(No Model.) 6 Sheets—Sheet 1.

S. LAKE.

SUBMARINE VESSEL.

No. 581,213. Patented Apr. 20, 1897.

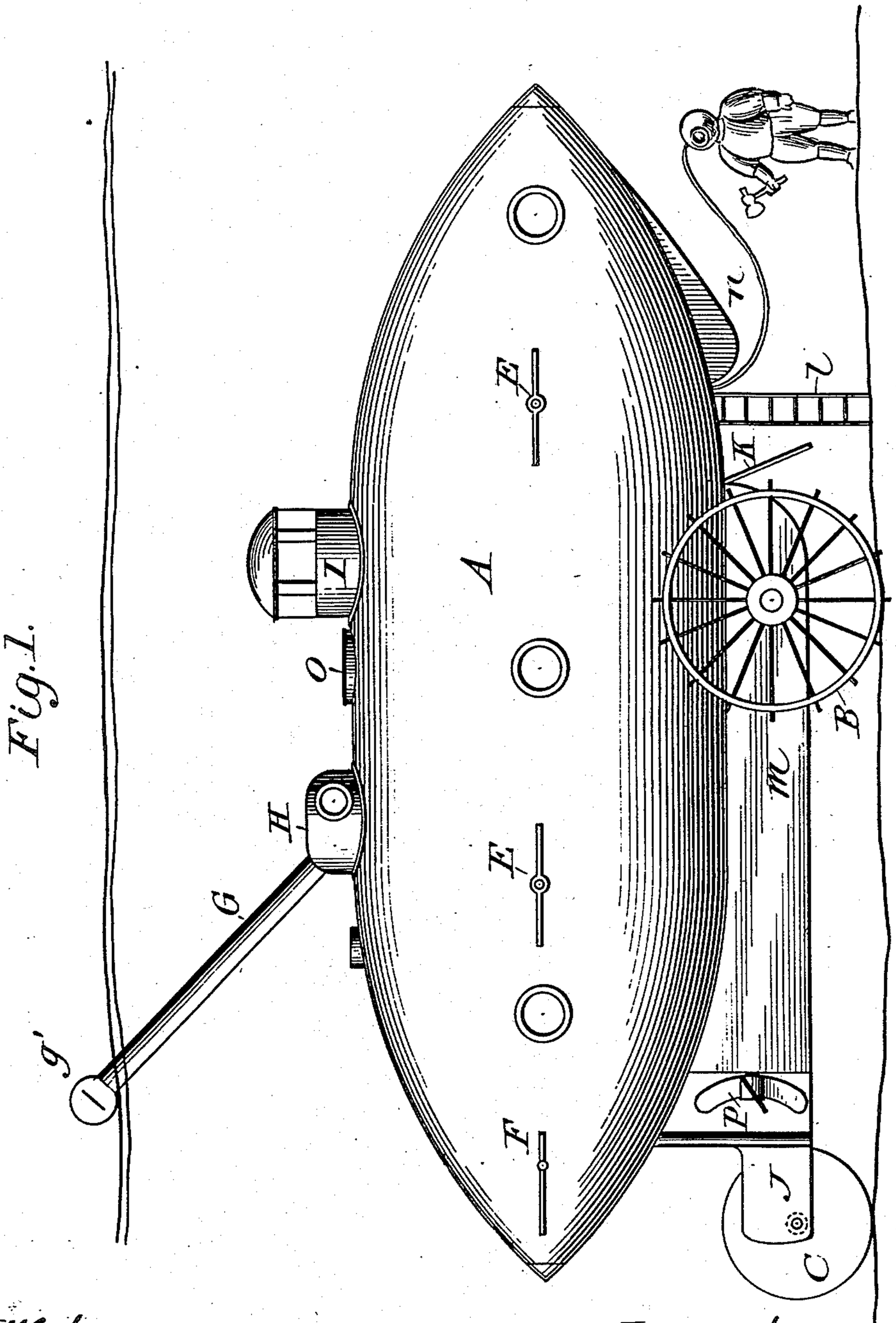

Fig. 1.

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(No Model.)

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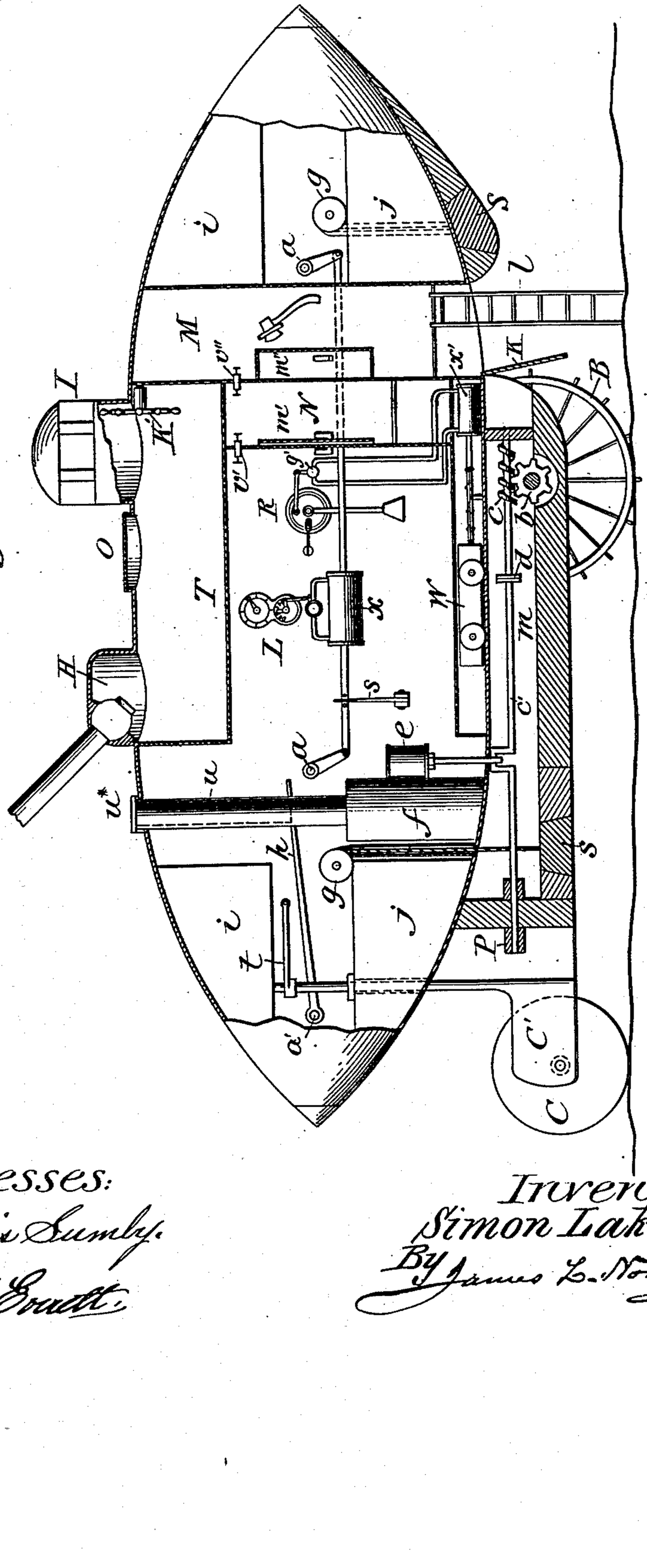
S. LAKE.

SUBMARINE VESSEL.

No. 581,213. Patented Apr. 20, 1897.

Fig. 2.



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S. LAKE.

SUBMARINE VESSEL.

