DOCUMENT
**GSM-G-CPL.016**

DOCUMENT TITLE
# FLIGHT INSTRUMENTS

# CHAPTER 15 – THE REMOTE INDICATING COMPASS

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# THE REMOTE INDICATING COMPASS

## INTRODUCTION

The Remote Indicating Compass is an instrument which provides an accurate and stable magnetic heading reference for the pilot. It is a remote instrument because the magnetic sensing element is positioned away from the cockpit and so away from most of the aircraft magnetic fields.

## COMPARISON WITH DG AND DIRECT READING COMPASS

To understand the Remote Indicating Compass it is useful to consider how the DG and Direct Reading Compass are used.



**COMPASS**

- senses the earth's magnetic field
- subject to turning and acceleration errors
- has short-term inaccuracy but long-term accuracy

**PILOT**

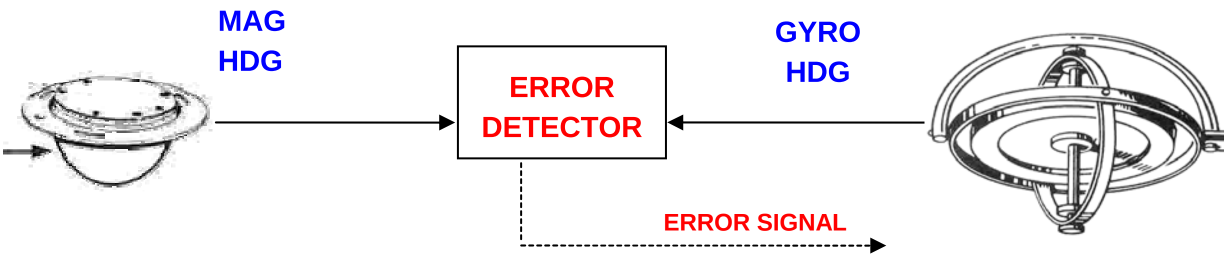
- compares compass and DG headings
- synchronises the DG with the compass periodically.[This follows consideration of whether the aircraft is in straight and level, unaccelerated flight]

**DIRECTIONAL GYRO**

- maintains alignment through gyroscopic property of rigidity.
- subject to real and apparent drift
- has short-term accuracy (largely unaffected by manoeuvres) but long-term inaccuracy.

## FUNCTION OF MAJOR COMPONENTS

By comparison with the previous paragraph, it can be seen that the elements of the Remote Indicating Compass have similar functions.




