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H. M. BUCK ET AL

3,055,428

WELL FLUID SAMPLER

Filed March 3, 1961

FIG. 1.

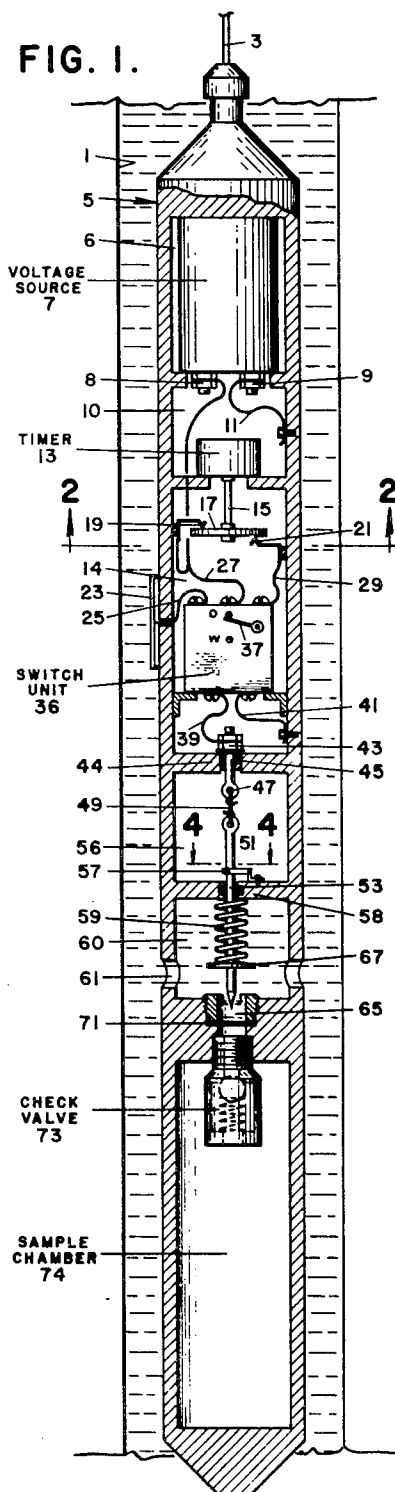


FIG. 2.

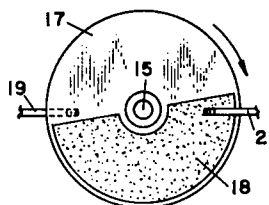


FIG. 3.

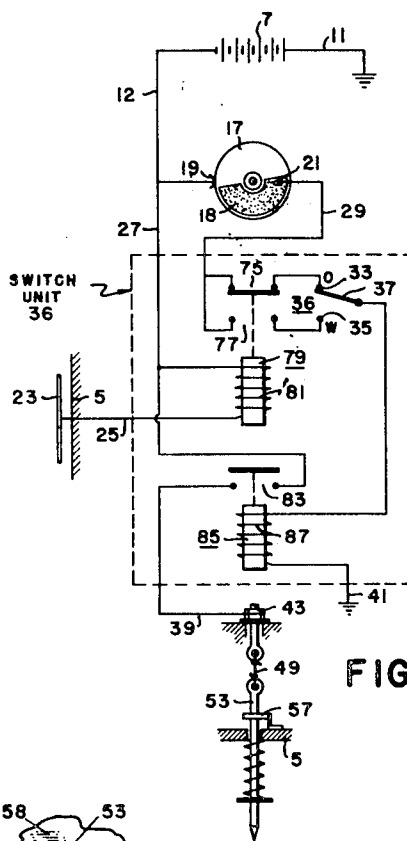
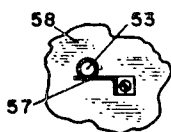


FIG. 4.



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WELL FLUID SAMPLER

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This invention relates to apparatus for obtaining fluid samples, and more particularly to apparatus for obtaining fluid samples under reservoir conditions in well bores.

For a number of reasons it is important to obtain samples of fluids at various levels in well bores, the most important reason being to determine conditions for and methods of production that will recover the maximum quantity of hydrocarbonaceous fluids from hydrocarbon-containing reservoirs. Inasmuch as hydrocarbon oil and gas produced at the surface of the ground have quite different physical characteristics at normal atmospheric temperature and pressure than the same fluids have in the reservoir at superatmospheric temperature and pressure, it is necessary to use special apparatus to obtain fluid samples which are truly representative of reservoir conditions.

