Mullard

High Speed

VALVE TESTER

OPERATING MANUAL

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THE MULLARD HIGH SPEED VALVE TESTER

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Mullard

HIGH SPEED VALVE TESTER

The valve tester makes it a simple matter to check the valves which are normally brought into the shop or repair department. The operator has only to work a switch and some push buttons and the results are shown by the position of a spot of light on the face of a small cathode ray tube. There is no objection to the tests being made by a person who is not technically minded provided the routine has been thoroughly taught. This is essential since it is possible to damage the valve under test; for example, by using the push buttons incorrectly.

The tests are as nearly as possible the same as those made during manufacture but allowance has been made for the normal ageing of the valve. It must be realised that any valve tester can reveal only the condition of the valve itself and not whether it will be satisfactory in an actual circuit. It has been found, however, that 95 per cent of the valves which pass the tests will give all the performance required, and the testing of valves brought in by members of the public is therefore both practical and reliable.

In the work of repair the valve tester must take its place with the other sources of information open to the radio mechanic. For instance, valves which have relatively low emission may be satisfactory in a television set in an area where the signal is strong. On the other hand, valves which pass the emission test but have only average properties might not be satisfactory for weak-signal areas.

It is good practice to test all the valves in receivers brought in for servicing. Not only does this help in the tracing of possible faults, but a written report on the condition of the valves can be supplied to the customer. A customer's report safeguards against loss of goodwill by showing whether a valve is likely to require early replacement after the repair has been completed.

OPERATION

It will be much easier to follow the instructions given later in this manual after becoming familiar with the parts of the equipment and the way in which they work. Each part as it is described can be identified on Fig. 1, but the instrument should not be handled at this stage.

There are a number of switches in the instrument which make it safe and automatic in operation.

Power Switches

First, the ON-OFF SWITCH is used to warm-up the valve tester by supplying power to its internal valve circuits. It does not, however, apply power to the valve to be tested. Before the test sockets can be made " live " the wiring connections must correspond to the valve about to be tested. The red PILOT LAMP will light up to show when the mains voltage has been applied.

The correct socket connections are made by placing a control card in the GATE and pulling the GATE SWITCH LEVER down. Inside the gate is a rectangular pattern of pairs of contacts arranged in 10 columns and 13 rows, holes having been punched in the control cards where a pair of contacts are to be joined. On pulling the gate switch lever down the contacts opposite these holes are brought together. To prevent the instrument from being damaged the lever also acts as a safety switch; thus unless the control card has been pushed right down into the gate the positive H.T. supplies to the instrument will not be applied when the lever is pulled down.

Finally, there is a relay switch which is not under the control of the operator. A faulty valve may cause an unusually large current to be drawn from the H.T. supply. When this current becomes too great the relay trips over and the H.T. and mains supplies are switched off. A RESET SWITCH in the form of a button on the top of the instrument is pressed to switch the relay on again for testing the next valve.

The relay will also trip if a fault in the instrument is causing overloading in some part of the circuit.

The MAINS ADJUST SWITCH will be described later.

The Test Switches

The actual tests are applied to the valve by means of the SELECTOR SWITCH and PUSH BUTTONS. The tests are made in the correct order by moving the selector switch through its six positions in turn. In two of the positions the push buttons are pressed to test the insulation resistance between the various electrodes, and in a third position to test for open-circuited electrodes.

The Indicator

The indicator is a small cathode ray tube mounted behind a rectangular mask. The face of the indicator is divided into three parts (Fig. 3) corresponding to the red, amber and green sections on the vertical coloured scales.

The result of each test is shown by the presence of a green spot of light in one of the sections of the face. For example, a fault in the valve is indicated by the spot remaining in or descending towards the " red " section of the scale.

A full description of the test routine is given on pages 7 and 8.

The Test Cards

As most of the control cards can be used for several valve types, the cards are given reference numbers which are listed in the test card index alongside the type numbers of the valves.

