March 3, 1953 M. G. LEONARD ET AL 2,630,092

CONTROL DEVICE

Filed Nov. 8, 1945 4 Sheets-Sheet 1

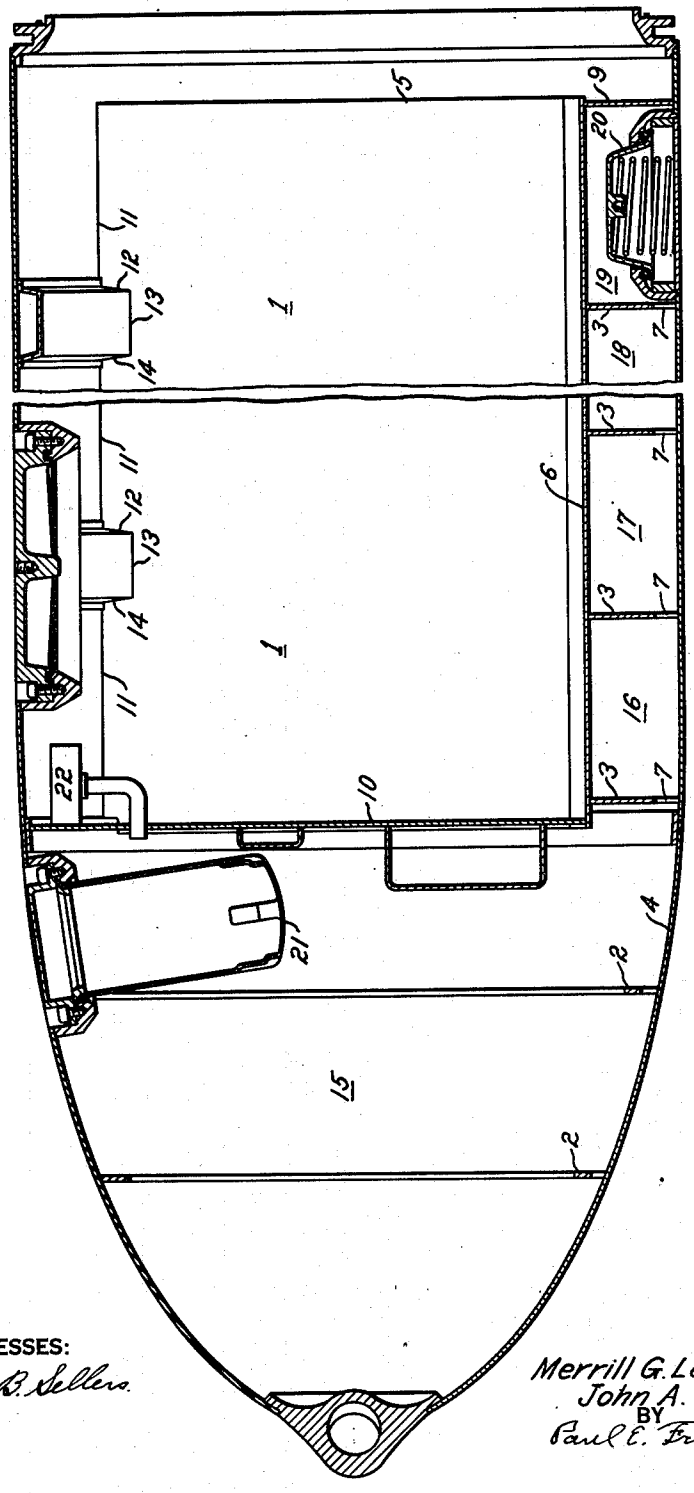


Fig. 1.

WITNESSES:
Wm. B. Sellers.

