M. L. PATTERSON.

STEERING GYROSCOPE.

APPLICATION FILED JULY 10, 1918.

1,332,302.

Patented Mar. 2, 1920.

2 SHEETS—SHEET 1.

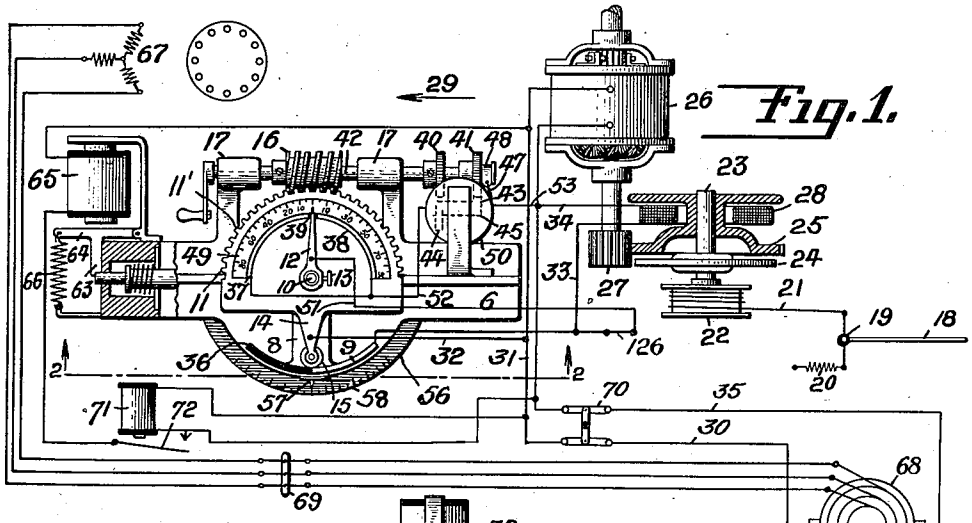


Fig. 1.

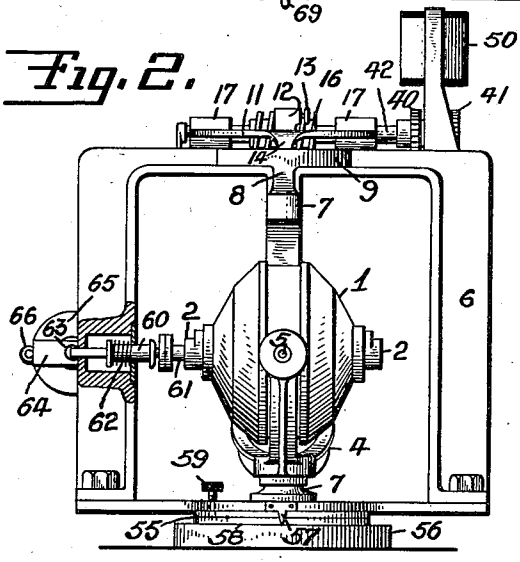


Fig. 2.

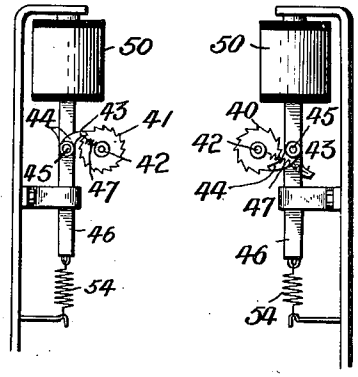


Fig. 3.

Fig. 3a.

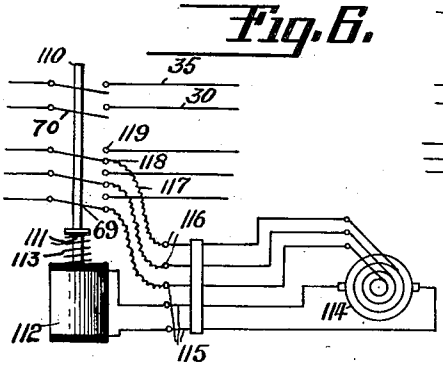


Fig. 6.

