United States Patent

[11] 3,597,778

[72] Inventor Hans Castelliz
Halifax, Nova Scotia, Canada

[21] Appl. No. 654,892
[22] Filed July 20, 1967
[45] Patented Aug. 10, 1971
[73] Assignee E M I Limited
Hayes, England
[32] Priority Aug. 19, 1966
[33] Great Britain
[31] 37,147/66

[54] **MOORING DEVICES**
10 Claims, 5 Drawing Figs.

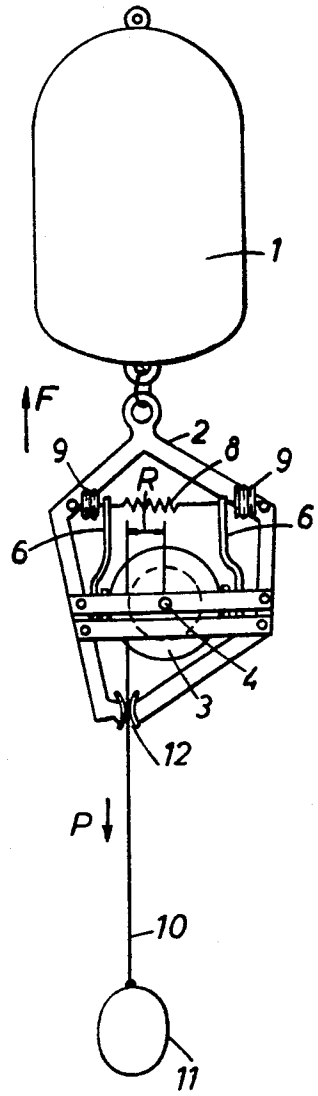
[52] U.S. Cl. 9/8
[51] Int. Cl. B63b 21/52
[50] Field of Search 9/8; 102/14

[56] References Cited
UNITED STATES PATENTS

1,011,152	12/1911	Bruck	102/14
3,109,370	11/1963	Elmer et al.	102/14

Primary Examiner—Trygve M. Blix
Attorney—William W. Downing, Jr.

ABSTRACT: The invention relates to a mooring device which includes a float intended for mooring below the surface of the sea, a sinker, a cable connecting the float to the sinker and means for paying out the cable. The device also includes control means for regulating the pay out of the cable in response to the ambient pressure at the float so as to tend to maintain the float at a predetermined depth below the surface during the mooring process, and in addition locking means operative to lock the paying out means when paying out ceases.



