Nov. 28, 1944. M. F. BATES 2,363,495

DIRECTIONAL GYROSCOPE

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FIG. 1.

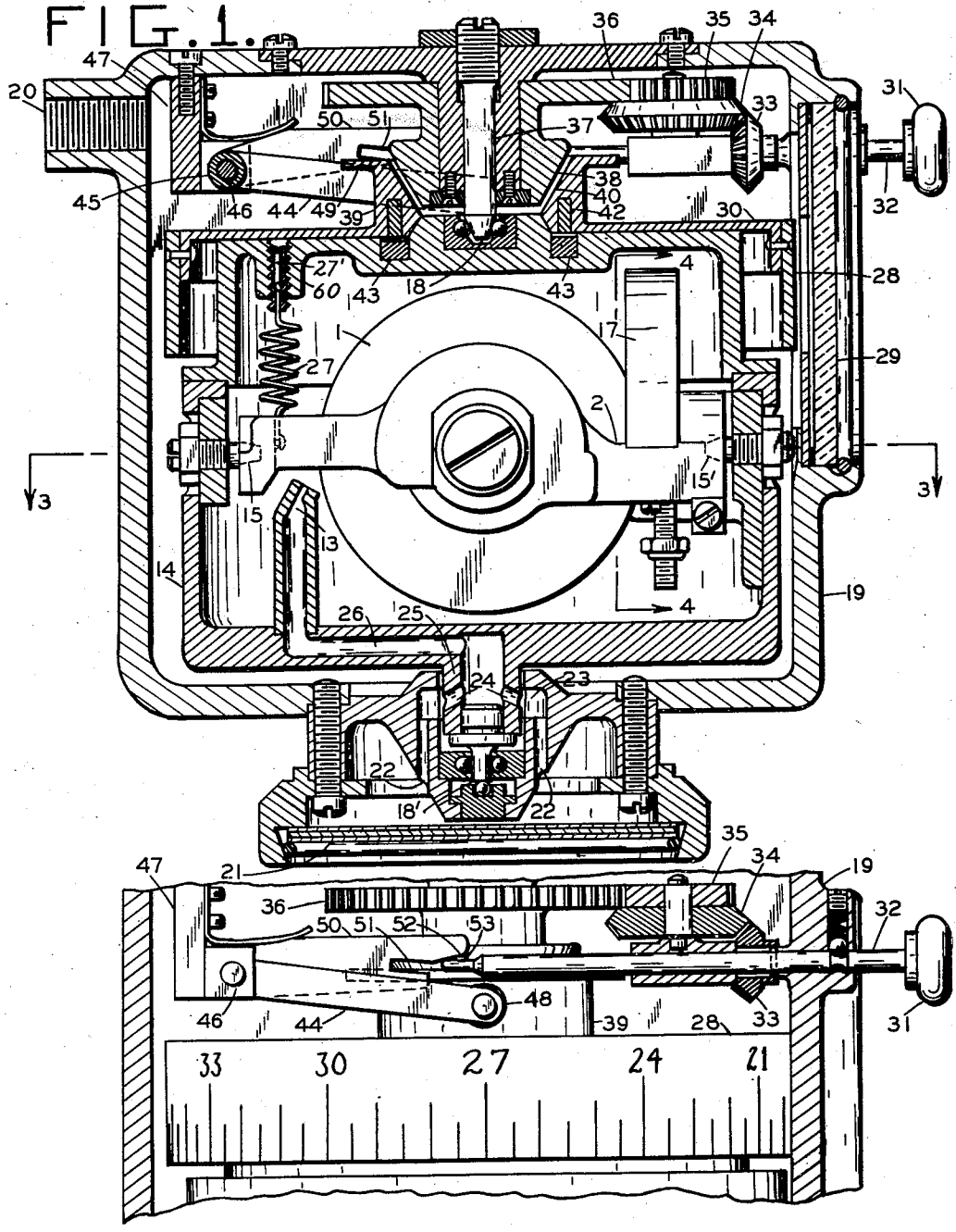


FIG. 2.

