



(22) Date de dépôt/Filing Date: 1999/12/22

(41) Mise à la disp. pub./Open to Public Insp.: 2000/06/29

(45) Date de délivrance/Issue Date: 2011/02/15

(62) Demande originale/Original Application: 2 356 131

(30) Priorités/Priorities: 1998/12/22 (GB9828234.6);
1999/01/15 (GB9900835.1); 1999/10/08 (GB9923783.6);
1999/10/12 (GB9923975.8); 1999/10/13 (GB9924189.5)

(51) Cl.Int./Int.Cl. *E21B 43/10* (2006.01),
E21B 29/00 (2006.01), *E21B 33/128* (2006.01)

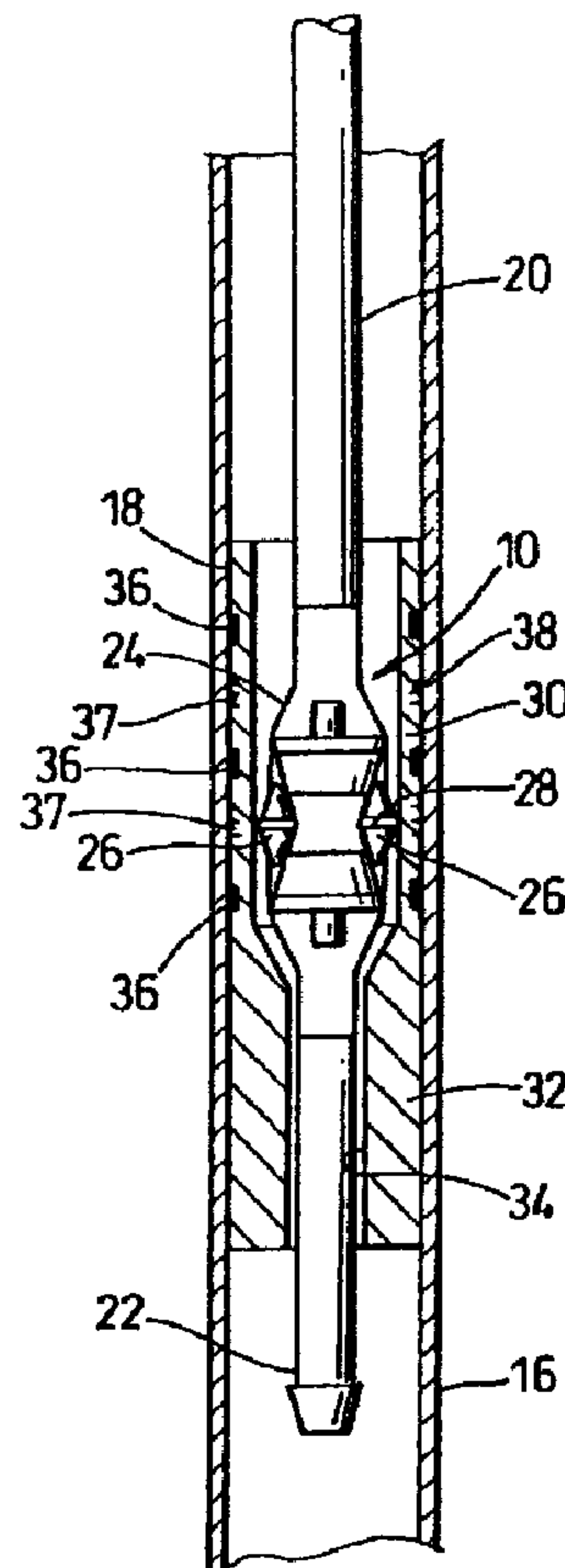
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(54) Titre : ETANCHEITE DE FOND DE TROU POUR TUBE DE PRODUCTION

(54) Title: DOWNHOLE SEALING FOR PRODUCTION TUBING



(57) Abrégé/Abstract:

A method of providing a downhole seal, such as a packer (12), in a drilled bore between inner tubing (11) and outer tubing (16) comprises: providing an intermediate tubing section (18) defining a seal arrangement for engaging with the inner tubing; and radially plastically deforming the intermediate tubing section downhole to form an annular extension (40a, 40b). The extension creates a sealing contact with the outer tubing (16).

ABSTRACT

A method of providing a downhole seal, such as a packer (12), in a drilled bore between inner tubing (11) and outer tubing (16) comprises: providing an intermediate tubing section (18) defining a seal arrangement for engaging with the inner tubing; and radially plastically deforming the intermediate tubing section downhole to form an annular extension (40a, 40b). The extension creates a sealing contact with the outer tubing (16).

DOWNHOLE SEALING FOR PRODUCTION TUBING

This is a divisional application of Canadian Patent Application No. 2,356,131 filed on December 22, 1999.

5 This invention relates to downhole sealing, and to an apparatus and method for use in forming an arrangement to allow creation of a downhole seal. In particular, but not exclusively, the invention relates to the provision of a seal or packer between concentric downhole tubing, such as
10 bore-lining casing and production casing. It should be understood that the expression "the invention" and the like encompasses the subject matter of both the parent and the divisional applications.

 In the oil and gas exploration and production
15 industry, bores are drilled to access hydrocarbon-bearing rock formations. The drilled bores are lined with steel tubing, known as casing, which is cemented in the bore. Oil and gas are carried from the hydrocarbon-bearing or production formation to the surface through smaller
20 diameter production tubing which is run into the fully-cased bore. Typical production tubing incorporates a number of valves and other devices which are employed, for example, to allow the pressure integrity of the tubing to be tested as it is made up, and to control the flow of
25 fluid through the tubing. Further, to prevent fluid from passing up the annulus between the inner wall of the casing and the outer wall of the production tubing, at least one seal, known as a packer, may be provided between the tubing and the casing. The tubing will normally be axially
30 movable relative to the packer, to accommodate expansion of the tubing due to heating and the like. The packer may be run in separately of the tubing, or in some cases may be

run in with the tubing. In any event, the packer is run into the bore in a retracted or non-energised position, and at an appropriate point is energised or "set" to fix the packer in position and to form a seal with the casing. A typical packer will include slips which grip the casing wall and an elastomeric sealing element which is radially deformable to provide a sealing contact with the casing wall and which energises the slips. Accordingly, a conventional packer has a significant thickness, thus reducing the available bore area to accommodate the production tubing. Thus, to accommodate production tubing of a predetermined diameter, it is necessary to provide relatively large diameter casing, and thus a relatively large bore, with the associated increase in costs and drilling time. Further, the presence of an elastomeric element in conventional packers limits their usefulness in high temperature applications.

It is among the objectives of embodiments of the present invention to provide a means of sealing production tubing relative to casing which obviates the requirement to provide a conventional packer, by providing a relatively compact or "slimline" sealing arrangement which does not require the provision of slips and elastomeric elements to lock the arrangement in the casing.

According to one aspect of the present invention there is provided a method of providing a downhole seal in a drilled bore between inner tubing and outer tubing, the method comprising: providing an intermediate tubing section

defining means for sealingly engaging with the inner tubing; and plastically deforming the intermediate tubing section downhole to form an annular extension, said extension creating a sealing contact with the outer tubing.

5 The invention also relates to a downhole seal as formed by this method.

10 The invention thus permits the formation of a seal between inner and outer tubing without requiring the provision of a conventional packer or the like externally of the inner tubing. In the preferred embodiment, the intermediate tubing section is of metal and the invention may thus be utilised to create a metal-to-metal seal between the intermediate tubing section and the outer tubing. The sealing means between the intermediate tubing section and the inner tubing may be of any appropriate form, including providing the intermediate tubing section with a polished bore portion and providing the inner tubing with a corresponding outer wall portion defining appropriate sealing bands of elastomer, which permits a degree of relative axial movement therebetween. In other embodiments, the sealing means may be in the form of a fixed location seal. In other aspects of the invention the intermediate tubing may be omitted, that is the inner tubing itself may be deformed to engage the outer tubing.

25 The outer tubing may be elastically deformed and thus grip the extension, most preferably the deformation resulting from contact with the extension as it is formed. In certain embodiments, the outer tubing may also be

subject to plastic deformation. Accordingly, the outer tubing need not be provided with a profile or other arrangement for engagement with the intermediate tubing portion prior to the formation of the coupling.