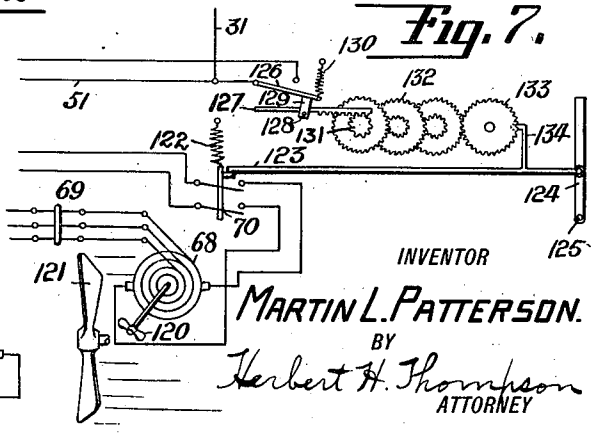


Fig. 7.

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Fig. 4.

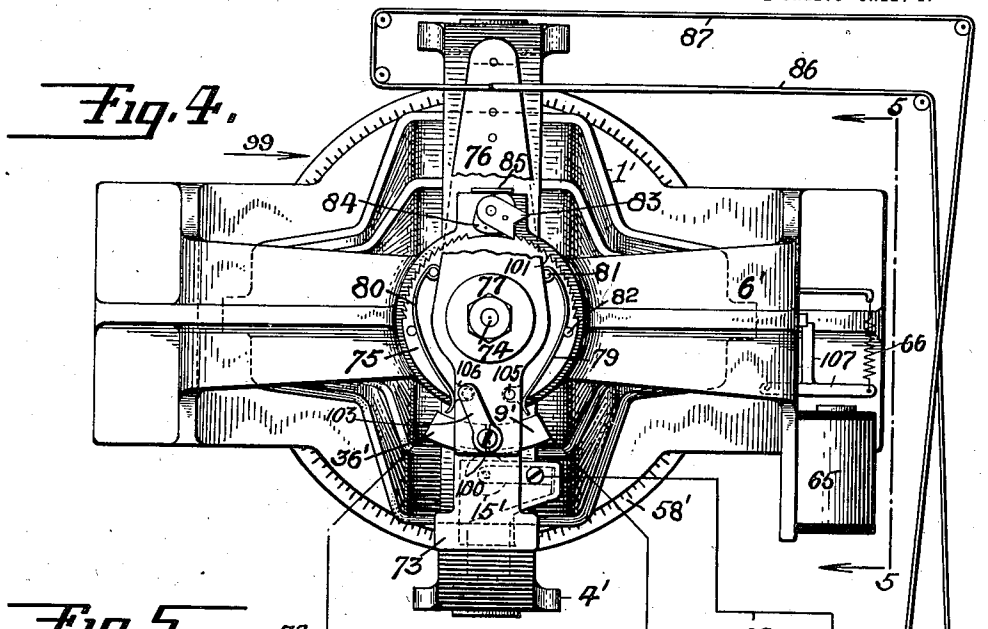
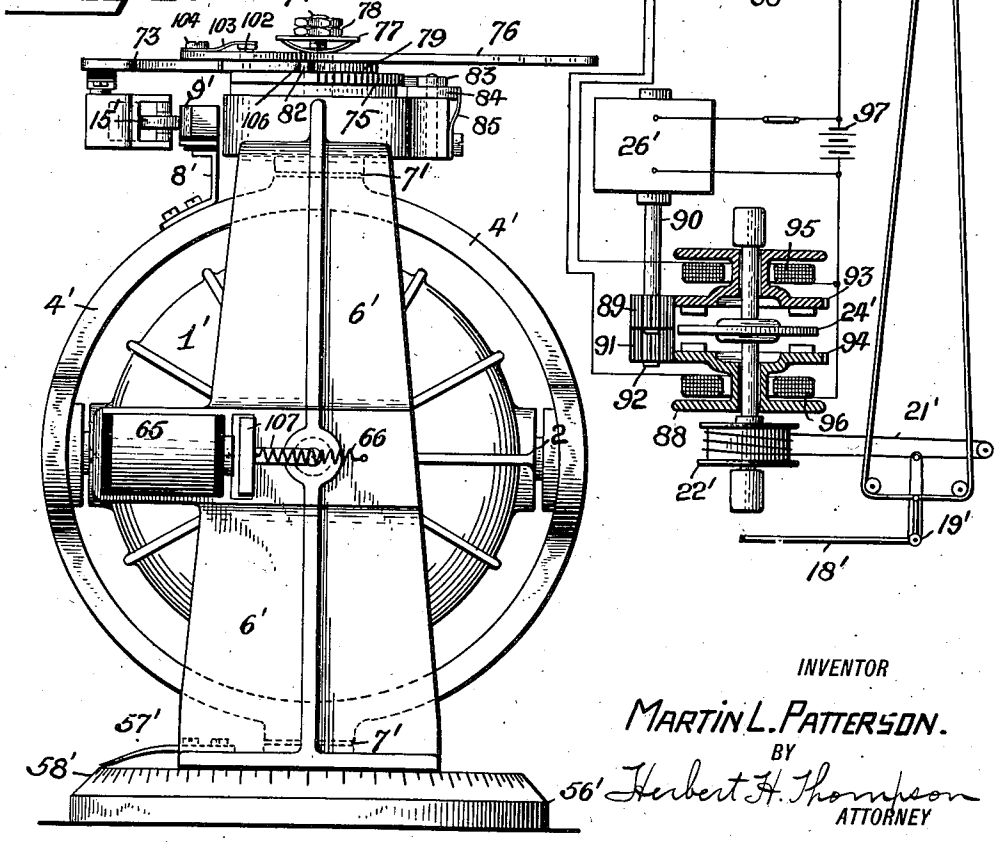


