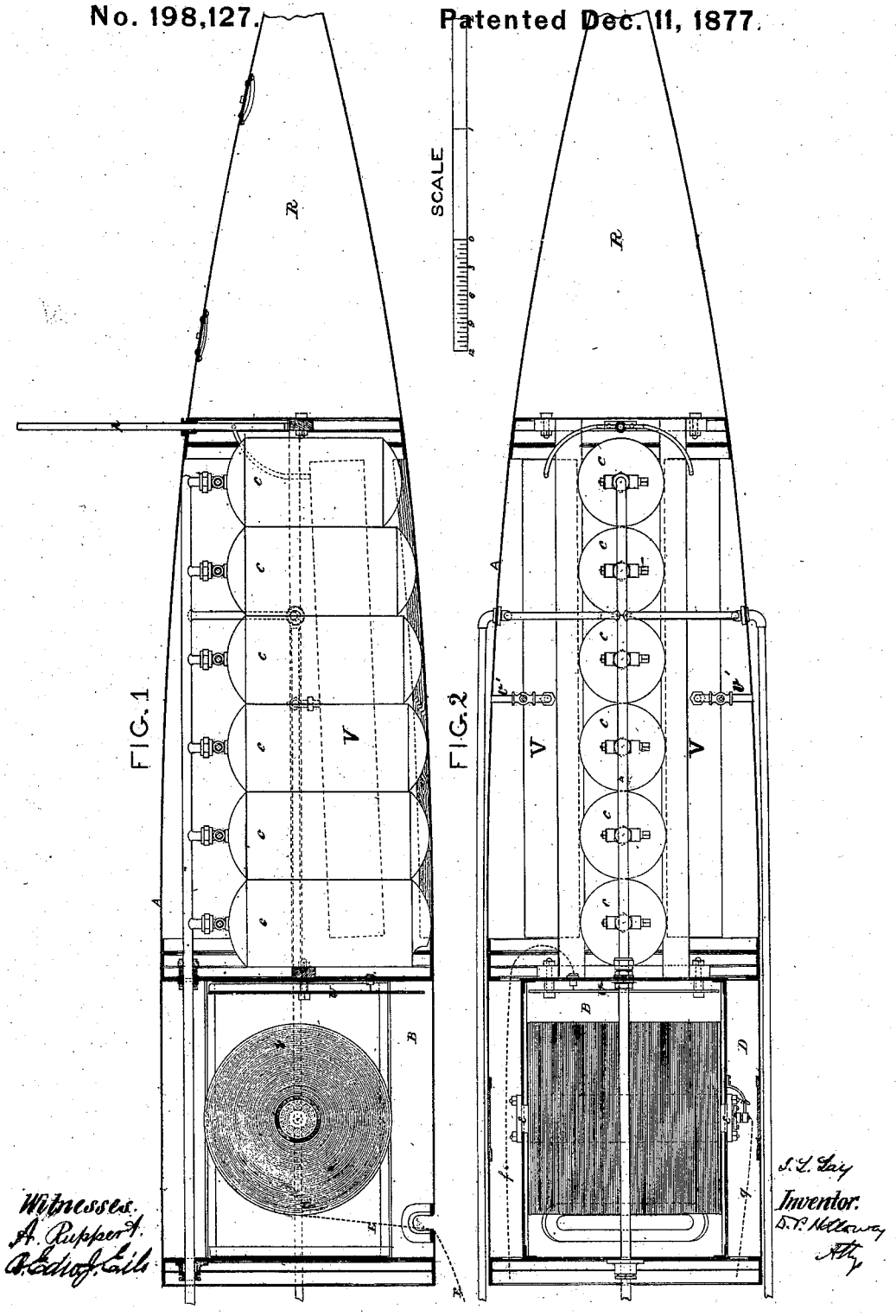
4 Sheets—Sheet 1.

J. L. LAY.

Electro-Magnetic Steering Apparatus for Submarine Boats.

No. 198,127. Patented Dec. 11, 1877.