**DETECTOR**

- senses the earth's magnetic field

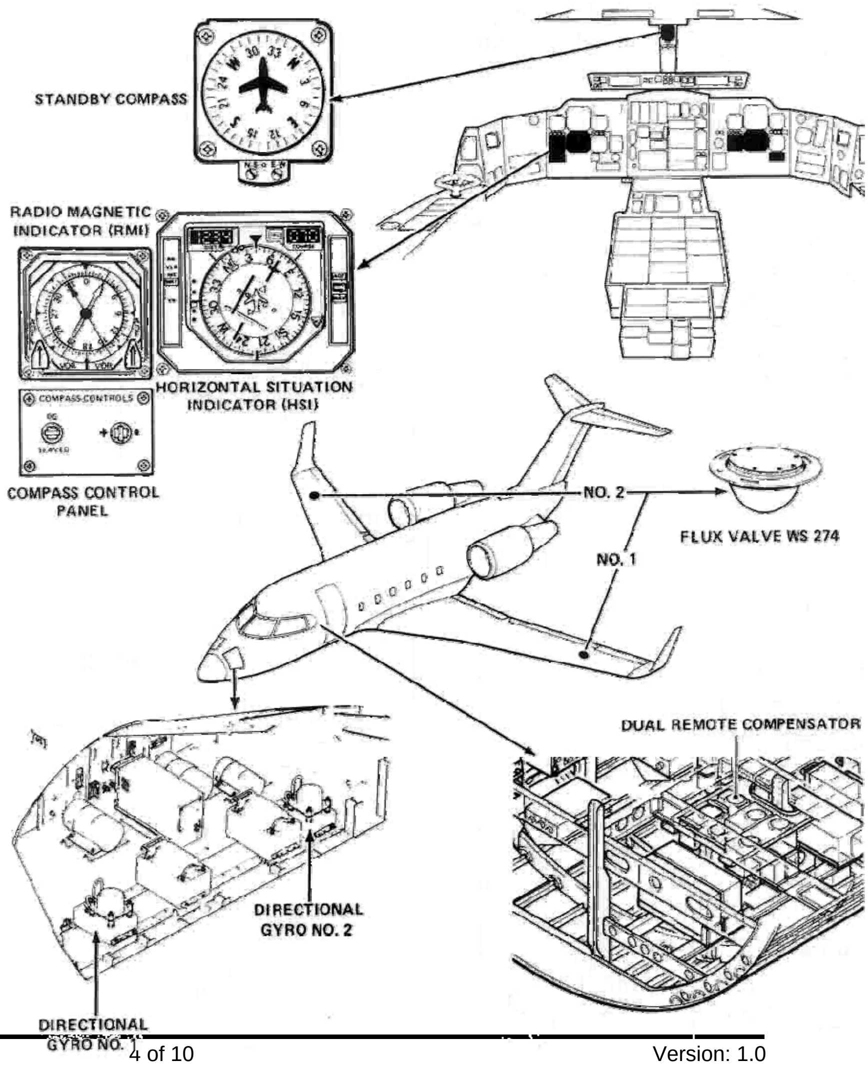
**SLAVING SYSTEM**

- compares detector and gyro unit heading outputs
- detects difference and provides error signal which results in synchronisation
- interrupts synchronisation if the aircraft is banked.

