Dec. 2, 1969 D. S. ROWLEY 3,481,412

CORING APPARATUS WITH HYDRAULICALLY RETRIEVABLE INNER CORE BARREL

Filed Aug. 24, 1967 2 Sheets-Sheet 1

FIG. 1a.

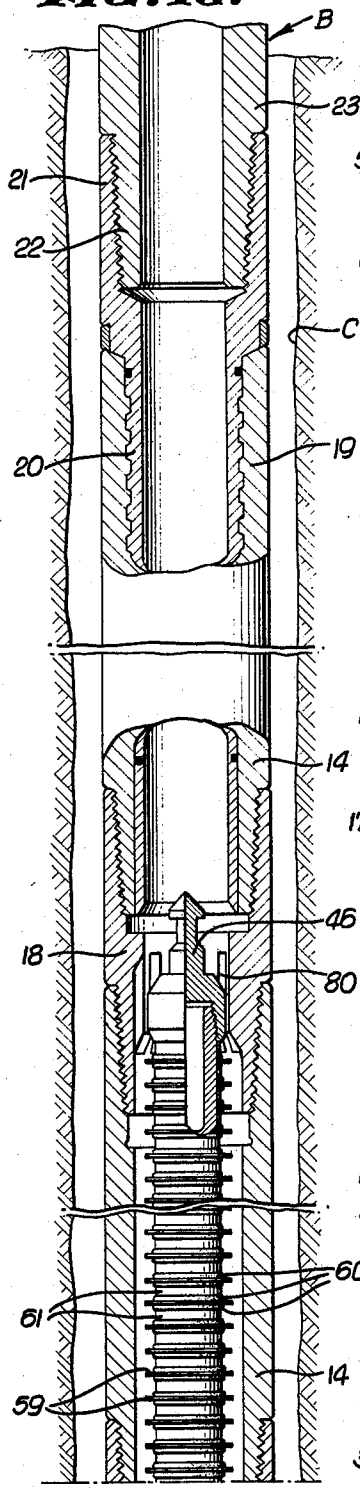


FIG. 1b.

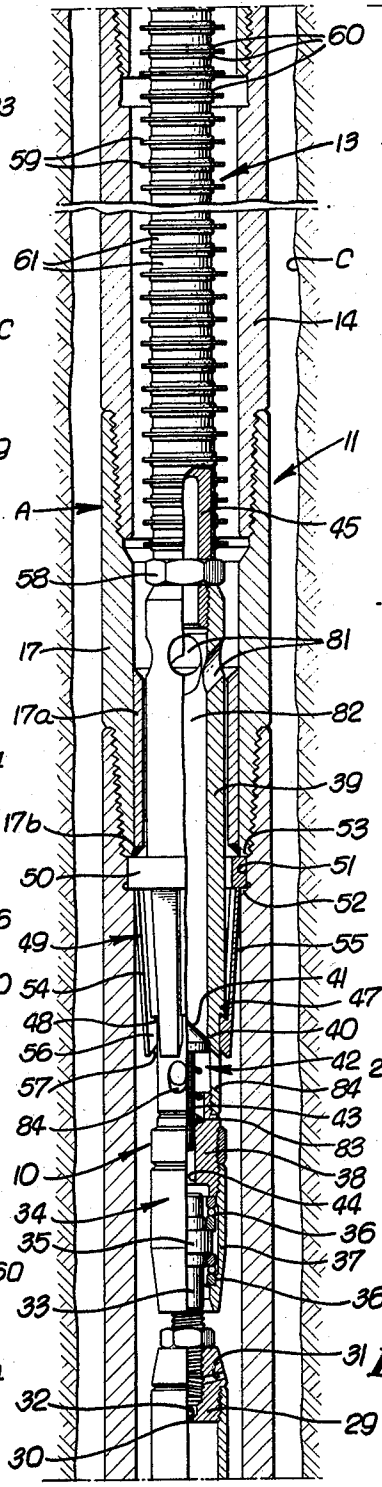
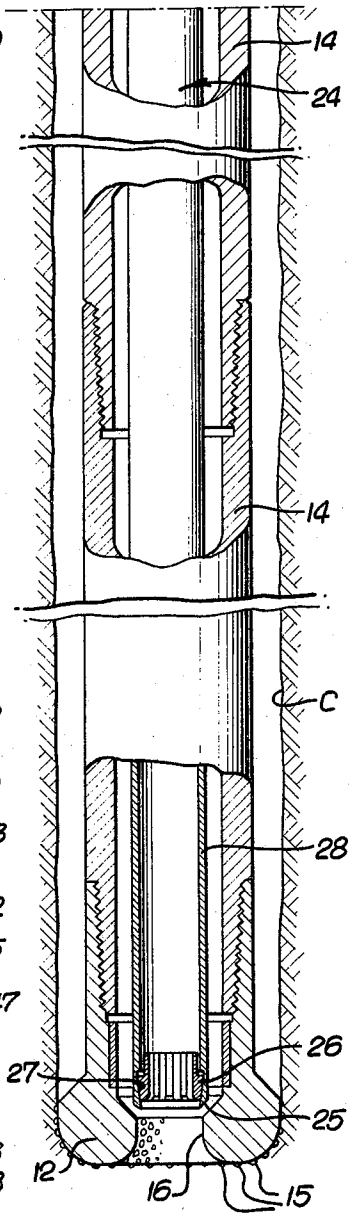


