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SELF-INFLATING BALLOON TYPE FORMATION TESTER

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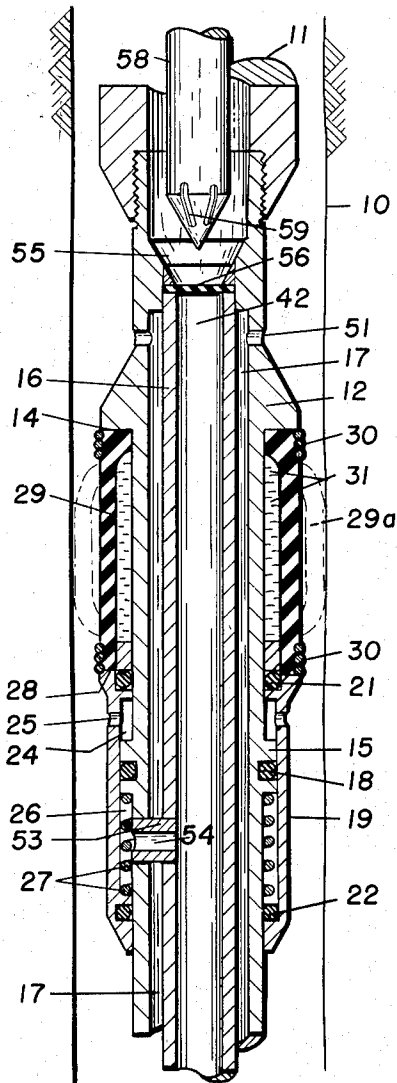


FIG. 1

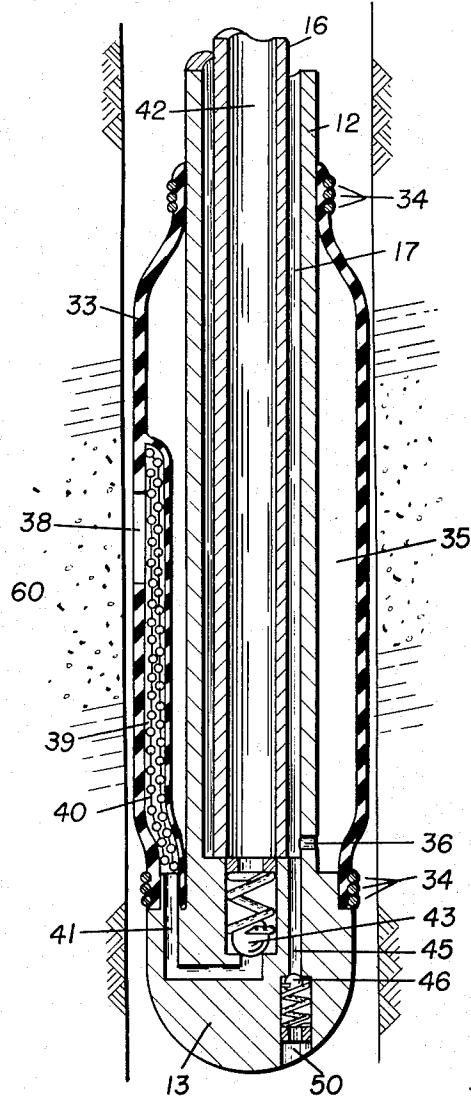


FIG. 2

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SELF-INFLATING BALLOON TYPE FORMATION TESTER

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5 Claims. (Cl. 166—100)

This invention is concerned with an improved apparatus for securing samples of formation fluids from a well bore to determine whether oil bearing strata have been encountered. More particularly the invention relates to an improved formation tester of the inflatable balloon packer type that may be attached to the lower end of a drill pipe, wherein novel means are provided for inflating and deflating the balloon packer.

In conventional oil well drilling operations fluids known as drilling muds are employed to aid in carrying away cuttings and also to maintain a hydrostatic head in the well to prevent the uncontrolled escape of gases or liquids from various formations encountered during drilling. One disadvantage of drilling with a drilling mud is that the sampling of natural fluids occurring in various formations is thereby rendered difficult. To overcome this disadvantage various types of formation testers have been devised which are provided with means for reducing the hydrostatic pressure in the vicinity of the formation to be tested in order that a sample of the natural fluids can be taken.

Many of these formation testers are provided with inflatable elastic sleeves or packers for sealing off the portion of the well in which it is desired to reduce the hydrostatic pressure. The use of such elastic packers is particularly desirable since they can be expanded to give a thorough seal and yet may be readily removed from the well after being deflated. Furthermore it is possible to position the elastic packers at any desired point in the well with very little difficulty.

