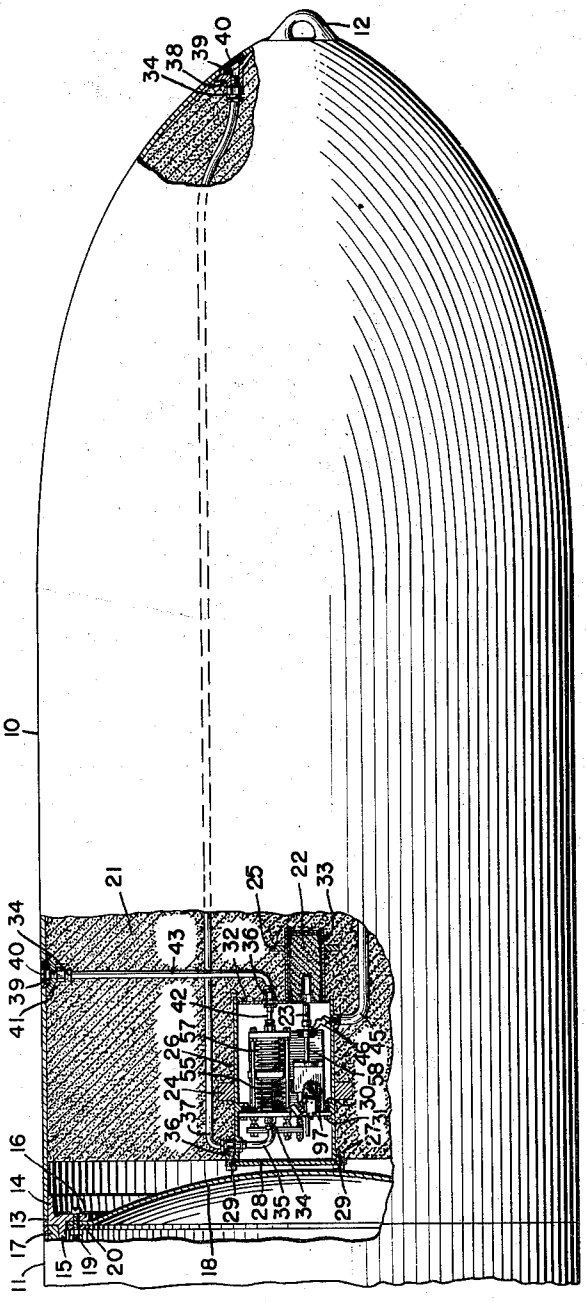
Nov. 1, 1960 E. R. HABERLAND 2,958,279

TORPEDO ARMING DEVICE

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FIG. 1.



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TORPEDO ARMING DEVICE

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FIG. 2.

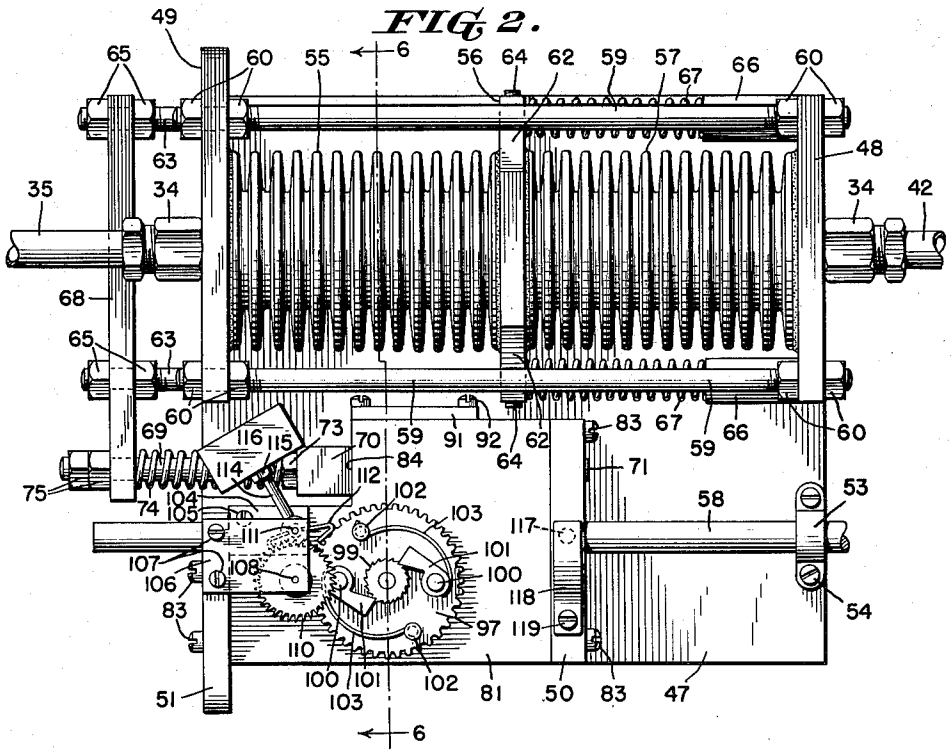


FIG. 3.

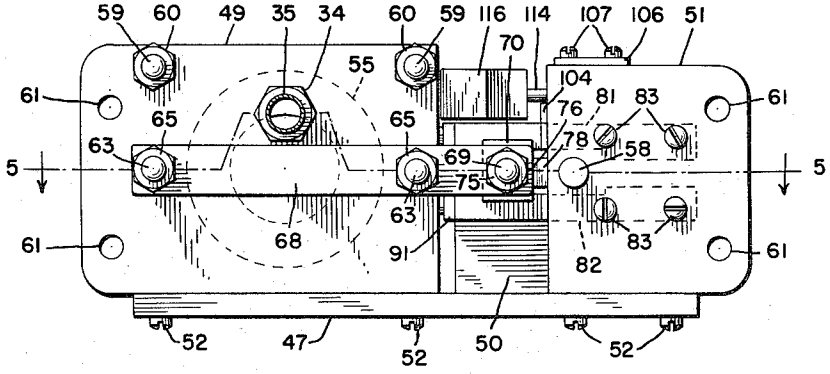
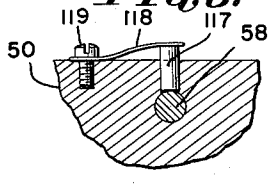


FIG. 8.



