Nov. 10, 1936. W. J. ASSEL 2,060,768

TUBE MILL

Filed Aug. 7, 1936 3 Sheets-Sheet 1

Fig. 1.

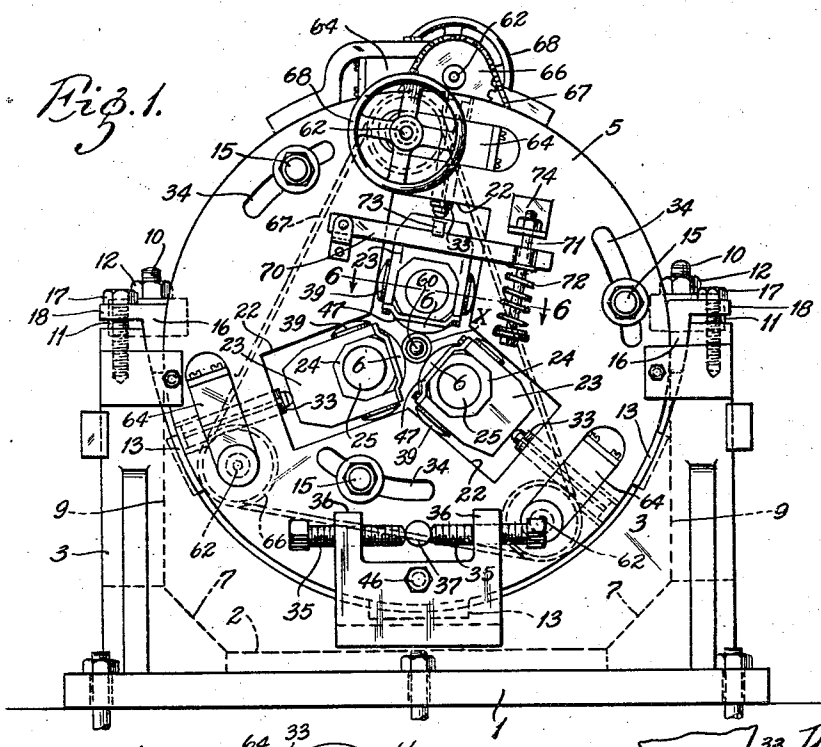


Fig. 2.

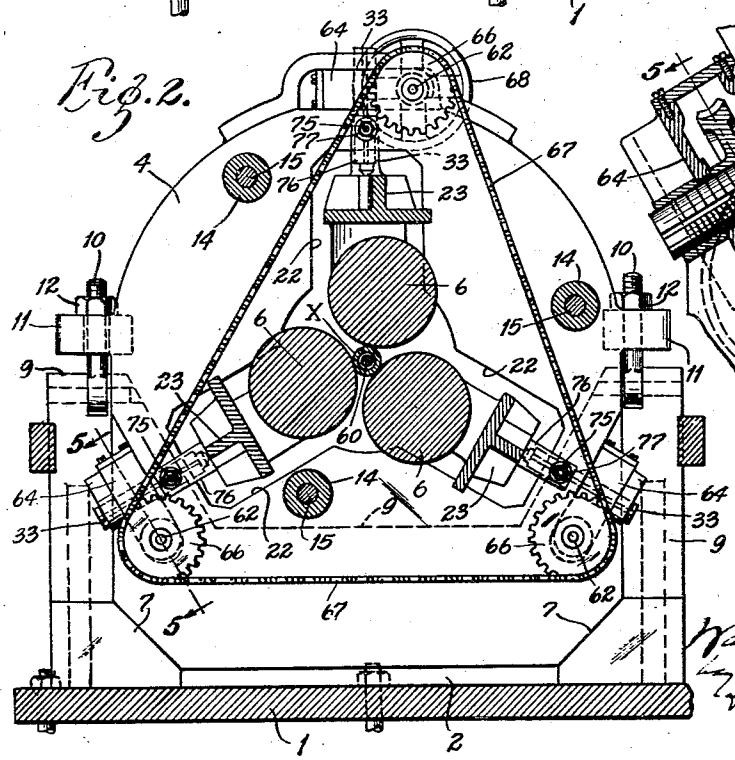
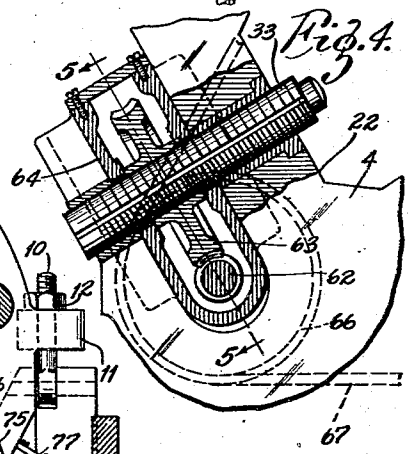


Fig. 4.



