United States Patent

Nakamura

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[54] **BULGING APPARATUS**

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[*] Notice: The portion of the term of this patent subsequent to Oct. 19, 1988, has been disclaimed.

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[52] **U.S. Cl.** **72/58**

[51] **Int. Cl.** **B21d 26/04**

[58] **Field of Search** 72/57, 58, 60, 61, 62

[56] **References Cited**

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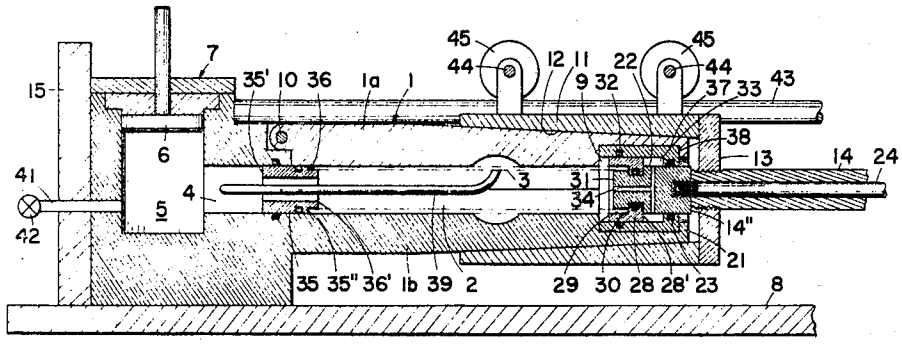
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[57] **ABSTRACT**

This invention relates to a bulging apparatus in which a horizontal die of split type consisting of upper and lower die members formed with a die cavity inside and tapered on the outside over a certain desirable distance from the front end and which is formed with an inlet port in communication with the piston chamber of hydraulic pressure generating means is associated with an outer cylinder for fastening the die with a tapered hollow adapted to receive the tapered die members together, said outer cylinder being movable horizontally with the axis of the die into and out of engagement with the die body.

