TESTERS, VALVE, AVO

TECHNICAL HANDBOOK - DATA SUMMARY

Note: *This regulation supersedes Tels Y 800, Issue 1, dated 20 Mar 50 and Tels Y 810, Issue 1, dated 4 Feb 54.*

TESTER, VALVE, AVO, NO 1

PURPOSE

To test standard British and American valves for emission, mutual conductance, heater continuity, cathode-heater insulation when hot and inter-electrode insulation when cold.

DESCRIPTION

The tester consists of a main unit and a subsidiary unit, connected together by a nine-core cable. The main unit contains the power supplies, selector switches and indicating meter. The subsidiary unit contains 12 types of valve holder, a rotary selector switch and an auto-transformer.

PHYSICAL DATA

	Main unit	Subsidiary unit
Weight:	13.1/2 lb (6.1kg)	4.1/2 lb (2.1kg)
Length:	10.1/4 in.	10.1/4 in.
Height:	5 in. overall	2.1/2 in. overall
Width:	8.1/4 in.	8.1/4 in.

PERFORMANCE

The voltages which can be applied to a valve under test are:-

Anode: from 12V in seven steps to 250V

Screen: from 60V in seven steps to 250V

Heater: from 2V in fourteen steps to 40V or from 0.28V to 5.6V

POWER REQUIREMENTS AND CONSUMPTION

200 - 250V, 50c/s single-phase, a.c. supply
Consumption 20VA approximately.

PART NUMBERS

Complete instrument	WY 0030
Tester	WY 0161
Valve panel	WY 0160

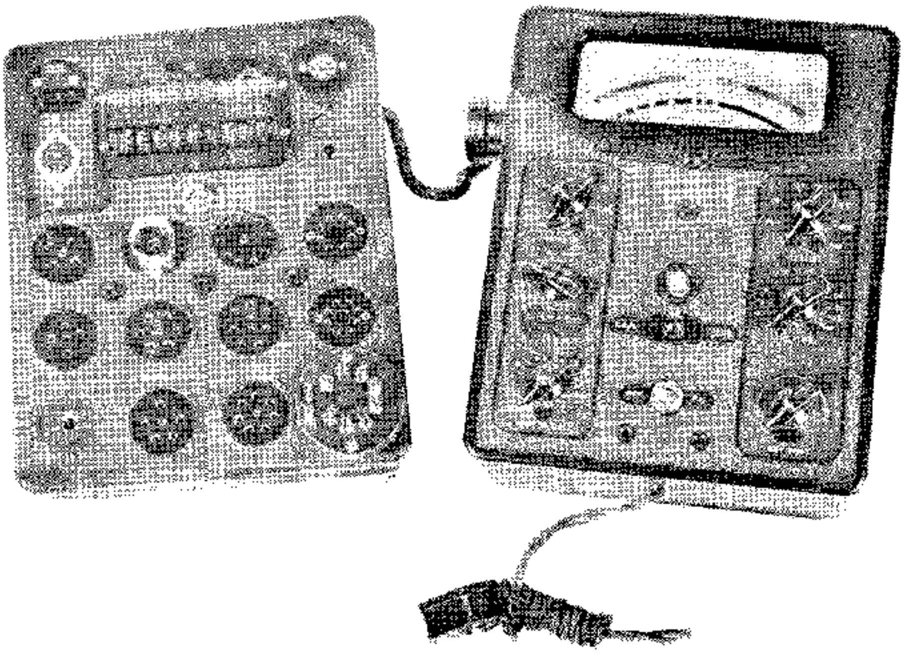

Fig 1 - Tester, valve, Avo, No 1

TESTER, VALVE, AVO, NO 3

PURPOSE

To test standard British and American valves under conditions corresponding precisely to any desired set of d.c. electrode voltages. Checks on inter-electrode insulation and heater continuity can be made with the valve cold or at working temperature.

DESCRIPTION

The tester is built into a case enabling any normal valve to be plugged into the valve holder panel and a variety of tests applied as detailed below. A polarised relay is incorporated which prevents damage to the instrument due to overloading the h.t. circuits. It will, in most cases, save the heater of a valve to which the h.t. or screen voltage has been inadvertently applied. Operation of the cut-out is shown by failure of the meter illumination. Heater voltages up to 126V are available.

PHYSICAL DATA

Weight:	34 lb (15.4kg)	Depth:	12.1/2 in.
Height:	18 in.	Width:	13 in.

APPLIED TESTS

Inter-electrode insulation and heater continuity:-

Faulty insulation between valve electrodes with heater hot or cold is shown on the resistance scale of the meter, the electrodes between which break down occurs being directly indicated.

Breakdown of cathode or filament to other electrodes.

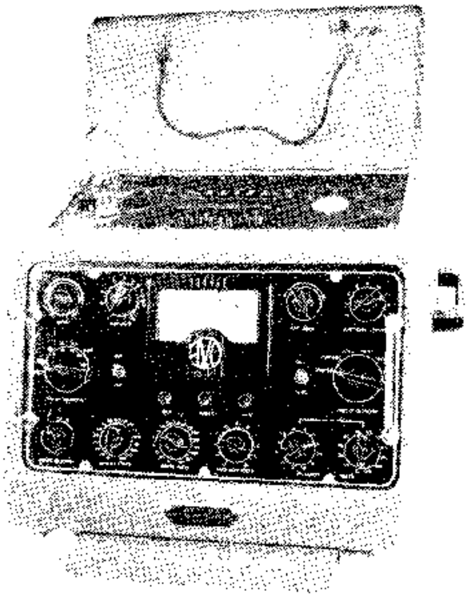

Fig 2 - Tester, valve, Avo No 3

Cathode/heater insulation:-

Cathode/heater insulation is measured with the heater hot.

Valve characteristics:-

The anode current of a valve can be measured at anode voltages from 20 to 400V, in sixteen steps, screen voltages from 20 to 300V, in sixteen steps, and with any value of negative grid bias to -100V. Complete Ia/Va, Ia/Vs, characteristics can therefore be drawn. Similar characteristics can be taken for screen current. Amplification factor and anode a.c. resistance may be derived. Direct measurement of mutual conductance in mA/V at any available electrode voltages. Mutual conductance comparison tests with the rated figure, on a coloured 'good/bad' scale. Press button 'gas' test-shows the presence of grid current, the value in μA being computed in terms of anode current change. Four meter ranges are provided, ie, 2.5mA, 10mA, 25mA and 100mA respectively, and similar ranges of mutual conductance in mA/V.

Rectifying valves:-

Tested under full load conditions with 8μF reservoir condenser. Current loads of 5mA, 15mA, 30mA, 60mA and 120mA are available for each anode, the efficiency of the rectifier at these load conditions being directly shown on a 'good/bad' scale. A d.c. load condition of 1mA is used when signal diodes are under test. A removable link in the anode circuit allows the use of external metering, the testing of valves under load conditions or the adaption of the equipment to test specialized, non-standard types of valve not catered for in normal circuit arrangements.

POWER SUPPLIES AND CONSUMPTION

Supplies: 100 - 130V) 50/60c/s
200 - 250V) single phase a.c.

Consumption: 60VA

VALVES

V1, CV 1078

PART NUMBERS

Instrument	Z4/ZD 00236
Equipment	Z4/ZD 00286

TESTER, VALVE, AVO, CT160

PURPOSE

To test standard British and American valves and valves of disc seal and flying lead types under conditions corresponding precisely to any desired set of d.c. electrode voltages. To give a rapid diagnosis of the conditions of a valve on a 'good/bad' basis.

DESCRIPTION

The instrument is housed in a robust metal suitcase. It is readily portable and showerproof. In the lower half, a metal panel is fitted on which is mounted the power supplies and the majority of the controls. The upper part, or lid, houses the valve holder panel and a rotary selector switch. A relay is incorporated which prevents damage to the instrument due to an inadvertent overload of the h.t. circuits. Both visual and audible warning is given when the 'cut-out' operates. Two eleven-position switches provide combinations of voltages for anode and screen electrodes, 20 - 400V for anode, 20 - 300V for screen. Variable bias from 0 - 40V and 32 heater voltages from 0.625V to 117V are available. The instrument is supplied with a mains input lead and two 14 inch 'wander' leads, for use with the nine-socket terminal board.

PHYSICAL DATA

Weight:	24 lb (10.89kg)	Depth:	11.1/2 in.
Height:	10 in.	Width:	15.1/2 in.

TEST APPLIED BY INSTRUMENT

Direct meter indication of heater continuity, insulation resistance between individual electrodes, with the valve cold, or between heater strapped to cathode and all the other electrodes strapped together, with the valve hot. Direct meter indication of cathode to heater insulation, with the valve hot. Direct indication of anode current and mutual conductance at predetermined combination of h.t. and g.b. voltages. Measurement of control grid current directly in µA.

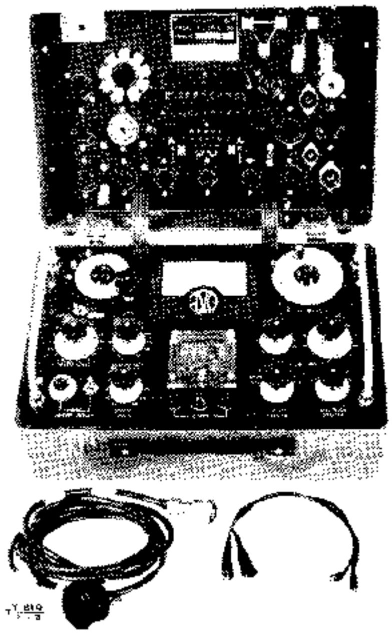

Fig 3 - Tester, valve, Avo - CT 160

Rectifiers, both half and full wave, tested under reservoir capacitor conditions and switched d.c. loads from 5mA to 120mA are available. A suitable d.c. load can also be selected for signal diodes on test. A coloured scale gives direct indication of valve 'goodness' when 'batch' testing. Valve characteristic curves can be drawn over a range of applied electrode voltages, and data thus determined. By the use of the removable links in the anode circuits of the instrument, valves can be tested under load conditions. In the same way external metering can be used to read the required anode currents or the instrument adapted for making tests on specialized, non-standard types of valve not catered for in normal circuit arrangements.

POWER REQUIREMENTS

105 - 120V)
175 - 250V) 50 - 500c/s a.c. single phase

Adjustments can be made every 5V.

POWER CONSUMPTION

50VA (maximum)

VALVES

V1, V2 CV 140

PART NO

ZD 02172

TESTERS, VALVE, AVO

TECHNICAL HANDBOOK—OPERATOR'S INSTRUCTIONS

This regulation supersedes Tels Y 801, Issue 3, dated 12 Feb 47

SUBJECT INDEX

Distribution—Class 930. Code No. 6

Subject Index—(contd) *Paras*

TESTER, VALVE, AVO, CT 160

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INTRODUCTION

1. The operator's instructions for the Testers, valve, Avo as detailed in this regulation enable general purpose Service valves and British and American valve types to be tested for serviceability. Testing is carried out by simulating the necessary d.c. test conditions and the true mutual conductance figures produced by application of a.c. voltages of suitable amplitude to all electrodes. A comprehensive table listing selector switch settings, test voltages and characteristics will be found at the end of this regulation (Table 6).

2. It should be noted that the capabilities of all the testers are not identical and the capability of any one tester will be found in the relevant section of this regulation.

3. It should also be noted that the instrument test results are not necessarily conclusive. For example, few circuit stages are of such critical design that a large percentage change, either in the slope of the valve, or its anode current cannot be tolerated. On the other hand, the fundamental characteristics of a valve may be found to be correct but when the valve is used in a particular circuit stage it may not perform in a satisfactory manner, eg an a.f. output pentode that is microphonic or an r.f. pentode that is noisy. Such defects can only be found by testing the valve in its correct stage in the particular equipment for which it is needed.

4. It is essential to read paras 5-19 before reading the instructions applicable to any one tester, as these paras are general instructions applicable to all testers. A full technical description of these testers will be found in Tels Y 812, Parts 1 and 2 of this regulation.

GENERAL

SETTING-UP VALVE TEST CIRCUITS—ALL TESTERS

5. Prior to the insertion of the valve to be tested, it is *essential* to determine the settings of the ROLLER SELECTOR switch to ensure the connection of the electrodes to their correct circuits and supplies. This information is detailed in Table 6 of this regulation. In addition, Table 7 will give the Service type equivalent of civilian type valves.

6. From Table 6 determine the pin basing connections for the valve in order of their standard numbering. Rotate the rollers of the SELECTOR SWITCH until the correct combination appears in the escutcheon windows, ie corresponding to the combination already determined from the table. For example, consider the Service type CV 138, an indirectly heated miniature h.f. pentode. This valve has a B7G base. For this valve, the left to right ROLLER SELECTOR switch settings are:—

4 1 2 3 6 1 5 0 0

7. Rotation of the nine switch rollers to bring the above numbers in the escutcheon windows, in the order left to right, provides the connections for the valve electrodes to their correct circuits. The method is illustrated in Fig 1. It will be seen that the valve grid, which is terminated at pin number 1 of the B7G base, is connected to circuit number 4 of the instrument, and so on for other electrodes.

8. For valves with electrodes brought out to a top cap or side terminal connection, the electrode such as a grid or anode is connected to the appropriate test circuit by means of a jumper lead provided with each instrument, to be plugged into the correct socket situated on the valve holder panel of the instrument. The number of sockets varies with each instrument and they are detailed as follows:—

Tester, valve, Avo, No 1	*Tester, valve, Avo, No 3*	*Tester, valve, Avo, CT 160*
G1—Circuit No 4	G1—Circuit No 4	C —Circuit No 1
S —Circuit No 5	S —Circuit No 5	H—Circuit No 2
A1—Circuit No 6	A1—Circuit No 6	H—Circuit No 3
	A2—Circuit No 7	G1 —Circuit No 4
	D1—Circuit No 8	S —Circuit No 5
		A1 —Circuit No 6
		A2 —Circuit No 7
		D1 —Circuit No 8
		D2 —Circuit No 9

VALVE TO BE TESTED	CV 138
COMMERCIAL EQUIVALENT	EF91
VALVE BASE TYPE	B7G
ROLLER SELECTOR SWITCH SETTING	412361500
FILAMENT VOLTS	6·0
NEG GRID VOLTS	2·0
ANODE VOLTS	250
SCREEN VOLTS	250

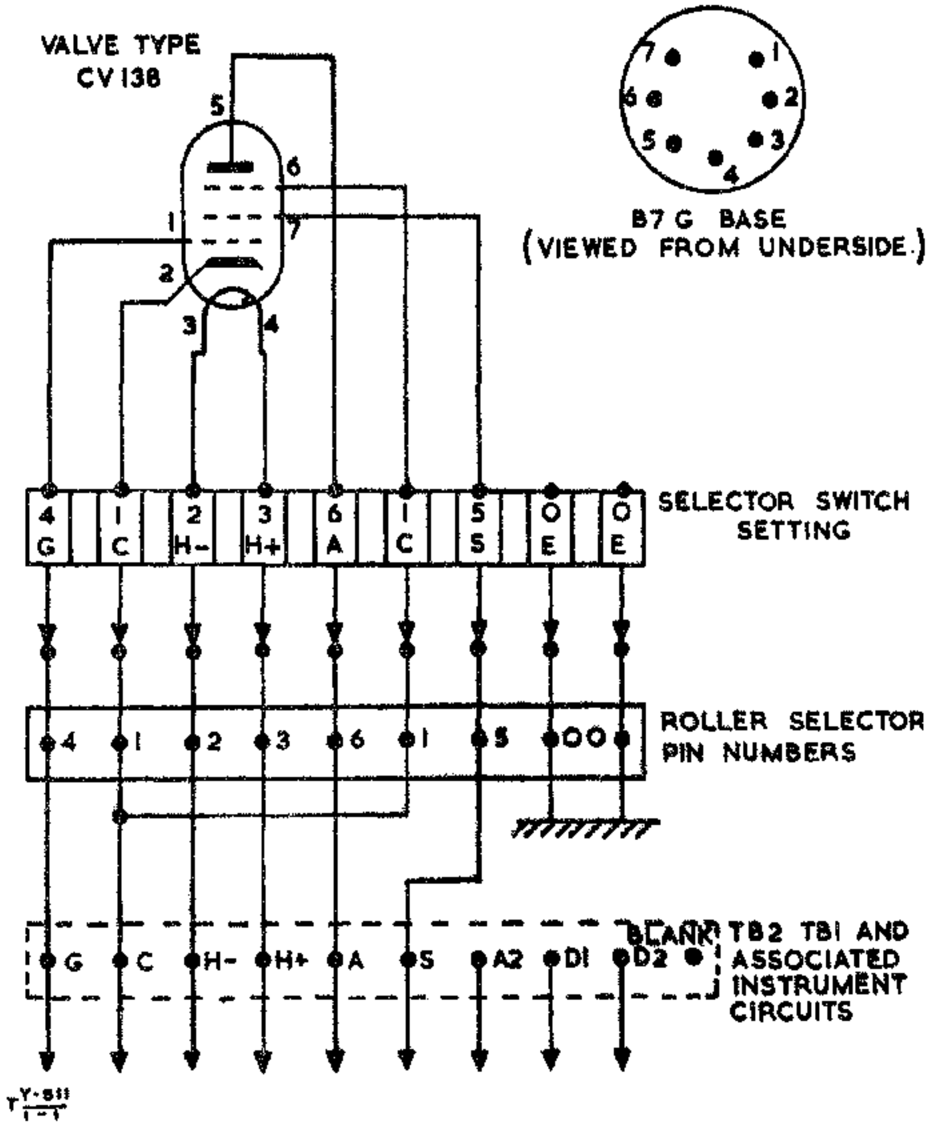

Fig 1—Method of setting-up test circuits

USE OF VALVE TESTING DATA CONTAINED IN TABLE 6

9. The function of a valve is indicated in Table 6 by a symbol in the form of letters in the TYPE column at the extreme right of the test data. The following coding is used:—

D	—Diode	DT	—Diode-triode
DD	—Double-diode	DDT	—Double-diode triode
DDD	—Triple-diode	DDDT	—Triple-diode triode
DP	—Diode-pentode	TH	—Triode-hexode
DDP	—Double-diode pentode	TP	—Triode-pentode
		H	—Hexode or heptode
P	—Pentode	O	—Octode
PP	—Double-pentode	R	—Half-wave rectifier
T	—Triode	RR	—Full-wave rectifier
TT	—Double-triode	CCR	—Cold cathode rectifier
TI	—Tuning indicator		

10. On each instrument there is a combination of switches to enable multiple valves to be tested. The basic methods only are outlined here, but detailed instructions are given later in this regulation.

11. The various switching combinations enable mutual conductance, and in the case of Tester, valve, Avo, No 3 and CT 160, the anode current, to be indicated on the meter. These readings are relevant either to the anode connected by the ROLLER SELECTOR switch to circuit 6 as denoted by the roller setting $\frac{6}{A_1}$, or to circuit 7 as denoted by $\frac{7}{A_2}$.

12. With all instruments, switching combinations will allow rectifiers and signal diodes to be tested. In the case of the Tester, No 1 the cathode current is measured with a fixed anode voltage and no external resistance whilst with the other testers the valves are tested 'on load'.

13. It should be noted that no complication exists in metering the majority of multiple valves such as double-diode triodes, double-triodes and double-pentodes. The ROLLER SELECTOR switch settings provide the key to the electrode arrangement, and thus the various valve systems can be metered individually.

14. The system can be summerized by an example. Consider the Service valve type CV 1428. Reference to Table 6 shows this to be a double-diode triode, coding DDT. The ROLLER SELECTOR switch setting is:—

0	2	3	1	8	9	0	6	0
E	H−	H+	C	D_1	D_2	E	A_1	E

The grid has a top cap connection. The triode element can be dealt with in a normal manner and the diode elements subsequently tested by using the anode selector switch.

15. In the case of triple-diodes, since only two anode systems are catered for in the instruments, a special procedure must be adopted. Table 6 provides the ROLLER SELECTOR switch settings, in which the third anode is represented by the symbol †. The valve should be tested normally with the ROLLER SELECTOR switch at $\frac{O}{E}$ for the † symbol. This test provides emission figures for diodes 1 and 2. For the third diode, the ROLLER SELECTOR switch should be reset so that diodes 1 and 2 are set to $\frac{O}{E}$ and the third diode denoted by the symbol † is set to $\frac{8}{D_1}$. Then the emission of the third diode can be tested.

Example: Valve, type AAB1

Selector setting 0 2 3 1 † 0 9 8 0

Selector setting for diode 1 and 2 tests:—

0	2	3	1	0	0	9	8	0
E	H−	H+	C	E	E	D_2	D_1	E

Selector setting for diode 3 test:—

0	2	3	1	8	0	0	0	0
E	H−	H+	C	D_1	E	E	E	E

FREQUENCY CHANGER TESTING

16. Heptodes and hexodes should be set-up on the instrument and tested as an h.f. pentode. Anode current and mutual conductance figures are provided in Table 6. In fact, a substitution test is the only true test of the serviceability of these valves.

17. An octode type can be tested as though it had two separate electrode assemblies.

18. The sections of a triode-hexode are not interdependent and they can be tested in two separate sections as a triode and pentode respectively. This arrangement is effected in the ROLLER SELECTOR switch settings.

EMISSION CHECK

19. An indication of failing emission in a valve can be obtained by reducing the heater voltage by 10 to 15% for a short period and noting the corresponding percentage change in anode current. In the case of a valve with failing emission this will result in an excessive decrease in the anode current, considerably greater than the percentage decrease in heater voltage. Such a result would indicate that the valve would not oscillate very satisfactorily and this test is particularly useful for valves or sections of valves required for use as oscillators.

TESTER, VALVE, AVO, No 1

GENERAL

20. The chief disadvantage of this instrument is that it is not possible to apply grid-bias to the valve being tested and consequently errors may arise due to grid current loading of the grid supply which is likely to vary between different valves of the same type.

21. Some high slope valves go into oscillation on the slope test and this may be recognized by a slight unsteadiness of the meter needle. This condition may usually be cured by connecting a small capacitor (say 0·001μF) between the grid and cathode pins of the valve.

Capabilities

22. General purpose diodes, triodes, tetrodes and pentodes can be tested in the normal manner and sections of multi-assembly valve types such as double-diode triodes and hexodes, etc, can be tested in sequence.

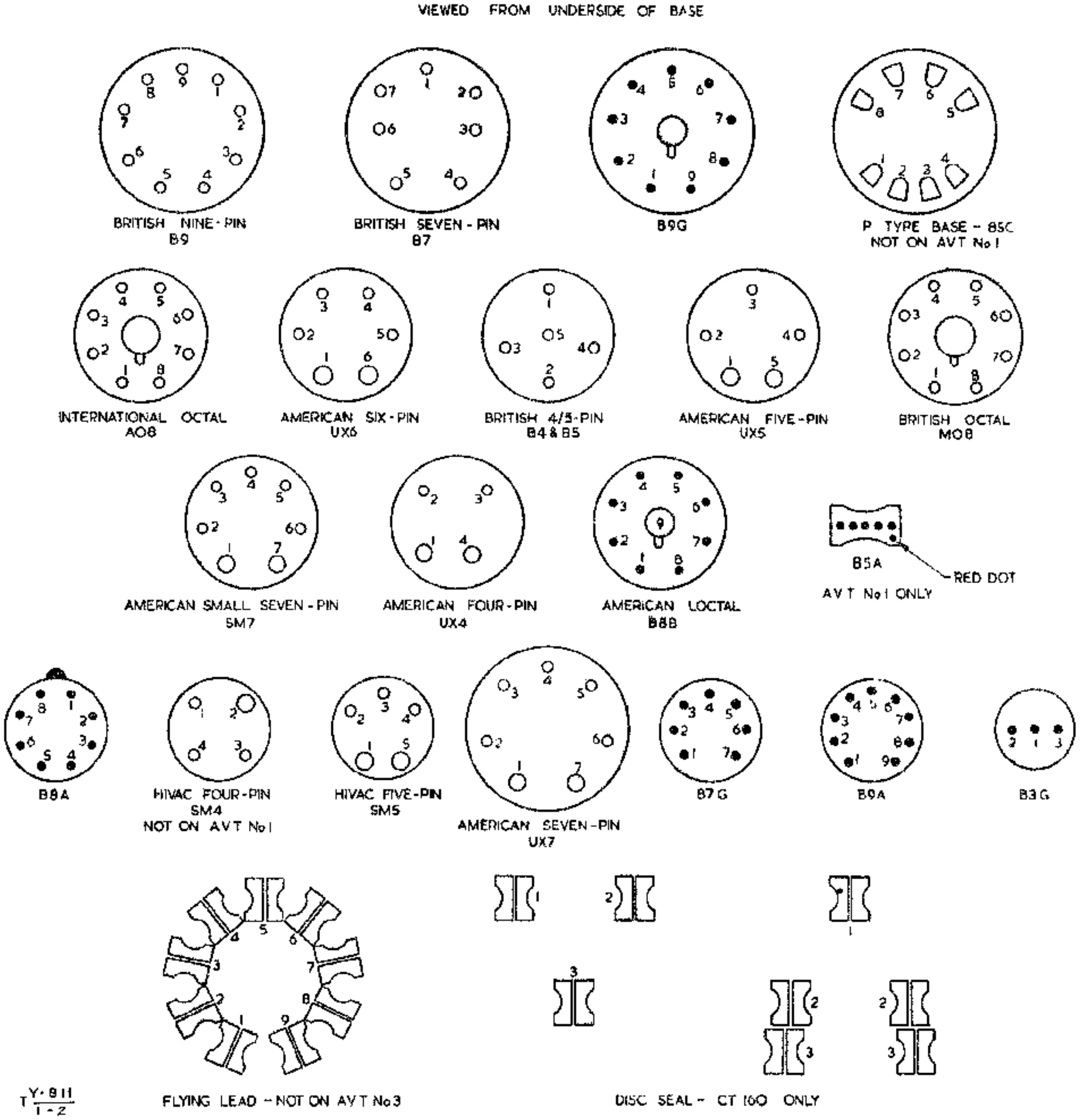

Fig 2—Valve pin connections

23. The full test facilities are detailed below:—

(*a*) Heater continuity

(*b*) Cathode to heater insulation (valve hot).

(*c*) Inter-electrode insulation (valve cold) by comparison tests using the glow of a neon lamp.

(*d*) Mutual conductance directly in mA/V.

(*e*) The indication of comparative 'goodness' on the basis of mutual conductance reading.

(*f*) Anode current of rectifiers to a maximum of 100mA.

(*g*) Signal diode current up to 10mA.

24. Valveholders are provided for valves with the following bases and the numbering of pin connections is given in Fig 2:

British 4/5-pin	B4 and B5
British 7-pin	B7
British octal	MO8
British 9-pin	B9
American 4-pin	UX4
American 5-pin	UX5
American 6-pin	UX6
American 7-pin	UX7
American small 7-pin	SM7
International octal	AO8

B9G, B7G, B9A, B3G, B8A, B5A, B5B — These valve bases have been added to the original instrument by modification action

Controls

25. A list of controls and their functions is shown in Table 3.

Power requirements

26. The instrument may be operated from the following a.c. supplies:—

200-250 volts 50 or 60c/s

The power consumption is approx 20VA.

General precautions

27. *Do not* insert a valve until the correct valve pin connections have been established as detailed in paras 5-8.

28. The key switch should not be moved from its central position until the inter-electrode insulation has been checked as detailed in paras 33 and 34, and the filament, screen and anode voltages have been set to the values appropriate to the valve under test.

