(No Model.)

4 Sheets—Sheet 1.

J. A. HOWELL.

MARINE TORPEDO.

No. 311,325. Patented Jan. 27, 1885.

Fig. 1.

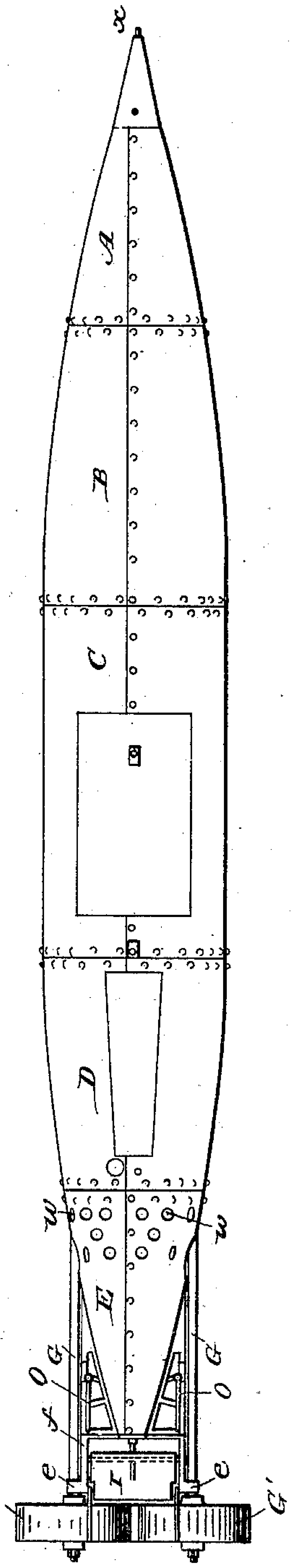
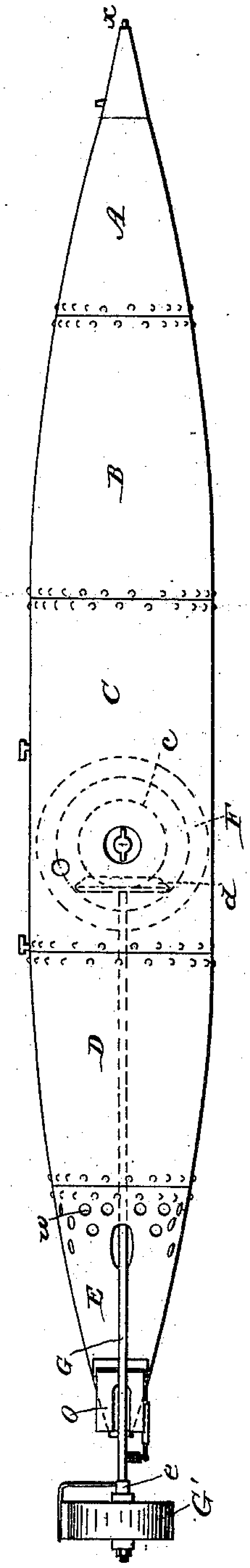


Fig. 2.



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by Marcellus Bailey

his attorney

N. PETERS. Photo-Lithographer, Washington, D. C.

(No Model.) 4 Sheets—Sheet 2.

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Fig. 5.

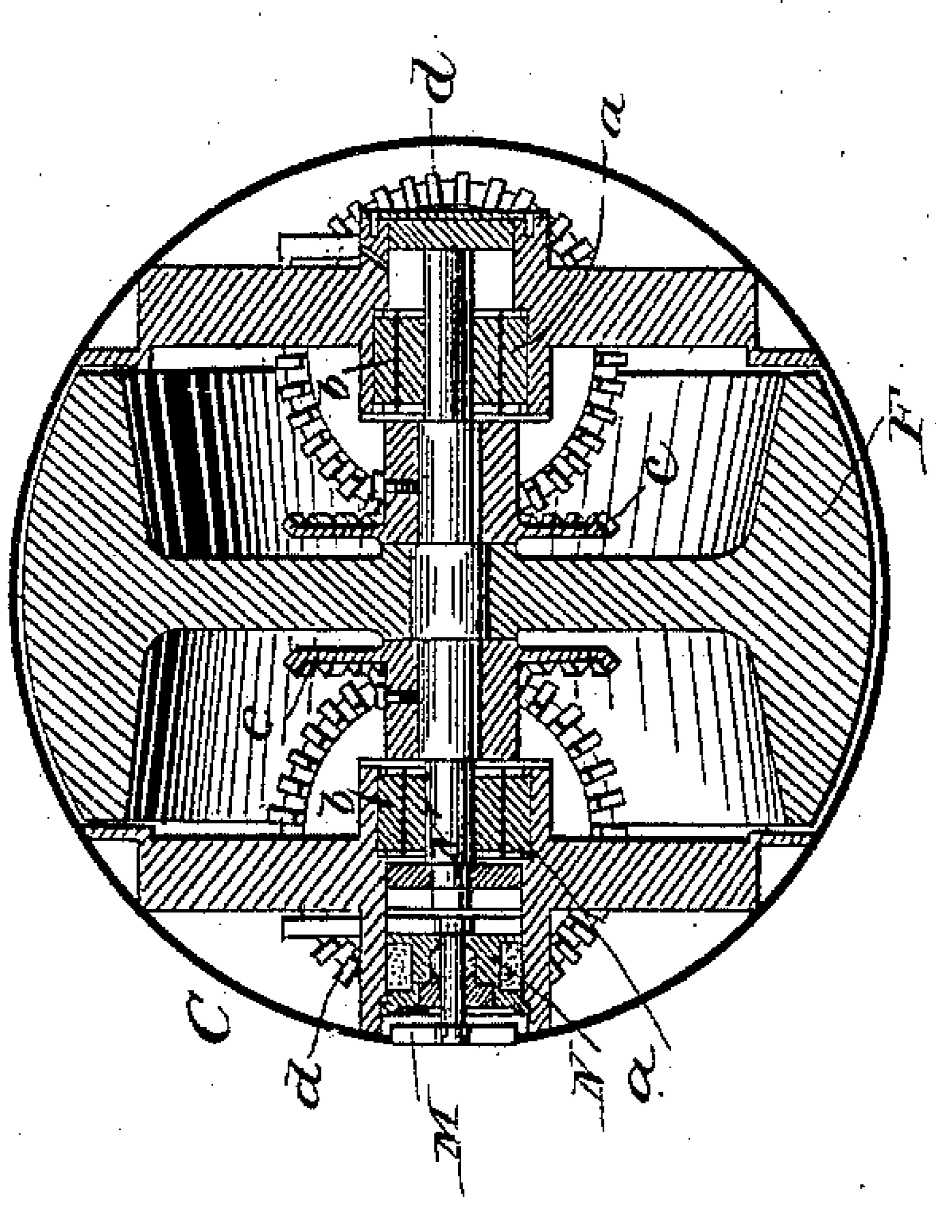


Fig. 8.

