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FORMATION FLUID SAMPLE TAKING APPARATUS

Filed July 27, 1955

2 Sheets-Sheet 1

FIG.1.

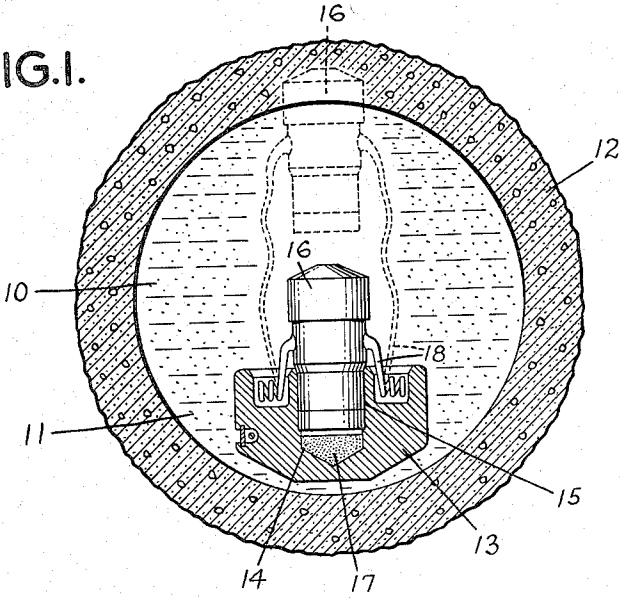
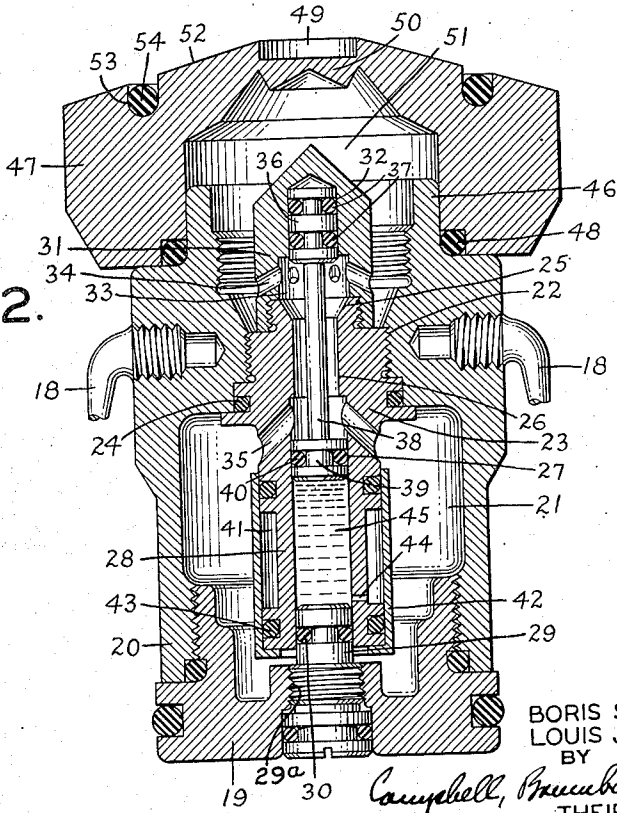


FIG.2.



