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Hess et al.

[11] **3,817,200**

[45] **June 18, 1974**

[54] **AMBIENT PRESSURE POWERED CABLE CUTTER**

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[21] Appl. No.: **135,409**

[52] **U.S. Cl.** ..... **114/221 A**

[51] **Int. Cl.** **B26d 1/26**, B26d 7/16, B26d 5/02

[58] **Field of Search** ..... 114/221 R, 221 A

[56] **References Cited**

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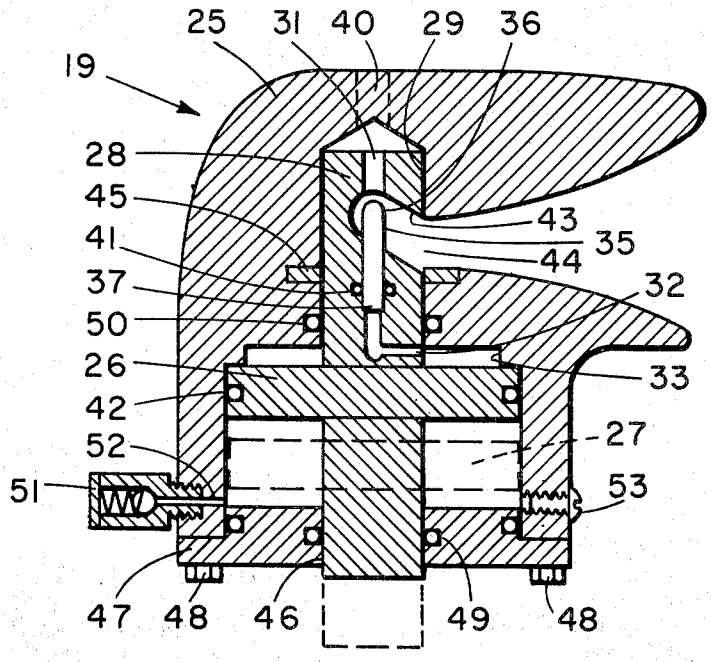
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[57] **ABSTRACT**

An underwater cable cutter consisting of a piston accommodated within a cylinder head and isolated from ambient pressure until the cable to be cut releases said pressure is provided. The trigger device is a glass tube sealed at its exposed end and open to a piston chamber at its open end. The piston is connected to a guillotine cutter positioned in the throat of the device such that the cable to be cut when guided into the throat actuates a valve, releasing water under ambient pressure through the open end of the valve to the exposed surface of the piston. Movement of the piston causes the guillotine cutter to sever the cable.

