

Sept. 4, 1962

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3,052,784

MANUAL ARM-SAFE SWITCH

Filed April 19, 1960

4 Sheets-Sheet 1

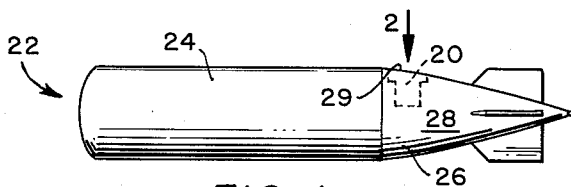


FIG. 1.

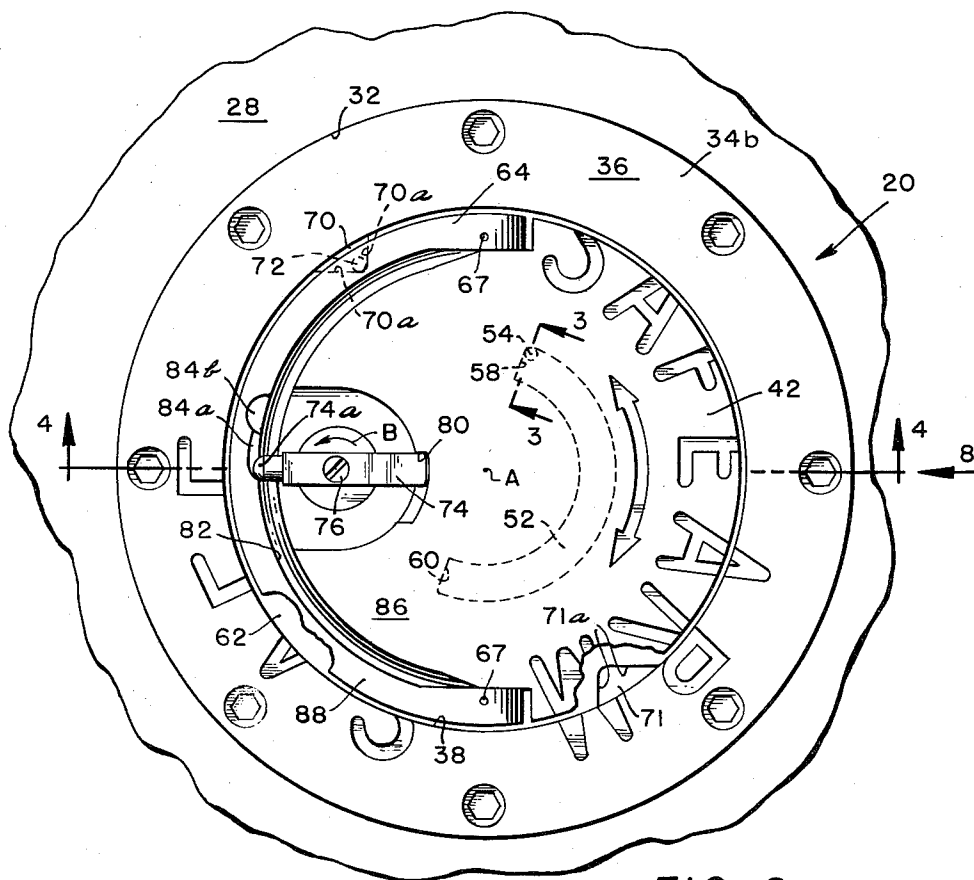


FIG. 2.

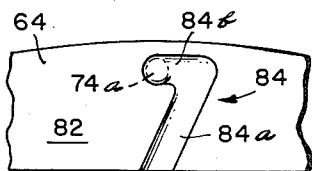


FIG. 10.

