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UNDERWATER EXPLOSIVE DEVICE

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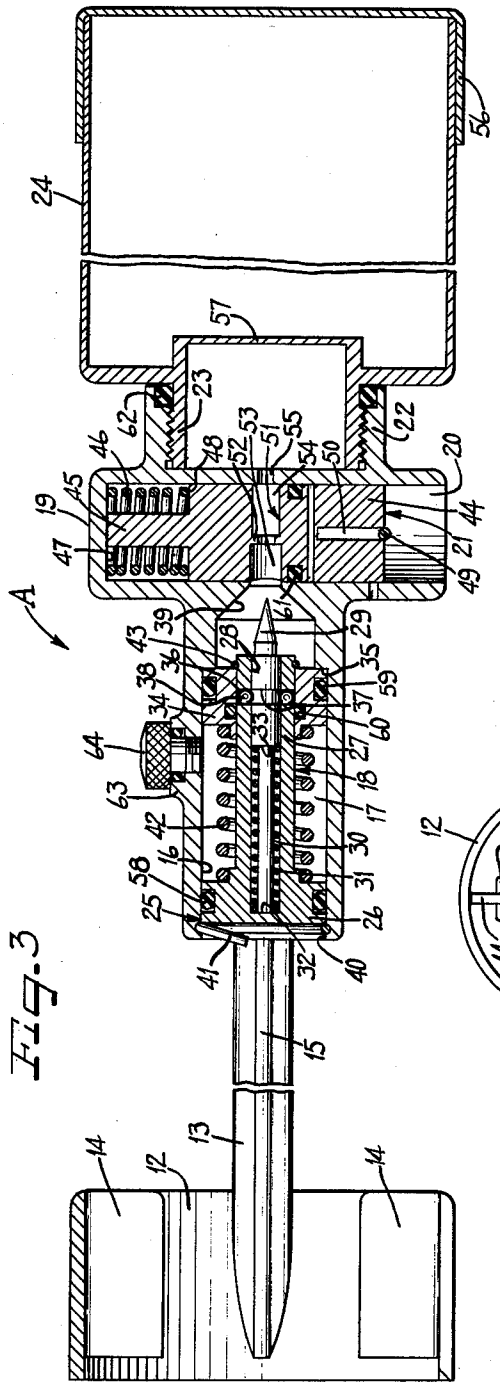


Fig. 3

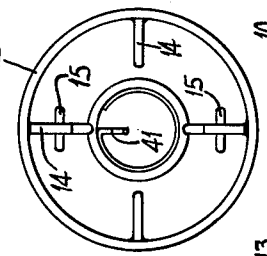


Fig. 2

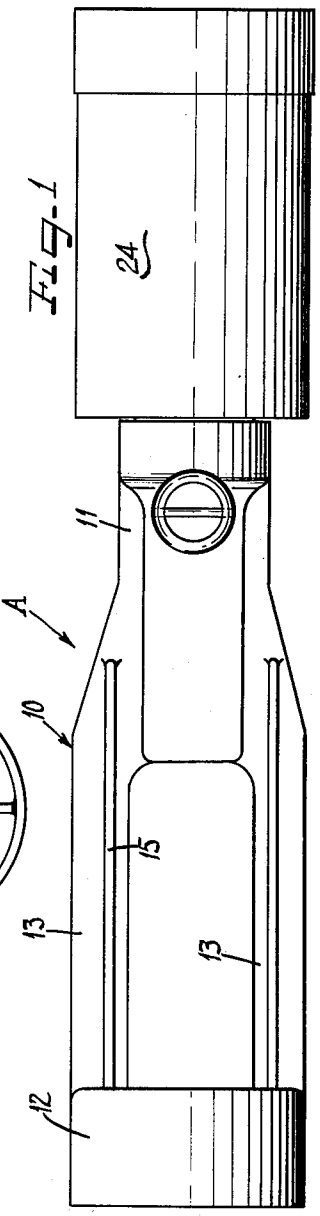


Fig. 1

Inventor

Samuel D. Bernard

by Hill, Sherman, Meroni, Gross & Simpson Attys

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UNDERWATER EXPLOSIVE DEVICE

Samuel D. Bernard, Penhook, Va., assignor to Thompson Ramo Wooldridge Inc., Cleveland, Ohio, a corporation of Ohio

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The present invention relates broadly to the art of demolition, and is more particularly concerned with a novel explosive device particularly well adapted for underwater use.

