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### Chapter 15

## VOLTAGE REGULATOR REFERENCE UNIT, E.E., TYPE AE7523, Mk.1

AND

## VOLTAGE REGULATOR AMPLIFIER UNIT, E.E., TYPE AE7518, Mk.1

### LIST OF CONTENTS

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<i>Introduction</i> ... ..	1	<i>Resistor and capacitor encapsulation</i> ...	18
<b>Description</b>		<i>Terminal blocks</i> ... ..	19
<i>Voltage regulator reference unit</i> ... ..	2	<i>Resistor and bracket assembly</i> ...	20
<i>Component assembly</i> ... ..	3	<i>Unit socket</i> ... ..	21
<i>Temperature compensating coil</i> ... ..	4	<b>Operation</b>	
<i>Potentiometer</i> ... ..	5	<i>Voltage regulator reference unit</i> ... ..	22
<i>Unit plug/potentiometer bracket assembly</i> ... ..	6	<i>Voltage regulator amplifier unit</i> ... ..	23
<i>Resistor encapsulation</i> ... ..	7	<b>Servicing</b>	
<i>Transformer</i> ... ..	8	<i>Procedure</i> ... ..	24
<i>Transductor</i> ... ..	9	<b>Testing</b>	
<i>Rectifier encapsulation</i> ... ..	10	<i>Supplies and meters</i> ... ..	25
<i>Rectifier assembly</i> ... ..	11	<i>Setting up procedure (AE7523)</i> ... ..	26
<i>Voltage reference tube bracket assembly</i> ... ..	12	<i>Functioning test (AE7523)</i> ... ..	27
<i>Voltage regulator amplifier unit</i> ... ..	13	<i>Insulation resistance test (AE7523)</i> ... ..	28
<b>Component assembly</b> ... ..	14	<i>Wiring check (AE7518)</i> ... ..	29
<i>Transductor assembly</i> ... ..	15	<i>Functioning tests (AE7518)</i> ... ..	30
<i>Input transformer assembly</i> ... ..	16	<i>Insulation resistance test (AE7518)</i> ... ..	32
<i>Damping transformer assembly</i> ... ..	17		

### LIST OF ILLUSTRATIONS

<i>General view of units</i> ... ..	Fig. 1	<i>Schematic diagram of amplifier unit</i> ... ..	Fig. 5
<i>Sectional view of reference unit</i> ... ..	2	<i>Functioning test circuit</i> ... ..	6
<i>Sectional view of amplifier unit</i> ... ..	3	<i>Characteristic limits (reference unit)</i> ... ..	7
<i>Schematic diagram of reference unit</i> ... ..	4	<i>Characteristic limits (amplifier unit)</i> ... ..	8

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## LEADING PARTICULARS

<b>Voltage regulator reference unit, E.E., Type AE.7523, Mk. 1 Ref. No. 5UC/7071</b>	
<i>Voltage regulator amplifier unit, E.E., Type AE.7518, Mk. 1 Ref. No. 5UC/6937</i>	
<i>Associated generator</i> ... ..	<i>E.E., Type AE.2054</i>
<i>Busbar voltage</i> ... ..	<i>200V a.c. (r.m.s.)</i>
<i>Busbar frequency</i> ... ..	<i>400 c/s</i>
<i>Phases</i> ... ..	<i>3</i>
<i>Regulation (over full climatic and load range)</i> ... ..	<i>±4V (r.m.s.)</i>
	<i>±1% of choke rectified voltage</i>
<i>Transient response:—</i>	
<i>Maximum load change</i> ... ..	<i>±5kVA, 0.8 to 1.0 p.f.</i>
<i>Voltage deviation</i> ... ..	<i>20V (r.m.s.) (maximum)</i>
<i>Duration of transient</i> ... ..	<i>20 m.s. (maximum)</i>
<i>Regulator load</i> ... ..	<i>1 ohm nominal</i>
<i>Regulator output</i> ... ..	<i>3A nominal</i>
<i>Time rating</i> ... ..	<i>Continuous</i>
<i>Cooling air</i> ... ..	<i>Up to 1.0 lb/minute at temperatures up to +85°C (continuous)</i>
<i>Ambient temperature range</i> ... ..	<i>−65°C to +110°C</i>
<i>Altitude range</i> ... ..	<i>0–60000 ft.</i>
<i>Weight (AE.7523)</i> ... ..	<i>2 lb. 7 oz.</i>
<i>Weight (AE.7518)</i> ... ..	<i>8 lb. 15 oz.</i>

### Introduction

1. The magnetic amplifier/voltage regulator units (E.E. Type AE7518 and AE7523) forms part of an aircraft electrical system which controls and protects the Type AE2054, 200V, 400 c/s, 3 phase, 20 kVA, a.c. generator. The unit provides a close control of the generator output and ensures a fast recovery from transient load switching.

### DESCRIPTION

#### Voltage regulator reference unit

2. A light alloy cover and base assembly secured together with screws, washers and clinch nuts, house the components which in turn are secured in position either to the base assembly or cover assembly. Holes in the base plate enable the unit to be secured to associate equipment and one large hole bleeds off blast air being fed to the amplifier unit. Protruding from one end of the cover is a control lock which is attached to the potentiometer; screws passing through the cover are utilized to stabilize components which are secured to the base assembly.

