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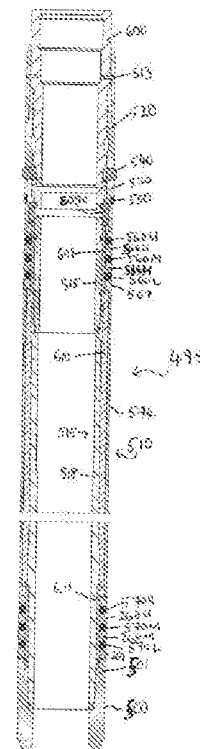
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(54) Title **DUAL ISOLATION BORE SEAL SYSTEM**
 (57) Abstract

A dual isolation bore seal system (15; 195; 495) for sealing and a method of sealing a tubing at two spaced apart locations (1, 3; 140, 100) within a generally cylindrical member (115) are described. The system (15; 195; 495) includes a body (210, 215) having at least first and second sealing elements (5; 260, 270; 560, 570) for sealing at the said two locations (1, 3; 140, 100). The first (5; 260; 560) and second (5; 270; 570) sealing elements are axially spaced apart on the body and are connected by at least one linkage (10; 310; 610). The linkage (10; 310; 610) is configured to transfer linear force between the at least first and second sealing elements (5; 260, 270; 560, 570) to energise and/or de energise the said sealing elements (5; 260, 270; 560, 570) between a first transit diameter and a second sealing diameter.



DUAL ISOLATION BORE SEAL SYSTEM

This invention relates to a sealing system. More particularly, this invention relates to a sealing system or straddle for isolating the region between two sealing locations within tubing, piping or otherwise cylindrical environment.

BACKGROUND

There are many applications within (but not limited to) downhole interventions where it is advantageous for a region between two locations to be isolated through the application of sealing element(s) at either end. This is generally to prevent the passage of fluid from one end to the other, but may also be to contain the fluid and pressure already in the region between the seals.

In downhole oil and gas applications it may be desirable to create a sealed environment between two seal bores within a length of tubing that is, for example, deployed within a wellbore. At present, this operation would require the use of sealing element(s) suited to each bore size which would have to be passed through the entire downhole system above the target location, potentially sustaining damage, wear, or causing blockages along the way, possibly compromising the effectiveness of the sealing elements once deployed. Upon reaching the desired sealing location, if the seals and/or sealing system have been damaged, it may be necessary to force the seal(s) into their final position, which may restrict the ability to conduct further work or may cause damage to the seal(s), reducing their efficacy. In an oil or gas well, this may in turn compromise the integrity of the well itself.

An example of such a downhole oil and gas application is where a tubing retrievable surface controlled sub-surface safety valve that is included in a production tubing string and, possibly after a number of years of satisfactory operation, has failed to function satisfactorily which results in the compromised integrity of the well. An example of such a tubing retrievable surface controlled sub-surface safety valve is shown in Fig. 4(a) as being included in a downhole tool 115 that is in turn included in a production tubing string (not shown), where the safety valve flapper 180 is in the open position, being held open by a flow tube 190. The most common root cause of

failures in tubing retrievable surface controlled sub-surface safety valves 175 include:-

- failure in the piston seals 160;
- failure in the safety valve flapper 180; or
- 5 - restricted movement of the flow tube 190.

Tubing retrievable surface controlled sub-surface safety valves 175 are conventionally included in most production tubing strings and in many jurisdictions around the world, are a legal requirement in order to provide control over the well to the operator of the well. The tubing retrievable surface controlled sub-surface safety valves 175 are arranged such that when they are supplied with hydraulic fluid through a hydraulic fluid control line 110 from the surface of the well, the pressurised hydraulic fluid enters a hydraulic chamber 150 which in turn is in fluid communication with a set of piston seals 160 formed at the upper end of a piston 162 which in turn is attached at its lower end to the upper end of a flow tube 190. The sub-surface safety valve 175 comprises a flapper valve 180 which is biased by a spring or the like (not shown in Fig. 4a) to shut across the through bore 95 of the tubing retrievable surface controlled sub-surface safety valve 175 (and thus the production tubing) and when the flapper valve 180 does shut across the through bore 95, the through bore 95 therefore cannot pass any production fluids from below the flapper valve 180 in the upwards direction and therefore the production tubing and therefore the well is shut in. However, as long as hydraulic fluid pressurised from the surface acts against the piston seal 160 then the piston 162 is forced downwards, against the biasing action of return spring 170 and forces the flow tube 190 through the flapper valve 180 into the position shown in Fig. 4a such that the flapper valve 180 is mechanically restrained in the open position and is therefore prevented from shutting the through bore 95 and thus the well can flow and thus the hydro-carbons from the well can travel from upstream (below) the safety valve 175 in the upwards direction through the through bore 95 and onwards (downstream) to the surface of the well.

30 However, as described above, the tubing retrievable surface controlled sub-surface safety valves 175 can sometimes fail. In such a circumstance, the operator will typically run a conventional “locking out” or “locking open” operation which entails running in a specialist tool (not shown) adapted to perforate or puncture a hole through the inner side wall 152 of the downhole tool 115 containing the sub-surface

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safety valve 175 at a point in fluid communication with the hydraulic chamber 150 (see Fig. 4(b)). Thus, once the specialist perforation tool is removed, the hydraulic fluid in the hydraulic chamber 150 will flow from the hydraulic chamber 150 through the puncture 154 formed in the side wall 152 and will therefore flow into the through bore 95 of the sub-surface safety valve 175. As can be seen in the more detailed close up view of Fig. 4b, the puncture 154 created by the perforation tool also causes an outer part of the side wall 152 to extend into the hydraulic chamber 150 and thus the puncture 154 also serves to prevent any upward or return movement of the piston seals 160 and thus the piston 162 beyond the point of the puncture 154 and thus the piston 162 and therefore the flow tube 190 are “locked out” or “locked open” and thus are prevented from moving and thus will remain in the position as shown in Fig. 4a such that the flapper valve 180 is locked open. At this point, the operator will pull out the perforation tool and will run in a pair of static sealing elements such as o-ring seals, etc (not shown) provided on the outer surface of a length of pipe (not shown), where the pair of seals are longitudinally spaced apart,. The operator will then, in order to take back control of the well, align the pair of seals such that they are located either side of the puncture 154. More specifically, the upper o-ring seal (not shown) on the pipe is arranged to be aligned with and seal against the polished upper seal bore 140 and the lower seal (not shown) on the pipe (not shown) is arranged to be aligned with the polished lower seal bore 100. The hydraulic fluid that will ordinarily flow from the hydraulic chamber 150 through the puncture 154 will thus be retained within the annulus between the outer surface of the pipe (not shown), the inner surface of the through bore 95 of the downhole safety valve 175 and at its upper end, the upper static seal and at its lower end, the lower static seal.

Moreover, conventionally, the pipe (not shown) will typically be provided with an insert safety valve (such as the insert safety valve 200 shown in Fig. 5a) at its lower most end and the pipe (not shown) is typically provided with a suitable hydraulic fluid conduit or pathway in order to transmit the hydraulic fluid that would otherwise collect in the said annulus and transmit it to the newly run in insert safety valve 200. In such a manner, the operator will thus regain control over the well because the hydraulic fluid that is transmitted to the newly run in insert safety valve 200 will operate the newly run in insert safety valve 200 and cause it to open and thus if for some reason the operator requires to shut in the production tubing, the operator can cut the

hydraulic fluid pressure at surface and that will result in the closure of the newly run in insert safety valve 200.

5 However, such a conventional pipe with static seal arrangement suffers from the great disadvantage that because the static seals, such as o-rings (not shown) need to be of a sufficient diameter in order to seal against the inner surface of the respective polished upper seal bore 140 and lower seal bore 100, the o-ring seals are liable to be scratched or be caught upon the inner surface of certain parts of the production tubing as the pipe is run in. Accordingly, it can be very risky for an operator to have to rely on such a static seal arrangement provided on such a conventional pipe.

10 It is an object of the present invention to obviate or at least mitigate some or all of the disadvantages of such a conventional pipe and static seal arrangement.

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SUMMARY OF THE INVENTION

According to the present invention, there is provided a dual isolation bore seal system for sealing at two locations within a generally cylindrical member, the system comprising:-

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a body having at least first and second sealing elements axially spaced apart on the body and connected by at least one linkage,

wherein the linkage is configured to transfer linear force between the at least first and second sealing elements to energise and/or de-energise the said sealing elements between a first transit diameter and a second sealing diameter.

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Typically, the generally cylindrical member comprises a pipe or tubular and may in preferred embodiments comprise a length of production tubing.

30 Typically, the linkage is configured to transfer linear force in a longitudinal axial direction between the at least first and second sealing elements.

Optionally the seal system is used in an oil, gas, or water well. Optionally the system may be used within an oil and/or gas tubular such as a length of production tubing through which produced fluids may flow when permitted to do so.

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Optionally the body of the system is a generally tubular body, with a throughbore through which fluids may pass. The outer diameter of the body of the system may be less than the inner diameter of the generally cylindrical member to be sealed.

5 Optionally the body of the system comprises at least one seal mandrel. Optionally the body of the system may comprise at least two seal mandrels, optionally axially spaced apart from one another. Optionally the sealing elements are held within recesses, grooves, notches or similar, optionally located on an outer surface or wall of the at least one seal mandrel. Optionally the sealing elements are annular.

10 Optionally the sealing elements may be formed of elastomer e.g. rubber. Typically, the first and second sealing elements each comprise at least one seal. The respective at least one seal may be an elastomeric o-ring seal or the like.

