April 29, 1969 L. J. MARTINSEN 3,441,098

CORE DRILLING SYSTEM

Filed Aug. 10, 1966 Sheet 1 of 4

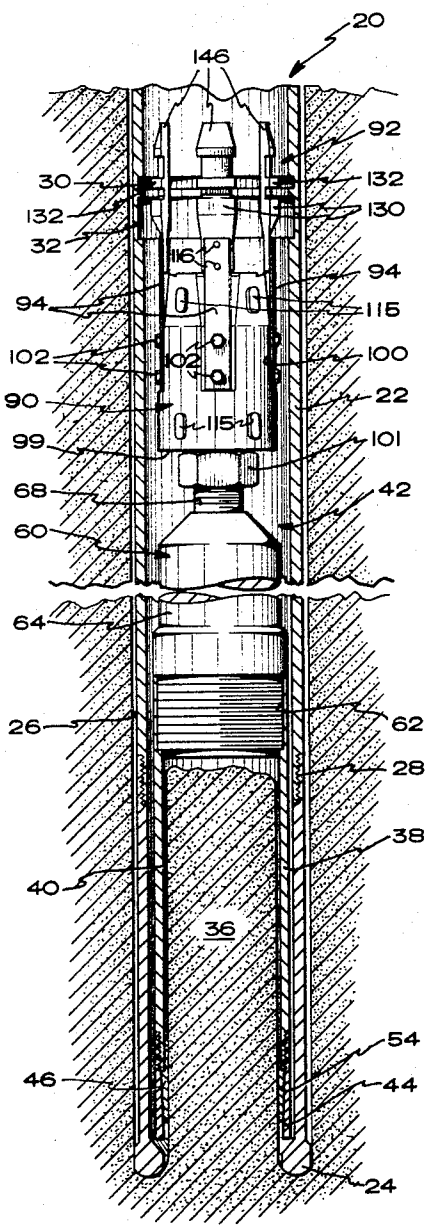


FIG. 1.

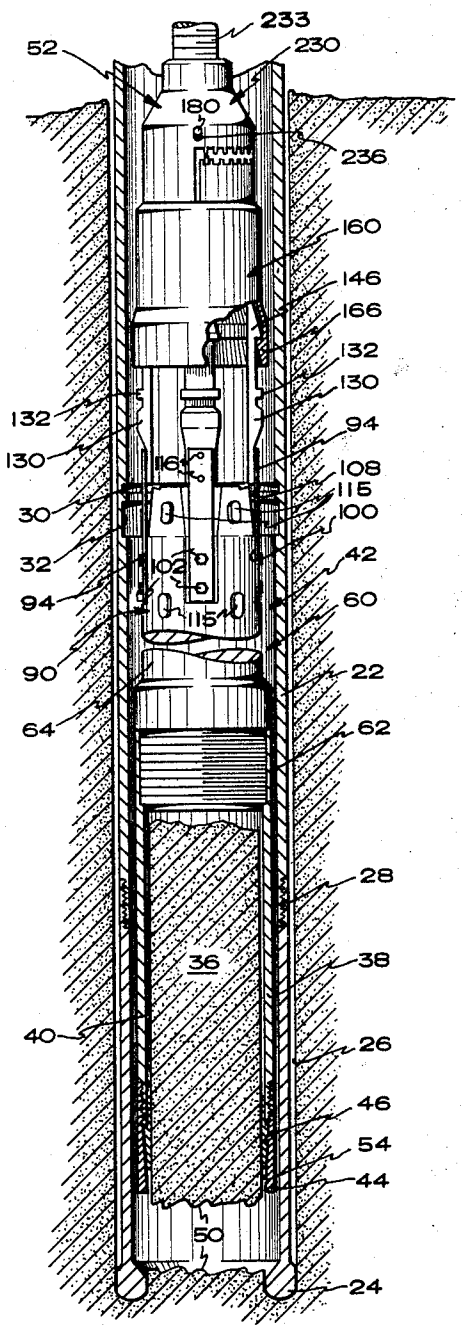


FIG. 2.

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April 29, 1969 L. J. MARTINSEN 3,441,098

CORE DRILLING SYSTEM

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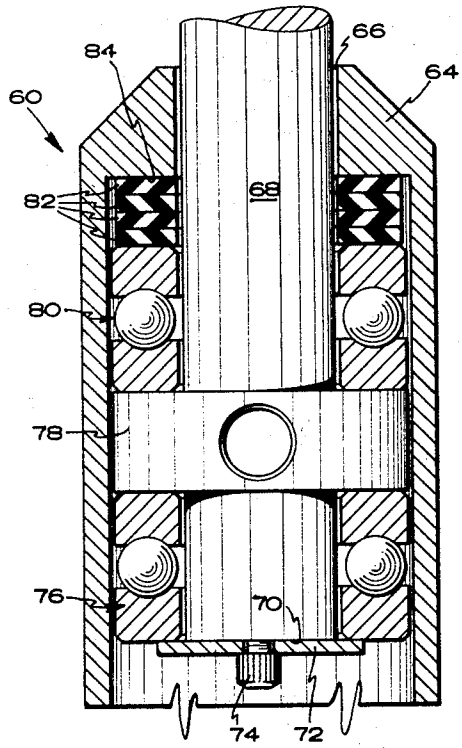


FIG. 3

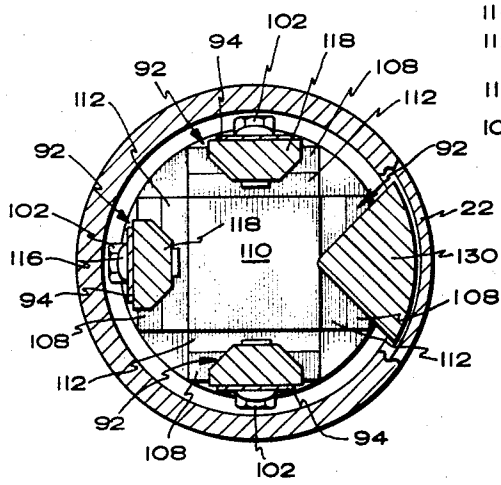


FIG. 5

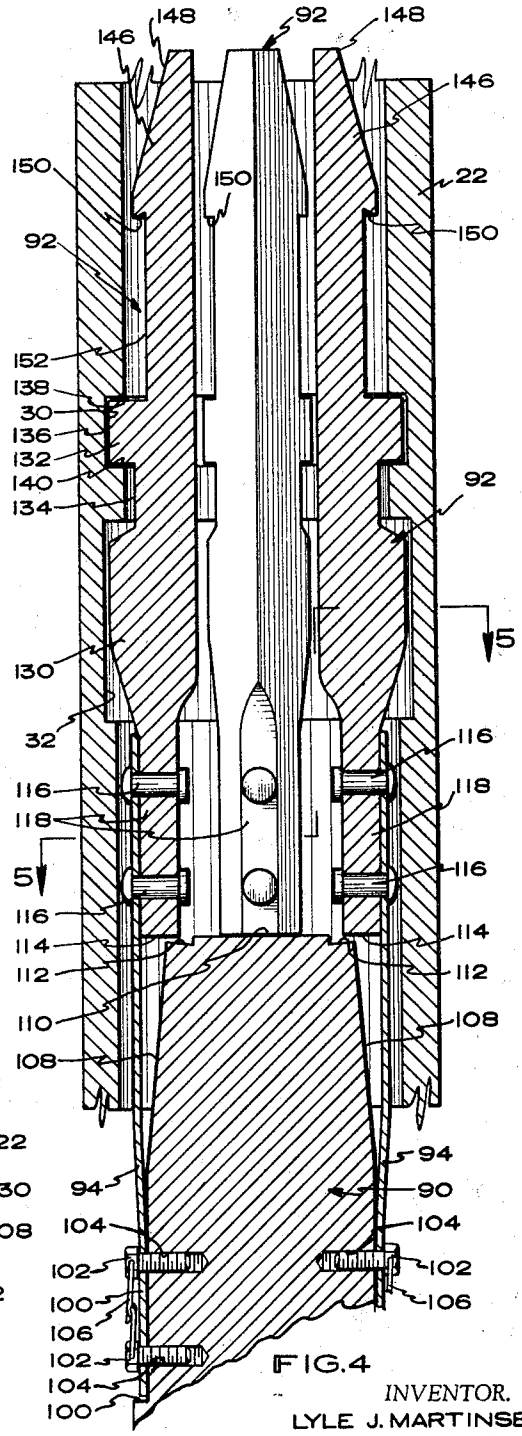


FIG. 4

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April 29, 1969 L. J. MARTINSEN 3,441,098

