Group 3.A.

AIR PRESSURE OPERATED FLIGHT INSTRUMENTS

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Introduction

1. This group contains a description of the air pressure operated flying instruments installed in this aircraft, the majority of which are operated by the pressure head installation. For a general description of the instrument installation as a whole, reference should be made to Group 1A of this chapter. The location and access to all the instruments and their associated equipment is given in Group 1C. Detailed information on the standard components used will be found in the relevant Air Publications listed in Table 1.

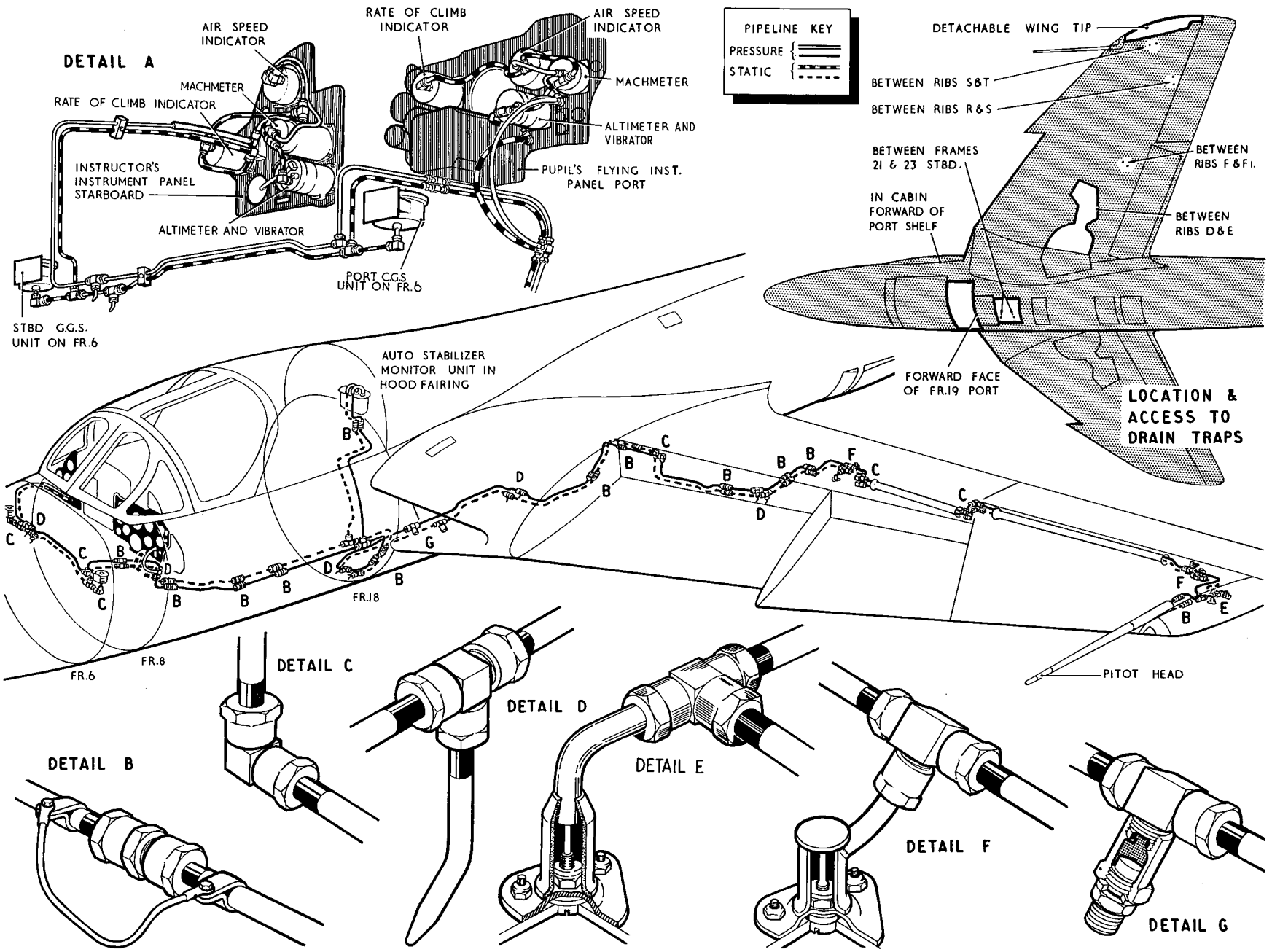

Fig. 1. Pressure head installation

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DESCRIPTION

Pressure Head installation

2. This installation operates the air speed indicators, machmeter, altimeters and rate of climb indicators. The installation, which is illustrated in fig.1, consists of an electrically heated pressure head, projecting forward from the port wing tip. The pressure head contains the pressure and static pipes, together with an electric heater element. The pressure and static pipes in the head are connected to the instruments on the pupil's flying instrument panel and the instructor's starboard instrument panel, by a system of pipe-lines extending to these panels. Moisture entering the pipe-lines is collected by a number of drain traps located in each pipe-line as shown on the illustration of the installation.

Pressure head heater

3. The electric heater element in the pressure head is controlled by a single-pole ON/OFF switch located on the leg panel adjacent to the camera master switch. A routeing and theoretical diagram of the electrical heater circuit, the operation of which will be obvious, is given in fig.2.

Note . . .

The pressure head heater must not be switched on before removal of the pressure head cover or damage to the cover will result. It is also important to ensure that the heater is not left switched on for any length of time, while the aircraft is on the ground, as the heater constitutes a danger to personnel should it be touched by accident.

