Group 2

FLYING INSTRUMENTS

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Introduction

1. This group contains descriptive and servicing information for the aircraft flying instruments and associated controls. These instruments provide indication of the aircraft's performance and attitude in flight and are installed on the pilots' panels and the plotter's instrument panel at the navigation station. All flight instruments used are of the fluorescent type and include the following:-

(1) Airspeed indicators
(2) Altimeters
(3) Rate-of-climb indicators
(4) Machmeters
(5) Turn and slip indicators
(6) Artificial horizon indicators
(7) Control surface indicator

The instrument panels are provided with anti-vibration mountings and the instruments are arranged as illustrated in fig.1.

2. Short lengths of Maricon tubing, Ref.No.32C/679, with clips, Type AGS.606 Mk.E, are used to connect the supply pipes for the pitot-static flight instruments to the main pressure and static lines. The pitot-static system is described in Group 1.

3. The text deals briefly with power supplies for the electrically-operated instruments but full details are given in Chapter 1 of this section. Routing charts for the instrument circuits are included in this group at the end of the text.

4. A full description of the instruments, including operating and servicing instructions, will be found in their associated Air Publication. A list of these publications including the instrument Mk. number is contained in Table 1. The following Vulcan Mods, are included in this group:-

Mod.353 - Introduction of Zero Reader.
Mod.395 - To transfer the G.4.B. compass and artificial horizon supply from the 100A inverter to the No.3 Type 350 inverter.
Mod.505 - Introduction of altimeter Mk.19B in lieu of Mk.19A.

The following modifications affecting the flying instruments are covered by this amendment:-

Mod.552 - Introduction of airspeed indicator (Ref.No.6A/3360) in lieu of Ref.No. 6A/4375) (first pilot) and (Ref.No.6A/4378) in lieu of (Ref.No.6A/4379) (second pilot).

Mod.1377- Introduction of airspeed indicator Ref. No. 6A/3360 at the second pilot's station.

◀ Mod.1700 Supersedes Mod.505 and introduces Mk.19F altimeters with vibrators in lieu of Mk.19B or 19C. ▶

TABLE 1
Flying Instruments

Component	Mk. No.	No. off	A.P. details
Air speed indicator,	-	1	A.P.1275B, Vol.1, Sect. 1
Air speed indicator,	-	2	
Altimeter	◀ 19F ▶	3	A.P.1275A, Vol.1, Sect.22
Rate-of-climb indicator	3P	2	A.P.1275A, Vol.1, Sect. 1
Machmeter	3A	2	A.P.1275B, Vol.1, Sect. 1
Turn and slip indicator	2	2	A.P.1275A, Vol.1, Sect. 2
Artificial horizon	4	2	
Control surface indicator, Type S167-1	-	1	A.P.1275A, Vol.1, Sect. 1
Position indicator, Type S132	-	9	

DESCRIPTION AND OPERATION

AIR SPEED INDICATORS

5. Three airspeed indicators connected to the pressure and static lines are installed one on each pilots' flight instrument panel and the plotter's instrument panel. These instruments are calibrated to indicate the aircraft's speed over a range 50 to 490 knots.

6. The first pilot's instrument, Type K.A.B.0506, is fitted with a magnetic indicator flag for warning the pilot to lower the alighting gear when the aircraft is being brought in to land. The other two instruments, Type K.A.B.0505, are not equipped with this warning device and differ only in this respect.

Mod.552

6A. After Mod.552 an airspeed indicator (Ref.No.6A/3360) is fitted at the first pilot's station and the second pilot's station is fitted with an airspeed indicator, Ref.No.6A/4378.

Mod.1377

6B. After Mod.1377 the airspeed indicator (Ref.No.6A/4378) at the second pilot's station is removed and an airspeed indicator Ref.No.6A/3360 fitted. This modification brings the second pilot's A.S.I. in line with the A.S.I. on the first pilot's panel and thus any risk of these instruments being mis-read is minimized.

FIRST PILOT'S WARNING INDICATOR

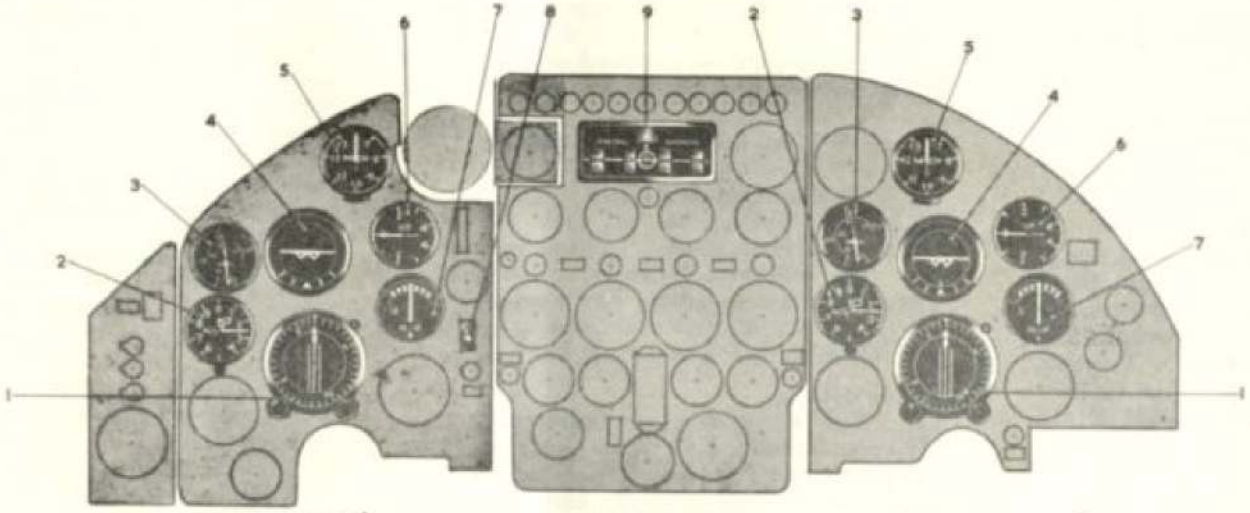
7. The first pilot's warning indicator is electrically-operated by an air speed pressure switch within the instrument and the electrical connections are made at the back of the instrument in the form of a 2-pin plug. The circuit is controlled by the main and nose wheel unit DOWN switches and forms part of the alighting gear indication circuit illustrated in Chapter 1, Group 7. When the speed of the aircraft has dropped to 160 knots the contacts of the air speed pressure switch will close. With the main wheel units at any position other than fully locked down, the warning flag will operate to indicate U/C on the upper part of the instrument scale (pre. Mod.552).