The socket in which the valve should be mounted is given on the test card as a number which can be identified with the aid of a plan on the instrument panel. The position of the number in the plan corresponds to the position of the socket on the top panel of the instrument. Where one of the electrode connections has been brought out to a top cap on the valve, the TOP CAP LEAD must be used to include it in the testing circuits.

Most valves can be tested with only one card. The type of electrode structure checked by each card is indicated alongside the word " test ", viz. triode, pentode, etc. When more than one valve section is mounted in the same bulb, the sections are tested separately and two or more cards are required. These cards are distinguished by letters A, B, C, etc., placed after the card number and are used in alphabetical order. Each card shows how many cards will be required to test all sections of the valve.

THE DEFECTS IN A VALVE

Although the testing of a valve is a purely routine matter, it may be of interest to see how faults develop in a valve and what effect these faults produce in an actual receiver.

Firstly it must be emphasised that the real cause of a fault in a valve is mechanical and chemical, rather than electrical. Therefore, although the components are inspected frequently during manufacture, the final works testing can only be performed electrically and may not show the likelihood of a fault developing. That in brief is why it is not possible to make a perfect valve. The manufacturer, however, does make sure that the proportion of valves which fail in service is kept to a satisfactorily low level.

With the Mullard High Speed Valve Tester each valve may be checked for defects by these seven tests:—

1 Heater continuity
2 Electrode insulation with H.T. not applied
3 Heater-to-cathode insulation
4 Electrode insulation with H.T. applied
5 Grid current
6 Emission
7 Open-circuited electrodes.

Poor insulation (tests 2, 3 and 4) may be caused by part of the coating, or even the metal of the electrodes themselves, being evaporated by the heat of the valve. This metal condenses again on colder spaces between the electrodes, making a path for current to flow between them. Another cause of poor insulation is the chemical breakdown of the glass which surrounds the pins at the base of the valve. Chemical breakdown (electrolysis) is brought about when current is carried between the pins by charged lead atoms (ions). As the process goes on, a conducting path of lead may be built up and the insulation between the electrodes destroyed.

Test 5, besides checking that the grid current is not excessive, gives some measure of the amount of gas in the valve. Although as much gas as possible is removed during manufacture, some may still be given off by the surfaces in the valve, and may not all be taken up by the chemicals provided. The particles of gas lose electrons by collision with the electrons drawn off from the cathode coating and themselves become positively charged carriers of current (ions). The positive gas ions move to the negative grid and so grid current flows.

Gas particles are also pulled towards the heated coating so that their bombardment weakens or perhaps destroys it, in addition to the normal wearing out of the coating. The emission from the cathode is checked in test 6 by measuring the anode current.

Tests 1 and 7 reveal crude mechanical failures inside the bulb. These may be due to the heat developed across a weak part of the electrode or to rough handling.

The faults in a valve can be arranged in three groups roughly according to the trouble they are likely to cause in the actual receiver.

(1) Faults likely to cause complete failure to operate:
  (a) Broken filament or heater
  (b) Short circuits between electrodes
  (c) Disconnected electrodes
  (d) Complete loss of emission.

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

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

INSTALLATION

MAINS LEAD

A mains lead is not supplied with the instrument, so that a convenient length of any three-core 5-amp cable may be connected.

The mains supply is connected to the tester through an ebonite terminal block which is reached by taking off the bottom cover. First remove the five screws in this cover, three along the rear edge and one on either side. As the front edge fits between a flange and the chassis, the cover should be drawn backwards to pull the front edge clear.

A diagram of the terminal block is given in Fig. 2. The mains leads are connected to terminals 1 and 2 and the earth lead to terminal 3.

IT IS ESSENTIAL THAT AN EARTH LEAD IS USED.

No connection is made to terminal 4, which is not intended to be used at present, but this terminal is " live " when the gate switch is closed.

The cable should be threaded through the rubber grommet in the back panel before replacing the cover, and a suitable mains plug attached.

