

H. H. THOMPSON.
GYROSCOPIC APPARATUS FOR SHIPS.
APPLICATION FILED APR. 11, 1917.

1,330,503.

Patented Feb. 10, 1920.

3 SHEETS—SHEET 1.

Fig. 1

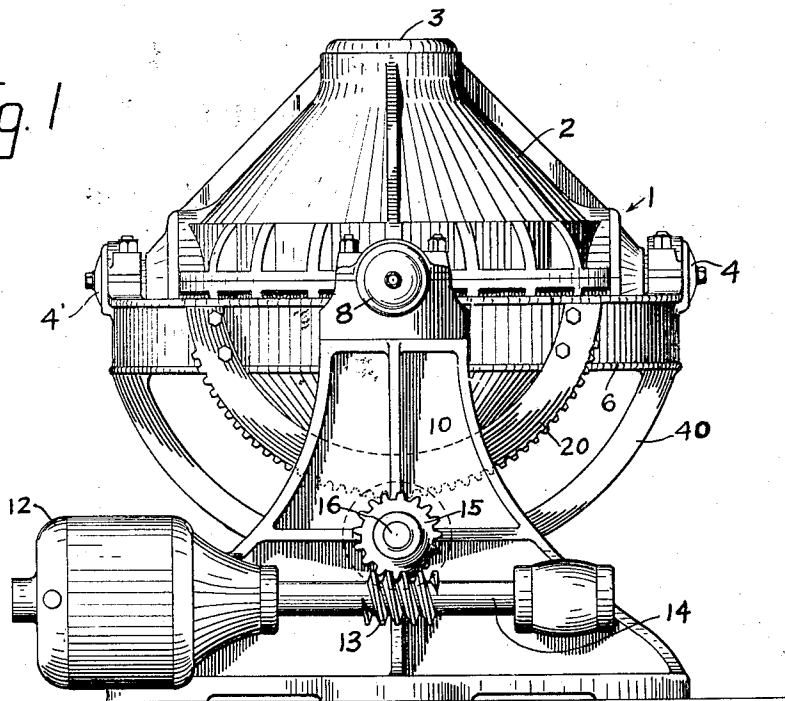
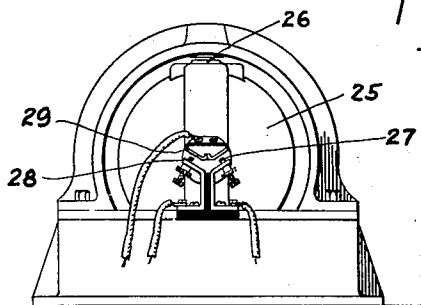
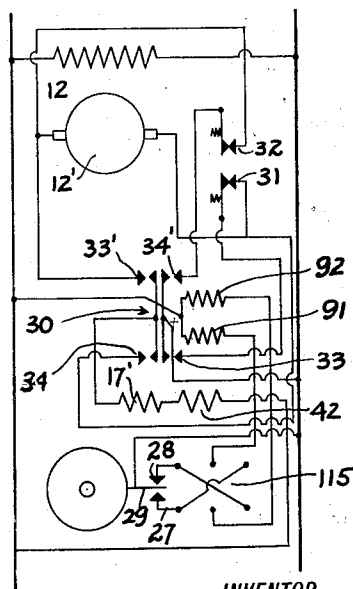


Fig. 2

Fig. 8



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3 SHEETS—SHEET 2.

