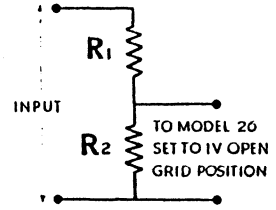
PART 2

CHAPTER 1

CALIBRATION AND MAINTENANCE OF THE INSTRUMENT

Instruments to be employed.

1. All measurements and tolerances stated do not include those of the testing instrument, and where necessary, these should be ascertained before commencement of the calibration procedure. Where possible, the recommended instruments should be employed. Where the Valve Voltmeter is not available in Dockyard Calibration Centres, the Electronic Instruments Model 26 Valve Voltmeter should be used on its 1V open grid position, in conjunction with a suitable potential divider as shown in Fig. 11.



Input Range	R_1	R_2
1 Volt	0	10M Ω
2·5 Volts	6M Ω	4M Ω
10 Volts	9M Ω	1M Ω
25 Volts	9·6M Ω	400K Ω
50 Volts	9·8M Ω	200K Ω

FIG. 11

R1 AND R2 MUST BE SELECTED TO WITHIN ±1% USING GRADE ONE HIGH STABILITY RESISTORS.

500 c/s A.C. Supply Operation and its Relation to Servicing

2. Whilst the instrument is suitable for use on 50—500 ~ A.C. supplies, service and calibration should normally be carried out using a 220/230V 50 ~ supply.

3. The following features play a vital part in the correct operation of the instrument on a 500 ~ supply.

(*a*) The two electrostatic screens (S1 and S2) on the H.T. transformer prevent spurious mA/V readings, and care must be taken when replacing a transformer to ensure that these screens are connected as shown in the Circuit Diagram (Fig. 3).

(*b*) The separate cable forms lying side-by-side across the instrument ensure that the grid circuit and its associated wiring is kept well apart from H.T. wiring to prevent the transference of energy from one circuit to the other at high mains frequencies. If at any time, it is necessary to displace wiring within the instrument, great care must be taken to ensure that it is replaced in its original position.

(*c*) The 0·02μF (C1) and 0·02μF (C2) capacitors prevent spurious readings on insulation ranges when the instrument is used at high mains frequencies.

To Check Accuracy of Instrument

4. Before commencing servicing work and on completion, the instrument should be checked to the following schedule:—

(i) Connect the instrument to an A.C. voltage supply of 200—250V, 50 ~ of known magnitude, and set the instrument voltage adjustment to its appropriate position.

(ii) Switch on, noting that panel indicator lights, and set MAINS VOLTAGE SELECTOR FINE CONTROL, such that the meter needle lies as near as possible to the centre of the " ~ " zone.

(iii) Using a CV455 strapped as a single triode which has been standardised for mutual conductance at 16mA anode current with 200V D.C. applied to anode (see para 5 for standardisation procedure), check that for 16mA anode current, the negative grid volts indication is within ± 5% of the nominal voltage, and slope (mA/V) is within ± 5% of standardised value, using an external AvoMeter in series with the A_1 link to read anode current. A reading of 8mA on the external instrument will be equivalent to a D.C. current of 16mA through the valve (this is the value normally indicated by the anode current controls when the meter is at its null position).

(iv) Remove valve and external meter. With NEG GRID VOLTS Control set at 40, connect a resistance of 680k Ω ± 5% between grid and cathode sockets on the top cap connector panel. With the CIRCUIT SELECTOR switch set to position " GAS ", panel meter should indicate full scale deflection ± 20%.

To obtain Standard Figures for a Valve using D.C. Supplies

5. The valve should be connected as shown in Fig. 12.

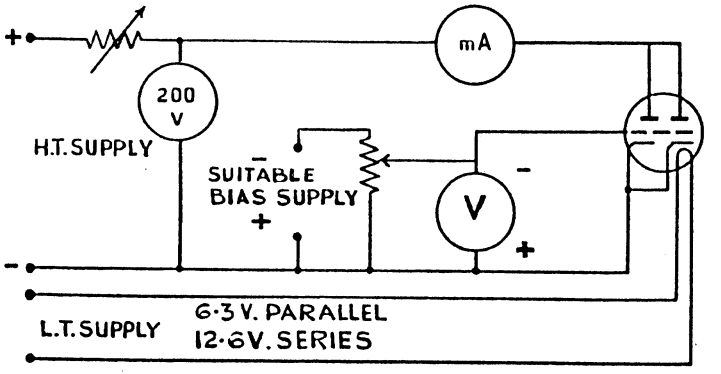


FIG. 12.