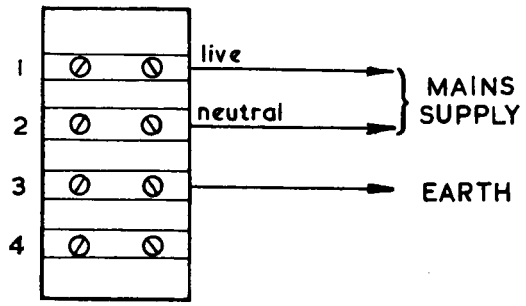


Fig. 2. TERMINAL BLOCK CONNECTIONS

SETTING-UP ADJUSTMENTS

Three adjustments may have to be made to the valve tester before it is ready for use and should be checked at regular intervals. Special " check " test cards, printed in blue and known as the **mains** card, the **reject** card and the **H.T.** card, are provided for the adjustments.

A hinged plate on the front cover protects all preset controls from being displaced.

WARNING. The mains check and adjustment must be made *before* the reject check is attempted.

Mains Check and Adjustment

The valve tester can be operated from any 50 c/s A.C. supply between 180 and 260 volts. Transformer tappings under the hinged plate at the front of the instrument provide a 20-volt coarse adjustment of the mains voltage between 180 and 240 volts, a fine adjustment being obtained by using the ten 2-volt tappings of the **mains adjust** switch on the panel.

The adjustment is made as follows:

The initial settings should be made quickly so that the instrument will not be running for any length of time on the wrong voltage.

(i) Set the 20-volt transformer tapping to the voltage expected from the mains supply. If the expected voltage lies between two of the tappings, choose the tapping giving the lower voltage. The tapping is set by pulling forward the plug from its socket, turning it to indicate the voltage required, and pressing the plug home again.

(ii) Put the mains switch on and allow 20 seconds for warming up. The pilot lamp should light up to show that power has been applied. If the pilot lamp does not light, this may be due to the H.T. cut-out being in the " off " position and the reset button should then be pressed.

(iii) Place the **mains** card in the gate.

(iv) Turn the selector switch to position 1.

(v) Pull down the lever to close the contacts in the gate.

(vi) Set the intrument to the mains supply by bringing the spot as nearly as possible on to the dotted line *a* (Fig. 3) by rotating the mains adjust switch.

(vii) Raise the lever, and leave the instrument running on the mains for TWO HOURS before passing on to the reject check.

(viii) At the end of the two-hour running-in period repeat the mains check using the mains card (operations iii to v). Use the mains adjust switch if necessary (operation vi) to make sure that the spot is still as near as possible to the dotted line.

A running-in period has to be allowed only when first installing the instrument, and is quite normal for high impedance test gear. The valve tester should be kept in a reasonably dry place to prevent it from being affected by dampness during periods when it is not in use.

The mains supply voltage should thereafter be checked with the mains card from time to time (operations ii to vi), especially if the mains supply is likely to vary to any great extent.

Reject Check

The **reject** card is used to make sure that the spot is giving a true reading on the scale: that is, only faulty valves must give a reading in the red part of the scale.

When the reject card is placed in the gate and the gate switch closed:

(a) With the selector switch in position 1 the spot should come to rest on the reject limit line *c*.

(b) With the selector switch in position 6 the spot should come to rest on the zero or base line *d* (See Fig. 3).

If these readings are not obtained, the adjustments described on page 10 should be carried out.

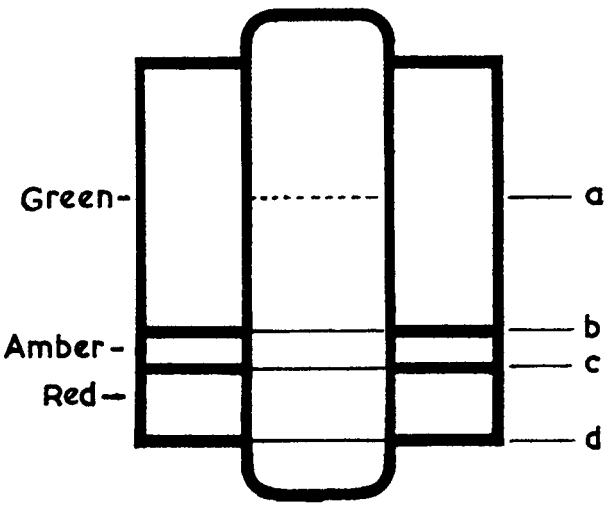


Fig. 3. INDICATOR SCALE

H.T. Check

After the reject check and any adjustment required has been made, the high-tension supply inside the instrument is accurately checked by using the **H.T.** card.