CORE DRILLING SYSTEM

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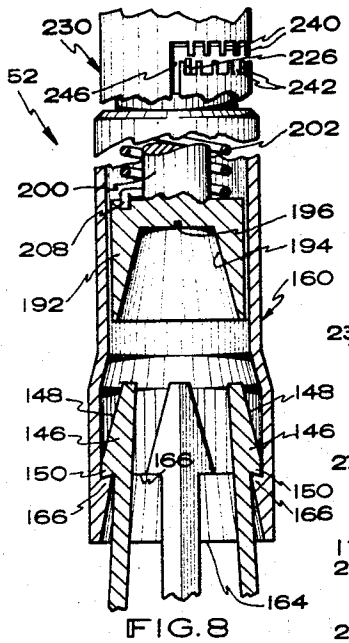


FIG. 8

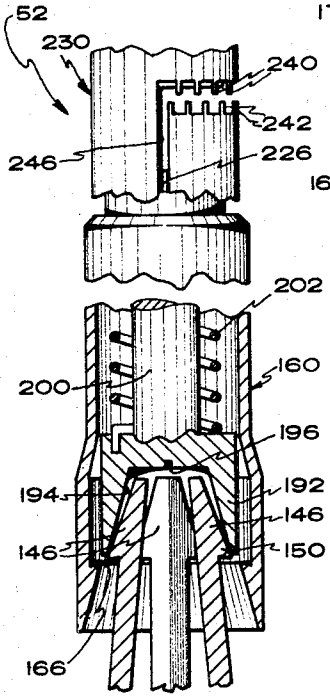


FIG. 9

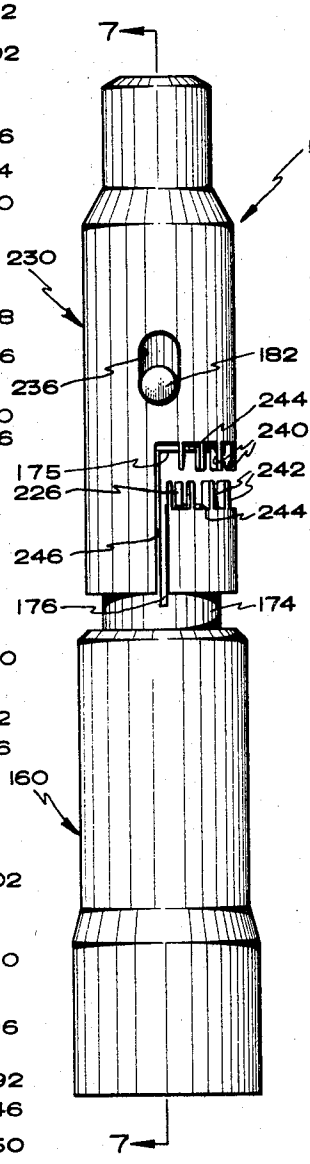


FIG. 6

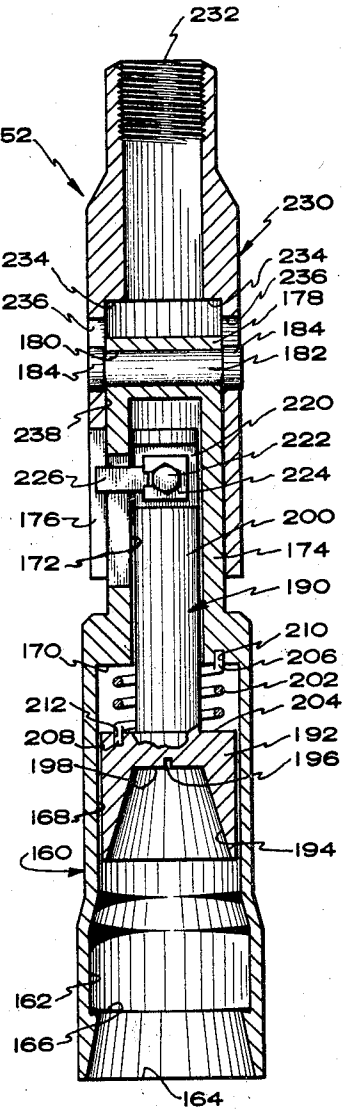


FIG. 7

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CORE DRILLING SYSTEM

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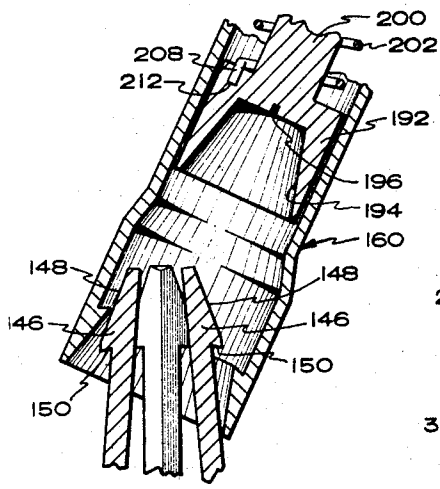


