Mullard

High Speed

VALVE TESTER
TYPE E7600

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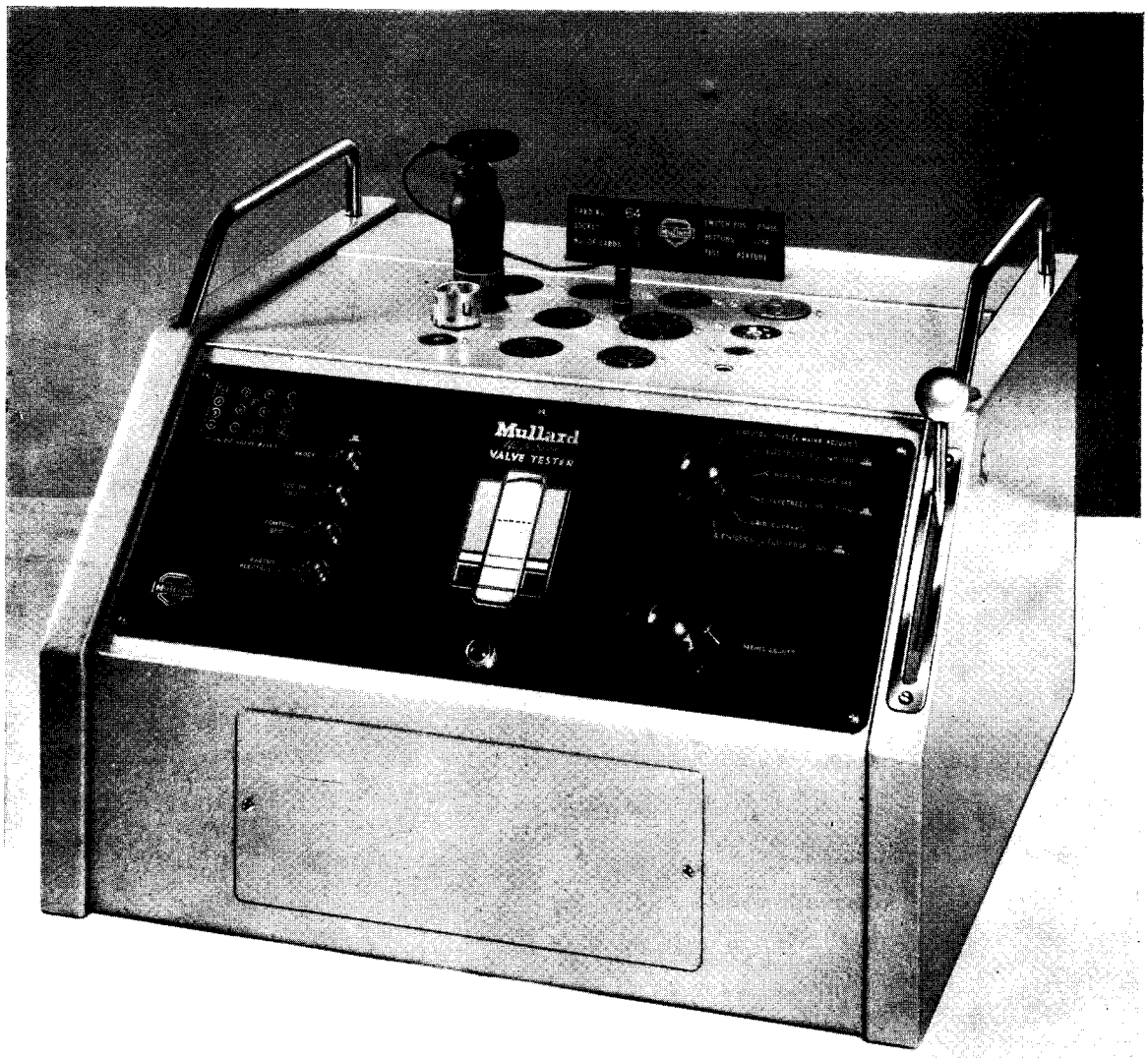

THE MULLARD HIGH SPEED VALVE TESTER

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1 INTRODUCTION

The Mullard High Speed Valve Tester is designed primarily for use by maintenance engineers for testing used valves to close limits. For this reason the tests applied are as similar as possible to the standard production tests to which all valves are submitted in the factory before being passed into stock.

Operation of the tester has been made very simple by the use of punched cards. The appropriate card for the type of valve under test is inserted in the gate switch and automatically makes all the required circuit connections. Thereafter a single rotary switch selects various tests in sequence and the results are indicated as a spot on the screen of a cathode ray tube, a coloured scale indicating whether the valve is within prescribed limits or should be considered unserviceable.

It should be recognised that any valve-testing instrument can reveal only the condition of the valve itself, and that although this information will generally indicate whether the valve should function efficiently in a receiver, it is always possible that conditions in the receiver will render the set inoperative even with a valve which by all manufacturers' standards can be considered to be in good condition.

The aim of the High Speed Valve Tester is to enable the engineer to satisfy himself that the valve under test is satisfactory in all respects insofar as it is within the approved tolerances of operation.

1.1 Classification of Valve Defects

Valve defects may be divided into three main groups:—

(1) Defects likely to cause complete failure to operate.
- (*a*) Faulty filament or heater.
- (*b*) Short circuits between electrodes.
- (*c*) Disconnected electrodes.
- (*d*) Complete loss of emission.

(2) Defects likely to result in noise, intermittent operation, or instability.
- (*a*) Faulty insulation between electrodes.
- (*b*) Faulty insulation between cathode and heater.
- (*c*) Intermittent short circuits between electrodes.
- (*d*) Disconnected or intermittently disconnected electrodes.
- (e) Mechanical faults in electrode assembly.

(3) Defects likely to cause poor amplification, distortion or inability to perform normal functions.
- (*a*) Any of the defects mentioned in paragraph (2) above.
- (*b*) Excessive grid current due to the presence of gas in the valve.
- (*c*) Emission below the manufacturer's limits.

The High Speed Valve Tester reveals any of these faults, if they exist, by means of a series of eliminating tests carried out automatically and in logical sequence.

2. GENERAL DESCRIPTION

A more detailed description of the tester and its method of operation is given in Section 5.

The Mullard High Speed Valve Tester shown in Fig. 1, is an apparatus for conducting rapidly and in correct sequence a standard testing routine on radio receiving valves.

Arrangement of the test circuits and selection of the correct test voltages is performed automatically by inserting, in a multiple gate switch, a perforated card which corresponds to the type of valve under test. To prevent damage to the instrument, a safety switch has been incorporated to ensure that power is not applied until a test card has been correctly inserted in the gate.

Selection of the tests in correct sequence is performed by a six-position selector switch, and four push-buttons permit the testing of individual electrodes for insulation, shorts and open circuits.

In place of the conventional moving coil instrument, a cathode ray tube and a vertical coloured scale are employed to indicate the results of the various tests. The spot is deflected to a part of the scale coloured green if the valve is within the prescribed limits and to a part of the scale coloured red if the valve fails to meet the test requirements. A reading in the intermediate yellow portion of the scale indicates that the valve will probably need early replacement. Means are provided for adjusting the instrument for variations in mains supply voltage and for checking the reject limit, zero setting and test voltages.

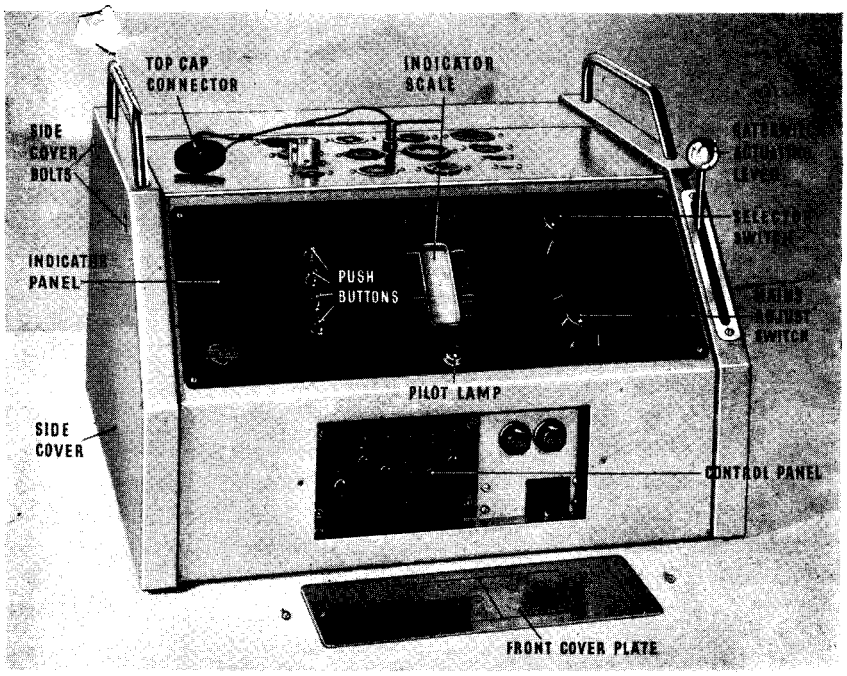


FIG. 1.—VALVE TESTER SHOWING CONTROLS.

2.1 Test Routine

The standard sequence of tests is as follows.—

(i) Filament or heater continuity.
(ii) Electrode insulation with H.T. not applied.
(iii) Heater-cathode insulation.
(iv) Electrode insulation with H.T. applied.
(v) Grid current.
(vi) Emission.
(vii) Electrode open circuits.

2.2 Construction

The test apparatus is mounted in a metal case with a sloping panel. All internal components are readily accessible for servicing by removing one or more sections of the case.

2.2.1 TOP PANEL

The top panel carries a complete range of valve holders to accommodate all current types of valves, and a flying lead for top cap connections. On the top panel also is a slot into which must be inserted the perforated card corresponding to the valve under test. The gate switch is operated by depressing the lever on the right-hand side of the instrument. This switch carries 130 pairs of contacts, which are selected by the punched card.

2.2.2 INDICATOR PANEL

The centre of the sloping panel is occupied by the cathode ray tube face and scale, and beneath it is a pilot lamp which lights when the gate switch is closed.

At the top right-hand corner of the panel is situated the switch which selects the tests in sequence, and below it is a rotary switch by means of which fine adjustment of the operating voltage can be made in accordance with the prevailing voltage of the supply mains.

To the left of the cathode ray tube are four push buttons by means of which individual electrodes may be tested for short circuits, insulation and open circuits. The extreme left of the panel carries a diagram giving a key to the valve sockets on the top panel.