It is known that fluids in well bores may be entirely hydrocarbonaceous in nature, may be entirely salt water, or may be mixtures of salt water and hydrocarbon fluids. When samples of well bore fluids are to be obtained, it is usually desired to obtain samples which are predominantly hydrocarbonaceous in character. However, there are circumstances under which an operator may want to obtain samples of well fluids which are predominantly salt water. For this reason it is desirable to use a well fluid sampler that is capable of distinguishing between well bore fluids that are predominantly hydrocarbonaceous and those that are predominantly salt water.

In connection with the present invention, there is provided a housing, including a sample chamber, adapted to be lowered into a well bore. A passageway from the exterior of the housing to the sample chamber includes a check valve adapted to permit unilateral fluid flow of fluids into the chamber from the exterior of the housing. The opening into the chamber through which fluids pass is provided with a sealing means. Also provided in cooperation with the sealing means is apparatus for opening the sealing means responsive to energization of an electrical conductor. There is further provided a source of electrical energy and timing circuit means connecting the energy source to the electrical conductor, adapted to energize the conductor after a predetermined time interval. Preferably, there is also provided in circuit relationship with the timing circuit means a conductivity sensing means adapted to measure the electrical conductivity of well fluids within which the housing is disposed, and to prevent energization of the electrical conductor until the housing is disposed in well fluids of predetermined electrical conductivity. Thus, the electrical conductor is energized after a given elapsed time interval only when the housing is disposed in well fluids having given electrical conductivity, to open the sealing means and permit flow of well fluids into the sample chamber.

Objects and features of the invention which are not apparent from the above discussion will become evident from the following description when taken in connection with the accompanying drawings, in which:

FIG. 1 is an elevational view, partially in cross section, of an embodiment of the invention in position in a well bore;

FIG. 2 is a fragmentary, cross-sectional view taken along section 2—2 of FIG. 1;

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FIG. 3 is a schematic diagram of the electrical circuitry of the apparatus of FIG. 1; and

FIG. 4 is a fragmentary, cross-sectional view taken along section 4—4 of FIG. 1.

With reference now to the embodiment of the invention shown in FIG. 1, reference numeral 1 designates a portion of a borehole filled with well fluids such as oil, gas, salt water, and mixtures thereof. An elongated housing 5 is suspended in the borehole fluid by means of a wire line 3. The housing 5 includes a plurality of compartments 6, 10, 14, 56, and 60 and a sample chamber 74. A port 61 provides fluid communication into compartment 60. Port 65 and check valve 73 provide fluid communication between compartment 60 and sample chamber 74. The port 61, compartment 60, port 65, and check valve 73 may be considered port means or passageway means for providing fluid communication between chamber 74 and the exterior of the housing. The check valve 73 is adapted to permit fluid flow into chamber 74 when a given differential pressure exists between the exterior of the housing and the chamber 74, but is adapted to oppose fluid flow out of the chamber. Sealing means, illustrated as frangible disk 71, provides a fluid seal to prevent fluid flow into the sample chamber 74 until the frangible disk 71 is broken.

For the purpose of breaking the frangible disk 71, there is provided an elongated spear-like member 53 that extends through the wall 58 dividing compartments 56 and 60. A coil spring 59 surrounding the lower portion of the spear-like member 53 between flange 67 and wall 58 is adapted to drive spear-like member 53 into frangible disk 71 to puncture or shatter the disk. The spear-like member 53 is formed of copper, brass, or other conductive metals for a reason that will become apparent. The spear-like member 53 is held away from frangible disk 71 in the position shown in FIG. 1 by means of a fusible electrical conductor 49 connected between eyelet 51 of the spear-like member 53 and eyelet 47 of an electrical terminal 43 that provides an electrical connection through wall 44 separating compartments 14 and 56. A spring contact member 57 is biased against the spear-like member 53 to provide good electrical contact between the spear-like member and the wall 58 of the housing 5 (see FIG. 4). Insulator 45 is for the purpose of mechanically securing electrical terminal 43 to the wall 44 and to electrically insulate the terminal from the wall.

Housed within compartments 6 and 10, respectively, are an electrical energy source 7 and a timing motor 13. The electrical energy source 7 may be a dry battery or a mercury cell. The timer motor 13 preferably is a conventional mechanical, clock-work actuated device adapted to drive output shaft 15 through one revolution over a preselected period between 15 minutes to one hour. In compartment 14 there is housed electrical control apparatus for energizing the fusible electrical conductor 49. The electrical control apparatus will be described below with reference to FIG. 3.