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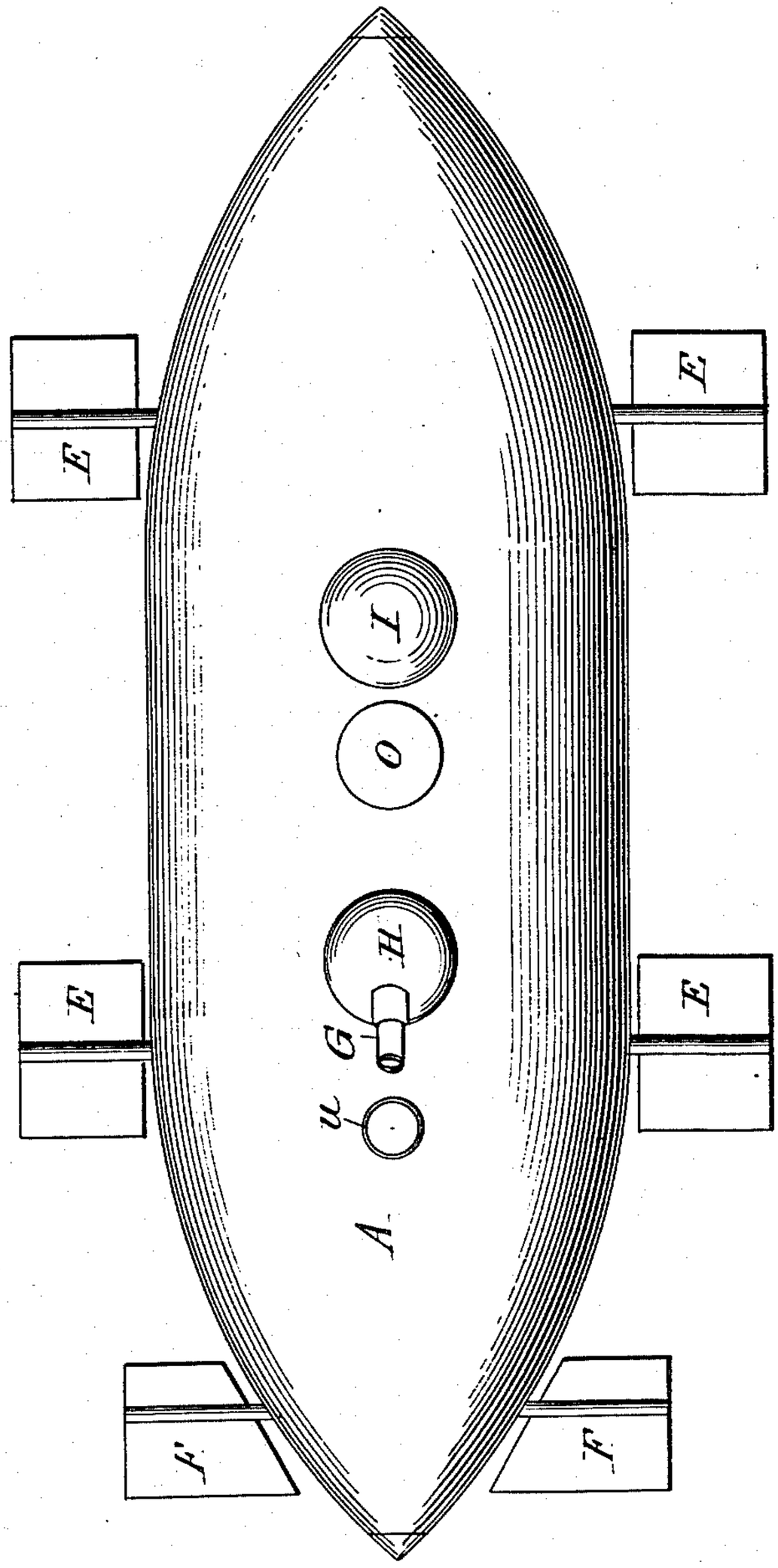
Fig. 3.



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(No Model.) 6 Sheets—Sheet 4.

S. LAKE.

SUBMARINE VESSEL.

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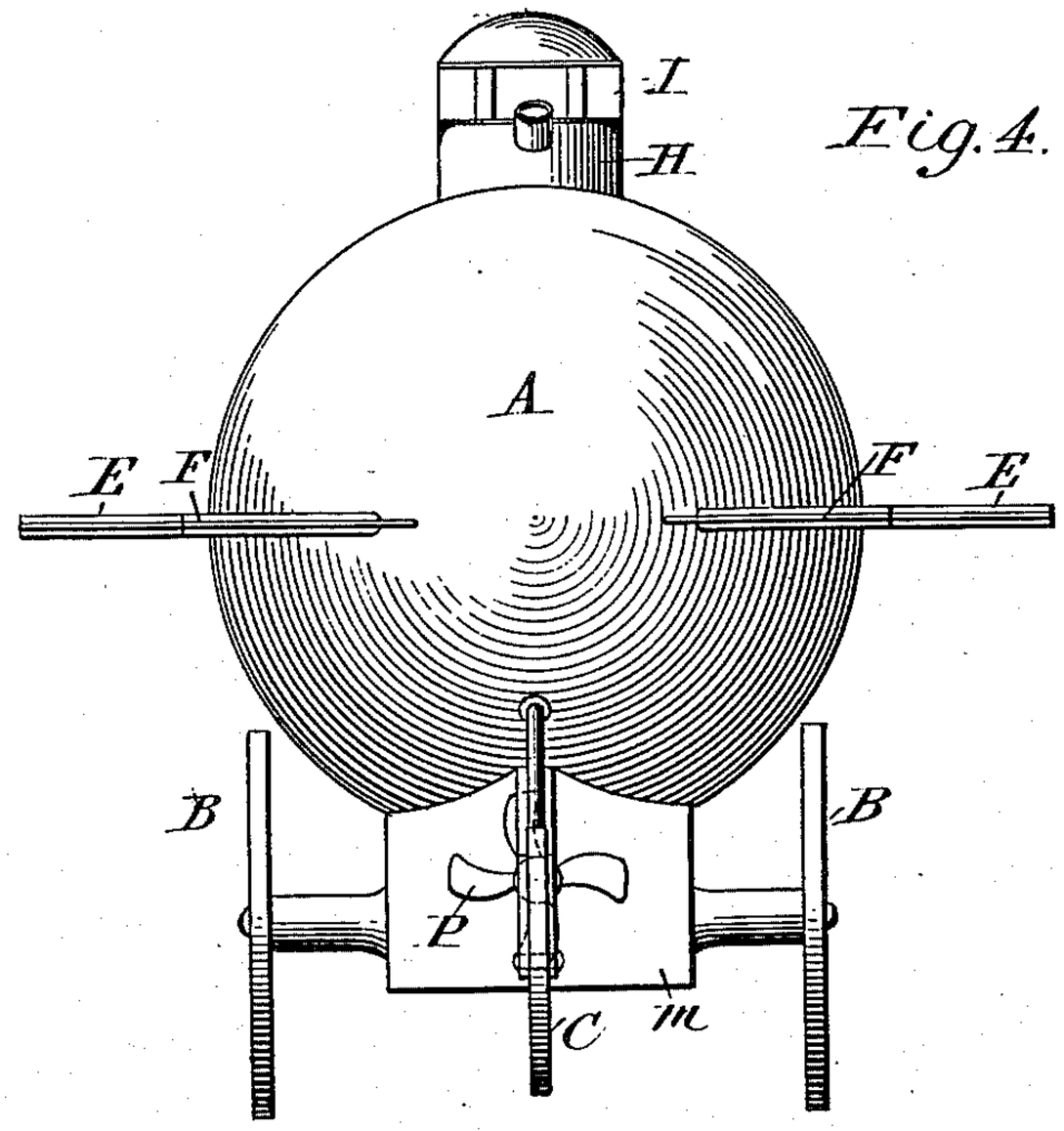

Fig. 4.