2.2.3 FRONT PANEL

The front panel carries a removable plate behind which are situated the controls for the adjustment of zero setting, reject limit setting, brilliance and focus, and for lateral shift of the spot so that, after a long period of service, a fresh part of the screen surface may be used.

IMPORTANT: The left-hand control " A " is preset by the manufacturers and should on no account be adjusted.

2.3 Test Cards

Three special punched cards are supplied with each valve tester for use when setting up or adjusting the instrument. Numbered and punched cards for valve testing are available, together with a list giving the valve types and the reference numbers of the corresponding test cards.

It is recommended that where the standard storage cabinet is not used for the test cards, reasonable care should be taken to keep them free from moisture and dirt as inaccurate readings may result due to surface leakage across the dirty portion of the card.

3. INSTALLATION INSTRUCTIONS

3.1 Mains Lead

A mains lead is not supplied with this instrument and it is left to the operator to select a length of cable sufficient for his particular requirements. Any three-core 5-amp cable is suitable for this purpose.

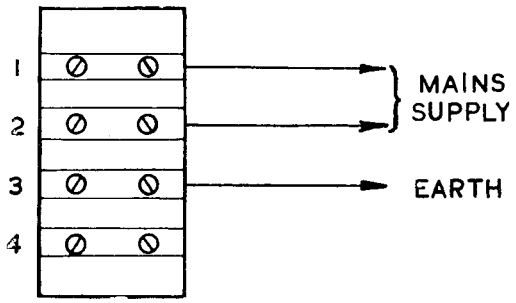


FIG. 2.—TERMINAL BLOCK CONNECTIONS.

The moulded bakelite terminal block is located under the bottom cover. Instructions for removing the cover are given in Section 5.1.1. The mains lead must be connected to terminals 1 and 2 on the terminal block and the earth lead to terminal 3. (See Fig. 2.) **It is essential that an earth lead is used otherwise inaccurate readings will be obtained.**

At present it is not intended to use terminal 4. However, its polarity is opposite to that of terminal 1 and it becomes " alive " when the gate switch is closed.

The lead should be threaded through the rubber grummet in the back panel before reassembling the instrument.

3.2 The Control Panel and Special Test Cards

The controls for the cathode ray tube are located behind the front cover plate and are shown in Fig. 3. These controls are set up at the factory and are unlikely to require adjustment when the instrument is first received.

In no circumstances must control " A " be adjusted.

Three special test cards (" REJECT," " MAINS " and " H.T.") are supplied with the valve tester to enable the operator to carry out periodical checks and ensure that the instrument is functioning correctly.

When inserting a card in the gate care should be taken that the cut away portion at the bottom of the card is to the left of the gate when facing the instrument. (See Fig. 4.)

No attempt must be made to insert or remove the card with the gate switch closed as damage, both to the card and to the switch contacts, will result.

3.3 Installation

The instrument has been designed to operate on a 50-cycle A.C. supply of from 180 volts to 260 volts. Adjustment for various voltages is by means of 20-volt tappings on the mains transformer located on the control panel, in conjunction with an eleven-position rotary switch operating in 2-volt steps, situated on the indicator panel and marked " MAINS ADJUST."

Before connecting the instrument, measure very carefully the mains supply voltage. Remove the front cover plate, by unscrewing the two 4 BA bolts (Fig. 1), and select the mains transformer tap corresponding to the mains supply (Fig. 3). If the supply lies between two tap positions the lower tap must be selected and the difference compensated by adjusting the " MAINS ADJUST." control on the indicator panel.

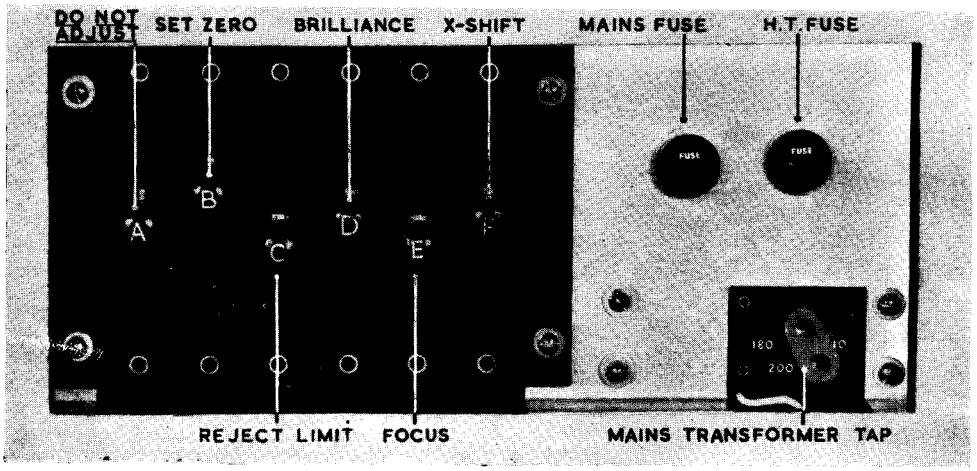


FIG. 3.—CONTROL PANEL.

Examples:

(i) For a mains supply of 220 volts, set the mains transformer tap to 220 volts and the " MAINS ADJUST." control to zero (position 1).

(ii) For a mains supply of 214 volts, set the mains transformer tap to 200 volts and the " MAINS ADJUST." to 14 volts (position 8).

3.4 Initial and Periodical Check Routine

To ensure that the instrument is functioning correctly, insert the " MAINS " card and close the gate switch. Turn the selector switch to " HEATER CONTINUITY & MAINS ADJUST." The pilot lamp should

light and, after a short warming-up period, a green spot should appear on the face of the tube. The "MAINS ADJUST." switch should now be adjusted to bring the spot as near as possible to line "A." Remove the "MAINS" card and insert the "REJECT" card, check that the selector switch is in the "HEATER CONTINUITY & MAINS ADJUST." position then close the gate switch. The spot should come to rest on line "C." (See Fig. 5.) Now, by turning the selector switch to "EMISSION & ELECTRODES O/C," the spot should move downwards to line "D."

FIG. 4.—INSERTING TEST CARD IN GATE.

Open the gate switch by placing the lever in the upright position. Remove the "REJECT" card and insert the "MAINS" card. Turn the selector switch to "HEATER CONTINUITY & MAINS ADJUST." and close the gate switch. When the spot appears it should come to rest on the dotted line "A." It now remains to check the H.T. Open the gate switch and remove the "MAINS" card and insert the "H.T." card. Turn the selector switch to the "EMISSION & ELECTRODES O/C" position and close the gate switch. When the spot appears it should come to rest within ± 3 mm. of the dotted line "A."

3.5 Realignment Routine

In the event of the spot not conforming to the positions indicated above the following routine will be necessary to realign the instrument.

(*a*) Check that the mains transformer tap is at the correct setting.

(*b*) Set the selector switch to "EMISSION & ELECTRODES O/C" and insert the "REJECT" card. Close the gate and wait for the spot to appear. When it comes to rest set it approximately to line "D" by means of the control "B" on the control panel (Fig. 3).

Turn the selector switch to "HEATER CONTINUITY & MAINS ADJUST." and note the position of the spot with respect to line "C."

(i) If the spot is low, note its approximate distance below the line and turn the selector switch to "EMISSION & ELECTRODES O/C." The spot will move to line "D." Then with control "C" set the spot to twice the distance below line "D" as it was below line "C." Now re-set the spot to line "D" by means of the control "B." Turn the selector switch to "HEATER CONTINUITY & MAINS ADJUST." and check the position of the spot with respect to line "C."

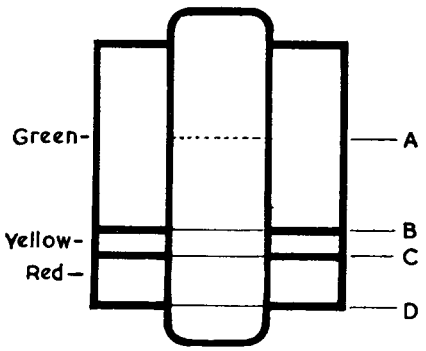


FIG. 5.—INDICATOR SCALE.

If necessary the above procedure should be repeated.

(ii) If the spot is high, the same routine as for (i)

should be carried out except that the spot should be set *above* line "D."

(*c*) Open the gate switch, remove the " REJECT " card and insert the " MAINS " card. Check that the selector switch is in the " HEATER CONTINUITY & MAINS ADJUST." position and close the gate switch. Adjust the " MAINS ADJUST." control until the spot is on line "A."

(*d*) Remove the " MAINS " card and, if it has been necessary to alter the " MAINS ADJUST." control more than one step, re-insert the " REJECT " card. Turn the selector switch to " EMISSION & ELECTRODES O/C " and check that the spot comes to rest on line " D." Turn the selector switch to " HEATER CONTINUITY & MAINS ADJUST." and check that the spot moves to line " C."

(*e*) Open the gate switch and remove the " REJECT " card and insert the " H.T." card. Turn the selector switch to " EMISSION & ELECTRODES O/C." The spot should now come to rest within $\pm$ 3 mm. of the dotted line " A." The instrument is now realigned and ready for use.

4. OPERATING INSTRUCTIONS

This instrument has been designed for the rapid checking of the condition of the valve. **It must not be used for " soak " tests.** When such a prolonged test is required the valve should be left working in a set and removed for checking when the fault exhibits itself and whilst the valve is still hot.

The test sequences to be carried out by the operator are descibed below.

4.1 Selection of Test Cards

Each test card is labelled with the following information:—

(*a*) **CARD NO.** This is merely a reference number and is obtained from the alphabetical valve chart.

The letters " A," " B " or " C " after the number indicate the sequence in which the cards must be used.

(*b*) **SOCKET.** The valve socket to be used is indicated by the number, for which reference is made to the diagram at the top left-hand side of the Indicator Panel.

(*c*) **NO. OF CARDS.** The figure indicates the number of cards to be used for the particular valve under test.

Most valves require a single card only, but frequency-changers and other multiple valves require two or sometimes three, as each electrode system is considered as a separate valve. Half-wave power rectifiers require two cards and full-wave rectifiers three cards.

(*d*) **SWITCH POS.** This shows the various positions in which the selector switch must be used. Only the positions indicated should be used, otherwise misleading results will be obtained.

(*e*) **BUTTONS.** The push buttons to be used are indicated by the numbers. They are only used in positions 2, 4 and 6 of the selector switch and this is indicated by the representation of a push button in these positions. Again, only the buttons indicated should be depressed.