Witnesses.
A. Pepper Jr.
A. Edwd. Faile

J. L. Lay
Inventor.
E. T. Holloway
Atty

4 Sheets—Sheet 2.

J. L. LAY.

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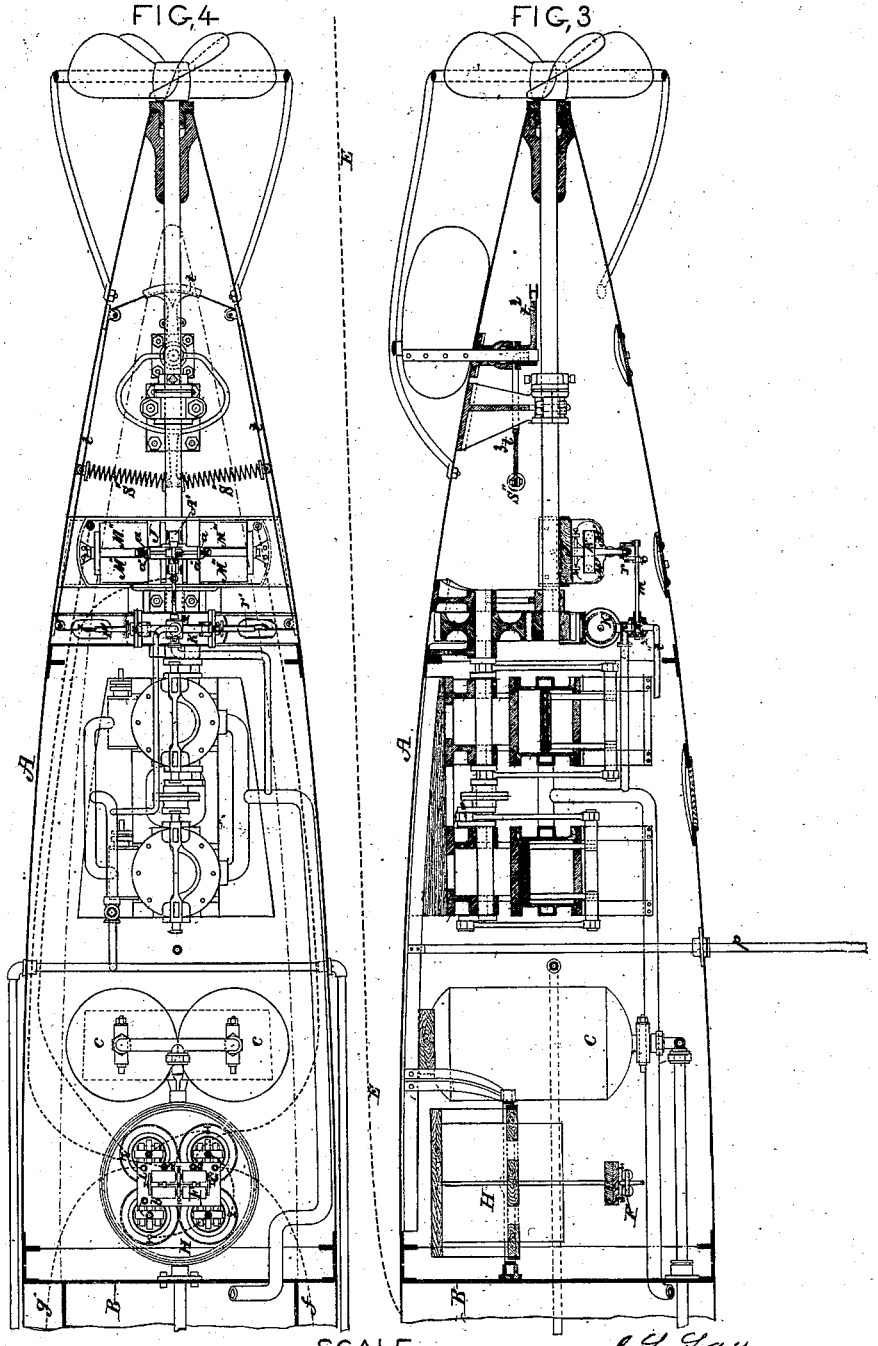
FIG. 4

