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H. L. TANNER

VERTICAL GYROSCOPIC COMPASS

Filed June 5, 1918

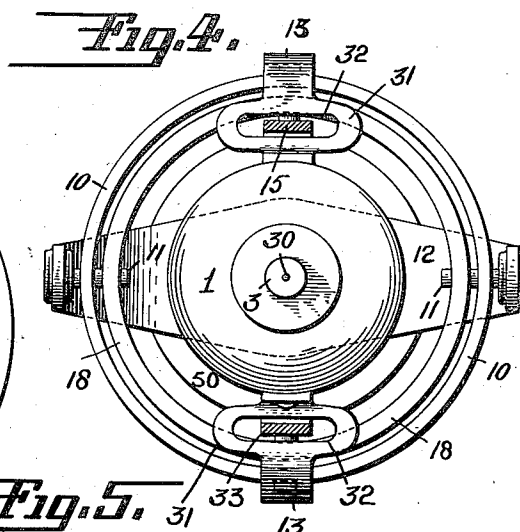
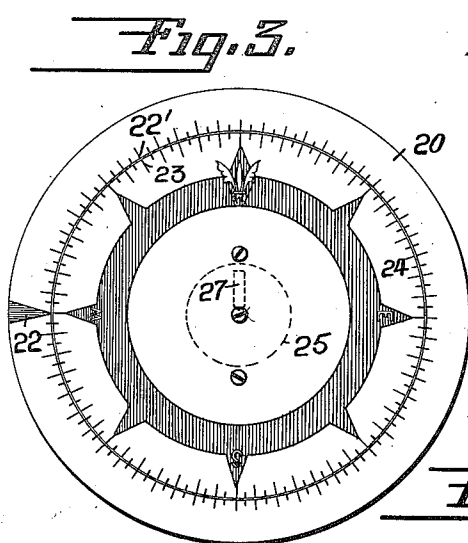
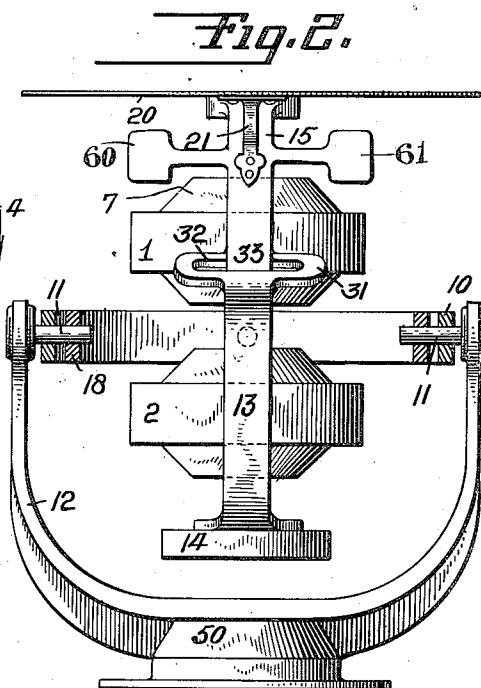
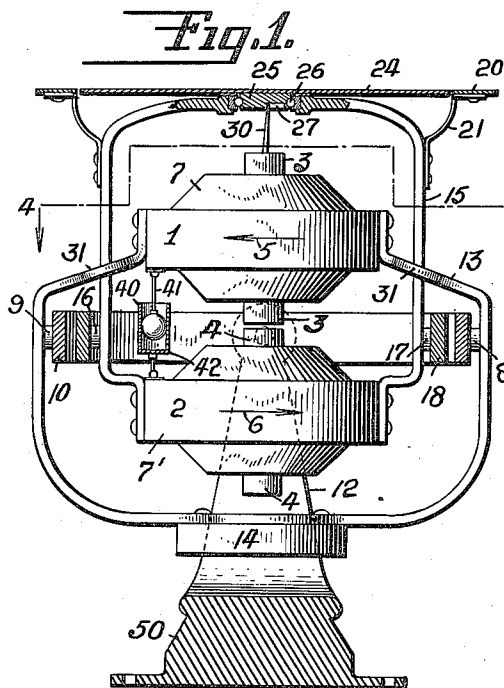
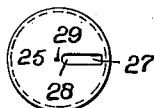


Fig. 5.



INVENTOR

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UNITED STATES PATENT OFFICE.

HARRY L. TANNER, OF BROOKLYN, NEW YORK, ASSIGNOR TO THE SPERRY GYROSCOPE COMPANY, OF BROOKLYN, NEW YORK, A CORPORATION OF NEW YORK.

VERTICAL GYROSCOPIC COMPASS.

Application filed June 5, 1918. Serial No. 238,252.

To all whom it may concern:

Be it known that I, HARRY L. TANNER, a citizen of the United States of America, residing at 1144 East 19th Street, Brooklyn, in the county of Kings and State of New York, have invented certain new and useful Improvements in Vertical Gyroscopic Compasses, of which the following is a specification.

