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[Continued on next page]

**(54) Title:** PACKER ASSEMBLY WITH PRESSURE DIVIDING MECHANISM

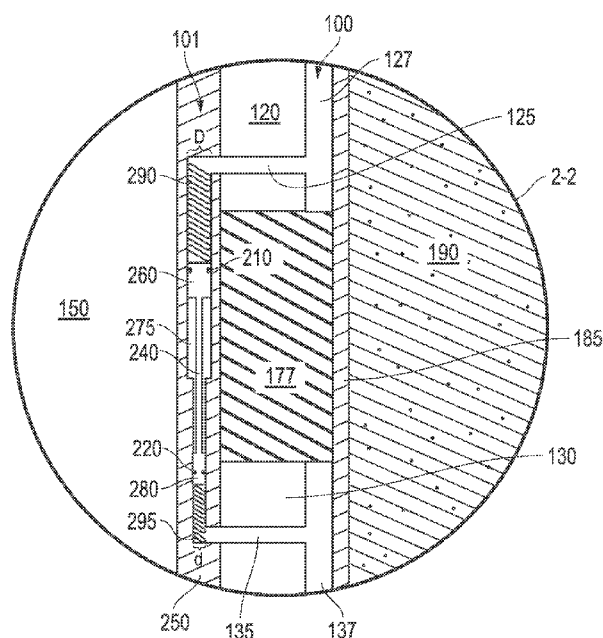


FIG. 2

**(57) Abstract:** A packer assembly of enhanced pressure rating. The assembly includes a pressure dividing mechanism in communication with a middle annular space which is defined between separate seal elements of the assembly once set in a well. The pressure dividing mechanism is also in simultaneous communication with a higher pressure annular space at the opposite side of one of the seal elements. Thus, pressure regulation of the middle annular space to a level below and based on the higher pressure is passively or responsively attainable.



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## **PACKER ASSEMBLY WITH PRESSURE DIVIDING MECHANISM**

### **BACKGROUND**

[0001] Exploring, drilling and completing hydrocarbon and other wells are generally complicated, time consuming, and ultimately very expensive endeavors. As a result, over the years, a significant amount of added emphasis has been placed on well monitoring and maintenance. By the same token, perhaps even more emphasis has been directed at initial well architecture and design. All in all, careful attention to design, monitoring and maintenance may help maximize production and extend well life. Thus, a substantial return on the investment in the completed well may be better ensured.

[0002] In the case of well design, architecture and subsequent maintenance, there is often the need to isolate high pressure regions of the well with a packer assembly. For example, isolation for the sake of targeted production from a particular region of a well is quite common. However, as well depths continue to become greater and greater, so do well pressures. Thus, the likelihood exists that the well may exceed 20,000 feet in depth, for example, with an architecture targeting an isolated region for production that exceeds 10,000-15,000 PSI.

[0003] Of course, a host of interventional applications may also be undertaken which have the effect of introducing such dramatically high pressures as well. For example, perforations may be formed into the wall of the well at a given location by way of a perforating application which involves isolating the location with a packer assembly. Thus, the packer assembly is subjected to such high pressures introduced by way of the adjacent explosive perforating application.

**[0004]** The ability of a packer assembly to maintain isolation in a well in the face of such pressures is dependent on a host of factors. For example, temperature extremes, say those exceeding 350°F or more, which are more common in wells of greater depths, may reduce the practical pressure rating of a given assembly. Similarly, a greater extrusion gap, which is more common as wells continue to become of greater architectural complexity, may reduce the pressure rating that is practical for a given assembly.

**[0005]** In terms of the extrusion gap, each packer assembly is equipped with one or more seal elements of an initial profile that is smaller than the diameter of the well. Once the packer assembly is positioned downhole in the well at the location to be isolated, the seal elements are expanded into engagement with a wall of the well in order to achieve the isolation. The initial clearance or gap between the surrounding architecture of each seal element in its unexpanded state and the inner diameter of the well is known as the extrusion gap. In some cases, the extrusion gap may be as little as 0.001 inches. However, in other circumstances, the well diameter at the location for isolating may be a full 0.25 - 0.50 inches or more larger than the initial unexpanded diameter of the seal element and surrounding architecture. As noted above, the larger the extrusion gap for the seal elements, the lower the pressure rating for a given assembly. Once more, in wells of more complex architecture, the odds of a greater extrusion gap are increased due to the need for the seal elements to remain of a profile that is smaller than the smallest architectural obstruction that is to be passed before reaching the location for isolation.

**[0006]** Unfortunately, given the greater depths and architectural complexities of more modern wells, the ability to provide an off-the-shelf packer assembly effectively pressure rated to an operator's needs is becoming ever more challenging. Indeed,

achieving an off-the-shelf packer assembly rating of greater than 15,000 PSI may be impractical.

[0007] Efforts to enhance pressure ratings for packer assemblies in light of more modern downhole well environments have been undertaken. For example, as opposed to relying on more conventional off-the-shelf packer assemblies, assemblies may be constructed, tailored and/or modified to suit the targeted isolation at hand. This may include a packer deployment and setting that adds the components of deformable backup or fold-back rings or other features that aid in maintaining the isolation. In this manner, pressures in excess of 15,000 PSI may be reliably held.

[0008] Unfortunately, such measures may add complexity and expense to the operation. For example, rather than an off-the-shelf, perhaps even re-usable packer assembly, the packer assembly utilized may be a single use device that requires added time and effort devoted to an individually dedicated and tailored design. Thus, not only is added expense found in terms of deployment or subsequent removal, but a significant amount of expense is added in terms of the required individual time devoted to a single use packer assembly's design and construction.

### **SUMMARY**

[0009] A packer assembly is provided with first and second seal elements for providing isolation at a well. The elements define a middle annular space therebetween upon installation in the well. The assembly further includes a pressure dividing mechanism that is in communication with the middle annular space and also in communication with another annular space at one side of one of the seal elements. The pressure dividing mechanism is configured for regulating pressure in the middle annular space to a level below and based on a higher pressure in the other annular space thereby enhancing a pressure rating of the packer assembly.

### **BRIEF DESCRIPTION OF THE DRAWINGS**

[0010] Fig. 1 is a sectional view of an embodiment of a packer assembly in a well and employing a pressure dividing mechanism.

[0011] Fig. 2 is an enlarged sectional view of the pressure dividing mechanism of Fig. 1.

