Dec. 25, 1956 G. S. McLAY 2,775,150

PILGER MILL APPARATUS

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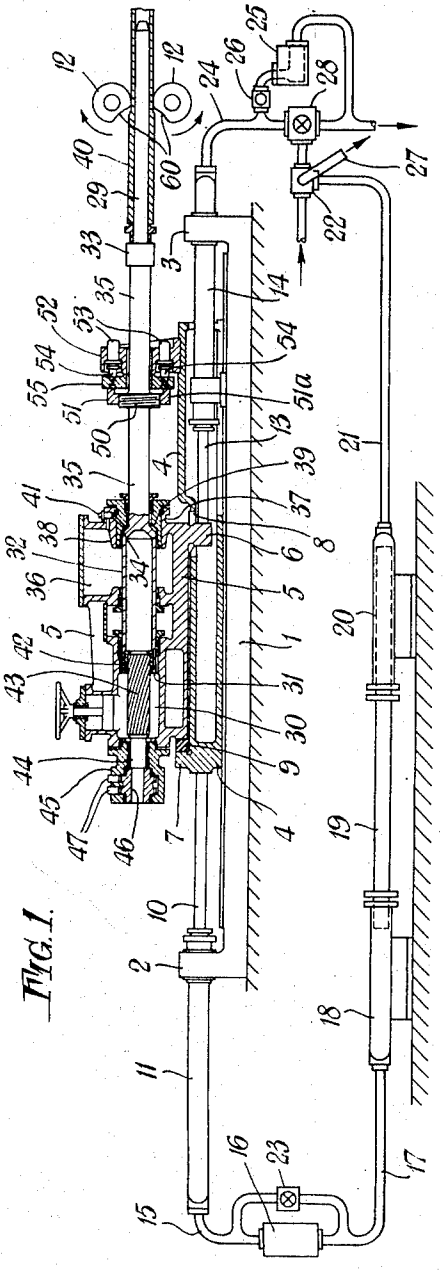

FIG. 1.

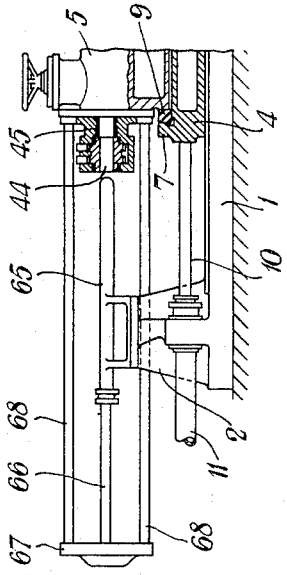

FIG. 3.

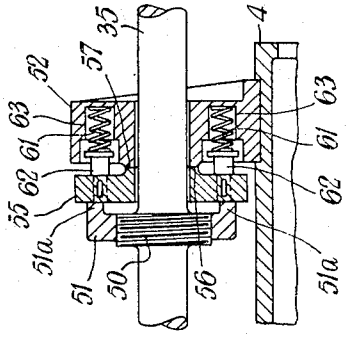

FIG. 2.

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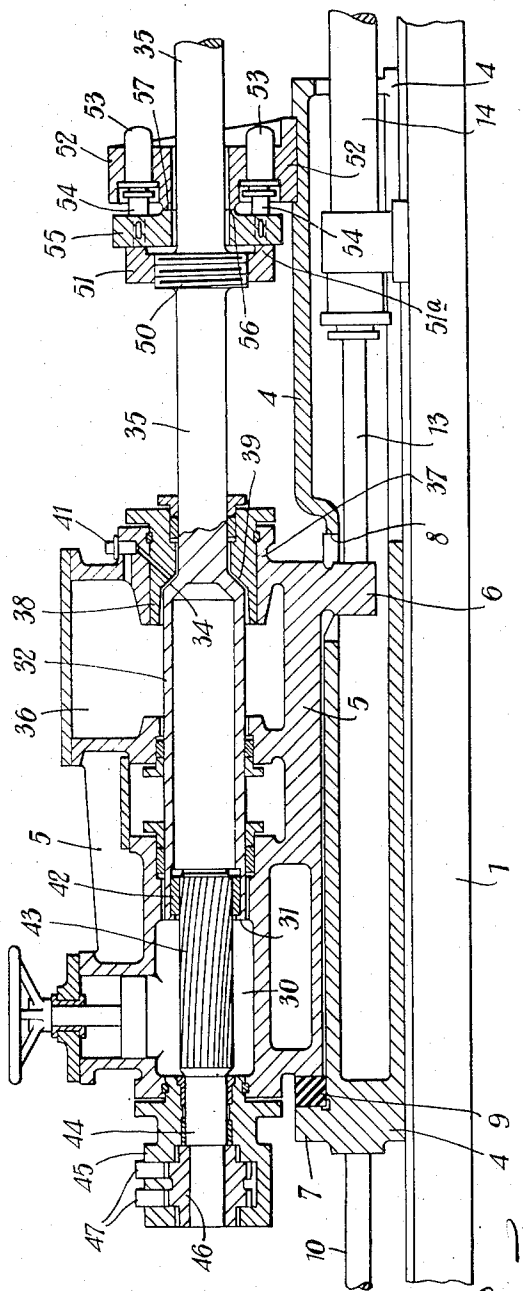
FIG. 4.



