Chapter 18

TEMPERATURE CONTROL UNITS, TYPE FLW

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LIST OF APPENDICES

Introduction

1. Temperature control units, Type FLW are sensitive relay controllers which embody a Wheatstone bridge network. The out-of-balance signals are arranged to operate directionally the sensitive relay so that a secondary relay is energized to close the circuit between the supply and either the "close" or "open" coil windings of a valve actuator.

2. Each type of control unit contains basic differences and therefore for detailed description, operation and testing, reference must be made to the appropriate appendix.

SERVICING

3. The control unit should be examined for damage, security of attachment and soundness of electrical connections.

4. The following tests should be applied before a control unit is installed in aircraft, at any time when serviceability is suspect and at appropriate re-examination periods at Equipment Depots.

Tests

5. The tests listed are common to all units. In addition to these tests, the tests peculiar to each unit must be applied (refer to appropriate appendix).

Insulation resistance

6. Refer to appropriate appendix.

Functional test

7. Refer to appropriate appendix.

Pressure test

8. Proceed as follows:—

(1) Connect a suitable adapter to the pressure test hole in the control unit rear cover.

(2) Connect a source of clean dry air to the adapter, and tee in a suitable pressure gauge or manometer into the air pressure line.

(3) Apply a pressure of 20 lb/in^2 to the control unit. There must be no leakage.

Bonding resistance

9. The bonding resistance between the plug shrouds and the control unit mounting plate must not exceed 0·025 ohms.

Appendix 1

TEMPERATURE CONTROL UNIT, TYPE FLW/A/2

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DESCRIPTION

1. The component deck assembly of the temperature control unit, Type FLW/A/2 (*Ref. No.* 5CZ/5563), is housed in a cylindrical cover retained between a front and a rear cover (*fig.* 1). Riveted to the underside of the cylindrical cover is the unit mounting plate.

2. Three 6-pole plugs (*fig.* 2) are mounted on the front cover which is a circular plate having a machined groove round the peripheral edge for location of a sealing ring. Integral lugs formed on the inside face secure the cover to the deck assembly by four 6 B.A. cheese-head screws and spring washers.

3. The rear cover is similar to the front cover and is secured to the deck assembly by two 2 B.A. hexagon-headed screws, with sealing washers, which screw into tapped blocks riveted to the rear end of the deck. After assembly the two screws are locked by wire passing through the two lugs on the cover face. On units pre-mod. 943 a silica gel desiccator is screwed into the rear cover and sealed with plain and sealing washers. A window on the outside of the desiccator indicates the moisture content within the unit. A centrally positioned tapped hole in the cover is used for pressure testing the unit (20 lb. in^2 differential) and is blanked off by a 4 B.A. cheese-head screw and sealing washer.

4. Mounted on the upper face of the deck assembly is a triangular platform positioned by spacers and secured by three 6 B.A. cheese-

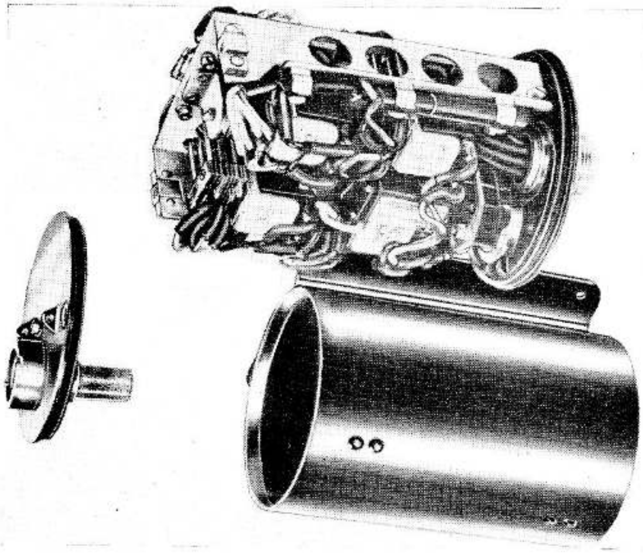


Fig. 1. Temperature control unit, Type FLW/A/2

head screws with plain and spring washers and nuts. A flange bent up from the platform carries a sensitive relay base. The relay plugs into the base and is retained by a spring clip. Directly behind the sensitive relay is a wire wound resistance former secured at the rear end to an angle bracket integral with the deck.

5. Two miniature relays are positioned on each side of the sensitive relay and the resistance former. The miniature relays are secured at their base by two 8 B.A. cheese-head screws with spring washers.

6. Two capacitors are mounted together in spring clips located on the under face of the deck. Two resistors, one on each side of the capacitors, are soldered to the terminal tags of two synthetic resin strips which are riveted to the deck. Behind the capacitors is a terminal block, secured to the deck by two 8 B.A. cheese-head screws with plain and spring washers and nuts. For details of the electrical circuit refer to fig. 3.

7. The unit measures $3\frac{3}{8}$ in. x $3\frac{1}{2}$ in. x $5\frac{7}{8}$ in. and weighs 2 lb. 1 oz.

OPERATION

8. This type of control unit is normally included in an engine anti-icing system. Control unit operation requires the unbalancing of a Wheatstone bridge network, this unbalance being arranged to operate a series of relays which in turn direct the motor current to the equipment necessary to nullify the icing conditions. The sections of the bridge network that produce the unbalance consist of two temperature sensitive resistance elements which are external to the control unit and are, of course, subjected to the temperature being controlled.

9. A sensitive relay is connected across the bridge network and the magnitude and direction of the current through the relay coil is governed by the state of balance of the bridge. The relay has a two-way action, closing one

Key to Fig. 2

1. MINIATURE RELAY
2. RELAY
3. RESISTANCE UNIT
4. MAIN COVER
5. REAR COVER
6. DESICCATOR UNIT (PRE-MOD. 943)
7. SEALING RING
8. 910-OHM RESISTOR
9. CAPACITOR
10. SEALING RING
11. FRONT COVER
12. NAME AND DATA PLATE
13. MINIATURE BREEZE PLUGS
14. COMPONENT DECK
15. RELAY FIXING PLATE

