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3,096,739

METHOD AND APPARATUS FOR STEERING UNDERWATER BODIES

Filed June 20, 1960

2 Sheets-Sheet 1

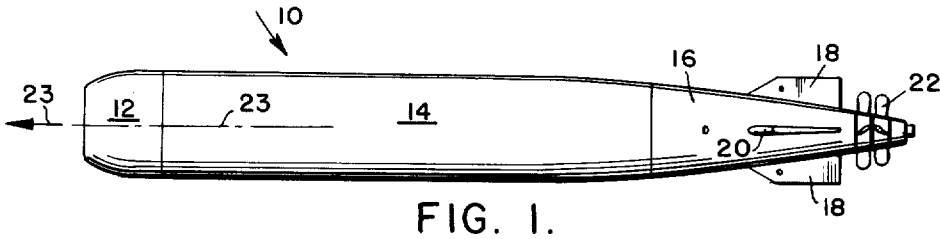


FIG. 1.

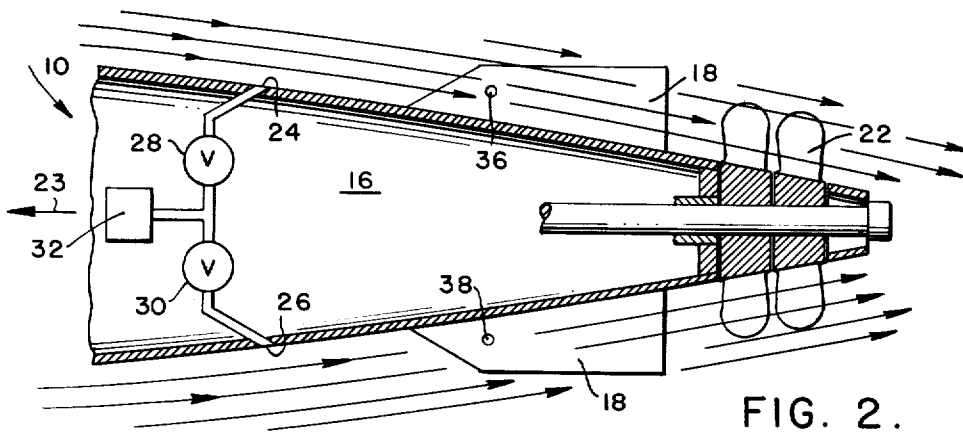


FIG. 2.

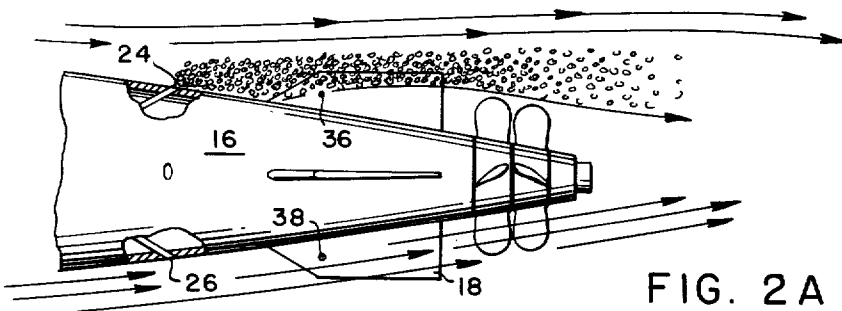


FIG. 2A

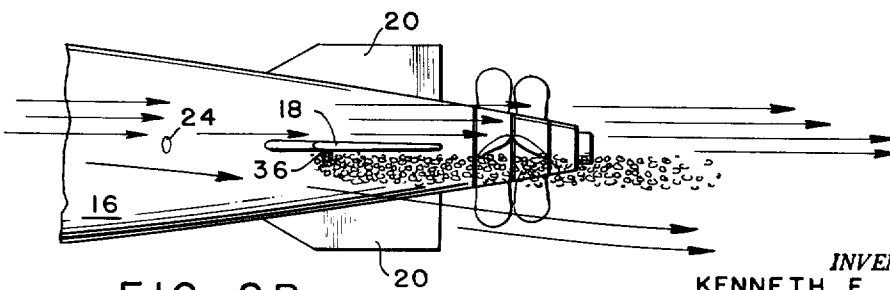


FIG. 2B.

