

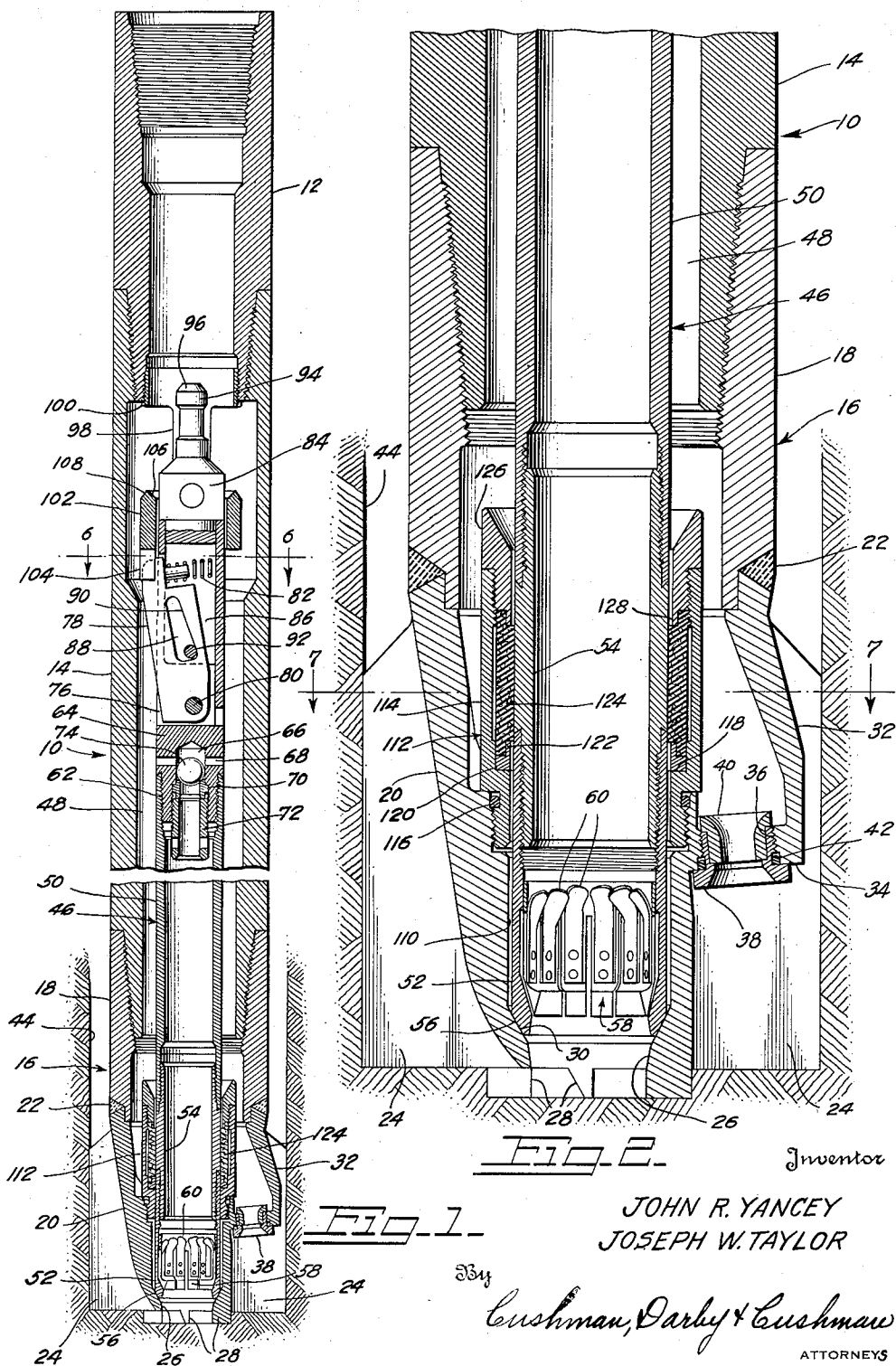
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J. R. YANCEY ET AL
CORE TAKING APPARATUS

