

## PART 2

## CHAPTER 13—INSTRUMENT SYSTEMS

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## PART 2

## CHAPTER 13—INSTRUMENT SYSTEMS

## GENERAL

**Flight Instrument Systems**

1. The flight instrument system comprises two completely separate arrays, one for each pilot. Information is displayed on separate course deviation indicators (CDI's), horizon director indicators (HDI's) and radio magnetic indicators (RMI's). Provision is

made for director-information, as selected by the first pilot, to be displayed simultaneously on both HDI's, or in radio modes for the supply of radio information to both sets of instruments from either VOR receiver.

## COMPASS SYSTEM

**General Description**

2. Accurate heading information is provided at all latitudes by twin polar path compass systems combined with an automatic compass variation system and heading change-over switch. Each compass system is electrically and physically separated and individually operated from its own controller. One supplies heading references to the course deviation indicator (CDI) on the 1st pilot's panel and the other to the CDI on the co-pilot's panel

**Twin Polar Path Compass Systems**

3. Magnetic heading is provided by means of a directional gyro, fluxgate transmitter, compass coupler and a controller for each system; a compass comparator and its warning lights are common to both systems.

4. Two modes of operation can be selected by the mode selector switch on each compass controller. In normal latitudes the slaved (SLA) mode is used, the directional gyro being controlled by the magnetic reference signal from the fluxgate transmitter. In high latitudes where the earth's magnetic field is unreliable, the directional gyro (DG) mode is used with the gyro corrected for apparent drift by the latitude corrector.

5. Heading and correction signals are summed in the compass coupler to give the magnetic heading. The heading information is held in the angular position of the compass coupler output shaft which is linked to four transmitting synchros. which feed the information to the course indicators and other equipment requiring heading information.

6. The outputs from the two systems are compared and if the difference exceeds 4 deg. a COMPARTOR COMPASS warning light on each pilot's panel comes on.

7. Compass failure, due to power failure, causes the COMPASS flag to show in the CDI operated by the affected system.

8. *Controls and Indicators — Compass System.* (See Table 1)

**Heading Information**

9. No. 1 compass system supplies heading information to No. 1 CDI at the 1st pilot's station and the compass cards of No. 1 VOR-RMI, No. 2 ADF-RMI and the ADF-RMI at the navigator's station and the No. 1 Nav. receiver.

10. No. 2 compass system supplies heading information to No. 2 CDI at the co-pilot's station and the compass cards of No. 2 VOR-RMI, No. 1 ADF-RMI and the VOR-RMI at the navigator's station and the No. 2 Nav. receiver.

11. a. The auto-pilots are each supplied by the corresponding compass system.  
b. Compass inputs for VOR/ILS operation are fed from the corresponding compass system.

**Directional Gyro Transmitters**

12. The directional gyros, on the radio racks, provide the inertial reference for the compass systems. The spinning axis of each gyro is maintained in the horizontal plane by a gravity-sensing mechanism on the inner gimbal. The gyro rotor is mounted in the inner gimbal which is pivoted within an outer gimbal which is free to turn within the gyro housing.

**Fluxgate Transmitters**

13. The fluxgate transmitters, in the wing tips, provide the magnetic reference for the compass systems.

**Table 1. Controls and Indicators — Compass System**

<i>Item</i>	<i>Location</i>	<i>Marking/Description</i>
Gyro supply switches	(2) Navigator's upper panel	GYRO SUPPLIES — No. 1 COMPASS — ON/OFF GYRO SUPPLIES — No. 2 COMPASS — ON/OFF
ADF radio-magnetic direction indicators (3)	(1) 1st pilot's panel (1) Co-pilot's panel (1) Navigator's panel	ADF ADF ADF
VOR radio-magnetic direction indicators (3)	(1) 1st pilot's panel (1) Co-pilot's panel (1) Navigator's panel	VOR VOR VOR
Course deviation indicators (2)	(1) 1st pilot's panel (1) Co-pilot's panel	CDI CDI
Compass controllers (2)	Navigator's panel	Mode selector switch DG/SLA/SYN. Latitude correction dial RATE COR. Set heading control DEC HDG/SET/INC HDG. Synchroniser indicator - +
Compass comparator warning lights (2)	(1) 1st pilot's panel (1) Co-pilot's panel	COMPARATORS — COMPASS COMPARATORS — COMPASS
◀ Compass power failure warning flags (2)	(1) 1st pilot's CDI (1) Co-pilot's CDI	COMPASS COMPASS ▶

**Compass Couplers**

14. The compass couplers, on the radio racks, compute magnetic heading and feed the information to all equipment requiring it:

*No. 1 Coupler*

- 1st pilot's CDI
- 1st pilot's VOR RMI
- Co-pilot's ADF RMI
- No. 1 Nav. unit
- No. 1 Auto-pilot
- No. 1 Doppler
- Flight director
- Command bars

*No. 2 Coupler*

- Co-pilot's CDI
- Co-pilot's VOR RMI
- 1st pilot's ADF RMI
- No. 2 Nav. unit
- No. 2 Auto-pilot
- No. 2 Doppler
- Navigator's VOR RMI

**Compass Controllers**

15. The two compass systems are independently controlled by separate compass controllers at the navigator's station. The controls on the controllers are:

a. A mode selector DG/SLA/SYN switch. The DG (directional gyro) mode selection is used for operating the system from the gyro without reference to the earth's magnetic field. It is in this mode that corrections can be made for gyro drift. When the SLA (slaved mode) setting is used, the gyro output is automatically corrected by the

direction of the earth's magnetic field. The SYN (synchronising mode) is used to obtain quick alignment of the compass system with the earth's magnetic field. It should normally be used on the ground or in steady unaccelerated flight conditions. The switch automatically returns to the SLA setting when released.

b. A DEC HDG/SET/INC HDG switch, spring-loaded to the central SET setting, which has two levels of spring feel. It should normally be used only in the DG mode for setting the heading indication to the desired datum. The first level of spring feel produces a slow driving rate and the second and higher spring feel gives a maximum driving rate. The system can be driven either to increase or decrease indicated heading.

c. A RATE COR (rate of correction) dial, calibrated in degrees of latitude plus or minus 30 deg., which permits correction for apparent drift due to the earth's rotation at various latitudes.

d. A synchroniser indicator - + which indicates the sense of latitude correction when in the DG mode, and shows when the system is synchronised in the SLA or SYN modes. When in the SLA mode the indicator oscillates slowly. A steady deflection when in the SLA mode indicates lack

of synchronisation. A perfectly steady central indication may be the result of a power failure in the system.

e. An amber warning light which comes on when the SET switch is operated and when the mode selector is set to the SYN position.

16. Compensation for gyro precession is made by offsetting the rate correction dial.

#### Compass Comparator

17. The compass comparator compares the magnetic heading information from the two systems and, if a difference of 4° is exceeded, causes a COMPARATOR-COMPASS warning light on each pilot's panel to come on.

#### Automatic Compass Variation System

18. The automatic compass variation system comprises a compass variation controller (at the navigator's station) and a magnetic variation computer. The system converts magnetic heading to true heading by adding the magnetic variation derived from the computer to the magnetic heading from the compass system. The computer requires inputs of latitude and longitude.

19. Manual setting of variation is possible and failure of the variation computer is indicated by an ACVU WARN light adjacent to the ACVU panel on the navigator's panel coming on. Pulsing of this light indicates correct functioning. An ACVU indicator on the ACVU panel shows OFF when the equipment is switched off, M when being operated manually, and A during automatic operation. Panel lighting can be adjusted by a control on the front panel.

#### Principle of Operation of the Compass Variation System

20. Inputs of latitude and longitude are fed to the magnetic variation computer and used to position a variation cam with respect to a sensing stylus. The stylus moves to and from the surface of the cam continuously so as to eliminate friction errors, the amplitude of the movement being very small. The stylus position relative to the cam datum sets the rotor position of a variation synchro, which supplies the variation to the variation controller.

21. Variation correction is applied either manually or automatically. In manual operation the variation dial on the front of the compass controller is set by the manual variation control and a counter shows the total variation. In automatic operation the variation dial and the counter still operate and fine adjustments are made by the FINE TRIM knob on

the front panel and shown on the variation dial. The variation output is the algebraic sum of the variation displayed on the counter and the fine trim dial.

#### Compass/GPI Selection

22. A separate COMPASS—PORT/STBD switch for each system on the ACVU panel permits selection of either compass system to the GPI or the navigator's compass master indicator (COMPASS MASTER IND) on the right of the variation controller. The magnetic compass information from both compass systems is fed via the heading change-over switch to the CDI on the pilots' panels when this switch is set to MAGNETIC.

#### Heading Changeover Switch

23. The COMPASS CHANGE-OVER—TRUE/MAGNETIC switch on the centre instrument panel permits selection of either true or magnetic heading for the 1st pilot's and co-pilot's course deviation indicators respectively. A magnetic indicator adjacent to each CDI shows MAG or TRUE as appropriate.