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2 Sheets-Sheet 2

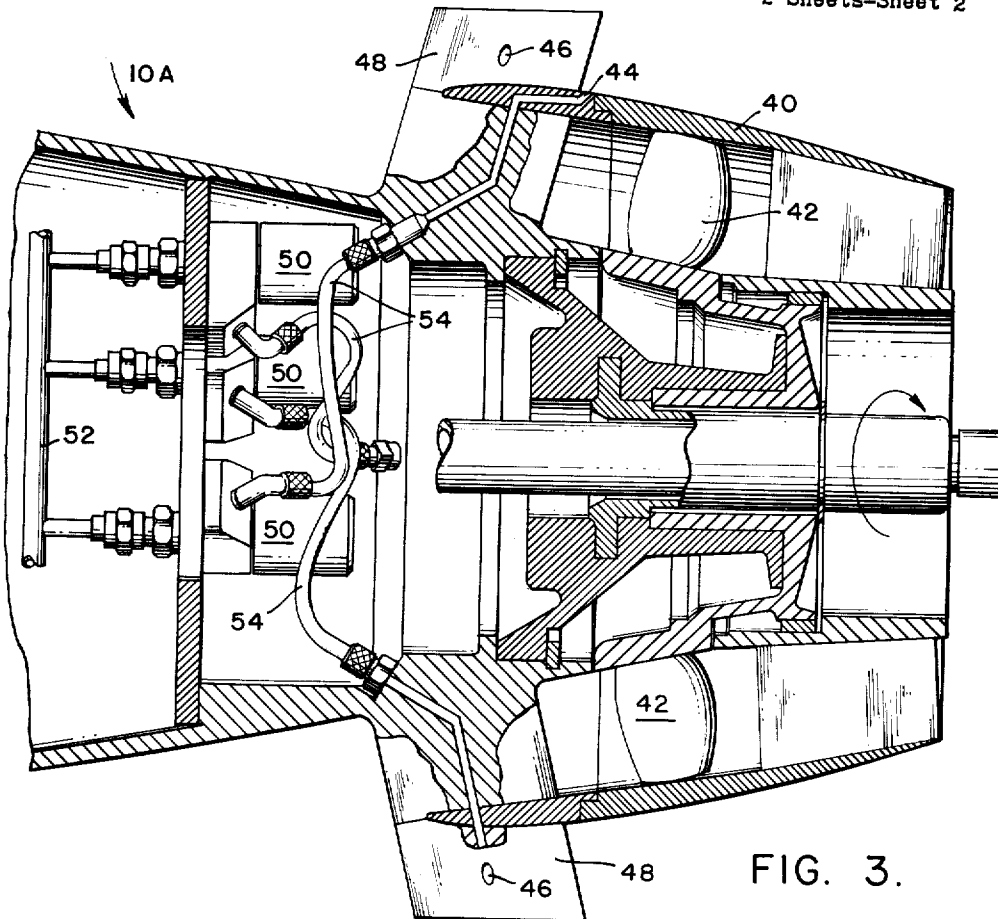


FIG. 3.

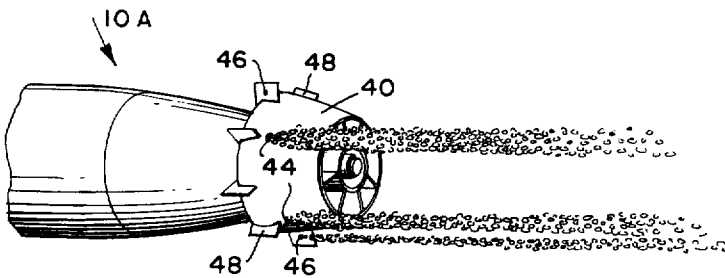


FIG. 4.

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METHOD AND APPARATUS FOR STEERING UNDERWATER BODIES

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7 Claims. (Cl. 114-23)

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

The invention described herein 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.

This invention relates to underwater bodies and more particularly to improvements in apparatus for steering same.

It has been conventional practice since the advent of the torpedo to steer it along its intended course by use of movable rudders which are controlled by a suitable guidance system. In its most simple form, a gyroscope senses deviation from the intended course and through suitable control mechanism, movement of the rudders is effected to correct the course. In the more modern homing torpedo, suitable sonic apparatus detects the target and through similar mechanism effects movement of the rudders. Usually, two pairs of rudders are employed, one pair for effecting steering in azimuth and the other in elevation, the latter sometimes being known as elevators or elevational rudders. The rudders are usually disposed in alignment with fixed stabilizing fins disposed adjacent the rear end of the torpedo and when moved away from a normal or central position, effect torpedo movement in one direction or the other. In some torpedoes the rudders are disposed near the front end, known as Canard controls, but in all types the rudders are usually pivoted for movement which is effected by mechanical linkage, hydraulic actuators and various other devices.

