March 25, 1969 A. M. ROSFELDER 3,434,551

BUOYANT CORING APPARATUS

Filed June 26, 1967

FIG. 1.

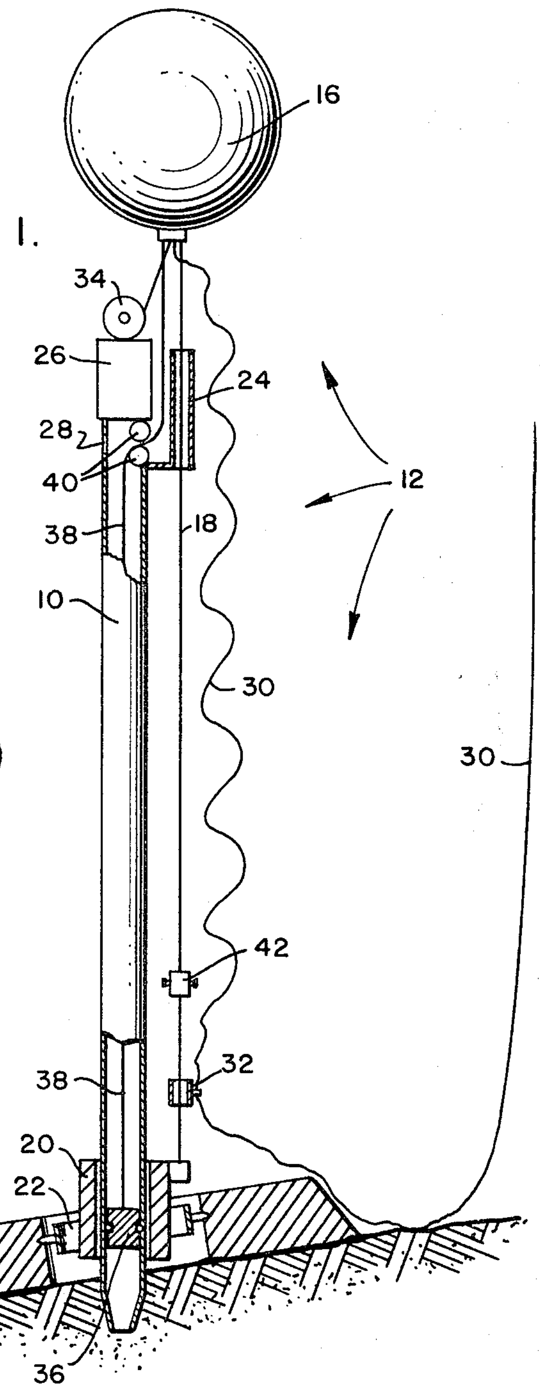
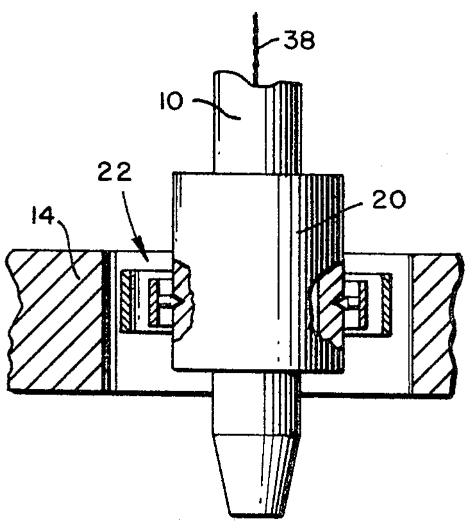


FIG. 2.



