

E. A. PARMELL AND T. McLEAN.

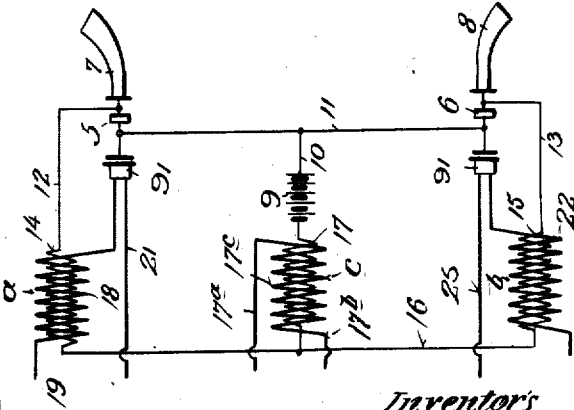
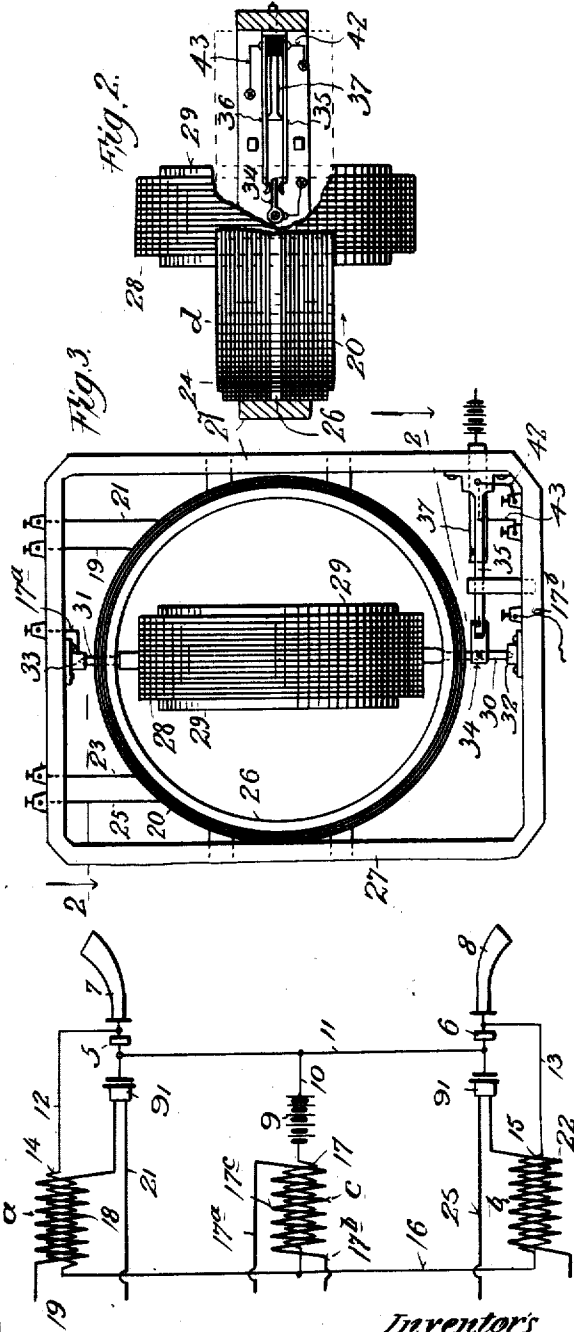
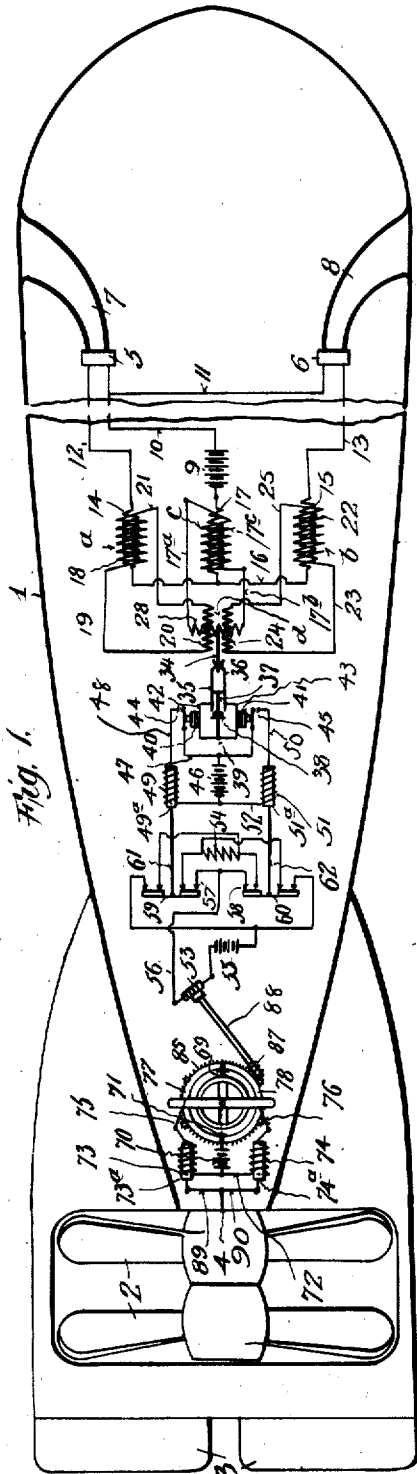
STEERING APPARATUS.

