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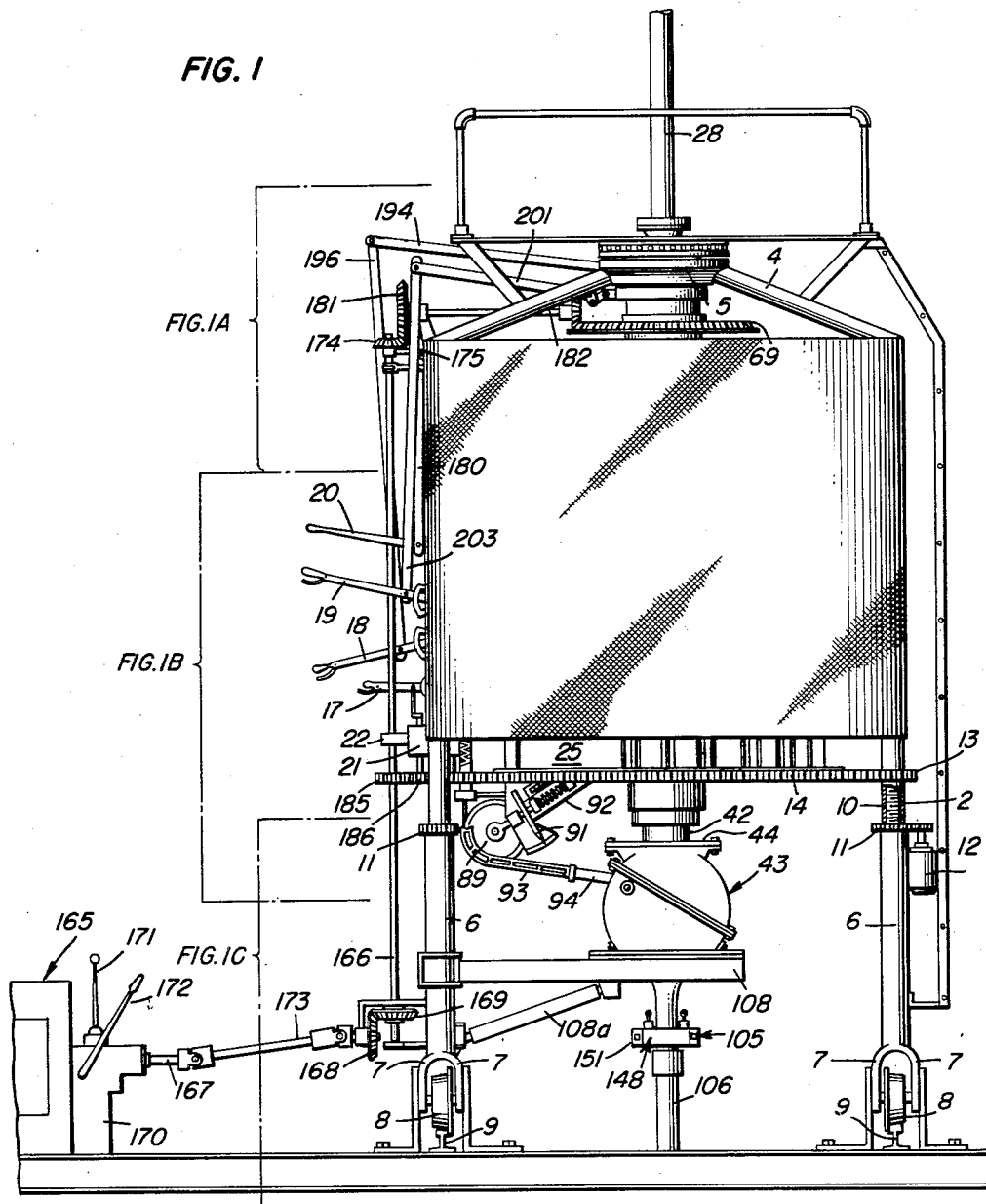
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3,154,157

SIDE WALL SAMPLING DEVICE

Filed Dec. 29, 1961

12 Sheets-Sheet 1



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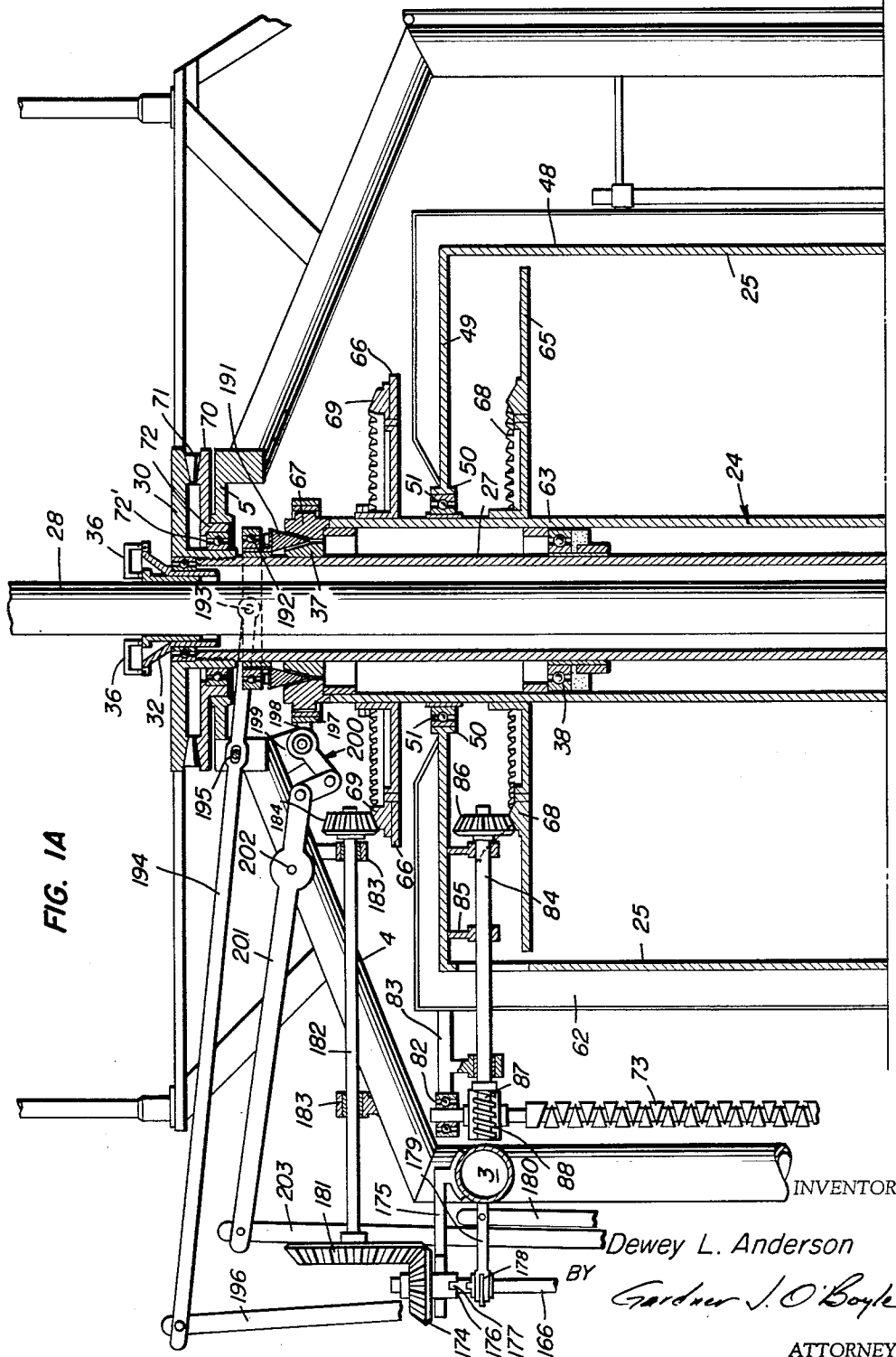
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SIDE WALL SAMPLING DEVICE

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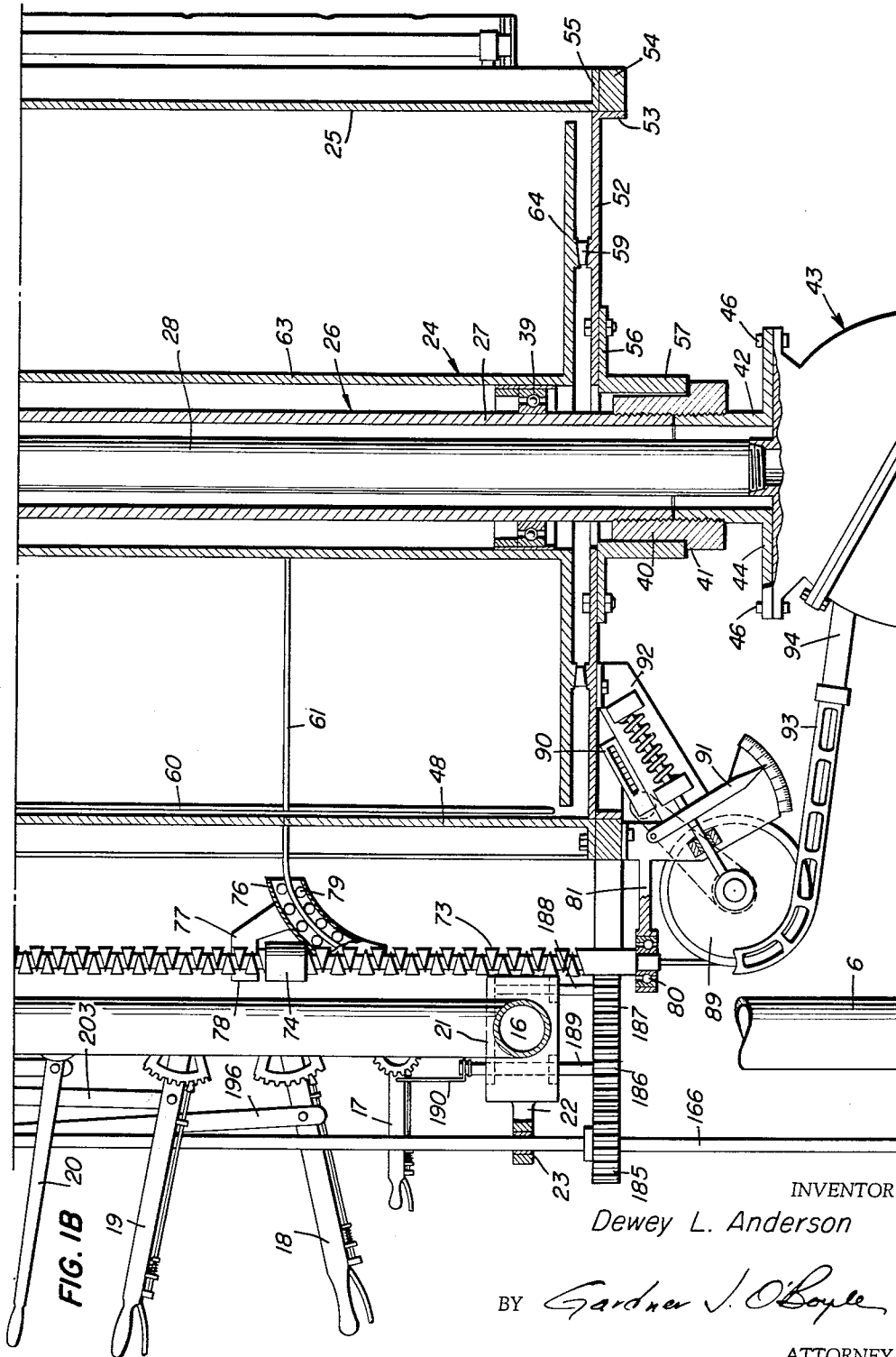
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SIDE WALL SAMPLING DEVICE