29. Particular care is needed in the setting-up of the FILAMENT VOLTS selector switch and the NORMAL ÷ BY 7 switch before the valve is inserted in the valveholder. *Nothing can save the heater from being burnt out* if excessive voltage is applied by the wrong setting of these switches. Hence it is good practice to return FILAMENT VOLTS to zero and the NORMAL ÷ BY 7 switch to NORMAL after a test has been applied and before a new valve is inserted, except of course, when testing a batch of valves.

Initial setting-up for use

30. Remove the disc plate from the underside of the main unit and adjust the mains input to the correct tapping.

31. In the 3-core mains lead the red and black leads are line and neutral respectively and the earth lead is green or yellow.

INITIAL VALVE TESTS

Heater continuity test—all valves

32. (*a*) Plug two flexible leads into the sockets below the ON/OFF switch.
   (*b*) Switch ON. (The neon lamp should not glow.)
   (*c*) Touch the ends of the leads together to check that the instrument is working. The neon lamp should glow.
   (*d*) Apply leads to heater pins, the neon lamp will serve as a continuity indicator.

N.B.—In making this test hold the leads by their insulated parts to prevent leakage through the body falsifying the result.

Insulation test—all hard valves

Inter-electrode insulation—valve cold

33. Using the flexible leads as in para 32, connect them to every possible combination of two pins on the valve base between which reference to Table 6 shows no direct connection. The neon lamp serves as a short-circuit indicator and the brighter it glows, the lower the resistance between the probes. If the lamp glows on any pair of contacts other than the heater or filament pins, the valve is unserviceable and no further test need be made. *The tests detailed in paras 32 and 33 must be carried out before proceeding further.*

Setting-up valve test voltages

34. From details given in Table 6 set up ROLLER SELECTOR switch, paras 5-8 refer, and all voltage controls. The setting of the voltage controls applies to all subsequent tests unless otherwise detailed.

Insulation test—Indirectly heated valves

Cathode to heater insulation test—valve hot

35. (*a*) Set the SET MA/V control to 100.
   (*b*) In the case of a pentode set SCREEN volts to 60.
   (*c*) Insert valve and after allowing time for it to warm up, turn the SET ZERO control anti-clockwise until meter reads zero.
   (*d*) Press the key switch to the right (to the C. INS. position) and the heater/cathode insulation resistance may be read off directly on the lower black scale.

MUTUAL CONDUCTANCE TESTS

Direct reading

Triodes, tetrodes, pentodes and heptodes

36. (*a*) Set SELECT ANODE to NORMAL.
   (*b*) Check the settings of the ROLLER SELECTOR switch and all voltage controls, para 34 refers.
   (*c*) Set MA/V control to 100.
   (*d*) Set the SET ZERO control fully clockwise.
   (*e*) If the mutual conductance is expected to be below 10mA/V turn the SET MA/V control to MA/V and zero accurately by means of SET ZERO control.
   (*f*) Press the key switch to the left (to the MA/V position) and the reading on the meter will be directly in mA/V.
   (*g*) If the mutual conductance is expected to be above 10mA/V then set the MA/V control to 100 and zero accurately by means of the SET ZERO control.
   (*h*) Press the key switch to the left (to the MA/V position) and the reading on the meter should be multiplied by ten to give the correct value of mutual conductance.

Double-triodes, double-tetrodes and double-pentodes

37. (*a*) For these valves only one set of figures is given in Table 6. These figures are applicable to each half of the valve.
   (*b*) To test one half of the valve proceed as for para 36 (*a*) to (*h*).
   (*c*) Set SELECT ANODE to A_2.
   (*d*) To test the other half of the valve proceed as for para 36 (*b*) to (*h*).

Triode-pentodes, triode-hexodes, triode-heptodes and octodes

38. (*a*) For these valves two sets of figures are given in Table 6.
   (*b*) Using the first set of figures proceed as for para 36 (*a*) to (*h*).

(c) Set SELECT ANODE to A_2.

(d) Using the second set of figures proceed as for para 36 (b) to (h).

Comparative reading

Triodes, tetrodes, pentodes and heptodes

39. (a) Set SELECT ANODE to NORMAL.

(b) Check the settings of the ROLLER SELECTOR switch and all voltage controls, para 34 refers.

(c) Set the SET MA/V control to the value given in Table 6 for the valve being tested.

(d) Rotate the SET ZERO control until the meter indicates zero.

(e) Press the key switch to the left (MA/V position) and all valves can be regarded as satisfactory if the meter needle lies within the green band on the scale.

Double-triodes, double-tetrodes and double-pentodes

40. (a) For these valves only one set of figures is given in Table 6. These figures are applicable to each half of the valve.

(b) To test one half of the valve proceed as for para 39 (a) to (e).

(c) Set SELECT ANODE to A_2.

(d) To test the other half of the valve proceed as for para 39 (b) to (e).

Triode-pentodes, triode-hexodes, triode-heptodes and octodes

41. (a) For these valves two sets of figures are given in Table 6.

(b) Using the first set of figures proceed as for para 39 (a) to (e).

(c) Set SELECT ANODE to A_2.

(d) Using the second set of figures proceed as for para 39 (b) to (e).

RECTIFIER AND DIODE TESTING

Half-wave rectifier

42. (a) Set ANODE volts to REC.

(b) Set SELECT ANODE to D1.

(c) Set the SET MA/V control to 100.

(d) Turn the SET ZERO control fully clockwise.

(e) Switch ON. The indicated meter reading is the current passed by the rectifier, full scale deflection representing 100mA.

Full-wave rectifier

43. (a) Set anode volts to REC.

(b) Set SELECT ANODE to D1.

(c) Set the SET MA/V control to 100.

(d) Turn the SET ZERO control fully clockwise.

(e) Switch ON. The indicated meter reading is the current passed by one half of the rectifier, full scale deflection representing 100mA.

(f) To test the other half of the valve set SELECT ANODE to D2, and repeat as for D1.

Signal diodes and diode sections of multiple valves

44. (a) Set ANODE volts to D.

(b) Set SELECT ANODE to D1.

(c) Set the SET MA/V control to MA/V.

(d) Turn the SET ZERO control fully clockwise.

(e) Switch ON. The indicated meter reading is the anode current of the valve, full scale deflection representing 10mA.

(f) Should the valve be a double-diode, the other half is tested by setting the SELECT ANODE to D2, and repeating as for D1.

TESTER, VALVE, AVO, No 3

GENERAL

Capabilities

45. General purpose diodes, triodes, tetrodes and pentodes can be tested in the normal manner, and sections of the multi-assembly valve types such as double-diode triodes, and hexodes etc can be tested in sequence.

46. The full test facilities are detailed below:—

(a) Heater continuity.

(b) Cathode to heater insulation (valve hot or cold).

(c) Inter-electrode insulation (valve hot or cold) up to 10·0MΩ.

(d) Anode or screen currents (100mA max).

(e) Gas current.

(f) Mutual conductance directly in mA/V.

(g) The indication of comparative valve 'goodness' on the basis of mutual conductance reading.

(h) Rectifier output with loadings variable between 5 and 120mA.

(j) Signal-diode output with d.c. loading up to 1mA.

(k) Mutual characteristics plotting.

47. Valveholders are provided for valves with the following bases, and the numbering of the pin connections is given in Fig 2:—

British 4/5-pin	B4 and B5
British 7-pin	B7
British octal	MO8
British 9-pin	B9
American 4-pin	UX4
American 5-pin	UX5
American 6-pin	UX6
American 7-pin	UX7
American small 7-pin	SM7
American loctal	B8B
Hivac 4-pin	SM4
Hivac 5-pin	SM5
International octal	AO8
P. type base 8-pin, side contact	8SC

Miniature 3-pin	B3G
Miniature 7-pin	B7G
Phillips 8-pin locking	B8A
Miniature 9-pin	B9A or noval
All glass 9-pin	B9G

To cover the introduction of new valve bases, a plug-in adaptor is provided with the instrument which enables non-standard valveholders to be adapted and plugged into a suitable base on the valveholder panel.

Controls

48. A list of controls and their functions is given in Table 4.

Power requirements

49. The instrument may be operated from the following a.c. supplies:—

95V-125V }
185V-255V } 50 or 60c/s

The power consumption is approximately 60VA.

General precautions

50. *Do not* insert a valve until the correct valve pin connections have been established as detailed in paras 5-8.

51. THE CIRCUIT SELECTOR switch must not be moved from the CHECK (C) position until the filament, grid, screen and anode voltages have been set to the values appropriate to the valve under test.

52. Particular care is needed in the setting-up of the FILAMENT VOLTS selector switches before the valve to be tested is inserted in the valveholder. *Nothing can save the heater from being burnt out* if excessive voltage is applied by the wrong setting-up of these switches. Hence it is good practice to return all voltage selector switches, especially the FILAMENT VOLTS, to zero after a test has been applied and before a new valve is inserted, except of course when testing a batch of identical valves.

53. Valves should be tested for inter-electrode insulation *before* the CIRCUIT SELECTOR switch is moved to position TEST.

54. The safety cut-out prevents damage to the transformers in the event of the h.t. supplies being short-circuited, but it does *not protect the meter movement against heavy d.c. currents* occurring in the valve anode or screen circuits. Where any doubt exists as to the probable value of the electrode current likely to be passed the METER SELECTOR switch (SG) should be set to the highest current range and the range subsequently reduced according to the value of the current passing.

55. Do not apply test voltages to a valve without ensuring that where necessary the top cap or side terminal connections have been correctly made. Furthermore, where the jumper lead termination is not of the shrouded type, particular care should be taken to ensure that it is not left lying on the valveholder panel when connected to one of the voltage supply sockets as there is a danger of it shorting to frame.

Initial setting-up for use

56. Check the coarse mains input transformer link LK1, situated at the rear of the instrument, for the setting appropriate to the normal mains voltage of the workshops supply.

57. Connect the mains lead to the supply. Red and black leads are line and neutral respectively, and the green or yellow the earth connection.

58. Check that 2·5A cartridge fuse is fitted in the holder at the rear of the instrument.

59. Ensure that the anode circuit link LK2 at the rear of the instrument is in circuit.

60. Switch on and operate RESET switch SL; the meter scale should then be illuminated.

INITIAL VALVE TESTS

Mains input fine adjustment

61. This adjustment is important as it establishes the correct electrode voltages for the calibrated controls. It should be carried out each time the tester is used and the setting checked at intervals if the instrument is in continuous use for a long period of time.

62. Turn the CIRCUIT SELECTOR to the CHECK (C) position and the ELECTRODE LEAKAGE switch to position ~. The meter needle should now rise and assume a position near the black region of the insulation scale denoting zero ohms. Rotate the SET ~ until the meter needle assumes its nearest point to the red line in the middle of the black scale marking. With a correct setting of the initial mains voltage adjustment, rotation of the SET ~ control should enable the needle to be moved either side of the red line. If this cannot be achieved, then the mains tapping link LK1 should be moved to the next appropriate tapping, ie the higher tapping if the needle is to the right of the marker, and the lower tapping if to the left.

Setting-up valve test voltages

63. (*a*) From the details given in Table 6 set up the ROLLER SELECTOR switch, paras 5-8 refer, and all voltage controls with the instrument switched off. The setting of the voltage controls applies to all subsequent tests unless otherwise detailed.
(*b*) Insert valve.
(*c*) Switch on and operate RESET button.
(*d*) The insulation tests as detailed in paras 64-67 must be carried out prior to mutual conductance testing.

Heater continuity test—all valves

64. (*a*) Set CIRCUIT SELECTOR switch to CHECK (C).
(*b*) Set ELECTRODE LEAKAGE switch to H.
(*c*) Heater continuity is indicated on the meter by deflection of the pointer to the SHORT marker.

Insulation test—all valves

Inter-electrode insulation—valve cold

65. (*a*) Set CIRCUIT SELECTOR switch to CHECK (C)
(*b*) Rotate ELECTRODE LEAKAGE switch through its various electrode positions without moving the CIRCUIT SELECTOR switch from its position CHECK (C).
(*c*) Thereafter any meter reading will show an electrode insulation breakdown corresponding to the electrode indicated by the ELECTRODE LEAKAGE switch setting. It should be noted that wherever electrode leakage occurs an indication will be seen at two positions of the ELECTRODE LEAKAGE switch.

For example, if the anode to screen cold insulation is down at 2·0MΩ, this leakage figure will be indicated by the meter at two positions, namely S and A1.

Insulation test—valve hot

66. (*a*) Set CIRCUIT SELECTOR switch to CHECK (H).

(*b*) In this position the cathode and heaters are strapped together and the remaining electrodes are strapped to each other. After allowing half a minute for the valve to warm up, any meter deflection indicates a leakage between cathode and heater strapped and all other electrodes.

Insulation test—indirectly heated valves

Cathode to heater insulation test

67. (*a*) Set CIRCUIT SELECTOR switch to C/H INS.

(*b*) A deflection on the meter indicates leakage between heater and cathode with valve hot.

Anode and screen currents

68. The following procedure with appropriate settings of the ROLLER SELECTOR and ANODE SELECTOR switches is applicable to all valves with the exception of those dealt with in paras 81-86.

69. (*a*) Check the settings of the anode, screen and grid voltage control switches.

(*b*) Set the METER SELECTOR switch to the 100mA meter range.

(*c*) Rotate the SET ZERO control fully clockwise.

(*d*) Set CIRCUIT SELECTOR switch to TEST.

(*e*) Set the ANODE SELECTOR switch to the electrode for which the current reading is required, ie A1 or A2 for the anode and S for the screen current.

(*f*) Reduce the current range setting if required by means of the METER SELECTOR switch. The meter indicates directly the anode or screen current.

(*g*) If the cut-out operates during this test, as will be shown by the meter lamps going out, *do not* operate the cut-out RESET button until the settings of the ROLLER selector switch and the electrode voltage controls have been checked. If these are correct then the valve is probably 'soft'.

MUTUAL CONDUCTANCE TESTS

Direct reading

Triodes, tetrodes, pentodes and heptodes

70. (*a*) Set the ANODE SELECTOR switch to A1.

(*b*) Check the settings of the ROLLER SELECTOR switch and voltage controls, para 63 refers.

(*c*) Set CIRCUIT SELECTOR switch to TEST.

(*d*) Ensure that the METER SELECTOR switch is set to the appropriate range for the valve anode current.

(*e*) Zero the meter reading by rotation of the SET ZERO control.

(*f*) Press the mA/V button. The indicated meter reading is the direct reading of mutual conductance in mA/V.

Double-triodes, double-tetrodes and double-pentodes

71. (*a*) For these valves only one set of figures is given in Table 6. These figures are applicable for each section of the valve.

(*b*) To test one section proceed as for para 70 (*a*) to (*f*).

(*c*) To test the other section set ANODE SELECTOR switch to A2.

(*d*) Repeat para 70 (*e*) and (*f*).

Triode-pentodes, triode-hexodes, triode-heptodes and octodes

72. (*a*) For these valves two sets of figures are given in Table 6.

(*b*) Using the first set of figures proceed as for para 70 (*a*) to (*f*).

(*c*) Set ANODE SELECTOR switch to A2.

(*d*) Using the second set of figures proceed as for para 70 (*b*) to (*f*).

Comparative testing

Triodes, tetrodes, pentodes and heptodes

73. (*a*) Set ANODE SELECTOR switch to A1.

(*b*) Check the settings of the ROLLER SELECTOR switch and all voltage controls, para 63 refers.

(*c*) Set CIRCUIT SELECTOR switch to TEST.

(*d*) Zero the meter reading by rotation of the SET ZERO control.

(*e*) Set METER SELECTOR switch to position mA/V.

(*f*) Rotate SET mA/V control to the value given in Table 6 for the mutual conductance of the valve.

(*g*) Press the mA/V button. All valves may be regarded as satisfactory if the meter needle lies within the green band on the scale.

Double-triodes, double-tetrodes and double-pentodes

74. (*a*) For these valves only one set of figures is given in Table 6. These figures are applicable to both sections of the valve.

(*b*) To test one section of the valve proceed as for para 73 (*a*) to (*g*).

(*c*) To test the other section set the ANODE SELECTOR switch to A2.

(*d*) Proceed as for para 73 (*b*) to (*g*).

Triode-pentodes, triode-hexodes, triode-heptodes and octodes

75. (*a*) For these valves two sets of figures are given in Table 6.

(*b*) Using the first set of figures proceed as for para 73 (*a*) to (*g*).

(*c*) Set ANODE SELECTOR switch to A2.

(*d*) Using the second set of figures proceed as for para 73 (*b*) to (*g*).

GRID CURRENT TEST

Method

76. (*a*) Set CIRCUIT SELECTOR switch to TEST.

(*b*) Set ANODE SELECTOR switch to appropriate position for the valve or valve section under test.

(c) Set METER SELECTOR switch to the appropriate range for the anode current of the valve or valve section under test.

(d) Reduce the standing anode current to zero by anti-clockwise rotation of the SET ZERO control and set METER SELECTOR switch to give the most sensitive current range of the meter.

(e) Press the GAS button and note the change of anode current.

77. The value of grid current flowing will then be given by:—

$$Ig(\mu A) = \frac{dIa \times 10}{g}$$

Where dIa is the anode current change and g is the mutual conductance in mA/V. The direction of anode current change will denote the nature of the grid current flowing.

Ig should not exceed 5μA.

78. It should be noted that with valves operated about zero bias, positive grid current may flow, as will be indicated in a change of anode current in the backward direction due to the polarity change of the voltage developed across the grid resistor. This change can be observed by establishing a false zero on the meter using the SET ZERO control, and the value of positive grid current calculated as in para 77.

PLOTTING OF MUTUAL CHARACTERISTICS

Static

79. When more comprehensive tests of a valve are required, static mutual characteristic curves may be plotted with this instrument with the CIRCUIT SELECTOR switch in position TEST. For example, Ia/Vg curves can be taken at fixed settings of anode and screen voltages, the readings of anode current being plotted against settings of the grid bias control.

Dynamic

80. By removing the anode link LK2, situated at the rear of the instrument and inserting a suitable load, dynamic characteristic curves may be obtained in a similar manner to that outlined for static curves, in para 79.

RECTIFIER AND DIODE TESTING

81. The setting-up and initial tests for insulation, etc as already described for other valve types should be carried out prior to making the following load tests, paras 64-67 refer.

Half-wave rectifiers

82. (a) Set the METER SELECTOR switch to a load current range appropriate to the valve. This load current setting can be determined from the valve data in Table 6, or can be related to the current the valve is required to deliver.

(b) Set the CIRCUIT SELECTOR switch to REC.

(c) Set the ANODE SELECTOR switch to A1.

(d) All valves can be regarded as satisfactory if the meter needle lies within the green band on the scale.

Full-wave rectifiers

83. The operations are the same as detailed in para 82, sub-paras (a) to (d), with the addition of checking the second rectifier element by switching the ANODE SELECTOR switch to A2, see para 12.

Gas-filled and cold cathode rectifiers

84. For these valves a suitable load must be used in the anode circuit at LK2, to limit the anode current. The CIRCUIT SELECTOR switch should be set to the TEST position and the anode voltage set in the normal way by means of the ANODE VOLTS switch. The value of the load resistor and its rating is provided in the mA/V column of Table 6. Anode current readings should be taken and compared with those detailed in the Table 6.

Signal diodes and diode sections of multiple valves

85. (a) Set METER SELECTOR switch for 1·0mA loading. Note that signal diodes are always tested with the METER SELECTOR switch in this position. Care must be taken when carrying out this test as the majority of diodes give full scale deflection or slightly above.

(b) Set CIRCUIT SELECTOR switch to DIODE.

(c) Set ANODE SELECTOR switch to A1 or A2, according to connection of diode elements.

(d) All valves can be regarded as satisfactory if the meter needle lies within the green band on the scale.

Tuning indicators

86. These can be tested with the controls set according to figures obtained from Table 6, and inserting the given anode load, Ra, at LK2. At the bias detailed in the table the triode section should be cut-off and the 'eye' fully closed. On reducing the bias to zero, the 'eye' should open fully and the value of indicated anode current should be that appearing in Table 6.

TESTER, VALVE, AVO, CT 160

GENERAL

Capabilities

87. General purpose diodes, triodes, tetrodes and pentodes can be tested in the normal manner, and sections of multi-assembly valve types such as double-diode-triodes and hexodes, etc, can be tested in sequence.

88. The full test facilities are detailed below:—

(a) Heater continuity.

(b) Cathode to heater insulation (valve hot or cold).

(c) Inter-electrode insulation (valve hot or cold) up to 25MΩ.

(d) Anode current (100mA max).

(e) Gas current (limited to 100μA).

(f) Mutual conductance directly in mA/V.

(g) The indication of comparative valve 'goodness' on the basis of mutual conductance reading.

(h) Rectifier output with loadings variable between 5 and 120mA.

(*j*) Signal diode output with d.c. loading up to 1mA.
(*k*) Mutual characteristics plotting.

89. Valveholders are provided with the following bases and the numbering of the pin connections is given in Fig 2.

British 4/5-pin	B4 and B5
British 7-pin	B7
British octal	MO8
British 9-pin	B9
American 4-pin	UX4
American 5-pin	UX5
American 6-pin	UX6
American 7-pin	UX7
American small 7-pin	SM7
American loctal	B8B or B8G
Hivac 4-pin	SM4
Hivac 5-pin	SM5
International octal	AO8
P type base 8-pin side contact	8SC
Miniature 3-pin	B3G
Miniature 7-pin	B7G
Phillips 8-pin locking	B8A
Miniature 9-pin	B9A or noval
All glass 9-pin	B9G
Disc seal	
Flying lead	

Controls

90. A list of controls and their functions is given in Table 5.

Power requirements

91. The instrument may be operated from the following 50-500c/s a.c. supplies.
105-120V
175-250V

The power consumption is approximately 50VA maximum.

General precautions

92. *Do not* insert a valve until the correct valve pin connections have been established as detailed in paras 5-8.

93. The CIRCUIT SELECTOR switch must not be moved from the H/CONT position until the filament, grid, screen and anode voltages have been set to the values appropriate to the valve under test.

94. Particular care is needed in the setting-up of the HEATER VOLTS selector switches before the valve to be tested is inserted in the valve holder. *Nothing can save the heater from being burnt out* if excessive voltage is applied by the wrong setting of these switches. Hence it is good practice to return all voltage selector switches, especially the HEATER VOLTS to zero after a test has been applied and before a new valve is inserted, except of course when testing a batch of identical valves.

95. Valves should be tested for inter-electrode insulation *before* the CIRCUIT SELECTOR switch is moved to position TEST.

96. The safety cut-out prevents damage to the transformers in the event of any of the h.t. supplies being short-circuited, but it does *not protect the meter movement against heavy d.c. currents* occurring in the valve anode circuit. Where any doubt exists as to the probable value of electrode current likely to be passed the ANODE CURRENT selector switch and fine control (SH and RV1) should be set to the highest current range and the range subsequently reduced according to the value of the current passing.

97. Do not apply test voltages to a valve without ensuring that, where necessary, the top caps or side terminal connections have been correctly made. Furthermore, where a jumper lead is used, particular care should be taken to ensure that it is not left lying on the valveholder panel when connected to one of the voltage supply sockets, as there is danger of it shorting to frame.

Initial setting-up for use

98. Check the coarse mains transformer link LK4 and the fine control SK, for the settings appropriate to the nominal mains voltage of the workshops supply.

99. Connect the mains lead to the supply. Red and blue leads are line and neutral respectively, and green the earth connection.

100. Check that two 2A cartridge fuses are fitted in the holders on the control panel.

101. Check that the anode circuit links LK1 and LK2 on the valveholder panel are secure.

INITIAL VALVE TESTS

Mains input fine adjustment

102. This adjustment is important as it establishes the correct electrode voltages for the calibrated controls. It should be carried out each time the tester is used and the setting checked at intervals if the instrument is in continuous use for a long period of time.

103. Turn the CIRCUIT SELECTOR to the SET ~ position and switch ON. The meter needle will rise after some 30 seconds and assume a position near the black region of the insulation scale denoting zero ohms. Set the voltage adjustment control so that the meter needle assumes its nearest position to the red line in the middle of the black zero. If the meter needle will not lie in the black zero, the mains tapping link LK4 requires adjustment and should be moved to the next higher tapping if the meter needle is to the right, and to the next lower tapping if the needle is to the left, of the black zero.

Setting-up valve test voltages

104. (*a*) From the details given in Table 6 set up the ROLLER SELECTOR switch, paras 5-8 refer, and all voltage controls with the instrument switched off. The setting of the voltage controls applies to all subsequent tests unless otherwise detailed.
(*b*) Insert valve and switch on.
(*c*) The insulation tests as detailed in paras 105-108 must be carried out prior to mutual conductance testing.

Heater continuity test—all valves

105. (*a*) Set CIRCUIT SELECTOR switch to H/CONT.
(*b*) Set ELECTRODE SELECTOR switch to C/H.
(*c*) Heater continuity is indicated on the meter by deflection of the pointer to the SHORT marker.

Insulation test—all valves

Inter-electrode insulation—valve cold

106. (*a*) Proceed with the tests in the order given in Table 1 below.
(*b*) Any breakdown between electrodes will be shown by deflection of the meter needle.

Circuit selector switch position	Electrode selector switch position	Insulation check
A/R	A_1	Checks insulation anode 1 to screen, filament, cathode, anode 2 and grid
A/R	A_2	Checks insulation anode 2 to screen, filament, cathode, anode 1 and grid
A/R	D_1	Checks insulation D_1 to screen, filament, cathode, anode 1 and grid
A/R	D_2	Checks insulation D_2 to screen, filament, cathode, anode 2 and grid
S/R	A_1	Checks insulation screen to filament, cathode and grid

Table 1—Insulation checks—valve cold. CT 160

Insulation test—valve hot

107. (*a*) Proceed with the tests in the order given in Table 2 below.

(*b*) Any deflection of the meter needle indicates a leakage between cathode and heater strapped and any other electrode.

Circuit selector switch position	Electrode selector switch position	Insulation check
CH/R	A_1	Checks insulation cathode and heater to A_1, A_2, G_1, S
CH/R	D_1	Checks insulation cathode and heater to D_1
CH/R	D_2	Checks insulation cathode and heater to D_2

Table 2—Insulation checks—valve hot. CT 160

Insulation test—indirectly heated valves

Cathode to heater insulation test

108. (*a*) Set CIRCUIT SELECTOR switch to C/H.

(*b*) Set ELECTRODE SELECTOR switch to C/H.

(*c*) A deflection of the meter needle indicates leakage between heater and cathode with the valve hot.

Anode current

109. The following procedure with appropriate settings of the ROLLER SELECTOR switch is applicable to all valves with exception of those dealt with in paras 124-129.

110. (*a*) Check the settings of the anode, screen and grid voltage control switches, para 104 refers.

(*b*) Set the ANODE CURRENT control switch and fine potentiometer to the value given in column 8 of Table 6.

(*c*) Set the CIRCUIT SELECTOR switch to TEST.

(*d*) Set the ELECTRODE SELECTOR switch to the anode for which the current reading is required, ie A_1 or A_2.

(*e*) Reduce the meter reading to zero by means of the ANODE CURRENT control switch and the fine control.

(*f*) Rotate the SET mA/V control to the SET ZERO position and finally zero the meter reading by means of the fine ANODE CURRENT control.

(*g*) The anode current is found by adding the readings of the ANODE CURRENT control switch and the fine control.

Operation of protective relay

111. Should the protective relay operate, switch off. Check for correct setting of the ROLLER SELECTOR switch and electrode voltages. If these are correct and the relay continues to 'buzz' when the instrument is switched on again the valve is probably 'soft', and the test should proceed no further.

MUTUAL CONDUCTANCE TESTS

Direct reading using recommended anode current

Triodes, tetrodes, pentodes and heptodes

112. (*a*) Set ELECTRODE SELECTOR switch to A_1.

