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Temple et al.

[11] **3,760,674**

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[54] **EXPLOSIVELY ACTUATED UNDERWATER ANCHOR LINE CUTTER**

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[52] **U.S. Cl.** ..... **83/370**, 83/639, 114/221 A

[51] **Int. Cl.** **B26d 5/38**

[58] **Field of Search** ..... 83/639, 600, 580, 83/370; 114/221 A

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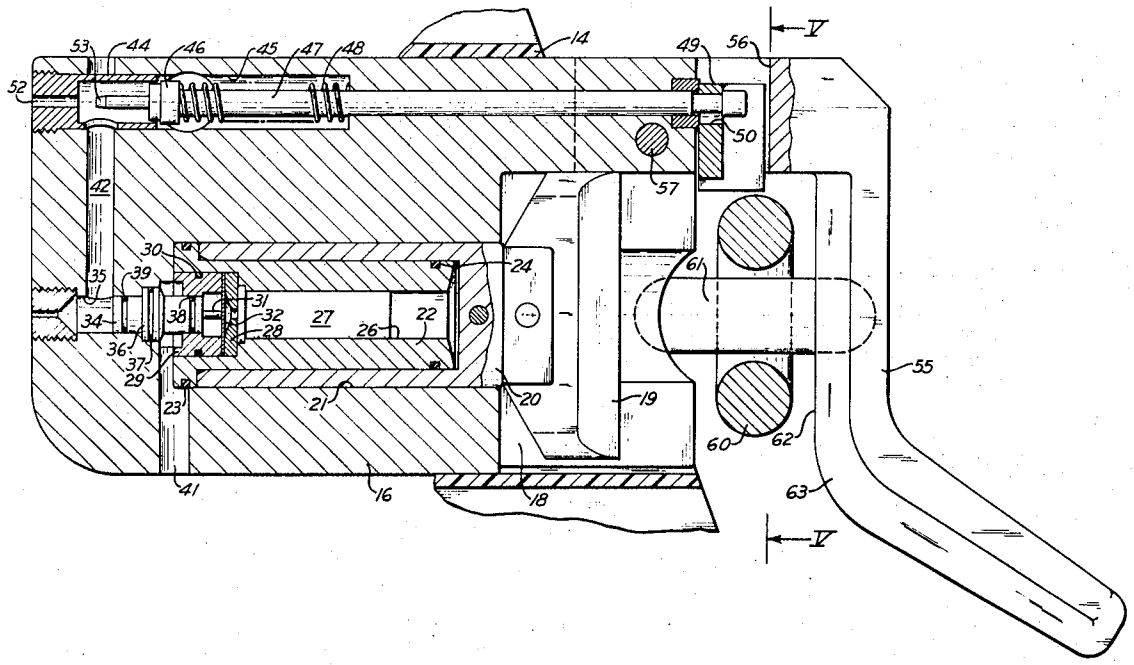
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[57] **ABSTRACT**

The frame of a chain cutter is mounted in a housing on a stabilizing fin. The housing and usually the fin are formed of material that will tear apart when the cutter is fired. The fin is held on a sweep line by a pair of pivoted lugs that can be released from the line by pulling back on a spring between the lugs. Attached to the front of the cutter frame is an anvil forming with the frame a chain-receiving recess that is only wide enough to receive a chain link lying broadside to the axis of a barrel in the frame. The barrel contains a piston for driving a chisel forward through the chain link in the recess. The piston is hollow and contains a cartridge holder provided with an axial passage having a breech block in its rear end. A plunger, slidably mounted in the breech block and in an opening in the frame behind it, carries a firing pin on its front end. The plunger is encircled by a collar joined to it between a pair of sealing rings. The frame has passages connecting the front and rear sides of the collar with the outside of the frame to hydraulically balance the plunger. The frame is provided with means, actuated by a mine anchor line in the chain-receiving recess, for suddenly increasing water pressure in the rear passage to drive the plunger and firing pin ahead.

