W. DIETER.

GYROSCOPIC STEERING MECHANISM.

APPLICATION FILED MAY 1, 1915.

1,153,678.

Patented Sept. 14, 1915.

2 SHEETS—SHEET 1.

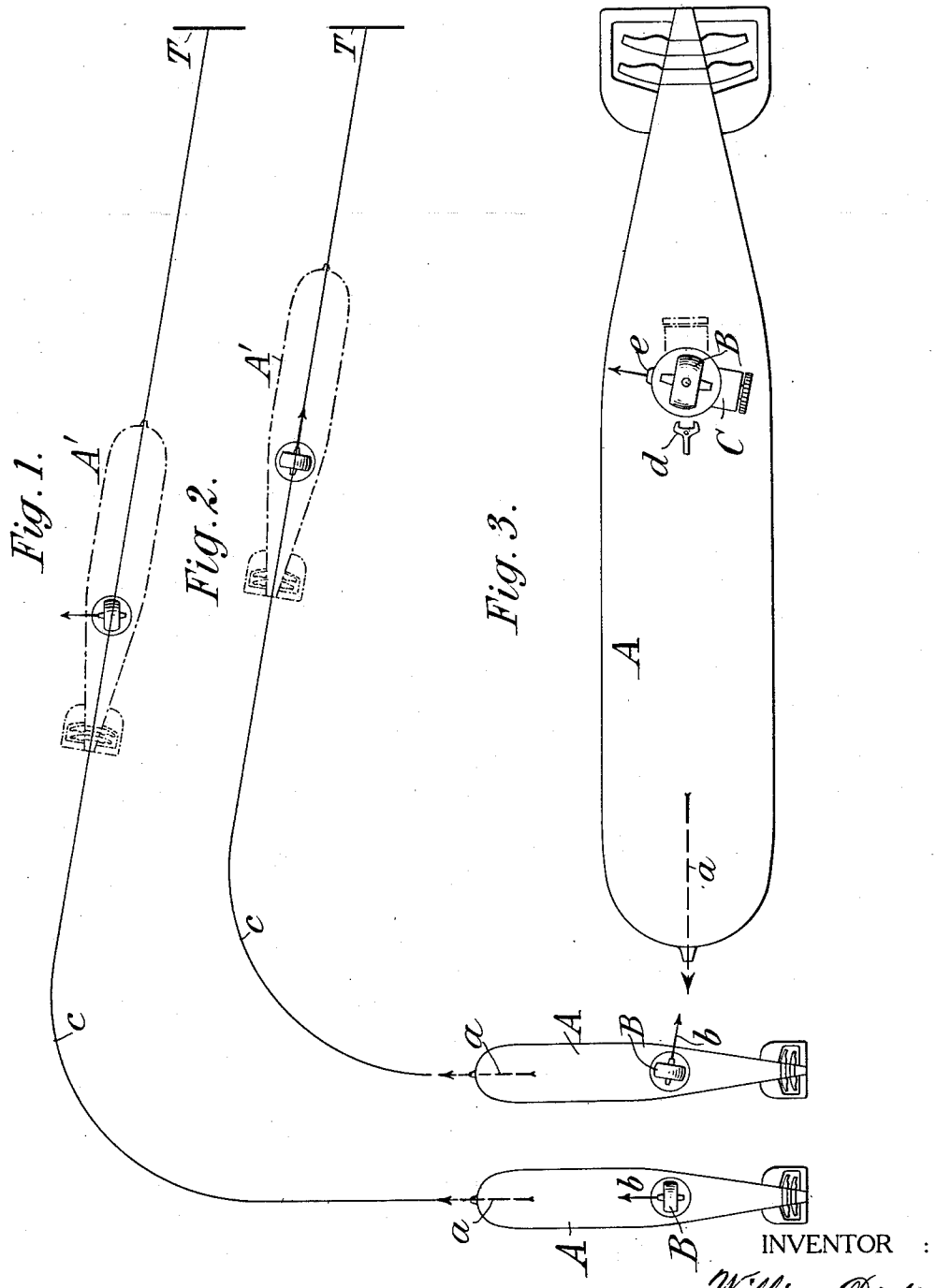

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Fig. 4.