(*b*) Check setting of ROLLER SELECTOR switch, all voltage controls, para 104 refers, and set the ANODE CURRENT controls to the value given in Table 6.

(*c*) Set CIRCUIT SELECTOR switch to TEST.

(*d*) *Do not* alter the ANODE CURRENT controls but adjust NEG GRID VOLTS control until meter indicates zero.

(*e*) Slowly rotate the SET mA/V control to the SET ZERO position and make any final adjustment to zero using the fine ANODE CURRENT control. Ensure that the valve has reached its correct working temperature, this being shown by no further rise of the meter needle, whilst the SET mA/V control is in the SET ZERO position.

(*f*) Continue rotation of the SET mA/V control until the meter needle reaches the calibration line in the centre of the 'good' zone, marked '1 mA/V'.

(*g*) Read the actual value of mutual conductance from the SET mA/V dial. This should be compared with the value given in Table 6.

Double-triodes, double-tetrodes and double-pentodes

113. (*a*) For these valves only one set of figures is given in Table 6. They are applicable to each section of the valve.

(*b*) To test one section of the valve proceed as for para 112 (*a*) to (*g*).

(*c*) To test the other section set ELECTRODE SELECTOR switch to A_2.

(*d*) Proceed as for para 112 (*d*) to (*g*).

Triode-pentodes, triode-hexodes, triode-heptodes and octodes

114. (*a*) For these valves two sets of figures are given in Table 6.

(*b*) Using the first set of figures proceed as for para 112 (*a*) to (*g*).

(*c*) Set ELECTRODE SELECTOR switch to A2.

(*d*) Using the second set of figures proceed as for para 112 (*b*) to (*g*).

Valves having a mutual conductance less than 1mA/V

115. Since the SET mA/V dial is not calibrated below 1mA/V it is not possible to check the valves on the coloured comparison scale. Such valves are checked by direct measurement of mutual conductance using the procedure set out in para 112 (*a*) to (*e*). Then rotate the SET mA/V dial to the 1mA/V position and read the mutual conductance on the scale calibrated 0·1-1mA/V.

Direct reading using recommended grid voltage

116. An alternative method of obtaining mutual conductance is by using the recommended grid voltage. Proceed as for paras 112, 113 or 114, since the only difference between this method and that outlined in those paras is that during the test the NEG GRID VOLTS control is left set to the value given in Table 6, and meter reading zeroed by means of the ANODE CURRENT controls.

Comparative reading using recommended anode current

Triodes, tetrodes, pentodes and heptodes

117. (*a*) Set ELECTRODE SELECTOR switch to A1.

(*b*) Check setting of ROLLER SELECTOR switch, all voltage controls, para 104 refers, and set the ANODE CURRENT control to the value given in Table 6.

(*c*) Set CIRCUIT SELECTOR switch to TEST.

(*d*) *Do not* alter the ANODE CURRENT controls but adjust NEG GRID VOLTS until the meter indicates zero.

(*e*) Slowly rotate the SET mA/V control to the SET ZERO position and make any final adjustment to zero, using the fine ANODE CURRENT control. Ensure that the valve has reached its correct working temperature, this being shown by no further rise of the meter needle whilst the SET mA/V control is in the SET ZERO position.

(*f*) Continue rotation of the SET mA/V control to the expected value of mA/V (meter needle should rise).

(*g*) All valves can be regarded as satisfactory if the meter needle lies within the green band on the scale.

Double-triodes, double-tetrodes and double-pentodes

118. (*a*) For these valves only one set of figures is given in Table 6. They are applicable to each section of the valve.

(*b*) To test one section of the valve, proceed as for para 117 (*a*) to (*g*).

(*c*) To test the other section set ELECTRODE SELECTOR switch to A2.

(*d*) Proceed as for para 117 (*d*) to (*g*).

Triode-pentodes, triode-hexodes, triode-heptodes and octodes.

119. (*a*) For these valves two sets of figures are given in Table 6.

(*b*) Using the first set of figures proceed as for para 117 (*a*) to (*g*).

(*c*) Set ELECTRODE SELECTOR switch to A2.

(*d*) Using the second set of figures proceed as for para 117 (*b*) to (*g*).

Comparative reading using recommended grid voltage

120. An alternative method of obtaining a comparative reading is by using the recommended grid voltage. Proceed as for paras 117, 118 or 119, since the only difference between this and that outlined in those paras is that during the test the NEG GRID VOLTS control is left set at the value given in Table 6, and the meter reading zeroed by the ANODE CURRENT controls.

GRID CURRENT TEST

Method

121. (*a*) Set ANODE SELECTOR switch to the appropriate position for the valve or valve section under test.

(*b*) Check all voltage controls, para 104 refers.

(*c*) Set CIRCUIT SELECTOR to GAS.

(*d*) Deflection of the meter needle will indicate grid current, if any, directly in μA.

(*e*) Ig should not exceed 5μA.

PLOTTING OF MUTUAL CHARACTERISTICS

Static

122. When more comprehensive tests of a valve are required, static mutual characteristic curves may be plotted using this instrument with the CIRCUIT SELECTOR in position TEST. For example, Ia/Vg curves can be taken at fixed settings of anode and screen voltages, the readings of anode current being plotted against settings of the grid bias control.

Dynamic

123. By opening the anode links LK1 or LK2 situated on the valveholder panel and inserting a suitable load, dynamic characteristic curves may be obtained in a similar manner to that outlined for static curves in para 122.

RECTIFIER AND DIODE TESTING

124. The setting-up and initial tests for insulation, etc as already described for other valve types should be carried out prior to making the following load tests, paras 101-105 refer.

Half-wave rectifiers

125. (*a*) Set the right-hand ANODE CURRENT control switch to a reading on the inner ring of figures corresponding to the load current given for the valve in Table 6.

(*b*) Set CIRCUIT SELECTOR switch to TEST.

(*c*) Set ELECTRODE SELECTOR to D1.

(*d*) All valves can be regarded as satisfactory if the meter needle lies within the green band on the scale.

Full-wave rectifiers

126. The operations are the same as detailed in para 125, sub-paras (*a*) to (*d*), with the addition of checking the second rectifier element by switching the ELECTRODE SELECTOR to D2, para 12 refers.

Gas-filled and cold cathode rectifiers

127. For these valves a suitable load must be inserted at the anode link or links (if a full-wave). The CIRCUIT SELECTOR should be set to TEST and the appropriate voltage and representative anode current figures found in Table 6. Full-wave examples of this class of valve are tested with the ELECTRODE SELECTOR at positions A1 and A2 in turn. The maximum loading on these rectifiers must be limited to 100mA per anode to avoid damage to the instrument. It should be noted that with these valves the anode voltage is set in normal manner by means of the ANODE VOLTS control switch.

Signal diodes and diode sections of multiple valves

128. (*a*) Set ANODE CURRENT control switch to figure given in Table 6, using the inner ring of figures. If no figure is given set ANODE CURRENT control switch to 1·0mA. Care must be taken when carrying out this test as the majority of diodes give full-scale deflection or slightly above.

(*b*) Set CIRCUIT SELECTOR switch to TEST.

(*c*) Set ELECTRODE SELECTOR switch to D1.

(*d*) All valves can be regarded as satisfactory if the meter needle lies within the green band.

(*e*) If a double-diode, test second diode with ELECTRODE SELECTOR switch set to D2.

Tuning indicators

129. (*a*) Check the settings of anode, screen and bias voltage controls, para 101 refers.

(*b*) Open LK1 and insert the anode load, the value of which is given in the REMARKS column of Table 6.

(*c*) Set CIRCUIT SELECTOR switch to TEST.

(*d*) Set ELECTRODE SELECTOR switch to A1.

(*e*) Insert valve and allow to warm up, when at the given value of bias the triode section should be cut off, ie the 'eye' fully closed and no anode current indicated.

(*f*) Reduce the bias to zero, the 'eye' should now be fully open and the indicated value of anode current that given in Table 6.

Control	Circuit ref	Function
OFF-ON	SA	Power supply on-off switch
HEATER	SB	Filament voltage selector switch
ANODE	SC	Anode voltage selector switch
SCREEN	SD	Screen voltage selector switch
SELECT ANODE	SE	Anode current metering switch
MA/V/C. INS	SF	Applies 1 volt change to grid for mA/V test Applies voltage to C/Heater for insulation test
SET mA/V	RV1	Variable meter shunt for mutual conductance test
SET ZERO	RV2	Resistor controlling anode current backing-off voltage
ROLLER SELECTOR	SG	Valve pin circuit selector switch
NORMAL / ÷ BY 7	SH	Filament voltage range control switch

Table 3—List of controls—Tester, valve, Avo, No 1

Control	Circuit ref	Function
OFF-ON	SA	Power supply on-off switch
SET ~	SB	Mains transformer input tapping selector switch
FILAMENT VOLTS	{ SC SD	High and low, filament voltage selector switches
ANODE VOLTS	SE	Anode voltage selector switch
SCREEN VOLTS	SF	Screen voltage selector switch
METER SELECTOR	SG	Meter shunt selector switch
ANODE SELECTOR	SH	Anode and screen current metering switch
CIRCUIT SELECTOR	SI	Test circuit selector switch
ELECTRODE LEAKAGE	SJ	Inter-electrode insulation test switch
GAS	SK	Reverse grid current switch
RESET	SL	Overload relay reset switch
MA/V	SM	Mutual conductance test push-button switch
Vgxl/Vgx10	SN	Grid voltage multiplier switch
SET ZERO	{ RV1 RV2	Ganged variable resistors controlling anode current backing-off voltage
NEG GRID VOLTS	RV3	Fine control grid voltage
SET MA/V	RV4	Variable meter shunt for mutual conductance test
ROLLER SELECTOR	SO	Valve pin circuit selector switch

Table 4—List of controls—Tester, valve, Avo, No 3

Control	Circuit ref	Function
OFF-ON	SA	Power supply on-off switch
HEATER VOLTS	SB SC	Heater voltage selector switch Heater voltage range switch
ANODE VOLTS	SD	Anode voltage selector switch
SCREEN VOLTS	SE	Screen voltage selector switch
ELECTRODE SELECTOR	SF	Anode current metering switch
CIRCUIT SELECTOR	SG	Test circuit selector switch
ANODE CURRENT	SH RV1	Anode current backing-off voltage range switch Anode current backing-off voltage fine control
SET mA/V	RV2	Variable control for mutual conductance test
NEG GRID VOLTS	RV3	Variable control of grid volts
ROLLER SELECTOR	SJ	Valve pin circuit selector switch
	SK	Mains input fine voltage control

Table 5—List of controls—Tester, valve, Avo, CT 160

TESTERS, VALVE, AVO

TECHNICAL HANDBOOK - TECHNICAL DESCRIPTION

Note: This Part 1, together with the Part 2, supersedes Tels Y 802, Issue 1, dated 19 Aug 44.

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Distribution - Class 930. Code No 6

Paras

TESTER, VALVE, AVO, CT 160

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INTRODUCTION

1. The complete testing of a thermionic valve is a complex procedure involving a range of apparatus that cannot be conveniently embodied in a single instrument. However, in workshops it is not necessary to carry out a complete range of tests as testing is normally confined to valves which have been previously and thoroughly checked at the manufacturers prior to issue.

2. The Testers valve are self-contained, mains-operated instruments for the simple testing of general purpose Service and commercial types.

3. The results obtained can be directly compared with the data as published in Table 6 of Tels Y 811, Issue 1. This gives details of ROLLER SELECTOR switch settings, test voltages and specification figures. Reference should be made to Tels Y 812 Part 2 for component values, circuit and layout diagrams.

TESTER, VALVE, AVO, NO 1

BRIEF TECHNICAL DESCRIPTION

Electrical

4. The instrument uses an a.c. testing method which eliminates the need for elaborate d.c. power packs. Full wave a.c. voltages are applied to the valve electrodes in a manner such that, when anode current and changes of anode current are measured in terms of d.c. currents, the general function of a static d.c. valve characteristic is maintained.

5. Valve holders are provided on the valve holder panel which is on the subsidiary unit. These holders cater for valves in current use and a nine-way rotary switch allows any one of the valve base sockets to be connected to any one of the electrode test circuits in the instrument.

6. Valve electrode test voltages are obtained from three multi-tapped transformers and unsmoothed half-wave rectified a.c. is used to 'back off' anode current when making mutual conductance measurements.

Power requirements

7. The power supply required is 200 - 250V at 50 - 60c/s. The consumption is approximately 20VA.

Mechanical

8. The complete instrument consists of two units, the main and the subsidiary. The main unit consists of a bakelite front panel on which are mounted all the components including the meter. The subsidiary unit consists of an aluminium front panel on which are mounted the valve holders and the nine-way rotary selector switch. A pressed aluminium case completes each unit.

DETAILED TECHNICAL DESCRIPTION

Method of characteristic testing (Fig 2001)

9. The manner of operation is shown in Fig 2001. The electrode voltage controls are directly calibrated in terms of d.c. voltages and provide the indicated test voltages.

10. With no backing-off voltage applied by the SET ZERO control, RV2 to the meter circuit, this meter indicates the standing anode current.

11. A direct reading of mutual conductance is obtained by backing-off the standing anode current to zero and applying a 1V a.c. positive charge to the grid. The meter deflection is a direct measurement of the valves mutual conductance, it being a change in anode current (milliamps) for a grid potential change of 1V

12. The grid potential is obtained from the 1V winding L1 on transformer T1, which is centre-tapped to chassis. The ends of this winding are connected to the key switch SF. When the switch is in its central position one end of the winding is connected to the grid, making it 0.5V negative with respect to cathode. On pressing the switch to the mA/V position the other end of the winding is connected to the grid, making the grid 0.5V positive with respect to the cathode, ie, a 1V change in all. The resulting change in anode current is therefore a direct reading of mutual conductance.

13. For quick batch testing in terms of mutual conductance a GOOD/BAD scale is provided on the meter. By adjusting the SET mA/V control, RV1, to a pre-determined mutual conductance figure, a shunt value is obtained for the meter, such that full scale deflection of the meter corresponds to this predetermined figure of mutual conductance. Then, on pressing the key switch to the mA/V position, the meter will give a reading which, after being multiplied by 10, gives the percentage efficiency of the valve (f.s.d. = 100%).

Method of rectifier and diode testing (Fig 2001)

14. Rectifiers are tested with 30V applied to the anodes via a limiting resistance R4. Full scale deflection indicates anode current of 100mA.

15. Signal diodes are tested in a similar manner but with 12V applied to anodes via R5. Full scale deflection indicates anode current of 10mA.

Continuity and insulation test circuits

16. The input to the h.t. transformer T1 is used as a means of testing insulation. Across this supply are two resistors, the neon lamp, and a switch. When prods are inserted in the sockets on the front panel of the main unit this switch is opened and the circuit broken. If the two prods are touched together the circuit is again completed. The insulation test takes the form of a comparison test between the glow obtained from the lamp when the prods are shorted together and the glow obtained when the prods are connected to the electrodes of a valve, between which it is desired to check the insulation. The brighter the glow, the less the insulation.

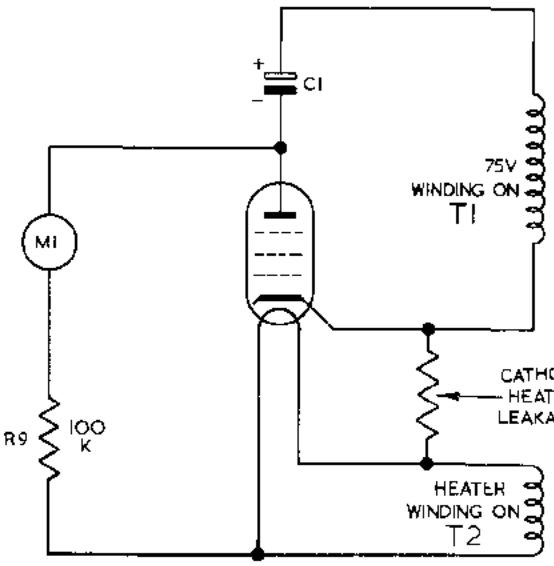


Fig 1 – Heater/cathode insulation test
Tester No 1

17. To test the cathode/heater insulation, however, this method is not used. From Fig 1 it will be seen that the valve under test is being made to act as a rectifier and the 0.05μF condenser C1 will charge up from the 75V tapping on the h.t. transformer. Any breakdown between cathode and heater will allow this charge to leak away through the meter, which will indicate the value of discharge current. Thus this leakage may be directly calibrated in megohms. This has been done on the lower black scale and the cathode/heater insulation is read directly from this scale.

Transformer assemblies (Fig 2001)

18. All supplies for the instrument are derived from the transformer assemblies consisting of the heater transformer T2, and the h.t. transformer T1. The normal mains supply tappings enable the input to T1 to be controlled by an auto-transformer arrangement.

19. T1 has three secondary windings which supply:-

(a) 1V for the direct readings of mutual conductance.

(b) 20V for the SET ZERO control.

(c) Eleven tappings to provide anode and screen voltages.

20. T2 has two secondary windings which supply:-

(a) The heater voltages in the range 0-40V as selected by switch SB.

(b) 30 and 100V fed to the ANODE VOLTS switch at REC and 100 respectively.

21. It will be seen from the circuit diagram, Fig 2001, that the 200V tapping on the SCREEN VOLTS control is the same as the 150V tapping on the ANODE VOLTS control. If measurements are taken of the various voltages they will correspond to the figures on the transformer. In fact, the SCREEN VOLTS are substantially the same as the positions of the switch denote whilst the actual voltage at the positions of the ANODE VOLTS control is somewhat higher. The reason for this is that when the instrument was designed the relationship that does exist between those voltages was empirically found to be the correct one to test valves on the straight portion of the characteristic.

Set zero

22. To obtain a direct reading of mutual conductance a backing-off circuit is used to balance out any deflection due to the standing anode current at the desired test conditions. The 20V winding on T1 feeds a potentiometer which forms part of the SET ZERO control. The other part of the control is a series resistor, ganged in such a manner that the backing-off potential network presents an approximately constant shunt across the meter circuit. By use of the SET ZERO control any potential up to 20V a.c. may be selected, rectified and fed to the meter circuit in opposition to the valve anode current.

Operation of key switch SF

23. This key is used to apply the 1V change to the grid of the valve when in the mA/V position and to apply 75V a.c. to the valve for testing the cathode/heater insulation when in the C.INS. position. In addition it disconnects the anode voltage. Table 1 gives the contacts on this switch and their functions.

Contacts	Position of centre key			Function of contacts
	C.INS	Central position	mA/V	
AB	closed	open	open	Metering circuit
BC	open	closed	closed	
DE	open	closed	closed	Cathode circuit return
FG	closed	open	open	Anode volts
GH	open	closed	closed	
JK	closed	open	open	Grid voltage
KL	open	closed	closed	
MN	closed	closed	open	Grid voltage
NP	open	open	closed	

Table 1 - Contacts of key switch SF

Valve holder panel and roller selector switch

24. On the subsidiary unit are mounted the valve holder panel which contains 17 valve holders when fully modified, the ROLLER SELECTOR SWITCH, three sockets for top cap or side terminal connections, and the NORMAL/ BY 7 switch, (SH). The valve holders are of the following types:-

(a) British 4/5 pin, 7 pin, and 9 pin

(b) B3G, B5A, B7G, B8A, B9A, B9G

(c) B8B or B8G (American loctal)

(d) British octal, International octal

(e) American 4 pin, 5 pin, 6 pin, small 7 pin UX

(f) Flying lead

These valve holders have the corresponding pin numbers wired in parallel. The three sockets are connected to anode, screen and grid circuits.

25. The ROLLER SELECTOR switch carries nine spring contacts, each of which can be rotated to make connection to any one of ten busbars arranged co-axially in the barrel of the switch. Thus any valve pin number can be connected to any one of the instrument circuits, as may be necessary. The rollers are held in their selected positions by leaf springs acting on the moulding escapement. The particular connection made for any one of the pin rotating contacts is indicated in the escutcheon window by suitably engraved position markers as under:-

1	2	3	4	5	6	7	8	9	0
C	H-	H+	G	S	A	A_2	D_1	D_2	E

26. The NORMAL/ ÷ BY 7 switch is for use with valves using lower heater voltages than can be obtained direct from the HEATER VOLTS selector switch. For example, to test a valve with a 1.4V filament, set the HEATER VOLTS selector switch to 10 volts and the NORMAL/ ÷ BY 7 switch to ÷ BY 7 and the resultant heater voltage will be approximately 1.4 volts.

TESTER, VALVE, AVO, NO 3

INTRODUCTION

27. The Tester, valve, Avo, No 3 is a self-contained, mains-operated instrument for the simple testing of general purpose Service and commercial type valves. Heater continuity, inter-electrode insulation, electrode currents and mutual conductance can be quickly measured. The instrument design enables static and dynamic characteristic curves to be obtained if required.

28. Two forms of the valve tester, designated by the manufacturers as the Valve characteristic meter Mk 1 and Mk 2 respectively are held by the Service under common nomenclature, Tester, valve, Avo, No 3. The differences between the two forms are minor. Identification of the two types is a simple matter. The Mk 2 version has two base runners, handles on either side of the front panel and a small compartment for the manual, whilst these are not provided on the Mk 1. It should be noted that circuit or positional changes may occur which have not been detailed in this regulation. This is due to the fact that the instrument was not designed solely for Service use and hence changes may occur without prior Service consultation.

BRIEF TECHNICAL DESCRIPTION

Electrical

29. The instrument uses an a.c. testing method which eliminates the need for elaborate d.c. power packs. Full-wave and half-wave unsmoothed a.c. voltages are applied to the valve electrodes in a manner such that, when anode current and changes of anode current are measured in terms of d.c. currents, the general function of a static d.c. valve characteristic is maintained.

30. Valve electrode voltages to establish the test conditions are derived from multi-tapped transformers via calibrated selector switches. One transformer provides heater voltages, the other h.t., g.b. and backing-off voltages. Unsmoothed 50c/s a.c. is applied direct to the anode and screen of a valve under test. Unsmoothed, half-wave rectified a.c. is used to fix the grid working point, to provide a grid swing and the anode current backing-off voltage to facilitate the measurement of mutual conductance.

31. A single 3.1/2 inch scale moving-coil meter, used in conjunction with three selector switches in combination, provides direct readings of inter-electrode insulation or electrode currents or mutual conductance.

32. A cut-out in the form of a double-circuit polarized electro-magnetic relay with its windings energized by the anode and screen currents provides protection against inadvertant or deliberate shorting of the supply voltages.

33. Valve holders are provided on the valve holder panel. These holders cater for valves in current use and a nine-way rotary switch enables any one of the valve base standard pin numbers to be connected to any one of the electrode test circuits in the instrument.

Power requirements

34. The power supply required is 95-125V or 185-255V at 50-60c/s. The consumption is approximately 60VA.

Mechanical

35. The instrument consists of 3 major assemblies as follows:-

(a) Front panel assembly

(b) Transformer assembly

(c) Valve panel assembly

These assemblies are mounted on a sand-cast aluminium framework of two main vertical side frames, bolted and screwed to four horizontal members consisting of 1/4 in. dia cross rod, two angled 1/2 in. x 1/2 in. strips and the top valve holder panel casting.

36. A pressed aluminium pedestal cabinet, complete with hinged lid, houses the instrument.

DETAILED TECHNICAL DESCRIPTION

Method of characteristic testing (Fig 2)

37. The general function for a d.c. static valve characteristic is

$$Ia = f\left(\frac{Va + \mu 1 Vg1 + \mu 2 Vg2}{Ra}\right) \qquad (1)$$

where Ia = anode current

Va = anode volts

Ra = anode slope resistance

Vg1 = control grid voltage

Vg2 = screen grid voltage

$\mu 1$ = amplification factor grid/anode

$\mu 2$ = amplification factor grid/screen

The relationship only holds under the conditions that $\mu 1$, $\mu 2$ and Ra are constant over the operating region.

38. In the instrument a patented a.c. method of operation is used whereby raw 50c/s a.c. voltages are applied to the anode and screen electrodes. The grid conditions are established with unsmoothed half-wave rectified a.c. but the IA is measured in terms of d.c. current. Co-relation between the a.c. and d.c. test conditions is arranged in the instrument design by maintaining the following relationships:-

Va r.m.s. = 1.1 indicated d.c. Va

Vg2 r.m.s. = 1.1 indicated d.c. Vg2

Vg1 (mean unsmoothed) = 0.52 indicated d.c. Vg1

Ia (mean d.c.) = 0.5 indicated Ia

The manner of operation is shown in Fig 2. Included are voltage waveforms at various points in the circuit, as is the current waveform in the anode circuit.

39. The electrode voltage controls are directly calibrated in terms of d.c. voltages and provide the indicated test voltages; for example, with the ANODE VOLTS switch set at 200V we have 220V r.m.s. applied to the anode and with NEG GRID VOLTS at -3V the mean d.c. voltage at the control grid is -1.56V. The factor of two has been introduced into the meter circuit by the shunt element RV7 and the actual mean d.c. Ia flowing in the anode circuit will be found to be half that indicated by the instrument meter.

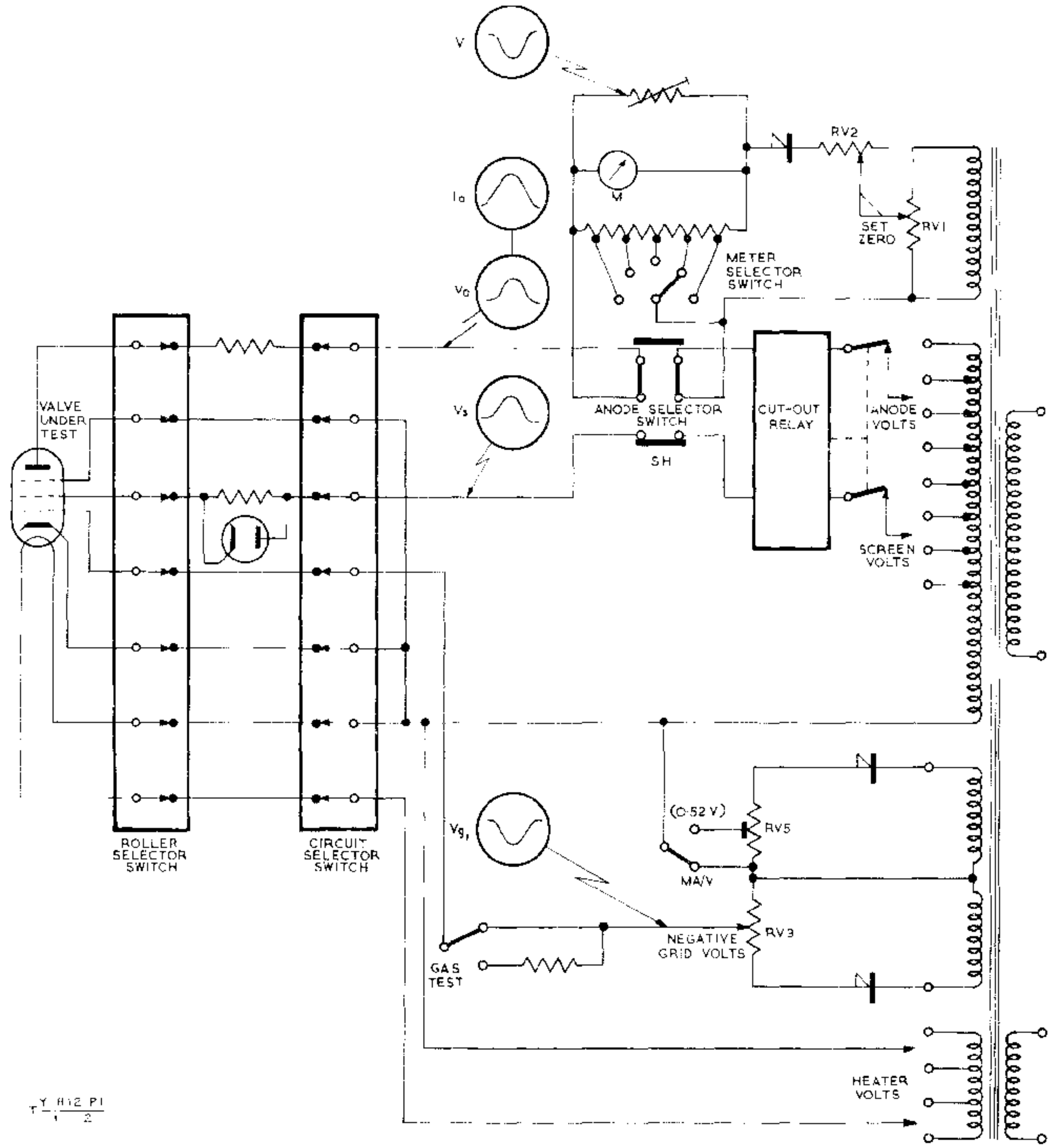


Fig 2 - Method of characteristic testing. Tester No 3

40. With no backing-off voltage applied by RV1 to the meter circuit, this meter indicates the standing anode or screen current according to the setting of the ANODE SELECTOR switch SH.