FIG. 3



SCALE

Witnesses
A. Ruppert.
B. Edwd. Hills

L. L. Lay
Inventor.
D. P. Holloway & Co.
Attys

4 Sheets—Sheet 3.

J. L. LAY.

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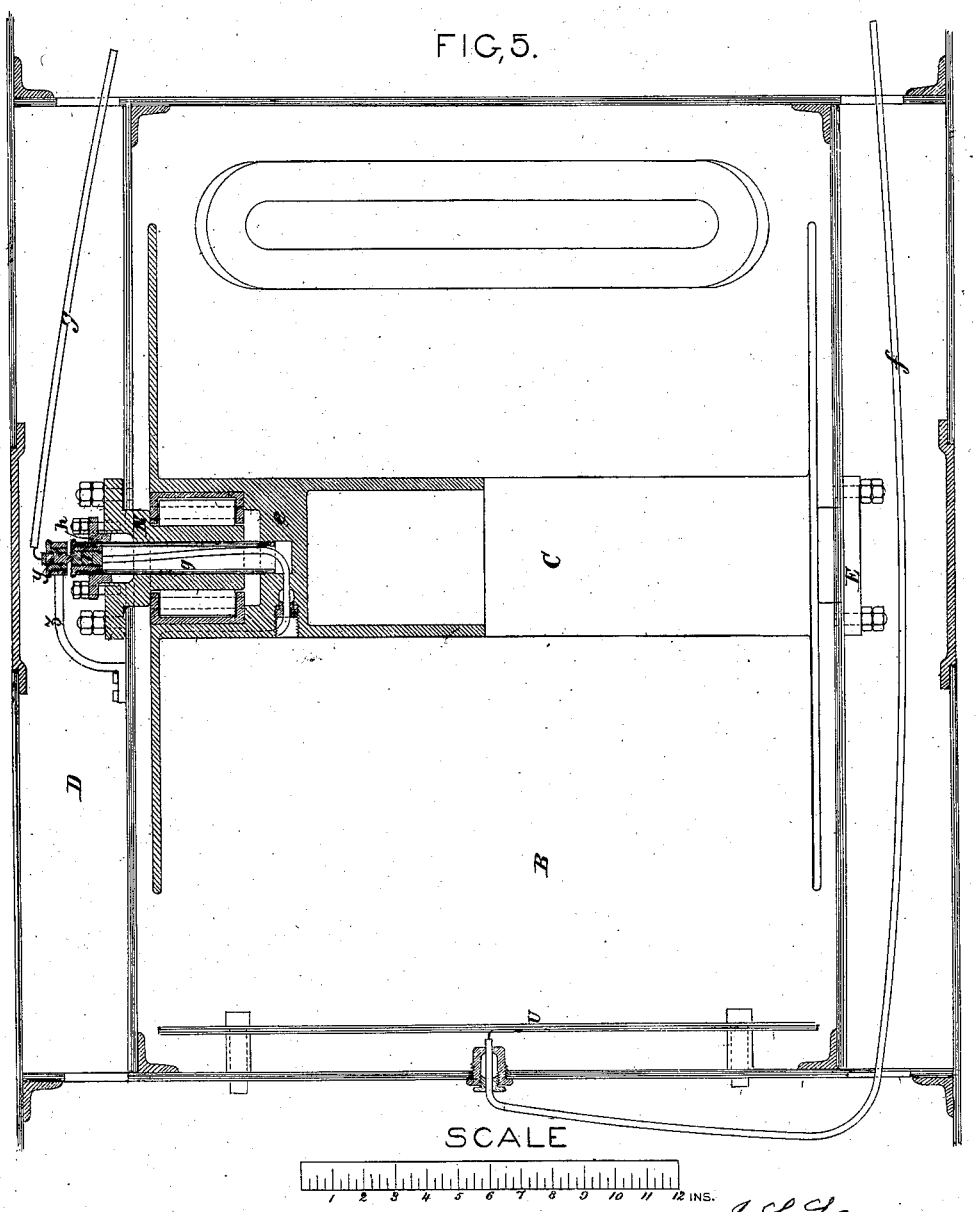
FIG. 5.