APPLICATION FILED AUG. 10, 1918.

Patented June 22, 1920.

2 SHEETS—SHEET 1.

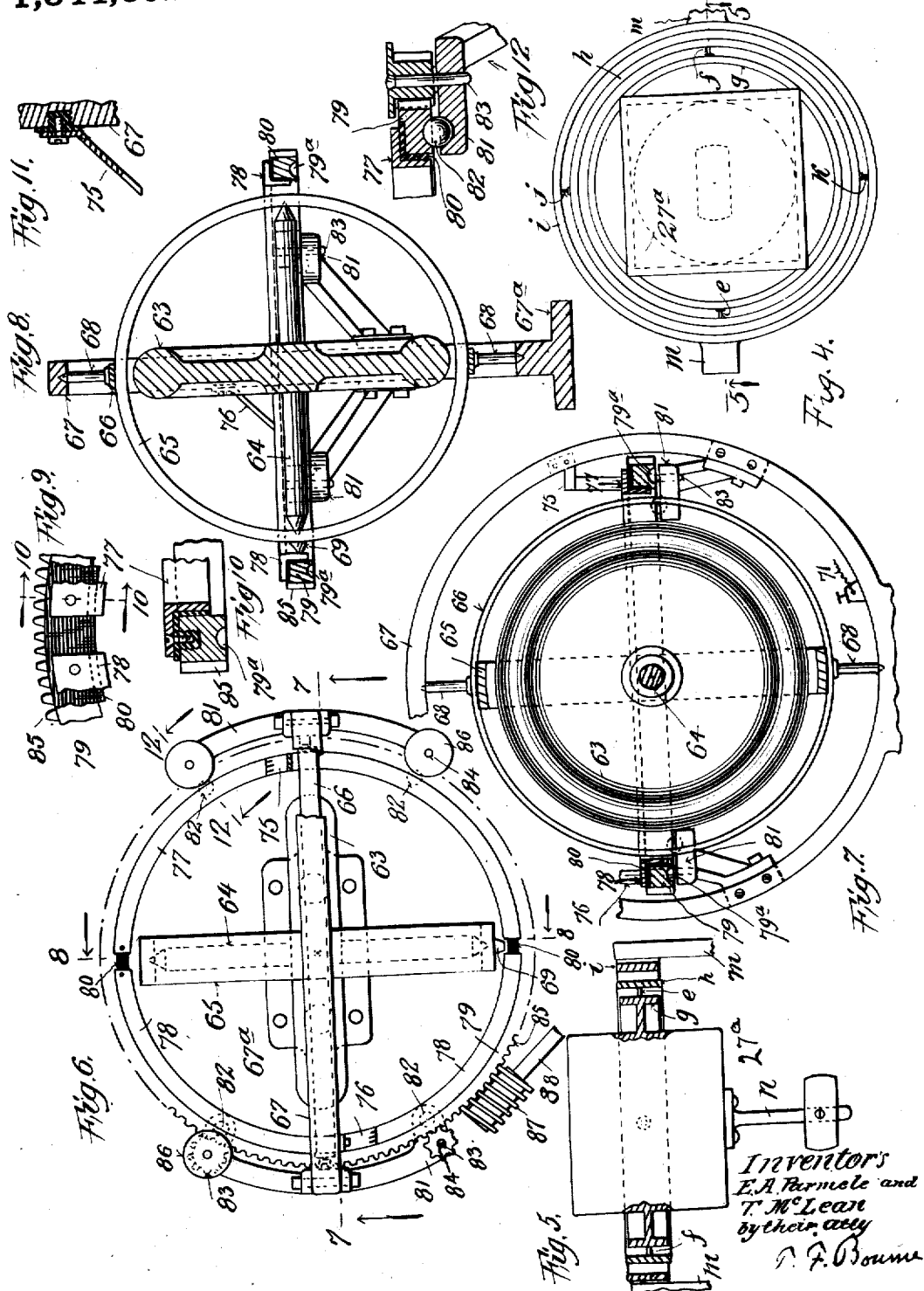
1,344,352.



