

Sept. 17, 1963

A. E. HARPER

3,103,981

WIRE LINE CORE BARREL

Original Filed May 13, 1957

5 Sheets-Sheet 1

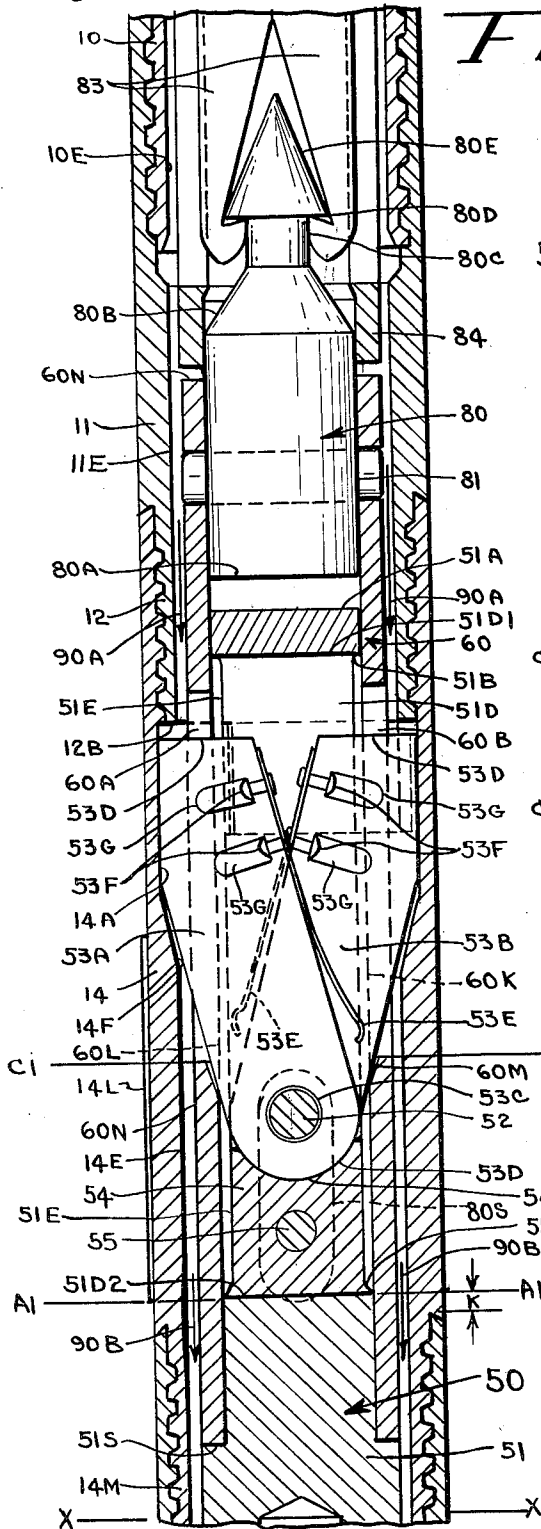


FIG. 1

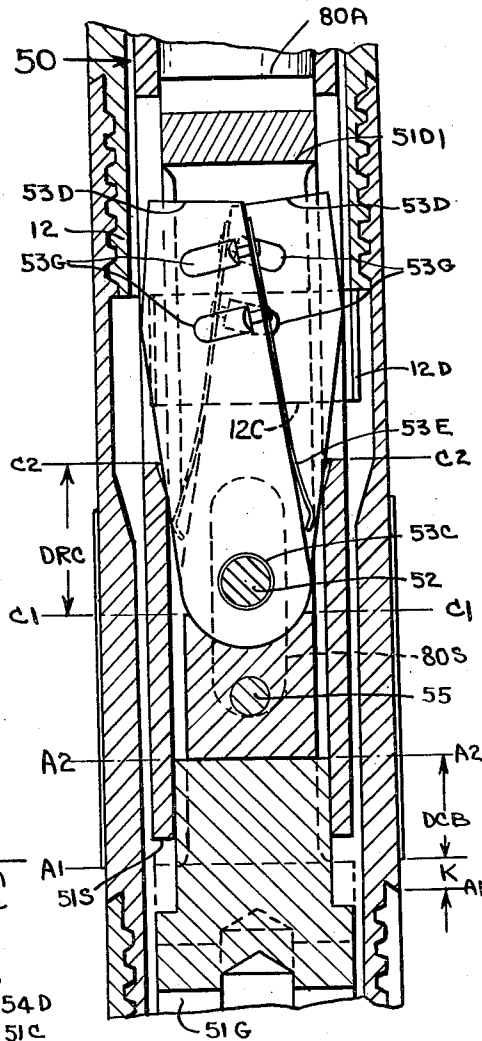


FIG. 4

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5 Sheets-Sheet 2

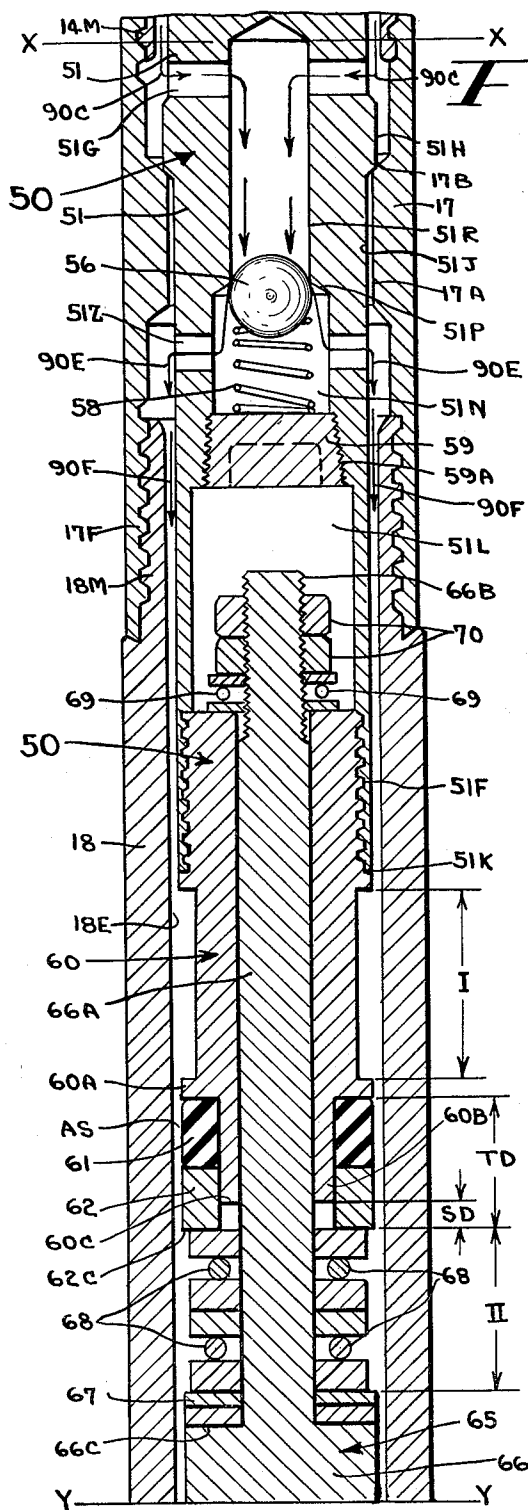


FIG. 2

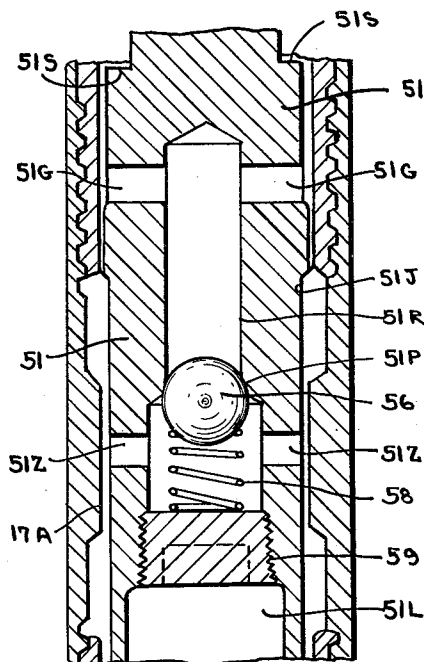