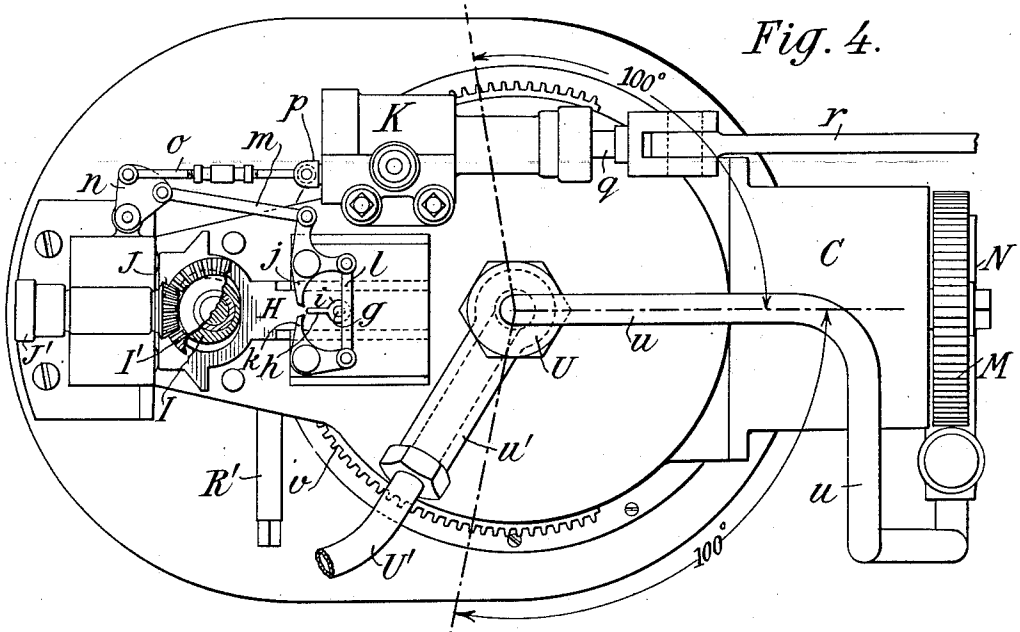
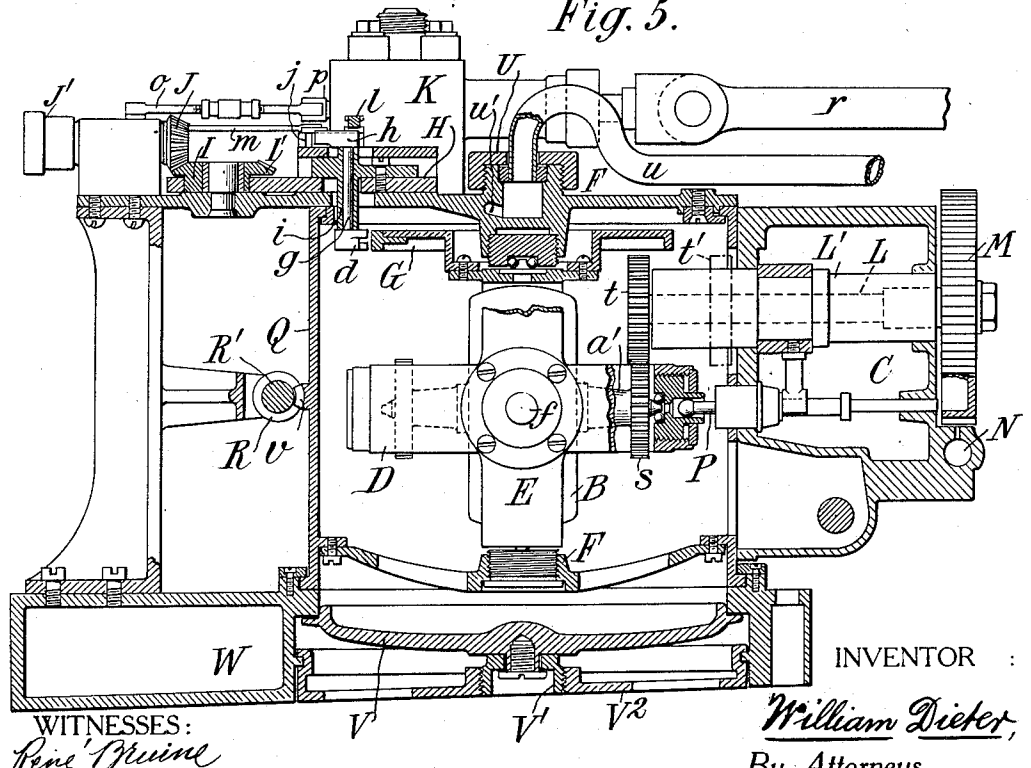