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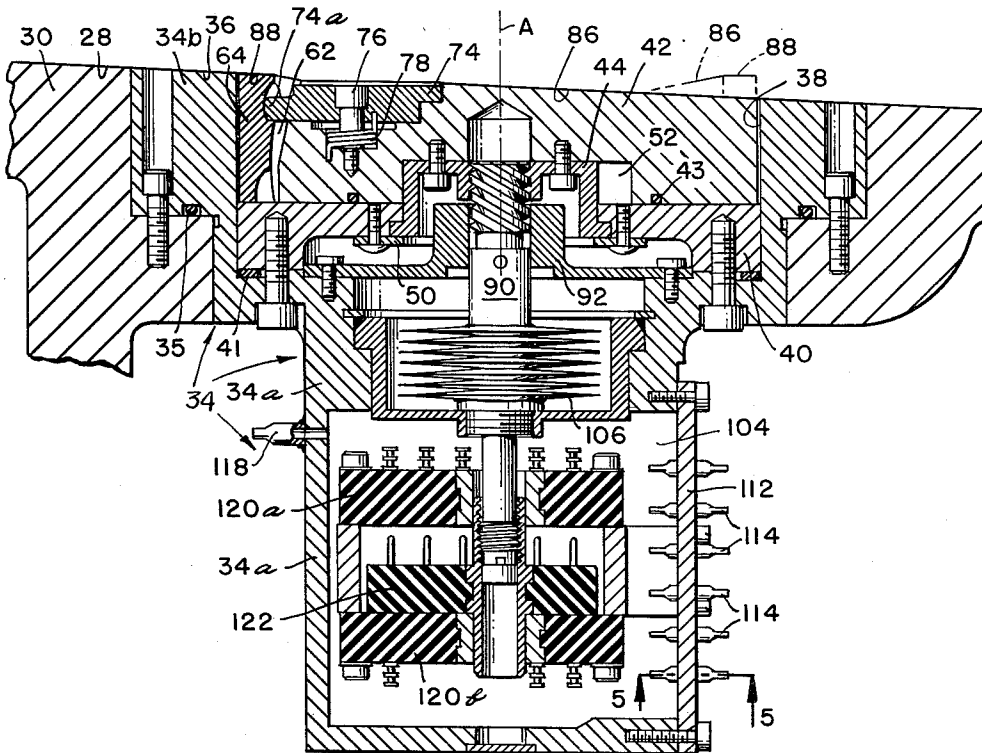


FIG. 4.

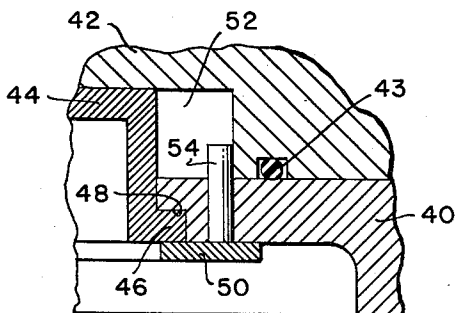


FIG. 3.

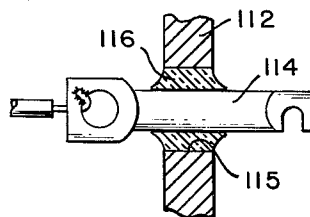


FIG. 5.

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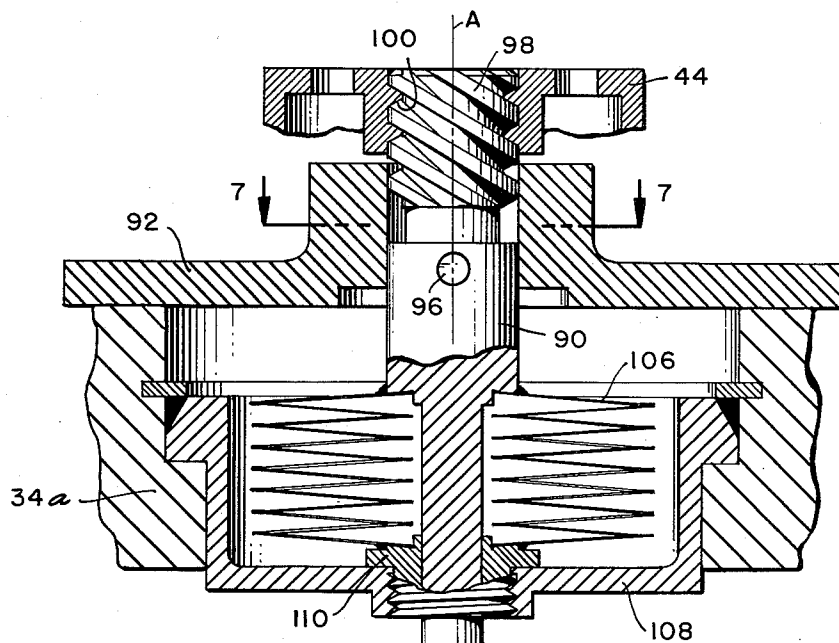