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12 Sheets-Sheet 3



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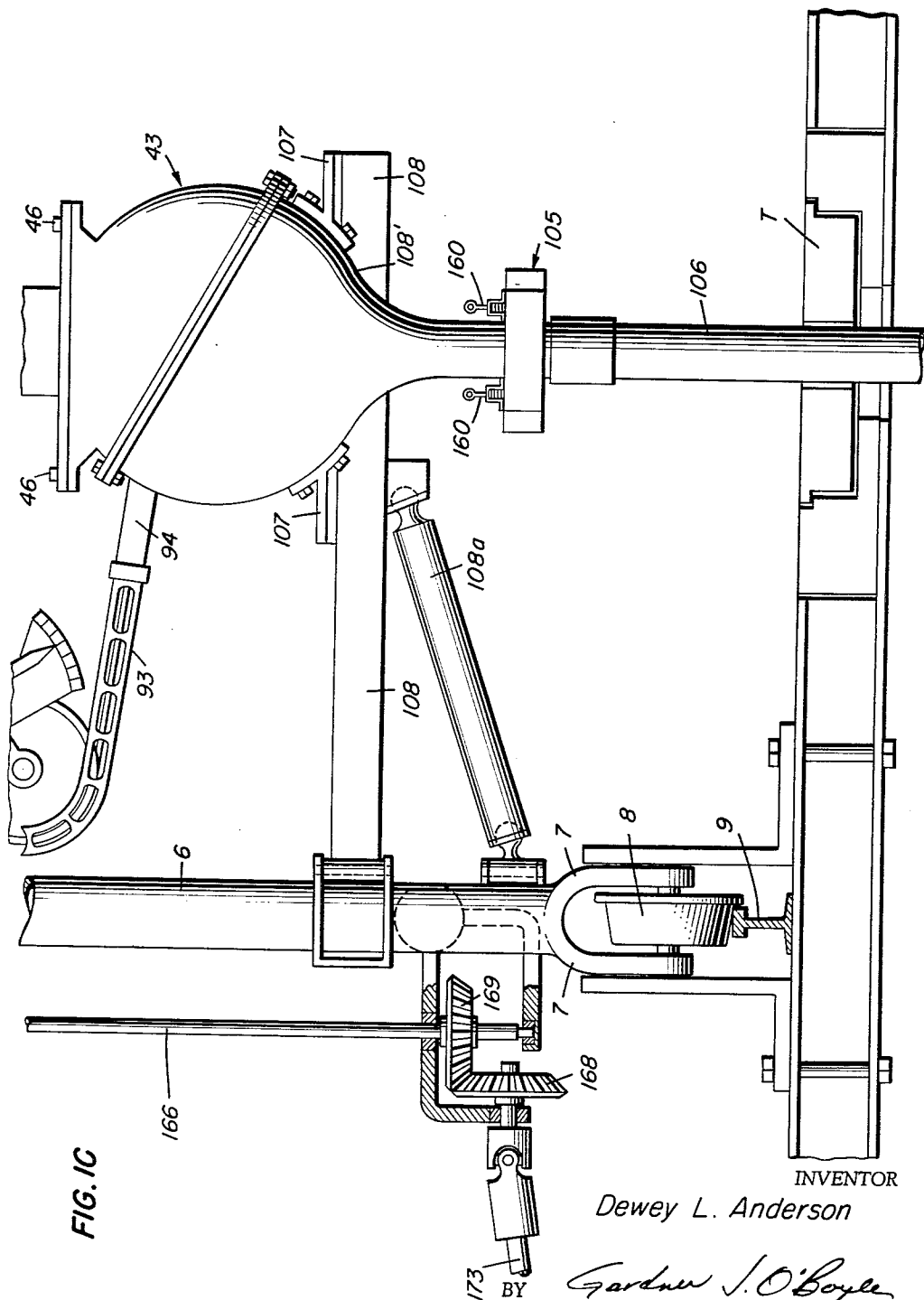
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12 Sheets-Sheet 4