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TUBE MILL

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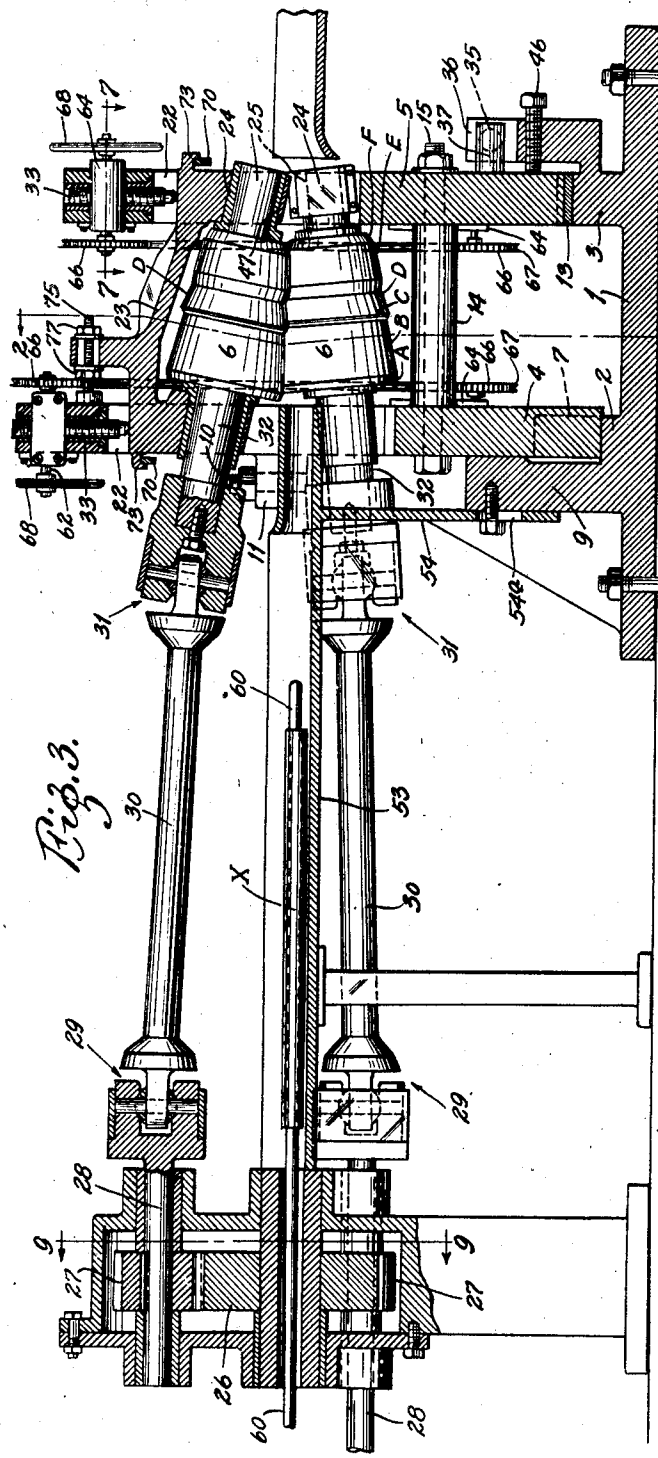


Fig. 3.

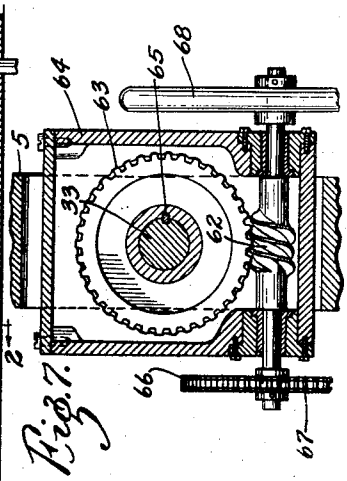


Fig. 7.

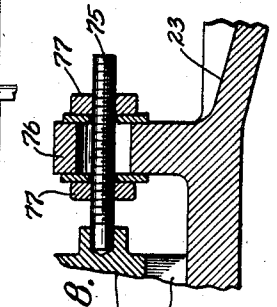


Fig. 8.

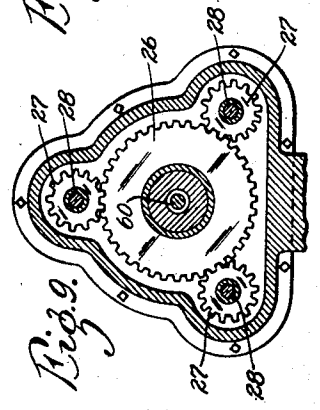


Fig. 9.

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TUBE MILL

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Fig. 5.

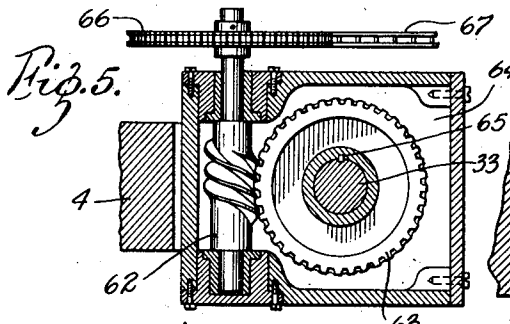


Fig. 6.