Fig. 5.



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MARTIN L. PATTERSON, OF BROOKLYN, NEW YORK, ASSIGNOR TO THE SPERRY GYROSCOPE COMPANY, OF BROOKLYN, NEW YORK, A CORPORATION OF NEW YORK.

STEERING-GYROSCOPE.

1,332,302. Specification of Letters Patent. Patented Mar. 2, 1920.

Application filed July 10, 1918. Serial No. 244,165.

To all whom it may concern:

Be it known that I, MARTIN L. PATTERSON, a citizen of the United States of America, residing at 3813 Avenue I, Brooklyn, in the county of Kings and State of New York, have invented certain new and useful Improvements in Steering-Gyroscopes, of which the following is a specification.

This invention relates to steering gyroscopes for automatically propelled and controlled dirigible devices, such as marine or aerial automobile torpedoes.

The use of gyroscopes for keeping such devices on a substantially straight course, and for causing the torpedo to execute a given turn in its course as in angle firing, is well known.

The principal object of my invention is to provide means in connection with such a gyroscope for causing the said turn in the course of the torpedo to be effected very gradually.

Among the advantages derived from a wide angle turn in the case of marine torpedoes, is that the torpedo is less apt to turn back upon the ship from which it is launched before crossing the bow or stern thereof, while in the case of aerial torpedoes, especially of the aeroplane type, greater stability of the craft is insured. When an aeroplane is making a short turn, a high banking angle must be maintained in order to prevent skidding. If the angle is not high enough, the craft will skid, while if it is too high, the craft will slide downwardly, and unless the banking angle is closely proportionate to the speed and turning angle, the craft is apt to turn over. In the case of a wide angle turn, on the other hand, the danger of skidding or slidding or of turning over when the banking angle is not precisely correct is negligible.

Referring to the drawings in which I have shown what I now consider to be the preferred form of my invention:

Figure 1 is a plan view showing the embodiment of my invention.

Fig. 2 is an elevation of the steering gyroscope taken approximately on line 2—2, Fig. 1.

Fig. 3 is a detail showing pawls and ratchet, and a solenoid for actuating the same for slowly shifting the position of electric contacts adjacent the gyroscope.

Fig. 3A is another view of the same mechanism as shown in Fig. 3, looking from the other side, and showing the actuating pawls in reversed position.

Fig. 4 is a plan view of a modified form of the invention.

Fig. 5 is an elevation of the gyroscopic unit taken on line 5—5, Fig. 4.