FIG. 1c.



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FIG. 3.

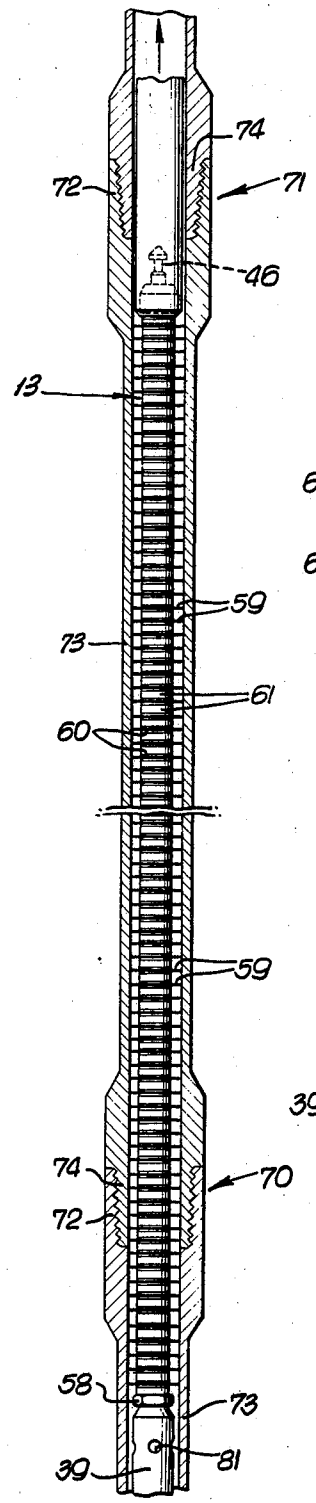


FIG. 4.

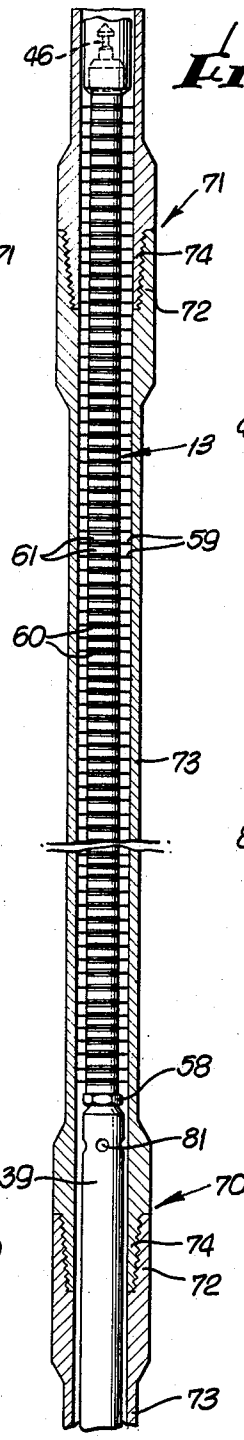
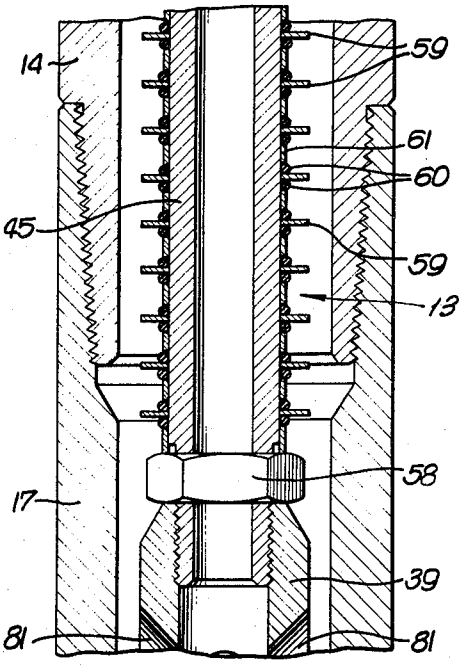


FIG. 2.