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PILGER MILL APPARATUS

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5 Claims. (Cl. 80—14)

The present invention relates to pilger mill apparatus.

A pilger mill comprises a mandrel on which a heated open-ended cylindrical hollow or tube blank is placed and by which it is passed between a pair of driven rolls having a grooved periphery with a gap therein. The mandrel is mounted on the outer end of a forwardly projecting extension of a piston which moves in an air cylinder. The piston and cylinder together constitute resilient means against which the mandrel is forced as the rolls rotate and operate on the tube blank. Inward movement of the piston in the cylinder by the action of the rolls on the tube blank compresses the air confined in the cylinder and the compressed air provides the necessary energy to move the mandrel and the tube blank forward, when the gap in the rolls is reached, to advance the tube blank between the rolls.

The front part of the piston is usually provided with a shoulder which, at the end of the forward movement of the piston by the expansion of the air compressed in the cylinder, forcibly engages a fixed shoulder of similar shape at the front part of a liquid container located at the front of the cylinder, i. e. between the cylinder and the rolls. This fixed shoulder is located at the end of a cylindrical portion of the container which is of slightly larger diameter than the piston and to reduce the shock on impact between the shouldered portion of the piston and the fixed shoulder it is arranged that the front, i. e. shouldered, part of the piston enters the cylindrical portion of the container to drive liquid (usually water) from the cylindrical portion into the main part of the container. The resistance offered to the displacement of the liquid by the slight annular space between the piston and the cylindrical portion of the container provides a certain amount of cushioning between the piston and the front end of the cylindrical portion. The cylinder and piston and also the liquid container are usually mounted on a carriage which, during rolling operations, is moved steadily forwards by hydraulic feed apparatus which is controlled in accordance with the required rate of feed of the tube blank between the rolls. With the known form of pilger mill apparatus it is found that, despite the cushioning provided by the liquid container, considerable shock is transmitted to this hydraulic feed apparatus each time the piston is brought to rest at the end of its forward stroke, with the result that the rate of feed varies considerably from the desired constant rate, thereby affecting the quality of work produced.

Pilger mill apparatus in which this disadvantage is at least partly overcome by providing means to reduce the transmission of shock to the hydraulic feed apparatus is described in my co-pending patent application No. 333,544 and the present invention is particularly suitable for embodiment in improved apparatus of this nature.

According to this invention, pilger mill apparatus comprising peripherally grooved and gapped rolls, means for driving such rolls, a mandrel on which a tube blank can be placed and by which the blank is passed between

the grooved and gapped rolls, a support table, a carriage slidably mounted on such table to move therewith with limited movement with respect thereto, said carriage supporting resilient means comprising a first part which is movable forward and backward on the carriage and supports the mandrel and a companion part which is fixed relatively to the carriage, and driving means to move the support table forward and backward, is characterised by a member mounted, preferably adjustably, on the first part of the resilient means and an abutment fixed to the support table and engageable by said member to determine the limit of forward movement of said first part of the resilient means with respect to said support table.

In this way the invention provides a means whereby the position relative to the support table of the first part of the resilient means, and hence of the mandrel attached thereto and the tube blank, can be determined with some precision after the mandrel has been brought to rest at the end of its forward stroke, that is after some at least of the shock occurring on deceleration of the moving parts has been taken up.

