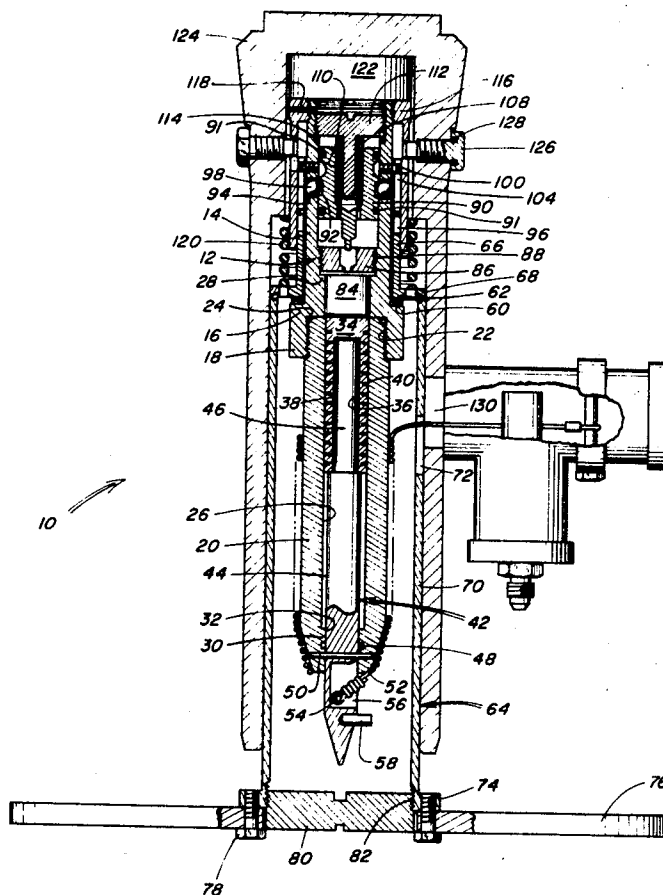


[72] Inventors **Kenneth E. Mueller**
Baltimore City;
John L. Critcher, Cockeysville; Franklin A.
Monson, Glenarm; William H. Turnbaugh,
Cockeysville; John E. Kosloski, Timonium,
Md.
[21] Appl. No. **740,817**
[22] Filed **June 19, 1968**
[45] Patented **May 11, 1971**
[73] Assignee **The United States of America as represented**
by the Secretary of the Navy

[56] **References Cited**
UNITED STATES PATENTS
3,054,123 9/1962 Moeller 114/206.1
3,060,436 10/1962 DeCaro et al. 89/1.01
3,154,042 10/1964 Thomason et al. 114/206.1
3,291,092 12/1966 Halberg et al. 114/206.1
Primary Examiner—Benjamin A. Borchelt
Assistant Examiner—Thomas H. Webb
Attorneys—R. S. Sciascia and J. A. Cooke

[54] **EXPLOSIVELY PROPELLED UNDERWATER**
EMBEDMENT ANCHOR ASSEMBLY
12 Claims, 4 Drawing Figs.
[52] U.S. Cl. **114/206,**
227/11, 89/1.34, 42/1
[51] Int. Cl. **B63b 21/28,**
B63b 21/26, F41c 27/00
[50] Field of Search **89/1.01,**
1.34; 114/206, 206.1; 42/1

ABSTRACT: An explosively propelled underwater embedment anchor assembly having a barrel with a smooth bore therethrough except for an internal flange near the muzzle extremity; a breech at the other end of the barrel; an explosive propellant cartridge within the barrel and adjacent the breech; a piston also within the barrel and adjacent the breech but on the muzzle side thereof, the piston having an outside diameter approximately equal to the diameter of the smooth bore; and a harpoon adjacent the piston and extending out of the barrel, the harpoon having a maximum outside diameter approximately equal to the inside diameter of the flange. A spring-biased firing pin is restrained by a plurality of ball lock detents held in place by a resiliently biased tube.