[0012] Fig. 3 is an overview of an oilfield with a well accommodating the packer assembly of Fig. 1 therein.

[0013] Fig. 4A is a side sectional view of a packer assembly employing another embodiment of a pressure dividing mechanism.

[0014] Fig. 4B is a side sectional view of a packer assembly employing another embodiment of a pressure dividing mechanism.

[0015] Fig. 5 is a flow-chart summarizing an embodiment of installing and utilizing a packer assembly in a well with a pressure dividing mechanism.

### **DETAILED DESCRIPTION**

[0016] Embodiments herein are described with reference to certain downhole applications. For example, downhole hardware that includes production tubing directed at a high pressure hydrocarbon reservoir. However, a variety of different types of packer assemblies may take advantage of embodiments as detailed herein. For example, mechanical packers and/or those utilized in stimulating, perforating or any number of fluid isolating applications whether temporary or otherwise may take advantage of embodiments as detailed herein. Indeed, along these lines, the term “packer assembly” as utilized herein is meant to refer to any number of device types, including packers, plugs or any other wellbore isolating device. So long as the isolating assembly includes an embodiment of a pressure dividing mechanism as detailed herein, the assembly may realize appreciable benefit in terms of overall pressure rating.

[0017] Referring now to Fig. 1, a sectional view of an embodiment of a packer assembly 100 is shown in a well 180. The assembly 100 is equipped with a pressure dividing mechanism 101 that is configured to regulate or divide pressure between multiple seal elements 175, 177. That is, rather than rely on a single seal element, the packer assembly 100 is outfitted with multiple elements 175, 177 which define a middle annular space 127 therebetween when the assembly 100 is set in the well 180. As detailed below, the pressure dividing mechanism 101 is in communication with the middle annular space 127 through a middle channel 125 of a seal spacer 120. Simultaneously, the mechanism 101 is also in communication with another, higher pressure, annular space 137 via a lower channel 135 running through a lower ring structure 130. As such, the pressure dividing mechanism 101 may be configured to regulate pressure at in the middle annular space 127 so as to minimize the differential imparted on the lower seal 177 (and even the upper seal 175). Ultimately, this may enhance the pressure rating of the entire packer assembly 100. That is, the working limit of either seal element 175, 177 is less likely reached where the pressure differential imparted on the elements 175, 177 is divided.

[0018] Continuing with reference to Fig. 1, the packer assembly 100 is provided to isolate and anchor production tubing 150 at a location downhole in the well 180 that may be of an extensive depth and pressure. For example, as shown, the well 180 may be lined with casing 185 to 20,000 feet or more in depth, and traversing various formation layers 190, 195 before reaching a high pressure annular space 137. This space 137 in turn may be adjacent a production region of the well 180 from which hydrocarbons may be drawn by the tubing 150. Given the depths involved in this example scenario, it would not be uncommon for the annular space 137 to reach 15,000 PSI.

[0019] While the high pressure annular space 137 may be quite high in pressure as indicated, the annular space 115 above the packer assembly 100 may be no more than 1,000 PSI or some other comparatively lower level more on par with surface pressures. That is, the isolation provided by the packer assembly 100 may maintain the dramatically higher pressure within the more downhole higher pressure space 137. Of course, in this particular example, this means that the assembly 100 utilized should be rated as able to withstand such pressure differentials.

[0020] As alluded to above, in order to enhance the pressure rating of the packer assembly 100, it is outfitted with multiple seals 175, 177, neither of which is forced to absorb the full impact of the high pressure annular space 137. Instead, a middle annular space 127 is formed through which an intermediate pressure is regulated and maintained. For example, in the embodiment shown, the pressure dividing mechanism 101 may be utilized to regulate a pressure of about 8,000 PSI in the middle annular space 127. Thus, rather than facing a pressure differential of 14-15,000 PSI, the lower seal element 177 is relied upon to hold no more than about 7,000 PSI (i.e. the differential between the 15,000 PSI in the high pressure space 137 and the 8,000 PSI in the middle annular space 127).

[0021] Similarly, continuing with the described example, the upper seal element 175 is also only relied upon to hold about 7,000 PSI (i.e. again, the differential between the middle annular space PSI of 8,000 and the 1,000 PSI in the upper annular space 115). Ultimately, this means that rather than a monolithic packer assembly that is forced to withstand pressures of 14-15,000 PSI alone, one may be provided in which the pressure is divided or shared among multiple seal elements 175, 177 as shown in Fig. 1. In the embodiment shown, this is achieved with a middle annular space 127 having a pressure regulated at about halfway between the pressures in the other annular spaces 115, 137 at the opposite sides of the seal elements 175, 177. Thus, even if each

seal element 175, 177 were individually rated at no more than about 7,500 PSI, the packer assembly 100 may nevertheless be doubled to a rating of about 15,000 PSI due to the pressure dividing that is afforded by the pressure dividing mechanism 101.

[0022] As indicated above, the pressure dividing mechanism 101 provides a way in which fluid pressure in the annular space 127 is regulated to minimize the overall differential on each element 175, 177 as noted. However, in other embodiments, the pressure in the middle annular space 127 may be imparted through non-fluid means. For example, in one embodiment pressure in the form of spring or other mechanical force type may be imparted on the adjacent elements 175, 177 as regulated by a piston in fluid communication with the adjacent annular spaces 127, 137. In yet another embodiment, the middle annular space 127 is occupied by a spring without intervening piston regulation. For example, one end of the spring may be against the lower element 177 with its other end accommodated at an upset shoulder on the outer diameter of the tubing 150. Thus, maintaining pressure in the middle annular space 127 may take place at a fraction of the high pressure annular space 137 by transmitting into the tubing 150 a portion of the force from pressure on the other side of the lower element 177.

[0023] Referring now to Fig. 2, the manner by which an embodiment of the pressure dividing mechanism 101 of Fig. 1 may be utilized to divide or share the pressure as noted above is shown. Specifically, an enlarged sectional view of the pressure dividing mechanism 101 is shown within a wall housing 250 of the production tubing 150. In this view, the inner workings of the mechanism 101 are shown adjacent the lower seal element 177 of the packer assembly 100. Thus, the dividing mechanism 101 may be oriented for simultaneous communication with both the middle annular space 127 and the higher pressure annular space 137. Indeed, along these lines, the pressure dividing mechanism 101 is in communication with the middle annular space 127 through the middle channel 125 and with the higher pressure space 137 through the

lower channel 135. Having this simultaneous communication with each annular space 127, 137 provides the pressure dividing mechanism 101 with the opportunity to regulate or divide pressure therebetween as noted above.