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CORING APPARATUS WITH HYDRAULICALLY RETRIEVABLE INNER CORE BARREL

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U.S. Cl. 175—247 25 Claims

ABSTRACT OF THE DISCLOSURE

A pump-out inner core barrel to which an elongate piston-like mechanism is secured which is longer than the distance between the tool joints of the drill pipe or drill collar sections of the drill string, so that a piston portion of the mechanism is always present within and makes a sufficiently close fit with the wall of a tool joint, permitting the inner core barrel to be pumped or forced hydraulically through the drill pipe to the surface by reverse circulation.

The present invention relates to core barrels, and more particularly to core barrels having inner barrels capable of being lowered through strings of drill pipe to coring position within associated outer barrels and of being removed from the coring position through the drill pipe to the surface.

Heretofore, wire line core barrels have been used for lowering an inner core barrel through a string of drill pipe into appropriate coring position within an outer barrel. After the inner barrel is full, it is elevated on a wire line through the string of drill pipe to the surface of the well bore. However, there are limitations on the speed at which the inner barrel can be moved by a wire line through the string of drill pipe. If high winding drum speeds are utilized, there is always danger of the apparatus hanging up and the wire line parting.

The present invention contemplates the pumping of a full inner core barrel to the surface of the well bore by reversely circulating fluid down around the string of drill pipe and then upwardly therethrough. In other words, the use of a wire line is dispensed with entirely. The inner core barrel can be reversed out through the drill pipe to the surface at a speed substantially exceeding the rate at which the inner core barrel could be safely elevated through the string of drill pipe by means of a wire line. A piston-like mechanism is connected to the upper portion of the inner core barrel device, and assurance is had that a portion of the piston-like mechanism is always present within a tool joint of the string of drill pipe to insure an appropriate fit with the wall of the tool joint so that full advantage of the hydraulic lifting force can be taken without any substantial leakage past the piston mechanism. In the event that the drill pipe between its tool joints has a discontinuous cylindrical wall, a smooth, continuous lifting force is still always available to insure the appropriate and rapid hydraulic elevation of the inner core barrel mechanism through the string of drill pipe. Stated in another manner, the hydraulic pump-out or lifting force on the inner core barrel mechanism is obtained by "leap-frogging" such hydraulic force from one tool joint to the next. A piston portion of the mechanism is always available to make a sufficiently close fit with the wall of the tool joint to insure a smooth, continuous lifting force under the reverse circulation action of the fluid down around the outside of the drill string and then upwardly through the interior of the latter.

If desired, the mechanism can be used appropriately for rapidly and safely pumping the inner barrel mechanism down through the string of drill pipe to its coring position within the outer core barrel. However, the inner core barrel mechanism can, if desired, be both lowered and raised within the string of drill pipe on a wire line.

This invention possesses many other advantages, and has other purposes which may be made more clearly apparent from a consideration of a form in which it may be embodied. This form is shown in the drawings accompanying and forming part of the present specification. It will now be described in detail, for the purpose of illustrating the general principles of the invention; but it is to be understood that such detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

FIGURES 1*a*, 1*b* and 1*c* together constitute a longitudinal section, with parts being shown in side elevation, of a core barrel mechanism embodying the invention, disclosing the inner core barrel in appropriate coring position within the outer barrel, FIGS. 1*b* and 1*c* being lower continuations of FIGS. 1*a* and 1*b*, respectively;

FIG. 2 is an enlarged cross-section through the lower portion of the piston or swab device at its location of attachment to the inner barrel mechanism, this combination being disposed within the outer barrel;

FIG. 3 is a somewhat diagrammatic view illustrating the piston portion of the mechanism, with its lower part disposed within a lower tool joint of the string of drill pipe; and

FIG. 4 is a view similar to FIG. 3 illustrating the upper part of the piston portion of the mechanism disposed within an upper tool joint of the drill pipe string.

The coring apparatus A illustrated in the drawings is particularly designed for use with a string of drill pipe B. It embodies an inner core barrel structure **10** movable both downwardly and upwardly through the string of drill pipe, which is connected to an outer core barrel or housing **11**, the purpose of which is to rotate a core head or bit **12** attached to the latter. After a desired length of core has been formed and moved into the inner barrel structure **10**, it is retrieved by reversely circulating fluid downwardly around the exterior of the drill pipe B and the outer barrel **11**, such fluid passing upwardly into the outer barrel and acting on an upper piston mechanism **13** attached to the inner barrel device for continued pumping of the entire inner mechanism through the string of drill pipe to the top of the well bore C.

