No. 768,291. PATENTED AUG. 23, 1904.

F. M. LEAVITT.

GYROSCOPIC APPARATUS FOR STEERING TORPEDOES OR OTHER USES.

APPLICATION FILED SEPT. 30, 1903.

NO MODEL. 4 SHEETS—SHEET 1.

FIG. 1.

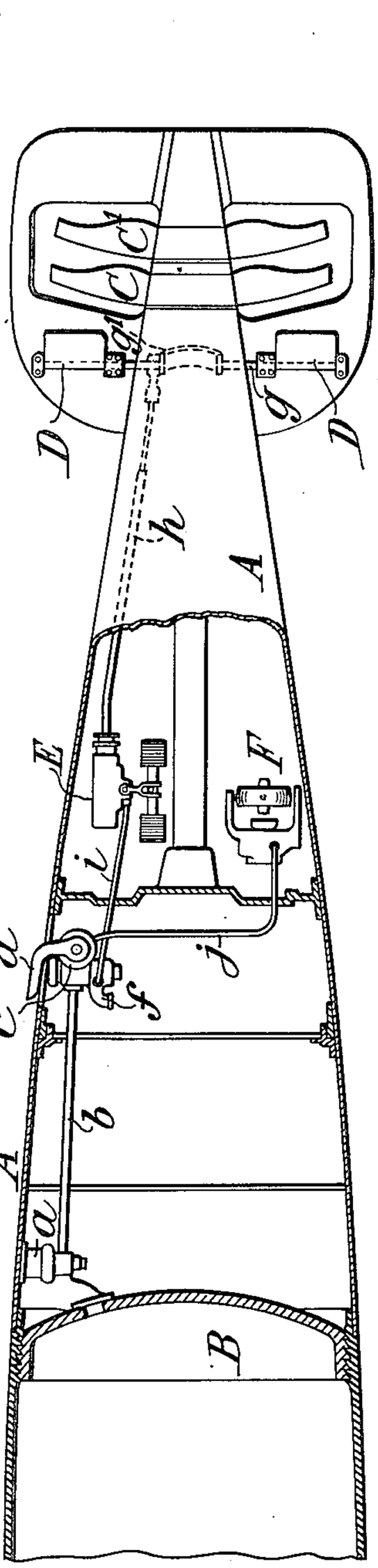
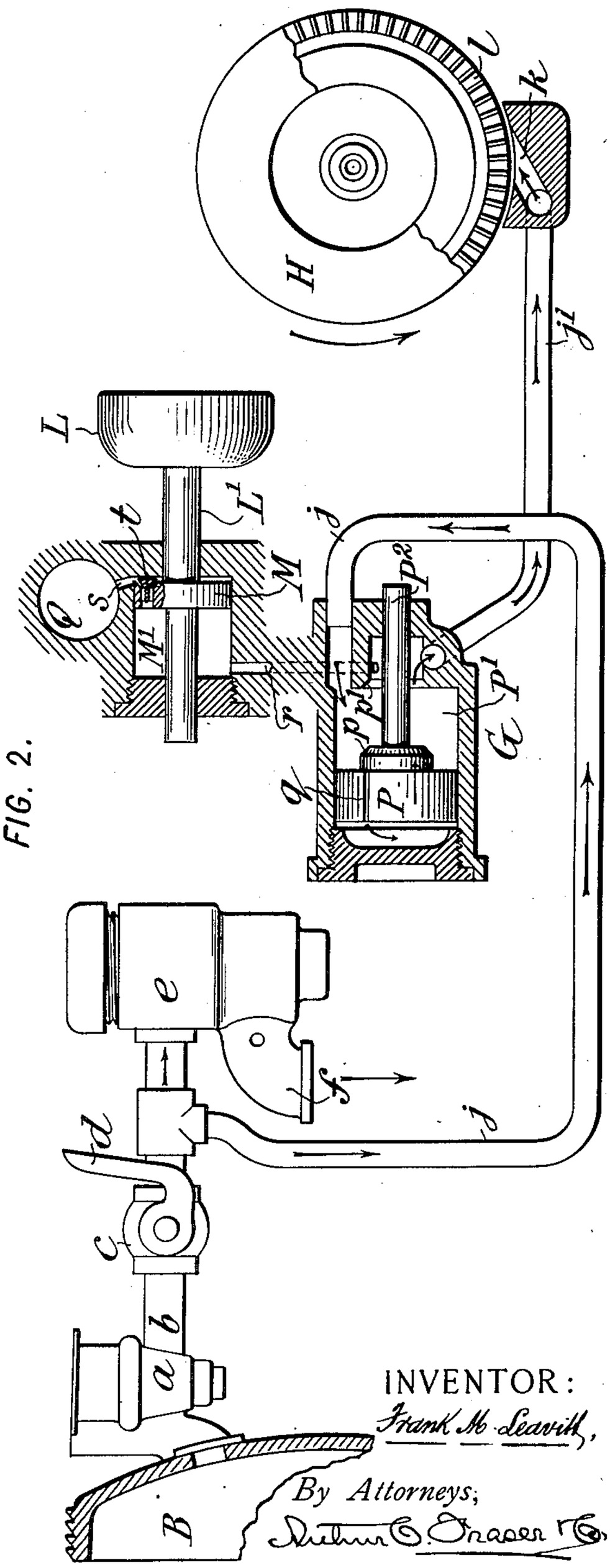