[0024] Continuing with reference to Fig. 2, in the embodiment shown, the sharing of the pressure between the annular spaces 127, 137 is achieved through a pressure multiplier 240 of the dividing mechanism 101. As shown, the multiplier 240 is outfitted with pistons 260, 280 that are oriented to fluidly communicate with the channels 125, 135. Specifically, a larger piston 260 is oriented to communicate with the middle channel 125 whereas, a smaller piston 280 is oriented to communicate with the higher pressure, lower channel 135. In this way, high pressure on the lower and smaller piston 280 may result in its upward movement to compress the volume in the middle annulus 127 via the upper larger piston 260. However, due to the larger area of the larger upper piston 260 as compared to the lower piston 280, an equilibrium may be reached and the position of the multiplier 240 stabilized with pressure in the middle annulus 127 being at a predetermined amount less than the pressure in the lower annulus 137. That is, keeping in mind that the force applied at either piston 260, 280 is equal to the pressure multiplied by the interfacing area of the pistons 260, 280, an equilibrium will be reached where the larger piston (260) has less pressure applied thereto.

[0025] The pressure multiplier 240 and its pistons 260, 280 may be biased by appropriately sized return springs 290, 295 as shown to aid in smoothly attaining a position as the pressure in the middle annular space 127 reaches its equilibrium relative the lower annular space 137. Of course, the position of the pressure multiplier 240 may adjust as the higher pressure in the lower annular space 137 fluctuates, thereby appropriately adjusting the pressure in the middle annular space 127. Thus, the

dividing of pressure continues in a way that continues to enhance the overall differential pressure rating of the packer assembly 100.

[0026] Continuing with reference to the inner workings of the pressure dividing mechanism 101, the above noted positional adjustment of the pressure multiplier 240 takes place relative a middle chamber 275 between the pistons 260, 280. Due to the depicted orientation, with adjacent channels accommodating differently sized pistons 260, 280, the volume of this middle chamber 275 may change as pressure in the middle annular space 127 is regulated. Thus, in one embodiment, in order to prevent any pressure impact on the ability of the multiplier 240 or pistons 260, 280 to move position for this regulation, a port is provided to this chamber 275 from a more atmospheric pressure location such as the upper annulus 115 as shown in Fig. 1.

[0027] In the example described herein, a roughly half-divided pressure situation may be achieved with the middle annular space 127 at about 8,000 PSI and 7,000 PSI higher in the lower annular space 137 (and 7,000 PSI lower in the upper annular space 115 (see Fig. 1)). Thus, with force equal to pressure multiplied by area, practical dimensions of the pressure dividing mechanism 101 and pistons 260, 280 may be set. For example, the larger upper piston 260 may be sealed by rings 210 within a channel having a diameter (D) of between about 0.25 inches and about 0.525 inches. Specifically, in one embodiment, this diameter (D) may be about 0.35 inches. By contrast, the smaller lower piston 280 may be sealed by rings 220 within a channel having a diameter (d) of between about 0.1875 inches and about 0.375 inches. Specifically, in one embodiment, this diameter (d) may be about 0.25 inches.

[0028] Of course, the pressure dividing mechanism 101 may employ a variety of other different specific dimensions. For example, factors may be involved such as the overall dimensions of the packer assembly 100, the degree of pressure dividing that is to take place, and/or the amount of the total pressure differential facing the assembly

100. By the same token, however, the packer assembly 100 may be relatively off-the-shelf in nature. That is, once the size of the assembly 100 is determined based on well dimensions and the pressure differential for the well 180 is known, the operator need only select the suitably sized and pressure rated assembly 100 for the downhole operations at hand.

[0029] Referring now to Fig. 3, an overview of an oilfield 300 is shown with a well 180 accommodating the packer assembly 100 of Figs. 1 and 2 therein. Indeed, Fig. 1 detailed above, is an enlarged view of the assembly 100 and surrounding environment taken from 1-1 of Fig. 3. Conventional surface equipment 325 is shown such as a well head 375 with a production line 360 emerging therefrom for diverting fluid uptake from the well 180 via the production tubing 150. A rig 350 is also shown for supporting any number of well completions or interventional applications. More specifically though, with reference to this larger overview of Fig. 3, the benefit of utilizing a packer assembly 100 with a pressure dividing mechanism 101 may be more fully appreciated.

[0030] In Fig. 3, the well 180 is shown defined by a casing 185 traversing various formation layers 190, 195 before reaching a production region 390. As the well 180 transitions into this region 390, it may be open or uncased with perforations 395 extending from the main bore and into the surrounding formation 195. Thus, hydrocarbon recovery from this portion of the formation 195 may be encouraged. While not necessarily shown to scale in Fig. 3, it would not be uncommon for such a well 180 today to extend 20,000 feet or more with pressures in the lower annulus 137 being in excess of 10,000 – 15,000 PSI. Accordingly, for sake of controlling fluid uptake through the production tubing 150, a packer assembly 100 may be utilized that is rated to withstand such pressures where possible.

[0031] Fortunately, as detailed hereinabove, embodiments of a packer assembly 100 which introduce an isolated middle annular space 127 and incorporate a pressure

dividing mechanism 101, may be reliably rated for operation at such pressures. This is due to the fact that neither seal element 175, 177 is forced to take on the full effect of the dramatic pressure differential presented by the high pressure lower annular space 137. Instead, the effect is more manageably divided among the seal elements 175, 177.

**[0032]** Indeed, where desirable any practical number of additional seal elements may be added to the assembly to further divide pressure and reduce the individual pressure rating required of any given element. Stated another way, an array of two, three, or any practical number of additional seal elements 175, 177 may be utilized which, in cooperation with pressure dividing mechanism(s) 101, are capable of cascading pressure into middle annular spaces 127 along the assembly 100. Thus, the overall pressure rating of the assembly 100 as a whole may be dramatically enhanced. Further, along these same lines, two, three or more entire packer assemblies 100 may also be utilized in the same well and attain similar pressure dividing advantages.

