Cancelled Obsolete

Chapter 2

AMPLIFIER UNIT, ULTRA, TYPE A431

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

LEADING PARTICULARS

Amplifier Unit, Ultra, Type A431	Ref. No. 5CZ/6253
Output at datum temperature	225*mA*
Input voltage	115*V*, 400*c/s*, 3 *phase*
Amplifier output (standing current)	50*mA*
Datum temperature variation, using datum trim potentiometer	20°C—30°C
Overall dimensions	6 *in.* x 4 *in.* x 9½ *in.*
Weight	8.5 *lb.*

Introduction

1. The magnetic amplifier unit, Ultra, Type A431 (*fig.* 1), is designed to limit jet-pipe temperature at any predetermined value. Selector bobbins are used in conjunction with the amplifier unit to enable specific datum temperatures to be selected. Each selector bobbin enables a maximum of three datum temperatures to be selected, which are arranged to suit a specific engine requirement. In current jet-pipe temperature control systems, incorporating the A431 amplifier unit, two datum temperatures are used, which correspond to 'take-off' and 'cruise' conditions; these are selected via remotely controlled selector relays.

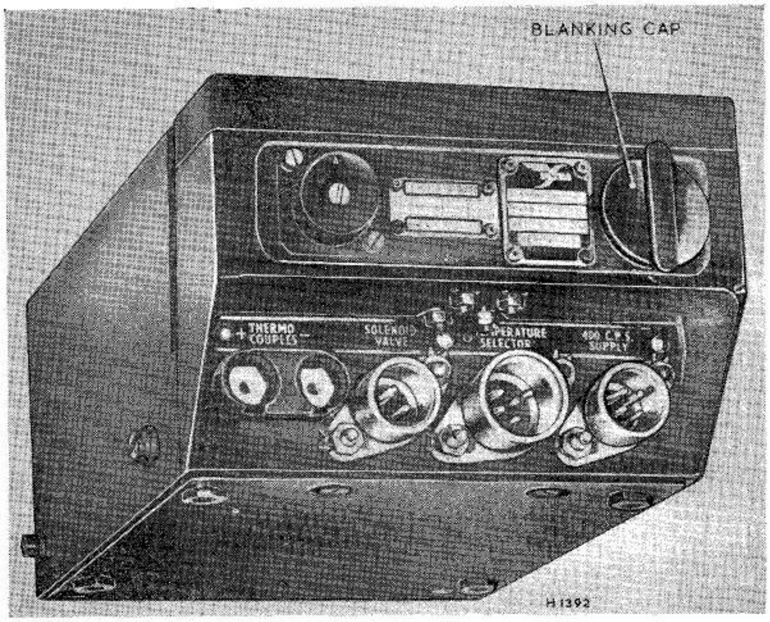

Fig. 1. Amplifier unit, Ultra, Type A431

2. Temperature is sensed by a thermocouple cluster attached to the engine jet-pipe. The thermocouple output is amplified and used to operate a solenoid valve which regulates the fuel flow to the engine, thus preventing it overheating. Principles of jet-pipe temperature control are described in A.P.4343, Vol. 1, Sect. 13, Chap. 4, and principles and applications of magnetic amplifiers are outlined in A.P.4343, Vol. 1, Sect. 1, Chap. 3.

DESCRIPTION

3. The components of the amplifier unit are mounted on two castings, which are assembled to form a single housing. Removing the top covers (*fig.* 2) of the respective castings reveals the amplifying stages, transformer unit, selector relays and the datum trim potentiometer. The illustration of the amplifier unit (*fig.* 1) shows a blanking cap which is removed when inserting a selector bobbin. Amplifying stages 1, 2 and 3, the transformer unit, the cold junction compensator (C.J.C.) and the datum depression unit, are housed in individual sealed cans. Access to their electrical connections is gained by removing the baseplate from the underside of the unit. A layout diagram (*fig.* 7) shows the location of components, together with their respective seal numbers which are mounted on the underside of the amplifier unit. These include the amplifier controls, i.e. gain, stage 1 zero, transient feedback and reference volts (load and balance).

4. The end-casting houses the datum trimmer control, the plug-in datum temperature selector bobbin (*fig.* 3), two selector relays and the following electrical connections:—

(1) A 4-pole plug for the 115V, 400 c/s, 3-phase supply.
(2) A 5-pole plug for the temperature selector switch.
(3) A 2-pole plug for the solenoid valve.
(4) Two terminals to which the compensating leads from the thermocouples are connected.

PRINCIPLES OF OPERATION

5. A block schematic diagram (*fig.* 4) illustrates the basic principle of the jet-pipe temperature control system with the respective amplifying stages. A three-phase input is applied to the transformer unit which provides the power supplies for the amplifying stages and the stabilizing bridge.

6. The required datum temperature level is obtained by energizing the selector relays, via the selector switch, which adjusts the balance of the cold junction compensator (C.J.C.) resistance bridge.

7. A stabilized voltage output from the

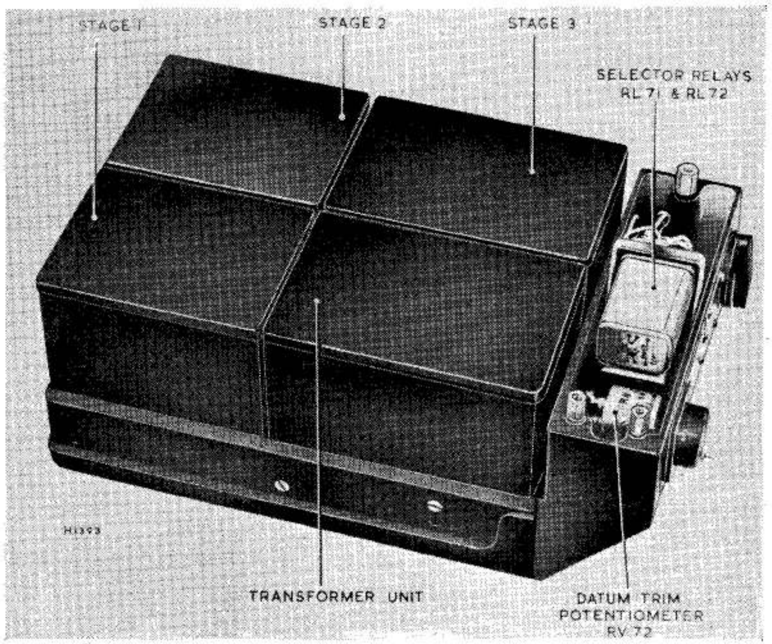

Fig. 2. Top of amplifier (cover removed)

stabilizing bridge, is applied to the C.J.C. bridge and is compared with the signal voltage derived from the thermocouples. The resulting error signal is applied to a three stage magnetic amplifier, the output of which operates a solenoid-actuated valve, regulating the fuel flow to the engine, thus preventing it from overheating.

CIRCUIT DESCRIPTION

8. A circuit diagram (*fig.* 8) shows the connections between individual components of the A431 amplifier unit together with the respective seal numbers which identify the terminals of the components.

Power supplies

9. The transformer unit consists of a three-phase, delta connected transformer, having eight secondary windings, a half-wave power rectifier (W51) and a reference voltage stabilizing bridge. The secondary outputs of the transformer provide power supplies for the amplifying stages and, via the half-wave power rectifier, a d.c. supply (42V) for the stabilizing bridge, and a 9mA supply for biasing the amplifying stages. Each stage incorporates its own bias shunt to adjust the bias current to the appropriate value.

Stabilizing bridge

10. The reference voltage stabilizing bridge provides a stabilized d.c. output of 2mA which is independent of fluctuations in the supply voltage. Stabilization is achieved by utilizing the Zener reverse voltage characteristic of a Silicone diode (WS52) which forms one arm of the bridge.

11. A reference voltage balance potentiometer (RV64) is connected into a further arm of the bridge, via terminals 10 and 20, and a reference voltage load potentiometer (RV68) is connected to the bridge output terminal (19). These two reference voltage potentiometers are pre-set and locked during manufacture to ensure that the correct stabilized reference voltage is applied to the C.J.C. bridge at terminals 2 and 3.

C.J.C. bridge

12. A thermocouple signal is applied to the C.J.C. bridge via the control windings of stage 1 and the datum trim potentiometer (RV72) to terminal 1, and via selector relays and a plug-in datum temperature selector bobbin to terminals 4 and 5. The input signal from the thermocouple, sensed by the thermocouple hot junction, is compared with the stabilized reference voltage at the C.J.C. bridge.

13. Adjustment of the C.J.C. bridge reference voltage, by means of the datum selector and datum trim potentiometer, enables the error signal between the stabilized reference voltage, and the thermocouple input to be set to approximately zero for any required datum temperature. After the initial 'setting-up' procedure, the datum trim potentiometer is used as a final trim when the amplifier is installed in the aircraft.

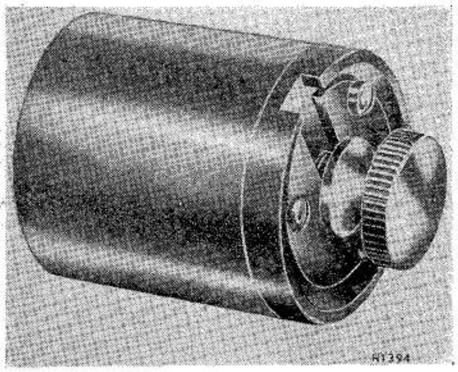

Fig. 3. Selector bobbin

Selector bobbin

14. Various datum temperatures are selected by suitable choice of the plug-in type of selector bobbin (*fig*. 3) which is inserted in the amplifier. Up to two datum temperatures can be selected depending upon the type of selector bobbin inserted. The bobbin incorporates two resistors (R71 and R72 in *fig*. 8) which form part of the C.J.C. bridge. Any one of the two datum temperatures are selected via change-over relays (RL71 and RL72 in *fig*. 8) which are operated from a 28V d.c. supply. The position of the contacts on relay RL72 determine the point on the resistance chain from which the reference voltage is taken. The datum selector control operates as follows:—

(1) With RL71 and RL72 energized, low datum is selected corresponding to cruise conditions.

(2) With both relays de-energized, high datum is selected corresponding to take-off conditions.

15. Datum selectors are designed to suit the requirements of engine manufacturers, and can be made to effect control at any temperature by suitable modification of the values of R71 and R72; the datum selector bobbin is engraved with a stroke letter (stroke A, stroke B, etc.) for identification purposes.

Ambient compensation

16. To limit engine temperature to a selected datum it is necessary to compensate for changes in amplifier thermocouple input signal, due to changes in cold junction ambient temperature. Compensation is effected by the inclusion of a copper resistance coil, located adjacent to the thermocouple input terminals, in one arm of the C.J.C. bridge. The resistance of the copper coil varies as the ambient temperature varies and therefore modifies the balance of the C.J.C. bridge. The subsequent change in the C.J.C. bridge reference voltage is equal and opposite to the voltage change, due to the change in cold junction ambient temperature, at the thermocouple input terminals. The amplifier control circuit is therefore referred to a thermocouple signal voltage which is proportional to the hot junction temperature.

Amplifying stages

17. The error signal, developed from the comparison of the stabilized reference voltage and the thermocouple input signal at the C.J.C. bridge, is applied to the control winding of stage 1. This stage comprises a push-pull pair of transductors with parallel-mixing, separate bias and bridge rectified output. The amplified and rectified output, which is sensed, i.e. of the same direction as the error signal, is subsequently applied to stage 2 via potentiometer RV62, by which means stage 1 is initially balanced.

18. The signal output from stage 1 is further amplified by stages 2, which again comprises a push-pull pair of transductors. The output of stage 2, which is also sensed, is fed onto the control winding of the output stage.

19. The output stage is a 3-phase, auto-self-excited transductor with separate bias, and provides amplification of the stage 2 signals that correspond to the jet-pipe temperatures above the specification datum. The transductor output is rectified to provide a d.c. supply for the solenoid actuated valve in the engine fuel servo system. An increase in engine temperature, above the specified datum, is subsequently corrected by reducing the fuel flow to the engine.