It is a primary aim of the present invention to provide an underwater explosive device which is armed and fired under the influence of predetermined water pressure.

Another object of this invention lies in the provision of an explosive package featuring extreme accuracy of operation and a readily fabricated and assembled structural arrangement.

Still another object of the invention is to provide a device for performance of underwater demolition tasks, comprising a body member carrying an explosive charge container at one end and guide means at the opposite end thereof, the body member housing arming and firing mechanisms sequentially actuated by water pressures exerted thereagainst during submergence of the device.

A further object of this invention lies in the provision of an explosive device particularly adapted for underwater use and which comprises a housing providing communicating open-ended arming and firing chambers, a charge container normally attached to the housing, a firing mechanism in the firing chamber movable towards the arming chamber under action of water pressures applied against said mechanism through the open end of the firing chamber, and an arming mechanism in the arming chamber passaged to receive the firing mechanism, the arming mechanism moving under action of water pressures applied against said mechanism through the open end of the arming chamber to align the passage in said mechanism with the firing mechanism, the latter mechanism moving under relatively greater pressures to detonate the charge in the container.

Other objects and advantages of the invention will become apparent as the description proceeds in accordance with the drawings in which:

FIGURE 1 is a bottom plan view of an underwater explosive device constructed in accordance with the principles of this invention;

FIGURE 2 is an end view of the device, showing particularly the guide fin means thereon; and

FIGURE 3 is a side elevational view, with parts in section, of the underwater explosive device of this invention.

Briefly stated, an explosive device for underwater use as constructed in accordance with the principles herein disclosed comprises a housing or body member which provides interiorly thereof communicating open-ended arming and firing chambers. The housing may be cast as an integral unit to provide guide fin means extending outwardly from said housing, while the opposite end of the body member or housing has suitably secured thereto a container or cannister for the explosive charge. The firing chamber receives in slidable contact the head portion of a piston, the head portion prior to piston movement closing the open end of the firing chamber. Slidably received in the firing piston is a firing pin restrained against movement prior to piston travel by ball means or the like engageable with the piston and sleeve means therefor.

The arming chamber formed within the housing is positioned between the firing chamber and charge container, and mounts therewithin a passaged slidable piston

maintained in non-arming position by suitable resilient means. The passage in the arming piston contains a percussion cap which initiates detonation of the explosive charge when the device is armed and fired.

The explosive device is armed by the action of particular water pressures and modifications may be made therein so that the arming takes place at a particular water lepth. After the explosive device has descended to a predetermined depth, the arming piston is moved against the force of the resilient means whereby the passage in the arming piston is aligned with the firing pin. Upon further descent of the explosive device in the water, the water pressures are exerted against the head portion of the piston to move said piston toward the arming chamber, and upon completion of predetermined travel of the piston the firing pin is released from its engagement with the piston and surrounding sleeve to detonate the percussion cap. If it is desired that the firing be delayed until the explosive device has descended an even greater depth, a depth selector plug may be removed from the housing walls surrounding the firing chamber to create a back pressure on the piston, thereby resisting dislodgement of the ball means from locking engagement with the firing pin and piston.

Referring now to the drawings, an explosive device particularly well adapted for underwater use is designated generally therein by the legend A. The device comprises a main body portion **10** which may be formed as an integral cast structure to provide a housing **11** for the operating mechanisms and a guide head **12** mounted at the ends of a pair of supporting members **13**. The annular guide head **12** stabilizes the explosive device A during descent, and fins **14** are provided along the inner diameter for this purpose. To rigidify the supporting members **13** and add strength thereto outwardly extending ribs **15** may be provided essentially entirely along the length of said members.

