

Sept. 16, 1958

M. A. GARRISON

2,852,230

SIDE WALL CORING AND BOTTOM HOLE DRILLING TOOL

Filed March 11, 1954

3 Sheets-Sheet 1

FIG. 1.

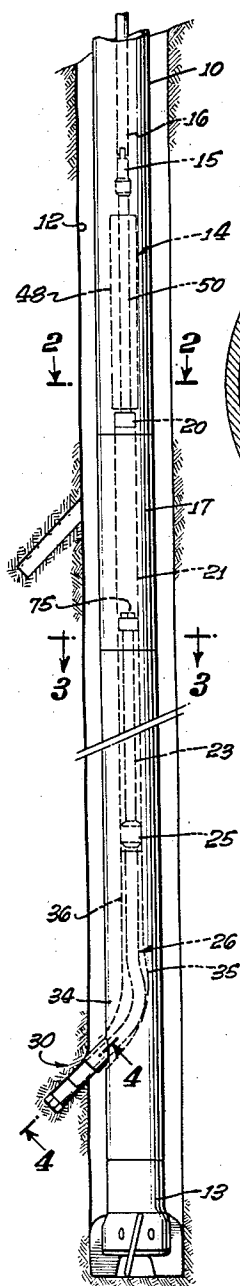


FIG. 2.

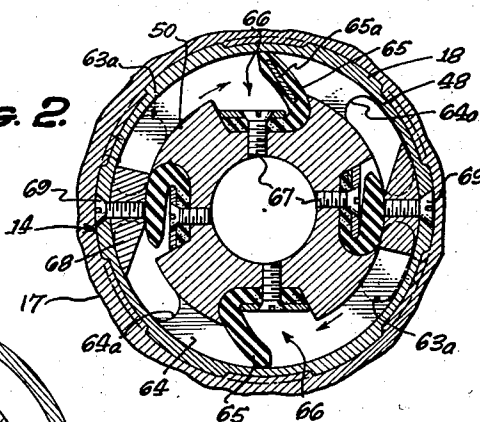


FIG. 3.

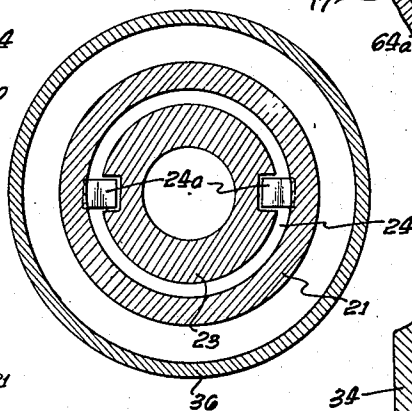
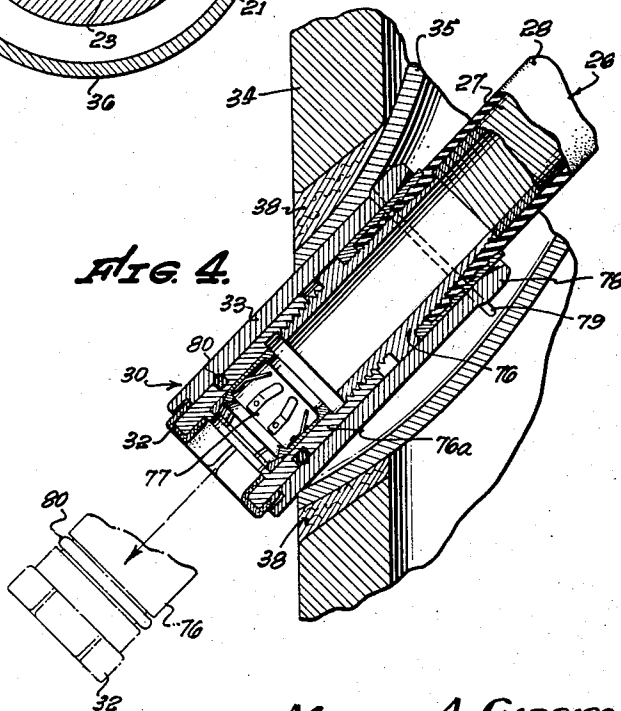


FIG. 4.



MARION A. GARRISON,
INVENTOR.

BY HIS ATTORNEYS

HARRIS, KIECH, FOSTER & HARRIS.

Sept. 16, 1958

M. A. GARRISON

2,852,230

SIDE WALL CORING AND BOTTOM HOLE DRILLING TOOL

Filed March 11, 1954

3 Sheets-Sheet 2

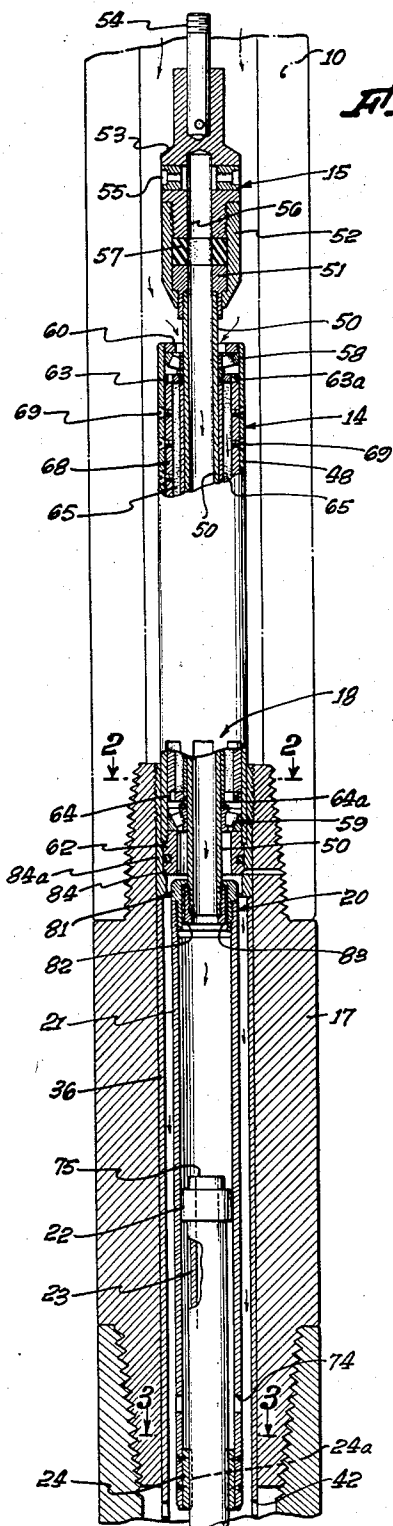


FIG. 5.

