

Jan. 6, 1970

C. H. HOLM ET AL

3,487,485

DEEP OCEAN BUOY ASSEMBLY

Filed Nov. 16, 1967

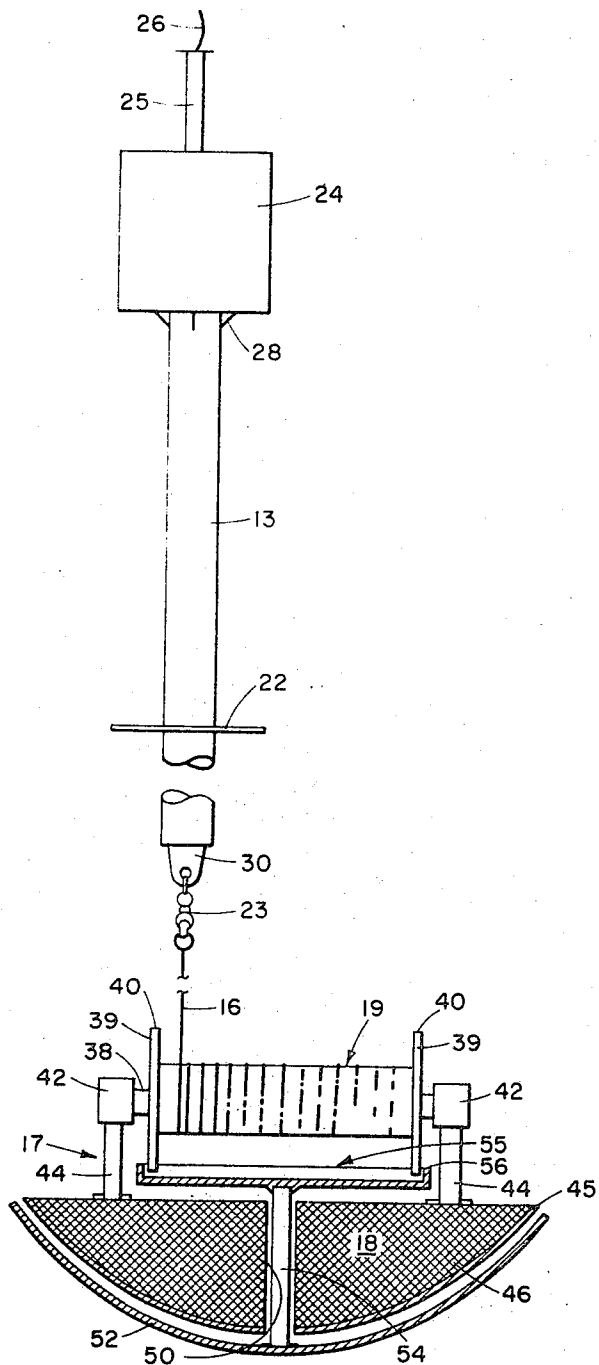


Fig. 2

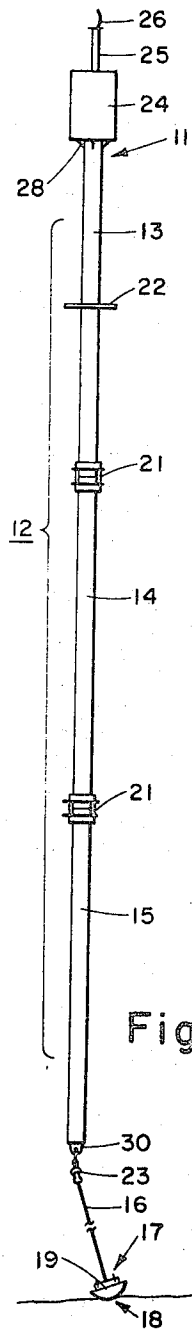


Fig. 1

INVENTORS
 Nicholas Marechal
 Carl H. Holm
 BY
CE. Vautour

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Carl H. Holm, Miami Beach, Fla., and Nicholas Marechal, Arlington, Va., assignors, by mesne assignments, to the United States of America as represented by the Secretary of the Navy

