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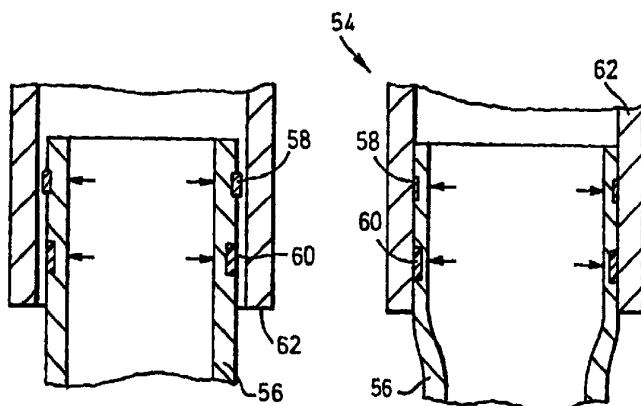


## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(54) Title: TUBING ANCHOR



## (57) Abstract

A method of installing a liner in a drilled bore below a section of bore previously lined with casing comprises the steps of: running a length of liner into the bore such that at least an upper end of the liner is positioned in overlapping relation with at least a lower end of the casing; and plastically deforming a portion of the liner such that an external face of the portion forms an interference fit with an internal face of a portion of the casing. The interference fit preferably provides both hanging support for the liner and a fluid-tight seal between the liner and casing.

TUBING ANCHOR

This invention relates to a tubing anchor, such as a liner hanger, that is a arrangement for locating and sealing a section of liner downhole relative to an existing casing. The invention also relates to a method and apparatus for use in providing such an anchor or hanger.

In oil and gas exploration and extraction, it is conventional to line the bores drilled to access subsurface hydrocarbon-bearing formations with steel tubing. The upper section of a bore is typically lined with steel "casing", while the lower section of the bore is provided with "liner", which is hung off the lowermost section of casing. The liner is secured and sealed to the casing using a liner hanger comprising an arrangement of slips and elastomer seals, which seals may also serve to energise the slips.

Conventional liner hangers are relatively complex and expensive and occupy a significant annular space, necessary to accommodate both the gripping slip segments which support the weight of the liner and resist the differential pressure forces which may be generated across the liner/casing overlap and the elastomeric seals which prevent pressure leakage past the overlap. Accordingly, there may be a significant loss in bore diameter at the liner: for example, accommodation of a 7" diameter liner normally requires provision of a 9 5/8" diameter casing,

and a 5" liner a 7" casing.

- 5           The maintenance of the integrity of the elastomeric seals used in conventional liner hangers has also proved problematic, particularly in high pressure high temperature wells, which are becoming increasingly more common.

- 10           In the majority of cases, the liner section will be cemented in place, by pumping cement slurry down through the liner and back up the annular space between the liner and the borehole wall. Recent developments have resulted in the provision of mechanisms which allow the liner to be rotated during the cementing process, to improve cement coverage around the liner and the subsequent bond between the liner and the bore wall. These mechanisms typically consist of bearings which isolate the  
15           slip and seal sections of the liner hanger while the casing is rotated from surface via the liner running tool assembly.

- 20           In addition, circulating ports are provided in the liner hanger to allow fluid displaced from the annulus by the cement slurry to bypass the liner hanger mechanism to the point where returning cement can also pass the liner hanger before the liner is finally set, thus ensuring that the annulus is filled with uncontaminated cement slurry.

- 25           The provision of these bearings and circulating ports add further complexity to an already complex system.

EP0881354 discloses a liner which can be expanded into casing by passing a conical die through the liner.

- 30           It is among the objectives of embodiments of the present invention to provide a liner hanger arrangement which obviates and mitigates at least some of these disadvantages. In particular, embodiments of the present invention provide relatively simple liner hangers which occupy only a very limited volume and which utilise metal-to-metal seals.

It is among the objectives of other embodiments of the present invention to provide a downhole method and apparatus for anchoring tubing, particularly expanding tubing, to a section of existing casing.

- 5 According to one aspect of the present invention there is provided a method of installing a liner in a drilled bore below a section of bore previously lined with casing, the method comprising the steps of: running a length of liner into the bore such that at least an upper end of the liner is positioned in overlapping relation with at least a lower end of the casing; and radially plastically expanding a portion of the liner such that said portion
- 10 forms an interference fit with a portion of the casing to provide hanging support for the liner; characterised in that the portion of the liner is expanded by producing compressive plastic deformation of the liner and a localized reduction in wall thickness resulting in a subsequent increase in liner diameter.
- 15 The term "comprising" (and its grammatical equivalents) as used herein, is used in the inclusive sense of "having" or "including" and not in the exclusive sense of "consisting only of".

