ABSTRACT

A device for automatically feeding plugs to the end of the mandrel in the gap between the rolling rolls of a plug mill in the rolling of a seamless steel tube, comprising a rotary device disposed adjacent the defined path of the seamless steel tube in passing through the rolling rolls of the plug mill such that on rotation of said rotary device a plug is discharged from a pocket therein to an inlet guide member forming part of said defined path which has one end thereof adjacent the gap between the rolling rolls, the plug being supported by the inlet guide member during its passage in the end of the seamless steel tube into the gap, the inlet guide member being adapted to provide a gap therein to allow the plug after completion of the rolling of the tube and before stripping of the tube to fall away from the mandrel in the gap between the rolling rolls and be returned to a lower unoccupied pocket in the rotary device.

11 Claims, 6 Drawing Figures
DEVICE FOR INSERTING PLUGS IN A PLUG MILL

The present invention relates to plug mills used in reducing the wall thickness of a heated seamless steel tube to gauge. In particular, the present invention relates to an improved means for feeding the plug to the free end of the water cooled mandrel between the rolling rolls of the plug mill in the rolling of the seamless tube and removal of the plug from the mandrel subsequent to the rolling of the seamless tube and before stripping thereof.

In the production of seamless steel tubing a tube round is heated in a rotary billet heating furnace which brings it up to rolling temperature of about 2,350°F. ready for a subsequent piercing operation. The heated tube round is then suitably passed to a Mannesmann rotary piercing mill where the heated billet is introduced into a piercer where it is gripped by two oblique rolls which spirally and horizontally advance the billet. In its passage through the rolls the cross rolling action forms a hollow and a centrally located plug forms the inner surface of the seamless tube which is thus elongated. Each piercer is driven by a 4,000 horsepower motor. The seamless tube exiting from the first mill is relatively heavy walled and suitably the heavy walled seamless tube is passed through a second piercing mill in which the tube is elongated and the wall thickness reduced with increase in internal diameter. From the Mannesmann rotary piercing mills the heated seamless tube is passed to a plug mill where the wall thickness is reduced substantially to guage and the pipe in passage through the mill achieves substantially its final length. In the plug mill the hot seamless tube is passed along a defined path through a pair of grooved rolling rolls which are disposed on either side of the path and have a gap therebetween which forms part of the defined path. The portion of the defined path upstream of the rolling rolls is primarily constituted by a guide trough and an inlet guide member immediately adjacent the gap between the rolling rolls. The plug mill also includes stripping rolls disposed on either side of the path downstream of the rolling rolls and having a gap therebetween forming part of the path. A water cooled mandrel is fixedly mounted at one end thereof downstream of the stripping rolls and extends along the defined path through the gap between the stripping rolls and has a removable plug on the free end thereof which is located in the gap between the rolling rolls. In operation a plug of required size is placed in the gap between the rolling rolls and in connection with the free end of the mandrel. A ram is then actuated which travels along the guide trough, the rolling rolls being moved into their operative rolling position to define the gap and are rotated at high speed. The ram pushes an end of the hot tube lying in the guide trough via the guide inlet into the gap between the rolling rolls whence it is gripped in the grooves in the rolling rolls and pulled through the gap over the plug on the end of the mandrel. When the grooved rolls pull the heated seamless tube through the gap, the ram is retracted. On completion of the rolling operation by the rolling rolls the plug is removed from the end of the mandrel and placed in a cooling water bath, the rolling rolls being moved to their inoperative position and the stripping rolls being moved to their operative position. The seamless tube is then returned via the stripping rolls along the defined path to the guide trough. It has been found in practice that in order to avoid cutting of the tube for the grooves in the rolling rolls to be elliptically shaped. The seamless tube resulting from a single path thereof through the rolling rolls, is slightly elliptical in shape and the roll is not of a uniform wall thickness. It is necessary in order to obtain uniformity in the walls and configuration of the tube for the seamless tube to be rotated through 90° by means of liftable rollers located in transverse gaps along the guide trough and to pass the heated seamless tube through the plug mill once more. Thus the stripper rolls are moved to their inoperative position, the rolling rolls are moved to their operative position, a plug is attached to the end of the mandrel and the operation repeated. It is found to get substantial reduction during the second pass of the seamless tube through the plug mill that the second plug is slightly larger than the first plug.

