VALVE MILLIVOLTMETER

Type TF 899A

MARCONI INSTRUMENTS LIMITED, ENGLAND

MARCONI
INSTRUMENTS

EB 899A
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OPERATING INSTRUCTIONS

No. EB 899A

for

VALVE MILLIVOLTMETER

TYPE TF 899A

Marconi Instruments Limited, St. Albans, Hertfordshire, England. Telephone : St. Albans 56161

CONTENTS

SCHEDULE OF PARTS SUPPLIED

The complete equipment comprises the following items:-

1. One Valve Millivoltmeter Type TF 899A, complete with attached mains lead and probe unit; with valves, etc., as under:-

Valves:	Two:	Type 6516, Pentodes.
	One:	Type QS95/10, Neon Stabilizer.
	One:	Type 6X5GT, Full Wave Rectifier.
Lamp:	One:	6.3-volt, 0.15-amp, M.B.C., Pilot Lamp.

2. One Instruction Book No. EB 899A.

DATA SUMMARY

for

Valve Millivoltmeter Type TF 899A

Serial Nos. JA212/001 and above

RANGES:	0.02 to 2 volts in three ranges. Full-scale deflections: 150 mV, 500 mV and 2 volts.
ACCURACY:	5% of full-scale calibration of the range in use.
FREQUENCY CHARACTERISTIC:	50 c/s to 50 Mc/s: ±1 dB. 50 to 100 Mc/s: ±2 dB.
INPUT CONDITIONS:	Capacitance, approx. 7 μμF. Resistance, greater than 1 MΩ at 1 Mc/s.
POWER SUPPLY:	100 to 125 volts, or 200 to 250 volts, as ordered; 40 to 100 c/s.

DIMENSIONS (over projections):	Height	Width	Depth
	10 3/4 in (26.5 cm)	7 3/4 in (20 cm)	6 3/4 in (17.5 cm)

WEIGHT:	7 3/4 lb (3.5 kg)

DESCRIPTION

1.1 GENERAL

The Marconi Valve Millivoltmeter Type TF 899A measures small a.f. and r.f. voltages; it has been designed to give high stability and freedom from zero-drift. The probe unit is fitted with input terminals, and is readily detachable from the main casing to enable short connecting leads to be used between the instrument and the apparatus under test. The Millivoltmeter can also be used as an a.m. signal detector, the detected a.f. output being available at a jack socket on the front panel.

The instrument has no conventional chassis, and all components are mounted on the rear of the sloping front panel, which hinges upwards for ease of servicing. The lid hinges back to form a support that allows the instrument to be used, if required, in a 45° sloping position. When the lid is closed, its hinged edge forms a convenient recessed carrying handle at the back of the instrument.

1.2 DESIGN DETAILS

The following detailed description is intended to be read in conjunction with the Functional Diagram, Drawing No. XC 29658, and the complete Circuit Diagram, Drawing No. TC 25451. Both drawings are located at the back of this handbook.

Basically, the TF 899A comprises a leaky-grid detector incorporated into an initially-balanced bridge circuit, with a meter as an out-of-balance indicator.

The detector valve (V1, a triode-connected pentode) is housed in the probe unit, and constitutes one arm of the bridge. The second arm of the bridge consists of a further triode-connected pentode (V2) arranged so that its anode impedance forms the resistance of this arm. The two remaining arms of the bridge are formed by pure resistances, one of which is variable to provide a FINE ZERO control; the junction of the two arms is formed by a variable potentiometer (RV5, the COARSE ZERO control), the slider of which is connected to the indicating meter. The zero-setting arrangements are such that, once set, the zero is the same for all three ranges.

1.2 (continued)

With the bridge initially balanced, an alternating voltage subsequently applied to the input circuit is detected at the grid of V1, producing a control bias which changes the anode impedance of the valve and so unbalances the bridge. The out-of-balance current in the bridge is indicated by the moving-coil microammeter which is calibrated in terms of r.m.s. voltage input to the instrument. The meter is equipped with series multipliers corresponding to full-scale voltage indications of 150, 500, and 2,000 millivolts. Each multiplier incorporates some variable resistance in order that the separate voltage ranges can be standardized. The voltmeter responds to peak values, but is calibrated in r.m.s. values of a sine wave.