The inner and outer barrel mechanism illustrated is generally of a known type, and any suitable core barrel mechanism can be used in practicing certain aspects of the present invention. As specifically shown, the outer core barrel or housing **11** includes a plurality of outer core barrel sections **14** threadedly secured to one another to provide the appropriate core barrel length, which will vary depending upon the length of the inner core barrel and of its piston mechanism **13**. The lower outer core barrel section **14** is threadedly attached to the core head or bit **12**, which may be of any suitable type and which is disclosed as having tungsten carbide or diamond cutting elements **15** secured thereto for cutting the well bore C to the desired diameter and for producing the inner core for relative upward movement through the central core bit opening **16**. This outer barrel includes a hanger sub **17** interconnecting outer barrel sections **14** in spaced apart relation and an upper sub **18** having a safety joint box **19** threadedly receiving a safety joint pin **20**. The upper portion of the pin member **20** is a threaded box **21** threadedly secured to the lower pin **22** of a drill collar section **23** forming part of the drill pipe string B, that will, as is well known, extend to the top of the well bore for appropriate rotation by an operating mechanism (not shown).

The inner core barrel mechanism **10** can be pumped down through the string of drill pipe B, coming to rest within the outer core barrel **11** in suspended relation with respect thereto. As specifically shown, the lower section **28** of a tubular non-rotating inner core barrel **24** has a tapered guide or nose **25** inclined in a downward and inward direction, this lower guide portion having a suitable core catcher **26** therein adapted to coact with an internal tapered surface **27** of the lower section **28** for the purpose of embracing the core (not shown) after it is formed and preventing it from dropping out of the inner core barrel.

The inner core barrel extends upwardly within the outer core barrel **11** and is of a suitable length, which may, for example, be 20 feet, 30 feet, 60 feet. The upper end of the inner core barrel is threadedly secured to a pressure relief valve member or sub **29** having a port **30** therethrough communicating with a lateral sub port **31** with the exterior of the sub. A valve element **32** can seat downwardly on the sub **29** to prevent downward flow of fluid into the inner barrel **24**, lifting in the sub to permit the core rising in the inner barrel to bleed fluid through the ports **30**, **31** to the exterior of the sub **29**. The sub **29** is threaded to a tubular shaft **33** forming the inner portion of a swivel **34**. The shaft has an external flange **35** supported between upper and lower ball bearing devices **36** carried by an outer bearing housing **37** threadedly secured to a lift valve guide **38**, which is, in turn, threadedly secured to the lower end of a tubular lift valve member **39** having a downwardly facing valve seat **40** engageable by the head **41** of a lift valve **42**, the stem **43** of which is slidable in a guide bore or passage **44** of the lift valve guide **38**. The upper portion of the lift valve member **39** is threadedly attached to an elongate tubular or swab mandrel **45** that has a spear head **46** threadedly secured to its upper end, the spear head being adapted to be grasped by a suitable overshot portion (not shown) attached to a wire line (not shown), although a wire line need not be used in operating the mechanism illustrated.

The lift valve member **39** has a downwardly facing shoulder **47** adapted to rest upon an inwardly directed stop shoulder **48** formed upon a supporting sleeve **49** secured to the outer barrel **11**. As shown, the sleeve includes an upper circumferentially continuous portion **50** received within a recess **51** in the outer barrel between an upwardly facing shoulder **52** on the upper portion of an outer barrel section **14** and the lower end **53** of the hanger sub **17**. The sleeve **49** is provided with a plurality of longitudinal and circumferentially spaced slots **54** opening through the lower end of the sleeve and forming spring-like latch legs **55** having lower inwardly directed feet **56**, the latch legs and feet normally tending to occupy an inward position with the feet **56** disposed under the downwardly facing shoulder **47** of the suspension head or valve member **39**. The feet and latch legs are adapted to be cammed outwardly so as to have an effective internal diameter which is slightly greater than the maximum external diameter of the inner core barrel **24** and its lower portion. However, when occupying the normal inward position, such as disclosed in FIG. 1*b*, the effective internal diameter across the latch feet **56** is substantially less than the outside diameter of the inner core barrel.

The lower inner portions **57** of the latch feet are inclined in a downward and outward direction so as to be cammed outwardly when parts of the inner core barrel mechanism move upwardly thereagainst. To insure against inadvertent release of the latch feet from the suspension head, the lower shoulder **47** of the suspension head **39** is inclined in a downward and outward direction, engaging the upper ends of the feet **56** which are inclined in the same direction. By virtue of the coaction between these inclined surfaces, the suspension head **39** tends to hold the latch feet inwardly against the periphery of the head and under its shoulder **47**.

