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(54) METHOD OF PROVIDING AN ANNULAR SEAL IN A WELLBORE

(57) A method of providing an annular seal in a wellbore 1 is disclosed. A tubular casing element 2 is assembled comprising a standard length of tubular steel casing 4 onto which an elastomeric sealing element 6 is mounted. A predetermined fluid pressure is applied by pumps on the surface to the inner diameter of deformation apparatus 10. This causes activation member 26 of the de-

formation apparatus 10 to move along body 12 and deform the deformation member 14 outwardly. The deformation member 14 contacts tubular casing 4 and pushes with sufficient force to deform the steel and form an annular deformation 28 in the casing. This pushes the elastomeric sealing element 6 against the surface of the wellbore 1 forming an annular seal.

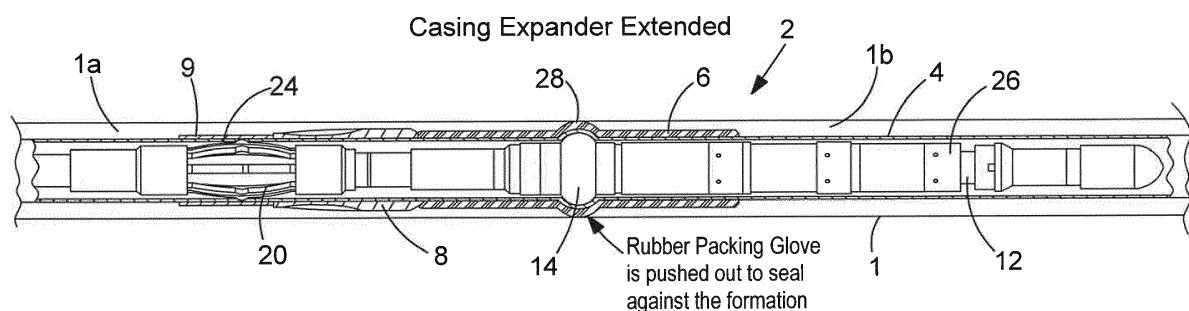


FIG. 3b

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Description

[0001] The present invention relates to a method of providing an annular seal in a wellbore and relates particularly, but not exclusively, to a method of expanding and deforming a casing element against the sides of a wellbore using an expandable downhole tool. The present invention also relates to a tubular casing element arranged to be deformed to provide an annular seal in a wellbore and an assembly comprising such a tubular casing element and a deformation apparatus.

[0002] During the production of hydrocarbons from wellbores, in many circumstances it is desirable to isolate zones of the wellbore for example to enable gas shut-off, acidizing, selective simulation and plug and abandonment.

[0003] For example, during the completion procedure, once an open wellbore has been lined with casing, the wellbore can be compartmentalised by providing a series of annular seals in the annulus between the casing and the surface of the wellbore. Compartmentalisation/zonal isolation enables greater control over hydrocarbon production. If one of the isolated zones produces large amounts of water, that zone can be shut off by use of an inflow control device (ICD) whilst the remaining zones defined by the respective annular seals continue to produce.

[0004] Known methods of providing annular wellbore seals for such zonal isolation procedures include using soft alloy expandable packer elements mounted onto or between lengths of casing. The expandable packer elements are inflated against the wellbore by using high downhole pressures.

[0005] This method suffers from the drawback that assembling casing incorporating such expandable packer elements increases cost and complexity of completion operation. The packer elements can also provide weak points in the casing prone to rupture and also a risk that the zonal isolation procedure will be incomplete if the packer fails to inflate and seal correctly.

[0006] Alternatively, swell packers mountable to the outside of casing can be used which react with wellbore fluid to swell in the annulus between the casing and the wellbore to provide a seal.

[0007] This method can suffer from the drawback that the swell packers take several days to form a seal which can be a costly delay in the production process. Also, if a swell packer fails to seal correctly, the zonal isolation process is incomplete and difficult to correct.

[0008] A preferred embodiment of the present invention seeks to overcome the above disadvantages of the prior art.

