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Sect.13, Chap.7)

DIRECTIONAL GYRO, TYPE D.L.2

GENERAL AND TECHNICAL INFORMATION

BY COMMAND OF THE DEFENCE COUNCIL

Ministry of Defence

FOR USE IN THE
ROYAL AIR FORCE

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Chapter 1

DESCRIPTION

Introduction

1. The directional gyro, (fig. 1) Type D.L.2, Pt. No. 16620-0 (Ref. No. 6A/2240) and Pt. No. 15206-0 are identical instruments, the latter being the civilian counterpart of the service version. The Type D.L.2 is an air-driven gyroscopic flight instrument which provides a reference in azimuth. Its purpose is similar in function to the magnetic compass, with the advantage that turning and acceleration errors and lag are entirely absent, and the instrument is not affected by magnetic disturbances. It must be noted, however, that the directional gyro has no magnetic directional detector and therefore does not replace the compass, but is used as an associated instrument, in conjunction with the compass.

Fig. 1. Directional gyro, Sperry, Type D.L.2

2. The instrument operates satisfactorily in manoeuvres of up to 55 deg. in bank, climb and dive. Should the aircraft exceed the instrument freedom, the gyro mechanism should be caged by operating the caging knob before the manoeuvre, and then uncaged after returning to level flight.

Principle of operation

3. The directional gyro consists of a gyroscopic rotor spinning on its horizontal axis within an inner gimbal frame. The latter is pivoted horizontally in a vertical gimbal ring which is mounted vertically in the instrument case. A compass card, visible through an aperture in the front of the case, is attached to the vertical gimbal ring.

4. The air-driven rotor is spun at high speed by an air jet which impinges on buckets cut in the periphery of the rotor wheel. To achieve the air jet, an engine-driven vacuum pump exhausts the air from the instrument case, causing air to be drawn into the case via a filter in the rear cover. The air then passes via the lower bearing assembly to a passage in the vertical gimbal ring, which terminates in an air nozzle. The air nozzle discharges into the rotor shroud, which decreases air turbulence and directs the air around the rotor to an exhaust port into the instrument case whence it is drawn off by the vacuum source. The exhaust from the rotor case is directed downwards on to a wedge-shaped plate mounted on the vertical gimbal ring, and provides a means of erecting the gyro.

5. When the exhaust air jet is equally dispersed over the wedge-plate, i.e., the rotor axis is at right-angles to the vertical ring, the reaction forces on the rotor will be equal, and the

rotor will be maintained in that position (fig.2(a)). If the rotor tilts to the left (fig.2 (b)), the air jet A produces an opposite reaction, force B, which produces a torque about the vertical axis of the vertical gimbal ring, greater than the reaction torque on the other side of the wedge plate. The reaction force can be visualized as being the same as a force applied to the rotor at C. Due to gyroscopic rigidity maintaining the plane of spin, the force at C will cause precession 90 deg. in advance of the direction of spin. Thus the rotor will precess about the inner gimbal ring pivots and the rotor axis will turn to regain its original attitude at right-angles to the vertical gimbal ring.