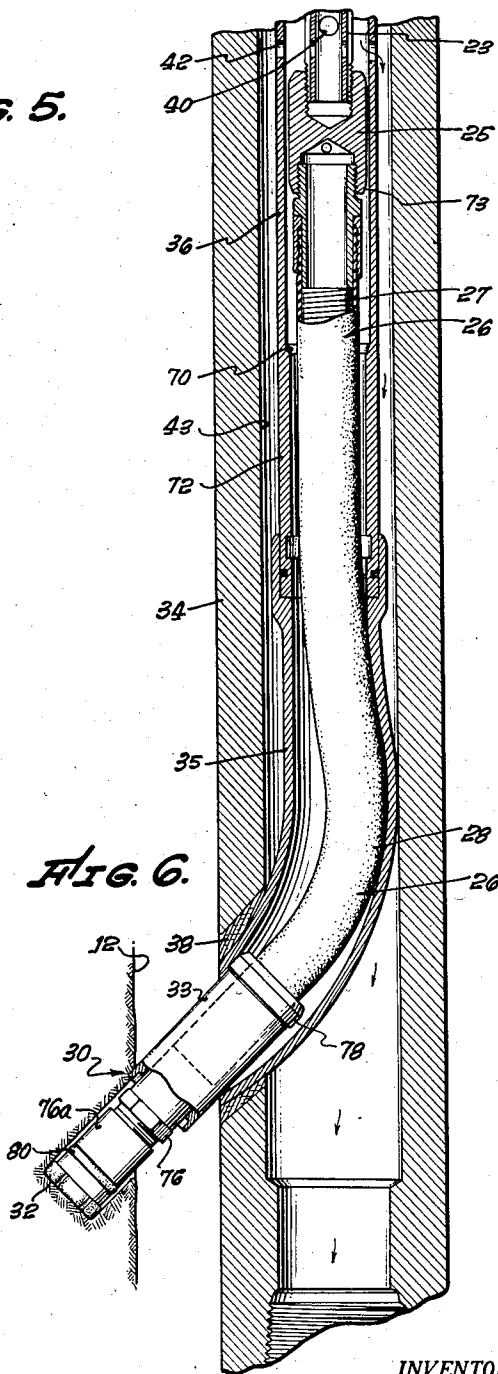


FIG. 6.

INVENTOR.
MARION A. GARRISON,
BY HIS ATTORNEYS.

HARRIS, KIECH, FOSTER & HARRIS.

Sept. 16, 1958

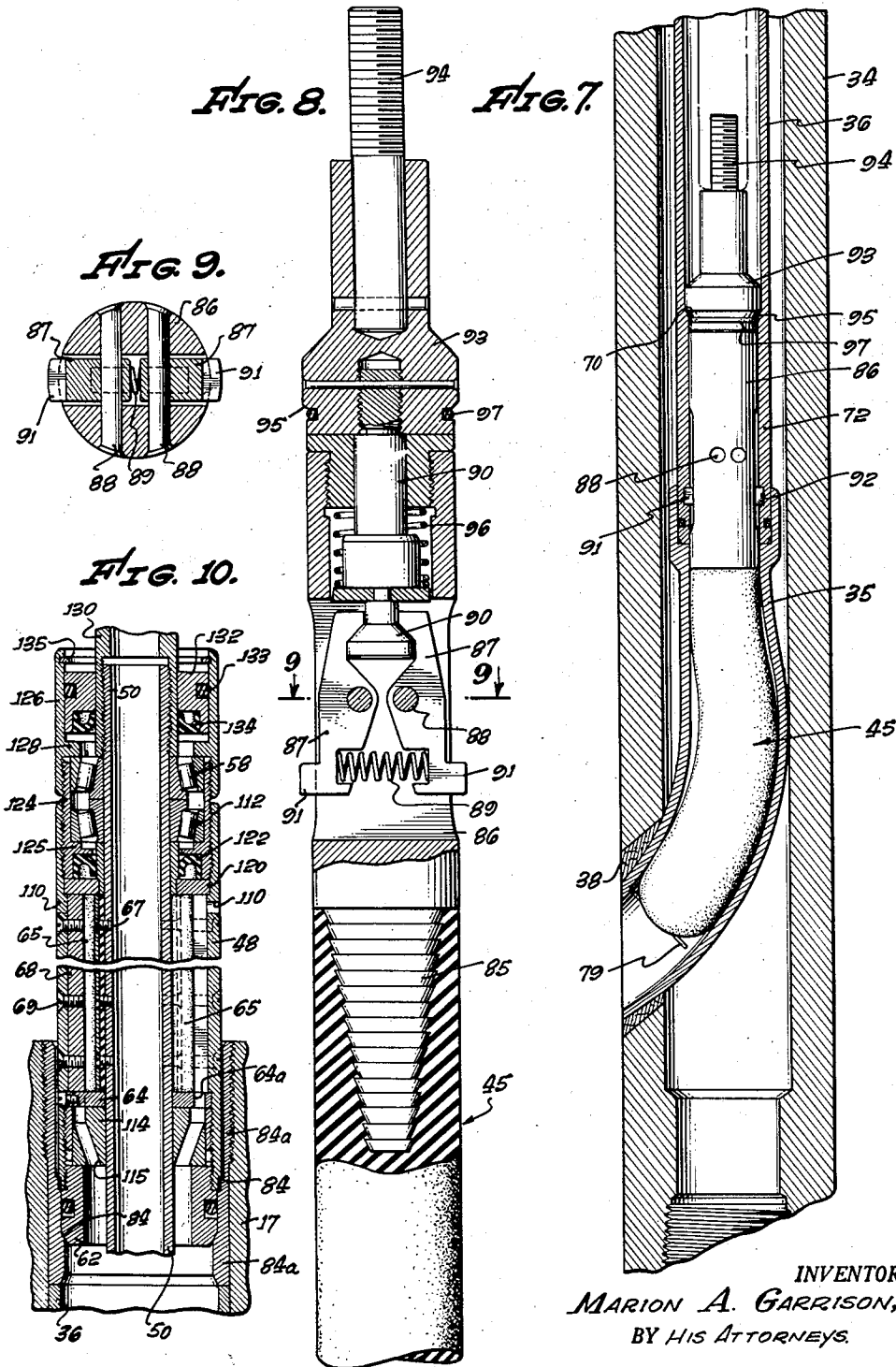
M. A. GARRISON

2,852,230

SIDE WALL CORING AND BOTTOM HOLE DRILLING TOOL

Filed March 11, 1954

3 Sheets-Sheet 3



INVENTOR.
MARION A. GARRISON,
BY HIS ATTORNEYS.