FIG. 6.

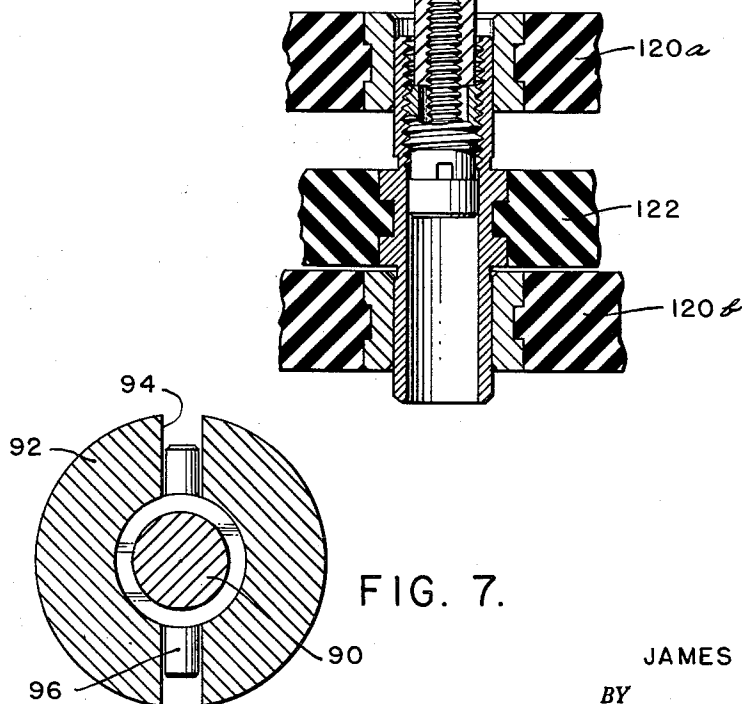


FIG. 7.