- 20 The invention also related to liner and casing for use in the method. In one embodiment of the invention, at least the portion of liner to be expanded is of a relatively ductile material.

- 25 The plastic deformation of the portion of liner to create an interference fit with the casing and provide hanging support for the liner obviates the requirements to provide slips or the like on the liner, and also a

mechanism to energise the slips, and thus the liner outside diameter may be relatively close to the inside diameter of the casing. The creation of fluid-tight seal obviates the requirement to provide conventional elastomeric seals requiring setting and energising.

Preferably, said portion of liner is deformed by rolling expansion, that is an expander member is rotated within the liner with a face in rolling contact with an internal face of said portion. The expander member may describe the desired diameter and is preferably urged radially outwardly into contact with the liner. Such rolling expansion causes compressive plastic deformation or yield of the liner and a localised reduction in wall thickness resulting in a subsequent increase in liner diameter.

Preferably, said deformed portion of the liner is annular.

Preferably, the portion of liner is deformed to create a pressure-tight seal between the liner and casing. Most preferably, the seal formed is a metal-to-metal seal. Conveniently, the portion of liner includes a relatively soft material, such as a relatively soft metal, which is plastically deformed during the expansion of the liner portion. The soft metal may be provided as an annular coating or insert. In other embodiments other sealing materials may be utilised, such as elastomers, or the relatively soft material may be provided on the casing.

The portion of liner may be deformed to extend into or

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otherwise engage a preformed profile in the casing. A step of a method in accordance with an embodiment of the invention may involve deforming the casing to define the profile prior to running the liner into the bore.

5 Alternatively, the portion of casing may also be deformed together with the liner, and the deformation of the casing may be elastic or plastic. The liner may be deformed at two or more axially spaced locations. Thus, the liner, and possibly also the casing, may be deformed to define a  
10 plurality of axially spaced profiles.

The liner may be initially secured in the casing, at least against relative rotation, by deforming the liner, in particular by radially extending circumferentially spaced areas of the liner to form corresponding areas of  
15 interference fit between the liner and the casing. Preferably, these areas are then extended circumferentially to form annular areas of interference fit between the liner and casing.

The portion of the liner may carry relatively hard  
20 material on its external face, which material will tend to bite into the opposing faces of the liner and casing to provide a more secure coupling therebetween. The material is preferably in the form of relatively small discrete particles or pieces, such as balls, chips or the like of  
25 relatively hard metal such as tungsten carbide. The hard material may be held in a matrix of softer material.

The method may further comprise the step of cementing the liner in the bore. This may be achieved by pumping

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cement from surface to the lower end of the liner, preferably through a combined running and cementing string and tool, directing the cement into the annulus between the liner and the bore wall and displacing well fluid from the annulus, to substantially fill the annulus with cement. Preferably, the portion of the liner is expanded once the cement is in place in the annulus; the displaced well fluid may therefore pass between the upper end of the liner and the lower end of the casing. Preferably, the liner is rotated as the cement is passed into the annulus; thus, there is preferably a releasable coupling between the running tool and the liner to permit transfer of torque therebetween.

Preferably, the liner is run into the bore on a running tool carrying an expander including a body and at least one radially extendable member mounted thereon, the running tool being rotatable to move the member around the portion of the liner to create the desired deformed portion. Preferably, the member is a roller, and the roller may define a raised surface portion to create a high pressure contact area. The expander may be provided with two or more rollers, and a plurality of the rollers may be radially movable. Most preferably, the member is fluid pressure actuated, but in other embodiments may be mechanically actuated. Conveniently, the member is coupled to an axially movable fluid pressure actuated piston, the piston defining a cam face for engaging a cooperating cam face on the member. In other embodiments, the expander may



include a cone or the like, and the cone may carry a number of rollers for engaging and expanding the liner. A cleaning pig, a wiper, or the like may be run through the liner running string and expander prior to activating the expander.

- 5 According to a further aspect of the present invention there is provide a method of securing a liner in a drilled bore to a section of previously fitted casing, the method comprising the step of expanding a portion of the liner such that an external face of said portion forms an interference fit with an internal face of a portion of the casing to provide at least one of hanging support for the liner and a fluid-tight seal between the liner and
- 10 casing, characterised in that the portion of the liner is expanded by compressive plastic deformation to produce a localized reduction in wall thickness.

