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Chapter 26

PHASE SEQUENCE UNIT, (E.E., TYPE AE5601)

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LEADING PARTICULARS

Phase sequence unit, E.E. Type AE5601	*Ref. No. 5UC/7294*
System voltage	*200 volts, 3-phase a.c.*
Frequency of system voltage	*400 ± 50 c/s*
Operating limits at 20°C	*Relay closes at 178·0 ± 5·75 volts* *Relay opens at 173·0 ± 3·0 volts*
Operating limits between −65°C to +100°C	*Relay closes at 176·0 ± 8·5 volts* *Relay opens at 167·0 ± 10·0 volts*

Introduction

1. The undervoltage phase sequence unit type AE5601 provides protection in the 200-volt, 3-phase, 400 c/s, system against undervoltage and reverse phase sequence connection. The unit is enclosed in a moulded black nylon cover. Early production models may have transparent covers.

DESCRIPTION

2. The unit comprises the following assemblies; some of these assemblies are linked with others but are described individually to avoid complexity.

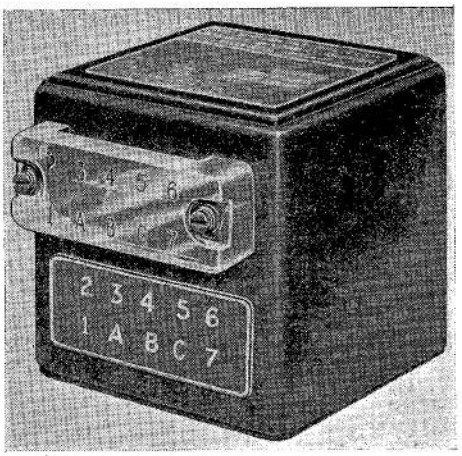


Fig. 1. General view of unit

Base assembly

3. This is an extruded light alloy component having holes in three of its sides. The holes provide housing for twelve silicon diodes and two transistors which are mounted vertically. The silicon diodes and transistors are fitted in Helsyn sleeves prior to mounting in the holes in the base. An anodized aluminium alloy base plate is attached to the base by four 6 BA countersunk brass screws.

Bottom board encapsulation

4. This assembly consists of eight resistors, a thermistor and four capacitors mounted on a tag board. Electrical connections from the encapsulation are provided to the base assembly by means of turret lugs and to the upper components of the unit by flying leads. A bonded glass top board is fixed in position and the whole assembly is encapsulated. A transfer bearing the item serial number is attached to the side of the encapsulation.

Transformers

5. Two transformers are fitted to the unit. The input to both is 200 volts but each have a separate output of 10·3 volts and 26·0 volts. The transformers are mounted on the top board of the encapsulation.

Relay

6. A type 'F' Clare relay is fitted adjacent to the two transformers. The relay is inserted in a Symel sleeve which provides protection against vibration and mechanical damage. The relay and the transformers are secured by two pressed light alloy brackets. The brackets are fitted above and below the transformers and the complete assembly attached to the base and encapsulated assembly by two stainless steel 6 BA cheese-headed screws fitted with light alloy spacers.

Potentiometer

7. A Painton potentiometer is mounted on a light alloy plate and secured by two 6 BA cheese-head screws.

Terminal block

8. A ten-way moulded terminal block is attached to the cover by two fixing screws which are tapped internally to accept the terminal cover fixing screws.

Cover

9. A moulded nylon cover is fitted to the unit and cemented to the base assembly. The terminal cover is retained in position by two captive 6 BA screws.

Wiring

10. Internal connections are made by means of P.T.F.E. equipment wire. Symel 1 mm bore sleeves are fitted over pins and tags after soldering.

