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(54) **METHOD AND APPARATUS FOR ISOLATING AND TESTING ZONES DURING REVERSE CIRCULATION DRILLING**

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(60) Provisional application No. 60/521,051, filed on Feb. 11, 2004.

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(57) **ABSTRACT**

An isolation tool for use with a concentric drill string for isolating a zone in a wellbore for testing is provided comprising a center tube and an outer casing forming an annular conduit therebetween and an expandable and contractible packer for sealing off an outside annular passage formed between a wall of the wellbore and an outer surface of the concentric drill string, whereby the isolation tool is adapted to be operably connected to the concentric drill string such that the isolation tool is in fluid communication with the concentric drill string.

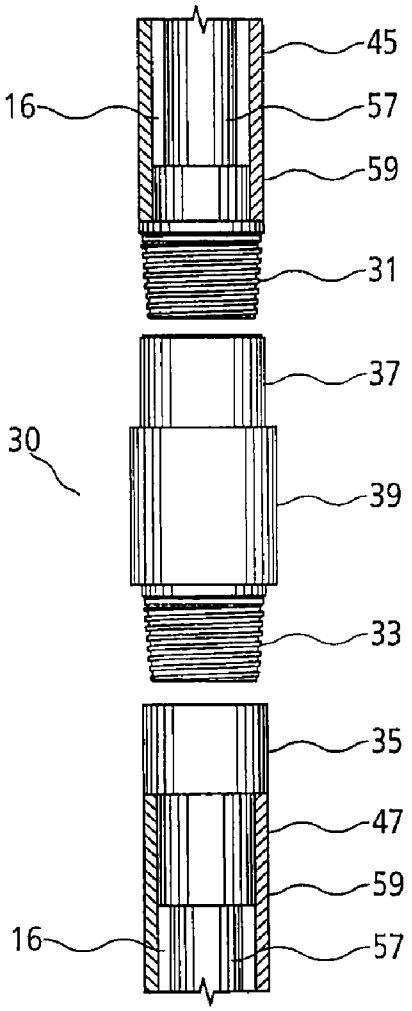

Fig. 1

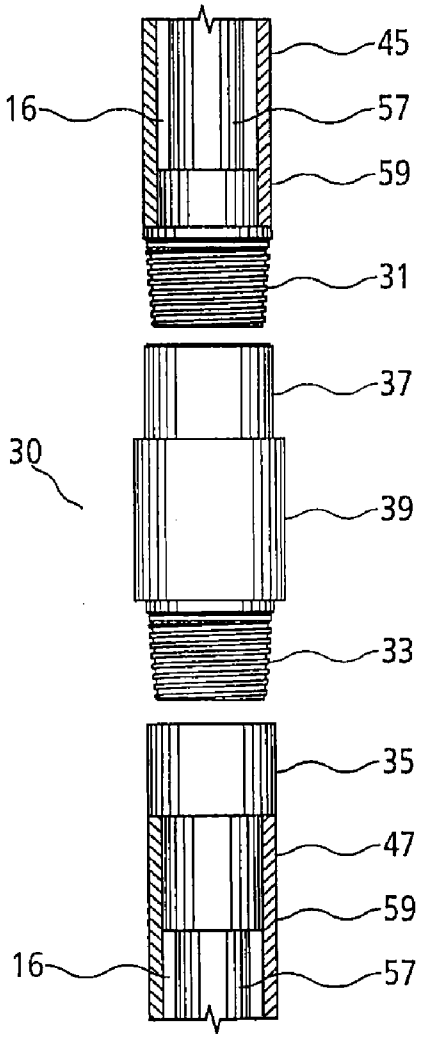
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Fig. 2

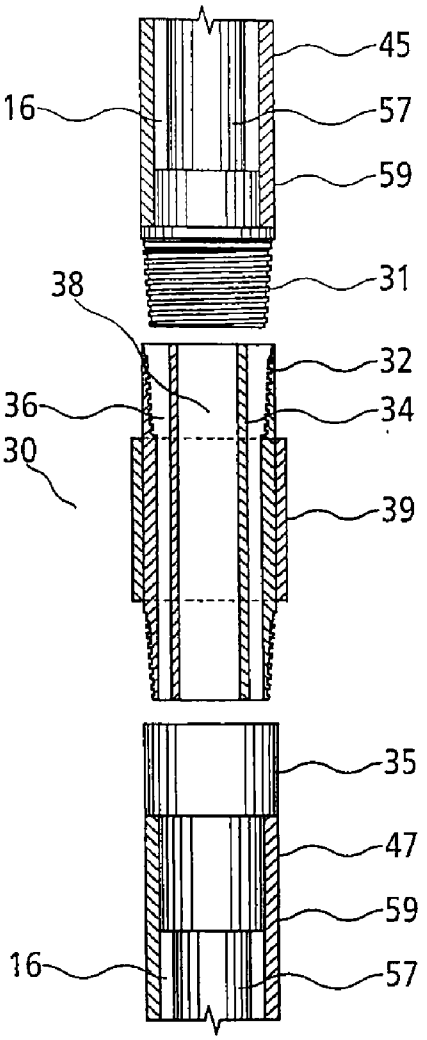
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Fig. 3a

