July 26, 1966 P. A. DANTZ 3,262,412

PAD-LOCK ANCHOR SYSTEM

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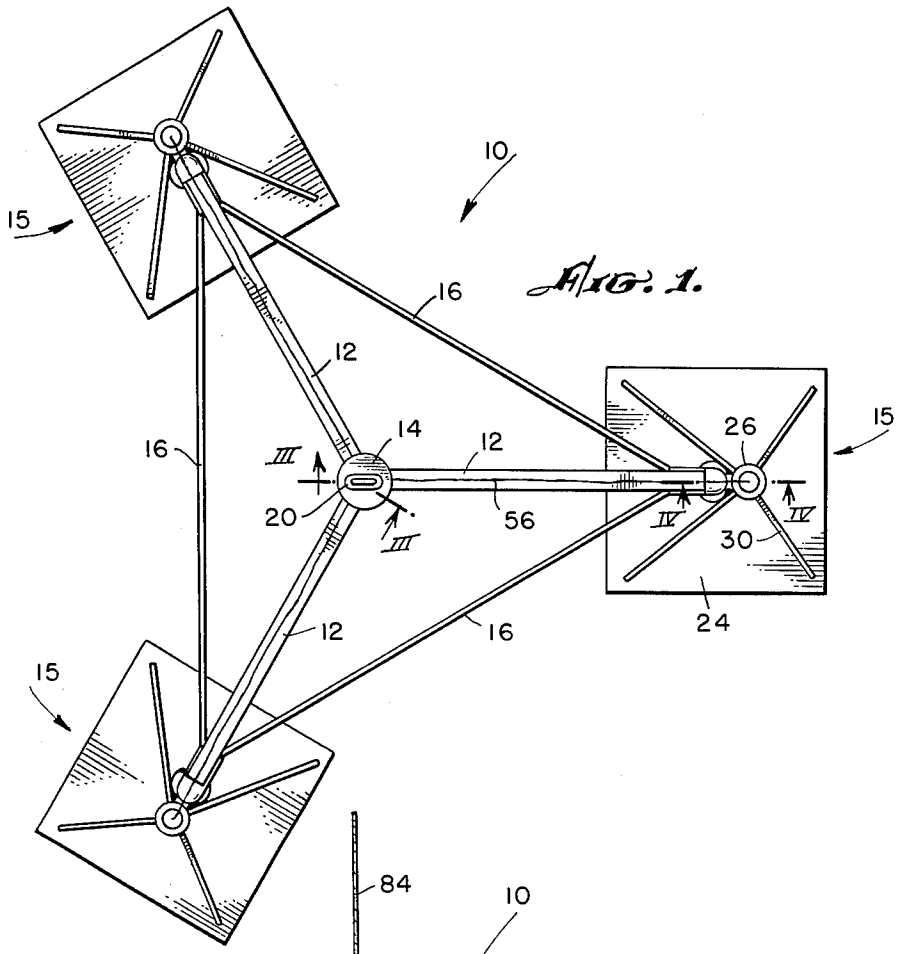

FIG. 1.

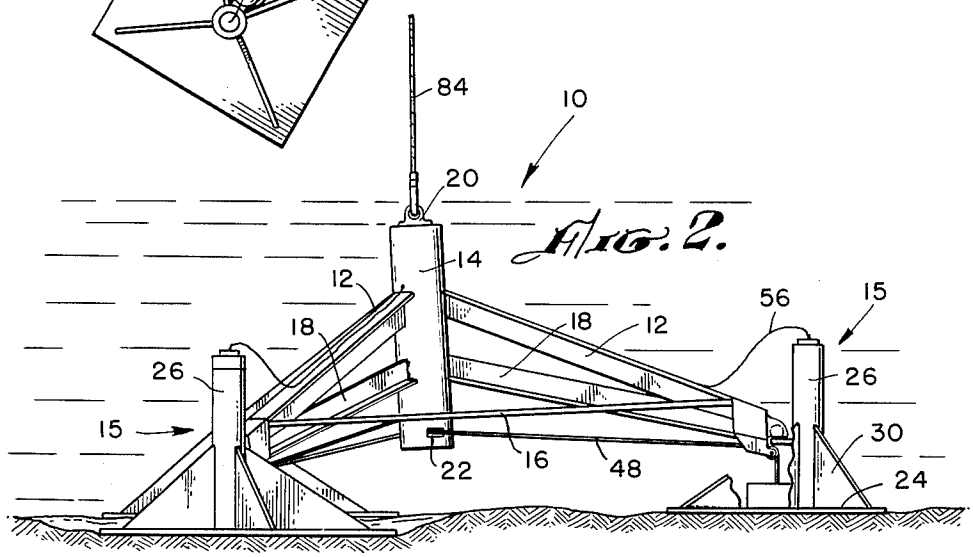

FIG. 2.