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1,344,352.

2 SHEETS--SHEET 2.



UNITED STATES PATENT OFFICE.

EDWARD A. PARMELE AND TRUE McLEAN, OF STATEN ISLAND, NEW YORK.

STEERING APPARATUS.

1,344,352.

Specification of Letters Patent. Patented June 22, 1920.

Application filed August 10, 1918. Serial No. 249,257.

To all whom it may concern:

Be it known that we, EDWARD A. PARMELE and TRUE McLEAN, citizens of the United States, and residents of Staten Island, borough of Richmond, and State of New York, respectively, have invented certain new and useful Improvements in Steering Apparatus, of which the following is a specification.

The object of our invention is to provide means for steering water craft, such for example as torpedoes, through the medium of sounds proceeding from another mechanically driven craft, such as an enemy, which sounds will affect our improvements in such a manner as to cause the craft having our improvements automatically to be steered at such enemy.

One of the particular features of our invention is to utilize the same in a self-propelled torpedo in such a manner that sound waves passing through the water from an enemy craft, such as a submarine, will affect the sound responsive member or members of our improvements when one or both of them receive such sound waves whereby to cause the steering rudder of the torpedo to be operated to steer the latter at the enemy craft so as to cause contact of the torpedo with the latter for its destruction.

In carrying out our invention we provide a self-propelled craft, such as a torpedo, with a pair of sound responsive instruments, such as submarine microphones, preferably near the head of the torpedo adapted to respond to submarine sounds, a rudder for steering the torpedo, electrically operating means controllable by said sound responsive instruments to control the rudder whereby the rudder will be turned to one side or another according to the direction from which sound proceeds to said sound responsive instruments for causing the torpedo to be steered in such direction, or if the sound is received in both of said sound responsive instruments equally, said rudder will be held in position to cause the torpedo to proceed in the direction of the sound, whereby the torpedo will be caused automatically to hit an enemy craft from which such sounds proceed. By the use of our improvements it only will be necessary to launch the torpedo in the general direction whence the sound waves from the enemy craft proceed, and our automatically operating mechanism responsive to such sounds will cause the torpedo to be steered at such enemy.

Means for carrying out our invention will be more fully hereinafter described and then pointed out in the claims.

Reference is to be had to the accompanying drawings forming part hereof, wherein

Figure 1 is a plan view illustrating our improvements diagrammatically, and showing conventionally in diagrammatic form a portion of a torpedo equipped with our improvements; Fig. 2 is a partly sectional plan view substantially on the line 2, 2, in Fig. 3, illustrating a translating device adapted to be controlled by the operation of the sound responsive instruments or microphones for controlling other circuits illustrated diagrammatically in Fig. 1; Fig. 3 is a side view of Fig. 2; Fig. 4 is a plan view illustrating means for balancing or stabilizing the last named device; Fig. 5 is a detail section substantially on the line 5, 5 in Fig. 4; Fig. 6 is a partly broken plan view illustrating rudder controlling devices in more mechanical form than in the diagram of Fig. 1; Fig. 7 is a side view of Fig. 4, partly in section on the line 7, 7, in Fig. 6; Fig. 8 is a section on the line 8, 8, in Fig. 6; Fig. 9 is an enlarged detail plan view of part of Fig. 6; Fig. 10 is a section on the line 10, 10, in Fig. 9; Fig. 11 is a detail section of a brush of the rudder controlling devices of Fig. 6; Fig. 12 is a section on the line 12, 12, in Fig. 6, and Fig. 13 is a diagrammatic view illustrating means to increase or intensify the action of the microphones herein-
after referred to.

Similar numerals and letters of reference indicate corresponding parts in the several views.

