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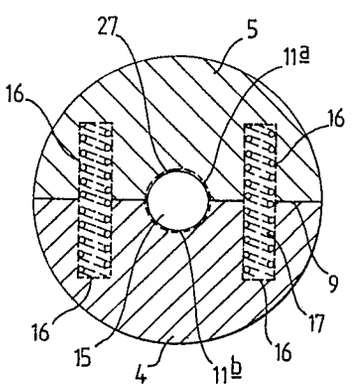
(54) Producing a thread on a tube.

(57) "A method of and apparatus for producing a formation such as a screw thread on a tube comprising the steps of forcing a surface of the tube such as by a mandrel against a pattern member having a pattern thereon so as to displace the material of the tube into the pattern to form the formation on the surface of the tube."

FIG 1



EP 0 336 783 A2

Description

Producing a Thread on a Tube

This invention relates to a method of and apparatus for producing a thread on a tube.

According to a first aspect of the invention there is provided a method of producing a formation on a tube comprising the steps of forcing a surface of the tube against a pattern member having a pattern thereon so as to displace the material of the tube into the pattern to form a formation on the surface of the tube.

The formation may comprise a screw-thread or at least one circumferentially extending ring.

The depth to width ratio of the formation may be at least 1 : 1.

By "tube" we mean hollow or part hollow component which may be of circular or other cross-sectional shape and of constant or varying shape logitudinally thereof, for example, frusto-conical.

The method may comprise the steps of forcing an external surface of the tube against the pattern member.

The external surface of the tube may be forced against the pattern member by displacing the material of the tube generally outwardly from a longitudinal axis of the tube.

The method may further comprise displacing the material of the tube into the pattern by introducing a mandrel into a hollow interior of the tube to swage the tube between the mandrel and the pattern member.

The method may include moving a die assembly which constitutes the pattern member between an operative position in which the die assembly is adapted to form a passage which at least partly surrounds the tube, and an inoperative position in which individual dies of the die assembly are spaced mutually apart.

The method may comprise moving the die assembly into the operative position to bring about temporary formation of a pattern such as a continuous thread formation or at least one continuous circumferentially extending ring on the inwardly facing wall of the passage.

The method may further comprise moving the die assembly into the operative position such that the radially innermost parts of the pattern such as the ridges of thread or ring firmly engage the external surface of the tube.

The method may include moving the die assembly between the operative and inoperative positions within a body which houses the die assembly, the movement of the dies being effected by movement of the body, in response to fluid pressure operated means, relative to the die assembly.

The method may further comprise actuating further fluid operated pressure means to move the mandrel between a first condition in which it extends into the hollow interior of the tube and a second condition in which it is withdrawn from the interior of the tube, the mandrel being of such dimensions relative to the dimensions of the tube that the introduction of the mandrel into the interior of the tube causes the material of the tube to be displaced outwardly of a longitudinal axis of the tube.

The method may comprise the steps of:
moving the die assembly to a position in which it forms the passage about the external surface of the tube,
introducing the mandrel into the hollow interior of the tube with concomitant displacement of the metal of the tube into the pattern of the die assembly,
withdrawing the mandrel from the tube, and
moving the die assembly away from the tube.

The method may comprise the steps of:
placing the tube in the body,
moving the body so as to bring the die assembly into the operative position,
moving the mandrel from the second condition to the first condition thus displacing the material of the tube into the pattern in the die assembly, moving the mandrel back to the second condition,
moving the body so as to bring the die assembly into the inoperative position,
and withdrawing the tube.

The method may comprise the step of forcing an internal surface of the tube against the pattern member.

The method may comprise the step of disposing the pattern member within the tube and moving a die axially of the tube to act on the external surface of the tube to displace the material of the tube into the pattern.

The method may comprise steps in which no material is removed from the tube.

The surface of the tube may have a coating thereon prior to performing the step of forcing the surface against the pattern member to form the formation.

The coating may be a plastics coating such as nylon or other polymer or a metal coating such as an electrolytically deposited zinc.

The tube may be made of steel or other metal.

According to a second aspect of the invention there is provided apparatus for producing a formation on a metal tube comprising a pattern member having a pattern thereon, and means to force a surface of the tube against the pattern member to form the formation on the surface of the tube.

