(No Model.) 5 Sheets—Sheet 1.

# ADOLF GRAF VON BUONACCORSI DI PISTOJA.

## AUTO-MOBILE TORPEDO.

No. 413,113. Patented Oct. 15, 1889.

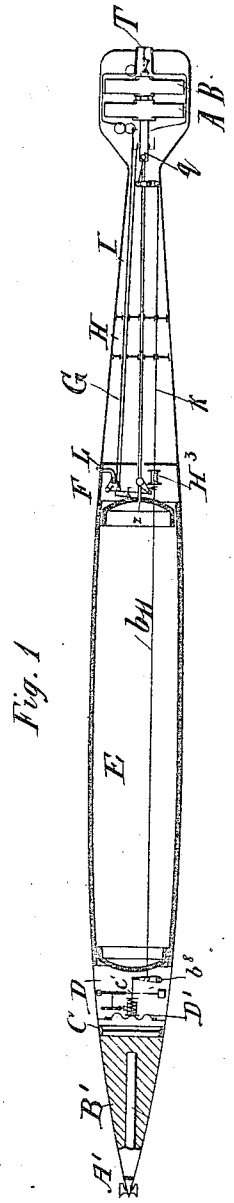



Fig. 1

Witnesses:
J. Thomson Cross.
Milt. E. Bouzee

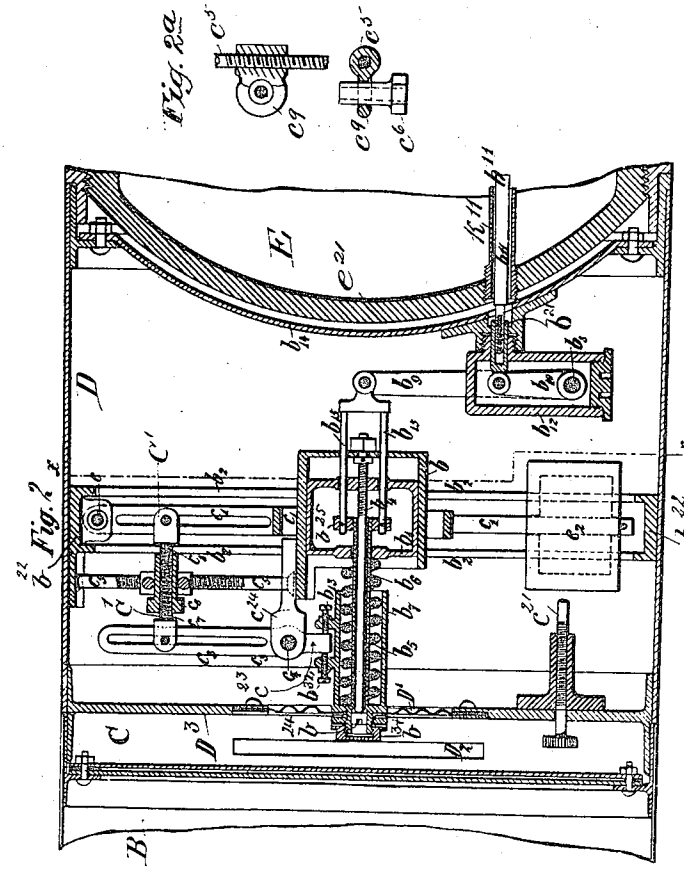
Inventor:
Adolf Graf von Buonaccorsi di Pistoja
per Henry Otto
Attorney

(No Model.) 5 Sheets—Sheet 2.

# ADOLF GRAF VON BUONACCORSI DI PISTOJA.

## AUTO-MOBILE TORPEDO.

No. 413,113. Patented Oct. 15, 1889.




Witnesses
Milt. E. Rouzee
J. Thomson Cross

Inventor
Adolf Graf von Buonaccorsi di Pistoja
by Henry Orth
his atty

(No Model.) 5 Sheets—Sheet 3.

# ADOLF GRAF VON BUONACCORSI DI PISTOJA.

## AUTO-MOBILE TORPEDO.

No. 413,113. Patented Oct. 15, 1889.

Fig. 6.

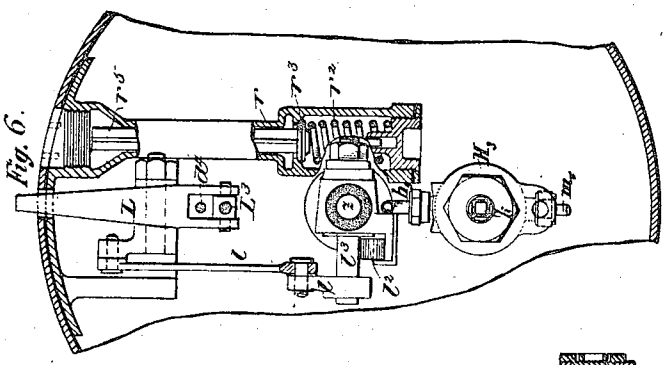
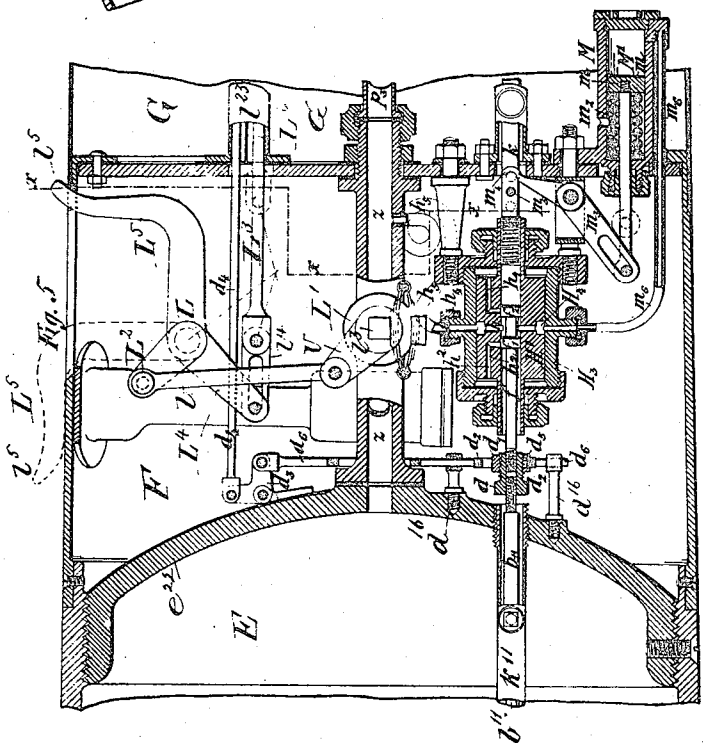


Fig. 5.



Witnesses:
J. Thomson Cross
Will. E. Rouzee

Inventor.
Adolf Graf von Buonaccorsi di Pistoja
per Henry Orth
Atty

(No Model.) 5 Sheets—Sheet 4.

# ADOLF GRAF VON BUONACCORSI DI PISTOJA.

## AUTO-MOBILE TORPEDO.

No. 413,113. Patented Oct. 15, 1889.

