Oct. 22, 1963 M. P. LEBOURG 3,107,730

SAMPLE TAKING APPARATUS

Filed Aug. 10, 1959 2 Sheets-Sheet 1

Fig. 1

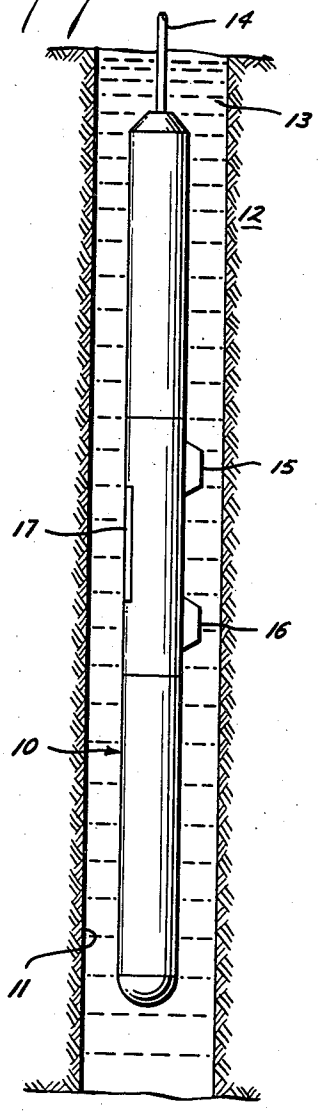
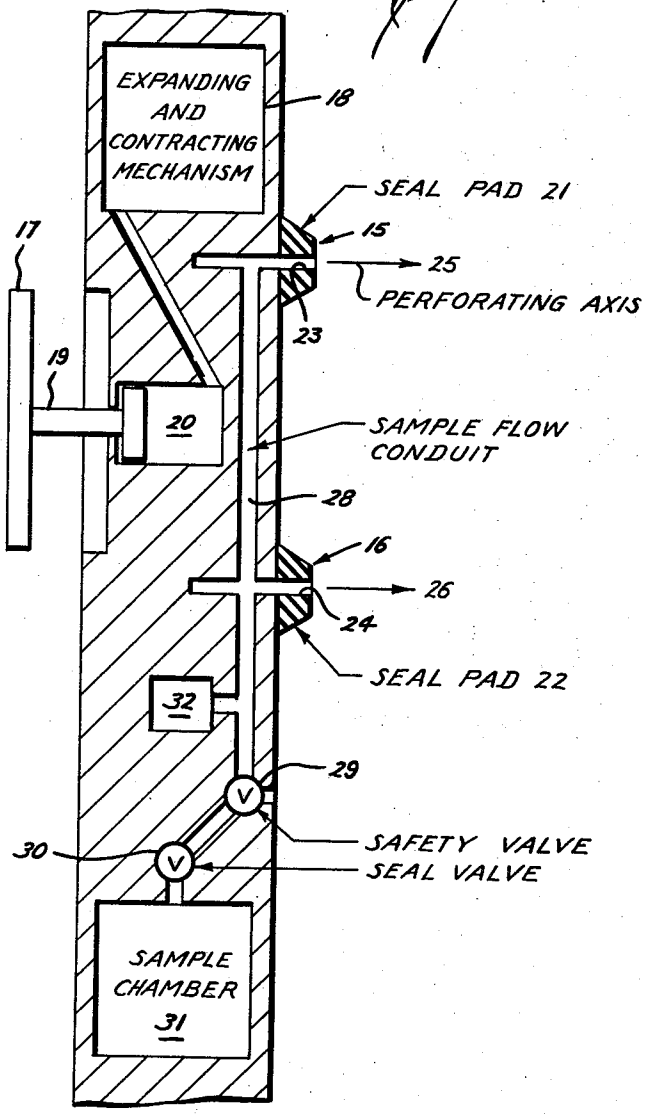