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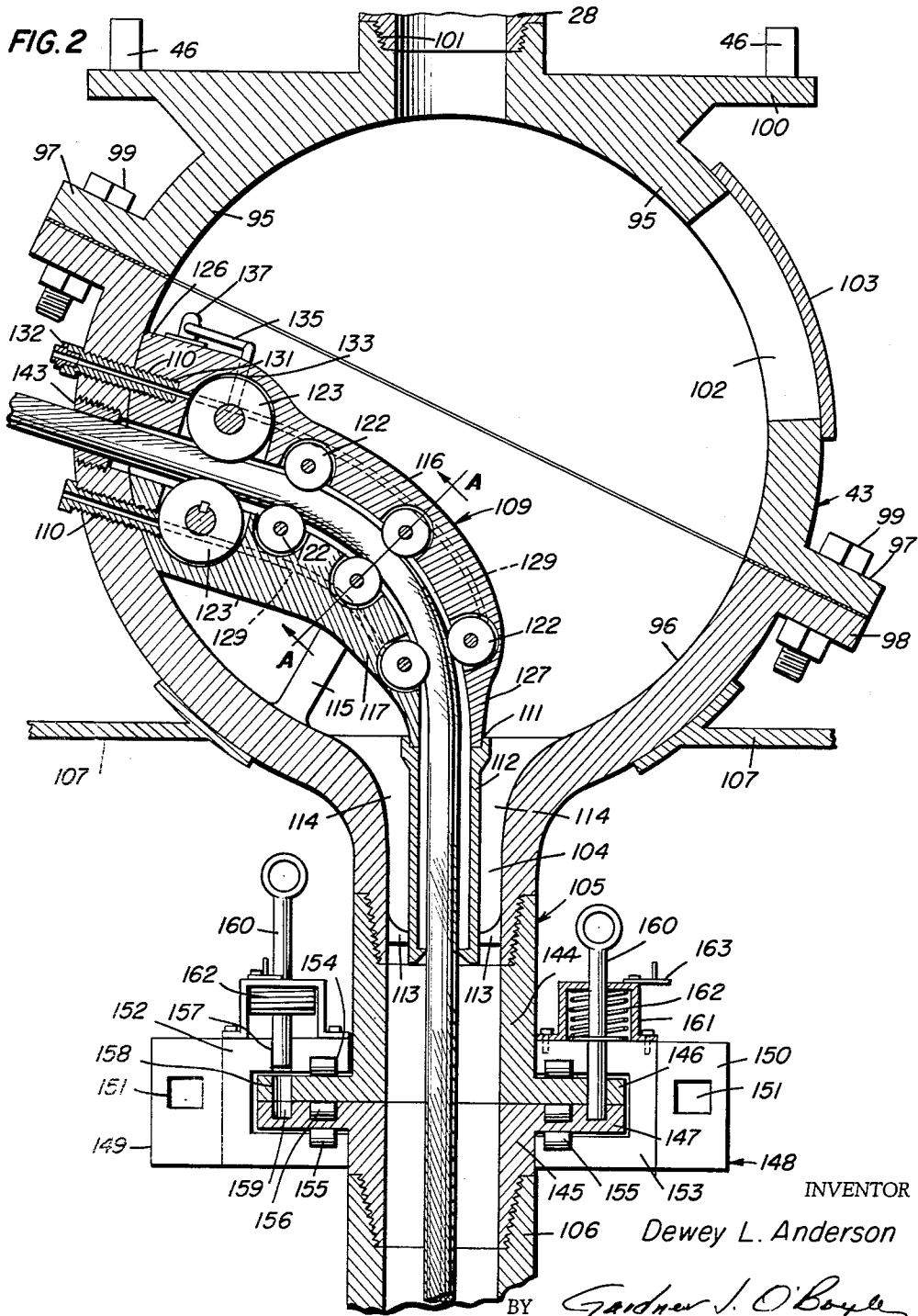
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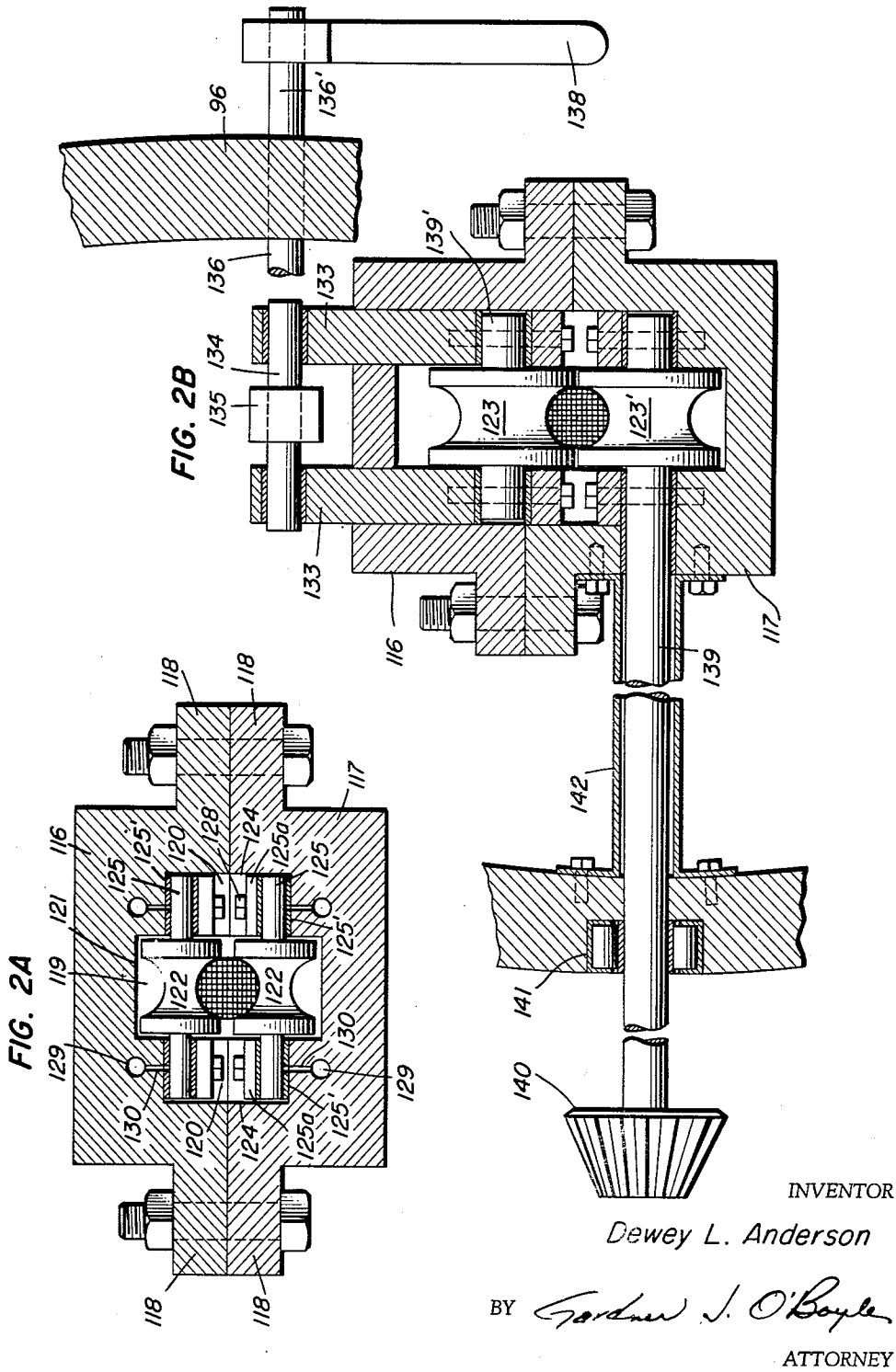
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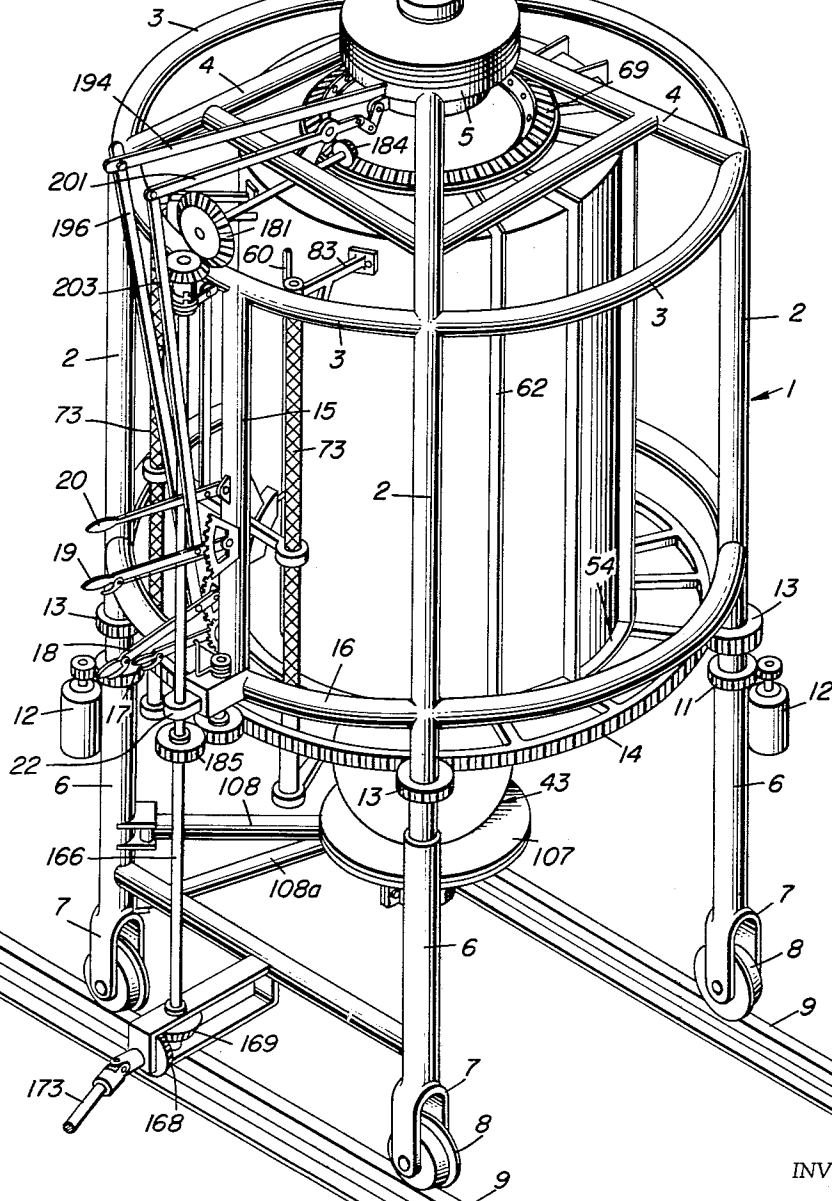
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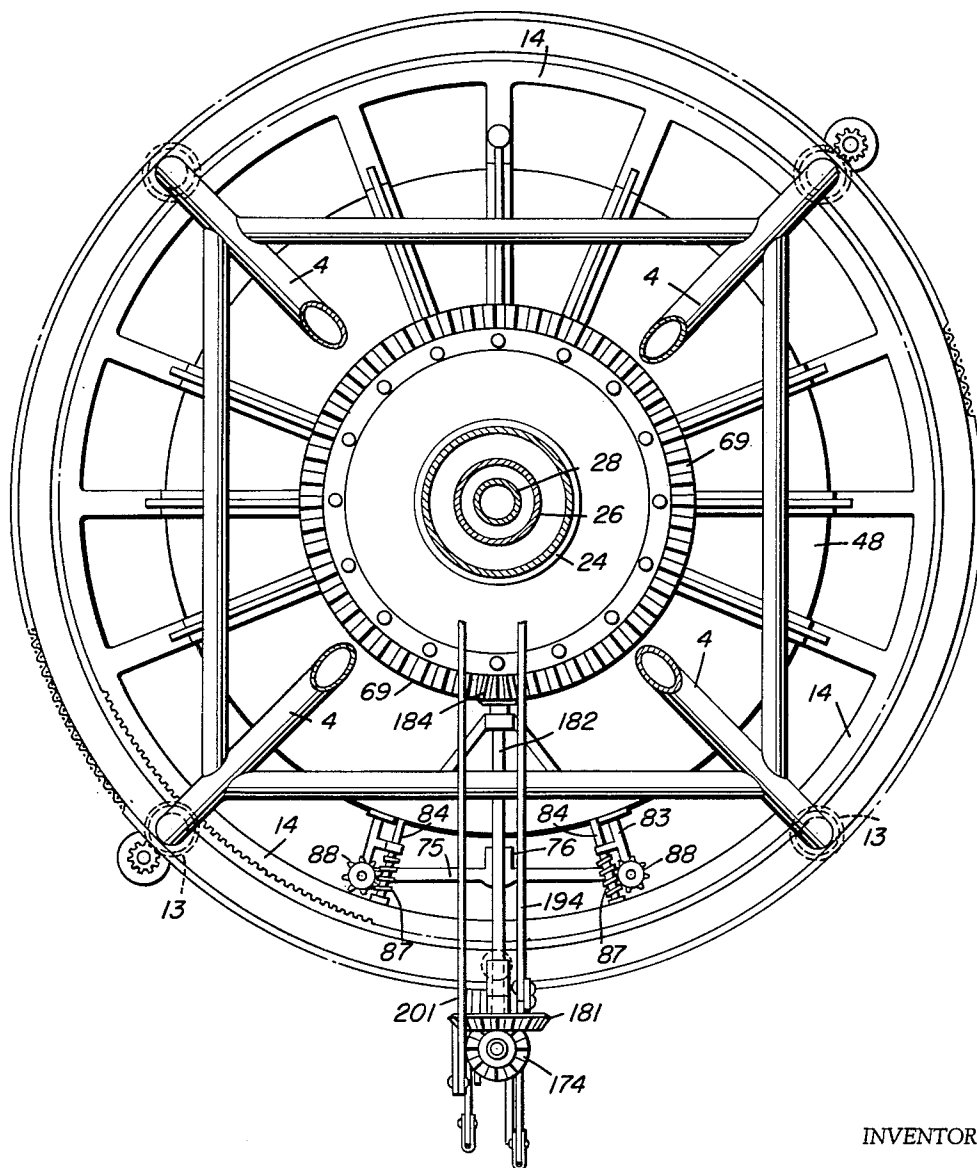
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FIG. 4