41. A direct reading of mutual conductance is obtained by backing off the standing anode current of the valve to zero and applying a 0.52V d.c. positive voltage change to the grid, which is obtained from the half-wave rectifier circuit when the mA/V button SM is pressed. The meter deflection is a direct measurement of the valve's mutual conductance, it being a change equivalent to 1V d.c.

42. For quick batch testing in terms of mutual conductance, a GOOD/BAD scale is provided on the meter. With the METER SELECTOR switch SG at mA/V - position 5, a variable shunt element consisting of R5 and RV4 is connected across the meter. By adjusting the SET mA/V resistor RV4 to a predetermined mutual conductance figure, a shunt value is obtained for the meter, such that half scale deflection occurs when the effective current change due to the grid potential change on pressing the SET mA/V button, SM, is equal to the pre-set mutual conductance figure. A good valve should give a reading of half the full scale deflection, or above.

Method of rectifier and diode testing (Fig 3)

43. Rectifiers can be tested to ensure that each section will produce sufficient current under suitable load conditions. A voltage of 150V r.m.s. from tapping (j) on T2 is applied to the anode of the rectifier under test which supplies the reservoir condenser C1. The resistors R21 to R25 provide six d.c. load conditions of 1mA, 5mA, 15mA, 30mA, 60mA and 120mA. Current in the load circuit is indicated by the meter, shunted to correspond with the selected load current. Each half of a full-wave rectifier can be individually tested by the selection of anode 1 or anode 2, as selected by the ANODE SELECTOR switch.

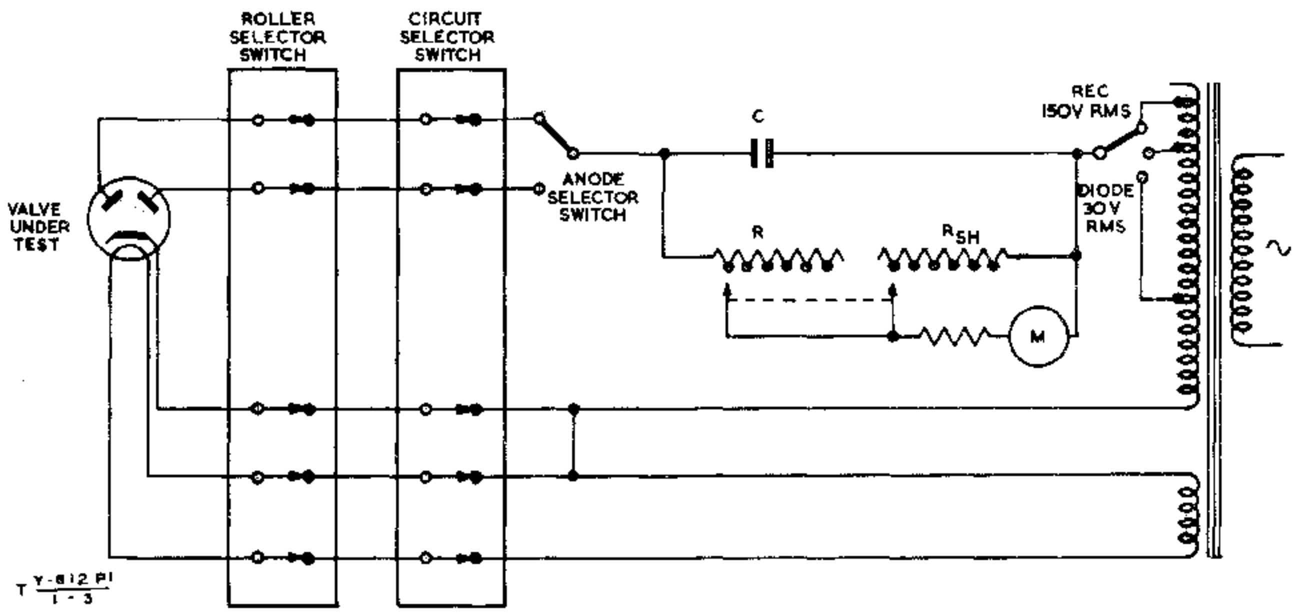
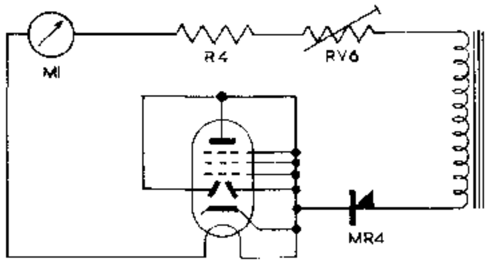
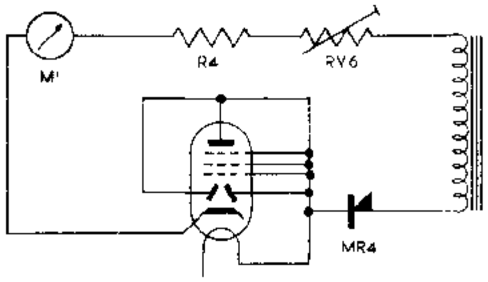


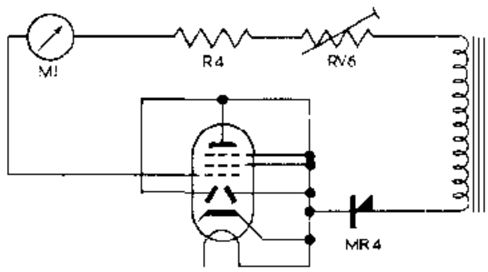
Fig 3 - Method of rectifier and diode testing. Tester No 3



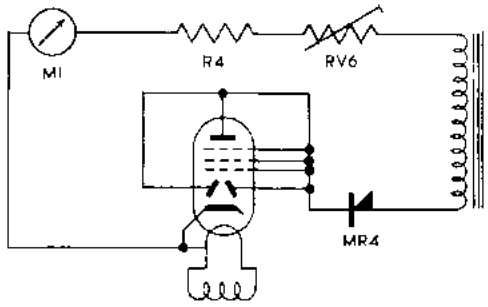
(a) HEATER CONTINUITY TEST — VALVE COLD
CIRCUIT SELECTOR SWITCH SET TO CHECK (C)
ELECTRODE LEAKAGE SWITCH SET TO H



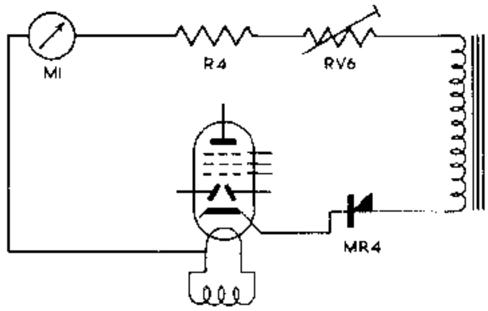
(b) INSULATION TEST — VALVE COLD
CIRCUIT SELECTOR SWITCH SET TO CHECK (C)
ELECTRODE LEAKAGE SWITCH SET TO C



(c) INSULATION TEST — VALVE COLD
CIRCUIT SELECTOR SWITCH SET TO CHECK (C)
ELECTRODE LEAKAGE SWITCH SET TO G



(d) INSULATION TEST — VALVE HOT
CIRCUIT SELECTOR SWITCH SET TO CHECK (H)



(e) CATHODE TO HEATER TEST (INDIRECTLY HEATED VALVE)
CIRCUIT SELECTOR SWITCH SET TO C/H in

Fig 4 - Continuity and insulation test circuits. Tester No 3

44. The load figures are chosen to correspond with the maximum emission specified by the valve manufacturers. The meter indicates the efficiency of the valve on the basis of the required d.c. load.

45. Signal diodes are tested in a similar manner but with the 30V r.m.s. from tapping (b) on T2 applied to the anode and with a d.c. loading of 1mA.

Continuity and insulation test circuits (Fig 4)

46. The output of rectifier MR4 is used as an unsmoothed d.c. supply for the continuity and insulation tests. The three circuits are established by the setting of the CIRCUIT SELECTOR switch SI and the ELECTRODE LEAKAGE switch SJ (paras 53 and 54 refer). The three positions are shown in Fig 4. There is the example for heater continuity (a), two examples of insulation test with valve cold, (b) and (c), and two examples of insulation test with valve hot, (d) and (e).

Transformer assembly (Fig 2005)

47. All supplies for the instrument are derived from the transformer assembly, consisting of the heater transformer T1 and the h.t. and g.b. transformer T2. In addition to the normal mains supply tappings, the primary of T1 has eleven 3V±10% subsidiary tappings. They are the fine controls for inputs to both transformers. The auto-transformer arrangement for the input to T2 enables the secondary outputs to be adjusted to maintain the d.c. calibration of the electrode supply controls.

48. T2 has five secondary windings. Four of these supply:-

(a) 6.3V±0.1V — Diode heaters

(b) 25V±1V — SET ZERO anode current backing-off circuit

(c) 2V±0.25V — mA/V positive grid swing voltage

(d) 145V±3V — grid working voltage circuit

The fifth winding has eighteen tappings to provide anode and screen voltages within the range 0-400V as selected by the ANODE VOLTS and SCREEN VOLTS switches SE and SF, respectively.

49. Secondary tappings of T1 provide the heater volts at the standard ratings within the range 1.1V to 110V, as selected by two FILAMENT VOLTS switches SC and SD. Switch SC is used to select heater voltages in the range 0-16V and switch SD selects heater voltages from 0-110V in 10V steps. By suitable positioning of the switches, voltages in either range may be used or the two voltages can be made additive (see Fig 5 for examples). It should be noted that the 10, 20, 30, 40 and 50V tappings do not exist as such but are in fact the differences between the 60V tapping and the 70, 80, 90, 100 and 110V tappings.

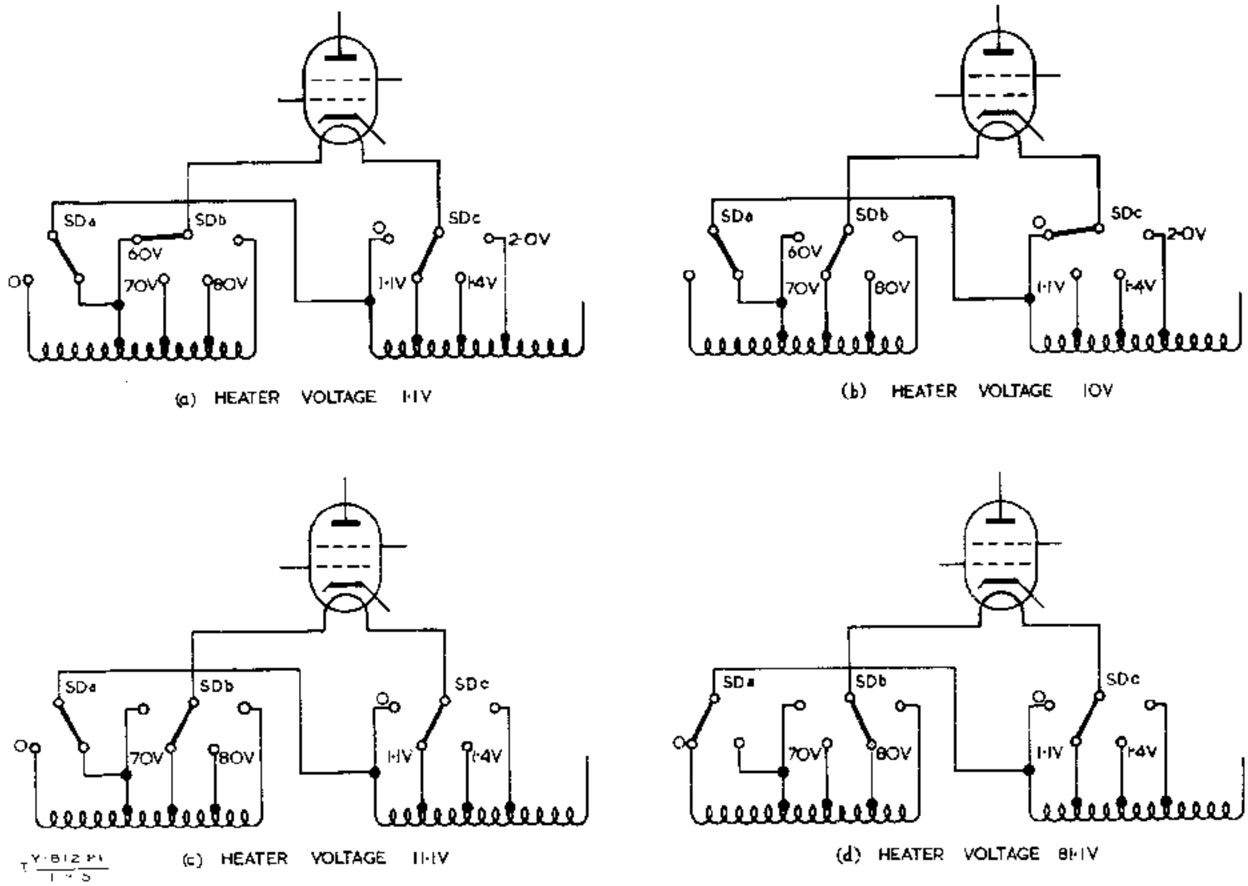


Fig 5 - Heater voltage supply - examples. Tester No 3

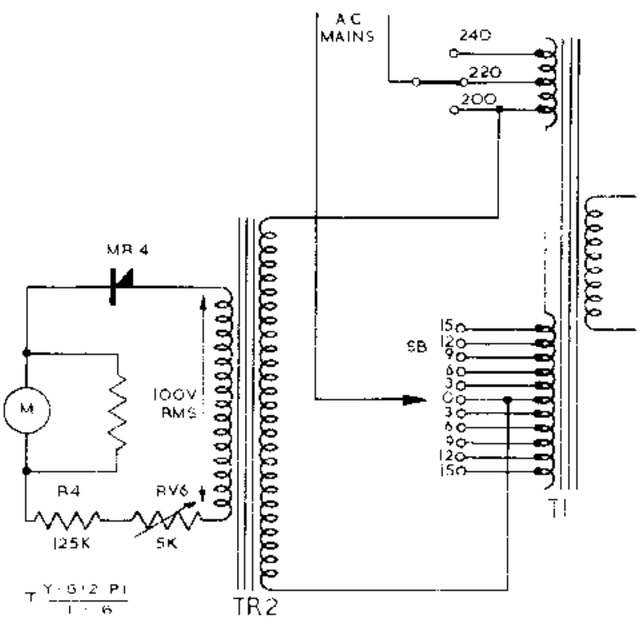


Fig 6 - Set ~ circuit. Tester No 3

Set ~ circuit (Fig 6)

50. Correct calibration of the electrode voltage controls is ensured in the setting up procedure by the SET ~ circuit. The CIRCUIT SELECTOR switch SI and the ELECTRODE LEAKAGE switch SJ establish the circuit conditions shown schematically in Fig 6. The selection of a fine tapping on T1 by means of SB ensures that the input to the primary of T2 will be such that the output voltage across the winding GB1 and GB2 is 100V r.m.s. A setting-up mark is provided on the meter scale and initial calibration in manufacture or major overhaul is made by adjustment of the preset control VG (RV6).

Circuit control arrangements

51. The instrument switching arrangements are complex because of the multiplicity of tests that have to be carried out on the varied valve types. It should be noted that the detached contact system for switches has been used in the circuit diagram (Fig 2005).

Circuit selector switch SI

52. The CIRCUIT SELECTOR switch has six positions with six double-sided, twelve-contact wafers, the function of the wafers being as follows:-

SIaa Controls anode circuit supply volts.

SIbb Routes the anode supply either to the meter or to the load in the case of rectifiers.

SIcb)
SIda) Control connections to meter.

The remaining wafers, - ab, ba, ca, db, ea, eb, fa and fb-select electrodes for the insulation tests in conjunction with the ELECTRODE LEAKAGE switch SJ.

53. In position 1, CHECK (C), all the electrode circuits are connected to the ELECTRODE LEAKAGE switch SJ. The instrument can then be set up for mains voltage adjustment (para 50 refers) or for electrode leakage tests with the valve cold. The electrodes of the valve under test are connected to SJ by SI(cb) and to the 100V negative supply by SI(da). Rotation of the switch SJ then tests the insulation which occurs between each of the valve electrodes taken in order and all others strapped. Continuity of the heater is indicated in position H of SJ. In this position of SI, SI(fa) removes the valve heater supply.

54. Position 2, CHECK (H). Heater supply to the valve is restored by SI(fa). The heater and cathode are connected together via SI(eb). All the other electrodes are strapped together via their respective contacts on SI and insulation resistance between them and the heater/cathode strapped, is checked.

55. Position 3, C/H Ins, checks the cathode/heater insulation. Here the 100V negative supply is applied via SI(da) meter M1, SI(cb) and SI(eb) to the cathode, the meter giving direct reading of the cathode to heater insulation.

56. Position 4, TEST, enables all mutual characteristic tests to be carried out in conjunction with switches SE, SF, SN, NEG GRID VOLTS control RV3, and with the meter, anode/screen selector switches correctly set. The anode supply is now connected by SI(aa) and SI(bb) to the anode 1 and anode 2 circuits. The meter is connected to the shunt circuits by SI(cb) and (da). The other contacts of SI connect the ROLLER SELECTOR switch to the appropriate power supplies.

57. Position 5, DIODE, is used for the testing of signal diodes. The anode supply is connected to a 30V tap on T2, tapping b, by SI(aa), and SI(bb) connects the diode anode circuits to the test load. SI(cb) and (da) connect the meter to the diode load circuit.

58. Position 6, REC, is in all respects similar to position 5 except that SI(aa) now selects the 150V tap on T2, tapping j.

Meter selector switch SG

59. This switch has a bank of two double-sided wafers. It has no effect on the meter circuit in positions 1, 2 and 3 of the CIRCUIT SELECTOR switch. With SI at position 4, positions 1, 2, 3 and 4 of SG provide meter current ranges of 100mA, 25mA, 10mA and 2.5mA by the switching of the meter shunt elements R10, R10 + R12, R10 + R12 + R28, R10 + R12 + R28 + R27.

60. For position 5, mA/V, of SG a special meter circuit condition is established whereby a meter shunt element of R5 in series with RV4 is connected across the meter. RV4, SET mA/V, is calibrated in terms of mA/V. Its value at a particular setting is such as to produce half scale deflection of the meter when a current equal in value to the selected setting is passed by the valve, consequent upon the positive grid swing voltage being applied by pressing the mA/V button. This arrangement is used for the comparative or batch testing of valves in terms of the mutual conductance.

61. In position 4 of SI, shunt selection is done by SG(ab) and (bb), SG(aa) and (ba) being inoperative.

62. With the CIRCUIT SELECTOR switch at positions 5 and 6, SG(aa) and (ba) become operative. SG(ba) determines the load resistance values for d.c. loadings of 1mA, 5mA, 15mA, 30mA, 60mA and 120mA by the switching of resistors R21 to R25. SG(aa) applies the appropriate meter shunt element of R15 to R20.

Grid voltage controls

63. A multiplier network of R6, R7, R8, R9 and RV3 across the 100V negative supply enables either 10V or 100V to be applied across RV3 by means of the switch SN (Vg, X1, X10). The arrangement of the network is such that the same load appears across the 100V negative supply in both positions of SN. Fine control of the grid voltage is given by RV3, the scale being calibrated 0-10. A 2V winding on transformer T2 and the half-wave rectifier MR3 supply the small positive change of grid bias obtained when the mA/V button is pressed. RV5 is a preset potentiometer used to set up this voltage.

64. The GAS press button switch is connected across R11, a 100,000Ω resistor in the grid circuit. Presence of gas in the valve will cause excessive grid current to flow. Operation of the GAS button, therefore, will cause a d.c. bias voltage to be developed across R11. The presence of this bias will be indicated by a change in anode current, an excessive change denoting a soft valve.

Anode selector switch SH

65. This is a double-sided twelve-contact wafer with group contacts and has three positions marked A1, A2 and S. It is used when testing valves with more than one anode or when it is desired to measure the screen grid current. In position 1 of SH (CIRCUIT SELECTOR switch to TEST) the anode 1 of the valve under test is connected to the metering circuit, anode 2 going via a limiting resistor R2 to the anode supply and screen grid to the screen supply. Diode anode 1 is also brought into circuit

but it is not connected to the load or metering circuits until the CIRCUIT SELECTOR switch is set to DIODE or REC. Position 2 of the ANODE SELECTOR switch reverses the anode connections, anode 2 going to the metering circuit and anode 1 via R2 to the anode supply. If the CIRCUIT SELECTOR switch is at DIODE or REC, then the diode anode connections are reversed by SH. In this case the diode anode, not being metered, is left floating. Position 3 of SH connects anodes 1 and 2 direct to the anode voltage supply and places the meter in the screen grid circuit of the valve under test.

Set zero

66. To obtain a direct meter reading of mutual conductance, a backing-off circuit is used to balance out any deflection due to the standing anode current at the desired test conditions. In order to prevent ripple which may affect the meter, used on a sensitive range after backing-off, a current similar in waveform but opposite in polarity to the anode current is used. A 25V winding on T2 supplies half-wave rectifier MR1 via the SET ZERO control RV1 and RV2, two ganged potentiometers. The negative-going half-wave rectified current flow from MR1 develops a p.d. across the meter shunt circuits, opposite in polarity to that developed by the anode current. RV1 and RV2 are adjusted to make these p.ds equal, indicated by the meter returning to zero.

Safety cut-out (Fig 7)

67. The cut-out is a two-circuit polarized relay with its windings supplied by the anode and screen currents of the valve under test. With the valve electrodes taking normal currents, half-wave rectified d.c. pulses will energize the windings, the direction and magnitude being such that, with anode current only or considerably larger anode current than screen current, the relay will hold in. If a short-circuit occurs on the anode or screen electrodes or on the valve holder sockets associated with these electrodes, the current flowing will be a.c., since rectification will not occur in the valve. The first negative-going half-cycle of the a.c. current will cause the relay to operate, contacts X, Y and Z will open with the following effects:-

(a) Anode voltage supply disconnected

(b) Screen voltage supply disconnected

(c) Lamps ILP1 and ILP2 illuminating the meter will go out.

68. If the screen current exceeds the anode current, the relay is so set that it will open, preventing damage to the valve.

69. The cut-out will NOT operate when heavy currents of a d.c. nature occur in the valve anode circuit and thus it will not protect the meter if it is wrongly set to a range lower than the value of current drawn by the valve.

70. When the RESET button is pressed, armature A is forced against the relay core. Contacts X, Y and Z are mechanically coupled to the armature and thus they close. Contacts P and Q also change over, connecting a rectified supply (due to MR2) across the top winding of the relay, its object being to 'replace' magnetism lost by the core. When the switch is released the armature is held in contact with the core,

due to the permanent magnetism of the core. Fig 2 represents a simplified diagram of a valve under test. The cut-out itself is enclosed by the heavy black line.

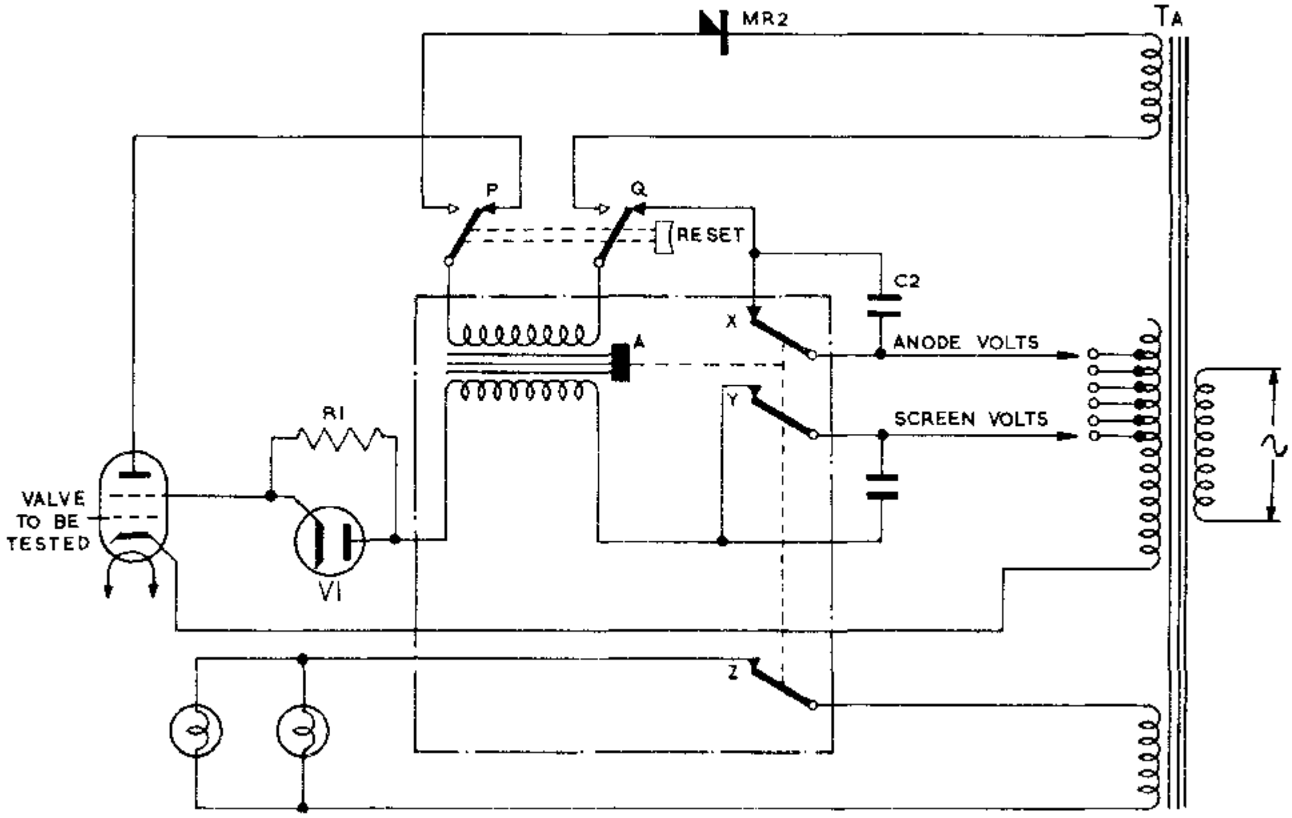


Fig 7 - Safety cut-out. Tester No 3

Anti-parasitic oscillation precautions

71. Comparatively long grid and anode leads are used in this equipment and along with stray capacities these can constitute tuned lines having a resonant frequency in the v.h.f. spectrum. A valve having a large value of mutual conductance may be able to overcome the inherent losses associated with such a line and burst into parasitic oscillations. Stoppers have been inserted in the valve panel wiring but these can only be used in a few positions as a large number of pin combinations have to be used for one valve holder. Stopper resistors could not be tolerated in what may be the anode or grid circuit of one particular type of valve and heater or cathode of another. Oscillation is only likely to occur when the valve is being tested at or near its maximum mutual conductance.