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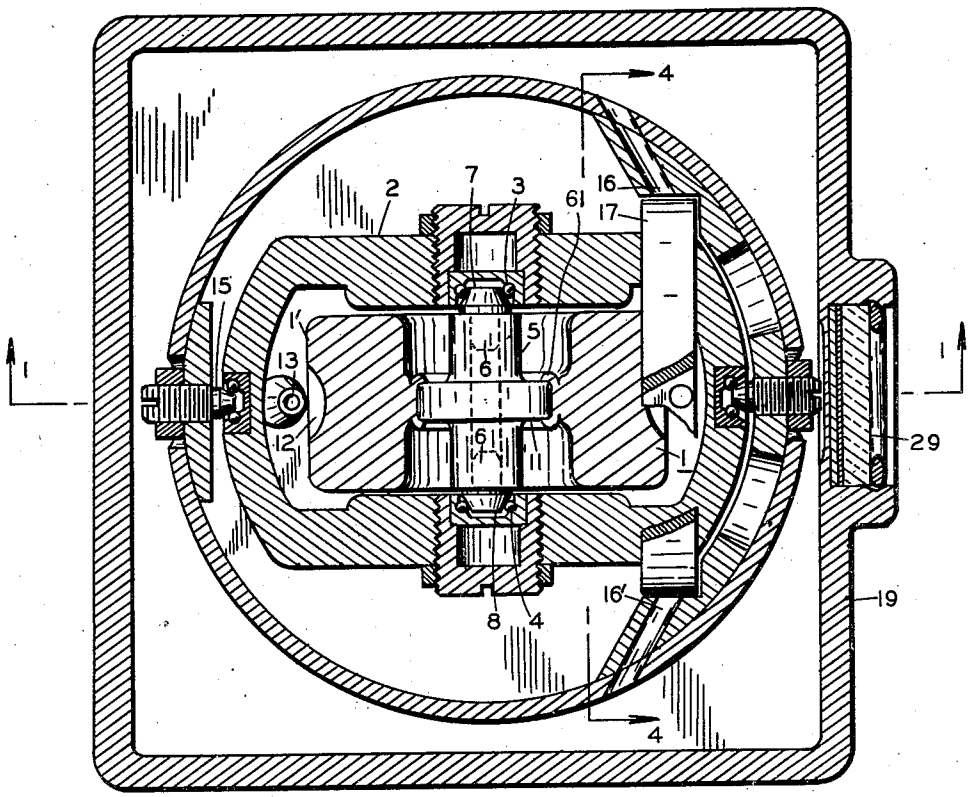
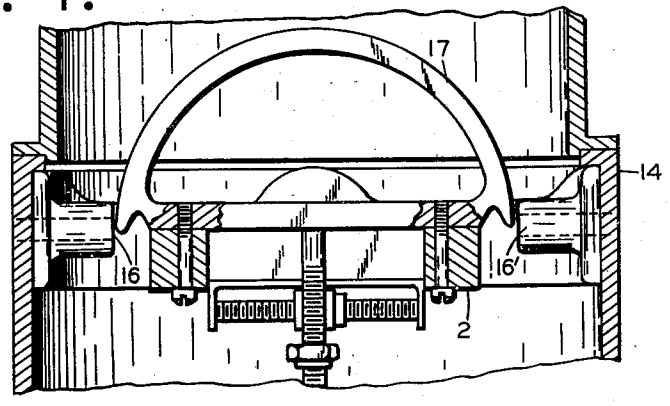


FIG. 3.

FIG. 4.



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2,363,495

DIRECTIONAL GYROSCOPE

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Application January 2, 1941, Serial No. 372,757

4 Claims. (Cl. 74—5)

This invention relates to improvements in small directional gyroscopes such as used on aircraft for navigation. My invention has especial application to air spun and air erected gyroscopes of the free or directional type which are very sensitive and easily disturbed by stray air currents. According to my invention, I prefer to enclose the rotor and its rotor-bearing frame in a substantially closed casing which constitutes or takes the place of the usual open vertical ring and I so discharge the used air from said casing that it serves to maintain the rotor erect. While my invention is applicable to either the pressure or vacuum driven type of instruments, I have shown the latter system in the drawings. Other improvements accomplished by my invention will be apparent from the following specification and claims.

