F. M. LEAVITT.

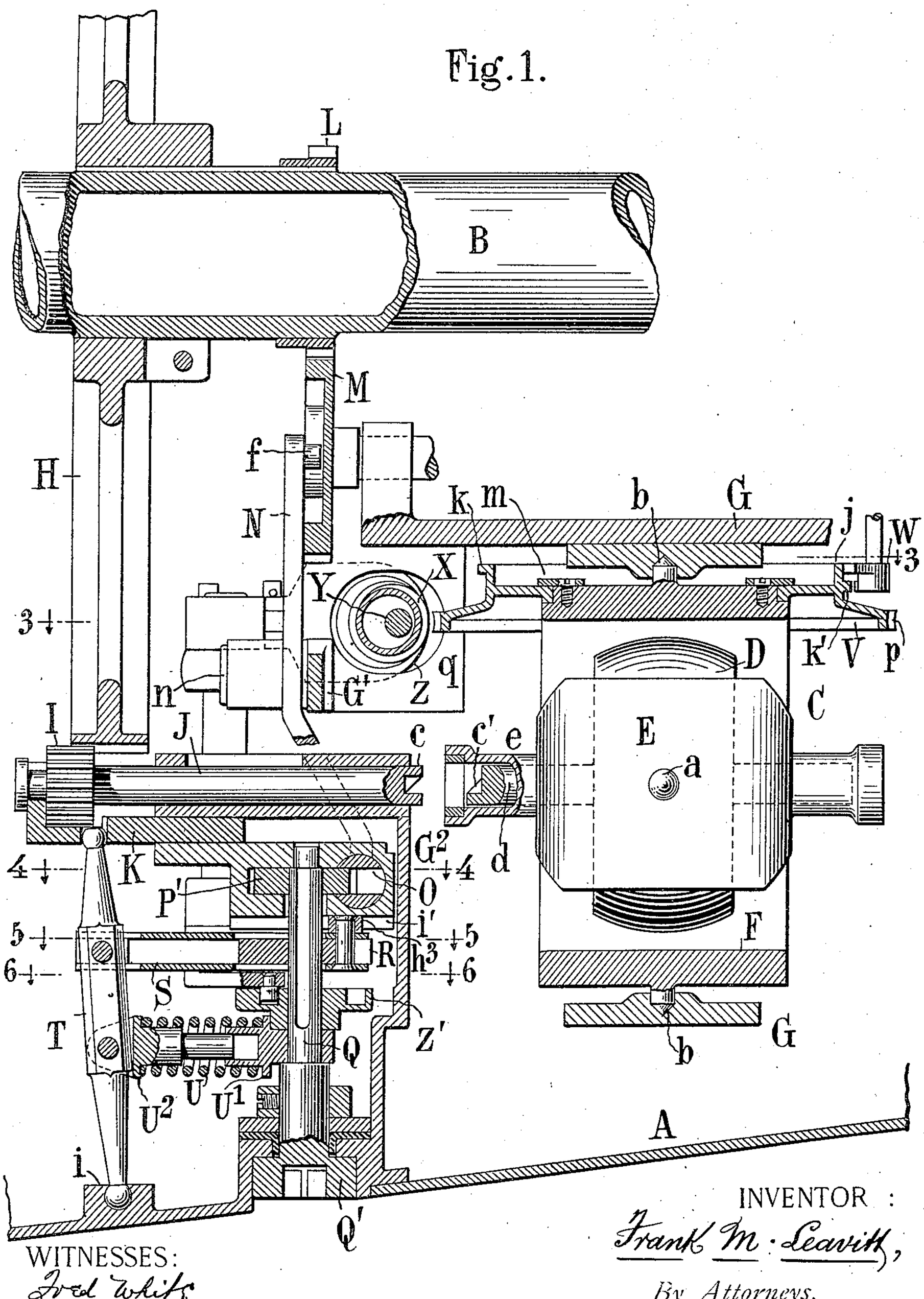
STEERING MECHANISM FOR TORPEDOES.

APPLICATION FILED JAN. 13, 1908.

925,710. Patented June 22, 1909.

3 SHEETS—SHEET 1.

Fig. 1.



