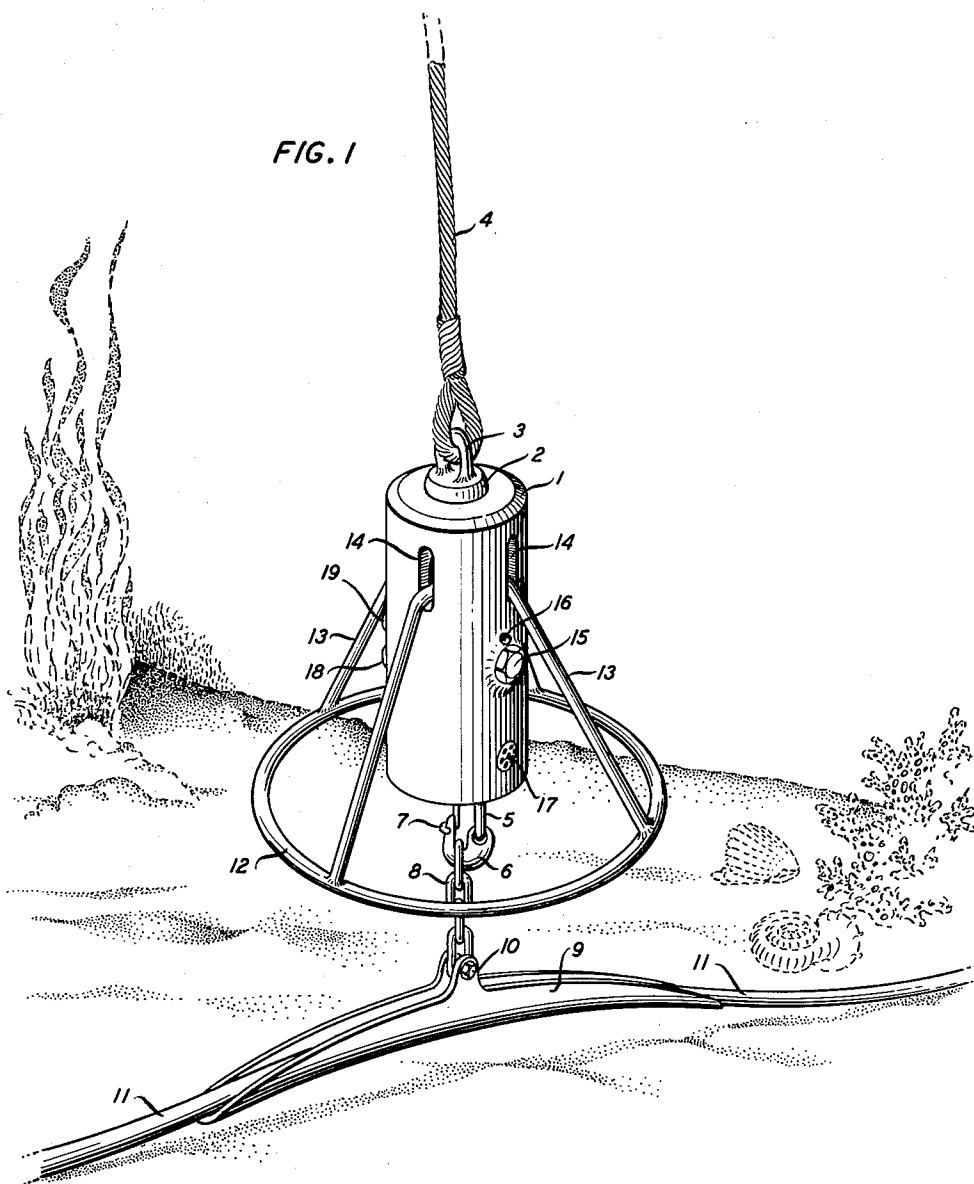


Filed July 29, 1959

UNDERWATER LOWERING DEVICE

3 Sheets-Sheet 1



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April 25, 1961

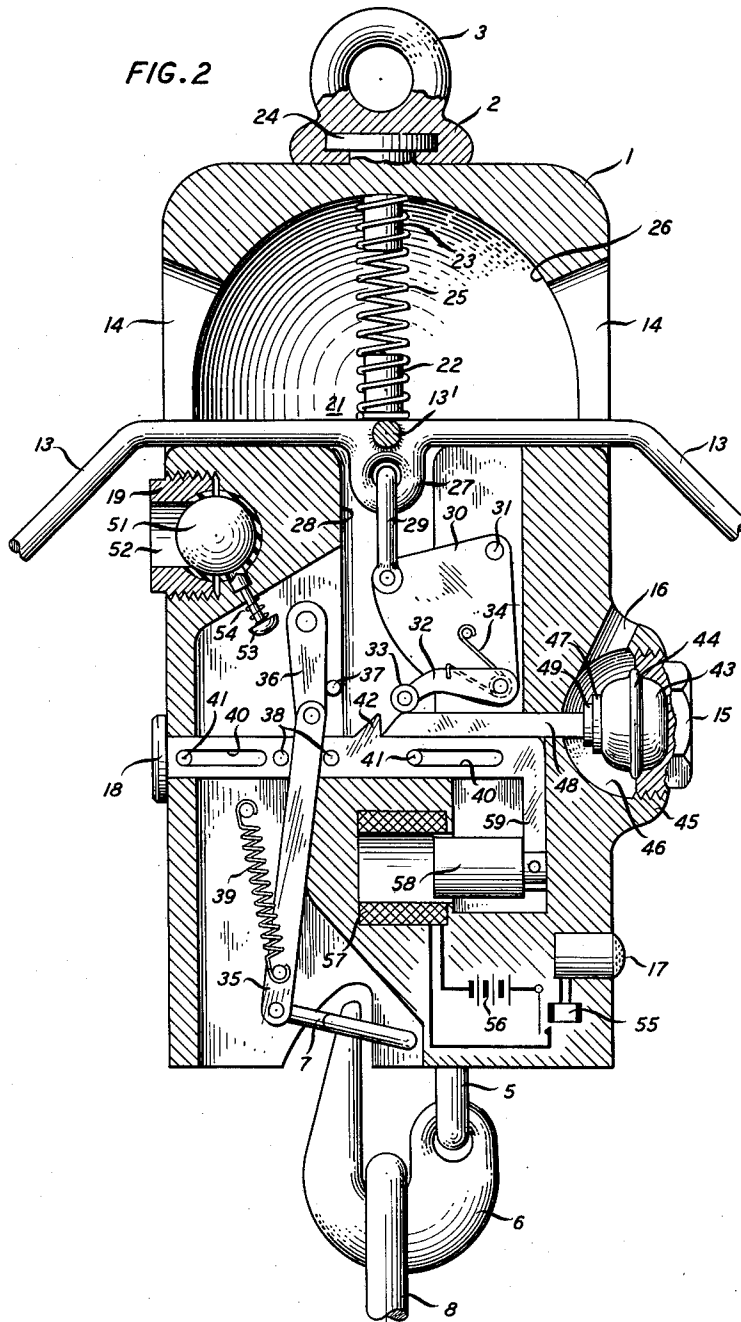
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2,981,074

UNDERWATER LOWERING DEVICE

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3 Sheets-Sheet 2



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UNDERWATER LOWERING DEVICE

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3 Sheets-Sheet 3

FIG. 3