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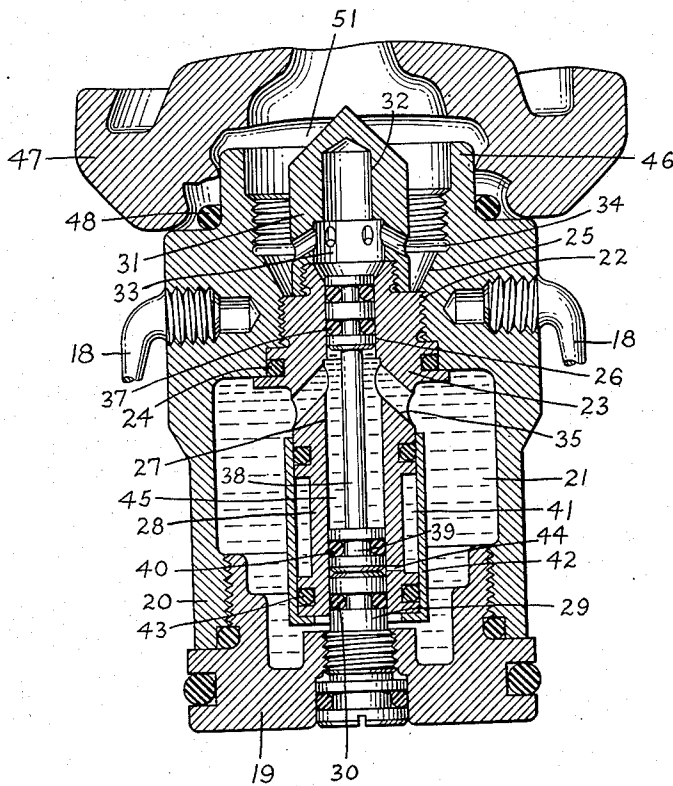
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FIG.3.



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FORMATION FLUID SAMPLE TAKING APPARATUS

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Claims priority, application France August 12, 1954

5 Claims. (Cl. 255—1.4)

The present invention relates to apparatus for taking samples of fluid (liquid or gas) in geological formations and particularly in formations traversed by a well drilled into the earth.

Apparatus for this purpose has previously been proposed and it comprises a hollow projectile adapted to be driven by the explosion of a powder charge, for example, against the formation constituting the side walls of the bore hole from which it is desired to take a fluid sample. The hollow projectile is usually provided with a cap member which is adapted to be sheared away when the forward part of the projectile strikes the formation, so as to provide access for the fluid sample to a fluid receiving chamber formed in the projectile. The projectile also has a valve which is adapted to close after the fluid sample has been taken in such fashion as to prevent escape of the fluid sample while the projectile is being brought up to the surface of the earth, the projectile being attached to the firing device by cables or similar elements in the usual manner.

In practice, the construction of apparatus of the above character presents problems in regard to fluid-tight sealing which are difficult to solve because of the varying fluid pressure conditions encountered. For example, when the projectile is in the formation from which the sample of fluid is taken, the pressure of the fluid sample collected in the sample receiving chamber in the projectile is appreciably lower than the normal pressure of the fluid present in the formation. When the projectile is removed from the formation and enters the bore hole, it is subjected to an external pressure (of the bore hole liquid) still considerably greater than that existing in the interior of the formation, and which, therefore, considerably exceeds the pressure of the fluid sample collected.

Conversely, as the projectile is raised by degrees within the bore hole, in order to bring it to the surface of the earth, the pressure exerted by the bore hole liquid decreases little by little, until at the earth's surface the pressure on the projectile is atmospheric pressure which is, of course, much lower than the pressure of the fluid collected. Therefore, the pressure inside the projectile, at the beginning of sample taking operation is much lower than the external pressure, and later on is, on the contrary, very definitely greater than the external pressure. The problem, then, is to maintain fluid-tightness under conditions of pressure which become inverted in the course of the operation.

This problem has been solved effectively in a variety of forms of sample taker apparatus which are disclosed in the pending applications Serial Nos. 386,279 and 503,541, filed in the United States Patent Office on October 15, 1953, and April 25, 1955, respectively. In these devices, fluid-tight sealing is achieved by providing means for exerting on the valve which serves to prevent the escape of fluid from the projectile, a force which, when added to the force produced by the pressure of the fluid sample inside the projectile, tends to overcome the force due to the outside pressure, produced either by the

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fluid filling the formations or by the bore hole liquid. This is accomplished in such a way that there is no danger of the valve being opened even by an external pressure considerably greater than the internal pressure. In the devices described in the aforementioned patent applications, this supplementary force is exerted by means of a system of differential pressures.