Anti-parasitic oscillation stopper circuits

72. For the Mk 1 instrument the circuits are as follows:-

(a) International octal base. Stoppers in the form of an r.f. choke fitted to pins 4 and 5.

(b) British 7 pin. 75Ω resistors fitted to pins 3 and 7.

(c) B8A. Pin 7 to earth via two 0.005µF condensers in series.

(d) Loctal base. 75Ω resistor fitted to pin 6.

(e) Resistors in three leads to ROLLER SELECTOR switch busbars, one of 5,000Ω and two of 75Ω.

73. For the Mk 2 instrument the circuits are as follows:-

(a) B9G: This valve holder has a 130Ω resistor in each lead to ROLLER SELECTOR switch. This resistor is in parallel with the loop, for any denomination of the roller switch, which connects all valve bases to the ROLLER SELECTOR switch. This resistor acts as a damping resistor across what may be looked on as a resonant line. Thus these lines will not oscillate.

(b) Resistors in four leads to ROLLER SELECTOR switch busbars. One resistor of 5,000Ω and three of 75Ω.

74. When a beam tetrode is being tested with a.c. voltages applied to its electrodes, a condition may arise when, due to the electrode voltages approaching zero during the a.c. cycle, the beam focusing is to some extent upset. This may give rise to reverse screen current, anode current will then rise and screen current decrease rapidly and become negative. This would give erroneous readings and, if allowed to continue, damage the valve. To overcome this a diode is placed in series with the screen supply to the valve. Under normal conditions, this will have little effect on the screen working conditions, but if there is a reversal of screen current, it will present a very high impedance and prevent the above conditions from occurring.

Valve panel and roller selector switch

75. The top panel of the instrument mounts nineteen valve holders (eighteen on the Mk 1) of different types, a five-way socket terminal board TB2, and the nine-way ROLLER SELECTOR switch SO. The valve holders are of the following types:-

(a) British 4/5 pin, 7 pin, 9 pin and 8 pin side contact.

(b) B3G, B7G, B8A, B9A (not in Mk 1), B8G.

(c) B8B or B9G (American loctal).

(d) British octal, International octal.

(e) Hivac 4 and 5 pin.

(f) American 4 pin, 5 pin, 6 pin, small 7 pin UX, medium 7 pin UK.

These valve holders have the corresponding pin numbers wired in parallel. The five-way socket terminal board is connected directly to the tag board TB2 and provides supplies for valves with top cap or side connections. The five connected circuits are GRID 1, SCREEN, ANODE 1, ANODE 2 and DIODE 1.

76. The ROLLER SELECTOR switch carries nine spring contacts each of which can be rotated to make connection to any one of ten busbars arranged co-axially in the barrel of the switch. Thus any valve pin number can be connected to any one of the instrument circuits, as shown in Fig 2004. The rollers are held in their selected positions by leaf springs acting on the moulding escapement. The particular connection made for any one of the pin rotating contacts is indicated in the escutcheon windows by suitably engraved position markers as under:-

1	2	3	4	5	6	7	8	9
C	H-	H+	G	S	A	A_2	D_1	D_2

TESTER, VALVE, AVO, CT 160

INTRODUCTION

77. The Tester, valve, Avo, CT160 is a self-contained mains-operated instrument for the simple testing of general purpose Service and commercial type valves. Heater continuity, inter-electrode insulation, anode current and mutual conductance can be quickly measured. The instrument enables static and dynamic characteristic curves to be obtained if required. The instrument may also be used as a simple 'go' or 'no go' device.

BRIEF TECHNICAL DESCRIPTION

Electrical

78. The instrument uses an a.c. testing method which eliminates the need for elaborate d.c. power packs. Full-wave and half-wave unsmoothed a.c. voltages are applied to the valve electrodes in a manner such that, when anode current and changes of anode current are measured in terms of d.c. currents, the general function of a static d.c. valve characteristic is maintained.

79. Valve electrode voltages to establish the test conditions are derived from multi-tapped transformers via calibrated selector switches. One transformer provides heater voltages, the other h.t., g.b. and backing-off voltages. Unsmoothed 50c/s a.c. is applied direct to the anode and screen of the valve under test. Unsmoothed half-wave rectified a.c. is used to fix the grid working point, to provide a grid swing and the anode current backing-off voltage to facilitate the measurement of mutual conductance.

80. A single 2.1/2 inch scale, moving-coil meter, used in conjunction with various switches in combination, provides direct readings of inter-electrode insulation or electrode currents or mutual conductances.

81. A cut-out in the form of a treble-circuit electro-magnetic relay with two of its windings energized by anode and screen currents provides protection against inadvertant or deliberate shorting of supply voltages.

82. Valve holders are provided in the valve holder panel. These holders cater for valves in current use and a nine-way rotary switch enables any one of the valve base standard pin numbers to be connected to any one of the electrode test circuits in the instrument.

Power requirements

83. The power supply required is 105-120V or 175-250V at 50-500c/s. The consumption is approximately 50VA.

Mechanical

84. The instrument consists of two major assemblies each of which is housed in one half of the suitcase-type case. The lid houses the valve holder panel which is a light aluminium plate on which the holders, rotary switch and external sockets are mounted. The remainder of the instrument, its transformers, controls, meter, etc, is in the bottom half of the case. The controls and the meter are mounted on the top panel, which is aluminium. The remainder of the components are mounted on a framework consisting of two 1/2 in. x 1/8 in. U shaped aluminium members screwed and bolted to two 1/2 in. x 1/2 in. x 1/8 in. angled sections. A pressed aluminium cabinet forms the suitcase and completes the instrument.

DETAILED TECHNICAL DESCRIPTION

Method of comparative testing (Fig 8)

85. The general function for a d.c. static valve characteristic is:-

$$Ia = f\left(\frac{Va + \mu 1 Vg1 + \mu 2 Vg2}{Ra}\right) \qquad (1)$$

Where Ia = anode current

Va = anode volts

Ra = mean slope resistance

Vg1 = control grid voltage

Vg2 = screen grid voltage

$\mu 1$ = amplification factor grid/anode

$\mu 2$ = amplification factor grid/screen

The relationship only holds under the conditions that $\mu 1$, $\mu 2$ and Ra are constant over the operating region.

86. In the instrument a patented a.c. method of operation is used whereby raw 50-500c/s a.c. voltages are applied to the anode and screen electrodes. The grid conditions are established with unsmoothed half-wave rectified a.c. but the Ia is measured in terms of d.c. current. Co-relation between the a.c. and d.c. test conditions is arranged in the instrument design by maintaining the following relationships:-

Va r.m.s. = 1.1 indicated d.c. Va

Vg2 r.m.s. = 1.1 indicated d.c. Vg2

Vg1 (mean unsmoothed) = 0.52 indicated d.c. Vg1

Ia (mean d.c.) = 0.5 indicated Ia

The manner of operation is shown in Fig 8. Included are voltage waveforms at various points as is the current waveform in the anode circuit.

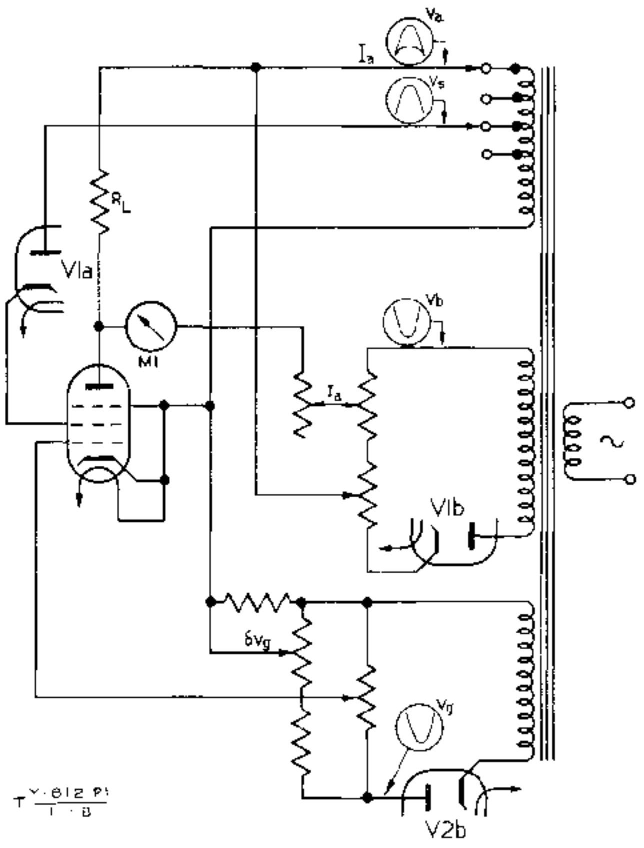


Fig 8 - Method of comparative testing. Tester CT 160

87. The electrode voltage controls are directly calibrated in terms of d.c. voltages and provide the indicated test voltages; for example, with the ANODE VOLTS switch set at 200V we have 220V r.m.s. applied to the anode and with the NEG GRID VOLTS set at -3V the mean d.c. voltage at the control grid is -1.56V. A factor of 2 has been introduced into the meter circuit and the actual d.c. Ia flowing in the anode circuit will be half that indicated on the ANODE CURRENT controls.

88. The principles of operation of the main function of the tester, ie, the comparative testing of mutual conductance, lie in the application of anode, screen, grid and heater voltages corresponding to the working point of the valve and backing off to zero the standing anode current thus obtained. A small incremental bias is applied to the valve and the change in anode current thus obtained is a measure of the mutual conductance of the valve. This change is then compared with the correct mutual conductance to give comparative 'goodness' on a coloured scale.

89. The basic circuit used is shown in Fig 8. With the correct electrode voltages applied to the valve, the half-wave current causes a voltage drop across the resistor RL, which is sufficiently low in value (200Ω) as not to influence the characteristics. This voltage is backed-off by a voltage (Vb) of similar form from the ANODE CURRENT controls. The voltage difference across the two arms of the bridge thus formed is shown on the meter. When the difference is zero, the voltage Vb is a measure of the anode current in RL and the control Vb is thus calibrated in mA anode current. A small change in bias is then applied from control dVg (SET mA/V) which causes an increased drop in RL, thus unbalancing the bridge. This unbalance is shown on the meter and is a measure of the mutual conductance. For a deflection on the meter of RL x Ia millivolts the mutual conductance of the valve in mA/V is $\frac{1}{dVg}$ (volts)

90. The f.s.d. of the meter is 1.3 x RL x Ia millivolts and the scale is zoned in three colours, green indicating a good, white a failing and red a reject valve.

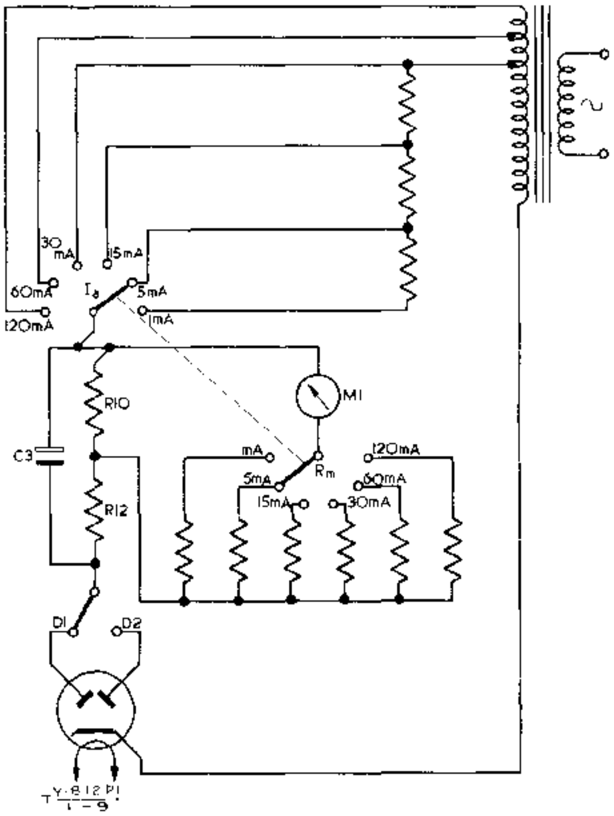


Fig 9 - Method of rectifier and diode testing. Tester CT 160

Method of rectifier and diode testing (Fig 9)

91. Rectifiers can be tested to ensure that each section will produce sufficient current under suitable load conditions. Tappings b, d and g on transformer T2 provide r.m.s. voltages of 44, 88.5 and 137.5V respectively and these are fed to the anode of the rectifier under test, which supplies the reservoir condenser, C3. The resistors R27, 28 and 29, in conjunction with resistors R10 and R12, provide six d.c. load conditions of 1mA, 5mA, 15mA, 30mA, 60mA and 120mA. The 44-volt tapping supplies the voltage for the 1mA test through R27, 28, 29, 10 and 12, for the 5mA test through R27, 28, 10 and 12, for the 15mA test through R27, 10 and 12 and for the 30mA test through R10 and 11. The 88.5V tapping supplies the voltage for the 60mA test through R10 and 12. The 137.5V tapping supplies voltage for the 120mA test through R10 and 12. Current in the load circuit is indicated by the voltage drop across R10 as read by the meter. The voltage multipliers R30 to R35 are so chosen that the meter will give a deflection in the centre of the 'green band' for a valve passing the required load current as chosen by the inner ring of figures on the ANODE CURRENT coarse control.

92. The load figures are chosen to correspond with the maximum emission specified by the valve manufacturers, which is to be found in Table 6 of Radar and FCE Y 811 Issue 1.

93. Signal diodes are tested only on the 1mA and 5mA ranges of the load test.

Continuity and insulation test circuits

94. The unsmoothed grid voltage is used for the continuity tests. The eight test circuits are established by settings of the CIRCUIT SELECTOR SG and ELECTRODE SELECTOR SF (paras 100-106 and 108-109 refer). The positions are shown in Fig 10. There is an example for heater continuity (a), two examples of insulation test with valve cold, (b) and (c), one for heater and cathode strapped to the rest, with valve hot (d), and the heater to cathode insulation test, with valve hot (e).

Transformer assembly (Fig 2009)

95. All supplies for the instrument are derived from the transformer assembly, consisting of the heater transformer T1 and the h.t. and grid voltage transformer T2. The mains tappings into T2 provide an auto-transformer control for the input to T1.

96. T2 has three secondary windings which supply:-

(a) 50V a.c. ANODE CURRENT backing-off voltage

(b) 55V a.c. grid working voltage circuit

(c) 12 tappings to provide anode and screen volts within the range 0-400 as selected by ANODE VOLTS and SCREEN VOLTS switches SD and SE, respectively.

97. Secondary tappings of T1 provide the heater volts in two ranges 0.625-117V and 1.4 to 80V. This changeover is effected by SC, a small toggle switch, and the selection of voltages by the HEATER VOLTS switch SB. The voltages in the range 0.625-117V are obtained with the auto-transformer input to T1 set at 200V on T2 and the voltages in the range 1.4 to 80V are obtained with this input set to 230V. Selected tappings only are used for this second range, These are 1.25, 2.5, 4.0, 5.0, 6.3, 11.0, 13.0, 16.0, 25.0, 30.0, 40.0, 48.0, 70.0, which have all been multiplied by the factor of 1.15 to give the voltages in the second range.

Set ~ circuit

98. Correct calibration of the electrode voltage controls is ensured in the setting-up procedure by the SET ~ circuit. With the CIRCUIT SELECTOR switch in the SET ~ position the meter is connected across the grid voltage circuit to earth and the mains selector adjusted for full scale deflection, ie, at the red mark in the centre of the SHORT mark on the insulation scale.

Circuit control arrangements

99. The instrument switching arrangements are complex because of the multiplicity of tests that have to be carried out on the varied valve types. It should be noted that the detached contact system for switches has been used in the circuit diagram (Fig 2007).

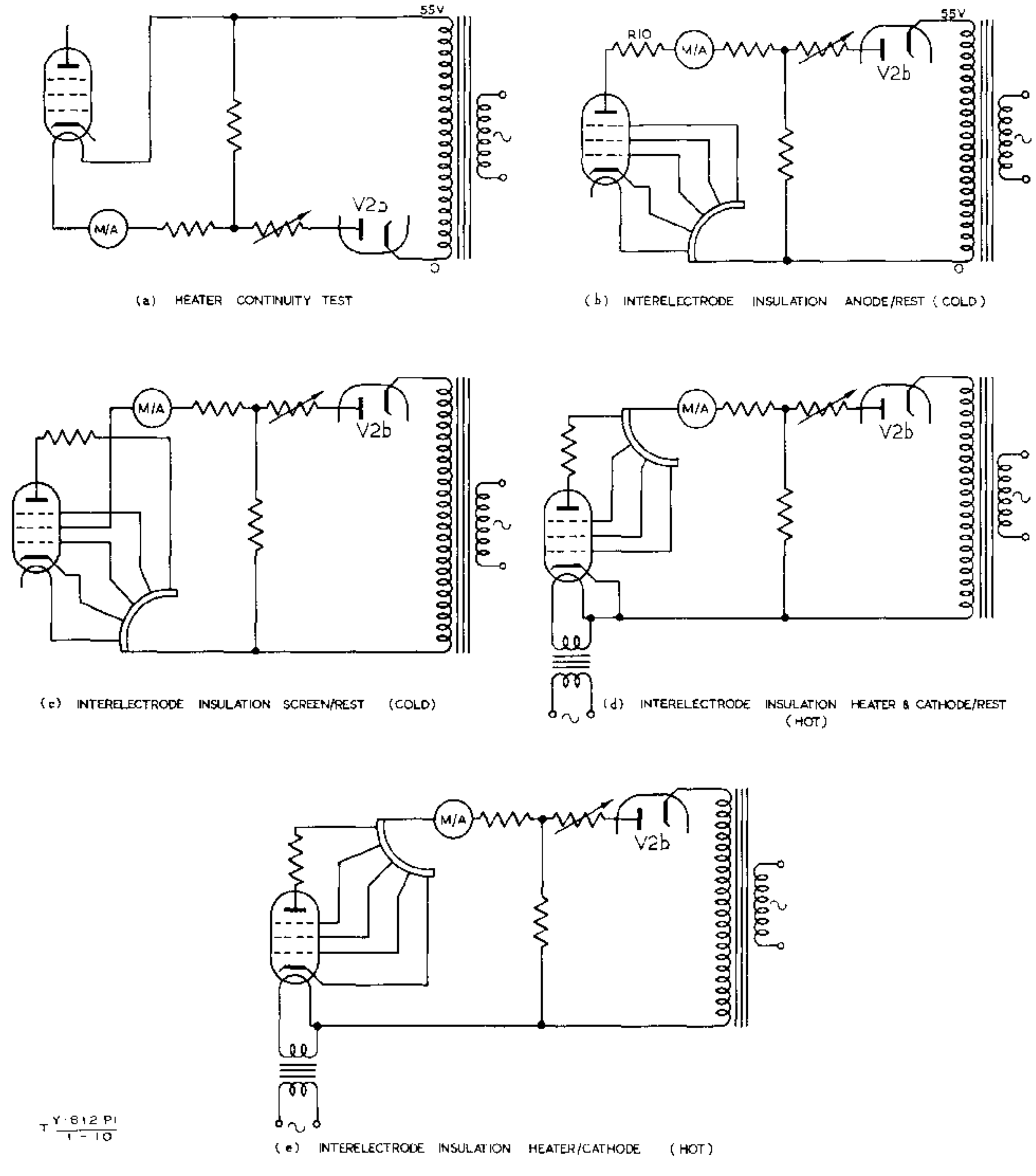


Fig 10 - Continuity and insulation test circuits. Tester CT 160

Circuit selector switch SG

100. The CIRCUIT SELECTOR switch has eight positions with three wafers each carrying eighteen contacts, only sixteen of which are used in conjunction with two wiper arms on each wafer. The functions of the wafers are:-

SG aa controls connections to the grid

ab controls connections to the screen

ba controls connections to the anode circuits

bb) controls connections to the meter
ca)

cb controls heater voltages connections

101. In position 1, SET ~ , the meter is connected across the grid working voltage supply to check this for a correct setting. If this supply is correct then all other supplies in the instrument are correct. All other connections to this switch are in a blank position.

102. Position 2, H CONT, connects the meter in series with the heater and limiting resistors across the grid voltage supply, to check the continuity of the heater.

103. Positions 3, 4 and 5, A/R, S/C and G H/R, respectively, are all positions for insulation tests. In each case the meter is connected in series with the first named electrode, the remainder strapped together and the grid working voltage. Condensers C1 and C2 prevent spurious readings on the insulation ranges when the instrument is used at high mains frequencies.

104. Position 6, C/H. In this position of the switch the insulation between cathode and heater is checked with the heater hot. To perform this test the ELECTRODE SELECTOR switch SF must be in position 1, C/H.

105. Position 7, TEST, enables the mutual characteristic tests to be carried out in conjunction with switches SD, SE, SH, NEG GRID VOLTS CONTROL, RV3, SET mA/V, RV2, and the ANODE CURRENT fine control, RV1. The anode supply is now connected via SG(ba), R10 and SF(bb) to the anode 1 or anode 2 circuits. The meter is connected by SG (bb) and (ca) to the backing-off circuits. SG (aa) connects the grid to the NEG GRID VOLTS control and SG (cb) the heater volts supply.

106. Position 8, GAS, SG (aa) connects two resistors R7 and 8 in series with the grid of the valve and SG (bb) and (ca) connect the meter across R8. The meter is directly calibrated in µA.Ig and this reads grid current.

Anode current switch SH and fine control RV1

107. The switch has six wafers but only three sliders. Reading from the front panel the sliders are on wafers a, c and d. The resistors R15 - 23 which form the potential divider across the backing off voltage are between wafers a and b. The remaining resistors between wafers e and f, ie, R24 - 26, R27 - 29, R30 - 35, are meter multipliers when on mutual conductance tests, load resistors for the rectifier under test, and meter multipliers when testing rectifiers, respectively.

Dependent upon the position of SH the backing-off voltage is applied to the meter to produce a zero. RV1 is in series with the potential divider R15 - 23 and provides a fine control of backing-off voltage, which is supplied by the 50V winding on the h.t. transformer T2.

Electrode selector switch SF

108. This is a double-sided twelve-contact wafer switch with six contacts on either side of each of the three wafers. It has five positions, marked C/H, A1, A2, D1 and D2. It is used when testing valves with more than one anode. In position 1, C/H, SF(ca) connects the cathode to the remaining electrodes with the exception of the heater. The grid working voltage is then applied to the circuit to test the cathode/heater insulation with the valve hot.

109. In the remainder of the positions meter multipliers are selected by SF(aa), (ab) in conjunction with SH as is the amount of backing-off voltage. The anode not under test in positions A1 and A2, is connected via SF(ab) and a limiting resistor R11 to the screen voltage supply. When rectifiers are being tested, however, the anode not under test is left floating and R12 is put in series with R10 via SF(ba) in the anode circuit under test.

Grid voltage supply and control

110. The grid voltage is supplied by the 55V winding on T2 and is rectified by V2(b). The positive side of the output is earthed and hence a negative potential is applied to the grid of the valve under test controlled by the NEG GRID VOLTS, RV3. The SET mA/V control, RV2, provides a small incremental change of grid voltage to enable the test to be made on mutual conductance.

111. The cathode of the other diode V2(a) is taken to the 60V tapping on transformer T1, from which 66V r.m.s. is obtained. The purpose of this diode is to apply a negative voltage to the grid during the half cycle when the anode and screen are negative and hence ensure the valve does not, under any circumstances, draw grid current.

Safety cut-out (Fig 11)

112. From Fig 11 it can be seen that the overload relay RL1 consists of three coils:-

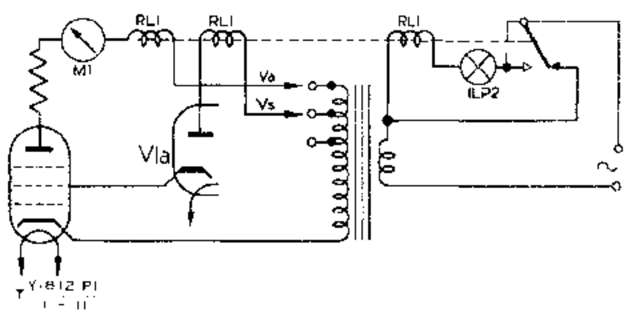


Fig 11 - Safety cut-out. Tester CT 160

(a) One in the anode voltage supply.

(b) One in the screen voltage supply.

(c) One connected in series with the primary of T2 if an overload occurs. This is the 'audible warning' coil.

Under normal test conditions sufficient current will not flow in the anode or screen circuits to operate the relay and the contacts will remain closed.

113. Should a short-circuit develop in either the valve or its associated sockets, with normal test voltages applied, the relay will operate with the following results:-

(a) Anode and screen voltages drop to zero

(b) The 'audible warning' coil chatters and a red warning lamp illuminates the meter scale from behind.

114. The cut-out will NOT operate when heavy currents of a d.c. nature occur in the valve anode circuit and thus it will not protect the meter if the ANODE CURRENT controls are set to a lower range than the value of current drawn by the valve. Normal working cannot be restored until the instrument has been switched off, the fault removed, and the instrument switched on again.

Anti-parasitic oscillation precautions

115. The problem of self oscillation can occur with high slope valves, which have a large enough value of mutual conductance to overcome the inherent losses of a tuned line. These tuned lines are formed by the connecting leads on the valve holder panel and the stray capacities and the oscillations would be in the v.h.f. spectrum. This problem has been overcome by having the connecting leads in loops of approximately the same length and configuration. These loops are closed on themselves via a connector loaded with ferrox-cube beads to give a high loss, so lowering the 'Q' of the line and making oscillation virtually impossible.

116. When a beam tetrode is being tested with a.c. voltages applied to its electrodes a condition may arise in which, due to the electrode voltages approaching zero during the a.c. cycle, the beam focusing is, to some extent, upset. This may give rise to reverse screen current, anode current will then rise and the screen current decrease rapidly and become negative. This would give erroneous readings and, if allowed to continue, damage the valve. To overcome this a diode is placed in series with the screen supply to the valve. Under normal conditions this will have little effect on the screen working conditions, but if there is a reversal of screen current it will present a very high impedance to this reversed current and prevent the above conditions from occurring.

Valve holder panel and roller selector switch

117. The valve holder panel, housed in the lid of the instrument, mounts twenty-two valve bases, a nine-way socket terminal board, anode links LK1 and LK2 and the nine-way ROLLER SELECTOR switch SJ. The valve holders are of the following types:-

(a) British 4/5 pin, 7 pin, 9 pin, and 8 pin side contact.

(b) B3G, B7G, B8A, B9A, B9G.

(c) B8B or B8G (American loctal).

(d) British and International octal.

(e) Hivac 4 and 5 pin.

(f) American 4 pin, 5 pin, 6 pin, small 7 pin Sm7, medium 7 pin UX7.

(g) Disc seal and flying lead.

118. These valve holders have the corresponding pin numbers wired in parallel. The nine way socket terminal board is connected to the sliding contacts on the ROLLER SELECTOR switch and provides supplies for valves with top cap or side connections. All the nine test circuits are connected to this tag board.