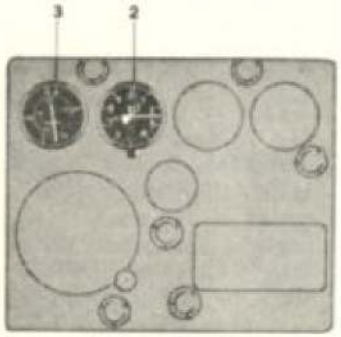
ALTIMETERS

8. The pilots' flight instrument panels and the plotter's instrument panel are each ◀ equipped with an altimeter, Mk.19F, connected to the static line. These altimeters ▶ are of the sensitive type and are designed to record very small changes in altitude ◀ over a range of 0 to 60,000 ft. To improve the performance of the Mk.19F altimeter a vibrator unit, Ref.No.6A/7041, is clamped around the altimeter casing and imparts vibration to the mechanism to clear sticking of the pointer at high altitudes. A routing chart is contained in fig.5. ▶

RATE-OF-CLIMB INDICATORS

9. Two rate-of-climb indicators, Mk. 3P, are installed, one on each pilot's flight instrument panel, and are connected to the static side of the pitot-static system. These indicators, which operate on a rate of change of atmospheric pressure, have a range of up to 4,000 ft. per minute.





KEY

1 G.B compass gyro unit
2 Altimeter
3 Air speed indicator
4 Artificial horizon indicator
5 Machmeter
6 Rate-of-climb indicator
7 Turn and slip indicator
8 Turn and slip emergency switch
9 Control surfaces indicator

* NOTE:- When Mod. 353 is embodied this indicator is replaced by a horizon gyro No.1.

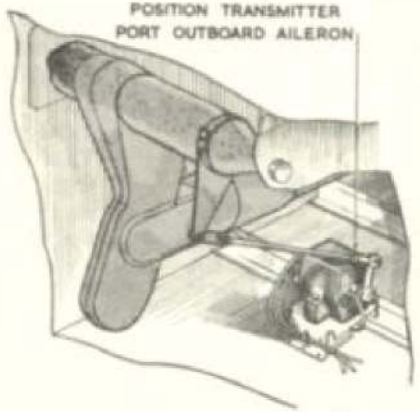


Fig. 1 Arrangement of flying instruments

MACHMETERS

10. A transonic machmeter, Mk.3A, is fitted to each pilots' flight instrument panel. The machmeters are connected to the pressure and static pipes of the pitot-static systems and are calibrated to give the pilots a continuous indication of the ratio of true air speed to the speed of sound. This ratio is known as the Mach number or (M). The machmeter, Mk.3A, is designed to operate over a range 0·7 to 1·3 Mach.

TURN AND SLIP INDICATORS

11. Two turn and slip indicators, Mk.2, are installed one on each pilots' flight instrument panel. This type of indicator is a combination of two instruments viz. (a) an electrically-operated gyroscopic turn indicator, and (b) a ball type inclinometer which indicates the amount of aircraft slip in flight.

Power supplies

12. The turn and slip indicators are connected to the aircraft's 28-volt d.c. supply. The first pilot's indicator is fed from fuse 25 in the port fuse and relay panel (3P) via an emergency switch; the second pilot's indicator is fed from fuse 143 in the starboard fuse and relay panel (4P). A routing chart of the circuit is contained in fig.2.

Power failure indication

13. A power failure warning device is incorporated in each instrument in the form of a flag type indicator. The flag will indicate OFF when no power is available. When the supply is connected the flag will move upwards and the word OFF will disappear from view.

Emergency operation

14. In the event of an electrical power failure the first pilot's turn and slip indicator will be fed from two 24-volt emergency batteries (Stores Ref.5J/3340) situated under the port console (6P). This is accomplished by a 2-position switch labelled SLIP AND TURN on the first pilot's instrument panel. When the switch is selected to the up (STAND BY) position the first pilot's indicator will be cut off from the aircraft 28-volt bus-bar and directly connected to the emergency batteries. These batteries also supply the emergency lighting circuit described in Chap.1, Group 10.

15. The second pilot's turn and slip indicator is fed directly from the aircraft supply and cannot be switched over to the emergency batteries.

ARTIFICIAL HORIZON INDICATORS
(Pre Mod. 353 and 395)

16. Two artificial horizon indicators, Mk.4, are fitted, one to each pilot's flight instrument panel. These indicators are electrically-driven gyroscopic instruments and provide a continuous indication of the aircraft's attitude in pitch and roll relative to the natural horizon.

Power supplies

17. The instruments are operated on a 115-volt, 3-phase, 400 cycles a.c. supply one phase wire from the instruments being connected to the aircraft earth return system. Fuses for the indicators, which are located in the a.c. supplies panel (11P), are numbered 255, 256 for the first pilot's indicator, and 257, 258 for the second pilot's indicator. A routing chart of the instrument supplies is contained in fig.3.

18. Power for the artificial horizon indicators is supplied from No.6 inverter This inverter, Type 100A, is mounted, together with its control panel, on a shelf at the starboard side of the cabin below the crew's floor. The inverter also provides power for the G-4.B. compass installation (Group 3).

19. Automatic and manual control for the inverter is provided by a 2-position switch on the a.c. switch panel at the navigation station. This switch is spring-loaded to the AUTO position. A further switch on the panel is used to stop the inverter. Should the power supplies to the artificial horizon indicators fail in flight, the circuit will automatically be transferred to No.3 inverter, Type 350. Full details of the a.c. supplies to the indicators will be found in Chap.1, Group 3 of this section.

