

March 13, 1951

R. O. POLLARD, JR
FORMATION TESTER AND SAMPLER

2,545,306

Filed Sept. 24, 1949

2 Sheets-Sheet 1

FIG. 1

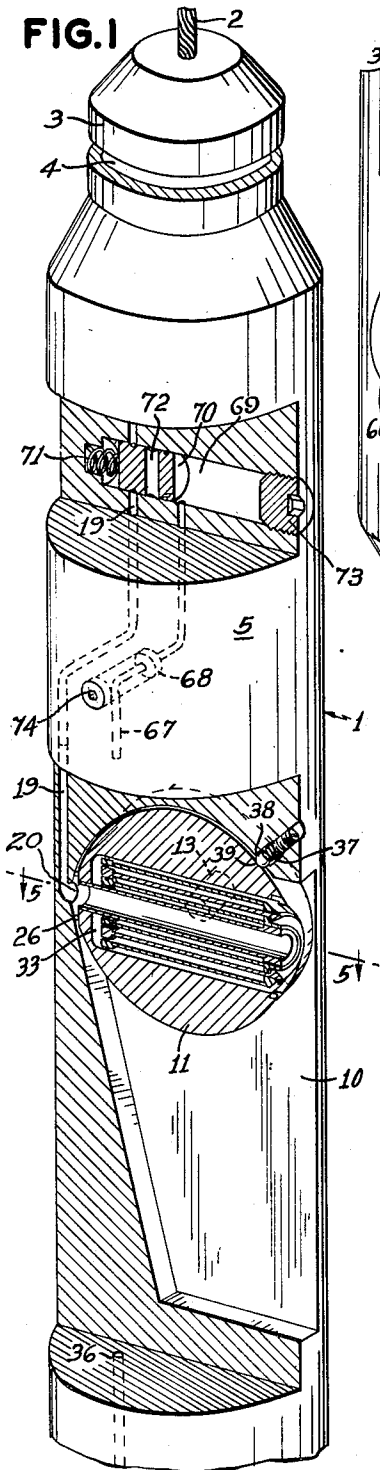


FIG. 2

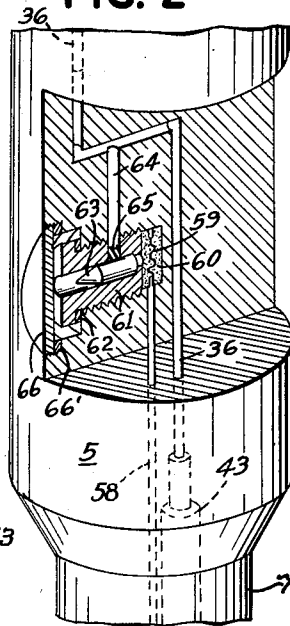


FIG. 3

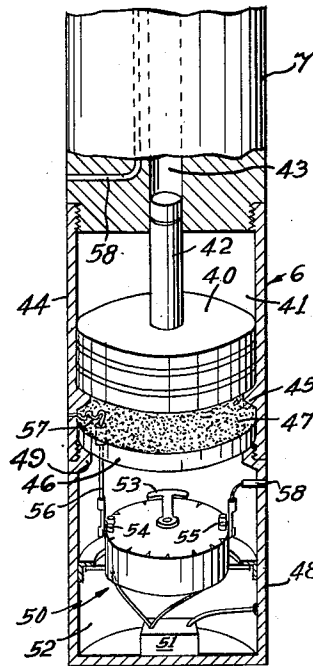


FIG. 6

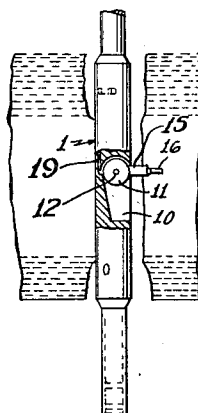
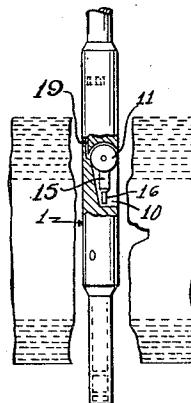