Air speed indicators

4. The air speed indicator for the pupil's use is mounted on the pupil's flying instrument panel and that for the instructor's use is located on the starboard instrument panel. Both are capsule type instruments operated by air pressure drawn from the pressure head installation, which is described in para.2.

Machmeters

5. Two machmeters are installed, one being located on the pupil's flying instrument panel and the other on the starboard instrument panel. They give a continuous indication of the ratio of true air speed to the speed of sound. The instruments are operated by the differential air pressure between the pressure and static pipe-lines of the pressure head installation described in para.2.

Altimeters

6. The Mk.28 altimeter for the pupil's use is located just below the air speed indicator on the pupil's flying instrument panel and the Mk.19B altimeter for the instructor's use is installed on the starboard instrument panel adjacent to the artificial horizon. Both instruments are atmospheric pressure operated and are provided to give a continuous indication of the aircraft's height. The instruments are connected to the static pressure pipe lines of the pressure head installation, described in para.3 of this group. Integral with the Mk.28 altimeter is an induction motor and an auto-transformer. The induction motor drives a mechanical vibrator and is supplied by the auto-transformer, the latter taking its supply from the aircraft a.c. supplies as shown in fig.3.

Cabin altimeter

7. This is an aneroid instrument and is located on the centre instrument panel just below the tail plane selector switch. It is not connected to the pressure head installation or to any other instrument, but is

Table 1

Equipment type and Air Publication reference

Equipment Type	Air Publication
Pressure head, Mk.9A Air speed indicator, Mk.12A Machmeters, Mk.3A	A.P.1275A, Vol.1, Sect.21
Altimeters, Mk.19F Altimeter Mk.28 Cabin altimeter Mk.21 Rate of climb indicators, Mk.3Q	A.P.1275A, Vol.1, Sect.22

open to the air in the cabin, as it indicates the equivalent pressure cabin altitude and not the aircraft's height.

Rate of climb indicators

8. The rate of climb indicators are installed on the starboard side of the pupil's flying instrument panel and on the starboard instrument panel. They are sensitive differential pressure gauges giving the rate of change of the atmospheric pressure in terms of rate of climb or descent, whenever the aircraft departs from level flight. The instruments are connected to the static pressure pipe-line of the pressure head installation, described in para.2.

SERVICING

General

9. The necessary servicing to maintain the instruments in an efficient condition and the standard serviceability tests, which should be applied, together with the equipment to be used and the method of conducting the tests is contained in the relevant Air Publications listed in Table 1.

Pressure head drain traps

10. Drain traps are provided in the pressure head installation to collect any moisture which may enter this installation. The drain traps, which are of three different types, are connected into the installation by tee-pieces and are located in pairs as illustrated in fig.1. Each type of drain trap is illustrated in the details given on the illustration and the means of access to the traps is also indicated. All the moisture etc., in the drains, should be removed periodically as follows:-

(1) The drain traps illustrated in detail D of fig.1 should be disconnected from the system and any moisture removed. When refitting the drains new rubber sealing rings should be inserted in the union nuts and after the nuts are tightened, an examination should be made to ensure that the unpainted ends of the drain traps do not show below the heads of the union nuts.

(2) The drain traps illustrated in detail E and F of fig.1 should be opened by unscrewing the slotted plugs in the wing skin until any moisture in the traps drains away.

(3) The drain traps illustrated in detail G of fig.1 should be opened by inserting a suitable length and diameter of hose into each drain in turn after removing the small access doors. Insertion of the hose pushes open the valve and allows any moisture to escape down the hose.

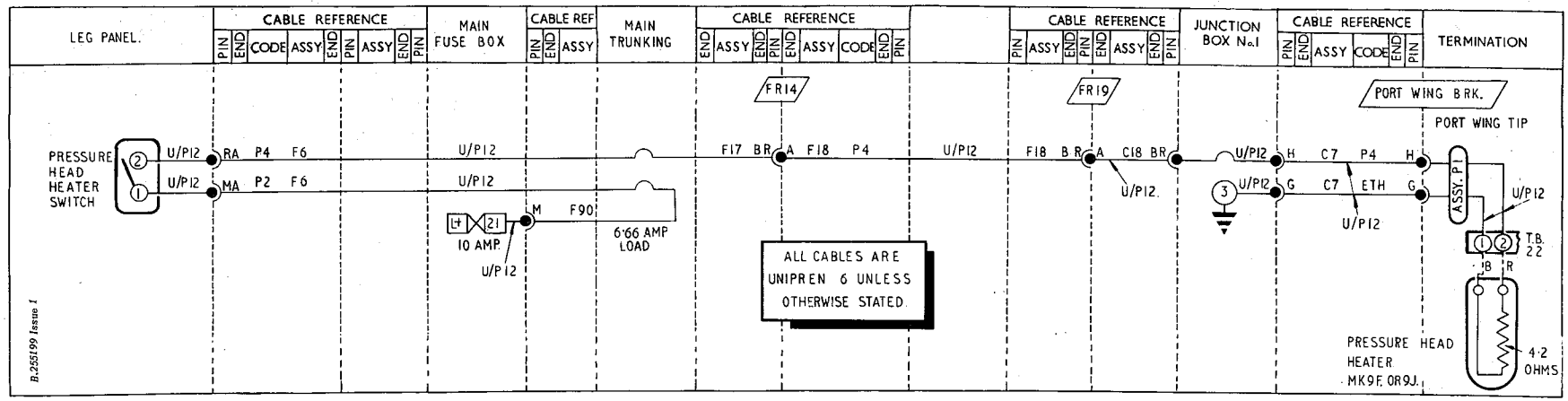

Fig.2. Pressure head heater (routeing and theoretical)