Power failure indication

20. The artificial horizon, Mk.4, is equipped with a flag type indicator which provides warning of power failure. The flag bearing the word OFF is visible when the instrument is disconnected from the electrical supply. When the supply is normal the flag will be rotated a few degrees and the OFF indication will disappear from view. Should the power supply to the instrument fail in one or more phases, the flag will drop back into position due to insufficient torque and will indicate OFF.

Fast erection push-switch

21. A push-switch fitted to the front flange of the instrument case, provides for fast erection of the gyro system. Operation of this fast erection switch bypasses an auto transformer which supplies a reduced line voltage to the torque motors for normal erection. When the switch is pressed the full line voltage (115) is applied to the motors and the gyro will be erected quickly at a rate of 2 deg. per second. This facility should be used only when the gyro has toppled or when the instrument does not settle after having been switched on.

ARTIFICIAL HORIZON INDICATORS
(Post Mod. 353)

22. On aircraft where Mod.353 has been embodied, a Zero Reader flight director is installed and the No.6 (Type 100A) inverter is removed. Also, the artificial horizon indicator Mk.4 on the second pilot's panel is replaced by a gyro horizon Mk.1. The 115-volt 3-phase 400 cycle a.c. supply is now fed from the No.3 (Type 350) inverter, and the artificial horizon and the gyro horizon are fed from this source. The No.3 inverter is switched on automatically with engine starting, and in the event of a failure of the inverter, the load automatically transferred to the No.2 (Type 350) inverter. Full details of the switching control of the supplies to the artificial horizon and gyro horizon indicators with Mod.353 will be included in Sect.5, Chap.1, Group 3 of this publication by amendment action.

ARTIFICIAL HORIZON INDICATORS (Post Mod. 395, Pre Mod. 353)

23. On aircraft where Mod. 353 has not been embodied, Mod. 395 is allocated to delete the No. 6 (Type 100A) inverter, and transfer the artificial horizon loads to the No. 3 (Type 350) inverter. In this case, however, due to the fact that the Zero Reader is not fitted, the artificial horizon indicator Mk. 4 on the second pilot's panel is not changed.

CONTROL SURFACES INDICATOR

24. Indication of the position of the aircraft powered flying control surfaces is given by a ratiometer indicator, Type 167-1, fitted on the pilots' centre panel (1P). Two datum lines, one vertical and one horizontal, are fixed in the centre of the face of the instrument and represent a view of the aircraft looking forward from the tail end. The horizontal datum is marked TAKE-OFF. Electrical connections are provided at the back of the instrument in the form of three Mk. 4 plugs. These plugs are colour identified red, green and yellow respectively to correspond with aircraft socket connections.

25. Indication is provided by nine fluorescent arms which move across the datum lines and simulate the rudder, the outboard and inboard ailerons, and the outboard and inboard elevators. The direction of movement of each arm is governed by an operating coil.

26. The control of each indicator arm is effected by a position transmitter operated by each flying control surface. The system is connected to the 28-volt d.c. supply which is separately fused to each transmitter. The fuses number 476 to 484 inclusive and are located in the rear distribution panel (26P).

Position transmitters

27. The position transmitter, Type S132, takes the form of a toroidal resistance winding connected to three terminals. An operating shaft within the assembly moves an arm which wipes over one side of the winding. The wiper arm is connected to the positive supply terminal No. 3.

28. Two adjustable arms make contact on the other side of the potentiometer and are operated by two knurled knobs B and C fitted on the outside of the transmitter housing. The two arms are locked in their selected positions by a locknut and are electrically connected to terminals 1 and 2, which in turn are connected to the pilot's indicator.

29. The shaft of each transmitter is mechanically linked by an operating rod and lever to its associated aileron, elevator or rudder. Movement of the control surfaces will cause each transmitter to vary the direction of current in the operating coil of its respective indicator arm within the pilots' instrument. The indicator arms representing the ailerons and elevators will move up or down accordingly from the TAKE-OFF position; the arm simulating the rudder will move to the left or right. A routing chart of the circuit is contained in fig. 4.

SERVICING

GENERAL

30. It is important that complete co-operation is maintained between the instrument and electrical tradesmen where the servicing of electrical instruments and the circuit functions are concerned. Power supplies to instruments must be checked prior to the removal of any instrument suspected of being unserviceable. Reference is given in the following paragraphs to the Standard Serviceability Test and associated Air Publication of each instrument.

AIR SPEED INDICATORS

31. The required tests and tolerances for both types of air speed indicators will be found in the Standard Serviceability Test of the appropriate appendix to A.P.1275B, Vol. 1, Sect. 1, Chap. 1.

First pilot's indicator

32. With a suitable manometer provided in the A.S.I. system the air speed pressure switch integral with the instrument can be tested to operate the magnetic warning flag. This function should be carried out during retraction tests of the alighting gear when the electrical tradesman is checking the alighting indication circuit and is outlined as follows:—

(1) Connect a suitable manometer in the port pressure line.

(2) With an applied pressure to the indicator equivalent to an indicated air speed of 170 knots check that there is no movement of the warning flag when the main wheel units are at any position other than fully locked down.

(3) Decrease the pressure slowly and the flag should operate to show U/C when the indicated air speed falls to 160 ± 4 knots.

(4) Check that the indicator flag resumes its original position and remains hidden when the alighting gear is fully locked down.

(5) Remove the manometer from the pitot-static system.

ALTIMETERS

33. The altimeters should be checked at intervals for accuracy. Should any instrument require adjusting by more than 50 ft. it is probable that the mechanism has sustained some damage. In this instance a check for accuracy should be made and any faulty altimeter replaced by a serviceable instrument. The tests and tolerances for altimeters, Mk. 19A, are given in the Standard Serviceability Test (S.G.69) which is contained in Appendix 1 of A.P.1275A, Vol. 1, Sect. 22.

RATE-OF-CLIMB INDICATORS

34. The rate-of-climb indicators should be inspected generally for security of fixings and for any signs of damage including soundness of the glass. Servicing instructions for the rate-of-climb indicators, Mk. 3P, are given in A.P.1275A, Vol. 1, Sect. 1, Chap. 16, and the Standard Serviceability Test for these instruments will be found in Appendix 1 of the same chapter.