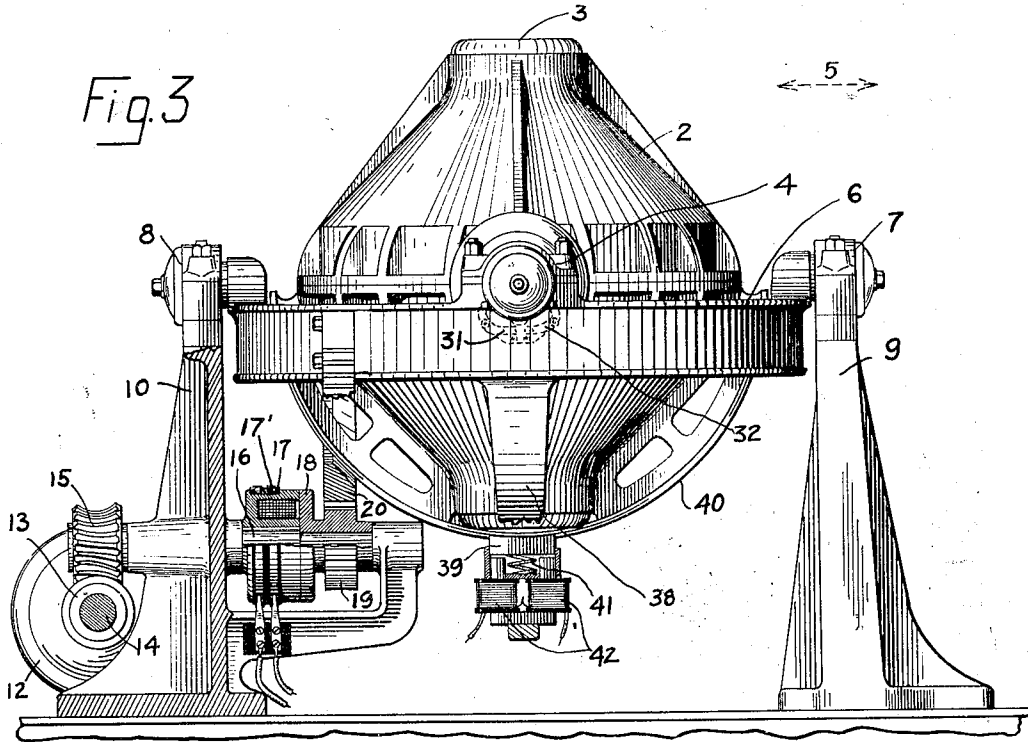
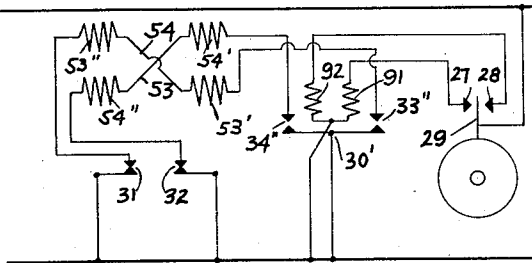


Fig. 9

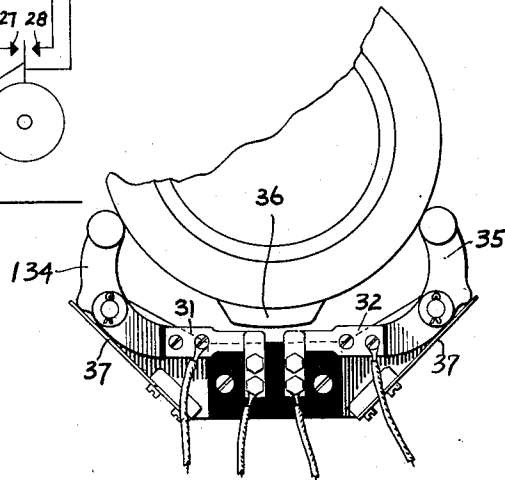
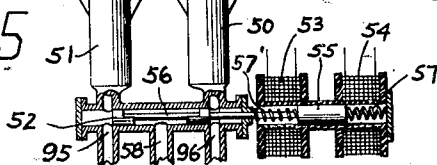


Fig. 4

Fig. 5



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3 SHEETS—SHEET 3.