In formation testing using an inflatable elastic packer run on drill pipe or tubing some means must be provided for inflating the packer. The conventional means for doing this involves pumping drilling mud or other fluid such as plain water down the pipe, so that with a suitable arrangement of valves the necessary inflation pressure can be applied to the inside of the packer. Suitable means are provided to hold the pressure in the packer until the test has been completed. After the packer has been set against the formation the usual procedure is to reduce the pressure inside the drill pipe until formation fluids can flow through it to the surface. This can be done merely by substituting plain water for drilling mud in the pipe but in many cases it is necessary to swab down the fluid level in the pipe to the desired extent. An alternative procedure is to place a previously evacuated sample chamber in the drill pipe and produce fluids into this sample chamber. With such a procedure the amount of fluid that can be sampled is limited by the capacity of the sample chamber. Obviously a procedure wherein the drill pipe can be run in empty is preferable since it provides for considerable test capacity without the necessity of swabbing out the pipe.

It is an object of the present invention to provide means for formation testing in which an inflatable packer is used but in which neither an evacuated sample chamber nor a swabbing operation is necessary. It is a further object to provide a formation testing device that may be

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run into the bore hole on an empty drill pipe and the packer inflated without requiring that fluids be pumped down the drill pipe, thus keeping the pipe empty for the collection of a sample of formation fluids.

5 Briefly the invention consists of an apparatus provided with means whereby the hydrostatic mud pressure in the bore hole at the level of the formation under test is utilized to inflate the packer and to automatically collect a sample of the formation fluids as soon as the packer has set against the selected formation.

10 The nature of the invention and the objects thereby accomplished will be more fully understood from the ensuing description and from the accompanying drawing in which:

15 Figure 1 is a vertical sectional view of the upper portion of a representative embodiment of the invention in position in a bore hole and

Figure 2 is a lower continuation of Figure 1.

Referring specifically to the drawing it will be seen 20 that the formation tester depicted is provided with a support member 12 that is attachable to a tool joint 11 which in turn can be attached to the lower end of a section of drill pipe (not shown). The apparatus is shown in position in a bore hole 10. The support 12 terminates in a lower rounded nose portion 13 to facilitate lowering through the bore hole. Positioned within the support member 12 is a cylindrical tube 16 which defines with the bore of the support member an annular passageway 17, whose function will be explained later. 25 There is no communication between passageway 17 and the bore 42 of tube 16. Adjacent its upper end, support member 12 is of enlarged external diameter to provide a shoulder 14 and some distance below this shoulder the support member has an annular projection 15 in which an external groove is provided to receive a ring seal 18. Fitting slidably over the exterior of support member 12 is a sleeve member 19 having adjacent each end an internal groove, each one of which receives a ring seal 21 or 22. The middle portion of the bore 30 of sleeve 19 is of enlarged diameter so that it fits slidably against projection 15 and defines with the adjacent portions of support member 12 an annular chamber 24 above the projection 15 and an annular chamber 26 below projection 15. A spring 27 is positioned within annular space 26 and presses at its upper end against the lower shoulder of projection 15 and at its lower end against the lower shoulder provided by the enlargement of the bore of sleeve 19. A port 25 in the wall of sleeve 19 provides exterior fluid access to chamber 24. A plug 53 set into suitably aligned openings in support member 12 and tube 16 has a central bore that provides a channel 54 connecting chamber 26 with bore 42 of tube 16. 45

At the upper end of sleeve 19 an exterior shoulder 28 55 is provided which supports the lower end of an annular mechanical packer 29 that surrounds support member 12. The upper end of packer 29 fits against downwardly facing shoulder 14 on support member 12. The packer 29 is attached at its upper end to the support member 12 and at its lower end to the sleeve 19 and is held in place at each end by suitable means, as for example, by the tightly wound wires 30. Thus as sleeve 19 moves upwardly with respect to support member 12 packer 29 will be made to expand against the walls 60 of the bore hole as represented by the dotted lines 29a. Preferably the expansion of the packer is aided by a body of fluid 31 retained with the annular space defined by the packer and the support member 12.

Fastened to the exterior of the lower portion of support member 12 is an inflatable elastic packer 33 held 70 in place at each end by suitable means such as tightly wound wire 34. Fluid communication between the

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annular passageway 17 and the inflation chamber 35 defined by packer 33 and the support member 12 is established through port 36.