The housing **11** is formed inwardly of one end with a variable diameter axial bore **16** providing an annular firing chamber **17** housing a firing mechanism generally designated by the numeral **18**. Downstream of the firing chamber **17** and inwardly of its opposite ends the body member or housing **11** is provided with a raised boss **19** having therein an annular recess **20** opening at one end and providing an arming chamber receiving an arming piston **21**. Preferably cast integral with the body member **11** and thereby forming a part of said member is an internally threaded collar **22** engaging a cap portion **23** of a charge container or cannister **24**. During use the container cap portion **23** houses a booster such as tetryl, and the explosive within the container **24** may be in the form of TNT or other desired materials.

The firing mechanism **18** comprises a piston member **25** having a generally cylindrical head portion **26** and substantially cylindrical stem portion **27** passaged at **28** to slidably support therein a firing pin **29** resiliently urged by spring means **30**. It is to be seen that the firing pin **29** has a reduced diameter stem portion **31** surrounded by the spring means **30**, and that the spring means bottoms at one end against base **32** of the passage **28** and at its opposite end against a shoulder **33** formed at the end of the firing pin reduced portion **31**.

The piston member stem **27** is slidably received within a guide collar or insert **34** which is restrained against forward axial movement by abutment with a shoulder **35** formed by the firing chamber bore **16**. The apertured insert **34** further functions in a novel manner to releasably lock the firing pin **29** in a rearward position prior to completion of a predetermined amount of piston travel. Specifically, the piston member stem **27** is provided with a plurality of circumferentially spaced holes or openings **36** each receiving a ball member **37** constructed of nylon

or Teflon material, steel or the like of about ⅛" diameter seated in an annular conical groove 38 in the firing pin 29 axially inwardly of the opposite ends thereof. The rotatable elements 37, in cooperation with the groove 38 and apertured insert 34 accordingly lock the firing pin 29 in the position shown, and as will be described in detail later, movement of the piston 25 toward the arming chamber 20 causes the rotatable elements 37 to be impelled outwardly to release the firing pin 29 from locked engagement with the piston member stem 27.

The piston 25 is guided as earlier noted by the apertured insert 34, and additionally the head portion 26 of the piston member travels in slidable contact with the piston chamber bore 16. It is to be seen from FIGURE 3 that the bore 16 is open at both ends, communicating with the arming chamber 20 by means of a convergent passage 39. The opposite end of the bore 16, as shown in FIGURE 2, provides an annular passage 40 to the entry of fluid pressures acting upon the end of the piston head 26 to cause piston travel when the explosive device A has submerged to a predetermined depth in a body of water. The piston member 25 is restrained against axial movement in a direction opposite from the arming chamber 20 by lock ring means or the like 41. Spring means 42 surrounding the piston member stem 27 and bottoming at one end against the piston head 26 and at the opposite end against the apertured insert 34 maintains the piston member head 26 against the lock ring 41. Lock ring means 43 may be provided at the opposite end of the piston 25 surrounding the stem portion 27 thereof, although this is not at all times required.

The arming piston 21 receivable in the radially extending arming chamber 20 comprises a generally cylindrical body portion 44 having formed at one end a reduced diameter generally cylindrical neck portion 45 encircled by spring means 46 bottoming at one end against bottom wall 47 of the annular recess 20 and at its opposite end against shoulder 48 at the juncture of the arming piston body portion 44 and neck portion 45. As appears in FIGURES 1 and 2, inwardly of the open end of the radially extending boss 19 there is provided pin means or the like 49 received at opposite ends in the boss walls and cooperating with a notch or slot 50 to guide the arming piston 21 during its axial travel within the radial passage 20.