Fig. 5.



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GYROSCOPIC STEERING MECHANISM.

1,153,678. Specification of Letters Patent. Patented Sept. 14, 1915.

Application filed May 1, 1915. Serial No. 25,124.

To all whom it may concern:

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

This invention relates to gyroscopic steering mechanisms such as are used for steering automobile torpedoes, and has particular reference to the adaptation of such mechanisms to what is called "angle fire" or "curved fire" whereby the torpedo is launched at a prescribed angle to the line of its ultimate course, and after launching steers through a curved course until it is alined with its ultimate course, whereupon it steers a substantially straight course to its target.

In gyroscopic steering for torpedoes as first introduced, the axis of the gyroscope fly-wheel was located transversely to the longitudinal axis of the torpedo. It was later found that better results were secured by locating the gyroscope axis fore and aft of the torpedo or parallel to the torpedo axis, and such has been the invariable practice of recent years. In adjusting a gyroscope, it is necessary not only to secure a perfect balance, but to adjust for disturbing forces, namely, those causing precession, those tending to orientation, and those due to the movements of the torpedo.

Without going into the consideration of the complicated forces and reactions involved, it is sufficient to state that it is the universal experience that a gyroscope has a more certain and reliable directive effect and generally operates better the nearer its axis lies during the run of the torpedo to parallelism with the torpedo axis, that is, to the mean course of the torpedo during its approximately straight run.

It has long been a desideratum to make gyroscopic steering apparatus that would efficiently steer the torpedo immediately after launching through a curve covering a prescribed number of degrees of angle, and thereupon when headed toward its target to steer a substantially straight course for the target; but such angle fire steering has heretofore been attended with serious disadvantages and has been liable to dangers that have detracted from the resort to angle fire. This is believed to have been due largely to the fact that while at launching the gyro axis was parallel with the torpedo axis, yet after swinging around the curve and heading off on the ultimate straight course, the gyro axis has diverted to a position more or less athwartships, so that to take the extreme case of a 90 degree angle, it would lie precisely across the mean course of the torpedo. In such position, and proportionally in any approach thereto, the directive force and the reliability of the gyroscope have been seriously impaired, as compared with its location with its axis parallel to the torpedo axis. Since the initial curved course occupies but a very small fraction of the time consumed in the total run of the torpedo, the disadvantageous location of the gyro axis has under such circumstances had tremendous preponderance over its initial advantageous location.

