Dec. 23, 1969 V. MILOSEVICH 3,485,310

WIRE LINE CORE BARREL APPARATUS

Filed Jan. 22, 1968 2 Sheets-Sheet 1

Fig 1.

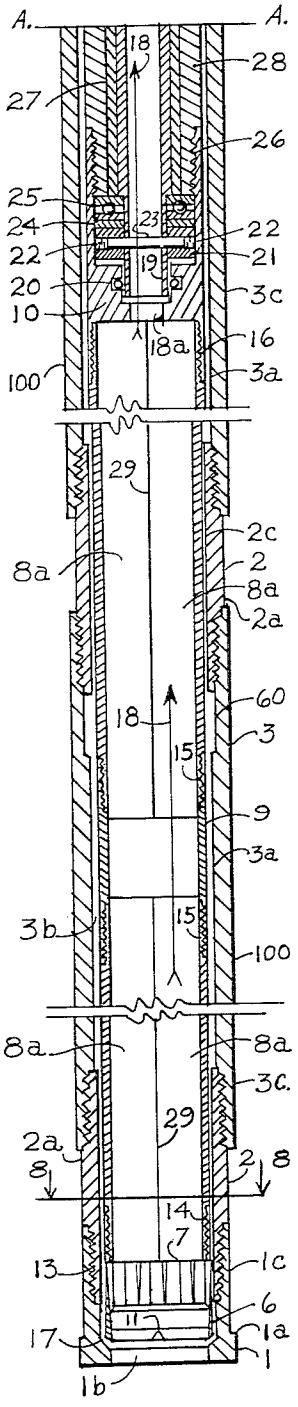
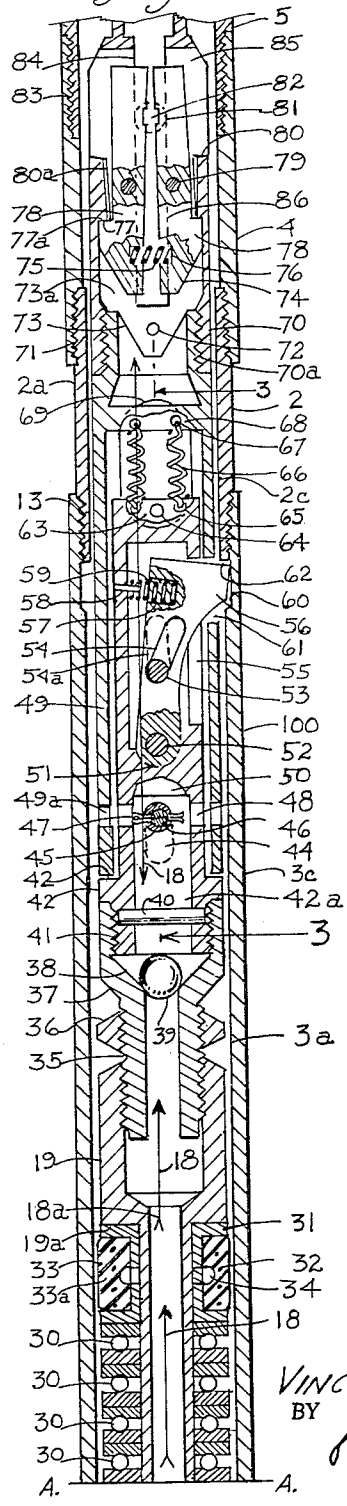


Fig 2.



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WIRE LINE CORE BARREL APPARATUS

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Fig 5.

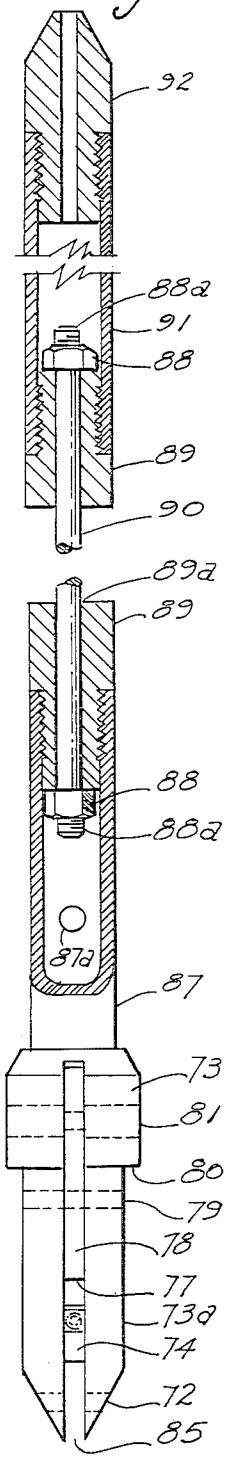


Fig 6.