[0009] According to an aspect of the present invention, there is provided a method of providing an annular seal in a wellbore, the method comprising:

locating a deformation apparatus comprising a body and a deformation member outwardly moveable rel-

ative to the body inside a tubular casing element comprising an elastomeric sealing element disposed in a wellbore; and

activating the deformation apparatus to deploy said deformation member to deform said tubular casing element outwardly and compress said elastomeric sealing element against the side of said wellbore to create an annular seal.

[0010] This provides the advantage of a method of providing an annular seal in a wellbore which comprises deforming standard wellbore casing into contact with a wellbore surface. No swell packers or expandable packer casing elements are required which significantly reduces cost and complexity of zonal isolation/compartmentalisation of wellbores.

[0011] This also provides the advantage of increasing the reliability of annular wellbore seals because use of expandable packers can form weak points in casing and both expandable packers and swell packers might fail to deploy correctly which can result in zonal isolation failure. On the other hand, the deformation apparatus can be located and operated at a predetermined pressure with accuracy.

[0012] By providing an elastomeric sealing element around the standard casing, this provides the advantage of significantly increasing the reliability of the seal provided.

[0013] In a preferred embodiment, said deformation apparatus comprises:

a body arranged to be disposed in a wellbore;

an activation member mounted to the body, wherein the activation member is moveable relative to the body from an unset condition to deform an elastomeric deformation element outwardly relative to the body; and

characterised by a plurality of pistons arranged to move the activation member relative to the body, each said piston defining a respective pressure chamber arranged to be filled with fluid in response to an increase in fluid pressure in the body to move each of the plurality of pistons relative to the body and cause the activation member to move relative to the body; and

wherein the step of activating the deformation apparatus to deploy said deformation member to deform said tubular casing element outwardly and compress said elastomeric sealing element against said wellbore comprises increasing fluid pressure in the body.

[0014] This provides the advantage of an apparatus that is modular in nature and therefore adjustable to provide a particular pressure required for particular casing

size and wellbore conditions. In other words, by increasing or reducing the number of pistons used to deploy the activation member, the deployment pressure and therefore the force provided to deform the casing can be accurately controlled.

[0015] This also provides the advantage of reducing the cost of providing annular seals in wellbores for zonal isolation/compartmentalisation by providing a reusable deformation tool.

[0016] The method further comprises reducing fluid pressure in the body to cause the elastomeric deformation element to return the activation member to the unset condition to enable the deformation apparatus to be moved.

[0017] This provides the advantage of reducing operational complexity. All an operator has to do to deactivate the deformation apparatus is to reduce fluid pressure in the wellbore which enables the elastomeric deformation element to move to the un-deformed condition and push the activation member back to the unset condition. This enables very straightforward repositioning of the deformation apparatus in the casing to enable movement between locations requiring casing deformation and annular sealing.

[0018] According to another aspect of the present invention, there is provided a tubular casing element for a wellbore comprising an elastomeric sleeve disposed thereon.

[0019] This provides the advantage of a casing element that can be used to provide a reliable annular seal in the annulus between casing and the surface of a wellbore. Such a casing element is particularly advantageous because it is low cost and based on a very straightforward modification of existing casing elements.

[0020] According to a further aspect of the present invention, there is provided an assembly comprising a tubular casing element as defined above and a deformation apparatus comprising:

a body arranged to be disposed in a wellbore;

an activation member mounted to the body, wherein the activation member is moveable relative to the body from an unset condition to deform an elastomeric deformation element outwardly relative to the body; and

characterised by a plurality of pistons arranged to move the activation member relative to the body, each said piston defining a respective pressure chamber arranged to be filled with fluid in response to an increase in fluid pressure in the body to move each of the plurality of pistons relative to the body and cause the activation member to move relative to the body, wherein when fluid pressure is reduced in the body, the elastomeric deformation element returns the activation member to the unset condition.

[0021] This provides the advantage of an assembly which provides a low cost and easy to operate means of providing an annular seal in casing in a wellbore to enable zonal isolation.