The pattern member may comprise a die assembly which is movable between an operative position in which the die assembly is adapted to form a passage which at least partly surrounds the tube, and an inoperative position in which individual dies of the die assembly are spaced mutually apart.

The apparatus may further comprise a mandrel which is adapted to extend into a hollow interior of the tube.

The pattern may be provided on the inwardly facing wall of the passage formed collectively by the dies when the die assembly is in the operative position.

The formation may be a continuous thread formation or at least one circumferentially extending

ring.

The formation may be produced by displacement of the material of the tube into the pattern as the tube is swaged between the mandrel and the die assembly when said die assembly is in the operative position.

In the operative position the radially innermost parts of the pattern such as the ridges of the thread may engage the external surface of the tube.

The die assembly may be movable within, and relative to, a moveable body, the movement of the body causing movement of the die assembly between the operative and inoperative positions.

The body and die assembly may be provided with co-operating cam surfaces whereby movement of the body in a direction parallel to the longitudinal axis of the tube causes movement of the dies generally transverse to said axis.

Movement of the body may be accomplished by actuation of fluid pressure operated means.

The or each pair of dies constituting the die assembly may have provided therein and acting therebetween resilient biasing means to bias the dies mutually apart such that when the die assembly is not placed in the operative position it tends to assume the inoperative position.

The mandrel may be movable between a first condition in which it extends into the hollow interior of the tube and a second condition in which it is withdrawn from the interior of the tube.

Preferably the mandrel is movable between said first and second conditions by fluid operated pressure means.

The mandrel may protrude from and be slidably movable within a hollow cylinder and it may be moved therein between the first and second conditions by fluid pressure acting on surfaces of the mandrel within the cylinder.

The mandrel may be of such dimensions relative to the dimensions of the tube that the introduction of the mandrel into the interior of the tube from the second condition causes the material of the tube to be displaced outwardly of a longitudinal axis of the tube.

Alternatively, the pattern member may comprise a mandrel assembly, having a pattern part, which may be movable between an inoperative position in which the mandrell is disposed outwardly of the tube and an operative position in which a pattern part of the mandrel is disposed within the tube and a die assembly may be movable between an inoperative position in which the die assembly is disposed axially outwardly of the tube and an operative position in which the die assembly is moved axially of the tube to act on the external surface of the tube to displace the material of the tube into the pattern of the mandrel.

The apparatus may be operated in accordance with the method of the first aspect of the invention.

The method and apparatus disclosed herein has several advantageous features over methods presently in use including greatly reduced cycle time and greater flexibility for the production different standards of threads.

Because no cutting operation is performed, any coating with which the tube is provided is preserved and no problem of change in formation shape due to a post coating operation is encountered.

Because the material of the tube is not cut, the wall thickness may be reduced compared with that conventionally used to allow for thread cutting. For example, the steel wiring conduit wall thickness is conventionally 1.5mm to 1.6mm thick whilst the present invention permits this wall thickness to be reduced to about 0.9-1.0mm with consequent cost saving, bearing in mind that each tube is typically three metres long.

Two specific embodiments of the invention will now be described by way of example and with reference to the accompanying drawings in which:-

FIGURE 1 is a longitudinal section through an apparatus embodying the invention;

FIGURE 2 is an end view of the die assembly on the line A-A of Figure 1; and

FIGURES 3 - 9 are diagrammatic cross-sections through a second embodiment.

Referring to Figure 1, an apparatus 1 for producing a formation comprising a thread on a tube 2 comprises a body 3 in which are housed a pair of dies and 5. The body 3 is provided with an opening 6 into which the tube 2 may be inserted and the opening 6 communicates with an interior well 7 in which are received the dies and 5.

The well 7 is frusto-conical having a side wall 8 which diverges away from a longitudinal axis of the tube 2 as the wall and the axis approach a wall 14 which closes a first end of the well 7 and in which wall 14 is formed the opening 6.

The dies 4 and 5 are also provided with frusto-conical side walls 4a, 5a which co-operate with the side wall 8 of the well.

It will be appreciated that a well having a shape other than frustoconical could be used e.g frusto-pyramidal, provided that the dies are of cooperating shape.

The body 3 is movable, by means hereinafter to be described, relative to the dies 4 and 5 in the direction of the longitudinal axis of the tube 2.

When the dies 4 and 5 are in contact with a second end wall 10 of the well 7 which is opposite to the end of the well provided with the wall 14, diametrical faces 9 of the dies are brought into mutual contact. This is best seen in Figure 2.

