Nov. 8, 1966 J. M. KELLNER 3,283,835

CONTINUOUS CORING SYSTEM

Filed May 19, 1964 3 Sheets-Sheet 1

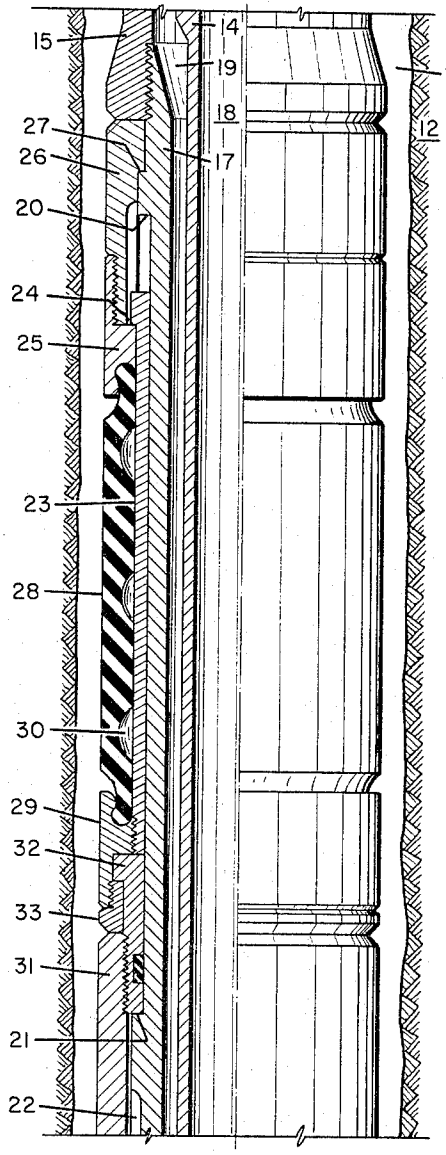


FIG. 1A

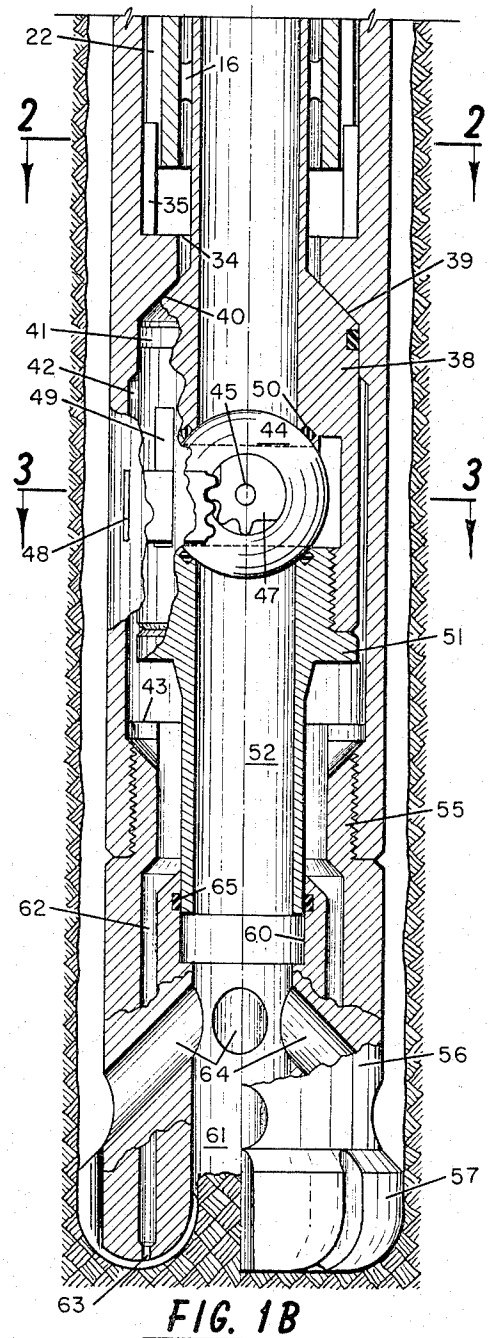


FIG. 1B

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CONTINUOUS CORING SYSTEM

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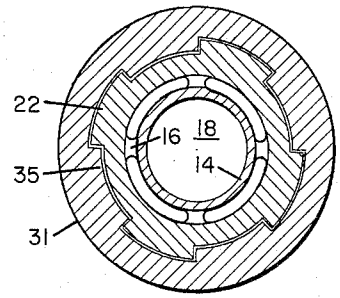