6 Claims, 2 Drawing Figures



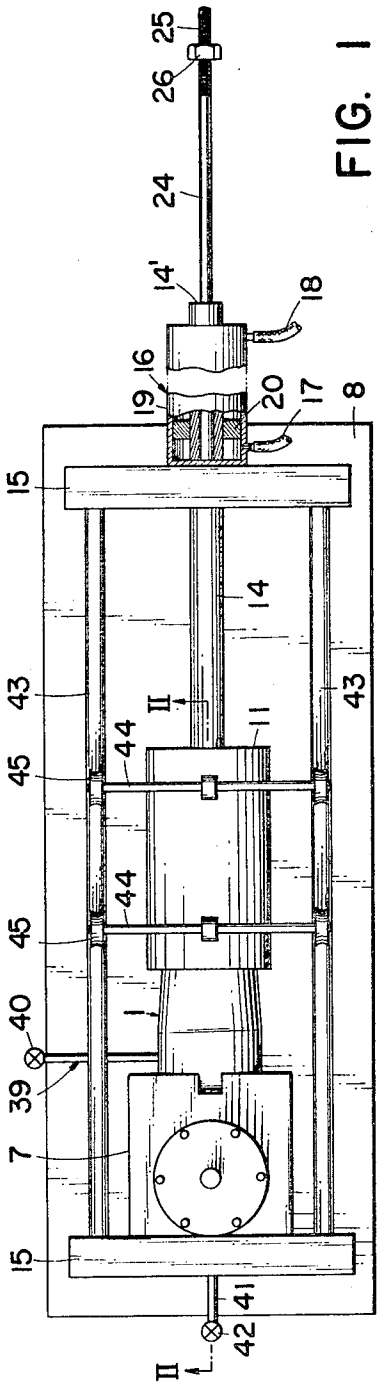


FIG. 1

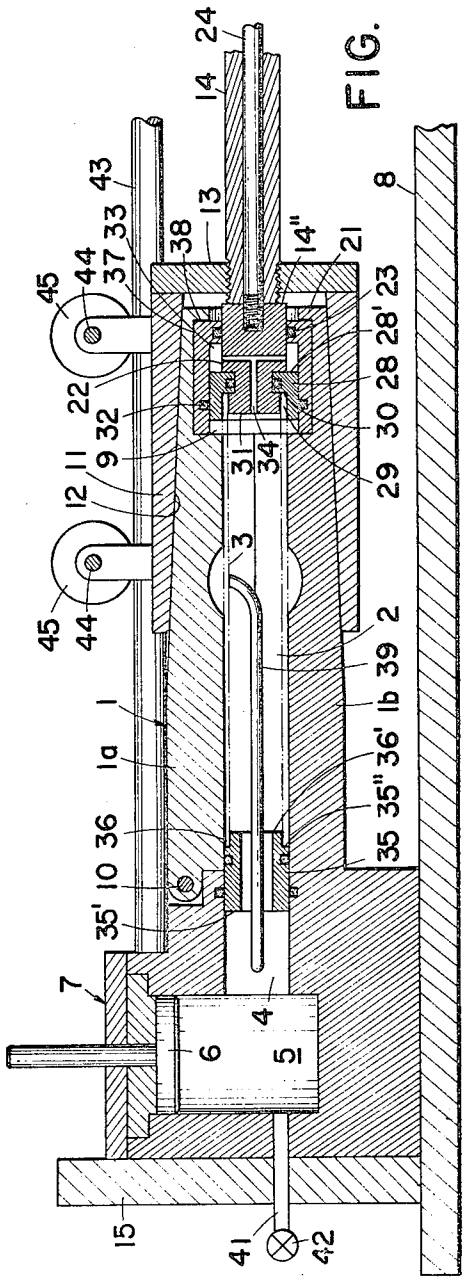


FIG. 2

MASANOBU NAKAMURA

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BULGING APPARATUS

This invention relates to a bulging apparatus, and it has for its object the provision of a new, improved horizontal type bulging apparatus in which a split type die of upper and lower die members are fastened together positively and solidly, and an outer cylinder to fasten the die members together is adapted to fit smoothly in the die, and a pipe inserted into the die is positively supported at both ends.

In the present invention, the above object is realized by an arrangement in which the horizontal die of split type consisting of upper and lower die members is tapered toward the front end, and an outer cylinder having a correspondingly tapered cylindrical hollow is adapted to move in the axial direction to receive the frontal portion of the die so as to fasten the upper and lower die members together, the outer cylinder being supported by flexible axles disposed normal to the traveling direction of the cylinder, in such a manner that, as the outer cylinder is moved ahead to receive the frontal portion of the die, the tapered hollow of the outer cylinder is concentrically aligned with the tapered frontal portion of the die.

The present invention will be more fully described hereunder in connection with the accompanying drawing showing a bulging equipment embodying the invention.

In the drawing:

FIG. 1 is a plan view, partly broken away, of the embodiment; and

FIG. 2 is a vertically sectional view, on an enlarged scale, taken along the line II—II of FIG. 1.

Referring to the drawing, a die is generally indicated at 1, as composed of an upper die member 1*a* and a lower die member 1*b*. The die members are formed with halves of a cavity 2 on the matching faces for receiving a pipe 3 to be worked, and the entrance (shown at the left end) of the die cavity 2 is communicated at 4 to a hydraulic pressure generating chamber 5 equipped with a piston 6 of a hydraulic pressure generator 7 which is installed on a base 8. The frontal end portion of the die 1 (shown at the right end) is formed with a large-diameter chamber 9 inside.

The lower die member 1*b* is fixed at the rear end to one side of the hydraulic pressure generator 7, and also the upper die member 1*a* is connected at the rear end, pivotally with a lateral pin 10, to the same side of the hydraulic pressure generator 7, so that the latter die member can turn up and down about the pin 10 to open or close the die. The contour of the die 1 is such that the frontal portion is tapered over a certain distance down to the front end. This enables the fastening outer cylinder 11 with a correspondingly tapered hollow 12, as it is driven backward over the die, to fasten the upper die member 1a and the lower die member 1b firmly together.

Through the front end wall 13 of this fastening cylinder 11, there is fixed one end of a sliding sleeve 14 which is horizontally supported by a pair of holder frames 15 on the base 8 and is adapted to be moved slidingly forward and backward by a suitable actuator 16. As the sliding sleeve 14 slides to and fro, the outer cylinder 11 is caused to reciprocate accordingly along the axis of the die 1 into and out of engagement with the die 1.

