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ADVANCING TYPE WELL PACKER

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This invention relates to a removable inflatable packer unit used in the drilling and operation of a well. It relates more particularly to an inflatable packer that automatically advances downwardly step-wise in a well bore as drilling progresses with no sliding friction between the packer and the wall of the well bore.

In conventional oil and gas well drilling operations in which a well hole or bore is drilled in the earth in order to locate formations or strata from which oil or gas may be obtained it is quite frequently advantageous and desirable to isolate the area in which the bit is drilling from the remainder of the annular space between the drill pipe and the walls of the well bore. It is known that by reducing the hydrostatic pressure on the face of the formation being drilled, that drilling efficiencies will be greatly increased, yet it is necessary to maintain relatively high hydrostatic pressures on the formations in the bore hole. One of the methods tried to obtain this result has been the use of a packing element combined with independently acting spring elements with the spring elements forcing the packer out against the walls of the well bore. The lower end of the packing element is sealed and secured to the drill pipe. As the drill pipe advances downwardly in the hole, the packing element likewise was intended to slide downwardly in contact with the wall of the well bore. This sliding action proves quite detrimental to the packing element and due to the wear and tear of the sliding motion, it is impossible to maintain an adequate seal in the well bore. Other methods such as the use of inflated packers rather than spring loaded packers have been attempted. The inflated packer was secured to the drill pipe and as the drilling progressed the inflated packer would slide down the walls of the well bore. However, in most cases the friction between the inflated packer and the wall of the well bore was too great to permit the packer to slide downward. In those few instances where the packer would slide downward, the abrasive action of the packer against the bore wall rendered the packer ineffective as a sealing medium. The combination of the spring loaded packer and the inflation packer have also been tried but the use was not successful due also largely to the friction between the packer and the wall preventing the sliding; and if the packer did slide, the relatively rough surface of the bore hole wall soon wore away the packer to such an extent that a seal could no longer be obtained. Other methods have likewise failed to be completely satisfactory. The present invention has eliminated these objections.

In the present invention an inflatable packer assembly is slidably mounted upon and around a drill stem pipe or tubular support which has an inflation means for inflating the packer and in a fixed interval above the inflation means on the drill pipe, a deflating means for deflating the packer. After the packer has been inflated it remains in a fixed and sealing position while the drill stem passes downwardly through the packer assembly until the deflating means is at the same depth as the packer at which time the packer is deflated. The de-

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flated packer then slides down the drill pipe where it is stopped at the inflation means which automatically reinflates the packer. This operation is repeated automatically as the drilling progresses, and the only action required by the operator or driller to insure continuous stepwise advance is to maintain fluid pressure continuously within the drill stem.

In a preferred embodiment an inflatable elastic packer is mounted on a slidable sleeve or packer mandrel which is concentric to and surrounds a tubular support or drill stem. Drilling fluid from the bore of the drill stem passes through an inflation valve and a conduit in the wall of the drill stem and inflates the packer. A hydrostatic pressure is maintained in the annulus between the drill stem pipe and the wall of the bore hole. The packer remains at this position with the drill stem sliding downwardly as the formation is drilled, through the packer mandrel or sleeve until the packer is deflated by ports or grooves at a fixed interval above the inflation means on the drill stem pipe.

When the packer is deflated, its weight and the hydrostatic pressure of the fluid in the annulus cause the packer unit to slide down the fixed interval to the inflation means which also serves to stop the packer unit. The force exerted by the dropping of the packer unit pushes open the inflation valve thus reinflating the packer.

As drilling progresses the drill stem pipe then slides down through the packer mandrel until the deflating means or splines on the drill pipe reach the packer at which time the packer is again deflated and again drops to the inflating means where the packer is again reinflated. The deflation and reinflation cycle is repeated at fixed depth intervals as the drilling progresses in accordance with the vertical distance between the inflation means and the deflation means. This arrangement is very desirable and advantageous inasmuch as the packer is not required to slide downwardly along the wall of the hole in an inflated position as the drill bit advances deeper into the earth. While the packer assembly slides downward, it is at least partially deflated to the extent that there is no friction between the packer and the wall of the bore. The rotating and sliding motion is between the metal sleeve on which the packer is mounted and the drill stem only.

