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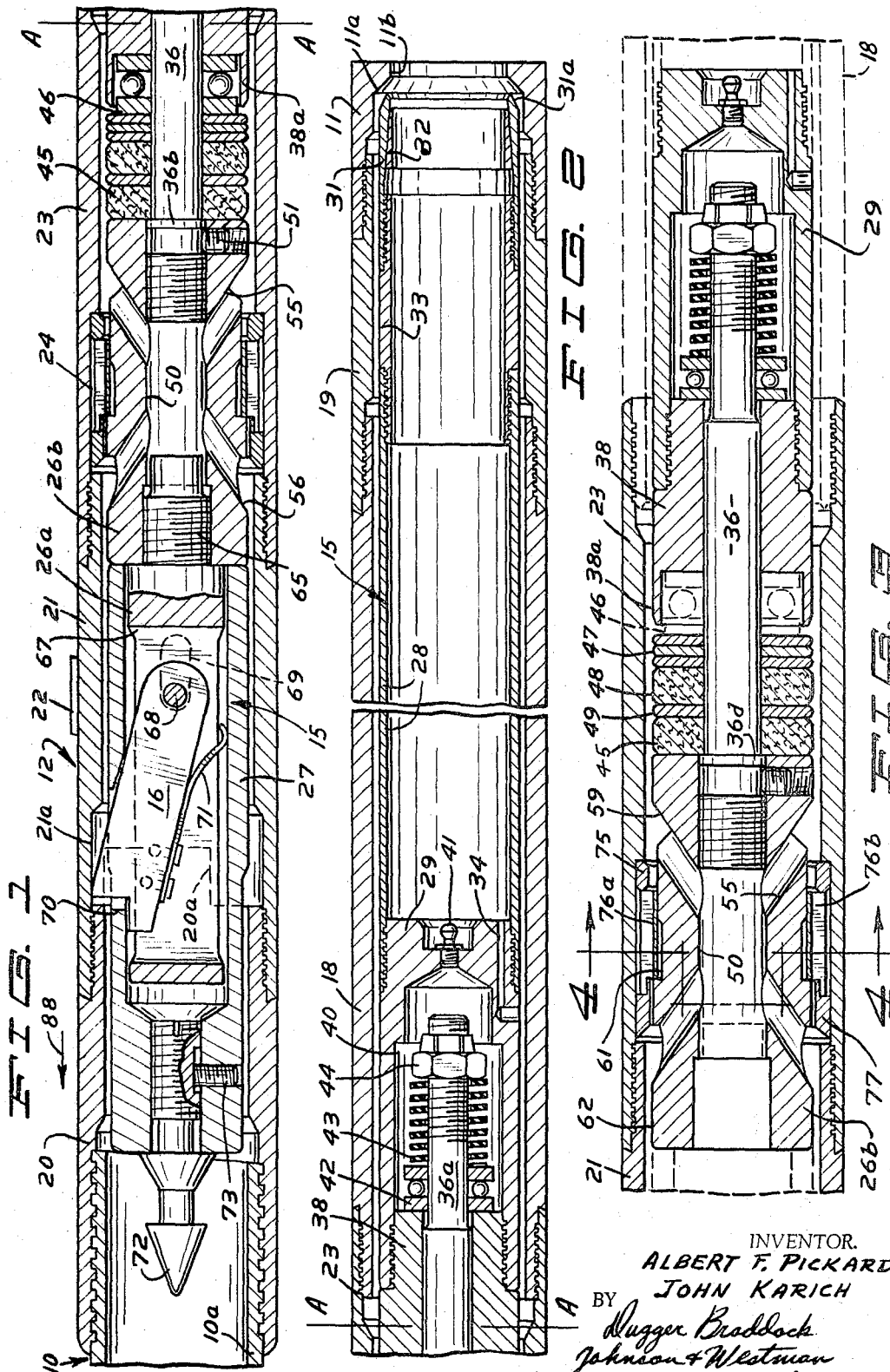
A. F. PICKARD ET AL