Fig. 2



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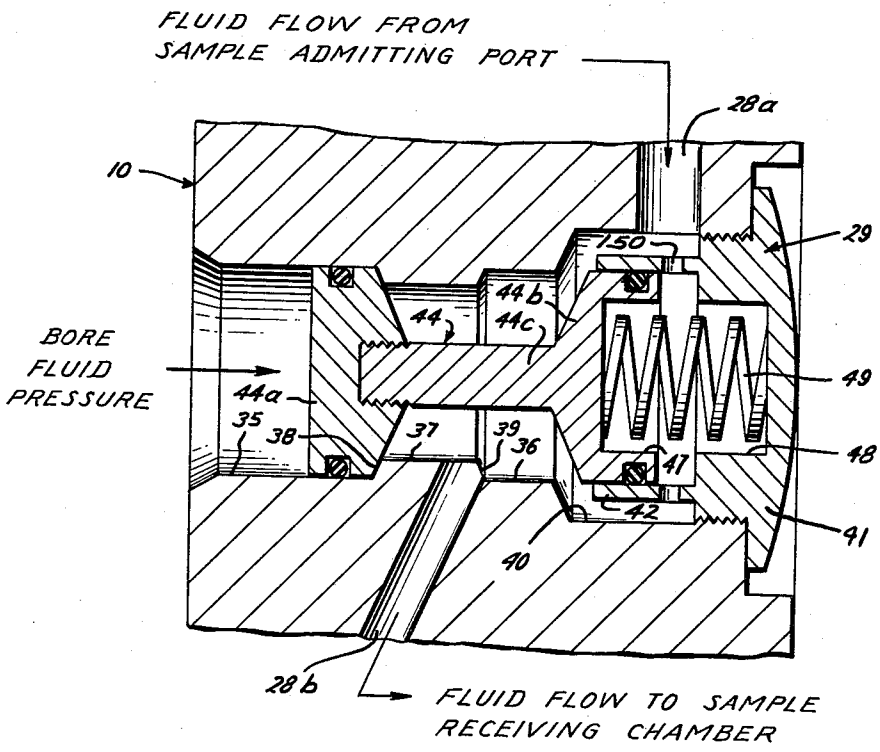


Fig. 3

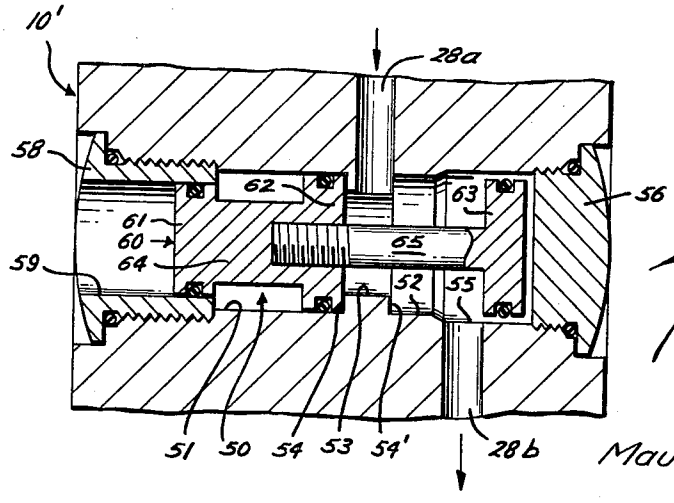


Fig. 4

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SAMPLE TAKING APPARATUS

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10 Claims. (Cl. 166—100)

The present invention relates to fluid sampling apparatus and, more particularly, to new and improved fluid sampling apparatus which reduces the possibility of contamination by bore fluid of a formation fluid sample obtained by the fluid sampling apparatus.

Generally, commercial formation fluid sample taking apparatus in present use employs a pack-off device with a sealing member which is brought into engagement with a portion of the sidewall of the bore so as to isolate a portion of the formation from the usual fluid in the bore. Thereafter, a sample-admitting port in the sealing member is opened, for example, by perforating means to permit fluids from the formation to flow via the sample-admitting port into a sample-receiving chamber in the apparatus. After a suitable period of time during which the formation fluids are collected, the sample-receiving chamber is closed, the pack-off device and sealing member retracted and the apparatus withdrawn from the bore so that a sample may be measured and analyzed. For further details of formation fluid samplers as above-described, reference may be made to Patent No. 2,674,313 by Lawrence S. Chambers, or to copending application Serial No. 817,769 by Frank R. Whitten, filed June 3, 1959, or copending application Serial No. 833,356 by Frank R. Whitten, filed Aug. 12, 1959.

In apparatus, as above described, occasionally it has been found that the seal of the sealing member with respect to the formation may fail or the apparatus otherwise malfunction so that while the sample chamber is open, the bore fluid may gain access to the interior of the tool and contaminate the fluid sample. Thus, the fluid sample when recovered has little or no value for analysis.

Accordingly, it is an object of the present invention to provide new and improved fluid sampling apparatus in which substantial contamination of a collected formation fluid sample by bore fluid is reduced if not eliminated.