An object of this invention is to provide an inflatable-deflatable packer that advances automatically downwardly step-wise, thus preventing sliding motion between the packer and the wall of the well bore. A further objective of the invention is to provide a means for lowering the hydrostatic pressure in the space in which the drill bit is drilling to a pressure below that in the annulus between the drill pipe and the wall of the bore hole. Further objects of this invention will become apparent and more fully understood from the ensuing description and from the accompanying drawings in which:

Figure 1 is a partial sectional vertical view of the packer unit mounted on a tubular support within a well bore; and

Figure 2 is similar to Figure 1 but shows the position of the inflatable packer when it is inflated.

Figure 3 illustrates in section a vertical view of an arrangement of the packer unit in relation to a system in which the pressure surrounding the drill bit has been reduced in relation to the pressure in the annulus.

Referring specifically to the drawing, it will be seen that a tubular support 10 which may be attached by tool joint 11 to an ordinary drill pipe suspended from the surface is suspended within bore hole 12. A tool joint 13 is provided at the lower end of tubular support 10 for attaching to a drill bit, drill collar, etc. Slidable sleeve or packer mandrel 14 is positioned upon tubular support

10 within a recessed section 16 and is free to turn and slide in relation to tubular support member 10 within the confines of recessed section 16. Slidable sleeve 14 is provided with packing seals 18 which maintain a seal between the sleeve and the surface of the recessed portion of the tubular support. The seals may preferably be made of rubber, plastic, leather, or a similar material. It may also be desirable to retain the seals in grooves in the innersurface of the sleeve 14. Annular sleeve 14 is also provided with at least one but preferably several closely spaced ports 20 extending through the sleeve. Affixed to the outer surface of the sleeve 14 and carried thereon is an inflatable packer 22 which is preferably made of rubber although various plastics, canvas or other fabrics may be used. Steel wire or other cord may be incorporated to the packer fabric to give added strength. The packer must possess sufficient elasticity to form a tight seal against the bore wall when inflated even though the wall surface may be somewhat irregular because of cave-ins and wash-outs.

In the upper portion of recessed section 16, there is at least one but preferably several deflating ports or grooves 24. These grooves are arranged to deflate packer 22 when the packer assembly is at the upper portion of recessed section 16. The grooves 24 break the seal between the packer sleeve and the wall of the recessed section of the tubular support or drill pipe. When the packer is deflated, it will automatically drop to the lower portion of recess section 16. The lower portion of recess section 16 is provided with inflation means consisting of inflation conduit 26 located within the walls of tubular support 10, and inflation valve 28 capable of opening and closing conduit 26. Two valves 28 will normally be employed as shown in the drawing; however, the number of valves used is not normally critical.

Valve spring 30 is arranged to hold inflation valve 28 in a closed position. Shoulder 32 extends from inflation valve 28 and is arranged to be in the vertical path of sleeve 14. The packer unit after deflation slides down the tubular support 10 within the confines of recessed section 16 and pushes against or strikes shoulder 32 of inflation valve 28 thereby forcing the valve plug 34 from seat 36 and opening conduit 26 thereby establishing fluid communication between the bore of tubular support member 10 and ports 20 of sleeve 14. Ports 20 are in communication with the interior of packer 22. This alignment and communication is obtained when the packer assembly is positioned in the lower portion of recessed section 16. A stop 38 is provided below shoulder 32 of the inflation valve to prevent unnecessary strain of the valve assembly and also to assure that the ports of sleeve 14 are in proper alignment for communication with conduit 26.

As an example of a normal operation, the packer assembly is mounted in recessed section 16 and is lowered into place with packer 22 in a deflated state. The weight of the packer assembly resting upon or pushing against shoulder 32 will open valve 28 in inflation conduit 26. As drilling fluid or other fluid is injected under pressure into the bore of the drill pipe, packer 22 will be inflated. After the packer is inflated, the packer assembly does not move but instead is held in a fixed position by the force of the packer against the borehole wall with the drill stem rotating within and sliding down through sleeve 14 of the packer assembly as drilling progresses.

