

[54] **DEVICE FOR CUTTING THE ANCHOR CABLES OF SEA MINES**

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[57] **ABSTRACT**

Two substantially parallel mine-sweeping lines are hauled by a boat, such as a mine sweeper, with floats at their ends which cause the sweeping lines to diverge. Water kites cause the sweeping lines to which cable cutting devices are attached, to move at a predetermined depth. Each cutting device comprises a mine anchor cable engaging member which owing to the pressure of an anchor cable against it releases first a mechanical impact member which, in turn, actuates a piezo-electric sensor whose voltage impulse ignites an explosive charge on said member destroying or cutting the anchor cable.

Subsequently, a second explosive charge on said member is ignited, which releases the cutting device from the mine-sweeping line.

12 Claims, 3 Drawing Figures

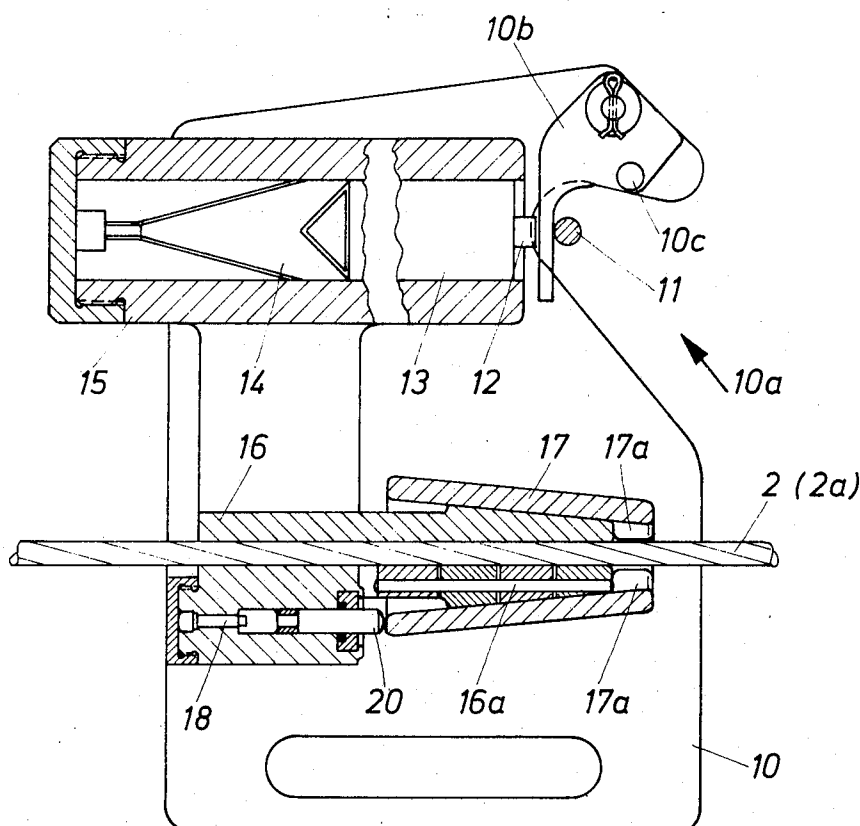


