Nov. 26, 1968 A. M. ROSFELDER 3,412,814

HYDROSTATIC CORER

Filed June 28, 1967 2 Sheets-Sheet 1

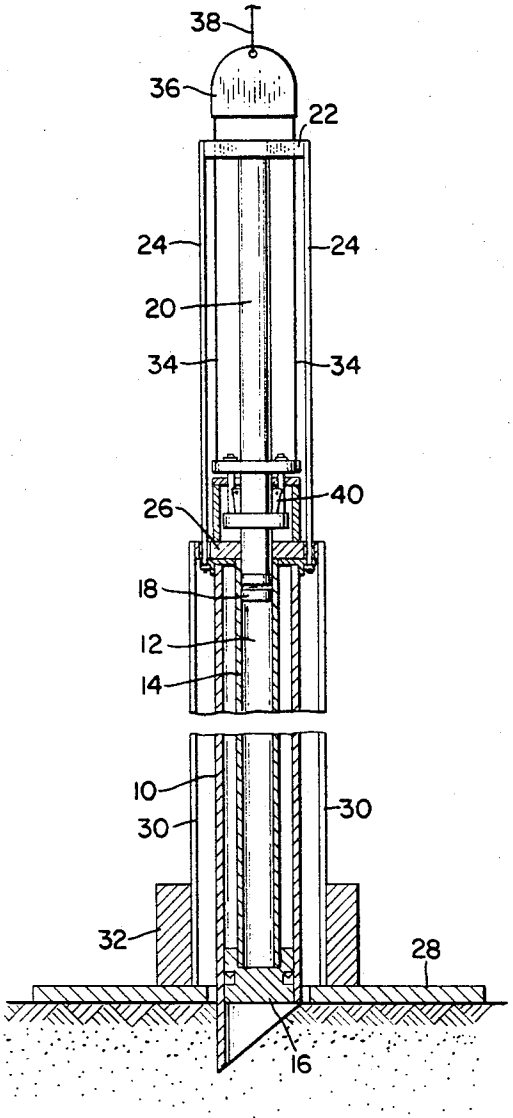


Fig. 1

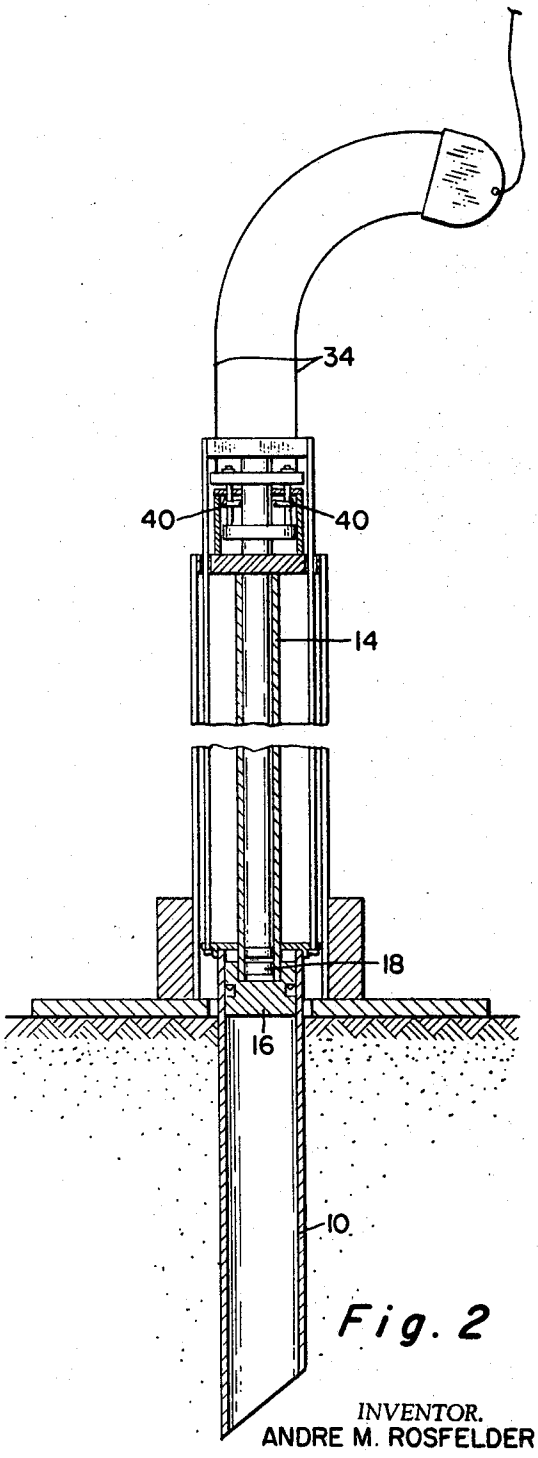


Fig. 2

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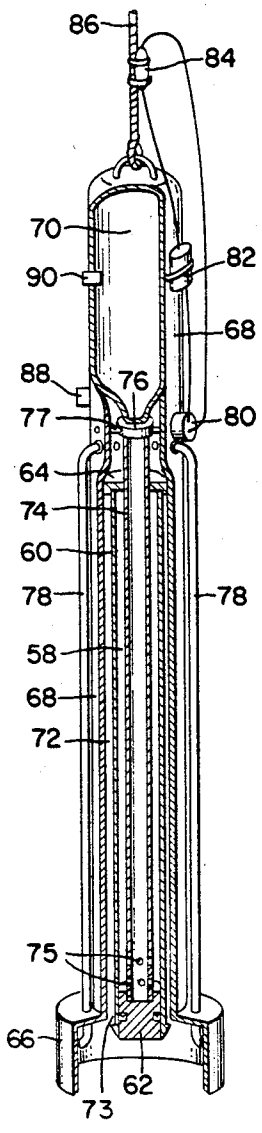