Valve V2 provides automatic stability control against the effects of small mains fluctuations and changes in emission; a preset potentiometer (RV1) enables the degree of stabilization afforded by V2 to be adjusted to an optimum working point.

An RC filter removes the r.f. products of detection, while a high-value capacitor (C5), between the anode and cathode of the detector valve, prevents any modulation from reaching the bridge circuit. A circuit-closing jack in series with the capacitor enables headphones to be connected, for aural monitoring of amplitude modulated inputs. The ability to include headphones in the circuit increases the versatility of the instrument to embrace such applications as signal tracing and i.f. circuit alignment when an a.m. signal is used.

The probe unit, which, for the lower frequencies, is stowed in a recess in the top of the instrument case, is removable to allow it to be taken very close to the signal source when higher frequencies (10 kc/s and upwards) are involved. When the probe is removed from its recess, the signal input capacitor is automatically changed to a lower value. The input connections to the probe are small screw terminals.

The TF 899A contains its own built-in a.c. power unit, which supplies 6.3 volts a.c. for the heaters of the two bridge valves, and 90 volts d.c. h.t. to the bridge. The h.t. supply is derived via full-wave rectifier V4, an RC smoothing filter, and voltage stabilizer V3. The instrument is supplied with either a 200-250 volt or 100-125 volt mains transformer as requested at the time of ordering.

2 OPERATION

2.1 INSTALLATION

The Millivoltmeter is despatched with its valves in their holders and with its mains input adjusted, unless otherwise specified, for immediate use with 40- to 100-c/s a.c. supplies in the voltage range 225 to 250 volts or 112 to 125 volts depending upon the transformer fitted. To check or alter the mains input tap, refer to Section 3.3 of this handbook.

2.2 SWITCHING ON AND SETTING ZERO

Having checked that the instrument is correctly adjusted to suit the local mains voltage, connect the supply - the mains lead is stowed, when not in use, under the hinged lid at the top of the case.

(1) Switch on by turning the Selector switch from the OFF position to '∞'. Allow at least half a minute for the valves to warm up before selecting any voltage range.

(2) Short-circuit the VOLTS A.C. (H and L) terminals on the probe unit, and set the Selector switch to the 2-volt range.

(3) Turn the FINE ZERO control to about halfway between its limits of travel, and adjust the COARSE ZERO control to set the meter pointer to zero.

(4) Turn the Selector switch to the 150-mV range, and set the meter pointer to zero using the FINE ZERO control. The zero will now be correct for all three voltage ranges.

The above procedure avoids the possibility of damage to the indicating meter by ensuring that the COARSE ZERO control is not operated other than on the least sensitive voltage range.

2.3 MAKING A MEASUREMENT

Connection of the signal to the instrument is made via small screw terminals on the top of the probe unit. The L terminal is directly coupled to the chassis of the Millivoltmeter and therefore must only be connected to a point at earth potential on the equipment under test.

2.3 (continued)

NOTE: Always turn the Selector switch to '∞' before connecting a signal source to the input of the voltmeter.

It should be borne in mind that the instrument responds to the peak value of an a.c. waveform, although it is calibrated in terms of the r.m.s. value of a sine wave. If the signal being measured is a distorted sine wave, errors will be introduced depending on the relative amplitudes and phase relationships of the harmonics present. Where one harmonic predominates, the percentage difference in either direction can be as high as the percentage distortion.

The peak voltage applied between the H and L terminals must not exceed 400 volts; allowance must be made for this fact when measuring a.c. superimposed on d.c.

2.3.1 Frequencies up to 10 kc/s

For frequencies up to 10 kc/s, the probe unit must be left in its recess in the top of the instrument case. With the probe in this position, a large-value input capacitor is brought into use to maintain the rated low-frequency response.

