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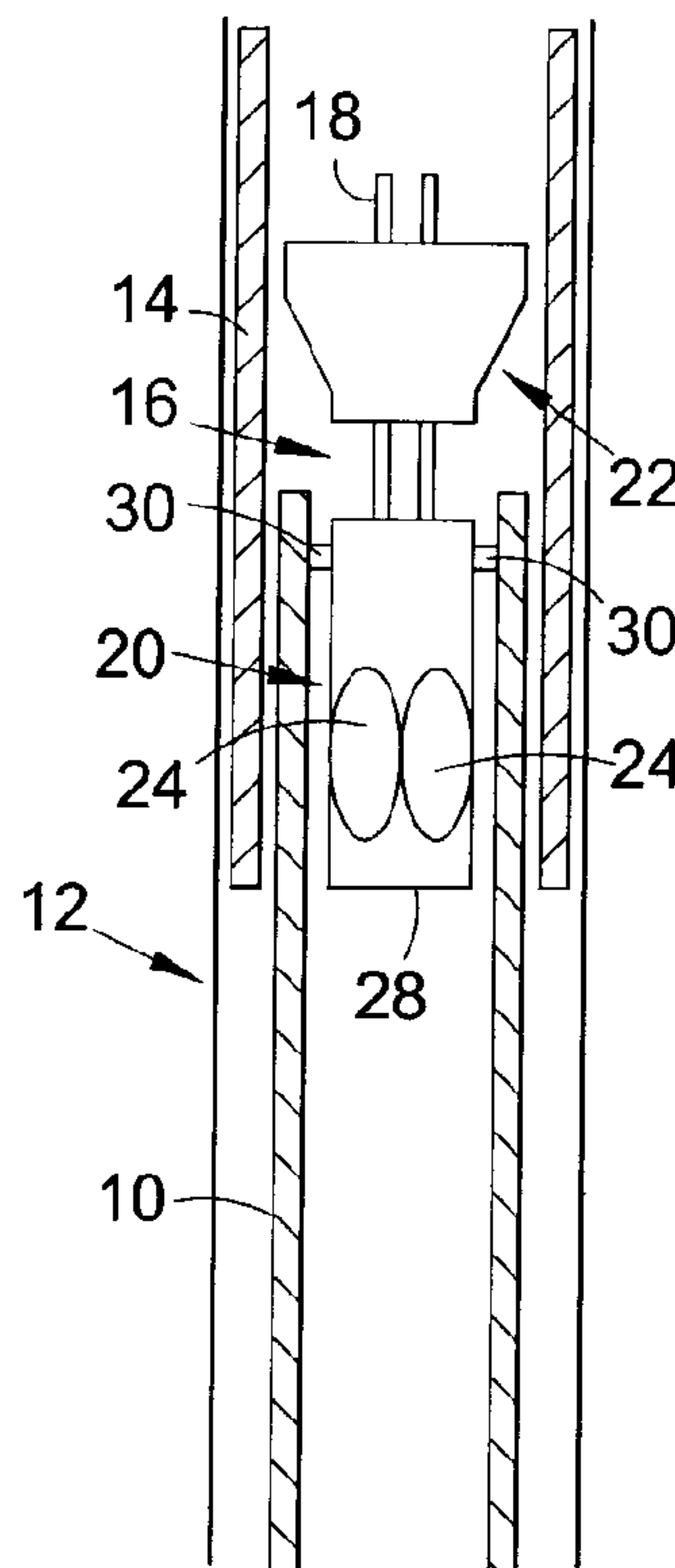
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(54) Title: EXPANDING TUBING WITH A RADIALLY EXTENDABLE EXPANDER AND CONE



(57) Abrégé/Abstract:

This invention relates to expanding tubing, and in particular to expansion of tubing downhole. Embodiments of the invention relate to anchoring and expanding tubing downhole. In one embodiment, a method of expanding tubing such as a section of casing (10) is disclosed, the method comprising the steps of locating the casing (10) in a bore (12), expanding a portion of the casing (10) to engage the bore wall using an expansion tool (16) having at least one radially movable expansion member, in the form of a roller (24) of a rotary expander (20), and then expanding a further portion of the casing (10) by advancing a cone expander (22) through the casing (10).

ABSTRACT

5 This invention relates to expanding tubing, and in particular to expansion of tubing downhole. Embodiments of the invention relate to anchoring and expanding tubing downhole.

10 In one embodiment, a method of expanding tubing such as a section of casing (10) is disclosed, the method comprising the steps of locating the casing (10) in a bore (12), expanding a portion of the casing (10) to engage the bore wall using an expansion tool (16) having at least one radially movable expansion member, in the form of a roller (24) of a rotary expander (20), and then
15 expanding a further portion of the casing (10) by advancing a cone expander (22) through the casing (10).