Heretofore plug feeding and removal into the gap between the rolling rolls and onto the end of the mandrel, i.e., plug setting has been done manually whereby the plug mill plugger sets the plug into the roll groove against the mandrel bar with a hand chain or tong depending on the size of the plug. After the hot seamless tube has passed through the rolling rolls the same plug mill plugger removes the plug so that the rolled heated seamless tube can be stripped off the mandrel bar and then the same process is repeated for the next roll path. However, manual plug setting is costly, slow, tiring, dangerous to the operators involved, dirty and hot. In particular, it is costly due to the labour costs involved, slow due to the time taken by the operator to remove and feed the plugs and dirty and hot due to the proximity of the operator to the heated tube during its passage along the defined path. The proximity of the operator to the tube during its passage along the defined path and the possible malfunctioning of the stripper rolls renders the plug setting dangerous particularly as the malfunction of the stripper rolls will cause the tube to pass at high speed along the defined path when the operator is manually removing a plug from the end of the mandrel.

A device has been proposed for automatically feeding plugs to the end of the mandrel in the gap between the rolling rolls. This device comprises a rotary member having four open pockets on the periphery thereof and rotatable on a horizontal axis such that the pockets which contain the plugs lie sequentially in the path of the tube as it passes along the defined path such that the tube picks up the first plug at the front end thereof and carries it into the gap during the rolling of the tube and at the completion of the rolling and before stripping of the tube the plug falls under its own weight from the gap between the rolling rolls down a chute to a diametrically opposed lower pocket in the rotary member. The rotary member after the stripping operation is completed indexes to place the second plug accommodated in the next pocket in the defined path when the procedure is repeated.

However such a device is subject to a number of disadvantages. In particular a gap is left in the defined path for passage of the plug member under gravity down the chute to the lower pocket in the rotary member on completion of the rolling of the seamless tube. As the rotary member is arranged such that its pockets sequentially lie in the defined path of the heated seamless tube as it passes into the gap between the rolling rolls it is necessary for the front end of the tube which has picked up the plug to move over the gap and during its passage over the gap it is clearly unsupported which
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is undesirable. Further the rotary member only contains one pair of plugs and it is desirable that the rotary member be able to hold a plurality of pairs of plugs which allows for the changing of plugs, the cooling of the plugs and the lubrication of the plugs while the plug mill is in operation.

The present invention provides an automatic plug feeder in which the plug is supported by guide means during its passage on the end of the heated tube along the defined path into the gap between the rolling rollers and in which a plurality of pairs of plugs may be alternatively fed to the gap providing for removal and replacement, lubrication and cooling of the plugs in the automatic feeder.

It has now been found according to the present invention that when the rotary member is disposed adjacent the defined path such that on rotation of said rotary member a plug is discharged from a pocket to the inlet guide member which has one face between the gap between the rolling rolls, the plug is supported by the inlet member during its passage on the end of the heated seamless tube into the gap between the rolling rolls and further the inlet guide member may readily be adapted to provide a gap therein to allow the plug after completion of the rolling of the seamless tube by the rolling mills and before stripping of the tube by the stripping rolls to fall away under gravity from the gap between the rolling rolls and be returned to an unoccupied pocket in the rotary member.