2.3.2 Frequencies above 10 kc/s

For the higher frequencies (up to 100 Mc/s), the probe unit should be removed from its recess and taken close to the signal source. To remove the probe unit, slide it slightly to the left and lift it, terminal-end first, out of the recess; the unit is held in the recess by a spring-loaded tongue, and slots at each end of its casing. When the unit is replaced, it can be simply pushed down into the recess against the spring pressure, when the tongue will lock the unit home.

On the 150-millivolt range, the electrical zero should be readjusted with the probe in the measurement position - the zero on this range may be affected slightly by the physical position of the probe. When taking the measurement care should be exercised to avoid accidental contact with the metal studs on the side of the probe body.

2.3.3 Monitoring Amplitude Modulation

Amplitude modulation on an applied signal may be heard by inserting the plug of a pair of high-impedance headphones into the front panel jack marked MODULATION. This facility will be found very useful in many cases where it is desirable either to detect the presence of any amplitude modulation on an existing high-frequency signal, or to check the presence of an amplitude-modulated signal. When aural monitoring is being carried out during quantitative tests, the headphones should be temporarily disconnected whilst a voltage measurement is being taken.

2.3.4 Typical Applications of the Instrument

The high input impedance and sensitivity of the TF 899A enables it to be used for tests which would otherwise require extra apparatus in the form of amplifiers, etc., and extra work on the part of the operator in the evaluation of results.

Frequency Response of Gramophone Pick-ups

Using test-disks with tone bands, the Valve Millivoltmeter can be connected directly to the output of most pick-up cartridges without affecting their response. For a test of this nature, the pick-up should work into its normal working load.

Resonance Indication

The instrument can be used - in conjunction with a signal generator or a.f. oscillator - as a resonance indicator for most types of tuned circuit. In instances where the shunt capacitance of the Millivoltmeter is sufficient to detune the resonant circuit, a suitable small-value series capacitor may be used to minimize this effect - provided, of course, that the attendant reduction in meter sensitivity can be tolerated.

3 MAINTENANCE

3.1 GENERAL

Section 1, DESCRIPTION, of this handbook deals with the internal circuits of the Millivoltmeter, and is intended to be read in conjunction with the Functional Diagram and the Circuit Diagram. It is recommended that, before commencing the adjustment or replacement of component parts of the instrument, the user should familiarize himself with the principles described in Section 1. The Circuit Diagram shows the values of all the electrical components in the instrument.

3.2 ACCESS TO COMPONENTS

3.2.1 Access to Preset Potentiometers and Valve Pins

(1) Lay the instrument on its back, to prevent the meter from falling out when the meter-surround panel is removed.

(2) Now remove the two 4-BA screws, one on each side of the meter-surround panel.

(3) Lift off the surround panel to expose the preset potentiometers RV1, RV2, RV3, and RV4, and also the underside of the valve-holders.

The preset potentiometers are situated as follows:-

With the instrument upright, with the front panel towards the user, the presets are mounted in a vertical row at the left-hand side. Reading from top to bottom, they are: RV2, RV3, RV4 and RV1.

The valves are situated as follows:-

V2 is just below the left-hand bottom corner of the meter, while V3 and V4 are just below the right-hand bottom corner of the meter - V4 is nearest the panel edge.

3.2.2 Access to Valves and Transformer Tappings

(1) Stand the instrument on its base, or lay it on its back.

(2) Remove the two 4-BA screws at the bottom corners of the front panel.

(3) Now swing the front panel upwards, being careful not to trap the cables in the two slots in the top edges of the case.

The mains transformer is mounted between the front panel and the rear inner panel. The input voltage tappings are made by soldered connections, and care must be exercised when the High/Low tap is being changed, since there is only a small space between the transformer tapping strip with its associated wiring and the rear inner panel.

With the front panel swung up to the vertical position, and hence inverted, the transformer tags are arranged in the following descending order:-

H.T., Y, H.T., Y, HI, X (live), LO, X (earth), and N.

The only tags concerned with the mains tapping arrangements are the HI and LO tags.

NOTE: Before swinging the front panel back to its normal position, the mains lead should be withdrawn to its fullest extend (if it is not already so), since, on replacing the front panel with the mains lead stowed inside the instrument, loops of the mains lead may become trapped behind the rear inner panel.