A self-propelled water craft, such as a torpedo, is indicated generally at 1, which may be of any well known or approved type equipped with one or more propellers 2 and apparatus for operating the same, and with one or more rudders 3 and means for operating the same for causing the torpedo to travel through the water at the desired depth, which parts form no portion of our invention, and need not be further described. The torpedo also may be equipped with a war-head and other essential parts for its proper operation and explosion, in any desired manner, provision, however, to be made within the torpedo to receive our improved mechanism for controlling the steering of the torpedo at an object or target from which sounds pass through the water. The

rudder 4 for steering the torpedo laterally may be vertically journaled in the torpedo in any well known manner to be operated as hereinafter described.

At 5, 6, are sound responsive instruments, such as microphones, adapted to receive submarine sounds, and as such microphones in themselves form no part of our invention, but are utilized therein, a detail description of such microphones will not be necessary, it being understood that the sound responsive instruments or microphones may be constructed in any approved manner, such as similar to the microphones now used on vessels to detect submarine sounds proceeding from other vessels. We have shown the sound responsive instruments 5, 6, as located adjacent to the head or bow of the torpedo and as communicating with sound receiving horns or tubes 7, 8, which instruments and horns may be located within the torpedo and the receiving ends of the horns may open through the side of the torpedo, (Fig. 1). An electric battery is indicated at 9 and one terminal thereof is connected by means of conductors 10, 11, with the corresponding terminals of the microphones. The other terminals of said microphones are shown connected by conductors 12, 13, with corresponding terminals of primary windings 14, 15, of induction coils or transformers *a*, *b*, the other terminals of which windings are shown connected together by conductor 16. The conductor 16 is connected to one terminal of the primary winding 17 of a third induction coil or transformer *c*, the other terminal of which winding is connected to the terminal of battery 9 opposite the conductor 10. One terminal of the secondary winding 18 of induction coil *a* is connected by conductor 19 with one terminal of coil 20 of a translating device *d*, from the other terminal of which coil a conductor 21, leads to the other terminal of coil 18. The device *d* may be operated on the principle of a dynamometer-frequency meter. One terminal of the secondary winding 22 of induction coil *b* is connected by conductor 23 with one terminal of coil 24 of translating device *d* from the other terminal of which coil a conductor 25 leads to the opposite terminal of coil 22. The coils 20 and 24 may be of insulated wire wound side by side in the same direction or parallel and spaced apart upon an insulating hollow core 26 which may be secured in a suitable frame 27 (see Figs. 2 and 3). Within coils 20 and 24 and normally at right angles thereto, is a coil 28 of suitable insulated wire wound upon an iron core 29, which may comprise laminated sheets, the direction of winding 28 being normally substantially at right angles to the direction of windings 20 and 24. The terminals of winding 28 are connected by conductors 17^a, 17^b with corresponding ter-

minals of secondary winding 17^c of coil *c*, (Fig. 1). Winding 28 is pivotally supported within the windings 20 and 24, so as to turn under the influence of current therein and in one or the other of the last named windings as well as by reason of the difference of current in said windings and to be at right angles thereto when both of said windings are equally excited. Pivots 30 and 31 project from the upper and lower parts of core 29, are insulated therefrom and pass freely through holes in core 26, which pivots are journaled in suitable bearings 32, 33 carried by frame 27 (Figs. 2 and 3). The rotary movements of coil 28 are intended to control circuits which in turn will control rudder 4. The amount of laminated iron in core 29 may be governed by the frequency of the sounds generated by the submarine enemy. We have shown an insulated finger 34 secured to and projecting from pivot 30 and disposed between opposing spaced spring-acting contacts 35, 36, normally in engagement with a contact 37 that is connected to one terminal of a battery 38 (Fig. 1). The opposite terminal of said battery is connected by branch conductor 39 to relays 40, 41, the other terminals of which relays are connected by conductors 42, 43 to contact springs 35, 36, respectively (Figs. 1, 2 and 3). The circuit of the relays is thus normally closed when winding 28 is normal or at right angles to windings 20 and 24, and whereby when winding 28 swings to one side or another the circuit of one or the other of said relays will be broken by operation of finger 34 against contact 35 or 36. The armatures of said relays thus are normally out of engagement with contacts 44 and 45 respectively, which armatures are connected to the corresponding terminal of battery 46 by branch conductor 47. Contact 44 is connected by conductor 48 to one terminal of the winding of a solenoid 49 and contact 45 is connected by conductor 50 to one terminal of the winding of a solenoid 51, the opposite terminals of which solenoids are connected by a branch conductor 52 to the terminal of battery 46 opposite the terminal thereof connected with the armatures of said relays (Fig. 1). The arrangement is such that when winding 28 swings to one side or another and operates the corresponding spring contact 35 or 36, the circuit of relay 40 or 41 will be broken, and its armature will make engagement with the corresponding contact 44 or 45 whereby the corresponding solenoid 49 or 51 will be energized.