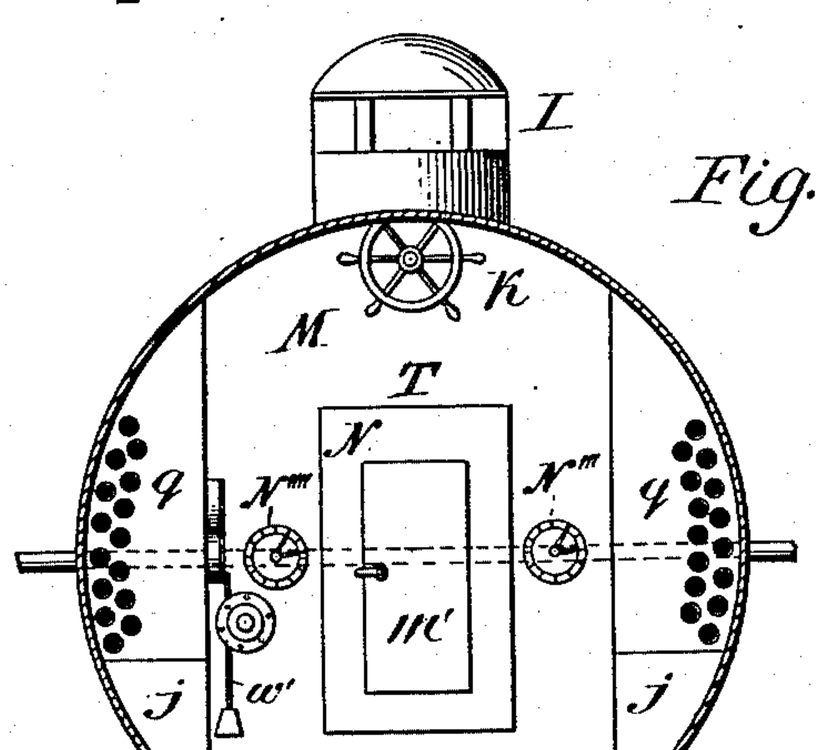

Fig. 5.

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6 Sheets—Sheet 5.

S. LAKE.

SUBMARINE VESSEL.

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Fig. 6.

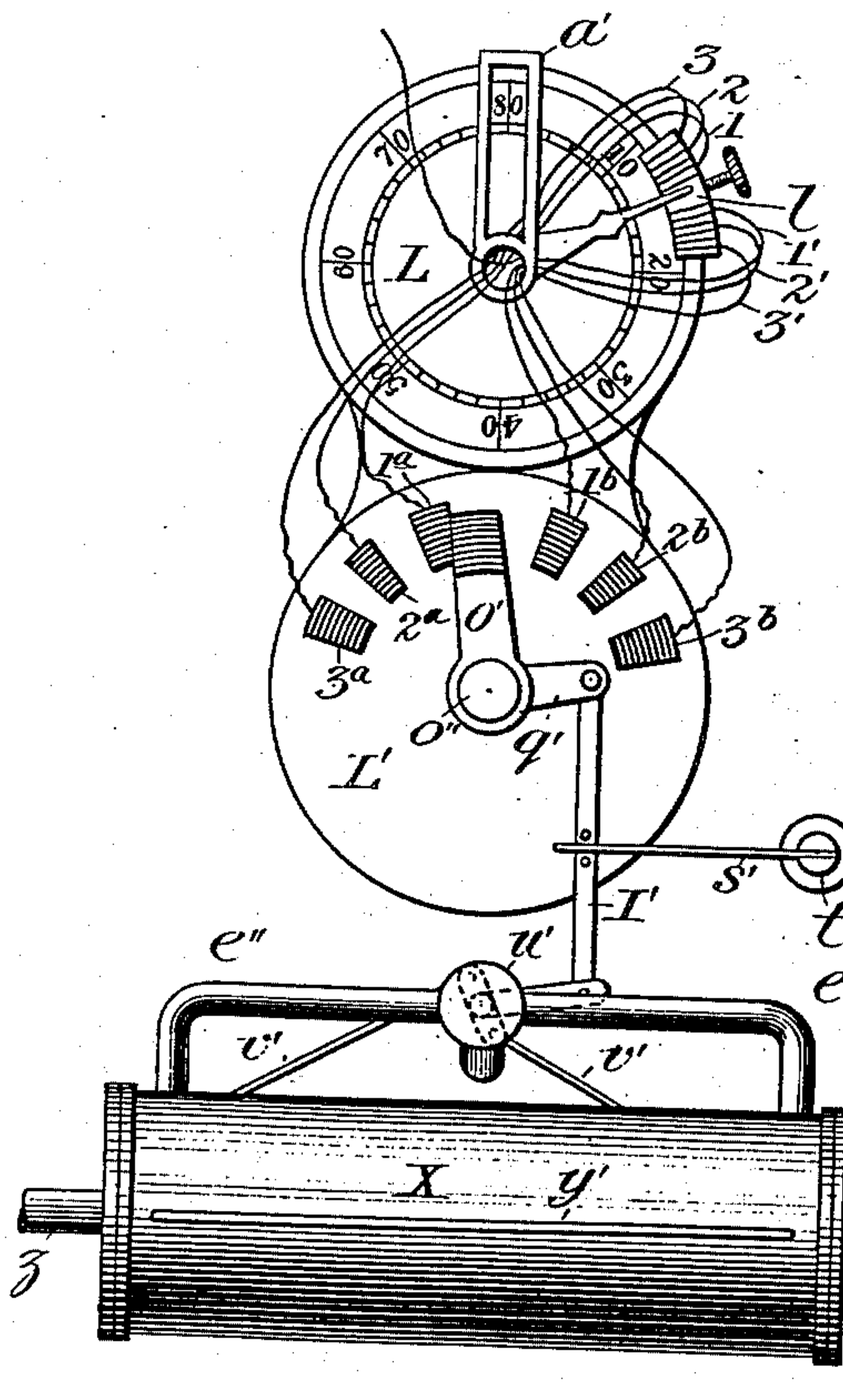


Fig. 7.

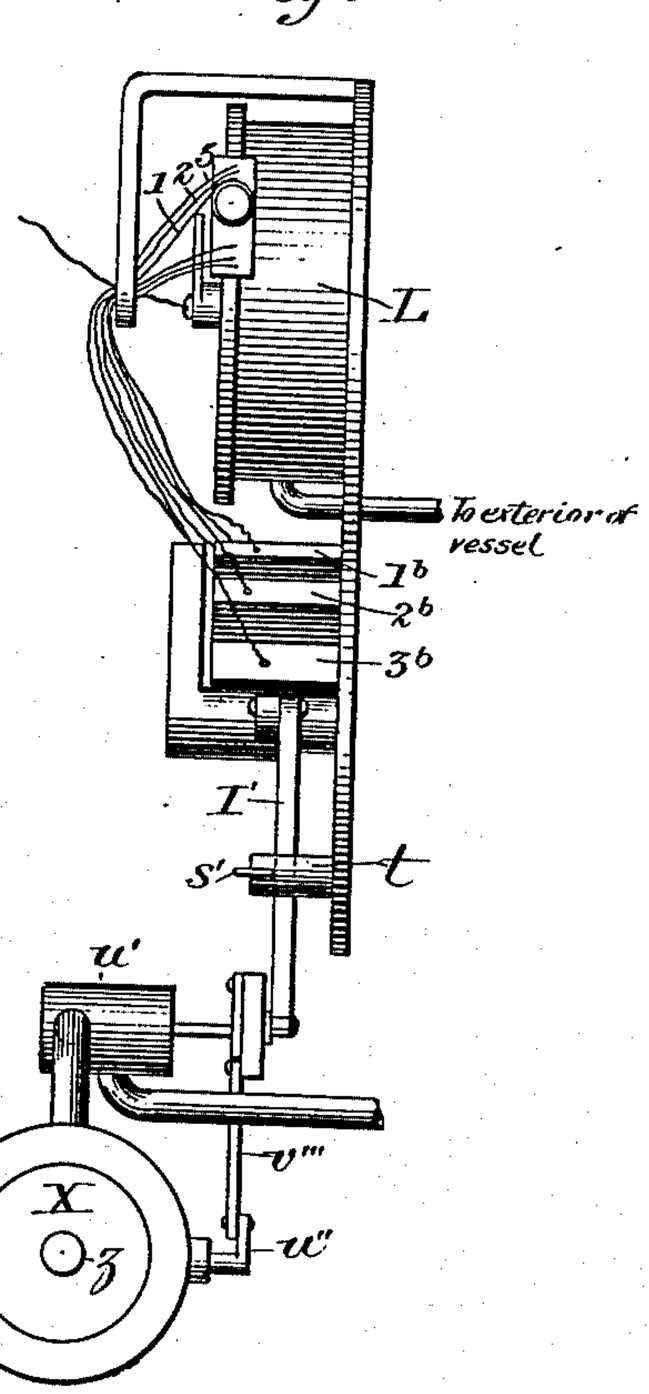


Fig. 8.