3,305,033

CORE BARREL

Filed March 4, 1964

2 Sheets-Sheet 1



Feb. 21, 1967

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2 Sheets-Sheet 2

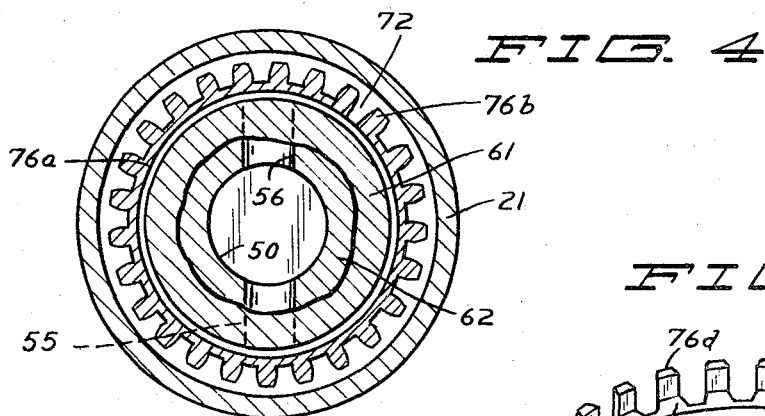
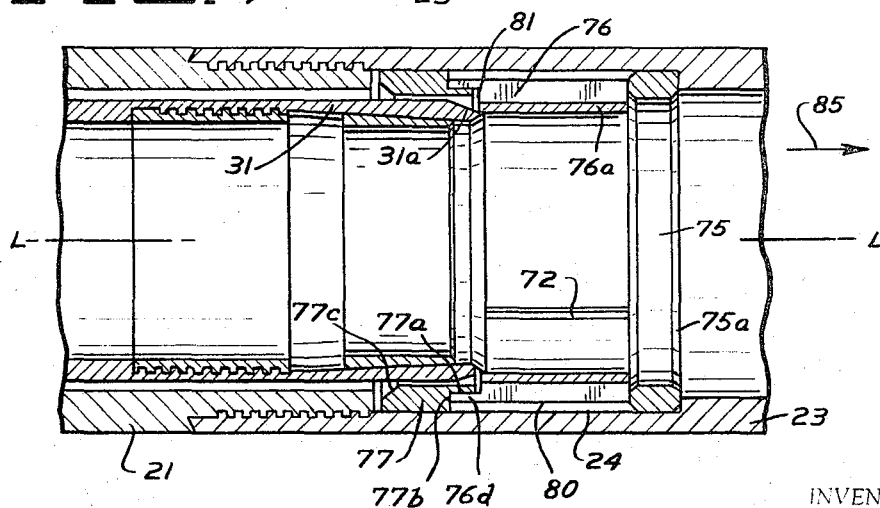
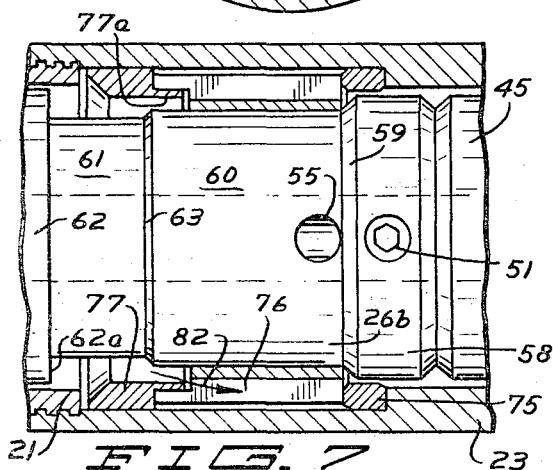
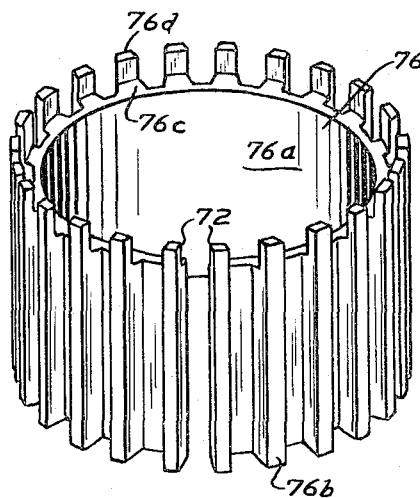


FIG. 5



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1

3,305,033

CORE BARREL

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12 Claims. (Cl. 175-246)

This invention relates to the art of deep core drilling in earth formations and to improvements in apparatus for so doing. While the invention is of particular usefulness in exploratory drilling in which smaller size holes are made and it is desired to optimize the outer diameter of the core taken relative to the size hole drilled, it is also useful in other type drillings.

More particularly, this invention relates to new and novel apparatus for suspendingly retaining a core barrel inner tube assembly adjacent the bit end of the drill stem, but out of contact with the drill bit; and to the provision of a kit for converting conventional wire line core barrel assemblies in which the core lifter case rests on the core bit shoulder to include the aforementioned features.

This invention has been made in order to provide wire line core barrel equipment for overcoming problems of the nature set forth hereinafter which are encountered in using core barrel equipment of the prior art. One of the problems encountered in using wire line core barrel equipment of the prior art is that where it is desired to latchingly retain a core barrel inner tube assembly adjacent to the bit end of the drill stem while at the same time support the core barrel inner tube assembly out of contact with the drill bit there has been provided a hanger coupling, having a suspension flange. Due to the provision of the hanger coupling, the maximum diameter of the portion of the core barrel inner tube assembly that extends through the hanger coupling to adjacent the drill bit is limited by the inner diameter of this hanger coupling flange. This results in a smaller diameter of core being taken relative a given diameter hole being drilled. However, frequently it is desirable to obtain a larger diameter core without increasing the diameter of the hole being drilled. For example, Mining Engineering, June 1955, in an article on pages 548-550 disclose wire line core barrel apparatus that includes a hanger coupling having a suspension flange and a latch body bottom having a ledge flange seatable on said suspension flange for retaining the core lifter case out of contact with the drill bit. Since the inside diameter of the suspension flange limits the maximum outside diameter of the core lifter case, it accordingly limits the maximum diameter of the core that can be taken. In the Series 10 wire line core barrels, sold by E. J. Longyear Company (assignee of this application), the drill stem couplings, other than for the latch seat and the threaded portions of said couplings are of a constant inside diameter, i.e. no suspension flange. Accordingly a larger diameter core can be taken for the same diameter hole as drilled with said apparatus of the Mining Engineering article. However, the core lifter case of the Series 10 during the core drilling operation abuts against the inner shoulder of the drill bit, which is not desirable. This invention has been in order to overcome problems of the aforementioned nature.

This invention relates to improvements in wire line core barrel apparatus such as disclosed in U.S. Patent 2,829,868, issued April 8, 1959; 2,857,138, issued October 21, 1958; and 3,103,981, issued September 17, 1963; which are incorporated herein by reference, the aforementioned Mining Engineering article and in said Series 10 apparatus.

In order that the invention described herein may be

2

more fully understood, the meaning of certain terminology as used in the specification will be set forth. The term "inner" refers to that portion of the drill stem or of an element of an assembly in its position "for use" in the drill stem which is located axially closer to the bit attached to the drill stem than any other portion of the drill stem or elements being referred to, except where the term refers to the transverse circumference, or the peripheral surface or the diameter of the drill stem or said elements.

The term "outer" refers to that portion of the drill stem or of an element in its "position for use" in a drill stem which is located axially closer to the mouth of the drill hole than the other portion of the drill stem or element being referred to except where the term refers to a transverse circumference or the peripheral surface of the diameter of an element or the drill stem.

One of the objects of this invention is to provide new and novel apparatus for suspendingly supporting the core lifter case of a wire line core barrel inner tube assembly out of contact with the drill bit while a core is being drilled and at the same time maximizing the diameter core that can be drilled. Another object of this invention is to provide in wire line core barrel apparatus new and novel expandable mechanism that is mounted on a hanger coupling for supportingly retaining the lower end of a core barrel inner tube assembly out of contact with the drill bit as the core is being drilled.