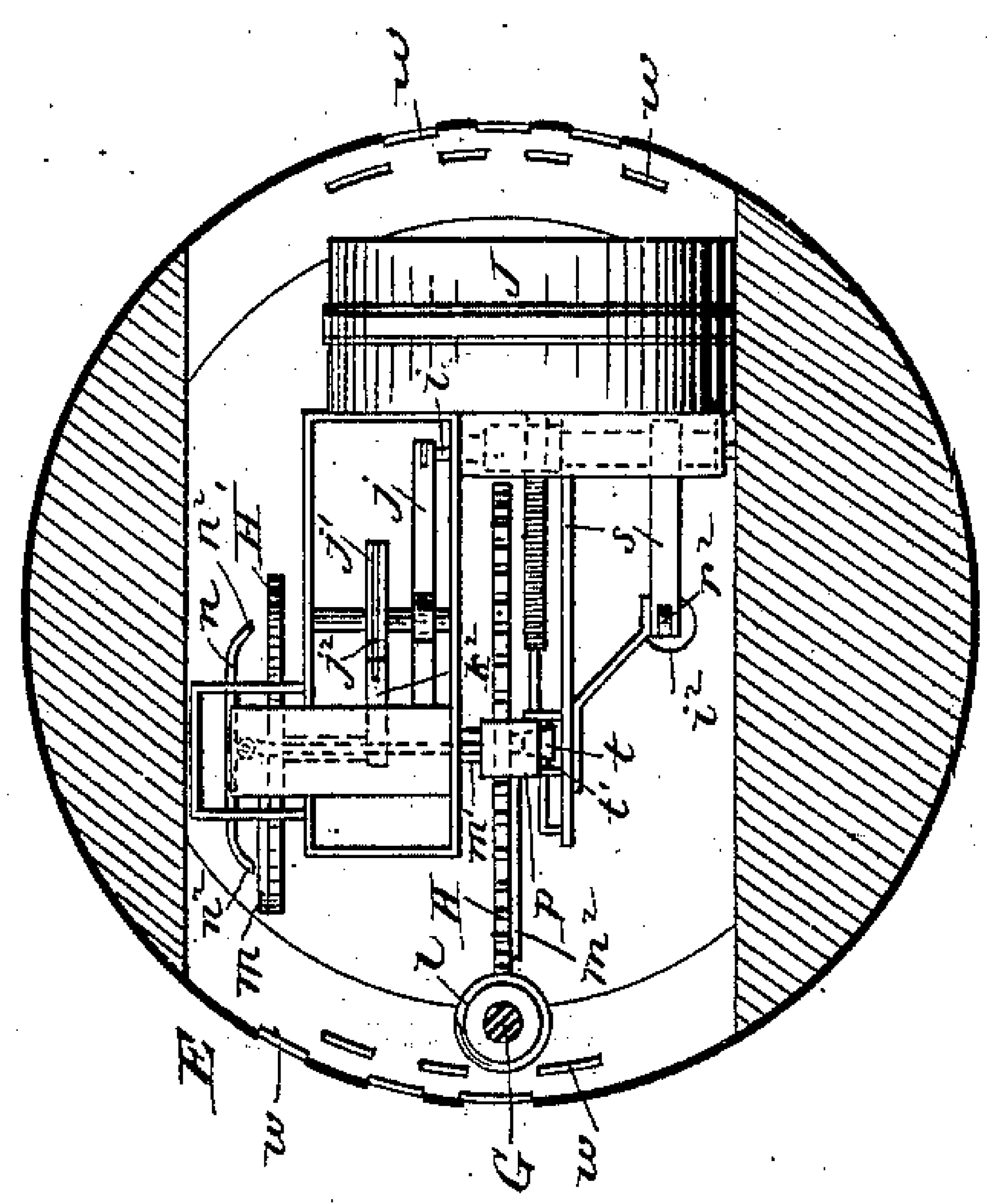


Fig. 3.

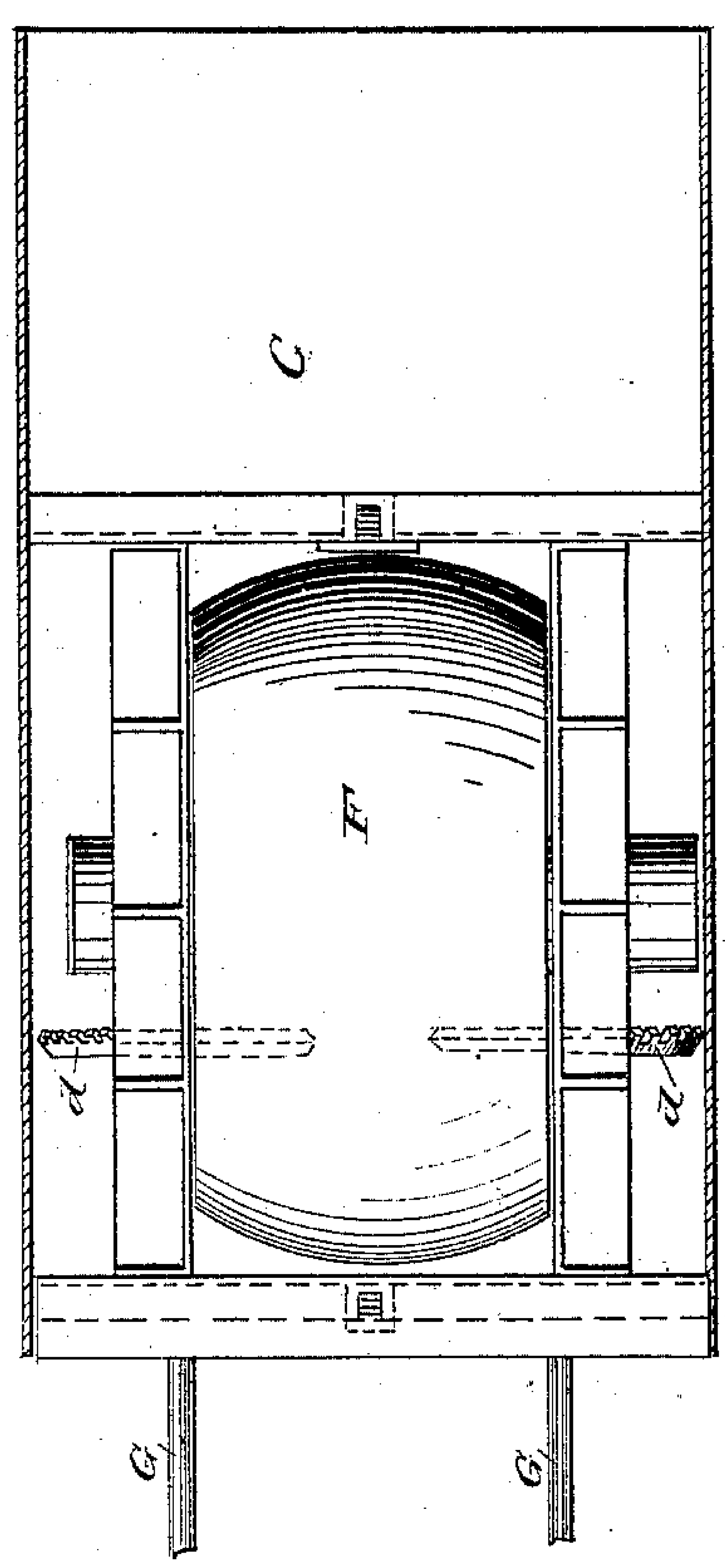
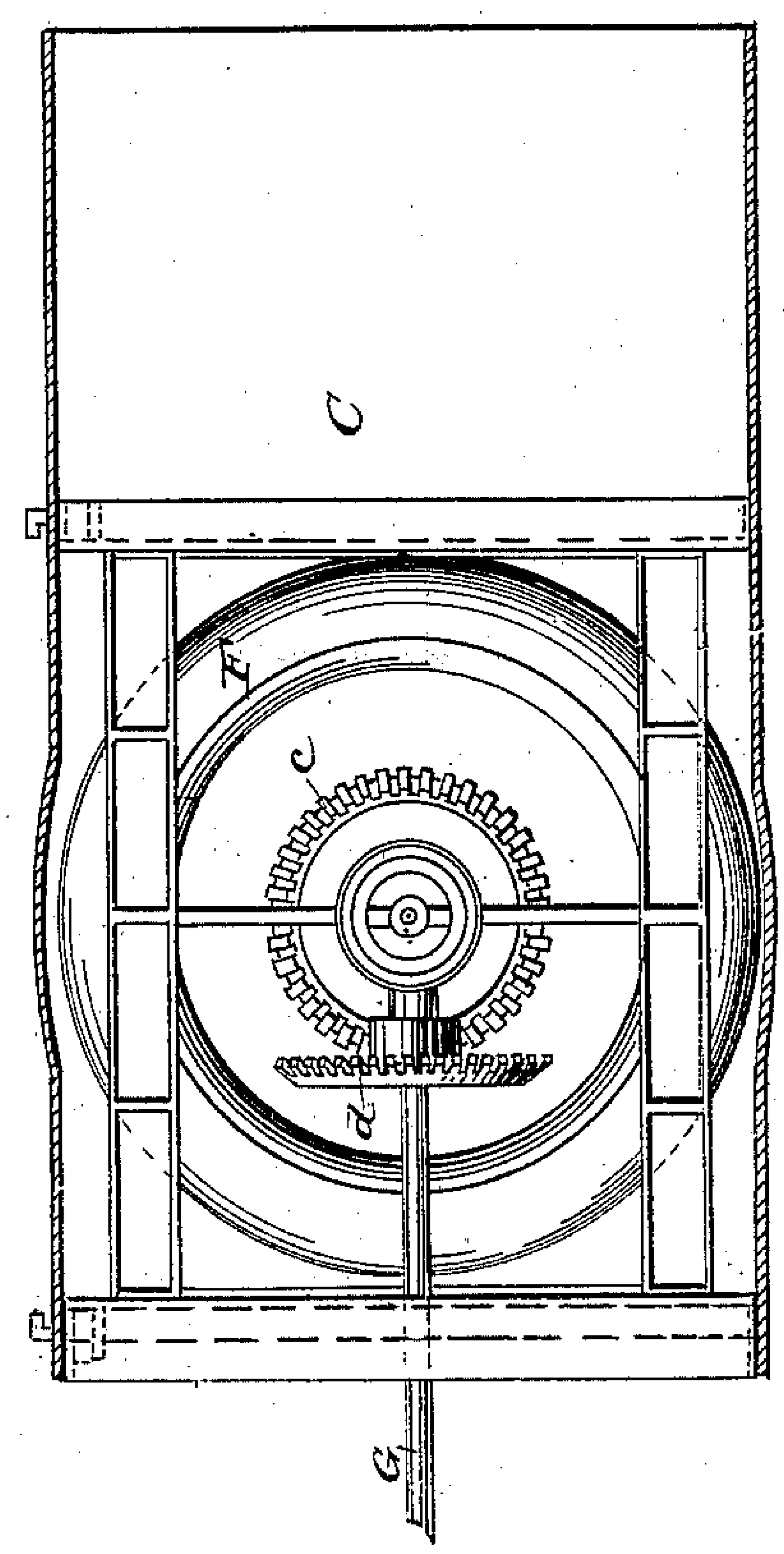