Datum depression

20. The datum depression circuit is connected between the output of stage 2 and the C.J.C. bridge. The function of this circuit is

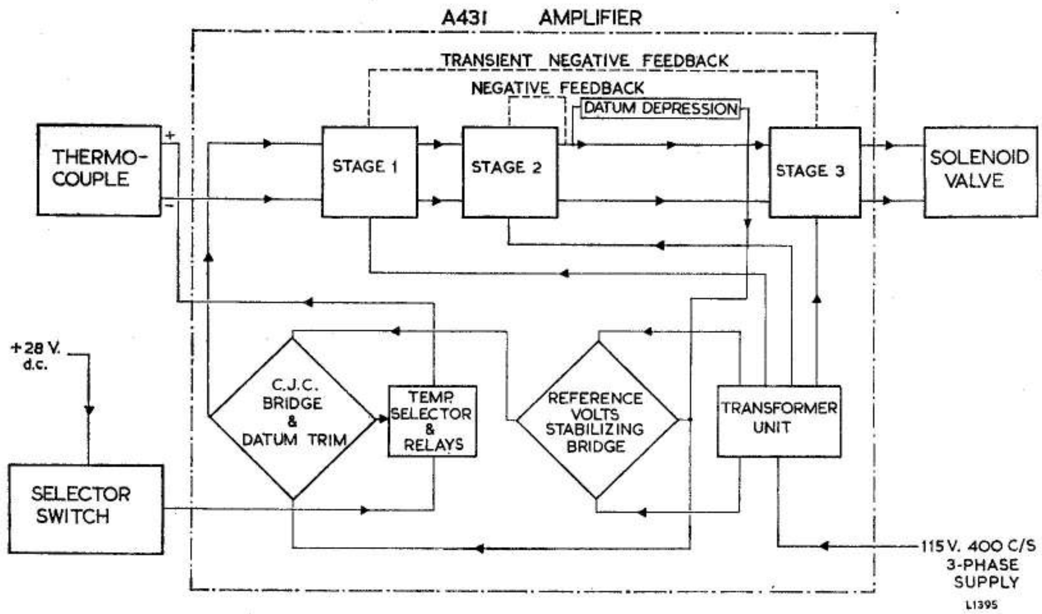

Fig. 4. Block schematic diagram of amplifier stages

to depress the datum temperature during conditions of fast increasing engine temperatures such as those which occur during the initial stages of take-off. This is to compensate for the time lag, which is peculiar to engines with long jet-pipes, between the engine and thermocouple temperatures. A portion of the output of stage 2, from the junction of R603 and R604, is fed back to the C.J.C. bridge via R601 and C63. Thus the datum is depressed by an amount proportional to the rate of rise of thermocouple temperature. When cruise conditions are selected R602 is inserted in the circuit and the effect of datum depression modified.

Feedback circuits

21. The feedback winding is incorporated in stage 1 which enables positive feedback to be applied to the amplifier if, during manufacture, gain is considered low. Should this occur the output terminal is transferred from terminal 7 to terminal 11, thus including the feedback winding in the output circuit.

22. Control of the amplifier gain is effected by adjusting the shunt potentiometer (RV61) in the negative feedback loop of stage 2 (terminals 7, 9, and 13).

23. Stage 3 has a transient negative feedback loop coupled to stage 1, which includes a shunt potentiometer (RV65) used as a velocity feedback control. This feedback loop introduces a small time lag into the amplifier which improves the stability of the control system.

Smoothing

24. Capacitors located in stages 1 and 2 provide smoothing for the bias circuit, voltage stabilizing circuit and the stage 2 output signal.

Datum trim

25. Datum trim control is effected by the potentiometer RV72 in the input circuit. This is a 'click' potentiometer which provides a temperature control range of approximately 25°C. in 15 steps; each step approximating to 1·7°C. The potentiometer is used as a final trim when the amplifier is installed in the aircraft.

Safety resistor

26. A 4·7K ohm resistor (R65), connected across the thermocouple and selector circuit, ensures that a negative signal is passed to the amplifier in the event of an open-circuit fault on the thermocouples.

TESTING

Bench test (Using test equipment type QE2230)

27. The following procedures are adopted to determine the datum temperature, gain and standing current of the amplifier. The equipment required for the bench test is detailed below:—

(1) Test set, Ultra, Type QT223.
(2) Nine-core test cable, Type QY2212.
(3) Four-core test cable, Type QY2216.
(4) A bench test rig made up as shown in the diagram (*fig.* 5).
(5) Temperature selector switch (*fig.* 5).
(6) Datum depression adaptor box, Ultra Type QE2232.
(7) A 115V, 3-phase, 400 c/s supply.
(8) A 28V d.c. supply.
(9) Stop watch.

Test rig connections

28. The thermocouple commoning leads are connected to the amplifier input terminals (thermocouple terminal + and —) and to the test plug (terminals 1 and 2) by special compensating leads. Therefore, it is essential that the connected cables in the bench test circuit shall include Chromel-Alumel leads as shown in fig. 5.

29. In the test rig the resistance of the thermocouple cluster is simulated by a 1 ohm resistor. It is important to ensure that the connecting leads to this resistor make good electrical contact since additional resistance in this circuit will adversely affect the test results.

30. The components of the test rig are assembled as follows:—

(1) Fit Datum Depression Adaptor Box to QT233 test set and connect the 9-pole socket to the corresponding test set plug.
(2) Connect cable QY2212 to the plug on the adaptor box, and to the test plug.
(3) Connect the two 4-pole sockets at the ends of the test leads QY2216 to the A431 amplifier and the test set QT223. Connect the junction box of the test lead QY2216 to the 3-phase, 115V, 400 c/s supply.
(4) Connect test rig sockets to amplifier, and connect the datum temperature selector switch and 28V d.c. supply as shown in fig. 5.
(5) Connect the cores (marked + and —) of the compensating leads to the corresponding terminals of the amplifier thermocouple block.
(6) Ensure the appropriate datum temperature plug is fitted to the amplifier.

Test set preparation

31. Check the test set batteries as follows:—

Reference source battery

(1) Set the TEMPERATURE DATUM and SIGNAL/TEMP. DATUM switch to the TEMPERATURE DATUM and SIGNAL position.
(2) Turn the TEST SELECTOR rotary switch to 'BATTERY'.
(3) Note the reading of Meter II which should be within the GREEN ZONE.

Temperature signal supply battery

(1) Set the TEMPERATURE DATUM and SIGNAL/TEMP. DATUM switch to the TEMPERATURE DATUM and SIGNAL position.
(2) Turn the TEST SELECTOR switch to T/C RES.
(3) Turn the T/C HARNESS SELECTOR to position 'H'.
(4) Depress the T/C RESIST key to the T/C RESIST TEST position.
(5) Turn the TEMP. SIGNAL 'COURSE' control slowly clockwise.
(6) Meter II should show full scale deflection when the 'COURSE' control is turned approximately three quarters full travel.

If either of the Meter II reading differ from those given above, then that particular battery is unserviceable and must be renewed. Instructions for fitting new batteries may be found in Sect. 10, Chap. 1.

32. Ensure that the test box controls are set as follows:—

(1) Datum depression adaptor box IN/OUT switch to OUT.
(2) SPEED DATUM/REHEAT 3-position switch to the centre (OFF) position.
(3) TEMPERATURE DATUM and SIGNAL/TEMP. DATUM 3-position switch to centre (OFF) position.
(4) TEMP. SIGNAL COURSE control is fully anti-clockwise and FINE control is in mid-travel position (i.e. 5 turns clockwise of 10 turn potentiometer).
(5) Meter II range switch to D.C. SOLENOID, 800mA position.
(6) Galvanometer to the FREE position and pointer to zero.

Note . . .

Automatic cold junction compensation is provided within the QT223 test set so that no connections for ambient temperatures variation is required.

Test rig power supplies

33. (1) Switch on the power supply and allow 5 minutes to elapse before proceeding with the tests.

(2) Set the TEST SELECTOR switch to C.P.S., 400c/s should be indicated by Meter I and the PHASING lamp should be extinguished.
(3) Set the TEST SELECTOR switch to VOLTS. The 115V. supply as indicated by Meter II which should be in the Blue Zone indicating the supply to be 110-120 volts. The PHASING lamp should light.

Note . . .
If the PHASING *lamp does not follow this sequence, either one phase is open-circuit, or the phase rotation is incorrect.*

Amplifier datum temperature

34. (1) Set the test rig TEMPERATURE SELECTOR (*fig.* 5) to TAKE-OFF.

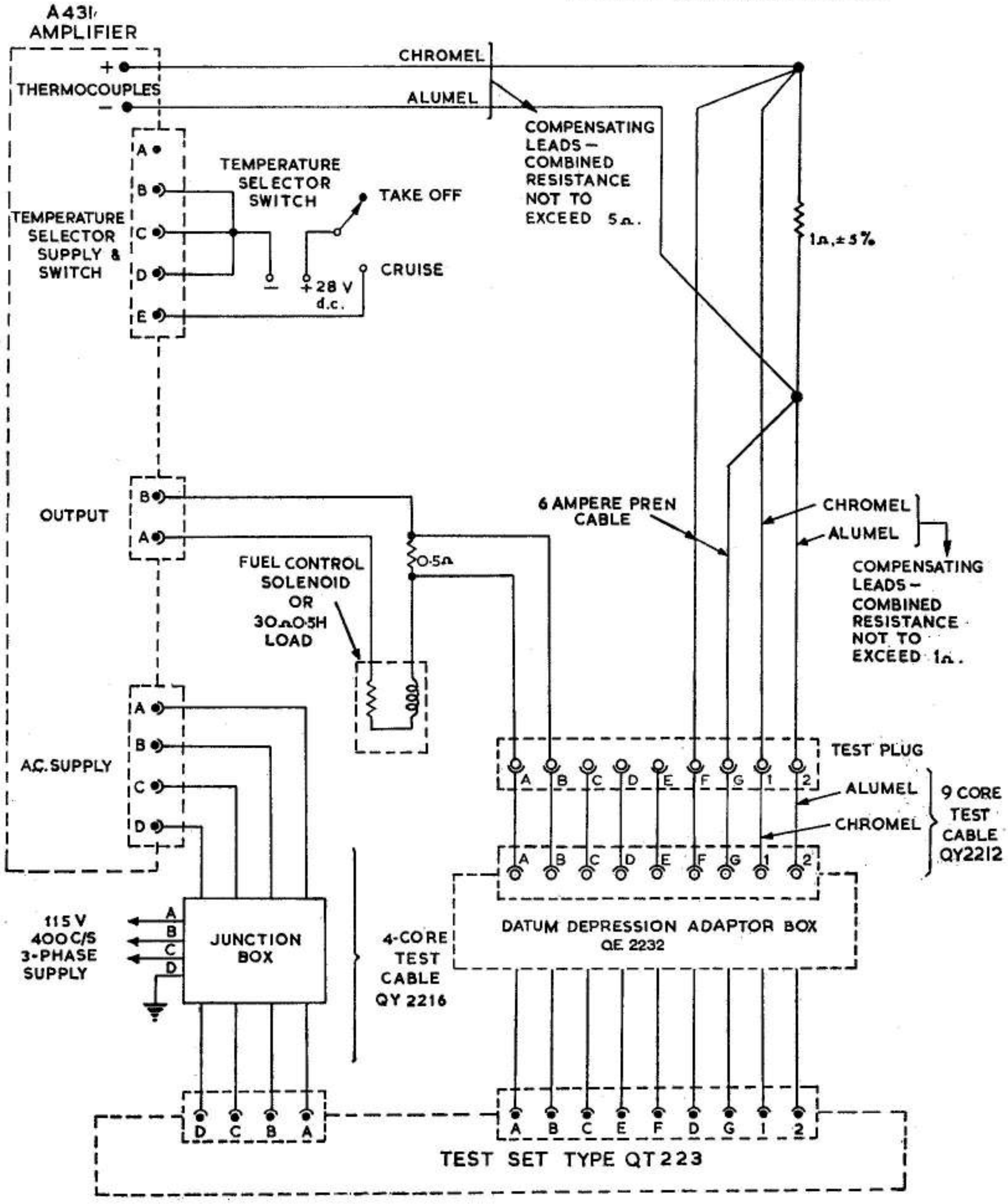

Fig. 5. Bench test circuit

(2) Set the DATUM TEMPERATURE scale on QT223 to the approximate datum temperature for the TAKE-OFF condition. (Red pointer indicates which portion of helix cursor line gives exact reading).

(3) Allow time for stabilization of power supply and re-check frequency and voltages (*para.* 33, *sub-paras.* 2 *and* 3).

(4) Set the T/C HARNESS SELECTOR switch to a position appropriate to the system under test. If a non-current drawing temperature indicator is used, the SERVO POT. position must be selected.

(5) Set the TEST SELECTOR switch to D.C. SOL.

(6) Set the TEMPERATURE DATUM and SIGNAL/TEMP. DATUM switch to TEMPERATURE DATUM and SIGNAL position.

(7) Set METER II range switch to ÷ 2 position.

(8) Set the TEMP. SIGNAL, COURSE control fully anti-clockwise, and ensure that the FINE control is in the mid-travel position (five complete turns from either limit stop).

(9) Turn the COURSE control slowly clockwise until Meter II indicates approximately 450mA. (True reading: 450 ÷2 = 225mA).

Note . . .

When adjusting the COURSE *control to obtain an output current reading on Meter II, allowance must be made for the inherent time lag. If allowance is not made, by careful setting of the* COURSE *control, overshoot of output current will occur.*

(10) Momentarily depress the galvanometer key to the SET-UP position and observe galvanometer. Adjust DATUM TEMPERATURE scale until galvanometer reads within 3 divisions of zero. If the galvanometer reading is to the left of the centre zero, the DATUM TEMPERATURE scale reading must be increased, and if the reading is to the right, the DATUM TEMPERATURE scale must be decreased.

Note . . .