**[0033]** Referring now to Fig. 4A, a side sectional view of the packer assembly 100 is shown employing another embodiment of a pressure dividing mechanism 401. In this case, the surrounding architecture of the packer assembly 100 continues to include the upper 175 and lower 177 seal elements or providing isolation between production tubing 150 and casing 185. Similarly, the middle annular space 127 is defined between these elements 175, 177 and the casing 185 in a manner that its pressure may be regulated by the pressure dividing mechanism 401 in relation to the pressure in the higher pressure annular space 137 below the lower seal element 177.

**[0034]** Furthermore, the pressure dividing mechanism 401 embodiment of Fig. 4A again includes a pressure multiplier 240 utilizing differently sized pistons 260, 280 within appropriately sized channels for regulating the degree of pressure division imparted on the middle annular space 127. However, as indicated above, this naturally

results in a middle chamber 275 between the pistons 260, 280 which changes in volume as the location of the pistons 260, 280 changes during the indicated regulating.

[0035] However, in the embodiment of Fig. 4A, the middle chamber 275 is in direct communication with the low pressure environment of the upper annular space 115 above the packer assembly 100. That is, even though this annular space 115 may be sealed, for example, between the assembly 100 and the well head 375, the space 180 is likely several thousand feet (see Fig. 3). Thus, the communication or porting between the middle chamber 275 and this space 115 allows for the pressure within the chamber 275 to be substantially unaffected by its potentially changing volume as described above.

[0036] With more specific reference to the configuration shown in Fig. 4A, the above noted porting between the chamber 275 and the upper annular space 115 is provided through a port 400 of the pressure multiplier 240 that is in communication with an extension channel 405 of the pressure dividing mechanism 401. The extension channel 405 runs through the body of the production tubing 405 and eventually aligns with a side channel 425 for communication with the annular space 115 as indicated.

[0037] From a structural standpoint, the port 400 is extended from communication with the chamber 275 and through the upper piston 260. This is achieved via a multiplier extension 475 which includes another piston through which the port 400 may extend (i.e. beyond the upper piston 260, spring 295, and any other intervening hardware). Thus, communication with the noted channel 405 may be defined and maintained even as the pressure multiplier 240 adjusts position from time to time depending on pressure in the higher pressure annular space 137 below the assembly 100 as detailed above. Regardless, a practical manner of allowing such adjustment in position to take place unaffected by pressure in the middle chamber 275 is provided in the embodiment of Fig. 4A.

[0038] Referring now to Fig. 4B, a side sectional view of a packer assembly 100 is shown employing another embodiment of a pressure dividing mechanism 410. In this embodiment, rather than utilizing a pressure multiplier 240 with multiple pistons 260, 280 as shown in Figs. 2 and 4A, pressure regulating valves 480, 485 are utilized. That is, rather than regulating pressure in the middle annular space 127 through a biased positional pressure multiplier 240, a stationary valve 480 is provided to regulate pressure between this annular space 127 and the lower higher pressure annular space 137. Indeed, in the embodiment shown, pressure in the middle annular space 127 is also regulated in light of pressure in the upper lower pressure annular space 115 via the valve 485 positioned between and communication with both this space 115 and the middle annular space 127.

[0039] The pressure dividing mechanism 410 embodiment of Fig. 4B avoids the use of a moving pressure multiplier 240 as well as any middle chamber 275 for which porting may be desirable as detailed above (see Figs. 2 and 4A). Thus, where suitable pressure regulating valves 480, 485 are available, benefit may be realized in such embodiments. For example, continuing with the same pressure examples noted above, in light of the specific embodiment of Fig. 4B, a lower pressure regulating valve 480 may be utilized which holds a downhole pressure of up to 15,000 PSI at the lower annular space 137 while maintaining a pressure in the middle annular space 127 of 8,000 PSI. Thus, the differential on the lower seal element 175 is only about 7,000 PSI.

[0040] Even without another pressure regulating valve 485, the differential imparted on the upper seal element 177 may be about 7,000 PSI where the upper annular space 115 is about 1,000 PSI (e.g. the difference between this value and the middle annular space pressure of 8,000 PSI). However, in the embodiment shown, another pressure regulating valve 485 is provided that is in communication with both the middle annular space 127 and the upper annular space 115. Not only does this

enhance regulating of the pressure in the middle annular space 127 to the desired level (e.g. 8,000 PSI), but it also depicts a readily scalable embodiment for a pressure dividing mechanism 410. That is, additional seal elements with intervening pressure regulating valves and middle annular spaces may be stacked beyond just the pairings shown. Thus, pressure may be further divided. In this manner, continuing with the current example, a packer assembly 100 may be rated to 15,000 PSI without any of the seal elements requiring an individual rating of even 7,500 PSI.

**[0041]** Referring now to Fig. 5, a flow-chart is shown which summarizes an embodiment of installing and utilizing a packer assembly in a well with a pressure dividing mechanism. Specifically, a packer assembly is deployed into a well with multiple seal elements that may be set adjacent one another in the well as indicated at 520, 540 and 560. Thus, a middle annular space is defined between the seal elements. As such, as noted at 580, a pressure in this space may be regulated to a level that is below and based on a higher pressure at an opposite annular space relative one of the seal elements. In the example embodiments detailed hereinabove, the higher pressure opposite annular space is found below the packer assembly. However, in other embodiments, such as those present in perforating, hydraulic fracturing or other temporary isolations, this higher pressure annular space may be found above the assembly. Regardless, the regulated intermediate pressure in the middle annular space may enhance the overall pressure rating for the entire packer assembly.

**[0042]** Embodiments described hereinabove provide packer assemblies of enhanced pressure ratings for use in high pressure downhole environments. Further, such packer assemblies may be made available in off-the-shelf, operator-friendly, configurations as opposed to requiring extensive amounts of on-site reconfiguring or single use customization. Thus, not only is a reliable higher pressure rating available at the outset,

but time and cost savings may also be realized through use of such packer assemblies taking advantage of built in pressure dividing mechanisms as detailed herein.

