This invention relates to the control of moving bodies and, more particularly, to an automatic means for controlling the direction of a torpedo and for causing the same to pursue an enemy ship.

The invention provides a mechanism whereby a series of high frequency compression waves are emitted from a torpedo and impressed upon a surrounding medium. These waves are reflected from a solid object such as an enemy ship and are again impressed upon the torpedo where they are picked up by suitable microphones and caused to actuate relay mechanisms for operating the rudder. The usual gyroscopic mechanism is employed for maintaining a torpedo on a pre-selected course until in the proximity of the target. It is then directed by the reflected compression waves and caused to automatically follow the target until a hit is obtained. The invention also consists in certain new and original features of construction and combinations of parts hereinafter set forth and claimed.

Although the novel features which are believed to be characteristic of this invention will be particularly pointed out in the claims appended hereto, the invention itself, as to its objects and advantages, the mode of its operation and the manner of its organization may be better understood by referring to the following description taken in connection with the accompanying drawings forming a part thereof, in which:

Fig. 1 is a broken sectional view of a portion of a torpedo hull showing the location of the gyroscope with the propellers and the steering rudders;

Fig. 2 is a broken sectional view of another portion of the torpedo showing the automatic mechanism for operating the gyroscope in accordance with received compression waves;

Fig. 3 is an enlarged detail of certain of the parts shown in Fig. 2;

Fig. 4 is an elevation of a torpedo showing the location of the various parts including the oscillator and the microphones;

Fig. 5 is a sectional view of the forward compartment of a torpedo showing the schematic arrangements of the oscillator, microphones and operating circuits therefor;

Fig. 6 is a section taken on the line 6—6 of Fig. 1, showing the steering mechanism in detail;

Fig. 7 is a plan view of the gyro pot head;

Fig. 8 is a section taken on the line 8—8 of Fig. 7;

Fig. 9 is a section taken on the line 9—9 of Fig. 8;

Fig. 10 is a section taken on the line 10—10 of Fig. 8.

Like reference characters denote like parts in the several figures of the drawings.

In the following description and in the claims parts will be identified by specific names for convenience, but they are intended to be as generic in their application to similar parts as the art will permit.

Referring to Fig. 1, there is shown a water borne body such as a carrier of explosives, having a water-tight torpedo hull 10, and arranged to be propelled by a pair of propellers 11, 11. The propellers 11 are mounted on a pair of concentric shafts, including an outer shaft 12, and an inner shaft 14. The shafts 12 and 14 are directly connected to a driving means such as a conventional compressed air turbine (not shown). A gear 17 is keyed to the outer shaft 12 for operative engagement with gear 18 to cause rotation of shaft 22.

Horizontal rudders for varying the direction of movement of the torpedo about its horizontal transverse axis may also be provided in a well-known manner, but as such rudders and depth control devices for controlling the same are well known, it is thought that a more detailed description thereof is unnecessary herein.

For varying the direction of movement of the torpedo about a vertical axis so as to steer the torpedo in azimuth, there is provided a pair of blade rudders 30 pivotally mounted upon a pair of rotatable vertical rudder posts 31, whereby the rudders 30 can be moved relative to the torpedo to control the direction of movement thereof. The rudder posts 31 are shown rigidly connected by a yoke 32 (see Fig. 6) which may be shifted according to requirements by a connecting rod 33 hav-
ing one end pivotally secured to a piston rod 34 of a piston 35 which is mounted for reciprocating movement in a cylinder 36. Adjacent the ends of the cylin-
der are provided ports 37, 38, which are controlled by a slide valve 39 operating in a fluid pressure chest 40, which is in communication with a source of fluid pressure through pipe 41. The ar-
rangement is such that the piston 35 is moved to the right or to the left according to the position of the valve 39 with respect to the ports 37, 38. The respective ports of the cylinder 36 exhaust by way of the open ends of the valve chest 40, when the valve 39 has been moved to full open position in either direction.

For actuating the slide valve 39 and also for maintaining it in position to cause the torpedo to move upon a predetermined course, two mechanisms are employed, one operating automatically under control of a stabilizing device and the other operating in accordance with the direction of the target as determined by the microphonic relays to be described. The parts common to the two mechanisms include an extension 50 of the slide valve 39, having its outer end operative-
ly connected to the free end of a rocking arm 51, the other end of which is securely fastened to a rock shaft 52, pivotally mounted in a fixed bracket 53.