HARRIS, KIECH, FOSTER & HARRIS.

1

2,852,230

SIDE WALL CORING AND BOTTOM HOLE
DRILLING TOOL

Marion A. Garrison, South Pasadena, Calif., assignor to
Empire Oil Tool Company, Denver, Colo., a corpora-
tion of Colorado

Application March 11, 1954, Serial No. 415,635

36 Claims. (Cl. 255—1.4)

This invention relates to deep well drilling apparatus, and a particular object is to provide drilling apparatus by means of which drilling on the bottom of the hole may be effected as required and when desired, side wall coring may be accomplished without the necessity of withdrawing the bottom hole drilling apparatus from the well.

More particularly it is an object of the invention to provide a bottom hole drilling combination which carries above the bottom hole bit a projectable side wall corer associated with a self-contained motor which may be operated at will by circulating mud, the bottom hole bit then serving to center the pipe means carrying the corer, the motor being retrievable on a wire line, in a preferred form, for removal from the drill pipe during ordinary bottom hole drilling.

Such a combination wherein the motor is retrievable makes it possible to obtain a bigger side wall core, and it is therefore also an object of this invention to provide a drilling and coring combination that permits side wall coring without removal of the bottom bit from the well and also permits the obtaining of a core of maximum diameter. With such a structure, both the coring motor, which is a fluid motor, and the coring tool are run in and out of the drill pipe on a wire line as required, or they may be dropped into operative position in the drill pipe.

A further object is to provide for plugging the coring tool retainer when drilling on bottom so as to control mud circulation to the bottom hole bit, a latchable plug or the like being used for such purpose and being removable on a line to run in the coring tool or to drain the drill pipe to prevent "wet strings" when pulling the drill pipe out of the hole stand by stand.

An additional object is to provide for taking side wall cores at any elevation merely by lifting the apparatus off the bottom as desired.

Another object of the invention is to provide a novel fluid motor arrangement suitable for the indicated use to be actuated by drilling mud pressure and adapted to be constructed in small diameters capable of being run into a mounting carried within a drill pipe and of being readily withdrawn.

Other objects of the invention are to provide novel constructions in coring tools and arrangements of the indicated nature, and still other objects will appear to those skilled in this art upon reference to the accompanying drawings and the following specification.

In the drawings:

Fig. 1 is an elevational view on a small scale showing the lower end of a drill pipe assembly equipped with a bottom hole bit at its lower extremity and with a side wall core bit thereabove, the core bit having its actuating mechanism contained within drill pipe portions above it;

Fig. 2 is an enlarged cross section through the core

2

bit actuating means, being taken approximately on the lines 2—2 of Figs. 1 and 5;

Fig. 3 is a similar cross section taken approximately as indicated by the lines 3—3 of Figs. 1 and 5;

Fig. 4 is a fragmentary longitudinal vertical sectional view through the core bit and its positioning means, being taken on the median vertical plane of Fig. 1 and approximately at right angles to that of the line 4—4 of Fig. 1;

Fig. 5 is principally a vertical sectional view of the upper portion of the assembly of Fig. 1 above the break in that figure, and on an enlarged scale;

Fig. 6 is a downward extension of Fig. 5 showing the rest of the structure of Fig. 1 on an enlarged scale from the break of Fig. 1 down to a position adjacent the drill bit on the bottom of the hole, the core bit and its actuating parts being shown largely in elevation within their positioning parts which are shown in vertical section;

Fig. 7 is a view similar to that of Fig. 6, the coring tool being replaced with a plug to close the coring tool retainer and control mud circulation during ordinary drilling on bottom;

Fig. 8 is a view largely in vertical section and on an enlarged scale of the latching and latch-releasing mechanism at the top of the plug of Fig. 7;

Fig. 9 is a cross section taken on the line 9—9 of Fig. 8; and

Fig. 10 is a broken, sectional detail of a modified bearing arrangement for the fluid motor.

Having reference to Fig. 1 of the drawings and also to Figs. 5 and 6 combined, the structure of this improvement is illustrated as being carried at the lower end of a standard drill pipe or drill string 10 which is shown as operating in a bore hole 12 which has been drilled by means of a conventional drill bit 13 working on the bottom of the hole at the lower end of the apparatus. As seen in Figs. 1 and 5, a vertically elongated motor 14 operated by mud pressure in the well is shown as being positioned in the lower portion of the lower section of drill pipe 10 and as carrying at its upper end a fishing connection 15 adapted to be engaged by an overshot 16 seen at the upper end of Fig. 1 and lowered into position on a wire line or the like. The lower end of the fluid motor 14, which is a positive displacement liquid-actuated device presently to be described more fully, has its outer shell seated against rotation within the upper end of a conventional joint section or "sub" 17 threaded on the lower end of the drill pipe section 10. Such seat is effected through the medium of splines and splineways in the upper end of the "sub" and on the lower end of the motor housing as indicated at 18 in Fig. 5.