Fig. 6 is a fragmentary view of the wiring diagram shown in Fig. 1, showing means for spinning up the gyroscope before the torpedo is launched

Fig. 7 is a modification thereof.

In the form of the invention shown in Figs. 1 and 2, the gyroscope casing is shown at 1, within which the gyroscope is mounted on a horizontal spinning axis 2—2. Casing 1 is in turn mounted in a yoke 4, for oscillation about a horizontal axis 5. The said yoke is pivotally mounted in a frame 6 on a vertical axis 7—7. A bracket 8 shown as integral with yoke 4 carries a contact 9. Fixed to the top of frame 6 is a pin or stud 10, on which is rotatably mounted a segmental gear member 11. A projection 14 on member 11 may carry a trolley 15 which is adapted to engage contact 9. A worm 16 mounted in brackets 17 integral with frame 6 may engage segmental gear 11, and normally hold said member 11 and consequently trolley 15 in fixed relation to frame 6. Frame 6, it is understood, will be carried by the torpedo in fixed relation thereto, so that trolley 15 is carried by the torpedo, while contact 9 is carried by the gyroscope.

The rudder which is to be controlled by the gyroscope for steering the torpedo is shown at 18, pivoted at 19. A spring 20 may be provided for tending to hold the rudder normally turned to one side. To turn the rudder to the opposite side, a wire 21 is shown attached thereto and wound upon a drum 22. Drum 22 is fixed on the same shaft 23 with a disk 24 forming one element of a friction clutch; the other element thereof being the geared member 25, loosely mounted on shaft 23 and adapted to be constantly rotated by motor 26 through pinion 27. Energization of coil 28 will cause members 24 and 25 of the clutch to be drawn together and effect the actuation of drum 22.

Presuming the torpedo to be moving in the direction of arrow 29, the torpedo will tend to turn to the left of its course through

the effect of spring 20 upon the rudder. This will cause trolley 15 to engage contact 9 and complete a circuit through coil 28, by way of lines 30, 31, 32, trolley 15, contact 9, line 33 and lines 34 and 35. Drum 22 will then rotate and turn the rudder to the other side and the torpedo will return to its course and begin to turn a little to the right thereof. Trolley 15 will then move back to the insulation 36, and the torpedo will again begin to turn to the left. Thus trolley 15 will move constantly on and off from contact 9, and the torpedo will hunt slightly on either side of a straight line. This turning to either side, however, will be negligible, and the torpedo will travel in a substantially straight line.

In order to cause the torpedo to turn, after it starts out upon its journey, to one side or the other through a given angle, and thereafter pursue a straight course to the target, the common practice is to shift the position of contact 15 relative to contact 9. This, it is understood, will cause the torpedo to turn until the normal relative positions of the contacts are restored. But where the angle through which the torpedo is to turn is a substantial one, the turn is apt to be too abrupt. I prefer, therefore, to accomplish the complete turn through an accumulation of successive smaller turns. For this purpose I desire to shift the contact 15 from its normal to its ultimate position by a series of small steps, allowing the relative position of the contacts to become restored between each step or in other words, allowing the torpedo to turn through an angle equal to the angle through which contact 15 will have turned about stud 10 between each step. This may be accomplished as follows:

Contacts 37 and 38 are fixed to member 11, and spaced apart by insulation 39. An arm 12 adjustably secured on stud 10 by means of a set screw 13 may constitute a cooperating contact and is shown resting on the insulated spot 39. A pair of oppositely pitched ratchets 40 and 41 may be fixed on the same shaft 42 with worm 16. Pawls 43 and 44 fixed on a shaft 45 rotatably carried by a rod 46 are adapted to engage said ratchets. A spring 47 may be attached at one end to one of the pawls 43 and at the other to a loose fitting collar 48 on shaft 42 to hold one or the other of the pawls into engagement with its ratchet. As shown in Figs. 3 and 3A, when one of the pawls is in engagement with its ratchet, the other one is in an inoperative position.

A reciprocatory up and down movement of rod 46 resulting from the intermittent energization of solenoid 50 and the intervening action of spring 54 will effect the turning of worm 16 in one direction or the other, depending upon whether pawl 43 is in engagement with ratchet wheel 41 as in Fig. 3 or pawl 44 is in engagement with ratchet 40 as in Fig. 3A.