(*f*) **TEST.** The word "DIODE," " TRIODE," etc., indicates the electrode system under test when using that particular card.

4.2 Preliminary

Certain of the older types of A.C. and A.C./D.C. valves require up to 40 seconds to attain their correct working temperature. Accurate readings in tests No. 5, No. 6, No. 10 and No. 11 will result only if this condition is fulfilled.

In all the following tests the indicator spot should remain in the green section of the scale (except for the " ELECTRODE O/C " test).

Should the spot move to the yellow section of the scale the valve should be suspect and although it may function in a set, early replacement is advisable. If the spot moves to the red section it indicates that the valve is definitely unserviceable and should be replaced.

When the appropriate buttons are pressed during the " Electrodes O/C " test, if the electrodes are continuous, the spot should make a definite movement downwards towards the red section of the scale. If they are open-circuited the spot will remain stationary in the green section.

This test is not necessary for power rectifier valves. When testing signal diodes for emission it may be found that in some cases the spot will rise above the green section of the scale. This simply indicates that the valve under test is working at its upper limits and is perfectly satisfactory.

4.3 Test Routine for all Valves except Power Rectifiers

Referring to the alphabetical valve chart ascertain the reference number of the card or cards required for the valve under test.

Turn the selector switch to Position 1 (" HEATER CONTINUITY & MAINS ADJUST.").

Insert the card, close the gate switch and note that the pilot lamp lights.

Wait until the green spot appears on the tube and approaches the zero line.

Referring to the diagram on the instrument panel, place the valve in its correct socket and connect the top cap if necessary.

4.3.1 TEST No. 1—FILAMENT OR HEATER CONTINUITY

The indicator spot should move to the green section of the scale indicating that the filament or heater is continuous. If the spot remains in the red section of the scale a broken filament or heater is indicated. If it moves only to the yellow section, a high resistance heater is indicated and the valve should be considered suspect.

4.3.2 TEST No. 2—ELECTRODE INSULATION (H.T. OFF)

Turn selector switch to No. 2 position (" ELECTRODE INSULATION. H.T. OFF "). The small representation of a button opposite this position of the switch is a reminder that the electrode test buttons indicated at the top of the card must be pressed for this test.

Depress in turn each button indicated and note the position of the spot.

Poor insulation between the electrode corresponding to the label at the side of the button and some other electrode or electrodes is indicated by the spot moving out of the green into the yellow or red section of the scale. If the indicator spot remains in the green section the electrode insulation may be considered satisfactory.

If a short circuit is found to exist it is inadvisable to proceed with further tests as damage may result to the instrument.

4.3.3 TEST No. 3—HEATER-CATHODE INSULATION

Turn selector switch to position No. 3 (" HEATER-CATHODE INS.") and note the position of the spot. Satisfactory insulation is indicated if the spot remains in the green section of the scale. Bad insulation is indicated if the spot moves into the red section.

It has been arranged that when testing directly-heated valves, the spot will remain in the green section when the selector switch is turned to this position.

4.3.4 TEST No. 4—ELECTRODE INSULATION (H.T. ON)

Turn selector switch to position No. 4 (" ELECTRODE INSULATION. H.T. ON ").

This test is similar to the test described in Section 4.3.2 above, but is performed with normal operating voltages applied to the various electrodes. The representation of a push button against this position of the selector switch is a reminder that the test buttons indicated at the top of the test card must be pressed during the test. Depress in turn each button indicated and note the position of the spot.

A short circuit or poor insulation between the electrode corresponding to the label at the side of the button and some other electrode or electrodes is indicated by the spot moving into the red section of the scale. If the indicator spot remains in the green section of the scale, the electrode insulation may be considered satisfactory.

4.3.5 TEST No. 5—GRID CURRENT (GAS TEST)

Turn selector switch to position No. 5 (" GRID CURRENT ") and note the position of the spot. If the amount of grid current passed by the valve does not exceed the permissible limit the indicator spot remains in the green section of the scale. If the valve is passing excessive grid current, indicating that the valve is " soft," the spot will move into the red section.

In certain types of valves the grid current is so small as to be negligible and this may cause the spot to rise above the top of the green section of the scale or even right off the face of the tube altogether. This does not indicate a fault in either the valve or the instrument.

4.3.6 TEST No. 6—EMISSION AND OPEN-CIRCUITED ELECTRODES

(*a*) Turn selector switch to position No. 6 (" EMISSION & ELECTRODE O/C "). The representation of a push button opposite this position is a reminder that the test buttons indicated at the top of the test card must be depressed during part of this test.

Before depressing any of the push buttons note the position of the indicator spot. If it remains in the green section of the scale the emission of the valve is within the prescribed service limits.

If the spot moves to the yellow section the valve is probably still serviceable in some types of receiver but will require early replacement. A valve which causes the spot to move into the red section has emission below the prescribed service limits and should be discarded.

(*b*) A further test with the selector switch in position No. 6 checks whether there are any open circuits in the electrode assembly. Momentarily depress in turn the test buttons indicated.

As each button is pressed the spot should make a definite movement downwards. If no spot movement occurs the electrode under test is open circuited.

IMPORTANT: In no circumstances should the button be held pressed for longer than two seconds as damage may result to the valve under test due to excessive current flowing to the screen grid.

4.4 Test Routine for Power Rectifiers

Referring to the alphabetical valve chart it will be found that two cards are required for half-wave rectifiers and three for full-wave rectifiers. It is important that the cards are used in their correct alphabetical sequence.

4.4.1 TEST No. 7—FILAMENT OR HEATER CONTINUITY

Check that selector switch is in No. 1 position (" HEATER CONTINUITY & MAINS ADJUST."). Insert Card " A " in the gate and close the gate switch. Then proceed as for Test No. 1 in Section 4.3.1.

4.4.2 TEST No. 8—ELECTRODE INSULATION (H.T. OFF)

Turn selector switch to No. 2 position (" ELECTRODE INSULATION. H.T. OFF ") and proceed as for Test No. 2 in Section 4.3.2.

4.4.3 TEST No. 9—HEATER CATHODE INSULATION

Turn selector switch to No. 3 position (" HEATER CATHODE INS."). The same indications as for Test No. 3 in Section 4.3.3 are applicable.

4.4.4 TEST No. 10—EMISSION

Remove Card "A" and insert Card "B." Turn selector switch to No. 6 position (" EMISSION & ELECTRODE O/C ").

The same indications as for Test No. 6 (Section 4.3.6 (*a*)) are applicable except that the push buttons are not used. The electrode open circuit test (Section 4.3.6 (*b*)) is not applicable to rectifier valves.

4.4.5 TEST No. 11—EMISSION

Where a full-wave rectifier is under test, remove Card "B" and insert Card "C." Check that the selector switch is still in No. 6 position (" EMISSION & ELECTRODE O/C ") then proceed as for Test No. 10 in Section 4.4.4.

5. TECHNICAL DESCRIPTION

In the paragraphs which follow are given a more detailed description of the mechanical construction and electrical circuit.

Sufficient information is given to enable the engineer to inform himself of the principle upon which the tester operates, to open up the instrument for examination, and to trace the various circuits.

Information concerning maintenance and service is given in Section 6.

5.1 Mechanical Details

The High-Speed Valve Tester is designed primarily as an instrument which can be used by the unskilled operator as well as the skilled engineer, and for this reason it is of robust construction. The internal components are, however, easily accessible by removing four metal covers and hinging the top panel upwards. The following details are intended to assist the service engineer should this be necessary.

5.1.1. COVERS

Before removing the covers make sure that the instrument is disconnected from the mains and also that the gate switch is left in the open position.

The bottom cover is secured by five 4BA screws, three along the rear edge and one on either side. The front edge is held in position between the flange of the front cover and the chassis. After removing the screws, draw the cover towards the rear so as to disengage the front edge.

Each side cover is held by two 4BA screws at the top and by two pins which engage in slots in the bottom of the cover. Before removing the right-hand side cover, the gate switch lever should be removed by unscrewing it from the block. After removing the two holding screws pull the top outwards, then, with a downward movement, free it from the pins at the bottom. When replacing the side covers, the bottom pins must first be engaged.

After replacing the right-hand side cover, the gate switch lever can be screwed in. By leaving the gate switch in the open position it will be quite easy to locate the threaded hole in the block.

5.1.2. TOP PANEL

The top panel carries all the test valve sockets, and having removed the covers, it can be completely removed by taking out the four retaining screws. However, for most purposes it will be sufficient to hinge the panel upwards by removing the two front screws and slackening the rear two. This will allow easy access to the interior.

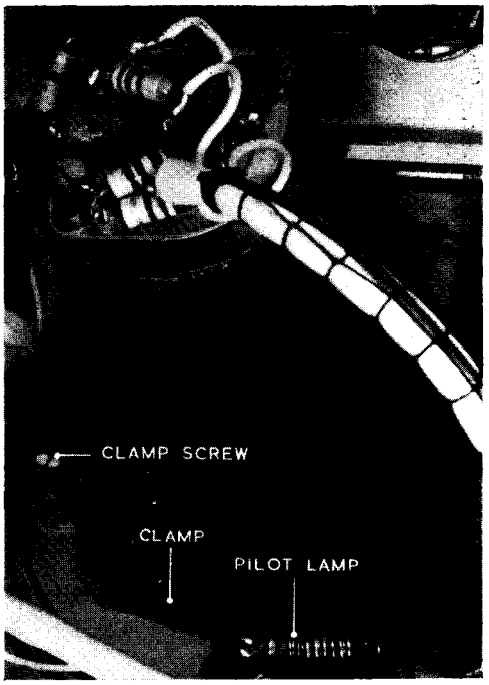


FIG. 6.—CATHODE RAY TUBE ASSEMBLY.

5.1.3. CATHODE RAY TUBE ASSEMBLY

To remove the cathode ray tube, first take off the front cover plate then, by inserting a screwdriver through the space between the control panel and the front cover, slacken the clamp screw (Fig. 6). The entire assembly may now be removed and the cathode ray tube becomes accessible.