Another object of the present invention is to provide new and improved safety devices for fluid sampling apparatus to prevent or eliminate substantial contamination or escapement of a collected formation fluid sample by bore fluid which is both simple and economical to manufacture and reliable in operation.

In accordance with the present invention, a fluid sampling apparatus having a sample-admitting port and sample-receiving chamber coupled for fluid communication is provided with a valve in the fluid sample flow line which is held open by the hydrostatic pressure of bore fluid so that the fluid may flow from between the sample-admitting port and sample chamber uninterrupted as long as the pressure of the borehole fluids exceeds the pressure of the formation fluid. Means are provided to close the valve and thereby block the fluid conduit whenever the pressure of the formation fluids approaches the hydrostatic pressure of the bore fluid. Hence, a collected formation fluid sample will be preserved should the bore fluid gain access to the fluid sample flow line.

The novel features of the present invention are set forth in the appended claims. The present invention, both as to its organization and manner of operation together with further objects ad advantages thereof may best be understood by way of illustration and example taken in conjunction with the accompanying drawings in which:

FIG. 1 is a diagrammatic view in elevation of fluid sampling apparatus embodying the present invention and shown disposed in a borehole;

FIG. 2 is a diagrammatic illustration of operating portions of the fluid sampling apparatus which are arranged for lowering into a well;

FIG. 3 is a cross-sectional view of a safety valve embodying the present invention; and

FIG. 4 is a cross-sectional view of another embodiment of the present invention.

In FIG. 1 of the drawings, a formation sampling apparatus 10 is shown disposed in a smooth-walled bore 11 such as those found in hard rock formations, the bore 11 traversing earth formations 12. Bore 11 contains a fluid 13 to provide a hydrostatic control pressure for the well in a conventional manner.

For convenience of explanation and illustration, apparatus 10 is the same as that described in the copending application Serial No. 833,356, filed Aug. 12, 1959, by Frank R. Whitten and reference may be made thereto for the detailed description. It will be appreciated, however, that the present invention may be employed in other fluid sampling apparatuses, for example, as disclosed, in copending application Serial No. 817,769, filed June 3, 1959, by F. Whitten or the aforesaid Chambers patent.

Apparatus 10 is suspended in the bore 11 by a cable 14 connected to a winch (not shown) located at the surface of the earth, the winch and cable serving to lower and raise the apparatus in a customary manner.

Apparatus 10 is provided with spaced sample-admitting means 15, 16 which are adapted to engage and seal with the portions of the borehead wall. Diametrically opposed from the sample-admitting means 15, 16 is a wall-engaging member 17 mounted so as to move between a retracted position and an extended position, the retracted position permitting movement of the apparatus through the bore while the extended position places the sample-admitting means in sealing engagement with the bore wall.

As shown in FIG. 2, an expanding and reracting mechanism 18 is provided to manipulate the movement of the wall-engaging member 17 between the extended and retracted positions by means of a piston 19 secured to the member 17 and a hydraulic cylinder 20. The sample-admitting means include seal pads 21, 22 which have normally-closed central ports 23, 24 (shown in an open condition). Perforating means (not shown) in the apparatus are adapted upon detonation to produce perforating jets extending along perforating axes 25, 26 when the sealing pads are in sealing engagement with portions of the borehole wall to open the ports 23, 24 as shown in the drawing. After perforation of the formations by the jets, the formation fluids may flow through the ports 23, 24, sample flow conduit 28, safety valve 29, and seal valve 30 to a sample chamber 31 which collects the fluid from the formation. A pressure recording device 32 may be connected to the sample flow conduit 28 to record the pressures of the fluids in the conduit. The seal valve 30 is adapted, upon actuation, to close off the sample chamber and thereby entrap a collected fluid sample.

With the above general explanation of sample taking apparatus, reference may now be made to FIG. 3 for an understanding of the safety valve 29 in relation to the sample taking apparatus. In FIG. 3, safety valve 29 is disposed between an upper conduit section 28*a* which is coupled to the sample-admitting means 15, 16 (FIG. 2) and a lower conduit section 28*b* which is coupled to the sample-receiving chamber 31 (FIG. 2).