In order to avoid undesired movement of winding 28 with respect to windings 20 and 24, due to rolling, pitching or other movements of the craft or torpedo, the frame 27 (Figs. 2 and 3) may be supported in a universal manner and preferably provided with a pendulating weight tending to maintain 1

said frame in a normal position of equilibrium. An arrangement for such purpose is illustrated in Figs. 4 and 5, wherein said frame may be inclosed in a box 27^a (or the frame may be in the form of a box), provided with pivots *e, f*, which are shown attached to a ring *g*, which pivots are supported by a surrounding ring *h*. The ring *h* is within a stationary frame or support shown in the form of a ring *i*, and pivots *j, k*, connect ring *h* with ring or frame *i* at right angles to the pivots *e, f*. The ring or frame *i* may have supports or uprights *m*, secured in suitable position within the torpedo or craft. At *n* is a weighted pendulum (Fig. 5) depending from frame 27 or its box 27^a. The arrangement is such that the coils 20, 24 and 28 will remain balanced in a normal position by reason of the ability of the rings *g* and *h* to assume different positions and the balancing of the coils by the pendulum during various positions, the craft or torpedo may assume in the water, and whereby the coil 28 will be maintained in a proper position for operating with respect to coils 20 and 24 in manner before described.

Solenoids 49 and 51 (Fig. 1) are utilized as a means to cause operation of rudder 4 to one side or another from its normal position for steering the torpedo on a straight course. A suitable motor may be utilized for controlling the operation of the rudder through the medium of the action of said solenoids. We have diagrammatically illustrated a reversible electric motor wherein 53 indicates the armature and 54 indicates the field winding of such motor, one terminal of which armature is connected to a battery 55 and the other terminal of which armature is connected by conductor 56 to contacts 57, 58 of a reversing switch. The other terminal of battery 55 is connected to contacts respectively controlled by switches 59, 60 and the terminals of field winding 54 are connected to contacts controlled by said switches in an ordinary manner for controlling reversing motors of the character specified, the circuits through the switches being normally open. The switch 59 is controlled by a rod or the like 61 connected with core 49^a of solenoid 49, and the switch 60 is connected by a rod or the like 62 with core 51^a of solenoid 51. The arrangement is such that when core 49^a is attracted the switch 59 will close the circuits of the motor through battery 55 to cause rotation of armature 53 in one direction, and when core 51^a is attracted the switch 60 will close the other corresponding circuits of the motor through battery 55 to cause rotation of armature 53 in a reverse direction. When neither solenoid core is attracted the armature will not rotate. To control the rudder 4 by the operation of the armature of such

motor we have illustrated the following arrangements designed to cause the rudder to turn to one side or another according to the sounds received in one or the other of the sound responsive instruments or microphones 5, 6, as well as to cause the rudder to steer the torpedo on a straight course in case the sound received in said instruments 5, 6 to which they are tuned, is equal, or in case no sound is received in said instruments. For such purpose we have illustrated a gyroscope having a contact that will maintain a substantially definite position regardless of the movement of other contacts coöperative therewith due to deviation of the craft or torpedo from a straight course, or due to shifted positions of such contacts due to sounds received in the sound responsive instruments or microphones 5, 6, for causing steering of the craft or torpedo in the direction from which such sounds proceed. The rotor of the gyroscope is indicated at 63 (Figs. 6, 7 and 8) and its supporting shaft 64 is shown pivotally supported in a ring 65 secured within a ring 66. Said parts of the gyroscope may be of any suitable or well known construction and any desired means may be provided to maintain rotation of rotor 63 during operation of our improvements. The ring 66 is pivotally supported within a frame 67 by means of pivots 68 shown connected with ring 66 and rotative in bearings in the ring 67. The base 67^a of frame 67 may be suitably secured in the craft or torpedo in such a manner that pivots 68 will extend vertically, whereby the axis of shaft 64 of the rotor may remain in a previously set direction during rotation of the latter regardless of the deviation of the craft or torpedo from a straight course, or from the direction in which the torpedo may be launched. The rotor or one of its rings, such as the ring 65, is provided with a contact 69 (Figs. 1 and 6), which contact is connected to one terminal of a battery 70, as by a conductor 71 (Fig. 1). The opposite terminal of said battery is shown connected by branch conductor 72 with corresponding terminals of the windings of solenoids 73, 74, the other terminals of which windings are respectively connected with brushes 75, 76. Said brushes respectively engage movable contact strips 77, 78 which are insulated from each other. Said contacts are shown supported upon a rotative ring or member 79, (Figs. 6, 7, and 8), that surrounds the rotor rings 65, 66 and is free therefrom, insulation at 80 being carried by said ring to which insulation the contacts 77 and 78 are secured in any suitable manner, whereby they will be out of circuit with ring 79. Ring 79 may be supported for rotation around the gyroscope rings and rotor in any suitable manner. We have shown frame 67 provided