20 Claims, 8 Drawing Figures



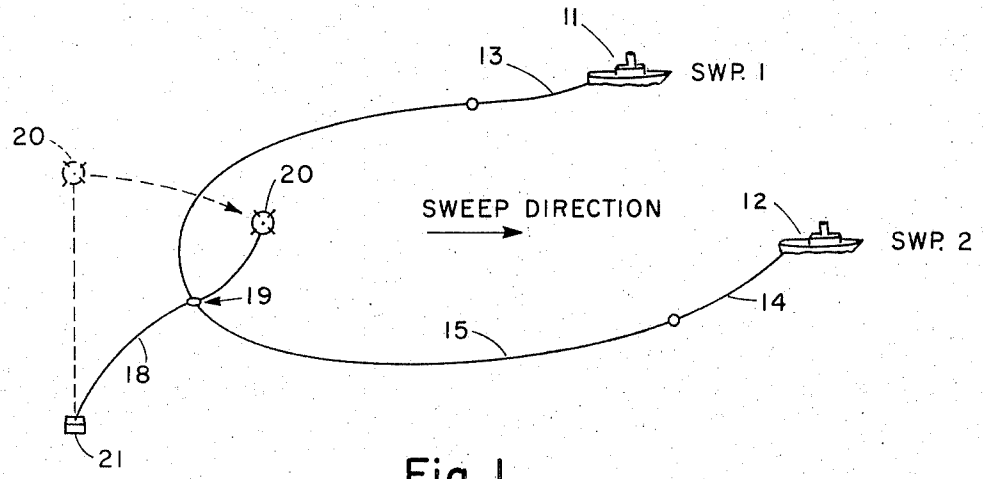


Fig. 1

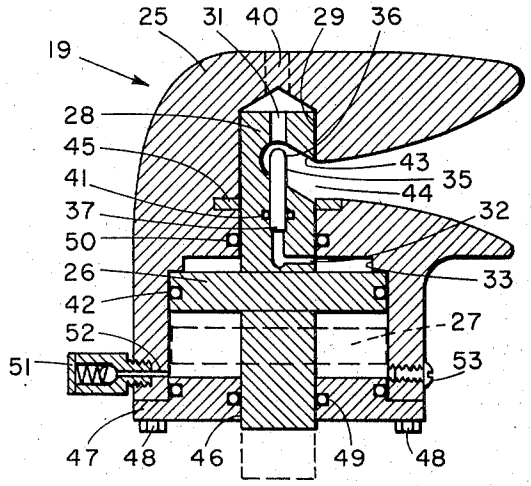


Fig. 2

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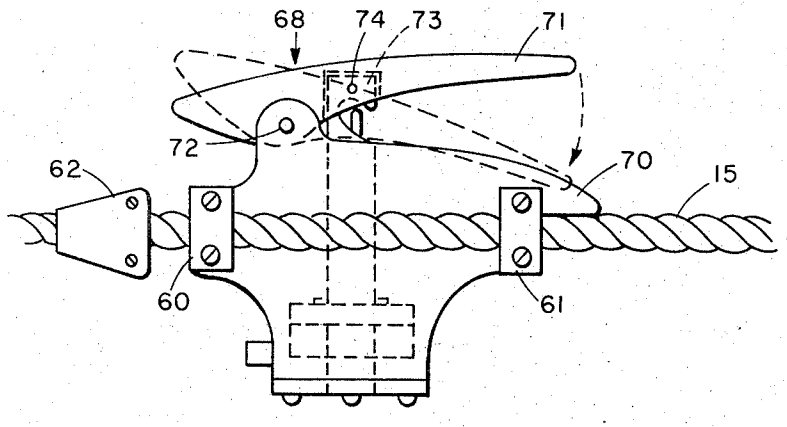


