Nov. 26, 1940. R. VON FREYDORF 2,222,754

CONTROL OF A GYROSCOPE

Filed Jan. 19, 1938

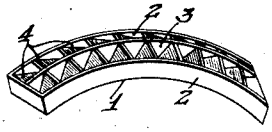


Fig. 1

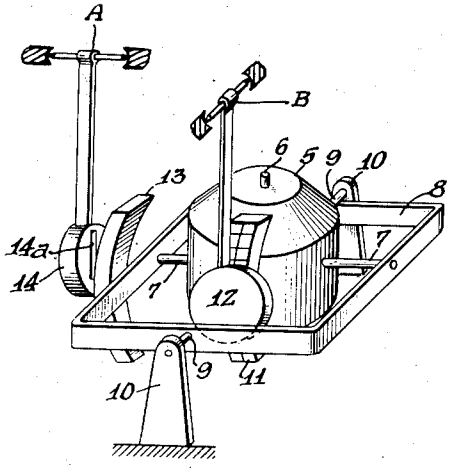


Fig. 2

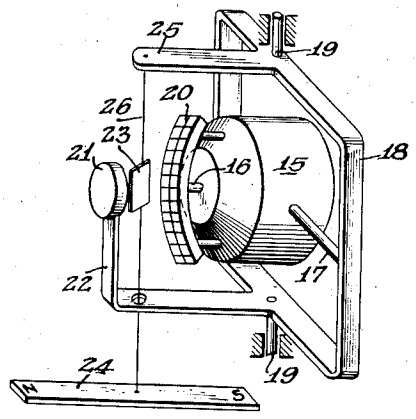


Fig. 3

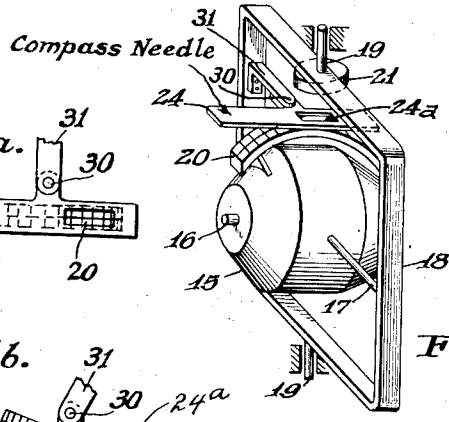


Fig. 4

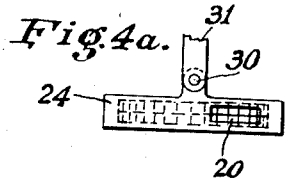


Fig. 4a.

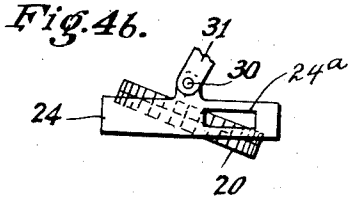


Fig. 4b.

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UNITED STATES PATENT OFFICE

2,222,754

CONTROL OF A GYROSCOPE

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Application January 19, 1938, Serial No. 185,759
In Germany December 9, 1935

5 Claims. (Cl. 33—222)

This invention relates to the control of a gyroscope and more particularly to a control device utilizing the precessional effect of the gyroscope for altering the orientation thereof or for maintaining the same in a given position.

An object of the invention is to provide a novel and improved mechanism of the type above indicated.

Another object is to provide a novel and improved system of the above type utilizing fluid pressure to exert a force tending to turn the gyroscope about its precession axis.

Another object is to provide a novel and improved surface against which a fluid is directed.

Various other objects and advantages will be apparent as the nature of the invention is more fully disclosed.

The above and further objects and novel features of the invention will more fully appear from the following detailed description when the same is taken in connection with the accompanying drawing. It is to be expressly understood, however, that the drawing is for the purpose of illustration only and is not intended as a definition of the limits of the invention, the reference for this latter purpose being had primarily to the appended claims.

In the drawing:

Fig. 1 is a perspective view of a ring-sector against which the fluid is directed in accordance with the present invention;

Fig. 2 is a perspective view showing the ring-sector applied to a gyroscope mounting of the type which is utilized with an artificial horizon or with an airplane control device for maintaining a plane on an even keel;

Fig. 3 is a perspective view illustrating the invention applied to a compass supervised course gyroscope;

Fig. 4 is a perspective view similar to Fig. 3 illustrating a different embodiment of the invention; and,

Figs. 4*a* and 4*b* are fragmentary detail views of two positions of operation of a portion of the structure disclosed in Figure 4.

In the following description and in the claims certain specific terms are used for convenience in referring to various details of the invention. These terms, however, are to be given as broad an interpretation as the state of the art will permit.

Referring to the embodiment of the invention shown in the drawing, the fluid pressure device comprises a ring-sector 1 bounded by side walls 2 and divided by a center wall 3. Between the side and center walls, there are disposed rows of inclined vanes 4. The vanes of the two rows are oppositely inclined so that the vanes of one row are adapted to produce a force in one direction, for example, to the right in Fig. 1, whereas the vanes of the other row are adapted to produce a force in the opposite direction, when a fluid medium is applied thereto in a radial direction toward the axis of said sector.