According to the present invention therefore there is provided in a plug mill for use in recasting the wall thickness of a heated seamless tube to the desired gauge, a said plug mill comprising guide means for guiding said heated seamless tube along a defined path in said mill, a pair of rotatable grooved rolling rolls disposed transversely of said path, said rolls in their rolling position providing a first gap therebetween forming a part of said defined path, said first gap being dimensioned such that said rollers grip said tube in said grooves whereby on rotation thereof said tube in said first gap is pulled therethrough, means for rotation of said rolling rolls in said rolling position, retractable means for moving said tube along said defined path into said first gap, a pair of stripper rolls disposed transversely of said path and downstream of said rolling rolls having a second gap therebetween forming part of said defined path adapted in their stripping position to return the seamless tube along said path after rolling thereof by said rolling rolls, a mandrel extending longitudinally of said path securely mounted at one end thereof and having the free end thereof adapted to receivably accommodate a plug member, said mandrel extending through the second gap between the stripper rolls with a plug member, in use, disposed in the first gap between the rolling rolls, the improvement comprising means for removably placing a plug in said first gap on said mandrel, said means comprising an inlet guide member disposed in said defined path upstream of and adjacent said first gap in said rolling rolls, a rotary device having a plurality of open pockets spaced around the periphery thereof, said rotary device being offset from said path and adjacent thereto, said rotary device and said inlet guide member being arranged to permit a plug contained in one of said pockets to be discharged into said inlet guide member, which inlet guide member supports the plug as it is moved along said defined path into the first gap between the rolling rolls and into abutment with the free end of said mandrel, said inlet guide member being adapted to provide a closable third gap adjacent said rolling rolls dimensioned to allow a plug to pass therethrough, means operatively associated with said inlet guide member for closing said third gap during the presence of the plug in said inlet guide member to provide said support of the plug as it is moved into said first gap and for opening said third gap to allow a plug falling from said first gap under gravity subsequent to operation of the rolling rolls to pass through said third gap, and means for guiding the plug passing through said third gap to an unoccupied pocket in said rotary device.

In a preferred embodiment of the present invention the inlet guide member in order to provide said closable gap is adapted to be moved between a rolling position in which an end thereof lies adjacent said first gap between said rolling rolls and a stripping position in which said end is spaced from said first gap between said rolling rolls to provide said third gap. Suitably the inlet guide member is a channel member slidable in a channel between said two positions and is actuated between said two positions by a hydraulic ram.

The rotary device preferably has an uneven number of pockets around the periphery thereof whereby one of the pockets is always unoccupied and preferably has at least five pockets to hold at least two pairs of plugs at the same time.

In one embodiment of the present invention the rotary device is arranged to rotate on a horizontal axis, the plug passing into said inlet guide member from an upper pocket and being guided by the plug guiding means into an unoccupied lower pocket in the rotary device. The guide means suitably includes a chute means. The rotary device is a preferred embodiment of the present invention is a rotary cartridge member having arms extending therefrom defining said pockets. With such a device the chute is readily capable of guiding the plug discharged from the third gap directly into an unoccupied pocket.

In a further embodiment of the present invention the rotary device takes the form of an endless chain belt having extension arms on links defining the pockets. With such a device it is possible to have a large number of pockets in the rotary device so as to hold a large number of pairs of plugs. It is found practical to include a pusher means adjacent the bottom of the chute to push the plug passing down the chute into an unoccupied lower pocket in the endless belt.

With the aforesaid rotary members disposed adjacent the defined path there is suitably provided a means for temporarily closing a pocket to retain the plug therein and to prevent passage into the inlet guide member. This allows the operator to prevent any particular plug entering into the inlet channel member if he so desires and this situation may occur when the operator realizes that the plug is of the wrong size or it is in some way damaged or unsuitable for the next operation of the plug mill. Preferably the rotary device is adapted to rotate through a water bath for cooling the plug returned from the first gap between the rolling rolls. The presence of a plurality of plugs in the rotary device provides more time for cooling of the plugs, replacement of the plugs and for lubrication of the plugs.

The present invention will be further illustrated by way of the accompanying drawings in which:

FIG. 1 is a side elevation of a portion of a conventional plug mill shown in phantom outline including a device including a rotor of the cartridge type for feed-
ing plugs to the free end of a water cooled mandrel thereof according to one embodiment of the present invention;

FIG. 2 is a side elevation taken in the direction of the arrows of the plug feeder of FIG. 1 as viewed along the line 2–2;

FIG. 3 is a side elevation of a portion of a conventional plug mill shown in phantom outline including a rotary device of the endless chain belt type for feeding plugs to the free end of the water cooled mandrel thereof according to a further embodiment of the present invention;

FIG. 4 is a sectional side elevation of the plug feeder of FIG. 3 taken along the line 4–4;

FIG. 5 is a plan view of the plug mill of FIG. 3 taken along the line 5–5 with the endless chain belt removed; and

FIG. 6 is a detail plan view of the endless chain belt plug setter viewed along the line 6–6 in FIG. 4.

