June 3, 1952 C. E. BANNISTER 2,599,040

SAMPLE-TAKING AND CASING-PERFORATING APPARATUS

Filed Nov. 8, 1947 2 SHEETS—SHEET 1

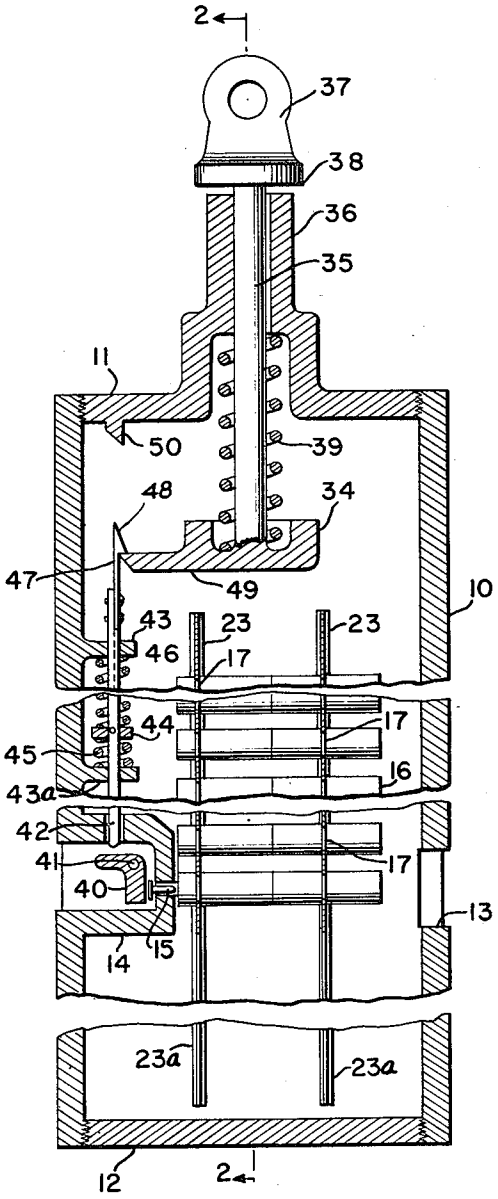



FIG.1

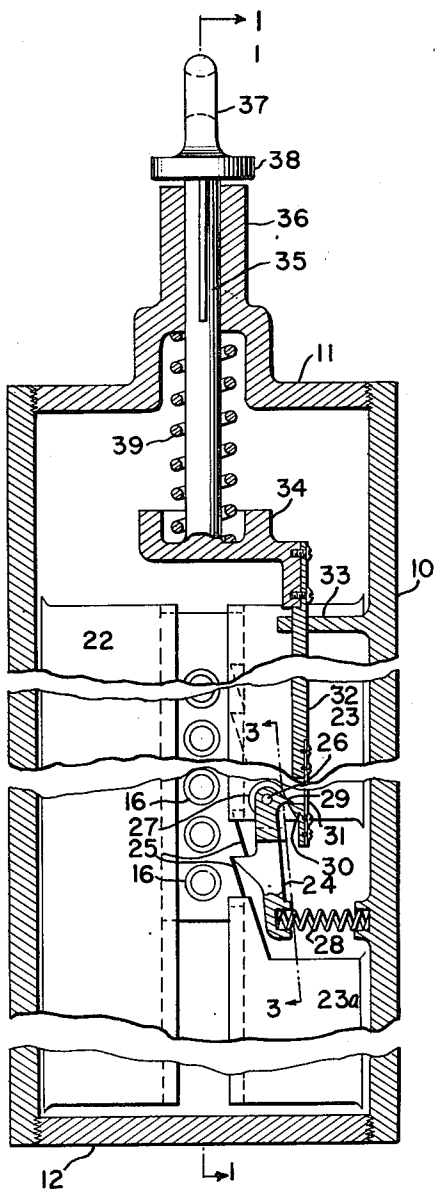



FIG.2

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SAMPLE-TAKING AND CASING-PERFORATING APPARATUS

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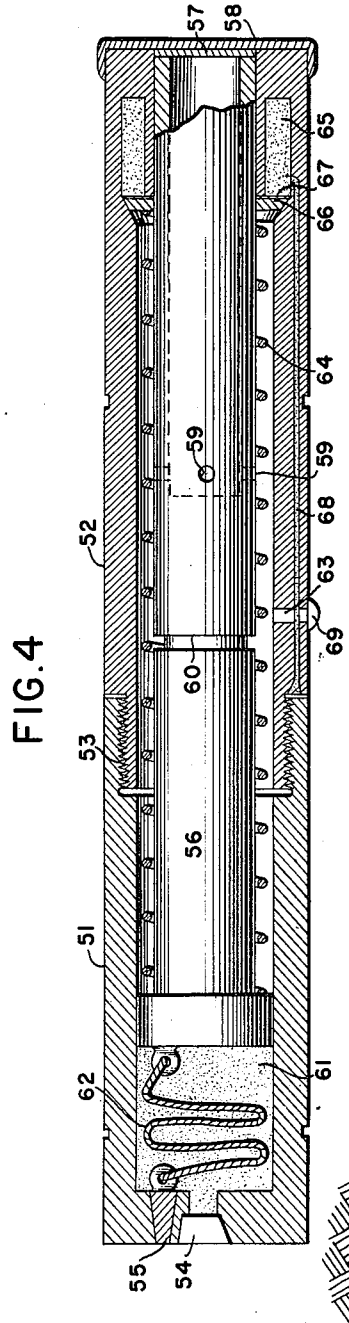



FIG. 4

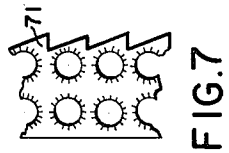



FIG. 7

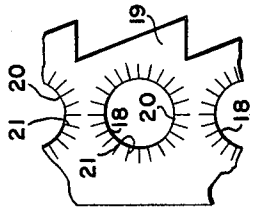



FIG. 5

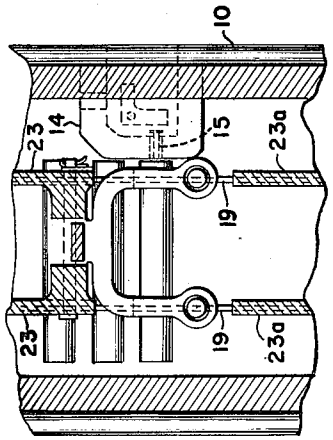



FIG. 3

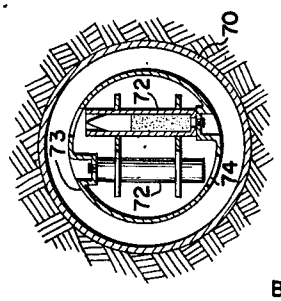



FIG. 6

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## SAMPLE-TAKING AND CASING-PERFORATING APPARATUS

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Application November 8, 1947, Serial No. 784,903

9 Claims. (Cl. 89—1)

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This invention relates to apparatus for assaying samples of earth materials in inaccessible places, as in the "surveying" of oil wells, or for otherwise operating upon a wall in an earth boring, as in perforating an oil-well casing.

In my U. S. Patent No. 1,955,166, I have described and claimed apparatus wherein samples are obtained by firing into the formation a projectile having a hollow forward portion adapted to receive a sample of the formation into which it is shot and to retain the sample as the projectile is recovered, and oil-well casing heretofore has been perforated by firing a projectile through it.

The chief objects of my present invention are to provide improved apparatus of this type adapted to be suspended and operated by a single cable or the like extending from the top of the well; to provide in a convenient and economical manner for taking numerous samples, or making numerous perforations in a casing, at different depths, with only one trip of the device into and out of the well; and, in the case of sample taking, to provide improved means for withdrawing a captive projectile from the formation, with the sample in it, in case the projectile becomes strongly anchored in a hard formation into which it is shot.

More specific objects will be manifest in the following description.