An external recess 38 is provided in the wall of the inflatable packer and communicating with this recess is a production tube 39 in which are positioned interconnected packing elements 40 in the manner disclosed in U. S. Patent 2,600,173 of Ben W. Sewell and George H. Ramsey. These packing elements establish a non-collapsible passageway for the entrance of production fluids as fully discussed in the aforementioned patent. Communication between the production tube 39 and the inner bore 42 of tube 16 is established through channel 41 in an enlarged portion of which is positioned a check valve 43, which is set to open at a low pressure differential, say 2 or 3 pounds. A channel 45 in the head portion 13 of the support member connects annulus 17 with an external port 50 through a check valve 46. The function of this channel and check valve will be explained later.

When the apparatus is prepared for lowering into a bore hole the packers 29 and 33 are both in the non-expanded position and a frangible or rupturable seal 56 is positioned in the top of tube 16 to seal off inner bore 42 from the enlarged bore 55 which is in open communication with the open drill pipe above. When the desired level has been reached in the bore hole a go-devil 58 or similar device is dropped down through the drill pipe to break the seal 56. To prevent the go-devil from sealing off the passageway it may be desirable to provide the go-devil with ribs 59.

When the seal 56 is broken the inner bore 42 will be exposed to atmospheric pressure, i. e. the pressure within the open drill pipe. Since the pressure of the drilling mud present in the bore hole at the depth of the apparatus is higher than atmospheric, sleeve 19 will slide upwardly with respect to support member 12.

When the pressure within bore 42 is essentially the same as the pressure in the bore hole annulus, which will be the case before seal 56 is broken, the force against the inner shoulder of sleeve 19 that defines the top of chamber 24 will be counterbalanced by the force against the inner shoulder of sleeve 19 that defines the bottom of chamber 26. When the pressure within chamber 26 is reduced, however, as a result of breaking seal 56, the upward force on the sleeve will be greater than the downward force. Hence sleeve 19 will move upward against the slight bias exerted by spring 27 and packer 29 will be expanded outwardly to the position indicated by the dotted lines 29a. Thus the packer 29 will be expanded to seal off the bore hole annulus below this packer from the bore hole annulus above the packer.

Spring 27 is not essential to the above described operation of sleeve 19 but it is preferred that it be used so that when the pressure in the borehole annulus is only slightly higher than the pressure in bore 42, which could occur as the apparatus is being lowered into the bore hole, the packer will not set prematurely. Thus a spring is selected such that sleeve 19 will not move up until the pressure difference exceeds say 50 pounds. The purpose of ring seals 18, 21 and 22 is to prevent fluid leakage past the sliding parts that they contact.

Because of the reduction in pressure within the bore 42 upon rupture of the seal 56, drilling mud will also begin to enter production tube 39 past valve 43 and into the inner bore 42. As the volume of mud in the bore hole annulus in the vicinity of the packer 33 is thus reduced drilling mud will enter through port 51 into annulus 17 and flow out through port 36 into the inflation chamber 35 within packer 33. This mud flow will continue as additional fluid enters production tube 39 until the packer 33 presses up against the walls of the bore hole. Fluid within formation 60 will then flow through the production tube 39 into the inner bore 42.

The purpose of check valve 46 is to control the in-

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flating pressure within the packer 33. Thus for example if the fluid pressure in the bore hole annulus above packer 29 should exceed the fluid pressure in the bore hole annulus at the bottom of the tester by more than say 50 lbs. fluid will flow down annulus 17 through the check valve 46 until the pressure differential drops below 50 lbs. It should be noted that packer 33 does not have to support more than a small differential pressure and hence its principal function is to isolate the portion of formation 60 being tested.

When it is desired to terminate the test, drilling mud or other fluid may be pumped down the drill pipe until the pressure within the inner bore 42 is about equal to the pressure in the bore hole annulus in the vicinity of sleeve 19. When the pressure within annular space 26 approaches the pressure in the bore hole annulus sleeve 19 will move downward and retract packer 29. As a result, the bore hole pressures above and below packer 29 will become equalized and packer 33 will become deflated, since the pressures inside and outside the packer 33 will also become equalized and the elasticity of the packer material will draw the packer inwardly, the inflating fluid in annular space 35 escaping through port 36, annulus 17 and port 51. The fluid sample that has been collected within the bore 32 will be prevented from escaping by the check valve 43.

