Chapter 19

FIRE DETECTION, D.C. CONTROL UNITS, FIREWIRE

(Completely revised)

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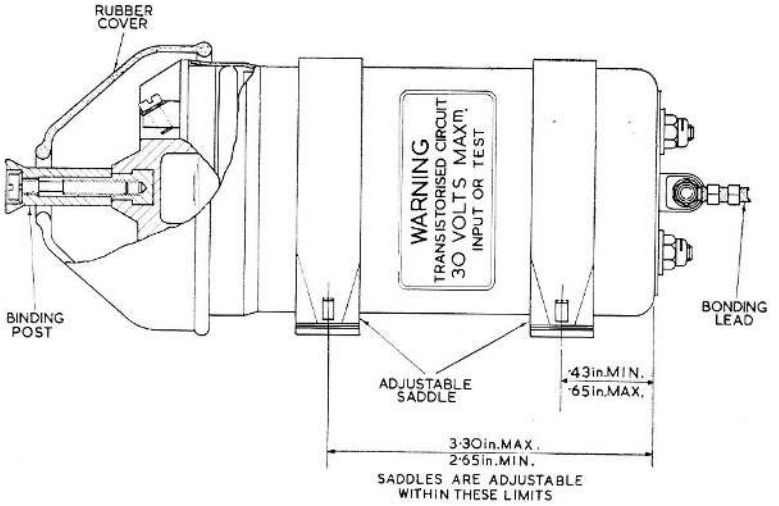

Fig. 1. Part section view of typical control unit

Introduction

1. The d.c. control units are single way units for use with the Graviner continuous wire type of fire detection systems where only d.c. supply is available or its use is preferred. They are basically identical in function with the a.c. units such as Type D879 and D1200 with which they are functionally interchangeable. This chapter deals with the typical control unit and details of individual units are given in the Appendices. General information on the Firewire system as a whole is given in A.P.4343, Vol. 1, Sect. 32, and information on the sensing elements and their accessories is in Chapter 2 of this Section.

DESCRIPTION

2. The units, shown in fig. 1, consist of a cylindrical case, a chassis, and a terminal block. The moulded terminal block is a circular plate screwed to the chassis and when the chassis is fitted into the case the terminal block fits into and closes the open end of the case. An "O" ring seal is used to seal the unit round the terminal block joint and two further "O" rings seal the securing