WITNESSES:

Fred White

René Bruine

INVENTOR:

Frank M. Leavitt,

By Attorneys,

Arthur C. Fraser & Co.

F. M. LEAVITT.

STEERING MECHANISM FOR TORPEDOES.

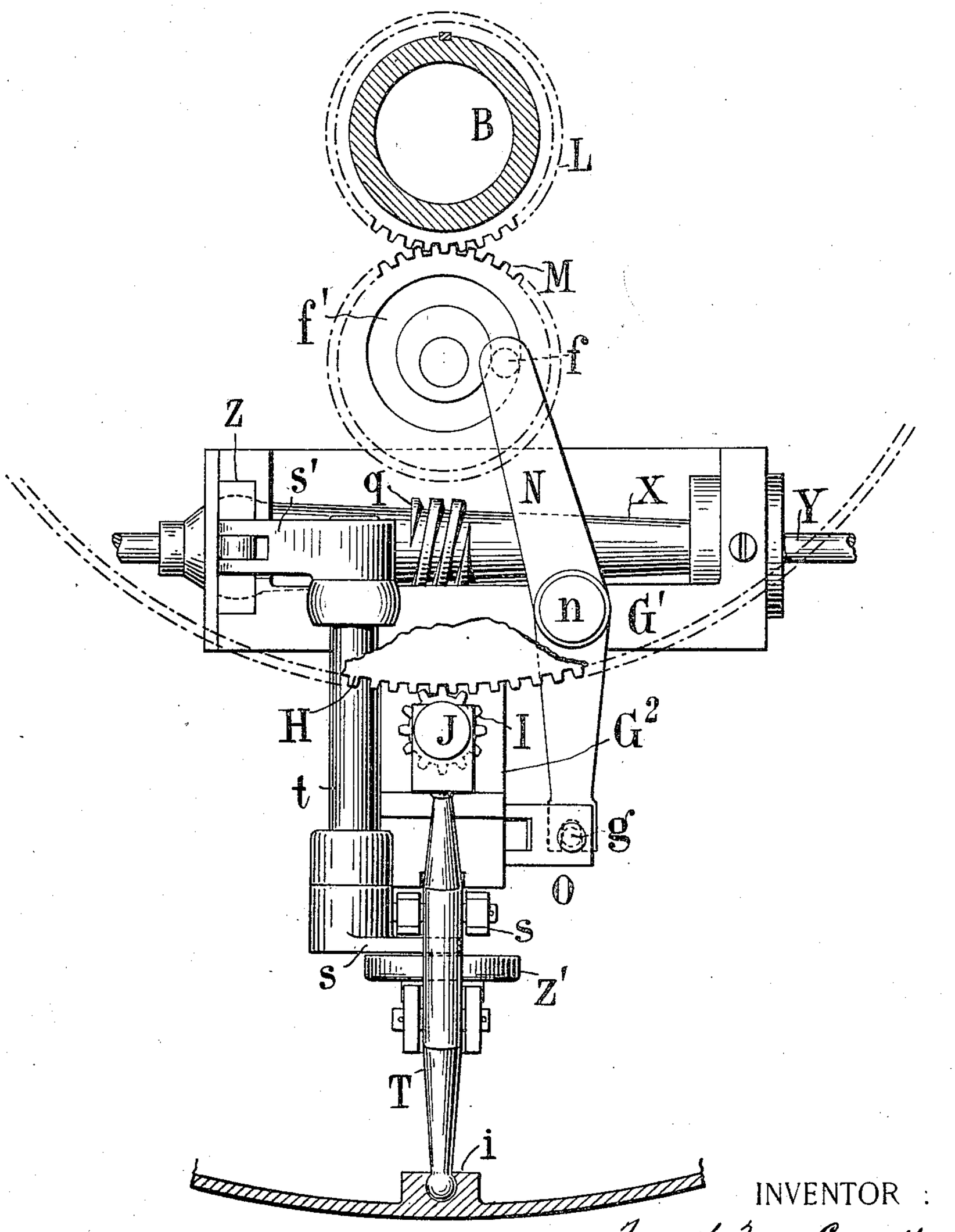
APPLICATION FILED JAN. 13, 1908.

925,710.

Patented June 22, 1909.

3 SHEETS—SHEET 2.

Fig. 2.



