# United States Patent [19]

**Houot**

[11] **3,889,307**

[45] **June 17, 1975**


[54] **REMOTE-CONTROLLED UNDERWATER BUOY**


[75] Inventor: **Georges Sylvain Houot,** La Garde, France

[73] Assignee: **Schlumberger Technology Corporation,** New York, N.Y.



[22] Filed: **Jan. 9, 1974**

[21] Appl. No.: **432,126**

[30] **Foreign Application Priority Data**

Jan. 12, 1973 France ..... 73.01003

[52] **U.S. Cl.** ..... **9/8 R**

[51] **Int. Cl.** ..... **B63b 21/52**

[58] **Field of Search** ..... 9/8 R, 9; 114/.5 R, .5 D, 114/16 R, 230; 61/69 R; 166/.5, .6; 242/85, 106



[56] **References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 3,125,975 | 3/1964 | Alsager et al. | 114/16 R |
| 3,293,676 | 12/1966 | Link | 9/8 R |
| 3,402,687 | 9/1968 | Tsuji | 9/8 R |
| 3,415,317 | 12/1968 | Drivet | 166/.6 |
| 3,638,722 | 2/1972 | Talley | 166/.5 |
| 3,722,014 | 3/1973 | Hill et al. | 9/8 R |
| 3,793,685 | 2/1974 | Knecht | 114/230 |



*Primary Examiner*—Trygve M. Blix
*Assistant Examiner*—Gregory W. O'Connor
*Attorney, Agent, or Firm*—David L. Moseley; William R. Sherman; Stewart F. Moore



[57] **ABSTRACT**

In accordance with an illustrative embodiment of the present invention, a remote-controlled, immersed buoy that makes it possible to connect an object placed on the ocean floor to the surface by means of a wire rope comprises a body member kept in the immersed position by a latching assembly capable of being freed by a beacon upon the reception of an acoustic signal. A wire rope attached to an anchoring element winds on a drum as the buoy is raised. A removable electric motor is used to wind the wire rope on its drum to bring the buoy to the immersed position.