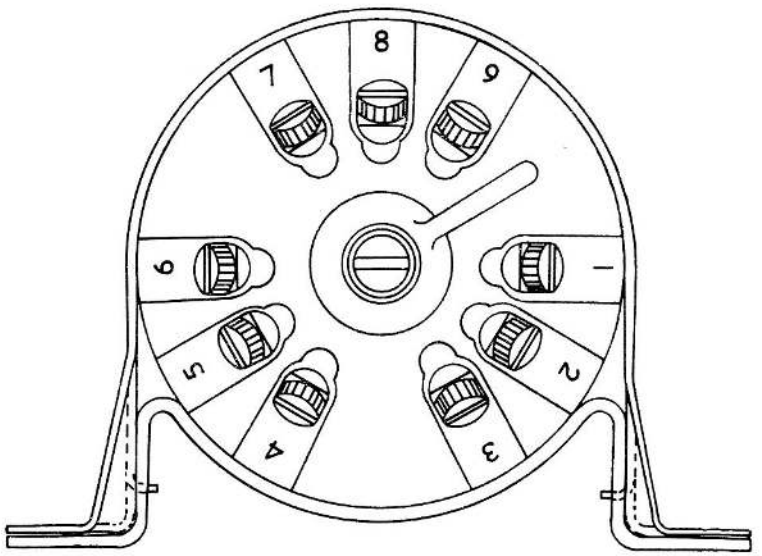

Fig. 2. Terminal block of control unit with cover removed

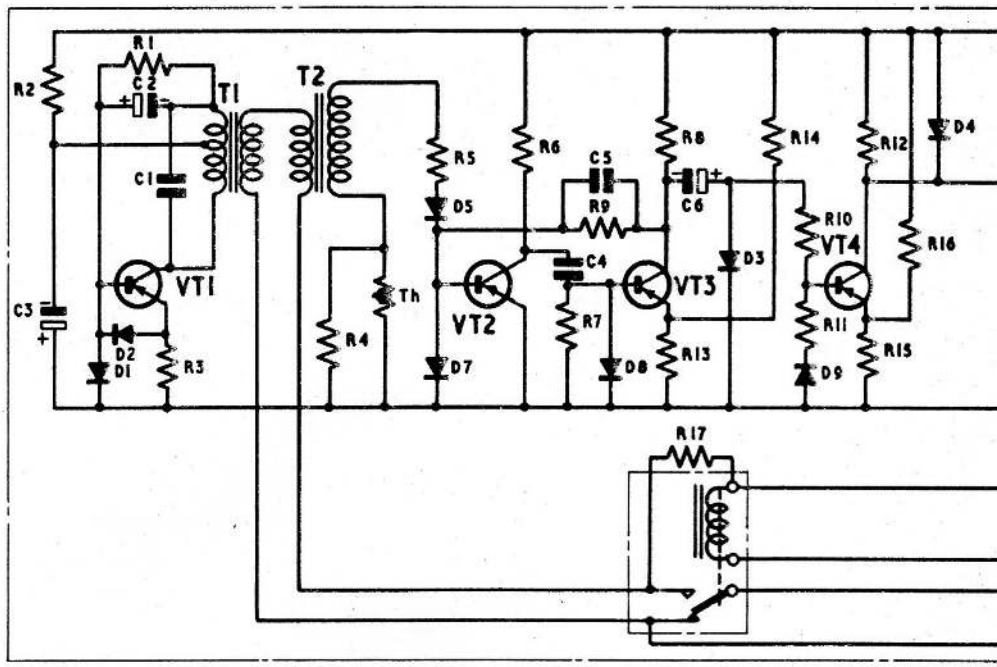

Fig.3 Control unit Type D3000 : circui

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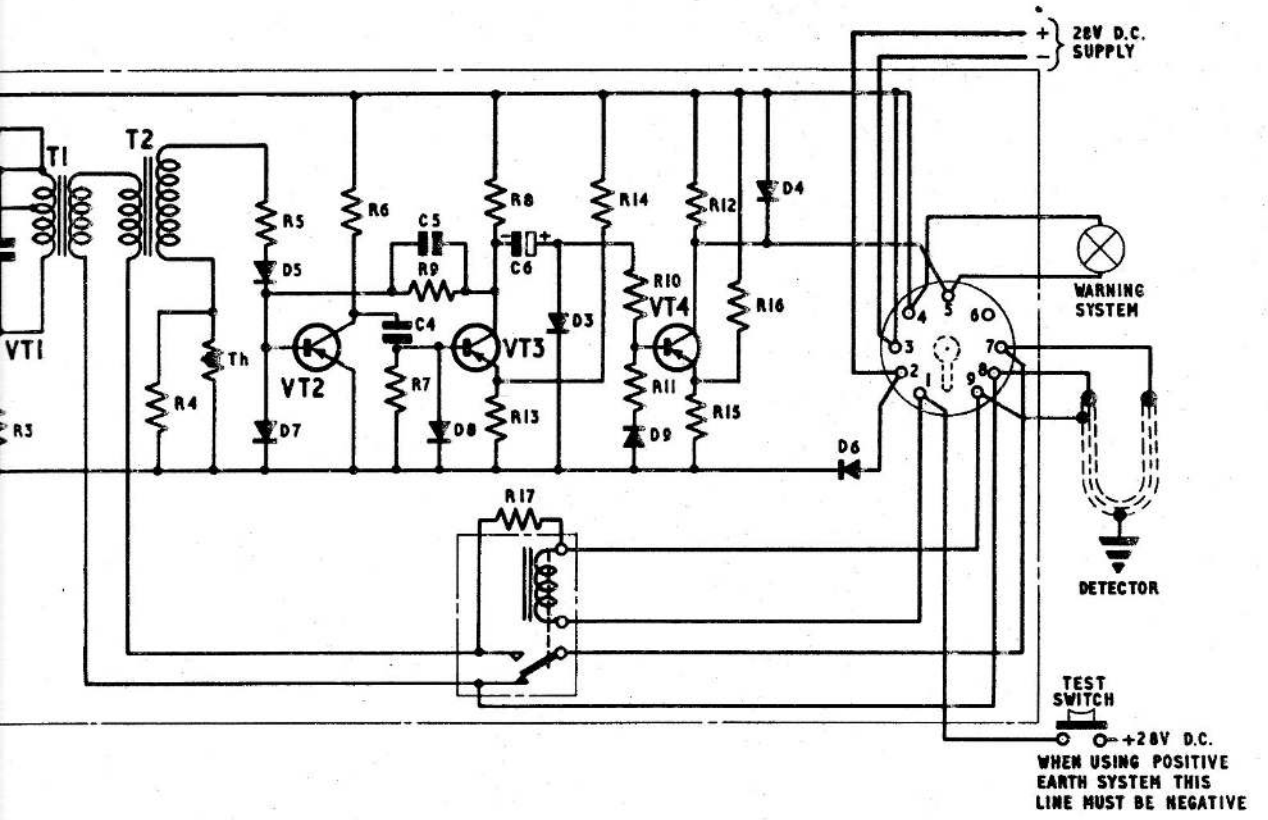

Control unit Type D3000 : circuit diagram Fig. 3

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studs which project from the chassis through two holes in the closed end of the case.