The galvanometer should be depressed for short periods of one or two seconds during 'searching' in order to prevent overload of the galvanometer should there be a large error.

(11) Switch the galvanometer key to the GALVO IN position. Make final adjustments to Meter II reading using the TEMP. SIGNAL, FINE control, if necessary, to give a 450mA indication (true reading 225mA). Adjust DATUM TEMPERATURE scale until zero indication on the galvanometer is obtained.

(12) Read off the datum temperature from the DATUM TEMPERATURE scale. This reading should be within +0 —4°C of the datum specified for TAKE-OFF condition. Return the galvanometer key to mid-position after taking reading.

(13) If the datum temperature is not within the specified limits, re-adjust the datum trim potentiometer over positions F.G.H.J.K. on the amplifier until an acceptable reading is obtained. If an acceptable reading is not obtainable, the amplifier unit, selector unit or the associated cables are at fault.

(14) Repeat the tests to obtain the datum temperatures corresponding to INTERMEDIATE (if applicable) and CRUISE conditions.

Gain

35. (1) Decrease the TEMP. SIGNAL FINE control until the output on Meter II indicates 200mA (true reading 200 ÷ 2 = 100mA, which is BELOW DATUM RESPONSE output current). Measure the temperature required to produce this current, by using the DATUM TEMPERATURE scale, in conjunction with the galvanometer as detailed in para. 34, sub-paras. (10) to (12). Return galvanometer key to mid-position after taking reading.

(2) Increase the TEMP. SIGNAL, FINE control until the output on Meter II indicates 700mA. (True reading 700 ÷ 2 = 350mA, which is above datum response output current). Note the temperature indicated on TEMPERATURE DATUM scale, with zero indication on the galvanometer as in previous sub-para.

(3) The temperature difference between the reading obtained in sub-para. (2) and that obtained in sub-para (1) should be 5·5 to 9·5°C.

(4) Return the galvanometer key to the centre (OFF) position.

Datum depression

36. (1) Ensure that the METER II range switch is in the ÷ 2 position, and that the test rig TEMPERATURE SELECTOR is in TAKE-OFF position.

(2) Decrease the TEMP. SIGNAL, FINE control until Meter II indicates 200mA (true reading 200 ÷ 2 = 100mA.) Note the temperature indicated on the TEMPERATURE DATUM scale for zero indication on the galvanometer. Return the galvanometer key to the centre (OFF) position.

(3) Reduce TEMPERATURE DATUM scale by 25±1°C. Set the IN/OUT switch on the

Datum Depression Adaptor Box QE2232 to IN. Set galvanometer key to GALVO IN and adjust COURSE and FINE controls on ADAPTOR BOX QE2232 until zero reading is obtained on galvanometer. Return galvanometer key to centre (OFF) position, and clamp.

(4) Set IN/OUT switch on ADAPTOR BOX QE2232 to OUT and allow 50 seconds for the reading on Meter II to stabilize to a minimum.

Note . . .

No further adjustments must be made to the controls on the datum Depression Adaptor Box.

(5) Ensure Meter II is indicating 200mA (true reading 200 ÷ 2 = 100mA). Adjust TEMP. SIGNAL, FINE control if necessary.

(6) Set the IN/OUT switch on adaptor box to IN, and after not less than 60 seconds, switch to the OUT position, and simultaneously start the stop watch.

(7) Note the following readings:—

(a) The time to reach peak output current.

(b) The actual peak current attained.

(c) The total time taken for the output current to return to 130mA.

(8) Record the mean of three results, in each case checking that the amplifier steadies at 100mA. The limits obtained should be as follows:—

(a) Time to reach peak current—9 to 16 seconds.

(b) Peak current attained—190 to 350mA.

(c) Time to return to 130mA—25 to 45 seconds.

(9) Ensure the IN/OUT switch on the Adaptor Box is switched to OUT.

Standing current

37. (1) Set the TEMPERATURE DATUM and SIGNAL/TEMP. DATUM switch to the mid-position (OFF).

(2) Observe the amplifier output indicated on Meter II, which must not exceed 100mA (true reading 100 ÷ 2 =50mA).

Disconnecting supplies

38. (1) Rotate COURSE and FINE controls fully anti-clockwise.

(2) Ensure that the galvanometer is CLAMPED.

(3) Switch off the power supply and disconnect the test leads.

Note . . .

Where the aircraft installation includes a 'direct reading' temperature indicator, further adjustment to the amplifier datum trimmer will be necessary to correct for the error introduced by the instrument.

39. If the datum temperatures cannot be obtained or any of the other test figures fail to comply with those specified, the amplifier should be considered unserviceable.

Aircraft test (using test set Type QE2230)

40. The equipment required for the aircraft test, using Ultra QE2230 test set, is detailed below and is connected as shown in the test circuit (*fig.* 6).

(1) Test set, Type QT223.

(2) Datum depression adaptor box QE2232.

(3) Nine-core test cable, Type QY2212.

(4) Nine-core test cable, Type QY2213, for use on aircraft not fitted with the 9-pole test plug.

(5) Four-core test cable, Type QY2166 for monitoring 115V, 400c/s supply.

41. Before commencing any tests, the relevant Aircraft Handbook should be consulted and any interlock or muting switches, which normally render the jet-pipe temperature control system inoperative whilst the aircraft is on the ground, should be made ineffective.

Test connections at aircraft

42. (1) Fit the datum depression adaptor box QE2232 to test set QT223 and connect the 9-pole socket from the adaptor box to the 9-pole plug on the test set.

(2) Remove the blanking cap from the 9-pole aircraft test plug and connect the adaptor box QE2232 to the aircraft test plug using test cable QY2122. In aircraft not fitted with a 9-pole test plug, the commoning terminal of the thermocouple cluster must be located and leads 1 and D of the test cable QY2213 connected to the common positive. Similarly connect leads 2 and G to the common negative of the thermocouples.

(3) Remove the socket from the a.c. supply plug on the A431 amplifier and substitute the socket on one of the two short leads from the junction box of test cable QY2216. Connect the remaining

short lead, from the junction box, with the socket previously connected to the amplifier a.c. supply plug. Connect the remaining socket of test cable QY2216 to the 4-pole plug (PHASING) of the test set.

(4) Connect a battery truck to the aircraft ground supply point and switch on the inverters.

Test set preparation

43. (1) Check the test set batteries in accordance with the instructions given in para. 31.

(2) Check that the SPEED DATUM/REHEAT 3-position switch is in the centre (OFF) position.

(3) Check that the COARSE and FINE controls are fully anti-clockwise.

(4) Check that the TEMPERATURE DATUM and SIGNAL/TEMP. DATUM 3-position switch is in the centre (OFF) position.

(5) Set METER II range switch to D.C.

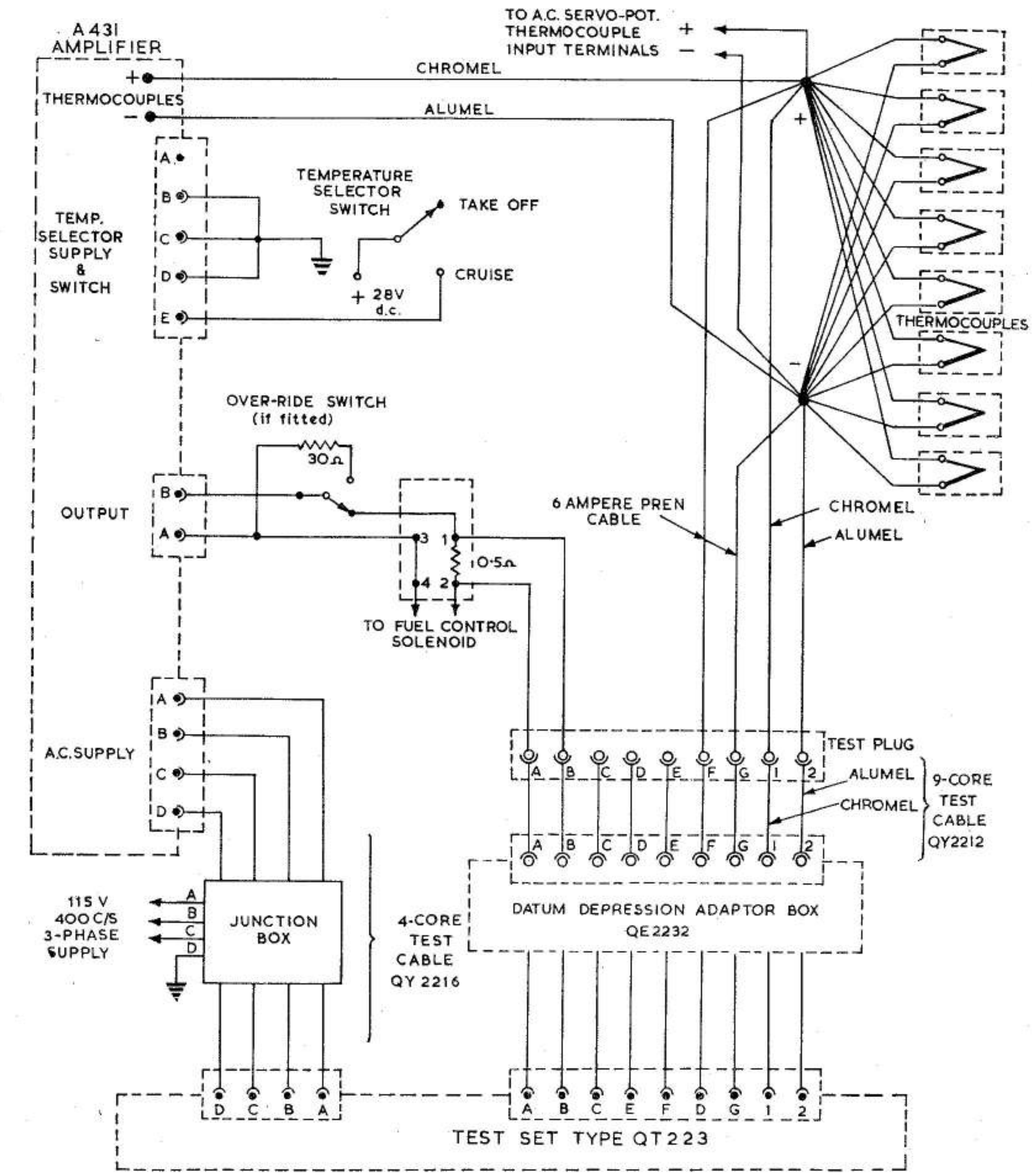

Fig. 6. Aircraft test circuit

SOLENOID 800mA position.
(6) Set the galvanometer to the FREE position and zero the pointer if necessary using the adjust screw.

44. Automatic cold junction compensation is provided within the QT233 test set so that no connection for ambient temperature variation is required.

Aircraft power supplies

45. (1) Allow 5 minutes to elapse after switching on the aircraft inverters.
(2) Set TEST SELECTOR switch to VOLTS. The 115V supply is indicated by Meter II, which should read in the blue zone indicating the supply to be 110—120 volts. The PHASING lamp should light.
(3) Set the TEST SELECTOR to C.P.S. The 400c/s supply is indicated by Meter I and the PHASING lamp should be extinguished.

Note . . .
If the PHASING *lamp does not follow this sequence either one phase is open-circuit, or the phase rotation is incorrect.*

Thermocouple harness resistance test

46. (1) With the T/C HARNESS SELECTOR switch select the standard resistor appropriate to the thermocouple cluster under test.
(2) Rotate the TEST SELECTOR switch to T/C RES.
(3) Set the TEMPERATURE DATUM and SIGNAL/TEMP. DATUM switch to TEMPERATURE DATUM and SIGNAL position.
(4) Rotate the COURSE control clockwise until the pointer of Meter II is directly over the red index line. This applies to a test signal to the thermocouples.
(5) Depress the key switch to T/C RESIS. TEST position thus switching the same test signal to the standard resistor. A change in the reading of Meter II of more than 3 divisions indicates a fault in the thermocouple circuit. This fault should be corrected before continuing the tests.

Note . . .
A high reading on Meter II will indicate a probable short-circuited thermocouple, and a low reading will indicate a probable open-circuited thermocouple.

(6) Rotate the COURSE control to the fully anti-clockwise position and the FINE control to the fully clockwise position.
(7) Set the TEMPERATURE DATUM and SIGNAL/TEMP. DATUM switch to centre (OFF) position.