While the rudders referred to have been developed to a high degree of perfection they have certain disadvantages. Among these are their complexity and high cost due to the requirement of precision moving parts, excessive weight resulting from their ancillary operating components, and tendency to cavitate at high speeds producing objectionable noise which interferes with acoustic homing signals. It becomes apparent, accordingly, that if steering could be effected without the use of such rudders the overall performance of a torpedo could be improved and attendant other advantages be obtained.

Among the objects of this invention are to provide steering apparatus for torpedoes which is simple in construction and relatively low in cost, devoid of moving parts which project into the water stream, operable by an available source of power which would otherwise be wasted, highly responsive in operation, hydrodynamically clean, and unaffected in operation by adverse temperature changes.

Another object is to provide steering apparatus in accordance with any of the preceding objects for use with submarines and other steerable underwater bodies.

A further object is to provide improved methods for steering such bodies.

Still further objects, advantages and salient features will become more apparent from the description to follow, the appended claims and the accompanying drawing, in which:

FIG. 1 is a side elevation of a torpedo employing the subject of the invention,

FIG. 2 is an enlarged central longitudinal section of the right or rear portion of FIG. 1,

FIG. 2A is a side elevation of the portion shown in FIG. 2,

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FIG. 2B is a side elevation like FIG. 2A but as viewed from a perpendicular plane,

FIG. 3 is a view similar to FIG. 2 of another application of the invention, and

FIG. 4 is a perspective of the torpedo of FIG. 3.

To provide a better understanding of a preferred form of the invention to be subsequently described, the invention, in its broader aspects, will first be described in a simplified form for which reference is made to FIG. 1 which illustrates any conventional self-propelled torpedo 10 which has been modified by the elimination of all of its rudders and the subject of this invention applied to same in lieu of such rudders. This torpedo may thus be considered as being circular in cross section, having a transducer type nose 12, a cylindrical central portion 14 and a frusto conical tail section 16 to which is affixed opposed pairs of immovable stabilizers 18, 18 and 20, 20 (one of which is shown). If steered by rudders, they would normally be disposed rearwardly of these stabilizers, forming relatively smooth continuations of same. One or more propellers 22 are disposed at the rear end for propelling the torpedo.

As best illustrated in FIG. 2, water flows around the torpedo producing hydrodynamic forces tending to move it laterally to its axis and course 23 but since the torpedo is circular and water velocity is uniform the force produced by any increment width of the water is balanced by a like diametrically opposite increment. If one of these increments of width is disturbed, however, to produce a different flow pattern then the forces become unbalanced and the differential force acts on the torpedo to divert it from its course. Rudders produce a similar effect, but by mechanically changing the configuration of the torpedo in the flow pattern. In the present invention the outside configuration remains unchanged but the flow pattern is altered along a desired locus by introduction of a gas into the water flow stream. If a pair of diametrically opposite ports 24, 26, controlled by valves 28, 30, supplied by a gas under pressure from a source 32, are added to the torpedo it becomes apparent that if gas is exhausted through one of these ports it will spoil the hydrodynamic stream rearwardly of the port, as shown in FIG. 2A. Since the hydrodynamic forces on the opposite side have not been disturbed it becomes apparent that a differential force is produced which will steer the torpedo away from its course 23. The discharge through the opposite port produces an opposite force which effects steering in the opposite direction. One pair of ports will thus effect steering in one plane which, as illustrated, is the vertical plane controlling the elevational direction of the torpedo. If a similar pair of ports are now added at right angles to the first pair then steering is effected in the horizontal plane to thus control azimuthal direction of the torpedo. If the torpedo is pendulous or otherwise has sufficient pull around then no roll control is necessary. If, however, control of roll is required this may be attained by employing a pair of ports 36, 38 disposed in the stabilizing fins 18, 18. FIG. 2B illustrates the manner in which a port 36 is employed in one of stabilizing fins 18 which will spoil the hydrodynamic flow around the fin, producing a torque on the torpedo which will correct its roll in one direction. The other port 38, will similarly effect control of roll in the opposite direction.

The elevational and azimuthal direction control ports may be disposed in transverse planes other than as shown such as in the nose section. Either the tail section, as shown, or the nose section, as referred to, provide more desirable locations than the central cylindrical section since in the former the flow stream is of such nature to produce higher control forces.