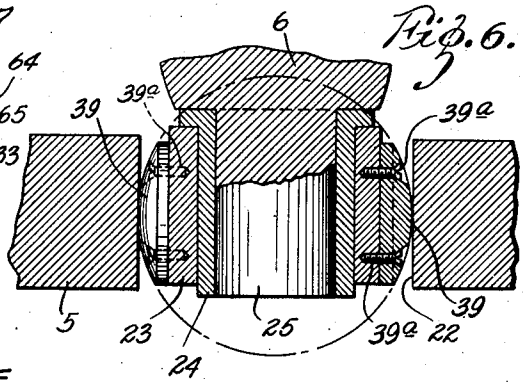


Fig. 10.

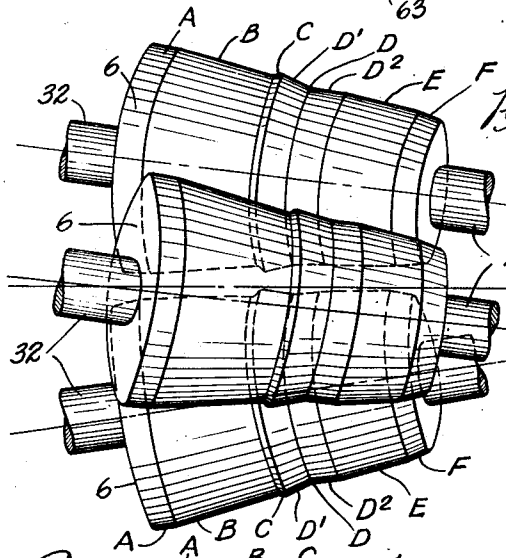


Fig. 12.

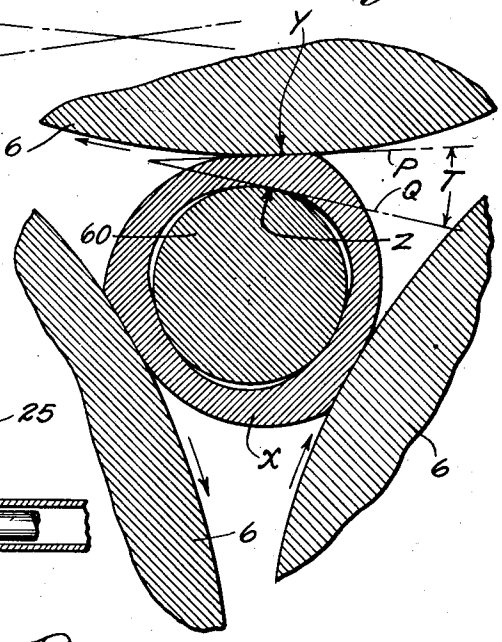


Fig. 11.

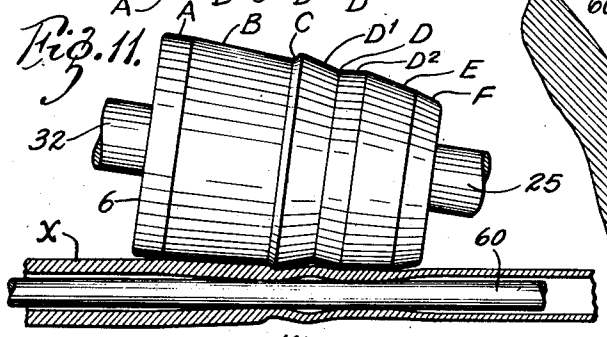
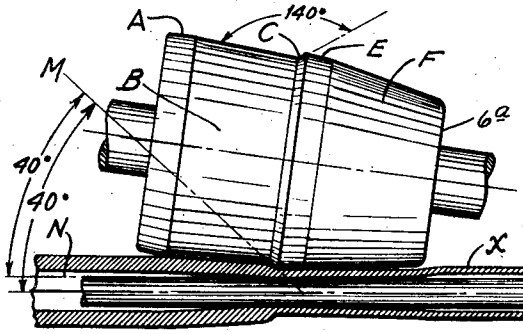


Fig. 13.



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Patented Nov. 10, 1936 2,060,768

UNITED STATES PATENT OFFICE

2,060,768

TUBE MILL

Walter J. Assel, Canton, Ohio, assignor to The Timken Roller Bearing Company, Canton, Ohio, a corporation of Ohio

Application August 7, 1936, Serial No. 94,841

15 Claims. (Cl. 80—13)

This is a continuation in part of my application for patent for Process of rolling tubes and rods, Serial No. 656,899 filed February 15, 1933 and of my application for patent for Tube mill, Serial No. 727,934 filed May 28, 1934.

My invention relates to the manufacture of seamless tubing. Heretofore the usual practice of manufacturing seamless tubing has been to make a rough and relatively short and thick-walled tube, as by means of the well-known Mannesmann piercing machine, the Stiefel disc piercing machine, or by press piercing, then pass the rough tube through a tube rolling mill to lengthen the same and decrease the wall thickness thereof, and then pass it through a reeling machine to make the tube round and even up irregularities of thickness. The efficiency of tube rolling mills heretofore used is limited by the practical necessity that the work must be passed through the mill repeatedly and in some cases must be reheated on account of the loss of heat occasioned thereby.

The principal object of the present invention is to devise a mill which will perform all the functions of the tube rolling mill and of the reeling machine in a single pass of the work therethrough. Other objects are to devise such a tube rolling mill that will be simple in construction, adjustable for use for producing tubes of different diameters and wall thickness with the same set of rolls, and efficient and economical in operation, and will produce work of more uniform wall and superior quality. The invention consists in the parts, arrangement and combination of parts hereinafter described and claimed.