3. The terminal block, shown in fig. 2, carries nine terminals which will accommodate either 4BA or No. 6 U.N.F. ring type cable ends. In the centre of the terminal block is a cable binding post which is removable and permits the removal of the cable assembly as a whole after disconnection from the terminals. The connecting cable and terminal block are protected by a rubber cover which fits over the end of the unit case and is internally fluted to assist the drainage of moisture.

Circuit

Types D2695 and D3000

4. The chassis uses a printed circuit and carries the transistorized oscillator and switching circuits, together with a miniature relay (S.T.C. Type 4184JD.) for the test facility. The germanium transistors are mounted within a light alloy block which serves as a temperature stabilizing heat sink. Similarly those resistors which are dissipating the stand-by power are potted in a light alloy disc, at the end of the chassis, for temperature stability. The remaining components are screwed to the top and bottom of the chassis.

Type D3600

5. The Type D3600 unit has a transistorized static inverter, the components of which are mounted similarly to the circuit components of the D3000 unit, with the saturable transformer output passed through a bridge rectifier to the warning relay coil and thence to the sensing element. A further relay provides the test facility.

OPERATION

Types D2695 and D3000

6. The unit consists essentially of an oscillator, a monostable multivibrator and an output stage. Referring to the circuit diagram (fig. 3) the transistor VT1, the primary winding of transformer T1 and capacitor C1 form an oscillator circuit; automatic bias being provided by a tapping of the transformer primary winding, through resistor R1 and capacitor C2. The oscillator generates from the d.c. supply the a.c. necessary for energizing the Firewire sensing element which is connected in series with the secondary winding of transformer T1 and primary winding of transformer T2.

7. The monostable multivibrator consists of transistors VT2 and VT3, the two being interconnected in conventional monostable manner. At stand-by, when the current through the Firewire is very small, the vibrator is stable with VT2 bottomed (fully conductive) and VT3 cut-off (non conductive). The base of transistor VT2 has a negative bias provided by the circuit through resistance R4, R5, the secondary coil of transformer T2, the rectifier D5, and resistors R8 and R9. Transistor VT3 is held cut-off by a positive potential on the base there being no volt drop through resistor R7 in the stable condition, and transistor VT4 is also held cut-off by a similar resistive-capacitive coupling.

8. Should the resistance of the sensing element fall due to fire or overheating in the monitored fire zone, the resistance across terminals 8 and 9 (or 7 and 9) will be decreased and the current in the secondary winding of transformer T1 and the primary of T2 will increase. This will give an associated increase in the output of transformer T2.

9. The increase in the output of transformer T2 boosts the potential on the base of transistor TV2 and the transistor becomes less conductive. The change in the collector potential allows capacitor C4 to become charged, and the associated volt drop across resistor R7 lowers the potential on the base of VT3 which then conducts and drives VT2 to cut-off. During the build up of current through VT3, capacitor C6 discharges through it and then charges up once more through R11 and R10. This reduces the potential on the base of VT4 which conducts and illuminates the fire warning lamp.

10. As current in the secondary circuit of transformer T2 flows for one half cycle only and the frequency of the oscillator is approximately 600 c.p.s. the base of VT2 is driven alternately positive and negative and the multivibrator has a repetition rate of approximately 600 c.p.s. This high repetition rate prevents the capacitor C6 from becoming totally charged or discharged as the state of the capacitor cannot change so quickly and hence transistor VT4 tends to remain conducting to give a continuous warning light.

11. Should the fire zone temperature subsequently fall the resistance of the element will increase and reduce the output of transformer T2. At the negative half cycle the multivibrator will resume its stable state and the next positive half cycle will be insufficient to trigger a warning thus the unit will be once more at stand-by.

12. Operation of the test switch will energize the test relay and the changeover of the relay conducts connect the centre electrode of the Firewire sensing element in series with the secondary winding of transformer T1 and the primary winding of transformer T2. The reduced impedance of the element circuit will then simulate the effect of heating the element and the fire warning signal will occur, on releasing the switch the warning will be cancelled similarly to the effect of a falling temperature of the fire zone following the fire.

Type D3600

13. The Type D3600 unit is a simplified d.c. control unit with a static inverter, providing the a.c. necessary to energize the Firewire, and fire warning and testing facilities. The static inverter consists of two transistors, VT1 and VT2, connected in common emitter push/pull arrangement to the primary of a saturable transformer, T1. The feedback winding of transformer T1 providing the base driving current to the transistors and the output winding providing the a.c. to the Firewire element. The starting circuit for the inverter is provided by rectifiers, MR1 and MR6, and the resistors, R1 and R2.

