No. 619,023. Patented Feb. 7, 1899.

W. D. LITCHFIELD.

TORPEDO CONTROLLING DEVICE.

(Application filed Aug. 30, 1897. Renewed Nov. 17, 1898.)

(No Model.) 3 Sheets—Sheet 1.

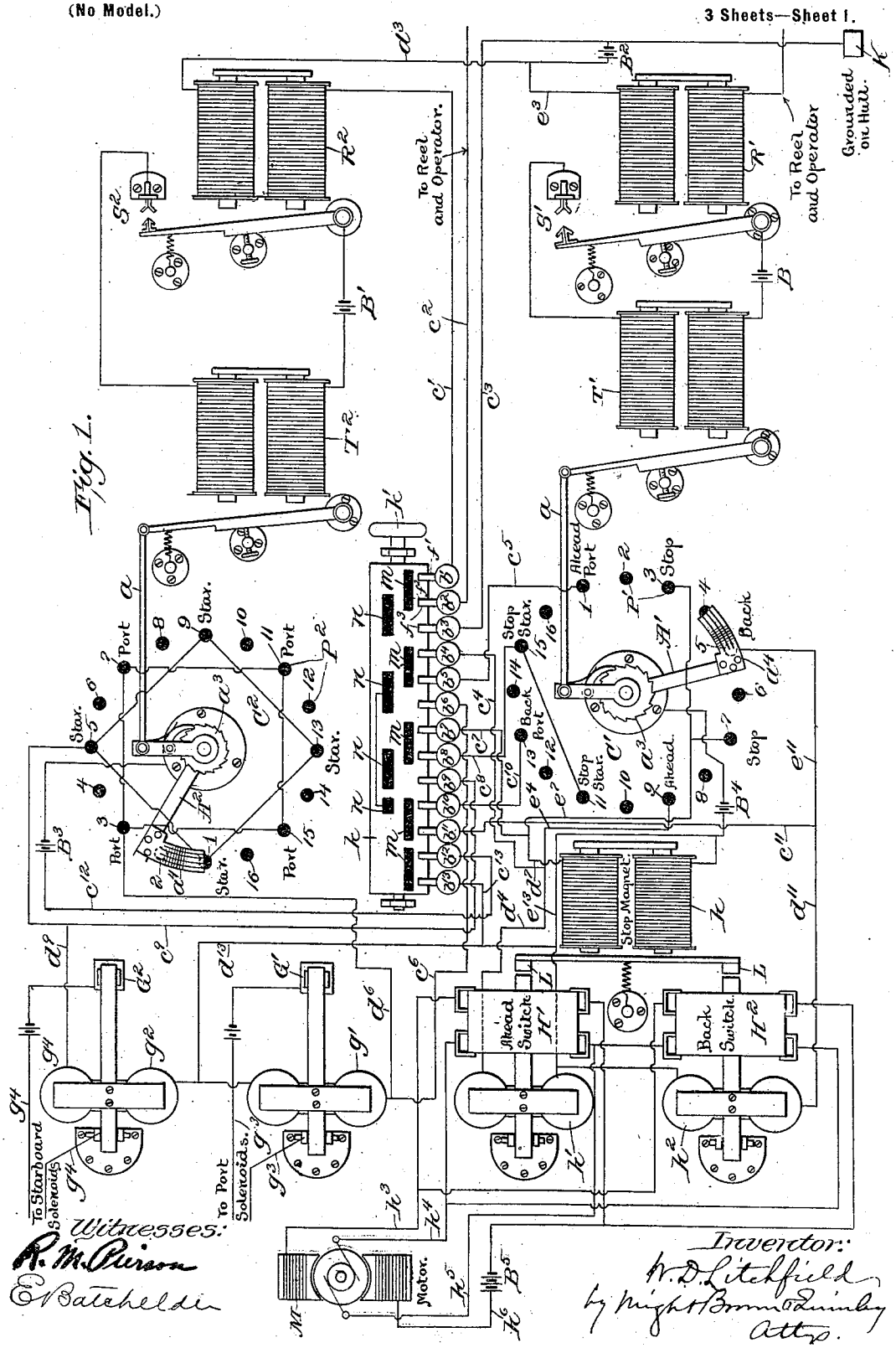


Fig. 1.