with brackets or arms 81 branched on opposite sides of frame 67 and carrying anti-friction balls or rollers 82 set in suitable recesses in said brackets or arms and receiving an annular groove 79^a in the under surface of ring 79, whereby the latter is supported for rotation in an almost frictionless manner. Gears or rollers 83 are shown disposed around ring 79 and supported by pivots 84 carried by brackets or arms 81 to guide ring 79 during its annular movements. Said ring is shown provided with peripheral teeth 85 cooperating with said gears. Disks 86 are shown disposed upon pivots 84 and overlie ring 79 to keep the latter from rising from its bearings. A gear, such as a worm 87, is in mesh with teeth 85 for rotating ring 79, and the shaft 88 of said worm is rotated by armature 53 (Fig. 1), of the reversing motor, whereby said ring with its contacts 77, 78, may be automatically adjusted in an annular direction with respect to contact 69 of the gyroscope rotor.

It will be noted in Fig. 6 that the opposing ends of contacts 77 and 78 are spaced apart, whereby the contact 69 may be in a position between said contact ends and the circuits (Fig. 1) from battery 70 through solenoids 73 and 74 will be broken. The cores 73^a, 74^a of said solenoids are respectively operatively connected by suitable means, such as levers 89, 90, with rudder 4 (Fig. 1) whereby when said solenoids are not energized said rudder will be maintained in a direction fore and aft for steering the craft or torpedo on a straight course, whereas if only one of said solenoids be energized the rudder will be turned to steer the craft or torpedo in a corresponding direction. If the craft or torpedo deviates from a straight course a contact 77 or 78 will be caused to engage contact 69 which will be maintained in a given direction by the gyroscope, and thereupon one or the other of said solenoids will be energized to cause operation of the rudder 4 for returning the craft or torpedo to the straight course, whereupon engagement between contact 69 and one of said contacts 77 or 78 will be broken, as the contact 69 will once more rest on insulation.

Assuming that the sound from the enemy craft, such as a submarine, is detected on a ship by the apparatus now in use as coming from a given general direction, or assuming that such submarine or its periscope may be seen before the torpedo is launched, the gyroscope will be set or aimed by means of contact 69 for steering the torpedo in the direction of such sound or submarine in an ordinary manner, and the torpedo will be launched. If contact 69 is not in engagement with contact 77 or 78 (Fig. 6) the torpedo will proceed on this straight course.

If the torpedo is not proceeding in a course such as to cause it to strike an enemy craft or submarine, in the direction in which it has been launched, the sounds from such enemy submarine or other craft, received in one of the microphones 5 or 6, will cause flow of current in primary winding 14 or 15 and in the primary winding 17. Assuming that the sound is received in microphone 5, the current flowing through windings 14 and 17 will cause flow of induced current in the secondary winding 18 and thence through winding 20, as well as through the secondary winding 17^c of coil *c* and thence through winding 28, whereupon the latter will be attracted to cause finger 34 to move to one side in Fig. 1 (depending upon the polarity of the coils to each other) breaking the circuit of relay 40. The circuit will then close between the armature of said relay and contact 44, through battery 46 and solenoid 49, whereupon its core will be attracted and switch 59 will close the circuit of motor 53, 54 to cause rotation of armature 53 in such a manner that it will rotate worm 87 in the proper direction for rotation of ring 79 to cause circuit to be closed between contacts 69 and 77, whereupon solenoid 70 will be energized and will cause turning of rudder 4, whereby the torpedo will be caused to turn in the direction of such sound. So long as microphone 5 receives the aforesaid sounds from the submarine or other enemy craft, the torpedo will continue to turn in the direction of such sounds until said sounds are received equally well in microphone 6, at which point the microphone circuits are balanced and coils 20 and 24 exert the same pull in each direction on coil 28 which remains stationary. When the sounds from an enemy craft are received in both microphones with substantially the same intensity the coil 28 returns to normal and the circuit of motor 53, 54 will be broken and rudder 4 will steer the torpedo dead ahead at the enemy and the torpedo will continue on such course so long as the sounds from the submarine are received equally in the microphones.