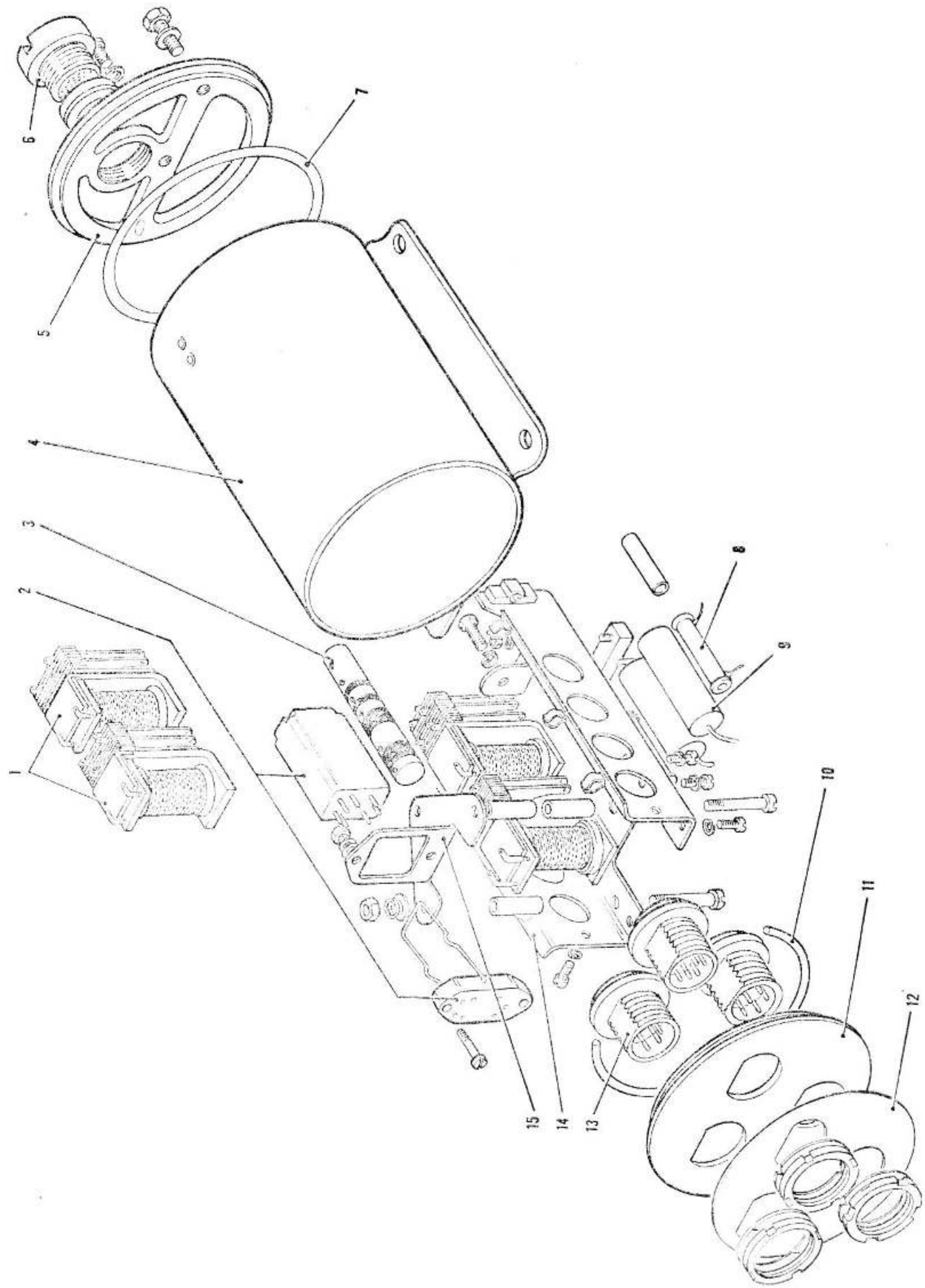


Fig. 2. Exploded view

pair of contacts when more heating is required and closing another pair of contacts when cooling is required. The contacts on closing energize a slave relay having contacts so arranged that the control valve actuator is driven in the direction required. The contacts of the slave relays also bring additional "hold on" resistors into the bridge, thus accentuating the unbalance and making relay action more positive.

10. Should the temperature of the hot air being supplied in the system rise above a pre-determined value the main action of the control unit is stopped by a further pair of override relays which are operated by an external thermal switch. Under these conditions, the contacts of the override relays short-circuits the supply to the slave relays and further heating is prevented.

INSTALLATION

11. Before installing a control unit refer to the appropriate aircraft air publication.

SERVICING

12. Should the serviceability of a control unit be in doubt apply the functional test (*para.* 16). If the desiccator (if fitted) indicates a high moisture content, remove the control unit for examination.

Testing

13. The tests given in this appendix are peculiar to this control unit and these tests are in addition to the common tests given under Servicing in Chap. 18. Fig. 4 shows the test circuit required and it should be noted that the control unit plugs are numbered for identification on fig. 3 and 4.

Electrical resistance

14. With plug 2, only, of the instrument connected to the test rig (*fig.* 4) and with switch S2 closed, the resistance between pole **E** of plug 1 and pole B of plug 3 should not exceed 0·05 ohms.

Insulation resistance

15. The insulation resistance must not be less

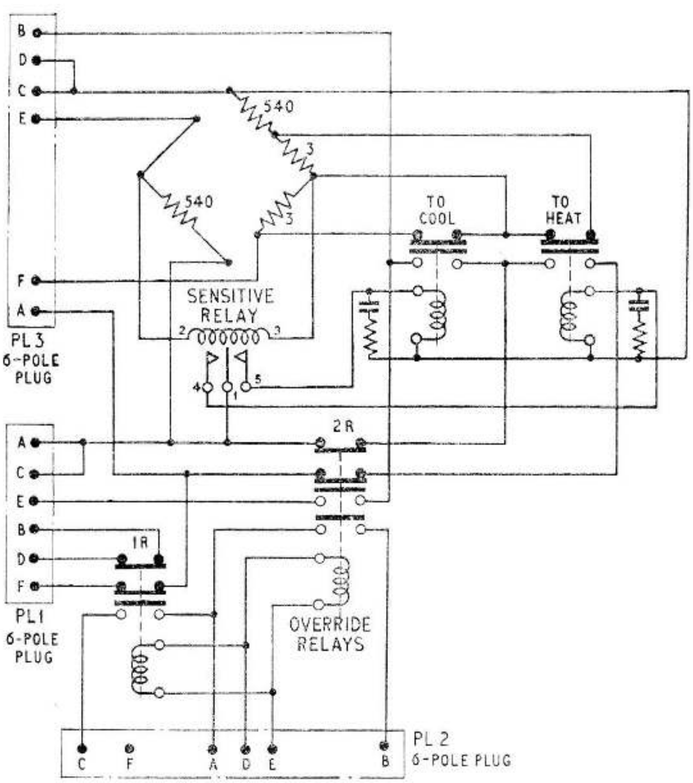


Fig. 3. Circuit diagram

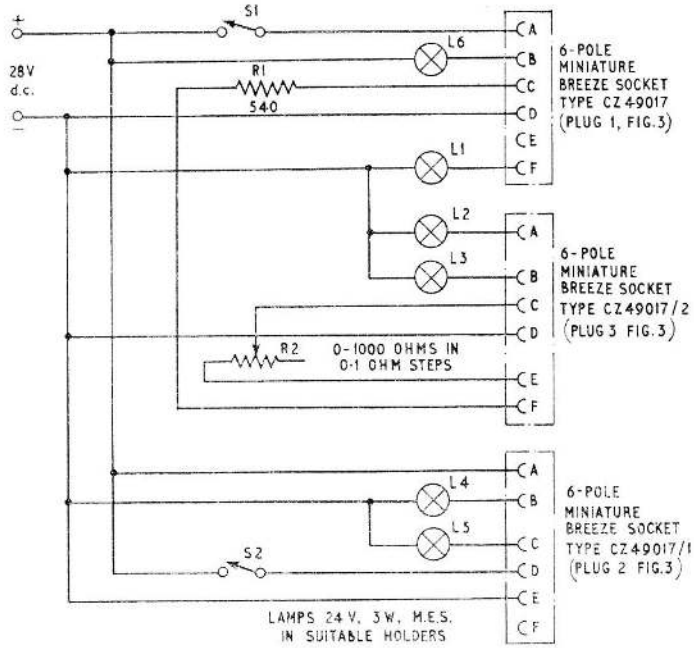


Fig. 4. Test rig circuit diagram

than 5 megohms at 250V d.c. between the following:—

(1) All plug poles and the unit cover
(2) Pole E of plug 1 and pole B of plug 3
(3) Pole A of plug 1 and pole B of plug 3
(4) Pole A of plug 1 and pole A of plug 3
(5) Pole A of plug 2 and pole B of plug 2
(6) Pole A of plug 2 and pole C of plug 2

Functional test

16. The test should be carried out at normal room temperature (20°C) and the control unit connected to the test rig (*fig.* 4) with a supply of 28V d.c.