**17 Claims, 3 Drawing Figures**

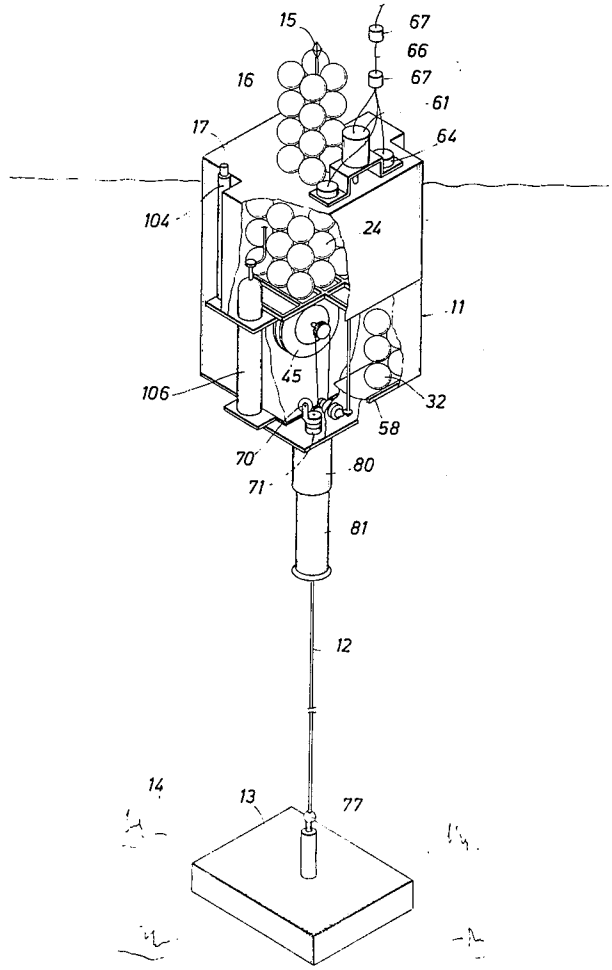


FIG. 1

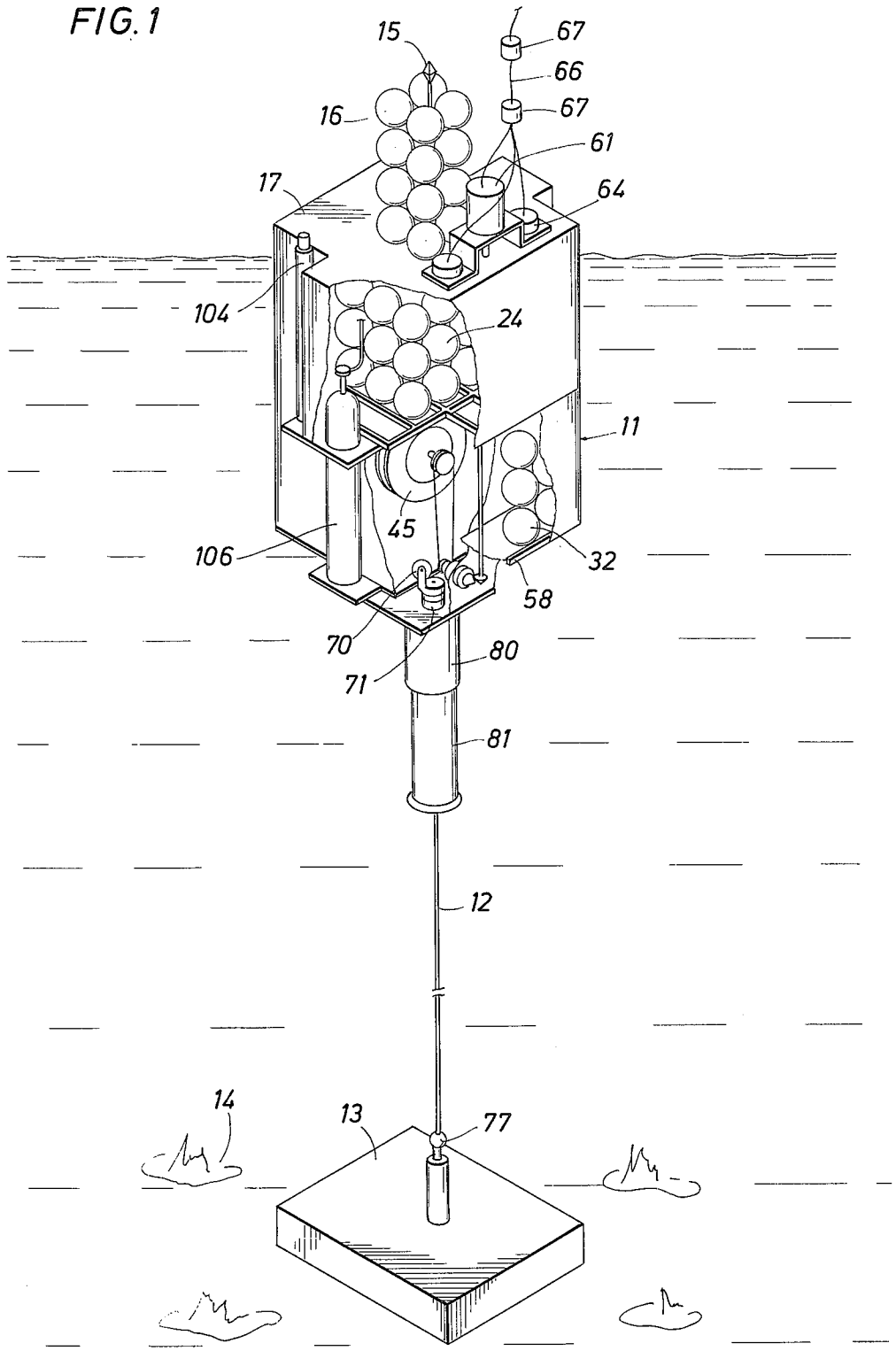