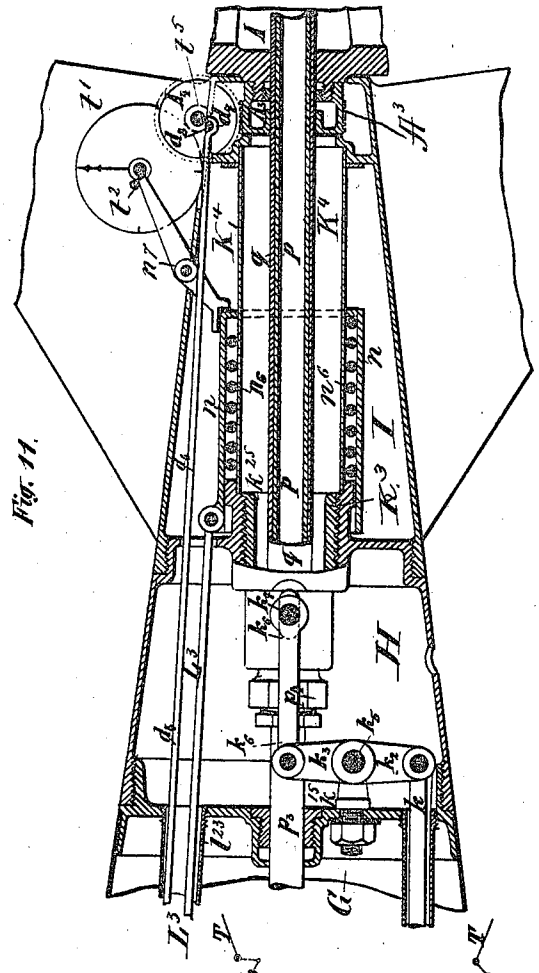


Fig. 11.

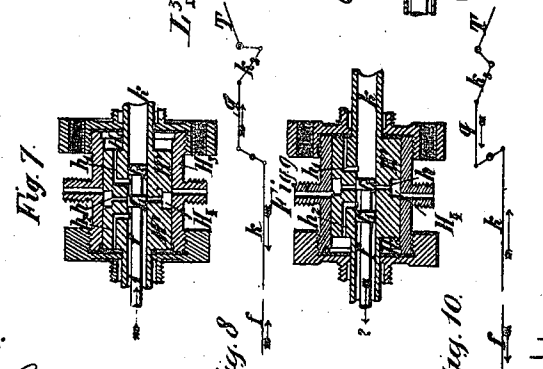


Fig. 7. Fig. 8. Fig. 10.

Witnesses:
J. Thomson Crosse
Will. E. Rouzee

Inventor
Adolf Graf von Buonaccorsi di Pistoja.
per Henry A. Wise
Atty.

(No Model.) 5 Sheets—Sheet 5.

# ADOLF GRAF VON BUONACCORSI DI PISTOJA.

## AUTO-MOBILE TORPEDO.

No. 413,113. Patented Oct. 15, 1889.

Fig. 12a

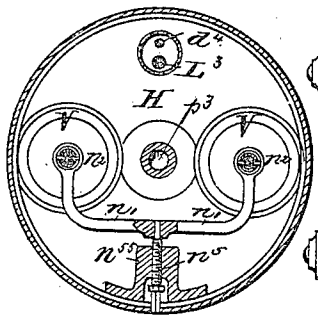


Fig. 12.

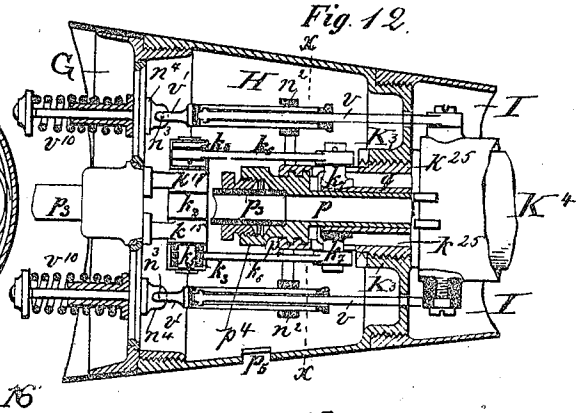


Fig. 15

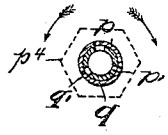


Fig. 16

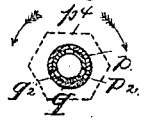
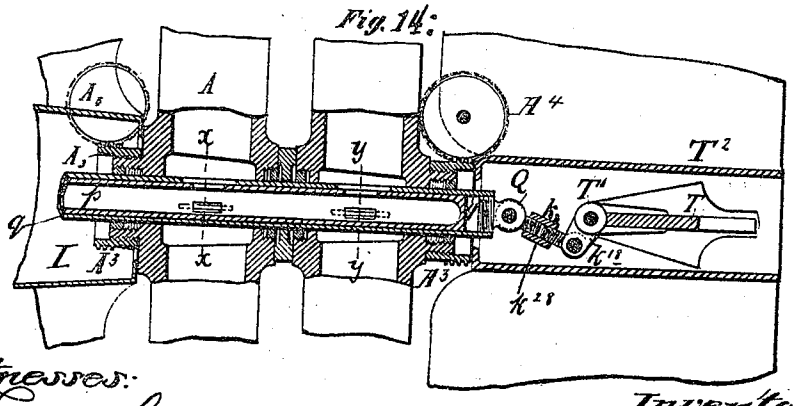


Fig. 13



Fig. 14.



Witnesses:
J. Thomson Cross.
Milt. E. Bouzee

Inventor
Adolf Graf von Buonaccorsi di Pistoja
by Henry Orth
Atty.

# UNITED STATES PATENT OFFICE.

ADOLF GRAF VON BUONACCORSI DI PISTOJA, OF VIENNA, AUSTRIA-HUNGARY.

## AUTO-MOBILE TORPEDO.

SPECIFICATION forming part of Letters Patent No. 413,113, dated October 15, 1889.

Application filed April 18, 1888. Serial No. 271,047. (No model.) Patented in Germany February 24, 1888, No. 49,124; in France February 24, 1888, No. 188,945; in Belgium March 12, 1888, No. 81,003; in England March 20, 1888, No. 4,297; in Italy March 31, 1888, XXII, 23,135 and XLV, 431; in Portugal May 17, 1888, No. 1,244; in Norway May 28, 1888, No. 934; in Austria-Hungary June 26, 1888, No. 8,093 and No. 21,102, and in Spain June 30, 1888, No. 8,035.

*To all whom it may concern:*

Be it known that I, ADOLF GRAF VON BUONACCORSI DI PISTOJA, a subject of the Emperor of Austria-Hungary, residing at Vienna, in the Province of Lower Austria, in the Empire of Austria-Hungary, have invented certain new and useful Improvements in Torpedoes, (for which I have obtained Letters Patent in Austria-Hungary, No. 8,093 and No. 21,102, dated June 26, 1888; in Germany, No. 49,124, dated February 24, 1888; in France, No. 188,945, dated February 24, 1888; in Belgium, No. 81,003, dated March 12, 1888; in Italy, Vol. XXII, No. 23,135, and Vol. XLV, No. 431, dated March 31, 1888; in Spain, No. 8,035, dated June 30, 1888; in Portugal, No. 1,244, dated May 17, 1888; in England, No. 4,297, dated March 20, 1888, and in Norway, No. 934, dated May 28, 1888;) and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to letters or figures of reference marked thereon, which form a part of this specification.