6. The meters used should be of sub-standard accuracy (E.I. Model 44) the current meter (having a maximum voltage drop of 100mV) preferably being scaled 0—25mA, the voltmeters having a sensitivity of 1,000 Ω/V. If rectified A.C. is used for the H.T. supply then it is essential that steps are taken to ensure that the supply circuit is adequately smoothed. The Solartron Varipack is a suitable source. The bias supply should be obtained from a suitable battery (note polarity of connection). The heater supply for the valve may be A.C. or D.C., but must be within ±5% of the rated voltage.

7. Set the grid bias voltmeter to read 9V, adjust H.T. supply to 200V, then by means of successive adjustments of the bias and H.T. voltage controls, set the anode current at 16mA (the anode voltmeter must read 200V). Note the bias voltage reading. Re-adjust the bias control, and if necessary, the anode voltage control until the anode current is 17mA (the anode voltmeter must read 200V). Note the new grid bias voltage reading. The standardised slope for the valve can now be obtained from:—

The difference between the two anode current readings (i.e. 1mA) over the difference between the two grid voltage readings $\frac{Ia_2 - Ia_1}{V_{g1} - V_{g2}}$

The result will generally be between 4 and 5mA/V.

For greater accuracy it is suggested that readings of grid voltage be plotted against values of anode current between 10 and 20mA and the slope taken from the curve at 16mA.

8. The valve should now be labelled as follows:—

Va =200V D.C.
Ia =16mA D.C.
Vg = ...
Slope= ..... mA/V
Date .....
CV455

The valve should now be re-standardised daily when in use.

Mechanical Features

9. The instrument comprises two units in a hinged transit case, the lid of which is not detachable. Electrical connection between the two units is affected by means of two 5-way side-by-side cables.

Removal of the Instrument from its case

10. To facilitate servicing or calibration of the instrument, it is necessary to remove both sections from the casing, this being accomplished by the removal of four hexagonal headed bolts, which form the feet of the control unit, from the underside of the case. The control panel will then be released. The Valve Panel can be withdrawn from its section of the case by the removal of eight fixing screws around its periphery.

Simple Faults

11.

Symptoms	Possible Fault	Action
(*a*) No dial light indication.	No mains input.	Check mains connector.
	Dial light bulb burnt out.	Replace LP1.
No dial light indication or meter deflection on SET ~ setting of CIRCUIT SELECTOR.	Fuse blown.	Check MAINS VOLTAGE SELECTOR setting and replace F1 and/or F2.
(*b*) No indication of meter current.	No anode volts at valve pin.	Check that links A_1 and A_2 are tight and making firm contact.
No indication of meter current and protective relay operates when testing tetrodes or pentodes.	No anode volts at valve pin, but screen volts present.	Check that links A_1 and A_2 are tight and making firm contact.

Relay operates and fails to clear

12. Should relay operate due to suspected faulty valve, and fail to clear after switching off and on again with no valve in panel, set ROLLER SELECTOR Switch to read 000 000 000 and remove top cap connecting lead. Switch instrument off and on.

13. If fault clears, the most likely cause of the trouble is a short on the Valve Panel, certain pin(s) being shorted out to earth by stray wire or solder, or a breakdown in insulation.

14. If the fault still persists however, check H.T. line for breakdown to earth between ROLLER SELECTOR switch on Valve Panel and H.T. transformer on control unit.

Voltage checks with no valve under test

15. Connect instrument to *known* 220—230V 50 ~ supply, and adjust coarse and fine settings of the mains voltage selector panel, to match the supply voltage as accurately as possible. Set the CIRCUIT SELECTOR to TEST and ELECTRODE SELECTOR to A_1 and proceed to check the relevant electrode voltages as follows:—

Heater Voltages

16. Use a Model '7', '8', '40', '47', '47A' or '48A' AvoMeter on its A.C. voltage ranges. Connect meter between H— and H— sockets on top cap connector panel. Rotate the HEATER VOLTAGE Switch through the full range of values, the external meter being set to the appropriate voltage range, as required. The heater voltage reading on the meter should conform to the voltage limits shown in table 4. Due allowance must be made for the limits of accuracy of the measuring instrument for each particular reading.