INVENTORS
Merrill G. Leonard and
John A. Guidosh.
BY
Paul E. Friedemann
ATTORNEY

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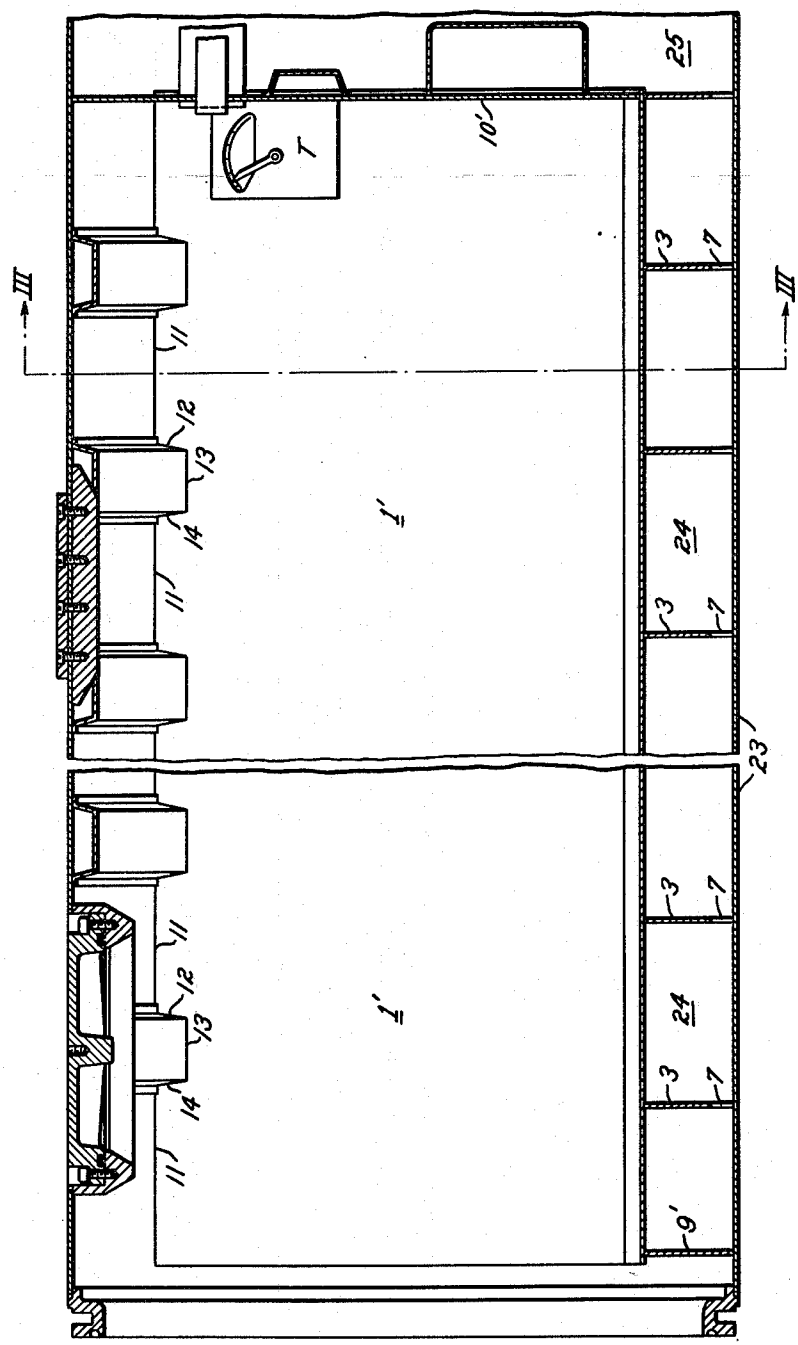


Fig. 2a.

WITNESSES:

Wm. B. Sellers.

INVENTORS

Merrill G. Leonard and
John A. Guidosh.

BY

Paul C. Friedemann

ATTORNEY

March 3, 1953 M. G. LEONARD ET AL 2,630,092

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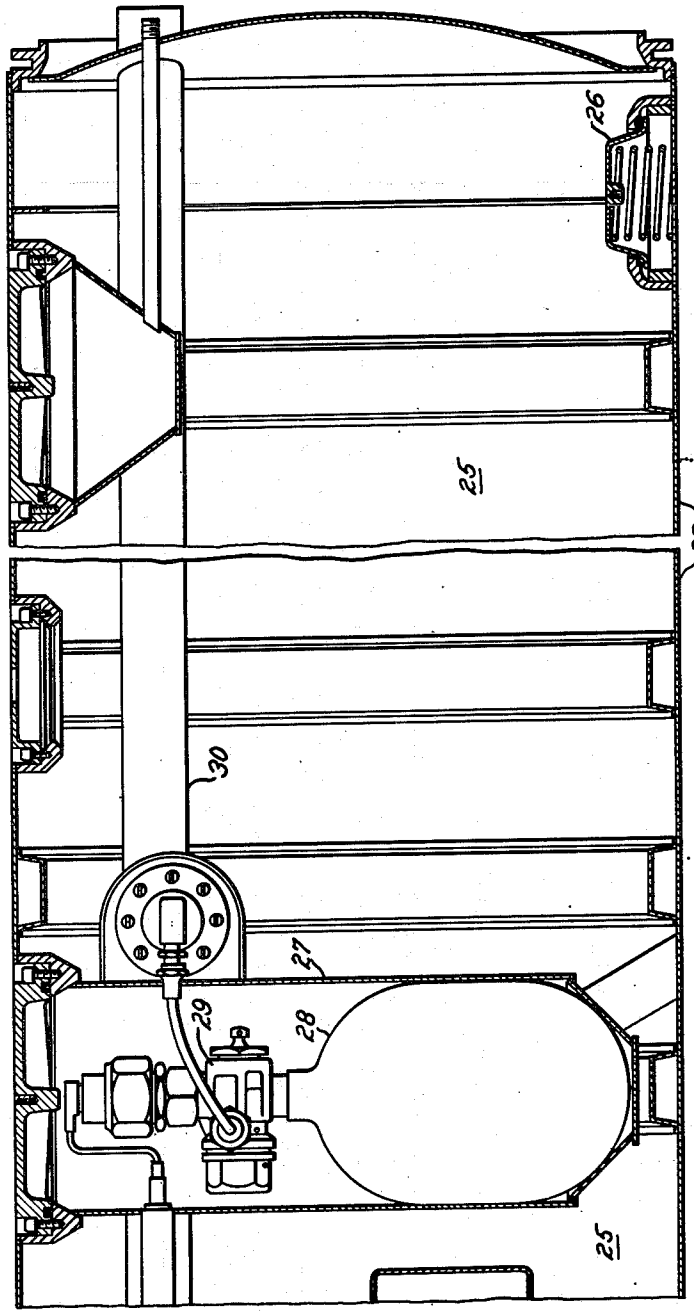