WITNESSES:

Fred White

René Bruine

INVENTOR:

Frank M. Leavitt,

By Attorneys,

Arthur C. Fraser & Sons

F. M. LEAVITT.

STEERING MECHANISM FOR TORPEDOES.

APPLICATION FILED JAN. 13, 1908.

925,710. **Patented June 22, 1909.**

3 SHEETS—SHEET 3.

Fig. 3.

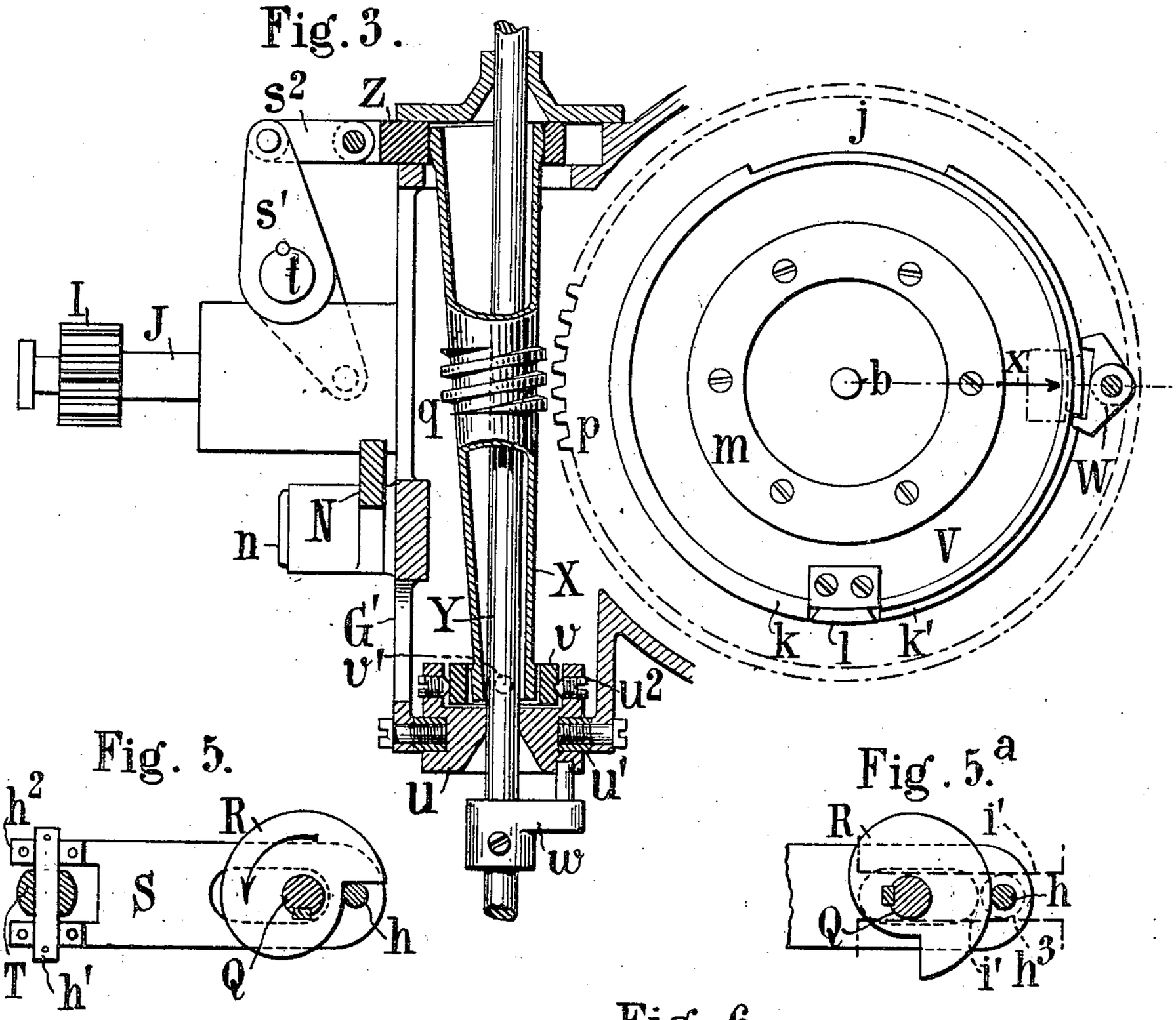


Fig. 5.