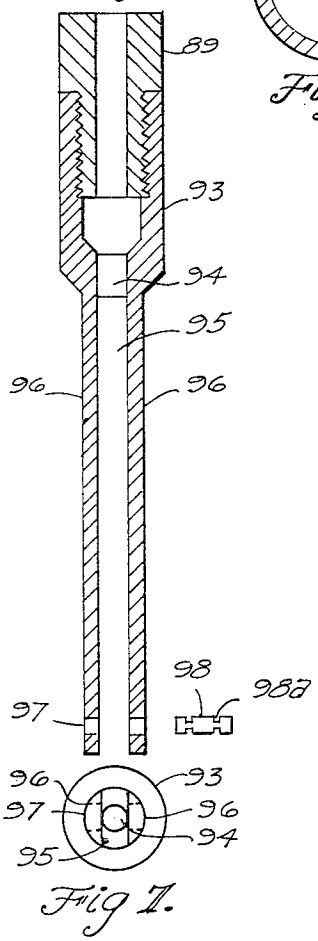


Fig 7.

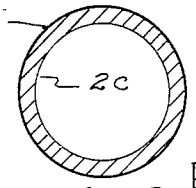
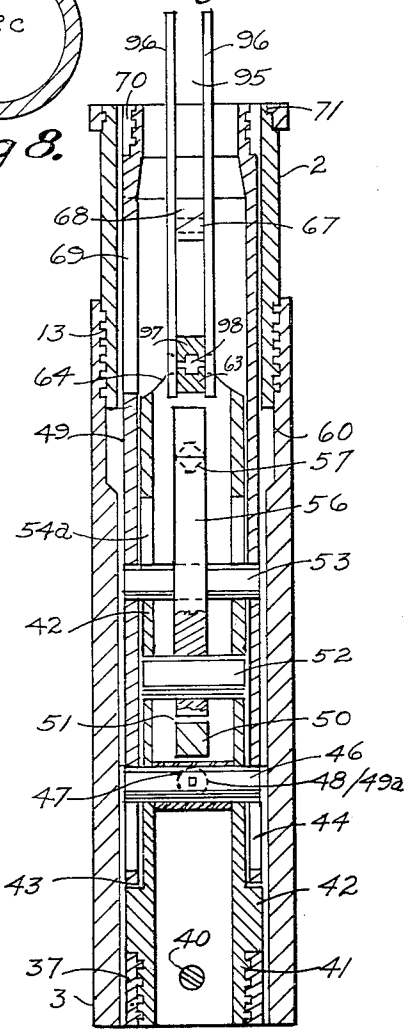


Fig 8.

Fig 3.



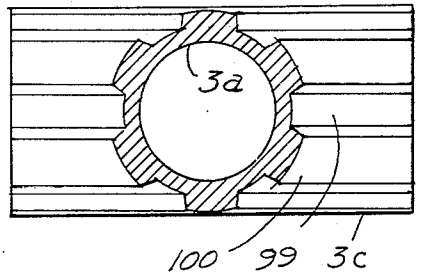


Fig 4.

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3,485,310

WIRE LINE CORE BARREL APPARATUS

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U.S. Cl. 175—246 10 Claims

ABSTRACT OF THE DISCLOSURE

The inner barrel is hollow throughout so that, on dropping it into a well, compression of the drilling fluid will not impede passage. Splines around the outer barrel, either longitudinal or spiral, stabilize the barrel and prevent wobbling. The rubber-like shut-off valve is bonded to metal to minimize sand abrasion. The core-receiving section is split longitudinally to facilitate core removal. A dry hole release shear pin simplifies removal. Springs hold the elevator in place, permitting drilling in any direction including horizontal and even upward directions. The length of the inner barrel can be changed without pulling the drill string out of the well.

This invention relates to the art of using a wire line core barrel for exploring, sampling and studying subterranean strata for mineral and other values. More particularly, this invention relates to improvement in wire line core barrel systems.

In the core drilling industry it is common practice to refer to the general component parts of a wire line core barrel as an outer barrel, outer head, inner head, inner barrel, core lifter, core lifter case and a means for lifting the inner barrel out of the drill string which is called an overshot. However, in this application, due to its construction the means for lifting the inner barrel, described in this application, out of the drill string will herein be referred to as an elevator instead of an overshot.

In the core drilling industry there is a great need to develop means and techniques to keep a drill bit, which is the focal point of any drilling operation, on the bottom of a drill hole or well working more of the time than has been the case to the present time.

It is an object of this invention to provide means to reduce the time required to transmit a wire line inner barrel from the working floor on the surface through the drill string to the drill bit. The reduction in transmission time is effected by the generally hollow construction of the inner head used in the development of this invention. The hollow center provides a means to relieve the resistance to downward travel through the drill string caused by the compressive action resulting from the limited clearance between the outer barrel and the inner barrel and between the outer barrel and a drilling fluid shut off valve and the general piston like action of the complete inner barrel assembly while in transit downwardly through the drill string.

In wire line core drilling systems there is a great need for more annular clearance between the outer barrel and the wall of the hole or well so that more desirable drilling fluids may be circulated through the system to better build up unconsolidated walls of the drill hole or well.