Fig. 2b.

WITNESSES:

Wm. B. Sellers.

INVENTORS

Merrill G. Leonard and
John A. Guidosh.

BY

Paul E. Friedemann

ATTORNEY

March 3, 1953 M. G. LEONARD ET AL 2,630,092

CONTROL DEVICE

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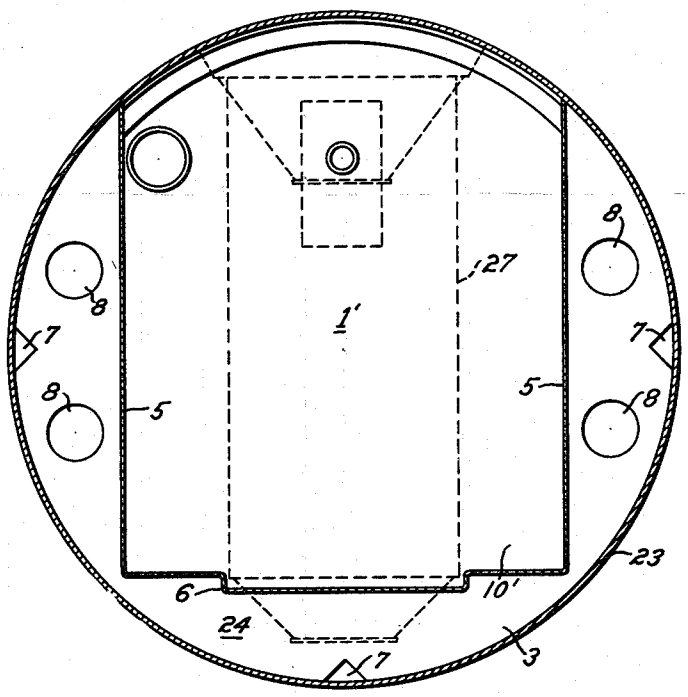


Fig. 3.

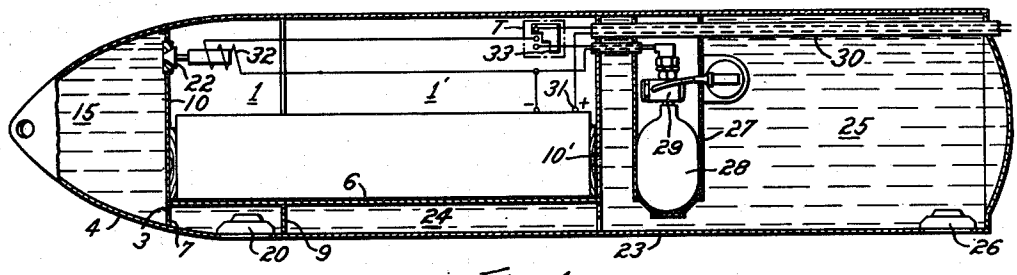


Fig. 4.