The lower end of the rotary vertical element of the motor 14 is connected by a flexible coupling generally indicated 20 in Fig. 5 to the upper end of a rotated cylinder 21 in which is disposed a piston 22 mounted upon the upper end of a hollow or tubular piston rod 23 keyed at 24a in a collar 24 fixed in the lower end of the cylinder 21 for simultaneous longitudinal movement in the cylinder 21 and rotary drive thereby. The lower end of the hollow piston rod 23 is fixed in a coupling 25 (Figs. 1 and 6) which is affixed by any appropriate or conventional means to the upper end of a hollow, reinforced, flexible drive shaft 26 which acts also as a core-receiving barrel. As seen in Fig. 4 the shaft 26 may include a helical spring element 27 which reinforces the outer hose 28 and renders it non-collapsible. Clamped to the lower and outer end of the flexible shaft 26 is a core head 30 which includes a projectable core bit 32 of abrasive material, such bit being projectable as seen in Figs. 1, 4 and 6 from a frangible bushing 33 which also is projectable for a distance such as illustrated in Figs. 1, 4 and 6 to a position where it engages the wall of the

well hole 12 conventionally spaced from the outer wall of the lowermost section 34 of the drill pipe, which section 34 is commonly known as a "drill collar" carrying the drill bit 13. The pipe sections 10 and 34 and the sub 17 may be considered as a drill pipe assembly. In Fig. 6 and in the lower portion of Fig. 1 the core head is shown as taking a core, and at a higher position in Fig. 1 there is illustrated a location where a core previously had been taken.

Referring to Fig. 4 and especially to Fig. 6, the frangible bushing 33, which might be of a brittle metal, or a brittle plastic or a suitable ceramic material, is shown as being receivable in and removable through an especially shaped tubular housing and guide 35 which may be a cast steel shell or the like and thus constitute a guide tube or shell, the shape of which is such as to position and provide for the passage of the frangible bushing 33 to and from core-taking position. The upper end of the especially shaped guide shell 35 is suitably secured to the lower end of an elongated inner sleeve or tube 36 which extends up through the drill collar 34 and into the upper end of the joint or "sub" 17 where it is seated as shown in Fig. 5 in alignment with the splines which receive the lower end of the motor housing of the motor 14. The lower end of the curved guide shell 35 is anchored in the wall of the drill collar 34 by appropriate welding 38 as seen in Figs. 4 and 6.

Circulating mud which passes down through the center of the motor 14 as presently to be described, after entering the cylinder 21 to drive the piston 22 downward, then passes through the hollow piston rod 23, being discharged through openings 40 into the inner tube 36 whence it passes to the exterior thereof by openings 42 and thence to the drill bit 13 through the bore 43 of the drill collar 34, as indicated in Fig. 6.

In order to prevent loss of mud by way of the inner tube 36 and the shell 35 during ordinary drilling with the bit 13, under which circumstances the above described coring apparatus will have been removed, a latching plug 45 is run down into the shell 35 to close the latter, as illustrated in Fig. 7 and as more fully described below.

Portions of the above-described coring mechanism and means for actuating the core bit will now be explained somewhat more fully.

As previously indicated, the motor 14 is provided with an outer cylindrical housing designated at 48, the lower end of this housing being removably but non-rotatably carried in the seat at the top of the "sub" 17 provided by the splines and splineways 18 previously described. The motor 14 also includes a vertically disposed hollow tubular rotary element 50 whose upper end is attached to the previously mentioned fishing connection 15 and receives through such connection drilling mud which passes down through the hollow element 50 and is discharged from the lower end thereof through the flexible coupling 20 into the cylinder 21 depending in the "sub" 17 whereby to supply such drilling mud under pressure to the piston 22 and its piston rod 23 which conducts the mud downward and discharges it from its lower end by way of the openings 40. The upper end of the tubular element 50 is attached to the fishing connection 15 by being threaded into the lower end of a shouldered bushing 51 whose upper end works within the bore of a shouldered sleeve 52, the upper end of which is in turn threaded on the lower end of a fitting 53 which carries in its top a fishing pin 54 to be engaged by the previously mentioned overshot 16. The intermediate and lower portions of the fitting 53 are provided with a vertical bore as shown in Fig. 5 which receives drilling mud from the interior of the drilling pipe sections 10 by way of ported members 55 commonly known as flow beans, the size of whose ports may be varied for the passage of the desired proportion of mud. The bore 56 of the fitting 53 communicates with the interior of the tubular rotary

member 50, which member 50 may be also considered as a drive shaft of the motor. Within the shouldered sleeve 52 between the lower end of the fitting 53 and the upper end of the bushing 51 a rubber bumper ring 57 is conveniently employed to absorb the shock of the overshot and the fishing connection 15 when the motor 14 is run in and landed on the splined seat 18. As shown, this bumper ring 57 is provided with a bore to pass the mud going to the tubular drive shaft 50. The upper and lower ends of the outer motor housing 48 carry an upper set 58 of roller bearings and a lower set 59 of roller bearings in which the hollow rotary shaft 50 is journaled. Into the upper end of the motor housing 48 there is threaded a screw ring 60 to position the upper set 58 of ball bearings, and into the lower end of the housing 48 there is threaded a lower screw ring 62 retaining the lower ball bearing set 59. The inner portions of these rings 60 and 62 are sufficiently spaced from the outer wall of the tubular drive shaft 50 to provide adequate passage of drilling mud through the bearings and to and from the space within the motor between the housing 48 and the hollow shaft 50. At the under side of the upper set 58 of roller bearings there is provided a ported fluid-inlet plate or ring 63, and above the lower set 59 of roller bearings there is provided a ported discharge plate or ring 64.

The tubular rotor or drive shaft 50 of the motor 14 is provided with a plurality of vertically extending rubber blades or vanes 65 which are held at their innermost portions in corresponding pockets 66 (Fig. 2) by means of retainer plates and series of screws indicated at 67 and extending longitudinally of the rotor shaft 50. These blades 65 are adapted to flex under mud pressure between collapsed positions as seen at the sides of Fig. 2 and extended operating positions as seen at the top and bottom of Fig. 2. In the form illustrated in Fig. 2, two diametrically opposed, longitudinally extending separator strips 68 are provided, these being secured to the inner wall of the outer housing 48 as by means of screws 69. In the form indicated, rotation is in the direction of the arrows of Fig. 2, and the inner faces of the separator strips 68 are inclined to effect the flexing and folding of the rubber blades 65 as shown. If desired, the moving portions of the blades 65 may have imbedded therein longitudinally extending steel strips 65a as seen in the uppermost blade of Fig. 2, whereby to improve the effectiveness of these blades 65 as drivers.