14. When d.c. is applied to the unit one of the transistors conducts more than the other, the starting circuit drives both transistors to conduct, the one with the higher amplification starting first. The current through one half of the primary winding sets up a flux in the core of the transformer such that the voltage induced in one half of the feedback winding drives the base of the conducting transistor more negative and that in the other half drives the base of a non-conducting transistor positive.

15. Assume the conducting transistor to be VT1 and fully conductive (bottomed) and the non-conducting transistor to be VT2 and fully non-conductive (cut-off), the current in the primary has then reached the stable state and the resultant flux is no longer increasing. The induced voltage in the feedback winding then falls reducing the driving current to the conducting transistor, VT1, thus reducing the current from the primary winding. The resulting change in flux, in the opposite sense, now induces a voltage in the

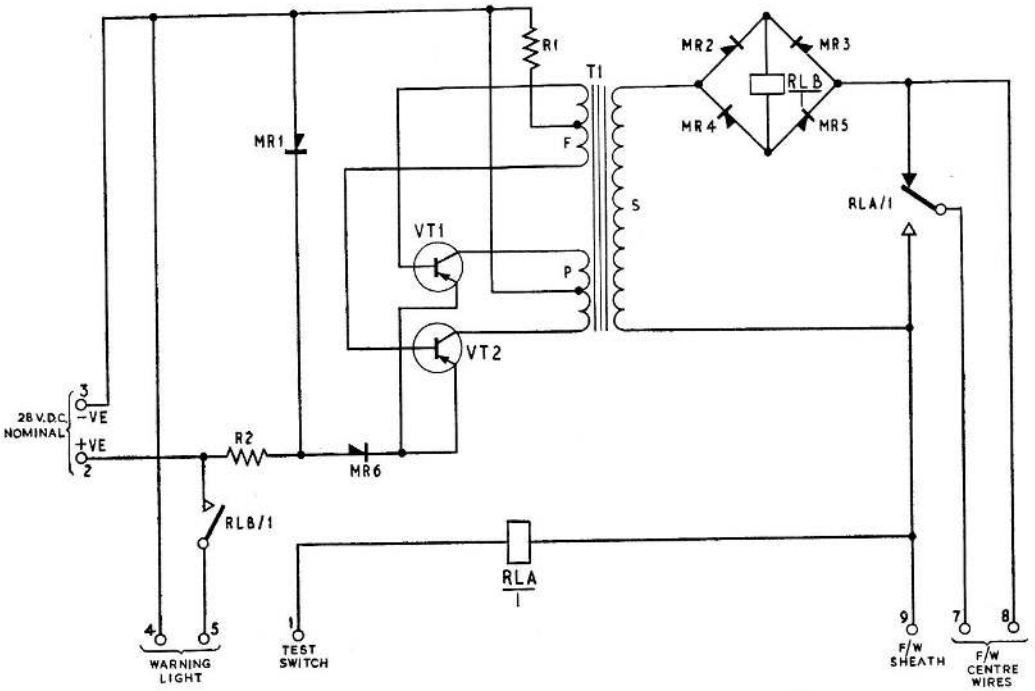

Fig. 4. Circuit diagram of Type D3600 control unit

feedback winding which causes transistors VT2 to be driven fully conductive and transistor VT1 to be driven fully non-conductive until such time as the driving transistor is again bottomed and the flux reaches the stable state. The cycle of operations is repeated at a frequency determined by the transformer characteristics.

16. The change in the flux in the core of the transformer produces an alternating voltage of square wave form in the secondary winding, S, which is then applied to the Firewire element through the coil of the warning relay RLB. When the Firewire resistance falls due to an increase in temperature the current through the coil will increase operating the relay and initiating the fire warning signal. Should the temperature subsequently fall the relay coil current will decrease and the relay drop-out cancelling the warning.

17. Operation of the remote test switch in the aircraft circuit puts a positive supply to the coil of the test relay RLA, the return circuit being made through the Firewire outer capillary to earth. Relay RLA is then energized and contacts RLA-1 change over completing the circuit of the secondary winding S through the centre electrode of the Firewire element. Relay RLB is then energized and a fire warning signal given thus proving the function of the control unit, continuity of the centre electrode and the earth connection to the outer capillary, and the warning circuit. When the test switch is released the two relays are de-energized and the warning cancelled.

INSTALLATION

18. The unit is mounted by means of feet on axially adjustable saddles which clamp around the case and secure the unit to the aircraft when the retaining bolts are tightened. The mounting saddles must be positioned within the limits shown in fig. 1.