2,760,758

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3 Sheets-Sheet 1



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3 Sheets-Sheet 2

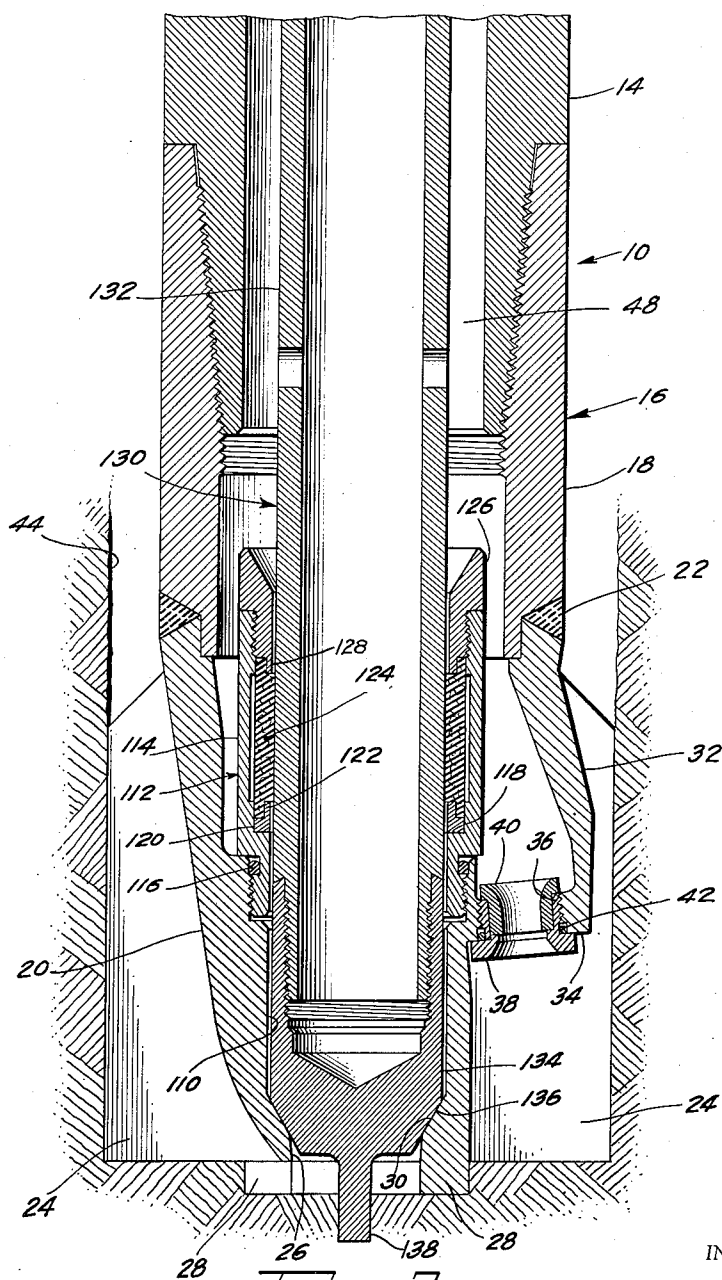


Fig. 3.