[0022] A preferred embodiment of the present invention will now be described by way of example only and not in any limitative sense, with reference to the accompanying drawings in which:

Figure 1 is a side view of a tubular casing element of an embodiment of the present invention;

Figure 2 is a side view of a deformation apparatus used in a method of providing an annular seal in a wellbore embodying the present invention;

Figure 3a is a cross-sectional view of an assembly of the tubular casing element of Figure 1 and the deformation apparatus of Figure 2 located downhole in a wellbore;

Figure 3b is a cross-sectional view of the assembly of Figure 3a showing the deformation apparatus and deformation member expanded outwardly to deform the tubular casing to provide an annular seal in the wellbore;

Figure 4a is a cross-sectional view of the deformation apparatus of Figure 2 in the unset condition; and

Figure 4b is a cross-sectional view of the deformation apparatus of Figures 2 and 4a in the set condition.

[0023] Referring to Figure 1, a tubular casing element 2 comprises a standard tubular length of steel casing 4 onto which an elastomeric sleeve 6 is mounted. Steel casing 4 is generally used to line and complete open wellbores. Elastomeric sleeve 6 is formed from an elastomeric material such as rubber and mounted onto the casing element 4 by means of adhesive such as an epoxy. A centralising element 8 is also provided to centralise the tubular casing element 2 when placed downhole in a wellbore and a casing collar 9 having an internal thread is threaded to an end of casing 4 to enable inter-connection to other lengths of casing.

[0024] The width of the elastomeric sleeve 6 will depend on the nature of the wellbore in which the tubular casing element 2 is to be placed but for the purposes of example, a 0.5 inch width of elastomeric sleeve 6 might be used on a 4.5 inch diameter casing for a 6.125 inch wellbore.

[0025] Referring to Figure 2, a deformation apparatus 10 comprises a body 12 and an elastomeric deformation element 14 outwardly moveable under compression relative to the body. The deformation apparatus 10 is mountable in a bottom hole assembly comprising a bull nose 16 and casing collar locator 18. The deformation apparatus can be deployed on coil tubing 22 or other methods

which will be familiar to persons skilled in the art. Casing collar locator 18 comprises a plurality of detent elements 20 biased outwardly from the body and being slidable along the internal surface of the tubular casing element 2 until it locates the joint between two lengths of casing at casing collar 9.

[0026] The operation of an assembly of tubular casing element 2 and deformation apparatus element 10 to provide an annular seal in a wellbore will now be described with referenced to Figures 3a and 3b.

[0027] Firstly, the tubular casing element 2 is assembled comprising a standard length of tubular steel casing 4 onto which the elastomeric sealing element 6, centralising element 8 and casing collar 9 are mounted. The tubular casing element 2 is then run into a wellbore 1 in a standard completion procedure to line wellbore 1.

[0028] A bottom hole assembly (BHA) comprising the deformation apparatus 10 is then run into the wellbore 1 on coil tubing 22 (or another suitable method). The bottom of the wellbore is tagged and the deformation apparatus 10 is then slowly pulled up through the wellbore until the outwardly biased detents 20 of the casing collar locator 18 locate casing collar 9. The deformation apparatus 10 is then held in position.

[0029] At this point, a predetermined fluid pressure is applied by pumps on the surface to the inner diameter of deformation apparatus 10 and held for a predetermined length of time. This causes activation member 26 of the deformation apparatus 10 to move along body 12 and compress and deform the elastomeric deformation member 14 outwardly. The deformation member 14 contacts tubular casing 4 and pushes with sufficient force to deform the steel and form an annular deformation 28 in the casing. This pushes the elastomeric sealing element 6 against the surface of the wellbore 1. This forms an annular seal to isolate sections 1a and 1b of wellbore 1.

[0030] Although only a single deformation apparatus 10 is shown in Figures 3a and 3b, it is preferable to run two deformation apparatuses at the same time, one below the casing collar locator 18 as shown in Figures 3a and 3b and one above (not shown) to form two annular casing deformations 28 at the same time and therefore form a casing compartment in a single operation. The second annular casing deformation would therefore be located at the top of annular wellbore section 1a.

[0031] An advantage of operating deformation apparatuses 10 in this manner is that the seals formed prevent casing collar leakage because the elastomeric seal elements 6 above and below the casing collar 9 prevent wellbore fluid reaching the casing collar 9. Furthermore, multiple sets of deformation apparatus 10 can be run at the same time in a single work string to form any number of annular seals 28 at the same time which greatly reduces cost and the amount of time taken to conduct a zonal isolation operation.