2 Sheets-Sheet 1

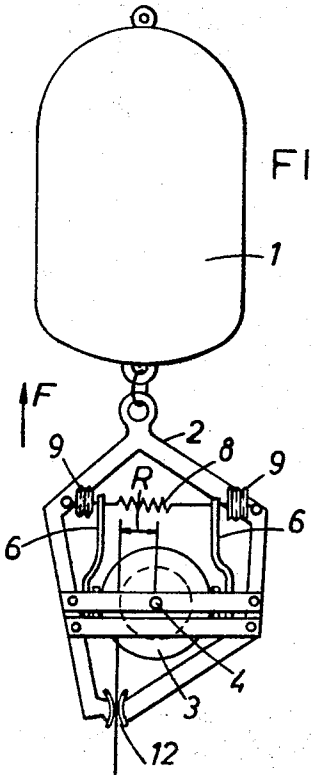


FIG.1

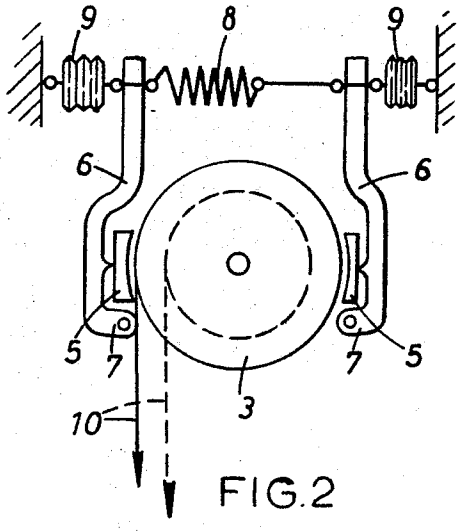


FIG.2

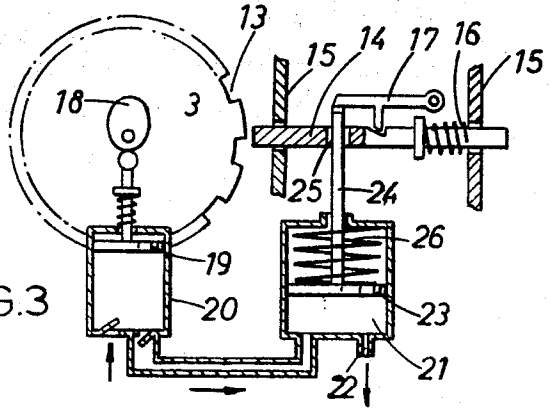


FIG.3

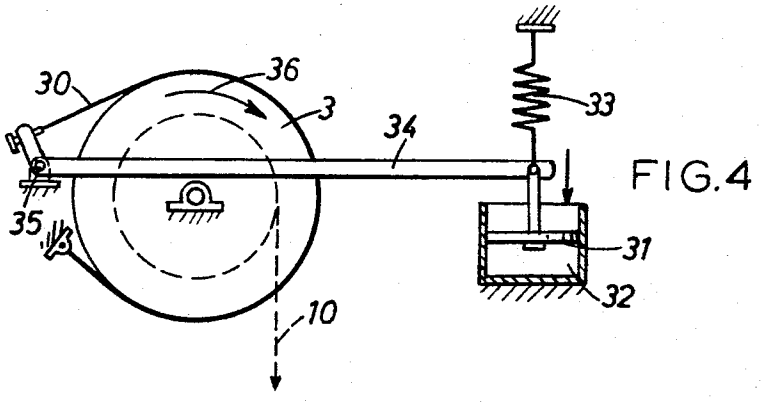


FIG.4

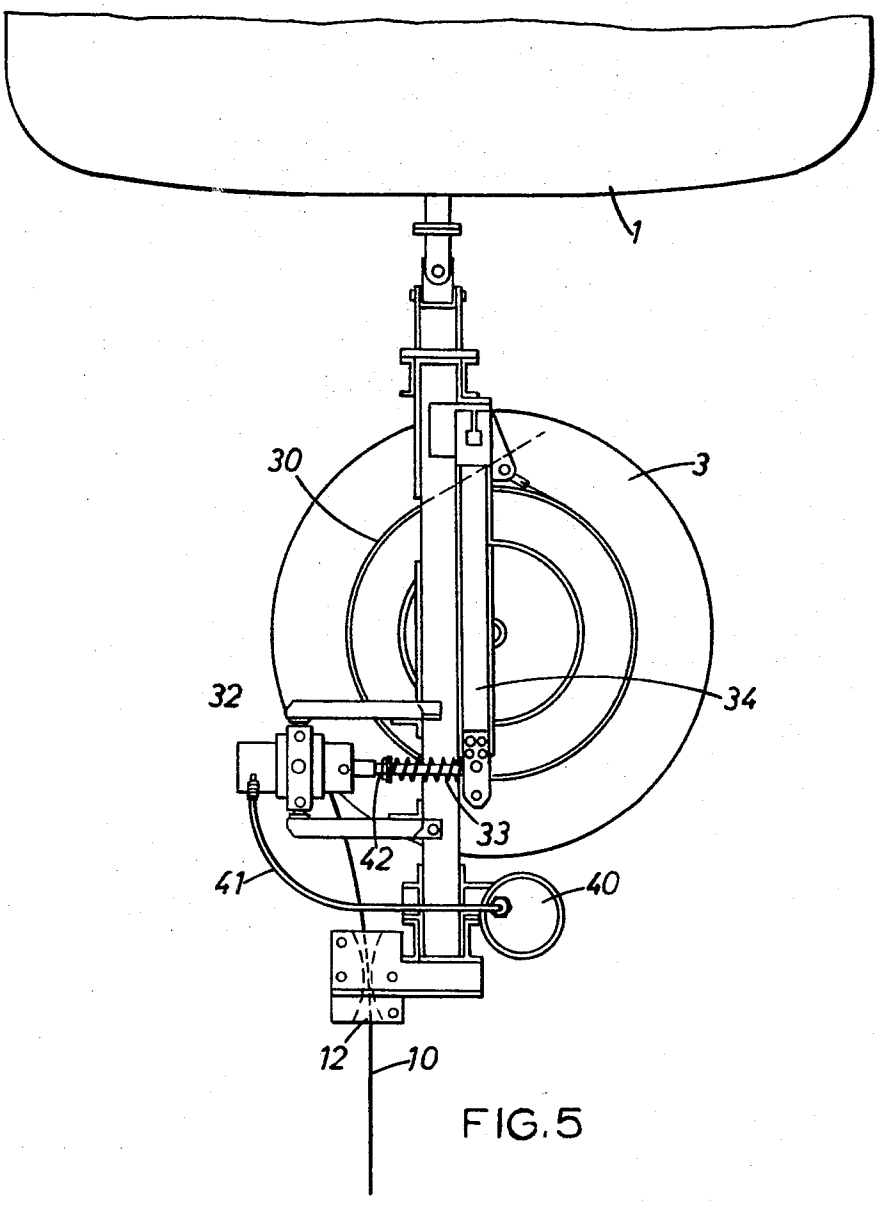


FIG. 5

MOORING DEVICES

This invention relates to mooring devices, and it relates in particular to mooring devices which include a float intended for mooring below the surface of the sea.

For oceanographic, navigational and other purposes it may be desired to moor a float so that it is submerged at a given depth below the surface of the sea, and various proposals have been made for achieving this result. For example where the depth of the sea is known, the float may be attached to a sinker or anchor by a length of cable which is such as to maintain the float at the correct depth. However, in deep water, depth soundings cannot usually be obtained with sufficient accuracy to ensure that the float is moored at the right depth. Another proposal is to sound the water depth with the mooring cable itself, but in this case while the sounding is being taken, the ship may drift due to wind and current so that the sinker while being lowered trails behind the ship, and the cable is measured too long. In addition the sounding operation can only be performed in low sea states and requires time and skill. Another proposal is to attach a pilot line, with a weight at its end, below the sinker and as the pilot line descends with the sinker, the cable is paid-out from the sinker, leaving the buoy on the surface. When the weight on the end of the pilot line touches the bottom, the winch is locked and the float is pulled under by the sinker as it descends to the bottom. HOwever this proposal is unsuited for deep water, because the float may drift while on the surface and give rise to excessive payout of the cable.

The object of the present invention is to provide an improved mooring device which includes a float which can be moored at a predetermined depth with a relatively high degree of accuracy.

According to the present invention there is provided a mooring device including a float, a sinker, a cable connecting said float to said sinker, means for paying out said cable between said float and said sinker, means for regulating the payout of the cable by said paying out means in response to the ambient pressure at said float so as to tend to maintain said float at a predetermined depth below the surface during the mooring process, and locking means for locking said paying out means, means for sensing when pay out ceases, and operating means responsive to said sensing means for operating said locking means to inhibit further payout of the cable.