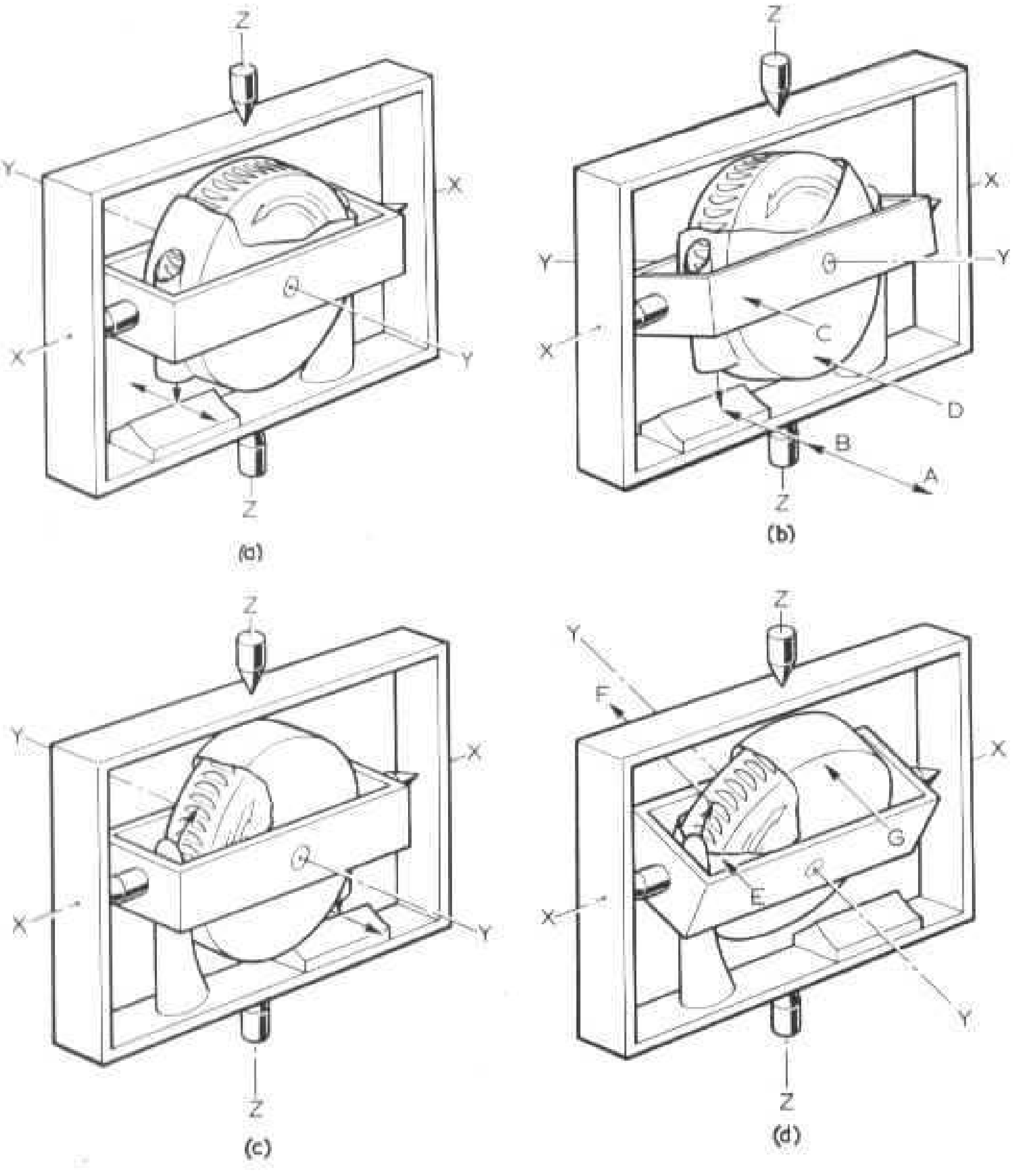

Fig. 2. Erection system

6. If the gyro has tilted excessively so that the air jet is not contacting the wedge plate, a secondary erection torque will be provided by the air jet issuing from the air nozzle on the vertical gimbal ring. With the rotor axis at 90 deg. to the vertical gimbal ring, the air jet is directed onto the centre of the buckets on the periphery of the rotor (fig.2 (c)). However, when excessive tilt takes place, the air jet strikes to one side of the rotor, which produces a force at F (fig.2 (d)). This is in effect, a force at E, which produces precession and turns the rotor towards its original position. The force at E will diminish as the rotor resumes its vertical position, but by this time the exhaust stream will be operating over the wedge plate for final erection.