Filed Nov. 16, 1967, Ser. No. 683,503

Int. Cl. B63b 21/52, 51/02

U.S. Cl. 9—8

16 Claims

ABSTRACT OF THE DISCLOSURE

This deep ocean spar buoy assembly comprises a body portion constructed of three 20-foot sections of heavy-duty pipe sealed by welding into watertight components and secured together by two bolted bands. A damper plate is welded either to the topmost section or the lower end of the lowermost section and a swivel is welded to the lower end of the lowermost section for attachment of an anchor wire. An anchor assembly includes spaced hemispherical steel shells the uppermost of which is filled with lead and supports a reel which is free-running on descent and on which the anchor wire is wound. The reel is braked intermittently during descent and is locked when the anchor section is on the bottom by a plate which is forced upward against and engages knurled flanges on the reel. The upward force is transmitted from the lower shell by a pipe which extends upward through a central opening in the upper steel shell.

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.

This invention relates to buoys and more particularly to a deep ocean spar buoy for providing an accurate, efficient reference position in the deep waters of the ocean.

There exists a need in the buoy art for a simply constructed, reliable buoy adapted to be anchored or implanted in deep water to serve as a comparatively accurate marker or navigational reference. Previous efforts to provide buoys which may be anchored or implanted at substantial depths have resulted in extremely complex mechanisms which are both costly and of questionable reliability. In some prior devices, bellows or other pressure-sensitive means operable at predetermined depths release an anchor which drops to the bottom while a flotation member carrying a reel of anchor line floats to the surface. In other devices, the anchor carries a reel of wire or cable and a flotation member to the bottom whereupon the flotation member is released carrying with it the reel from which anchor line is paid out. Still other devices employ a plummet plus an anchor weight to set the scope of the anchor line at the depth where the buoy has been dropped. Other existing devices are set in operation by timing devices which are actuated by water action shortly after the buoy has been dropped into the water. None of the presently available devices have the simple yet reliable means for setting the length of anchor line which the present invention possesses nor means for damping vertical oscillations among other features of the invention. No timing or pressure-responsive devices are required in the operation of the invention.

The present invention consists essentially of an elongate body portion made up of three sections each of which is at least partially buoyant and one of which has attached to it means for damping vertical oscillations of the buoy. A buoyancy chamber at the top provides the necessary additional buoyancy while at the bottom an anchor assembly is attached which includes a free-spool-

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ing reel of anchor line and a reel brake which is operable both during descent and upon the anchor weight reaching the bottom.

Accordingly, it is an object of the present invention to provide a buoy which may serve as an efficient, substantially fixed and accurate navigational reference in the deep waters of the ocean.

Another object of the invention is to provide a deep ocean buoy which is especially adapted to assist in marking deep submerged objects.

A further object is to provide a deep ocean buoy having a minimum of vertical movement in response to wave motion and low tides.

A still further object of the invention is to provide a method of and means for establishing and maintaining a vertically stable deep ocean bottom marker and navigational reference whose scope of anchor line is set upon initial placement at the precise depth thereof without the use of auxiliary means such as pressure-responsive or timing devices.

Other objects, advantages and novel features of the invention will become apparent from the following detailed description thereof when considered in conjunction with the accompanying drawings in which like numerals represent like parts throughout and wherein:

FIG. 1 is a schematic view of the buoy as it is deployed in its environment; and

FIG. 2 is a schematic view of the components of the buoy and its anchor assembly.

Referring to FIG. 1, a buoy 11 is shown in substantially true proportion suspended in water and tethered to the bottom. The buoy 11 includes a body portion 12 formed preferably of three individual cylindrical hollow closed sections, 13, 14 and 15, and is connected by an anchor line 16 to an anchor assembly 17 which includes a ballast 18 and a cable reel 19. Each of sections 13, 14 and 15 preferably is formed of heavy-duty pipe individually sealed preferably by welding so as to form three separate watertight compartments. Adjacent sections preferably are secured together by conventional means such as a pair of bolted bands as indicated at 21.