As more clearly illustrated in Figs. 7 and 8, for actuating the rock shaft 52 there is provided a lever arm 60 terminating in a ball 51, which is straddled by the bifurcated end of a bell crank 62, movement of which causes the shaft 52 to rock in a desired direction. The bell crank 62 is pivotally mounted on a bracket 63 which is secured to the outer face of rotatable cover plate 64. The cover plate 64 is mounted on a housing 65 by means of a pin 66 which is screwed into a bracket 67 of the housing 65. Pivoted to the lower arm of the bell crank 62 is a link 68, the opposite end of which is pivotally connected to an L shaped member 70 rotatably mounted upon a vertical pin 71 of the cover plate 64. A similar member 72 is pivoted to the cover plate at 73. For actuating member 73 a link 74 is provided pivotally connected to the inner ends of the members 70 and 72. Fingers 75 and 76 are formed on the lower end of member 76 for a purpose to be described. Slightly mounted between the feet of the bracket 69 is a reciprocating plate 75 in which is rotat-
ably mounted a member 76, the upper end of which is provided with a finger 77 which, when the plate 75 is reciprocated, engages either the member 70 or the member 72. The member 75 is provided with a slot which surrounds a cam 81, rotatably mounted on the pin 66. The upper part of the cam 81 is provided with a beveled gear 82 adapted to mesh with a second beveled gear 83 secured to the end of the shaft 22 having a bearing in the bracket 53. The shaft 22 is provided with a gear 18, which meshes with the gear 17 secured to the shaft 12.

Within the housing 65 is pivotally mounted a vertical gimbal ring 90, within which a horizontal gimbal ring 91 is mounted bearing rotatable massive element 95. Secured to the vertical gimbal ring 90 is a circular plate 96 cut-away on either side as at 97 and 98. The cut-away portions are arranged in different horizontal planes such that the cut-away portion 97 lies in the same plane as the finger 78 and the cut-away portion 98 lies in the plane of the finger 79. When the torpedo is discharged, the element 95 is set in rotation by means of a driving mechanism not shown, which is automatically disconnected when the element is brought up to the desired speed. The gyroscopic action of the element 95 will tend to keep its axis in a fixed direction in space. Thus the plate 96 will always remain in its original position regardless of a change in direction of the torpedo.

For controlling the valve 39 by the above described apparatus the shaft 22 is rotated at a high speed by means of the gears 17 and 18, causing the beveled gear 83 to rotate the gear 82 and cam 81 rapidly. Rotation of the cam 81 imparts a corresponding rapid reciprocation to the plate 75, carrying with it the member 76. Thus, as the torpedo continues on a straight course, the fingers 78 and 79 will move in and out of the same plane as the 97 and 98 of the plate 96, without affecting the position of the member 76 or the finger 77, which will reciprocate between the ends of the members 70 and 72 without changing their positions. If the torpedo should deviate from a straight course, say for example to the left, the casing 65 being carried by the torpedo will be rotated in a counter-clockwise direction, thus carrying with it the member 76. As the fingers 78 and 79 are moved back and forth with the finger 78 will strike the plate 96 at a point where it is not cut away, thus causing a relative rotation of the member 76 in a counter-clockwise direction, which will cause the finger 77 to strike the L shaped member 72 rotating it in a counter-clockwise direction, which by means of the link 74 will rotate the member 70 in a like direction, thus causing the link 68 to be moved to the right, causing the bell crank 62 to be rotated in a counter-clockwise direction, thereby rotating the shaft 52 in a clockwise direction by the connection therewith of the ball 61 and arm 60. By referring to Fig. 1 it may be readily seen that, by connection of the arm 51 to the shaft 52, rotation of the shaft 52 causes movement of the arm 51, thus moving the valve 39 to the left. This will uncover the ports 37 and 38, thus allowing air to enter the left-hand side of the cylinder 36 and pass from the right hand side, causing the piston 35 to be moved to the right which, by means of the piston rod
and the rod 53 will cause the rudders 30 to be moved to the right, thereby restoring the torpedo to its course.

If the torpedo deviates to the right a similar action, but in the opposite direction, will take place, causing the rudders to be moved to the left. In this way, the torpedo is maintained upon a predetermined straight course under the control of the gyroscopic element 95.