3.2.3 Access to Probe Interior

Having removed the probe unit from its recess in the case:-

(1) Hold the probe unit with its flat top downwards, and remove the two 6-BA screws in the contact panel on the side of the unit.

(2) Now remove the two 4-BA screws, one from each end of the unit.

3.2.3 (continued)

(3) Swing the curved casing off the unit, sliding it back, up the connecting lead.

NOTE: When removing or inserting the probe valve, it is recommended that the valveholder should be supported to prevent undue movement of the associated wiring.

3.3 MAINS INPUT ARRANGEMENTS

The TF 899A can be operated from any supply within the range 200 to 250 volts or 100 to 125 volts, according to the type of transformer fitted, at mains frequencies of 40 to 100 c/s. Voltmeters intended for operation from 200- to 250-volt supplies are fitted with mains transformers marked 'TM 3651H'; for 100- to 125-volt operation the transformer should bear the marking 'TM3651G'. The voltage range of each transformer is covered in two steps, viz: High - 225 to 250 volts (or 112 to 125 volts), Low - 200 to 225 volts (or 100 to 112 volts).

To change the tap on the mains transformer, proceed as in Section 3.2.2. For the Low voltage range, the connecting wire should be on the 'L' tag, and for the High voltage range, the connecting wire should be on the 'H' tag.

3.4 REPLACEMENT OF VALVES

Access to the detector valve (V1) may be gained by following the procedure described in Section 3.2.3.

Access to the bridge stabilizer valve (V2) may be gained by following the procedure described in Section 3.2.2.

After replacing the detector or stabilizing valves, it may be necessary to reset the internal stability control (RV1) - see Section 3.5.1 for details of the procedure involved. New valves for V1 and V2 should first, if possible, be aged for at least 50 hours (if aging is conducted within the instrument, set the selector switch to '∞').

3.5 ADJUSTMENT OF PRESETS

3.5.1 Bridge Stability Control (RV1)

(1) Connect the Millivoltmeter to a convenient mains supply, the voltage of which can be varied by about 6%. Check, and if necessary, set the zero of the instrument - see Section 2.2.

(2) Set the range selector to the 150-mV range, and by means of the FINE ZERO control, set the meter pointer to a 'false' zero at the .05-volt mark on the bottom scale - call this point 'Z'.

(3) Increase or decrease the mains voltage by 6%, and note the movement with respect to point 'Z', of the meter pointer over a period of about 20 seconds.

(4) If when the mains voltage rises, the meter pointer overall movement is in a positive (rising) direction (or if the pointer falls with a fall in mains voltage), set the Selector switch to the 2-volt range and then turn the stability control (RV1) clockwise by a small amount. Should the pointer behave in a converse manner to the above, turn the stability control counterclockwise by a small amount.

(5) Return the mains voltage to its correct value, and reset the zero by means of the COARSE ZERO control (RV5).

(6) Now repeat steps (2) to (5) until, with a change in mains supply, the overall pointer movement is insignificant.

If RV1 and RV5 are at the end of their travel, the instrument should be switched off, and either V1 or V2 replaced.

TO AVOID DAMAGE TO THE METER, DO NOT TURN RV1 or RV5 WITH THE SELECTOR SWITCH SET TO '150 mV'.

3.5.2 Meter Range Standardizing Controls (RV2, RV3, and RV4)

These controls are correctly set before the instrument is despatched, and must not be disturbed; if they are accidentally moved, proceed as follows:-

3.5.2 (continued)

(1) Switch on and zero the meter as described in Section 2.2.

(2) Set the Selector switch to the 2-volt range, and apply 2 volts from a 1-kc/s source of accurately-known level.

(3) Now adjust RV4 so that the meter reads exactly full-scale deflection.

(4) For the 500-mV range, set the signal source to a level of 500 mV, and switch the Millivoltmeter to the 500-mV range.

(5) Now adjust RV3 so that the meter reads exactly full-scale.