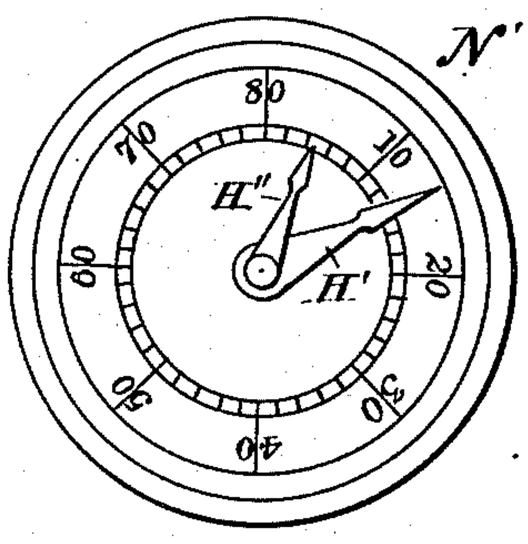
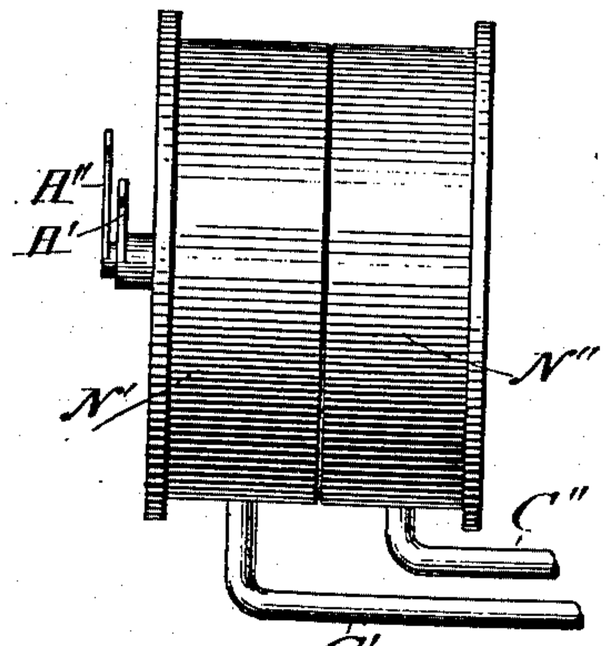


Fig. 9.



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S. LAKE.

SUBMARINE VESSEL.

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Fig. 10.

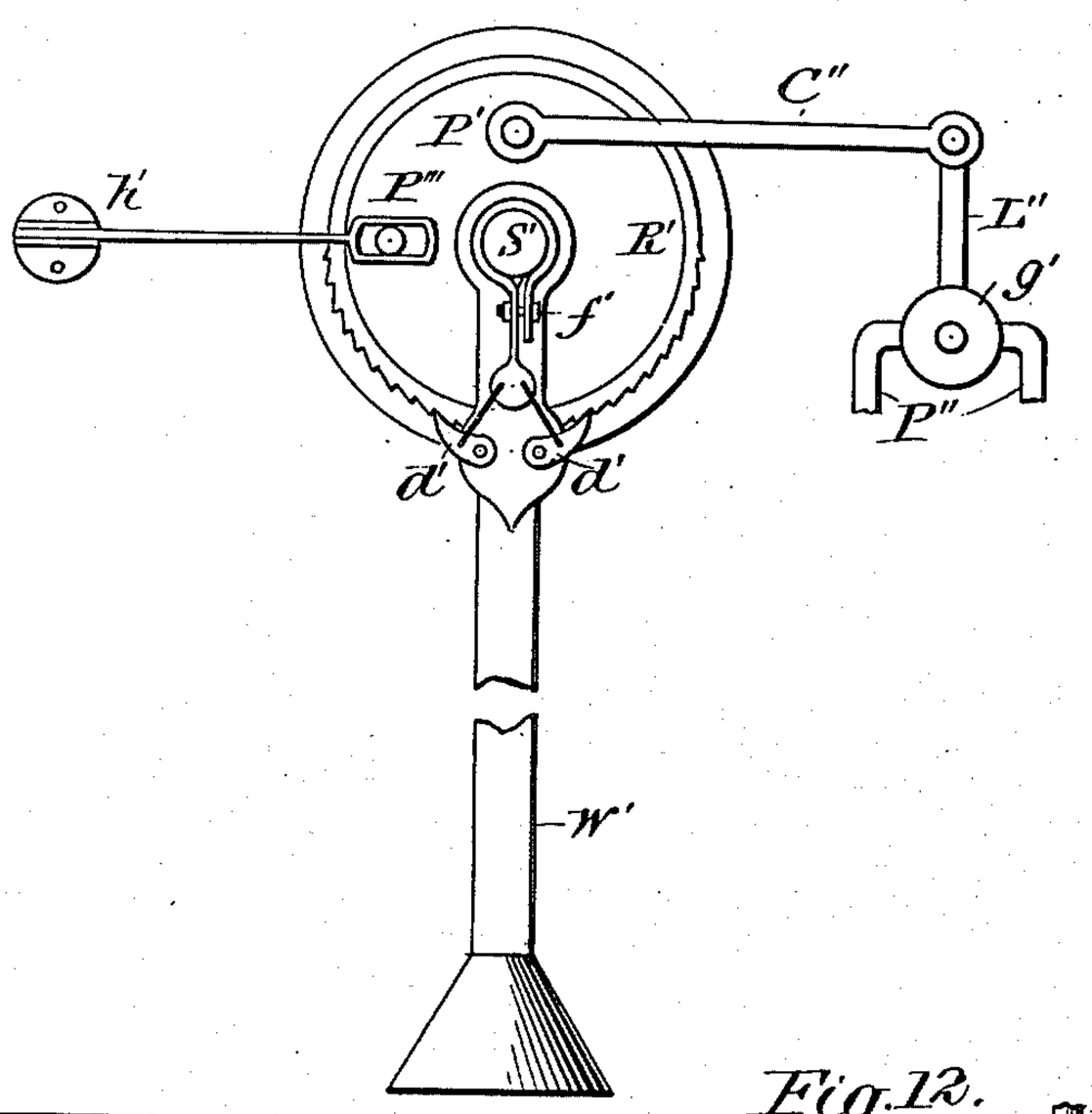


Fig. 11.

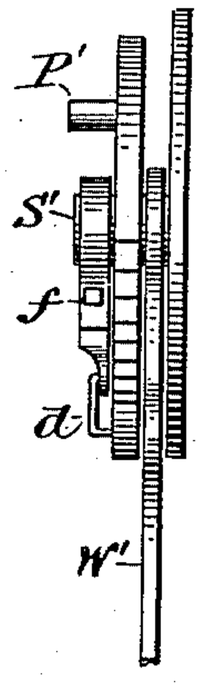


Fig. 12.