Fig. 6

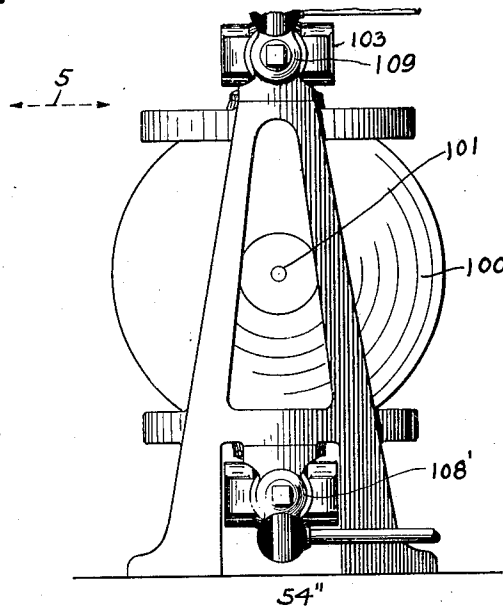
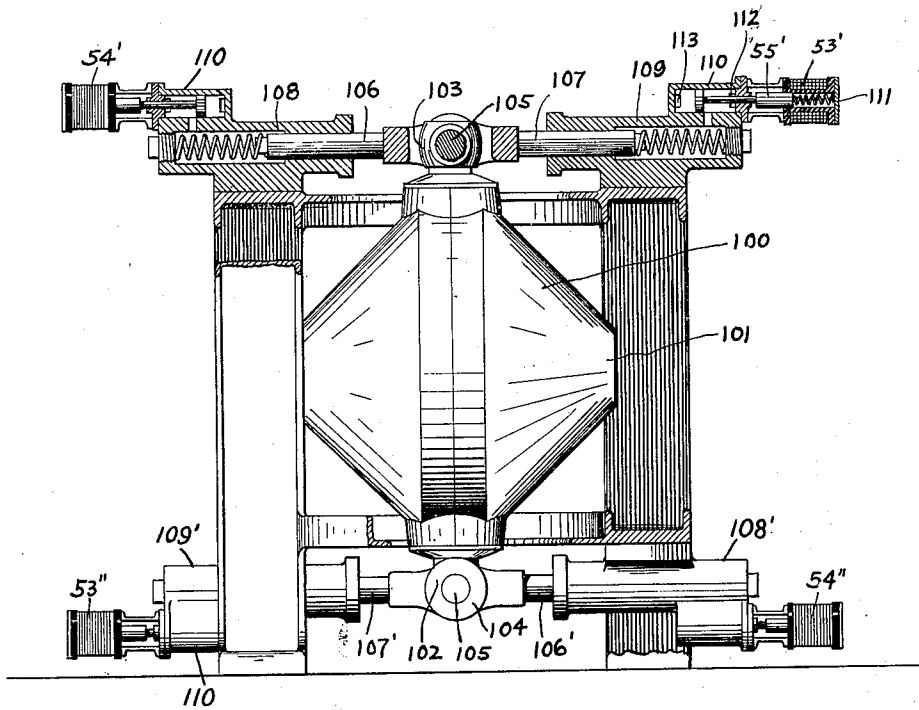


Fig. 7

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UNITED STATES PATENT OFFICE.

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GYROSCOPIC APPARATUS FOR SHIPS.

1,330,503.

Specification of Letters Patent.

Patented Feb. 10, 1920.

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To all whom it may concern:

Be it known that I, HERBERT H. THOMPSON, a citizen of the United States of America, residing at 1001 Ocean avenue, Brooklyn, in the county of Kings and State of New York, have invented certain new and useful Improvements in Gyroscopic Apparatus for Ships, of which the following is a specification.

10 This invention relates to gyroscopic apparatus for ships and other bodies subject to or capable of oscillation.

The broad object of the invention is to improve upon gyroscopic apparatus of this character so that the ship may be stabilized under all conditions and the amount of rolling reduced to substantially zero.

It has been found that the so-called passive stabilizer, such as shown in the patent to E. O. Schlick, No. 769,493, Sept. 6, 1914, will not hold the ship within 4 to 6 degrees of roll. This failure is doubtless largely due to the large inertia of the gyroscope about the precession axis, so that when the ship first starts to roll, a movement takes place in the direction of the roll before the gyroscopic reaction due to the precession has reached enough value to overcome the rolling tendency.

30 It is one of the objects of this invention to overcome this defect in the passive stabilizer by means adapted to take up this initial movement of the ship without allowing movement thereof. I am aware that it has been proposed to control the precession of stabilizing gyroscopes so as to increase the efficiency thereof, but my invention does not relate primarily to the control of the precession.

40 Referring to the drawings, in which what I now consider to be the preferred forms of my invention, are shown:

Figure 1 is a front view of a stabilizing gyroscope as mounted on a ship.

45 Fig. 2 is a side elevation of an auxiliary or control gyroscope.

Fig. 3 is a side elevation of the gyroscope as shown in Fig. 1.

50 Fig. 4 is a detail view of the limit switches on the said gyroscope.

Fig. 5 is a small diagrammatic view of a modified form of the invention.

Fig. 6 is a side elevation of a second modified form of stabilizing gyroscope.

Fig. 7 is a front elevation thereof.

Figs. 8 and 9 are wiring diagrams of two forms of the invention.

The gyroscopic stabilizing plant is shown in Fig. 1 as a gyroscope 1 comprising a rotor bearing casing 2 supporting the rotor (not shown) on vertical spinning axis 3. The rotor may be spun in any desired manner, preferably by building it as a part of the armature or rotor of an electric motor entirely inclosed within the casing 2. The said casing is mounted on horizontal trunnions 4 and 4' extending across the ship as indicated by the arrow 5 in Fig. 3 representing the fore and aft line of the ship. The trunnions 4 and 4' instead of being fixed to the ship, as shown in Schlick's patent above referred to, are mounted for movement with respect thereto.

