

April 24, 1956

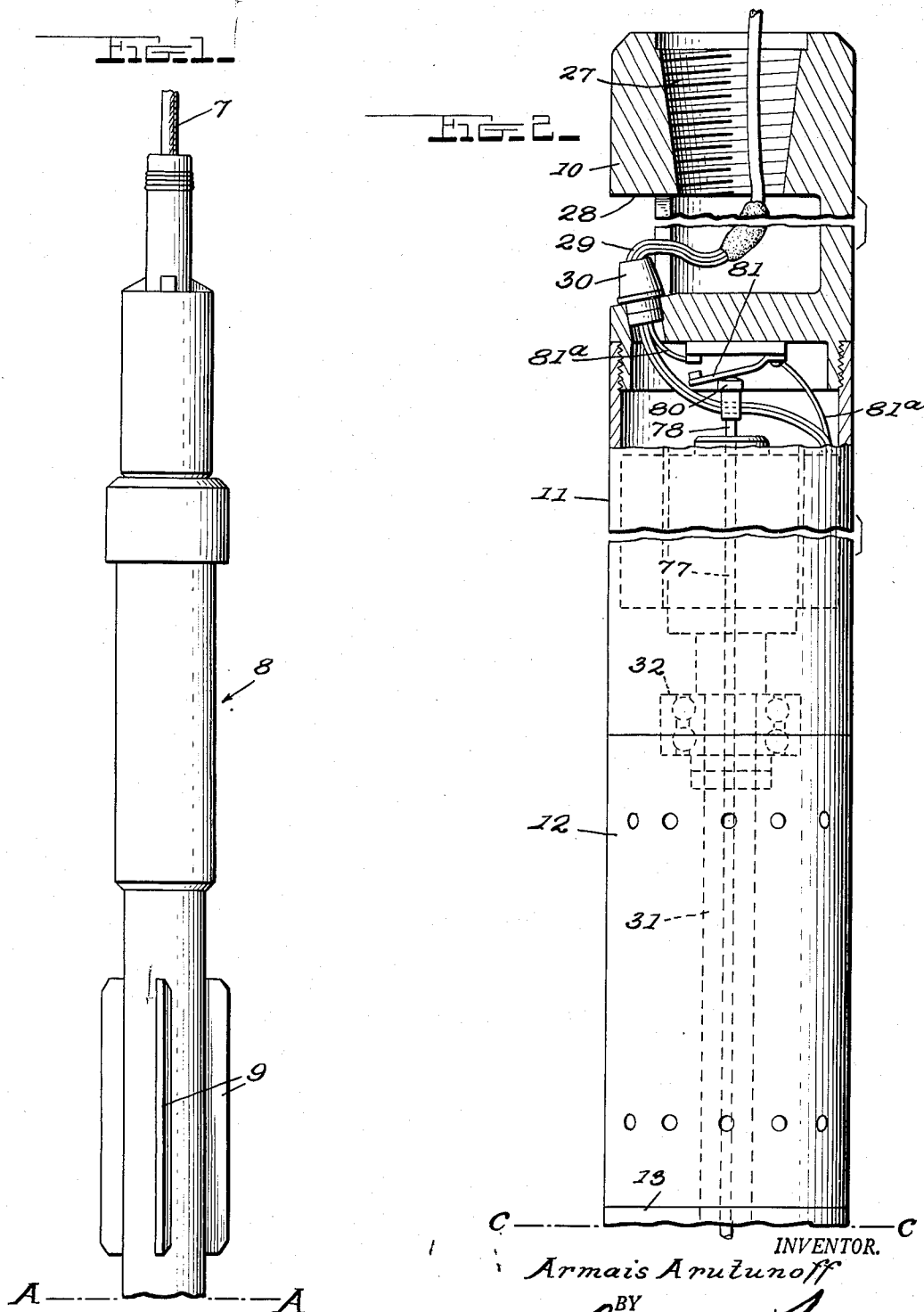
A. ARUTUNOFF

2,743,084

DRILLING APPARATUS WITH SEDIMENTATION RESERVOIR

Filed Sept. 10, 1952

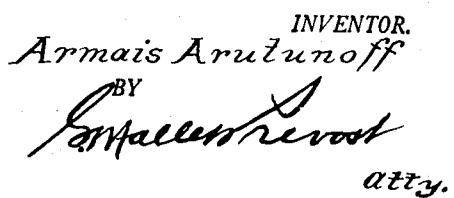
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DRILLING APPARATUS WITH SEDIMENTATION RESERVOIR