PAUL A. DANTZ,
INVENTOR.

By Erwin T. Johnston

ATTORNEY.

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FIG. 3.

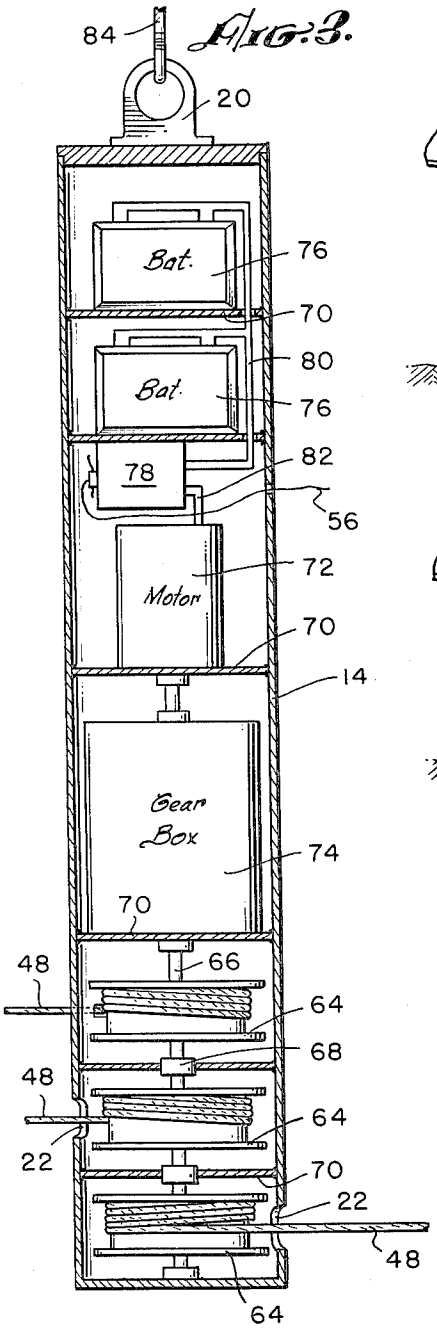


FIG. 4.

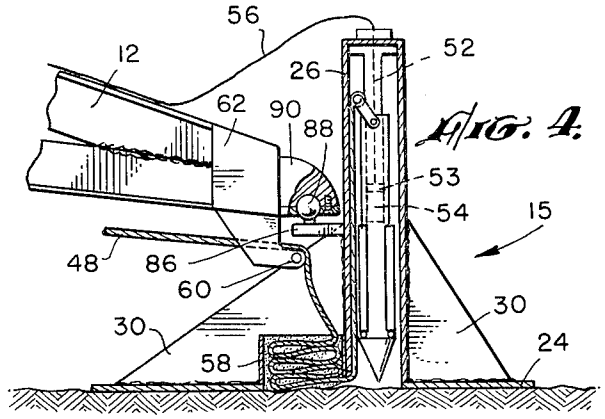
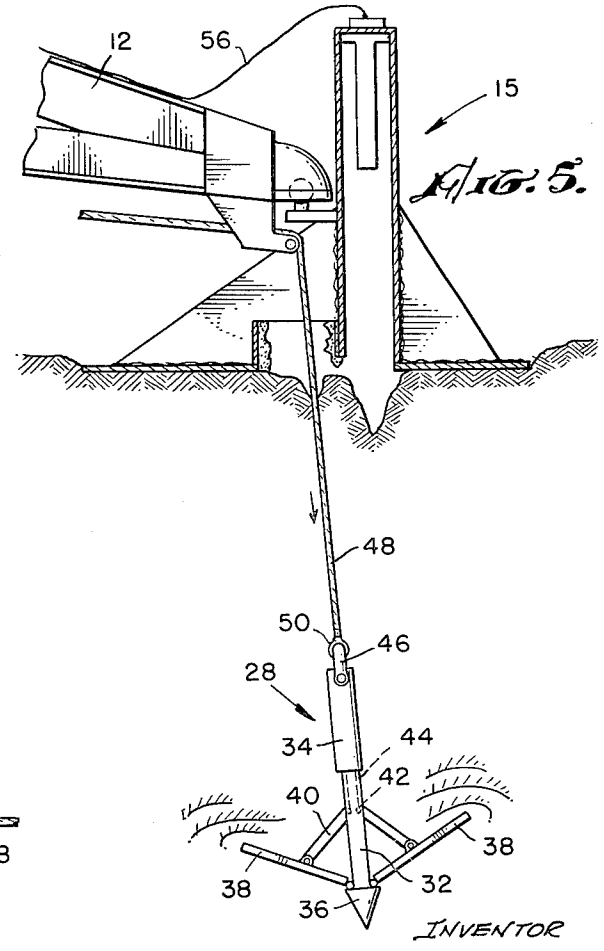