It will be understood, of course, in regard to the terms "forward" and "backward" used herein to designate movements, that "forward" means in the direction in which the completed tubes pass from the apparatus and that "backward" has the opposite meaning.

Preferably there is provided further resilient means mounted between said member and said abutment. This further resilient means may be rigidly attached either to said member or to said abutment and be engageable by either the abutment or the member respectively to cushion the engagement between said member and said abutment.

In one form of the apparatus, the first-mentioned resilient means comprise an air cylinder and a piston movable therein as hereinbefore described and the further resilient means between the abutment and the member may comprise apparatus including a piston and a co-operative cylinder of which one is carried or engageable by the member and the other is fixed to the abutment. Alternatively, the further resilient means may comprise one or more springs of which one end is fixed to the member or the abutment and the other end is engageable either by the abutment or by the member respectively.

In a preferred arrangement, the further resilient means comprises a plurality of pistons and cylinders and a disc or annulus carried by the pistons and arranged to be engaged by a member mounted, preferably adjustably on the first part of the first-mentioned resilient means, said disc or annulus having a stop face to engage a corresponding stop face on the abutment.

Apparatus in accordance with the invention preferably also includes means to take up shock caused on the forward movement of the mandrel by the first-mentioned resilient means, one part thereof being connected to the carriage and the other part being fixed, for example, to the ground.

In order to enable the invention to be readily understood, reference is directed by way of example to the accompanying more or less diagrammatic drawings in which:

Fig. 1 is a part sectional elevation of one form of pilger mill apparatus in accordance with the present improvements,

Fig. 2 is a fragmentary sectional elevation to a larger scale illustrating a modification,

Fig. 3 is a similar view of a further modification, and

Fig. 4 is an enlarged view of the resilient means.

The apparatus shown in Figure 1 comprises a sole plate 1 fixed to the ground and having at each end an

upstanding pillar 2 or 3. A support table 4 is mounted to slide on the upper face of the sole plate between the pillars 2, 3 and a carriage 5 is mounted to slide on the upper surface of the support table, see also Figure 4. The amount of relative movement between the carriage and the support table is controlled by two projections, one, marked 6, from the carriage and the other, marked 7, from the support table. These projections engage respectively the forward end of the support table at 8 and the rear-end of the carriage, a cushioning block 9 being provided between the projection 7 and the rear end of the carriage.

Driving means provided for the support table 4 comprises opposed co-axial hydraulic cylinders mounted respectively on the pillars 2, 3 of the sole plate 1 and having co-operating pistons, the piston 10 of one cylinder 11 (usually termed the feed cylinder), engaging the rear end of the support table 4 to feed the latter and the carriage 5 towards the pilger rolls 12, and the piston 13 of the other cylinder 14 (usually termed the stripper cylinder), engaging the projection 6 extending downwards from the front end of the carriage 5 to move the latter and the support table 4 in the opposite direction. The feed cylinder 11 may be connected at 15 to a hydraulic accumulator system, as is well known, or, as shown, to a variable delivery type of hydraulic pump 16. The latter is connected by duct 17 on its suction side with a further and fixed hydraulic cylinder 18 having a piston 19 which is common to a still further and fixed hydraulic cylinder 20 which through duct 21, is supplied with pressure liquid from a hydraulic accumulator system (not shown) through a control valve 22. This pressure liquid may be water whilst that in the hydraulic cylinder 18 and the feed cylinder 11 may be oil. Means, such as a restricted and adjustable orifice type hydraulic valve 23 of known form, may be connected in parallel with the variable delivery type hydraulic pump 16 so that the latter acts as a quantitative measuring device for the feed cylinder 11 and is only called on to deal with a part of the volumetric requirements of the feed cylinder. The stripper cylinder 14 is connected by duct 24 to exhaust through a valve 25 and means which will offer a constant resistance to the travel of the stripper cylinder piston 13. Such means may be as normally employed for this purpose, namely a second hydraulic valve 26 having a restricted and adjustable orifice. The valve 22 which controls the supply of hydraulic liquid to the cylinder 20 also controls the connection of that cylinder to exhaust at 27 and the connection of hydraulic liquid, through another valve 28, to the stripper cylinder 14 when the latter is disconnected from exhaust.