FIG. 2.



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NO MODEL. 4 SHEETS—SHEET 2.

FIG. 4.

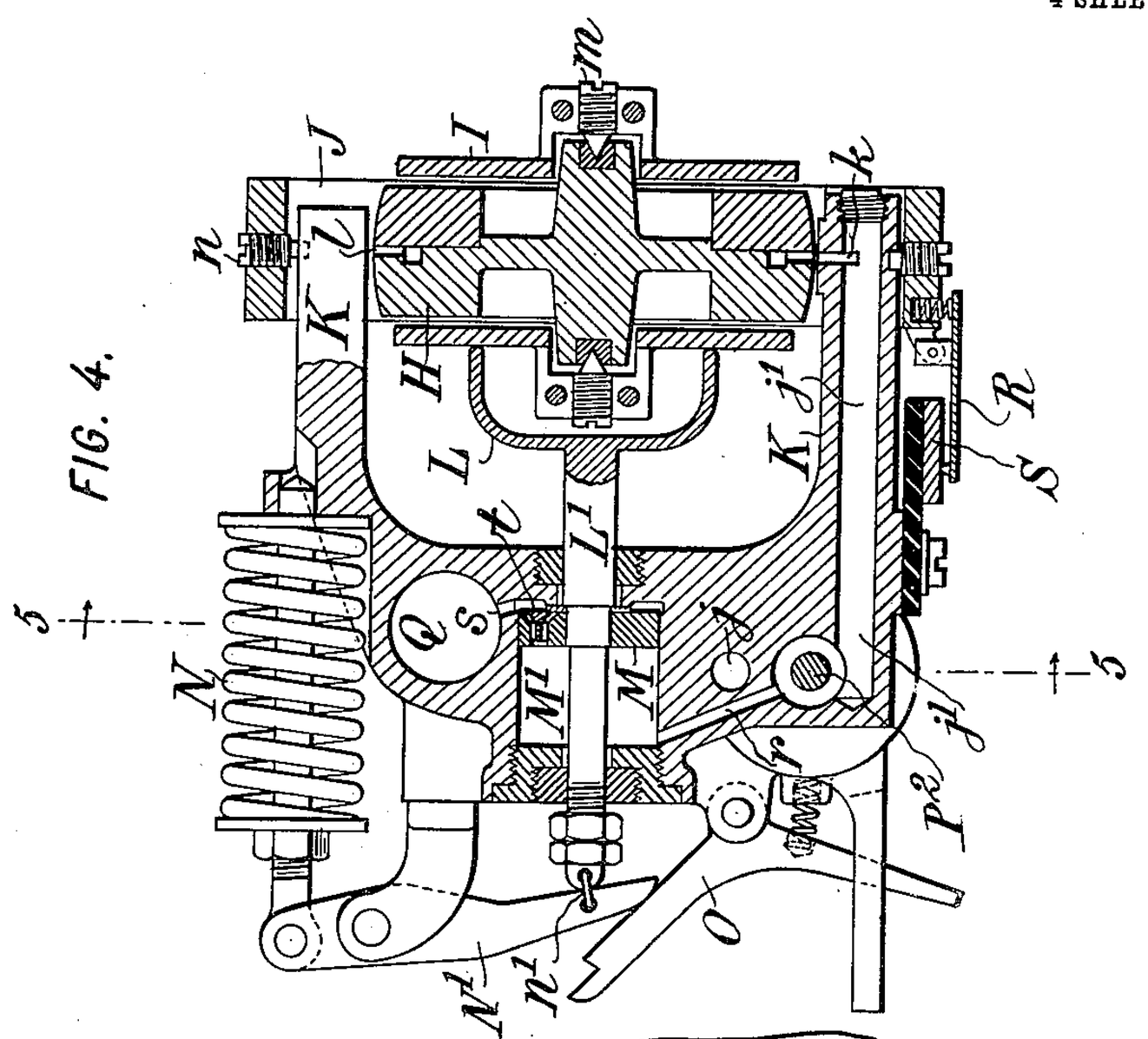

FIG. 3.

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NO MODEL. 4 SHEETS—SHEET 3.

FIG. 6.