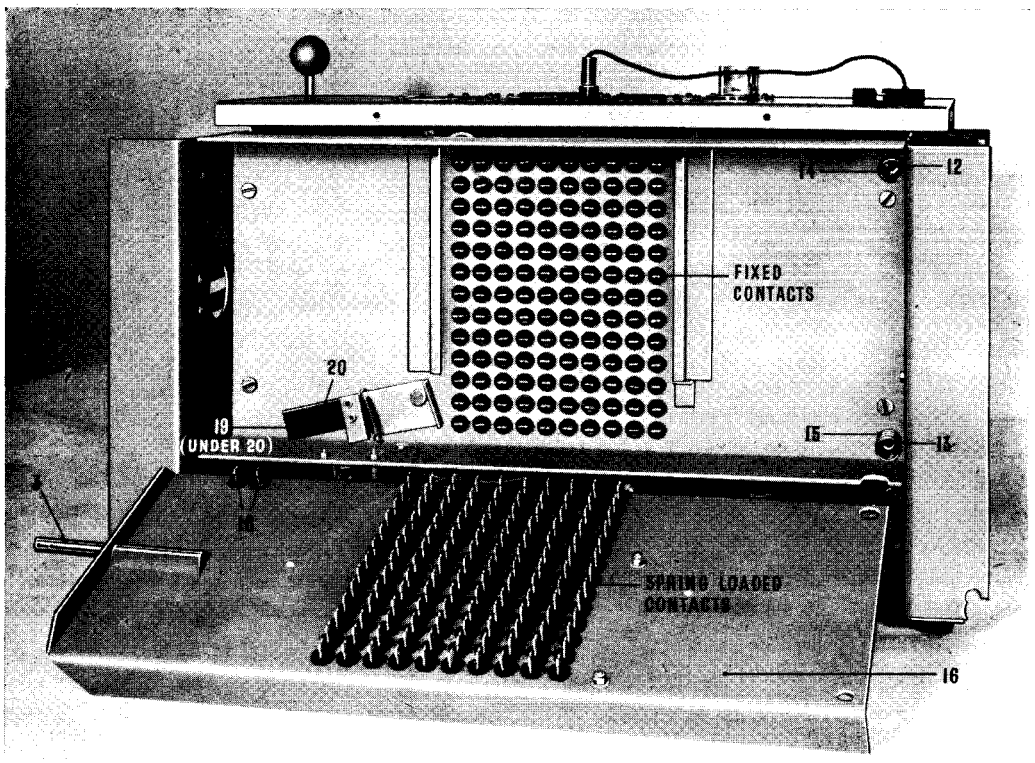


FIG. 7.—GATE SWITCH DISMANTLED SHOWING CONTACTS AND SAFETY DEVICE.

5.1.4. GATE SWITCH

The gate switch consists of 130 pairs of contacts, each pair comprising a fixed contact and a movable contact, arranged in thirteen rows of ten pairs (Fig. 7). The 130 movable contacts are individually spring loaded and are mounted on a plate which is hinged so that it may be moved bodily in relation to the fixed contacts.

(*a*) *Gate Actuating Mechanism*

Fig. 8 shows the gate in the closed position. The gate switch lever (1) is screwed into a steel block (2) which is coupled to the gate pin (3) by the link bar (4). The link bar is mounted eccentrically in relation to the block pin so that when the lever is depressed the moving half of the gate is pulled forward. With the gate switch in the open position (i.e. the lever upright) the "C" spring (6), located between the gate pin and the guide plates (7), holds the moving half of the gate in its position of rest. The upper pin (8) acts as a stop pin. When the gate switch lever is depressed and it passes out of line with the link bar in the downward direction (i.e. past the top dead centre), the gate is closed and locked against the lower stop pin (5) by the tension on the "C" spring. On opening the gate, the "C" spring forces the gate backwards into its position of rest.

(*b*) *Gate Switch Suspension*

The moving half of the gate switch is hinged to the fixed half at the left-hand side and is positioned on the right-hand side by the guide plates (7) and the "C" spring (6).

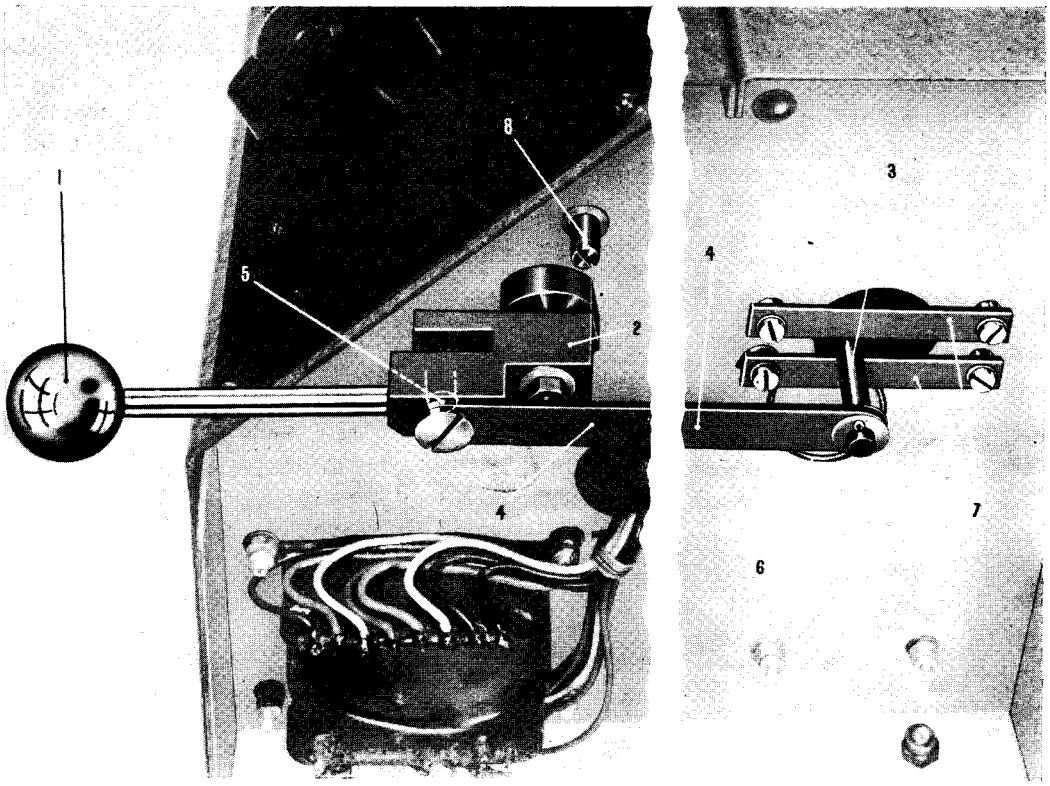


FIG. 8.—GATE SWITCH ACTUATING MECHANISM.

(c) *Safety Switch*

A single pole switch consisting of two sets of contacts (18 and 19) (Fig. 7) on each half of the gate forms the mains on/off switch. A pivoted shutter (20) is interposed between each set of contacts so that, should the gate switch lever be depressed without a card being in position, power will not be applied to the circuit. Only the correct insertion of the card will move the shutter clear and allow the contacts to make when the gate is closed.

(d) *Dismantling and Re-assembling the Gate.*

When handling the gate great care must be taken not to damage the contacts or the copper foil connecting straps.

To dismantle the gate switch, remove the split pin holding the link bar (4) to the gate pin (3). The hinge bar (9) (Fig. 10) can now be removed by unscrewing the two $1\frac{1}{2}$-inch 4BA bolts (10) and (11) which pass through the two pillars (12) and (13) (Fig. 7). These bolts are secured by two nuts inside the chassis. Two springs (14) and (15) are interposed between the two halves of the gate switch and care should be taken when unscrewing the bolts that the moving half of the switch (16) does not spring outwards and damage the contacts. The moving half of the switch is now free and can be removed by disengaging the gate pin from the guide plates and the "C" spring. To assemble the gate switch insert the gate pin between the

guide plates making sure that the "C" spring is correctly in position. Bring the moving half of the gate into position and replace the hinge bar. In order to align the moving half of the gate, two $\frac{1}{8}$-inch holes have been made in both the fixed and the moving halves of the gate. When the moving half of the gate is correctly positioned, both sets of holes should be in line. This

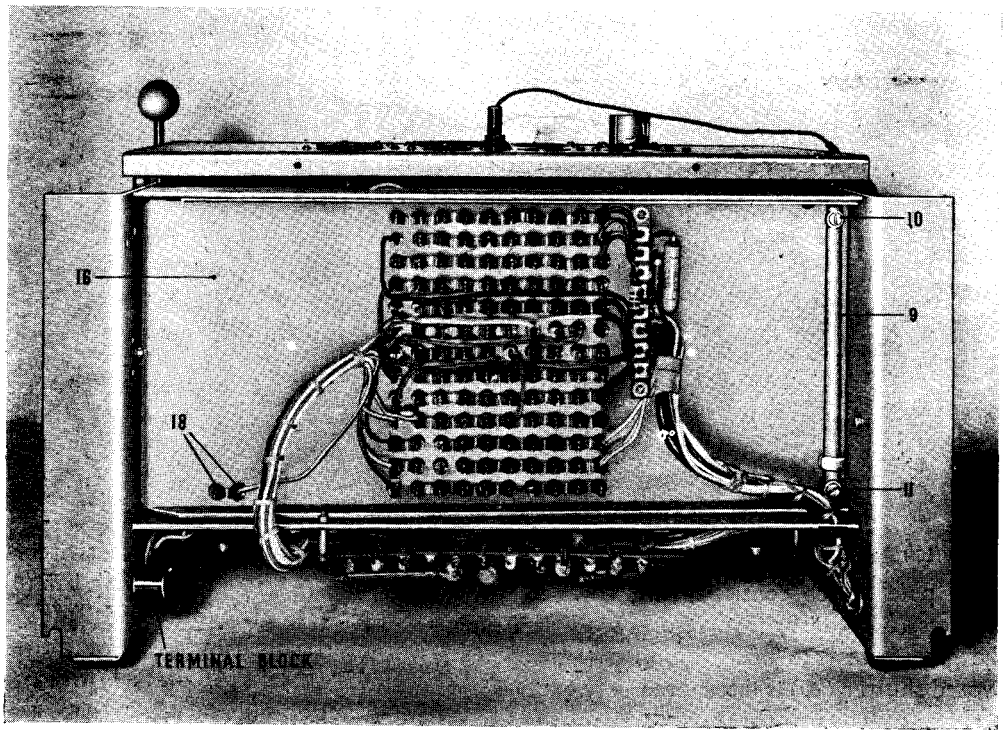


FIG. 9.—GATE SWITCH SHOWING HINGE BAR AND TERMINAL BLOCK.

can be checked by inserting the shanks of $\frac{1}{8}$-inch drills in each set of holes. Should it be necessary, the gate can be re-aligned by adjusting the position of the guide plates. Particular care must also be taken to ensure that the moving half of the gate does not become trapped between the pillars and the hinge bar. The link bar can now be replaced on the gate pin and secured by the split pin.