The present invention is based upon the desirability of so locating the gyroscope that its axis will occupy its most advantageous position during the greater part of the run, that is to say, during the straightaway course assumed after the initial curve is traversed. To this end provision is made whereby in setting the steering mechanism for angle fire the gyroscope itself shall be initially swung around within the torpedo to whatever angle is required, in contradistinction to maintaining the gyro axis initially parallel with the torpedo axis and shifting solely the angle of the intermediary control mechanism. The improved steering device results in the launching being effected with the gyro axis deflected more or less toward the athwartships position, whereupon the torpedo automatically steers through the initial curve until its direction is brought into parallelism with that assumed by the gyro axis, and upon such parallelism being attained the torpedo then steers its straightaway course, such course being parallel with the direction of the gyro axis. Thus for the major part of the run of the torpedo the gyroscope is in its most effective location. For conveniently effecting this result the improved steering mechanism provides for the spinning up of the gyroscope in whatever position it may occupy at the instant of launching, that is to say, either on a longitudinal axis for a straightaway fire or a more or less deflected location for

an angle fire. This is best accomplished by mounting the spinning mechanism so that it swivels with the gyro. The detailed construction will be made apparent with reference to the drawings.

Figure 1 of the accompanying drawings is a diagram illustrating the relative location of the gyroscope and torpedo at launching and during the running on angle fire as heretofore practised; Fig. 2 is a similar diagram of the same showing the location resulting from the present invention; Fig. 3 is a diagram showing the torpedo in plan and the gyroscope and its spinning mechanism, these being of disproportionate size; Fig. 4 is a plan of the gyro mechanism; Fig. 5 is a vertical longitudinal section through the latter.

Referring to Figs. 1 and 2, A is the torpedo, the dotted arrow *a* showing its longitudinal axis; B is the gyroscope fly-wheel, the arrow *b* showing its axis of rotation. *c* indicates diagrammatically the course of the torpedo to the target T. The torpedo is shown in full lines at its starting or launching position, and in dotted lines at A′ after it has traversed the initial course and is on its straightaway course. In the diagrams this course is shown as straight, it being well understood that in practice it is slightly sinuous. A comparison of these diagrams shows the difference introduced by the present invention. Heretofore the gyroscope axis at launching has been in line with the torpedo axis, (Fig. 1) so that after swinging to the ultimate course the gyro axis is more or less transverse to the torpedo axis, that is, to the direction of the straightaway course. By the present invention (Fig. 2) the gyro is turned before launching through as many degrees as the angle of fire, so that when the torpedo is steered around the initial curve the gyro axis and torpedo axis coincide in direction, both pointing toward the target.

Heretofore in preparing for angle fire the control mechanism intervening between the gyroscope and the steering engine has been thrown out of coincidence, the one of the reciprocal members which is carried by the torpedo and not by the gyro being swung around to either side for the number of degrees required. That is to say in the Bliss-Leavitt torpedo where the control is accomplished through the coaction of a cam carried by the gyro ring, and a pallet mounted in the torpedo, the pallet has been swung around to divert it to the required angle. By the present invention the pallet is mounted in an invariable position in the torpedo, and the gyroscope itself carrying its cam is turned to the required angle. This is illustrated in the diagram Fig. 3, where the cam *e* and pallet *d* are shown diagrammatically. The gyro has been turned to one side through about 100 degrees, carrying with it the cam *e*. To enable the gyro to be spun up in this angled position, its spinning mechanism shown in outline at C is carried by the casing of the gyro so that it swings with the gyro. The pallet *d* is mounted in an invariable location in the torpedo. It results from this that upon launching, the torpedo being automatically steered (in the customary manner) in such direction as to bring the pallet and cam into coincidence, will swing around the initial curve until the pallet finds itself opposite the cam, that is to say, until the torpedo axis has been brought into line with the gyro axis; thereupon the cam and pallet function in the ordinary manner and the torpedo is steered in the direction of this axis.