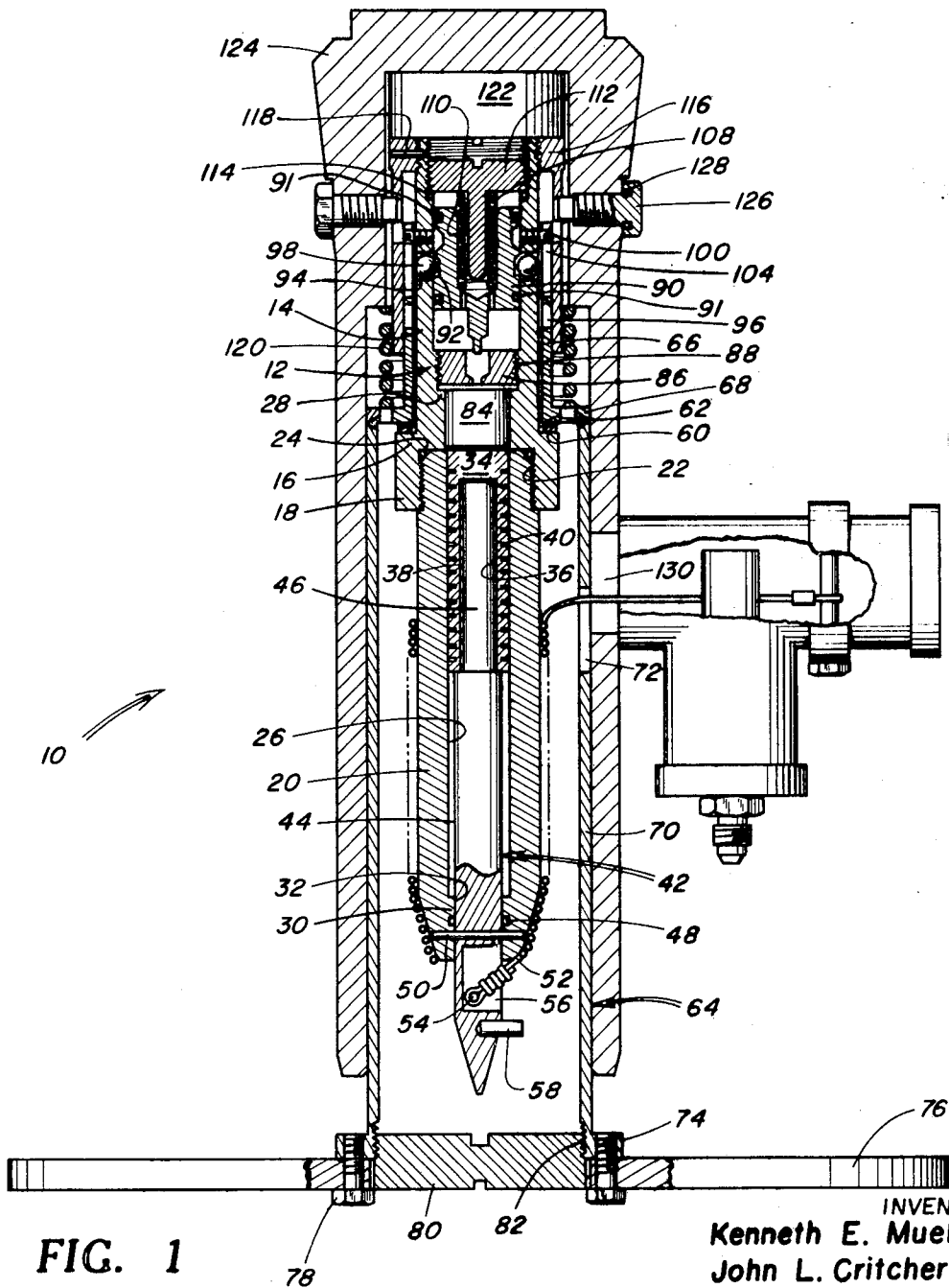


FIG. 1

INVENTORS

Kenneth E. Mueller
John L. Critcher
Franklin A. Monson
William H. Turnbaugh
John E. Kosloski