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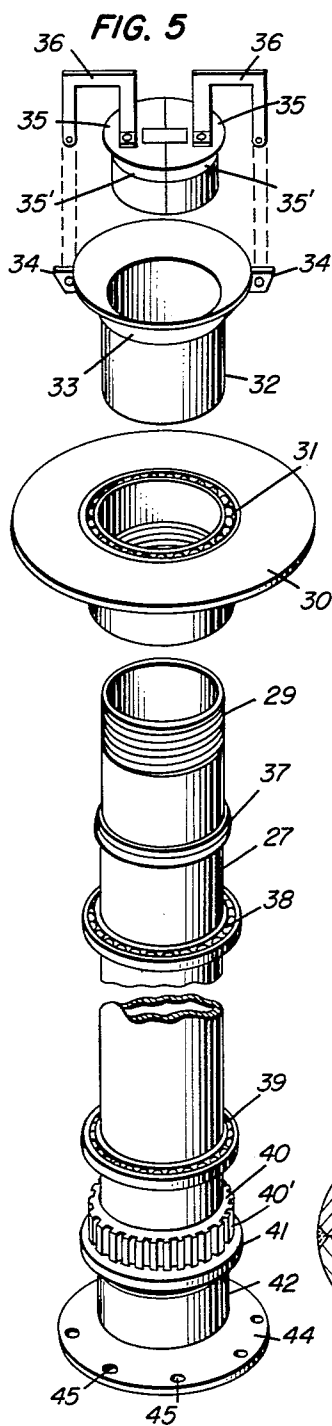
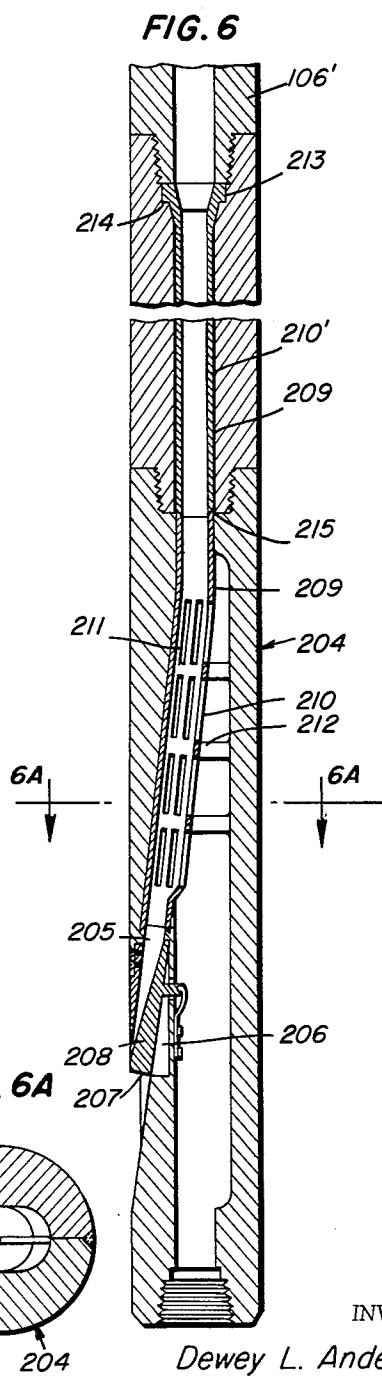
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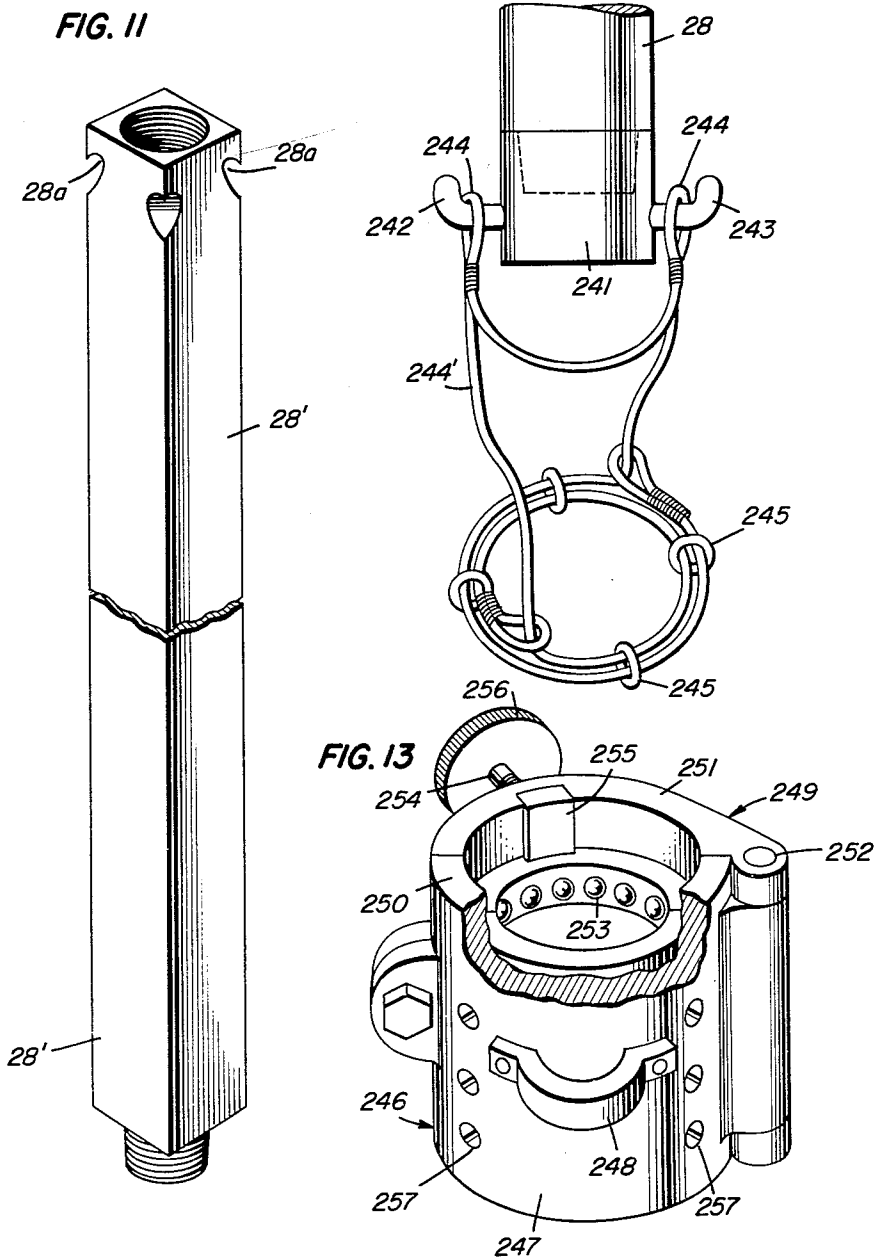
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FIG. 12



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FIG. 14

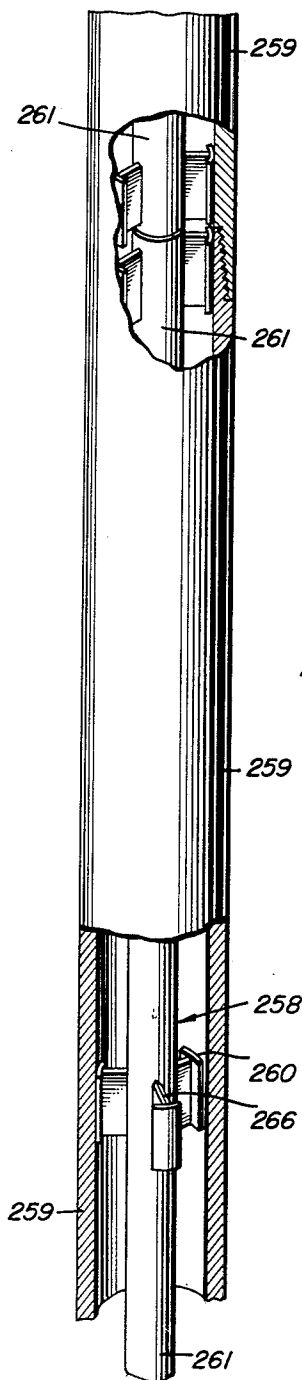


FIG. 14A

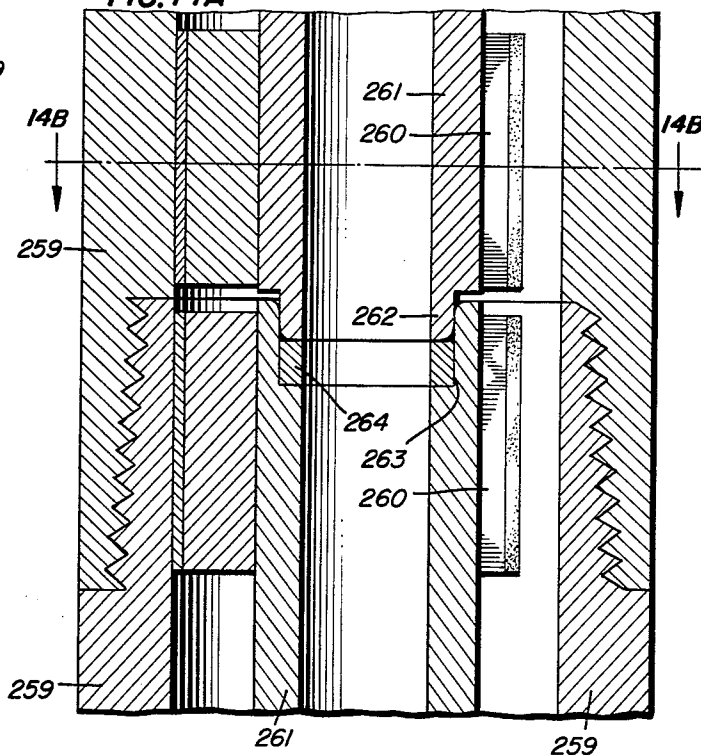
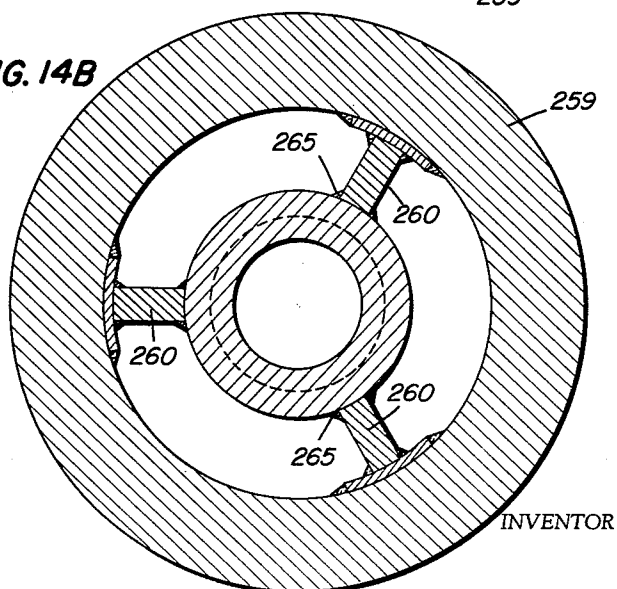


FIG. 14B



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SIDE WALL SAMPLING DEVICE

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20 Claims. (Cl. 175-78)

This invention relates to deep well drilling apparatus, and more particularly to means for securing samples of underground formations without necessitating removal of the drill string from the bore hole.

As is well known, during the drilling of oil, gas and other wells, it is generally advisable to obtain samples of the underground formations, as the drilling proceeds. In the past, several suggestions have been advanced for accomplishing such sampling, for example, by utilizing a motor adapted to be lowered into the drill column and actuated by the circulating drilling mud, or by use of other types of coring devices, wherein the coring tool is secured to the lower end of the drill string and rotated thereby.

In accordance with the present invention, a novel association of an independently operable coring assembly with the conventional drilling equipment is provided, whereby samples can be taken and retrieved expeditiously without disturbing the drilling equipment.

An object of the invention is to provide improved apparatus for securing side wall cores at any desired level in a drill formation without removal of the drill string from the bore hole.

Another object of the invention is to provide a novel coring tool assembly adapted to be quickly and easily lowered into and withdrawn from a drill string, with minimum interruption of the drilling operation.

Yet another object of the invention is to provide a self-contained, independently driven coring apparatus mounted at the well head, adapted to be optionally moved into aligned operative relationship with the drill string.

Still another object of the invention is to provide a novel, self-contained coring arrangement incorporating an improved coring bit and a rotary cable for actuating the bit.

A further object of the invention is to provide a novel coring assembly, adapted for operation within a drill column, with or without mud circulation.

A still further object of the invention is to provide an improved coring tool assembly, controllable independently of the drilling operation, and movable at will into and out of functional correlation with the drill string.

Yet a further object of the invention is to provide means for accelerating the passage of the coring tool downwardly through the circulating mud in the drill string.

With these and other objects in view, which may be incident to my improvements, the invention consists in the parts and combinations to be hereinafter set forth and claimed, with the understanding that the several necessary elements comprising my invention, may be varied in construction, proportions and arrangements, without departing from the spirit and scope of the appended claims.

In order to make my invention more clearly understood, I have shown in the accompanying drawings means for carrying the same into practical effect, without limiting the improvements in their useful application to the particular constructions, which for the purpose of explanation, have been made the subject of illustration.