When the drill pipe has passed downwardly through sleeve 14 until deflating grooves 24 are at the same depth as the packer assembly, the packer will be deflated with the pressure within the packer being released through ports 20 and deflation grooves 24 which are not sealed by seals 18. As soon as the packer is sufficiently deflated to relieve friction between the wall of the well bore, the packer is forced down by gravity and also partially by the hydrostatic pressure of the fluid above the packer in the annulus between the drill stem pipe and the wall of

the well bore. The mandrel or sleeve 14 of the packer assembly pushes valve 28 downwardly which opens the inflation valve 28 and the fluids in the bore of drill stem pipe 10 flow through inflation conduit 26 and ports 20 and reinflate packer 22. As the drill stem is lowered with subsequent drilling the packer no longer holds valve 28 in an open position, and spring 30 forces the valve shut. The pressure of the fluid within the bore of the drill pipe also aids in holding the valve closed. The vertical distance between the inflation means and the deflating means may vary as desirable with the operation problems encountered, but for normal drilling operations of oil and gas wells will vary between about 5 feet to about 60 feet.

The pumps which drive the circulating fluid are stopped when the packer assembly is being lowered into or being brought out of the hole. As the pumps are stopped the packer will not be inflated by valve 28 when coming out of the hole although the packer normally being in the lower position of the recess section will open valve 28. The packer which is used should be of a type which is normally deflated or collapsed. Surges, if any, in the fluid in the drill string or borehole will not be sufficient to inflate the packer. However, should a surge inflate the packer, the packer will immediately deflate if it is in the lower or the upper position. If in an intermediate position, the packer is not inflated by surges as the interior of the packer is not in fluid communication with the fluid in the borehole or drill pipe. The packer is normally at the bottom of the recess when being lowered into or being withdrawn from the hole, and the drag, if any, which the packer may have with the wall of the bore hole is very small as the packer is set in a recessed section and, being normally collapsed, the outer surface of the packer will normally lie within the recessed section and will thus be protected.

Sometimes it may be necessary or desirable to stop drilling operations when the packer is positioned between the deflating and the inflating means. Before the packer can be removed it must, of course, be deflated. This, however, poses no problem inasmuch as the packer can be deflated by merely lifting the drilling pipe and reducing the fluid pressure within the bore of the drill pipe. The drill pipe is lifted until the shoulder of the inflation valve is forced against the mandrel or sleeve of the packer unit thus opening valve 28 and providing fluid communication between the ports 20 and the bore of the drill stem. The pressure holding the packer inflated will quickly be bled off and the packer will be deflated.

It is to be understood that various types of inflatable packers may be utilized in the invention which has been disclosed herein. It should also be noted that this system may be used with various arrangements of drilling and testing devices where it is desired to isolate the area of operation at the drill bit from an annular space above the packer.

As an example, this packer assembly may be used in a drilling operation such as illustrated in Figure 3. A return conduit 40 is located within a tubular support member 42 and is provided with a high velocity jet pump 44. The packer assembly such as described hereinbefore is provided and mounted on a recessed section completely between inlet 46 and outlet 48 of return conduit 40. A drilling fluid passes downwardly through the bore of tubular member 42 with a part of the fluid passing through drilling bit assembly 50 and is returned through inlet 46 through return conduit 40. A portion of the downwardly injected fluid passes through jet pump 44 which operates to lower the pressure in the area surrounding the bit. Drill bit 50 may be attached to tubular member 42 by a conventional tool joint as indicated at 51. A male tool joint 53 is provided for attaching tubular member 42 to a drill pipe joint. The packer assembly effectively seals the annular space above the packer and the area surrounding the drill pipe. As the drilling advances, the packer automatically deflates and advances downwardly

step-wise and is reinflated in the manner described herein above. By the use of this arrangement as shown in Figure 3, the hydrostatic pressure surrounding the drill bit is maintained substantially less than that in the annulus above the packer. The reason that pressure on the bit is reduced is that jet pump 44 draws fluid up through inlet 46. By reducing the pressure in the area in which the drill bit is drilling, the efficiency of the drilling operation will be greatly increased. It should be noted that the principle and operation of a jet pump such as the one used in Figure 3 is found in most mechanical engineering handbooks and also in many other publications. When the packer deflates and slides down the recess section of the tubular support, the pressure about the bit may momentarily tend to increase; however, as soon as the packer reinflates, the jet pump again reduces the pressure in the borehole about the bit. The time for the packer to deflate sufficiently to slide down and be reinflated is very short as the packer will be forced down by its weight and the weight of the fluid it is supporting as soon as the seal between the packers and the borehole wall is broken.