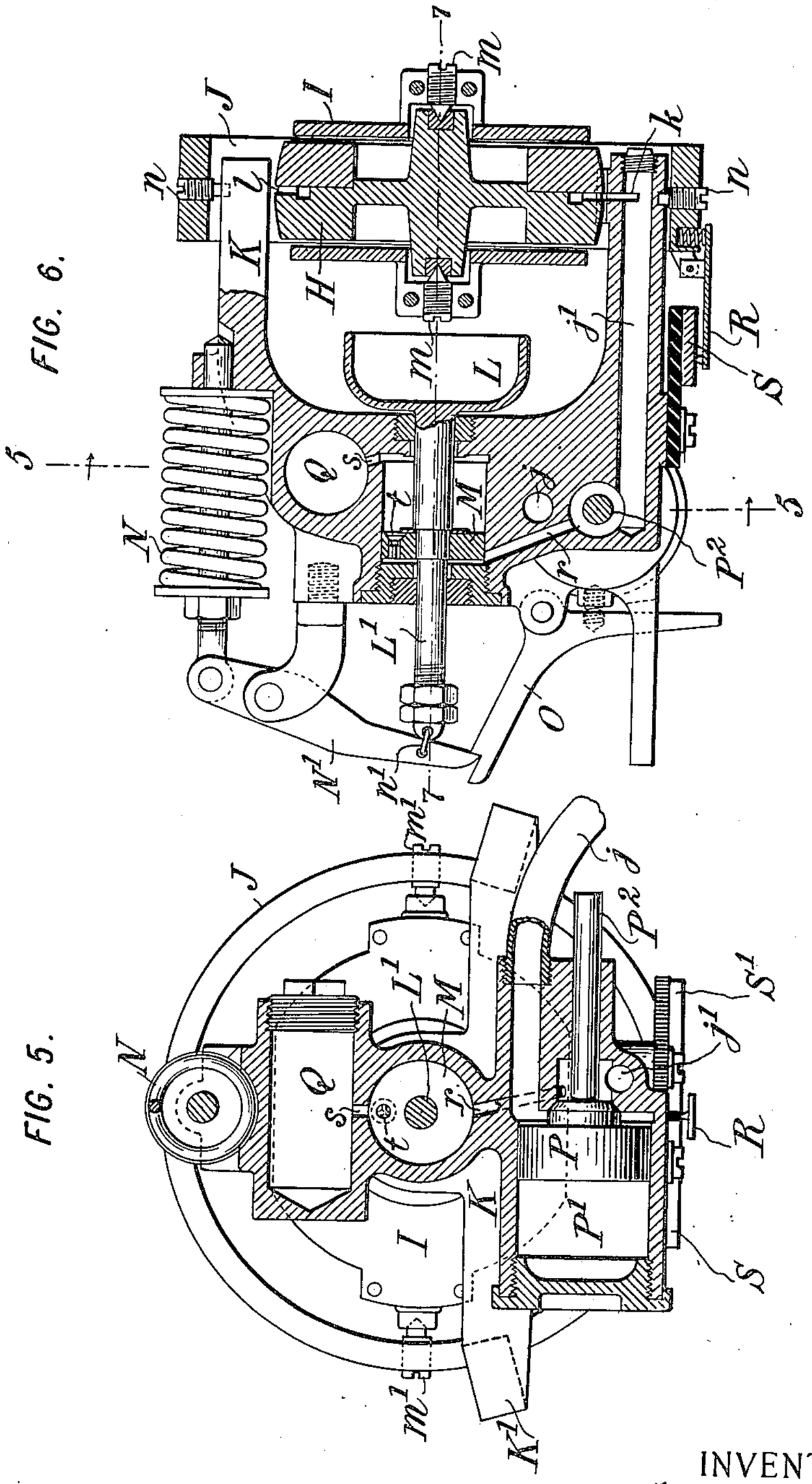

FIG. 5.

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NO MODEL. 4 SHEETS—SHEET 4.

FIG. 8.