EXPANDING TUBING WITH A RADIALY EXTENDABLE
EXPANDER AND CONE

FIELD OF THE INVENTION

This invention relates to expanding tubing, and in particular to expansion of tubing downhole. Embodiments of the invention relate to anchoring and expanding tubing downhole.

BACKGROUND OF THE INVENTION

The present applicant and others have made various proposals relating to anchoring tubing in a bore by diametrically expanding the tubing into engagement with surrounding tubing. For example, in applicant's GB-A-2 345 308 there is disclosed a method of creating a tubing hanger by expanding tubing into engagement with existing tubing using a radially expandable tool, and subsequently advancing the tool through anchored tubing to expand the tubing.

It is among the objectives of embodiments of the invention to provide alternative methods for anchoring and expanding tubing.

SUMMARY OF THE INVENTION

According to the present invention there is provided a method of anchoring and expanding tubing, the method comprising:

locating tubing in a bore;

expanding a portion of the tubing to engage the bore wall using an expansion tool having at least one radially movable expansion member; and then

5 expanding a further portion of the tubing by advancing a cone expander through the tubing.

According to another aspect of the invention there is provided apparatus for expanding tubing, the apparatus comprising:

10 an expansion tool having at least one radially movable expansion member; and
a cone expander.

The invention has particular utility in downhole applications, but may be utilised in other situations,
15 for example in subsea risers or in subsea or surface pipelines. For downhole applications the tubing may take any appropriate form or serve any appropriate function, but will typically be bore-lining casing.

Initial expansion of a portion of the tubing using
20 the expansion tool may serve to anchor the tubing relative to the bore wall, which will typically be defined by existing tubing, which existing tubing may be cemented and thus of fixed diameter and not capable of expansion. The use of an expansion tool having at least
25 one radially movable expansion member avoids many of the risks inherent in attempting to expand tubing in such

situations, as the expansion tool may accommodate anomalies in tubing shape, condition and internal diameter (ID) dimension. The cone expander may then be utilised to expand a further portion of the tubing, which may comprise all or a substantial portion of the remainder of the tubing below the anchor. The cone expander may be advanced through the tubing relatively quickly, and may be better suited to expanding extended lengths of tubing than other forms of expansion tools.

The expansion tool for expanding said portion of the tubing may take any appropriate form, including a cone which is one or both of compliant and expandable, such as an expansion tool having a substantially cone-shaped expansion member adapted to be advanced axially through the tubing and capable of radial deflection to accommodate, for example, sections of tubing which cannot be expanded to a desired diameter. The cone may be adapted for sliding contact with the tubing or may feature a surface at least partially defined by rolling elements. Most preferably however, the expansion tool is a rotary expander, and may feature a plurality of circumferentially spaced expansion members. Examples of rotary expanders are set out in applicant's W000/37766.

The expansion tool may be actuated to extend the expansion member by any appropriate means, but is most preferably fluid-pressure actuated.

The tubing may be cemented prior to or following expansion.

Said portion of the tubing may be expanded to engage the bore wall while retaining a fluid passage between the tubing and the wall. The passage may be useful to allow displacement of fluid in subsequent cementing operations. Alternatively, ports or other means may be provided to permit fluid bypass.

In another aspect, the invention provides an apparatus for expanding tubing, the apparatus comprising:

- an expansion tool having at least one radially movable expansion member for, in use, expanding a portion of a tubing; and

- a cone expander for, in use, expanding a further portion of the tubing.

BRIEF DESCRIPTION OF THE DRAWINGS

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 illustrations of tubing being anchored in a bore and then expanded, in accordance with a preferred embodiment of the present invention.

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DETAILED DESCRIPTION OF THE DRAWINGS

The figures illustrate steps in the process of anchoring and then expanding a section of casing 10 in a drilled subsurface bore 12. In particular, the casing 10 is located with an upper end overlapping the lower end of existing casing 14, and the remainder of the casing 10

extending into an unlined section of bore below the existing casing 14.

The casing 10 is run into the bore 12 together with an anchoring and expansion apparatus 16, and mounted on the lower end of an appropriate pipe string 18. The apparatus comprises two expansion tools 20, 22, a compliant rotary expander 20 and a cone expander 22. Initially, the rotary expander 20 is located within the upper end of the casing 10, and is run into the bore in this position.

The expander 20 features a number of piston-mounted rollers 24 on the hollow tool body 28. The rollers 24 are initially retracted, but application of elevated fluid pressure to the interior of the body 28, via the pipe string 18, urges the rollers 24 radially outwardly, as will be described. The expander 20 is initially fixed axially relative to the casing 10 by retractable dogs 30.