Fig. 4

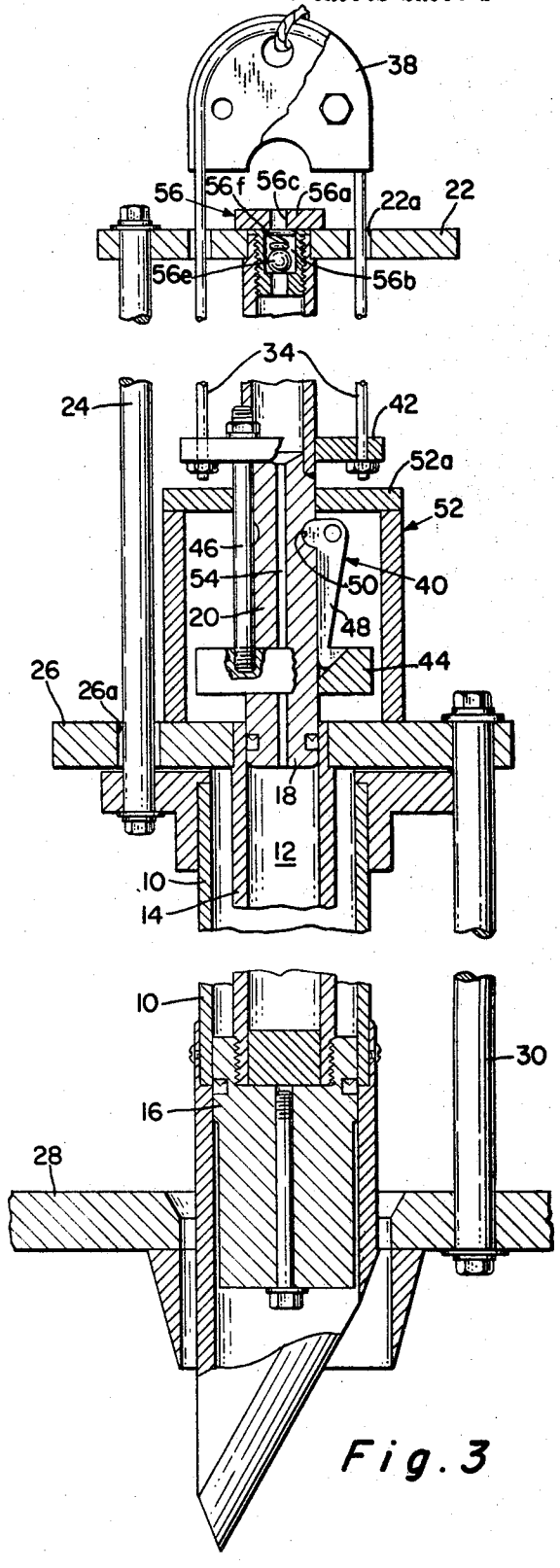


Fig. 3

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3,412,814

HYDROSTATIC CORER

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10 Claims. (Cl. 175—6)

ABSTRACT OF THE DISCLOSURE

The present invention relates to a hydrostatic corer which may be used for obtaining core samples from the bottom of a body of water such as the ocean. The corer includes a coring barrel which at a selected time is powered by hydrostatic pressure within the body of water. The hydrostatic motive force is obtained by providing a vacuum chamber within the coring barrel, this vacuum chamber normally being at atmospheric pressure. A pair of pistons seal the top and bottom of the vacuum chamber, the top piston being adapted to drive the coring barrel into the water bottom and the bottom piston being adapted to remain stationary on the water bottom and undergoing piston action within the coring barrel during the barrel's penetration. Stability of the hydrostatic corer is accomplished by a skirt at the bottom of the corer which is subjected to a vacuum to draw it tight against the water bottom prior to penetration of the coring barrel.

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 taking of core samples from the bottom of the ocean serves many purposes, such as enabling strength determinations prior to erection of bottom located structures; enabling reflective characteristics for predicting sonar responses; and providing indication of the presence of minerals for mining purposes. Man's interest in these fields has been steadily increasing, thus requiring a corresponding increase in the demand for ocean bottom data. Extensive exploration of the continental shelves has been taken, thus requiring improvements in the coring art, which art has been dormant for a number of years.

An important step forward in the coring act was the use of hydrostatic pressure as the motive force for driving a coring barrel into the ocean bottom. The basic concept on this approach is attributable to Varney and Redwine who disclosed their concept in U.S. Patent No. 2,176,477. Several coring devices have been patterned after the Varney and Redwine concept and have been successful for their intended purposes. These coring devices have been somewhat cumbersome, however, and have required heavy material handling equipment for their implacement on the ocean bottom. The demand now is for a hydrostatic corer which is more compact so that more core samples can be obtained for the same amount of material handling time.