FIG. 5

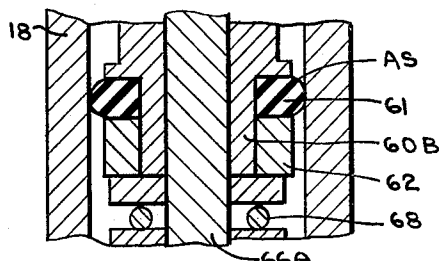


FIG. 6

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FIG. 3

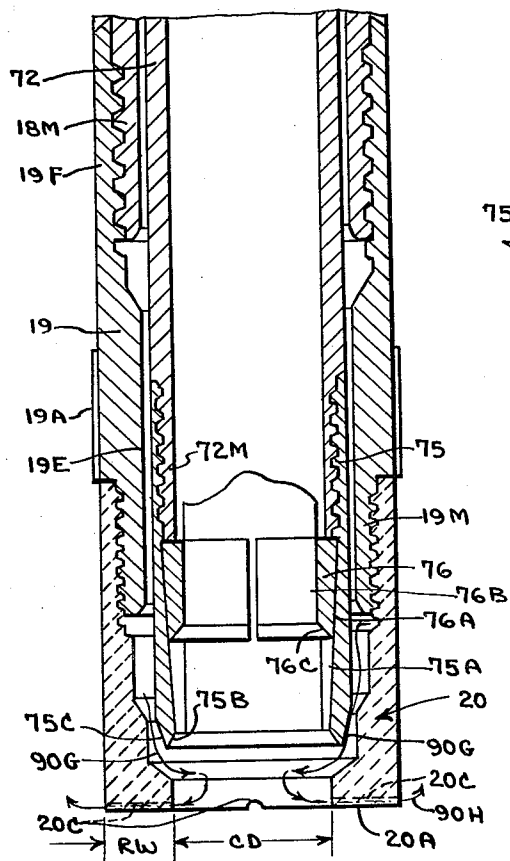
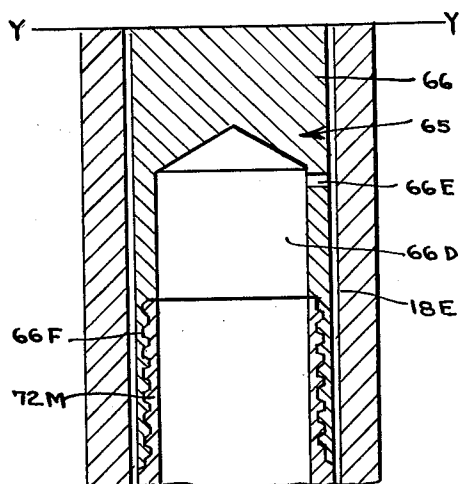
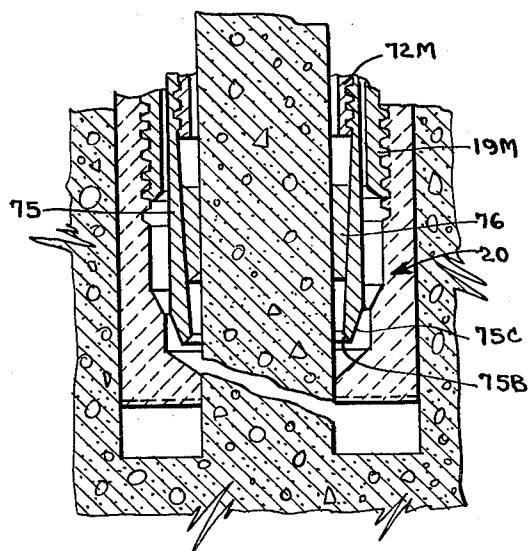


FIG. 7



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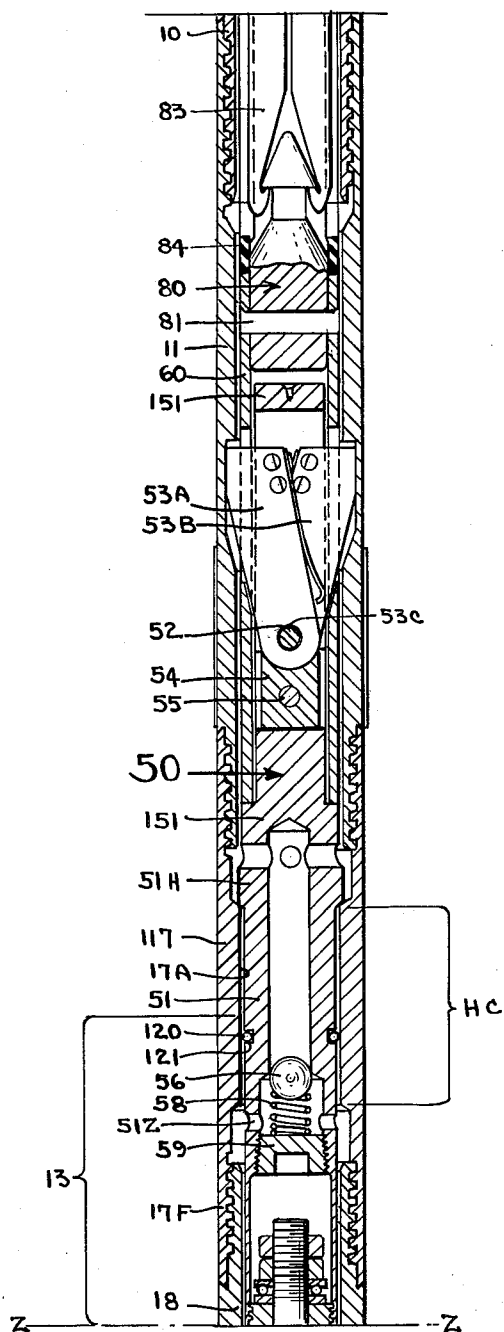