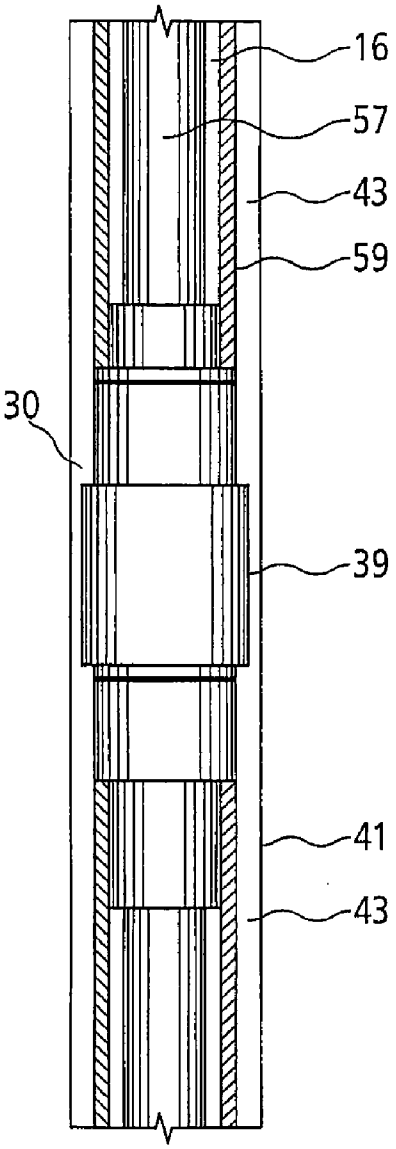


Fig. 3b

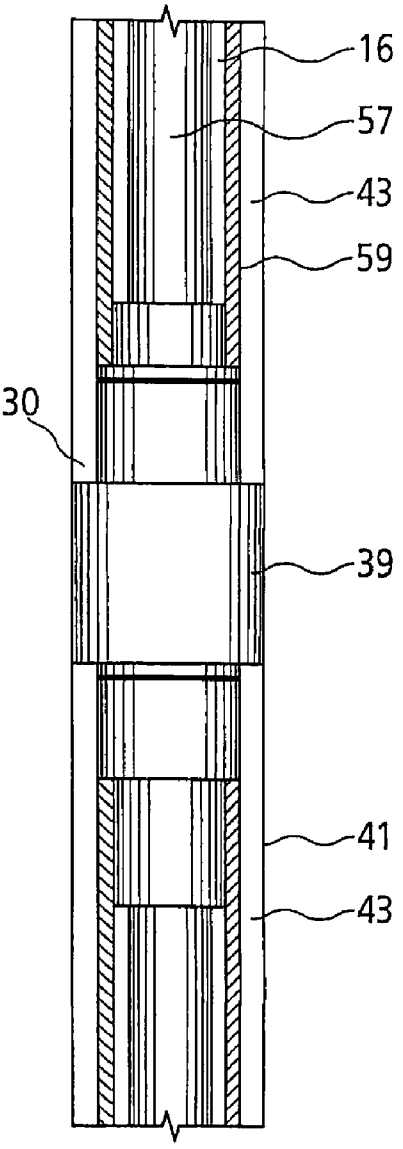


Fig. 4

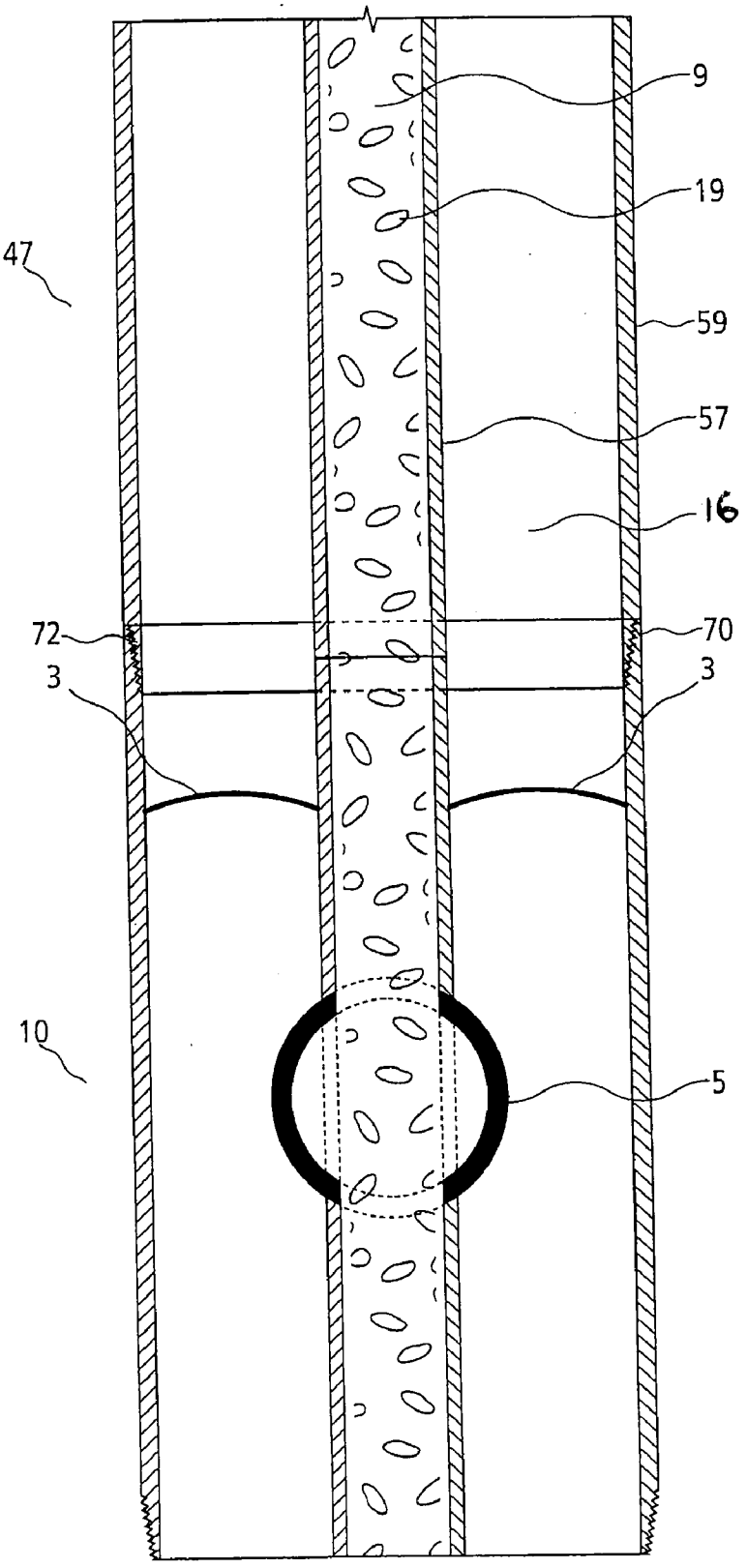


Fig. 5

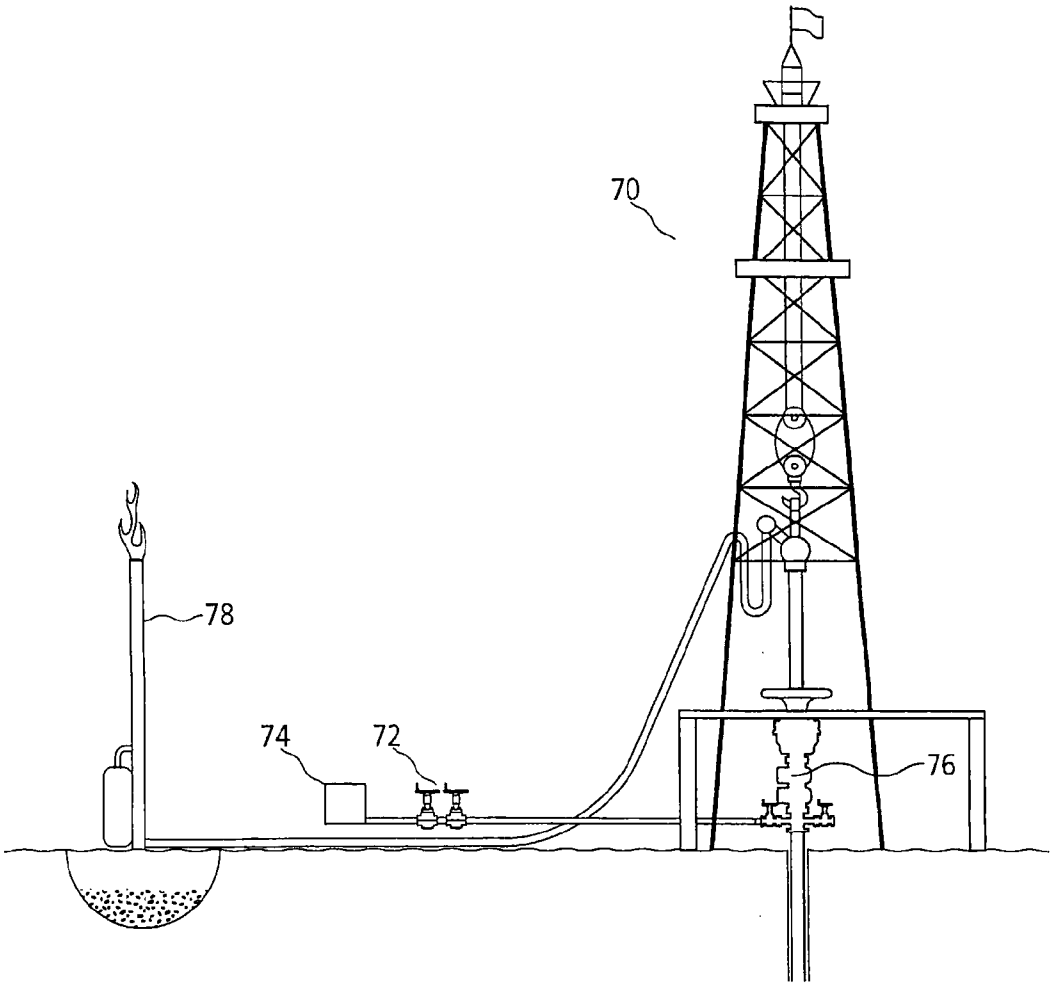


Fig. 6

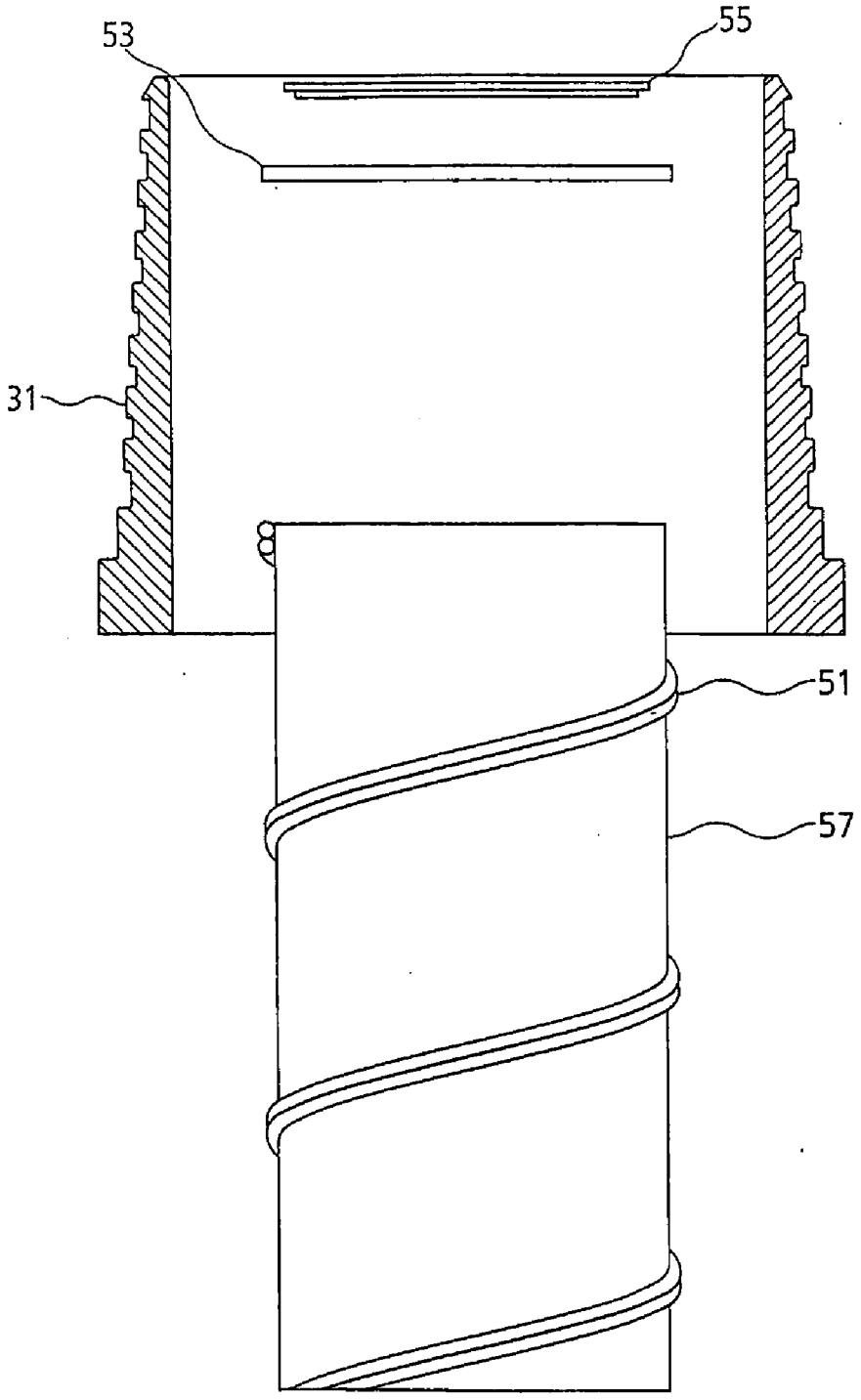


Fig. 7

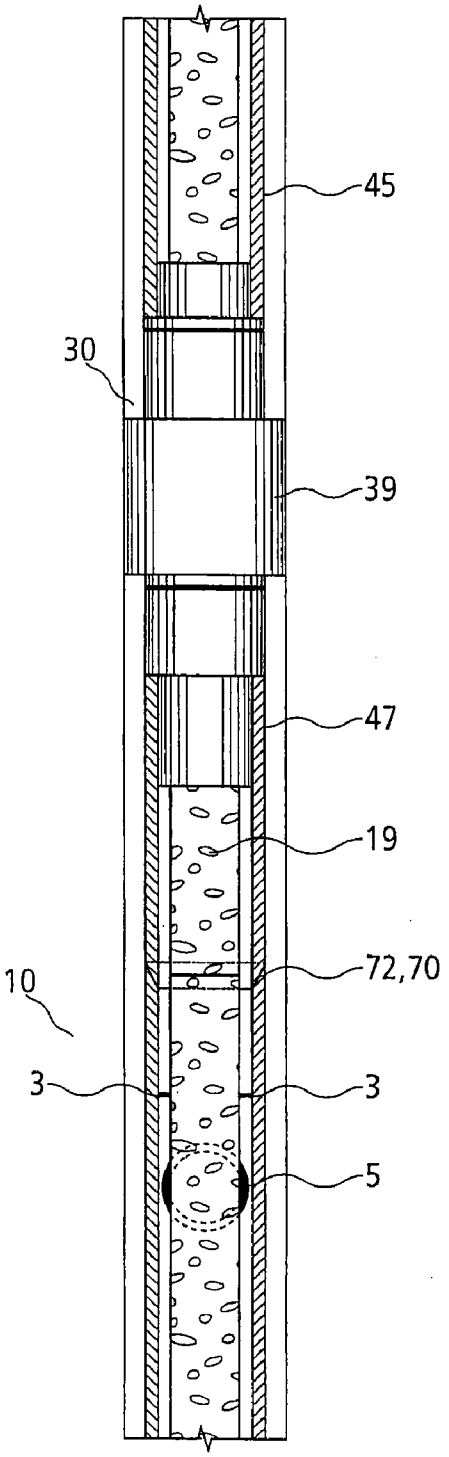
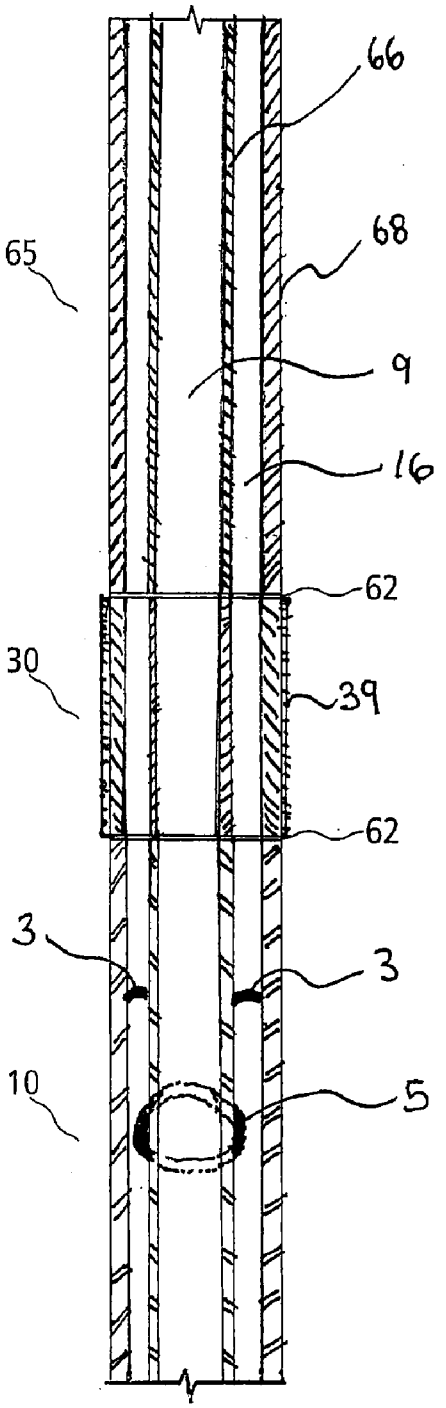


Fig. 8



METHOD AND APPARATUS FOR ISOLATING AND TESTING ZONES DURING REVERSE CIRCULATION DRILLING

[0001] This is a continuation application of U.S. application Ser. No. 10/907,849, filed Apr. 18, 2005 and presently pending. U.S. Pat. No. 10/907,849 is a continuation-in-part of U.S. application Ser. No. 10/906,241 