The present invention has accomplished this purpose by providing a vacuum chamber within the coring barrel itself. Heretofore, the volume within the coring barrel has been wasted space and has resulted in a corer which is larger than it need be for accomplishing the same purposes as the present invention. In one embodiment of the invention a vacuum tube is disposed within the coring barrel for providing the vacuum chamber and in another embodiment of the invention the coring barrel itself provides the vacuum chamber. When the hydrostatic corer comes to rest on the ocean bottom the vacuum chamber is subjected to atmospheric pressure or less while the area outside the vacuum chamber is subjected to hydrostatic pressure. A pair of pistons may be employed for utilizing this potential power to drive the coring barrel into the ocean bottom.

Another feature of the present invention, as illustrated in one of its embodiments, has been the provision of stability of the hydrostatic corer while the coring barrel is undergoing penetration. This has been accomplished by providing the bottom of the hydrostatic corer with a skirt along with means for evacuating the bottom of the skirt so as to retain the hydrostatic corer tightly against the bottom during the penetration period.

An object of the present invention is to provide a more compact hydrostatic corer.

Another object is to provide a hydrostatic corer which is easier to handle both prior to and after disposition in a body of water.

A further object is to provide a compact hydrostatic corer which has increased stability on the ocean bottom during penertation of the coring barrel.

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 side view of one embodiment of the invention shown partially in longitudinal cross section and prior to penetration of the coring barrel into the ocean bottom;

FIG. 2 is the same view as shown in FIG. 1 except the hydrostatic corer has been actuated and the coring barrel has penetrated the ocean bottom;

FIG. 3 is a detailed longitudinal cross sectional view of the embodiment shown in FIGS. 1 and 2; and

FIG. 4 is an isometric view of another embodiment of the invention shown partially in cross section.