[0032] Once the annular seals 28 are formed, reducing fluid pressure in the deformation apparatuses 10 causes un-setting by enabling the elastomeric deformation mem-

ber 14 to push the activation member 26 back along body 12 from the position shown in Figure 3b to that of Figure 3a. The deformation apparatuses 10 can then be moved up to another casing joint if required to repeat the process to provide further annular seals.

[0033] Referring to Figures 4a and 4b, the deformation apparatus 10 comprises a body 12 and an activation member 26 mounted to the body. The activation member is slideable along the body 12 from an unset condition to deform the elastomeric deformation element 14 outwardly as shown in Figure 4b. A plurality of internal ports 30 are provided in body 12 to enable fluid to flow into concentric piston chambers 32. A plurality of annular ports 34 are provided to provide a fluid exhaust. When fluid pressure is increased in the body 12, fluid flows under dynamic pressure through ports 30 into piston chambers 32. This pushes activation member 26 along the body to compress and deform the elastomeric deformation element 14 outwardly.

[0034] The elasticity of element 14 is sufficient such that when fluid pressure is reduced below a predetermined level, the elastomeric deformation element 14 pushes activation member 26 back along the body from the condition shown in Figure 4b to the unset condition of Figure 4a.

[0035] It will be appreciated by persons skilled in the art that the above embodiment has been described by way of example only, and not in any limitative sense, and that various alterations and modifications are possible without departure from the scope of the invention as defined by the appended claims.

Claims

1. A method of providing an annular seal in a wellbore, the method comprising:

locating a deformation apparatus comprising a body and a deformation member outwardly moveable relative to the body inside a tubular casing element comprising an elastomeric sealing element disposed in a wellbore; and activating the deformation apparatus to deploy said deformation member to deform said tubular casing element outwardly and compress said elastomeric sealing element against the side of said wellbore to create an annular seal.

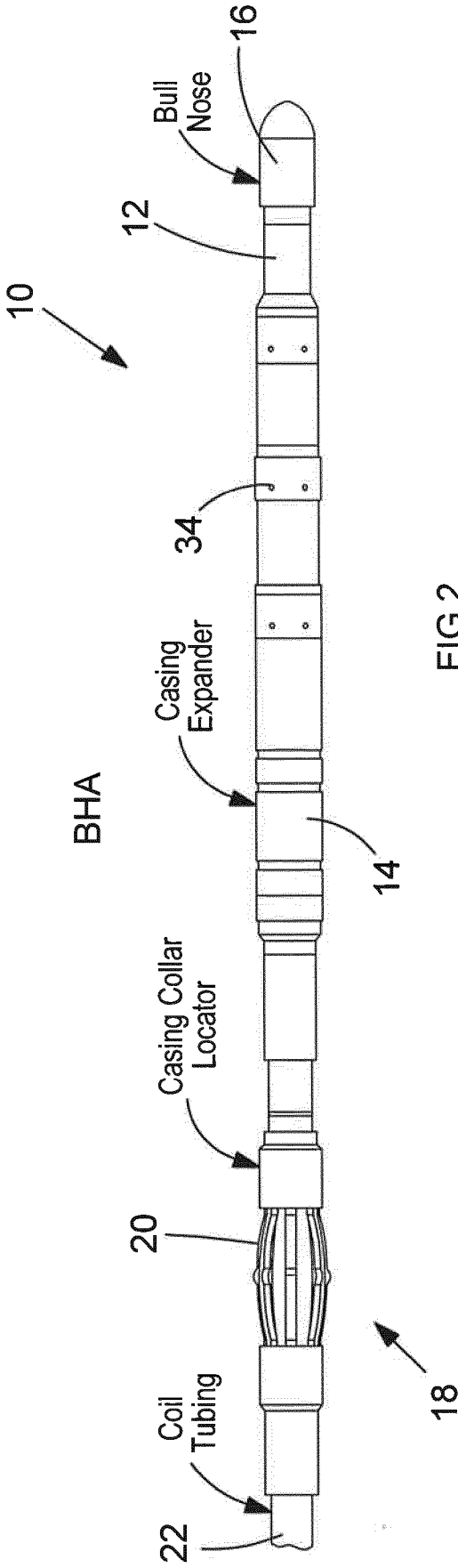
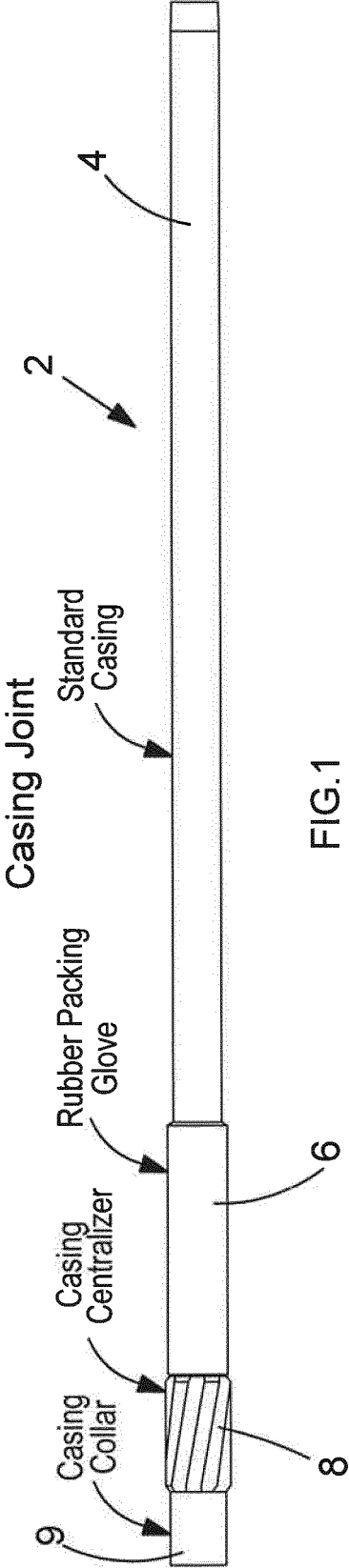
2. A method according to claim 1, wherein said deformation apparatus comprises:

