ABSTRACT OF THE DISCLOSURE

Apparatus for reducing and elongating tubular stock and provided with a pair of opposed, oppositely inclined rotatable rolls forming a pass through which the stock advances and also provided with opposed rotatable disks at the roll pass for confining the stock therebetween has long been known. Such apparatus is disclosed, for example, in Letters Patent 1,870,209, issued Aug. 2, 1932, to Samuel E. Diescher and such apparatus is frequently known as a “Diescher” type mill.

While such apparatus has been generally satisfactory, it has not been widely used, despite the high quality of the tubing produced thereby, because of three principal factors: Firstly, productive output has been slower than that of other tube reducing and elongating apparatus. Secondly, maintenance has been costly because of the productive time lost in maintaining and replacing the disks which, by the very nature of the apparatus, are subject to relatively rapid wear. Thirdly, the manufacture of some of the larger tube sizes has been impractical.

SUMMARY OF THE INVENTION

While the use of modern disk materials and close control of the material of the tubing stock can reduce the frequency of disk maintenance and replacement, disk wear remains relatively rapid. It is, therefore, an object of the present invention to reduce the undesirable consequence of rapid disk wear by making disk removal and replacement far easier than before. The foregoing object is accomplished by rotatably mounting each disk in its own sub-frame which is easily removed from and replaced in its normal working position. Thus, when the working faces of the disks need attention, such disks along with their sub-frames may readily be removed and replaced with sub-frames mounting new disks or disks which have previously been put in working condition. The apparatus may then be placed in production once again while the worn disks are leisurely removed from their sub-frame, refinished or replaced as necessary, and then replaced in their sub-frames for subsequent future installation in the apparatus.

In addition to rendering disk replacement far easier and quicker than before, the present invention contemplates increased productivity, without loss of quality, by a novel method of rotation and advancement of the mandrel disposed within that tube being elongated. In apparatus of the present type, rotation of the tube and its rate of advancement through the pass formed by the working rolls and the tube-confining disks is a combined function of the peripheral speed of the working rolls, their angle of inclination, the exterior diameter of the tube being elongated, and the peripheral speed of the tube-confining disks. The mandrel, however, because of its mass, heretofore tended to retard both rotation of the tube and its longitudinal advance through the pass. Thus, production has suffered, especially where the mandrel has been long in length (for the manufacture of long tube sections) and/or where the mandrel has been large in diameter (for manufacture of large inside diameter tube sections). The improved method, therefore, lies in eliminating the retarding effect of the mandrel by rotating the latter at no less than the rotational speed imparted to the tube by working rolls and by advancing the mandrel at a speed no less than the longitudinal speed of the tube as it exits from the pass provided by the working rolls and the tube-confining disks.

These and other advantages of the present invention will readily become apparent from a study of the following description and from the appended drawings, and in these drawings:

DRAWING DESCRIPTION

FIG. 1 is a side elevational view, devoid of supporting structure, of the working rolls and disks used in apparatus of the present invention.

FIG. 2 is an end elevational view of the parts seen in FIG. 1 and generally corresponding to the line 2—2 thereof.

FIG. 3 is a fragmentary, generally diagrammatic side elevational view of apparatus embodying the present invention.

FIG. 4 is a view like FIG. 1, but with certain parts omitted.

FIG. 5 is a transverse section view, generally corresponding to the line 5—5 of FIG. 1, but showing supporting structure for the rolls and the disks.

FIG. 6 is a fragmentary section view generally corresponding to the line 6—6 of FIG. 5.

FIG. 7 is a view similar to FIG. 5 but showing certain parts in other positions.

FIG. 8 is a side elevational view of a sub-assembly.

FIG. 9 is an exploded view of the sub-assembly seen in FIG. 8 and with certain parts shown in section to better illustrate the underlying structure.

FIG. 10 is a fragmentary enlarged view, partially in section, of a modified sub-assembly, and

FIG. 11 is a view similar to FIG. 6 but of the modification seen in FIG. 10.

