ROLL GROOVING APPARATUS

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ABSTRACT
A roll grooving apparatus has a back-up roller, a grooving roller positioned vertically below the back-up roller, and a hydraulic jack positioned directly vertically below the grooving roller, with the hydraulic jack exerting an upward force to push the grooving roller towards the back-up roller to form a circumferential groove in a pipe segment that is positioned between the rollers.
ROLL GROOVING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a roll grooving apparatus, and in particular, to tools that create circumferential grooves in pipes to allow the pipes to be connected together end to end using mechanical couplings.

2. Description of the Prior Art

Mechanical couplings are used to couple pipes and to one another and effect a fluid tight joint. Couplings may comprise a pair of pipe segments that are joined to one another end to end by fasteners to circumferentially surround the ends of the pipe segments. To effect a substantially rigid joint (i.e., a joint which resists relative rotation of the pipe segments about their longitudinal axes, resists axial motion of the pipe segments relatively to one another due to internal pressure, and resists angular deflection of the pipe segments relatively to one another), it is advantageous to position circumferentially extending grooves around each pipe. The grooves are positioned in spaced relation to the ends of the pipe segments and are sized to receive accurately shaped keys extending from each pipe segment. Engagement of the keys with grooves helps the joint formed by the coupling to stay rigid.

Assembly of piping networks using mechanical pipe couplings may require that pipe stock be cut to a desired length, the cut pipe segments be reamed to remove burrs and sharp edges, and grooves be formed in both ends of each cut pipe segment. The cut, reamed and grooved pipe segments may then be joined to one another using the couplings described above.

Forming circumferential grooves in pipes made of malleable materials such as plastics, copper, steel and aluminum can be accomplished by cold working the material beyond its yield stress, thereby causing a permanent deformation in the material. Existing techniques for forming circumferential grooves in metal and plastic pipes entail sandwiching the pipe sidewall between the circumferences of two adjacent rotatable rollers. One roller, known as the back-up roller, is positioned on the inside of the pipe, and the other, known as the grooving roller, is positioned on the outside. The back-up roller has a concave die around its outer circumference and the grooving roller has a raised grooving surface around its outer circumference. With the pipe sidewall between them, the rollers are rotated in opposite directions and are forced toward one another so that they apply pressure to the sidewall. The die and the grooving surface traverse the pipe circumference and cooperate to cold work the sidewall and produce a circumferential groove of the desired size and shape. The rollers may move relatively to the pipe or the pipe may rotate about its longitudinal axis and move relatively to stationary rollers.

The method using a grooving roller and a back-up roller is effective at forming grooves in pipe walls while maintaining the roundness of the pipe because the pipe sidewall is mutually supported between the rollers and is never subjected to compressive point loads which would tend to collapse the pipe or force it out of round. Both rollers cooperate to work the material comprising the pipe, the grooving roller forming the groove and the back-up roller acting as a die to control the flow of material during cold working and precisely define the groove shape.

Unfortunately, many of the conventional roll grooving apparatus suffer from one of many drawbacks. For example, many of these conventional roll grooving apparatus are bulky and not convenient to use. In this regard, some of these conventional roll grooving apparatus are large and heavy, are difficult to install, include many components, and occupy a lot of space during use. As another example, in some conventional roll grooving apparatus, the construction and interaction of the grooving and back-rollers restrict the use of the roll grooving apparatus to pipes having certain diameters.

SUMMARY OF THE DISCLOSURE

It is an object of the present invention to provide a roll grooving apparatus which addresses the drawbacks set forth above.

In order to accomplish the objects of the present invention, the present invention provides a roll grooving apparatus having a back-up roller, a grooving roller positioned vertically below the back-up roller, and a hydraulic jack positioned directly vertically below the grooving roller, with the hydraulic jack exerting an upward force to push the grooving roller towards the back-up roller to form a circumferential groove in a pipe segment that is positioned between the rollers.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a roll grooving apparatus according to the present invention mounted on a power drive unit.

FIG. 2 is an exploded perspective view of a portion of the roll grooving apparatus of FIG. 1.

FIG. 3 is a side plan view of the roll grooving apparatus of FIG. 1 shown without the side plate.

FIG. 4 is a front plan view of the roll grooving apparatus of FIG. 1.

FIG. 5 is a top plan view of the roll grooving apparatus of FIG. 1.

FIG. 6 is a side plan view of the roll grooving apparatus of FIG. 1 shown with the side plate.

FIG. 7 is an exploded perspective view of a bearing housing assembly for the back-up roller of the roll grooving apparatus of FIG. 1.