FIG. 10

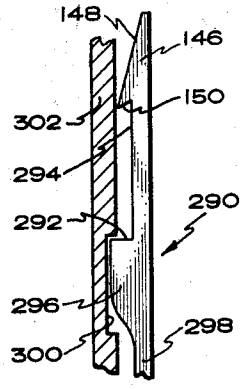


FIG. 12

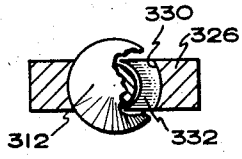


FIG. 14

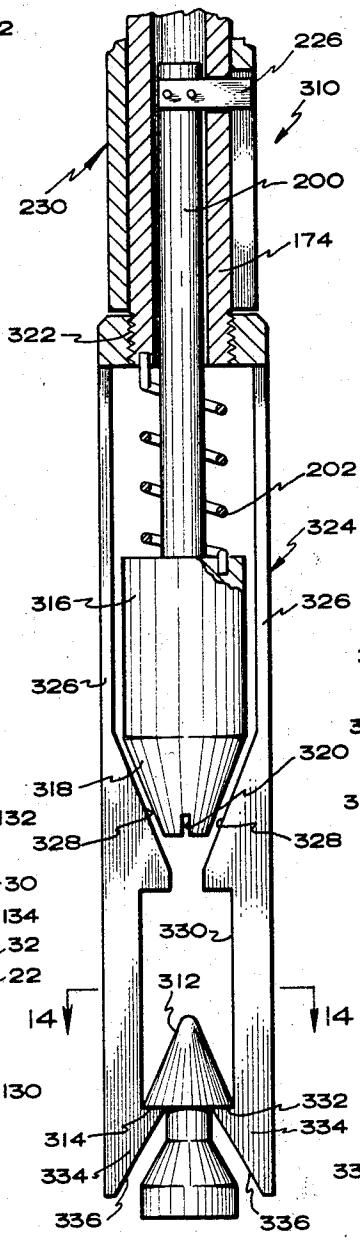


FIG. 13

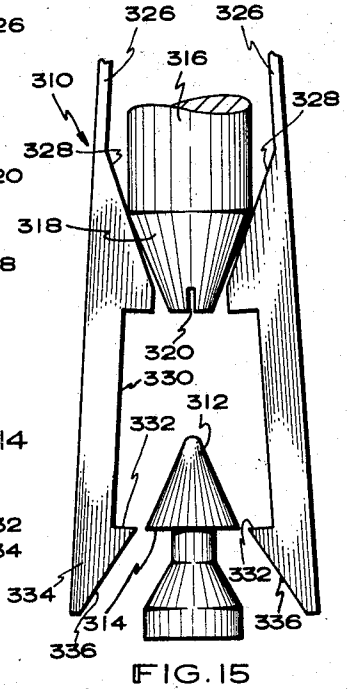


FIG. 15

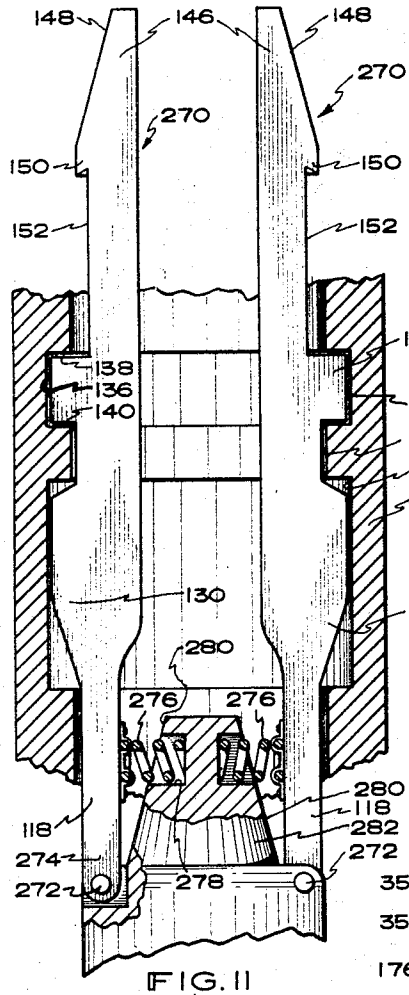


FIG. 11

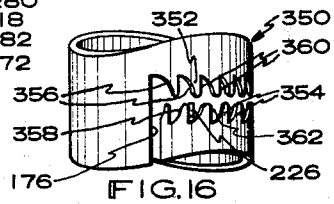


FIG. 16

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United States Patent Office 3,441,098 Patented Apr. 29, 1969

3,441,098

CORE DRILLING SYSTEM

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Filed Aug. 10, 1966, Ser. No. 571,521
Int. Cl. E21b 9/20, 25/00, 31/00
U.S. Cl. 175—246 10 Claims

ABSTRACT OF THE DISCLOSURE

A core barrel assembly comprising a novel spearhead latching-outer tube coupling latch structure, having no mechanically moving parts thereby avoiding the "sanding up" problems of the prior art and which (a) securely couples the core barrel assembly to an outer tube of a drill string during drilling, and (b) latches to a novel overshot for reliable placement and removal of the core barrel assembly in and from coupled relation with the outer tube, the overshot being adapted to uncouple the core barrel assembly from the outer tube immediately prior to latching the overshot to the spearhead structure. The latched condition between the overshot and the core barrel assembly is sure and cannot inadvertently be severed. The presently preferred novel overshot provides a new release feature which accommodates selective or controlled release of its coupling relation with the spearhead of the core barrel assembly within the drill hole when an operator pumps the wire line, to which the overshot is attached, up and down a prescribed number of times. Structurally, the preferred overshot comprises a bell housing, a biased interior plunger and plunger release mechanism including a release housing which, in combination, can be situated in a latched posture or a released posture according to the desire of the operator. Structurally, the preferred latch structure of the core barrel assembly comprises circumferentially-spaced fingers each yieldable in a radial direction through fish-tail motion and each seriatim presenting at the outer surface a ski, adapted to solely contact the interior surface of the outer tube and/or drill string when the core barrel assembly is, for example, being displaced by gravity into its drilling position, an outer tube-coupling ridge, which locks the core barrel assembly to the outer tube against axial displacement in either direction, and a spearhead hook, for receiving and latching to the overshot only after the fingers have been gathered to cause uncoupling of the core barrel assembly from the outer tube.

The present invention relates generally to a novel core drilling system, including method and apparatus, and more particularly to a unique wire line core barrel assembly and a novel overshot. The core barrel assembly of this invention features a new combination spearhead latching-outer tube coupling structure which requires no mechanically moving parts and which accommodates fail-safe coupling with the outer tube of a drill string regardless of the direction of drilling. The core barrel assembly is uncoupled from the outer tube as a result of advancing the overshot toward the bit at a point in time before latching of the overshot onto the core barrel assembly takes place, rather than after overshot latching and during retracting of the overshot as has been the practice in the art until this invention. Hence, it is not possible to latch the overshot onto the core barrel assembly only to find out that the latch assembly is "sanded up" or otherwise "frozen" in coupled position with the outer tube. Moreover, the overshot of this invention provides a new release feature to, under precise control of the operator, selectively accommodate unlatching and/or prevent subsequent latching to the core barrel assembly.

In core drilling, it has been customary to employ an annular drilling bit which is disposed at the distal end of an outer tube carried at the distal end of a drill string and which progressively cuts through rock, responsive to rotation of the drill string, leaving an uncut, upwardly projecting rock core central of the bit. As drilling proceeds the core incrementally becomes disposed within a core-receiving barrel or inner tube of the core barrel assembly, which has been positioned in the drill string and releasably coupled with the outer tube by a latch assembly of the core barrel assembly. A swivel mechanism is interposed between the core-receiving barrel and the core barrel latch assembly so that the latch assembly normally rotates with the drill string and the core-receiving barrel normally is stationary during drilling.

When the length of core has become disposed in the core-receiving barrel sufficient to fill the barrel (usually several feet long), the drill string and/or the core barrel is displaced a short distance away from the leading end of the hole adequate to break the core from the rock formation. Afterward, the overshot, carried at the end the the wire line (cable), is latched to the spearhead of the core barrel assembly, the core barrel assembly is uncoupled from the outer tube by movement of the core barrel assembly away from the bit and the overshot and latched core barrel assembly are withdrawn, along with a broken core, from the drill string.

Use of such prior art systems has presented several significant problems, some of which are enumerated and discussed below.

Experience has shown that such prior art systems are not safe for all drilling directions. More specifically, when drilling in an upward direction, either vertically up or at an upward angle with respect to the horizontal, prior core barrel assemblies have tended to inadvertently become uncoupled from the outer tube. When so uncoupled, such core barrel assemblies have been known to accelerate, as a projectile, down the hole to the surface causing extensive human injury and suffering, to say nothing of equipment damage. In its broadest aspect, this problem arises because the latch assembly of prior art core barrel assemblies releases the outer tube coupling as the core barrel assembly is displaced away from the end of the hole by a latched overshot. Consequently, the relatively heavy weight of such prior art core barrel assemblies tends to inherently release the outer tube coupling when drilling counter to gravity.

Prior commercially utilized core barrel latch assemblies have conventionally contained a number of mechanical parts which have been required to mechanically move relative to each other when coupling and uncoupling the core barrel assembly from the outer tube. Such latch assemblies, under certain drilling conditions, will become "sanded up" so that it is difficult, if not impossible, to cause the parts to mechanically move a sufficient distance relative to each other to uncouple the core barrel assembly from the outer tube. To release a "sanded up" latch assembly from the outer tube, significantly high forces are exerted on the latch assembly through the wire line and latched overshot, often resulting in shear failure of the spearhead at the distal end of the core barrel assembly. Thereafter, expensive and time-consuming techniques must be used to remove the broken core barrel assembly from the hole or to remove the entire drill string.