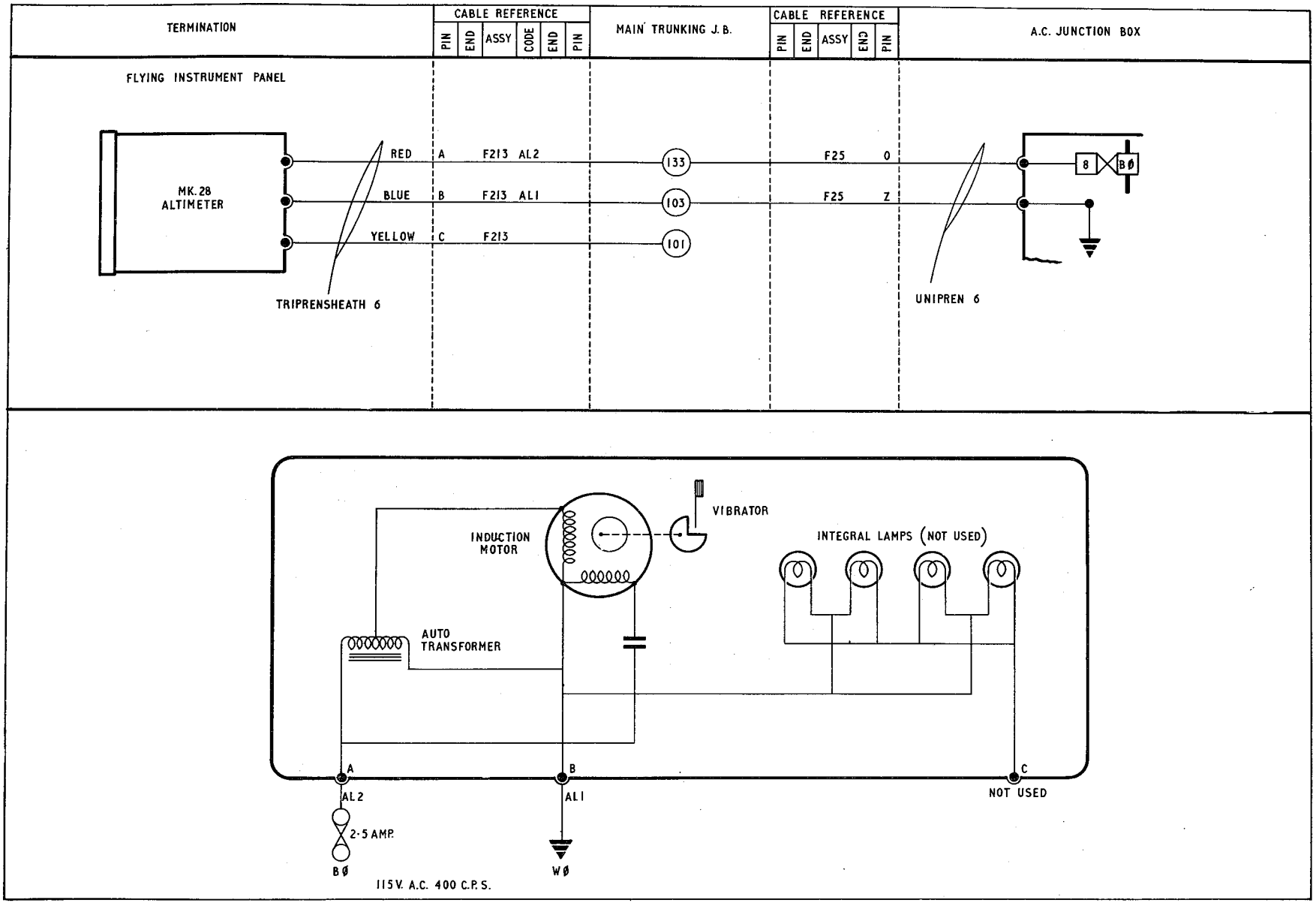

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Fig. 3 Altimeter (routeing and theoretical)

Pressure head leak tests

11. The pressure and static systems are as leak-tight as possible and every care must be taken to maintain the system in this condition since even a moderate leak may develop into a more serious leak and cause instrument failure. To ensure that the leakage rate is within the required tolerances, the system must be tested in accordance with the instructions given in A.P.1275A, Vol.2, Leaflet A.9 whenever the system is suspect or its pipeline joints and connections to instruments are disturbed.

REMOVAL AND ASSEMBLY

General

12. The removal of the instrument panels carrying the flying instruments is fully described in Group 1.B. The removal of the pressure head is covered in Sect.3, Chap.2 and once access has been obtained, the removal of the remaining items of equipment should present no difficulties.

Appendix 1 MOD. 1378

(AUTOMATIC HEIGHT ENCODING ALTIMETERS)

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Introduction

1. This appendix contains a description of the altimeter installation introduced by Mod. 1378 and which provides height encoded data to the IFF/SSR 1520 installation to enable that equipment to reply to MODE C interrogation. A description of the IFF/SSR installation is given in Sect.6, Chap.2, App. 1. Servicing information is given, but for more detailed information on the equipment used reference should be made to the publications listed in Table 1.