The output shaft 15 of timer motor 13 drives a disk 17 which is formed of electrically conductive metal. A nonconductive sector 18 is provided in or on the disk. The nonconductive sector may be cemented to the surface of the disk or may be inserted in a cutout portion of the disk. A pair of electrical contact members 19 and 21 are insulatively supported by housing 5 in compartment 14 and engage the disk 17. Contact members 19 and 21 are positioned so that contact member 19 is electrically insulated from contact member 21 during a predetermined portion of the revolution of shaft 15 and disk 17. As shown, nonconductive sector 18 occupies any desired portion of the disk 17; in FIG. 3 it is shown as occupying half of the disk. When contact members 19 and 21 en-

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gage the conductive portion of the disk, an electrical connection between contact members 19 and 21 is completed.

Contact member 19 is electrically connected to one terminal 8 of the energy source 7. The other terminal 9 of the energy source 7 is connected to the housing by means of electrical conductor 11. Switch unit 36 includes relays 79 and 85 and manually actuatable SPDT switch 36. The electrical interconnection of switch 36, relays 79 and 85, and the other components of the apparatus is illustrated in FIG. 3.

With reference now to FIGS. 1 and 3 taken together, a conductivity probe 23 on the exterior of the housing comprises a conductive disk insulatively supported on the exterior of the housing so as to sense the electrical conductivity between the disk and the housing. The probe 23 is connected to the coil 81 of relay 79 by electrical lead 25. The other end of the coil is connected to the terminal 8 of energy source 7 by means of electrical leads 27 and 12. Thus, electrical conduction between the disk of probe 23 and the housing 5 through the well fluid will cause current to flow through coil 81 to actuate relay 79. The magnitude of current required to actuated relay 79 may be set by any conventional means, such as a mechanical adjustment on the relay, or a resistor (not shown) in parallel with the actuating coil 81.

Relay 79 is further provided with a normally-closed contact means 75 and a normally-open contact means 77. An electrical lead 29 electrically connects contact member 21 to contact means 75 and 77.

The operation of the electrical circuit shown in FIG. 3 will be best understood by considering the following description of operating cycles thereof. Let it be assumed that the timing mechanism has been set so that contact member 21 engages the conductive portion of disk 17 after a given predetermined interval, and that the apparatus is as shown in FIG. 1. The housing is lowered into the well until a desired depth is reached. If the fluid in which the housing is suspended is predominantly salt water, electrical conduction between probe 23 and the housing will energize coil 81 to close normally-open contact means 77. Assuming further that it was desired to collect a sample of oil so that movable switch 37 engages contact means 33, no current will flow through coil 87 of relay 85. If, however, the housing is suspended in oil so that only a small current flows through coil 81 insufficient to actuate relay 79, normally-closed contact 75 will remain closed. Therefore, when contact member 21 engages the conductive portion of disk 17, current will flow from energy source 7 through lead 12, disk 17, lead 29, contact 75, switch 37, coil 87, lead 41, and the housing to close normally-open contacts 83 of relay 85. Current will thereupon flow from energy source 7, through lead 9, lead 27, contacts 83, lead 39, fusible electrical conductor 49, spear-like member 53, and housing 5. Fusible conductor 49 will fuse to release spear-like member 53 and puncture frangible disk 71. Inasmuch as the borehole pressure is substantially greater than the pressure required to open check valve 73, the check valve will open and fluid will flow into the chamber. When the pressure between the borehole and the sample chamber 74 equalizes, check valve 73 will close. The apparatus thereupon may be withdrawn from the well bore with the fluids in the sample chamber in substantially reservoir condition.

When it is desired to collect a sample of water, switch member 37 is thrown to its lower position so that it engages contact 35. When the housing is suspended in salt water, relay 79 will be actuated to close normally-open contact 77 to complete the electrical circuit through winding 87 when contact member 21 engages the conductive portion of disk 17. As described above, this will close normally-open contact 83 so that electrical current flows through fusible conductor 49 to fuse the conductor and to release the spear-like member 53.

To avoid unnecessary detail in the drawings, the housing 5 has been shown as being a unitary body. However,

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it is evident that the housing may be formed of a number of sections connected together by mating threads so the apparatus can be easily assembled and so that access is available into the housing for replacing frangible disk 71, resetting the spear-like member 53 by replacing the fusible electrical conductor 49, and setting the manual switch 37 to either the oil-collecting or water-collecting position thereof. The time delay provided by the timing mechanism may be adjusted by suitably initially positioning contact member 21 on nonconductive sector 18, or by substituting other disks having larger or smaller nonconductive sectors than sector 18.

The apparatus described above is relatively simple and fool-proof and eliminates the necessity of elongated electrical leads to the earth's surface that can cause operating difficulties. The apparatus has been found to withstand the rugged use and abuse normal in oil field operations.