It is apparent that numerous modifications and variations may be made in the apparatus described without departing from the spirit and scope of the present invention and it is intended that the invention be limited only by the scope of the following claims.

We claim:

1. An inflatable packer unit for use in a well bore which comprises a tubular support, a sleeve sealingly and slidably mounted on the exterior of said tubular support with said sleeve having a port therein, an elastic packer mounted on the exterior of said sleeve with said packer being adapted to sealingly engage the wall of the well bore, inflation means fixedly mounted at a first position on said tubular support to be operative to inflate said elastic packer when said sleeve is at said first position, and deflation means in a second position spaced along said tubular support from said first position and operative to deflate said elastic packer when said sleeve is adjacent said second position.

2. An inflatable packer unit for use in a well bore which comprises a tubular supporting having a recessed section on its outer periphery, a sleeve slidably, rotationally, and sealably mounted on the exterior of said tubular support in said recessed section and having at least one port extending therethrough, an elastic packer mounted on the exterior of said sleeve, at least one conduit in said tubular support near a first end portion of the recessed section of said tubular support and extending from the bore of said tubular support to said recessed section, a valve biased toward a closed position in said conduit, said valve having a shoulder member extending into said recessed section in the path of the longitudinal movement of said sleeve such that when said sleeve is disposed near said first end portion of said section said shoulder member is operative to open said valve, and deflation means near the other end portion of said recessed section operative to deflate said elastic packer when said sleeve is near the other end portion of said recessed section.

3. An inflatable packer unit for use in a well bore which comprises a tubular support having a recessed section on its outer periphery, a sleeve slidably and rotationally mounted on the exterior of said tubular support in said recessed section and having at least one port extending therethrough, sealing means between said sleeve and said recessed section, an elastic packer mounted on the exterior of said sleeve, deflation means comprising at least one groove in one portion of said recessed section

and extending beyond said recessed section adapted to deflate said packer when said packer and said sleeve are positioned around said groove whereby said groove establishes fluid communication between the interior of said packer and the exterior thereof, at least one inflation conduit in the wall of said tubular support near a second portion of the recessed section of said tubular support in fluid communication with the interior of said sleeve and the bore of said tubular support, a valve biased toward a closed position within said conduit, said valve having a shoulder member extending into said second portion of said recessed section in the longitudinal path of said sleeve so that said valve is opened when said sleeve is disposed near said second portion of said recessed section.

4. An inflatable packer unit for use in a well bore which comprises a tubular support suspended in a well bore and having a recessed section on its outer periphery, a sleeve slidably, rotationally, and sealably mounted on the exterior of said tubular support in said recessed section and having at least one port extending therethrough, an elastic packer mounted on the exterior of said sleeve, deflation means comprising at least one groove in the upper end portion of said recessed section extending beyond said recessed section and arranged to establish fluid communication between the interior of said packer and the exterior thereof when said packer and said sleeve is positioned around said groove thereby deflating said packer, at least one inflation conduit in the wall near the lower end portion of said recessed section of said tubular support and extending from the bore of said tubular support to said recessed section, a valve biased toward a closed position in said conduit, said valve having shoulder member extending into said recessed section in the path of said sleeve so that said valve is opened when said sleeve is disposed near said lower end portion of said recessed section.

5. An inflatable packer unit for use in a well bore which comprises a tubular support suspended in a well bore and having a recessed section on its outer periphery, a sleeve slidably and rotationally mounted on the exterior of said tubular support in said recessed section and having at least one port extending therethrough, sealing means between said sleeve and said recessed section, an elastic packer mounted on the exterior of said sleeve, deflation means comprising at least one groove in the upper end portion of said recessed section and extending beyond said recessed section and establishing fluid communication between the interior of said packer and the exterior thereof when said packer and said sleeve are positioned around said groove thereby deflating said packer, at least one inflation conduit in said tubular support near the lower end portion of said recessed section and extending from within the interior of said sleeve to the bore of said tubular support, a valve biased toward a closed position in said conduit, a valve spring arranged to hold said valve closed, said valve having a shoulder member extending radially into said recessed section whereby said shoulder member is adapted to receive said sleeve and operative to open said valve when said sleeve is disposed upon said shoulder.

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