G. C. DAVISON.

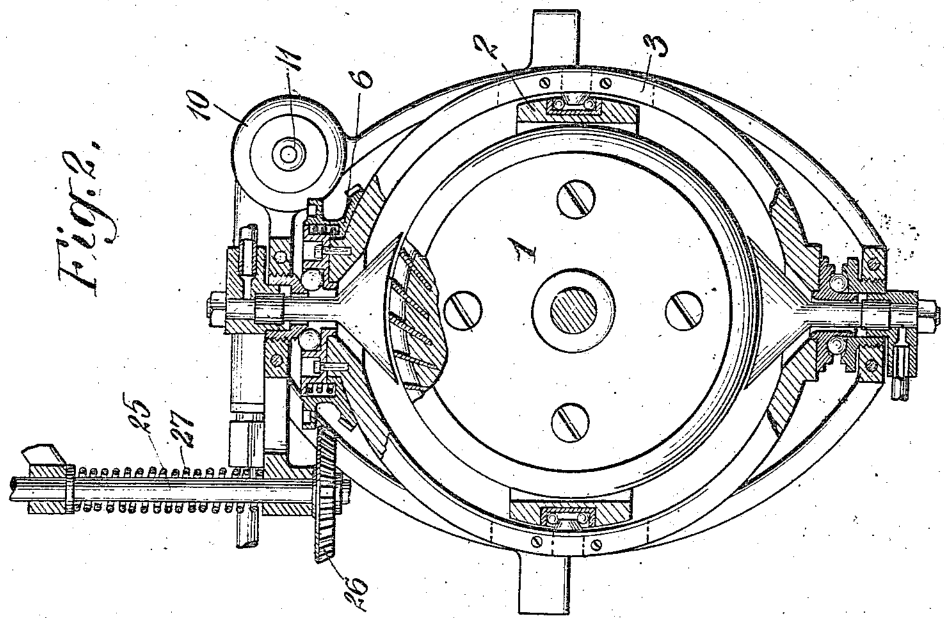
VALVE CONTROL MECHANISM FOR GYROSCOPIC STEERING GEAR.

APPLICATION FILED NOV. 21, 1910.

1,033,994. Patented July 30, 1912.

2 SHEETS—SHEET 1.

Fig. 2.



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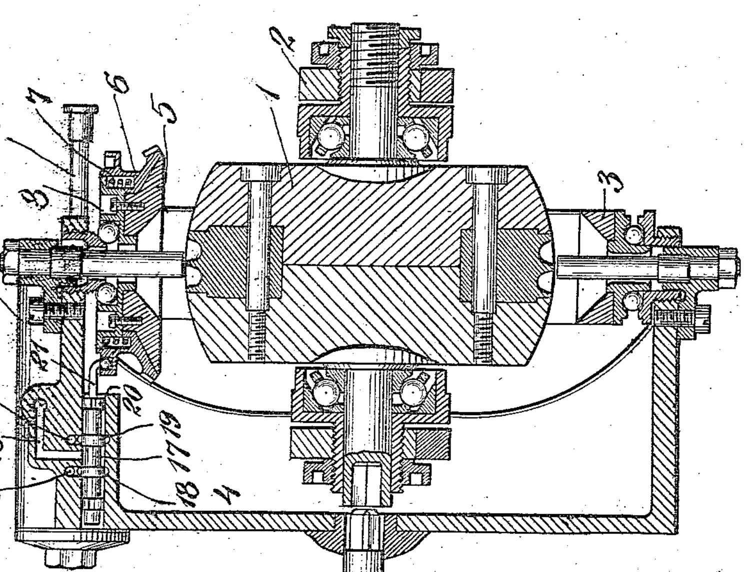

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Fig. 4.