FIG. 8 is an exploded perspective view of a secondary housing for the grooving roller of the roll grooving apparatus of FIG. 1.

FIG. 9 is a top plan view of a hydraulic jack that can be used with the roll grooving apparatus of FIG. 1.

FIG. 10 is a perspective view of the roll grooving apparatus of FIG. 1 shown with the power drive unit and a carriage.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The following detailed description is of the best presently contemplated modes of carrying out the invention. This description is not to be taken in a limiting sense, but is made merely for the purpose of illustrating general principles of embodiments of the invention. The scope of the invention is best defined by the appended claims.

FIG. 1 shows a roll grooving apparatus according to the present invention being removable mounted on a power drive unit of a pipe machine for power operation. Referring also to FIGS. 2-6, the apparatus has a housing on which
are mounted a back-up roller 16 and a grooving roller 18, positioned adjacent to the back-up roller 16. The back-up roller 16 is rotatable about an axis 20, and the grooving roller 18 is rotatable about an axis 22. Both axes of rotation 20 and 22 are preferably substantially parallel to one another and to the longitudinal axis (which is the same as the axis 20) of a pipe segment 26, shown in phantom line in FIG. 1. With its sidewall 28 positioned between the rollers 16 and 18 for formation of a circumferential groove. As best shown in FIG. 3, the grooving roller 18 is positioned directly below the back-up roller 16 at a six o’clock position with respect to the back-up roller 16.

[0023] The housing 14 has a generally inverted S-shape, with a horizontal top plate 32. A vertical front plate 34 extends vertically downwardly from the front edge of the top plate 32. The front plate 34 has a recessed bottom vertical portion 36 that extends vertically from the rear surface of the front plate 34 adjacent the bottom of the front plate 34. A horizontal base plate 38 extends horizontally forward from the bottom of the vertical portion 36. The portion 36 is recessed from the front plate 34 to provide clearance for the hydraulic jack 100 (described below) to be positioned in a manner such that the piston 104 can be in turn positioned so that the force of the grooving roller 18 is directed to maximize the energy through the sidewalk 28 into the surface 134 of the back-up roller 16.

[0024] The back-up roller 16 is attached to a drive shaft 40 housed in a bearing housing assembly 42 that is rotatably mounted to the front plate 34 of the housing 14 adjacent the top plate 32. Referring also to FIG. 7, the bearing housing assembly 42 has a bearing housing 44 with two bearings 46 positioned at opposite ends of the bearing housing 44. A snap ring 48 is positioned adjacent each bearing 46, with a shaft spacer 50 positioned between the rear snap ring 48 and two nuts 52. The drive shaft 40 extends through the bearings 46, the bearing housing 44, the snap rings 48 and the spacer 50, and the nuts 52 are screwed on to the threaded end of the drive shaft 40. The drive shaft 40 directly turns the back-up roller 16 about axis 20. As best shown in FIG. 2, the drive shaft 40 extends outwardly from housing 14 and is engageable with a chuck 56 of the power drive unit 12. Chuck 56 has jaws 58 that are movable into and out of engagement with drive shaft 40 by rotating a chuck ring 60. The apparatus 40 is mounted on the power drive unit 12 for power operation by rotating the chuck ring 60 to open the jaws 58 (see FIG. 2), engaging the drive shaft 40 within the jaws 58, and then turning the chuck ring 60 to lock the jaws 58 onto the drive shaft 40. An electric motor (not shown) in the power drive unit 12 rotates the drive shaft 40, thereby rotating the back-up roller 16. A pair of anti-torque support bars 158 extend from the housing 14 and are adapted to be rested on top of corresponding stationary carriage rails 160 extending from the power drive unit 12 to prevent the housing 14 from turning when torque is applied to the drive shaft 40.

[0025] The grooving roller 18 is rotatably mounted in a secondary housing 70 that is mounted to the housing 14. Referring to FIGS. 1, 3 and 8, the secondary housing 70 has a U-shaped mount 72 whose bottom surface is secured to a platform 74. The U-shaped mount 72 defines an interior space 76 that receives the grooving roller 18 and two bearings 78 positioned on either side of the grooving roller 18. A shaft 80 extends through openings (e.g., 82) in the walls of the mount 72, the bearings 78 and the grooving roller 18. One of the walls (see 84) of the mount 72 is positioned adjacent to a portion of the front plate 34 at a location below the back-up roller 16. A block 86 is secured to the rear of the front plate 34 at the location opposite to the wall 84, and carries a threaded bolt 88. Another threaded bolt 90 extends from the rear of the recessed vertical portion 36, and the bolts 88, 90 are used to secure opposite ends of a spring 92. The spring 92 forcibly retracts the grooving roller 18 from the groove which was formed into the sidewalk 28 of the pipe segment 26, and also forces the piston 104 of the hydraulic jack 100 down to its bottom starting position (after the release valve 106 has been opened). By performing these two functions, the spring 92 allows the pipe segment 26 to be removed so that a new segment of pipe can be placed between the rollers 16 and 18.