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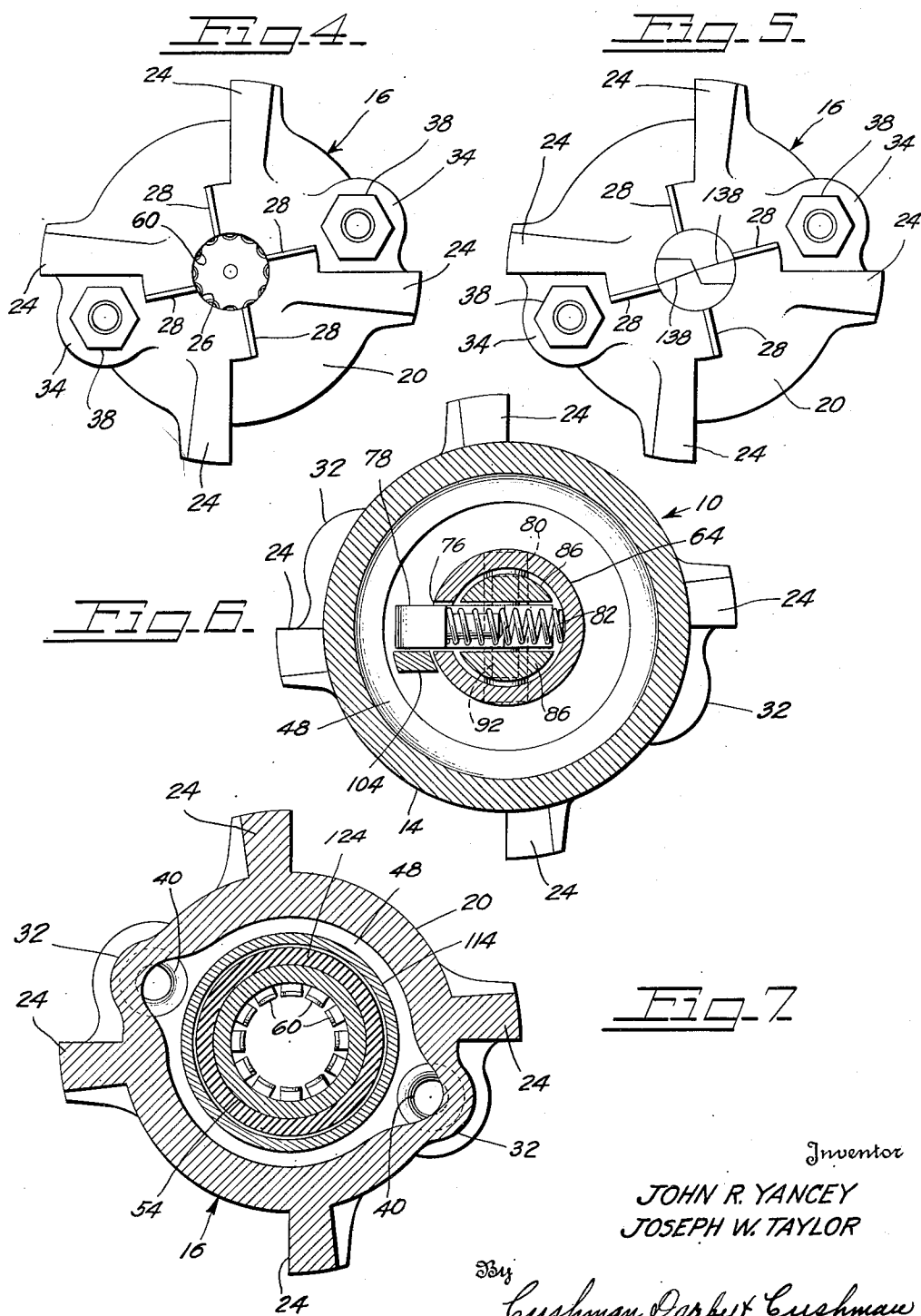
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CORE TAKING APPARATUS

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8 Claims. (Cl. 255—72)

This invention pertains to apparatus for obtaining cores or samples of formation from the bottom of a well, particularly an oil well, when drilling the same for subsequent inspection and analysis of the sample. More particularly, this invention relates to wire line coring equipment wherein a core barrel is insertable in and removable from a core drill through the operating string of pipe. In such instances the core barrel is retrieved through the drill string by a fishing or retrieving tool attached on the end of a wire line, whereby the retrievable core barrels of this type have become known as wire line core barrels.

Wire line type coring equipment is known in the art, but previous apparatus of this nature has necessitated a reduction, below normal drilling rates, of both R. P. M. of the core drill and pressure of the drill fluid which is pumped down through the operating string for discharge from the drill at the bottom of the well. The drill fluid returns upwardly to the mouth of the well through the space between the operating string of pipe and the walls of the well to provide a circulation which carries away the cuttings and also cools the bit. Additionally, such fluid usually is jetted from the drill at high velocity against the face of the formation being cut in order to aid the actual cutting operation.