Each of the dies 4 and 5 has provided therein, at the middle portion of the face 9, a generally semi cylindrical recess 11a, 11b the longitudinal axes of which, when the die faces 9 are in contact, are coincidental with the longitudinal axis of the frusto-conical walls 4a, 5a of the dies. The recesses 11a, 11b extend perpendicular to and between parallel end faces 12 and 13 of the dies.

The semi cylindrical recesses 11a, 11b are each provided thereon with a thread formation and when the faces 9 of the dies 4 and 5 are in mutual contact the semi-cylindrical recesses 11a, 11b form a generally cylindrical passage 15 having a continuous thread formation 27 of the wall thereof. The thread formation 27 is of a suitable configuration to provide a pattern for a desired thread to be formed on the tube 2. When the passage 15 is formed moreover,

the ridges of the thread formation 27 firmly engage the external surface of the tube 2.

The dies 4 and 5 also have provided therein blind bores 16 which extend perpendicular to the faces 9 partly into the body of the or each die. The bores 16 are provided on either side of the semi cylindrical recesses 11a, 11b and are equidistant from the longitudinal axis of the passage 15. The bores 16 on the die 4 are aligned with the bores 16 on the die 5 and the aligned bores 16 have provided therein coil compression springs 17 which bear against opposite blind ends of the aligned bores 16 and urge the faces 9 of the dies 4 and 5 mutually apart.

In the embodiment shown in Figures 1 and 2 a total of 4 springs acting between the two dies 4 and 5 are illustrated but it will be appreciated that two, three or more than four such springs may be used.

It will further be appreciated that whilst the specific embodiment shown in the diagrams has two dies, three, four or more dies may be provided, each die having provided therein a part cylindrical recess and thread formation, and blind bores for the reception of resilient biasing means so as to provide a die assembly which is adapted to form a generally cylindrical passage analogous to the passage 15 having a continuous thread formation, and the individual dies of which are urged mutually apart by the resilient biasing means.

The body 3 has an opening 36 therein which extends from an end 37 of the body which is distant from the wall 14, to the well 7. A cylinder 19 is partly located and fixed within the opening 36, the end wall 39 of the cylinder 19 being flush with the second end wall 10 of the well 7.

A mandrel 18 is slidably movable within the cylinder 19. A first region 20 of mandrel 18 is adapted to be introduced into the well 7 of the body and hence into the passage 15 of the die assembly and into the hollow interior of the tube 2 during formation of a thread on the tube. A second region 21 of the mandrel 18 is of greater diameter than the first region 20 and a shoulder 38 is provided at the junction of the two regions which shoulder 38 abuts against the end face 13 of the dies 4 and 5 when the faces 9 of the dies are in mutual contact, to limit the travel of the first region 20 into the passage 15. The second region 21 connects the first region 20 to a third region 22 of the mandrel which forms a fluid tight seal with the internal surface of the cylinder 19. The first, second, and third regions 20, 21 and 22 respectively of the mandrel 18 may be formed as a single member.

The mandrel may be moved within the cylinder 19 so as to introduce the first region 20 into the hollow interior of the tube 2 by introduction of fluid into a region 26 behind the third region 22 of the mandrel 15.

The second region 21 is of smaller diameter in transverse cross section than the third region 22 and thus there is a clearance 23 between the second region 21 of the mandrel and the cylinder 19. Fluid may be introduced into the region provided by the clearance 23 via conduits 24. Introduction of fluid through the conduits 24 into the clearance space 23 exerts a pressure on the annular shoulder 25 which exists at the junction of the second and third regions 21 and 22 respectively of the mandrel 18, and thus the mandrel is moved in the cylinder 19 in such a manner as to withdraw the first region 20 of the mandrel from the hollow interior of a tube 2 which may be placed in the body 3.

The dies 4 and 5 are movable within the well 7 of the body 3 by movement of the body 3 relative to the dies 4 and 5 in response to fluid operated pressure means.

The fluid operated pressure means comprises a plurality of individual piston means 28, each of which includes chambers 29 and 30 divided from each other by a piston 31 to which is connected a piston rod 32. The piston rod 32 is further connected to the body 3. Each piston rod 32 is movable in an aperture 33 provided in the wall of the piston means 28, there being a fluid tight seal between the piston rod 32 and the aperture 33. The piston is moved in response to introduction of fluid through a port 34 into the chamber 29 and through a port 35 into the chamber 30.