FIG. 5.



INVENTOR
PAUL A. DANTZ,
By Erwin A. Johnston
ATTORNEY.

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3,262,412

PAD-LOCK ANCHOR SYSTEM

Paul A. Dantz, Ventura, Calif., assignor to the United States of America as represented by the Secretary of the Navy

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10 Claims. (Cl. 114—206)

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 to an underwater anchoring apparatus and more particularly to an anchoring apparatus which will provide upward, bearing and horizontal support at the floor of the ocean or at the bottom of any other body of water.

Anchors constitute one of the oldest arts known to man and have been used for anchoring all types of waterborne objects such as ships, buoys, towers, off-shore drilling rigs and platforms. Quite often these objects, such as towers, drilling rigs and platforms, require an anchoring device or devices which will withstand forces in all directions. The United States Navy is presently working on projects for the construction of underwater sea laboratories. These submerged laboratories must be anchored by an anchoring device which is capable of resisting uplift, bearing and horizontal forces. In order to provide such an anchoring device it has been necessary in the past to use driven or cast-in-place piles. While pilings provide a good support in all directions, they are very time consuming to install and are generally limited to depths of about three hundred feet, since the driving or boring operation must be carried on by a barge at the surface of the water.

Three other known anchoring devices for mooring objects in the ocean are the conventional drag type of anchor, the dead weight type of anchor and the propellent embedded anchor. The drag type anchor consists basically of a stem and flukes. When the anchor is drawn along the ocean floor the flukes are tilted at a downward angle and embedded in the floor to provide holding resistance to a connecting line. The holding power of the drag anchor is generally restricted to the direction in which it was drawn and there is only limited holding power in other directions. Other disadvantages of the drag type anchor is that it must be dragged a considerable distance before it finally embeds in the ocean floor and even after embedment a large area is required for its use because of the necessary catenary in the mooring line.

Dead weight anchors are masses of material which, when placed on the ocean floor, provide a resistance primarily to uplift and bearing forces. In order to provide the dead weight anchor with good horizontal holding power it must be made excessively large which materially increases the handling problems. Accordingly, this type of anchor has been generally confined for anchoring small objects or installations.

The propellant embedded or explosive anchor includes an anchor which is driven into the ocean floor by an explosive charge. After firing, this type of anchor is usually set by applying an upward force on a connecting line so as to cause anchor flukes to open and embed in the ocean floor. The holding power of this anchor in the upward and horizontal directions is good, however, it provides a very poor bearing support. Because of the advantages of the explosive anchor it would be desirable to provide a means or apparatus which would be capable of combining the holding power of a plurality of explosive anchors as well as providing bearing support therefor.