It is another object of this invention to provide means for more annular clearance between the outer barrel and the wall of the hole or well and to provide means to keep the bit and core barrel stabilized by utilizing a plurality of splines, grooves, or flutes around the periphery and longitudinally or spirally or at an angle the full length of the outer barrels excepting or including the connecting bushing couplings, the outside set diameter

of the bit being a little greater than the outside diameter of the splines, grooves or flutes. The spaces between the splines, grooves or flutes become drilling fluid passage ways allowing the passage of the more desirable drilling fluids and allowing the annular passage of larger cavings, cuttings and grindings encountered in the drilling of unconsolidated and brecciated formations. The couplings connecting the outer barrels are with or without splines, grooves, or flutes, depending on the formation, if the connecting bushing couplings are used without the splines, grooves or flutes the outside diameter of the coupling bushings will then be of the same dimension as the minor outside diameter of the outer barrels between the splines, grooves or flutes. When the coupling bushings are used without the splines, grooves or flutes the annular spaces between the coupling bushings and the walls of the hole become annular chambers in which the larger cavings are crushed, ground up and dispersed before entering the passageways between the splines, grooves or flutes on the outer barrels.

It is another object of this invention to provide means to crush, grind and further dissipate any extraneous and troublesome cavings, cuttings and mineral deposits by incorporating the splines, grooves or flutes around the periphery and the full longitudinal length of the outer barrels spirally or at any angle. The aforementioned provisions will greatly reduce the costly time now necessary to cement or case off the caving and troublesome formations that are adverse to the drilling operation. The general shape, angle or form and the number of splines, grooves or flutes around the periphery and the longitudinal length of the outer barrels and the bushing couplings is governed by the formations, rock types and drilling conditions to be encountered.

There is a great need to develop a resilient drilling fluid shut off valve, to indicate a full or blocked inner barrel, that does not fail because of allowing sand, cuttings and solids to become forced around and behind itself and rendering itself useless.

It is another object of this invention to provide a shut off valve constructed by the bonding of a resilient material shape to metal mounting bodies with controlled compression limits and relaxing aids included in the resilient material. These provisions will eliminate sand and other solid "build up" around the shut off valves, thereby reducing costly down time used up while replacing and repairing faulty shut off valves.

The primary function of a core drilling operation is to recover an accurate, reliable and representative sample of the formation being explored and studied. It is not uncommon to encounter friable formations that will not readily lend themselves to the demanded coring results. Some of the formations, and in some instances an undeterminable amount of mineral and other values are washed away or lost by the use of wire line core barrels that are not designed to cope with these friable formations. There is a great need for wire line core barrels that will recover more core in the friable, easily dissolved, sticky and unconsolidated formations. There is a great need for inner barrels that may be emptied of adverse formation cores with less loss of core, less damaging of core and with less damage to the inner barrel.

It is another object of this invention to provide an outer barrel with means incorporated to accommodate more than one inner barrel of varied lengths, one at a time, without hoisting the drill string out of the hole to use a core barrel of a longer or shorter length. This will encourage the use of the more desirable inner barrel in the adverse formations.

It is another object of this invention to provide an inner barrel made up of precisely cooperating sections

having transverse and corresponding longitudinal joints, the tubular sections, made up of the component sections, are connected by threaded couplings to permit disassembly of the core receiving section of the inner barrel to effect the removal of the core with much less loss and damage to both the core and the inner barrel.

It is another object of this invention to chrome plate, when necessary, the entire inside diameter of the inner barrels, and to chrome plate or hard surface or harden any other part or component parts of this invention for the purpose of preventing wear of the aforementioned parts or for the improvement of the efficiency of this invention and to use any available material feasible for the purpose of reducing or eliminating undesirable magnetism or magnetic "build up" in this or any component part of this invention.

It is another object of this invention to provide tools, which are a part of this invention, for lifting and lowering the inner barrel inside the drill string. The lifting and lowering tools will hereinafter be referred to as an elevator and a dry hole release. The dry hole release is provided with a shear pin jointed linkage between the wire line and the inner barrel. This linkage will prevent accidental dropping and damaging of the inner barrel inside the drill string that is devoid of drilling fluid due to encountering formations that will not hold fluids. When the inner barrel is lowered into place and engaged in the drilling position the connecting shear pin is sheared by an upward force on the wire line thereby permitting the removal of the dry hole release so that drilling may commence. When the bore hole will hold fluids it is not necessary to lower the inner barrel on the wire line as the inner barrel will "float" down through the fluid in the drill string after it is simply dropped into the drill string. The elevator is provided with outwardly expanding hooks engaging a lifting shoulder inside the elevator cage for lifting the core laden inner barrel out of the drill string.

It is another object of this invention to provide the inner barrel assembly with a valving mechanism, which is a part of this invention, to relieve the pressure "build up" inside the core receiving section of the inner barrel while the inner barrel is progressing downwardly over the core during the drilling operation. This same valving mechanism will provide a means to keep undesirable fluid pressures away from the core and prevent washing and dissolving the core while drilling is in progress and while hoisting the core laden inner barrel out of the drill string.

Still another object of this invention is to provide a simple inner barrel locking system in holes that are drilled in an other than a downward direction and in holes to be drilled in an upward direction. When drilling holes in an upward direction it becomes necessary to overcome gravitational force to keep the inner barrel locked in the drilling position.

A further object of this invention, therefore, is to provide a simple tension spring actuated locking system for locking the inner barrel in the upward drilling position.

It is another object of this invention to provide an adjusting mechanism to control the overall longitudinal length of the inner barrel. The adjusting mechanism is made up of a member of hollow center construction which is engaged onto the valve chamber of the inner barrel valving mechanism and locked in place by a jam nut.