MACHMETERS

35. Instructions for the servicing of the transonic machmeters, Mk. 3A, will be found in A.P.1275B, Vol. 1, Sect. 1, Chap. 2. Tests to be applied to these instruments are contained in the Standard Serviceability Test, Appendix 1 of the same chapter.

TURN AND SLIP INDICATORS

36. The turn and slip indicators, Mk. 2, are to be tested in accordance with the Standard Serviceability Test (S.G.64) contained in Appendix 1 of A.P.1275A, Vol. 1, Sect. 2, Chap. 8. These tests are to be carried out on the indicators immediately prior to their being installed in the aircraft, or at any time when the correct functioning of an instrument is suspect. No other servicing is required.

ARTIFICIAL HORIZON INDICATORS

37. The artficial horizon indicators, Mk. 4, are hermetically sealed and specially designed to give long life without attention. Warning of failure of the indicators to operate correctly due to breakdown of any of the supply phases will be given by the instrument power failure warning flags. Should the serviceability of either of the artificial horizon indicators be suspect, it is important that the 115-volt, 3-phase, 400 cycle, a.c. supply be checked, with suitable testmeters, for correct voltage and frequency prior to removal of the instrument. Details for testing the output supplies of the No. 6 inverter, Type 100A, including the correct phase rotation, will be found in Chap. 1, Group 3 of this section.

38. Servicing instructions for these indicators are contained in A.P.1275A, Vol. 1, Sect. 2, Chap. 16. Tests to be applied to instruments suspected of being faulty are detailed in the Standard Serviceability Tests (S.G.74), Appendix 1 of the same chapter. ◄ Servicing information for the gyro horizon indicator Mk. 1 (Mod. 353) will be found in A.P.1275B, Vol. 1, Sect. 17, Chap. 15, App. 1. ►

Warning

The fast erection push-switch must not be pressed within 15 *seconds of switching on and must not be held pressed for longer than* 1 *minute, otherwise damage to the torque motors may result.*

CONTROL SURFACES INDICATOR

39. The control surfaces indicator, Type S167-1, should be checked periodically for security of fixings and general signs of damage. It is important that the electrical plug and socket connections be inspected for tightness and that the indicator glass be kept clean. No other servicing of this instrument is permitted.

40. The instrument can be checked for correct functioning in conjunction with the airframe and electrical tradesmen during ground tests of the powered flying control as laid down in the servicing schedule. Failure of any of the nine indicating arms to respond to the movement of the associated control surface, may be due to an unserviceable fuse. In this event, a new fuse should be fitted in the correct holder of the rear distribution panel (26P).

41. A defective indicator should be replaced by a serviceable one and care taken to ensure that the plugs and sockets are connected according to their colour identification. The tests required for an instrument prior to being installed will be found in A.P.1275A, Vol. 1, Sect. 1. The calibration outlined in para. 42 will also be necessary when a new instrument is fitted, if the limits of travel are not accurately shown when each control surface is operated.

POSITION TRANSMITTER

42. No routine servicing is necessary for the position transmitter, Type S132. The correct setting of the transmitters will be shown on the indicator during the normal checks of the flying control movements. Should failure occur of any control surface indicating circuit, the fuse supplying the respective transmitter should be checked and replaced if unserviceable (para. 38). The method of testing transmitters prior to installation, or transmitters whose accuracy is suspect, will be found in A.P.1275A, Vol. 1, Sect. 1.

43. When a new transmitter is installed, the associated control surface should be in the TAKE-OFF position (para. 44). The operating rod and lever should be connected to the transmitter shaft so that the pointer on the shaft is in line with the engraved marking on the body. Part of the operating rod is threaded to allow for adjustment of the lever. The calibration outlined in the following paragraphs is necessary when the new transmitters are fitted in place of defective items, or when any adjustment of the control surface indicating system is required.

Calibration

44. The calibration of the position transmitters with the pilots' indicator must be done in conjunction with the airframe and electrical tradesmen. Power supplies of 112V and 28V should be available at the aircraft ground supply plugs, since it will be necessary to operate the powered flying controls as described in Chap. 1, Group 6.

45. The transmitters should be set so that the position of the flying control surfaces will be indicated on the pilots' instrument as follows:—

(1) Rudder at neutral showing neutral.

(2) Ailerons at nominal neutral showing TAKE-OFF.

(3) Elevators raised to 3 deg. above nominal neutral showing TAKE-OFF.

The nominal neutral position for the horizontal control surfaces is 3 deg. above the wing chord line.

46. The following instructions for calibration are applicable to all nine position transmitters.

(1) Switch on the motors for the required set of flying controls.

(2) Ensure that the control surfaces are trimmed to the following TAKE-OFF positions as required:—

Rudder at neutral

Aileron at nominal neutral

Elevators at 3 deg. above nominal neutral.

This will be done by the airframe tradesman as described in Book 1, Section 3, Chap. 4.

(3) Ensure that the transmitter shaft is connected as detailed in para. 41.

(4) Loosen locknut A on the transmitter. Rotate knob B fully clockwise and knob C fully anti-clockwise.

(5) Operate the flying control surface to one end of its travel, checking that the associated indicating arm in the pilots' instrument moves in the desired direction.

(6) With the control surface at the end of its travel, rotate knob B or C to bring the indicating arm to the end scale position.

(7) Move the control surface to the opposite end of travel and rotate the other knob to bring the indicating arm to the opposite end scale position.

(8) Repeat operations (6) and (7) until correct readings are obtained.

(9) Lock the adjusting device by means of lock-nut A.

(10) In the case of the elevators, ensure that these are trimmed back to the neutral position.

(11) Switch off the flying control motors.

REMOVAL OF COMPONENTS

GENERAL

47. No special instructions are required for the removal of the flying instruments and position transmitters. It is important that care be taken to ensure that the instruments suffer no jarring effects during removals. This applies particularly to gyroscopic instruments where the mechanism is delicately balanced.