The cone expander 22 is a fixed diameter cone of suitable hard-wearing material, and may include metallic or ceramic elements. The expander is mounted on the pipe string 18 above the rotary expander 20, and is initially located above the upper end of the casing 10.

The casing string 10 will be made up on surface and then run into the bore 12 with the anchoring and expansion apparatus 16 and located relative to the existing casing 14 as illustrated in Figure 1. The

rotary expander 20 is then actuated to extend the rollers 24 into contact with the surrounding casing 10 and to deform the casing 10 such that the outer surface of the casing 10 contacts the inner surface of the existing casing 14, as illustrated in Figure 2. It may be sufficient simply to extend the rollers 24 and deform the casing to achieve an initial hanging support for the casing 10 from the casing 14, as described in applicant's GB-A-2 345 308. However, in other cases it may be desirable or necessary to rotate the expander 20 within the casing 10 to create a larger area contact between the casings 10, 14. In this case the initial deformation of the casing 10 need only be sufficient to prevent relative rotation between the sections of casing 10, 14, and of course this would require the provision of a swivel between the expander 20 and the dogs 30.

In any event, the dogs 30 may then be released (Figure 3), to allow the apparatus 16 to be moved axially upwards relative to the casing 10, and the expander 20 utilised to expand the portion of the casing 10 overlapping with the existing casing 16, as illustrated in Figure 4. The use of a compliant expander 20 at this stage will accommodate and compensate for any anomalies in the casing shape, condition or ID dimension. Once

this section of the casing has been expanded the rollers 24 may retract.

5 The remainder of the casing 10, extending into the unlined section of bore below the casing 14, may then be expanded by driving the cone expander 22 axially down through the casing 10, as illustrated in Figure 5. As a degree of clearance will remain between the expanded casing 10 and the surrounding bore wall, anomalies in the casing 10, for example an area of increased wall thickness, may be accommodated without difficulty.

Those of skill in the art will appreciate that the invention provides a method of anchoring and expanding tubing which takes advantage of the attributes of the different forms of expansion tools.

15 Those skilled in the art will also recognise that this embodiment is merely exemplary of the present invention and that various modifications and improvements may be made thereto, without departing from the present invention. For example, rather than casing 10 as
20 described above, the invention may be utilised to anchor and locate liner in a bore.

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

1. A method of anchoring and expanding tubing, the method comprising:

 locating tubing in a bore;

 expanding a portion of the tubing to engage the bore wall using an expansion tool having at least one radially movable expansion member; and then

 expanding a further portion of the tubing by advancing a cone expander through the tubing.

2. The method of claim 1, wherein the tubing is expanded downhole.

3. The method of claim 2, further comprising running the expansion tool and cone expander into the bore together with the tubing.

4. The method of claim 3, comprising initially locating the expansion tool within the tubing.

5. The method of any one of claims 1 to 4, wherein the tubing is bore-lining casing.

6. The method of any one of claims 1 to 4, wherein the tubing is liner.

7. The method of any one of claims 1 to 6, wherein expansion of said portion of the tubing using the expansion tool anchors the tubing relative to the bore.

8. The method of any one of claims 1 to 7, wherein said portion of the tubing is expanded by the expansion tool within a section of existing tubing.

9. The method of claim 8, comprising locating an upper end of the tubing in overlapping relation with a lower end of a section of existing tubing.

10. The method of any one of claims 1 to 9, wherein said further portion of the tubing is located in unlined bore.

11. The method of any one of claims 1 to 10, wherein the expansion tool for expanding said portion of the tubing comprises a compliant cone.

12. The method of any one of claims 1 to 11, wherein the expansion tool for expanding said portion of the tubing comprises an expandable cone.

13. The method of any one of claims 1 to 10, wherein the expansion tool for expanding said portion of the tubing comprises a rotary expander.

14. The method of claim 13, wherein the expansion tool for expanding said portion of the tubing comprises a rotary expander having a plurality of circumferentially spaced expansion members.

15. The method of any one of claims 1 to 14, wherein the expansion tool for expanding said portion of the tubing comprises a fluid-pressure actuated expansion member.

16. The method of any one of claims 1 to 15, further comprising cementing the tubing in the bore.
17. The method of claim 16, comprising cementing the tubing prior to expansion.
18. The method of claim 16, comprising cementing the tubing following expansion.
19. The method any one of claims 1 to 18, comprising expanding said portion of the tubing to engage the bore wall while retaining a fluid passage between the tubing and the wall.
20. An apparatus for expanding tubing, the apparatus comprising:
- an expansion tool having at least one radially movable expansion member for, in use, expanding a portion of a tubing; and
 - a cone expander for, in use, expanding a further portion of the tubing.
21. The apparatus of claim 20, adapted for operation downhole.
22. The apparatus of claim 21, in combination with downhole tubing.
23. The apparatus of claim 21 or 22, adapted for mounting to downhole tubing.