When fluid is introduced through ports 34 into chambers 29 the pistons 31 and piston rods 32 are moved in such a direction as to move the body 3 away from the piston means 28 thus causing the dies 4 and 5 to close about the tube 2 within the well 7. Introduction of fluid through the ports 35 into the chambers 30 causes the pistons 31 and piston rods 32 to move in the opposite direction within the piston means 28 such that the body 3 is moved closer to the piston means 28. The dies 4 and 5 are then biased apart by the spring means 17 acting between them as the diameter of the well 7 increases due to divergence of the wall 8.

The wall 8 of the well 7 and the walls 4a and 5a of the dies 4 and 5 comprise co-operating cam surfaces whereby movement of the body 3 in a direction parallel to the longitudinal axis of the tube 2 causes movement of the dies 4, 5 generally transverse to said axis.

It will be appreciated that mechanical means other than fluid operated pressure means may be used to move the body and mandrel.

The apparatus is operated according to the following method:

To begin with the body 3 is in a position such that the first end wall 14 of the body is in contact with the first end 12 of the dies 4 and 5 and the mandrel 18 does not extend into the well 7 of the body 3.

A tube 2 is introduced through the opening 6 in the wall 14 of the body 3 and extends into the well 7.

The piston means 28 are actuated to move the body 3 relative to the dies 4 and 5 such that the second end wall 10 of the chuck approaches or comes into contact with the end wall 13 of the dies 4 and 5, thus bringing about the concomitant mutual contact of the faces 9 of the dies 4 and 5 and the formation of the generally cylindrical passage 15 which now surrounds and end part of the tube 2.

The first region 20 of the mandrel 18 is then introduced into the hollow interior of the tube 2 and is of such dimensions relative to the tube that its introduction therein simultaneously causes dis-

placement of the material of the tube 2 into the thread formation 27 which is located on the surface of the passage 15 surrounding the tube.

When the mandrel 18 has travelled to its limit it is moved back in the opposite direction in the cylinder 19 and is thus withdrawn from the tube 2.

When the mandrel has thus been removed the body 3 is moved to bring about divergence of the dies 4 and 5, which separate due to springs 16 the tube 2 can then be withdrawn from the opening 6 of the body 3 and has a thread formed thereon.

It will be apparent the whole operation lends itself to automation such that actuation of the fluid operated pressure means may occur in response to valve switching means.

In a modification the same results can be achieved by an apparatus in which the walls 4a, 5a of the dies 4 and 5 and the wall 8 of the well 7 diverge in the opposite direction to that shown in Figure 1 and in such an arrangement the dies would be opened and closed by movement of the chuck in the directions contrary to those which apply to the arrangement shown in the diagram.

It will also be appreciated that whilst Figure 1 shows the longitudinal axis of the tube lying in a horizontal plane the apparatus could equally well be operated at 90° to such a position such that the tube 2 extends upwardly or downwardly from a vertical opening 6, or indeed in any desired orientation.

Any desired configuration of formation may be produced.

If desired a thread or other formation may be provided on an internal surface of a tubular member by providing a pattern member internally of the tube, for example a mandrel with a suitably configured surface such as to form a screw thread, and then swaging or otherwise forcing the internal surface of the tubular member into pattern forming engagement with the pattern member. The pattern member is then removed by utilising a collapsible pattern member, or in the case of a screw thread, by unscrewing the pattern member.

An example of providing thread on an internal surface of a tubular member will now be described with reference to Figures 3 - 7 of the accompanying drawings.

In this embodiment an apparatus 101 for producing a formation comprising a thread on a tube 102 comprises a die flow collar 103 having an axially extending passage 105 with a counterbored portion 106 at one end. Mounted within the passage 105 is a mandrel 107 of a diameter to be a snug fit in the main part of the passage 105 and to provide an annular space 108 between the counterbored part 106 and the mandrel 107. At one end the mandrel 107 has a shoulder 109 and a pattern part 110 which is configured to provide a pattern for a desired thread configuration. In use, the tube 102 is held in a clamp 111 and the mandrel 107 and flow collar 103 are moved towards the tube 102 until the shoulder 109 engages the end 112 of the tube 102. This ensures that the longitudinal extent of the thread to be formed in the tube 102 is properly controlled.