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TORPEDO ARMING DEVICE

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FIG 4.

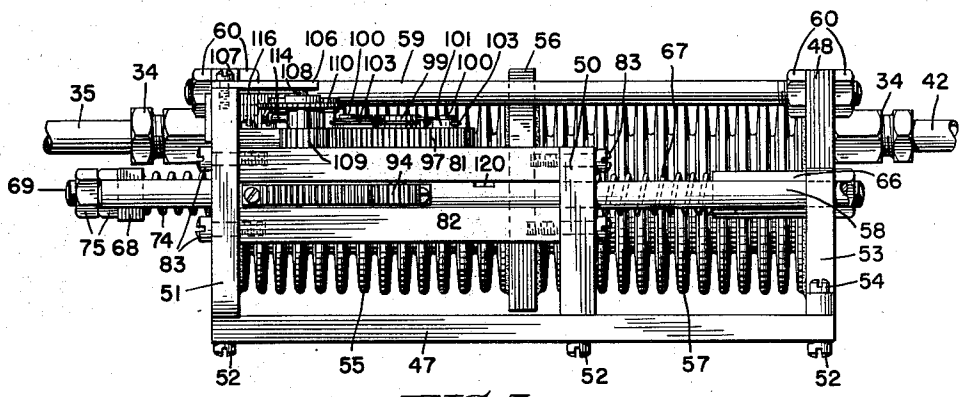
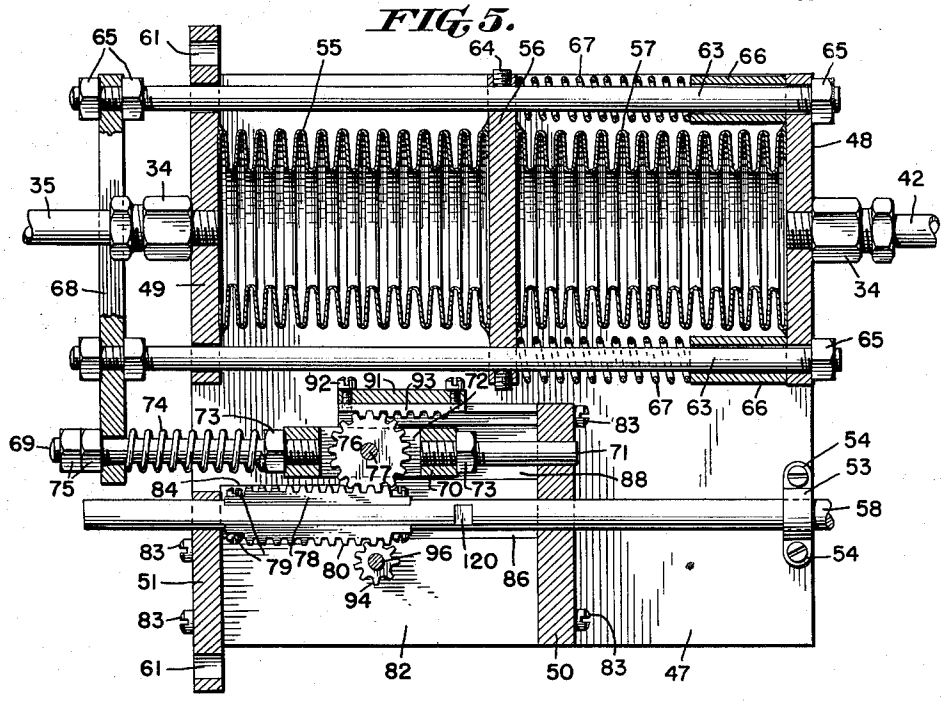


FIG 5.



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TORPEDO ARMING DEVICE

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FIG. 6.

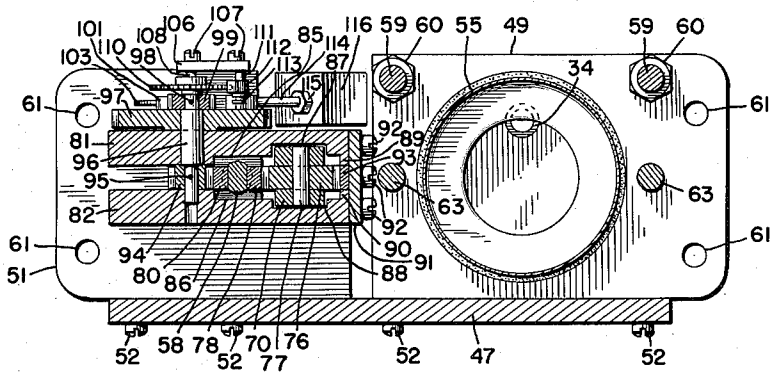
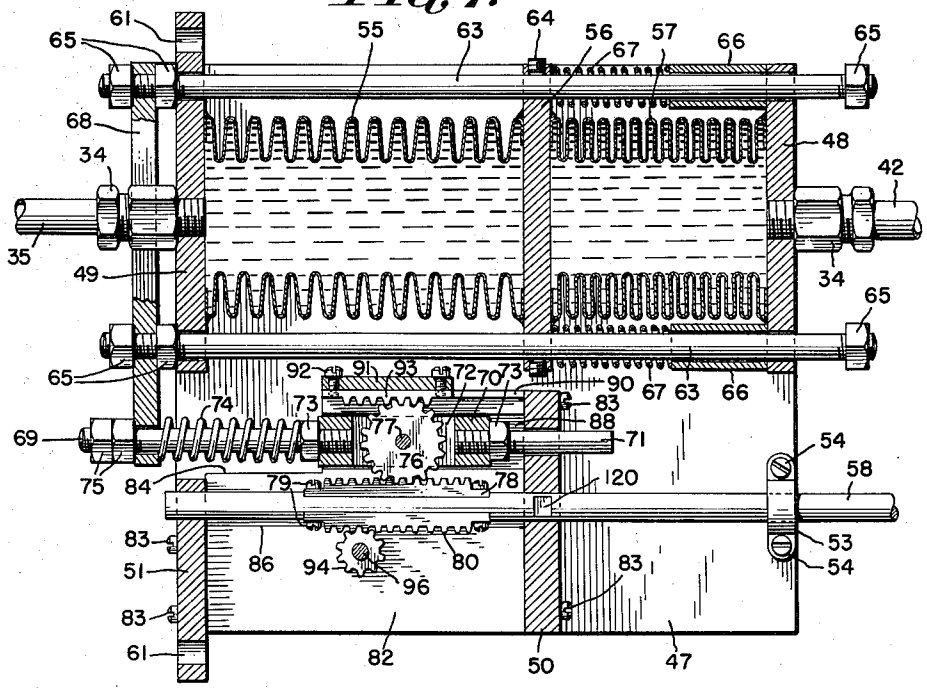