FIG. 8

FIG. 10

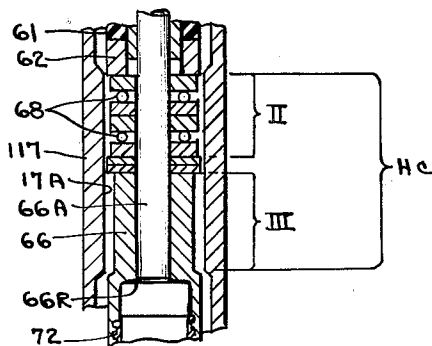
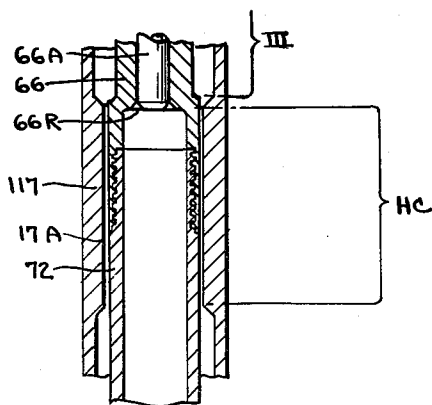


FIG. 11

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WIRE LINE CORE BARREL

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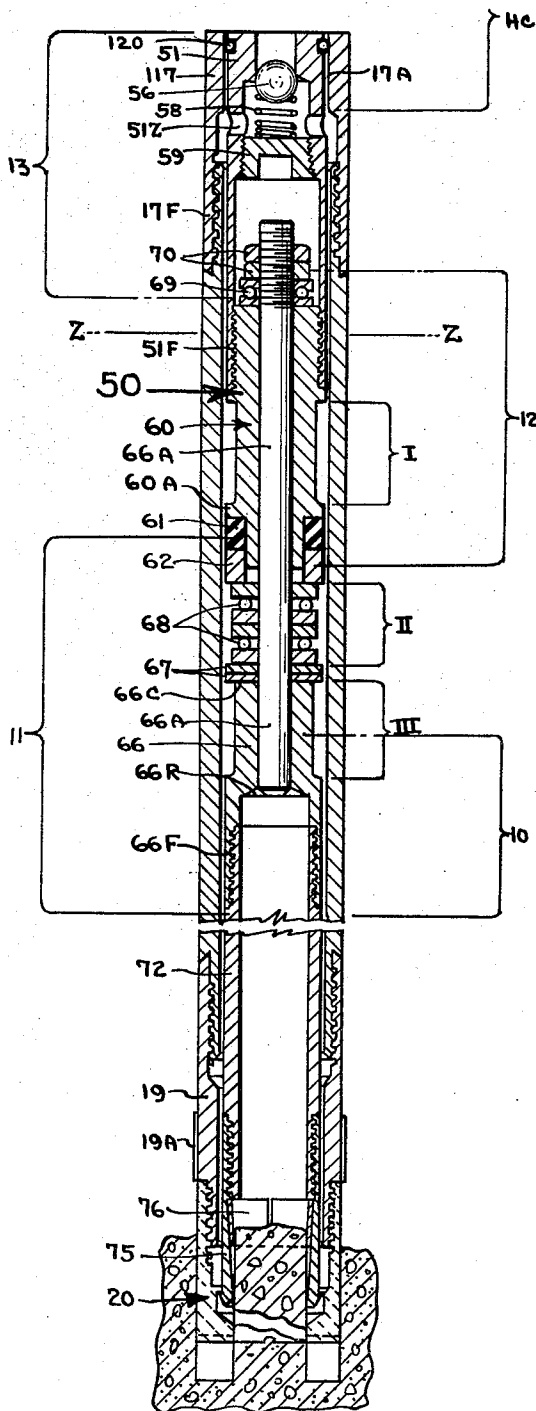


FIG. 9

FIG. 12

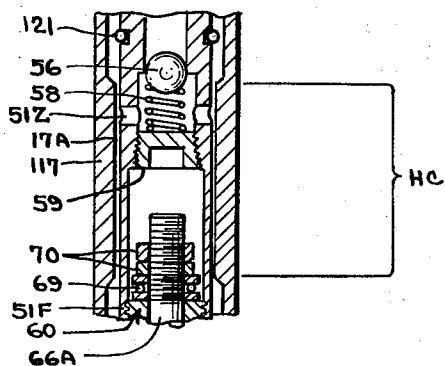
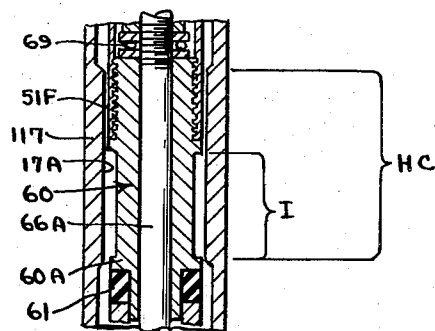


FIG. 13

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3,103,981

WIRE LINE CORE BARREL

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Continuation of application Ser. No. 657,001, May 13, 1957. This application June 8, 1961, Ser. No. 116,920
21 Claims. (Cl. 175-236)

This invention relates to the art of deep core drilling in deep formations and to improvements in apparatus for so doing. While the invention is of particular usefulness in exploratory drilling in which smaller sizes of holes are made and cores are taken, it is also useful in production drilling, involving large size holes.

More particularly, this invention relates to bits for drilling cores and detachable retractable core barrels and means for withdrawing the core barrel from the core drill without the necessity for withdrawing the complete drill stem and bit from the hole. These devices are commonly known as wire line core drills and wire line core barrels, since the core barrel is removed from the drill stem by use of a wire line carrying a grappling tool (called an "overshot") at its lower end.

This invention relates to and forms an improvement of the inventions covered by applications Ser. No. 374,204, filed August 14, 1953, now Patent 2,829,868 and Ser. No. 440,942, filed July 2, 1954, now Patent 2,857,138 which are incorporated herein by reference.

It is an object of this invention to provide improved wire line core barrel equipment which is capable of giving service fully equal to that provided by equipment previously available as exemplified by that shown in the aforementioned applications but which may be manufactured at lower cost.

It is another object of the invention to provide wire line core barrel equipment composed of rugged parts which may be made at lowered costs from stock materials without extensive machining.

Other objects 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 indicative, however, of 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:

FIGURES 1, 2 and 3, when arranged one above the other with the centerlines aligned and with FIGURE 1 at the top, FIGURE 2 in the middle and FIGURE 3 at the bottom, form a composite longitudinal section through the core barrel assembly. Some portions of these figures are shown in elevation. The meeting line between FIGURES 1 (at the top) and FIGURE 2 (next below) is at the line X—X. Similarly the meeting line between FIGURE 2 and FIGURE 3 (at the bottom) is at line Y—Y.

FIGURE 4 corresponds generally to a fragment of FIGURE 1 and shows the parts positioned as when the core barrel inner sleeve assembly is unlatched and is being withdrawn.

FIGURE 5 is a fragmentary longitudinal sectional view of a portion of FIGURE 2 and illustrates the position of the parts before the core barrel inner sleeve has seated, during which period a valving function of the device operates as a signal, to indicate incomplete seating and when seating is accomplished.

FIGURE 6 is a fragmentary longitudinal section of a

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portion of FIGURE 2 indicating another valving function which produces a signal to show when the core barrel inner sleeve is held against downward movement while drilling continues as when a full sample of core (or jamming of the core in the core barrel inner tube occurs).