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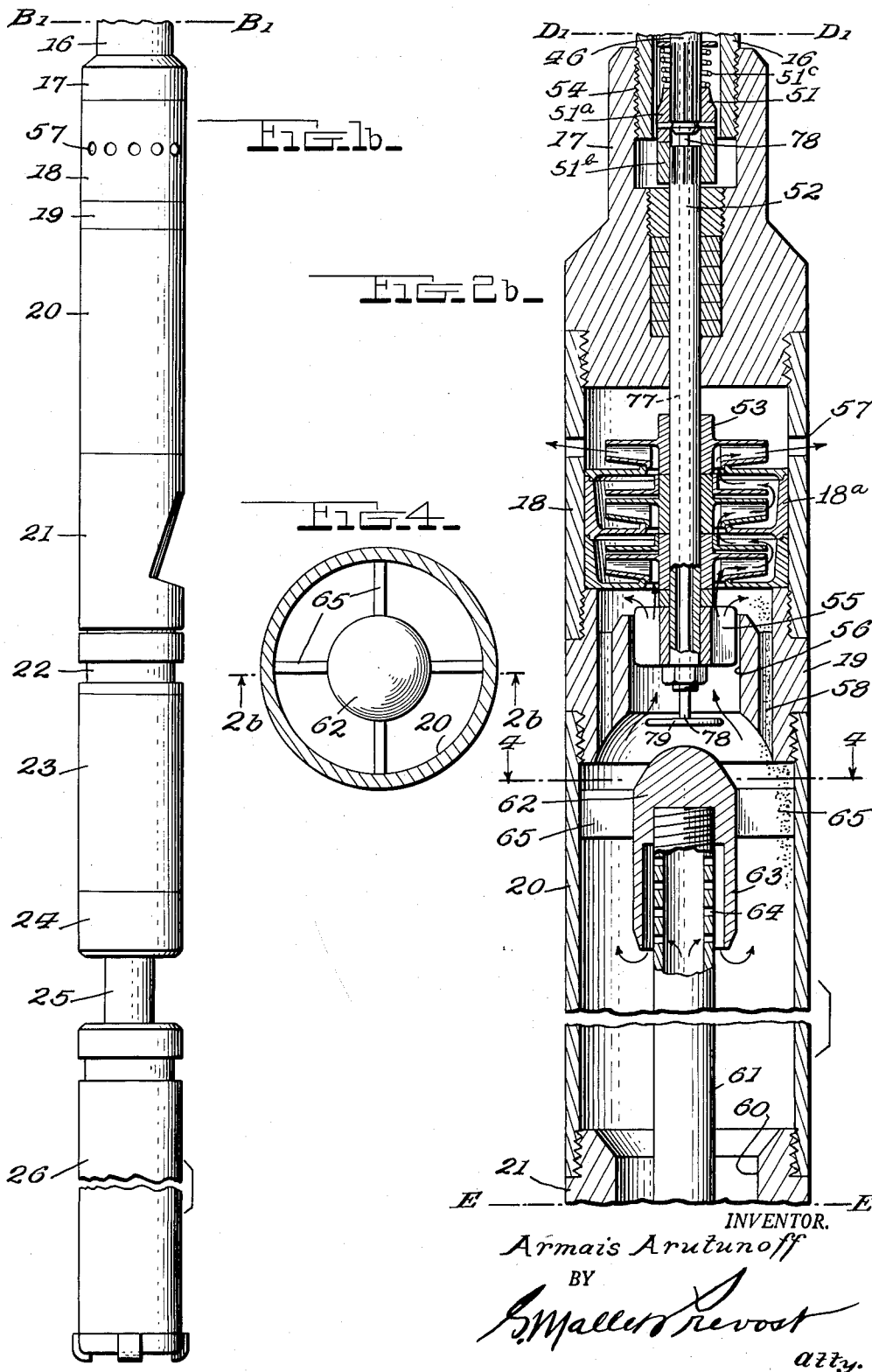
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