FIG. 7.



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2,958,279

TORPEDO ARMING DEVICE

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Filed Jan. 19, 1945, Ser. No. 573,623

16 Claims. (Cl. 102—16)

(Granted under Title 35, U.S. Code (1952), sec. 266)

This invention relates to a device for arming a torpedo, and, more specifically, to an arming apparatus and mechanism controlled thereby in which the apparatus is operated by the pressure differential existing between the nose of the torpedo and the side of the torpedo head as the torpedo travels through the water.

The invention according to the broader aspects thereof contemplates the provision of means operatively connected to the arming mechanism for causing the arming mechanism to be actuated from an initial safe position to an armed position only in response to a force continuously applied thereto for a predetermined period of time, and in which the arming apparatus is prevented from moving from the initial safe position to the armed position in response to a force such, for example, as the force of inertia, applied to the arming mechanism for a relatively short period of time. Furthermore, the arming mechanism is restored to the initial safe position at the completion of each short period of time when the force momentarily applied thereto is dissipated and thus the torpedo employing the present invention is rendered safe during the assembly, transportation and launching thereof regardless of the shocks which the torpedo may receive. The arming arrangement of the present invention, therefore, provides means whereby there is no possibility of the torpedo being fired until a pressure differential has been applied continuously thereto for a predetermined period of time in excess of the period of time of such shocks which the torpedo may receive prior to and during the launching thereof.

One of the objects of the present invention is to provide a new and improved arming mechanism for a torpedo which will be controlled by the pressure differential of the surrounding water as the torpedo travels toward a target.

Another object of the invention is to provide a differential pressure actuated arming device for a torpedo in which the device is prevented from arming the torpedo in response to shocks or sudden impulses applied thereto.

A further object of the invention is to provide a pressure actuated arming device which will be automatically restored to an initial or safe position when the actuating force is applied thereto for less than a predetermined period of time.

An additional object of the present invention is to provide an apparatus and a mechanism for arming a torpedo by moving a detonator to an armed position in operative relation with an explosive charge in response to a pressure differential applied continuously to the arming apparatus for a predetermined period of time and in which the detonator is locked in the armed position.

Still other objects, advantages, and improvements will be apparent from the following description taken in connection with the accompanying drawings, in which:

Fig. 1 is a side elevation view of the war head of a torpedo, the casing being partially broken away to show the arming apparatus and mechanism and the forward and side fluid pressure connections;

Fig. 2 is a top plan view of the arming apparatus and mechanism;

Fig. 3 is an end elevation view of the arming apparatus and mechanism looking toward the right in Fig. 2;

Fig. 4 is a side elevation view of the arming apparatus and mechanism;

Fig. 5 is a sectional view taken substantially along the line 5—5 of Fig. 3 showing the fluid pressure responsive device in the initial safe position;

Fig. 6 is a sectional view taken on the line 6—6 of Fig. 2 showing the mechanism for operating the escapement;

Fig. 7 is a view similar to Fig. 5 but showing the fluid pressure responsive device filled with water and in the armed position; and,

Fig. 8 is a detail view showing the detent for locking in the armed position the plunger which carries the detonator.

Referring in particular to Fig. 1 of the drawings on which like numerals of reference are employed to designate like parts on the several views, the reference numeral 10 designates the shell of the war head of a torpedo. This shell is attached to the base 11 which is of the same diameter as the shell and contains the propulsive means, the particular propulsive means forming no part of the present invention. The shell 10 has the conventional ring 12 in its nose to facilitate handling. The particular attachment means for securing shell 10 of the war head and the base 11 of the torpedo together is likewise no part of the present invention. As shown, this attachment means comprises a cylindrical ring 13 having a rim 14, and an annular flange 15 of reduced diameter, and an inwardly extending radial flange 16. A second cylindrical ring 17 is mounted inside the base 11, the outer edges of the base and the ring being flush. The ring 17 is machined on its outer and inner peripheries so as to have a force fit within the base 11 and over the flange 15 on the ring 13 and the rim 14 of the latter is likewise machined to have a force fit within the shell 10 of the war head. It will be obvious that the ring 13 can be secured in the shell 10 and the ring 17 within the base 11 by brazing, soldering, welding, or the like. An outwardly depressed bowl shaped crown sheet 18 is secured across the circular aperture formed through the inwardly extending radial flange 16 of the ring 13 and is secured to this flange by arcuately spaced bolts 19. The bolts 19 extend through the flange 16, the periphery of the crown sheet 18 and a flat retaining ring 20 which serves to equalize the stress on the crown sheet.