Optionally the sealing elements can be fully housed within the recesses/grooves etc. during run-in of the seal system into e.g. the bore of the generally cylindrical member to be sealed. Optionally the first transit diameter of the sealing elements is smaller than the second sealing diameter of the sealing elements. Preferably, the linkage is configured to transfer linear force in an axial direction between the at least first and second sealing elements to energise and/or de-energise the said sealing elements

20 between a first transit diameter and a second sealing diameter by radially increasing both the inner and outer diameters of the said first and second sealing elements. Advantageously, this arrangement reduces the risk of damage or wear to the sealing elements during transit of the seal system, as the sealing elements are somewhat protected within the recesses.

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Optionally the body of the seal system comprises an inner mandrel with a throughbore and a housing. Optionally the inner mandrel is disposed within the housing and is more preferably the housing is an outer housing with the inner mandrel preferably being disposed in the outer housing. Optionally the inner

30 mandrel and housing are arranged such that they are co-axial. Optionally the inner mandrel is fixed to the housing by at least one frangible member such as a shear pin, such that the inner mandrel is selectively restrained from moving relative to the housing and more preferably such that the inner mandrel is selectively restrained from moving in a linear axial direction (i.e. parallel to the longitudinal central axis of

35 the inner mandrel and outer housing) relative to the housing.

Preferably, the linkage forms part of the inner mandrel. The inner mandrel further preferably comprises a first seal mandrel and a second seal mandrel, where the first seal mandrel is preferably an upper seal mandrel and the second seal mandrel is preferably a lower seal mandrel. Typically, the first sealing element is located on and more preferably located around the outer circumference of the first seal mandrel. Typically, the second seal element is located on and more preferably is located around the outer circumference of the second seal mandrel. Most preferably, the upper and lower seal mandrels are connected by the linkage.

Optionally the housing comprises at least one locking member, optionally a plurality of locking members, optionally circumferentially spaced apart around the housing. Optionally the locking members are contained within apertures in the housing. Optionally the locking members are movable, for example radially movable, relative to the housing. Optionally the generally cylindrical member to be sealed comprises one or more profiles such as one or more recesses on its inner surface against which or into which a respective locking member can be placed into contact in order to lock there against. Optionally the locking members are shaped to be complementary to at least one profiled area on the inner surface of the generally cylindrical member to be sealed. Optionally the generally cylindrical member to be sealed comprises a no-go profile for restricting the axial travel of the seal system within the generally cylindrical member to be sealed.

After the seal system is in position within the generally cylindrical member to be sealed and when sealing is required, a linear force may be applied to the inner mandrel. Preferably, the linear force is applied in a longitudinal axial direction. Optionally, when the force applied exceeds a threshold value, the frangible member holding the inner mandrel to the housing of the system may break, thereby permitting movement of the inner mandrel relative to the housing in a longitudinal axial direction. Accordingly, the inner mandrel may move axially under the influence of the applied linear force.

Optionally the outer surface of the inner mandrel and more preferably the outer surface of at least one and more preferably both of the first and second seal mandrels comprise one or more changes in outer diameter, preferably comprising at

least one relatively smaller diameter portion and one relatively larger diameter portion and most preferably further comprising a tapering diameter portion leading between the said relatively smaller diameter portion and the relatively larger diameter portion.

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Optionally the inner mandrel further comprises at least a first locking portion having an increased outer diameter. Optionally, as the inner mandrel moves relative to the housing in an axial direction, the first locking portion may engage the locking members and more preferably, the said first locking portion of the outer surface of the inner mandrel may engage an inner surface of the locking members. Optionally the said engagement and further axial movement of the inner mandrel relative to the housing causes the locking members to extend radially outwards and more preferably such outward movement causes the outer surface of the locking members to engage the at least one profiled area on the inner surface of the generally cylindrical member to thereby lock the housing in position.

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Optionally the generally cylindrical member to be sealed comprises two or more sealing profiles on its inner surface (which may be polished sealing bores) against which one or more respective said at least first and second sealing elements can be placed into contact in order to seal there against.

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Preferably, when the first and second seal elements are de-energised, they are respectively located on and more preferably are located around the outer circumference of the relatively smaller diameter portion of their respective first and second seal mandrel such that they are in their transit diameter for running in of the seal system into the generally cylindrical member.

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Typically, when the linkage is transferring linear force in an axial direction, the inner mandrel moves relative to the housing in an axial direction and the tapering diameter portion of the first seal mandrel engages an inner surface of the first sealing element. Optionally the said engagement and further axial movement of the inner mandrel relative to the housing causes the tapering outer diameter portion to continue to expand the first sealing element radially outwards and more preferably, continued axial movement of the inner mandrel relative to the housing causes the first sealing element to move radially outwards onto the relatively larger diameter portion of the

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first seal mandrel such that the first sealing element reaches the second sealing diameter and such outward radial movement causes the outer surface of the first sealing element to engage and seal against a first sealing profile on the inner surface of the generally cylindrical member to thereby seal the annulus there between.

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Typically, when the linkage is transferring linear force in an axial direction, the inner mandrel moves relative to the housing in an axial direction and the tapering diameter portion of the second seal mandrel engages an inner surface of the second sealing element. Optionally the said engagement and further axial movement of the inner mandrel relative to the housing causes the tapering outer diameter portion to continue to expand the second sealing element radially outwards and more preferably, continued axial movement of the inner mandrel relative to the housing causes the second sealing element to move radially outwards onto the relatively larger diameter portion of the second seal mandrel such that the second sealing element reaches the second sealing diameter and such outward radial movement causes the outer surface of the second sealing element to engage and seal against a second sealing profile on the inner surface of the generally cylindrical member to thereby seal the annulus therebetween.

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Optionally the linkage is provided by one or more rods, or alternatively by a sleeve. Optionally the linkage is provided by another suitable means, rigid and/or hydraulic, which is capable of transferring linear (preferably in an axial direction) motion between the two sealing elements.

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Optionally the linkage may connect to a mandrel by e.g. hooking the linkage into, through or over a portion of the mandrel. Optionally the mandrel may hook into, through or over a portion of the linkage. Alternatively, the mandrel and linkage may be connected by a mechanical-type connection such as threading, joining, or another suitable connection.

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Optionally the sealing elements are expanded and/or contracted simultaneously. Optionally the sealing elements are expanded and/or contracted sequentially.

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Optionally at least one valve may be coupled to the seal system and therefore be included as part of the seal system when it is run into the tubing to be sealed, for

example an insert safety valve. Optionally the valve may be coupled to an end of the seal system, for example to the downhole end of the seal system when the seal system is used within a well.

5 In the event that an already deployed tubing-retrievable surface controlled subsurface safety valve fails, for example if the seals on the piston of the already deployed valve fail, the said insert safety valve may be used to take over safety valve operations/functions from the failed valve. Optionally the seal system isolates and seals off a section of the throughbore of the tubing to be sealed at a location
10 where the hydraulic fluid pathway of the subsurface safety valve has been punctured and it enters the throughbore of the tubing for bleed off. Optionally this reseals and reinstates the hydraulic pathway, redirecting it to the insert safety valve, typically via a sealed hydraulic fluid pathway, which optionally then allows hydraulic control of the insert safety valve.

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According to the present invention, there is further provided a method of sealing a tubing at two spaced apart locations, the method comprising the steps of running a dual-bore isolating seal system into a tubing, the system comprising a body having at least first and second sealing elements axially spaced apart on the body and
20 connected by at least one linkage; and transferring linear force between the at least first and second sealing elements to thereby change the first and second sealing elements between a first transit diameter to a second sealing diameter.

Accordingly, from another aspect there is provided a system for sealing at two
25 locations within tubing, piping or otherwise cylindrical environment which comprises one or more sealing element(s) at each location which are deliberately expanded and contracted between an undersized transit diameter and the final sealing diameter through the application of a linear force, translated between the two by a rigid linkage.

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The linkage may be provided by a number of push/pull rods.

Alternatively, the linkage is provided by a sleeve.

35 Alternatively, the linkage is provided by hydraulic means.

The activation of each sealing element may occur simultaneously at each location.

5 Alternatively, the activation of each sealing element occurs sequentially, as required by the application.

Typically, a seal or seals expand in diameter by the sliding of a mandrel of variable diameter underneath.

10 Typically, a seal or seals are recessed within a containing body during transit and can then be expanded to sealing diameter as desired.

The various aspects of the present invention can be practiced alone or in combination with one or more of the other aspects, as will be appreciated by those skilled in the relevant arts. The various aspects of the invention can optionally be provided in combination with one or more of the optional features of the other aspects of the invention. Also, optional features described in relation to one aspect can typically be combined alone or together with other features in different aspects of the invention. Any subject matter described in this specification can be combined with any other subject matter in the specification to form a novel combination.

Various aspects of the invention will now be described in detail with reference to the accompanying figures. Still other aspects, features and advantages of the present invention are readily apparent from the entire description thereof, including the figures, which illustrates a number of exemplary aspects and implementations. The invention is also capable of other and different examples and aspects and its several details can be modified in various respects, all without departing from the scope of the present invention. Accordingly, each example herein should be understood to have broad application and is meant to illustrate one possible way of carrying out the invention, without intending to suggest that the scope of this disclosure, including the claims, is limited to that example. Furthermore, the terminology and phraseology used herein is solely used for descriptive purposes and should not be construed as limiting in scope. Language such as "including", "comprising", "having", "containing" or "involving" and variations thereof, is intended to be broad and encompass the subject matter listed thereafter, equivalents and additional subject matter not recited

and is not intended to exclude other additives, components, integers or steps. Likewise, the term "comprising" is considered synonymous with the terms "including" or "containing" for applicable legal purposes. Thus, throughout the specification and claims unless the context requires otherwise, the word "comprise" or variations thereof such as "comprises" or "comprising" will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

Any discussion of documents, acts, materials, devices, articles and the like is included in the specification solely for the purpose of providing a context for the present invention. It is not suggested or represented that any or all of these matters formed part of the prior art base or were common general knowledge in the field relevant to the present invention.