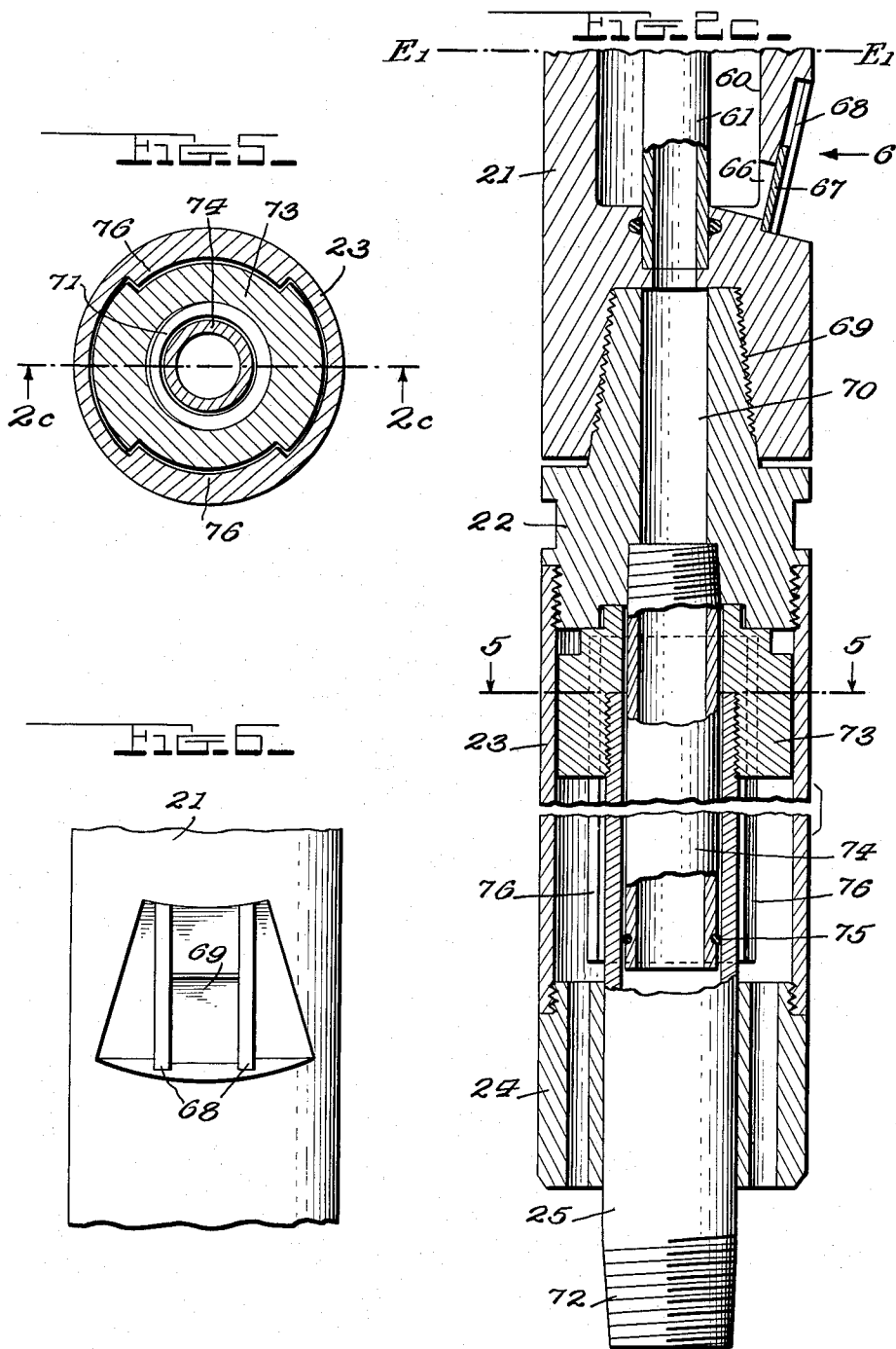
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2,743,084