The operation of the device is as follows: Assuming that it is desired to set the mechanism to cause a 40° turn to the right, the arm 12 will be turned on stud 10 in a counter-clockwise direction until it indicates 40 on the scale 49 provided on member 11. After the torpedo is launched, spring 20 will, as we have seen, cause it to begin to turn to the left, bringing contact 15 into engagement with contact 9 and causing the torpedo to begin to turn to the right. Closure of contacts 15—9 will now also effect the energization of solenoid 50 through wires 30—31—32, contacts 15—9, wire 51, arm 12, contact 37, wire 52, through said solenoid and back through wires 53 and 35. Energization of solenoid 50 will attract rod 46 which may act as the armature of said solenoid. It will be seen that the lifting of arm 46 will cause pawl 43 to turn ratchet 41 and worm 16 so as to turn member 11 slightly in a counter-clockwise direction. This will cause contact 15 to encroach further upon contact 9, so that the torpedo must now turn a little to the right of its original course, in order to return contact 15 to insulation 36. When contact 15 again reaches the said insulation, both solenoids 50 and 28 will become deënergized, permitting spring 54 to return arm 46 to its normal position, and permitting spring 20 to cause the torpedo to tend to turn to the left again. This will close contacts 15—9 once more and the foregoing cycle will be repeated.

When step-by-step member 11 has been turned counter-clockwise through an angle of 40°, insulation 39 will again rest under contact 12, breaking contact 12—37, so that no further energization of solenoid 50 will take place. The torpedo will then have turned through an angle of 40°, and will thereafter continue upon its new course.

It has been found that a gyroscope maintains its plane of rotation more reliably when its spinning axis is parallel or at right angles to the course. For this reason the gyroscope is shown with its spinning axis 2—2 parallel to the original course. When, however, the torpedo is set and turned through an angle, the greater part of the journey will ordinarily take place over the new course. Means may be provided, therefore, to fix the spinning axis with respect to the new course before the torpedo is launched. Frame 6, therefore, may be pivotally mounted at 55 upon a pedestal 56. A pointer 57 on frame 6 coöperating with a scale 58 on pedestal 56 may serve to indicate the relative positions of the gyroscope and the torpedo. When the torpedo is to turn 40° to the left, the frame 6 may be turned 40° to the left with respect to the torpedo and secured in this position by

means of a thumb screw 59 threaded through frame 6 and adapted to engage pedestal 56. When the torpedo has turned into its new course, it will have alined itself with the axis of the gyroscope for the remainder of the run.

Prior to launching, the gyroscope is locked to frame 6 by means of a sleeve 60 held in telescopic engagement with the end of stud 61 against the action of a spring 62 by a catch 63 carried by the armature 64 of an electromagnet 65, fixed on frame 6. A spring 66 may be provided to hold the catch normally in locked position.

The gyroscope may be driven by a motor 67 receiving current from any suitable source, such as the A. C. side of a double current generator 68. The gyroscope may be spun up before launching of the torpedo by closing switch 69. Switch 70 may be closed either manually or automatically when the torpedo is being launched for supplying current from the D. C. side of generator 68 to the other parts of the apparatus. A retarded relay 71 may be provided to close a switch 72 a predetermined length of time after the closure of switch 70 to effect the energization of electromagnet 65 for releasing the gyroscope.

Numerous other ways may be provided for spinning up the gyroscope before launching the torpedo, either by generator 68 or by some external source and shifting over to generator 68 upon launching. In Fig. 6 I have shown the latter method. For this purpose switches 69 and 70 in the A. C. and D. C. lines respectively may be operated by a common member 110. This member may be attached at one end to the armature 111 of a solenoid 112 so that energization of said solenoid will hold said switches in the position shown, against the action of spring 113.