Fig. 1

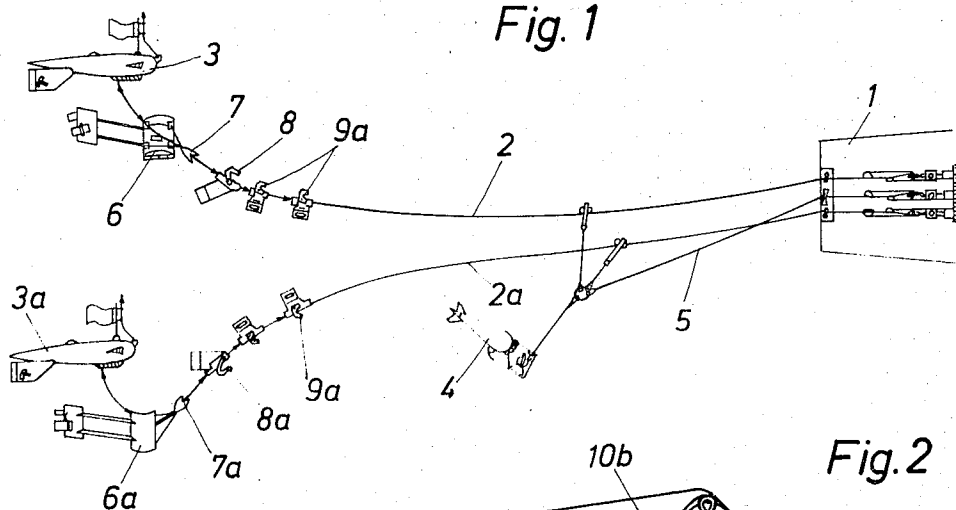


Fig. 2

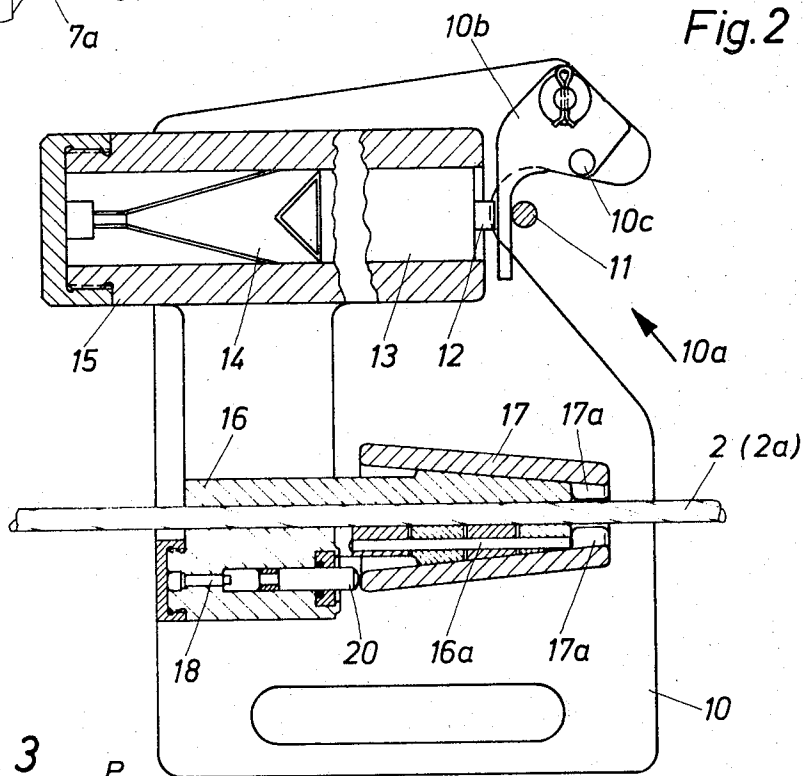
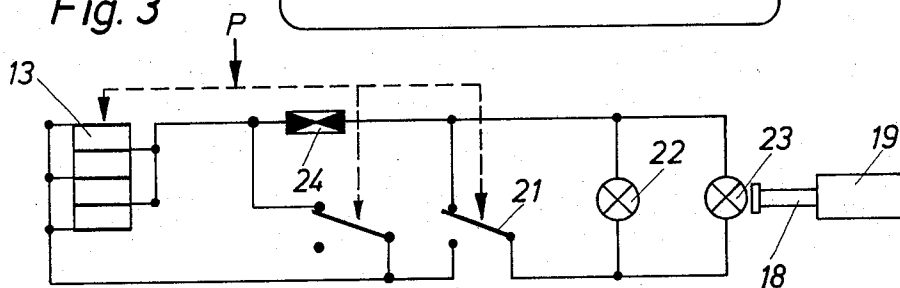


Fig. 3



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DEVICE FOR CUTTING THE ANCHOR CABLES OF SEA MINES

The invention relates to a device for the cutting of the anchor cables or the like of sea mines, whereby two mine sweeping mines emanating from a trawler extend at first substantially parallel to one another, then are spread by means of floats in a diverging course and finally are held in the desired depths by means of a water-kite. On these wires are attached a variable plurality of devices for the cutting of the anchor cables or the like of sea mines, whereby the cutting of the anchor cables takes place by the ignition of an explosive charge, which is just as much integrating constituent of each cutting device as is the means for releasing the device from its sweeping wire.