Moreover, the existence of the mentioned "sanded up" condition cannot be ascertained, using prior art equipment, until after the overshot has been securely latched to the spearhead and a retraction force applied. Thereafter, unlatching of the overshot from the spearhead, when necessary, is awkward, time consuming, and un-

reliable. The most common way of unlatching the overshot from the spearhead of the core barrel assembly is to use a split sleeve which, under certain conditions, slides over the back ends of conventional lifting dogs, which function as jaws, to thereby counter-bias the dogs into an open, unlatched position. The same problem holds true when endeavoring to release the core barrel assembly for coupling with the outer tube after the core barrel assembly has been lowered into the drill string using an overshot carried at the end of a wire line. In either case, close control by the wire line operator over the placement of the split sleeve over the back ends of the lifting dogs to release the core barrel assembly from the overshot is not possible. Inadvertent unlatching of the core barrel assembly from the overshot is common place.

When the split sleeve is inadvertently actuated to bias the lifting dogs in open position and release the core barrel assembly, as when the overshot and latched core barrel assembly are being placed in a downwardly extending "dry" hole or removed from a hole which deviates from being straight as is often the case, the core barrel assembly will fall with great force against and frequently break the expensive bit.

Other prior art problems include: (1) failure to maintain the leading end of the core barrel assembly in spaced relation to and out of wearing-contact with the bit during drilling, counter to water pressure, and (2) failure to provide an adequate spearhead latching surface area.

In summary, the core drilling system according to this invention features a new combination spearhead latching-outer tube coupling latch structure for a core barrel assembly and comprises yieldable fingers, requiring no mechanically moving parts. The latch structure accommodates fail-safe coupling with the outer tube of a drill string regardless of the direction of drilling. The core barrel assembly is uncoupled from the outer tube by the gathering of the resilient fingers as a result of advancing the overshot toward the bit at a point in time before latching of the overshot onto the spearhead structure core barrel assembly takes place, rather than after the overshot latching and during retraction of the overshot. The latched condition between the overshot and core barrel assembly cannot be destroyed inadvertently, but is possible only when the operator elects to sever the relation. The overshot of this invention thus provides a new release feature to, under precise control of the operator, selectively accommodate unlatching and/or prevent subsequent latching of the spearhead structure of the core barrel assembly. When a wire line operator desires to release the overshot, the operator merely pumps up and down on the wire line, which is attached to the overshot, a preset number of times until the overshot becomes disposed in a disabled position and the core barrel assembly is released from the overshot.

Accordingly, the present invention is a worthwhile contribution to the core drilling art because it provides a system which substantially overcomes the above-mentioned problems of the prior art. Though not anticipatory of the present invention, the most structurally comparable known prior art patents are U.S. Patents 1,716,092 and 2,508,285.

In view of the foregoing, it is a primary object of this invention to provide an improved, inherently safe wire line core barrel system possessing novel features for securely coupling to and easily uncoupling from an outer tube of a drill string.

Another important object is the provision of an inherently safe system for securely latching a core barrel assembly to an outer tube against inadvertent release for drilling with or counter to gravity.

A further principal object is the provision of a core barrel latch assembly comprising an open construction including yieldable prong means for both coupling to an outer tube and latching with an overshot, which prong means does not require mechanical moving parts and cannot normally become "sanded up."

Other significant objects are: (1) provision of a core barrel latch assembly which, counter to water pressure, retains the inner tube of the core barrel assembly separate from the rotating bit during drilling operation to reduce wear; (2) provision of a core barrel assembly which compressively yields in an axial direction during breaking of hard core so that the distal end of the inner tube will come to rest on the bit and, hence, the principal core-breaking load will be borne by the outer tube rather than the core barrel assembly; (3) provision of a core barrel assembly-overshot combination which reduces the likelihood of spearhead shear failure by manifoldly increasing the spearhead latching surface area; and (4) provision of a combination overshot-core barrel assembly which accommodates easy manual separation of the overshot from the core barrel assembly at the drilling surface.

These and other objects and features of the present invention will become more fully apparent from the following description and appended claims taken in conjunction with the accompanying drawings wherein:

FIGURE 1 is a fragmentary elevation shown partly in cross section of a presently preferred novel core barrel assembly embodiment of this invention operatively coupled to the outer tube of a drill string disposed in a hole;

FIGURE 2 is an elevational view similar to FIGURE 1 showing the core barrel assembly uncoupled from the outer tube and being removed from the hole, along with the broken core, using one presently preferred overshot embodiment of this invention;

FIGURE 3 is a fragmentary cross section shown in elevation of a centrally disposed swivel mechanism of the core barrel assembly of FIGURE 1;

FIGURE 4 is a fragmentary cross section elevation of the novel outer tube coupling-spearhead latching assembly of the core barrel assembly of FIGURE 1;

FIGURE 5 is a cross section in plan taken along line **5—5** of FIGURE 4;

FIGURE 6 is an elevation of the overshot of FIGURE 2;

FIGURE 7 is an elevational cross section of the overshot of FIGURE 2 taken along line **7—7** of FIGURE 6;

FIGURE 8 is a fragmentary cross section shown in elevation of the overshot of FIGURE 6 shown with the plunger thereof in the retracted position and the spearhead or prong hooks, disposed at the distal end of each prong, latched to the overshot;

FIGURE 9 is a fragmentary cross section similar to FIGURE 8 illustrating the plunger in the extended position which (a) detaches the spearhead or prong hooks from the overshot when previously latched, and (b) prevents subsequent latching of the spearhead hook with the overshot;

FIGURE 10 is a fragmentary elevation shown partly in cross section illustrating the easy mode of manual surface detachment of the overshot of FIGURE 2 from the core barrel assembly of FIGURE 2;

FIGURE 11 is a fragmentary elevation of a second presently preferred outer tube coupling-spearhead latching assembly of this invention with parts omitted and broken away for clarity;

FIGURE 12 is a fragmentary elevation of a third presently preferred outer tube coupling-spearhead latching assembl of this invention;

FIGURE 13 is a fragmentary elevation shown partly in cross section of a second presently preferred overshot embodiment of this invention shown with a plunger retracted and the overshot latched to a conventional spearhead;

FIGURE 14 is a cross section in plan taken along line **14—14** of FIGURE 13;

FIGURE 15 is a fragmentary elevation of the overshot of FIGURE 13 with the plunger extended and the conventional spearhead unlatched; and

FIGURE 16 is a fragmentary side elevation illustrating another presently preferred overshot embodiment having modified teeth construction at the release housing.

General

Reference is now made to the drawings wherein like numerals are used to identify like parts throughout. FIGURES 1 and 2 depict a core drilling system manufactured according to the present invention and generally designated **20**. Some parts of the core drilling system **20** are conventional and some are decidedly novel. More particularly, the core drilling system **20** comprises an outer tube **22**, a bit **24**, and a string of drill pipe (not shown) positioned in a downwardly extending hole **26** in the earth, all of which is conventional. The sections of the drill string are normally threadedly coupled one to another and the last section is threadedly coupled to the outer tube **22**. In turn, the outer tube **22** is threadedly connected at **28** to the hollow bit **24**. The bit **24** may be of any suitable type capable of drilling through rock formations, diamond bits being commonly used for this purpose.

For purposes which will subsequently become more fully understood, the outer tube **22** is provided with an upper two-way coupling annular recess **30** and a closely spaced somewhat larger lower annular recess **32**.