In the drawings:

FIGURE 1 is an elevational view showing the cable actuating means of the improved coring assembly;

FIG. 1A, FIG. 1B and FIG. 1C are detail views of the bracketed portions 1A, 1B and 1C respectively, of the cable actuating means shown in FIG. 1;

FIG. 2 is an enlarged sectional view of the drill column cable direction;

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FIG. 2A is a sectional view taken along line A—A of FIG. 2;

FIG. 2B is a detail view, partly in section, of the cable driving arrangement associated with the cable director unit;

FIG. 3 is an isometric view, showing the supporting framework for the cable drum assembly and its associated actuating mechanism;

FIG. 4 is a detail view, partially in section, showing the top of the cable drum and driving means associated therewith;

FIG. 5 is an exploded view of the kelly housing assembly;

FIG. 6 is a sectional view of the coring tool sub;

FIG. 6A is a sectional view on line 6A—6A of FIG. 6; FIG. 7 is a longitudinal sectional view of the coring tool assembly;

FIG. 8 is a sectional view on line 8—8 of FIG. 7;

FIG. 9 is a bottom plan view of the cutter head;

FIG. 10 is a detail view of the core severing device;

FIG. 11 is a perspective view of a kelly section of abbreviated length;

FIG. 12 is a perspective view of the lifting means for use with kelly sections of the type shown in FIG. 11;

FIG. 13 is a perspective view of the cover for the open end of the upper section of the drill string;

FIG. 14 is a detail view of a section of a drill string having a cable carrying and guiding tube mounted therein;

FIG. 14A is a vertical sectional view of a joint between sections of cable carrying and guiding tube shown in FIG. 14; and

FIG. 14B is a sectional view taken on line 14B—14B of FIG. 14A.

The improved means for obtaining side wall cores comprises, essentially, a flexible cable and associated coring device adapted to be lowered and rotated within a conventional drill string. The cable is wound on a suitable drum, carried by a support structure designed to be optionally moved into an out of aligned operative relationship with the drill string, the cable drum embodying a reel and housing is arranged whereby the reel may be rotated independently of the housing or simultaneously therewith.

Referring to the drawings, and more particularly to FIGS. 1 and 3, the main support structure for the cable drum and its associated mechanism comprises a unitary frame member 1, embodying vertical columns or posts 2, interconnected and braced by means of upper and lower horizontal curvilinear strut members 3, and by inwardly and upwardly directed struts 4 connected at their inner ends to a heavy support collar. Preferably the frame embodies four symmetrically positioned, rugged, tubular members 2, of relatively high strength, heavy gauge steel, or other metal alloy, to which the struts are integrally secured, as by welding, the tubular members being supported for vertical movement with respect to enlarged tubular members 6, having terminal bifurcated portions 7 which journal flanged wheels 8 rotatably supported on rails 9, secured to the floor of a derrick rig. The construction of the frame is such that a cable drum and its housing structure, to be more fully described hereinafter, is adapted to be suspended and supported on the collar 5, and the frame member 1, together with the cable drum assembly, moved at will, across the derrick floor into and out of registering position with respect to a drill column.

Suitable means are provided for elevating and lowering the upper frame posts 2 with respect to the members 6, comprising elongated screws 10, adapted for threaded engagement with the frame posts internally thereof, rotation of each of the screws being effected by means of

a gear 11, secured to the screw shaft 10, and adapted to be driven by a reversible motor 12, mounted on a contiguous tubular member. The motors 12 are connected to a source of current, through a single switch, not shown, whereby they must be energized simultaneously to raise or lower the upper frame posts.

An idler or free wheeling gear 13 is mounted in suitable anti-friction bearings on a lower portion of each vertical post 2 of the frame, which idlers are adapted to mesh with a ring gear 14, secured to the cable drum housing, the idlers functioning to maintain the suspended cable drum and its housing structure in a horizontally stabilized position with respect to the main support frame. The main frame is further provided with means to mount and support certain components of the cable drum driving and control elements, and as shown, such support means comprises a vertical bar or tube 15 securely attached at one end, as by welding, to an upper horizontal strut 3, and to a lower horizontal strut 16 attached to and extending between two adjacent vertical frame posts. The bar 15 provides a mounting and support means for a series of brake and clutch control levers 17, 18, 19 and 20, used in certain phases of the operation of the cable drum assembly. The horizontal strut 16 serves to support a bearing block 21 in which gear elements of the reel housing driving means are mounted. The bearing block is formed with an extension 22, having a bushing or anti-friction bearing 23 (FIG. 1B), the extension providing lateral support for the main drive shaft of the reel housing driving mechanism. The materials utilized in constructing the supporting frame, and its attached supplemental support units, may be of any suitable type or design, such as high tensile ferrous and/or non-ferrous alloys in desired or functionally appropriate shape, such as extruded or seam welded tubes, bars, angles, channel-shaped members, and the like. The several elements comprising the frame may be secured together in any desired manner, as by bolts or rivets, but preferably, by welded joints.

The cable drum assembly (FIG. 1A) comprises, essentially a vertically positioned cable reel 24 and a coaxial, independently rotatable reel housing 25, which assembly is mounted on a central kelly housing assembly 26, supported on the collar 5 of the main support frame. The kelly housing assembly (FIG. 5) comprises an elongated tubular member 27, through which a suitable kelly 28 (FIG. 1A) extends, the upper end portion of the housing being threaded as at 29, to receive a collar 30 having bearings 31 supported thereon. The collar is adapted to receive a tubular insert member 32, having a flared upper rim 33, and diametrically opposite apertured ears or lugs 34. A pair of kelly keys 35 formed with flared upper portions 35', and provided with lift handles 36, are adapted to the positioned in seated engagement within the insert member 32, the free ends of the lift handles being secured to the lugs 34 by means of pins or other suitable fastening devices.

It will be observed that when the insert member 32, and the associated kelly keys are in seated nested position with respect to the collar 30, the kelly 28 is freely rotatable independently of its housing, and is maintained in axial alignment therewith. The kelly housing is further provided with a peripheral brake shoe surface 37, and with upper and lower thrust bearing units 38 and 39, respectively, to permit free rotation of the reel on the housing.

As shown in FIGS. 1B and 5, the lower end of the kelly housing 27 is provided with a tubular fitting 40 adapted to receive and position the reel housing 25 in precise axial alignment with the housing and with the reel 24. The fitting may be of any suitable design and of rugged structure and, as shown, preferably incorporates a splined section 40', of any desired length, and an integral, laterally extending flange 41, which fitting is attached to the kelly housing in any suitable manner, as by screw threaded engagement with the exterior portion of the

lower end of the housing. The fitting 40 is adapted to receive and support a coupling member 42, through the medium of which the kelly housing is connected to a drill column cable director 43, to be more fully described hereinafter. The coupling embodies a tubular section and an integral base flange 44, which flange is apertured at 45 to receive a series of positioning lugs 46 of the cable director unit 43, the tubular section being externally screw threaded to engage with the internally screw threaded lower portion of the fitting.

As will be seen in FIG. 1A, the reel housing 25 is of drum-like configuration, the cylindrical shaped body portion 48 thereof having a centrally apertured head 49 formed with an enlarged peripheral thrust collar 50 adapted for engagement with roller bearings 51 carried by the reel. The reel housing is supported on the kelly housing 27 by means of a centrally apertured, circular plate 52 (FIG. 1B), formed with a depending peripheral flange 53 adapted to be secured to the annulus 54 of the ring gear 14 (FIG. 3), which annulus is secured to a flange 55 formed on the lower end of the drum housing. Plate 52 is secured in the vicinity of its inner peripheral portion to a flange 56 of an internally splined collar 57, fitted over the splined portion of member 40, and seating on flange 41 thereof, the reel 24 being supported on the plate by means of suitable roller bearings 59. The body portion 48 of the reel housing is cut away as at 60 (FIG. 3) to provide an elongated opening through which a cable 61 may be payed off from the reel for introduction into the cable director 43, and thence into the drill column, in a manner to be described hereinafter. The body portion of the reel housing may be strengthened and rigidified in any desired manner, as by means of a series of angle irons 62 bolted or otherwise secured to the outer surface of its cylindrical section.

The reel unit embodies a barrel section 63 (FIG. 1B), provided with a lower cable-supporting flange 64, and vertically spaced, horizontally positioned circular plates 65 and 66 (FIG. 1A). The barrel section is also provided with a detachably mounted circular brake block 67, positioned adjacent the brake shoe 37 carried by the kelly housing. The reel unit is supported on the reel housing in coaxial, spaced relationship to the kelly housing, and is maintained in spaced, aligned position by means of the anti-friction thrust bearing 38 and 39. As shown, the upper plate 65 is of substantially the same diameter as the lower flange 64 and defines, with the upper plate 65 and the barrel section a spool on which the cable 61 may be wound and unwound during the sampling operations. The plate 65 is provided, on its upper surface, with a ring gear 68 comprising a component of a cable level winder driving mechanism, to be more fully described. The uppermost plate 66 is secured to the barrel section in the vicinity of its upper end, above the upper end of the reel housing, and is provided with a ring gear 69, which gear comprises a component of a motor driven mechanism for selectively rotating the reel independently of its housing during certain phases of operation of the core sampling device.

As previously noted, the superstructure of the coring assembly, including the reel housing, the reel and the kelly housing is supported on the ring 5 at the top of the frame, and is designed to provide stable support for the reel and its housing while permitting rotation of the kelly housing relative to the frame. The supporting arrangement includes a bearing plate 70 interposed between the ring 5 and the superposed kelly housing support collar 30, each of which engages heavy roller bearings 71, which bearing plate 70 is formed with a terminal flange 72 adjacent a roller bearing unit 72' adapted for engagement with the kelly housing.

Means are provided for guiding and levelling the cable as it is wound on the cable reel, comprising a pair of reversely threaded or grooved shafts 73, (FIGS. 1B and 3), each of which is provided with a sleeve 74 having

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a tongue or pawl engageable with the grooves, whereby reciprocating movement is imparted to the sleeve when the shaft is rotated. The sleeves 74 are interconnected by a bar or strut 75 (FIG. 4) having a tubular, open-ended cable guide 76 supported thereon, intermediate the ends of the strut, by means of an arm 77 having an integral extension 78 adapted to fit over the strut in seated engagement therewith. The cable guide member is provided with a series of anti-friction rollers 79 between which the cable passes during winding and unwinding from the reel.

Each of the shafts 73 is rotatably supported at its lower end in a bearing 80, carried by a bracket 81 secured to the ring gear 14, and at its upper end in an anti-friction bearing 82 (FIG. 1A) carried by a laterally extending bracket 83 secured to one of the reel drum reinforcing angle irons 62. Simultaneous rotation of the grooved shafts 73 is accomplished through the medium of drive shafts 84, supported on suitable hangers 85 carried by the upper flange or head 49 of the reel housing. Each of the drive shafts is provided with a bevel gear 86 and a worm 87, adapted for meshing engagement with the ring gear 68 and a worm gear 88, respectively, the latter being keyed or otherwise secured to the upper end portion of the grooved shaft. The cable is guided in its passage from the guide member 76 to the cable director 43 by means of a conventional pulley 89 (FIG. 1B) provided with a counter 90 and cable tension indicator 91, the pulley being rotatably supported in direct alignment with the guide 76 on a bracket 92 attached to the bottom plate 52 of the reel housing. In order to prevent injury to personnel, in event of breakage of the cable, a portion of the pulley and the cable may be enclosed by a suitable guard member 93, the cable being guided into the cable director by means of a packing gland 94, threadable into the director housing.