Fig. 2 also shows that, by reason of the two separator strips 68, two corresponding driving fluid chambers are formed, at the lower ends of which the above-mentioned discharge ring 64 is located, this ring 64 having two discharge ports 64a, each of which is located at the side of the respective chamber toward which the rubber blades travel. At the nearer sides of the two respective chambers there are indicated the relative positions, in dotted lines, of two inlet ports in the overlying inlet ring 63 at the top of the motor 14. These inlet ports are designated 63a.

In the light of the foregoing, it will be apparent that drilling mud working down the drill string 10 under pressure enters the upper end of the motor 14 by way of the upper roller bearing set 58 through the annular space between the upper screw ring 60 and the rotor drive shaft 50, passing thence through the inlet ports 63a of the upper or inlet ring 63 and into the two vertical chambers in the motor between the separator strips 68. The pressure of the drilling mud thus entering the inlet ports 63a causes the extended rubber blades 65 to move in the direction of the arrows in Fig. 2 toward the discharge ports 64a in the lower or discharge ring 64, thereby imparting the required rotary movement to the rotor drive shaft 50, the blades 65 folding and riding over the separator strips 68 as they come to them. The mud leaving the discharge ports 64a in the discharge ring 64 leaves through the lower roller bearing set 59 and enters the elongated annular space which is within the lower screw ring 62 and the

5

underlying previously mentioned inner sleeve or tube 36 which lies outside the flexible coupling 20, the cylinder 21 for the piston 22 and the projecting lower portion of the hollow piston rod 23, such mud discharging from the conducting tube 36 through the previously described openings or ports 42 in the lower portion thereof into the bore 43 of the drill collar 34 whence it passes downward to the drill bit 13.

The described travel of the drilling mud under pressure through the motor 14 thereby causes rotation of the rotor shaft 50, which rotation is imparted to the cylinder 21 through the flexible coupling 20 and thence through the keyed connection 24a to the hollow piston rod 23, the rotation being thence imparted through the previously described coupling 25 to the flexible cable 26 and to the annular core bit 32.

At the time that the fluid motor 14 operates to rotate the core bit 32, the drilling mud under pressure, which enters the flow beans 55 in the fishing connection 15 and passes downward through the hollow rotor shaft 50, acts upon the piston 22 to advance the latter slowly down through the cylinder 21, such downward movement being imparted to the hollow piston rod 23 and through the coupling 25 to the flexible drive cable 26 which projects the core head 30 and its core bit 32 into the coring position illustrated in Fig. 6, whereby a core is taken, the core is taken, the core passing up into a hollow drive shaft 26.

The projection of the core bit 32 continues until the pressure upon the piston 22 moves the piston 22 into engagement with the collar 24 which acts as a stop at the downward limit of the stroke of the piston 22. Or, an annular shoulder 70 (Fig. 6), at the lower end of the inner conducting tube 36 where the latter joins a thickened extension 72 thereof (whose lower end is secured in the upper end of the guide tube 35) could be disposed to be engaged by an annular shoulder 73 on the lower end of the coupling 25. The fact that the core bit 32 has completed its excursion when the piston 22 engages the collar 24 will be signalled to the driller at the surface of the well by a showing on his gauge of a drop in mud pressure which results from the fact that the piston 22, having reached the bottom of the cylinder 21, will have uncovered a series of ports 74 (Fig. 5) in the lower end of the cylinder 21. Thus, the mud that has been passing through the hollow piston rod 23 under considerable back pressure is directly vented through the ports 74 to the inner conducting tube 36 which is in turn vented through a considerable series of the previously mentioned openings 42 to the bore 43 of the drill collar 34 and thence to the drill bit 13. The pressure differential created at the piston 22 is usually considerable because of the fact that a flow bean 75 is carried at the top of the piston 22 and builds up the required differential or back pressure.

When it becomes apparent that the taking of a core has been completed, the driller retrieves the motor 14, the cylinder 21, the piston rod 23, the flexible shaft 26 and the core head 30 with its core drill 32, by engaging the over-shot 16 (Fig. 1) over the fishing pin 54 to draw the removable unit out of the hole with a wire line.

If another core is at once required, the drill string may be rotated somewhat to another position, or elevated above the previous core location. The above described coring operation may then be repeated and another core taken, merely by again lowering the coring unit on a wire line or circulating it down to position with the mud.

In connection with the detailed construction and functioning of the core head 30, including the annular core bit 32 and the frangible bushing 33, the shape of the guide tube or shell 35 is such that the whole core head 30, including the frangible bushing 33 is readily movable down through the guide tube 35 during running in of the apparatus into the position seen in Fig. 4 and on out into the position seen in Fig. 6 where the outer end of the frangible bushing 33 strikes the wall of the well hole 12 and is disposed on a fixed axis. As has been previously

6

indicated, this spacing is established by the drill bit 13 in the lower portion of the hole and on the lower end of the string of apparatus. It will be noted that there is an elongated combined core barrel and connector sleeve 76 secured both to the lower end of the reinforced flexible drive shaft 26 and to an outer barrel member 76a whose outer end carries the core bit element 32. The lower end of the flexible shaft 26 is firmly clamped to the outside of the upper portion of the connector sleeve 76 in a conventional or preferred manner, and the barrel member 76a carrying the core bit element 32 itself is conveniently threaded onto the lower end of the connector sleeve 76. Within the barrel member 76a there is appropriately mounted any conventional or preferred core catcher 77. As a consequence of this arrangement, the core being taken and moved up through the core catcher 77 is received in the connector sleeve 76 which thus becomes in effect a core barrel retaining the core when the coring unit is removed from the drill string.

Having further reference to the mounting of the frangible bushing 33 upon the core bit 32 and on the connector sleeve 76 and associated parts, it is to be noted that the lower end of the guide tube 35 is shaped to receive the cylindrical frangible bushing 33 in the core-taking position illustrated. It is also to be noted that the upper end of the frangible bushing 33 is in the form of a slightly enlarged collar 78 which serves as a positioning member and limiting means for outward movement of the bushing 33 as the core bit 32 is projected out into the core-taking position best illustrated in Fig. 6. Should the wall of the bore hole 12 not stop the end of the frangible bushing 33 before it reaches the limit of its projection, the collar 78 will hang up on a shoulder 79 shown in Fig. 4 which is disposed at the overlying and side portions of the inner wall of the guide tube 35. When the frangible bushing 33 reaches the limit of its projection, the core bit with its barrel 76a and connecting sleeve 76 continue to be projected by the action of the piston 22 as the core bit 32 is rotated, this being permitted by reason of an appropriate rubber O-ring 80 carried in a corresponding groove in the barrel 76a and frictionally engaging the inner wall of the bushing 33. It is to be particularly noted that the outer end of the bushing 33 is recessed to receive the core bit element 32 and to overhang it so as to protect the various portions of the guide tube 35 against the abrasive action of the core bit element 32 when being run into position.