Of the accompanying drawings:

Fig. 1 is a vertical middle section, on line 1—1 of Fig. 2, of a device embodying my invention in its preferred form.

Fig. 2 is a vertical middle section of the same, on line 2—2 of Fig. 1.

Fig. 3 is a fragmentary section of the same on line 3—3 of Fig. 2.

Fig. 4 is a longitudinal middle section, on a much larger scale, of one of the firing devices.

Fig. 5 is a fragmentary face view, on a somewhat larger scale than that of Figs. 1 to 3, of one of a pair of sheet-metal strips for holding a large number of the firing devices in orderly arrangement while they are moved past the firing position and in succession perform their functions.

Fig. 6 is a horizontal section of apparatus embodying the invention as applied to the perforation of well casing.

Fig. 7 is a fragmentary face view of one of a pair of cartridge-holding metal strips which are shown in Fig. 6.

Referring first to Figs. 1 to 5 of the drawings, the device there shown is adapted for sample-taking and comprises a casing which preferably

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is made up of several separable parts, here shown as a generally cylindrical body member 10, and, suitably secured to it, an upper end-closure member 11 and a lower end-closure member 12.

At the firing position the body member is formed at one side with a hole 13 through its wall for the passage outwardly and back of successive captive projectiles and at the diametrically opposite position is formed with an inwardly bayed portion 14 which provides a reaction-sustaining member in the nature of a breech block and which has slidably mounted in an aperture extending through it a firing pin 15.

In the present embodiment, although the invention is not wholly limited to this, each of the cartridges, 16, 16, is in effect a gun barrel, of which the inner construction and arrangement will be later described. For holding them in orderly arrangement for moving them in procession past the firing position each of them is formed with two spaced-apart annular grooves 17, 17 in which are adapted to engage respective circumferential series of spring fingers 18, 18, Fig. 5, formed in each of a pair of sheet-metal strips 19, 19 by stamping out holes, such as the holes 20, 20 in Fig. 5, and making radial cuts 21, 21 extending outward from the holes, this construction being such that each cartridge can be mounted, as a step of a ladder-like structure, in a pair of metal strips as the side members of the ladder, by being forced through the holes 20 until the spring fingers 18 snap into the grooves 17.

For guiding the ladder-like structure past the firing position the body member 10 of the casing is internally formed with two pairs of laterally extensive guide-way ribs 22, 22 and 23—23a, 23—23a, the latter pair, at one side of the device, being interrupted, as shown clearly in Figs. 2 and 3, to accommodate an escapement device comprising a pawl member 24, the guide-way ribs being formed with vertical guide-way grooves in their inwardly-facing edges for receiving with an easy sliding fit the margins of the metal strips 19.

Each of the metal strips 19 has its margin adjacent the pawl member 24 formed with ratchet-like teeth 25, 25, adapted to support the ladder-like structure upon the pawl member 24, against gravity, when the pawl member is engaged with a pair of the teeth, one on each of the two metal strips.

The pawl member 24, pivoted at 26 between two bosses 27, 27 projecting from the guide-way ribs, is downwardly forked, each of the fork arms being formed with a pawl hook for engaging the ratchet teeth of the adjacent cartridge-holding

strip 19 and with a seat for a compression spring 28 interposed between the arm of the pawl member and a spring seat formed on the inner face of the casing, so that these two springs 28 constantly urge the pawl member about its pivot 26 toward its position of engagement with the ratchet teeth of the cartridge-holding strips.

Adjacent its pivot the member 24 is formed with a short, horizontal, cam-latch, pawl-lifting arm 29, Fig. 2, adapted to be engaged and released by a cam-latch hook 30 mounted on the lower end of a flat spring 31, as the hook and spring are moved relatively downward and upward. The spring 31 has its upper end secured to the lower end of a vertical bar 32 which slidably extends through suitable brackets, such as the bracket 33, projecting from the inner face of the casing. The upper end of the bar 32 is secured to a spring-seat head 34 formed on the lower end of a supporting bar 35 which slidably but non-rotatably extends upward through a spring-seat and bar-guiding neck 36 formed on the upper end-closure member 11. Above the neck 36 the bar 35 has removably secured upon it, as by screw threads, a head member 37 formed with an eye for the anchoring of a cable to it and formed also with a stop-flange 38 at its lower end adapted to abut the upper end of the neck 36 to limit relative downward movement of the bar 35 and members mounted upon it.