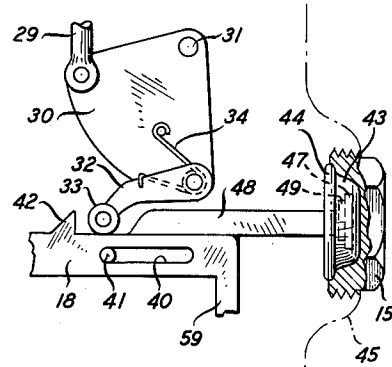
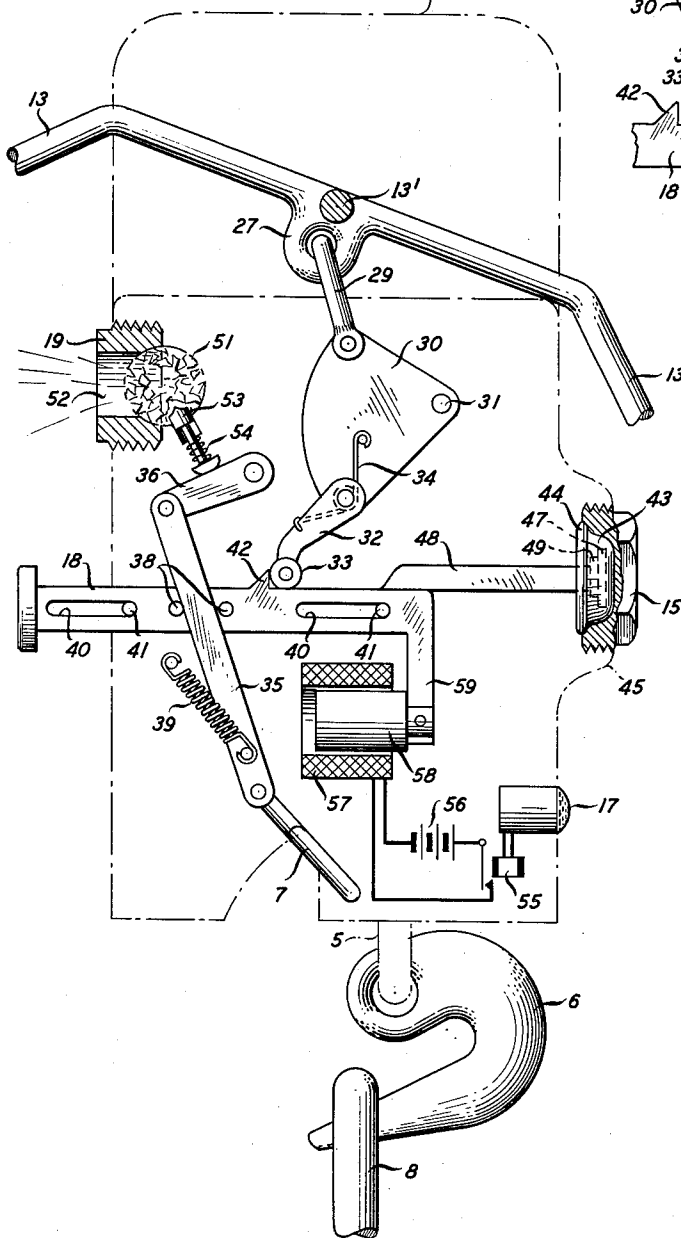


FIG. 4



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2,981,074

UNDERWATER LOWERING DEVICE

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4 Claims. (Cl. 61—72)

This invention relates to a device for lowering an object beneath the surface of a body of water and, more particularly, to an underwater lowering device having improved means for securely retaining an object until it is released automatically in response to the completion of the lowering process.