In a modification of the invention packer 29 may be omitted, and instead a conventional mechanical packer substituted. Such a packer would be mounted on support members movable relative to each other, the upper one attaching to the drill pipe and the lower one to support 12. A conduit within the support members would connect annulus 17 with an exterior port above the mechanical packer in the same manner as port 51. A conventional tail pipe would be attached to the bottom of support 12 and would reach to the bottom of the borehole so that the mechanical packer could be set by placing weight on the drill pipe, as in conventional practice. The inflation of packer 33 would then proceed upon rupture of seal 56 and the test proceed in the same manner as above described. To terminate the test it would merely be necessary to raise the drill pipe sufficiently to unseat the mechanical packer after which the inflatable packer 33 would deflate in the same manner as already explained.

It is to be understood that the invention is to be limited only by the following claims, and not by the exact description contained in the foregoing specification, which has been presented merely by way of example and not of limitation.

What is claimed is:

1. A formation tester assembly for sampling fluids from strata encountered in a well bore which comprises an elongated support member attachable to the lower end of a drill pipe and having a central bore communicating with the interior of the drill pipe, an inflatable elastic packer attached to said support member, said packer having at least one test port in a side wall thereof, a mechanically expansible packer supported by the support member above the said inflatable elastic packer, means for expanding said mechanically expansible packer, a passageway within said assembly terminating at its lower end within said inflatable packer and at its upper end in a port opening exteriorly of said assembly above said mechanical packer, said passageway lacking communication with the central bore of the support member, a conduit connecting the test port of the inflatable elastic packer with the central bore of the support member, a check valve within said last named conduit and a frangible seal within an upper section of said central bore above said last named conduit.

2. Formation tester assembly as defined by claim 1 including a pressure relief conduit communicating with said passageway and terminating in a port exterior of

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said support member below said inflatable packer, and a pressure relief valve in said pressure relief conduit.

3. A formation tester assembly for sampling fluids from strata encountered in a well bore which comprises an elongated support member attachable to the lower end of a drill pipe and having a central bore communicating with the interior of the drill pipe, a rigid sleeve slidably arranged on the exterior of said support member, a first flexible packer member surrounding said support member adjacent said sleeve, means fastening one end of said packer member to said support member, means fastening the other end of said packer member to said sleeve whereby on longitudinal motion of said sleeve relative to said support member said packer member will expand outwardly, an inflatable elastic packer fastened to said support member below said first packer member, said inflatable elastic packer having at least one test port in a sidewall thereof, a passageway within said support member terminating at its lower end within said inflatable packer and at its upper end in a port opening exteriorly of said support member above said first packer member, said passageway lacking communication with the central bore of the support member, a conduit connecting the last named port of the inflatable elastic packer with the central bore of the support member, a check valve in said last named conduit, and a frangible seal within an upper section of said central bore above said last named conduit.

4. A formation tester assembly for sampling fluids from strata encountered in a well bore which comprises an elongated support member attachable to the lower end of a drill pipe and having a central bore communicating with the interior of the drill pipe, a portion of said support member being of enlarged cross-sectional thickness, a rigid sleeve slidably arranged on the exterior of said support member and enclosing and slidably

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engaging said enlarged portion thereof, said sleeve being of enlarged bore in its mid-portion whereby to also slidably contact said support member above and below said enlarged portion and to define with said enlarged portion an upper annular chamber and a lower annular chamber, a port in said sleeve communicating with one of said chambers, a conduit in said support member connecting said central bore with the other of said chambers, a first flexible packer member surrounding said support member adjacent said sleeve, means fastening one end of said packer member to said support member, means fastening the other end of said packer member to said sleeve, whereby on longitudinal motion of said sleeve said packer member will expand outwardly, an inflatable elastic packer fastened to said support member below said first packer member, said inflatable elastic packer having at least one test port in a side wall thereof, a passageway within said support member terminating at its lower end within said inflatable packer and at its upper end in a port opening exteriorly of said support member above said first packer member, said passageway lacking communication with the central bore of the support member, a conduit connecting the test port of the inflatable elastic packer with the central bore of the support member, a check valve in said last named conduit, and a frangible seal within an upper section of said central bore above said last named conduit.

5. Formation tester assembly as defined by claim 4 including a spring within one of said chambers exerting a bias on said sleeve in a direction resisting expansion of said first named packer member.

References Cited in the file of this patent

UNITED STATES PATENTS

2,600,173 Sewell et al. June 10, 1952