## OPERATION

#### General

24. When power is connected to the compass system the directional gyros run up to speed and are erected by a motor erection system.

#### Synchronisation

25. The azimuth position of a directional gyro after erection is random, alignment of the compass system to the magnetic heading is effected by turning the stator of the follow-up synchro by a correction servomotor. This correction servomotor is controlled by the fluxgate signals and aligns the system at 1.3° per minute. To speed up the alignment the correction drive ratio is changed when the mode selector is set to SYN. During fast alignment the amber compass warning light comes on to show that the compass readings are inaccurate. The servo loop is finally stabilised by rate feedback.

#### Slaved Mode

26. When the directional gyro follow-up synchro is aligned with the magnetic heading any change of heading or change in the azimuth relationship between the spinning axis of the gyro and the gyro housing will cause a change in the indicated heading. A directional gyro, however, precesses due to variations in operating latitude, manufacturing tolerances, etc, hence fixed and latitude corrections are applied by the compass coupler to counteract this effect.

### Directional Gyro Mode

27. In areas where the magnetic field is unreliable, the fluxgate transmitters are disconnected and the compass uses the directional gyro inertia as its reference. Due to the rotation of the earth at 15° per hour, directional gyros exhibit an apparent drift, the amount of which depends on latitude, being zero at the equator and maximum at the poles, consequently the follow-up synchros must be constantly corrected to prevent a slow change of heading. The correction for this apparent drift is introduced as a sine voltage corresponding to the latitude by the RATE COR dial on the compass controller. This sine voltage is fed to the correction servo-amplifier which rotates the follow-up synchro to cancel the drift.

### Set Heading Control

28. Any desired heading can be set on the course deviation indicators and RMI by turning the SET control to INC or DEC as required. The first tension produces a compass card rotation of 2° per second and the second tension a speed of 12° per second. This control overrides all sources of correction which, however, still act on the system. The control is mainly used in the DG mode for setting the initial heading. When the knob is turned off centre, the amber synchroniser light is on.

## ATTITUDE AND FLIGHT DIRECTOR INSTALLATION

### General Description

29. The installation consists of two identical systems fed from separate gyros and a common flight director system. Each system displays a composite pictorial representation of the aircraft heading and course deviation on a course deviation indicator (CDI) and of aircraft pitch and roll attitude on a horizon director indicator (HDI). Steering commands are computed from the navigational information supplied to the No 1 flight system and presented on both HDI split command bars. The mode of operation of the flight steering computer is controlled by a five-position switch on the left of the centre instrument panel.

30. Normally the two systems operate from separate navigational references, but the LOC/VOR CHANGE-OVER switches on the sill panels at each pilot's station enable either CDI to be operated from the other system. In the case of the left-hand system the flight steering computer reference is also changed over.

31. A comparator compares the information from the two systems; any difference causes the COMPARATOR-HORIZON warning lights on each pilot's panel to come on.

32. Two vertical gyros are fitted and a VERTICAL GYRO CHANGEOVER switch on the left outer sill panel enables either HDI to be controlled from either gyro. <sup>AL16</sup>

32A. ~~Paragraph 307.~~ A NORMAL/VG TEST switch, adjacent to the VERTICAL GYRO CHANGEOVER switch, provides a means of checking the availability of the alternative supply to the No 1 HDI. Setting the switch to VG TEST when the VERTICAL GYRO CHANGEOVER switch is set to BOTH ON No 2 VG introduces a bias voltage (from a transformer on panel RR) to the No 2 system, causing a pitch and roll displacement indication of both HDI. When the switch is returned to NORMAL both HDI should revert to normal operation. The test can be made on the ground or in flight.

33. *Controls and Indicators — Attitude and Flight Directors.* (See Table 2).

### Vertical Gyros

34. The vertical gyros are the inertial reference for the flight control and flight director systems and provide pitch and roll information for their associated HDI. A gyro unit consists of an electrically-driven gyro which is erected by a gravity-sensitive erection system, which initially erects the gyro and then maintains it in the vertical plane as the aircraft moves over the surface of the earth. The erection system consists of two electrolytic switches, one for roll and one for pitch, which operate two torque motors which erect the gyro.

35. The flight steering computer uses No 1 gyro only and failure of the gyro results in the complete loss of steering commands. Selected heading information and VOR radial information to control the autopilots is taken from the corresponding CDI. When the No 1 CDI is operating from the No 2 VOR/ILS system the required VOR radial must be set on both CDI to enable a signal of the correct sense to be fed to the flight steering computer. Failure of the heading or VOR/ILS signals causes warning flags to show on both CDI. Loss of attitude or flight steering commands causes warning flags to show on both HDI.

36. Power supplies for the vertical gyros are controlled by two ON/OFF switches at the navigator's station. A vertical gyro changeover switch at the 1st pilot's station permits either vertical gyro to supply either HDI.

### Course Deviation Indicators (CDI)

37. Each CDI displays aircraft heading on an azimuth ring surrounding a fixed aircraft symbol, VOR and localiser information by the position of a course bar, and glideslope deviation by the vertical

**Table 2 — Controls and Indicators — Attitude and Flight Directors**

<i>Item</i>	<i>Location</i>	<i>Marking/Description</i>
Course deviation indicators (two)	(1) 1st pilot's panel (1) Co-pilot's panel	See text See text
Horizon director indicators (two)	(1) 1st pilot's panel (1) Co-pilot's panel	See text See text
Mode selector	Centre instrument panel	MODE SELECTOR — BACK BEAM/ OFF/HDG/VOR LOC/GS
LOC/VOR changeover switches (two)	(1) Left outer sill panel  (1) Right inner sill panel	LOC/VOR CHANGE-OVER — NORMAL No 1/ALTERNATE No 2  LOC/VOR CHANGE-OVER — NORMAL No 2/ALTERNATE No 1
Vertical gyro power switches (two)	(1) Navigator's panel  (1) Navigator's panel	GYRO SUPPLIES No 1 VERTICAL and COMP MON-ON/OFF  GYRO SUPPLIES No 2 VERTICAL and COMP MON-ON/OFF
Vertical gyro changeover switch	Left outer sill panel	VERTICAL GYRO CHANGE-OVER— BOTH ON No 1 VG/NORMAL/BOTH ON No 2 VG
◀ Vertical gyro test switch <del>(two)</del> <del>mod 9077</del> AL 16	Left outer sill panel	NORMAL/VG TEST ▶
Horizon comparator warning lights (two)	(1) 1st pilot's panel (1) Co-pilot's panel	COMPARATOR — HORIZON COMPARATOR — HORIZON
Compass comparator warning lights (two)	(1) 1st pilot's panel (1) Co-pilot's panel	COMPARATOR — COMPASS COMPARATOR — COMPASS

movement of a horizontal bar. The azimuth ring is graduated in 5 deg intervals; a fixed lubber line on the longitudinal axis of the fixed aircraft symbol is used as reference. Both CDI are fed with heading information from the corresponding compass system through closed servo loops. COMPASS warning flags show in both CDI when the corresponding system or its power supply fails. The selected heading knob (HDG) controls the position of a triangular index relative to the azimuth ring; after being set the index rotates with the azimuth ring.

38. The course deviation bar is controlled by the heading drive servo system and is positioned by the COURSE knob at the lower left of the indicator. An index is set against the azimuth ring and the selected course is also set on a digital counter in the instru-

ment face. After the required course has been set the course deviation bar and the course index move round with the azimuth ring.

39. The deviation bar is also controlled by displacement signals from the VOR/ILS unit. The bearing of the selected course relative to the aircraft is indicated by the angle between the longitudinal axis of the fixed aircraft symbol and the course deviation bar. The position of the aircraft to the left or right of the course is shown by the course deviation bar being to the right or left of the fixed aircraft symbol.

40. Radio input signals to both CDI are normally from their own VOR and G/S receivers and both CDI can be supplied from either pair of receivers by operation of the LOC/VOR changeover switches on the pilots' sill panels. Each CDI can also provide

preset heading and preset course signals for its associated autopilot and in addition, the 1st pilot's CDI provides preset heading and preset course signals for the flight steering computer.

41. During VOR operation the CDI course deviation bar is centred, the reciprocal ambiguity existing on a VOR radial is resolved by a to-from arrow which points towards the bearing of the VOR station. When a VOR or localiser signal is inadequate or if a fault develops in the VOR/ILS receiver or power supply fails, an L-C warning flag appears in the CDI. The flag disappears when the signal from the radio beacon is sufficiently powerful to give correct operation of the indicator.

42. Glideslope vertical displacement is shown by a horizontal bar moving over a five dot scale. Alignment of the aircraft with the glideslope is shown by the alignment of the bar with a horizontal broken line and circle reference. The glideslope bar is actuated by the glideslope receiver. Failure of power supplies, or unsatisfactory signals causes a GS warning flag to appear in the CDI.