A further object of this invention is to provide in a core barrel inner tube assembly a reduced diameter portion that cooperates with an expandable mechanism mounted in a hanger coupling of a drill stem and a core lifter case for expanding said mechanism as the inner end of the core barrel inner tube assembly passes therethrough. Still another object of this invention is to provide an adaptor kit for converting wire line core barrel apparatus of the general nature described in the aforementioned patents and in particular said Series 10 apparatus to accomplish the aforementioned objects.

Other and further objects are those inherent in the invention herein illustrated, described, and claimed and will become 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 invention may be employed.

The invention is illustrated in the drawing in which the corresponding numerals refer to the same part and in which:

FIGURES 1 and 2 when arranged one above the other, with the center line aligned with FIGURE 1 at the top and FIGURE 2 at the bottom, form a composite longitudinal section through the core barrel inner tube assembly and the drill stem, said assembly being shown in a latched core receiving position. The meeting line between FIGURE 1 (top) and FIGURE 2 (below) is at the line A-A;

FIGURE 3 is a somewhat enlarged view of part of the structure illustrated in FIGURES 1 and 2, said view showing the structure to be sold as the kit assembly in solid lines other than for the upper end of the adaptor coupling and the core lifter case, and illustrating portions of conventional wire line core barrel equipment on which the adaptor kit structure is to be mounted in phantom;

FIGURE 4 is a transverse cross sectional view generally taken along the line and in the direction of the arrows 4-4 of FIGURE 3 to illustrate the structure at the hanger coupling for supportingly holding the core lifter case of the core inner tube assembly out of contact with the drill bit;

3

FIGURE 5 is an enlarged perspective view of the landing ring of this invention;

FIGURE 6 is an enlarged fragmentary longitudinal cross sectional view illustrating core lifter case just as it is entering the outer axial end portion of the landing ring to show the expandable feature thereof; and

FIGURE 7 is a view corresponding to that of FIGURE 6 other than that the wire line core barrel inner tube assembly is being withdrawn and the inner axial maximum diameter portion of the latch body assembly is just entering the inner axial end of the landing ring to show the expandable feature of the landing ring as the core barrel inner tube assembly is being withdrawn.

Referring now in particular to FIGURES 1 and 2, there is illustrated a hollow drill stem 10 which is made up of sections of the pipe coupled together and having an annular drill bit 11 mounted on the inner end thereof. Even though the longitudinal axis of the drill stem as illustrated in FIGURES 1-3 shown is extending in a horizontal direction, it is to be understood that this is for purposes of illustration only; and that, the apparatus of this invention is for use not only when the direction of drilling is generally downwardly such that the angle of drilling direction is not inclined from the vertical in an amount greater than which the core barrel inner tube assembly, generally designated 15, will free fall through the drill stem; but also where the latch body latch release tube and latches are of a modified construction so that the core barrel inner tube assembly is fluidly propellable to the bit end of the drill regardless of the drilling direction such as disclosed in U.S. Patent 3,120,282, issued February 4, 1964, and U.S. Patent 3,120,283, issued February 4, 1964.

The portion of the drill stem attached to or extending below pipe section 10a is commonly referred to as a core barrel outer tube assembly, generally designated 12; the core barrel outer tube assembly being provided for receiving and retaining the core barrel inner tube assembly 15. Details of construction of the core barrel outer tube assembly of the general nature used in this invention are set forth in the aforementioned patents, however, as will become more apparent hereinafter the construction of portions of the assembly 12 is different from that described in the aforementioned patents. The core barrel outer tube assembly 12 is composed of a core barrel outer tube 18, a reaming shell 19 threadedly connected to the inner end of the tube 18, said shell having hardened material such as diamond (not shown) on the transverse outer reaming surface and an annular drill bit 11 for drilling into the earth formation from which the core sample is taken, said bit being threadedly connected to the inner end of the reaming shell. The outer end of the assembly 12 includes a locking coupling 20 which connects the assembly 12 to the adjacent pipe section 10a of the drill stem. At the opposite end of the coupling 20 from the aforementioned pipe section, an adaptor coupling 21 is connected. The adaptor coupling is provided with hardened lands 22. The lower end of the locking coupling in conjunction with the annular recess 21a of the adaptor coupling formed a seat inside the surface of the adaptor coupling against which the latch dogs 16 of the core barrel inner tube assembly are seated for removably retaining the assembly 15 adjacent the core bit, only one of the latch dogs being illustrated. Also the lower end portion of the locking coupling has a projection flange 20a which extends as a partial cylindrical surface more adjacent the core bit than the main part of said coupling. The side faces of this flange bear against the face of the latch dogs and cause them and other portions of the core barrel inner tube assembly to rotate with the drill stem when the latch dogs are in a latch position such as indicated by FIGURE 1.

Threadedly connected to the inner end of the adaptor coupling is a hanger coupling 23, the opposite end of the hanger coupling being threadedly connected to the core barrel outer tube 18. As may be noted from FIGURES 1 and 3 of the drawings, the hanger coupling of this in-

4

vention does not include a suspension flange of the nature described in the aforementioned patents; but rather, is provided with an annular recess 24 for mounting structure which will be described hereinafter. The inner thread end of coupling 21 provides a shoulder at the outer end of recess 24.

The core barrel inner tube assembly 15 includes a latch body assembly made up of an outer portion 26a that at its lower end is threadedly connected to the bottom portion 26b, and has latch dogs 16 mounted thereon, a latch release tube 27 for retracting said latches, a core receiving tube 28, an inner tube cap 29 threaded into the outer end of the core receiving tube, and a spindle 36 for connecting the cap to the inner portion of the latch body assembly for limited slidable movement relative to said cap. The core receiving tube has a core receiving tube extension 33 and a replaceable core lifter case 31 threaded on the inner end of said extension. A core lifter 32 is mounted in the core lifter case. The structure and function of the core lifter case and core lifter, other than set forth hereinafter, are of the general nature set forth in U.S. Patent 2,829,868 and therefore will not be described.