5 Preferably, the inner tubing is production tubing, or some other tubing which is run into a drilled bore subsequent to the outer tubing being run into the bore. Preferably also, the outer tubing is bore-lining casing. Accordingly, this embodiment of the invention may be
10 utilised to obviate the need to provide a conventional production packer, as the intermediate tubing section forms a seal with the outer tubing and sealingly receives the inner tubing. This offers numerous advantages, one being that the inner tubing may be of relatively large diameter,
15 there being no requirement to accommodate a conventional packer between the inner and outer tubing; in the preferred embodiments, the intermediate tubing section requires only a thickness of metal at the sealing location with the outer tubing, and does not require the provision of anchoring
20 slips or a mechanism for allowing slips or a resilient element to be energised and maintained in an energised condition. Alternatively, the outer tubing may be of relatively small diameter to accommodate a given diameter of inner tubing, reducing the costs involved in drilling
25 the bore to accommodate the outer tubing.

 Preferably, said deformation of the intermediate tubing section is at least partially by compressive yield, most preferably by rolling expansion, that is an expander

member is rotated within the tubing section with a face in rolling contact with an internal face of said section to roll the tubing section between the expander member and the tubing section. Such rolling expansion causes compressive plastic deformation of the tubing section and a localised reduction in wall thickness resulting in a subsequent increase in diameter. The expander member may describe the desired inner diameter of the extension, and is preferably urged radially outwardly into contact with the section inner diameter; the expander member may move radially outwardly as the deformation process progresses, progressively reducing the wall thickness of the intermediate tubing section.

Preferably, at the extension, the intermediate tubing section is deformed such that an inner thickness of the tubing section wall is in compression, and an outer thickness of the wall is in tension. This provides a more rigid and robust structure.

At least a degree of deformation of the intermediate section, most preferably a degree of initial deformation, may be achieved by other mechanisms, for example by circumferential yield obtained by pushing or pulling a cone or the like through the intermediate section, or by a combination of compressive and circumferential yield obtained by pushing or pulling a cone provided with inclined rollers or rolling elements.

Preferably, the intermediate tubing section is plastically deformed at a plurality of axially spaced

locations to form a plurality of annular extensions.

Preferably, relatively ductile material, typically a ductile metal, is provided between the intermediate tubing section and the outer tubing, and conveniently the material is carried on the outer surface of the intermediate tubing section. Thus, on deformation of the intermediate tubing section the ductile material will tend to flow or deform away from the points of contact between the less ductile material of the intermediate tubing and the outer tubing, creating a relatively large contact area; this will improve the quality of the seal between the sections of tubing. Most preferably, the material is provided in the form of a plurality of axially spaced bands, between areas of the intermediate tubing section which are intended to be subject to greatest deformation. The intermediate tubing section and the outer tubing will typically be formed of steel, while the relatively ductile material may be copper, a lead/tin alloy or another relatively soft metal, or may even be an elastomer.

Preferably, relatively hard material may be provided between the intermediate tubing section and the outer tubing, such that on deformation of the intermediate tubing section the softer material of one or both of the intermediate tubing section and the outer tubing deforms to accommodate the harder material and thus facilitates in securing the coupling against relative axial or rotational movement. Most preferably, the relatively hard material is provided in the form of relatively small individual

elements, such as sharps, grit or balls of carbide or some other relatively hard material, although the material may be provided in the form of continuous bands or the like. Most preferably, the relatively hard material is carried in a matrix of relatively ductile material.

Preferably, the method comprises the step of running an expander device into the bore within the intermediate tubing section and energising the expander device to radially deform at least the intermediate tubing section. The expander device is preferably fluid actuated, but may alternatively be mechanically activated. The device may be run into the bore together with the intermediate tubing section or may be run into the bore after the tubing section. Preferably, the device defines a plurality of circumferentially spaced tubing engaging portions, at least one of which is radially extendable, and is rotated to create the annular extension in the tubing section. Most preferably, an initial radial extension of said at least one tubing engaging portion, prior to rotation of the device, creates an initial contact between the intermediate tubing section and the casing which is sufficient to hold the tubing section against rotation.

As noted above, in other aspects of the invention the intermediate tubing section may be omitted, or provided integrally with the inner tubing. For example, the inner tubing may be production tubing and may be deformed to engage surrounding casing. Embodiments of this aspect of the invention may include some or all of the various

preferred features of the first-mentioned aspect of the invention, and may be installed using substantially similar apparatus.

Other aspects of the invention relate to locating tubing sections in existing tubing for use in other applications, such as serving as a mounting or support for a downhole device, such as a valve.

According to another aspect of the present invention there is provided apparatus for use in forming a downhole arrangement for permitting sealing between inner tubing and outer tubing utilising an intermediate tubing section fixed to and in sealing contact with the outer tubing and for sealingly engaging the inner tubing, the apparatus for location within the intermediate tubing section and comprising a body carrying a plurality of circumferentially spaced tubing engaging portions, at least one of the tubing engaging portions being radially extendable to plastically deform the intermediate tubing section, the body being rotatable to form an annular extension in the intermediate tubing section for sealing engagement with the outer tubing.

The invention also relates to the use of such an apparatus to form said downhole arrangement.

Preferably, the apparatus comprises at least three tubing engaging portions.

Preferably, the tubing engaging portions define rolling surfaces, such that following radial extension of said at least one tubing engaging portions the body may be

rotated, with the tubing engaging portions in contact with the intermediate tubing section, to create the intermediate tubing section extension. In other embodiments the extension may be created in a step-wise fashion.

5 Most preferably, the tubing engaging portions are in the form of radially movable rollers. The rollers may have tapered ends for cooperating with inclined supports. At least one of the supports may be axially movable, such movement inducing radial movement of the rollers.
10 Preferably also, each roller defines a circumferential rib, to provide a small area, high pressure contact surface.

Preferably, said at least one tubing engaging portion is fluid actuated. Most preferably, the tubing engaging portion is coupled to a piston; by providing a relatively
15 large piston area with respect to the area of the portion which comes into contact with the tubing it is possible to produce high pressure forces on the tubing, allowing deformation of relatively thick and less ductile materials, such as the thicknesses and grades of steel conventionally
20 used in downhole tubing and casing. Most preferably, a support for the tubing engaging portion is coupled to a piston, preferably via a bearing or other means which permits relative rotational movement therebetween.

The apparatus may be provided in conjunction with a
25 downhole motor, or the apparatus may be rotated from surface.

The apparatus may further include other tubing expansion arrangements, particularly for achieving initial

deformation of the tubing, such as cones, which cones may include inclined rollers.

The apparatus may be provided in combination with an intermediate tubing section.

In other aspects of the invention, the apparatus may be utilised to locate a tubing section for use in other applications, for example as a mounting for a valve or other device, in a bore.

Accordingly in one aspect, the invention provides a method of providing a downhole seal in a drilled bore between inner tubing and outer tubing, the method comprising providing an intermediate tubing section defining means for sealingly engaging with the inner tubing, and plastically deforming the intermediate tubing section downhole to form an annular extension, the extension creating a sealing contact with the outer tubing.

In another aspect, the invention provides a method of providing a downhole seal in a drilled bore between inner tubing and outer tubing, the method comprising providing an intermediate tubing section defining means for sealingly engaging with the inner tubing, and deforming a portion of the intermediate tubing section downhole by compressive plastic deformation with a localised reduction in wall thickness resulting in a subsequent increase in diameter of the intermediate tubing section to form an annular extension, the extension forming a sealing contact with the outer tubing.

In another aspect, the invention provides an apparatus for use in forming a downhole arrangement for permitting sealing between inner tubing and outer tubing utilizing and intermediate tubing section fixed and in sealing contact with the outer tubing and for sealingly engaging the inner tubing, the apparatus comprising an intermediate tubing

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section and a body carrying a plurality of circumferentially spaced tubing engaging portions for location within the tubing section, at least one of the tubing engaging portions being radially extendable to plastically deform a portion of the intermediate tubing section, the body being rotatable to form an annular extension in the intermediate tubing section for sealing engagement with the outer tubing.