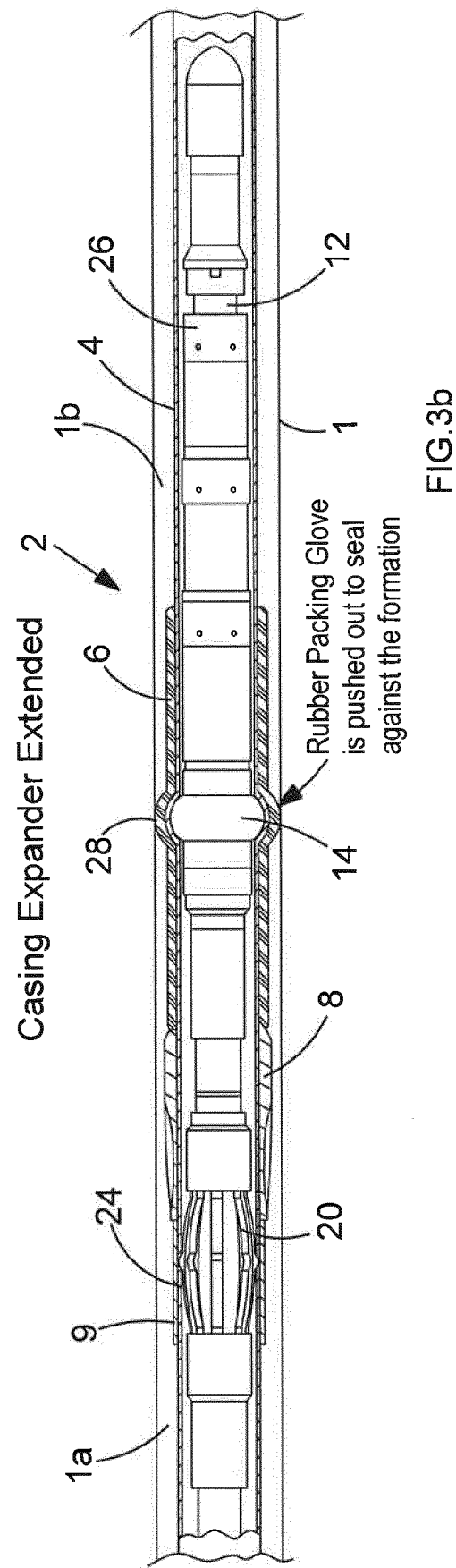
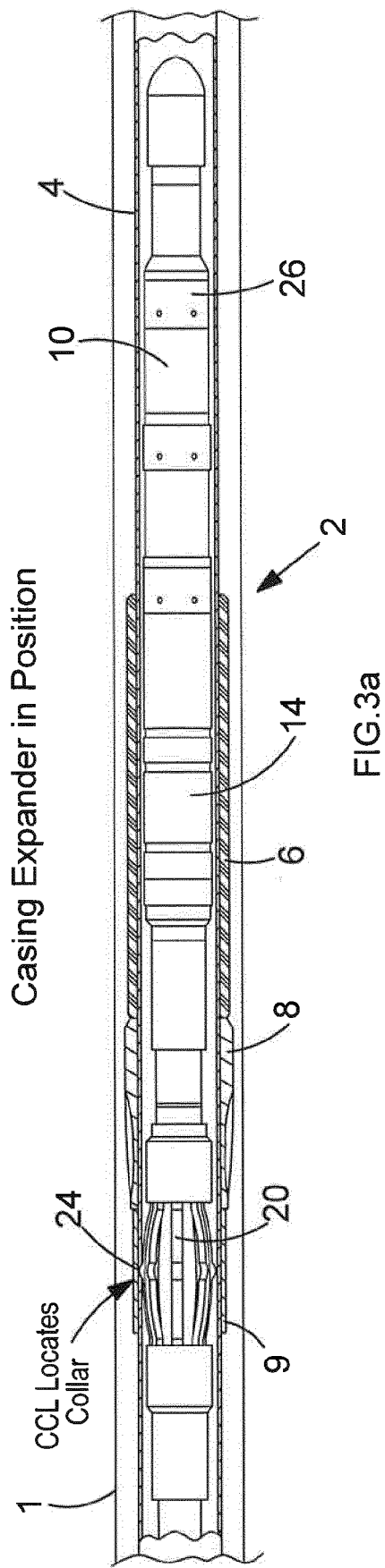
a body arranged to be disposed in a wellbore; an activation member mounted to the body, wherein the activation member is moveable relative to the body from an unset condition to deform an elastomeric deformation element outwardly relative to the body; and