For actuating the slide valve 39 at will, for example from the microphones to be described, the cover 64 has a portion of its periphery toothed as at 100, which is in mesh with a worm 101, integral with a shaft 102 (see Fig. 9). The shaft 102 is journaled in spaced bearings 104, 104 and terminates in a beveled gear 105, which is in mesh with a gear 106 mounted on a rotatable shaft 120, which is journaled in a suitable bearing 108.

The opposite end of the shaft 120 protrudes into a compartment 121 shown in Fig. 2 and has fixedly secured thereto a pair of ratchets 123, 124 (see Figs. 2 and 3), arranged in reversed relation so that one may turn the shaft 120 in a clockwise direction, and the other counternoturn the shaft in a counter-clockwise direction. The operating means for these ratchets consists of a gear 125 loosely mounted upon the shaft 120 between the ratchets, and having on opposite faces pivoted paws 126, 128 for engaging the ratchets 122, 124 respectively. Each of the paws is yieldingly maintained in engagement with its respective ratchet by a spring such as 129. In order to cause either paw to be moved from engagement with its ratchet so that the shaft 120 can be turned in one desired direction without interference from the other paw and ratchet, the paws are respectively provided with laterally disposed lugs 130, 131, with which are respectively arranged to engage trip members 132, 133, which are secured to the wall of the compartment 121. From the foregoing it will be apparent that, if the gear 125 is moved in a clockwise direction through an angular distance of 180°, the paw 126 will engage its ratchet 122 and likewise turn the shaft 120 through an angular distance of 180°. While turning in a clockwise direction, the lug 131 of the paw 126 engages one face of the respective trip member 133, and thus during the turning movement of the gear 120, the paw 126 is oscillated about its pivot in a clockwise direction, and will be held out of engagement with the ratchet 124, so that upon the return of the gear 125 to its normal position the paw 128 will be held in inactive position with the respective ratchet and will not be engaged thereby. Thus it will be seen that rotation of the gear 125 through an angular distance of 180° operates the shaft 120 in a similar manner, but that restoration of the gear does not restore the shaft similarly if the gear 125 is moved in a counter-clockwise direction.

For controlling movement of the loose gear 125 there is provided a reciprocating rack gear 140, having a lug 141 in engagement with a pair of restoring springs 142, 143. The springs 142, 143 are mounted on a rod 144 and are held by brackets 146, 147 respectively, secured to the compartment 121. Springs 142, 143 have substantially equal tension, and serve to restore the rack 140 to the normal position shown in Figs. 2 and 3. One end of the rack 140 is secured to a piston 150 snugly fitted for reciprocating movement within a cylinder 151. The ends of the cylinder are respectively provided with ports 152, 153, the port 152 being controlled by an electrically operated slide valve 154, and the port 153 being controlled by a similar valve 155. The slide valves 154, 155 are arranged to be actuated by solenoids 156, 157 respectively, and each is provided with a retractile spring, such as 158. Each slide valve is arranged so that upon energization of the respective solenoid, the valve port is connected to a branch pipe 160 leading to the source of compressed air (not shown) and the piston 150 is moved accordingly. Upon release of the magnet the valve is restored by the action of the respective spring 158, and the valve port is connected to atmosphere through a vent 161. The piston is restored to its initial position under control of springs 142, 143. The arrangement is such that actuation of piston 150 as just described moves the rack 140 sufficiently to rotate the gear 125 through an angular distance of slightly more than 180°, and thus moves the shaft 120 one half a revolution, consequently turning of the cover plate 64, thru a given angle thus shifting the position of the member 76 which in a manner already described moves the arm 51 and rod 50, to operate the rudder arm 33 and turn the torpedo through the given angle such as 3°.

Referring to Fig. 5 the torpedo 510 is shown as provided at its nose with a metal diaphragm 511 which is operatively connect ed to an oscillator 512 which may be of any desired form. A suitable oscillator is shown and described in the patent to Lawther No. 1,518,123 issued December 2, 1924. This oscillator is operated by means of a superaudible frequency producing means 513, the output circuit of which is connected to two contacts 514 and 515 which are located adjacent to a movable arm 516 which is supported on a bracket 517 and is pressed downwardly by means of a spring 518. Secured to the lower side of the arm 516 is a roller 520 which engages a cam 521, provided with a depression 522. This cam is driven by a clock-work mechanism 523 which may be wound as by a key 524.