Referring to the drawings, Figure 1 is a longitudinal axial schematic section of a torpedo constructed according to my invention; and Figs. 2 to 16 are detail views, drawn to an enlarged scale, of which Fig. 2 is a vertical axial section of that part of the torpedo immediately in rear of the charge-chamber and in front of the reservoir for the motive fluid, illustrating the devices that control the movements of the horizontal or immersing rudder or fin through the medium of the hydrostatic pressure of the ambient water. Fig. $2^a$ is a detached detail view of a portion of said mechanism. Fig. 3 is a section on line $x\,x$ of Fig. 2, the hull or shell of the torpedo being broken away. Fig. 4 is a diagram of the pendulum and parts connected therewith. Fig. 5 is an axial section of that part of the torpedo immediately in rear of the reservoir or storage-chamber for the motive fluid, illustrating the main distributing-valve and a portion of the shifting devices thereof, the intermediate mechanism controlled by the hydrostatic pressure and controlling the horizontal or immersing rudder. Fig. 6 is a section on line $x\,x$ of Fig. 5. Figs. 7 and 9 are axial sections of the piston-cylinder and the piston that controls the immersing-rudder; and Figs. 8 and 10 are diagrams illustrating the operation and effect of the piston upon its connections and the immersing-rudder when said piston is in the position shown in Figs. 7 and 9, respectively. Fig. 11 is an axial section of that part of the torpedo immediately in rear of the immersing or sinking chamber, illustrating the connection between the rod of the piston shown in Figs. 5, 7, and 9 and the propeller-shaft; also a portion of the shifting mechanism for the distributing and sinking valves; also the devices for timing the operation of said shifting devices. Fig. 12 is a horizontal axial section of the forward chamber, shown in Fig. 11, illustrating the mechanism for shifting the sinking-valve and disconnecting the valve rods or spindles therefrom. Fig. $12^a$ is a section on line $x\,x$ of Fig. 12. Figs. 13 and 14 are axial sections of the tail end of the torpedo, illustrating the propellers and immersing-rudder, a portion of the vertical rudder and of the propellers being broken away in Fig. 14; and Figs. 15 and 16 are sections taken on lines $x\,x$ and $y\,y$, respectively, of Fig. 14, the hexagonal head on the tubular bearing for the propeller-shaft being shown in dotted lines.

The invention relates to self-propelling, offensive or fish torpedoes; and it has for its primary object to provide means for automatically controlling the depth of immersion of the torpedo during its course through the water.

The invention has for its further object to so construct the torpedo and so arrange the propelling, immersion-regulating, valve-shifting, and other mechanisms relatively to the charge-chamber and the storage-chamber for the motive fluid as to divide the weight of the operative parts in a substantially uni-

form manner throughout the length of the torpedo, and to simplify or compact said mechanisms as that they may be contained within the torpedo-shell, thereby materially reducing the cost of construction and increasing the efficiency of the torpedo.

To these ends the invention consists in the general construction of the torpedo and the arrangement of the operative mechanisms within the shell thereof; in means for controlling the operation of the immersing-rudder through the medium of the hydrostatic pressure of the ambient water; in the combination, with the mechanism for controlling the immersing-rudder, and with the distributing and sinking valves, of shifting mechanism controlled by the propeller, and timing and synchronizing devices operating so that as the distributing-valve is closed the sinking-valves will move off their seats, and the mechanism that controls the immersing-rudder thrown out of operation; in means for locking the immersing-rudder out of operation, and in combination therewith of a time-releasing mechanism controlled by the propeller, and, lastly, in details of construction and combinations of mechanisms and parts, substantially as hereinafter fully described, and as specifically pointed out in the claims.

The torpedoes to which the invention relates have heretofore been driven almost exclusively by means of compressed air utilized in the same manner as steam is—that is to say, by admitting the air to a piston cylinder or cylinders and drive a piston or pistons by the expansive power of the air, the reciprocating motion of the piston or pistons being converted into a rotary motion by connection of the piston-rod to a crank-shaft, the motion of the latter being transmitted by suitable gearing to the propeller-shafts in such a manner as to cause the propellers to revolve in reverse directions.

In order to better maintain the torpedo in its course—that is to say, in order to counteract the variable action of a single screw-propeller—two such propellers have been used and the driving mechanism so arranged as to revolve the propellers in reverse directions. This mode of propulsion presents great disadvantages, in that considerable space is required for the accommodation of the piston-cylinders, the connections between their pistons and the driving-shafts, the governors, the slide-valves that control the operation of the pistons, and for the gearing between the driving and propeller shafts, a comparatively great amount of power being necessary to overcome the inertia of these mechanisms. There are, however, still further losses of power due to various causes—as, for instance, to frictional resistance to the flow of the compressed air through the line-pipes, both when admitting the air to or exhausting it from the piston-cylinders, thus limiting the speed of the torpedo accordingly.

By the application of the principles of the Barker reaction-wheel to the propulsion of the torpedo the air-engines, their controlling-valves and governors, the crank-shafts, the connections between said shafts and the power-pistons, and the gearing between the crank and propeller-shafts are dispensed with, a single shaft carrying both propellers and serving at the same time as a conduit for the motive fluid being employed, and this shaft is connected directly with the compressed-air reservoir, which occupies nearly one-half the length of the shell of the torpedo. The principle involved in the novel application of power whereby the mechanism referred to can be dispensed with consists in applying the power directly to the propellers, so that the live force, instead of the static pressure of the compressed air, is made available and utilized, and in admitting the compressed air in the form of jets of great velocity and density to the points where the power is to be applied, the air acting by aerodynamic impact upon the blades of the screw-propeller. It is evident that by such an application of the motive fluid the range of speed of the torpedo is very materially increased, while the inner space of the torpedo can be utilized to greater advantage, in that all the operating mechanisms may be arranged or contained within the torpedo-shell, instead of having to locate a great portion of such mechanism on the outside of such shell, as has been the case heretofore.

Inasmuch as the propeller-shaft is a non-rotating one, the said shaft may itself be used as a duct for the motive fluid, as above stated, both to the propellers as well as to other mechanisms—as, for example, the mechanism or intermediate mechanism that governs or controls the depth of immersion of the torpedo and automatic cut-off devices, there being sufficient space left for the use of a plurality of sinking or immersing valves instead of a single one, as has been the case heretofore, and such valves may be operated directly instead of indirectly, thereby increasing the efficiency of the mechanism employed for sinking the torpedo in case it should miss its aim, and such mechanism may be made to operate automatically and at the proper time, while the time required for filling the ballast or sinking chamber is materially shortened.

As a means for controlling the depth of immersion of the torpedo during its course through the water, I utilize the hydrostatic pressure of the ambient water, so that any variation in the depth of immersion will cause the correspondingly-varying hydrostatic pressure to operate the immersing rudder to maintain the torpedo at a given depth during its course through the water.