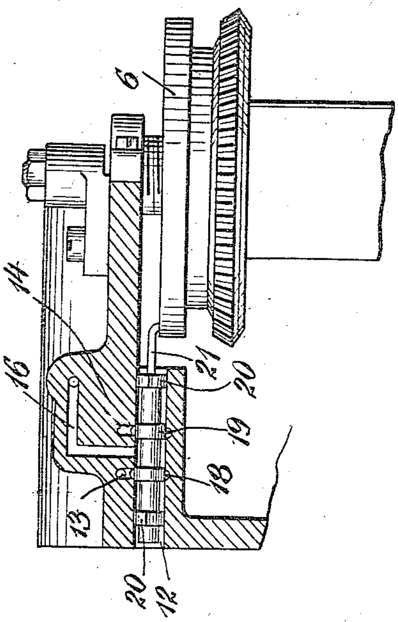
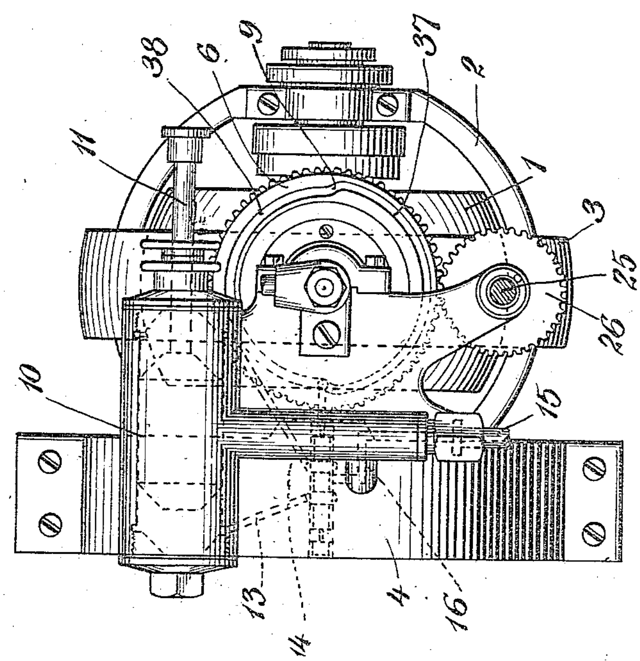


Fig. 3.



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VALVE-CONTROL MECHANISM FOR GYROSCOPIC STEERING-GEAR.

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Application filed November 21, 1910. Serial No. 593,479.

To all whom it may concern:

Be it known that I, GREGORY C. DAVISON, a citizen of the United States, residing at Quincy, county of Norfolk, State of Massachusetts, and whose post-office address is care of Electric Boat Company, Quincy, Massachusetts, have invented certain new and useful Improvements in Valve-Control Mechanism for Gyroscopic Steering-Gear; 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.

The invention relates particularly to valve control mechanism for that type of automatic steering gear in which a gyroscope is employed in conjunction with a fluid operated steering motor connected to the rudder or rudders and in which a control valve for the motor is so connected to the gyroscope that the relative movement of the gyroscope with respect to its support, due to a deviation of the vessel from a straight course, imparts a corresponding movement to the control valve and consequently to the fluid motor and the rudder or rudders.

The object of the invention is to provide valve control mechanism which will be instantly responsive to the slightest relative movement of the gyroscope support with respect to the gyroscope, so that the vessel will be kept closely to its intended course.

The particular nature of the invention will be understood from the following description and accompanying drawings which describe and illustrate the preferred embodiment.

In the drawings Figure 1 is a vertical section of a gyroscope and its support, together with the improved valve and valve control mechanism; Fig. 2 is an elevation, partly in section, of the same parts, looking at Fig. 1 from the right; Fig. 3 is a plan view of the same parts; and Fig. 4 is a detail, partly in section, and partly in elevation, on a larger scale, illustrating the construction of valve and its connection to the actuating cam.

The gyroscope is here shown as of the turbine-driven type and of an improved design, but the gyroscope itself forms no part of the present invention, which may be applied to gyroscopic steering mechanism of all types.

The flywheel 1 is mounted in the inner gimbal-ring 2, which is in turn mounted in the outer gimbal-ring 3, supported on the bracket 4. On the outer gimbal-ring, and concentric with its vertical axis of rotation, is formed a bearing surface 5, on which is mounted the combined bevel pinion and cam disk 6, which is pressed into frictional engagement with the surface 5 by the coil spring 7, held down by the flanged disk 8 bolted to the outer gimbal-ring and carrying the ball bearings for the upper pivot point thereof. On the upper surface of the member 6 is formed the actuating cam groove comprising two concentric arc-shaped groove portions 37 and 38 united at diametrically opposite points by the inclined groove sections 9. The steering motor, which is shown as a suitable servo-motor of ordinary type, is represented at 10, and its piston rod 11 is to be connected in the usual way with the steering rudder or rudders. This motor is mounted on the bracket 4, and its opposite ends are in communication with the valve-chamber 12 through the duct 13 which leads to the forward end of the motor cylinder, and 14 which leads to the rear end of that cylinder. Air is supplied to the valve-chamber 12 through a pipe 15 connected to a nipple on the casing as shown in Fig. 3, and from the nipple the air passes to the valve-chamber through a duct 16, which opens into the valve-chamber at a point between the openings of the ducts 13 and 14.