Note . . .

Prior to installation in an aircraft the Types D2695 and D3000 units should be energized by connecting a 24V d.c. supply across terminals 2 (positive) and 3 (negative) for a period of not less than 10 minutes to polarize the electrolytic capacitors.

SERVICING

19. Servicing should be confined to examination to ensure that the unit is undamaged and free from corrosion, the mounting saddles should be moved to check for corrosion beneath them. The rubber terminal cover should be removed and the terminal block checked for cracks and the connections for security.

Testing

20. A functional test of the system may be made by the operation of the aircraft test switch, failure to operate or to reset may be due to a fault in either the sensing element system or the control unit. The sensing element system should be serviced and tested as given in Chapter 2 of this Section, the control unit may be removed and functionally tested using the procedure given in the Standard Serviceability Tests, Appendices A and B. Additionally the following tests may also be made after energizing the unit as given in paragraph 18.

Current consumption test

21. With the control unit connected to a circuit similar to that given in fig. 1 of Appendix A and with an applied voltage of 28·5V the current taken by the unit when giving a warning signal (i.e. warning lamp illuminated) should be approximately 250mA for the Type D2695 and D3000 units and approximately ◀280mA▶ for the Type D3600 unit. The current taken by the unit when stand-by (i.e. warning lamp extinguished) should be approximately 120mA for control units Type D2695 and D3000 and approximately 160mA for control unit Type D3600.

◀*Open circuit voltage test, Type D*3000 *only.*▶

22. Connect the control unit to a 28·5V supply and using a test meter, with an internal resistance of not less than 100,000 ohms, connected across terminals 8 and 9 the open circuit voltage should be ◀between 3·5V and 7·5V.▶ Repeat the test with the test meter connected across terminals 7 and 9.

◀*Short circuit current test, Type D*3000 *only.*▶

23. Connect the control unit to a 28·5V supply and using a moving coil type milliammeter with a range of 0–5mA connected across terminals 7 and 8 the short circuit current should be not less than 1·6mA.

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Volume 1, Book 3

MINISTRY OF DEFENCE

ELECTRICAL MANUAL - FIRE WARNING
EXTINGUISHING, SAFETY AND RESCUE EQUIPMENT

ADVANCE INFORMATION LEAFLET NO. 1/66

Insert this leaflet in A.P.4343E, Vol. 1, Book 3, Sect. 14, Chap. 19, to face para. 22.

Para. 22 should read:-

(1) Connect the control unit to a 28·5V d.c. supply.

(2) Measure the open circuit voltage across terminals 8 and 9, this should be not less than 3·5V.

(3) Measure the open circuit voltage across terminals 7 and 9, this should be not less than 3·5V.

Note . . .
For (2) and (3) above use multimeter Type 12889, Ref. No. 5QP/17447. Inter service No. 6625-99-105-7049. If using an equivalent meter it must have an internal resistance not less than 100,000 ohms.

Notes

(1) The information contained in this leaflet will be incorporated by normal amendment list action in due course.

(2) If, after receipt of this leaflet, an amendment list with a prior date and conflicting information is received, the information in the leaflet is to take precedence.

ENGINEER

Appendix A

STANDARD SERVICEABILITY TEST FOR FIRE DETECTION D.C. CONTROL UNITS (R.N.)

Introduction

1. The following tests may be made to ascertain the serviceability of a unit, or prior to installation in an aircraft.

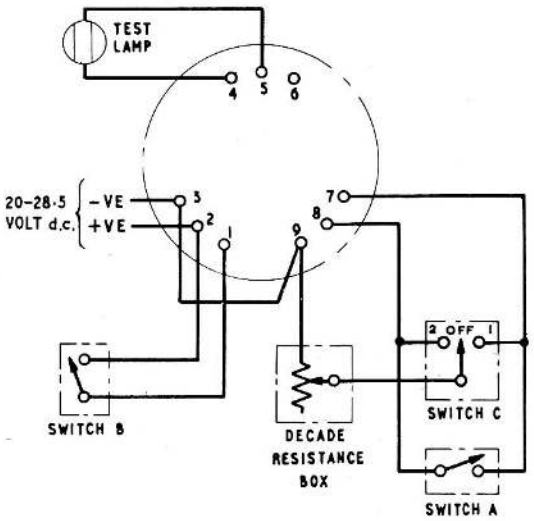

Fig. 1. Test circuit diagram

TEST EQUIPMENT

2. The following test equipment, or suitable equivalents, will be required:—

(1) Two single-pole ON/OFF switches Ref. No. 5CW/6430, and one single-pole changeover switch with centre-off position, Ref. No. 5CW/6431.