The flow collar 103 is then forced over the end of the tube 102 thus causing reduction of the outside dimension of the tube 102 and causing the metal to flow into the troughs of the pattern part 110 of the mandrel 107, thereby forming a thread in the bore 113 of the tube 112.

The diameter of the counterbored part 106 is predetermined in combination with the internal and external diameters of the tube 102 and the configuration of the part 110 of the mandrel to ensure that correct thread formation is formed.

Thereafter the flow collar 103 is withdrawn to give clearance from the end of the component followed by rotation of the mandrel 107 to unscrew it from a thread 114 now formed in the bore 113 of the tube 102. The finished component is shown in figure 7.

In a modification, shown in Figure 8, the tube 102 may be initially formed with an enlarged end portion 115 and the mandrel and flow collar 103 correspondingly dimensioned so that after performing the above described method the final tube is of constant external diameter, as illustrated in Figure 9.

Whilst in the above described embodiment the tube 102 is of cylindrical internal and external configuration, if desired external configuration of the tube may be of other shape, for example, hexagonal or anyother cross-sectional shape, the flow collar 103 being provided with a bore corresponding to the bore 105 and counterbore part 106 of corresponding configuration. Furthermore, although the workpiece in the above described embodiment is a tube, if desired the workpiece may be any component with a tubular part capable of being subjected to a method as hereinbefore described.

In essence, the flow collar causes the metal to flow to fill the troughs and to flow around the crests of the pattern on the mandrel to give exactly the same technical features of commercial effectiveness which the external threading embodiment described hereinbefore provides.

In the present examples, the tube is made of steel provided with a galvanised coating. The tube is intended for use as electrical wiring conduit. The method preserves the galvanised zinc coating so that, in use, corrosion of the threaded portion is avoided which is important in electrical wiring conduit so that electrical conductivity is maintained.

The tube may be made of other plastically deformable material and may be coated with any other suitable coating such as nylon or other polymer.

The thread may have a root to rib height which is equal to the thread pitch but, if desired, the ratio of thread height to width may be greater than 1 : 1.

The tube may be swaged to reduce the diameter of the end of the tube to provide a shoulder to the threaded part thereof.

The present invention enables threads to be produced on very much lighter gauges of steel tube than hitherto possible, there is a reduction in labour cost as a result of reducing cycle time.

A stronger thread is produced by virtue of the fact that metal has not been removed. The thread or other formation being made solely by metal displacement.

Swarf is eliminated, maintenance costs are re-

duced, the cost of replacement of considerable cutting tools is reduced and the capital cost of the equipment may be reduced compared with conventional methods of forming threads.

The features disclosed in the foregoing description, or the following claims, or the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method of process for attaining the disclosed result, or a class or group of substances or compositions, as appropriate, may, separately or in any combination of such features, be utilised for realising the invention in diverse form thereof.

Claims

1. A method of producing a formation on a tube comprising the steps of forcing a surface of the tube against a pattern member having a pattern thereon so as to displace the material of the tube into the pattern to form a formation on the surface of the tube.

2. A method according to Claim 1 wherein the formation comprises a screw-thread or at least one circumferentially extending ring.

3. A method according to Claim 1 or Claim 2 wherein the method comprises the steps of forcing an external surface of the tube against the pattern member.

4. A method according to Claim 3 wherein the external surface of the tube is forced against the pattern member by displacing the material of the tube generally outwardly from a longitudinal axis of the tube.

5. A method according to Claim 3 or Claim 4 wherein the method includes moving a die assembly which constitutes the pattern member between an operative position in which the die assembly is adapted to form a passage which at least partly surrounds the tube, and an inoperative position in which individual dies of the die assembly are spaced mutually apart.

6. A method according to Claim 5 wherein the method further comprises moving the die assembly into the operative position such that the radially innermost parts of the pattern firmly engage the external surface of the tube.

7. A method according to Claim 5 or Claim 6 wherein the method includes moving the die assembly between the operative and inoperative positions within a body which houses the die assembly, the movement of the dies being effected by movement of the body, in response to fluid pressure operated means, relative to the die assembly and the method further comprises actuating further fluid operated pressure means to move the mandrel between a first condition in which it extends into the hollow interior of the tube and a second condition in which it is withdrawn from the interior of the tube, the mandrel being of such dimensions relative to the dimensions of the tube that the introduction of the mandrel into the interior of the tube causes the material of the tube to be displaced outwardly of a longitudinal axis of the tube.