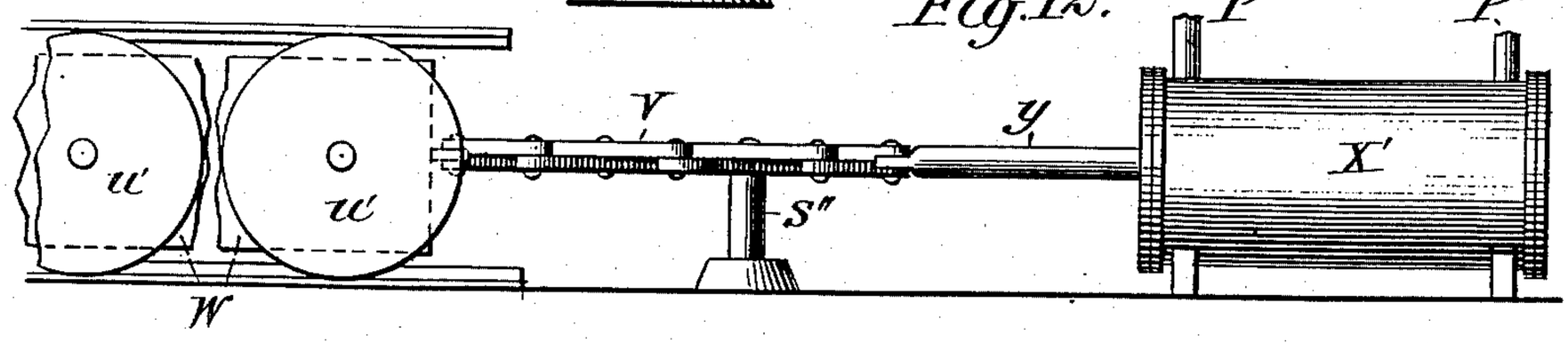
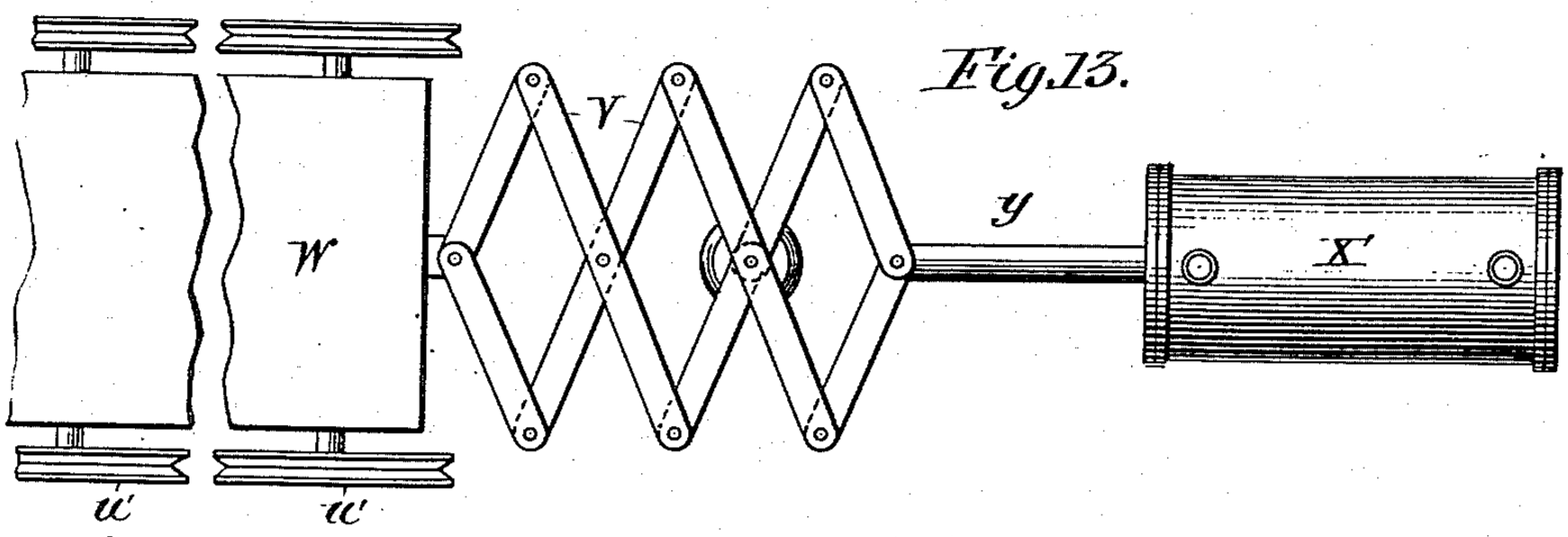


Fig. 13.



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UNITED STATES PATENT OFFICE.

SIMON LAKE, OF BALTIMORE, MARYLAND.

SUBMARINE VESSEL.

SPECIFICATION forming part of Letters Patent No. 581,213, dated April 20, 1897.

Application filed April 5, 1893. Serial No. 469,109. (No model.)

To all whom it may concern:

Be it known that I, SIMON LAKE, a citizen of the United States, residing at Baltimore city, State of Maryland, have invented certain new and useful Improvements in Submarine Vessels, of which the following is a specification.

My invention relates to an improved submarine vessel, and has for its object, first, to provide novel means for sinking the vessel to the bottom of the water when it is at a state of rest or has no headway and for permitting the vessel to rise to the surface of the water; second, to provide means whereby the vessel is enabled to travel upon the bottom or bed of the water; third, to provide mechanism automatically controlled by the pressure of the water for submerging the vessel and maintaining it submerged at any desired or predetermined depth when under way; fourth, to provide means for automatically maintaining the vessel on a level keel irrespective of the disposal or shifting of the weights in the vessel; fifth, to provide novel means for affording ready ingress and egress from and to the vessel when submerged, and, lastly, to improve the construction generally and render more safe and certain the operation of submarine vessels.

To these ends my invention consists in a submarine vessel constructed and operating in the manner hereinafter fully described, and afterward definitely set forth in the claims following the description, due reference being had to the accompanying drawings, forming a part of this specification, wherein—

Figure 1 is a side elevation of my improved submarine vessel, illustrating the same as resting upon the bottom or bed of the water. Fig. 2 is a similar view, the outer sheathing or shell being partially broken away to illustrate the interior arrangement of the vessel. Fig. 3 is a top plan view of the vessel. Fig. 4 is an end view of the vessel, looking at the stern. Fig. 5 is a transverse section taken through the engine-room, looking forward. Fig. 6 is an enlarged front elevation of the mechanism for regulating the depth of submergence of the vessel. Fig. 7 is a side elevation of the same. Fig. 8 is a front view of one of the pressure-indicating gages. Fig. 9 is a side elevation of same. Fig. 10 is a detail front elevation of the mechanism for automatically controlling the motor for shifting the movable ballast. Fig. 11 is a partial elevation of the same. Fig. 12 is a side elevation of the shifting ballast and the motor for operating the same. Fig. 13 is a top plan view of the parts shown in Fig. 12.

Throughout the several views similar letters and figures of reference refer to corresponding parts.

Referring to the drawings, the letter A indicates the hull of the vessel, which is preferably cylindro-conoidal in shape, both ends being conoids, and which is strongly and tightly constructed to prevent the entrance of water and to withstand the pressure of the latter when the vessel is submerged.

In the forward and after portions of the vessel are arranged tanks *i j*, which are designed to be connected to pumps (not shown) by means of which said tanks may be filled with water and emptied, as occasion may require, and for the purpose hereinafter made apparent.

To the bottom of the vessel is secured a hollow keel *m*, within which is journaled a two-part shaft *c'*, the after portion of the shaft being cranked and projecting through the after end of the keel and carrying at its extreme end a screw-propeller P of ordinary construction. The two parts of the shaft *c'* are detachably coupled together by a coupling or clutch *d* of any desired construction, and said shaft is rotated by an engine *e*, which is connected with the cranked portion of the shaft and is supplied with steam by a boiler *f*. The furnace of the boiler *f* is provided with a telescoping smoke-stack *u*, which may be extended up through the top of the vessel when the latter is on the surface of the water, a water-tight cover *u** serving to exclude the water when the stack is withdrawn into the vessel.

In suitable recesses formed in the keel and in the under forward portion of the vessel are arranged weights S, to which are connected cables, the said cables being led up through water-tight tubes into the interior of the vessel, the upper ends of said cables being wound about drums or windlasses arranged in water-tight casings *g*, that communicate with the water-tight tubes, whereby said weights S

may be raised and lowered without admitting water to the interior of the vessel.

Within suitable compartments arranged upon each side of the interior of the vessel are arranged a series of tubes *q q*, that are adapted to be connected together at their opposite ends by manifolds, said tubes being designed to contain a charge of compressed air, which is employed for running the engine *e* when the vessel is submerged, and for other purposes hereinafter described.

In the upper portion of the vessel is constructed a compartment provided with a conning-tower I, within which is arranged the steering-wheel K', that is connected in the usual manner by tiller ropes or cables with a tiller *t*, carried by the rudder-post. Said compartment is also provided with a companion-hatch O, that is adapted to be closed water tight, and communication between the compartment and the interior of the vessel is had by a companion-way or ladder.