The necessity of reduced R. P. M.'s and drill fluid pressures when coring, below those normally employed in ordinary drilling, is caused by the fact that heretofore an effective seal has not been obtained between the core barrel and the core drill to prevent escape of drill fluid through the central core receiving passageway in the core drill. Previous seals of this nature leaked at ordinary drill fluid pressures which are quite high, so that the combination of high pressure and the extreme abrasive characteristics of drill fluid rapidly wore away the parts forming the seal. Even if metal-to-metal seals were employed, such metal would be abraded away by any leaks therebetween, thereby rapidly increasing the size of the leak and ultimately destroying the equipment in a relatively short time. Additionally, because of the ineffectiveness of previous seals, a part of the drill fluid would be diverted through the central core-receiving passageway with consequent reduction in available jetting pressure. Further, previous seals because of their structural arrangement and also because of developed leaks, would permit formation being cut to become lodged between the core barrel and the core drill with resultant sticking of the barrel within the drill. Upon the occurrence of this latter event all the advantages of wire line coring are lost because when a core barrel sticks it can not be retrieved by a wire line and the entire drill string must then be pulled to remove the core barrel for analysis of the sample therein.

Another objection to some existing types of wire line coring equipment is the fact that non-metallic packing means, when employed to form the seal between the core barrel and the core drill, is mounted on the core barrel. Hence, when lowering the barrel through the drill string or retrieving the same therethrough, the packing is so damaged by contact with various abutments or projections,

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during travel of the barrel through the drill string, that all its sealing effectiveness is destroyed.

In order to eliminate the foregoing objections to previous types of wire line coring equipment, wire line coring equipment presently in use is operated at reduced drill fluid pressures to avoid leaking of the same past the barrel into the core-receiving passageway. Such pressure reductions necessitated corresponding reductions in R.P.M.'s of the drill, so that present wire line coring operations are carried on at rates of penetration considerably less than that of normal drilling operations. Since drilling equipment and the labor necessary to operate the same are quite expensive, reduced rates of penetration increase drilling costs materially. This is especially true of exploratory wells.

Accordingly, it is an object of this invention to provide wire line coring equipment that is effective for its intended purpose and which may be operated at drill fluid pressures and drill R.P.M.'s as high as those employed for ordinary drilling, with consequent high penetration rates.

It is another object of this invention to provide an effective seal between a wire line core barrel and a core drill which will not leak at high drill fluid pressures and will not permit formation to become lodged between the core barrel and the drill to thereby stick the barrel in the drill and prevent wire line retrieving of the former.

It is still another object of this invention to provide wire line coring equipment having a seal between the core barrel and the core drill that is effective at high drill fluid pressures and in which the core barrel may be replaced by a wire line plug bit for ordinary drilling.

It is still another object of this invention to provide wire line coring apparatus with an improved plug bit.

It is still another object of this invention to provide wire line coring apparatus of improved design which reduces turbulence of the high velocity drill fluid within the apparatus to thereby decrease the abrasive effect of the drill fluid on the apparatus.

It is still another object of this invention to provide wire line coring equipment with an improved seal between the drill and the core barrel, which seal is fixed within and to the core drill to thereby be undamaged by travel of the core barrel through the drill string.

It is a further object of this invention to provide improved wire line core taking equipment which is relatively simple in design and, therefore, economical to manufacture.

Other objects and advantages of the invention will be apparent from the following description and accompanying drawings, in which:

Figure 1 is a vertical sectional view of wire line coring equipment embodying this invention and showing the equipment in operative position at the bottom of a bore hole.

Figure 2 is an enlarged fragmentary view of the drill bit and the lower end of the core barrel shown in Figure 1.

Figure 3 is a view corresponding to Figure 2, but showing the core barrel replaced by a plug bit embodying this invention.

Figure 4 is a view of the forward or lower end of the equipment shown in Figure 2.

Figure 5 is a view of the forward or lower end of the equipment shown in Figure 3.

Figure 6 is a cross-sectional view taken substantially on line 6—6 of Figure 1.

Figure 7 is a cross-sectional view taken substantially on line 7—7 of Figure 2.

Referring now to the drawings, there is shown in Figure 1 a hollow core drill 10 which is connectable by a sub 12 to the usual operating string of pipe (not shown) for rotation thereby and for reception of drill fluid therefrom.