A fluid passageway 34 is formed in the cap 29 to at one end open to the interior upper end of the core receiving tube and at the opposite end to open to the annular clearance space between the core barrel inner tube assembly and the core barrel outer tube 18 that forms a part of the fluid channel to permit fluid to bypass the core barrel inner tube assembly when it is in a core taking position such as illustrated in FIGURES 1 and 2.

The cap 29 includes an axially elongated bore 40 that in cross section is generally shaped as illustrated in FIGURE 2 for receiving the inner diameter reduced end portion 36a of the spindle 36. A grease fitting 41 is threadedly into the opposite end of the bore 40. A bearing 42 is mounted on the reduced diameter portion 36a of the spindle in abutting engagement with the cap 29 and for slidable movement relative to said portion 36a; there being provided a coil spring 43 that at one end abuts against said bearing and at the opposite end abuts against the nut 44 threaded on the inner end portion of the spindle. The spring 43 resiliently urges the spindle toward the core receiving tube while at the same time retains the bearing 42 in abutting engagement with the bearing housing 38 which is threaded into the outer end portion of the cap bore 40.

The bearing housing includes an outwardly extending annular flange 38a that provides a recess for receiveably mounting the thrust bearing assembly 46 on the central portion of the spindle 36 (see FIGURE 3). A plurality of spacer washers 47 are mounted on the spindles 36 in an abutting relationship with one another, one of the washers abutting against the bearing assembly 46 and another abutting against the adjacent surface of the resilient shut off valve washer 48 which is also mounted on said spindle. An opposite surface of the shut off washer 48 abuts against a metal spacer washer 49 which in turn abuts against one surface of the resilient shut off washer 45. The opposite surface of the shut off washer 45 for the most part abuts against the outer surface of the latch body bottom portion 26b and in part against the enlarged diametric angular flange 36b which is formed integral with the spindle 36. The outer threaded end of the spindle 36 is threadedly mounted in the lower threaded portion of the bore 50 which extends axially through the latch body bottom portion 26b. A set screw 51 is threadedly extended in a transverse aperture formed in the latch body portion 26a to extend into the groove of the spindle located intermediate the outer threaded end portion and the annular flange 36b to retain the spindle in position such that the inner surface of the annular flange is located in substantially the same plane as the inner surface of the latch bottom body portion.

Referring in particular to FIGURE 7, it is to be noted that the latch body bottom portion 26b has an inner

5

6

maximum diameter cylindrical portion 58 that is of the same diameter as the outer maximum diameter portion 62, the outside diameter of portions 58 and 62 being substantially the same as the outside diameter of the latch release tube 27, the shut off valve washers 48, 50, spacers 47, 49; the non-threaded cylindrical surface of the bearing housing 38, the inner tube cap 29, the core receiving tube 28, the inner tube extension 33, and the core lifter case 31. A frusto-conical portion 59 at its major base is integrally joined to maximum diameter portion 58 and its minor base is integrally joined to the intermediate diameter portion 60 which in turn is integrally joined with the major base of the frusto-conical portion 63. The minor base of the frusto-conical portion 63 in turn is integrally joined to one end of the minimum diameter portion 61 of the latch body portion 26b while the opposite end is integrally joined to the diameter portion 62 to form a generally planar transverse shoulder 62a. The purpose of making the latch body bottom portion 26b of the above described construction will become more apparent hereinafter.

A pair of circumferentially spaced, transverse and inwardly inclined inlet holes (ports) 56 are provided in the latch body bottom portion to at one end open through the maximum diameter portion 62 to the fluid channel between the core barrel inner tube assembly and the drill stem, and at the opposite ends to open into the central portion of the bore 50. A second pair of holes (ports) 55, which are oppositely transverse inwardly inclined are formed in the latch body bottom portion to at one end open through the intermediate diameter portion 60 closely adjacent the frusto-conical shoulder 59 and at the opposite end open to the bore 50 outwardly of, but closely adjacent to, the threaded end of the spindle 36; and are substantially axially inwardly spaced from the opening of the inlet holes 56 to the bore 50. The inlet holes 56, the central portion of the bore 50, and the outlet holes 55 provide a fluid bypass channel to bypass structure which will be described hereinafter.

The latch body top portion 25a for the major portion of its axial length is of a substantially smaller diameter than the outer diameter of portions 62, and a larger diameter than the diameter of the bore 50. The outer end of latch body portion 26b has a reduced diameter stud 65 that is threaded into the upper portion of the bore 50, the inner end of the stud ending outwardly of the opening of the holes 56 to the bore 50. The opposite end of the stud is joined to the main body of latch body portion 26a to form a shoulder that abuts against the outer surface of latch body bottom portion 26b.

A rectangular slot 67 is formed in the latch body top portion, there being a through pin 68 extended through said slot and appropriate apertures in the latch body top portion for pivotally mounting a pair of latch dogs 16 in side by side relationship, only one of the latch dogs being shown. The opposite axial ends of the through pin 68 extend into axially elongated slots 69 formed in the latch release tube 27 to mount said latch release tube for limited slidable movement similar to that described in U.S. Patent 2,857,138. The latched release tube has a slot 70 radially opposite the outer half of each latch dog through which the respective latch dog can be extended to engage the latch seat 21a, there being provided a spring 71 on each latch dog to resiliently urge the respective latch dog to pivot about the through pin 68 and extend radially outwardly through the slot 70. Since the aforementioned mounting of the latch dogs and the latch release tube, and the function thereof has been more fully described in U.S. Patent 2,857,138, and are the same as the Series 10 apparatus, it will not be set forth in further detail. It is to be understood that the mounting of the latch dogs and the latch release tube on the latch body top portion including provision of an insert block such as described in U.S. Patent 3,103,918 could be used in place of that described herein.

A spear point plug 72 is threaded into the outer end portion of the latch release tube 27 and is held against loosening by a set screw 73 threaded into a transverse socket formed in the latch release tube. The spear point is provided to be clampingly engaged by an overshot assembly for retracting core barrel inner tube assembly in a manner similar to that described in one or more of the aforementioned patents.