A generator 114 may be provided without the torpedo and connected thereto by means of brushes or plugs 115 connected to the generator, engaging contacts 116 in the torpedo. Some of said contacts 116 may be connected by wires 117 to contacts 118 on switch 69, while the others may be connected to solenoid 112. When the plugs or brushes 115 are in place it will be seen that solenoid 112 will be energized and switch 69 will connect the gyroscope with generator 114 to effect the initial spinning up. As the torpedo moves away in the act of launching, contacts 115—116 will be broken, deënergizing solenoid 112 and allowing spring 111 to close switch 70 and move switch 69 from contacts 118 to contacts 119. Switch 69 will now connect the gyroscope with generator 68, while switch 70 will effect the energization of the other parts of the gyro control unit.

In Fig. 7 I have shown a further modification. In this form, generator 68 may be started before the torpedo is launched. In the case of an aerial torpedo, this may be accomplished by placing the fan 120 which may serve to actuate said generator behind the propeller 121 of the craft so as to receive the force of the slip stream as soon as the engine is started and before the craft begins to move. Thus, the spinning of the gyroscope may be attained before launching. It is not desired, however, that the gyroscope shall be set free until about the time of launching. For this purpose, switch 70 may be provided by a spring 122 with a tendency to close, but is held open by a rod 123. Said rod is attached to a lever 124 pivotally mounted at 125 within the torpedo. Tripping of lever 124 either manually or automatically during the act of launching will effect the releasing of the gyroscope and the energization of the other parts of the control unit. Obviously, where the gyroscope is spun up before closure of switch 70, the retarded action relay 71 may be dispensed with, since the purpose of this relay is to allow the gyroscope to attain its speed before being set free.

In Fig. 7 I have also shown means for controlling the time or distance to be traveled by the torpedo before it begins to turn. In this connection, switch 126 in wire 51 which forms a part of the circuit with contact 12 may be held open by an arm 127 engaging a pin 128 on projection 129 on said switch. A spring 130 tends to close the switch. Arm 127 may constitute a rack bar meshing with pinion 131 of a revolution counter 132. The counter may be actuated by a spring-containing drum 133, normally held inoperative by a projection 134 on arm 123. The tripping of lever 124 will therefore also set the revolution counter in operation. Rack 127 will thus be slowly withdrawn so as to release switch 126. To vary the time or distance traveled after launching before the switch is closed, rack 127 may be shifted on pinion 131 to vary the distance through which it will be carried before releasing the switch.

In Figs. 4 and 5 I have shown a modified form of my invention. In this form the gyro casing is shown at 1′, rotatably mounted in ring 4′, which ring is in turn mounted for oscillation about a vertical axis 7′—7′ in frame 6′. A pair of contacts 9′—36′ are shown secured to ring 4′ by means of a bracket 8′. Coöperating with said contacts is a trolley 15′ suspended from an arm 73 which is rotatably mounted on a stud 74 secured in the top of frame 6′. Adjacent arm 73 and also rotatably mounted on stud 74 is a double ratchet member 75. A pair of springs 79 and 80 fixed to ratchet member 75 by pins 81 and 82 may rest against the opposite sides of arm 73 for tending to hold

arm 73 and member 75 in fixed relationship with respect to each other. Mounted on frame 6′ is a double pawl 83. Integral with said pawl is a cam 84. A flat spring 85 secured on frame 6′ may press against cam 84 for holding one or the other of the points of pawl 83 in engagement with one or the other side of ratchet member 75. A second arm 76 may be rotatably mounted on stud 74 over arm 73, and held in frictional engagement therewith by a resilient washer 77 and lock nuts 78, so that rotation of arm 76 on stud 74 will carry arm 73 with it. Follow-up wires 86 and 87 are shown running from arm 76 to the rudder 18′. The rudder is pivoted at 19′ and adapted to be turned in both directions by wire 21′ wound around drum 22′ of servo-motor 88.

Suitable means, such as an electric motor 26′ may be used to actuate the servo-motor. A pinion 89 is shown on the shaft 90 of motor 26′, while a second pinion 91 on shaft 92 may mesh with pinion 89. The two pinions will thus turn in opposite directions. Pinions 89 and 91 mesh with gear members 93 and 94 so that said members are rotated constantly in opposite directions. Energization of one or the other of coils 95—96 will effect the engagement of members 93 or 94 with friction disk 24′ and thus cause the rudder to turn in one direction or the other.