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3 Sheets—Sheet 2.

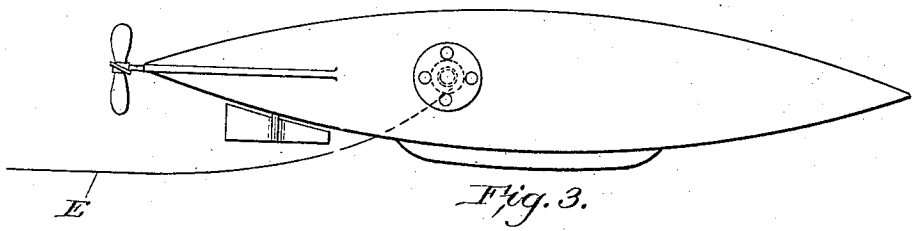
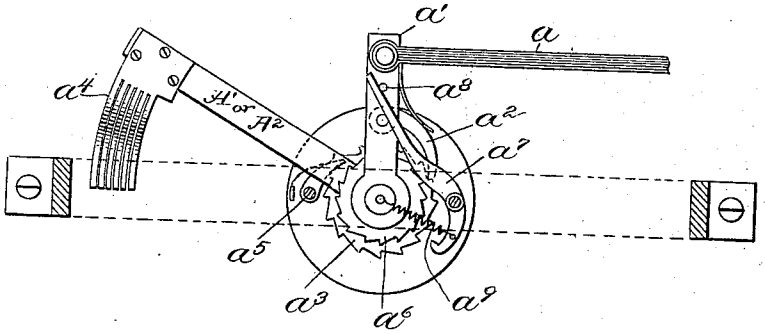


Fig. 3.

Fig. 2.



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(No Model.) 3 Sheets—Sheet 3.