FIG. 7



INVENTOR.
Robert O. Pollard, Jr.
BY
Adams, Townsend & McLean
ATTORNEYS

March 13, 1951

R. O. POLLARD, JR
FORMATION TESTER AND SAMPLER

2,545,306

Filed Sept. 24, 1949

2 Sheets-Sheet 2

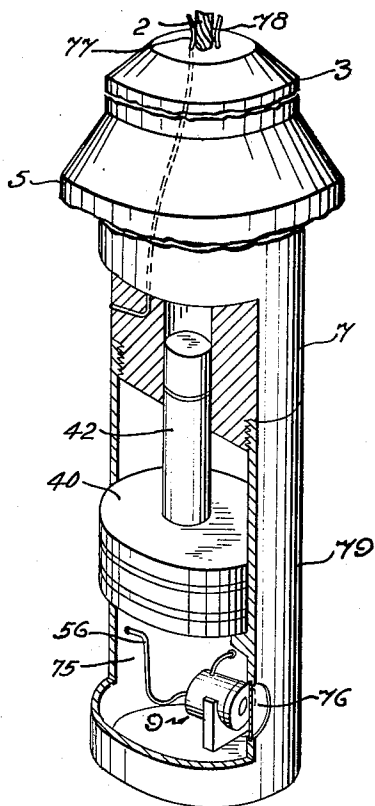


FIG. 4

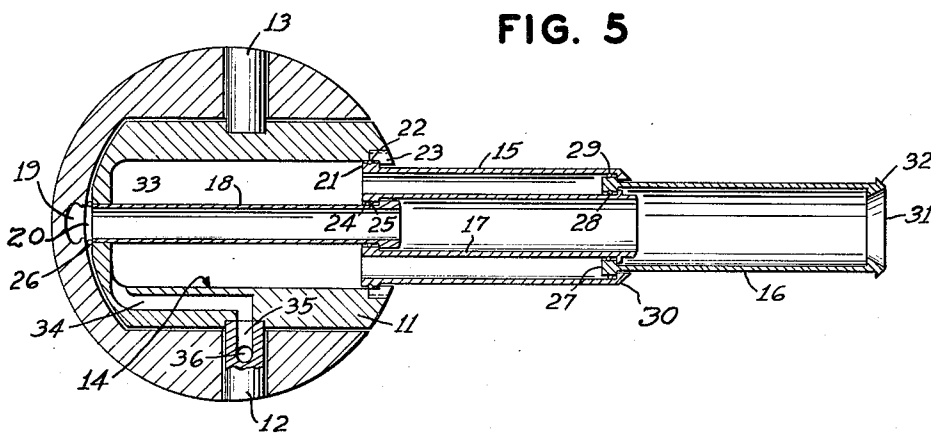


FIG. 5

INVENTOR.
Robert O. Pollard, Jr.
BY
Adams, Howard & McKean
ATTORNEYS

UNITED STATES PATENT OFFICE

2,545,306

FORMATION TESTER AND SAMPLER

Robert O. Pollard, Jr., Downey, Calif., assignor
to Richfield Oil Corporation, Los Angeles, Calif.,
a corporation of Delaware

Application September 24, 1949, Serial No. 117,660

2 Claims. (Cl. 255-1.4)

1

2

My invention relates to improvements in equipment for taking samples of formation and formation fluids from well bores—wells for production of oil and gas particularly. The work of the production engineer improves as his knowledge of the formations in which he is working increases, as this knowledge becomes more complete and more dependable. The factors involved include permeabilities and porosities of the formations, composition of formation fluids and formation pressures. The advantages of my invention resides particularly in the ease, speed and economy with which dependable samples of formation and of formation fluids can be taken and recovered for examination and analysis and, therefore, in the very complete data which, with my invention, can be obtained in short order and at reasonable cost for a well or group of wells or a productive area.

My invention comprises a tester-sampler adapter to be lowered through a well bore which, at a predetermined position in the well bore, will take, simultaneously, a sample of the formation and, under formation pressure, a sample of the formation fluids and which will retain those samples, that of the formation fluids under formation pressure, as the tester-sampler is withdrawn through the well bore with a minimum of contamination, for example with muds or other drilling fluids used for drilling or sealing off the walls of the bore.

The formation tester and sampler of my invention consists essentially of a body member adapted to be lowered through a well bore with its long axis approximately coincident with that of the well bore, a base member positioned within the body member and pivoted therein on an axis normal to the long axis of the body member, a projectable tubular member open at its outer end carried by the base member which, when retracted with its axis of projection normal to the long axis of the body member, lies within the body member and which, when extended with its axis of projection normal to the long axis of the body member, projects beyond the body member in a plane approximately normal to the axis of the well bore, a recess in the body member adapted to receive the projectable member when extended with said base member turned so that the axis of projection of the suspended projectable member is approximately parallel to the long axis of the body member, power means carried by the body member for driving the projectable member into the formation around the well bore in a plane approximately normal to the axis of

the well bore when the body member is in predetermined position within the well bore, and means for releasing the projectable member to permit withdrawal of the body member through the well bore.