24. The apparatus of any one of claims 20 to 23, adapted for mounting to downhole tubing with said expansion tool located within the tubing.

25. The apparatus of any one of claims 20 to 24, wherein the expansion tool comprises a compliant cone.

26. The apparatus of any one of claims 20 to 25, wherein the expansion tool comprises an expandable cone.

27. The apparatus of any one of the claims 20 to 24, wherein the expansion tool comprises a rotary expander.

28. The apparatus of claim 27, wherein the expansion tool comprises a rotary expander having a plurality of circumferentially spaced expansion members.

29. The apparatus of any one of claims 20 to 28, wherein the expansion tool comprises a fluid-pressure actuated expansion member.

30. The apparatus of any one of claims 20 to 29, wherein the expansion tool comprises a plurality of circumferentially spaced expansion members.

31. The apparatus of any one of claims 20 to 30, wherein the at least one expansion member comprises a roller.

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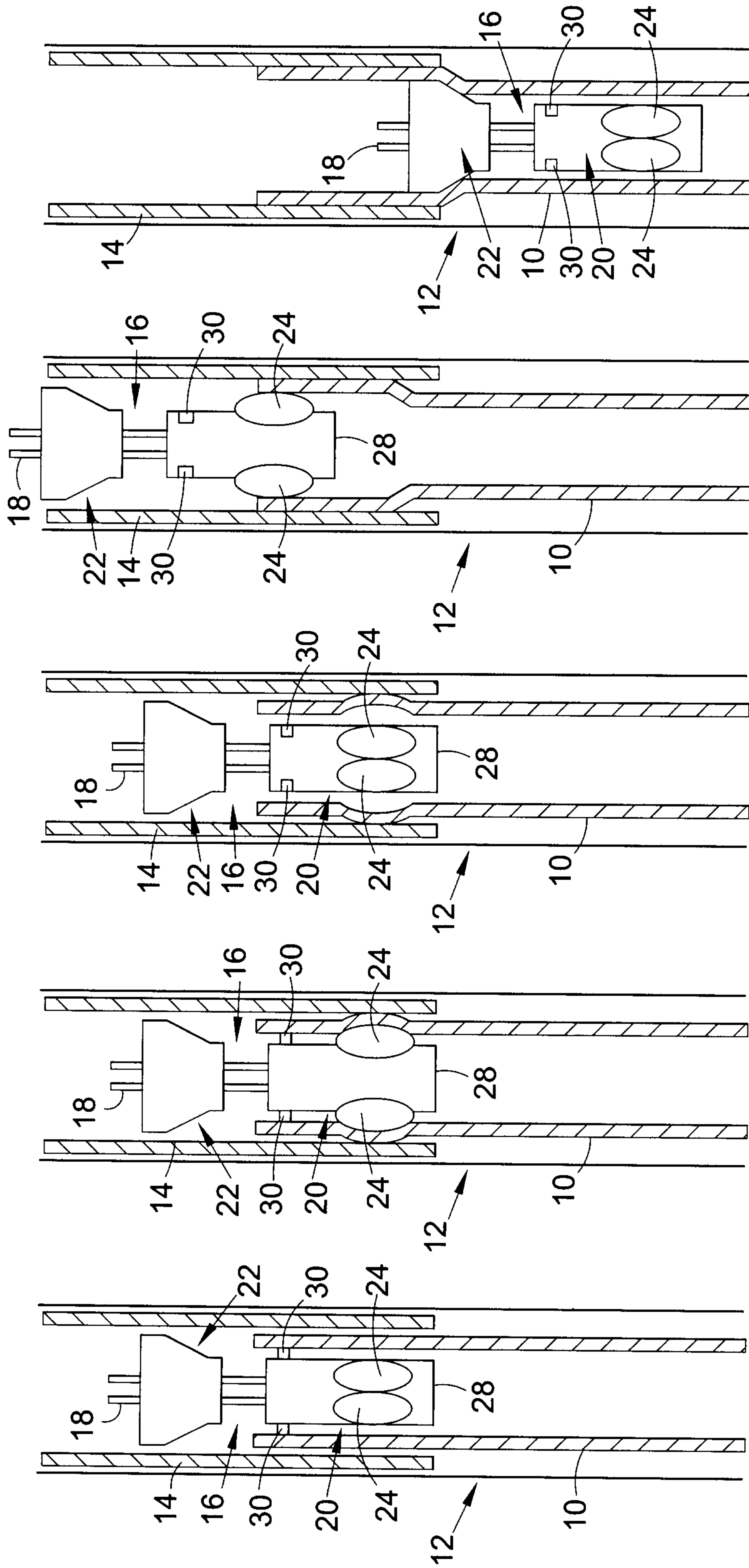


Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