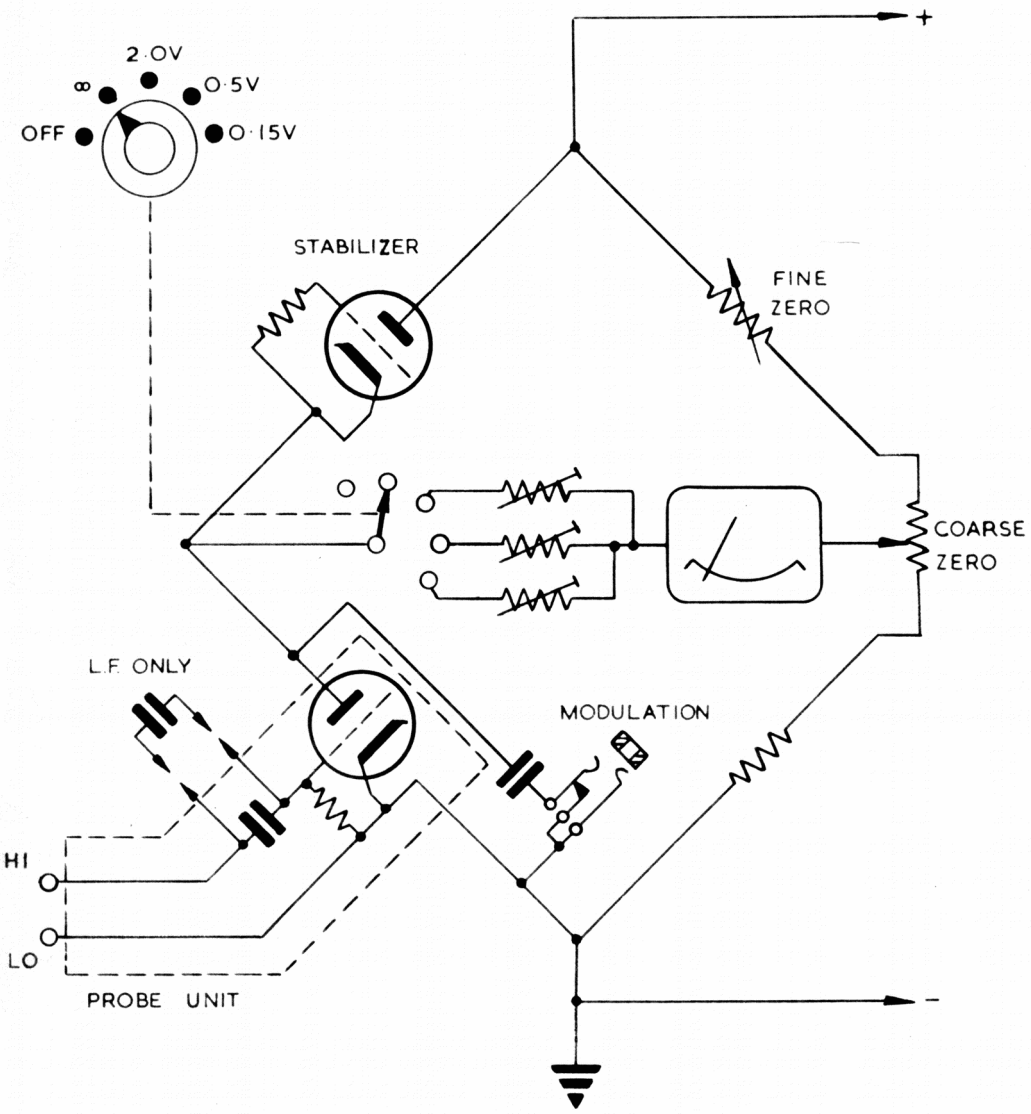
(6) For the 150-mV range, set the signal source to 150-mV, and switch the Millivoltmeter to the 150-mV range.

(7) Now adjust RV2 so that the meter reads exactly full-scale.

3.6 STATIC VOLTAGES

The following supply voltages were measured on a typical TF 899A, using a meter with a resistance of 20,000 ohms per volt (i.e. a Model '8' Avometer).

L.T. at 'XX'	6.3 volts a.c.
L.T. at 'YY'	6.3 volts a.c.
A.C. H.T. at T1 Sec.	140-0-140 volts a.c.
D.C. H.T. V4 pin 8 to E	130 volts d.c.
D.C. H.T. across V3	95 volts d.c.