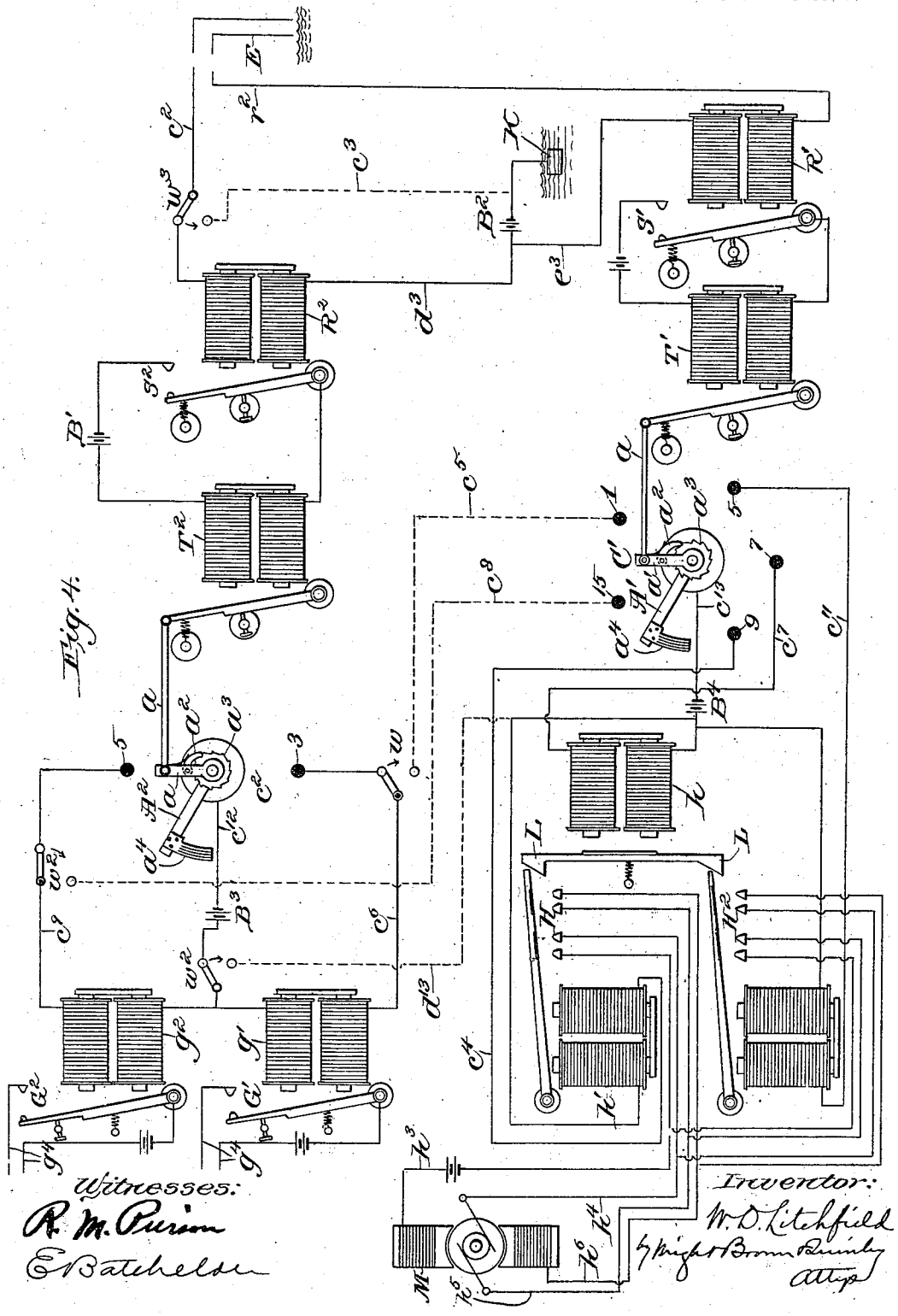


Fig. 4.

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UNITED STATES PATENT OFFICE.

WALTER D. LITCHFIELD, OF SOMERVILLE, MASSACHUSETTS.

TORPEDO-CONTROLLING DEVICE.

SPECIFICATION forming part of Letters Patent No. 619,023, dated February 7, 1899.

Application filed August 30, 1897. Renewed November 17, 1898. Serial No. 696,738. (No model.)

To all whom it may concern:

Be it known that I, WALTER D. LITCHFIELD, of Somerville, in the county of Middlesex and State of Massachusetts, have invented certain new and useful Improvements in Torpedo-Controlling Devices, of which the following is a specification.

This invention relates to dirigible torpedoes of the self-propelling type; and it has for its object to provide a controlling device whereby both the guiding and propelling-mechanism contained in the torpedo may be operated from the shore, or from a ship, or from any point at a distance from the torpedo.

The term "torpedo" is intended to include any marine vessel carrying or adapted to carry an explosive, and as the description proceeds it will be observed that my invention possesses features which render it applicable to any automobile body moving in a fluid medium.

To the end of accomplishing the object stated the invention consists in certain features of construction and arrangement, which I shall proceed to explain with the aid of the accompanying drawings and then point out in the claims hereto appended.

Figure 1 of the drawings represents a diagrammatic view of an electrical controlling device constructed in accordance with my invention. Fig. 2 represents a detail view of one of the ratchet movements. Fig. 3 represents a side elevation of a torpedo, showing the controlling electric cable. Fig. 4 represents a diagrammatic view showing only such parts and circuits as are necessary to illustrate the operation of the device.

The same reference characters indicate the same parts or features in the several figures.

The piece of apparatus illustrated in the drawings is designed to give absolute control of a dirigible torpedo, a torpedo-boat, or, in fact, any craft or vessel which it is desired to send out from the shore or from a ship and still keep the control in the hands of an operator who is not on board, but who may be on the shore, in another boat, or at any temporary base. It consists of a switchboard, which is contained in the torpedo or torpedo-boat or other vessel, (hereinafter for the sake of brevity I will assume that it is a torpedo,) an electric battery divided into convenient sections for operating said switchboard, which battery is also in the torpedo, and a reel of wire or cable so attached to the torpedo that as the torpedo advances or moves away from the operator this reel will unwind the wire which it contains, thus allowing the operator to keep the end of it in his hand and be in constant communication with the torpedo whether it be moving or standing still. This reel is wound with what is technically known as "twin" wire—that is to say, the one outside insulating-covering contains two wires or cables, which are made up separately and well insulated and then put side by side and covered with the final insulating-covering. This makes up a single cable E, Fig. 3, which contains two electric conductors, each insulated from the other. The center or core of the reel contains at each end an insulated and water-tight bearing, in which there is an electrical contact. When the wire is wound onto this reel, the inner end of each of these two circuits in the wire is connected to the electrical contact-points in the core of the reel, one wire going to one of the contact-points and the other to the other contact-point. The outside or stationary contact member is in each case carried on into the hull of the torpedo by means of insulated wires, which run to the proper binding-posts or terminals on the switchboard. This allows the operator to keep in connection with the torpedo by means of two electric conductors, which will not twist off as the reel is paying out its cable. When the torpedo is working in salt water or water sufficiently alkaline to be a conductor of electricity, both of these reel-conductors are of the same polarity and the water forms the common return for both; but in water which is not a good electrical conductor one wire becomes the return-circuit for the other. This is more fully explained later on. These wires which the operator has are connected after leaving the reel and running on into the hull to the switchboard to electromagnets, which are marked R' and R^2 and which I shall hereinafter call the "relay-magnets" or simply "relays," their functions being similar to those of a relay in telegraph work. From these magnets the circuits run to the battery, except as explained later, and then to the hull of the boat

