Feb. 26, 1963 D. G. MOORE 3,078,931

FREE CORER

Filed Dec. 8, 1960 2 Sheets-Sheet 1

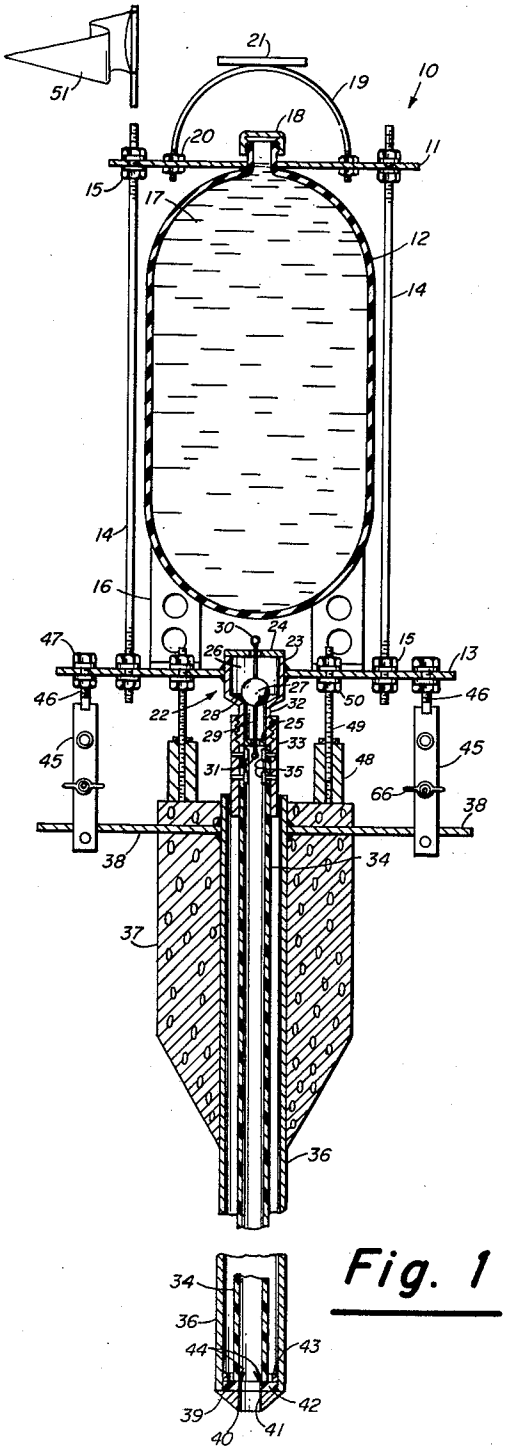


Fig. 1

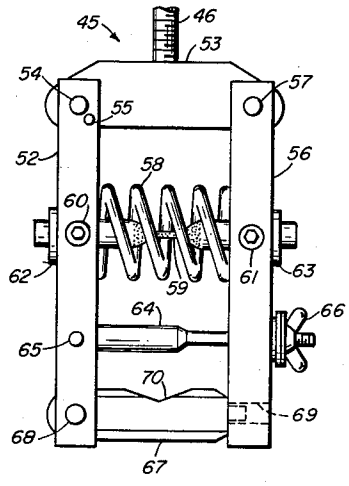


Fig. 2

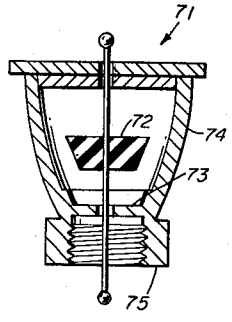


Fig. 3

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Fig. 5

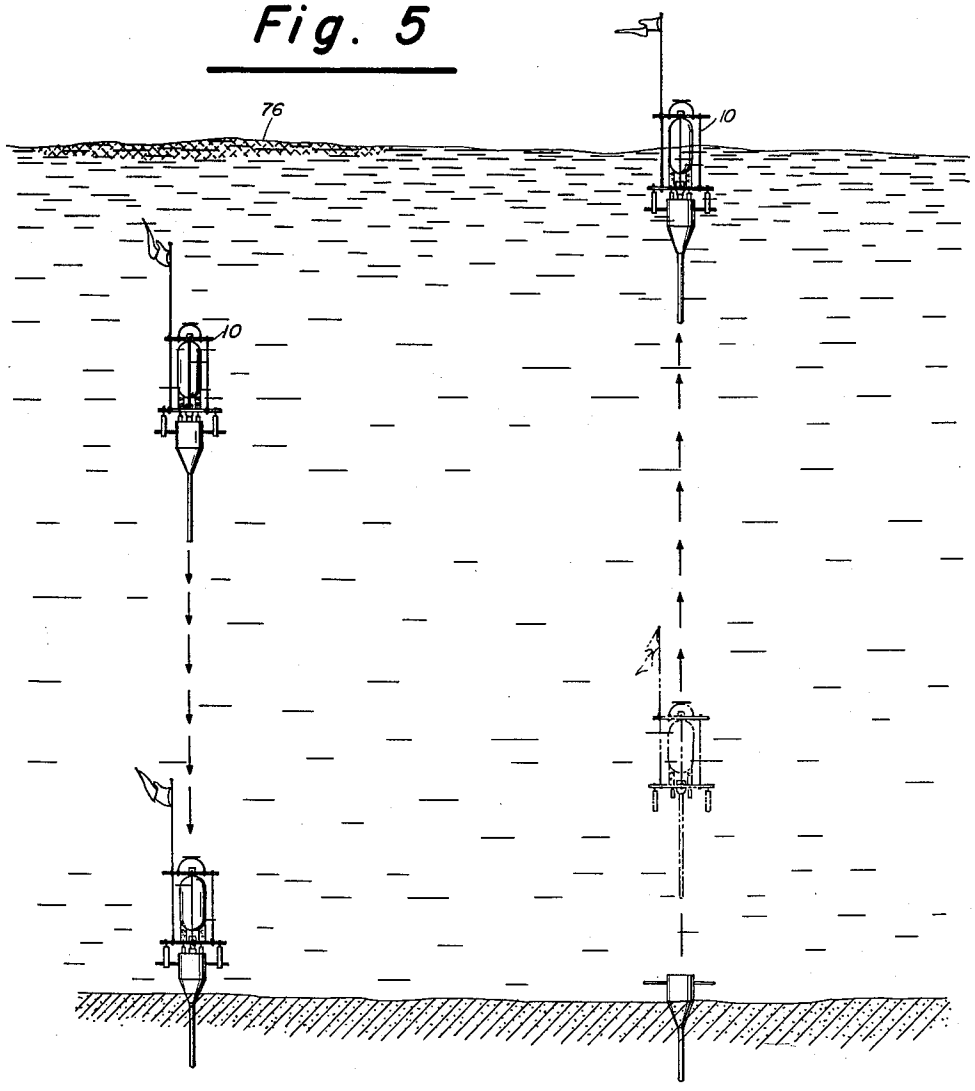
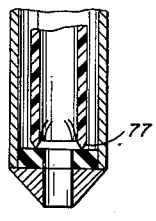


Fig. 4



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FREE CORER

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The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

The present invention relates generally to apparatus for extracting earth core samples from the ocean floor. In particular, it relates to an improved, free-falling, earth corer which may be dropped into the ocean as a completely self-contained unit from any convenient carrier vessel, whereupon it descends to the floor thereof, extracts a sample core therefrom, and ascends in part to the ocean surface with the extracted core contained substantially unimpaired in said ascending part while an expendable, weighted, core-cutting portion thereof remains abandoned in the ocean floor.