In the accompanying drawings, wherein like numerals refer to like parts wherever they occur,

Fig. 1 is an elevation of my mill facing the rear or delivery end thereof and with the outlet guide removed;

Fig. 2 is a vertical cross-section of the mill on the line 2—2 of Fig. 3;

Fig. 3 is mainly a longitudinal vertical sectional view but showing some of the parts, including the rollers, in side elevation;

Fig. 4 is a fragmentary sectional view illustrating the worm gearing for rotating the cradle adjusting screw;

Fig. 5 is a cross-section on the line 5—5 in Fig. 4;

Fig. 6 is a fragmentary section on the line 6—6 in Fig. 1;

Fig. 7 is a horizontal section on the line 7—7 in Fig. 3;

Fig. 8 is an enlarged fragmentary sectional view illustrating the arrangement for adjusting the cradle endwise;

Fig. 9 is a vertical cross-sectional view of the driving mechanism, the section being taken on the line 9—9 in Fig. 3;

Fig. 10 is a diagrammatic top plan view showing the grouping of the working rolls;

Fig. 11 is a longitudinal sectional view along the line of contact of one roll with the work piece;

Fig. 12 is a diagrammatic view illustrating the transverse flow angle; and

Fig. 13 is a view similar to Fig. 11 showing a modified form of roll with certain angles indicated thereon.

The base 1 of my machine has upstanding members spaced apart and constituting the end frames 2, 3 on which the housing members 4, 5 for the working rolls 6 of the mill are supported. The front roll housing member 4 is a thick vertically disposed plate with vertical sides and with a horizontal bottom and beveled lower corners 7 that fit in a correspondingly shaped seat provided therefor on said frame.

Welded to or otherwise mounted on the base 1 forward of the front roll housing member 4 is a thick forked plate 9 whose sides extend upwardly about as high as the longitudinal axis of the mill; and at the top of each of said sides is pivotally mounted a threaded eyebolt 10 in position to swing into a slot provided therefor in a lug 11 on the side edge of said front roll housing member. When said bolts are engaged in said slots and their nuts 12 tightened, the front housing member 4 is firmly clamped against its seat. The rear roll housing member 5 is preferably made of a thick disk or circular plate, whose periphery is seated on arcuate seats provided therefor on the base or preferably on three arcuate bearing blocks 13 detachably provided therefor in said base. The end members of the housing are spaced apart preferably by tubular spacing members 14 welded to the front housing member 4. Extending through said spacing members are threaded through bolts 15 which serve to clamp the rear end housing member 5 against said spacing members, whereby the two end housings 4 and 5, together with the rolls 6, are adapted to be mounted on and removed from the base 1 as a unit, thus facilitating roll changing by substituting one preassembled unit for another.

The rear end frame 3 of the base 1 extends upwardly at its sides above the horizontal diameter of the rear roll housing member 5, which is firmly clamped in place by means of wedge blocks 16 interposed between the periphery of said

housing member and the edges of said rear end frame. The upper portion of said wedge blocks are located above the horizontal diameter of the rear end frame 3 and are secured to the top of the main frame by cap screws 17 that extend through perforated lugs 18 provided therefor on said wedges into threaded holes in the top of said rear end frame. Thus, both end members of the housing are firmly clamped in place.

Each roll housing member is provided with equidistant radially disposed slots or windows 22 constitutng guideways for the cradle members 23. These cradle members extend from the front roll housing member 4 to the rear roll housing member 5 and their ends have sliding engagement in the outer portions of said guideways. As shown in Fig. 6, the inner faces of the end portions of said cradle members 23 are shaped to form seats for bearing members 24 for the necks 25 of working rolls 6 hereinafter described. Preferably there are three working rolls 6, each being mounted in the radial guideways 22 in the front and rear roll housing members. These rolls are equidistant from one another and from the longitudinal axis of the mill. The axes of the working rolls 6 are not parallel with one another and are not in radial planes through the longitudinal axis of the mill; but they all incline rearwardly of the mill, that is to say, in the direction of longitudinal movement of the work piece, toward the longitudinal axis of the mill and they all skew a few degrees from any plane through said axis. This skew setting in operation is known as the feed angle and controls the speed of the work through the mill.

Each of the tapered working rolls 6 is operatively connected to a driving means common to them all. As illustrated, the driving means comprises a large driven gear 26, having pinions 27 meshing therewith, one of these pinions constituting a drive gear. The shaft 28 of each pinion 27 is connected by a universal joint 29 to one end of a spindle 30, whose other end is connected by a universal joint 31 to an extension 32 of the neck of one of the working rolls 6. In this way, the working rolls are all driven at the same speed and in the same direction and may be shifted without affecting the drive.

Provision is made for adjusting the working rolls to accommodate work of different diameters, and to adjust the angular as well as the longitudinal setting of the rolls and also to adjust the skew thereof. Adjustment for work of different sizes is readily effected by means of screws 33 extending radially through the outer end walls of the guideways of the respective housing members 4 and 5 and constituting movable abutments for the ends of the respective cradle members 23. In order to adjust the longitudinal inclination of the axes of the working rolls, it is only necessary to change the setting of the screws 33 on one end housing member relative to the screws 33 on the other end member, thereby shifting the relative position of the two ends of the cradle members 23.