A damper plate 22 which may be secured to the upper section 13 as shown or may be affixed to the lower end of section 15 preferably by welding operates to damp vertical oscillations of the buoy initiated by waves and low tides which drop the buoy and cause slack in the anchor line. It has been determined that the amplitude of oscillation of the present embodiment may be reduced by a factor of over five at the fourth oscillation from an initial three-foot oscillation as compared to the same configuration without a damper plate.

A swivel 23 may be secured at the bottom of lower section 15 to provide for attachment of mooring line 16, while a reserve buoyancy canister 24 which preferably is constructed entirely of metal is secured to the upper part of section 13. A mast 25 may be mounted on top of canister 24 and may have mounted at its top a light and radar reflector 26. Canister 24 may be secured to section 13 both internally and by gussets 28 attached to the base thereof and to the outer surface of section 13. Swivel 23 may be secured to section 15 by means of a bracket 30 which may be attached preferably by welding to the bottom surface of section 15.

In FIG. 2, the buoy 11 is shown foreshortened because of its extreme length and to enable the anchor assembly 17 to be shown in detail. Anchor assembly 17 is connected to body portion 12 at swivel 23 by mooring line 16 which preferably is made of wire rope wound on free-spooling reel 19. Reel 19 is mounted for rotation on a shaft 38 and includes a pair of end flanges 39 whose edges 40 are knurled to promote efficient braking. Shaft 38 is mounted

in blocks 42 which in turn are attached to anchor weight 18 by posts 44 which are secured to the anchor weight by conventional means such as bolting or embedment. Anchor weight 18 preferably is formed of a hemispherical, dish-shaped plate 45 ballasted preferably with lead as indicated at 46. Plate 45 and lead ballast 46 are provided with a central passage 50 which receives a force transfer component of braking means 51. Braking means 51 includes a hemispherical steel shell 52 which has welded thereto at its pole a connecting rod 54, preferably made of pipe, to which is attached a breaking plate 55 which is preferably oval in shape and is provided with a raised edge 56 disposed to engage knurled flanges 40 when in the operative condition. Connecting rod 54 has an outer diameter appreciably smaller than the diameter of central passage 50 so as to permit freedom of movement of the connecting rod within the passage.

At launching, which preferably is at high tide, hemispherical steel shell 52 and braking plate 55 are disposed downward a maximum distance from reel 19 such that plate 55 contacts lead ballast 46. Body portion 12 assumes a vertical attitude shortly after buoy 11 is released, and anchor assembly 17 descends through the water at a rate determined by the shape and weight thereof. The curved underside of steel shell 52 serves to control the descent velocity of free-spooling reel 19 and the remainder of the anchor assembly, increasing tension in anchor line 16 but limiting such tension to a value sufficiently low so that body portion 12 and canister 24 will remain afloat during the descent of the anchor assembly. Only enough anchor line is paid out until the time of locking of reel 19 at the bottom to produce a minimum of slack in the anchor line. At the depths contemplated, this slack should be sufficient to accommodate tidal variations as well as oscillations caused by wave motion. Anchor assembly 17 preferably carries a wire reel of $\frac{3}{16}$ -inch high tension wire rope.

The braking action which ultimately locks the reel in place on contact with the ocean bottom is capable of controlling the descent velocity of the anchor and reel assembly by virtue of the hydrodynamic pressure on the lower hemispherical steel shell 52 and considerably reduces the terminal descent velocity. For example, in the specific embodiment described the unrestricted free fall terminal velocity of the anchor and reel assembly would be on the order of 42 f.p.s.; however, because the hydrodynamic pressure forces the brake to engage on descent, the average terminal velocity is attenuated to less than 10 f.p.s. Specific values are dependent upon the interrelationship of ballast weight 46 and the lower shell area and its C_D (drag coefficient).