In the forward portion of the hollow keel *m* is journaled a transverse shaft *b*, provided with a gear-wheel meshing with a worm *c*, carried by the forward part of the two-part shaft *c'*. To the opposite ends of the transverse shaft *b* are rigidly affixed wheels B, that project below the bottom of the keel and are provided upon their peripheries with projecting studs or spurs that are adapted to engage and take into the bottom or bed of the water, as hereinafter described. A wheel C is also journaled in a suitable bearing carried by the rudder, both the wheel C and the rudder turning with the rudder-post as the latter is operated by the tiller and steering-wheel.

When the vessel is submerged, ingress and egress to and from the vessel may be had by the following means: M indicates a closed chamber, which I denominate a "diver's" chamber, arranged, preferably, in the forward portion of the vessel and provided at its bottom with a hinged or removable trap K, that fits the chamber water-tight and preferably opens outward. The chamber M is provided with a water-tight door *m''*, that affords communication with an auxiliary chamber N, that in turn is provided with a tight-fitting door *m'*, that communicates with the interior of the vessel. Valves V' V'' are provided, that afford communication between the chambers M and N and the chamber N and the interior of the vessel, the valves being capable of being opened and closed from either chamber or the vessel's interior, as hereinafter more clearly appears, and said chambers are also connected by valved pipes with the compressed-air reservoirs *q q*, so that compressed air may be admitted to either of said chambers to any desired pressure.

In Figs. 5, 8, and 9 are illustrated pressure-gages that are designed to indicate the pressure of the air in the chambers M and N and of the water surrounding the vessel. Said gages are made in pairs, as more clearly shown in Fig. 9, one gage, as N', being arranged in front of the gage N'' and both being provided with a common dial arranged on the front of the gage N'. Each gage operates an independent index-hand arranged in the same manner as the hands of a clock to indicate upon the common dial the pressure of both gages. A detailed description of the construction of said gages is not deemed necessary, as such are of well-known construction. There are two sets of said gages employed, (see Fig. 5,) one set, N''', for indicating the pressure of the air in the chambers M and N and the other set, N'''', for indicating the pressure of the air in the chamber M and the pressure of the water surrounding the vessel. One of the gages, as N', of the set N''' (see Fig. 9) is connected by a pipe C' with the chamber M, and the other gage, as N'', is connected by a pipe C'' with the chamber N, whereby the air-pressure of each of said chambers is indicated by the index-hands on the dials, and when both of said hands register or point to the same numeral on the dial it is known that the air-pressure in the two chambers is the same. The chamber N and the interior of the vessel may in like manner be connected with a set of gages for the same purpose. The two gages comprising the set N'''' are also connected, respectively, to the chamber M and the exterior of the vessel by two pipes to indicate the pressure of air in said chamber and that of the water surrounding the vessel.

I will now proceed to describe the mechanism for automatically submerging the vessel and maintaining it submerged at any desired depth.

Referring to Figs. 1, 2, and 3, the letter E indicates vanes, preferably four in number, arranged upon the opposite sides of the vessel and at approximately equal distances between the top and bottom of the hull and rigidly mounted on horizontal transverse shafts extending into the interior of the vessel, where they are provided with cranks *a*. By rocking the shafts carrying said vanes the forward ends of the latter are inclined at an angle either above or below the horizontal plane in which the vessel is traveling, the position of the vanes and the angle of their inclination depending upon the direction in and the extent to which their shafts are rocked or oscillated. By inclining said vanes so that they will assume an angle extending downward and forward, and the vessel being in a state of equilibrium, it will be readily understood that by propelling the vessel forward it will be caused to descend in the water, and the pressure of the water caused by the forward motion of the boat being exerted upon the forward and after vanes alike the vessel will, if it be evenly ballasted and unaffected by any extraneous influences, be caused to descend upon an even keel until the vanes are again caused to assume a horizontal position. To cause the vanes to automatically assume a horizontal position when the desired depth

has been attained, and to maintain such depth, I provide the following mechanism:

Referring to Figs. 2, 6, and 7, X indicates a cylinder arranged in the interior of the vessel, in which is adapted to be reciprocated a piston rigidly mounted on a rod Z, extending through both ends of said cylinder and connected at its opposite ends to the cranks *a*, carried by the shafts of the vanes.

u' indicates a two-way valve adapted to alternately communicate with the opposite ends of the cylinder X by pipes *e' e''*, said valve communicating by means of a suitable supply-pipe with the compressed-air-reservoir tubes *q* and operating to control the admission of the compressed air to either end of the cylinder.

L indicates a pressure-gage of ordinary construction that is connected by means of a suitable pipe with the exterior of the vessel, so that the index-hand of the gage will always indicate upon the dial the pressure of the water surrounding the vessel. To the outer rim or periphery of the gage, which is insulated or formed of a non-conductor of electricity, is secured by means of a set-screw a segmental clip *l*, also of non-conducting material, and carrying two series of independent contacts 1 2 3 and 1' 2' 3', the contacts of one series having no electrical connection with those of the other series or with each other. The index-hand *y'* of the gage L is connected to the one terminal of an electric conductor, the other terminal of which is connected to one pole of a battery or other electrical generator, and the free end of said index-hand is adapted to successively engage said contacts as the hand is rotated.

L' is a disk carrying two series of electromagnets 1^a 2^a 3^a and 1^b 2^b 3^b, arranged in the arc of a circle, the magnets 3^a and 3^b being more powerful than the magnets 2^a and 2^b and the magnets 2^a and 2^b being likewise more powerful than the magnets 1^a and 1^b. The magnets 1^a 2^a 3^a are connected by conductors with the contacts 1 2 3, while the magnets 1^b 2^b 3^b are in like manner connected with the contacts 1' 2' 3'. The conductors connecting the contacts and magnets are preferably passed through an eye centrally supported in front of the center of the dial of the gage L by an arm *a'*, by which means the clip *l* may be readily shifted about the rim of the dial without disturbing the conductors. The said conductors, after passing about the magnets, are led back and form the return-wires to the battery or other electric generator before mentioned. It will thus be seen that when the index-hand *y'* of the gage L is moved so as to contact with one of the other contacts—say 3, for example—the circuit will then be closed and may be traced from the battery through the index-hand, hence through the contact 3 to the magnet 3^a and back to the battery, thus energizing the magnet 3^a. I have shown six contacts and six magnets, but it will be evident that the number may be increased to any desired extent.

Pivoted centrally upon the disk L' is an armature O', adapted to oscillate in the magnetic field of the magnets and carrying a lever *q'*, arranged at a right angle to the armature, and to said lever is pivotally secured one end of a link I', the other end of which is in the same manner connected to a crank on the valve *u'*. One end of a leaf-spring *s'* is loosely connected to the link I', the other end of said spring being rigidly fixed in any suitable support, and operates to return and hold the parts in their normal position when the circuit is broken. The cylinder X is provided at its opposite ends with exit or exhaust valves *u''*, which are connected by links *v' v'* with the valve *u'* in such manner that when the valve *u'* is turned so as to admit compressed air into one end of the cylinder the exhaust-valve at the opposite end of the cylinder will be opened to permit the escape of the air from behind the piston.

The operation of this portion of the invention is as follows: Let it be assumed that the vessel is being propelled upon the surface of the water and that it is desired to submerge it to a certain depth below the surface of the water—say, for example, twenty feet. The clip *l* is then adjusted upon the rim of the gage L so that its center, or the non-conducting portion between the two series of contacts, is opposite the point on the dial that indicates a pressure of the water that occurs at a depth of twenty feet. The water-tanks in the vessel are then supplied with water until the vessel is in a state of equilibrium, and in sinking to establish the equilibrium the index-hand *y'* is caused by the pressure of water upon the gage to move slightly, when it will make contact with the first contact 3 and close the circuit through the magnet 3^a, thus attracting the armature O' and throwing the valve *u'* open, so as to admit a charge of compressed air to one end of the cylinder and move the piston and its rod *z* in the direction to incline the vanes E forward and downward. This causes the vessel to descend, and the index-hand successively engages the contacts 2 and 1, magnetizing in turn the magnets 2^a and 1^a, thus gradually closing the valve *u'* through the medium of the armature O' and its connections until the desired depth is reached, when the pressure of the water will cause the index-hand of the gage to point toward that portion of the dial that indicates a pressure corresponding to a depth of twenty feet. The index-hand will then rest between the two series of contacts and the circuit will be broken. When the circuit is broken, the spring *s'* causes the armature O' and valve *u'* to resume their normal positions, and a similar spring *s*, engaging with the rod *z*, connecting the cranks *a*,

causes the vanes to assume a horizontal position and permit the vessel to run a steady level or horizontal course.