In case the sound from the submarine should have affected the sound-responsive instrument or microphone 6, instead of 5, the operations above described respecting microphone 5 would be reversed, that is to say, finger 34 would have been moved sideways in Fig. 1 to cause breaking of the circuit of relay 41 and operation of the motor armature 53 in the reverse direction to cause contact 78 to engage contact 69, whereupon the solenoid 74 would be energized to cause the rudder to turn correspondingly to steer the torpedo in the direction of the sound until such sound equalizes in both microphones, or substantially so, to cause the rudder to steer the torpedo dead ahead. It

will be understood that whenever the torpedo is steered at the enemy in such a manner that the sounds proceeding from the latter to both microphones 5, 6 substantially affect coils *a*, *c* equally, the currents therein will become and will remain balanced, and the rudder will have returned to and will remain in normal position for steering dead ahead until the target is struck. It will be understood, furthermore, with the enemy submarine or target in motion the torpedo will follow the same, because the circuits through windings 20, 24 and 28 will be differently affected if the sound is greater in one microphone than another by reason of such movements of the enemy, whereby the steering of the torpedo will correspond until both microphones again receive the sound equally and the torpedo will then proceed toward the enemy on a straight course or dead ahead.

In case it should be desired to increase or intensify the action of the microphones, receivers 91, such as telephone receivers, may be included in the circuits of the coils of the secondary windings 18 and 22 of the induction coils or transformers *a* and *b*, (Fig. 13) the battery conductor 11 being connected to the appropriate terminals of said receivers, whereby when current is induced in windings 18 and 22 by the action of the corresponding microphone 5, 6 said receivers will act by their proximity to the microphones to increase the vibration of their respective diaphragms to intensify the current in the primary windings of the coils or transformers *a*, *c*. Said receivers may be adjustably supported adjacent to the microphones so that the receivers may be set in proper position with relation to the latter to produce the proper responsive tone and maximum amplification, hence the desired effect.

To avoid danger of the torpedo following sounds other than those emanating from the enemy craft, it is deemed advisable to provide a correct amount of iron in core 29 or to tune the regenerative instruments 5, 91 and 6, 91 or both such iron and tuning, so that they will respond the more readily to the particular frequency of the enemy sounds. By such means in the torpedo it may not be necessary to stop the ship from which the torpedo is fired, particularly if the sound frequency of the enemy craft is sufficiently different from that proceeding from such ship.

Although in Fig. 1 the cores of the solenoids 73 and 74 are shown as directly connected with the rudder by the interposed levers 89, 90, it will be understood that said solenoids may be caused to operate valves for controlling well known compressed air means for operation of the rudder in a well known manner. It will be understood

that the contacts 77 and 78 may be resistance contacts in case the arrangement last described for operation with compressed air is used for controlling the rudder operations, whereby the action of the solenoids may be variable with respect to governing said valves, and the brushes 75, 76 will be applied to such resistance contacts at the proper positions.

We have referred to our improvements as adapted to control vertically pivoted rudder 4 for lateral steering of the craft or torpedo, but it will be understood that our invention may be utilized in connection with a horizontally pivoted rudder adapted to steer the craft or torpedo in vertical directions so as to seek an enemy submarine at varying depths in the water.

While we have illustrated and described an apparatus adapted to carry out the purposes of our invention, it will be understood that our invention is not limited to the particular devices set forth nor to the particular arrangement of the parts, instruments and circuits specified, as the same may be varied, within the scope of the appended claims, without departing from the spirit of our invention. Although we have referred to our invention as being useful in a torpedo of the class specified, it will be understood that the same may be used in any other form of craft or vehicle capable of self-propulsion and self-steering without the aid of human agency for such operations.

Having now described our invention what we claim is:

1. A craft having means for steering it and provided with sound responsive means, transformers having primary coils in circuit respectively with said sound responsive means, a translating device having coils respectively in circuit with the secondary coils of said transformers, a transformer having its primary winding in circuit common with the primary windings of the first named transformers and with said sound responsive means, said translating device having a movable coil in circuit with the secondary winding of the second named transformer, and electrically operating means interposed between said steering means and said translating device and operated by the movable member of the latter for controlling the operation of said steering means.

