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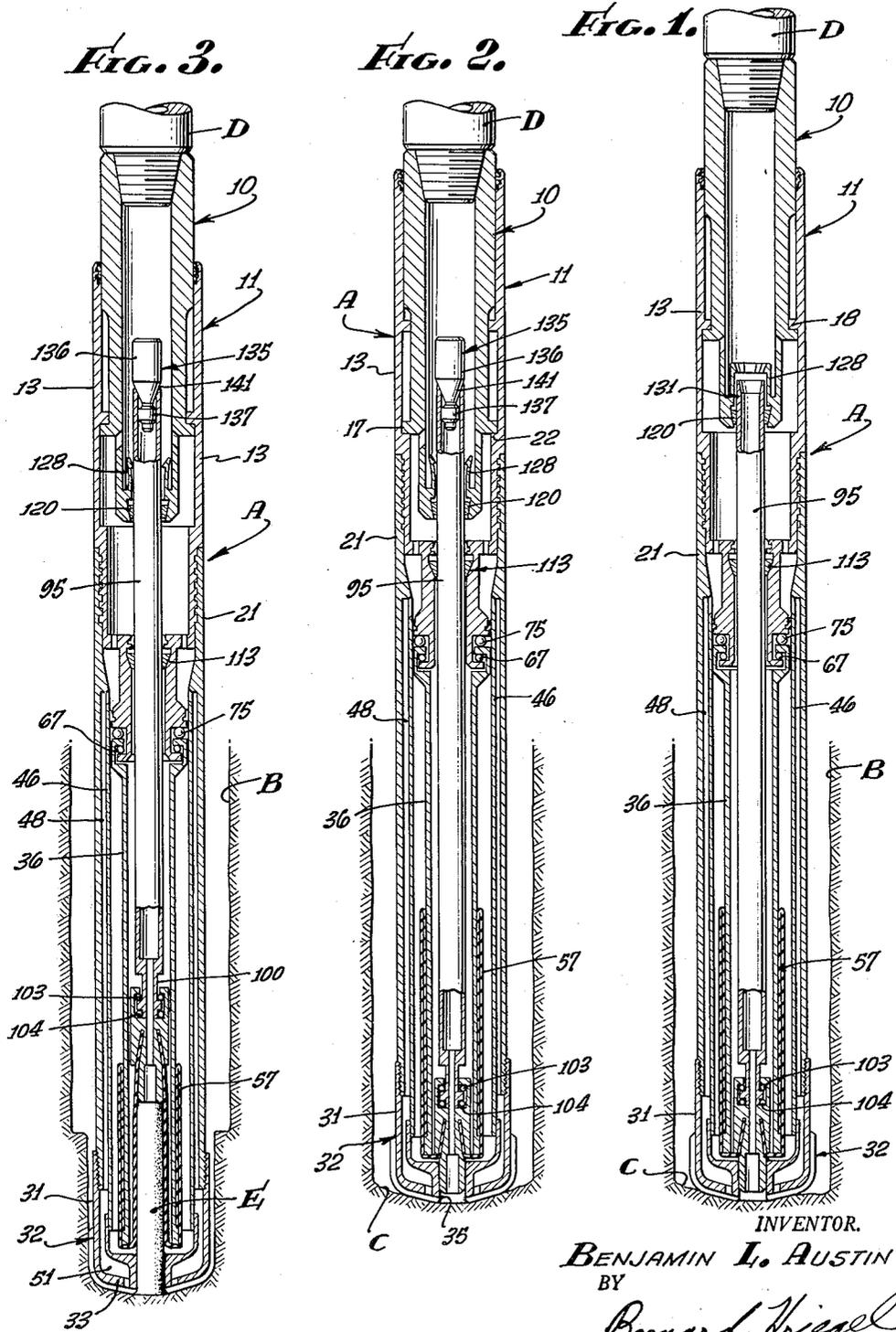
B. L. AUSTIN

3,012,622

CORE BARREL APPARATUS

Filed April 20, 1959

4 Sheets-Sheet 1



INVENTOR.
BENJAMIN L. AUSTIN
BY
Bernard Hiegel
ATTORNEY.

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B. L. AUSTIN

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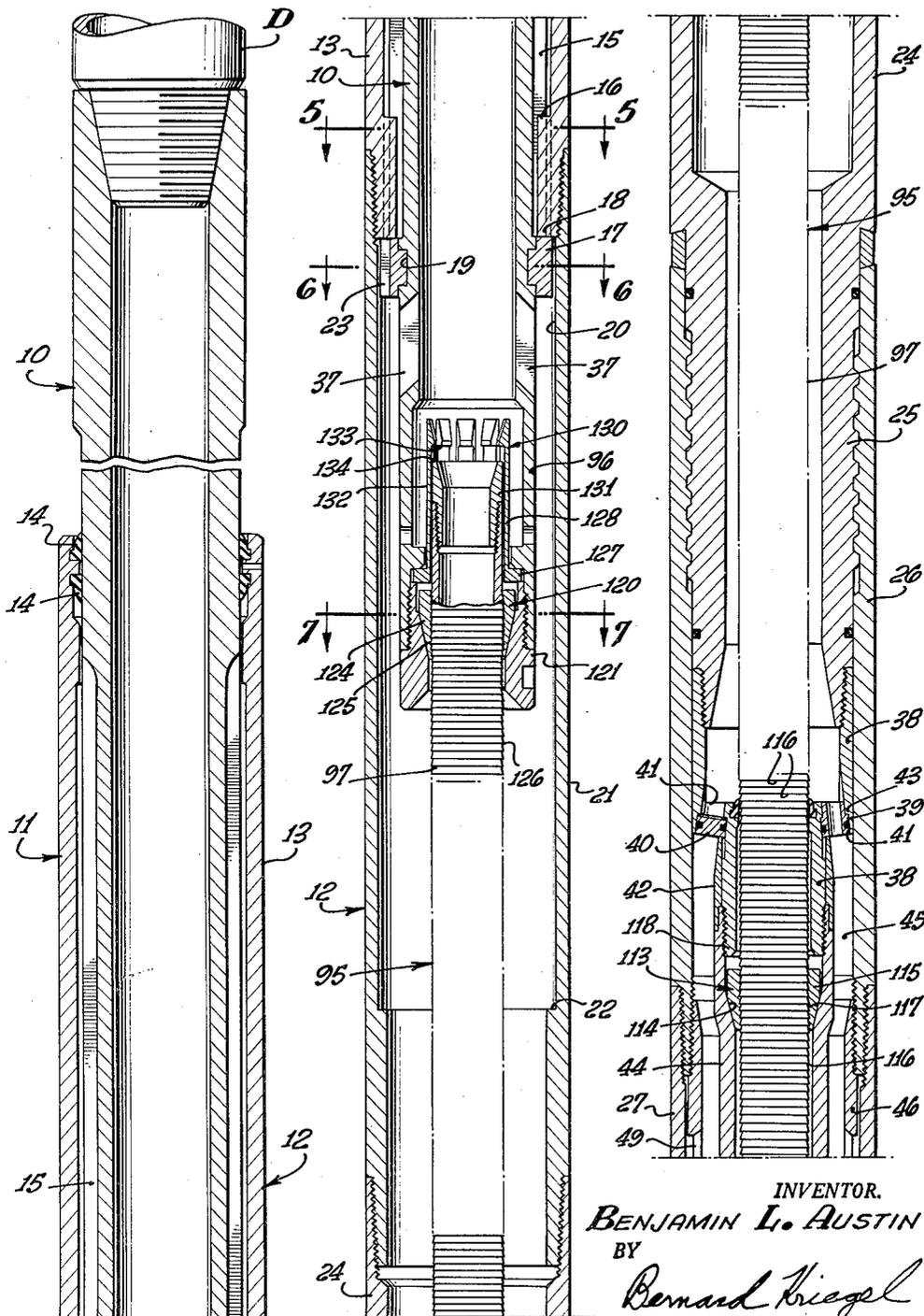
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FIG. 4.