During the drilling, as is conventional, the drill string along with the outer tube **22** and the bit **24** are rotated by conventional apparatus (not shown) causing the bit to progressively cut an annular hole in the rock, leaving an uncut rock core **36** within the hollow of the bit, which core incrementally increases in length as drilling proceeds.

As the core **36** lengthens beyond the bit **24**, it is accepted within a core receiving hollow **40** of an inner tube **38** of a core barrel assembly, generally designated **42**, through the inner tube shoe **44** and a core spring **46**. This also is conventional.

Once the core **36** has grown to substantially fill the inner tube **38**, the outer tube **22** along with the core barrel assembly **42**, is elevated slightly to break the core as at **50** (FIGURE 2). When the core is particularly soft, it may only be necessary to elevate the core barrel assembly to break the core. Thereafter, the core barrel assembly is uncoupled from the outer tube and elevated to the surface, using an overshot, in the case of this invention the novel overshot generally designated **52** (FIGURE 2) is used.

The core spring **46**, which rests along the inner tapered angular surface **54** of the shoe **44**, is contiguous at its outer surface with the core **36**. Thus, as the core barrel assembly **42** is elevated, as mentioned, the weight of the core will cause the core spring **46** to slide downward a short distance along the tapered surface **54** to be compressively wedged against the core **36** to hold the core within the barrel **40** as the core barrel assembly is elevated to the surface.

The core barrel assembly **42** also comprises a swivel mechanism, generally designated **60**, which is conventional in all respects except one. The swivel mechanism **60** functions to accommodate rotation of the upper portion of the core barrel assembly with the drill string while maintaining the lower portion of the core barrel assembly, as at the inner tube, in a stationary position to receive the core and to accommodate water circulation. More particularly, as best shown in FIGURE 3, the swivel mechanism **60**, which is threadedly connected at **62** (FIGURE 1) to the inner tube **38**, exteriorly comprises a bearing retainer **64** with top aperture **66** through which a bearing shaft **68** rotatably passes. The shaft **68** terminates at planar surface **70** and is retained in position by a base plate **72** held in position by a cap screw **74** threaded into a bore (not shown) axially disposed and opening at the shaft surface **70**. The retaining plate **72** confines a lower bearing assembly **76** in the illustrated operational position against a spacer **68** concentric of the shaft **68** while an upper bearing assemby **80** is interposed concentric about the shaft **68** between the spacer **78** and one or more resilient washers **82** made of a suitable wear resistant material such as neoprene. The neoprene washers **82** rest between the upper bearing assembly **80** and an abutment face **84** of the bearing retainer **64**. The swivel is conventional except for the resilient washers.

When the core is hard to break, normally the operator will pull the entire drill string a slight distance to break the core. When this happens the neoprene washers compress sufficiently to allow the shoe **44** (FIGURES 1 and 2) to contact the bit **24** so that the principal portion of the breaking load is transferred through the outer tube **22** rather than through the core barrel assembly **42**.

Coupling-spearhead assembly of FIGURES 1–5

The upper portion of swivel mechanism **60** comprises a body **90**, a plurality of radially yieldable prongs or bars, generally designated **92**, preferably fabricated of tool steel, and leaf spring **94**, interposed between each prong **92** and the body **90** as seen in FIGURES 1, 2, 4 and 5. While four prongs **92** are shown, it is to be appreciated that any suitable plural number could be utilized, if desired. Together each leaf spring and associated prong comprise a resilient or yieldable finger.

The body **90**, illustrated in detail in FIGURES 4 and 5, is preferably of tool steel and, in the configuration illustrated in FIGURE 4, comprises a solid piece, which adds weight to the core barrel assembly and provides the solid support base for the prongs **92**.

The bearing shaft **68** is threaded into a threaded bore (not shown) axially disposed in the body **90** and opening at the bottom surface **99** (FIGURE 1). A lock nut **101** secures the shaft **68** in such threadedly connection relation with the body **90**. An open notch **100** is provided along each of the four side positions of the body at 90° spacings. One leaf spring **94** is securely mounted at each open notch **100** against axial and circumferential movement by use of a pair of bolts **102** which are securely threaded into threaded bores **104**. Lockwires **106** are used to prevent inadvertent loosening of the bolts **102** during use of the core barrel assembly. At the same time, the mentioned bolt mounting of each resilient leaf spring **94** to the body **90** enables essentially radial movement inward in a fish-tail motion accommodated by tapered flat walls **108**, one disposed immediately adjacent each leaf spring **94**.

The top of the body **90** has an essentially traversely-flat centrally-located top surface **110** and four inwardly tapered open grooves **112**, each accommodating the mentioned radial inward yielding of the prongs **92**, when the core barrel assembly is being uncoupled from the outer tube and latched to the overshot. A very close tolerance space is provided between each open groove **112** and the adjacent base surface **114** of each prong **92**. Thus, when and if the prongs **92** are subjected to a downward axial force which slightly bows the spring **94**, the base surface **114** will bottom out at the adjacent groove **112** before the stress on the adjacent leaf spring **94** exceeds the elastic limit. Of course, it is to be appreciated that, since the inward radial yielding of the prongs **92** approximately traverses an arcuate path, the open groove **112** could conveniently comprise a curvilinear rather than a linear tapered surface.

A number of weldments **115** of suitable radially projecting length are integrally disposed upon the cylindrical surfaces of the body **90** so that they will have an arcuate surface adjacent the inside wall of the outer tube **22** which arcuate surface will be radially spaced very closely from the inside wall of the outer tube **22** during drilling. In this way, any wobbling of the body **90** will not be excessive.

The spearhead latching-outer tube coupling prongs **92** are preferably fabricated from tool steel and, in the illustrated embodiment, are all of identical construction,

material and dimensions. Importantly, the prongs are constructed and arranged in an array such that a hollow space is provided between to obviate "sanding up" problems of the type experienced by prior art core barrel assemblies when in coupled position with the outer tube. Significantly, it should be noted that the prongs use no mechanical parts which must move relative to each other other during a coupling and uncoupling of the core barrel assembly. It should be kept in mind that the prongs **92** serve a two-fold purpose; namely, to selectively accommodate coupling of the core barrel assembly with the outer tube and to accommodate spearhead latching to an overshot and outer tube uncoupling for retrieval of the core barrel assembly from the hole. Inadvertent unlatching or mislatching of one prong does not affect the outer tube coupling or the spearhead latching characteristics of this invention.

Structurally, in transverse cross section, each prong **92**, as shown on the right of FIGURE 5, is wedge shaped with an arcuate surface disposed at the exterior. As shown in FIGURE 4, each prong comprises a ski or cam **130**, the purpose of each cam **130** being to prevent "hanging up" of the core barrel assembly within the drill string, such as on a poor tolerance lip at a threaded drill string coupling.

During the process of placing the core barrel assembly in the downward, water-filled hole by force of gravity, the prongs and leaf springs, normally cambered or biased radially outward, are flexed radially inward by contact with the inside wall of the outer tube **22** counter to the outward camber bias of the leaf springs. Thus, the only part of the prongs and the springs that touches the inside surface of the drill string, as the core barrel assembly is gravity displaced relative to the drill string, are the curved exterior surfaces of the cams **130**. Each cam **130** may be provided with one or more surface exposed tungsten carbide buttons (not shown) or the like to prevent excessive wear.

A second basic purpose of each cam **130** is to prevent wear on the adjacent coupling ridge **132**, which is separated from the cam **130** in the embodiment of FIGURE 4 by an arcuate groove **134**, each disposed at the exterior surface of the prong **92**. In the drilling position, each cam **130**, of the four illustrated prongs **92**, is disposed within the annular recess **32** previously mentioned. This disposition, accommodates close coupling of the ridge **132** within the upper two-way coupling annular recess **30**.