In another aspect, the invention provides a packer for providing a downhole seal in a drilled bore between inner tubing and outer tubing, the packer comprising an intermediate tubing section defining means for sealingly engaging with the inner tubing and a radially plastically deformed annular extension for sealing contact with the outer tubing.

In another aspect, the invention provides a method of providing a downhole seal in a drilled bore between inner tubing and outer tubing, the method comprising: plastically deforming at least a portion of the inner tubing downhole to form an annular extension, the extension creating a sealing contact with the outer tubing.

In another aspect, the invention provides a packer arrangement comprising outer and inner tubing for location downhole, the inner tubing having a radially plastically deformed annular extension for sealing contact with the outer tubing.

In another aspect, the invention provides an apparatus for providing a sealing connection with outer tubing in a drilled bore to permit an item operatively associated with the apparatus to be sealingly located in the bore, the apparatus comprising a tubing section having a radially plastically deformed annular extension for sealing contact

10b

with the outer tubing and a non-deformed section for cooperating with the item to be located in the bore.

In another aspect, the invention provides an apparatus for use in forming a seal between an inner tubing and an outer tubing, using an intermediate tubing section in sealing contact with the outer tubing for creating a sealed engagement between the inner and outer tubings, the apparatus comprising an intermediate tubing section, and a body with at least two circumferentially spaced tubing engaging portions for location within the tubing section, at least one of the tubing engaging portions being radially extendable to plastically deform a portion of the intermediate tubing section to form an annular extension in the intermediate tubing section for sealing engagement with the outer tubing.

In another aspect the invention provides a method of sealing an annular area in a wellbore comprising providing a tubular member, deforming the tubular member in a manner whereby an outer surface of the tubular assumes a shape of a non uniform inner surface of an outer tubular therearound and forms a seal therebetween.

In another aspect the invention provides an apparatus for forming a seal between an inner tubular and an outer tubular, the apparatus comprising a body disposable within the inner tubular, the body having radially extendable, fluid actuated members to expand an outer surface of the inner tubular into sealing contact with the outer tubular.

In another aspect, the invention provides a method of selectively deforming a tubular to form at least two annular extensions of the tubular within a wellbore, the method including disposing an apparatus in the wellbore adjacent a first section of the tubular to be deformed, energizing the apparatus to bring at least one tubing

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engaging portion of the apparatus into contact with the first section, deforming the first section, repositioning the apparatus in the wellbore to a position adjacent a second section of the tubular to be deformed, re-energizing the apparatus to bring the at least one tubing engaging portion of the apparatus into contact with the second section, and deforming the second section.

In another aspect, the invention provides a method of providing a downhole seal in a wellbore, the wellbore having a lined portion, the method comprising running a first tubular into the wellbore, the first tubular having a polished bore portion and an expandable portion, suspending the first tubular at a selected depth within the wellbore, wherein at least the expandable portion of the first tubular is in an overlapping relationship with the lined portion of the wellbore, expanding the expandable portion of the first tubular, wherein the expandable portion of the first tubular is sealingly engaged to the lined portion of the wellbore, running a second tubular into the wellbore, and mating a lower portion of the second tubular with the polished bore portion of the first tubular, wherein the lower portion of the second tubular is configured to sealingly land into the polished bore portion of the first tubular.

In another aspect, the invention provides a method of providing a downhole seal in a wellbore, the wellbore having a lined portion, the method comprising running a first tubular into the wellbore, the first tubular having a polished bore portion and an expandable portion, wherein the polished bore portion is disposed below the expandable portion, suspending the first tubular at a selected depth within the wellbore wherein at least the expandable portion of the first tubular is in an overlapping relationship with

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the lined portion of the wellbore, expanding the expandable portion of the first tubular, wherein the expandable portion of the first tubular is sealingly engaged to the lined portion of the wellbore, running a second tubular into the wellbore, and mating a lower portion of the second tubular with the polished bore portion of the first tubular, wherein the lower portion of the second tubular is configured to sealingly land into the polished bore portion of the first tubular.

In another aspect, the invention provides a tubular for use with a downhole seal assembly in a wellbore, the wellbore having a lined portion, the tubular comprising an expandable portion, the expandable portion being sealingly expandable against the lined portion of the wellbore by a radial outward force applied on an inner wall thereof, and a polished bore portion, the polished bore portion configured to sealingly receive a second tubular.

In another aspect, the invention provides an apparatus for use in forming a downhole seal assembly in a wellbore, the wellbore having a lined portion, the apparatus comprising at least one radially extendable member, and an axially movable means, wherein the axially movable means can be selectively operated to mechanically direct the at least one radially extendable member radially outwards or inwards relative to the longitudinal axis of the apparatus, thereby allowing the radially extendable member to contact the inner surface of an expandable portion of a tubular to sealingly engage the tubular with the lined portion of the wellbore.

In another aspect, the invention provides a method of sealing an annular area in a wellbore, the method comprising providing a tubular member, and deforming the tubular member in a manner whereby an outer surface of the

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tubular member assumes a shape of a non-uniform surrounding surface and forms a seal therebetween.

In another aspect, the invention provides a method of forming a profile in a section of tubing within a wellbore, the method comprising providing an expander device having at least one radially extendable expander member, positioning the expander device in the wellbore at a predetermined location in the section of tubing, and extending the member to deform the tubing at the location to create the profile in the internal face of the tubing.

These and other aspects of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figures 1 to 5 are schematic sectional views of apparatus for use in forming a downhole arrangement for permitting sealing between inner tubing and outer tubing utilising an intermediate tubing section, and showing stages in the formation of the downhole arrangement, in accordance with a preferred embodiment of the present invention;

Figure 6 is an enlarged perspective view of the apparatus of Figure 1;

Figure 7 is an exploded view corresponding to Figure 6;

Figure 8 is a sectional view of the apparatus of Figure 6; and

Figures 9 and 10 are schematic sectional views of apparatus for use in forming a downhole sealing arrangement in accordance with further embodiments of the present invention.

Reference is first made to Figures 1 of the drawings, which illustrated apparatus in the form of an expander device 10 for use in forming a downhole arrangement 12 (Figure 5) for permitting provision of a seal between inner tubing, in the form of production tubing 11 (Figure 5), and outer tubing, in the form of bore-lining casing 16, utilising an intermediate tubing section 18. In Figure 1 the device 10 is illustrated located within the tubing section 18 and is intended to be run into a casing-lined bore, with the section 18, on an appropriate running string 20. A running mandrel 22 extends from the lower end of the device 10, and extends from the lower end of the tubing section 18.

The general configuration and operation of the device 10, and the "setting" of the tubing section 18, will be described initially with reference to Figures 1 to 5 of the drawings, followed by a more detailed description of the device 10.

The device 10 comprises an elongate body 24 which carries three radially movable rollers 26. The rollers 26 may be urged outwards by application of fluid pressure to the body interior, via the running string 20. Each roller 26 defines a circumferential rib 28 which, as will be described, provides a high pressure contact area. The device 10 is rotatable in the bore, being driven either from surface via the string 20, or by an appropriate downhole motor.

The tubing section 18 comprises an upper relatively

thin-walled hanger seal portion 30 and, welded thereto, a thicker walled portion 32 defining a polished bore 34. Once the tubing section 18 has been set in the casing 16, the polished bore 34 allows an appropriate section of the production tubing 11, typically carrying sealing bands, to be located within the bore 34 and form a fluid-tight seal therewith.

The seal portion 30 carries three axially-spaced seal rings or bands 36 of ductile metal. Further, between the bands 36, the seal portion 30 is provided with grip banding 37 in the form of carbide grit 38 held in an appropriate matrix.

To set the tubing section 18 in the casing 16, the device 10 and tubing section 18 are run into the casing-lined bore and located in a pre-selected portion of the casing 16, as shown in Figure 1. At this point the tubing section 18 may be coupled to the device 10, running mandrel 22 or running string 20, by an appropriate releasable connection, such as a shear ring. The outer diameter of the tubing section 18 and the inner diameter of the casing 16 where the section 18 is to be located are closely matched to provide limited clearance therebetween.