Each adjusting screw 33 of each roll housing member is adjusted by means of a worm 62 and a worm wheel 63 mounted in a suitable gear housing 64 fixed to said roll housing member. The adjusting screw slidably engages the bore of the worm wheel 63; and a key 65 is fixed in the bore of said worm wheel and slides in a keyway cut through the threads of said screw. By this arrangement, the worm wheel and screw rotate together, but the screw is free to slide longitudinally through the bore of the worm wheel. As it is desirable to adjust the respective ends of all the rolls 6 an equal amount, a single means is provided for simultaneously adjusting the three adjusting screws of each roll housing. Said means preferably comprises sprocket wheels 66 mounted on the inner ends of the shafts of the worm 63, an endless sprocket chain 67 passing around said sprocket wheels, and a hand wheel 68 fixed to the outer end of one of the worm shafts. By this arrangement, rotation of the hand wheel 68 on each roll housing member brings about an equal adjustment of the three roll adjusting screws thereon.

In order to adjust the skew or lateral angularity of the axis of the work rolls relative to the axis of the mill, the front and rear end members of the roll housing are made relatively rotatable to a limited extent. For this purpose, the rear housing member 5 is provided with elongated arcuate slots 34 through which the through bolts 15 inside the tubular spacing members 14 extend. When these through bolts 15, wedges 16 and screws 35 and 46 hereinafter referred to are loosened, the rear housing member 5 of the roll housing may be turned enough relative to the front housing member 4 to give the axes of the working rolls the required equal degree of skew, whereupon the through bolts 15, wedges 16 and screws 35 and 46 are tightened to clamp the parts of the roll housing in adjusted position. This rotary or turning movement is facilitated by the screws 35 which work in lugs 36 on the frame on opposite sides of a pin 37 or lug provided therefor on said rear end member of the roll housing.

In order to accommodate adjustment of the skew and inclination of the working rolls, spherical bearings are interposed between the ends of the respective cradle members 23 and the slots or guideways 22 in the end members of the roll housing members. Each of such bearings comprises spherical faced plates 39 interposed between each side of the cradle member and the adjacent wall of the guideway 22 in the housing members. Plates 39, which are attached to the ends of the cradle member by means of countersunk screws 39a, have their convex faces disposed in a spherical surface about a center on the axis of the roll. By this arrangement, each cradle member is pivotally or universally connected at its ends to the respective end members of the roll housing, thereby permitting the cradle member to slide and to cock as far as the various adjustments may require.

In order to keep the rolls in proper position, suitable straps 47 are mounted on the ends of the cradles inwardly of the bearing members or boxes 24 of the roll necks 25. Likewise, to support the weight of the top roll and spindle, a bar 70, which is pivoted at one end and supported by a bolt 71 and a spring 72 at the other end, bears against a lug 73 on the cradle member. By tightening up the bolt and the spring against a lug 74, which is fixed to the housing member, the cradle is held against the screw.

Each cradle member, together with the roll therein, is properly adjusted and fixed longitudinally, preferably by means of a screw 75, which is fixed to the front housing member 4 and passes through an enlarged hole in a lug 76 on the cradle member. Nuts 77 are threaded on the screw on opposite sides of the lug 76. By adjusting and tightening these nuts against the lug 76, the longitudinal position of the cradle member may be

fixed. A horizontal screw or screws **46** are provided in the rear of the base member opposite the rear end member of the roll housing so as to constitute an adjustable abutment therefor.

The mill is provided with a feed trough **53** which supports the work and centers it in the mill. In order to adapt this feed trough to work of different sizes, the delivery end thereof is vertically adjustable. For this purpose, said end is supported by a plate **54** which is provided with an elongated vertical slot or slots **54***a* through which extend locking screws or bolts arranged to clamp said plate to the frame of the mill. By this arrangement, the trough supporting plate may be adjusted to higher or lower positions as occasion requires.

Each of the working rolls **6** is of conical general form with its surface divided into zones with different functions. The first zone A, being the zone at the front or large end of the roll, is preferably a narrow zone of cylindrical shape which, in cooperation with like zones on the other working rolls, serves to facilitate the entry of the end of the work piece X between the rolls.

The next adjacent zone B is of conical form with a taper toward the rear of the machine slightly less than the angle between the axis of the roll and the axis of the machine. This angle is illustrated as being approximately 10°, but may be varied to meet requirements. The main functions of this zone B are to grip or frictionally engage the work piece and cause it to rotate on its own axis and to feed it longitudinally; but a secondary function is to press the wall of the tubular member against the mandrel preparatory to the main reduction that is effected by the next zone C. Accordingly, the rolls, when assembled, are so set that the pass-forming portions of their zones B converge slightly.