10 This invention relates to gyroscopic navigational apparatus in which one or more gyroscopes spinning about normally vertical axes are employed. Heretofore there have been two types of gyroscopic position indicators: First, one in which one or more pendulous gyroscopes spinning about horizontal axes are employed; said gyroscopes having their spinning axes parallel with the axis of the earth. This type of apparatus, since it always points to the true north, is properly termed a "gyroscopic compass." Second, there is the non-pendulous gyroscope, or gyroscope having three degrees of freedom and usually spinning about a vertical axis. This gyroscope theoretically remains fixed in space and hence may serve as a position indicator by indicating the latitude, but is not a compass since if displaced it will not return to a north-south position.

This invention relates to the former type of gyroscope, namely, the gyroscopic compass, but the gyroscopes spin about a vertical spinning axis and are under gravity control.

Referring to the drawings, in which, what is now considered the preferred form of the invention, is shown:

Fig. 1 is a side elevation partly in section of an apparatus constructed according to my invention.

Fig. 2 is a front elevation partly in section of the same showing also a slight modification.

Fig. 3 is a plan view, and

Fig. 4 is a section taken on broken line 4—4 of Fig. 1, looking in the direction of the arrow.

Fig. 5 is a detail of the central underneath portion of the card.

As shown, the apparatus consists of a pair of gyroscopes 1 and 2, mounted to spin about normally vertical spinning axis 3—3 and 4—4 within casings 7 and 7'. The gyroscopes may be rotated in any manner such as

by electric motors each built as an integral part of the gyroscope within the casings as will be readily understood. Casing 7 is mounted for oscillation about horizontal axis 8—9 by being secured to the outer frame 13 which is pivoted to the gimbal ring 10. Said frame 13 and gyroscope are shown as pendulously mounted about said horizontal axis, a weight 14 being shown as attached to the frame to illustrate this fact. It is obvious that the gravity control of the gyroscope may be effected otherwise than by securing a weight directly to the frame. Casing 7' is also secured in a frame 15 which is pivoted about the horizontal axis 16—17 normally parallel to the said axis 8, 9 and within a second gimbal ring 18. The two rings 10 and 18 are pivotally mounted about a second horizontal axis 11—11 so as to oscillate about the same axis. The rings are shown as pivotally supported on the arms 12 of the pedestal 50. The gyroscope 2 is also obviously pendulous about both horizontal axes, since the main portion of the gyroscope is below said axes. The frame 15 may have secured thereto a ring 20 by means of brackets 21. Said ring may have a lubber line 22 marked thereon or other reference mark 22'. The frame is also shown as having journaled thereon the compass card or compass rose 24, having markings thereon. The card is shown as having a central boss 25 journaled in the frame 15 by means of anti-friction bearings 26. Boss 25 is shown as having a slot 27 on the under surface thereof; said slot extends from a point 28 adjacent but preferably spaced slightly from the center of the card 29 to some distance therefrom. Casing 7 is shown as having a projection 30 thereon which engages in said slot. It will be readily apparent that if one or both of the gyroscopes should tend to be relatively inclined in a certain plane that the projection 30 moving in said slot will turn the card so that the slot lies in the plane of said movement. By stopping the slot short of the central portion of the boss or card a dead center or point in which the card may not be so turned is avoided. The frame 13 is shown as provided with enlarged portions 31 in which slots 32 are cut. The frame 15 passes through said slots. The two gyroscopes may be connected by an energy absorbing means in order to damp the oscillation of the gyroscope. This means is shown

as a dash pot 40; the cylinder end 42 being shown as linked to the casing 7' and the piston 41 is linked to the casing 7.

The operation of my invention is as follows:

The two gyroscopes 1 and 2 are designed to be driven in opposite directions as represented by arrows 5 and 6. Let us assume that the gyroscopes are started in a vertical position. As the earth rotates out from under the gyroscope 1, for instance, in a plane perpendicular to the paper the force of gravity will be exerted about axis 8—9. The said force will cause precession according to the well known gyroscopic law in a plane at right angles to axis 8—9; or in other words, in the plane of the paper, and in a clockwise direction—assuming Fig. 1 to be the west elevation. Similarly, gravity acting on the gyroscope 2 will cause precession in the same plane, but in a counter-clockwise direction. This relative movement of the gyroscopes will, as explained, turn the card 24 so that the slot 27 lies in the plane of relative movement; or in other words, in the north-south plane at the equator or at a small definite and known angle thereto according to the latitude in which the instrument is placed. As the gyroscopes precess in said plane, however, gravity will be called into action about the east and west axis to cause precession about the axis 9—8 in such a direction as to follow the movement of the earth. The result will be that the two gyroscopes will finally assume a definite position relative to the earth in which their vertical axis will be inclined in opposite directions, but substantially in the north-south plane or at a known angle thereto as aforesaid. Said axes will, of course, finally settle in a plane perpendicular to the earth about the axis 9—8 and 16—17, and no movement of the card will be effected. The oscillation of the gyroscopes in seeking the meridian will be damped by the dash-pot connection. It will be understood that the action will be the same independently of the position in which axes 8—9 and 11 are placed upon the ship, the axis 8—9 being assumed to lie in the meridian merely for the purpose of the above description.