FIGURE 7 is a fragmentary longitudinal sectional view through the bit end which is a part of FIGURE 3 and shows the action of the core lifter outer ring and core lifter as occurs when a core has been broken off prior to removal by retraction of the core barrel inner sleeve mechanism.

FIGURES 8-13 illustrate a modified form of the invention. FIGURES 8 and 9 should be arranged with FIGURE 8 above FIGURE 9 and with the line Z—Z of these figures brought together. Thus arranged FIGURES 8 and 9 are a composite longitudinal view partly in section through the modified form of the invention. FIGURES 10-13 are fragmentary longitudinal views partly in section showing the action of the mechanism during lowering or withdrawal of the core barrel inner tube assembly.

It will be understood that with FIGURES 1, 2 and 3 arranged one above the other with FIGURE 1 at the top and FIGURE 3 at the bottom as stated that the FIGURE 1 is highest and that the bit at the bottom of FIGURE 3 is lowest. Wire line core barrels are best adapted for operations where the drilling direction is generally downward, but it is not necessary to be exactly vertical. Relatively wide divergence from vertical can be accepted so long as progress is downward.

Referring to the drawings in core drilling there is provided a hollow drill tube which is made up of pipe having modified Acme female threads at each end. The pipe sections are joined by couplings having opposite ends provided with male threads upon which the pipes are screwed. The assembly of drill tube is sometimes called "drill rod," "drill string," or "drill stem." In FIGURE 1 the last male coupling at the lowermost end of drill string is shown at 10 and to it is attached the device of FIGURES 1, 2 and 3, which collectively is called a "core barrel." The bit 20 is at the bottom end of the core barrel and drills into the earth formation which is to be sampled by coring.

To coupling 10 is attached a sleeve 11 terminating at male threaded end 12, and to this is attached a wear coupling 14 having hardened lands 14L thereon. The coupling 14 also terminates at male threaded end 14M (see lower end of FIGURE 1 and upper end of FIGURE 2). The end 12B of sleeve 11 forms a seat inside the surface 14A of the wear coupling against which the latch dogs seat and restrain the core barrel inner tube assembly 50 from upward movement. Also the end 12B has a projection flange 12C which extends as a partial cylindrical surface around and from surface 12B for about 125-130° more or less. The side faces 12D of this flange 12C bear against the faces of the latch dogs and hence cause them (and everything propelled thereby) to rotate with drill string. The shell of coupling 14 has the same inside diameter at surface 14E as does the coupling 11 at 11E and the drill string coupling at 10E. The surface 14A is larger in radius and portion 14F is conical inside, following generally the slant of the outer surfaces of the latch dogs when they are extended.

A hanger and valve coupling 17 (FIGURE 2) is threaded onto the end 14M of the wear coupling 14. Hanger coupling 17 has a minimum diameter at 17A and a conical seat at 17B. The thickened wall at 17A and seat 17B have a twofold function in that 17B serves as an internal suspension flange upon which the core barrel inner tube assembly generally designated 50 hangs suspended. The surfaces 17A-17B also serve as valving surfaces. The hanger coupling 17 terminates at female threads 17F and onto these is screwed the male threaded

end 18M of the core barrel outer tube 18, which is a long tube and has identical male threads at 18M and 18M' (see FIGURE 3). This is done to permit the core barrel outer tube 18 to be reversed end-for-end to distribute wear. The inner diameter at 18E is slightly larger than at 17A.

To the lower end of the core barrel outer sleeve there is screwed on the reaming shell 19 having female threads 19F at the upper end, and hard material such as diamonds or bort at 19A. This reaming shell has fine male threads 19M at the lower end upon which a standard bit 20 is screwed.

The bit face 20A is annular and can be of any desired configuration such as a step bit, round nose, or flat, as shown. The bit face is set with diamonds, bort or other hard material. Usually, one or more "water channels" 20C extend radially across the bit face and the flow of drilling fluid (whether water, air, drilling mud or other fluid) is radially outwardly across the bit face. The radial width RW of the bit face is such as to produce a core diameter CD which will suitably enter the core collector tube of the core barrel inner tube assembly.

The entire core barrel inner tube assembly 50 is made so that it can be pulled upwardly through the drill stem, by means of a grapple or "overshot" on a wire line, to empty the core. The core barrel inner tube assembly 50 is then simply dropped back down the hole in the drill stem, its velocity being sufficiently restrained by the drilling fluid, when the fluid is water or liquid.

The rate of free fall of the core barrel inner tube assembly 50 is determined by the clearance between the inner diameter of the drill string and the outer diameter of flange 51H. The fluid cannot flow up through fluid passage 51Z, 51R, 51G because of the check valve 51P—56, and the velocity of the downwardly falling assembly 50 is accordingly restrained by the resistance to fluid flow generated by the proximal surfaces 51H and the inside of the drill string. Of course, when the assembly 50 has seated and latched in place, drilling fluid can flow freely through passage 51G, 51R, 51Z for the check valve 51P—56 then opens.

Referring to FIGURE 2, the hanger coupling 17 having the conical surface 17B forms the sole support by which the core barrel inner tube assembly 50 is suspended. This occurs as follows: Referring to FIGURES 1 and 2, the main suspension fitting, also referred to as a rod, 51 is machined from bar stock. Its upper end is at 51A, FIGURE 1 where the end has a diameter such that it fits with a sliding fit in the inner diameter of the dog retractor sleeve 60. Then, down a little, the diameter is reduced at 51E which reaches from the fillet 51B to fillet 51G. This reduced diameter portion is milled out straight through at slot 51D which reaches from line 51D1 to 51D2. A through pin 52 is set through the slot in fitting 51 and is riveted tight but does not extend out beyond the diameter 51E. Pin 52 serves as pivot locator for two dogs 53A and 53B which are side by side. The hole 53C in the dogs at pin 52 is a little larger than the pin. Each of the dogs is machined off with smooth bottom radii at 53D and under both dogs is a support block 54 which has a matching radius 54D. When the bottom radii 53D of the dogs rest on block 54 the pin 52 has slight clearance all around in hole 53C. Block 54 is held in place by rivet 55 which extends outwardly through slots 80S to approximately the outer diameter of tube 60.

Immediately above line X—X on FIGURE 1 the diameter of fitting 51 increases at shoulder 51S and down a little farther there is a cross bore water inlet hole 51G, below which the diameter increases again at suspension flange 51H. The underside of flange 51H is bevelled to fit the slope 17B of the suspension coupling 17 and below flange 51H the diameter is reduced at 51J to allow a little clearance inside the bore 17A and this diameter is carried on down to the lower end 51K. The suspension element 51 is bored out at 51L and is internally

threaded at 51F. At the upper part of the bore 51L, the hole continues to form a valve chamber 51N which has a seat at 51P and continues at reduced diameter 51R to intersect the crossbore 51G. A ball check valve 56 is held against seat 51P by spring 58 which bottoms on a pipe plug 59 screwed in at threads 59A.