or to any metallic point which is always in the water. The armatures of these relays are so arranged that when drawn toward the magnet they bring together two contact members which close another electrical circuit which has no electrical connection with the first or relay circuits. This circuit-closing takes place at the switches S' S^2 and in each case completes an electric circuit which, starting from the batteries B B', goes through the switches S' S^2, and then runs to two other magnets, (marked T' T^2,) and then back to the opposite poles of the batteries. The armatures of these two magnets T' T^2 are so arranged that each time the magnets become energized they attract their armatures, and by means of a pawl and ratchet cause a revolving arm A' or A^2 to move through one-sixteenth of a complete revolution, there being sixteen teeth on each ratchet. About the circles described by the ends of these revolving arms are in each circle sixteen metallic contact-points P' P^2, so placed that when the arm A' or A^2 comes to rest after each movement its trailer a^4 is resting fairly on one of these points. Eight of the points in each circle (alternate ones) are blanks or dead-points—that is, are not connected electrically to anything. The other eight points of one circle are connected with magnets h h' h^2, operating switches H' H^2 and latches L L, which cause the torpedo to go ahead, to stop, or to back, while the points of the other circle are connected with magnets g' g^2, operating switches G' G^2, which cause the torpedo to steer to port or to starboard, as the case may be. One circle will hereinafter be called the "motor-circle" and the other the "rudder-circle," (marked C' and C^2, respectively.)

On the motor-circle the sequence of evolutions beginning at, say, 3 is 3, "stop;" 4, blank; 5, "back;" 6, blank; 7, "stop;" 8, blank; 9, "ahead;" 10, blank; 11, "stop;" 12, blank; 13, "back;" 14, blank; 15, "stop;" 16, blank; 1, "ahead;" 2, blank. When either the "ahead" or "back" switch is pulled down by its magnet, it is caught and held down by a latch L. These two latches are so fastened to the armature of the electromagnet H that when this magnet is energized by the trailer of the motor-circle arm A' coming in contact with any one of the points 3, 7, 11, or 15 both of the latches are drawn back, allowing either the "ahead" switch H' or the "back" switch H^2 to fly up and break contact, and thus stop the machine going ahead or backing, as the case may be. The advantage of employing the latches to hold down the switches is that the moment the operator starts the torpedo, say, going ahead he can move the motor-circle arm around one more notch, thus bringing it onto a blank spot and saving the battery's continually working through the magnet-coils. It is not only a saving of battery, but of the magnets themselves.

When neither of the steering-switches G' or G^2 is closed, the rudder is brought back amidships, thus steering the torpedo straight ahead, and as there are no latches on these switches they open at all the alternate points on the steering-circle, thus steering a straight course without drawing on the battery.