For automatically starting this mechanism
a heavy weight 525 is secured to the end of a flat spring 526, the upper end of which is fastened to the casing of the clock mechanism 523. The weight 525 is provided with a projection 527 which normally engages a finger 528 which controls the starting of the clock-work mechanism. Engaging the end of the finger 528 is a spring 530 which is supported on a bracket 531. When weight 525 is moved out of engagement with finger 528 as by the sudden starting of the torpedo, spring 530 forces the arm inwardly and releases the clock mechanism.

For receiving the reflected sound waves two electrical oscillators or receivers 533, and 534 are provided on the left and the right sides of the hull, which may be of any desired form, for example, that shown at 105 in Fig. 20 of patent to Dorsey No. 1,628,245 dated April 19, 1927. The winding of the receiver 533 is connected to two conductors 535 and 536 and the winding of the receiver 534 is connected to two conductors 537 and 538. The conductors 536 and 538 are connected to a contact 540 located adjacent to the arm 516. The conductors 535 and 537 are connected to the grids of two vacuum tubes 541 and 542. The plate circuits of these tubes are connected to the ends of two solenoids 543 and 544, which are returned to one side of a plate supply battery 545. The filaments of the two vacuum tubes are connected across a battery 546, in the usual manner grid polarizing battery 547, is connected by conductor 548 to a contact 549, located adjacent to the arm 516 by means of which the grid circuit is completed through receivers 533 and 534. Two condensers 550 and 552 are connected between the plates and filaments of the two tubes 541 and 542 for controlling the oscillation-frequency thereof.

Pivoted mounted adjacent to solenoids 543 and 544 is an arm 551 which is provided at its lower end with an armature 552 made of magnetic material. The arm 551 is held in a central position by means of springs 553 and 554. Located adjacent to the arm 551 are two contacts 555 and 556 which are connected by means of two conductors 557 and 558 to the windings of the two solenoids 156 and 157. The other sides of the windings of these solenoids are connected by a conductor 562 to a battery 563, the other side of which is connected by a conductor 564 to the arm 551.

In the operation of this system when the torpedo is fired, the inertia of the weight 525 causes it to be moved backward relative to the torpedo thus disengaging projection 527 from the finger 528 which is moved upwardly under the action of the spring 530. This causes the clock-work mechanism to start turning the cam 521 at a predetermined speed which, for example, may be one revolution per second. When the depression 522 in the cam comes beneath the roller 520 the arm 516 will be moved downwardly under the action of the spring 518, thus connecting the two contacts 514 and 515 together. This will cause the generator of super-audible frequency 513 to generate a current of high frequency, say 20,000 cycles per second which is impressed upon the diaphragm 511, thus generating a series of compressional waves in the water ahead of the torpedo. This will continue until the cam has rotated sufficiently to lift the arm 516 out of engagement with the contacts 514 and 515 and close contacts 549, 540 thereby energizing receivers 533, 534 to the two vacuum tubes 541 and 542.

It will thus be seen that a short pulse of high frequency compressional waves will be emitted from the nose of the torpedo. This will travel through the water in all directions ahead of the torpedo and when it strikes the side of the enemy ship will cause a reflection or echo which will travel back to the torpedo and be received by the receivers 533 and 534. These will cause small currents to be generated in their windings of a frequency to which the tuned circuits of the vacuum tubes 541, 542 are responsive. The plate circuit of said vacuum tubes is thus energized and, direct current pulsations caused to pass through solenoids 543 and 544, the strength of these currents being dependent upon the strength of the sound waves received by receivers 533 and 534. Thus if the enemy ship is to the left of the course of the torpedo more energy will be received by the receiver 533 than by the receiver 543, thus causing a greater current to pass through solenoid 544 than through solenoid 543. This will cause the armature 552 to be moved to the right, thus rotating the arm 551 in a counter-clockwise direction until it engages contact 555, thus closing a circuit from the battery 563, conductor 564, arm 551, contact 555, conductor 557, solenoid 156, conductor 562 back to the other side of the battery 563. This will energize the solenoid 156 which will cause the shaft 120 to be rotated so as to turn the top of the gyro pot in a clock-wise direction. The rudders 11 are thus turned to the left as previously described causing the torpedo to steer to the left until it has turned through a predetermined angle. It will then proceed upon this new course until a second impulse has been sent out by the oscillator 512 and received by the receivers 533 and 534.