The use of the ring-sector of Fig. 1 in a gyroscope system is illustrated in Fig. 2, which shows a gyroscope driven by any suitable means and mounted on a shaft 6 which is carried in a housing 5. The housing 5 is cardanically mounted in a gimbal ring 8 by means of a shaft 7. The gimbal ring 8 is mounted by means of a shaft 9 on a support 10 which may be fixed to the aircraft or the like. The housing 5 carries a ring-sector 11 similar to that shown in Fig. 1, the axis of which lies parallel to the axis of the shaft 7. Suitable means is provided for supplying a fluid current to the ring-sector 11. In the embodiment shown, this means comprises an air current generator 12 which may be of the type illustrated in the co-pending application of Friedrich Lauck, Serial No. 185,770, filed January 19, 1938 which is pendulously mounted as shown in Fig. 2 and is supported by the aircraft in a manner such that it is rotatable about the transverse axis generally designated at B of said craft.

The gimbal ring 8 also carries a ring-sector 13 similar to that shown in Fig. 1, whose axis lies parallel to the axis of the shaft 9. Suitable means is also provided for supplying fluid current to the ring-sector 13. In the form shown, this comprises an air current generator 14, similar to generator 12 and also pendulously mounted in this case for rotation about the longitudinal axis generally designated at A of the aircraft.

Air current generators 12 and 14 may be of any convenient type, such as the acoustic nozzle type having a vibrating diaphragm adapted to produce pulsating air currents which are discharged through an elongated slot 14*a* onto the cooperating ring-sector.

The gyroscopic system is utilized in connection with any suitable means such as a servomotor or the like (not shown) for stabilizing the aircraft about its transverse and longitudinal axes. Assuming that the gyroscope axis is correctly positioned, air currents from the generators 12 and 14 will be centered with respect to the ring-sectors 11 and 13. In that case, the reactive forces exerted on the vanes 4 in the two halves of the ring-sectors will be equal and op-

posite and no resultant force will be applied to the gyroscope. If, however, the gyroscope is deflected due, for example, to bearing friction, the gyroscope will effect a corresponding control of the plane by means of either the elevator or the ailerons, not shown, until the plane is in a position corresponding to that of the new axis of the gyroscope. Thereupon, either pendulum 12 or 14 will be deflected, depending upon whether the control is about the transverse or the longitudinal axis of the plane, causing the air current to be shifted to one side or the other of the center of the corresponding ring-sector 11 or 13 and to build up a resulting force parallel to the axis of rotation of the gyroscope and tending to turn the gyroscope about its precession axis. The precession effect of the gyroscope is thus caused to turn the gyroscope about its precession axis until the ring-sector 11 or 13 has again been centered with respect to its air current generator. The gyroscope will thus return the aircraft to its original position and the pendulum 12 or 14 will return to the position in which the reaction forces on the corresponding ring-sector are again equalized. It will be noted that, in the above system, the gyroscope is automatically maintained in a set position, any deviation thereof due to precessional effect being corrected by the forces above mentioned.

In Fig. 3 the invention is shown as applied to a course gyroscope supervised by a compass. In this embodiment, the gyroscope rotates about a shaft 16 mounted in a housing 15 which is cardanically mounted by a shaft 17 in a gimbal ring 18. The gimbal ring 18 is mounted about a shaft 19 in suitable stationary bearings attached to the aircraft. A ring-sector 20 of the above type is mounted on the housing 15 with its axis parallel to the shaft 17. An air current generator 21 of the type above mentioned is rigidly mounted on an angle piece 22 attached to the gimbal ring 18. A deflector or guide surface 23 is mounted for rotation with a compass needle 24. In the embodiment shown, the guide surface and compass needle are suspended by suitable suspension means 26 from a bracket 25 attached to the gimbal ring 18. In this embodiment, when the gyroscope is correctly oriented with respect to the compass needle 24, namely, when the gyro spin axis is parallel to the longitudinal axis of the compass needle, the deflector 23 causes the air current from the generator 21 to be applied centrally to the ring-sector 20 and no resultant force is produced. If, however, the gyroscope is deflected from its course, the compass needle 24 causes the deflector 23 to deflect the air current to the right or left on the ring-sector 20, thereby producing a force in a direction adapted to cause the precessional effect of the gyroscope to return the ring sector to central position. In this way, any precession of the gyroscope is automatically compensated and the latter is caused to maintain a position corresponding to that of the compass needle 24.