TABLE 1

Equipment type and Air Publication reference

Equipment Type	A.P. Reference
Altimeter Mk.30A	A.P.112G-1031-1
Altimeter Mk.29B	A.P.112G-1028-1
Pressure Error Correction Unit Part No. L83271-00-000	A.P.112G-1031-1
Correction Module Part No. L84340-00-070	A.P.112G-1031-1
Inverter Type F1.45E	A.P.113D-0315-13A6

DESCRIPTION

General

2. The Mk.19 and Mk.28 altimeters described in the main chapter are replaced by a Mk.30A barometrically operated servo encoding altimeter and a Mk.29B servo controlled altimeter. During normal flight the Mk.30A altimeter displays pressure corrected altitude information, and transmits an altitude signal to the Mk.29B altimeter by servo. It also transmits encoded altitude data to the IFF/SSR transponder. The Mk.29B altimeter, under servo control, displays similar altitude information. Alternative power sources are provided together with automatic or 'on demand' reversion to uncorrected barometric capsule operation in the event of power or other failure.

3. A Pressure Error Correction Unit (P.E.C.U.) provides a correcting factor to the Mk.30A altimeter to correct for pressure errors generated when the aircraft is flown in the 4 x 100 gallon drop tank configuration. Provision is made for the P.E.C.U. to be rendered inoperative when the aircraft is to be flown in the 'clean' condition. A static inverter Type F.1. 45E is fitted to cater for the additional 115V. a.c. power loading, but a stand-by power supply, taken from the Type 108 TACAN inverter is available should the necessity arise.

Altimeter Mk.30A

4. The Mk.30A altimeter is a single-phase 115V a.c., servo barometric instrument displaying corrected altitude over a calibrated range of -900 ft. to 60 600 ft. The instrument is housed in a pressure sealed 3¼ in. square flanged case and is mounted on the stb'd instrument panel. Electrical connections are made through the rear of the case by a 30 in. flying lead which terminates in a 41 pole plug. The interior of the case is connected to the aircraft's static pressure system through a threaded pipe insert also at the rear of the case.

5. Indication of altitude is given by pointer and dial and by a counter drum assembly both of which are fluorescent when exposed to ultra-violet light. In the event of a servo malfunction or power failure a red and black diagonally striped failure flag drops to obscure the counter drum display. To bring attention to altitudes below 10 000 ft. the left hand counter drum is marked with diagonal white stripes and to indicate negative altitudes the right hand counter drum is marked with red and white diagonal stripes. A setting at the front of the instrument provides adjustment to the altimeter so that it indicates altitude relative to a selected barometric pressure which is displayed on a four digit millibar counter. A malfunction of the associated P.E.C.U. causes a warning flag marked P.E. to drop into view at the top of the display.

6. Static pressure changes within the instrument case cause deflection of a barometric capsule, the deflecting movement, mechanically amplified, drives the display mechanism through a synchro transmitter, servo motor and gear train. The gear train drives a second synchro transmitter which is servo connected to the Mk.29B altimeter, a brush type binary altitude encoder connected to the IFF/SSR transponder, and twin ganged potentiometers. The twin potentiometers produce two output signals, one of which is proportional to altitude ($\triangle$H) and the other inversly proportional to static pressure (I/S). The two signals are fed to the P.E.C.U. for use as correction factors.

7. An electronic circuit receives correction signals computed in the P.E.C.U. and intergrates the signals into the altimeter mechanism. The electronic circuit also monitors the electrical supply, detects malfunction and controls the various failure indicators and fail safe reversion previously described.

Altimeter Mk.29B

8. The Mk.29B altimeter is a servo controlled instrument normally slaved to the Mk.30A altimeter but with automatic reversion to barometric capsule operation in the event of power or other failure. The instrument is housed in a 3¼ in. square flanged case and is mounted on the port instrument panel. Electrical connections are made through the rear of the case by a flying lead terminating in a 19 pole plug. The interior of the case is connected to the aircraft's static pressure system through a threaded pipe insert in the rear of the case.

9. Altitude indication is given by pointer and dial and counter drum assembly which are fluorescent when exposed to ultra-violet light, the range of the instrument is from 1000 ft. to 60 500 ft. A setting control knob on the front of the instrument provides adjustment to the instrument so that it indicates altitude relative to a selected barometric pressure which is displayed on a millibar counter. A second control knob marked RESET/ST. BY provides for operational mode selection and a flag indicates the mode selected. To bring attention to altitudes below 10 000 ft.

the left hand drum of the counter assembly is marked with diagonal white stripes and to show that negative altitudes are being indicated the right hand drum is marked with red diagonal stripes.

10. When operated in the normal (RESET) mode the indication mechanism is driven by drag cup motor and a synchro servo connected to the transmitter in the Mk.30A altimeter. In the ST.BY. mode the instrument operates as an uncorrected barometric pressure altimeter. A fail safe electronic assembly will automatically revert the instrument to the ST.BY. mode in the event of an a.c. power failure and bring into operation a buzzer type vibrator. After restoration of a.c. power the instrument can be restored to normal operation by momentarily operating the RESET/ST.BY. switch to RESET.

Pressure Error Correction Unit (P.E.C.U)

11. The P.E.C.U. provides a servo linked correction factor to the Mk.30A altimeter to compensate for static pressure errors generated when the aircraft is flown with a 4 x 100 gallon drop tank configuration. The P.E.C.U., which is located on the port side of the radio bay can be made inoperative when the aircraft is to be flown without this drop tank configuration. Because different aircraft types generate different pressure error patterns the P.E.C.U. consists of two parts, a common basic unit and a specially formulated plug-in module specific to the aircraft type. The unit and module after assembly are treated as a single unit. The mechanism is housed in a 3 in. flange mounting case, with pitot and static pressure pipe unions and a 26 pole plug fitted to the flanged face.

