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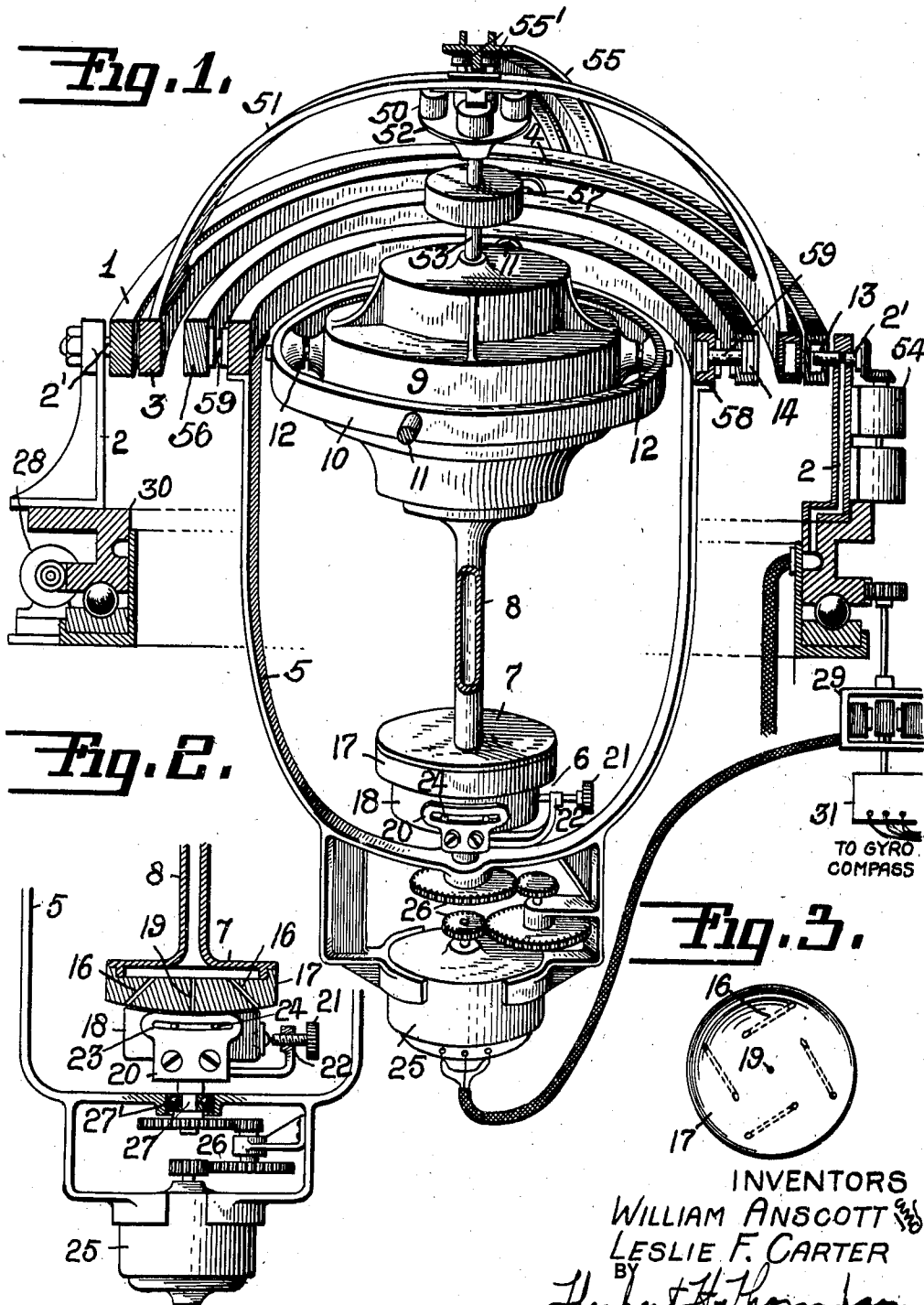
W. ANSCOTT ET AL