Sliding within the valve-chamber is a light valve-stem 17, having annular enlargements or bosses 18 and 19, adapted, when the valve-stem is in the position shown in Figs. 1 and 4, to close the ducts 13 and 14. At each end of the valve-stem is a guiding spider 20, and the two ends of the valve-chamber are open to the atmosphere so that the exhaust may pass between the arms of the one spider or the other, as the case may be. Projecting from the end of the valve-stem is the valve-rod 21, having a turned-down end carrying a knob which lies in the cam groove of the cam disk 6.

Although the features of the present invention, including the form of cam disk and its support, are applicable generally to the operation of either sliding or rotary valves, yet the sliding valve just described is admirably adapted to the intended purpose, because it is extremely light and cannot be in any way unbalanced by the pressure, and the slightest movement from the position shown in the drawings will immediately admit pressure fluid to one end of the motor cylinder and exhaust the other end, the quantity of fluid admitted depending measurably upon the degree of movement of the valve. If, for example, the relative movement of the gyroscope support, with respect to the gyroscope, due to a deviation of the vessel from its course, is in a clock-wise direction, as viewed in Fig. 3, the knob on the end of valve rod 21 will ride up the incline joining the groove sections 37 and 38, and the valve-stem will be moved to the left. The instant this movement begins, the duct 13 will begin to open, admitting pressure to the rear end of the motor cylinder, and, at the same time, and to the same extent, the duct 14 will be put into communication with the atmosphere through the right-hand end of the valve-casing, permitting the exhaust of the forward end of the motor cylinder. It will thus be seen that the control is extremely delicate, and the rudders will instantly respond to any deviation from the intended course.

It is frequently desirable, when steering mechanism of this character is to be used on self-propelled torpedoes or the like, to provide for "wide angle" fire. That is, to make provision for causing the torpedo to steer through a certain arc before it assumes the intended straight line of fire. For example, it may be desired to fire torpedoes from the bow or stern of a vessel, and cause them to proceed in a broadside direction. For this purpose, with the present invention, it is only necessary to turn the cam disk so that the inclined portion of the cam is moved away from the end of the valve rod. The control valve will then be held in such position that the rudders will be turned to one extreme or the other, depending upon whether the end of the valve rod is in the cam groove 37, or in the cam groove 38, and the torpedo will hold a correspondingly curved course until the relative movement of the gyroscope support with respect to the gyroscope, brings the inclined portion of the groove up to the end of the valve-rod, whereupon the valve-stem will be quickly moved to the closing position, and beyond it, so that the rudders will be brought into the central position, and thereafter the torpedo will be maintained on a straight course. The frictional engagement of the combined bevel gear and cam disk 6, with its support, makes it possible to easily effect such an adjustment, and this might be done by hand before the torpedo is put into the firing tube, since a hand opening is commonly provided in the torpedo shell to permit adjustment of the gyroscope. It is, however, convenient to provide an index spindle for the purpose. Such a spindle is indicated at 25 on the drawings, and carries at its lower end a bevel pinion 26. This pinion is normally held in the elevated position shown by the coil spring 27, but may be forced down by hand into engagement with the teeth on the disk 6, whereupon, by turning the spindle 25, the cam disk 6 may be set to the desired position. The index spindle will be provided with a scale and pointer in the usual manner.

It will be understood from the foregoing that, after the gyroscope has been spun up and released so as to assume its normal plane of rotation, it will maintain that plane regardless of any deviation of the vessel from its true course, and the resulting movement between the gyroscope support, which is attached to the vessel, and the gyroscope, will cause the cam disk to turn with respect to valve rod 21. So long as the end of the valve rod is in cam groove 37 or 38, the valve will be held in one or the other extreme position but as soon as an inclined portion of the cam groove reaches the end of the valve-stem, the valve will immediately be moved to the central position, in which it closes the ducts 13 and 14, and since the inclined portion of the valve groove extends over a very small arc on the disk, the slightest movement of the disk, with respect to its support, will instantly move the valve far enough to supply motive fluid to one side or the other of the steering motor, and thereby bring the vessel back into its true course.

Having thus described my invention what I claim is:

1. In gyroscopic steering mechanism of the character described, a gyroscope comprising a fly-wheel and its supporting gimbal-rings, a fluid-operated steering motor, and a control valve for the motor, in combination with an actuating cam moving with the gyroscope and having two arc shaped cam surfaces of different radius connected by an inclined cam surface, and a valve rod engaging the cam and connected to the control valve.