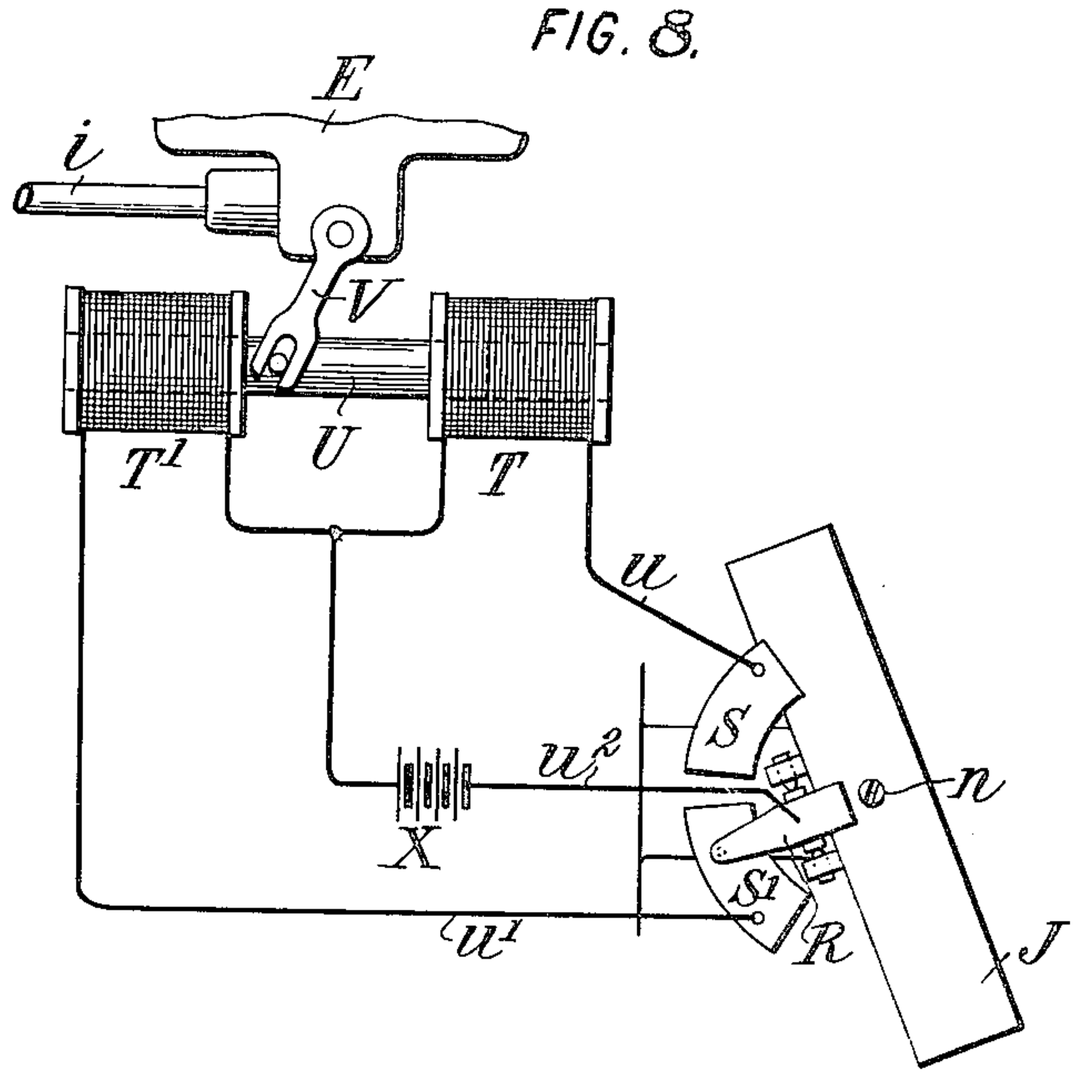