8. A method according to Claim 10 wherein the method comprises the steps of:
moving the die assembly to a position in which it forms the passage about the external surface of the tube,
introducing a mandrel into the hollow interior of the tube with concomitant displacement of the metal of the tube into the pattern of the die assembly,
withdrawing the mandrel from the tube, and
moving the die assembly away from the tube.

9. A method according to Claim 7 or Claim 8 wherein the method comprises the steps of:
placing the tube in the body,
moving the body so as to bring the die assembly into the operative position,
moving the mandrel from the second condition to the first condition thus displacing the material of the tube into the pattern in the die assembly, moving the mandrel back to the second condition,
moving the body so as to bring the die assembly into the inoperative position,
and withdrawing the tube.

10. A method according to Claim 1 wherein the method comprises the step of forcing an internal surface of the tube against the pattern member.

11. A method according to Claim 10 wherein the method comprises the step of disposing the pattern member within the tube and moving a die axially of the tube to act on the external surface of the tube to displace the material of the tube into the pattern.

12. A method according to any one of the preceding claims wherein the surface of the tube has a coating thereon prior to performing the step of forcing the surface against the pattern member to form the formation.

13. An apparatus for producing a formation on a metal tube comprising a pattern member having a pattern thereon, and means to force a surface of the tube against the pattern member to form the formation on the surface of the tube.

14. An apparatus according to Claim 13 wherein the pattern member comprises a die assembly which is movable between an operative position in which the die assembly is adapted to form a passage which at least partly surrounds the tube, and an inoperative position in which individual dies of the die assembly are spaced mutually apart and wherein the pattern is provided on the inwardly facing wall of the passage formed collectively by the dies when the die assembly is in the operative position.

15. An apparatus according to Claim 14 wherein the die assembly is movable within, and relative to, a moveable body, the movement of the body causing movement of the die assembly between the operative and inoperative positions.

16. An apparatus according to Claim 15 wherein the body and die assembly are provided with cooperating cam surfaces whereby

movement of the body in a direction parallel to the longitudinal axis of the tube causes movement of the dies generally transverse to said axis.

17. An apparatus according to Claim 15 or Claim 16 wherein fluid pressure operated means are provided to effect said movement of the body.

15. An apparatus according to any one of Claims 14 to 17 wherein the or each pair of dies constituting the die assembly has provided therein and acting therebetween resilient biasing means to bias the dies mutually apart such that when the die assembly is not placed in the operative position it tends to assume the inoperative position.

19. An apparatus according to any one of Claims 1 to 18 wherein the apparatus further comprises a mandrel which is movable between a first condition in which it extends into the hollow interior of the tube and a second condition in which it is withdrawn from the interior of the tube.

20. An apparatus according to Claim 13 wherein the pattern member comprises a mandrel assembly, having a pattern part, which is movable between an inoperative position in which the mandrel is disposed outwardly of the tube and an operative position in which the pattern part of the mandrel is disposed within the tube and a die assembly is movable between an inoperative position in which the die assembly is disposed axially outwardly of the tube and an operative position in which the die assembly is moved axially of the tube to act on the external surface of the tube to displace the material of the tube into the pattern of the mandrel.