Amplifier datum temperature

47. (1) Set aircraft TEMPERATURE SELECTOR switch (*fig.* 6) to the TAKE-OFF position.
(2) Set the DATUM TEMPERATURE scale of test set QT223 to the approximate datum temperature for the TAKE-OFF condition. (Red pointer indicates which position of helix cursor line gives exact reading).
(3) Allow time for stabilization of power supply and re-check frequency and voltage, see para. 45.
(4) Set the T/C HARNESS SELECTOR switch to a position appropriate to the system under test. If a non-current drawing temperature indicator is used, the SERVO POT position must be selected.
(5) Set the TEST SELECTOR switch to D.C. SOL.
(6) Set METER II range switch to the 800mA position.
(7) Ensure TEMP. SIGNAL, COURSE control is fully anti-clockwise and the FINE control is fully clockwise.
(8) Set the DATUM TEMPERATURE scale to approximately 5°C above the datum temperature of the system.
(9) The 'standing current' as indicated by Meter II should be 50mA approximately.
(10) Set the TEMPERATURE DATUM and SIGNAL/TEMP. DATUM switch to TEMPERATURE DATUM and SIGNAL position.
(11) Set the galvanometer to the FREE position, and zero as necessary using the adjusting screw.
(12) Turn the COURSE control slowly clockwise until Meter II indicates 350-400mA.

Note . . .
When adjusting the COURSE *control, to obtain an output current on Meter II, allowance must be made for the inherent time lag. If allowance is not made, by careful setting of the* COURSE *control, overshoot of output current may occur.*

(13) Depress galvanometer key momentarily to the SET-UP position, and observe the deflection of the galvanometer pointer. Adjust the COURSE control until the pointer is 'swinging freely' on the scale. (Do not attempt to obtain zero reading). Wait 30 to 40 seconds and set the key switch to the GALVO IN position.

(14) Turn the TEMP. SIGNAL, FINE control anti-clockwise until the reading on Meter II is 250mA approximately.

(15) Set the METER II, D.C. SOLENOID/A.C. ACTUATOR range switch to ÷ 2.

(16) Slowly turn the TEMP. SIGNAL, FINE control anti-clockwise until the reading on Meter II is 450mA (true reading 450 ÷ 2= 225mA).

Note . . .

Any clockwise operation of the FINE *control must be followed by a* 30 *second wait before a reading of Meter II is made.*

(17) Turn the TEMPERATURE DATUM scale in the decrease direction until galvanometer reads zero, ensuring that Meter II is still indicating 225mA.

(18) Read off the datum temperature

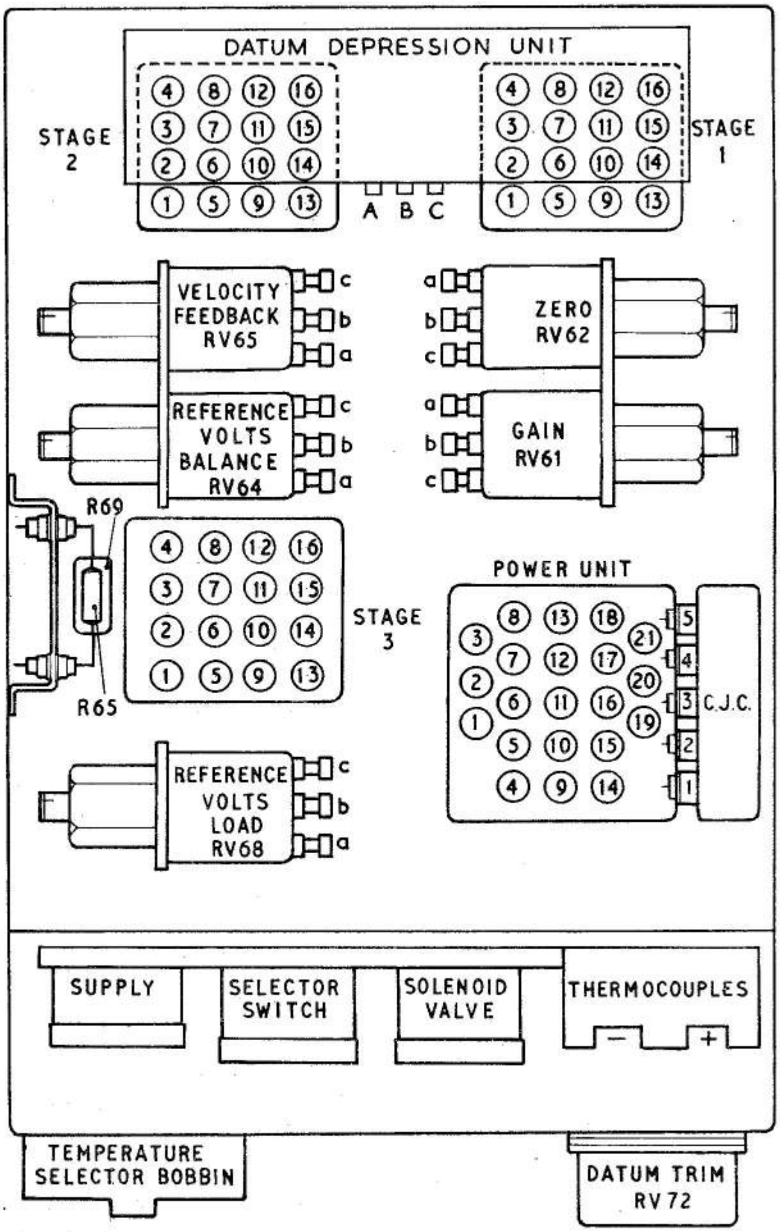

Fig. 7. Layout of amplifier, showing seal numbers

from DATUM TEMPERATURE scale. This reading must be within +0 —4°C of the datum specified for the TAKE-OFF condition, or as specified in the relevant Aircraft Handbook or Engine Manual.

(19) If the datum temperature is not within the specified limits, re-adjust the temperature trimmer on the amplifier until an acceptable figure is obtained. If an acceptable figure is not obtainable, the amplifier unit, selector unit or the associated cables are at fault, and the faulty equipment should be renewed.

(20) Repeat the tests to obtain datum temperatures corresponding to INTERMEDIATE (if applicable) and CRUISE conditions.

(21) Set the GALVO IN/SET-UP switch key to the centre (OFF) position.

(22) Set the TEMPERATURE DATUM and SIGNAL/TEMP. DATUM switch to centre (OFF) position.

Datum depression test

48. (1) Set aircraft TEMPERATURE SELECTOR switch to the TAKE-OFF position.

(2) Set the TEMPERATURE DATUM and SIGNAL/TEMP. DATUM switch to TEMPERATURE DATUM and SIGNAL.

(3) Decrease TEMPERATURE SIGNAL, FINE control until Meter II indicates 200mA (true reading 200 ÷ 2 = 100mA). Note the temperature indicated on the TEMPERATURE DATUM scale for zero indication on the galvanometer.

(4) Return galvanometer to centre (OFF) position.

(5) Reduce TEMPERATURE DATUM scale by 25 ± 1°C.

(6) Set the IN/OUT switch on the Datum Depression Adaptor Box QE2232 to IN.

(7) Set the galvanometer key to the GALVO IN position, and adjust the COURSE and FINE controls on the ADAPTOR BOX until zero indication is obtained on the galvanometer.

(8) Set the galvanometer key to the centre (OFF) position and CLAMP the galvanometer movement.

(9) Set the IN/OUT switch on the Adaptor Box to OUT and allow 50 seconds for the reading on Meter II to stabilize to a minimum.

Note . . .
No further adjustment should be made to the Adaptor box COURSE *and* FINE *controls.*

(10) Ensure Meter II is still indicating 200mA (true reading 200 ÷ 2 = 100mA). Use the TEMP. SIGNAL, FINE control on the test set QT223, to adjust as necessary.

(11) Set the IN/OUT switch on the Adaptor Box to IN and after not less than 60 seconds switch to the OUT position and simultaneously start the stop watch.

(12) Note the following readings:—

(a) The time to reach peak output current.

(b) The actual peak current attained

(c) The total time taken for the output current to return to 130mA.

(13) Record the mean of three results, in each case checking that the amplifier steadies at 100mA. The limits obtained should be as follows:—

(a) Time taken to reach peak current 9 to 16 seconds.

(b) Peak current attained—190 to 350mA.

(c) Time to return to 130mA—25 to 45 seconds.

(14) Ensure the IN/OUT switch on the adaptor box is switched to OUT.

Gain

49. (1) Increase the TEMP. SIGNAL, FINE control very slowly until the output on Meter II indicates 700 to 800mA (true reading 350 to 400mA), which is ABOVE DATUM RESPONSE output current. Decrease the FINE control slowly until the reading on Meter II is 700mA.

(2) Free the galvanometer movement and momentarily depress the key to SET-UP, and observe the galvanometer. Adjust the DATUM TEMPERATURE scale until the galvanometer reads within 3 divisions of zero. If the galvanometer reading is to the left of the centre zero, the DATUM TEMPERATURE scale reading must be increased, and if the reading is to the right, the scale reading must be decreased.

Note . . .
The galvanometer key should be depressed for short periods of one or two seconds during 'searching' in order to prevent overload on the galvanometer should there be a large error.

(3) Switch the galvanometer key to the GALVO IN position. Make final adjustments, if necessary, to the Meter II reading with the TEMP. SIGNAL, FINE control to give

700mA (true reading 750 ÷ 2 = 350mA). Adjust the DATUM TEMPERATURE scale until zero indication on the galvanometer is obtained. Note this temperature reading.
(4) Set the galvanometer key to the centre (OFF) position. Decrease the TEMP SIGNAL, FINE control until the output on Meter II indicates 200mA (true reading 200 ÷ 2 = 100mA). which is BELOW DATUM RESPONSE output current.
(5) Measure the temperature indicated on the DATUM TEMPERATURE scale with zero indication on the galvanometer, in the manner described in sub-paras (2) and (3).
(6) The temperature difference between the reading obtained in sub-para (3) and that obtained in sub-para (5) should be 5·5 to 9·5°C.
(7) Return the galvanometer key to the centre (OFF) position.

Standing current and muting

50. (1) Set the TEMPERATURE DATUM and SIGNAL/TEMP. DATUM switch to the Centre (OFF) position.
(2) Observe amplifier output indicated on Meter II which should not exceed 100mA (true reading 100 ÷ 2 = 50mA.)
(3) Operate the muting switch on Pilot's console, observe that Meter II now reads zero, indicating the amplifier output has been switched from solenoid valve to dummy resistor.

Disconnecting supplies

51. (1) Rotate the TEMP. SIGNAL, COURSE and FINE controls fully anti-clockwise.
(2) Lock the galvanometer in the CLAMP position.
(3) Switch off the inverters.
(4) Disconnect the 4-pole amplifier supply socket from the junction box of QY2216 test lead and re-connect the amplifier socket to the amplifier.
(5) Disconnect the 9-way test cable from the aircraft test plug and replace the blanking cap.

Insulation tests

52. The insulation resistance between the points given below should not be less than 5 megohms when measured with a 250V insulation tester:—
(1) Thermocouple +ve terminal to chassis
(2) Supply pole A to chassis.
(3) Solenoid Pole A to supply pole A.
(4) Solenoid pole A to chassis.
(5) Thermocouple +ve terminal to solenoid pole A.
(6) Thermocouple +ve terminal to supply pole A.

Note . . .
The appropriate selector plug should be connected to the amplifier during the insulation tests.