filed Feb. 10, 2005, which claims the benefit of U.S. Provisional Application No. 60/521,051 filed Feb. 11, 2004.

FIELD OF USE

[0002] The present invention relates to an apparatus and method for isolating and testing individual zones in a vertical, directional or horizontal wellbore during drilling. More particularly, the present invention relates to a zone isolating and testing apparatus and method of use thereof to allow testing of isolated zones for flow of hydrocarbons, formation fluids and/or drill cuttings during vertical, horizontal or directional reverse circulation drilling of wellbores using concentric drill pipe, concentric coiled tubing, or the like.

BACKGROUND OF THE INVENTION

[0003] The oil and gas industry uses various methods to test the productivity of wells prior to completing a well (see, for example, U.S. Pat. No. 4,898,236). After drilling operations have been completed and a well has been drilled to total depth, or prior to reaching total depth in the case of multi-zoned discoveries, it is common to test the zone to estimate future production of oil and gas. Current technologies used for testing reservoirs such as drill stem testing (DST) are often too expensive to test multi-zone reservoirs, particularly at shallow depths. Furthermore, isolating and testing zones using conventional packer technology can be slow, expensive and sometimes difficult to set and then release.

[0004] Traditionally the DST process involves flowing a well through a length of drill pipe reinserted through the static drilling fluid. The bottom of the pipe will attach to a tool or device with openings through which fluid can enter. This perforated section is placed across an anticipated producing section of the formation and sealed off with packers, frequently a pair of packers placed above and below the part of the formation being tested. This packing off technique permits an operator to test only an isolated section or cumulative section.