The preferred manner of applying the invention is shown in detail in Figs. 4 and 5. In these figures the gyroscope fly-wheel B is mounted in the usual manner in a gimbal ring D in a normally horizontal plane, and this in turn is pivoted on a transverse axis *f* in an outer gimbal ring E, which is pivoted on a vertical axis to the frame or housing F, all in the usual manner, ball bearings being preferably provided at the respective pivots. The outer ring carries a disk G on the periphery of which is formed the cam in the manner well understood, this cam coacting with the pallet *d*, which as usual has an upright spindle *g* and tappet arm *h*, the spindle *g* being carried in a sleeve *i* mounted on a slide H, so that the pallet is reciprocated toward and from the disk G. The reciprocation is imparted to the slide by means of an eccentric hub I on a bevel gear I′ which is driven by a bevel pinion J on a small countershaft J′ which is driven from the propeller shaft in the manner well understood. The tappet *h* when turned to either side strikes one or other of two elbow-levers *j* or *k*, which have parallel arms connected by a link *l*, so that movement of either moves the other, and such movement is communicated through a link *m* and rock lever *n* to a rod *o* which operates the valve stem *p* of the steering engine K. The piston rod *q* of this engine operates through a tiller rod *r* in the usual manner to turn the rudder.

The spinning mechanism shown is, by way of illustration, of the air turbine type. The fly-wheel axle *a′* has a pinion *s* which at spinning is in mesh with a pinion *t* on a shaft L housed in a sleeve L′, and on which shaft is fixed a small turbine M receiving jets of air from a nozzle N, the compressed air being led thereto by a pipe *u*. The gyroscope is held fixedly during spinning by a bolt or lock P which enters a socket in the inner ring D, as shown in Fig. 5. By means of a mechanism not shown the compressed air at high pressure is turned

on for a moment at the instant of launching, and after a sufficient interval to insure the spinning up of the fly-wheel to the required velocity, the sleeve L is displayed by mechanism not shown so as to bring the pinion *t* to the position shown in dotted lines at *t'*, and by the same movement the bolt P is retracted so as to leave the gyroscope free.

The gyroscopic mechanism so far as thus described is substantially of the well known construction as heretofore used in the Bliss-Leavitt torpedo, differing only in matters of arrangement, the essential operation being the same as heretofore.

According to the present invention a part of the gyroscope housing is mounted to turn or swivel upon an axis coinciding with the vertical axis on which the outer ring E is pivoted. In the construction shown the swivel portion is a cylindrical shell Q which at its top and bottom ends has an annular engagement with the fixed parts of the housing. For conveniently turning it, it is formed with worm teeth at *v* engaged by a worm R on a transverse shaft R' which is in any suitable way accessible from the exterior, so that by turning it the operator may swing the gyroscope to right or left through the required number of degrees. The entire spinning mechanism C is mounted on the shell Q so as to turn therewith. This necessitates a swivel connection through which to supply the compressed air to the pipe *u* leading to the nozzle of the spinning turbine. For this purpose the pipe *u* is carried as shown into coincidence with the axis of oscillation, that is to say, to the top of the housing where it engages a swiveled stuffing box U communicating with a central chamber which receives air through a duct *u'* to which is led an air pipe U'. The pipe U' receives air from the starting valve in the usual manner.

The bottom of the housing is closed by a packed cover V tightened to its seat by a screw thimble V' engaging a removable head V^2 which is locked by a rotary engagement to the opening in the base plate W which supports the entire gyroscope, in the usual manner.

The new mechanism differs from the gyro mechanism heretofore used in that the pallet *d* and its connected parts are mounted in an invariable location with respect to the top plate, so that they do not swivel around the central vertical axis; in that a portion of the gyro shell or housing is mounted to swivel, and in that the spinning mechanism with its lock which determines the location of the fly-wheel axis during spinning and at the instant of its release, is also mounted to swivel with this shell; and in that for an air spinning mechanism the air duct is swiveled so as to permit of the angular deflection of the gyroscope and spinning device.