FIG. 4a.

FIG. 4b.



INVENTOR.
BENJAMIN L. AUSTIN
BY
Bernard Krieger
ATTORNEY.

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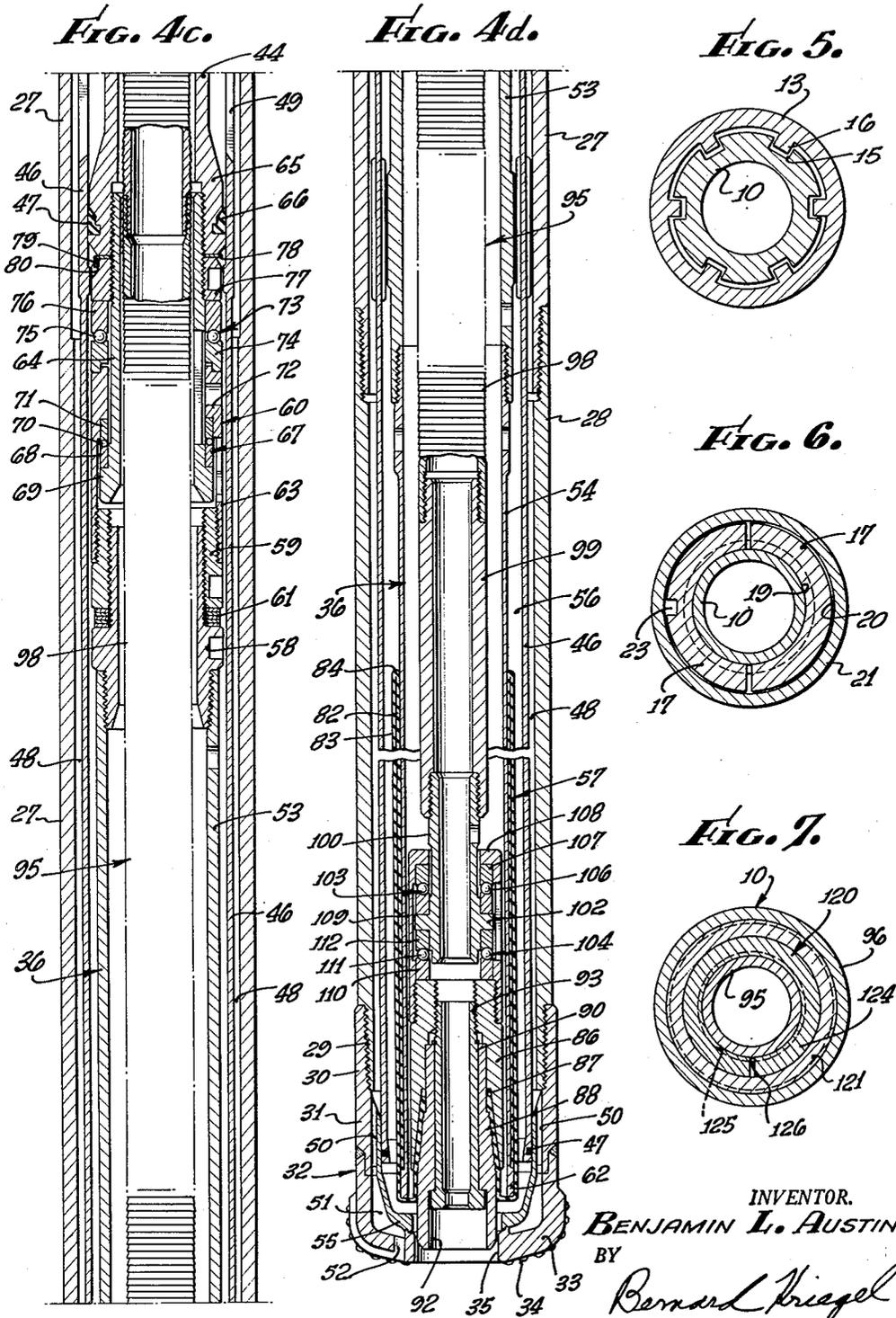
B. L. AUSTIN

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CORE BARREL APPARATUS

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4 Sheets-Sheet 3



INVENTOR.

BENJAMIN L. AUSTIN

BY

Bernard Krieger
ATTORNEY.

1

3,012,622

CORE BARREL APPARATUS

Benjamin L. Austin, Ogden, Utah, assignor to Christensen Diamond Products Company, Salt Lake City, Utah, a corporation of Utah

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The present invention relates to subsurface well bore equipment, and more particularly to apparatus for obtaining cores from formations in well bores.

Difficulty has heretofore been experienced in securing proper or any cores from certain types of formations in well bores. As an example, coring in soft formations, unconsolidated formations, conglomerates, or badly fractured rock has resulted in the washing away of the core by the circulating fluid, or in its crumbling or other disturbance, so that any core which is recovered in the core barrel is not properly representative of the formation. In addition, cores that are recovered are very often disturbed in handling, so that, upon examination, they present a false or misleading sample of the formation from which the core was taken.

Accordingly, it is an object of the present invention to provide an improved coring apparatus that insures relatively high core recovery from all types of formation.