In order that the present invention may be clearly understood and readily carried into effect it will now be described with reference to the accompanying drawings in which:

FIG. 1 illustrates diagrammatically one example of a mooring device according to the present invention,

FIG. 2 is a detailed view on a larger scale of part of the device illustrated in FIG. 1,

FIG. 3 illustrates a locking device incorporated in the device illustrated in FIG. 1, which is however not visible in that FIG.,

FIG. 4 illustrates a modification of the arrangement shown in FIG. 1, and

FIG. 5 illustrates part of a mooring device incorporating the modification illustrated in FIG. 4.

Referring to the drawings, the device illustrated in FIG. 1 comprises a float 1 which is called a subsurface float because it is intended to be moored below the surface of the sea. A frame 2 suspended from the underside of the float 1 carries a cable drum 3, the drum 3 being freely rotatable in bearings one of which is denoted by the reference 4. As can be seen more clearly in FIG. 2, the drum 3 has brake shoes 5 which can be applied by levers 6 pivoted at 7. The top ends of the levers 6 are biased by a tension spring 8 which tends to maintain the shoes 5 applied to the drum so as to brake the drum. Bellows 9 are connected between the levers 6 and the frame 2 in such a way that, when an increase in ambient pressure causes the bellows to contract, the action of the spring 7 is countered and the pressure of the shoes 5 on the drum 3 is reduced. Components 2 to 9 are referred to as the winch. A cable 10 in the form of a steel wire is wound on the drum 3, the free end of the cable being attached to a sinker 11, the cable passing from the frame 2 through a hawse pipe 12.

The winch is provided with a locking device adapted to lock the drum 3 so that no more cable can be paid-out after the sinker 11 has reached the ocean bottom. This locking device comprises a series of notches 13 (FIG. 3) provided at intervals around the periphery of the drum 3. A locking plunger 14, which can slide in guides 15, is biased by a spring 16 so that the plunger tends to move towards the drum and engage in one of the notches 13 so locking the drum. However a latch 17 is fitted which can hold the plunger withdrawn from the notches, allowing the drum to rotate. A cam 18 is mounted on the winch shaft so as to rotate with the winch, and this operates the piston 19 of a water pump 20, which is arranged to pump water into a dashpot cylinder 21, which has a metering hole 22. The dashpot has a piston 23 attached to a rod 24, and when the piston is raised by water in the cylinder 21, the rod 24 can enter a hole 25 in the locking plunger 14 and thereby lock the plunger and at the same time release the latch 17.