In the past, ocean floor cores have been obtained in a number of ways, each of which may be satisfactory for some particular purpose or under some particular circumstances. For instance, it is known in the art to drop free-falling earth corers into the ocean where they fall until they stick themselves into ocean floor, after which they are forcefully withdrawn therefrom as an entire unit, along with the desired earth core, by an impact actuated latch and spring mechanism acting in compression between the ocean floor surface and the corer lift means. Usually, in order to provide suitable buoyant or lift forces, the weights which initially caused the corer to sink are released and perhaps ejected from the corer unit at the time the corer is withdrawn from the sea floor, thereby allowing a buoyant tank means to float the corer and the core to the ocean surface. Obviously, there are several disadvantages in using such a coring apparatus. First, it is usually difficult to withdraw the core cutting tube once it is stuck in the sea floor sufficiently far to obtain a useful earth core. Thus, the withdrawing force must be considerable. Second, if all of the corer apparatus is floated to the surface with the exception of the weights, a considerable buoyant force is required. And third, if the sea floor sediment is excessively soft, it may not provide enough bearing surface for the withdrawal spring and bearing plate mechanism to work against, thereby causing a malfunctioning of the withdrawing apparatus which, in turn, may prevent or adversely delay the return of the ocean surface.

In addition to the free corers of the aforementioned type, it is well known to use cables, winches, and associated power machinery to lower and raise submarine corers to and from the ocean floor. Of course, this is an awkward, expensive, difficult and time consuming proposition. Furthermore, in the deep-sea, (about 2,000 fathoms) it is extremely difficult to predict or predetermine where the core will actually be extracted due to the difficulty of properly maneuvering the boat containing the winch and power equipment during coring operation, especially during rough weather, high winds, or high water current conditions. To say the least, under most circumstances, it leaves a great deal to be desired.

The subject invention overcomes most of the disadvantages of the known prior art earth coring devices adapted for extracting cores from the ocean bed because the core cutting tube is never withdrawn therefrom, the weights are released, and both, being expendable, are abandoned at the bottom of the sea. Only a light plastic sleeve containing the core sample is timely floated to the surface by a simple but effective buoyant means. Thus, no elaborate release or withdrawing mechanism is required, and the condition of the sea-floor sediment is of negligible consequence, since no bearing force is applied thereto for withdrawal purposes.

Obviously, since no cable, winch, or power equipment is employed, the size and maneuverability of the carrier or retrieving vessel is relatively unimportant and they are free to move as desired. And the closeness of core sample patterns obtainable is only limited by the physical size and fall characteristics of the corers themselves.

It is, therefore, an object of this invention to provide an improved free-drop earth corer.

Another object of this invention is to provide an automatic marine geological earth extractor means that requires no payout-cable, winch machinery, or power equipment for lowering or raising same to and from the ocean floor.

A further object of this invention is to provide an improved, easily-handled, free-drop, self-returning, submarine, earth corer that is not adversely affected by extreme depth pressure or temperature variations.

Another object of this invention is to provide an earth corer that obtains marine geological samples at substantially predetermined underwater locations in accordance with controlled pattern dropping procedures facilitated by dead reckoning or electronically aided navigation.

Still another object of this invention is to provide an improved marine earth corer that may be launched economically from very small boats, aircraft, large ships, submarines, experimental submergible crafts, or other carrier vessels.

A further object of this invention is to provide an efficient means for obtaining a sea-floor earth core sample which requires less ship time consumption and less tedious ship handling.

A still further object of this invention is to provide an improved earth corer that is not adversely affected by the type of ocean floor sediment to be sampled and permits extraction of earth cores of any reasonable length.

Another object of this invention is to provide a method of safely obtaining earth cores from the ocean floor without being seriously handicapped or adversely effected by weather or other ambient environmental conditions.

Another object of this invention is to provide a means for easily, safely, and economically obtaining marine earth cores from great ocean depths.

Still another object of this invention is to provide an improved earth corer that is subject to time-controlled operation.

A further object of this invention is to provide a free corer having such stability that it will right itself after being rolled off the deck of a carrier vessel.