FIG. 2

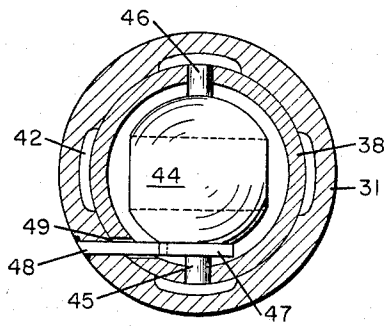


FIG. 3

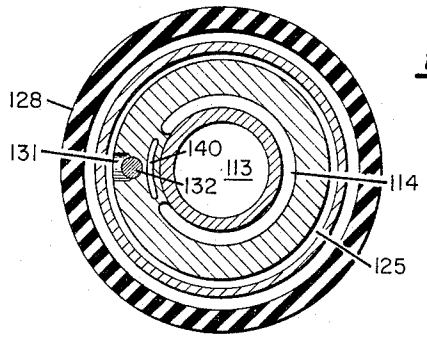


FIG. 5

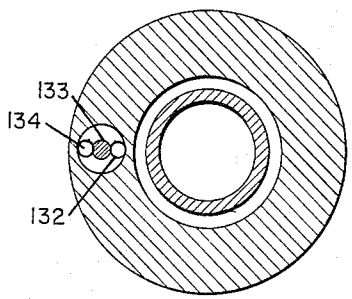


FIG. 6

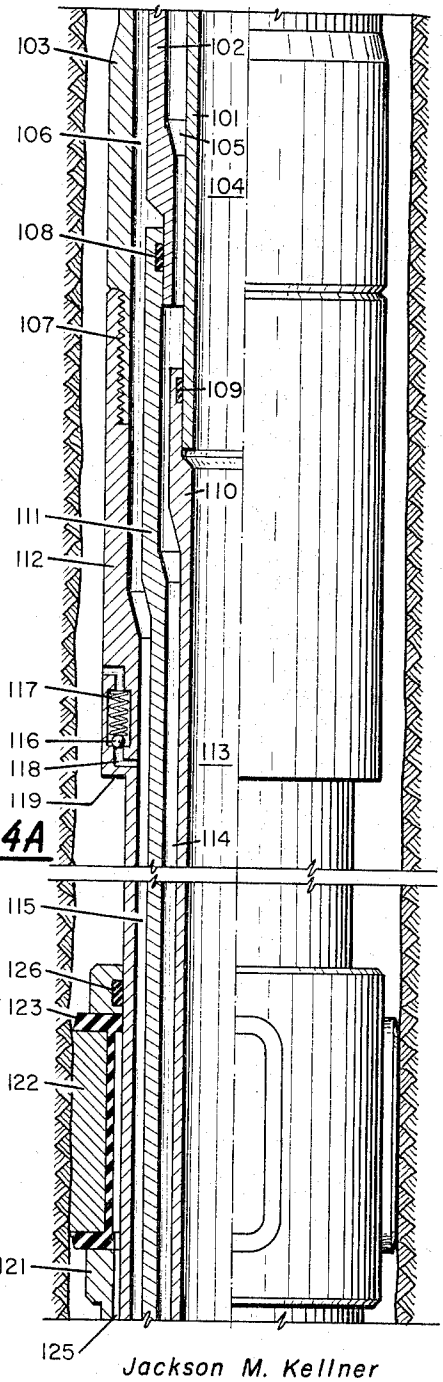


FIG. 4A

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CONTINUOUS CORING SYSTEM

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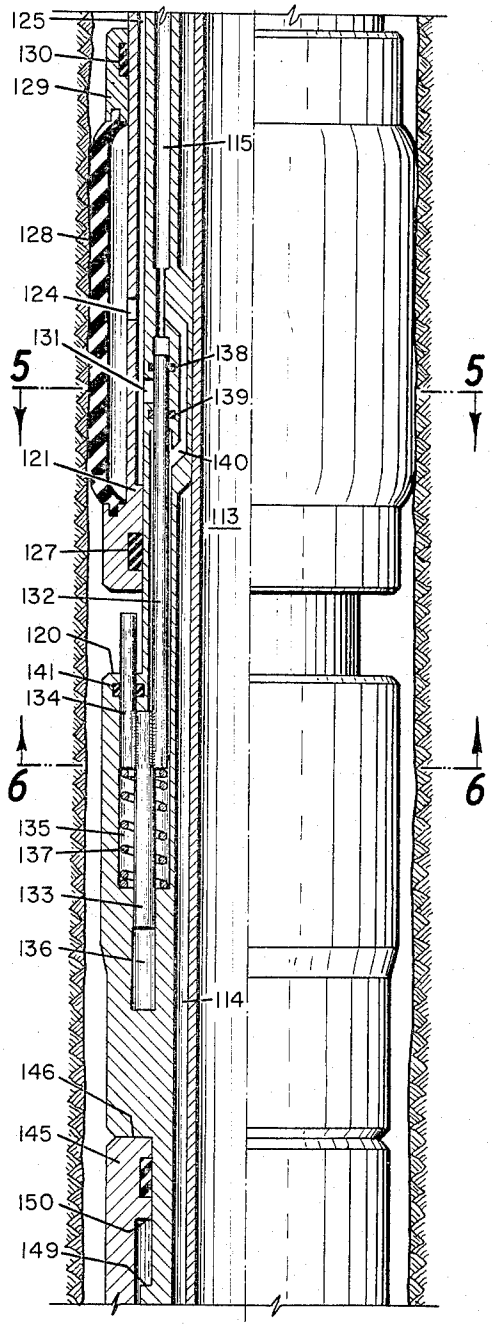