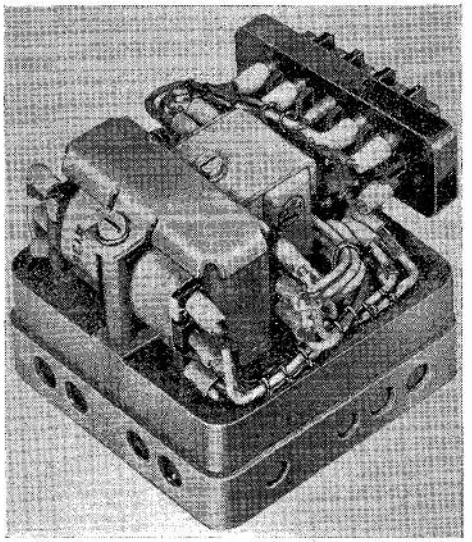


Fig. 2. View of unit with cover removed

OPERATION

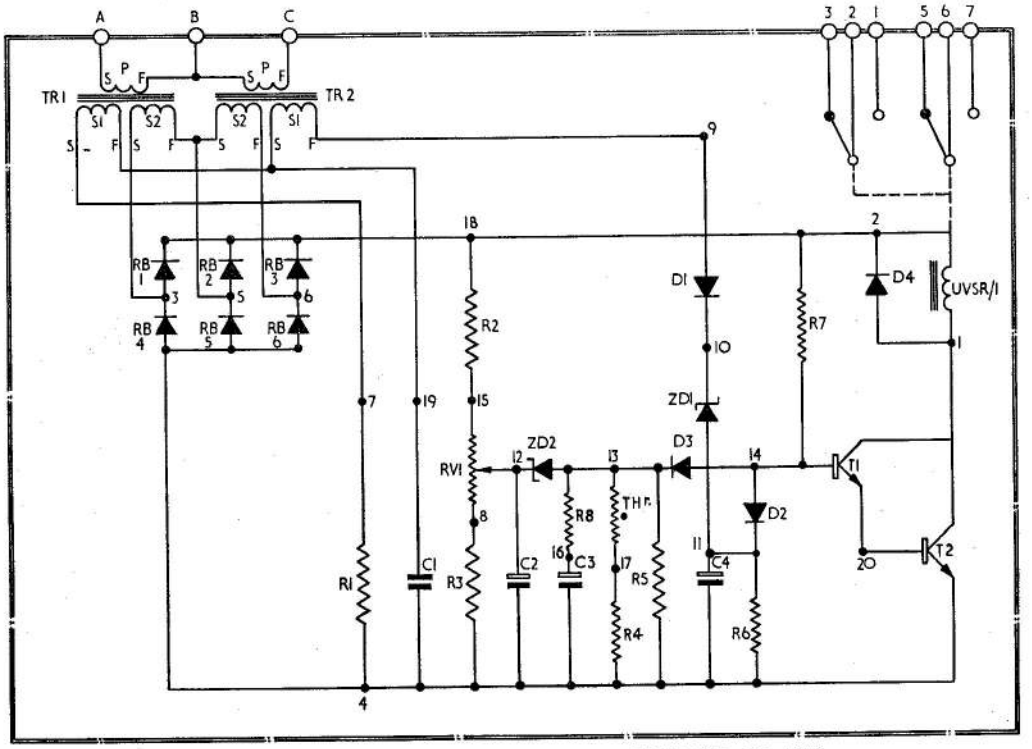
General

11. The unit operates on an input of 200 volts. 3-phase, 400 c/s which is fed to the primary windings of two step down transformers. The outputs from the secondary windings of the tranformers supply the

voltage and phase sensing circuits which control the operation of a transistorised amplifier circuit. This in turn operates a sealed relay which allows the generator to be connected to its load, providing the input voltage is above a predetermined value and the phase sequence is correct. The unit will not allow the generator on the line if an undervoltage or incorrect phase sequence condition exists.

Detail

12. Each transformer has two secondary windings, S1 and S2, providing two separate output voltages. The output of the S1 windings supply the phase sequence circuit whilst the output of S2 windings supply the voltage sensing circuit. These circuits control the operation of a two-stage amplifier circuit consisting of transistors T1 and T2. The amplifier operates the sealed relay which controls the closing of the generator circuit breaker. To enable the relay to close the input voltage must be above a predetermined value and the phase sequence must be correct. To monitor these two quantities simultaneously the dual input 'AND' circuit comprising D2, D3, R5, thermistor Thr. and