The formation tester and sampler of my invention also comprises, with advantage, a chamber carried by the body member for receiving a sample of formation fluids through a connection opening into the interior of the projectable tubular member, means for opening this connection after the open end of the projectable member has entered the formation and means for closing this connection after the projectable member has been extended and before it is withdrawn from the formation.

The formation tester and sampler of my invention can be lowered into the well bore on a wire line, particularly where speed is important as where samples are to be taken at a number of horizons, or it can be lowered on a run-in string of tubing or drill pipe, as where a production test of some duration is to be run on one or more of any producing formations penetrated by the well bore. In such cases, the connection opening into the interior of the projectable member is arranged to communicate with the lower end of the tubing or drill pipe rather than the sample chamber carried by the body member of the tester-sampler.

To facilitate understanding of my invention, I will described it further by reference to the accompanying drawings illustrating, diagrammatically and conventionally, two embodiments of my improved tester-sampler, and its general mode of operation, but it will be understood that this detailed exemplification is by way of illustration, not limitation, of the invention above stated. In these drawings:

Figs. 1, 2 and 3 are fragmentary representations, the first two isometric and the third in elevation, with parts broken away, of the upper, middle and lower portions, respectively, of a tester-sampler embodying my invention.

Fig. 4 is a similar isometric representation, corresponding generally to Figs. 1, 2 and 3, taken together with the detail of Fig. 2 omitted, of a modified tester-sampler embodying my invention;

Fig. 5 is a section on the line 5-5 of Fig. 1; and

Figs. 6 and 7 illustrate, as views in elevation and partly in section and with parts broken away, the operation of tester-samplers, such as

3

those of the preceding figures, embodying my invention.

Although my invention is a combination of elements in a particular relationship, I will refer first to Figs. 6 and 7 which illustrate the mode of operation of one of the characteristic elements of the tester-sampler of my invention, some details of which in particular embodiments are also shown in Figs. 1 and 5. The assembled formation tester and sampler is lowered through the well bore by means of 2, to the horizon at which samples are to be taken with the base member 11 in the position illustrated in Fig. 6 but with the projectable member comprising elements 15 and 16 retracted as shown in Fig. 1. With the tester-sampler in position, the operation proceeds in a sequence of steps timed either through one or more control conductors extending to the surface or by means of a control timer carried by the tester-sampler. First, the projectable member is driven into the formation. The open end of the projectable member may be initially covered with a sheet of appropriate plastic mechanically destroyed as the projectable member is extended, to exclude fluids before the projectable member is extended. Since, as the projectable member is extended, it moves in a plane approximately normal to the axis of the well bore, the entering edge of the advancing tubular member establishes a seal excluding fluids other than formation fluids, drilling muds for example, as soon as it begins to encounter resistance from the formation. With the projectable member fully extended, a formation sample similar to a core sample fills the outer part of the extended tubular member 16. As the projectable member reaches the limit of its extension, or shortly thereafter, connection 19 between the interior of the extended tubular member, and thus the formation, and a sample chamber carried by the tester-sampler is opened to permit the taking, through the extended projectable member, of a sample of formation fluids under formation pressure. Prior to the opening of this connection, the sample chamber may be at atmospheric pressure, or, for example, it may be charged with nitrogen to some predetermined pressure. Then, either before the tester-sample is retracted or as withdrawal of the tester-sampler begins, this connection 19 is closed to retain the sample of formation fluids as taken. Also, before the tester-sampler is retracted, the force driving the projectable member into the formation is released. The tester-sampler is then pulled out of the well bore, the extended projectable member swinging, on the axis of pivots 12 and 13, into the position illustrated in Fig. 7, to permit recovery for examination and analysis of the samples thus taken of the formation and of the formation fluids. Pressure recording devices or temperature recording devices or both, responsive to the pressure and temperature of the formation fluids flowing through connection 19, can also be carried by the tester-sampler.