The present invention provides an anchoring apparatus

which overcomes the aforementioned disadvantages of the prior art anchors. The present anchoring apparatus can be located at a precise area on the ocean floor to resist forces from all directions. This may be accomplished by providing a frame assembly having a top and a bottom; a housing mounted within said frame assembly; support and anchor driving means mounted at a plurality of frame locations for providing bearing support and for driving anchors downwardly into the bottom of the water; a cable connected to each respective anchor and extending therefrom into said housing; a cable winding assembly mounted within said housing, each of said cables being connected to said cable winding assembly so as to be capable of being wound thereon; and means within said housing for driving said cable winding assembly. Accordingly, after firing the anchor driving means the frame can be drawn tight against the bottom of the water by winding the cables on the cable winding assembly. The present anchoring assembly may be provided with additional advantages by pivoting each support means to the frame assembly so that the anchoring apparatus will automatically adjust to the irregular contours of the floor of the ocean and pulleys may be mounted at selected locations on the frame assembly to cooperate with the cable so to greatly enhance the holding power of the anchoring assembly. Further, the construction of the present anchoring assembly enables it to be operated at practically any depth within the ocean. This may be accomplished by providing an actuation means, within the housing, which is responsive to remote control from the surface for actuating the anchor driving means and the cable winding assembly.

An object of the present invention is to provide an underwater anchoring apparatus which overcomes the aforementioned disadvantages of prior art anchors;

Another object is to provide an anchoring apparatus which will resist upward, horizontal and downward forces with a greater holding power than that obtained with prior art anchoring devices;

A further object is to provide a simply installed anchoring apparatus which will resist forces from all directions, can be installed at a precise location on the oceans floor and which will automatically adjust to irregular floor bottoms to provide a good bearing support;

Still another object is to provide an anchoring apparatus which will resist forces from all directions and which can be remotely operated from a surface location; and

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 top plan view of the anchoring apparatus;

FIG. 2 is a side elevation view of the anchoring apparatus installed on an irregular floor of the ocean;

FIG. 3 is a vertical cross-sectional view through a cylindrical housing with some of the components therein shown in schematic form;

FIG. 4 is a side view of a portion of the frame and the support and anchor driving means prior to firing the anchor and with portions cut away to show the details thereof; and

FIG. 5 is a side view similar to FIG. 4 after the anchor has been fired into the floor of the ocean.

Referring now to the drawings wherein like reference numerals designate like or similar parts throughout the several views, there is shown in FIGS. 1 and 2 an anchoring apparatus 10 which may include a tripodial frame assembly having three legs 12 which are joined at their top ends to a cylindrical housing 14. The legs 12 may be connected at their bottom ends to respective support and anchor driving means 15 for providing bearing sup-

port and for driving an anchor downwardly into the bottom of the water. The frame assembly may include lateral bracing bars **16** which are connected between the legs **12**. If desired, another series of legs **18** may be connected in tripodial relationship at their upper ends to the housing **14** and at their bottom ends to the support and anchor driving means **15**. The cylindrical housing **14** may be positioned with its longitudinal axis lying along the central axis of the tripodial frame assembly. A top end of the housing **14** may be provided with a mooring eye **20** and the cylindrical wall may be provided at its lower end with three apertures **22** which are adapted to receive cables within the housing, as will be fully described hereinafter.

The support and anchor driving means **15** may include a bearing plate **24** and an upstanding anchor firing tube **26** which is connected at its bottom end to the top of the bearing plate. The bottom end of the firing tube **26** may open through the bearing plate **24** and housed within the firing tube is an anchor **28** which is directed downwardly for firing through the tube opening. Triangular web plates **30** may be welded to the exterior of the firing tube **26** and the top of the bearing plate **24** so as to provide reinforcement.

The anchor **28** may include a lower cylindrical rod **32** which is rigidly connected to and aligned with an upper cylindrical tube **34**. The lower cylindrical rod **32** may be partially inserted within the cylindrical tube **34** so as to close off the bottom end of the tube **34**, leaving the remainder of the tube open. Connected to the bottom end of the cylindrical rod **32** is a conical shaped nose **36** which is capable of cutting through the material in the bottom of the water. A pair of flukes **38** may be pivoted at their bottom ends to the bottom of the rod **32** immediately above the anchor nose **36** so that the flukes may be rotated between a closed position against the rod **32**, as shown in FIG. 4, to an open position, as shown in FIG. 5. An arm **40** may be pivotally connected at one end to each respective fluke **38** and may be slidably connected at an opposite end to rod **32** by a crosswise bar **42** which rides within an internal slot **44** along the rod **32**. The internal slot **44** may be terminated at a predetermined distance above the bottom end of rod **32** so that the flukes **38** will open at an acute angle with respect to the rod **32**, as shown in FIG. 5. Accordingly, after driving the anchor **28** into the bottom of the water an upward pull on the anchor will cause the flukes **38** to open. If desired, the upper end of each fluke **38** may be slightly flared so as to enhance the opening operation of the flukes.