Referring to the drawings showing the preferred form of my invention,

Fig. 1 is a vertical section through the outer casing and inner casing of a gyroscope constructed in accordance with my invention, the section being taken substantially on line 1—1 of Fig. 3.

Fig. 2 is a side elevation, partly in section, of the resetting mechanism for the card.

Fig. 3 is a horizontal section on line 3—3 of Fig. 1.

Fig. 4 is a vertical section taken substantially on line 4—4 of Fig. 1.

The rotor 1 of my directional gyroscope is shown as of the air spun type, being journaled for spinning about a normally horizontal axis in the rotor bearing frame 2 on anti-friction bearings 3 and 4. The rotor proper or rim 1' is preferably made of some heavy material, such as brass, but the shaft 5 is preferably made of the same metal as the frame 2 to avoid troubles with temperature compensation, the material preferably being aluminum alloy or other light metal. The shaft 5 is shown as having a short bore at its ends in which the reduced inner ends 6 of the tapered studs 7 and 8 fit. The outer cone faces of said studs form the inner member of the ball bearings 3 and 4. The shaft 5 is shown as having a central collar 11 to which the heavy rim 1' is clamped. As shown, the interior surface of the ring-rotor is provided with an interior collar 61 which is rolled over its edges to grip the collar 11 around its periphery. By securing the rim to the central portion only of the shaft 5, the shaft is left free to expand and contract naturally at its known rate of expansion so as to avoid binding of the bearings, due to unequal expansion of the shaft and ring 2.

The rotor is shown as having buckets 12 cut therein, against which an air jet discharged from the nozzle 13 impinges to spin the rotor. But a single nozzle may be employed, if desired, since the spinning jet is not relied on, as in prior inventions, to maintain the shaft horizontal, since I prefer to employ additional means for this purpose. According to my invention, the vertical ring or gimbal 14, within which the rotor bearing frame 2 is journaled on horizontal axis 15—15', is made in the form of a cylindrical casing completely enclosing the rotor and its bearing frame. The used air discharged from the nozzle 13 is discharged from the casing through ports 16 and 16' which are normally partially closed by a shutter or cut-off ring 17 secured to the frame 2 (Fig. 4). Normally, the discharge ports 16 and 16' are equally open, as shown in Fig. 4, but upon relative tilt of the gyroscope and its vertical ring, one of the ports is covered more than the other, resulting in greater discharge of air from the latter and hence causing an unbalanced torque around the vertical axis 18—18' of the vertical ring or casing 14.

An outer casing or housing 19 encloses the entire instrument and in it the inner casing 14 is journaled about the aforesaid vertical axis 18—18' on anti-friction bearings. Air is continuously exhausted from the case 19 through pipe coupling 20. Air is admitted through a screened opening 21 in the bottom of the case 19. Thence it passes through vertical passages 22 22', around the bearing 18', thence into annular channel 23, and thence through inclined bores 24 within the stem 25 projecting downwardly from the casing 14. Thence the air passes through a channel 26 to the nozzle 13.

Preferably, also, I provide a weak spring connection 27 between the frame 2 and the vertical casing ring 14 so as to exert a weak torque about the horizontal axis 15—15' upon relative tilt of the rotor frame 2 and the vertical casing. This is for the purpose of reducing wandering about the vertical axis due to friction about the horizontal axis 15—15', which might otherwise be caused by the torque exerted by the erection jets 16, 16'. Adjustment of the spring tension may be secured by anchoring the upper end of the spring in a set screw 27' threaded in an interior boss 60 within casing 14.

The compass card 28, shown as of the side reading cylindrical type, is visible through the front window 29 in casing 19. Instead of resetting the gyroscope, as is the present general practice, I propose to reset the card only. For this purpose

I have shown the card as secured to a separable disc 30 normally resting on the flat top of the vertical ring casing 14. I also provide a means for lifting the card and resetting it while lifted. Such means is shown as comprising a knob 31 mounted on a shaft 32 entering the casing 19 near the top and slidably and rotatably mounted therein. Said shaft is shown as splined in a bevel pinion 33 meshing with a bevel gear 34, to which is secured a spur pinion 35 meshing with a larger gear 36. The gear 36 is shown as journaled on a central stem 37 and as carrying a conical clutch face 38. The disc 30 is also shown as having a collar 39 thereon having an inner complementary conical clutch surface 40 adapted to engage the surface 38 when lifted. Lifting of the disc 39 will also free the disc from engagement with the casing 14 so that turning of the disc, when lifted, does not disturb the gyroscope.