Numerals 17 and 18 indicate lines for supplying hydraulic oil to the cylinder 19 of the hydraulic actuator 16. A piston 20 is fitted to the sliding rod 14, and the cylinder 19 is secured fixedly at one end to the holder frame 15.

Through a shielding wall 21 at the front end of the large-diameter chamber 9 of the die is extended a plunger 22 which slides while being kept liquidtight by and O ring 23. To the outer end (shown at the right end) of this plunger 22, the inner end (shown at the left end) of a rod 24 which is inserted in the sliding sleeve 14 is connected.

The outer end portion of the rod 24 protrudes from the sleeve 14 and is engaged at an externally threaded part 25 with a nut 26, which serves as a stopper in such a way that, at a point where sliding sleeve 14 has receded bringing the fastening cylinder 11 completely out of engagement with the die 1, the outer end 14′ of the sleeve 14 comes in contact with the nut 26 and is thereby kept against further backward movement.

On the inner end of the plunger 22 that is located inwardly of the rod 24 there is fitted a cylindrical chuck 28 having a tapered mouth 29 to receive the front tip of the pipe 3 to be worked. At the depth 30 of the mouth 29 is provided a plug 31 adapted to fit in the front end of the pipe 3.

Between the outer surface of the chuck 28 and the inner surface of the large-diameter chamber 9 a liquidtight seal is established by means of an O ring 32, and the chuck 28 is freely slidable through the said chamber. There is defined an enclosed chamber 33 between the outer end face 28′ of the chuck 28 and the inner face of the shielding wall 21 at the front end of the large-diameter chamber 9. The plunger 22 is formed with oil passages 34, which extend from the inner end face of the plug 31 to the enclosed chamber 33.

In the hydraulic oil inlet of the cavity 2 of the die 1 there is inserted a stepped cylindrical presser 35, which has a reduced-diameter projection 36 adapted to be fitted in the rear end (shown at the left end) of the pipe 3 to be worked.

The area of the inner end surface or of the end surface 36′ of the projection 36 to be fitted in the rear end of the pipe 3 is slightly less than the area of the outer end surface 35′ on the side of the hydraulic oil inlet.

Accordingly, as hydraulic oil under pressure is forced into the pipe 3, the presser 35 is driven deep into the cavity 2 by the pressure difference attributable to the difference of the pressure-receiving areas of the inner and outer end surfaces thereof, until the projection 36 fits tightly in the rear end of the pipe 3 while, at the same time, the stepped end surface 35″ at the shoulder of the presser 35 that is defined by the reduced-diameter stepped part 36 presses the rear end of the pipe 3 outwardly and thereby grips it securely.

In order to define the large-diameter chamber 9, the die 1 is formed with a cylindrical hollow 37 of an increased diameter in the frontal portion and a cylinder 38 having the shielding wall 21 at the front end, so that the inside of the cylinder 38 represents the large-diameter chamber 9.

Referring specifically to FIG. 1, a pipe 39 is provided to serve as an air vent upon the filling of the work pipe 3 with hydraulic oil, and it is open at the inner end in a

suitable upper part of the hollow of the pipe 3. A valve 40 is provided intermediate with the air vent pipe 39 to open or close the line. Numeral 41 indicates a line for the supply of hydraulic oil to the piston chamber 5 of the hydraulic pressure generator 7. The line 41 is equipped with a valve 42 for the opening and closing of the line. As hydraulic oil enters the pipe 3 and the air inside the pipe is completely urged out through the air vent pipe 39, or when the hydraulic oil begin to overflow from the outer end of the air vent pipe 39, the valves 40, 42 are both closed suitably and automatically.

In the equipment embodying the invention, considerations are given to ensure positive, light and smooth engagement of the outer cylinder 11 with the die 1 for the purpose of fastening the latter without any possibility of off center alignment.

To be more specific, two horizontal rails 43 are held parallel with the axis of the die 1 between the holder frames 15 installed at both ends of the base 8, and axles 44 of a slightly flexible material are connected midway to the outer cylinder 11 at right angles to the directions in which the cylinder 11 is moved forward and backward. The axles 44 are provided with wheels 45 at both ends, which wheels riding on the rails 43 in such a manner as to hang the outer cylinder 11 between the rails 43 with no possibility of derailing.

The operation of the bulging equipment according to the invention will now be explained.