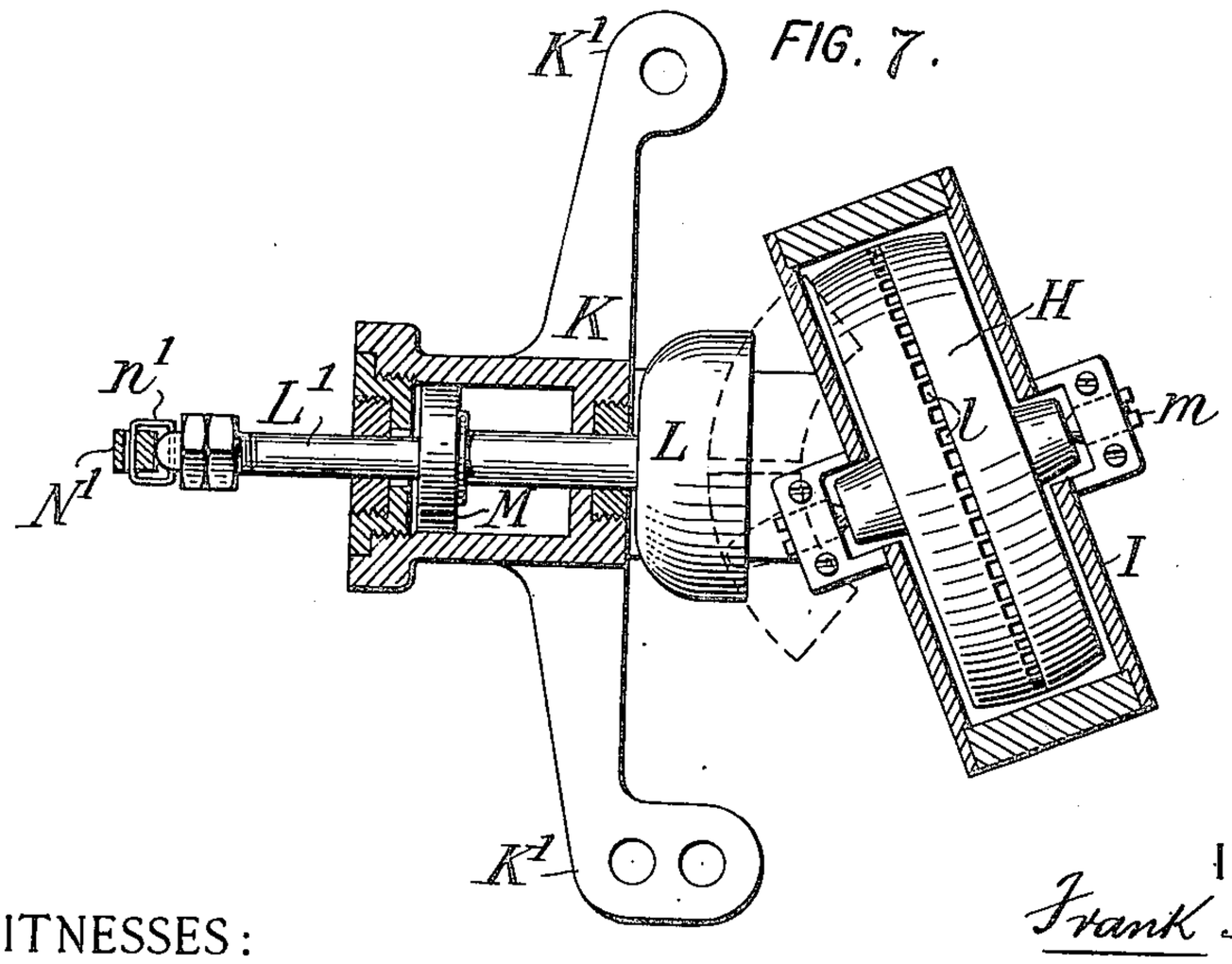