The braking action during descent is highly desirable since without the payout line control which it provides the mooring line and reel inertia could be sufficient to either severely damage the brake mechanism on contact with the bottom or allow the reel to continue to turn thus increasing the mooring scope beyond tolerable limits for an accurate navigational device or precision marker. Although payout line control increases the actual mooring time by a ratio comparable to the difference in descent velocities, minimum-scope mooring nevertheless is achieved because the braking force transmitted into the mooring line tends to remove some of the stretch, due to unlaying, as well as minimizing the mooring cable trajectory curvature. Minimum-scope mooring further is achieved because of the reduced rotational inertia of the reel due to its paying out line at a lower rate, preventing paying out of excessive line at the time of contact with the ocean bottom and thus rendering the brake more efficient.

Upon striking the sea floor steel shell 52, which is deployed a maximum distance below shell 45, is forced toward shell 45 driving connecting member 54 upwards and causing the raised edge 56 of braking plate 55 to jam against the knurled flanges 39 of reel 19. The com-

plementary hemispherical shape of shells 45 and 52 result in an upward force being imparted to rod 54 at a wide range of points of contact between the underside of shell 52 and the sea floor. The force exerted against knurled edges 40 of flanges 39 abruptly stops rotation of reel 19 and thereafter asserts a locking action against the reel. This locking action is maintained so long as anchor weight 18 rests on the bottom thereby assuring against the further rotation of reel 19 and preventing subsequent paying out of cable 16.

In the preferred embodiment, sections 13, 14 and 15 of body portion 12 preferably are made of 20-foot sections of 12-inch pipe and damper plate 22 preferably is positioned at the lower end of section 15. Rod 54 preferably is made of 3-inch pipe. The buoy may be embellished with more sophisticated appendages than light and radar reflector 26 within the scope of the invention. For example, a lamp and a radio transmitter set in operation remotely could be added to the existing mast or another mast could be provided to accommodate such additional equipment.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings.

What is claimed is:

1. A deep water buoy adapted to provide a fixed scope of anchor line at a variety of depths comprising:

an elongate body portion having buoyancy means disposed at one end and anchor means including anchor line dispensing means disposed at the other end;

said dispensing means including an anchor line and a braking means actuatable by hydrodynamic reaction forces during descent and by the weight of said anchor means when said anchor means reaches the bottom;

said braking means having a peripheral member disposed remote from and movable with respect to said anchor dispensing means; and

said braking means released when said anchor means is substantially disengaged from the bottom, the scope of said anchor line being so fixed as to render said deep water buoy a substantially fixed navigational reference and submerged object marker.

2. The device of claim 1 wherein said dispensing means further includes a reel of anchor line attached to said anchor means;

said braking means operable against said reel to permit substantially continuous rotation of said reel during descent and to prevent rotation of said reel and thereby further dispensing of anchor line while said anchor means remains on the bottom.

3. A deep water buoy comprising:

an elongate body portion which provides part of the buoyancy of the assembly;

a buoyant section attached at the upper end of said body portion for providing the balance of the buoyancy necessary;

anchor means including an anchor weight, a cable, a reel and reel braking means attached at the bottom end of said body portion;

said braking means actuatable by hydrodynamic reaction forces during descent and by said anchor weight when said anchor means reaches the bottom;

said braking means having a peripheral member disposed remote from and movable with respect to said reel; and

said braking means released when said anchor means is substantially disengaged from the bottom.

4. The device of claim 3 wherein said braking means includes jamming means disposed adjacent to said reel and connected to said peripheral member so that when at the bottom said anchor weight maintains said jamming means in locking engagement with said reel.

5. The device of claim 4 and further including damping

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means attached to said body portion for substantially reducing the amplitude of vertical oscillations of the buoyant portions of said buoy assembly.

6. The device of claim 5 wherein said damping means is a plate symmetrically disposed and attached at the lower end of said elongate body portion.

