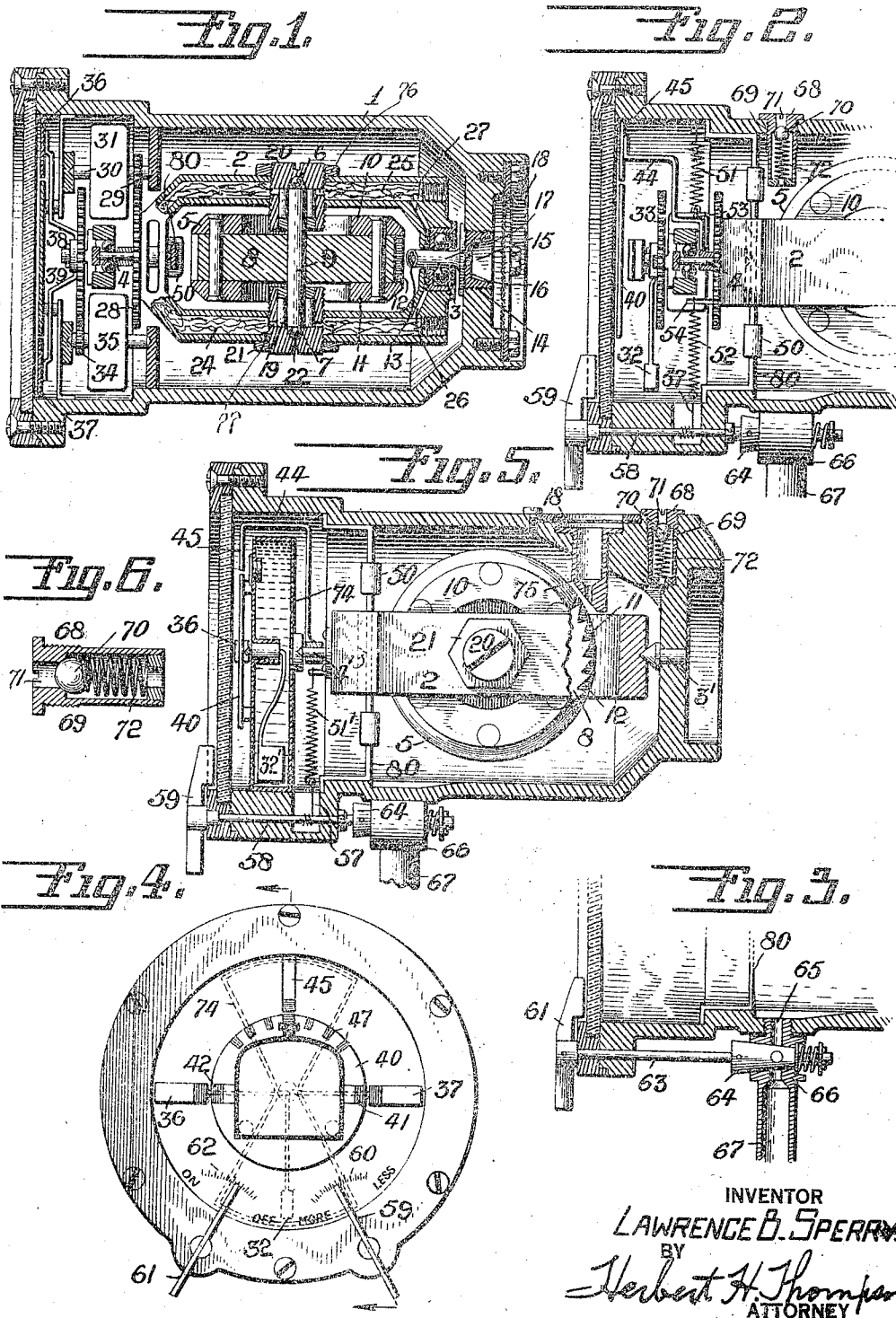


L. B. SPERRY.
TURN INDICATOR.
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TURN INDICATOR.

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To all whom it may concern:

Be it known that I, LAWRENCE B. SPERRY, a citizen of the United States of America, residing at Garden City, Long Island, in the county of Nassau and State of New York, have invented certain new and useful Improvements in Turn Indicators, of which the following is a specification.