The objects and features of the invention having been completely described, what is claimed is:

1. A well fluid sampler, comprising:
 - a housing; a sample chamber in said housing;
 - fluid inlet port means between said chamber and the exterior of said housing;
 - a fusible electrical conductor adapted to fuse upon passage therethrough of a given current;
 - closure means closing said port means;
 - means coupled to said conductor and positioned relative to said closure means to engage said closure means and open said port means upon fusing of said conductor;
 - an electrical energy source; and
 - circuit means including timing circuit means connected to said energy source and to said conductor adapted to connect said energy source to said conductor to fuse said conductor after a predetermined time interval.
2. A well fluid sampler, comprising:
 - a housing; a sample chamber in said housing;
 - fluid inlet port means between said chamber and the exterior of said housing;
 - an electrical conductor;
 - closure means closing said port means;
 - means coupled to said conductor and positioned relative to said closure means so as to engage said closure means and open said port means after electrical energization of said conductor;
 - an electrical energy source;
 - conductivity sensing means connected to said housing adapted to sense the electrical conductivity of well fluid in which said housing is disposed;
 - an electrical control circuit;
 - timing means connected to said energy source and said control circuit adapted to energize said electrical control circuit after a predetermined time interval; and
 - circuit means in circuit relationship with said conductivity sensing means, said control circuit, and said electrical conductor adapted to connect said energy source to said electrical conductor upon energization of said control circuit, when the fluid conductivity sensed by said conductivity sensing means is within predetermined limits whereby said electrical conductor is energized.
3. A well fluid sampler, comprising:
 - a housing; a sample chamber in said housing;
 - a fluid inlet port means between said sample chamber and the exterior of said housing;
 - a check valve connected to said port means for preventing fluid egress from said chamber;
 - a frangible disk in said port means for sealing said chamber;
 - a spring-biased spear-like member positioned in said housing to puncture said disk;
 - an electrical terminal connected to said housing;
 - a fusible electrical conductor connecting said terminal

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to said spear-like member for holding said spear-like member away from said disk;
 an electrical energy source; and
 timing circuit means connected to said energy source and to said terminal, adapted to connect said energy source to said terminal through said fusible electrical conductor after a predetermined time interval to fuse said electrical conductor.

4. A well fluid sampler, comprising:
 a housing; a sample chamber in said housing;
 a fluid inlet port means between said chamber and the exterior of said housing;
 a check valve connected to said port means for preventing fluid egress from said chamber;
 a frangible disk in said port means for sealing said chamber;
 a spring-biased spear-like member positioned in said housing to puncture said disk;
 an electrical terminal connected to said housing;
 a fusible electrical conductor connecting said terminal to said spear-like member for holding said spear-like member away from said disk;
 an electrical energy source;
 conductivity sensing means connected to said housing adapted to sense the electrical conductivity of well fluids in which said housing is disposed;
 electrical control circuit means;
 timing circuit means connected to said control circuit means and to said energy source adapted to energize said control circuit means after a predetermined time interval; and
 circuit means in circuit relationship with said conductivity sensing means, said control circuit means, and said fusible electrical conductor, adapted to connect said electrical energy source to said fusible electrical conductor upon energization of said control circuit means when the fluid conductivity sensing means is within predetermined limits whereby said fusible electrical conductor is fused and said spear-like member is released at said frangible disk;

5. A well fluid sampler, comprising:
 a housing; a sample chamber in said housing;
 a fluid inlet port means between said chamber and the exterior of said housing;

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a check valve connected to said port means for preventing fluid egress from said chamber;
 a frangible disk in said port means for sealing said chamber;
 a spring-biased spear-like member positioned in said housing to puncture said disk;
 an electrical terminal connected to said housing;
 a fusible electrical conductor connecting said terminal to said spear-like member for holding said spear-like member away from said disk;
 an electrical energy source;
 conductivity sensing means, including first relay means having first normally-closed and second normally-open contact means, connected to said energy source and adapted to sense the electrical conductivity of well fluids in which said housing is disposed to close said first contact means and open said second contact means when the electrical conductivity of the well fluids is at least a given conductivity;
 second relay means having actuating winding means and third normally-open contact means;
 circuit means including said third contact means, connected to said energy source and to said electrical terminal and said fusible conductor adapted to fuse said electrical conductor upon closure of said third contact means;
 a timing contactor adapted to complete an electrical circuit after a predetermined elapsed time interval; and
 manually actuatable switch means selectively connecting said first and second contact means in serial circuit relationship with said electrical energy source, said actuating winding, and said timing contactor whereby said second relay is actuated after said predetermined elapsed time interval upon closure of the one of said first and second contact means to which said switch means is connected.

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