Fluid pressure is then applied to the interior of the device body 24, causing the three rollers 26 to extend radially outwardly into contact with the inner surface of the adjacent area of the seal portion 30. The rollers 26 deform the wall of the seal portion 30 (to a generally triangular form) such that the outer surface of the tubing

section 18 comes into contact with the inner surface of the casing 16 at three areas corresponding to the roller locations. Further, the pressure forces created by the rollers 26 may be sufficient to deform the casing 16, thus creating corresponding profiles to accommodate the radial extension of the intermediate tubing section 18. The carbide grit 38 carried by the sealing section 30 is pressed into the softer material of the opposing tubing surfaces, keying the surfaces together.

This initial deformation of the intermediate tubing section 18 is sufficient to hold the tubing section 18 against rotation relative to the casing 16.

The device 10 is then rotated relative to the tubing section 18 with the rollers 26 in rolling contact with the inner surface of the sealing portion 30, to create an annular extension 40a in the sealing portion 30 and a corresponding profile 42a in the casing 16, as shown in Figure 2. The deformation of the sealing portion 30 is by rolling expansion, that is the rollers 26 are rotated within the sealing portion 30 with the ribs 28 in rolling contact with an internal face of the portion 30, with the sealing portion 30 being restrained by the relatively inflexible casing 16. Such rolling expansion causes compressive plastic deformation of the portion 30 and a localised reduction in wall thickness resulting in a subsequent increase in diameter. In the illustrated embodiment this increase in diameter of the sealing portion 30 also deforms the adjacent casing 16, to form the profile

42a, by compression.

5 The device 10 is initially located in the intermediate tubing section 18 such that the roller ribs 28 are located adjacent one of the grip bands 37, such that on extension of the rollers 26 and rotation of the device 10, the area of greatest deformation at the extension 40a corresponds to the grip band location. Following the creation of the first extension 40a, the fluid pressure in communication with the device 10 is bled off, allowing the rollers 26 to retract. The device 10 is then moved axially by a predetermined distance relative to the tubing section 18 before being energised and rotated once more to create a second extension 40b and casing profile 42b, as shown in Figure 3. If desired, this process may be repeated to create subsequent extensions. The deformation at the two tubing section extensions 40a, 40b continues into the seal bands 36, such that the bands 36 are brought into sealing contact with the casing inner surface, between the areas of greatest deformation of the tubing section 18, and flow or deform as the bands 36 and the casing surface are "squeezed" together; this creates fluid tight seal areas at least between the tubing section 18 and the casing 16.

15 Following creation of the second extension 40b, the device 10 is retrieved from the bore, as illustrated in Figure 4, leaving the deformed tubing section 18 fixed in the casing 16.

25 The production tubing 11 is then run into the bore, as shown in Figure 5, a lower section of the tubing being of

corresponding dimensions to the polished bore 34 of the tubing section 18 and provided with appropriate seal bands to provide a seal between the production tubing and the intermediate tubing section 18.

5 The "set" intermediate tubing section 18 may thus be seen to act in effect as a permanent packer, although the configuration and "setting" procedure for the tubing section 18 is quite different from a conventional packer.

10 It is apparent that the set tubing section 18 may only be removed by milling or the like, however the absence of large parts of relatively hard materials, such as is used in forming the slips of conventional packers, facilitates removal of the tubing section 18.

15 Reference is now made to Figures 6, 7 and 8 of the drawings, which illustrate the device 10 in greater detail. The device body 24 is elongate and generally cylindrical, and as noted above provides mounting for the three rollers 26. The rollers 26 include central portions each defining a rib 28, and taper from the central portion to circular bearing sections 50 which are located in radially extending slots 52 defined in body extensions 54 provided above and below the respective roller-containing apertures 56 in the body 24.

25 The radial movement of the rollers 26 is controlled by conical roller supports 58, 59 located within the body 24, the supports 58, 59 being movable towards and away from one another to move the rollers radially outwardly and inwardly. The roller supports 58, 59 are of similar

construction, and therefore only one support 58 will be described in detail as exemplary of both, with particular reference to Figure 7 of the drawings. The support 58 features a loading cone 60 having a conical surface 62 which corresponds to the respective conical surface of the roller 26. The cone 60 is mounted on a four point axial load bearing 64 which is accommodated within a bearing housing 66. A piston 68 is coupled to the other end of the bearing housing 66, and has a stepped profile to accommodate a chevron seal 70. The piston 68 is located in the upper end of the body, below a connection between the body 24 and a crossover sub 72.

Accordingly, increasing the fluid pressure in the running string 20 produces an increasing pressure force on the piston 68, which tends to push the loading cone 60 in the direction A, towards and beneath the roller 26. Similarly, a fluid line leads from the upper end of the body 24 to the area beyond the other roller support 59, such that an increase in fluid pressure tends to urge the other loading cone 61 in the opposite direction. Accordingly, this forces the rollers 26 radially outwardly, and into contact with the inner surface of the intermediate tubing section 18.

This arrangement allows creation of very high pressure forces and, combined with the rolling contact between the roller ribs 28 and the intermediate tubing section 18, and the resulting deformation mechanism, allows deformation of relatively heavy materials, in this case providing

deformation of both the tubing section 18 and the surrounding casing 16. Further, the nature of the deformation is such that the deformed wall of the intermediate tubing section 18 features an inner thickness of metal which is in compression, and an outer thickness of metal which is in tension. This creates a rigid and stable structure.

Reference is now made to Figures 9 and 10 of the drawings which illustrate an alternative expander device 110 for use in forming downhole arrangements 112, 113 for permitting provision of a seal between inner tubing, in the form of production tubing (not shown), and outer tubing, in the form of bore-lining casing 116, utilising an intermediate tubing section 118. The form of the tubing section 118 is substantially the same as the section 18 described above and in the interest of brevity will not be described in detail again. However, these embodiments of the present invention utilise a different form of expander device 110, as described below.

The device 110 comprises an elongate hollow body 124 which carries three radially movable rollers 126. The rollers 126 may be urged outwards by application of fluid pressure, via the running string 120, to the body interior. The device 110 is rotatable in the bore, being driven either from surface via the string 120, or by an appropriate downhole motor. The rollers 126 are rotatably mounted on relatively large area pistons such that, on application of elevated fluid pressures to the body

interior, the 126 rollers are urged radially outwardly into contact with the tubing section 118.

5 The deformation of the section 118a as illustrated in Figure 9 is carried out in substantially the same manner as the deformation of the section 18 described above, that is by deforming or crimping the tubing section 118 at two locations 140a, 140b. However, the deformation of the section 118b as illustrated in Figure 10 is achieved by deforming or crimping the section 118 along an extended
10 axial portion 140c. This may be achieved in a step-wise fashion, or alternatively by locating the device 110 in the upper end of the section 118, activating the device 110, and then rotating the device 110 and simultaneously applying weight to the device 110 to move the device 110
15 downwards through the section 118.

It will be clear to those of skill in the art that the above-described embodiments of the invention provide a simple but effective means of allowing the annulus between production tubing and casing to be sealed, using a metal-
20 to-metal seal, the intermediate tubing section acting as a "slimline" replacement for a conventional packer, without requiring the provision of slips and elastomeric seals.

It will also be apparent to those of skill in the art that the above-described embodiments are merely exemplary
25 of the present invention, and that various modifications and improvements may be made thereto without departing from the scope of the invention. For example, the above-described embodiment features an arrangement in which the casing is subject to plastic deformation. In other

embodiments, the casing may only be subject to only minor, if any, elastic deformation, sufficient to form a secure coupling between the intermediate tubing section and the casing; where heavy gauge casing is securely in a bore cemented it may not be desirable or even possible to deform the casing to any significant extent. In other aspects of the invention, an intermediate tubing section may be provided for purposes other than creating a seal between inner and outer tubing; the tubing section may provide a sealed mounting for a valve or other device in the outer tubing.

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

1. A method of providing a downhole seal in a wellbore having a lined portion, the method comprising:

running a first tubular into the wellbore, the first tubular having a polished bore portion and an expandable portion, the expandable portion having a thinner wall than the polished bore portion;

suspending the first tubular at a selected depth within the wellbore, wherein at least the expandable portion of the first tubular is in an overlapping relationship with the lined portion of the wellbore; and

expanding the expandable portion of the first tubular into frictional engagement with the lined portion of the wellbore.