Before the mooring device is installed, the cable 10 is fully wound on the drum and the locking plunger 14 is cocked by withdrawing it from the drum 3 and latching it by means of the latch 17. At this time, the piston 23 of the dashpot 21 is at the lower end of its travel and the rod 24 does not project into the hole 25. The mooring device, can then be lowered into the sea at the selected area and allowed to sink under the influence of the sinker. When the device reaches a predetermined depth, called the "setting depth" the compression of the bellows 9 releases the pressure of the brake shoes 5 sufficiently to allow the drum to turn under the pull of the sinker 11 which separates from the float 1 as the cable is paid-out. If the float depth tends to change from the setting depth, the brake is either tightened to lower the float if ascending or loosened to allow the float to rise, if descending. Thus the brake automatically tends to maintain the float at the setting depth at all times until the sinker reaches the ocean bottom.

As long as the sinker is descending relative to the float, the winch drum 3 rotates and the pump 20 is operated by the cam 18. The first few strokes of the pump 20 fill the dashpot cylinder 21 and drive the piston 23 to its upstroke position, pushing the rod 24 through the hole 25 and releasing the latch 17. The locking plunger 14 then moves horizontally a short distance towards the drum 3 by the action of the spring 16 sufficient to prevent the latch 17 from becoming reengaged but not sufficient to cause the plunger 14 to enter any notch 13. Further movement of the plunger is prevented by the rod 24. When the sinker 11 reaches the ocean bottom, the pump 20 ceases to operate and the piston 23 slowly returns towards its down stroke position under the action of spring 26, the rate of return being determined by the rate of which water can flow through the metering hole 22 in the cylinder 21. The dashpot is designed so that the time taken for the piston 23 to reach its down stroke position is about 2 minutes. When the piston reaches its down stroke position the rod 24 is withdrawn from the hole 25 in the locking plunger 14 and the plunger is now forced into its locking position by the spring 16. The time delay provided by the dashpot mechanism is required because the winch drum may stop rotating for short periods of time during the payout of the cable, and these short stoppages could otherwise cause premature locking of the drum. It will be appreciated that if the rotation of the drum is restarted prior to the end of the two minute period, the pump 20 quickly returns the dashpot piston 23 to its up stroke position and prevents the release of the plunger 14.

The device described has the advantage that the float is kept below the surface of the sea from the beginning of the cable payout and so the float is not exposed to surface currents and wind. The possibility of a horizontal offset between it and the sinker is therefore reduced and when the float is moored, the cable is taut and vertical. Moreover knowledge of the water

depth is not required prior to launching as long as it is less than the cable length, and weather conditions have no detrimental effect on the mooring operation.

During the operation, when the ambient pressure at the float corresponds to the "setting depth," , the resulting force on the brake levers **6** is such that the drum is allowed to rotate under a cable pull P, and P is equal to the upward force F provided by the buoyancy of the float **1** less the weight in water of the winch assembly, there being equilibrium between the forces P and F. The weight W of the sinker under water is greater than the force P and the sinker descends with such a speed that the drag against it compensates for the excess weight. In any position of the subsurface float lower than the equilibrium depth the ambient pressure tends further to release the brake shoes **5** which results in a cable pull P less than the upward thrust F. This restores the float **1** to the equilibrium position. In positions of the float **1** higher than the equilibrium position the converse occurs. Therefore the system is a servosystem and the equilibrium state is a stable state.

The torque which is applied to the winch drum **3** by the cable **10** is T=PR where R is the effective spool radius. As the cable is paid out, R and therefore the torque decreases and rotation tends to cease. Consequently the system is pulled to a greater depth until the brake is released sufficiently to let the drum rotate under the reduced torque. Thus the float **1** tends to descend to a depth somewhat below the setting depth as the cable unwinds. On the other hand the buoyancy F and therefore also the cable tension P increase as the cable weight is taken off the drum **3**. Under this influence, the torque PR tend to increase and the float **1** rises. These two influences, namely change of weight and change of spool radius, counteract each other in their effect and may be made to compensate one another by a suitable selection of the drum dimensions. Incomplete compensation results in a certain change of equilibrium depth during cable payout, but this can be made negligible.