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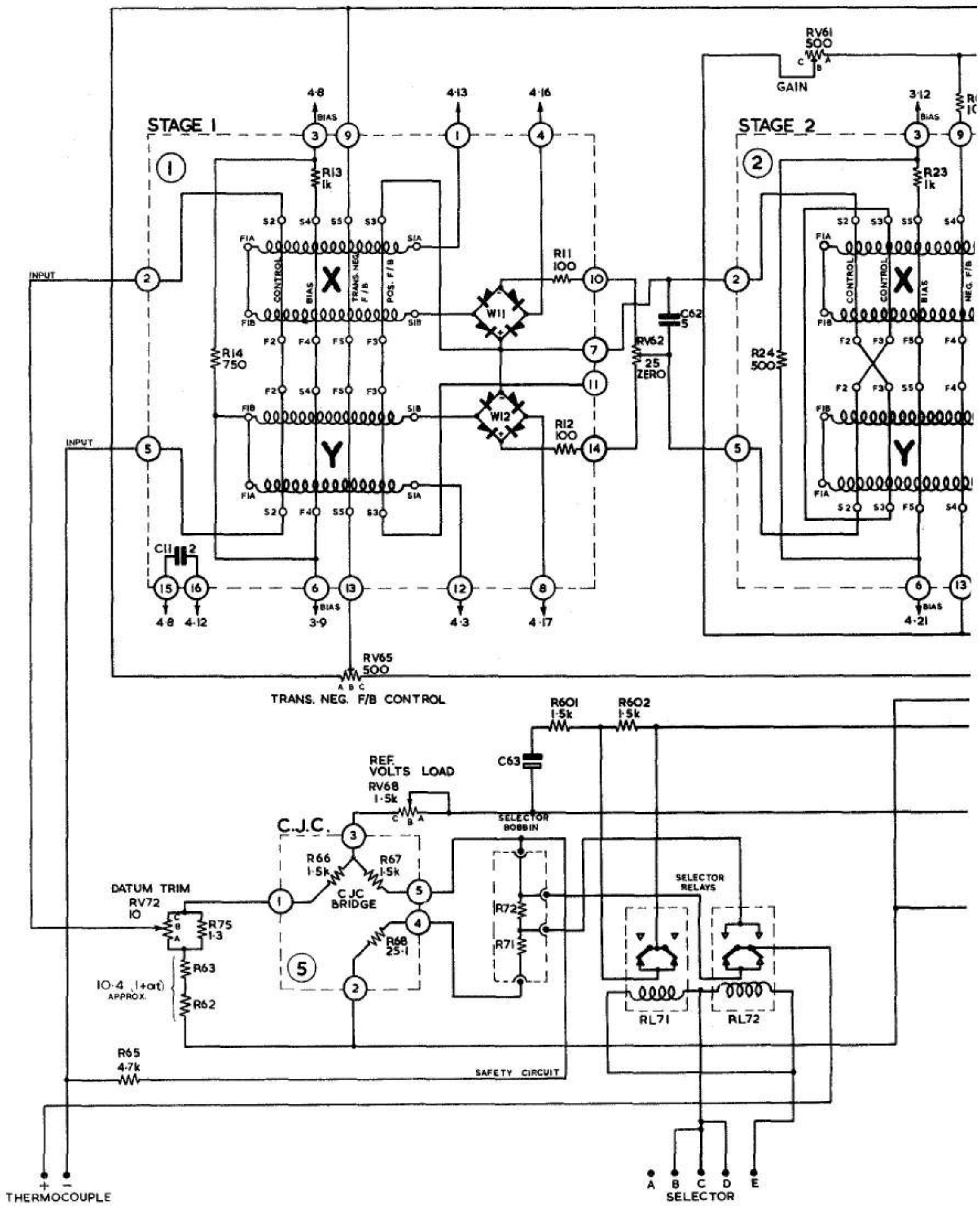
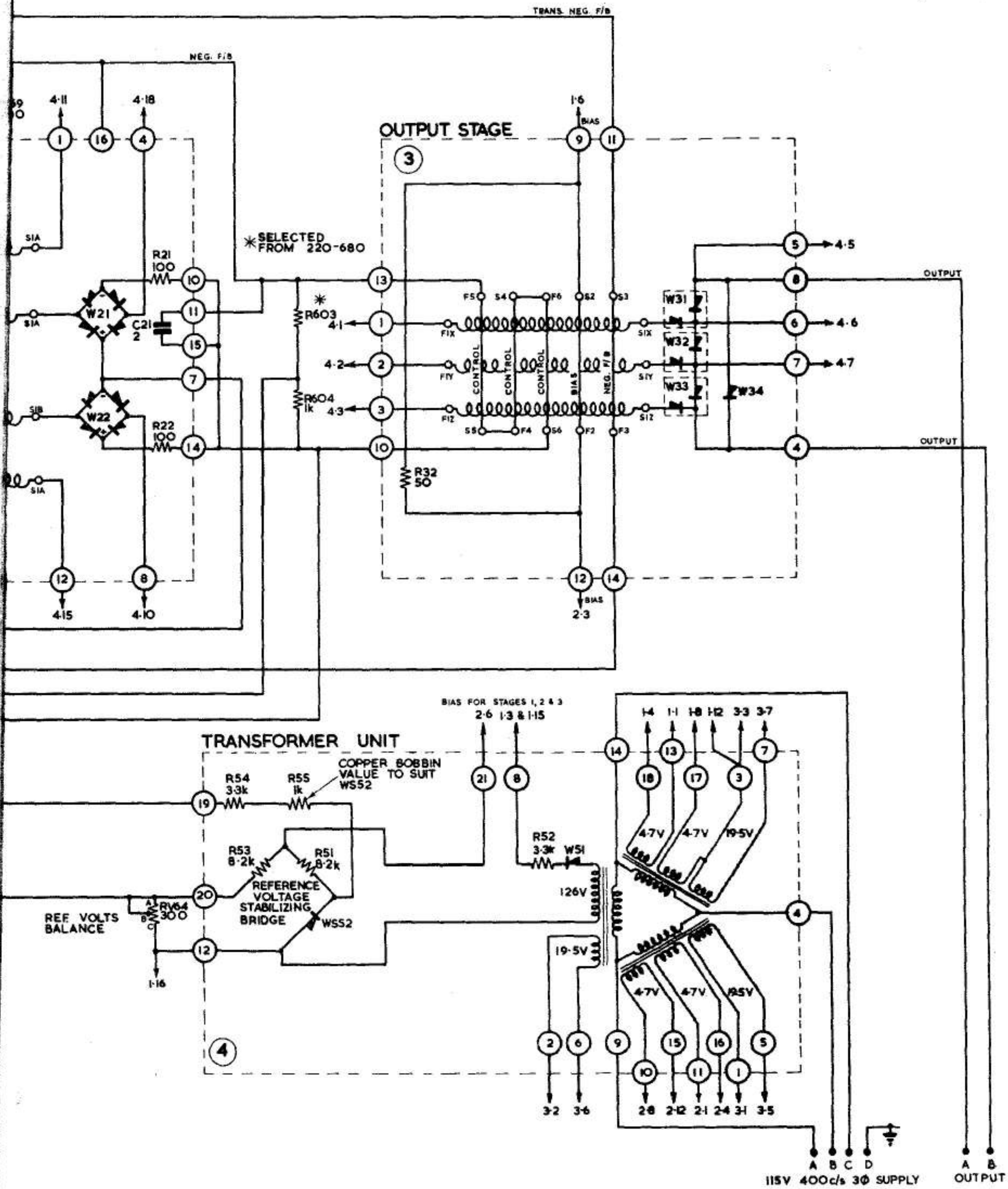


Fig. 8

Circu

RES



it diagram

Fig. 8

TRICTED

Chapter 3

AMPLIFIER UNIT, ULTRA, TYPE A133/1

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LEADING PARTICULARS

Amplifier unit, Ultra, Type A133/1	*Ref. No.* 5CZ/5040
Output at datum temperature	200 *mA*
Input voltage	115*V*, 400 *c/s*, 3 *ph.*
Standing output current	50 *mA or below*
Maximum datum temp. variation, using trim pot	30–40 *deg. C*

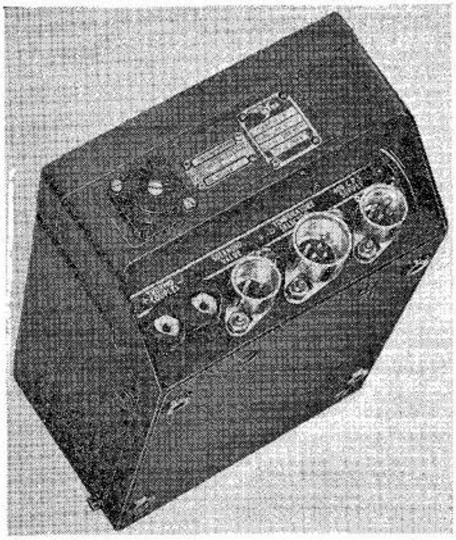

Fig 1 Amplifier unit, Ultra, Type A133/1

Introduction

1. The amplifier (*fig.* 1), is designed to limit jet-pipe temperature at any selected value. Provision is made for variation of the temperature datum point by means of a selector, which may be manually operated, or mechanically coupled to the engine throttle, so that any temperature within the engine flight range may be selected.

2. The output from the thermocouple cluster, located in the jet-pipe, is utilized to operate, through the amplifier, a solenoid actuated valve which regulates the fuel flow to the engine, thus preventing overheating.

3. The thermocouple output is compared with a highly stable reference source and the resulting error signal appears at the output of the amplifier as a current which operates the solenoid valve in the fuel servo system.

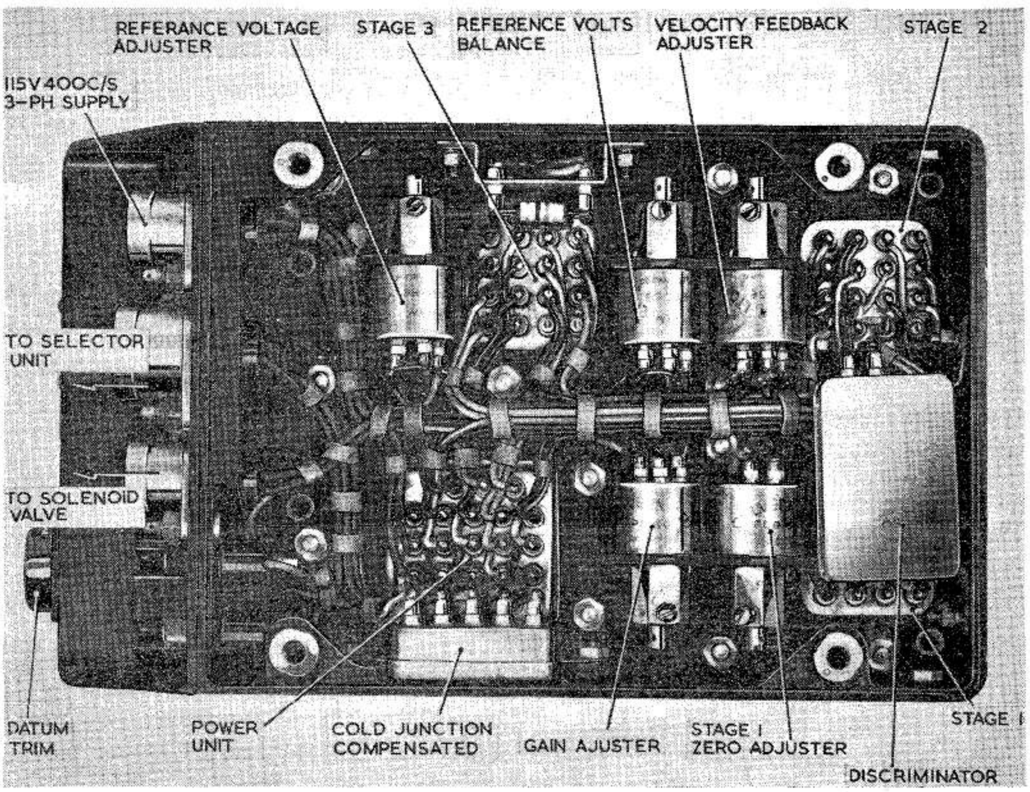

Fig 2. Underside of amplifier, with cover removed

Adjustment of the reference voltage determines the level at which the error signal appears, thus limiting the jet-pipe temperature at any desired level within the range of adjustment.

DESCRIPTION

General

4. Stage 1, stage 2, stage 3, the power unit, the cold junction compensator and the discriminator are all housed in separate sealed cans and can be seen on removal of the amplifier base plate (*fig.* 2). On the same casting are fitted the amplifier controls namely, gain, stage 1 zero, velocity feedback, and reference volts load and balance.

5. A separate end casting houses the datum trimmer control and the following plugs:—

- Four-pole plug for the 115V, 400 c/s, 3 phase supply
- Five-pole plug for the temperature selector unit
- Two-pole plug for the solenoid valve.

In addition to the above plugs, there are two terminals, to which are connected the thermo-couples compensating leads.

Power unit

6. The amplifier power unit includes a 3-phase, delta-connected transformer having eight secondary windings. Four 4·7-volt secondaries feed the power coils of the first and second stages. Three 19·5-volt secondaries, one per phase, feed the power coils of the output stage. A further 126-volt secondary feeds the half-wave power rectifier which provides d.c. for the voltage stabilizing bridge and a 9 milliamp current for the bias windings of all three amplifying stages.

Reference voltage bridge

7. The reference bridge is fed by a smoothed d.c. current of 9 milliamps and provides a stabilized d.c. output current of 2 milliamps which is independent of supply fluctuation. Stabilization is effected by utilizing the Zener reverse voltage characteristic of a silicon diode in one arm of the bridge.

Cold junction compensator

8. The stabilized output of the reference bridge is applied to a second bridge network known as the cold junction compensator or C.J.C. The C.J.C. automatically corrects the output of the reference voltage bridge for changes in thermo-couple e.m.f. when the cold junction ambient temperature varies.

9. Adjustment of the reference voltage signal by means of the temperature selector and datum trim incorporated in the C.J.C. bridge provides for the error signal between reference voltage and thermo-couple input to be approximately zero (*para.* 3) for any required datum. The plug-in selector normally used for the A133/1 amplifier provides for alternative datum temperature of 351 deg. C. or 645 deg. C.

Amplifying stages

10. Stage 1 and 2 amplification is by two similar bias-excited, single-phase, push-pull pairs of transductors connected in cascade. The error signal is applied to the control windings of the stage 1 transductor; the amplified and rectified output is then applied to the control windings of the stage 2 transductor via a potentiometer (RV62), by means of which stage 1 is initially balanced. Both stages are balanced and so respond to signals of either polarity. The output of stage 2 is fed to the control winding of stage 3 via a discriminator, consisting of a germanium diode and a capacitor, whose function is to block the negative signals from stage 2.

11. Stage 3 is a 3-phase, bias excited transductor which provides d.c. output, for operating the solenoid valve, only when the engine jet-pipe temperature is above the datum control temperature.