Fig. 4.



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4 Sheets—Sheet 3.

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MARINE TORPEDO.

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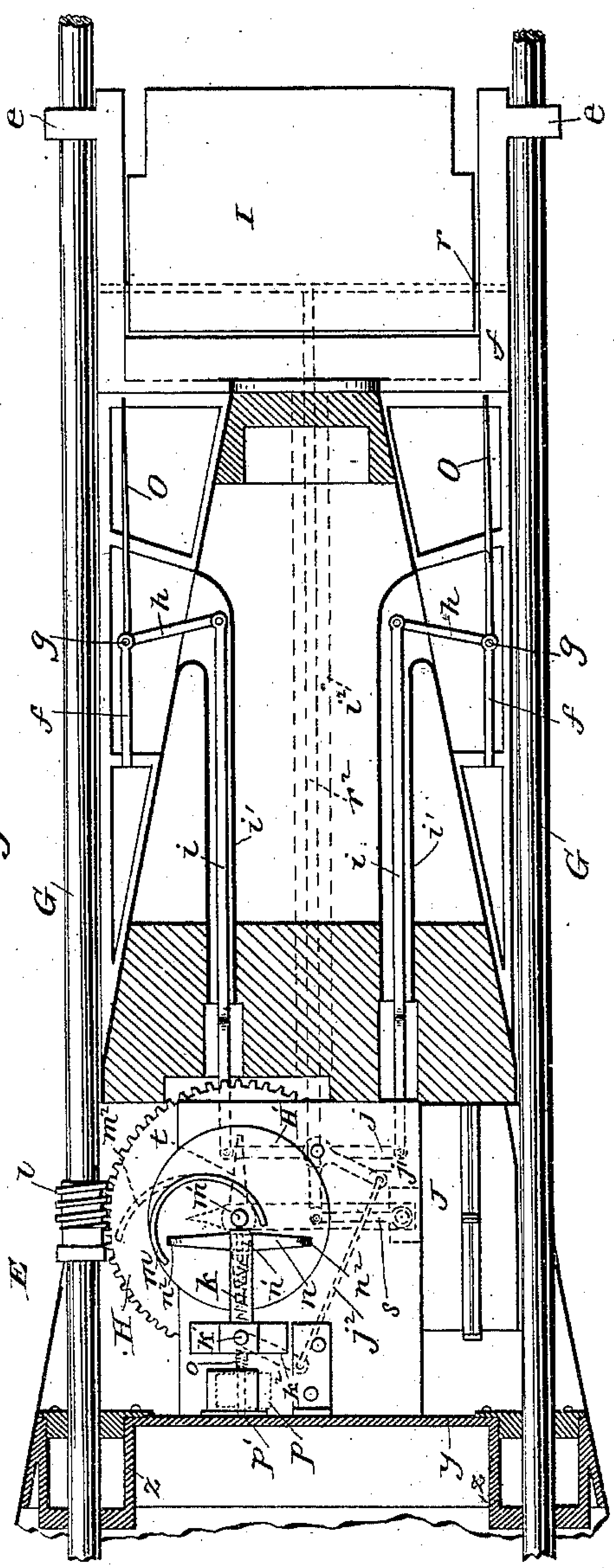

Fig. 6.