In the modification which is illustrated in FIG. **4** the brake shoes are replaced by a band **30**. Moreover the bellows **9** are replaced by a piston **31** which moves in a cylinder **32**. The piston **31** is biased by a tension spring **33** against the pressure of the sea on the upper surface of the piston. The piston is connected to a lever **34** fulcrumed at **35** and coupled to the band **30** so as to adjust the tension thereof. The direction of rotation of the drum **3** during unwinding is denoted by the arrow **36** and it can be seen that the lever **35** operates on the taut end of the band **30**, rather than on the slack end. This renders the brake torque practically independent of the coefficient of friction, which is desirable because the coefficient of friction may change considerably under water, as a result of organic material being caught in the mechanism. The setting depth of the float **1** may be adjusted before launching by changing the tension of the spring **33**. Such adjustment can alternatively be achieved by connecting the underside of the piston **31** (as seen in the drawing) to an air container and by adjusting the air pressure.

FIG. **5** illustrates one example of a mooring device incorporating the brake of FIG. **4**. The references used in FIG. **5** are the same as those of FIGS. **1** and **4** where applicable. The reference **40** denotes a container for compressed air, coupled to the cylinder **32** at the underside of the piston **31** by means of a pipe **41**. By adjusting the air pressure in cylinder **32** before launching, the setting depth can be adjusted. The piston in the cylinder **32** is connected to the lever **34** by a piston rod **42** which is biased by the spring **33**.

The launching of a mooring device in accordance with the invention may be facilitated by arranging that the float portion and the sinker are firmly locked together by connecting means which is released once the device is in the sea. The operation of releasing the connecting means may be initiated by a pressure sensitive device or alternatively by the chemical or physical action of the sea water.

What I claim is:

1. A mooring device including a float, a sinker, a cable connecting said float to said sinker, means for paying out said cable between said float and said sinker, means for regulating payout of cable by said paying out means in response to the ambient pressure at said float so as to tend to maintain said float at a predetermined depth below the surface during the mooring process, locking means for locking said paying out means, sensing means for sensing when said payout ceases, and operating means responsive to said sensing means for operating said locking means to inhibit further payout of the cable.

2. A device according to claim **1** in which said paying out means comprises a rotatable drum carried by said float and on which said cable is initially wound, and said sensing means includes means to sense when said drum ceases to rotate.

3. A device according to claim **1** in which said operating means includes timing means to retard operation of said locking means for a predetermined time after said sensing means has sensed that payout of the cable has ceased.

4. A mooring device including a float, a sinker, a cable connecting said float to said sinker, means including a rotatable drum carried by said float and on which said cable is initially wound for paying out said cable between said float and said sinker, means for regulating payout of cable by said paying out means in response to the ambient pressure at said float so as to tend to maintain said float at a predetermined depth below the surface during the mooring process, locking means for locking said paying out means, sensing means including a hydraulic pump operated by rotation of said drum for sensing when said payout ceases, and operating means responsive to the cessation of operation of said hydraulic pump for operating said locking means to inhibit further pay out of the cable.

5. A mooring device including a float, a sinker, a cable connecting said float to said sinker, means including a rotatable drum carried by said float and on which said cable is initially wound for paying out said cable between said float and said sinker, a brake acting on said drum, spring means including a pneumatic reservoir containing a compressible fluid for applying said brake, and ambient pressure dependent release means acting in opposition to said spring means to release said brake means thereby to regulate payout of cable so as to tend to maintain said float at a predetermined depth below the surface during the mooring process, locking means for locking said paying out means, sensing means for sensing when said payout ceases, and operating means responsive to said sensing means for operating said locking means to inhibit further payout of the cable.

6. A device according to claim **4** in which said operating means includes timing means to retard operation of said locking means for a predetermined time after operation of the said pump ceases, said timing means including a dashpot into which fluid is forced by the operation of said pump, said dashpot being arranged to allow operation of the locking means when the fluid in the dashpot falls below a predetermined level.

7. A device according to claim **1** in which said regulating means includes a brake acting on said drum, spring means for applying said brake, and pressure dependent release means acting in opposition to said spring means.

8. A device according to claim **5** including means for adjusting the pressure of said compressible fluid in said reservoir to determine the depth of mooring of said float beneath the surface.

9. A device according to claim **5** in which said pressure dependent means comprises a piston forming one wall of said reservoir, and exposed on its outer side to ambient pressure.

10. A device according to claim **5** in which said brake is a friction band brake controlled at the taut end thereof by said spring means.