Fig. 4

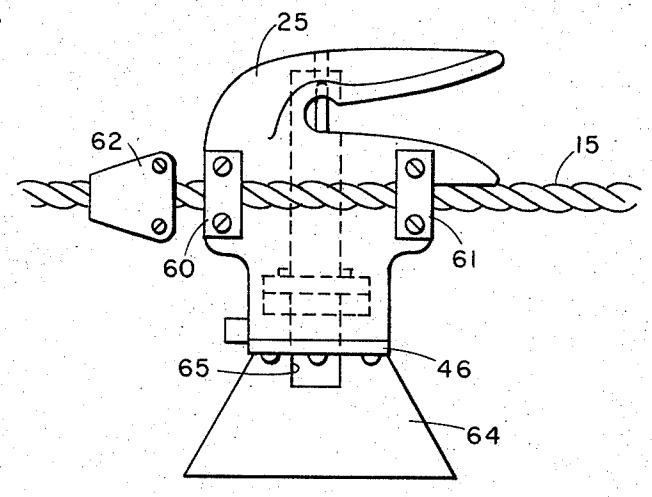


Fig. 3

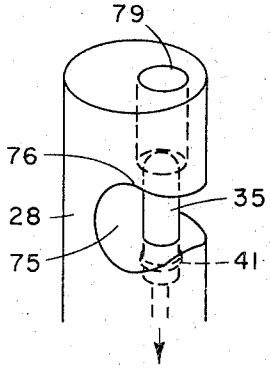


Fig. 5

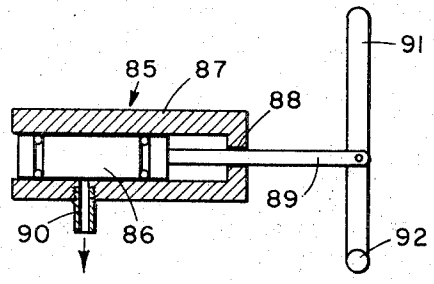


Fig. 6

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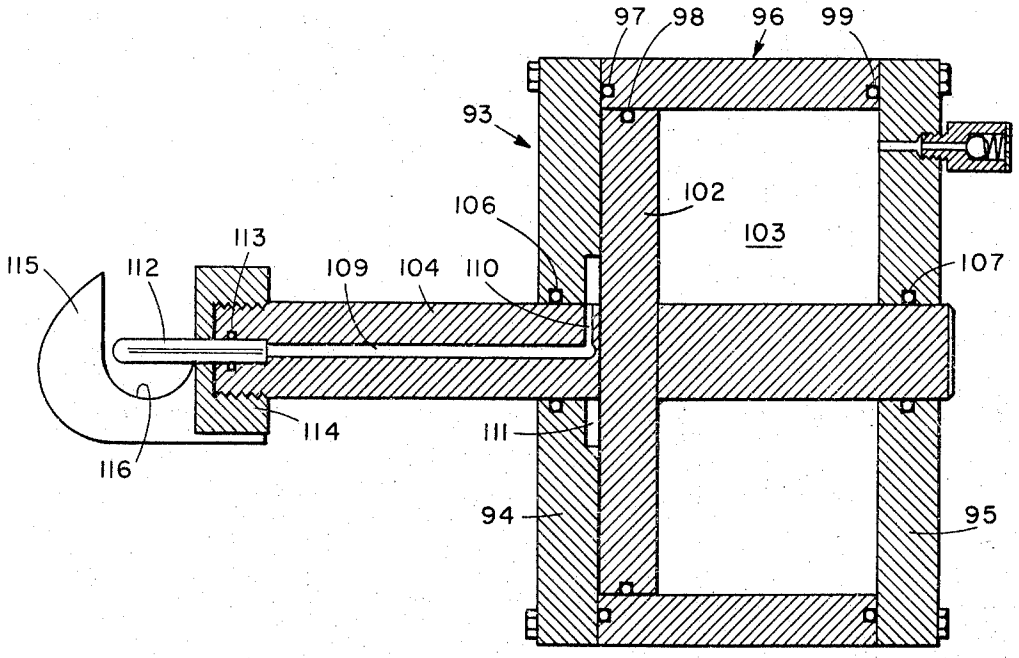


Fig. 7

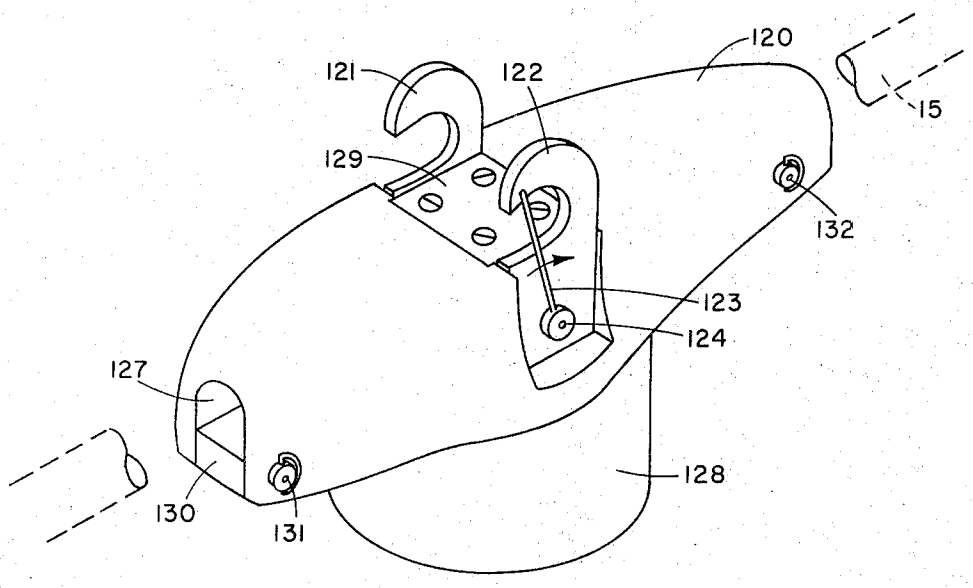


Fig. 8

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AMBIENT PRESSURE POWERED CABLE CUTTER

The invention described herein may be manufactured and used by or for the Government of the Unites States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to cable cutters and, more particularly, to a direct acting cutter which is actuated by ambient pressure at the depth where the cable is to be cut.

In underwater exploration where positively acting cable cutting devices are essential to sever cables at precise locations, the need has long existed for a reliable, effective cable cutter. For example, in antimine measures, when mine sweepers act in tandem towing a sweep wire which is submerged and intercepts the mine mooring cable, very often a cutter disposed along the sweep line is blocked from being actuated by the mine itself. When this happens, the mine and its anchor will drag through the water, the anchor bouncing along the bottom and presenting the danger to personnel and equipment of a live mine being snagged in the sweep gear.