[0005] The present invention allows a fast, safe and economic way to isolate and test zones during reverse circulation drilling by using the already inserted concentric drill string used during drilling. This alleviates the need to first remove the drill string used for drilling and then reinsert a length of drill pipe or coiled tubing for testing.

SUMMARY OF THE INVENTION

[0006] A zone isolating and testing apparatus comprising an isolation tool and a downhole flow control means and a method of using such apparatus is disclosed. The zone isolating and testing apparatus is particularly useful for testing zones during reverse circulation drilling using concentric drill string, e.g., concentric drill pipe, concentric coiled tubing and the like, said concentric drill string comprising an inner tube and an outer tube forming an annular conduit therebetween. The zone isolating and testing apparatus is operably connected to a concentric drill string so as to be in fluid communication with both the inner tube and the annular conduit of the concentric drill string.

[0007] The isolation tool of the zone isolating and testing apparatus comprises a center tube and an outer casing, forming an annular passage therebetween. The isolation tool further comprises an expandable packer means surrounding the outer circumference of the outer casing. The isolation tool is adapted to connect to the bottom of a piece of concentric drill string and is generally positioned near the drilling means.

[0008] When the isolation tool is connected to the concentric drill string, the center tube of the isolation tool is in fluids communication with the inner tube of the concentric drill pipe and the annular passage of the isolation tool is in fluid communication with the annular conduit of the concentric drill string.

[0009] The packer means of the isolation tool can assume two functional positions. When the packer means is in the expanded position, the isolation tool is in the "closed position" and when the packer means is in the contracted position the isolation tool is in the "open position". In a preferred embodiment, the expansion of the packer means is controlled by an electric current for quicker opening and closing of the isolation tool.

[0010] It is understood in the art that the area of the zone tested will be dictated by the distance the isolation tool is placed away from the drilling means. In some instances where the bands of the pay zones are known to be quite broad the isolation tool and the drilling means can be separated from one another by several joints of concentric drill string.

[0011] The downhole flow control means of the zone isolating and testing apparatus also comprises a center tube and an outer casing forming an annular passage therebetween. The downhole flow control means is attached either directly to the isolation tool or to an intervening piece of concentric drill string in such a fashion so as to be in fluid communication with both passageways of the concentric drill string. The downhole flow control means further comprises two valves, one for closing off its annular passage, thus closing off the annular conduit of the concentric drill string and the other for closing off the inner passage of its center tube, thereby closing off the inner conduit of the inner tube of the concentric drill string.

[0012] During the drilling process, the isolation tool is in the open position, i.e. the packer means is contracted. When the tool is in the open position it does not significantly restrict the flow of hydrocarbons through the annulus formed between the wellbore and the concentric drill string, as the outside diameter of the isolation tool when in the open position is preferably equal to or less than the outside diameter of the concentric drill string. However, it is understood that the outside diameter of the open isolation tool can also be less than or greater than the outside diameter of the concentric drill string and still not significantly restrict the flow of hydrocarbons.

[0013] The downhole flow control means is also in the complete open position during drilling, i.e., both valves are

open. This allows drilling fluid to be pumped down either the annular conduit or inner conduit of the inner tube of the concentric drill string and exhaust drilling fluid and drill cuttings to be removed through the other of said annular conduit or inner conduit.

[0014] However, when testing is required during the reverse circulation drilling process, the isolation tool is in the closed position, i.e. the packer means expands to abut the adjacent wellbore walls. Further, one of the two valves of the downhole flow control means is also in the closed position. Which valve will be closed is dependent upon whether drilling fluid is being pumped through the annular conduit or the inner conduit. For example, if drilling fluid were being pumped down the annular conduit then during testing the annular passage valve would be closed during testing.

[0015] Thus, during testing, the zone of the wellbore below the isolation tool is shut off or isolated from the portion of the wellbore above the tool as the expanded packer means will not allow hydrocarbons to flow passed it. The materials present in the isolated zone can then flow through either the annular conduit or inner conduit of the concentric drill string to the surface of the well for testing.

[0016] The disclosed invention has one or more of the following advantages over conventional isolation packer technology and drill stem testing:

[0017] when drilling vertical, directional, and/or horizontal wellbores, individual zones can be isolated and tested much quicker and cheaper without having to interrupt drilling for extended periods of time;

[0018] open hole testing provides very valuable production data;

[0019] zones which may otherwise be damaged by testing fluids when using drill stem testing can now be tested without damage as testing fluids are not necessary;

[0020] easier to measure the flow of formation fluids into a zone;

[0021] decisions on well stimulation can be made while the well is being drilled; and

[0022] more accurate information on reservoir pressure, temperature, flow rate etc. can be obtained from individual zones.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] FIG. **1** is a schematic of one embodiment of the isolation tool of the invention.

[0024] FIG. **2** is a cross-sectional view of the isolation tool shown in FIG. **1**.

[0025] FIGS. **3***a* and **3***b* are schematics of the isolation tool in the open and closed position, respectively.

[0026] FIG. **4** is a cross-section view of the downhole blow out preventor.