BY

J. O. Treanor
ATTORNEY
Jack C. Goldstein
AGENT

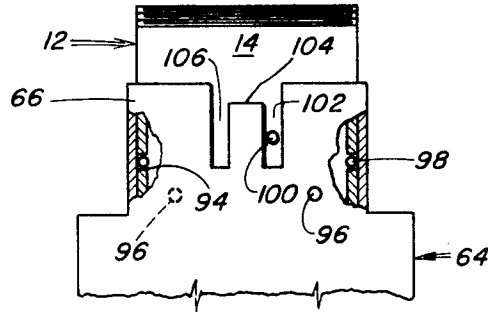


FIG. 2

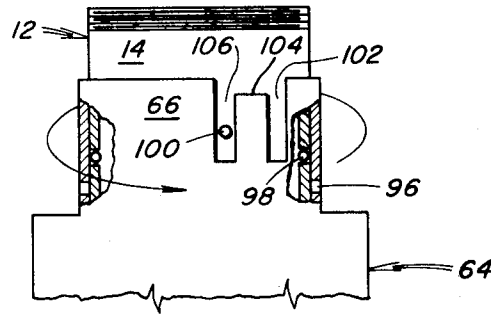


FIG. 3

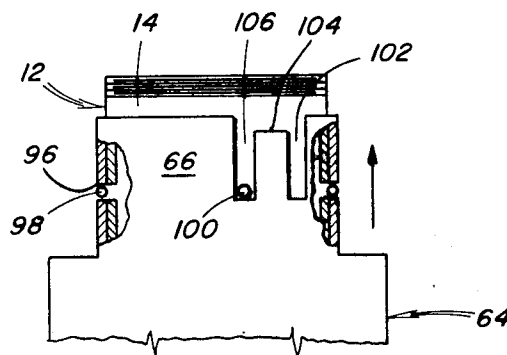


FIG. 4

EXPLOSIVELY PROPELLED UNDERWATER EMBEDMENT ANCHOR ASSEMBLY

BACKGROUND OF THE INVENTION

This invention relates generally to underwater anchors, and more particularly to explosively actuated underwater embedment anchors.

In the recent past, the use of more sophisticated and costly surface and subsurface equipment has increased at a rapid rate thusly making it desirable that the emplacement of such equipment be ensured with a positive and reliable anchoring system. Because of certain limitations in conventional anchoring systems and the requirements for lighter and more reliable mooring equipment, a considerable effort has been exerted to improve underwater anchoring through the use of propellant-driven embedment anchors. Moreover, when such equipment is utilized for military purposes by an underwater swimmer in enemy waters during hostile conditions, the basic necessities that the anchoring system be lightweight, highly reliable, and small in size are compounded by the essential requirement that no large volume of expanded propellant gases be abruptly discharged when the anchor is emplaced or anytime thereafter since a mass of bubbles at the surface may tend to alert the enemy that an underwater propulsion of some sort has occurred and/or that an underwater swimmer is or has been present in the vicinity.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is the provision of a new and improved embedment anchor characterized by a high degree of safety and reliability, small size, lightweight and simplicity in both construction and operation.

Another object is to provide an explosively propelled embedment anchor wherein no large volume of expanded propellant gases are abruptly discharged when the apparatus is discharged or anytime thereafter.

Still another object of the invention is the provision of an explosively propelled underwater ejection or launching assembly suitable for use with a variety of projectiles.

Yet another object is to provide an explosively propelled underwater ejection assembly which operates in such a manner that its presence is not unintentionally revealed.

Still a further object is to provide an explosively propelled underwater ejection assembly which substantially reduces and/or eliminates the shock wave and vibrations customarily inherent in such devices.

Briefly, in accordance with one embodiment of this invention, these and other objects are attained by providing in an explosively propelled embedment anchor assembly, the combination of a barrel having a smooth bore therethrough except for an internal flange near the muzzle extremity and a piston slidably disposed within the barrel between an explosive propellant and the embedment harpoon such that the piston will drive the harpoon in response to the reaction of the explosive propellant but will be stopped by the internal flange thereby to contain the expanded gases generated by the propellant within the barrel. A plurality of axially displaced circumferential grooves may be disposed around the piston to help absorb the shock of the piston impact against the flange.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of the invention and many of the attendant advantages thereof will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

FIG. 1 is a side elevation view, partly in section, of the explosive embedment anchor assembly according to the present invention; and