The core drill 10 consists of the usual drill collar 14 of any desired practical length and having a tubular bit 16 threaded onto the lower end thereof. This bit 16 preferably is manufactured in two parts 18 and 20 which are subsequently welded together as at 22 to facilitate the fabrication of the forward or lower part 20 of the bit. The bit 16 is provided with a plurality of circumferentially spaced large cutting teeth 24 having both radial and axial cutting edges. In the forward end of the bit 16 there is provided a central core-receiving passageway 26, preferably surrounded by a plurality of cutting teeth 28 of lesser radial dimension than the large teeth 24 and which extend axially forwardly of the large teeth to cut in advance thereof. The bit 16 is interiorly enlarged adjacent the rearward end of the core-receiving passageway 26 to form a rearwardly facing frusto-conical surface that provides an inside seat 30.

A plurality of lateral enlargements 32 in the bit 16, two as shown in the drawings, provide forwardly facing wall portions 34, each having a tapped opening 36 therein. Threaded into each port 36 is an orifice fitting 38 provided with a wear-resistant insert 40 to avoid cutting away or undue abrasion of the fitting by the high velocity jet of drill fluid emerging therethrough. Preferably, an O-ring 42 is disposed in a circumferential groove between each fitting 38 and the walls of each port 36 to provide a fluid-tight seal. It will be noted that in operation of the drill 10, drill fluid is jetted at high velocity against the bottom of the bore hole 44 to both aid the cutting action of the bit 16 and to wash away the cuttings. Additionally, as is well known in the art, drill fluid serves to cool the bit.

Disposed within the core drill 10 is a wire line core barrel assembly 46 of a substantially uniform outer diameter less than the inner diameter of the drill 10 (and of the sub 12) to provide a passageway 48 for drill fluid therebetween. The assembly 46 has a tubular core-receiving barrel 50, to the forward end of which a core catcher head 52 is connected by a barrel sub 54. The forward end of the core catcher head 52 is bevelled to provide a frusto-conical surface 56 substantially complementary to the inside seat 30 for seating engagement thereon. Rotatably mounted within the core catcher head 52 is a core catcher assembly 58 having the usual spring fingers 60 which grip the cylindrical formation rising into the barrel assembly 46 through the core-receiving passageway 26 during a coring operation. When the core barrel assembly 46 is withdrawn from the drill 10 through the sub 12 and upwardly through the drill string, as will be explained later, the spring fingers 60 break off the formation and retain the same within the barrel assembly to provide a core for analysis at the surface of the well. It will be noted that the inner diameter of the entrance end of the core catcher head 52 is no smaller than that of the core-receiving passageway 26 of the bit 16 so that the entering core, properly sized by the bit, is undisturbed in its passage into the core catcher head.

The upper end of the barrel 50 has the plug-like end 62 of a latch body 64 threaded thereinto. This end 62 of the latch body is provided with an axial recess 66 having lateral ports 68 at its inner end in communication with the fluid passageway 48 between the core barrel assembly 46 and the inner walls of the drill collar 14. The recess 66 is counterbored to provide a shoulder against which seats a valve seat insert 70 that is held in place against the shoulder by a nipple 72 threaded into the recess. A ball valve 74 is disposed within the inner portion of the recess 66 for seating engagement with the valve seat 70, so that drill fluid is prevented from entering the core barrel assembly 46 via the ports 68, but air or other fluid trapped within the core barrel assembly by formation rising upwardly therein may escape through the recess and out of the lateral ports in the latch body 64 when the pressure of such trapped fluid becomes sufficient to raise the ball valve 74 from its seat 70.

The upper portion of the latch body 64 is tubular and provided with a longitudinal slot 76 in the side wall thereof. A latch 78 is pivotally secured within the upper tubular portion of the latch body 64 for movement through the slot 76 radially of the core barrel assembly 46 by means of a hinge pin 80 extending transversely through the latch body at the lower end of the tubular portion thereof. Thus, the latch 78 may be moved radially outwardly into the position thereof shown in Figure 1, but may be moved inwardly within the confines of the latch body 64 by means later described. A latch spring 82 is interposed between the free end of the latch 78 and an opposed side wall portion of the latch body 64 opposite the slot 76, so that the latch is constantly urged to move radially outwardly into the position shown in Figure 1.