The usual main explosive charge 21 substantially fills the interior of the shell 10 of the war head. Adjacent the rear portion of the body of the charge 21 cross members 24—24 and 25—25 extend chordally of the shell 10 of the war head. The members 24—24 support a well casing 26 which has a flanged rim 27, substantially flush with the base of the charge 21, and an insert bottom 32. A cover 28 is secured to the well casing by machine screws 29 which extend through suitable registering holes in the periphery of the cover and the rim 27 of the well casing. Approximately one third of the depth of the well casing there is formed on the inner wall of same a circumferential shoulder 30. To this shoulder there is attached by suitable machine screws 31 the main and auxiliary rear plate members 49 and 51, respectively, of the fluid pressure responsive apparatus and arming mechanism, to be later described. A second and auxiliary well casing 33 is attached to and extends through an eccentric hole in the bottom 32 of the main well casing 26 and is supported by the second pair of cross members 25—25. This auxiliary well casing contains the booster charge 22 into which a detonator 23

is adapted to be inserted by the plunger 58, as described hereinafter.

Considered generally, the fluid pressure responsive apparatus and arming mechanism comprises a bed plate 47, positioned vertically as shown in Fig. 1, and four upright plate members, the fluid pressure responsive device 55—57 being mounted between a first pair of these plate members, the main front and rear plate members 48 and 49, and the detonator plunger 58 being slideably mounted in parallel relationship in the second pair, the auxiliary rear and intermediate plate members 51 and 50, respectively. The main rear plate member 49 and the auxiliary rear plate member 51 are secured in any suitable manner, as by screws 52, to the rear edge of the vertical bed plate member 47 in the same vertical plane but spaced apart in that plane (Figs. 2, 5, and 7), the main front plate member 48 is secured to the front edge of the bed plate member 47, also by screws 52, in parallel relationship to the main rear plate member 49, and the auxiliary intermediate plate member 50 is secured to the bed plate member 47, likewise by screws 52, in parallel spaced relationship to the auxiliary rear plate member 49 and spaced therefrom a distance slightly more than half the length of the bed plate member 47 (Figs. 2, 4, 5, and 7).

Aligned centrally with the auxiliary rear plate member 51 and the auxiliary intermediate plate member 50, and secured to the front edge of the bed plate member 47 in the same vertical plane with the main front plate member 48, there is a guide member 53 which is secured to the bed plate member 47 by screws 54 (Fig. 4). The plunger 58, which carries the detonator 23, is journalled for reciprocative movement in aligned holes in the auxiliary rear plate member 51, the auxiliary intermediate plate member 50, and the guide member 53. Intermediate the main front plate member 48 and the main rear plate member 49 there is positioned the two part pressure responsive bellows 55—57 which is secured at one end to the main front plate member 48 and at the other end to the main rear plate member 48 by brazing, soldering, welding, and the like. The pressure responsive bellows 55—57 transmits motion to the plunger 58 by suitable mechanism, to be later described. Adjacent their upper edges the main front plate member 48 and the main rear plate member 49 are secured together by spaced parallel tie rods 59, each rod having threaded ends with nuts 60 on either side of each plate. For securing the entire supporting plate structure to the well casing 26, the main rear plate member 49 and the auxiliary rear plate member 51 are provided with holes 61 (Fig. 3) through which the screws 31 pass to secure these plate members to the circumferential shoulder 30 on the inner wall of the well casing 26, as previously described.

A conduit 35 is connected through the main rear plate member 49 by a suitable pipe fitting 34 to the rear section 55 of the fluid pressure responsive bellows 55—57 and extends through the side wall of the well casing 26 by a suitable pipe coupling 36; this conduit continues as section 37 to the nose end of the torpedo shell. The coupling 36 is of the flange and nut type and performs the dual function of securing the conduit sections 35 and 37 in fluidtight relationship and of rigidly attaching the joint thus formed between these sections to the side wall of the well casing 26. The conduit section 37 at its forward end is secured by a suitable pipe fitting 34 to a horn-shaped element 38, which in turn is secured to the inner wall of the torpedo shell 10 by brazing, soldering, welding, and the like, and the mouth of which overlies an aperture in the wall of the shell. The base of the horn-shaped element 38 is obliquely disposed with respect to the tube to allow for curvature of the wall of the shell 10. An insert 39 is secured in the aperture in the wall of the shell and this insert carries a screen element 40 which prevents the entry of solid matter into the conduit 37.

A second conduit 42 is connected through the main front plate member 48 by a suitable pipe fitting 34 to the front section 57 of the pressure responsive bellows 55—57 and extends through the bottom 32 of the well casing 26 by a suitable pipe coupling 36; this conduit continues as section 43 to a suitable aperture in the wall of the shell 10, located near the rear end of the torpedo head. Likewise, this conduit terminates in a horn-shaped element 41, to which it is connected by a suitable pipe fitting 34, the mouth of the horn-shaped element overlying the aperture in the wall of the torpedo shell. The horn-shaped element 41 differs from the previously described horn-shaped element 38 only in that the mouth and the tube are here concentric, the oblique disposition of the mouth with respect to the tube of the horn-shaped element 38 being here unnecessary. Likewise an insert 39 is mounted in the aperture in the wall of the torpedo shell 10 and this insert likewise carries a screen element 40.

A conduit 45 extends through the side wall of the well casing 26 near the bottom 32 thereof to a suitable compartment (not shown) in the forward portion of the war head. This compartment contains a source of electromotive force, such as a battery, and a magnetically responsive circuit making apparatus. The source of electromotive force and the magnetically responsive circuit making apparatus are conventional in magnetic mines and, forming no part of the present invention, they are not here illustrated or further described. Wires 46 extend through the conduit 45 and connect the detonator 23 to the source of electromotive force and the magnetically responsive circuit making apparatus.