(i) Warm up the tester and place the H.T. card in the gate.

(ii) Turn the selector switch to position 6 and close the gate switch.

(iii) Note whether the spot settles within 3 millimetres ($\frac{1}{8}$-inch) above or below the dotted line *a*. If the spot settles outside the 3 mm. limit—unless it is due to the H.T. cut-out being " off "—the circuits will need attention and the services of a Mullard representative should be sought.

TESTING ROUTINE

These detailed instructions should not be studied until the section on operation (page 3) has been read.

The seven tests are applied in strict order by the selector switch and push buttons. This order is fixed by the six positions of the selector switch. One test is made in each of the first five testing positions but in position 6 two are made, first for anode current and then for open-circuited electrodes using the buttons. Here is a complete list of the seven tests:—

1 Heater continuity
2 Electrode insulation with H.T. not applied (using the push buttons)
3 Heater-to-cathode insulation
4 Electrode insulation with H.T. applied (using the push buttons)
5 Grid current
6 Emission (anode current)
7 Electrode open circuits (using the push buttons).

The *switch positions* required are shown on each of the test cards. The tests on cathode ray tubes, for example, are made in the first three positions; directly heated valves do not require heater-to-cathode insulation test and diodes do not require test 5. The switch position numbers on the card make it possible for people not familiar with the various types of valves to use the valve tester.

For some of the tests the switch has only to be turned to the particular position number and the position of the spot read from the coloured scales. For tests 2, 4 and 7, however, the buttons will have to be pressed and as a reminder a small symbol has been placed on the panel alongside the names of these tests.

The buttons are numbered 1 to 4 downwards, as follows:—

1 Anode
2 Screen grid
3 Control grid
4 Earthy electrodes.

The buttons to be pressed are listed as numbers on the test card.

Buttons must be used only for tests 2, 4 *and* 7. *The buttons listed on the card should be pressed down one at a time in the order listed, and only these buttons may be used.*

A button should never be held down for longer than is strictly necessary (*say*, 2 *seconds*).

The results of tests 1 to 6 only are read from the position of the green spot of light on the face of the indicator, which is divided into three parts by the coloured scales on either side. The meaning of the colours can be remembered perhaps from the " Stop, Caution, Go " of the traffic lights. Thus as soon as the spot settles in the *red* part of the face no further tests need be made and the valve should be replaced. Borderline cases give an indication in the *amber* section and may need to be replaced in the near future (but for signal diodes see page 9). For the valve to be in good condition the spot should be in the *green* section of the scale for all tests 1-6.

The result of test 7 is not read from the coloured scales. Instead, when one of the electrode buttons is pressed, a downward movement of the spot of light indicates that the electrode is not open-circuited.

While enough has now been said to show how the tests are made, here are a few notes and some reminders which will show how to interpret the results correctly and how to take the best possible care of the instrument.

1. *Heater continuity*

This test of course can be applied to either a filament or heater, according to whether the valve is directly or indirectly heated.

For indirectly heated valves only, a red indication may be due to either a short circuit between heater and cathode or to a broken heater. No harm will be done by carrying out tests 2 and 3 to decide the issue,

but test 3 will definitely indicate whether a short circuit exists between heater and cathode and none of the subsequent tests need be made.

2. *Electrode insulation (H.T. off)*

The buttons numbered on the card have to be pressed for this test. Pressing one of the buttons applies the insulation test to that particular electrode, and a deflection to amber or red shows that the insulation is poor.