Fig. 5ª

Fig. 6.

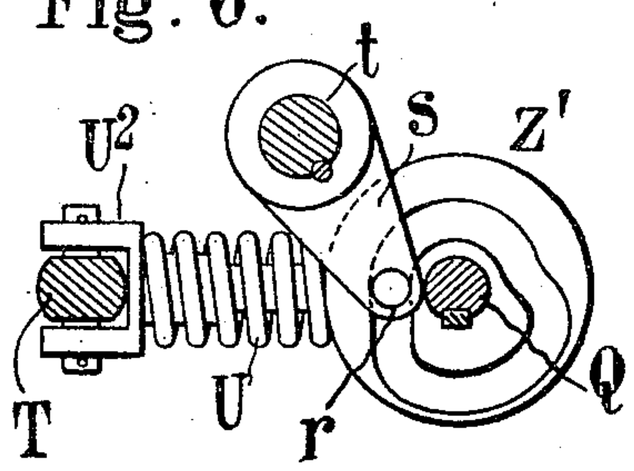


Fig. 4.

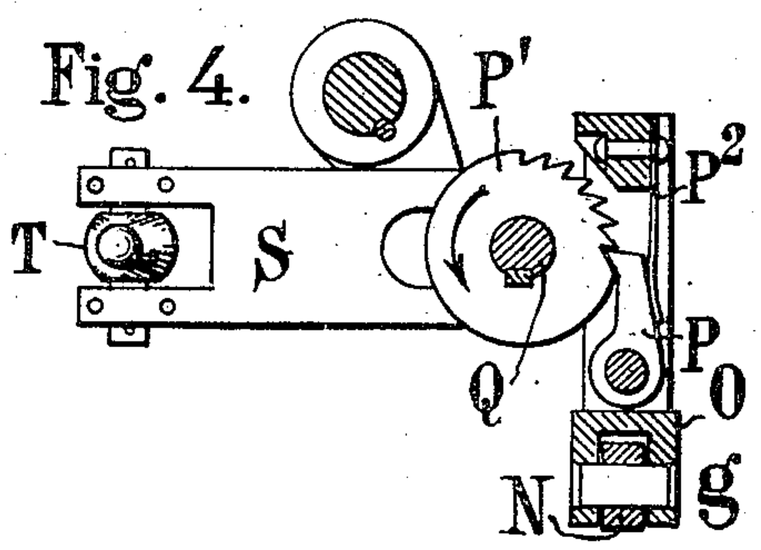
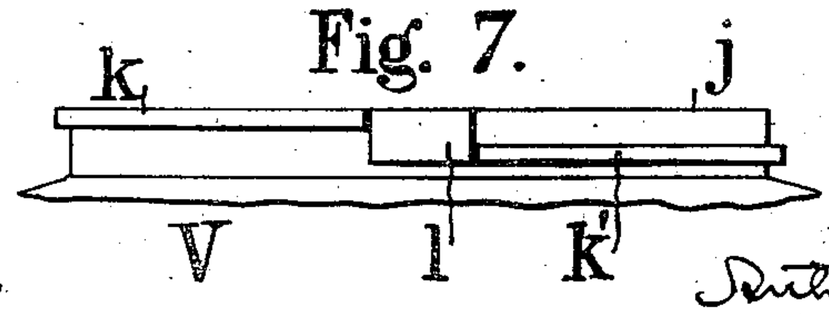


Fig. 7.



WITNESSES:

Fred White

René Meine

INVENTOR:

Frank M. Leavitt,

By Attorneys,

Arthur O. Fraser & Sons

UNITED STATES PATENT OFFICE.

FRANK M. LEAVITT, OF NEW YORK, N. Y., ASSIGNOR TO E. W. BLISS COMPANY, OF BROOKLYN, NEW YORK, A CORPORATION OF WEST VIRGINIA.

STEERING MECHANISM FOR TORPEDOES.

No. 925,710. Specification of Letters Patent. Patented June 22, 1909.

Application filed January 13, 1908. Serial No. 410,707.

To all whom it may concern:

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

This invention relates to gyroscopic steering apparatus for automobile torpedoes.