WITNESSES:
Wm. B. Sellers

INVENTORS
Merrill G. Leonard and
John A. Guidosh.
BY
Paul E. Friedemann
ATTORNEY

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UNITED STATES PATENT OFFICE

2,630,092

CONTROL DEVICE

Merrill G. Leonard, Sharon, Pa., and John A. Guidosh, Hubbard, Ohio, assignors, by mesne assignments, to the United States of America as represented by the Secretary of the Navy

Application November 8, 1945, Serial No. 627,498

13 Claims. (Cl. 114—20)

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Our invention relates to torpedoes and more particularly to torpedo elements utilized for proving the operating elements of a torpedo.

In making exercise runs of torpedoes and particularly electrically propelled torpedoes it has been conventional practice to use a forward section, or exercise head, which is similar in shape and size to a warhead and arranged so that it can be loaded with a relatively high specific gravity ballast liquid so that the exercise head when filled with the ballast liquid has an overall specific gravity substantially equal to the overall specific gravity of the warhead when charged with the torpex or other explosive charge. Some attempt is thus made by the kind of ballast liquid chosen and the disposition of some of the operating elements of the exercise head that the exercise shot will as near as possible simulate the running conditions to be expected for the war shot, but will at the same time permit the expelling of the ballast liquid at the end of the exercise run so that the torpedo becomes buoyant and floats instead of sinking.

As a matter of convenience in the case of electrically propelled torpedoes, both the exercise head and battery compartment are used for range tests and as a matter of economy are used in this way repeatedly. The main purpose of the repeated range tests, or exercise runs, is to prove—establish the unfailing function—the operation of the afterbody and tailcone and particularly the equipment these elements of the torpedo contain. The exercise head and battery compartment serve only to give the entire body the proper size, shape, and weight necessary to simulate war shot conditions, whereas the battery serves only to provide the necessary power for the propulsion motor and the other electrically operated elements.

The practice briefly outlined hereinbefore has some serious drawbacks. Putting all the ballast liquid at the forward end of the two sections, exercise head and battery compartment, is very undesirable particularly in the case of electrically propelled torpedoes, because when the ballast liquid is expelled at the end of an exercise run the torpedo turns nose upward and the battery is thus standing on end instead of in its normal and desirable horizontal position. This introduces serious problems of retaining the electrolyte without spillage and at the same time provision has to be made to either condense, absorb in a suitable absorbent, or expel the gases produced in the cell. Furthermore, the relatively loose sediment which always collects at the bottom of the battery cells is displaced from the position where it can do no harm, to the sides or

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top where the sediment may cause trouble by short-circuiting the plates. Still further, since the ballast liquid is all near the front in a relatively small compartment a high specific gravity liquid has to be chosen. Since the ballast liquid is lost at the end of each range run the cost of each range run is increased.

One broad object of our invention is the elimination of all the disadvantages to which reference has been made.

A more specific object of our invention is to so arrange the disposition of the ballast liquid that it would not only provide the proper trim to simulate war shot conditions, but would also provide the proper trim after the ballast liquid is expelled so that the torpedo will float in a substantially level position and the battery remain horizontal.

Another object of our invention is to so devise the battery compartment and exercise head that sea water can be used as a ballast liquid for a torpedo.

Another and somewhat more specific object of our invention is to so expel the ballast liquid from a torpedo at the end of a range run that the torpedo rises to the surface with the nose slightly higher than the afterbody and tailcone.

The objects specifically stated are illustrative objects and not in any sense an exhaustive statement of all the objects of our invention. Other objects and advantages of our invention will become more apparent from a study of the following specification and the accompanying drawings, in which:

Figure 1 shows a longitudinal sectional view of our novel exercise head;

Figs. 2*a* and 2*b* show a longitudinal section of our novel forward portion of the torpedo, namely the portion disposed between the afterbody and the exercise head;

Fig. 3 is a transverse sectional view on section line III—III of Fig. 2*a* looking in the direction indicated by the arrow at each end of the section line; and

Fig. 4 is a somewhat schematic view in longitudinal section illustrating our combined construction of forward section and exercise head.

The various objects of our invention are obtained by the novel construction we devised and which provides for and makes possible a suitable re-location of the battery in the torpedo shell and provides for a corresponding change in the location of the ballast liquid so as to obtain the required conditions both before and after the ballast is expelled.

In order to obtain the novel results it will be noted that the exercise head, shown in Fig. 1, now includes a portion of the propulsion battery,

i. e., includes a battery compartment. In this battery compartment 1 reference numerals 2 and 3 represent reinforcing ribs welded to the inner surface of the shell 4. The ribs 2 are annular in shape whereas the ribs 3 have a generally U-shape. These ribs 3 are substantially of the same shape as the ribs 3 shown in Fig. 3. The ribs 3 are at their outer edges welded to the inner surface of the shell 4 and at their inner edges are welded to the side walls 5 and bottom 6 of the battery compartment. The ribs 3 are provided with suitable notches 7 and holes 8 so that the sea water can flow freely from one region to another region between the ribs 3. No ballast water will thus become trapped between the ribs in the shell 4 when the ballast water is to be expelled.