If this test indicates poor insulation, no further tests need be made.

3. *Heater-to-cathode insulation*

This switch position applies the necessary heater-to-cathode voltage for the insulation test, the voltage being automatically selected by holes in the card, as required for any particular valve.

4. *Electrode insulation (H.T. on)*

The buttons must be used for this test. It is similar to No. 2 but with normal operating voltages applied to the electrodes.

When a short-circuited or poorly insulated electrode is tested the spot will give a reading in the red or amber part of the scale.

5. *Grid current*

Accurate readings in the next two tests, Nos. 5 and 6, will be obtained with certain types of valves only if they have been allowed to reach their working temperature. At least 40 seconds should therefore be allowed for them to warm up. A downward movement of the spot indicates the presence of grid current.

6. *Emission (Anode current)*

Note the steady position of the spot when the selector switch is first moved to position 6. For some valves, in particular small battery diodes, the spot may rise above the green of the scale and perhaps even right off the face of the indicator. This is not necessarily due to a fault in either the valve or the instrument.

An amber indication here means that the valve will still be serviceable in some types of equipment but will need early replacement (for signal diodes, however, see page 9).

7. *Open-circuited electrodes*

Immediately following the emission test and keeping the switch in position 6, the test for open-circuited electrodes is made using the push buttons.

The colours on the scale are not used to read the result of this test. Instead, as each button is pressed, a downward movement of the spot will show that the connections of that electrode have not become open-circuited.

Sometimes the downward movement of the spot will be very slight, a particular example being the test made with button 4 (earthy electrodes) on the valve type EL38.

It will be useful for the service engineer to realise when this is likely to occur, so that such a result can be correctly interpreted. Usually this behaviour is found with types of valves having a suppressor grid or internal screening connected to a separate pin. The construction of the valve may be such that the anode current will not be changed appreciably by a negative voltage, which is applied to the electrode when button 4 is pressed. The downward movement will then only be very slight or occasionally non-existent, although the earthy electrode is not open-circuited. Button 4 has been listed on the cards for these types in order that a complete check on insulation will be made in positions 2 and 4.

Note: A button should not be held down for longer than TWO SECONDS in this test, or the valve may be damaged.

A shortened version of the test routine will be found, printed on stiff card, in the pocket at the back of the manual.

Power Rectifiers

Rectifiers always require two or more test cards, the first being used to test electrode insulation and the others to make the emission tests. The sections of the valve are tested separately; for example, half-wave rectifiers require two cards, and full-wave rectifiers usually require three.

The card used for testing insulation (the first or "A" card) has been designed to make the tests in positions 1 and 2, or 1, 2 and 3, as indicated on the card.

The cards for testing emission (" B ", " C ", etc.) need to be used only in position 6, and the selector switch should be turned to this position—numbered on the card—before it is placed in the gate. The buttons should not be pressed, as only the emission test is to be made.

For the emission test on an indirectly heated rectifier, plenty of time must be allowed for warming up before reading the position of the spot. Heavy current rectifiers sometimes cause the cut-out to

" chatter " during this test; severe sputtering in the valve, however, will trip the cut-out and it may be necessary to press the reset button.

The spot on the indicator may be elongated when a power rectifier is under test. No adjustment should be made to the slider controls as the appearance of the spot will return to normal for other types of valves.

Cathode Ray Tubes

Most of the information required by the service engineer can be obtained by observing the behaviour of the cathode ray tube when it is operated in the receiver. Three further tests, however, can conveniently be made with the valve tester.

Six cards are provided for the testing of cathode ray tubes and are distinguished by the letters ' CRT ' placed in front of the card number.

It is advisable to leave television tubes in their mounting to reduce the risk of damage. The tube is connected to the tester by means of an adaptor, the wiring and type of adaptor being indicated on page 22. The adaptors all plug into the International Octal socket (No. 2).

It is essential that the television receiver is disconnected from the mains supply before starting the tests.