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. Thus instead of making both the gyroscopes pendulous in the ordinary sense, and rotating them in opposite directions to obtain opposite precession in the plane of the meridian as shown in

Fig. 1, one of the gyroscopes may be made top heavy or like an inverted pendulum with its center of gravity above its axes of support, and the gyroscopes rotated in the same direction. This possibility is suggested in Fig. 2 by indicating masses 60 and 61 secured to the frame work 13 of the gyroscope 2 so that the center of gravity of the said gyroscope and frame work is above the pivots 16—17. According to this modification, both gyroscopes would hence remain under the control of gravity, the application of the force of gravity being reversed instead of the direction of rotation. 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. A gyroscopic compass comprising a gyroscope, means for pendulously mounting the same for oscillation about a horizontal axis and for spinning upon a normally substantially vertical axis, a compass card rotatably mounted independently of said gyroscope and interconnecting means between said card and the gyroscope whereby the tilt of the gyroscope in elevation causes angular setting of the card in azimuth.
2. A gyroscopic compass comprising a gyroscope means for pendulously mounting the same for oscillation about a horizontal axis and for spinning upon a substantially vertical axis, a card mounted for rotation in azimuth and a connection between said card and gyroscope which causes the card to assume a definite relationship to the direction of tilt of said gyroscope away from its vertical position.
3. A gyroscopic compass comprising a plurality of gyroscopes means for supporting the same on normally vertical spinning axes, means whereby the same are adapted to be revolved in opposite directions and means responsive to the relative opposite inclinations of said gyroscopes for indicating the meridian.
4. In a gyroscopic compass, the combination with two gyroscopes, means for mounting the rotor of each gyroscope for oscillation about a substantially horizontal axis and for spinning about a vertical axis, an azimuth indicating means rotatably mounted on one of said gyroscopes, means connecting said indicating means and said other gyroscope to rotate the same, and an energy absorbing means connecting said gyroscopes about said horizontal axes.
5. In a gyroscopic compass, a gyroscope means for mounting the same on a substantially vertical spinning axis, a second gyro-

scope, means whereby the same is independently mounted on a substantially vertical axis said gyroscope being adapted to revolve in the opposite direction, a rotatable indicating element mounted on one of said gyroscopes having a slot therein, and a member on the other gyroscope adapted to move in said slot.

6. A gyroscopic compass comprising a pair of gyroscopes means for pendulously mounting the same for oscillation about horizontal axes and for spinning in opposite directions upon substantially vertical axes, rotatable indicating means associated with said gyroscope and an energy absorbing connection between said gyroscopes.

7. A gyroscopic compass comprising a gyroscope means for pendulously mounting the same for oscillation about horizontal axes and for spinning upon a substantially vertical axis, a card mounted for rotation in azimuth, one of said members having a slot and a pin on the other of said members, whereby the card will be turned so that said slot is parallel to the path of movement of said pin.

8. A gyroscopic compass comprising a pair of gyroscopes means for pendulously mounting the same for oscillation about horizontal axes and for spinning in opposite directions upon substantially vertical axes, a card rotatably mounted on one of said gyroscopes, and a connection between said card and the other gyroscope which causes the card to assume a definite relationship to the direction of tilt of the two gyroscopes away from their vertical position.

9. A gyroscopic compass comprising a

plurality of substantially vertical gyroscopes means for supporting the same about horizontal axes so as to be under the control of gravity, means adapted to revolve the same in such directions as to cause opposite inclination, and means responsive to the relative opposite inclinations of said gyroscopes for indicating the meridian.

10. In a gyroscopic compass, a gyro rotor and a bearing frame therefor, means for mounting the frame for oscillation about horizontal axes, the spinning axis of the rotor being substantially vertical, a direction indicating member rotatably mounted adjacent said frame, and means connecting said frame and member to turn the latter in azimuth or inclination of said frame.

11. In a gyroscopic compass, a gyro rotor, a bearing frame therefor, means for mounting the frame for oscillation about horizontal axes, the spinning axis of the rotor being substantially vertical, a direction indicating member rotatably mounted on said frame, and means responsive to inclination of said frame for orienting said member.

12. A gyroscopic instrument including a pair of gyroscopes adapted to be oppositely rotated, means for mounting the rotor of each gyroscope for oscillation about substantially horizontal axes and for spinning about a substantially vertical axis, a hollow cylinder on one gyroscope and a ball on the other gyroscope working in said cylinder to couple said gyroscopes.

In testimony whereof I have affixed my signature.

HARRY L. TANNER.