It is an object of the present invention to provide novel sample taker apparatus in which fluid-tightness of the fluid receiving chamber in the projectile in both directions is achieved in a different way.

This and other objects of the invention are attained by providing for the fluid receiving chamber a locking shut-off device which functions after the fluid sample has been taken, and which insures absolute fluid-tightness in a positive way, independently of differences in pressure exerted in either direction. The shut-off device is preferably provided with means for delaying its operation in such a way that it is locked in position only after enough time has elapsed following opening of the chamber to the fluid so as to allow a sufficient quantity of the fluid to penetrate into the chamber.

In a preferred embodiment, the locking shut-off device comprises cylindrical slide valve means adapted to slide in a bore of the same shape and provided with an interior passage positioned in such a way as to afford access for the formation fluid to the fluid receiving chamber in the projectile when the latter has penetrated into the formation. The slide valve means is adapted to be displaced after the fluid sample is collected so as to block the entrance to the bore. Once the slide valve means is in this closed position, it is adapted to be maintained closed by locking means actuated, for example, by a pressure differential which is independent of the pressure differential existing between the outside and inside of the fluid receiving chamber.

The invention also contemplates the provision of means such as a dash pot, for example, for delaying the movement of the slide valve means while the fluid sample is being taken.

Other objects and advantages of the invention will become apparent from the following detailed description of a typical embodiment taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a view in transverse section through a bore hole drilled into the earth, showing formation fluid sampling means in position therein;

Fig. 2 is a view in longitudinal section through a formation fluid sampling projectile according to the invention, prior to the taking of a sample;

Fig. 3 is a view showing the sampling projectile of Fig. 2 after a fluid sample has been taken.

In Fig. 1, a bore hole 10 containing water and mud 11 is drilled through the earth formations 12, which may comprise, for example, sands drenched with fluid (liquid or gas) of which samples are to be taken. Disposed within the bore hole 10 is conventional sample taking gun apparatus 13, comprising the usual powder chamber 14 communicating with a gun barrel 15 in which a sampling projectile 16 is received. The powder chamber 14 contains a powder charge 17 which is adapted to be set off in the well known manner to drive the projectile 16 against the adjacent side wall of the bore hole 10.

While only one gun barrel 15 and projectile 16 are visible in Fig. 1, actually the sample taking apparatus 13 has formed therein a plurality of superimposed powder chambers and gun barrels, each of the latter containing a sampling projectile 16. The projectiles are connected by cables 18 to the body of the apparatus 13 in the usual manner so that when the latter is brought to the surface, the projectile 16 is carried therewith and also brought to the surface of the earth.

The formation fluid sampling projectile 16 is especially adapted for collecting and retaining samples of the fluid contained in the bore hole. To this end, it comprises (Fig. 2) a hollow cylindrical body formed by two elements 19 and 20, screwed or otherwise secured to one another so as to facilitate fabrication and assembly, and having a fluid receiving chamber 21 formed therein. The element 20 has an aperture 22 formed therein in which is threaded a bushing 23, a sealing ring 24 being provided to insure a tight joint. The bushing 23 has a tapered opening 25 at the forward end thereof leading to a longitudinal bore 26 communicating with a bore 27 of slightly larger diameter formed in a portion 28 of the bushing 23 which extends into the chamber 21. The lower end of the bore 27 is closed by an inwardly projecting partially threaded member 29 disposed in a partially threaded opening 29a in the body element 19, the member 29 also serving as a stop member, as described below, suitable sealing ring means 30 being provided to insure a fluid-tight joint.

Threaded or otherwise secured on the forward end of the bushing 23 is a pointed member 31 having a blind bore 32 formed therein communicating with a chamber 33 leading to the tapered opening 25 in the bushing 23. Formed in the member 31 are a plurality of passages 34 providing communication between the chamber 33 and the exterior of the member 31. Similar passages 35 are formed in the bushing 23 and they provide communication between the upper end of the bore 27 and the fluid receiving chamber 21.

