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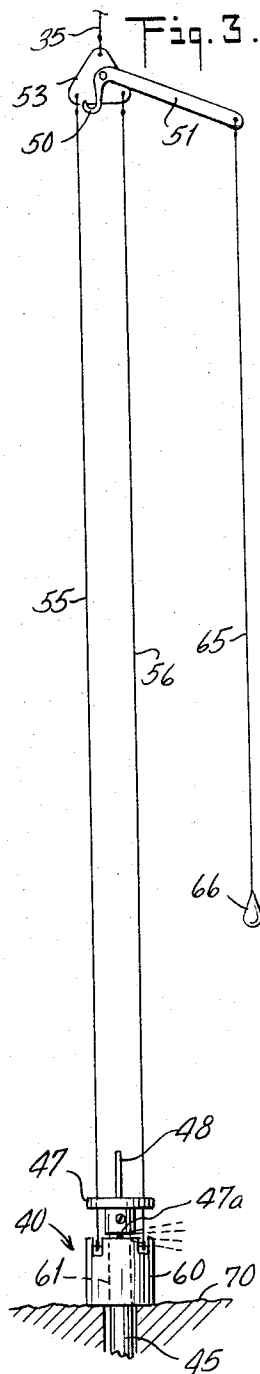
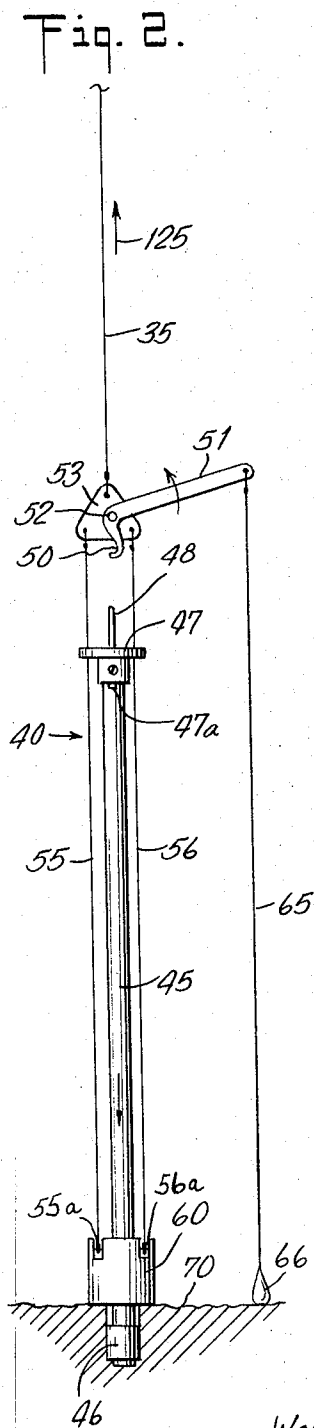
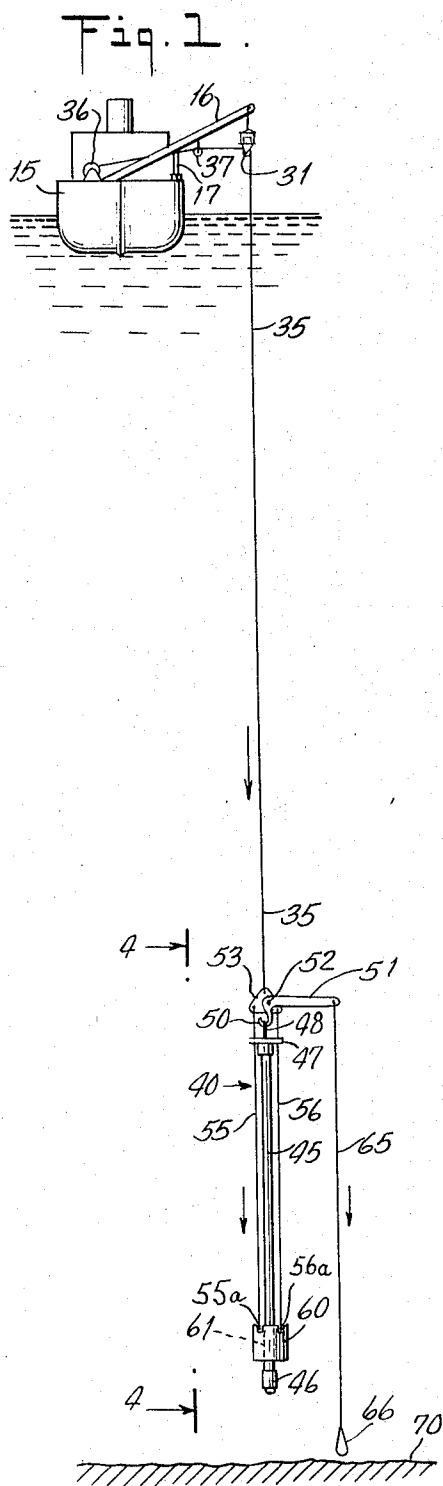
W. W. MOUNT