The invention is particularly applicable for use with equipment employed in laying or repairing ocean cable. For example, when an ocean cable has been damaged, the cable must be pulled aboard a ship in order to be repaired. These repairs usually involve excision of the injured portion, after which the undamaged ends of the cable are spliced together. This forms a long bight in the cable extending from the deck of the repair ship to the floor of the ocean which, in some instances might be at a depth of two or more miles.

Such a long cable bight should not be simply pushed overboard and allowed to fall back into the ocean without any guidance because the tension inherent in the cable would cause it to become snarled and tangled and this might create new injuries in the cable. Therefore, it is desirable that means be employed for lowering a spliced cable bight from the ship to the ocean floor in a manner such that the speed of descent can be readily controlled at all times.

In shallow water, this can be accomplished by means of the so-called "doubled-line" technique. This method comprises looping or doubling a line around a cable, lowering the cable by means of this loop until the bed of the water is reached, then throwing one end of the line into the water, and, finally, hauling the entire length of line aboard the ship with one-half of the line sliding underneath the cable bight.

The "doubled-line" technique is not practical for use in deep water for various reasons, such as the extremely long length of line that would be required. Instead, it would be preferable to use a single line with one end supporting the cable bight in such a manner that this end of the line could be readily released from the cable when the ocean floor is reached.

Accordingly, it is an object of this invention to provide an improved underwater lowering device for retaining a long cable bight during the process of lowering it in deep water.

It is also an object of this invention to release a cable bight that has been lowered under water by providing improved releasing apparatus adapted to operate automatically in response to the completion of the lowering process.

An additional object of this invention is to prevent premature operation of the releasing apparatus in an underwater lowering device by providing improved arming equipment for holding the releasing apparatus in an inoperative condition until a selected partial extent of the lowering process has been completed.

Another object of the invention is to provide improved emergency equipment for effecting the release of a cable bight in the event of a failure in the releasing apparatus of an underwater lowering device.

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A further object of the invention is to provide improved signalling means for producing a signal which is indicative of the operation of apparatus for releasing a cable that has been lowered by an underwater lowering device.

These and other objects of the invention are accomplished by constructing an underwater lowering device in such a manner that it includes holding equipment adapted to retain a cable bight and to support it while it is being lowered to the bottom of a body of water. The lowering device also comprises releasing apparatus designed to effect the release of the cable automatically in response to the completion of the underwater lowering process. At the beginning of the lowering process, the releasing apparatus is locked in an inoperative condition so that it cannot be operated prematurely. In response to the completion of a selected partial extent of the lowering process, an arming device is automatically operated for putting the releasing apparatus in an enabled condition for subsequent operation. In the event of a failure of the releasing apparatus, emergency equipment is provided for effecting the release of the cable. The lowering device further includes signaling means for producing an indication of the operation of the releasing apparatus.

These and other features of the invention are more fully discussed in connection with the following detailed description of the drawings in which:

Fig. 1 is a pictorial representation of one embodiment of an underwater lowering device constructed in accordance with this invention and illustrating the manner in which it retains and supports a cable bight;

Fig. 2 is a sectional view of the underwater lowering device showing the locations and relationships of its components;

Fig. 3 is a side view of the arming mechanism together with a portion of the releasing apparatus and illustrates the manner in which the releasing apparatus becomes enabled for subsequent operation; and

Fig. 4 is a schematic view of the components of the underwater lowering device indicating in particular the manner of operation of the releasing apparatus and the signaling means.

In Fig. 1, an embodiment of an underwater lowering device constructed in accordance with this invention is represented as including a cylindrical body member 1 which also functions as a housing for other components of this lowering device. The body member 1 may be made of any suitable material, such as iron. The top portion of the body member 1 is provided with a rotatable swivel 2 having an eye 3 to which is fastened the lower end of a rope 4. The other end of the rope 4 is not shown in the drawing for the purpose of simplicity. However, it is to be understood that the upper end of the rope 4 is secured to a winch carried on a ship so that the device can be raised or lowered at a rate of speed controlled by an operator on the ship.

Another eye 5 is attached to the bottom of the body member 1 for supporting a pelican hook 6 which is pivotally mounted thereon so that it can move from a closed position, shown in Fig. 2, to an open position, shown in Fig. 4. As is indicated in Fig. 1, during the underwater lowering process, the pelican hook 6 is normally held in its closed position by a catch 7. It is to be noted that, for purposes of illustration, the catch 7 is shown in Fig. 1 to be positioned slightly below the bottom of the body member 1. While this arrangement is operable, it is preferable for the catch 7 to be located within a recess formed in the bottom of the body member 1 as is shown in Figs. 2 and 4.

When the hook 6 is in its closed position, it supports a short chain 8 from which a relatively long sleeve mem-

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ber 9 is suspended by means of a bolt 10. The sleeve member 9 is formed in the shape of a trough for receiving therein an ocean cable 11. The ends of the sleeve member 9 are somewhat flared so that they will not cut or scrape the cable 11. It is to be noted that the longitudinal axis of the sleeve member 9 is slightly curved to conform to the curve of the cable 11 when it is hanging therefrom in the form of a bight.