The improvements relate chiefly to what is known as the "unlocking gear," comprising the gyroscope spinning means, the means for setting the gyroscope free after spinning and upon the launching of the torpedo, and means for resetting the parts for a new operation; and to what is called the "angle-gear" whereby the steering mechanism may be set to cause the torpedo to steer in a course differing by a determined angle from the direction in which it is aimed.

Figure 1 of the accompanying drawings is a fragmentary vertical section in a plane coincident with the longitudinal axis of the torpedo. Fig. 2 is mainly an elevation looking aft, the torpedo shell and propeller shaft being in transverse section. Fig. 3 is a horizontal section mainly in the planes of the line 3—3 in Fig. 1. Figs. 4, 5 and 6 are fragmentary horizontal sections taken respectively in the planes of the lines 4—4, 5—5, and 6—6, in Fig. 1. Fig. 5ª is a fragmentary plan of a part of Fig. 5. Fig. 7 is a fragmentary elevation.

Referring to the drawings, let A designate the shell or hull of the torpedo, B the main driving shaft thereof, which is usually placed in the axis of the torpedo, and C the gyroscope as a whole. The latter comprises a fly-wheel D universally suspended in an ordinary manner by means of inner and outer gimbal rings E and F, the former having pivots *a* by which it is pivoted on a horizontal axis in the ring F, and the latter having pivots *b* by which it is pivoted on a vertical axis in a fixed frame G.

For spinning the gyroscope the same means is employed as that set forth in my Letters Patent No. 814,969, granted March 13, 1906. That is to say, a gear wheel H, keyed on the shaft B, drives a pinion I formed on a movable shaft J arranged in line with the normal axis of the fly-wheel, and having its end formed as a clutch *c* adapted for engagement with a reciprocal clutch *c'* formed on the end of the axial shaft or spindle *d* of the fly-wheel. The inner ring E is formed with a neck or sleeve *e* inclosing the spindle *d* and adapted to be entered by the shaft J. This shaft is movable longitudinally, being slidable in its bearings, and for this purpose being engaged by a slide K.

To set the apparatus ready for launching, the shaft J is advanced so that its rear end enters the sleeve *e*, thereby holding the gyroscope rings fixedly in position, so that the gyroscope is "locked;" the clutch end *c* of the shaft also engages the clutch end *c'* of the fly-wheel spindle, so that the turning of the former must turn the latter. Upon the launching of the torpedo the engine is started in the well known manner, so that the main shaft B is revolved, turning at first slowly, and rapidly accelerating its speed; its rotation is communicated through gear H and pinion I to more rapidly turn the shaft J, which by its engagement with the spindle *d* spins up the fly-wheel to high velocity. It is necessary, after allowing a sufficient interval of time for accomplishing this result, to quickly withdraw the shaft J, whereby it is disengaged from the fly-wheel and pulls out of the sleeve *e*, so as to set free the rings of the gyroscope. This operation is called "unlocking." The unlocking mechanism will now be explained.

The main shaft B has fixed upon it a gear wheel L which meshes with and drives a cam gear M which rotates on a fixed axis. This gear has an eccentric cam groove *f'* which is engaged by a pin *f* on a rock-lever N fulcrumed on a stud *n* fastened to a part G' of the fixed frame G. The lower arm of lever N engages and reciprocates a slide O which is movable horizontally and transversely in a slideway formed in a fixed part or frame G². The slide O is shown as a cylindrical part sliding in a cylindrical bore and having a transverse pin *g* engaged by the forked lower end of the lever N. The slide O carries a pawl P (Fig. 4) engaging the teeth of a ratchet wheel P'. The pawl is shown as carried in a slot formed centrally through the slide, which slot is also partly entered by the ratchet wheel. A spring P² is fastened to the slide and presses the pawl against the ratchet teeth.

The ratchet wheel P' is fixed on an upright spindle Q which constitutes the unlocking spindle, and the lower end of which

passes out through a stuffing box in the shell, and has a head Q′ by which it may be turned from the exterior. This spindle has fixed to it an unlocking cam R, shown best in Fig. 5. This is a snail cam, and engages a pin *h* forming part of a link S which is pivoted by a pin *h′* to an unlocking lever T. This lever has its lower end fulcrumed in a fixed part *i*, and its upper end engages the slide K. The lever is pressed outward by a strong spring U which tends to throw the parts into the unlocked position. In the preliminary setting, the spindle Q is turned by the operator in the direction of the arrow in Fig. 5, so that the snail cam R presses back the pin *h*, and, through the link S, pulls the lever T aftward to bring the parts to the locked position. This leaves the cam R in the position shown in Fig. 5ª.