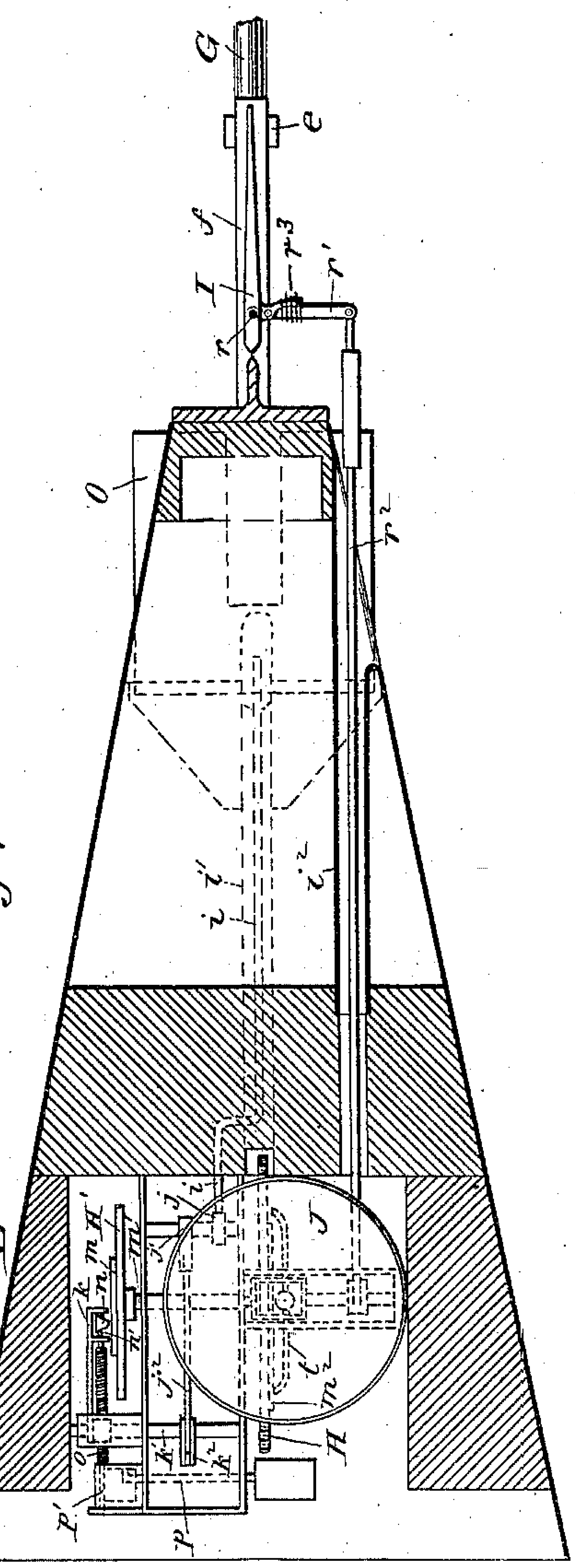

Fig. 7.

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(No Model.) 4 Sheets—Sheet 4.

J. A. HOWELL.

MARINE TORPEDO.

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Fig. 10.

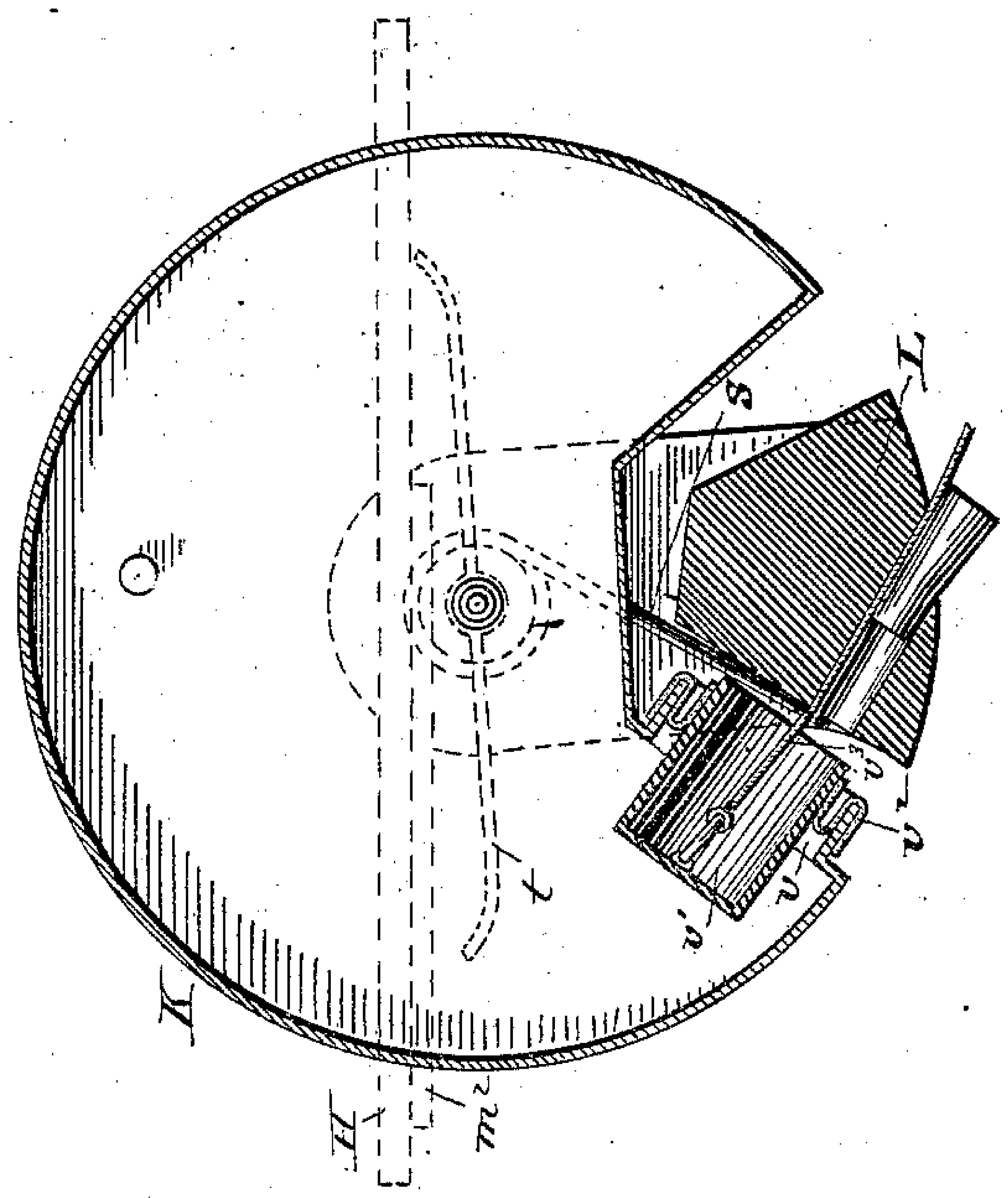


Fig. 9.