PILOTS' INSTRUMENTS

48. The pilots' instrument panels are easily detached by unscrewing the fastening studs as detailed in Group 1. When the supply services are disconnected the removal of the flying instruments is straightforward.

NAVIGATOR'S INSTRUMENTS

49. Access to the rear of the plotter's instrument panel is gained by lowering the plotter's main panel. The air speed indicator and altimeter can be removed when the instruments are disconnected from the pipe lines and the perspex front on the panel is unscrewed.

POSITION TRANSMITTERS

50. The position transmitters are mounted adjacent to the motors for the powered flying control. The transmitters will be exposed for removal when the hinged panels covering the motors are lowered.

T20035 345667/8099 2/58 500 C & P Gp 375

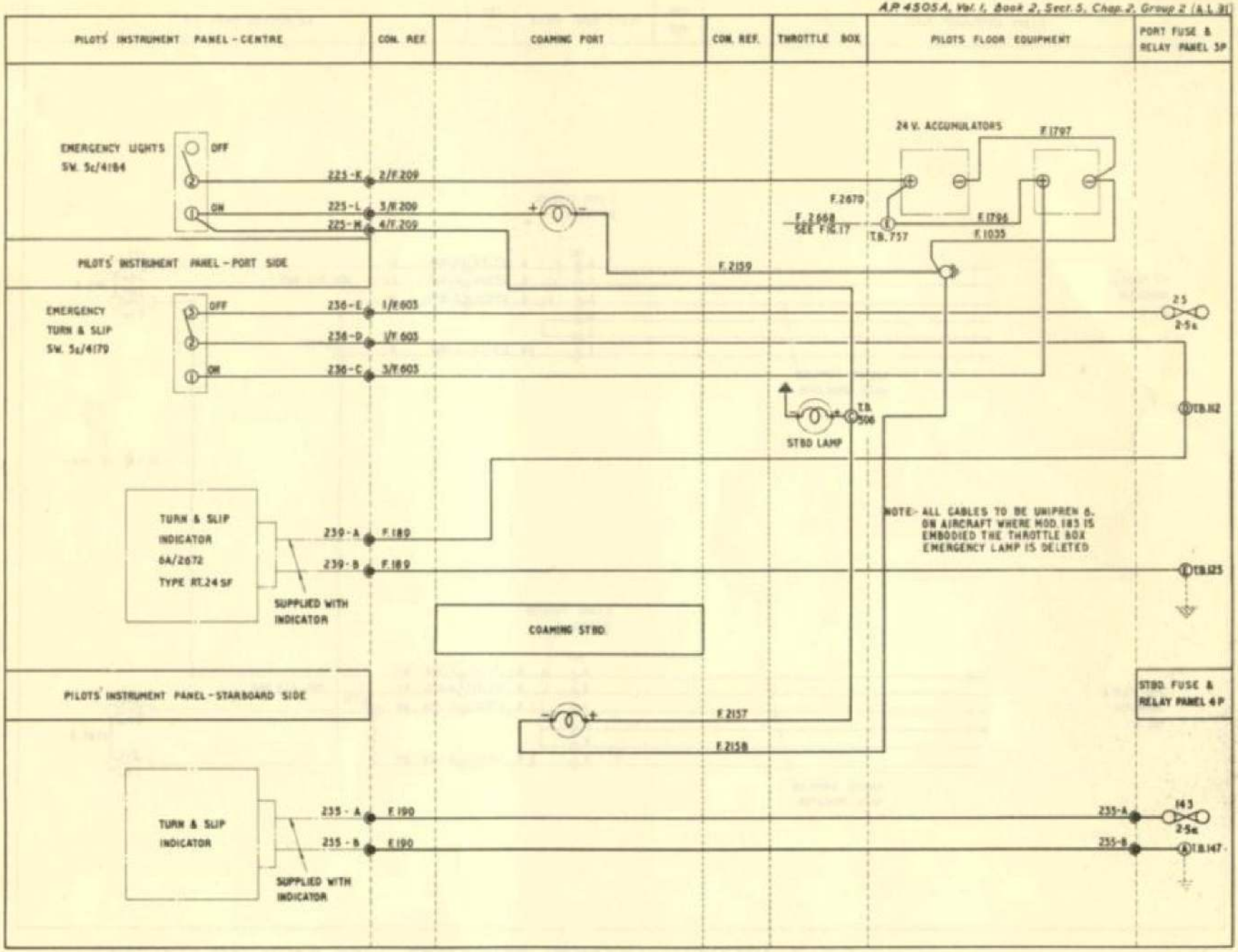


FIG. 2 EMERGENCY LAMPS AND TURN AND SLIP INDICATORS

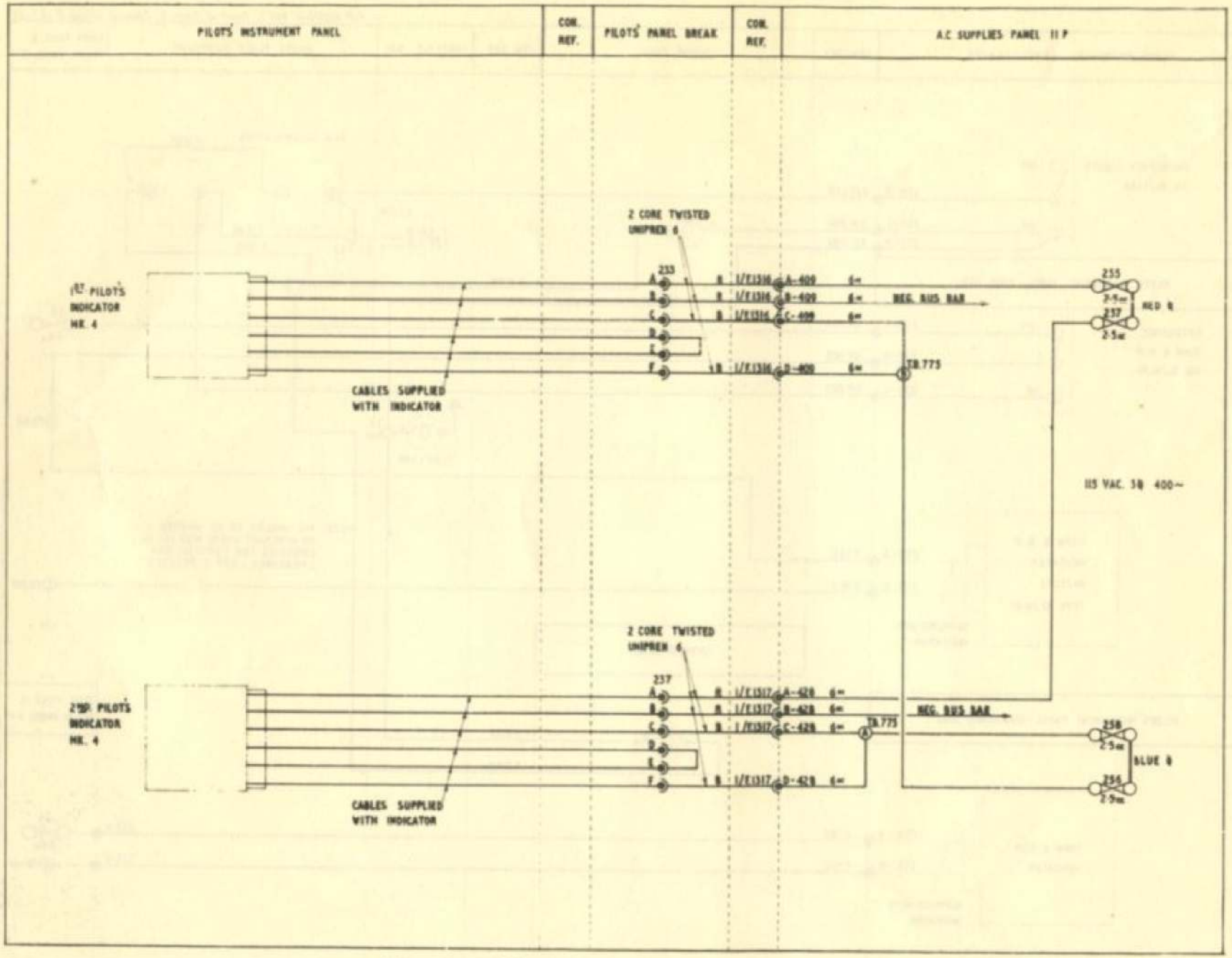


FIG. 3 ARTIFICIAL HORIZON INDICATORS (PRE MOD. 353 AND 395)

RESTRICTED

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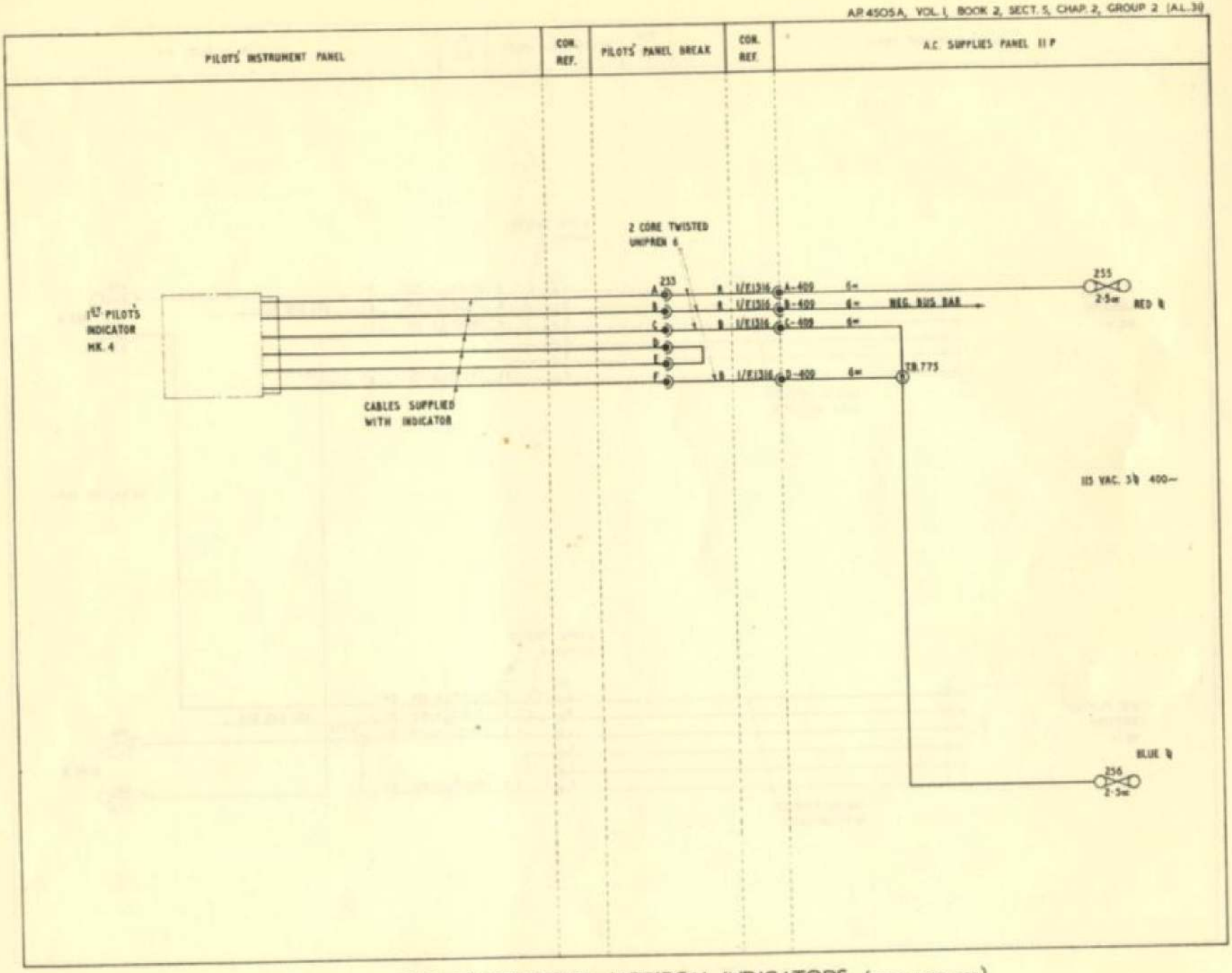