In the choice of the outlines of the torpedo it is the aim to preserve that form which presents the least resistance to motion through the water and has the least tendency to the formation of eddies, and at the same time to give to the compressed-air chamber a per-

fectly symmetrical form and to locate the same as near the bow or head of the torpedo as possible, thereby reducing the labor and cost of the construction of the air-chamber and facilitating the distribution of the weight of the entire structure and its contained mechanism, so that the persistence of the torpedo in its course through the water, which depends chiefly upon a perfect equalization or distribution of weight, is greatly increased.

In order that the invention may be better understood, I will describe the same in detail, referring to the accompanying drawings.

The general construction and arrangement of the torpedo are as follows, reference being had to Fig. 1. In outline the torpedo has a form approximately that of a fish, with a view to reduce to a minimum the resistance to its motion through the water.

The striking head or bow of the torpedo is indicated by the letter A′, and B′ is the chamber that contains the explosive charge; C, a chamber to which the ambient water has free access, and through which it has free circulation through the medium of ports $D^2$, and to an opening in the rear wall $D^3$ of which chamber is secured the diaphragm D′, that controls the horizontal or immersing rudder or fin T, hereinafter called the "immersing-rudder" that serves to regulate the degree of immersion of the torpedo.

D is the chamber or compartment that contains the mechanism through which the vibrations or pulsations of the diaphragm D′ are transmitted to the immersing-rudder or to intermediate devices.

E indicates the reservoir for the compressed motive fluid, air being preferably used as a motive power.

F indicates the compartment or chamber that contains the intermediate mechanism controlled by the diaphragm D′ and the transmitting mechanism, also the distributing-valve and its shifting mechanism; G, the ballast or sinking chamber or compartment; H, the chamber or compartment that contains the mechanism for shifting the sinking-valves; and I, the compartment in which is arranged the actuating mechanism that impels the sinking and distributing valve shifting mechanisms, and outside of which are arranged the timing-wheels for timing the operation of the valve-shifting mechanisms and for automatically releasing the mechanism that controls the immersing-rudder, which wheels constitute the only mechanism located outside of the shell of the torpedo.

The entire shell of the torpedo is constructed of comparatively light material—as sheet metal—except the reservoir for the compressed air, which is of course of sufficient weight and strength to resist the necessary pressure and to whose ends the bow and stern portions of the torpedo are secured. This reservoir E is of perfectly symmetrical form, its general outline being in conformity to the outline of the torpedo, and is located as near the bow thereof as possible, to which bow is attached the firing mechanism, which may be of any desired construction and arrangement, though I prefer the construction of firing mechanism which I have made the subject-matter of a separate application for patent, in rear of which is located the charge-chamber B, or chamber that contains the explosive charge. The operation of the firing mechanism, as described in said application, is timed to the distance the torpedo is to travel, and in order to adjust the firing mechanism accordingly it is necessary that the number of revolutions of the screw propeller or propellers be known, to which end I provide a registering mechanism operated by the propellers, as will hereinafter appear.

In rear of the charge-chamber is the water-compartment C, that has ports or openings $D^2$, so as to freely admit the ambient water thereto, and to permit its free circulation therethrough.

Referring more particularly to Figs. 1, 2, $2^a$, 3, and 4, to an opening in the front wall $D^3$ of chamber D is secured a diaphragm D′, constructed of sheet metal, and preferably corrugated to increase the superficial area and flexibility thereof, said diaphragm being exposed to the hydrostatic pressure of the water in chamber C—that is to say, to the pressure of the ambient water when the torpedo is immersed. To the diaphragm D′ is rigidly secured a cylindrical guide-casing $b^7$, in which is concentrically arranged a tube $b^6$, that contains an adjusting-rod $b^4$. The rod $b^4$ has at its outer or front end a head $b^{24}$, that lies within a tubular extension of the casing $b^7$, extending through the diaphragm D′, and being hermetically closed by a screw-cap $b^{34}$, that also serves to connect the diaphragm to the casing $b^7$. The rear or inner end of the rod $b^4$ is connected with a stationary casing $b$ and is free to revolve in its bearings in both casings $b^7$ and $b$, and is screw-threaded at that end which is within casing $b^7$, its screw-threaded portion working in a correspondingly-threaded opening formed in the rear wall of a hollow adjusting-nut $b'$, that is contained and free to slide in casing $b$. Around the inner tube $b^6$ of casing $b^7$ is coiled a spring $b^5$, one end of which abuts against the outer wall of casing $b^7$ and the other against the outer wall of the adjusting-nut $b'$, through which wall the tube $b^6$ passes freely. To the inner end of the tube $b^6$ within the nut $b'$ is secured a cross-head $b^{25}$, and to the latter are connected the rods $b^{15}$ of a cross-head pivoted to the free end of a radial arm $b^9$, mounted on one end of a shaft $b^8$, that has its bearings in a tight casing $b^{12}$, and carries within said casing a second radial arm $b^{10}$, that is connected to a transmitting-rod $b^{11}$. This rod $b^{11}$ is contained in a tube $k^{11}$, whose ends are screwed into the opposite heads $e^{21}$ $e^{22}$, Figs. 2 and 5, of the air-reservoir E, and to prevent all escape of air from the said reservoir a second head $b^{14}$ is provided in chamber D, to which

is secured a suitable coupling, to which the casing $b^{12}$ is screwed, as shown, and through which the rod $b^{11}$ passes freely. The rod $b^{11}$ serves to transmit the movements of the diaphragm D′ to the horizontal rudder through the medium of intermediate mechanism, to be described hereinafter.

By means of the screw-rod $b^4$, nut $b'$, and spring $b^6$ the pressure exerted upon the diaphragm D′, and through the latter upon the levers $b^9$ $b^{10}$, may be counterbalanced by a proper adjustment of the rod, so that as long as the torpedo remains at a normal depth, at which the pressure of the water on the diaphragm has been counterbalanced, no displacement of the diaphragm will take place. When, however, the torpedo rises or sinks, the pressure of the water in chamber D upon the diaphragm will correspondingly decrease or increase and the diaphragm will move outwardly or inwardly and transmit this motion to the rod $b^{11}$ through the mechanism described. In the first case the spring $b^5$ overcomes the pressure of the water upon the diaphragm, and in the second case the pressure of the water upon the diaphragm overcomes the tension of the spring, thus causing the tube $b^6$ and casing $b^7$ to move to the left or the right, thereby moving the levers in corresponding directions, sufficient space being left in the screw-cap $b^{34}$ to permit this movement, the rod $b^4$ remaining stationary. The amplitude of the movements of the rod $b^{11}$ will depend upon the leverage exerted thereon, or, in other words, upon the length of levers $b^9$ $b^{10}$, and must in all cases be sufficient to actuate the devices controlled by said rod, irrespective of the amplitude of the displacement of the diaphragm D′ under hydrostatic pressures, and this amplitude of motion of the diaphragm, if insufficient, may be amplified through the medium of the levers $b^9$ $b^{10}$, as will be readily understood. The casing $b$ is rigidly connected with the shell of the torpedo by means of four arms $b^2$, formed thereon or connected therewith, and on or with segmental brackets $b^{22}$.