FIG. 2

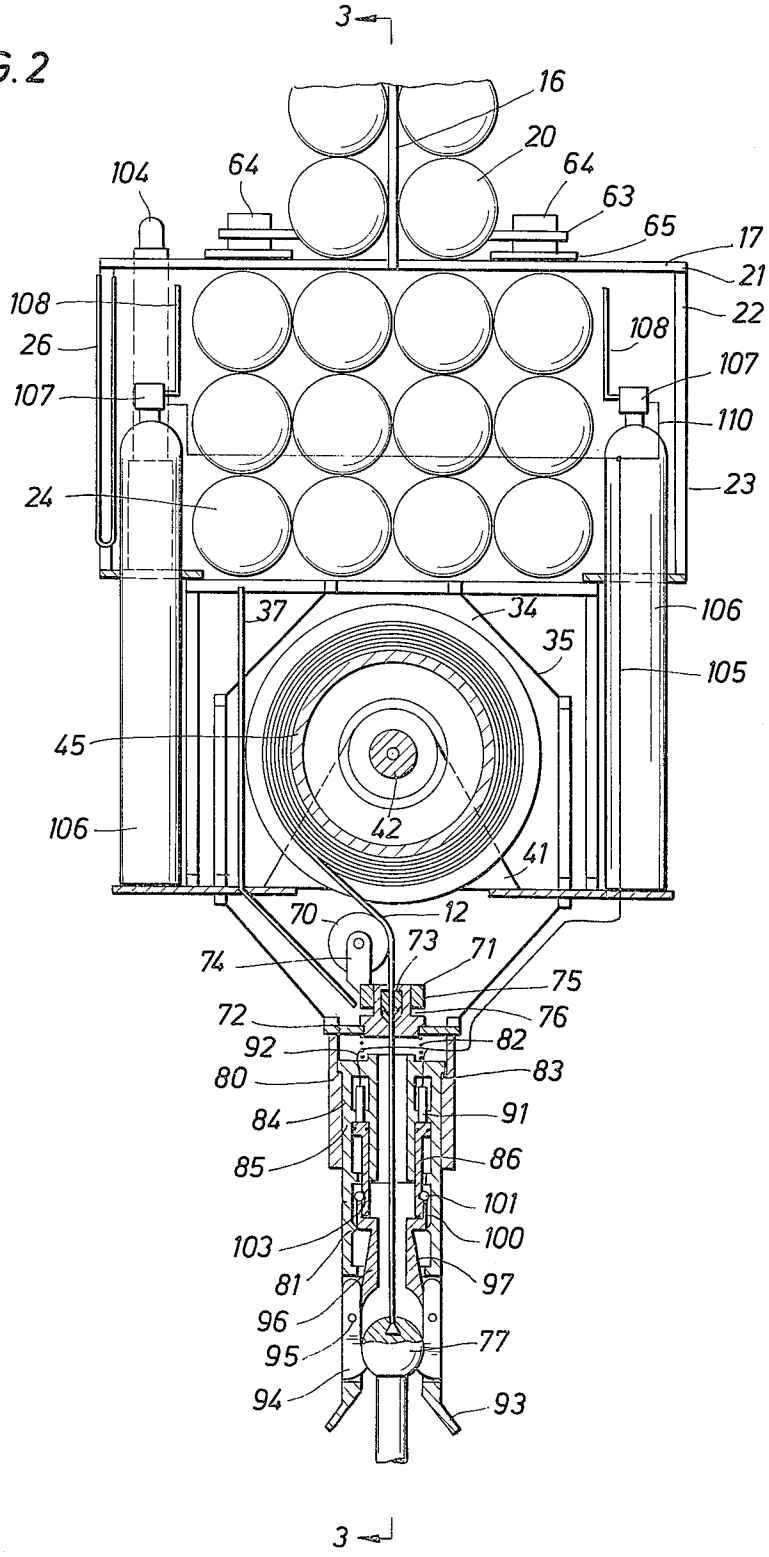
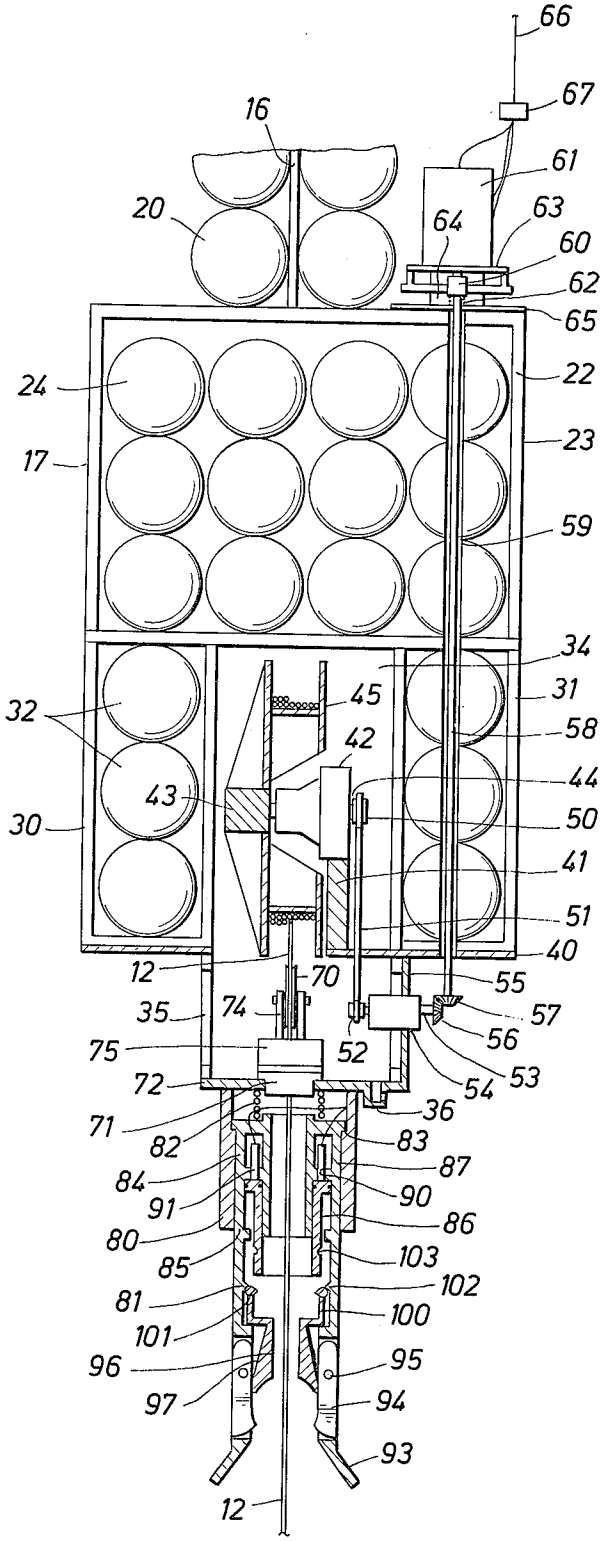