2. A craft having means for steering it and provided with sound responsive means, transformers having primary coils in circuit respectively with said sound responsive means, a translating device having coils respectively in circuit with the secondary coils of said transformers, a transformer having its primary winding in circuit common with the primary windings of the first named transformers and with said sound responsive means, said translating device

having a movable coil in circuit with the secondary winding of the second named transformer, a motor to control said steering means, and electrically operating means interposed between said motor and said translating device and provided with circuits controllable by the movable member of the latter for controlling the operation of said motor.

3. A steering apparatus comprising a rudder, means to control operation of the rudder, sound responsive instruments, transformers having their primary windings in circuit with said instruments, a translating device controlled through said transformers, relays having normally closed circuits controllable by said translating device, a reversible motor for controlling the operation of the rudder controlling means, switch means to control the direction of rotation of the motor and solenoids having normally open circuits controlled by said relays for controlling the operation of the motor.

4. A steering apparatus comprising a rudder, means to control operation of the rudder comprising a reversible motor, solenoids having normally open circuits to control the circuits of the motor, relays having normally closed circuits to control the circuits of the solenoids, a translating device having a movable member to control the circuits of the relays, sound responsive instruments and electrically operating means operative by the sound responsive instruments for controlling said translating device.

5. A steering apparatus comprising a rudder, means to control operation of the rudder comprising a reversible motor, solenoids to control the circuits of the motor, relays to control the circuits of the solenoids, a translating device having a movable member to control the circuits of the relays, sound responsive instruments, transformers respectively having their primary windings connected with said sound responsive instruments and an electric generator and having their secondary windings in circuit with corresponding coils of said translating device, and a transformer having its primary winding in common with the first named primary windings and having its secondary winding in circuit with a movable winding of the translating device.

6. A plurality of sound responsive means, transformers having primary coils in circuit respectively with said sound responsive means, a translating device having coils respectively in circuit with the secondary coils of said transformers, a transformer having its primary winding in circuit common with the primary windings of the first named transformers and with said sound responsive means, said translating device having a movable coil in circuit with the secondary winding of the second named trans-

former, and mechanism controlled by said translating device.

7. A steering apparatus comprising a rudder, a gyroscope having a contact, movable contacts to cooperate therewith and out of contact with the first named contact when steering dead ahead, electrically operating means controllable through said movable contacts to control said rudder, electrically operating means to control said movable contacts because of engagement of one of the latter with the gyroscope contact when not steering dead ahead, and sound responsive instruments to control said second named electrically operating means.

8. A steering apparatus comprising a rudder, a gyroscope having a contact, movable contacts to cooperate therewith and out of contact with the first named contact when steering dead ahead, solenoids operatively connected with said rudder, brushes connected with said solenoids and cooperative with the movable contacts respectively, electrically operating means to operate the movable contacts because of engagement of one of the latter with the gyroscope contact when not steering dead ahead, and sound responsive instruments to control said electrically operating means.

9. A steering apparatus comprising a rudder, a gyroscope having a contact, movable contacts to cooperate therewith and out of contact with the first named contact when steering dead ahead, a translating device, electrically operating means controllable by said device to control said movable contacts, transformers having secondary windings connected with corresponding windings of said translating device, and sound responsive instruments having circuits connected with the primary windings of the transformers respectively.

10. A steering apparatus comprising a rudder, a gyroscope having a contact, movable contacts to cooperate therewith and out of contact with the first named contact when steering dead ahead, a translating device having stationary coils and a movable coil to control said movable contacts, transformers having their secondary windings connected with said stationary coils respectively, another transformer having its secondary winding connected with said movable coil, and sound responsive instruments connected with the primary windings of the first named transformers respectively and in common with the primary winding of the second named transformer.

11. A craft having means for steering it and provided with sound responsive means, transformers having primary coils in circuit respectively with said sound responsive means, a translating device having coils respectively in circuit with the secondary coils of said transformers, amplifiers included in

the circuits of said secondary coils and co-
operative with said sound responsive means,
a transformer having its primary winding
in circuit with the primary windings of the
5 first named transformers and with said
sound responsive means, said translating de-
vice having a movable coil in circuit with
the secondary winding of the second named
transformer, and electrically operating
10 means interposed between said steering
means and said translating device and op-

erated by the movable member of the latter
for controlling the operation of said steer-
ing means.

Signed at New York, county of New York 15
and State of New York, and Ithaca, county
of Tompkins and State of New York, re-
spectively, this 1st day of August, 1918, and
6th day of August, 1918, respectively.

EDWARD A. PARMELE.
TRUE McLEAN.