119. The ROLLER SELECTOR switch carries nine spring contacts, each of which can be rotated to make connections to any one of nine busbars arranged co-axially along the barrel of the switch. Thus any valve pin number can be connected to any one of the instrument circuits as shown in Fig 2007. The rollers are held in their selected positions by leaf springs acting on the moulding escapement. The

particular connection made for any one of the pin rotating contacts is indicated in the escutcheon windows by suitably engraved markers as under:-

1	2	3	4	5	6	7	8	9
C	H-	H+	G	S	A	A_2	D_1	D_2

120. 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 the h.t. wiring to prevent the transference of energy from one circuit to the other at high mains frequencies.

57/Maint/5921

END OF PART 1

TESTERS, VALVE, AVO

TECHNICAL HANDBOOK - FAULT-FINDING AND REPAIR DATA

Note: This Part 2, together with the Part 1, supersedes Tels Y 802, Issue 1, dated 19 Aug 44.

This Part 2 contains fault-finding and repair data in tabular and diagrammatic form. The text, describing how various operations are to be carried out, is in the Part 1 and the regulations dealing with unit, field and base repairs.

INDEX TO TABLES

INDEX TO FIGURES

Distribution - Class 930, Code No 6

Table 2001 - Tester, valve, Avo, No 1 - components

Part No	Circuit ref	Value	Tolerance and rating	Type	Figure and location
			RESISTORS		
W4/WY 2049	R1	9Ω + 1Ω	0.5%	W.W. card	2001/J1
W4/WY 2050	R2	40Ω (approx)		W.W. card	2001/H1
W4/WY 2024	R3	50Ω		W.W. bobbin	2001/L2
Z/Z 111427	R4*	82Ω	10% 1W	Carbon, grade 2, insulated	2001/K5
Z1/ZA 15503	R5	470Ω	20% 0.5W	No 3A	2001/M3
Z/Z 223038	R6	100kΩ	10% 0.5W	Carbon, grade 2, non-insulated	2001/H5
Z/Z 223079	R7	220kΩ	10% 0.5W	Carbon, grade 2, non-insulated	2001/N5
Z/Z 223079	R8	220kΩ	10% 0.5W	Carbon, grade 2, non-insulated	2001/N5

* Preferred value replacement

Part No	Circuit ref	Value	Tolerance and rating	Type	Figure and location
			CAPACITORS		
Z1/ZA 318925	C1	0.05μF	20% 1000V	Paper, metal, tubular	2001/F4
Z1/ZA 17113	C2	0.001μF	20% 1000V	Paper, metal, tubular	2001/A1
Z1/ZA 21380	C3	25μμF		Ceramic	2001/B2
Z1/ZA 17113	C4	0.001μF	20% 1000V	Paper, metal, tubular	2001/C1
			POTENTIOMETERS		
W4/WY 1997	RV1	90Ω		W.W.	2001/J1
W4/WY 1996 / W4/WY 1995	RV2	500Ω (inner) / 1.88kΩ (outer)		W.W.	2001/M1
			SWITCHES		
Z1/ZA 8724	SA	-	3A 250V	Toggle, single-pole, one-way	2001/P8
-	SB	-	Special	Rotary, 1-pole, 14-position	2001/L 7, 8
-	SC	-	Special	Rotary, 1-pole, 8-position	2001/L3
-	SD	-	Special	Rotary, 1-pole, 8-position	2001/L2
-	SE	-	Special	Rotary, 1-pole, 4-position	2001/E2
-	SF	-	Special	Key-operated, leaf, centre-loaded, 6 + 1-pole, 2-way	2001/G3,4,5

Table 2001 (cont)

SWITCHES (cont)

Part No	Circuit ref	Value	Tolerance and rating	Type	Figure and location
-	SG	-	Special	Assemblies, rotary, 9-unit, 1-pole, 10-position	2001/A5, 6
Z1/ZA 6675	SH	-	3A 230V	Toggle, double-pole, 2-way	2001/B8
			TRANSFORMERS		
W4/WY 2019	T1	Multi secondary	230V	h.t. & g.b. supplies	
W4/WY 2018	T2	Multi secondary	200-250V	Heater supplies	
W4/WY 2023	T3	7:1 step down	-	Auto-wound	
			RECTIFIER		
Z1/ZA 21751	MR1	-	1/6A	Metal	2001/L2
			METER		
-	M1	-	0.7mA f.s.d.	$5\frac{1}{2}$ in. scale	2001/G2
			VALVES		
Z1/ZA 0608		-	-	Neon G.E.C. Tuneon	2001/P5

Table 2002 - Consolidated test equipment

Type of repair	Equipment
Unit	Instrument, testing, Avometer, universal, 50-range, Mk 1 WY 0760

Table 2003 - Tester, valve, Avo, No 3 - components

Part No	Circuit ref	Value	Tolerance and rating	Type	Location
			RESISTORS		
Z/Z 223079	R1	220kΩ	10% 0.25W	Carbon, grade 2, insulated	2005/E3
Z/Z 244166	R2	24kΩ	5% 6W	W.W. vitreous, wire end	2005/H1
Z4/ZD 00482	R3	150Ω	5% -	W.W. bobbin	2005/Q5
Z1/ZA 38770	R4	125kΩ	1% 0.5W	Carbon, grade 1, non-insulated	2005/P8
-	R5	22Ω	- -	Supplied as part of RV4	2005/L6
Z1/ZA 38774	R6	175kΩ	5% 1W	Carbon, grade 1, non-insulated	2004/Q8
Z/Z 222089	R7	4.7kΩ	10% 0.5W	Carbon, grade 2, insulated	2004/Q8
Z/Z 222089	R8	4.7kΩ	10% 0.5W	Carbon, grade 2, insulated	2005/Q8
Z/Z 218087	R9	20kΩ	10% 0.75W	Carbon, grade 1, non-insulated	2005/Q7

Table 2003 (cont)

RESISTORS (cont)

Part No	Circuit ref	Value	Tolerance and rating		Type	Location
Z4/ZD 00483	R10	2.5Ω	0.5%	-	W.W. bobbin	2005/K6
Z/Z 223038	R11	100kΩ	10%	0.5W	Carbon, grade 2, insulated	2005/M7
Z4/ZD 00484	R12	7.5Ω	0.5%	-	W.W. bobbin	2005/L6
Z/Z 217075	R13	200Ω	5%	0.25W	Carbon, grade 1, non-insulated	2005/R6
Z4/ZD 00487	R14	50Ω	0.5%	-	W.W. bobbin	2005/J6
Z4/ZD 00488	R15	80.8Ω	0.5%	-	W.W. bobbin	2005/J6
Z4/ZD 00490	R16	12.78Ω	0.5%	-	W.W. bobbin	2005/H6
Z4/ZD 00489	R17	3.21Ω	0.5%	-	W.W. bobbin	2005/H6
Z4/ZD 00491	R18	1.61Ω	0.5%	-	W.W. bobbin	2005/G6
Z4/ZD 00492	R19	0.793Ω	0.5%	-	W.W. bobbin	2005/G6
Z4/ZD 00493	R20	0.807Ω	0.5%	-	W.W. bobbin	2005/F6
Z4/ZD 00462	(R21	900Ω	5%	-	Strips, resistance, 900Ω ± 5% + 900Ω ± 5%	2005/F7
	(R22	900Ω	5%	-		2005/G7
Z/Z 244030	R23	2kΩ	5%	6.0W	W.W. vitreous, wire end	2005/G7
Z4/ZD 00495	R24	4.2kΩ	5%	-	W.W. bobbin	2005/H7
Z4/ZD 00494	R25	17kΩ	5%	-	W.W. bobbin	2005/H7
Z4/ZD 00487	R26	50Ω	0.5%	-	W.W. bobbin	2005/M6
Z4/ZD 00486	R27	75Ω	0.5%	-	W.W. bobbin	2005/M6
Z4/ZD 00485	R28	15Ω	0.5%	-	W.W. bobbin	2005/L6
Z/Z 222089	R29	4.7kΩ	10%	0.5W	Carbon, grade 2, insulated	2005/E10 J10
Z1/ZA 41516	R30≠	75Ω	25%	0.5W	Carbon, grade 2, insulated	2005/E10
Z1/ZA 41516	R31	75Ω	25%	0.5W	Carbon, grade 2, insulated	2005/E10, K10
Z1/ZA 41516	R32	75Ω	25%	0.5W	Carbon, grade 2, insulated	2005/E10, J10
Z/Z 221122	R33	120Ω	10%	0.5W	Carbon, grade 2, insulated	2005/B10
	(R34≠	120Ω	10%	0.5W	Carbon, grade 2, insulated	2005/B10
	(R35≠	120Ω	10%	0.5W	Carbon, grade 2, insulated	2005/B10
	(R36≠	120Ω	10%	0.5W	Carbon, grade 2, insulated	2005/B10
Z/Z 221122	(R37≠	120Ω	10%	0.5W	Carbon, grade 2, insulated	2005/B11
	(R38≠	120Ω	10%	0.5W	Carbon, grade 2, insulated	2005/B11
	(R39≠	120Ω	10%	0.5W	Carbon, grade 2, insulated	2005/C12
	(R40≠	120Ω	10%	0.5W	Carbon, grade 2, insulated	2005/C12
	(R41≠	120Ω	10%	0.5W	Carbon, grade 2, insulated	2005/D12
	(R42*	75Ω	25%	0.5W	Carbon, grade 2, insulated	2005/K11
Z1/ZA 41516	(R43*	75Ω	25%	0.5W	Carbon, grade 2, insulated	2005/L11
	(R44*	75Ω	25%	0.5W	Carbon, grade 2, insulated	2005/F10

≠ Not in the circuit of the Mk I instrument
* Not in the circuit of the Mk 2 instrument
⁄ Preferred valve replacement

correction

Table 2003 (cont)

CAPACITORS

Part No	Circuit ref	Value	Tolerance and rating	Type	Location
Z/Z 145059	C1	8μF	20% 350V	Electrolytic, ins., tub.	2005/F6
Z1/ZA 38925	C2	0.05μF	20% 1000V	Paper, metal, tubular	2005/P1
Z1/ZA 38925	C3	0.05μF	20% 1000V	Paper, metal, tubular	2005/P3
Z 115281	C4*	0.005μF	20% 750V	Paper, metal, tubular	2005/G11
Z 115281	C5*	0.005μF	20% 750V	Paper, metal, tubular	2005/G12

* Not in the circuit of the Mk 2 instrument

POTENTIOMETERS

Part No	Circuit ref	Value	Tolerance and rating	Type	Location
Z4/ZD 00457	RV1) RV2)	500Ω + 1400Ω	-	W.W.special	2005/R5
Z4/ZD 00458	RV3	20.0kΩ	---	W.W.special	2005/Q7
Z4/ZD 00456	RV4	333.3Ω+ 22Ω (R5)		W.W.special	2005/N6
Z1/ZA 38773	RV5	1kΩ	- 1W	W.W.linear, miniature	2005/Q6
Z1/ZA 38772	RV6	5kΩ	- 1W	W.W.linear, miniature	2005/R8
Z1/ZA 38771	RV7	2.5kΩ	- 1W	W.W.linear, miniature	2005/L5

RECTIFIERS

Part No	Circuit ref	Value	Tolerance and rating	Type	Location
Z1/ZA 21751	MR1	-	- 1/6A	Metal	2005/Q5
Z1/ZA 21751	MR2	-	- 1/6A	Metal	2005/N3
Z4/ZD 00460	MR3	-	3.5V 5mA	Metal, type KG1	2005/R6
Z4/ZD 00459	MR4	-	135V 8mA	Selenium, type 16K9	2005/R7

RELAY

Part No	Circuit ref	Value	Tolerance and rating	Type	Location
Z4/ZD 00461	RL1	-	50-70mA	Two-coil, polarized, electro-magnetic	2005/N2, 3

FUSE

Part No	Circuit ref	Value	Tolerance and rating	Type	Location
Z1/ZA 3586	FS1	-	- 2.0A	Cartridge	2005/T7

METER

Part No	Circuit ref	Value	Tolerance and rating	Type	Location
Z4/ZD 00449	M1	-	460μA f.s.d.	3½ in. scale, flush mounting	2005/L5

TRANSFORMERS

Part No	Circuit ref	Value	Tolerance and rating	Type	Location
Z4/ZD 00473	T1	-	0 - 95V/255V 0-16V+0-116V (tapped)	Heater supplies	
Z4/ZD 00474	T2	-	200V Multi-secondary	Power, g.b. and h.t. supplies	

Table 2003 (Cont)

SWITCHES

Part No	Circuit ref	Value	Tolerance and rating	Type	Location
Z1/ZA 37451	SA	-	250V 3A	Toggle, 2-pole, 1-way	2005/T7
Z4/ZD 00467	SB	-	-	Rotary, wafer, 1-bank, 1-pole, 11-position	2005/T11, 12
Z4/ZD 00468	SC	-	-	Rotary, wafer, 1-bank, 1+1-pole, 12-position	2005/Q9, 10
Z4/ZD 00470	SD	-	-	Rotary, wafer, 2-bank, 2+2-pole, 12-position	2005/NP11, 12
Z4/ZD 00465	SE	-	-	Rotary, 1-pole, 17-position	
Z4/ZD 00465	SF	-	-	Rotary, 1-pole, 17-position	
Z4/ZD 00469	SG	-	-	Rotary, wafer, 2-bank, 2 + 2-pole, 6-position	
Z4/ZD 00471	SH	-	-	Rotary, wafer, 2-bank 3 + 3-pole, 3-position	
Z4/ZD 00472	SI	-	-	Rotary, wafer, 6-bank, 2 x 6-pole, 6-position	
Z4/ZD 00466	SJ	-	-	Rotary, wafer, 1-bank, 1 + 1-pole, 9-position	
Z4/ZD 00464	(SK (SL (SM	- - -	- - -	) Push button,) three unit 2 + 2 + 1-) pole, 2-position	
Z1/ZA 32606	SN	-	-	D.P. changeover	
Z4/ZD 00463	SO	-	-	Assemblies, rotary, 9-unit 1-pole, 10-position	

VALVES

Part No	Circuit ref	Value	Tolerance and rating	Type	Location
Z/CV 1092	V1	-	-	Valves, electronic	2005/E4

LAMPS

Part No	Circuit ref	Value	Tolerance and rating	Type	Location
Y3/X951225	ILP1		6.5V 2.36W	Lamps, filament, vac, M.E.S.C., clear	2005/N4
Y3/X951225	ILP2		6.5V 2.36W	Lamps, filament, vac, M.E.S.C., clear	2005/N4

Table 2004 - Consolidated test equipment

Type of repair	Equipment
Unit	Instrument, testing, Avometer, universal, 50-range Mk 1 (WY 0760)
Field	(Instrument, testing, Avometer, universal, 50-range Mk 1 (WY 0760) (Voltmeter, valve, No 2, Mk I/I (WD 4188)

Table 2005 - Tester, valve, Avo, CT 160 - components

Part No	Circuit ref	Value	Tolerance and rating	Type	Location
			RESISTORS		
Z1/ZA 48258	R1	2.34kΩ	1% 0.75W	Carbon, high stability, non-insulated	2007/N5
Z1/ZA 41469	R2	70Ω	1% 0.25W	)	2007/P6
	R3	)2 resistors		)	
Z1/ZA 48265		)matched to	1% 0.25W	)	2007/M5, 6
	R4	)total 1.32MΩ		)	
Z1/ZA 48251	R5	500Ω	1% 0.25W	)Carbon, high stability,	2007/N6
	(R6a	)2 resisotrs		)grade 1, non-insulated	
Z1/ZA 48263	(	)matched to	2% 0.25W	)	2007/Q5
	(R6b	)total 730Ω		)	
Z/5905-Z21698	R7	330kΩ	2% 0.25W	)	2007/M4
Z/Z 216211	R8	10kΩ	2% 0.25W	)	2007/M6
Z/Z 216206	R9	10kΩ	1% 0.25W	)	2007/K6
Z1/ZA 48264	R10	200Ω	2½% 4.5W	W.W. vitreous, (over-wound by AVO)	2007/G4
Z1/ZA 48259	R11	8kΩ	5% 4.5W	W.W. vitreous	2007/G2
Z1/ZA 48260	R12	500Ω	2½% 4.5W	W.W. vitreous	2007/G4
Z/Z 216291	R14	22kΩ	2% 0.25W		2007/F6
	(R15	80Ω)			2007/E9
	(R16	80Ω)			2007/F9
	(R17	80Ω)			2007/F9
	(R18	80Ω)			2007/G9
Z1/ZA 39593	(R19	80Ω)	2% 0.25W	Carbon, high stability,	2007/G9
	(R20	80Ω)		grade 1, non-insulated	2007/H9
	(R21	80Ω)			2007/H9
	(R22	80Ω)			2007/J9
	(R23	80Ω)			2007/J9
	(R24	240Ω)			2007/J6
Z/5905-Z215490	(R25	240Ω)	2% 0.25W	Carbon, high stability,	2007/J6
	(R26	240Ω)		grade 1, non-insulated	2007/H7
Z1/ZA 48252	R27	600Ω	2% 0.25W	)	2007/R3
Z/Z 215750	R28	3kΩ	2% 0.25W	)	2007/R3
Z/Z 216251	R29	15kΩ	2% 0.25W	)	2007/N3
Z1/ZA 48253	R30	814kΩ	2% 0.25W	)Carbon, high stability,	2007/H5
Z1/ZA 48254	R31	406kΩ	2% 0.25W	)grade 1, non-insulated	2007/J5
Z1/ZA 48255	R32	202kΩ	2% 0.25W	)	2007/J5
Z/Z 216450	R33	100kΩ	2% 0.25W	)	2007/J5
Z1/ZA 48256	R34	31.5kΩ	2% 0.25W	)	2007/J4
Z1/ZA 48257	R35	4.35kΩ	2% 0.25W	)	2007/H4
			CAPACITORS		
Z/Z 115830	(C1a	0.04μF	)20% 150V	Paper, insulated, tubular	2007/L2
	(C1b	0.04μF	)		
Z/Z 115828	C2	0.02μF	20% 150V	Paper, insulated, tubular	2007/L2
Z/Z 145504	C3	8μF	20% 450V	Electrolytic, insulated	2007/M3

Table 2005 (cont)

Part No	Circuit ref	Value	Tolerance and rating	Type	Location
			POTENTIOMETERS		
Z1/AP 64433	RV1	90Ω	2% 1.5W	W.W.linear	2007/K9
Z1/AP 64434	RV2	2.5kΩ	5% 1.5W	W.W.linear	2007/N6
Z1/AP 64435	RV3	10kΩ	5% 1.5W	W.W. special low	2007/N6
Z1/AP 61373	RV4	500Ω	5% 0.5W	W.W.linear	2007/N5
			RELAY		
Z4/ZD 03406	RL1			Three-coil, single-pole electro-magnetic	2007/R1, 2
			FUSE		
Z1/ZA 3586	F1, F2		2.0A	Cartridge	2007/U6
			METER		
Z4/ZD 03419	M1	-	30µA f.s.d. (Int res 3,250Ω)	Moving coil, 2½ in. scale, flush mounting	2007/K6
			TRANSFORMERS		
	T1		0 - 230V 0 - 5.8V 0 - 117V	Heater supplies multi-tapped secondary	
	T2		0 - 105V/250V 0 - 50V 0 - 55V 0 - 440V	Power supplies h.t. and g.b. Multi-tapped secondary	
			SWITCHES		
Z1/ZA 37452	SA	-	250V 3A	Toggle, 2-pole, 2-way	2007/U8
	SB	-	-	Rotary, 1-pole, 18-position	
	SC	-	230V 3V	Toggle, 2-pole, 2-way	2007/T5
	SD	-	-	Rotary, wafer, 1-bank, 1-pole, 11-position	
	SE	-	-	Rotary, wafer, 1-bank, 1-pole, 11-position	
	SF	-	-	Rotary wafer, 3-bank, 5-position	
Z4/ZD 03390	SG	-	-	Rotary, 3-bank, 3 x 2-pole, 8-position	
	SH	-	-	Rotary, wafer, composite	
Z4/ZD 03391	SJ	-	-	Assemblies, rotary, 9-unit, 1-pole, 10-position	
	SK	-	-	Single-pole, 5-way and screw-tapping(IK4)	2007/T4

Table 2005 (cont)

Part No	Circuit ref	Value	Tolerance and rating	Type	Location
			VALVES		
Z/CV 140	V1	–	–	Valves electronic	2007/N1 2007/R5
Z/CV 140	V2	–	–	Valves electronic	2007/Q4
			LAMPS		
Y3/X951225	ILP1		6.5V 2.36W	Lamps,fil.,vac.,M.E.S.C. clear	2007/R9
Z1/ZA 7846	ILP2		200V 15W	Pigmy,SBC,overload indicator	2007/T2

Table 2006 - Consolidated test equipment

Type of repair	Equipment
Unit	Instrument, testing, Avometer, universal, 50-range Mk 1 (WY 0760)
Field	(Instrument, testing, Avometer, universal, 50-range Mk 1 (WY 0760) (Voltmeter, valve, No 2, Mk I/I (WD 4188)

Table 2007 - Valve holders - all testers

Part No	Designation	T.V.A. No 1	T.V.A. No 3	T.V.A. CT 160
Z/Z 560049	Holder, valve, 3-pin, B3G, No 2	1	1	1
Z1/ZA 38910	Holder, valve, 4-pin, DA4(Sm 4), No 1	–	1	1
Z/Z 560020	Holder, valve, 4-pin, UX4, No 1	1	1	1
Z/Z 560013	Holder, valve, 5-pin, B5, No 3	1	1	1
Z1/ZA 38913	Holder, valve, 5-pin, DA5(Sm 5), No 1	–	1	1
Z/Z 560007	Holder, valve, 5-pin, UX5, No 2	1	1	1
Z1/ZA 40820	Holder, valve, 5-pin, B5A, No 1	1	–	–
Z/Z 560008	Holder, valve, 6-pin, UX6, No 1	1	1	1
Z/Z 560018	Holder, valve, 7-pin, B7, No 2	1	1	1
Z/Z 560009	Holder, valve, 7-pin, USM7, No 1	–	1	1
Z/Z 561120	Holder, valve, 7-pin, USS7 (UX7), No 1	1	1	1
Z1/ZA 41514	Holder, valve, 7-pin, B7G, No 12	1	1	1
Z1/ZA 38924	Holder, valve, 8-contact, SC8, No 1	–	1	1
Z1/ZA 41515	Holder, valve, 8-pin, B8A, No 1	1	1	1
Z1/ZA 38911	Holder, valve, 8-pin, B8G, No 1	1	1	1
Z/Z 560027	Holder, valve, 8-pin, IO, No 1	1	1	1
Z/Z 560031	Holder, valve, 8-pin, IO, No 2	1	1	1
Z1/ZA 38912	Holder, valve, 9-pin, B9, No 1	1	1	1
Z1/ZA 41513	Holder, valve, 9-pin, B9A, No 6	1	1	1
Z/Z 560101	Holder, valve, 9-pin, B9G, No 2	1	1	1
Z4/ZD 02328	Adaptor, valve base, B5B/B8D flying lead	1	–	–
Z4/ZD 03489	(Contacts, valve pin, ceramic, insulated,)1.1/4in.) (x 1/2 in. x 1/2 in. overall (To make up flying) (lead and disc seal bases))	–	–	17