DESCRIPTION

Rotor Assembly

7. The rotor consists of a dynamically balanced wheel with a heavy rim, fitted on a hollow shaft, which is carried on two ball-bearing assemblies screwed into the inner gimbal ring. Buckets are cut into the periphery of the rotor so that the rotor may be spun at high speed, 12,000 rev/min. approximately, by means of an air jet. Each rotor shaft bearing assembly consists of a housing containing seven ball bearings in a fibre cage. A strut through the rotor shaft engages cone pivots held in the ends of the bearing housings, which are adjusted so that the strut is under compression. This acts as a thrust bearing and also provides temperature compensation for differential expansion of the rotor shaft and bearings. The rotor is enclosed in a thin metal shroud, which forms part of the rotor spinning and erection system.

Gimbal ring assembly

8. The gimbal rings are die castings of approximately rectangular shape. The inner gimbal ring is pivoted horizontally on the fore-and-aft axis within the vertical gimbal ring by means of pivots and ball-bearing assemblies, the end thrust being taken on each side by a ball bearing engaging the end of the respective pivot. Balance screws and weights are attached to the gimbal ring assemblies for static balancing and calibration purposes. A card in the form of a ring graduated from 0 deg. to 360 deg. is attached to the vertical gimbal ring. The card is finished in matt black, with the graduations treated with fluorescent compound.

9. The upper pivot assembly of the vertical gimbal ring is formed by a conical pivot, screwed into the instrument case, engaging a ball race fitted in a recess at the top of the gimbal ring. This top pivot is adjusted to provide correct end-float for the vertical gimbal ring, and the ball race is loaded by a spring washer to compensate for differential expansion across the gimbal ring pivots. The lower pivot assembly on the gimbal ring is provided by a parallel pivot engaging in a ball race carried in the lower bearing housing, which protrudes through the bottom of the instrument case. End thrust of the gimbal assembly is taken on a steel ball in contact with the end of the parallel pivot. This arrangement of a parallel pivot assembly incorporates the connecting ports from the air intake in the lower bearing housing to the air passage in the inner gimbal ring, which terminates in the air nozzle pillar adjacent to the rotor. The path of the air passages is shown in fig.3.