[0043] The preceding description has been presented with reference to presently preferred embodiments. Persons skilled in the art and technology to which these embodiments pertain will appreciate that alterations and changes in the described structures and methods of operation may be practiced without meaningfully departing from the principle, and scope of these embodiments. For example, embodiments of pressure dividing mechanisms detailed herein are shown accommodated within a body of a tubular or mandrel about which seal elements are disposed. However, pressure dividing mechanisms may also be located within other structure between seal elements outside of the tubular. For example, as a matter of enhanced manufacturability, a pressure dividing mechanism may be located at a ring spacer or structure between seal elements and outside of the tubular and/or mandrel. Furthermore, the foregoing description should not be read as pertaining only to the precise structures described and shown in the accompanying drawings, but rather should be read as consistent with and as support for the following claims, which are to have their fullest and fairest scope.

CLAIMS

We Claim:

- 1 1. A packer assembly for providing fluid isolation at a location in a well, the  
2 assembly comprising:  
3 first and second seal elements defining a middle annular space therebetween  
4 upon installation of the assembly at the location in the well; and  
5 a pressure dividing mechanism in communication with the middle annular space  
6 and in communication with another annular space at a side of one of the seal elements  
7 opposite the middle annular space, the mechanism configured for regulating pressure in  
8 the middle annular space to a level below and based on a higher pressure in the other  
9 annular space, the regulating to enhance a pressure rating of the packer assembly.
- 1 2. The assembly of claim 1 wherein the other annular space is below the middle  
2 annular space, the assembly further comprising a tubular for accommodating the seal  
3 elements thereabout.
- 1 3. The assembly of claim 1 wherein the other annular space is above the middle  
2 annular space, the fluid isolation to support a pressure inducing intervention above the  
3 assembly.
- 1 4. The assembly of claim 1 wherein the higher pressure annular space is adjacent  
2 the second seal element opposite the middle annular space, the first seal element  
3 defining a lower pressure annular space adjacent thereto and opposite the middle  
4 annular space, the pressure in the middle annular space being between the higher and  
5 lower pressures.

1     5.     The assembly of claim 4 wherein pressure differentials on the seal elements are  
2     minimized by the middle annular space pressure being between the higher and lower  
3     pressures.

1     6.     The assembly of claim 4 wherein the middle annular space pressure is about  
2     halfway between the higher and lower pressures.

1     7.     The assembly of claim 1 wherein the pressure dividing mechanism comprises  
2     one of a pressure regulating valve and a multiple piston pressure multiplier in  
3     simultaneous communication with the middle annular space and the higher pressure  
4     annular space.

1     8.     A pressure dividing mechanism for incorporation into a packer assembly to  
2     provide fluid isolation in a well, the mechanism comprising a pressure multiplier for  
3     positioning between a middle annular space defined by seal elements of the packer  
4     assembly when set in the well and another annular space at a side of one of the seal  
5     elements opposite the middle annular space, the pressure multiplier to regulate pressure  
6     in the middle annular space to a level below and based on a higher pressure at the other  
7     annular space, the regulating to enhance a pressure rating of the packer assembly.

1     9.     The pressure dividing mechanism of claim 8 wherein the pressure multiplier  
2     comprises:  
3         a first piston in fluid communication with the middle annular space; and  
4         a second piston in fluid communication with the higher pressure annular space,  
5     the second piston smaller than the first piston.

1 10. The pressure dividing mechanism of claim 9 wherein the pressure multiplier  
2 and pistons thereof are positionally adjustable for the regulating of the pressure in the  
3 middle annular space.

1 11. The pressure dividing mechanism of claim 10 wherein a volume in a chamber  
2 accommodating the pressure multiplier is variable based on the positionally adjusting.

1 12. The pressure dividing mechanism of claim 11 wherein the chamber is ported to  
2 another location to allow for a substantially constant pressure therein during the  
3 variability in volume therein.

1 13. The pressure dividing mechanism of claim 12 wherein the other location is a  
2 low pressure annular space at an opposite side of the packer assembly relative the  
3 higher pressure annular space.

1 14. A method of providing fluid isolation in a well, the method comprising:  
2 deploying a packer assembly into the well;  
3 setting a first seal element of the assembly at a first location in the well;  
4 setting a second seal element of the assembly at a second location adjacent the  
5 first location; and  
6 regulating a pressure in a middle annular space between the seal elements to a  
7 level that is below and based on a higher pressure in another annular space at a side of  
8 one of the seal elements opposite the middle annular space.

1 15. The method of claim 14 wherein the regulating of the pressure in the middle  
2 annular space minimizes a pressure differential on each of the seal elements to enhance  
3 a pressure rating of the packer assembly.

1 16. The method of claim 14 wherein the packer assembly comprises a pressure  
2 dividing mechanism with a pressure regulating valve in simultaneous communication  
3 with the middle annular space and the higher pressure annular space to govern the  
4 regulating of the pressure in the middle annular space.

1 17. The method of claim 14 wherein the packer assembly comprises a pressure  
2 dividing mechanism with a positionally adjustable pressure multiplier in simultaneous  
3 communication with the middle annular space and the higher pressure annular space,  
4 said regulating of the pressure in the middle annular space comprising adjusting a  
5 position of the multiplier.

1 18. The method of claim 17 wherein the position of the multiplier is re-adjustable to  
2 change the pressure in the middle annular space based on changing pressure in the  
3 higher pressure annular space.

1 19. The method of claim 14 wherein the higher pressure annular space is below the  
2 packer assembly, the method further comprising producing a well fluid from the higher  
3 pressure annular space and through a tubular accommodated by the assembly.

- 1    20.    The method of claim 14 further comprising performing a pressure inducing
- 2    intervention in the well at a location above the packer assembly that includes the other
- 3    annular space, the intervention to introduce the higher pressure thereat.