Present cable cutters are basically of two types, one using the towing strain on the sweep wire to force the cable being cut into a pair of knife edges where the mine mooring cable is severed. When the tension on the mine mooring cable is sufficient, this method is fairly satisfactory. However, when the mooring cable is not sufficiently taut, the cable cutter and the sweep line are pulled along the sweep wire, eventually stopping at the mine since the mine will not slip through the "V" of the knife edges. Another method utilizes explosive means to cut the cable, the explosive means being included in a heavy body which receives the cable and slides down the mooring cable until an explosive cutter is actuated at a selected depth. Such explosive cutters operate satisfactorily at shallow depths; however, at deeper depths, the devices do not provide enough power to sever the cable. These explosive devices require careful handling, especially during reloading. The present invention avoids the many disadvantages of the prior devices and introduces a cable cutter which is completely inert and harmless out of the water environment and whose cutting capability increases with depth.

The cable cutter of the present invention has in the preferred embodiment a single slidable cutting blade which is connected to a piston disposed within the cutter, the blade being positioned in a throat into which the cable to be cut is directed by the sweep wire towed by a pair of mine sweepers. A piston is actuated by the cable to be cut by the cable breaking a glass tube closed at one end and communicating with the upper surface of the piston at its other end. When the tube is broken, water under ambient pressure is immediately forced through the tube to the exposed piston surface, acting thereon to provide a positive, instant piston actuating force which results in the cutter shearing the cable. As greater depths are encountered, a greater cutting force obviously is afforded by the ambient pressure.

Accordingly, it is an object of the present invention to provide a cable cutter which is operable at any depth and is powered by the pressure at that depth.

Another object of this invention is to provide an ambient pressure powered cable cutter wherein pressure

is released at the depth where the triggering means of the device is actuated.

A further object of the invention is to provide a cable cutter wherein the cable to be cut is the means for releasing ambient pressure which acts to sever the cable.

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

FIG. 1 is a schematic diagram of towing operations using two mine sweepers;

FIG. 2 is a schematic drawing in section of a preliminary embodiment of the invention;

FIG. 3 is a side elevation of the embodiment of FIG. 1 mounted on a sweep line with an appendage added;

FIG. 4 is a side elevation of another embodiment of the invention;

FIG. 5 is a detailed perspective drawing of the actuating means of the embodiment of FIG. 3;

FIG. 6 is a schematic drawing in section of an alternate trigger valve for use in the embodiment of FIG. 3;

FIG. 7 is a side elevation partly in section of an alternate embodiment of the invention; and

FIG. 8 is a perspective view of a further embodiment of the invention using twin cutters.

Referring to the drawings, FIG. 1 illustrates a mine sweeping operation using two mine sweepers **11** and **12**, each towing a cable **13** and **14** to which is connected a sweep line **15**. The sweep line is drawn through the water at a selected depth depending upon the speed of the sweep and other factors such that when intercepting a mine cable **18** that cable will slide or ride along the sweep line until a cutter **19**, which is affixed at a selected point on sweep line **15**, is intercepted. The desired operation then is for the forward motion of the sweep line to force the mine cable into the jaws of the cutter, actuating a cutting mechanism which causes the jaws to be closed and the cable to be severed. As indicated above, several factors may occur which together cause the cable to not be engaged in the cutter but instead result in the mine itself being drawn up to the sweep line and thereafter both the mine **20** and its anchor **21** being drawn through the water.

FIG. 2 illustrates in sectional view one embodiment of the cutter of the present invention which includes a main body **25** which is adapted to receive a piston **26** in a chamber **27** and a piston rod **28** which is slidably received in a transverse cavity **29** in the cutter. Piston rod **28** has a central passage **31** which extends through the rod and terminates in an outlet **32** which in the inoperative position communicates with the upper portion **33** of piston chamber **27**. Inserted in passage **21** is a glass tube **35** which is sealed at its upper end **36** and open at its lower end **37**, tube **35** being secured to piston rod **28** at end **37** in a watertight fitting. An opening **40** is provided in cutter body **25** to permit positioning tube **35** in passage **31** and an O-ring **41** is disposed about tube **35**. Piston **26** is provided with an O-ring seal **42** for preventing the escape of air or water between the seal and the cutter body. Chamber **27** is selectively shaped to allow piston travel to assure that a cutting edge **43** on rod **28** will traverse a throat **44** in the cutter body. A cable directed through throat **44** is cut by