DETAILED DESCRIPTION

With reference to FIGS. 1 and 2, a pair of barrel-shaped, working rolls 10 are disposed in adjoining relation to define a pass therebetween for the tube T to be elon-
gated. Rolls 10 are disposed in opposed relation relative to the tube and their axes are inclined in opposite directions with respect to the tube axis, as best seen in FIG. 1 for reasons to appear. Although not shown, rolls 10 are adapted to be simultaneously rotated in the directions indicated by any suitable means.

To prevent transverse movement of the tube from between the rolls 10, disks 11 are disposed in diametrically opposed relation for engagement with opposite sides of the tube being elongated at the pass provided by the rolls and are adapted to be rotated in the directions indicated by any suitable arrangement. Preferably, the peripheries of disks 11 are configured for conformity with the exterior of the tube being elongated.

Assuming that the spacing between the rolls 10 is less than the transverse size of the entering tube and that the rolls and the disks are being rotated as indicated, a tube T will be fed from left to right between the rolls 10. Since the latter are inclined in opposite directions, they will not impart rotation to the tube, but will also draw the tube between the rolls and move it axially to the right. Since the spacing between the rolls is less than the transverse size of the entering tube, such tube will exit from the pass reduced in transverse size and elongated in length. In order to establish a definite limit in transverse size and elongation, a definite wall thickness of the exiting tube, a suitably sized mandrel 12 is disposed within the tube prior to passage thereof between the rolls 10, such mandrel rotating and moving axially with the tube as it passes through the rolls.

Turning now to FIG. 3, it is to be noted that the rolls 10 are rotatably mounted in a suitable housing or frame 13 and in the position of parts shown, a tube entry table 14 is disposed to the left of frame 13 while a tube exit table 15 is disposed to the right thereof. For supporting the rotating tube T, the exit table may be provided with the usual tube supporting rollers 16 or the like; however, at the entry table 14, a conveyor 17 mounts a series of V-blocks 18 in which the entering tube is cradled.

Slidably mounted on the entry table 14 in any convenient manner is a carriage 19 having a rotatably mounted head 20 engageable with the previously mentioned mandrel 12. A suitable drive motor 190 effects rotation of head 20 and consequent rotation of the mandrel 12 in a manner later to appear. The means presently provided for advancing the carriage 19 and the engaged mandrel to the right may comprise a link 21 connecting the carriage to the conveyor 17. Upon movement of conveyor 17 to the right as by a drive motor 22, the V-blocks cradling the entering tube will feed the latter from left to right into the pass provided by the working rolls 10 and the tube-confining disks 11 while the carriage 19, moving with the conveyor, will feed the mandrel 12 to the right with the tube. As will later appear, it is an important feature of the present invention that since the V-blocks 18 have only frictional engagement with the tube portion resting thereon, such blocks may move to the right at a rate of movement greater than the axial rate of movement to the right of the supported tube portion into the previously mentioned, working roll pass.

With reference now to FIG. 4 wherein but a single roll 10, the disks 11 and the tube T are shown, if it be assumed that the axes of rolls 10 are disposed at, for example, an angle of six degrees with the axis of the tube and if it further be assumed that rolls 10 are rotated at a peripheral speed of, say 1000 feet per minute and disregarding for the moment the disks 11, the tube will in theory be rotated by the rolls at the same peripheral speed as that of the rolls and a resultant movement will be developed which will in theory axially shift the tube through the pass provided by the rolls 10 at a rate of 105 feet per minute. In normal practice, however, the disks 11 are rotated in the directions indicated and at respective peripheral speeds considerably in excess of the rate of tube advance caused by the rolls and thus the tube is assisted in its passage between the rolls and the disks. By way of example, the "over-driven" disks 11 may cause the tube to advance beyond the pass at a rate of 135% of the theoretical rate resulting from operation of the working rolls alone. In the present example, therefore, the tube would be discharged from the pass at a speed of about 140 feet per minute.