43. If the compass card fails, the VOR track or localiser QDM should be set on the course counter and the COURSE knob pulled out and rotated until the course cursor is at the 12 o'clock position. By this action the compass card is immobilised and the beam bar is positioned vertically to enable the CDI to be used as an ILS or VOR indicator allowing continued use of radio information in the conventional manner. A large red flag pivoted at the 7 o'clock position is visible whenever the COURSE knob is pulled out.

#### **Horizon Director Indicators (HDI)**

44. Each HDI displays aircraft attitude in pitch and roll by the angular and positional relationship between a horizon spheroid and a fixed aircraft symbol. The fixed aircraft symbol consists of three elements, a left wing, a right wing and a vertical fin symbol, which are coloured green to provide maximum contrast and readability.

45. The horizon spheroid rotates on two axes corresponding to pitch and roll and displays information supplied by the vertical gyro. The upper half of the spheroid is coloured light blue with short white climb graduations every 5 deg and full sphere graduations at 30 and 60 deg. The lower half of the spheroid is black with white dive graduations and perspective lines to provide a more natural attitude display. The perspective lines extended would converge on the 5 deg pitch-up position but they terminate at the horizon line. The angular position of the spheroid is unlimited in roll and limited to +88 deg about the pitch axis.

46. Roll attitude is shown by a triangular pointer moving against a fixed scale at the bottom of the display. The first three graduated divisions are 10 deg intervals followed by two divisions at 30 deg intervals, either side of zero bank.

47. The pitch and roll commands are displayed on a split command bar which is coloured yellow and is read relative to the fixed aircraft symbol. The command bar is controlled by the flight steering computer via the flight instrument amplifier. The command symbol is biased out of view when the mode selector is switched off. The close proximity of the command bars, spheroid and the fixed aircraft symbol reduce parallax errors to an absolute minimum. Lighting should be turned up fully in extremely bright conditions, in order to reduce further parallax errors.

48. Provision is made on the instrument, above the display, to annunciate the LOC, BACK BEAM, and GS operating modes; these annunciators are not used in this aircraft.

49. Failure of the controlling vertical gyro is indicated by the appearance of a GYRO warning flag in the HDI. When the HDI is operating from the alternative gyro the flag monitors the alternative gyro and the coupling between both HDI.

50. A CMPTR flag appears in both HDI if a fault develops in the steering computer or in No 1 vertical gyro. A fault affecting one HDI only, causes the CMPTR flag to appear in the affected HDI only. When the mode selector is set to OFF the CMPTR flag appears in both HDI.

#### **Flight Instrument Amplifiers**

51. These units, in the radio racks, amplify the signals from the compass coupler, vertical gyro and steering computer to a level suitable to operate both the CDI and HDI at each pilot's station.

#### **Mode Selector**

52. A five-position MODE SELECTOR — BACK BEAM/OFF/HDG/VOR LOC/GS switch mounted on the centre instrument panel controls the mode of operation of the flight steering computer.

#### **Flight Steering Computer**

53. This unit, in the left radio rack, converts course and heading error information into pitch and roll commands for display on both HDI.

#### **Comparators**

54. Compass and horizon comparators compare the information supplied to the two sets of instruments; any significant difference causes the COMPASS or

HORIZON COMPARATOR warning lights on both instrument panels to come on.

### Power Supplies

55. The flight steering computer is supplied with 115 volt AC at 400 Hz, from No 1 normal radio supplies.

56. The No 1 flight instrument amplifier is supplied with three 115 volt AC 400 Hz supplies, two from No 1 normal radio supplies and the third from No 1 emergency radio supplies, to enable the No 1 CDI azimuth ring to operate under emergency power conditions.

57. The No 2 flight instrument amplifier is supplied with three 115-volt AC at 400 Hz supplies, two from No 2 normal radio supplies and the third from No 1 normal radio supplies via an isolating transformer, to enable both HDI to be powered by the same supply but retaining separate earthing and servo loops.

58. All flight director supplies are from phase A busbars.

59. The horizon and compass warning lights and flags are operated from the 28-volt DC aircraft supplies.

## OPERATION

### General

60. During normal operation the gyros supply pitch and roll information to the associated flight system. If one gyro fails, the affected HDI may be controlled from the other HDI by operating the gyro changeover switch. Isolating properties of the synchros prevent a fault condition being transferred to the serviceable system. During changeover conditions the attitude comparison circuit is isolated and the GYRO flag on the slaved HDI is coupled to the operating gyro system.

61. Separate power supply switching is not provided for the flight director and flight instrument amplifiers. Compass and attitude information are displayed when the No 1 and No 2 VERTICAL and COMP MON isolation switches at the navigator's station are set ON. The flight director does not operate until the No 1 vertical gyro is fully erected and the mode selector turned from the OFF position.

62. During emergency power conditions, compass

information is displayed on No 1 CDI, which operates normally; attitude and flight steering information are absent from both HDI; No 2 CDI operates normally, attitude and flight steering information are absent from both HDI; No 2 CDI operates as a conventional ILS indicator if the COURSE control is pulled out, the course deviation pointer aligned with the centre-line of the aircraft symbol and the right-hand VOR/LOC switch is set to ALTERNATE.

63. With the mode selector set to OFF, the flight steering computer is inoperative, the command bars of both HDI are withdrawn from view and the CMPTR warning flag is displayed in both HDI.

### Heading Mode (HDG)

64. With the mode selector set to HDG, turning the heading knob on a CDI sets the position of the triangular index on the azimuth ring and the rotor of the heading synchro transformer. The stator of the transformer is fed with heading information from the compass coupler, hence the rotor output is proportional to the difference between the actual heading and the selected heading. This error signal is fed to the respective autopilot and from the No 1 CDI to the flight steering computer. The flight steering computer then computes the course to capture the selected heading and to maintain it.

### VOR/LOC Mode

65. In VOR operation the navigational receiver is tuned to the VOR station and the required radial bearing is set on the course arrow of the CDI. Two 30 Hz signals are detected by the navigational receiver, the relative phase between them being a function of the bearing of the VOR station. The relative angle is resolved and fed to the flight steering computer, which computes the required course to capture and track the radial, and presents this information on both HDI.

### Back Beam Mode

66. When the aircraft is flying on the reciprocal of the localiser beam, the fly-left and fly-right commands are reversed, hence the deviations signals are reversed in the equipment before display. The CDI and autopilots are not affected by the reversal.

### Glide Slope Mode

67. The glideslope receiver is tuned and brought into operation by the selection of the localiser

frequency on the VHF nav receiver. When signals of a suitable level are received the CDI GS warning flag disappears.

68. The glideslope is modulated by 90 Hz above and 150 Hz below the beam centre line and these signals are used to control the CDI horizontal glideslope bar which moves above or below the horizontal fixed reference to denote that the aircraft position is above or below the beam centre. As the aircraft flies along the localiser beam the horizontal bar, which is normally just visible below the CDI azimuth ring, moves towards the fixed reference.

## AIR DATA INSTRUMENTATION

### Pitot and Static System

69. The pitot and static points on the outer skin of the aircraft are connected to the air data instruments and sensors by pitot and static lines. The pressure in the pitot system is the ram air pressure due to the aircraft's movement through the air; the static pressure is that of the local atmosphere.

70. The measurement of pitot and static pressures and their comparison provides information on altitude, airspeed and other data essential to aircraft management.

◀ 70A. A supply socket (115 volt, 400 Hz 3-phase and 115 volt, 400 Hz single-phase) for the Mk 3 pitot-static test set is on panel RL junction box. ▶

### Pitot System

71. The flow of air past the aircraft is sampled by four pressure heads; the two forward heads each incorporate two static vents and are situated at station 78. The other two pressure heads each incorporate two pitot probes and are situated at station 370.

### Static System

72. Static vents on either side of the aircraft sample the local atmospheric pressure; the vents are connected in pairs one on either side of the aircraft, so that the effects of sideslip cancel out. The two forward vents on either side are fitted in the forward pressure heads, the foremost vent on each side being linked with the rearmost vent on the other side to cancel any inequality due to their relative positions on the heads. All vents are labelled for identification purposes.

### Pitot-Static Changeover Valves

73. The lines from the two forward pressure heads are fitted with changeover valves so that if one fails the other can be connected to supply both sets of instruments. The changeover valves are controlled from two guarded PITOT AND STATIC SELEC-

TOR VALVES switches on a panel on the flight deck walls outboard of each pilot. The STATIC selector switches on both panels are marked NORMAL/ALTERNATIVE SOURCE. The 1st pilot's PITOT selector switch is marked LEFT-HAND/RIGHT-HAND; the co-pilot's PITOT selector switch markings are reversed, ie RIGHT-HAND/LEFT-HAND. Operation of a selector switch opens one inlet and closes off the other, thereby connecting the outlet to the alternative supply source.

### Pitot and Static Distribution

74. P1 and S3 feed the 1st pilot's air data instruments normally and P2 and S1 alternatively.

75. P2 and S6 feed the co-pilot's, engineer's and navigator's air data instruments normally, and P1 and S2 alternatively.