Interposed between the spring-seat head 34 and the spring seat formed in the neck 36, and surrounding the bar 35, is a compression spring 39 of such strength and of such pre-loading as to support the casing and the parts within it other than those that are directly supported by the post 35, and thus to hold the neck 36 in contact with the stop-flange 38, whenever the cable is supporting the weight, or a force only a little greater than the weight, of the casing and its contents.

The spring 39 however has such strength, pre-loading, range and modulus that when it is subjected to a determinately greater load, as by lowering the device and suddenly stopping it or reversing its movement by means of the cable, or by suddenly accelerating it upward from a stationary condition by means of the cable, the spring is further compressed and the bar 35 and parts directly supported by it move upward with relation to the casing until the spring-seat head 34 is stopped by contact with the inner face of the upper end-closure member 11.

In such manipulation of the device the inertia of the casing and some of the other parts, or their inertia plus the resistance of fluid in the well, causes the relative upward movement of the bar 35 and parts carried by it.

In the first part of this relative upward movement the cam-latch hook 30, engages with the cam-latch pawl-lifting arm 29, rotates the pawl member 24 about its pivot 26 until angular movement of the arm 29 disengages it from the hook, which is sufficient rotation to lift the pawl's hooks from the pair of ratchet teeth and to permit the ladder-like cartridge assembly to be started relatively downward by gravity and/or its inertia.

Then the springs 28 immediately return the pawl member 24 to contact the metal strips 19, to engage the next pair of ratchet teeth and thus stop the next cartridge or gun in firing position.

When the cable, the head 37 and the bar 35 are again held still the spring lifts the casing and other parts back to the original position, in which



they are shown in Fig. 2, the cam faces of the arm 29 and the hook 30 flexing the spring 31 and thus allowing them to pass each other and reengage for the next cycle of operation as described.

For actuating the firing pin 15 near the end of the relatively upward movement of the bar 35 and its head 34, after the new cartridge has been brought to firing position as described, an L-shaped hammer 40, Fig. 1, is pivotally suspended at 41 in the bayed portion 14 of the casing and has a horizontal arm in position to be struck by a vertical bar 42 upon descent of the latter through a large-clearance hole formed in the upper wall of the inwardly bayed portion of the casing.

The bar 42 is slidably but non-rotatably mounted in brackets 43, 43a projecting from the inner wall of the casing and at a little distance above the lower bracket has secured upon it a spring-seat collar 44 which is adapted to contact, at almost the limit of the downward movement of the bar, the upper end of a compression spring 45 seated upon the lower bracket and adapted to permit the bar to complete its stroke to fire the cartridge but of such strength that it then lifts the bar slightly, to release the firing pin so that the next cartridge can crowd the firing pin out of its way by contact with the tapered front end of the firing pin.

In so lifting the bar 42 slightly the relatively strong spring 45 re-establishes a preloaded condition of a long spring 46 which is mounted between the spring-seat collar 44 and the upper bracket 43.

Secured to the upper end of the bar 42 and projecting upward therefrom is a flat spring 47 having a cam-latch head 48 on its upper end. The head 48 is adapted to interlock with a cam-latch arm 49 projecting horizontally from the spring-seat head 34 of the bar 35, and is adapted to be disengaged therefrom by cam action of a cam-lug 50 projecting downward from the inner face of the end-closure member 11, just before the spring-seat head 34 is stopped by contact with the end-closure member, at which time the long spring 46 has been highly compressed by upward movement of the bar 42 and its collar 44.