3,301,336

METHOD AND APPARATUS FOR DEEP SEA BOTTOM CORE SAMPLING

Filed March 24, 1964

3 Sheets-Sheet 1



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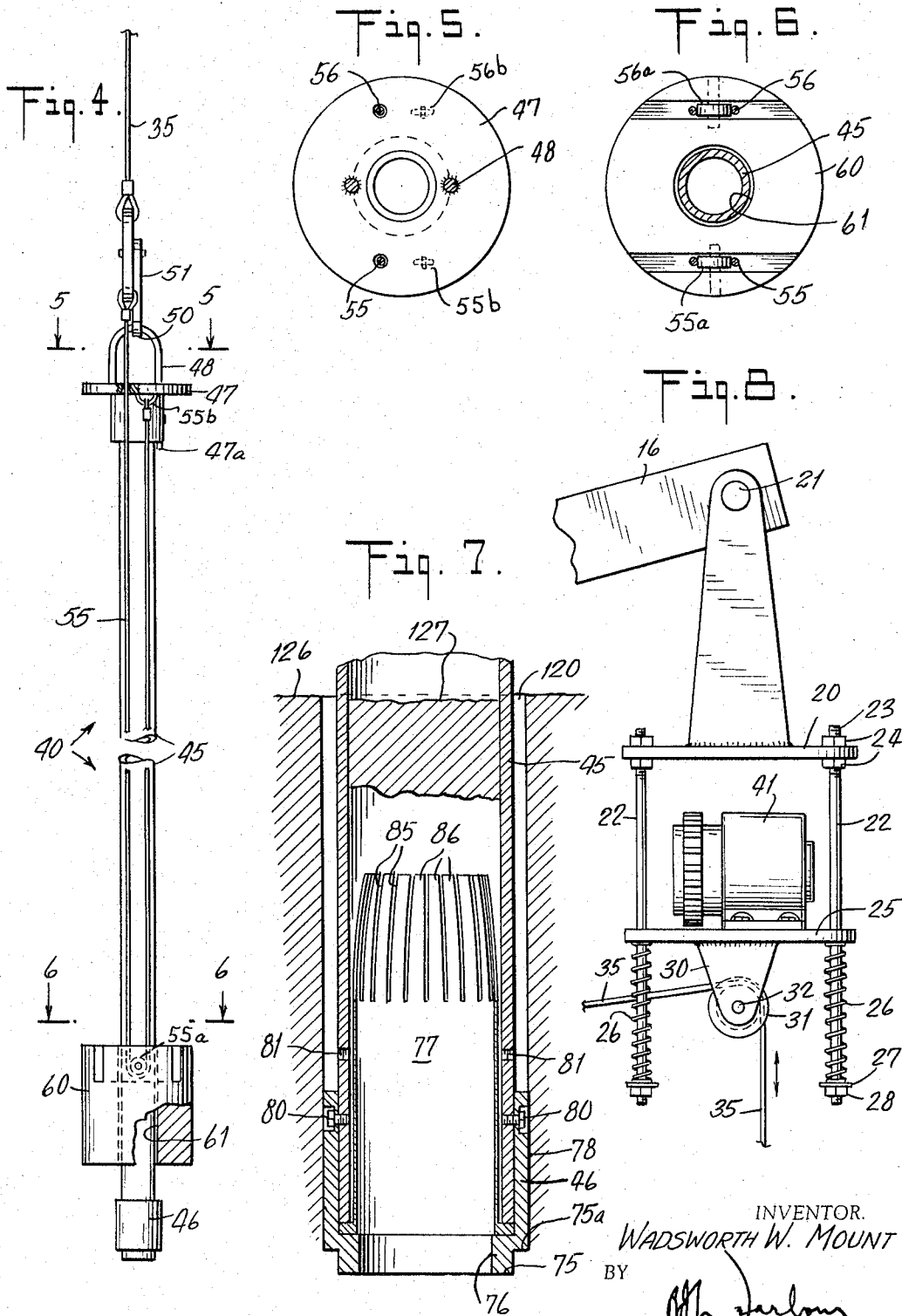
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METHOD AND APPARATUS FOR DEEP SEA BOTTOM CORE SAMPLING

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3 Sheets-Sheet 2



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3 Sheets-Sheet 3

Fig. 9.