At the upper end of the anchor rod **34** is pivotally connected a U-shaped swivel **46** which is capable of pivoting to one side of the tube **34** so as to leave the top end of the tube open. A cable **48** is connected by an eye **50** to the swivel **46** and may extend from the firing tube **26** to a respective aperture **22** within the housing **14** for a purpose which will be described fully hereinafter.

The anchor **28** may be driven into the floor of the water explosively as shown in FIGS. 4 and 5. This may be accomplished by providing a rod **52** which is mounted within the firing tube **26** so as to extend downwardly and slidably within the anchor tube **34**. The rod **32** terminates a distance above the bottom closed end of the anchor tube **34** so as to provide a space for a charge of propellant **54**. An ignitor wire **56** is connected to a top end of the firing tube **26** and may extend downwardly within the rod **52** until it terminates at a squib **53** adjacent the charge of propellant **54**. The ignitor wire **56** may extend in an opposite direction from the firing tube **26** along a respective frame assembly leg **12** and then into the housing **14** to an actuator which will be described fully hereinafter. It is to be understood that while an explosive firing means has been described for driving the anchor **28** into the bottom of the water, other driving means may be employed, such as pneumatic power or even the water pressure itself.

A cable reservoir **58** may be mounted on the top of the bearing plate **24** adjacent to the firing tube **26**. The cable reservoir **58** may be open at its top as well as its bottom with the bottom opening being open through the bearing plate **24**. A pulley **60** may be connected to a respective frame leg **12** by a pair of plates **62** so as to substantially overlie the top opening in the reservoir **58** as well as the bottom area in which the anchor **28** is to be driven. Prior to firing the anchor **28**, as shown in FIG. 4, the cable extends from the anchor swivel **46** downwardly within the firing tube **26**, through the bottom opening in the firing tube **26**, into the cable reservoir **58** where it is coiled to provide a sufficient length, over the pulley **60** and then into the housing **14** as described hereinabove. Accordingly, after firing the anchor **28**, as shown in FIG. 5, the holding power of the anchor **28** can be transferred substantially upward from the anchor to the pulley **60** and thereafter substantially horizontally to the housing **14**.

Mounted within a lower portion of housing **14** is a cable winding assembly which is capable of winding each of the cables **48** until they are drawn tightly against the driven anchors **28**. The cable winding assembly may include three separate drums **64** which are rotatably mounted within the housing **14** by a shaft **66**. The shaft **66** extends along the longitudinal axis of the housing **14** and is journaled within a plurality of bearings **68** which are in turn mounted to transverse plates **70** within the housing. Each of the cables **48** is connected to a respective drum **64** and is capable of being wound thereon.

Mounted within the housing **14** above the winding assembly is a motor **72** and a gear box **74**, the motor having an output shaft which is connected to the gear box and the gear box having a final stage gear (not shown) connected to the uppermost winding assembly shaft **66**. The gear box may be supported by one of the transverse plates **70** and another transverse plate **70** may support the motor **72**. The plate **70** supporting the gear box **74** may also seal the gear box from the water environment. Mounted on still further transverse plates **70** and within the housing **14** is a pair of batteries **76** for providing the necessary current to operate the motor **74** and ignite the squibs **53**.

Mounted on one of the transverse plates **70** is an actuation means **78** which may draw current from batteries **76** through batttery cables **80** and may be operatively connected to the motor **72** by a lead **82** and further may be operatively connected to the propellant ignitor squibs **53** by the ignitor wires **56**. Accordingly, upon operation of the actuation means **78** the motor is driven so as to operate the cable drums **64** and current is fed through the ignitor wires **56** to ignite the propellant charge **54** and drive the anchor **28** into the floor of the water.

The actuation means may be remotely operated by radio control from a ship at the surface of the water. This may be accomplished by providing the actuation means **78** with a small receiver (not shown) which is responsive to a transmitter at the ship. The actuation means receiver may have two channels, one channel for operating the motor **72** and the other channel for igniting the propellant. Since remote control between a transmitter and a receiver is so well known in the art it will not be described in any more detail herein. If desired, leads could be run directly from the motor **72** and the propellant squib **53** to the surface ship, however, these leads may become quite long when the anchoring apparatus **10** is operated at great depths within the ocean.

