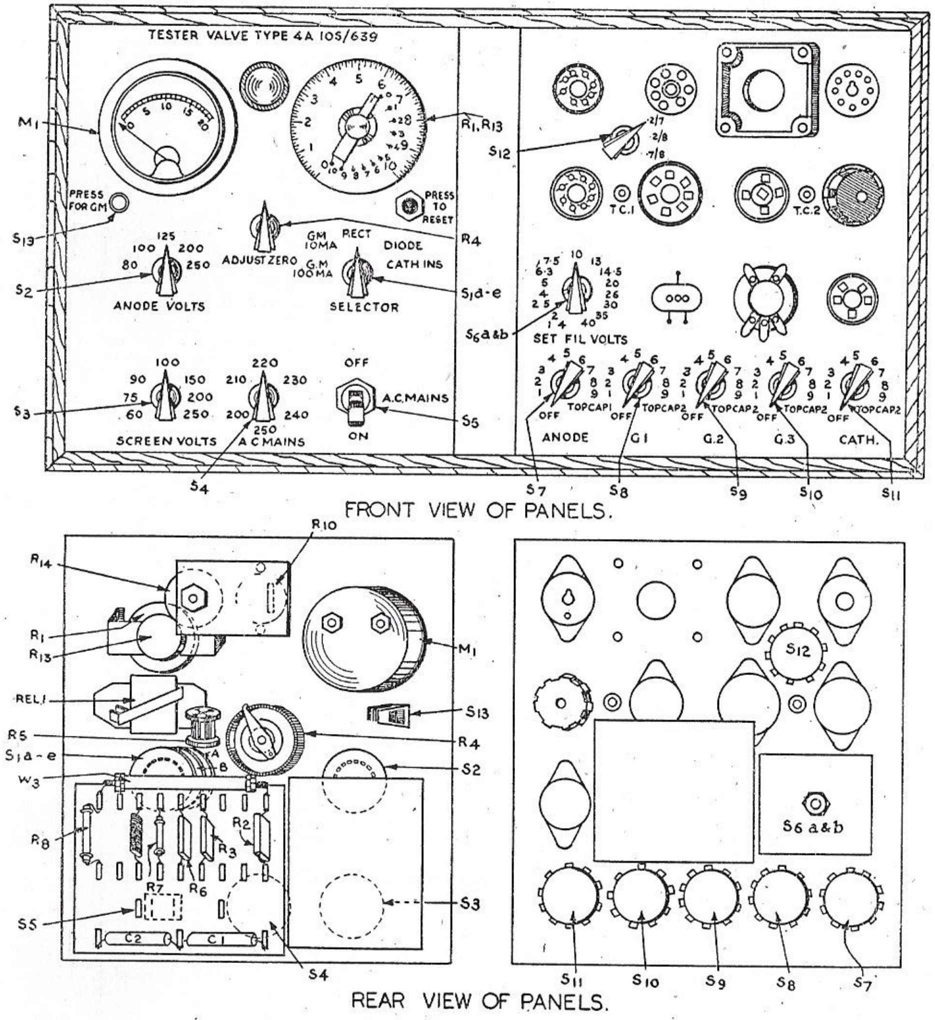

Fig. 1.—Front and rear views of panels

VALVE TESTER, TYPE 4A

(Stores Ref. 10S/639)

Introduction

1. The valve tester, type 4A, has been designed to measure the mutual conductance of valves, the emission of H.T. rectifiers and diodes, and also heater-cathode insulation of indirectly heated valves. The mutual conductance (Gm) may be measured at the following anode, screen and heater potentials:—

Anode voltage	*Screen voltage*	*Heater voltage*	
80	60	1·4	13·0
100	75	2·0	14·5
125	90	2·5	20·0
200	100	4·0	26·0
250	150	5·0	30·0
	200	6·3	
	250	7·5	35·0
		10·0	40·0

2. The instrument is entirely A.C. mains operated and an overload relay is connected in the mains input circuit as a precautionary measure. This relay switches off the mains to the valve tester in the event of the tester being seriously mishandled.