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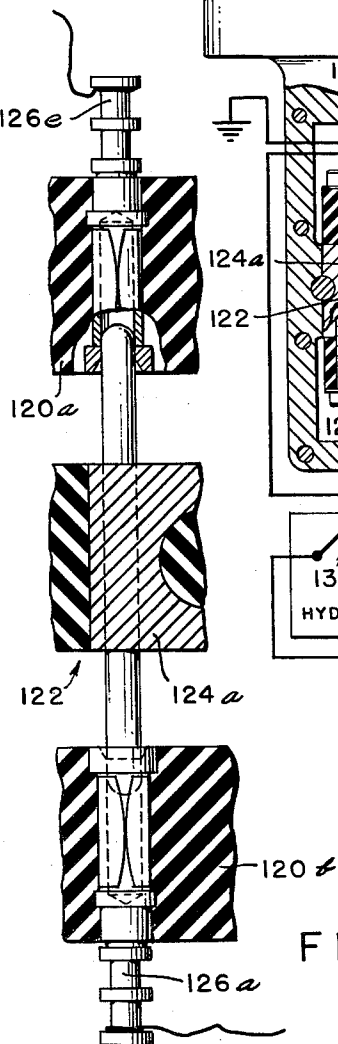
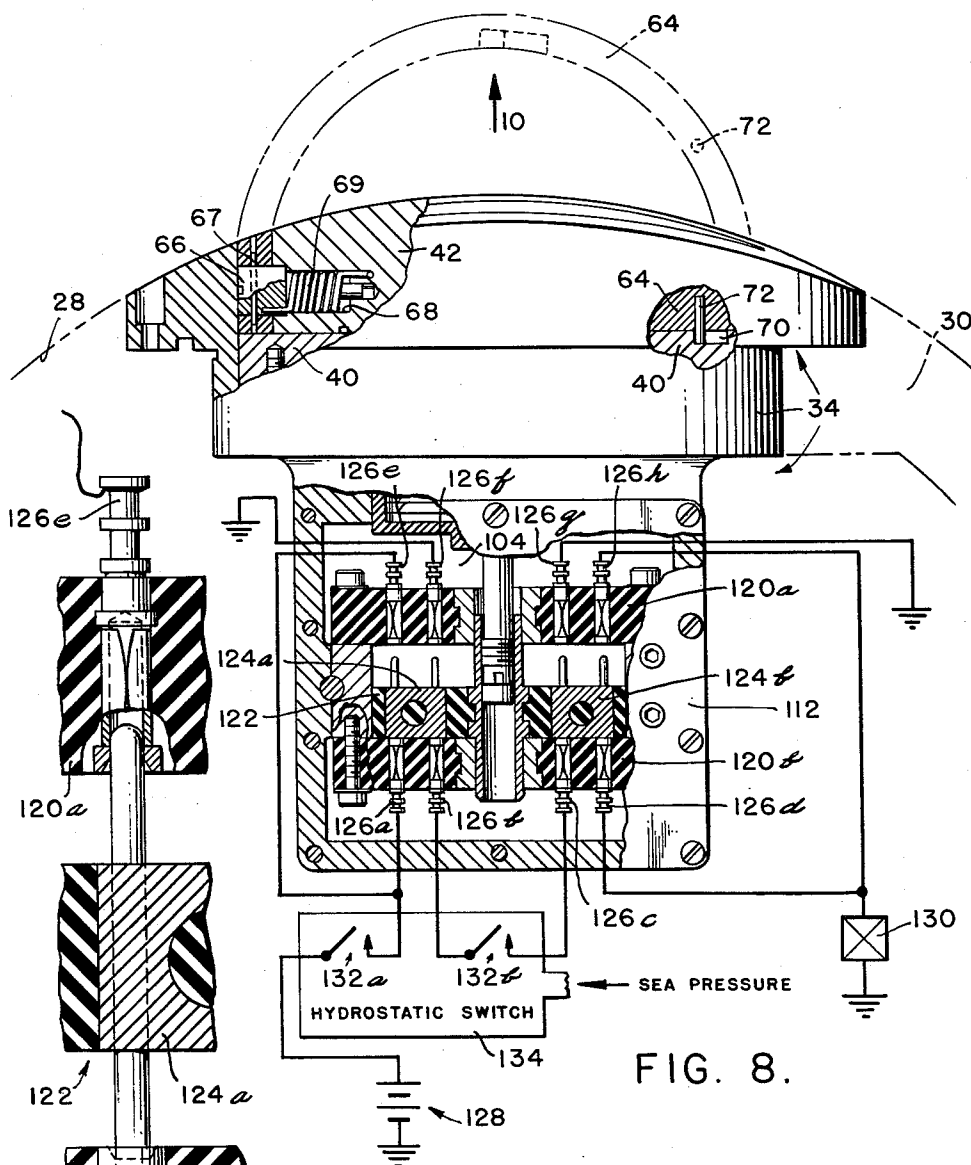
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MANUAL ARM-SAFE SWITCH

4 Sheets-Sheet 4



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3,052,784

MANUAL ARM-SAFE SWITCH

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12 Claims. (Cl. 200—158)

The present invention relates to manual arm-safe switches for use with explosive ordnance and more particularly to arm-safe switches having special utility in connection with underwater ordnance.

Explosive underwater ordnance devices, such as depth charges, are commonly provided with manual arm-safe switches which are accessible from the exterior of the device's hull to establish electrical circuits within the hull which render the warhead armed, or alternatively to establish circuits which render the warhead safe.