6 Claims, 5 Drawing Figures



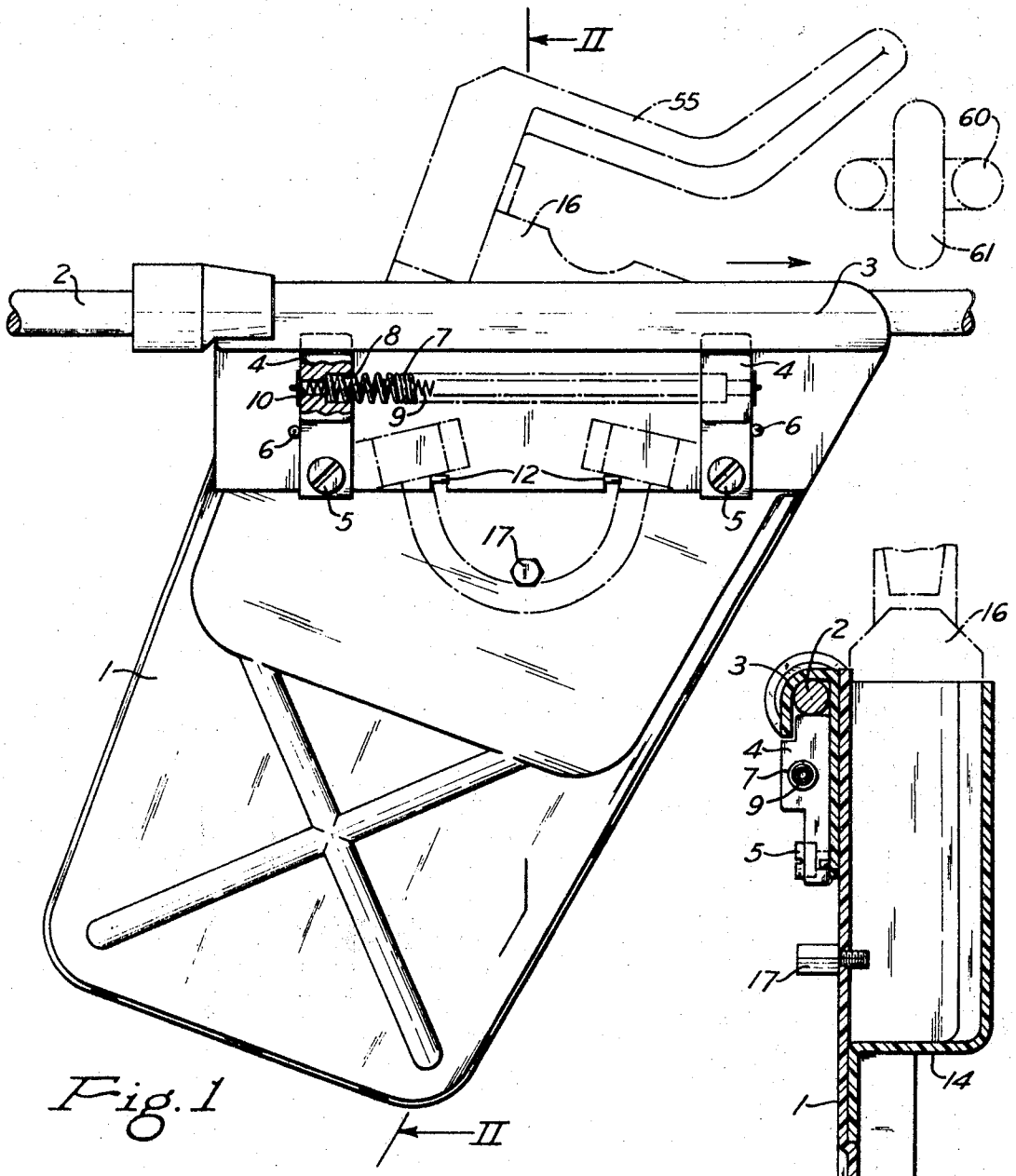


Fig. 1

Fig. 2