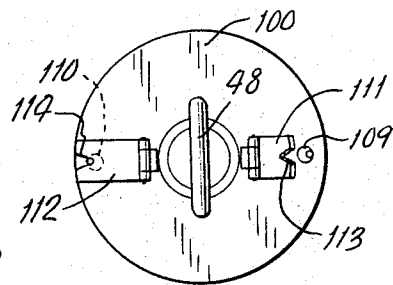
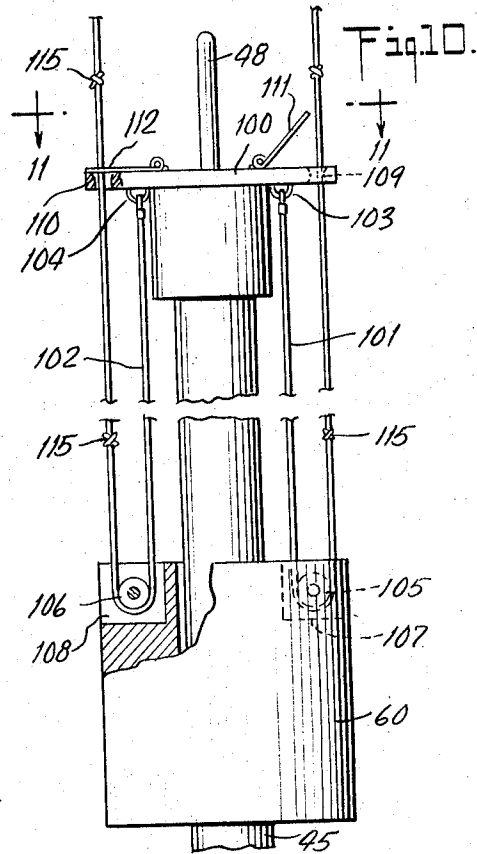
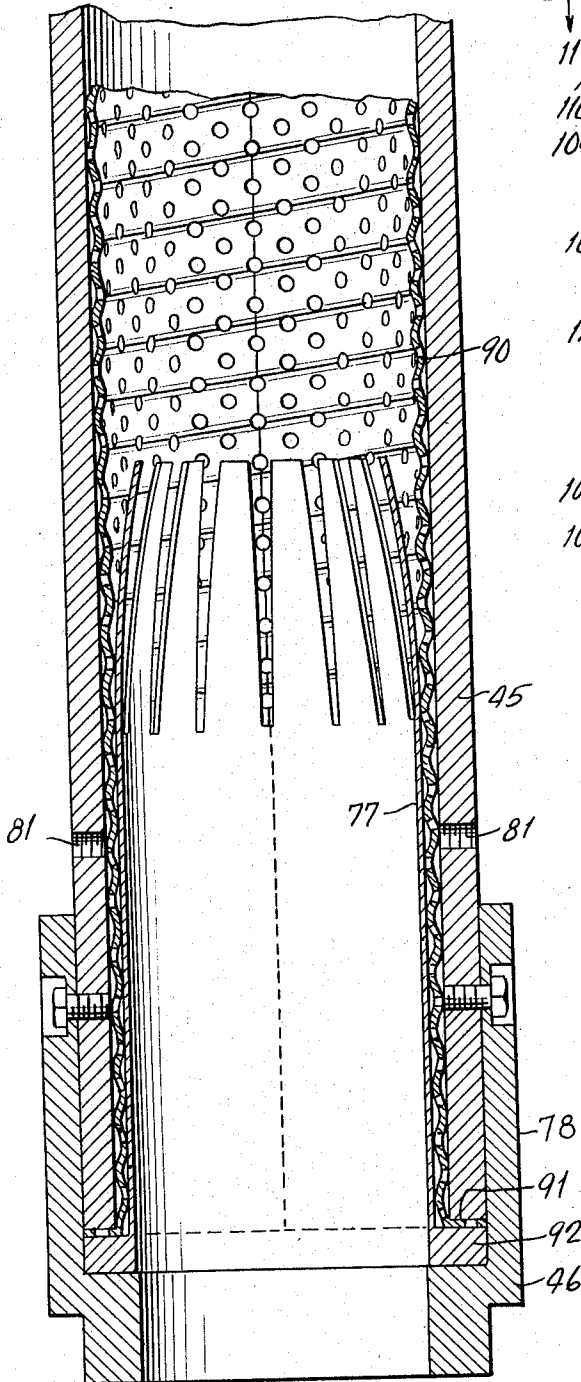


Fig. 11.

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3,301,336

METHOD AND APPARATUS FOR DEEP SEA BOTTOM CORE SAMPLING

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20 Claims. (Cl. 175—5)

This invention relates to the sampling of deep sea bottoms and particularly to methods and apparatus for obtaining core samples of the sea bottom at great depths below the surface of the ocean.

One object of this invention is to obtain cores of much greater length and truly characteristic of the formation from which the cores are obtained.

Previous attempts to obtain formation cores from the ocean bottom at great depths have encountered almost insurmountable difficulties, with the result that often cores have been short and not truly characteristic of the formation. A high percentage of trials have failed completely because of damage to the coring equipment and the impossibility of removal of the core tube, and because a large percentage of the core obtained is made up of ground surface material sucked into the core tube and is not at all indicative of the true formation of the earth from which a core is derived.