TABLE 4

Heater Switch setting with Toggle Switch set to its 0·625—117 Position.	Voltmeter must read between these limits.
0·625	0·5— 0·8
1·25	1·2— 1·45
2·0	2·2— 2·45
2·5	2·6— 3·0
4·0	4·2— 4·7
5·0	5·1— 5·5
6·3	6·6— 7·0
10·0	10·3— 10·9
11·0	11·3— 11·9
13·0	13·5— 14·1
16·0	16·3— 17·3
20·0	20·7— 21·7
25·0	26·0— 27·0
30·0	31·0— 32·2
48·0	50·3— 52·3
70·0	73·0— 76·0
117·0	123·0—130·0
Heater Switch setting with Toggle Switch set to its 1·4—80 position.	
7·5	7·6— 8·0

Anode Voltages

17. Use a Model '7', '8', '40', '47', '47A' or '48A' AvoMeter on its A.C. voltage ranges. Connect meter between A_1 and C sockets on top cap selector panel, rotate the ANODE VOLTAGE Switch through successive positions, the actual meter being set to the appropriate range as required. The meter readings obtained should be 1·1 × the voltage indicated by the ANODE VOLTAGE Switch ±5%. Due allowance must be made for the limits of accuracy of the measuring instrument for each particular reading e.g., with the ANODE VOLTAGE Switch set to 100, actual *voltage* reading should be 110 ± 5% volts, i.e., between 104·5 and 115·5V.

Screen Voltages

18. Use a Model '7', '8', '40', '47', '47A' or '48A' AvoMeter on its A.C. voltage ranges. Short the anode of V_1(a) to cathode (pins 2 and 5. See Fig. 13). Connect meter between S and C on the top cap selector panel, rotate the SCREEN VOLTAGE switch through successive positions, the external meter being set to the appropriate range as

required. The meter readings obtained should be 1:1 the voltage indicated by the SCREEN VOLTAGE switch ± 5"„. Due allowance must be made for the limits of accuracy of the measuring instrument for each particular reading, e.g. with the SCREEN VOLTAGE switch set to 200, the actual *voltage* reading should be 220 ± 5"„ volts, i.e. between 209 and 231V.

Calibration of the Instrument

19. Use a D.C. Valve Voltmeter with an input impedance greater than 1M Ω, e.g. the "AVO" Electronic Test Meter, or the Multimeter Electronic C.T.38. The meter should be standardised at the appropriate voltages before making any adjustment mentioned in the following sections. When using the Valve Voltmeter Model 26, a potential divider should be used as in Fig. 11.

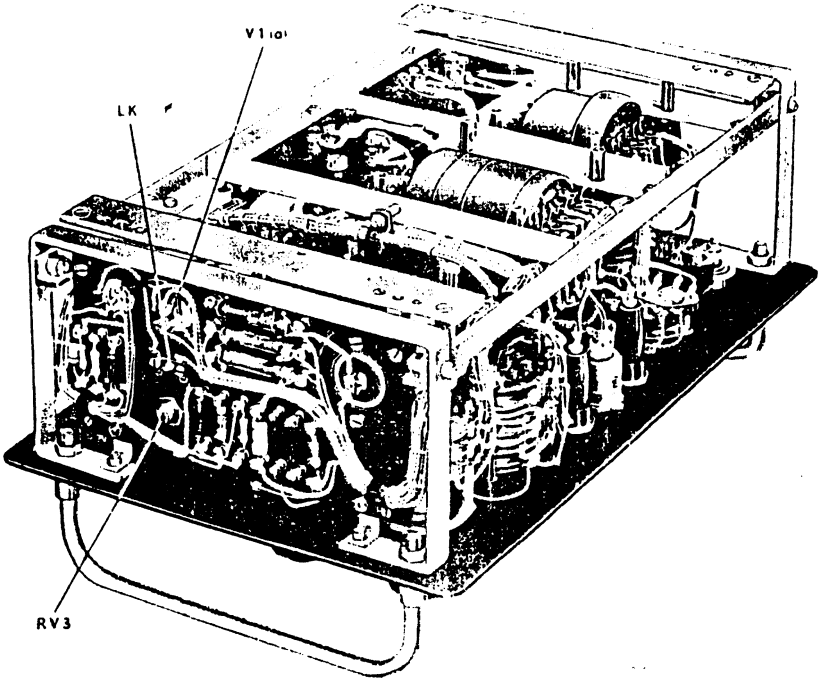


FIG. 13.

