandrel is employed in conjunction with the cross-rolls, and the metal against which the cross-rolls press is supported interiorly against such pressure by the mandrel. In sinking, however, no such interior support exists, and the pressure on the tube is limited to that which can be resisted by the tube itself. It has been sought heretofore to sink metal tubes in cross-rolling mills, but the efforts which have been made to do so have not, so far as I know, met with success. One reason for the failure to effect substantial sinking of tubes by cross-rolling has been, as I believe, that, unless the tubes have very thick walls as related to the tube diameter,—a condition in which a sinking operation is hardly likely to be needed,—the grip of the cross-rolls on the unsupported wall of the tube cannot be sufficient to rotate and advance the tube against the frictional resistance of the fixed guides used for confining the tube between the rolls. Furthermore, even had the process been successful otherwise, the decrease of tube diameter, would have gone into increase of wall thickness to such an extent as to lessen the value of the process.

Tubes are sunk successfully by cross-rolling, according to the present invention, by reducing the peripheral friction between the tube and the guides, and pulling the tube forward in the direction of its movement longitudinally through the pass, by using for confining the tube between the cross-rolls guides which move in contact with the tube in the direction of its longitudinal movement and at greater speed. By providing such moving guides in the form of discs having suitably grooved peripheries set to engage the tube between the cross-rolls so as suitably to confine the tube at the place where it is subjected to the reducing pressure of the cross-rolls, and by driving the discs to rotate with a peripheral speed suitably in excess of the speed of longitudinal movement of the tube, the peripheral friction between the tube and the guides may be greatly reduced or even substantially eliminated, with the result that the rotating tube enters and passes freely between the guides and any such resistance to rotation of the tube by the guides as would interfere with the desired rotation of the tube by the rolls is prevented, and at the same time not only is longitudinal frictional resistance to the movement of the tube through the pass entirely avoided but the moving surfaces of the discs exert a positive forward pull on the tube, tending to accelerate its longitudinal movement through the pass. Moreover, the pulling action of the discs on the tube during the sinking operation results in a certain flow of the metal in a longitudinal and forward direction during the helical movement of the tube, with the result that the reduction of the diameter of the tube goes more into increased length and less into increased wall-thickness than would otherwise be the case.

I have heretofore pointed out that if the peripheral speed of the guide disc is made to equal approximately one-half the peripheral speed of the work-piece (the tube) divided by the sine of the average angle of the helix of feed of the work-piece through the pass, the condition under which frictional resistance peripherally of the work-piece is theoretically eliminated will obtain, provided the axis of rotation of the guide disc is perpendicular to the axis of the tube or other work-piece. The reduction of the peripheral friction is greatest during the first stages of the increase in speed of the guide disc and is but slight during the last stages as the speed approaches the theoretical figure of the formula; so that speeds much less than the formula speed are often sufficient for successful results.

The invention thus comprises a method wherein the tube is sunk by applying to successive portions thereof circumferentially acting forces which press inward the interiorly unsupported wall of the tube and rotate the tube and other, longitudinally acting, forces which confine the tube and pull it longitudinally forward.

My improved method is particularly adapted for the sinking of tubes having relatively thin walls. This operation, as stated above, has not been accomplished hitherto by means of cross-rolling because of the inherent difficulties encountered in the methods heretofore available.

In the present method the tube of thin walls that are entirely unsupported interiorly traverses a pass formed by surfaces moving in several directions and which confine the walls of the tube to such extent that the diameter is reduced and, at the same time, the tube is rotated and is moved longitudinally by the moving surfaces. The longitudinally movable surfaces pull the tube longitudinally to divert the reduced cross-sectional area into elongation and thus at least partially offset the tendency of the mill to thicken the walls of the tubes as the diameter is reduced by the pressure surfaces.

The practice of my invention will be the more readily understood by reference to the accompanying drawing, in which Fig. 1 is a side elevation, partly in section, of a cross-roll stand with a tube under sinking treatment in place therein, and Fig. 2 is a section on the line II—II of Fig. 1.