### Component assembly

3. The component assembly comprises the following: temperature compensating coil, potentiometer (R5), unitor plug potentiometer bracket assembly, resistor encapsulation (R6, R2, R7, R3, R1, R4), transformer (200/50V 2VA 400 c/s), transductor assembly (No. 1), rectifier encapsulation (REC 2), rectifier assembly (REC 1), voltage reference tube (T1, T2) bracket assembly, capacitor (0.25 µF 400V) and unitor plug.

#### Temperature compensating coil

4. The temperature compensating coil comprises a spindle on which is wound copper wire; copper strips are secured to the ends of the wire which enables the component to be connected to associate equipment. Shrouding the assembly (except for the ends of the copper strip) is a moulding in which are four holes which permit the component to be secured in position by c'sk. hd. screws, which have an anchorage in the base assembly of the transformer described in paragraph 8.

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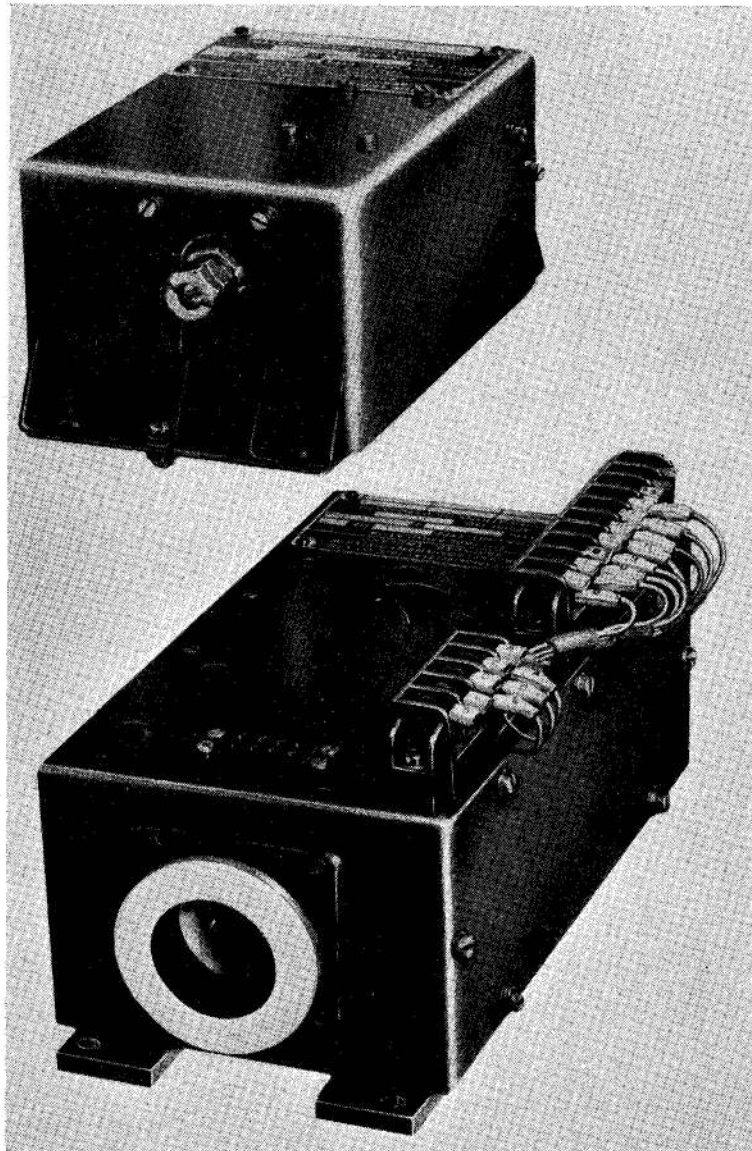


Fig. 1. General view of units

*Potentiometer*

5. The potentiometer is secured to the unitor-potentiometer bracket assembly by a tabwasher, packing washer and a pre-set control lock device, which is positioned on the spindle of the potentiometer to prevent variance of the potentiometer setting.

*Unitor plug/potentiometer bracket assembly*

6. A light-alloy, unitor plug bracket riveted to the light alloy potentiometer bracket provides a mounting for an eight way unitor plug. (The unitor plug is secured to the bracket with ch. hd. screws, spring washers and nuts). Also secured to the potentiometer

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bracket is a terminal board and two spring clips; these clips provide a mounting for the capacitor. Leads from the capacitor terminate at eyelet tags anchored in the board. The bracket assembly is secured to the base assembly with c'sk. hd. screws, nuts and spring washers.

*Resistor encapsulation*

7. Housed within the resistor encapsulation are six resistors which are totally enclosed within a moulding. Projecting from one end of the encapsulated assembly are turret lugs which are used to connect the assembly in circuit. Projecting from the other end of the encapsulation is a stud and location dowel, the stud and dowel locate in the base assembly and the encapsulation is held in position by a nut and spring washer positioned on the stud.