The invention will be more easily understood by reference to the specification and to the drawings, as follows:

FIG. 1 is an elevation which shows a ship on the surface of the water and an embodiment of this invention with the coring equipment near the ocean bottom.

FIG. 2 is an elevation on a larger scale of the coring equipment after it has contacted the ocean bottom.

FIG. 3 is a view corresponding to FIG. 2 in which the core tube has been completely driven into the ocean bottom and is ready to be extracted.

FIG. 4 is a partially sectional elevation on the line 4—4 of FIG. 1.

FIG. 5 is a sectional plan view on the line 5—5 of FIG. 4.

FIG. 6 is a sectional plan view on the line 6—6 of FIG. 4.

FIG. 7 is a sectional elevation, on a larger scale, of the lower end of the core mechanism showing clearly the core catcher which forms an important feature of this invention.

FIG. 8 is a partial elevation at the top of the main cable showing the yardarm, a spring-mounted vibrator and the main sheave at the ship level.

FIG. 9 is a view on a comparatively large scale of a core tube with cutter attached at the bottom and provided with a perforated and corrugated liner within which the core catcher is located.

FIG. 10 is a modified structure for driving the core; and

FIG. 11 is a sectional plan view on the line 11—11 of FIG. 10.

Referring to FIG. 1, a ship 15 has a yardarm or derrick 16 supported by an upright 17 and extending upward and outward over the side of the ship. These parts are shown on a larger scale in FIG. 8. A frame 20 is pivotally hung from the arm 16 near its outer end on an axle pin 21. A plurality of rods 22, which may be three or four in number, are firmly attached to the frame 20. For example, each of the rods 22 extends through frame

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20, is threaded near the top 23 and has lock nuts 24 mounted one on each side of the frame. These rods 22 may be attached to the frame 20 by any suitable means and extend downwardly through holes in a platform 25, constituting guides which permit the platform 25 to slide up and down on the rods 22. Helical springs 26 are mounted on the rods 22 below platform 25 and are held in place by washers 27 and nuts 28 on the bottom of the rods.

The platform 25 has a downwardly projecting support 30 which is bifurcated to receive sheave 31 which is mounted to rotate on axle pin 32.

The main cable 35, as shown in FIG. 1, is wound at its upper end on a winch 36 and extends over guide pulley 37 and over sheave 31. Thence it extends downwardly for a sufficient length to reach the ocean bottom and at its lower end carries a core mechanism 40.

As shown in FIG. 8, a vibrator 41 is bolted or otherwise firmly mounted on platform 25. The arrangement is such that when the vibrator 41 is operated, vibration is imparted through sheave 31 to the main cable 35. The main cable may, of course, be of great length, but tests have proven that the vibration produced by vibrator 41 will be transmitted through the cable, and this action is put to use as hereinafter described for both driving and retrieving the core mechanism.

The core mechanism 40, as shown in FIGS. 1, 2 and 3, includes a tube 45 with a cutter 46 attached at the bottom. A crown 47 is attached to the tube 45 at the top and has a loop 48 which is mounted on the hook 50 of a yardarm 51 pivotally mounted at 52 upon a triangular plate 53. The upper corner of plate 53 is securely fastened to the lower end of the main cable 35. Cables 55 and 56 extend downwardly from the lower corners of the plate 53. The upper corner of plate 53 is securely fastened which the tube 45 is free to slide. The cables 55 and 56 pass through sheaves 55a and 56a, respectively, attached to the weight 60 and thence upwardly to the crown 47 to which they are attached at 55b and 56b, respectively (FIGS. 4, 5 and 6).

A cable 65 is attached to the outer end of the yardarm 51 and has a small weight 66 attached to its lower end. The length of the cable 65 is such that the weight 66 will strike the ocean bottom indicated at 70 a short time before the cutter 46 reaches that point.

As soon as the weight 66 strikes the bottom, the yardarm 51 swings upwardly, as shown in FIG. 2, the crown 47 is released from the hook 50, and the entire weight of the tube 45 with its attachments forcibly descends and pushes the cutter 46 down into the sea bottom as indicated in FIG. 2. An immediate acceleration is provided to the downward drive of the core tube the moment the heavy weight is released, as the cable springs violently upward to recover the stretch exerted by the weight of the entire coring apparatus, as indicated by the arrow 125 on FIG. 2. This spring-back can readily be as much as forty or more feet. If at the same time the winch is reversed to pull upward on main cable 35, at least half of its upward pull is diverted to downward drive of the crown 47 and its attached core pipes.