One of the objects of the present invention is to provide an improved manual arm-safe switch for underwater ordnance capable of withstanding hydrostatic pressures likely to be encountered at maximum operating depths.

Another object is to provide an improved manual arm-safe switch having a long shelf storage life and a high degree of resistance to corrosive atmospheres.

Another object is to provide an improved arm-safe switch having a manual actuating mechanism which presents a substantially smooth outer surface.

Another object is to provide a switch in accordance with the preceding objective, the unlocked condition of which is readily detectable.

Another object is to provide a switch in accordance with the preceding object which can be subjected to severe water entry shocks with little likelihood of the locking mechanism becoming accidentally unlocked.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawing wherein:

FIG. 1 is a side elevation of a depth charge employing the switch device of the present invention;

FIG. 2 is an enlarged top plan view of the switch device of FIG. 1 taken in the direction of arrow 2, FIG. 1;

FIG. 3 is an enlarged section taken along line 3—3, FIG. 2;

FIG. 4 is a section taken along line 4—4, FIG. 2;

FIG. 5 is an enlarged section taken along line 5—5, FIG. 4;

FIG. 6 is an enlarged detail of a central portion of FIG. 4;

FIG. 7 is a section taken along line 7—7, FIG. 6;

FIG. 8 is an end view of the device in the direction of arrow 8, FIG. 2, partially broken away, and including exemplary warhead firing circuitry;

FIG. 9 is an enlarged section of a detail of FIG. 8 with certain parts shown in an alternate position; and

FIG. 10 is a view taken in the direction of arrow 10, FIG. 8.

Referring to the drawing and in particular FIG. 1, the invention comprises a manual arm-safe switch assembly 20, which may be employed with various explosive ordnance devices, as for example, depth charge 22, which comprises a main body section 24 and an afterbody section 26. The outer surface 28 of afterbody section 26 is so contoured that all sections taken in planes transverse to the longitudinal axis of the depth charge are circular, with the diameter of such circular sections decreasing in the direction of the tail. Switch assembly 20 is mounted in afterbody section 26 with its outer surface 29 flush with surface 28. The depth charge hull 30, FIG. 4, is adapted to withstand sea pressure and prevent entry

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of sea water into the non-pressurized interior. A generally circular opening 32, FIG. 2, is formed in hull 30 to receive switch assembly 20.