Referring to FIG. 2, the drill column cable director 43 comprises a generally spherical shaped housing comprised of an upper section 95 and a lower section 96, formed with integral flanges 97 and 98, respectively, the sections being clamped together by bolts 99, or other suitable fastening means. The upper section 95 is formed with a lateral flange 100 of substantially the same diameter as the flange 44 of the coupling 42 (FIG. 1) carried by the kelly housing, and with an internally threaded throat portion 101 to which the kelly 28 is secured. The upper section is also provided with an opening 102 and a detachable cover member 103, so that access may be had to the interior of the director housing.

The lower semi-spherical section 96 merges into an integral tubular throat 104, the lower tapered end portion of which is externally screw threaded for connection to a clutch coupling 105, which, in turn, is connected to the upper section 106 of the drill column. The section 96 is provided with laterally extending arms 107, adapted to rest on a support member 108 (FIG. 1C), having a conformed opening 108' to receive the lower portion of the section. The member 108 is pivotally mounted on a post 6 of the main frame, and additionally supported thereon by an articulated strut 108a, whereby the cable director, when disconnected from the kelly 28 and the drill column, may be swung out of its operative position below the reel housing.

The cable is supported and directed into the drill column by means of a guide unit, designated generally by numeral 109 (FIG. 2), secured at one end of the inner wall of the lower section of the director housing by means of hollow bolts 110, the opposite end portion of the unit being seated in a recess 111 in the upper end of a tubular fitting 112, adapted to be supported on lugs 113, attached to the inner wall of the tapered portion of the throat 104, by means of fins 114 carried by the fitting. Intermediate its ends, the guide unit is supported by an abutment member 115 attached to the inner wall of the section. The guide unit comprises a

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pair of similar metal sections 116 and 117, each of which is formed with lateral flanges 118, FIG. 2A, a central channel 119, and oppositely disposed side channels 120, the central channel defining a housing 121 for a series of apposed, grooved wheels or pulleys 122 (FIG. 2), a tensioning pulley 123 and a cable driving pulley 123'; the side channels defining a pair of smaller housings 124 to receive the pulley shafts 125, and their associated mounting means. The sections 116 and 117 are of curvilinear profile and gradually tapered from their cable entrant ends 126 to the cable exit ends 127, seated in the recess 111 of the tubular fitting 112. The shafts 125 of the pulleys are provided with bearings 125' and are maintained in seated position within the housings 124 by means of pillow blocks 125a, adapted to be clamped against the bearings by means of bolts 128, threadable into the body portions of the mating sections 116 and 117.

As will be seen in FIG. 2A each of the guide unit sections is provided with a pair of grease passages 129, and a series of ducts 130 in open communication with the passages and with the several bearings 125'. The passages 129, in the vicinity of the entrant end of the guide unit, terminate in screw threaded enlargements 131 adapted to receive the hollow bolts 110, which bolts are provided with suitable fittings 132, whereby a lubricant may be introduced into the passages and fed through the ducts 130 to the pulley bearings. In connection with the construction and arrangement of the cable guide unit, and more particularly the manner in which it is supported within the lower section 96, it will be noted that the bolts 110 are threaded through the wall of the section into the screw threaded enlargements 131, and that the ends of the sections 116 and 117 of the guide unit are conformed to the curvature of the inner surface of the lower section of the cable director, and are drawn into abutting relation therewith when the bolts are turned down into the end of the guide.

With reference to the arrangement of the pulleys at the entrant end of the guide unit, the upper pulley 123 is rotatably supported on spaced arms 133, FIGS. 2 and 2B, which arms are pivotally connected at their upper ends to a cross-rod 134 having one end of a lever 135 pivotally attached thereto, the opposite end of the lever being keyed to a shaft 136 carried by a bracket 137 mounted on the cable guide unit 109. The end portion 136' of the shaft, which extends outwardly of the cable director housing, is provided with a hand lever 138, whereby the shaft may be oscillated to raise or lower the pulley 123 and thus vary the pressure on the cable. The lower pulley 123' is keyed to a drive shaft 139, FIG. 2B, having a gear 140 secured thereto adapted for meshing engagement, through a clutch mechanism, not shown, with a gear secured to a drive shaft of a power unit, to be described hereinafter, operatively connected to the components of the cable drum assembly. The shaft 139 is rotatably supported in section 117 of the cable guide unit 109, and in a roller bearing 141 secured in the wall of the cable director housing, the portion of the shaft between the cable guide and the inner wall of the director housing being enclosed by a tubular shield 142, to protect the shaft from contact with drilling mud during certain phases of the sampling operations. The packing gland 94 (FIG. 1) is detachably secured in the threaded aperture 143 of the cable director housing, whereby the gland may be removed and the aperture closed by means of a suitable plug, when the cable is completely withdrawn from the housing, upon termination of the sampling operation.

As previously noted, the cable director housing is connected to the upper section 106 of the drill column by means of the clutch coupling 105. Referring to FIG. 2, the coupling comprises a pair of tubular members 144 and 145, formed with integral circular flanges 146 and 147, respectively, which tubular members are respectively adapted for threaded engagement with the cable director

housing 96 and the upper section 106 of the drill column. The flanges are operatively enclosed within an annulus 148 comprised of two mating sections 149, secured together at their abutting marginal flange portions 150 by means of bolts 151. The apposed spaced legs 152 and 153 of the annulus are provided with recesses to receive roller bearings 154 and 155, adapted to contact the contiguous faces of the flanges 146 and 147, respectively, and suitable roller bearings 156 are interposed between the flanges. The upper leg 152 of the annulus is formed with diametrically poistioned apertures 157 in registry with apertures 158 formed in the flange 146, and with recesses 159 in the flange 147. The annulus and the flanges are adapted to be coupled by means of reciprocable locking pins 160, slidably mounted in brackets 161 secured to the upper face of the annulus, each of the pins being normally biased into seated position with respect to its associated aligned apertures by means of a compression spring 162, interposed between the pin and bracket. When it is desired to uncouple the flanges, the pins are adapted to be withdrawn from their aligned apertures and maintained in retracted position by means of latch devices 163, carried by the brackets.

The novel coring tool assembly is adapted to be lowered into and withdrawn from a drill string with minimum interruption of drilling operations, and accordingly, an auxiliary power unit is provided, which unit is operable, independently of the rotary table, through a suitable transmission mechanism for rotating the cable reel 24 and reel housing 25, either independently or simultaneously during certain phases of operation of the coring assembly, including lowering the cable 61 into and retracting it from the drill string, and rotating the cable when a core sample is to be taken. The cable reel and drum housing driving mechanism comprises a suitable power unit 165 (FIG. 1) secured to the derrick floor, and adapted to be optionally coupled to a power take-off shaft 166 carried by the movable frame, through the medium of a main drive shaft 167 and associated gears 168 and 169. The power unit includes a conventional gear transmission 170 provided with the usual gear shift and clutch levers 171 and 172, respectively. The main drive shaft 167 is adapted to be connected and disconnected from driving engagement with the power take-off shaft 166 by means of a splined-universal joint connection 173, whereby the stationary power unit may be disconnected from driving engagement with the take-off shaft when it is desired to move the cable drum carriage out of operative alignment with the drill column. As shown, the power take-off shaft extends vertically upwards from the post 6 of the carriage to a point in the vicinity of the top of the drum housing, and is laterally supported intermediate of its ends in the bearing 23. The upper end of the shaft is adapted to seat in the hollow hub of a pinion gear 174, rotatably supported on a bracket 175 secured to a horizontal strut 3 (FIG. 1A) of the main supporting frame. The hub portion of gear 174 is recessed as at 176 to receive the detent 177 of a clutch member 178, vertically slidable on a splined portion of the power take-off shaft. The clutch member is provided with a lever 179, pivotally mounted on the strut 3, and adapted to be actuated by the hand lever 20, connected to the lever 179 through a link 180. The gear 174 meshes with a gear 181, keyed to one end of a shaft 182, rotatably supported in brackets 183 mounted on the main frame, the opposite end of the shaft having a bevel gear 184 secured thereto in meshing engagement with the ring gear 69, carried by the circular plate 66 attached to the barrel section 63 of the reel unit.

Rotation of the reel housing 25 (FIG. 1B) is effected by means of a gear 185 keyed to the power take-off shaft and adapted for meshing engagement with an idler gear 186, interposed between the gear 185 and a driving gear 187, keyed to a shaft 188 rotatably supported in the bearing block 21, the latter gear being in mesh with the

ring gear 14 (FIG. 1), secured to the cable reel housing. The idler gear 186 is keyed to a shaft 189, rotatably supported in the bearing block, and adapted to be moved upwards out of meshing engagement with the gears 185 and 187 by means of a link 190 connected between the lever 17 and the upper end of the shaft 189. It will thus be seen that the reel housing 25 may be rotated independently of the cable reel 24 by depressing clutch lever 20 to unclutch pinion gear 174 from driven engagement with power take-off shaft 166 and depressing clutch lever 17 to effect driving connection between shaft 166 and ring gear 14 of the reel housing and, conversely, the reel 24 may be positively rotated independently of the reel housing by reversing these operations, that is, by elevating clutch lever 17 to disconnect gear 186 from meshing engagement with gears 185 and 187 and elevating clutch lever 20 to connect shaft 166 in driving engagement with pinion gear 174 and its connected gear train.

As previously explained, the cable 61 is adapted to be rotated during the core sampling procedure. This may be effected by temporarily connecting the cable reel 24 and reel housing 25 for simultaneous rotation, and is accomplished by coupling the cable reel and housing by means of a wedge-shaped clutch ring 191 (FIG. 1A), adapted for frictional engagement with the conformed surfaces of the clutch blocks 37 and 67, carried by the reel and reel housing, respectively. The clutch ring is secured to the inner race of a circular ball bearing unit 192, spaced from and enclosing the kelly housing 27, the outer race of which is pivotally connected as at 193 to the opposite bifurcated end portion of a clutch lever 194 pivotally connected at an intermediate slotted section 195 on the upper strut of the main supporting frame, which lever is pivotally connected through a link 196 to the control lever 18, previously described. It will be seen that when the control lever 18 is elevated, the clutch ring 191 will engage and lock the adjacent clutch blocks 37 and 67 on the drum housing and cable spool, respectively, causing simultaneous rotation of the spool and drum housing, during which period the inner race of the ball bearing unit 192 rotates freely with respect to the outer race.