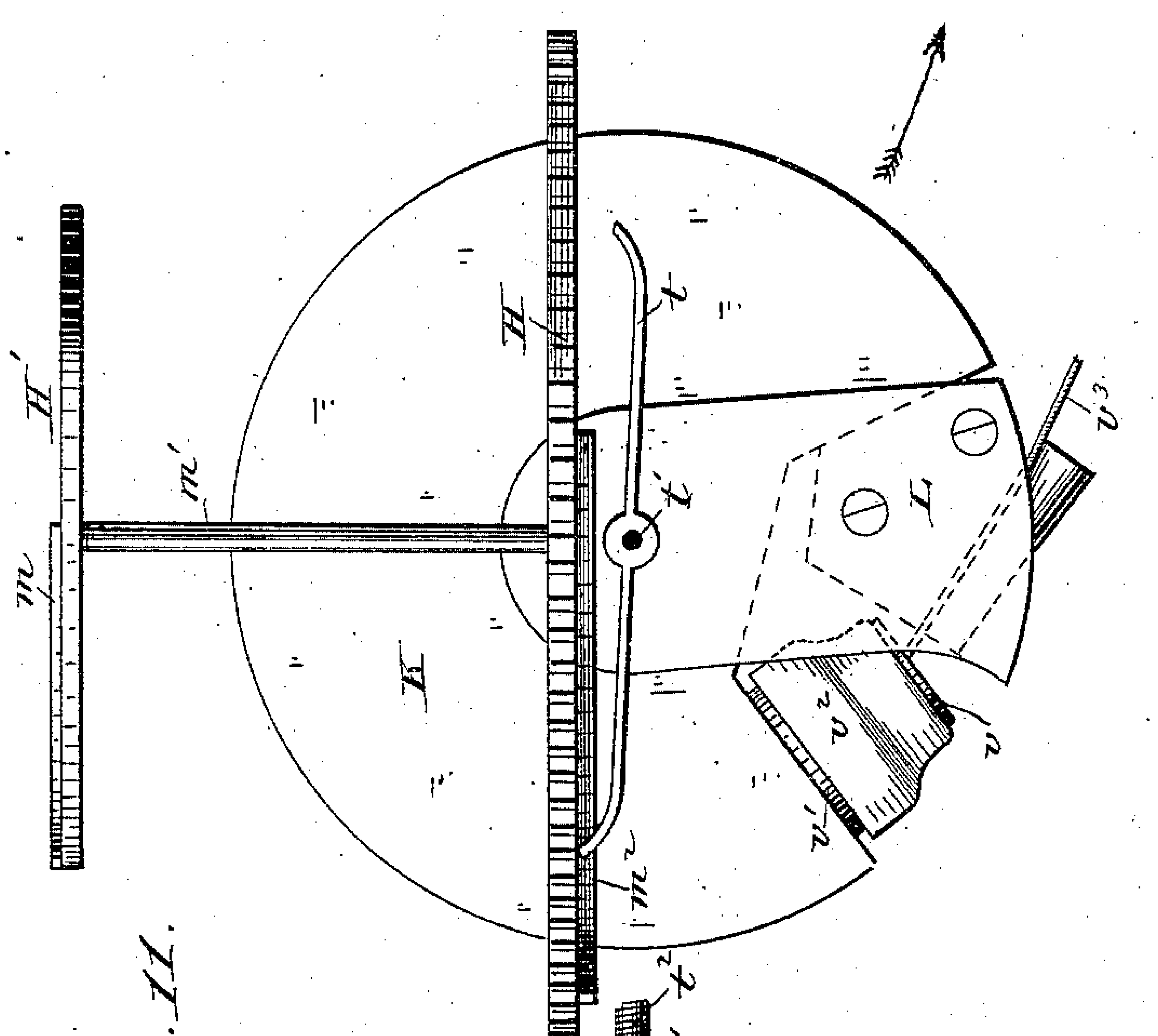
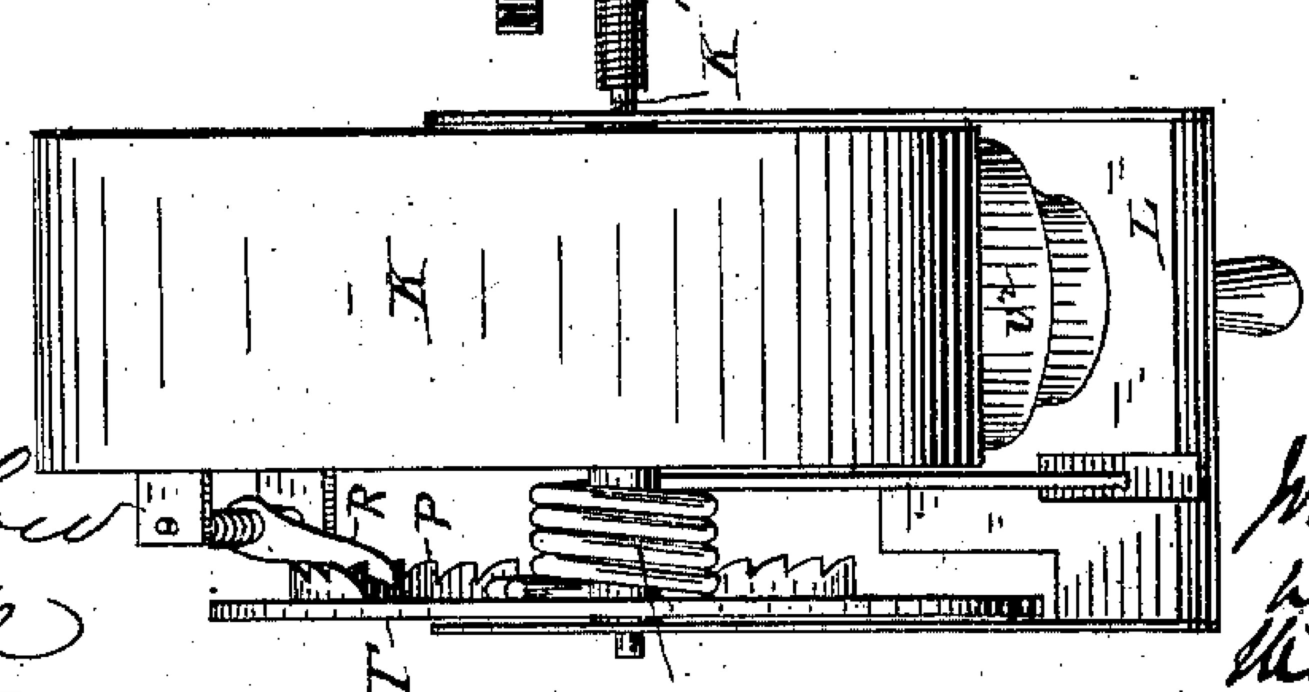


Fig. 11.



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UNITED STATES PATENT OFFICE.

JOHN A. HOWELL, OF THE UNITED STATES NAVY.

MARINE TORPEDO.

SPECIFICATION forming part of Letters Patent No. 311,325, dated January 27, 1885.

Application filed October 6, 1884. (No model.)

To all whom it may concern:

Be it known that I, JOHN ADAMS HOWELL, of the United States Navy, have invented certain new and useful Improvements in Marine Torpedoes, of which the following is a specification.

My invention relates to what are known as "self-propelling marine torpedoes," and it is directed to both the propulsion and the guidance of the torpedo, intending by the term "guidance" not only the maintenance of the torpedo in the direction in which it was pointed before launching, but also its maintenance at a constant depth in the water. My main object is to provide means whereby it will automatically be caused to steer the proper course—that is to say, maintain itself in the course in which it was originally pointed or launched and during its travel to maintain itself at a determinate depth in the water after reaching that depth.

The torpedo in which my invention is embodied may be termed a "fly-wheel torpedo," the motor being of the same general character as that described in my Letters Patent No. 121,052, dated November 21, 1871—to wit, a fly-wheel to which a very rapid movement of rotation is imparted by any power extraneous to the torpedo. From this motor motion is imparted to one or more propellers, which serve to drive the torpedo through the water. If a fly-wheel torpedo be acted on by any force which tends to revolve or turn it about any axis not parallel to the axis of rotation of the fly-wheel, there will be resultant motion about an axis perpendicular to the plane of the two first-named axes. For instance, if the fly-wheel revolve about a horizontal axis, and an extraneous force act against the torpedo so as to tend to turn it about a vertical axis, then the resultant motion will be not about the vertical axis, but about a horizontal axis perpendicular to the plane of the other two axes. This fact I avail of to offset and oppose lateral deflection of the torpedo, so as to compel it to travel in the course in which it was originally pointed or launched. Inasmuch as a laterally-deflecting force tends to turn the torpedo about a vertical axis, it follows that the axis of rotation of the fly-wheel should be horizontal, and I generally prefer to have this horizontal axis of rotation transverse to the longitudinal axis of the torpedo. Under these conditions the axis of resultant rotation, or motion due to the application of a laterally-deflecting force, will be the longitudinal axis of the torpedo; in other words, the torpedo will roll, and this rolling can be conveniently availed of to bring into action steering mechanism arranged and operating to apply automatically an opposite deflecting or deviating force which will restore the *status quo*. As soon as the rolling ceases the steering mechanism becomes inactive; but until then it constantly offers to the deflecting force an opposition which in the end overcomes and suppresses it.