At starting, during the launching operation the first few turns of the main shaft B transmit motion through the cam M and lever N and reciprocate the slide O, so that the pawl turns the ratchet wheel P′ through approximately 90 degrees, thereby turning the cam R from the position shown in Fig. 5ª to that shown in Fig. 5, so that the pin *h* is released by the projecting part of the cam, and under the impulse of the spring U moves to the position shown in Fig. 5, so that the lever T and slide K are moved forcibly and instantly to the position shown in Fig. 1, thereby performing the unlocking movement. The ratchet wheel P′ has teeth on only a portion of its circumference, say 90 degrees, so that when turned through a corresponding angle the teeth pass beyond the pawl and the wheel stops, the pawl afterward moving impotently against the toothless portion of the wheel.

Owing to the cramped space available, it is preferable to construct the link S of two plates passing above and below the cam R, connected at one end by the pin *h*, and at the other by blocks h^2 riveted through, and which receive the pivot pin *h′* as shown. The pin *h* is prolonged upwardly and carries a head or roller which moves in a guiding groove *i′* formed in the fixed frame G^2, this groove serving to keep pin *h* in a straight path. In Fig. 5ª the roller is shown by the dotted circle h^3, and the groove is shown by the dotted lines *i′*.

The spring U is shown as mounted between a stationary ear U^1 supported on the spindle Q, and a movable plunger U^2 having a pivotal connection with the lever T.

The gyroscope controls the steering mechanism through any suitable connection, either mechanical or electrical. An example of an electrical connection is shown in my United States Letters Patent No. 785,425, granted March 21, 1905. A suitable mechanical connection is that set forth in my United States Letters Patent No. 795,045, granted July 18, 1905. In either case the outer ring F of the gyroscope carries a disk or turn-table V which constitutes a part of the means for transmitting control to the steering mechanism. In case the mechanical transmission claimed in my last-named patent is used this disk V carries some suitable form of cam for coacting with the "feeler" of said patent. A suitable arrangement is that illustrated, where the disk has an upright flange *j* formed with ribs *k* and *k′* in different planes, which, at a given point in the circumference, meet through the interposition of a cam-tooth *l*. The feeler W is of the shape shown in Fig. 3, with its opposite projections, or those in different planes, corresponding to those of the ribs *k k′*, and spaced apart a distance corresponding to the width of the tooth *l*. The feeler is mounted to reciprocate rapidly toward and from the flange *j*, touching it lightly and then retreating from it, so that it receives from the disk a position which depends upon whether it touches the disk coincidently with the cam *l*, or to one side or the other thereof; and in retreating therefrom it communicates control according to such position to the steering mechanism. This device forms no part of my present invention, and is here illustrated only to make clear the description of the angle-gear which follows.

The disk or turn-table V is mounted rotatively upon the ring F, so that while the ring is held stationary the disk may be turned to any desired angle thereon. A frictional engagement of the two is preferable. This may be accomplished as shown in Fig. 1, where the disk engages an annular bearing formed on the ring, and is held in place by a detachable ring or flange *m*. The purpose of thus adjusting the disk is to vary the direction of the course to be steered by the torpedo relatively to the direction in which it is aimed or pointed in launching. If the torpedo is to travel in the direction in which it is thus aimed, the disk V is set to its normal or zero position, (*x*, Fig. 3) so that the tooth *l* exactly coincides with the feeler W. If, however, the course of the torpedo is to deviate by any desired angle from the direction in which it is aimed, it is only necessary to turn the disk V in the appropriate direction through an angle equal to the angle of deviation desired. Thus if the course of the torpedo is to diverge by 90 degrees from the initial direction of launching, the disk V is turned through 90 degrees from the zero position, as shown in Fig. 3. The effect of this turning is that the feeler W is tilted as there shown, and consequently through its control of the steering mechanism turns the rudder in the appropriate direction, to steer the torpedo through an