characterised by a plurality of pistons arranged to move the activation member relative to the body, each said piston defining a respective pressure chamber arranged to be filled with fluid in response to an increase in fluid pressure in the body to move each of the plurality of pistons relative to the body and cause the activation member to move relative to the body; and wherein the step of activating the deformation apparatus to deploy said deformation member to deform said tubular casing element outwardly and compress said elastomeric sealing element against said wellbore comprises increasing fluid pressure in the body.

3. A method according to claim 2, further comprising reducing fluid pressure in the body to cause the elastomeric deformation element to return the activation member to the unset condition to enable the deformation apparatus to be moved.
4. A tubular casing element for a wellbore comprising an elastomeric sleeve disposed thereon.
5. An assembly comprising a tubular casing element according to claim 4 and a deformation apparatus comprising:

a body arranged to be disposed in a wellbore; an activation member mounted to the body, wherein the activation member is moveable relative to the body from an unset condition to deform an elastomeric deformation element outwardly relative to the body; and **characterised by** a plurality of pistons arranged to move the activation member relative to the body, each said piston defining a respective pressure chamber arranged to be filled with fluid in response to an increase in fluid pressure in the body to move each of the plurality of pistons relative to the body and cause the activation member to move relative to the body, wherein when fluid pressure is reduced in the body, the elastomeric deformation element returns the activation member to the unset condition.