The carriage 5 is formed with resilient means for the mandrel 29, this means comprising a horizontal air cylinder 30 and a piston 31 having a hollow extension 32. This piston 31, which extends through glands in the front wall of the cylinder 30, reduces beyond the air cylinder 30, i. e. at a shoulder 34 of relatively steep inclination, to a further extension 35 of less diameter than such piston and which carries the mandrel holder 33 at its forward end. The piston extension 32 passes through a liquid container 36 which is disposed on the carriage 5. As shown, this liquid container has a cylindrical portion 37 containing a liner 38 having an internal shoulder 39 of similar shape to the shoulder 34. The internal diameter of the liner 38 is only slightly larger than the piston and its wall preferably converges slightly towards its front end. The construction thus described constitutes a cushion through which the impact shock due to rapid deceleration of the moving parts comprising the piston 31, the mandrel 29, and the tube blank 40 is transmitted to the carriage 5 as will be described. A pressure relief valve 41 controls an outlet from the front end of the slight annular space within the part 37 so that liquid may escape into the main part of the container when the pressure in such space reaches a predetermined amount.

The piston 31 of the air cylinder 30 is fixedly fitted, internally, with a nut 42 co-operating with a series of helical grooves 43 in a spindle 44 revolubly mounted in bearings in a fixture 45 on the rear end of the cylinder 30, the nut having internal spiral grooves of similar shape and pitch as those marked 43. The pitch of each helix of grooves 43 is four times the working length of the pilger rolls 12. The spindle 43 carries a double ratchet wheel 46 which is housed in the fixture 45 and is able to rotate in one direction but is prevented from rotation in the opposite direction by spring pawls 47. By these several means, the piston 31 and hence the mandrel 29 and tube blank 40 are caused to rotate through about 90° during each forward movement of the piston thereby continually presenting a fresh working surface of the tube blank to the rolls 12.

In the operation of the apparatus thus far described a tube blank 40 having been placed on the mandrel 29, the feed cylinder and piston 10, 11 are operated under control of the means shown in the lower part of Figure 1, to effect forward movement of the support table 4 and with it the carriage 5 and mandrel 29 to introduce the blank into the pilger rolls 12. As the rolls act on the blank the piston 31 of the resilient means is moved backward into the air cylinder 30 until the gaps 60 in the rolls are reached, whereupon the piston 31 moves suddenly outwards under the pressure in cylinder 30 and in the hollow extension 32. During this time, the mandrel 29 has been moved steadily forward by the feed cylinder piston 10 and a further part of the blank 40 is therefore acted on. At the same time, the mandrel is turned about its axis by the interaction of the helical grooves at 43 on the aforesaid spindle 44 and in the nut 42 thereby bringing the work to a different radial relationship with the peripheral grooves in the rolls 12. When the tube has been completed the stripper cylinder and piston 13, 14 are operated to remove (strip) the tube from the mandrel 29 and return the support table 4 and carriage 5 to the commencing position for the mandrel to receive another tube blank, and so on.

In accordance with the invention, a further resilient means is provided for ensuring that the mandrel 29 shall be brought to rest at exactly the same point with respect to the support table 4 during each forward movement of the piston 31. For this purpose the forward extension 35 of the piston is provided with a screw-threaded portion 50 on which is mounted a member constituted by an internally threaded collar 51 which is thus adjustable lengthwise of the piston extension. The forward face of the collar is extended at 51*a* (cf. also Figure 2) in the direction of the rolls 12. Fixed to the support table 4 is an abutment 52 carrying two hydraulic cylinders 53 the co-operating rams 54 of which carry an annular disc 55 (see also Figure 2). The extension 35 passes freely through the abutment 52 and the annular disc 55. The inner surface of this disc has a machined face constituting a stop face 56 (see Figure 4) to engage a corresponding stop face 57 on the abutment 52. The collar 51 and disc 55 are arranged to co-operate so that, when the collar moves forward on forward movement of the piston extension 35, it causes movement of the disc to bring its stop face 56 into contact with the stop face 57 on the abutment. Thus, the position of the piston extension 35 and hence of the mandrel 29 and tube blank 40 relative to the support table 4 can be accurately determined at each forward stroke of the piston 31. This position can be adjusted before rolling commences to suit particular rolling requirements by axial adjustment of the collar 51 on the screwed portion 50 of piston extension 35. The hydraulic apparatus 53, 54 disposed between the abutment 52 and the disc 55 constitutes cushioning means between the member 51 fixed to the piston extension 35 and the abutment 52 as will be understood.