It is desirable to provide means to control the speed of rotation of the cable spool, and hence the rate of descent of the cable as it is being payed out into the drill column. As shown in FIG. 1A, this control may be achieved by means of suitable braking mechanism associated with the exterior surface of the clutch block 67 of the cable spool. The braking mechanism comprises a replaceable segmental brake shoe 197 secured to an arm 198 carried on a bracket 199 mounted on the upper strut 4, which arm is moveable horizontally by means of a toggle linkage 200 pivotally interconnected between the arm 198 and one end of a lever 201 pivotally mounted as at 202 on the strut 4, and connected at its opposite end to the brake lever 19, through a link 203. It will thus be seen that when the lever is elevated or depressed, the brake shoe is moved into or out of frictional contact, respectively, with the adjacent surface of the brake block 67 of the cable reel.

The correlation of the cable reel and reel housing driving mechanism, together with the associated clutch and brake controls, during different phases of the core sampling operation, will be appreciated from the foregoing description. Assuming that drilling has progressed to the extent that it is deemed desirable to obtain a core sample, the carriage 1 is moved along the rails 9 until the kelly 28 and the drill column cable director 43 are in axial alignment with the drill column. A length of cable 61 is payed off manually from the cable reel or spool 24, over the guide wheel 89, through the guide unit 109 of the cable director, and out through the coupling 105. A suitable coring tool, coupled to the end of the cable through the medium of a steel tube or rod, to be described hereinafter, is inserted in the open end

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of the upper section of the drill column, or in the upper end of a short kelly section secured to the upper section of the drill column, which section is coupled to the swivel joint or clutch coupling 105. The cable may then continue to be payed off the reel and mechanically forced downwardly of the drill column, until the weight of the unwound portion of the cable is sufficient to overcome the inertia of the cable reel, and the friction between the cable and the cable guiding elements. During subsequent descent of the cable, due to its own weight, the rate of descent may be controlled by means of the brake lever 19, operatively associated with the clutch block 67 of the cable reel.

When the cable reel 24 is locked to its housing 25, by elevating the clutch lever 18, the reel and housing rotate as a unit, and the portion of the cable within the drill column will be rotated throughout its entire length, thereby imparting relative movement to the coring tool to secure a sample. After a sample has been obtained, the cable may be rewound on the drum or reel by actuating the clutch lever 18 to release the reel for rotation independently of its housing, and then rotating the reel in a reverse direction, that is to say, opposite to the direction of rotation when lowering the cable into the drill column, which reverse rotation is accomplished by means of the auxiliary power unit 165, whereby the coring tool and contained sample core are retrieved. As an alternative method, the tool and core can be removed from the drill column by actuating the reel locking mechanism to prevent rotation of the reel, and connecting the drill column in driving engagement with the reel housing by locking the swivel joint. With the reel in a stationary position, the cable will be rewound when the drill column is rotated through the conventional rotary table.

Referring to FIG. 6, the coring tool sub, designated generally by numeral 204, is adapted for threaded engagement with the end of the lowermost section 196' of the drill column, the opposite end portion of the sub being interiorly threaded to receive the well drilling bit, not shown. In order to permit a coring tool or other instrument to move outwardly through the sub, the lower wall portion thereof is cut away as at 205 to form a passage 206 having an opening 207, which is normally closed by means of a spring biased gate member 208. It will be noted that the passage 206, which is angularly disposed with respect to the wall of the sub, gradually merges with the central bore 209 thereof, and is provided with a tube 210 adapted to guide the coring tool downwardly and outwardly through the opening 207 and into the adjacent wall portion of the well. The tube is formed with suitable mud passages 211, and is maintained in fixed position by means of support members 212 secured to the tube and having frictional bearing engagement with a wall portion of the central bore 209. The upper portion of the sub is fitted with a tube section 219' having a flared upper end 213 adapted to seat in a conformed recessed portion 214 of the sub, the lower end of the tube section being seated in the upper end of tube 210, as at 215.

With reference to the construction and arrangement of the lower section 210 of the cable guide tube, it will be noted that the diameter of the opening in the upper end thereof is equal to the diameter of the central bore 209 of the sub, and is of gradually reduced diameter in the direction of the lower end of the tube. The purpose of this arrangement is to convey the lower portion of the cable and associated coring tool or other instrument downwardly and laterally into the cut-away portion 205 of the sub with minimum angulation.

Referring to FIG. 7, the coring tool assembly comprises essentially, a cylindrical shaped housing 216, a cutter head 217, a core severing device 218 and a trip mechanism 219, constructed and arranged to penetrate hard and semi-hard formations to secure a core sample of the formation and to enclose the same within the tubular body portion of the instrument. The size of the coring

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instrument in relation to its length and diameter will depend on whether a core is to be taken from the bottom in the same linear direction as the drilled hole.

For securing a core sample from the bottom, the coring tool, which may have an inside diameter of 1'-3", or more, and be several feet in length, is attached to the end of the lowermost section of the drill column or to the drill collar, and when the drill column is actuated the coring instrument will penetrate the formation and secure a sample. If a side wall core is desired, the instrument, which is of reduced length and of relatively small internal diameter, is attached to a rotatable cable, and when the cable is rotated, during passage of the tool through the opening in the coring sub, the instrument penetrates the formation of the wall of the drilled hole. The drill column is not removed from the hole in taking a side wall sample, for the reason that the sample is retrieved by the cable which passes through the opening of the drill column.

Reference being had to FIGS. 7 and 8, the inner wall 220 of the housing of the coring instrument is formed with four longitudinal grooves 221 in the vicinity of the central portion thereof, adapted to receive complementary flanges 222 secured to the outer wall 223 of an inner hollow cylinder 224, whereby rotation of the inner cylinder with respect to the housing is prevented. The inner cylinder is adapted for vertical movement with respect to the grooves and is retained in the raised position (FIG. 7) against a compression spring 225, by means of the trip mechanism 219, supported on a flanged member 226, seated in the upper end of the instrument housing, and retained in position by means of a spring steel pipe or tube 227, which is adapted for threaded engagement with the housing. The trip mechanism comprises a trigger member 228, connected to the support 226 by means of a ball and socket joint 229 and a trip member 230 connected to the trigger by a ball and socket joint 231. The trigger member is formed with a projection 232 adapted to seat in a recess 233 of the cylinder 224, when the cylinder is in the raised position.

The cutter or core head 217 is threadably attached to the lower end of the housing 216 as at 234, in abutting relationship with a metal ring 235 removably mounted in the distal end of the housing. The cutting surface of the core head is rounded, as shown, and the sharp cutting projections 236 thereof are arranged in a spiraling direction and are so positioned that the individual projections do not "track" each other. Grooved courses 237 (FIG. 9) are provided for carrying drilling fluids, which courses are arranged in a special design in such fashion as not to extend to the inner surface of the cutting head, in order to prevent the drilled core from undue saturation by the drilling fluid. As shown in FIG. 10, the core severing device comprises a substantially triangular-shaped cutter 238 pivotally mounted within the housing 216 of the coring tool assembly as at 239, the altitude of the cutter being of such length as to permit the vertex 240 of the cutter to extend slightly beyond the center of the core sample when the trip mechanism (FIG. 7) is actuated and the cutting surface 238' of the cutter is forced inwardly against the core to sever the same when, for example, a core is to be taken from the bottom of the drill hole, the coring tool (FIG. 7) is attached to the lowermost section of the drill column, and as the drill column is rotated the core head 217 will penetrate the formation, the severed material being forced upwardly of the axial opening of the coring tool. Continued rotation of the drill column causes the severed material to rise within the tool until the material contacts the trip member 230 and releases the trigger member 228. As soon as the projection 232, of the trigger clears the recess 233, the cylinder 224 moves downwardly under the force of the compression spring 225, which movement of the cylinder forces the cutter 238 of the core severing device inwardly about

its pivot 239, against the core to sever the same. The coring tool, together with the enclosed sample, is then brought to the surface by removal of the drill string from the hole. When the coring tool is used to obtain a sidewall sample, the tool and enclosed sample are retrieved by means of its actuating cable.

The distance between the clutch coupling 105 and the rotary table T (FIG. 1C) is approximately six feet, and accordingly, short kelly sections of graduated lengths, 2'-10' for example, one of such sections being shown in FIG. 11, are provided, together with short sections of drill pipe of corresponding lengths, in order to compensate for variation in the distance between the top of an uppermost section of a drill stem of standard length and the clutch coupling. A short section of kelly, when attached to the drill pipe and lowered into the well, is actuated by the rotating table. As will be seen in FIG. 11, the upper end portion of the short kelly 28' is formed with cut-out portions 28a adapted for engagement with a snare for lifting the section when placing or removing the same with respect to the drill pipe, as will be described.

Referring to FIG. 12, the snare lift arrangement comprises an interiorly threaded cap 241 adapted for threaded engagement with the lower end of a conventional kelly 28, said cap having integral, diametrically opposite arms 242 and 243 to which the looped ends 244 of a semi-flexible cable 244' are attached, the contiguous portion of the cable being looped to form a slip knot, the looped portions of the cable being retained in sliding operative position by means of metal rings 245 or the like. In use, the looped portion of the cable is lowered over the top portion of the short kelly 28' and when the conventional kelly 28 is raised the slip knot tightens and gradually slides upwardly into seated position in the undercut portions 28a of the short kelly section. By suitable manipulation of the lift means, not shown, used to transport sections of drill pipe, kelly sections and other elements, to or from operative position with respect to the bore hole or drill string, the short kelly section is brought to desired position. It will be understood that the need for modified kelly sections, together with short sections of drill pipe, arises when it is desired to obtain a sample at a specified depth and at which depth the top of the uppermost standard section of the drill stem cannot be attached directly to the clutch coupling associated with the cable director.

As explained hereinbefore, the cable is forced downwardly through the drill column until the side wall sampling device reaches and penetrates the wall of the drill hole, and after a core is obtained the cable, together with coring attachment and core, are withdrawn from the drill column. When the distal end of the cable or its associated instrument reaches the lower end of the cable director, the director and the upper end of the drill pipe are disengaged, and the side wall coring instrument, with its contents, are removed for scientific examination and study.

In order to expedite removal of the coring instrument from the cable and to prevent the cable and attached weighted rod from accidentally falling into the open end of the drill column, a cover member designated generally by numeral 246 (FIG. 13) is provided. The cover comprises a skirt portion 247 of a diameter to fit over the open end of the upper drill pipe section which receives the cable and its coring attachment. The cover is preferably formed from relatively lightweight materials, for example, a metal or metal alloy, so that it can be manually lifted into seated position on the end portion of the drill pipe, or removed therefrom. Suitable handles 248 are provided for lifting and carrying the cover. The lid 249 of the cover is formed of two similar sections 250 and 251, section 250 being secured to the upper rim of the skirt, and section 251 being hinged on section 250 as at 252 in such fashion as to allow section 251

to swing outwardly to enable the lid to encircle the in dwelling steel tube or cable. The inner periphery of the lid is provided with ball bearings 253 to facilitate passage of the cable through the opening defined by the lid sections.