In this disclosure, whenever a composition, an element or a group of elements is preceded with the transitional phrase "comprising", it is understood that we also contemplate the same composition, element or group of elements with transitional phrases "consisting essentially of", "consisting", "selected from the group of consisting of", "including" or "is" preceding the recitation of the composition, element or group of elements and vice versa. In this disclosure, the words "typically" or "optionally" are to be understood as being intended to indicate optional or non-essential features of the invention which are present in certain examples but which can be omitted in others without departing from the scope of the invention.

All numerical values in this disclosure are understood as being modified by "about". All singular forms of elements, or any other components described herein are understood to include plural forms thereof and vice versa. References to directional and positional descriptions such as upper and lower and directions e.g. "up", "down" etc. are to be interpreted by a skilled reader in the context of the examples described to refer to the orientation of features shown in the drawings and are not to be interpreted as limiting the invention to the literal interpretation of the term, but instead should be as understood by the skilled addressee. In particular, positional references in relation to the well such as "up" and similar terms will be interpreted to refer to a direction toward the point of entry of a borehole into the ground or the seabed and "down" and similar terms will be interpreted to refer to a direction away

from the point of entry, whether the well being referred to is a conventional vertical well or a deviated well.

BRIEF DESCRIPTION OF THE DRAWINGS

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The invention will now be described solely by way of example and with reference to the accompanying drawing in which:

Figure 1 shows a cross-section of an example of a cylindrical section having an upper seal bore and lower seal bore in which the seal system of Figure 2 may be deployed;

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Figure 2 shows an external view of a first embodiment of a seal system in accordance with the present invention with linkage connecting upper and lower mandrels, each with two sealing elements, which in use will be aligned with the upper and lower seal bore locations of a cylindrical section to be sealed (such as that of Figure 1);

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Figure 3 shows a section view of the seal system of Figure 2; allowing, in particular, the internal components of the seal system to be seen;

Fig. 4(a) shows a cross-sectional view of a tubing retrievable surface controlled subsurface safety valve which has failed and within which the second embodiment of dual-bore isolation seal system of Fig. 5(a) and the attached insert safety valve also shown in Fig. 5(a) may be deployed (but have not yet been deployed in Fig. 4(a));

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Fig. 4(b) is a more detailed view of the highlighted area DV4b of Fig. 4 (a), showing in more detail the inner side wall 152 of the downhole tool 115 having been punctured at location 154 in order to lock out the piston seals 160 and the piston 162 and thus the flapper safety valve 180 such that it is locked open;

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Fig. 5(a) shows an example of a second embodiment of a dual-bore isolation seal system 195 in accordance with the present invention with attached insert safety valve 200 having been deployed into the wellbore, run in down the production tubing and positioned within the downhole tool 115 containing the failed tubing retrievable safety valve 175 of Fig. 4(a);

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Fig. 5(b) is a more detailed view of the highlighted area DV5b of the second embodiment of dual-bore isolation seal system 195 of Fig. 5(a) showing the no-go ring 250 of the dual-bore isolation seal system 195 having just landed out on the no-go shoulder 130 of the downhole tool 115 and also shows that the first (upper)

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sealing elements 260 have been aligned with the upper seal bore 140 of the downhole tool 115;

Fig. 5(c) shows a more detailed view of highlighted area DV5c of the second (lower) set of sealing elements as having been aligned with the lower seal bore 100 of the downhole tool 115;

Fig. 6(a) shows the seal system 195 and attached insert safety valve 200 of Fig. 5(a) being locked and therefore secured within the downhole tool 115 containing the safety valve 175;

Fig. 6(b) is a more detailed view of highlighted area DV6b of the seal system 195 with attached inert safety valve 200 and particularly shows one of the lock keys or lock dogs 240 as having been moved radially outward into the landing nipple profile 120 in order to securely lock the seal system 195 to the downhole tool 115 containing the tubing retrievable safety valve 175 and therefore also the production tubing;

Fig. 6(c) shows a more detailed view of highlighted area DV6c of Fig. 6(a) showing the lower set of sealing elements 270 starting to be moved radially outwards;

Fig. 7(a) shows that further linear axial movement of the inner mandrel 215 downwards (with respect to the outer housing 210 of the seal system 195 from its position shown in Fig. 6(a)) has caused the upper 260 and lower 270 sealing elements of the seal system 195 of Fig. 5(a) being energised to create a seal against their respective seal bore 140, 100 on the inner surface of the downhole tool 115;

Fig. 7(b) shows a more detailed view of highlighted area DV7b of the seal system 195 of Fig. 7(a) showing the upper set of sealing elements 260 have been energised to create a seal against the upper seal bore 140 on the inner surface of the downhole tool 115;

Fig. 7(c) is a more detailed view of highlighted area DV7c of the seal system 195 of Fig. 7(a) and in particular shows the lower set of sealing elements 270 of the seal system 195 having been energised to create a seal against the lower seal bore on the inner surface of the downhole tool 115;

Fig. 8(a) shows pressurised hydraulic fluid supplied from the surface down hydraulic fluid control line 110 passing into a hydraulic chamber 150 of the safety valve 115 and on into the newly run in insert safety valve 200 in order to operate that newly run in insert safety valve 200 to keep it open so that production fluids can be

safely produced again up through the production tubing under the control of the operator;

Fig. 8(b) shows a more detailed view of the highlighted area DB8b of Fig. 8(a) and in more detail shows the path taken by the pressurised hydraulic fluid being supplied down hydraulic fluid control line 110 and passing into the hydraulic chamber 150 and then passing into the isolated region 155 from where it can then pass into hydraulic fluid chamber 201 and then into the newly run in insert safety valve 200;

Fig. 8(c) shows a more detailed view of the highlighted area DV8c of Fig. 8(a) showing in detail, the newly run in insert safety valve 200 being kept open by the supplied hydraulic fluid from the hydraulic fluid chamber 201 via the isolated region 155; and

Fig. 9 shows a third embodiment of a downhole seal system 495 in accordance with the present invention and which is similar to the seal system 195 of Fig. 5(a) but having two sets of three sealing elements (instead of two sets of two sealing elements) arranged to be capable of sealing against respective upper and lower seal bore locations in a production tubing, where the downhole seal system 495 of Fig. 9 is provided with a blank sub 600 at its lower end instead of an insert safety valve - the seal system 495 is intended to be run into the production tubing and operated to seal against the upper and lower seal bore locations in the production tubing to test the seal obtained and assuming a suitably good seal is obtained, the seal system 495 can be deactivated, pulled out of the production tubing and the blank seal sub 600 can be swapped out for an insert safety valve and the combination of the seal system 495 and the blank seal sub 600 can then be run into the production tubing and activated.

DETAILED DESCRIPTION OF EXAMPLES AND/OR EMBODIMENTS OF THE INVENTION

In Figure 1, cross-section of an example of a cylindrical section 99 such as the inner surface of a production tubing or other generally cylindrical member which requires to be sealed and, more particularly, three distinct areas of the cylindrical section 99 can be seen. These are the:-

- 1) uphole sealing location 1 which may be in the form of an upper seal bore 1 (which when the cylindrical section 99 is a section of production tubing is typically polished during manufacture to provide an enhanced inner surface against

which a seal can act once the tubing 99 has been run in and installed into a wellbore such as an oil and gas wellbore);

2) isolated region 2 (which is typically a region to be isolated from or sealed with respect to both the upper seal bore 1 and lower seal bore 3); and

5 3) downhole sealing location 3 which may be in the form of a lower seal bore 3 (which when the cylindrical section is a section of production tubing 99 is typically polished during manufacture to provide an enhanced inner surface against which a seal can act once the tubing 99 has been run in and installed into a wellbore such as an oil and gas wellbore).

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In operation, a first embodiment of a seal system 15 in accordance with the present invention and as shown in Figure 2 would be run in from surface in the direction from uphole sealing location in the form of the upper seal bore 1 to the downhole sealing location in the form of the lower seal bore 3 until the sealing elements 5UU, 5UL; 15 5LU, 5LL of the seal system 15 lie within the respective uphole 1 and downhole 3 locations. The system 15 could then be activated resulting in the isolated region 2 becoming cut off in terms of fluid not being able to flow from the rest of the locations 1 and 3 shown in Figure 2.

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In Figure 2, the exterior of an assembly making use of the proposed seal system 15 is shown. Each sealing element 5 comprises a suitable seal 5 such as an elastomeric o-ring seal 5 and two pairs of seals 5 are shown as being provided in the system 15, one upper pair (5UU, 5UL) to lie within the uphole sealing location 1 and the lower pair (5LU, 5LL) to lie within the downhole sealing location 3 once the system has been run into the wellbore and has been aligned with said uphole 1 and 25 downhole 3 locations. Both pairs of seals 5 are separated by a seal spacer ring 6 with another seal spacer ring positioned after the right hand seal 5 of each pair (as viewed in Figure 2). An upper seal sleeve 4U forms the housing around the uphole (left most) pair of seals 5UU, 5UL with variable bottom sub 7 positioned at the 30 downhole end of the second (lower) pair of seals 5LU, 5LL. The components around the seals 5 serve to contain them to prevent unwanted axial expansion of the seals 5 and to maintain the position of the seals 5 relative to one another and the main body and/or housing of the tool 15. The number of seals 5 and spacers 6 need not be as shown in Figure 2 so long as there is at least one seal 5 at each end of the region 2 35 to be isolated and they are unable to move axially relative to the housing of the tool

15 in which they are set; in the example shown in Figure 2 and Figure 3, the said housing is formed by the combination of seal sleeves 4 and bottom sub 7.