The swab or piston-like mechanism **13** is secured to the lift valve member or suspension head **39**, the lower end of the mandrel being threadedly attached thereto, as described above, there being a jam nut **58** threaded on this mandrel and engaging the upper end of the suspension head to prevent inadvertent unscrewing of the mandrel from the suspension head. The mandrel **45** itself is rather long, being longer than the length of a drill pipe or drill collar section, which typically may be 30 feet in length. The mandrel has a multiplicity of swab elements **59** mounted thereon, these swab elements comprising thin, flexible, metallic shims, which may be made of brass, surrounding the mandrel and longitudinally spaced from one another by short distances. Rubber or rubber-like O-ring seals **60** engage the upper and lower surfaces of each shim or swab element, and also bear against the periphery of the mandrel, there being spacer rings **61** between adjacent upper and lower O-ring seal members. The upper spear head **46** engages the uppermost spacer ring **61**, and by being tightened appropriately on the mandrel it will cause the O-rings **60** to snugly engage the inner portions of the swab or piston shims **59**, and the spacer rings **61**. Thus, each lift swab or piston segment or assembly consists of a brass, or similar, shim **59** disposed around the mandrel **45**, with an upper O-ring **60** bearing against the upper surface of the shim and an adjacent spacer ring **61**, and with a lower O-ring **60** bearing against the lower surface of the shim and a spacer ring therebelow, the O-ring seal members **60** also sealingly engaging the periphery of the mandrel.

The overall distance between the uppermost shim **59** and the lowermost shim **59** is substantially greater than the length of a drill pipe or drill collar section, so that assurance is had that, at any time, one or a plurality of shims or piston-like elements **59** are disposed within at least one of the tool joints of the drill pipe string. As is well known in the art, a tool joint **70** or **71** (FIGS. 3 and 4) includes a threaded box portion **72**, as at the upper end of a drill pipe section **73**, which threadedly receives a pin **74**, as at the lower end of an adjacent drill pipe section. The threaded pin member and the threaded box member are accurately machined so as to have a predetermined inside diameter; whereas, there may be a drift from the desired internal diameter of the extended portion of a section of drill pipe or drill collar between its upper box **72** and its lower pin portion **74**.

The external diameter of each shim **59** is such that the shim makes a close fit with the inside diameter of the tool joint **70**, **71**. As an example, the outside diameter of each shim or each piston element may have a diameter which is less by 0.050 inch than the inside diameter of the tool joints. This leaves adequate clearance and provides flexibility to prevent any of the pistons or shim elements from hanging up on a pin shoulder while the apparatus is being pumped upwardly through the string of drill pipe B. However, the shim is sufficiently close to the inside diameter of the tool joint as to secure appropriate hydraulic lift on a piston or shim, to raise the entire internal mechanism through the drill pipe to the surface. As an example, if a section of drill pipe is 30 feet in length, the distance between the uppermost and lowermost shims or piston elements **59** can be selected at about 32 feet, which will insure the presence of a plurality of shims or pistons **59** within one of the tool joints **70**, **71** in the entire drilling string at all times.

Assuming the string of drill pipe B is disposed in the well bore in connection with the outer barrel **11** and the core bit **12**, but that the inner barrel **24** and swab assembly **13** are at the top of the well bore, the latter is suitably elevated and inserted into the drill pipe string B and then pumped downwardly therethrough. After the inner barrel reaches and moves within the outer barrel, the lower end **25** of the barrel **24** engages the latch feet **56** and deflects them laterally outwardly, permitting the inner barrel to move downwardly to its final position. The latch legs **55**

and feet **56** then spring inwardly so that the shoulder **47** on the suspension head comes to rest upon the upper ends of the latch feet **56**, the parts then occupying the relative positions illustrated in FIGS. 1*a*, 1*b* and 1*c*. It will be noted that the inside diameter of the outer barrel sections **14** above the hanger sub **17** is greater than the outside diameter of the shims **59**, but that the hanger member **39** fits closely within a sleeve **17***a* secured to the sub by welding material **17***b*. Fluid pumped downwardly through the string of drill pipe B will then flow through by-pass passages or grooves **80** in the sub **18** surrounding the spear head **46**, and then downwardly around the exterior of the shims **59**, the drilling fluid passing inwardly through ports **81** in the lift valve member or suspension head to the interior passage **82** of the latter, shifting the valve head **41** downwardly from its seat **40** against the force of a return spring **83**, the fluid proceeding outwardly through lower ports **84** in the valve member and then around the exterior of the swivel **34** and the inner tube **24**, discharging through passages (not shown) in the bit **12** and across the face of the latter and its cutting elements **15**, to convey the cuttings upwardly around the exterior of the outer barrel **11** and the drill pipe B back to the surface of the well bore C. While the fluid is being circulated, the drill string B and bit **12** are being rotated and appropriate drilling weight applied to the bit to cut the annular portion of the formation and produce the core, which passes relatively upwardly through the central opening **16** in the bit and through the core catcher or lifter **26** into the inner barrel **24**.