Safety resistor

12. A 4·7k resistor across the thermo-couple and selector circuit ensures that in the event of a thermo-couple open circuit fault, a negative signal is seen by the amplifier. This means that when the thermo-couple and reference volt signals are equal, there is a signal approximately equal to 8–12 deg. C. at the input of stage 1 in the negative sense.

FUNCTIONING

13. A block schematic diagram of the amplifier stages is shown at fig. 3 and a complete circuit diagram at fig. 7. In order to simplify the circuit diagram, the connections have

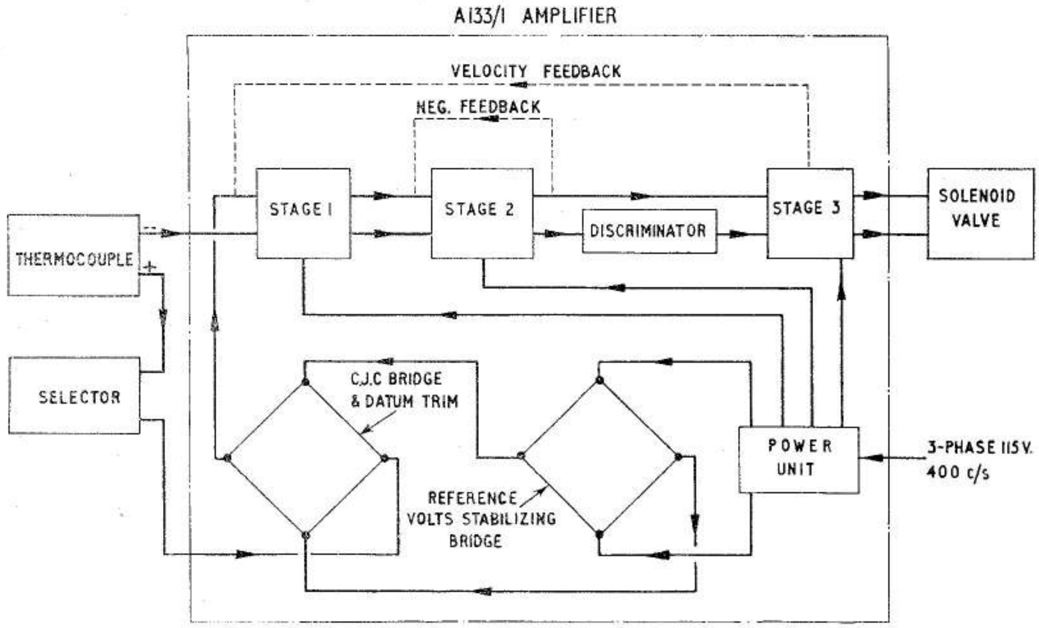

Fig. 3. Block schematic diagram of amplifier

been shown as entering and leaving a main loom. The small letters which appear on the circuit diagram are to enable the circuit to be traced out and do not appear on the cables. The connections entering the main loom are radiused to give the direction which one must follow to pick up the point at which a certain connection leaves the main loom, this being indicated by the same small letter which appeared where it entered, e.g., the — ve bias connection leaves the power unit and enters the main loom bearing the letter " a," it curves to the left and reappears, bearing the same letter, to connect with terminal 6 of stage 2.

14. The 126-volts from the secondary winding of the transformer is rectified and applied via the bias windings of stages 1, 2 and 3 to the reference voltage stabilizing network. The reference voltage is stabilized against supply fluctuations by the silicon diode rectifier and leaves via terminals 10, 19 and 20 of the power unit.

15. Terminals 10 and 20 are connected to a reference volts balance potentiometer (RV64) while terminal 10 is connected to the reference voltage load potentiometer. These two potentiometers are pre-set and locked during manufacture to supply the correct reference voltage to the C.J.C. bridge network.

16. The reference voltage is applied to terminals 2 and 3 of the C.J.C. bridge. There it is compared with the input signal from the thermo-couples which is fed into the C.J.C. at terminal 1, via the datum trim potentiometer (RV72), and terminals 4 and 5 via the external temperature selector.

17. The error signal which results from the comparison between the two voltages is then applied to the control windings of stage 1 via terminals 2 and 5. The signal is amplified, rectified by the two rectifier bridges and, since stage 1 comprises a push-pull pair of transductors, the output is ' sensed ' i.e. of the same direction as the signal.

18. The rectified output of stage 1 is then applied to the control windings of stage 2 (terminals 2 and 5) where it is amplified and rectified in exactly the same manner as in stage 1.

19. The output from stage 2 is applied to the control windings of stage 3 via the discriminator which blocks the negative signals from stage 2 which result from engine jet pipe temperatures below the datum control temperature.

20. Stage 3 is a 3-phase, bias excited transductor and the output from the a.c. windings is rectified and appears as the output of the amplifier at terminals A and B of plug 1.

Feedback

21. Terminals 7 and 11 of stage 1 allow the manufacturers to introduce positive feedback into the first stage if the gain was found to be too low during manufacture. Normal gain control is effected by adjustment of the shunt potentiometer in the negative feedback loop in stage 2 (terminals 7, 9, 11 and 13).

22. Stage 3 has a transient negative feedback loop coupled to stage 1 which includes a shunt potentiometer used as a velocity feedback control. This feedback loop has the effect of introducing a small time lag into the amplifier which improves the stability of the control system.

Bias

23. The d.c. rectified current of 9 milliamps obtained from the 126-volt winding of the power unit provides bias for stages 1, 2 and 3 in series. Each stage incorporates its own bias shunt to adjust the bias winding current to the appropriate value.

Smoothing

24. Capacitors positioned in stage 1 and stage 2 provide smoothing for the bias and voltage stabilizing circuit, and the stage 2 output signal respectively.

TESTING

Bench testing (using test equipment Type QE2230)

25. The following tests will check the datum temperature, gain, time response and standing current of the amplifier. The equipment required for carrying out the bench test is detailed below.

(1) Test set, Ultra, Type QT223.

(2) Nine-core test cable, Type QY2212.

(3) Four-core test cable, Type QY2216.

(4) A bench test rig made up as shown in fig. 4.

(5) A 115V 3-phase, 400 c/s, supply.

(6) Stop watch.

(7) Temperature selector plug.

Connections

26. Since in the aircraft, compensating leads connect the amplifier input terminals to the thermocouple commoning terminals, and also connect the commoning terminals to the test plug, similar leads must be used in the test rig. These leads should be made from Chromel and Alumel as shown in fig. 4.

27. In the test rig the thermocouple cluster is simulated by a resistor of equivalent resistance, and the resistor is connected to the amplifier terminals by Chromel-Alumel compensating leads. These leads should have a resistance equivalent to the leads used in the aircraft, or alternatively a set of actual aircraft leads may be used. It is important to ensure that the leads connecting the thermocouple simulating resistor make good electrical contact, since any additional resistance in the circuit will adversely affect the results.

Test set batteries

28. Check the test set batteries as follows:—

Reference source battery

(1) Set the TEMPERATURE DATUM and SIGNAL/TEMP. DATUM switch to the TEMPERATURE DATUM and SIGNAL position.

(2) Turn the TEST SELECTOR rotary switch to BATTERY.

(3) Note the reading on METER II which should be in the green zone.

Temperature signal supply battery

(4) Set the TEMPERATURE DATUM and SIGNAL/TEMP. DATUM switch to TEMPERATURE DATUM and SIGNAL position.

(5) Turn the TEST SELECTOR switch to T/C RES.

(6) Turn the T/C HARNESS SELECTOR to position 'H'.

(7) Depress the T/C RESIST key to the T/C RESIST TEST position.

(8) Turn the TEMP. SIGNAL COARSE control slowly clockwise.

(9) METER II should show full scale deflection when the COARSE control is turned approximately three-quarters full travel.

If either of the METER II readings differ from those given above, then that particular battery is unserviceable and should be renewed.

Power supplies

29. Connect the 115V, 3-phase, 400 c/s supply to the 4-core test cable, QY2216 and check the supply as follows:—

(1) Switch on the power supply and allow five minutes to elapse before proceeding with the test.

(2) Set TEST SELECTOR switch to C.P.S. The 400 c/s is indicated by METER I and the PHASING lamp should be extinguished.

(3) Set the TEST SELECTOR switch to VOLTS. The 115V supply is indicated by METER II, which should read in the blue zone, indicating the supply to be 110–120 volts the PHASING lamp should now be alight.

Note . . .

If the PHASING *lamp does not follow this sequence, either one phase is open-circuit or the phase sequence is incorrect.*

Removal of test cable QY2216

30. Disconnect and remove the test cable QY2216 from the test circuit. Connect the 115V supply direct to the amplifier supply plug.

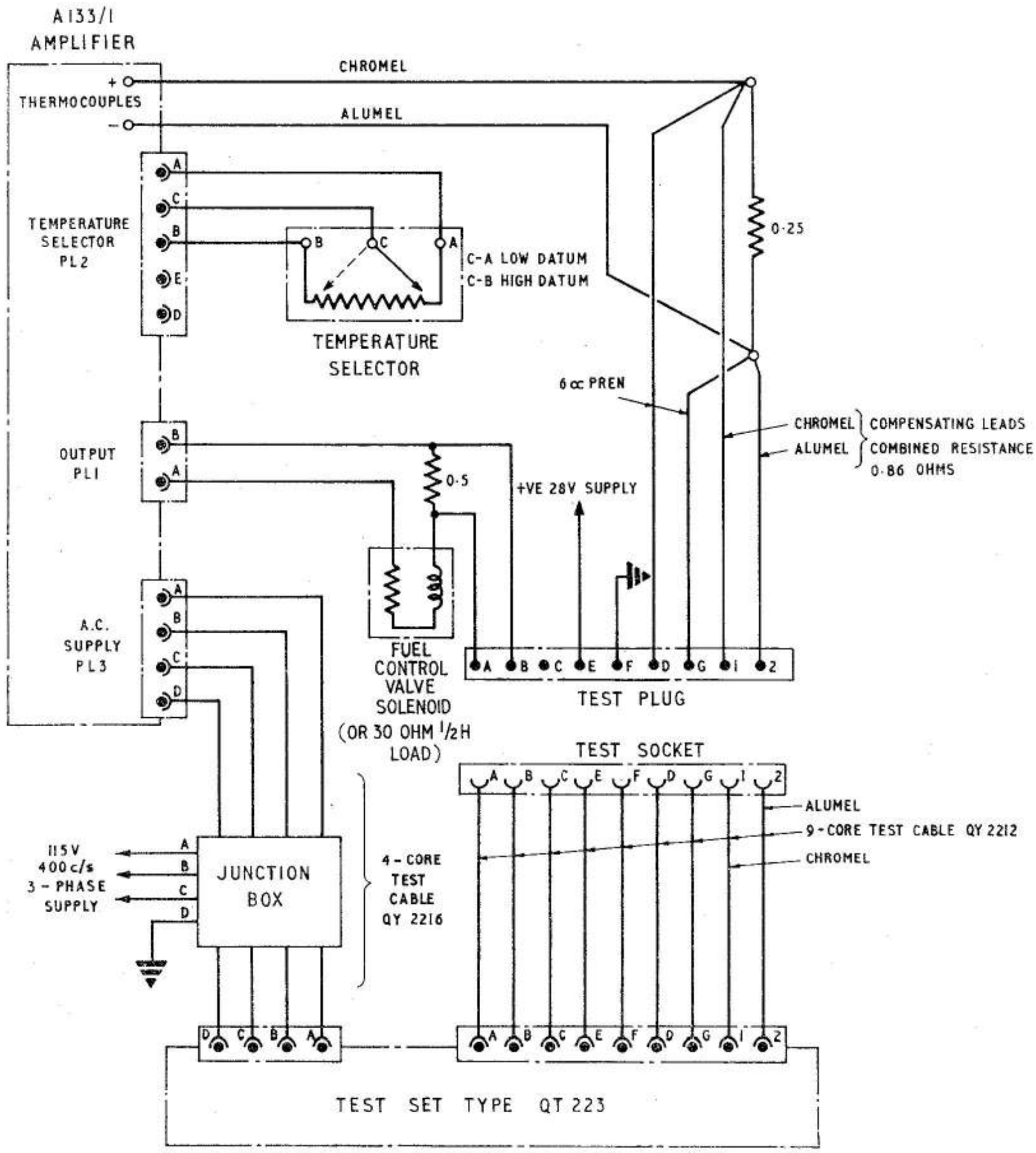

Fig 4. Bench test circuit

Test set preparation

31. (1) Check that the SPEED DATUM/REHEAT 3-position switch is in the centre position (OFF).

(2) Check that the DATUM TEMPERATURE and SIGNAL/TEMP. DATUM, 3-position switch is in the centre position (OFF).

(3) Check that the COARSE control is fully anticlockwise and the FINE control is in the mid-travel position (i.e. 5 clockwise turns of the 10-turn potentiometer).

(4) Set the METER II range switch to the D.C. SOLENOID 800mA position.

(5) Set the galvanometer to the FREE position and zero the pointer if necessary, using the adjusting screw.

Note . . .