Figure 3 shows the section view in the direction of view as indicated in Figure 2.

5 Here, the internal workings required for the activation of the seals 5 can be seen, along with the proposed linkage between the two.

The tool 15 in general comprises an inner mandrel 13 surrounded by an outer housing 14.

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The inner mandrel 13 comprises from left to right in Figure 3 (which in use will be top to bottom when located in the well) a top sub 8 which is connected at its lower end to the upper end of an upper seal mandrel 9 which in turn is connected at its lower end to the upper end of a linkage component 10 which in turn is connected at its lower end to the upper end of a lower seal mandrel 11.

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The outer housing 14 comprises from left to right in Figure 3 comprises the upper seal sleeve 4U and which has butted against its lower end the upper seal 5UU of the upper pair of seals 5 and which is also butted against its lower end by the uppermost seal spacer ring 6UU of the upper pair of the same 6 and which has butted against its lower end the lower seal 5UL of the upper pair of seals 5. The lower end of the seal 5LU is also butted against by the lowermost seal spacer ring 6UL of the upper pair of the same 6. The lower end of the seal spacer ring 6UL is connected to the upper end of a lower seal sleeve 4U which in turn has butted against its lower end the upper face of the uppermost seal 5LU of the lowermost pair of seals. The lower face of the uppermost seal 5LU is butted against by the upper end of the uppermost seal spacer ring 6LU of the lower pair of the same 6 and which has butted against its lower end the upper face of the lower seal 5LL of the lower pair of seals 5. The lower face of the lower seal 5LL is butted up against the upper end of the lowermost seal spacer ring 6LL of the lower pair of the same 6 and which is connected at its lower end to the upper end of the variable bottom sub 7.

20

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The upper seal mandrel 9 comprises a pair of bands or grooves 16U, 16L of reduced outer diameter compared to the greater outer diameter 16G of the upper seal mandrel 9 either side of said grooves 16U, 16L. The outer diameter of the upper

35

seal mandrel 9 tapers smoothly at an angle at each end of each groove 16U, 16L outwards along a tapered surface 16T until it meets the greater outer diameter 16G of the majority of the rest of upper seal mandrel 9. The upper most seal 5UU is arranged, when the system 15 is being run in or transited into the well to be located
5 around the outer circumference of the upper seal mandrel 9 around the uppermost groove 16U of reduced outer diameter and the lower most seal 5UL is arranged, when the system 15 is being run in or transited into the well to be located around the outer circumference of the upper seal mandrel 9 around the lowermost groove 16L of reduced outer diameter.

10

Similarly, the lower seal mandrel 11 comprises a pair of bands or grooves 17U, 17L of reduced outer diameter compared to the greater outer diameter 17G of the majority of the rest of the lower seal mandrel 11 either side of said grooves 17U, 17L. The outer diameter of the lower seal mandrel 11 tapers smoothly at an angle at
15 each end of each groove 17U, 17L outwards along a tapered surface 17T until it meets the greater outer diameter 17G of the majority of the rest of lower seal mandrel 11. The uppermost seal 5LU is arranged, when the system 15 is being run in or transited into the well to be located around the outer circumference of the upper seal mandrel 9 around the uppermost groove 17U of reduced outer diameter and the
20 lower most seal 5LL is arranged, when the system 15 is being run in or transited into the well to be located around the outer circumference of the lower seal mandrel 11 around the lowermost groove 17L of reduced outer diameter.

25

The seal system 15 is typically run into a wellbore, through production tubing, on a string which also incorporates a conventional jarring tool (not shown) that can exert an axial force when actuated by the operator, where the axial linear force is applied to the uphole end of the tool 15 and which is transferred to the upper end of the inner mandrel 13 through the top sub 8 which is connected to the upper seal mandrel 9. This upper seal mandrel 9 is in turn connected to the linkage component 10 which
30 is likewise connected to the lower seal mandrel 11. None of these components of the inner mandrel 11 is constrained axially to the main outer housing 14 (comprising the upper seal sleeve 4 and the bottom sub 7 as shown here in Figure 3) and therefore the applied axial force would move inner mandrel 13 components 8, 9, 10 and 11 as one. The connections between each of these components 8, 9, 10 and 11
35 is shown to be a hooking of one around the next, however this may be achieved

through threading, joining or other mechanical type connection. The linkage component 10 may be one or more rods, a sleeve or other means rigid or hydraulic.

As this movement occurs, the seal mandrels 9 and 11 will move relative to the seals
5 5. In the position shown in Figure 3, the seals 5 are in their transition or running in
state with their outer diameter below the outer body profile of the system 15 as can
be seen in Figure 2. In other words, the outer diameter of the seals 5 is less than the
outer diameter of the outer housing 14 such that the seals 5 are protected within
their respective recesses within the outer housing 14 during the transit of running in
10 of the system 15. As the seal mandrels 9 and 11 move axially relative to the outer
housing 14, the seals 5 will be forced to expand because they will move up their
respective tapered surface 16T; 17T until they move up onto the respective greater
outer diameter 16G; 17G. This is the consequence of seal mandrels 9 and 11
moving relative to the seals 5, such that the band of greater diameter 16G; 17G is
15 encountered, expanding each of the seals 5, resulting in a greater outside diameter
thereof 5. This expansion results in the seals 5 resting in their final sealing diameter,
protruding past the outer diameter of the outer housing 14 and sealing against the
respective uphole sealing location / upper seal bore 1 and downhole sealing location
/ lower seal bore 3 in order to seal off the isolated region 2 as desired by the
20 operator.

In the system 15 as shown in Figure 3 both the uphole 5UU, 5UL and downhole 5LU,
5LL sets of seals would expand at the same time however the two sets 5UU, 5UL;
5LU, 5LL may be made to expand separately by changing the location on either seal
25 mandrel 9 or 11 at which the diameter of the mandrel changes at the respective
tapered surface 16T; 17T.

Fig. 5(a) shows a second and more preferred embodiment of a dual-bore isolation
seal system 195 in accordance with the present invention as having been run into a
30 wellbore on a string which may incorporate a conventional jarring tool (not shown),
and run in down the production tubing thereof and positioned within the downhole
tool 115 containing the failed tubing retrievable safety valve 175 of Fig. 4(a), where
the tubing retrievable safety valve 175 has (like that shown in Fig. 4(a)) had its inner
side wall 152 burst to create the puncture 154 from the through bore 95 into the
35 hydraulic chamber 150, such that the piston seals 160, piston 162 and thus the

flapper valve 180 are locked open. The seal system 195 and attached insert safety valve 200 have been run in as far as possible, such that a no-go ring 250 provided around the outer circumference of the lower end of an outer lock sleeve 220 (which forms part of the outer housing 210) lands on and therefore is prevented from moving any further downwards by a no-go shoulder 130 formed on the inner through bore of the downhole tool 115 and which projects slightly radially inwards into the through bore of the downhole tool 115. Accordingly, the outer housing 210 of the seal system 195 cannot move any further downwards within the downhole tool 115.

10 The outer housing 210 of the dual-bore isolation seal system 195 comprises from top to bottom as shown in Fig. 5(a) the following main components:-

- 5 i. an outer lock sleeve 220 which comprises apertures around its circumference through which the lock keys or lock dogs 240 can be moved radially outwardly there through and at the lower end of which is provided the no-go ring 250 around its outer circumference;
- 15 ii. upper seal sleeve 254;
- iii. the upper seal 260U which forms part of the upper set (i.e. pair) of sealing elements 260;
- iv. seal spacer ring 266;
- 20 v. the lower seal 260L which forms the other part of the upper set or pair of sealing elements 260;
- vi. seal spacer ring 267;
- vii. middle seal sleeve 274;
- viii. the upper seal 270U (which forms part of the lower set or pair of sealing elements 270);
- 25 ix. seal spacer ring 268;
- x. the lower seal 270L which forms the other part of the lower set or pair of sealing elements 270;
- xi. seal spacer ring 269; and
- 30 xii. variable bottom sub 277.

The lower end of the variable bottom sub 277 is connected to the upper end of the insert safety valve 200 via any suitable means such as screw threads, etc..

The inner mandrel 215 of the dual-bore isolation seal system 195 comprises from top to bottom as shown in Fig. 5(a) the following main components:-

- i. an inner lock body 300;
- ii. a ball sleeve 305 which has an aperture at the upper end thereof through its side wall in which is located a ball bearing 303;
- iii. connecting portion 309C;
- iv. upper seal mandrel 309 (where the upper seal mandrel 309 and the connecting portion 309C are preferably separate components in order to aid construction/assembly of the seal system 195 but which could in certain circumstances be formed from one integral component (not shown));
- v. linkage component 310; and
- vi. lower seal mandrel 311.

It should be noted that for running in/transit purposes, the inner mandrel 215 is initially secured to the outer housing 210 by means of a frangible component such as shear pin 213. Accordingly, when the dual-bore isolation seal system 195 is being run in through the production tubing, the inner mandrel 215 is locked to the outer housing 210. However, when the seal system 195 reaches the required location within the downhole tool 115 and the no-go ring 250 of the outer housing 210 lands upon the no-go shoulder 130 of the downhole tool 115, further downward linear force applied from the surface (typically via the jarring tool) to the inner mandrel 215 (by virtue of the inner mandrel 215 being connected to the jarring tool in the work string (not shown) via its inner lock body 300)) will act to shear the shear pin 213.