initial arc, the rudder being held hard over in this position until the torpedo shall have traversed such initial arc, at the termination of which it is headed upon its ultimate course 90 degrees from the direction in which it was launched. During this time the disk V, by reason of the persistence of direction of the gyroscope, remains fixed in direction, the other parts of the torpedo swinging gradually around it. Or, otherwise stated, the gyroscope and disk V turn relatively to the other parts of the torpedo until the cam tooth *l* passes from (for example) the position shown in full lines in Fig. 3, to the zero position shown in dotted lines. On reaching the latter position, the feeler W, which thus far has been tilted, is straightened, and as the torpedo swings across its ultimate course the feeler is tilted in the contrary direction, so that by its control of the steering mechanism the rudder is brought first to the mid-ships position, and then turned sufficiently to the opposite side to straighten the torpedo on its course. After this occurs the torpedo follows approximately its ultimate course, any variation therefrom being automatically corrected by the operation of the steering mechanism under control of the gyroscope.

The present invention provides for conveniently setting the disk or turn-table V to the desired angle just preparatory to launching, and after the parts are all assembled in the torpedo, or even after the torpedo is in the launching tube, so that the course of the torpedo may be determined at the last moment before firing or launching. To this end the turn-table V is provided with peripheral gear teeth *p* making it a worm wheel, these teeth being engaged by a worm *q* carried on a tubular shaft X, which is swiveled to a shaft Y. When the mechanism is set ready for launching, the worm *q* is in engagement with the teeth *p*, so that by turning the shaft Y, which also turns the tube X, the worm acts to rotate the turn-table V while the gyroscope rings are locked fast by the engagement of the shaft J. By turning the shaft Y in the proper direction, and for a suitable number of revolutions, the turn-table V may be displaced any desired number of degrees in either direction from its normal or zero position. The torpedo being then launched, the operation of the unlocking mechanism, as hereinbefore described, takes place, and at the same instant the worm *q* is carried out of mesh with the teeth *p*, so as to leave the turn-table free, and carried solely by the gyroscope ring. The construction of these several parts will now be explained. The shaft Y extends horizontally, and either end may be prolonged to and through the shell of the torpedo for convenience in turning it. The tube X carrying the worm *q* is conveniently made conical. One end of this tube is swiviled to the shaft Y, and its other end is carried in a movable bearing or slide Z by the movement of which the tube may be so displaced as to carry the worm into or out of mesh with the worm wheel. This movable bearing or slide takes its motion from the unlocking shaft Q. This shaft carries a cam Z′, best shown in Fig. 6, the groove in which is engaged by a pin *r* carried on a lever arm *s* fixed upon a vertical shaft *t* to which is fixed another arm *s′* which connects by a link s^2 to the slide Z. Before launching, the cam Z′ is in such position that its groove holds the pin *r* away from the shaft Q, and the slide Z is moved toward the right so as to carry the conical tube X into position concentric with the shaft Y; the worm is thus in mesh with the worm wheel, so that any desired adjustment of the latter can be made by turning the shaft and worm. During the launching operation the partial rotation of the shaft Q, as already described, turns the cam Z′ to such position (see Fig. 6) that the cam groove acting on the pin *r* displaces the bearing slide Z to the position shown.

The swivel for connecting the shaft Y with the tube or hollow shaft X may be variously constructed. The construction shown comprises a collar *u* through which passes the shaft Y which has fixed on it an arm *w* having a pin which enters a hole in the collar *u* by which to turn it. The collar has a peripheral groove turning within a split ring *u′* which is fastened to the frame G′ by screws. The collar *u* has a flange provided with pivot screws u^2 which engage at diametrically opposite points a swivel ring or gimbal *v*. This ring is in similar manner provided with pivot screws *v′*, shown in dotted lines in Fig. 3 (on a diametrical axis at right-angles to that of the screws u^2) by which the ring *v* is engaged with the tube X.

So far as concerns the angle gear and the means for disconnecting the angle adjusting device from the disk or turn-table V, it is immaterial to my invention what means may be adopted for transmitting control from the gyroscope to the steering mechanism. This means may be electrical or mechanical as in my aforementioned patents. The means herein shown as an example, however, is deemed preferable.