In Fig. 4, a different embodiment of the invention is shown in which the gyroscope and the gimbal ring 18 are mounted in the manner above mentioned and are identified by similar reference characters. In this embodiment, the ring-sector 20 is mounted directly on the housing 15 and the air current generator 21 is mounted directly on the gimbal ring 18 in a position normally central with respect to the ring-sector 20. The compass needle 24 is loosely mounted for movement about a pivot 30 carried by a bracket 31 secured to the gimbal ring 18 in such a manner that one of its ends extends between the ring-sector 20 and the air current generator 21 and is provided with a slot 24*a* through which the air current is directed onto the ring sector. In this embodiment, while the directional gyroscope maintains a correct course, the slot 24*a* allows the air jet to strike the ring-sector centrally so that the reaction forces are balanced. The central disposition of compass needle 24 with respect to the ring sector 20 under such condition is clearly shown in Figure 4*a*. Upon a course deflection, however, the compass needle 24 shifts relatively laterally about its pivot 30, thereby shifting the air current in such a manner that a force is produced by the ring-sector 20 tending to rotate the gyroscope about the shaft 17. The position assumed by the shifting needle 24 with respect to the ring sector is that disclosed in Figure 4*b*. The precessional effect of the gyroscope thereupon shifts the latter until the ring-sector 20 is again centralized under the magnetic needle 24.

It is to be understood that the mounting of the gyroscope may be varied in any suitable manner and that the gyroscope may be used to control any desired apparatus such as the control surfaces of an aircraft or an indicator or the like.

Although a particular embodiment has been shown for purposes of illustration, various changes and modifications may be made therein, as will be readily apparent to a person skilled in the art. The invention is only to be limited in accordance with the scope of the following claims when interpreted in view of the prior art.

What is claimed is:

1. In a device of the character described, a gyro mounted for freedom about two mutually perpendicular axes, a segment-shaped element having its axis parallel to one of said axes and mounted for movement with said gyro, parallel rows of oppositely inclined vanes carried by said ring on the outer circumference thereof, an impulse generator, and means pendulously mounting said generator in a position adjacent said ring element, whereby the impulses emitted by said generator normally impinge radially and uniformly upon said element and also so that upon movement of said gyro about the other of said axes a reactive force about said one axis is produced by dissymmetrical impingement of said impulses upon said ring to cause said gyro to precess to its initial position.

2. In a device of the character described, a gyro mounted for freedom about two mutually perpendicular axes, a segment-shaped element having its center of curvature parallel to one of said axes and mounted for movement with said gyro, parallel rows of oppositely inclined vanes carried by said ring on the outer circumference thereof, an impulse generator for emitting impulses radially and symmetrically upon said ring vanes, and direction maintaining means mounted for rotation relative to said gyro interposed in the path of said impulses between said impulse emitter and said ring element, whereby upon relative movement of said gyro and direction maintaining means impulses are intercepted by the latter being thereby emitted unsymmetrically upon said ring to produce a reaction returning said gyro to its normal position.

3. In a device of the character described, a gyro mounted for three degrees of freedom about three mutually perpendicular axes, a housing for said gyro, a ring-shaped element attached to said

gyro housing, said ring being provided with parallel rows of oppositely inclined vanes, an impulse emitter attached to said gyro mounting for directing its impulses uniformly upon said ring, means in the path of said impulses for directing the same, and means connected to said last-named means responsive to the earth's magnetic field for moving the latter means thereby deflecting said impulses upon relative movement of said responsive means and said gyro to return them to their original relative position.

4. In combination, a gyroscope comprising a rotor mounted for spinning about one axis and for angular movement about two other axes normally perpendicular to each other and to said spin axis, a ring sector having its axis of curvature substantially coincident with one of said last-named two axes connected to said gyroscope for deviation therewith about one or the other of said last-named two axes, said ring sector being provided with parallel rows of oppositely inclined vanes, means normally directing a fluid current radially against said ring sector in a position such that balanced forces are normally produced thereby, whereby during angular movement of said rotor said ring sector is moved with said rotor to thereby cause said current directing means to produce a force upon said sector which causes precession of the gyroscope to return the gyroscope and ring sector to their original position with respect to said fluid current directing means.

5. In combination, a gyroscope comprising a rotor mounted for spinning about one axis and for angular movement about two other axes, perpendicular to each other and to said spin axis, a pair of ring sectors mounted on said gyroscope having their mounting axis normal to each other, the axis of curvature of one of said ring sectors being substantially coincident with one of said two other axes, and the axis of curvature of the other of said ring sectors being substantially coincident with the remaining one of said two other axes, each ring sector comprising parallel rows of oppositely inclined vanes, a fluid current nozzle normally directing fluid current centrally and radially against one of said ring sectors, said nozzle being mounted for relative movement transversely to said last-named sector during angular movement of said rotor about one of said two named axes, thus producing a force causing the rotor to precess to return the ring sector to its initial position, and a second fluid current nozzle normally directing fluid current centrally and radially against the other of said ring sectors and mounted for relative movement transversely to its corresponding ring sector during angular movement of said rotor about the other of said first two named axes thus producing an unbalanced force causing the rotor to precess to return the last-named ring sector to its initial position.

RUDOLF v. FREYDORF.