[0027] FIG. **5** is a schematic of the surface drilling and testing equipment used in the invention.

[0028] FIG. **6** is a schematic of one embodiment of the inner drill string of concentric drill string of the invention.

[0029] FIG. **7** is a cross-sectional view of one embodiment of the zone isolating and testing apparatus typically used with concentric drill pipe.

[0030] FIG. **8** is a cross-sectional view of one embodiment of the zone isolating and testing apparatus typically used with concentric coiled tubing.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0031] A zone isolating and testing apparatus comprising an isolation tool and a downhole flow control means and method of using such apparatus will now be described with reference to the following preferred embodiment.

[0032] FIG. **1** schematically illustrates the isolation tool **30** of the zone isolating and testing apparatus and means for attaching the isolation tool **30** between two pieces of concentric drill string **45** and **47**. Concentric drill string **45** and **47** both comprise an inner tube **57** and an outer tube **59**. Concentric drill string is designed such that at one end of concentric drill string is a threaded pin end and at the other end is a threaded box end. Thus, pieces of concentric drill string can be connected end to end by screwing the threaded pin end of the new piece of concentric drill string to be added into the box end of the drill string below.

[0033] As can be seen in FIG. **1**, concentric drill string **45** has threaded pin end **31** at its bottom end and concentric drill string **47** has threaded box end **35** at its top end. Isolation tool **30** is adapted to be inserted between concentric drill string **45** and **47** by means of threaded box end **37** and threaded pin end **33**. Thus, threaded pin end **31** of concentric drill string **45** screws into threaded box end **37** and threaded pin end **33** screws into threaded box end **35** of concentric drill string **47**.

[0034] Isolation tool **30** further comprises packer means **39**. Packer means **39** can be expanded or contracted by any means known in the art, for example, by means of an electric current flow path as shown in FIG. **6**. In another embodiment, the packer means comprises an inflatable ring which can be inflated and deflated by pumping various types of fluid into and out of the ring.

[0035] With reference to FIG. **2**, isolation cementing tool **30** further comprises a center tube **34**, an outer casing **32**, an annular passage **36** between the center tube and outer casing, an inner passage **38**, and a packer means **39** surrounding said outer casing **32**. When isolation cementing tool **30** is inserted between concentric drill string **45** and **47**, the center tube **34** of the isolation cementing tool **30** is in fluid communication with the inner tube **57** of the concentric drill string **45** and **47** and the annular passage **36** of the isolation cementing tool **30** is in fluid communication with the annular conduit **16** of the concentric drill string **45** and **47**.

[0036] FIGS. **3***a* and **3***b* schematically illustrate the isolation tool **30** attached to the concentric drill string in the open and closed position, respectively. During drilling the isolation tool **30** is in the open position and during testing it is in the closed position.

[0037] When packer means **39** is contracted or deflated as shown in FIG. **3***a*, the isolation tool **30** is in the open position and hydrocarbons can flow freely through the wellbore annulus **43** formed between the outer wall of the concentric

drill string and the wellbore wall **41**. When packer means **39** is expanded or inflated as shown in FIG. **3***b*, the packer means **39** is forced against wellbore wall **41** thereby closing annulus **43** to hydrocarbon movement above or below the packer means **39**. Thus, the testing region below the packer is isolated from the surface of the wellbore.

[**0038**] In order to test for hydrocarbon flow, formation fluids, drill cuttings and the like present in the testing zone, the isolation tool is used in conjunction with a downhole flow control means or downhole blow out preventor (downhole BOP) as shown in FIG. **4**. In FIG. **4**, downhole BOP **10** is shown in cross-section attached to the lower end of concentric drill string **47** by threaded pin end **72** of concentric drill string **47** screwing into threaded box end **70** of downhole BOP **10**.

[**0039**] In this embodiment, downhole BOP **10** comprises two valve means **3** and **5** for shutting off the flow of drilling fluid, exhausted drilling fluid, drill cuttings and/or hydrocarbons through one or the other of the annular conduit **16** formed between inner tube **57** and outer tube **59** of concentric drill string **47** and inner conduit **9** of inner tube **57**. It is understood that other downhole flow control means can also be used, for example, the downhole flow control means as described in U.S. Patent Applications Publication Nos. 20030155156 and 20030173088, incorporated herein by reference.

[**0040**] Thus, in one embodiment of the invention, the isolation tool **30** and the downhole BOP **10** of the zone isolating and testing apparatus can be separated by a single joint of varying lengths of concentric drill string **47**. However, it is understood that in some instances the isolation tool and downhole BOP can be directly threaded or connected by other connection means to each other. Further, it can be appreciated that the orientation of the two components is not critical; in some instances it may be desirable to have the downhole BOP attached to the bottom of the concentric drill string first and the isolation tool connected either directly or by means of one or more joints of concentric drill string below the downhole BOP.

[**0041**] It is understood that the drilling means (not shown) can be either directly attached to the bottom of the downhole flow control means, the isolation tool, other downhole tools or an intervening joint of concentric drill string. In general, however, the drilling means is attached to the last in the series of downhole tools.