- Preferably, said portion of liner is deformed by rolling expansion, that is an expander member is rotated within the liner with a face in rolling contact with an internal
- 15 face of said portion. The expander member may describe the desired diameter and is preferably urged radially outwardly into contact with the liner.

- According to another aspect of the present invention, there is provided a liner running and setting tool comprising: a body for mounting on a running string and for
- 20 location within a section of liner to be positioned with a section of casing; characterised by a radially movable pressure actuated expander member mounted on the body, and means for applying fluid pressure to the expander member so as to expand a portion of the liner section by radial compressive plastic deformation such that an external face of the portion forms an interference fit with an internal face of a portion of the casing
- 25 section to provide hanging support for the liner.

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in a step-wise fashion.

Most preferably, the tubing engaging portions are in the form of radially movable rollers. The rollers may have tapered ends for cooperating with tapered supports. At least one of the tapered supports may be axially movable, such movement inducing radial movement of the rollers. Preferably also, each roller defines a circumferential rib, to provide a small area 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 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 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 downhole motor, or the apparatus may be rotated from surface.

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 and 2 are schematic illustrations of the formation of a liner hanger in accordance with a first

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embodiment of the present invention;

Figures 3 and 4, Figures 5 and 6, Figures 7 and 8, Figures 9 and 10 and Figures 11 and 12 are schematic illustrations of the formation of liner hangers in accordance with other embodiments of the present invention;

Figures 13 to 17 are schematic views illustrating steps in the running and setting of a liner in accordance with a preferred embodiment of the present invention; and

Figures 18 and 19 are schematic sectional plan views, on lines 18-18 and 19-19 of Figures 15 and 16 respectively, illustrating the initial temporary setting of the liner.

A variety of liner hangers in accordance with embodiments of the present invention will first be described, followed by a description of an apparatus and method which may be utilised to form the hangers.

Reference is first made to Figures 1 and 2 of the drawings which are schematic illustrations of the formation of a liner hanger 10 in accordance with a first embodiment of the present invention. The figures show the lower end of a section of pre-installed casing 12 and the upper end of a section of liner 14 which has been run into a borehole lined with casing 12. The upper end of the liner 14 is positioned in overlapping relation with the lower end of the casing 12.

The casing 12 features two axially spaced annular female profiles 16, 17. As will be described, the upper end of the liner 14 is deformed by rolling expansion, that is an expander member in the form of a roller is rotated

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within the liner 14 with a face in rolling contact with the internal face of the liner, to cause compressive plastic deformation of the liner 14 and a localised reduction in wall thickness resulting in a subsequent increase in liner diameter, as is apparent from Figure 2. The expansion is carried out in two steps, and the expanding rollers feature a raised portion or rib such that the liner 14 experiences greater deformation at the area in contact with the raised portion, the raised portion being located adjacent the casing profile 16, to form a corresponding male profile 18 in the liner 14. A second male profile 19 is created by moving the roller expander to a second lower location for the second step of the expansion process.

The interference fit between the expanded liner 14 and the casing 12, and also the cooperation between the profiles 16, 17, 18 and 19 is such that the resulting liner hanger 10 provides both hanging support for the liner 14 and a pressure-tight seal between the liner 14 and the casing 12.

To enhance the grip between the liner 14 and the casing 12, the liner 14 carries chips of carbide 20 held in a matrix of softer metal; on deformation of the liner 14, the carbide chips bite into the opposing faces of the liner 14 and casing 12.

Reference is now made to Figures 3 and 4 of the drawings, which illustrate a liner hanger 24 in accordance with a second embodiment of the present invention. The method of forming the liner hanger 24 is substantially the

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same as described above, however the liner 26 is provided with bands of relatively soft material 28, 29 at the locations corresponding to the casing profiles 30, 31. Accordingly, when the liner 26 is deformed to create the male profiles 32, 33, the bands of ductile metal 28, 29 extend into the casing profiles 29, 30 and deform to provide a sealing contact with the opposing surfaces of the profiles 29, 30.

Reference is now made to Figures 5 and 6 of the drawings, which illustrate a liner hanger 36 in accordance with a third embodiment of the present invention. Like the second embodiment, the liner 38 carries bands of relatively ductile material 39, 40, however there are no preformed profiles provided in the casing 42. In this embodiment, sufficient internal force is applied to the liner 38 to cause compressive plastic deformation of the liner 38 and subsequent radial expansion of the casing 42 up to and exceeding the casing yield point.