5.2 Circuit Details

Fig. 10, at the back of the manual, is the complete circuit diagram of the valve tester. Each component is given a reference number, and the value and Part Number of any component can be ascertained by reference to the Parts List in Section 7. Figs. 11 to 14 show the positions of the numbered components in the instrument.

The only connections not shown in the diagram are the connections to the sockets for the valve under test. For the sake of simplicity the circuit description which follows is divided into six sections:—

1. Metering Circuit
2. H.T. and Grid Bias Supplies
3. Heater and Filament Supplies
4. Gate Switch
5. Selector Switch
6. Push Buttons

5.2.1 METERING CIRCUIT

In place of the moving coil meter usually employed in valve testers, the Mullard High-Speed Valve Tester employs an electrostatic cathode ray tube, type DG7-5, the deflector plates of which are supplied by a push-pull voltage amplifier using a double triode, type ECC35. This amplifier and its independent rectifier are supplied from insulated windings (S3, S5 and S6) on the mains transformer.

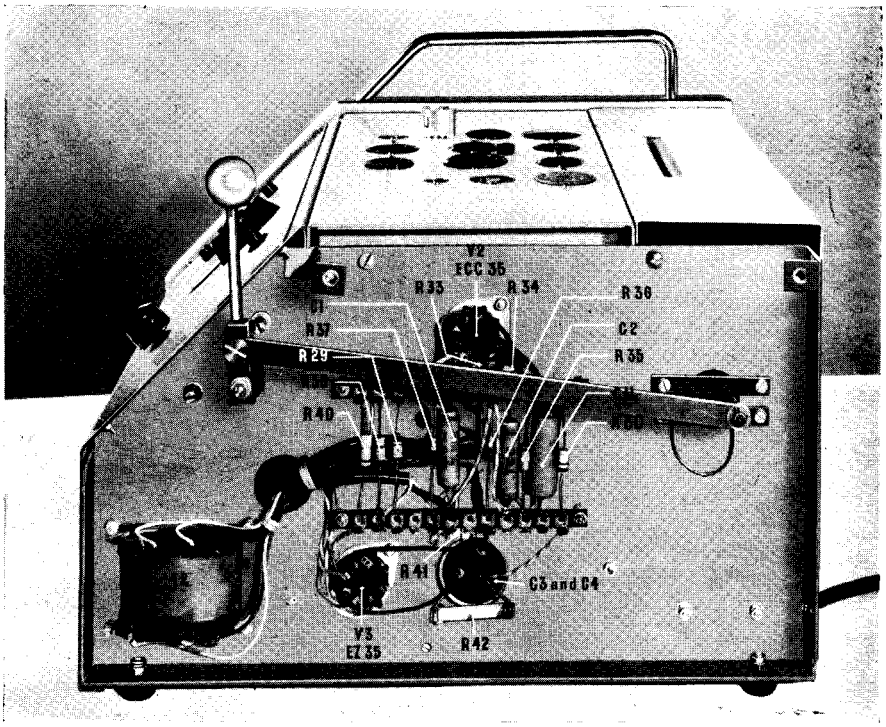


FIG. 11.—RIGHT-HAND SIDE OF CHASSIS SHOWING NUMBERED COMPONENTS.

The H.T. supply is obtained through V3, type EZ35, used as a half-wave rectifier, the applied potential from S3 being approximately 370 volts. C4 is the reservoir capacitor and a rectified output of about 475 volts is available after the filter circuit R42, C3. The voltages for the cathode, grid and first anode of the cathode ray tube V1 are obtained from the resistance chain R22, R23, and R24. Of these resistors, R22 is the brightness control and R23 the focus control.

The final anode voltage is obtained from the centre tap of R27 and R28 which are connected between the anodes of V2 in order to reduce astigmatism. One of the " X " plates is connected to the final anode of V1 and the other via R25 to the slider of R24. This permits the spot to be shifted horizontally so that, after a long period of service, a different portion of the tube face can be used, thus increasing the useful life of the tube. This " X " plate is also connected via R26 to the final anode in order to reduce the effect of changes in the mean anode potentials of V2.

The double triode has anode loads R29 and R30, and the variable resistor R31 is connected between the two anodes to permit the sensitivity to be

adjusted to the required value. The cathode resistor for this valve comprises R36, R38, R39 and R40 in series. Of these, R36 provides the grid bias for V2A via grid leak R41. R41 is the input resistor of the amplifier and can be shunted by one or more of the resistors R69 to R79 inclusive by means of the gate switch. R37 and C1 form a filter circuit at the input of V2A. C2 performs the same function at the grid of V2B, while C11 acts as an A.C. shunt across the two anodes and so prevents any hum deflection from appearing on the spot.

The grid of V2B is fed from the anode of V2A via the potential divider R33, R34 and R35. R35 is returned to the slider of R39 in the cathode circuit to enable correct bias to be applied to V2B. This control also provides vertical shift of the spot for zero setting. R33 is shorted during the grid current tests to deflect the spot to the centre of the scale. The heater of cathode ray tube V1 is fed from winding S6 on the mains transformer T1, and the heaters V2 and V3 from winding S5. The capacitor C5 decouples the negative supply line of the cathode ray tube circuit to chassis, thus preventing hum appearing on the cathode ray tube.

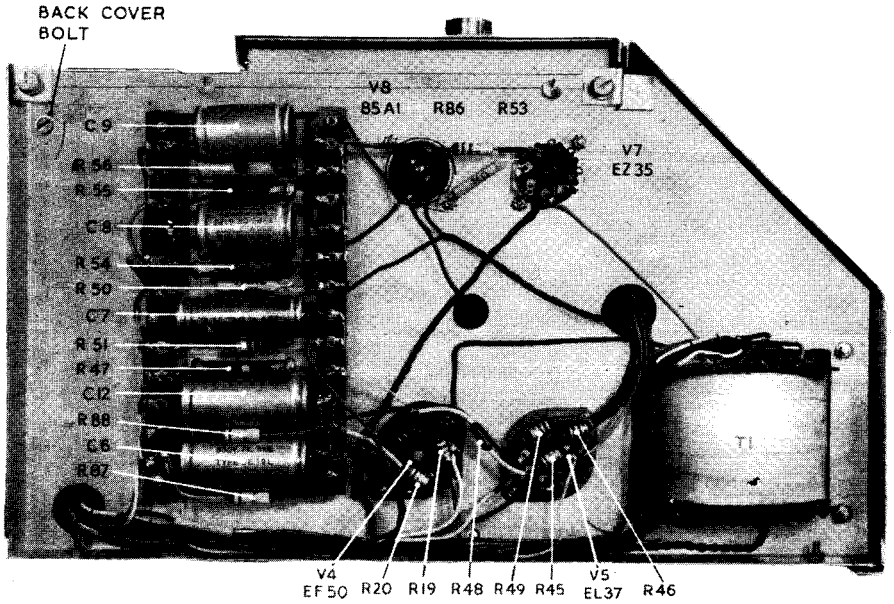


FIG. 12.—LEFT-HAND SIDE OF CHASSIS SHOWING NUMBERED COMPONENTS.

5.2.2 H.T. AND GRID BIAS SUPPLIES

Positive high tension supplies are obtained from the full-wave rectifier V6, type FW4-500, supplied from winding S1 on mains transformer T1. This winding is centre-tapped and has outputs of 100-0-100; 250-0-250; and 400-0-400 volts. Fuse F2 is included between the filament of the rectifier and the reservoir capacitors C6 and C12. R87 and

R88 equalise the voltages across C6 and C12. The rectifier output is applied via anode stopper R49 to the series stabiliser valve V5, which is an output pentode type EL37 connected as a triode, and provided with screen and grid stoppers R46 and R45. The voltage drop in V5 is controlled by V4, type EF50, the anode load of which is R47 and the cathode load R19. The reference voltage applied via R20 to the control grid of V4 is obtained from the potential divider formed by either R7, or R7 and R8 in series, and one or more of the resistors R1 to R6 inclusive as selected by the gate switch. The positive end of this potential divider is connected to the cathode of V5 where the stabilised H.T. voltage appears, and the negative end is referred to the stabilised potential of 85 volts derived from the reference voltage stabiliser tube V8, type 85A1.

The anode of V4 is connected via R48 to the control grid of V5; and R47, the anode load of V4, is fed from the unsmoothed H.T. supply from C6. The potential divider R43, R44 can be used to supply a reduced voltage to the screen of the valve under test.

When testing power rectifiers, V5 is used as a load resistor. This is achieved by earthing its cathode via R60, R61 and R68, either singly or in combination, and connecting its control grid to the cathode of V4. The grid of V4 is set at the required potential by means of R1 to R7, the junction of R7 and R8 being earthed, and the cathode of V4 then applies a proportional voltage to the grid of V5.

Negative high tension voltages and grid bias supplies are obtained from V7, type EZ35, operated as a half-wave rectifier and supplied

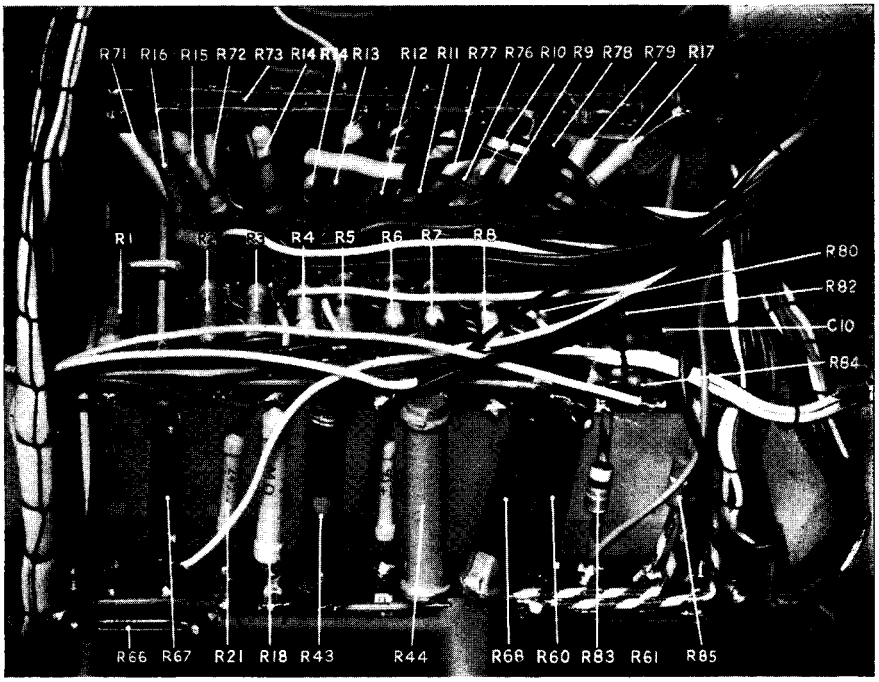


FIG. 13.—INTERIOR SHOWING NUMBERED COMPONENTS.

from a 200-volt tap on winding S1 of T1. This valve operates through R86 into the reservoir capacitor C9, and smoothing is provided by R55, R56 and C8. R54 feeds the neon stabiliser V8, type 85A1, which provides an accurate negative supply for the grid bias of valves on test. Between V8 and V7 negative voltages of 85 and 200 volts are available for various tests.