A still further object of the present invention is to provide an automatic marine geological sample extractor that may readily be adapted for echo-range and sound tracking and trajectory regulation during its fall to the ocean floor and return therefrom.

A further object of this invention is to provide a free-falling earth corer that may be magnetically held to and released from a carrier vehicle.

Another object of this invention is to provide an improved means and method for obtaining and studying deep-sea floor sediments.

A further object of this invention is to provide an improved earth corer means that keeps an earth core sample substantially intact while ascending from the ocean floor.

Another object of this invention is to provide a free corer having floatable portion and a detachable weight and core cutting means that are abandoned at the sea

floor after extraction and confinement of an earth core sample in said floatable portion.

A further object of this invention is to provide an earth corer having minimum pull-out friction.

Another object of this invention is to provide a free corer that is inexpensively manufactured and maintained and easily stored.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in conjunction with the accompanying drawing in which like reference numerals designate like parts throughout the figures thereof and wherein:

FIG. 1 illustrates an elevational view, partly in cross-section and partially in pictorial form, of a preferred embodiment of the present invention;

FIG. 2 is an elevational view of an exemplary latch mechanism that may be incorporated in the device of FIG. 1;

FIG. 3 shows a cross section of a plug and seat valve that may be substituted for the ball check valve of the device of FIG. 1;

FIG. 4 depicts a cross-sectional view of a core cutter-sleeve combination that may be substituted for the core cutter-sleeve arrangement in the device of FIG. 1; and

FIG. 5 discloses the descending and ascending operation of the subject invention as it respectively travels through the water before and after the earth core sample has been extracted from the sea floor.

Referring now to FIG. 1, a preferred embodiment of a free corer **10** constituting the subject invention is shown as having a top retaining plate **11** containing a plurality of holes one of which is adapted for fitting over the neck of a flexible polyethylene bottle **12** for securely fastening same thereat. A bottom retaining plate **13** is disposed near the lower end of said polyethylene bottom and is rigidly connected to said top retaining plate by a plurality of threaded rods **14** which are attached to both of said plates by means of nuts **15** or other suitable attachment means. A plurality of support members **16** are connected to said bottom retaining plate and are interposed between same and said polyethylene bottle for firmly positioning, supporting, and securing same between said top and bottom retaining plates and within the cage effectively formed thereby in combination with said plurality of rods.

Polyethylene bottle **12** contains a compressible buoyant fluid **17** such as gasoline having, for instance, a density of 0.7 gm./cm.^{3}, that is sealed therein by a cap **18** or other appropriate sealing means which will prevent the aforesaid fluid or gasoline from escaping therefrom when said polyethylene bottle is subjected to the considerable hydrostatic pressures existing at great ocean depths.

A threaded lifting bail **19** is attached to top retaining plate **11** by nuts **20** or any other appropriate attachment means. At a suitable position thereon, a magnetic hold plate **21** is attached thereto by welding or the like.

Mounted at the center of bottom retaining plate **13** is a check valve assembly **22** containing a valve body **23** which is fastened to said bottom retaining plate by welding or other suitable means. A top end plate **24** and a bottom end plate **25** respectively fastened to the top and bottom ends of valve body **23** form a chamber **26** within which is disposed a ball **27** adapted to abut against a seat portion **28** of the aforesaid valve body. Ball **28** is securely connected to a guide rod **29** which is slidably disposed in bearing-like apertures located in said top and bottom end plates. Stops **30** and **31** may be attached to the ends of said guide rod **29** if so desired to limit the movement of ball **27** within chamber **26**.

The lower extremity of said valve body may, for example, have an extended portion **32** containing external threads. A core liner adapter **33** having internal threads complementary with those external threads of extended portion **32** is attached to said valve body. Inserted telescopically in the end of said adapter is a rigid, thin-walled, light-weight, plastic, hollow core liner or sleeve **34**, which is elongated sufficiently to collect and contain an earth core sample of predetermined size and depth. Said sleeve may be secured to said adapter by means of a plurality of rivets **35** or any other conveniently suitable connection means, such as by welding, screw threads, or the like.