20. Open LK (Fig. 13) and set the panel controls as follows:—

CIRCUIT SELECTOR to TEST, ELECTRODE SELECTOR to A_1 and NEG GRID VOLTS to 40.

21. Connect measuring leads of Valve Voltmeter across RV2 (Fig. 6) and adjust RV3 (Fig. 13) until a voltage reading of 20·8V is obtained. Transfer measuring leads to G_1 and C sockets on the top cap connection panel, or if panel has been dis-connected for servicing, to the G_1 and C positions on the tag board at back of unit. (See Fig. 6.) Check that at the 13 and 4 marks of the dial readings of 6·75V and 2·1V ± 5% are obtained. If either or both readings are out of tolerance, the dial should be adjusted mechanically to split the error. If it is necessary to make an adjustment, slacken the three counter-sunk headed screws on the top of the dial, which will then be free to move within the latitude of kidney shaped slots. After adjustment, re-tighten screws and check readings. The areas marked 0, 5, 15 and 40 should correspond within the indicated area to 0V, 2·6V, 7·8V and 20·8V ± 5% respectively.

Checking the set mA V Control

22. Using the Valve Voltmeter set to a suitable D.C. range with the link still open, and measuring leads connected across R5, check that when the dial is advanced to its 10, 5 and 2mA/V positions, readings of 52·5mV, 105mV and 260mV ± 3% are obtained. If for any reason the relationship between the dial and the potentiometer has been upset, the procedure headed "SETTING THE mA/V DIAL" should be adopted. (See para 34.)

Checking the set ~ indication

23. Standardise the Valve Voltmeter at 47V D.C. Close the link LK (Fig. 13) and set the panel controls as follows:—

CIRCUIT SELECTOR to SET ~ and ELECTRODE SELECTOR to A_1.

24. With the Valve Voltmeter connected across RV_2, a reading of 47 volts should now be obtained, whilst the meter on the instrument panel should indicate within the "~" zone. If voltage reading is correct, but panel meter indication is outside "~" zone, check resistors R_3 and R_4.

Ia Calibration check

25. Open the A_1 link on the valve base panel, and insert a suitable D.C. Moving Coil Ammeter, e.g. a Model '7', Model '40' or similar AvoMeter into the circuit. Set up the instrument, and place under test any power valve capable of passing 100mA anode current, e.g. KT33C (CV1503), KT66 (CV1075), or 807 (CV124). Set the ANODE CURRENT controls to 100mA (90mA ÷ 10mA), and with the instrument set to its TEST position, allow the valve to warm up, and return the panel meter needle to zero by means of the NEG GRID VOLTS control. The external meter should then indicate between 47·5mA and 52·5mA (0·5 × indicated value on ANODE CURRENT controls ± 5%), the panel instrument indicating zero. If required, repeat this test at any other settings of ANODE CURRENT controls.

The Indicating Meter

26. This is a self-contained unit which may be withdrawn from the control panel by the removal of two 2BA screws (see Fig. 6).

27. When used in the instrument as an anode current null indicator, the meter has a full scale deflection for approximately 10mA (not critical). When removed from the instrument, the meter has a full scale deflection of 30μA and an internal resistance of 3,250Ω. When shunted by R9 only (see circuit diagram), the meter has a full scale deflection of 39·8μA.

Adjustment of Protective Relay

28. The protective relay should seldom require attention, but if, for any reason, parts are replaced, the adjustment is simple, it only being necessary to position two 4BA screws (insulated tools must be used for this adjustment). (See Fig. 6.) It should be noted that the bobbins, if replaced, should be positioned such that the flux which they produce is additive.

29. Operational limits are as follows:—

(i) Anode overload—Relay should operate on 100V short circuit.
(ii) Screen overload—Relay should operate on 60V short circuit.
(iii) The relay should not arc excessively on a 200V short circuit on anode or screen.
(iv) The Relay should not operate when checking a 120mA rectifier.