FIG. 3A ARTIFICIAL HORIZON INDICATORS (POST MOD. 353)

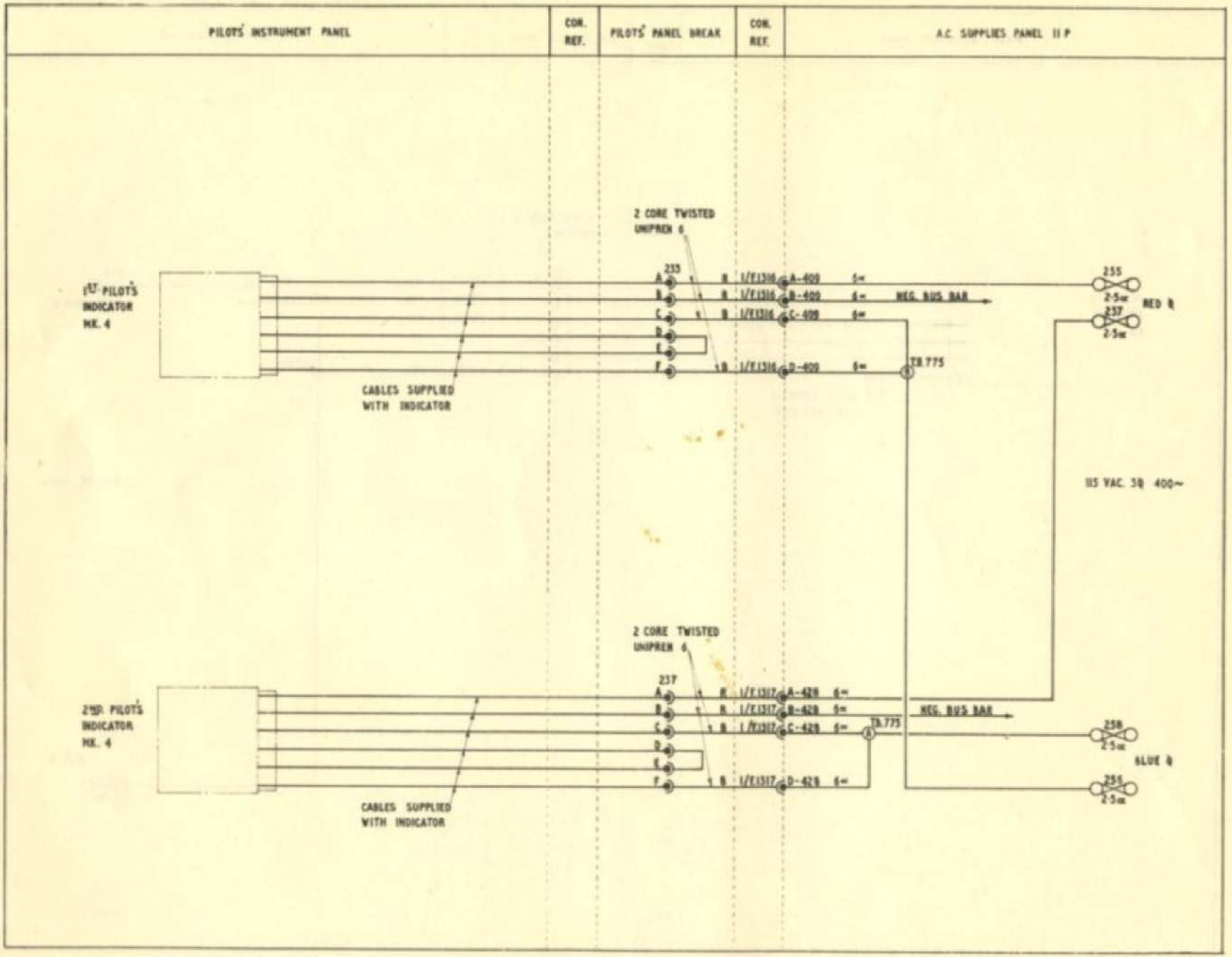

FIG. 3B ARTIFICIAL HORIZON INDICATORS (POST MOD. 395)