Another object of the invention is to provide an improved coring apparatus in which the core is continuously protected and supported during the coring operation, and also during subsequent handling, thereby insuring that the core is a proper sample of the formation from which it was recovered.

A further object of the invention is to provide coring apparatus embodying an expansion joint and a contractible rubber or rubber-like sleeve disposed over the core as it is produced to protect the same, the apparatus being capable of securing a core that is much greater in length than the stroke of the expansion joint, enabling the latter to be made comparatively short in length. In fact, the length of core that can be obtained is independent of the stroke of the expansion joint. As a result of the relatively short expansion joint, the over-all length of the apparatus and its cost are reduced considerably.

An additional object of the invention is to provide coring apparatus embodying a contractible rubber or rubber-like core retaining sleeve and an expansion joint attachable to a drill pipe or similar string and through which the drilling torque is transmitted, the apparatus permitting the drill string to be lowered or slacked off at any time during the coring operation to determine progress without interfering with the core heretofore formed, or with subsequent appropriate action of the apparatus in continuing the coring operation.

Yet another object of the invention is to provide coring apparatus embodying a rubber or rubber-like core retaining sleeve that is progressively pulled upwardly into the core barrel and around the core as it is formed, in which the apparatus can be used, prior to commencement of the actual coring operation, for circulating fluid and rotating and reaming the well bore without danger of inadvertently pulling the rubber sleeve upwardly into the core barrel.

Still a further object of the invention is to provide coring apparatus embodying a rubber or rubber-like core retaining sleeve and an expansion joint attachable to a drill pipe or similar string and through which the drilling torque is transmitted, in which an additional joint or joints of drill pipe can be added at the top of the well bore after the coring operation has commenced without interfering with the proper functioning of the apparatus.

This invention possesses many other advantages, and has other objects which may be made more clearly ap-

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parent 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:

FIGURE 1 is a diagrammatic longitudinal section of the coring apparatus, with its parts in their relative positions prior to the commencement of the actual coring operation;

FIG. 2 is a view similar to FIG. 1 illustrating the apparatus released for the commencement of the coring operation;

FIG. 3 is a view similar to FIG. 1 illustrating the relative position of the parts of the apparatus after a length of core has been produced;

FIGS. 4, 4a, 4b, 4c and 4d together constitute a longitudinal section through the apparatus, with the parts in condition for lowering the apparatus in the well bore, FIG. 4a being a lower continuation of FIG. 4, FIG. 4b being a lower continuation of FIG. 4a, FIG. 4c being a lower continuation of FIG. 4b, and FIG. 4d being a lower continuation of FIG. 4c;

FIG. 5 is a cross-section taken along the line 5—5 on FIG. 4a;

FIG. 6 is a cross-section taken along the line 6—6 on FIG. 4a;

FIG. 7 is a cross-section taken along the line 7—7 on FIG. 4a;

FIG. 8 is an enlarged longitudinal section of the latch and one-way clutch or ratchet mechanism shown in FIG. 4a;

FIG. 9 is an enlarged longitudinal section through the lower portion of the apparatus disclosed in FIG. 4d.

The coring apparatus A illustrated in the drawings is adapted to be lowered in a well bore B to the bottom C thereof by means of a string of drill pipe D, or the like, the lower end of which is threadedly attached to the upper end of an inner mandrel 10 forming a portion of an expansion or telescopic joint 11. This inner mandrel is telescoped within the upper portion of an outer housing 12 to which it is slidably splined. The outer housing includes an upper housing section 13 carrying upper and lower side seals 14 adapted to slidably seal against the periphery of the inner mandrel 10 to prevent leakage of fluid in both directions between the inner mandrel and the outer housing. The slidably splined connection includes a plurality of longitudinally extending and circumferentially spaced grooves 15 in the exterior of the mandrel which receive companion ribs or keys 16 integral with or extending inwardly from the lower end of the upper housing section 13. Upward extensible movement of the inner mandrel 10 within the outer housing 12 is limited by engagement of a stop ring 17 with the lower end 18 of the upper housing section, which ring is made in two pieces and which fits within a peripheral groove 19 in the inner mandrel. The two-piece ring 17 is maintained in the mandrel groove 19 by the inner wall 20 of an intermediate housing section 21 threadedly attached to the lower end of the upper section 13 and depending therefrom. Downward or contractible movement of the inner mandrel 10 within the housing 12 is limited by engagement of the stop ring 17 with an inwardly directed stop shoulder 22 formed on the lower portion of the intermediate housing section 21. The extent of longitudinal movement of the mandrel 10 within the housing 12 need not be very great. As an example, the inner mandrel may have a stroke of about two feet within the outer housing. During the entire stroke, torque can be trans-

mitted from the inner mandrel 10 to the outer housing 12 through the slidable spline connection 15, 16. In view of the close proximity of the stop ring 17 to the inner wall 20 of the intermediate housing section 21, a longitudinally extending fluid by-pass 23 is formed in the stop ring to prevent the drilling mud, or other liquids, in the housing from interfering with the telescopic movement of the mandrel 10 therewithin.

The lower end of the intermediate housing section 21 is threadedly attached to a safety joint sub 24 having a lower pin 25 threadedly secured to a companion box 26, the lower end of which is threadedly attached to an outer tube 27. The lower end of this outer tube is threadedly secured to the upper end of a tube sub 28 (FIG. 4d), which has a lower pin 29 threadedly secured to the upper box 30 of the shank or body portion 31 of a core bit 32 having a core head 33 welded or otherwise suitably attached thereto, which may have diamond cutting elements 34 embedded in its lower portion and side portions for cutting the bottom of the hole around a central core inlet passage 35 in the head, through which the core can pass upwardly into the core barrel 36 of the apparatus. The wall of the central passage 35 may also have inner reaming diamonds or other cutting elements 34 therein to insure the appropriate formation of the periphery of the core.

The drilling mud or other fluid is pumped downwardly through the string of drill pipe D into the mandrel 10 and will pass outwardly through fluid outlet ports 37 in the lower portion of the mandrel into the housing 12, then flowing downwardly through the intermediate housing section 21 into and through the safety joint sub 24. Threadedly attached to the lower end of the sub 24 is a nozzle carrier 38 that has a plurality of circumferentially spaced nozzles 39 mounted in its intermediate wall through which the drilling fluid will pass. The flow of fluid is restricted in passing through the nozzles 39 and will build up a back pressure acting in a downward direction on the nozzle carrier 38 and on the entire housing 12 to which the carrier is secured, this downwardly directed hydraulic force being transmitted through the outer tube 27 and sub 28 to the drill bit 32, being availed of for providing the proper downward drilling force or weight of the drill bit against the bottom of the well bore. In lieu of some of the nozzles, one or more blanks 40 can be inserted in one or more of the carrier passages 41 capable of receiving the nozzle to reduce the effective passage area through which the drilling mud can flow through the nozzle carrier. In this manner, the back pressure that is built up can be varied and also the hydraulic force or drilling weight imposed on the core bit 32. The downward drilling weight can also be controlled by the rate of flow of fluid supplied by the mud pumps at the top of the well bore.