In order to supportingly hold the core barrel inner tube assembly out of contact with the core bit while at the same time permitting its latch dogs to latchingly engage the latch seat in the drill stem there is provided a shoulder ring 75, a landing ring 76 and a stabilizer ring 77, rings 75-77 being mounted in the recess 24 of the hanger coupling 23. The closed shoulder ring is mounted to have its inner edge surface bottom against the inner generally planar surface of the recess 24, and has an inside diameter that is less than the inside diameter of the hanger coupling and the remaining portion of the core barrel outer tube assembly that extends axially inwardly thereof, other than for the aperture through the drill bit. However the inside diameter of the shoulder ring is greater than the maximum outside diameters of the core receiving tube, the latch body bottom portion and parts intermediate said core lifter case and the latch bottom body portion in order to permit these members to pass therethrough. As may be noted from FIGURES 6 and 7, the shoulder ring is provided with a transverse inwardly inclined beveled surface at its inner end, the reason for providing surface 75a to be set forth hereinafter.

The landing ring 76 is mounted in the recess 24 to have the inner edge thereof bear against the outer horizontal surface of the shoulder ring 75. The landing ring is made of a spring type steel and is axially split at 72 as may be noted in particular from FIGURE 5 in order to permit expansion thereof. That is, there is provided a slot extending the axial length of the ring in order to provide a split snap ring construction.

The landing ring includes a thin wall, generally tubular, casing 76a that has a smooth inner surface. The inner diameter of the casing 76a when in a relaxed (contracted) condition is substantially equal to the outer diameter of portions 60 of the latch body assembly. Integrally joined to outer surface portions of the casing 76a to extend radially outwardly therefrom are a plurality of circumferentially spaced teeth 76b. As may be noted from FIGURE 7, the axial length of the teeth is approximately equal to the axial length of portions 60; and when portions 60 is axially located within the ring 76, the maximum diametric dimension of diametrically opposite teeth is substantially less than the transverse diametric dimension of the annular peripheral wall portion of the hanger coupling forming recess 24. Each tooth 76 is notched at the outer interior corner portion to provide a shoulder 76c, the axial length of the unnotched portion 76d of the tooth being the same as that of the casing 76a. Thus each tooth has a radially extending, outwardly projecting portion 76d that extends axially outwardly of the outer edge of the casing 76a.

The stabilizer ring 77 is a closed ring having an inner annular flange 77a that is of a slightly smaller axial length than the axial length of the projections 76d. As may be noted in particular from FIGURES 6 and 7, the inside diameter of flange 77a is the same as the main body portion of the stabilizer ring and that of the shoulder ring 75. However the outside diameter of flange 77a is substantially less than the diameter of the recess 24, and accordingly, provides a planar edge 77b that is of a substantially greater radial dimension than the corresponding dimension of projection 76d which abuts against said edge.

When the landing ring and the stabilizer ring are mounted in the recess 24 as shown in FIGURES 6 and 7 and no core barrel inner tube assembly is adjacent said rings, the inner transverse peripheral surfaces of the pro-

jections 76d bear against the outer transverse peripheral surface of the flange 77a and thereby limits the amount of "contraction" of the landing ring. At this time, provided ring 77 and ring 76 are concentric to the longitudinal axis of the drill stem, the outer wall of the casing 76a (area between adjacent pair of teeth 76b) is more closely adjacent the central axis L—L than the inner peripheral wall of the flange 77a. Further due to the relative axial lengths of the flange 77a and the projections 76b, there is provided an annular space between the adjacent annular edge thereof. Accordingly there is provided a fluid flow path 82 (see FIGURE 7) through the space between the inner peripheral wall of the recess 24 and the landing ring tooth portions to clean or wash out the dirt or any other material that would tend to collect in said area.

Also to be noted from FIGURES 6 and 7 is that when the adjacent arcuate surface portions of flange 77a and projections 76b abut, there is provided a substantial annular clearance 80 between the outer peripheral surfaces of the teeth 76b and the inner peripheral wall of the recess 24 (assuming the landing ring is concentric to the axis L—L). The cross sectional area of the space 80 is sufficiently great that the landing ring may be expanded there into whereby the inside diameter of the landing ring casing will be at least as large as the inside diameter of the cylindrical portions of the shoulder ring 75 and the stabilizer ring 77; and preferably slightly larger to allow for a certain amount of eccentricity of the landing ring in an expanded condition.

As may be noted from FIGURE 6 the lower circumferential edge of the adaptor coupling forms the upper edge of the recess 24 and that the said edge is slightly axially spaced from the outer circumferential edge of the stabilizer ring. Also to be noted is that this axial spacing is less than the axial dimensions of the teeth projections 76b and the flange 77a to preclude dislodgement of said members from recess. Further the axially outer interior peripheral surface of the stabilizer ring is beveled at 77c, the maximum diameter of the beveled surface portion 77c being equal or greater than the inside diameter of the adaptor coupling. That is the maximum diameter portion of the surface 77c is more closely adjacent the coupling 21 than the constant inside diameter surface portion of the stabilizer ring. Further the inside diameter of the cylindrical surface portion of the stabilizer ring is less than the inside diameter of the adaptor coupling, but is slightly greater than the maximum diameter of any portion of the core barrel inner tube assembly extending below the latch body top portion when the core barrel inner tube assembly is in a latched position.

The structure of the core barrel apparatus of this invention having been described, the operation thereof will now be set forth. For purposes of describing the operation, assume that the drilling operation has progressed to a state that the bit end of the drill stem is located a substantial distance inwardly from the surface of the earth formation being drilled and that the operator is about to place the core barrel inner tube assembly in the outer end of the drill stem prior to continuing the core taking operation. At this time the latch release tube 27 has been retracted so that the pin 68 bottoms in the opposite end of the slot 69 from that illustrated in FIGURE 1. Now the latches 16 are retracted and the inner circumferential edge of the latch release tube is axially spaced from the outer edge of the latch body bottom portion 26b. Further at this time the interior arcuate surfaces of the projection 76d of the landing abut against exterior arcuate surface portions of the flange 77a of the stabilizer ring due to the resilient nature of the landing ring. Now the core barrel inner tube assembly 15 is positioned in the drill stem and if the drilling direction is downwardly it is allowed to drop through the drill stem towards the bit end thereof, i.e., move in the direction of the arrow 85 of FIGURE 6. In the event the core barrel

inner tube assembly is not concentric to the longitudinal axis L—L of the drill stem, when the core lifter case initially is axially adjacent (just entering) the stabilizer ring, the core barrel inner tube assembly is forced to a more nearly centered position due to the provision of the beveled surface 31a at the inner end of the core lifter case and the beveled surface 77c of the stabilizer ring. In this connection it is to be noted that the beveled surface 31a is of a greater inclined length level than normally provided on the core lifter cases in the patents mentioned heretofore.