While disks 11 can be driven at even greater speeds to still further increase tube output speed, the increased burning action may prove detrimental to the tube outer surface and, disk wear increases markedly to a point where the increase in tube output speed is offset by rapid disk wear.

It has been found that if the mandrel 12 disposed within the tube is rotated at a speed corresponding to the theoretical speed of rotation imparted by the rolls 10 and, if the mandrel is at the same time shifted axially in the same direction as the tube and at a speed corresponding to the speed at which the tube is discharged from the pass provided by the rolls 10, materially faster and higher quality production will result. By so rotational feeding the mandrel, its drag upon the tube is eliminated thus making possible throughput tube efficiencies of approximately 150% as against the prior art efficiency where the mandrel is allowed to float with the rotating tube. By releasing the friction developed therebetween. At the same time, the peripheral speed of disks 11 may be reduced somewhat thus improving their wear rate.

It is to be understood that since the tube is elongated in its passage through the roll disk pass, the tube will exit from the pass at a speed greater than the speed at which it enters the same. This results because the squeezing action of the pass on the tube causes metal flow in a reverse direction to tube movement and this flow causes a reduction in the rate of tube advance into the pass. Now, since the mandrel is being advanced by the carriage 19 attached to the conveyor 17 at a rate at least equal to tube exit speed, it follows that the conveyor must travel at a rate in excess of the rate of advance of the tube into the roll disk pass. It is for this reason important that the conveyor have only frictional engagement with the pass-entering tube portion to permit such differential speed.

It has been found that the mandrel is rotated at a speed equal to the rotational speed imparted to the tube by the working rolls and the mandrel is advanced at a speed equal to the speed at which the tube exits from the roll disk pass, it is to be understood that the present invention contemplates both rotation of the mandrel and advance thereof at even greater speed to still further increase tube throughput speed.

Referring now to FIG. 5, the rolls 10 are rotatably mounted in respective chocks 23 which are slidable along ways 24, formed in the previously mentioned housing or frame 13, toward and away from each other to vary the spacing between the rolls. The positions of chocks 23 along the ways 24 may be adjusted by any convenient means and, as herein disclosed, bearing supports 25 are rotatably anchored in respective chocks and pass through threaded apertures in respective bridging members 26 removably secured to the frame 13.

Disks 11 are also movable toward and away from each other to vary the spacing therebetween and since the structures mounting these disks are similar, that mounting the upper disk 11 will only be described in detail. Still referring to FIG. 5. but also referring to FIGS. 6 and 7, upper disk 11 is carried by a sub-frame 27 providing spaced arms 28 between which the disk is disposed. The free ends of arms 28 support a bridge 29 to provide seats 29 for receiving respective bearings 30. Only one of which can be seen in FIG. 5) mounted in axially spaced relation on a shaft 31. Disk 11, of course, is mounted on the shaft 31 intermediate the bearings 30 in a manner later to be described in detail. Bearing seats 29 are split longitudinally along the axis of shaft 31 to provide cap portions 32 removably secured in position by suitable fastening members 33. Shaft
is preferably elongated at 34 for removable connection to a suitable drive shaft which, however, is not shown in the drawings.

As herein shown, the central portion 35 of shaft 31 has a diameter greater than the outside diameter of bearing 30 for a purpose to appear and is further provided with a fixed shoulder 36 for abutting and axially locating the disk 11. The latter has a bore 37 closely fitting with shaft portion 35 and an internally threaded locking ring 38 is threaded upon shaft portion 35 to removably retain the disk assembled with the shaft. Although not shown, a suitable key or spline arrangement may be provided to insure against rotation between the shaft and the disk.