FIG. 7.



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No. 768,291. Patented August 23, 1904.

UNITED STATES PATENT OFFICE.

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GYROSCOPIC APPARATUS FOR STEERING TORPEDOES OR OTHER USES.

SPECIFICATION forming part of Letters Patent No. 768,291, dated August 23, 1904.

Application filed September 30, 1903. Serial No. 175,241. (No model.)

To all whom it may concern:

Be it known that I, FRANK M. LEAVITT, a citizen of the United States, and a resident of the borough of Brooklyn, county of Kings, city and State of New York, have invented certain new and useful Improvements in Gyroscopic Apparatus for Steering Torpedoes or other Uses, of which the following is a specification.

This invention relates to gyroscopic apparatus applicable for the steering of automobile torpedoes and also for other uses, such as the preserving of a fixed axis or plane on a ship or other moving body. A gyroscope consists of a rotative body or fly-wheel so supported through the medium of rings or gimbals that it is free to maintain by inertia its original plane of rotation unaffected by the movements of the external support.

My present invention is an improvement upon the gyroscopic apparatus set forth in my application, Serial No. 705,022, filed February 9, 1899; renewal application, Serial No. 145,445, filed February 27, 1903, (Patent No. 741,683, dated October 20, 1903.) My present invention is designed to improve and simplify the apparatus set forth in that application.

The preferred construction is shown in the accompanying drawings, wherein—

Figure 1 is a vertical longitudinal section of the after-body of a Whitehead torpedo, showing the application of the present invention thereto. Fig. 2 is a diagrammatic view illustrating the course of the compressed air. Fig. 3 is a fragmentary cross-section of the torpedo-shell, showing the gyroscope in end elevation viewed from the rear, being partly in vertical section. Fig. 4 is a vertical longitudinal mid-section of the gyroscope on the line 4 4 of Fig. 3, showing the gimbals locked immovably and ready for the spinning up. Fig. 5 is a vertical transverse section on the line 5 5 of Fig. 4. Fig. 6 is a similar section to Fig. 4, but showing the gyroscope unlocked after spinning up. Fig. 7 is a horizontal section on the line 7 7 in Fig. 6. Fig. 8 is a partial inverted plan, showing in diagram the electric circuits.

Referring to Fig. 1, let A designate the hull or shell of an automobile torpedo, of which B is the compressed-air reservoir and C C′ the propeller-screws. Before launching, the stop-valve *a* being opened, the compressed air passes through pipe *b* to the starting-valve *c*, which during the act of launching is opened by the engagement of its arm *d* with the launching-tube in the well-known manner. Thereupon the compressed air enters the reducing-valve *e*, (which is commonly constructed in one with the starting-valve *c*,) and the air, reduced in pressure, is delivered through the branch *f* to the engine. (The engine is not shown.) For steering the torpedo in the horizontal plane, two vertical rudders D D are mounted in the tail of the torpedo upon a vertical shaft *g*, having a tiller-arm *g′*, to which connects a rod *h*, which leads forward to any suitable steering-engine E, which may be operated by compressed air taken through a pipe *i*. This steering-engine E (or any other suitable rudder-actuating means) is controlled by the gyroscope F, which according to my invention is spun up by means of compressed air taken through pipe *j* from beyond the valve *c* to an impact-motor or turbine, so that the instant this valve is opened compressed air is momentarily admitted to spin up the gyroscope. The course of the compressed air is best shown in Fig. 2. Upon the opening of the valve *c* air passes through pipe *j* to the time-valve G, from which it passes by pipe or duct *j′* to a nozzle *k*, which directs the stream of compressed air against the blades or reaction-surfaces *l l* of the turbine-motor. For compactness the fly-wheel H is formed with the reaction-surfaces *l*, although a separate motor-wheel might be provided.