Telescopically disposed around said plastic core sleeve is a coring tube or casing **36** of steel or other material having pertinent strength characteristics. Said casing is cast or embedded in a concrete weight **37**, and connected to said casing and extending therefrom in a direction substantially normal to the longitudinal axis thereof is a pair of arms **38** that are likewise embedded in said concrete weight for a portion of their lengths and which have a portion of their lengths extending external of said concrete weight.

As viewed in FIG. 1, the lower extremity of casing **36** contains a casing shoe **39** which may be attached thereto as by tack-welding or the like. Casing shoe **39** is so tapered or otherwise contoured as to provide a cutting edge **40** and has an aperture **41** that has an inside diameter which substantially equals to the inside diameter of the hollow end of sleeve **34**. Interposed between the upper end shelf of said casing shoe and the lower end of said core sleeve is a resilent washer **42** of rubber or the like which acts as a seating gasket therebetween. If so desired, a centering ring **43** of plastic, rubber, metal, or any other suitable material may be disposed radially between core sleeve **34** and casing **36**. It should be understood that the longitudinal axis of said core sleeve, said casing, and said casing shoe should be in such alignment as to provide an easy passageway therethrough, and that the size thereof should be such as would facilitate guiding an earth core sample into the hollow-portion of the core sleeve as the casing shoe cuts into the sediment of the ocean floor due to the impact of the subject free corer thereat.

A plurality of bronze, spring-leaf, core catchers **44** are attached to the lower end of sleeve **34** by suitable molding or other attachment means as appropriate in order that an earth core sample will be retained within said sleeve once it has been forcibly deposited therein.

A pair of delay release timer latch mechanisms **45** are rigidly mounted on bottom retaining plate **13** by bolts **46** and nuts **47** in such manner as to be suspended therefrom and surround and timely latch the aforesaid arms **38**. Although for the purpose of completely disclosing a preferred embodiment of this invention a particular detailed latch mechanism is illustrated herein, it is to be understood that the subject latch mechanism is merely exemplary and that any number of well known suitable latch mechanisms may be substituted therefor without violating the spirit, scope, or purview of this invention. For instance, an impact operated latch mechanism, an inertial operated latch mechanism, a clock controlled latch mechanism, a pressure or temperature controlled latch mechanism, and others could obviously be substituted for the herein disclosed latch mechanism by those skilled in the art.

A plurality of adjustable spacers **48** are mounted between the aforementioned bottom retaining plate **13** and the top surface of concrete weight **37**. Said spacers include threaded studs **49** fastened to plate **13** by means of nuts **50**, but other conventional fastening means may be used if desired. Moreover, the attachment means used in conjunction with studs **49** may also be employed to fasten the aforesaid polyethylene support members if convenient. Said spacers give rigidity to the assembled corer which facilitates the handling thereof. Furthermore, they effectively provide alignment between the buoyant chamber assembly and the detachable weight and casing assembly which, in turn, promotes substantially straight and true

descent of the entire corer assembly through the ocean water column, thus providing greater accuracy of earth core sampling and optimum ocean floor impact characteristics.

In many instances, one or more of rods 14 may be extended, and a flag 51 of such material and markings, as would provide greater visibility and ease of identification, may be attached thereto. Said flag, of course, may also be of such material as would reflect electromagnetic energy and acoustical energy for improving search and control procedures during any given type of operation, whether the subject corer is momentarily stuck in the ocean floor, traveling through the ocean water column, or floating on the ocean surface. Although not shown in the drawing, it would appear to be obvious to the artisan to combine movable control surfaces, regulatory radio and sonar equipment for adjusting said control surfaces, and perhaps suitable propulsion motors with the disclosed structural assembly of FIG. 1 for the purpose of guiding and propelling the otherwise free-falling corer to a predetermined sea floor destination or possibly a predetermined sea surface destination after the earth core sample had been extracted. So combining should, therefore, be considered as a part of the inventive concept taught herein.