R1	1KΩ WELWYN AW 3101	**Thr.**	MULLARD VA 1046
R2	680Ω WELWYN AW 3115±1%	**D1**	GEC. DIODE CV 4073
R3	220Ω WELWYN AW 3115±1%	**D2**	GEC. DIODE CV 4073
R4	2·2KΩ WELWYN	**D3**	GEC. DIODE CV 4073
R5	1·2KΩ WELWYN±1% AW 3101	**D4**	GEC., DIODE CV 4073
R6	1·5KΩ WELWYN	**ZD1**	GEC. SX 82
R7	120KΩ WELWYN METOX TYPE F20	**ZD2**	GEC. SX 68
R8	330Ω WELWYN AW 3101	**T1**	TEXAS INST. 25004
RV1	100Ω PAINTON FLAT POT. 316510	**T2**	TEXAS INST. 25017
C1	·25μf 200V.	**RB**	6 OFF GEC. DIODE CV 4073
C2	47μf±20% 20V.	**TR1**	P=200V 400 c/s
C3	220μf±10% 10V.		S1=10V
C4	100μf±20% 10V.	**TR2**	S2=26V
		UVSR/1	C.P. CLARE TYPE RP 7630/G7 975Ω

Fig. 3. Wiring diagram

R4 is used. The supply to the amplifier is via R7 and when a signal from the phase sequence and voltage sensing circuit blocks diodes D2 and D3 respectively the amplifier is energized. If either of these signals are absent current flows through the appropriate diode and resistors to earth. In the absence of a blocking voltage to either of the diodes the voltage at the base of transistor T1 is not sufficient to drive T1 and T2 in series. Diode D4 suppresses voltage surge which results from the breaking of the relay coil circuit and thereby prevents possible damage to the transistors, it also increases the drop out time of the unit.

13. The output of the S2 windings of the transformers is fed to the rectifier bridge, Rb, and is reduced by R2, RV1 and R3 to a value suitable for supplying the voltage sensing circuit. The reference in this circuit is zener diode ZD2 which is loaded by the thermistor Thr and resistors R4 and R5. When the input voltage is within the accepted limits ZD2 breaks down and D3 is blocked. Conversely, if the voltage falls to a value which is determined by the setting of the potentiometer RV1, D3 is not blocked and the amplifier output ceases allowing the relay to open. The opening of the relay contacts is delayed by capacitors C2 and C3. Resistor R8 reduces the relay pull-in time when the voltage is increasing but has no appreciable effect on the drop out time. The thermistor Thr, is used to reduce variations in the time delay characteristics of the unit which would otherwise occur due to temperature variations.

14. The output of the S1 windings of the transformers provide the supply to the phase sequence circuit. The main components are resistor R1 and capacitor C1 which are connected in two of the lines. The voltage in the third line is considerably greater when the phase sequence is correct than when it is incorrect. The voltage is rectified by diode D1 and if the phase sequence is correct the zener diode ZD1 breaks down and gives a blocking signal to diode D2. Provided diode D3 is also blocked a supply is fed to the amplifier which operates the relay UVRS/1 allowing the generator to be connected to its load. If the phase sequence is incorrect the voltage applied to the zener diode ZD1 is not sufficient to break it down and since diode D2 is not blocked, current flows through D2 and R6 instead of into T1.

INSTALLATION

15. Four holes, tapped 4 BA, for $\frac{3}{8}$ in. long screws are provided in the base of the unit for fixing purposes. Electrical connections to the unit from the aircraft system are made through the terminal block.

SERVICING

16. When installed in the aircraft, servicing is limited to the following inspections.

(1) Nylon cover and terminal block cover for mechanical damage; if damaged, remove unit from aircraft.

(2) Security of unit.

(3) Electrical connections at terminal block for security and signs of deterioration of insulation.

The design and construction of the unit does not permit repair of any component and replacements are limited to the relay and the potentiometer.

TESTING

Setting-up procedure

Note . . .

This procedure need not be carried out if the functional test of the unit is satisfactory.

17. (1) Remove cover from unit using a thin bladed knife or other suitable tool; care must be taken not to damage cover.

(2) ▶◀

(3) Set potentiometer to extreme clockwise position.

(4) Connect a 200 volt, 3 phase, 400 c/s variable supply of correct phase sequence (A-B-C) to terminals A, B, C and a suitable continuity tester between terminals 1 and 2.

(5) At a setting of 200 volts the relay contacts should close.

(6) Reduce the supply voltage to 173 volts and adjust the potentiometer, until the relay contacts open.

(7) Increase the supply voltage to 184 volts to close relay contacts.

(8) Decrease the supply slowly, repeat slowly, until the contacts of the relay open; this should occur at 173 volts. If

this does not happen re-adjust the potentiometer slightly and repeat operation from foregoing paragraph until correct setting is achieved.

(9) ▶◀

(10) Fit cover on unit and cement in position using Araldite "F".