The pelican hook 6 and the chain 8 are encircled by a hoop member 12 of relatively large diameter having a plurality of bracket-like arms 13. These arms 13 pass through slots 14 in the body member 1 and are supported thereby in the manner shown in Fig. 2. It is to be noted that each of the slots 14 has a vertical axis which is made relatively long in order to permit the arms 13 to move or tilt upward as is indicated in Fig. 4. Thus, when the underwater lowering process is completed, the hoop member 12 will rest on the ocean floor thereby causing its arms 13 to move or tilt with respect to the body member 1.

During the underwater descent, releasing apparatus, described hereinafter, will become conditioned for operation by an arming or enabling device attached to a large nut 15 and adapted to be actuated by hydrostatic pressure applied through a hole 16 in the body member 1. The subsequent movement of the arms 13 will cause the releasing apparatus to move the catch 7 out of engagement with the pelican hook 6. At this time, a signaling device, enclosed by a ring 19, will produce a signal that is indicative of the operation of the releasing apparatus. If the releasing apparatus should fail to operate, emergency equipment, which includes a hydrophone 17, can be operated to effect the removal of the catch 7. In either case, the removal of the catch 7 enables the pelican hook 6 to pivot to its open position thereby allowing the chain 8 to slide off the hook 6. The lowering device can now be pulled up to the ship while leaving the chain 8, the sleeve member 9, and the cable 11 on the ocean floor. When the lowering device has been pulled aboard the ship, a plunger 18 can be operated to restore the releasing apparatus to its normal condition.

The internal components of the lowering device will now be described with particular reference to Fig. 2 in which it can be seen that the hoop-supporting arms 13 are connected together to form an integral junction 21 having a stud 22 projecting upward therefrom. Another stud 23 is positioned above the stud 22 and is located beneath a flange 24 on which the swivel 2 is rotatably mounted. These studs 22 and 23 serve to retain the ends of a coiled spring 25 which is designed to push down on the junction 21 so as normally to keep the arms 13 at the bottom of the slots 14.

As is illustrated in Fig. 2, the arms 13, the spring 25, and the studs 22 and 23 are located in a hemispherical cavity 26 in the upper portion of the body member 1. Although Fig. 2 shows only two slots 14 opening into this cavity 26, it is to be understood that two other similar slots 14 also open into the cavity 26, one behind the spring 25 and one in front of it. Each of these two last-mentioned slots 14 admits an arm 13, one extending from the rear of the junction 21 and the other projecting in front of it as is indicated by its cross-section 13'.

This construction permits the arms 13 to tilt in any one of four directions. For example, the contact between the hoop 12 and the ocean floor may be such as to force the left arm 13 upward, as is indicated in Fig. 4. The extent of this upward movement is limited by the engagement of this arm 13 with the top of its respectively associated slot 14. During this tilting movement, the assembly of the arms 13 pivots at the point where the right arm 13 engages the bottom of its associated slot 14. Due to the flexibility of the coiled spring 25, the junction 21 of the arms 13 is permitted to rise upward, as is represented in Fig. 4. If the hoop 12 should settle in a level position without tilting its arms 13, then the body

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member 1 would continue to move downward with the spring 25 becoming compressed until the upper ends of the slots 14 came to rest upon the arms 13. This relative movement between the body member 1 and the arms 13 will cause the junction 21 to move to substantially the same position that it would be in if the arms 13 has been tilted.

Referring again to Fig. 2, it can be seen that an eye 27 is located under the stud 22 and is formed integrally with the junction 21 of the four arms 13. This eye 27 is loosely received within a well-like cavity 28 in the body member 1. The upper portion of the cavity 28 is flared so as to permit the eye 27 to be easily dragged thereover when the arms 13 are tilted in the manner shown in Fig. 4. The eye 27 holds the upper end of a link member 29 which is free to rotate therein as is indicated in Fig. 4. The lower end of the link member 29 is rotatably attached to a bell-crank 30 which is pivotally attached to the body member 1 by means of a pivot 31. The lower portion of the bell-crank 30 carries a pawl 32 having its right end pivotally attached to the bell-crank 30 and having a roller 33 rotatably mounted on its left end. This pawl 32 is normally forced downward by a spring 34 for a purpose that is explained hereinafter.

As was stated above, the pelican hook 6 is held in its closed position by a catch 7 as is shown in Fig. 2. The catch 7 has its right end pivotally attached to the body member 1 and has its left end rotatably attached to the bottom end of a toggle linkage comprising a lower toggle link 35 rotatably joined to an upper toggle link 36 which has its top end pivotally attached to the body member 1. The bottom end of the upper toggle link 36 is prevented from swinging to the right by means of a stop 37. The movement of the upper portion of the lower toggle link 35 is controlled by two pins 38 carried on the plunger 18 previously mentioned above. This lower toggle link 35 is normally biased by a coiled spring 39 which tends to force it in an upward direction so as to release the catch 7 as is represented in Fig. 4. However, this upward movement of the lower toggle link 35 is prevented by the pins 38 when the plunger 18 is in the position shown in Fig. 2.