Apparatus 10 is generally cylindrical and valve 29 is generally arranged transversely to the longitudinal axis of the apparatus. Valve 29 includes first and second bores 35, 36 of equal diameter separated by section having a bore 37 of smaller diameter, the respective junc-

tions of the bores forming seats 38, 39 which are beveled inwardly towards the bore 37. Adjoining bore 36 is an enlarged bore 40 which threadedly receives a cap member 41. Cap member 41 has a tubular extension 42 which has an outside diameter less than the diameter of bore 40 and an inside diameter similar to the diameter of bores 35, 36. Conduit 28*a* opens into bore 40 while conduit 28*b* opens into bore 37, the terminal end of cap extension 42 being spaced from the junction of bores 36 and 40 to permit fluid flow between conduit sections 28*a*, 28*b*.

In the valve 29 is a spool-type piston arrangement 44 which includes pistons 44*a*, 44*b* rigidly spaced from one another by a member 44*c* of smaller diameter than bore 37, the piston 44*a* being slidably and sealingly received by bore 35 while piston 44*b* is arranged to be slidably and sealingly received by bore 36. In the position of the piston arrangement 44 shown, piston 44*b* is slidably received within the cap extension 42 while piston 44*a* abuts seat 38 whenever the pressure of the bore fluid exceeds the pressure of the fluid in the conduit 28 by a certain amount.

The adjacent end surfaces of cap member 41 and piston 44*b* have aligned and similar cylindrical recesses 47, 48 which receive a spring 49. Spring 49 is normally under compression when the piston arrangement 44 is in position shown to permit fluid flow through conduit 28. Extension 42 is also provided with fluid access ports 150 suitably located to prevent a fluid lock of piston 44*b* in extension 42.

From the foregoing described apparatus, it will be apparent that the hydrostatic pressure of the bore fluid acts on one side of the piston 44*a* while the pressure of the formation fluid plus the spring force act on the other side of piston 44*a* to oppose the hydrostatic pressure. Thus, whenever the pressure of the fluids in conduit 28 approaches the hydrostatic pressure of the bore fluid, for example, if a seal should fail or a substantial leak in the apparatus occur, the fluid pressure in conduit 28 plus the spring force will exceed the hydrostatic bore fluid pressure on 44*a* so that the piston 44*a* is moved to the left moving piston 44*b* into bore 36 to abut seat 39 and block the conduit 28*b*. An O ring in piston 44*b* is arranged to seal with the bore 36 insuring the interruption of fluid communication between conduit sections 28*a*, 28*b*. Piston 44*b* and bore 36 of the housing constitute cooperating valve elements such as a valve seat and valve member which are relatively movable between a position permitting fluid flow through conduit sections 28*a*, 28*b* and a position blocking fluid flow between sections 28*a*, 28*b*. The piston 44*a* in bore 35 in the housing is subject to a pressure differential between the pressure in the well bore and the pressure in the conduit sections 28*a*, 28*b*. Piston 44*a* is coupled to piston 44*b* thereby providing relative movement between the valve elements in response to a pressure differential across piston 44*a*. Hence, fluid sample collected prior to the seal failure or leakage will be preserved by virtue of the fact that valve 29 will automatically close whenever the bore fluid gains access to the flow conduit.

Referring now to FIG. 4, in another embodiment of the present invention, a valve 50 is disposed in an apparatus 10' between an upper conduit 28*a* from a sample-admitting port and a lower conduit 28*b* to a sample-receiving chamber. Valve 50 includes first and second bores 51, 52 of equal diameter separated by a section having a bore 53 of smaller diameter, the respective junctions of the bores forming seats 54, 54'. Adjoining bore 52 is an enlarged bore 55 which is threaded at one end to receive a cap member 56. Adjoining bore 51 is an enlarged threaded bore which threadedly receives a tubular sleeve 58 having a central bore 59 of smaller diameter than bore 51. Conduit 28*a* opens into bore 53 while conduit 28*b* opens into enlarged bore 55.

A spool-type piston arrangement 60 includes pistons 61, 62, 63 rigidly spaced from one another by sections 64 and 65 of smaller diameter than the diameter of the pistons. Pistons 61, 62 and 63 are arranged to be sealingly received by bores 59, 51 and 52 respectively. In the position shown of the piston arrangement 60, piston 63 is disposed within enlarged bore 55 thereby permitting fluid flow between conduits 28*a*, 28*b* while piston 62 in bore 51 abuts seat 54 and piston 61 is in bore 59. By construction, piston 61 has a smaller area than piston 62 or 63, the pistons 62, 63 having equal areas. The area of piston 61 multiplied by the hydrostatic pressure of the bore fluid will have a greater value than the area of piston 62 multiplied by the formation fluid pressure so that the valve will stay open while a sample is being taken. However, if the bore fluid enters the flow line, the area of piston 62 being larger than the area of piston 61 will cause the pistons to shift to the left so that piston 63 enters bore 52 to abut shoulder 54' thereby blocking the conduit 28*b* and preserving the collected fluid sample.