Contact drop test

18. (1) Connect a 200 volt, 400 c/s, 3-phase, A-B-C phase sequence, supply to terminals A, B and C of the unit. Short terminals 2 and 6 together and apply a d.c. voltage source to terminals 1 and 7 adjusting the current flow to 3 amperes. Break and make the relay contacts ten times by switching the a.c. supply and then measure the millivolt drop across each pair of contacts. The value should not exceed 150 millivolts.

(2) Transfer the d.c. voltage source from terminals 1 and 7 to terminals 3 and 5 and adjust the current flow to 3 A. Break and make the relay contacts ten times by switching the a.c. supply and then measure the millivolt drop across each pair of contacts. The value should not exceed 150 millivolts.

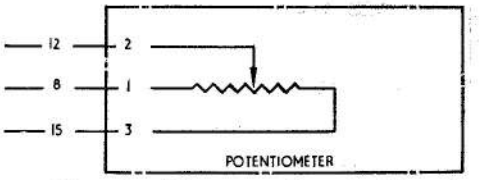


Fig. 4. Diagram of potentiometer connections

Appendix A

STANDARD SERVICEABILITY TEST for PHASE SEQUENCE UNIT (E.E., TYPE AE5601)

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LIST OF ILLUSTRATIONS

Introduction

1. The following tests can be used on the phase sequence unit, before it is put into use, or at any time to determine its serviceability.

TEST EQUIPMENT

2. The following equipment is required:—

		Ref. No.
(1)	Variac	5P/3450
(2)	Interval timer	5G/3733
(3)	Continuity tester	F19/6625-99-943-1224 or equivalent
(4)	Voltmeters V1, and V2	
(5)	3 resistors 200Ω, 50W.	
(6)	Switches S1	10F/16887
	S2	5CW/6435
	S3	5CW/877
(7)	Switches S4, S5, S6	5CW/6429
(8)	Multimeter 0·50 A	Type 12889 Ref. No. 5QP/17447
(9)	Resistor 0·5 megohm, ¼W.	

Note . . .

A 200 volts, 400 c/s, 3 phase supply free from harmonics greater than 2 per cent of the fundamental and sub-harmonics greater than 1 per cent is required. The difference between line voltages must not exceed 0·2 volts r.m.s. Precision grade meters must be used and the a.c. line voltmeters (r.m.s. 400 c/s) must be accurate between 170 and 175 to ± 1·5 volts.

TEST PROCEDURE

Functional test

3. (1). Connect unit to test circuit shown in fig.1.

(2) Select switches S1, S2 and S6 to position 1, and switches S4 and S5 to position 2. Gradually increase incoming supply voltage V1 until the relay contacts close. This should occur at 178 ± 5·75V.

(3) Reduce supply voltage to zero. Select switch S2 to position 2, and apply 200V for 5 seconds during which time the relay contacts should remain open.

(4) On completion of (3), disconnect and remove the continuity meter C1. Connect the interval timer as shown in fig. 1.

(5) With switches S2, S4 and S6 in position 1, and switches S1, S3 and S5 in position 2, wind variac down to zero and adjust incoming supply voltage so that V1 indicates 200V. Select switch S1 to position 1, and record the time delay indicated on the interval timer. Replace switch S1 to position 2 and reset timer. The time delay should not exceed 60 milliseconds.

(6) Select switches S1, S2, S3, S4, S5 in position 1, and switch S6 in position 2. Incoming supply V1 should be 200 volts. Adjust variac so that V2 indicates 155V. Select switch S1 to position 2 and record time delay as indicated on interval timer. Replace switch S1 to position 1 and reset timer.

(7) Repeat procedure of sub-paragraph (6) with V2 values of 85V and 45V and finally obtain the highest value of V2 that allows unit to operate. The resulting characteristic is to be contained completely within the envelope shown in fig. 2.

Insulation test

4. Measure the leakage current using a multimeter Type 12889 with a 0·5 megohm ($\frac{1}{4}$W), resistor in series with the positive probe as shown in fig. 3. Connect test circuit (fig. 3) to a d.c. variable supply of 28V. The leakage current should not exceed 1·4μA, when this voltage is applied between:—

(1) All terminals and frame.

(2) Terminal A, and 1, 3, 5, 7 shorted together. Before removing test circuit decrease voltage gradually to zero.