Into the threads 51F there is threaded a bearing tube 63 having a flange 63A and a reduced end portion 63B. A rubber collar 61 is seated on the flange and below it is a metal collar 62. The diameter of metal collar 62 and the (relaxed) diameter of rubber collar 61 is the same as the diameter of flange 63A which, in turn equal the outer diameter of the main suspension fitting 51 at 51J (i.e. below suspension flange 51H).

The axial dimension TD of the rubber and metal collars, when the rubber collar is not loaded axially, is such that the bottom face 62C of the metal collar will be spaced below the lower end 63C of the bearing tube by a prescribed compression distance SD. The collar 62 is slidable upwardly on end 63B and when it is pushed upwardly to the FIGURE 6 position the rubber collar 61 will be axially compressed and radially expanded until it reaches the inner wall 18E of the core barrel outer tube thus pinching off (valving) the annular space AS. This occurs due to the upward push of the core barrel inner tube when it is full of core or when the core jams and holds it. The described valving operation of rubber washer 61 serves to increase water pressure at the surface and this serves as an indication of the conditions in the core barrel inner tube.

The core barrel inner tube assembly generally designated 65 (FIGURES 2 and 3) is constructed as follows: At the upper end is a bearing element 66 having an upwardly extending end shaft 66A which has a size such that it journals freely in bearing tube 63. Upon shoulder 66C are placed two or more wear washers 67 and two or more thrust bearing assemblies 68, the upper such bearing resting against the under side 62C of collar 62. Then, the upper end of shaft 66A is threaded at 66B and a smaller thrust bearing assembly 69 is placed and held under nut and lock nut 70. The bearings 68 and 69 are preferably of the self contained pre-assembled type in which the balls and races cannot separate if the load is removed. As illustrated they are of the open type but this is for ease of illustration.

The bearing element 66 is bored out at 66D (FIGURE 3) and female threaded at 66F to receive the upper end of the core barrel inner tube 72, and the latter being threaded identically with male threads 72M—72M at the top and bottom ends. This is done to permit the tube 72 to be reversed end-for-end to distribute wear. The bearing element has a relief port at 66E.

On the lower threads 72M is screwed a core lifter outer tube 75, shaped as shown. It has a tapered inner wall 75A, and the lower mouth is belled at 75B to assist entrance of core. The outer surface 75C is thinned to give good water clearance. Inside 75 is a core lifter ring 76 which has an outside tapered surface 76A fitting the inside taper 75A of the core lifter outer tube, a cylindrical inner surface 76B belled at 76C so as to facilitate core entrance and split axially at 76D. The lifter ring normally resiliently drags on the core and is held against the lower edge of the core barrel inner tube 72 as the latter progresses downwardly coincidental to drilling.

The core barrel inner tube assembly 50 is thus suspended, but if the core lodges in or fills the tube 72 the whole assembly tends to be lifted off the suspension seat provided by 17B and 51H, or stated another way, the entire assembly 50 stops progressing downwardly but the bit 20 continues to drill on. This tends to "lift" the entire assembly 50 relative to the downwardly progressing drill string 10, the core barrel outer tube and all parts carried thereby. The latch dogs 53A and B (FIGURE 1) are provided to prevent this relative upward motion of the assembly 50. The upper edges of the dogs rise into

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engagement with surface 12B of coupling 11 and their lower radii 53D bottom on the block 54, which in turn rests on the suspension fitting 51. Latch dogs 53A and B are spring biased outwardly by springs 53E which are attached (one to each dog) by rivets 53F that are placed through apertures 53G in the dogs. Hence, once latched, the downward progression of the bit 20 and drill string will gradually apply more and more pressure through dogs 53A and 53B to block 54, thence to fitting 51 and through it to bearing tube 63, thence through rubber collar 61 and steel washer 62 and through bearings 67—68 to the core barrel inner tube assembly 65, 72. If drilling is continued and the core does not disintegrate the entire weight of the drill string would soon transfer to the core and the bit would spin idly.

But the driller is provided with a signal, for as weight is transferred as aforesaid, the rubber collar 61 is compressed from the position of FIGURE 2 to the condition of FIGURE 6, thus pinching off annular space AS, and the pressure at the pump supplying drilling fluid is raised. The driller then knows it is time to withdraw the core barrel inner tube. To do this, the driller first stops the drill rotation and then pulls (upwardly) slowly on the drill string. The core lifter ring 76 resiliently "hangs" to the core and as the drill string is pulled up the whole inner tube assembly 50 stands still until collar 51H engages 17B, and the rubber collar 61 meanwhile returns to the FIGURE 2 condition. Then as the drill string is pulled up farther the core lifter outer tube 75 moves upwardly relative to the split core lifter ring 76 which stays with the core, and soon the matching tapered surfaces 75A and 76A engage and cause the ring 76 to contract to some position such as FIGURE 7. Then the pull of the drill string is on the core below ring 76 and this breaks off the core. This action meanwhile permits release of pressure on the latch dogs 53A and 53B.

Now to get the core out, the entire mechanism 50 must be retracted and to do this, there is provided mechanism as follows: It will be noted the suspension fitting 51 has a certain portion at its upper end (between lines 51A and 51D1) which is of the same diameter as that portion above the shoulder 51S (FIGURE 1). Between lines 51D1 and 51D2 this suspension element is necked down to diameter 51E. Around element 51 is sleeved a tube generally designated 60 of uniform internal and external diameter throughout its length. The bottom end of this tube 60 normally seats on the shoulder 51S and its upper end extends (in coupling 11, FIGURE 1) well above line 51A which is the upper end of the suspension fitting 51. In the upper end 60A of tube 60 there is positioned a plug 80 which extends down to line 80A, and is riveted to tube 60 by rivet 81. There is a clearance space between lines 51A and 80A. Plug 80 extends upwardly beyond the upper end 60N of the tube 60 and is then provided with a conical surface 80B which meets the neck 80C, the latter extending to the conical point 80D—80E. The point is adapted to be gripped by a grapple which, in the trade, is sometimes called an "overshot." The grapple has a self-contained centering collar 84 thereon which sleeves on to member 80 as shown in FIGURE 1, and even when the overshot and core barrel assembly are together as shown in FIGURE 1, they will not slip sideways when out of the drill string, which is an operational advantage, as many a core barrel inner tube has been dropped just as it began to emerge, at the surface, from the drill string.