Each of the nozzles 39 and the nozzle blanks 40 has a suitable side seal 41 engaging the wall of the nozzle passage 41 in which it is mounted to prevent leakage therearound. Both the nozzles 39 and the nozzle blanks 40 are retained in place by a retainer sleeve 42 bearing against their lower ends to hold them upwardly against shoulders 43 in the nozzle carrier. This retainer 42 is maintained in such upward position by a tubular clutch housing 44 which is threaded on the lower end of the nozzle carrier 38 and which bears against the nozzle retainer.

The fluid emanating from the nozzles 39 will flow downwardly through the annular space 45 between the housing box 26 and the nozzle retainer and clutch housing 44, then passing downwardly between the outer clutch housing 44 and an intermediate tube 46, the upper end of which is threadedly attached to the housing box 26, and which extends downwardly to the core bit 32, its lower end fitting within the body of the bit 31. Leakage of fluid between the tube 46 and body 31 is prevented by a suitable side seal ring 47 mounted on the lower end of

the intermediate tube and sealingly engaging against the inner wall of the bit body. The intermediate tube 46 is spaced from the outer housing or tube 27 to provide an annular space 48 therebetween. The drilling fluid will pass from the annular space 45 between the intermediate tube 46 and the outer clutch housing 44 through inlet ports 49 in the upper portion of the intermediate tubing into the annular space 48 between the intermediate tube 46 and outer tube 27, this fluid then flowing downwardly through such annular space and through longitudinal fluid channels 50 in the core bit body 31 into a fluid chamber 51 in the core bit head 33. From this fluid chamber the fluid can discharge through suitable ports 52 in the lower end of the head onto and against the bottom of the well bore, in order to remove the cuttings and convey them laterally toward the periphery of the bit 32, the fluid and cuttings then flowing upwardly around the exterior of the outer tubing 27 and the drill pipe D to the top of the well bore.

The apparatus includes the inner tube or barrel 36, which is stationary in the sense that it does not rotate with the intermediate tubing 46 and the outer tubing or housing 27 during the coring operation. The inner barrel or tubing 36 includes an upper section 53, the lower end of which is threadedly secured to a lower section 54 that extends to the lower end of the apparatus, terminating above the lower inner portion 55 of the core bit body. This inner barrel is spaced from the intermediate tubing 46, particularly along the length of its lower section 54, to provide an annular space 56 for the reception of a rubber or rubber-like sleeve 57, which, as described hereinafter, is adapted to be pulled upwardly into the barrel 36 for the purpose of encasing and embracing the core as the latter is formed and moved relatively upwardly into the barrel.

The upper end of the barrel section 53 is threadedly attached to a coupling 58, which, in turn, is threadedly secured to a bushing portion 59 of a swivel 60 that enables the inner barrel or tubing 36 to be carried by the outer housing 25-28, while permitting the latter and the inner tubing 46 to rotate relative to the inner barrel 36. Shims 61 may be provided between the coupling 58 and the bushing 59 to insure the proper makeup of their threaded interconnection and the appropriate disposition of the lower end 62 of the barrel with respect to the end 55 of the bit body 31. The bushing 59 is threadedly attached to a bearing housing 63 that extends upwardly along the lower portion of a tubular bearing shaft 64, the upper end of which is threadedly attached to the lower head portion 65 of the outer clutch housing 44. This lower head portion carries a rubber or rubber-like side seal ring 66 which engages the inner wall of the intermediate tube 46 below its inlet ports 49, and is of a type to prevent fluid from passing downwardly between the head 65 and the intermediate tube 46.

The bearing housing 63 is supported by the bearing shaft 64 through the agency of a ball bearing 67, the lower race 68 of which rests upon an outwardly directed flange 69 at the lower end of the bearing shaft, this lower race having a series of balls 70 in its upper end face that are engaged by an upper race 71 engaged by an inwardly directed flange 72 of the bearing housing 63. It is apparent that the barrel is supported by the swivel bearing connection 67 from the bearing shaft 64, but is prevented from moving downwardly relative to the shaft.

Similarly, upward movement of the barrel 36 relative to the bearing shaft 64 is prevented by an axial type of ball bearing 73, including a lower race 74 resting upon the upper end of the bearing housing 63, there being a series of bearing balls 75 riding upon the upper end of the lower race, which are engaged by an upper race 76 engaged by a lock nut 77 threaded on the bearing shaft 64. The lock nut is prevented from turning on the shaft by a lock washer 78 between the nut and the lower end of the outer clutch housing head, suitable tabs 79 on the

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lock washer being bent into recesses 80 in the bearing nut and the housing head 65 to prevent relative turning of the nut with respect to the housing head.

As illustrated in the drawings, the rubber sleeve 57 is mounted upon the exterior of the lower section 54 of the inner tubing or barrel 36. This sleeve consists of an inner layer 82 engaging the periphery of the barrel 36 and an outer layer 83 engaging the periphery of the inner layer, resulting from a pulling back of the outer layer over the inner layer. The layers are actually integral with one another and merge into one another at their upper ends 84. The lower portion 85 of the outer layer 83 extends inwardly over the lower end 62 of the inner tubing or barrel 36, which is rounded so as to function as a guide over which the rubber sleeve 57 is pulled. The lower portion extends into the inner tubing or barrel 36 and is clamped to a sleeve 86 within the barrel. This sleeve has a downwardly diverging bore 87 therein, a bushing 88 being inserted upwardly in the sleeve 86 and having a companion divergent exterior, serrated surface 89, in order to clamp the end 85 of the rubber sleeve between the clamp sleeve and the bushing. The bushing 88 is urged and held upwardly within the clamp sleeve 86 by a clamp bolt 90 having a head 91 received within a counterbore 92 in the clamp bushing 88 and with its upper end 93 threaded into the upper end of the clamp sleeve 86. Tightening of the bolt 90 will force and hold the clamp bushing 88 upwardly within the clamp sleeve 86 and will wedge the end of the rubber sleeve therebetween.