A cylindrical latch spear 84 is mounted for reciprocation within the tubular portion of the latch body 64 and is provided with lower bifurcated portions 86 straddling the latch 78. The latch 78 has a longitudinal slot 88 therein provided with an inclined side edge 90. A pin 92 extends through the slot 88 in the latch 78 and has its ends secured to the bifurcations 86 of the latch spear 84. This pin 92 engages against the inclined side edge 90 of the slot in the latch, so that upon upward or rearward movement of the latch spear 84 the latch is cammed back into the confines of, or within the peripheral outline of, the latch body 64. The upper end of the spear 84 is provided with a stem which terminates in an enlarged head 94 for engagement by a fishing or retrieving tool (not shown). Preferably the head 94 has a bevelled outer end 96 for reasons later described.

Suspended by legs 98 depending from a supporting ring 100 threaded into the lower end of the sub 12 is a driving collar 102 which relatively loosely embraces the outer periphery of the core barrel assembly 46. When the latch 78 is in the position shown in Figure 1, it will be seen that the free end of the latch is disposed directly beneath the undersurface of the driving collar 102, so that the entire core barrel assembly 46 is locked in position on the inside seat 30 in the drill 10. Depending from the undersurface of the drill collar 102 is a tooth 104 for engagement against the side surface of the latch 78 upon rotation of the core drill 10 by the operating string, so that the core barrel assembly 46 rotates with the drill during the coring operation.

It will be noted that the upper edge of the driving collar 102 is oppositely bevelled, the inner bevel 106 serving as a means for centering and guiding the core barrel assembly 46 in its downward movement through the collar into position within the bit 16, and the outer bevel 108 serving as an aid in streamlining the flow of drill fluid downwardly past the collar during the coring operation. The elimination of turbulence is essential in order to attain the high flow rates necessary for effective jet action. In this latter connection it is also to be noted that the bevelled formation 96 of the spear head 94 also aids in streamlining the flow of drill fluid downwardly past the spear head. It also is pointed out that the drill collar 14 is interiorly enlarged adjacent the driving collar 102 to prevent choking of the downward flow of drill fluid at this point.

Rearwardly of the inside seat 30 within the bit 16 there is provided a smooth-walled cylindrical section 110 of only slightly larger diameter than that of the core barrel assembly 46. Rearwardly of this section 110 the bit 16 is interiorly enlarged for reception of a tubular seal assembly 112 adapted to embrace the core barrel assembly 46. The seal assembly 112 has a tubular housing 114 threadedly connected, at its lower or forward end, to the bit 16. Preferably, an O-ring seal 116 is disposed in an annular groove between the seal housing 114 and the bit 16 just rearwardly of the threads connecting the same to provide a fluid-tight seal between the housing and the bit.

The seal housing 114 is interiorly enlarged above its

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threaded lower end to provide an upwardly facing shoulder 118 against which seats a seal ring 120 having an inner axially-extending circumferential flange 122. Received within the housing 114 and having one of its ends interfitting with the seal ring 120 is a packing sleeve 124 of resilient heat-resistant material which snugly embraces the outer surface of the core barrel assembly 46. Although this sleeve 124 may be formed of any appropriate packing material having the aforementioned desired characteristics, various types of synthetic rubber have been found to be suitable for this purpose. The sleeve 124 is clamped within the seal housing 114 by means of a retaining nut 126 threaded into the upper end of the seal housing 114 and having an inner axially-extending circumferential flange 128 at the lower end thereof interfitting with a complementary upper end of the sleeve 124. The upper edge of the nut 126 is interiorly bevelled to guide the core barrel assembly 46 into the seal assembly 112.