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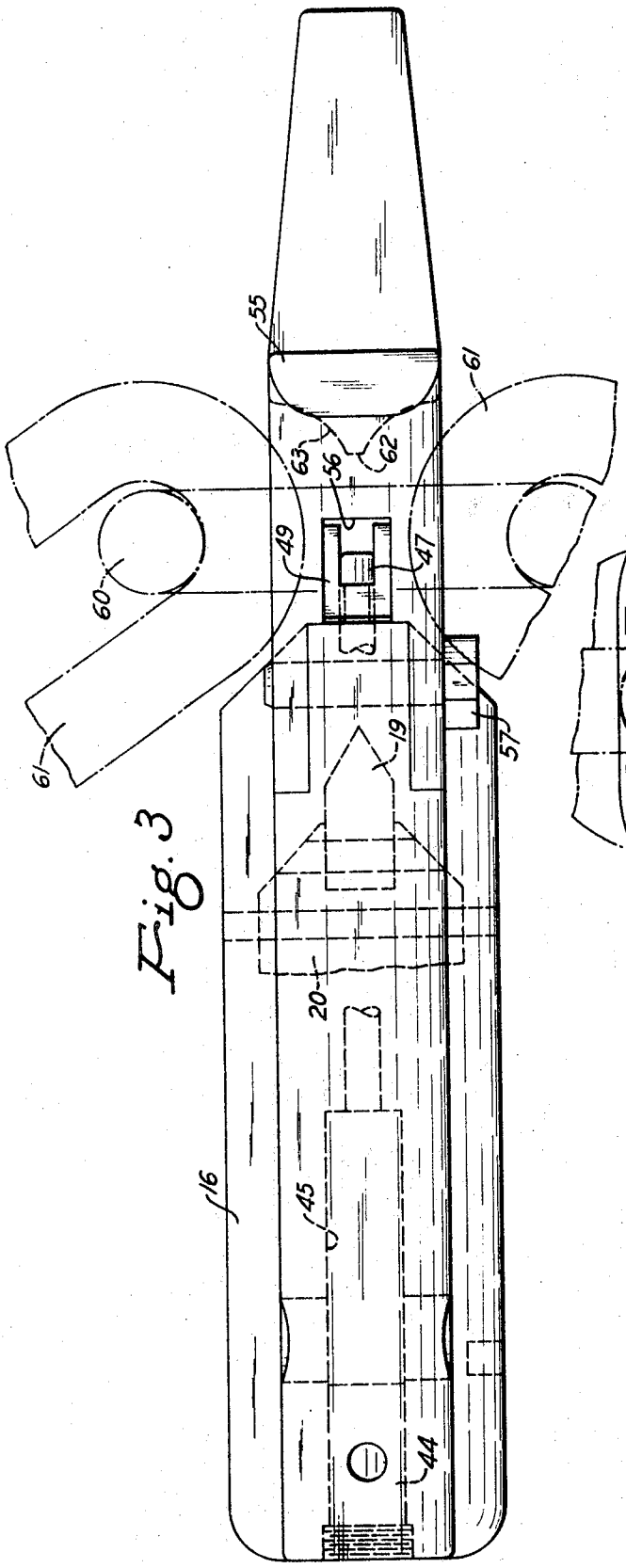