One side of the electrical supply source 97 is shown as connected to trolley 15′ by line 98, while the other side of said source is connected through each of coils 95—96 to contacts 9′—36′.

The operation of this form of the invention is as follows:

Assuming arrow 99 to represent the heading of the torpedo, and it is desired to effect a given turn to the left after launching, frame 6′ will be rotated counter-clockwise on its base 56′ as in the previous form through an angle equal to the turn to be executed. Arm 76 being connected to the rudder through follow-up wires 86, 87 will not turn. Arm 73 will, of course, because of the aforesaid frictional engagement remain with arm 76, as will ratchet 75 through the action of springs 79—80, so that it is necessary to turn arm 73 separately. Pawl 83 will be disengaged from ratchet 75 while arm 73 is rotated against said frictional engagement on stud 74 until trolley 15′ is brought into engagement with insulation 100 between contacts 9′ and 36′. Obviously this will change the position of ratchet 75 with respect to pawl 83 so that when said pawl is now returned to engagement with ratchet 75 it will engage said ratchet at another point, dependent upon the angle through which the ratchet has been turned, as for instance, in notch 101.

When the torpedo is launched and begins to sway from side to side, as soon as the torpedo turns slightly to the right, carrying trolley 15′ over contact 36′ and energizing coil 96, thereby shifting the rudder 18′ to bring the torpedo back upon its course, the shifting of the rudder will, through wires 86—87, effect a counter-clockwise movement of arm 76. This movement of arm 76 will tend to carry arm 73 and ratchet 75 with it, but will be prevented from doing so by pawl 83, so that slippage will take place between arms 76 and 73. As the torpedo straightens out upon its course, and trolley 15′ passes into engagement with contact 9′, the rudder is turned to the other side and arm 76 is turned clockwise. Arm 73 and ratchet 75 will now follow; ratchet 75 passing, say, one notch under pawl 83. This cycle will be repeated several times until ratchet 75 is restored to its normal position with respect to arm 76 as in Fig. 4.

Thus it will be seen that trolley 15′ will have accumulated a series of clockwise movements with respect to insulation 100, so that the torpedo will have had to turn to the left through an angle equal to the total of said movements of trolley 15′ to bring said trolley back to said insulation. This angle will, of course, be the angle through which frame 6′ arm 73 and ratchet 83 were turned relative to base 56′ prior to launching, so that the desired turn will now have been executed.

To turn the torpedo to the right, the preliminary steps will of course be reversed. In this connection pawl 83 will be turned around on its pivot so as to engage the other side of ratchet member 75.

In order to prevent arm 73 from passing beyond its central position after it has been returned thereto, a pin 102 on a resilient member 103 pivotally secured to arm 76 may be provided. This pin may project downwardly through one of holes 105 in arm 76 so as to be struck by arm 73 when it reaches its central position; notches 106 being provided in the sides of said arm 73 as indicated by dotted lines in Fig. 4, so as to permit said arm to reach said central position before being stopped.

The gyroscope may be provided with unlocking means 107 similar to that shown in Figs. 1 and 2.

In accordance with the provisions of the patent statutes, I have herein described the principle of operation of my invention, together with the apparatus, which I now consider to represent the best embodiment thereof, but I desire to have it understood that the apparatus shown is only illustrative and that the invention can be carried out by other means. Also, while it is designed to use the various features and elements in the combination and relations described, some of these may be altered and others omitted without

interfering with the more general results outlined, and the invention extends to such use.

Having described my invention, what I claim and desire to secure by Letters Patent is:

1. In an azimuth steering gyroscope for dirigible devices, a member carried by said gyroscope, a coöperating member carried by said device, means whereby the relative positions of said members may be changed for angle fire, and means responsive to the relative positions of said members for actuating said first mentioned means.

2. Steering mechanism for an automobile torpedo, comprising a steering gyroscope adapted to be carried by the torpedo, a member adapted to be carried by the torpedo, a member carried by the gyroscope, means responsive to the relative positions of said members for steering the torpedo, adjustable means for shifting the relative positions of said members, and step-by-step means responsive to the actual heading of the torpedo for actuating said adjustable means.