In the form of the invention shown in Figs. 1 and 3 said trunnions are mounted on a gimbal ring 6 which in turn is mounted on horizontal trunnions 7, 8 fixed to the ship as by means of brackets 9 and 10. The casing of said trunnions extends preferably parallel to the fore and aft axis of the ship. Means are provided for locking and unlocking the gyroscope about the axis of the trunnions 7, 8 so that the gyroscope may be either locked about said axis so as to be rolled with the ship or it may be unlocked and hence be entirely free from the rolling effect of the ship. In connection with said locking means, I also prefer to provide a power means for applying a positive torque about said axis, 7, 8 for causing a movement between the gyroscope and the ship in such a direction as to compensate for the motion that would occur in the ship before the gyroscope reacted with its fullest power. The said power means and locking device are shown in Figs. 1 to 3 as an electric motor 12 mounted adjacent the base of the gyroscope and having a worm 13 secured to the shaft 14 thereof. Said worm meshes with worm wheel 15 on shaft 16 journaled in bracket 10. On said shaft is also mounted one portion of electromagnetic clutch 17, the other portion 18 being slidably and rotatably mounted adjacent thereto on a reduced

extension of shaft 16. To clutch member 18 is secured or formed integrally therewith a pinion 19 which meshes with a large gear sector 20 secured to the gimbal ring 6. The clutch and motor are preferably controlled from an auxiliary gyroscope shown as a much smaller gyroscope 25 which is shown as mounted on a horizontal spinning axis for precession about vertical axis 26, the spinning axis being normally placed across the ship. This type of auxiliary gyroscope is well known, being employed in connection with the so-called active type of stabilizer such as shown in the British patent of Elmer A. Sperry, No. 582 of 1914.

As soon as the ship starts to roll, this small auxiliary gyroscope with its comparatively small inertia precesses to bring into contact with one or the other of contacts 27 or 28 the contact member 29 mounted thereon. In circuit with the respective contacts are placed the coils 91 and 92 of double acting relay 30 (see Fig. 8.) When coil 91 is energized contact points 33 and 33' will be closed, while when coil 92 is energized contact points 34, 34' will be closed. This will cause current to be sent in opposite directions through the armature 12' of motor 12 when member 29 moves from one contact to the other, as will be readily apparent from an inspection of the wiring diagram of Fig. 8. At the same time an electric current will be sent through the winding 17' on clutch 17 which is in the common return circuit of the relay thereby connecting the motor to the gimbal ring, the clutch being normally disengaged. As soon as the gyroscope is locked to the ship and the motor 12 operated, precession will occur about the axis 4, 4'. The pitch of the worm 13 is preferably such that it will lock the gyroscope when clutch 17 is energized.

In order to limit the precession about said axis I may provide circuit breaking switches 31 and 32 (see Fig. 4) which are opened when the gyroscope reaches a predetermined limit of precession in either direction. The opening of switch 31 (for instance) will break the circuit from contacts 33, 33' on the relay. This will not, however, affect the circuit to the opposite contacts 34, 34' on said relay so that as soon as the ship starts to roll in the other direction motor 12 and clutch 17 will again be energized. The switches are shown as pivoted to bell crank levers 134 and 135 against the outer ends of which a lug 36 on the gyroscope is adapted to strike. The switches are normally held in the closed position by leaf springs 37.

At about the same time that one or the other of said switches is open I prefer to apply a brake about the precession axis of the gyroscope. Said brake is shown as mounted on a loop 38 secured to ring 6 and comprises a block or shoe 39 normally pressed against

brake band 40 on casing 2 by means of a strong spring or other yielding means 41. The said brake however is normally held retracted by electromagnets 42 in the motor circuit, but as soon as one or the other of limit switches opens as shown, shoe 39 is released and applies a powerful brake on the gyroscope. At the same time and preferably by the same means, the clutch 17 is de-energized and the gyroscope unlocked from the ship about the fore and aft axis. This will at once eliminate the rolling force of the ship on the gyroscope so that the force causing the precession will be at once removed. By this means I am enabled to stop the precession of the gyroscope in very much less time and with a much less powerful brake than is required where the gyroscope is permanently fixed to the ship.