*Transformer*

8. The 200/50V, 50 c/s, single phase transformer is capable of delivering 40 milliamperes at 0.75 power factor. The ends of the primary and secondary windings terminate at double ended tags which permit a soldered joint on connection of the unit in circuit to

other equipment. The unit is secured to the base assembly by c'sk. hd. screws which pass through the temperature compensating coil encapsulation (see paragraph 4).

*Transductor*

9. The transductor is an encapsulated assembly which is connected in circuit by means of turret lugs. Within the moulding are two bobbin and laminated assemblies around which are wound three windings, the ends of each winding are secured to the turret lugs stated above. C'sk. hd. screws engaged in inserts (moulded in position in the assembly) secure the transductor to the base assembly.

*Rectifier encapsulation*

10. The encapsulated assembly comprises an insulated board on which are mounted six silicone diodes (three each side of board). Wire leads from the diodes finish at terminal lugs and flexible wires secured to the lugs emerge from the encapsulation via an insulated block which is attached to the insulated board. Spacers positioned in the encapsulated assembly permit the passage of screwed studs which are anchored in the transductor assembly; nuts and spring washers secure the rectifier encapsulation in place.

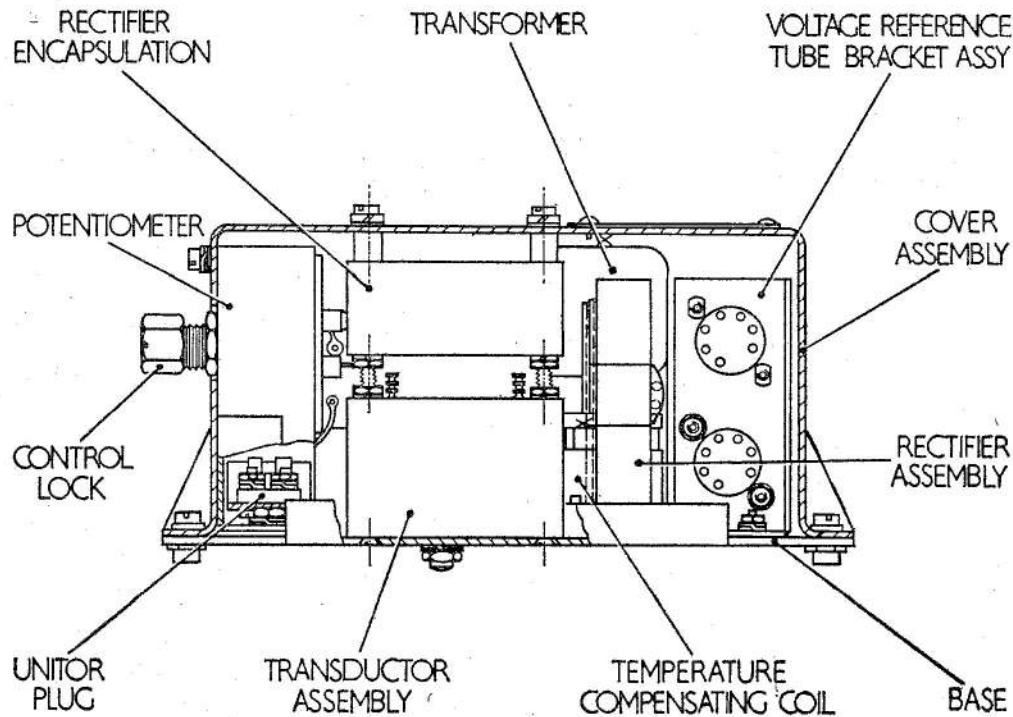


Fig. 2. Sectional view of reference unit

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*Rectifier assembly*

**11.** Fixed in a light alloy metal bracket (which is secured to the base assembly with c'sk. hd. screws, nuts and spring washers) is the rectifier encapsulation. The encapsulation comprised four silicone diodes, the leads of which are secured to turret lugs which are positioned in an insulation board. A moulding shrouds the diodes and insulated board.

*Voltage reference tube bracket assembly*

**12.** Secured to a light alloy bracket with tapped spacers, plain washers, spring washers, ch. hd. screws and nuts, are two valve bases. Positioned in the bases are two reference tubes which are protected by spring-loaded metal screens which are clipped on to the valve bases. The bracket is secured to the base assembly with c'sk. hd. screws, spring washers and nuts.

*Voltage regulator amplifier unit*

**13.** The components are positioned on and are secured to a light alloy base and cover assembly. Secured to one end of the cover is a manacle flange duct which enables a blast air supply pipe to be clamped to the unit, louveres punched in the end of the cover (opposite end to manacle flange) provides an exit for the blast air supply. Straps which form part of the base assembly (drilled to permit the passage of studs or bolts) enables the unit to be mounted in position on installation. Access to the unit can be obtained by the removal of a plate attached to the cover assembly or by removal of the cover assembly from the base assembly. Anchor nuts positioned on the light alloy components provide the means of anchoring the screws used in securing components in place.

*Component assembly*

**14.** The component assembly comprises the following: transductor assembly, input transformer assembly, damping transformer assembly, resistor and capacitor encapsulation (R3 to R9, 2 $\mu$ F capacitor) terminal blocks (5 way and 10 way), resistor and bracket assembly (R1, R2) and unit socket.