Means are provided for guiding vertical movement of sub-frame 27 and as best shown in FIG. 6, frame 13 is provided with an enlarged opening 39 for receiving the sub-frame, and pairs of opposed ribs 40 closely fit within respective slots 41 formed in the sub-frame and which extend longitudinally of respective sub-frame legs 28. In a manner similar to the chocks 23, the vertical position of sub-frame 27 may be adjusted by a screw threaded rod 42 which is rotatably anchored to the sub-frame and passes through a threaded aperture in a bridging member 43 removably secured to the frame 13.

Since the sub-frame mounting the lower disk 11 is identical to the upper one hereinabove described, corresponding parts are identified with the same reference characters as before but with the suffix “a” added. For reasons to appear, bridging member 43a is formed integrally with the main frame 13 rather than being separable therefrom as is member 43. Moreover, threaded rod 42a preferably is not rotatably anchored to the sub-frame 27a but merely bears against the lower end thereof. As hereinabove mentioned, disks 11 are prone to wear since they are generally driven at high rotational speed in excess of the speed of axial movement of the tube being elongated, accordingly, it is necessary to restore the working periphery of such disks at relatively frequent intervals and to replace them with new disks when they are no longer serviceable.

If only the upper disk need be serviced, the drive shaft (not shown) normally connected to the shaft 31 will be disconnected therefrom and the bolts securing the bridging member 43 will be removed to permit the entire sub-frame 27 with its disk to be raised along the ribs 40 until such sub-frame assembly is free of the main frame 13. A previously prepared, identical sub-frame assembly will next be lowered in place, properly secured in position and the drive shaft reconnected to the shaft 31 of such identical assembly whereupon production may be resumed.

The worn disk 11 may now leisurely be removed from its subframe by lateral movement of the shaft (see FIG. 9). With the shaft and disk removed as a unit from the sub-frame, the disk may readily be re-ground to restore its working periphery.

If, however, the disk 11 must be removed from the shaft for replacement, it is unnecessary to disturb either of the shaft bearings 30. In such event, the locking ring 38 will be unscrewed from the shaft and then disassembled therefrom by axial movement to the left, in the position of parts seen in FIG. 9. With the ring 38 removed, the disk 11 will follow in the same manner. Remover 45 will be removed from the ring and the disk from the shaft as above described is made possible by reason that the external diameter of the left-hand bearing 30 is shown at 44 to be less than the diameter shown at 45 of the disk bore 37. With the new disk installed on and secured to the shaft 31, the latter will be reassembled with its sub-frame by a reversal of the above-described operations and the now completed sub-frame assembly may be stored until it is to be substituted for the assembly then in use.

Although removal and replacement of only the upper disk 11 has been described it is much more common to replace both disks at the same time in view of the fact that both will wear at about the same rate. Accordingly, following removal of the sub-frame 27 from the main frame 13 as previously detailed, the chocks 23 mounting the ribs 10 will be shifted from their normal positions seen in FIG. 5 to the widely spaced-apart positions seen in FIG. 7. With the chocks 23 thus separated, sub-frame 27a may be raised along its ribs 40a, passed between the ribs 10, and removed from the main frame. A previously prepared sub-frame assembly may now be substituted for the one just removed and following removal of the lower sub-frame 27a to their normal positions and installation of the upper sub-frame assembly, production may be resumed. The previously removed lower sub-frame assembly may now be disassembled for necessary repair or replacement of parts heretofore described with respect to the upper sub-frame and then re-assembled, may be stored for subsequent reuse.

To facilitate removal of the lower sub-frame assembly from the main frame as above described, the sub-frame may be dimensioned to pass freely between rather than slidably along the main frame ribs 40 which cooperate with the upper sub-frame. Such construction, of course, would require the main frame ribs 40a to be dimensioned to slidably fit with the lower sub-frame.

In the embodiment of the invention seen in FIGS. 10 and 11 wherein corresponding parts are identified by the same reference characters as before but with the suffix “1” added, the right-hand bearing 301 is not mounted directly in the seat 291 of the sub-assemble leg 281 but instead is mounted in a sleeve 46 which is in turn disposed in the leg seat 291. Sleeve 46, however, is not tightly gripped in the leg seat 291 but rather is slidably axially therein for a purpose to appear.