The arming piston 21 is in its armed position as shown in FIGURE 3, and formed in the arming piston body portion 44 for axial alignment with the firing pin 29 is a stepped diametral bore 51. The bore 51 is divided by an annular rib 52 into a pair of communicating compartments 53 and 54, the compartment 54 containing a percussion cap (not shown) and communicating with the interior of the container cap 23 by means of a passage 55 in one wall of the arming chamber boss 19. It is thus to be seen that the path of axial travel of the firing pin 29 is through the convergent passage 39, into the first compartment 53, through the annular rib 52 and into the compartment 54 containing the percussion cap. By detonation of the percussion cap ignition of the booster in the container cap interior is effected through the passage 55, and the explosive material within the container or cannister 24 thereby detonated.

The container 24 is preferably extruded from aluminum or similar materials and is to be seen to be of relatively thin wall construction. The container 24 carries at one end a surrounding cap 56, and the cap after loading of the explosive material in the container is secured by a suitable adhesive, which may be one of the epoxy resins. It is to be further seen from FIGURE 3 that the neck portion or cap portion 23 has a relatively thin bottom wall 57 extending into the container interior 24, and it is of course appreciated that the wall 57 is fractured or essentially disintegrated upon ignition of the booster within the cap or neck portion 23.

In accordance with best manufacturing practice and to assure a proper functioning of the parts, the explosive device A incorporates therein at various locations seal means of the desired type. Specifically, an O-ring or the like 58 may be received in a suitable annular groove in the piston head 26, and a similar ring 59 seated in an annular groove in the apertured guide or insert 34. Seal means 60 may be located in contact with the piston member stem 27 and inner diameter of the apertured insert 34, and the arming piston body member 44 may be grooved to seat therein seal means 61 in rubbing contact with the inner walls of the arming chamber 20. Further, an O-ring or the like 62 may be seated in a suitable groove in the housing collar portion 22 bearing the neck portion 23 of the container 24. Seal means may be employed at other locations as desired or required.

While modifications may be made therein to effect arming and firing of the explosive device at particular water depths, the structure described in the preceding paragraphs is designed to be armed at a depth of approximately 20 feet and thereafter fired at a depth of approximately 60 feet. However, in accordance with the principles of this invention, there is provided depth selector means whereby the firing of the device may be effected at particular depths in excess of 60 feet. Referring now again to FIGURE 3, the body portion 11 of the device A is provided with an internally threaded apertured embossment 63 communicating with the firing chamber 17 and receiving therein a threaded plug or the like 64. Accordingly, should it be desired to delay the firing of the explosive device until water depths substantially in excess of 60 feet have been reached, the plug 64 may be removed prior to dropping of the explosive device and water pressures are thereupon exerted against the backside of the piston head 26 to prevent piston travel and firing until a particular water depth has been reached. While the construction disclosed may be varied to effect the delayed firing at various steps, it has been found that utilization of the depth selector means 63—64 shown effects a firing at water depths of approximately 300 feet.

The operation of the explosive device A may be described as follows. The explosive device A is dropped into the water over the object to be demolished, and during descent in the water the guide fin assembly 12 stabilizes the device so that it pursues an essentially vertical course downward to the object beneath the water surface. The device upon reaching a water depth of approximately 20 feet is armed by the effect of water pressure upon the arming piston 21, causing said piston to travel axially within the bore or recess 20 toward the closed end of the arming chamber and into essentially the position shown in FIGURE 3, whereat the bore 51 in the piston body portion 44 is axially aligned with the firing pin 29.

Further descent of the explosive device A in the water to a depth of approximately 60 feet causes the firing to be initiated. This is effected by the greater water pressures at this depth exerting a force against the front side of the firing piston head portion 26, causing forward axial travel of the piston 25 with the head portion 26 and stem portion 27 thereof in sliding contact with the firing piston bore 16 and inner diameter of the sleeve or insert 34, respectively. This movement is of course in resistance to the spring means 42 which acts to hold the piston member 25 in a rearward position with the piston head 26 against the locking spring 41, as shown in FIGURE 3. Continued axial travel of the piston stem member 27 in sliding contact with the sleeve or insert 34 moves the rotatable elements 37 beyond the front face of said insert, whereby the rotatable elements are cast radially outwardly through the apertures 36 in the piston stem 27 and out of locking engagement with the firing pin 29 through the groove 38 therein. The firing pin 29 is thereupon impelled axially forwardly under action of the spring means 31 into firing contact with the percussion cap means in the compartment 54 of the diametral bore

51 in the arming piston body portion 44. The explosive train is thereupon ignited by the percussion cap, firing the booster in the cap member 23 and detonating the explosive material in the container or cannister 24, to demolish the underwater object.