The steering mechanism I prefer consists of one or more vertical rudders and rudder-operating devices so arranged that when the torpedo rolls to starboard the helm automatically will be put to starboard, and vice versa. If, as above supposed, the horizontal axis of rotation of the fly-wheel be transverse to the longitudinal axis of the torpedo, then it becomes necessary to provide a diving-rudder to keep the torpedo during its travel at a given depth in the water. This rudder, which moves on a horizontal transverse axis parallel to the rotation-axis of the fly-wheel, is operated automatically by mechanism whose action is controlled by a combined pendulum and regulator, the action of the regulator being governed by the pressure of the water in which the torpedo is immersed, which pressure of course varies with varying depth. The office of the regulator is to cause the torpedo to seek and maintain itself at the required depth; that of the pendulum is to prevent the torpedo from diving or rising too abruptly. The regulator, in the first instance, is so adjusted that when acted on by a pressure equivalent to that which obtains at the depth to which the torpedo is to be immersed the diving-rudder will be in its horizontal or neutral position, and the arrangement of all the parts is such that when the pressure exerted upon the regulator exceeds or falls below that pressure, which may be termed the "normal," the diving-rudder will be moved in a direction to bring back the torpedo to the depth required. Consequently, supposing the required depth of immersion for the torpedo be twelve feet, the diving-rudder will at the time the torpedo is dropped or launched be in a position to cause the torpedo to dive. When the torpedo reaches the required depth, normal pressure on the hydrostatic regulator is attained, and the diving-rudder will assume its neutral position, and thenceforward any tendency of the torpedo to seek a different level will be counteracted by the rudder, which will be thrown up or down, according as the hydrostatic pressure exceeds or falls below the normal.

Having indicated in a general way the nature of my invention, I shall now proceed to more particularly describe the same and the manner in which it may be carried into practical effect by reference to the accompanying drawings, in which—

Figure 1 is a plan, and Fig. 2 is a side elevation, of a self-propelling marine torpedo embodying my invention. Fig. 3 is a plan, on enlarged scale, of the fly-wheel and parts adjacent thereto. Fig. 4 is a side elevation of the same. Fig. 5 is a vertical section of the same in the plane of the axis of the wheel. Fig. 6 is an enlarged sectional plan of the rear portion of the torpedo containing the rudders and their actuating mechanism. Fig. 7 is an enlarged sectional side elevation of the same. Fig. 8 is a front elevation of the same, partly in section. Fig. 9 is an enlarged side elevation of the combined pendulum and regulator. Fig. 10 is a section of the same in a plane transverse to its axis of oscillation. Fig. 11 is an edge or end view of the same.

The shell or case of the torpedo is made of thin metal, and is shaped as shown in Figs. 1 and 2. It can conveniently be made in five sections, A, B, C, D, E, which are united by interior rings, to which they are bolted or screwed. The explosive is placed in A and B, and the firing attachment in A.

x in Figs. 1 and 2 represents the projecting end of the rod, which, when struck, is forced back against the cap within to effect the explosion of the charge. Section C contains the fly-wheel and gearing for driving the propellers, and is in communication with section D. Both of these sections are water-tight, as of course are also A and B.

Between sections D and E is a water-tight partition, *y*, Fig. 6, in which are stuffing-boxes *z* for the propeller-shaft. The after portion of section E is made water-tight, as seen in Figs. 6 and 7. The forward portion is open to the water, as shown in the figures referred to, and also in Fig. 8, where openings for the water are represented at *w*. The latter portion of section E contains the mechanism for controlling the steering and diving rudders, and is filled in with wood, so that it will receive only the minimum volume of water needed.

I now proceed to a more particular description of those parts of the torpedo in which my invention is more particularly comprised. The fly-wheel F (shown in Figs. 3, 4, 5) is mounted on an axle which is at right angles to the longitudinal axis of the torpedo, and is designed, when the torpedo is launched, to occupy a horizontal position. The axle is supported in suitable roller-bearings, *a*, fixed in place in the central section, C, of the torpedo, the friction-rollers being indicated at *b*, Fig. 5. On each side of the central web of the fly-wheel a beveled gear, *c*, is fixed to the axle. From these gears are driven the two propeller-shafts, G, each having a beveled gear-wheel, *d*, which gears with one of the gears *c*. These shafts are parallel to one another in the same horizontal plane and on opposite sides of the longitudinal axis of the propeller. They pass aft through suitable stuffing-boxes and stern-bearings, *e*, in the after frame-work *f* of the torpedo shell or case, and have attached to them screw-propellers, which revolve in tubes G′, secured to the after frame-work *f*, and open from end to end. The function of these tubes will be hereinafter pointed out. I here remark that in some cases it may be found desirable to use only a single propeller instead of two; and I desire to be understood as not restricting myself either to the particular number of propellers or to the particular manner of connecting them to the fly-wheel.

The steering mechanism will now be described. I make use of two steering-rudders, O, in the present instance, although I may use one only, or even more than two, if desired. These rudders are vertical, and turn on vertical posts or axes *g* in the frame-work *f*, and are arranged one on each side of the after portion of rear section, E. Each of them is slotted, as indicated by dotted lines in Fig. 7, so that it will straddle the adjoining propeller-shaft and frame-work, and be free to move without interfering with the latter. These rudders are by arms *h* and links or rods *i* (which latter pass through tubes *i′* in the water-tight part of section E into the forward open part of said section) connected to opposite ends of a centrally-pivoted lever, *j*, whose axle is provided with a radial arm, *j′*, connected by a link, j^2, to a crank-arm, k^2, on the axle *k′* of the tiller *k*. Under this arrangement it will be seen that both rudders can, by moving the tiller, be moved to starboard or port or be brought midships, as occasion may demand. The automatic action of the tiller for this purpose is brought about as follows: On one of the propeller-shafts G is a worm, *l*, Fig. 6, which gears with and drives a wheel, H, mounted on a vertical axle, *m′*, in the open part of section E, and on the same axle is fixed a wheel, H′, having a cam-rib, *m*, on its upper face. The axle revolves continuously so long as the propeller-shaft revolves. The tiller *k* overhangs the cam-wheel H′, and at its outer end carries a pivoted arm, *n*, arranged crosswise of the torpedo, the axle *n′* of which is hung in ears or bearings on the under side of the outer end of the tiller and is connected by means of a flexible shaft, *o*—for instance, a shaft of closely-coiled wire—to the axle p' of a pendulum, p, as indicated in Figs. 6 and 7. The axle n' of the arm n is horizontal, and extends in the direction of the length of the torpedo, and the axis of the pendulum is on the prolongation of it. The arm n at its ends has points n^2, one or the other of which will engage the cam-wheel whenever the latter is inclined laterally in one direction or the other relatively to the arm.