A cable **84** may be connected between the mooring eye **20** and a surface ship. This cable may be used for lowering the anchoring apparatus into the water until it comes to rest on the bottom thereof. The unitary compact construction of the anchoring apparatus enables it to be placed at a predetermined location on the bottom of the water.

Often the bottom of the water is irregular, as shown in FIG. 2. In order that the bearing plates **24** will provide a good bearing support for the anchoring apparatus on an irregular bottom, the support and anchor driving means **15** may be pivotally connected to a respective one of the frame legs **12**. This may be accomplished by a ball and socket joint, as shown in FIG. 4. A flange **86** may extend radially from the firing tube **26** for the support of a ball **88** and a socket extension **90** may be mounted at the end of the frame leg **12** so as to receive the ball. Each socket extension **90** may be provided with a release mechanism so that the socket extension **90** may be released from the ball **88**. Accordingly, the ball and socket joint enables the support and anchor driving means **15** to be pivoted in any vertical plane. As shown in FIG. 2, the left support and anchor driving means **15** is located on a lower portion of the bottom of the water than the right support and anchor driving means **15**. In spite of this irregularity in the bottom, both support and anchor driving means **15** rest substantially flat on the bottom by the pivoting action described above.

In the operation of the anchoring apparatus the cable **84** may be used to lower the anchoring apparatus **10** into the water until it comes to rest on the bottom of the water. At that time the bearing plates **24** are pivoted until the anchoring apparatus provides a good bearing support. After the anchoring apparatus has come to rest at a desired location on the bottom of the water the radio transmitter at the support ship may be used to actuate a receiver channel in the actuation means **78** so as to fire the anchors **28** into the bottom of the water. After the anchors **28** have been fired the radio transmitter may be used to activate another receiver channel in the actuation means **78** so as to drive the motor **72**. This will cause the cable drums **64** to reel in the cables **48**. Upon applying a tension to the cables **48**, the flukes **38** of the anchors **28** will open and secure the anchors **28** to the bottom material. The motor **72** can be of a predetermined power capacity so that it will stall out when the flukes **38** open or alternatively, a limiting switch may be used in conjunction with the motor to allow it to make only a specified number of turns. After the cables **48** have been tensioned the anchoring apparatus is fully operative for anchoring purposes. Various objects, whether floating or submerged, may then be anchored to the anchoring apparatus at the mooring eye **20** or by connections to the frame legs **12** and **18**.

It is to be noted that upon firing the anchor **28** that the swivel **46** will be to one side of the anchor tube **34** and will not interfere therewith. After the anchor **28** is driven into the bottom of the water the cable **48** will follow the anchor out of the firing tube **26** and will then commence to pay out of the cable reservoir **58**. By locating the pulley **60** so as to substantially overlie the cable reservoir **58** and the bottom area where the anchor **28** is driven, a substantially vertical pull is applied between the pulley **60** and the anchor **28**, as shown in FIG. 5. This will provide for a maximum holding power at the pulleys **60** against any upward force.

It is now readily apparent that the present invention provides a unique anchoring apparatus and had advantages long sought for in the anchoring art. The anchoring apparatus is compact and yet has unusual holding power in all directions whether the forces be applied downwardly, horizontally or upwardly. The unique operation of the anchoring apparatus **10** enables it to be installed at any known depth within the ocean. By providing ball and socket joints between the frame legs **12** and the support and anchor driving means **15**, the anchoring apparatus will provide a good bearing support even on an irregular bottom of water. Further by locating the pulleys **60** in a predetermined location, maximum holding power is provided for the anchoring apparatus against upward pulls.

I claim:

1. An underwater anchoring apparatus which is fixable to the bottom of a body of water comprising:
- a frame assembly having a top and a bottom;
- a housing mounted within said frame assembly;
- support and anchor driving means mounted at a plurality of respective locations on said frame assembly for providing bearing support and for driving anchors downwardly into the bottom of the water;
- a cable connected to each respective anchor and extending therefrom into said housing;
- a cable winding assembly mounted within said housing, each of said cables being connected to the winding assembly so as to be capable of being wound thereon; and
- means within said housing for driving said cable winding assembly whereby after driving the anchors into the bottom of the water the frame can be drawn tight against the bottom by winding said cables on the cable winding assembly.