In addition to the foregoing evident advantages, it will also be appreciated that should the seal valve 30 fail to close at the end of a test, the separation of the seal pads 23, 24 from the bore wall will admit bore fluid and thus the safety valve will close to preserve the collected sample from contamination and the sample cannot escape through conduit 28*a*.

While particular embodiments of the present invention have been shown and described, it is apparent that changes and modifications may be made without departing from this invention in its broader aspects, and therefore the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of this invention.

What is claimed is:

1. A fluid sample taking apparatus for use in a fluid-filled well bore including sample-receiving means for collecting a sample of fluids from earth formations, sample-admitting means for isolating a section of earth formations from the fluids in the well bore to pass formation fluids to said sample-receiving means, and flow conduit means providing a fluid communication path between said sample-receiving means and said sample-admitting means, the improvement in said apparatus comprising a valve having a valve seat and a valve member disposed in said conduit means and cooperative upon relative movement to move between positions to open and close said conduit means, said apparatus further having a bore extending between said conduit means and the exterior of said apparatus, a piston in said bore exposed on one side to the fluids in said flow conduit means and exposed on an opposite side to fluids exterior of said apparatus, said valve member being coupled to said piston and resilient means normally urging said valve member towards a position for closing said conduit means.

2. A fluid sample taking apparatus for use in a fluid-filled well bore including sample-receiving means for collecting a sample of fluids from earth formations, sample-admitting means for isolating a section of earth formations from the fluids in the well bore to pass formation fluids to said sample-receiving means, and flow conduit means providing a fluid communication path between said sample-receiving means and said sample-admitting means, the improvement in said apparatus comprising a valve having a valve seat and a valve member disposed in said conduit means and cooperative upon relative movement to move between postiions to open and close said conduit means, said apparatus further having a bore extending between said conduit means and the exterior of said apparatus, a piston in said bore exposed on one side to the fluids in said flow conduit means and exposed on an opposite side to fluids exterior of said apparatus, a shoulder in said bore limiting movement of said piston in one direction when said conduit means is open, said piston being coupled to said valve member, and spring

means operating on said valve member tending to close said conduit means.

3. A fluid sample taking apparatus for use in a fluid-filled well bore including sample-receiving means for collecting a sample of fluids from earth formations, sample-admitting means for isolating a section of earth formations from the fluids in the well bore to pass formation fluids to said sample-receiving means, and flow conduit means providing a fluid communication path between said sample-receiving means and said sample-admitting means, the improvement in said apparatus comprising a valve having a valve seat and a valve member disposed in said conduit means and cooperative upon relative movement to move between positions to open and close said conduit means, said apparatus further having a bore extending between said conduit means and the exterior of said apparatus, said bore having sections of different diameters, a piston in said bore having sections of different diameters to correspond to said bore and being exposed on one side to the fluids in said flow conduit means and exposed on an opposite side to fluids exterior of said apparatus, said piston being coupled to said valve member and functioning together to operate said valve.

4. A fluid sample taking apparatus for use in a fluid-filled well bore including sample-receiving means for collecting a sample of fluids from earth formations, sample-admitting means for isolating a section of earth formations from the fluids in the well bore to pass formation fluids to said sample-receiving means, and conduit means providing a fluid communication path between said sample-receiving means and said sample-admitting means, the improvement in said apparatus comprising a valve having a valve seat and a valve member disposed in said conduit means and cooperative upon relative movement to move between positions to open or close said conduit means, said apparatus further having a bore extending between said conduit means and the exterior of said apparatus, said bore having sections of different diameters wherein the larger diameter section is intermediate of the smaller diameter section and said conduit means, a piston in said bore having sections of different diameters to correspond to said bore, said piston being coupled to said valve member and functioning together to operate said valve.

5. In a cable supported well tool apparatus for use in a fluid-filled well bore wherein such apparatus has an internally contained conduit for fluid flow only in said apparatus and wherein the pressure of fluids in said conduit are different from the pressure of the fluids in the well bore, the improvement in said apparatus comprising valve means for opening or closing said conduit dependent upon the pressure differential between fluids within the conduit and fluids in the well bore, said valve means including a valve seat and a valve member disposed in said conduit and cooperative upon relative movement therebetween to either open or close said conduit, said apparatus further having a bore extending between said conduit and the exterior of said apparatus, a piston in said bore, said piston being coupled to said valve member and functioning together to operate said valve, said piston and valve members having an effective area in fluid communication with the pressure of fluids in said conduit which is greater than the effective area in fluid communication with the fluid in the well bore.