The reference-letters b' to b^{13}, inclusive, Fig. 1, represent a series of binding-posts connected with the various parts of the apparatus as follows: Binding-post b' is connected by wire c' with relay-magnet R^2. From binding-post b^2 wire c^2 runs to the reel and operator. Binding-post b^3 is connected by wires c^3, d^3, and e^3 with a grounding-plate K on the hull of the boat and with the relay-magnets R' and R^2. Binding-post b^4 is connected by wires c^4, d^4, and e^4 with the "ahead" magnet h' and with the contact-point 9 on the motor-circle C'. Binding-post b^5 is connected by wire c^5 with the contact-point 1 on the circle C'. Binding-post b^6 is connected by wires c^6 and d^6 with the port-magnet g' and with the contact-points 3, 7, 11, and 15 on the steering-circle C^2. Binding-post b^7 is connected by wires c^7, d^7, and e^7 with the "stop" magnet h and with the contact-points 3 and 7 on the circle C'. Binding-post b^8 is connected by wire c^8 with the contact-points 11 and 15 on the circle C'. Binding-post b^9 is connected by wires c^9 and d^9 with the starboard-magnet g^2 and with the contact-points 1, 5, 9, and 13 on the circle C^2. Binding-post b^{10} is connected by wire c^{10} with the contact-point 13 on the circle C'. Binding-post b^{11} is connected by wire c^{11}, d^{11}, and e^{11} with the "back" magnet h^2 and with the contact-point 5 on the circle C'. Binding-post b^{12} is connected by wire c^{12} with the trailer-arm A^2. Binding-post b^{13} is connected by wires c^{13}, d^{13}, and e^{13} with magnets g', g^2, h, h', and h^2 and with the trailer-arm A'. These binding-posts form part of a multiple two-way switch, which, as here shown, comprises a series of brushes f' f^2, &c., connected with the several binding-posts, and a cylinder k, composed of an insulating substance, in which are embedded two series of metallic contact-plates m and n. The cylinder k is mounted in suitable bearings and is provided with a handle k', whereby it may be rotated to bring either the one or the other series of contact-plates under the brushes. When the five contact-plates m are under the brushes, the switch is in what I term its "salt-water" position—that is, the apparatus is then ready for use with two separate controlling-circuits having a water return. When the four contact-plates n are under the brushes, the switch is in its "fresh-water" position, or, in other words, the apparatus is then adapted for operation with a single metallic circuit formed by the two reel-wires which run to the operator. These two positions of the multiple switch will be more fully referred to hereinafter.

The wires g^3 g^3 and g^4 g^4, which are connected with the members of the steering-switches G' and G^2 and which are represented

on the drawings as running "to port solenoids" and "to starboard solenoids," respectively, form parts of circuits which may control any suitable form of steering mechanism operated by electricity, compressed air, or other agent. The circuits from the switches H′ and H² may in like manner control any suitable propelling mechanism, though I have here shown an electric propelling-motor M, controlled directly by the switches. When the "ahead" switch H′ is closed by its magnet, the terminals h^3 and h^4 from the motor are electrically connected to each other, as are also the terminals h^5 and h^6. Current from a battery B⁵ then causes a rotation of the motor-armature and the screw of the torpedo in a forward-propelling direction. When the "back" switch H² is closed and the "ahead" switch open, the terminals h^3 and h^5 are connected to each other and the terminals h^4 and h^6 are connected to each other. The current then flows in the same direction as before through the field of the motor, but in a contrary direction through the armature, so that the direction of rotation of the armature and the propeller is reversed.

By referring to Fig. 4, in which a simplified arrangement of the circuits is shown, the effect of manipulating the two operating-wires c^2 and r^2 may readily be observed. The full lines indicate the parts which are used in controlling with two separate operating-circuits having a water return. When the wire c^2 is dipped into the water, a circuit is completed through said wire, the magnet R², the wire d^3, the battery B², the ground-plate K, and the water. The magnet R² is thereby energized, and its armature is attracted, with the effect of closing the switch S² and completing a circuit through the magnet T² and battery B′. Said magnet thereby becomes energized and attracts its armature, which causes the trailer a^4 to be moved forward a distance corresponding to one tooth of the ratchet a^3. When the wire c^2 is removed from the water, the circuit through the magnet R² is broken and the armature of said magnet is retracted by a spring, with the effect of breaking contact at the switch S² and demagnetizing the cores of the magnet T². A retracting-spring then causes the armature of said magnet to fly back, and the pawl a^2, which is connected with an oscillating arm a', is allowed to take a new tooth on the ratchet a^3. Thus each time that the wire c^2 is dipped into the water the trailer a^4 moves around a certain distance. As soon as said trailer rests on the contact-point 5 a circuit is completed through the trailer-arm A², wire c^{12}, battery B³, magnet g^2, and wire c^9. The magnet in attracting its armature completes a circuit at the switch G² and causes the torpedo to be steered to starboard.