Referring now to the drawings wherein like reference numerals designate like or similar parts throughout the several views, there is shown in FIGS. 1 through 3 one embodiment of the invention. There is shown a coring barrel **10** and means for providing a vacuum chamber **12** which is located within and extends along the coring barrel. In this particular embodiment the means providing the vacuum chamber includes a vacuum tube **14** and a pair of pistons **16** and **18**.

The vacuum tube **14** is located within the coring barrel **10** and may be aligned concentrically therewith. The piston **16** is connected to the bottom of the vacuum tube **14** so as to seal the bottom of the vacuum chamber **12** and is mounted within the coring barrel **10** for piston action along the inner wall thereof. The piston **16** is adapted to remain substantially stationary on the ocean bottom as the coring barrel **10** penetrates the ocean bottom and will accordingly hereinafter be referred to as the stationary piston. The piston **18** is fixedly mounted at the top of the coring barrel **10** by means which will be explained hereinafter and is mounted within the vacuum tube **14** for piston action therein thereby sealing the top of the vacuum chamber **12**. This piston is connected to the coring barrel **10** and is in communication with the outside ocean pressure environment so that upon its release the differential in pressure between the ocean environment and the vacuum chamber the coring barrel **10** will be driven into the ocean bottom. Because of its driving action the piston **18** will hereinafter be referred to as the driving piston.

The means mounted the driving piston **18** at the top of the coring barrel **10** may include several components. First, a piston rod **20** may be connected to the top of the driving piston **18** and may extend upwardly therefrom. A driving head **22** may be connected to the top of the piston rod **20** and at the outer extremeties of the driving head there may be elongated means such as rods **24** which rigidly connect the driving head **22** to the top of the coring barrel **10**. Accordingly, the top of the driving head **22** is exposed to the outside hydrostatic pressure environment while the bottom side of the driving piston **18** will be subjected to the low pressure within the vacuum chamber **12**.

This potential power is then usable for driving the coring barrel **10** into the bottom of the ocean.

It is desirable that the hydrostatic corer be provided with a support means other than the stationary piston **16** when the core comes to rest on the bottom of the ocean. This support means may include a transverse element **26** which is connected at the top of the vacuum tube **14**. A skirt **28** may be provided at the bottom of the coring barrel **10** and the skirt **28** may be rigidly connected to the transverse element **26** by a series of rods or slender tubes **30**. A wide diameter skirt **28** provides lateral stability for the hydrostatic corer when it comes to rest upon the ocean bottom. As shown in the figures the skirt **28** may be substantially co-planar with the stationary piston **16**. Weights **32** may be disposed on the top of the skirt **28** for preventing recoil of the hydrostatic corer upon penetration of the coring barrel **10** into the ocean bottom.

As shown in FIGS. 1 through 3, the hydrostatic corer may be lowered into the ocean by a cable **34** which is laced through a bail **36**, the bail **36** in turn being connected to a lowering cable **38** from a surface vehicle (not shown). The bottom ends of the cable **34** may be connected to the piston rod **20** through a latch means **40** which will be described in detail in the following paragraph.

In FIG. 1 the driving piston **18** is shown in its upper retained position and in FIG. 2 the driving piston **18** has been released to cause the differential in pressure to drive the coring barrel **10** into the ocean bottom. This action is accomplished by a means **40** which retains the driving piston **18** at the top of the vacuum tube **14** and which releases the driving piston when penetration of the coring barrel is desired. The particular latch means, which is shown in detail in FIG. 3, may be held in its retaining position when the cable **34** is undergoing strain upon lowering the corer and may be released when this cable is slackened. As shown in FIG. 3, the latch means **40** may include a top annular plate **42** and a bottom annular plate **44** which are interconnected by a series of rods **46** (one being shown in the figure) and which both are slidable along the piston rod **20**. Interposed between the plates **42** and **44** may be a series of latches **48** (one of which is shown in the figure) which interlock with an annular groove **50** in the piston rod when the plates **42** and **44** are in the up position as shown in FIG. 3 and pivot to release the piston rod **20** when the bottom plate **44** is lowered to free the bottom ends of the latches. The latches **48** may be pivoted by any suitable means such as the small frame assembly **52** which may be rigidly connected to the transverse support element **26**. The top of this frame assembly may have an annular plate **52***a* for guiding longitudinal movement of the piston rod **20**. The bottom ends of the cable **34** are connected to the top annular plate **42** so that upon lowering of the corer the latches **48** hold the piston rod **20** in a retained position and when the cable **34** is slackened the bottom annular plate **44** is lowered to release the latches **48** and the piston rod **20**. This action releases the driving piston.