Reference is now made to Figures 7 and 8 of the drawings, which illustrate a liner hanger 36 in accordance with a fourth embodiment of the present invention. In this embodiment, sufficient internal rolling compression and subsequent expansion of the upper section of the liner 48 creates high radial interference between the outside diameter of the upper section of the liner 48 and the inside diameter of the lower section of the casing 50.

Reference is now made to Figures 9 and 10 of the drawings, which illustrates a liner hanger 54 in accordance

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with a fifth embodiment of the present invention. The method of formation of the liner hanger is similar to that of the liner hanger 46 as described above, however in this embodiment the outer face of the upper section of the liner 56 carries a band of ductile metal 58 and an annular elastomeric seal 60, such that on expansion of the liner 56 the metal 58 is deformed and flows between the liner 56 and the casing 62, and the seal 60 is brought into sealing contact with the casing 62.

Reference is now made to Figures 11 and 12 of the drawings which illustrates a liner hanger 66 in accordance with a sixth embodiment of the present invention. In this embodiment, the casing 68 is formed of expandable tubing which has only been partially expanded at its lower end 70 to form a cone 72. The liner 74 is then run into the casing 68 and the liner top 76 expanded to form a matching cone 78 to the casing cone 72, such that the liner 74 may be hung from the casing 68. The upper end of the liner 74 is then subsequently expanded by compressive deformation to create a pressure seal, as illustrated in Figure 12.

Reference is now made Figures 13 through 17, which illustrate the stages in the running and cementing of a liner in accordance with a preferred embodiment of the present invention, and also illustrate the apparatus which may be utilised to form a liner hanger.

Reference is first made to Figure 13 of the drawings, which illustrates the liner 100 which has been run into the uncased section of a bore 102, below the lowermost casing

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section 104. An upper section of the liner 100a overlaps the lower end of the casing 104, this section of liner 100a being formed of a relatively ductile material and being welded to the upper end of the lower section of liner 100b.

5 The liner 100 is run in to the bore on a running and cementing string 106, the liner 100 being mounted to the string 106 via a rotary hydraulic expander 108 and a locking swivel 110. The expander 108 is located at the upper end of the liner, with the swivel 110 below, and a  
10 wiper plug 112 is mounted to the lower end of the swivel 110. The liner 100 itself defines a stop collar 114 and the lower end of the liner 100 is provided with a float shoe 116 including two one-way valves 118.

The liner 100 is coupled to the swivel 110 by a series  
15 of retractable pins which, in the initial configuration, prevent relative axial movement between the string 106 and the liner 100. A further series of pins extends from the expander 108 and, in the initial configuration, prevent relative rotational movement between the string 106 and the  
20 liner 100.

From Figure 13 it will be noted that the expander 108 and swivel 110 are tubular, such that cement and other fluids may be pumped from the surface through the string 106, and the expander 108 and the swivel 110 through the  
25 interior of the liner 100 and out from the valves 118 in the float shoe 116. As cement slurry is pumped in, as illustrated in Figure 14 of the drawings, the fluid in the bore externally of the liner 100, and in particular the

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fluid in the annulus 120 between the liner 100 and the uncased bore wall 122 is displaced upwardly through the annular gap 124 between the lower end of the casing and the upper end of the liner. This fluid may be "clean" fluid  
5 pumped through the string 106 ahead of the cement, in order to displace the well fluid which originally occupied the annulus 120.

As the cement is being pumped into the annulus 120 the string 106 is rotated from surface, to ensure an even  
10 distribution of cement throughout the annulus 120. Suitable seals located above and below the expander 108 prevent contamination of the expander by cement during the cementing operation.

The predetermined volume of cement slurry that is  
15 pumped into the bore is followed by a dart 126, which is itself followed by clean mud or water; the dart 126 is pumped down through the string 106, the expander 108 and the swivel 110. The dart 126 lands in the wiper plug 112, and pulls the plug 112 from the swivel 110.

20 The dart 126 then continues to move downwardly through the string 106, with the wiper plug 112, to "clean" the interior of the liner, until the plug 112 engages the stop collar 114, as shown in Figure 16.