[0026] The platform 74 also serves as a shield for the hydraulic jack 100 from debris and pipe scale dropping from the grooving roller 18.

[0027] A hydraulic jack 100 is positioned on the base plate 38, and functions to raise and lower the secondary housing 70 and the grooving roller 18 carried thereon. The hydraulic jack 100 can be embodied in the form of a hydraulic bottle jack, an example being the SIDEWINDER JACK™ being sold by SPX Corporation under its POWERTeam™ trademark. Referring to FIGS. 3, 4 and 9, the hydraulic jack 100 has a body 102 with a piston 104 oriented vertically. A fluid reservoir (not shown) is contained inside the body 102. The piston 104 is adapted to push the platform 74 upwardly. A release valve 106 is positioned at one side of the body 102, and a plunger 108 extends from the body 102 at a location that is about ninety degrees from the location of the release valve 106. A socket 112 is provided at the end of the plunger 108, and a removable handle 110 is coupled to the socket 112. The hydraulic jack 100 may be operated by pivoting the handle 110 left and right in a plane which is parallel to the ground, causing the piston 104 to elevate, thereby pushing the platform 74 and the secondary housing 70 upwardly. To lower the secondary housing 70, the user merely opens the release valve 106.

[0028] A depth adjustment mechanism is provided to control or restrict the extent to which the hydraulic jack 100 can raise the platform 74. The depth adjustment mechanism has a threaded bar 120 which extends vertically from the base plate 38 and through the platform 74. A plurality (e.g., two) nuts 122 are threadably adjusted along the length of the bar 120 at the top surface of the platform 74 to control the height to which the platform 74 can be raised by the hydraulic jack 100.

[0029] The roll grooving apparatus 10 can be operated in the following manner. A pipe segment 26 is positioned so that its sidewalk 28 is located between the rollers 16, 18, and with the end of the pipe segment 26 resting on a shoulder 118 adjacent the back-up roller 16 along the front surface of the front plate 34. The grooving roller 18 is raised toward the back-up roller 16 by operating the hydraulic jack 100 until both rollers 16, 18 engage opposite surfaces of the sidewalk 28. The power drive unit 12 is switched on and turns the drive shaft 40, which in turn rotates the back-up roller 16 about its axis 20, the back-up roller 16 being engaged with the inner surface of the sidewalk 28. Friction between the back-up roller 16 and inner surface causes the pipe segment 26 to rotate about its longitudinal axis in response to the rotation of the back-up roller 16. Preferably, the back-up roller 16 has knurled circumferential surfaces 130 (see FIG. 7) which provide increased friction between the back-up roller 16 and the pipe segment 26 to ensure that the pipe segment 26 rotates. When the pipe segment 26 rotates, friction between it and the grooving roller 18 causes the grooving roller 18 to rotate...
about its rotation axis 22, the grooving roller 18 thereby traversing the circumference of pipe segment 26. The grooving roller 18 has a raised circumferential surface 132 (see FIG. 8) that engages the outer surface of the sidewall 28 and forms a groove in the sidewall 28 by cold-working the sidewall 28. The hydraulic jack 100 is pumped incrementally as the pipe segment 26 rotates to apply greater pressure between the rollers 16, 18 and the sidewall surfaces with each revolution of the pipe segment 26 so as to gradually form the groove to the desired depth and shape. The depth is determined substantially by the height of raised surface 132 and the degree to which it is pressed into the outer surface of sidewall 28. The shape of the groove is determined by the shape of the raised surface 132 and by the shape of the opposing surface 134 of the back-up roller 16 (see FIG. 7), which acts as a die to control the flow of material comprising the sidewall 28.

The housing 14 further includes two angled side plates 150, each side plate 150 being secured to opposite sides of the roll grooving apparatus 10. Referring to FIGS. 4 and 6, each side plate 150 has a top edge 152 that is welded to the top plate 32, and a bottom edge 154 that is welded to the base plate 38. A threaded opening 156 is provided for receiving opposing support bars 158 that extend transversely to the orientation of the roll grooving apparatus 10. Couplers 190 extend from each side plate 150, and each support bar 158 is adapted to be threadably connected to a corresponding coupler 190. Each coupler 190 can have an inspection hole 192 so that the user can see if the support bar 158 has been completely threaded into the coupler 190. The support bars 158 are adapted to be rested on top of corresponding carriage rails 160 (see FIG. 1) that extend from the power drive unit 12.