Referring now to Figs. 2 to 7, inclusive, these figures show the mechanism by which the fluid pressure differential between the nose and the rear portion of the torpedo head is translated into reciprocative motion of the plunger 58 which carries the detonator 23. The pressure responsive bellows sections 55 and 57 are each attached at their inner ends to the intermediate plate member 56 as by brazing, soldering, welding, and the like. The intermediate plate member 56 is mounted for reciprocative movement with respect to the bed plate 47 and its upper corners are cut away as at 62 (Fig. 2) to provide clearance for the tie rods 59. Positioned at approximately the axis of the pressure responsive bellows sections 55 and 57 and about half way between the bed plate 47 and the tie rods 59 (Figs. 3 and 4), and mounted in parallel relationship to the tie rods, there is a pair of parallel guide rods 63. These rods extend through suitable holes in the intermediate plate member 56 in tight relationship which joints are further secured by a pair of screws 64 mounted in threaded cross holes in the said intermediate plate member.

The guide rods 63 also extend loosely through suitable holes in the main front and rear plate members 48 and 49, respectively, and have nuts 65 on each outer end. Around each of the inner guide rods 63 there are mounted a sleeve member 66 and a spring 67, the former abutting at its outer end the main front plate member 48 and the latter abutting at its outer end the intermediate plate member 56 and the two abutting each other at their inner ends. The function of the springs 67 is to bias the pressure responsive bellows sections 55 and 57 to the initial normal position of Fig. 5 beyond which position they cannot be moved by further expansion of the springs as the nuts 65 on the guide rods 63 abut the main front plate member 48 and function as a stop means. The springs 67 also restore the bellows to the initial normal or unarmed position in the event that the bellows has been moved therefrom by a force applied thereto for less than a predetermined period of time, as the force is removed. The pressure differential within the bellows sections 55 and 57 resulting from movement of the torpedo through the water causes the springs 67 to be compressed and the detonator plunger 58 to be moved toward the armed position.

On the rear ends of the guide rods 63 duplicate nuts

65—65 are mounted in pairs, spaced apart and in face-to-face relationship. Between the pairs of nuts 65—65 on both of the guide rods there is gripped a cross head 68 which extends inwardly and terminates in alignment with the space between the vertically aligned main rear plate member 49 and the auxiliary rear plate member 51. Adjacent its inner end the cross head 68 is provided with a hole through which loosely extends one section 69 of a two part plunger 69—71. The plunger 69—71 is mounted in parallel relationship to the plunger 58, which carries the detonator 23, the section 71 of the first mentioned plunger being loosely journalled for sliding movement in a suitable hole in the auxiliary intermediate plate member 50. The plunger section 69 is threaded on both ends and the plunger section 71 on its inner end. Mounted intermediate the plunger sections 69 and 71 there is a rectangular bar 70 (Fig. 2) having threaded bores in both ends into which the inner ends of the plunger sections 69 and 71 are respectively secured; lock nuts 73 make fast the joints in well known manner. On the outer end of the plunger section 69 there are mounted nuts 75—75 in well known lock nut relationship. Intermediate the lock nut 73 on the inner end of the plunger section 69 and the cross head 68 there is positioned a spring 74, surrounding the plunger section. The spring 74 and the nuts 73 and 75 on either end of the plunger section 69 cooperate with the cross head 68 to form a lost motion connection between the latter and the plunger.

The driving connection between the plunger 69—71 and the detonator plunger 58 is as folows: The rectangular bar 70 is formed with an elongated slot 72 which extends lengthwise of the bar from the middle towards either end for approximately one quarter of the length of the bar. In this slot there is mounted a spur pinion 76 which is journalled on a pin 77 extending cross-wise of the slot. Mounted on opposite sides of the detonator plunger 58 in portions suitably flattened, as by milling, are two identical rack members 78 and 80, these members being secured to the plunger 58 by suitable screws 79. The first rack member 78 is in engagement with the pinion 76 carried by the rectangular bar 70 and the second rack member 80 is in engagement with the spur gear 94 of the escapement mechanism, to be later described.

Two parallel plate members 81 and 82 are mounted, one above and one below, the plunger 58 in parallel relationship with the bed plate member 47, and extend between the auxiliary intermediate plate member 50 and the auxiliary rear plate member 51, being secured to these latter plate members by suitable screws 83. On one inner corner, adjacent the auxiliary rear plate member 51, and extending for about one third of their lengths, the plate members 81 and 82 are cut away at 84 (Fig. 2), the width across the cut-away section being reduced to that of the auxiliary rear plate member 51 (Figs. 2, 5, and 7). The cut-away section in the upper plate member 81 provides space for the oscillation of the pendulum 116 of the escapement mechanism, to be later described; no similar function exists for the cut-away section in the lower plate member 82 but the making of the two plate members of identical shape assists in holding down production costs.

As shown in Fig. 6, the upper and lower plate members 81 and 82 are formed with matched channel sections 85—86 and 87—88, and at their inner edges terminate in inwardly extending side flanges 89 and 90, respectively. The channel section 85—86 provides clearance for the rack members 78 and 80 on the detonator plunger 58 and the channel section 87—88 provides clearance for the rectangular bar 70 intermediate the plunger sections 69 and 71. Along the inner edges of the section of the plate members 81 and 83 which are not cut away, and for about one half of the length of same, the plate members 81 and 82 are lapped by a side plate member 91, which

is secured to the plate members 81 and 82 by suitable screws 92. On the inner face of the plate member 91 there is mounted a rack member 93, this rack member being secured to the plate member by suitable screws 92 (Fig. 6), and being positioned between and abutting on either side the inwardly extending side flanges 89 and 90 on the upper and lower plate members 81 and 82, respectively. The rack member 93 is likewise in engagement with the spur pinion 76 carried by the rectangular bar 70. By the principle of instantaneous centers, it will be seen that any motion of the plunger 69—70—71 in the forward direction (toward the main front plate member 48) will be translated by the gearing 93—76—78 into reciprocation of the detonator plunger 58 in the same direction but of double the travel.