Automatic cold junction compensation is provided within the QT223 test set so that no correction for ambient temperature variation is required.

Amplifier datum temperature

32. Before performing the following tests the supply to the amplifier must be switched on, and time allowed for the temperature of the unit to stabilize.

(1) Select LOW DATUM.

(2) Set the DATUM TEMPERATURE scale, of the test set QT223, to the appropriate datum temperature for the LOW DATUM condition. (Red pointer indicates which portion of the helix cursor line gives the exact reading).

(3) Set the T/C HARNESS SELECTOR switch to a position appropriate to the system under test. If a non-current drawing temperature indicator is used, the SERVO POT. position must be selected.

(4) Set the TEST SELECTOR switch to D.C. SOL.

(5) Set the TEMPERATURE DATUM and SIGNAL/TEMP. DATUM switch to the TEMPERATURE DATUM and SIGNAL position.

(6) Set METER II range switch to the $\div 2$ position.

(7) Turn the COARSE control slowly clockwise until meter II indicates approximately 400mA. (True reading: $400 \div 2 = 200$mA). This operation applies a signal to the thermocouple terminals and simulates the appropriate datum temperature.

Note . . .

When adjusting the COARSE *control, to obtain an output current reading on meter* II, *allowance must be made for the inherent time lag of the amplifier. If allowance is not made by careful setting of the* COARSE *control, overshoot of the output current will be experienced.*

(8) Momentarily depress the galvanometer key to the SET-UP position and observe galvanometer. Adjust DATUM TEMPERATURE scale until galvanometer reads within 3 divisions of zero. If the galvanometer reading is to the left of the centre zero, the DATUM TEMPERATURE scale reading must be increased, if the reading is to the right, the DATUM TEMPERATURE scale must be decreased.

Note . . .

The galvanometer key should be depressed for short periods of 1 *or* 2 *seconds during 'searching' in order to prevent overload of the galvanometer should there be a large error.*

(9) Switch the galvanometer key to the GALVO-IN position. Make final adjustments to METER II reading with the temp. signal FINE control, if necessary, to give a 400mA indication (true reading 200mA). Adjust DATUM TEMPERATURE scale until zero indication on the galvanometer is obtained.

(10) Read off the datum temperature from the DATUM TEMPERATURE scale. This reading must be within $\pm 2\frac{1}{2}$ deg. C of the datum specified for the LOW DATUM condition. Return the galvanometer key to the mid-position after taking the readings.

(11) If the datum temperature is not within the specified limits, readjust datum temperature trimmer of the amplifier until an acceptable figure is obtained.

(12) Repeat the tests to obtain the datum temperature corresponding to the HIGH DATUM condition.

Gain tests

33. (1) Decrease the temp. signal FINE control until the output on METER II indicates 100mA (true reading 50mA). Measure the temperature indicated on the datum temperature scale with zero indication on the galvanometer. Return galvanometer key to mid-position after taking readings.

(2) Increase the temp. signal FINE control until the output of METER II indicates 700mA (true reading 350mA). Note the temperature indicated on the datum temperature scale, with zero indication on the galvanometer as in the previous sub-para.

(3) The temperature difference indicated on the datum temperature scale for sub-para. (1) and (2) should be 6 to 10 deg. C.

(4) Return galvanometer key to the centre (OFF) position.

Time response test

34. (1) Ensure the datum selector is set to the HIGH DATUM position.

(2) Ensure METER II is reading 700mA (true reading 350mA).

(3) Switch TEMPERATURE DATUM and SIGNAL/TEMP. DATUM switch to mid-position (OFF).

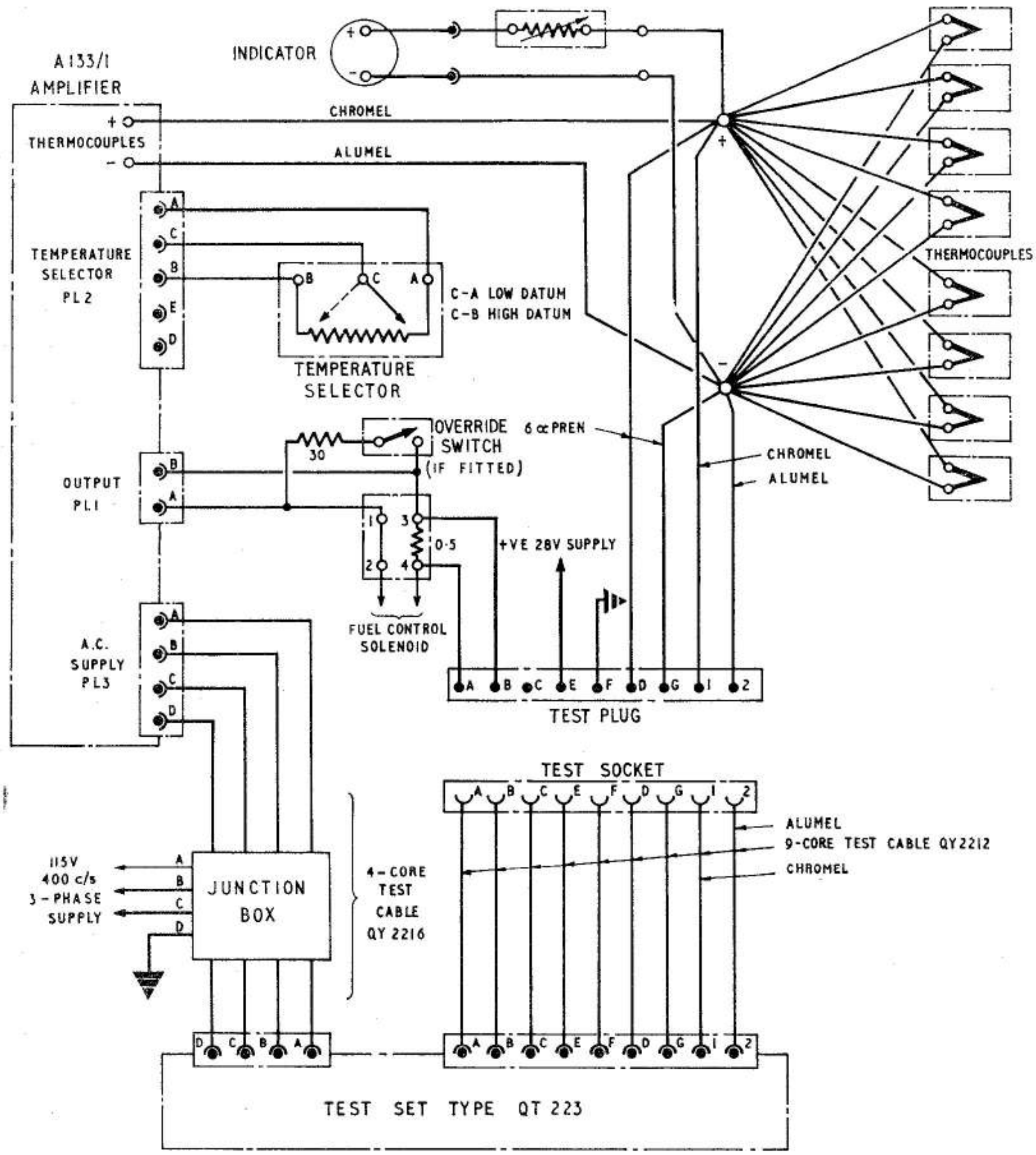

Fig 5. Aircraft test circuit

(4) Wait until amplifier output current has fallen to zero and then set the TEMPERATURE DATUM and SIGNAL/TEMP. DATUM switch to TEMPERATURE DATUM and SIGNAL position.

(5) Check with a stop watch, the time taken for the output current indicated on METER II, to rise from 100 to 250mA. Ensure that the output finally reaches 350 $\pm$20mA. The time taken to reach 100mA should not be greater than $7\frac{1}{2}$ seconds, and the time to change from 100mA to 250mA should be between 5 and 9 seconds.

Standing current test

35. (1) Set the TEMP. DATUM/TEMPERATURE DATUM and SIGNAL switch to the mid-position (OFF).

(2) Observe amplifier output indicated on METER II, which must not exceed 100mA (true reading 50mA).

Aircraft test (using test equipment, Type QE2230)

36. The equipment required for the aircraft test, using the Ultra QE2230 test equipment, is detailed below and is connected as shown in the test circuit (*fig*. 6).

(1) Test set Type QT223.

(2) Nine-core test cable Type QY2212.

(3) Nine-core test cable Type QY2213 for use on aircraft not fitted with a 9-pole test plug.

(4) Four-core test cable Type QY2216 for monitoring 115V, 400 c/s supply.

37. Before commencing any tests, the relevant Aircraft Handbook should be consulted, and any interlock or muting switches which normally render the jet-pipe temperature control system inoperative whilst the aircraft is on the ground, should be made ineffective.

Test connections at aircraft

38. (1) Remove the blanking cap from the 9-pole aircraft test plug and connect the test set QT223 (A/C test plug) to the aircraft test plug using test cable QY2212. In aircraft not fitted with a 9-pole test plug, the commoning terminal of the thermocouple cluster must be located and leads 1 and D of test cable QY2213 connected to the common positive. Similarly connect leads 2 and G to the common negative of the thermocouples.

Test set preparation

39. (1) Check the test set batteries, see para. 28.

(2) Prepare the test set in the manner described in para. 31.

Thermocouple harness resistance test

40. (1) With the T/C HARNESS SELECTOR switch, select the standard resistor appropriate to the thermocouple cluster under test.

(2) Rotate the TEST SELECTOR switch to T/C RES.

(3) Set the TEMP. DATUM/TEMPERATURE DATUM and SIGNAL switch to the TEMPERATURE DATUM and SIGNAL position.

(4) Rotate the COARSE control clockwise until the pointer of METER II is directly over the red index line. This supplies a test signal to the thermocouples under test.

(5) Depress the key switch to the T/C RESIST. test position thus switching the same test signal to the standard resistor in the test box. A change in reading of METER II, from the red index line, of more than 3 divisions indicates a fault in the thermocouple circuit. This fault should be corrected before continuing with the tests.

Note . . .

A high reading of meter II *will indicate a probable short-circuit thermocouple, and a low reading will indicate a probable open-circuit thermocouple.*

(6) Rotate the COARSE control to the fully anti-clockwise position.

(7) Set the TEMP. DATUM/TEMPERATURE DATUM and SIGNAL switch to the centre position (off).

Amplifier datum temperature

41. After allowing time for the power supplies and amplifier to stabilize check the amplifier datum temperature in a similar manner to that described in para. 31.

Gain

42. Check the amplifier gain by the method described in para. 33.

Standing current and muting

43. (1) Set the TEMPERATURE DATUM and SIGNAL/TEMP. DATUM switch to the mid-position (OFF).

(2) Observe amplifier output indicated on METER II, which should not exceed 100mA (true reading 50mA).

(3) Operate the muting switch on pilots console (observing that METER II now reads zero, indicating that amplifier output has been switched from solenoid valve to dummy resistor).

Disconnecting supplies

44. (1) Rotate COARSE and FINE controls fully anti-clockwise.

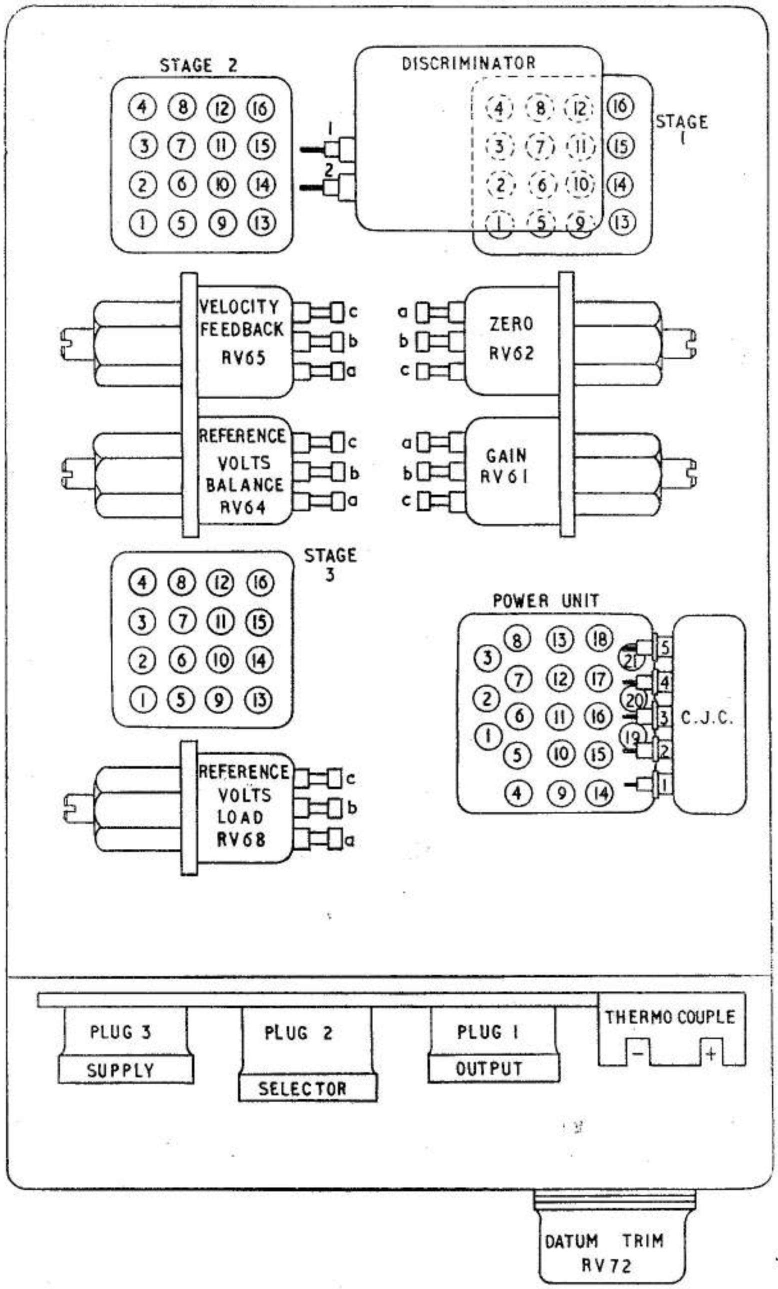

Fig 6. Layout of amplifier showing seal numbers

(2) Lock the galvanometer in the CLAMP position.