DRILLING APPARATUS WITH SEDIMENTATION RESERVOIR

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Application September 10, 1952, Serial No. 308,807

6 Claims. (Cl. 255—4.8)

The present invention relates to electric motor-driven well coring and drilling apparatus of the type wherein an elongated string of mechanisms, carrying a drilling or coring device at its lower end, is lowered and raised in a well hole, on weight-carrying electric cable. More particularly, the invention consists in new and useful improvements in apparatus of this type, including a unit in the string, in form of a revolving reservoir, designed for the accumulation of cuttings produced in the drilling or coring operation.

An object of the invention is to provide a series of coaxial units for suspension in a well bore, including an electric motor at its upper end and a drilling or coring device at its lower end, with a rotatable sedimentation reservoir section with built-in circulating pump, a reduction gear unit operatively connecting the latter to the motor, whereby the collection and sedimentation of cuttings by gravity is enhanced by the centrifugal force of the revolving reservoir.

Another object of the invention is to provide mechanism of this character which is relatively simple in construction and which eliminates the narrow liquid passages used in previous designs where the circulated liquid was required to pass around the electric motor housing and the reduction gear housing.

A still further object of the invention is to provide a reservoir of this type which comprises a self-contained unit, whereby liquid circulation is confined to the rotating reservoir and connected drilling unit, the reservoir containing a circulating pump, the shaft of which automatically engages with the shaft of the electric motor when the string is assembled.

Another object of the invention is to provide a rotating reservoir adapted for the collection of cuttings and including a convenient access door for the removal of sedimentation.

It is important with this apparatus that some means be provided to prevent the progress of the drilling tool in the event that circulation, for any hydraulic or mechanical reason, fails or becomes insufficient for properly carrying the cuttings into the depository, so that the bit will not become buried and will not become stuck in the hole.

It is therefore a still further object of this invention to provide an electrical signalling device which at all times is adapted to indicate to the operator, on the surface, whether or not the circulating mechanism is functioning properly. According to the present invention a signalling device of this character is provided which, if so desired, can also automatically stop the motor if circulation is impaired.

With the above and other objects in view which will appear as the description proceeds, the invention consists in the novel features herein set forth, illustrated in the accompanying drawings and more particularly pointed out in the appended claims.

Referring to the drawings in which numerals of like

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character designate similar parts throughout the several views,

Figures 1, 1a and 1b collectively represent the entire length of a string of units including the present invention. It will be understood that in considering these figures, line A—A is to be matched with line A1—A1, and line B—B is to be matched with line B1—B1.

Figures 2, 2a, 2b and 2c collectively represent enlarged sectional views of certain of the units shown in Figures 1 to 1b.

Figure 2 shows the upper end of the string including the motor unit, the motor protecting unit not shown in detail and the signalling switch.

Figure 2a shows the reduction gear unit.

Figure 2b shows the circulating pump and the upper portion of the sedimentation reservoir.

Figure 2c shows the lower portion of the sedimentation reservoir and the core-breaking unit to which the drilling bit or core bit is attached.

It will be understood that in considering Figures 2 to 2c, line C—C is to be matched with line C1—C1, line D—D is to be matched with line D1—D1, line E—E is to be matched with line E1—E1.

Figure 3 is a transverse sectional view taken on line 3—3 of Figure 2a.

Figure 4 is a transverse sectional view taken on line 4—4 of Figure 2b.

Figure 5 is a transverse sectional view taken on line 5—5 of Figure 2c and

Figure 6 is a fragmentary elevation taken in the direction of the arrow 6 in Figure 2c, and illustrating the dumping door of the sedimentation reservoir.

In the drawings, referring first to Figures 1 to 1b collectively, I have shown a complete string of coaxial cylindrical units which together, make up the drilling or coring mechanism and which are suspended in a well hole by an electrical weight-carrying cable 7. The uppermost units of the string, generally indicated by the numeral 8, are of conventional structure and include, among other parts a torque shoe assembly 9, adapted to engage the walls of a well bore to prevent rotation of the casings of the connected units of the string.