As the core E is formed during the rotation of the core bit 32, it moves relatively upwardly through the central opening 35 in the core bit head and into the rubber sleeve 57, which is progressively pulled relatively upwardly within the barrel 36, the clamp device 36-93 moving upwardly therewith. Actually, the drill bit 32 and outer housing 27, 28, together with the intermediate tube 46 and the inner tubing or barrel 36, are moved downwardly as drilling progresses, the inner portion 85 of the rubber sleeve 57 and the mechanism 86-93 to which it is clamped remaining in a fixed position in the well bore. As the inner tubing, intermediate tubing, and outer housing and drill bit move downwardly, the rubber sleeve 57 is pulled around the lower guide 62 and will fit around the core E being formed. The normal unrestrained diameter of the rubber sleeve 57 is less than the diameter of the core E being formed, such that the rubber sleeve will contract around and against the core, and will grip and hold it securely.

The rubber sleeve 57 is pulled around the lower guide 62 on the inner tubing or barrel 36 by a stripper device which is connected for longitudinal movement to the clamp sleeve 86, but is rotatable without rotating the clamp sleeve 86. The stripper device includes a stripper tube 95, the upper end of which extends upwardly within a lower portion 96 of the inner mandrel 10 of the expansion joint. The stripper tube consists of an upper section 97 that extends downwardly through the nozzle carrier 38 and outer clutch housing 44, and is threadedly attached to a lower section 98 that extends downwardly through the upper swivel 67 and through the inner tubing or barrel 36, this lower section, in turn, being threadedly attached to a tubular sub 99 within the lower section 54 of the barrel, that is, in turn, secured to a tubular shaft 100 of a lower swivel 101, by means of which the entire stripper device is connected to the clamp sleeve 86 to prevent relative longitudinal movement therebetween, but to permit rotation of the stripper mechanism relative to the clamp sleeve 86 and the rubber core retaining sleeve 57 attached thereto.

The swivel 101 includes the tubular shaft 100, which has an external flange 102 coacting with an upper ball bearing 103 and also with a lower ball bearing 104. The lower race 105 of the upper ball bearing rests upon the flange 102, there being balls 106 engaging the end face

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of this race, which, in turn, are engaged by an upper race 107 that supports an inwardly extending flange 108 of a bearing housing 109 which extends downwardly along both ball bearings 103, 104 and is threadedly attached to the coupling sleeve 86. The lower bearing 104 includes a lower race 110 resting upon the upper end of the clamp sleeve 86, there being a series of ball bearing elements 111 resting upon the upper end of this race, which, in turn, are engaged by an upper race 112 engaged by the tubular shaft flange 102. It is, accordingly, evident that the tubular shaft 100, as well as all of the stripper tubing 95 connected thereto, can rotate within the housing 36 and with respect to the clamp sleeve 86, while the clamp sleeve and the lower end 85 of the rubber sleeve 57 cannot move longitudinally with respect to the stripper tube.

The stripper tube 95 is permitted to move upwardly with respect to the outer tubing 27, intermediate tubing 46, and inner tubing or barrel 36, but is prevented from moving downwardly with respect thereto. To accomplish this purpose, a one-way ratchet or clutch device 113 is provided. This clutch device includes the outer clutch housing 44 which has a frusto-conical or tapered internal surface 114 converging in a downward direction, and which is adapted to cooperate with a companion external tapered surface on an inherently contractile, split clutch or ratchet ring 115 disposed between the housing 44 and the exterior of the stripper tube 95. The stripper tube has downwardly facing ratchet teeth 116 along substantially its entire length which are adapted to engage internal upwardly facing ratchet teeth 117 on the split ring 115. It is apparent that upward movement of the stripper tube 95 within the clutch housing 44 will carry the ring upwardly with it to an extent limited by engagement of the ring with the lower end 118 of the nozzle carrier 38, after which the teeth 116 on the stripper tube will cam the ring 115 outwardly and thereby be released therefrom. However, any tendency for the tube 95 to move downwardly within the clutch housing 44 will effect a wedging of the ring 115 against the tapered surface 114 in the housing, which will urge and hold the clutch teeth 116, 117 coengaged, thereby precluding downward movement of the stripper tube 95 relative to the clutch housing 44 and the entire apparatus surrounding the tube. Accordingly, the stripper tube 95 is prevented from moving the clamp device 86-93 and the rubber sleeve 57 downwardly out of the inner tubing or barrel 36.

The inner mandrel 10 is movable downwardly within the outer housing 12 and also with respect to the stripper tube 95, but is prevented from moving upwardly relative to the stripper tube by a one-way clutch or ratchet device 120 between the mandrel and the stripper tube. A one-way clutch or ratchet housing 121 is threadedly attached to the lower end of the mandrel portion 96, and has a frusto-conical inner surface 122 converging in a downward direction which coacts with a companion external tapered surface 123 on the exterior of an inherently contractile split ratchet or clutch ring 124 disposed between the housing and the periphery of the stripper tube 95. This clutch ring has upwardly facing clutch or ratchet teeth 125 adapted to coact with downwardly facing ratchet teeth 126 on the stripper tube 95. The mandrel 10 can move downwardly along the stripper tube 95, since the clutch housing 121 will first move downwardly a slight distance along the stripper tube 95, whereupon the outwardly directed lower flange portion 127 of a latch sleeve 128, which is clamped between the mandrel 10 and the end of the housing 121, will engage the ring 124 and force it downwardly along the ratchet teeth 126 on the stripper tube, the latter camming the ring 124 outwardly within the housing 121, whereupon the ring or sleeve will merely ratchet freely in a downward direction over the stripper tube teeth 126. Conversely, any tendency for the mandrel 10 to move upwardly along the stripper tube 95 will cause its tapered surface 122 to engage the companion tapered surface 123 on the ring 124 and wedge and

hold its teeth 125 inwardly in engagement with the tube teeth 126, thereby coupling or clutching the mandrel 10 to the stripper tube 95 so that they move upwardly as a unit.

Prior to the commencement of the actual coring operation, it is desired to hold the mandrel 10 of the expansion joint 11 upwardly within the housing 12 of the joint, or in the extended position, and to preclude downward movement of the mandrel 10 within the expansion joint housing, as well as along the stripper tube 95. Accordingly, a latch device 130 is provided that includes the latch sleeve 128 heretofore described which extends upwardly around the upper end of the stripper tube 95 and around a bushing 131 threaded into the upper end of the stripper tube. This latch sleeve 128 has a plurality of longitudinally extending spring arms 132 which terminate in upper, inwardly extending fingers 133 projecting inwardly over the upper end 134 of the bushing so that downward movement of the mandrel 10, to which the latch sleeve 128 is attached, will carry the latch sleeve downwardly only to a slight extent, in which the fingers 133 engage the upper end 134 of the bushing, whereupon further downward movement is precluded.