The rib 9 is not provided with the notches 7 nor the holes 8. Furthermore, this rib is carefully hermetically welded to the inner surface of the shell 4 and right-hand ends of the side walls 5 and the right-hand end of the bottom 6. This hermetic seal of rib 9 together with the liquid tight end wall 10 and the hermetic seals at 11, 12, 13, and 14 effectively seal the battery compartment from the ballast water normally in the spaces 15, 16, 17, 18 and 19.

The lower aft end of the exercise head or shell 4 is provided with the ballast liquid discharge valve 20. A flare producing unit is disposed at the upper region of the forward end of the exercise head in the container 21. A suitable valve 22 is disposed in the upper forward region of the battery compartment. In normal operation just before a range run is to be made the battery compartment is filled with air at about fifty pounds per square inch or somewhat less. At or near the end of the run valve 22 is operated to open the air pressure in the battery compartment to the space 15. The air pressure in the battery compartment thus forces the ballast water out through discharge valve 20.

In our construction the forward section shown in Fig. 2*a* shows the same ribs 3 having the same construction and function as ribs 3 in the exercise head. We therefore use the same reference characters to designate these ribs.

Rib 9' corresponds in structure and function to rib 9 in the exercise head, except that rib 9' is at the forward end of the battery compartment 1'. The seals 11, 12, 13, and 14 are the same. The side walls 5 and bottom 6 are the same in construction as those shown in Fig. 1. End wall 10' corresponds to end wall 10 both in structure and function, except that this end wall 10' is at the aft end of that part of the forward section 23 shown in Fig. 2*a*.

With the construction shown in Fig. 2*a* it is apparent that the ballast water fills the regions 24 and the region 25 to the right of end wall 10'.

Fig. 2*b* is a showing of the aft end of the forward section and in effect is but a continuation toward the right of the showing in Fig. 2*a*. The structure of the showing in Fig. 2*b* is, however, radically different.

The aft end of the forward section is provided at its lower aft end with a ballast liquid discharge valve 26 and, at the mid-region in a hermetic case 27, houses a CO_2 flask 28. The flask is provided with an electrically operable valve 29. The valve 29 is in electrical connection with the battery and the battery leads and control leads are carried to the afterbody and tailcone through suitable sealed cable 30.

Aside from the equipment just mentioned the aft region of the forward section is substantially empty and is thus suitable for storing a considerable amount of ballast water. This will be especially apparent from the schematic showing in Fig. 4.

In operation, when the torpedo is fired for its range run, the propulsion equipment is set in operation and also a suitable timer T is set in operation. At or near the end of the exercise run but preferably while the torpedo is still in motion the timer T establishes a circuit from the battery terminal 31, through suitable switching means in the afterbody, the segment of the timer and the actuating coil 32 for the valve 22.

The valve 22 opens and the air pressure in the battery compartments 1 and 1' begins to expel the ballast liquid from the exercise head. About ten seconds later the segment 33 moves to the position to energize the actuating armature or squib, used in valve 29. Operation of valve 29 connects the flask to the ballast water containing space 25 to expel the ballast water from this space through valve 26.

Since the expulsion of the ballast water from the exercise head begins some ten seconds earlier than the expulsion of the ballast water from the forward section 23 it is apparent that the torpedo head will rise to the surface somewhat ahead of the main portion of the torpedo. When all the ballast water has been expelled the torpedo floats with the longitudinal axis substantially horizontal and with the discharge valves 20 and 26 at the bottom.

From the foregoing description it will be apparent that we have provided a novel type of torpedo structure in which the exercise head and battery compartment of former structures are treated as a single unit. The battery, being mounted much farther forward in this unit and thus providing considerable space aft of the battery for ballast water, thus prevents the torpedo from taking a vertical position in the sea when the torpedo is made buoyant.

The fact that the torpedo rises with the nose slightly higher than the aft end thereof facilitates the flow of the water toward the regions occupied by the discharge valves.

Further, with our novel construction there is no particular difficulty in simulating war shot conditions without the use of high specific gravity ballast liquid.

With our construction the use of a low-density solution, sea water, or even fresh water as a ballast liquid becomes practicable, with a corresponding reduction in cost and labor required for setting up a unit for test.