Fig. 5 illustrates a modification of the invention in which the electric motor and clutch are replaced by fluid operated cylinders 50 and 51. The gyroscope in this figure is again shown as mounted on a vertical spinning axis within casing 2' and is supported within the gimbal ring 6' on horizontal axis 4'. The gimbal ring in turn is pivoted on horizontal axis 7' which extends preferably parallel to the fore and aft line of the ship. The cylinders 50, 51 are controlled from any suitable valve mechanism such as double piston or slide valve 52. Said valve is preferably controlled by windings 53, 54 constituting a double solenoid. The movable core 55 of the solenoid connected to the valve rod 56 is normally held in a central position by means of springs 57 and 57'. In this position the exhaust ports 95 and 96 of both cylinders 50 and 51 are open so that the gyroscope has three degrees of freedom.

As shown in Fig. 9 the solenoid 53 is controlled by one of the contacts 27 while the other solenoid 54 is controlled by the opposite contact 28. When the auxiliary gyroscope therefore precesses in a counterclockwise direction as shown in Fig. 9, solenoid 53 will draw core 55 forwardly, thus throwing solenoid 51 into communication with the supply pipe 58 through which any suitable fluid such as water or compressed air may be introduced. This will exert a powerful torque on the gyroscopic ring 6' and will in effect not only couple it to the ship, but will cause movement in the direction of the applied force. Similarly the solenoid 54 will throw the valve 56 rearwardly and actuate piston 50' within the cylinder 50.

A somewhat similar system is shown in Figs. 6 and 7 in which hydraulic or air pressure is made use of for applying force on the gyroscope. Figs. 6 and 7, however, illustrate a modified mounting of the gyroscope in several respects. It will, of course, be understood, that the system described with respect to Figs. 1 to 5 is equally well adapt-

ed for gyroscopes mounted on horizontal spinning axis. Figs. 6 and 7 illustrate such an arrangement, it being understood of course that when this arrangement is employed at least two coupled and oppositely rotated gyroscopes are preferably made use of, but for the sake of simplicity however only one such gyroscope is shown. A second modified feature is in the method of mounting the gyroscope. In these figures the gyroscope is shown as inclosed within the casing 100, the spinning axis being indicated at 101. The casing is mounted for precession about a vertical axis by means of trunnions 102 and 103. Instead of supporting said trunnions in a gimbal ring however I may mount them for limited movement, only, with respect to the ship. For this purpose the trunnions are shown as mounted in blocks 104 which support said trunnions for oscillation about horizontal axes by means of pins 105. The said blocks are connected to or formed integrally with oppositely extending pistons or piston rods 106 and 107 which enter the cylinders 108 and 109. Both trunnions of the gyroscope are shown as supported in similar manner, although it is obvious that one set of cylinders may be omitted if desired.

The cylinders are shown as controlled by valves 110 which are operated from solenoids 53 54 as before. In this embodiment, however, the solenoid coils are separated into two parts 53' and 53'' and 54' and 54'' so that the cylinders will be actuated in unison.

Normally the cones of the solenoids are held in the position shown in Fig. 7 by means of springs 111 so that the cylinder is in communication with the exhaust ports 112. When, however, the solenoids are energized the cores 55' are drawn rearwardly which throws the cylinders into communication with the inlet ports 113. The actuation of the solenoids may be substantially the same as disclosed in connection with Fig. 5. In both forms the fluid pressure is preferably so adjusted as to be substantially equal to the maximum pressure exerted by the gyroscope under normal conditions on the trunnions 102, 103. As soon, therefore, as the ship starts to roll one or the other of pistons 106 or 107 will be moved forwardly until the gyroscopic reaction thereon equals the fluid pressure, or in other words, until the precession of the gyroscopes has reached a predetermined velocity. By this means the motion that would otherwise occur in the ship before the gyroscope has reached the said predetermined velocity will be taken up between the ship and the gyroscope and the ship held substantially on an even keel. A similar adjustment is preferable in the form shown in Fig. 1.

It will, of course, be understood, however,

that my invention is equally well adapted for rolling the ship to release it from ice or for any purpose that may be desired, and to this extent possesses a remarkable advantage over the passive stabilizer. To cause the apparatus to roll the ship, it is only necessary to throw the reversing switch 115 (see Fig. 8) which reverses the relation between the auxiliary gyroscope and the control gear of the main gyroscope. By this means, the control gear may be made to push on the gyroscope in the direction to increase the rolling during each cycle of the roll, and thus gradually will impart to the ship a roll of great amplitude. During such an operation the operation of the motor switches and other devices will remain substantially the same. An initial roll may be imparted to the ship, if necessary, by completing a circuit between points 27 or 28 and 29 on the auxiliary gyroscope.