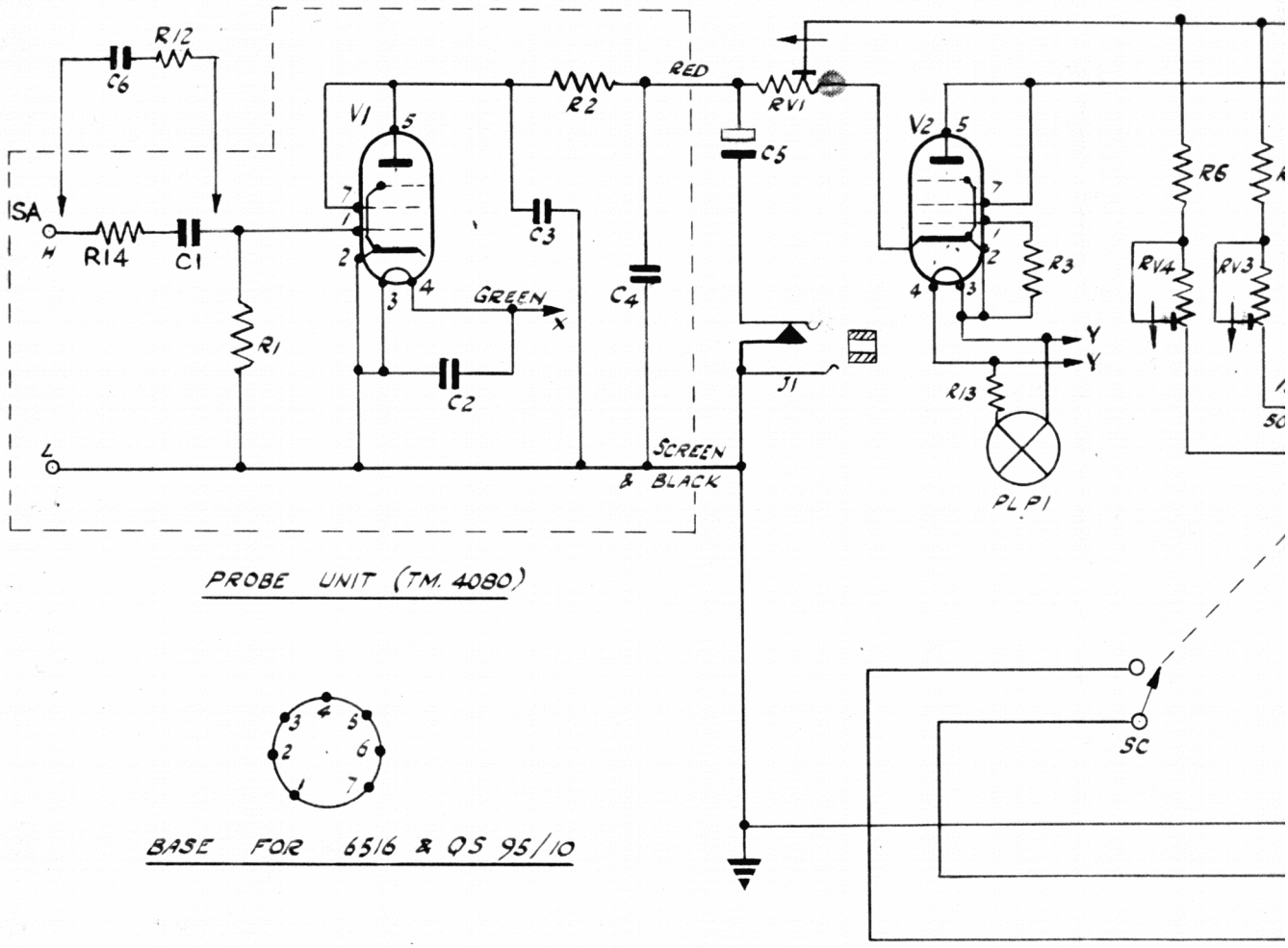
TYPE TF 899A

ST | DRAWING NUMBER

A | XC 29658

SHEET 1 OF 1 SHEET

FUNCTIONAL DIAGRAM



PROBE UNIT (TM. 4080)