At this point, the fluid pressure within the string  
25 106 will increase, indicating that the cementing phase of the liner hanging operation is complete, and allowing activation of the rotary hydraulic expander 108. Reference should now also be made to Figures 18 and 19 of the



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drawings, which illustrate the schematic sections on lines 18 - 18 and 19 - 19 of Figures 15 and 16, respectively. The expander 108 comprises three rollers 128 mounted in a body 130 and radially movable relative to thereto. In the preferred embodiment, the rollers 128 have tapered ends for co-operating with a corresponding taper on an annular piston which, when exposed to elevated string bore pressure, moves axially within the expander body 130 and urges the rollers 128 radially outwards. Figure 18 illustrates the initial position of the rollers 128 relative to the liner 100 and casing 104 (it should be noted that the diameters of the rollers 128 have been exaggerated), and on application of elevated fluid pressure to the interior of the expander 108 the rollers 128 are pushed outwardly, as illustrated in Figure 19 of the drawings. The outward movement of the rollers 128 is such that the wall of the liner 100 is deformed to create three initial areas of contact 132 between the liner outside diameter and casing inside diameter, which prevent further relative rotation between the liner 100 and the casing 104. The deformation of the liner 100 also disengages the liner from the coupling pins on the expander 108, allowing relative rotation between the expander 108 and the liner 100.

The string 106 and expander 108 are then rotated from surface, and thus the expander 108 rotates relative to the liner 100, the rollers 128 progressing around the inner diameter of the liner 100, in rolling contact therewith.

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The contact between the rollers 128 and the liner 100 causes compressive plastic deformation of the liner 100 and a localised reduction in wall thickness resulting in a subsequent increase in liner diameter, such that the liner outside diameter forms an interference fit with the casing inside diameter. Thus, a liner hanger, such as those as illustrated in Figures 1 to 12, may be created.

The running string 106, with the expander 108 and the swivel 110, is then pulled out of the hole, as shown in Figure 17, the locking pins extending between the swivel 110 and the liner 100 being arranged to disengage from the liner 100 when the swivel 110 is moved downwards as elevated fluid pressure is applied to the string 106.

It will be apparent to those of skill in the art that the liner hanger thus formed is relatively simple and slim in profile, thus providing enhanced reliability and minimising the loss of diameter between the casing and liner.

It will also be apparent to those of skill in the art that the above described embodiments are merely exemplary, and that various modifications and improvements may be made thereto without departing from the scope of the present invention. For example, although reference is made primarily herein to liner hangers, the invention may be utilised in locating and sealing many different forms of expandable tubing in existing tubing.

The claims defining the invention are as follows:

1. A method of installing a liner in a drilled bore below a section previously lined with casing, the method comprising the steps of:

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running a length of liner into the bore such that at least an upper end of the liner is positioned in overlapping relation with at least a lower end of the casing; and

radially plastically expanding a portion of the liner such that said portions forms an interference fit with a portion of the casing to provide hanging support for the liner;

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characterized in that the portion of the liner is expanded by producing compressive plastic deformation of the liner and a localized reduction in wall thickness resulting in a subsequent increase in liner diameter.

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2. The method of claim 1, wherein the portion of the liner is expanded by rotating an expander member within the liner with a face of the expander member in rolling contact with an internal face of said portion so as to produce the compressive plastic deformation of the liner.

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3. The method of claim 1 or 2, wherein said deformed portion of the liner is annular.

4. The method of claim 1, 2 or 3, wherein the portion of liner is deformed to create a fluid-tight seal between the liner and the casing.

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5. The method of claim 1, 2 or 3, wherein the portion of liner is deformed to create a pressure-tight seal between the liner and casing.

6. The method of claim 4 or 5, wherein the seal formed is a metal-to-metal seal.

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7. The method of claim 4, 5 or 6, further comprising providing the portion of liner with a band of relatively soft metal which is plastically deformed during the expansion of the liner portion.

8. The method of anyone of the preceding claims, further comprising providing a band of relatively hard material on the external surface of the liner portion.

9. The method of any of the preceding claims, wherein the portion of liner is deformed to extend into a preformed profile in the casing.

10. The method of claim 9, further comprising deforming the casing to define the profile prior to running the liner into the bore.

11. The method of claim 9, further comprising deforming the portion of casing together with the liner.

12. The method of any one of the preceding claims, wherein the liner is deformed at two or more axially spaced locations.

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13. The method of any one of the preceding claims, wherein the liner is initially secured relative to the casing by radially plastically extending circumferentially spaced areas of the liner to form corresponding areas of interference fit between the liner and the casing.

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14. The method of claim 13, wherein said areas are then extended circumferentially to form annular areas of interference fit between the liner and casing.