In order to permit the spring *s* to gradually turn the vanes to a horizontal position, I may connect the opposite end of the cylinder X with a tube *y'* of small diameter, so that when the spring *s* acts to force the rod *z* back to turn the vanes the air can pass from behind the piston to the other end of the cylinder. Should, however, the vessel seek to rise or sink above or below the selected depth, the pressure of the water upon the gage L will immediately cause the index-hand to engage either the contact 1 or 1^a, depending upon whether the vessel rises or sinks, and thus again incline the vanes in the proper direction to cause the vessel to resume the proper or desired depth. It will thus be seen that after setting the clip *l* to the proper position on the dial to correspond with the depth at which it is desired to travel the mechanism is entirely automatic in its action, requiring no attention on the part of an engineer or attendant.

In order to keep the vessel on a level keel when traveling beneath the water, I provide the following mechanism: Referring to Figs. 2, 10, 11, 12, and 13, the letter W indicates a weight mounted upon grooved wheels traveling between rails arranged above and below said wheels, whereby said weight is prevented from leaving its ways when the vessel lists to either port or starboard, said rails being arranged fore and aft the vessel. In proximity to one end of the ways is rigidly mounted a cylinder X', containing a piston, the piston-rod *y* of which is connected to one end of the weight W by lazy-tongs V. Pipes P'' communicate with the opposite ends of the cylinder X', and also communicate with a four-way valve *g'*, that is connected with the compressed-air-reservoir tubes *q* by means of a suitable supply-pipe. By turning the valve in one direction compressed air is permitted to enter the cylinder at one end and move the piston, while the air behind the piston is allowed to escape through an exhaust-port in the valve, a reverse movement of the valve operating to move the piston in the opposite direction, the movement of the piston operating to expand and contract the lazy-tongs, and thus move the weight back and forth upon its ways to shift it either forward or aft, as the trim of the vessel may require.

The valve *g'* is controlled automatically to admit compressed air to either end of the cylinder as occasion may require by means of mechanism which I will now describe. The letter R indicates a support, rigidly affixed to which is a trunnion S', and upon the latter is journaled a disk R', the lower half of the periphery of which is provided with oppositely-disposed ratchet-teeth, as shown more clearly in Fig. 10. Also journaled upon the trunnion S' is a weighted pendulum W', carrying two oppositely-disposed pivoted pawls *d'*, that are adapted to respectively engage the oppositely-cut ratchet-teeth on the disk R'. Encircling the trunnion S' is a friction-spring *f'*, that is caused by a set-screw to clasp the trunnion with a moderate degree of friction, and to an eye formed in one end of said spring are loosely connected the upper ends of links which at their other ends are connected to the pawls *d'*.

To a fixed support *h'* is rigidly secured one end of a leaf-spring, the other end of which is slotted to engage a pin P''', secured to the face of the disk R', said spring operating to maintain the disk in its normal position. To a pin P', also secured to the face of the disk R', is pivotally secured one end of a rod *c''*, the other end of which is in like manner secured to a lever L'', fixed upon the stem of the valve *g'*.

The operation of the mechanism just described is as follows: When the vessel is riding on a level keel, the weight W will be amidships or at such other point as will so trim the vessel that it will be level. Now let it be assumed that the vessel sinks by the bow, caused, for example, by some member or members of the crew going forward or by the action of currents upon the hull. The pendulum will remain stationary, while the trunnion S' will move with the vessel and make a partial revolution relatively to the pendulum, and, owing to the friction with which the spring *f'* clasps the trunnion, the spring will move with the trunnion, pulling one of the pawls into engagement with its corresponding ratchet-teeth on the disk R' and forcing the other pawl out of engagement with its teeth. This imparts a partial rotation to the disk R' relative to the trunnion S', which, through the medium of the rod *c''* and lever L'', rocks the valve *g'* and admits compressed air to one end of the cylinder X' and moves the piston in the proper direction to shift the weight W aft and bring the vessel back to a level keel. As the vessel resumes a level position the action of the pawls *d' d'* is reversed, permitting the spring to turn the disk R' back to its normal position and shutting off the supply of compressed air from the cylinder. Should the vessel sink by the stern the action of the mechanism will be reversed to shift the weight W forward, the device automatically acting to always maintain the vessel on a level keel. If desired, vanes F may also be employed to assist in maintaining the vessel on a level keel and to aid in causing the ascent and descent of the vessel. Said vanes are rigidly affixed to the outer ends of a transverse shaft *a'*, passing horizontally through the after part of the vessel, and are designed to be operated by hand by means of a tiller *h*, keyed to the shaft *a'*. The vanes F, however, may be dispensed with.

In order that a clear view of the surface of the water to the horizon may be had without exposing any portion of the hull of the vessel

above the water, I provide the upper portion of the vessel with a turret H, in which is fitted by a hinged or ball-and-socket joint one end of an observation-tube G, that at its upper end is provided with a sight-opening covered by heavy glass. The tube G is sufficiently large for the entrance therein of one of the crew, who may ascend or be hoisted into the upper portion of the tube, from whence, when the vessel is submerged just sufficiently to permit the top of the tube to project slightly above the surface of the water, an unobstructed view may be had to the horizon. The upper portion of the tube may be provided with an adjustable mirror, by means of which the surface may be viewed without the necessity of the entrance of one of the crew into the tube. The inner end of the tube may also be provided with a cover to prevent the entrance of water into the vessel in the event of accident to the tube. By connecting the tube to the vessel by a hinged joint it will assume a horizontal position when the vessel is in motion and thus offer but slight resistance to the water.

In practice the vessel will be provided with air and water pumps for filling and emptying the tanks and storing the air-reservoirs with compressed air, but I have not shown said pumps, as they are of ordinary construction and are commonly employed in submarine vessels. Windows covered with heavy glass will also be located in the hull of the vessel at convenient points, and I also provide the vessel with an electric-light plant, search-lights, and incandescent lights for illuminating the interior. The driving power when the vessel is afloat is preferably steam, and when submerged compressed air is employed, but it will be evident that other motive power can be advantageously employed, such as chemical engines, storage batteries, and the like.

A vessel constructed as above described is adapted to be employed either as a wrecking vessel for locating sunken ships, removing their cargoes, and raising them, for performing all kinds of submarine work, for scientific research, or as a torpedo boat and ram, and when used for the latter purpose will be provided with torpedo-tubes.

My improved vessel is operated as follows: When it is desired to travel upon the surface of the water, the tanks *i* and *j* are filled with atmospheric air, the forward part of the shaft *c'* is uncoupled by opening the clutch *d*, and the smoke-stack *u* is projected above the top of the vessel. Steam may be now generated in the boiler *f* to operate the engine *e*, which drives the propeller P. The vessel thus equipped can be operated in all respects like ordinary vessels. When it is desired to travel beneath the surface, the fires are drawn from the boiler-furnace, the smoke-stack is withdrawn into the interior of the vessel and tightly closed, and water admitted to the tanks until the vessel is in a state of equilibrium. The clip *l* is now set upon the gage L at the point corresponding to the depth it is desired to submerge the vessel and the engine connected with the compressed-air-reservoir tubes *q* and the vessel thus propelled forward. The index-hand *y'* engages the contact 3, closing the circuit through the magnet 3^a, which in the manner before described opens the valve *w'* and admits compressed air to one end of the cylinder X, thus inclining the vanes E and causing the vessel to sink. As the pressure of the water increases during the descent the index-hand *y'* is caused to successively engage the contacts 2 and 1, until, when the desired depth is attained, it rests between the contacts 1 and 1', when the circuit is broken and the springs *s* and *s'* cause the vanes E to resume a horizontal position and restore the valve-controlling mechanism to its normal position. The vessel will now continue to run at the selected depth unless influenced by extraneous causes, but should it commence to either ascend or descend above or below said depth the index-hand will immediately engage the contact 1 or 1', again closing the circuit and inclining the vanes in the proper direction to cause the vessel to resume the former depth of submergence, when the mechanism is again thrown out of operation, as described. The vessel is thus automatically kept at the desired depth without any attention on the part of an attendant. Should it be desired to submerge the vessel to a greater depth or to rise to the surface it is only necessary to adjust the clip on the dial of the gage L to the proper point, as will be readily apparent. When traveling beneath the surface, the vessel will be kept upon a level keel by the shifting weight W, and said weight will be automatically shifted to trim the vessel as the crew move about or as the weights carried by the vessel are shifted by the mechanism and in manner heretofore described.