If instead of resting on the contact 5 the trailer-arm should rest on the contact-point 3, a circuit would be completed through the trailer-arm A², wire c^{12}, battery B³, magnet g', and wire c^6, and another circuit at the switch G′, in which case the torpedo would be steered to port. The operation of the apparatus shown in the upper part of Fig. 1 is exactly similar to that of the apparatus just described when the multiple switch is in its salt-water position with the exception that there are four contact-points in the circle corresponding to the point 5 in Fig. 4 instead of one and four corresponding to the contact 3.

Referring again to Fig. 4, it will be seen that the relay-magnet R′, ratchet-magnet T′, and ratchet-trailer a^4 in the motor-controlling apparatus are similar to the like parts in the steering apparatus just described and are operated in a similar step-by-step manner by dipping the wire r^2 into the water. When the trailer a^4 of the lower circle rests on the contact-point 9, a circuit is completed through the magnet h', which closes the switch H′ and arranges the motor-terminals in such a way that the torpedo goes ahead. When the trailer rests on the contact-point 5, a circuit is completed through the magnet h^2, which closes the switch H² and reverses the motor. When the trailer rests on the contact 7, the stop-magnet h becomes energized and the latches L L are retracted. The arrangement of the lower part of the apparatus (shown in Fig. 1) is the same as that above described with the exception that there are in the circle two "ahead" contacts, two "back" contacts, and four "stop" contacts. In Fig. 1, as previously explained, connections are shown running from the last four live points of the motor-circle C′—viz., 11, 13, 15, and 1—to the multiple switch and connections from the trailer and all of the live points of the steering-circle to said switch. The latter connections are represented in Fig. 4 by the dotted conductors c^5, c^8, and d^{13}, the function of the multiple switch being performed by the individual switches w, w', and w^2.

When the multiple switch is set in the salt-water position, the above-mentioned last four live points of the motor-circle are connected to the "ahead," "stop," and "back" magnets in just the same order as are the first four points 3, 5, 7, and 9, and when said switch is in the first or salt-water position the rudder-circle is ready for operation. The operator may now dip the wire c^2 into the water and either send the machine ahead, or back, or stop it, as he wishes, and the other wire r^2 allows him to steer the torpedo by simply dipping the wire into the water. Under these conditions the steering of the torpedo is entirely independent of the starting, stopping, or backing of it.

Now when the multiple switch is moved to its second or fresh-water position the four points of the motor-circle 11, 13, 15, and 1 are disconnected from the "ahead," "back," and "stop" magnets and are connected with the magnets of the two steering-switches 11 and 15, being connected to the starboard-magnet, and 13 and 1 being connected to the port-

magnet. In this position the feed-wire, which runs to the arm of the steering-circle, is not connected to anything, so that no matter on what point this arm is left no current flows, and the steering-switches are not operated from this source. This position of the multiple switch also changes the steering-reel wire from relay R^3 directly to the negative side of the battery. This latter change would be performed in Fig. 4 by switching over at w^3 to the dotted conductor c^3. Now the relay R^2 and the steering-circle are "dead," and the evolutions are performed entirely on the motor-circle. Supposing the trailer of the arm A′ to be at 9, the motor is going ahead, and the switch H is locked down and held by the latch L. At 10 the torpedo is still going ahead; but all current has been cut off from the switchboard. The next four points are now steering-points in this order: 11, starboard; 13, port; 15, starboard; 1, port. Having the steering-arm trailer on 10 and the torpedo going straight ahead, should it be desired to steer to starboard it is necessary merely to touch the two reel-wires together once. The steering-wire now being a metallic return for the other one, this causes the arm of the motor-circle to move to 11, which is now connected with the starboard-switch. The operator waits until the torpedo has deflected to the right sufficiently and then touches the wires together again. This brings the arm onto 12, (a blank spot,) releases the starboard mechanism, and sends the topedo straight ahead again. All this time the machine has been going ahead, and it will continue to do so until the operator works the arm of the motor-circle around to 3, where the latch L is pulled back and the motor stopped.