It is another object of this invention to provide a hardened core lifter case having fluid passages spaced around the lowermost end of the lifter case; the general construction of these fluid passages is governed by the characteristics of the formation to be drilled, thereby providing a means for controlling the amount of drilling fluid to communicate with the core.

It is another object of this invention to provide a core lifter with fluid passages spaced around the inside diameter, the circumference of the core lifted is broken by a part in one of the fluid passages. The general construction, the number of fluid passage ways and the degree of resiliency of the lifter are determined by the characteristics of the formation to be encountered.

It is another object of this invention to rest the inner barrel assembly on a shoulder provided for this purpose inside the throat of the core bit while the inner barrel is in the drilling position.

Field tests indicate that inner barrels that are in communication with the bit will build up less undesirable magnetism and will remain more static while drilling is in progress than will the inner barrels that are suspended in the outer barrel just above a shoulder in the throat of the bit. Field tests, also, tend to indicate that when a certain amount of magnetism is built up in the inner and outer barrels the indicated resulting attraction between the two barrels appears to rotate the inner barrel when it should be static. Field tests also tend to show that less core is exposed to the washing action of the drilling fluid when the inner barrel rests on the shoulder in the bit, thereby effecting the recovery of more core than can be recovered by a system which exposes a greater amount of core to the washing action of the drilling fluid.

Other and further objects are those inherent in the invention herein illustrated and described in the claims, and will be apparent as the description proceeds.

To the accomplishment of the foregoing and related ends, this invention then comprises the features hereinafter fully described and particularly pointed out in the claims, the following description setting forth in detail certain illustrative embodiments of the invention, these being but a few of the various ways in which the principles of the invention may be employed.

The invention is illustrated in the drawings in which the same numerals refer to corresponding parts and in which:

FIGURE 1 and FIGURE 2, taken together, constitute a longitudinal sectional view of a wire line core barrel assembly including the core bit, the outer barrels, the outer barrel connecting coupling bushings, the outer head or adapter, the complete inner barrel assembly and the lower portion of the elevator assembly embodying the present invention, FIGURE 1 showing the lower and FIGURE 2 showing the upper portion of the core barrel. A composite longitudinal sectional view may be arranged by placing FIGURE 2 above FIGURE 1 at the lines A—A.

FIGURE 3 is a longitudinal sectional view of the upper portion of the hollow center inner head assembly embodying the inner barrel locking means and the lower portion of the dry hole release mechanism taken along the lines and in the direction of the arrows 3—3 of FIGURE 2, these parts being a part of this invention.

FIGURE 4 is a revolved section taken out of the outer barrels 3c which are a part of this invention, illustrating one of the ways the splines, grooves or flutes may be arranged around the outside diameter of the outer barrels.

FIGURE 5 is a partly elevational and partly sectional view illustrating the general construction and shape of the elevator or tool for lifting the inner barrel out of the drill string, the elevator being a part of this invention.

FIGURE 6 is a longitudinal sectional view illustrating a form of the dry hole release mechanism used in this invention to safely lower the inner barrel inside a drill string that is without drilling fluid. The shear pin 98 is a part of FIGURE 6.

FIGURE 7 is an elevational end view, looking upwardly, of the dry hole release showing the slot and bore therein.

FIGURE 8 is a transverse sectional view of the connecting coupling bushings when without splines, grooves or flutes taken along the line and looking in the direction of the arrows 8—8 in FIGURE 1 and is representative of the outer diametric shape of all the coupling bushings when used without splines, grooves or flutes and the minor outside diameter of the drill bit used in this invention.

Referring now to the drawings and particularly to FIGURES 1 and 2, FIGURE 2 aligned above FIGURE 1, there are here illustrated embodiments of this invention comprising generally an outer barrel made up of like sections 3*c* and like coupling bushings **2** and an outer barrel head or an adapter **4** to attach by threaded means **71** the outer barrel assembly to a drill string by threaded means **83** of which the drill rod **5** is the lowermost part. The core bit **1** is threaded onto the lowermost coupling bushing **2** by the threads **13**. The outside diameter of the coupling bushings **2**, when without splines, grooves or flutes, is of the same dimension as the outside diameter **1***c*, the minor outside diameter of the core bit **1** and is also of the same dimension as the minor outside diameter or bottom **99** of the splines, grooves or flutes of the outer barrel 3*c* illustrated in FIGURE 4. The inside diameter 2*c* of the coupling bushings **2** may be smaller in dimension that the dimension of the inside diameter 3*a* of the outer barrals 3*c* so as to provide a stabilizing bushing for the inner barrel. The annular clearance at **1***a* between the outside set diameter of **1** and **1***c* is of a highly critical nature in that this annular clearance is of paramount importance when drilling broken, unconsolidated and brecciated formations.

The aperture **1***b* governs the outside diameter of the core being taken, the outside diameter **1***a* of the bit determines the size of the hole being drilled and the major outside diameter at **100** of the outer barrels 3*c* determine the average inside diameter and generally accurate consistency and straightness of the hole being drilled. In other words were it not for the splines, grooves or flutes **99** and **100** the bit **1** would drift or deviate in a sideways manner in the direction of least resistance while drilling is in progress and the bit would maintain its deviated direction until the direction of deviation is terminated by the engagement of the outer diameter of the core barrel against the wall of the hole. Unless the outside diameter of the core barrel is generally the same in dimension as the outside diameter of the bit the hole will be drilled with crooked, irregular and uneven walls, the core will be crooked and uneven and such a hole is difficult to core and difficult to lower casing into in the event the hole has to be cased or cased and reduced in size. The splines, grooves or flutes **99–100** keep the hole out to the desired and stabilized diameter.