In accordance with the provisions of the patent statutes, I have herein described the principle of operation of my invention, together with the apparatus, which I now consider to represent the best embodiment thereof, but I desire to have it understood that the apparatus shown is only illustrative and that the invention can be carried out by other means. Also, while it is designed to use the various features and elements in the combination and relations described, some of these may be altered and others omitted without interfering with the more general results outlined, and the invention extends to such use.

Having described my invention, what I claim and desire to secure by Letters Patent is:—

1. In a gyroscopic apparatus for ships, the combination with a ship, of a stabilizing gyroscope, a control gyroscope, means movable in the direction of the ship's roll connecting said stabilizing gyroscope and the ship, and means brought into action by the control gyroscope for causing movement of said means against the reaction of the stabilizing gyroscope.

2. The combination with an oscillatory support, of a gyroscopic rotor and rotor bearing frame, a pivotal mounting for said frame, means for permitting motion of said mounting and frame about an axis at an angle to the pivotal axis of said mounting, and means for applying a torque on the gyroscope about said last named axis while leaving the gyroscope free to precess about the first named axis.

3. The combination with an oscillatory support, of a gyroscopic rotor and rotor bearing frame, a mounting for said frame permitting oscillation about axes respectively substantially parallel and at an angle to the axis of oscillation of the support, and means responsive to the oscillation of said

support for exerting a torque on the frame about said first named axis while leaving the gyroscope free to precess about the first named axis.

5 4. The combination with an oscillatory support, of a gyroscopic rotor and rotor bearing frame, a mounting for said frame permitting oscillation about axes respectively substantially parallel and at an angle
10 to the axis of oscillation of the support, means responsive to the oscillation of said support for exerting a torque on the frame about said first named axis, and means brought into action by precession of said
15 gyroscope for releasing the frame about said first axis.

5. The combination with an oscillatory support, of a gyroscopic rotor and rotor bearing frame, a mounting for said frame
20 permitting oscillation about axes respectively substantially parallel and at an angle to the axis of oscillation of the support, means responsive to the oscillation of said support for causing the frame to move with
25 the support about said first named axis, and means brought into action by precession of said gyroscope for releasing the frame about said first axis.

6. The combination with an oscillatory
30 support, of a gyroscopic rotor and rotor bearing frame, a mounting for said frame permitting oscillation about axes respectively substantially parallel and at an angle to the axis of oscillation of the support,
35 means for causing the frame to move with the support about said first mentioned axis under predetermined conditions, and means for releasing the frame about said axis under other conditions.

40 7. The combination with a ship, of a control gyroscope and a stabilizing gyroscope mounted thereon on precession gudgeons, a movable mounting for the gudgeons of the stabilizing gyroscope and power means re-

sponsive to the precession of the control 45 gyroscope for applying a torque on said gudgeons in either direction to move the same about an axis at an angle thereto.

8. In a device for rolling ships and the like, the combination with a gyroscope 50 mounted on the ship for precession with respect thereto, of power means for applying torques thereon in the direction of the ship's roll without disturbing the normal precessional movement of the gyroscope. 55

9. In a device for rolling ships and the like, the combination with a gyroscope mounted on the ship for precession with respect thereto, of power means for applying torques thereon in the direction of the ship's 60 roll, and means including an auxiliary gyroscope for governing the application of said means in synchronism with the ship's period.

10. The combination with an oscillatory body, of a gyroscope mounted thereon for 65 precession about an axis and having a releasable connection with the ship about another axis, a brake for retarding precessional movements, means for releasing said connection, and means responsive to a predeter- 70 mined precession of said gyroscope for operating said brake and said releasing means.

11. The combination with an oscillatory body, of a gyroscope mounted thereon for movement about a plurality of axes and 75 means for coupling said gyroscope to the body about one of said axes responsive to oscillation thereof about said axis.

12. The combination with an oscillatory body, of a gyroscope mounted thereon for 80 movement about a plurality of axes and means for coupling said gyroscope to the body about one of said axes including a worm and worm wheel and a clutch for connecting the gyroscope to the worm wheel. 85

In testimony whereof I have affixed my signature.

HERBERT H. THOMPSON.