3. Provision is made for testing valves fitted with the following bases:—

British 4 and 5 pin; British 7 pin; British octal; U.S. medium 5 pin; U.S. medium 7 pin; International octal; Eight pin side contact for EF8 valves; Large British 4 pin; British 9 pin; Acorn holder; Diode holder.

4. The valve tester comprises two units which are housed in a substantial wooden case. General views of the tester are given in fig. 1.

GENERAL DESCRIPTION

5. A theoretical circuit diagram of the valve tester is shown on pages 14 and 15, in fig. 4. All the supplies to the particular valve under test are alternating and are provided by the mains transformer T_1; the appropriate voltages being selected by the switches S_{1A}, S_2, and S_3. The design of the instrument is such that the mutual conductances measured at the stated voltages are the same as would be obtained if the supplies were D.C.

6. The emission of rectifiers and diodes is measured at 100 volts and the meter M_1 is calibrated to indicate the correct emission at this D.C. voltage, minus the voltage drop across R_6 or R_7, as the case may be. The resistances R_6 and R_7 are current limiting resistances connected in the anode circuit of the rectifier and diode valves respectively, to prevent damage to the valve through excessive emission.

7. The heater-cathode insulation of valves is also measured at 100 volts D.C.

Principle of measurement of mutual conductance

8. Reference should now be made to the simplified theoretical diagram in fig. 2 by which mutual conductance measurement in this valve tester may be most easily understood.

9. All supplies to the valve under test are alternating voltages. The front of the measuring panel carries engraved knobs to enable correct anode and screen voltages to be selected. These voltages are chosen so as to give a reading of mutual conductance that would be obtained with the same D.C. supplies, i.e. the voltages shown are peak voltages and not r.m.s.

10. With the anode positive cycle, the grid of the valve is made slightly negative with respect to its cathode by the voltage which is induced into the secondary winding C of the transformer T_1. This voltage is applied to the grid of the valve *via* S_{13} and the resulting unidirectional anode current is indicated on the meter M_1. This meter deflection is balanced out by the variable resistance R_4 which feeds a current of opposite sign from the T_1 transformer winding B to the meter and enables the meter deflection to be reduced to zero.

11. The Gm switch S_{13} is then closed by pressing a button, thus making the grid positive in voltage with respect to the cathode and causing an increase in anode current. At the same time the circuit R_2, R_1 is connected to the anode. The increased anode current reading is again balanced to zero by varying R_1, which applies an equal and opposite current to that producing the meter deflection. The mutual conductance is read directly from a scale calibrated in milliamperes per volt on the variable resistance R_1.

12. It can be shown that the mutual conductance is determined by the voltages e_1, e_2 and the resistance R_2 in the following relationship:—

$$\text{Gm in milliamperes per volt} = \frac{e_1}{e_2} \times \frac{1000}{R_2}$$

Since the measurement depends on the ratio $\frac{e_1}{e_2}$ and not on their absolute value, this measurement is independent of the mains voltage and variations from this source do not affect the calibration. The anode current read on the meter is arbitrary as the wave form depends on the characteristics of the valve under test.

Heater-cathode insulation test circuit

13. A simplified theoretical circuit diagram of the heater-cathode insulation test circuit is shown in fig. 3. A source of 100 volts, which is rectified by the metal rectifier W_3, is applied across the heater and cathode of the valve under test, through the 0·5-megohm resistance R_9.