Further down in the string, the cylindrical head 10 of a motor unit 11, is fixed to the preceding sections of the string, and below the motor unit a motor protector or breather 12 is secured, for equalization of pressure and for compensating expansion and contraction of oil in the motor unit.

Below the protector unit 12 and adapter 13 supports a reduction gear unit 14 which in turn carries a shaft bearing unit 15. The main shaft 16 extends longitudinally through the bearing unit 15 and its lower extremity is operatively connected to a head 17 which together with the cylindrical section 18 forms the housing of the centrifugal pump unit 18a. The latter is connected by an adapter 19 to a cylindrical sleeve or casing 20 which forms the upper portion of a sedimentation reservoir 21.

An adapter 22 is connected into the lower end of the sedimentation reservoir and supports the cylindrical housing 23 of a core-breaking unit which may be of the same type as that described and illustrated in my copending application Serial No. 260,177, filed December 6, 1951.

As in said copending application the lower end of the core-breaker 23 is closed by a collar or abutment 24 which slidably supports a sleeve 25 to the lower end of which is connected the core drill 26.

The foregoing description is of a very general nature and is simply given as an aid in locating the various essential portions of the invention now to be described in detail.

Referring to Figure 2, it will be seen that the head 10

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is drilled and threaded as at 27, for connection to the upper units 8 of the string and is recessed from one side of its periphery as at 28, to accommodate and afford room for splicing of the electrical wires 29 to the wires which extend upwardly to the ground surface, through the units 8 of the string of casing. The electric wires 29 pass through a suitable opening in the head 10 for connection to the motor in unit 11 and are held in place by an insulated collar 30 which also seals motor from intrusion of liquid.

The motor shaft shown in dotted lines at 31 in Figure 2, extends through the motor protector unit 12 and is mounted in suitable bearings 32 also shown in dotted lines. Referring to Figure 2a, it will be seen that the lower end of the motor shaft 31 extends into the reduction gear unit 14, where it is reduced in diameter to receive the central gear 33 of a planetary gear system, comprising a series of planetary gears 34, mounted in a spider assembly 37 with cover 35 for rotary travel therewith around the motor shaft 31. The inner periphery of the casing 14 of the reduction gear unit is provided with a series of vertically disposed, annularly arranged teeth 36 forming a ring gear with which the teeth of the planetary gears 34 are adapted to mesh.

A gear 39 with its part 38 is fixed to the spider 37 and comprises the central gear of a second planetary gear system, including a series of planetary gears 40 which are supported for rotary movements around the axis of the shaft 31, by a spider 42 with cover 41. The spider 42 carrying the bearings of planetary gears 40 which is formed as integral part of the main shaft 16 which, as hereinafter will appear, supports and rotates the housing of circulating pump, the sedimentation reservoir, the core breaker and the core bit.

The lower extremity of the reduced end of motor shaft 31 is splined as at 44 to operatively engage splined collar 45 which as shown in Figure 2a, fits within a suitable recess in the upper end of the main shaft 16. The gear 39 and shaft 16 are hollow to accommodate the extension of the motor shaft and shaft sections 46 which are connected to the motor shaft by splined coupling 45. Arranged coaxially with the shaft 31 is the shaft 46 of the circulating pump unit, said shaft 46 being splined as at 47 at its upper end, for operative engagement with the collar 45 by means of which the shaft is supported so as to rotate with and at the same rate of speed as the motor shaft 31. Suitable bearings 48 and 49 rotatably support the main shaft 16 within the casing of the bearing unit 15, the lower end of the latter being closed and sealed by any suitable sealing means 50.

The shaft 46 extends longitudinally through the central opening in hollow shaft 16 where, by means of an automatic spring-actuated coupling device 51, Fig. 2b, it is connected to the splined upper end of the impeller shaft 52 of the circulating pump 53, located in the casing 18 and later described more in detail.

The coupling device 51 consists of an upper member 51a which is movable on the splines of shaft 46 and urged into engagement with a lower counterpart 51b, by a spring 51c. The part 51b is fixed to the shaft 52.