FIG. 4B

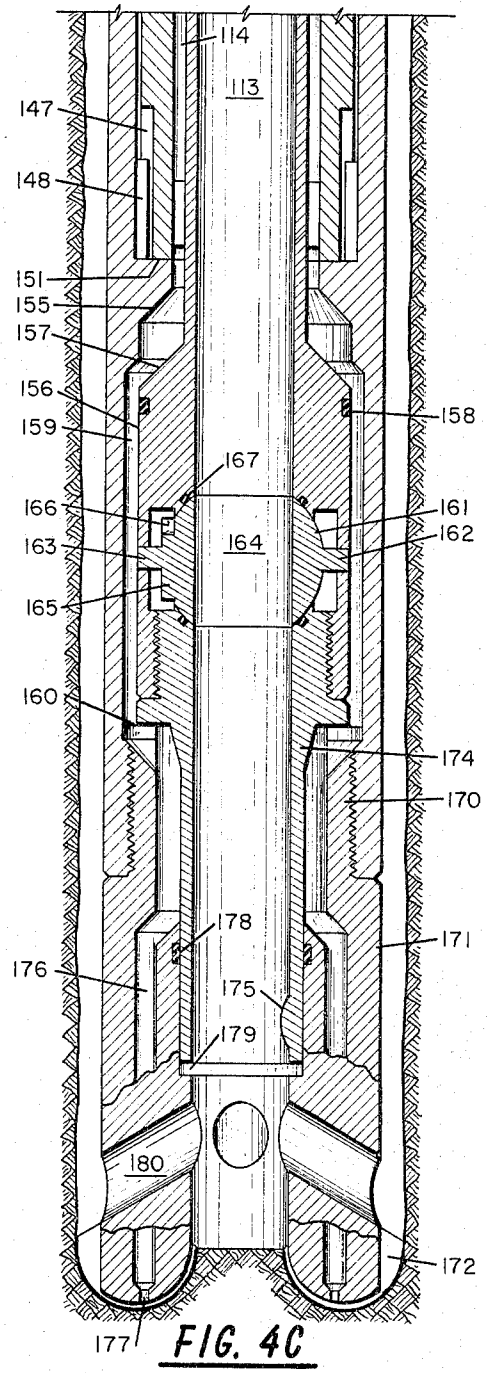


FIG. 4C

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United States Patent Office

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CONTINUOUS CORING SYSTEM

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Filed May 19, 1964, Ser. No. 368,536
9 Claims. (Cl. 175—317)

The present invention relates to rotary systems for drilling boreholes in the earth and is particularly concerned with an improved continuous coring system for drilling oil wells, gas wells and similar boreholes.

Systems designed to permit continuous core recovery during oil field rotary drilling operations have been proposed in the past. The most promising of these are similar to that shown in U.S. Patents 2,657,016, 2,663,545, 2,701,122 and 3,075,589 in that they contemplate the injection of drilling fluid through one channel of a multichannel drill string and the recovery of fluid and core segments through a second channel. This avoids continued circulation of fluid in contact with the borehole wall, permits the use of fluids which promote higher drilling rates than can generally be obtained with ordinary drilling muds, and makes possible the use of annulus fluids particularly suited for conditioning the borehole and preventing the entry of liquids and gases from the surrounding formation. Experience has shown, however, that the potential benefits of such systems are seldom achieved. One reason for this is that the annulus fluids generally tend to displace the lighter drilling fluids at the bottom of the borehole each time circulation is interrupted. The hydrostatic pressure exerted by the annulus fluid is normally greater than that due to the drilling fluid and hence annulus fluid fills the drill string for a considerable distance above the bottom of the hole. When drilling is resumed following such an interruption in circulation, this annulus fluid must be displaced before circulation of the drilling fluid can be resumed. Where the drilling fluid is a gas, displacement may be difficult unless injection pressures considerably higher than those normally available are used. Even if clear water or a similar liquid of relatively low density is employed in the annulus, the presence of annulus fluid in substantial quantities following an interruption in circulation has an adverse effect in drilling rates and reduces the overall efficiency of the drilling operation.

It is therefore an object of the present invention to provide an improved continuous coring system which will permit the efficient use of separate drilling and annulus fluids. A further object is to provide a continuous coring system in which circulation of the drilling fluid can be interrupted without the entry of substantial quantities of annulus fluid into the drill string. Another object is to provide a coring system utilizing a gaseous drilling fluid and a heavy annulus liquid which will permit the resumption of drilling fluid circulation following an interruption without necessitating the use of pressures substantially greater than those normally employed to circulate the drilling fluid. Still other objects will become apparent as the invention is described in greater detail hereafter.

In accordance with the invention, it has now been found that many of the difficulties encountered in the past with continuous coring systems utilizing separate drilling and annulus fluids can be avoided by closing off the drill string a short distance above the bottom of the borehole before interrupting circulation of the drilling fluid and by sealing the annulus above the bottom of the hole before circulation is resumed. This prevents the displacement of substantial quantities of the drilling fluid by annulus fluid, simplifies the resumption of drilling fluid circulation following an interruption of the drilling operation, and minimizes adverse effects due to the presence of annulus

fluid at the bottom of the borehole following an interruption in fluid circulation. As a result, the system of the invention normally permits higher overall drilling rates and lower drilling costs than can be obtained with continuous coring systems available in the past.