30. Before making any adjustments, check that the lamp LP1 is operative. When the instrument is used solely on a 110V supply, it may be preferable to replace LP1 with a 100V, 15W Pigmy lamp.

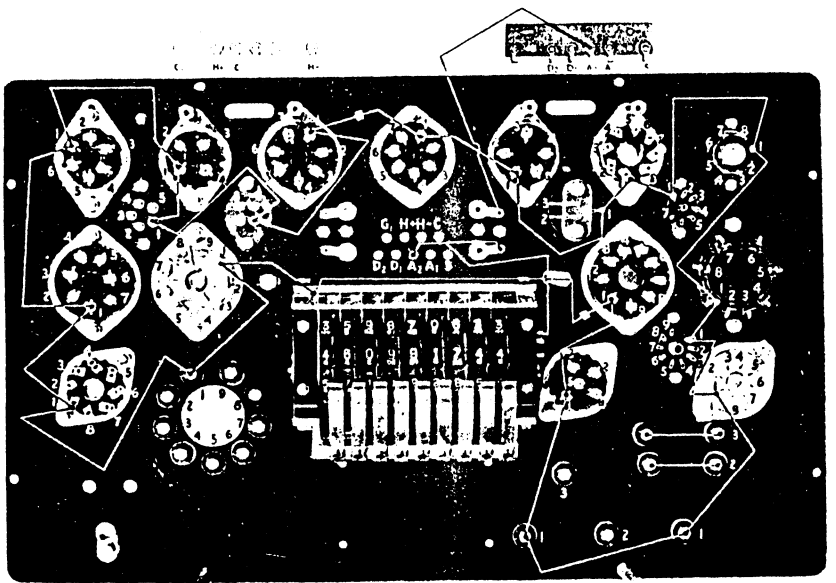


FIG. 14.

Servicing the Valve Holder Panel

31. The Valve Holder Panel is connected electrically to the control panel by means of two 5-way side-by-side cables. One of these cables embodies two thicker sections (16/·012") for H+ and H— leads. Connections to tag boards on either unit are shown in Fig. 14.

32. The wiring of the valve holders on the panel is in the form of nine separate loops, all pins 1 comprising a loop and linking in roller 1 of the ROLLER SELECTOR switch. This form of loop connection is used likewise for pins 2—9, all nine circuits approximating in length and following a similar route around the panel. These loops are further loaded with beads of ferroxcube which sufficiently damp the loop to prevent the valve under test breaking into parasitic oscillation. A diagramatic layout is shown in Fig. 14. Ferroxcube is also used on leads feeding the SELECTOR SWITCH, as a precaution against L.F. oscillation. Where it is necessary to replace valve holders, these, with the exception of the B8B, are fitted to the panel with nuts and bolts, and are, thus, easily removable. Care should be taken to replace all wiring in its original position.

Removal and Replacement of Knobs and Setting of Knob Skirts

33. To remove any knob, remove 6BA screw and spring washer. To remove knob spindle and skirt release locking pin. The switch nut is now accessible. To adjust skirt, slacken lock nut, rotate skirt to desired position, and re-tighten lock nut. Reverse procedure to replace.

Setting the mA/V Dial

34. With the link open, and the SET mA/V dial at rest, turn RV1 to its maximum anti-clockwise position (viewing from the front panel) and adjust friction tight the locking nuts of the U shaped stirrup. Connect Valve Voltmeter, set to a suitable range across R5 and advance SET mA/V dial to a reading of 5. Rotate the RV1 spindle further, by means of the stirrup, in a clockwise direction until the D.C. Valve Voltmeter shows a reading of 105mV. If this reading is achieved without further clockwise advancement of the stirrup, or if its procurement necessitates an anti-clockwise movement of the stirrup, then investigate the accuracy of R1, R2, R5 and RV1. The locking nuts on the stirrup should now be tightened, and the reading of 105mV on the voltmeter checked. Again check that the D.C. millivolts developed across R5 at the 2mA/V and 10mA/V settings of the dial are 260mV and 52·5mV $\pm$ 3%. Check that the dial can now be rotated to its 1mA/V position and that motion is eventually arrested by the stop screw on the dial, and not by the stop at the end of the potentiometer track.