The coupling ridge **132** couples directly with the outer tube, not necessitating a third piece suspension device, and comprises an arcuate mating surface **136**, an upper coupling surface **138** and a lower coupling surface **140**. The upper coupling surface **138** achieves fail-safe coupling with the upper surface of the recess **30** against rearward release during drilling regardless of whether the drilling is with or counter to gravity. This makes the weight of the core barrel assembly an uninfluential factor in uncoupling the core barrel assembly from the outer tube, contrary to the prior art.

The lower coupling surface **140** of the ridge **132** provides fail-safe coupling against forward release of the core barrel assembly in the direction of the bit. Thus, damage to the rotating bit and wear to the normally stationary shoe **44** are essentially obviated because the bit and shoe are not brought together by pressure force of the downward circulating water, which water is conventionally used to cool the bit during drilling. It should be appreciated that approximately 800 percent greater outer tube coupling surface area is provided using the described features of this invention as compared with present commercially accepted core barrel assemblies.

The distal end of each prong **92** comprises a spearhead hook **146** having an exterior tapered surface **148** and an overshot latching shoulder **150**. The shoulder **150** is spearated from the adjacent coupling ridge **132** by an arcuate groove **152** disposed in each prong. Inspection of FIGURE 4 shows that, during drilling, the transverse position of each spearhead hook **146** is spaced from the inner wall of the outer tube **22**.

The tapered surface **148** of each prong **92** accommodates inward radial gathering or clustering of the prongs when the overshot **52** is advanced toward the end of the hole **26** and brought in contact with the tapered surface **148** of each prong during such advance. The inward gathering of the prongs toward the radial center line of the core barrel assembly thereafter accommodates further displacement of the overshot along the tapered surface **148** of each prong thereby first radially uncoupling the coupling ridge **132** from the annular recess **30** and thereafter latching the overshot upon the shoulder **150** of each prong. The advance of the overshot is then discontinued and the overshot and the core barrel assembly (with the trapped core) are retrieved from the hole. In this way, it is not necessary or possible to first latch the overshot to the core barrel assembly before ascertaining whether or not the core barrel assembly can in fact be uncoupled from the outer tube. Also, by utilization of a plurality of prongs with overshot latching hooks **150**, approximately 300 percent greater overshot latching surface area is provided than with commercial prior art spearhead configurations. Hence, the probability of shear failure of the spearhead during overshot retrieval of a core barrel assembly is significantly diminished, if not prohibited.

The overshot of FIGURES 6–10

The overshot **52** of FIGURES 6–10 is useful not only for removing novel core barrel assemblies of the type previously described from coupling relation with the drill string but also for overshot placing the core barrel assembly in a dry hole without risk of inadvertent release of the core barrel assembly and damage to the bit. The overshot is also useful, when disabled, as an accelerated weight to place a core barrel assembly in coupled relation with a downwardly extending outer tube of a drill string, when the drill string is filled with water.

Structurally, with special reference to FIGURES 6 and 7, the overshot **52** comprises a shoe **160** having a bell-shaped recess **162** disposed near the bottom opening **164**. A short distance above the opening **164** exists an annular core barrel assembly latching shoulder **166** which extends in the illustrated embodiment through the entire 360° of the inside circumference of the recess **162**. The central interior of the shoe **160** comprises a cylindrically hollow counterbore **168** terminating in an abutment surface **170** and opening not only into recess **162** but also into an elongated bore **172** which extends upwardly. The bore **172** comprises the inside surface of an upper telescopic, reduced diameter portion **174** of shoe **160**. The cylindrical telescopic portion **174** contains an "L-shaped" slot having a downwardly extending leg **176** and a circumferentially extending leg **175**.

The upper end of the reduced diameter cylindrical portion **174** is solid at **178** and contains a diametrical bore **180** through which a pin **182**, having enlarged ends **184**, passes.

A plunger **190** is concentrically disposed inside the shoe **160**. The plunger **190** comprises a spool head **192** having a frusto-conical recess **194** and a reload slot **196** disposed at the top wall **198** of the recess **194**. A cylindrically shaped integral stem **200** extends upwardly from and concentric to the spool head **192** and is slidably and rotationally disposed within the bore **172** of shoe **160**.

A release spring **202** functions as a combined torsion and compression spring between the shoe abutment surface **170** and the top spool surface **204**. The ends **206** and **208** are respectively anchored in anchor recesses **210** and **212** at surfaces **170** and **204**. Thus, a two-way bias is provided, i.e., (a) bias of the plunger axially toward the shoe latching shoulder **166**, and (b) bias of the plunger rotationally right to left, as viewed in the figures.

The plunger **190** is normally retained in the retracted (enabling) position illustrated in FIGURES 7 and 8 counter to the mentioned axial bias. Provision is made for release of the plunger **190** to an extended (disabling) position (FIGURE 9) due to the bias of the spring **202** in a manner subsequently to be described.

An open groove **220** is provided in the top of stem **200**, which groove extends essentially diametrically and is provided with a threaded bore (not shown) in which a bolt **222** is securely fastened. The bolt **222** passes through an aperture (not shown) in a locking plate **224** and through an aperture (not shown) in a release dog or release pawl **226** to integrally unite the pawl **226** with the stem **200** and thereby insure joint movement of the plunger **190** and the pawl **226**.

The pawl **226** passes through the previously mentioned "L-shaped" slot in the upper end **174** of the shoe **160**, the pawl being disposed in the circumferentially extending portion of the slot **175** when the plunger **190** is in the retracted position (FIGURES 7 and 8) and in the downwardly extending leg **176** (FIGURE 7) of the "L-shaped" slot when the plunger **190** is disposed in its extended position (FIGURE 9). Thus, the disposition of the pawl in the L-shaped slot in telescopic cylindrical portion **174** accommodates both plunger rotation in the circumferentially extending slot leg **175** and axial displacement of the plunger in the downwardly extending slot leg **176**.

The overshot **52** also comprises a release housing, generally designated **230**. The release housing **230** has a threaded axial bore **232** adapted to threadedly couple with a wire line coupling member **233** (FIGURE 2) to which a wire line or cable is conventionally secured. The release housing **230** has a stop shoulder **234** near which the solid end **178** of the shoe **160** is disposed when the release housing **230** is in its downwardmost relative position as viewed in the figures. Oppositely disposed pin slots **236** are fabricated in the walls of the release housing **230** near the top of the bore **238** and each slot receives one of the two enlarged pin ends **184** so as to accommodate a limited amount of up and down movement of the release housing corresponding to the length of the slot **236** for purposes which will become more fully apparent subsequently.

A plurality of top and bottom teeth, **240** and **242** respectively, exist along a circumferentially extended portion of the release housing slightly below the pin slots **236**. Each top tooth is offset relative to the adjacent bottom teeth and vice versa. The top teeth are spaced from each other by a predetermined distance represented by a recess **244**, as are the bottom teeth. The array of teeth **240** and **242** terminates in a downwardly extending release slot **246**. The circumferential portion of the release housing occupied by the teeth **240** and **242** is coextensive with and concentric to the circumferential leg **175** of the mentioned L-shaped slot in the upper telescopic portion **174** of the shoe **160**. Likewise, the release slot **246** is coextensive and radially aligned with the downwardly extending leg **176** of the mentioned L-shaped slot.