If desired, the vessel may be submerged in the manner before described until the bottom or bed is reached, when, by admitting a sufficient additional quantity of water to the tanks to cause the wheels B and C to rest firmly upon the bottom, the vessel may continue its course over the bottom or bed, the propeller P serving as the motive power. However, when traveling upon the bottom I prefer to positively drive the wheels B to propel the vessel forward, which is accomplished by coupling the two parts of the shaft *c'* together by the clutch *d*, the engine *e*, as before, serving as the motive power. When thus traveling upon the bottom, the vessel is steered by the wheel C, carried by and forming a part of the rudder, which is operated by the tiller *t* and steering-wheel K in the same manner as when the vessel is traveling between the surface and bottom or upon the surface, the same steering mechanism being used under all conditions.

When the vessel is at rest upon the surface and it is desired to descend to the bottom, or when it is desired to descend to the bottom

in a vertical direction, the vessel being first prepared, as before described, for submergence, the descent is made as follows: Let it be assumed that the weights S each weigh one-half a ton. Water is admitted to the vessel's tanks until the buoyancy of the vessel is only one ton. The weights S are then lowered by the cables and drums to the bottom, when the buoyancy of the vessel will be increased to two tons. An additional one and one-half tons of water are then admitted to the tanks, reducing the buoyancy of the vessel to one-half a ton. The drums about which are wound the cables secured to the weights are then operated to wind in the cables, thus drawing the vessel down upon the bottom, when the weights are hoisted up into their seats in the keel. It is obvious that the vessel is now resting on the wheels on the bottom with a weight of one-half a ton, which may be increased or diminished by pumping into or out of the tanks a suitable quantity of water. The vessel may be now propelled over the bottom in the manner before described with the greatest accuracy, the course of the vessel being unaffected by changing currents or any of the causes affecting a floating or partially-submerged vessel. When it is desired to ascend, it is only necessary to again lower the weights upon the bottom and pay out the cables attached to the weights, upon which the vessel, having a buoyancy of one-half a ton, will arise to the surface, when the tanks are pumped out and the weights hoisted to their seats.

When the vessel is resting upon the bottom, egress and ingress thereto may be had in the following manner: It being desired to have egress from the vessel, the diver enters the diver's room M, closing the doors *m'* and *m''* after him. Compressed air is then admitted to the diver's room from the compressed-air reservoir *q* until the two hands of the gages N'''' register, which indicates that the pressure of the air in the diver's chamber and the pressure of the water surrounding the vessel is the same. The diver then opens the trap in the bottom of the chamber, and the pressure of the air contained therein and the pressure of the water being equal the water is prevented from rising in the chamber. The diver may now clothe himself in a diver's suit and descend to the bottom by a ladder or similar means. To return to the interior of the vessel, it is merely necessary for the diver to enter the diver's chamber, and by admitting compressed air into the compartment N until the pressure is equal to that of the diver's chamber the door *m''* may be opened, and the diver then enters the compartment N, closing the door *m''* after him. He then opens the valve V', communicating with the compartment N and the interior of the vessel, thus equalizing the pressure of the air in the two, upon which the door *m'* is opened and he then enters the interior of the vessel. Entrance to the vessel may also be effected by entering the diver's chamber and then closing the trap in the bottom of the chamber. The valve V'', communicating with the chambers M and N, is then opened, equalizing the pressure in the two chambers. The door *m''* is then opened, the diver enters the compartment N, and proceeds in the manner before described.

Having described my invention, what I claim is—

1. In a submarine vessel provided with means for propelling the same, the combination of oscillatory vanes arranged upon both sides of the vessel, a pressure-gage communicating with the exterior of the vessel and provided with an index-hand actuated by the pressure of the surrounding water, a motor for oscillating said vanes, and an electrical controlling device thrown into and out of operation by said index-hand for starting, stopping, and reversing said motor, substantially as described.

2. In a submarine vessel, provided with means for propelling the same, the combination with oscillatory vanes arranged upon both sides of the vessel, of a cylinder provided with a piston, piston-rods connected to cranks carried by said vanes, a compressed-air reservoir, means controlled by a valve for admitting compressed air to the opposite ends of the cylinder, a pressure-gage actuated by the pressure of the surrounding water, an armature carried by the stem of the air-valve, two series of electromagnets adapted to be connected with an electrical generator by independent conductors and operating to move said armature in opposite directions, two series of contacts adjustably arranged in the path of the index-hand of said pressure-gage, and conductors connecting said contacts and electromagnets, substantially as described.

3. In a submarine vessel, the combination with a shifting weight adapted to move in fore-and-aft ways, of a motor for shifting said weight in opposite directions, and means controlled by the movements of the vessel for automatically starting, stopping and reversing the motor to keep the vessel on a level keel, substantially as described.

4. In a submarine vessel, the combination with a shifting weight adapted to move in fore-and-aft ways, of a cylinder and piston for shifting the weight in opposite directions, a compressed-air reservoir communicating with the opposite ends of said cylinder, a valve for controlling the admission of compressed air to said cylinder, and a pendulum for operating said valve when the vessel sinks by the bow or stern, substantially as described.

5. In a submarine vessel the combination with a shifting weight adapted to move in fore-and-aft ways, of a cylinder and piston, lazy-tongs connecting the piston and weight, a compressed-air reservoir communicating

with the opposite ends of said cylinder, a valve for controlling the admission of compressed air to said cylinder, and a pendulum for operating said valve when the vessel sinks by the bow or stern, substantially as described.

6. In a submarine vessel, the combination with an air-tight diver's chamber provided at its bottom with a trap, an auxiliary chamber communicating therewith by a door, a door affording communication between said auxiliary chamber and the interior of the vessel, a compressed-air reservoir, valved pipes connecting said chambers with the air-reservoir, pressure-gages for indicating the pressure of the air in the chambers, and a pressure-gage for indicating the pressure of the water surrounding the vessel, substantially as described.

7. The combination with a submarine vessel provided with means for submerging the same, of wheels projecting below the bottom of said vessel and adapted to rest upon the water-bed, means for holding the vessel in contact with the water-bed, means for propelling said vessel over the water-bed upon said wheels when submerged, and means for guiding the vessel over the water-bed, substantially as described.

8. The combination with a submarine vessel provided with means for submerging the same and maintaining it in contact with the water-bed, of wheels adapted to support the vessel upon the water-bed, means for propelling the vessel upon said wheels, and a steering-wheel for guiding said vessel over the water-bed, substantially as described.

9. The combination with a submarine vessel provided with means for submerging the same and maintaining it in contact with the water-bed, of wheels adapted to support the vessel upon the water-bed, means for propelling the vessel upon said wheels, and a steering-wheel projecting below the bottom of the vessel and aiding to support the latter upon the water-bed and operated from the interior of the vessel to guide the latter, substantially as described.

10. The combination with a submarine vessel provided with means for submerging the same and maintaining it in contact with the water-bed, of wheels adapted to support the vessel upon the water-bed, means for driving said wheels for propelling the vessel, and a steering-wheel journaled in the rudder of the vessel and projecting below the bottom of the same to engage the water-bed, said wheel serving to guide the vessel over and help support the same upon the water-bed, and means for operating said steering-wheel from the interior of the vessel when the latter is submerged, substantially as described.

In testimony that I claim the foregoing I have hereunto set my hand this 5th day of April, 1893.

SIMON LAKE.

Witnesses:
FELIX R. SULLIVAN,
M. LAKE.