shearing action between the right-angle edge 43 of piston rod 28 and a shear plate 45 which is disposed in cutter 19 in close proximity to the piston rod. At its base, piston rod 28 extends through an opening 46 in a plate 47 which is secured to the base of cutter body 25 in watertight engagement by conventional means such as bolts 48. O-rings 49 and 50 complete the seals about piston 28. An exhaust check valve 51 is secured at one side of piston chamber 27, communicating with the chamber through a passage 52, while a vent screw 53 is provided at a position in chamber 27 opposite to that of check valve 50.

FIG. 3 is a side elevation of cutter 25 and illustrates the manner in which the cutter is mounted on sweep line 15 by at least two clamps 60 and 61 which permit free revolution of the cutter about the sweep line. A stopper 62 is secured to the sweep line at a desired position therealong. Cutter 25 may have secured to closure plate 46 a fin or tail sheet 64, the tail sheet being cut away as indicated at 65 to receive the end of piston rod 31 when the device is actuated.

FIG. 4 illustrates an alternate embodiment of the invention wherein a cutter 68 is provided with a lower jaw 70 and an upper jaw 71, the latter pivotable about an axis 72 which is offset substantially from the vertical centerline of the device. Upper jaw 71 is retarded or restricted from opening beyond the open position shown by a piston rod-cutter 73 which is pivotally attached to upper jaw 71 by a pin 74. The piston rod-cutter is disposed substantially adjacent to pivot axis 72, upper jaw 71 being moved downward with piston rod-cutter 73 when the cutter is actuated and held down thereafter to present a faired surface to a mooring line or other object which may move along sweep line 15 after the cutter has been actuated.

FIG. 5 illustrates one manner in which piston rod 28 may be made to form a throat 75 which includes a right-angled cutting edge 76 along its upper periphery and accommodates glass triggering means 35. A clearance hole 79 is provided to permit insertion and replacement of the glass triggering means. The glass trigger tube is securely mounted at its base or open end in the cutter body and the opening or passage accommodating the tube is sealed by O-ring seal 41.

FIG. 6 shows an alternate triggering means 85 which uses an intermediate oil buffer to keep the corrosive seawater from the piston cylinder. A shuttle 86 is disposed in a cylinder 87 which is open at one end and provided with an opening 88 at the opposite end to accommodate a shuttle shaft 89. Shuttle 86 may be moved in either direction to open a valve 90 and admit either oil under ambient pressure or seawater through either the open end or about shaft 89 into the piston chamber. Shuttle 86 may be actuated by a lever arm 91 which is pivoted about an axis 92 which would replace the trigger actuator in a manner to be shown later. The shuttle is balanced on either side, i.e., with seawater or oil directly acting on both ends under ambient pressure. An embodiment using oil for the fluid medium would be disposed in a bladder or chamber, not shown, containing oil under ambient pressure. The only force to be overcome in actuating shuttle 86 is that necessary to overcome the friction in the O-rings which seal the shuttle in cylinder 87.

In FIG. 7, a cutter piston assembly is shown having a valve body 93 formed of upper and lower plates 94 and 95, respectively, secured and sealed to a cylinder 96. O-rings are inserted as indicated at 97, 98 and 99 to provide an effective seal against ambient pressure. A piston 102 is disposed in chamber 103 in the cutter, piston 102 having a piston rod 104 extending therethrough and penetrating both the upper and lower plates. The openings receiving piston rod 104 are sealed by O-rings 106 and 107, respectively. The upper portion of piston rod 104 is cored to provide passages 109 and 110 for admitting water under ambient pressure to a recess 111 in the lower surface of plate 94. The outer end of passage 109 is closed by a glass trigger means 112 which is sealed at its remote end against entry of water and along the opposite surface by an O-ring 113. A cutter head 114 is attached to the end of rod 104 by threading or other conventional means and carries a shearing member 115 having a throat 116 in which is positioned glass trigger means 112. A cable entering throat 116 is sheared by a shear plate, not shown, mounted in the cutter body, not shown.