2,133,793

GYROVERTICAL

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2 Sheets-Sheet 1



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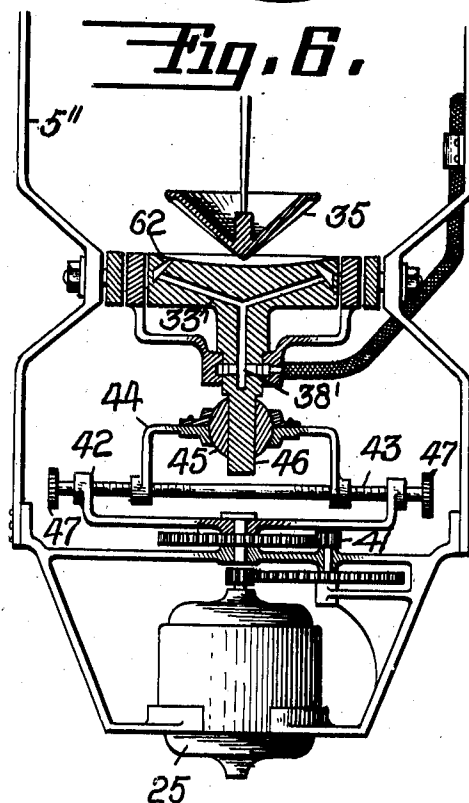
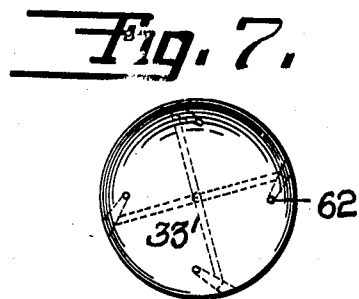
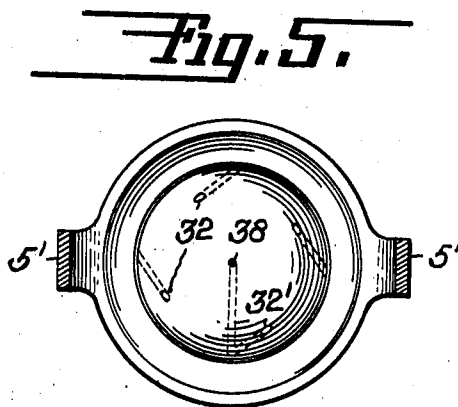
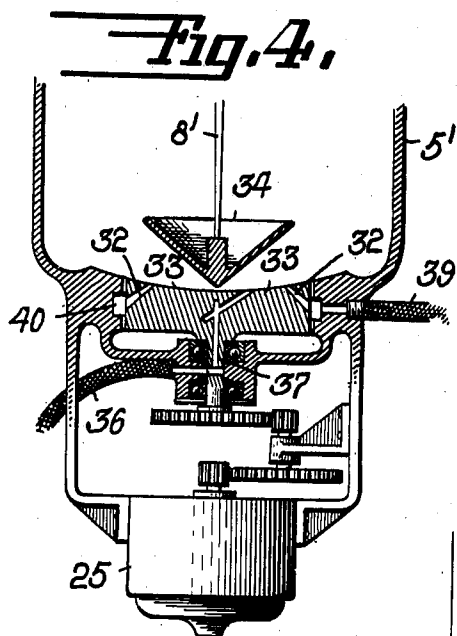
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2 Sheets-Sheet 2



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2,133,793

GYROVERTICAL

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9 Claims. (Cl. 33—204)

This invention relates to gyro-verticals or artificial horizons, especially of the accurate type designed for use as a base line for gunfire on ship-board.

According to our invention, we independently and universally support the gyroscope and a controlling pendulum therefore and employ an erecting force acting on the gyroscope upon relative inclination of the pendulum and gyroscope, in a plane at right angles to the tilt. Preferably, air is employed to exert the erection force and it is also used to provide an air bearing between the pendulum and gyroscope to avoid frictional or metallic contact. Preferably, also, means are provided to overcome the tilting effect due to the rotation of the earth, which means is maintained stabilized in azimuth from a gyro-compass or the like.

Referring to the drawings, in which several preferred forms of our invention are shown,

Fig. 1 is a perspective view, partly in section, of a form of air driven gyro-vertical with an electrical pick-off device therefor.

Fig. 2 is a sectional detail of the pendulous controller and cooperating button on the gyroscope.

Fig. 3 is a bottom view of said button, showing the tangential air jets.

Fig. 4 is a detailed view corresponding to Fig. 2, showing a modified form of the invention.

Fig. 5 is a top plan view of the member on the pendulum from which the air issues.

Fig. 6 is a view similar to Fig. 4, showing a still further modification.

Fig. 7 is a corresponding top view of the member containing the air jets.