FIG. 2 depicts the aforementioned exemplary latch mechanism as a marine release delay timer having a fixed jaw 52 connected to an attachment plate 53 by means of a rivet 54 and a pin 55. A movable jaw 56 is rotatably attached to attachment plate 53 by rivet 57. A jaw-opening compression spring 58 is disposed between said two jaws in such manner as to urge their separation. A restraining rod 59 of magnesium or other suitable erodible material or material breakable by a predetermined physical jolt is inserted along the longitudinal axis of said spring and is attached securely to said jaws by means of pivot set screws 60 and 61 and/or rod chucks 62 and 63, respectively. A spring-compressing screw 64 is attached to fixed jaw 52 by pin 65, and a wing nut 66 provides sufficient bearing force against movable jaw to move it toward fixed jaw 52, so that a release pawl 67 pivotally attached to said fixed jaw by a pin 68 may be latched in a slot 69 in said movable jaw. A groove 70 in said release pawl is adapted for holding and center-positioning the aforesaid arms 38 therein when adjustable spacers 48 are properly elongated to give rigidity to the entire corer assembly.

The device of FIG. 3 represents another check valve 71 which may be substituted for the aforementioned ball type check valve. It is essentially comparable to said ball type check valve with the exception that a plug 72 and mating seat 73 are employed in a suitable valve body 74 in event a tighter fit is required therebetween to prevent the core sample from being flushed from the plastic sleeve when the free corer is ascending and the core sample is a soft, easily-flowing sediment. The water pressure applied against the top of the plug achieves such action in an improved manner. With such a check valve body, the plastic sleeve may be attached thereto by having external threads which are screwed in a threaded, bossed, end portion 75, thus eliminating the need for the aforementioned adapter 33 depicted in FIG. 1.

FIG. 4 is another embodiment of the core cutter assembly and is very similar to that of FIG. 1 with the exception that the plastic sleeve has slanted or beveled surfaces 77 at the end thereof which converge to a point that is tightly embedded in the resilient washer located on the upper shelf surface of the casing shoe. During some operational procedures the tight seal thus provided thereat in conjunction with the inner slanted surface thereof provides appropriate centering of the sleeve within the casing, and alleviates the necessity of accurate manufacture of said sleeve and said casing shoe, since said inner slanted surface acts as a guide for the incoming core sample during penetration of the casing shoe and casing in the ocean floor.

Briefly, the operation of the subject invention is disclosed in conjunction with FIG. 5 as follows:

The free corer is put overboard from any appropriate carrier vessel in any convenient manner as, for instance, by rolling it off the deck of a ship, launching it from an ejector means, or magnetically releasing and jettisoning it from an aircraft or submarine vehicle. In any event, upon free contact with the water, it begins to descend toward the bottom. Due to the inherent stability provided by the concrete weight appropriately positioned at the end of the corer opposite the end containing the float assembly, and due to elongated overall shape of the corer, it rights itself as it freely falls through the water column of the ocean, and in so doing positions the cutting point of the core cutting casing and shoe assembly in a downwardly direction.

The descending speed, of course, depends mostly on the difference between the opposing forces created by the overall weight of the corer, including the concrete weight, and the buoyancy of the buoyant gasoline-filled bottle. Because the concrete weight provides the greater force as a result of gravity acting thereon, the subject corer gathers speed as it descends and ultimately hits the ocean bottom with sufficient impact to cause the core cutting point of the casing to penetrate the ocean floor which, in turn, simultaneously causes an earth core sample to be intruded through the apertures in the casing shoe and gasket into the hollow inside portion of the rigid plastic sleeve, where it is held therein by the core catchers. At this instant, the entire corer unit is, so to speak, stuck in the sea floor.