While we have disclosed a certain specific group of details of our construction we do not wish to be limited to the specific details disclosed but wish to be limited only by the scope of the claims hereto appended.

We claim as our invention:

1. In torpedo elements for use in connection with exercise runs of torpedoes, in combination, an exercise head and forward section hermetically joined to each other to in effect form a single unit, a battery compartment, extending a relatively great distance toward the front into the aft end of the exercise head and extending in the aft direction into the forward portion of the forward section, secured to the aft end of the exercise head, a hermetic sealing rib at the aft end of the exercise head hermetically engaging the outside surface of the battery compartment and the inner surface of the exercise head to thus form a sealed off ballast liquid

compartment in the exercise head, a similar sealing rib at the forward end of the forward section hermetically engaging the outer surface of the battery compartment and the inner surface of the forward section to thus form a relatively large ballast liquid compartment in the forward section, and discharge valve means for the ballast liquid.

2. In a torpedo for making range test, in combination, an exercise head comprising a hermetically closed chamber having a reentrant cavity at the aft end, a forward section of a torpedo comprising a hermetically closed chamber having a reentrant cavity at the forward end, means for hermetically connecting the aft end of the exercise head to the forward end of the forward section so that the reentrant cavities are in alignment, said aligned reentrant cavities forming a single battery compartment for the torpedo and said chambers in the exercise head and forward section, respectively, forming ballast liquid containing chambers, and ballast liquid discharging valve means for each of said chambers and means for initiating the expulsion of the ballast liquid from the chamber in the exercise head a predetermined time interval ahead of the initiation of the explusion from the forward section.

3. In a torpedo for making range tests, in combination, an exercise head comprising a hermetically closed chamber having a reentrant cavity at the aft end, a forward section of a torpedo comprising a hermetically closed chamber having a reentrant cavity at the forward end, means for hermetically connecting the aft end of the exercise head to the forward end of the forward section so that the reentrant cavities are in alignment, said aligned reentrant cavities forming a single battery compartment for the torpedo and said chambers in the exercise head and forward section, respectively, forming ballast liquid containing chambers, a discharge valve for the chamber in the exercise head, said battery compartment containing a gas under a given pressure, a ballast liquid control valve for opening the battery compartment to the chamber in the exercise head, and means for operating said valve.

4. In a torpedo for making range tests, in combination, an exercise head comprising a hermetically closed chamber having a reentrant cavity at the aft end, a forward section of a torpedo comprising a hermetically closed chamber having a reentrant cavity at the forward end, means for hermetically connecting the aft end of the exercise head to the forward end of the forward section so that the reentrant cavities are in alignment, said aligned reentrant cavities forming a single battery compartment for the torpedo and said chambers in the exercise head and forward section, respectively, forming ballast liquid containing chambers, a discharge valve for the chamber in the exercise head, said battery compartment containing a gas under a given pressure, a ballast liquid control valve for opening the battery compartment to the chamber in the exercise head, means for operating said valve, a flask containing gas under relatively high pressure in the forward section, a second ballast liquid control valve for connecting the flask to the chamber in the forward section to thus admit the gas in the flask to this chamber, a discharge valve for discharging the ballast liquid from the last-mentioned chamber.

5. In a torpedo for making range tests, in combination, an exercise head comprising a hermetically closed chamber having a reentrant cavity at the aft end, a forward section of a torpedo comprising a hermetically closed chamber having a reentrant cavity at the forward end, means for hermetically conecting the aft end of the exercise head to the forward end of the forward section so that the reentrant cavities are in alignment, said aligned reentrant cavities forming a single battery compartment for the torpedo and said chambers in the exercise head and forward section, respectively, forming ballast liquid containing chambers, a discharge valve for the chamber in the exercise head, said battery compartment containing a gas under a given pressure, a ballast liquid control valve for opening the battery compartment to the chamber in the exercise head, means for operating said valve, a flask containing gas under relatively high pressure in the forward section, a second ballast liquid control valve for connecting the flask to the chamber in the forward section to thus admit the gas in this flask to the chamber, a discharge valve for discharging the ballast liquid from the chamber in the forward section.

6. Certain elements of a torpedo for use with the exercise runs of otherwise conventional torpedoes, in combination, an exercise head conventional in outer contour but having a reentrant cavity at the aft end of the torpedo hermetically sealing the exercise head to provide a sealed ballast liquid containing chamber in the exercise head, means for hermetically connecting the portions aft of the exercise head to the exercise head to thus seal the open end of the reentrant cavity to provide a sealed battery compartment, a valve for opening the battery compartment to the ballast liquid containing chamber, and a discharge valve at the lower aft end of the chamber in the exercise head, said battery compartment for normal range runs, or exercise runs, being provided with a gas under a pressure just sufficient to expel the ballast liquid from the chamber in the exercise head through the discharge valve upon opening of the valve between the battery compartment and the ballast liquid containing chamber.