The downward forces on the core tube 45 can best be appreciated with reference to FIGS. 2 and 4. After the core tube is released from the yardarm 51, as explained above, the tension in the cables 55 and 56, which support the weight 60, tend to pull the core tube 45 downwardly. In particular, one half of the force exerted by the weight

60 is transmitted as tension through the portions of the cables 55 and 56 which are attached to the crown 47 and which extend to the sheaves 55a and 56a. If the weight 60 is stationary, the tension in these cable portions is equal to one-half the weight. If, however, the weight 60 is dropping rapidly, as is the case when the entire coring assembly is released by the yardarm 51 and the cable 35 is snapped upwardly, one-half the reactive force, equal to one-half the mass of the weight 60 times its relative or retarded downward acceleration, is also transmitted to the core tube 45 through the cable portions. It will be noted, then, that as soon as the coring assembly is released, a substantial and fast-operating downward force is exerted on the core tube 45.

If, when the cutter 46 has started to penetrate the sea bottom, as shown in FIG. 2, the vibrator 41 is put into operation while the cable is kept taut by an upward pull, the action will be transmitted through the entire length of the main cable 35 and is such that the tube 45 will gradually continue downwardly until the crown 47 strikes the top of the weight 60, as shown in FIG. 3. The downward force on the tube 45 is produced when the weight 60 is accelerated upwardly by the vibrating action of the main cable 35. If the weight 60 rests on the bottom and the main cable 35 is pulled upward, whether the vibrator is turned on or not, the upward force on the cable is translated to downward force on the tube 45 by reaction, via the sheaves 55a and 56a, against the mass of weight 60.

A great advantage of having the driving weight at or near the ocean bottom, instead of mounted at the top of a long string of core pipes, is the way this arrangement permits driving and extracting the core pipes by use of the main cable only, without having the pipes bent over by a heavy weight hung high up on the pipes when their trajectory is not perfectly vertical. In the arrangement shown on FIGS. 1, 2 and 3 the tautness of the main cable 35 acts to stabilize the trajectory of the coring pipes into the ocean bottom and gives the winch operator a lot of opportunity to control the whole operation more efficiently than heretofore.

A contact explosive 47a is attached to the bottom of crown 47 and is fired by the contact of crown 47 with weight 60, as shown in FIG. 3. The explosion is clearly indicated at the ship 15, and the operator knows that the tube has been forced as far as possible into the sea bottom formation or that the weight 60 in any event is at the top of the core tube 45. Accordingly, if the operator's cable tension meter (not shown) indicates that weight 60 is on or near the ocean bottom, the operator then can determine that the coring apparatus is ready to be lifted to the surface by the operation of the winch 36 on the ship.

It will, of course, be understood that the core tube 45 will normally be as long as from 40 to 100 feet, made up in sections, and hence will have a very substantial weight. The main cable may be several miles in length, and its weight is very great.

If a very long coring tube has been driven deeply, especially into hard sediments and especially at great depths, the amount of pull required to be exerted on the main cable may well be greater than the available strength of the cable, and if the winch is used in the usual manner to pull up the cable, in such a case the tension required may be so great as to part the cable and lose the core mechanism.

However, if pull is gradually exerted at the winch and if the vibrator 41 is put into operation, the vibration imparted through the cable to the core mechanism is such that the entire core tube 45 may be retrieved without too great a strain on the cable.

Thus it becomes apparent that the vibrator acting on the taut cable not only is successfully used to drive the core tube into the ocean bottom, but also serves the very important function of permitting the core tube to be retrieved from a deep penetration and hauled out into the ship, all by operation through the cable 35.

The cutter 46 is shown on a larger scale in cross section in FIG. 7 and has square cutter surfaces 75 and 75a and is in the form of a ring 76 with an inside diameter corresponding to the interior of a core catcher 77, or slightly less, which is set into the bottom end of the core tube 45. The cutter 46 has a sleeve 78 which is larger in diameter than the ring 76 and the core tube 45 and fits closely onto the end of the core tube 45. The cutter 46 is securely fastened to the lower end of the core tube 45 in any suitable manner, preferably by bolts 80 which screw into the walls of the tube 45, the holes in the sleeve 78 being countersunk to admit the bolt heads as clearly shown in FIG. 7.

The core catcher 77 may be formed of metal, but as an alternative which has certain specific advantages, the core catcher may be formed of a rubber or plastic material.

Near the lower end of the core tube 45, but above the cutter sleeve, are located one or more holes 81 to admit water. These holes are positioned below the slots 85 of the spring fingers 86 of the core catcher so that water coursing down the annular space 120 and entering the inside of the core tube at high pressures cannot directly jet against the sediment around which the core tube is falling, while its purpose is to provide a lubricant between the outside of the core sediment and the inside of the core tube. By this means the water can maintain an hydraulic balance on the ends and sides of the sediment core inside the core tube and prevent the development of a differential pressure the effect of which is to cause the sediment to stick against the inside of the core tube, thus permitting longer sediment cores to enter the core pipe. The core catcher has slots 85 producing spring fingers 86 which are bent inwardly by the weight of the entrapped sediment and lift the core when the tube is retrieved, thus preventing the core from dropping out as the tube is finally raised through the water.