[**0042**] During reverse circulation drilling with concentric drill string, both valves **3** and **5** of the downhole BOP **10** are in the open position (not shown). In one embodiment, drilling fluid is pumped from surface equipment through the annular conduit **16** of the concentric drill string and exhausted drilling fluid, drill cuttings and/or hydrocarbons **19** flow through the inner conduit **9** to the surface of the wellbore. It is understood that drilling fluid could also be pumped from surface through the inner conduit **9** and exhausted drilling fluid, drill cuttings and/or hydrocarbons removed through the annular conduit **16**.

[**0043**] When drilling is stopped for testing, the isolation tool **30**, which is located at or near the downhole BOP, is put in the closed position as shown in FIG. **3***b* to isolate the testing region below the packer means. In the instance where drilling fluid is being pumped down the annular conduit **16** and exhausted drilling fluid, drill cuttings and/or hydrocarbons flow through the inner conduit **9** to the surface of the wellbore, valve means **3** of the downhole BOP **10** is also put in the closed position as shown in FIG. **4**, as no fluids are being flowed from surface equipment during testing.

[**0044**] Valve means **5**, however, remains in the open position as shown in FIG. **4** thereby allowing hydrocarbons, formation fluids and/or drill cuttings (collectively referred to as reference **19**) present in the isolated zone to flow to surface. Well flow test equipment known in the art will be able to determine the hydrocarbon content of the isolated testing area. Optionally, a surface blow out preventor (surface BOP, not shown) is provided to shut off the flow of hydrocarbon from the annulus formed between the concentric drill string and the wellbore walls that may be present in the zone above the packer means.

[**0045**] FIG. **5** schematically shows the surface equipment used during drilling and testing. Drilling rig **70** is equipped with well testing equipment **74**. The hydrocarbons in the test region flow through the inner conduit of the inner tube of the concentric drill string and then through the choke manifold system as shown in **72**. Well flow test equipment can also be located at the end of blewie line **78**. Surface BOP **76** ensures that there is no escape of hydrocarbons to the surface through the annulus formed between the concentric drill string and the wellbore walls.

[**0046**] The isolation tool is preferably powered by an electric current for quicker opening and closing operations. FIG. **6** is a schematic of a portion of concentric drill string having threaded pin end **31** at one end. The outer tube has been removed to reveal inner tube **57**, which is preferably made of a rubber type material, rubber/steel, fiberglass or composite material, capable of withstanding the forces and pressures of the drilling operations. Inner tube **57** further comprises electrical wires **51** that allow the flow of the electric current. Wire coils **53** and **55** are compressed in each end of the concentric drill string when two pieces of concentric drill string are torqued (screwed) together. This provides the electric current to operate the isolation tool, e.g., to expand or contract the packer means as needed.

[**0047**] Other means of operating the isolation tool could include fiber optic cables, radio frequency and electric magnetic forces. When using concentric coiled tubing the isolation tool can be operated using small diameter capillary tubes which transmit hydraulic or pneumatic pressure to an actuator at or near the tool.

[**0048**] FIG. **7** shows a cross-section of one embodiment of the assembled zone isolating and testing apparatus of the present invention, which is typically used with concentric drill pipe. In this embodiment, the isolation tool **30** and the downhole BOP **10** are spatially separated by means of a single joint of varying lengths of concentric drill pipe **47**. Typically, the drilling means (not shown) is attached either directly to the downhole BOP **10** or to other downhole tools that can be attached to the downhole BOP. It may be desirable, however, particularly in instances where the bands of the pay zones are known to be quite broad (i.e., **40** ft or greater), to have the isolation tool and the drilling means separated even further by additional joints of concentric drill string.

[**0049**] FIG. **8** shows another embodiment of the assembled zone isolating and testing apparatus, which is

typically used when the concentric drill string comprises a continuous length of concentric coiled tubing **65** having a continuous length of inner coiled tubing **66** and a continuous length of outer coiled tubing **68**, thereby forming annular conduit **16** and inner conduit **9**. In this embodiment, the isolation tool **30** is connected to the bottom of the concentric coiled tubing **65** by connection means **62** known in the art. The downhole BOP **10** is then connected to the isolation tool **30** by similar connection means **62** known in the art.

[**0050**] The foregoing disclosure and description of the invention are illustrative and explanatory thereof. Various changes in the size, shape and materials as well as the details of the illustrated construction may be made without departing from the spirit of the invention.

I claim:

1. An isolation tool for use with a concentric drill string for isolating a zone in a wellbore for testing, comprising:

(a) a center tube and an outer casing, said center tube and outer casing forming an annular conduit therebetween; and

(b) an expandable and contractible packer means for sealing off an outside annular passage formed between a wall of said wellbore and an outer surface of said concentric drill string; whereby the isolation tool is adapted to be operably connected to the concentric drill string such that the isolation tool is in fluid communication with the concentric drill string.

2. The isolation tool as claimed in claim 1, wherein said packer means expands or contracts by means of an electric current.

3. The isolation tool as claimed in claim 1 wherein said packer means comprises an inflatable ring.

4. The isolation tool as claimed in claim 3 wherein said inflatable ring expands or contracts by pumping fluids into or out of the inflatable ring.

* * * * *