The normal position of the immersing-rudder T, Figs. 13 and 14, is a horizontal one to prevent the torpedo from traveling in a circular path and to assist in guiding it in a straight course, from which position the rudder is displaced by the variations in the hydrostatic pressure upon the diaphragm to assume a more or less inclined position in one or the other direction, according to the direction of motion of the diaphragm, and to prevent the torpedo from deviating from its course the rudder must be brought back to its normal position whenever displaced. The mechanism for attaining this consists of a pendulum $c'$, having its pivot at $c$, Fig. 2, and carrying the weight $c^2$, Figs. 2 and 3, which pendulum swings in the angle of inclination the torpedo assumes under the displacement of the horizontal rudder. The pendulum is slotted and has connected thereto a rod that connects said pendulum with a two-armed lever $c^3$, fulcrumed at $c^4$ to a bracket-arm $c^{24}$, secured to the casing $b$. The arm $c^{23}$ of lever $c^3$ lies between the ends of two screws $b^{32}$ and $b^{13}$, screwed into lugs or ears formed on the diaphragm-casing $b^7$.

It is obvious that when the pendulum swings from left to right, as shown in Fig. 4, it will move the casing $b^7$, and through the latter the diaphragm D′ in a reverse direction, or from right to left, and consequently also the rod $b^{11}$, through the intermediate mechanism $b^4$ $b^{25}$ $b^{15}$ $b^8$ $b^9$ $b^{10}$ described, the reverse being the case when the pendulum swings from right to left.

In the use of the mechanism described for returning the diaphragm D′ into the position from which it is moved by a variation in the hydrostatic pressure, to which the diaphragm and the mechanism controlled thereby has been adjusted, it is necessary to provide means for adjusting or regulating the effect of the pendulum-weight $c^2$, a component of which acts upon the diaphragm through the mechanism described, according to the resistance opposed to the action of said weight, in order to prevent detrimental action upon the diaphragm. This I effect by adjusting the leverage exerted by the pendulum, and to this end the connecting-rod C′ is made adjustable vertically on the pendulum $c'$, and the actuating-lever $c^3$ and said rod C′ is adjustable as to length to permit of the adjustment of the relative vertical position of the lever and pendulum. To these ends the connecting-rod C′ is made in two sections $c^7$ and $c^8$ screwed into a sleeve $c^6$. The sleeve is loosely held in a ring $c^9$, in which works a screw-rod $c^5$, (see detail view in Fig. $2^a$,) said screw-rod being revoluble in fixed bearings. By revolving the screw-rod in one or the other direction the pivot-pins of the rod C′, which lie in a slot formed in the pendulum-arm and the lever $c^2$, respectively, may be elevated or lowered to vary the leverage accordingly, and by screwing the sections $c^7$ and $c^8$ of the rod C′ into or out of the sleeve $c^6$ the relative vertical position of the lever C′ and pendulum $c'$ can be adjusted, the vibrations of the pendulum being limited by screws $c^{21}$, one of which is shown in Fig. 2.

As the feeble impulses imparted to the diaphragm D′ by the variations in the hydrostatic pressure in chamber C cannot be conveniently amplified to such an extent as to operate the immersing-rudder directly, I employ intermediate mechanism, as hereinbefore indicated, which I will now describe, and which is contained in the chambers F, G, H, and I, astern of the air-chamber E.

It has hereinabove been stated that with a view to simplify the construction of the operating mechanisms and increase the efficiency of the torpedo, and with a view to economize space and admit of the more uniform distribution of the weight, I have as a means of propulsion applied the principles of the reaction-wheel.

Inasmuch as the propelling mechanism will form the subject-matter of a separate application for patent, it will not be necessary to describe such mechanism in its full details. I will therefore confine the description to those parts which are related to or directly connected with the operation of the immersing-rudder.

Referring now to Figs. 5 to 14, *z*, Fig. 5, is the distributing-main, in which is arranged the distributing-valve, or, preferably, a stop-cock L′. To the main *z* is connected a pipe $p^3$, by means of a suitable coupling, and in such manner as to admit of the rotation of said pipe, and to the pipe $p^3$ is rigidly connected the distributing-pipe *p*, said pipe having a squared coupling-head $p^4$, Figs. 11 and 12, so that by the application of a key or wrench introduced through the aperture $p^5$, Fig. 12, the said pipe *p*, with pipe $p^3$, may be rotated to adjust the area of the delivery-ports, through which the compressed air is delivered to the reaction screw-propellers A and B, Figs. 13 and 14. The pipe *p* serves as a bearing for the tubular propeller-shaft *q*, on which are loosely mounted the propellers A and B, said shaft being provided with delivery-ports, the position of pipe *p* within shaft *q* determining the port area of said shaft, as indicated in Figs. 15 and 16. The shaft *q* has an endwise or longitudinal motion on its tubular bearing *p*, and it is closed at its rear end by a screw-plug Q, that is connected by a link $k^8$ with the immersing-rudder T, arranged in the immersion-tube $T^2$. The link $k^8$ is a compound link, or composed of two sections united by a coupling-sleeve $k^{28}$, into which the link-sections are screwed, so as to provide for an adjustable connection between the immersion-rudder and the propeller-shaft *q*, which here performs the function of tiller, the link being connected to a radial arm $k^{18}$ on the immersing-rudder shaft T′. It has been stated that the propeller-shaft *q*, that operates the immersing-rudder T, is movable lengthwise on its tubular bearing, (the pipe *p*.) This movement is imparted to the shaft by the diaphragm D′, through intermediate mechanism, the forward end of shaft *q* being provided with trunnions $k^7$, to which are connected radial arms $k^6$, keyed to or formed on a shaft $k^5$, that has its bearings in bracket-arms $k^{15}$, secured to the rear wall of the sinking-chamber G, Figs. 11 and 12, said trunnions projecting through slots formed in a sleeve $k^{25}$, secured to the rear wall of chamber or compartment H, to the outer end of which sleeve is screwed the head $p^4$ of the bearing or pipe *p* by means of endless male and female screw-threads formed in and on the sleeve-bearing and pipe-head, respectively, as shown in Fig. 12. The shaft $k^5$ has a third radial arm $k^2$, to which is connected a piston-rod *k*.

Referring now more particularly to Figs. 5 to 10, inclusive, the rear end of the transmitting-rod $b^{11}$, whose forward end is adjustably secured by means of an interiorly-screw-threaded coupling-link $b^{21}$ to the radial arm $b^{10}$ on shaft $b^8$ of the mechanism actuated by the diaphragm D′, Fig. 2, is likewise connected with a valve stem or spindle *f* by means of an interiorly-threaded coupling-sleeve *d*, said valve-spindle forming substantially a continuation of the transmitting-rod $b^{11}$.