When the coring operation is to commence, the latch sleeve 128 is released by dropping or pumping a release plug 135 down through the string of drill pipe D, which will pass through the mandrel 10 and move within the latching device 130 to release the fingers 133. As specifically disclosed, the release plug 135 includes an upper body 136 having a valve head 137 threadedly secured to its lower end. Clamped between the valve head 137 and the valve body 136 is a side seal ring 138 having an upwardly extending lip 139, this seal ring being adapted to seat within the cylindrical seating surface 140 constituted by the inner wall of the bushing. As the valve head 137 moves within the bushing 131, a downwardly tapering cam surface 141 on the valve body will engage companion downwardly tapering cam surfaces 142 on the fingers 133 and cam the fingers outwardly, deflecting the spring arms 132 to a position in which they cannot extend across the upper end 134 of the bushing. The cam portion 141 of the release plug 135 will come to rest against a companion tapered seating surface 143 on the upper portion of the bushing 131, the plug body 136 above the cam surface 141 then holding the fingers 133 in their outward or released position. The mandrel 10 can now move downwardly within the housing 12 and along the stripper tube 95 to the maximum extent, limited by engagement of the stop ring 17 with the lower shoulder 22 of the housing.

In the operation of the core barrel apparatus, the parts are at first disposed in the relative position illustrated in FIGS. 4 to 9, inclusive, and diagrammatically in FIG. 1. In the assembly of the rubber sleeve 57 on the inner barrel 36, a suitable liquid spacer, such as chassis grease, will have been injected between the inner and outer layers 82, 83 of the rubber sleeve to separate such layers or folds and eliminate, or at least considerably minimize, the friction therebetween, thereby avoiding any resistance to the proper pulling of the outer layer 83 downwardly along the inner layer 82, around the inner tubing guide 62 and upwardly into the interior of the inner tubing 36. The lower end 150 of the inner layer of the rubber or pliant elastic core receiving and retaining sleeve 57 will engage the stop shoulder 151 at the lower end of the inner tubing and will remain in such position.

During the downward movement of the apparatus in the well bore, the telescopic joint 11 will remain in its extended position and cannot move from such extended position because of the latch device 130. Any tendency for the mandrel 10 to move downwardly of the housing 12 will be resisted by engagement of the fingers 133 with the upper end 134 of the bushing 131, this downward force being transmitted through the stripper tube 95 to the one-way clutch 113 between the stripper tube and

the outer clutch housing 44, which is connected to the outer housing or tubing 12 of the apparatus through the nozzle carrier 38. Thus, the downward force is transmitted in substantially solid fashion from the drill pipe D and the mandrel 10 to the outer tubing 12 and the drill bit 32, the parts being prevented from moving relatively with respect to one another.

With the parts in the position and condition just referred to, fluid can be circulated down through the string of drill pipe D and the apparatus, passing out through the drill bit 32 and thence upwardly through the annulus around the apparatus and the drill pipe back to the top of the well bore. In this manner, the hole may be conditioned. For that matter, a reaming action can be performed in the well bore to eliminate tight spots and the like in the formation. Until the latch device 130 is released, the formation of a core that will move upwardly within the barrel 36 cannot occur. The pliant, elastic or rubber core retaining sleeve 57 will remain in the position and condition in which it has been assembled in the apparatus.

The condition just referred to is exemplified in all of the figures in the drawings with the exception of FIGS. 2 and 3.

After the well has been properly conditioned and the bottom C of the hole B has been reached, the coring operation can commence. The release plug 135 is first pumped downwardly through the drill pipe D, and will engage the fingers 133, camming them outwardly from their holding position, and thereby releasing the latch device to permit the mandrel 10 to move downwardly within the housing 12 to the extent limited by engagement of the mandrel stop ring 17 with the lower shoulder 22 of the outer housing of the expansion joint 11. The lower one-way clutch device 113 will prevent the stripper tube 95 from moving downwardly. However, the upper clutch device 120 permits telescoping of the mandrel 10 downwardly over the stripper tube. The apparatus is now in the condition illustrated in FIG. 2. It can be rotated by the drill pipe D while fluid is being pumped downwardly through it, the fluid under pressure being restricted in flowing through the nozzles 39 in the carrier 38 and exerting a downward pressure which will be transmitted through the outer housing 24, 26, 27, 28 to the drill bit 32, thereby imposing the proper drilling force or weight against the bottom C of the well bore. The drilling fluid will also discharge through the ports 52 of the bit to convey the cuttings back to the top of the hole.

As drilling proceeds, the drill bit 32 and outer housing 12, as well as the intermediate tubing 46 and the inner tubing or barrel 36, move downwardly with respect to the stripper tube 95 and the mandrel 10. The mandrel is not moved downwardly at all, but is held in the position that it occupied when it was first shifted downwardly within the outer housing 12 to the position shown in FIG. 2. The mechanism surrounding the stripper tube 95 can all move downwardly along the stripper tube, as permitted by the lower one-way clutch 113. As the core bit 32 forms the core E and moves downwardly therealong, the core barrel 36 moves downwardly with it, the lower end 62 of the core barrel pressing down against the rubber sleeve 57 to shift its outer layer 83 along the inner layer 82 and cause the rubber to move relatively upwardly within the inner tubing or barrel 36 and contract around the core E that is being formed (FIG. 3). Rotation of the apparatus and the pumping of the drilling fluid therethrough is continued until the outer housing 12 of the telescopic joint 11 is shifted downwardly to the fully extended position once again, such as illustrated diagrammatically in FIG. 3. When this occurs, the operator at the top of the well bore will be advised of that fact by a reduction in torque on the equipment at the top of the hole and also by the return of the weight indicator to the original drilling weight of the

string D, which will be determined with the pumps operating at the pressure used during the coring operation. The mechanism at the surface for rotating the drill string is disengaged and the pumps stopped, whereupon the drill string D and the mandrel 10 are again lowered the necessary distance required to again collapse the expansion joint 11, which is to bring the mandrel stop ring 17 into engagement with the housing shoulder 22. Such downward movement can occur without disturbing the core E previously produced since the upper clutch 130 will merely ratchet downwardly freely over the stripper tube 95, whereas the stripper tube is prevented from moving downwardly within the barrel 36 by the downward clutching or coupling action of the lower clutch device 113.