*Transductor assembly*

**15.** The transductor windings are housed within a moulding; protruding from one end of the moulding are turret lugs which enables the unit to be connected to associate

equipment. The unit is secured to the base assembly with shakeproof washers and c'sk. hd. screws which are anchored in tapped inserts moulded in the feet of the transductor.

*Input transformer assembly*

**16.** The transformer is a 3 phase, 400 c/s, 200/17 volt step down transformer which is capable of delivering a current of 35A at 0.75 p.f. The primary winding is connected in a delta configuration and the secondary in a star configuration; the ends of the windings finish at turret lugs which allows the connection of wire leads. The transformer is secured to the base assembly with c'sk. hd. screws, spring washers and thin nuts.

*Damping transformer assembly*

**17.** The transformer is totally enclosed in a moulding except for the inserts, the outer periphery of the core and turret lugs. The turret lugs provide a terminal for the primary and secondary windings of the (step up) transformer and also enable the unit to be connected to associated equipment. Inserts moulded in position provide an anchorage for c'sk. hd. screws which secure the transformer assembly to the base assembly. The screws are locked in place with red anti-track enamel.

*Resistor and capacitor encapsulation*

**18.** Positioned on an insulated board are seven resistors and one capacitor. Flexible leads from the resistors and capacitors terminate at turret lugs which are also used to connect the encapsulated assembly to associate equipment. A moulding shrouds the resistors, capacitor, insulation board and housed in the moulding are three inserts which locate in the board. The encapsulated assembly is secured to the cover assembly with c'sk. hd. screws which are locked in position with red anti-track enamel.

*Terminal blocks*

**19.** The terminal blocks are of moulded construction and are designed to accommodate quick release terminal tags which are sleeved and identified. The block is secured to the cover assembly with ch. hd. screws and washers.

*Resistor and bracket assembly*

**20.** Two resistors (with brackets fitted) are

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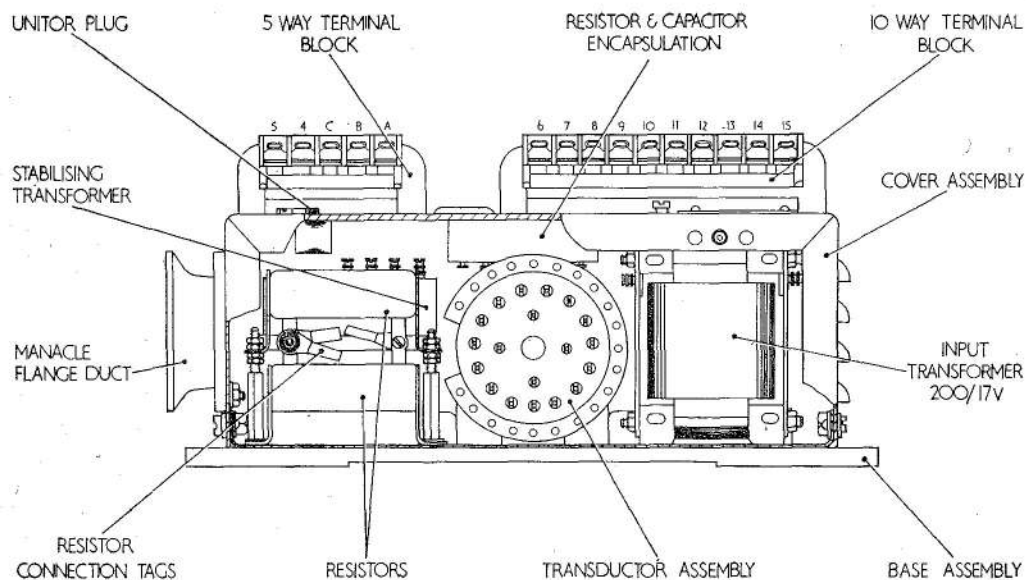


Fig. 3. Sectional view of amplifier unit

positioned one above the other by means of pillars; c'sk. hd. screws secure one resistor to the base assembly by engaging in the pillars and the other resistor is positioned on the stud section of the pillars by thin nuts. Tags enable the resistors to be connected to associate equipment.

*Unitor socket*

21. Positioned within a cutaway of the cover assembly is a unitor socket. The socket

is secured to the cover with ch. hd. screws, spring washers and nuts.

**OPERATION**

Reference should be made to fig. 4 when reading paragraph 22 and fig. 5 when reading paragraph 23.