Referring to the drawings in which similar reference numerals denote similar parts, the plug mill is conventional and comprises a pair of grooved rolling rolls 1 having slightly elliptical grooves 2 therein, the upper roll being movable from a rolling position as shown in FIGS. 1 and 2 to an inoperative stripping positions. The mill also comprises a pair of stripping rolls (not shown) downstream of the rolling rolls 1 which also have an operative stripping position and an inoperative rolling position. A water cooled mandrel 3 extends through the gap between the stripping rolls and is fixedly mounted at one end thereof, the other end thereof being disposed to releasably retain a plug 4 in the gap between the rolling rolls 1.

Upstream of the gap between the rolling rolls 1 is a guide trough 5 which holds the heated seamless tube 6 which is to be passed through the plug mill so as to reduce the walls thereof to gauge. The trough 5 includes a plurality of transverse gaps spaced longitudinally therealong in which gaps liftable rollers (not shown) are located which are capable in their elevated position of axially turning the seamless tube 6 in the guide trough 5 through an angle of 90°. An inlet guide 7 is disposed between the end of the inlet trough 5 and the rolling rolls 1, the tube 6 moving along the trough 5 into the gap between the rolling rolls 1 via the inlet guide 7 and is pulled through the gap by rotation of the rolling rolls 1 in the direction shown by the arrows. In order to accommodate seamless tubes 6 different diameters the inlet guide 7 is vertically adjustable by means of a hydraulic ram 8.

The plug mill above described as aforesaid is conventional and is used in reducing the gauge of the walls of the seamless tube 6 and operates as follows. A plug 4 of appropriate size is releasably attached to the end of the mandrel 3. The rolling rolls 1 in their operative position are rotated and the seamless tube 6 in the trough 5 is pushed at high speed by means of a retractable ram (not shown) along the trough 5 into the gap between the rolling rolls 1 whence the tube 6 is pulled by the rolling rolls 1 through the gaps and over the plug 4 and the mandrel 3. The rolling rolls 1 are then moved to their inoperative position, the stripping rolls are moved to their operative position and the plug 4 is removed from the end of the mandrel 3. The stripping rolls are then actuated and the seamless tube 6 is returned to the trough 5 where it is rotated through 90° by means of the liftable rollers. A plug 4 of slightly larger size is then attached to the end of the mandrel 3 and the rolling and stripping process is repeated.

Turning now to FIGS. 1 and 2 the plug 4 is fed to the end of the mandrel 3 in the gaps between the rolling rolls 1 by a plug feeding device through which it is returned after passage of the seamless tube 6 through the rolling rolls in the rolling operation and before stripping thereof. The device comprises a cartridge rotor 10 having arms 11 defining a plurality of peripheral pockets 12 dimensions to accommodate plugs 4 and rotatable on a horizontal shaft 60 in a bearing 13. On rotation of the rotor 13 the pockets pass through a water trough formed by the casing 14. In order to readily remove a plug 4 from the device the casing 14 includes a swingably mounted door 15 latchable on lug 16 whereby on opening the door 15 the plug may roll down the ramp 17. This allows a plug 4 to be readily removed from the device and replaced by a new plug when the pocket 12 is lifted out of the water trough on rotation of the rotor 10. The device is located adjacent the inlet guide 7 which is adapted to move between a rolling position in which one end thereof lies adjacent the rolling rolls 1 as shown in FIG. 1 and a stripping position shown in phantom in FIG. 1 in which there is a gap between the end of the inlet guide 7 and rolling rolls 1. The gap is of sufficient size to allow a plug 4 falling from the end of the mandrel 3 in the gap between the rolling rolls 1 to pass therethrough under gravity. Movement of the inlet guide between the two positions is provided by actuation of a hydraulic ram 18, the inlet guide being attached to the piston rod 19 of the hydraulic ram by means of mounting 20. The inlet guide 7 slides in support guides 21, the movement of the inlet guide 7 being controlled by fixedly mounted guide bar 22 along which an eye member 23 welded to the guide 7 slides.