In the drawing, the reference characters 10 and 11 designate a pair of helically acting cross-

rolls, mounted on driven shafts 10*a* and 11*a*, respectively, disposed at an angle to each other and to the line of feed of a tube between them. They are shown as of "barrel" shape, but they might be of any other of the several shapes well known in cross-roll operations, and their place might be taken by discs operating helically in a manner that is also well known. Between these cross-rolls, which are rotated in the direction indicated by the arrows, the tube *b* to be sunk is entered. The tendency of the cross-rolls is to force the tube from a circular into an oval cross-sectional shape, and this is restrained by confining discs 12 and 13 mounted on shafts 12*a* and 13*a* and disposed in or about the plane intersecting the space between the rolls 10 and 11. The cross-rolls, being unable, because of the confining discs, to force the tube into the oval form which would correspond with the narrowing space between the cross-rolls on the entering side thereof, the tube is reduced in diameter and increased in length.

The confining discs are driven in the direction indicated by the arrows, i. e., to move in contact with the tube in the direction of the longitudinal movement of the tube, at a peripheral speed in excess of the speed of longitudinal movement of the tube, in order to reduce friction peripherally of the tube between the latter and the confining discs and to pull the tube forward. As shown, the distance, *c*, between the confining discs at their closest points is equal to the width of the throat of the rolls, i. e., the distance, *d*, between the cross-rolls at their closest points. In those circumstances, and the confining discs being disposed, in the example shown, so that a plane including their axes passes through the throat of the rolls, the tube will be maintained circular while in the throat of the rolls. The confining discs may, however, be adjusted otherwise than as shown,—as, for instance, somewhat wider apart so as to permit some ovality of the tube when the latter is confined in the shortest space between them. This will lessen the reduction of tube diameter, for any given setting of the cross-rolls, but has the advantage of providing a ready means for precisely controlling the diameter of the product without resorting as well to an adjustment of the cross-rolls. In thus variously placing the discs, both as to the distance separating them and in other respects, apparatus according to the invention of my co-pending application Serial No. 631,511, filed September 2, 1932, may be employed.

By the method of this application I am enabled to reduce tubes very considerably in a single pass through the cross-rolls,—as much, for instance, as would require a number of passes through the grooved rolls of an ordinary sinking mill. Moreover, the resulting tube is perfectly circular both inside and outside, and is of uniform wall thickness from one end to the other. By simple adjustment, the same mill becomes available for varying diameters of workpiece and/or product, and wear of the rolls or discs can be readily taken up. The method is applicable to the sinking of tubes either in the hot or the cold state.

I claim:

1. The method of sinking tubes, which comprises subjecting the tube to forces acting on opposite sides of successive portions thereof to press inward the interiorly unsupported wall of the tube and to rotate the tube, and simultaneously subjecting the successive portions of the tube to other forces acting to confine the tube exteriorly and to pull the tube longitudinally forward in the pass.

2. The method of sinking tubes, which comprises subjecting the tube to the action of helically acting cross-rolls bearing on opposite sides of the tube with the wall of the tube unsupported interiorly against the pressure of the cross-rolls, and exteriorly confining the tube between the cross-rolls and pulling it forward in the pass by surfaces moving in the direction of longitudinal movement of the tube and at greater speed.

3. The method of sinking tubes, which comprises passing an interiorly unsupported tube through a pass of smaller diameter than the tube formed in part by moving surfaces having a movement principally in the direction to rotate the tube about its axis and in part by moving surfaces having a movement principally in the direction of the longitudinal movement of the tube through the pass.

4. The method of sinking tubes, which comprises passing an interiorly unsupported tube through a pass of smaller diameter than the tube formed in part by surfaces of cross-rolls set to rotate the tube about its axis and in part by moving surfaces having a movement principally in the direction of the longitudinal movement of the tube through the pass.

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