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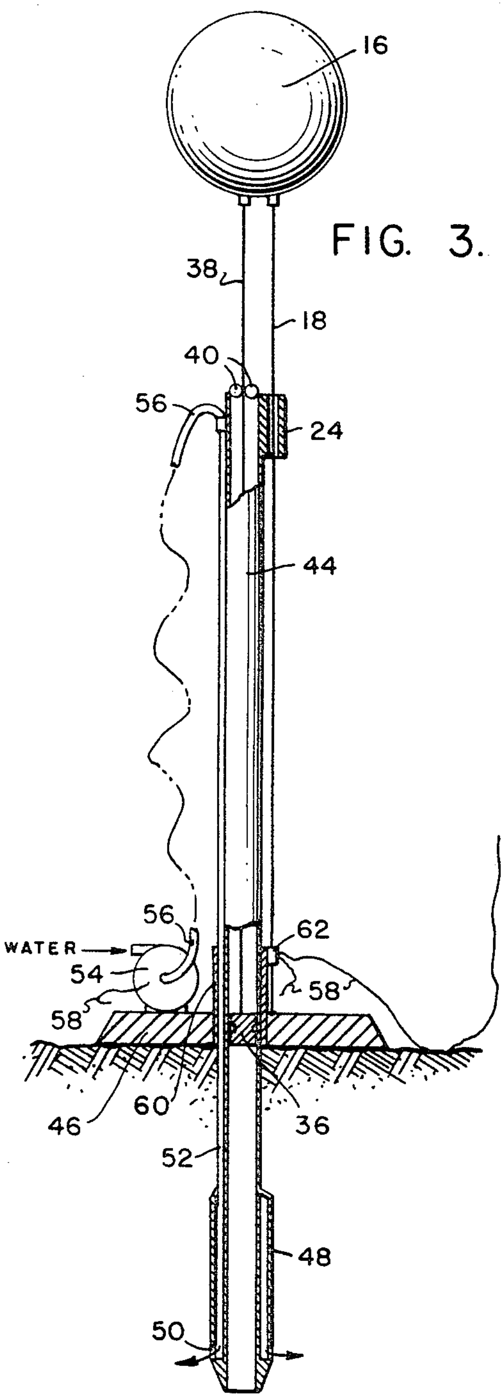

FIG. 3.

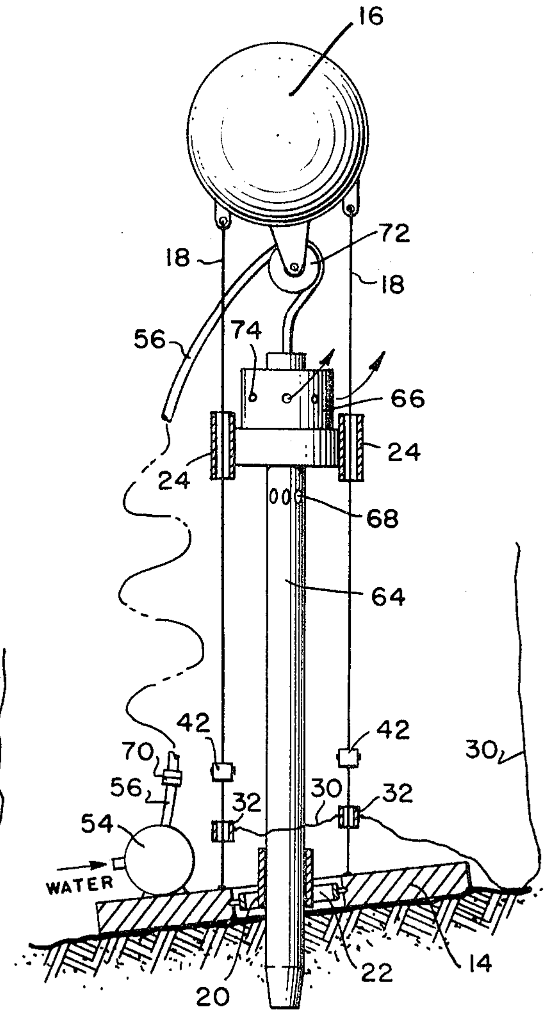

FIG. 4.

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U.S. Cl. 175—6 10 Claims

ABSTRACT OF THE DISCLOSURE

The description discloses a buoyant rig for supporting coring operations of an underwater coring barrel. The buoyant rig includes a float and a bottom weighted stand which are interconnected by at least one guide wire. The core barrel slidably extends through the weighted stand and is positioned parallel to the guide wire and is slidable therealong by a guide means. When the core barrel is powered the barrel will be guided along the guide wire as it penetrates the ocean bottom. A gimbal connection between the core barrel and the stand for uneven ocean bottoms and the guide wire may be separated from the stand after a sample is obtained so that the float will raise the core barrel and the remaining rigging apparatus to the ocean surface.