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Fig. 3

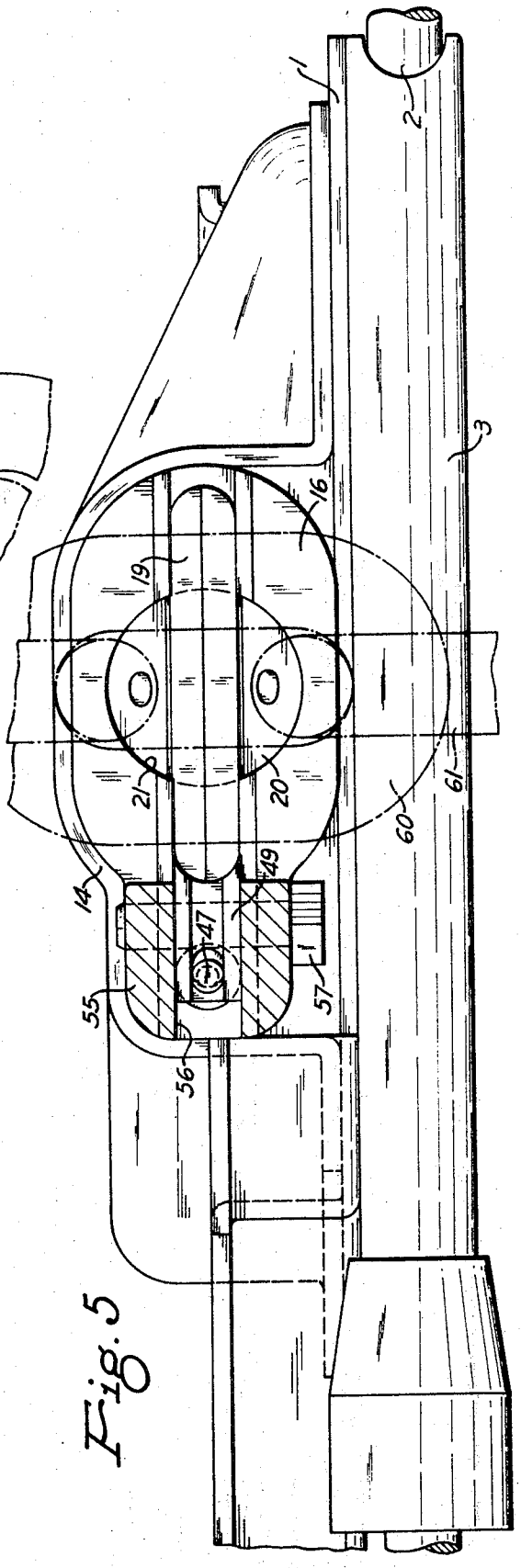

1
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Fig. 5

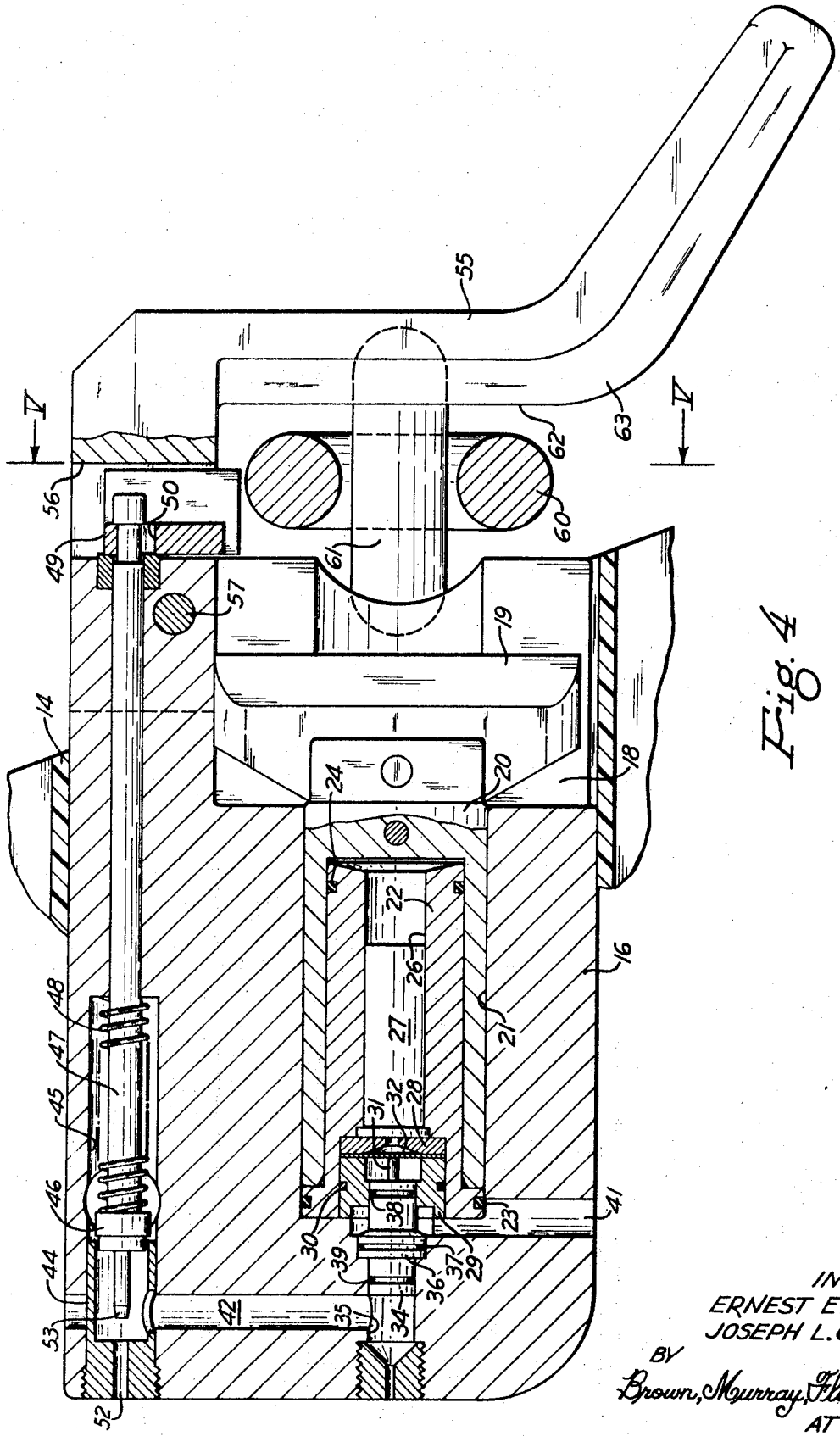


Fig. 4

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EXPLOSIVELY ACTUATED UNDERWATER ANCHOR LINE CUTTER

It is among the objects of this invention to provide an explosively actuated underwater anchor line cutter which is particularly suitable for cutting chains, which can be quickly and easily attached to a sweep line, which is relatively lightweight, which has a hydraulically balanced firing pin, and most of which will break away from the sweep line when the cutter is fired.

The preferred embodiment of the invention is illustrated in the accompanying drawings, in which

FIG. 1 is a plan view of the stabilizing fin;

FIG. 2 is a longitudinal section taken on the line II—II of FIG. 1;

FIG. 3 is an enlarged rear view of the cutting unit itself;

FIG. 4 is a central horizontal section of the cutting unit; and

FIG. 5 is a cross section taken on the line V—V of FIG.4, but including the sweep line and fin.

Referring to FIGS. 1 and 2 of the drawings, a holder for a mine anchor line cutter includes a stabilizing fin 1 that can be drawn through a body of water by means of a sweep line 2 extending outwardly away from a mine sweeper in a well-knwon manner. The fin has a leading front edge and is disposed more or less horizontally as it is drawn through the water. To attach the fin to the sweep line a channel member 3 extends along the leading edge of the fin and is joined to its top or bottom surface. This member has an open side facing the trailing edge of the fin so that the channel member can be hooked over the sweep line. In order to lock the fin on the line, a pair of laterally spaced lugs 4 are disposed in substantially parallel relation with their front ends projecting into the channel member and their rear ends pivotally connected by means of pivots 5 to a flat rearward extension of the channel member. The lugs are held in this locking position by spring means between them normally pressing their outer sides against stop pins 6. Preferably, the spring means are formed from two concentric coil springs. The ends of the outer spring 7 are mounted in sockets 8 in the inner sides of the lugs and this spring is under slight compression to hold the lugs against the stop pins. The inner spring 9 extends out of the opposite ends of the outer spring and the rest of the way through the lugs, where the outer ends of the inner spring are held by clips 10. This spring is under slight tension.