Switch 20 comprises a body member 34, FIG. 4, having a flange portion 34f provided with bolt holes through which it is bolted to hull 30 with an O-ring 35 therebetween, and has a surface 36 contoured to conform to afterbody outer surface 28 and a portion 34a which extends into the depth charge hull. Body member 34 has a cylindrical cavity 38 formed therein and an annular member 40 is disposed at the bottom thereof, being suitably fastened to body member 34 with an O-ring 41 therebetween. A rotatable member 42 is seated on member 40 with an O-ring 43 therebetween and is mounted for rotation about an axis A by an arrangement comprising a cup-shaped member 44 fastened to rotatable member 42 and having an annular flange 46, best shown in FIG. 3, which journally engages in a race 48 formed between member 40 and a ring 50. Rotatable member 42 is so shaped to provide an arcuate slot 52, shown by a broken line in FIG. 2, between same and member 44. A pin 54, FIGS. 2 and 3, is fixed to member 40 and extends into slot 52 where it may abut against end walls 58 and 60 of slot 52, which are 180° apart, establishing corresponding limit stop positions of rotatable member 42. The limit stop position wherein pin 54 abuts against end wall 58 constitutes the armed position of rotatable member 42 and the limit stop position wherein pin 54 abuts against end wall 60 constitute the safe position. Rotatable member 42 is so shaped to provide an arcuate slot 62, FIG. 2, between same and body member 34. A bail 64 is pivotally mounted to rotatable member 42 at each end by a suitable pin 66, FIG. 8. Each pin 66 is secured to bail 64 for movement therewith by a force fit pin 67 with the end of each pin 66 pivotally extending into a blind hole 68 formed in rotatable member 34, so that bail 65 may rotate between a fully folded position best shown in FIG. 4 wherein the bail is disposed in arcuate slot 62 and an upright position, shown by alternate position lines, FIG. 8. The upright position of bail 64 constitutes its operating position wherein it may be readily manipulated to rotate rotatable member 42 about axis A. A torsion spring 69 mounted on pin 66 with one of its ends engaging rotatable member 34 and its other end engaging the head of pin 66 resiliently urges bail 64 to rotate away from its folded position. As shown in FIGS. 2 and 8, a pair of slots 70, 71 are formed in member 40 and are so placed that a pin 72 fixed to bail 64 is in registry with slot 70 when rotatable member 42 is in armed position, and in registry with slot 71 when in the safe position. In any other position of rotatable member, movement of bail 64 to its fully folded position is prevented by abutment of pin 72 against member 40. Slots 70 and 71 are so shaped that pin 72 is in abutting relationship against the side walls 70a of slot 70 or side walls 71a of slot 71 when the bail is in a fully folded position, preventing relative rotation between rotatable member 42 and member 40. Accordingly the fully folded position of bail 64 constitutes its locking position wherein rotatable member 42 is locked against rotation. A latch 74, FIGS. 2 and 4, is pivotally mounted to rotatable member 42 by a suitable bolt 76 in a position whereat it is accessible for ready manipulation. A torsion spring 78, mounted on bolt 76 with one of its ends engaging body member 34 and its other end engaging latch 74, resiliently urges latch 74 to rotate in the direction of arrow B and urges it against a limit stop surface 80. As best shown in FIG. 10 there is formed in the concave surface 82 of bail 64 a groove 84 comprising an inclined portion 84a and a latching portion 84b. Groove 84 is so arranged that as bail 64 is rotated into its folded position, the tip 74a of latch 74 is cammed along inclined portion 84a, and upon reaching the intersection of groove por-

tions 84a and 84b springs into its phantom line position, FIG. 10, in response to urge of spring 78, latching bail 64 in its folded position. Bail 64 may be unlatched by manually rotating latch 74 in the direction of rotation opposite to arrow B, moving latch tip 74a to the intersection of groove portions 84a and 84b, whereupon torsion bail 64 springs up out of slot 62, in response to urge of springs 69, to a protruding position wherein it may be grasped and rotated to its operating position. Surface 86 of rotatable member 42 is so contoured to conform to surfaces 36 and 28, when in the armed position. Bail 64 is so shaped that its edge surface 88 is flush with surface 86 of rotatable member 42 when disposed in its fully folded position in slot 62. Surfaces 86 and 88 are contoured to conform to the curvature of surface 36 when rotatable member 42 is in its armed position so that outer surface 29 presented by the switch assembly as a whole is substantially smooth and conforms to the curvature of the depth charge. It is to be understood that the outer surface 29 presented by switch assembly may be similarly adapted to conform to right cylindrical surfaces, flat surfaces or other smooth surfaces. When rotatable member 42 is in its safe position, the switch assembly does not present a smooth surface, presenting instead a profile as shown by alternate position lines, FIG. 4.