Seated in the blind bore 32 in the member 31 is a piston 36 having suitable packing means 37 and connected by a rod 38 to a piston 39 of slightly larger diameter resting in the bore 27 just below the fluid passages 35 and also provided with suitable packing 40.

Formed in the outer wall of the bushing portion 28 is an annular groove 41 over which is fitted a sleeve member 42, suitable packing means 43 being provided to insure a fluid-tight assembly. A narrow passage 44 in the wall of the bushing portion 28 provides communication with the interior of the bore 27 and the latter, between the rear end of the piston 39 and the forward end of the stop member 29 is filled with an incompressible liquid 45.

The body element 20 is formed with a forward skirt portion 46 on which is tightly fitted a cylindrical cap member 47, a sealing ring 48 being provided to insure fluid-tightness. In the front face of the cap member 47 is a central opening 49, temporarily closed by a frangible closure member 50, leading to a chamber 51, into which the member 31 projects. The cap member 47 is preferably made of a relatively soft material such as pure aluminum and that part of it which forms a neck around the closure member 50 is relatively wide. Also, its front face 52 is preferably a truncated conical surface with a large angle at the top. In the front face 52 surrounding the opening 49 is an annular groove 53 in which is received a sealing ring 54.

In operation, the gun type sampling apparatus 13 (Fig. 1) is lowered to the desired level in the bore hole 10, and the projectile 16 is driven against the side wall of the bore hole by setting off the powder charge 17 in the known manner. The projectile 16 penetrates only a little way into the wall of the bore hole as can be seen from the dashed and dotted lines in Fig. 1, the depth of penetration depending on the nature of this wall itself. Because of the violent impact against the wall of the bore hole 10, the forward face 52 of the cap member 47 is deformed and moulds itself as it were, into the formation constituting the side wall of the bore hole, and forms a joint with this wall. This effect is notably increased by the presence of the sealing ring 54 in the groove 53.

At the same time, under the effect of the external pressure exerted on the frangible closure member 50, the latter shears away and there is an inrush into the chamber 51 of the substance (sand soaked with fluid, for example) constituting the wall of the bore hole.

Since the forward face of the cap member 47 is in effect molded against the wall of the bore hole, as described above, the liquid 11 filling the bore hole 10 cannot reach the orifice 49. Accordingly, practically only those substances proceeding from the formation itself enter the chamber 51. The substances which have thus penetrated into the chamber 51 pass through the passages 34 into the chamber 33, through the tapered portion 25, the bore 26 and the passages 35 to the inside of the chamber 21.

At the same time, the substances from the formation exert a very strong pressure on the piston 39 and as a result, cause the attached rod 38 and piston 39 to be displaced downwardly. Due to the damping effect produced by the fluid 45 initially contained in the bore 27, this downward movement is braked, and the whole assembly consequently is displaced only relatively slowly, the piston 39 forcing the liquid 45 into the annular groove 41 through the narrow passage 44. This movement continues so as to allow the collected substances to fill the chamber 21 until the piston assembly has reached its rearmost position, as shown in Fig. 3.

In this position, the piston 36 closes the bore 26, and consequently shuts off all communication between the inside of the fluid receiving chamber 21 and the outside. As has been stated, the piston 36 has a slightly lesser diameter than the piston 39. Hence, the pressure existing in the chamber 21 and in the bore 26 which is exerted on these pistons, tends constantly to press the piston 39 rearwardly against the stop member 29, where it remains, no matter what difference in pressure may exist between the inside of the projectile and the outside. The projectile 16 is then brought to the surface, and the substances contained in the cavity 21 are recovered in any suitable manner.

Many modifications, of course, may be made in the specific device described above without departing from the scope of the invention. In particular, blocking of the slide valve means formed by the pistons 36 and 39 could be achieved by other means than by difference of pressure, for instance, by mechanical means. In addition, of course, the shape and composition of the frontal element can be different from that described, and be in accordance with the disclosure contained in any of the aforementioned copending patent applications. The invention, therefore, is not to be limited to the specific embodiment described but comprehends all modifications falling within the scope of the following claims.