2. In gyroscopic steering mechanism of

the character described, a gyroscope comprising a fly-wheel and its supporting gimbal-rings, a fluid-operated steering motor, and a control valve for the motor, in combination with an actuating cam supported on the outer gimbal-ring concentric with its axis of rotation, said cam having two arc-shaped cam surfaces of different radius connected by an inclined cam surface, and a valve rod engaging the cam and connected to the control valve.

3. In gyroscopic steering mechanism of the character described, a gyroscope comprising a fly-wheel and its supporting gimbal-rings, a fluid-operated steering motor, and a control valve for the motor, in combination with an actuating cam disk adjustably connected to said gyroscope and having two arc-shaped cam surfaces of different radius united at diametrically opposite points by inclined cam surfaces, and a valve rod engaging the cam and connected to the control valve.

4. In gyroscopic steering mechanism of the character described, a gyroscope comprising a fly-wheel and its supporting gimbal-rings, a fluid-operated steering motor, and a control valve for the motor in combination with an actuating cam disk adjustably connected to said gyroscope and having two arc-shaped cam surfaces of different radius united at diametrically opposite points by inclined cam surfaces, a valve rod engaging the cam and connected to the control valve, and an index spindle and connections for adjusting the position of the cam disk with respect to the gyroscope.

5. In gyroscopic steering mechanism of the character described, a gyroscope comprising a fly-wheel and its supporting gimbal-rings, a fluid-operated steering motor, and a control valve for the motor, the outer gimbal-ring having a friction surface formed thereon concentric with its axis of rotation, an actuating cam in frictional engagement with said surface and having two arc-shaped cam surfaces of different radius connected by an inclined cam surface, and a valve rod engaging the cam and connected to the control valve.

6. In gyroscopic steering mechanism of the character described, a gyroscope comprising a fly-wheel and its supporting gimbal-rings, a fluid-operated steering motor and a control valve for the motor, the outer gimbal-ring having a friction surface formed thereon concentric with its axis of rotation, an actuating cam disk in frictional engagement with said surface and having two arc-shaped cam surfaces of different radius united at diametrically opposite points by inclined cam surfaces, and a valve rod engaging the cam and connected to the control valve.

7. In gyroscopic steering mechanism of the character described, a gyroscope comprising a fly-wheel and its supporting gimbal-rings, a fluid-operated steering motor, and a control valve for the motor, the outer gimbal-ring having a friction surface formed thereon concentric with its axis of rotation, an actuating cam disk in frictional engagement with said surface and having two arc-shaped cam surfaces of different radius united at diametrically opposite points by inclined cam surfaces, a valve rod engaging the cam and connected to the control valve; and an index spindle and connection for adjusting the position of the cam disk with respect to the gyroscope.

8. In gyroscopic steering mechanism of the character described, a gyroscope comprising a fly-wheel and its supporting gimbal-rings, a fluid-operated steering motor, and a control valve for the motor, the outer gimbal-ring having a friction surface formed thereon concentric with its axis of rotation, a valve actuating member in frictional engagement with said surface, and an index spindle and connections for adjusting the position of the valve actuating member with respect to the gyroscope.

9. In gyroscopic steering mechanism of the character described, a gyroscope comprising a fly-wheel and its supporting gimbal-rings, a fluid-operated steering motor, a valve casing having a valve chamber and passage opening into said chamber and communicating with the fluid supply and with the respective sides of the steering motor, together with exhaust passages from said chamber, a sliding valve-stem within the chamber having enlargements lying on opposite sides of the fluid-supply opening and separating it from the exhaust passages, said enlargements being adapted in one position to close the passages to the steering motor, a valve rod connected to said stem, and connections between the valve rod and the gyroscope whereby relative movement of the gyroscope with respect to its support correspondingly moves the valve rod to actuate the steering motor in one direction or the other.

10. In gyroscopic steering mechanism of the character described, a gyroscope comprising a fly-wheel and its supporting gimbal-rings, a fluid-operated steering motor, a valve casing having a valve chamber and passages opening into said chamber and communicating with the fluid supply and with the respective sides of the steering motor, together with exhaust passages from said chamber, a sliding valve stem within the chamber having enlargements lying on opposite sides of the fluid-supply opening and separating it from the exhaust passages, said enlargements being adapted in one po-

sition to close the passages to the steering motor, in combination with an actuating cam moving with the gyroscope and having two arc-shaped cam surfaces of different radius connected by an inclined cam surface, and a valve rod engaging the cam and connected to the valve stem.

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

GREGORY C. DAVISON.

Witnesses:
J. E. FITZGERALD, Jr.,
F. L. BRAKE.