The clamping means for securing the cable and attached weighted rod from accidentally dropping into the drill hole while the sampling device is being removed from the distal end of the rod, or while the rod is being disconnected from the cable prior to withdrawal of the cable from the cable director, comprises a bolt 254 threadable through the top portion of lid section 251, the inner end of the bolt being provided with an arcuate-shaped shoe 255 adapted for engagement with the cylindrical shaped surface of the cable, rod or other element, when the bolt is turned down by means of the hand-wheel 256 to clamp the cable or other element against the inner wall of the cover. In order to retain the cover in seated position over the top portion of the drill pipe, a plurality of set screws 257, threadable through the skirt portion 247 of the cover, are provided.

The foregoing description of the improved means for obtaining side wall cores is directed to use with a so-called "mud unit," that is to say, in a system wherein the cable, weighted rod, and core sampling device moves through the mud-filled lumen of the drill string. As an alternative method, a tube or small pipe 258 (FIG. 14) is positioned in a drill string 259 coaxially thereof and supported therein by means of spiders 260. A conventional left lay or a specially designed drill cable is passed through the tube or pipe 258, the feed of which is mechanically effected and controlled at the surface, as described in connection with the first sampling method. The tube 258 serves as a conveyor or cable housing unit, and by use of the spiders 260, or other suitable supports it can be arranged so as to occupy a central portion of the drill column and its component parts, and the central portion of the upper portion of the instrument housing unit. The tube comprises a plurality of sections 261, formed from steel, plastic or other suitable material, the inner diameter of the tube being sufficiently large to accommodate a cable of desired size, and the thickness of the wall of the tube being sufficient to withstand the relatively high pressure encountered within the drill stem lumen. As will be seen in FIG. 14A, one end of a tube section 261 is formed with a reduced end portion 262 adapted to seat within a recessed portion 263 of the end of an adjacent tube section in abutting relation with a plastic washer 254, which washer when properly seated will prevent mud or drilling fluid from entering the tube from the drill string. The section of the tube occupying the instrument sub or housing 204 (FIG. 6) will deviate from its central position in the upper portion of the housing to the valved opening through which the coring device emerges.

In connection with the construction and arrangement of the spider supports 260, it will be noted that they are welded to the tube sections, as at 265 (FIG. 14B), and that the outer ends of the arms of each support are rounded to conform with the curvature of the drill pipe or other element which the support occupies. The supports in the vicinity of the ends of the tube sections are welded to the drill pipe or other element which they occupy. It will be further noted that the top portions of the arms of the spider supports are tapered to form relatively thin edges 266 (FIG. 14), whereby to prevent accumulation of mud.

By means of the improved sampling arrangement of the present invention, in conjunction with special bits designed to indicate temperature and/or pressure, the temperature and pressure of the bottom hole or of intermediate areas may be determined. The device may also be used to secure and record chemical-physical, and other properties of ice, snow, sediment deposits, as well as the structure of substances beneath such bodies, whenever a

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drill pipe or cable-carrying hose, pipe, tube or the like can be used as conveying means for test devices. Additionally, materials such as acids, solvents, etc., may be deposited within a restricted area without disturbing the drill stem. By attaching a conventional air compressor to the revolving cable-housing structure, heat at the bottom of the hole may be dissipated, by forcing air through the cable tube when the cable is not in use. Accordingly, overheating of the lower drill stem can be minimized while the sampling device is not in use, and a substantially constant temperature could be maintained for practical purposes, as well as scientific investigation and study. In this connection it will be appreciated that if the lower drill stem and bit are kept relatively cool, greater rotational speeds might be attained, thereby promoting faster penetration of the bit with resultant economies in time, labor, and other operating costs.

While I have shown and described the preferred embodiment of my invention, I wish it to be understood that I do not confine myself to the precise details of construction herein set forth by way of illustration, as it is apparent that many changes and variations may be made therein, by those skilled in the art, without departing from the spirit of the invention or exceeding the scope of the appended claims.

I claim:

1. A sampling device for use with conventional well drilling equipment, including a drill column, a kelly, a rotary table and a drill bit, comprising a wheeled support adapted to be moved into and out of aligned operative position with respect to the drill column, a cable down assembly including a relatively flexible cable, rotatably mounted on the wheeled support, said cable drum assembly embodying a cable reel and a housing for said reel therefor, the reel and its housing being constructed and arranged for selective independent and simultaneous rotation, a kelly housing carried by the wheeled support, a drill column cable director unit carried by the wheeled support for introducing the cable into the drill column, a coring tool assembly detachably secured to the free end portion of the cable insertable in the drill column, a coring tool sub connected into the drill column, said coring tool sub having a side port for egress of the coring tool assembly to secure a side wall core of the earth formation traversed by the drill bit, a source of power for actuating the cable drum assembly and the cable director unit, for feeding the cable and associated coring tool assembly into the drill column and withdrawing the same from the column, and means for selectively rotating the cable reel housing whereby to rotate the cable and the attached coring tool assembly.

2. A sampling device in accordance with claim 1, wherein the cable reel housing is supported on the kelly housing, and the cable reel is rotatably supported on the cable reel housing.

3. A sampling device in accordance with claim 1, wherein the cable reel embodies a barrel section, a circular shaped brake block mounted on said barrel section, and a brake shoe carried by said kelly housing adjacent said block, whereby the angular velocity of the reel may be controlled during certain phases of the sampling operation.

4. A sampling device in accordance with claim 1, wherein the cable reel embodies a barrel section, a ring gear supported on said barrel section above the upper end of the reel housing, and a motor driven mechanism operatively connected to the ring gear for selectively rotating the reel independently of its housing.

5. A sampling device in accordance with claim 1, wherein the cable reel is supported on the reel housing in coaxial spaced relation with respect to the kelly housing, and the cable reel embodying a barrel section, a ring gear supported on said barrel section, and a cable level winder driving mechanism operatively connected to the ring gear.

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6. A sampling device in accordance with claim 1, wherein the drill column cable director unit comprises a generally spherical-shaped housing, a horizontally positioned support pivotally mounted on the wheeled support and an opening formed in said horizontally positioned support, said spherical-shaped housing being seated in said opening, whereby the cable director unit, when not in use may, if desired, be swung out of its operative position below the reel housing.

7. A sampling device in accordance with claim 1, wherein the drill column cable director unit incorporates a power driven, cable-feeding and guide unit for supporting and directing the cable into the drill column.

8. A sampling device in accordance with claim 1, wherein the drill column cable director unit comprises a generally spherical-shaped housing having an upper section and a lower section, a lateral flange formed on said upper section, a complementary flange carried by the kelly housing, the lateral flange on said upper section abutting said complementary flange carried by said kelly housing, an internally threaded throat portion formed on said upper section, the lower end portion of the kelly being secured to said threaded throat portion, an integral tubular throat formed on the lower section of said spherical-shaped housing, and a clutch coupling, said clutch coupling interconnecting the lower end portion of said tubular throat to the upper section of the drill column.

9. A sampling device in accordance with claim 1, wherein the wheeled support comprises a unitary frame embodying a plurality of vertical columns, upper and lower curvilinear struts, and inwardly and upwardly directed struts interconnecting said vertical columns, the inwardly and upwardly directed struts having free ends which terminate in a collar member, each vertical column being seated in a respective tubular member and adapted for vertical movement with respect to said tubular member, means for imparting vertical movement simultaneously to the tubular members, and flanged wheels journaled to the terminal portions of said tubular member for supporting the unitary frame on rails secured to the floor of the well drilling rig.

10. A sampling device in accordance with claim 9, wherein the cable drum assembly is supported on the collar member of the unitary frame of the wheeled support.

11. A sampling device in accordance with claim 9, wherein the means for simultaneously imparting vertical movement to the columns of the wheeled support includes electric motors carried by the tubular members in which the respective columns seat.

12. Side wall coring apparatus of the character described, including a drill column, a kelly, a cable drum assembly rotatably mounted on a wheeled support whereby the cable drum assembly may be moved into and out of aligned operative position with respect to the drill column, said cable drum assembly including a relatively flexible cable, a cable reel and a housing for said reel, a drill column cable director unit for introducing the cable into the drill column, a coring tool sub connected into the drill column, said coring tool sub having a side port for egress of a coring tool assembly to secure a side wall sample, a coring tool assembly detachably secured to the free end portion of the cable insertable in the drill column, said coring tool assembly comprising an open-ended, cylindrical shaped housing, a cutter head secured to the end of the housing opposite its cable attaching end, a core severing device pivotally mounted within said cylindrical housing in the vicinity of the lower end thereof, and trip mechanism actuated by the core sample introduced into said cylindrical housing whereby to sever the core and to close the open end of said cylindrical housing; a source of power for actuating the cable drum assembly, and means for selec-

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tively rotating the cable reel housing, whereby to rotate the cable and the attached coring tool assembly.

13. Side wall coring apparatus in accordance with claim 12, wherein the wheeled support comprises a unitary frame embodying a plurality of vertical posts telescopically supported in complementary tubular members, said posts being vertically movable with respect to the tubular members.

14. Side wall coring apparatus in accordance with claim 12, wherein the drill column cable director unit comprises a generally spherical-shaped housing interposed between the lower end of the kelly and the end of the upper section of the drill column.

15. Side wall coring apparatus in accordance with claim 12, wherein the drill column cable director unit incorporates a power-driven, cable feeding and guiding unit for supporting and directing the cable into the drill column.

16. A sampling device for use with conventional well drilling equipment, including a kelly, a rotary table and a drill bit, comprising a wheeled support adapted to be moved into and out of aligned operative position with respect to a drill column, said drill column having a coaxial tube supported therein, said tube comprising a plurality of interfitted sections forming a cable housing unit, a cable drum assembly rotatably mounted on the wheeled support, said cable drum assembly including a relatively flexible cable, a drill column cable director unit carried by the wheeled support for introducing the cable into the drill column, a coring tool assembly detachably secured to the end portion of the cable insertable in the drill column, a coring tool sub connected into the drill column, a source of power for actuating the cable drum assembly and the cable director unit for feeding the cable into the drill column and withdrawing the same from the column.

17. Side wall coring apparatus in accordance with claim 16, wherein the cable drum assembly embodies a

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reel and a housing for the reel, said reel having a barrel section, a ring gear supported on said barrel section above the upper end of the reel housing, and a motor driven mechanism operatively connected to the ring gear for selectively rotating the reel independently of its housing.

18. Side wall coring apparatus in accordance with claim 16, wherein the drill column cable director unit comprises a hollow, generally spherical-shaped housing having a power driven, cable-feeding guide unit incorporated therein.

19. Side wall coring apparatus in accordance with claim 16, wherein the drill column cable director unit is interposed between the lower end of the kelly and the end of the upper section of the drill column.

20. Side wall coring apparatus in accordance with claim 16, wherein the coring tool assembly comprises an open-ended, cylindrical shaped housing, a cutter head secured to the end of the housing opposite its cable-attaching end, a core severing device pivotally mounted within the housing in the vicinity of the lower end thereof, and trip mechanism actuated by the core sample, whereby to sever the core and to close the open end of the housing.

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