When desiring to engage and withdraw the core barrel inner tube, the driller lowers the overshot 83—84 into the drill string 10. The pawls (or hooks or claws, of the overshot, however denominated) engage upon the spearpoint 80E—80D with collar 84 in centering alignment on 80. Then the driller is ready to pull core. The wire (not shown, by which 83—84 is suspended) is pulled and this pulls up on tubular sleeve 60. The latter has slots so situated to permit the dogs 53A and 53B to ex-

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tend. These slots are at 60A (for dog 53A) and 60B (for dog 53B). The slots are off-center from the diametrical plane of contact between adjacent faces of dogs to slip through. Hence slot 60A through which dog 53A actuates is off center and spring 53E (for dog 53A) bears against the inside of tube 60 at 60K. Similarly slot 60B through which dog 53B actuates is off center the opposite way and its spring 53E bears against the inside of tube 60 at 60L. Each slot (60A and 60B) has an internally bevelled lower end as at 60M and 60N, the bevels having an average slant corresponding to the edges of the dogs. What happens is this: When the driller drops the grapple 83—84 and latches it, he then pulls and tube 60 is pulled up. Bevels 60M and 60N engage the dogs (53A and 53B) and force them radially inwardly until their upper surfaces 53D no longer engage the lower edge 12B of coupling 11. Then the sleeve (tube 60) pulls up further as shown in FIGURE 4. The tube 60 cannot simply pull off member 51 because it has two elongated slots 80S in it, through which the rivet 55 extends. Hence as tube 60 pulls up slot 80S finally stops against the outwardly protruding ends of rivet 55 as shown in FIGURE 4, and from then on the grapple 83—84 lifts the entire core barrel inner assembly 50 right on up out of the drill string 10. As the grapple emerges the points 83—83 cannot slip sideways off of the spear 80D—80E because collar 84 holds them centered, and maladministration is avoided. The driller then empties the core (and when the drill string is full of water or drilling mud) simply drops the core barrel assembly 50 down the drill string. It will not drop too fast because water (or drilling mud) in the drill string is a velocity deterrent. The downward progress of the falling assembly 50 can be heard at the surface, click-click, click-click, as it passes the couplings 10 on the way down. The assembly 50 is supposed to seat at 17B—51H, but if it does not, this is known. The driller has (after inserting and dropping the assembly 50) meanwhile reconnected the "water swivel" and drilling fluid is pumped down through the drill string. Now ordinarily the path of the drilling fluid is via arrows 90A—90B (FIGURE 1), thence via arrows 90C—90D—90E (through ports 51G, 51R, valve 51P—56 and ports 51Z, FIGURE 2) thence down (via arrows 90F, FIGURE 2, and 90G, FIGURE 3) through the annular space between the core barrel inner and outer tubes, and thence (via arrows 90H, FIGURE 3) across the bit face and up around the core barrel and drill string to the surface. Now as the core barrel inner tube assembly 50 falls it reaches a position as shown in FIGURE 5 where the ports 51Z—51Z are substantially closed off by the surface 17A, which indicates that the assembly 50 has not yet settled to bring 51H onto surface 17B and dogs 53A and 53B have not snapped into latching position. When this occurs the pump pressure at the surface abruptly increases and the driller knows that assembly 50 has not latched in place. The driller will then correct the situation before proceeding.

The modified form of the invention shown in FIGURES 8—13 is constructed upon the same principles as the form shown in FIGURES 1—7, except for the particulars specified below, it being understood that in other respects the several forms of the invention are alike.

In this form of the invention the principal differences in construction are in that portion of the apparatus shown at the level of the bracket HC, namely in the hanger coupling which in FIGURES 1—7 is element 17 and in FIGURES 8—13 has been given the designation 117. In the form shown in FIGURES 1—7 the portion of this coupling having the minimum diameter 17A has a short axial dimension, but in the form shown in FIGURES 8—13 this portion has been lengthened to the extent shown by bracket HC. This dimension is selected so that it exceeds the axial length of all sections of reduced diameter (such as those shown opposite brackets I, II and III in

FIGURE 9) occurring on the core barrel inner tube assembly 50 below the level of the seating and valving flange 51H (see FIGURES 8 and 9). As a result a very reliable pressure signal will be given to the driller to advise him when the core barrel inner tube assembly 50 has seated itself and latches 53A and 53B have latched into locking position. This occurs as follows: The core barrel inner tube assembly 50, after being emptied of core at the surface, is assumed to be ready to be dropped down into the drill string. The driller simply drops it into the drill string (when water is the drilling fluid) or lowers it with the wire line and overshot as when the air is the drilling fluid. Assuming water as the drilling fluid, and this is by far the most common, the entire core barrel assembly 50 simply settles down through the drill string at a moderate velocity as determined by the resistance afforded by the water. The water swivel is meanwhile connected to the drill string and water pressure applied. As long as the core barrel inner tube assembly 50 is still falling the pressure will be low because the water, in being pumped down meets no undue resistance. The inner tube assembly 50 at this time simply moves along. Then, as the lower end of the inner tube assembly 50 (at core lifter outer tube 75) enters the reduced diameter section 17A of the coupling 117, the clearance for flow of water is abruptly reduced and the pump pressure builds up and the driller hence knows that at least the lower end of the assembly has reached the hanger coupling 117. From this point on, the assembly has no portion of reduced diameter below flange 51H, which has an axial length greater than the axial length HC of the portion 17C of the coupling 117. Consequently the water is essentially valved off and the water pressure remains high. This is true even when the reduced diameter sections I, II and III (see FIGURE 9) pass through the bore of coupling 117 because they are shorter axially than the bore 17C of coupling 117. The pressure does not drop until ports 51Z are exposed below bore 17C of coupling 117 for when that happens the water flow may then proceed through these ports with consequent reduction in water pressure. Ports 51Z are not clearly exposed until the latches 53A and 53B are brought to a position to move to latching condition and hence the driller knows that when the pressure drops the core barrel inner tube assembly 50 has seated and latched in place.

The form shown in FIGURES 8-13 includes an O-ring 120 provided in groove 121 in portion 51 of the assembly. The ring closes off the clearance between the surface of 51 and the bore 17C when the assembly is seated. This prevents blow-back of the drilling fluid in the event the drill hits a pocket of high pressure gas in the earth formation being penetrated. It has been found that when using the device shown in FIGURES 1-7 and where a high pressure gas pocket is breached the gas may reverse the flow of the cooling water by blowing back in a direction opposite to arrows 90G (see FIGURE 3). The valve 56 will, of course, close and the drilling fluid is then, in the modification shown in FIGURES 1-7, blown back in the clearance space between 17A and 51J because the flange 51H unseats a little from surface 17B even though still latched down. Hence the bit may be deprived of water before the driller can take corrective action. In the modification shown in FIGURES 8-13 such reverse flow is prevented. The driller will notice a sudden rise in pressure on the water pump at the surface, and even though actual water flow is stopped there will still be enough water at the bit to enable the driller to correct the procedure. Hence for drilling into formations which are suspected of containing gas pockets the modification of FIGURES 8-13 is preferred.

This application is a continuation of my application Ser. No. 657,001, filed May 13, 1957 which is a continuation-in-part of my application Ser. No. 592,235, filed June 15, 1956, both now abandoned.

It is apparent that many modifications and variations

of the invention as hereinbefore set forth may be made without departing from the spirit and scope thereof, the specific embodiments described are given by way of example only, and the invention is limited only by terms of the appended claims.

What I claim is:

1. In a rotary core barrel assembly to be connected to the lower end of a drill string, a tubular extension adapted to be attached to said lower end of the drill string, said tubular extension having a downwardly facing latch seat, said tubular extension having a bit on the lower end thereof, a core barrel inner tube assembly having a tubular core receiver in the lower end thereof, an upwardly extending fitting connected to said core receiver, said fitting being provided with latch means adapted to be movable into and out of engagement with said latch seat for holding the fitting against upward movement when the inner tube is positioned adjacent the bit, means mounting the latch means on the fitting to permit said latch means to have limited bodily movement relative to the fitting, a portion of the latch means engaging said seat, said latch means mounted in said fitting having a lower portion engageable with the fitting to transmit a downward force from the drill string to said fitting, and means connected to the fitting and moveable relative thereto whereby said latch means is unseated from said latch seat.