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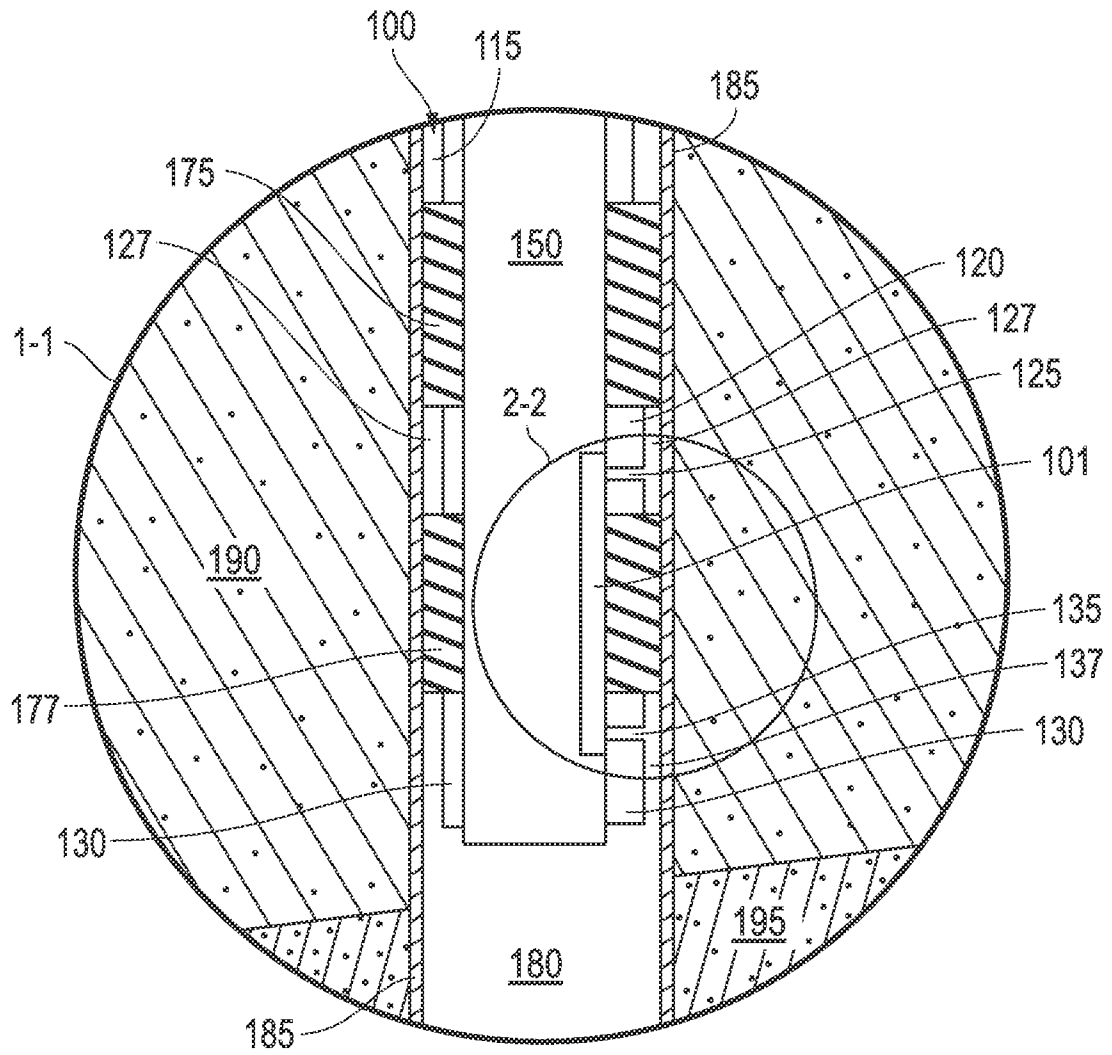