As the core receiving case beveled surface 31a continues to move inwardly it enters the outer axial end portion of the landing ring casing, the minimum diameter of the beveled surface 31a at the inner end of the casing being less than the inside diameter of the casing 76a when it is mounted in the recess 24. Thus even though the core lifter case is not concentric to the axis L—L (such as illustrated in FIGURE 6), the movement of the beveled surface 31 into the landing ring casing will force the ring to expand, i.e., the teeth 76 to move more closely adjacent the inner peripheral wall of the recess 24. This results in the rate of fall (rate of movement through the drill stem) of the core barrel inner tube assembly being decreased, the interior surface of the landing ring casing then frictionally abutting against the core lifter case. The core barrel inner tube assembly continues to move through the landing ring which is in friction engagement therewith, none of the reduced diameter portions of the core barrel inner tube assembly located beneath the latch body bottom portion 58 being of a smaller axial length than the axial height of the landing ring casing 76a.

After the portion 60 of the latch body bottom portion has initially entered the landing ring casing, there is an annular clearance space between said portions 60 and casing 76a due to portion 58 retaining the landing ring in an expanded condition. However immediately after portion 58 is moved beneath the inner circumferential edge of the landing ring, the landing ring starts to contract due to the progressively decreasing diameter of the frusto-conical portion 59. After the frusto-conical portion 59 has completed its downward passage through the landing ring, the landing ring will abuttingly engage the intermediate diameter portion 60 in a manner similar to that illustrated in FIGURE 7.

Further movement of the core barrel inner tube assembly in an inward direction brings the ledge 62a into abutting engagement with the shoulder 76c. Since neither ledge 62a nor the shoulders 76c are beveled and the landing ring is in a contracted condition, this stops the descent of the assembly 15 in the drill stem; the axial length of diametric portions 60, 61 being sufficiently greater than the axial length of the landing ring casing to ensure that the landing ring has time to retract to the condition of FIGURES 2 and 4 prior to the ledge 62a reaching the elevation of the shoulder 76c. At the time the ledge 62a seats on the shoulder 76c, the inner edge of the core lifter case is adjacent to but spaced from the interior annular shoulder 11a of the drill bit (see FIGURE 2).

At the time the ledge 62a is seated on the shoulder 76c of the landing ring, the latches are axially adjacent the latch seat 21a and accordingly move transversely outwardly through the slots 70 of the latch release tube due to the resilient action of the springs 71. Thus the latches and the latch release tube move relative to the latch body assembly to the position illustrated in FIGURE 1.

Due to the provision of the coil spring 43 the bearing housing, cap 29 and structure axially inwardly thereof can move on spindle 36 to cause additional compression of the spring 43 at the time the ledge 62a initially engages the landing ring shoulder 76a. As a result the entire stopping force for the core barrel inner tube assembly is not momentarily applied to the ledge 62a and the shoulder 76a.

As the core is being drilled, the latches in being seated

in the latch seats preclude the latch body assembly and the structure outwardly thereof being moved in the direction of the arrow 88. When the core receiving tube is filled with core (or a core jam develops) the core in abutting against the cap forces the cap and bearing housing and thrust bearing to move in an outward direction relative to the spindle to cause compression of the shut off valve rubber washers. Due to the provision of the metal spacer 49 intermediate shut off valve washers 48 and 50, approximately twice the compressive force is required to cause said shut off valves to expand to abut against the inner peripheral wall of the drill stem than if the shut off valve washers 48 and 50 were mounted in abutting relationship or if there was provided a single shut off valve washer of the same axial dimension as the combined axial dimensions of washers 48 and 50. Thus even though washers 48 and 50 are the same durometer hardness, the force required to compress them to a shut off position may be varied by a factor of approximately two by alternately positioning the metal washer 49 between resilient washers 48 and 50 and positioning resilient washer 48 in abutting engagement with resilient washer 49.

When the core barrel inner tube assembly is seated on the landing ring, the inlet ports 56 open into the annular clearance space between the core barrel inner tube assembly and the drill stem at a location adjacent to and outwardly of the beveled surface of the stabilizer ring while the outlet openings of ports 55 open into an annular space between the core barrel inner tube assembly and the drill stem inwardly of the shoulder ring (which is in fluid communication with the drill bit aperture by the spacing of the core lifter case from the drill bit) in order to provide a fluid bypass channel that bypasses a major portion of the drilling fluid past the landing ring. However as has been previously indicated, a small fluid flow takes place between latch body portion 62 and the stabilizer ring, thence through the spaces between the adjacent annular edge of the flange 77a and the casing 76 into the area between the casing and the peripheral wall of the recess. The fluid flow path 82 continues axially to pass through the cut out portions of the teeth and the interior surface of the shoulder ring to join the fluid flowing through holes 55. The fluid flow through the tooth portions serve to clean a grit, grease, or other foreign material that would otherwise tend to clog the space 80, particularly, if the exterior surface of the landing ring were a smooth cylindrical surface having an outside diameter in a contracted position greater than the inside diameter of flange 77a. It is to be understood that it is highly desirable to keep this space 80 clear of foreign material since if this space was filled, it would preclude or limit the expansion of the landing ring and thereby its functioning in a manner described heretofore.