By the action described it is to be seen that the explosive device A is armed at about 20 feet of water depth, and fired at approximately 60 feet. However, to effect a demolition of objects at depths substantially greater than 60 feet, the depth selector means 63—64 is utilized. Specifically, when the object to be demolished is at a depth in the neighborhood of 300 feet, the plug 64 is removed from the apertured embossment 63 prior to release of the underwater explosive device A. The device is armed in essentially the same manner as described at about 20 feet, and during further descent into the water pressures are exerted within the firing chamber 17 against the backside of the piston head 26 to resist water pressures exerted against the opposite side of said piston head. The back pressures are sufficient to restrain the piston member 25 against slidable axial travel until depths of approximately 300 feet are reached, whereupon the pressures applied against the front or exposed side of the piston head 26 are greater than the back pressures, and the piston member 25 moves slidably forwardly until the rotatable elements 37 are released from locking engagement in the groove 36 of the firing pin 29. The explosive train comprising the percussion cap, booster and explosive is thereupon fired in the manner described in the preceding paragraph.

It will be appreciated that the components of the underwater explosive device A may be suitably modified to effect arming and firing at depths other than those stated, and that other variations and modifications may be effected in the structure disclosed without departing from the novel concepts of the present invention.

I claim as my invention:

1. An explosive device particularly adapted for underwater use, comprising a generally T-shaped housing having integral leg and arm portions, said leg portion having a variable diameter passage extending entirely therethrough and defining a firing chamber, said arm portion being open at one end only and defining an arming chamber communicating with said firing chamber, a firing mechanism in said firing chamber comprising a piston having a head portion normally located at one end of said passage in closing relation thereto and a tubular stem portion provided with a plurality of circumferentially spaced openings adjacent one end, an annular stationary collar slidably receiving said stem portion and spaced from the opposite end of said passage, a relatively slender firing pin slidably received in said stem portion and having an annular groove formed therein, a plurality of balls housed in said stem openings and said pin groove locking said pin to said stem to maintain said pin in a retracted position, first spring means bottoming at opposite ends against said piston head portion and collar maintaining said head portion in closing relation to said one end of said passage, second spring means within said tubular stem portion urging said firing pin toward said arming chamber, an arming piston slidable in said arming chamber and having a passage therethrough to receive said firing pin when said pin and said passage are aligned, third spring means bottoming at one end against the closed end of said arming chamber and at its opposite end against said arming piston for urging said piston toward said open end of said arming chamber and said piston into a non-arming position, and an explosive charge container attached to said housing arm portion, said arming piston first moving under action of a relatively low hydrostatic pressure to align the passage therein with said firing pin, and said piston head portion moving under action of relatively greater hydrostatic pressures to move said piston stem portion relative to said collar member until the openings in said stem portion are beyond the end of said collar member and the balls are cast into said space and out of locking engagement to permit said firing pin to be driven by said second spring means into the passage in the arming piston to detonate the explosive.

2. An explosive device of the character defined in claim 1, in which one end of the arming piston is provided with a diametral slot therein and in which the housing arm portion mounts pin means received in said slot for guiding said arming piston during slidable travel in said arming chamber.

3. An explosive device of the character defined in claim 1, in which the housing leg portion mounts removable depth selector means for delaying firing of the explosive device after arming until a particular water depth is reached, and also in which the housing leg portion connects with guide means for controlling the path of descent of the device.

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