As time goes by, the latches are opened because the restraining rods of the latch mechanisms deteriorate to the breaking point as a result of the electrochemical action of the sea water thereon, permitting the jaw-opening springs to separate the latch jaws and trip the releasing pawls. This frees the arms originally locked therein and allows the rigid plastic sleeve containing the core sample to separate from the weight and core cutter casing assembly and float to the ocean surface due, for the most part, to the lifting forces produced by the buoyant gasoline filled polyethylene tank or bottle attached thereto. Of course, only a relatively small lifting force is required to break the core sample from the sea floor at the lower end of the plastic sleeve compared to the lifting force which would be required to both sever the core sample from the sea floor and withdraw the core cutter casing assembly from its embedded position therein. Although core severance and lifting is ordinarily easily accomplished by the float chamber, once the arms attached to the weight are unlatched, the resilient washer which acts as a seating gasket between the end of the rigid plastic sleeve and the upper shelf surface of the casing shoe releases its potential energy by expanding, thereby forcibly urging the end at the sleeve away from the shoe which, in turn, tends to force said sleeve out of the upper end of the core cutter casing. Obviously, the aforesaid resilient washer may be made as resilient as necessary to provide whatever disengagement force is required to part the core sample from the sea floor and thrust the plastic sleeve and its captive core sample toward the ocean surface. Furthermore, it would be obvious to the artisan to incorporate additional resilient means such as, for example, a spring means or the like between the separable units constituting the float assembly and weight-casing assembly, which would urge separation thereof when timely unlatched by the aforementioned latch mechanism.

As the float assembly and the rigid plastic sleeve containing the desired earth core sample are floated to the ocean surface, the weight and core cutter casing assembly, being expendable, are abandoned at the bottom of the sea. Thus, it can readily be seen that since no attempt is made to remove the core cutter casing from its stuck position in the sea floor and float it to the sea sur-

face, excellent operational effects are produced by the subject invention.

The ball check valve of FIG. 1 and the plug check valve of FIG. 3, which may be substituted for the ball check valve of FIG. 1, facilitates retaining the intruded core during ascent of the floatable assembly portion to the ocean surface. Although the upward water force through the hollow inside diameter of the sleeve and the guide rod aperture in bottom end plate 25 tends to keep the check valve open during descent of the corer, the opposite effect takes place during ascent, and the check valve tends to be forced closed. Thus it can be seen that an open check valve allows easy intrusion of the core sample during sea floor penetration without any adverse hydraulic stop effects, but a closed check valve assists in holding the captive core sample in the sleeve by preventing its being flushed out by downwardly flowing sea water therethrough and at the lower end thereof, and by simultaneously maintaining a substantial hydraulic pressure lock within said sleeve between the check valve and the top surface of the earth core sample,

As illustrated in FIG. 5, a dye marker 76 or other marker may be employed to assist in keeping visual track of the location of the area where each of the free falling earth cores was launched. Of course, use thereof would ostensively assist in predicting the vicinity in which each of said corers will surface after extraction of their respective earth core samples.

Obviously, many modifications and variations of the present invention are possible in the light of the above teachings. It is, therefore, to be understood, that within the scope of the appended claims, the subject invention may be practiced otherwise than as specifically described.

What is claimed is:

1. An earth corer comprising in combination weighted core cutting means, means slidably disposed within said weighted core cutting means for receiving the earth core cut thereby, a float means connected to said earth core receiving means, and latch means inter-connecting said float means and said weighted core cutting means for timely latching and unlatching same.

2. The device of claim 1 wherein said latch means interconnecting said float means and said weighted core cutting means includes an erodible means adapted for electrochemical action thereon by sea water for effecting the aforesaid timely latching and unlatching of same.

3. A geological sample extractor comprising in combination, a weighted cylindrical pipe casing having a core cutting tip at one end thereof, a rigid sleeve slidably disposed within said cylindrical pipe casing, means for releasably latching said rigid sleeve to said cylindrical pipe casing, means coupled to said latching means for effecting the opening thereof at a predetermined time, and means connected to said rigid sleeve for completely lifting same out of said cylindrical pipe casing when said latching means is opened.