After a core of the desired length has been cut, the drilling is stopped and the "water coupling" (not shown) is removed from the surface end of the drill stem. Then the drill stem is pulled outwardly a short distance to break the core. The initial lifting force applied to the drill stem is exerted on the landing ring to cause the latch body assembly and spindle to move outwardly. Due to the provision of the coil spring 43 (which could be a rubber washer) the spindle is moved relative the bearing housing, the core tube cap 29, the core receiving tube and core receiving tube extension, and the core lifter case which "stands still" on the core. When the core lifter case bottoms against the shoulder 11a of the drill bit, the force for breaking the core comes through the drill stem, the drill bit, the core lifter case and core lifter rather than being transmitted through the landing ring. In this connection it is to be mentioned that large cores may require several tons of force to break the core.

After the core is broken, an overshot assembly (not shown) is dropped in the drill stem to clampingly engage the spear point plug 72. The initial retraction of the spear point plug 72 moves the overshot release tube rela-

tive to the latch body to retract the latches from the latch seat and after the latches have been retracted, the latch release tube is moved sufficiently relative to the latch body so that pin 68 engages the inner surfaces of slots 69 and thereby move the latch body assembly and assembly 15 structure extending axially inwardly thereof in outer direction (arrow 88). After the assembly 15 has been moved a short distance in an outward direction, the latch body bottom portion is moved to the position of FIGURE 7 wherein the frusto-conical portion 59 initially engages the inner edge of the casing. Due to the bevel of the frusto-conical portion 59, further withdrawal of the core barrel inner tube assembly forces the split landing ring to expand radially to have an inside diameter that forms a sliding fit with diametric portion 58 and similar size diametric portions on the inner part of the core barrel inner tube assembly. To be mentioned is that the reduced diameter portion 61 serves as a pocket to accumulate dirt and other material that is wiped off the joints of the drill stem as the core barrel inner tube assembly is dropped through or propelled through the drill stem to the bit end thereof and retracted through the drill stem. After the core barrel inner tube assembly has been withdrawn from the drill stem, it is important that this area be clean.

The core barrel structure described heretofore may be sold as a complete unit, or else there may be provided a kit for converting convention type water line equipment such as the Series 10. The structure which would be sold for a conversion kit includes all of the structure illustrated in solid lines of FIGURE 3 (does not include the thrust bearing assembly 46, the core receiving tube or the latch body top portion). Additionally structure sold as part of the kit would include the core lifter case. This conversion kit would permit modifying prior art wire line core barrel structure to incorporate the features of this invention.

With reference to the above mentioned conversion kit, it is to be noted the core receiving tube 28, the drill bit 11 and the outer tube 23 are the ones sold as parts of the conventional Series 10. The inner diameter of the cylinder surfaces of the kit shoulder ring 75 and stabilizer ring 77 are less than the inside diameter of the outer tube but greater than the outside diameter of the core receiving tube 28. Thus rings 75, 77 extend into the normal clearance space provided between the Series 10 outer tube assembly and core barrel inner tube assembly. However, due to the beveled surface 77c and beveled surface 31a, the core barrel inner tube assembly is forced to a more nearly central position as the inner end thereof passes through the stabilizer ring. As a result, the Series 10 apparatus can through the provision of the kit of this invention be converted to supportably retain the core lifter case axially spaced from the drill bit shoulder 11a while core is being drilled without any reduction in the diameter of the core being taken.

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

What we claim is:

1. Rotary core drilling apparatus for taking a core sample comprising a drill stem having an apertured core bit at the inner end thereof, a latch seat axially spaced from said core bit and a hanger coupling axially intermediate said latch seat and the core bit, said hanger coupling having an annular recess, and a wire line core barrel inner tube assembly that includes a latch, a latch body portion mounting said latch for movement between an extended position to latchingly engage said latch seat and a retracted position, latch release means mounted by said latch body portion for limited movement between a latch retracted position and a latch extended position, means for receiving and retaining a core sample, and means for connecting the core receiving means to

the latch body portion to extend axially inwardly of the latch body portion, the last mentioned means having a reduced diameter portion to form a shoulder, and resiliently expandable means mounted in said recess for expanding as the part of the core barrel inner tube assembly inwardly of said reduced diameter portion passes therethrough and alternately contracting onto said reduced diameter portion for abutting against said shoulder to hold the core receiving means out of contact of the core bit as core is being drilled, said core receiving means having an outer diameter greater than the inner diameter of the expandable means in a contracted condition, and said connecting means including means having a fluid channel for bypassing said expandable means in a core barrel inner tube assembly latch seated position, a spindle, means for connecting one end portion of the spindle to said latch body portion, two resilient washers mounted on said spindle that are expandable in girth to form a fluid seal with the drill stem when sufficiently compressed, a metal washer on the spindle intermediate said resilient washers and means mountingly retained on said spindle for limited relative slidable movement to connect the core receiving means to the spindle and compress said washers to expand the resilient washers in girth when the core receiving means is filled with core and the latch engages the latch seat.

2. Rotary core drilling apparatus for taking a core sample comprising a drill stem having an apertured core bit at the inner end thereof, a latch seat axially spaced from said core bit and a hanger coupling axially intermediate said latch seat and the core bit, said hanger coupling having an annular recess, and a wire line core barrel inner tube assembly that includes a latch, a latch body portion mounting said latch for movement between an extended position to latchingly engage said latch seat and a retracted position, latch release means mounted by said latch body portion for limited movement between a latch retracted position and a latch extended position, means for receiving and retaining a core sample, and means for connecting the core receiving means to the latch body portion to extend axially inwardly of the latch body portion, the last mentioned means having a first diameter portion, and a second portion having a maximum diameter smaller than the diameter of said first diameter portion, said second diameter portion being joined to said first diameter portion to form a shoulder and to extend axially inwardly of the first diameter portion, resiliently expandable means mounted in said recess for expanding as the part of the core barrel inner tube assembly inwardly of said second diameter portion passes therethrough and alternately contracting onto said second diameter portion for abutting against said shoulder to hold the core receiving means out of contact of the core bit as core is being drilled, said core receiving means having an outer diameter greater than the inner diameter of the expandable means in a contracted condition, said expandable means comprising a split landing ring, and means mounted in said recess for cooperating with the landing ring to retain it in said recess.