Sea mines are a maritime weapon of great importance. They serve essentially for the blocking of enemy water-routes, harbor entrances or the like. In addition, sea mines also permit of being used defensively, in that they are utilized for the blocking off of one's own coastal waters, harbor entrances or the like.

In general, two types of mines are to be differentiated, namely, anchor-cable-mines and bottom mines. The ignition of these mines may be of manifold type: anchor-cable-mines as a rule are equipped with devices, which are ignited upon contact with a body floating in the water, for example, the hull of a boat (contact-ignition). For the defense against submerged traveling U-boats for example, bottom mines are used, which selectively operate with magnet- or with acoustic-ignition, or, however, may also be equipped in combination with both types of ignition.

The invention described in the following has to do solely with the area of anchor-cable-mines.

Anchor-cable-mines may be laid down to a depth of approximately 400 meters. Their effect is relatively great through the favorable damming of the water. The mine casing consists of metal and in most cases has a spherical form. It contains an explosive charge, an ignition device, a blasting canister, and a contact- and unpriming- or disarming- device (the latter prescribed according to the VIIIth Agreement at The Hague relating to the laying of submarine automatic contact mines of 1907, which still today forms the basis of martial law of the sea for the use of sea mines), as well as an attachment to the anchor-cable.

The mine laying procedure and the adjustment of the mine to a predetermined depth takes place for example with the leading anchor-cable-mine as follows:

Mine and anchor are thrown overboard; the mine floats up again by virtue of a buoyancy air-space. Thereupon the leading weight is released, so that mine and anchor float further on the surface of the water. As soon as the lead-weight has reached the depth position of the mine, the anchor is removed from the mine, the anchor casing is flooded, and the anchor cable starts or runs off; it is braked and held tight as soon as the lead-weight has reached the bottom of the sea. Now, the anchor takes the mine along downwardly until it is deposited on the bottom. When the mine has reached its final position, a pull on the anchor cable brings about (through upthrust of the mine) a release of the contact-lock in the ignition circuit, and the mine is primed.

This procedure of the mine-laying makes it very clear with what care, accuracy and conscientiousness, this work must be carried out, in order to obtain an effective

weapon, still the detection of laid mines is not of lesser importance:

The detection- and mine-sweeping devices employed by trawlers, particularly mine-detection- and mine-sweepers comprise generally steel lines, which are kept by water-kites at a predetermined depth (approximately 5 to 20 m), in order to sweep the anchor cable of the mine and then cut the anchor cable but mechanically operating cutting devices or explosive bodies and bring the mine to floating position, in order to render it harmless possibly by firing at the same from the trawlers.

A known mine-detector-method still used even today operates as follows:

On the stern of the trawler, such as a mine-detector, mine sweeper or the like, two mine sweeping paid lines are out, whose length amounts to approximately 650 m. The course of the two lines is somewhat parallel over a relatively large stretch. Toward its ends the two lines diverge, however, when dragged by a float attached at each of its ends. Furthermore, each line has attached thereto in series a shearing kite a double cutting gripper and several firing bolt grippers in direction of the stern of the boat. The firing bolt grippers are constructed as single cutting grippers; their number is dependent upon the manner of cruising of the boat. On the parallel parts of both sweeper lines, are arranged each a guide roller for the guidance of the kite controlling the depth control, whose depth course may be made variable through letting out or hauling in of a line attached to the stern of the boat.