Referring to Figs. 3 to 7, the fly-wheel H is pivoted on screws *m m* in an inner gimbal I, which in turn is pivoted on screws *m′ m′* in an outer gimbal J, and the latter is hung by pivot-screws *n n* to a fixed frame K, which frame has ears K′, by which it is removably

fastened by screws to a frame A′, Fig. 3, which is permanently fastened in the hull A of the torpedo. The fly-wheel axis *m m* may be arranged fore and aft, the axis *m′ m′* transversely, and the axis *n n* may be vertical, these three axes giving free universal motion to the fly-wheel when unlocked. The outer gimbal J is shown as a ring, the frame K entering within it in order that its lower arm, through which is formed the passage *j″*, may bring the nozzle *k* close to the reaction-surfaces of the fly-wheel. (See Fig. 3.) The inner gimbal I instead of being of the usual ring form is shown as a flat casing. Against one flat side of the gimbal I acts a locking-cup or holder L, which is mounted on a sliding stem L′, carrying a piston M, which slides in a cylindrical chamber M′. The stem L′ passes through the chamber, and its protruding end receives the pressure of a spring N, transmitted through a lever N′. A spring-catch O holds the lever N′ when fully pressed back. (See Fig. 6.) The stem L′ is connected to lever N′ by a link *n′*, so that the catch O also holds the holder L retracted.

The time-valve G has a differential piston P moving in a cylinder P′ and is formed with a stem P^2 projecting through one end thereof. The piston actuates any suitable kind of closure—for example, a cone *p*, seating at *p′* to cut off communication between *j* and *j″*. The air can flow past the piston through any restricted channel, such as a groove *q*, Fig. 2, or the narrow space between the piston and cylinder. From the discharge side of the valve G a duct *r* leads to the outer end of the cylinder M′, and from its inner end a duct *s* leads to a chamber Q. The piston M has a check-valve *t*.

Operation: Before starting, the catch O is disengaged, so that the spring N presses the holding-cup L against the gimbal I (see Fig. 4) to hold the gyroscope immovable. Upon the opening of the valve *c* air under high pressure flows through *j* to the time-valve G and presses back the piston P to the position shown in Fig. 2, thereby opening the valve and flowing through *j″* to the nozzle *k*, from which the blast of air blows obliquely against the reaction-surfaces of the turbine-motor, thereby spinning up the fly-wheel H to a high velocity—say ten thousand revolutions per minute. Simultaneously upon the opening of the valve G the air flows through duct *r* to cylinder M′, passes the valve *t*, and flows through *s* into chamber Q until the compressed air in this chamber reaches the same pressure as at *r*. Meanwhile a restricted flow of air leaks through the channel *q* to the space behind the piston P, where, acting against the full area of the piston, it overcomes the pressure against the front side, (the area of which is diminished by the area of the stem P^2,) and hence moves the piston P forward until it closes the valve. The flow through *q* is proportioned to close this valve after sufficient time has elapsed to spin up the fly-wheel, say, for example, one second. Thereupon the pressure in *j″* escapes at *k*, and a backflow of air compressed in the chamber Q occurs. This backflow first closes the valve *t* and then forces back the piston M until the lever N′ is caught by the catch O, thus withdrawing the holder L and unlocking the gyroscope. In a torpedo these operations occur while the torpedo is advancing through the launching-tube, so that the fly-wheel is set spinning with its axis pointing to the target at which the launching-tube is directed. If the torpedo is deflected on entering the water, the fly-wheel axis, being free, continues its original direction, and the deflection of the torpedo relatively to the fly-wheel is utilized to control the steering apparatus. This may be variously accomplished, preferably by an electromagnetic connection. For this purpose the gyroscope may control electric circuits leading to magnets which operate the valves of a steering-engine. As shown, the outer gimbal J carries a delicately-pivoted metal arm R, which swings over metal segments S S′, (see Fig. 8,) connected through wires *u u′* with electromagnets or solenoids T T′, the circuit being completed by a connection (indicated at u^2) through a battery X to the arm R. The armature or core U of these magnets engages the arm V of the valve of the steering-engine E. This valve and engine may be identical with those used in the Whitehead torpedo. Hence as the torpedo is deflected it carries one of the segments S or S′ into contact with the arm R, which closes the circuit through the corresponding magnet, which turns the valve of the steering-engine, which latter throws the rudder to port or starboard, whereby to steer the torpedo back toward its original course.