As seen in Fig. 2b, the lower extremity of the main shaft 16 is threaded as at 54 to engage complementary threads in the head 17 which forms the top of the circulating pump unit. The casing 18 of the circulating pump unit thus rotates with the main shaft 16 at the reduced speed caused by the section of the planetary gear system above described, while the impellers 53 of the circulating pump which are keyed to the impeller shaft 52, rotate at the full speed of rotation of the motor shaft 31.

The impellers 53 are arranged in several stages on the shaft 52 which at its lower end carries a radiating slinger 55, located in a central passageway 56 of the adapter 19, by means of which the casing 18 is connected to the casing 20 of the sedimentation reservoir. The circulating pump discharges through radial openings 57 in the casing 18, the

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liquid which has been drawn upwardly through tube 61 and hence downward through annulus formed by skirt 63 into the casing 20 and central opening 56, thus, as will later be described, causing a constant circulation of the liquid in the well. The sedimentation is caused by sudden reverse of laden liquid flow which is downwardly directed by skirt 63 and which sends its particles of detritus down toward the bottom 60 of the reservoir and, due to rotation of the reservoir, along the walls of casing 20. A secondary stripping of any particles retained in the liquid is caused by the centrifugal force of the vanes of the high speed slinger 55 which through a series of vertical ports 58 in the body of the adapter 19, permit the return of entrained particles, to the reservoir, while allowing the clean liquid to pass to the pump.

The circulating pump and reservoir comprise a cylindrical body, the casing 20 of which is secured at the lower end of the adapter 19 and in turn is connected to a cylindrical base member 21. This base member is centrally drilled to provide a well 60 which as will be seen from Figs. 2b and 2c, forms the bottom of sedimentation reservoir, formed by the casing 20. A vertical tube or stand pipe 61 is centrally disposed in the reservoir 60 and fixed at its upper end, so as to rotate with the reservoir unit. The upper end of the tube extends into the casing 20 and has secured to its upper extremity, a hood 62 which is located in line with and immediately below the passageway 56 in adapter 19, said hood having a downwardly extending skirt 63 which surrounds the upper portion of the tube 61 in spaced relation thereto, as shown in Figure 2b. That portion of the tube 61 within the confines of the skirt 63, is provided with a series of radial perforations 64, whereby fluid passing upwardly through the tube is forced outwardly into the annular space defined by the skirt 63.

In order to adequately support the upper end of the tube 61 and the hood 62, the latter is provided with a series of radiating arms 65 which are welded or otherwise secured to the inner periphery of the casing 20 as shown in Figures 2b and 4. Thus, upon rotation of the reservoir unit, the tube 61 and hood 62 are maintained in proper alignment with the passageway 56 in adapter 19.

At the lower end of the well or reservoir 60, I provide a radial opening 67 through the wall of the base 21 which, by means of an angularly inset trackway 68 and a slidably mounted door 67, affords access to the interior of the well 60, so that cuttings and sedimentation collected in the reservoir, may be removed.

The lower end of the case 21 is drilled and internally threaded as at 69, to receive the complementary threads on the connecting element of adapter 22, the latter being centrally drilled as at 70 in line for communication with the central passageway in tube 61. The adapter 22 supports the casing 23 of the core breaker unit which may be of the type illustrated and described in my copending application Serial No. 260,177, filed December 6, 1951.

Although the specific construction of this core breaking unit forms no part of the present invention, it may be briefly described as comprising a centrally disposed sleeve member 25, threaded at its lower end 72 for connection to a conventional core bit or drilling bit 26, as shown in Figure 1b. The sleeve 25 is slidably embraced in a central opening in the bottom closure 24 of the core breaker unit and its upper end is screwed into a knocker 73, the sleeve and knocker being mounted for vertical sliding movement in the casing 23 between the vertical limits defined by the lower end of the adapter 22 and the upper end of the case or abutment 24.

Arranged telescopically within the sleeve 25 is an inner sleeve 74 the upper end of which is screwed into the lower end of the opening 70 in the adapter 22, so as to form a continuation of said passageway. A sealing ring 75 surrounds the lower end of the inner sleeve 74, so as to prevent the entrance of fluid into the clearance space between the two sleeves.