Zone C is a relatively narrow zone in the form of a steep conical shoulder which, in the particular design of roll illustrated in Fig. 11, makes an angle of approximately 120° to zone B and thus, when the rolls are assembled, makes an angle of about 60° to the axis of the machine. The main reduction of diameter of the work piece is effected by this shoulder which constitutes zone C, the amount of such reduction in diameter being double the height of the shoulder. When assembled in the mill, the rolls are adjusted so that their shoulders will form the gorge of the pass; that is, the pass-forming portions of the shoulders will lie in substantially the same plane perpendicular to the axis of the pass and present abruptly converging surfaces in the path of the peripheral portion of the work piece. In this position, the points of intersection of the proximate surfaces of the pass-forming portions, with any plane normal to the pass line or axis of the pass, lie in a circle in the plane having the point of intersection of the pass line as a center, the proximate surfaces of the feeding zones being nearly parallel with the axis of the pass but converging rearwardly to a slight extent.

The fourth zone D is in the form of a shallow groove, preferably made with a conical band D^1 next to the shoulder and with a greater taper (say 120°) than the general taper of the roll and with a second band D^2 which may be cylindrical. The main purpose of this depression is to keep the work roll free from contact with the portion of the work piece that is just past the shoulder thereby avoiding changing the peripheral speed of the work piece with consequent twisting thereof.

The fifth zone E is of conical form with an angle of taper substantially equal to the angle between the axis of the working roll and the axis of the machine, whereby the portion of its surface in contact with the work is substantially parallel with the axis of the work. This zone E has three principal functions: namely, first, to frictionally engage and rotate the work at approximately the same speed ratio as that of zone B, whereby the tendency of the work to twist is minimized; second, as in the case of zone B, it helps to feed the work piece longitudinally; and third, zone E smooths down any ridges and unevenness of surface and rolls out any unevenness of wall thickness and causes the tube to balloon slightly so that it is loose on the mandrel and can be easily stripped therefrom.

The last zone F is a relatively narrow band which tapers toward the axis of the roll at a greater angle than zone E, whereby the tip of the roll is further from the axis of the mill than the machine zone E. An important purpose of the zone F is to insure the roundness of the work piece, especially in the case of tubes, whose shape in cross-section opposite zone E is triangular or polygonal.

In the set position of the helically acting rolls, the working faces thereof in their active positions form the exterior of a tubular pass and the mandrel forms the interior of said pass, and together the rolls and mandrel form three successive pass zones. In the first pass zone, the rolls and mandrel are shaped to form cooperating active faces substantially parallel to each other and to the line of pass to feed the blank longitudinally. In the second pass zone, the rolls and mandrel are formed to converge abruptly in the direction of longitudinal movement of the work piece to reduce the wall thickness of the blank without material expansion. In the third pass zone, the rolls and mandrel are shaped to form cooperating faces substantially parallel to each other and to the line of pass to feed the reduced blank longitudinally and smooth its inner and outer surfaces.

The operation of the mill hereinbefore described is as follows:

Assuming the work piece X to be a pierced billet, a cylindrical mandrel **60** is inserted therein, said mandrel being urged forwardly along the feed trough by any suitable device. This mandrel travels with the work piece, affords interior support for the wall of the work piece and cooperates with the rolls as the inner member of the pass formed thereby. The end of the work piece enters longitudinally between the zones A of the rotating working rolls **6** and is frictionally engaged by the zones B thereof which feed it along and cause it to rotate on its own axis and incidentally reduce its wall thickness slightly. When the work presses against the oblique shoulders, being zones C of the working rolls, the metal is squeezed or rolled thereby to a smaller diameter. The effect of this rolling is to greatly lengthen the work piece, reduce its wall thickness and reduce its general diameter, leaving it out of round and with unevenness in its periphery. When the work piece reaches zone E, the frictional engagement thereof with the work piece rotates such work piece on its axis, feeds it longitudinally, smooths its surface, and evens up the wall thickness and slightly increases the circumference. The rearmost zones F bring the work piece to true roundness.

As the taper of the rear portion E of the working rolls is the same as the angle between the

axis of the mill and the axes of the rolls but closer to the axis of the mill, enough "ballooning", that is, increase in the diameter of the bore of the work, takes place at this point of the operation to permit easy removal of the mandrel from the finished tube.

The specific design of roll illustrated in Fig. 11 is especially adapted for reducing light-walled tubes and the groove zone D thereof is intended to eliminate twisting of the tube due to the abrupt increase in peripheral speed of the roll at this point if the tube was in tight contact with the roll. Such grooved zone D is not needed nor is it desirable for use with thick-walled tubes for such tube is strong enough to resist the twisting in which case the work roll is modified as illustrated in Fig. 13. Except for the omission of the grooved zone D, the roll 6a of Fig. 13 is substantially similar to the roll of Fig. 11, heretofore described. However, its conical shoulder C is shown as making an angle of about 140° with the feeding zone B and thus, assuming the taper angle of the feeding zone to be about equal to the inclination angle of the roll, the conical shoulder makes an angle of about 40° to the axis of the work. This angle of 40° is equal to the longitudinal flow angle of the pass; namely, the angle between the line N in which a radial plane through the axis of the pass intersects the outer surface of the mandrel and a second line M in which said plane intersects the inclined surface of said shoulder. The numerical value of this longitudinal flow angle admits of considerable variation. On the one hand, it must be such that the length of the shoulder along the pass line is greater than the advance of the tube from roll to roll, and preferably greater than the angle of friction between the metal being worked and the roll surface so that the metal can flow longitudinally from under the impinging shoulder of the roll; and as the angle of friction between hot steel and the roll surface is about 22°, the lower limit of this angle is about 22°. On the other hand, it is important that the longitudinal flow angle shall be greater than the transverse flow angle in order to favor longitudinal flow or elongation of the metal, rather than transverse flow, causing ballooning of the tube. The term "transverse flow angle", as used herein in connection with tubing, is the angle T between two lines in a plane through the middle of the shoulder perpendicular to the axis of the pass, one of said lines P being tangent to the work roll at the middle Y of its arc of contact with the work and the other line Q being tangent to the mandrel at the middle Z of its arc of contact with the work (see Fig. 12). Under ordinary working conditions, the transverse flow angle is so low that satisfactory elongation of the work can be effected when the longitudinal flow angle is as low as 30°. Accordingly, the word "steep" as applied to the shoulder is to be taken as including any angle which, in the set position of the roll, will produce a longitudinal flow angle of from about 30° to about 70°.