2. An underwater anchoring apparatus which is fixable to the bottom of a body of water comprising:
- a frame assembly having at least three legs which are joined at their tops and which slope downwardly and terminate at their bottom ends substantially in a common plane;
- an elongated housing which is joined to the tops of the legs and which extends downwardly generally along the central axis of said frame;
- support and anchor driving means connected to the bottom end of each respective leg for providing bearing support at each leg end and for driving a respective anchor downwardly into the bottom of the water;
- a cable connected to each respective anchor and extending therefrom into said housing;
- a cable winding assembly mounted within said housing, each of said cables being connected to the winding assembly so as to be capable of being wound thereon; and
- means within said housing for driving said cable winding assembly whereby after driving the anchors into the bottom of the water the frame can be drawn tight against the bottom by winding said cables on the cable winding assembly.

3. An underwater anchoring apparatus as claimed in claim **2** wherein:
- the support and anchor driving means is pivotally connected to the bottom end of each respective leg.

4. An underwater anchoring apparatus as claimed in claim **2** wherein:
- a pulley is connected to each leg so as to substantially overlie the bottom area in which the respective anchor will be driven; and
- each of the cables extending over a respective pulley.

5. An underwater anchoring apparatus as claimed in claim **2** wherein:
- the support of the support and anchor driving means includes a bearing plate which is adapted to rest on the bottom of the water;
- the anchor driving means includes an upstanding blast tube mounted on said bearing plate and opens downwardly therethrough;
- each of said anchors being located within a respective one of the blast tubes;
- a cable reservoir mounted on said bearing plate adjacent said blast tube and opening upwardly as well as downwardly through said bearing plate; and
- each of said cables extending into a respective reservoir and into a respective blast tube where it is connected to one of the anchors.

6. An underwater anchoring apparatus as claimed in claim **5** wherein:
- each of said blast tubes is pivotally connected to a respective end of one of said legs.

7. An underwater anchoring apparatus as claimed in claim 5 wherein:

a pulley is connected to each leg so as to substantially overlie a respective cable reservoir; and

each of the cables extending over a respective pulley.

8. An anchoring apparatus as claimed in claim 2 wherein:

the cable winding assembly includes drum means mounted with its axis of rotation along the longitudinal axis of said housing; and

the driving means is connected to the drum means so as to be capable of simultaneously winding the cables on said drum means.

9. An anchoring apparatus as claimed in claim 2 including:

means responsive to remote control, mounted within said housing and operatively connected to each anchor driving means and the cable winding drive means for selective actuation thereof.

10. An underwater anchoring apparatus which is fixable to the bottom of a body of water comprising:

a tripodial frame assembly having three legs which are joined at their tops and which slope downwardly and terminate at their bottom ends substantially in a common plane;

an elongated housing which is joined to the tops of said legs and which extends downwardly generally along the central axis of said frame, said housing having a mooring eye mounted at a top thereof;

support and explosive anchor driving means connected to the bottom end of each respective leg for providing bearing support at each leg and for driving a respective anchor downwardly into the bottom of the water;

the support of the support and explosive anchor driving means including a bearing plate which is adapted to rest on the bottom of the water;

said explosive anchor driving means including an upstanding blast tube mounted on said bearing plate and opening downwardly therethrough;

each of the anchors being located within a respective blast tube;

a cable reservoir mounted on said bearing plate adjacent said blast tube and opening upwardly as well as downwardly through said bearing plate;

a pulley connected to each leg and located so as to substantially overlie a respective cable reservoir;

a cable winding assembly mounted within said housing;

a cable connected to each respective anchor, wound within a respective cable reservoir, extending over a respective pulley and connected to said cable winding assembly;

means within said casing for driving said cable winding assembly; and

means responsive to remote control, mounted within said housing and operatively connected to each explosive anchor driving means and the anchor assembly driving means for selective actuation thereof.

No references cited.

MILTON BUCHLER, *Primary Examiner.*

T. M. BLIX, *Assistant Examiner.*