FIGS. 2—4 are side elevation views, partly in section, of a portion of the apparatus in the safe, armed, and firing positions, respectively.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings wherein like reference characters designate identical or corresponding parts throughout the several views, and more particularly to FIG. 1 thereof wherein the embedment anchor assembly according to the preferred embodiment of the present invention is indicated generally by reference numeral 10 and is shown as comprising a generally cylindrical firing assembly housing 12 having an elongate cylindrical portion 14, an intermediate external flanged portion 16, and an enlarged forward cylindrical end portion 18. An elongate generally cylindrical barrel 20 is sealingly secured to the extremity of enlarged cylindrical end portion 18 of firing assembly housing 12 by any conventional means, as by threaded connection 22. An O-ring 24 may be provided at the connection. Barrel 20 has a smooth elongate cylindrical bore 26 centrally formed therethrough, which bore is coaxial with the generally cylindrical stepped bore which provides an internal flange 28 in firing assembly housing 12. Bore 26 is provided with an internal annular flange 30 near the forward extremity of the barrel in which is formed a smaller diameter smooth cylindrical bore 32, coaxial with bore 26, extending through the forward end of the barrel thereby providing free access between bore 26 and the exterior environment.

Positioned within bore 26 at the rearward extremity thereof is a cup-shaped piston 34 having a generally cylindrical exterior shape and a smooth cylindrical bore 36 extending from the forward extremity through a major portion thereof in which is inserted a cylindrical sleeve 38, preferably by press fitting, to give the piston greater strength for purposes to be discussed hereinafter. Piston 36 has a plurality of axially displaced radial grooves 40 formed in the outer surface thereof to allow greater compressibility as will be described later.

A harpoon assembly 42, having an enlarged cylindrical portion 44 of a diameter approximately equal to that of bore 32 and a rear portion 46 of a reduced diameter which is slightly smaller than the inside diameter of cylindrical sleeve 38, is positioned within barrel 20 with rear portion 46 extending into cylindrical sleeve 38. An O-ring 48 is positioned between barrel 20 and enlarged portion 44 of harpoon 42 to maintain a fluidtight seal therebetween. Additionally, a shear pin 50 is inserted through a transverse aperture formed in barrel 20 and harpoon 42 to prevent relative movement therebetween prior to ejection of the harpoon. Obviously, shear pin 50 may be press fitted, or secured in place by other conventional techniques. A cable 52 is fastened to the forward portion of harpoon 42 extending beyond barrel 20 by means of an end loop engaging a cable dowel pin 54 disposed within a cavity 56 formed in harpoon 42. A harpoon dowel pin 58 is secured to the tip of harpoon 42 to provide protection for cable 52 as the harpoon penetrates a solid body, customarily the water bed. Cable 52 is wrapped around the tapered forward portion of barrel 20 using a reverse twist and is closely helically wound around the barrel over a major portion of its length.

A ring-shaped detent spring pad 60 is inserted onto firing assembly housing 12 around cylindrical portion 14 thereof so as to bear against intermediate external flanged portion 16, and a ring-shaped axially resilient detent spring 62 is similarly positioned adjacent pad 60.

Positioned around firing assembly housing 12 is a cylindrical pressure plate tube assembly 64 shown herein composed of a rearward reduced portion 66, an intermediate external flange 68, and a forward enlarged diameter portion 70. An opening 72 is formed therein through which cable 52 extends. Although pressure plate tube 64 is shown herein as being of two separate pieces welded together at flange 68, it is to be understood that the pressure plate tube may be fabricated as a single integral member. In its assembled configuration flange 68 bears against detent spring 62 for reasons which will become more apparent hereinafter. A collar 74 is affixed, as by welding, to the forward end of pressure plate tube 64 to which an apertured pressure plate 76 may be fixedly secured

by any conventional means, such as by bolts 78. It should be further understood that collar 74 may be an integral part of enlarged portion 70 of pressure plate tube 70, as shown instead of being welded thereto. A cylindrically shaped safety plug 80 is detachably secured to pressure plate tube 64 by any conventional means, such as threaded connection 82, to mechanically seal the pressure plate tube as a safety measure to stop the forward progress of the harpoon if it is prematurely ejected.

Positioned within firing assembly housing 12 in the portion thereof delineated by internal flange 28 is a cylindrically shaped explosive cartridge 84 containing a propellant which, upon initiation generates a large volume of expanding gas. Explosive cartridge 84 is urged into abutting relationship with piston 34 by a cylindrical centrally apertured breech member 86 which may be removably secured to firing assembly housing 12 by any conventional means, as by a threaded connection 88. Slidably positioned within the firing assembly housing is a generally cylindrical firing piston 90 having a pair of O-rings 91 positioned therebetween to provide a fluidtight seal. Firing piston 90 has a central bore extending therein from the rear portion thereof and an extended firing pin tip at the front thereof.