According to the modification illustrated in Figure 2, instead of the further resilient means being fitted with hydraulic cylinder and piston cushioning means as in Fig-

ure 1, these hydraulic parts are substituted by helical springs **61** which are suitably fixed to stubs **62** mounted on the annular disc **55** and bear within recesses **63** in the abutment **52**. It is believed that the operation of this modification will be understood without any further description beyond stating that parts shown in Figure 2 which are similar to those shown in Figure 1 are similarly numbered.

The modification shown in Figure 3 illustrates how the apparatus of Figure 1 and Figure 2 may be fitted with means for taking up the shock of impact at the shoulders **34**, **39**, Figure 1, on the return (forward) movement of the piston **31**, piston extension **32**, **35**, mandrel **29** and tube blank **40** under the reactive impulse of the resilient means on release of these parts when the gaps **60** in the rolls **12** come round to the blank.

In accordance with this modification, the rear end of the carriage **5** is connected to one part of means to take up shock, the co-operating part being fixed to the ground. Such means, as shown in Figure 3, conveniently comprises a fluid pressure cylinder and piston combination including a hydraulic cylinder **65** fixed to the upper end of the pillar **2** of the sole plate **1** and a co-operating piston **66** fixed to a cross-head **67** which is connected by connecting rods **68** to the carriage **5**. The normal hydraulic pressure in the cylinder **65** is relatively low, for example 150 lbs. per sq. inch, but is, of course, raised considerably when the carriage **5** is submitted to shock and is controlled to a predetermined value by the employment of a pressure relief valve (not shown) in the feed circuit to such cylinder.

The invention is not restricted to the constructions of apparatus above particularly described because other modifications are possible without departing from the scope of the appended claims. For example, the resilient means first-mentioned and the mandrel rotating means may be made of the construction described in the specification belonging to the co-pending patent application No. 333,544 aforesaid.

What I claim is:

1. Pilger mill apparatus for the production of seamless metal tubes, comprising a set of pilger rolls, a feed table movable forward and backwards with respect to said rolls, a carriage slidably mounted on said feed table, stops on said feed table to limit the sliding movement of said carriage on said feed table, means to move said table and said slidably mounted carriage thereon constantly towards said rolls until the latter have completed the rolling of a tube, a mandrel carrier mounted in said carriage, a mandrel operatively connected to said mandrel carrier, resilient means at one end of said carriage and responsive to cushion the rearward axial movement of said mandrel carrier on said carriage under the action of said rolls on their rolling stroke and braking means at the opposite end of said carriage between and coaxial with said mandrel carrier and said carriage to take up the forward thrust movement of the said mandrel carrier under the reactive action of said resilient means when the rolls free the work piece and stop means for said mandrel carrier comprising a first and second cooperating means, said first means being mounted on said mandrel carrier and said second means being mounted on said feed table between the rolls and the said mandrel carrier so that immediately after said braking means comes into action, the said stop means will arrest the said forward movement of said mandrel carrier so that the mandrel carrier will be in same position relative to the feed table at the end of every such forward movement of said mandrel carrier.

2. Pilger mill apparatus in accordance with claim 1, wherein said first and second cooperating means have resilient means disposed between said means to cushion the engagement of the means.

3. Pilger mill apparatus in accordance with claim 1, wherein said first and second cooperating means have resilient means disposed between said means to cushion the engagement of the means and said resilient means comprises a piston attached to one of said cooperating means and the mating cylinder attached to the other of said cooperating means.

4. Pilger mill apparatus in accordance with claim 1, wherein said first and second cooperating means have resilient means disposed between said means to cushion the engagement of the means and said resilient means comprises a plate and a plurality of springs mounted on one of said cooperating means and an abutment means on said other cooperating means.

5. Pilger mill apparatus in accordance with claim 1, wherein said first and second cooperating means have resilient means disposed between said means to cushion the engagement of the means and said resilient means comprises a plurality of pistons operatively connected to an annular plate, said pistons being received in cylinders in one of said cooperating means, the other of said cooperating means being a disc to engage said annular plate.

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