This invention relates to gyroscopic turn indicators for aircraft or other dirigible vehicle and more particularly to the improvements in the apparatus shown and described in the copending application of Elmer A. Sperry for turn indicators, Serial No. 353,739, filed January 20, 1920.

According to this invention a small gyroscope mounted for precession about a horizontal axis upon turning of the craft upon which it is mounted is made use of to indicate turning by means of a suitable indicator. Such an instrument has been found to be very sensitive but in its original form many defects appeared, the purpose of this invention being to overcome the defects in the original instrument.

A further object of the invention is to provide means for use in conjunction with the turn indicator proper for showing the banking angle of the airplane.

Referring to the drawings in which are now considered preferred forms of the invention are shown:

Fig. 1 is a horizontal section of one form of turn and banking indicator.

Fig. 2 is a vertical section of the same.

Fig. 3 is a detail in section of the controlling valve for exhausting the air in the casing.

Fig. 4 is a front elevation of a modified form of indicator.

Fig. 5 is a vertical section of the same.

Fig. 6 is a sectional detail of the regulating valve.

The turn indicator comprises preferably a closed casing 1 in which is pivotally mounted a frame 2 supported on horizontal pivots 3 and 4. Said pivots are preferably in practice placed fore and aft of the airplane. In said frame the rotor proper is journaled in suitable anti-friction bearings 6 and 7. Said rotor is preferably built up of a plurality of parts comprising a central flat disc 8 shrunk or otherwise secured to the shaft 9 and a pair of heavy rings 10

and 11 riveted or otherwise secured near the periphery of said disc. The face of said disc is preferably provided with suitable buckets 12 or vanes adapted to receive the impulse of the air jet from nozzle 13.

The bearings for the rotor shaft 9 are shown as roller bearings 19 mounted in threaded blocks 20 which may be adjusted for taking up the end play of the shaft and then locked in place by lock nuts 21. Balls 22 may be placed between the ends of the shaft and the bearing members for reducing end thrust friction. The bearings may be lubricated by oil wicks 24 and 25 extending throughout the length of the frame as shown in Fig. 1. Suitable passages 26 and 27 may lead from said wicks to the frame bearing 3 and other passages 76, 77 may lead from said wicks to the rotor bearings. By such construction the bearings remain oiled indefinitely and water is excluded therefrom.

As shown in Fig. 1 the air is introduced into the casing through a hollow pivot 14 communicating with the exterior of the casing at 15. Said pivot may be made in the form of a separate closure 16 threaded in an aperture in the end of the casing and having a tube 17 constituting pivot 14 secured to, or integral with, the same. A screen 18 may also be secured to the outer end of the casing for preventing foreign matter from being carried into the casing with the air.

At the forward end of the frame 2 is shown secured a gear 28 which meshes with a pinion 29 on the shaft 30. A light paddle or blade 31 is shown as mounted on said shaft for the purpose of damping the oscillations of the gyroscope. Also mounted within said frame 1 is a simple pendulum 32 or other pendulous device. Said pendulum is shown as having secured thereto a gear 33 meshing with pinion 34 also carrying a blade or paddle 35 for damping purposes. Also secured to said gear and pendulum are a pair of normally horizontal indicators 36 and 37 secured to the outer ends of oppositely extending arms 38 and 39. Said indicators are readable upon a stationary dial or index 40 which has marked thereon reference indications 41 and 42 to simulate the horizon line, in other words, to simulate the line the aviator normally employs as indicating horizontality. The gy-

roscope also has secured to the frame 2 thereof an arm 44 bearing a normally vertical indicator 45. Said indicator is preferably readable upon the same dial 40. Said dial is preferably marked in such a manner as to indicate roughly the outline of the radiator or hood of the airplane since it is the cap on the radiator which is usually observed by aviators with reference to a distant object to ascertain whether the airplane is turning or not. A number of graduations 47 may be provided to indicate the rate of turning of the airplane.

Suitable stops 50 are, of course, provided within the casing for preventing the gyroscope from turning too far or from turning over. Said stops are shown as pieces of rubber tubing mounted on transverse lead 80 and adapted to cooperate with the bearing frame 2 of the gyroscope. Also it is important that a centralizing means be employed for normally holding the gyroscope in the vertical or other predetermined position and only permitting turning or precession thereof upon turning of the aircraft. Spring or springs as ordinarily secured to the gyroscope are unsuited for this purpose owing to the fact that if made weak enough to permit sufficient sensitiveness of the gyroscope to indicate a slight turn, when a sharp turn is taken the gyroscope will immediately precess over and strike the stop from whence it will start oscillating back and forth and become useless. On the other hand if the spring is made stiff enough to prevent its being too sensitive under the conditions stated it will not be sensitive to slight turns of the aircraft and will not fulfill its complete function.