3
16
20
64
64
104
63
65
17
21
22
108
108
26
107
107
110
24
23
37
34
106
35
105
45
42
106
41
70
12
73
71
74
75
72
76
92
82
80
83
84
91
85
86
101
103
100
81
97
96
77
95
94
93
3

FIG. 3


66
67
16
61
20
64
63
60
62
65
24
22
17
23
59
34
32
45
31
42
58
43
44
30
50
41
51
40
12
70
55
35
74
57
56
75
52
53
72
54
36
71
82
83
84
87
91
90
80
86
85
103
81
102
101
100
96
95
97
94
93
12

# REMOTE-CONTROLLED UNDERWATER BUOY

This invention relates generally to a remote-controlled immersed buoy, and particularly a buoy that makes it possible to connect an object placed on the ocean floor with the surface by means of a wire rope or the like.

There are prior-art buoys of the type which are normally immersed and which can be raised to the surface in response to a remote-control signal. This type of buoy comprises a body member connected by a cable to an anchoring element lying on the sea bottom, and a thrust device bringing the body member to the surface under the action of a release mechanism remote-controlled from the surface. When the buoy floats, a wire rope is used for linking the anchoring element with the surface. An embodiment of such an arrangement is described, for example, in U.S. Pat. No. 3,487,486.

This type of buoy has many applications. Offshore drilling operations require the installation of wellheads, valves, separators, and so forth, on the ocean bottom. In order to reach these installations for maintenance or the like, it is necessary to provide guide cables between them and the surface, so as to make it possible to lower the necessary maintenance equipment down to the wellhead. By means of these immersed buoys, it is possible to keep cables attached permanently to the wellhead on the sea floor and to bring one end of the cable up to the surface when desired.

In oceanography, it is becoming increasingly common practice to set up recorders on or near the ocean floor for temperature, pressure, salinity or pH recordings, and to collect recorded data at regular intervals. This makes it necessary to periodically retrieve these recorders in order to collect the recorded information and to recondition these instruments. An immersed buoy allows these operations to be carried out easily. After these retrieval operations, the equipment must be put back in the same position it occupied previously.