If the enemy ship is still to the left of the new course of the torpedo the action just described will be repeated. This will continue until the torpedo has been moved through a sufficient angle to bring it in line with the enemy ship so that the reflected wave of sound will be equal on each of the receivers 533 and 534. In this case currents through solenoids 543 and 544 will be equal and the arm 551 will not be moved out of its central
position. The torpedo will therefore not change its course, but continue directly at the enemy.

If the enemy should move off to the right a similar but reverse action would take place, thus causing the torpedo to be steered to the right until it is again in line with the enemy. It will thus be seen that the torpedo will always be headed in the direction of the reflected wave from the enemy so that it will follow the enemy's movements until it strikes.

While certain novel features of the invention have been shown and described and are pointed out in the annexed claims, it will be understood that various omissions, substitutions and changes in the forms and details of the device illustrated and in its operation may be made by those skilled in the art without departing from the spirit of the invention.

What is claimed is:

1. In combination with a self-propelled body, means for automatically steering said body on a predetermined course, means for propagating compressional waves means associated therewith for receiving reflected compressional waves, and means operable in response to said reflected compressional waves for altering said course.

2. In combination with a self-propelled body, means for automatically steering said body on a predetermined course, means for propagating compressional waves, flexible diaphragms mounted on opposite sides of said body for receiving reflected compressional waves, and means operable in response to said reflected compressional waves for steering said body in the direction of the diaphragm having the greatest movement.

3. Steering means for a self-propelled body comprising flexible diaphragms on opposite sides thereof, means for propagating impulses of a definite frequency electric receiving circuits associated with said diaphragms and tuned to said frequency, means for energizing said receiving systems when said diaphragms are vibrated at said frequency and means operable by said receiving systems for steering said body.

4. In a self-propelled body, a rudder, means for operating said rudder comprising a pair of solenoids, space discharge devices associated with said solenoids, means for operating said space discharge devices in accordance with compressional waves of a predetermined frequency, and means associated with said torpedo for propagating compressional waves of said predetermined frequency.

5. In a torpedo, an electrical oscillator, a diaphragm associated therewith and adapted to transmit compressional waves to the surrounding medium, receiving devices located on opposite sides of said torpedo for receiving reflected compressional waves, space discharge oscillators operable in accordance with said receiving devices and means operable by said space discharge oscillators for steering said torpedo in the direction of greatest compressional waves.

6. In a torpedo, an electrical oscillator, a diaphragm associated therewith and adapted to transmit compressional waves to the surrounding medium, receiving devices located on opposite sides of said torpedo for receiving reflected compressional waves, space discharge oscillators operable in accordance with said receiving devices, means operable by said space discharge oscillators for steering said torpedo in the direction of greatest compressional waves and means for alternately rendering operative said transmitting device and said receiving devices.

7. In a self-propelled vessel, a steering mechanism comprising a rudder, actuating means therefor, a gyroscopic means associated with said gyroscopic means for energizing said actuating means in accordance with the relative positions thereof, means for modifying said last mentioned means for causing said vessel to follow a given object, comprising a rotatable shaft adapted to vary the relationship between said gyroscopic and said actuating means, a pawl and ratchet mechanism for selectively operating said shaft in opposite directions, means for operating said ratchet mechanism comprising a pair of solenoids, means associated with said vessel for transmitting compressional waves to a surrounding medium comprising a vibratory diaphragm and a space discharge device associated therewith and adapted to vibrate said diaphragm at a definite predetermined frequency, electromagnetic receiving devices located on opposite sides of said vessel and adapted to receive compressional waves reflected from a distant object, space discharge devices associated with said receiving devices, means whereby said devices are caused to respond to said frequency, the response being proportional to the amplitude of the received compressional waves, and means for operating said solenoids in accordance with the response of said space discharge devices.

8. In a self-propelled torpedo, a steering mechanism comprising a rudder, actuating means therefor, a gyroscopic means associated with said gyroscopic means for energizing said actuating means in accordance with the relative positions thereof, means for modifying said last mentioned means for causing said torpedo to follow a given object, means for operating said modifying means comprising a pair of solenoids, means associated with said torpedo for transmitting compressional waves to a surrounding medium at a definite predetermined frequency, devices located on opposite sides of said torpedo and responsive to reflected compressional waves at said predetermined frequency, the response being
proportional to the amplitude of the received compressional waves, and means for operating said solenoids in accordance with the response of said devices.