After the hydrostatic corer has obtained a bottom sample and has commenced its ascent toward the ocean surface it is to be noted that the small space between the driving piston **18** and the stationary piston **16**, as seen in FIG. 2, will tend to expand thereby causing the driving piston to withdraw from the vacuum tube **14** and push the bottom sample from the coring barrel **10**. Accordingly, it is necessary that a means be provided for relieving the hydrostatic pressure within the small space between the pistons during ascent of the hydrostatic corer. Referring to FIG. 3, this has been accomplished by providing the driving piston **18** and the piston rod **20** with a central bore **54** which communicates the vacuum chamber **12** with the outside pressure environment. At the top of the piston rod **20** there is provided a one-way pressure relief valve **56** which will allow a higher pressure within the vacuum chamber to be relieved therefrom but not vice versa. The relief valve **56** may include a hollow plug **56***a* which is threaded into the top of the piston rod **20**. The plug **56***a* has a central chamber **56***b* which communicates with the outside pressure environment through opening **56***c* and communicates with the vacuum chamber **12** through a bottom opening **56***d*. Disposed within the central chamber **56***b* is a ball **56***e* which is forced downwardly to seal with the opening **56***d* by a diverging compression spring **56***f* which is located between the top of the ball **56***e* and the top of the central chamber **56***b*. Accordingly, the outside hydrostatic pressure is not imposed upon the vacuum chamber **12** but when the pressure within the vacuum chamber becomes sufficiently greater than the outside pressure the ball **56***e* will move upwardly to relieve this pressure.

The details of the connections of the various components of the first embodiment have not been described in detail since they do not form a part of this invention and are very clearly illustrated in FIG. 3. While the driving head **22** and the transverse support element **26** are shown as plates it is to be understood that they may take different forms such as transverse elongated members. When plates are used it will be necessary to provide the driving head **22** with openings **22***a* for the passage of cable **34**, and the transverse support element **26** with openings **26***a* for the passage of the longitudinal rods or tubes **24**. The bottom edge of the cutting head of the coring barrel **10** is shown with a slanted configuration which has proven to facilitate penetration of the coring barrel into the ocean bottom. The operation of the first embodiment shown in FIGS. 1 through 3 will be described in detail after the following description of another embodiment shown in FIG. 4.

The embodiment shown in FIG. 4 is similar to the first described embodiment in that a vacuum chamber **58** is provided within a coring barrel **60**. One essential difference is that the coring barrel **60** itself forms the vacuum chamber **58** rather than a vacuum tube **14** as used in the first embodiment. Like the FIG. 1 embodiment, a stationary piston **62** is mounted for piston action within the coring barrel **60** and seals the bottom of the vacuum chamber **58** and in the same manner a driving piston **64** seals the top of the vacuum chamber **58**. The difference between the two embodiments is that the driving piston **64** is connected directly to the top of the coring barrel **60**. Similar to the FIG. 1 embodiment, a skirt **66** is provided and is located substantially coplanar with the stationary piston **62**. The remaining structure of the FIG. 4 embodiment varies considerably from the FIG. 1 embodiment. Connected to the top of the skirt **66** is an outer tube **68** which extends upwardly and concentrically about the coring barrel **60** beyond the top of the coring barrel. An upper portion of this outer tube forms an atmospheric chamber **70** and a lower portion of the outer tube forms a suction chamber **72**. The suction chamber **72** is open to hydrostatic pressure at the bottom by a space **73** between the skirt **66** and the core barrel **60**. This space may be of such a size to dampen the rate of barrel penetration by the resistance to water outflow from chamber **72**.