BASE FOR 6516 & QS 95/10

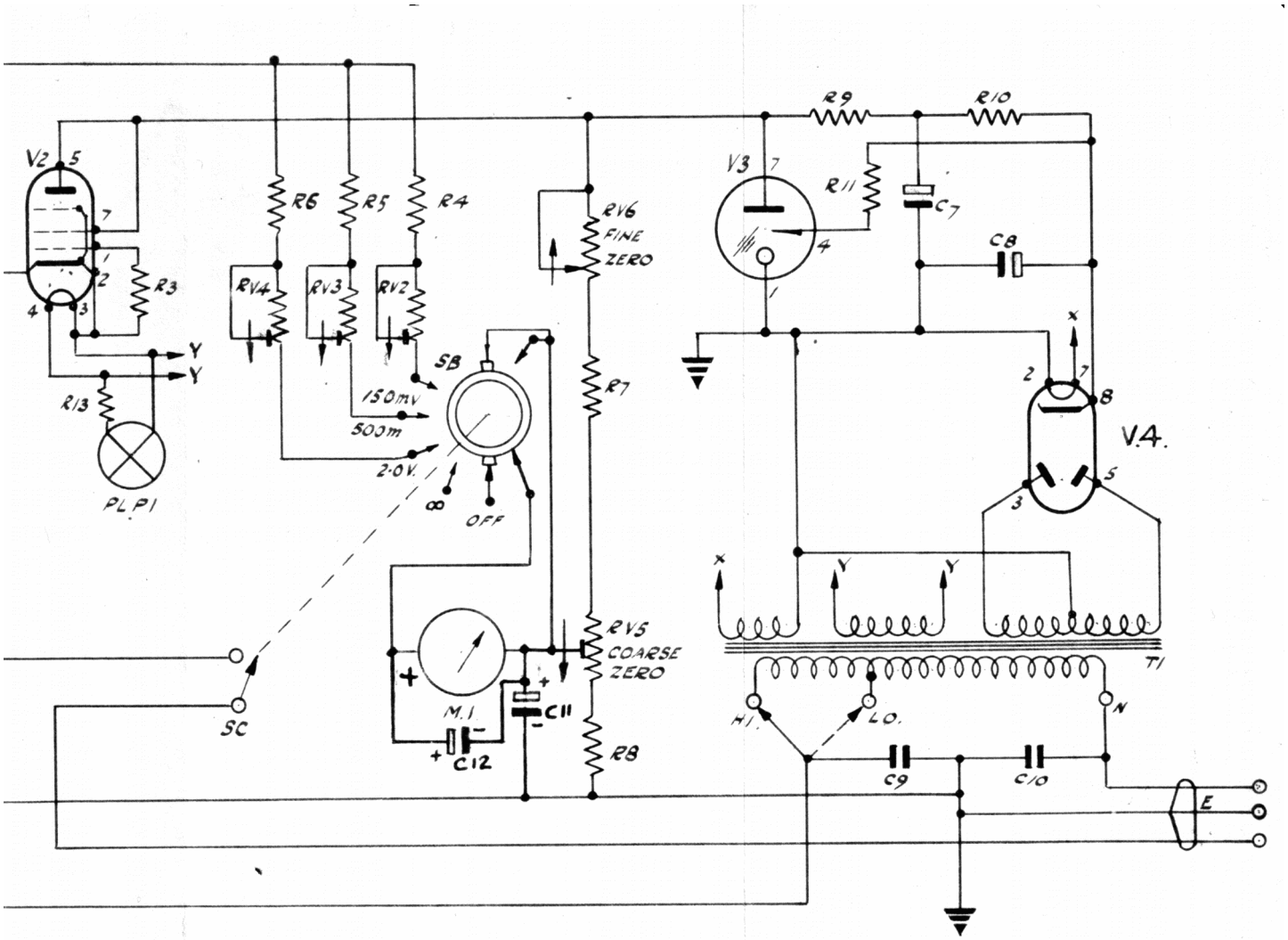
REF.	RESISTORS		S.L. REF.
R1	10 MΩ	± 10% ¼ W.	TM4080/16
R2	100Ω	± 10% ¼ W.	TM4080/17
R3	10 MΩ	± 10% ¼ W.	TF.899A/44
R4	3·3kΩ	NOM. S.I.C. ¼ W.	TF.899A/45
R5	33kΩ	NOM. S.I.C. ¼ W.	TF.899A/42
R6	120kΩ	NOM. S.I.C. ¼ W.	TF.899A/47
R7	5·1kΩ	± 5% 1 W.	TF.899A/41
R8	5·1kΩ	± 5% 1 W.	TF.899A/41
R9	1kΩ	± 10% 1 W.	TF.899A/48
R10	1·5kΩ	± 10% 6 W.	TF.899A/49
R11	220kΩ	± 10% ¼ W.	TF.899A/50
R12	100kΩ	± 10% ¼ W.	TF.899A/43
R13	10Ω	± 10% ½ W.	TF.899A/46
R14	68Ω NOM. S.I.C.	½ W.	TM4080/18