In certain prior-art systems, the cable is placed in a compartment of the body member and unwinds from this compartment when the buoy is raised. On important feature of this system is that the cable does not lie on the bottom and therefore cannot become tangled or snarled on jagged rocks or other objects. This type of buoy however has several drawbacks. Firstly, the cable is generally exposed to corrosion by the sea water which penetrates into the compartment. This is troublesome because the replacement of a deteriorated cable generally involves underwater operations, particularly when the anchoring element is secured as in the case of a wellhead. Moreover, this type of buoy must be allowed to sink to the ocean bottom and therefore cannot be placed with great accuracy, or must be placed by a diver if a predetermined location is involved. A fixed immersion location is of particular value for oceanographic measurements which must be made preferably at specific points, as well as for locating wellheads which are generally surrounded by all kinds of equipment in which a buoy placed by sinking can get caught.

It is an object of this invention to provide a new and improved remote-controlled immersed buoy having a connection cable that is particularly well protected from any deterioration.

Another object of the invention is to provide a new and improved remote-controlled immersed buoy which



can be placed easily in an exact underwater location.

These and other objects are attained in accordance with the concepts of the present invention through the provision of a remote-controlled immersed buoy comprising a body member connected by a wire rope to an anchoring element placed on the sea floor, and a thrust device for driving the body member to the surface under the action of a remote-controlled release mechanism. The wire rope runs over a drum mounted in the body member inside an oil-filled chamber. Drum driving means are provided to wind the wire rope on the drum and to bring the body member to a given immersed position with respect to the anchoring point. The driving means comprise a mechanical transmission rotatingly connected to the drum with one end projecting beyond the body member for coupling to a removable electric motor fixed temporarily on the body member, by means of electromagnets for example. When the buoy is in the immersed position, the electromagnets can be freed, thereby disengaging the electric motor which can be brought up to the surface by means of its electric cable.

The buoy according to the principles of the present invention also includes a latching assembly for securing the body member on a head fixed to the anchoring element. This latching assembly includes latching components adapted to engage the head, unlatching means releasing the latching components, and control means, preferably comprised of a pyrotechnical cylinder, for actuating the unlatching means in response to an electric signal from the remote-controlled release mechanism. The thrust device includes a ballast which is normally filled with water and in which floats are placed in order to give permanent buoyancy to the apparatus. Compressed gas cylinders whose opening is controlled by the release mechanism make it possible to fill the ballast with gas. After the reception of the release signal, the buoy comes up to the surface by simple buoyancy while unwinding its wire rope. To return the buoy to its immersed position, the wire rope is wound on the drum by means of the removable electric motor.

For a better understanding of the invention together with further objects and advantages thereof, reference may be made to the following description and to the drawings in which:

FIG. 1 is a perspective view of a buoy according to the invention shown floating on the surface, this view being cut away partially to show the internal components;

FIG. 2 is a longitudinal section of the buoy of FIG. 1 shown in the immersed position; and

FIG. 3 is a section along the line 3—3 of FIG. 2, the buoy being shown during lowering to its immersed position.

Referring initially to FIG. 1, a buoy 11 according to the invention is shown floating on the surface of the sea and is connected by a wire rope 12 to an anchoring element 13 lying on the ocean floor 14. The anchoring element 13 shown here in the form of a deadman, can be an underwater wellhead. The buoy 11 comprises a radar reflector 15 mounted on a mast 16 itself attached to a body member 17. The mast 16 can be surrounded by floats 20 which cooperate with other floats described hereinbelow to give the buoy 11 a permanent positive buoyancy of a predetermined value.

The body member 17, shown in greater detail in FIGS. 2 and 3, comprises a frame, metallic for example,

made of square-section tubing elements such as **21.** The frame comprises a substantially rectangular upper part **22** whose sides and upper face are closed by a thin plate **23.** This upper part **22** of the body member **17** constitutes a ballast open on its lower face and in which are placed several rows of spherical floats **24.** This ballast also includes, on one of its sides, a U tube **26** allowing the air to escape when the buoy is placed in the water.

The lower part of the frame forms two lateral rectangular cages **30** and **31** (FIG. 3) in which floats **32** are also placed. The floats **20, 24** and **32** give the buoy a permanent buoyancy of the order of one hundred or so kilograms.