Removably secured within the right-hand end of sleeve 46 by any suitable means, as by threading the parts together, is a plate 47 to which is anchored an adjustment screw 48. Secured to the leg 281 in concentric relation with the sleeve 46 is a housing 49 rotatably mounting a worm gear 50 having threaded engagement with the right-hand bearing 301. A worm 52 the engaging worm gear 50 and has operative connection with an adjusting shaft 52 whereby rotation of the latter effects rotation of the worm and consequent rotation of the worm gear. Although not shown, the bearing 301 in the other sub-assemble leg 281 may be axially slidable within its seat in the leg to provide for axial movement of the shaft 311 as will next appear.

With the construction seen in FIG. 10, rotation of the worm gear 50 will effect axial movement of the screw 48 and consequent axial movement of the shaft 311 and the attached disk 111. This arrangement provides a highly desirable axial adjustment of the disk 111 and, while only an upper sub-frame assembly 271 has been described, it will be clear that the lower sub-frame assembly may be similarly constructed for axial adjustment of the lower disk.

With reference now to FIG. 11, means are also provided for adjusting the position of the upper disk 111 relative to the working rolls and in a direction along the path of stock travel. As herein disclosed, the main frame ribs 401, instead of being integral as seen in FIG. 6, are formed of separate pieces which include laminations or shims 53. Capscrews 54 retain respective rib pieces in assembled relation. When adjustment of the upper disk along the path of stock travel is desired, shims 53 on one side of the sub-frame assembly 271 may be removed and installed on the opposite side of such assembly. As will clearly be visible, this will not change the spacing between opposed ribs but will shift such spacing thereby re-positioning the sub-frame and its disk. The transfer
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7 aforesaid of the shims 53, of course, will be effected after the sub-frame has been removed from the main frame and, while shim adjustment of only the upper sub-frame has been disclosed, similar structure may be provided for adjusting the lower sub-frame.

1. Apparatus for elongating tubular stock and providing a pair of opposed, oppositely inclined rotatable rolls forming a path through which the tubular stock advances and further providing a pair of opposed, rotatable disks at said roll pass for confining the stock therebetween, the improvement comprising:

a main frame rotatably supporting said rolls, and a pair of sub-frame assemblies each rotatably mounting respective disk and each removably secured to said main frame to provide, with minimum loss of production time, for ready disassembly of said sub-frame assemblies therefrom and ready assembly of other sub-frame assemblies therewith, when said disks must be refaced or replaced.

2. The construction of claim 1 wherein each disk is mounted on a supporting shaft which is journaled in a respective sub-frame assembly, and wherein adjustment means is mounted on each sub-frame assembly and each has connection with respective shafts aforesaid for axially shifting the latter and the disks mounted thereon.

3. The construction of claim 1 wherein said main frame and respective sub-frame assemblies are provided with cooparable, interengaging guide means along which said sub-frame assemblies are shiftable toward and away from assembled relation with said main frame.

4. The construction of claim 3 wherein one of said main frame and one of said sub-frame assemblies provides elongated ribs in opposed relation forming a part of said guide means, and wherein a portion of one of said ribs is transferable to the other of said ribs to shift the path of movement of said sub-frame and thus vary the position of the disk carried thereby in a direction longitudinally of the path of stock travel without effecting the spacing between said ribs.

5. The construction of claim 1 wherein said disks are respectively disposed above and below the line of stock travel, wherein said rolls are disposed on respective sides of the line of stock travel, and wherein said roll pass are mounted for movement away from each other an amount sufficient to provide for passage between said rolls of the sub-frame assembly mounting the lowermost of said disks.