When the inner barrel is filled with the core produced by the drill bit, rotation of the drill pipe B is discontinued and the entire drill pipe string picked up to break the core at the bit **12**, the core lifter **26** moving slightly downwardly and inwardly to snugly embrace the core. The suction side of the mud pumps (not shown) at the top of the well bore may be connected to the interior of the string of drill pipe B and the discharge side connected to the annular space between the string of drill pipe B and the wall of the well bore C, fluid being pumped downwardly through the annular space and then upwardly into the space between the inner core barrel **24** and outer barrel **11**. The upwardly moving fluid closes the lift valve **42** and shifts the piston-like head **39** upwardly within the sleeve **17***a*, carrying the entire inner barrel mechanism upwardly as a unit and shifting the uppermost shims **59** into the safety joint pin **20**, with which they make a close fit. With the shims in the pin **20**, the hanger **39** can be out of the sleeve **17***a*, the fluid then acting on the swab or piston elements **59** to lift the entire inner core barrel assembly upwardly and bringing the uppermost shims through the pin of the safety joint into the drill pipe string B. Because of the multiplicity of piston elements or shims, which, for example, may be separated from one another by about a half inch, assurance is had that several shim or piston elements **59** will be disposed within a closely confining tool joint **70**, **71** at all times, so that the fluid moving upwardly through the pipe B exerts a positive lifting force on the swab or piston assembly to raise the inner core barrel **24** with it through the entire string of drill pipe to the top of the well bore. As disclosed in FIG. 3, for example, when a series of lowermost shims **59** on the mandrel are disposed within a lower tool joint **70**, upper shims are on the verge of entering the upper tool joint **71**. Before the lowermost shims leave or rise above the lower tool joint **70**, upper shims will be disposed within an upper tool joint **71** (FIG. 4). Shims **59** will be located within the upper tool joint **71** until shims on the mandrel **45** have entered the next higher tool joint, such progression of shims from tool joint to tool joint continuing all the way to the top of the well bore.

Because of the presence of shim or piston elements **59** in at least one tool joint at all times, it is immaterial whether the main length of a drill pipe or drill collar joint between its pin and box is non-cylindrical over a portion or of oversize internal diameter. The tool joints each have appropriate cylindrical inner walls, and if the portion of a section of drill pipe or drill collar between tool joints tends to substantially by-pass fluid, the hydraulic lift on the swab mechanism is obtained in the bores of the tool joints, in effect causing the lifting force to pass from one tool joint to the next tool joint, thereby giving a smooth and continuous hydraulic lift with reverse circulation to the apparatus, and permitting it to be conveyed at rather rapid and safe speeds through the string of drill pipe B to the top of the well bore.

Actual field tests of the mechanism have demonstrated that the travelling assembly can be displaced safely from the bottom of the well bore to the rig floor at speeds of 540 feet per minute. Thus, wire lines are unnecessary to the operation of the apparatus, although, if desired, retrieval can be effected through use of a wire line (not shown), since the spear head **46** is present to be grasped by an overshot on the lower end of the wire line, the inner core barrel assembly then being removed in a conventional manner.

During removal of the inner assembly **10** from the outer core barrel **11**, elevation of the inner assembly causes the several elements to engage the lower inclined surfaces **57** of the feet **56** of the latch sleeve **49** to deflect them out of the way, until the lower end **25** of the barrel **24** passes upwardly through the latch assembly.

I claim:

1. In apparatus for performing a coring operation in a borehole: a string of drill pipe comprising pipe sections secured to one another by tool joints; an outer core barrel operatively associated with said string of drill pipe; an inner core barrel structure adapted for longitudinal movement through the string of drill pipe between a position within the outer core barrel and a position at the top of the bore hole; and elongate piston means connected to said inner core barrel structure and having a length greater than the distance between succeeding tool joints, whereby a portion of said piston means always fits closely within a tool joint during travel of said piston means in said drill pipe to be acted upon by fluid moving through the drill string to hydraulically convey said piston means and inner core barrel structure through the string of drill pipe.

2. In apparatus as defined in claim **1**; wherein said piston means comprises a mandrel and a multiplicity of spaced piston elements mounted on said mandrel, the distance between the uppermost and lowermost piston elements exceeding the length of each pipe section, said piston elements being of a diameter to fit closely within said tool joints.