In a torpedo, a steering mechanism comprising a rudder, actuating means therefor, a gyroscope and means associated with said gyroscope for energizing said actuating means in accordance with the relative position thereof, means for modifying said last mentioned means for causing said torpedo to follow a given object, comprising a shaft adapted to vary the relationship between said gyroscope and said actuating means, means for operating said shafts comprising a pair of solenoids, means associated with said torpedo for transmitting compressional waves to a surrounding medium at a definite predetermined frequency, electromagnetic receiving devices located on opposite sides of said vessel and adapted to receive compressional waves reflected from a distant object, space discharge devices associated with said receiving devices, means whereby said devices are caused to respond to said frequency, the response being proportional to the amplitude of the received compressional waves, and means for operating said solenoids in accordance with the response of said space discharge devices.

In a self-propelled vessel, a steering mechanism comprising a rudder, actuating means therefor, a gyroscope and means associated with said gyroscope for energizing said actuating means in accordance with the relative positions thereof, means for modifying said last mentioned means for causing said vessel to follow a given object, comprising a rotatable shaft adapted to vary the relationship between said gyroscope and said actuating means, a pawl and ratchet mechanism for progressively operating said shaft in opposite directions, means for operating said ratchet mechanism comprising a pair of solenoids, means associated with said vessel for transmitting compressional waves to a surrounding medium comprising a vibratory diaphragm and a space discharge device associated therewith and adapted to vibrate said diaphragm at a definite predetermined frequency, electromagnetic receiving devices located on opposite sides of said vessel and adapted to receive compressional waves reflected from a distant object, space discharge devices associated with said receiving devices, means whereby said devices are caused to respond to said frequency, the response being proportional to the amplitude of the received compressional waves, and means for operating said solenoids in accordance with the differential energization of said receiving devices.

In a self-propelled vessel, a steering mechanism comprising a rudder, actuating means therefor, a gyroscope and means associated with said gyroscope for energizing said actuating means in accordance with the relative positions thereof, means for modifying said last mentioned means for causing said vessel to follow a given object, comprising a shaft adapted to vary the relationship between said gyroscope and said actuating means, means for selectively operating said shaft in opposite directions comprising a pair of solenoids, means associated with said vessel for transmitting compressional waves to a surrounding medium comprising a vibratory diaphragm and a space discharge device associated therewith and adapted to vibrate said diaphragm at a definite predetermined frequency, electromagnetic receiving devices located on opposite sides of said vessel and adapted to receive compressional waves reflected from a distant object, space discharge devices associated with said receiving devices, means whereby said devices are caused to respond to said frequency, the response being proportional to the amplitude of the received compressional waves, and means for operating said solenoids in accordance with the differential energization of said receiving devices.

In a self-propelled vessel, a steering mechanism comprising a rudder, actuating means therefor, a gyroscope and means associated with said gyroscope for energizing said actuating means in accordance with the relative positions thereof, means for modifying said last mentioned means for causing said vessel to follow a given object, comprising a shaft adapted to vary the relationship between said gyroscope and said actuating means, means for selectively operating said shaft in opposite directions comprising a pair of solenoids, means associated with said vessel for transmitting compressional waves to a surrounding medium comprising a vibratory diaphragm and a space discharge device associated therewith and adapted to vibrate said diaphragm at a definite predetermined frequency, electromagnetic receiving devices located on opposite sides of said vessel and adapted to receive compressional waves reflected from a distant object, space discharge devices associated with said receiving devices, means whereby said devices are caused to respond to said frequency, the response being proportional to the amplitude of the received compressional waves, and means for operating said solenoids in accordance with the differential energization of said receiving devices.
located on opposite sides of said torpedo and responsive to reflected compressional waves at said predetermined frequency, the response being proportional to the amplitude of the received compressional waves, and means for operating said solenoids in accordance with the response of said devices and means for alternately energizing said transmitting apparatus and said receiving apparatus whereby compressional waves are alternately impressed upon the surrounding medium and received by said receiving devices.