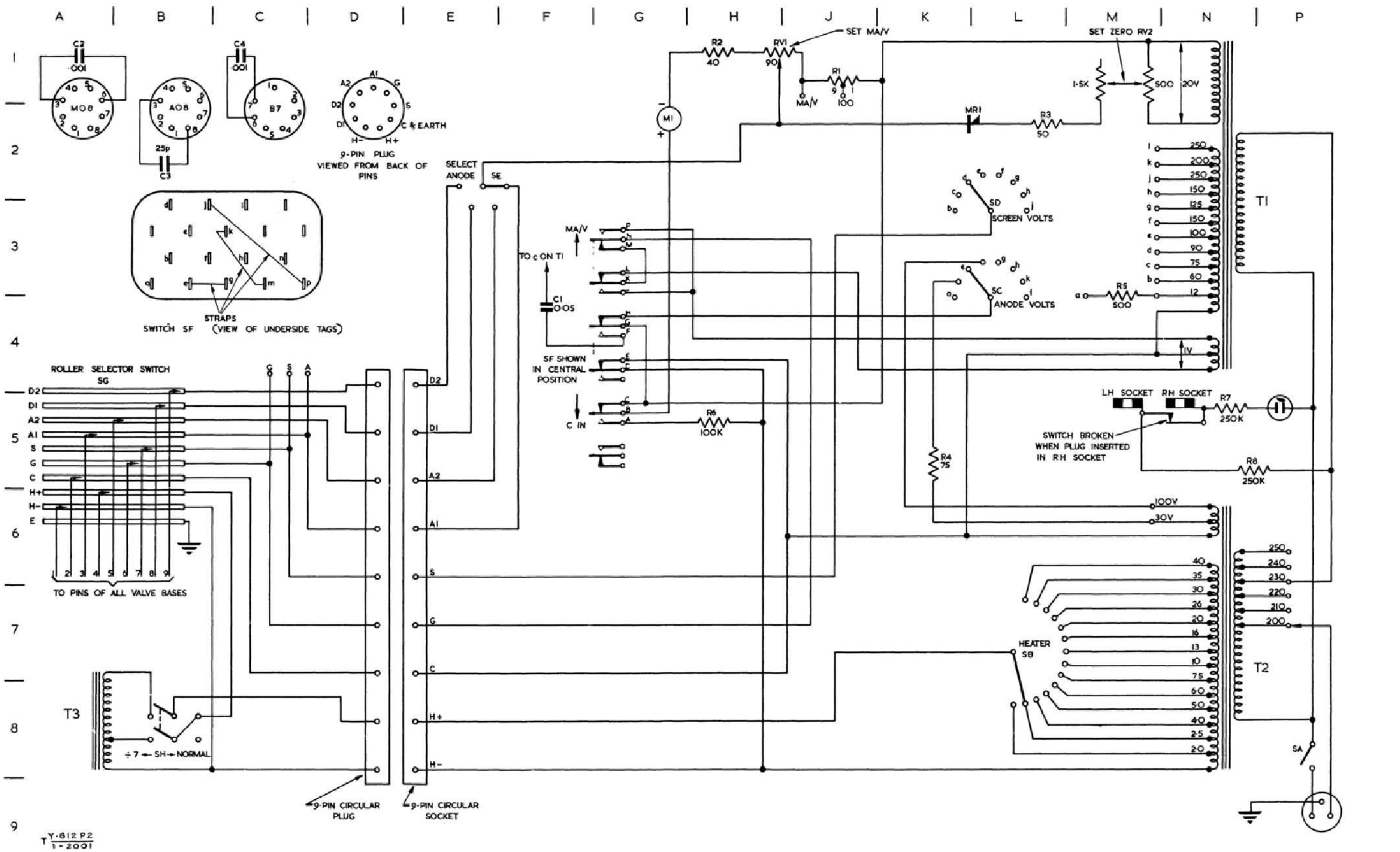


Fig 2001 - Circuit diagram T.V.A. No 1

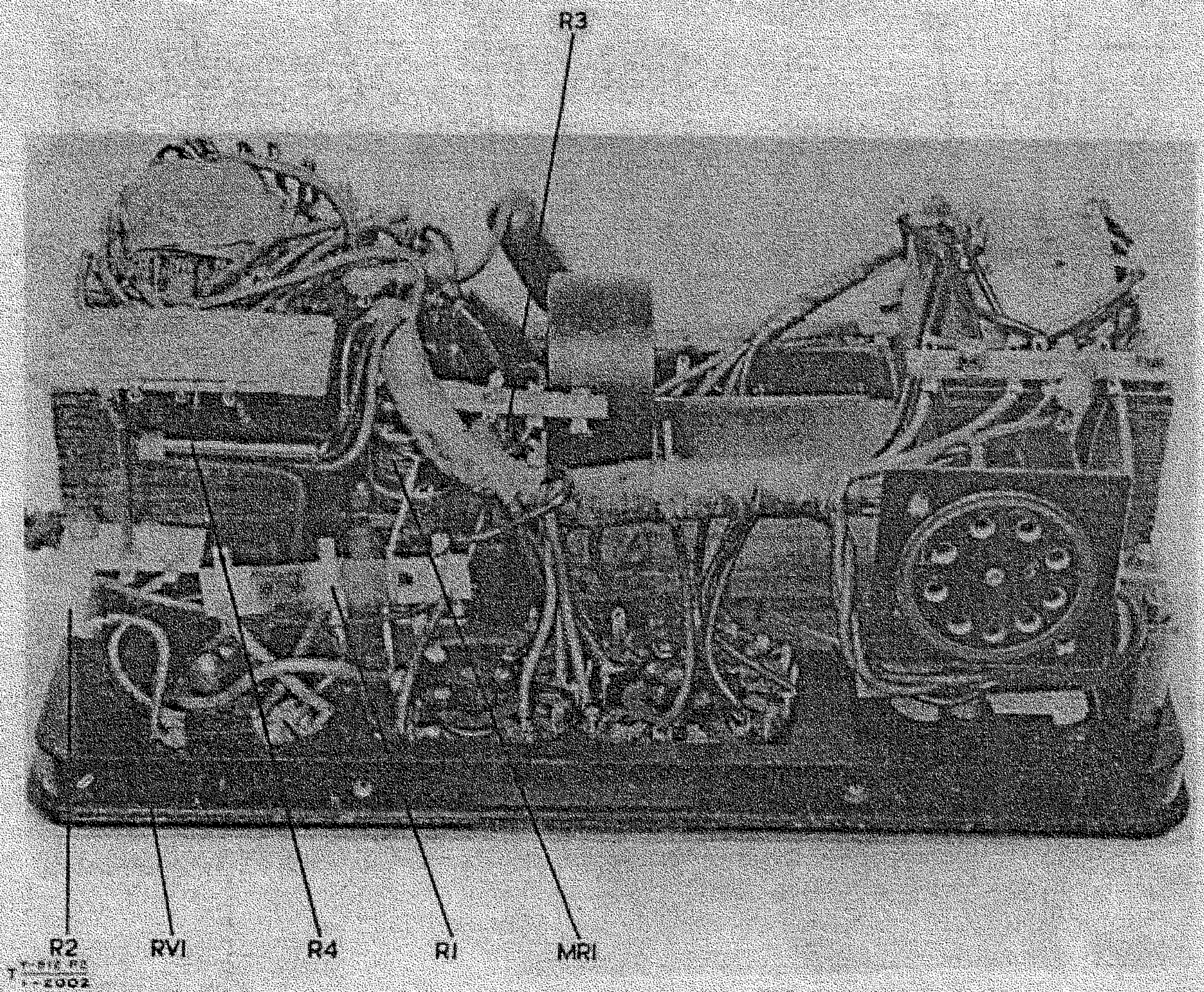


Fig 2002 - Underside view of main unit (r.h. view) T.V.A. No 1

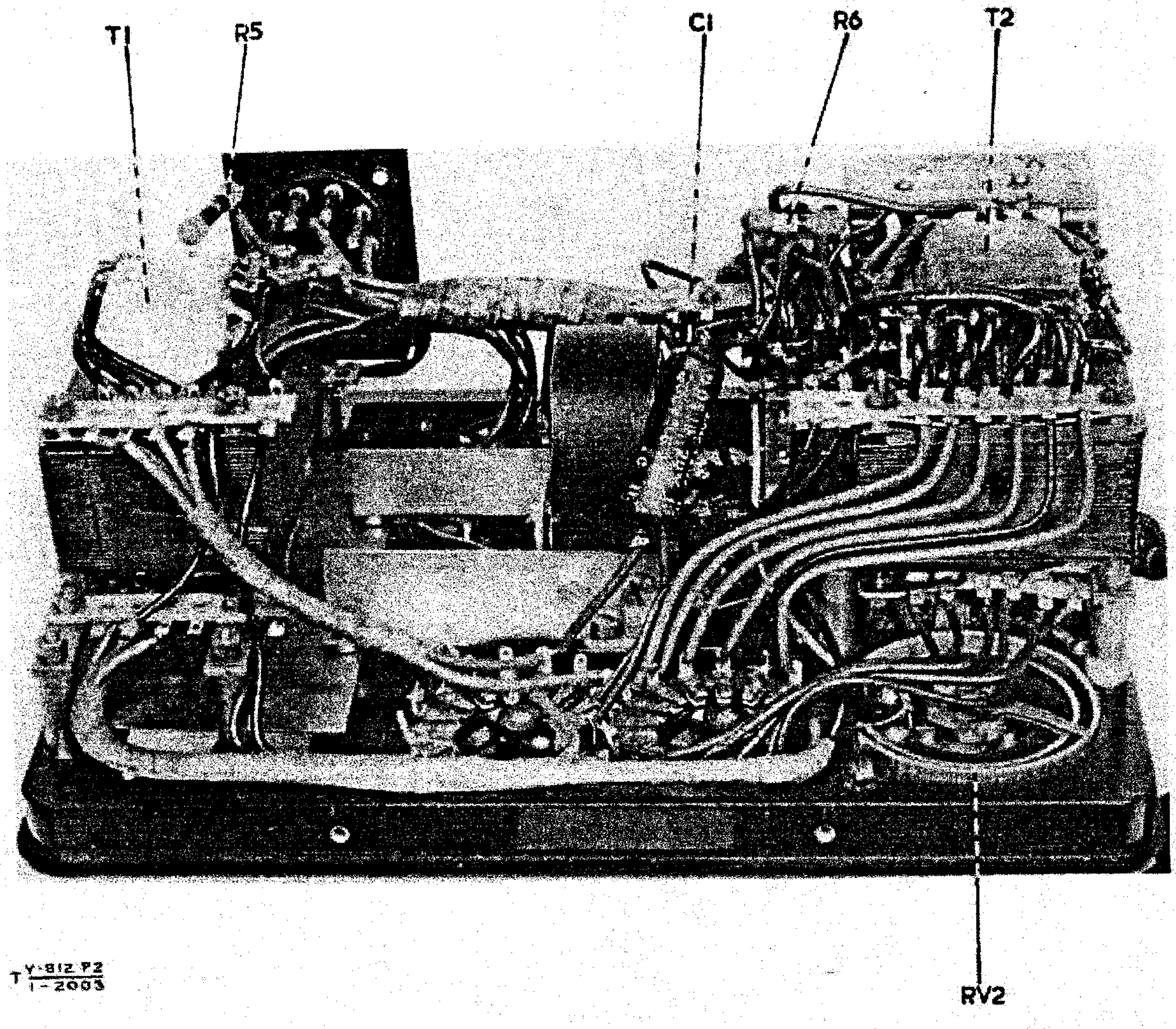
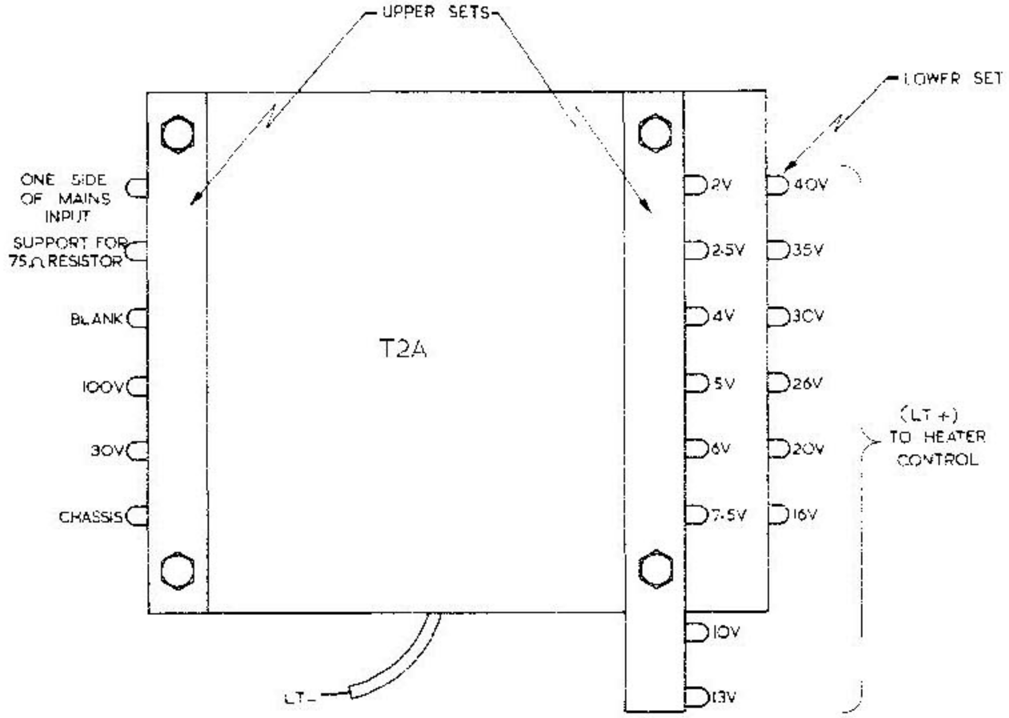


Fig 2003 - Underside view of main unit (l.h. view) T.V.A. No 1



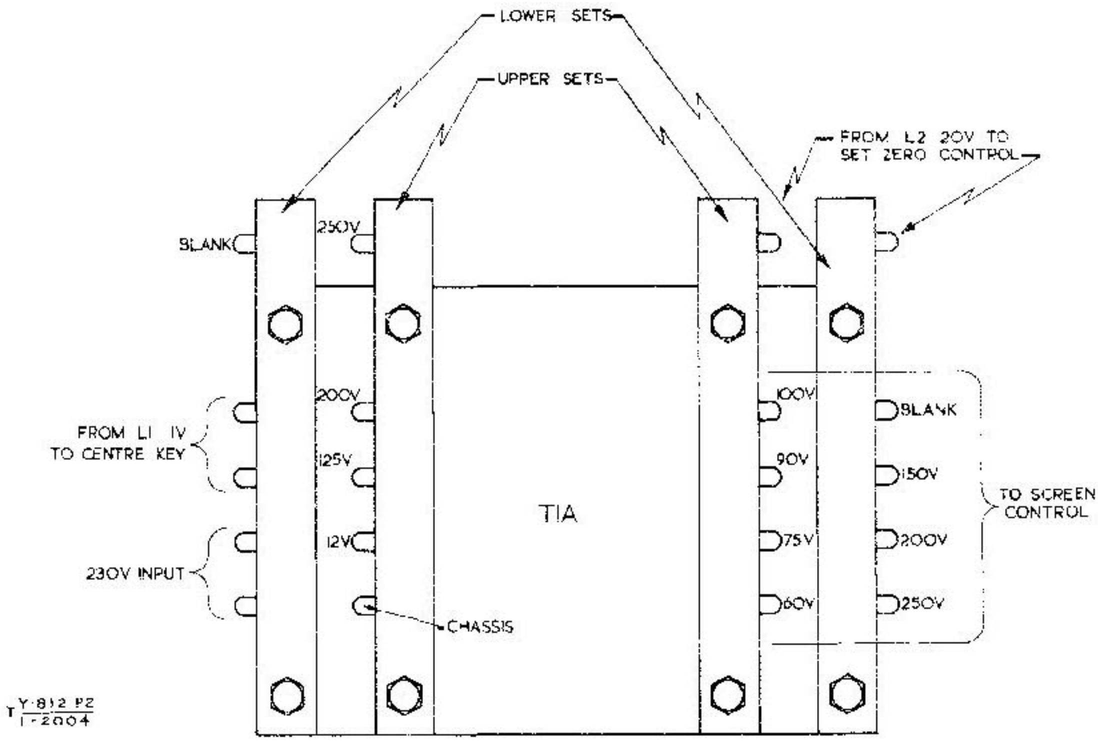


Fig 2004 - Diagrams of transformer tappings T.V.A. No 1

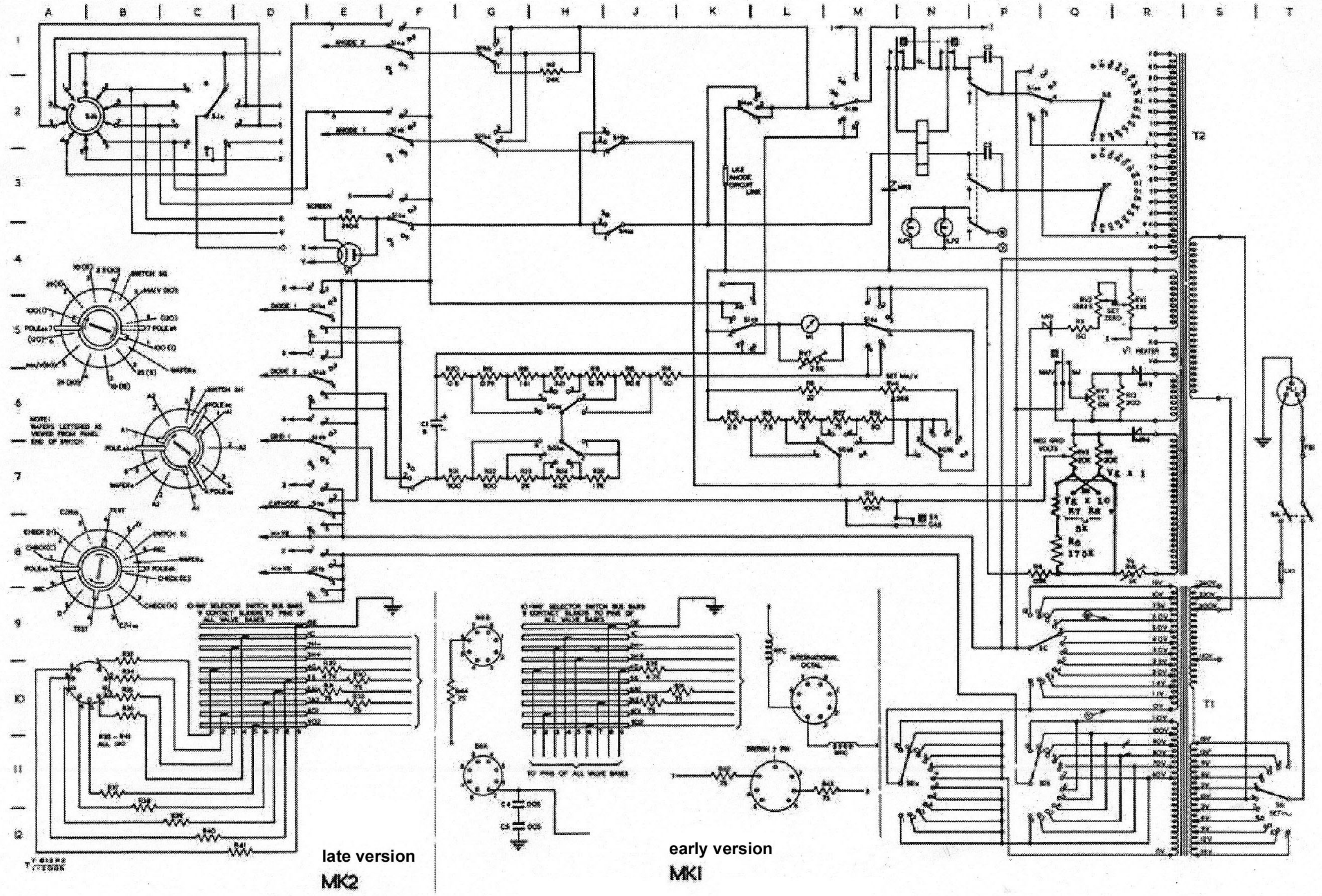


Fig 2005 - Circuit diagram T.V.A. No 3

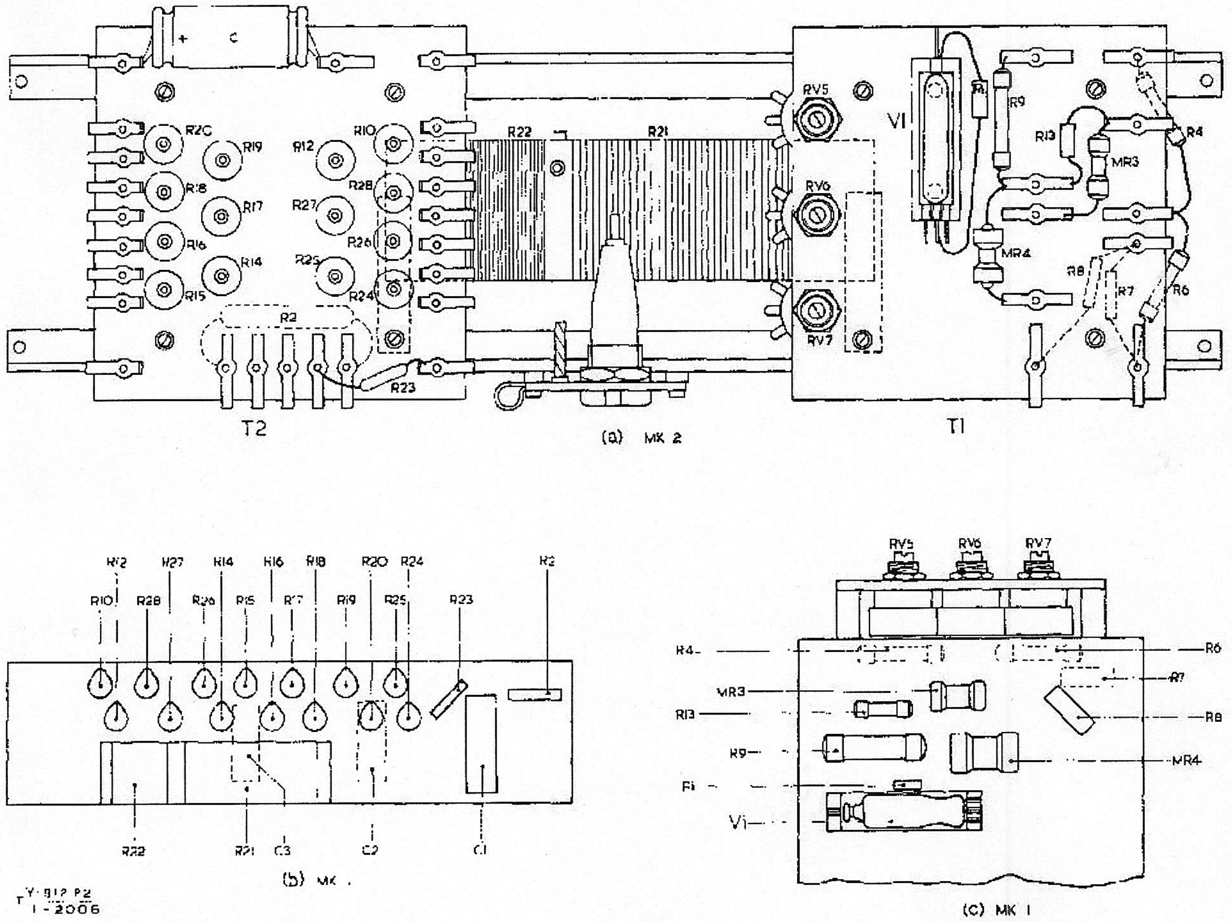


Fig 2006 - Transformer assemblies T.V.A. No 3

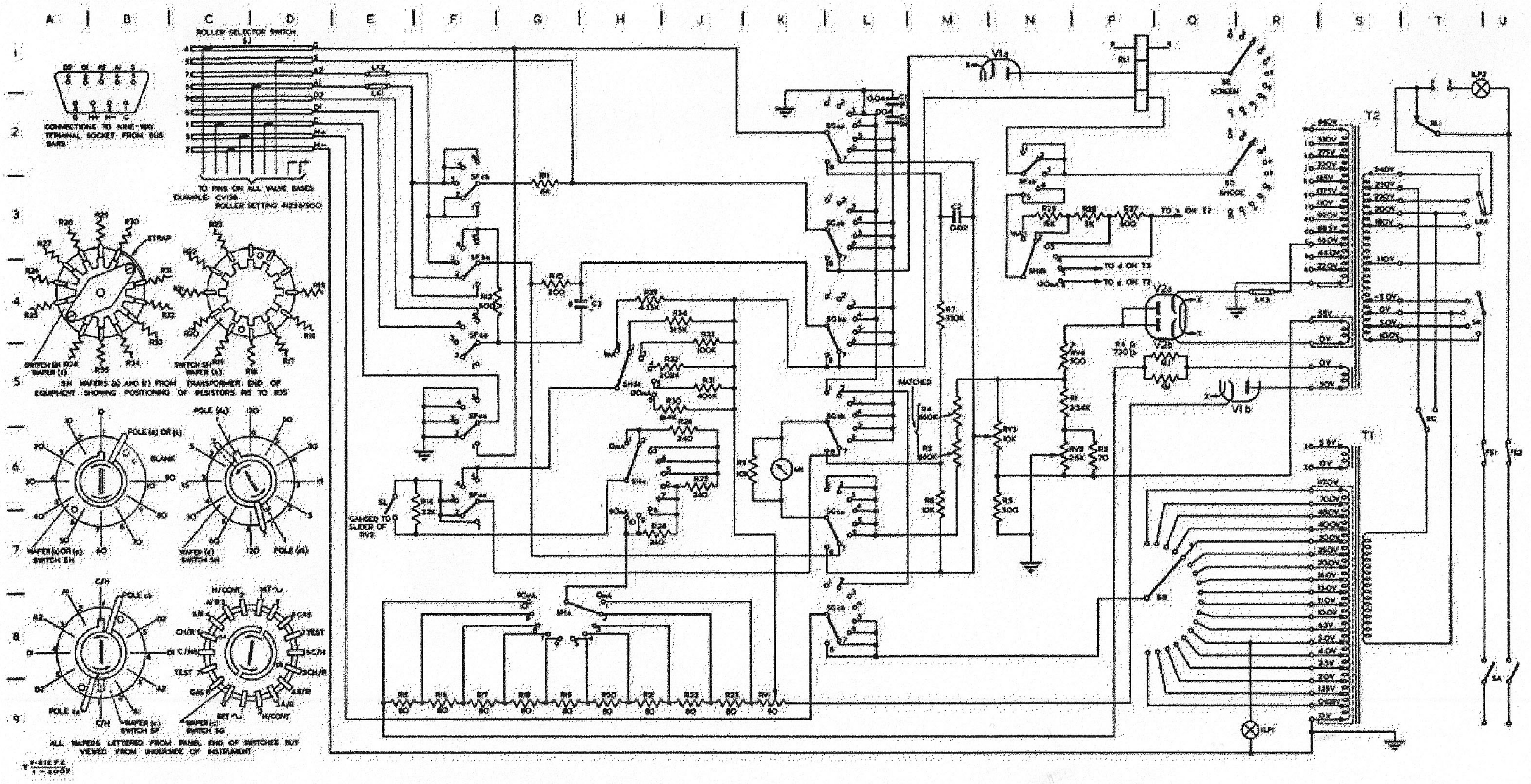


Fig 2007 - Circuit diagram T.V.A. CT 160

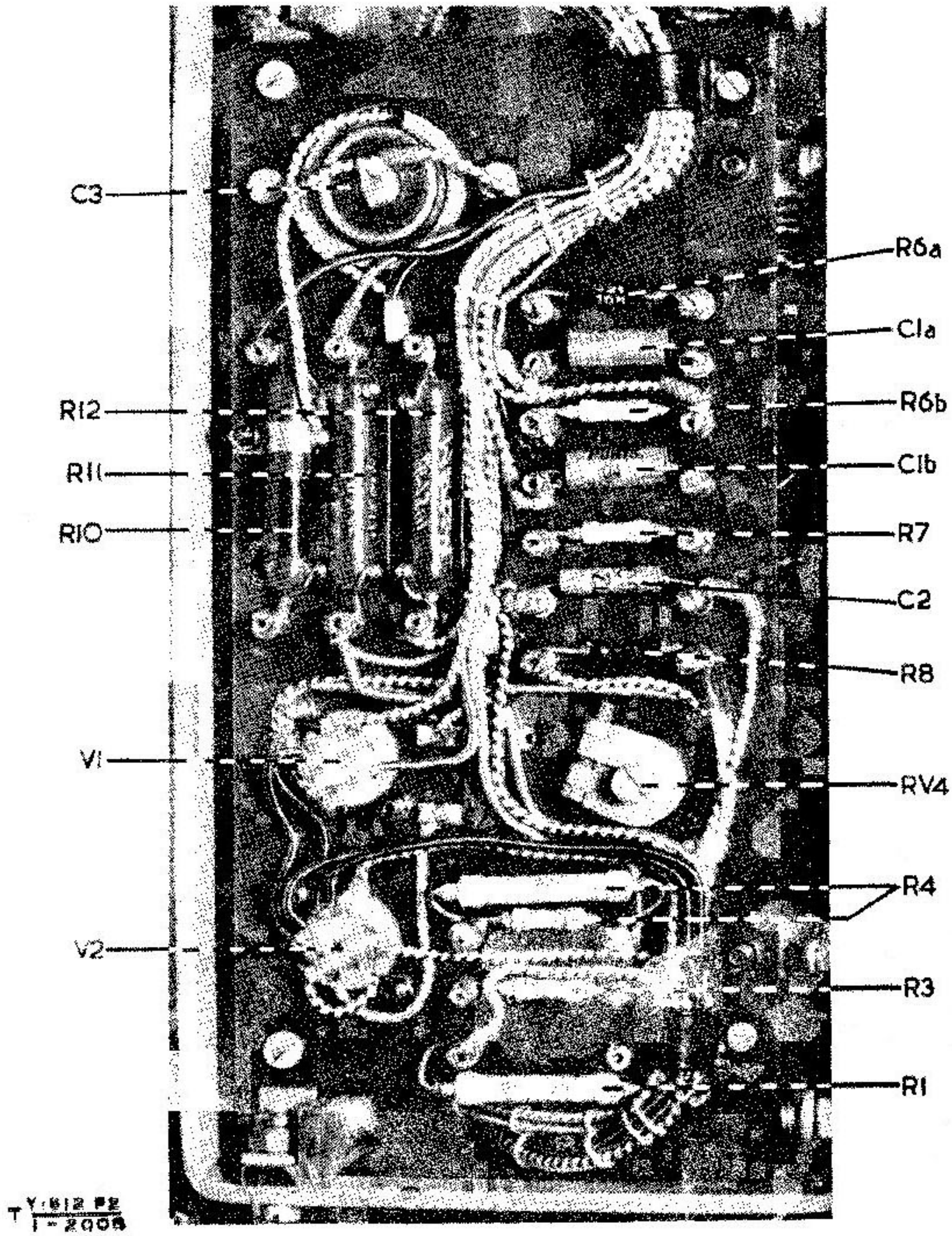


Fig 2008 - Component panel T.V.A. CT 160

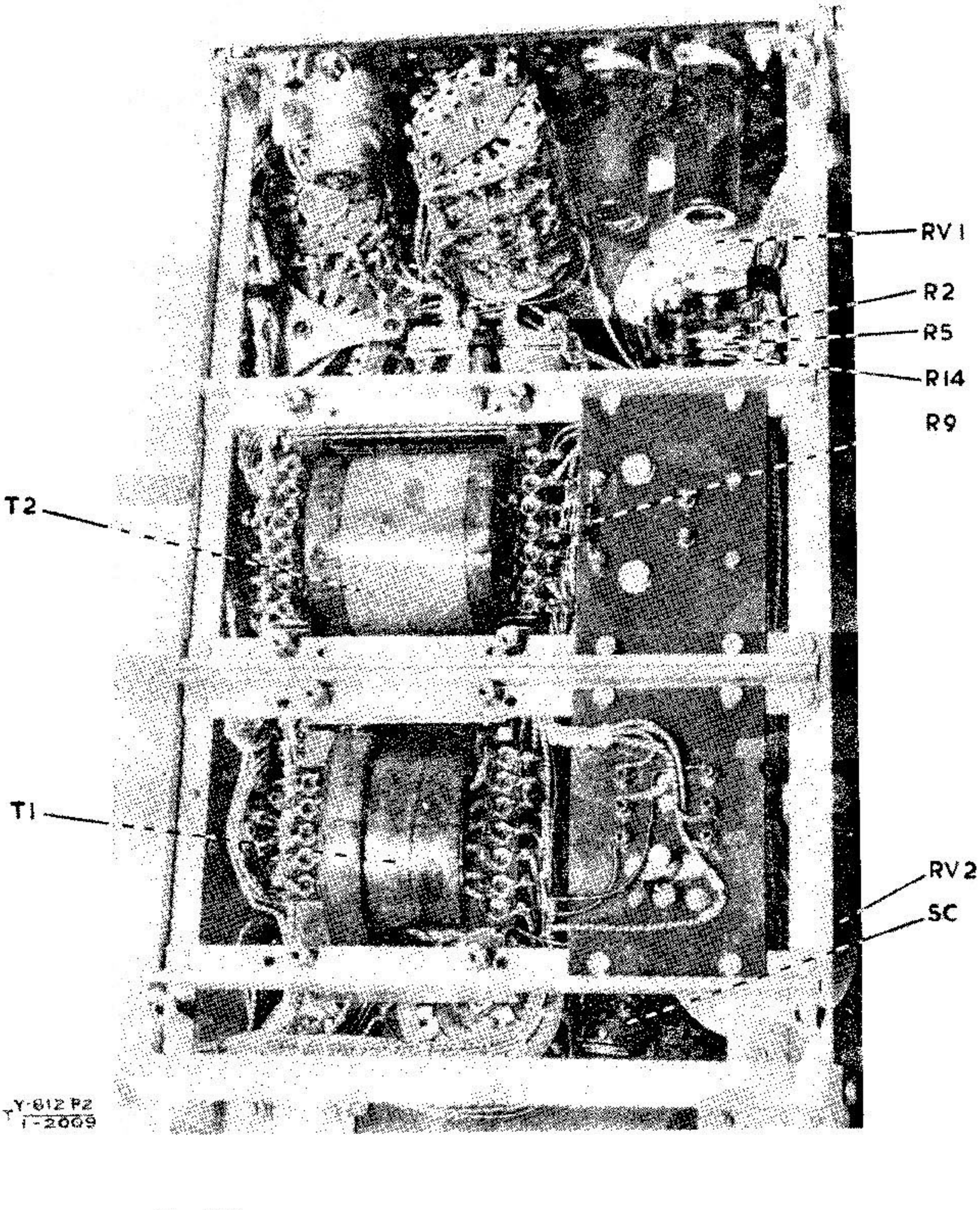


Fig 2009 - Underside of control unit T.V.A. CT 160

END

TESTERS, VALVE, AVO

TECHNICAL HANDBOOK - FIELD AND BASE REPAIRS

SUBJECT INDEX

Distribution - Class 930. Code No 6

Paras

TESTER, VALVE, AVO, CT 160

INDEX TO TABLES

INTRODUCTION

1. This regulation deals with the Testers, valve, Avo, Nos 1, 3 and CT 160 and details field and base repair work. It should be used in conjunction with Tels Y 812, Parts 1 and 2, to which reference should be made for technical description, circuits and layout diagrams.