FIG. 1

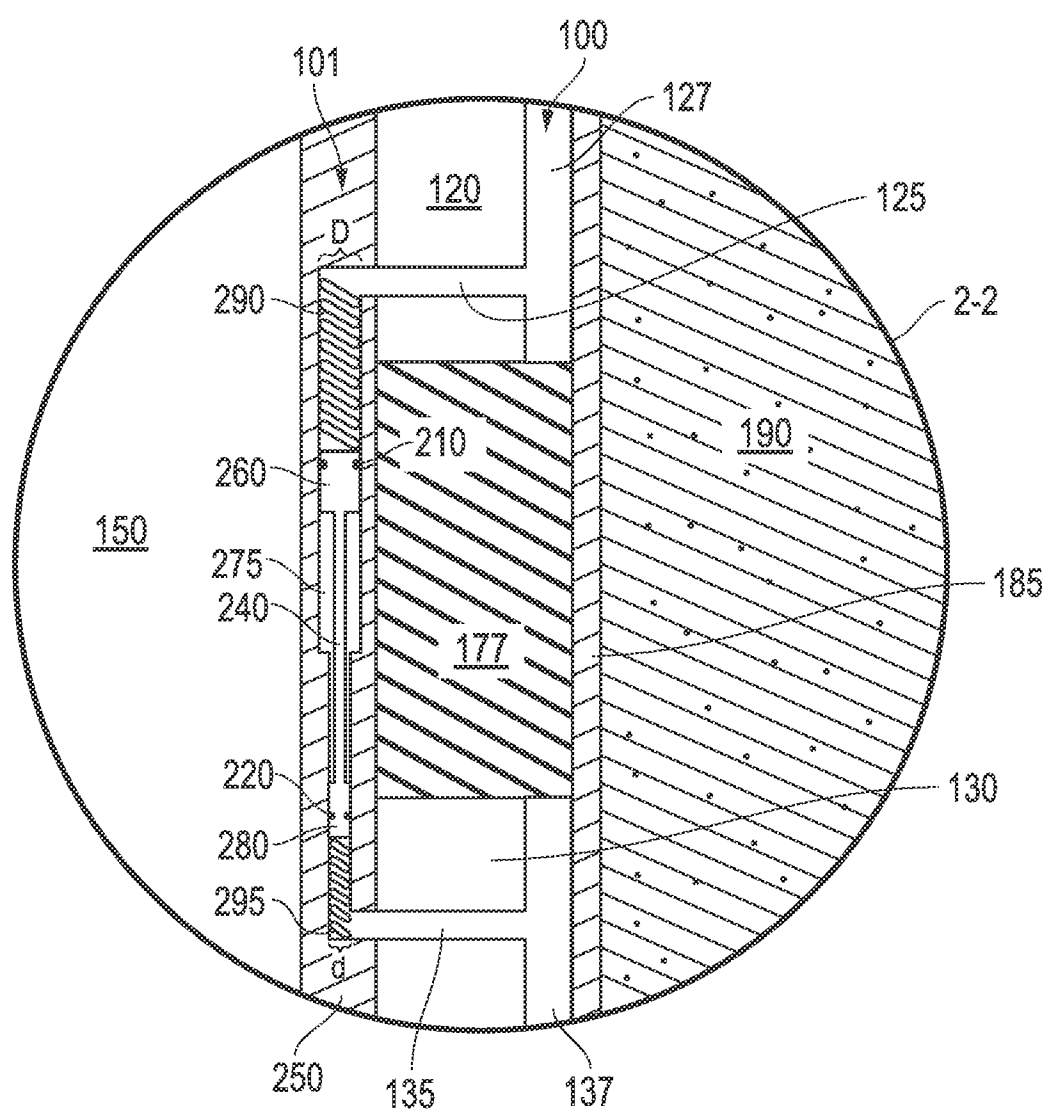


FIG. 2

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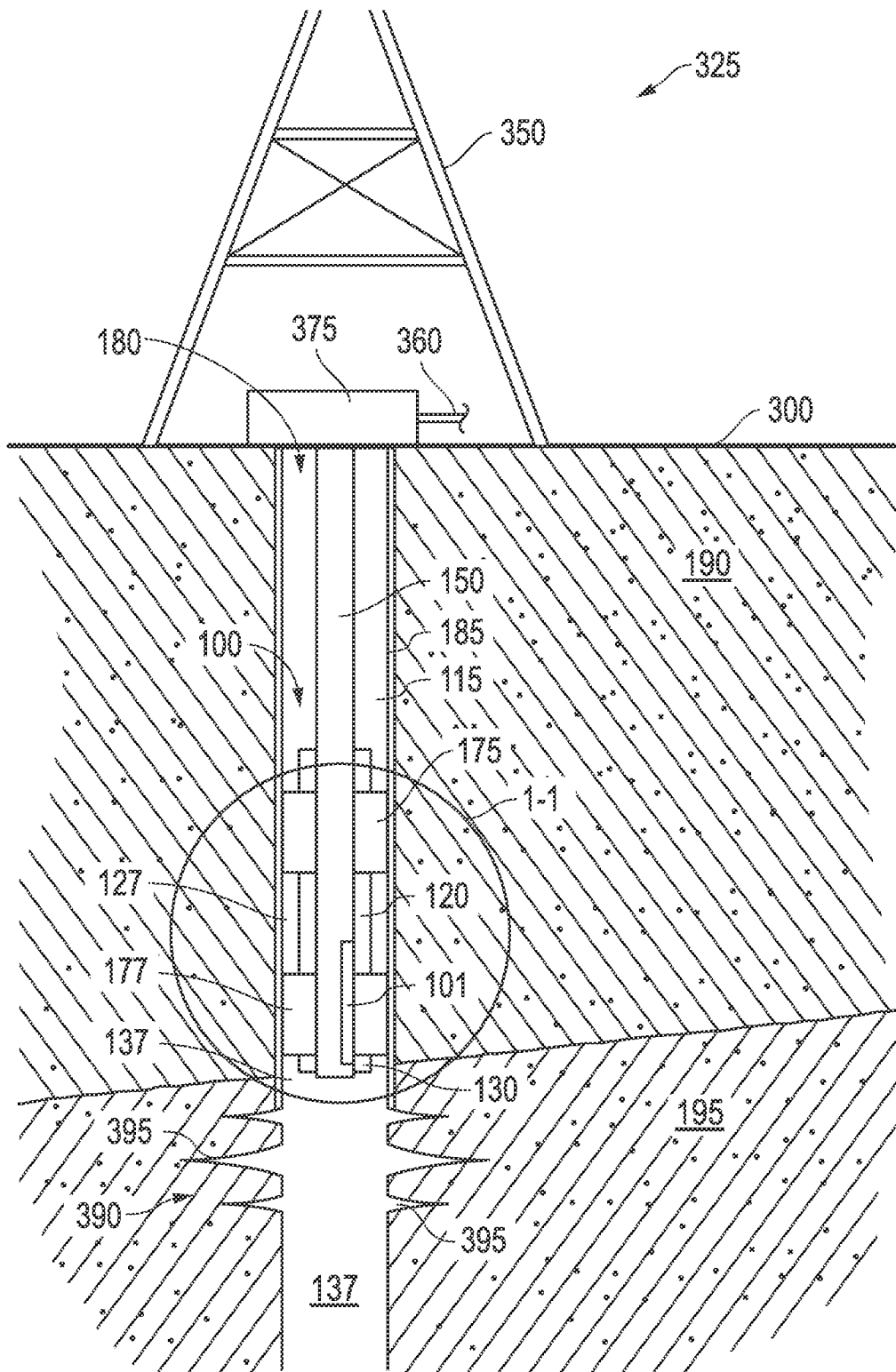