**Voltage regulator reference unit**

22. The a.c. voltage of the generator is tapped and fed into the voltage reference

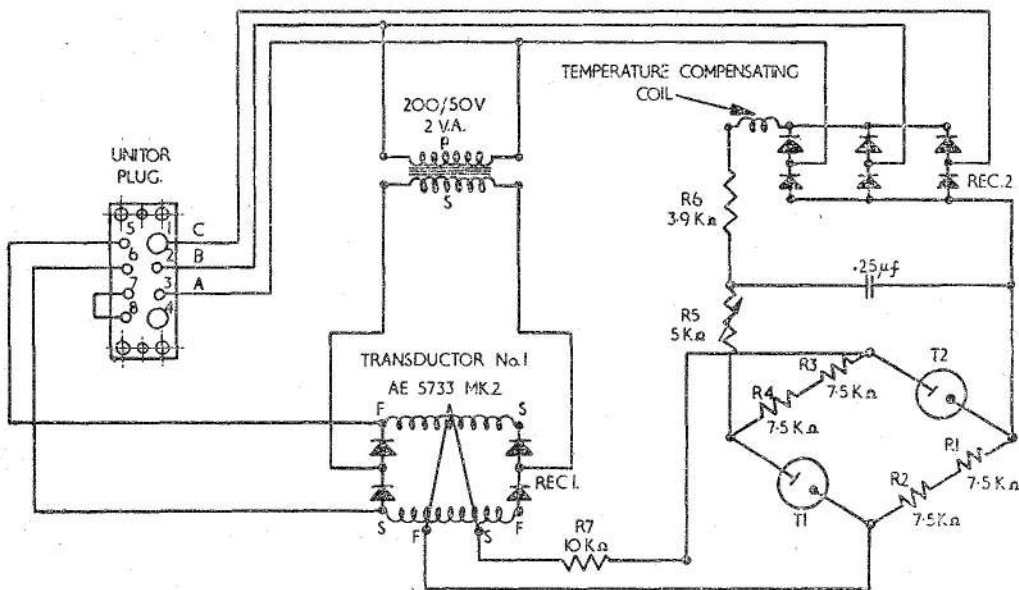


Fig. 4. Schematic diagram of reference unit

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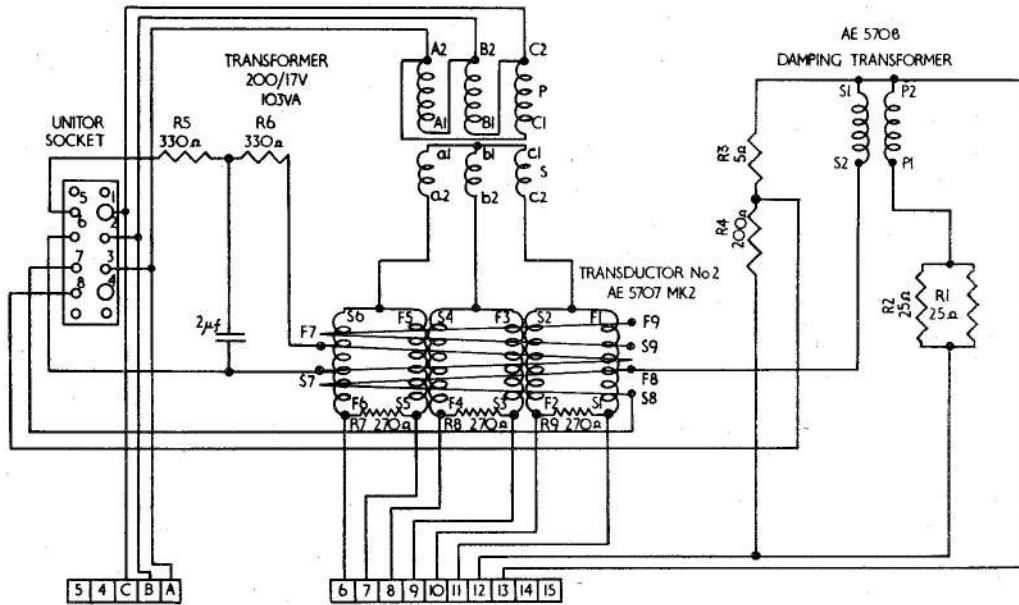


Fig. 5. Schematic diagram of amplifier unit

unit via the unitor plug. The voltage is applied to the rectifier bridge and to the step down transformer. The output from the rectifier bridge is fed via a temperature compensating coil, resistor capacitor smoothing circuit and a variable resistor to a trigger tube-resistor bridge network, the output of which feeds a control winding on transducer No. 1. With an increase in the generator voltage an increased current will flow through the trigger tube-resistor bridge, which will cause a potential difference at the junction of the resistors and trigger tubes (since the voltage drop across the tubes is constant). When the current rises in the control winding the impedance of the main winding increases and the output from the transducer main winding decreases. The increased voltage from the main windings is then applied to one of the control windings on the transducer (No. 2) in the voltage regulator amplifier unit.

#### Voltage regulator amplifier unit

23. The tapped output of the generator which is fed into the voltage regulator amplifier unit via the unitor plug is applied to the step down transformer, the output of which is fed into the main windings of transducer No. 2. The output of transducer No.

2 is controlled by two control windings, one of which is fed by the output of transducer No. 1. The effect of this control winding is to increase the regulator supply to the generator exciter fields by permitting a larger output from the transducer main windings, thus decreasing the self excitation of the generator by reducing current flow in the fields, hence a reduction in the generated terminal voltage. The stabilizing transformer primary winding is fed from the exciter armature and fields circuit; a change in exciter voltage causes a change in the output of the secondary of the stabilizing transformer which feeds the second control winding on transducer No. 2. The action of the second control winding is to counteract the change produced by the first control winding which is fed from transducer No. 1, thus the stabilizing transformer slows down the action of the transducer (No. 2) reducing overshoot and damping tendency to oscillation.