Witnesses.
A. Ruppert.
Edw. J. Gils

Inventor.
J. L. Lay
D. P. Holloway & Co.
Attys.

4 Sheets—Sheet 4.

J. L. LAY.

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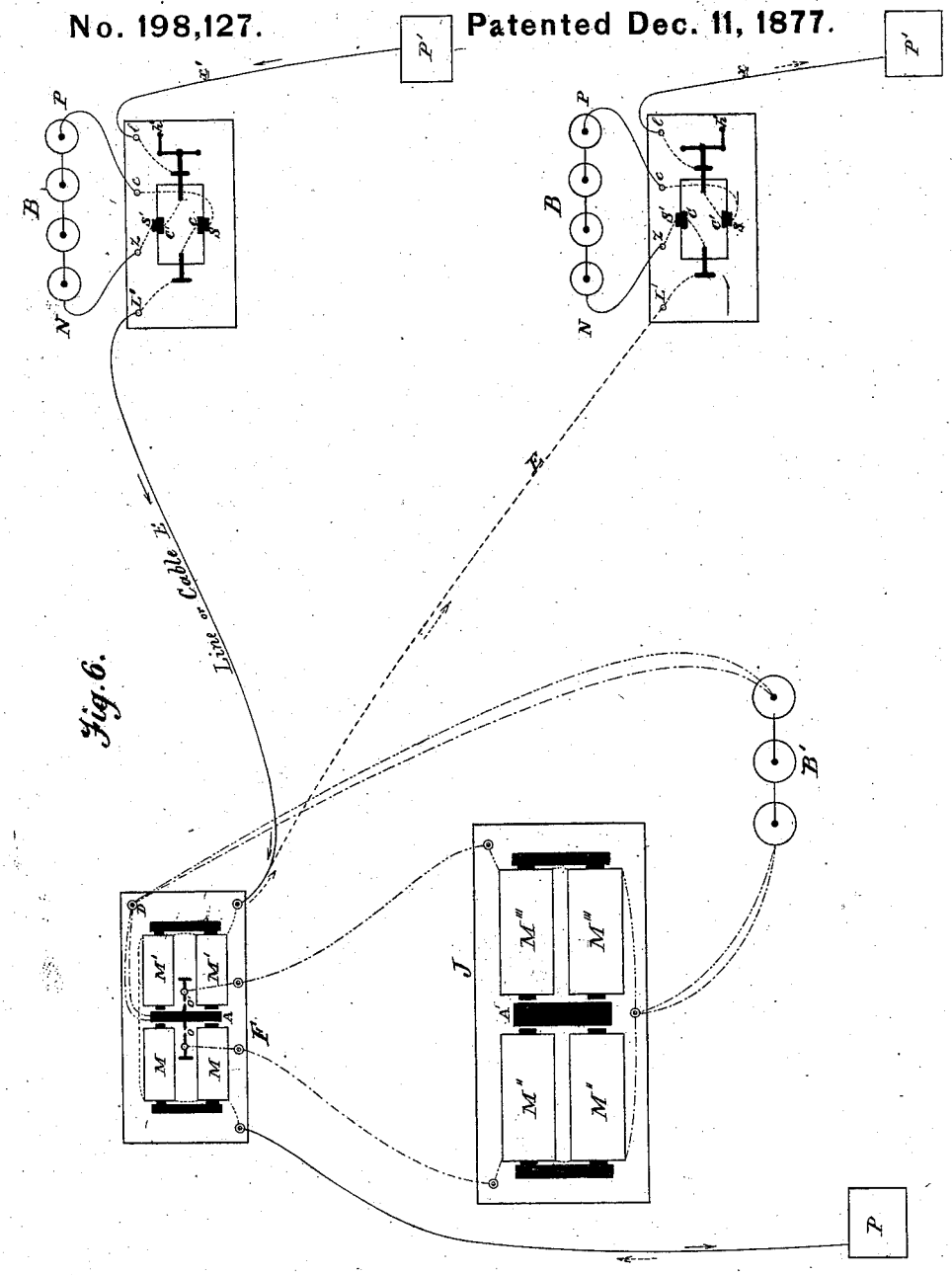

Fig. 6.