With the foregoing in mind and assuming an orientation wherein the plunger **190** is disposed in its retracted position as shown in FIGURES 7 and 8 and with the overshot **52** suspended from a wire line, the pin **182** will be oriented so that the enlarged ends **184** will be disposed in the bottom of the adjacent slot **236** due to the weight force of the plunger and shoe. In this position, up and down pumping of the wire line by the operator will shift the release housing up and down through the distance permitted by the pin slots **236**. This will first shift the pawl, which is biased left to right by the spring **202**, to the right surface of the next top tooth **240** (on the down stroke of the release housing) and then to the right surface of the next bottom tooth **242** (on the up stroke of the release housing). Hence, when and if the operator desires, the up and down pumping may be continued to successively move the pawl right to left across the requisite number of teeth, top and bottom, so that the pawl thereafter becomes disposed in the release slot **246** accommodating movement of the plunger **190** from the retracted position (FIGURES 7 and 8) to the extended position (FIGURE 9) under force of the spring **202**. In the extended position, the spool **192** shields the shoe latching shoulder **166** against prong latching. The effects of so extending the plunger **190** are, therefore (a) to release the prongs **92** from the overshot in the hole at the operator's will, such as when the core barrel assembly is being placed in coupled relation with the outer tube and the hole is dry, and/or (b) to prevent subsequent latching between the overshot at shoulder **166** and the prong spearhead latching shoulders **150**. Also, with the plunger extended in a disabling position, the overshot may be utilized as an accelerating weight when downwardly placing the core barrel assembly in coupled relation with the outer tube when the hole is substantially filled with water.

As illustrated in FIGURE 10, once the overshot and the latched core barrel assembly have been retrieved from the hole to the surface, the overshot may easily be manually separated from the prongs simply by angularly rotating the overshot relative to the prongs so that the centerlines of the two components are obliquely related. The prongs are thus gathered toward the longitudinal center line of the core barrel assembly and the shoulders **150** are displaced out of latching engagement with the annular shoulder **166** of the overshot. Thereafter the overshot and prongs are parted.

To return the plunger **190** from the extended position of FIGURE 9 to the retracted position illustrated in FIGURES 7 and 8, once the overshot has been returned to the surface, it is merely necessary for the operator to place a suitable tool, such as a screwdriver, in the reload slot **196** and thereafter exert an axial force sufficient to overcome the axial bias of the spring **202** and shift the pawl **226** to the top of release slot **246**. Thereafter, while maintaining such axial force, a rotational force sufficient to overcome the torque exerted by spring **202** is exerted by the tool upon the plunger **190** as the release housing **230** is shifted to and fro, a suitable number of times, through the distance allowed by pin slot **236**. In this way, the release pawl **226** will be displaced sinuously through the array of top and bottom teeth **240** and **242** left to right until the pawl **226** is disposed at the right side of whichever tooth is desired, at which time the axial and rotational force exerted by the tool will be withdrawn. The torque force of the spring will hold the pawl **226** in such position against the right side of the next left tooth so long as the release housing **230** is not pumped up and down. The operator may select to position the pawl against any desired tooth depending on how many up and down pumping motions in the hole may subsequently be deemed sufficient for later displacement of the plunger **190** into the extended position of FIGURE 9, as previously explained.

Prong embodiment of FIGURE 11

Reference is now made to FIGURE 11 which depicts a second presently preferred spreadhead latching-outer tube coupling prong, generally designated **270**. Functionally, each prong **270** is identical in structure and operation to the prong **92** previously explained except in place of the leaf springs **94** a hinged-joint at pin **272** is used in conjunction with an apertured end **272** of prong stem **118**. Also, a coiled compression spring **276** resiliently biases each prong **270** radially outwardly but accommodates opposite inward radial displacement. Each spring **276** is suitably fastened to the stem **118** of the adjacent prong **270** and is disposed within a bore **278** in the tapered wall **280** of the modified body **282**.

Prong embodiment of FIGURE 12

FIGURE 12 depicts a third prong embodiment with a one-way latch feature. The prong, only one of which is fragmentarily illustrated and which is generally designated

290, has the previously-described spear-head hook configuration 146 separated from a latch surface 292 by a recess 294. The latch surface 292 is integral and coextensive with the cam 296 shaped similar to and performing a comparable function to the ski or cam 130 (FIGURE 4). The stem 298 may be suitably joined to the remainder of the core barrel assembly by means of a leaf spring similar to the leaf spring connection at 94 shown in FIGURE 4 or by means of a hinge spring bias mechanism similar to that shown at 272 and 276 in FIGURE 11. The prong configuration of FIGURE 12 is of utility only where it is not necessary or important to latch the core barrel assembly in spaced relation to the bit, as the surface 292 only couples the core barrel assembly against inadvertent release in a direction away from the bit. Where prongs 290 are utilized, a single recess 300 disposed in the outer tube 302 will also be used to create the one-way outer tube coupling. Otherwise, the operation and purposes of the prong 290 are the same as those set forth with regard to the previously described prongs.

Overshot embodiment of FIGURES 13–15

Reference is now made to FIGURES 13–15 which depict a second presently preferred overshot, generally designated 310, utilized for coupling which and uncoupling from a conventional core barrel assembly spearhead 312 having a latching shoulder 314. Certain portions of the overshot 310 are substantially identical to components of the previously described overshot 52 and are correspondingly numbered. These include the release housing 230, the cylindrical telescopic portion 174, the plunger stem 200 and the torsion-compression spring 202.

The appreciable differences between the overshot 310 and the overshot 52 include the plunger head 316 which has a conical tapered surface at distal end 318 and a reload slot 320, fashioned at the tip of the conical end 318. The cylindrical portion 174 is preferably threadedly coupled at 322 to a spearhead latching mechanism, generally designated as 324.

The latch mechanism 324 comprises a plurality of radially yieldable depending fingers 326, preferably formed of spring steel. Each finger has a tapered conical surface 328 closely spaced from the surface of the conical end 318 of the plunger head 316 when the plunger is retracted. Each finger 326 also comprises a spearhead receiving recess 330 which terminates in a latching shoulder 332. Each latching shoulder 332 constitutes part of a spearhead hook 334 which also includes a tapered surface 336. The surface 336 accommodates spreading of the radially yieldable fingers 326 when the overshot 310 is advanced against the upper tapered cone of the spearhead 312 to latch the shoulders 332 of the overshot 310 under the annular shoulder 314 of the conventional spearhead 312 (FIGURE 13).

The operation of the overshot 310 is essentially the same as the previously described operation of the overshot 52 except the standard core barrel assembly, of which spearhead 312 is a part, will be uncoupled from the outer tube on the up stroke of the overshot after latching between the spearhead 312 and the overshot 310. Thus, when the wire line operator pumps the release housing 230 a sufficient number of times to dispose the release pawl 226 in the release slot 246 (FIGURES 6 and 7) the plunger will move from the retracted position of FIGURE 13 to the extended position of FIGURE 15 bringing the surface of the conical end 318 into forcible contact with the tapered conical surfaces 328 of the radially yieldable fingers 326 spreading the fingers to create a space between the two hooks 334 which is greater than the diametrical distance across the shoulder 314. Hence, the conventional spearhead can be released in this way at the will of the wire line operator.

To reload the plunger 316 from the extended position of FIGURE 15 to the retracted position of FIGURE 13, a suitable tool, such as a screwdriver, is placed in the reload slot 320 and an axial force is exerted through the tool sufficient to overcome the axial bias of spring 202 and displace the release pawl 226 to the top of the release slot 246. Thereafter, while maintaining the axial force of the tool a rotational force is exerted left to right upon the plunger as the release housing is moved to and fro until the release dog is positioned at the right side of whichever tooth is desired, at which time the tool is removed.

Overshot embodiment of FIGURE 16

Where it is important to reduce frictional resistance of the overshot components to rotational displacement of the pawl 226 from tooth to tooth responsive to down and up displacement of the wire line, the overshot of FIGURE 16 may be effectively employed. The overshot of FIGURE 16 may be identical in structure and operation to either of the two previously described overshots 52 and 310 except for the toothed construction of release housing 350 (FIGURE 16).