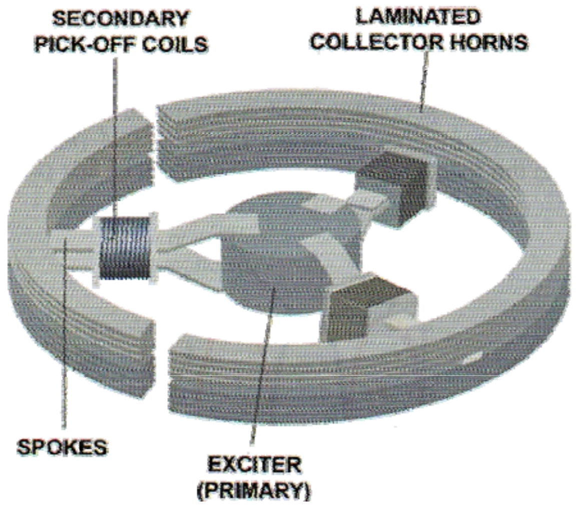
**GYRO UNIT**

- maintains alignment through gyroscopic property of rigidity

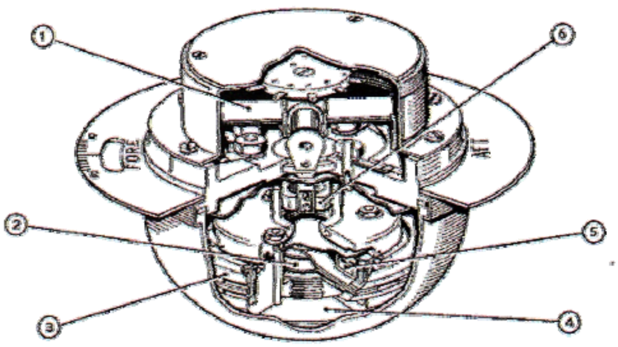
## TYPICAL COMPASS INSTALLATION



## THE DETECTOR UNIT



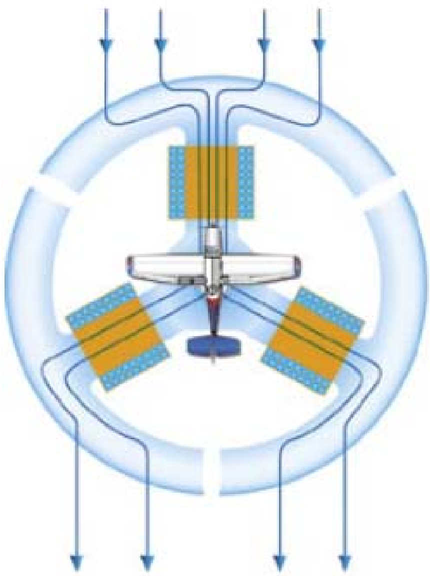

The detector unit, which may be referred to as a flux valve, senses the aircraft's heading relative to the Earth's magnetic field. This is achieved electro-magnetically by means of a very sensitive transformer which is excited by alternating current. The Earth's field influences (adds or subtracts) to the amount of induction which occurs in each leg of a three spoked core. The current flow in each secondary coil has a frequency that is twice that of the exciter current and an amplitude that varies with the alignment of the spoke with the earth's field.



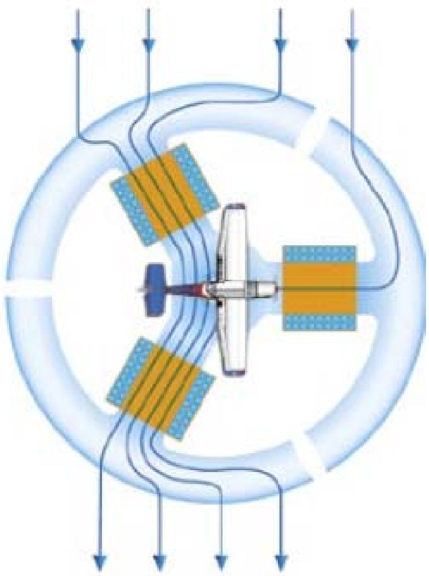

1. ELECTRO-MAGNETIC DEVIATION COMPENSATOR
2. EXCITER COIL
3. FLUX VALVE
4. PENDULOUS WEIGHT
5. PICK-OFF COIL
6. UNIVERSAL JOINT

The spokes and coils of some flux valves are pendulously suspended from a universal joint (a Hooke's joint) which allows freedom of about 25° in pitch and roll. Note that the flux valve does not rotate. The whole unit is sealed and a damping fluid prevents excessive oscillations

The effect of the Earth's magnetic field on the current flow from the pick-off coils depends on the alignment of the spokes.This changes with change of heading,