14. The D.C. flowing through R_{13} produces a potential across the grid of the magic eye indicator V_1. The value of this potential is controlled by the setting of R_{13}. With a short circuit from the valve heater to the cathode, the circuit resistance is approximately 1·75 megohm and this is designated 0 on the scale of R_{13}. The resistance R_{14} is made variable (pre-set adjustment), to cover variation in the sensitivity of the magic eye and is adjusted so that with the heater-cathode

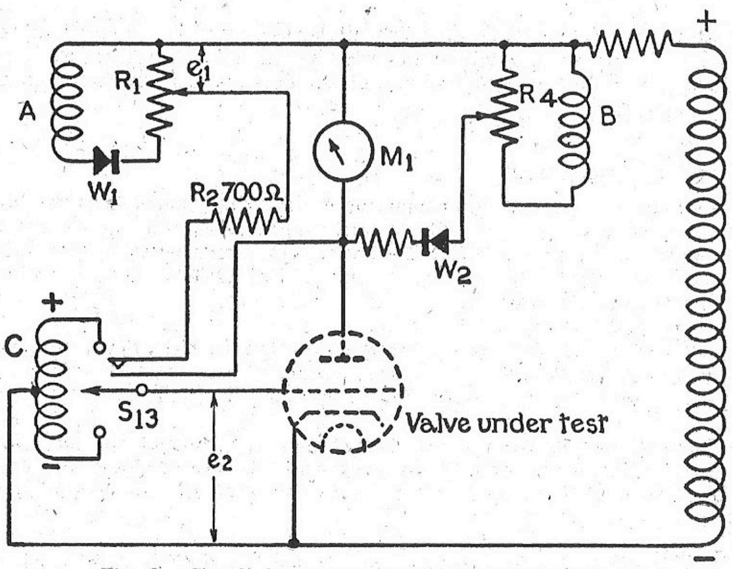

Fig. 2.—Circuit for measurement of mutual conductance

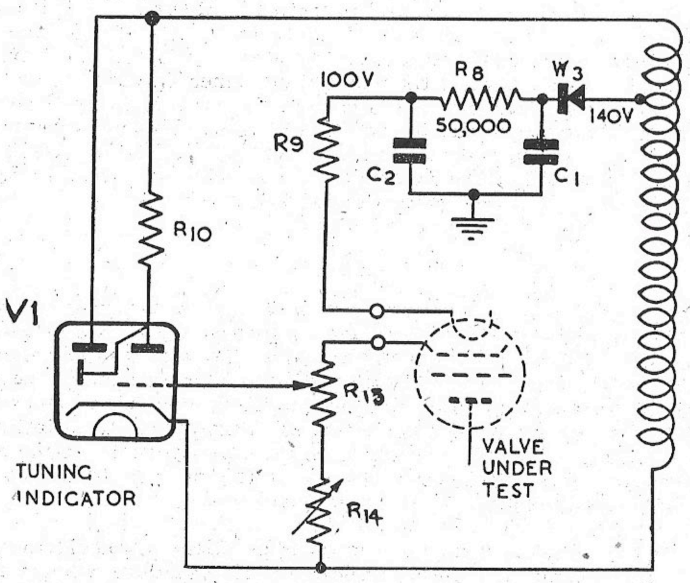

Fig. 3.—Cathode insulation test circuit

short-circuited, the dial reads zero. With higher values of heater-cathode resistance the current through R_{13} will be less, thus it will be necessary to increase the setting of R_{13} to obtain the same grid potential. This potential is chosen so as to just close the magic eye.

Switches and valve holders

15. The mutual conductance measurement circuit is connected to the anode of the valve under test by means of the switches S_{1A}, S_{1B}, and S_{1C}, as shown in fig. 4. The switches S_2 and S_3 select the anode and screen voltages respectively and S_{13} reverses the phase of the voltage (e_2 in fig. 2) which is applied from winding C to the control grid of the valve.

16. The heater-cathode test circuit is connected to the appropriate valve *via* the switches S_{1D} and S_{1E} and when this circuit is in use the switches S_{1A} to S_{1E} will be in position 5, thus open-circuiting the Gm circuit.