RESTRICTED

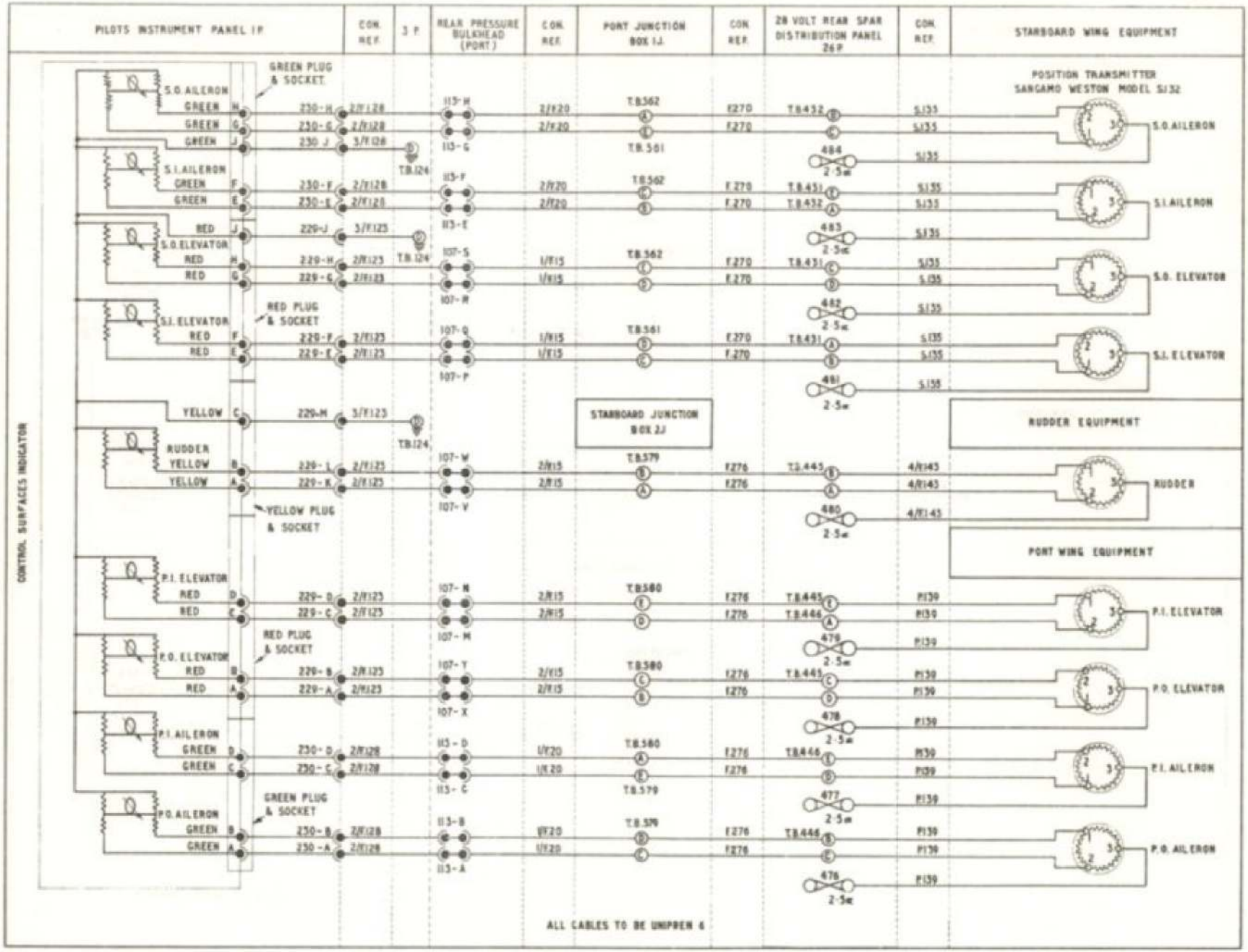

Fig. 4 Control surfaces indicator

RESTRICTED

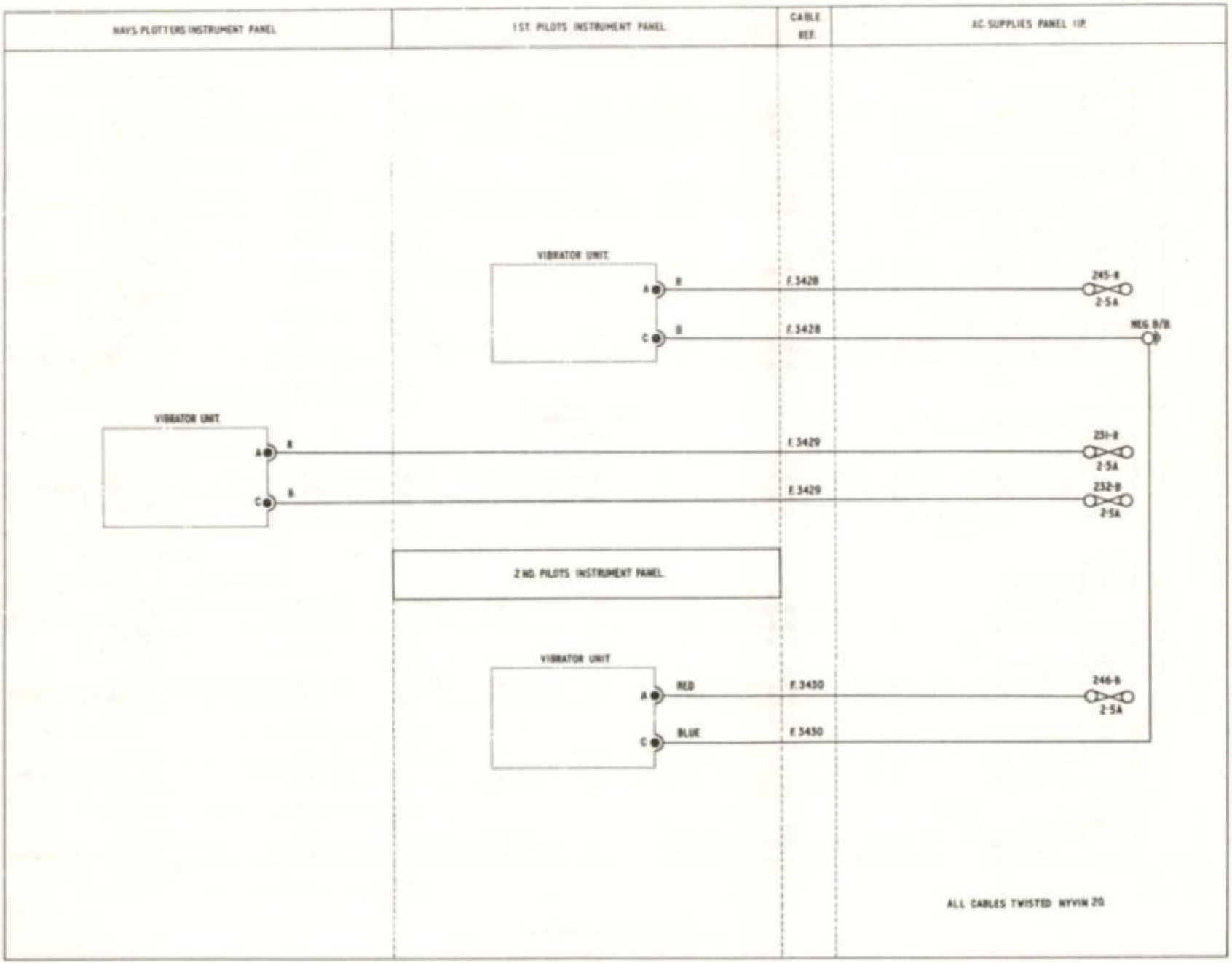

Fig. 5 Vibrator unit control

RESTRICTED