In assembling the device, firing piston 90 is inserted into the firing assembly housing and rotated therein until a circumferential radial groove 92 formed therein is axially and radially aligned with a plurality of ball lock holes 94 formed in firing assembly housing 12 which have been aligned previously with a plurality of ball-release holes 96 formed in reduced portion 66 of pressure plate tube 64. A plurality of ball detents 98 are inserted through ball-release holes 96 into ball-lock holes 94 where they are seated in radial groove 92, and the firing assembly housing is rotated with respect to the pressure plate tube so that the ball detents are secured in place and thereby restrain firing piston 90 from axial movement in either direction.

As more clearly shown in FIGS. 2—4, a plurality of setscrews 100 are inserted through an elongate portion 102 of U-slot 104 formed in pressure plate tube 64 and are tightly screwed into narrow elongate cylindrical portion 14 of firing assembly housing 12. Elongate portion 102 of U-slot 104 may be referred to as the safe slot for reasons which will become apparent. Another elongate portion 106 of U-slot 104 may be referred to as the armed slot for similar reasons. The circumferential displacement of U-slot 104 from ball-release holes 96 is not apparent in FIG. 1 wherein the setscrews and slots have been illustrated as being aligned with the ball-release holes, for purposes of clarity.

A coil spring 108 is inserted into a bore 110 centrally formed in firing piston 90 from the rear portion thereof, and a spring guide 112 is threaded into the firing assembly housing thereby compressing coil spring 108 so that a reduced elongate portion of the spring guide extends within coil spring 108 to guide it and so as to resiliently urge firing piston 90 forward against the restraint provided by the ball detents. Between spring guide 108 and firing assembly housing 12, there is positioned an O-ring 114 to provide a fluidtight seal therebetween. A generally cylindrical guide tube 116 is screwed onto the rear of firing assembly housing 12 and is secured in place by any conventional means, such as a cotter pin 118, extending through aligned apertures formed therein.

A larger coil spring 120 is disposed around guide tube 116 and bears against external flange 68 on pressure plate tube 64. A buffer 122, made of a resilient material, abuts the rear extremity of firing assembly housing 12 and guide tube 116 as well as the rear inner wall of a generally cylindrical anchor housing 124 which is secured to the guide tube by a plurality of circumferentially displaced locking bolts 126 having sealing O-rings 128 in the head thereof. Locking bolts 126 are threaded into anchor housing 124 and extend into a plurality of longitudinal slots in guide tube 116; in this manner the firing assembly housing is radially and circumferentially restrained while, at the same time, free to slide in the axial

direction over a limited distance. Anchor housing 124 has formed therein an opening 130 which is in fluid communication with opening 72 in pressure plate tube 64 so that cable 52 may extend out of the embedment anchor assembly.

Any suitable means for cutting the cable may be used with the embedment anchor assembly of the present invention. By way of illustration, the cutter may comprise an anvil and an air-driven piston having a cutting edge between which cable 52 passes. Upon the application of air pressure, the piston slides into contact with the anvil thereby severing the cable.

To operate the embedment anchor assembly of the present invention, safety plug 80 is first removed and discarded. Initially, the assembly is in its safe position, that is, setscrews 100 are in safe slots 102 and ball detents 98 are held in place by pressure plate tube 64, as more clearly shown in FIG. 2, thereby restraining firing piston 90 in the axial position shown in FIG. 1.

To arm the assembly, pressure plate 76 and pressure plate tube 64 are manually pulled forward, relative to firing assembly housing 12 and anchor housing 124, against the resilient force provided by detent spring 62 until setscrews 100 are at the open end of U-slot 104 in narrow portion 66 of pressure plate tube 64. Next, pressure plate 76 and pressure plate tube 64 are manually rotated slightly with respect to firing assembly housing 12 and anchor housing 124 until setscrews 100 are aligned with armed slots 106 of U-slot 104, and then released. When pressure plate 76 and pressure plate tube 64 are released, they will move rearward relative to firing assembly housing 12 and anchor housing 124 due to the resilient biasing force provided by detent spring 62 until that resilient force equals the oppositely applied resilient force provided by enlarged coil spring 120 as it is so compressed. The mechanism is now in its armed position in which ball detents 98 are circumferentially aligned with, but longitudinally displaced from, ball-release holes 96, as can be most clearly seen in FIG. 3.