The operation of the parts is as follows: The pendulum p tends to keep the points n^2 of the arm n always in a horizontal plane, and the cam-wheel normally lies in a plane parallel thereto. With the parts in this position the tiller is midships, as represented in the drawings; but whenever by an extraneous deflecting force the torpedo is caused to roll upon its longitudinal axis in one direction or the other the cam-wheel is tilted or inclined in a corresponding direction with reference to the arm n, which by its pendulum is maintained horizontal. Consequently the continuously-revolving cam-wheel is thrown into engagement with one or the other of the points n^2 of the arm, with the result of putting the helm to port or starboard, as the case may be, the flexible shaft o permitting this movement. The steering-rudders when thus moved set up a deflecting force opposed to the initial extraneous deflecting force, with the result of producing in the torpedo a tendency to roll in the opposite direction, the helm being put to starboard when the torpedo rolls to starboard, and vice versa. This action will continue until the rudders have rolled the torpedo back far enough to permit the disengagement of the arm n and cam-wheel, or, in other words, until the cam-wheel is in its normal horizontal position. In this way it will be seen that the torpedo can be automatically steered or kept from leaving the course in which it was pointed at the time it was launched. The rudders are not simply turned to starboard or port, as the case may be, and held there until the torpedo is brought back to its course. The revolving cam-wheel imparts to them a series of impulses, and this is kept up so long as the tilting arm engages the cam-wheel. The cam-rib may be so formed as to impart one or more impulses to the rudder or rudders for each revolution.

I come now to the mechanism by which the torpedo is caused to seek a determinate depth in the water, and to maintain itself at that depth during its course. The rudder I use for the purpose, hereinbefore termed the "diving-rudder," is shown at I. It is a horizontal rudder, hung at the rear of the torpedo shell or case on a horizontal axis parallel to the rotation-axis of the fly-wheel. This rudder, by a crank-arm, r', and link r^2, (the latter passing through a tube, i^2, into the forward open portion of section E,) is connected to a vertically-pivoted tiller, s, Fig. 8, which extends crosswise of the torpedo, and, like the steering-rudder tiller, is controlled by a tilting arm and a cam-wheel. The tilting arm t for the tiller s is pivoted to it on a horizontal transverse axis, t', and tilts in the direction of the length of the torpedo. The cam-wheel which co-operates with arm t may be the wheel H, or may, like wheel H', be a separate wheel fixed on the axle m'. The former arrangement is represented in the drawings, the wheel H having on its under face the cam-rib m^2, which is to be engaged by one or the other of the ends of arm t, according to the direction in which the latter is tilted. Normally the diving-rudder is horizontal and the arm t is out of engagement with the cam-wheel H. When, however, the torpedo is at a greater or less depth than that at which it is to travel, the rudder stands in a position to deflect the torpedo up or down, as the case may be. The position of the tilting arm t for this purpose is controlled by a pendulum, but this pendulum itself is in turn under the control of a regulator which is carried by the pendulum, and is operated by hydrostatic pressure due to the depth of water in which the torpedo is immersed. The pendulum (shown more clearly and in detail in Figs. 9, 10, 11) comprises an air-tight hollow case, K, of cylindrical form, with a recess in the under part of it to receive the pendulum-bob L. The case is journaled in a cylindrical shell, J, Figs. 6, 7, 8, fixed on the forward part of division E and open to the water, and the pendulum-bob L is mounted and can swing freely on the journals of the case K as an axis. The movement of the pendulum-bob with reference to the pendulum-case is, however, circumscribed and controlled by the regulator, which consists of a piston, v', playing loosely in a cylindrical neck, v, opening into the interior of the case K, the parts v v' being connected by a sleeve or thimble, v^2, of vulcanized rubber or other thin pliable material. The case K is virtually an air-chamber closed by the piston and thimble. The piston fits loosely in the cylinder v, so loosely, in fact, that there is ample room between it and the walls of the cylinder for reception of two thicknesses of the material of which the sleeve or thimble is composed. The sleeve hermetically seals the joint between the cylinder and piston, and at the same time permits the latter all needed freedom of movement. At one end it is stretched over and made fast to the outer end of the cylinder. It thence extends around the piston, and is fastened to the outer end of the latter.

In Fig. 9 the piston is represented in its outermost position, and in this position the cylindrical body of the piston is closely surrounded and clasped by the body of the sleeve. Suppose the piston to be subjected to hydrostatic pressure, the result will be to force it back into the cylinder. As it moves back the sleeve will unroll from the exterior of the piston, and in proportion to the extent to which this takes place will roll down upon the interior face of the cylinder, as seen in Fig. 10, the water entering the annular space thus formed between the piston and cylinder, keeping the two folds of the rubber sleeve separate, and preventing them from sticking together, or in any way interfering with one another.

I here remark that the device just described by reference to Figs. 9 and 10 is susceptible of many other uses than that to which it is here applied, and I desire it to be understood that I purpose making the device the subject of a separate application for Letters Patent.

The regulator-piston, as above stated, is mounted on the case K, to one side of the axis of the latter, and by a cord, v^3, or equivalent instrumentality, is connected to the pendulum-bob L, so that the two must move together. Under this arrangement it will be seen that in proportion as the piston moves in or out the pendulum-bob will correspondingly shift its position, thus changing the center of gravity of the pendulum K, and causing the latter to turn in one direction or the other.

In order to prevent the bob from being moved by the piston before the requisite pressure of water upon the latter is obtained, I provide a spring, S, which bears against the pendulum-bob and offers a yielding resistance to the pull of the piston. This spring, obviously, may be arranged in a variety of ways. In the arrangement shown in the drawings it is represented as consisting of a steel wire having its center portion coiled around the axle of the pendulum-case, with its lower end bearing against the pendulum-bob and its upper end made fast to a wheel, T, which revolves on the axle of the pendulum-case as an axis, and is provided on its rear face with ratchet-teeth P, to engage a spring-pawl, R, attached to case K. By means of this wheel the tension, and consequently the resistance of the spring, can be readily varied and adjusted. The movement of the pendulum K, I avail of to actuate the tilting arm t, to which end I connect the axle K′ of the pendulum to the axle t' of the arm by a flexible shaft, t^2, the result being that when the pendulum turns corresponding movement will be imparted to the arm t, thus causing the latter to tilt in one direction or the other, as the case may be. The weight of the bob and resistance of the spring S bear such relation to the power exerted by the piston when subjected to the pressure obtaining at the depth to which the torpedo is to be immersed, and all the parts are so adjusted, that the piston v' when subjected to the pressure (which may be termed the "normal pressure") will draw the bob far enough over to cause the case K by the change in its center of gravity to turn to a position which will bring the tilting arm t parallel with the cam-wheel H if the latter be horizontal. In this position the arm t will be out of engagement with the cam-wheel, and the diving-rudder will be horizontal. A greater or less pressure than that will effect a movement of the pendulum to one side or the other of the normal line, with the effect of turning the pendulum-case K far enough to bring one or the other of the points of the tilting arm t into engagement with the cam-wheel H, which will result in imparting to the rudder a series of impulses in an upward or downward direction, as the case may be. The pressure at the time of launching the torpedo is of course less than the normal. Consequently the parts will be in a position to cause the torpedo to dive as soon as it reaches the water. When the torpedo reaches the required depth, the piston, by the hydrostatic pressure at that depth, is pushed in far enough to bring pendulum K to a position in which the tilting arm t will be disengaged from the cam-plate H if the torpedo be horizontal. It is possible that the torpedo, by reason of its momentum, may in diving go below the required depth; but this is soon corrected, because the increased pressure will, by still farther pushing in the piston, bring the pendulum K to a position in which the arm t will be tilted in a direction to bring into engagement with the cam-wheel that one of its points which will move the tiller in a direction to throw the diving-rudder up, thus causing the torpedo to rise. In this way the torpedo will finally be brought to the required depth, and will be maintained at that depth during its course. The pendulum acts to correct the too abrupt ascent or descent of the torpedo. In Fig. 9, for instance, where the rear end or arm t is in engagement with its cam-wheel, let it be supposed that the torpedo should dive in the direction of the arrow. If the angle of inclination be too abrupt, the position of the pendulum with reference to the cam-wheel will necessarily be shifted, and this will bring the whole device—the combined pendulum and regulator—in the direction of the arrow far enough either to disengage the arm t from the cam, or, if need be, to throw the front end of the arm into engagement with the cam, and thus impart to the rudder impulses tending to cause the torpedo to rise. In this way the torpedo is compelled to dive and at an easy angle. The tubes G′, by reason of the mass of water which they contain, serve to steady the torpedo and to stiffen it against irregular movement in a vertical plane. The water in the tubes, having mass and velocity, will resist motion in a direction perpendicular to the axis of the tubes, and it thus serves as a drag, particularly to prevent undue oscillation of the torpedo about the axis of the fly-wheel. The tubes are represented as surrounding the propellers. This, however, is a matter of convenience, and not a necessity. The propellers need not be in the tubes, and instead of two tubes one centrally-located tube might be used.