The pumps are again started, the rotary mechanism at the top of the well bore engaged, and the coring action reinstated. During the coring, the drill string D and mandrel 10 will be prevented from moving downwardly in the well bore, the necessary drilling weight then being supplied by the throttling action of the drilling fluid as it passes through the nozzles 39. As the core E is formed, the core bit 32 and the outer, intermediate and inner tubular members 12, 46, 36 are shifted downwardly to cause the outer layer 83 of the rubber sleeve 57 to peel from and down the inner layer 82 and shift around the lower guide 62 of the inner tubing 36 and move upwardly within the latter, the rubber portion disposed within the inner tubing or barrel contracting around the core E as it is formed to retain and hold it in its initial condition.

When an additional core length has been produced corresponding to the stroke of the expansion joint 11, the foregoing operation can be repeated, the rotary mechanism being disengaged, the pumps stopped, and the drill pipe D and mandrel 10 again lowered to again collapse the telescopic joint 11, followed by restarting of the pumps, engagement of the rotary mechanism, and continuation of the coring operation.

The stroke of the telescopic joint 11 need only be of a fraction of the length of core that can be produced and encased within the rubber retaining sleeve 57 when it is shifted within the inner tubing or barrel 36. As an example, the length of stroke of the joint 11 may only be two feet and yet a core of twenty feet, forty feet, or sixty feet obtained in a barrel 36 and in a coring mechanism that must, of course, be of the proper length. The coring operation can only proceed after the expansion joint 11 has been fully telescoped and should stop when a length of core has been produced corresponding to the stroke of the expansion joint, whereupon the latter is again placed in its collapsed or telescoped position and coring recommenced. However, during the coring operation, the drill string D and the mandrel 10 are prevented from moving downwardly in the well bore. The stripper tube 95, however, can move relatively upwardly within the mandrel 10, as permitted by the automatic release of the one-way clutch 130. However, the stripper tube cannot move downwardly of the mandrel, since the clutch 130 automatically engages to preclude such movement. Nor can the stripper tube move in a downward direction within the inner, intermediate and outer tubings 36, 46, 12 because such movement is prevented by the lower clutch device 113.

At any time that the expansion joint 11 is in its fully expanded position, a joint of drill pipe can be added at the top of the well bore in the normal manner without affecting the operation of the apparatus. The elevation of the string of drill pipe D will merely elevate the entire coring apparatus A as a unit, the drill bit 32 moving away from the bottom C of the hole, but the core that has previously been produced remaining within the rubber sleeve 57 of the apparatus. Upon the addition of another drill pipe section at the top of the well bore and reconnection of the usual kelly at the top of the well bore, the apparatus can be lowered in the well bore B. It is desirable to pump fluid down through the drill string during

such lowering action since the pump pressure will keep the expansion joint 11 in its extended position, thereby precluding inadvertent upward and downward movement of the outer housing 12 and the other portions of the apparatus with respect to the mandrel 10, which would result in undesired upward movement of the stripper tube 95 within the mandrel 10 and the pulling of the portion of the rubber sleeve 57 around the lower end 62 of the inner tubing 36 and into the interior of the latter.

After the desired length of core E has been cut, the apparatus can be removed from the well bore in the usual manner by elevating the drill string D. When the coring apparatus is at the top of the hole, it can be disassembled and the core E, still encased within the rubber sleeve 57 that is constricted therearound, removed from the apparatus. The core E will remain in an intact position, since it is protected by the contractile rubber sleeve. The sleeve 57 with the core therein can be easily handled and transported, with assurance that the core therewithin remains undisturbed. When the core E is to be inspected and analyzed, the rubber sleeve can be cut away from the core to reveal the latter.

The inventor claims:

1. In apparatus for producing and retrieving a core in a bore hole: a driving structure adapted to be connected to a bit for cutting a core in the bore hole; driving means adapted to be connected to a drill string and slidably splined to said structure; an inner tubular member within said structure; an elastic sleeve on the exterior of said tubular member extending around the lower end of said tubular member and adapted to move upwardly thereinto around a core extending therewithin; pulling means in said inner tubular member connected to said sleeve and extending upwardly therefrom; and means releasably coupling said driving means to said pulling means, whereby said driving means is coupled to said pulling means when said driving means moves upwardly and said driving means is uncoupled from said pulling means when moving downwardly relative thereto.

2. In apparatus for producing and retrieving a core in a bore hole: a driving structure adapted to be connected to a bit for cutting a core in the bore hole; driving means adapted to be connected to a drill string and slidably splined to said structure; an inner tubular member within said structure; an elastic sleeve on the exterior of said tubular member extending around the lower end of said tubular member and adapted to move upwardly thereinto around a core extending therewithin; pulling means in said inner tubular member connected to said sleeve and extending upwardly therefrom; means releasably coupling said driving means to said pulling means, whereby said driving means is coupled to said pulling means when said driving means moves upwardly and said driving means is uncoupled from said pulling means when moving downwardly relative thereto; and means releasably coupling said pulling means to said driving structure to permit upward movement of said pulling means relative to said driving structure but to prevent downward movement of said pulling means relative to said driving structure.

3. In apparatus for producing and retrieving a core in a bore hole: a driving structure adapted to be connected to a bit for cutting a core in the bore hole; driving means adapted to be connected to a drill string and slidably splined to said structure; an inner tubular member within said structure; an elastic sleeve on the exterior of said tubular member extending around the lower end of said tubular member and adapted to move upwardly thereinto around a core extending therewithin; pulling means in said inner tubular member connected to said sleeve and extending upwardly therefrom; and means releasably coupling said pulling means to said driving structure to permit upward movement of said pulling means relative to said driving structure but to prevent downward movement of said pulling means relative to said driving structure.

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sleeve and extending upwardly therefrom; and one-way clutch means releasably coupling said pulling means to said driving structure to permit upward movement of said pulling means relative to said driving structure but to prevent downward movement of said pulling means relative to said driving structure.

12. In an apparatus for producing and retrieving a core in a bore hole: a driving structure adapted to be connected to a bit for cutting a core in the bore hole; driving means adapted to be connected to a drill string and slidably splined to said structure; an inner tubular member within said structure; an elastic sleeve on the exterior of said tubular member extending around the lower end of said tubular member and adapted to move upwardly thereinto around a core extending therewithin; pulling means in said inner tubular member connected to said sleeve and extending upwardly therefrom; and one-way clutch means releasably coupling said driving means to said pulling means to permit upward movement of said pulling means relative to said driving means and to prevent downward movement of said pulling means relative to said driving means, said one-way clutch means comprising an outer housing secured to said driving means and having a downwardly tapering inner surface, and a clutch ring in said housing engageable with said surface to be wedged into clutching engagement with said pulling means.