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.

In deep sea coring operations it is highly impractical to attempt drilling from a surface ship because of the weight of the long driving elements which would be required between the ship and the coring barrel. One of the easiest methods of obtaining a deep sea core sample is to utilize a free corer such as that illustrated in the patent to Charlton et al., U.S. Patent No. 3,295,616, or that illustrated in a patent to Moore, U.S. Patent No. 3,078,931. While such free fall coring devices are simple to operate, the length of core sample obtainable therefrom is limited since the driving force for a such a corer is entirely dependent upon the submerged weight of the device.

In order to obtain long core samples from a deep sea environment it is necessary that the coring barrel be powered by a submerged power means and that some sort of rigging be set up on the ocean floor to support the core barrel during the driving operation. Conventional rigging has taken the form of tripods, quadripods, or other kinds of rigid frames. This type of rigging has been very difficult to handle aboard an oceanographic vessel and also it is very difficult to set up firmly on an uneven ocean bottom. In view of the increasing demand for deep sea core samples, there now exists an urgent need for a simpler rigging apparatus which can be easily handled.

The present invention provides a rigging apparatus which is not perplexed with the problems of material handling and set up on the ocean bottom. This has been accomplished essentially by a float and a bottom weight stand which are interconnected by one or two guide wires. The core barrel slidably extends through the weight stand and upon penetration into the ocean bottom the guide wire acts as a rail in guiding the downward movement. Such an arrangement avoids the complexities of conventional rigid framed rigs and is much simpler to handle from an oceanographic vessel. Of considerable importance is the ease with which such an arrangement can be set up on the ocean bottom. The weight stand provides the lowest possible center of gravity of the overall apparatus and will quickly assume a steadfast position on the ocean bottom.

On uneven bottoms the present invention may be easily adapted to obtain vertical core samples. This may be ac-

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complished by a gimbal connection between the coring barrel and the weighted stand. The coring operation may also be facilitated by a piston which is slidably disposed within the coring barrel and is attached by a wire to the float. This piston will cause a suction which facilitates entry of the bottom sediment into the coring barrel. The present invention also lends itself to a quick and easy retrieval of the coring barrel after a bottom sample has been obtained. This may be accomplished by a means for separating the guide wire from the weight stand whereupon the float will withdraw the coring barrel from the ocean bottom and raise the apparatus less the weight stand to the ocean surface.

An object of the present invention is to overcome all of the aforementioned problems of the prior art.

Another object is to provide a submerged power driven coring barrel and a simple and easy to use rigging apparatus for positioning the coring barrel on the ocean bottom.

A further object is to provide an underwater powered coring barrel and bottom rigging apparatus therefor which, after the core sample has been obtained, can be raised to the ocean surface without using a raising cable.

Still another object is to provide an underwater powered coring barrel and a bottom rigging apparatus which, upon coming to rest upon an uneven bottom, will vertically position and guide the coring barrel during its penetration of the ocean bottom.

Other objects, advantages and novel features of the invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings wherein:

FIG. 1 is a schematic side view, partly in cross section, showing a coring barrel positioned by a rigging apparatus on the ocean bottom;

FIG. 2 is an enlarged detail illustration of the connection of the coring barrel to the weighted stand;

FIG. 3 is a schematic side illustration, partly in cross section, showing another embodiment of my invention wherein a coring barrel is supported on the ocean bottom by a buoyant rigging apparatus; and

FIG. 4 is a schematic side view, partly in cross section, illustrating still another embodiment of my invention.

Referring now to the drawings wherein like reference numerals designate like or similar parts throughout the several views, there is shown in FIG. 1 a coring barrel **10** which is supported in a coring position on the ocean floor by a buoyant rigging apparatus which is generally designated at **12**. The rigging apparatus **12** includes a weighted bottom stand **14** and a float **16** which are interconnected by a guide wire **18**. The guide wire **18** may be connected directly to the weighted stand **14** or as shown may be connected to other elements which are in turn connected to the weighted stand. Because of the action of the float **16** the guide wire **18** will assume a vertical positoin which is desirable for coring operations to be described hereinafter.