(2) A decade resistance box 0–11110 ohms, Ref. No. 10S/16239.

(3) A warning lamp Type B, Ref. No. 5CX/1553, fitted with a 24 volt 3·5 watt filament lamp.

(4) A 20-28·5V d.c. supply, containing not more than 1% ripple.

(5) A multimeter, Type F, Ref. No. 5QP/1, or suitable equivalent.

TEST PROCEDURE

3. Prior to carrying out a S.S.T. on a new unit, or a unit which has not been energized for three months or more, the electrolytic capacitors must be re-polarized as follows:—

(1) Connect the unit to a 2V d.c. supply (terminal 2 positive and terminal 3 negative).

(2) Slowly increase the voltage to 24V and leave the unit so energized for a period of not less than 10 minutes.

4. (1) Connect the relay unit to a test circuit as shown in fig. 1 ensuring correct polarity of the supply, at 28·5V.

(2) With all switches off, set the decade resistance to its maximum value.

(3) Operate switch C to positions 1 and 2 in turn ensuring that the warning lamp remains out.

(4) Set switch C to position 1 and slowly decrease the decade resistance until the warning lamp is illuminated.

(5) The value of the decade resistance at which this occurs must be within the limits; 500 to 1000 ohms for Type D2695 and D3000 units and 500 to 1100 ohms for Type D3600 units.

(6) Change switch C to position 2, ensuring that the lamp remains illuminated, and then slowly increase the decade resistance until the warning lamp goes out.

(7) The value of the decade resistance at which this occurs must be within the following limits:—

(a) Type D2695 and D3000 units. 800±400 ohms greater than that at which the lamp was illuminated in (5), (e.g. for an operate resistance of 700 ohms, between 1100 and 1900 ohms).

(b) Type D3600 units. Between 1400 and 3250 ohms.

(8) Return switch C to OFF and close switches A and B and ensure that the warning lamp is illuminated.

(9) Repeat the tests outlined in (2)–(6) with the supply voltage reduced to 22·5 volts.

Insulation resistance test

Note . . .

On no account must an insulation resistance tester or any meter with an output in excess of 30V be connected to any terminal of the unit.

5. The insulation resistance of the unit may be measured with a suitable multimeter (multimeter Type F, Ref. No. 5QP/1) connected between terminal 3 and the bonding lug at the end of the case, the reading obtained should be not less than 20 megohms.

Appendix B

STANDARD SERVICEABILITY TEST FOR FIRE DETECTION D.C. CONTROL UNITS (R.A.F.)

Introduction

1. The following tests may be carried out to ascertain the serviceability of a unit, or prior to its installation in an aircraft.

TEST EQUIPMENT

2. The following test equipment, or suitable equivalents, will be required:—

(1) A comprehensive Firewire test kit, Ref. No. 5G/3487.

(2) A multimeter, Type 12889, Ref. No. 5QP/17447.

(3) A 18–28V d.c. supply.

TEST PROCEDURE

3. ◀Prior to carrying out a S.S.T. on a new unit, or a unit which has not been energized for three months or more, the electrolytic capacitors must be re-polarized as follows:—

(1) Connect the unit to a 2V d.c. supply (terminal 2 positive and terminal 3 negative).

(2) Slowly increase the voltage to 24V and leave the unit so energized for a period of not less than 10 minutes.▶

4. Set switches SA, SB and SC to position 1 and the resistance control RV2 fully counter clockwise and then connect the No. 6 cable to plug PLB. Connect to the 28V supply ensuring that for the Type D2695 and D3000 units it is ripple free (i.e. obtained from a battery source) and that the polarity is correct, positive to pin A and negative to pin B. Remove the terminal shroud, the terminal post and the terminal screws from the control unit and than plug the unit into the circular Connector 1 on the test kit.

Functional test

5. (1) Set switch SA to position 1, SB to position 7, SC to position 8, switch on the 28V supply and ensure that lamp LP4 is illuminated.

(2) The control unit standby current indicated on meter M3 should be not more than 120mA for Type D2695 and Type D3000 units and not more than 160mA for Type D3600 units.

(3) Depress switch SG, lamp LP2 should be illuminated and the control unit operating current indicated on meter M3 should be not more than 250mA for Type D2695 and Type D3000 units and not more than 260mA for Type D3600 units.

(4) Release switch SG, lamp LP2 should extinguish.

(5) Decrease the resistance of RV2, by rotating it clockwise, until lamp LP2 is again illuminated.

(6) The resistance value of RV2 at which this occurs should be noted and must be within the following limits:—

(a) Type D2695 and Type D3000 units.

Between 500 and 1000 ohms.

(b) Type D3600 units.

Between 500 and 1100 ohms.