15. The method of any one of the preceding claims, further comprising the step of cementing the liner in the bore.

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16. The method of claim 15, wherein cementing is achieved by pumping cement from surface to the lower end of the liner through a combined running and cementing string and tool, directing the cement into the annulus between the liner and the bore wall and displacing fluid from the annulus, to substantially fill the annulus with cement.

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17. The method of claim 15 or 16, wherein the portion of the liner is expanded once the cement is in place in the annulus.

5 18. The method of claim 17, wherein the liner is rotated as the cement is passed into the annulus.

19. The method of any one of the preceding claims, wherein the liner is run into the bore on a running tool carrying an expander including a body and at least one radially

10 extendable expander member mounted thereon, the running tool being rotatable to move the member around the portion of the liner to create the desired deformed portion.

20. A method of securing a liner in a drilled bore to a section of previously fitted casing, the method comprising the step of expanding a portion of the liner such that an  
15 external face of said portion forms an interference fit with an internal face of a portion of the casing to provide at least one of hanging support for the liner and a fluid-tight seal between the liner and casing, characterized in that the portion of the liner is expanded by compressive plastic deformation to produce a localised reduction in wall thickness.

20 21. The method of claim 20, wherein said portion of liner is deformed by rolling expansion.

22. A liner running and setting tool comprising: a body for mounting on a running string and for location with a section of liner to be positioned within a section of casing;  
25 characterized by a radially movable pressure actuated expander member mounted on the body and means for applying fluid pressure to the expander member so as to expand a portion of the liner section by radial compressive plastic deformation such that an external face of the portion forms an interference fit with an internal face of a portion of the casing section to provide hanging support for the liner.

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23. The tool of claim 22, wherein the tool is adapted to be selectively rotatable relative to the liner and the expander member is a roller such that the portion of liner may be deformed by rolling expansion, that is the expander member is rotated within the liner with a face in rolling contact with an internal face of said portion.

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24. The tool of claim 23, wherein the roller defines a raised surface portion to create a high pressure contact area.

25. The tool of claim 23 or 24, wherein the tool is provided with two or more rollers.

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26. The tool of claim 25, wherein a plurality of the rollers are radially movable.

27. The tool of anyone of claims 22 to 26, wherein the member is coupled to an axially movable piston, the piston defining a cam face for engaging a cooperating cam face on the member.

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28. The tool of any of claims 22 to 27, wherein the tool defined a through bore to permit fluid to be passed through the tool.

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29. The tool of anyone of claims 22 to 28, wherein the tool comprises a coupling for releasably engaging the liner to permit transfer of torque therebetween.

30. The tool of any of claims 22 to 29, in combination with a section of liner wherein at least the portion of liner to be expanded is of a relatively ductile material.

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31. The tool and liner combination of claim 30, wherein the portion of liner includes an annular band of relatively soft material on an outer surface thereof.

32. The tool and liner combination of claim 30 or 31, wherein the portion of the liner carries relatively hard material on an external face, which material will tend to bite into

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the opposing faces of the liner and causing to provide a more secure coupling therebetween.

33. The tool and liner combination of claim 32, wherein the hard material is in the form of relatively small discrete pieces.

34. The tool and liner combination of claim 33, wherein the hard material is held in a matrix of softer material.

35. The tool and liner combination of claim 32, where the hard material is in the form of a band.

36. A method of installing a liner in a drilled bore below a section of bore previously lined with casing, said method being substantially as herein described with reference to Figs. 1 and 2, or Figs. 3 and 4, or Figs. 5 and 6, or Figs. 7 and 8 or Figs 9 and 10, or Figs. 11 and 12 together with Figs 13-19 of the drawings.

37. A liner running and setting tool substantially herein described with reference to Figs 13-19 of the drawings.

38. The tool as claimed in claim 37 in combination with a section of liner.

Dated this 26<sup>th</sup> day of February, 2004

WEATHERFORD/LAMB, INC.