3. In apparatus as defined in claim **1**: wherein said piston means comprises a mandrel and a multiplicity of spaced flexible piston elements mounted on said mandrel, the distance between the uppermost and lowermost piston elements exceeding the length of each pipe section, said piston elements being of a diameter to fit closely within said tool joints.

4. In apparatus as defined in claim **1**; wherein said piston means comprises a mandrel and a multiplicity of spaced metallic piston shims mounted on said mandrel, the distance between the uppermost and lowermost piston shims exceeding the length of each pipe section, said piston shims being of a diameter to fit closely within said tool joints.

5. In apparatus as defined in claim **1**; wherein said piston means comprises a mandrel, a multiplicity of piston elements mounted on said mandrel, the distance between the uppermost and lowermost piston elements exceeding the length of each pipe section, said piston elements being of a diameter to fit closely within said tool joints, and spacer means on said mandrel between said elements to hold said elements longitudinally spaced from each other.

6. In apparatus as defined in claim **1**; wherein said piston means comprises a mandrel and a multiplicity of

metallic piston shims mounted on said mandrel, the distance between the uppermost and lowermost piston shims exceeding the length of each pipe section, said piston shims being of a diameter to fit closely within said tool joints, and spacer means on said mandrel between said shims to hold said shims longitudinally spaced from each other.

7. In apparatus for performing a coring operation in a bore hole: a string of drill pipe comprising pipe sections secured to one another by tool joints; an outer core barrel operatively associated with said string of drill pipe; an inner core barrel structure adapted for longitudinal movement through the string of drill pipe between a position within the outer core barrel and a position at the top of the bore hole; elongate piston means connected to said inner core barrel structure and having a length greater than the distance between succeeding tool joints, whereby a portion of said piston means always fits closely within a tool joint during travel of said piston means in said drill pipe to be acted upon by fluid moving through the drill string to hydraulically convey said piston means and inner core barrel structure through the string of drill pipe; said inner core barrel structure including an inner core barrel and an upper portion carrying said inner core barrel and connectible to said outer core barrel to suspend said inner core barrel therefrom, said upper portion having a fluid passage therethrough, and valve means adapted to close said passage against upward flow of fluid therethrough but opening to permit downward flow of fluid therethrough.

8. In apparatus as defined in claim 7; wherein said piston means comprises a mandrel and a multiplicity of spaced piston elements mounted on said mandrel, the distance between the uppermost and lowermost piston elements exceeding the length of each pipe section, said piston elements being of a diameter to fit closely within said tool joints.

9. In apparatus as defined in claim 7; wherein said piston means comprises a mandrel and a multiplicity of spaced flexible piston elements mounted on said mandrel, the distance between the uppermost and lowermost piston elements exceeding the length of each pipe section, said piston elements being of a diameter to fit closely within said tool joints.

10. In apparatus as defined in claim 7; wherein said piston means comprises a mandrel and a multiplicity of spaced metallic piston shims mounted on said mandrel, the distance between the uppermost and lowermost piston shims exceeding the length of each pipe section, said piston shims being of a diameter to fit closely within said tool joints.

11. In apparatus as defined in claim 7; wherein said piston means comprises a mandrel and a multiplicity of metallic piston shims mounted on said mandrel, the distance between the uppermost and lowermost piston shims exceeding the length of each pipe section, said piston shims being of a diameter to fit closely within said tool joints, and spacer means on said mandrel between said shims to hold said shims longitudinally spaced from each other.

12. In apparatus as defined in claim 7; wherein said inner core barrel is disposed below said elongate piston means; said outer core barrel including an elongate portion receiving said elongate piston means when said inner core barrel is suspended from said outer core barrel, said elongate portion having an inside diameter greater than the outside diameter of said piston means to permit fluid to flow around the exterior of said piston means and into said fluid passage; said upper portion of said inner core barrel fitting closely within a portion of said outer barrel when said inner core barrel is suspended from said outer core barrel to enable fluid forced upwardly in said outer barrel to act on said upper portion and elevate said inner core barrel structure and piston means in said outer core barrel to a position in which said piston means is disposed in said drill pipe with a portion of said piston means fitting within a tool joint.

13. In apparatus for performing an operation in a bore hole: a string of drill pipe comprising pipe sections secured to one another by tool joints; and outer member operatively associated with said string of drill pipe; an inner structure adapted for longitudinal movement through the string of drill pipe between a position within the outer member and a position at the top of the bore hole; and elongate piston means connected to said inner structure and having a length greater than the distance between succeeding tool joints, whereby a portion of said piston means always fits closely within a tool joint during travel of said piston means in said drill pipe to be acted upon by a fluid moving through the drill string to hydraulically convey said piston means and inner structure through the string of drill pipe.