In use of the apparatus, the core barrel assembly 46 is lowered or pumped down through the drill pipe until it seats in operating position against the inside seat 30 in the bit 16. As the core barrel assembly 46 enters the sleeve 124, the resulting choking effect on fluid flow (which theretofore partially flowed outwardly through the core receiving passageway 26) effects a pressure rise of the drill fluid that forces the barrel assembly firmly against the inside seat 30 of the bit and also forces fluid through the jet orifice fittings 38 at high velocity. Thereupon, the coring operation commences by rotation of the drill string and the resultant drilling action of the bit, which, in turn, permits the drill string, together with the core drill 10, to move downwardly. The bit 16, in moving downwardly, cuts an annular hole in the formation so that the central undisturbed formation rises through the core-receiving passageway 26 into the core-barrel assembly 46.

During this coring operation the effectiveness of the sleeve 124 in forming a tight fluid seal between the core barrel assembly and the bit permits rotation of the bit at normal drilling speeds and also permits normal drilling pressures to be employed. Additionally, because all of the drilling fluid escapes through the jet orifices 38 without a portion thereof being diverted past the inside seat 30 and through the core-receiving passageway 26, the desired high velocity fluid jets are attained. Because fluid pressure during the coring operation is greater within the core drill 10 than in the bore hole 44, the fluid pressure passing between the retaining nut 126 and the core barrel assembly 46 acts on the upper end edge of the resilient sleeve 124 to compress the latter into tight sealing engagement with the outer periphery of the core barrel assembly.

When the coring operation has been completed, i. e. the drill 10 has moved downwardly a distance sufficient to obtain a core of the desired length for sampling purposes, the pumps (not shown) at the surface of the well are stopped so that the fluid pressures within the core drill 10 and in the bore hole 44 may equalize through the jet orifices 38. Thereupon the drill string is raised slightly so that the core catcher assembly 58 breaks off the core. A retrieving tool (not shown) then is lowered by a wire line through the drill string into engagement with the spear head 94. A subsequent upward movement of the tool first serves to retract the latch 78 by the camming action of the latch pin 92 against the inclined side edge 90 of the slot in the latch, and then pulls the entire core barrel assembly 46 upwardly through the drill string to the surface where the core may be removed from the core barrel assembly for inspection and analysis.

After the coring operation has been thus accomplished and it is desired to resume normal drilling, a separate plug bit assembly 130 of the same uniform diameter as the core barrel assembly 46 is either pumped or lowered by a wire line through the operating string to replace

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the core barrel assembly. This separate plug bit assembly 130 is shown in Figure 3, and since the upper portions thereof including a ball check valve, a latch assembly, and a spear head assembly are identical with those of the core barrel assembly 46, a detailed description of these parts is unnecessary. The lower portions of the separate bit assembly 130 consist of a plug barrel 132 having a plug bit 134 threaded to the lower end thereof. This bit 134 is provided, at its forward or lower end, with a bevelled surface 136 for seating engagement against the inside seat 30 in the bit. A plurality of teeth 138, two as shown in the drawings, project out of the core-receiving passageway 26 and extend beyond the smaller teeth 28 of the main bit 16, so that during the normal drilling operation the separate bit 134 acts somewhat like a pilot, in that it drills a small central hole in advance of the action of the main bit.

It will be noted that the plug bit 134 is imperforate and that the packing sleeve 124 makes a tight seal thereagainst so that the same effectiveness of jet action is obtained by the drill 10 with the separate bit assembly in place as when the core barrel assembly is in use. A large pressure differential between the interior of the core drill 10 and the bore hole 44 also serves to maintain the separate bit assembly 130 firmly seated against the inside seat 30 as well as increasing the effectiveness of the sealing action of the packing sleeve 124. Even though the separate bit assembly 130 (and also the core barrel assembly 46) may be unseated slightly during the drilling operation and bits of formation consequently tend to work their way upwardly past the inside seat 30, since there is no fluid movement upwardly toward the seal between the sleeve 124 and the exterior of the separate bit assembly (or of the core barrel assembly), no difficulty is encountered in such bits of formation tending to damage the sleeve.

Whenever normal drilling is to be interrupted for the purpose of taking a core, the pumps are again shut down, the drill string raised slightly, and the separate bit assembly 130 pulled upwardly through the drill string by means of a retrieving tool on the end of a wire line, in exactly the same manner as the withdrawal of the core barrel assembly. Thereupon, the core barrel assembly 46 is either pumped down or lowered through the operating string, as before, the pumps are started again, and the drill string is rotated for the core taking operation.