The driving piston **64** is mounted for piston action within the outer tube **68** and is adapted to slide along a stationary hollow piston rod **74**. The hollow piston rod **74** is open at its bottom into the vacuum chamber **58** and opens at its top into the atmospheric chamber **70** or the outside ocean environment through a three way valve assembly **76**. The valve assembly opens at its top into chamber **58** and opens into the ocean environment through a tube **77** which may extend through the wall of the outer tube **68**.

It can be visualized as the driving piston **64** undergoes downward movement within the outer tube **68** that the suction chamber **72** between the driving piston and the

atmospheric chamber **70** will be subjected to a vacuum. This vacuum has been utilized in the present invention for evacuating the bottom of the skirt **66** and retaining the corer tightly against the ocean bottom to prevent recoil as the coring barrel **60** penetrates the ocean bottom. This vacuum is subjected within the skirt **66** by a series of conduits **78** which extend between the upper portion of the suction chamber **72** and the interior of the skirt **66**.

The chamber **70** will normally be at atmospheric pressure which is obtained while the corer is at the surface of the water and prior to its descent therein. During descent the vacuum chamber **58** is closed to chamber **70** and is open to hydrostatic pressure by the valve **76**. After the corer comes to rest on the ocean bottom the lower pressure within chamber **70** is introduced into the vacuum chamber **58** by the actuation of the valve **76**. This valve actuation may be accomplished by any suitable means such as a valve controller **80** which is shown mounted on the exterior of the outer tube **68**. The valve controller **80** may be powered by a battery pack **82** which may be mounted to the exterior of the outer tube **68**. The controller **80** may be energized by a mercury switch **84** which is mounted to a lowering cable **86** and which will close when the cable **86** is slackened to form a catenary. Such a switch is well known in the art.

In order to relieve the vacuum in the suction chamber **72** above the driving piston **64** after the skirt **66** has been sufficiently drawn against the ocean bottom, a relief valve **88** may be provided in the wall of the outer tube **68**. This relief valve may be similar to the relief valve **56** of the first embodiment except it would normally have a stronger compression spring. In order to relieve the higher pressure within the vacuum chamber **58** after actuation of the driving piston **64** and ascent of the corer, a relief valve **90** may be provided in the upper portion of the outer tube **68** within the atmospheric chamber **70**. This relief valve **90** may also be similar to the relief valve **56** described for the first embodiment.

In the operation of the embodiment shown in FIGS. **1** through 3 the corer is placed in the ocean by a surface vehicle (not shown) with the driving piston **18** in the upward position as shown in FIG. 1. In this position the vacuum chamber **12** is under atmospheric pressure. The corer is then brought to rest on the ocean bottom at a desired location, as shown in FIG. 1, and the cable **38** is slackened so as to operate the latch means **40** and release the piston rod **20**.

This release frees the driving piston **18** so that hydrostatic pressure forces the driving piston **18** downwardly within the vacuum tube **14**. This downward movement of the driving piston **18** subjects the coring barrel to a downward force through the driving head **22** causing the coring barrel **10** to penetrate the ocean bottom, as shown in FIG. 2. A strain may then be taken on the cable **38** to withdraw the coring barrel from the ocean bottom and upon ascent the relief valve **56**, as shown in FIG. 3, will relieve the now high pressure between the two pistons.