2. A method as claimed in claim 1, wherein the expandable portion of the first tubular is disposed above the polished bore portion.

3. A method as claimed in claim 1 or 2, wherein an outer surface of the expandable portion of the first tubular comprises at least one seal member for providing a seal between the outer surface of said first tubular and the lined portion of wellbore when said first tubular is expanded into frictional engagement with the lined portion of wellbore.

4. A method as claimed in any one of claims 1 to 3, further comprising:

running a second portion of tubular into the wellbore; and mating a lower portion of the second tubular with the polished bore receptacle of the first tubular, wherein the lower portion of the second tubular is configured to sealingly land into the polished bore portion of the first tubular.

5. A method as claimed in claim 4, wherein the second tubular comprises a production tubing, thereby forming a fluid path to the surface of the wellbore.

6. A method as claimed in any one of claims 1 to 5, wherein the expandable portion of the first tubular is expanded with an expander device having at least one outwardly actuatable member disposed thereon.

7. A method as claimed in claim 6, wherein the expander device is run into the tubular with the first tubular.

8. A method as claimed in claim 7, wherein the first tubular is connected to the expander device using a releasable connection.

9. A method as claimed in any one of claims 1 to 8, wherein an outer surface of the expandable portion of said first tubular comprises at least one gripping member for

assisting in the engagement between said first tubular and the lined portion of the wellbore.

10. A method as claimed in any one of claims 1 to 9, wherein the lined portion of the wellbore comprises a bore-lining casing.

11. A tubular for use in a wellbore, comprising:

an expandable portion expandable by a radial outward force applied from an interior thereof; and

a polish bore portion having a polished bore receptacle formed therein, the polished bore portion having a thicker wall than the expandable portion.

12. A tubular as claimed in claim 11, wherein the expandable portion is configured to be sealingly expandable against the lined portion of a wellbore by said radial outward force.

13. A tubular as claimed in claim 11 or 12, wherein the polish bore portion is configured to sealingly receive a second tubular.

14. A tubular as claimed in any one of claims 11 to 13, wherein the polish bore portion is disposed below the expandable portion.

15. A tubular as claimed in any one of claims 11 to 14, further comprising at least one seal member disposed

circumferentially around the outer surface of the expandable portion.

16. A tubular as claimed in any one of claims 11 to 15, further comprising at least one gripping member disposed on the outer surface of the expandable portion.

17. A tubular as claimed in any one of claims 11 to 16, wherein the polished bore receptacle is an integral part of the tubular.

18. Apparatus for providing a downhole seal, comprising a tubular as claimed in any one of claims 11 to 17 and an expander device having at least one outwardly actuatable member disposed thereon for expanding the expandable portion.

19. An apparatus as claimed in claim 18, wherein the expander device is connected to the tubular with a releasable connection such that it can be run into the wellbore with the tubular.

20. A tubular for use with a downhole seal assembly in a wellbore, the wellbore having a lined portion, the tubular comprising:

an expandable portion, the expandable portion being sealingly expandable against the lined portion of the wellbore by a radial outward force applied on an inner wall thereof, wherein the deformation is accomplished with at

least two radially extendable members that are fluid actuated; and

a polished bore portion, the polished bore portion configured to sealingly receive a second tubular.

21. The tubular of claim 20, wherein the polished bore portion is disposed above the expandable portion of the tubular.

22. The tubular of claim 20, wherein the polished bore portion is disposed below the expandable portion of the tubular.

23. The tubular of any one of claims 20 to 22, wherein the second tubular comprises a production tubing.

24. The tubular of any one of claims 20 to 23, wherein the expandable portion of the tubular is expanded with an expander device having the at least two outwardly actuatable members disposed thereon.

25. The tubular of claim 24, wherein the expander device is run into the wellbore with the tubular, and the tubular is connected to the expander device with a releasable connection.

26. The tubular of any one of claims 20 to 25, wherein an outer surface of the expandable portion of the tubular comprises at least one grip member and at least one seal

member for assisting in the sealing engagement between the tubular and the lined portion of the wellbore.

27. The tubular of any one of claims 20 to 26, wherein the lined portion of the wellbore is bore-lining casing.

28. A method of completing a wellbore, comprising:

expanding a first tubular member within the wellbore;

coupling a second tubular member to the first tubular member by expanding the second tubular member within the first tubular member in a location where the first tubular member was expanded; and

inserting a tubular string into a polished bore receptacle portion of the second tubular member, wherein the polished bore receptacle portion is not expanded.

29. The method of claim 28, wherein the first tubular member is expanded with outer radial force applied on an inner wall thereof.

30. The method of claim 28 or 29, wherein expanding the second tubular member comprises expanding a portion thereof above the polished bore receptacle portion.

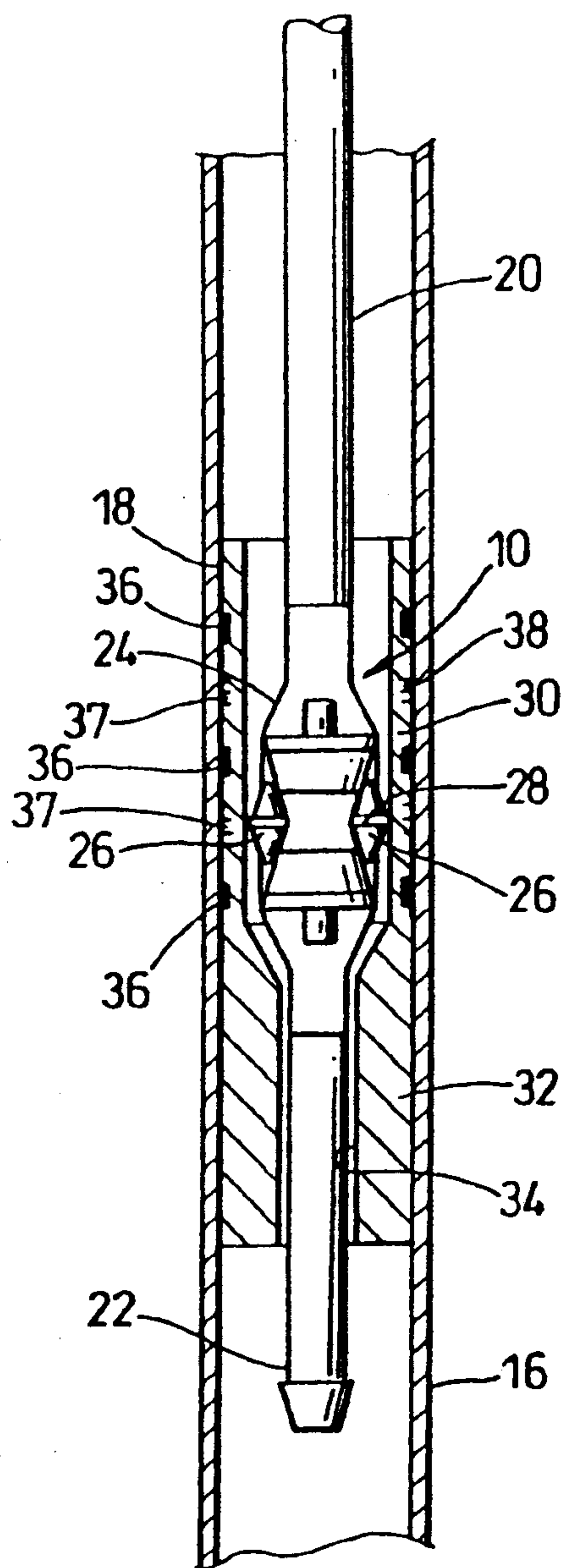
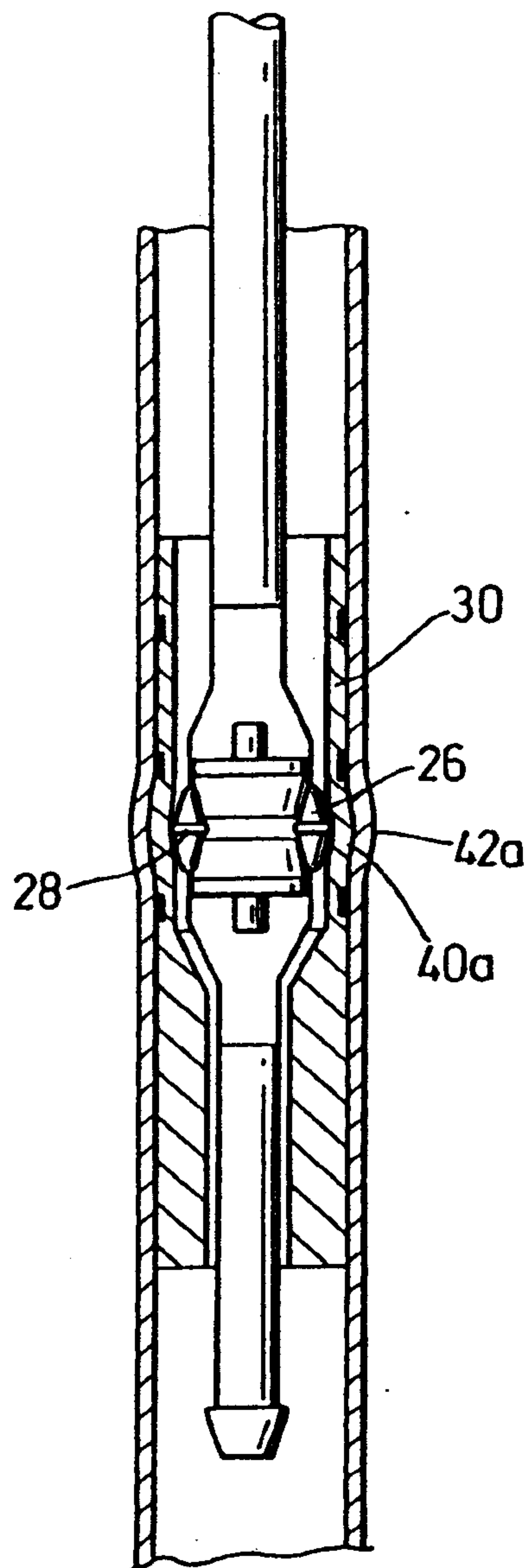
31. The method of any one of claims 28 to 30, wherein the first and second tubular members are expanded with an expander tool having at least one outwardly actuatable member disposed thereon.