In this known mine-detector-method, the boat travels with definite speed, and with an operative detection device in the detection areas assigned to it. By maintaining the depth of the detection device, one of the sweeper lines may hopefully contact the anchor cable of a mine. As a result of the forward movement of the boat, the anchor cable now slides along on the sweeper line until it reaches the first (of several), firing bolt grippers attached to the sweeper line and is fixed thereon by its clamping jaw. Through the pull which is exerted by the traveling boat on the sweeper line and exerted by the latter on the anchor cable fixed in the clamping jaw, either a mechanical cutting gripper or, however, a firing bolt gripper is released, which finally destroys the anchor cable and brings the mine fastened to the same to floating position, so that, as always mentioned, it can be destroyed by firing at the mine with weapons from the deck of the boat.

It is believed to be obvious that particularly the mechanical cutting bolt grippers which contain a large number of individual parts must be constructed especially sturdily, in order to withstand not only the rough sea- and deck-operation, but also the cutting of the anchor cable of the mine. The condition is the same also with firing bolt grippers, which on account of the effect of sea passage, etc. are inclined to fail in igniting the explosive charge.

It is an object of the invention to replace the known cutting bolt gripper with its relatively many individual parts by an improved firing bolt gripper which has a smaller number of easily produceable individual parts, and which completely excludes ignition- and other failures or misfirings of the explosive charge.

According to the invention, the ignition of the explosive charge directed to an anchor cable disposed in the clamping jaw takes place by means of a pressure im-

pulse produced through the traveling speed of the boat on a piezo-electric sensor associated with the explosive charge, said sensor converting the pressure impulse, in a manner known per se, into a voltage impulse which without delay effects the ignition of the explosive and which at the same time — if need be controlled by a delay member — ignites a second explosive charge, which brings about the operation of a mechanical member which releases the cutting device from the mine sweeper line.

Of particular importance is a further development of the invention, in which the cutting of the anchor cable takes place by means of an explosive charge directed to the anchor cable and which consists of a hollow-(explosive)-charge, known per se.

In accordance with another object of the invention the gripping jaw is associated with a lever rotatably disposed outside of the jaw, and from which the pressure forces emanating at a corresponding ratio from the anchor cable located in the gripping jaw, are transmitted to the piezo-electric sensor.

In a further development of the invention, the lever is arrested by a pin which is sheared off under pressure of the anchor cable, whereby the lever after overcoming a distance member lying between it and a pressure member connected with the piezoelectric sensor, strikes the pressure member with at least the available shearing force, the explosive charge is arranged on a supporting plate of the device in a housing sealed against sea-water, and resistant to pressure, whose outlet opening intersects at right angles the anchor cable located in the gripper jaw, and finally the piezo-electric sensor is arranged below the outlet opening.

According to still another object of the invention, an insert is arranged at definite parallel distance from the housing receiving the explosive charge, which serves for fastening the cutting-device on the mine sweeper, said insert holding the mine sweeper line by means of a sleeve provided with a hinge. In this connection, as a result of two further objects of the invention, the exterior of the insert facing the boat is provided with a cone, which corresponds with the sleeve constructed in similar manner and provided on its interior with several clamping jaws distributed about the periphery, and in the side of the insert facing away from the boat, a second, smaller explosive charge is arranged for effecting the cutting of the anchor cable, the energy of said explosive charge acting on a striker member slidably positioned axially parallel to the mine sweeper line, said striker member on its part separating the sleeve with a sudden shock from the cone of the insert and separating at the same time the mine sweeper line from the cutting device.

To the same extent as particular attention was paid to the development of the mechanical structural parts, and to the highest effective arrangement of the explosive charge, also the electric circuit required for the operation of the cutting device was carefully developed.

The invention provides that a switch is arranged in the electric circuit between piezo-electric sensor and the ignition means for the explosive charges, said switch shortcircuiting the piezo-electric sensor in its safe condition, for which purpose, in a further development of this invention the shortcircuit of the piezo-electric sensor is removed automatically upon bringing the cutting device out in the water.

The electric switch is completed in that the ignition means for the hollow (explosive-) charge is provided for the protection against static charges with a conventional Faraday shield.

It will be obvious and at the same time convincing that the present invention has quite a number of advantages.