(1) Set the variable resistor at 540 ohms. Open switch S2 and close S1. Increase the resistance until lamp L3 lights, the increase must be between 3 to 7 ohms.

(2) Decrease the variable resistor until lamps L1 and L2 light, then increase until they extinguish. The increase must be between 3 to 7 ohms.

(3) The resistance value at which lamp L3 lights must be less than 550 ohms and that at which lamps L1 and L2 light must be greater than 530 ohms. The difference between the two values must be greater than 8 ohms.

(4) Reset the variable resistor so that lamp L3 lights. Open switch S2 and close S1, lamps L3 and L6 should now light. Close switch S2 and lamps L3 and L6 should extinguish and lamps L4 and L5 light simultaneously.

(5) The control unit must function satisfactorily when 21 and 29V d.c. are supplied although the unit will not necessarily meet the resistance change requirements.

Fault finding

17. For fault finding (*Table* 1) the control unit must be connected to the test rig (*fig.* 4).

Table 1
Fault finding

Fault	Possible cause and procedure
(1) One or more lamps on test rig fail to light or extinguish under the conditions of the functional test, though associated relays operate	Check the associated relay contacts, clean and reset if necessary. If this does not cure the fault, check unit wiring (*fig.* 3)
(2) Unit functions but not within the specified limits of 550 or 530 ohms	Check values of the resistance unit; if these are satisfactory then the sensitive relay is unserviceable
(3) Unit functions but the value between L3 lighting and L1 and L2 lighting is less than specified 8 ohms	Sensitive relay unserviceable
(4) Relay "hold-on" below specified 3 ohms on either the "heat" or "cool" side	Disconnect unit from test rig. Check for correct functioning of the 3 ohms section of the bridge and associated relay contacts
(5) Relay chatter	Ensure that the unit supply polarity is correct, then check as in (4)
(6) L3 or L1 and L2 remain alight at all values of variable resistor	Remove unit from test rig and check values of resistance unit. If correct, check wiring associated with the bridge circuits. Failing this, sensitive relay unserviceable

Appendix 2

TEMPERATURE CONTROL UNIT, TYPE FLW/A/6

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

DESCRIPTION

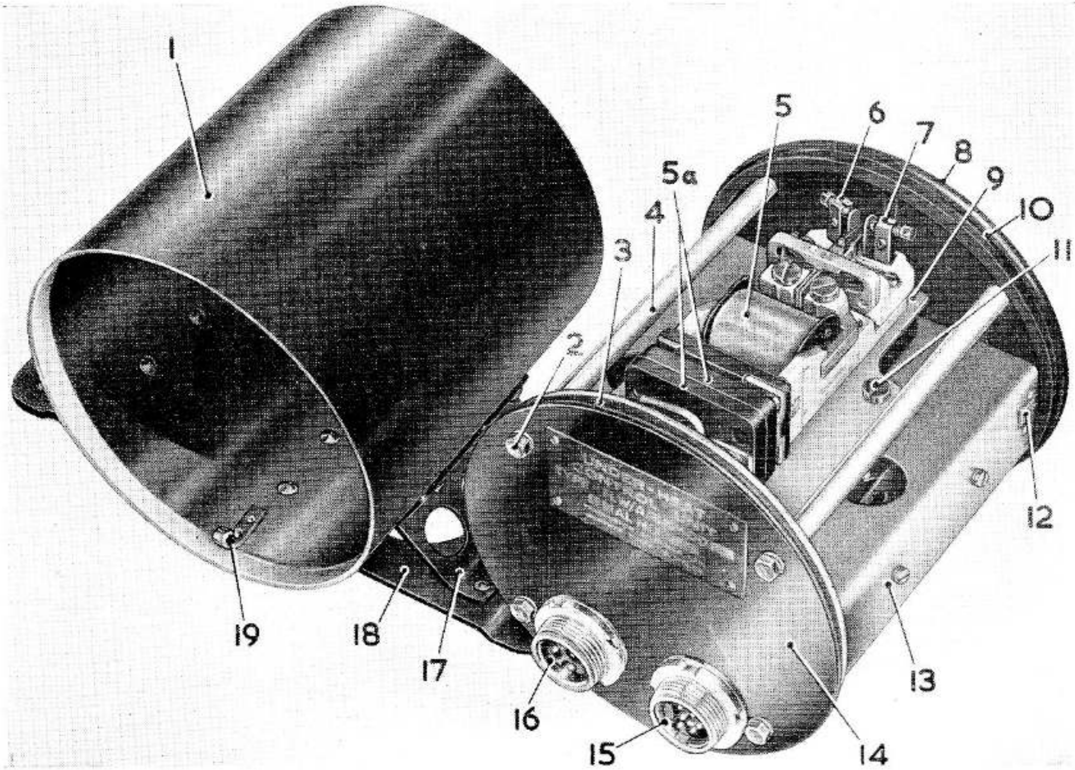
1. The component deck assembly of the temperature control unit, Type FLW/A/6 (*Ref. No.* 5CZ/5078), is housed in a cylindrical cover retained between a front and a rear cover (*fig.* 1). Riverted to the undeside of the cylindrical cover is the unit mounting plate.

2. A 6-pole and a 3-pole plug are mounted on the front cover which is a circular plate having a machined groove round the peripheral edge for location of a sealing ring. Integral lugs formed on the inside face secure the cover to the deck assembly by four 6 B.A. cheese-head screws and spring washers.

3. The rear cover is similar to the front cover and is secured to the deck assembly by two 2 B.A. hexagon-head screws with sealing washers, which screw into tapped holes riveted to the rear end of the deck. After assembly the two screws are locked by wire passing through the two lugs on the cover face. Four pillars are interspaced between and secured to the front and rear covers. On units pre-mod. 966 a silical gel desiccator is screwed into the rear cover and sealed with plain and sealing washers. A window on the outside of the desiccator indicates the moisture content within the unit. A centrally positioned tapped hole in the cover is used for pressure testing the unit (20 lb/in.^{2} differential) and is blanked off by a 4 B.A. cheese-head screw and sealing washer.

4. The instrument deck has four turned-over lugs which are secured by four screws and nuts to the sides of a chassis. Two further lugs on the deck support the ends of the pillar type multiple resistance unit, one end of the resistance unit being held in position by a 6 B.A. cheese-head screw.

5. Two anti-vibration pads on the chassis support the front and rear ends of the relay fixing plate. Three upwardly turned lugs on the plate, one at the rear and two at the front, receive three screws which carry the relay. The two screws at the front pass through two composition relay connecting blocks and into two tapped holes in two plates each secured by two screws to the relay. Two screws fixed to the chassis pass through, and serve to steady, the resiliently supported fixing plate.



1 CASE	**9** RELAY FIXING PLATE
2 4 SCREWS	**10** SEALING RING
3 SEALING RING	**11** 2 STEADY SCREWS
4 4 SPACING PILLARS	**12** 2 BONDING AND LOCATING BLOCKS
5 SENSITIVE RELAY	**13** CHASSIS
5a TWO COMPOSITION RELAY CONNECTING BLOCKS	**14** FRONT COVER
6, **7** PILLARS CARRYING 2 FIXED CONTACTS	**15** 6-POLE PLUG
	16 3-POLE PLUG
	17 2 MOUNTING PLATE BRACKETS
	18 MOUNTING PLATE
8 REAR COVER	**19** BONDING AND LOCATING SPRING

Fig. 1. Temperature control unit, Type FLW/A/6 (front view)

6. The sensitive relay, dependent on the direction of the current through it, moves the contact-carrying armature (mounted on a vertical axis) against either one of the two fixed contacts mounted on pillars.