The splines, grooves or flutes **99–100** will also crush, grind up and disperse into the drilling fluid the unconsolidated cavings and undesirable solids which will then be carried and flushed upwardly out of the hole thereby reducing the chances of "packing off" the drill string and lessening the chances of differentially sticking the drill string in addition to allowing more clearance for more viscous drilling fluids.

When the outside diameters 2*a* of the coupling bushings **2** are used without splines, grooves or flutes **99–100** the annular spaces at these points 2*a* will permit additional undesirable solids to enter the drilling fluid system to be crushed, ground up and carried out of the hole. The coupling bushings may be used with or without the splines, grooves or flutes.

While this invention is illustrated by reference to a diamond core drilling system, it is to be understood, however, that this invention is not limited thereto but on the contrary is applicable to all types of hollow core bit drilling systems such as are conventionally used in taking core samples or earth boring in general or with non-coring bit systems using the stabilized outer barrel without the inner barrel.

The parts 8*a* and **9**, the core lifter case **6**, and the core lifter **7** make up the core receiving section of the inner barrel, an embodiment of this invention. The core lifter case **6** is provided with a plurality of water ways **11** to permit drilling fluid to pass between the core lifter case **6** and the shoulder **17** in the throat of the bit **1**. The number and shape of the water ways **11** also determine the amount of drilling fluid that is to come into contact with the core while drilling is in progress.

The inner barrel sections 8*a*, the couplings **9** and **10**, the core lifter case **6** and the core lifter **7** are built and machined to a very high degree of accuracy and precise tolerances. The sections 8*a* come exactly together or apart at the joints **29** to permit simple removal of the core. The core lifter case **6** is threaded onto the lowermost section of the inner barrel by the threads **14**, **15**, or **16**, the sections 8*a* being reversible, thereby holding the sections 8*a* together. The threaded couplings **9** and **10** are threaded onto the remaining sections 8*a* to complete the desired composite section and attach the inner head asembly. The overall length of the inner barrel assembly may be lengthened or shortened by the addition or removal of sections 8*a* and couplings **9**. The outer barrel, likewise, may be lengthened or shortened to any desired length by removing or adding sections **3** and coupling bushings **2**. The versatile and composite construction of the inner and outer barrels permits the use of inner barrels of varying lengths and the corresponding cooperating outer barrel without removing the drill string from the hole to effect the change in the inner barrel length.

The coupling **10** is provided with a hollow center to permit the passage of drilling fluid therein at 18*a*. The journal box **28** is attached to the coupling **10** by the threads **26**. The shoulder at the aperture 18*a* in the coupling **10** serves as a stop when the shoulder meets the core and the inner barrel is fully core laden. The sealing system **20** makes up a seal between the coupling **10** and the hollow journal spindle shaft **19** to keep undesirable solids away from the hanger bearing **25** and the journal bushing **27**. The hollow spindle journal shaft allows the passage of drilling fluid axially therein. The journal bushing **27**, the coupling **10**, the inner barrel sections 8*a*, the couplings **9**, the core lifter **7**, and the core lifter case **6** all remain static while drilling and coring is in progress.

The friction created between the core lifter **7** and the core as the inner barrel proceeds downwardly over the core while drilling is in progress, tends to urge the inner barrel assembly and the core lifter case **6** inwardly off of the shoulder **17** in the bit. The drilling fluid passing between the shoulder **17** and the core lifter case **6** further enhances the inner barrel assembly upwardly away from the shoulder **17**, thereby making the core receiving sections of the inner barrel buoyant, static and quiescent.

Referring now to FIGURE 2 of the drawings the shut off valve asembly **33** is composed of two mounting bushings **31** free to move axially along the hollow spindle journal shaft **19** until the mounting bushings **31** come together and axial movement stops at the point **34**, and a body 33*a* of a resilient material shape having a relaxing aid **32** imbedded within the resilient shape. The resilient body shape 33*a* is bonded to and united with the mounting bushings **31**.

As the inner barrel progresses downwardly over the core resistance will be encountered in the core receiving station of the inner barrel, this resistance will be due to a fully laden inner barrel or a "block" caused by the wedging of core fragments or by the wedging of muddy and sticky core in the core receiving section of the inner barrel. When the inner barrel is fully laden or a "block" occurs thrust will be transmitted downwardly by the drill string through the inner barrel head to the shut off valve assembly **33**, the resistance to downward progress caused by the fully laden inner barrel or the "block" has stopped downward movement of the core receiving section of the inner barrel, when the downward thrust of the drill string meets the stopped inner barrel resistance at the shut off valve assembly **33** the resilient body shape 33*a* will start to undergo compression. As the resilient body shape 33*a* is compressed it will expand in girth and become shorter in length, axially, until compression is stopped by the meeting at **34** of the mounting bushings

31. Simultaneously the resilient body shape 33*a* will have expanded in girth until it has met the inside diameter of the outer barrel 3*c* and shut off the flow of the drilling fluid in the annular space 3*b* between the inside diameter of the outer barrel and the outside diameter of the inner barrel, thereby raising the drilling fluid pressure or stalling the pump which, in turn, will notify the drill operator that the inner barrel is fully laden or a "block" has been encountered and the inner barrel must be hoisted out of the drill string.