Of these advantages there is to be mentioned first of all, the simple mechanical construction, which results in an economical production of the device. This the more, as both a storing of substitute parts as well as also the requirement of exchangeability and maintenance of production-tolerances is eliminated. Additionally there is also eliminated to a fargoing extent the servicing of the device, so that no qualified experts, such as mine mechanics, are necessary for the maintenance work, as the small amount of maintenance may be accomplished without difficulty by the regular sailors on board the boat.

Of substantial advantage is also the overall low weight. Through the use of electric ignition, according to the invention, by means of a piezo-electric sensor as well as the use of a hollow charge strictly aimed at the anchor cable or the like, all of the heavy mechanical parts used heretofore for a device of this type are eliminated. The weight of the device of the invention is rather determined by the control- or conducting-surface. On account of the substantially decreased weight, the sagging of the mine sweeper lines at all traveling points of the boats is held within reasonable limits.

The hollow charge provided for the cutting of a mine-anchor cable in the invention is measured optimally: due to the concentrated effect of this charge, as tests carried out have shown, high-strength anchor cables of the order of size of 10 mm. diameter, as well as also stud-link cables of the order of size of 20 mm. per link have been severed reliably and without any difficulties.

The opening for the entrance of an anchor cable, that is, the clamping jaw, — on account of the constructive features, may be made larger than in the conventional devices. It lies in the order of size of approximately 100 mm. The device may be used at air temperatures of approximately — 30° to +60° and is absolutely safe in operation.

As explosive material for the hollow charge, the invention employs reliable and permissible explosives.

When the device in accordance with the invention operates with an inserted hollow charge and with a piezoelectric sensor, which contains no movable parts, for example, no firing-pins, in its safe condition is short-circuited, the hollow charge itself cannot be ignited even upon a free drop from about 3 m height on a wooden board. The hollow charge, which is arranged similarly to the piezo-electric sensor in a light-weight metal housing is waterproof against an excess pressure of about 20 kp/cm², and therefore is operative.

In the device according to the invention, it is of particular advantage to provide a secondary explosive charge, which after a delayed ignition caused by a retarding member breaks the sleeve which connects the device with the mine sweeper line, so that after the ignition of this explosive charge, no remnants of parts of the device will remain on the mine sweeper line. The effect of this explosive charge is however, so calculated that with certainty, a damaging or destruction of the mine sweeper line is effectively avoided.

The advantages of the invention are in no manner limited to the ones mentioned in the foregoing. Of particular importance is, above all, the electric ignition principle coming into use which starts with the general knowledge, of inducing by means of mechanically produced forces, for example, tension- or pressure-forces, momentary high electric voltages in a piezo-ceramic sensor. These voltage impulses ignite in the device according to the invention, in a preconceived sequence first the hollow charge and then the explosive charge for the removal of the parts of the device from the mine sweeper line.

In the drawing, the invention is illustrated in an embodiment by way of example.

In the drawings:

FIG. 1 illustrates a conventional detection-apparatus dropped from the stern of a mine-detector- or mine-sweeper, respectively;

FIG. 2 illustrates a device of the invention when attached in operative position on a mine sweeper line, and

FIG. 3 is a block diagram of the electric circuit arrangement.

In FIG. 1 is indicated at 1 the stern of a mine-detector- or mine-sweeper, respectively. This boat is hauling two mine sweeper lines 2, 2a, whose length may amount to several hundreds of meters. The mine sweeper lines 2, 2a, when viewed from the stern of the boat, extend firstly somewhat parallel to one another. They assume, however, by the float 3, 3a attached to their ends a diverging course. The depth control of the detector-apparatus takes place by means of a suitably constructed water kite 4, which, on the other hand, is connected with the two mine sweeper lines and, on the other hand, is connected by a single line 5 with the stern of the boat. By paying out or pulling in of the line 5, the depth travel may be varied within predetermined limits.