Further downward movement/linear force applied to the inner mandrel 215 (by for instance setting down weight at surface on the work string or more likely the jarring tool continuing to exert axial liner force to the lower portion of the workstring) and in particular the inner lock body 300 will continue to move the inner lock body 300 downwards and that downward movement results in the ball bearing 303 being pushed into the recess 221 formed in the inner surface of the outer lock sleeve 220 such that the inner lock body 300 continues to move downwards until its lower end meets a shoulder 304 which projects radially inwards toward the upper end of the ball sleeve 305. The inner lock body 300 at that point also has a recess 302 formed on its outer surface which allows the ball bearing 303 to move radially inwards into that recess 302. That movement of the ball bearing 303 allows the ball bearing 303

to move out of the recess 221 thus then permitting the ball sleeve 305 to start moving downwards with respect to the outer housing 210. The seal system 195 is now in the position shown in Figs. 6(a), 6(b) and 6(c).

5 Continued downward movement of the work string applies a linear force to the inner lock body 300 and thus the ball sleeve 305 and the rest of the inner mandrel 215 and thus the inner lock body 300, and in particular its tapered surface 300T, starts to move the lock key or lock dogs 240 radially outwards into the landing nipple profile 120 and in particular once the greater outer diameter section 300G of the inner lock
10 body 300 is moving underneath the inner circumferential surface of the lock dogs 240, the lock dogs are thus fully moved radially outwards into the landing nipple profile 120 and thus the outer housing 210 is locked in position with respect to the inner surface of the downhole tool 115.

15 Continued application of linear force in the downwards direction to the inner mandrel 215 moves the upper seal mandrel 309 and lower seal mandrel 311 downwards and thus, like the first embodiment of seal system 15 hereinbefore described, the respective sets of sealing elements 260, 270 are moved radially outwards from their respective reduced outer diameter grooves 316, 317 and are moved up their
20 respective tapered surface 316T, 317T until they move up onto the respective greater outer diameter 316G, 317G of their respective upper seal mandrel 309 and lower seal mandrel 311.

Accordingly, both the upper and the lower set of sealing elements 260, 270 have
25 been moved radially outwards and compressed and thus seal against their respective upper seal bore 140 and lower seal bore 100.

At this stage, it is important for the skilled person to note that the inner mandrel 215 axially moves down in an annulus between the inner surface of the outer
30 housing 210 and an outer surface of an inner most sealing tube 218 which extends from the upper end of the insert safety valve 200 upwards through the through bore 95. A hydraulic fluid chamber 201 is provided at the lowermost end of the annulus in the area defined between:-

- a) the inner surface of the outer housing 210;

- b) the outer surface of the inner most sealing tube 218;
- c) the upper end of the insert safety valve 200; and
- d) the lower end of the inner mandrel 215.

5 The hydraulic fluid chamber 201 (once the upper and lower sets of sealing elements 260, 270 have been energised/radially expanded against their respective sealing bores 140, 100) is in hydraulic fluid communication with the hydraulic chamber 150 by means of a hydraulic fluid pathway comprising:-

- i. the isolated region 155; and
- 10 ii. fluid access post(s) 275 formed through the side wall of the middle seal sleeve 274 (there are an upper set 275U of fluid access ports formed through the side wall of the middle seal sleeve 274 at a location just below the upper end thereof (and therefore just below the upper set of sealing elements 260) and a lower set of fluid access ports 275L located just above the lower end
- 15 of the middle seal sleeve 274 (and therefore just above the lower set of sealing elements 270); and
- iii. in the annulus around the outer surface of the linkage component 310 and the inner surface of the lower seal mandrel 311.

20 It should be noted that the aforementioned hydraulic fluid pathway is sealed at its upper and lower end by the following seals which together form a hydraulic fluid pathway sealing arrangement :-

- i. the outer and inner sealing surfaces of the upper set of sealing elements 260;
- 25 ii. one or more (two are provided) suitable seals such as o-ring seals 308U, 308L arranged to act between the inner most surface of the upper seal mandrel 309 and the outer most surface of the upper end of the inner most sealing tube 218;
- iii. the inner and outer sealing surfaces of the lower set of sealing
- 30 elements 270; and
- iv. a suitable seal such as an o-ring seal 312 provided on the outer surface of the lower most end of the lower seal mandrel 311 and which acts

against the inner most surface of the variable bottom sub 277 to seal the annulus therebetween.

5 Accordingly, by virtue of the said hydraulic fluid pathway sealing arrangement outlined above, the hydraulic fluid supply from the surface is directed without any leaks into the hydraulic fluid chamber 201 and can therefore act directly against the insert safety valve 200 to operate the same and therefore provide control over the production fluids to the operator again (by virtue of the newly run in and installed insert safety valve 200), without having to remove the failed tubing
10 retrievable surface controlled sub-surface safety valve. In other words, the integrity of a subsurface safety valve system can be reinstated.

Accordingly, the preferred embodiment of the dual-bore isolation seal system 195 has the great advantage that it can be run into the well bore, through the
15 production tubing with the sets of sealing elements 260, 270 being protected within their respective recesses within the outer housing 210 during the transit of running in of the seal system 195. However, the application of linear force by means of downward weight acting upon the inner mandrel 215 is transferred by the linkage component 310 via the upper 309 and lower 311 seal mandrels to
20 transfer that linear force to the upper set of sealing elements 260 and the lower set of sealing elements 270 to radially move the same and therefore energise and/or de-energise the said sealing elements 260, 270 between their transit (reduced) diameter and their actuated (greater) sealing diameter.

25 It can be common for the seal bores within a tubing retrievable safety valve to become damaged over time due to frequent well intervention operations through said safety valve. In view of this problem, a third embodiment of a preferred dual-bore isolation seal system 495 has been developed and is shown in Fig. 9 in the running in or in transit configuration (i.e. before the sets of sealing elements
30 560, 570 have been energised). The third embodiment of seal system 495 is very similar to the second embodiment of seal system 195 and all identical or very similar components thereto are denoted with the same reference number but with the addition of 300 thereto.

Therefore, only the differences between the second embodiment 195 and third embodiment 495 of seal system will be detailed herein below.

5 The main difference in the third embodiment of seal system 495 is that it now comprises three seals in each set of upper sealing elements 560 and lower sealing elements 570. Specifically, there is, in addition to the two sealing elements of the second embodiment, there is now a third seal 560M provided in the middle of the upper seal 560U and the lower seal 560L and therefore there is
10 consequently an additional middle seal spacer ring 566M located in between the middle seal 560M and the lower seal 560L. The third embodiment of seal system 495 is preferred over the second embodiment 195, particularly where it is intended to be used in a production tubing (not shown) that is potentially damaged and therefore the additional middle seals 560M, 570M increase the
15 likelihood of obtaining a good seal when the two sets of sealing elements 560, 570 are energised to seal against the potentially damaged upper seal bore and/or lower seal bore.

In addition, the third embodiment 495 of sealing system shown in Fig. 9 has a
20 blank sub 500 attached to the lower end of its outer housing 510 instead of an insert safety valve. This dual-bore isolation seal system 495 and blank sub 500 combination will likely be used by an operator to test the integrity of both the upper and lower seal bores to ascertain if a good seal can be achieved when the upper 560 and lower 570 sets of sealing elements are energised. If a good seal
25 is achieved in the said test, then the upper 560 and lower 570 sets of sealing elements are de-energised and the seal system 495 and blank sub 500 are pulled out of the well, the blank sub 500 can be removed and after redressing of the seal system 495, a new insert safety valve such as that hereinbefore described with reference numeral 200 can be attached to the lower end of the
30 seal system 495 and both can be run in in the knowledge that a good seal will be achieved.

This has the advantage that the upper and lower seal bore can be tested with an easily redressable seal system 495, whereas it is very difficult to redress an insert safety valve 200 if it is run in and a good seal isn't obtained (i.e. without first having conducted a test and the seal with the upper and lower seal bores is not a good seal after activation of the seal system 195). Moreover, an insert safety valve 195 can typically only be redressed onshore and thus use of the seal system 495 and blank sub 500 is likely to significantly reduce expensive wasted rig time. Accordingly, by installing a dual bore isolation seal straddle system 495 in the configuration illustrated in Fig. 9, the integrity of both the upper 140 and the lower 100 seal bores can be tested and determined, prior to the installation of an insert safety valve 200.

The skilled person will appreciate that once the upper set 560 and lower set 570 of sealing elements have been energised, hydraulic fluid can be supplied from the surface and will collect in the hydraulic fluid chamber 501 but cannot continue to flow further down the blank sub 500 and thus the operator will know at the surface whether they hydraulic fluid pressure is maintained, in which case if it is then the operator knows that a good seal has been achieved against the upper and lower seal bores. On the other hand, if the hydraulic fluid pressure is not maintained at the surface then the operator will know that the hydraulic fluid is escaping past either or both of the upper or lower seal bores.

Otherwise, the seal system 495 of Figure 9 has all of the advantages afforded by the second embodiment of seal system 195.

Modifications and improvements may be made to the embodiments hereinbefore described without departing from the scope of the invention.

30

CLAIMS

1. A dual isolation bore seal system for sealing at two locations within a generally cylindrical member, the system comprising:-

5 a body having at least first and second sealing elements for sealing at the said two locations, the at least first and second sealing elements being axially spaced apart on the body and connected by at least one linkage,

10 wherein the linkage is configured to transfer linear force between the at least first and second sealing elements to energise and/or de-energise the said sealing elements between a first transit diameter and a second sealing diameter.

2. A dual isolation bore seal system according to claim 1, wherein the linkage is configured to transfer linear force in a longitudinal axial direction between the at least first and second sealing elements.

15

3. A dual isolation bore seal system according to either of claims 1 or 2, wherein the body of the system comprises at least two seal mandrels, axially spaced apart from one another and wherein each sealing element is held within a reduced diameter portion provided around the outer circumference of the respective seal mandrel during running-in of the seal system into the bore of the generally cylindrical member to be sealed and wherein the first transit diameter of the sealing elements is smaller than the second sealing diameter of the sealing elements.