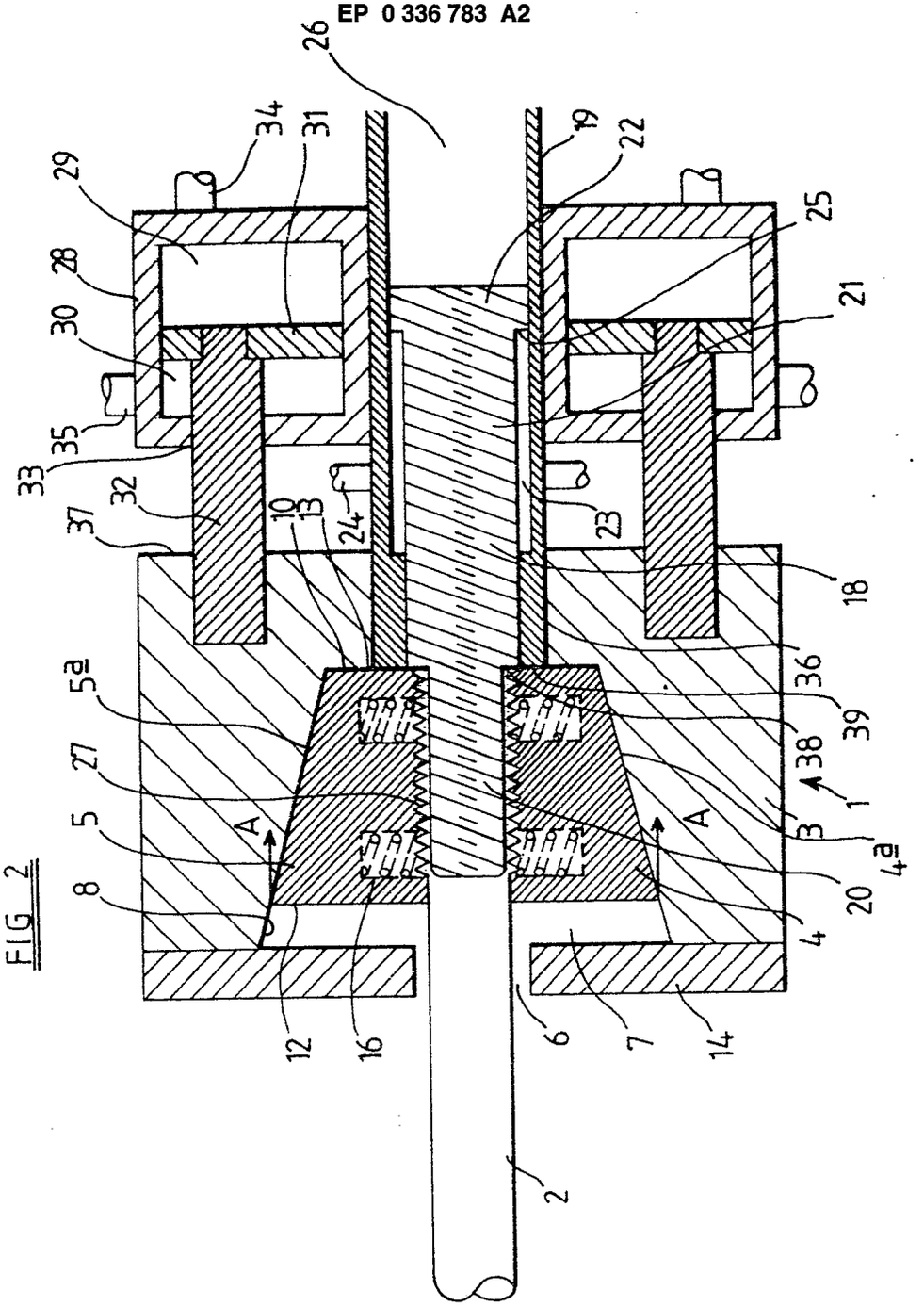

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FIG 2

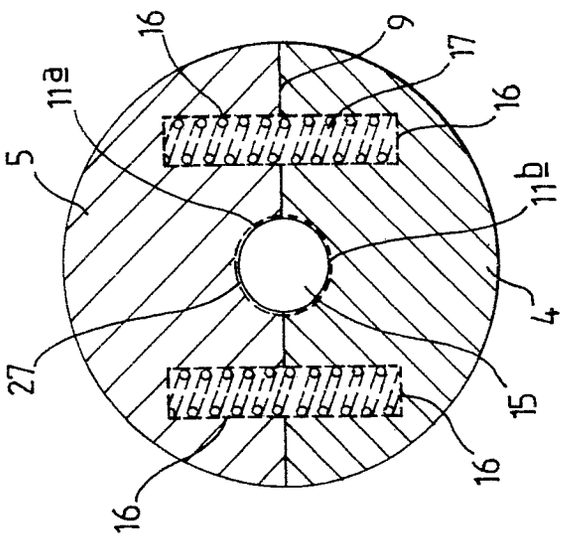
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FIG 1