For the purpose of overcoming these difficulties I have shown one or more sensitive spiral springs 51 and 52 secured between opposite points 53 and 54 on frame 2 and points on the casing. The springs are preferably in line with each other and under little tension when the gyroscope is in the normal position. It will readily be seen that with this arrangement very little force will oppose the initial precession of the gyroscope so that it will be very sensitive to slight turns of the airplane. On the other hand the force exerted by the springs will rapidly increase with the angle of precession of the gyroscope so that not only will the gyroscope be prevented from striking the stops but also the angle that the gyroscope is able to turn against the springs will furnish a ready indication of the rate of turning of the aircraft in a similar manner that a spring balance shows the acceleration of gravity upon a mass hung thereon, since gyroscopic effort is directly proportional to the rate of turning of its precession axis.

Preferably means are provided for adjust-

ing the tension of one or both springs 51 or 52. For this purpose at the outer end of the spring 52 is secured a thread 57 which in turn is secured to the rotatable rod 58 mounted in the casing. Said rod has fixed thereto at its forward end a combined thumb piece and indicator 59 readable on scale 60 so that the tension of the spring may be readily adjusted to any desired extent. A second thumb piece and indicator 61 is mounted preferably at the lower part of the casing, being readable upon the scale 62. Said thumb piece is mounted on a shaft 63 to which is secured a rotary valve 64 for closing and opening the outlet passage 65 from the casing. Said outlet passage is preferably connected to a low point on the casing 1, as shown, so that any condensed vapor may be readily withdrawn therefrom. The valve 64 is journaled in the valve fitting 66, said fitting being provided with an extension 67 to which a flexible hose may be secured. It will be understood that in operation, air is exhausted from the casing through the opening 65 and fitting 66 by coupling any suitable type of exhaust pump thereto, such as a Venturi tube mounted on the airplane, as illustrated in the aforesaid copending application of Elmer A. Sperry.

Preferably also the casing is provided in connection with the valve or separate therefrom with a safety or speed limiting device such as valve member 68 consisting of a fitting 69 and a ball or other closure adapted to normally close the aperture 71 thereby preventing the ingress of atmospheric air. Said ball is normally held on its seat by spring 72 but in case the pressure within the casing becomes too low, atmospheric pressure will force the ball off its seat and admit enough air to bring the pressure up to the desired amount for maintaining the proper speed of the gyroscope. By this means the speed is maintained comparatively constant irrespective of the variations in the rate of exhausting due to changes in the speed of the airplane or other cause.

While the principal features of the turn indicator shown in Fig. 5 are the same as already described, a modified form of damping means for the pendulum 32' is illustrated. In this form of the invention the pendulum illustrated is suspended within the closed casing 74 filled with liquid as a damping medium. At the same time the fan for damping the gyroscope, as well as the fan on the pendulum, is also omitted. The damping action of the bearings and the centralizing springs are depended upon in this instance to damp the gyroscope. In addition only one centralizing spring 51' is shown. Also, instead of bringing in the air through the hollow trunnion 3 of the

frame 2, it is in this instance brought through a separate nozzle member 75 in the top of the casing so as to impinge upon buckets 12 at a point approximately in line with the horizontal bearings 3', 4'.

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

1. In a gyroscopic turn indicator, the combination with a gyroscope mounted for precession about an axis, of yielding centralizing means therefor which increasingly opposes precession of the gyro as it becomes further displaced from its normal position, and means for adjusting said yielding means.

2. A flying indicator for aircraft comprising a reference member, a movable normally horizontal member symbolizing the horizon adjacent thereto, a second normally vertical indicator, a pendulous device connected to the first mentioned member and a gyroscope mounted for precession on turning of the aircraft connected with said vertical indicator.

3. In an air driven gyroscope, the combination with the rotor, of a closed casing, a tube communicating with the interior thereof and connected to the same at a low point on the casing to draw air and condensed vapor therefrom, and an intake nozzle adjacent the rotor.