Referring now to Fig. 6, it will be seen that the escapement mechanism is connected to the detonator plunger 58 by a spur gear 94 which is in mesh with the rack member 80 on the detonator plunger and which is mounted on a shaft 96, this shaft being journalled in the lower plate member 82 and the upper plate member 81 and extending through the latter plate member. The spur gear 94 is secured to the shaft 96 by a pin 95 and a ratchet gear 99 is likewise secured to this shaft at its upper end by a pin 98. Intermediate the ratchet gear 99 and the top face of the upper plate member 81 a second spur gear 97 is freely mounted on the shaft 96. As shown in Fig. 2, two clicks 101—101 are pivoted on the upper face of the spur gear 97 by a pair of diametrically disposed pins 100—100. These clicks are arranged to engage the ratchet gear 99 and are biased into engagement therewith by springs 103—103, each of which at one end is coiled around one of the second pair of diametrically disposed pins 102—102 and at the other end is attached to one of the clicks 101—101.

As previously stated, any forward motion of the plunger 69—70—71 (toward the main rear plate member 48) will be translated by the gearing 93—76—78 into motion in the same direction but of double the travel of the detonator plunger 58. Such motion of the plunger 58, and the rack member 80 attached thereto, will rotate the spur gear 94 and the ratchet gear 99 in a clockwise direction (Fig. 2) and this motion will be transmitted to the spur gear 97 by the clicks 101—101. Movement of the plunger 69—70—71 and of the detonator plunger 58 in the backward direction (toward the main rear plate member 48) will not, however, be transmitted by the rack member 80, the spur gear 94, and the ratchet gear 99 to the spur gear 97 as the clicks 101—101 will merely ride over the teeth of the ratchet gear 99 when the latter is rotated in the counterclockwise direction.

A bearing plate member 104 is mounted on the top face of the upper plate member 81 by suitable screws 105 at one corner of the cut away section 84 of this plate member and abutting at one edge the auxiliary rear plate member 51. Attached to the top edge of this main rear plate member by suitable screws 107 there is a second plate member 106 which partially overlies the bearing plate member 104 (Fig. 2) and partially overhangs same. A shaft 108 is journalled in the upper plate member 81 and in the overhanging portion of the plate member 106. The shaft 108 has attached thereto a spur gear 109, which is in mesh with the gear 97 freely carried by the shaft 96, and above the spur gear 109 (Fig. 4) there is an escape wheel 110, also attached to this shaft. Mounted in parallel relationship to the shaft 108 there is a second shaft 111 which is journalled in the bearing plate member 104 and the overlying portion of the plate member 106 and this shaft has affixed thereto a two pronged escapement fork 112 which is arranged to have either fork in engagement with the escape wheel 110. The shaft 111 has fixed thereon a hub 113 in which is radially mounted the stem 114 of a pendulum 116. The stem 114 is screw threaded on both ends for attachment to the hub 113 and the pendulum 116, respectively, a

lock nut 115 being employed to make the latter joint secure.

In order to lock the detonator plunger 58 in its most advanced or armed position, a detent device is provided as shown in Fig. 8. This detent device comprises a pin 117 mounted in a suitable hole in the auxiliary intermediate plate member 50, this hole being diametrically disposed with respect to and intersecting the hole in this plate member through which the detonator plunger 58 extends. The pin 117 is biased downwardly by a spring 118 which is secured to the auxiliary intermediate plate member 50 as by a screw 119. The detonator plunger 58 has a slot 120 (Figs. 5 and 7) into which the pin 117 is adapted to seat and thereby lock the plunger.

It is believed that the operation of the fluid pressure actuated arming apparatus and mechanism will be obvious from the preceding description of the structure and parts. The conduit 37—35 is connected to the exterior of the torpedo shell 10 at the nose which is a region of high pressure and this conduit communicates with the rear section 55 of the pressure responsive device; the conduit 42—43 is connected through the side wall of the torpedo shell near the rear end of the head of the latter which is a region of low pressure. It has been found that in the case of a torpedo moving through the water at a velocity of about thirty knots, the pressure differential between the nose and the side wall of the torpedo will be about twenty-five pounds per square inch. As the torpedo is moved through the water by the propulsive means in the base 11, water under pressure enters the conduit 37—35 and through this conduit the rear section 55 of the pressure responsive device. Water will likewise enter the conduit 43—42 and through this conduit the front section 57 of the pressure responsive device but at a less pressure than the water entering the rear section. The pressure responsive device and connected parts will be moved from the normal position of Fig. 5 to the armed position of Fig. 7, the rate of such movement being controlled by the aforesaid escapement mechanism.

The actuating force applied to the intermediate plate member 56, which is a partition between the fluid sections 55 and 57, is proportioned to the pressure differential between these two sections, which is a function of the velocity of the torpedo through the water, and the modulus of elasticity of the spring 67. The force that this plate member transmits to the connected parts is determined by the foregoing factors in addition to the diameter of the fluid sections 55 and 57. As the intermediate plate member 56 moves forwardly from the position of Fig. 5 to that of Fig. 7, the guide rods 63 and cross head 68 are carried along against the compressive force of the spring 67, as also is the plunger 69—71 and the intermediate bar 70 carried by this plunger. The pinion 76 mounted in the intermediate bar 70 coacts with the fixed rack member 93 and also with the rack member 78 on the detonator plunger 58 and drives the latter forward to twice the degree of movement of the plunger 69—71. When the detonator plunger 58 reaches its fully advanced or armed position at the completion of a predetermined period of time, the detonator 23 will be inserted within the booster charge 22 in operative relation therewith and the detent pin 117 will become seated in the slot 120 in the detonator plunger thereby locking the detonator plunger in this position.