#### Note . . .

*The output from transducer No. 2 main winding is rectified by a rectifier unit in the control system of the generator before injection into the exciter armature field circuit.*

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**Procedure SERVICING**

24. Check the security of all external fixing screws and locking devices and examine for mechanical damage and corrosion.

**Note . . . TESTING**

Tests stated in paragraphs 26 to 28 apply only to type AE7523 unit. Tests stated in paragraphs 29 to 32 apply only to type AE7518 unit.

**Supplies and meters**

25. The a.c. supply should have a regulation of less than one volt (r.m.s.) and is to be free from sub-harmonics greater than 0.2 volt (r.m.s.) and harmonics greater than 2% of the fundamental. A precision grade meter should be used for the line voltage (r.m.s. 400 c/s) otherwise industrial grade meters are to be used.

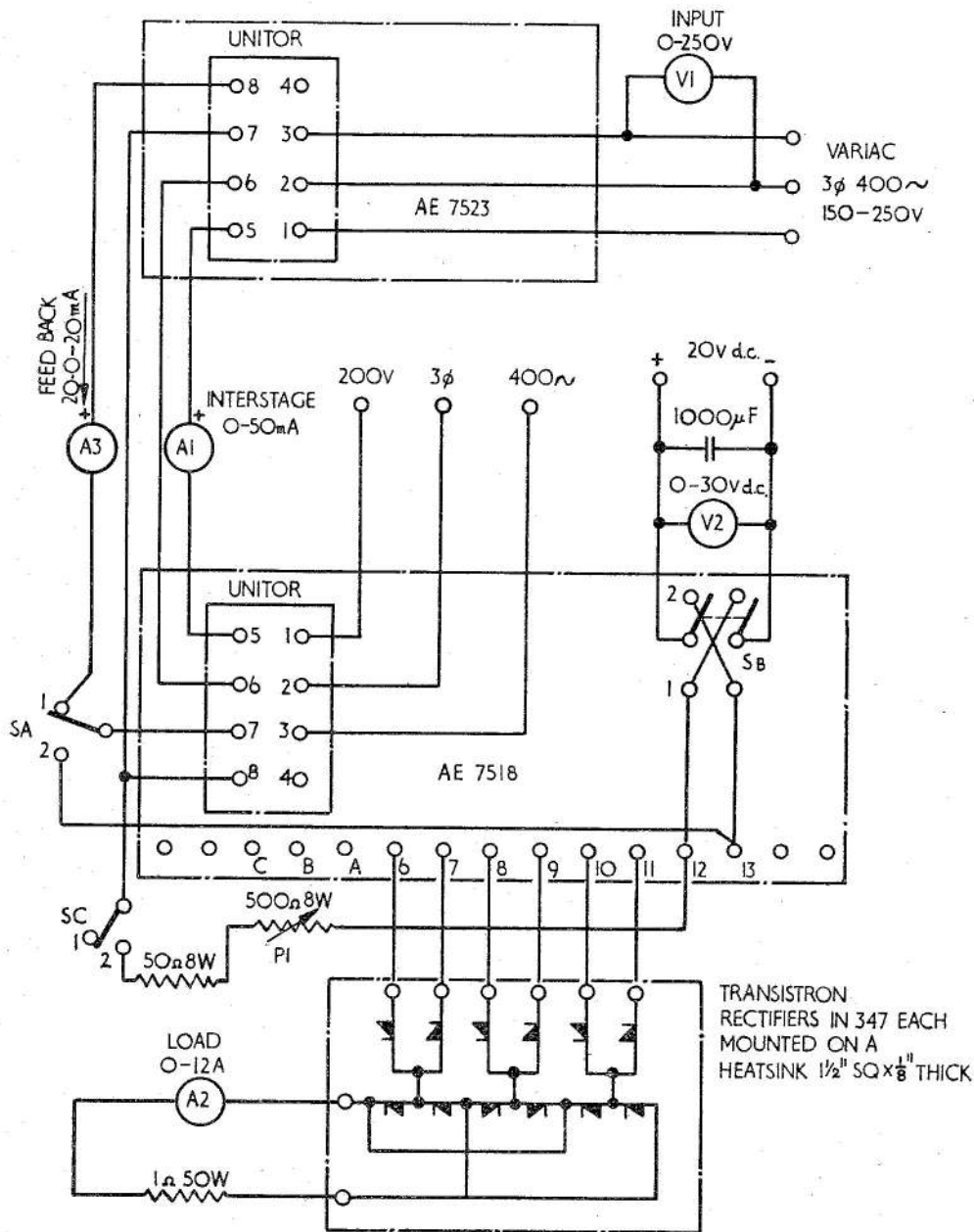


Fig. 6. Functioning test circuit

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**Setting up procedure (AE7523)**

26. The unit is to be connected to the test circuit shown in fig. 6 using a slave AE7518 unit of proven serviceability. The switches SA, SB and SC are to be set to position 1 and the reading of V2 adjusted to 20V. With reading 200 volts the trimmer on the AE7523 unit is to be set to give an inter-stage current as indicated on A1 of 18 mA.