With reference to the flexible coupling 20 above described as providing a connection between the lower end of the rotor shaft 50 and the top of the cylinder 21, this includes an outer bushing member 81 (Fig. 5) secured to the upper end of the cylinder 21 and an inner bushing member 82 secured to the lower end of the rotor shaft 50, both of these members being vulcanized to an intervening rubber ring 83 to form a fluid-tight joint providing for a limited but sufficient amount of flexing so that the joint acts in many respects as a universal joint. In connection with the splined seat at the lower end of the motor housing 48 which is indicated at 18, the bottom of this structure provides a seat which fixes the position of the lower end of the motor 14, or the lower end of the lower screw ring 62 may seat upon an annular shoulder 84 as indicated in Fig. 5 whereby to position the motor 14, such shoulder being on a splined bushing 84a in the "sub" 17.

As previously indicated, when it is desired to drill ahead after having taken a core, the motor 14 and the coring mechanism are withdrawn from the drill pipe string, and a plug 45 shown in Figs. 7 and 8 is run into position to close the guide tube 35. This plug 45 is conveniently a rubber plug somewhat elongated, although it need not be particularly tight. The plug 45 is secured to a pin 85 on a base member 86 which carries within it two latch members 87 mounted on pins 88 and pressed by a spring 89 to engage a latch-releasing actuating member 90. The latches 87 carry fingers 91 which

are adapted to engage in notches 92 at the lower end of the tube 36. An upper member 93 carrying a fishing pin 94 is adapted to be engaged by an overshot to pull on the latch-releasing member 90 to actuate the latches 87 and release the fingers 91 for pulling out the plug by a wire line or the like on an overshot. When the plug 45 is in operative position as seen in Fig. 7, an annular shoulder 95 on the top member 93 rests on the shoulder 70 previously described as possibly engageable by the shoulder 73 of the coupling 25 when the coring tool reaches the end of its stroke. Since the lowermost part of the latch-actuating member 90 has a beveled upper face engaged by inclined upper portions of the latches 87, it is apparent that such upper portions will be spread upon upward movement of the actuating member 90 whereby to compress the spring 89 and disengage the fingers 91 from the detent notches 92. Except when under draft of an overshot and its wire line, the actuating member 90 is urged downward by the weight of the member 93 and by a spring 96 in a chamber within the upper part of the body member 86 below its threaded connection with a stop nut below the top member 93 to which the actuator 90 is threadedly attached. If desired, O-rings 97 may be used on the top member 93 for sealing purposes when the plug 45 is in operative position during drilling operations on the bottom of the hole by the drill bit 13.

It will be noted that the previously described mounting and positioning of the bushing 33 which is frangible or otherwise appropriately yieldable or deformable, are such that, when the bushing 33 is disposed in the outer end of the tubular guide 35, it is disposed on a fixed axis so that the core barrel 32 and its core bit are directed outward toward the wall of the well hole during core taking on the same fixed axis. It is also to be noted that the outer extremity of the bushing 33 overhangs the annular core bit 32 around its periphery so as to protect the various parts of the drill string assembly and the guide 35 from the abrasive action of the annular core bit 32 of the coring unit as it is lowered into position. The principal object in having the bushing 33 of a frangible or otherwise sufficiently deformable character is to insure that the whole coring unit may be withdrawn, by breaking of the bushing 33 if necessary, even though burrs are formed on the outer end of the bushing by engagement with the wall of the hole or otherwise, which burrs or the like would prevent retrieving of the motor and coring unit if the bushing could not in any manner deform to permit such withdrawal. The construction of the flexible shaft 26 is adequate to handle all described movements of the core bit 32 and associated parts. Instead of employing the described helical wire reinforcements, or in addition thereto, the hose may be reinforced through conventional braided wire constructions or other known or preferred constructions adequate for the purpose both of rotating the core bit and of withdrawing the same even though the bushing 33 requires rupture to effect extraction of the core bit.

It will be evident from the foregoing that straight drilling may be accomplished with the plug 45 in position as in Fig. 7. When it is desired to take a side wall core, the plug 45 is withdrawn by an overshot and wire line, the motor 14 and core drill unit are run in on a line or circulated in with the mud until the motor is seated at 18, and circulating mud pressure is applied to rotate the motor shaft 50 and the core bit 32 and to advance the core bit 32 by the piston 22 until the coring has been completed. Thereupon the overshot 16 and a wire line are used to retrieve the motor 14 and attached coring means including the hollow flexible drive shaft 26 and core head 30. Additional cores may be successively taken at different elevations if desired by lifting the bit 13 off the bottom of the hole 12. Drilling down may be promptly resumed by returning the plug 45. In this manner, regular drilling is accomplished without inter-

ference by the presence of the motor 14 and the attached coring means which may be leisurely examined at the surface of the well while drilling proceeds. Similarly, coring is accomplished without the necessity of withdrawing the drill string 10 and drill bit 13 from the hole.

Having further reference to the motor 14 which has been described as providing for liquid passage through the roller bearing sets 58 and 59 to drive the rotor 50 by way of its blades 65, this motor structure may be satisfactorily modified, as illustrated in Fig. 10, to avoid passage of the usual drilling mud through the roller bearings, mud introduction taking place instead through inlet ports 110 in the upper portion of the motor housing 48 whence the mud passes downward between the rotor blades 65 to the discharge ports 64a in the lower discharge ring 64 at the bottom of the motor. Instead of positioning the lower roller bearing set 59 at the bottom of the motor, a corresponding roller bearing set 112 is transferred to the top of the motor to underlie the upper roller bearing set 58, and the roller bearing set 59 is replaced with a stepped bearing 114 which underlies the discharge ring 64 and is provided with outlet passages 115 discharging into the space between the lower portion of the rotor 50 and the lower screw ring 62 which adjust the bearing 114 in the lower end of the motor housing 48. In this form of the motor, the two roller bearing sets 58 and 112 (wherein the rollers are oppositely pitched as illustrated to perform their respective functions) are sealed in an oil bath whereby to prevent mud passage therethrough. Such sealing is effected by a washer ring 120 and an enclosed cup ring packing 122 underlying the lower roller bearing set 112. The bearing sets 58 and 112 are carried in an externally threaded connecting sleeve 124 whose lower end is threaded into the upper end of the motor housing 48 and whose lower portion is provided with an internal flange 125 upon which rests the lower bearing set 112 and under which the packing 122 is compressed against the washer 120.