3. The structure of claim 2 further characterized in that said landing ring comprises an axially split tubular casing and a plurality of circumferentially spaced teeth joined to said casing to extend radially outwardly therefrom, the radial outermost surfaces of said teeth being radially spaced from the peripheral wall of said recess in the expandable means contracted position.

4. The structure of claim 3 further characterized in that the said teeth have axially outwardly extending projections, the transverse inwardly axial surfaces of which are generally more radially outwardly from the central axis of the drill stem than the inner peripheral wall of the casing.

5. The structure of claim 4 further characterized in that said landing ring cooperating means comprises a stabilizer ring having an inner diameter approximately

the same as the inner diameter of the major portion of the drill stem, said stabilizer ring having an axially elongated inwardly extending flange that extends along side of the landing ring projections to retain said projections radially intermediate thereof and the adjacent peripheral wall of said recess.

6. The apparatus of claim 5 further characterized in that said core receiving means includes a core lifter case that has a beveled exterior surface at the inner end thereof, the diameter of said beveled surface at the inner edge being less than the inner diameter of landing ring casing, and that the means having a fluid channel includes a frusto conical portion that at its minor base is joined to said second diameter portion and has a major base axially inwardly of said minor base.

7. In wire line core barrel apparatus that includes a drill stem having a core bit at one end thereof and a latch seat axially spaced from the core bit, and a core barrel inner tube assembly having a retractable latch that is extended into said seat, means for mounting said latch for movement and means for receivingly retaining a core sample, the improvement being a drill stem hanger coupling having a recess of substantial axial length, axially elongated means for attaching said core receiving means to the latch mounting means to extend axially inwardly of said latch mounting means, said axially elongated means having a reduced diameter portion, said reduced diameter portion providing an axially outward shoulder, expandable means mounted in said hanger coupling recess for expansion as the part of said assembly inwardly of said reduced diameter portion passes therethrough and contractable into said reduced diameter portion to abut against said shoulder to retain the inner end of said assembly spaced from the core bit as the core is being drilled, and a stabilizer ring mounted in said recess, said stabilizer ring having an axially inwardly extending flange providing an annular clearance between it and the inner peripheral wall of the recess, said expandable means having an outwardly extending projection extended in said annular clearance that is of a radial dimension substantially less than the corresponding dimension of said clearance.

8. The structure of claim 7 further characterized in that said axially elongated means includes an annular beveled surface portion having a minimum diameter axially end joined to the end of the reduced diameter portion opposite said shoulder and that said expandable means includes an axially split ring joined to said projection that in a contracted condition position said projection abuts against the stabilizer ring flange, said split ring in a contracted condition having a smaller inside diameter than the outside diameter of portions of the core barrel inner tube assembly axially on either side of said first mentioned reduced diameter portion and an outside diameter substantially less than the inside diameter of said recess.

9. In wire line core barrel apparatus that includes a drill stem having a core bit at one end thereof and a latch seat axially spaced from the core bit, and a core barrel inner tube assembly having a retractable latch that is extended into said seat, means for mounting said latch for movement and means for receivingly retaining a core sample, the improvement being a drill stem hanger coupling having a recess of substantial axial length, axially elongated means for attaching said core receiving means to the latch mounting means to extend axially inwardly of said latch mounting means, said axially elongated means having a reduced diameter portion, said reduced diameter portion providing an axially outward shoulder, expandable means mounted in said hanger coupling recess for expansion as the part of said assembly inwardly of said first mentioned reduced diameter portion passes therethrough and contractable into said first mentioned reduced diameter portion to abut against said shoulder to retain the inner end of said assembly

13

spaced from the core bit as the core is being drilled, said core receiving means having an outer diameter greater than the inner diameter of the expandable means in a contracted condition, said expandable means comprising an axially split landing ring having transverse outwardly peripheral toothed surfaces that in an expandable means contracted position are substantial transversely spaced from the recess inner peripheral wall.

10. The structure of claim 9 further characterized in that there is provided a stabilizer ring and a shoulder ring mounted in said recess in abutting engagement with opposite axial ends of said landing ring, said stabilizer and shoulder rings having interior oppositely faced beveled surfaces at the ends thereof opposite the landing ring, and inner peripheral, generally cylindrical, surfaces of an inside diameter greater than the outside diameter of the core barrel inner tube assembly.

11. A conversion kit for wire line core barrel apparatus that includes a drill stem having a core bit at the inner end thereof and a wire line core barrel inner tube assembly movable through the drill stem to the bit end of the drill stem and having a core receiving tube comprising a hanger coupling having an axially elongated annular recess, a spindle, means for connecting one end portion of the spindle to the adjacent end of the core receiving tube, a latch body portion connected to the opposite end of the spindle, said latch body portion having an axially elongated reduced diameter portion that is axially intermediate the opposite ends of said latch body portion, said reduced diameter portion providing an axially outward shoulder, expandable, generally annular means mounted in said recess for contracting into said reduced diameter portion to abut against said shoulder to prevent further axial inward movement of said latch body portion and a core lifter case having

14

inwardly exterior beveled surface for initially expanding said expandable means, said core lifter case non-beveled portion having an outer diameter greater than the inner diameter of the expandable means in a contracted condition, and said expandable means in a contracted condition having a maximum diametric dimension that is greater than the inner diameter of said hanger coupling immediately axially inwardly of said recess, a shoulder ring mounted in the inner axial end of said recess to abut against one axial end of said expandable means and a stabilizer ring mounted in the recess to abut against the opposite end portion of said expandable means.

12. The kit of claim 11 further characterized in that shoulder ring and stabilizer ring each have an inner diameter that is less than the inner diameter of the hanger coupling axially inwardly of said recess, said stabilizer and shoulder rings having oppositely faced beveled surfaces inclined transversely inwardly toward each other and located at opposite axial ends of said shoulder and stabilizer ring, said latch body portion having a frusto conical portion with a minor base end joined to said reduced diameter portion at the axial end opposite said surface.

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