The plunger 18 is designed to slide in and out of the body member 1 with its extent of travel being limited in one direction by the contact of its head with the outside surface of the body member 1 as is shown in Fig. 2. In order to limit its movement in the other direction, the plunger 18 is provided with two slots 40 designed to receive therein respectively associated pins 41 attached to the body member 1. Thus, when the plunger 18 is moved to its position shown in Fig. 4, it will slide along the pins 41 until the right ends of the slots 40 come into contact with the pins 41. It can be understood that this combination of slots 40 and pins 41 also functions as guiding means for preventing any irregular up-and-down motion of the plunger 18.

In order to move the plunger 18 from its position shown in Fig. 2 to its position shown in Fig. 4, the plunger 18 is equipped with a tooth 42 which, under a condition described hereinafter, is adapted to be engaged by the roller 33 on the pawl 32. Accordingly, when the arms 13 become tilted, their central eye 27 will be raised up thereby pulling the associated link 29 upward. This will cause the bell-crank 30 to swing upward about its pivot 31 with the result that the pawl 32 will be shoved to the left. If it is assumed that the roller 33 is now in contact with the tooth 42, then the plunger 18 will also be moved to the left. This movement of the plunger 18 will cause its pins 38 to force the toggle links 35 and 36 into their operated positions shown in Fig. 4 where they will be held by the "over-the-center" action of the spring 39. In moving to its operated position, the lower toggle link 35 will pull the catch 7 upward thereby releasing the pelican hook 6 and allowing it to swing downward to its open position.

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This will permit the chain 8 to slide off the hook 6 thus terminating the retention of the cable 11.

However, it can be understood that it would not be desirable to allow the roller 33 to be normally in contact with the tooth 42 because the equipment would then be subjected to the hazard of being operated prematurely with the result that the cable 11 might be released before it had been lowered to a safe depth. For example, the hoop 12 might be unintentionally tilted during the process of lowering the device over the side of the ship. Also, during the descent of this underwater lowering device, the hoop 12 might be accidentally actuated by striking against some submerged object. Therefore, in order to prevent premature release of the cable 11, it is preferable to normally keep the releasing apparatus in a disabled or ineffectual condition by means of an arming device which will be automatically operated at some preassigned depth under water for putting the releasing apparatus in an enabled condition for subsequent operation.

One embodiment of an arming device in accordance with this invention is designed to be operatively responsive to an assigned amount of hydrostatic pressure. Accordingly, it utilizes a pressure-sensitive instrumentality represented in the drawings by a bellows 43 which may conveniently be made of molded rubber forming a watertight chamber having a flexible circumferential ridge 44. In order to provide a strong backing plate for the bellows 43, the previously mentioned large nut 15 has a concavity formed therein of such size as to snugly receive the right half of the bellows 43. This half of the bellows 43 is preferably firmly bonded to the nut 15 so that the bellows 43 and the nut 15 can be handled as a unit.

The bellows 43 is received within a hollow protuberance 45 formed on one side of the body member 1. The external opening of this protuberance 45 is threaded so that the nut 15 can be securely retained therein. It is to be noted that, when the nut 15 is fastened in place, the bellows 43 does not completely fill the interior of the protuberance 45. Instead, the interior of the protuberance 45 is made substantially larger than the bellows 43 so as to form a chamber 46. A hole 16, previously mentioned above, extends from the outside surface of the protuberance 45 into the chamber 46 for the purpose of admitting water thereto so that the surrounding hydrostatic pressure will be applied to the bellows 43 during the underwater lowering process.

The left half of the bellows 43 has a small metallic plate 47 securely bonded thereto for movement therewith. The plate 47 holds the right end of a rod 48 which is attached thereto by means of a swivel 49. The reason for using the swivel 49 is that, since the bellows 43 is bonded to the nut 15, the bellows 43 will turn whenever the nut 15 is turned on its threads but, due to the swivel connection 49, the rod 48 will not turn. This rod 48 is slidably received within a slot formed in the body member 1 which prevents any irregular up-and-down motion of the rod 48. The extent of the sliding movement of the rod 48 is controlled by the bellows 43. Thus, when the bellows 43 is in its fully expanded condition, the rod 48 will be in the position shown in Fig. 2. When the bellows 43 becomes compressed as is described hereinafter, the rod 48 will be pulled into the position shown in Fig. 4. It is to be noted that the left end of the rod 48 is slanted for a purpose that is explained hereinafter.

As is shown in Fig. 2, when the bellows 43 is in its normally uncompressed condition, the left end of the rod 48 extends under the roller 33 on the pawl 32 and abuts against the tooth 42 on the plunger 18. It can be understood that, in moving to this position, the slanted end of the rod 48 will slide under the roller 33 and will force the pawl 32 upward against the bias exerted by the spring 34. Thus, when the rod 48 is in this position, it holds the roller 33 and the pawl 32 out of engagement with the tooth 42 thereby locking them in an ineffectual condition.

This serves to disable the releasing apparatus in a

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manner that will now be explained. Assuming that the hoop 12 is moved so as to cause the arms 13 to tilt, then the eye 27 will be moved upward as is shown in Fig. 4. This causes the link 29 to pull the bell-crank 30 upward about its pivot 31 as is also shown in Fig. 4. In so moving, the bell-crank 30 will shove the pawl 32 and the roller 33 toward the left. Since the roller 33 is now held out of engagement with the tooth 42, the movement of the pawl 32 and the roller 33 will be ineffectual at this time to accomplish any useful purpose. Thus, the arming equipment, comprising the bellows 43 and the rod 48, functions to disable the releasing apparatus with the result that the pelican hook 6 is locked in its closed position so that the cable 11 cannot be prematurely released.