A form of tube and core catcher which I now believe to be preferable is shown in FIG. 9. Like parts have the same reference characters as those used in the previous figures, but this arrangement differs radically from the one previously described in that the tube has a liner 90 of thin corrugated and perforated metal, separated into two halves longitudinally. This liner extends the entire length of the core tube. The bottom end is flanged outwardly, as shown at 91, and is made fast between the bottom end of the tube 45 and the cutter 46 by washer or ring 92 of the core catcher.

In this structure the core catcher 77 is the same as in the previous structure, but its size is such as to fit within the liner 90. As with the cutter 46 of FIG. 7, the opening in the cutter 46 of FIG. 9 is equal in size to, or preferably smaller than, the interior of the core catcher so that the internal water lubrication will have an opportunity to prevent internal friction from developing.

When the liner 90 is omitted, it has been found that the core material tends to pack against the smooth interior of the core tube, and the resulting surface friction acts to limit the length of undisturbed sediment which can enter the core tube, in relation to the depth the core pipe penetrates so that in many instances when the core tube is retracted, the core is found to be very short and unsatisfactory.

On the other hand, when the perforated and corrugated liner is used, tests have shown that the resistance to the core entering the tube is greatly reduced, so that longer, undisturbed cores are readily obtainable.

As the sediment slides by each ledge of the corrugations, the adjacent perforations feed water lubricant to the sediment so that the periphery of the internal sediment is never permitted to grab tightly on the interior wall of the coring tube. The water entering through holes 81 at the lower end of the core tube, along with water feeding down from the top, keeps the spaces between the liner 90 and the inside of the core tube con-

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stantly full of water and in balance with the water pressure of the depths involved.

Another advantage is that when the perforated and corrugated liner is removed from the core tube with its entrapped sediment, on the ship's deck, by lifting off one longitudinal half, the sediment can be rolled out of the other half into its shipping container, without being distorted by being pushed out of the core tube by a winch-driven piston, as is usually done when no such liner is used. Of course, the liner may be formed from more than two longitudinal segments, if desired.

A modification of the structures shown in FIGS. 2 and 3 is illustrated on a larger scale in FIGS. 10 and 11, to which reference will now be had. The weight 60 mounted on the core tube 45 is connected to a crown 100 by cables 101 and 102, which are attached to the crown at rings 103 and 104 and extend over sheaves 105 and 106 which are rotatably mounted in pockets 107 and 108 of the weight 60. The cables then project upwardly through openings 109 and 110 in the crown 100.

Hinged to the crown are gate pawls 111 and 112 which have notches 113 and 114 through which the cables extend.

The upper ends of the cables which correspond to the cables 55 and 56 are fastened to the triangular plate 53 as shown in FIGS. 2 and 3.

The cables 101 and 102 differ from the cables 55 and 56 by being provided with knots or enlargements 115 which are located at predetermined distances along the cables. When the core mechanism is lowered from the ship, the weight 60 is near the lower end of the core tube 45 and the crown 100 is at the top so that these parts are then widely separated depending on the total length of the core which is made up of sections and may be forty or eighty feet in length, or even longer.

In the arrangement of FIGS. 10 and 11, as the tube 45 is driven into the ocean bottom, such as by lifting of the main cable 35, the tube and the crown 100 are lowered, and as the crown moves downwardly with reference to the cables 101 and 102, the knots on the cable pass upwardly through the holes 109 and 110 and in so doing temporarily lift hinged gate pawls 111 and 112 so that they assume the position of 111 in FIG. 10 and then fall back onto the top of crown 100, when the cable is lowered by winch action, for instance.

The ship, under normal conditions, will cause the main cable and whatever is attached to it to rise and fall periodically as much as ten or fifteen feet, and under some weather conditions the rise and fall of the ship may be greater. As the cable 35 falls, the knots 115 on the cables shown in FIGS. 10 and 11 will consequently come down against the closed gate pawls 111 and 112 with great force and will permit the full downward momentum of the weight 60 to push the crown 100 and the core tube 45, which is connected to it, down into the sea bottom. Thus the arrangement of FIGS. 10 and 11 may be utilized without the necessity of the vibrator 41, or may be used in conjunction with it.

While the enlargements 115 have been referred to as knots, they may constitute ring clamps fastened to the cables 101 and 102, but in any event they are of such a size as to pass upwardly through the holes 109 and 110, but will not pass downwardly in the opposite direction when the gate pawls are closed.

The knots or enlargements on the cable may be placed about ten feet apart, but this distance may be varied without modifying the operation.

The crown 100 has loop 48 which is adapted to be hooked onto the yardarm 51, as described in connection with FIGS. 1, 2 and 3.