In order to disconnect the fin from the sweep line, or to prepare the fin for connection to a sweep line, the central portion of the spring system is pulled rearwardly to the dotted line position shown in FIG. 1, which causes the inner tension spring to swing the front ends of the lugs inwardly toward each other and rearwardly until they engage stops 12 that are located far enough back to prevent the bowed outer compression spring from swinging the lugs forward again. That is, the pressure of the ends of the compression spring outwardly against the sides of the lug sockets is exerted along lines passing behind the axes of the lug pivots 5, so that the compression spring actually causes the lugs to be pressed against stops 12. There is sufficient room between the retracted lugs and the entrance to the channel member to accommodate the sweep line, whether it is being removed from the channel or inserted in it. If the latter, the springs then are pushed forward a short distance to swing the lugs forward far enough for an overcenter action to take place, upon the occurrence of which the tendency of the springs to straighten out will quickly swing the lugs the rest of the way forward against the stop pins 6 as shown in full lines. Consequently, with this locking system a fin can be attached to a sweep line very quickly and easily by simply first pulling back on the springs to retract the lugs, then hooking the channel member over the line and then pushing the springs forward until they snap the lugs forward into locking position.

The side of the stabilizing fin opposite to the channel member supports a housing 14 that is rigidly secured to it. This housing is at the front end of the fin and has an open front end so that an anchor line cutter can be inserted in it, as indicated in dotted lines in FIGS. 1 and 2 and in full lines in FIG. 5. The cutter, to be described later, is of the explosively actuated type in which a chisel is driven forward by an explosive charge to sever a mine anchor line that has been caught in the cutting recess of the cutter ahead of the chisel. A feature of this invention is that housing 14, and preferably the stabilizing fin also, are formed mainly of rupturable material, such as a plastic or a low strength metal. When the explosive charge is fired, the chisel is driven forward to cut the anchor line, but the recoil against housing 14 causes the housing and the fin to break or tear apart so that the cutter and the major portions of the housing and the fin are separated from the channel member that remains on the sweep line. This remnant of the device hanging from the sweep line is easily by-passed by another mine anchor line for cutting by a cutter located farther out along the sweep line.

As shown in FIGS. 3, 4 and 5 of the drawings, the cutting tool itself includes a block-like frame 16 that fits within housing 14 on the stabilizing fin, where it is held by a set screw 17 (FIGS. 1 and 2) extending from the opposite side of the fin into a threaded opening in the frame. The front end of the frame projects a short distance from the housing and is provided with a rearwardly extending opening 18, in which a cutting chisel 19 is slidably mounted. This chisel is held in the bifurcated front end of a piston 20 disposed in a barrel 21 extending rearwardly from the back of the opening. The rear end of the piston is spaced a short distance from the rear end of the barrel and is provided with a forwardly extending axial bore that receives a cartridge holder 22 (FIG. 4) having a radial flange at its rear end between the piston and the rear end of the barrel. This flange and the front end of the cartridge holder are encircled by sealing rings 23 and 24 to prevent water from passing them.

The cartridge holder has an axial passage 26 through it that has an enlarged rear end portion. The portion of the passage between this enlargment and the front end of the holder contains an explosive charge or cartridge 27. Since the cartridge holder is encased in the hollow piston, the holder and piston can be made of steel to withstand the pressure of the gases produced when the cartridge is fired. This will allow the frame 16 to be made of lightweight metal, such as aluminum, to reduce the weight of the cutter.