In direction of boat stern 1, there are arranged on the mine sweeper lines 2, 2a, in addition to the two floats 3, 3a, the two shearing kites 6, 6a: two double-cutting grippers 7, 7a, two firing bolt grippers 8, 8a and a number of single cutting grippers 9, 9a whose number is dependent ordinarily on the manner of operation of the boat.

In view of the substantial costs, the substantial expense of producing the known single cutting grippers and also in view of the fact that under the motion of the sea, the known firing bolt cutting grippers are inclined to failure, the present invention provides that both gripper categories are replaced by a plurality of firing bolt grippers which are simpler in construction and manufacture and are also more reliable in effect under sea- and on-board-ship conditions.

In FIG. 2 is illustrated such a gripper. The upper part of the base plate 10 is provided with a gripper-jaw 10a. Above the gripper jaw 10a is rotatably mounted a lever 10b which normally is arrested by means of a shearing pin 10c. If now the anchor cable 11 of a mine enters the gripper jaw 10a, then through the pull on the mine sweeper line 2 (2a) produced by the travel of the boat, on the one hand, and the pressure of the mine-anchor-cable 11 on the lever 10b, on the other hand, the pin 10c is sheared off. Therefore, the lever 10b will strike against the pressure member 12, which is connected with the piezoelectric sensor 13. The pressure impulse produced upon the impact is converted in the piezo-

electric sensor, in a manner well known within the shortest period of time (about 8 . . . 10 μ s) into an electric voltage impulse. The electric voltage produced in this manner ignites the cutting charge 14 directed onto the mine-anchor-cable 11, and the anchor cable is destroyed or cut. The mine which was fastened to the anchor cable now floats to the surface of the sea on account of the buoyancy inherent in it and may be rendered harmless with deck weapons or the like. As a cutting charge is preferably used a hollow explosive charge of known material, which is arranged in the waterproof and pressure resistant housing 15, in such manner, that its hollow cone is directed directly toward the mine-anchor-cable 11 to be cut. The piezo-electric sensor 13 together with its pressure member 12 as well as the lever 10b striking against the same, is arranged below the hollow-explosive-charge, so that the latter may act directly on the mine-anchor cable 11.

With the destruction of the mine-anchor-cable 11, the cutting-device has accomplished its purpose. In order that the device does not, however, hamper the detection-or sweeping operation, respectively, of another mine, it is removed in the manner described in the following from the mine sweeper line:

On about the center portion of the base plate 10 is arranged — approximately in direction parallel to the hollow charge 14 — a mounting member 16, with which the cutting-device is attached to one of the mine sweeper lines 2, (2a). The attachment of the line takes place by the closing of a conically formed sleeve 17 which is attached by a hinge 16a to the mounting member 16. The reduced end of the conical sleeve is provided in its interior with several circumferentially distributed clamping jaws 17a for the clamping engagement with the mine sweeper line.

Upon the ignition of the hollow charge 14 already described in the foregoing, at the same time, through the retarding member 18, a charge 19 in the hinge 16a (FIG. 3) is ignited. This has the result that the impact member 20 is shot against the sleeve 17, and on account of the conical construction of the sleeve 17, the latter is axially moved and thereby is released from the mounting member 16 and the mine sweeper line 2, (2a) is released from the cutting device. After the separation of the cutting-device from the mine sweeper line, neither the cutting-device itself, nor any parts thereof will be found on the mine sweeper line, so that the anchor cable of another mine may be engaged by the next cutting device fastened to the mine sweeper line.

In FIG. 3, the electric circuit arrangement is illustrated in the form of a block diagram.

Referring to FIG. 3, the mechanical impulse P produced by the pressure of the mine-anchor-cable 11 is converted in the piezo-electric sensor 13 within a time period of 8 to 10 μ s into an electric impulse. The pressure impulse P at the same time closes the switch 21. The switch 21 short-circuits the piezo-electric sensor in the unactuated safe position, and this short-circuit is broken and the circuit completed to the charge when the switch 21 is actuated. As will be appreciated by those versed in the art, this can be accomplished by a two contact switch such as shown in FIG. 3. Hereupon the primer 22 provided for the ignition of the hollow charge 14 (FIG. 2) is ignited by the electric voltage and the hollow charge is brought into action. Another primer 23 is connected in parallel to the primer 22, the former igniting through the retarding member 18, the

explosive charge 19, which effects the removal of the cutting device from the mine sweeper line 2, (2a). For the protection against static charges, the primer 22 for the hollow charge 14 is provided with a conventional Faraday-screen 24 as charge eliminator.