Thereupon the spring 46 drives the bar 42 rapidly downward and thus fires the cartridge and the springs 46 and 45, opposing each other, then hold the bar and its cam hook 48 in position for reengagement of the cam-latch arm 49 for repetition of the cycle as described, the coaction of the cam faces of the members 48 and 49 flexing the spring and thus permitting them to pass each other in the relatively downward movement of the member 49.

Each of the cartridges or guns preferably is of the construction shown in Fig. 4. The main body, casing or gun barrel consists of two tubular members, 51, 52, shouldered and screw-threaded to each other as clearly shown at 53. The member 51 at its outer end has an end wall formed with suitable apertures for an inwardly-seating percussion cap 54 and an inwardly withdrawable tapered plug 55.

A captive projectile 56 is mounted in the gun-barrel structure. It has at its rear end a piston-like head which slidably fits in a large-diameter part of the bore and a shank or shaft portion of less diameter extending forward from the head and slidably fitting in a bore of like diameter in the forward end portion of the member 52. Its forward end portion is hollow and potentially

open at the front for reception of a sample of an earth formation into which it is to be shot, but, to withstand the high hydrostatic pressure of driller's mud in a deep well, and to seal off the interior of the cartridge from the mud, the front end of the projectile is closed by a metal plate 57 and the muzzle of the gun is sealed by an application of a sealing material, such as a thick coating of a hardening plastic, 58, overlying the plate, both of them being adapted to be ruptured and wholly or in part driven into the projectile ahead of the sample, when the gun is fired or at least when the projectile hits the formation.

Preferably the projectile is formed with air-venting apertures 59, 59 at the inner end of its sample-receiving cavity. It can also be formed with a weakening circumferential groove 60 a little way back of that position, so that if the projectile can not be withdrawn from a hard formation it can be broken off, and the apparatus thus released, by lowering or forcibly raising the apparatus.

For impelling the projectile forward a charge of powder 61 is suitably placed, and for pulling out the plug 55 and thus venting the powder chamber for return movement of the projectile, but only after the powder blast has given the necessary velocity to the projectile, the plug 55 is connected to the piston-like head of the projectile by a cable 62 of suitable length.

To vent air from the annular space around the shank portion of the projectile, in front of its piston portion, in the first part of its forward movement, and then to vent hot combustion gases from back of the piston, the casing member 52 is formed at a suitable position with a vent hole 63.

In dealing with soft formations, a spring 64 in the annular space just referred to, interposed between the piston head and a shoulder in the casing member 52, can have sufficient strength to withdraw the projectile from the formation and into the gun-barrel structure, so that the latter can pass on downward in the device.

To make sure of such withdrawal of the projectile, however, a charge of powder 65 is placed in an annular pocket formed in the shouldered, small-inner-diameter portion of the member 52 and sealed off by a pouring 66 of a hardening flowable material such as paraffin or sealing wax, with an interventing layer 67 of paper or the like if desired.

For timed firing of this charge of powder, after the projectile has completed or almost completed its forward movement, which may be of variable length according to the nearness and the hardness of the formation, a time fuse or a thin column of powder 68 is placed in a hole which extends from the shoulder face of the member 52, through its vent aperture 63, and into the chamber occupied by the powder 65.

When the piston head of the projectile, in its forward movement, passes the vent aperture 63, the hot gases escaping through the vent ignite the fuse or thin powder column and in a suitable length of time the combustion of the latter progresses to and ignites the powder charge 65, which, acting against the shoulder of the piston, returns the projectile to its starting position.

To prevent driller's mud or moisture from entering the gun through the vent hole 63, the hole is closed and sealed by a large-headed, short-shanked plug 69 of sealing-wax or the like, adapted to be blown out by the explosion gases, or by vented air.

Figs. 6 and 7 show an embodiment of the invention adapted to shoot holes in well casing 70, Fig. 7, as for permitting oil to enter the casing from the formation.

In this embodiment the construction and arrangement are substantially as above described for sample taking, except that the projectiles do not have to have sample-receiving chambers but can be ordinary bullets, and do not have to be recovered. In these figures I have shown a dual arrangement of cartridges, for firing bullets in opposite directions at the same time, by duplication of firing devices above described.