4. A free drop submarine earth corer comprising in combination, a float chamber, a rigid sleeve connected to said float chamber, a core cutting means slidably surrounding said sleeve, a weight attached to said core cutting means, a pair of arms extending from said core cutting means, and means interconnecting said float chamber and said arms for respectively securing and releasing same before and after formation of a submarine earth core by the aforesaid core cutting means.

5. The device of claim 4 wherein said float chamber includes a flexible-walled, polyethylene, gasoline-filled bottle.

6. The device of claim 4 wherein said rigid sleeve is a light-weight plastic having a thin wall.

7. The device of claim 4 wherein said weight attached to said core cutting means is a cast concrete weight that is expendable along with the aforesaid core cutting means.

8. The device of claim 4 wherein said means interconnecting said float chamber and said arms for respectively securing and releasing same before and after formation of a submarine earth core includes a latch mechanism adapted for being opened upon impact of said core cutting means at the ocean floor.

9. The device of claim 4 wherein said means interconnecting said float chamber and said arms for respectively securing and releasing same before and after formation of a submarine earth core comprises a latch adapted for being opened at a predetermined time by electrochemical action thereon of the ambient sea water within which it is submerged.

10. The device of claim 4 further characterized by having a resilient means effectively disposed between said float chamber and said weighted core cutting means for urging each from the other upon release thereof by the aforesaid securing and releasing means.

11. An automatic marine geological sample extractor comprising in combination, a buoyant float chamber, means releasably coupled to said buoyant float chamber for cutting an earth core upon impact thereof at the ocean floor, means connected to said buoyant float chamber adapted for receiving the earth core cut by said cutting means as same penetrates said ocean floor as a result of the impact thereon, and means effectively interconnecting said earth core cutting means and said earth core receiving means for timely and automatically separating same after said earth core is cut and received thereby respectively.

12. A free corer adapted for extracting earth core samples from the ocean floor consisting of a flexible polyethylene bottle, a buoyant, substantially incompressible fluid having a density less than one substantially filling said bottle, a cage confining said bottle therewith, a check valve connected to one end of said cage, a rigid elongated hollow sleeve, an adapter interconnecting said check valve and one end of said sleeve, a casing, a concrete weight cast around one end of said casing, a plurality of arms connected to said casing and extending through said concrete weight, means connected between said cage and said arms for releasably latching same together for a predetermined time, a tapered shoe connected to the other end of said casing, a resilient washer compressively disposed between said shoe and the other end of said sleeve, and a plurality of adjustable spacers interconnecting said cage and the aforesaid concrete weight for maintaining rigidity therebetween.

13. The device of claim 12 wherein said buoyant fluid having a density less than one is gasoline.

14. The device of claim 12 wherein said check valve is a ball check valve.

15. The device of claim 12 wherein said check valve is a contoured plug check valve.

16. The device of claim 12 further characterized by having a centering ring disposed between said sleeve and said casing adjacent said shoe.

17. The device of claim 12 further characterized by having a lifting bail attached to said cage at the end thereof opposite the end connected to said relief valve, and means fastened to said bail adapted for magnetically securing same to a carrier vessel.

18. The device of claim 17 further characterized by having core catching means connected at the end of said rigid elongated hollow sleeve at the end thereof adjacent said tapered shoe.

19. A free drop submarine earth core comprising in combination, a float chamber, a rigid sleeve connected to said float chamber, a core cutting means slideably surrounding said sleeve, a weight attached to said core cutting means, a pair of arms extending from said core cutting means, and latch means adapted for being opened at a predetermined time by electrochemical action of the ambient sea water within which it is submerged interconnecting said float chamber and said arms for respectively securing and releasing same before and after forma-

tion of a submarine earth core by the aforesaid core cutting means.

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