4. In a banking indicator, the combination with a pendulous device, an indicator connected thereto a dial on which said indicator is readable, and a gyroscopic turn indicator readable on the same dial.

5. A gyroscopic turn indicator comprising a gyroscope, means for mounting the same for precession about a normally horizontal axis, said gyroscope being fixed about the vertical axis, yielding centralizing means connected to the gyroscope about said horizontal axis which opposes precession of the gyroscope about said axis with increasing force as said gyroscope becomes displaced from its normal position and means for damping the oscillation of said gyroscope about said axis.

6. A turn indicator comprising a gyroscope, means for mounting the same for precession about an axis at an angle to the vertical, said gyroscope being fixed about the vertical axis, and means comprising a spring under a slight initial stress when the gyroscope is in its normal position for offering very little force to small precessional movements of the gyroscope but for opposing further precession with greater force whereby the extent of precession of the gyroscope furnishes an indication of the rate of turn.

7. In a turn indicator for dirigible vehicles, a gyroscope mounted for precession about an axis at an angle to the vertical in response to turning of the vehicle in azi-

muth, and a plurality of springs connected with said gyroscope in line with each other each of which opposes precession of said gyroscope about said axis in each direction.

8. In a turn indicator for aircraft, a frame, a support, pivots connecting said frame and said support for permitting movement of said frame about an axis at an angle to the vertical, a rotor mounted in said frame for rotation about another axis, a spring connected to said frame adjacent one of said pivots for opposing movement of said frame in either of opposite directions about said axis and means for adjusting the tension of said spring at will.

9. In a flying indicator for aircraft, means including a reference member for indicating when the aircraft turns about an axis, and means including the aforesaid reference member for indicating when the aircraft turns about another axis.

10. In a flying indicator for aircraft, a pendulous device, an indicator connected thereto, a reference member in connection with which said indicator is readable, a second indicator readable in connection with said reference member, a gyroscope mounted for precession upon turning of the aircraft, and connecting means between said gyroscope and said second indicator.

11. In a turn indicator for aircraft, a frame, a support, pivots connecting said frame and said support for permitting movement of said frame about an axis, at an angle to the vertical, a rotor mounted in said frame for rotation about another axis, and a spring connected to said frame adjacent one of said pivots for opposing movement of said frame in either of opposite directions about said axis.

12. In a turn indicator for dirigible vehicles, a casing, a gyroscope mounted for precession within said casing about an axis at an angle to the vertical, a passage for a current of air through one end of said casing, and means for causing said current of air to rotate said gyroscope.

13. In a turn indicator for dirigible vehicles, a gyroscope mounted for precession about an axis at an angle to the vertical, yielding means for opposing said precession, and means comprising a rotatable member for altering at will the resistance offered by said yielding means to said precession.

14. In a turn indicator for aircraft, a casing, a gyroscope mounted in said casing for precession about an axis, a tube connected to said casing to conduct air therefrom, a passage for the entrance of air into said casing, means for directing the air to drive said gyroscope as the air is drawn through the casing, a valve in said tube and means for adjusting said valve at will to vary the speed of rotation of the gyroscope.

15. In a turn indicator for aircraft, a cas-

ing, a gyroscope mounted in said casing for precession about an axis, a tube connected to said casing to conduct air therefrom, a passage for the entrance of air into said casing, means for directing the air to drive said gyroscope as the air is drawn through the casing, a valve in said tube, a stem connected to said valve for adjusting the latter to vary the speed of rotation of the gyroscope, an indicator connected to said stem for movement therewith, and a reference member adjacent said indicator for cooperating therewith to show the extent of adjustment of said valve.

15 16. In a gyroscopic turn indicator for dirigible vehicles, the combination with a gyroscope mounted for precession about an axis at an angle to the vertical, of yielding centralizing means therefor which is very

sensitive when the gyroscope is near its normal position, but which opposes precession about said axis with greater force when the gyroscope is further displaced from its central position and indicating means associated with said gyroscope for showing the rate of turn of the vehicle. 20 25

17. In a turn indicator for dirigible vehicles, a gyroscope mounted for precession about an axis at an angle to the vertical, yielding means for opposing said precession, means comprising a rotatable member for altering at will the resistance offered by said yielding means to said precession, and a rate of turn indicator associated with said gyroscope. 30 35

In testimony whereof I have affixed my signature.

LAWRENCE B. SPERRY.