The nature and objects of the invention can be best understood by referring to the following detailed description of apparatus useful for continuous coring during oil field rotary drilling operations and to the accompanying drawing, in which:

FIGURES 1A and 1B depict the upper and lower section of apparatus utilizing a two-channel drill string and mechanically actuated means for closing off the borehole annulus;

FIGURE 2 is a cross-sectional view of the apparatus of FIGURES 1A and 1B taken about the line 2—2 in FIGURE 1B;

FIGURE 3 is a cross-sectional view of the apparatus of FIGURES 1A and 1B taken about the line 3—3 in FIGURE 1B;

FIGURES 4A, 4B and 4C show the upper, intermediate, and lower sections of an alternate embodiment of the invention utilizing a three-channel drill string and hydraulically actuated means closing off the borehole annulus;

FIGURE 5 is a cross-sectional view of the alternate embodiment taken about the line 5—5 of FIGURE 4B; and

FIGURE 6 is a cross-sectional view of the alternate embodiment taken about the line 6—6 in FIGURE 4B.

The apparatus depicted in FIGURES 1A and 1B of the drawing is shown suspended in a borehole **11** surrounded by subterranean formations. The borehole wall is designated by reference numeral **12**. The upper section of the apparatus, shown in FIGURE 1A, includes an inner conduit **14** and a concentric outer conduit **15**. These are threaded to the lower end of a string of concentric two-channel drill pipe by means of a tool joint which does not appear in the drawing, and are interconnected by means of a spider **16** and an intermediate member **17** as shown in FIGURES 1B and 2 to permit their rotation as an integral unit. Passageways **18** and **19** extend downwardly within the inner conduit and between the inner conduit and surrounding outer conduit respectively. The two-channel drill string and tool joint utilized may be of any conventional design. If segmental rather than concentric pipe is employed, a cross-over from the segmental system to the concentric utilized in the tool can be provided. Various types of multi-channel pipe and fittings have been described in the literature and will therefore be familiar to those skilled in the art.

The intermediate member **17** in FIGURE 1A is threaded or otherwise connected to the lower end of member **15**. Together these members constitute the upper housing of the apparatus. The outer diameter of the intermediate member is reduced between an upper shoulder **20** and a lower shoulder **21**. The lower end of the intermediate member is provided with external splines **22** as shown more clearly in FIGURE 2. Packer sleeve **23** is mounted on the outer surface of the upper housing between shoulders **20** and **21** and is free to rotate and move longitudinally with respect thereto. The sleeve contains an external shoulder **24** near its upper end which engages an internal shoulder near the upper end of upper packer retainer **25**. The upper retainer is threaded to the lower end of collar **26**, which is free to rotate between the lower end of member **15** and shoulder **27** on the intermediate member. The packer sealing element **28** is mounted on the outer surface of sleeve **23** and is held in place by upper retainer **25** and lower packer retainer **29**. The latter member is threaded to the lower end of the sleeve. The sealing element shown is made

of rubber, plastic or similar resilient material and contains grooves 30 in its inner face to increase its flexibility. Other sealing element designs may be utilized if desired.

Lower housing member 31 is connected to the lower end of the packer assembly by means of connecting member 32 and retainer 33 and extends downwardly below the lower end of the intermediate member 17. The lower end of member 32 engages shoulder 21 to limit downward movement of the lower housing with respect to the upper housing. Shoulder 34 in the lower housing, shown in FIGURE 1B, engages the lower end of the intermediate member to limit movement in the opposite direction. Internal splines 35 which mate with splines 22 are provided to permit the transfer of torque between the two members. Below shoulder 34, the inner diameter of the lower housing member is enlarged to accommodate a valve assembly connected to conduit 14. The valve assembly includes a generally cylindrical upper body section 38 having a tapered upper surface 39 which seats against a tapered shoulder 40 on the inner housing wall when the housing is in its lowermost position with respect to the valve body as shown in FIGURE 1B. An annular groove containing a rubber ring or similar sealing element 41 is located in the body just below the lower edge of the tapered upper surface. This sealing element engages the inner wall of the lower housing member below shoulder 40 to prevent the movement of fluid downwardly around the valve body from passageway 19. The housing wall adjacent the valve body contains longitudinal passageways 42 which extend from points a short distance below shoulder 40 to points below the enlarged section of the housing. Movement of the housing upwardly with respect to the valve body so that sealing element 41 is located below the upper end of these passageways permits the flow of fluid downwardly about the body into the sections of the tool beneath the valve assembly. Shoulder 43 in the housing engages the lower end of the valve body assembly and thus limits upward movement of the housing relative to the assembly.

Upper valve body section 38 contains an axial passageway and an enlarged opening within which is located ball valve 44. The ball valve contains an opening which, in the valve position shown, extends through it at right angles to the longitudinal axis of the body. Axles 45 and 46 extend into openings in the body to support the valve as shown in FIGURE 3. A gear 47 is connected to the valve and axle 45 to permit rotation of the valve through a 90° angle. The teeth on this gear engage those on gear rack 48 attached to the housing so that rotation takes place in response to relative longitudinal motion between the valve body and housing. The rack extends inwardly through an opening 49 in the body surrounding the valve. Seals 50 set in grooves in the body prevent the leakage of fluid around the valve. Lower valve body section 51 is threaded into the upper section and includes passageway 52.