Small magnets 42 are shown in the bottom of the collar 39, cooperating with a small soft iron annular inset 43 in the casing 14 for the purpose of holding the card firmly on top of the casing 14 when in the operating position.

For lifting the card, I have shown a pivoted fork 44 with its inner end secured to a sleeve 45 journaled at 46 in a bracket 47. At its open end said fork is provided with inwardly facing rollers 48 loosely fitting between the top of the disc 30 and a circular flange 49 on the collar 39. It will be evident, therefore, that when the forked end of the lever 44 is raised, the disc will be lifted from the casing 14 and the conical clutch surfaces 38 and 40 will engage. For this purpose there is also secured to the sleeve 45 an arm 50 having a notch 51 in the end thereof with a beveled entrance 52 thereto. The inner end 53 of the shaft 32 is shown as reduced and rounded so that when the shaft is pushed inwardly, the reduced end 53 thereof engages the beveled surface 52 to raise the lever 50 to enter the notch 51, thereby lifting the collar and disc 30 and card 23. Thereupon the knob 31 may be rotated to reset the card through the gearing 33, 34, 35 and 36, and clutch 38 and 40 as described.

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

1. In a directional gyroscope having an air spun rotor and rotor bearing frame, a closed casing in which said frame is mounted for oscillation about a horizontal axis, means mounting said casing for freedom about a vertical axis, means for introducing a jet of air into said casing for spinning the rotor, a pair of oppositely directed ports in said casing for discharging the used air, and a shutter on said frame for differentially closing and opening said ports upon relative tilt of said frame and casing, whereby tilt of the frame is prevented.

2. In a directional gyroscope, a rotor and rotor bearing frame, a closed casing having an air inlet and in which said frame is mounted for freedom about a normally horizontal axis, means mounting said casing for freedom about a normally vertical axis, a pair of opposed ports in said casing so positioned as to discharge air therefrom in directions to exert normally equal and opposite torques on said casing about said vertical axis, and a shutter on said frame for differentially closing the entrances to said ports upon relative tilt of said frame and casing, whereby tilt of the frame is prevented.

3. A gyroscopic instrument comprising, a housing functioning as an outer gimbal, means supporting said outer gimbal for pivotal movement about a first axis, an inner gimbal pivotally carried by the outer gimbal about a second axis disposed at right angles to the first axis, said inner gimbal being located within said housing, a gyro-rotor pivotally mounted in said inner gimbal about a third axis at right angles to the second axis, an air jet device for impelling the gyro-rotor, means defining an air duct supported by said housing and leading through the means supporting it for pivotal movement to said jet device, a plurality of jet nozzles supported on said housing, extending substantially tangentially thereof in opposite directions and constituting exhaust ports therefor, and selective valve means to control flow through the jet nozzles in response to movement of the inner gimbal relative to the outer gimbal, whereby when a current of air is passed through said air jet device and said jet nozzles in series the gyro-rotor is caused to turn and the reaction of the jets from said jet nozzles applies a couple to the outer gimbal about the first axis to bring the inner gimbal to a predetermined position relative to the outer gimbal by precession of the gyro-rotor when the inner and outer gimbals are away from said predetermined position.

4. In a air-driven gyroscope instrument, an outer enclosing housing, means whereby air is exhausted therefrom, an inner casing, bearing means mounting said casing within said housing for freedom about an axis, said bearing means having passageways leading therethrough to admit atmospheric air within said casing, a rotor-bearing frame pivotally mounted within said casing upon a second axis, a spinning jet connected to said passageways for spinning the rotor, ports discharging air from said casing into said housing in opposite directions for exerting normally balanced opposing torques about said first axis, and a shutter on said frame for differentially closing and opening the entrances to said discharge ports upon relative tilt of said frame with respect to said casing about said last-mentioned axis.

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