As was stated above, the purpose of the arming mechanism is to prevent the cable 11 from being prematurely released due to accidental operation of the releasing apparatus. It can be understood that such unintentional actuation of the releasing apparatus would be most liable to occur during the procedure of moving the lowering device from the ship and placing it in the ocean. After the device has been immersed in the ocean and has been lowered to a safe distance beneath the ship, there would be only a slight chance of the hoop 12 and the arms 13 becoming accidentally operated during the subsequent lowering process. Therefore, as a practical matter, the releasing apparatus can be unlocked and placed in its efficacious condition at some empirically selected depth, such as 33 fathoms. Accordingly, when this selected partial extent of the underwater lowering process has been completed, the arming mechanism is designed to become operatively responsive for the purpose of unlocking the releasing apparatus and putting it in an enabled condition. This can be conveniently accomplished by so selecting the thickness and quality of the rubber forming the bellows 43 that it will become fully compressed in response to that amount of hydrostatic pressure which corresponds to the particular depth that has been selected.

This objective is attained in a manner that will now be explained. It can be understood that, when the lowering device is first immersed in the ocean, sea water enters the hole 16 and fills the chamber 46. During the process of descent, the instantaneous hydrostatic pressure surrounding the lowering device will be transmitted through the hole 16 and into the chamber 46 where it will be applied to the bellows 43. The right half of the bellows 43 is unable to yield in response to this pressure because it is securely bonded to the nut 15 as was described above. However, the left half of the bellows 43 is able to yield with the result that it becomes compressed by the hydrostatic pressure and is gradually forced inward toward the nut 15 while carrying with it the metallic plate 47 and the rod 48. The extent of this travel is terminated when the bellows 43 becomes fully compressed as is shown in Figs. 3 and 4.

Referring now to Fig. 3, it can be seen that the compression of the bellows 43 has caused the rod 48 to move a sufficient distance for it to become withdrawn from its former position under the roller 33. Accordingly, this permits the spring 34 to force the pawl 32 downward thereby bringing the roller 33 into contact with the plunger 18 and into engagement with the tooth 42. Now, when the bell-crank 30 is moved upward about its pivot 31 in response to the upward movement of the link 29 in the manner described above, this motion of the bell-crank 30 will shove the pawl 32 toward the left with the result that its roller 33 will push against the tooth 42 and will consequently slide the plunger 18 toward the left as is represented in Fig. 4. This actuates the toggle links 35 and 36 and causes them to move the catch 7 upward thereby terminating the retention of the cable 11 by the pelican hook 6 as was explained above.

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When the cable 11 is thus released from the pelican hook 6, it is desirable that personnel on board the ship be informed of the operation of the releasing mechanism. Accordingly, the lowering device is equipped with signaling means for this purpose. One embodiment of such signaling means includes a glass ball 51 located within a cavity in the body member 1 and retained therein by means of the ring 19 that was previously mentioned above. This ring 19 is threaded so that it can be readily removed from the body member 1. It is also provided with a central bore 52 having a somewhat smaller diameter than the glass ball 51. The signaling means further comprise a small plunger 53 that is slidably mounted in the body member 1 with one end near the upper toggle link 36 as is indicated in Fig. 2. The other end of the plunger 53 is positioned close to the glass ball 51 and is so shaped as to form a point. This pointed end of the plunger 53 is normally prevented from pressing against the glass ball 51 by means of a coiled spring 54.

When the releasing apparatus is operated, the plunger 18 is moved to the left, as was explained above, thereby causing its pins 38 to snap the toggle links 35 and 36 into the position shown in Fig. 4. In moving to this position, the upper toggle link 36 will strike the head of the plunger 53 with sufficient force to cause its pointed end to implode the glass ball 51 as is represented in Fig. 4. This produces a sound signal which can be detected by a hydrophone at the ship, thus providing an indication of the actuation of the releasing apparatus.

In the event the releasing apparatus should fail to operate, it can be understood that, instead of hauling the lowering device and the cable 11 back up to the ship, it would be preferable to employ some form of emergency equipment for effecting the release of the cable 11. Therefore, the lowering device is provided with such emergency equipment which, in this embodiment of the invention, includes the hydrophone 17 that was previously mentioned above. The output terminals of the hydrophone 17 are connected to a relay 55 which controls an energizing circuit leading from a battery 56 to a solenoid 57. This solenoid 57 is provided with a large armature 58 which is securely mounted on an extension 59 of the plunger 18 for movement therewith.

This emergency equipment is designed to operate in response to the reception by the hydrophone 17 of an assigned low frequency sound signal transmitted under water from the ship. When this signal is received at the hydrophone 17, it is converted into electric energy in a manner well known to those skilled in the art. The electric energy thus produced is applied to the relay 55 which responds by operating its armature to close the energizing circuit of the solenoid 57. Upon being thus energized, the solenoid 57 moves its armature 58 from the position shown in Fig. 2 to the position shown in Fig. 4. Since the armature 58 is attached to the extension 59 of the plunger 18, this movement of the armature 58 produces a corresponding movement of the plunger 18 which, in turn, effects the actuation of the toggle links 35 and 36 thereby operating the catch 7 and releasing the cable 11.