The shut off valve assembly 33, the thrust bearings 30, the journal box 28, the journal bushing 27, the hangar bearing 25 and the spacer washer 24 are interposed on the hollow journal spindle shaft 19 between the shoulder 19*a* and the retaining collar 21. The pin 23 and the set screws 22 secure the assembly of the afore mentioned parts to the hollow spindle journal shaft 19 without the use of threads, thereby providing a smooth sealing surface for the sealing system 20.

Still referring to FIGURE 2 of the drawings the hollow centered valve chamber 37 is threadably engaged into the hollow spindle journal shaft 19 by means of the threads 34–35 which form an adjustable joint to control the overall length of the inner barrel assembly. The jam nut 36 locks the joint in position.

While drilling is in progress the valve 39 closes the fluid passage way 18 by resting on the valve seat 38. The valve 39 prevents drilling fluid from washing away the core while drilling is in progress and while the inner barrel is being hoisted out of the drill string. The valve 39 also permits the relief of the pressure built up in the core receiving section of the inner barrel as the inner barrel proceeds downwardly over the core. There is no need for other pressure relief holes or vents in any other part of the inner barrel.

When drilling holes in an upward direction or in a direction other than downward, a spring and spring guide (not shown in the drawings) are interposed between the valve 39 and the valve stop pin 40 to provide a positive valving system when drilling angle holes.

The hollow centered locking pawl carrier tube 42 is connected to the valve chamber 37 by the threaded means 41, the valve stop pin 40 is held in place by the female upper section of the valve chamber 37. The valve stop pin 40 prevents the valve 39 from wandering upwardly while the inner barrel is being lowered into the drill string. The inside diameter 42*a* of the hollow centered locking pawl carrier tube 42 is of a larger dimension than the outside diameter of the valve 39, thereby permitting drilling fluid to be displaced therein when the valve 39 is held against the stop pin 40 by the displacing fluid.

The lower elevator cage 49 slips over the locking pawl carrier tube 42 and comes to rest on the shoulder 43 when engaged in the drilling position. The lower elevator cage 49 is secured to work slidably on the locking pawl carrier tube 42 by the travel limiting pin 46. The length of the opposed slots 44 through the lower elevator cage 49 govern the axial movement of the lower elevator cage 49 over the locking pawl carrier tube 42. A retaining bushing 45 is provided to fit over the travel limiting pin 46, a hole transversely through the center of the retaining bushing 45 and a hole transversely through the center of the travel limiting pin 46 accomodate a cotter pin 47 to secure the travel limiting pin 46 in position. A transverse access hole 49*a* through the lower elevator cage 49 and a transverse access hole 48 through the locking pawl carrier tube 42 provide a passage for installing the cotter pin 47.

The locking pawl 56 is mounted on a transverse pivot pin 52 through the locking pawl carrier tube 42. The transverse pivot pin 52 is secured in the transverse holes through the locking pawl carrier tube 42 by the inside diameter of the lower elevator cage 49 as shown in FIGURE 3. The locking pawl support 50 relieves some of the load placed on the pivot pin 52 at the point 51.

In order that the inner barrel may be urged downwardly over the core as the bit and the following outer barrel and drill string penetrate the formation the inner barrel is united with the outer barrel 3*c* by the outward engagement of the locking pawl 56 through the window 55 in the locking pawl carrier tube 42 and through the window 61 through the lower elevator cage 49 against the major inside diameter 60 of the outer barrel 3*c* as shown in FIGURE 2 of the drawings. The inner barrel is forced downwardly by the coupling bushing 2 at the contact point 62. A compression spring 59 interposed between the inside diameter 42*a* of the locking pawl carrier tube 42 and the recess 57 in the locking pawl 56 on a spring guide 58 in the locking pawl carrier tube 42 urges the locking pawl 56 outwardly in engagement with the outer barrel 3*c* and the coupling bushing 2 at the contact point 62.

The upper elevator cage 70 is threadedly attached to the lower elevator cage 49 by the threads 70*a* to permit easy replacement of the elevating shoulder 77*a*.

The core laden inner barrel is lifted out of the drill string by the elevator 73. The elevator 73 is a part of this invention.

The inner barrel is freed so that it may be lifted out of the drill string when the locking pawl 56 is disengaged by upward movement of the release pin 53 which is positioned in and attached to the lower elevator cage 49 as shown in FIGURE 3 of the drawings. The release pin 53 is allowed to move upwardly in the locking pawl carrier tube 42 by the slots 54*a*, when the release pin 53 moves along upwardly in the angular slot 54, in the locking pawl 56, the inclined plane therein will disengage the locking pawl 56 and thereby allow movement of the inner barrel slidably out of the drill string.