Witnesses
A. Ruppert
Edw. J. Eil

L. L. Lay
Inventor.
D. P. Holloway & Co
Atty

UNITED STATES PATENT OFFICE.

JOHN L. LAY, OF BUFFALO, NEW YORK.

IMPROVEMENT IN ELECTRO-MAGNETIC STEERING APPARATUS FOR SUBMARINE BOATS.

Specification forming part of Letters Patent No. **198,127**, dated December 11, 1877; application filed April 20, 1874.

To all whom it may concern:

Be it known that I, JOHN L. LAY, of Buffalo, in the county of Erie and State of New York, have invented new and useful Improvements in Boats Intended for Submarine Operations, of which the following is a specification:

This invention relates to a boat for submarine operations, and has for its object the propulsion of such a boat by condensed gases, preferably such as under pressure become liquids, acting by their expansion upon an engine and driving a propeller; and also the steering of such a boat from the shore or other fixed point from which it is dispatched, by means of an electric current acting on an electro-magnetic apparatus, so that the helm may, by means of positive mechanism, be set and held in one of the three positions of "port," "starboard," or steady," at the will of the operator; and to this end my invention consists in providing for the regular paying out of the insulated wire cable from a submerged boat, by constructing the boat with a compartment filled with water and containing the cable-reel, and having an opening in the bottom for the escape of the cable as the vessel progresses; also, to the same end, in providing appropriate means for transmitting an electrical current through the insulated wire carried on the submerged cable-reel from a battery on shore to electro-magnetic apparatus carried on said boat, such current passing from the compartment filled with water to the parts of the boat from which the water is excluded; also, in providing means for automatically maintaining the uniform specific gravity of the boat by the regulated admission of water to suitable compartments, to compensate for the loss of weight incident to the paying out of the cable and the consumption of the material from which the power is derived; also, in providing guides for indicating the position and direction of the submerged boat to the operator on shore, and also in so constructing such guides that they may also serve for escape-pipes for the gas and air discharged from the interior of the boat; also, in sundry special combinations of parts connected with the detail of the construction of the driving and steering apparatus, which will be particularly indicated in the following description and claims.

In the annexed drawings the boat is represented as divided into sections fore and aft, and these sections are further divided horizontally and vertically.

Figure 1 is a vertical section through the center of the forward section of the boat. Fig. 2 is a horizontal section of the same. Fig. 3 is a vertical central section of the aft-section of the boat. Fig. 4 is a horizontal section of the same. Fig. 5 is a vertical section of the reel-chamber, showing the means for maintaining an electrical connection between the submerged cable on the reel and the connecting-wires on the boat. Fig. 6 is a plan, showing the relative arrangement of the electrical apparatus on shore and on the boat.

The hull is of the form commonly called "cigar-shaped," tapering to a point fore and aft, and having a propeller-shaft carrying a screw-propeller projecting from the stern, where it is carried through a stuffing-box. The propeller is operated by any suitable engine. I prefer to use as the motive power the expansion of a substance, which, in its normal state, is a gas, but which, under pressure, is converted into a liquid, and so remains until the pressure is relieved, when it resumes its gaseous form. Regarding carbonic acid as the most suitable for this purpose, I have illustrated an apparatus adapted for that purpose.

The liquid carbonic acid, in passing from its liquid state to the gaseous form, loses its latent heat so rapidly that, if the operation takes place rapidly, the liquid inclosed in its containing-vessel will be solidified, and in that condition gives off the gas too slowly for the purpose here required. To avoid this difficulty, I inclose it in a number of close vessels—say, from ten to twenty, or even more. These vessels connect with the eduction-pipe, and as the evaporation from each will be slow the temperature in each vessel will be kept above the point of congelation. To the same end the eduction-pipe conveying the gas from the vessels *c* must be warmed. This may be done by carrying the pipe through the hull, and leading it through the surrounding water; or it

may be heated by alcohol or other lamps. The former means I have found adequate for the purpose.