The escapement mechanism designated by the reference numerals 94–116, inclusive, functions to permit the return of the detonator plunger 58 to the initial normal position in the event that the fluid pressure responsive device is brought to rest within a predetermined period of time and before the torpedo has been fully armed, prevents premature arming of the torpedo due to acceleration on launching, and eliminates surges in the forward movement of the detonator plunger 58. If the fluid pressure differential between the sections 55 and 57 of the bellows diminishes within the aforesaid predetermined period of time due to any cause whatever, the spring 67 will return the auxiliary intermediate plate member 56 to the normal unarmed position of Fig. 5. As previously stated, the gear 97 moves in clockwise direction (Fig. 2) upon forward movement of the detonator plunger 58, which, of course, results in the gear 109 and the escapement wheel 110 rotating in the counterclockwise direction. During the movement of the intermediate plate member 56 to the initial position under the action of the spring 67, the detonator plunger 58 is likewise moved backward through the connecting mechanism to an initial unarmed position. The ratchet gear 99 moves correspondingly in the counterclockwise direction but the fork 112 and escapement wheel 110 are arranged to lock the escapement mechanism including the gears 108 and 97 against reverse rotation, the clicks 101—101 on the gear 97 riding over the teeth of the ratchet gear 99.

In launching torpedos from underwater vessels, the initial acceleration of the torpedo through the torpedo tube would, of course, produce a very large pressure in the section 55 of the pressure responsive device. The setback force applied to the pendulum 116, however, while the torpedo is being accelerated through the torpedo tube causes the escape wheel 110 to be locked until the force of acceleration has been dissipated and the escapement mechanism thus prevents movement of the detonator 23 from the initial unarmed position until substantial terminal velocity of the torpedo through the water has been attained. In the event that the torpedo should become stuck within the torpedo tube during a launching operation, the pressures in the fluid sections 55 and 57 of the fluid pressure responsive device will be equalized shortly after the forward motion of the torpedo ceases and the torpedo remains unarmed.

In the case of surface vessels, where the torpedoes are launched from tubes some distance above the water line of the vessel, there would, of course, be a very large pressure differential developed in the section 55 of the fluid pressure responsive device upon the torpedo striking the water. This large pressure differential would also be developed if the torpedo should be travelling through rough water and pass from the trough of a wave into the wall of another wave. However, when this occurs, the set forward force applied to the pendulum 116 momentarily locks the escapement mechanism thereby preventing premature arming of the torpedo and, as heretofore set forth, the escapement mechanism 94—116 limits the rate at which the detonator plunger can be driven forward, the lost motion connection comprised by the lock nut 73, spring 74, and the lock nuts 75 between the cross head 68 and the plunger 69—71 permitting relative motion of the cross head with respect to the plunger 69—71, the latter being limited to one half the distance of the movement of the detonator plunger 58 due to the interconnecting gearing 76—93—78.

As the torpedo moves through the water toward its target the fluid pressure responsive device 55—57 and connected parts will be moved from the position of Fig. 5 to that of Fig. 7 at the completion of a predetermined period of time controlled by the escapement mechanism, and the detonator plunger 58 will be moved by the connecting and driving mechanism to the position also shown in Fig. 7, wherein the slot 120 in this plunger is within the hole in the auxiliary intermediate plate member 50 through which the plunger extends. In this position of the plunger the detent pin 117 will be seated in the slot 120 by the spring 118 and the plunger will be locked against further forward or backward movement. If while the torpedo is still short of its target and within the aforesaid predetermined period of time, the pressure inside the section 55 of the fluid pressure responsive device 55—57 should diminish, due for instance, to deceleration of the propulsive mechanism for any reason, the pressure responsive device would tend to reassume the position of

Fig. 5 and, the plunger 58 being locked and the escape wheel 110, the gear 109, and gear 97 being incapable of reverse rotation, the resultant backward movement of the plunger 69—71 would be permitted by the clicks 101—101 on the gear 97 running over the teeth of the ratchet gear 99 without causing the detonator plunger 58 to be moved from its armed position.

While there is shown and described herein a certain preferred embodiment of the invention, many other and varied forms and uses will present themselves to those versed in the art without departing from the spirit of the invention, and the invention, therefore, is not limited either in structure or in use except as indicated by the terms and scope of the appended claims.

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

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. In a torpedo, a booster charge, a detonator adapted to be moved into operative relationship with the booster charge, differential fluid pressure responsive means for moving the detonator, and a pair of fluid connections for applying said differential pressure from the surrounding water to the fluid pressure responsive means and respectively extending therefrom to the forward portion and to the side portion of the torpedo.

2. In a torpedo, a booster charge, a detonator adapted to be moved into operative relationship with the booster charge, differential fluid pressure responsive means for moving the detonator, a fluid connection extending from the fluid pressure responsive means to the surrounding water at the forward portion of the torpedo, and a second fluid connection extending from the fluid pressure responsive means to the surrounding water at a point remote from the forward portion of the torpedo, said fluid connections being effective to apply said differential pressure to said pressure responsive means.

3. In a torpedo, a booster charge, means carrying a detonator adapted to be moved into operative relationship with the booster charge, differential fluid pressure responsive means for operating the detonator carrying means, a pair of ducts in communication with the surrounding water and sealed to the wall of the torpedo at two points corresponding to two points of different dynamic pressure thereon for applying differential pressure to the pressure responsive means, and a lost motion connection and a motion multiplying means for transmitting motion from the fluid pressure responsive means to the detonator carrying means.

4. In a torpedo, a booster charge, means carrying a detonator adapted to be moved into operative relationship with the booster charge, fluid pressure responsive means for operating the detonator carrying means, driving connections between the fluid pressure responsive means and the detonator carrying means, and an escapement mechanism connected to the detonator carrying means, said escapement mechanism limiting the drive of the detonator carrying means by the fluid pressure responsive means to one direction into operative relationship with the booster charge and limiting the rate of travel of the detonator carrying means in said direction.

5. In a torpedo, a booster charge, means carrying a detonator adapted to be moved into operative relationship with the booster charge, fluid pressure responsive means for operating the detonator carrying means, a lost motion connection for transmitting motion from the fluid pressure responsive means to the detonator carrying means, and an escapement mechanism connected to the detonator carrying means for timing the movement thereof.