In FIGS. 7 and 9, the sleeve 78 of the cutter 46 is somewhat larger in diameter than the core tube 45, and hence when the core tube is driven into the sea bottom, the hole formed by the cutter will be a little larger than the core tube, and an annular space 120, which clearly shows

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in FIG. 7, has the important function of permitting water to surround the tube and to enter through holes 81 to lubricate the core. The holes 81 have been found adequate for providing the water lubrication that enters around the core catcher, but the tendency of the core to pack within the core tube 45 and to build up friction against the smooth interior of the tube 45 is best overcome by the use of the perforated liner 90 throughout the entire length of the tube 45, as shown in FIG. 9, along with the water entering through holes 81 and at the top of the core pipe. FIG. 7 illustrates the core tube 45 driven into the ocean floor, indicated at level 126, to a considerable distance and shows the core within the tube at substantially the same level 127. Ordinarily a lower level of undisturbed sediment results from friction between the core and the inner surface of the core tube.

The embodiments of this invention which are illustrated in the drawings and are hereinbefore described in the specification are the best now known, but those skilled in this art may think of numerous modifications and variations which may be made without departing from the spirit of this invention. Consequently, only such limitations should be imposed as are indicated in the appended claims.

What is claimed is:

1. A core sampler for sea bottom use, comprising a core tube, a weight suspended in part from the top of the core tube and in part from the ship and mounted for movement along the core tube, and cable means for raising the weight upwardly along the tube, so that a force is produced urging the tube downwardly when the tube is positioned at the bottom of the sea.

2. A core sampler for sea bottom use, comprising a core tube, a weight mounted for movement along the core tube, a sheave mounted on the weight, a cable for suspending the weight attached at one of its ends to the upper end of the core tube and passing through the sheave and means for actuating the cable from the surface of the sea whereby a force is produced urging the core tube downwardly when the tube is positioned at the bottom of the sea.

3. A core sampler for sea bottom use, comprising a core tube having a crown at its upper end, a weight mounted for movement along the core tube, a sheave mounted on the weight, a cable for suspending the weight attached at one of its ends to the upper end of the core tube and passing through the sheave, the free end of the cable passing through the crown at the upper end of the core tube, and an enlargement provided on the cable, the crown including means permitting upward but not downward movement of the enlargement on the cable through the crown, thereby to apply the entire force of the weight as a downward force on the core tube as the free end of the cable is lifted and lowered and the enlargement on the cable engages the crown in a downward motion.

4. A core sampler for sea bottom use, comprising a core tube having therein a perforated liner to reduce the friction of a core sample against the interior of the tube, a weight mounted for movement along the core tube, a sheave mounted on the weight, a cable for suspending the weight attached at one of its ends to the upper end of the core tube and passing through the sheave and means for actuating the cable from the surface of the sea whereby a force is produced urging the core tube downwardly when the tube is positioned at the bottom of the sea.

5. A core sampler for sea bottom use, comprising a core tube having therein a perforated, corrugated and longitudinally segmented liner to reduce the friction of a core sample against the interior of the tube, a weight mounted for movement along the core tube, a sheave mounted on the weight, and a cable for suspending the weight attached at one of its ends to the upper end of the core tube and passing through the sheave and thence to a ship on the surface.

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6. A core sampler for sea bottom use, comprising a core tube having therein a perforated liner to reduce the friction of a core sample against the interior of the tube, the liner being split longitudinally into at least two sections so that the liner may be dismantled to aid in the removal of a core from the tube, a weight mounted for movement along the core tube, a sheave mounted on the weight, a cable for suspending the weight attached at one of its ends to the upper end of the core tube and passing through the sheave and means for actuating the cable from the surface of the sea whereby a force is produced urging the core tube downwardly when the tube is positioned at the bottom of the sea.

7. A core sampler for the sea bottom use, comprising a core tube having water entry openings therethrough near the bottom end of the tube, an internal sleeve mounted inside the core tube adjacent the water entry openings so that lubricating water entering through the openings does not directly impinge upon a core sample inside the core tube, a weight mounted for movement along the core tube, a sheave mounted on the weight, a cable for suspending the weight attached at one of its ends to the upper end of the core tube and passing through the sheave and means for actuating the cable from the surface of the sea whereby a force is produced urging the core tube downwardly when the tube is positioned at the bottom of the sea.

8. A core sampler for sea bottom use, comprising a core tube having water entry openings therethrough near the bottom end of the tube, an internal sleeve mounted inside the core tube adjacent the water entry openings to prevent lubricating water entering through the openings from directly impinging upon a core sample inside the tube, the internal sleeve including a plurality of resilient fingers directed generally toward the interior of the core tube and positioned above the water entry openings for preventing a core from falling out of the core tube, a weight mounted for movement along the core tube, a sheave mounted on the weight, a cable for suspending the weight attached at one of its ends to the upper end of the core tube and passing through the sheave and means for actuating the cable from the surface of the sea whereby a force is produced urging the core tube downwardly when the tube is positioned at the bottom of the sea.