When the drilling holes in an upward direction the locking pawl 56 is held in position by the action of the tension springs 66, one end of the springs are anchored in the holes 65 to a transverse bar 63 in the locking pawl carrier tube 42 while the opposite spring ends are anchored in the holes 67 to a transverse bar 68 in the lower elevator cage 49. The action of the tension springs 66 urges the lower elevator 49, the release pin 53 and the locking pawl 56 to remain in the engaged drilling position regardless of the angular direction of the hole being drilled.

For drilling in a downward direction the springs 66 are unnecessary and are therefore removed.

Access to the springs 66 is gained through the window 69 in the lower elevator cage 49.

The tools provided as part of this invention for lifting the inner barrel out of the drill string and for lowering the inner barrel into a "dry" drill string are herein called the elevator 73 and the dry hole release 93 as shown in FIGURES 5 and 6. The lower section of the elevator 73 is shown in a longitudinal sectional view in FIGURE 2 of the drawings, herein the elevator 73 is shown in the engaged position for lifting the inner barrel assembly out of the drill string. The elevator 73 is united with the inner barrel after the elevator body 73*a* enters the hollow centered upper elevator cage 70. Downward travel of the elevator 73 is stopped when the stop shoulder 80 on the elevator body 73*a* meets the top of the upper elevator cage 70, at this time a pair of lifting pawls 78, independently pivoted in the elevator body 73*a*, are expanded outwardly under the lifting shoulder 77*a* by the action of the compression spring 75 thereby engaging the hooks 77 to the lifting shoulder 77*a*. The compression spring 75 is retained in position by the recesses 76 in the lifting pawls 78.

The lifting pawls 78 are forced inwardly into the slot 85 in the elevator body 73*a* to permit the elevator 73 to enter the upper elevator cage 70 by the tapered aperture 80*a* in the upper elevator cage 70 and the action of the tapers 74 on the lifting pawls 78. The lifting pawls pivot on the pivot pins 79 which are installed through the holes provided in the elevator body 73*a*.

The elevator 73 is disconnected from the inner barrel by inserting a screwdriver into the access hole 81 in the elevator body 73*a* and between the notches 82 in the lifting pawls 78 and thereby forcing the upper ends of the pawls outwardly and pivoting the lower ends of the pawls 78 and the hooks 77 inwardly away from the lifting shoulder 77*a* to release the upper elevator cage.

A utility hole 72 in the lower portion of the elevator body 73*a* is optional and may be used for attaching various lifting lines, chokers or hooks.

The wire line or cable by which the elevator and inner barrel are lifted out of the drill string is attached to the elevator assembly by the cable socket 92; the cable socket 92 is connected to a tube 91 and the aforementioned parts are joined with the upper shank 87 of the elevator by a reversible rod 90 having threaded ends 88*a* to which are attached the nuts 88 which secure the rod slideably through the couplings 89. The rod 90 may be sweat soldered to the coupling 89 at the point 89*a*. Optionally, the cable socket 92 may be attached directly to the elevator body at the shank 87, thereby omitting the intermediate parts 88–89–90–91.

The elevator body 73*a* is grooved 86 to form a bore 84 therethrough to relieve the pressure through hole 87*a* in the shank of the elevator body 73*a* built up while the elevator is lowered into the drilling fluid in the drill string.

To lower the inner barrel into a drill string that is without drilling fluid the elevator 73 is removed from the coupling 89 in order to attach the dry hole release 93 to the coupling 89. The dry hole release 93, having a bore 94 therethrough, is then attached to the locking pawl carrier tube 42 by straddling the forks 96 over the spring mounting bar 68 in the lower elevator cage 49 and straddling the slot 95 between the forks 96 over the spring mounting bar 63 in the locking pawl carrier tube 42 until the hole 97 in the forks 96 is in alignment with hole 64 in the spring mounting bar 63, the grooved shear pin 98 is then inserted into the aligned holes through the access window 69, thereby making the inner barrel ready for safe lowering into the "dry" drill string. The inner barrel is positively attached to the wire line and therefore, can not be purposely or inadvertently released until the inner barrel is lowered to the bit and the locking pawl 56 is united with the outer barrel 3*c* at the contact point 62 of FIGURE 2.

The inner barrel is disconnected by an upward force on the dry hole release great enough to shear the pin 98 at the grooves 98*a*. The depth of the grooves 98*a* determine the amount of upward force necessary to shear the pin 98. After the pin 98 is sheared the dry hole release 93 may then be lifted out of the drill string and drilling may commence.

The arrows 18 generally indicate the hollow center of the entire inner barrel assembly so that drilling fluid will be displaced through the entire inner barrel as the inner barrel is transmitted toward the bit through the drill string.

As many apparently widely different embodiments of this invention may be made without departing from the spirit and scope thereof, it is to be understood that I do not limit myself to the specific embodiments herein.