The tests made on cathode ray tubes are identical with the first three made on valves, viz.:

1 Heater continuity
2 Electrode insulation with H.T. not applied
3 Heater-to-cathode insulation.

The buttons listed on the card are pressed in the usual way for test 2.

Signal Diodes

As signal diodes will give satisfactory service even when their emission is relatively low, a slightly different meaning is given to the colours on the scales when a signal diode is being tested for emission. For test 6 a deflection of the spot anywhere above line *c* (Fig. 3) shows that the signal diode is satisfactory.

To prevent misunderstanding with the customer, it may be helpful to make a separate scale for signal diodes. A strip of perspex or celluloid, 2½-inches long by ⅛-inch wide, should be fixed to one side of the indicator window. A line should be etched across the scale, level with the top of the red section. The space above the line can be coloured green, or marked " good ", and the space below the line coloured red or marked " reject " (Fig. 4).

Valve Types requiring Special Adaptors

Valve types which require special adaptors are indicated in the test card index by a number e.g.: EY51 . . . . 579—6.

It has been found necessary to use adaptors for testing a few valves, and diagrams on page 23 show how they can be made. The " plug " in fact is a valve base obtained by dismantling a faulty valve, in which none of the pins required for the plug are missing.

Alternatively, sets of ready made adaptors are supplied to members of the High Speed Tester Maintenance Plan or are obtainable from The Spear Engineering Co., Titan Works, Warlingham, Surrey.

The diagrams are labelled to show for which types they are required, but the corresponding test card can only be found from the test card index. Where the adaptor shows a connection from the top cap of the valve to one of the pins of the plug, the top cap lead on the tester should not be used.

In the diagrams the valve holder and the plug are viewed from the underside.

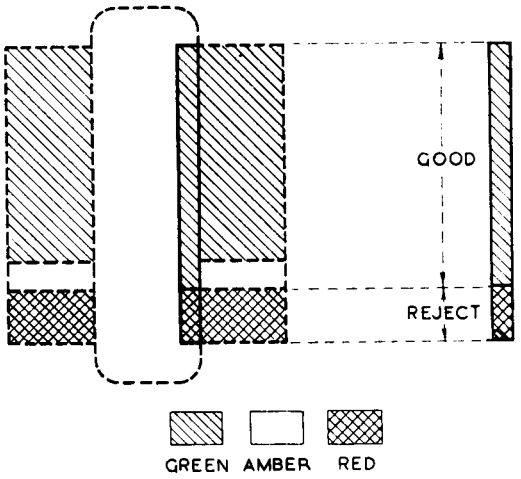


Fig. 4. INDICATOR SCALE FOR SIGNAL DIODES

Indications in the Green Section of the Scale

It is important to remember that the dotted line *a* (Fig. 3) in the green section of the scale is only to be used for the mains adjustment; it should not be used as a reference line for comparing the performance of two different types of valve. This restriction applies also to valves of the same type, since for matching purposes more than one point on the characteristic curves of the two valves would need to be checked.

Installation Adjustments

A hinged cover on the front panel protects the six slider controls provided for these adjustments from being accidentally displaced. The mains transformer tapping and the mains fuse are also built in behind the front cover (see Fig. 1).

The six slider controls are labelled A to F in the diagram reading from left to right.

WARNING. *The left-hand control A is preset and sealed during manufacture and must not on any account be moved.*

This warning should not be taken to mean that the remaining controls B to F can be handled " just to get the feel of the thing ". Once these sliders have been carelessly moved it will only be possible to set them correctly by following strictly the routine about to be described.

Sliders B and C should be moved only if the correct readings were not obtained when using the **reject check card** (see page 6). The adjustment to B and C is made in the following way with the mains switch on:

(i) Place the **reject** card in the gate, and with selector switch in position 1, adjust B control to bring spot on to line *c*.

(ii) Turn selector switch to position 6 and adjust C control to bring spot to line *d*.

(iii) Repeat 1 and 2 until spot is correctly positioned, viz. on position 1 spot is on line *c*; on position 6 spot is on line *d*.