These may be determined by referring the RV2 scale reading to the calibration chart in the lid of the test set.

(7) Rotate RV2 counter-clockwise until lamp LP2 is extinguished.

(8) The resistance value of RV2 at which this occurs should be within the following limits:—

(a) Type D2695 and Type D3000 units. 400 to 1200 ohms greater than that at which the lamp was illuminated in (6) (e.g. for an operate resistance of 700 ohms, between 1100 and 1900 ohms).

(b) Type D3600 units.
Between 1400 and 3250 ohms.

Type D2695 and D3000 units only

(9) Rotate RV2 fully counter-clockwise, set switch SB to position 6 and operate and hold switch SE in the VOLTS position. The open circuit detector voltage indicated on meter M4 should be between 3·5 and 7·5 volts.

(10) Release switch SE and then operate it to the mA position and ensure that lamp LP2 is illuminated. The short circuit detector current now indicated on meter M1 should be not less than 1·6mA.

(11) Set the d.c. supply to 18 volts, depress switch SG and ensure that lamp LP2 is illuminated.

(12) Release switch SG and ensure that lamp LP2 is extinguished.

Insulation resistance test

Note . . .

On no account must an insulation test or any meter with an output in excess of 30V be connected to any terminal of the unit.

6. The insulation resistance of the unit may be measured with a multimeter Type 12889 connected between terminal 3 and the bonding lug at the end of the case and should be not less than 20 megohms.

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MINISTRY OF DEFENCE

ELECTRICAL MANUAL - FIRE WARNING
EXTINGUISHING, SAFETY AND RESCUE EQUIPMENT

ADVANCE INFORMATION LEAFLET NO. 2/66

Insert this leaflet in A.P.4343E, Vol. 1, Book 3, Sect. 14, Chap. 19, App. B, to face para. 5, sub-para. (9).

Para. 5 sub-para. (9) should read:-

The open circuit detector voltage indicated on meter M4 should be not less than 3·5V.

Notes

(1) The information contained in this leaflet will be incorporated by normal amendment list action in due course.

(2) If, after receipt of this leaflet, an amendment list with a prior date and conflicting information is received, the information in the leaflet is to take precedence.

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Appendix 1

D.C. CONTROL UNIT TYPE D. 3000

LEADING PARTICULARS

D.C. control unit, Type D.3000	**Ref. No. 5CZ/6245**
Ambient temperature range	—40°C. to + 55°C.
Power consumption	
Standby	◀ 3·3 ▶ *watts*
Operation	... 6·0 *watts*
Weight	1·09 *lb.*

1. This unit is identical to that described and illustrated in the main chapter, and is a later model than the Type D.2695 which it supersedes, having small circuit changes and an improved transistor VT4.

Appendix 2

D.C. CONTROL UNIT TYPE D. 2695

LEADING PARTICULARS

D.C. control unit, Type D2695	**Ref. No. 5CZ/6152**
Ambient temperature range	—40°C. to + 55°C.
Power consumption	
Standby	◀ 3·3 ▶ *watts*
Operation	... 6·0 *watts*
Weight	1·11 *lb.*

1. The Type D2695 is an earlier version of the d.c. control unit and is similar to that described in the main chapter with small circuit alterations and a different transistor VT4. A circuit diagram is shown in fig. 1.