2. The apparatus of claim 1 further characterized in that the fitting has a slot formed therein and that the latch means includes a pivot, said slot and pivot being located so that the slot slides relative to the pivot.

3. The apparatus of claim 2 further characterized in that said latch means is loosely pivoted on said pivot and a bearing seat is provided in said fitting adjacent the latch against which the latch bears when the latch is seated.

4. The structure of claim 1 further characterized in that said means connected to the fitting and moveable relative thereto includes a sleeve having an elongated axially extending slot formed therein slidably mounted on said fitting and that a pin is mounted on said fitting to extend into said sleeve slot to slidably retain said sleeve on said fitting.

5. In a wire line core barrel assembly a tubular extension adapted to be attached to the lower end of a drill string, said extension having a bit on the lower end thereof and an inwardly extending ledge flange of substantial depth thereon, a core barrel inner tube assembly of a diameter such that it will slide down through the ledge flange, said assembly having a suspension flange located for engaging said ledge flange for suspending the core barrel inner tube thereon, a latch for holding said core barrel inner tube against upward movement when its suspension flange is on said ledge flange, the internal diameter of said extension and external diameter of said assembly being such that an annular fluid passage is provided between them which is closed by said ledge flange when the suspension flange is engaged thereon, said assembly being provided with a fluid channel therethrough extending from a position above the suspension flange thereof and terminating at a port which is located below said ledge flange when the assembly is suspended thereon, and a valve element in said fluid channel and movable relative thereto for interrupting flow of fluid through said channel.

6. The apparatus of claim 5 further characterized in that said fluid channel is shaped to include a valve seat against which the valve element is adapted to seat for valving action.

7. The apparatus of claim 6 further characterized in that spring means is provided on said assembly for biasing said valve element for movement in one direction.

8. The apparatus of claim 7 further characterized in that the spring means biases said valve element in a direction opposite to the direction of normal fluid flow through said channel.

9. In a wire line core barrel assembly a tubular exten-

sion adapted to be attached to the lower end of a drill string, said extension having a bit on the lower end thereof and an inwardly extending ledge flange of substantial depth thereon, a core barrel inner tube assembly of a diameter such that it will slide down through the ledge flange, said assembly having a suspension flange located for engaging said ledge flange for suspending the core barrel inner tube thereon, a latch for holding said core barrel inner tube against upward movement when its suspension flange is on said ledge flange, the internal diameter of said extension and external diameter of said assembly being such that an annular fluid passage is provided between them which is closed by said ledge flange when the suspension flange is seated thereon, said assembly being provided with a fluid channel therethrough extending from a position above the suspension flange thereof and terminating at a port which is located below said ledge flange when the assembly is suspended thereon and resilient sealing means around the assembly below the seating surfaces of said suspension flange for closing the clearance space between the ledge flange and the assembly.

10. In a wire line core barrel assembly, a tubular extension adapted to be attached to the lower end of a drill string, said extension having a bit on the lower end thereof and an inwardly extending ledge flange thereon, a core barrel inner tube assembly of a maximum transverse dimension such that it will slide down through the ledge flange, said assembly having a suspension flange extending outwardly therefrom for engaging said ledge flange for suspending the core barrel inner tube assembly thereon, the internal transverse dimension of said extension and the external transverse dimension of said assembly being such that a fluid passage is provided between them which is restricted by said ledge flange when said ledge flange is at the level of a portion of said assembly having said maximum dimension, a latch for holding said core barrel inner tube against upward movement when said suspension flange is on said ledge flange, said assembly being provided with a fluid channel therethrough extending from a position above the suspension flange and terminating at a port which is located below said ledge flange when the suspension flange is on said ledge flange, said ledge flange having an axial length greater than the axial length of said port and said ledge flange acting to restrict said channel when the port is at the level of said ledge flange.

11. In a wire line core barrel assembly, a tubular extension adapted to be attached to the lower end of a drill string, said extension having a bit on the lower end thereof and an inwardly extending ledge flange of substantial depth near the upper end thereof, a core barrel inner tube assembly of a diameter such that it will slide down through the ledge flange, said assembly having a suspension flange near its upper end for engaging said ledge flange for suspending the core barrel inner tube thereon, a latch for holding said core barrel inner tube against upward movement when its suspension flange is on said ledge flange, the internal diameter of said extension and external diameter of said assembly being such that an annular fluid passage is provided between them which is restricted by said ledge flange, said assembly being provided with a fluid channel therethrough extending from a position above the suspension flange thereof and terminating at a port which is located below said ledge flange when the assembly is suspended thereon, said ledge flange having an axial length greater than the axial length of said port and acting to restrict said passage when the port is at the level of said ledge flange.

12. The apparatus of claim 11 further characterized in that resilient means are provided around the circumference of the assembly between the suspension flange and said port for closing the clearance between the ledge flange and the assembly.

13. The apparatus of claim 11 further characterized in that said assembly includes a fitting having the sus-

pension flange thereon, a core barrel inner tube, and frame means for suspending the core barrel inner tube from said fitting to mount said inner tube for limited axial sliding movement and rotation relative to said fitting.

14. The apparatus of claim 13 further characterized in that a resilient collar is provided between the core barrel inner tube and said frame and positioned to be compressed axially and expanded radially for closing the annular fluid passage when so compressed.

15. In a rotary core drill comprising a tubular extension having an annular bit on the lower end thereof and adapted to be attached at its upper end to a tubular drill string of standard drill pipe terminating at a coupling, said extension having an outer diameter substantially equalling that of the drill string, the inner diameter of the extension including a portion approximately equal to the crest diameter of the threads on said coupling throughout a short vertical latch recess below the said coupling, the inner diameter of said extension then being decreased to form a short internal flange and then increased in diameter to said bit, a fitting having a suspension flange between the top and bottom thereof and a diameter such that said suspension flange will rest upon said short internal flange when the fitting is dropped axially into said tubular extension, bearing means extending downward from the fitting, a core barrel inner tube journaled in said bearing means for rotation and vertical sliding movement relative to said bearing means, said core barrel inner tube extending downwardly to adjacent said bit, a grapple element slidably attached for limited sliding movement on and relative to the top of said fitting, said grapple element including a tube slidable axially on the fitting and a grapple point fixed to and extending from the upper end of said tube, and detent dogs on the fitting positioned to engage the latch recess when the fitting suspension flange is seated on said internal flange, said tube being slotted to permit said dogs to extend outwardly therethrough in latching position, said fitting mounting said dogs for limited vertical movement, said dogs being positioned to be moved to releasing position when said grapple element is moved vertically upwardly.