What I claim is:

1. Mine sweeping apparatus with means for cutting the anchor cables of sea mines, comprising two mine-sweeper lines hauled by a sea-boat and firstly extending substantially parallel to one another, then spread by floats at the ends of the mine-sweeper lines to assume a diverging course, and held at the desired depth by water kites attached to the sweeper lines, whereby the cutting of the anchor cables is effected by an explosive charge which is mounted on a cutting device attached to a sweeper line, wherein the improvement comprises:

- an anchor cable receiving jaw;
- a piezo-electric sensor for converting a pressure impulse into an electric voltage impulse mounted on the jaw;
- a mechanical engagement member positioned on said jaw to be engaged by the cable to receive a pressure impulse and connected to said sensor to convert the pressure impulse from the cable to an electrical impulse;
- a first explosive charge on the jaw connected to the sensor to be ignited thereby;
- means for supporting the jaw on a mine sweeper line;
- and a second explosive charge connected to the sensor to be ignited thereby,
- said second charge connected to the jaw support means and releasing the jaw from the line with explosion of said second charge.

2. Device according to claim 1, in which the first mentioned explosive charge which is directed toward the anchor cable is a hollow-explosive-charge.

3. Device according to claim 1, wherein said mechanical engagement member includes a rotatably mounted lever on said cutting device having a cable gripper jaw, said lever transferring the pressure force exerted by the anchor cable in said jaw to said piezoelectric sensor.

4. Device according to claim 3, including a pin for arresting the pivotal movement of said lever, said pin being adapted to be sheared off under the pressure of the anchor cable entering said jaw, whereupon said lever engages a pressure member connected with said piezo-electric sensor with at least the available shearing force.

5. Device according to claim 1, in which said first

mentioned explosive charge is arranged in a housing mounted on a supporting plate of said cutting device, said housing being waterproof and pressure resistant, said plate having an opening intersecting at a right angle the anchor cable located in a gripper jaw, and that said piezo-electric sensor is arranged adjacent the outlet of said housing.

6. Device according to claim 1, wherein said jaw supporting means includes a mounting member arranged at a predetermined parallel distance from a housing containing the first mentioned explosive charge, said mounting member serving for the attachment of the cutting device to the mine sweeper line and including a conical sleeve provided with hinge means securing said sleeve to said mounting member.

7. Device according to claim 6, in which said conical sleeve is attached to said mounting member at the end facing the sea-boat, said conical sleeve being provided in its interior with several circumferentially distributed clamping jaws for engaging said mine sweeper line.

8. Device according to claim 6, that at the end of the mounting member facing away from the sea-boat said second explosive charge is arranged opposite said first mentioned explosive charge for cutting the anchor cable, the energy of said second explosive charge acting on a striking member axially slidably disposed parallel to the mine sweeper line, said striking member on its part separating said conical sleeve in a sudden burst from said mounting member and at the same time separating the mine sweeper line from the cutting device.

9. Device according to claim 1, including a switch in an electric circuit between said piezo-electric sensor and a primer for said explosive charges, said switch being adapted to short-circuit the piezoelectric sensor in a safe condition.

10. Device according to claim 9, in which the short-circuit of said piezo-electric sensor is automatically removed when said cutting device is lifted from the water.

11. Device according to claim 9, in which the primer for the first mentioned charge is provided with a Faraday-screen for the protection against static charges.

12. A mine sweeping apparatus constructed in accordance with claim 1, and including means connected to said second explosive charge for delaying the explosion thereof relative to the explosion of the first charge so that the jaw is released from the line after the cable is cut.

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