In the operation of the embodiment shown in FIG. 4 the corer is placed in the water with the chamber **70** at atmospheric pressure. At this time the valve **76** is in a first position which opens the vacuum chamber **58** to the outside sea environment. When the corer comes to rest at a desired location on the ocean bottom the cable **86** is slackened and the switch **84** will actuate the controller **80** and cause the valve **76** to close the vacuum chamber **58** to the seal environment and open such chamber to the atmospheric chamber **70**. The bottom of the piston **64** within the vacuum chamber **58** is now subjected to atmospheric pressure and the top of the piston is subjected to hydrostatic pressure through the conduits **78**. This differential in pressure between the top and bottom of the driving piston forces the piston downwardly, thus driving the coring barrel **60** into the ocean bottom. The downward movement of the driving piston **64** causes a vacuum in the suction chamber **72** just above the driving piston, which vacuum is transmitted via the conduits **78** to the skirt **66** so as to draw the skirt tightly against the ocean bottom. This latter action prevents recoil of the corer while the coring barrel **60** is penetrating the ocean bottom. If this vacuum becomes too great the relief valve **88** will come into operation. After the core sample has been obtained and during ascent of the corer the now hydrostatic pressure within the vacuum chamber **58** between the two pistons is relieved by the relief valve **90**.

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. A hydrostatic corer comprising:
a coring barrel;
means providing a vacuum chamber which is within and extends along said coring barrel, said means including:
a stationary piston means sealing the bottom of the vacuum chamber and movably mounted within the coring barrel for piston action along the inner wall thereof, said piston means being adapted to remain substantially stationary on the ocean bottom as the coring barrel penetrates the ocean bottom; and
a driving piston means sealing the top of the vacuum chamber and communicable with the ocean pressure environment and fixedly mounted at the top of the coring barrel for driving the coring barrel into the ocean bottom when a differential in pressure exists between the ocean environment and said vacuum chamber;
means for retaining the driving piston at the top of the vacuum chamber and releasing the driving piston when penetration of the coring barrel into the ocean bottom is desired.

2. A hydrostatic corer as claimed in claim **1** including:
a skirt; and
means mounting the skirt to the stationary piston means with the skirt substantially co-planar therewith.

3. A hydrostatic corer as claimed in claim **2** including:
means for evacuating the bottom of the skirt so that the skirt will be drawn tight against the ocean bottom.

4. A hydrostatic corer as claimed in claim **1** including:
means for relieving pressure within said vacuum chamber upon ascent of the hydrostatic corer, the pressure relieving means comprising:
a hollow piston rod connected to the top of the driving piston and extending upwardly therefrom; and
a relief valve connected at the top of said piston rod.

5. A hydrostatic corer as claimed in claim **1** wherein:
the means providing the vacuum chamber includes a vacuum tube mounted concentrically within said coring barrel.

6. A hydrostatic corer as claimed in claim **5** wherein and including:
said driving piston means being slidably mounted in said vacuum tube;
a transverse element mounted at the top of the vacuum tube;
a piston rod connected to the driving piston and extending upwardly through said transverse element;
a driving head connected to the top of the piston rod; and
elongated means rigidly connecting the driving head to the top of the coring barrel.

7. A hydrostatic corer as claimed in claim **6** including:
said transverse element extending transversely from the vacuum tube beyond said coring barrel;
said elongated means extending through the transverse element extension;

a skirt disposed substantially co-planar with said stationary piston means; and

means connecting the transverse element extension to said skirt.

8. A hydrostatic corer as claimed in claim **7** wherein and including:

the retaining and releasing means includes a latch means, connected to the transverse element, for fixedly engaging and releasing said piston rod; and

cable means connected to the latch means for fixedly engaging the latch means with the piston rod when the cable is under strain and releasing the latch means from the piston rod when the cable is slackened.

9. A hydrostatic corer as claimed in claim **3** wherein: the coring barrel forms said vacuum chamber.

10. A hydrostatic corer as claimed in claim **9** wherein and including:

an outer tube connected to said skirt and extending upwardly concentrically about the coring barrel, said outer tube forming a suction chamber and extending upwardly beyond the top of the coring barrel to form an atmospheric chamber;

the driving piston being fixedly connected to the top of the coring barrel and mounted in the suction chamber of the outer tube for piston action therein;

a hollow piston rod extending from the atmospheric chamber of the outer tube through the driving piston, and into the coring barrel;

conduit means extending from a top portion of said suction chamber to said skirt; and

valve means for opening and closing said atmospheric chamber to the coring barrel through said hollow piston.

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