7. A deep water buoy comprising:

an elongate body portion which provides part of the buoyancy of the assembly;

a buoyant section attached at the upper end of said body portion for providing the balance of the buoyancy necessary;

anchor means including an anchor weight, a cable, a reel and reel braking means attached at the bottom end of said body portion,

said braking means adapted to permit substantially continuous rotation of said reel during descent and to prevent rotation of said reel while said buoy assembly is anchored;

said braking means including jamming means disposed adjacent to said reel and means disposed between the anchor weight and the bottom and connected to said jamming means so that when at the bottom said anchor weight maintains said jamming means in locking engagement with said reel;

damping means adapted to said body portion for substantially reducing the amplitude of vertical oscillations of the buoyant portions of said buoy assembly,

said damping means being a plate symmetrically disposed and attached at the lower end of said elongate body portion;

said reel being provided with end flanges having knurled edges;

said jamming means being disposed between said anchor weight and said knurled edges; and

said connected means extending centrally through said anchor weight so that said means disposed between the bottom and said anchor weight is forced upward by hydrodynamic pressure during descent and by the weight of said anchor means when the anchor means reaches bottom whereby said connected jamming means is forced upward against said knurled edges.

8. A deep ocean marker and navigational reference buoy comprising:

an elongate body portion formed of a plurality of closed hollow sections connected end to end;

a buoyancy chamber attached to one end of said body portion;

an anchor assembly including an anchor line attached to the end of said body portion opposite said buoyancy chamber;

said anchor assembly further including a reel on which said anchor line is wound;

said reel being attached to and remaining at the bottom with said anchor assembly; and

braking means in said anchor assembly actuated by hydrodynamic reaction forces during descent and by the weight of said anchor assembly when the anchor assembly reaches the sea floor so that braking action is maintained so long as the anchor assembly remains on the sea floor;

said braking means having a peripheral member disposed remote from and movable with respect to said reel.

9. A deep ocean marker and navigation reference buoy comprising:

an elongate body portion formed of a plurality of closed hollow sections connected end to end;

a buoyancy chamber attached to one end of said body portion;

an anchor assembly including an anchor line attached to the end of said body portion opposite said buoyancy chamber;

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said anchor assembly further including a reel on which said anchor line is wound,

said reel being attached to and remaining at the bottom with said anchor assembly;

a braking means in said anchor assembly operable intermittently during descent and fully when the anchor assembly reaches the sea floor so that braking action is maintained so long as the anchor assembly remains on the sea floor,

said anchor assembly including an anchor weight having a curved underside and an outer shell having a curvature complementary to that of said anchor weight and disposed adjacent thereto;

said outer shell connected to said braking means so as to transmit a braking force thereto during descent and upon the anchor assembly striking the sea floor.

10. The device of claim 9 wherein said reel is mounted on the side of said anchor weight remote from the curved underside thereof;

said anchor weight having a central passage communicating between its curved underside and the side remote therefrom; and

means extending through said passage and connecting said outer shell and said braking means.

11. The device of claim 10 wherein said reel is provided with circular end flanges having knurled edges and said braking means includes a curved plate having a raised edge;

said raised edge contacting said knurled edges under a force transmitted to said curved plate by said means extending through the passage in said anchor weight.

12. The device of claim 11 wherein said body portion includes damping means attached to said body portion for damping vertical oscillations of said buoy.

13. The device of claim 12 wherein said damping means is a circular disc disposed symmetrically about the longitudinal midpoint of said body portion;

said disc having a diameter substantially thrice that of said body portion.

14. The device of claim 13 and further including a swivel interconnecting said body portion and said anchor line for maintaining said anchor line free of turns;

said disc affixed at the end of said body portion adjacent said swivel.

15. The method of paying out mooring line so as to provide a minimum mooring scope for an object to be moored comprising the steps of:

controlling the descent velocity of the anchor means to which the mooring line is attached by increasing mooring line tension during descent of said anchor means; and

said increase in mooring line tension achieved by intermittently braking a means for paying out said mooring line through the application of hydrodynamic reaction forces to said paying out means during descent of the anchor means.

16. The method as defined in claim 15 and further including the step of:

locking the means for paying out mooring line by applying the weight of the anchor means thereto when the anchor means is on the bottom.

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TRYGVE M. BLIX, Primary Examiner

U.S. Cl. X.R.