(iv) These settings may have to be repeated several times. Once B and C have been set, the mains adjustment (page 5) should be repeated.

Slider D (brilliance) alters the brightness of the spot.

Slider E (focus) expands or contracts the spot to a suitable definition.

Slider F (X-shift) provides a means for moving the track of the spot sideways after a long period of use. It is possible that a thinning of the screen material may occur along the vertical track of the spot in the course of time, and if the fluorescence of the screen fades the life of the indicator can be increased by moving the spot sideways.

SERVICING

Dismantling the Valve Tester

The outside of the valve tester is completed by a number of covers which have to be removed, before the interior can be inspected. Before taking off the covers make sure that the instrument is not connected to the mains and that the gate switch lever is in the open position.

The **bottom cover** is held by five screws, three along the rear edge and one on either side. After removing these screws, draw the cover backwards to pull the front edge clear.

Each **side cover** is held by two screws at the top and by two pins which engage in slots in the bottom of the cover. Before taking off the right-hand side cover, the gate switch lever should be removed by unscrewing it from the block (2 in Fig. 5). After removing the two holding screws, pull the top outwards, then with a downward movement free it from the pins at the bottom.

The **back cover** plate can now be removed by unscrewing the two back cover bolts, one on each side. One of these bolts is shown in the top left-hand corner of Fig. 10.

When reassembling replace the back cover plate first, then the bottom cover. On replacing the side covers, the bottom pins must be engaged in the slots first.

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

The inside of the instrument (Fig. 8) can be reached by raising the **top panel** carrying the valve sockets. Once the covers have been taken off it can be raised after taking out the two retaining screws on each side. It is recommended that the front screws only are removed, and the rear ones slackened; the panel will then hinge upwards.

The cathode ray tube and its metal mounting (Fig. 8) are held in position by three six-sided pillar nuts which should be unscrewed if it is necessary to remove the tube.

Selector Switch and Push Button Contacts

A good proprietary brand of switch cleaning liquid should be applied periodically to the contacts.

The Gate Switch

The design of the gate is such that it can be dismantled and reassembled quite easily. Instructions on dismantling the gate, together with labelled diagrams (Figs. 5, 6 and 7), are given on pages 12 and 13.

Cleaning the Gate Switch Contacts

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

Care should be taken not to displace the contacts as this may cause a poor connection to be made when the gate switch lever is pulled down.

Replacing Faulty Gate Switch Contacts

All the contacts are spring loaded and each contact fits into a moulded plastic bush. The fixed and moving contacts, however, cannot be replaced in exactly the same way.

Fixed Contacts. Each fixed contact is retained in its bush by a small compression spring. To remove a faulty contact, unsolder the connecting strap and then push the spring clear of the retaining tag. The spring can then be removed and the contact withdrawn from the bush.

Insert the new contact, checking that it moves freely along the guide-ways in the bush. Replace the spring, making sure that the contact is securely held in the bush and moves in and out freely when pressed from the rear.

Moving Contacts. The rear retaining tag is bent outwards on each of the moving contacts, and the contact retained by a compression spring which presses the tag against the rear outer surface of the bush.

To remove the contact, unsolder its connecting strap and then straighten the tag. Unless the contact is held, the spring and the contact will jump out from the bush.

To fit a new contact, place the spring in position over both retaining tags and insert it in the bush. Check that the contact moves freely along the guide-ways. Push it in until the rear retaining tag is clear of the back of the bush, then bend the tag outwards to, as nearly as possible, the same angle as that of the original contact. Solder on the connecting strap and reassemble the gate.

Dismantling the Gate

Great care must be taken not to damage the copper foil connecting straps or the contacts themselves. Each of the parts can be referred to by its number, Nos. 1 to 8 being on Fig. 5, Nos. 9 to 11 on Fig. 6 and Nos. 12 to 15 on Fig. 7.