76. *The remainder of the Pitot/Static distribution is shown in Table 3, which also shows the alternatives where these exist.*

### Water Drains

76A. Water drains are fitted at low points in the pitot and static pipe lines. Each drain consists of a transparent water trap with a spring-loaded valve fitted at the base. An internal float indicates the water content. Upward pressure on the valve button at the base opens the valve and releases the accumulated water. A valve should not be operated unless the float indicates water content.

## OTHER FLIGHT INSTRUMENTS

### Precision Altimeter System — Pilots

77. The precision altimeter system calculates and displays true height in the range from minus 2000 to plus 50,000 feet. It also calculates true air temperature correction and provides the DC supply for the true outside air temperature gauge. The mechanism includes an encoder, which provides an automatic coded height reporting output to the IFF/SSR transponder.

78. Two identical systems are fitted, each consisting of a height display unit (precision altimeter) and a transducer unit connected to the pitot-static system. The precision altimeters are mounted one on each of the two pilots' instrument panels and the transducers are in the radio racks.

### 79. Height Display Unit

a. Height in the range minus 2000 to plus 50,000 feet is shown on a four-digit counter in steps of 50 feet, the final 0 being fixed. A height of minus 1000 feet is displayed on the counter as 99,000 feet. A pointer moving round a fixed circular scale graduated from 0 to 9 gives a fine height indication, one revolution equalling 1000 feet.

**Table 3. Pitot and Static Distribution (other than main flight instruments)**

	<i>Location</i>	<i>Pitot</i>	<i>Static</i>
Anti high-speed roll switch ... ..	Left	P3	S10
Artificial feel units, R, A and E ... ..	Left	P3	S10
Artificial feel units, R, A and E ... ..	Right	P6	S11
Auto-pilot air data sensor 1 ... ..	Left	P4	S4
Auto-pilot air data sensor 2 ... ..	Right	P5	S8
Auto-pilot comparison air data sensor ... ..	Left	P3	S5
Auto-pilot comparison air data sensor ... ..	Right	P6	S7
Cabin differential pressure gauge ... ..	Engineer's station	—	S6/S2
Cabin pressure controller ... ..	Right	—	S15
Duct differential pressure switch ... ..	Right	—	S14
Duct differential pressure switch ... ..	Left	—	S13
Duct relief valve ... ..	Right	—	S13
Duct relief valve ... ..	Left	—	S14
Flight data recorder transducers ... ..	Right	P2/P1	S6/S2
Overspeed switch (Mach/airspeed warning) ... ..	Left	P3	S10
Overspeed switch (Mach/airspeed warning) ... ..	Right	P6	S11
Precision altimeter pressure transducer unit ... ..	Left	P1/P2	S3/S1
Precision altimeter pressure transducer unit ... ..	Right	P2/P1	S6/S2
Pressure switch U/C warning horn ... ..	Left	P3	S10
Recirc. fans altitude switch ... ..	Left	—	S10
Safety valve ... ..	Front	—	S9
Safety valve ... ..	Rear	—	S12
Speed brake limiter ... ..	Left	P3	10
Stall identification switch (auto-ignition) ... ..	Left	P3	S10
Stall identification switch (auto-ignition) ... ..	Right	P6	S11
Standby altimeter ... ..	Centre panel	—	S11
True airspeed unit ... ..	Right	P2/P1	S6/S2

b. A knob at the lower right corner of the instrument provides adjustment for barometric pressure. This pressure is set on two four-digit counters, one graduated in millibars and the other in inches of mercury.

c. At the top of the indicator is a three-digit counter and two fixed 0's which can be adjusted to give indications from 0 to 99,000 in steps of 100 by the knob in the upper right corner of the instrument as a memory aid.

d. A TEST button on the left side of the dial enables the system electrics to be checked. Pressing the button operates a check circuit which drives the meter to read 10,500 ft. ± 500 ft. No test is however made of the pitot/static system by this means. The button must not be used in flight, as it is possible to cause desynchronisation of the indicator from the transducer unit, producing altimeter errors in multiples of 12,500 feet.

e. A warning system causes an illuminated amber striped screen to be uncovered if any phase of the three-phase supply fails. A CANCEL WNG LT

button on the right of the dial is provided to put out the light; the striped screen remains exposed.

f. The encoder is driven by the mechanical input to the control transformer and its position is therefore related to the height display. The encoder provides a digital height output signal to indicate (in 100 ft. steps) altitude from 0 to 50,000 ft. Failure of the display unit power supply operates a switch to energise the encoder power failure relay and isolate the encoder, thus preventing false height output from the encoder during a display unit power failure.

80. *Transducer Unit*

a. The transducer receives static and pitot pressures and supplies true altitude, air temperature correction and power supply to a precision air temperature gauge. The unit consists of a static pressure transducer, an airspeed mechanism, mach-meter mechanism and the synchro and mechanical drives required to compute by analogue the true outside air temperature correction and altitude data outputs.

b. The three basic mechanisms which control this equipment are a static pressure transducer, an airspeed mechanism and a machmeter; the first provides a shaft position output to drive the first differential, and the other two give three-wire synchro outputs to drive synchros which form part of an electro-mechanical servo-loop.

c. The second input to the first differential is the follower displacement from a pressure error correction cam driven by the airspeed synchro. The output of this differential is the static pressure + airspeed correction and this provides the first input to the second differential and drives the pressure/height difference cam.

d. The mach number synchro drives two cams the follower of the first providing correction for the true air temperature, and controlling the angular position of a potentiometer. The second provides pressure error correction; this is the second input to the second differential.

e. The output of the second differential is static pressure + airspeed and mach correction. This positions the stator of the output synchro, the rotor of which is controlled by the follower of the pressure/height differential cam, hence the static pressure is corrected for airspeed, mach number and pressure/height differential. The three-wire synchro output is an electrical analogue of this, which drives the precision altimeter via a servo loop.

f. The power failure motor is fed from 26-volt 400 HZ quadrature voltage from phase C and the star neutral of the three-phase supply, together with the A and B phases. It drives a shutter which covers an amber cross-hatched warning screen. Should any phase of the power supply fail, the motor ceases to operate and the shutter is pulled by a spring to uncover the screen. When the shutter is released the warning screen is lit from the rear. Pressing the CANCEL WNG LT button puts out the light but leaves the screen exposed.

#### Altimeters — Navigator's and Engineer's

81. The navigator's and engineer's altimeters operate in the range -1,000 to 50,000 ft., the reference ground level pressure setting being adjustable by a knob on the front of the instrument and shown in millibars on a four-digit counter in the face of the instrument.

82. The indication is shown on a dial graduated from 0 to 9 and three pointers turn in front of the same scale. The 100 ft. pointer is straight and almost the radius of the scale. The 1,000 ft. pointer is diamond shaped and shorter than the 100 ft. pointer. The 10,000 ft. pointer is equal to the full radius of the scale and has an enlarged white tip; a white

trace follows the movement of this pointer.

83. A striped low-altitude warning flag starts to show on descent at 16,000 ft. and increases in size until at zero feet it fills its aperture.

#### Airspeed Indicators

84. The airspeed indicators operate over the range 60 to 430 knots. The instruments operate from pitot and static pressures. Each indicator contains a sensitive capsule which responds to the pitot/static differential. Variation in the shape of the capsule is magnified by the mechanism and used to operate the split-pointer presentation.

85. Indication is given on two scales, the outer graduated from 6 to 20 knots and the inner from 20 to 43, the scales requiring multiplication by 10. Two pointers indicate; on the outer scale from 60 to 200 knots when the longer pointer is obscured, and the short one indicates from 200 to 430 knots on the inner scale.

85A. a. An adjustable 'bug', in the shape of a white triangle, is fitted to the indicator dial; it may be set by rotating the knob at the bottom left of the instrument. It should be set to indicate the  $V_2$  speed prior to take-off, the buffet boundary speed during cruise and the threshold speed prior to landing.

b. A fixed index at 229 knots indicates the take-off flap (20°) limiting speed.

c. A yellow/black striped  $V_{MO}$  pointer indicates the maximum safe speed for the altitude at which the aircraft is flying.

#### Machmeter

86. The machmeter indicates mach number from mach 0.5 to 1.0 up to an altitude of 50,000 ft. The linear scale is graduated in steps of 0.01 mach. An adjustable reference marker is fitted, which can be moved round the scale by rotating a knob on the front of the instrument. The instrument is connected to both pitot and static lines.

#### True Airspeed Unit (TAS)

##### 87. General

a. The true airspeed unit computes an accurate indication of the aircraft's true airspeed, air miles flown and pressure controlled mach number. In this installation only the true airspeed is used. The unit provides optimum accuracy by compensating the mechanism for pitot-static probe pressure errors and for airstream temperature.

b. The installation consists of two units connected to the pitot-static system and a temperature probe.

88. *True Airspeed Unit.* The true airspeed unit is

in the right radio rack and supplies true airspeed to the GPI which displays the information on the TAS indicator. The unit consists of a transducer assembly consisting of a static transducer, a pitot-static transducer, a log, gearbox, amplifiers and a power unit mounted in a common case.