I have hereinbefore described the means for adjusting the diaphragm to a given hydrostatic pressure, and in order that the valve-rod and the immersing-rudder connections may be adjusted accordingly to properly position the valves and rudder the connections between said rudder and the propeller-shaft and between the transmitting-rod $b^{11}$ and the valve-spindle *f* must also be made adjustable, and these adjustments may be readily made through the means above stated. The spindle *f* carries two cylindrical or disk valves *f*′ $f^2$, that perform the function of slide-valves and slide in the axial bore of a piston H′, contained in a piston-cylinder $H^3$. To prevent escape of air from the piston-cylinder, and at the same time guide the valve-rod and allow it to slide freely within the piston, the latter is provided at both ends with a tubular extension that extends through a stuffing-box in the cylinder-heads, and to the left extension is screwed the rod *k*, that imparts longitudinal motion to the propeller-shaft *q*, said rod being partially hollow and provided with an exhaust port or ports $m^5$. The piston is a solid cylinder, in which are formed the axial cylindrical passage for the valves and their spindle, the distributing-passages $h^2$ *h*′, leading from the axial bore or passage to opposite ends of the cylinder, the diametral admission-passage *h*, and a port and passage $H^4$, leading to an auxiliary cylinder M, the admission-passage being connected with the compressed-air-pipe section *z*, preferably by means of a coiled pipe $h^5$, connected with the diametral passage through the screw-cap $h^4$. It will be seen that the movements of the rod $b^{11}$ in either direction are transmitted to the valve-rod *f*, and the said rod will move either from right to left or from left to right, according to the movements of rod $b^{11}$ under the influence of the diaphragm D′, the initial position of the valves being shown in Fig. 5, the valves closing both ports of the distributing-passages $h^2$ *h*′. It will be seen that when the valves are in their initial positions, as described, the compressed air from the distributing-pipe *z* has free access to the space between said valves in the axial bore of the cylinder, but not to the ends thereof until the valve-rod is moved by the diaphragm and intermediate mechanism to uncover said ports, and as the air exerts its pressure upon the valves equally in opposite directions said valves are equilibrated, so that they will move under the slightest vibrations or pulsations of the diaphragm. In this position of the valves the compressed air has also free access to the cylinder M. Now, if the valve-rod is

moved from left to right, Fig. 7, the port or passage $h'$ is uncovered. The air coming through $h$ passes through $h'$ to the right end of the piston-cylinder, driving the piston H' and piston-rod $k$ from right to left, and thereby imparting to the propeller-shaft $q$ a movement in a reverse direction, or from left to right—that is to say, the translation of motion of the connecting-rod $b^{11}$ is such that the shaft $q$ will move in the same direction as said connecting-rod. This movement of the shaft $q$ will tilt the immersing-rudder T so as to incline upwardly, (see Fig. 8,) the torpedo at once taking a downward course; but as soon as the torpedo assumes a position in a plane at an angle to the horizontal the pendulum will swing in that angle and return the diaphragm into its normal position, thereby returning the spindle to its normal position. The air will be exhausted from the right-hand end of the cylinder H' through connecting-rod $k$ and port $m^5$, and as the immersing-rudder will again be free to assume its normal position it will carry with it the piston H', or move it from left to right, the parts returning to their initial or normal positions. A reverse movement of rod $b^{11}$, or in a direction from right to left, will result in a reversal of the movements above described, and shown in Figs. 9 and 10.

It is of importance that the immersing-rudder T should be inclined at a certain angle to the horizontal during the first portion of the course of the torpedo in order that it may descend into the water; and to this end it is necessary that the immersion-regulating mechanism should be held against operation until the torpedo has reached a given depth. To this end the coupling-sleeve $d$, Fig. 5, that connects the transmission-rod $b^{11}$ with the valve-rod $f$, carries a nut $d'$ screwed thereto, said nut having a peripheral groove in which lies the lower end of a locking-ring $d^2$, which is preferably of oval or elliptical form, said ring being formed on a vertical rod $d^6$, whose vertical movements are guided by brackets $d^{16}$, screwed into the head of the air-reservoir, said ring locking the valve-rod, and consequently all the mechanism controlling the same, as well as the mechanism controlled thereby, into their normal position, to which they were adjusted before launching. When the ring is moved downward out of engagement with the nut $d'$, the parts referred to are free to be controlled by the diaphragm D'. This downward movement of the locking-ring is effected automatically through the following instrumentalities: The rod $d^6$ is pivoted to a bell-crank lever $d^3$, to which is also pivoted a rod $d^4$, that passes through a tube $l^{23}$, extending through the ballast or immersing chamber G, and thence through chambers H and I to the tail or stern of the torpedo, where it terminates in a hook $d^7$, that lies in the path of a pin $d^8$, projecting from the side of the registering worm-wheel $A^4$ of screw-propeller A, as shown in Fig. 11. As the propeller A revolves, the worm-wheel $A^4$ also revolves, said wheel meshing with a worm-thread on the propeller-hub $A^5$, and when the pin $d^8$ engages the hook $d^7$ of rod $d^6$ said rod is drawn backward, thereby moving the rod $d^6$ downward.

At launching exercises, in order to impart to the rudder T the required upward inclination to cause the torpedo to rise or jump up as soon as the admission of air is automatically cut off, as hereinafter explained, I employ the following devices: As above stated, during the period of the admission of air to the piston-cylinder said air is free to flow through the port and passage $H^4$ of piston H', Fig. 5, thence through pipe $m^6$ to the right end of a cylinder M, in which is a spring-actuated piston $m$, the spring $m^2$ being coiled on the piston-rod at the left of the piston and antagonizes the air-pressure in space M' of cylinder M. The piston-rod is connected to a lever $m^3$, whose hook-arm $m^4$ engages a pin projecting from the transmitting-rod $k$. So long as the air is not cut off from the space between the valves $f'$ $f^2$ the pressure exerted upon the piston will hold the lever in the position shown in Fig. 5; but as soon as the air is cut off the piston is thrown from left to right by the spring $m^2$, and consequently the piston-rod $k$ and piston H are moved from right to left, thereby imparting to the rudder the position shown in diagram Fig. 10. Of course in practical or effective use this mechanism is thrown out of operation by disengaging the lever from the pin $m^4$. It has, however, been shown that in launching exercises, in order to bring the torpedo to the surface, it is necessary that means should be provided to automatically cut off the communication between the compressed-air reservoir and the supply-pipes for the operating mechanisms. In service or practical use of the torpedo it also becomes necessary that this communication should be cut off after the torpedo has completed its course, and that the sinking-valves be simultaneously shifted off their seats, as and for the purposes fully described in a separate application for patent, and I do not desire herein to claim said mechanisms, except in so far as they co-operate with those mechanisms that form the subject-matter of this application.

As hereinbefore stated, the means for admitting the compressed air to and cutting it off from the supply-pipes consist of a stop-cock L', interposed in the supply-main $z$. To the plug $l^3$ of the stop-cock is secured a radial arm U, that is connected by a link $l$ to the arm $L^2$ of a three-armed lever L, whose arm $L^5$ is bent at right angles and terminates in a turned-up lip $l^5$. When the distributing-cock is closed, the lever L lies in the position shown in dotted lines in Fig. 5, and when said stop-cock is open it lies in the position shown in full lines in said figure. The stop-cock is au-

tomatically shifted from the position shown in dotted lines to that shown in full lines in Fig. 5 during the act of launching, and it is shifted from the position shown in full lines to that shown in dotted lines by means of the following instrumentalities: To the third arm $L^4$ of lever L is connected a chain or a slotted link $l^4$, and to said chain or link is connected a rod $L^3$, that extends through the same tube $l^{23}$, that contains the rod $d^4$, that serves to release the valve-rod $f$, hereinabove described. The rod $L^3$ is connected with a sleeve or cylinder $n$, loosely mounted on the boss $K^3$ on the front wall of the chamber I, to which the sleeve $k^{25}$ is secured, that serves as a bearing for the propeller-shaft $q$, and on a cylinder $K^4$, secured to said boss and to the rear wall of chamber I. In the space between the cylinder $K^4$ and the sleeve or cylinder $n$ is arranged a coiled spring $n^6$, the tendency of which is to throw the sleeve $n$ backward, and as the rod $L^3$ is connected with said sleeve and with the lever L of the stop-cock said lever is shifted from its position shown in full lines to that shown in dotted lines in Fig. 5, thereby cutting off the communication between the reservoir E and the supply-pipes.