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As shown in Figure 5, the inner periphery of the casing 23 is provided with a pair of opposed, vertically elongated, guide ribs 76 adapted to register with complementary recesses on the adjacent periphery of the knocker 73. Thus, the rotation of the cylinder or casing 23 causes the knocker 73 to rotate therewith, which in turn, rotates the outer sleeve 25 carrying at its lower end the drilling bit 26. As in the case of my said copending application, during the drilling operation the knocker 73 is in abutment with the lower face of the adapter 22 and when the apparatus is raised in the well hole, the knocker 73 and the core barrel 26 remain stationary being held by the core catcher to the core which is the part of the rock, until the bottom closure 24, rising up, hits the knocker 73 thus breaking the core from the rock.

Turning now to the signalling mechanism for indicating to the operator, the functioning of the circulation in the system, it will be seen from Figures 2, 2a and 2b, that the motor shaft 31, the impeller connecting shaft 46 and the main impeller shaft 52, are provided with a continuous central passageway 77 which extends from the lower extremity of the impeller shaft 52 to the upper extremity of the motor shaft. Within this passageway is arranged a rod 78, carrying at its lower projecting end, a circular disk 79 which lies at the entrance of and restricts the passageway 56 in the adapter 19. The upper end of the rod 78 carries a head 80 (Fig. 2) which engages the under side of a normally open spring contact 81 and under its own weight, the rod 78 normally tends to assume its lowermost position in the passageway 77, so that the contact 81 remains open. The contact 81 may be interposed either in an electric signalling circuit or a motor stopping relay circuit (not shown), by electrical conductors 81a, the arrangement being such that the breaking of the circuit by opening the contact 81, will operate the signal or stop the motor or both.

Under the influence of a volume of circulating fluid passing upwardly through the passageway 56, the disk 79 is caused to rise and with it the rod 78. Thus, so long as circulation continues in the desired volume, the head 80 on rod 78 maintains the contact 81 in circuit closing position. However, upon failure of the circulation for any reason, the disk 79 and the rod 78 are permitted to drop to their lower positions, opening the contact 81 and breaking the electric circuit, which, as before stated, either actuates the alarm or through said relay, stops the motor. Thus, the bit is prevented from becoming buried or stuck in the hole because of failure of circulation.

While I have shown and described mechanical means for actuating the electrical signalling device, it will be understood that other suitable means may be employed with equal effect, in the combination of elements comprising my invention.

In operation, the apparatus is lowered into a well hole on the weight-carrying cable 7 and the operation of the electric motor unit 11, through the series of shafts and planetary gears, causes the rotation of the centrifugal pump unit and the sedimentation reservoir 20—21, as well as the core bit. It will be understood that in operation, the entire string of units is kept submerged in liquid at least to the cable 7, so that there is a constant hydrostatic head of sufficient volume to drive the cuttings into the core barrel or bit 26. The shaft of centrifugal pump 53, through direct connection, is rotated at the high speed of the electric motor unit 11, while the sedimentation reservoir and the housing of the centrifugal pump unit, is caused to rotate at a reduced speed through the system of planetary gears.

The laden liquid is stripped of the particles of the rock which it carries by directing the stream downwardly, thus shooting the particles to the bottom 60 where they remain, while the liquid reverses direction of its flow and rises toward pump intake.

This stripping action is further enhanced by the fact that sedimentation reservoir 20 itself is revolving and centrifugal force of the revolving liquid in the reservoir

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throws the particles toward the walls of the reservoir while the cleaned fluid rises in the central portion.

However, to strip the liquid entering the pump from the smallest particles, the vanes of high-speed slinger 55 acting as a centrifuge, direct the remaining particles to the periphery where they sink through the series of holes 58 to the bottom, while cleanest liquid passes freely to the pump.

After a sufficient quantity of sedimentation has collected in the reservoir 60, it may be removed by opening the door 67 in the bottom of the reservoir.

During this operation the signal control rod 78 is maintained in its uppermost position by the force of the circulation fluid, on the disk 79, thus maintaining the contact 80 in closed position. However, as before explained, upon failure of the circulation, the disk 79 is permitted to drop and with it the rod 78 which breaks the contact 81 and actuates a signalling device or relay for stopping the motor.