20

4. A dual isolation bore seal system according to any preceding claim, wherein the linkage is configured to transfer linear force in an axial direction between the at least first and second sealing elements to energise and/or de-energise the said sealing elements between a first transit diameter and a second sealing diameter by radially increasing both the inner and outer diameters of the said first and second sealing elements.

30

5. A dual isolation bore seal system according to any preceding claim, wherein the body of the seal system comprises an inner mandrel with a throughbore, the inner mandrel being disposed within an outer housing and wherein the inner mandrel and outer housing are co-axially arranged.

35

6. A dual isolation bore seal system according to claim 5, wherein the inner mandrel is fixed to the housing by at least one frangible member, such that the inner mandrel is selectively restrained from moving in a linear axial direction relative to the housing.

5

7. A dual isolation bore seal system according to claim 5 when dependent upon claim 3, wherein the linkage forms part of the inner mandrel along with an upper seal mandrel and a lower seal mandrel and wherein the first sealing element is located around the outer circumference of the first seal mandrel and the second seal element is located around the outer circumference of the second seal mandrel and wherein the upper and lower seal mandrels are connected by the linkage.

10

8. A dual isolation bore seal system according to any of claims 5 to 7, wherein the housing comprises at least one locking member contained within an aperture in the housing, wherein the at least one locking member is radially movable relative to the housing, and wherein the generally cylindrical member to be sealed comprises one or more recessed profiles on its inner surface against which or into which a respective locking member can be moved radially outwards and placed into contact in order to lock there against.

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9. A dual isolation bore seal system according to any of claims 5 to 8, wherein after the seal system is in position within the generally cylindrical member to be sealed, and when sealing is required, the inner mandrel is moveable by means of a linear force being applied thereto in order to break the frangible member holding the inner mandrel to the housing of the system, thereby permitting movement of the inner mandrel relative to the housing in a longitudinal axial direction.

25

10. A dual isolation bore seal system according to claim 7 or to either of claims 8 or 9 when dependent upon claim 7, wherein the outer surface of both of the upper and lower seal mandrels comprise one or more changes in outer diameter, comprising at least one relatively smaller diameter portion and one relatively larger diameter portion and also comprising a tapering diameter portion leading therebetween.

30

11. A dual isolation bore seal system according to claim 10, wherein in use when the linkage is transferring linear force in an axial direction, the inner mandrel moves relative to the housing in an axial direction, and the tapering diameter portion of the respective seal mandrel engages an inner surface of the respective sealing element,
5 and further axial movement of the inner mandrel relative to the outer housing causes the tapering outer diameter portion to continue to expand the sealing element radially outwards, and causes the sealing element to move radially outwards onto the relatively larger diameter portion of the respective seal mandrel such that the sealing element reaches the second sealing diameter and such outward radial movement
10 causes the outer surface of the sealing element to engage and seal against a sealing profile on the inner surface of the generally cylindrical member to thereby seal the annulus therebetween.

12. A dual isolation bore seal system according to claim 8 or to either of claims 8
15 to 10 when dependent upon claim 8, wherein the inner mandrel further comprises at least a first locking portion having an increased outer diameter such that, in use, as the inner mandrel moves relative to the outer housing in an axial direction, the said first locking portion is adapted to engage an inner surface of the at least one locking member, wherein in use, the said engagement and further axial movement of the
20 inner mandrel relative to the outer housing causes the at least one locking member to extend radially outwards, and such outward movement causes the outer surface of the at least one locking member to engage the at least one profiled area on the inner surface of the generally cylindrical member to thereby lock the outer housing in position.

25
13. A dual isolation bore seal system according to any preceding claim, wherein the linkage is provided by one or more rods.

14. A dual isolation bore seal system according to any of claims 1 to 12, wherein
30 the linkage is provided by a sleeve.

15. A dual isolation bore seal system according to any of claims 1 to 12, wherein the linkage is provided by a hydraulic means capable of transferring linear motion between the two sealing elements.

35

16. A dual isolation bore seal system according to any preceding claim, wherein the sealing elements are expanded and/or contracted simultaneously.

5 17. A dual isolation bore seal system according to any of claims 1 to 15, wherein the sealing elements are expanded and/or contracted sequentially.

10 18. A dual isolation bore seal system according to any preceding claim, wherein at least one insert safety valve is coupled to the seal system and is also run in with the seal system into the tubing to be sealed, wherein the valve is coupled to a lower in use end of the seal system.

15 19. A dual isolation bore seal system according to claim 18, wherein In the event that an already deployed tubing-retrievable surface controlled subsurface safety valve fails, the said insert safety valve is adapted to take over safety valve operations/functions from the failed valve.

20 20. A dual isolation bore seal system according to claim 19, wherein the seal system is adapted to isolate and seal off a section of the throughbore of the tubing to be sealed at a location where a hydraulic fluid pathway of the subsurface safety valve has been punctured and it enters the throughbore of the tubing for bleed off, and the seal system reseals and reinstates the hydraulic pathway, redirecting it to the insert safety valve, via a sealed hydraulic fluid pathway, which allows hydraulic control of the insert safety valve.

25 21. A method of sealing a tubing at two spaced apart locations, the method comprising the steps of running a dual-bore isolating seal system into a tubing, the system comprising a body having at least first and second sealing elements axially spaced apart on the body and connected by at least one linkage; and transferring linear force between the at least first and second sealing elements to thereby change
30 the first and second sealing elements between a first transit diameter to a second sealing diameter.