3. Steering mechanism for an automobile torpedo, comprising a steering gyroscope adapted to be carried by the torpedo, a member adapted to be carried by the torpedo, a coöperating member carried by the gyroscope, means responsive to the relative positions of said members for steering the torpedo, and adjustable means responsive to the relative positions of said members for altering said relative positions.

4. The combination with a gyroscope and a rudder for torpedoes, of a member carried by said gyroscope, a coöperating member carried by the torpedo, a third member having a follow-up connection with the rudder, means for turning both the first and second members for angle fire, and means for causing a relative step-by-step adjustment of one of said first two members with respect to said third member.

5. Mechanism for steering an automatically controlled automobile device, including a rudder, a gyroscope adapted to be adjustably mounted in the device, a member carried by said gyroscope, a coöperating member adapted to be carried by said device, means responsive to the relative positions of said members for controlling said rudder and means for automatically changing the relative positions of said members after launching.

6. Mechanism for steering an automatically controlled automobile device, including a rudder, a gyroscope adapted to be adjustably mounted in the device, a member carried by said gyroscope, a coöperating member adapted to be carried by said device, means responsive to the relative positions of said members for controlling said rudder and means for automatically changing step-by-step the relative positions of said members after launching.

7. In an automobile torpedo steering mechanism, a gyroscope adapted to be adjustably mounted in the torpedo, a member carried by said gyroscope, a member adapted to be carried by the torpedo, means controlled by the relative positions of said members for steering the torpedo, and means for automatically changing the relative positions of said members.

8. In an azimuth steering gyroscope for dirigible devices, a member adapted to be carried by the device, a coöperating member adapted to be carried by said gyroscope, means responsive to the relative positions of said members for shifting the relative positions thereof and means for limiting the amount of said shifting.

9. Steering mechanism for a dirigible device, including a rudder, a servo-motor adapted to actuate said rudder, a gyroscope adapted to control said servo-motor, means for varying the control of said gyroscope upon said servo-motor step-by-step to change the course of the torpedo and means responsive to the distance traveled by said device for effecting the actuation of said first mentioned means.

10. Steering mechanism for an automatically controlled automobile device, including a rudder, a gyroscope adapted to be mounted in the device, a member carried by said gyroscope, a coöperating member adapted to be carried by said device, means responsive to the relative positions of said members for actuating said rudder and means brought into action after the device has traveled a predetermined distance for changing the relative positions of said members step-by-step.

11. Steering mechanism for an automatically controlled automobile device, including a rudder, a gyroscope adapted to be adjustably mounted in the device, a member carried by said gyroscope, a coöperating member adapted to be carried by said device, means responsive to the relative positions of said members for actuating said rudder and means brought into action after the device has traveled a predetermined distance for automatically changing step-by-step the relative positions of said members.

12. Steering mechanism for an automobile torpedo, including a gyroscope adapted to be mounted therein, a member carried by said gyroscope, a member adapted to be carried by said torpedo, said gyroscope and said members being adapted to be adjusted with respect to said torpedo, means controlled by the relative positions of said members for steering the torpedo, and means brought into action after the torpedo has

traveled a predetermined distance for automatically changing the relative positions of said members.

13. In an azimuth steering gyroscope for dirigible devices, a member adapted to be carried by the device, a coöperating member adapted to be carried by said gyroscope, means responsive to the relative positions of said members for steering said device, means for shifting the relative positions of said members and means brought into action after the device has traveled a predetermined distance for effecting the actuation of said second mentioned means.

14. Controlling mechanism for an automobile torpedo, including a steering gyroscope, means controlled by said gyroscope for steering said torpedo in a course bearing a given relation to the position of said gyroscope, said gyroscope being adapted to be adjusted relative to said torpedo and retarded means for causing said torpedo to reassume, after launching, said given relation with respect to said gyroscope.

15. Steering mechanism for an automatically controlled automobile device, including a rudder, a gyroscope adapted to be mounted in the device, a member carried by said gyroscope, a coöperating member adapted to be carried by said device, means responsive to the relative positions of said members for actuating said rudder, and means brought into action after the device has traveled a predetermined distance for slowly changing the relative positions of said members.

In testimony whereof I have affixed my signature.

MARTIN L. PATTERSON.