It will thus be seen that the objects of this invention have been fully and effectively accomplished. It will be realized, however, that various changes may be made in the specific example illustrated and described for the purpose of disclosing the invention without departing from the principles thereof. Therefore, this invention includes all modifications which are encompassed by the spirit and scope of the following claims.

We claim:

1. A core taker comprising: a core drill attachable to an operating string for receiving high pressure drilling fluid therefrom and having a central core-receiving passageway and a rearwardly-facing inside seat at the inner end of said passageway, said drill being adapted to have a core barrel insertable therein and removable therefrom through the operating string with the barrel, when in core-taking position, seating on said seat; means defining a fluid outlet in said drill separate from said passageway for discharging fluid from the interior to the exterior of said drill adjacent the cutting edges thereof; a resilient packing sleeve within said drill inwardly of said seat for snugly and slidably engaging the outer periphery of a core barrel seated on said seat for forming a fluid-tight seal between the barrel and said drill to prevent fluid flow between the barrel and said seat; and rigid means secured to said drill confining the end portions and outer side of said packing sleeve for positively retaining the latter in operative position within said drill.

2. The structure defined in claim 1 in which the rigid

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means comprises a tubular housing assembly secured at its forward end to the drill.

3. The structure defined in claim 1 in which the packing sleeve has an annular groove in each end thereof, said grooves being spaced inwardly of the outer edges of said ends, and the rigid means comprises a tubular housing having the forward end thereof threaded into said drill and a sleeve-retaining ring threaded into the other end of said housing against the corresponding end of said sleeve, said ring and housing having annular means interfitting in said sleeve end grooves for retaining said sleeve in operative position.

4. In a hollow core drill attachable to an operating string for rotation thereby and reception of high pressure drilling fluid therefrom and having a central core-receiving passageway, an inside seat for seating engagement of a wire-line core barrel, and an outlet for drilling fluid separate from the passageway, the combination of resilient packing means within the drill in position to releasably receive and to snugly and slidably engage with the periphery of the core barrel when seated on the seat for sealing with the barrel and preventing flow of drilling fluid between the barrel and the seat from the interior to the exterior of the drill via the core-receiving passageway; and rigid means secured within and to the drill and securely retaining said packing means in said position.

5. The structure defined in claim 4 in which the packing means comprises a sleeve of heat-resistant material.

6. A core taker comprising: a core drill attachable to an operating string for rotation thereby and reception of high pressure drilling fluid therefrom, said drill having a central core-receiving passageway and a rearwardly facing inside seat; a core barrel positionable within said drill to seat on said seat, said barrel being removable from and insertable in said drill through the operating string; means defining a fluid outlet in said drill separate from said passageway for discharging fluid from the interior to the exterior of said drill adjacent its cutting edges; resilient packing means positioned within said drill to releasably receive and to snugly and slidably engage with the outer periphery of said barrel when seated on said seat for sealing with said barrel and preventing flow of fluid between the latter and said seat from the

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interior to the exterior of said drill via said core-receiving passageway; and rigid means detachably secured within and to said drill and securely retaining said packing means in said barrel-receiving and engaging position.

7. In a core drill attachable to an operating string for rotation thereby and reception of high pressure drilling fluid therefrom and having a central core-receiving passageway, an outlet for drilling fluid separate from the passageway, and a frusto-conical inside seat for seating engagement by a complementary end of a wire-line core barrel, the combination comprising: a rigid tubular housing detachably secured within and to the drill above and in alignment with the inside seat; and a resilient packing sleeve secured to and within said housing for reception of and for snugly and slidably releasably engaging a core barrel seated on the seat to form a fluid-tight seal between the barrel and the drill at a location between the fluid outlet and the core-receiving passageway, the inner diameter of said sleeve normally being only slightly less than the outer diameter of the core barrel to permit insertion and removal of the latter into and from said sleeve.

8. The structure defined in claim 7 in which both ends of the sleeve are provided with interior annular recesses, and the housing includes rigid axially-extending circumferential flanges engaged within said recesses to secure said sleeve within said housing.

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