16. In a self-propelled torpedo, a steering mechanism comprising a rudder, actuating means therefor, a gyroscope and means associated with said gyroscope for energizing said actuating means in accordance with the relative positions thereof, means for modifying said last mentioned means for causing said torpedo to follow a given object, means for operating said modifying means comprising a pair of solenoids, means associated with said torpedo for transmitting compressional waves to a surrounding medium at a definite predetermined frequency, devices located on opposite sides of said torpedo and responsive to reflected compressional waves at said predetermined frequency, the response being proportional to the amplitude of the received compressional waves, and means for operating said modifying means comprising a pair of solenoids, means associated with said diaphragm and a space discharge device associated therewith and adapted to vibrate said diaphragm at a definite predetermined frequency, devices located on opposite sides of said torpedo and responsive to reflected compressional waves at said predetermined frequency, said solenoids in accordance with the relative positions thereof, means for modifying said last mentioned means for causing said torpedo to follow a given object, means for operating said modifying means comprising a pair of solenoids, means associated with said torpedo for transmitting compressional waves to a surrounding medium at a definite predetermined frequency, devices located on opposite sides of said torpedo and responsive to reflected compressional waves at said predetermined frequency, the response being proportional to the amplitude of the received compressional waves, and means for operating said modifying means comprising a pair of solenoids, means associated with said diaphragm and a space discharge device associated therewith and adapted to vibrate said diaphragm at a definite prede-
terminated frequency, receiving devices located on opposite sides of said torpedo and adapted to receive reflected compressional waves at said predetermined frequency and means for operating said solenoids in accordance with the relative positions thereof, means for modifying said last mentioned means for causing said torpedo to follow a given object, comprising a shaft adapted to vary the relationship between said gyroscope and said actuating means, means for operating said shafts comprising a pair of solenoids, means associated with said torpedo for transmitting compressional waves to a surrounding medium comprising a vibratory diaphragm and a space discharge device associated therewith and adapted to vibrate said diaphragm at a definite predetermined frequency, receiving devices located on opposite sides of said torpedo and adapted to receive reflected compressional waves at said predetermined frequency and means for operating said solenoids in accordance with the differential energization of said receiving devices.

19. In a torpedo, a steering mechanism comprising a rudder, actuating means therefor, a gyroscope and means associated with said gyroscope for energizing said actuating means in accordance with the relative positions thereof, means for modifying said last mentioned means for causing said torpedo to follow a given object, comprising a shaft adapted to vary the relationship between said gyroscope and said actuating means, means for operating said shafts comprising a pair of solenoids, means associated with said torpedo for transmitting compressional waves to a surrounding medium comprising a vibratory diaphragm and a space discharge device associated therewith and adapted to vibrate said diaphragm at a definite predetermined frequency, receiving devices located on opposite sides of said torpedo and adapted to receive reflected compressional waves at said predetermined frequency and means for operating said solenoids in accordance with the differential energization of said receiving devices.

20. In a torpedo, a steering mechanism comprising a rudder, actuating means therefor, a gyroscope and means associated with said gyroscope for energizing said actuating means in accordance with the relative positions thereof, means for modifying said last mentioned means for causing said torpedo to follow a given object, comprising a shaft adapted to vary the relationship between said gyroscope and said actuating means, means for operating said shafts comprising a pair of solenoids, means associated with said torpedo for transmitting compressional waves to a surrounding medium comprising a vibratory diaphragm and a space discharge device associated therewith and responsive to reflected compressional waves at said predetermined frequency, the response being proportional to the amplitude of the received compressional waves, and means for operating said solenoids in accordance with the response of said devices.

21. In a self-propelled vessel, a steering mechanism comprising a rudder, actuating means therefor, a gyroscope and means associated with said gyroscope for energizing said actuating means in accordance with the relative positions thereof, means for modifying said last mentioned means for causing said vessel to follow a given object, comprising a rotatable shaft adapted to vary the relationship between said gyroscope and said actuating means, a pawl and ratchet mechanism for selectively operating said shaft in opposite directions, means for operating said ratchet mechanism comprising a pair of solenoids, means associated with said vessel for transmitting compressional waves to a surrounding medium comprising a vibratory diaphragm and a space discharge device associated therewith and adapted to vibrate said diaphragm at a definite predetermined frequency, electromagnetic receiving devices located on opposite sides of said vessel and adapted to receive compressional waves reflected from a distant object, space discharge devices associated with said receiving devices, means whereby said devices are caused to respond to said frequency, the response being proportional to the amplitude of the received compressional waves, and means for operating said solenoids in accordance with the response of said space discharge devices, and means for alternately energizing said transmitting apparatus and said receiving apparatus whereby compressional waves are alternately impressed upon the surrounding medium and received by said receiving devices.