The enlarged rear end of passage 26 contains a breech block that is formed from a rigid disc 28 directly behind the cartridge, and a ring 29 behind the disc. The ring is encircled by a sealing ring 30. The disc is provided with a central aperture large enough to receive a firing pin 31 when the latter is driven forward. Be-

tween the pin and this aperture there is a thin diaphragm **32** that is clamped between the disc and the breech block ring. The diaphragm is thin enough to be punctured when the firing pin is driven forward. It holds the firing pin back until firing, thereby insuring a positive firing stroke. It also prevents accidental firing if the tool is dropped.

The firing pin is supported by the front end of a plunger **34**, the opposite ends of which are slidably mounted in the breech block ring **29** and in an opening **35** in the frame behind the breech block. The front portion of the frame opening is enlarged to receive in its rear end a collar **36** encircling the plunger and preferably integral with it. The collar is encircled by a sealing ring **37** and the opposite ends of the plunger are encircled by sealing rings **38** and **39** because the plunger at both sides of the collar is exposed to the surrounding water. This is due to the fact that the frame is provided with a passage **41** that extends inwardly from one side to the area between the collar and front sealing ring **38**, while the frame is also provided with another passage **42** that extends inwardly to frame opening **35** behind the plunger. Consequently, the front side of the collar and the rear end of the plunger are exposed to water pressure when the tool is submerged. The front sealing ring prevents water from getting into the space inside the breech block around the firing pin. The rear sealing ring on the plunger prevents water from exerting any pressure against the rear face of the plunger collar.

It is a feature of this invention that the front of the collar and the rear end of the plunger are substantially equal in area so that the plunger is balanced and will not press the firing pin against the thin diaphragm. Preferably, the area of the front of the collar is very slightly greater than the area of the back of the plunger to make certain that the plunger will remain in its rearmost position. Yet, since the plunger is nearly balanced, it does not require much force to move it forward to fire the cartridge.

In order to drive the firing pin ahead, the rear water passage **42** communicates with the inside of a hollow plug **44** that is screwed into the rear end of a bore **45** that extends forward throughout the length of the frame. The front end of the hollow plug is open and contains a piston **46** on the rear end of a firing rod **47** that extends forward through the bore and out of its front end. A coil spring **48** compressed between the piston and a shoulder in the frame urges the piston rearwardly, but it is normally held in a retracted forward position by a trip slide **49** that engages the front end of the frame and is provided with a slot **50** through which the front end of the rod extends. A short distance behind the front end of the rod it is reduced in diameter where it passes through the slide slot. This forms a head on the rod that overlaps the slide at the outer end of the slot to hold the spring compressed.

If the slide is pushed outwardly by a mine anchor line, it will become disengaged from the head of the firing rod, whereupon the spring will expand and drive the rod and its piston toward the rear end of the frame. Since passage **42** and the hollow plug **44** are full of water, due to an axial passage **52** in the rear end of the plug, the sudden pressure of the piston against the water will cause the latter to exert pressure against the rear end of the firing pin plunger. This pressure is enhanced by providing the piston with a rearwardly projecting pin **53** that will close the plug passage so that water in the plug will not be forcd out of that passage. The sudden increase of water pressure against the rear end of the firing pin plunger will drive it forward and cause the firing pin to penetrate diaphragm **32**, pass through the aperture in the breech block disc and detonate the explosive charge. This will cause piston **20** to drive the chisel forward. It will be seen that the cutter can be fired only under water. If it is removed from the water without being fired, it can be handled safely at once because the water will quickly drain away from the firing mechanism.

When the chisel is driven forward it cuts through a mine anchor line that has been caught in a recess formed between the front end of the frame and an anvil **55** spaced a short distance ahead of it. The end of the anvil adjacent the trip slide **49** is forked to provide a passage **56** for the slide and to straddle the frame, to which it is connected by a screw **57**. The anvil directly in front of the chisel is parallel to the front end of the frame, but has a forwardly inclined front end to help guide a mine anchor line into the cutting recess. As the cutter is towed through the water by the sweep line, the line will engage mine anchor lines and slide across them until one of them enters the cutter recess between the chisel and the anvil. The pressure of the anchor line against the trip slide moves it and releases the firing rod, which results in the cartridge being fired and the anchor line being cut by the chisel.