A chute 24 is located beneath the inlet guide 7 and is arranged to return the plug 4 falling through the gap between the end of the inlet guide and the rolling rolls to an unoccupied lower pocket 12 in the rotor 10.

In operating the device a plug 4 on rotation of the rotor 10 rolls out of an upper pocket 12 through a gap (not shown) in the wall of the inlet guide which is in its stripping position and passes into the inlet guide 7. The inlet guide (7) moves forward to the rolling position. On actuation of the rolling rolls 1 and the ram pushing the seamless tube 6 along the guide trough 5 and into the guide inlet 7 the plug 4 is picked up by the front end of the seamless tube 6 and carried into the gap between the rolling rolls 1 whence the plug locates in the end of the mandrel 3. When a substantial portion of the seamless tube 6 has passed through the gap between the rolling rolls 1 the inlet guide 7 is retracted by the ram 18 into its stripping position such that on completion of the rolling of the seamless tube 6 the plug 4 falls under gravity through the gap between the end of the inlet guide 7 and the rolling rolls 1 into the chute 24. The chute 24 guides the plug 4 into a lower unoccupied pocket 12 in the rotor 10. The stripping operation is then effected. The rotor 10 is then indexed so that the plug in the next pocket 12 which is of slightly larger size than the previous plug 4 which passes into the inlet guide 7. The inlet guide is returned to its rolling position, and the operation of the plug mill is repeated.

In passing around the rotor 10 each plug 4 which has been returned from the plug mill is cooled in the water bath and after cooling may have lubricant, e.g., graphite applied thereto whilst the pocket 12 is in an upper
position. The rotor 10 shown in FIG. 2 has 5 pockets 12 allowing for two pairs of plugs to be in service at one time which allows for ready replacement of the plugs 4 in the device when they are worn or damaged and further provides for better cooling of the plugs for lubrication purposes.

Referring to FIGS. 3 to 6 the rotary device comprises an endless chain belt 30 mounted on a pair of sprockets 31, said chain belt having connecting links 32 and arm links 33 defining a plurality of peripheral pockets 34 dimensioned to accommodate plugs 4. The use of an endless chain belt 30 provides for more pockets 34 and allows more pairs of plugs 4 to be in service at any one time. Sprockets 31 are mounted on a shaft 9 in bearings 35 with the lower run of the endless chain belt 30 passing through a water bath defined by the casing 36 for the cooling of the plugs 4.

Pivot rods 37 of the links 32 and 33 in the endless chain belt 30 include inner rollers 38 and outer rollers 39. Inner rollers 38 in the upper run of the belt 30 run on plate 40 located on support 55 and are picked up in teeth 41 of the sprocket 31. The outer rollers 39 support the chain belt by passage along upper plate 42 and lower plate 43 attached to the casing 36 of the water path. The upper plate 42 has a gap 54 therein to allow descent of the rollers 39 on passage of the belt 30 around the sprockets 31.

A plug guide 44 is located adjacent the inlet guide 7 which inlet guide 7 has an opening (not shown) in the wall thereof to allow passage of the plug 4 there through. The plug guide 44 comprises a pair of finger member 45 mounted by blocks 46 on a shaft 47, the shaft 47 being rotatably mounted in bushings 56. Thus the fingers 45 may be rotated on the shaft 47 from a position as shown in FIG. 4 in which they support and guide the plug 4 from the upper pocket 34 into the inlet guide 7 and a position in which they prevent such passage. When the passage of the plug 4 into the inlet guide 7 is prevented, the plug 4 is thus rejected and will pass downwardly around the sprocket 31 in the pocket 34 and roll out of the pocket 34 and be pushed by the pusher member 51 as will be explained hereinafter, into the next forward adjacent pocket 34. Thus the plug 4 will bypass the inlet guide 7.

As with FIGS. 1 and 2 the inlet guide 7 is adapted to move between a rolling position and a stripping position, the movement of the guide 7 being provided by actuation of hydraulic ram 18 through piston rod 19 attached to the base of the guide 7 which slides between the two positions in supporting guide 21 by a mounting 20. The inlet guide 7 is guided in its movement by guide bar 21 along which slides an eye member 23 welded to the belt 30 of the guide 7.