89. *Control Panel.* The control panel is at the navigator's station and carries the following controls: MAIN — ON/OFF switch. A TAMI — ON/OFF switch. A GROUND TEST button and three fuse holders.

90. *Power Supplies.*

3-phase AC from No 2 Normal radio supplies.  
28-volt DC Normal from No 2 Normal radio supplies.

91. *Ground Testing.* Pressing the GROUND TEST button on the control panel applies artificial input signals in place of the transducer inputs. With a probe temperature of 0°C the TAS meter drives to 400 knots  $\pm$  8 knots. Due to difference in temperature this reading will vary and the following table lists the possible variations with a plain PEC cam fitted:

Probe temp °C	TAS knots
Minus 30	377
Minus 20	385
Minus 10	392
0	400
Plus 10	407
Plus 20	414
Plus 30	421
Plus 40	428
Plus 50	435

### E2B Compass

92. An E2B compass with integral lighting is fitted at the lower left corner of the forward roof panel. The light is controlled by a COMPASS LIGHT — ON switch on the right of the roof panel. The switch also controls the integral lighting of the IFF/SSR control unit. The supply is from the No 2 28-volt DC Essential Busbar.

### Turn-and-Slip Indicators

93. Each instrument, one on each pilot's panel, consists of two indicators in a case, giving separate indications on a common dial:

a. *Turn Indicator.* Each turn indicator actuates a pointer which moves relative to a graduated scale to indicate aircraft rate-of-turn about the true vertical. The scale markings represent rates of turn of 0.25, 0.5 and 1 equivalent to 45°, 90° and 180° per minute.

b. *Slip Indicator.* Each slip indicator actuates a

disc which indicates any aircraft movement from the correct bank attitude during a turn.

c. *Warning Flag.* A warning flag marked OFF is displayed on each indicator until the gyro has attained its operational speed.

d. *Operation*

(1) *Turn Indicator.* When power is applied, the gyro is energised which causes the rotor to run up to operating speed. As the speed gradually increases, the OFF warning flag disappears. If the rotor speed falls below a predetermined value the OFF flag appears.

(2) *Slip Indicator.* During a turn, a pendulum assembly carrying a disc indicator, is acted on by centrifugal and gravitational forces. In a correctly banked turn these forces balance, thus holding the pendulum in the centre zero slip position. Any departure from the correct bank path during a turn causes one of the two forces to predominate and the pendulum and disc to move from the central position indicating slip or skid.

### Standby Gyro Horizon and Altimeter

94. The standby gyro horizon on the centre instrument panel provides indication of pitch and roll attitude by direct mechanical coupling from a gyro housed in the instrument. A fast-erection system is provided to permit rapid erection of the gyro before or in flight. The FAST ERECTION BUTTON on the instrument is pushed fully in to actuate the fast erection system. This should be done in level flight only.

95. The power supply is from the 115/200-volt AC phase B Auxiliary Busbar through a cut-off relay which is energised when the GROUND/FLIGHT switch is set to FLIGHT. The gyro electrical supply and the continuity of the motor windings is monitored by a flag warning system; a failure results in the OFF warning flag appearing in the instrument.

96. A standby altimeter, of the same type as fitted at the navigator's and engineer's station (para 81) is on the centre instrument panel.

### Accelerometer

97. A remote reading accelerometer and a RESET switch are on the centre instrument panel. The accelerometer is a commutator type instrument producing DC voltage signals representing incremental g in 0.2g steps, but does not differentiate between positive and negative increments. Acceleration values of plus 2.6 or minus 1.0g cause a warning light below the instrument to come on. Use of the RESET switch cancels the light.

98. The power supply is from No 1 Essential 28-volt DC Busbar.

### **Vertical Speed Indicator**

99. The vertical speed indicator on the co-pilot's instrument panel, indicates speed of ascent and descent in the range 0 to 6000 feet per minute. The dial is graduated every 0.1 up to 1 and every 0.5 up to 6; the scale is numbered at 0, .5, 1, 2, 4 and 6; all indications require to be multiplied by 1000.

100. The indicator contains a sensitive differential capsule which responds to the rate of change of static pressure. Static pressure is fed to the capsule direct, and to the inside of the vase via a metering unit which restricts the air flow. When the altitude changes, the case pressure lags behind that of the capsule, the resulting differential pressure actuates the mechanism and causes pointer deflection. Over-load stops prevent excessive capsule movement in the event of extreme pressure changes.

### **Inertial Lead Vertical Speed Indicator**

101. This indicator, on the 1st pilot's instrument panel, provides a highly responsive indication for ascent or descent within the range 0 to 6000 feet per minute. The instrument has graduations every 0.1 up to 1 and every 0.5 up to 6, the scale being marked at 0, .5, 1, 2, 4 and 6; all indications require to be multiplied by 1000.

102. The unit consists of a pressure sensitive capsule connected to static pressure via a diffuser in a case which is also connected to static pressure through a diffuser. A dashpot accelerometer is connected to the capsule tubing. This consists of two cylinders each containing a piston balanced by a spring and its own weight. An amplifying linkage transmits capsule diaphragm movement to the indicator pointer.

103. When the vertical speed of the aircraft changes, the pistons rise or fall, depending on the direction of the change of speed. The piston movement causes an immediate change in pressure which deflects the capsule diaphragm and hence the pointer. The effect of the accelerometer then fades and the pressure differential across the diffuser maintains the pointer deflection until a further change in vertical acceleration takes place.

### **Air Temperature Gauges**

104. The outside air temperature is indicated on:

- a. Three OAT gauges, one on the centre instrument panel adjacent to the ice detector warning light, and one at each of the navigator's and engineer's stations.
- b. One true OAT gauge (TOAT) on the centre instrument panel, adjacent to the undercarriage selector.

105. Four temperature probes are fitted on the aircraft skin, at station 40, two on either side. Each consists of a stainless steel bulb housing a temperature-sensitive element fitted with a solar screen to prevent errors due to direct sunlight. On the left, the

upper probe is connected to the true OAT gauge (TOAT) and the lower one to the navigator's OAT gauge. On the right, the upper probe is connected to the OAT gauge on the centre instrument panel and the lower one to the flight engineer's OAT gauge.

106. The TOAT gauge is calibrated from minus 80 to plus 60°C and the OAT gauges are calibrated from minus 60 to plus 60°C.

107. The TOAT gauge obtains its correction for the ram air temperature rise with airspeed and mach number from the precision altimeter system, from which the gauge also obtains its power supply. The other three OAT gauges are supplied from the 28-volt DC Non-Essential Busbars, the gauge on the centre panel and the navigator's gauge from No 1 supplies, and the engineer's gauge from No 2 supplies.

108. The gauges operate on the ratiometer principle, in which the movement is controlled by the ratio of the currents through two coil windings which are supported in unequal magnetic fields. The current through one winding is kept constant while the other is controlled by the resistance of the probe element. The pointer indicates off-scale when the power is disconnected.

109. *Paragraph Not Used.*

### **Periscopic Sextant**

110. A pressure-tight sextant mounting for a periscopic sextant Mk 2A is on the roof of the flight deck at station 117. The mounting which is provided with an integral heating element, holds the sextant in the retracted or operating position without loss of cabin pressure.

111. A lever in the mounting allows the sealing plate to be opened only when the sextant has been inserted in the carrier tube. The sextant cannot be removed until the sealing plate is closed.

112. An ON/OFF switch on the mounting controls the 28-volt DC supply to the built-in electrical de-misting and de-icing system in the instrument. The switch is wire-locked ON. A second SEXTANT HEATER—ON switch on panel R controls the supply to the periscopic sextant and a wander lamp adjacent. The power supply for the mounting, sextant and the wander lamp is from the No 1 Essential 28-volt DC Busbar via a circuit breaker on panel C.

113. When not required, the sextant is housed in a case which is stowed at the navigator's station.

### **Periscopic Viewer**

113A. A periscopic viewer which may be fitted to one of two pressure-tight mountings in the roof, one on either side of the fuselage centre line at the aft ALM station, is provided to facilitate in-flight inspection of the tailplane assembly, eg check for

icing. Each mounting is similar to the periscopic sextant mounting referred to in para 110 above, and holds the periscope in the retracted or operating position. ▶◀ The integral heating element in each mounting is inoperative when the weight of the aircraft is on its wheels (see Chapter 18, para 24).

113B. The periscope is provided with an internal electrical demisting system, which is operative when a plug on the periscope is inserted into a 28-volt DC supply socket adjacent to the mounting.

113C. When not in use, the periscope is stowed at the aft ALM station.

## FLIGHT DATA RECORDER

### General

114. The flight data recorder (ADR Mk 4) provides records of the following flight parameters:

- Airspeed
- Altitude
- Heading
- Pitch
- Roll
- Vertical acceleration
- Tailplane movement
- Elevator movement

In addition, indication of the number of hours of recording time available (in 0.1 hour steps from a total of 30 hours) is given by means of a drum-type counter on an indicator at the navigator's station.