As will subsequently appear, the control forces may be still more effective if the torpedo is of the pump jet type or otherwise provided with a shroud ring which serves, in effect, as a circular or continuous stabilizer in addition to its other functions. Such type torpedo is illustrated in FIG. 3 wherein torpedo 10A is provided with a circular shroud ring 40 surrounding impeller 42, which ring forms an annular duct for the water exhausted by the impeller. Such type torpedo is also illustrated in the patent to Fogarty et al. 2,795,201 except that the rudders shown in such patent would be omitted. In the construction shown four equiangularly spaced ports 44, one of which is shown in FIG. 4, are provided to exhaust gas into the stream passing rearwardly around the shroud ring. As will be apparent one pair of diametrically disposed ports will effect steering in one plane and the other pair of diametrically disposed ports, disposed at a right angle to the first pair, will effect steering in the perpendicular plane. To correct for roll, a pair of ports 46, 46 are disposed in stabilizing fins 48, 48 which correct roll in the same manner as ports 36, 38, previously described. Suitable valves, such as electromagnetically actuated valves 50, connected between a manifold 52 and conduits 54 supply the various ports with gas from any suitable source of gas connected to manifold 52.

FIG. 4 illustrates the manner of discharging gas when it is desired to change course in azimuth and elevation and correct roll simultaneously. Gas is being delivered to two of the ports in the shroud ring disposed at right angles to each other which effect steering in both azimuth and elevation and gas is being delivered to a port in one of the fins which corrects roll.

In the embodiments of the invention so far described two stabilizing fins, each provided with a gas discharge port, are employed for correcting roll. While two discharge ports are the minimum required for this purpose it is not necessary that each be associated with a separate fin. Thus, a single fin may be employed with ports which selectively discharge gas from each of opposite sides of the fin which will modify the hydrodynamic or lift forces on one side, producing a lateral force on the fin which in turn produces a movement about the torpedo axis. If two fins are employed, as shown, these forces or moments are distributed to the two fins or become additive forces which may be desirable if the individual fin areas are relatively small. If a couple is desired for correcting roll, rather than a moment, then two diametrically opposite fins are the minimum number required with gas discharge ports for opposite sides of each fin. With this construction gas is simultaneously discharged from one side of each fin to produce two equal moments, or a couple, about the torpedo axis.

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

What is claimed is:

1. The method of steering an underwater body of the type having a surface adjacent which water is adapted to flow and produce hydrodynamic force lateral to the direction of movement of the body, comprising the step of

delivering a gas in a quantity insufficient to produce a jet reaction steering force but in a quantity sufficient for flow adjacent said surface for spoiling the water flow and producing a different lateral hydrodynamic force on the body.

2. In combination, apparatus for steering an underwater body of the type having a surface adjacent which water is adapted to flow and produce a hydrodynamic force lateral to the direction of movement of the body, and means for delivering a gas in a quantity insufficient to produce a jet reaction steering force but in a quantity sufficient for flow adjacent said surface for spoiling the water flow and producing a different lateral hydrodynamic force on the body.

3. In combination, a torpedo having a pair of diametrically opposed surfaces of revolution symmetrically disposed with respect to its longitudinal axis about which water is adapted to flow rearwardly to produce opposed balanced hydrodynamic lift forces, and means for steering said torpedo in the plane of said surfaces comprising a pair of ports associated therewith for selectively discharging gas into water in a quantity insufficient to produce a jet reaction steering force but in a quantity sufficient for rearward flow adjacent either of said surfaces to produce opposed unbalanced hydrodynamic lift forces, whereby a steering force is applied to said torpedo in said plane.

4. A torpedo in accordance with claim 3 including a second pair of like surfaces disposed in a plane perpendicular to the first named pair and a second pair of like ports associated therewith for effecting steering of said torpedo in said second named plane.

5. A torpedo in accordance with claim 3 wherein said surfaces are portions of the outer surface of a circular shroud ring surrounding the torpedo and spaced therefrom by an annular passageway through which water is adapted to flow.

6. A torpedo having a radially extending fixed stabilizing fin having opposed surfaces about which water is adapted to flow rearward to produce opposed balanced lift forces, and means for correcting roll of said torpedo about its longitudinal axis comprising a port associated with said fin for discharging gas into water in a quantity insufficient to produce a jet reaction roll force but in a quantity sufficient for rearward flow adjacent one side of same to produce an unbalanced hydrodynamic lift force on said fin, whereby said fin produces a moment about said axis.

7. A torpedo in accordance with claim 6 including a circular shroud ring surrounding the torpedo and spaced therefrom by an annular passageway through which water is adapted to flow, said stabilizing fin projecting outwardly from said shroud ring.

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