16. In a rotary core drill comprising a tubular extension having an annular bit on the lower end thereof and adapted to be attached at its upper end to a tubular drill string of standard drill pipe terminating at a coupling, said extension having an outer diameter substantially equalling that of the drill string, the inner diameter of the extension including a portion approximately equal to the crest diameter of the threads on said coupling throughout a short vertical stage below the coupling, the inner diameter of said extension being decreased to a minimum diameter to form a short internal flange and then increased in diameter from said short flange to said bit, a fitting having a suspension flange between the top and bottom thereof and a diameter such that said suspension flange will rest upon said short vertical flange when the fitting is dropped axially into said tubular extension, bearing means extending downwardly from the fitting, a core barrel inner tube journaled in said bearing means, said core barrel inner tube extending downwardly to adjacent said bit and forming an annular clearance space for fluid flow between the outer wall thereof and the inner wall of said tubular extension, said core barrel inner tube being mounted for vertical sliding movement relative to said fitting, normally open valve means including resilient means positioned to be compressed axially when the core barrel inner tube is moved towards said fitting to close said valve means and restrict fluid flow in said clearance space, a grapple actuated element slidably attached for limited sliding movement on and relative to the top of said fitting and detents on the fitting positioned at the level of the short vertical stage to engage the tubular extension when the suspension flange is seated on said internal flange, said detents being positioned to be

movable to a releasing position when said grapple element is moved vertically upwardly.

17. In a wire line core barrel assembly a tubular extension adapted to be attached to the lower end of a drill string, said extension having a bit on the lower end thereof and an inwardly extending ledge flange of substantial depth near the upper end thereof, a core barrel inner tube assembly of a diameter such that it will slide down through the ledge flange, said assembly including a core barrel inner tube, a rod-like frame having a suspension flange and a latch mounted on said frame above said flange for holding said frame against upward movement when its suspension flange is on said ledge flange, said latch mounted to directly transmit a force from said latch to said extension, said frame including a sleeve vertically slidable through a limited range thereon which is apertured so that the latch can extend outwardly there-through, said sleeve being shaped to retract the latch to a nonlatching position when the sleeve is elevated relative to the frame, and a grapple engaging end being provided on the sleeve, the internal diameter of said extension and external diameter of said assembly being such that an annular fluid passage is provided between them which is restricted by said ledge flange, said assembly being provided with a fluid channel therethrough extending from a position above the suspension flange thereof and terminating at a port which is located below said ledge flange when the assembly is suspended thereon, said ledge flange acting to restrict said passage when the port is at the level of said ledge flange.

18. In a wire line core barrel assembly a tubular extension adapted to be attached to the lower end of the drill string, said extension having a bit on the lower end thereof and an inwardly extending ledge flange of substantial depth near the upper end thereof, a core barrel inner tube assembly of a diameter such that it will slide through the ledge flange, said assembly having a suspension flange near the upper end for engaging said ledge flange for suspending the core barrel inner tube thereon, a latch for holding said core barrel inner tube assembly against upward movement when the suspension flange is on said ledge flange, the internal diameter of said extension and external diameter of said assembly being such that an annular fluid passage is provided between them which is restricted by said ledge flange, said assembly being provided with a fluid channel therethrough extending from a position above the suspension flange thereof and terminating at a port which is located below said ledge flange when the assembly is suspended thereon, said ledge flange having a portion of minimum inside diameter which is sufficiently long in an axial direction that it will restrict fluid flow when any portion of the core barrel inner tube assembly below said suspension flange is at the level of the ledge flange prior to seating the suspension flange on the ledge flange, said ledge flange acting to restrict said passage when the port is at the level of said flange.

19. A core barrel comprising an outer tube having a coupling at one end and a coring bit at the opposite end, a core receiving inner tube having an outer diameter slightly less than the inner diameter of the outer tube, said inner tube being nested within the outer tube so as to provide a fluid passage clearance space between them, said inner tube extending from adjacent the bit to adjacent the coupling, mounting means at the coupling end of the outer tube for connecting the inner and outer tubes to mount the inner tube for limited axial movement relative to said outer tube, said mounting means in co-operation with the outer tube forming a fluid passage extending axially from above the mounting means to the

fluid passageway clearance space between said tubes, said mounting means including a housing, said core barrel inner tube having a shaft extending from the upper end thereof and fixedly secured thereto, said shaft being mounted in said housing for limited slidable axial movement relative to said housing, and a resilient fluid control member mounted between the core barrel inner tube and said housing in position to be axially compressed and expanded in girth when the inner tube is moved towards said housing for closing said fluid passage.

20. The core barrel as defined in claim 19 further characterized in that said resilient fluid control member comprises a washer of substantial thickness having a diameter slightly less than the inside diameter of said outer tube so as normally to provide clearance space for passage of the drilling fluid and positioned at the mounting means between the inner tube and said outer tube so as to be compressed axially and expanded in girth when the inner tube moves toward said mounting means to restrict said clearance space.

21. In a rotary core drill comprising a tubular extension having an annular bit on the lower end thereof and adapted to be attached at its upper end to a tubular drill string of standard drill pipe terminating at a coupling, said extension having an outer diameter substantially equalling that of the drill string, the inner diameter of the extension including a portion approximately equal to the inner diameter of said drill string throughout a vertical first stage below said coupling, a second vertical stage of said extension consisting of a portion having a greater inner diameter than that of said drill string, the inner diameter of said extension being decreased to a minimum diameter to form an internal flange extending throughout a short vertical third stage below said coupling, the inner diameter of said extension being increased throughout a vertical fourth stage below said third stage and extending to said bit, a fitting having a suspension flange between the top and bottom thereof and a diameter such that said suspension flange will rest upon said internal flange when the fitting is dropped axially into said tubular extension, said fitting having a fluid flow channel extending axially and which has an entrance port positioned to be above the internal flange of the extension and a delivery port at the surface of the fitting positioned to be immediately below said internal flange when the fitting is positioned with the suspension flange seated thereon, the internal flange having an inner diameter only slightly greater than the portion of said fitting at said delivery port for substantially restricting said channel until the fitting has fully seated with its suspended flange on said internal flange with the delivery port therebelow, bearing means extending downwardly from the fitting, a core barrel inner tube rotatably supported on said bearing means, said core barrel inner tube extending downwardly to adjacent said bit, a grapple element slidably attached for limiting sliding movement on and relative to the top of said fitting and detent means on the fitting positioned below the coupling to engage the extension when the fitting suspension flange is seated on said internal flange, said detent means being positioned to be moveable to a releasing position when said grapple element is moved vertically upwardly.

References Cited in the file of this patent

UNITED STATES PATENTS

2,381,845	Stokes	Aug. 7, 1945
2,532,716	Havlick	Dec. 5, 1950
2,555,580	Deely	June 5, 1951
2,829,868	Pickard et al.	Apr. 8, 1958
2,857,138	Svensen et al.	Oct. 21, 1958

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,103,981

September 17, 1963

Allyn E. Harper

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 3, line 52, for "51G" read -- 51C --; column 6, line 3, after "dogs" insert -- 53A and B and each one is just wide enough for its dog --; line 6, strike out -- ates is off center and spring 53E (for dog 53A) bears --; column 10, line 74, for "he" read -- the --; column 12, line 56, for "limiting" read -- limited --.

Signed and sealed this 31st day of March 1964.

(SEAL)

Attest:
ERNEST W. SWIDER

EDWARD J. BRENNER

Attesting Officer

Commissioner of Patents