### Flight Data Recorder

115. The flight data recorder, comprising inverter, signal conditioning units and recorder junction box is mounted on the aft face of the aft engine-beam, the composite assembly being enclosed by a hinged cover.

### Flight Data Recorder Controls and Indicators

116. The system is controlled by a three-position ADR—TEST/OFF/ON switch (which is spring-loaded from TEST to OFF), adjacent to the HOURS REMAINING indicator on the navigator's panel (panel R). When the TEST button on the indicator is pressed, the count rate is speeded up; failure of the counters to rotate, indicates that the recording wire is broken. When carrying out a ground test, the three-position switch must be held at TEST at the same time as the TEST button is pressed. The counters can be reset by use of a resetting lever and knob on the indicator.

117. A test switch, which is spring-loaded to OFF, on the recorder junction box enables ground tests to be made at that location.

118. An oleo-operated relay is provided to ensure that the equipment is automatically switched on after take-off should the normal control switch be inadvertently left at OFF.

### Data Supplies

119. The parameters of airspeed and altitude are supplied from transducers which obtain signals by sensing pitot and static pressures via  $P_2$  and  $S_0$  respectively.

120. The heading parameter is supplied from No 1 compass system.

121. Pitch and roll parameters are supplied from No 1 HDI.

122. The parameter for vertical acceleration is obtained from an accelerometer fitted above the right hat rack near the trim datum. (Station 955.)

123. Parameters of tailplane and elevator movement are obtained from transducers fitted above the appropriate hinge lines.

### Power Supplies

124. The power supplies for the system is from the No 2 28-volt DC Essential busbar.

### Operation of the Flight Data Recorder

125. The system is normally switched on by setting the control switch to ON and, provided that the Ground Power busbar is isolated, the system operates and remains operating until either the switch is set to OFF or a supply is connected to the Ground Power busbar.

126. If take-off is made with the control switch set to OFF, the system is automatically switched on by the operation of the oleo-operated relay; on touch-down, the recorder remains on until the control switch is set to ON and then OFF.

## STRAIN RANGE COUNTER

### General

127. Two independent installations, one for each wing, measure and record the severity and number of wing oscillations in flight. There are no control switches, the system being automatic in operation.

### Description

128. Each installation consists of a transmitter, a recorder and a suppression unit positioned beneath the mainplane centre section, immediately forward

of the main wheel bays. The transmitters are mounted above the ADF sense aerials. The recorders and suppression units are on panels on the left side of the underwing fairing above the fuel pump and water-drain access door. The units are supplied with 28-volt DC from the Essential busbars.

### Operation

129. Each transmitter contains four switching mechanisms which operate in turn as oscillations increase. The resulting pulses pass through a radio interference suppressor to a recorder containing four visible counters, which record the number of cycles of operation performed by the switching mechanisms.

## CLOCKS

### Aircraft Clock

130. An eight-day-movement aircraft clock on the engineer's panel provides an accurate general purpose time datum. The time of day is shown on a conventional twelve-hour dial and a second sweep hand is provided.

131. The clock is wound by the winder at the bottom-left of the dial. The time-of-day hands are reset after pulling out the winder. After resetting the hands the winder must be pushed in.

### Time-of-Flight Clocks (2)

132. An eight-day-movement time-of-flight clock is fitted at each pilot's station. They provide an accurate time datum for the purpose of astro-navigation and, when required, record the time taken to complete a flight.

133. The time of day is shown on a twelve-hour dial by hour, minute and second sweep hands.

134. Indications of the hour on a 24-hour basis is shown on a subsidiary dial marked AM/PM at the twelve o'clock position.

135. The time of flight is shown on a subsidiary 12-hour dial at the 6 o'clock position.

136. The clock winder is at the four o'clock position on the face of the dial. Pulling the winder button out stops the clock, resets the second hand to zero, and permits resetting of the time of day and the AM/PM hands; the time-of-flight hands are not affected. Pushing the winder button in restarts the clock.

137. The hands of the time-of-flight dial are driven by the time-of-day mechanism and are inoperative while the clock is stopped; they are controlled, when the clock is running, by the three-pressure action push-button at the 6 o'clock position. The first pressure starts the time-of-flight hands, the second pressure stops them, and the third pressure returns both hands to zero. An indicator, behind a window, at the three o'clock position on the dial, shows the condition of the mechanism; black indicates that the time-of-flight hands are running and white indicates that they are stopped or are at zero.

### Elapsed Time Clocks (3)

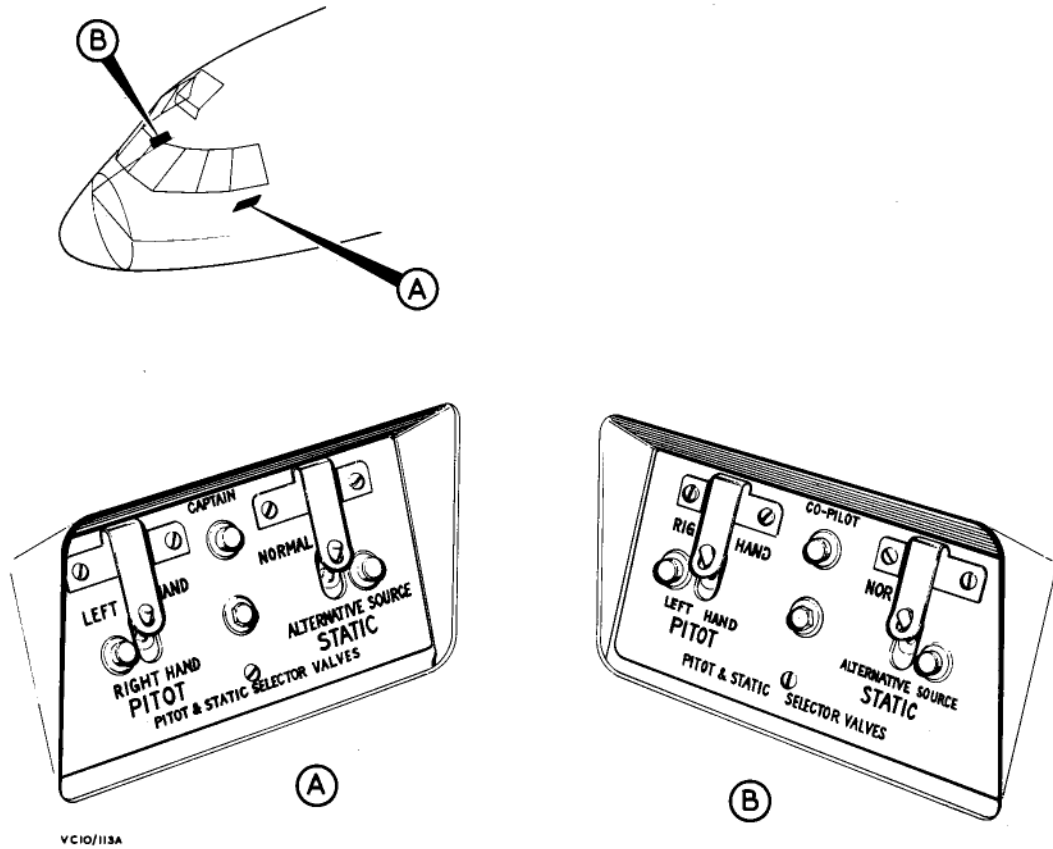
138. A thirty-six hour movement elapsed time clock is fitted at each pilot's station and at the navigator's station. They permit the various stages of pattern flying to be accurately timed. The elapsed time is shown up to 12 minutes on the centre minute recorder scale, and in seconds up to one minute on the outer scale.

139. Starting and stopping of the clock is by depressing the winder (bottom right-hand corner). ie, the first pressure starts the clock, the second stops it.