The metal cartridge holding strips, such as the strip 71, are each formed with two rows of holes, in ranks of twos for holding two of the cartridges, 72, 72, Fig. 6, in respective adjacent firing positions at the same time, and the casing 73 of the device is formed with a suitably positioned outlet hole, 74, for each of the projectiles.

Although the two cartridges are off-set from each other and from the center of the device, the recoils or reactions of the two simultaneous explosions almost wholly counteract each other as to displacement of the device. The chief advantages of the simultaneous firing of the two projectiles, however, is the assurance of perforating the casing at diametrically opposite positions.

The word "wall" as used in the appended claims is intended to be inclusive of structures underlying water, as in the case of an ocean floor.

Various modifications are possible without departure from the scope of the invention as defined in the appended claims.

I claim:

1. Apparatus for operating upon a wall in an earth boring, said apparatus comprising a frame structure adapted to be lowered in the boring, suspension means for so lowering it, means for firing a succession of projectile cartridges at a single firing position on said frame, resilient means supportingly interposed between the said suspension means and the said frame structure for supporting the latter from the former through said resilient means, and step-by-step feeding means mounted on the frame structure and actuated by relative movement of the frame structure and said suspension means, with change of stress in said resilient means, for bringing the cartridges in succession to the said firing position, the said frame structure and the said means defined as being mounted upon it both applying stress to said resilient means by reason of their weight and, by reason of their inertia, varying their strain upon said resilient means in accordance with manipulation of said suspension means.

2. Apparatus as defined in claim 1 in which the assembly includes means mounted on the defined frame structure and actuated by relative movement of the defined frame structure and the defined suspension means for actuating the defined firing means.

3. Apparatus as defined in claim 1 in which the assembly includes a spring for actuating the defined firing means, said spring being mounted upon the defined frame structure and having such engage-and-release connection to a part of the defined suspension means as to be stressed by relative movement of the frame structure and the suspension means and be released, by further such relative movement, for actuating the firing means by its recoil.

4. Apparatus as defined in claim 1 in which, of the defined firing means and the defined

means for bringing the cartridges to firing position, each includes a spring mounted upon the defined frame structure and having such engage-and-release connection to the defined suspension means as to be stressed by relative movement of the frame structure and the suspension means and be released by further such relative movement.

5. Apparatus as defined in claim 1 in which the means for bringing the cartridges to the firing position comprises guiding means for a succession of the cartridges and ratchet-and-pawl means for step-by-step feeding of the cartridges.

6. Apparatus as defined in claim 1 in which the means for bringing the cartridges to the firing position comprises means for holding them in orderly arrangement as a gravity procession and step-by-step means for permitting them to be moved in succession to the firing position by gravity.

7. Apparatus as defined in claim 1 in which the means for bringing the cartridges to the firing position comprises, for holding them in orderly arrangement as a gravity procession, a sheet-metal strip formed with holes for the reception of the respective cartridges, the assembly including step-by-step means for permitting them to be moved in succession to the firing position by gravity.

8. Apparatus as defined in claim 1 in which the means for bringing the cartridges to the firing position includes a gun barrel for each of the cartridges and means engaging the gun barrels for feeding each cartridge and its respective gun barrel to the firing position.

9. Apparatus for operating upon a wall in an earth boring, said apparatus comprising a frame structure adapted to be lowered in the boring, suspension means for so lowering it, resilient means supportingly interposed between the said suspension means and the said frame structure for supporting the latter from the former, a



tool member mounted on the frame structure and adapted to be projected therefrom for operating upon the said wall, and means mounted on the frame structure and actuated by relative movement of the suspension means and the frame structure, with change of stress in said resilient means, for effecting such projection of the said tool member, the tool member and the projection effecting means acting as a unit with the frame structure, by virtue of being mounted thereon, as inertia means for effecting relative movement of the frame structure and the suspension means in accordance with manipulation of the latter.

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