It is noted that steel billets are worked hot but that copper and other soft metals may be worked cold.

While my invention is especially useful for elongating tubes, it is applicable also to elongating solid rods, in which case, of course, the mandrel is dispensed with.

What I claim is:

1. A rolling mill comprising a plurality of rolls similarly arranged equidistantly from the axis of the pass with their own axes askew with relation to the planes of said axis, each roll having a relatively wide work feeding zone at its front end and a narrow truly conical work reducing zone contiguous with the rear end of said work feeding zone, the proximate portions of the surfaces of the feeding zones of the respective rolls being nearly parallel with the axis of the pass but converging in the direction of longitudinal movement of the work piece to a slight extent, and the proximate portions of the surfaces of the respective reducing zones converging in the direction of longitudinal movement of the work piece toward one another at a steep angle to the axis of the pass.

2. A rolling mill comprising a plurality of rolls similarly arranged equidistantly from the axis of the pass with their own axes askew with relation to the planes of said axis and inclining rearwardly toward the axis of the pass at an angle approximately equal to half the angle included between the lines of intersection of planes passing through the roll axis, with the taper surfaces of the respective rolls, each roll having a relatively wide work feeding zone at its front end and a truly conical narrow work reducing zone contiguous with the rear end of said work feeding zone, the proximate portions of the surfaces of the respective feeding zones being nearly parallel with the axis of the pass and the proximate portions of the surfaces of the respective reducing zones converging in the direction of longitudinal movement of the work piece at an angle in the neighborhood of sixty-five degrees to the axis of the pass.

3. A rolling mill comprising a plurality of rolls similarly arranged equidistantly from the axis of the pass with their own axes askew with relation to the planes of said axis, each roll having a relatively wide work feeding zone at its front end and relatively narrow work reducing zone which is contiguous with and of steeper inclination than said feeding zone; the points of intersection of the proximate surface with any plane normal to the pass line lying in a circle on the plane having the point of intersection of the pass line as a center, the proximate surfaces of the feeding zones being nearly parallel with the axis of the pass but converging in the direction of longitudinal movement of the work piece to a slight extent, and the proximate portions of the surfaces of the work reducing zones converging in the direction of longitudinal movement of the work piece toward one another more steeply than the convergence of the feeding zones, whereby feeding of the work is mainly effected by the feeding zones and the reduction of the work is effected mainly in the relatively narrow zone of the work piece opposite the working zones of the rolls.

4. A mill for elongating tubes and reducing the wall thickness thereof, said mill comprising a plurality of rolls similarly arranged equidistantly from the axis of the pass with their own axes askew with relation to the planes of said axis, each roll having a relatively wide work feeding zone at its front end with the proximate surfaces of the respective rolls nearly parallel but converging slightly in the direction of longitudinal movement of the work piece so as to rotate and feed the work without materially affecting its wall thickness, and means for concentrically decreasing the cross sectional area of the pass, said means having a surface which inclines in the direction of longitudinal movement of the work piece for a distance that is short relatively to the

width of the feeding zone and terminates the gorge of the pass, whereby the work of reducing the wall thickness of the work piece is substantially effected in the short zone of the work opposite said inclined surface.

5. A cross-rolling mill for elongating and reducing the wall thickness of a tubular blank, comprising a plurality of helically acting rolls provided with working faces which in their active positions form the exterior of a tubular pass, means for preventing said rolls from spreading apart, and a longitudinally movable mandrel lying in the pass and forming the interior thereof, the rolls and mandrel forming three successive pass zones in the first of which the rolls and mandrel are shaped to form cooperating active faces substantially parallel to each other and to the line of pass to feed the blank longitudinally, in the second of which the rolls and mandrel are formed to converge abruptly to reduce the wall thickness of the blank without material expansion and in the third of which the rolls and mandrel are shaped to form cooperating faces substantially parallel to each other and to the line of pass to feed the reduced blank longitudinally and smooth its inner and outer surfaces.