Between the two lateral cages **30** and **31** is placed a closed octogonal chamber **34** limited by a thin plate **35** welded on the square tubing. This chamber, filled with oil by means of filler and drain plugs, such as **36,** is kept at ambient pressure by a tube **37** (FIG. 2) which connects the lower part of the chamber with the outside. Within the chamber, on a plate **40** integral with the frame, is fixed a substantially triangular support **41** at the top of which is mounted a reducer **42** having an output shaft **43** and an input shaft **44.** On the output shaft **43** is fixed a drum **45** on which the wire rope **12** is wound.

The reducer **42** is an element of a transmission system which connects the drum **45** to a point located at the upper part of the body member **17.** The input shaft **44** of the reducer carries a sprocket **50** on which engages a chain **51** which also runs over a second sprocket **52** located at the lower part of the chamber. The second sprocket **52** is fixed to a horizontal shaft **53** mounted rotatively in a casing **54** fixed through a partition **55.** Watertightness between the casing **54** and the horizontal shaft **53** is provided by lip seals (not shown) allowing a watertight passage through the partition **55.** Owing to its position at the bottom of the chamber **34,** poor watertightness in this passage will result only in filling with water the lower part of this chamber, the winch and the reducer running in oil, even in this unfavorable case. The outer end of the horizontal shaft **53** is equipped with a bevel gear **56** meshing with a second bevel gear **57** fixed on a vertical shaft **58** which extends to the upper part of the body member through a tube **59** and terminates at the top by a nylon-toothed coupling **60.** This coupling makes it possible to establish a connection with the output shaft of a motor **61** simply by fitting in the motor. The vertical shaft **58** is driven upward by a spring **62** which uncouples the bevel gear **57** from the bevel gear **56** when the motor **61** is disengaged from the body member. On the other hand, when the motor **61** is maintained against the body member as shown in FIG. **3,** its output shaft drives the vertical shaft **58** downward and engages the gears **56** and **57.** This makes it possible to minimize friction which opposes the movement of the drum **45** when the buoy is raised to the surface.

The motor **61** is fixed on a support **63** carrying, on either side of the motor, two electromagnets **64** which are applied, when they are supplied with current, to soft iron plates **65** attached to the body member **17.** To prevent water pressure from keeping the electromagnets **64** applied on their soft iron plates **65,** a gap is provided, for example by means of a nylon thread arranged in loops between each plate **65** and the corresponding electromagnet **64.** A multiconductor electric cable **66,** which extends up to the surface, allows the supply of the motor **61** and of the electromagnets **64.** The cable **66** is equipped with floats **67** giving it a constant slight upward tension during the lowering of the buoy.

At the exit of the drum **45,** the wire rope **12** runs over a guide pulley **70** and then goes through a stuffing box **71** fixed through a lower partition **72** of the chamber **34.** The stuffing box **71** is equipped with a packing **73** (FIG. **2**). The guide pulley **70** is rotateably mounted on uprights **74** fixed to a crown **75** itself mounted rotateably around the stuffing box **71** by means of a bearing **76.** The pulley **70** can thus move around a vertical axis ensuring a regular winding of the wire rope **12** on the drum **45.** The end of the wire rope **12** is attached to a spherical head **77** fixed to the anchoring element **13.**

The bottom of the buoy includes a latching assembly capable of engaging with the spherical head **77.** This latching assembly includes a support crown **80** attached to the partition **72** and in which is slidingly mounted a skirt **81** driven downward by a spring **82** compressed between the partition **72** and the upper face of the skirt **81.** A stop **83** limits the downward movement of the skirt **81** with respect to the crown **80.** At the upper part of the skirt **81** are placed drive means consisting of a pyrotechnical gas generator **84** and a cylinder **85** in which is slidingly mounted an annular piston **86.**

The pyrotechnical gas generator **84** consists of an annular chamber **87** communicating with the upper part of the cylinder **85** through openings **90** in which are placed cartridges **91** fired by an electric signal. Electric conductors **92,** going through the top of the gas generator in a sealed manner, are used for this firing.

At the lower part of the skirt **81,** which ends in a cone **93** facilitating the introduction on the head **77,** are mounted latching elements or tumblers **94** capable of rotating around axes **95.** The lower part of the tumblers **94** has a section of greater thickness so as to bear under the head **77** and block the upward movement of the skirt **81** with respect to this head.