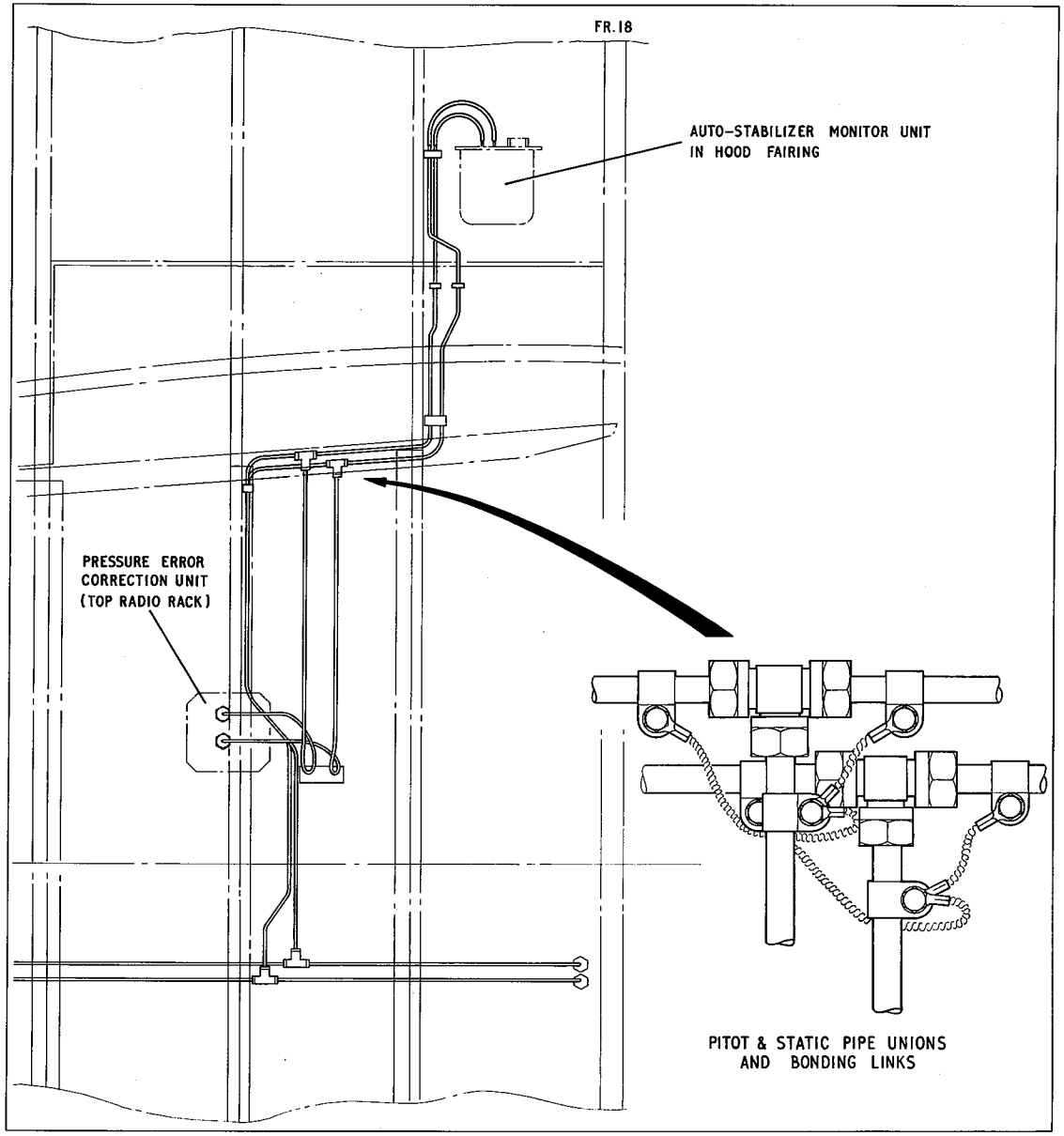

Fig.1 Pitot – Static Installation

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12. The mechanism consists of a differential pressure capsule mechanically linked to a servo synchro, motor and potentiometer and an electronic assembly into which the correction module is plugged. The assembly receives altitude factors produced in the Mk.30A altimeter and computes an altitude-airspeed related error signal which is returned to the altimeter. A monitor circuit automatically switches out the P.E.C.U. and controls the warning flag in the altimeter should a malfunction occur.

13. When the aircraft is to be flown without the 4 x 100 drop tank installation cable F200 end G is removed from the P.E.C.U. and connected to the adjacently fitted P.E.C.U. OUT plug, and so completes a d.c. supply to the P.E. warning flag solenoid.

Power Supplies

14. Power source selection is made at the NORMAL/ST.BY power supply change-over switch located on the port flying instrument panel which controls a change-over relay (RL. L) in the A.C. Junction Box. In the NORMAL mode 115V. 400 Hz a.c. is supplied to the installation from a Type F.1.45E inverter located on the forward face of Frame 15. The d.c. supply to drive the inverter is taken from 20 A H.R.C. fuse in the Supply Panel through the contacts of a Type 9B relay also located on Frame 15. This relay is energized when the Engine Master Switch is selected ON by a d.c. supply taken from fuse F12 in the Main Fuse Box, (Sect.5, Chap.1, Group C.1). This fuse also supplies the vibrator in the Mk. 29B altimeter and the P.E.C.U. OUT plug.