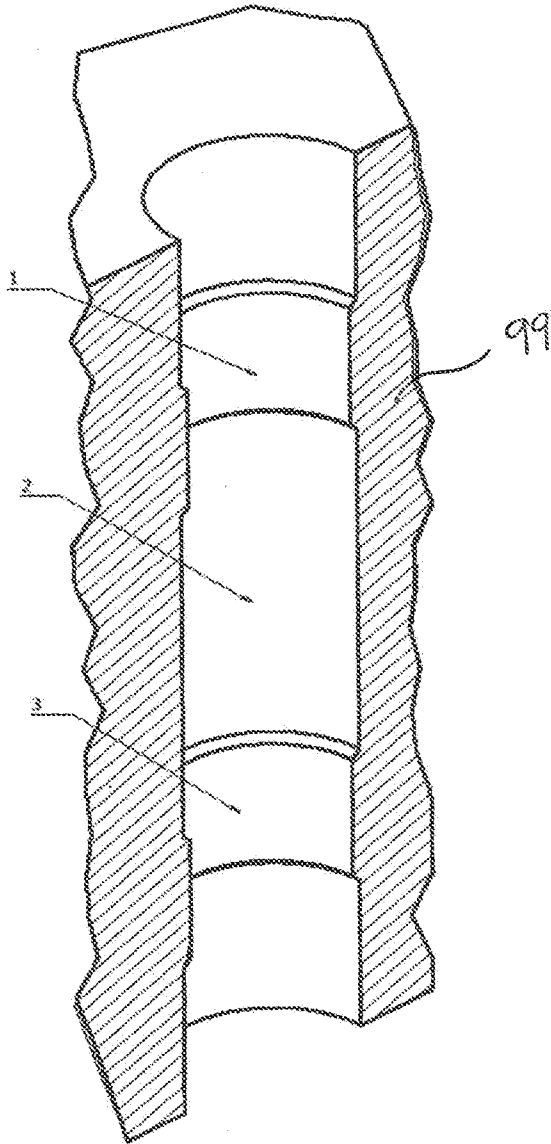


Figure 1

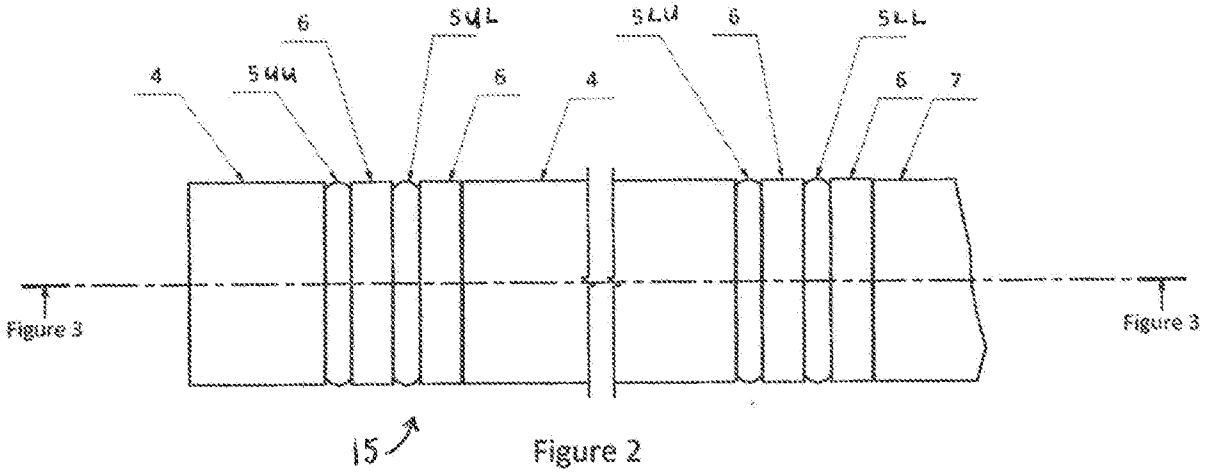


Figure 2

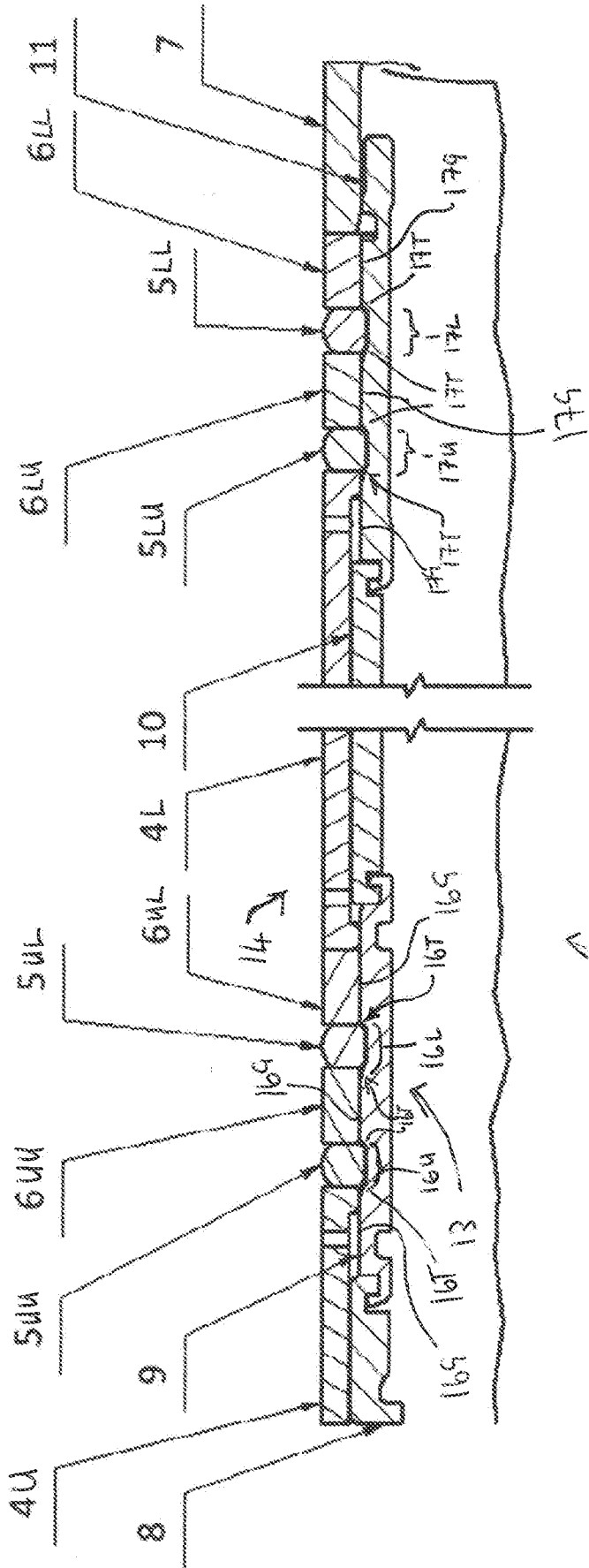


Figure 3

115 ~>

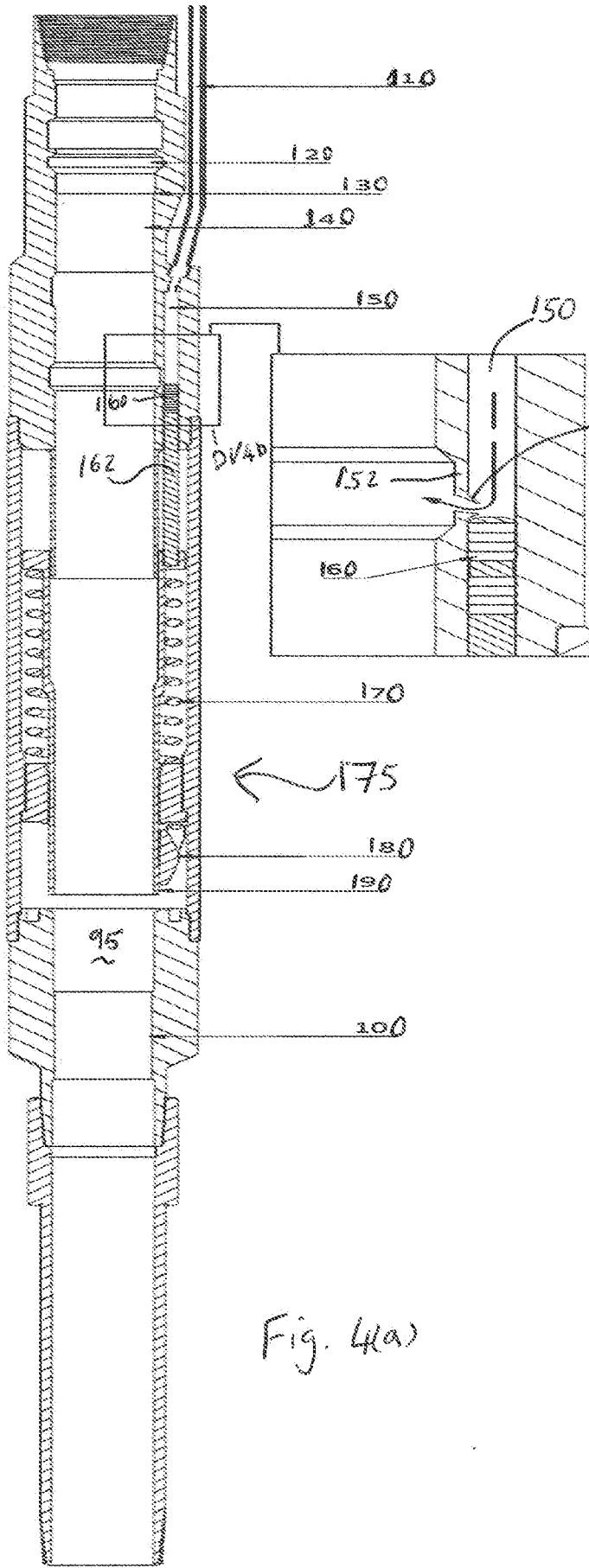