From the foregoing it is believed that my invention may be readily understood by those skilled in the art without further description, it being borne in mind that numerous changes may be made in the details of construction without departing from the spirit of the invention as set forth in the following claims.

I claim:

1. In a drilling apparatus, a drill operating electric motor, a motor shaft, a reduction gear assembly driven by said motor shaft, a main shaft, concentric with said motor shaft, means operatively connecting said main shaft with said reduction gear assembly for rotation at a reduced speed, a common cylindrical casing enclosing said motor and reduction gear assembly and the upper portion of said main shaft, means preventing rotation of said casing, said main shaft projecting from the lower end of said casing, a combined sedimentation collecting and fluid circulating unit, comprising a cylindrical housing fixed to and rotatable with the projecting end of said main shaft, a pump chamber in the upper end of said housing, a circulating pump in said chamber, a sedimentation reservoir formed by and rotatable with said housing below said pump chamber, a fluid duct connecting said reservoir with said chamber, a shaft extension connecting said pump with said motor shaft for rotation at the speed of said motor, a drilling unit carried at the lower end of said housing for rotation therewith, a passageway through said drilling unit, a centrally disposed standpipe in said reservoir fixed to said housing for rotation therewith and directly connected at its lower end to said passageway, the upper end of said standpipe being closed and terminating adjacent said fluid duct, a series of radial perforations in the upper portion of said standpipe, and discharge ports in said pump chamber leading to the exterior of said housing, whereby liquid under the action of said pump, is drawn through said drilling unit, upwardly through said rotating standpipe, discharged radially through said perforations, and any entrained particles of cuttings are separated from the liquid by the centrifugal force generated by the rotation of said standpipe and reservoir, and deposited in said reservoir.

2. In a drilling apparatus including a non-rotatable power unit having a motor, a motor shaft, and a reduction gear assembly therein, driven by said motor shaft, a main shaft driven by said reduction gear assembly and depending concentrically from said power unit, and a core drilling unit connected to and rotatable by said main shaft, and including a fluid conducting passageway, opening at its upper end; a combined sedimentation collecting and fluid circulating unit interposed concentrically between said power unit and core drilling unit, said combined unit comprising a cylindrical casing fixed to and rotatable with said main shaft, and serving as the connection between the latter and said core drilling unit, a circulating pump in the upper portion of said casing, means connecting said pump to said motor shaft for rotation

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at the speed of the motor, a fluid duct connecting the inlet of said pump to the lower portion of said casing, a vertical standpipe concentrically disposed in and fixed to said casing, connected at its lower end to said fluid conducting passageway and terminating in a closed head below said fluid duct, the annulus formed by said standpipe and cylindrical casing, comprising an annular sedimentation collecting reservoir, a series of radial perforations adjacent the upper end of said standpipe, and radial discharge ports in said casing adjacent the discharge side of said pump, leading to the exterior of said casing, whereby liquid under the action of said pump is drawn through said drilling unit, upwardly through said standpipe, discharged radially through said perforations, and any entrained particles of cuttings are separated from the liquid by the centrifugal force generated by the rotation of said standpipe and reservoir, and deposited in said reservoir.

3. Drilling apparatus as claimed in claim 2, wherein the closed head of said standpipe is provided with a downwardly directed annular apron, spaced from said standpipe and surrounding said perforations, whereby any particles of cuttings entrained in the fluid ejected from said standpipe, are deflected to said reservoir.

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4. Drilling apparatus as claimed in claim 2, wherein the wall of said casing forming said reservoir, is provided with a radial opening having a closure for removing sedimentation collected in the reservoir.

5. Drilling apparatus as claimed in claim 2, including means adjacent the fluid duct leading to said pump, for deflecting particles of cuttings back to said reservoir anterior to the pump inlet.

6. Drilling apparatus as claimed in claim 2, including a rotatable spinner, connected to said pump shaft and located in said fluid duct for deflecting particles of cuttings passing through said duct, back to said reservoir.

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