15. When NORMAL power supply is selected the change-over relay (RL.L) is energized completing the 115V a.c. supply from the Type F.1.45E inverter to the Mk.30A altimeter through which distribution to the other equipment is made. The inverter also supplies a fused A.C. Test Socket located in the radio bay. When ST.BY. power is selected the change-over relay is de-energized and a 115V. 400 Hz a.c. supply is provided by the TACAN Type 108 inverter through a fuse in the A.C. J.B.2 in the nose bay. Complete wiring information is given in Fig.2 and 3, T.B 100 on the cabin stb'd shelf provides the means whereby an external 28V d.c. supply can be connected to operate the power failure relay in the Mk.29B altimeter and to cause the instrument to change over to the ST.BY mode.

SERVICING

General

16. For general servicing of the electrical system reference should be made to Group A1, and for general servicing of the pitot-static pressure system to Group 3A. Standard servicing instructions for equipment removed from the aircraft is given the publications listed in Table 1. Normal inspection techniques for fitted equipment should be carried out and the equipment tested periodically as instructed in the following paragraphs using the test equipment listed.

Test Equipment

17. The following test equipment is required:-

(1) Pitot-Static test set
(2) IFF/SSR Transponder test set Type CRM 544
(3) Multimeter
(4) Insulation test set 250V.
(5) Test lamp 28V.

Pitot-Static System

18. Service and test the Pitot-Static system as detailed in Chap.2, Group 3A.

Electrical System

19. (1) Ensure that the Battery and Engine Master Switches are set to OFF.

(2) Remove the electrical connectors from the Mk.30A and Mk.29B altimeters, P.E.C.U., Type F.1.45E inverter and the IFF/SSR cable NSM 3050–R3 at Frame 19. Remove connector F201 from A.C. J.B.2 in the nose bay.

(3) Remove fuses 9 and 29 in the Supply Panel and fuse 12 from the Main Fuse Box.

(4) Refer to Fig.2 and 3. Carry out continuity and insulation checks on the installation wiring. On satisfactory completion re-connect all electrical connectors and refit fuses.

CAUTION. . .

Do not attempt to carry out an insulation test on any instrument.

20. (1) Connect an external 28V d.c. supply to the aircraft.

(2) Select the Altimeter Power Supply switch to NORMAL.

Select the Engine Master switch to ON.
The Type F.1.45E inverter should operate together with the Stand-by Flight Instrument inverters.
The Power Failure flag in the Mk. 30A altimeter should retract and the STD-BY flag in Mk.29B altimeter should appear in the dial window.

(3) Check for 28V. d.c. across pins F(+ve) and E(-ve) at the IFF/SSR Test Set Supply socket in the Radio Bay. Check for 115V. a.c. at pins A(L) and D(N) at the A.C. Test Set Supply socket in the Radio Bay.

(4) Select the TACAN NORMAL/TEST switch to TEST check that the TACAN inverter functions correctly as described in Sect.5, Chap. 1, Group H.1.

IFF/SSR Encoder-Altimeter Tests (without P. E.C.U. in circuit)

21. (1) Check that connector F200 G is connected to the adjacent plug identified P.E.C.U. OUT.

(2) Refer to Sect.6, Chap.2, App.1 and using Test Set Type CRM 544 functionally test the IFF/SSR equipment.

(3) Select the RESET/ST.BY mode control on the Mk.29B altimeter to RESET and check that the P.E. flag on the Mk.29B altimeter remains extended.

(4) Set both altimeters to 1013.25 mb. atmospheric pressure. Using the Pitot/Static Test Set adjust the static pressure in the aircraft system to obtain the altitude readings on the Mk.30A instrument as given in Table A. The coded altitude information transmitted by the IFF/SSR transponder and displayed on Test Set CRM 544 must be as tabulated.

TABLE A

Altitude	Output Code				CRM 544 Setting			
Feet	D	A	B	C	A	B	C	D
0	00	000	001	010	0	6	2	0
1,600	00	000	111	011	0	7	6	0
2,700	00	000	100	001	0	1	4	0
5,300	00	001	011	100	4	6	1	0
10,000	00	011	101	010	6	5	2	0
25,000	00	101	110	010	5	3	2	0
31,000	01	100	000	010	1	0	2	4

(5) Record the readings of the two altimeters at each altitude test point, the differences between the two instruments must be within the tolerances given in Table B.

TABLE B

Mk.30A Alt. Reading	Mk.29B Alt. Difference in Indication (Feet)
0	35
1,600	35
2,700	35
5,300	40
10,000	40
25,000	50
31,000	50

Note. . .

Due to prevailing ambient pressure conditions it may be impractical to check at zero ft.

IFF/SSR Encoder-Altimeter tests (with P.E. C.U. in circuit)

22. (1) With power OFF transfer connector F200G to the plug on the front face of the P.E.C.U. Restore power to the system (Para. 20).

(2) Select the RESET/ST.BY mode control on the Mk.29B altimeter to RESET and note that the P.E. flag is retracted within 75 secs.

(3) Repeat test 21(4), check that the TACAN transmissions do not influence the Test Set CRM 544 read-out.

(4) Repeat test 21(5).