While I do not restrict myself to the specific dimensions about to be stated, I may say that a satisfactory result has been obtained by employing with a torpedo eight feet long and thirteen inches in diameter two tubes each three inches long and seven inches in diameter, equivalent to one tube six inches in length and seven inches in diameter. The fly-wheel F is put in motion by any suitable means, which will readily suggest themselves to the skilled mechanic. One convenient way is to provide in a recess in the side of the torpedo a clutch, M, which passes through a stuffing-box, N, and engages at its inner end the adjoining end N′ of the fly-wheel axle, which is formed with wings to engage the wings of the clutch. The clutch may, as shown, have a sliding movement in its stuffing-box sufficient to permit it to be drawn out of engagement with the axle, in which position it is represented in Fig. 5. The outer end of the clutch can be engaged by the end of the driving-shaft of any suitable motor—as, for instance, a Barker's mill or aeropile. After the fly-wheel has reached the requisite speed of rotation—say two hundred or more revolutions per second—the motor is detached, and the torpedo is ready for launching.

In order to maintain both the steering-rudders and the diving-rudder normally in neutral position, or amidships, they may be provided with light springs, which, when the till-tillers are released from control of their cam-wheels, will act to bring the rudders back to neutral position and to hold them there.

At the time the torpedo is launched or dropped overboard the operating mechanism of the diving-rudder is in action, and to prevent the shock or strain to which this mechanism would otherwise be subjected when the horizontal diving-rudder strikes the water, I connect the rudder by a yielding or spring connection to the arm r', as indicated at r^3, Fig. 7.

I have described what I believe to be on the whole the best way of carrying my improvement into practical effect. I do not, however, restrict myself to the mechanical details set forth, for it is manifest that the same can be widely varied without departure from the principle of my invention. The axis of rotation of the fly-wheel has been represented as transverse to the torpedo, with a view to converting lateral deviation into a rolling motion; but the rotation-axis might be lengthwise of the torpedo, and in this case the resulting motion of the torpedo due to a laterally-deflecting force would be in a vertical plane, which could be corrected by a steering-rudder similar to those already described. So, also, in case the torpedo were intended to be a surface-torpedo—that is to say, were intended to move on the surface of the water—the twin-propeller arrangement shown in the drawings might be availed of to correct the rolling. The torpedo in rolling would lift one propeller and sink the other, and the effect of this would be to correct the deviation.

The gist of my invention, so far as concerns the correcting of deviations in the course of the torpedo, lies in so placing the rotation-axis of the fly-wheel as to obtain a resultant axis of motion in the case of deviating forces acting on the torpedo, and in combining with the fly-wheel thus placed mechanism, termed by me "steering mechanism," brought into action by the resultant motion, and arranged and automatically operating to set up an opposite deviating force which will counteract and neutralize the initial extraneous deviating force.

What I claim as new and of my own invention is as follows:

1. The combination, with the torpedo case or shell and the fly-wheel mounted therein, with its rotation-axis located, substantially as described, to obtain a resultant axis of motion in case of deviating forces acting on the torpedo, of steering mechanism, and suitable devices for controlling the same, arranged and operating substantially in the manner hereinbefore set forth, whereby said steering mechanism shall be brought into action upon occurrence of the resultant motion, and when thus brought into action shall be caused to set up an opposite deviating force, which will counteract and neutralize the initial extraneous deviating force.

2. The torpedo case or shell and the fly-wheel mounted therein with its axis of rotation at right angles to the longitudinal axis of the torpedo, whereby the application to the torpedo of a laterally-deflecting force effects the rolling of the torpedo upon its longitudinal axis, in combination with steering mechanism arranged and automatically operating, substantially in the manner hereinbefore described, to offer to the initial deflecting force an opposing deflecting force which will suppress the rolling of the torpedo and bring it to normal position.

3. The combination of the torpedo case or shell, the fly-wheel having its axis at right angles to the longitudinal axis of the case, the propelling mechanism geared to and driven by said fly-wheel, the steering rudder or rudders, the tiller connected to said rudders, the tilting arm or beam carried by said tiller, the pendulum connected to said arm and acting to maintain the same in horizontal position, and the rotating cam-wheel which co-operates with said arm, the combination being and acting substantially as hereinbefore set forth.

4. The combination, with the torpedo case or shell, of the tiller, the pendulum-controlled rocking arm carried thereby, the rotating cam-wheel, and the steering rudder or rudders connected to said tiller, these parts being arranged to operate substantially in the manner hereinbefore set forth, so that when the torpedo rolls to starboard the helm will be automatically put to starboard, and when it rolls to port the helm automatically will be put to port.

5. The combination, substantially as set forth, of the fly-wheel having a transverse horizontal axis of rotation, the automatically-operating steering mechanism, the diving-rudder, and the mechanism for automatically operating the same, these parts being combined and arranged to jointly operate, substantially in the manner hereinbefore set forth.

6. The combination of the fly-wheel, one or

more propellers, one or more steering-rudders, the diving-rudder, and means, substantially as described, whereby the propeller and rudders are actuated from the fly-wheel at the times and in the manner substantially as hereinbefore set forth.

7. The tiller-controlling pendulum, in combination with the hydrostatic regulator carried by said pendulum and connected to the pendulum-bob, substantially as and for the purposes set forth.

8. The combined pendulum and regulator, in combination with the diving-rudder, the tiller for moving the same, and the tiller-controlling cam, substantially as and for the purposes hereinbefore set forth.

9. The combination of the pivoted pendulum-case, the spring-controlled pendulum-bob swiveled on the axis of the case, and the hydrostatic regulator carried by the case and connected to the bob, substantially as and for the purposes set forth.

10. The combination, with the tiller, and a tilting arm carried by the same and adapted to engage at either end the motor by which the tiller is actuated, of a pendulum, and a flexible shaft connecting the axle of the pendulum with that of the tilting arm, substantially as and for the purposes hereinbefore set forth.

11. The combination, with the torpedo, of one or more steadying-tubes, G′, placed at the rear of and axially in line or parallel with the longitudinal axis of the torpedo, substantially as and for the purposes hereinbefore set forth.

In testimony whereof I have hereunto set my hand this 6th day of October, 1884.

JOHN A. HOWELL.

Witnesses:

EWELL A. DICK,

M. BAILEY.