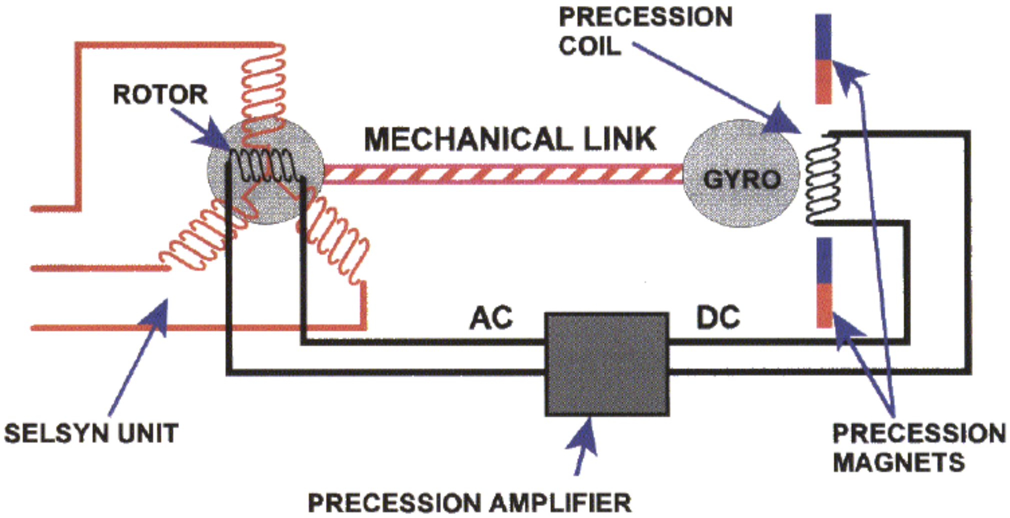


**Here the aircraft is heading North**

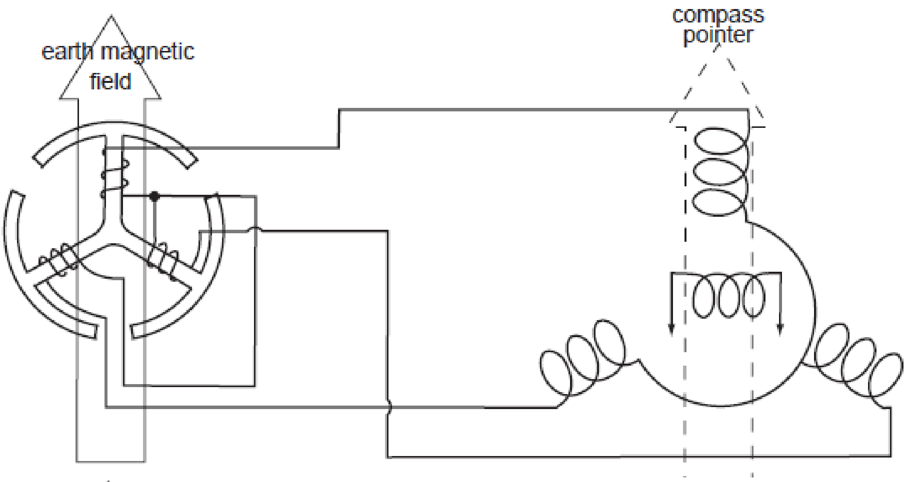


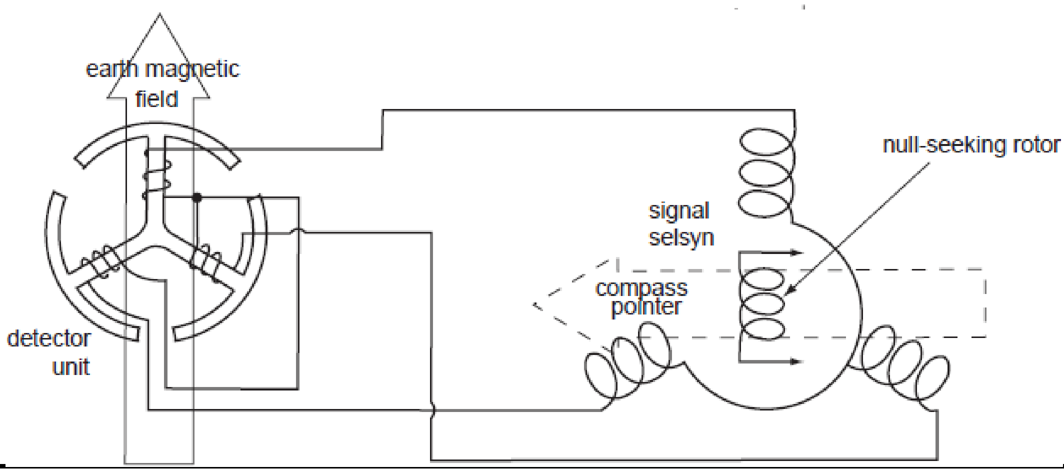
**Here the aircraft is heading West**

## SELFSYNCHRONOUS (SELSYN) TRANSMISSION

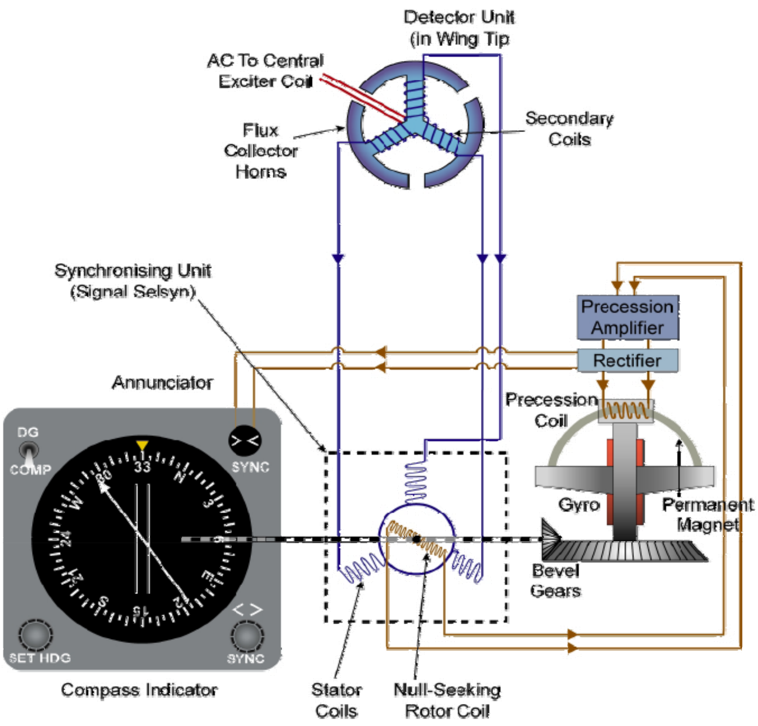



Each secondary coil outputs to its own transmission line. These three lines then connect directly to a similar set of coils (stators) in the error detector. In the error detector the phased signals interact in the coils producing a resultant magnetic field which is representative of the Earth's magnetic field. A receiver rotor which is on the output shaft of