RV1	2kΩ ± 10% W.W. PRESET	TF.899A/35
RV2	2kΩ ± 10% W.W. PRESET	TF.899A/40
RV3	25kΩ ± 20% PRESET	TF.899A/36
RV4	100kΩ ± 20% PRESET	TF.899A/37
RV5	1kΩ ± 10% W.W. PRESET	TF899A/59
RV6	100Ω ± 10% W.W. POT.	TF.899A/38

	CAPACITORS	
C1	100 pF +100% +0% 500V.	TM. 4080/12
C2	500 pF ± 20% 350V.	TM. 4080/13
C3	100 pF +100% -0% 500V.	TM. 4080/12

C4	·001 μF ± 25% 500 V.	TM 4
C5	2 μF +100% -20% 150V.	TF.8
C6	·01 μF ± 20% 400V.	TF.8
C7	8-8 μF +50% -20% 350V.	TF.8
C8	8-8 μF +50% -20% 350V.	TF89
C9	·001 μF 300 V.A.C. WK.	TF.8
C10	·001 μF 300 V.A.C. WK.	TF.89
C11	1 μF +100% -20% 150V	TF.8
C12	50 μF +100% -20% 12V	TF.8

	MISCELLANEOUS	
V1	VALVE BRIMAR 6516	TM 4



	C4	·001 μF ± 25% 500 V.	TM 4080/14	V2	VALVE BRIMAR 6516	TF899A/64
	C5	2 μF +100% -20% 150V.	TF 899A/54	V3	VALVE QS 95/10	TF899A/65
	C6	·01 μF ± 20% 400V.	TF.899A/55	V4	VALVE 6X5 OR 6X5GT	TF899A/66
	C7	8-8 μF +50% -20% 350V.	TF899A/56			
	C8	8-8 μF +50% -20% 350V.	TF899A/56			
	C9	·001 μF 300 V.A.C. WK.	TF.899A/57	M1	METER 0-50 μA	TF899A/4
	C10	·001 μF 300 V.A.C. WK.	TF.899A/57			
	C11	1 μF +100% -20% 150V	TF899A/52			
	C12	50 μF +100% -20% 12V	TF.899A/53	SA.	SWITCH CLOSED WITH PROBE IN CASE	TF899A/24
				SB.	SWITCH 5 POS OAK	
				SC.	SWITCH MAINS ON/OFF	
				J1	JACK	TF899A/62
				T1	TRANSFORMER MAINS	TF899A/1
		MISCELLANEOUS		PLP1	PILOT LAMP 6·3V 0·15A	TF.899A/72
	V1	VALVE BRIMAR 6516	TM 4080/20			

TITLE	CIRCUIT DIAGRAM FOR VALVE MILLIVOLTMETER
DRAWN G FILDES	ASSY. TE 2545O
DATE 23-9-58	WIRING
CHKD. A. HAVILAND	S. LIST TF899A
APP.	DRG. No TC.25451
TRACED H.F.	

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