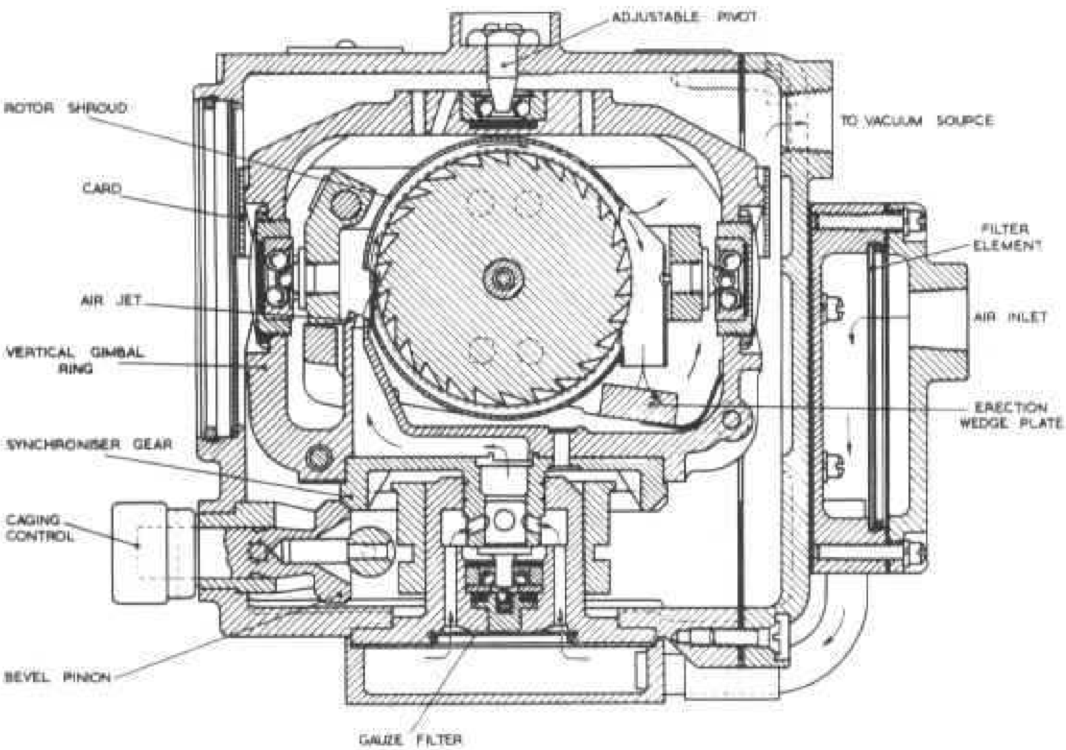

Fig. 3. Sectional view showing direction of airflow

Caging mechanism (fig.4)

10. A caging mechanism is provided in order to lock the rotor assembly with its axis at right-angles to the vertical gimbal ring and also to enable the gyro mechanism and card to be turned manually to a desired setting. Caging and uncaging is provided by a push-pull action of the caging control. Spring-loaded ball plungers are incorporated in the caging bracket secured to the instrument case, to hold the caging control in both the caged and uncaged positions. The control shaft is fitted with a bevelled pinion, the inside of which is cone-shaped to accommodate the face end of the synchronizer lever pivoted on the caging bracket. The synchronizer lever has two arms fitted with pins, in engagement with an annular groove on the synchronizer ring, which is a sliding fit over the lower bearing housing of the vertical gimbal ring. The top face of the synchronizer ring is in contact with a spring-loaded plunger, carried on the centralizing lever, which is pivoted to the side of the vertical gimbal ring immediately below the inner ring carrying the rotor assembly. A large bevelled gear wheel attached to the base of the vertical gimbal ring is part of the card setting mechanism.

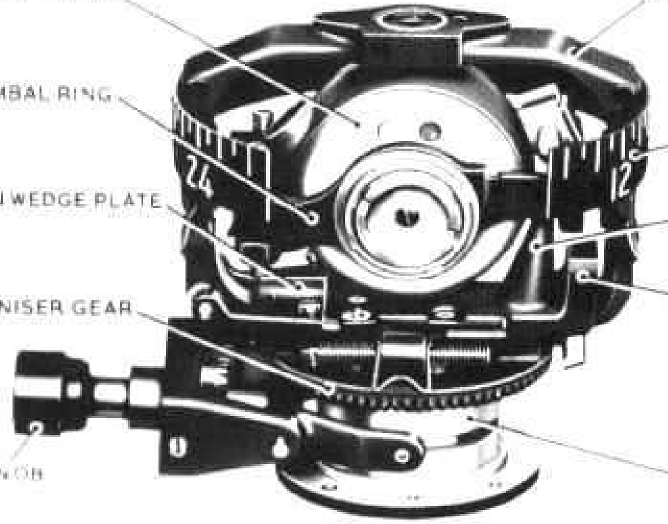

Fig. 4. Mechanism of directional gyro, Type D.I.2

11. When the caging knob is pressed, centralizing action of the cone-shaped interior of the pinion lowers the end of the synchronizer lever, which lifts the fork end and the synchronizer ring. This action lifts the centralizing lever which after a small amount of free travel, contacts the inner gimbal ring and holds it with the rotor axis at right-angles to the vertical gimbal ring. Simultaneously the pinion meshes with the bevel gear on the base of the vertical gimbal ring and hence the card and gimbal assembly can be rotated by turning the caging control. When the caging control is pulled out to the uncaging position, the centralizing lever is lowered clear of the gyro assembly to allow the rotor axis 55 deg. of freedom on each side of the horizontal.

Instrument case

12. The bezel is integral with the case casting and accommodates the dial and bezel glass, which are fitted from the front and secured by a circlip. The compass card is observed through an aperture in the dial which carries the fluorescent lubber line. The instrument is mounted on the flight instrument panel by four corner lugs, which accommodate self-locking anchor nuts. The case is enclosed at the back by the rear cover, which incorporates three threaded bosses to provide alternative connections for the aircraft vacuum supply.