the gyro unit, senses the resultant magnetic field and if it is not aligned with the field, an error signal is induced.

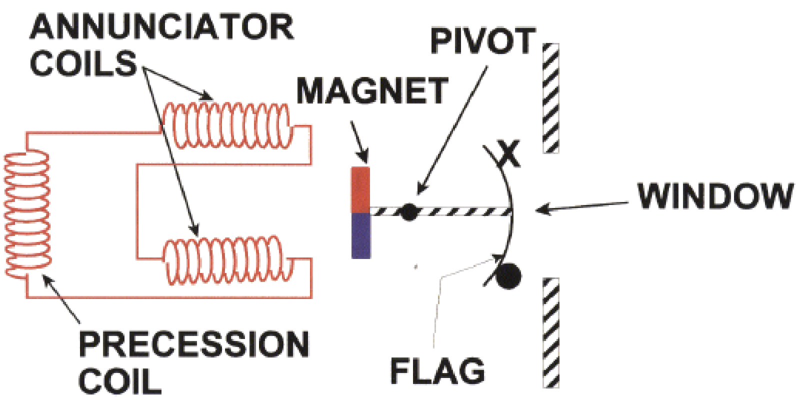


The rotor error signal is fed to an amplifier and from there to a precession device on the gyro which drives the rotor to align with the field created by the current flow through the stators. When aligned, the rotor error signal reduces to zero and precession stops. The rotor is on the output shaft of the gyro and so by moving the rotor to its null (zero) position, the remote indicating compass card is brought into synchronization with the magnetic heading sensed by the flux valve.