9. A core sampler for sea bottom use, comprising a core tube, a weight mounted for movement along the core tube, a sheave mounted on the weight, hook means releasably connected to the upper end of the core tube, a first cable for suspending the hook means above the bottom of the sea, a second cable attached at one end to the hook means and at its other end to the upper end of the core tube, the second cable passing through the sheave, and means for releasing the connection between the hook means and the upper end of the core tube.

10. A core sampler for sea bottom use, comprising a core tube, a weight mounted for movement along the core tube, a sheave mounted on the weight, hook means releasably connected to the upper end of the core tube, a first cable for suspending the hook means above the bottom of the sea, a second cable attached at one end to the hook means and at its other end to the upper end of the core tube, the second cable passing through the sheave, and means responsive to a positioning of the core tube above the sea bottom for releasing the connection between the hook means and the upper end of the core tube.

11. A mechanism for obtaining cores from deep sea bottoms, comprising a tubular core sampler, a weight adapted to drive the tubular core sampler into the sea bottom, a sheave mounted on the weight, a cable attached to the top of the tubular core sampler after passing through the sheave, and means for vibrating the cable to transmit a vibratory motion to the weight whereby the

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core sampler is gradually driven downwardly into the sea bottom to be sampled to a desired depth.

12. The structure of claim 11 in which a penetrating foot is provided on the bottom of the core tube and has a flat circular cutting surface.

13. A mechanism for obtaining cores from deep sea bottoms, comprising a yardarm extending over the open sea water above the spot where a core is to be obtained, a resiliently supported platform attached to the yardarm, a sheave hung from the bottom of the platform, vibrating means attached to the platform, a long cable extending over the sheave and downwardly into the water, means for paying out and gathering in the cable, a core tube connected to the lower end of the cable, a weight on the cable initially hung near the lower end of the core tube for forcing the core tube downwardly into the sea bottom, and means for actuating the vibrating means whereby the core tube is gradually forced by the action of the vibrating means through the taut cable into the bottom to be sampled and subsequently recovered therefrom.

14. The mechanism of claim 13 in which a platform is spring-supported from the yardarm and a vibrator is mounted on the platform.

15. In combination with a ship mounted on the sea surface, a yardarm extending over the side of the ship, a sheath hung from the end of the yardarm, a long cable extending over the sheave and downwardly into the water, means on the ship for paying out and gathering in the cable, a core tube connected to the cable at its lower end, a weight on the core tube, a sheave mounted on the weight over which the cable is connected intermediate its ends, and means dependent on a lifting and lowering of the cable from the ship on the surface of the water for forcing the core tube downwardly into the sea bottom from which the core is to be taken.

16. The mechanism of claim 15 in which at least one auxiliary cable extends through a hole in a crown in the core, and an enlargement is provided on the cable above the crown, whereby the weight of the entire assembly produces a downward drive on the core tube as the other end of the cable is lifted and lowered by the ship on the water at the surface.

17. A core sampler for sea bottom use, comprising a core tube, a weight mounted for movement along the core tube, a cable connected to the top of the core tube and slidably coupled to the weight, and remote control means for imparting an upward movement to the cable whereby a force is produced urging the core tube downwardly when the tube is positioned at the bottom of the sea.

18. A core sampler for sea bottom use, comprising a cable, means to gather in and pay out the cable into the sea, a core tube attached to the cable, a heavy weight slidably mounted on the core tube and means connecting the cable to the top of the core tube, means for slidably connecting the cable to the weight, and means for vibrating the weight from the surface whereby it gradually forces the core tube into the sea bottom and aids in the extraction of the core tube from the ocean floor.

19. In a core sampler for sea bottom use that includes a core tube and a weight to drive the core tube, the combination comprising a perforated, corrugated and longitudinally segmented liner for providing an uniformly rough surface for the core sample to contact, with all points lubricated with water at all times, whereby the outside surface of the core sample will never develop any suction against the inside of the core tube and thereby to reduce the friction of a core sample against the interior of the tube.

20. A core sampler for sea bottom use, comprising a cable, means to gather in and pay out the cable into the sea, a core tube attached to the lower end of the cable, a heavy weight slidably hung on the cable and mounted for movement along the core tube, and means for vibrating

the weight from the surface through the cable whereby it gradually forces the core tube into the sea bottom and aids in the extraction of the embedded core tube from the ocean floor.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,301,336

January 31, 1967

Wadsworth W. Mount

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 2, line 35, strike out "plate 53. The upper corner of plate 53 is securely fastened" and insert instead -- plate 53 to a weight 60 having a vertical hole 61 through --; column 7, line 14, strike out "the"; column 8, line 23, for "pring-supported" read -- spring-supported --.

Signed and sealed this 14th day of November 1967.

(SEAL)

Attest:

Edward M. Fletcher, Jr.

Attesting Officer

EDWARD J. BRENNER

Commissioner of Patents