(3) Switch off inverters.

(4) Disconnect the 9-core test cable from the aircraft test plug and replace the blanking cap.

Fault finding

45. In the event of the bench or aircraft test indicating unserviceability of the amplifier, it may be possible to locate the fault in the amplifier by measuring the voltage and resistance existing between certain terminals inside the amplifier.

46. Table 1 gives the values which should be obtained when measuring between certain seals and the function of the winding and/or resistor whose resistance or potential is being measured. Fig. 6 gives the layout of the amplifier and the seal numbers and should be referred to, in conjunction with Table 1, when these voltage and resistance measurements are being carried out.

Access to seals

47. The seals of the C.J.C., power unit, stage 2 and 3 are accessible on removal of the amplifier baseplate. To gain access to the seals of stage 1, however, the main cover must be removed to allow one of the screws securing the discriminator to be removed. The discriminator may then be rotated round the remaining fixing screws, thus revealing the seals of stage 1.

Insulation resistance

48. The insulation resistance between the points given below, should not be less than 5 megohms when measured with a 250V insulation resistance tester:—

(1) Thermocouple positive terminal to chassis.

(2) Supply pole A to chassis.

(3) Solenoid pole A to chassis.

(4) Solenoid pole A to supply pole A.

(5) Thermocouple positive terminal to solenoid pole A.

(6) Thermocouple positive terminal to supply pole A.

Note . . .

A dummy datum selector should be connected to the amplifier during insulation tests.

TABLE 1

Voltages and resistances

Component	Function	Seal Reference	Voltage	Resistance (ohms)
Power unit	(a) Supply to power unit	4-14	115V. a.c.	34 ± 8
		9-4	115V. a.c.	34 ± 8
		9-14	115V. a.c.	37 ± 8
	(b) Supply to stage 1	10-15	4·7V. a.c.	3·4 ± 0·7
		11-16	4·7V. a.c.	3·4 ± 0·7
	(c) Supply to stage 2	12-17	4·7V. a.c.	3·4 ± 0·7
		13-18	4·7V. a.c.	3·4 ± 0·7
	(d) Supply to stage 3	1-5	19·5V. a.c.	1·5 ± 0·3
		2-6	19·5V. a.c.	1·5 ± 0·3
		3-7	19·5V. a.c.	1·5 ± 0·3
Cold Junction Compensator	Bridge network	1-3	1·5V a.c.	1·5k
		3-5	1·5V. d.c.	1·5k
		2-4	25·1mV. d.c.	25·1
		1-2	12·1mV. d.c.	12·1
Stage 1	(a) A.C. windings	1-4	4·7V. a.c.	
		8-12	4·7V. a.c.	
	(b) Control	2-5		90 ± 18
	(c) Bias	3-6	4·11V. d.c.	456
	(d) Positive feedback	7-11		10 ± 2
	(e) Velocity feedback	9-13		40 ± 8
Stage 2	(a) A.C. windings	1-4	4·7V. a.c.	
		8-12	4·7V. a.c.	
	(b) Control	2-5		310 ± 60
	(c) Bias	3-6	3·18V. d.c.	354 ± 71
	(d) Negative feedback	9-13		24 ± 5
Stage 3	(a) A.C. windings	1-5	19·5V. a.c.	
		2-6	19·5V. a.c.	
		3-7	19·5V a.c.	
	(b) Control	10-13		305 ± 61
	(c) Bias	9-12	0·05V. d.c.	◀ 5·4 ± 1* ▶
	(d) Velocity feedback	11-14		70 ± 14
Potentiometers	(a) Gain (RV61)			500
	(b) Zero (RV62)			25
	(c) Reference volts (RV64)			◀300 or 100**▶
	(d) Reference volts (RV68)			1·5k
	(e) Velocity feedback (RV65)			500
	(f) Datum trim (RV72)			10

◀*12 ± 1·5 with modified stage 3 (see fig. 7).
**See fig. 7.▶

Where not stated tolerances are ± 10 per cent.

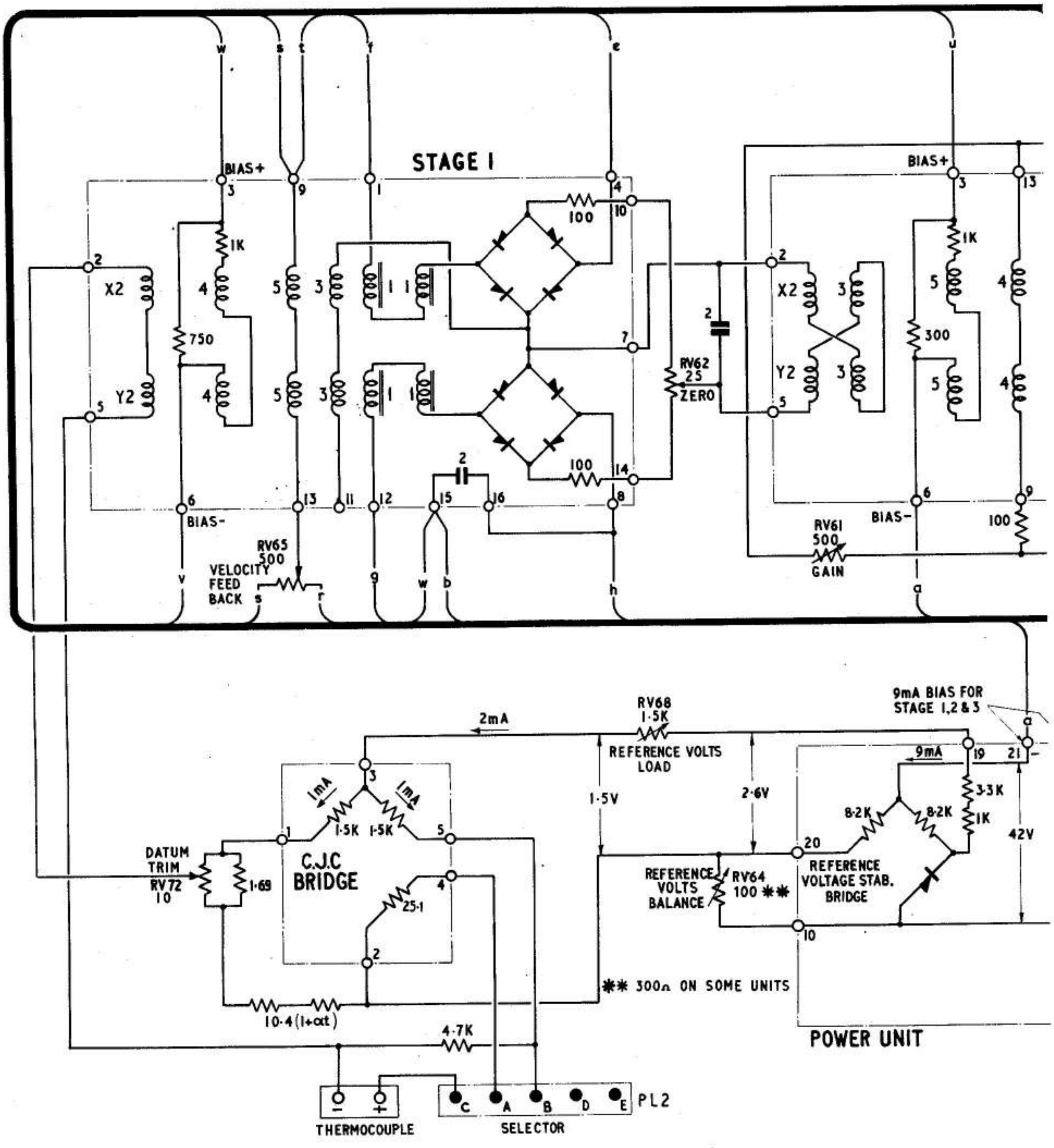

Fig.7

Circuit diagrar
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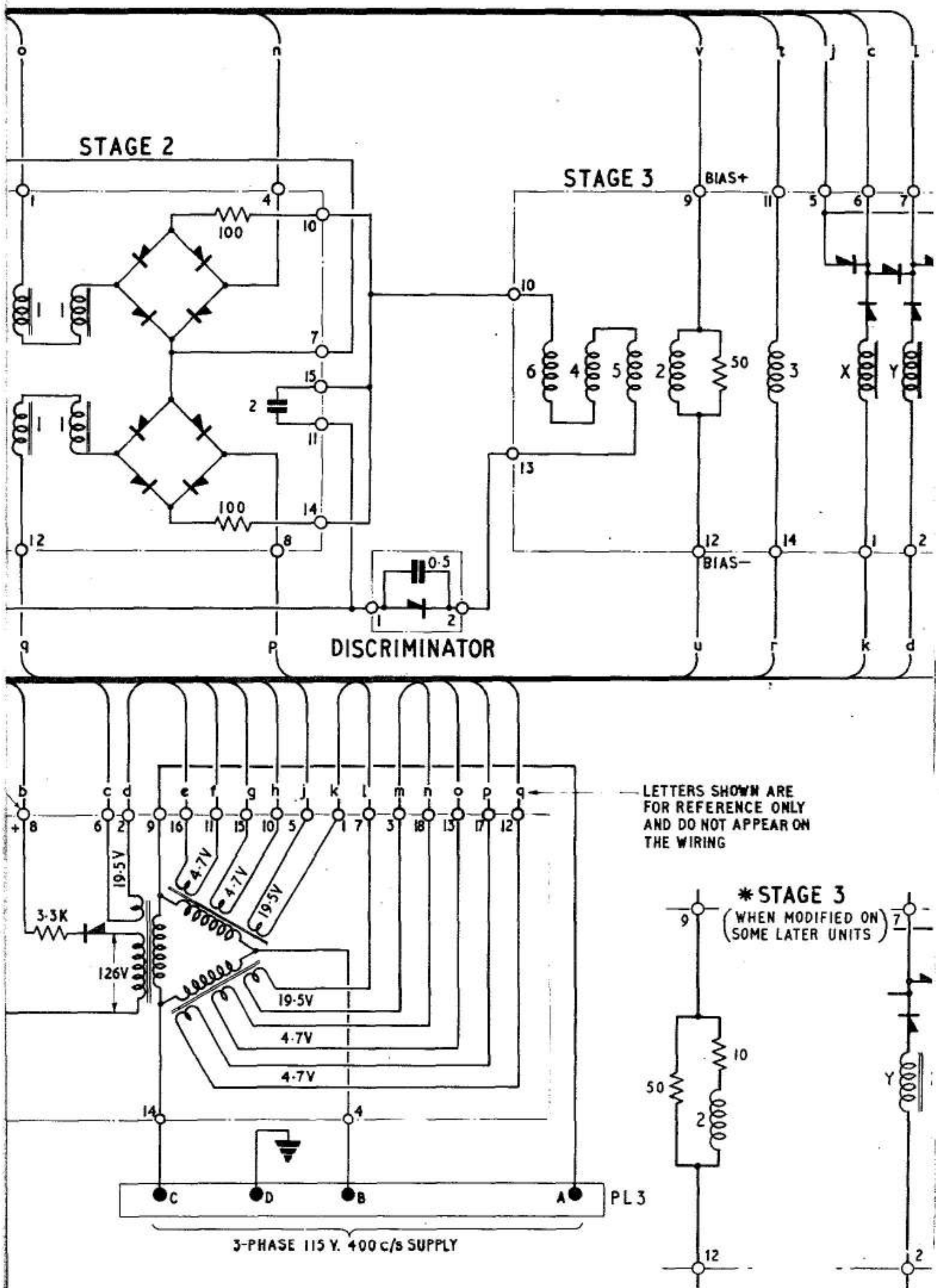

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