7. The rear end of the deck supports three potentiometers of 2 ohms, 100 ohms and 2 ohms. Each is adjusted by a screw which is locked by a collet and a collet nut. The 0–100 ohm potentiometer is for setting the balance point about which the bridge functions. The 0–2 ohm potentiometers are hold-on resistors, and when one side of the secondary relay functions, the resistor associated with that side short-circuits, thereby increasing the out-of-balance condition and preventing relay chatter.

8. The secondary relay is fixed to the deck by two hexagon-head screws, nuts and lock-washers. The two nuts hold a plate which overlaps and locates the rocking armature of the relay.

OPERATION

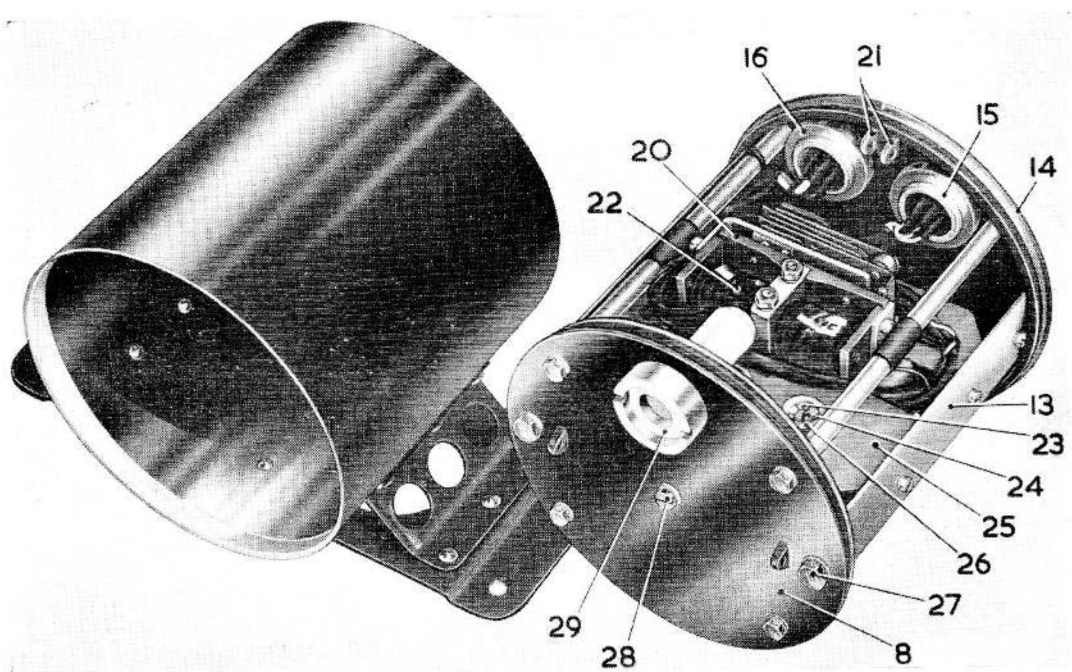
9. The controller is normally included in a cabin air control system and is designed to prevent the cold air unit in the system from developing air temperatures which would cause icing conditions.

10. A temperature-sensitive double resistance unit, or ductstat, is situated in the cabin air duct and in two opposed arms of the controller bridge network, each on a parallel circuit with a fixed resistor R2 and R4. Referring to the 6-pole plug in fig. 3, one of the ductstats is applied across AB, and the other across CD. The positive supply is connected to A and the negative to F. The remainder of the bridge circuit consists of two fixed resistors R1 and R3, a variable resistor across EA which is operated by a follow-up linkage and three potentiometers, two having a value of 0–2 ohms and the other a value of 0–100 ohms. The resistor R5 serves to drop some of the voltage across the bridge.

11. The circuit across the bridge is wired through the two opposing coils of the sensitive relay, so that, dependent upon the direction of an out-of-balance potential, the relay closes one or other of its set of contacts.

12. The 24-volt d.c. (nominal) supply is fed from poles A and F through the bridge, and when the duct air temperature rises above a pre-determined "band", the bridge has an out-of-balance potential across it which energizes the sensitive relay so that the secondary relay becomes energized and closes the circuit between the supply and the "close" coil winding of a by-pass valve actuator.

13. Should the air temperature fall to the upper value of the "band", the ductstat resistance increases and unbalances the bridge in the opposite direction. This signal energizes the sensitive relay so that the secondary relay becomes energized and closes the circuit between the supply and the "open" coil windings of the by-pass valve actuator. The movement of the valve is transmitted to the follow-up



8	REAR COVER
13	CHASSIS
14	FRONT COVER
15	6-POLE PLUG
16	3-POLE PLUG
20	ROCKING ARMATURE
21	PAIR OF LUGS
22	SECONDARY RELAY
23	COLLET
24	POTENTIOMETER ADJUSTING SCREWS
25	DECK
26	COLLET UNIT
27	2 SCREWS
28	4 B.A. SCREW
29	DESICCATOR (PRE-MOD. 966)

Fig. 2. Temperature control unit, Type FLW/A/6 (rear view)

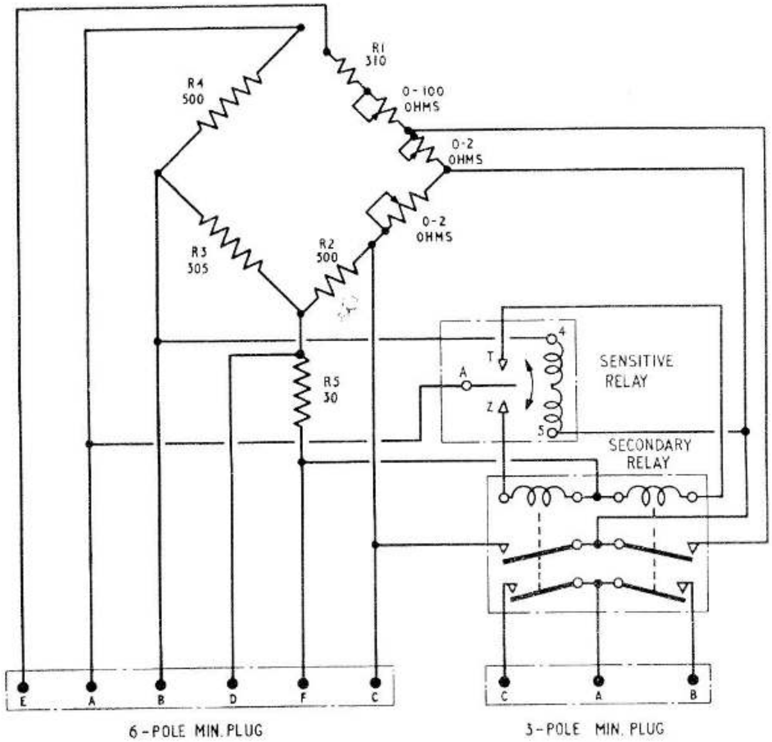


Fig. 3. Circuit diagram

resistor across the poles EA of the 6-pole plug in the bridge which alters value and cancels the out-of-balance signal from the ductstat.