13. In apparatus for producing and retrieving a core in a bore hole: a driving structure adapted to be connected to a bit for cutting a core in the bore hole; driving means adapted to be connected to a drill string and slidably splined to said structure; an inner tubular member within said structure; an elastic sleeve on the exterior of said tubular member extending around the lower end of said tubular member and adapted to move upwardly thereinto around a core extending therewithin; pulling means in said inner tubular member connected to said sleeve and extending upwardly therefrom; first one-way clutch means releasably coupling said driving means to said pulling means to permit upward movement of said pulling means relative to said driving means and to prevent downward movement of said pulling means relative to said driving means, said one-way clutch means comprising an outer housing secured to said driving means and having a downwardly tapering inner surface, and a clutch ring in said housing engageable with said surface to be wedged into engagement with said pulling means; and second one-way clutch means releasably coupling said pulling means to said driving structure to permit upward movement of said pulling means relative to said driving structure, said second one-way clutch means comprising a second outer housing secured to said structure and having a second downwardly tapering inner surface, and a clutch ring in said second outer housing engageable with said second surface to be wedged into clutching engagement with said pulling means.

14. In apparatus for producing and retrieving a core in a bore hole: a driving structure adapted to be connected to a bit for cutting a core in the bore hole; driving means adapted to be connected to a drill string and slidably splined to said structure; an inner tubular member within said structure; an elastic sleeve on the exterior of said tubular member extending around the lower end of said tubular member and adapted to move upwardly thereinto around a core extending therewithin; pulling means in said inner tubular member connected to said sleeve and extending upwardly therefrom; and one-way clutch means releasably coupling said pulling means to said driving structure to permit upward movement of said pulling means relative to said driving structure but to prevent downward movement of said pulling means relative to said driving structure, said one-way clutch means comprising an outer housing secured to said struc-

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ture and having a downwardly tapering surface, and a clutch ring in said housing engageable with said surface to be wedged into clutching engagement with said pulling means.

15. In apparatus for producing and retrieving a core in a bore hole: a driving structure adapted to be connected to a bit for cutting a core in the bore hole; driving means adapted to be connected to a drill string and slidably splined to said structure; an inner tubular member within said structure; an elastic sleeve on the exterior of said tubular member extending around the lower end of said tubular member and adapted to move upwardly thereinto around a core extending therewithin; tubular pulling means in said inner tubular member connected to said sleeve and extending upwardly therefrom; one-way clutch means releasably coupling said driving means to said pulling means to permit upward movement of said pulling means relative to said driving means and to prevent downward movement of said pulling means relative to said driving means; coengageable releasable latch means on said driving means and tubular pulling means to prevent upward movement of said pulling means relative to said driving means; and means movable down the drill string into engagement with said latch means and into said tubular pulling means to release said latch means and close said tubular pulling means.

16. In apparatus for producing and retrieving a core in a bore hole: a driving structure adapted to be connected to a bit for cutting a core in the bore hole; driving means adapted to be connected to a drill string and slidably splined to said structure; an inner tubular member within said structure; an elastic sleeve on the exterior of said tubular member extending around the lower end of said tubular member and adapted to move upwardly thereinto around a core extending therewithin; tubular pulling means in said inner tubular member connected to said sleeve and extending upwardly therefrom; one-way clutch means releasably coupling said driving means to said pulling means to permit upward movement of said pulling means relative to said driving means and to prevent downward movement of said pulling means relative to said driving means; coengageable releasable latch means on said driving means and tubular pulling means to prevent upward movement of said pulling means relative to said driving means; means movable down the drill string into engagement with said latch means and into said tubular pulling means to release said latch means and close said tubular pulling means; and one-way clutch means releasably coupling said pulling means to said driving structure to permit upward movement of said pulling relative to said driving structure but to prevent downward movement of said pulling means relative to said driving structure.

17. In apparatus for producing and retrieving a core in a bore hole: a driving structure adapted to be connected to a bit for cutting a core in the bore hole; driving means adapted to be connected to a drill string and slidably splined to said structure; an inner tubular member within said structure; an elastic sleeve on the exterior of said tubular member extending around the lower end of said tubular member and adapted to move upwardly thereinto around a core extending therewithin; tubular pulling means in said inner tubular member connected to said sleeve and extending upwardly therefrom; means releasably coupling said driving means to said pulling means to permit said pulling means to move upwardly relative to said driving means but to prevent downward movement of said pulling means relative to said driving means; a latch element carried by said driving means and overlying the upper end of said tubular pulling means to engage such upper end and prevent upward movement of said pulling means relative to said driving means; and a release plug movable down the drill string into engagement with said latch element and into said tubular pulling means to shift said latch element outwardly from en-

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gement with said upper end and close said tubular pulling means to prevent fluid flow thereinto.

18. In apparatus for producing and retrieving a core in a bore hole: a driving structure adapted to be connected to a bit for cutting a core in the bore hole; driving means adapted to be connected to a drill string and slidably splined to said structure; an inner tubular member within said structure; an elastic sleeve on the exterior of said tubular member extending around the lower end of said tubular member and adapted to move upwardly thereinto around a core extending therewithin; pulling means in said inner tubular member connected to said sleeve and extending upwardly therefrom; and means releasably coupling said driving means to said pulling means to prevent relative longitudinal movement in at least one direction between said driving means and pulling means.

19. In apparatus for producing and retrieving a core in a bore hole: a driving structure adapted to be connected to a bit for cutting a core in the bore hole; driving means adapted to be connected to a drill string and slidably splined to said structure; an inner tubular member within said structure; an elastic sleeve on the exterior of said tubular member extending around the lower end of said tubular member and adapted to move upwardly thereinto around a core extending therewithin; pulling means in said inner tubular member connected to said sleeve and extending upwardly therefrom; means releasably coupling said driving means to said pulling means to prevent relative longitudinal movement in at

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least one direction between said driving means and pulling means; and means movable down the drill string into engagement with said coupling means to release the same.

20. In apparatus for producing and retrieving a core in a bore hole: a driving structure adapted to be connected to a bit for cutting a core in the bore hole; driving means adapted to be connected to a drill string and slidably splined to said structure; an inner tubular member within said structure; an elastic sleeve on the exterior of said tubular member extending around the lower end of said tubular member and adapted to move upwardly thereinto around a core extending therewithin; pulling means in said inner tubular member connected to said sleeve and extending upwardly therefrom; means releasably coupling said pulling means to said driving structure to permit upward movement of said pulling means relative to said driving structure but to prevent downward movement of said pulling means relative to said driving structure; and means releasably latching said driving means to said pulling means for preventing substantial downward movement of said driving means relative to said pulling means.

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