The boat must be steered from the shore or other fixed point from which it is dispatched. This I accomplish by means of an electro-magnetic mechanism operated by means of an insulated wire in a small telegraphic cable. This cable is carried on a submerged reel, placed in a tight compartment, B, in the middle of the boat, in the bottom of which is a transversely-elongated opening through the hull, for the free escape of the cable. The reel is suspended on anti-friction journals, supported on the lateral bulk-heads of the said compartment.

I have adopted the following means for transmitting the electric current from the cable to the electro-magnetic apparatus carried in the boat: On one end of the shaft of the reel C is a chamber, *g*, into which the insulated wire E is extended, passing through a water-tight stuffing-box, *x*, and fastened to an insulated plug, I, screwed into the tube *g*, and projecting through the stuffing-box *h* into the dry compartment D. This plug, of course, revolves with the reel as the cable is paid out. In compartment D there is an insulated copper point, *y*, sustained by a spring, *z*, which presses the point *y* against the revolving plug I, and, accommodating itself to the lateral motion of the shaft of the reel, maintains a continuous electrical circuit from the cable E to the insulated wire *q* inside the boat, one end of which is attached, by the binding-screw L, to the relay F. The binding-screw *b* on the relay is attached to the carbon pole of a battery, H, connected with the relay, and operating the electro-magnets M″ and M‴ by means of wires attached to the binding-screws *a* and *d* on the relay. Another wire, *f*, attached by the binding-screw G, connects the relay with a plate, U, in the submerged compartment B, thus forming one ground-wire for the circuit. The armature A is a steel magnet.

The circuit is completed by means of the cable E, the outer end of which is fastened, by the screw L′, to the pole-changer connected with the shore-battery B′, Fig. 6. Any form of pole-changer may be used. I have illustrated one form, in which the connection with the battery is made by wires attached by screws *z* and *c*, respectively connected with the zinc and carbon poles of the battery. A wire, *x′*, attached to the screws *l*, extends to a plate, P′, placed in the water, and forming the other ground-wire. The pole-changer is duplicated in Fig. 6, to indicate the two positions of the crank which shifts the poles. This pole-changer consists of two metallic plates, C C′, fastened onto the vulcanite cylinder turned by the crank *h′*, so as to connect alternately with the plates S and S′, connected, respectively, as indicated by dotted lines, with the carbon and zinc poles of the shore-battery B′, and also with the journals of the cylinder, and through these with the cable and ground-wire.

The two electro-magnets M″ and M‴ are placed with their poles opposed in the ordinary manner, having a soft-iron armature, A′, placed midway between them, oscillating on a vertical rod hinged below, to which it is attached, so as to be drawn to one magnet or the other as they are electrized by positive or negative currents transmitted through the coils. The vertical rod to which the armature is attached extends through the sliding rod *w*, slotted to receive it. This rod slides in bearings *a″ a″*, and to it are attached springs, the tension of which will maintain the armature midway between the magnets when neither of them are charged. It also carries a pin, *r*, Fig. 3, which is inserted in the slot in the crank-arm *v* of the valve-stem *m*, carrying the rotary valve *n*, which operates in the three-ported valve-seat of the valve-chest *x*. The gas is admitted to the ports in the chest *x* through a pipe, *t*, on the top thereof. The ports are so arranged that when the armature rests in its midway position the eduction-ports of both ends of the cylinder will be open, so that all the gas may escape and entirely relieve the piston from pressure. The valve-chest *x* is attached to the cylinder *k*, having a piston-head and rods *r′ r′* extending through each head. To these rods *r′ r′* cords *t¹ t* are respectively attached. These cords are connected from each side to the tiller *t²*, thereby actuating the rudder in the movement to port or starboard. Another tiller, *t³*, is attached on the opposite side of the rudder-post, and springs S″ S″ are connected therewith to bring the rudder to the amidships position of "steady," when both tiller-ropes are relaxed, and at the same time, by the reversed action of the ropes, bringing the piston-head back to the middle of the cylinder.