We claim:

1. In sample taking apparatus including a hollow projectile enclosing a fluid receiving chamber and having a first opening in one end providing access to said chamber, a cup shaped cap member tightly fitted on said one end of the projectile and cooperating therewith to form a second chamber, said cap member having means defining a second opening therein and frangible closure means for said second opening, the combination of a bushing member secured in said first opening, said bushing member having a rear portion extending into said fluid receiving chamber and a forward portion extending into said second chamber, means forming a first blind bore of first diameter in said bushing member forward portion, means forming in said bushing member rear portion a second bore having one end communicating with said first bore and its other end closed, said second bore being of greater diameter than said first bore, first means providing fluid access between said second chamber and said first bore at a location intermediate the ends of the latter, second means providing fluid access between said fluid receiving chamber and said second bore in the vicinity of the upper end of the latter, slide valve means comprising first piston means of substantially said first diameter initially seated in said first bore above said first fluid access providing means, second piston means of substantially said greater

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diameter linked to said first piston means and initially seated in said second bore at a position below said second fluid access providing means, and means limiting the rate of rearward movement of said slide valve means in response to fluid pressure.

2. Sample taking apparatus as defined in claim 1 in which a member closes the other end of said second bore, said member also serving as a stop member for said slide valve means to limit its travel, liquid filling the space between said stop member and the second piston means in its initial position, means forming a third chamber in the bushing member lower portion, and means forming a narrow passage placing the bottom of the second bore in communication with the third chamber, to limit the rate of rearward movement of the slide valve means in response to fluid pressure.

3. In sample taking apparatus including a hollow projectile having an enclosed fluid receiving chamber therein, a cup shaped cap member tightly fitted on one end of said projectile and cooperating therewith to form a second chamber, said cap member having means defining an opening therein and frangible closure means for said opening, the combination of means forming a bore in said one end of the projectile communicating with the second chamber and extending therefrom towards the enclosed fluid receiving chamber, means providing fluid access from the bore to the enclosed fluid receiving chamber, slide valve means in said bore movable from a first position permitting fluid flow through the bore into the enclosed fluid receiving chamber to a second position blocking fluid flow through the bore, said slide valve means being moved from said first position to said second position in response to fluid pressure in the second fluid chamber greater than the fluid pressure in the enclosed sample chamber, said pressure differences providing a pressure differential across the slide valve means, and means to limit the rate of movement of said slide valve means from said first position to said second position.

4. In a sample taking apparatus, the combination of a hollow projectile having a bore, a fluid receiving cham-

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ber in the projectile, first passage means providing fluid access to said bore from outside the projectile, second passage means providing fluid access from the bore to the fluid receiving chamber, whereby fluid may flow from outside the projectile through the bore into the fluid receiving chamber, and slide valve means in the bore movable from a first position permitting fluid flow through the bore to a second position blocking fluid flow through the bore, said slide valve means being moved from said first position to said second position in response to fluid pressure acting in the bore through the first passage means greater than the fluid pressure in the fluid receiving chamber, said pressure differences providing a pressure differential across the slide valve means, said valve movement between the first position and the second position requiring a finite time interval.

5. In sample taking apparatus, the combination of a hollow projectile having a bore at one end, a fluid receiving chamber in the projectile, first passage means providing fluid access to said bore from outside the projectile, second passage means providing fluid access from the bore to the fluid receiving chamber, whereby fluid may flow from outside the projectile through the bore into the fluid receiving chamber, slide valve means in the bore movable from a first position permitting fluid flow through the bore into a second position blocking fluid flow through the bore, said slide valve means being moved from said first position to said second position in response to fluid pressure acting in the bore through the first passage means greater than the fluid pressure in the fluid receiving chamber, said pressure differences providing a pressure differential across the slide valve means, and means to control the rate of movement of said slide valve means.

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