In FIG. 8, a fourth embodiment is shown which includes a cutter body 120, dual cutting heads 121 and 122 and a rotary trigger arm 123 which is pivotable about an axis 124. The sweep wire 15 in this embodiment passes through an opening 127 in cutter body 120 in a free-moving manner so that the cutter body may slide freely along the sweep wire. Trigger arm 123 is connected interiorly in a manner not shown to a pressure-releasing lever arm such as 91 in FIG. 6 Actuation of cutter blades 121 and 122 is provided by movement of a piston, not shown, but similar to that in FIG. 7, having a piston rod 128 on which are mounted cutting blades 121 and 122. The cutter blades taper inwardly and cause a cable therebetween to be sheared against a replaceable shear plate 129. The opening 127 in cutter body 120 is closed by a longitudinal bar 130 which is removable and held in place by removable pins 131 and 132. These pins may be detent locking pins or other suitable removable pins.

In operation, the cutter of the present invention is secured about a sweep wire by means such as the two free-swinging clamps 60 and 61. With the cutter free swinging, motion of the sweep wire will cause the piston end of the cutter to be disposed outside the curve of the sweep wire, this effect being enhanced where the cutter is provided with a tail sheet such as shown at 64. With the cutter therefore deployed substantially parallel to the plane of the sweep wire, a mooring cable when encountered will slide along the sweep wire until it encounters the cutter at which time the cable will ride up the cutter in an attitude substantially transverse to the upper and lower jaws thereof. With the open jaws of the cutter thus facing upstream, i.e., in the direction of sweep motion, any mine or other mooring cable will, as described above, ride along the sweep wire and become engaged in the cutter.

As the wire enters the throat of the cutter, a frangible valve is broken or a lever arm is rotated, thereby exposing the passage connecting the trigger means and the piston chamber to water or oil under ambient pressure. Since the closed end of glass trigger means 35 is easily capable of withstanding pressure in any amount that is expected to be encountered, but at the same time easily broken by any movement which would attempt to bend it, it serves as a very effective watertight seal for keeping seawater under ambient pressure from reaching the upper surface of piston 26 in FIG. 2. When the trigger is broken, the passage through piston rod 28 allows sea-

water under ambient pressure to enter and drive the piston downward, pulling with it the rod and also cutting edge **43** in the throat of the guillotine. The opening in the cutter is shaped as shown in FIGS. **2** and **4** to curve sufficiently forward of the cable so that it catches the cable and prevents it from being moved in or forced out of the throat during the cutting action.

Since air entrapped in the cutter in chambers **27** or **103** is at one atmosphere, the piston in either embodiment when exposed to seawater at ambient pressure is driven away from the throat by a force directly related to the piston area and the operating depth. The cutting force available therefore varies with depth — of course, increases with depth. This force may be determined by the following equation:

$$F_{(lbs)} = (D/2)\ (A_{piston} - A_{rod}) \quad (1)$$

where D is depth in feet and A is cross-sectional area in inches^2.

For example, if the piston is 6 inches in diameter and the rod is 1 ½ inch in diameter, the force available at 1,000 feet is

$$F = (1{,}000/2)\ (28.26 - 1.77) = 500 \times 26.49 = 13{,}250 \text{ lbs.} \quad (2)$$

or over 6 tons.

A 4-piston with the same rod and depth would provide a force of 5,400 lbs.

For deep mine sweeping operations, the forces available from cutters having relatively small diameter pressure cylinders are nevertheless more than adequate to cut cables on one-half inch or more in diameter. The force available is a straight line ratio between depth in feet and piston area so that virtually any amount of force desired is obtainable by actuation of an appropriately sized piston.

Once the cable cutter has been actuated, resetting is a very simple procedure involving opening vent **53** and pushing the piston rod upward to the position shown in FIGS. **2** and **3**. Where conventional exhaust check valves such as that shown at **51** in FIG. **2** are used, the piston will remain in the downward or actuated position upon return of the cutter to the surface. Without such check valves, the release of pressure upon return to the surface would permit the air compressed in the lower part of the piston chamber to force the piston up at least part way. This could result in particles of the cut wire being jammed in a cutter thereby locking it in a downward position so that personnel handling the cutter might jar it loose to cause sudden upward movement and possible injury. The lower end of the piston rod protruding from the rear of the device could serve as a warning, if painted a bright, day-glow color, to alert personnel that the device has not been fired.