The upper end of the connecting sleeve 124 is threaded into the lower end of a head 126 so that an internal flange 128 bears upon the outer race of the upper bearing set 58 to adjust the latter. Also in this form, instead of running the rotor 50 up into the shouldered bushing 51 in the upper sleeve 52, a rotor adapter 130 is used whose upper end is threadedly connected to the bushing 51 and whose lower end is threadedly engaged over the threaded upper end of the rotor 50. Within the head 126 and above its flange 128 a floating seal is disposed around the lower end of the adapter 130, this seal comprising a floating ring 132 whose upper portion is annularly grooved to receive an O-ring 133 sealing against the inner wall of the head 126 and whose lower portion is internally rabbetted to receive a cup ring packing 134. A snap ring 135 engages in an internal groove in the upper end of the head 126 and prevents upward displacement of the floating ring 132. With this construction well pressure tends to force the described floating seal combination downward toward the internal flange 128, the O-ring seal 133 and the cup ring 134 sealing against loss of oil within the chamber carrying the ball bearing sets 58 and 112.

Thus, with the structure of Fig. 10, the roller bearing sets 58 and 112 which position the rotor 50 within the motor housing 48 are sealed against the entrance of drilling fluid thereto, such fluid, which is used to drive the rotor 50 by way of its blades 65, entering through a plurality of inlet ports 110 in the upper portion of the motor housing 48, such inlet ports 110 being disposed just forward of the respective separator strips 68, and the discharge ports 64a being disposed just rearward of such separator strips 68, whence the drilling fluid mentioned passes downward and outward through the discharge passages 115. Thus, this form of motor serves

to drive the rotor 50 in the same manner as the form of Fig. 5 without, however, passing the drilling fluid through the roller bearings.

It is intended to cover all such modifications of the disclosed structures as fall within the scope of the patent claims.

I claim as my invention:

1. In combination: an elongated drill pipe assembly providing for a bottom hole bit on its lower end; a fluid-driven motor having a housing and a drive member removably received in a lower portion of said assembly above said lower end; seat means in said portion removably retaining said motor housing against rotation; rotary driven cylinder means below said motor and connected with said motor drive member to be driven thereby; a piston movable in said driven cylinder means and having a longitudinally sliding rotary drive connection with said cylinder; means providing passage of drive fluid from said assembly to said cylinder to move said piston; a core bit connected with said piston and disposed below said piston, said bit being advanced downward by said piston and being rotatable through said sliding drive connection; a flexing connection between said piston and said core bit to actuate said bit; and curved hollow guide means below said cylinder in said drill pipe assembly and receiving said core bit and being shaped to guide said core bit laterally outward at an angle through a side of the lower part of said assembly to engage the side wall of a hole drilled by said bottom hole bit.

2. A combination as in claim 1 including means to withdraw said motor, cylinder and core bit from said assembly and guide means; and plug means to be lowered into and seal said guide means.

3. A combination as in claim 2 including a bottom hole drill bit mounted on the lower end of said drill pipe assembly.

4. A combination as in claim 1 including a bottom hole drill bit mounted on the lower end of said drill pipe assembly.

5. A combination as in claim 1 wherein said sliding drive connection includes a tubular piston rod which carries said piston and has said sliding connection with said cylinder, said motor providing for passage of fluid from said drill pipe assembly to said cylinder to move said piston, said rod and said core bit through said connections.

6. A combination as in claim 5 wherein said rod has passage means for conducting fluid through a wall thereof to the exterior thereof, passage means being also provided for conducting such fluid to a central passage in said lower part of said assembly and to said bottom hole bit.

7. A combination as in claim 6 wherein said motor has bearings at its opposite ends and driven blades between said bearings, said motor providing passages for a driving fluid into and through the motor in operative contact with said blades.

8. A combination as in claim 7 wherein said drive member of said motor includes a hollow shaft carrying and driven by said blades, said shaft conducting pressure fluid from said drill pipe assembly to said cylinder and said piston.

9. A combination as in claim 1 wherein said motor has bearings at its opposite ends and driven blades between said bearings, said motor providing passages for a driving fluid through the motor in driving communication with said blades.

10. A combination as in claim 9 wherein said drive member of said motor includes a hollow shaft carrying and driven by said blades said shaft conducting pressure fluid from said drill pipe assembly to said cylinder and said piston.

11. In combination in a retrievable motor and core

drill: a drill pipe assembly having a bottom hole bit at its lower end and a drilling mud passage therethrough to said bit; an elongated motor lowerable into said assembly and having a motor housing and a hollow rotor shaft therewithin providing a mud passage connecting with upper and lower portions of the mud passage of said pipe assembly; means removably receiving said housing against rotation in said assembly; hollow guide means in a lower portion of said assembly and occupying a portion of the mud passage therethrough; and core bit means lowerable into said guide means to be projected therefrom at its lower end and connected with and driven by said rotor shaft, said lowerable motor, its rotor shaft and the connected core bit means constituting a unit removable from and through said receiving means.

12. A combination as in claim 11 including: a cylinder connected with said hollow shaft to be driven thereby; means connecting said cylinder with said hollow shaft to receive drill mud therefrom; and a piston and piston rod in said cylinder having rotary drive connection with said cylinder and connected with said core bit means to project said core bit means along said guide means by action of mud pressure supplied to said cylinder.

13. A combination as in claim 12 wherein said guide means extends partially axially of said drill pipe assembly and curves laterally outward in its lower portion to communicate with an external lateral opening in said assembly and direct said core bit means against the wall of a well hole in which said assembly is disposed, and flexible drive means connecting said piston and piston rod to said core bit.