7. Certain elements of a torpedo for use with the exercise runs of otherwise conventional torpedoes, in combination, an exercise head conventional in outer contour but having a reentrant cavity at the aft end of the torpedo hermetically sealing the exercise head to provide a sealed ballast liquid containing chamber in the exercise head, means for hermetically connecting the portions aft of the exercise head to the exercise head to thus seal the open end of the reentrant cavity to provide a sealed battery compartment, a valve for opening the battery compartment to the ballast liquid containing chamber, a discharge valve at the lower aft end of the chamber in the exercise head, said battery compartment for normal range runs, or exercise runs, being provided with a gas under a pressure just sufficient to expel the ballast liquid from the chamber in the exercise head through the discharge valve upon opening of the valve between the battery compartment and the ballast liquid containing chamber and a plurality of perforated reenforcing ribs disposed between the inner surface of the exercise head and the outer surface of the reentrant cavity.

8. Certain elements of a torpedo for use with the exercise or range runs of otherwise conventional torpedoes, in combination, an exercise

head sealed at the aft end by a reentrant cavity, a forward section sealed at the forward end by a reentrant cavity, means for hermetically connecting the aft end of the exercise head to the front end of the forward section, said reentrant cavity in the forward section having an appreciable lesser axial length than the length of the forward section to thus provide a relatively large ballast liquid containing chamber at the aft end of the forward section, said aligned reentrant cavities forming a closed single battery compartment, a discharge valve at the lower aft end of the exercise head, a discharge valve at the lower aft end of the forward section, and means for expelling the ballast liquid in the exercise head and forward section in timed sequence.

9. Certain elements of a torpedo for use with the exercise or range runs of otherwise conventional torpedoes, in combination, an exercise head sealed at the aft end by a reentrant cavity, a forward section sealed at the forward end by a reentrant cavity, means for hermetically connecting the aft end of the exercise head to the front end of the forward section, perforated reenforcing ribs rigidly secured between the inner surface of the exercise head and the outer surface of the reentrant cavity in the exercise head, perforated reenforcing ribs rigidly secured between the inner surface of the forward section of the outer surface of the reentrant cavity in the forward section, said reentrant cavity in the forward section having an appreciable lesser axial length than the length of the forward section to thus provide a relatively large ballast liquid containing chamber at the aft end of the forward section, said aligned reentrant cavities forming a closed single battery compartment, a discharge valve at the lower aft end of the exercise head, a discharge valve at the lower aft end of the forward section, and means for expelling the ballast liquid in the exercise head and forward section in timed sequence.

10. Certain elements of a torpedo for use with the exercise or range runs of otherwise conventional torpedoes, in combination, an exercise head sealed at the aft end by a reentrant cavity, a forward section sealed at the forward end by a reentrant cavity, means for hermetically connecting the aft end of the exercise head to the front end of the forward section, said reentrant cavity in the forward section having an appreciable lesser axial length than the length of the forward section to thus provide a relatively large ballast liquid containing chamber at the aft end of the forward section, said aligned reentrant cavities forming a closed single battery compartment, a discharge valve at the lower aft end of the exercise head, a discharge valve at the lower aft end of the forward section, a buoyancy control valve connecting when open the battery compartment to the ballast liquid containing chamber in the exercise head, said battery compartment during normal range runs being filled with gas under pressure so that opening of the buoyancy control valve will cause the expulsion of the ballast liquid in the exercise head through the discharge valve in the lower aft end of the exercise head, a source of gas under pressure, a second buoyancy control valve for connecting the source of gas under pressure to the ballast containing chamber in the forward section to thus expel the ballast liquid therein through the discharge valve at the lower aft end of the forward section.

11. Certain elements of a torpedo for use with the exercise or range runs of otherwise conventional torpedoes, in combination, an exercise head sealed at the aft end by a reentrant cavity, a forward section sealed at the forward end by a reentrant cavity, means for hermetically connecting the aft end of the exercise head to the front end of the forward section, said reentrant cavity in the forward section having an appreciable lesser axial length than the length of the forward section to thus provide a relatively large ballast liquid containing chamber at the aft end of the forward section, said aligned reentrant cavities forming a closed single battery compartment, a discharge valve at the lower aft end of the exercise head, a discharge valve at the lower aft end of the forward section, a buoyancy control valve connecting when open the battery compartment to the ballast liquid containing chamber in the exercise head, said battery compartment during normal range runs being filled with gas under pressure so that opening of the buoyancy control valve will cause the expulsion of the ballast liquid in the exercise head through the discharge valve in the lower aft end of the exercise head, a source of gas under pressure, a second buoyancy control valve for connecting the source of gas under pressure to the ballast containing chamber in the forward section to thus expel the ballast liquid therein through the discharge valve at the lower aft end of the forward section, and means operable at or near the end of the exercise run for opening the first buoyancy control valve and the second buoyancy controlled valve in timed sequence in the order recited.