6. In a torpedo, a booster charge, means carrying a detonator adapted to be moved into operative relationship with the booster charge, fluid pressure responsive means for operating the detonator carrying means, motion multiplying means for transmitting motion from the fluid pressure responsive means to the detonator carrying means, and an escapement mechanism connected to the detonator carrying means.

7. In a torpedo, a booster charge, means carrying a detonator adapted to be moved into operative relationship with the booster charge, fluid pressure responsive means for operating the detonator carrying means, a lost motion connection and a motion multiplying means for transmitting motion from the fluid pressure responsive means to the detonator carrying means, and an escapement mechanism connected to the detonator carrying means.

8. In a torpedo, a booster charge, means carrying a detonator adapted to be moved into operative relationship with the booster charge, differential fluid pressure responsive means operatively connected to the detonator carrying means for moving said detonator into operative relationship with respect to the booster charge in response to a predetermined difference in pressure applied thereto, a pair of ducts in communication with the surrounding water for applying said differential fluid pressure to the pressure responsive means, and means for locking the detonator carrying means in advanced position with the detonator in operative relationship with the booster charge.

9. In a torpedo, a booster charge, means carrying a detonator adapted to be moved into operative relationship with the booster charge, fluid pressure responsive means operatively connected to the detonator carrying means, an escapement mechanism connected to the detonator carrying means, and means for locking the detonator carrying means in advanced position with the detonator in operative relationship with the booster charge.

10. In a torpedo, expansible fluid pressure responsive means for arming the torpedo, said fluid pressure responsive means being expansible in the direction of the axis of the torpedo, a booster charge, a detonator, means carrying the detonator operatively connected to the fluid pressure responsive means and adapted to move the detonator into operative relationship with the booster charge, an escapement mechanism connected to the detonator carrying means, said escapement mechanism comprising an escape wheel, a pendulum oscillatory in a plane parallel to the axis of the torpedo, and a double pronged fork carried by the pendulum, the prongs being alternatively engaged with the escape wheel, one prong of said fork locking the escape wheel upon sudden forward surge of the fluid pressure responsive means.

11. In a torpedo, expansible fluid pressure responsive means for arming the torpedo, said fluid pressure responsive means being expansible in the direction of the axis of the torpedo, a booster charge, a detonator, means carrying the detonator operatively connected to the fluid pressure responsive means and adapted to move the detonator into operative relationship with the booster charge, an escapement mechanism connected to the detonator carrying means, said escapement mechanism comprising an escape wheel, a pendulum oscillatory in a plane parallel to the axis of the torpedo, and a double pronged fork carried by the pendulum, the prongs being alternatively engaged with the escape wheel, one prong of said fork locking the escape wheel upon setback movement of the pressure responsive means.

12. In a torpedo, expansible fluid pressure responsive means for arming the torpedo, said fluid pressure responsive means being expansible in the direction of the axis of the torpedo, a booster charge, a detonator means carrying the detonator operatively connected to the fluid pressure responsive means and adapted to move the detonator into operative relationship with the booster charge, an escapement mechanism connected to the detonator carrying means, said escapement mechanism comprising an escape wheel, a pendulum oscillatory in a plane parallel

to the axis of the torpedo, a double pronged fork carried by the pendulum, the prongs being alternatively engaged with the escape wheel, one prong of said fork locking the escape wheel upon sudden forward surge of the fluid pressure responsive means, the other prong of said fork locking the escape wheel upon setback movement of the fluid pressure responsive means.

13. In an arming device for a torpedo, in combination, a pressure responsive device adapted to be moved from an initial position to a final position by the differential pressure of the water against the nose and side of the torpedo respectively as the torpedo moves through the water, a pair of ducts for establishing fluid communication between said pressure responsive device and the surrounding water at said nose and side of the torpedo respectively, a detonating device, a support for said detonating device adapted to be moved from an initial safe position to an armed position, means including a motion multiplying device for causing the support to be moved from said safe position to the armed position by said pressure responsive device as the pressure responsive device moves from the initial position to said final position, means including an escapement mechanism for retarding the movement of said pressure responsive device whereby the detonating device is moved to said armed position at the completion of a predetermined period of time, and means for restoring said detonating device to said safe position when the detonating device is not moved to the armed position within said predetermined period of time.

14. In an arming device for a torpedo, in combination, a pressure responsive device adapted to be moved from an initial position to a final position by the differential pressure of the water against the nose and side of the torpedo respectively as the torpedo moves through the water, a pair of ducts for establishing fluid communication between said pressure responsive device and the surrounding water at said nose and side of the torpedo respectively, a detonating device, a support for said detonating device adapted to be moved from an initial safe position to an armed position, means including a motion multiplying device for causing the support to be moved from said safe position to the armed position by said pressure responsive device as the pressure responsive device moves from the initial position to said final position, means including an escapement mechanism for retarding the movement of said pressure responsive device whereby the detonating device is moved to said armed position at the completion of a predetermined period of time, and means for locking said support in said armed position.

15. In a torpedo, a detonating device, means responsive to differential pressure of the water at two remote points in spaced relation along the surface of the torpedo for moving the detonating device into an armed position, and means operatively connected to the first named means for controlling the rate of such movement.

16. In a torpedo, expansible fluid pressure responsive means for arming the torpedo, a booster charge, a detonator means carrying the detonator operatively connected to the fluid pressure responsive means and adapted to move the detonator into operative relationship with the booster charge, and an escapement mechanism connected to the detonator carrying means for controlling the rate of movement of the detonator, means connected to said escapement mechanism to control the period thereof comprising an inertia member movable in a plane parallel to the axis of the torpedo and constructed and arranged to lock the detonator carrying means momentarily during movement of the detonator in response to a sudden change in the rate of forward movement of the torpedo during the run thereof.

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