The mode of operation is as follows: The boat being loaded so as to sink to the desired depth, and so as to be horizontal fore and aft, the loss of weight from the paying out of the cable and the consumption of the liquid used in propelling it having been carefully determined, the valve for admitting water to the tank must be accurately arranged, to admit it fast enough to compensate for the loss of specific gravity. The cable E being attached to the pole-changer, and the boat properly headed in the designated direction, the machinery for propelling it is to be started and the boat tightly closed. The operator, standing at the pole-changer, holds the crank vertically, so as to permit the springs to hold the rudder at "steady." Watching the guides, if necessary, with a powerful telescope, if the leading guide turns to one side or the other, he promptly meets the deflection with the rudder. Thus, if the crank is turned to the right, as shown in Fig. 6, the current will flow from the carbon pole of the battery and through the connecting-wire and contiguous surfaces *c s*, and the journal opposite to the crank to the cable E attached to the pole-changer. This current will act on the relay-magnets M and M′. The ar-

mature, being of steel and permanently magnetized, is held midway between the magnets by a spring, (not shown;) but when the magnets are rendered active by the transmission of positive or negative currents, as the case may be, it will be repelled by the magnet having corresponding p larity, and attracted by the one having opposite polarity.

Supposing the relay-magnet M to be the one which, under the influence of the positive current from the carbon pole of the battery, will attract the armature A, the magnet M, under the same influence, will repel it, and thus the platinum-tipped point o' will be brought into contact with its corresponding point, and bring the boat-battery B′ into circuit with the magnet M‴, which, through the mechanism, will set the helm to, say, port, and there it will be held as long as this circuit is maintained.

If the crank h' is then turned upward the current will be cut, the magnets become neutral, and the springs bring the armatures back to their midway positions, and the helm to "steady."

If, now, the crank b is turned to the left, the reverse action of the currents will be established, the magnet M will attract the armature A, and the boat-battery magnetize the magnet M″, and cause the helm to be brought to starboard, where it will be held as long as the circuit is maintained.

The operator may thus shift the rudder, and consequently steer the boat precisely as a pilot would do if on board.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. An automatic torpedo-boat constructed with a coil-chamber, in combination with a coil of insulated telegraphic cable extending from said compartment to a point outside of the boat, and adapted to being payed out with the forward movement of the boat through an opening under the surface of the water, substantially as set forth.

2. In combination with a submerged reel, and telegraphic cable carried thereon, and magnetic apparatus to be connected through said cable, an insulated termination of such cable revolving with the reel, and an insulated connection for the internal system of wires held in contact therewith, for the transmission of electric currents, substantially in the manner set forth.

3. In combination with the reel C, the pipe g, insulated plug I, point y, and wire q, substantially as set forth.

4. In combination with the parts last aforesaid, the spring z, for maintaining the contact of the plug and point, and at the same time allowing the free lateral motion of the reel and shaft.

5. In combination with a submerged boat, and means for steering the same from a point outside of the boat, guides for indicating the position and direction of such boat.

6. In combination with a propelling-engine, constructed to operate by the expansion of a substance which, while a gas in its normal state, becomes a liquid under compression, a series of vessels for carrying the same, substantially such as set forth.

7. In combination with such engine and vessels, an induction-pipe for conveying the gas from the vessels to the engine, led outside of the boat, and exposed to the warmer water, substantially as and for the purpose set forth.

8. In combination with the electro-magnets M″ M‴, the armature and springs for holding it in its intermediate position, the sliding arm, crank, and valve-rod, and rotary or oscillating valve, for regulating the admission of the gas or vapor used in moving the piston which actuates the rudder.

9. In combination with the rudder and tiller, and electro-magnetic apparatus for operating the same from a point outside of the boat, springs for bringing the rudder to "steady" when the magnets are inactive.

10. In combination with a submarine boat and its steering apparatus, an insulated wire for conveying an electric current from a point outside of said boat, an electro-magnetic apparatus for operating a piston to set the rudder at "port" or "starboard," and independent mechanism for bringing it back from either of said positions to "steady."

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

JOHN L. LAY.

Witnesses:
R. MASON,
B. EDW. J. EILS.