Release housing 350 comprises an array of spaced upper teeth 352 and an array of spaced lower teeth 354, each upper tooth being located intermediate spaced bottom teeth in offset relation, and vice versa. The right surface 360 (as viewed in FIGURE 16) of each top tooth 352 extends linearly in a generally vertical direction, as does the right surface 362 of each bottom tooth 354. Thus, the pawl 226 may flatly and forcibly abut such right tooth surfaces 360 and 362 sequentially responsive to the torsional bias of the overshot spring as the release housing 350 is displaced down and up by the wire line.

The left ramp surface 356 of each top tooth 352 extends curvilinearly from the distal end of one top tooth to the proximal attachment of the next left top tooth at the right surface 360 thereof. Similarly, the left ramp surface 358 of each bottom tooth 354 extends curvilinearly from the distal end of one bottom tooth to the proximal attachment of the next left bottom tooth at the right surface 362.

Thus, assuming the plunger of the overshot to be retracted and upon dropping the wire line-suspended release housing 350 relative to the remainder of the overshot, the pawl 226 will be relatively displaced by the torsion spring from the right side 362 of one bottom tooth to the right side 360 of the next left adjacent top tooth traversing the opposite ramp surface 356 with a minimum of friction where resistance to such pawl movement is substantial, as when a fluid other than water, having a relatively heavy viscosity, is used as a cooling fluid and/or where there is an appreciable amount of sand or the like in the fluid near the bottom of the hole. In like manner, subsequent upward displacement of release housing 350 relative to the remainder of the overshot will displace the pawl 226 from biased contiguous relation with the right surface 360 of the top tooth to biased contiguous relation with the right surface 362 of the next left adjacent bottom tooth across the opposed ramp surface 358, where said substantial resistance exists.

What is claimed and desired to be secured by U.S. Letters Patent is:

1. In a core barrel assembly, adapted to be latched in recess means in an outer tube of a drill string during drilling, comprising core-receiving means disposed at the leading end of the core barrel assembly, swivel means interposed at an intermediate portion of the core barrel assembly and body means connected to and disposed rearward of the swivel means, the improvement comprising latch structure comprising a plurality of outwardly essentially radially biased spaced fingers solely comprising the trailing portion of the core barrel assembly, each finger being non-rotatably connected at the leading end thereof to the body means so that each finger terminates in a free end and the greater portion of each finger cantilever-projects rearward generally parallel to but off-

set from the longitudinal axis of the core barrel assembly beyond any other part of the core barrel assembly to present unencumbered open space peripherally around and inwardly between the fingers accommodating unobstructed inward and outward essentially radial displacement of the fingers through fish tail motion of said greater portion, said greater portion of each finger comprising (a) male coupling means adapted to be disposed in said recess means following said outward radial displacement caused by said outward bias to restrain the core barrel assembly against movement relative to the outer tube during drilling, and (b) spearhead means adapted to be spaced from the outer tube during drilling and to be struck by overshot means to cause said inward essentially radial displacement of the fingers and thereby separate the coupling means from the recess means counter to said outward bias and latch the spearhead means to the overshot means to accommodate removal of the core barrel assembly from the drill string.

2. In a core barrel assembly for disposition in an outer tube of a drill string during core drilling, a plurality of prong means comprising the trailing end of the core barrel assembly, said prong means being disposed in spaced relation one to another in a generally concentric array about the longitudinal axis of the core barrel assembly and biased outward essentially radial of the outer tube but accommodating essentially inward radial displacement counter to said bias into space between the prong means, the outer face portions of each prong means seriatim comprising (a) spearhead means disposed at the distal end of the prong and comprising reverse direction hook means sized and shaped to be spaced from the outer tube during drilling and to latch with overshot means following essentially inward radial displacement of the prong means, (b) generally radially-extending first ridge means forwardly adjacent the spearhead means and separated therefrom by a generally radially-disposed groove, the first ridge means presenting an outer peripheral surface interposed between front and back generally radially-directed surfaces, the first ridge means being sized and shaped to couple with first recess means disposed within the outer tube responsive to said outward bias, during drilling, and (c) generally radially-extending second ridge means forwardly adjacent the first ridge means and separated therefrom by another generally radially-disposed groove, the second ridge means presenting an outer peripheral surface interposed between front and back surfaces and adapted to be received in a second recess means disposed within the outer tube, the last-mentioned front surface comprising a tapered cam surface adapted to contact the inside surface of the drill string and absorb wear caused by gravity-displacement of the core barrel assembly toward the drilling position and to obviate inadvertent hanging up the core barrel assembly on a drill string protrusion and the like.

3. An apparatus as defined in claim 2 wherein each said prong means is cantilever-mounted to the adjacent portion of the core barrel assembly.

4. An apparatus as defined in claim 2 wherein said spearhead means comprises rearwardly exposed, outwardly and forwardly tapered exterior surface adapted to be struck by overshot means to cause the mentioned inward essentially radial displacement of the prong means to accommodate release of the first ridge means from the first recess means and latching of the reverse-direction hook means to the overshot and wherein said first ridge means of each prong means comprises a circumferentially arcuate pawl means comprising an essentially radially-projecting circumferentially arcuate tooth extending outwardly beyond the spearhead means when in the drilling position, said circumferentially arcuate tooth being adapted to be engaged within said first recess means to prohibit rearward uncoupling of the core barrel assembly and to maintain the core barrel assembly axially spaced from the bit during drilling.

5. An apparatus as defined in claim 2 wherein a leat spring joins each prong means to the remainder of the core barrel assembly and biases the joined prong means essentially radially outward in a fish tail fashion to accommodate coupling of the prong means in the first recess means of the outer tube, each leaf spring accommodating essentially inward radial yielding in a fish tail fashion to release the prong means from coupled relation in the first recess means of the outer tube during latching of an overshot to the spearhead means.

6. An apparatus as defined in claim 2 wherein at least a portion of each prong means, directly juxtaposed the drill string during placement and drilling, comprises a hard highly wear-resistant material.

7. In a core barrel assembly, adapted to be latched to an outer tube of a drill string during drilling, comprising core-receiving means disposed at the leading end of the core barrel assembly, swivel means disposed at an intermediate portion of the core barrel assembly, and substantially rigid body means connected to and disposed rearward of the swivel means, the improvement comprising an assemblage of fingers extending rearward from the body means and comprising the trailing end of the core barrel assembly, each finger comprising a resilient member non-rotatably joined to the body means and providing an intermediate portion biased outwardly in a direction generally radial with respect to the longitudinal axis of the core barrel assembly, the intermediate portion being capable of being flexed in either radial direction in a fish-tail manner, each finger further comprising an axially-extending rigid coupling and latching bar having a trailing free end and presenting exterior teeth, one tooth in the vicinity of the trailing free end of the bar for latching to an overshot and another tooth for coupling to the outer tube, the leading portion of the bar being non-rotatably joined to the resilient member so that (a) the bar will be normally biased generally radially outward to maintain said coupling and latching states, when one is established, and (b) the bar can be dislodged from the coupling and latching states by inward generally radial displacement of the bar accommodated by inward flexing of the intermediate portion of the resilient member.

8. The core barrel assembly as defined in claim 7 wherein each resilient member is an outwardly cambered leaf spring.

9. The core barrel assembly as defined in claim 7 wherein each said bar comprises a forward abutment surface axially separated from a generally opposed rearward abutment surface of the body means by only a narrow space under normal conditions, the abutment surfaces engaging each other in force-transmitting relation when the bars are subjected to an axial force sufficient to bow the resilient member, to alleviate structural damage.

10. The core barrel assembly as defined in claim 7 wherein the non-rotatable juncture between each resilient member and the body means comprises a lap joint at the outer periphery of the body means and outwardly exposed removable fasteners.

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