A rotary core bit is threaded to the lower end of lower housing member 31 below the valve assembly. The bit shown includes an upper shank 55, a body 56, and a crown 57 for engaging the formation at the bottom of the borehole. The lower end of lower valve body section 51 extends into the shank of the bit and seats in socket 60 above axial core opening 61 in the crown. A core breaker, not shown, is located near the core opening and serves to fracture the core into segments as the tool moves downwardly about it. An annular passageway 62 in the body of the tool extends downwardly about the core openings to a plurality of discharge ports 63 in the lower crown surface. Lateral passageway 64 above the crown extends through the body to the core passage to permit the return of fluid into the tool. An O-ring or similar member 65 provides a seal between the lower valve body section and the surrounding inner wall of the bit body.

In utilizing the apparatus depicted in FIGURES 1A, 1B, 2 and 3 of the drawing, the apparatus is first lowered into the borehole in the position shown. The packer assembly, lower housing and bit occupy their lowermost position with respect to the upper housing assembly, inner conduit and valve assembly. In this position, the packer sealing element 28 is held against the packer sleeve 23 in retracted position due to the tension in the element. Similarly, ball valve 44 is held in a closed position by rack 48. The fluid present in the borehole is therefore displaced upwardly as the tool assembly is lowered in place and does not rise in the drill string. The injection of drilling fluid is preferably commenced before the bit reaches the bottom of the hole. The fluid injected at the surface flows downwardly through the drill string and through passageway 19 between conduit 14 and the housing members until it reaches seal 41. Because the seal prevents escape of the fluid into the lower section of the assembly, the pressure in the upper part of the apparatus increases. After the desired pressure level has been obtained, the drill string is lowered further until the bit crown 57 rests against the formation at the bottom of the hole. The weight of the drill string above the tool forces inner conduit 14 and the upper housing downwardly with respect to the lower housing 31 until shoulder 20 rests against the upper end of packer sleeve 23 and the lower end of the intermediate member 17 engages shoulder 34 of the lower housing. Packer retainer 25 moves downwardly with the upper housing and forces the packer sealing element 28 outwardly against the borehole wall 12. This closes off the borehole annulus and prevents the fluid in the upper part of the hole from moving downwardly about the tool into the lower section of the hole adjacent the bit. Simultaneously, the downward movement of the upper valve body 38 and gear 47 with respect to rack 48 rotates the ball valve in a clockwise direction. This opens the valve, providing communication from passageway 52 in the lower part of the assembly through the valve into passageway 18 in the upper part of the assembly. Downward movement of the valve body assembly until it contacts shoulder 43 in the lower housing also provides clearance between the tapered surface 39 on the valve body and tapered shoulder 40 in the lower housing. The fluid injected into passageway 19 thereupon passes downwardly around the valve body through passageway 42 into passageway 62 in the bit. This fluid is discharged through ports 63 in the crown and flows upwardly adjacent the inner crown surfaces surrounding the core and the outer crown surfaces next to the borehole wall. The discharged fluid then re-enters the bit through lateral passageways 64, flows upwardly through passageway 52 and the valve and is conducted to the surface through passageway 18. Once complete circulation of the drilling fluid has thus been established, rotation of the drill string from the surface can be commenced. The torque imparted to the string is transmitted through splines 22 and 35 from the intermediate member 17 to the lower housing member 31. The core formed as the bit advances into the formation is broken off in segments by the core breaker and is carried to the surface with the drilling fluid passing upwardly through the assembly.

When it becomes necessary to interrupt circulation, to add a length of pipe or for some other reason, the drill string is lifted in the borehole. Upward movement of the string causes the inner conduit 14, the upper housing, and the associated valve assembly to move upwardly with respect to the packer sleeve 23 and lower housing member 31. Packer retainer 25 moves upwardly with the upper housing member until it engages shoulder 24 on the packer sleeve 23. This places the packer sealing element 28 in tension and thus retracts it. At the same time, shoulder 39 on the valve body engages shoulder 40 on the lower housing member, shutting off the flow

of fluid from the surface into the lower part of the tool. Movement of the valve body relative to the lower housing and rack **48** closes the valve and prevents entry of annulus fluid into the tool. The pumps at the surface can now be shut down. This eliminates the necessity for discharging the annulus fluid from the apparatus before circulation can be resumed and greatly facilitates the use of two separate fluids in a continuous coring operation.

FIGURES 4A, 4B, 4C, 5 and 6 in the drawing illustrate a further embodiment of the invention utilizing three channel drill pipe and a hydraulically-actuated packer in lieu of the two-channel pipe and mechanical packer described earlier. The three-channel pipe shown is of the concentric type and includes an inner conduit **101**, an intermediate conduit **102** and an outer conduit **103**. These are interconnected by suitable spacers, not shown, which permit rotation of the string as an integral unit. The conduits making up the pipe define an inner passageway **104**, an intermediate passageway **105**, and an outer passageway **106**. A tool joint including threads **107** on the outer conduit and seal rings **108** and **109** on the inner and intermediate conduits is provided for connecting the pipe to the upper end of the tool. Again other types of three-channel pipe including cross overs for adapting them to a concentric system may be employed if desired.