First, the outer cylinder 11 is moved away from the die 1, and the upper die member 1*a* is turned up pivotally about the pin 10 to open the die. A length of pipe 3 to be worked is placed in the half of the cavity 2 formed in the lower die member 1*b*. At this time, the pipe 3 is inserted at the front end (or the right end as viewed in the drawing) into the mouth 29 of the chuck 28 and is received at the rear end (or the left end) by the presser 35.

Next, the upper die member 1a is turned down to close the die and the sliding sleeve 14 is moved toward the die 1 by means of the hydraulic actuator 16, so that the fastening outer cylinder 11 is urged over the tapered frontal portion of the die 1, thereby to fasten the upper die member 1*a* and the lower die member 1*b* together.

At this point, the valves 40, 42 of the hydraulic pressure generator are turned open to introduce hydraulic oil under pressure into the piston chamber 5, the passage 4 and the pipe 3. As the pipe 3 is filled up with the hydraulic oil, the valves 40, 42 are closed.

The piston 6 of the hydraulic pressure generator 7 is urged downward suitably as by a press to exert a pressure on the hydraulic oil in the cylinder 5, so that the pressure is conducted to the oil inside the pipe 3 to cause bulging of the pipe as desired to the contour of the cavity 2.

In the present bulging equipment, a part of the hydraulic oil pumped into the pipe for the bulging purpose is led through the passages 34 of the plunger 28 inserted in the shielding wall of the large-diameter chamber 9, into the enclosed chamber 33 between the outer end surface 28′ of the chuck 28 and the shielding wall 21, thereby exerting a pressure against the outer end surface 28′ of the chuck 28.

Since the plunger 22 for the chuck 28 is slidably extended through the shielding wall 21 of the large-diameter chamber 9, the chuck 28 is urged toward the pipe 3 until the tapered mouth 29 gets in further contact with the front end of the pipe 3 to secure the pipe in position, while the inner depth 30 of the mouth 29 presses the front end of the pipe 3 fixedly.

As already stated, the presser 35 inserted in the rear end portion of the cavity 2 of the die 1 is such that its outer end surface 35′ is larger in area than its inner end surface 36′. Therefore, by the pressure difference during the bulging operation due to the difference of the pressure-receiving areas, the presser 35 is forced deep into the cavity 2 and the projection 36 at the front end fits in the rear end of the pipe 3 while the shoulder 35″ presses the rear edge of the pipe 3 frontwardly.

Thus, during the bulging operation, the pipe 3 is automatically supported and gripped at both ends by the presser 35 and the chuck 28 and, therefore, the bulging can be accomplished positively without the possibility of the pipe 3 being held off-center.

In order to take out the bulged pipe from the die 1, the hydraulic oil is drained from the pipe 3 through the passage 4 and then the procedure to be described below is followed.

The hydraulic actuator 19 is caused to operate in the reverse direction to bring the sliding sleeve 14 backward (or rightward as viewed in the drawing) until the fastening outer cylinder 11 is moved completely away from the die 1. The upper die member 1*a* is now ready for pivotally turning upward about the pin 10 to open the die. However, the pipe 3 cannot be taken out yet because it is still in the grip of the chuck at the front end.

As the sliding sleeve 14 moves further backward to the point where the outer end surface 14′ hits the nut 26, the rod 24 is pulled out together with the sliding sleeve 14, and the plunger 22 at the inner end of the rod 24 is moved in the direction outward from the shielding wall 24 of the large-diameter chamber 9. As a result of this movement, the chuck 28 provided integrally with the rod is also moved toward the shielding wall 21 of the large-diameter chamber 9, whereby the chuck 28 is disengaged from the front end of the pipe 3.

Then, the pipe 3 is disconnected from the presser 35 at the other end, and it can now be simply taken out of the lower die member 1*b*.

For another cycle of bulging operation, another length of pipe is placed in the cavity, the sliding sleeve 14 is caused to advance by means of the hydraulic actuator 16, and the outer cylinder 11 is moved forward to cover the die 1. In this case, it is of course so designed that when the outer cylinder 11 has covered the die to a certain extent, the inner end surface 14″ of the sliding sleeve 14 presses the outer end surface of the plunger 22 which is pulled out of the shielding wall 21 of the large-diameter chamber 9 and brings the plunger 22 back to the original position and positively define the enclosed chamber 33 in the large-diameter chamber 9.