140. To reset the hands to zero, press the push-button at the 6 o'clock position.

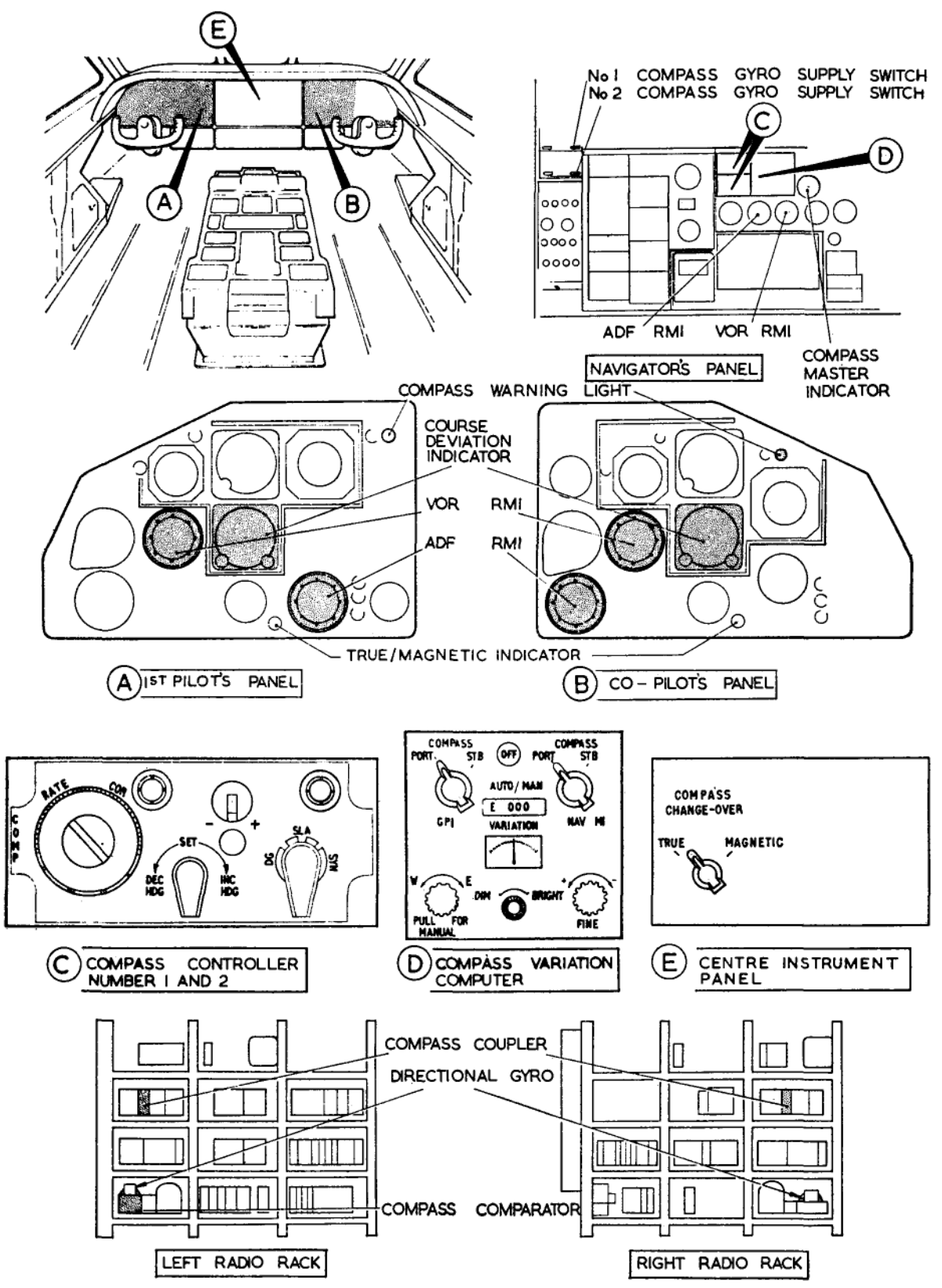
141. After being stopped, if the clock is restarted before the hands are returned to zero, time elapsed from the stopped position is recorded.

142. The clock can be started at any time in flight and allowed to run; pressing the button at the 6 o'clock position causes the hands to return to zero and restart simultaneously, thus recording the time as it elapses from a zero datum.