The coring barrel **10** slidably extends through the weighted stand **14** and as shown this may be accomplished by a support sleeve **20** which slidably receives the coring barrel and is connected by suitable means to the weighted stand **14**. For flat bottom coring the support sleeve **20** may be rigidly connected in an upright position to the weighted stand **14**, however on an uneven bottom such an arrangement will result in a non-vertical core. To obtain vertical core samples from an uneven ocean bottom I have found it desirable to connect the support sleeve **20** to the weighted stand **14** by a gimbal arrangement **22** (see FIG. 2). The support sleeve **20** and the weighted stand **14** may form inner and outer rings respectively of the gimbals with a middle ring alternately pinned thereto at 90° intervals. Accordingly, when the weighted stand is brought to rest on the ocean bottom the coring barrel **10** will have freedom of movement in any direction thereabove.

It is highly desirable during coring operations to obtain a vertical core sample since all coring data is documented and correlated on a vertical depth basis. The obtaining of a vertical core sample from an inclined ocean bottom is quite difficult with conventional corers. I have enabled vertical core sampling by utilizing the vertical extension of the guide wire **18**. This may be accomplished by a means which slidably interconnects the core barrel **10** to the guide wire **18** for positioning the barrel substantially parallel to the guide wire and guiding penetration of the barrel along the vertical extension of the wire. This positioning and guidance may be simply a guide tube **24** which receives the guide wire **18** and may be rigidly connected to the side of the core barrel **10** by any suitable means such as welding.

The particular coring barrel **10** shown in FIG. 1 is powered by a vibrohammer **26** which may be rigidly connected at the top of the coring barrel **10**, the coring barrel **10** having a port **28** immediately below the vibrohammer for discharging water in the coring barrel upon penetration. The vibrohammer **26** may be hydraulically operated by a pump (not shown) mounted on the weighted stand **14**, or alternatively may be electrically powered by an electric cable **30** which extends from a surface ship (not shown). The electric cable **30** extends first to a ring **32** which is slidable along the guide wire **18**, thence to the bottom of the float **16**, and then to a spring actuated reel **34** which may be mounted at the top of the vibrohammer **26**. From the reel the electric cable **30** is electrically connected to the vibrohammer and is unreeled as the coring barrel **10** penetrates the ocean bottom.

In order to facilitate penetration of the coring barrel **10** into the ocean bottom I have found it desirable to slidably mount a piston **36** within the coring barrel **10** and connect the piston to the float **16** by a wire **38** which extends longitudinally along the interior of the coring barrel **10**. Accordingly, when the coring barrel is operated to penetrate the ocean bottom the piston **36** will remain stationary on the ocean bottom and provide a suction force within the coring barrel immediately above the core sample. Upon withdrawal of the coring barrel **10** from the ocean bottom there will be a tendency for the piston **36** to be drawn downwardly within the coring barrel because of suction in the coring hole immediately below the coring head of the barrel. This action would result in a loss of the core sample and is highly undesirable. Loss of the core sample may be prevented by a locking means **40** which is connected at the top of the coring barrel **10** and receives the wire **38** for locking the piston wire to prevent downward movement of the piston **36** within the coring barrel. The locking means **40** may be actuated by the vibrohammer **26** and unlocked. During raising and lowering of the rig the clamp means **40** will lock the wire **38** in place since during these periods the vibrohammer is inoperative.