14. If the air temperature continues to fall the cycle will be repeated until, at the "band" lower value, the valve is fully open and the bridge remains biased in this direction. On rising temperature the converse occurs, the valve commences to close at the "band" lower value and is fully closed at the upper value.

INSTALLATION

15. Before installing a control unit refer to the appropriate aircraft air publication.

SERVICING

16. Should the serviceability of a control unit be in doubt apply the functional test (*para.* 19). If the desiccator (if fitted) indicates a high moisture content, remove the control unit for examination.

Testing

17. The tests given in this appendix are peculiar to this control unit, and these tests are in addition to the common tests given under Servicing in Chap. 18. Fig. 4 shows the test circuit required.

Insulation resistance

18. The insulation resistance must not be less than 5 megohms at 250V d.c. between the following:—

(1) All plug poles and the unit cover
(2) Each pole of the 6-pole plug and each pole of the 3-pole plug.

Functional test

19. The test should be carried out at normal room temperature (20°C) and the control unit connected to the test rig (*fig.* 4) with a supply of 28V d.c.

(1) With R3 set to 30 ohms and R1 and R2 set initially at 900 ohms, L1 must light when R1 and R2 are increased simultaneously to 1100±15 ohms.

(2) With R1 and R2 adjusted to the value which caused L1 to light (operation (1)) and R3 set initially to 30 ohms, L1 must

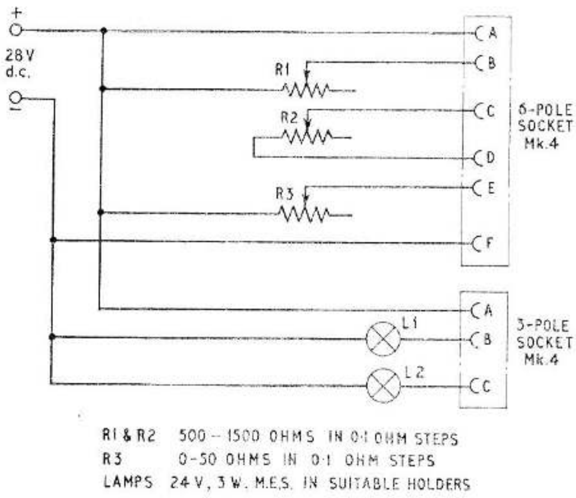


Fig. 4. Test rig circuit diagram

extinguish when R3 is increased and before R3 exceeds 36 ohms.

(3) With R3 set at 30 ohms and R1 and R2 set initially to the value which caused L1 to light (operation (1)), L2 must light when R1 and R2 are decreased simultaneously and before R1 and R2 decrease below 900 ohms.

(4) With R1 and R2 set to the value which caused L2 to light (operation (3)) and R3 set initially to 30 ohms, L2 must extinguish when R3 is decreased and before R3 decreases below 24 ohms.

(5) With R3 set at 0 ohms and R1 and R2 set initially to the value which caused L2 to light (operation (3)), L2 must light when R1 and R2 are decreased simultaneously and before R1 and R2 decrease below 800 ohms.

(6) The control unit must function satisfactorily when 21 and 29V d.c. are applied.

Appendix 3

TEMPERATURE CONTROL UNIT, TYPE FLW/A/7

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LIST OF ILLUSTRATIONS

DESCRIPTION

1. The component deck assembly of the temperature control unit, Type FLW/A/7, is housed in a cylindrical cover retained between a front and a rear cover (*fig*. 1). Riveted to the underside of the cylindrical cover is the unit mounting plate.

2. Three 6-pole plugs (*fig*. 2) are mounted on the front cover which is a circular plate having a machined groove round the peripheral edge for location of a sealing ring. Integral lugs formed on the inside face secure the cover to the deck assembly by five 6 B.A. cheese-headed screws and spring washers.

3. The rear cover is similar to the front cover and is secured to the deck assembly by two 2 B.A. hexagon-headed screws with sealing washers, which screw into tapped blocks riveted to the rear end of the deck. After assembly the two screws are locked by wire passing through the two lugs on the cover face. On units pre-mod. 943 a silica gel desiccator is screwed into the rear cover and sealed with plain and sealing washers. A window on the outside of the desiccator indicates the moisture content within the unit. A centrally positioned tapped hole in the cover is used for pressure testing the unit (20 lb/in^2 differential) and is blanked off by a 4 B.A. cheese-headed screw and sealing washer.

4. Four spacing rods are fitted between the front and rear cover. The ends of the rods are shouldered and screwed 4 B.A. and are secured by nuts on the outer faces of both covers. Bonded rubber sealing washers are fitted over the rods on both the inner and outer faces of the covers.

5. Located on the deck assembly upper face is a polarised relay complete with socket type base. The base is mounted on a lug bent up

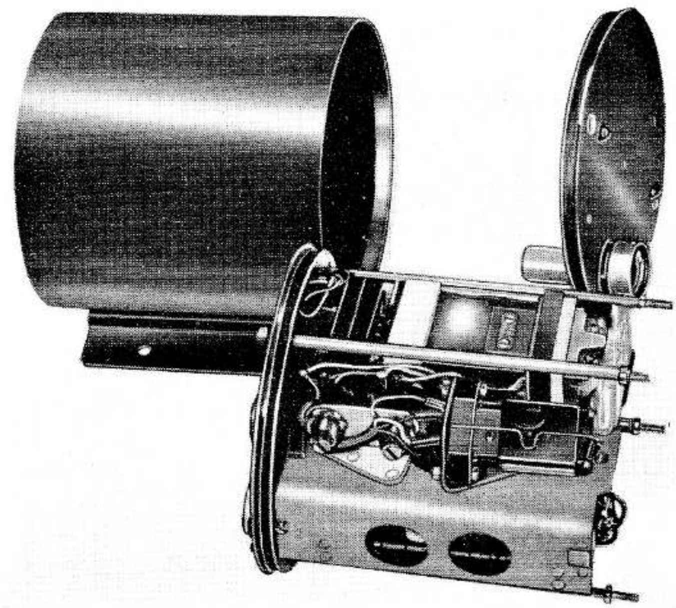

Fig. 1. Temperature control unit

from the front edge of the deck, and on an angle bracket which is screwed to the deck. A 4 B.A. and 6 B.A. cheese-headed screws, each with plain and spring washers, pass through the lug and angle bracket respectively and on through the relay base to screw into tapped holes in the end of the relay. The relay has a perspex cover and is held to the deck face by a phosphor bronze clip. The clip is secured by two 6 B.A. cheese-headed screws, with plain and spring washers, which thread into anchor nuts on the deck; shims may be used to take up any gap between the clip and the anchor nuts.

6. To one side of the polarised relay an angle bracket, riveted to the deck face, provides side by side mounting for two miniature potentiometers secured to the bracket by tab washers and nuts. At the rear of the potentiometers is another angle bracket carrying a relay base. A sensitive relay, with pin contacts, plugs into this base and is retained by a spring clip integral with the base. On the other side of the polarised relay is a carbon resistor soldered to the tags of an insulated terminal strip.