6. The construction of claim 1 wherein a sub-frame assembly aforesaid provides a pair of legs in spaced, side-by-side relation, wherein a shaft extends transversely of and between said legs, wherein a disk aforesaid is mounted on said shaft between said legs, wherein bearing assemblies are secured to said shaft and are interposed between the latter and respective legs aforesaid, wherein retaining means removably retain said bearings assembled with respective legs and said retaining means being removable to provide for assembly and disassembly of said shaft with said legs in a direction longitudinally of the latter, wherein said shaft provides a seat intermediate said bearing assemblies for mounting said disk, wherein said disk is centrally apertured to pass one end of said shaft during assembly and disassembly operations therewith, and wherein said disk aperture is of a size to pass the bearing assembly at said shaft one end to provide for removal of said disk from said shaft without disturbing said shaft bearings.

7. Apparatus for elongating tubular stock and providing a pair of opposed, oppositely inclined rotatable rolls forming a path through which the tubular stock advances, and further providing a pair of opposed, rotatable disks at said roll pass for confining the stock therebetween, the improvement comprising:

a frame having horizontal guide surfaces on opposite sides of said pass, a bearing for each roll slidable along a respective horizontal guide surface toward and away from said pass, said frame also having vertical guide surfaces above and below said pass, a bearing for each disk, slidable along a respective vertical guide surface toward and away from said pass, the bearing for the upper disk being movable upwardly along the upper vertical guide surface to disassembled relation with said frame, the upper vertical guide surface being in vertical alignment with the lower vertical guide surface but being constructed and arranged so that after the bearing for the upper disk has been disassembled from said frame, the bearing for the lower disk may be moved upwardly along its vertical guide surface, upwardly through the pass area and upwardly through said upper vertical guide surface to disassembled relation with said frame, said roll bearings being slidable away from said pass an amount sufficient to permit said lower bearing and its disk to move vertically through the pass area.

8. Apparatus for elongating tubular stock and providing a pair of opposed, oppositely inclined rotatable rolls forming a path through which the tubular stock advances, and further providing a pair of opposed, rotatable disks at said roll pass for confining the stock therebetween, the improvement comprising:

a frame having horizontal guide surfaces on opposite sides of said pass, a bearing for each roll, slidable along a respective horizontal guide surface toward and away from said pass, said frame also having a pair of spaced vertical guide surfaces above and below said pass, a bearing for each disk, slidable along a respective pair of vertical guide surfaces toward and away from said pass, the bearing for the upper disk being movable upwardly along the upper pair of vertical guide surfaces to disassembled relation with said frame, the upper and lower pairs of vertical guide surfaces being in vertical alignment, with the spacing between the lower pair of guide surfaces and the bearing confined therewith being sufficiently less than the spacing between the upper pair of guide surfaces and the bearing confined therewith, respectively, so that after the bearing for the upper disc has been disassembled from the frame, the bearing for the lower disk may be moved upwardly along its pair of lower vertical guide surfaces, upwardly through the pass area, and upwardly between said pair of upper vertical guide surfaces to disassembled relation with said frame, said roll bearings being slidable away from said pass an amount sufficient to permit said lower bearing and its disk to move vertically through the pass area.

9. The construction of claim 8 wherein a cap plate is removably connected to said frame and is connected to the bearing for the upper disk to provide for adjustment of such bearing toward and away from said pass, said cap plate when disconnected from said frame being movable with the bearing for said upper disk when such bearing is slid upwardly to disassembled relation with said frame.

10. The construction of claim 9 wherein said bearing for the lower disc is adjusted toward said pass by means of an adjustment carried by said frame but which has
only abutting relation with such bearing so as not to hinder disassembling movement thereof.

11. The construction according to claim 1 wherein the stock is moved through the pass as a consequence of roll rotation and roll inclination, and further including, a mandrel disposed within said tubular stock and means for rotating said mandrel in the same direction and at no less than the rotational speed imparted to said stock by said rolls, and means for simultaneously advancing said mandrel with said stock at no less than the speed of advance of said stock as it is discharged from said pass.

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