The upper section of the tool shown in FIGURE 4A of the drawing is connected to the lower end of the three-channel pipe string and includes inner tubular member **110**, intermediate member **111**, and upper housing member **112**. These form concentric passageways **113**, **114** and **115** which communicate with those in the drill pipe. A back pressure valve, including ball **116** and spring **117** mounted in passageway **118**, is provided below the tool joint to permit the discharge of fluid from the outer passageway between housing **112** and intermediate member **111** into the borehole annulus surrounding the upper housing member. Below this back pressure valve, the outer diameter of the housing member is reduced between an upper shoulder **119** and a lower shoulder **120** shown in FIGURE 4B. The length of this section of reduced diameter is preferably somewhat longer than the length of a section of drill pipe. A packer sleeve **121** is mounted on the reduced section of the housing and is free to rotate and move longtiudinally between the two shoulders. The packer sleeve includes circumferentially-spaced windows within which anchor shoes **122** are mounted. Each shoe is embedded in rubber or a similar resilient material **123** which is bonded to the inner wall of the surrounding window and permits movement of the shoe in response to differential hydrostatic pressure across it. Fluid passing downwardly through passageway **115** between intermediate conduit **111** and upper housing **112** flows through port **124** in the housing wall, shown in FIGURE 4B, and into recess **125** to provide the pressure required to extend the shoes. Seal rings **126** and **127** are set in grooves in the inner face of the packer sleeve near its upper and lower ends to prevent escape of the fluid. Although four shoes spaced at 90° intervals are employed in the tool shown, other shoe arrangements may be utilized.

The packer employed in the apparatus is depicted in FIGURE 4B. This includes a packer sealing element **128** of rubber or similar material which is mounted on the packer sleeve below the shoe assembly. The sealing element is affixed to the packer sleeve near its lower end and is connected to a sliding collar **129** at its upper end. Ring **130** set in the inner face of the collar provides a seal between the sleeve and collar. The packer is inflated by fluid admitted from recess **125** through port **124** in the packer sleeve. The packer and shoes are thus inflated and deflated simultaneously. Inflation and deflation are controlled by means of a valve assembly including an upper rod **132**, a lower **133** and an outer rod **134**. The three are connected together to form an integral unit. Lower rod **133** is housed in an enlarged section of the outer housing below shoulder **120** containing an upper cylindrical recess **135** and a lower recess **136**. Spring **137** is seated in the upper recess about the lower rod and bears against the lower ends of rods **132** and **134** to hold the assembly in an upward position as shown. The upper end of rod **133** in this position extends above port **131**. Rings **138** and **139** provide a seal above and below the port. By-pass **140** permits the passage of fluid around the seals and port into recess **135** to equalize the pressure on the rod assembly. The arrangement of the by-pass is shown more clearly in FIGURE 5 of the drawing. Outer rod **134** extends upwardly above shoulder **120** so that it may be depressed by the lower end of packer sleeve **121**. Seal ring **141** prevents the escape of fluid around the outer rod. The interconnected rods are shown more clearly in FIGURE 6 of the drawing.

Lower housing member **145** is connected to the upper housing **112** below external shoulder **146** by means of splines **147** and **148**. External shoulder **149** on the upper housing member and internal shoulder **150** on the lower housing member limit upward movement of the one with respect to the other. The lower end of the upper housing member seats against shoulder **151** on the lower member when the upper member is in its lowermost position as shown. The upper housing and intermediate conduit are interconnected above shoulder **146**. The internal diameter of the lower housing member is enlarged below tapered shoulder **155** to accommodate valve housing **156** as in the earlier embodiment. Tapered surface **157** on the valve housing seats against the tapered shoulder. A seal is provided by ring **158** located in an annular groove below the tapered surface. Longitudinal passageways **159** extend downwardly around the valve housing and thus permit the circulation of fluid when the housing is in its lowermost position as shown. In this position, the valve body seats against shoulder **160**, thus providing clearance for the escape of fluid from the longitudinal passageways.

The ball valve utilized in the apparatus shown in FIGURE 4C is similar to that employed in the upper apparatus but is shown in a position rotated 90° about the longitudinal axis of the tool. The valve **161** is supported on axles **162** and **163** and contains a passageway **164** through which fluid may pass into conduit **113** from the lower portion of the tool. A gear **165** attached to the valve engages a rack **166** which is connected to the lower housing member. Longitudinal movement of the valve body with respect to the lower housing rotates and thus opens and closes the valve. Seals **167** prevent the escape of fluid around the valve.

A face discharge core bit including an upper shank **170**, a body **171** and a crown **172** is connected to the lower end of the lower housing member by means of threads **173**. The lower end of lower valve body sections **174** extends downwardly into the body of the bit below the valve body and includes a core breaker **175** of conventional design. The body of the bit contains an annular passageway **176** which terminates in discharge ports **177** in the lower surface of the crown. Seal rings **178** prevent the entry of fluid from this passageway into the core opening defined by the lower conduit. The lower end of the lower conduit extends into an enlarged section **179** in the bit body. Lateral passageways **180** are provided for the return of fluid from the annulus surrounding the bit into the core opening.