Glass trigger means **35** in FIG. **2** and **112** in FIG. **7** is an ordinary piece of 6mm glass tubing flame-tipped at one end which sits in a passage in the piston rod and is sealed with an O-ring as shown. In some operations it may be advantageous to provide for cutter actuation through the medium of an intermediate oil buffer. In such cases, the trigger valve shown in FIG. **6** may be substituted for the glass trigger means. In these instances, the shuttle to be actuated may be moved either upward or downward by conventional linkage such as lever arm **123** disposed alongside the throat of the cutter. The shuttle may be balanced with oil pressure on both sides or with seawater pressure on both sides so that in either event the only actuating force required is that necessary to overcome the friction of a pair of O-rings.

The cutter of the present invention preferably is made from a stainless steel casting to avoid the corrosive effects of seawater on the materials. Other materials having the desired strength may, of course, be used within the concept of the invention. The jaws of the cutter preferably are removable inserts of tool steel so that replacement of the piston rod will not be necessary in the event the cutter becomes dull or damaged.

The embodiment shown in FIG. **4** assures that a second mooring wire which may be encountered by the sweep wire after a first one may be severed will not become entangled in the already actuated cutter. The upper jaw of such an embodiment is shaped so as to provide a smooth run or faired surface over the cutter assembly when closed which will be encountered by succeeding wires. This outer or upper jaw need not have any considerable strength since it serves only to either guide a mooring cable into the cutter or, after firing, to guide such a wire over the cutter.

Although glass triggering means **35** provides a simple, reliable trigger mechanism and is substantially foolproof, it does not readily lend itself to use in the dual cutter embodiment shown in FIG. **8.** In such an embodiment, an alternate trigger mechanism such as rotary valve actuator **123** or a latched shuttle is preferred. If desired, a combination of glass tube and rotary valve actuator could be provided such that the trigger arm of the actuator would rotate a cam which would break the glass tubing, thereby admitting water under ambient pressure into the cutter.

There is thus provided a substantially foolproof and injury-proof cable cutter which uses the force available at any depth to do the cutting. This feature serves to have the cutting force increase with operating depth which is directly contrary to the effect of hydrostatic pressure on explosive cutters wherein the explosive cutters' force is opposed by ambient depth and therefore decreases with increase in depth. Also, no explosives of any sort are necessary with the present invention and the cutter is completely inert and harmless on the deck of the mine sweeper. A further advantage is, of course, that no problems are presented in the handling and storage of explosives.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. For example, the cutting member could be increased in area so as to grip a captured cable instead of cutting it, thereby preventing escape of an object or objects connected to the cable. Detents could be provided along the piston rod to prevent premature release of the captured cable. Also, a cable cutter of the present invention could be secured to one's own mine cable to sever enemy sweep wires.

What is claimed is:

1. A cable cutter actuable by ambient water pressure comprising:

a cutter body having at least one piston and a shaft cutting means secured thereto;

said piston and shaft cutting means being received in a seal chamber and a cavity transverse thereto, respectively, in said cutter body;

said shaft cutting means including throat means configured to receive and retain a cable therein and exposed to the environment;

means for rotatably mounting said cable cutter on a sweep wire with said throat means facing the direction of approach of a cable to be cut;

means in the area of said throat means for contacting a cable to be cut and when actuated causing water to be admitted under ambient pressure to said piston chamber; and

a shear plate in said cutter body for shearing a captured cable when said shaft cutting means is urged downward by motion of said piston in response to ambient pressure acting thereon.

2. The device in claim 1 wherein axial movement of said piston is controlled by said shaft cutting means in the unactuated condition extending through said piston, said piston chamber and a close-fitting opening in the adjacent portion of said cutter body,

said extension of said shaft cutting means protruding a substantial distance beyond said cutter body when said piston is in the actuated condition,

said protruding portion of said shaft cutting means serving as a visual warning that the device is in the actuated condition.

3. The device as defined in claim 2 and further including an exhaust check valve attached to said cutter body and communicating with the portion of said piston chamber remote from said throat means to evacuate said piston chamber upon actuation of said piston thereby precluding further movement of said piston and shaft cutting means.

4. The device as defined in claim 3 wherein said shaft cutting means and said throat means are a piston rod having a throat formed therein, and

a pair of jaws in said cutter body for intercepting a cable to be cut,

said jaws terminating at the throat of said piston rod.