14. In apparatus as defined in claim 13; wherein said piston means comprises a mandrel and a multiplicity of spaced piston elements mounted on said mandrel, the distance between the uppermost and lowermost piston elements exceeding the length of each pipe section, said piston elements being of a diameter to fit closely within said tool joints.

15. In apparatus as defined in claim 13; wherein said piston means comprises a mandrel and a multiplicity of spaced metallic piston shims mounted on said mandrel, the distance between the uppermost and lowermost piston shims exceeding the length of each pipe section, said piston shims being of a diameter to fit closely within said tool joints.

16. In apparatus as defined in claim 13; wherein said piston means comprises a mandrel and a multiplicity of metallic piston shims mounted on said mandrel, the distance between the uppermost and lowermost piston shims exceeding the length of each pipe section, said piston shims being of a diameter to fit closely within said tool joints, and spacer means on said mandrel between said shims to hold said shims longitudinally spaced from each other.

17. An inner core barrel structure adapted for longitudinal movement through a string of drill pipe disposed in a bore hole between a position within an outer core barrel operatively associated with the drill pipe string and a position at the top of the bore hole, the drill pipe string including pipe sections secured to one another by tool joints, comprising an inner core barrel, and elongate piston means connected to said inner core barrel and having a length greater than the distance between succeeding tool joints, whereby a portion of said piston means always fits within a tool joint during travel of said piston means in said drill pipe to be acted upon by a fluid moving through the drill string to hydraulically convey said piston means and inner core barrel structure through the string of drill pipe.

18. In apparatus as defined in claim 17; wherein said piston means comprises a mandrel and a multiplicity of spaced piston elements mounted on said mandrel, the distance between the uppermost and lowermost piston elements exceeding the length of each pipe section, said piston elements being of a diameter to fit closely within the tool joints.

19. In apparatus as defined in claim 17; wherein said piston means comprises a mandrel and a multiplicity of spaced metallic piston shims mounted on said mandrel, the distance between the uppermost and lowermost piston shims exceeding the length of each pipe section, said piston shims being of a diameter to fit closely within the tool joints.

20. In apparatus as defined in claim 17; wherein said piston means comprises a mandrel and a multiplicity of metallic piston shims mounted on said mandrel, the distance between the uppermost and lowermost piston shims exceeding the length of each pipe section, said piston shims being of a diameter to fit closely within the tool

joints, and spacer means on said mandrel between said shims to hold said shims longitudinally spaced from each other.

21. In apparatus as defined in claim 17; wherein said piston means comprises a mandrel and a multiplicity of spaced flexible piston elements mounted on said mandrel, the distance between the uppermost and lowermost piston elements exceeding the length of each pipe section, said piston elements being of a diameter to fit closely within the tool joints.

22. An inner core barrel structure adapted for longitudinal movement through a string of drill pipe disposed in a bore hole between a position within an outer core barrel operatively associated with the drill pipe string and a position at the top of the bore hole, the drill pipe string including pipe sections secured to one another by tool joints, comprising an inner core barrel, and elongate piston means connected to said inner core barrel and having a length greater than the distance between succeeding tool joints, whereby a portion of said piston means always fits within a tool joint during travel of said piston means in said drill pipe to be acted upon by a fluid moving through the drill string to hydraulically convey said piston means and inner core barrel structure through the string of drill pipe; said inner core barrel structure further including an inner core barrel and an upper portion adapted to carry said inner core barrel and adapted for connection to the outer core barrel to suspend the inner core barrel therefrom, said upper portion having a fluid passage therethrough, and valve means adapted to close said passage against upward flow of fluid therethrough but opening to permit downward flow of fluid therethrough.

23. In apparatus as defined in claim 22; wherein said piston means comprises a mandrel and a multiplicity of spaced piston elements mounted on said mandrel, the distance between the uppermost and lowermost piston elements exceeding the length of each pipe section, said piston elements being of a diameter to fit closely within the tool joints.

24. In apparatus as defined in claim 22; wherein said piston means comprises a mandrel and a multiplicity of spaced metallic piston shims mounted on said mandrel, the distance between the uppermost and lowermost piston shims exceeding the length of each pipe section, said piston shims being of a diameter to fit closely within the tool joints.

25. In apparatus as defined in claim 22; wherein said piston means comprises a mandrel and a multiplicity of metallic piston shims mounted on said mandrel, the distance between the uppermost and lowermost piston shims exceeding the length of each pipe section, said piston shims being of a diameter to fit closely within the tool joints, and spacer means on said mandrel between said shims to hold said shims longitudinally spaced from each other.

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