A locking and release sleeve **96** is mounted slidingly in an intermediate part of the skirt **81** so as to be able to move between a high position where it locks the tumblers **94** (FIG. **2**) and a low position where it releases these tumblers (FIG. **3**). The sleeve **96** has a tapered outer surface **97** and is extended upward by flexible fingers **100.** Each flexible finger **100** comprises at its upper part a head **101** which engages, in the low position of the sleeve **96,** under a boss **102** made on the inner surface of the skirt **81** (FIG. **3**) and, in the high position (FIG. **2**), in a groove **103** cut in the outer surface of the piston **86.** In the high release position of the sleeve **96,** the tumblers **94** cannot move away from the spherical head **77.** On the other hand, in the low position, the tapered outer surface **97** allows the tumblers to rotate around their axes **95** so that their lower part can move away from the head **77.**

At the upper part and on the side of the body member is fixed an acoustic beacon **104** of a conventional type adapted to produce an electric signal upon reception of a coded acoustic signal. The beacon **104,** supplied by a built-in electric energy source, is connected via an insulated electric conductor **105** to the cartridges **91** of the gas generator **84.** The buoy is moreover equipped with compressed air bottles **106** communicating, through an explosive plug **107** and a conduit **108,** with the upper part of the ballast **22.** The explo-

sive plugs **107** are also connected via an electric conductor **110** to the acoustic beacon **104.** The heads of the cylinder **106** are placed under side projections of the ballast **42** which recover the air in case of leaks from the plugs **107.**

To consider the operation of the system, let us first assume the buoy **11** to be in the immersed position latched on the spherical head **77** as shown in FIG. **2.** The wire rope **12** is wound on the drum **45** and the locking and release sleeve **96** is in the high position thereby locking the tumblers **94** on the head **77.** The acoustic beacon **104** is in the standby mode and the buoy maintains a substantially vertical position owing to the buoyancy of the floats **20, 24** and **32.** The upper ballast **22** is filled with water.

On reception of a coded acoustic signal, transmitted by a service vessel, the acoustic beacon **104** is energized and sends an electric signal to the gas generator **84** and to the explosive plugs **107.** The compressed air from the bottles **106** drives the water out of the ballast, thereby greatly increasing the buoyancy of the buoy, by **500** kg for example. The generator **84** sends gas under pressure into the cylinder **85** and the piston **86** moves downward, driving the release sleeve **96.** This sleeve bears on top of the spherical head **77,** thereby freeing the tumblers **94** so that their lower parts can move and clear this spherical head. Under the effect of buoyancy, the buoy has a tendency to move upward. If the separation does not take place, the sleeve **96** reaches the end of its travel and bears on the spherical head **77** thereby pushing the buoy upward. As the buoy **11** moves toward the surface, the wire rope **12** unwinds from the drum **45.**

Upon reaching the surface, the buoy **11** floats, with the mast **16** and the radar reflector **15** being clearly emerged from the water, thereby allowing easy detection of the buoy either by radar or by sight. The service vessel can then recover the unit and unwind the wire rope **12** completely to use it as a guide cable if necessary for the contemplated operations, after having drained any oil and water which may have replaced the volume of the cable in the octogonal chamber **34** during the raising of the buoy.

During various operations, for example involving specific work on a wellhead or the retrieval of oceanographic recordings, the buoy **11** is prepared prior to its return to the ocean floor in the following manner. The electric energy source of the beacon, the gas generator **84,** the compressed air bottles **106** and the explosive plugs **107** are charged or replaced. Then, the upper end of the wire rope is wound on its drum, the chamber **34** is filled with oil and the latching elements are placed in the position shown in FIG. **3,** i.e. the piston **86** in the high position and the release sleeve **96** in the low position, the heads **101** of the flexible fingers **100** being engaged under the boss **102.**

To lower the buoy **11** to its immersed position, the electric motor **61** is installed, the electromagnets **64** are supplied and the assembly is placed in the water. The buoy then has the position shown in FIG. **1.** The electric motor **61** is then energized and drives the drum **45** through a vertical shaft **58,** bevel gears **56** and **57,** the shaft **53,** the chain **51** and the reducer **42,** thereby winding the wire rope **12** which takes the assembly down to the bottom. Upon reaching the bottom, the skirt **81,** guided by the cone **93,** fits over the spherical head **77** which engages under the tumblers **94** and drives the release sleeve **96** upward. The heads **101** of the flexible fingers **100** clear the boss **102** and engage in the groove **103** of the piston **86.** The sleeve **96** is then in the high position where it locks the tumblers **94.** The motor **61** continues to wind the wire rope and drives the assembly downward while compressing the spring **82.** The increase in the electric power required by the motor **61** opens the circuit-breaker located aboard the vessel. The supply of the electromagnets **64** is then cut and the electric motor **61** is recovered by pulling on the electric cable **66.** The latching system remains locked on the spherical head **77** as long as the cylinder **85** is not actuated.