The exact grid bias voltage required for the particular valve on test is obtained from the junction of the potential divider formed by R17 (or R17 and R18 in parallel) and one or more of the resistors R9 to R16 inclusive as selected by the gate switch. For checking the mains input voltage setting, a bridge type circuit is employed, the input for which is applied between the anode of V7 and earth. The output is taken from the stabilised —85 volts at the cathode of V8 and the junction of R52 and R53.

It will be seen that R50, R52 and R53 are connected between the anode of V7 and earth. These are high stability resistors and R52 is set at the factory so that —85 volts appear at the junction of R52 and R53 when the mains transformer tap on the primary of T1 is set to the correct position for the voltage applied. R51 and C7 smooth this —85 volts supply before applying it to the metering circuit.

A further high stability resistor R21 is used in conjunction with R58 so that a potential of 0.24 volts can be accurately tapped from the —85 volts for setting the sensitivity of the metering circuit (i.e., the reject limit).

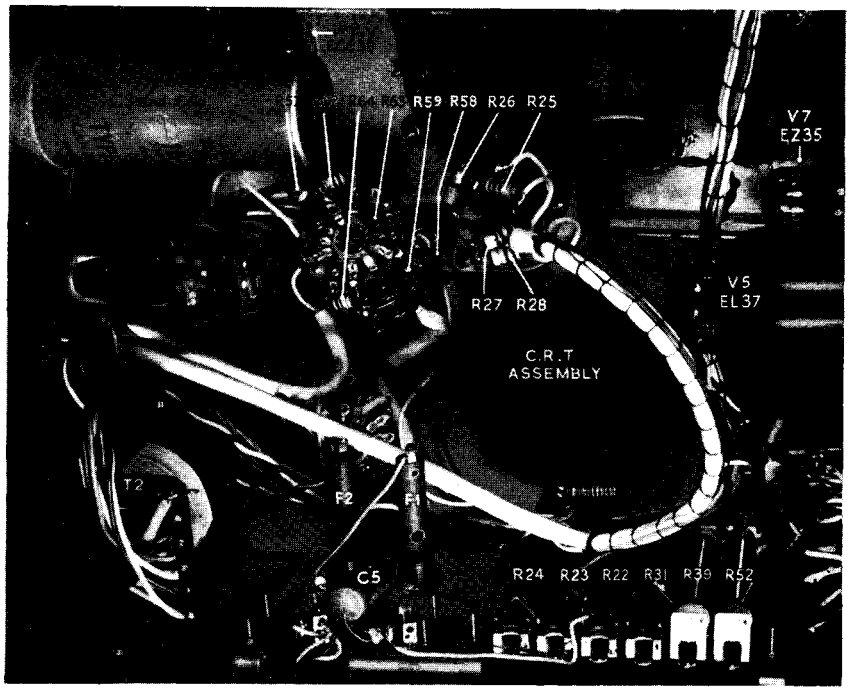


FIG. 14.—INTERIOR SHOWING NUMBERED COMPONENTS.

5.2.3 HEATER AND FILAMENT SUPPLIES

The heater transformer T2 has an input of 200 volts which is supplied from the primary of T1. It is applied to one of eight primary taps, enabling

the voltage at the nine secondary taps to be varied about a nominal value. In this way a complete and accurate range of output voltages from 0.28 volts to 140 volts is available for selection by the gate switch.

5.2.4 GATE SWITCH

Any desired combination of the 130 connections in the gate switch can be obtained by inserting, between the fixed and movable contacts, a sheet of insulating material in which are punched holes corresponding to the contacts it is required to close.

The gate switch is used to route supplies to the valve under test, to select all the electrode voltages required for the test, to adjust the sensitivity of the metering circuit, and to arrange the appropriate circuit for the particular type of valve under test.

In conjunction with special punched cards the gate switch arranges circuits for testing the mains supply input voltage and for checking the H.T., reject limit and zero setting.

The resistors R89, R90 and R91 are anode ,screen and grid stoppers respectively and are used to reduce the risk of parasitic oscillations in the valve under test. R66 and R67 provide an artificial centre tap for directly heated valves.

When testing diodes for signal emission, R60 and R61 are used as a potential divider between the cathode of V5 and earth, the diode test voltage being taken from the centre tap.

R60 and R61 are also used in conjunction with R63 to convert V5 to a resistive load when testing the emission of power rectifiers.

R69 to R79 inclusive are shunts for the metering circuit. R80, R82, R83, R84, R85 and C10 are used to provide the correct voltages and reject limits when making the heater-cathode insulation test.

The gate also operates safety switch SW11 in the mains input lead, thus ensuring that the mains can be switched on only when the card is correctly inserted in the gate and the gate switch closed.

5.2.5 SELECTOR SWITCH

The rotary selector switch is a bank of wafer switches marked SW1 to SW10 inclusive in the circuit diagram. In conjunction with the gate switch it selects the sequence of the various tests.

R57 and R58 form a potential divider between —200 volts and earth, the junction of which is completed by the filament of the valve under test. A continuous filament will cause a voltage to appear across R58 which forms the input to the metering circuit, causing the spot to be deflected.

R59 is used as a series safety resistor when returning the electrodes to negative in the " Electrodes O/C " test.

R62 to R65 inclusive are used to apply the correct voltages and reject limits for the " Electrode Insulation " tests.

Position 1 of this switch is also used for the mains test and reject limit test, and position 6 for checking the stabilised H.T. supply.

5.2.6 PUSH BUTTONS

Four push buttons marked PB1 to PB4 inclusive in the circuit diagram, and labelled "Earthy Electrodes," " Control Grid," " Screen Grid," and "Anode" respectively on the instrument panel, normally connect the valve to the requisite electrode voltages. When a button is depressed, the corresponding electrode is disconnected from its normal supply and the appropriate test for short circuit or open circuit within the valve is applied.

6. MAINTENANCE AND SERVICE NOTES

6.1 Accessibility

Instructions for gaining access to the internal components are given in Section 5.1.1 and 5.1.2.

Care must be exercised when removing the covers not to damage the components.

6.2 The Cathode Ray Tube and Assembly

Instructions for removing the cathode ray tube assembly are given in Section 5.1.3.

Before removing the assembly it is advisable to note its approximate position in the clamp and so simplify

the procedure of replacing the assembly in its correct position. Having removed the assembly from the clamp the tube can be withdrawn by pressing on the tube spigot.

6.3. Gate Switch Contacts—Cleaning

Dismantle the gate switch as described in Section 5.1.4. (*d*).

The contacts should be cleaned with a soft tooth brush using trichlorethylene or a similar cleaning agent. On no account must they be cleaned with any abrasive material.

6.4 Gate Switch Contacts—Replacement

The contact is retained in its bakelite holder by three prongs, the centre one of which is bent outwards.

Having dismantled the gate switch a faulty contact can be removed by unsoldering its connecting strap and bending the centre prong into line with the other two.

When inserting the new contact, care must be taken to ensure that it is firmly seated in the bakelite holder before bending the centre prong outwards. The spring should be lightly lubricated with " cycle " oil. Solder the connecting strap in position and reassemble the gate switch.

FAULT INDICATION TABLE

CARD IN USE	INDICATION	FAULT
" MAINS "	No Indicator spot— Pilot lamp not lighting	1. Mains off. 2. Mains fuse blown. 3. Card incorrectly inserted in gate. 4. Gate switch not closed. 5. " MAINS ADJUST." switch contacts faulty.
	No indicator spot— Pilot lamp lights	1. Mains tap in wrong position. 2. Faulty Stabiliser (V8). 3. C3, C4, C8 or C9 short circuited. 4. EZ35 (V3) and/or (V7) faulty. 5. X shift out of adjustment.
" REJECT "	Spot off centre	1. ECC35 (V2) faulty. 2. X shift out of adjustment.
" H.T. "	Spot out of prescribed limits	1. Low emission in EF50 (V4), EL37 (V5) or FW4–500 (V6).
VALVE TEST (Selector switch in Pos. 6)	No indicator spot	1. EL37 (V5) or EF50 (V4) faulty.
	Spot in Red section of scale with good valve under test	1. H.T. fuse blown. 2. FW4-500 (V6) faulty.

6.5 Service Notes

The following test voltages are measured with a 1000-ohm per volt meter with the " H.T. " card in the gate.

D.C. volts across C3	455 V
,, ,, ,, C4	470 V
,, ,, ,, C6 and C12	270 V
,, ,, ,, C9	220 V
Stabiliser 85A1 volts	85 V
Screen volts EF50 (V4)	72 V
Anode volts EF50 (V4)	90 V
Anode volts to earth (not chassis) EL37 (V5)	260 V
Screen volts to earth (not chassis) EL37 (V5)	260 V
Cathode and V_{g3} volts to earth (not chassis) EL37 (V5)	90 V

6.5.1 FAULTS

The table on page 18 has been compiled to assist the operator in locating faults which may occur during the life of the instrument. It is naturally not a complete fault-finding table and technical and servicing data will be issued from time to time.

NOTE: To avoid burning a spot on the screen the instrument must be switched off when not in use.

6.6 Service Facilities

In the event of a fault developing in the apparatus described in this manual, the defective parts should be dealt with in accordance with the conditions of the Guarantee issued with the instrument.
Any defective part should be returned to the Service Department, Wandsworth.

If it is found impossible to diagnose the fault, or the fault is of a major nature, the instrument itself should be returned. It should be very carefully packed, and, to avoid transit delay, despatched by passenger train.

All correspondence of a technical nature on service matters should be addressed to:—

Mullard Electronic Products Ltd.
Service Department
Brathway Road
Wandsworth
London, S.W.18

All other correspondence should be addressed to:—

Mullard Electronic Products Ltd.
Valve Sales Dept.
Century House
Shaftesbury Avenue
London, W.C.2

7. PARTS LIST

In order to avoid undue delay when ordering replacements, the Code Number shown against each part should be quoted together with the description of the part or parts required.