Now when the arm of the motor-circle was at 10, with the machine going ahead, if instead of wishing to steer to starboard the operator had wished to steer to port he would merely have touched his two wires together three times in quick succession. This would have moved the arm out to the "starboard-point," then to a blank or "steady-point," and then to the "port-point" at 13. As the time required to make these three steps is only three-tenths of a second, the arm only rested on the starboard-point a small fraction of a second, not long enough for the torpedo even to get an impulse in this direction.

When operating in fresh water, there is arranged on the circle C′ a regular sequence of evolutions, all that a ship is put through—namely, ahead, starboard, port, stop, and back. As it takes but a fraction over a second for an operator to cause the arm to move all the way around the circle (just as quickly as he can touch two wires together) and as the greatest interval through which he will ever have to move it in a hurry is eleven points, it follows that at any time within a second at most he can have his torpedo started on the required evolution.

When operating in salt water, there is a more perfect and quick control of the torpedo, for here there are two circuits, one for propelling and one for steering. Here the greatest interval is from 3 to 9 on the motor-circle or from 2 to 5 on the steering-circle. Thus the greatest required number of quick moves is only six to bring the boat to the desired evolution.

For the purpose of operating the various magnets the main switchboard-battery in the torpedo may be conveniently divided into five sections. The sections B and B′ operate the two ratchet-magnets, section B^2 operates the relays R′ and R^2, section B^3 operates the magnets of the two steering-switches, and section B^4 operates the magnets of the "ahead," "back," and "stop" switches. Other batteries are used to directly control or operate the steering and propelling mechanism. It is not necessary, however, to divide the battery into different sections, for all of the switchboard-magnets may be operated from the same set or section. In this case the magnets would all be designed and wound to work on the same voltage.

In practice the relay-magnets R′ and R^2, which are the only ones electrically connected to the controlling-cable E, are wound with a great length of very fine wire, so as to give a high resistance. It has been found practicable to control the torpedo at distances up to eleven miles in salt water, and therefore with this length of wire on the reel there is always the resistance of eleven miles of wire and sometimes as much as eleven miles of water between the torpedo and the operator. The resistance of the relays is made about one hundred and thirty times that of the water, and therefore the actual power available to operate them can only fall one one-hundred-and-thirtieth of its maximum. As they are given about fifty per cent. excess of power over that required it will be seen that there is a large margin of power to insure reliable working. The large number of turns and high resistance of the relay-magnets admits of the use of a very light current and consequently a small controlling-cable.

The currents used on the ratchet-magnets T′ and T^2 may be comparatively strong, if desired; but the currents which are used on the contact-circles C′ and C^2 are necessarily quite weak, as otherwise there would be excessive sparking between the trailers and the contact-points, which would fuse the contact members and would result in impairing the smooth working of the ratchet-arms. By my improved arrangement and construction the main steering and propelling currents are carried through the members of the switches G′ G^2 and H′ H^2, and the currents carried on the rudder and motor circles need only be strong enough to operate the magnets controlling these switches.

Since the ratchet-arms A′ and A^2 and trailers are obliged to work with but little friction on their pivots and over the contact-points in

the circles, a strong throw given them by the ratchet-magnets would be apt to throw them too far if a simple ratchet-and-pawl device were employed in this connection. In order to obviate such uncertainty and secure a positive definite throw of the ratchet-arms, I employ a construction illustrated in Fig. 2, which shows a plan view of either of the ratchet mechanisms. a designates the connecting-rod, which joins the end of the armature of either of the ratchet-magnets T' or T^2 with a pivoted swinging arm a' occupying the center of the circle of contact-points. Said arm carries a pawl a^2, which engages a ratchet a^3, to which is affixed the ratchet-arm or trailer-arm A' or A^2, carrying the trailer a^4. The ratchet a^3 is duplicated below the said arm, and a spring-detent a^5 is provided for the lower ratchet to prevent back motion. As a means for preventing too great a throw of the trailer-arm I provide a ratchet a^6 to revolve with said arm, a detent a^7 to engage said ratchet, and a pin a^8 on the swinging arm a' to actuate said detent. The teeth of the ratchet a^6 are equal in number to those of ratchet a^3 and extend in the opposite direction. When the swinging arm a' is drawn to the right by a pull from the magnet, the pawl a^2 moves its ratchet ahead the distance of one tooth, and at the same time the hooked detent a^7 is drawn by a spring a^9 into engagement with one of the teeth of the ratchet a^6. The parts are so adjusted that this latter engagement takes place just as the trailer-arm has moved its proper distance, and it is thereby prevented from going any farther. When the swinging arm returns to its initial position, the pin a^8 causes the return of the detent a^7, and the pawl a^2 takes a new tooth. By means of the above construction a positive locked throw is obtained.