It will be understood that the precise gyroscopic mechanism shown in Figs. 4 and 5 is illustrated only as a suitable concrete example of the practical development of the invention, the latter not being limited to this precise type of gyroscopic mechanism, that is to say, to one in which the gyroscopic control is communicated to the steering engine through a cam and pallet; nor is it limited to the specific air spinning mechanism shown. In place of these, any known construction of gyroscope steering mechanism and spinning device may be substituted, it being only necessary that these be modified in order to carry out the *modus operandi* of the present invention.

The advantages of this invention may be made apparent by considering what is necessary in the adjustment of a steering gyro. Such gyro is adjusted for precession, orientation, and disturbances due to the movements of the torpedo itself, such adjustments being made under a variety of conditions. The adjustments are first made for a straightaway run, and when the gyro has thus been brought into perfect adjustment, it has been found as heretofore constructed that with an angle run the gyro required further adjustment. A serious difficulty has been encountered by reason of the fact that the deviations from those of true adjustment occur in contrary directions according to whether the steering angle is to the right or to the left. To adjust for angle fire to the right would bring the gyro out of adjustment for direct fire, and still more out of adjustment for angle fire to the left, and vice versa. Consequently it has resulted that the only practicable adjustments were those for direct fire, and the variations occuring in angle fire have had to be tolerated. This has been a serious defect in angle fire, and has deterred the use of such fire because while the gyro was in correct adjustment at the instant of launching, it reached a condition of maladjustment during the initial curve, and continued in such condition during the entire following straightaway run. As such run lasts for commonly 50 times or more the duration of the curve, there was an immense preponderance of the duration of the disadvantageous condition.

With the present invention, on the contrary, when the gyro has been brought into proper adjustment for a direct run and is then swung through an angle preparatory to an angle fire, the disadvantage or condition of maladjustment thereby induced persists during the run for an extremely brief period, and is corrected during the initial curved course, so that the remaining or straightaway course is made during the most nearly ideal conditions of operation of the gyroscope. In other words assuming (which

is substantially correct) that the initial curve occupies two per cent. of the total run, the disadvantageous condition is eliminated during the first 2 per cent. of the run, and is wholly absent during the remaining 98 per cent. thereof. While with the old arrangement the advantageous condition occured only at the beginning of the curve and disappeared during the first 2 per cent. of the run and during the remaining 98 per cent. thereof the gyroscope was operated under its worst condition.

I claim as my invention:—

1. In an automobile torpedo, a gyroscopic steering mechanism comprising a gyroscope and controlling means actuated thereby tending to steer the torpedo on a course coincident with the gyroscope axis, the gyroscope having a swivel mounting whereby it may be initially turned to either side for an angle fire, whereby upon launching the torpedo steers a curved course until it points in the direction of the gyroscope axis, and thereupon steers a substantially straight course coinciding with such axis.

2. In a torpedo, a gyroscopic steering mechanism comprising a gyroscope and means for spinning it both mounted to swivel on a vertical axis relatively to the torpedo, and controlling means actuated by the gyroscope and tending to steer the torpedo on a course coincident with the gyroscope axis, whereby for an angle-fire the gyroscope is turned initially to either side, and upon launching the torpedo steers a curved course until it points in the direction of the gyroscope axis, and thereupon steers a substantially straight course coinciding with such axis.

3. In a torpedo, a gyroscope steering mechanism comprising a gyroscope with its flywheel and gimbals, and an air driven spinning means therefor, both mounted to swivel on a vertical axis relatively to the torpedo, and an air pipe leading from a source of compressed air to such spinning device and having a swivel connection coincident with said axis, and controlling means actuated by the gyroscope and tending to steer the torpedo on a course coincident with the gyroscope axis, whereby for an angle-fire the gyroscope is turned initially to either side, and upon launching the torpedo steers a curved course until it points in the direction of the gyroscope axis, and thereupon steers a substantially straight course coinciding with such axis.

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

WILLIAM DIETER.

Witnesses:

ARTHUR C. FRASER,

FRED WHITE.