In Fig. 1, an outer gimbal ring 1 is shown as pivotally supported on axis 2'—2' in fixed brackets 2. Ring 1, in turn, supports inner ring 3 on an axis 4 at right angles to axis 2'—2'. The inner ring is stabilized about both axes from an inductive type controller 50 secured to a yoke 51 on ring 3, with which an iron disc 52 on a post 53 on the gyro-casing 9 cooperates. Said controller operates follow-up motors on the two major axes of rings 1 and 3, one of which is shown at 54, and the other operates through yoke 55 and trolleys 55' in the well known manner. Within the stabilized rings is pivoted a third ring 56 on trunnions 57, to universally mount ring 58 through trunnions 59. Secured to the ring 58 is a U-shaped framework 5 forming a pendulous device and carrying at its lower end a control member 6 which cooperates with a control member 7 secured by a long stem 8 to the bottom of the gyro-casing 9. The gyro-case

is independently supported within the ring 58 by means of a gimbal 10 pivoted within ring 58 on axis 11—11, the casing, in turn, being pivoted in said ring on trunnions 12—12. It will be understood that the rotor is mounted for spinning about a normally vertical axis within the casing 9, the rotor being spun by any suitable means such as an electric motor or air jets, the air for the latter being supplied through the hollow gimbal ring and trunnions, as indicated at 13, 14, etc., as well known in the art (see the patent to Sperry #1,651,845, dated December 6, 1927).

The exhaust air, or a portion thereof, is led downwardly through the hollow stem 8 and emerges through inclined jets or bores 16 in the button or spinner 17, which is preferably rotatably mounted in member 7. The air supply for the bores 16 may be derived from the spin of the rotor in case the gyroscope is electrically driven (see patent to Bates #1,518,892 of December 9, 1924). Said bores extend downwardly and outwardly diagonally, that is, more or less tangentially as indicated in Figs. 2 and 3. Cooperating with said jets is a cut-off block or baffle 18 mounted on the pendulous frame 5 under button 17. Said block preferably has a spherical or cup shaped seat on its upper surface which closely fits, without touching, the spherical shaped bottom of the button 17, the edge lying adjacent and preferably partially overlying the nozzle openings from the bores 16. It will readily be seen, therefore, that upon relative inclination of the gyroscope and pendulum, resulting in greater uncovering of the jets on one side than the other, a differential torque will be exerted about an axis substantially at right angles to the angle of tilt due to the tangential direction of the jets. Preferably, also, a portion of the air is carried axially downwardly through the vertical bore 19 and emerges laterally between the cup surface of block 18 and the button 17 so as to provide an air bearing between the same and prevent frictional engagement. Also, by having the pendulum element 6 under the gyro element 7, wear on the bearings of the former will not cause binding.

In order to prevent the tilting effect due to the rotation of the earth, we may interpose a small, continuous torque annulling such tilt. Such torque, of course, should be variable with the latitude and maintained on the same side of the compass (that is, in the E—W plane) regardless of the turning of the ship, and to this end we have shown the block 18 as slidably mounted in a cradle 20 which in turn is mounted on a stub

shaft 27 pivoted in bearing 27', the block being adjustable in the E-W plane for changes in latitude by means of a small set screw 21 threaded in a bracket 22 on cradle 20. Said cradle is shown as having slots 23 on its sides in which engage pins 24 on the block 18, the curvature of the slots 23 being preferably on the same center as that of the upper surface in block 18. The cradle is stabilized in azimuth as from a repeater motor 25 driven from a gyro-compass or the like, and which is shown as turning the cradle through reduction gearing 26 connected to shaft 27.

Where the outer brackets 2 are not fixed to the ship, but are rotatably mounted so that the trunnions may be maintained in line with the trunnions of a gun through repeater means, such as a motor 28, the repeater motor 25 should be actuated from a transmitter 29 geared to the rotatable base 30, but which is also differentially controlled from a repeater motor 31 actuated from the gyro-compass, as more completely shown and described in the copending application of one of the joint applicants herein, William Anscoff, and Bruno A. Wittkuhns, now Patent No. 2,093,503, dated September 21, 1937, for Artificial horizons.

A somewhat similar erecting means is shown in Figs. 4 to 6. In this case, however, the air jets 32 are placed in the auxiliary pendulum 5', being provided in a cup shaped member 33 rotatably mounted in the frame 5'. The bores or jets are in this case also mainly tangential, as shown in Fig. 5, so that they tangentially engage the conical surface of the inverted cone 34 secured to the stem 8' depending from the gyro-casing. It will readily be seen that the component of the tangential thrust from the air streams about the horizontal axis will be balanced as long as the cone 34 is symmetrically positioned, but in case of relative inclination, a greater force will be exerted at right angles to the direction of tilt. This effect may be increased by providing small radial blades 35 on the cone, if desired (see Fig. 6).