From the foregoing description of my invention it will be seen that I have provided an effective system of control for torpedoes and other self-propelling dirigible vessels.

I do not wish to be confined to the exact construction herein described, since it is obvious that to those skilled in mechanical and electrical arts many modifications will be suggested which come within the scope of my invention. For instance, it will be readily understood that an apparatus could be constructed in which the steering-circle C^2 would be entirely dispensed with and both steering and propelling mechanism controlled, as hereinbefore described, from one circle in both fresh and salt water. In torpedoes intended for use in salt water only one of the wires in the cable E could in this case be dispensed with and the controlling-circuit operated on a water-return. Again, although the simplest method of operating the controlling-circuits consists in touching the two wires e^2 and r^2 together or dipping them into the water it is obvious that a simple switchboard or key could be arranged at the shore end of the cable for making and breaking contact.

Having thus explained the nature of my invention and described an embodiment of the same without, however, having attempted to set forth all the forms in which it may be made or all the modes of its use, I declare that what I claim is—

1. In a vessel having propelling and steering mechanisms operated by power generated or stored within the vessel, electromagnetic devices for controlling said mechanisms, the said devices being operated through circuits contained entirely within the vessel, a step-by-step mechanism contained within the vessel for making and breaking said circuits to actuate the controlling devices, and means operated by the making and breaking of one or more independent circuits at a distance from the vessel for actuating the said step-by-step mechanism.

2. In a vessel having a propelling mechanism operated by power generated or stored within the vessel, electromagnetic devices for controlling said mechanism, the said devices being operated through circuits contained entirely within the vessel, a step-by-step mechanism contained within the vessel for making and breaking said circuits to actuate the controlling devices, and means operated by the making and breaking of a single circuit at a distance from the vessel, for actuating the said step-by-step mechanism.

3. In a vessel having a propelling mechanism and a steering mechanism operated by power generated or stored within the vessel, two step-by-step devices carried by the vessel for controlling said mechanisms and operated by the making and breaking of two circuits at a distance from the vessel.

4. A device of the character specified, comprising means contained within a vessel for electrically governing a propelling mechanism, means therein for electrically governing a steering mechanism, and two electrical conductors connected with the respective means, for communicating from a distance with the vessel, together with provisions whereby the said conductors may become portions of two circuits having a water-return, or may become portions of the same circuit in which one conductor is the return for the other.

5. A device of the character specified, comprising means contained within a vessel for governing a propelling mechanism, means therein for governing a steering mechanism, two magnetically-operated step-by-step devices for actuating the respective means, and two electrical conductors arranged to control said devices by manipulations at a distance from the vessel, the said conductors forming portions of two independent circuits having a water-return.

6. A device of the character specified, comprising means contained within a vessel for electrically governing the propelling mechanism, means contained therein for electrically governing a steering mechanism, two series of contact-points having connections with the

respective means, a trailer for each series of points, devices for moving said trailers successively upon the several contact-points, two metallic electrical conductors for operating the said devices by manipulations at a distance from the vessel, and means whereby the said conductors may be caused to operate said devices independently on separate circuits having a water-return, or may be caused to control both the propelling and steering means by operating one of said devices on one metallic circuit.

7. A torpedo-controlling device comprising means contained within the torpedo for electrically governing a propelling mechanism, means therein for electrically governing a steering mechanism, two series of electrical contact-points having connections with the respective means corresponding to the several evolutions of the torpedo, a multiple switch adapted to have positions whereby the connections may be transferred so that both propelling and steering evolutions are controlled from one series of contact-points, a trailer for each series of points, and devices for moving said trailers successively upon the several contact-points.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 27th day of August, A. D. 1897.

WALTER D. LITCHFIELD.

Witnesses:
C. F. BROWN,
E. BATCHELDER.