To eject harpoon 42, pressure plate 76 is manually pressed against the embedment surface with sufficient force to urge tube 64 rearward with respect to firing assembly 12 and anchor assembly 124 against the resilient force of coil spring 120. When tube 64 so moves a sufficient distance, ball-release holes 96 become aligned with ball-lock holes 94, as shown in FIG. 4, whereupon ball detents 98 are forced out of radial groove 92 in firing piston 90 due to the resilient force provided by coil spring 108 acting against firing piston 90. Thusly released, firing piston 90 is driven forward by coil spring 108 until the forwardmost point of firing piston 90 strikes the rear portion of explosive cartridge 84 thereby initiating the propellant reaction. As a result, a large volume of expanding gases is generated and a great pressure is exerted on piston 34; when the pressure reaches a sufficient magnitude, the force acting on piston 34 affects shearing of pin 50. Hence, the expanding propellant gases drive piston 34 and harpoon 42 forward in barrel 20 until piston 34 collides with flange 30 of barrel 20. At that point the forward progress of piston 34 is abruptly halted, but harpoon 42 continues onward by freely sliding out of bore 36 in piston 34. When the harpoon first starts to move forward and throughout its movement cable 52 is payed out by merely unwinding around the tapered end of barrel 20. Upon impact of piston 34 with flange 30, grooves 40 in the piston allow the piston to compress more readily thereby absorbing some of the shock of the collision; the additional strength provided by cylindrical sleeve 38 prevents the piston from failing upon impact. As can be readily seen, when piston 34 has completed its stroke and is in its forwardmost position bearing against flange 30, piston 34 acts as a stopper so as to retain the expanded propellant gases within the embedment anchor assembly and thusly allows them to leak out of the assembly very gradually so that no large mass of bubbles will appear at the water surface at any one time for detection thereof. Moreover, it is apparent from the foregoing that the entrapment of the expanded propellant gases within the assembly substantially reduces and/or eliminates the shock and vibrations deleteri-

ously sustained heretofore by underwater swimmers during the use of prior art embedment anchors.

Obviously, numerous modifications and variations of the present invention are possible in the light of the above teachings. For example, it is specifically contemplated that this invention might be practiced in combination with a variety of small, lightweight underwater ejection devices ranging from underwater swimmer warfare weapons to harpoon sporting gear. It is therefore to be understood that, within the scope of the appended claims, the invention may be practiced otherwise than is specifically described herein.

I claim:

1. An underwater ejection assembly comprising:
barrel means having a continuous peripheral wall and a through channel formed longitudinally therein defining barrel apertures only at opposed extremities thereof, one extremity of which is adapted to be fluidly sealed;
piston means slidably positioned within said channel forming an expandible chamber at said extremity adapted to be fluidly sealed;
means for increasing the pressure within said expandible chamber;
stop means for limiting the forward movement of said piston means so as to contain at least a portion thereof within said channel to substantially restrict fluid discharge out of the barrel; and
projectile means operatively connected to said piston means to accelerate said projectile means by the force acting on said piston means in response to an increase in pressure within said expandible chamber.
2. The assembly of claim 1 wherein said means for increasing the pressure within said expandible chamber comprises an explosive propellant cartridge.
3. The assembly of claim 1 further comprising cable means having one end thereof secured to said projectile means.
4. The assembly of claim 1 wherein said stop means comprises an internal flange disposed within said channel.
5. The assembly of claim 4 wherein said piston means has a plurality of axially displaced circumferential grooves therein.
6. In an underwater ejection assembly, the combination comprising:
barrel means having a continuous peripheral wall and a first channel extending from one end thereof through at least a portion thereof and having a second channel extending from the opposite end thereof through at least a portion thereof defining barrel apertures only at the opposed ends thereof;
projectile means positioned at least in part within said first channel;
piston means positioned at least in part within said second channel and operatively connected to said projectile means;
means for exerting fluid pressure to one end of said piston means; and
stop means for restraining said piston means within said first channel, whereby said projectile means may be accelerated by the force acting on said piston means in response to an increase in the fluid pressure exerted on said one end of said piston means.
7. The assembly of claim 6 wherein said first and second channels are coaxial.
8. The assembly of claim 7 wherein said first and second channels are interconnected.
9. The assembly of claim 8 wherein said second channel has a greater cross-sectional area than said first channel.
10. The assembly of claim 8 wherein said piston means has a bore therein and a portion of said projectile means extends into said bore.
11. An explosively actuated underwater embedment anchor assembly comprising:
a generally cylindrical firing assembly housing;
an elongate generally cylindrical barrel sealingly secured at a first extremity thereof to said firing assembly housing at