The operation of the sleeve is timed to the distance the torpedo is to travel as follows: The hub $A^3$ of the propeller A has a worm-thread formed thereon, with which meshes a worm-wheel $A^4$, whose arbor carries a pinion $l^5$, that meshes with the timing and registering wheel $t'$, from the face of which projects a pin $t^2$. The sleeve $n$ is held against the stress of its spring $n^6$ by a detent $n^7$, whose outer arm projects through the torpedo-shell into the path of the pin $t^2$, which latter, when it comes in contact with the detent-arm, tilts the same and releases the sleeve $n$. The sleeve $n$ and rod $L^3$ are thrown backward by the spring $n^6$, thereby shifting the lever from its position shown in full lines back into the position shown in dotted lines, and through the described connections rotating the plug $l^3$ of the stop-cock ninety degrees, to cut off the communication between the reservoir E and the supply-pipes. Simultaneously with the shifting of the stop-cock L′ to cut off the communication between the reservoir E and the supply-pipes the sinking-valves are also moved off their seats, so that in case the torpedo should miss its mark it may at once be sunk. This is effected as follows, said mechanism being actuated by the cylinder $n$ and timed by the timing and registering wheel $t'$ above described:

V V are the sinking-valves, having their seats formed in the partition or rear head $k^{21}$ of the sinking or ballast chamber G astern of the chamber containing the mechanism for operating the admission-valve, and part of which chamber G is shown in Figs. 5, 11, and 12. The valves V V are held to their seats by means of a spring $v^{10}$, and are connected with the spring-actuated sleeve $n$ by means of tubular rods $v'$ and rods $v$, which latter have a slight independent motion within the tubular rods $v'$, so that during the first portion of the rearward movement of the sleeve $n$ the rods $v'$ will move independently of the rods $v$, and then with said rods to fully move the valves V off their seats, which latter corresponds to the closure of the cut-off valves, so that both the cut-off valve and the sinking-valves will operate simultaneously. This is desirable, in fact, necessary, in order that the course of the torpedo may be arrested and the torpedo simultaneously sunk, for if the sinking-valves were to operate after the cut-off valve the torpedo would necessarily travel a distance corresponding with the interval between the operation of said valves, while if the cut-off valve were to operate sooner than the sinking-valves the torpedo would be liable to drift or rise to the surface.

Inasmuch as it is not desired to sink the torpedo, except when actually used for offensive purposes, it is necessary for torpedo practice to provide means for maintaining the valves on their seats, and this is effected by disconnecting the valve-operating rods $v$ from the actuating-tube $n$ in the following manner: The connecting-rods $v$ $v'$ are guided in rings $n^2$, formed at the end of arms of a shifting-fork $n'$, pivotally connected with a screw $n^5$, that works in a boss $n^{55}$, secured to the torpedo-shell, said screw being provided with a squared head projecting into the enlarged bore of the boss, and so as to be accessible from the outside. By rotating the screw in the proper direction the rods $v$ $v'$ are lifted, being hooked to the valve-heads, their hooked ends $n^3$ being thus lifted out of the eyes $n^4$, secured to said heads, thereby disconnecting the valves from their operating-rods.

Inasmuch as the distributing and sinking valves are operated simultaneously and timed to the distance to be traveled by the torpedo, and inasmuch as the firing mechanism, as hereinabove referred to, is preferably timed likewise, it is necessary to ascertain the number of revolutions of the propellers under a given pressure of air and within a given time or for a given distance traveled by the torpedo. To this end the hubs $A^3$ of the propellers A B are provided with a worm-thread with which gears a registering-wheel $A^4$, Figs. 11, 13, and 14; or, if desired, the timing-wheel $t'$, Fig. 11, that is driven from the propeller A, may be used as a registering-wheel to indicate the revolutions of the said propeller.

As hereinbefore described, the immersing-rudder is operated by the propeller-shaft, which latter is controlled by the hydrostatic pressure of the ambient water, and the reasons for this peculiar arrangement have been fully set forth. It will be, however, understood that in torpedoes of usual construction other means may be provided for connecting the piston-rod with the rudder.

Having described my invention, what I claim is—

1. In a torpedo, the combination, with an immersing-rudder and a diaphragm exposed to the hydrostatic pressure of the ambient water, of a power-operated piston between said rudder and diaphragm, transmitting devices between the diaphragm and piston and controlling the power for said piston, and operating devices between the piston and the immersing-rudder, substantially as described.

2. In a torpedo, the combination, with an immersing-rudder and a diaphragm exposed to the hydrostatic pressure of the ambient water, of a cylinder connected to the supply of motive fluid, a valve for said cylinder controlling the admission and exhaust of said motive fluid and connected to be operated by the motion of said diaphragm, and a piston in said cylinder and connected to operate said rudder, substantially as described.

3. In a torpedo, the combination, with an immersing-rudder and a diaphragm exposed to the hydrostatic pressure of the ambient water, of a pneumatic cylinder, a compressed-air supply connected to said cylinder, a controlling-valve for the same having its rod connected to be actuated by said diaphragm, and a piston within said cylinder and having its rod connected to operate said rudder, substantially as described.

4. In a torpedo, the combination, with an immersing-rudder, a diaphragm exposed to the hydrostatic pressure of the ambient water, and a propeller, of an intermediate transmitting device having a power-supply, means connected to said diaphragm for controlling said power-supply, a locking device engaging said controlling means, a trip mechanism for said locking device and having its gearing engaged with and operated by said propeller, and operating means connected to said transmitting device and to said rudder, substantially as described.

5. In a torpedo, the combination, with an immersing-rudder, a diaphragm exposed to the hydrostatic pressure of the ambient water, and a propeller, of a cylinder connected with the supply of motive fluid, a valve for said cylinder controlling the admission and exhaust of said motive fluid and connected to be operated by the motion of said diaphragm, a locking device engaging the rod of said valve, a trip mechanism for said locking device and having its gearing engaged with and operated by said propeller, and a piston in said cylinder connected to operate said rudder, substantially as described.

6. In a torpedo, the combination, with an immersing-rudder, a diaphragm exposed to the hydrostatic pressure of the ambient water, and a propeller, of a pneumatic cylinder, a compressed-air supply for said cylinder, a controlling-valve for the same, having its rod connected to be actuated by said diaphragm, a locking device engaging the rod of said valve, a trip mechanism for said locking device and having its gearing engaged with and operated by said propeller, and a piston within said cylinder and having its rod connected to operate said rudder, substantially as described.

7. In a torpedo, the combination, with an immersing-rudder and automatic operating mechanism for the same, of a locking device which engages said operating mechanism, and a tripping mechanism for said locking device and operated and controlled by the propelling mechanism of the torpedo, substantially as described.