(5) Vent the static pressure line to atmospheric pressure.
Adjust the Mk.30A instrument to read zero ft. Apply pitot pressure to give speed values as in

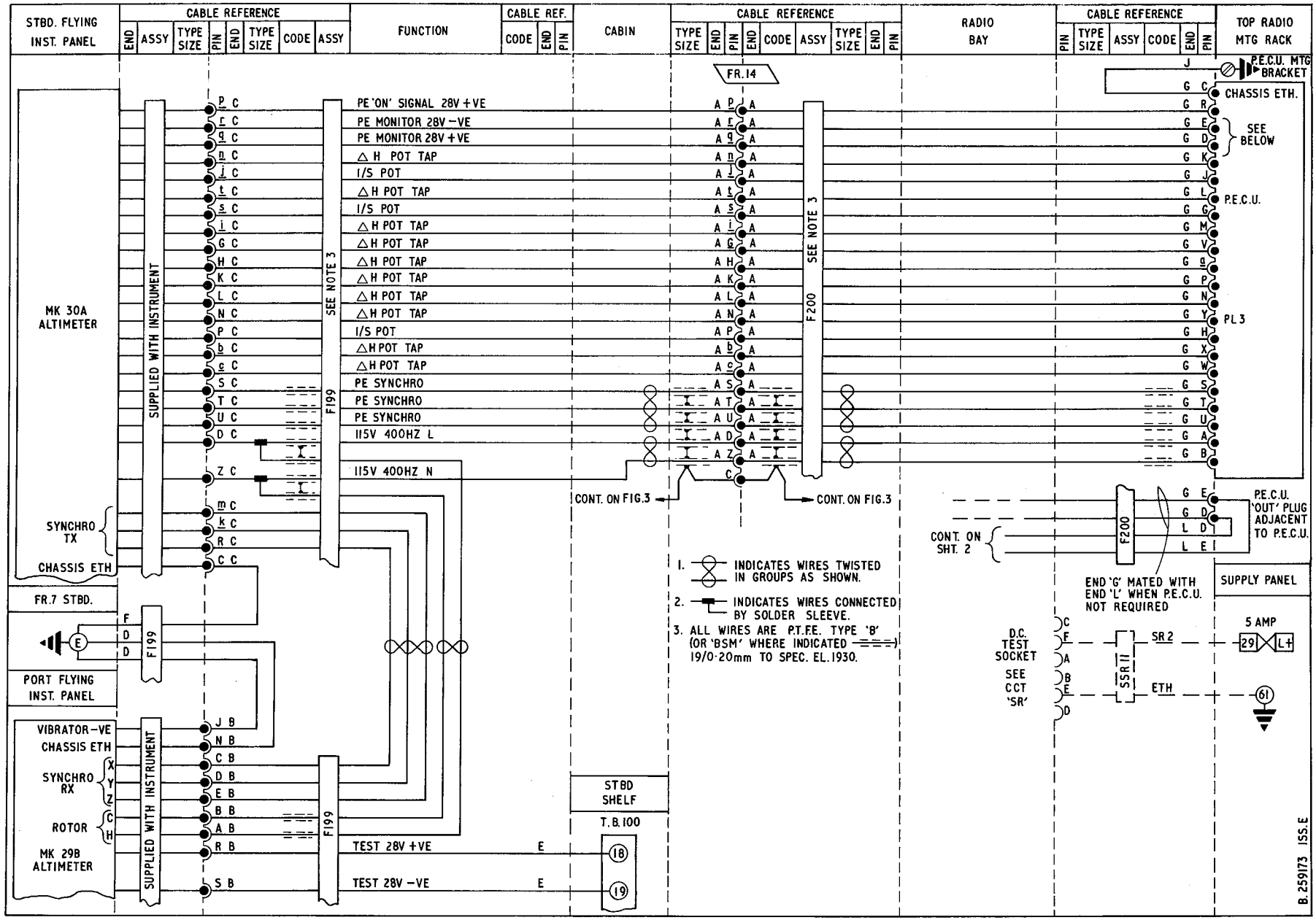

Fig.2 Altimeter — Height Encoding, Routeing

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Table C. The altitude readings (indicated by the Mk.30A altimeter) will vary according to the applied pressure error correction. This correction at the defined speeds shall be as given in Table C within the stated tolerances.

(6) Set the Mk.30A and Mk.29B altimeters to 1 013.25 mb. Set the Mk.29B altimeter to ST.BY. Reduce the static pressure until the Mk.30A altimeter is indicating 30 000 ft altitude and seal off, noting that the Mk.29B altimeter indicates a similar altitude.

Adjust the pitot pressure to give speed values as given in Table D. The altitude indicated by the Mk.30A altimeter will vary according to the applied pressure error correction given in Table D within the stated tolerances. Check that the altitude indicated on the Mk. 29B altimeter does not change from the intial indication.

TABLE C

Corrections at zero ft. altitude

Mach No.	Airspeed (Knots)	Correction (Ft)	Tolerance (±Ft)
0.5	331	186	50
0.6	397	325	70
0.7	463	478	100
0.8	529	616	220
0.85	562	766	220

TABLE D

Corrections at 30 000 ft. altitude

Mach No.	Airspeed (Knots)	Correction (Ft)	Tolerance (±Ft)
0.5	184	−193	50
0.6	223	− 54	70
0.7	263	99	100
0.8	304	237	220
0.85	325	387	220

Power Failure Test

23. (1) With the Pitot-Static Test set connected to the aircraft system and the ground pressure setting on both altimeters set to 1 013 mb. Adjust the static pressure to give an altitude indication of 10 000 ft on the Mk.30A altimeter. Set the Mk.29B altimeter to the RESET Mode.