6. In a cable supported well tool apparatus for use in a fluid-filled well bore wherein such apparatus has an internally contained conduit for fluid flow only in said apparatus and wherein the pressure of fluids in said conduit are different from the pressure of the fluids in the well bore, the improvement in said apparatus comprising valve means for opening or closing said conduit dependent upon the pressure differential between fluids within the conduit and fluids in the well bore, said valve means including a valve seat and a valve member disposed in said conduit and cooperative upon relative movement

therebetween to either open or close said conduit, said apparatus further having a bore extending between said conduit and the exterior of said apparatus, a piston in said bore, said piston being coupled to said valve member and functioning together to operate said valve, and a spring operative upon said valve member to urge said valve member towards a position to close said conduit said piston and valve member having a first effective area in fluid communication with the pressure of fluids in said conduit providing a force acting in one direction and having a second effective area in fluid communication with the pressure of the fluids in the well bore providing a force acting in an opposite direction, said valve closing whenever the combined force acting in one direction and force of said spring exceed the force acting in the opposite direction.

7. Fluid sample-taking apparatus for use in a well bore containing a fluid comprising: a support adapted for passage through a borehole and having sample-admitting means adapted for sealing engagement with the wall of a borehole, sample-receiving means for receiving a fluid sample, a flow line conduit providing a fluid communication path between said sample-admitting means and said sample-receiving means, and a valve having relatively movable valve elements operable to permit or block fluid flow through said flow line conduit and including differential pressure-responsive means, and means providing a pressure communication path between said differential pressure-responsive means and the exterior of said support and between said differential pressure-responsive means and said flow line conduit whereby a pressure differential across said differential pressure-responsive means controls the operative condition of said valve.

8. Fluid sample-taking apparatus for use in a well bore containing a fluid comprising: a support adapted for passage through a borehole and having sample-admitting means adapted for sealing engagement with the wall of a borehole, sample-receiving means for receiving a fluid sample, and a flow line conduit providing a fluid communication path between said sample-admitting means and said sample-receiving means; a valve including relatively movable valve elements carried by said support arranged to close or open said flow line conduit and control fluid flow therethrough, and slidable piston means in a cylinder in said support, said cylinder extending on one side of said piston means to the exterior of said support and extending on the other side of said piston means to said flow line conduit, the effective pressure area to the one side of said piston means being greater than the effective area to the other side of said piston means so that a pressure differential between the fluids in the well bore and the fluids in said flow line conduit acting on said piston means and valve elements effects an operation of said valve.

9. Fluid sample-taking apparatus for use in a well bore containing a fluid comprising: a support adapted for passage through a borehole and having sample-admitting means adapted for sealing engagement with the wall of a borehole, sample-receiving means for receiving a fluid sample, and a flow line conduit providing a fluid communication path between said sample-admitting means and said sample-receiving means; a valve including relatively movable valve elements carried by said support arranged to close or open said flow line conduit and control fluid flow therethrough, and slidable piston means in a cylinder in said support, said cylinder extending on one side of said piston means to the exterior of said support and extending on the other side of said piston means to said flow line conduit whereby effective pressure areas are provided on opposite sides of said piston means, and spring means acting on said piston means and one valve element for normally urging said one valve element toward a position closing said flow line conduit so that when the force of said spring combined with the force provided by the fluids in the flow line acting on one of said pressure

areas exceeds the force provided by the fluids in the well bore acting on the remaining pressure area, the valve will close.

10. In a cable-supported well tool apparatus for use in a fluid-filled well bore wherein such apparatus has an internally-contained conduit for fluid flow only in said apparatus and wherein the pressure of fluids in said conduit are different from the pressure of the fluid in the well bore exterior of said apparatus, the improvement in said apparatus comprising a valve for said conduit having valve elements arranged for relative movement to open or close said conduit relative to fluid flow therethrough and including differential pressure-responsive means, said differential pressure-responsive means including a piston

slidably received in a cylinder, said cylinder extending on one side of said piston to the exterior of the apparatus and extending on an opposite side of said piston to said conduit whereby a pressure differential across said differential pressure-responsive means controls the operative condition of said valve.

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