FIG. 3

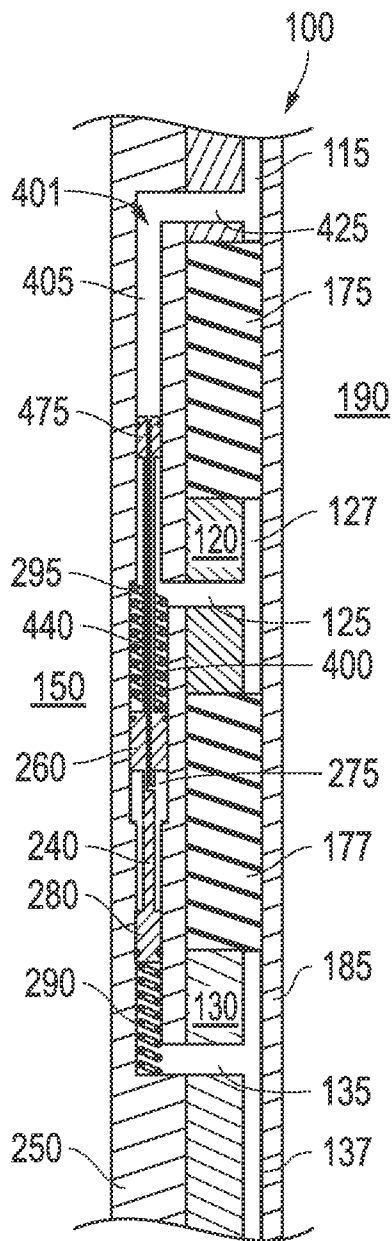


FIG. 4A

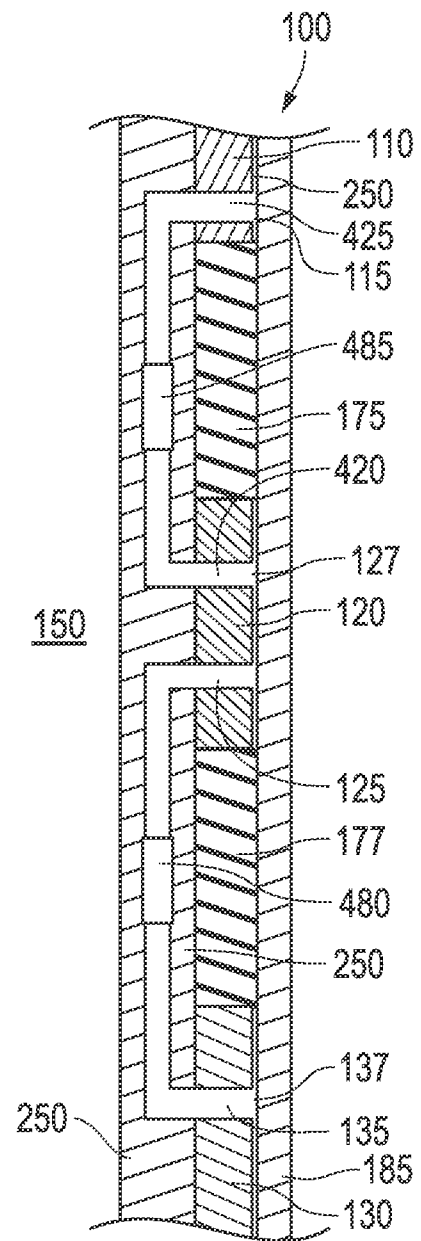


FIG. 4B

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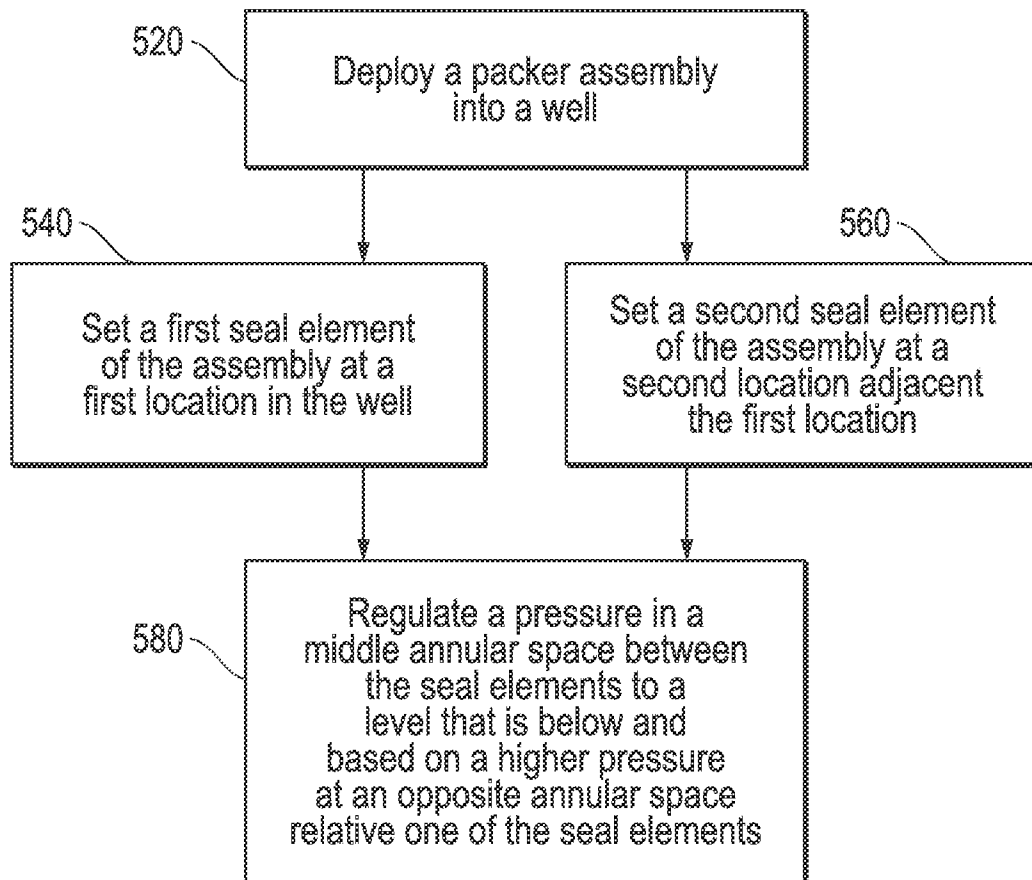


FIG. 5

## INTERNATIONAL SEARCH REPORT

International application No.  
**PCT/US2015/017257****A. CLASSIFICATION OF SUBJECT MATTER****E21B 33/12(2006.01)i, E21B 34/06(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

E21B 33/12; E21B 23/04; E21B 43/12; E21B 34/00; E21B 23/00; E21B 34/08; E21B 17/00; E21B 34/06

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) &amp; Keywords: packer, middle annular space, pressure dividing mechanism, pressure multiplier, and piston

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                      | Relevant to claim No. |
|-----------|-------------------------------------------------------------------------------------------------------------------------|-----------------------|
| A         | US 2011-0101613 A1 (MCROBB et al.) 05 May 2011<br>See paragraphs [0025]–[0028] and figures 2-3.                         | 1-20                  |
| A         | US 2014-0190708 A1 (HALLUNDBAEK, JORGEN) 10 July 2014<br>See paragraphs [0085], [0096]–[0098] and figures 2a-2b, 8, 11. | 1-20                  |
| A         | US 6568470 B2 (GOODSON, JR. et al.) 27 May 2003<br>See column 2, lines 63-67, column 4, lines 40-60, and figure 3.      | 1-20                  |
| A         | US 4340088 A (GEISOW, BERNARD H.) 20 July 1982<br>See column 8, line 55 - column 9, line 49 and figures 2A-2B.          | 1-20                  |
| A         | US 7455114 B2 (MACDOUGALL, THOMAS D.) 25 November 2008<br>See column 3, lines 13-39 and figure 3.                       | 1-20                  |

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&amp;" document member of the same patent family

Date of the actual completion of the international search

25 September 2015 (25.09.2015)

Date of mailing of the international search report

**01 October 2015 (01.10.2015)**

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**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/US2015/017257**

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Publication<br>date                                                                                                                                                                                                                                                                                                                                                                                  |
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| US 4340088 A                              | 20/07/1982          | None                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                      |
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