BY:

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Patent Attorneys for the Applicant

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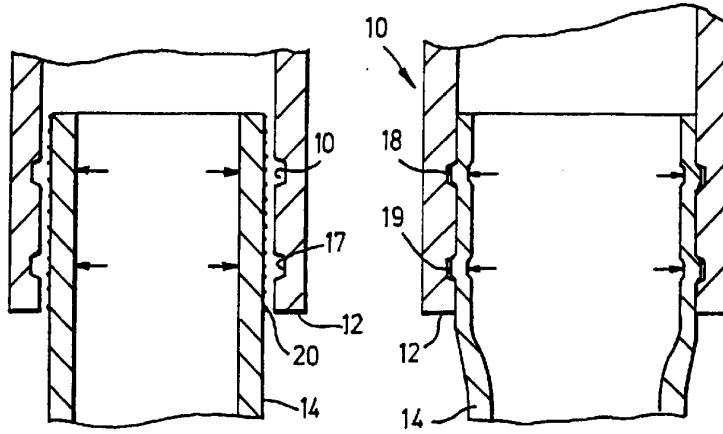


Fig. 1

Fig. 2

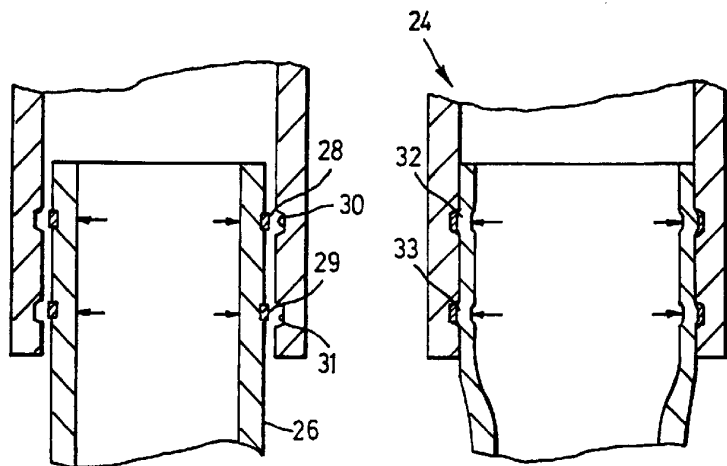


Fig. 3

Fig. 4

SUBSTITUTE SHEET (RULE 26)



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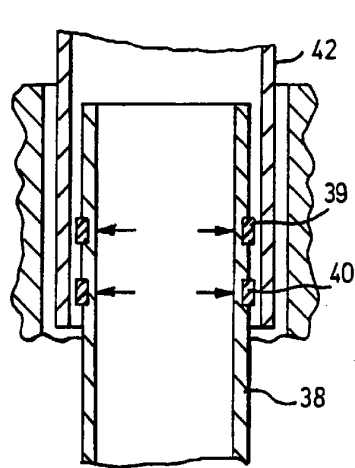


Fig. 5

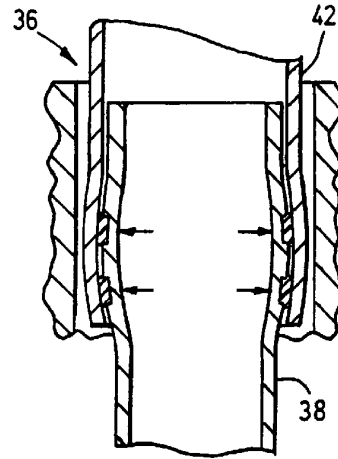


Fig. 6

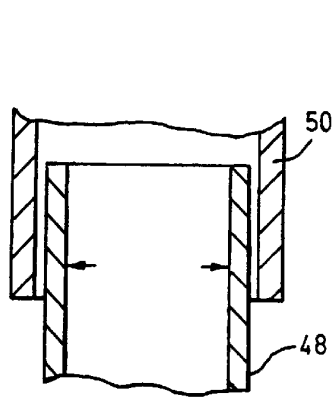


Fig. 7

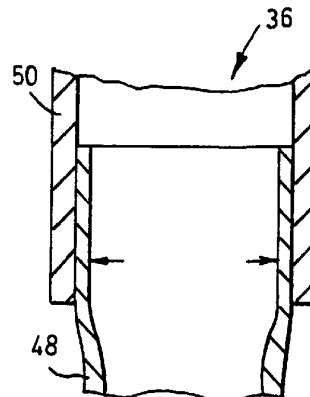


Fig. 8

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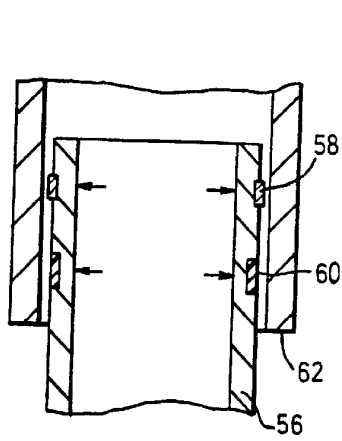