Wiring check

5. Check the unit for resistance between the following terminals using a d.c. measuring device.

Terminals	*Resistance*
A and B	500 ± 50 ohms.
B and C	500 ± 50 ohms.

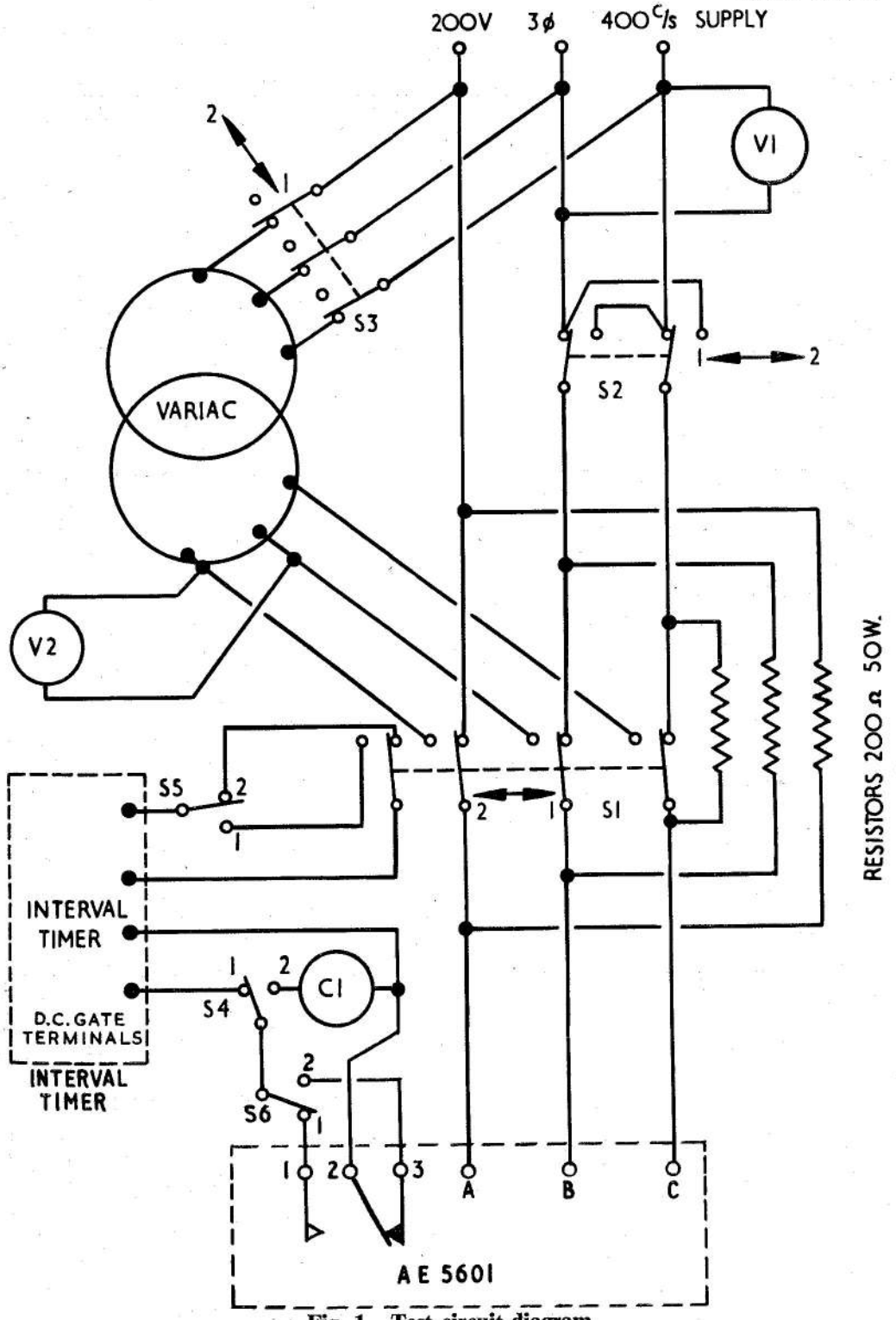