What I claim is.

1. A gyroscope comprising gimbal rings and an unlocking mechanism therefor comprising a locking part, a spring tending to withdraw it, and a progressively moving part for restraining said locking part adapted to release it at the end of a predetermined movement.

2. A gyroscope comprising gimbal rings and an unlocking mechanism therefor comprising a locking part, a spring tending to withdraw it, a cam for restraining said part,

and means for progressively displacing said cam to release said part.

3. A gyroscope comprising gimbal rings and an unlocking mechanism therefor comprising a locking part, a rotatable cam controlling the latter and adapted upon a given movement to unlock the gyroscope, a propeller shaft, and means driven by said shaft for turning said cam.

4. A gyroscope comprising gimbal rings and an unlocking mechanism therefor comprising a locking part, a rotatable unlocking shaft, a cam on said shaft adapted upon a given movement to release said locking part, a propeller shaft, and means driven by said propeller shaft for turning said unlocking shaft.

5. A gyroscope comprising gimbal rings and an unlocking mechanism therefor comprising a locking part, a rotatable unlocking shaft, a ratchet and pawl for turning said shaft, and means connected with said shaft and locking part adapted upon the completion of a given movement of the shaft to withdraw said locking part.

6. A gyroscope unlocking mechanism comprising a rotatable shaft, a ratchet wheel thereon having a toothed portion and a toothless portion, a reciprocating pawl engaging said ratchet wheel and adapted to engage its teeth and to turn it a distance corresponding to its toothed portion, said shaft having means whereby it may be turned manually to its starting position.

7. A gyroscope unlocking mechanism comprising a locking shaft J, a slide K, a shaft Q, a spring U tending to press said slide to the unlocking position, a cam R on the latter shaft, and a connection to said slide engaged by said cam.

8. A gyroscope unlocking mechanism comprising a locking shaft J, a lever T for displacing said shaft, a spring U pressing against said lever, a link S engaging said lever, a restraining cam R engaging said link, and means for turning said cam.

9. A gyroscope unlocking mechanism comprising a locking part, a rotatable shaft Q, a ratchet wheel P′ on said shaft, a reciprocating slide O, a pawl carried thereby engaging said ratchet wheel, a lever N for reciprocating said slide, and a cam M for moving said lever.

10. A gyroscope comprising gimbal rings, a turn-table adjustable thereon, a locking part for holding said rings stationary, an adjusting device engaging said turn-table for turning it, and an unlocking mechanism adapted to withdraw said locking part and to disengage said adjusting device to free the gyroscope.

11. A gyroscope comprising gimbal rings, a turn-table adjustable thereon, a locking part for holding said rings stationary, an adjusting device engaging said turn-table for turning it, and means adapted to disengage said adjusting device.

12. A gyroscope comprising gimbal rings, a turn-table adjustable thereon having gear teeth, an adjusting device for turning said turn-table comprising a gear engaging said teeth, and means for disengaging said adjusting device adapted to displace said gear out of engagement with said teeth.

13. A gyroscope comprising gimbal rings, a turn-table adjustable thereon having gear teeth, an adjusting device for turning said turn-table comprising a worm, a shaft carrying said worm movable toward and from said turn-table, and means for disengaging said adjusting device adapted to displace said shaft to bring said worm out of mesh with said teeth.

14. A gyroscope comprising gimbal rings, a turn-table adjustable thereon, an adjusting device for turning said turn-table comprising a movable shaft, and means for laterally displacing said shaft comprising a rotatable cam operatively connected to said shaft.

15. A gyroscope comprising gimbal rings, a turn-table adjustable thereon, a locking part for holding said rings stationary, an adjusting device engaging said turn-table for turning it, and an unlocking mechanism adapted to withdraw said locking part comprising a rotative cam, and connections therefrom to said adjusting device.

16. A gyroscope comprising gimbal rings, a turn-table adjustable thereon, a locking part for holding said rings stationary, an adjusting device engaging said turn-table for turning it comprising a rotatable shaft, a tubular shaft swiveled thereon, and a gear carried by the latter and engaging teeth on said turn-table.

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

FRANK M. LEAVITT.

Witnesses:

ARTHUR C. FRASER,

FRED WHITE.