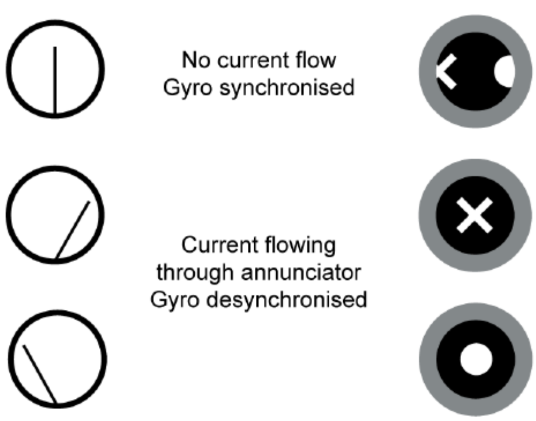



## THE ANNUNCIATOR

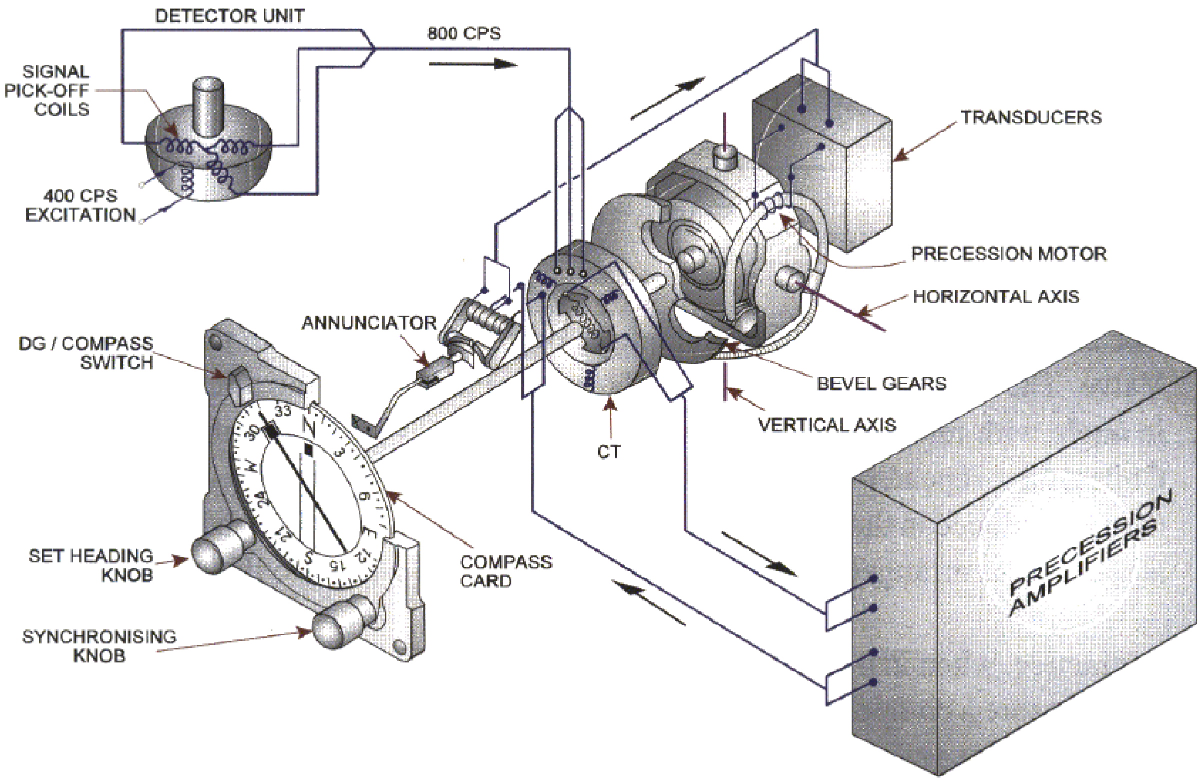



Note that the magnetic alignment of the gyroscope is automatic and an annunciator is provided to show that the slaving process is occurring. As DC current flows to the gyro precession coil, an indicator shows a dot or a cross depending on the direction of the current.

Correct slaving is indicated by oscillating dot and cross. A continuous dot or cross indication means the gyro is precessing in one direction and the rotor has not reached its null.




Instead of a dot/cross annunciator, some modern systems use a small centre reading ammeter in the torque motor circuit. If the torque motor current is zero (centre) the selsyn rotor has reached its null position and the gyro is synchronised with the signal from the flux valve.




## OFF FLAG

If electrical power is lost an 'OFF' flag will appear informing the pilot that the heading information is no longer valid.

## OPERATION IN A TURN

In a turn, the gyro maintains its alignment through rigidity and the case, which is attached to the aircraft, turns around it. A system of gears causes the output shaft to rotate so altering the heading indication. Attached to the output shaft is the rotor and, provided the gyro and detector remain synchronised, the changing direction of the rotor is matched by the changing output of the detector. Note that it is rigidity and not precession that provides the change in the heading indication.

## SLAVING

Once it is initially aligned the detected field and the gyroscope will remain in fairly close alignment. However, some gyroscopic drift will occur and so an error will be induced in the selsyn rotor and the gyro will be slaved back into alignment. The normal slaving rate is approximately 2° per minute. This slow rate is ample for normal operation and reduces the risk of introducing turning error when the aircraft banks.