The apparatus shown in FIGURES 4A, 4B, 4C, 5 and 6 of the drawing is employed in a manner simliar to that described in conjunction with the earlier apparatus. As the tool assembly is first lowered into the borehole, shoulder **150** of the lower housing will rest upon shoulder **149** on the upper structure. In this position, tapered shoulder **155** seats against the tapered upper surface **157**

of the valve body. The seal ring **158** prevents the passage of fluid from the intermediate conduit **114** into passageways **159** surrounding the valve body. The ball valve **161** is closed in this position so that passageway **164** extends at right angles to the longitudinal axis of the tool. This prevents the entry of fluids from the wellbore into conduit **113** above the ball valve.

The packer sleeve **121** rests upon shoulder **120** on the housing as the tool is initially lowered in place. This holds outer rod **134** down so that upper rod **132** does not cover port **131**. The hydrostatic pressure in recess **125** is less than that in the borehole annulus surrounding the tool and hence the anchor shoes **122** and packer sealing element **128** remain in the retracted positions.

After the tool assembly has reached a point a short distance above the bottom of the borehole, the fluid to be utilized in the borehole annulus is injected into the drill string at the earth's surface through outer conduit **106**. This fluid passes downwardly through the outer conduit, flows through ports **124** and **131**, and thus inflates the packer and anchor shoes. The injection pressure employed initially will be normally less than that required to actuate the back pressure valve near the upper end of the apparatus. This pressure may be maintained or may be increased after the packer and anchor shoes have been set in order to operate the valve and circulate fluid from the outer conduit into the borehole annulus above the packer. Once the packer and anchor shoes have been set, drilling fluid is injected into the apparatus through intermediate conduit **114**. The fluid thus injected passes downwardly through conduit **114** until it reaches the seal ring **158** surrounding valve body **156** and can progress no further. The pressure is allowed to build up to the desired level. The drill string is then lowered so that the apparatus moves downwardly through the packer and shoe assembly. Both the upper and lower housing members move downwardly until the bit rests on the formation at the bottom of the borehole as shown in the drawing. Thereafter the upper housing member moves downwardly within the lower member until tapered surface **157** clears the upper ends of passageways **159** and the ball valve has opened. This permits the movement of fluid downwardly around the valve body and into the annular passageway **176** in the bit. The fluid is discharged from the bit through ports **177** and flows upwardly adjacent the inner and outer surfaces of the crown. Fluid from the annulus passes through lateral passageway **180** into the core opening, moves upwardly through the opened ball valve, and is conducted to the surface through central passageways **113** and **104**. Once circulation has been obtained, the coring operation can be commenced. The core formed as the bit rotates in contact with the formation is broken off by core breaker **175**. The broken segments are carried to the surface with the discharged fluid. During normal operation the packer and anchor shoe assembly will occupy an intermediate position between shoulders **119** and **120** on the upper housing.

When it becomes necessary to interrupt the coring operation, either because the upper housing has moved downwardly until shoulder **119** rests against the upper surface of the packer sleeve or for some other reason, the drill string is lifted at the surface. This causes the upper housing and associated elements including valve body **156** to move upwardly with respect to the lower housing **145**. Seal rings **158** on the valve body seal against the surrounding wall of the lower housing and thus shut off the flow of fluid injected into the intermediate conduit of the apparatus. Simultaneously, ball valve **161** is closed as gear **165** rotates in contact with the rack connected to the lower housing member, thus closing off the flow of fluid upwardly in the apparatus. The injection of annulus fluid into the outer conduit **106** is now halted. The drill string is lifted further until rod **134** contacts the lower end of the packer and anchor shoe sleeve and is depressed. This opens port **131** and allows the packer and anchor shoes to deflate. The packer and anchor shoe assembly will now rest on shoulder **120**. The tool can now be withdrawn from the borehole or lowered in the hole to permit the addition of another length of drill pipe.

Drilling may be resumed following the interruption of circulation by lowering the drill string in the borehole until the valve body seats against shoulder **160** in the lower housing and the valves in the lower part of the apparatus have thus been opened. Fluid is then injected through the outer conduit of the drill string and outer passageway **115** to set the packer and anchor shoes. The relatively small amount of annulus fluid below the packer is displaced by injecting drilling fluid through the bit and withdrawing fluid from passageway **104** at the surface. Once the packer and anchor shoes have been set, drilling can be resumed.

It will be apparent from the foregoing that the operation of the three-channel embodiment of the apparatus is similar to that of the two-channel embodiment described earlier. In both cases the invention makes possible the continuous coring of subterranean formation utilizing separate drilling and annulus fluids without the difficulties which have characterized continuous coring operations proposed heretofore.