It is to be understood that the relay 55 remains energized only during the time that the hydrophone 17 is receiving the signal from the ship. When this signal is terminated, the relay 55 ceases to be energized and consequently releases its armature thereby opening the energizing circuit of the solenoid 57. Although the solenoid 57 now becomes deenergized, its armature 58 remains in its operated position until the plunger 18 is manually returned to the position shown in Fig. 2 as is described hereinafter.

Considering now the over-all manner in which the lowering device of this invention is used, let it be assumed that the device is on the deck of a ship with its components in the condition illustrated in Fig. 2 in pre-

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paration for the lowering process. In order for a cable bight 11 to be retained by this device, the bolt 10 is withdrawn so as to detach the sleeve 9 from the chain 8. A portion of the cable 11 is then placed in the longitudinal trough formed in the sleeve 9. After this has been done, the bolt 10 is replaced so that the sleeve 9 is again suspended from the chain 8. This results in the cable 11 being held in the manner shown in Fig. 1.

The lowering device and the cable 11 are now hoisted above the deck and are swung over the side of the ship. They are then lowered into the ocean by means of rope 4 which has its rate of movement controlled by a winch. During these operations, the hoop 12 is liable to become accidentally tilted, such as by being bumped against the side of the ship. However, the cable 11 will remain held by the lowering device because its releasing apparatus is disabled at this time due to the arming mechanism being in its unoperated condition as is shown in Fig. 2.

When the lowering device is immersed in the ocean, sea water will enter through the hole 16 into the chamber 46 surrounding the bellows 43. During the underwater descent of the lowering device, the surrounding hydrostatic pressure will gradually increase with the result that the bellows 43 will become compressed as was explained above. Assuming that the thickness and quality of the rubber forming the bellows 43 have been so selected that the bellows 43 will be fully compressed at the assigned depth of 33 fathoms, then, when this depth is reached, the rod 48 will be withdrawn from under the roller 33 thereby enabling it to engage the tooth 42 and thus arming the releasing apparatus. In other words, the arming mechanism, comprising the bellows 43 and the rod 48, responds to the completion of this selected partial extent of the underwater lowering process by putting the releasing apparatus in an enabled condition for subsequent operation.

The releasing apparatus will remain in its enabled condition until either the hoop 12 is actuated or the relay 55 is energized. Considering firstly the actuation of the hoop 12, it can be understood that, when the cable bight 11 reaches the ocean floor, it assumes a position compatible with any tension or stress to which it may be subjected. Any tendency to form an upright loop or kink of the portion of the cable within the sleeve 9 is prevented by the hoop 12 which continues to descend until it rests over the cable 11 and the sleeve 9 upon the ocean floor. Since this contact between the hoop 12 and the combination of the ocean floor, the sleeve 9, and the cable 11 is ordinarily not level, it will usually cause the arms 13 to become tilted so as to pull the link 29 upward as is represented in Fig. 4.

However, it is possible that the hoop 12 might settle squarely on the ocean floor without tilting its arms 13. In this event, the body member 1 would continue to move downward with the spring 25 becoming compressed until the upper ends of the slots 14 are supported upon the arms 13. This relative motion between the body member 1 and the arms 13 causes substantially the same upward movement of the link 29 as that described above.

Thus, in either event, the link 29 is pulled upward so as to move the bell-crank 30 about its pivot 31 as is shown in Fig. 4. Since the roller 33 is now in contact with the tooth 42, the plunger 18 is consequently pushed to the left. Although the extension 59 of the plunger 18 carries the armature 58 inside the solenoid 57, this does not serve any useful purpose at this time. The leftward movement of the plunger 18 snaps the toggle links 35 and 36 into their operated positions shown in Fig. 4. This causes the lower toggle link 35 to pull the catch 7 out of engagement with the pelican hook 6 which accordingly swings downward to its open position thereby releasing the chain 8, the sleeve 9, and the cable 11. At the same time, the upward movement of the upper toggle link 36 implodes the glass ball 51 to produce a

signal indicative of the actuation of the releasing apparatus.

As was explained above, if the releasing apparatus should fail to operate, then a low frequency sound signal is transmitted under water to the hydrophone 17. This causes the relay 55 to become energized which, in turn, effects the energization of the solenoid 57. Accordingly, the solenoid 57 draws its armature 58 into the position shown in Fig. 4 with the result that the plunger 18 is moved into its operated position and performs the functions described above.

After the cable 11 has been released, the winch on board the ship is operated to pull up the rope 4 for the purpose of retrieving the lowering device. The chain 8 and the sleeve 9 are considered to be expendable and remain on the ocean floor with the cable 11. As soon as the weight of the lowering device is supported by the rope 4, the hoop 12 and the arms 13 will return to their normal condition. This permits the link 29 and the bellcrank 30 to resume their positions shown in Fig. 2. However, the roller 33 on the pawl 32 will temporarily remain in contact with the plunger 18.

During the hoisting process, the hydrostatic pressure surrounding the bellows 43 is gradually reduced thus permitting the bellows 43 to return to its normal condition by the time the lowering device emerges from the ocean. This movement of the bellows 43 pushes its associated rod 48 toward the left with the result that the slanted end of the rod 48 forces the roller 33 and the pawl 32 to move upward into their ineffectual condition shown in Fig. 2. Accordingly, any tilting or upward movement of the arms 13 will not perform any useful function at this time.