**Functioning test (AE7523)**

27. With the unit connected as stated in paragraph 26 the reading of V1 is to be varied from 160 to 260 volts by means of the variac. Ten readings of V1 and A1 are to be taken in the voltage variation stated above and a static characteristic obtained which is to be within the limits indicated in fig. 7.

**Insulation resistance test (AE7523)**

28. Using a 500 volt insulation resistance tester check that the insulation resistance measured between each of the unitor plug terminals and the frame is not less than 5 megohms.

**Wiring check (AE7518)**

29. The unit is to be tested for correct internal connections by measuring the resistance between the terminals detailed below.

**Note . . .**

*The prefix U denotes unitor socket terminals.*

**Terminals**

Terminals	Resistance
A-B, B-C, C-A	$4.7 \pm 0.5$ ohms
A-U3, B-U2, C-U1	Short circuit
12-13	$13.3 \pm 0.7$ ohms
U6-U5	$677 \pm 35$ ohms

**Functioning tests (AE7518)**

30. Connect the unit in the circuit detailed in fig. 6 using a slave AE7523 unit of proven serviceability. Operate each of the switches SA, SB and SC to position 1 and adjust the reading of V2 to 20 volts. The feed back current is to be within +5 and +8mA. By adjusting the voltage reading of V1 with the variac, set the interstage current (indicated by A1) to 18 mA. If the output is less than 3.0A close switch SC and using P1 increase the feedback current indicated by A3 so that the output current shown on A2 is 3.0A. The required change in A3 must not be more than 14 mA. Vary the interstage current over the range 0 to 30 mA in at least 10 suitable increments, taking readings of output and interstage currents. The characteristic obtained is to be within the limits outlined in fig. 8.

31. Change switch SA to position 2, open switch SC to position 1; set V2 to 20V and adjust the reading of V1 until the output current is 3.0A. Operate switch SB to position 1 and check that the load increases momentarily. Operate switch SB to position 2 and check that the load current decreases momentarily.

**Insulation resistance test (AE7518)**

32. Using a 500 volt insulation resistance tester check that the insulation resistance measured between each terminal and case is not less than 5 megohms.

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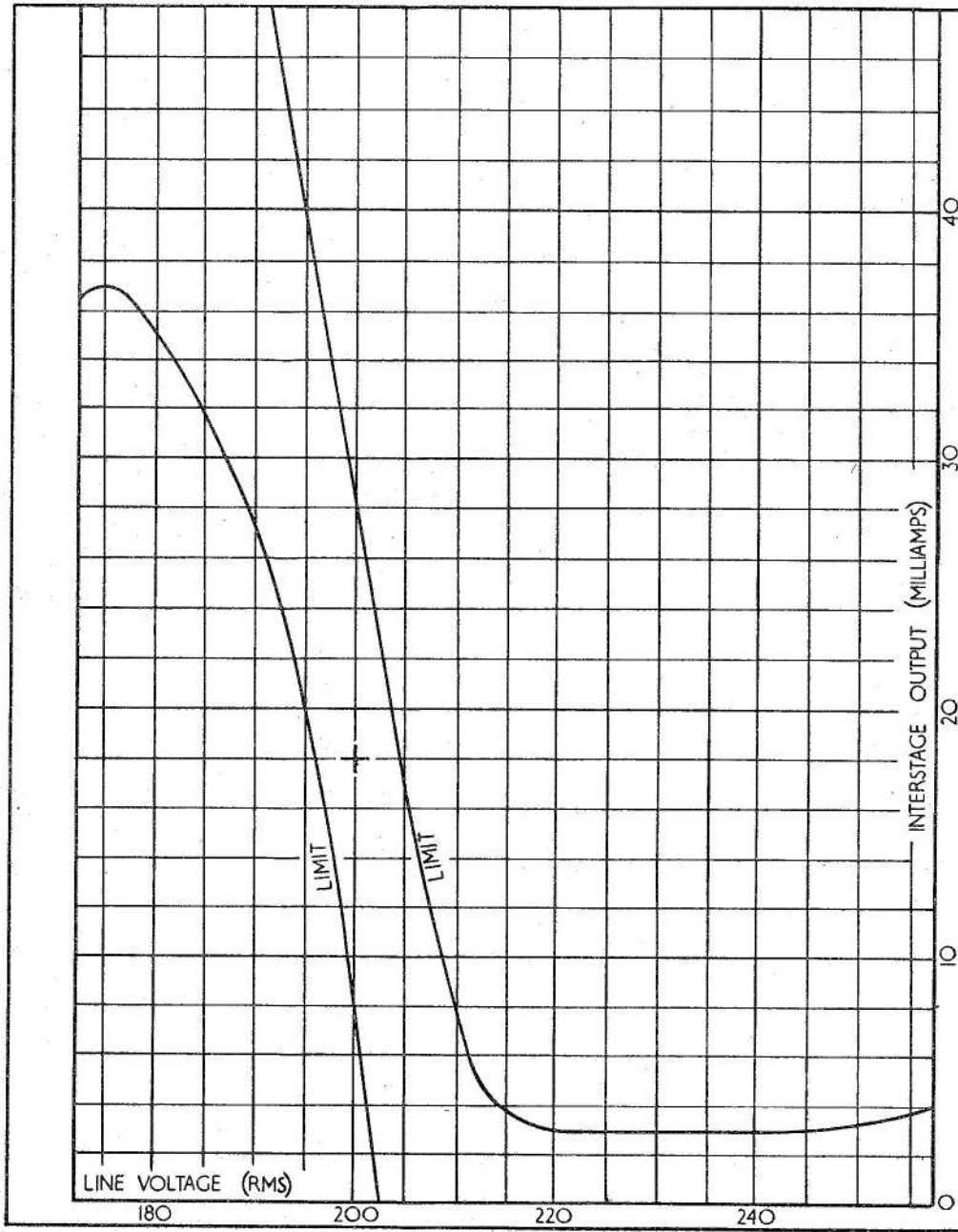