6. A mill for elongating and reducing the wall thickness of a tubular blank, comprising a plurality of helically acting rolls provided with working faces which in their active positions form the exterior of a tubular pass, means for preventing said rolls from spreading apart, and a mandrel lying in the pass and forming the interior thereof, the rolls and mandrel forming three successive pass zones in the first of which the rolls and mandrel are shaped to form cooperating active faces substantially parallel to each other and to the line of pass to feed the blank longitudinally, in the second of which the rolls and mandrel are formed to converge at an angle greater than the transverse flow angle between the mandrel and rolls to reduce the wall thickness of the blank without material expansion, and in the third of which the rolls and mandrel are shaped to form cooperating faces substantially parallel to each other and to the line of pass to feed the reduced blank longitudinally and smooth its inner and outer surfaces.

7. A work reducing mill comprising a frame, working rolls of general conical shape mounted on said frame equidistant from the axis of the mill and with their large ends on the entering side thereof, said rolls comprising two work driving zones and an intermediate reducing zone in the form of a steep conical shoulder facing the large ends of the rolls and extending radially beyond the driving surfaces of the roll, said rolls being disposed with their axes askew and at an inclination rearwardly to the axis of the mill so as to feed the work against said reducing shoulder and rotate the work at a rate that is substantially the same at the unreduced portion thereof as at the reduced portion thereof.

8. A tube rolling mill comprising a frame, working rolls of general conical shape mounted on said frame equidistant from the axis of the mill and with their large ends on the entering side thereof, said rolls comprising two work driving zones, an intermediate reducing zone in the form of a steep conical shoulder facing the large end of the roll and extending radially beyond the driving surfaces of the roll with an annular groove between said reducing zone and the rear work driving zone of smaller diameter than the front edge of said rear work driving zone, said rolls being disposed with their axes askew and at an inclination rearwardly to the axis of the mill substantially equal to the angle of the roll cone, whereby the rolls feed the work against said reducing shoulders and rotate the work at a rate that is substantially the same at the unreduced portion thereof as at the reduced portion thereof.

9. A tube rolling mill comprising a frame, working rolls of general conical shape mounted on said frame equidistant from the axis of the mill and with their large ends on the entering side thereof, said rolls comprising two work driving zones, an intermediate reducing zone in the form of a steep conical shoulder facing the large ends of the rolls and extending radially beyond the driving surfaces of the roll with an annular groove between said reducing zone and the rear work driving zone, and a rearmost zone of more oblique taper than said rear driving zone, said rolls being disposed with their axes askew and at an inclination rearwardly to the axis of the mill substantially equal to the cone angle of the roll, whereby the rolls feed the work against said reducing shoulder and rotate the work at a rate that is substantially the same at the unreduced portion thereof as at the reduced portion thereof.

10. A roll for rolling rods and tubes, said roll being somewhat larger at one end than at the other and having relatively wide work driving zones and also having a relatively narrow work reducing zone in the form of a steep shoulder between said driving zones and extending outwardly beyond the main surface of the roll and facing the large end of said roll, the working surface of said shoulder being substantially a zone of a cone whose apex lies in the axis of the roll near the large end thereof and the inner margin of said zone substantially coinciding with the main surface of the roll.

11. A roll for rolling rods and tubes, said roll being somewhat larger at one end than at the other and having a work reducing zone in the form of a steep shoulder extending outwardly beyond the main surface of the roll and facing the large end of said roll, the working surface of said shoulder being substantially a zone of a cone whose apex lies in the axis of the roll near the large end thereof, and the inner margin of said zone substantially coinciding with the main surface of the roll, said roll also having a work driving zone forward of said shoulder.

12. A roll for rolling rods and tubes, said roll being somewhat larger at one end than at the other and having a work reducing zone in the form of a steep shoulder extending outwardly beyond the main surface of the roll and facing the large end of said roll, the working surface of said shoulder being substantially a zone of a cone whose apex lies in the axis of the roll near the large end thereof and the inner margin of said zone substantially coinciding with the main surface of the roll, said roll also having a work driving zone in position to feed the work to said reducing zone.

13. A tube rolling mill comprising members arranged to form a pass for the work, means for effecting movement of said members transversely of the pass and means for effecting movement of the work longitudinally of said pass, the proximate surfaces of said members at the pass comprising a narrow zone of each pass-forming member which zones converge in the direction of longitudinal movement of the work piece rearwardly at a steep angle towards the axis of the

pass, and said surfaces being so disposed longitudinally of the pass that a plane normal to the axis of the pass will intersect all said proximate surfaces at points equidistant from the axis of the pass.

14. A tube rolling mill comprising members arranged to form a pass for the work, means for effecting movement of said members transversely of the pass and means for effecting movement of the work longitudinally of said pass, the proximate surfaces of said members at the pass comprising a narrow zone of each roll which zones converge abruptly in the direction of longitudinal movement of the work piece rearwardly towards the axis of the pass so as to concentrate the rolling pressure on a short length of the work and said surfaces being so disposed longitudinally of the pass that a plane normal to the axis of the pass will intersect all said proximate surfaces at points equidistant from the axis of the pass.

15. A tube rolling mill comprising members arranged to form a pass for the work, means for effecting movement of said members transversely of the pass and means for effecting movement of the work longitudinally of said pass, the proximate surfaces of said members at the pass comprising a narrow zone of each pass-forming member which zones converge in the direction of longitudinal movement of the work piece at a steep angle towards the axis of the pass and intersecting the same plane perpendicular to said axis at points equidistant therefrom.

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