What is claimed is:

1. Apparatus for drilling boreholes in the earth comprising:

(a) a tubular upper housing provided with means for connecting said housing to the outer conduit of a string of multiple channel pipe;

(b) a tubular lower housing slidably connected to said upper housing and rotatable therewith;

(c) a bit connected to the lower end of said lower housing, said bit containing a port near the longitudinal axis thereof and an outlet laterally displaced from said port;

(d) a tubular inner member connected to said upper housing and extending downwardly in said upper housing, said lower housing and said bit to form an inner passageway communicating with said port and an outer passageway communicating with said outlet, said inner member including means for connecting said member to an inner conduit of a string of multiple channel pipe;

(e) an expansible packer mounted on the outer surface of said upper housing and rotatable with respect thereto;

(f) means for maintaining said packer in an expanded position while drilling and in a retracted position during trips into and out of the borehole;

(g) valve means connected to said inner member near the lower end thereof for closing off said inner passageway in response to relative axial movement of said inner member with respect to said lower housing and bit; and

(h) valve means in said lower housing for closing off said outer passageway in response to relative axial movement of said inner member with respect to said lower housing and bit.

2. Apparatus as defined by claim **1** wherein said packer is a mechanical packer actuated in response to relative movement of said upper housing with respect to said lower housing.

3. Apparatus as defined by claim **1** wherein said packer is a hydraulic packer and said upper housing includes a passageway for conducting fluid to said packer from one channel of said string of multiple channel pipe.

4. Apparatus as defined by claim **1** wherein said valve means connected to said inner member includes a ball valve, a gear connected to said ball valve, and a rack connected to said lower housing, said gear meshing with said rack.

5. Apparatus as defined by claim **1** wherein said valve means in said lower housing includes a shoulder on said inner member which seats against a corresponding shoulder

on said lower housing in response to relative axial movement between said inner member and said lower housing.

6. Continuous coring apparatus which comprises:

(a) a tubular upper housing including means near the upper end thereof for connecting said housing to the outer conduit of a string of concentric two channel pipe;

(b) a tubular lower housing slidably connected to said upper housing and depending therefrom, said upper and lower housings including means for preventing rotation of said upper housing relative to said lower housing;

(c) an anular core bit connected to the lower end of said lower housing, said bit including a plurality of fluid discharge ports located in the lower surface thereof at intervals about the core opening therein;

(d) a tubular inner member connected to said upper housing and extending downwardly within said upper housing, said lower housing and said core bit in sliding relationship thereto, said inner member defining an inner passageway communicating with the core opening in said bit and an outer passageway communicating with said ports in said bit;

(e) a mechanical packer element connected at one end to said upper housing and at the lower end to said lower housing, said packer element being expansible in response to relative motion of said upper housing with respect to said lower housing;

(f) a ball valve assembly for closing off said inner passageway within said lower housing, said assembly including a ball valve in said inner member, a gear connected to said ball valve, and a rack connected to said lower housing for engaging said gear and rotating said valve in response to axial movement of said lower housing with respect to said inner member and ball valve; and

(g) valve means in said lower housing for closing off said outer passageway in response to relative axial movement of said inner member with respect to said lower housing.

7. Continuous coring apparatus which comprises:

(a) a tubular upper housing including means near the upper end thereof for connecting said housing to the outer conduit of a string of concentric three channel pipe, said upper housing including an annular passageway communicating with the outer passageway in said string of pipe, an outlet from said annular passageway containing a back pressure valve, and a lateral port in the outer wall surrounding said annular passageway below said outlet;

(b) a packer assembly mounted on the outer surface of said upper housing, said packer assembly being slidable thereon between a point adjacent said lateral port and a point below said outlet and being rotatable with respect to said upper housing;

(c) valve means in said annular passageway for admitting fluid to said packer assembly, said valve means opening in response to movement of said packer assembly into a downward position on said upper housing over said lateral port;

(d) a tubular lower housing slidably connected to said upper housing and depending therefrom, said upper and lower housings including means for transmitting torque from said upper housing to said lower housing;

(e) a core bit connected to the lower end of said lower housing, said bit including a core opening near the longitudinal axis of the bit and a plurality of fluid discharge ports located about said core opening;

(f) a tubular inner member connected to said upper housing and extending dowwardly within said upper housing, said lower housing and said core bit to form an inner passageway communicating with said core opening and an outer passageway communicating with said discharge ports in said bit, said inner tubular member including means for engagaing the inner conduit of said three channel pipe at the upper end of said apparatus;

(g) valve means connected to said inner tubular member near the lower end thereof for closing off said inner passageway in response to relative axial movement of said inner member and upper housing with respect to said lower housing; and

(h) valve means in said lower housing for closing off said outer passageway in response to relative axial movement of said upper housing and inner member with respect to said lower housing.

8. Apparatus as defined by claim 7 wherein said packer assembly includes anchor shoes expansible in response to pressure exerted by fluid admitted to said packer assembly.

9. Apparatus as defined by claim 7 wherein said valve means for closing off said inner passageway comprises a ball valve actuated by a rack attached to said lower housing and said valve means for closing off said outer passageway comprises a tapered shoulder in said lower housing against which a corresponding shoulder on said inner member seats.

References Cited by the Examiner

UNITED STATES PATENTS

2,229,635	1/1941	Boynton	175—318
2,663,545	12/1953	Grable	175—215 X
2,806,539	9/1957	Green	166—226
2,942,667	6/1960	Blood	166—226 X
2,998,077	8/1961	Keithahn	166—226

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