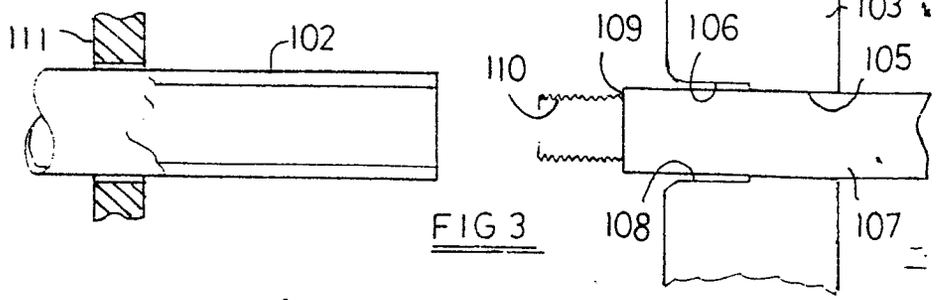

FIG 3

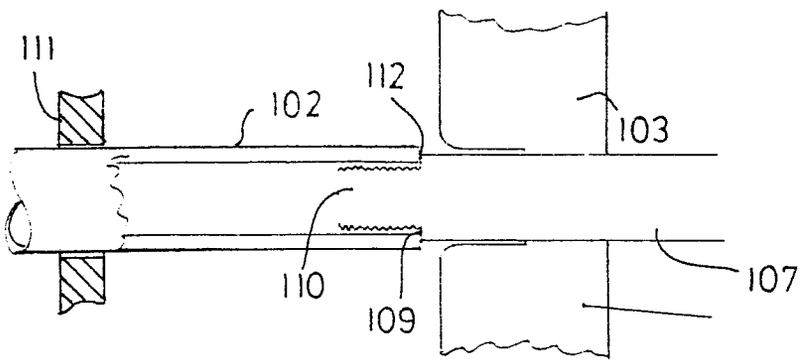

FIG 4

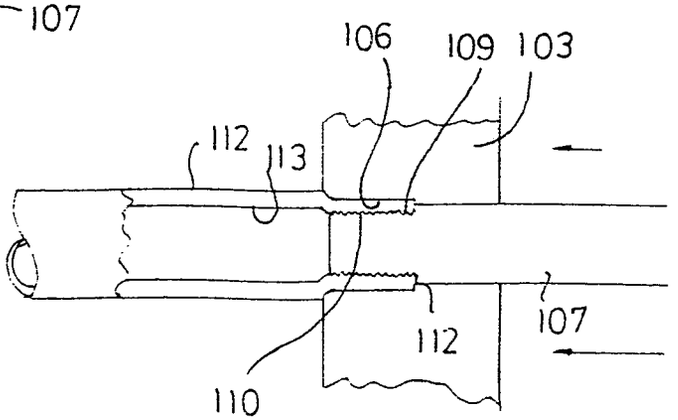

FIG 5

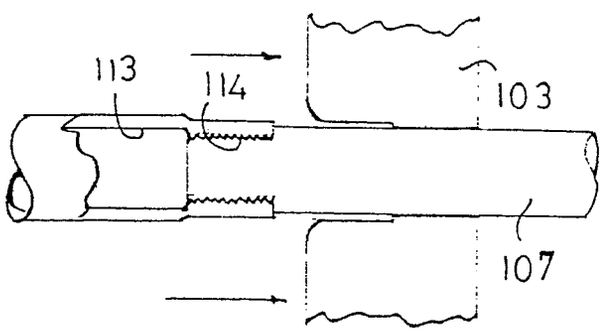

FIG 6

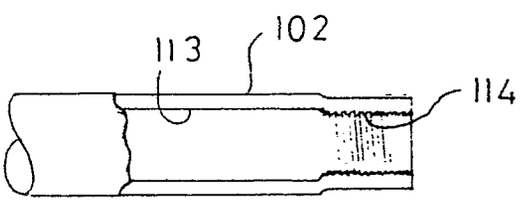

FIG 7

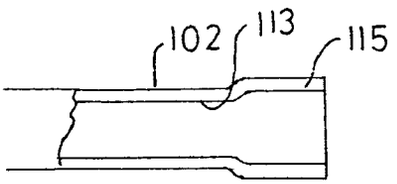

FIG 8

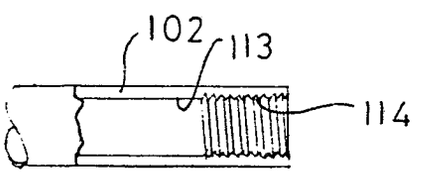

FIG 9