TESTER, VALVE, AVO, NO 1

Permissive repairs

2. All repairs, replacements and adjustments detailed for this instrument may be carried out in field workshops unless otherwise stated.

Instruments used in repair

3. Instrument, testing, Avometer, universal, 50-range, Mk 2 ZD 00021.

DISMANTLING, REPAIR AND ASSEMBLY

Removal of main unit from case

4. (a) Remove the eight No 6 B.A. screws, two in each side of the case, and the two No 4 B.A. screws holding the 9-pin socket to the left-hand side of the case.

(b) Lift the panel, with components attached, clear of case.

Removal of the meter

5. (a) Unsolder the two leads connecting the movement to a tag panel.

(b) Remove the two No 2 B.A. screws, one on either side of the magnet.

(c) Lift the movement up and back, taking care that the meter scale clears the wiring.

(d) To replace, reverse the above procedure.

Repair of meter

6. General details of meter repair will be found in Inst Z 414, and will only be carried out in base workshops. The internal resistance of the meter is 27Ω and the current at full scale deflection is 600μA.

Removal of sub-unit from case

7. (a) With the unit face downwards remove the four screws which hold the case.

(b) Lift the case clear of the unit.

SPECIFICATION TESTS

Measurement of heater voltages

8. (a) Set the ROLLER SELECTOR switch as follows:-

036 500 210

(b) Insert the prods of the Avometer in pins 2 and 7 of the International octal base.

(c) Set the NORMAL/÷ by 7 switch to NORMAL.

(d) Rotate the HEATER VOLTS switch through the full range of values.

(e) Compare the readings obtained with those shown in Table 1.

HEATER switch SB	Permissible limits	Avometer range
1.4 *	1.4 - 1.65	10V a.c.
2.0	2.0 - 2.3	10V a.c.
2.5	2.5 - 2.8	10V a.c.
4.0	4.1 - 4.5	10V a.c.
5.0	5.2 - 5.6	10V a.c.
6.0	6.2 - 6.8	10V a.c.
7.5	7.9 - 8.5	10V a.c.
10	10.3 - 11.0	100V a.c.
13	13.5 - 14.5	100V a.c.
16	16.5 - 17.5	100V a.c.
20	21.0 - 22.5	100V a.c.
26	27.0 - 29.5	100V a.c.
30	31.0 - 34.0	100V a.c.
35	37.0 - 40.0	100V a.c.
40	42.0 - 45.0	100V a.c.

* HEATER switch SB set to 10V and ÷ BY 7 switch SH set to ÷ BY 7 position

Table 1 - Heater voltage T.V.A. No 1

Measurement of anode voltages

9. (a) With the ROLLER SELECTOR switch set as in para 8 (a), insert the prods of the Avometer in pins 3 and 8 on the International octal base.

(b) Rotate the ANODE VOLTS control through the full range of values.

(c) Compare the readings obtained with those shown in Table 2.

ANODE VOLTS switch setting	Permissible limits	Avometer range
D	11.4 - 12.6	100V a.c.
REC	28.5 - 31.5	100V a.c.
80	106.5 - 117.5	400V a.c.
100	133 - 147	400V a.c.
125	166 - 183	400V a.c.
150	199.5 - 220.5	400V a.c.
200	266 - 294	400V a.c.
250	332.5 - 367.5	400V a.c.

Table 2 - Anode voltages T.V.A. No 1

Measurement of screen voltages

10. (a) With the ROLLER SELECTOR switch set as in para 8 (a), insert the prods of the Avometer in pins 4 and 8 of the International octal base.

(b) Rotate the SCREEN VOLTS control through the full range of values.

(c) Compare the readings obtained with those shown in Table 3.

SCREEN VOLTS switch setting	Permissible limits	Avometer range
60	57 - 63	100V a.c.
75	71 - 79	100V a.c.
90	85.5 - 94.5	100V a.c.
100	95 - 105	400V a.c.
Pen LF	142.5 - 157.5	400V a.c.
150	142.5 - 157.5	400V a.c.
200	190 - 210	400V a.c.
250	237.5 - 262.5	400V a.c.

Table 3 - Screen voltages T.V.A. No 1

TESTER, VALVE, AVO, NO 3

Permissive repairs

11. All repairs, replacements and adjustments detailed for this instrument may be carried out in field workshops unless otherwise stated.

Instruments used in testing

12. Instrument, testing, Avometer, universal, 50-range, Mk 2 — ZD 00021
Voltmeter, valve, No 3 — ZD 00121

DISMANTLING REPAIR AND ASSEMBLY

Removal of the case (Mks I and II)

13. (a) With the instrument standing normally remove the two bolts in each lifting handle, using a wrench setscrew (5/32 in.).

(b) Lift the case clear of the instrument.

Removal of valve holder panel (Mks I and II)

14. (a) With the case removed, unscrew the four bolts, two on either side frame.

(b) Unsolder the ten-way tag panel at the rear of the instrument.

(c) Lift off the valve holder panel.

Note: If it is desired to reach some component on the under side of the panel, remove the two front bolts only and loosen the two rear ones. The panel can then be raised like a lid.

Access to rear of front panel

15. Mk I. (a) Remove the four nuts and bolts, two on either side, which hold the front panel to the main frame.

(b) The panel can now be drawn forward sufficiently to enable most component changes to be made.

16. Mk II. (a) Loosen the two grubscrews in each of the collars at the base of the handles.

(b) Unscrew the collars and the handles will be removed with them.

(c) Unscrew the brass retaining studs now exposed.

(d) The panel can now be drawn forward sufficiently to allow the replacement of most components.

Note: In both Mks I and II it is necessary to unsolder several leads at the rear of the panel before attempting to replace a banked switch.

Removal of transformers

17. Mk I. (a) Remove the base of the instrument by unscrewing the four bolts, one in each rubber foot.

(b) Unsolder the connections to the transformer being replaced.

(c) Remove the small paxolin panel mounted on top of the transformer (T1 only).

(d) Remove the four screws holding the paxolin strip to the runners which support the transformers.

(e) Remove the four bolts which hold the transformer to the runners.

(f) To reassemble, reverse the above procedure.

18. Mk II. (a) Unsolder the mains input lead from the transformer and then remove the base of the instrument by unscrewing the six bolts, three in each runner, which hold it to the frame.

(b) Unsolder the connections to the transformer being replaced.

(c) Remove the paxolin panel by unscrewing the four No 6 B.A. bolts which hold it to the transformer.

(d) Remove the four No 4 B.A. bolts holding the transformer to the runner.

(e) To reassemble, reverse the above procedure.

Removal of the meter (Mks I and II)

19. (a) Remove control knobs.

Note: These Pages 7-10, Issue 2, supersede Pages 7-10, Issue 1, dated 20 Feb 58. The paragraphs marked ● are additional or have been amended.

(b) Remove the front panel from the frame as detailed in para 15 or 16.

(c) Remove the screws which hold the engraved metal panel to the front panel.

(d) Remove the paxolin panel at the rear of the meter.

(e) Remove the screws holding the meter in position.

(f) To replace the meter reverse the above procedure.

Repair of the meter (Mk I and II)

20. General details of meter repair will be found in Inst Z 414, and will only be carried out in base workshops. The internal resistance of the meter is 100Ω and the current at full scale deflection is 460µA.

SPECIFICATION TESTS

Initial setting up

● 21. Measure the local mains supply and set LK1 and SB (SET ~) to correspond to this voltage. Connect the instrument to the mains supply and switch on.

Measurement of heater voltages

22. (a) Set the ROLLER SELECTOR switch as follows:-

036 500 214

(b) Insert the prods of the Avometer in pins 2 and 7 on the International octal base.

(c) Set CIRCUIT SELECTOR to TEST.

(d) Rotate the HEATER VOLTS switches through the full range of values.

(e) Compare the readings obtained with those shown in Table 4.

Table 4 - Heater voltages T.V.A. No 3

Setting of HEATER VOLTS switches	Permissible limits	Avometer range
1.1	1.0 - 1.2	10V a.c.
1.4	1.4 - 1.65	
2.0	2.0 - 2.3	
2.5	2.5 - 2.85	
3.0	3.0 - 3.3	
4.0	4.0 - 4.3	
5.0	5.0 - 5.35	
6.0	6.3 - 6.7	
7.5	7.5 - 7.85	

Table 4 - (cont)

Setting of HEATER VOLTS switches	Permissible limits	Avometer range
10.0	10.0 - 10.5	100V a.c.
16.0	16.0 - 16.75	
60.0	60.0 - 63.5	
70.0	70.0 - 74.5	
80.0	80.0 - 85.0	
90.0	90.0 - 95.5	
100.0	100.0 - 106.0	400V a.c.
110.0	110.0 - 117.0	

Measurement of anode voltages

23. (a) With the ROLLER SELECTOR switch set as in para 22(a), insert the prods of the Avometer in pins 3 and 8 on the International octal base.

(b) Rotate the ANODE VOLTS control switch through the full range of values.

(c) Compare the readings obtained with those shown in Table 5.

Table 5 - Anode and screen voltages T.V.A. No 3

ANODE VOLTS switch SE	SCREEN VOLTS switch SF	Permissible limits	Avometer range
20	20	21 - 23	100V a.c.
-	30	31.5 - 34.5	
40	40	42 - 47	
50	50	53 - 58	
60	60	63 - 70	
75	75	78 - 87	
90	90	94 - 104	400V a.c.
100	100	105 - 115	
125	125	130 - 145	
150	150	155 - 175	
175	175	180 - 205	
200	200	210 - 230	
225	225	235 - 255	
250	250	260 - 290	
-	275	285 - 315	
300	300	310 - 350	
350	-	365 - 405	1000V a.c.
400	-	420 - 460	

Measurement of screen voltage

24. (a) With the ROLLER SELECTOR switch as in para 22(a), connect the Avometer between the anode of V1 and pin 8 on the International octal base.

(b) Rotate the SCREEN VOLTS control switch through the full range of values.

(c) Compare the readings obtained with those shown in Table 5.

Ia calibration

25. (a) Open link LK2 on the panel at the rear of the instrument and connect the Avometer in circuit set to the 100mA d.c. range.

(b) Using a CV1075 (KT66) or a similar valve capable of passing 100mA, set up the tester controls so that the panel meter indicates that the valve is passing 100mA. (In the case of the CV1075, it is necessary to decrease the bias from the figure given in Table 6 of Tels Y 811 to achieve this).

(c) With the panel meter indicating 100mA, the external meter should read between 47.5 and 52.5mA. If this is not the case, adjust RV7(S).

Measurement of grid voltage

● 26. Set the CIRCUIT SELECTOR switch to TEST. With the ROLLER SELECTOR switch as in para 22(a), connect the valve voltmeter between pins 8 and 9 of the International octal base. Set switch SE to Vg x 10 and set the NEG GRID VOLTS control fully clockwise. Adjust RV6(VG) to give a reading of 52V d.c. on the valve voltmeter. Set switch SH to Vg x 1 and check that the valve voltmeter reads 5.2V d.c.

27. Check that on pressing the mA/V button there is a 0.52V positive change on the reading as obtained in para 26, ie a decrease of 0.52V. If this is not the case, adjust RV5(GM), until the desired 0.52V change is obtained on pressing the button.

● 28. Set the CIRCUIT SELECTOR switch to CHECK (C) and set the ELECTRODE LEAKAGE switch to ~. Check that the meter pointer lies within the black square denoting zero ohms on the insulation resistance scale.

TESTER, VALVE, AVO, CT 160

Permissive repairs

29. All repairs, replacements and adjustments detailed for this instrument may be carried out in field workshops unless otherwise stated.

Instruments used in testing

30. Instrument, testing, Avometer, universal, 50-range, Mk 2 ZD 00021
Voltmeter, valve, No 3 ZD 00121

DISMANTLING, REPAIR AND ASSEMBLY

Removal of units from the case

31. (a) Unscrew the four hexagonal-headed bolts, which form the feet of the unit.

(b) Remove the eight No 4 BA screws, two in each side of the valve holder panel, securing it in the lid.

(c) Withdraw the two units from their respective halves of the case.

Removal of the meter

32. (a) Support the meter with the hand and remove the two No 2 BA screws from the paxolin panel directly behind it.

(b) Withdraw the meter carefully through the front panel until the hexagonal pillars can be unscrewed from the meter, thus releasing the connections to the meter. Do not disturb the locknuts as they will position the meter on replacement.

Repair of the meter

33. General details may be found in Inst Z 414, and will only be carried out in base workshops. The internal resistance of the meter is 3,250Ω and the current at full scale deflection is 30μA.

Replacement of ILP 2

34. (a) Remove the two No 6 BA nuts and bolts securing the lamp mounting bracket to the paxolin panel behind the meter.

(b) The lamp can now be withdrawn for unsoldering and replacement.

Removal of transformer T1

35. (a) Unsolder the connections to the transformer.

(b) Remove the two No 2 BA screws securing the plain metal strip adjacent to the transformer.

(c) Remove the four No 4 BA nuts and bolts securing the runners to the main frame.

(d) Supporting the transformer with the hand, remove the four tapped hexagonal pillars holding the transformer to the runners.

(e) Lift the runners just clear of the transformer studs and withdraw the transformer carefully.

(f) To replace, reverse the above procedure.

Removal of transformer T2

36. (a) Remove the meter as detailed in para 32.

(b) Unsolder the connections to the transformer.

(c) Remove the nut and bolt securing the two cableforms to the centre runner supporting the transformer.

(d) Remove the two No 4 BA nuts and bolts that hold this runner to the main frame.

(e) Loosen the four No 4 BA nuts and bolts that hold the paxolin panel to the runners.

(f) Supporting the transformer with the hand, remove the four threaded hexagonal pillars securing it.

(g) Carefully lower the transformer until the transformer studs are clear of the runners and slide out the centre runner.

(h) The transformer can now be carefully removed.

(j) To replace the transformer, reverse the above procedure.

SPECIFICATION TESTS

Initial setting up

37. Connect the instrument to a known 230 - 250V 50c/s supply and adjust coarse and fine settings on the voltage selector panel, until the meter needle lies within the ~ zone on the scale. If it is not possible to do this para 48 must be carried out before any readings are made or other calibrations carried out.

Measurement of heater voltages

38. Set the CIRCUIT SELECTOR to TEST, and the ELECTRODE SELECTOR to A1 and check the relevant electrode voltages as follows:-

(a) Connect the Avometer between the H+ and H- sockets on the nine-way terminal board.

(b) Set the HEATER VOLTAGE range switch to 0.625 - 117V.

(c) Rotate the HEATER VOLTAGE control switch through the full range of values.

(d) Compare the readings obtained with those shown in Table 6.

(e) Set the HEATER VOLTAGE range switch to 1.4 - 80V.

(f) Repeat sub-paras (c) and (d).

Table 6 - Heater voltage T.V.A. CT 160

HEATER VOLTS RANGE switch (SC) set at:-

0.625 - 117V			1.4 - 80V		
HEATER VOLTS (SC) set at:	Permissible limits	Avometer range	HEATER VOLTS (SC) set at:	Permissible limits	Avometer range
0.625	0.5 - 0.8	10V a.c.	-	-	-
1.25	1.2 - 1.45	10V a.c.	1.4	1.4 - 1.55	10V a.c.
2.0	2.2 - 2.45	10V a.c.	-	-	-
2.5	2.6 - 3.0	10V a.c.	3.0	3.1 - 3.4	10V a.c.
4.0	4.2 - 4.7	10V a.c.	4.5	4.9 - 5.3	10V a.c.
5.0	5.1 - 5.5	10V a.c.	5.7	6.0 - 6.4	10V a.c.
6.3	6.6 - 7.0	10V a.c.	7.5	7.6 - 8.0	10V a.c.
10.0	10.5 - 11.0	100V a.c.	-	-	-

Table 6 - (cont)

HEATER VOLTS RANGE switch (SC) set at:-					
0.625 - 117V			1.4 - 80V		
HEATER VOLTS (SC) set at:	Permissible limits	Avometer range	HEATER VOLTS (SC) set at:	Permissible limits	Avometer range
11.0	11.5 - 12.0	100V a.c.	12.6	12.5 - 13.0	100V a.c.
13.0	13.5 - 14.0	100V a.c.	15.0	15.0 - 15.5	100V a.c.
16.0	16.5 - 17.5	100V a.c.	18.0	18.0 - 19.0	100V a.c.
20.0	20.5 - 21.5	100V a.c.	23.0	23.0 - 24.0	100V a.c.
25.0	26.0 - 27.0	100V a.c.	28.0	29.0 - 30.0	100V a.c.
30.0	31.0 - 32.0	100V a.c.	35.0	36.0 - 37.0	100V a.c.
40.0	42.5 - 43.5	100V a.c.	45.0	47.0 - 48.0	100V a.c.
48.0	50.5 - 52.5	100V a.c.	55.0	58.0 - 59.0	100V a.c.
70.0	73.0 - 76.0	100V a.c.	80.0	83.0 - 89.0	100V a.c.
117.0	123.0 - 130.0	400V a.c.	-	-	-

Measurement of anode voltage

39. (a) Connect the Avometer between A1 and C sockets on the nine-way terminal board.

(b) Rotate the ANODE VOLTAGE control switch through the full range of values.

(c) Compare the readings obtained with those shown in Table 7.

ANODE VOLTS switch SD	SCREEN VOLTS switch SE	Permissible limits	Meter range
20	20	21 - 23	100V a.c.
40	40	42 - 47	100V a.c.
60	60	60 - 70	100V a.c.
75	75	77 - 87	100V a.c.
90	90	94 - 104	400V a.c.
100	100	105 - 115	400V a.c.
-	125	130 - 145	400V a.c.
150	150	155 - 175	400V a.c.
200	200	210 - 230	400V a.c.
250	250	260 - 290	400V a.c.
300	300	310 - 350	400V a.c.
400	-	420 - 460	1000V a.c.

Table 7 - Anode and screen voltage T.V.A. CT 160

Measurement of screen voltage

40. (a) Connect a shorting link between pin 2 and pin 5 of V1.

(b) Connect the Avometer between the S and C sockets on the nine-way terminal board.

(c) Rotate the SCREEN VOLTAGE control switch through the full range of values.

(d) Compare the readings obtained with those shown in Table 7.

Checking the NEG GRID VOLTS control

41. (a) Open link LK3 on the component panel (Tels Y 812 Pt 2, Fig 2008).

(b) Set the panel controls as follows:-

(i) CIRCUIT SELECTOR to TEST
(ii) ELECTRODE SELECTOR to A1
(iii) NEG GRID VOLTS to 40

(c) Connect the valve voltmeter across RV3.

(d) Adjust RV4 until a voltage reading of 20.8V is obtained.

(e) Transfer the valve voltmeter leads to G1 and C sockets on the nine-way terminal board.

(f) Check that at the 13 and 4 marks on the dial of the NEG GRID VOLTS control, readings of between 6.4 and 7.1V and between 2.0 and 2.2V are obtained.

42. If either or both readings are out of tolerance, the dial should be adjusted mechanically to split the error. Proceed as follows:-

(a) Slacken the three countersunk-headed screws on top of the dial, which will then be free to move within the latitude of the kidney-shaped slots.

(b) Adjust the dial, retighten screws and check that the readings at the 13 and 4 marks lie within the limits specified in para 41 (f).

(c) Setting the marker to lie within the area marked 0, 5, 15 and 40, readings of between 0; 2.55 - 2.75; 7.4 - 8.2; 19.8 - 21.8V should be obtained respectively.

Checking the SET mA/V control

43. (a) Open link LK3 (Tels Y 812 Pt 2, Fig 2008).

(b) Connect the valve voltmeter across R5.

(c) Check that when the dial is advanced to the 10, 5 and 2mA/V positions, readings of 51 - 54mV; 102 - 108mV; 252 - 268mV are obtained.

44. If for any reason the relationship between the dial and the potentiometer has been upset, the following procedure must be adopted:-

(a) Open link LK3 and ensure that the SET mA/V control is at rest.

(b) Loosen the locking nuts on the U-shaped stirrup and turn RV2 to the maximum anti-clockwise position (viewing from the front panel) and then adjust the nuts friction tight.

(c) Connect the valve voltmeter, set to a suitable range, across R5.

(d) Advance the SET mA/V dial to a reading of 5.

(e) Rotate the spindle of RV2 further by means of the stirrup, in a clockwise direction until a reading of between 102 - 108mV is obtained.

(f) If this reading is obtained without further clockwise advancement of the stirrup, then check that the values of R1, R2, R5 lie within their percentage tolerance. If they are within tolerance, then check RV2.

(g) Tighten the locking nuts on the stirrup, checking that the reading of the valve voltmeter remains steady.

(h) Check that the readings across R5 at the 2 and 10mA/V positions are as obtained in para 43 (c).

(j) Check that the dial can now be rotated to the 1mA/V position and that the motion is arrested by the stop screw on the dial and not by the stop at the end of the potentiometer track.

Ia calibration check

45. (a) Open link LK1 on the valve holder panel and insert the Avometer set to the 100mA d.c. range.

(b) Using a CV 1075 (KT66) or a similar valve capable of passing 100mA, set up the tester controls so that the valve is passing 100mA. (In the case of the CV 1075 it is necessary to decrease the bias from the figure given in Table 6 of Tels Y 811 to achieve this).

(c) With the ANODE CURRENT control set to 100mA and the panel meter indicating zero, the external meter should read between 47.5 and 52.5mA. If this is not the case check the value of the meter shunt R9.

Checking GAS test circuit

46. (a) Set NEG GRID VOLTS control to 40.

(b) Connect a resistor of 860kΩ ± 5% between G and C sockets on the nine-way terminal board.

(c) Set CIRCUIT SELECTOR to GAS and ELECTRODE SELECTOR to A1.

Note: This Page 15, Issue 2, supersedes Pages 15 and 16, Issue 1, dated 20 Feb 58. Para 47 has been amended.

(d) Check that the panel meter reading is between 59 and 92µA.

(e) If the meter reading is not within tolerance, the NEG GRID VOLTS having been set up as in para 41, check the values of R7 and R8.

Checking and adjustment of safety cut-out

47. Before making any adjustments check that lamp ILP2 is operative (when the instrument is used solely on a 110V a.c. supply, it is preferable to replace ILP2 by a 100V, 15W pygmy lamp). Using insulated tools, adjust the two No 4 BA screws in the paxolin panel. One adjusts the gap setting and the other the spring tension, the action of the two being complementary. Adjust the relay as follows:-

(a) Check, with the instrument disconnected from the mains, that the gap between the contact screw and relay armature contact is approximately 1/8" when armature is pulled down to pole piece. Adjust contact screw to produce correct distance, then connect to the mains and switch on.

(b) Set up for U.52 or equivalent rectifier valve but strap diodes in parallel, ie 030808020 roller switch setting. With maximum current range selected on 'Diode and Rectifier', use an insulated screwdriver to tighten spring setting screw (ie decrease spring tension) until the relay chatters.

(c) Increase tension (ie loosen off screw) until chattering ceases.

(d) Remove rectifier, set electrode selector to A and anode volts to 100. With a lead, short C - A_1. Relay should break and will also buzz. Increase anode volts to 200 and repeat short check. Relay should break without excessive arcing.

(e) Set screen volts to 60, allow instrument to warm up and short C - S. Relay should break with a click. Do not leave short on, as when relay is operating the primary current in the transformers is limited by 15W lamp in series with windings. This means that the heaters on the two diode valves in the instrument are almost extinguished. The diode in series with the screen volts supply will become severely damaged if a short circuit exists whilst the heaters are at a low temperature, and will damage the cathode coating.

(f) If the relay operates successfully except for check (e) a replacement CV140 should be fitted.

Checking the SET ∼ indication

48. The above check may only be carried out in base workshops and the method is as follows:-

(a) Standardize the valve voltmeter at 47 volts d.c.

(b) With LK3 closed, set the tester controls as follows:-

(i) CIRCUIT SELECTOR to SET ∼
(ii) ELECTRODE SELECTOR to A_1

(c) With the valve voltmeter connected across RV3 a reading of 47V should be obtained and the panel meter needle should lie within the ∼ zone. If the voltage reading is correct but the panel meter needle lies outside the zone, check resistors R3 and R4.

END