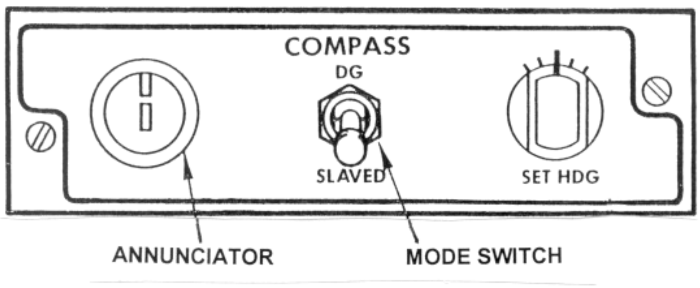
Some systems incorporate a turn cut-out which operates whenever the angle between the gyro gimbals exceeds $10^{O}$. The cut-out interrupts the slaving process so preventing an incorrect input from the Detector Unit (flux valve) from causing turning error.

On starting, or if manoeuvring or turbulence has caused the gyro to topple (gimbal limits ± 85°) a synchronising push switch (fast slaving/fast erection) is provided. This function fast slaves the gyro to its correct alignment and fast erects the gyro to ensure the axis is horizontal. These precession rates are usually about 60° per minute.

**Caution**: Do not operate the fast slaving system continuously for more than 15 seconds. The high current could overheat and damage the gyro unit.

## OPERATING MODES - SLAVED OR FREE

A mode switch is provided. This is normally left in the SLAVED position, which means the system will operate as discussed. A FREE or DG position is also available. This is a reversionary mode where if the transmission system or flux valve was to fail it could be switched out and the gyro used as a directional gyro, pilot aligned about every 15 minutes.

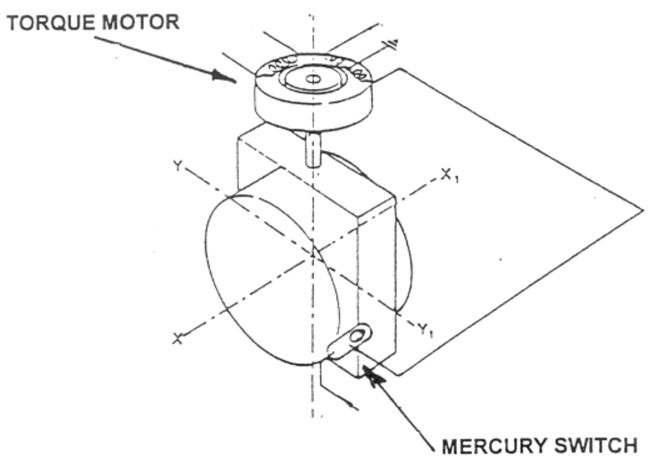



## CALIBRATION

The flux valve is situated in a wing tip or at the rear of the aircraft to remove it from the aircraft magnetic fields. Additionally, compensation circuits are fitted to counteract (minimise) the aircraft magnetism. After a compass swing, which is for compensation and calibration, the remote indicating compass delivers a stable, magnetic heading accurate to airworthiness requirements (deviation not greater than 1° for gyro stabilized compasses).

## LEVELLING

As described, the horizontal gyro is slaved in azimuth. It may however topple (wander in the vertical plane) and so a levelling device is provided to maintain the rotor axis horizontal. A mercury switch and torque motor are used for this purpose.



## ADVANTAGES OF THE REMOTE INDICATING COMPASS

The following are the advantages of the Remote Indication Compass when compared with Direct Reading types:

1. **Reduced Deviation**. The remote location of the detector unit isolates the magnetic sensing element from the effects of the aircraft's magnetic field so allowing deviation to be reduced to no more than $1^{O}$.

2. **Turning and Acceleration Errors.** Gyroscopic rigidity provides the system with a stable reference so that it is largely unaffected by turning and acceleration errors.

3. **Improved Presentation**. The display of heading can be means of a vertical card, or by EFIS, so eliminating the parallax errors associated with Direct Reading types.

4. **Power Output of Heading**. The Remote Indicating Compass provides heading to alternative displays such as the RMI and HSI. It also provides heading to the autopilot and flight director.