7.1 Resistors

Circuit Ref.	Value (Ω)	Make	Tolerance (%)	Rating (Watts)	Type No.	Code No.
R1	4 M	Welwyn	1	1	SA 3634	GH 55041/4M
R2	2 M	Erie	1	½	100	GH 55017/2M
R3	1 M	Erie	1	¼	108	GH 55015/1M
R4	.5 M	Erie	1	¼	108	GH 55015/M5
R5	250 K	Erie	1	¼	108	GH 55015/M25
R6	125 K	Erie	1	¼	108	GH 55015/125K
R7	200 K	Erie	1	⅛	109	GH 55008/200K
R8	51 K	Erie	1	⅛	109	GH 55008/51K
R9	1 M	Erie	1	¼	108	GH 55015/1M
R10	.5 M	Erie	1	⅛	109	GH 55008/M5
R11	250 K	Erie	1	⅛	109	GH 55008/M25
R12	125 K	Erie	1	⅛	109	GH 55008/125K
R13	62.5 K	Erie	1	⅛	109	GH 55008/62K5
R14	31.2 K	Erie	1	⅛	109	GH 55008/31K2
R15	15.6 K	Erie	1	⅛	109	GH 55008/15K6
R16	7.8 K	Erie	1	⅛	109	GH 55008/7K8
R17	50 K	Erie	1	⅛	109	GH 55008/50K
R18	1.5 M	Erie	1	½	100	GH 55017/1M5
R19	22 K	Erie	10	¼	9	GH 42210/22K
R20	10 K	Erie	5	¼	9	GH 42205/10K
R21	24 K	Erie	1	½	100	GH 55017/24K
R25	4.7 M	Erie	10	¼	9	GH 42210/4M7
R26	3.3 M	Erie	10	¼	9	GH 42210/3M3
R27	1 M	Erie	10	¼	9	GH 42210/1M
R28	1 M	Erie	10	¼	9	GH 42210/1M
R29	100 K	Erie	5	¼	9	GH 42205/100K
R30	100 K	Erie	5	¼	9	GH 42205/100K
R33	3.3 M	Erie	5	¼	9	GH 42205/3M3
R34	9.1 M	Erie	5	¼	9	GH 42205/9M1
R35	470 K	Erie	5	¼	9	GH 42205/M47
R36	1.5 K	Erie	10	¼	9	GH 42210/1K5
R37	220 K	Erie	10	¼	9	GH 42210/220K
R38	3.3 K	Erie	10	¼	9	GH 42210/3K3
R40	100 K	Erie	10	½	8	GH 42510/100K
R41	115 K	Erie	1	½	109	GH 55017/115K
R42	4.7 K	Erie	10	½	8	GH 42510/4K7
R43	27 K	Erie	5	2	1	GH 42605/27K
R44	33 K	Erie	5	2	1	GH 42605/33K
R45	10 K	Erie	10	¼	9	GH 42210/10K

Circuit Ref.	Value (Ω)	Make	Tolerance (%)	Rating (Watts)	Type No.	Code No.
R46	100	Erie	10	$\frac{1}{4}$	9	GH 42210/100E
R47	560 K	Erie	10	1	2	GH 42210/M560
R48	1 M	Erie	10	$\frac{1}{4}$	9	GH 42210/1M
R49	100	Erie	10	$\frac{1}{4}$	9	GH 42210/100E
R50	68 K	Erie	2	$\frac{1}{8}$	109	GH 55010/68K
R51	560 K	Erie	10	$\frac{1}{4}$	9	GH 42210/560K
R53	180 K	Erie	5	$\frac{1}{4}$	109	GH 55012/180K
R54	8.2 K	Erie	10	1	2	GH 42310/8K2
R55	6.8 K	Erie	10	1	2	GH 42310/6K8
R56	4.7 K	Erie	10	1	2	GH 42310/4K7
R57	12 K	Erie	5	1	2	GH 42305/12K
R58	68	Erie	1	$\frac{1}{8}$	109	GH 55008/68E
R59	100 K	Erie	10	$\frac{1}{2}$	8	GH 42510/100K
R60	680	Welwyn	2	7	AX 3512	GH 03100/680E
R61	680	Welwyn	2	7	AX 3512	GH 03100/680E
R62	10 M	Erie	5	$\frac{1}{4}$	9	GH 42205/10M
R63	2.7 M	Erie	5	$\frac{1}{4}$	9	GH 42205/2M7
R64	10 M	Erie	5	$\frac{1}{4}$	9	GH 42205/10M
R65	6.8 M	Erie	5	$\frac{1}{4}$	9	GH 42205/6M8
R66	20	Welwyn	2	7	AX 3512	GH 03100/20E
R67	20	Welwyn	2	7	AX 3512	GH 03100/20E
R68	120	Welwyn	2	2	A 3635	GH 55062/120E
R69	8.2 K	Erie	1	$\frac{1}{8}$	109	GH 55008/8K2
R70	4.3 K	Erie	1	$\frac{1}{8}$	109	GH 55008/4K3
R71	2.2 K	Erie	1	$\frac{1}{8}$	109	GH 55008/2K2
R72	1.1 K	Erie	1	$\frac{1}{8}$	109	GH 55008/1K1
R73	560	Erie	1	$\frac{1}{8}$	109	GH 55008/560E
R74	300	Erie	1	$\frac{1}{8}$	109	GH 55008/300E
R75	160	Erie	1	$\frac{1}{8}$	109	GH 55008/160E
R76	82	Erie	1	$\frac{1}{4}$	108	GH 55015/82E
R77	43	Erie	1	$\frac{1}{4}$	108	GH 55015/43E
R78	22	Erie	1	$\frac{1}{2}$	100	GH 55017/22E
R79	11	Erie	1	$\frac{1}{2}$	100	GH 55017/11E
R80	470 K	Erie	5	$\frac{1}{4}$	9	GH 42205/470K
R82	1.2 M	Erie	5	$\frac{1}{4}$	9	GH 42205/1M2
R83	3.6 M	Erie	5	$\frac{1}{4}$	9	GH 42205/3M6
R84	2.7 M	Erie	5	$\frac{1}{4}$	9	GH 42205/2M7
R85	39 K	Erie	5	$\frac{1}{4}$	9	GH 42205/39K
R86	1.5 K	Erie	10	$\frac{1}{2}$	8	GH 42510/1K5
R87	150 K	Erie	20	$\frac{1}{2}$	8	GH 42520/150K
R88	150 K	Erie	20	$\frac{1}{2}$	8	GH 42520/150K
R89	100	Welwyn	2	1	SA 3634	GH 55042/100E
R90	100	Erie	5	$\frac{1}{2}$	8	GH 42505/100E
R91	10 K	Erie	5	$\frac{1}{4}$	9	GH 42205/10K

7.2 Capacitors

Circuit Ref.	Value (μF)	Make	Rating (V. DC wkng.)	Type No.	Code No.
C1	0.1	T.C.C.	350	343	GH 38210/0.1 mfd.
C2	0.1	T.C.C.	350	343	GH 38210/0.1 mfd.
C3 & C4	16 + 16	T.C.C.	500	CE 36PA	GH 35434/16 + 16 mfd.
C5	0.1	T.C.C.	350	343	GH 38210/0.1 mfd.
C6	16	T.C.C.	350	CE 19L	GH 35157/16 mfd.
C7	0.5	T.C.C.	350	343	GH 38210/0.5 mfd.
C8	16	T.C.C.	350	CE 11LE	GH 35158/16 mfd.
C9	16	T.C.C.	350	CE 11LE	GH 35158/16 mfd.
C10	0.1	T.C.C.	350	343	GH 38210/0.1 mfd.
C11	0.25	T.C.C.	350	343	GH 38210/0.25 mfd.
C12	16	T.C.C.	350	CE 19L	GH 35157/16 mfd.
C13	0.001	T.C.C.		CP 305	GH 38030/0.001 mfd.

7.3 Miscellaneous

Circuit Ref.	Description	Code No.
F1	Cartridge Fuse 2 A	G8 14001
F2	Cartridge Fuse 250 mA	G8 14000
—	Bulgin Fuse holder Type F115	G8 14539
PB1–4	Push Button Unit	MD 88382
PL1	Philips Lamp 6.37 V 0.15 A	8044–07
SW1	Rotary Switch, 6 bank—6 way	MD 88336
SW12	Rotary Switch, single pole, 11 way	MD 88333
T1	Transformer	MD 51004
T2	Transformer	MD 51005
—	Welwyn Pre-set Resistor Board	MD 79002
—	EF50 Valve retaining ring	GH 54674
—	Tag strip, 12 way	MK 88653
—	Tag strip, 8 way	MK 86945
—	Mains Connector Block	G8 18223
—	Press pahn Terminal Board	MD 27594
—	Terminal Board Spacers $\frac{1}{2}$" × 6 BA	MD 11546
—	Valve holder Panel, Complete	MD 86433
—	Stationary Contacts, Gate Assembly	MD 88334
—	Moving Contacts, Gate Assembly	MD 88337
—	Hinge Pin	MD 61509