The entire gyroscopic apparatus may be removed from the torpedo by taking off a cap-plate W, Fig. 3, and removing the screws which fasten the ears K′ to the frame A′.

It will be observed that my present construction differs from that of my former application in several respects, namely: The nozzle of the turbine-motor is immovable instead of being retracted after spinning up, and it forms no part of the unlocking mechanism. The gyroscope is held immovable during the spinning up by a holder L being pressed against it by spring-pressure and retracted by the action of compressed air on a piston, a spring-catch being provided to retain the holder after retraction. The gyroscope is constructed with its inner gimbal as a flat case, or with at least one flat face, against which the holder, formed substantially as a cup, may act to both restore the fly-wheel to its normal or initial position and hold it there during spinning up, and the support for the outer gimbal instead of being exterior thereto, as heretofore, is constructed with two arms entering within the outer gim-

bal and between it and the fly-wheel, and in at least one of these arms the nozzle of the turbine-motor is formed.

I claim as my invention the following-defined novel features, substantially as hereinbefore set forth, namely:

1. A gyroscope comprising a fly-wheel, and inner and outer gimbals, combined with locking means comprising a spring-pressed holder engaging the inner gimbal, and compressed-air-actuated means for forcibly retracting said holder.

2. A gyroscope comprising a fly-wheel, and inner and outer gimbals, combined with locking means comprising a holder engaging the inner gimbal, compressed-air-actuated means for forcibly retracting said holder, and a catch for retaining it after retraction.

3. A gyroscope comprising a fly-wheel, an inner gimbal inclosing it, having a flat face, and an outer gimbal, combined with a spring-pressed holder engaging the flat face of said inner gimbal to bring the latter to its normal position, and means for retracting said holder to free the gyroscope.

4. A gyroscope comprising a fly-wheel, an inner gimbal inclosing it, having a flat face, and an outer gimbal, combined with a holder in substantially cup form engaging the flat face of said inner gimbal, to bring the latter to its normal position, and means for retracting said holder to free the gyroscope.

5. A gyroscope comprising a fly-wheel, and inner and outer gimbals, combined with locking means comprising a holder, a sliding rod L′ carrying it, a piston M on said rod, a cylinder M′ inclosing said piston, a spring N acting against said rod to normally press said holder into engagement, and means for admitting compressed air to act against said piston to retract said holder against the pressure of said spring.

6. A gyroscope comprising a fly-wheel and inner and outer gimbals, combined with locking means comprising a holder L, rod L′, spring N, lever N′ communicating the pressure of said spring to said rod, catch O for retaining said holder when retracted, and compressed-air-actuated means for forcibly retracting said holder.

7. A gyroscope comprising a fly-wheel, and inner and outer gimbals, combined with a fixed support having arms entering within the outer gimbal and to which said gimbal is pivoted.

8. A gyroscope comprising a fly-wheel, and inner and outer gimbals, combined with a fixed support having arms entering within the outer gimbal and to which said gimbal is pivoted, said fly-wheel formed with reaction-surfaces, and an arm of said support formed with a nozzle communicating with the compressed-air conduit for directing compressed air obliquely against said surfaces to spin up the fly-wheel.

9. A gyroscope comprising a fly-wheel having reaction-surfaces, gimbals supporting it, a fixed nozzle connected with a source of compressed air for spinning up said fly-wheel, a holder for maintaining the axis of said fly-wheel immovable during spinning up, and compressed-air-actuated means for retracting said holder after spinning up.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

FRANK M. LEAVITT.

Witnesses:

THOMAS F. WALLACE.

FRED WHITE.