32. The method of any one of claims 28 to 30, wherein an expandable tool is located adjacent the first tubular member during run in of the first tubular member.

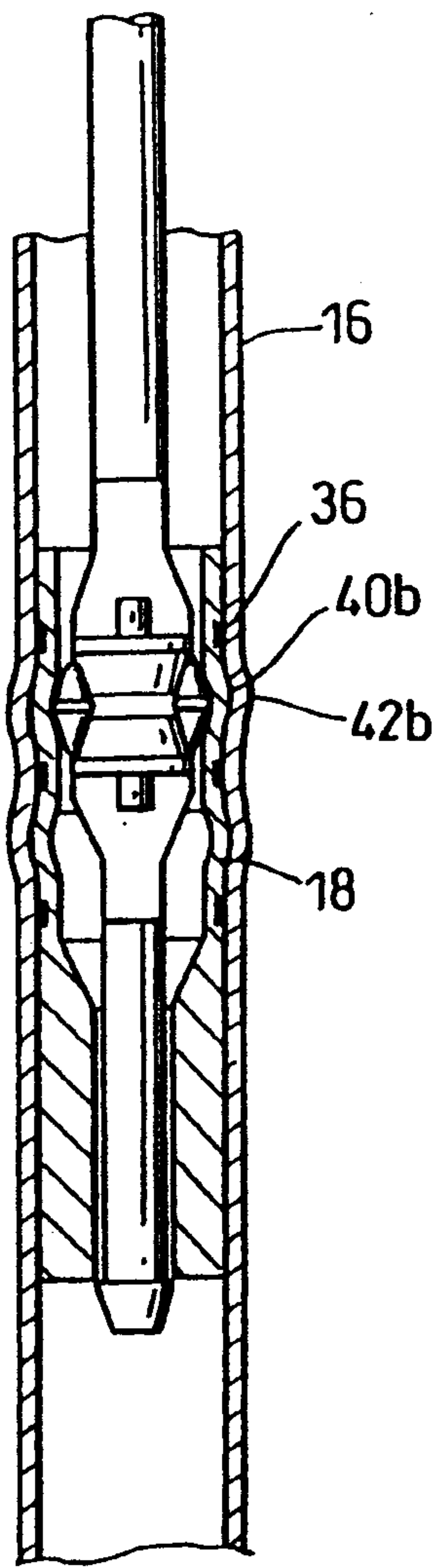
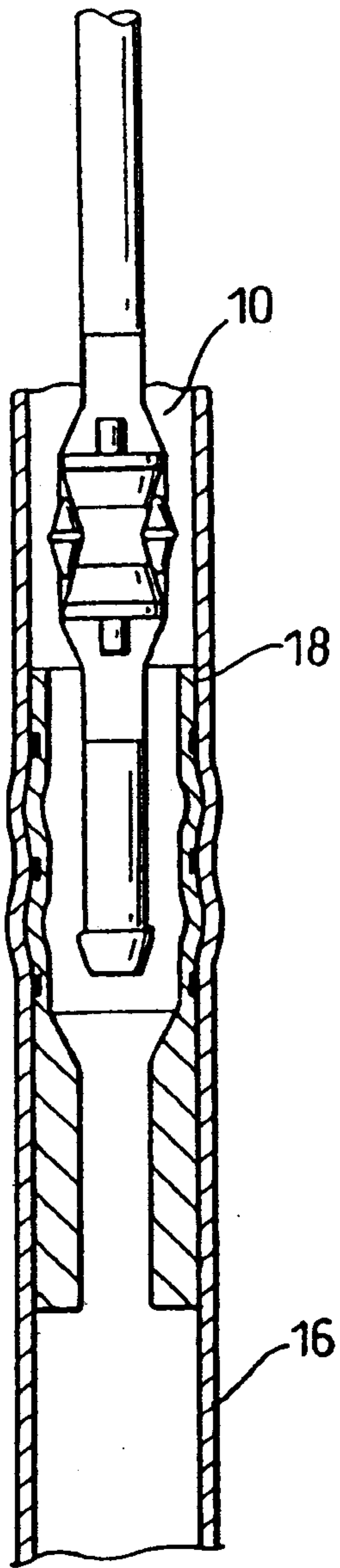
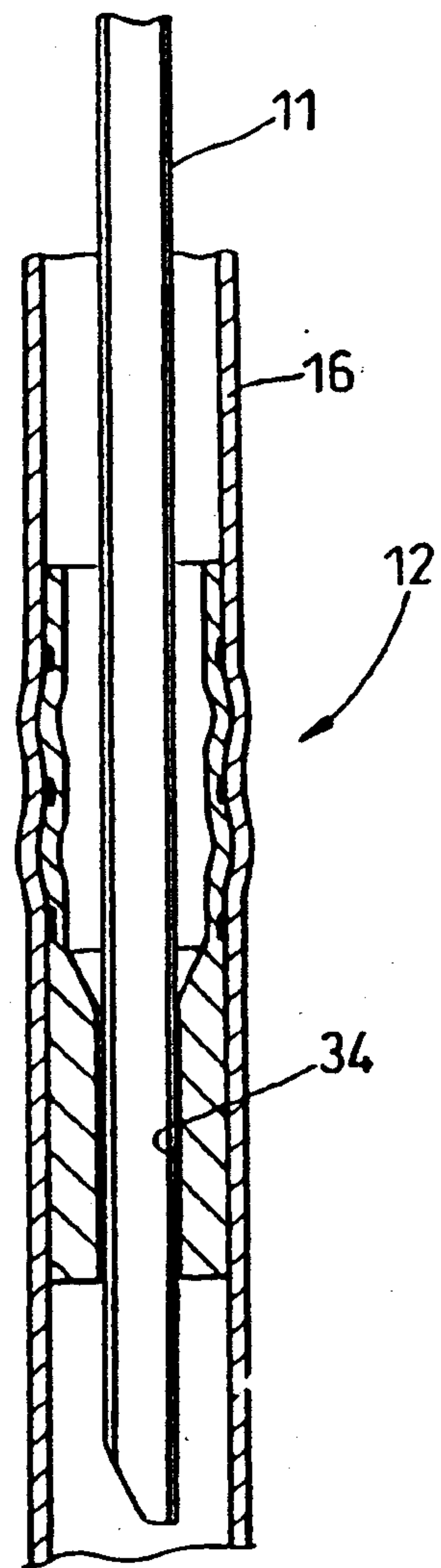
33. The method of any one of claims 28 to 32, wherein the first tubular member has a sealing member on an outer surface thereof.