7. Four miniature relays are positioned along one side of the under face of the deck. Each relay has a spacer fitted beneath it and is secured to the deck from above with two 6 B.A. countersunk screws which engage in tapped holes in the relay frame. A canister resistance unit is located adjacent to the contact leaves of the four relays, and is secured

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Key to Fig. 2

- **1** FRONT COVER
- **2** NAME AND DATA PLATE
- **3** SEALING RING
- **4** OVERHEAT BRIDGE RESISTANCE UNIT
- **5** POTENTIOMETER (OVERHEAT CONTROL) 0–150 OHMS
- **6** CARBON RESISTOR, 195-OHMS
- **7** RELAY CLIP
- **8** POLARISED RELAY
- **9** MAIN CASE
- **10** SEALING RING
- **11** REAR COVER
- **12** MOD. PLATE
- **13** DESICCATOR UNIT (PRE-MOD. 943)
- **14** MINIATURE RELAY
- **15** COMPONENT DECK
- **16** MAIN CONTROL BRIDGE RESISTANCE UNIT
- **17** CAPACITOR
- **18** STABILISING RESISTANCE UNIT
- **19** MINIATURE RELAY (OPEN TYPE)
- **20** STRIP BETWEEN RELAY AND DECK
- **21** 6-POLE BREEZE PLUG, TYPE CZ48995/5
- **22** 6-POLE BREEZE PLUG, TYPE CZ48995/1
- **23** 6-POLE BREEZE PLUG, TYPE CZ48995

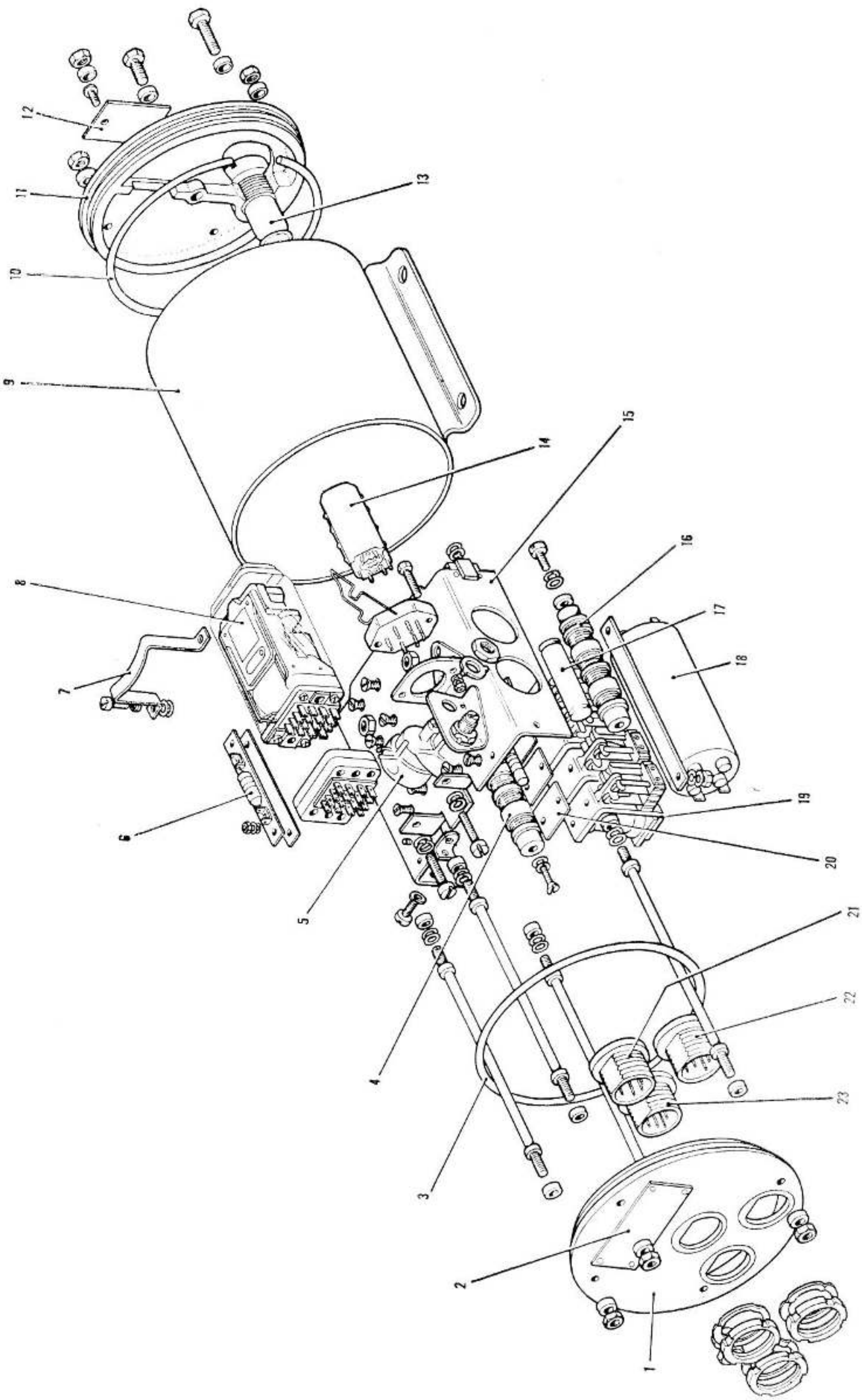

Fig. 2. Exploded view

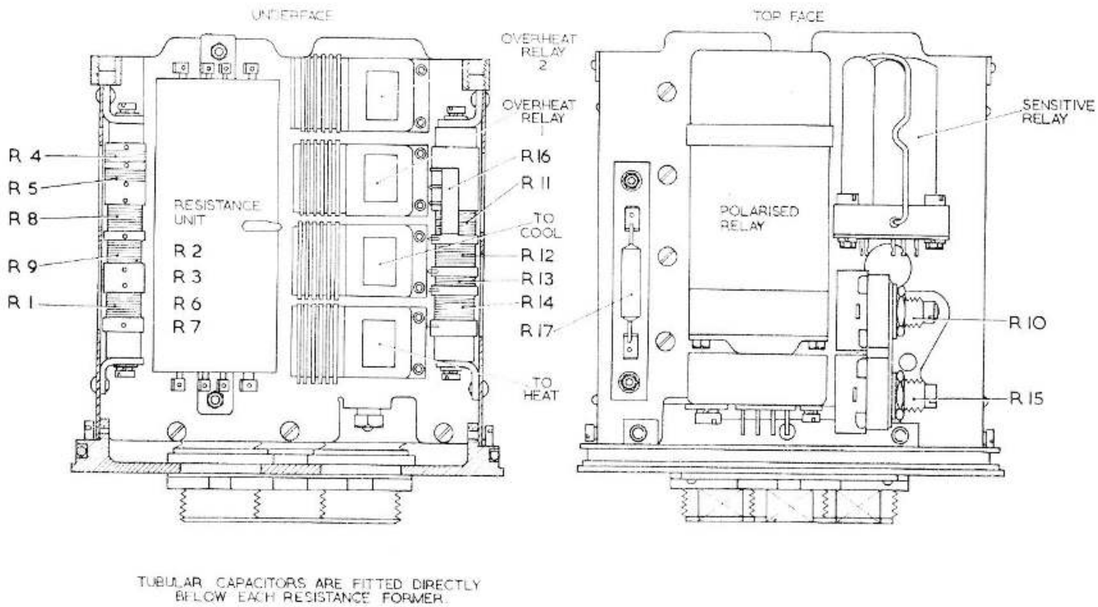

Fig. 3. Component layout

to the deck by two 6 B.A. countersunk screws with plain and spring washers and nuts.

8. At each side of the deck under face is a capacitor mounted in a riveted spring clip. Above each capacitor is a wire wound resistance former each being end-mounted to an angle bracket by a 4 B.A. cheese-headed screw with plain and spring washers. A carbon resistor is soldered between two terminal pins of one of the resistance formers. For the layout of the components refer to fig. 3 and for details of the electrical circuit refer to fig. 4.