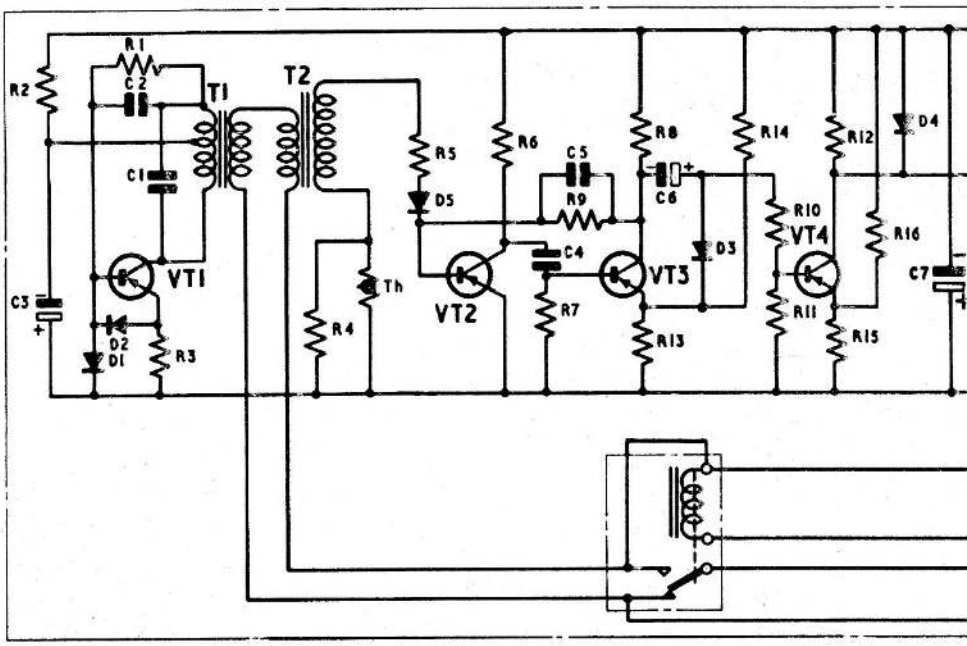

Fig.1 Control unit Type D2695 : circuit dia

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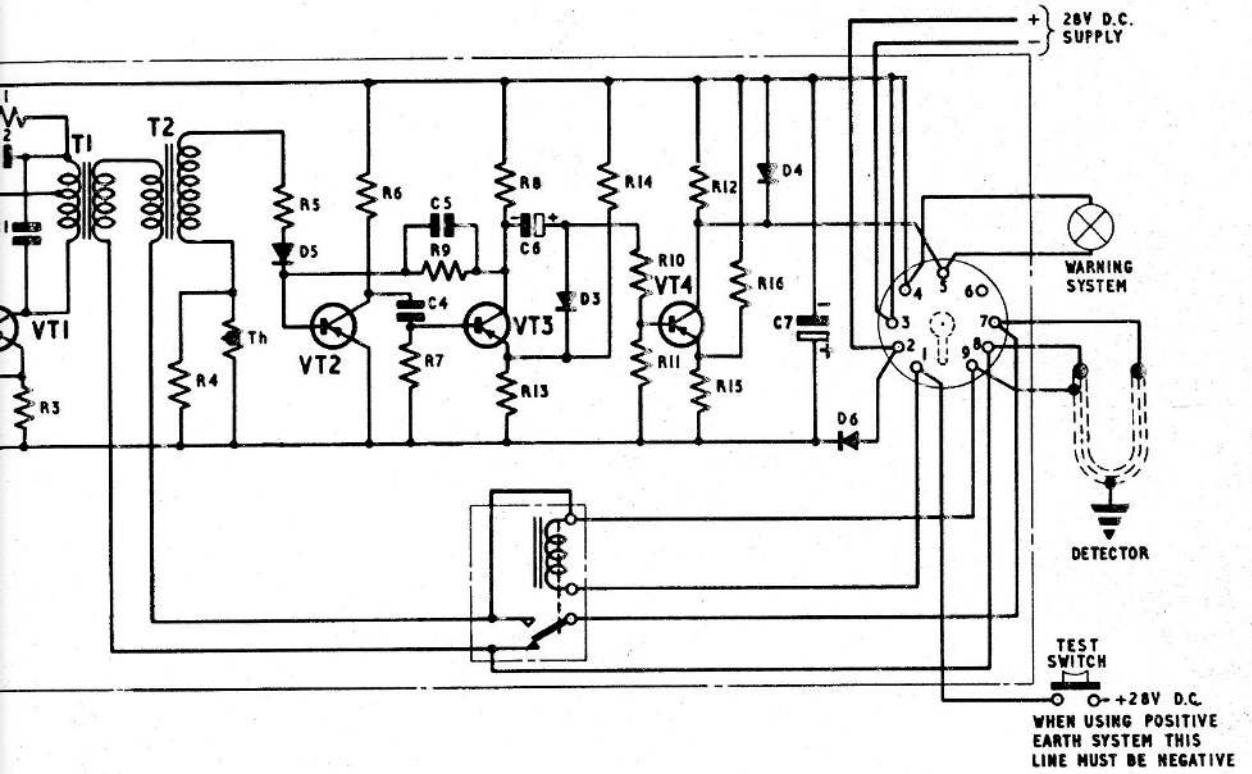

Control unit Type D2695 : circuit diagram Fig.1

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Appendix 3

D.C. CONTROL UNIT TYPE D.3600

LEADING PARTICULARS

D.C. control unit, Type D3600	**Ref. No. 5CZ/7491**
Ambient temperature range	—65°C. *to* +70°C.
Power consumption	
Stand-by	4·5 *watts*
Operation	5 *watts*
Weight	1 *lb.*
Bonding lead	*Ref. No.* 5K/3355

1. The Type D3600 control unit is a simplified version of the earlier d.c. units, Types D2695 and D3000, which it supersedes. The unit has increased performance and reduced operating power consumption, is lighter in weight and may be positioned in locations having a larger range of ambient temperature than the early units.