Also, as stated above, the outer cylinder 11 to fasten the die 1 can be lightly and smoothly moved into or out of engagement with the die 1, because it is hung by the pair of parallel rails 43 on which the wheels 45 attached to the flexible axles 44 that are coupled midway to the outer cylinder 11 run.

The axles 44 for the outer cylinder 11 have some flexibility and the wheels 45 can be deviated in the direction somewhat sidewise over the rails 43. Therefore, even if the outer cylinder 11 is slightly tilted as it is urged over the die 1, the cylinder 11 is allowed to achieve self-centering with respect to the die 1, so that it can engage with the latter positively and accurately without the application of any excessive or localized force.

I claim:

1. A horizontal pipe bulging apparatus comprising:
   a. a split type horizontal die having upper and lower die members formed with a mold cavity inside and tapered on the outside over a certain desirable distance from the front end and having an inlet port;
   b. hydraulic pressure generating means for generating liquid under pressure having a piston chamber in communication with said inlet port;
   c. an outer cylinder having a tapered hollow adapted to receive said tapered upper and lower die members, said outer cylinder being moveable horizontally with respect to the axis of said die and into and out of engagement with said die;
   d. a plunger axially coupled to said outer cylinder and aligned with said die members, said plunger having a first passage axially disposed therethrough and a second passage transverse to said first passage and integral therewith;
   e. a chuck concentrically disposed about said plunger and coupled thereto, said chuck having a portion thereof in juxtaposition with said second passage and being responsive to the liquid under pressure whereby said chuck and plunger are urged against the pipe; and
   f. means for moving said outer cylinder horizontally comprising axles coupled to and disposed transverse to said outer cylinder, guide rails parallel to and on opposite sides of said die, and wheels pivotally coupled upon said axles and adapted to be rollingly received by said guide rails.

2. An apparatus according to claim 1 wherein the outer end of the pipe to be bulged is supported by an inner end of said sliding sleeve, said plunger and said chuck.

3. An apparatus according to claim 1 wherein said outer cylinder is moved horizontally forward and backward by a sliding sleeve adapted to be slidingly moved by hydraulic actuating means.

4. An apparatus according to claim 1 wherein a stepped cylindrical presser having a reduced diameter projection at the front adapted to fit in the rear of the pipe to be bulged is inserted in the inlet whereby hydraulic oil is supplied to the cavity of said die.

5. An apparatus according to claim 4 wherein the end surface of the reduced diameter projection of said stepped cylindrical presser has a cross-sectional area smaller than the cross-sectional area of the end surface of said presser on the oil inlet side.

6. A pipe bulging apparatus comprising:
   a. a split die having two separate die members pivotally coupled to each other at an end thereof and having complementary axial cavity portions therein for holding the pipe and a recess corresponding to the bulge to be disposed in the pipe, said cavity having first and second ends;
   b. a presser coupled within the first end of said cavity having an aperture axially disposed therethrough and an axial end thereof adapted to abut and be received by the first end of the pipe;
   c. hydraulic generating means for supplying liquid under pressure coupled to the first end of the cavity in juxtaposition to said presser whereby liquid under pressure is supplied through the aperture in said presser;
   d. an inner cylinder axially disposed in said die at the second end thereof;
   e. a plunger slidably coupled within a portion of said inner cylinder having at least a first passage at and end thereof axially disposed in said plunger and at least a second passage integral with said first passage and transversely aligned through said plunger, the end of said plunger being adapted to abut and be received by the second end of the pipe;
   f. a chuck concentrically coupled about said plunger and having a radial face in axial opposition with a corresponding radial face of said inner cylinder, said second passage being intermediate the radial faces of said chuck and said inner cylinder whereby liquid under pressure is forced through said first and second passages urging said plunger and coupled chuck against the pipe;
   g. an outer cylinder coupled to said plunger having a tapered hollow adapted to receive said die members; and
   h. moveable means for moving said outer cylinder axially to fasten said die members comprising an axle secured to and disposed transverse said outer cylinder, guide rails in parallel spaced relation to the axis of said die members, and wheels pivotally supported upon said axle and adapted to be rollingly received by said guide rails.

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