Referring now to FIG. 10, a carriage 170 can be mounted to the front ends of the carriage rails 160. A pipe cutter 172 and a pipe reamer 174 (both of which are well-known in the art) can be attached to the carriage 170. As best shown in FIG. 10, the roll grooving apparatus 10 can be conveniently fitted into the space defined by the carriage 170 and the carriage rails 160 without the need to remove the carriage 170. This is to be contrasted with other conventional roll grooving apparatus, where the carriage (such as 170) must first be removed before the roll grooving apparatus can be installed on the power drive unit 12.

The overall construction of the roll grooving apparatus 10 and the orientation of its various components allow for the provision of a compact roll grooving apparatus 10 that occupies minimal space and which is convenient to use.

First, by positioning the hydraulic jack 100 directly below (i.e., at six o’clock position) the grooving roller 18, pipe segments having different sizes can be grooved. Exerting an upward force on the grooving roller 18 maintains the bottom planar alignment of pipe segments with different diameters because the elevation (i.e., the floor or the ground) is constant or uniform. Therefore, pipe stands to support longer pipe segments do not require adjustment up or down when grooving pipe segments of different diameters. In contrast, some conventional roll grooving apparatus that push the grooving roller downwardly (i.e., from a twelve o’clock position) require that pipe stand be adjusted up or down when grooving pipe segments of different diameters. This is because these conventional roll grooving apparatus which push a grooving roller down from the twelve o’clock position are limited to the space between the back-up roller and the ground.

Second, all of the required hydraulics (including the hydraulic fluid reservoir) are located inside the hydraulic jack 100. Therefore, it is not necessary to provide an auxiliary hand pump and hose located in a separate location, thereby minimizing components and making the hydraulic system more compact. The location of the handle 110 does not provide clearance problems because it is neatly positioned below the rollers 16, 18 and does not protrude clumsily. The handle 110 utilizes a left-right pumping axis which does not interfere with any of the other components of the roll grooving apparatus.

Third, the roll grooving apparatus 10 can be quickly and conveniently installed for use. As shown in FIGS. 1 and 10, the housing 14 can be simply lowered into place with the support bars 158 rested on top of corresponding carriage rails 160 that extend from the power drive unit 12, and the roll grooving apparatus 10 is ready for use. There is no need to remove any of the other components of the power drive unit 12 or the roll grooving apparatus 10.

Fourth, the overall construction of the roll grooving apparatus 10 is compact, thereby making it portable and easy to move around, and to handle.

Fifth, the carriage frame 170 can serve as a support surface when placing or removing a pipe segment 26 between the rollers 16, 18. For example, referring to FIG. 10, the pipe segment 26 can be temporarily rested on the frame of the carriage 170 before fitting it against the shoulder 118 between the rollers 16, 18. In addition, when the grooved pipe segment 26 is removed after grooving, the pipe segment 26 can be removed from the rollers 16, 18, and temporarily rested on the frame of the carriage 170 so that the user can inspect the groove for proper depth. If the groove is acceptable, the user can remove the pipe segment 26. If the groove is not acceptable, the user can conveniently place the pipe segment 26 back between the rollers 16, 18 for further grooving. This feature further illustrates the convenience afforded by the construction of the roll grooving apparatus 10.

While the description above refers to particular embodiments of the present invention, it will be understood that many modifications may be made without departing from the spirit thereof. The accompanying claims are intended to cover such modifications as would fall within the true scope and spirit of the present invention.

11. (canceled)

12. A roll grooving apparatus and power drive unit in combination, the combination comprising:

- a back-up roller and a grooving roller of the roll grooving apparatus, the back-up roller and the grooving roller positioned in mutual proximity with axes thereof arranged in mutually parallel positions;
- or a back-up roller and the grooving roller engaged with the power drive unit; and the other of the back-up roller and the grooving roller supported by a movable platform of the roll grooving apparatus, the movable platform in contact with a jacking device of the roll grooving apparatus:

- a pair of transverse support bars of the roll grooving apparatus resting on carriage rails of the power drive unit in supporting the weight of the roll grooving apparatus;

- the jacking device extendable and retractable over a range of motion, with extendable motion thereof drawing the back-up roller and grooving roller into mutually intimate proximity, and with retractable motion of the jacking device drawing the back-up roller and the grooving roller into mutually distant proximity.

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