17. The switches S_7 to S_{11} introduce either the mutual conductance or cathode test insulation circuits to the appropriate valve holder; the correct combination of switch settings being given in the appendix at the end of this publication.

18. Switch S_{12} is so arranged to provide for the various combinations of heater pin connections met with in international octal valves.

CONSTRUCTIONAL DETAILS

19. This valve tester, of which an illustration is shown in fig. 1, is conventional in construction. It comprises two units mounted in a wooden case. The left-hand panel accommodates the mutual conductance and cathode-heater test circuits, associated switching, and the mains transformer T_1, which provides the test potentials for these circuits. The right-hand panel has mounted on it the various test valve holders and also the switches S_7 to S_{12}. These switches connect the required test circuit to the appropriate valve holder. The tapped filament transformer T_2 is mounted on the underside of the panel and the switches S_{6A} and S_{6B} apply the required filament voltage to the valve under test.

OPERATION

20. These operational instructions should be used in conjunction with the front panel illustration in fig. 1. Set the main adjusting switch S_4 to the correct voltage and connect the valve tester to the mains. The mains supply should be between 200 and 250 volts, 40 to 100 cycles. Switches for the anode, screen grid, control grid, suppressor grid and cathode are provided, to enable correct connection to be made to any of the valve holders fitted. The appropriate switch should be set, in accordance with the information given in the appendix, to the correct valve pins of the valve under test. Always set the switches to the positions listed in the Appendix before inserting the valve.

21. After having inserted the valve in the appropriate valve holder, a period of approximately one minute should be allowed to elapse before taking readings. This will allow the valve to reach stable operating conditions.

Mutual conductance test

22. (i) Set the filament switch $S_{6_{A-B}}$ to the heater voltage of the valve under test and set the selector switch S_{1a-e} to Gm 100mA.

(ii) If it is known that the emission of the valve to be tested is less than 10mA, the switch S_{1a-e} may be set to the Gm 10mA position.

(iii) Balance out the resulting meter reading by means of the balance control R_4. This adjustment should be carefully made and the meter pointer brought back to zero.

(iv) The key engraved PRESS FOR GM (S_{13}) should be pressed and the meter M_1 deflection balanced out by means of the pointer marked R_1, R_{13}. The reading given on this dial (outer scale) is the mutual conductance of the valve under test. Since the mutual conductance of the valve varies with the anode and screen voltages, ascertain that the test is made at the correct test voltage.

Heater-cathode insulation test

23. The heater-cathode insulation tests are effected as described below:—

(i) Set the selector switch (S_{1a-e}) to the position marked CATH. INS.

(ii) Slowly rotate the pointer R_1, R_{13} from zero, until the magic eye indicator V_1 just closes. This point should be carefully checked until experience is gained in operating this control.

The value indicated on the inner scale, by the pointer R_{13}, is the heater-cathode resistance in megohms. No change in the magic eye indication occurs if the pointed R_1, R_{13} is turned past the correct point and the correct position is when the magic eye just closes.

Rectifier and diode emission test

24. Rectifier and diode valves may be tested for emission as described below:—

(i) Set the selector switch S_{1a-e} to either the RECT or DIODE position.

(ii) The emission of the valve is then read directly from the meter M_1 scale. (20mA full scale for diodes and 200mA full scale for rectifiers.)

In full wave rectifiers the emission of each half is measured in turn by moving the anode switch S_7 to the appropriate valve pin.

25. A relay is connected in the anode and screen circuits to protect the instrument from damage through incorrect handling. This is interlocked with the main switch such that the relay cannot be reset without first switching off the supply. The action of turning the main switch to the "OFF" position operates a shutter: this reveals a knob for resetting the relay.

SERVICING

26. Apart from keeping the switch contacts clean and valve pins in good order, it is unlikely that any other form of servicing will be required. The switches are of the self-cleaning type and should not be interfered with unless they prove erratic in operation. If this occurs, they may be cleaned with a brush and if necessary reset to increase the contact pressure.