5. The device as defined in claim 4 wherein said means in the area of said throat is a frangible tube extending into said throat,

said frangible tube being closed at the end disposed in said throat and open at the opposite end, and

a passage in said piston rod connecting said throat and said piston chamber,

said opposite end of said tube seated in sealing engagement in said passage.

6. The device as defined in claim 5 and further including vane means secured to said cutter body remote from said jaws and extending transverse thereto a substantial distance to align said cutter body with the direction of motion of said sweep wire, causing said jaws to be deployed more nearly transverse to a cable intercepted by said sweep wire,

said vane means being cut away to accommodate said extension of said piston rod.

7. The device as claimed in claim 6 wherein the upper jaw of said cutter body is recessed to receive the end of said piston rod,

said upper jaw being pivotable about an axis remote from said throat;

the end of said piston rod adjacent said throat being pivotally connected to said upper jaw; and

said cutter body being recessed to receive the end of said upper jaw when said piston has been actuated so that other cables or objects intercepted by the sweep wire will be diverted over the outer surface of said upper jaw.

8. The device as defined in claim 3 wherein said means for mounting is at least a pair of removable spaced clamps configured to receive said sweep wire in free-moving relationship.

9. The device as defined in claim 3 wherein said means for rotatably mounting a cable cutter is a passage extending longitudinally through said cutter body, said shaft cutting means includes a piston rod and at least a pair of spaced cutters extending outward from said cutter body and disposed parallel to said passage, and said contacting means includes a pivotable lever arm disposed adjacent to at least one of said cutters, a valve operable by said lever arm, and a passage connecting said valve and said piston chamber.

10. The device as defined in claim 9 wherein said cutters each have a throat portion,

said throat portions beveled on their outer edges to shear a section of cable between them, and

a shear plate removably attached to said cutter body between said cutters.

11. Apparatus for cutting marine cables utilizing ambient water pressure as the power source comprising:

a cutter housing having a sealed chamber and a slidable pressure-operated member disposed in a portion of said chamber;

an elongate cutting means connected to said slidable member and extending exteriorly of said cutter housing,

said cutting means being configured to intercept and retain a cable to be cut;

a valve means associated with said cutting means so as to be actuated by a cable intercepted by said cutting means; and

a passage in said cutting means communicating between said valve means and the adjacent surface of said slidable member,

whereby said valve means when actuated by a cable in the environment admits water under ambient pressure into said passage, displacing said slidable member and said cutting means to effect shear of said cable.

12. Apparatus as defined in claim 11 wherein said elongate cutting means extends through opposite walls of said sealed chamber to closely define axial movement of said slidable member,

the end of said cutting means remote from said valve means protruding beyond said cutter body when in the actuated condition, serving as a visual warning that the device remains in the actuated condition.

13. Apparatus as defined in claim 12 and further including an exhaust check valve attached to said cutter body and communicating between the environment and an area of said sealed chamber remote from said adjacent surface thereof to evacuate said chamber and preclude further movement of said slidable member.

14. Apparatus as defined in claim 13 wherein said elongate cutting means is a shaft having an arcuate throat area whose longitudinal axis is canted to define an acute angle along its upper extremity for capturing and holding a cable.

15. Apparatus as defined in claim 14, wherein said valve means is a frangible tube extending into said throat area,

said frangible tube having an open end disposed in said passage in sealing engagement therewith and a closed end disposed in said throat area.

16. Apparatus as defined in claim **14** wherein said valve means includes a lever arm pivotable about a shaft mounted in said cutter body and a valve connected to said shaft,

said valve when actuated by said lever arm communicating between the environment and said passage in said cutting means,

said lever arm being disposed alongside said throat area so as to be actuated by a cable entering said throat area.

17. A method of cutting cables at any depth without need of an external power source comprising the steps of

intercepting a cable with a sweep wire;

directing said cable to a cable capturing device;

interposing pressure release means in the path of said cable at said cable capturing device; and

severing said cable by shear means propelled by ambient water pressure released by said pressure release means.

18. The method of claim **17** and further including deploying said shear means substantially transverse to said cable.

19. The method of claim **17** and further including closing said cable capturing device after severing of said cable by means connected to said shear means.

20. The method of claim **19** and further including the step of mounting said cable capturing device on said sweep wire in freely rotating relationship therewith.

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