(2) Switch the Engine Master Switch to OFF removing power supplies from both altimeters.

The Mk.30A altimeter power failure and P.E. flags should appear and the Mk.29B should revert to the stand-by mode with the flag showing ST.BY., the vibrator should not operate.

(3) Progressively reduce static pressure to atmospheric pressure and observe that the instruments follow the pressure reduction.

(4) Switch the Engine Master Switch to ON, the Mk.29B altimeter should indicate ST.BY. with vibrator operating. Select RESET, the ST. BY. flag should retract and the vibrator cease operating.

(5) Select the TACAN Ground Test Switch to TEST, and check that the TACAN inverter operates.

Select the Altimeter Power Supply Switch to STANDBY, both altimeters should be supplied from the TACAN inverter. Return the TACAN Ground Test Switch to NORMAL and remove power from the altimeters.

Select the Altimeter Power Supply Switch to NORMAL and the altimeters should again be supplied from the Type F.1.45E inverter.

(6) SELECT the Engine and Battery Master Switches to OFF, remove the external 28V d.c. supply and

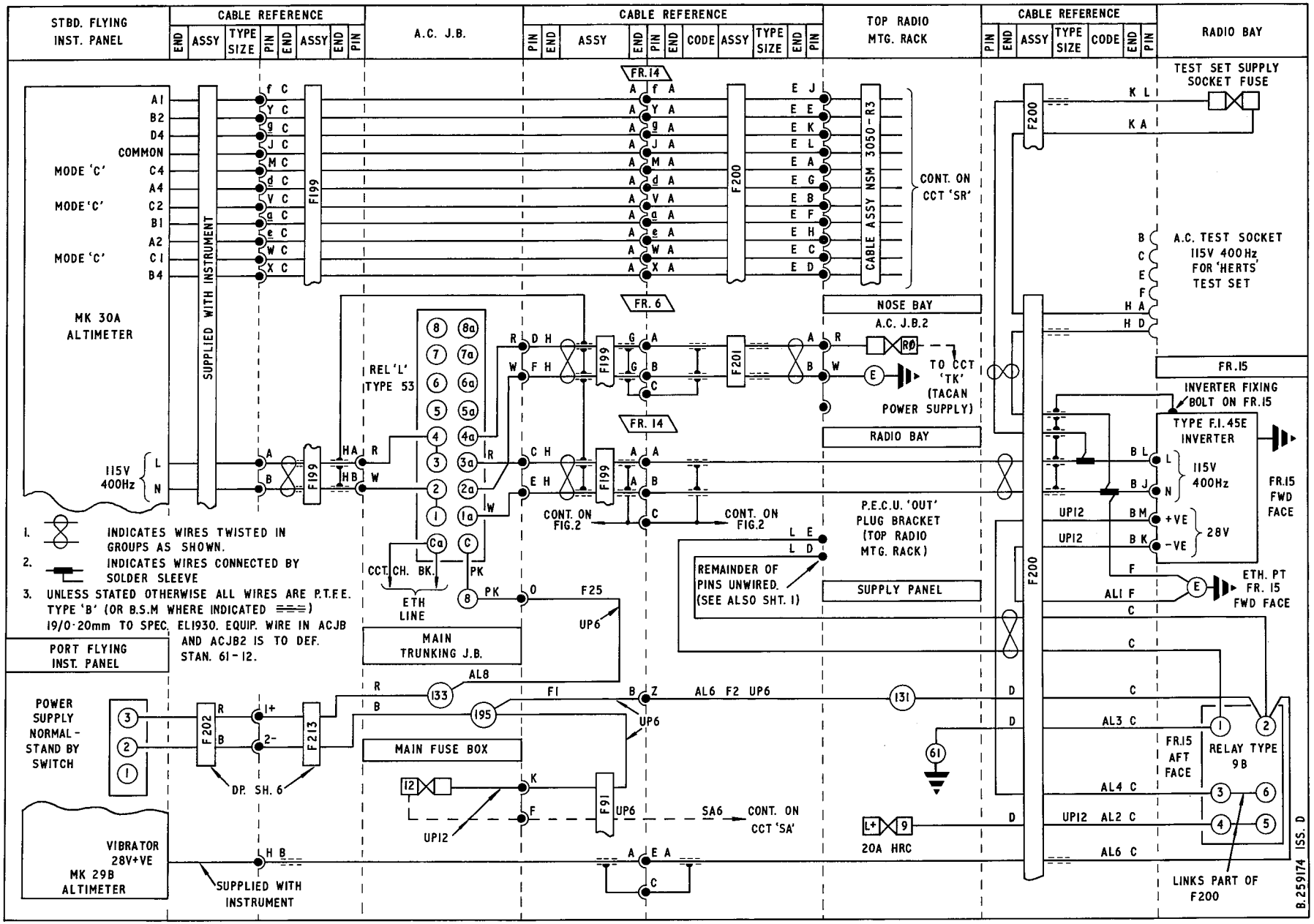

Fig.3 Altimeter — Height Encoding Routeing

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test equipment.
Fit protective caps th the A.C. and D.C. Test Set Supply Sockets in the Radio Bay.

REMOVAL AND ASSEMBLY

General

24. Removal of the altimeters necessitates removal of the relevant instrument panel and is fully described in Chap.2, Group 1B. Removal and assembly procedures for all other equipment presents no difficulty once access has been gained.