13. The rear cover also carries the air intake assembly, which consists of a filter enclosed in a moulded body, the inlet orifice being threaded for use where an external filter is employed. The air intake filter is of wire gauze and felt, climatically proofed and V.P.I. impregnated. From the filter body, two external pipes connect with the lower bearing housing, where two additional gauze filter screens are accommodated.

Note; "VPI" means a saturated "Vapour Phase Indicator" powder impregnated filter.

Chapter 2

STANDARD SERVICEABILITY TEST

Introduction

1. The tests laid down in this Chapter are to be applied on receipt, when serviceability is suspect, on completion of servicing or repair, and during inspections made at Equipment Depots.

METHOD OF TESTS

2. Unless otherwise stated the instruments are to be tested in the normal position, i.e. with the dial upright and in a vertical plane. Suction at $3\frac{1}{2} \pm \frac{1}{2}$ in Hg, measured adjacent to the outlet connection on the instrument case, is to be applied throughout the tests.

TEST EQUIPMENT

3. The equipment required for the test is a gyro instrument test table, Mk.4 (Ref. No. 6C/790) with air adaptor (Ref. No. 6C/868) or Mk.4A (Ref. No. 6C/1566). These tables are described, together with their method of use, in A.P. 112T-0111-1.

EXERCISING

4. Prior to applying the tests, exercise the instrument by running it for 15 min. under roll, pitch and yaw conditions with reversal at one minute intervals using the automatic reversing switch.

TESTS

5. Before commencing the tests, examine the filter of the instrument for cleanliness and change it if necessary.

Starting test

6. Set the test table level and turn the suction supply ON, slowly increasing to $1\frac{1}{2}$ in Hg. The rotor should commence to run. Increase the suction to $3\frac{1}{2}$ in Hg, and allow ten minutes for the rotor to reach full speed.

Drift test

7. (1) Set the gyro unit at ZERO and uncage.

(2) Set the test table to produce $7\frac{1}{2}$ deg. roll, pitch and yaw conditions. Using the automatic reversing switch, operate for ten min. at minimum speed.

(3) Level the test table and check ZERO heading. Maximum possible drift is 4 deg.

(4) Set the gyro unit to ZERO heading and uncage.

(5) Set the test table to produce $1\frac{1}{2}$ deg. roll, pitch and yaw conditions. Using the automatic reversing switch, operate for ten min.

(6) Level the test table and record the gyro unit reading.

(7) Rotate the test table through 90 deg., reset the gyro unit reading, as necessary to new heading and repeat operations (5) and (6).

(8) Repeat operations (5), (6) and (7) on headings of 150 deg. and 270 deg. Maximum permissible total drift, irrespective of signs is 12 deg.

Note...

It is permissible to have 4 deg. drift on any two headings only.

(9) Level the test table.

Rotation test

8. (1) Set the test table for rotation in azimuth and adjust the motor speed so that the test table completes one revolution in 1 min. 40 s to 2 min.

(2) Note reading of the azimuth pointer on the periphery of the table.

(3) Set the gyro unit to ZERO heading and uncage.

(4) Rotate the test table through 360 deg.

(5) Check the gyro unit against its former heading. Maximum permissible drift is $\pm 1\frac{1}{2}$ deg.

(6) Cage the gyro and turn the suction supply off.

Chapter 3

SERVICING

1. The vacuum supply of the aircraft should be checked to ensure that a vacuum supply of $3\frac{1}{2} \pm \frac{1}{2}$ in mercury is available at the instrument when the engine is running at normal revolutions. If the vacuum supply relief valve has been correctly set and the required vacuum is not obtained, the installation must be checked for leaky connections, kinks in flexible hoses or choked filters.

2. Check the instrument and its installation for security and signs of damage, and ensure that the caging control moves smoothly over its range. Push the caging control to the caged position and then rotate it, checking that the card turns freely and smoothly through the whole 360 deg.

3. The filter element must be changed at periods detailed in the relevant Servicing Schedule.

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