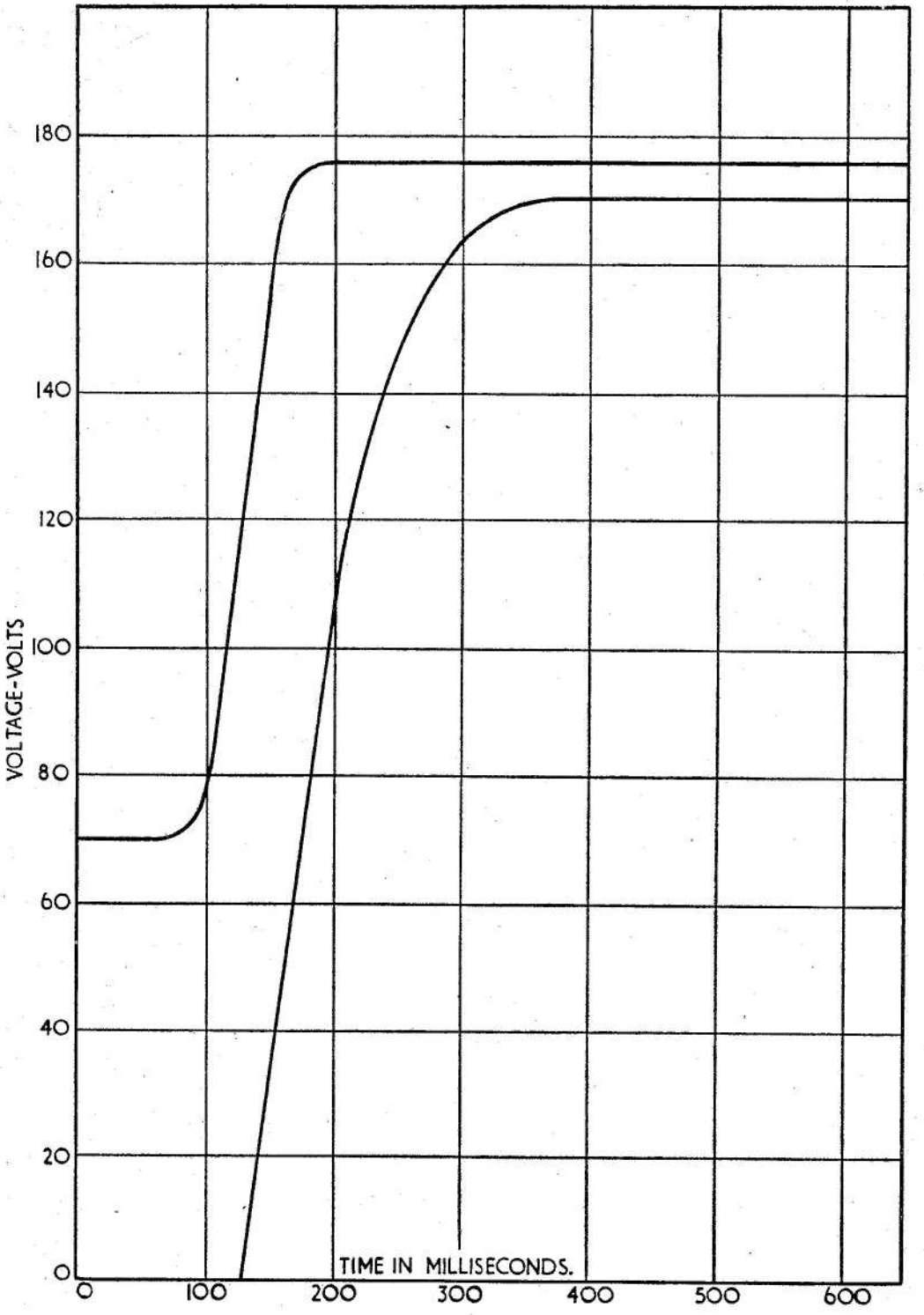


Fig. 1. Test circuit diagram



TIME DELAY CHARACTERISTIC CURVE

Fig. 2. Time delay characteristic curve

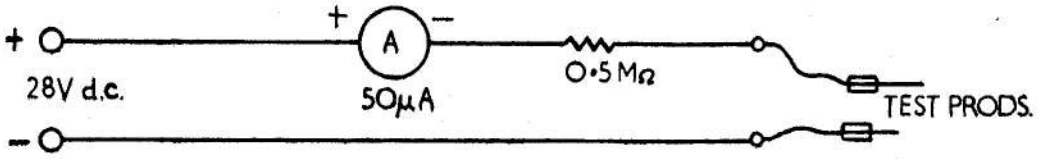


Fig. 3. Insulation test circuit