In the embodiment shown in FIG. 1 the float **16** is utilized for the purpose of raising the coring barrel **10** to the surface of the water after a sample has been obtained. This has been accomplished by separating the guide wire **18** from the weighted stand **14** and making the float **16** sufficiently buoyant to withdraw the coring barrel **10** from the ocean bottom and lift the coring barrel, its sample, and the rigging except for the weighted stand **14** to the surface of the water. The guide wire **18** may be separated from the weighted stand **14** by an annular explosive bolt (not shown) which is disposed within the slidable ring **32**. The explosive bolt will be actuated by an initiator (not shown) which is connected to and is actuated by a small electric wire (not shown) which extends along the cable **30**. In order to perform the raising operation after separation of the guide wire **18**, the clamp means **40** locks the piston wire **38**. As a supplementary raising means, a raising head **42** may be rigidly connected at a desired location on the guide wire **18** above the sliding ring **32**. This raising head **42** serves as a stop for the downward penetration of the coring barrel **10** when the head **42** comes into engagement with the bottom of the guide tube **24**. When core penetration has ceased due to this stopping action, the electrical load on the vibrohammer **26** will be lessened which can be detected at the surface ship as an indication that the coring barrel has penetrated the ocean bottom to a desired depth. Upon such an indication the explosive bolt within the ring **32** can be actuated to cut the guide wire below the raising head **42**. The raising head **42** may be adjustable along the guide wire **18** so as to select the desired depth of penetration of the coring barrel **10**.

The float **16** may be simply a hollow spherical glass float. The weighted stand **14** may be constructed of any suitable heavy material such as concrete and should be heavy enough to provide a negative buoyancy for the entire apparatus when it is connected thereto. The weighted stand **14** preferably has a large lateral bottom area so as to ensure secure emplacement on the ocean bottom.

In the operation of the FIG. 1 embodiment the coring barrel **10** and the rigging apparatus **12** are placed in the water from a surface ship. The weighted stand **14** causes the entire assembly to descend in an upright position and come to rest on the ocean bottom. If the ocean bottom is uneven and the weighted stand **14** assumes a slanted position, as shown in FIG. 1, the float **16**, by action of the guide wire **18**, pivots the coring barrel **10** within the gimbals **22** to cause the coring barrel to assume an upright position. The surface ship then feeds electrical power to the vibrohammer **26** which causes the coring barrel **10** to penetrate the ocean bottom. The coring barrel **10** is guided in a downward vertical direction by action of the guide tube **24** about the guide wire **18**. When the bottom of the guide wire **24** engages the top of the raising head **42** penetration ceases which will lessen the electrical load on the vibrohammer **26**. When this change in electrical load is detected at the surface ship the explosive bolt charge within the sliding ring **32** is actuated to cut the guide wire **18** below the raising head **42**. This then releases the float **16** and the coring barrel **10** from the weighted stand **14**. The upward force of the float **16** is applied to the coring barrel through the locked clamp means **40** and/or to the bottom of the guide tube **24** by the raising head **42** to cause withdrawal of the coring barrel **10** from the coring hole and the support sleeve **20** and raise the entire assembly less the weighted stand to the surface of the water. The assembly will then float on the surface of the water until retrieved by the surface ship.

In FIG. 3 there is shown another embodiment of the invention which is similar to the FIG. 1 embodiment except that the FIG. 3 embodiment shows the use of a hydraulic jet type coring barrel **44** which is not gimbal mounted in a weighted stand **46**. The jetting action of the coring barrel **44** is enabled by a short tube **48** which is mounted about the coring barrel just above the cutting head. The short tube **48** is sealed at its top and bottom to the coring barrel with the exception of a series of small ports **50** at its bottom end and a rigid hydraulic duct **52** which opens into the top of the tube **48** and extends longitudinally upward along the side of the coring barrel. A hydraulic pump **54** is connected to the top of the duct **52** by a hose **56** for interjecting water through the ports **50**. The jetting action of the water through the ports **50** cuts the bottom sediment to allow downward penetration of the coring barrel **44**. The pump **54** may be electrically powered by a cable **58** from the surface ship.

The coring barrel **44** may extend slidably through the weighted stand **46** by a support sleeve **60**. The exterior of the sleeve **60** may be rigidly fixed to the weighted stand and the coring barrel **44** will be slidable therethrough. The support sleeve **60** will be provided with an annular depression (not shown) for slidably receiving the duct **52** along the side of the coring barrel.

A slip ring **62** (not containing an explosive bolt) is used for raising and lowering the whole assembly by engagement with the bottom of guide tube **24**. The clamp means **40** is a one way lock of the piston wire **38** allowing the piston **36** to only slide in an up direction within the coring barrel **44**. This clamp means may simply comprise a pair of eccentric clamps.