Now, I will refer more particularly to the embodiment of my invention illustrated in Figs. 1, 2, 3 and 5. The tester-sampler of my invention comprises a body member 1 adapted to be lowered through a well bore with its long axis approximately coincident with that of the well bore, a base member 11 positioned within this body member on pivots 12 and 13, a projectable tubular member comprising telescopic tubes 15 and 16, a recess 10 in the body member 1 adapted to receive the projectable member when extended

4

with the base member 11 turned so that the axis of projection of the projectable member is approximately parallel to the long axis of the body member, power means comprising the piston 42 working in the power cylinder 43, and thus through appropriate hydraulic connections and control means, for driving the projectable member into the formation around the well bore, and means for releasing the projectable member to permit withdrawal of the body member through the well bore and for controlling the taking samples of formation fluids. The base member 11 is chambered to receive the several tubular elements 15, 16, 17 and 18. This chamber 33 connects, hydraulically, with the power cylinder 43 through ducts 34, 35 and 36. The flanged inner ends of these tubular elements 21, 24 and 27, sealed by means of rubber rings 22, 25, 28 and 29, move as pistons in the annular space between the cylindrical wall 14 of chamber 33 and the conductor tube 18 secured to the inner part of the base member. Retaining ring 23 holds the assembly in place. The outer end of tube 16 is provided with a cutting edge 31, to facilitate entry into the formation, and clearance is provided by the retreating flanges 32 and 30 on the tubes 16 and 15, respectively. When the axis of projection of the projectable member is normal to the long axis of the body member 1, conductor tube 18 communicates through port 20 with connection 19. When the base member 11, and thus the projectable member is turned from this position, this port 20 is closed by revolution of the base member. A rubber seal 26 is provided to make this closure effective. A spring lock comprising ball 38 loaded by spring 37 and recess 39 in the base member 11 is provided to hold the base member in position as the tester-sampler is lowered into position. The body member 1 comprises a center part 5, an upper part 3 of reduced diameter carrying a sample chamber 4 and any pressure or temperature recording devices, and a lower part 7 carrying the power means. This center part 5 may carry control elements in addition to the base member and projectable member just described. In the embodiment illustrated, connection 19 between the conductor tube 18 and the sample chamber 4 is also controlled by a pressure actuated valve comprising piston 70 (accessible through plug 73) which, when the pressure in chamber 69 exceeds that exerted by spring 71, moves (to the left in Fig. 1) to open this connection through port 72, otherwise to close it. The spring 71 and the area of the piston 70 may be proportioned to effect the desired control, or a frangible disc 68 (accessible through plug 74) in connection 67 between chamber 69 and connection 36 may be arranged to rupture at a predetermined pressure and thus to open the connection 19 only after this pressure has been exceeded in the hydraulic system through which the power means operates. Also in this embodiment, means are provided for releasing through passage 64 the hydraulic pressure imposed by the power means through connection 36 after the power means has been actuated. These means comprise a frangible disc 66 seated on gasket 66', a projectile 63 to be discharged through plug 61 (seated on gasket 62) and disc 66 and thus into the well bore and at the same time to release plug 65 and a powder charge 60 for discharging this projectile when igniter wire 59 is heated. The power means comprises a piston 42 moving in power cylinder 43 and driven by piston 40

5

6

moving in cylinder 41. These pistons are provided with appropriate sealing rings as indicated. In the embodiment illustrated in Fig. 3, the piston 40 is actuated by a powder charge 47 in the chamber between the piston 40 when in the lower position defined by the limit rim 45 and the base plate 46 on the annular rim 49 fired by heating, electrically, igniter wire 51. The hydraulic system, cylinder 43, connections 36, 64 and 67 and the initial volume of cylinders 33 and 69, are filled with an hydraulic fluid, oil for example, pistons 40 and 42 are positioned and casing 44 is secured to the body member 1, after installing discs 66 and 68, prior to each test and sampling operation. Similarly, casing 48, carrying in chamber 52 a timing clock 50 with two adjustable contacts 54 and 55 adapted to close circuits through battery 51 and insulated conductors 56 and 58 and thus through wires 57 and 59, respectively, by operation of the revolving contact arm 53, is secured to the lower end of casing 44 after the timing clock is set. A sleeve is provided over casing 44 or 48 or both (or casing 79 in Fig. 4) to protect any control conductors carried past the power cylinder externally of casing 44.

In the embodiment illustrated in Fig. 4, instead of actuating the power piston 40 with a powder charge, it is actuated by the pressure of the liquid column in the well bore when a projectile firing mechanism 9, similar to 59-63, ruptures frangible disc 76 admitting the liquid to the space within casing 79 beneath piston 40. In the embodiment of Fig. 4, the power means is put in operation by an impulse transmitted over conductor 77, the release mechanism (59-66) by an impulse transmitted over conductor 78. It will be apparent that either power means, that of Fig. 3 or that of Fig. 4, or the release means may be controlled by either of such mechanisms and thus by controls carried by the tester-sampler or from the upper end of the well bore.