34. The method of any one of claims 28 to 33, wherein the second tubular member has a sealing member on an outer surface thereof.

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***Fig. 1******Fig. 2***

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*Fig. 3**Fig. 4**Fig. 5*

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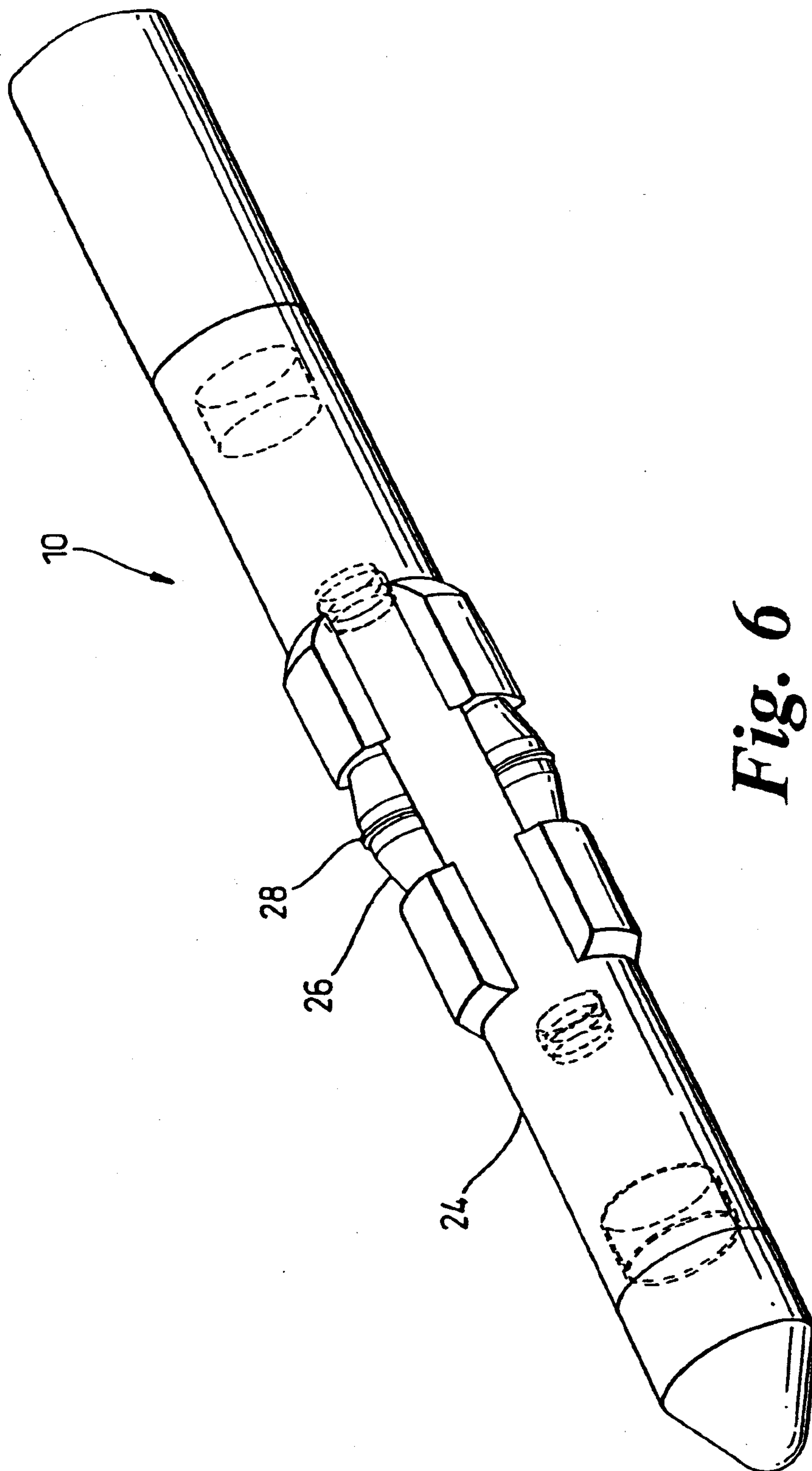