- one extremity thereof and coaxial therewith, said barrel having
a first smooth bore coaxially extending from said first extremity thereof over a major portion of the longitudinal length thereof and
a second smooth bore of a diameter substantially smaller than said first bore coaxially extending from a second extremity thereof over a minor portion of the longitudinal length thereof and into said first bore; an elongate generally cylindrical piston slideably disposed within said first bore of said barrel and positioned near said first extremity thereof, said piston having
an outside diameter slightly less than that of said first bore but substantially greater than that of said second bore,
a plurality of longitudinally spaced radially extending circumferential grooves on the outer surface thereof, and
a generally cylindrical channel of a diameter less than that of said second bore extending from the extremity of said piston nearest said second extremity of said barrel over a major portion of the longitudinal length of said piston;
a generally cylindrical tube, having an outside diameter substantially equal to that of said channel and a length substantially equal to that of said channel, press fitted to said piston within said channel;
an elongate harpoon having first and second generally cylindrical portions;
said first generally cylindrical portion having a diameter slightly less than the inside diameter of said tube and a length less than that of said tube,
said second generally cylindrical portion having a diameter slightly less than that of said second bore, said harpoon positioned within said barrel so that said first generally cylindrical portion extends into said tube and said second generally cylindrical portion abuts said tube and piston and extends through said second bore so as to protrude therefrom and so as to be slideably disposed therein;
means, including a shear pin, for releasably securing said harpoon to said barrel to prevent relative movement therebetween;
seal means positioned between said harpoon and said barrel in said second bore therein to effect a fluidtight seal therebetween;
a cable having one end thereof fixedly secured to said harpoon and being helically wound around said barrel;
explosive cartridge means for generating gas positioned within said firing assembly housing near said one extremity thereof;
a breech removably secured within said firing assembly housing, said breech having a small central opening therein; and
a firing pin axially aligned with said opening and resiliently biased toward said explosive cartridge means but releasably restrained within said firing assembly housing so as to be capable of being selectively released whereby said firing pin may strike said explosive cartridge means.
- 12. An explosively actuated underwater ejection assembly for launching an elongate, generally cylindrical projectile, comprising:
a generally cylindrical firing assembly housing;
an elongate generally cylindrical barrel sealingly secured at a first extremity thereof to said firing assembly housing at one extremity thereof and coaxial therewith, said barrel having
a first smooth bore of a diameter substantially larger than that of said projectile coaxially extending from said first extremity thereof over a major portion of the longitudinal length thereof, and
a second smooth bore of a diameter slightly larger than that of said projectile coaxially extending from a second extremity thereof over a minor portion of the longitudinal length thereof and into said first bore;

a generally cylindrical piston, having a diameter slightly less than that of said first bore but substantially greater than said second bore, slideably disposed within said first bore of said barrel and positioned near said first extremity thereof, said piston having
a plurality of longitudinally spaced radially extending circumferential grooves on the outer surface thereof;
explosive cartridge means for generating gas positioned within said firing assembly housing near said one extremity thereof;
a breech removably secured within said firing assembly housing, said breech having a small central opening therein; and

a firing pin axially aligned with said opening and resiliently biased toward said explosive cartridge means but releasably restrained within said firing assembly housing so as to be capable of being selectively released whereby said firing pin may strike said explosive cartridge means;
whereby said projectile may be slideably disposed within said second bore and operatively connected to said piston to accelerate said projectile by the force acting on said piston in response to an increase in pressure acting on said piston due to the gas which may be generated by said explosive cartridge means.

5
10
15
20
25
30
35
40
45
50
55
60
65
70
75