22. In a self-propelled vessel, a steering mechanism comprising a rudder, actuating means therefor, a gyroscope and means associated with said gyroscope for energizing said actuating means in accordance with the response of said space discharge devices, and means for alternately energizing said transmitting apparatus and said receiving apparatus whereby compressional waves are alternately impressed upon the surrounding medium and received by said receiving devices.
mechanism comprising a rudder, actuating means thereof, a gyroscope and means associated with said gyroscope for energizing said actuating means in accordance with the relative positions thereof, means for modifying said last mentioned means for causing said vessel to follow a given object, comprising a rotatable shaft adapted to vary the relationship between said gyroscope and said actuating means, a pawl and ratchet mechanism for selectively operating said shaft in opposite directions, means for operating said ratchet mechanism comprising a pair of solenoids, means associated with said vessel for transmitting compressional waves to a surrounding medium comprising a vibratory diaphragm and a space discharge device associated therewith and adapted to vibrate said diaphragm at a definite predetermined frequency, electromagnetic receiving devices located on opposite sides of said vessel and adapted to receive compressional waves reflected from a distant object, space discharge devices associated with said receiving devices, means whereby said devices are caused to respond to said frequency, the response being proportional to the amplitude of the received compressional waves, and means for operating said solenoids in accordance with the response of said space discharge devices, a plurality of contacts, a time operated mechanism having means thereon for intermittently and alternately closing and opening said contacts, and means associated with said contacts for selectively energizing said transmitting apparatus and said receiving apparatus whereby compressional waves are alternately impressed upon the surrounding medium and received by said receiving devices.

25. In a self-propelled torpedo, a steering mechanism comprising a rudder, actuating means thereof, a gyroscope and means associated with said gyroscope for energizing said actuating means in accordance with the relative positions thereof, means for modifying said last mentioned means for causing said torpedo to follow a given object, means for operating said modifying means comprising a pair of solenoids, means associated with said torpedo for transmitting compressional waves to a surrounding medium at a definite predetermined frequency, devices located on opposite sides of said torpedo and responsive to reflected compressional waves at said predetermined frequency, the response being proportional to the amplitude of the received compressional waves, and means for operating said solenoids in accordance with the response of said devices, a switch and a time operated mechanism having means thereon for intermittently closing and opening said switch for alternately energizing said transmitting apparatus and said receiving apparatus whereby compressional waves are alternately impressed upon the surrounding medium and received by said receiving devices.

26. In a torpedo, a steering mechanism comprising a rudder, actuating means therefor, a gyroscope and means associated with said gyroscope for energizing said actuating means in accordance with the relative positions thereof, means for modifying said last mentioned means for causing said torpedo to follow a given object, comprising a shaft adapted to vary the relationship between said gyroscope and said actuating means, means for operating said shafts comprising a pair of solenoids, means associated with said torpedo for transmitting compressional waves to a surrounding medium at a definite predetermined frequency, devices located on opposite sides of said torpedo and responsive to reflected compressional waves at said predetermined frequency, the response being proportional to the amplitude of the received compressional waves, and means for operating said solenoids in accordance with the response of said devices comprising a differential relay associated with said space discharge devices, an armature therefor, circuits associated with said solenoids, and means whereby said armature selectively closes said circuits for initiating the steering movement of the torpedo.

27. In a self-propelled torpedo, a steering mechanism comprising a rudder, actuating means therefor, a gyroscope and means associated with said gyroscope for energizing said actuating means in accordance with the relative positions thereof, means for modifying said last mentioned means for causing said torpedo to follow a given object, means for operating said modifying means comprising a pair of solenoids, means associated with
said torpedo for transmitting compressional waves to a surrounding medium at a definite predetermined frequency, devices located on opposite sides of said torpedo and responsive to reflected compressional waves at said predetermined frequency, the response being proportional to amplitude of the received compressional waves, and means for operating said solenoids in accordance with the response of said devices comprising a differential relay associated with said space discharge devices, an armature therefor, circuits associated with said solenoids, and means whereby said armature selectively closes said circuits for initiating the steering movement of the torpedo, a time operated mechanism having means thereon for alternately energizing said transmitting apparatus and received by said receiving apparatus whereby compressional waves are alternately impressed upon the surrounding medium and said receiving devices.

In combination with a self propelled body, means for automatically steering said body on a predetermined course, means carried by said body for propagating energy waves, means associated therewith for receiving said waves when reflected from a distant object and means operable in response to said reflected waves for altering the course of said body.

In testimony whereof I have hereunto set my hand.

JOHN HAYS HAMMOND, Jr.