12. Certain elements of a torpedo for use with the exercise or range runs of otherwise conventional torpedoes, in combination, an exercise head sealed at the aft end by a reentrant cavity, a forward section sealed at the forward end by a reentrant cavity, means for hermetically connecting the aft end of the exercise head to the front end of the forward section, said reentrant cavity in the forward section having an appreciable lesser axial length than the length of the forward section to thus provide a relatively large ballast liquid containing chamber at the aft end of the forward section, said aligned reentrant cavities forming a closed single battery compartment, a discharge valve at the lower aft end of the exercise head, a discharge valve at the lower aft end of the forward section, a buoyancy control valve connecting when open the battery compartment to the ballast liquid containing chamber in the exercise head, said battery compartment during normal range runs being filled with gas under pressure so that opening of the buoyancy control valve will cause the expulsion of the ballast liquid in the exercise head through the discharge valve in the lower aft end of the exercise head, a source of gas under pressure, a second buoyancy control valve for connecting the source of gas under pressure to the ballast containing chamber in the forward section to thus expel the ballast liquid therein through the discharge valve at the lower aft end of the forward section, perforated reenforcing ribs rigidly secured between the inner surface of the exercise head and the outer surface of the reentrant cavity in the exercise head, perforated reenforcing ribs rigidly secured between the inner surface of the forward section of the outer surface of the reentrant cavity in the forward section, said reentrant cavity in the forward section, said reentrant cavity in the forward section having an appreciable lesser axial length than the length of the forward section to thus provide a relatively large ballast liquid containing chamber at the aft end of the forward section, said aligned reentrant cavities forming a closed single battery compartment, a discharge valve at the lower aft end of the exercise head, a discharge valve at the lower aft end of the forward section, a buoyancy control valve connecting when open the battery compartment to the ballast liquid containing chamber in the exercise head, said battery compartment during normal range runs being filled with gas under pressure so that opening of the buoyancy control valve will cause the expulsion of the ballast liquid in the exercise head through the discharge valve in the lower aft end of the exercise head, a source of gas under pressure, a second buoyancy control valve for connecting the source of gas under pressure to the ballast containing chamber in the forward section to thus expel the ballast liquid therein through the discharge valve at the lower aft end of the forward section, and means operable at or near the end of the exercise run for opening the first buoyancy control valve and the second buoyancy controlled valve in timed sequence in the order recited.

13. Certain elements of a torpedo for use with the exercise or range runs of otherwise conventional torpedoes, in combination, an exercise head

sealed at the aft end by a reentrant cavity, a forward section sealed at the forward end by a reentrant cavity, means for hermetically connecting the aft end of the exercise head to the front end of the forward section, perforated reenforcing ribs rigidly secured between the inner surface of the exercise head and the outer surface of the reentrant cavity in the exercise head, perforated reenforcing ribs rigidly secured between the inner surface of the forward section of the outer surface of the reentrant cavity in the forward section, said reentrant cavity in the forward section having an appreciable lesser axial length than the length of the forward section to thus provide a relatively large ballast liquid containing chamber at the aft end of the forward section, said aligned reentrant cavities forming a closed single battery compartment, a discharge valve at the lower aft end of the exercise head, a discharge valve at the lower aft end of the forward section, a buoyancy control valve connecting when open the battery compartment to the ballast liquid containing chamber in the exercise head, said battery compartment during normal range runs being filled with gas under pressure so that

opening of the buoyancy control valve will cause the expulsion of the ballast liquid in the exercise head through the discharge valve in the lower aft end of the exercise head, a source of gas under pressure, a second buoyancy control valve for connecting the source of gas under pressure to the ballast containing chamber in the forward section to thus expel the ballast liquid therein through the discharge valve at the lower aft end of the forward section, and means operable at or near the end of the exercise run for opening the first buoyancy control valve and the second buoyancy controlled valve in timed sequence in the order recited.

MERRILL G. LEONARD.
JOHN A. GUIDOSH.

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