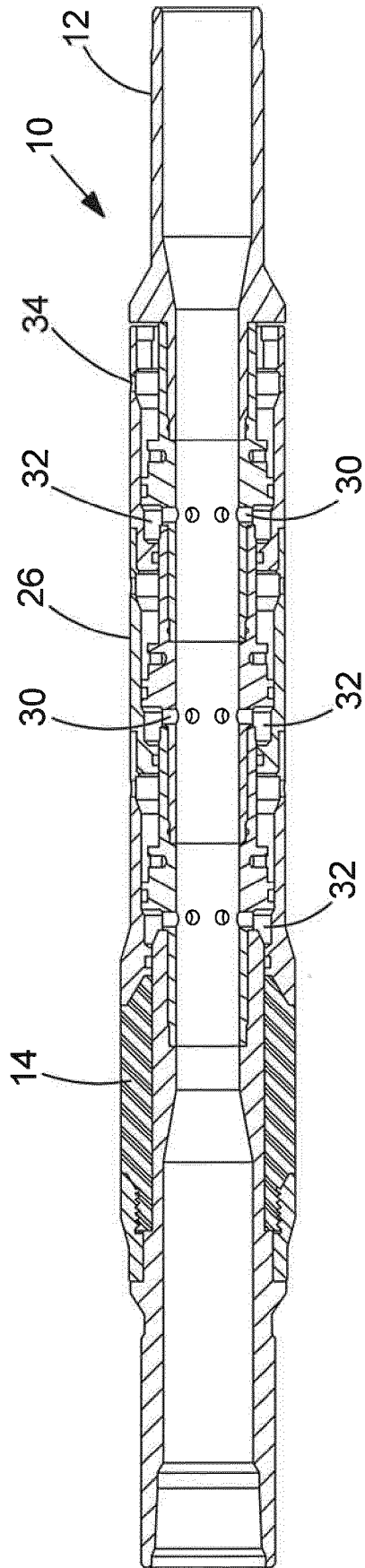


FIG. 4a

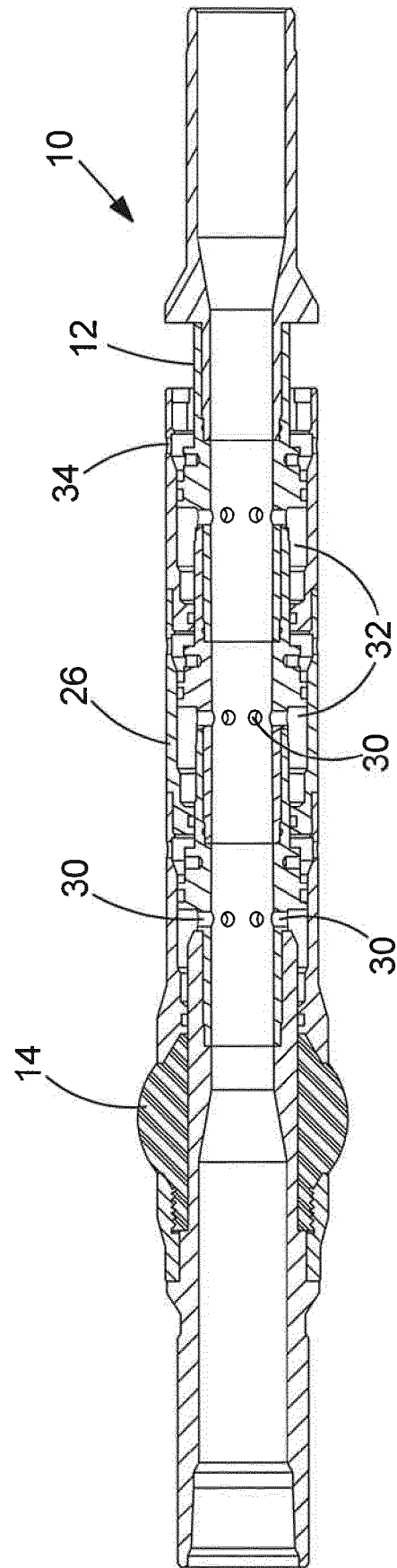


FIG. 4b



EUROPEAN SEARCH REPORT

Application Number
EP 16 17 8708

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Y	* pages 3, 16 - page 18; figure 5 *	2,5	

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			TECHNICAL FIELDS SEARCHED (IPC)
			E21B
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 8 December 2016	Examiner Patrascu, Bogdan
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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