A shaft 90, FIGS. 4 and 6, is supported for rectilinear movement along axis A by a bushing member 92 secured to body member 34 and having a transverse slot 94, FIG. 7, formed therein, and a pin 96 diametrically extending through shaft 90 which rides in slot 94. Rotary movement of rotatable member 42 is transformed into rectilinear movement of shaft 90 by a nut and screw arrangement comprising threads 98 formed on shaft 90 which engage mating threads formed on a central bore 100 extending through member 44. Body member portion 34a forms a cubical chamber 104, and shaft 90 extends into chamber 104 through a shaft sealing arrangement comprising a bellows 106, shown in the drawing in somewhat simplified form, and a bellows cup 108 fixed to body member 34 and having a central aperture with a bushing 110. The end of the bellows adjacent to the bottom of the bellows cup is hermetically secured to bushing 110 by a suitable process such as silver soldering and the other end is similarly secured to shaft 90. Such shaft sealing arrangement prevents sea water, which may penetrate the seals of O-rings 41 and 43 under the hydrostatic pressures encountered by underwater ordnance, from entering chamber 104, and also prevents gases from entering or escaping chamber 104 for reasons to be hereinafter apparent. Bellows 106 is preferably of a commercially available type having its adjacent folded sections tightly stacked together in its collapsed condition so as to withstand high hydrostatic pressures against its exterior without rupturing, and the mechanism is so arranged that the bellows are so collapsed (not shown) when rotatable member 42 is in its armed position. Chamber 104 is closed at one side by a panel 112 having a plurality of electrical connector bars 114 extending therethrough to provide electrical communication between the interior of chamber 104 and the exterior of the switch assembly. As shown in FIG. 5, each connector bar 114 extends through an aperture 115 and is surrounded by fused glass 116, which insulates the electrically connector bar and provides a water and gas seal. All possible interstices leading into chamber 104, including those around and about bellows cup 110 and panel 112 are sealed by a suitable fuseable material such as solder (not shown) to completely seal chamber 104 against gases entering or escaping, and an inert gas such as argon is introduced into the chamber through a tube 118, which is subsequently crimped and sealed with solder.

Disposed in chamber 104 is a pin and socket switch contact arrangement comprising multiple socket assemblies 120a, 120b, which are stationary relative to body member 34, in spaced relationship to one another, and

secured to body member 34 in any suitable manner. A multiple pin assembly 122 is disposed between socket assemblies 120a, 120b and is secured to shaft 90 in any suitable manner for movement therewith. Multiple pin assembly 122 comprises a plurality of shorting bars 124a, 124b, imbedded in an insulating material, each shorting bar having a pair of pins extending therethrough, with opposite ends of each pin projecting toward socket assembly 120a and 120b, respectively. Socket assemblies 120a, 120b comprise a plurality of sockets 126a, 126b, imbedded in an insulating material, each in registry with a corresponding shorting bar pin. In FIG. 8, sockets 126 are shown schematically interconnected in typical depth charge firing circuitry, it being understood that the sockets electrically communicate with the circuit elements outside chamber 104 through connector bars 114. When rotatable member 42 is in its armed position, shorting bar 124a short circuits sockets 126a and 126b, and shorting bar 124b short circuits sockets 126c and 126d, establishing a series circuit between the ungrounded terminal of a battery 128 and the ungrounded terminal of a squib 130, with a pair of initially opened switch contacts 132a and 132b of a hydrostatic switch mechanism 134 included in such circuit. Hydrostatic switch 134, a component of depth charge 22, provides the final actuation to ignite squib 130 by simultaneously closing switch contacts 132a, 132b, in response to sea pressure when the depth charge reaches a predetermined depth. When rotatable member 42 is in its safe position shorting bar 124a short circuits sockets 126e and 126f establishing a series circuit which connects the ungrounded terminal of battery 128 to ground in the event switch contact 132a should accidentally close, and shorting bar 124b short circuits sockets 126g and 126h establishing a series circuit connecting the otherwise ungrounded terminal of squib 130 to ground. Socket assemblies 120a, 120b and pin assembly 122 are so spaced that in moving rotatable member 42 from its safe position to its armed position, pin assembly 122 is momentarily in the position shown in FIG. 9 wherein the shorting bar pins engage both the sockets of assembly 120a and the sockets of assembly 120b, so that any electrostatic charges upon the lead wires and circuit elements connected to the sockets 126a, 126b, 126c and 126d are shorted to ground, to obviate the likelihood of accidental firing by static electricity. In its preferred form, the firing circuitry includes a plurality of squibs like squib 130 connected in parallel relationship, to reduce the likelihood of malfunction through failure of any one or more of such squibs to fire, with a plurality of pin and socket arrangements to individually and simultaneously connect each such squib in the firing circuit in the armed position and to ground the otherwise ungrounded end of each squib in the safe position.