9. The unit measures $4\frac{5}{8}$ in. x $4\frac{3}{4}$ in. x $5\frac{7}{8}$ in. and weighs 3 lb. 4 oz.

OPERATION

10. This type of control unit is normally included in an aircraft system to maintain, within predetermined limits, the temperature at the leading edge of the aircraft mainplanes for anti-icing purposes. Control unit operation requires the unbalancing of Wheatstone bridge networks, this unbalance being arranged to operate a series of relays which in turn direct the motor current to the equipment necessary to nullify the icing conditions. The sections of the bridge networks that produce the unbalance consist of two temperature sensitive thermistor elements which are external to the control unit and are, of course, subjected to the temperature being controlled. Two bridge networks are included in the unit, one for normal control and the other to over-ride normal control should the temperature rise to a predetermined maximum.

11. When the temperature is at the desired level, the main control bridge is balanced and, consequently, no current will flow through the coil of the polarised relay (*fig.* 4) connected across it. Should, however, the temperature rise or fall from this value, a change will occur in the resistance value of the thermistor (thermistor units have a negative coefficient of temperature). As a result the bridge will unbalance, causing a flow of current through the polarised relay.

12. When the current reaches a sufficient value its centrally balanced armature will move to close one of two pairs of contacts (A to Z or A to T); which pair of contacts will depend upon the direction of the current. This will energize the "to heat" or "to cool" slave relay, as applicable, and will bring into operation three associated pairs of contacts:—

(1) One pair will close to drive the heating apparatus in the direction necessary to correct the temperature change.

(2) One pair will open to bring into the

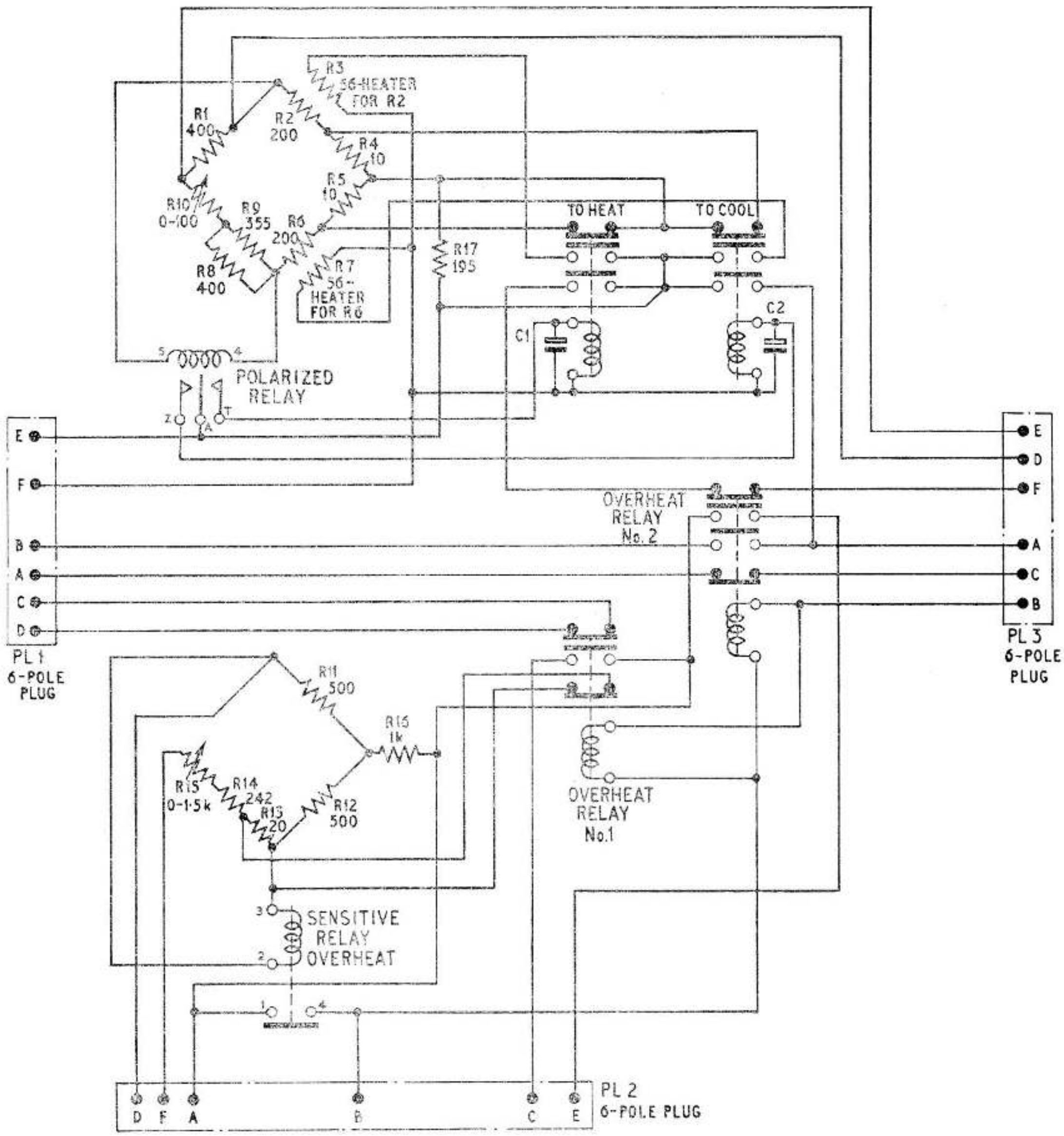

Fig. 4. Circuit diagram

bridge an additional resistance (R4 or R5), which accentuates the bridge unbalance to make relay action more positive and to determine the temperature change necessary to cause the relays to be de-energized.

(3) One pair will close to complete the supply to a heating element (R7 or R3) which is closely wound over but insulated from a temperature sensitive resistance (R6 or R2). The heating effect of R7 or R3 will cause a rise in the resistance value of R6 or R2, and this is so arranged as to offset the existing bridge unbalance until it becomes sufficient to produce balance conditions once again.

13. As a result, relay action will cease and further movement of the external heating equipment will be suspended. R7 or R3 will discontinue heating, and R6 or R2 will cool until their resistance value has returned to nominal. Should the temperature not have been corrected, the sequence of operations will re-commence and cycle until the temperature is once more at the desired level.

14. Should the temperature rise above that normally corrected by the main bridge and rise to a predetermined maximum, the overheat bridge will become sufficiently unbalanced, due to the change in the thermistor resistance, to energize a sensitive relay connected across it. This in turn energizes two overheat slave relays which, by arrangement of their contacts, over-ride the main bridge, set the external heating equipment in to the cooling position, operate the various warning and indicating devices and also bring into the overheat bridge the additional resistor (R13) which has an action similar to R4 and R5 in the main bridge.

15. When the overheat condition has been corrected, the sensitive relay will release due to the resultant change in thermistor resistance and the two overheat slave relays will be de-energized, thus allowing normal control action to be restored. The overheat relays may alternatively be heated by a thermal switch positioned in the duct supply hot air to the aircraft surfaces being heated and is operated when the hot air reaches a pre-determined maximum. The temperature levels at which both bridge networks become operative is pre-set by potentiometers, R10 and R15 respectively.