In the apparatus hereinabove described, it will be noted that during the waiting periods in the immersed position, the wire rope **12** is wound on the drum **45.** This wire rope consequently is not in danger of entanglement and, since it is placed in an oil-filled chamber, it is protected against corrosion, electrolytic effects and undersea animals. Except for the anchoring element, the spherical head and the wire rope itself, all the equipment can be brought to the surface, and consequently, maintained and replaced easily. This indicates the importance of the care given to the maintenance of the rope which, with the anchoring element, remains constantly under water.

The apparatus hereinabove described can of course involve many variations and modifications both as regards the choice of the materials used, for the frame for example, as well as the design of the latching and locking assembly or of any other component. Thus it is the aim of the appended claims to cover all changes or modifications falling within the true spirit and scope of the present invention.

I claim:

**1.** A remotely controlled buoy apparatus adapted to be submerged below the surface of a body of water, comprising: a body having thrust means for applying an upward force thereto; an anchoring element; latching means for maintaining said body in a predetermined immersed position relative to said anchoring element; remotely controlled means for releasing said latching means to allow said body to be moved upwardly to the surface of the water by said thrust means; a drum rotatably mounted and enclosed within said body; a line wound on said drum and having one end extending from said body and fixed to said anchoring element so as to unwind from said drum when said body is moving upwardly; a motor releasably attached to the exterior of said body; and transmission means connected between said motor and said drum for enabling said motor to wind said line on said drum, thereby moving said body downwardly within said water to the predetermined immersed position therein.

**2.** The apparatus of claim **1** further including oil-filled chamber means in said body for enclosing said drum.

**3.** The apparatus of claim **2** further including a stuffing box means sealingly engaging said line as it leaves said chamber means.

**4.** The apparatus of claim **3** further including means for maintaining the oil in said chamber means at substantially the same pressure as the pressure of the water outside of said body.

**5.** The apparatus of claim **4** wherein said chamber means contains line guiding means located between said drum and the exit point of said line from said

chamber means to allow regular winding of said line on said drum.

**6.** The apparatus of claim **1** wherein said transmission means includes a drive train having one end connected to said drum and the other end extending beyond said body and adapted to be coupled with said motor.

**7.** The apparatus of claim **6** wherein said other end of said drive train extends beyond the upper side of said body.

**8.** The apparatus of claim **7** further including chamber means for enclosing said drum within said body, and wherein said drive train extends through a wall of said chamber means in a sealed manner at a point located at a lower portion of said chamber means.

**9.** The apparatus of claim **8** further including means for disengaging said drive train when said other end thereof is uncoupled from said motor.

**10.** The apparatus of claim **6** further including means remotely operable from the surface of the water for releasably attaching said motor to said body.

**11.** The apparatus of claim **10** wherein said motor is an electric device supplied from the surface through an electric cable equipped with floats.

**12.** The apparatus of claim **1** further comprising a head on said anchoring element, said latching means being cooperable with said head for securing said body thereto.

**13.** The apparatus of claim **12** wherein said latching means comprises latching components adapted to engage said head, said releasing means including means for locking and releasing said latching components.

**14.** The apparatus of claim **13** wherein said releasing means further comprises control means for actuating said releasing and locking means.

**15.** The apparatus of claim **14** wherein said control means comprises pressure responsive means for actuating said releasing and locking means, and a gas generator sensitive to a control signal for applying pressure to said pressure responsive means.

**16.** The apparatus of claim **15** wherein said releasing means comprises means for separating said head from said latching components.

**17.** The apparatus of claim **16** wherein said thrust means comprises floats giving permanent buoyancy to said buoy apparatus and a reservoir adapted to be filled with gas to furnish additional buoyancy during the raising of said buoy apparatus to the surface of a body of water.

* * * * *