Although the mine anchor line may be a cable, this cutter is designed primarily for cutting chains and it is formed so that the link **60** that is caught in the cutting recess will be held broadside to the chisel, whereby both sides of the link will be cut simultaneously rather than in succession. For this purpose the recess is only wide enough to receive a chain link lying in a plane substantially perpendicular to the axis of the frame barrel; that is, broadside to the chisel. The narrow recess also brings the anvil closer to the frame for more forceful cutting. This permits the cutter to be made shorter, and therefore lighter, than heretofore. To help guide a link into cutting position in the recess, the chain-engaging side of the anvil is shaped to substantially engage the adjacent ends of the two chain links **61** that are connected directly to the link between them in the cutting recess. The planes of the two links just mentioned will be perpendicular to the plane of the link being cut. Depending upon the size of the links and the width of the anvil, the anvil may or may not engage both links **61** at the same time. Generally, the anvil will only engage one of those links, or it may slide up and down on the link **60** in the recess. The chain-engaging side of the anvil preferably has a longitudinally extending central flat area **62** for engaging link **60**, and side areas **63** diverging from the opposite edges of the flat area for engagement by the adjacent curved end portions of the two adjoining links. Also, as shown in FIG. **3**, the front end of frame **16** in the recess is bevelled to permit entrance of a link **60** where the adjoining links **61** are rather close together.

According to the provisions of the patent statutes, we have explained the principle of our invention and have illustrated and described what we now consider to represent its best embodiment. However, we desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

We claim:

1. An explosively actuated underwater anchor line cutter comprising a stabilizing fin having top and bottom faces and a leading front edge, a housing formed mainly of rupturable material rigidly mounted on one of said faces and having an open front end, anchor line cutting means disposed in said housing and projecting forward therefrom and from the front edge of the fin, and means connected with the opposite face of the fin along said front edge for attaching the fin to a sweep line, said cutting means including an explosively operated member for severing an anchor line, the recoil from actuation of said member being sufficient to rupture said housing and thereby release the cutting means.

2. An underwater cutter according to claim 1, in which said rupturable material is plastic.

3. An underwater cutter according to claim 1, in which said fin also is formed mainly of rupturable material.

4. An explosively actuated underwater anchor line cutter comprising a tool frame provided with a barrel, a cartridge holder mounted in the barrel and having an axial passage therethrough for receiving an explosive cartridge, cutting means slidably mounted in the barrel in front of said holder, a breech block fitting in the rear end of said passage and having an axial opening therethrough, the frame having an opening behind the breech block opening and aligned therewith, a plunger

slidably mounted in both openings, a sealing ring encircling the plunger in each of said openings, a firing pin carried by the front end of the plunger, the front portion of said frame opening being enlarged and the plunger being encircled by a collar joined thereto in the rear end of said enlargement between said sealing rings, a sealing ring encircling the collar, the frame having a passage connecting the front end of said enlarged portion of the frame opening with the outside of the frame and having another passage connecting said frame opening behind the plunger with the outside of the frame, whereby the front side of said collar and the rear end of the plunger are exposed to water pressure when the cutter is submerged, the areas of the front of the collar and the rear end of the plunger being substantially equal, and means in the frame for suddenly increasing water pressure in the last-mentioned frame passage to drive the plunger and firing pin ahead.

5. An underwater cutter according to claim 4, including a sealing ring around said breech block.

6. An underwater cutter according to claim 4, in which said breech block includes a disc directly behind the cartridge provided with a central aperture for the firing pin, a ring behind the disc, and a diaphragm clamped between the ring and disc, the diaphragm being thin enough to be punctured when the firing pin is driven ah ead.

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