INSTALLATION

16. Before installing a control unit, refer to the appropriate aircraft air publication.

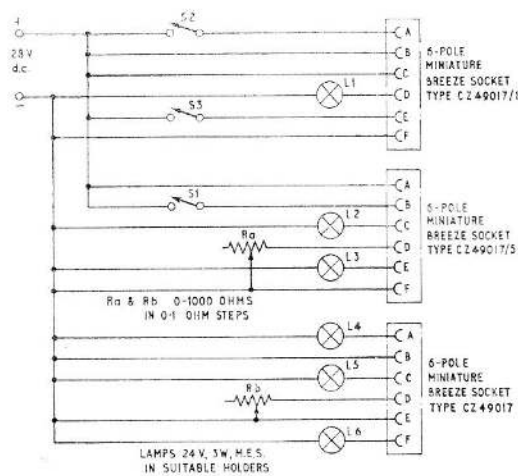

Fig. 5. Test rig circuit diagram

SERVICING

17. Should the serviceability of a control unit be in doubt apply the functional test (*para.* 20). If the desiccator (if fitted) indicates a high moisture content remove the control unit for examination.

Testing

18. The tests given in this appendix are peculiar to this control unit and these tests are in addition to the common tests given under Servicing in Chap. 18. Fig. 5 shows the test circuit required and it should be noted that the control unit plugs are numbered for identification on fig. 4 and 5.

Insulation resistance

19. The insulation resistance must not be less than 5 megohms at 250V d.c. between the following:—

(1) All plug poles and the unit cover.

(2) Pole A of plug 1 to all plug poles except pole C of plug 3.

(3) Pole B of plug 1 to all plug poles.

(4) Pole C of plug 1 to all plug poles except pole D of plug 1.

(5) Pole E of plug 1 to all plug poles except pole F of plug 1 and poles D and E of plug 3.

(6) Pole F of plug 1 to all plug poles except pole E of plug 1 and poles D and E of plug 3.

(7) Pole A of plug 2 to all plug poles except poles D and F of plug 2.

(8) Pole B of plug 2 to all plug poles except pole B of plug 3.

(9) Pole C of plug 2 to all poles of plugs 2 and 3.

(10) Pole E of plug 2 to all poles of plugs 2 and 3.

(11) Pole A of plug 3 to all poles of plug 3.

Functional test

20. The test should be carried out at normal room temperature (20°C) and the control unit connected to the test rig (*fig.* 5) with a supply of 28V d.c.

21. *Main bridge.* (1) Set Ra at 500 ohms and Rb at 650 ohms. Close switch S3. Lamps L4 and L6 should be extinguished.

(2) Increase Rb until L6 lights. Switch off S3 immediately and note value of Rb which must be 765±27 ohms.

(3) Allow at least thirty minutes to elapse with S3 left at off, then repeat operation (1).

(4) Decrease Rb until L4 lights. Switch off S3 immediately and note the value of Rb which must be 540±15 ohms.

(5) Set Rb at 27 ohms greater than the value obtained in operation (2). Lamp L6 should now cycle, i.e. it should remain alight for a short period followed by a further period during which it should be extinguished and continue in this manner whilst the setting is held. The "on" period must be between 3 to 5 sec. and the "off" period between 2 to 4 min.

(6) Set Rb at 15 ohms less than the value obtained in operation (4). Lamp L4 should now cycle, and the on and off times should be as specified in operation (5).

(7) The unit must function satisfactorily with a supply voltage of 21 and 29V, though not necessarily meet the specified limits.

22. *Overheat bridge*. (1) Increase Rb so that lamp L6 is cycling on and off. Close S2. Lamps L1 and L5 should light and L6 should cycle.

(2) Decrease Ra until L2, 3 and 4 light (L4 should not cycle). Simultaneously, L1 and L5 should extinguish and L6 remain constantly extinguished. The value of Ra at which this occurs must be 345±10 ohms.

(3) Increase Ra until L2, 3 and 4 are extinguished and, simultaneously, L1 and L5 light with L6 recommencing to cycle. The value of Ra at which this occurs must be 19 to 120 ohms greater than that obtained in operation (2).

(4) Reset Ra at 500 ohms. Reset Rb so that L6 is cycling. Lamps L1 and L5 should be alight.

(5) Close S1 and L2, 3 and 4 should light (L4 should not cycle) and simultaneously, L1 and 5 should extinguish and L6 should remain constantly extinguished.

(6) Open S1 and all lamps should revert to their original condition.

(7) The unit must function satisfactorily with a supply voltage of 21 and 29V, though not necessarily meet the specified limits.

Fault finding

23. For fault finding (*Table* 1) the control unit must be connected to the test rig (*fig*. 5).

Table 1

Fault finding

Fault	Possible cause and procedure
(1) A particular lamp on the test rig does not light or extinguish under the conditions of the functional test though associated relays operate	Check the relay contacts associated with the lamp for correct functioning, cleaning or resetting if necessary Check wiring associated with the contacts If associated relay armature is not pulling in or releasing as required, check wiring to, and continuity of the relay coil. If satisfactory, change polarised relay or sensitive relay, as applicable. If this does not effect a cure, disconnect instrument from the test rig and remove polarised relay or sensitive relay, as applicable. Check the associated bridge circuit for continuity and correct resistance values. (To check these values the bridge circuit must be broken at some convenient junction)

 RESTRICTED

Table 1 *(continued)*

Fault finding

Fault	Possible cause and procedure
(2) Lamp L4 or L6 remaining alight at all values of Rb	Disconnect instrument from test rig and remove polarised relay. Check the bridge circuit for continuity and correct resistance values. (To check values bridge circuit must be broken at some convenient junction)
	Change polarised relay
(3) Instrument not meeting the hold-on limits specified in the Setting Instruction (see Note 1)	If the value is less than 50 ohms, check R4 or R5 as applicable for correct value, and associated contacts for correct functioning
	If the value is greater than 110 ohms, check R4 or R5 for correct value. If satisfactory, change polarised relay
(4) The "To Heat" or "To Cool" relay chattering	Ensure that the supply to the instrument is of the correct polarity
	Check R4 or R5, as applicable, for correct value, and associated contacts for correct functioning
	Change polarised relay
(5) Instrument cannot be set to meet the limits specified in Setting Instructions (see Note 2)	Disconnect instrument from the test rig and remove sensitive relay. Check the overheat bridge for continuity and correct resistance values
	If the value of Ra between the lamps lighting and extinguishing is less than 19 ohms, check R13 for correct value and its associated relays for correct functioning
	Change sensitive relay
(6) Instrument fails to cycle on one or both sides, though in all other respects satisfactory	Check contacts associated with heating elements, R3 or R7, as applicable, for correct value
	Check wiring associated with R3 or R7, as applicable

Note 1 . . .

Set the variable resistances Ra and Rb at 500 ohms and 650 ohms respectively. Switch on S3 and allow a minimum of 15 minutes for the unit to settle down. Decrease Rb until lamp L4 lights, then decrease until it extinguishes. The difference in these values should be 50 to 110 ohms. Continue to decrease Rb until lamp L6 lights, then decrease until it extinguishes. The difference in these values must also be 50 to 110 ohms.

Note 2 . . .
Set Ra at 345 ohms and Rb at 650 ohms.

Increase Ra until lamps L2, L3 and L4 extinguish.

Decrease Ra until lamps L2, L3 and L4 light once more, to obtain an accurate measurement of the resistance Ra. It should be 345 ohms ± 10 ohms. Readjust on the potentiometer, if necessary, to obtain a value as near the nominal 345 ohms as possible.

Increase Ra until the lamps extinguish. This should occur at a value of resistance between 19 and 120 ohms from that necessary to cause the lamps to light.

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