27. The magic eye indicator forms part of the measuring circuit for heater-cathode insulation and if it is necessary to renew it, the calibration should be checked. This is undertaken by short-circuiting the heater and cathode pins and rotating the pointer R_{13} to the point marked 0. At the rear of the panel will be found a variable resistance R_{14} with a saw cut across the spindle. This spindle should be adjusted until the eye just closes.

28 This adjustment may be checked by connecting a resistance across the heater and cathode pins of the magic eye tuning indicator and resetting the variable resistance if necessary so that the reading of the R_{13} scale when the magic eye just closes agrees with the value of the test resistance. If this method is used, it is advisable to measure the value of the resistance used for checking purposes as the tolerance allowed on small carbon units is sometimes large.

APPENDIX 1
Valve data and valve tester switch positions

Note.—A number of spaces have been left blank in the emission and mutual conductance columns, due to the figures being unobtainable. This information will be given when available.

Stores Ref. Section 10E	Valve Type No.	Base (see below)	Electrode switch positions: Anode	Grid (Grid 1)	Screen (Grid 2)	Sup'ressor (Grid 3)	Cathode	Filament Volts Setting	Anode Volts Setting	Screen Volts Setting	Emission (Diodes and Rectifiers) mA	Mutual conductance mA/v	Remarks
7846	VR19	B4	1	2	OFF	OFF	OFF	2·0	100	—	—	1·2	
7813	VT20	B4	1	2	OFF	OFF	OFF	2·0	100	—	—	2·0	
7738	VR21	B4	1	2	OFF	OFF	OFF	2·0	125	—	—	0·7	
7958	VR22	B4	1	2	OFF	OFF	OFF	2·0	125	—	—	2·9	
8062	VT23	B4	1	2	OFF	OFF	OFF	2·0	125	—	—	2·2	
521	VT23A	B4	1	2	OFF	OFF	OFF	2·0	125	—	—	2·2	
7312	VT25	L4	1	4	OFF	OFF	OFF	7·5	250	—	—	1·3	
8239	VR27	B4	1	2	OFF	OFF	OFF	2·0	125	—	—	0·7	
8399	VR28	B4	T.C.1	2	1	OFF	OFF	2·0	125	60	—	1·1	
9141	VR32	B7	7 3	1 2	OFF	OFF	OFF	2·0	100	—	—	1·1	Test each half separately
9779	VR35	B7	7 3	1 2	6	OFF	OFF	2·0	200	150	—	1·6	Test each half separately
9851	VW36	B4	1	2	OFF	OFF	OFF	2·0	125	—	—	2·9	
9598	VR37	B5	1	2	OFF	OFF	5	4·0	100	—	—	1·9	
9599	VR38	B5	1	2	OFF	OFF	5	4·0	100	—	—	1·7	
9600	VU39	B4	1 and 2	OFF	OFF	OFF	OFF	4·0	—	—	65	—	F.W. rectifier,
574	VU39A	B4	1 and 2	OFF	OFF	OFF	OFF	4·0	—	—	84	—	Test each half separately
9601	VR40	B4	1	2	OFF	OFF	OFF	4·0	100	—	—	5·4	
9049	VR41	B4	T.C.1	2	1	OFF	OFF	2·0	125	90	—	0·9	
10299	VW42	B4	1	2	OFF	OFF	OFF	2·0	125	—	—	0·7	
10542	VR44	B5	1	T.C.2	OFF	OFF	OFF	2·0	125	—	—	1·1	
10557	VT45	B4	1	2	OFF	OFF	OFF	2·0	100	—	—	2·1	
10558	VT46	B5	1	2	5	OFF	OFF	4·0	250	200	—	4·0	
10559	VT47	L4	1	4	OFF	OFF	OFF	6·3	250	—	—	2·0	
10585	VW48	B4	T.C.1	2	1	OFF	OFF	2·0	125	75	—	0·8	
10931	VR49	B7	T.C.1	2	7	3	OFF	2·0	125	60	—	0·9	