To drive the power piston 40 in the embodiment illustrated in Fig. 3, conventional slow-burning powders may be used. For example, the powder used in conventional railroad fuses composed of a mixture of carbon and sodium nitrate and sodium perchlorate may be used. In such compositions, the carbon is usually supplied as wood dust but I prefer to use carbon black as more uniform and more reliable. The charge of powder is proportioned to the area and travel of the power piston, to deliver, through the hydraulic system, the necessary driving force for extension of the projectable member into the formation. Satisfactory results are usually obtained with maximum pressures in the power cylinder approximating 7000 lbs. per square inch, and such pressures are easily obtained and controlled with conventional powders.

The mode of operation of the formation tester and sampler of my invention illustrated in the accompanying drawings is as follows: The powder charges 47 and 60 are inserted the frangible discs 66 and 68 (and 76 if used) are inserted, the hydraulic system is charged, a clean sample chamber 40 is inserted, and the tester-sampler is assembled with the base member 11 and the projectable member in the position shown in Fig. 1. The assembled tester-sampler is then lowered to the horizon at which samples are to be taken on cable 2. With the tester-sampler in position, the power piston 40 is actuated, by a timing mechanism as in Fig. 3 or through a conductor to the surface as in Fig. 4, and pressure in the

hydraulic system begins to increase. First, as the pressure in the chamber 33 increases, the tubular elements 15 and 16 are driven into the formation. Next, as the pressure continues to increase and thus after these tubular elements have entered the formation, connection 19 is opened establishing communication between the sample chamber 4 and the formation, under formation pressure, through tubes 16, 17 and 18. Next, the pressure in the hydraulic system is released, by firing of projectile 63, closing connection 19 and releasing the projectable member comprising tubes 15 and 16. Finally, the tester-sampler is pulled to the surface for recovery of the sample of formation fluids retained in the sample chamber 4 and the formation sample retained in tube 16 or tubes 16 and 17. As pull-out of the tester-sampler begins, the extended projectable member swings downwardly, by revolution of the base member 11 on the pivots 12 and 13, into the recess in the body member 1, this revolution also closing connection 19 at port 20. It will be apparent that this operation, producing a simultaneous sample of formation fluids and of the same formation, can be completed virtually as quickly as the tester-sampler of my invention can be run in and out of the well bore. Time usually being the most expensive factor in drilling operations, the tester-sampler of my invention thus provides a particularly important economy in making a test or series of tests.

I claim:

1. A formation tester and sampler comprising a body member adapted to be lowered through a well bore with its long axis approximately coincident with that of the well bore, a base member positioned within said body member and pivoted on an axis therein normal to the long axis of the body member, a projectable tubular member open at its outer end carried by said base member which, when retracted with its axis of projection normal to the long axis of the body member, lies within said body member and which, when extended with its axis of projection normal to the long axis of the body member, projects beyond the body member in a plane approximately normal to the axis of such well bore, a recess in said body member adapted to receive said projectable member when extended with said base member turned so that the axis of projection of said projectable member is approximately parallel to the long axis of the body member, power means carried by said body member for driving said projectable member into the formation around the well bore in a plane approximately normal to the axis of the well bore when the body member is in position within the well bore, and means for releasing said projectable member to permit withdrawal of said body member through the well bore.

2. A formation tester and sampler comprising a body member adapted to be lowered through a well bore with its long axis approximately coincident with that of the well bore, a base member positioned within said body member and pivoted on an axis therein normal to the long axis of the body member, a projectable tubular member open at its outer end carried by said base member which, when retracted with its axis of projection normal to the long axis of the body member, lies within said body member and which, when extended with its axis of projection normal to the long axis of the body member, projects beyond the body member in a plane approximately

normal to the axis of such well bore, a recess in said body member adapted to receive said projectable member when extended with said base member turned so that the axis of projection of said projectable member is approximately parallel to the long axis of the body member, power means carried by said body member for driving said projectable member into the formation around the well bore in a plane approximately normal to the axis of the well bore when the body member is in position within the well bore, a chamber carried by said body member for receiving a sample of the formation fluids through a connection opening into the interior of said projectable tubular member, means for opening said connection after the open end of said projectable member has entered the formation and means for closing said connection after

said projectable member has been extended and before said projectable member is withdrawn from the formation, and means for releasing said projectable member to permit withdrawal of said body member through the well bore.

ROBERT O. POLLARD, JR.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,013,457	Burt	Sept. 3, 1935
2,198,821	Jessup	Apr. 30, 1940
2,334,428	Miller	Nov. 16, 1943
2,391,869	Bandy	Jan. 1, 1946