When the lowering device has been brought back to the deck of the ship, another chain 8, carrying another sleeve 9, is hung on the pelican hook 6 which is then manually swung upward to its closed position. The extended portion of the plunger 18 is manually pushed inside the body member 1 to return the toggle links 35 and 36 to their normal condition shown in Fig. 2. This causes the lower toggle link 35 to move the catch 7 downward so as to lock the pelican hook 6 in its closed position. Since the upper toggle link 36 has now moved away from the plunger 53, the spring 54 will return the plunger 53 to its unoperated position. The ring 19 is now unscrewed and the fragments of the broken glass ball 51 are removed from the cavity in the body member 1. A new glass ball 51 is then inserted into this cavity and is retained therein by replacing the ring 19.

If it should subsequently be desired to have the releasing apparatus armed at a depth different from the above-mentioned depth of 33 fathoms, this can be accomplished by substituting another bellows for the bellows 43. The substitution is effected by unscrewing the large nut 15 and removing it together with the bellows 43 and the associated rod 48. It is to be noted that, during this procedure, the rod 48 does not turn in its slot due to the above-mentioned swivel 49 which connects it to the plate 47 affixed to the bellows 43. A different bellows 43, which is designed to become completely compressed by the desired amount of hydrostatic pressure, is then inserted into the chamber 46 together with a corresponding rod 48 and nut 15.

In the event that it should be desired to operate the releasing apparatus before the lowering device has reached the ocean floor, this can be accomplished by means of the emergency equipment comprising the hydrophone 17, the relay 55, and the solenoid 57. Accordingly, by transmitting the above-mentioned low frequency sound signal to the hydrophone 17, the relay 55 will become energized and will, in turn, cause the solenoid 57 to become energized as was described above. This will actuate the armature 58 and will cause it to move to the left carrying with it the plunger 18 and thereby operating the releasing apparatus. The releasing apparatus can be op-

erated in this manner at any time during the underwater lowering process regardless of whether the bellows 43 has been compressed to perform its arming function.

It is to be understood that this invention has been described above with reference to a specific underwater lowering device for the purpose of explaining the principles and features of operation of the invention. It is to be further understood that this invention is not to be restricted to this particular embodiment as various modifications may be made without exceeding the scope of the invention. For example, instead of using an implosive signaling device, such as the glass ball 51, an explosive charge could be employed or the plunger 53 could be designed to release a buoyant device which would rise to the surface of the ocean. Also, the arming equipment could utilize a temperature-sensitive device in place of the pressure-sensitive instrumentality represented by the bellows 43. In addition, the arming apparatus and the emergency equipment could be designed to use timing mechanisms or water-soluble materials for initiating their operation.

What is claimed is:

1. A device for lowering an object to the bed of a body of water, said device comprising holding means for retaining an object during the underwater lowering process, releasing means for effecting the termination of the retention of an object by said holding means, said releasing means including a slidable plunger operating means adapted to be normally actuated by contact with the bed of a body of water for operating said releasing means, said operating means including a plurality of arms having their lower portions protruding beneath the bottom of said device, means in said device for supporting the upper portions of said arms for movement thereof in response to contact with the bed of said body of water, said operating means further including an instrumentality adapted to operate said plunger, said instrumentality being linked to said arms for movement therewith, and control means for normally rendering premature actuation of said operating means ineffectual to accomplish the operation of said releasing means, said control means including a rod interposed between said instrumentality and said plunger, and limiting means for terminating the control normally exercised by said control means over the premature actuation of said operating means, said limiting means including a hydrostatically operated member responsive to the completion of only a selected partial extent of said underwater lowering process for withdrawing said rod from interposition between said instrumentality and said plunger.

2. A device for lowering an object to the bed of a body of water, said device comprising a hook having a closed position for retaining an object during the underwater lowering process, said hook also alternatively having an open position for releasing an object retained by said hook when in its closed position, locking means including a toggle linkage for holding said hook in its closed position, means for normally maintaining said hook in its closed position during the underwater lowering process, releasing means including a plunger adapted to operate said toggle linkage for enabling said hook to move to its open position, coupling means for coupling said toggle linkage to said plunger for movement therewith, said releasing means being normally unoperated, and operating means adapted to be actuated by contact with the bed of a body of water for operating said releasing means, said operating means including a hoop encircling said hook, said hoop having a plurality of arms attached thereto, said arms being so constructed and arranged as to meet in a common center portion, means for supporting said arms for permitting movement of said arms and their common center portion in response to contact between said hoop and the bed of the body of water, said operating means further including actuating means for actuating said plunger, said actuating means

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being linked to the common center portion of said arms for movement therewith.

3. A device in accordance with claim 2 for lowering an object beneath the surface of a body of water, said device additionally comprising second operating means for operating said releasing means at any time during the underwater lowering process, said second operating means being operatively effective alternatively with respect to said first mentioned operating means, and said second operating means including a hydrophone and an electromagnetic instrumentality adapted to be energized by said hydrophone for effecting the actuation of said plunger.

4. An underwater lowering device in accordance with claim 2 and further comprising signaling means responsive to the actuation of said releasing means for trans-

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mitting to the surface of said body of water a signal that is indicative of the actuation of said releasing means, said signaling means including an instrumentality adapted to be operated by said toggle linkage when actuated by said plunger.

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