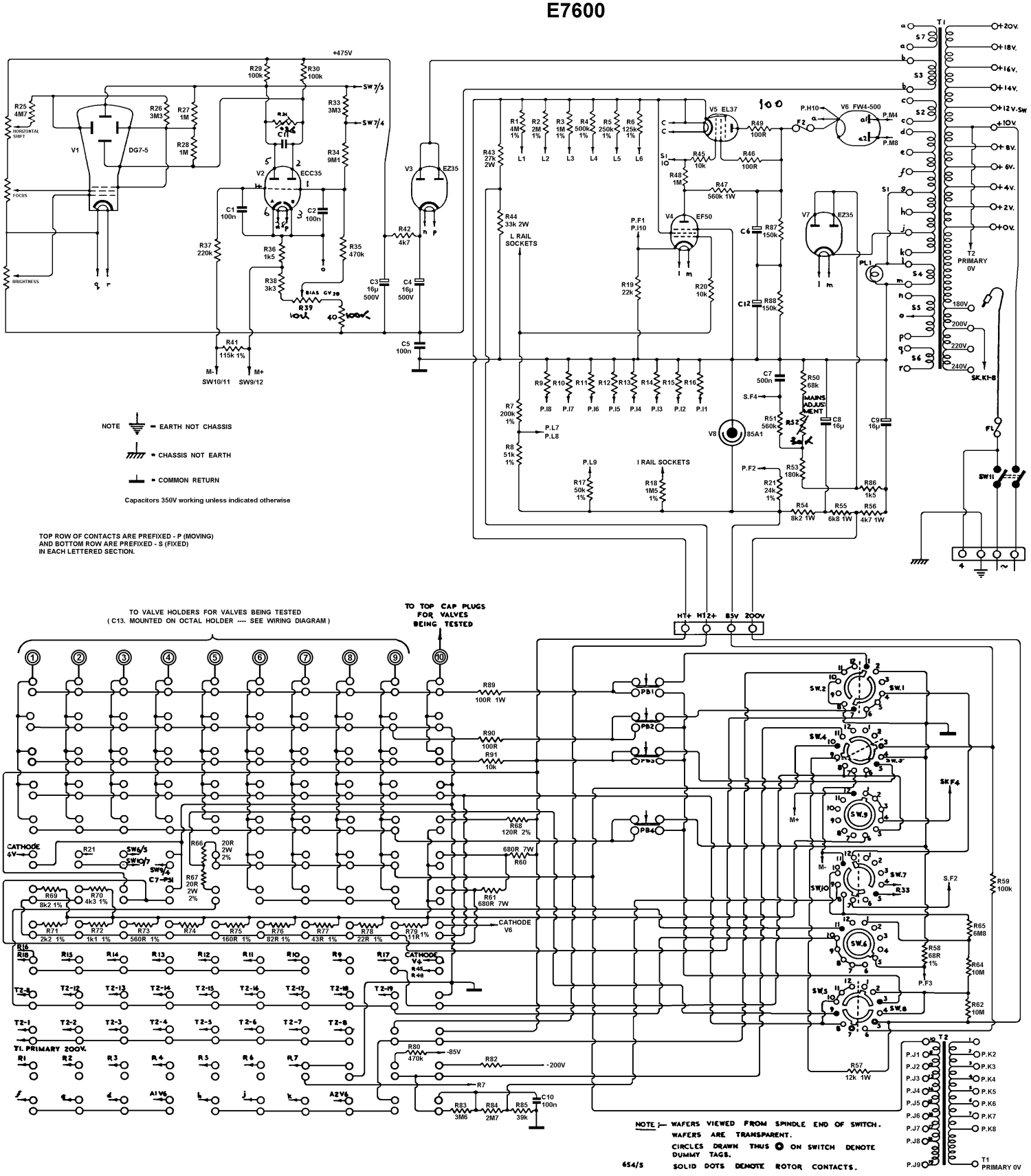
Circuit Ref.	Description	Code No.
—	T.C.C. Type 7840 Capacitor Clips	MD 90417
—	Clix Type P.42 Wander Plug	GH 05003
—	Clix Type S.353 Socket	GH 05004
—	Bulgin Type D.180 (Red) Lamp-holder	GH 54951
—	Benjamin Type 75/570, B3 Valve-holder	49 23189
—	Benjamin Type 75/734, B4 Valve-holder	GH 54713
—	McMurdo Type SP5/US, B5 Valve-holder	GH 54706
—	McMurdo Type SP7/E, B7 Valve-holder	GH 54703
—	McMurdo Type BM7U, B7G Valve-holder	MK 22544
—	Benjamin Type 76/214, B8A Valve-holder	GH 54719
—	Benjamin Type 75/349, B9G Valve-holder	MK 22522
—	McMurdo Type SP4/US, UX4 Valve-holder	GH 54707
—	McMurdo Type RS6/US, UX6 Valve-holder	GH 54704
—	McMurdo Type SP7/US, UX7 Valve-holder	GH 54702
—	McMurdo Type B8/E, Brit. Oct. Valve-holder	GH 54701
—	McMurdo Type SP8/US, Int. Oct. Valve-holder	GH 54700
—	Benjamin Type 75/865 Loctal Valve-holder	GH 54720
—	McMurdo Type BM9U Novel Valve-holder	MK 22543
—	Belling-Lee Type L1164 P. Base Valve-holder	25 16192
—	Clix Type YH 359/9 Valve-holder	GH 54724
—	Side Cover Assembly L.H. Complete	MD 86435
—	Side Cover Assembly L.H. Handle	MD 91404
—	Side Cover Assembly R.H. Complete	MD 86437
—	Side Cover Assembly R.H. Return Spring	MD 76000
—	Bottom Cover	MD 27595
—	Back Cover	MD 86439
—	Front Cover Assembly	MD 86440
—	Label	MD 69514
—	Rubber Feet	MD 92401
—	Lever Assembly	MD 85201
—	Link Bar	MD 67570
—	Block	MD 10252
—	Stop Pin	MD 64521
—	Pivot Bolt	MD 93615
—	Guide Plate	MD 67569
—	Spacers	MD 11549
—	Springs	MD 73003
—	Contact Assembly, fixed " A "	MD 83138
—	Contact Assembly, spring loaded " B "	MD 83139
—	Bakelite Bush	MD 13507
—	Contact	MD 67558
—	Spring	MD 73002
—	6" Copper contact strap	MD 67572

Circuit Ref.	Description	Code No.
—	Mains Switch Safety Device	MD 82235
—	Mains Switch Safety Device Spring	MD 74008
—	Side Fixing Bracket L.H. & R.H.	MD 04502
—	Etched Label	MD 69513
—	Graticule	MD 27594
—	Spacers $\frac{3}{8}$" × 4 BA	MD 11548
—	Push Button, Black	MD 92002
—	Brackets C.R.T. Holder	MD 06057
—	C.R.T. Clamp Assembly " A "	MD 07003
—	C.R.T. Clamp Assembly " B "	MD 07004
—	C.R.T. Shield	MD 22003
—	Mains Voltage Selector Panel	MD 83015
—	Mains Voltage Selector Plug	MD 83016
—	Switch Knobs	RA 260180

7.4 Valves

Circuit Ref.	Make and Type No.
V1	Mullard DG7–5
V2	Mullard ECC35
V3	Mullard EZ35
V4	Mullard EF50
V5	Mullard EL37
V6	Mullard FW4–500
V7	Mullard EZ35
V8	Mullard 85A1

E7600


+475V
R29 100k
R30 100k
SW7/3
SW7/4
R25 4M7
HORIZONTAL SHIFT
R26 3M3
R27 1M
R28 1M
R33 3M3
R34 9M1
V1
DG7-5
V2
ECC35
V3
EZ35
FOCUS
BRIGHTNESS
C1 100n
C2 100n
R37 220k
R36 1k5
R35 470k
R38 3k3
BIAS CV28
R39 100K
C3 16µ 500V
C4 16µ 500V
R42 4k7
C5 100n
R41 115k 1%
M-
M+
SW10/11
SW9/12
R1 4M 1%
R2 2M 1%
R3 1M 1%
R4 500k 1%
R5 250k 1%
R6 125k 1%
L1
L2
L3
L4
L5
L6
R43 27k 2W
R44 33k 2W
L RAIL SOCKETS
V5 EL37
R49 100R
R45 10k
R46 100R
R48 1M
R47 560k 1W
V4 EF50
V6 FW4-500
P.H10
P.M4
P.M8
F2
V7 EZ35
C6 R87 150k
C12 R88 150k
R19 22k
R20 10k
P.F1
P.I10
T1
T2 PRIMARY 0V
+20V.
+18V.
+16V.
+14V.
+12V.SW
+10V
+8V.
+6V.
+4V.
+2V.
+0V.
180V
200V
220V
240V
SK.KI-8
R9 R10 R11 R12 R13 R14 R15 R16
P.I8 P.I7 P.I6 P.I5 P.I4 P.I3 P.I2 P.I1
R7 200k 1%
R8 51k 1%
P.L7
P.L8
P.L9
I RAIL SOCKETS
C7 500n
S.F4
R50 68k
MAINS ADJUSTMENT
R52 2M
R51 560k
C8 16µ
C9 16µ
V8 85A1
R17 50k 1%
R18 1M5 1%
P.F2
R53 180k
R21 24k 1%
R54 8k2 1W
R55 6k8 1W
R56 4k7 1W
R86 1k5
FL
SW11
NOTE = EARTH NOT CHASSIS
= CHASSIS NOT EARTH
= COMMON RETURN
Capacitors 350V working unless indicated otherwise
TOP ROW OF CONTACTS ARE PREFIXED - P (MOVING)
AND BOTTOM ROW ARE PREFIXED - S (FIXED)
IN EACH LETTERED SECTION.
TO VALVE HOLDERS FOR VALVES BEING TESTED
(C13. MOUNTED ON OCTAL HOLDER ---- SEE WIRING DIAGRAM)
TO TOP CAP PLUGS FOR VALVES BEING TESTED
HT1+ HT2+ 85V 200V
R89 100R 1W
R90 100R
R91 10k
R68 120R 2%
680R 7W
R60
CATHODE 4V
R21
SW6/5
SW6/6
SW6/7
SW6/4
C7-P5H
R66 20R 2W 2%
R67 20R 2W 2%
R69 8k2 1%
R70 4k3 1%
R61 680R 7W
CATHODE V6
R71 2k2 1%
R72 1k1 1%
R73 560R 1%
R74
R75 160R 1%
R76 82R 1%
R77 43R 1%
R78 22R 1%
R79 11R 1%
R16 R15 R14 R13 R12 R11 R10 R9 R17
CATHODE V4
R45
R46
T2-1 T2-2 T2-3 T2-4 T2-5 T2-6 T2-7 T2-8
T2-9 T2-10 T2-11 T2-12 T2-13 T2-14 T2-15 T2-16 T2-17 T2-18 T2-19
T1 PRIMARY 200V.
R1 R2 R3 R4 R5 R6 R7
A1V6
A2V6
R80 470k -85V
R82 -200V
R7
R83 3M6
R84 2M7
R85 39k
C10 100n
PB1
PB2
PB3
PB4
SW.1
SW.2
SW.3
SW.4
SW.5
SW.6
SW.7
SW.8
SW.9
SW10
SK.F4
M+
M-
S.F2
R59 100k
R65 6M8
R58 68R 1%
R64 10M
P.F3
R62 10M
R57 12k 1W
T2
P.J1 P.J2 P.J3 P.J4 P.J5 P.J6 P.J7 P.J8 P.J9
P.K2 P.K3 P.K4 P.K5 P.K6 P.K7 P.K8
T1 PRIMARY 0V
NOTE :- WAFERS VIEWED FROM SPINDLE END OF SWITCH.
WAFERS ARE TRANSPARENT.
CIRCLES DRAWN THUS O ON SWITCH DENOTE DUMMY TAGS.
654/5 SOLID DOTS DENOTE ROTOR CONTACTS.