14. A combination as in claim 13 wherein said guide means is fixed in said assembly at said external opening and said core bit means includes: a flexible shaft movable in said guide means; a core barrel connected with said flexible shaft; and a core bit carried at the outer end of said core barrel, said flexible shaft being drivingly connected to said piston and piston rod.

15. A combination as in claim 14 including a projectable bushing which is movable in said tubular guide means and in which said core barrel and its core bit are received and are projectable therefrom, said guide means and bushing having co-operating means to limit the projection of said bushing from said guide means.

16. A combination as in claim 11 wherein said guide means extends partially axially of said drill pipe assembly and curves laterally outward in its lower portion to communicate with an external lateral opening in said assembly and direct said core bit means against the wall of a well hole in which said assembly is disposed, and flexible drive means connecting said piston and piston rod to said core bit.

17. A combination as in claim 16 wherein said guide means is fixed at said opening and said flexible drive means is a flexible shaft movable in said guide means, the combination including: a core barrel connected with said flexible shaft; and a core bit carried at the outer end of said core barrel.

18. A combination as in claim 17 including a projectable bushing which is movable in said tubular guide means and in which said core barrel and its core bit are received and are projectable therefrom, said guide means and bushing having co-operating means to limit the projection of said bushing from said guide means.

19. A combination as in claim 18 wherein said bushing is a deformable bushing which will yield under predetermined stress.

20. In combination in a retrievable motor and core drill unit for deep well drilling strings: a string of drill pipe having a circulating mud passage therethrough; an elongated fluid motor having a housing adapted to be lowered into said drill pipe and withdrawn therefrom;

cooperating retention means in said pipe and on said housing to seat said housing in said pipe and to prevent rotation of said housing in said pipe, said motor also having a fluid driven central rotor shaft mounted to rotate in said housing and having circulating mud passages therethrough communicating with said drill pipe passage to drive said motor; and a core bit assembly connected to the lower end of said rotor shaft and driven thereby and extending therebelow.

21. A combination as in claim 20 wherein said core bit assembly includes: a flexible shaft having driving connection with said rotor shaft; a core barrel on the outer end of said flexible shaft; and an annular core bit on the outer end of said core barrel.

22. A combination as in claim 21 including a curved tubular guide disposed in said pipe passage and fixed at its lower end in an opening in the side wall of said pipe and receiving said core bit assembly and directing the core bit laterally from the axis of said rotor shaft.

23. A combination as in claim 22 including a guiding bushing disposed about said core barrel to be positioned in the outer end of said tubular guide to direct said core barrel and core bit laterally outward on a fixed axis.

24. A combination as in claim 23 including cooperating means on said bushing and its guide to limit outward movement of said bushing in said guide.

25. A combination as in claim 24 wherein said core barrel and core bit are projectable beyond said bushing.

26. In combination in a retrievable motor and core drill unit for deep well drilling strings: an elongated fluid motor having a housing adapted to be lowered into a drill pipe and withdrawn therefrom; means on said housing to seat said housing in said drill pipe and prevent rotation of said housing in said pipe, said motor having a fluid driven central rotor shaft mounted to rotate in said housing and being hollow to pass driving fluid under pressure; a core bit assembly connected to the lower end of said rotor shaft and driven thereby and extending therebelow; a cylinder connected with the lower end of said rotor shaft and receiving pressure fluid therefrom and driven thereby; and a piston and piston rod working in said cylinder and depressible by said pressure fluid, said piston rod having driving connection with said cylinder and with said core bit assembly to rotate the latter and to advance the latter during coring.

27. A combination as in claim 26 wherein: said core bit assembly includes a flexible shaft having driving connection with said rotor shaft, a core barrel on the outer end of said flexible shaft and an annular core bit on the outer end of said core barrel; and including a curved tubular guide for receiving said core bit assembly and directing the core bit laterally from the axis of said rotor shaft.

28. A combination as in claim 27 wherein a guiding bushing is disposed about said core barrel to be positioned in the outer end of said tubular guide to direct

said core barrel and core bit laterally outward on a fixed axis.

29. A combination as in claim 28 wherein said bushing is frangible under predetermined stress.

30. A combination as in claim 22 including a deformable bushing about said core bit means to position the latter in said guide and to yield on predetermined stress.

31. A method for drilling and coring wells: drilling by advancing into the earth a hollow drill pipe having a bottom hole drill bit on its lower end and having in a side thereof a hollow laterally directed guide for a side wall core bit and having an internal seat; circulating drilling fluid during advancing of said drill pipe and drill bit; plugging said guide during drilling and circulation; ceasing drilling; pulling said plug from said guide without pulling said drill pipe; lowering into said hollow drill pipe a fluid motor having an advancing core bit at its lower end while extending said core bit into said guide and seating said motor on said seat; circulating drilling fluid through said drill pipe to actuate said motor and advance said core bit cutting core; and retrieving said motor and attached core bit with its core.

32. A method as in claim 31 including restoring said plug following removal of said motor and core bit, and resuming drilling with said bottom hole drill bit.

33. In a retrievable motor and core drill combination: a drill pipe section; an elongated motor having a motor housing disposed in said section and having a rotor shaft; means receiving said housing against rotation in said section; tubular guide means in said section and opening laterally from said section; core bit means lowerable into said guide means to be projected therefrom at its lower end; flexible drive means connecting said core bit means to said rotor shaft; and a projectable bushing receiving said core bit means and movable in said tubular guide means, said guide means and said bushing having co-operating means limiting the projection of said bushing from said guide means.

34. A combination as in claim 33 wherein said bushing is a deformable bushing which will yield under predetermined stress.

35. A combination as in claim 33 wherein said bushing is frangible under predetermined stresses.

36. A combination as in claim 33 wherein said core bit means includes a core barrel working within said projectable bushing and a core bit connected with the core barrel.

References Cited in the file of this patent

UNITED STATES PATENTS

2,268,514	Oberwetter	Dec. 30, 1941
2,324,682	DeLong	July 20, 1943
2,545,306	Pollard	Mar. 13, 1951
2,558,452	Mennecier	June 26, 1951
2,594,292	Cornelius	Apr. 29, 1952