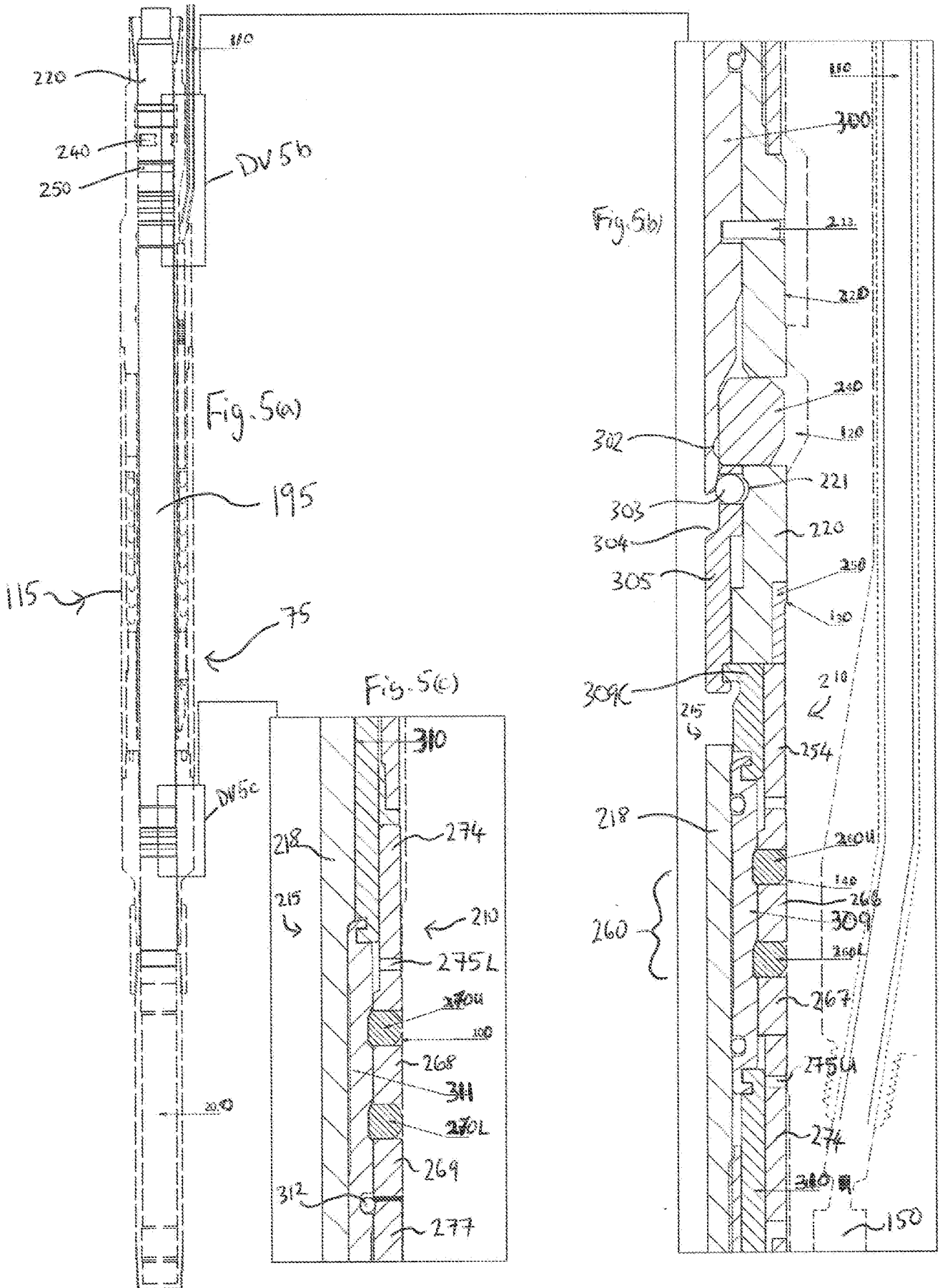
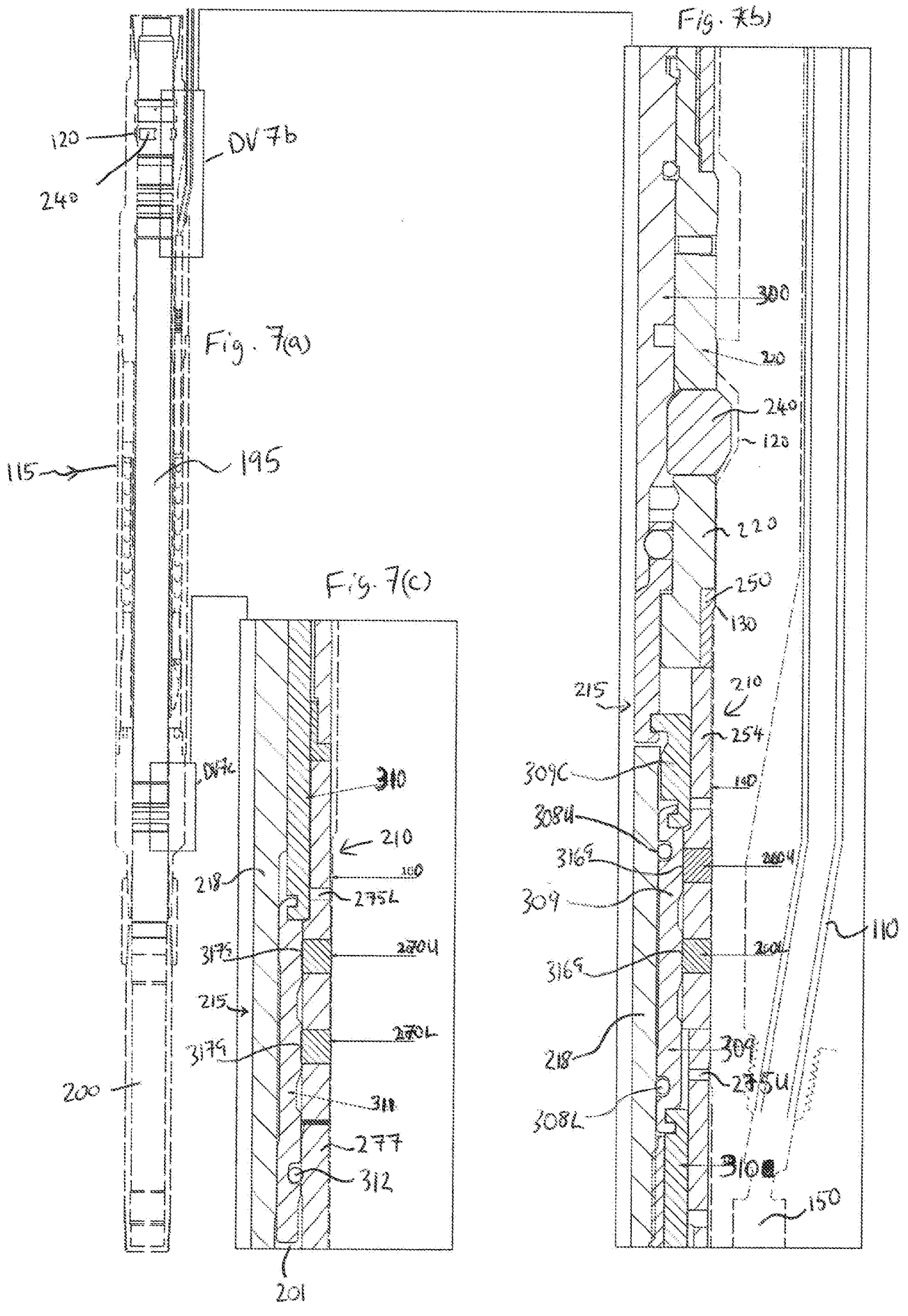
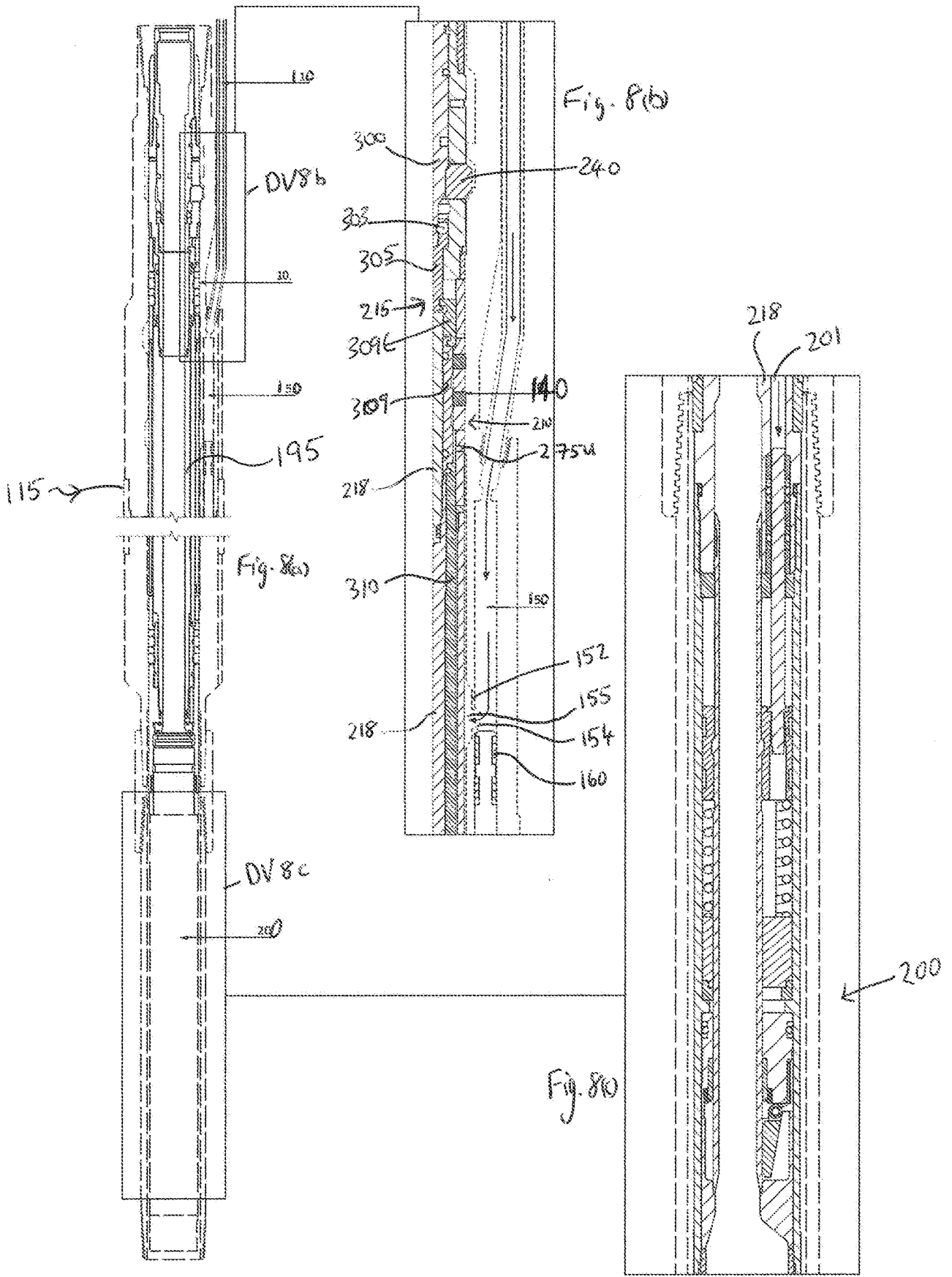


Fig. 4(b)

Fig. 4(a)







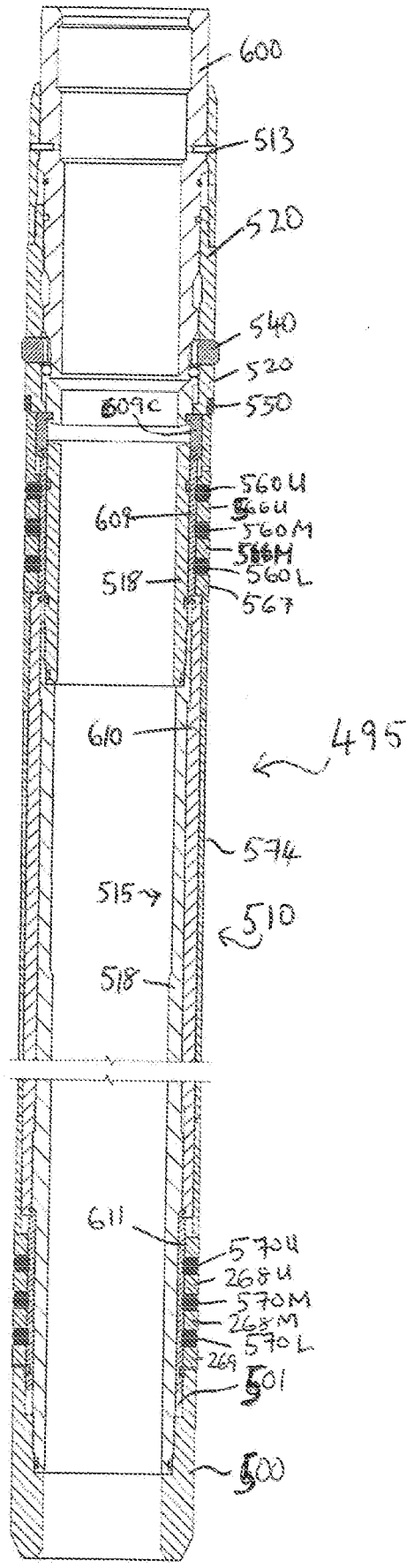


Fig. 9