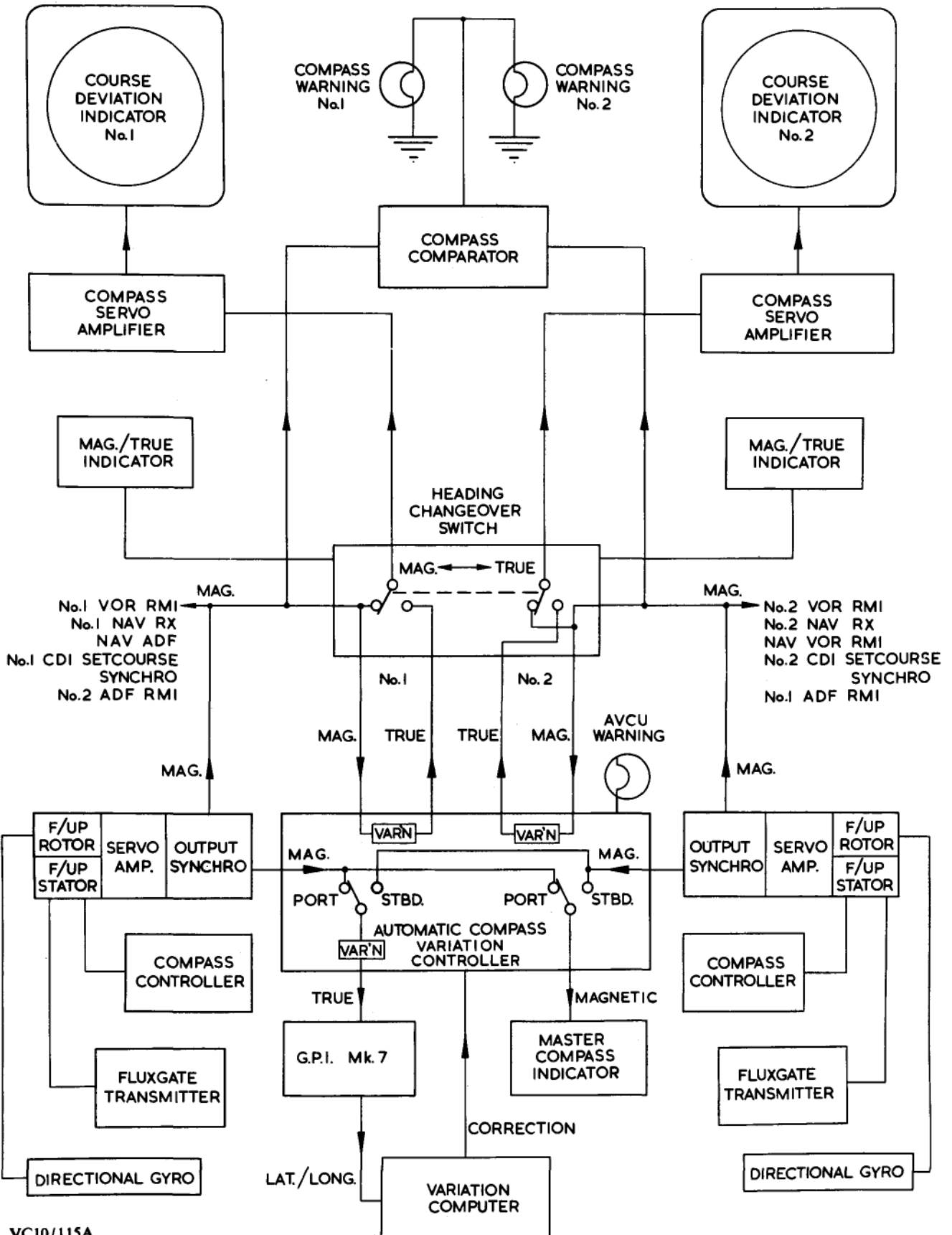
VC10/113A

2.13 Fig. 1. Pitot-Static Selector Valves Change-over Switches  
◀Minor Amendments▶



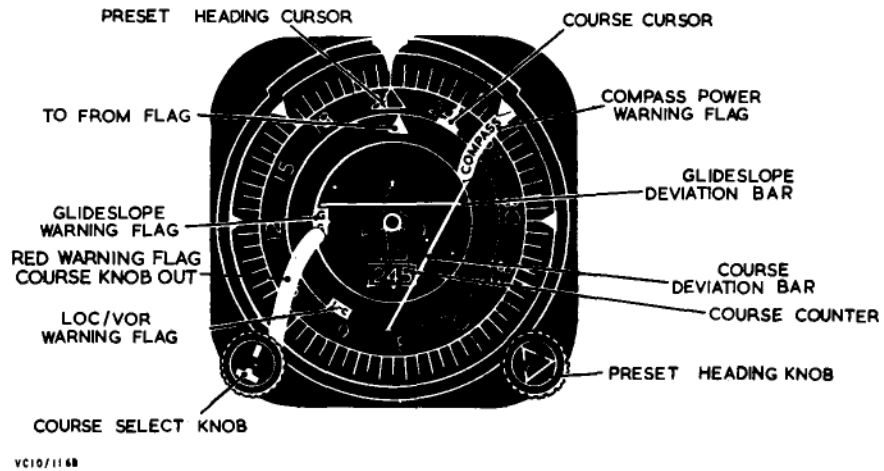
2.13 Fig. 2. Compass Installation

VC10/114A

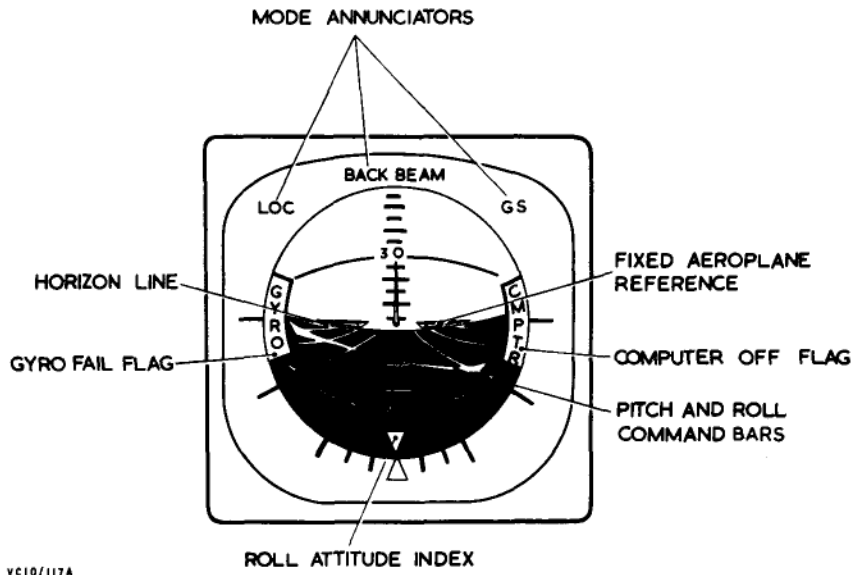


VC10/115A

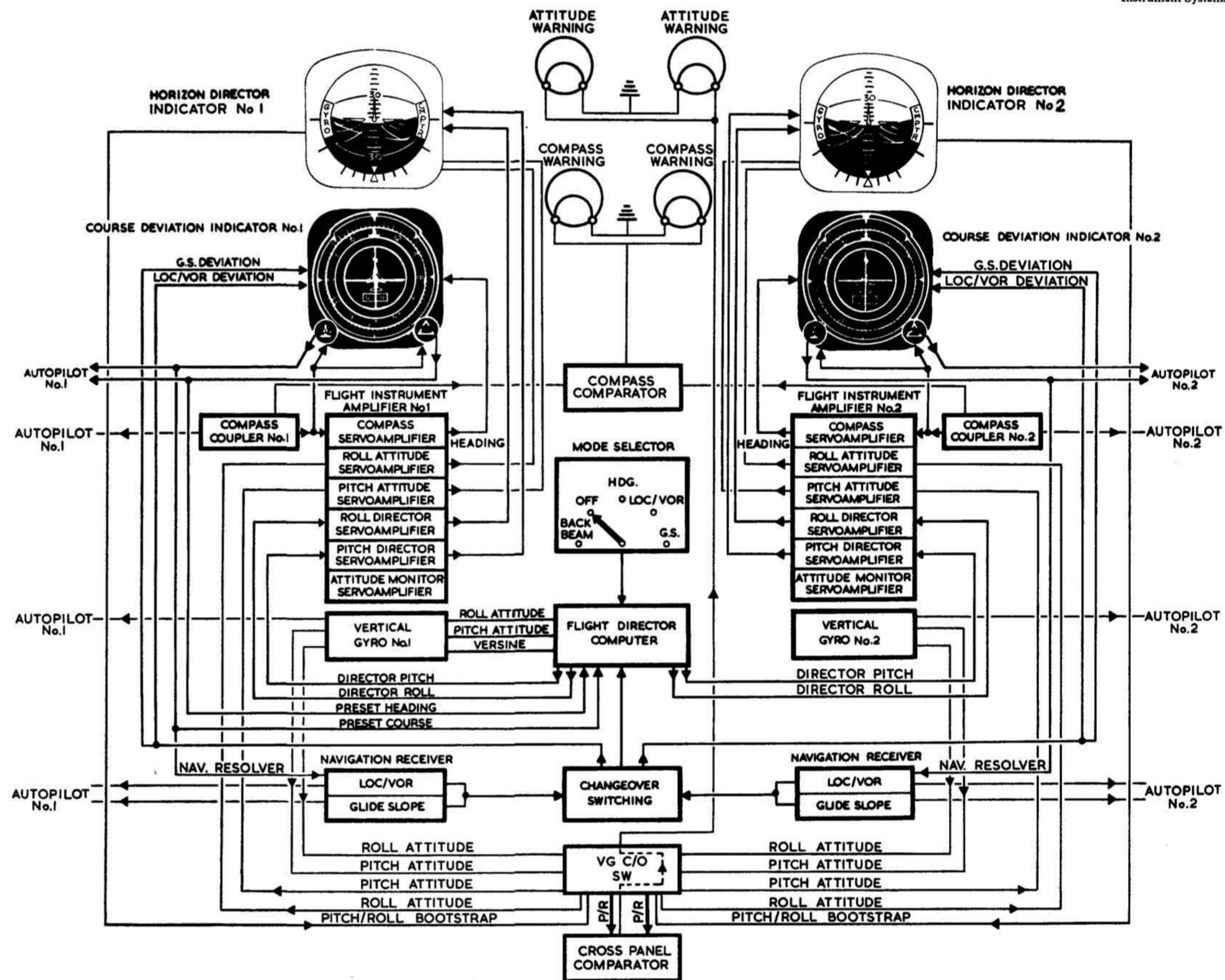
2.13 Fig. 3. Compass System — Block Schematic



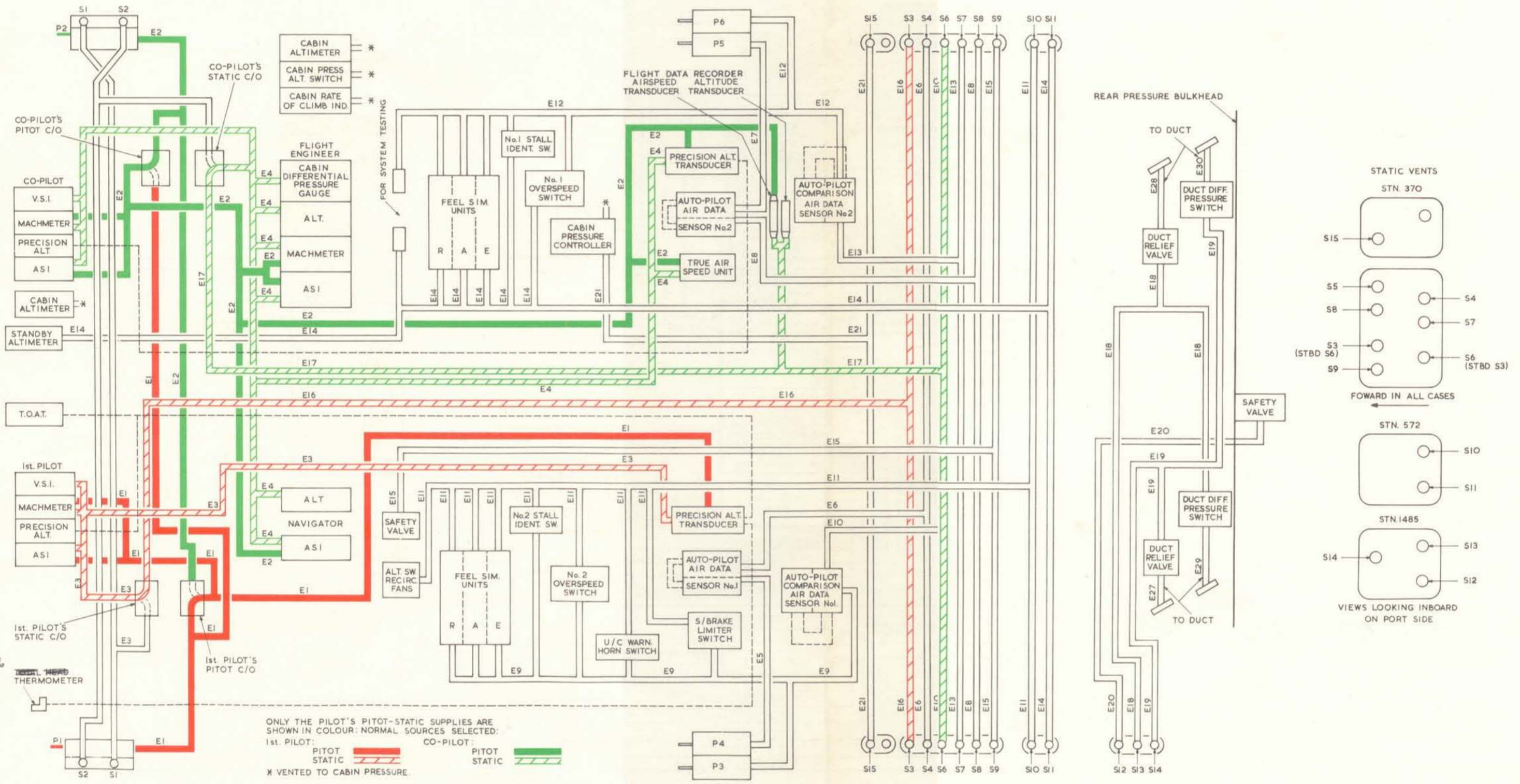
2.13 Fig. 4. Course Deviation Indicator (CDI)  
 ◀ Red Warning Flag Annotated ▶



2.13 Fig. 5. Horizon Director Indicator (HDI)



2.13 Fig. 6. Flight Director Installation



2.13 Fig. 7 Pitot Static System  
 Illustration up-dated  
 OMEGA DETAILS TO BE ISSUED BY AL  
 RESTRICTED AC 16

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