Still another embodiment of the present invention is shown in FIG. 4. The FIG. 4 embodiment differs from the previously described embodiments in that two guide wires **18** are used for interconnecting the float **16** to the weighted stand **14**. A coring barrel **64** is slidably mounted through the weighted stand **14** by the support sleeve **20** and gimbal means **22**. The coring barrel **64** is disposed between the guide wires **18** and at its top it is provided with a rotary head **66** for rotatably driving the coring barrel **64** into the ocean bottom. Upon such driving action ports **68** within the top of the coring barrel **64** discharge water trapped therein.

A pair of guide tubes **24**, each receiving a respective guide wire **18**, are mounted at opposite sides to the rotary head **66**. The rotary head **66** may be operated hydraulically by a pump **54** which is connected to the head by a hose **56**. If expendable, the pump **54** may be mounted on the stand **14** and if not it may be mounted on top of the rotary head **66**. The hose **56** is provided with a quick pull disconnect **70** and may be fed into the top of the head by a pulley **72** mounted at the bottom of the float **16**.

Since operation of the rotary head **66** will tend to apply a twisting action to the guide wires **18**, oppositely directed ports **74** may be provided within the head for providing a jetting action to counteract the torque of the rotary head.

In a manner similar to the FIG. 1 embodiment, each of the guide wires **18** of the FIG. 4 embodiment is provided with a respective lifting head **42** and an explosive bolt ring **32** for cutting the guide wire **18** therebelow.

The operation of the FIG. 4 embodiment is similar to the FIG. 1 embodiment. When the bottom of the guide tubes **24** come to rest on the lifting heads **42** the load on the rotary head **66** is lessened and this indication tells surface personnel to actuate the explosive rings **32**. The explosive rings **32** cut the guide wires **18** and the float **16** lifts the whole assembly with the exception of the weighted stand **14** and the pump **54** to the water surface. The hose **56** will be disconnected by the quick disconnect **70**.

It is now readily apparent that the present invention provides a deep sea coring apparatus which is considerably more efficient to handle than conventional corers.

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 invention may be practiced otherwise than as specifically described.

I claim:

1. In combination with an underwater powered core barrel, a buoyant rig comprising:

a weighted bottom stand adapted to rest on the ocean bottom, said core barrel extending slidably therethrough;

a float;

at least one guide wire connecting the float to the stand so that the float will extend the wire substantially vertically upright from the stand; and

means slidably interconnecting the core barrel to the guide wire for positioning the barrel substantially parallel to the guide wire and guiding penetration of the barrel along the vertical extension of the wire.

2. The combination as claimed in claim **1** including: means for separating the guide wire from said stand.

3. The combination as claimed in claim **2** wherein:

said float is sufficiently buoyant to lift the rig and barrel with a sample after separation of the guide wire.

4. The combination as claimed in claim **1** wherein:

gimbal means slidably interconnects the core barrel to said stand.

5. A combination as claimed in claim **1** including:

a second guide wire connecting the float to the stand so that the float will extend the second wire substantially vertically upright from the stand;

a second means slidably interconnecting the core barrel to the second guide wire and cooperating with the first mentioned positioning means for positioning the barrel substantially parallel to the guide wires and guiding penetration of the barrel along the vertical extension of the wires.

6. A combination as claimed in claim **1** including:

a piston slidably mounted within the core barrel and adapted to remain stationary on the ocean bottom and provide a suction within said barrel as the barrel penetrates the ocean bottom;

a second wire, the second wire extending along the interior of the barrel and interconnecting the float and said piston; and

one way locking means connected to the core barrel for locking the piston wire to prevent downward movement of the piston within the core barrel.

7. A combination as claimed in claim **6** wherein:

gimbal means slidably interconnects the core barrel to said stand.

8. A combination as claimed in claim **7** including:

means for separating the guide wire from said stand.

9. A combination as claimed in claim **8** wherein:

said float is sufficiently buoyant to lift the rig and barrel with a sample after separation of the guide wire.

10. A combination as claimed in claim **9** including:

a lowering cable; and

means slidably connecting the lowering cable to the guide wire.

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U.S. Cl. X.R.

175—245, 248