What I claim is:

1. A wire line core barrel apparatus for use in a rotary drill string comprising

an outer barrel consisting of sections fluted on the outside and having major and minor inside diameters, of coupling bushings connecting said sections, the bushings being less in diameter than the sections, and of an outer barrel head for connection to a drill rod;

a bit connected to the lower end of said outer barrel, said bit being an annular core bit when cores are to be obtained;

an inner barrel including fistular sections and fistular couplings and containing elements permitting axial passage of drill fluid, the inner barrel being slideably contained in said outer barrel;

a core lifter in a case connected as the lower end of said inner barrel;

a section of said inner barrel for receiving cores, directly above said core lifter case, said section comprising at least one hollow tube longitudinally split into two semi-cylinders, said semi-cylinders being accurately machined at the edges to form a cylinder in drilling use;

means permitting changing the length of said core receiving section by changing the number of hollow tubes composing it;

means permitting changing the length of said outer barrel adjacent to said core receiving section by changing the number of sections;

a coupling section in said inner barrel above said core receiving section;

a hollow journal spindle shaft above said coupling section;

a sealing system interposed between said hollow journal spindle shaft and said coupling section;

a journal box and bushing surrounding the lower part of said hollow journal spindle shaft and inside said outer barrel;

a pin connecting said bushing to said hollow journal spindle shaft at its lower end;

a hanger bearing surrounding the lower part of said hollow journal spindle shaft between said pin and said journal box and bushing;

thrust bearings surrounding said hollow journal spindle shaft above said journal box and bushing, whereby said core receiving section remains non-rotating while drilling is in progress;

a resilient shut off valve assembly surrounding said hollow journal spindle shaft above said thrust bearings whereby longitudinal compression of the shut off valve assembly by upward pressure of a full inner barrel causes transverse expansion of the valve assembly, shutting off flow of drilling fluid between outer and inner barrels as a signal to the operator;

a valving mechanism comprising a ball valve, retaining pin and body, whereby flow of drilling fluid through all axial passages toward the bit is stopped during drilling in any direction and while hoisting the inner barrel, yet permitting relief of pressure in the core receiving section;

locking adjusting thread means adjustably connecting said valving mechanism body to the upper end of said hollow journal spindle shaft, whereby the length is adjustable;

a pawl carrier tube incorporating as an integral part at its lower end said valving mechanism body;

an elevator assembly comprising an elevator, a lower elevator cage and an upper elevator cage threaded thereto, said lower elevator cage surrounding and resting on a shoulder of said pawl carrier tube,

locking pawl means in said lower elevator cage and gimballed in said pawl carrier tube comprising a locking pawl, a spring urging said locking pawl radially outward, the major inside diameter of an outer barrel section and the end of a coupling bushing of the outer barrel forming a shoulder detent, whereby said inner barrel and outer barrel are operatively united by said locking pawl;

a transverse pin extending through an oblique slot in said pawl and a longitudinal slot in said pawl carrier tube, whereby upward motion of the elevator assembly releases the pawl;

spring means resiliently connecting said lower elevator cage to said pawl carrier tube; and

a dry hole release for use in place of said elevator when the hole is dry.

2. A wire line core barrel apparatus in accordance with claim 1 in which said outer barrel connecting bushings have generally longitudinal alternate grooves and splines in the outer surfaces thereof, and in which the inside

diameters of the bushings are less than the inside diameters of the outer barrels sections.

3. A wire line core barrel apparatus in accordance with claim 1 in which all parts thereof are hardened at least on the surfaces whereby wear is minimized.

4. A wire line core barrel apparatus in accordance with claim 1 in which all parts thereof are made of substantially non-magnetic material.

5. A wire line core barrel apparatus in accordance with claim 1 in which said dry hole release comprises a grooved shear pin, whereby said lowering means is capable of controlling the transmission of said inner barrel downward to the drilling position, then shearing the grooved pin by an upward cable jerk, then hoisting the dry hole release.

6. A wire line core barrel apparatus in accordance with claim 1 in which said elevator comprises

two jaws embracing a slot;

a pair of pivoted lifting pawls in said slot;

hooks on said pawls;

shoulders on said upper elevator cage mating with the hooks;

a spring urging said lifting pawls apart to mate pawls and cage whereby said elevator and inner barrel assembly are locked together for lifting out of the drill string;

an access hole in said upper elevator body for releasing said lifting pawls; and

means on the upper end of said elevator for attaching a wire line.

7. A wire line core barrel apparatus in accordance with claim 1 in which said outer barrel sections, coupling and coupling bushings, outer barrel head, inner barrel sections and couplings, core receiving sections, pawl carrier tube, upper and lower elevator cages, hollow journal spindle shaft, valving mechanism and all other parts inside the inner barrel are fistular.

8. A wire line core barrel apparatus in accordance with claim 1 in which said spring means resiliently connecting said lower elevator cage to said pawl carrier tube are interposed between two spring mounting bars, whereby said tube and cage are operatively held in the drilling position in drilling in any direction.

9. A wire line core barrel apparatus in accordance with claim 1 in which said resilient shut off valve assembly comprises

a body of resilient material having embedded therein and bonded thereto a relaxing aid; and

a compression limiting means axially slideable on said hollow journal spindle shaft and bonded to said body of resilient material.

10. A wire line core barrel apparatus in accordance with claim 1 in which said locking pawl means contains an elongated oblique slot, said pawl being disengaged by a transversely operatively mounted pin through said oblique slot said pawl carrier tube and said lower elevator cage, said oblique slot having a side constituting an inclined plane to effect the disengagement of the locking pawl, the oblique slot limiting the axial movement of the lower elevator cage over the pawl carrier tube.

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