Exhaustive tests of switch assembly 20 have revealed that it may be subjected to the hydrostatic pressures likely to be encountered at the maximum depths at which underwater ordnance devices are operated without penetration of water into chamber 104. Also, tests have shown that assembly 20 may be subjected to the severe water entry shocks encountered in being dropped from an aircraft or as payload in a rocket propelled anti-submarine missile, without benefit of a parachute, without damage or likelihood of the latching mechanism becoming unlatched.

Further, it will be seen that when the manual actuating mechanism is in its locked condition, bail 64 is in its folded position and surfaces 86 and 88 are flush, and when in the unlocked condition spring 69 urges bail 64 to a protruding position, so that the unlocked condition of the actuating mechanism may be readily detected by protrusion of the bail. It will also be seen that the inert gas sealed in chamber 104 inhibits corrosion of the electrical contacts therein providing a long shelf storage life as well as a high degree of resistance to corrosive atmospheres, such as salt water air.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. Arming switch apparatus comprising; a body member having means for affixing same to the hull of a submersible ordnance device and having a closed chamber adapted to be disposed within the hull, a rotatable member carried by said body member, said rotatable member being accessible from outside of said hull and having an outer configuration forming a flush continuation of the hull, a shaft extending into said chamber and operatively connected to said rotatable member, switch means within said chamber adapted to be actuated by said shaft, shaft seal means for preventing entry of water into said chamber, said rotatable member having a ball pivotally carried thereby adapted to be rotated between an operating position and a locking position, means co-operating with said bail for locking said rotatable member against rotation when said bail is in locking position, said bail when in the locking position, only, being flush with said rotatable member, and manually releasable latching means adapted to latch said bail in locking position to thereby lock said rotatable member against rotation when said bail is in the locking position.

2. Apparatus in accordance with claim 1 wherein said switch means comprises a first electrical contact carried by said shaft for movement between a first position engaging a first contact, only, and a second position engaging only a second contact, said first contact being engageable with both said first and second contacts in a position intermediate said first and second position.

3. Apparatus in accordance with claim 2 including means connecting said rotatable member and said shaft for reciprocating said shaft upon rotary motion of said member.

4. Apparatus in accordance with claim 3 wherein said closed chamber is sealed to prevent gases from entering or escaping same, said shaft seal means being further adapted to prevent gases from entering or escaping said chamber as said shaft is reciprocated.

5. Apparatus in accordance with claim 1 wherein said rotatable member has an armed position and an unarmed position, and means co-operating with said bail adapted

to lock said rotatable member, only when said rotatable member, only when said rotatable member is in one of said positions.

6. Apparatus in accordance with claim 5 including means connecting said rotatable member and said shaft for reciprocating said shaft upon rotation of said member.

7. Apparatus in accordance with claim 6 wherein said switch means comprises a set of pins carried by said shaft, one end of each of said pins adapted to engage a first set of mating sockets when said rotatable member is in its unarmed position, the other end of each of said pins adapted to engage a second set of mating sockets when said rotatable member is in its armed position, said pins adapted to engage both said first and second sets of sockets prior to final movement of said rotatable member between its armed and unarmed position.

8. Apparatus in accordance with claim 7 wherein said closed chamber is sealed to prevent gases from entering or escaping same, said shaft seal means being further adapted to prevent gases from entering or escaping said chamber as said shaft is reciprocated.

9. Apparatus in accordance with claim 1 wherein said manually releasable latching means comprises a spring urged latch pivotally carried by said rotatable member, and a camming groove formed on said bail adapted to cam said latch into latching position by folding movement of the bail.

10. Apparatus in accordance with claim 1 wherein said means for locking said rotatable member comprises a pin carried by said bail and a co-operating abutment stationary relative to said body member.

11. Apparatus in accordance with claim 1 including means connecting said rotatable member and said shaft for reciprocating said shaft upon rotary motion of said member.

12. Apparatus in accordance with claim 11 wherein said means connecting said rotatable member and said shaft comprises a screw formed on said shaft and a nut carried by said rotatable member.

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