Fig. 7. Characteristic limits (reference unit)

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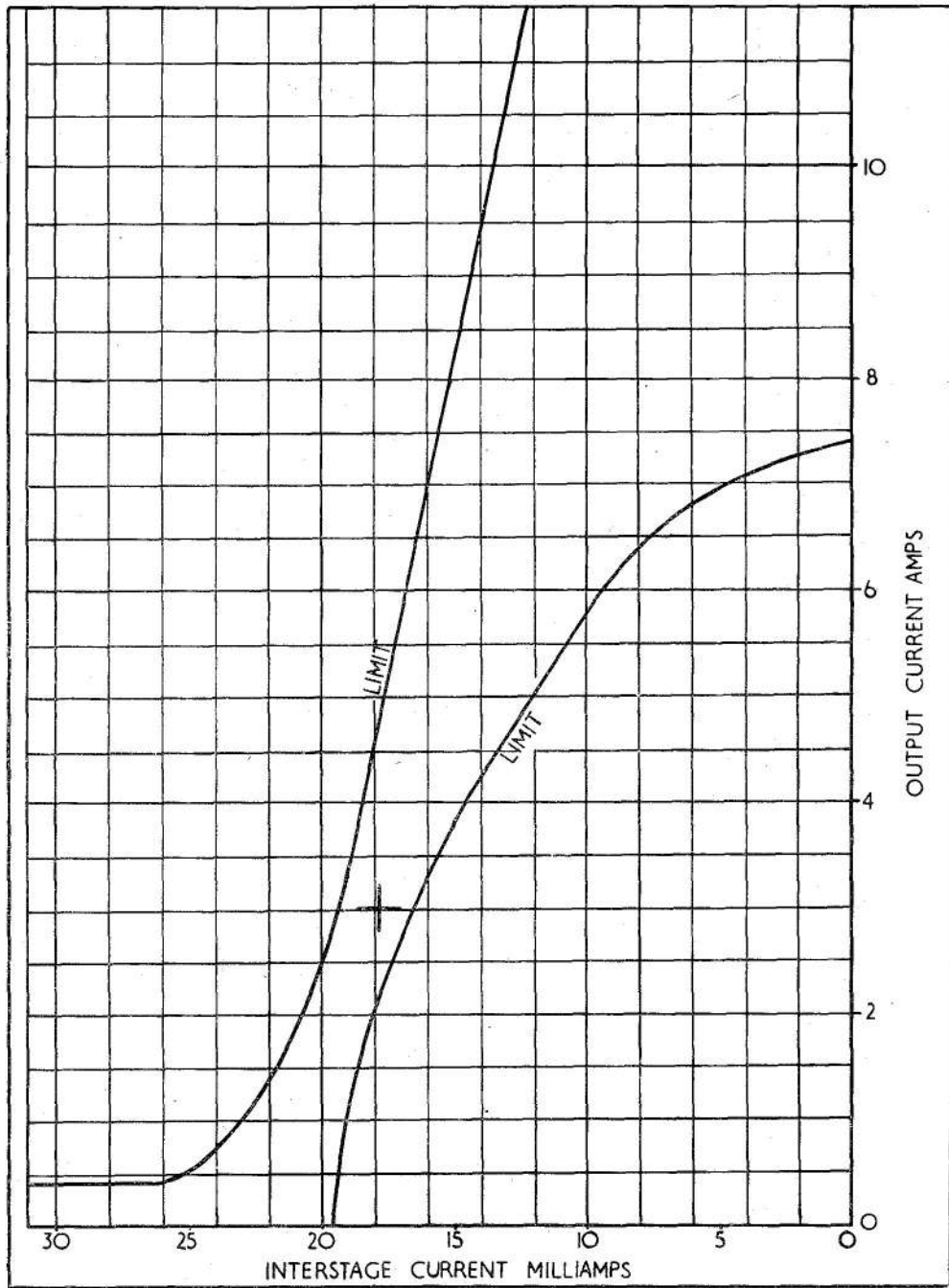


Fig. 8. Characteristic limits (amplifier unit)

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