8. In a torpedo, the combination, with an immersing-rudder and an automatic operating mechanism for the same, which consists of a diaphragm exposed to the hydrostatic pressure of the ambient water, and devices for communicating the movement of said diaphragm to said rudder, of a locking device which engages said devices, and a trip mechanism for said locking device and operated from a time mechanism, substantially as described.

9. In a torpedo, the combination, with an immersing-rudder, a diaphragm exposed to the hydrostatic pressure of the ambient water, and a pneumatic transmitting device having its piston-rod connected to operate said rudder and having its valve-rod connected to said diaphragm and formed with a groove or recess, of a rod sliding in suitable guides and formed with a ring which engages said groove or recess from below, a bell-crank having one arm pivoted to said rod, a rod pivoted to the other arm of said bell-crank, and a disk connected to be revolved by the propelling mechanism of the torpedo and having a pin upon its face which engages the hooked end of said rod, substantially as described.

10. In a torpedo, the combination, with an immersing-rudder, a diaphragm exposed to the hydrostatic pressure of the ambient water, a pneumatic transmitting device having its piston-rod connected to operate said rudder and having its valve-rod connected to said diaphragm and formed with a groove or recess, and a screw-propeller formed with a worm upon its hub, of a rod sliding in guides and formed with a ring which engages said groove or recess with its lower end, a bell-crank having one arm pivoted to said rod, a connecting-rod having one end pivoted to the other arm of said bell-crank and formed with a hook at its other end, and a cogged disk engaging the worm upon the propeller and provided with a pin upon its face for engaging said hook, substantially as described.

11. In a torpedo, the combination, with an immersing-rudder and a diaphragm exposed to the pressure of the ambient water, of a pneumatic cylinder having an inlet-pipe and a central annular port, a piston in said cylinder having an axial bore, and channels extending

from the middle of said bore to the end of the piston, a valve connected to said diaphragm and reciprocating within the central bore of said piston, and a rod secured to said piston and connected to said rudder, substantially as described.

12. In a torpedo, the combination, with an immersing-rudder and a diaphragm exposed to the pressure of the ambient water, of a pneumatic cylinder having an inlet-pipe at its middle and an annular port connected with said pipe, a piston having tubular extensions sliding through the head of said cylinder and formed with an axial bore and with channels opening at the middle of said bore and at the ends of the piston, a valve within said bore and connected to be operated by said diaphragm, and a rod secured to one of the extensions of said piston and connected to operate said rudder, substantially as described.

13. In a torpedo, the combination, with an immersing-rudder, a diaphragm exposed to the hydrostatic pressure of the ambient water, and a pneumatic transmitting apparatus for operating said rudder, of a casing secured to the middle of said diaphragm, a lever having one arm pivoted to said casing, and a valve-rod for said transmitting apparatus having its end pivoted to the other arm of said lever, substantially as described.

14. In a torpedo, the combination, with an immersing-rudder, a diaphragm exposed to the hydrostatic pressure of the ambient water, and a pneumatic transmitting apparatus for operating said rudder, of a casing secured to the middle of said diaphragm, a pendulum connected to said casing, a lever having one arm pivotally connected to the end of said casing, and a valve-rod for said transmitting apparatus having its end pivoted to the other arm of said lever, substantially as described.

15. In a torpedo, the combination, with an immersing-rudder, a diaphragm exposed to the hydrostatic pressure of the ambient water, and a pneumatic transmitting apparatus for operating said rudder, of a casing secured to the middle of said diaphragm and formed with a tube through its axis, a hollow nut sliding in guides and having said tube projecting into it, guides for said nut, a spring coiled around said tube and bearing against said nut and the outer closed end of said casing, a rod secured to said closed end of the casing and passed through said nut and adjustably secured to the guides for the same, rods secured to the end of said axial tube, a lever having one arm pivoted to the united ends of said rod, and a valve-rod for said transmitting apparatus and pivoted to the other arm of said lever, substantially as described.

16. In a torpedo, the combination, with an immersing-rudder, a diaphragm exposed to the hydrostatic pressure of the ambient water, a pneumatic transmitting apparatus for operating said rudder, and a valve-rod connected to control the operation of said apparatus, of a casing secured to the center of said diaphragm and provided with lugs upon its upper side, a lever having one arm adjustably connected to said casing and the other arm adjustably connected to said valve-rod, a lever having a slotted upper arm and having its lower short arm projecting between the lugs of said casing, a pendulum having a longitudinal slot, and a rod having its ends adjustably secured in the slots of said lever and pendulum, substantially as described.

17. In a torpedo, the combination, with an immersing-rudder, a diaphragm exposed to the hydrostatic pressure of the ambient water, a pneumatic transmitting apparatus for operating said rudder, and a valve-rod connected to control the operation of said apparatus, of a casing secured to the center of said diaphragm and provided with lugs upon its upper side, a lever having one arm adjustably connected to said casing and the other arm adjustably connected to said valve-rod, two set-screws in the lugs of said casing, a lever having a long slotted upper arm and a short lower arm projecting between the ends of said set-screws, a pendulum having a longitudinal slot, a set-screw projecting toward said pendulum to limit its play, screw-threaded rods having their ends sliding in the slots of said lever and pendulum, a screw-threaded sleeve connecting said rods, a revoluble screw, and a nut upon said screw and formed with a ring fitting around said sleeve, substantially as described.

18. In a torpedo, the combination, with a screw-propeller and the immersing-rudder, of endwise-movable propeller-shaft connected with and controlling the operation of the rudder by such movement, substantially as described.

19. In a torpedo, the combination, with a reaction screw-propeller and the immersing-rudder, of a tubular endwise-movable propeller-shaft connected with and controlling the operation of the rudder by its longitudinal movement, substantially as described.

20. In a torpedo, the combination, with a reaction screw-propeller and the immersing-rudder, of a pipe for supplying compressed air to the propeller and a tubular propeller-shaft mounted and movable endwise on said pipe, said shaft being connected with and controlling the operation of the rudder by its longitudinal movement, substantially as described.

21. In a torpedo, the combination, with a reaction screw-propeller, the immersing-rudder, a diaphragm exposed to the hydrostatic pressure of the ambient water, and a pipe for supplying compressed air to the propeller, of a tubular propeller-shaft mounted and movable endwise on said pipe, a connection between the shaft and rudder, and transmitting mechanism connecting the diaphragm with the propeller-shaft, substantially as and for the purposes specified.

22. The combination, with the diaphragm

D′, of the compressed-air main, the cut-off valve connected to and operated by said diaphragm, the piston-cylinder $H^3$, connected with said main, the piston H′, having annular passage $H^4$, and the piston-rod $k$, provided with a radial pin $m^4$, of the piston-cylinder M, a pipe connecting one end of said cylinder with the cylinder $H^3$ and the piston-passage $H^4$, the spring-actuated piston $m$, and lever $m^3$, connected with said piston $m$ and engaging the pin $m^4$ on piston-rod $k$, substantially as and for the purposes specified.

In testimony whereof I affix my signature in presence of two witnesses.

ADOLF GRAF VON BUONACCORSI DI PISTOJA.

Witnesses:

EDMUND JUSSEN,

OTTO SCHIFFER.