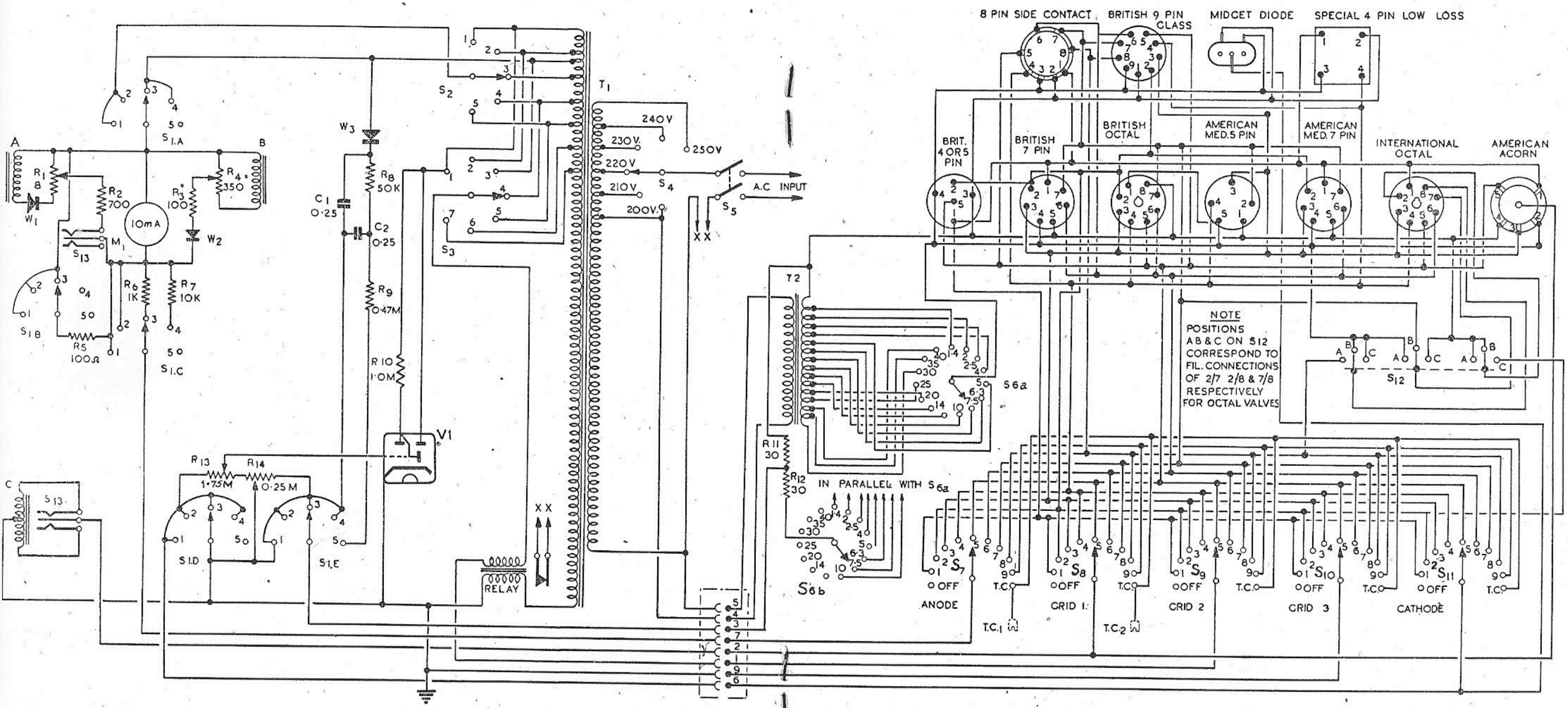

Fig. 4.—Valve tester, type 4A, circuit

Note.—The valveholders are shown as viewed from top of panel.