Fig. 9

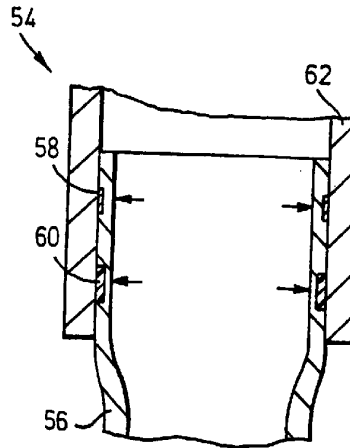


Fig. 10

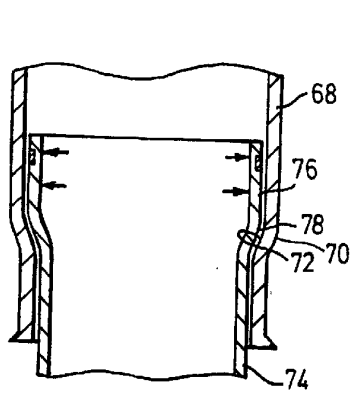


Fig. 11

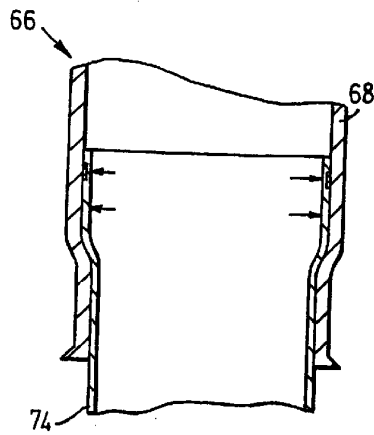


Fig. 12

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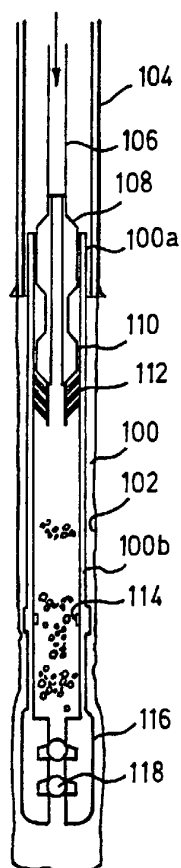


Fig.13

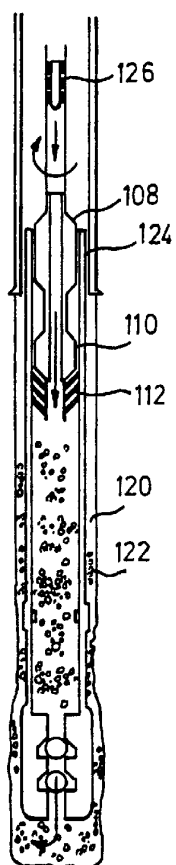


Fig.14

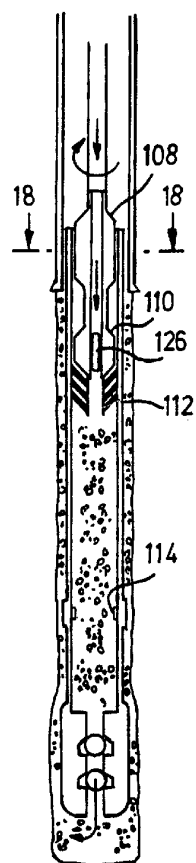


Fig.15

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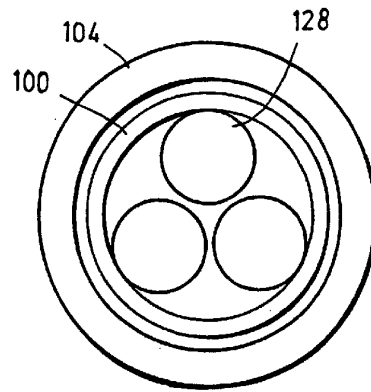


Fig.18

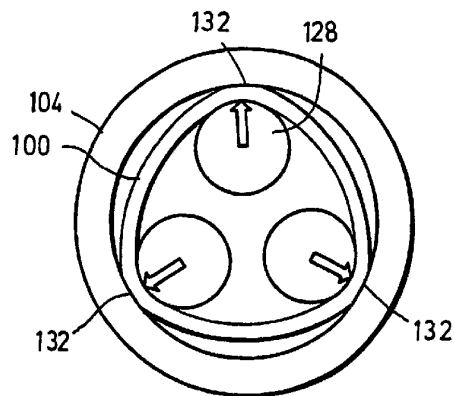


Fig.19

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