In this form of the invention, tilt is prevented by making the westerly jet 32' slightly stronger than the others, a separate air supply being provided through the tube 36 which brings air into the center of the bearing 37, the air emerging upwardly through the bore 38 and tangentially outwardly, as shown in Fig. 5. The air to the other three jets is shown as supplied from the pipe 39, the air entering the circumferential channel 40, whence it enters the several bores leading to the jets. A repeater motor 25 is provided, as before, for orienting the part 33 to maintain it in the same E-W position.

In Figs. 6 and 7 a further slight modification of Fig. 4 is shown. In this modification the control block 33' may be tilted slightly with respect to the pendulous framework 5'' in order to prevent the tilt due to the earth's rotation. In this case, the repeater motor 25 is shown as stabilizing in azimuth, by means of reduction gearing 41, a bracket 42 in which is journaled a threaded shaft 43. On said shaft is threaded a second U-shaped bracket 44 which carries a universal bearing 45 engaging a stem 46 projecting downwardly from the block 33'. In this case the block is universally pivoted within frame 5''. Air may be supplied to all of the jets 62 equally from a central bore 38' and the compensation for the earth's rotation is secured by the turning of the threaded shaft 43 through thumb pieces 47 so

that the jets are tilted slightly in the E-W plane.

Block 33' may be either rotatable or stationary, as desired. Allowing the same to rotate as in Fig. 2 has the advantage that the resultant torque is better distributed and is therefore more nearly in the true required direction than where four fixed ports or jets are employed.

As many changes could be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

Having described our invention, what we claim and desire to secure by Letters Patent is:

1. In a gyro-vertical, a neutral, universally mounted gyroscope, a coaxial, pendulous device universally mounted and supported independently of said gyroscope, and a two part controller having one part on the gyroscope and the other on said device, one of said parts having a plurality of circumferentially arranged ports forming air jets and the other part acting as a cut-off member for said jets.

2. In a gyro-vertical, a neutral, universally mounted gyroscope, a universally mounted pendulous device, a two part controller having one part on the gyroscope and the other on said device, one of said parts having a plurality of circumferentially arranged ports forming air jets and the other part acting as a cut-off member for said jets, means for relatively adjusting said parts E-W in accordance with the latitude to compensate for the tilting effect of the earth's rotation, and means for maintaining E-W the plane of adjustment.

3. In a gyro-vertical, a neutral, universally mounted gyroscope, a coaxial, pendulous device universally mounted and supported independently of said gyroscope, a two part controller having one part on the gyroscope and the other on said device, one of said parts having a plurality of directed air ports forming air jets therein and the other acting as a cut-off plate for said jets, means for supplying air under pressure to said ports, and between said parts to prevent contact between said parts.

4. In a gyro-vertical, a neutral, universally mounted gyroscope, a coaxial pendulous device universally mounted independently of said gyroscope, a two part controller having one part on the gyroscope and the other on said device, the latter being under the former, and one of said parts having a plurality of circumferentially arranged ports forming jets and the other part acting as a cut-off member for said jets.

5. In a gyro-vertical, a universally mounted, substantially neutral gyroscope, a coaxial pendulous device universally mounted independently of said gyroscope, and a two part controller responsive to relative inclination of said gyroscope and device for erecting the gyroscope, one of said parts being on said device and the other on the gyroscope, one part having air jets differentially intercepted by the other part, and means to continuously rotate one of said two parts.

6. In a gyro-vertical, a universally mounted, substantially neutral gyroscope, a universally mounted pendulous device, and a two part controller responsive to relative inclination of said gyroscope and device for erecting the gyroscope,

comprising a plurality of spaced, tangentially directed air jets on said device and a member on said gyroscope against which said jets impact normally equally on all sides, whereby a resultant torque is exerted on said gyroscope upon relative inclination of said device and gyroscope substantially at right angles to such relative inclination.

7. A gyro-vertical as claimed in claim 6, in which the westerly jet is the stronger.

8. A gyro-vertical as claimed in claim 6, in which said jets are continuously spun.

9. In a gyro-vertical, a neutral universally

mounted gyroscope, a juxtaposed universally mounted pendulous device, and a two part controller having one part on the gyroscope and the other on said device, one of said parts being in the form of a spinner having air ports therein both to spin the same and to exert normally balanced torques on the gyroscope about its axes of mount, the other of said parts acting as a differential cut-off for said ports on relative inclination of said parts.

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