The chute 24 beneath the inlet guide 7 is arranged to return the plug 4 falling through the gap between the end of the inlet guide 7 and the rolling rolls 1 to the vicinity of the unoccupied lower pocket 34 in the endless chain belt 30 and the plug 4 is pushed into the pocket 34 by actuation of the ram 50 having pusher member 51 on the end of the piston rod 52 which contacts the plug 4. Operation of the device of FIGS. 3 to 6 is similar to operation of the device of FIGS. 1 and 2.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In a plug mill for use in reducing the wall thickness of a heated seamless tube to the desired gauge, said plug mill comprising guide means for guiding said heated seamless tube along a defined path in the mill, a pair of rotatable grooved rolling rolls disposed transversely of said path, said rolls in their rolling position providing a first gap therebetween forming a part of said defined path, said first gap being dimensioned such that said rolls grip said tube in said grooves whereby on rotation thereof said tube in said first gap is pulled therefrom, means for rotation of said rolling rolls in said rolling position, retractable means for moving said tube along said defined path into said first gap, a pair of stripper rolls disposed transversely of said path and downstream of said rolling rolls having a second gap therebetween forming part of said defined path adapted in their stripping position to return the seamless tube along said path after rolling thereof by said rolling rolls, a mandrel extending longitudinally of said path securely mounted at one end thereof and having the free end thereof adapted to releasably accommodate a plug member, said mandrel extending through the second gap between the stripper rolls with a plug member, in use, disposed in the first gap between the rolling rolls, the improvement comprising means for removable placing a plug in said first gap on said mandrel, said means comprising an inlet guide member disposed in said defined path upstream of and adjacent said first gap in said rolling rolls, a rotary device having a plurality of open pockets spaced around the periphery thereof, said rotary device being offset from said path and adjacent thereto, said rotary device and said inlet guide member being arranged to permit a plug contained in one of said pockets to be discharged into said inlet guide member, which inlet guide member supports the plug as it is moved along said defined path into the first gap between the rolling rolls and into abutment with the free end of said mandrel, said inlet guide member being adapted to provide a closable third gap adjacent said rolling rolls dimensioned to allow a plug to pass therethrough, means operatively associated with said inlet guide member for closing said third gap during the presence of the plug in said inlet guide member to provide said support of the plug as it is moved into said first gap and for opening said third gap to allow a plug falling from said first gap under gravity subsequent to operation of the rolling rolls to pass through said third gap, and means for guiding the plug passing through said third gap to an unoccupied pocket in said rotary device.

2. A mill as claimed in claim 1 in which the inlet guide member is adapted to be moved by said means operatively associated with said inlet guide member between a rolling position in which an end of said inlet guide member lies adjacent said first gap between said rolling rolls and a stripping position in which said end is spaced from said first gap an amount sufficient to provide said third gap through which said plug passed subsequent to operation of the rolling rolls.

3. A mill as claimed in claim 2 in which the rotary device has an uneven number of pockets around the periphery thereof.

4. A mill as claimed in claim 2 in which the rotary device has at least five pockets spaced around the periphery thereof to hold at least two pairs of plugs.

5. A mill as claimed in claim 2 in which the rotary device is arranged to rotate on a horizontal axis, the plug passing into said inlet guide member from an upper pocket and being guided by the plug guiding means into an unoccupied lower pocket in said rotary device.
6. A mill as claimed in claim 5 in which the plug guiding means includes a chute.

7. A mill as claimed in claim 6 in which the rotary device is a cartridge member having arms extending exi-
ally therefrom defining said pockets.

8. A mill as claimed in claim 6 in which the rotary de-
vice is an endless chain belt having extension arms on
links defining said pockets.

9. A mill as claimed in claim 8 including means for pushing a plug adjacent the bottom of the chute into the lower pocket.

10. A device as claimed in claim 6 including means for temporarily closing a pocket to retain the plug therein and prevent passage thereof into said inlet guide member.

11. A mill as claimed in claim 1 in which the rotary device is adapted to rotate through a bath for cooling plugs returned from the first gap after the rolling operation.