Fig. 6

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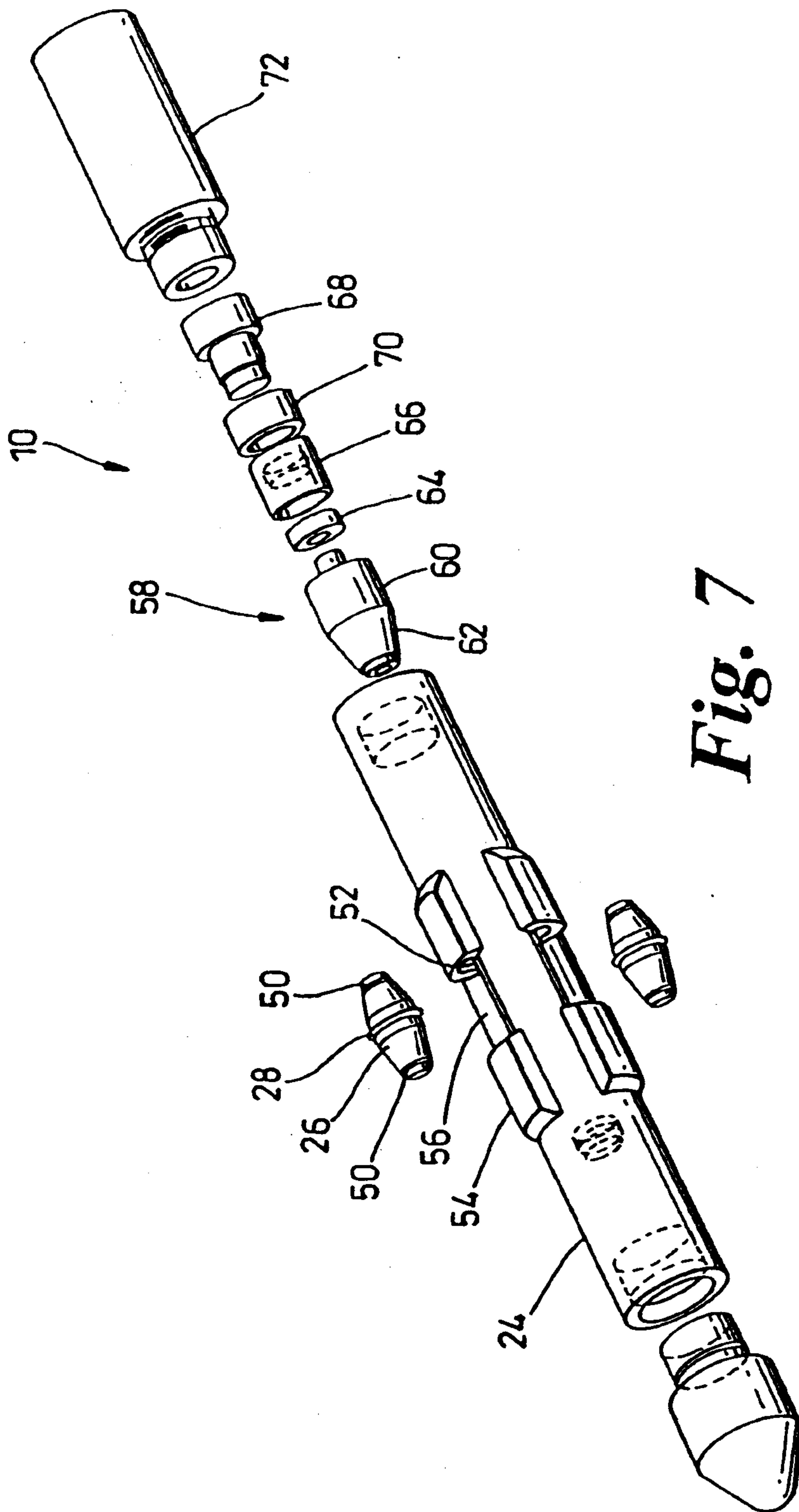
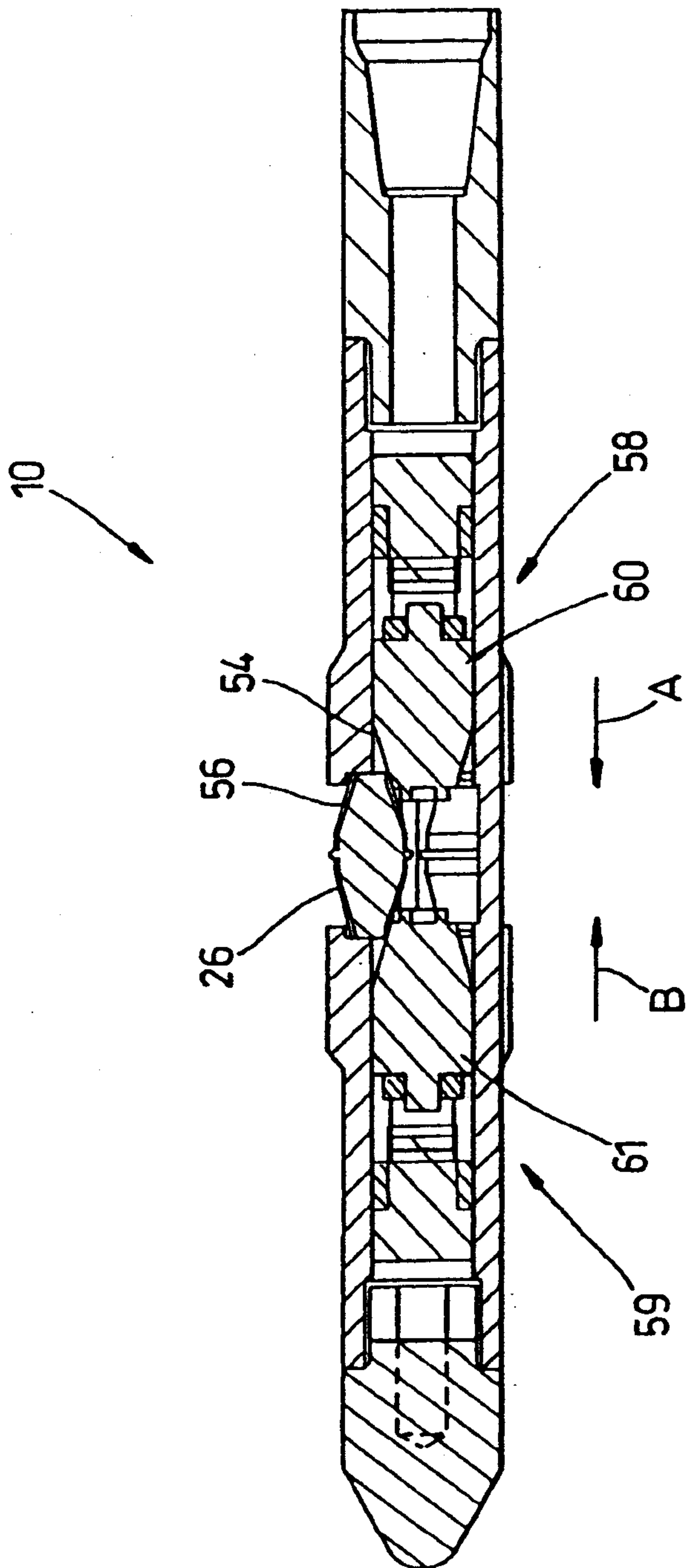
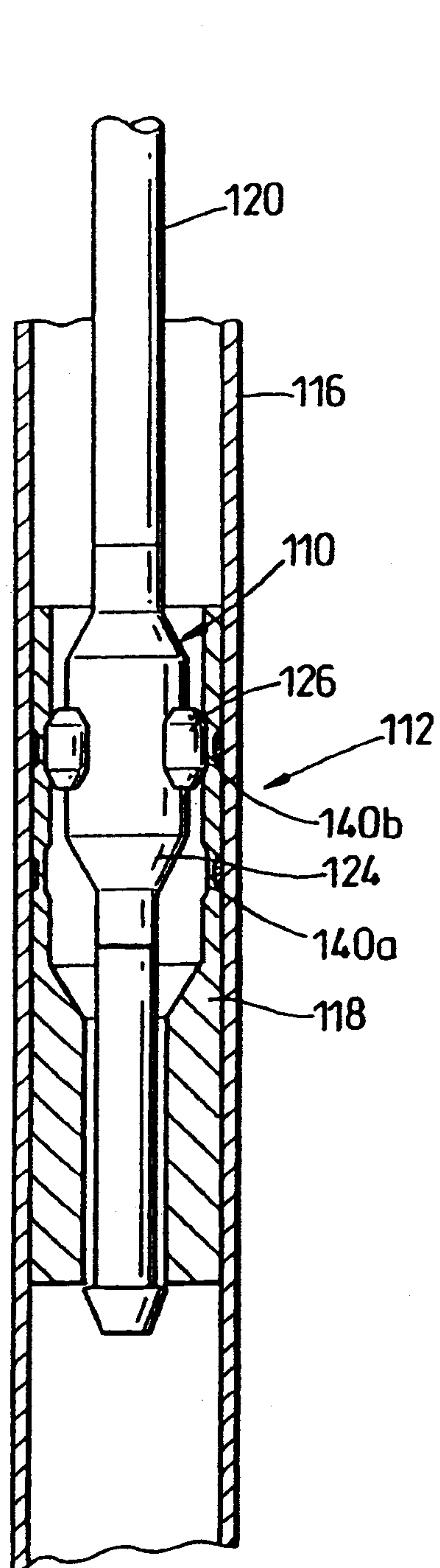
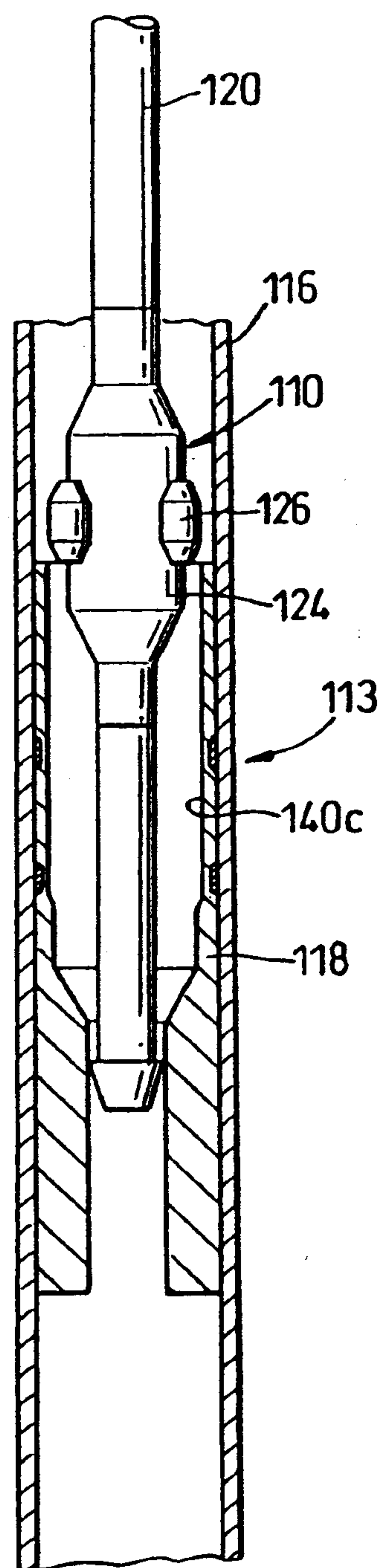


Fig. 7

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**Fig. 8**

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**Fig. 9****Fig. 10**