The gate consists of a moving and fixed set of contacts which can be reached only after the covers have been removed. The moving half of the gate swings round a vertical hinge bar (9) and is mated with the fixed contacts by pulling down the gate switch lever (1). A link bar (4) transfers the motion of the lever eccentrically to the guide pin (3) and hence to the moving set of contacts. The guide pin moves between two guide plates (7) under the tension of a C-spring (6). Thus there is a position between the stops (5 and 8) where the lever and link bar are in line —top dead centre—and on either side of this the pull of the spring draws the lever over to one of the stops.

To dismantle the gate switch, remove the split pin holding the link bar (4) to the gate pin (3). Before the gate can be taken apart, the ebonite microswitch must be unscrewed and moved out of the way on its lead. Care should be taken not to damage the flexible reed which has been aligned to make correct contact with the moving part of the gate. The hinge bar (9) is now removed by unscrewing the two bolts (10 and 11) which pass through the pillars (12 and 13). These bolts are secured by two nuts inside the chassis. Springs (14 and 15) are held between the two halves of the gate and care should be taken when unscrewing the bolts that the moving half of the gate does not jump out and damage the contacts. The hinged side of the gate can now be moved outwards, the rubber grommet carrying the bundle of leads from the contacts being removed from the slot in the bottom lip of the moving gate. The moving half of the gate is now freed by a sideways movement which disengages the gate pin from the guide plates and the C-spring.

To reassemble the gate, insert the gate pin between the guide plates making sure that the C-spring is correctly in position. Bring up the moving half of the gate and replace the hinge bar.

A careful check should now be made to see that the two parts of the gate have been correctly fitted together. Two corresponding pairs of $\frac{1}{8}$-inch holes have been made in the moving half of the gate and the pillars (12 and 13). The alignment is checked by gently pushing the shank of a $\frac{1}{8}$-inch drill through each set of holes, **and the moving half of the gate should then be riding free from the pillars and the hinge bar on the springs (14 and 15).** If necessary the guide plates can be moved slightly in order to align the moving and fixed parts of the gate correctly.

When the alignment is correct, replace the bolts and secure the link bar to the gate pin with the split pin.

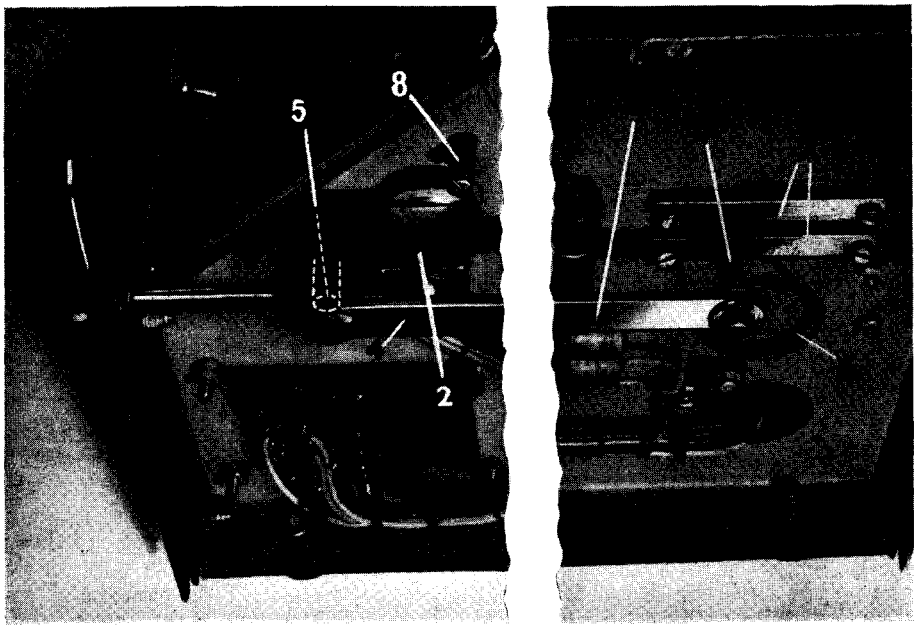


Fig. 5. GATE SWITCH MECHANISM

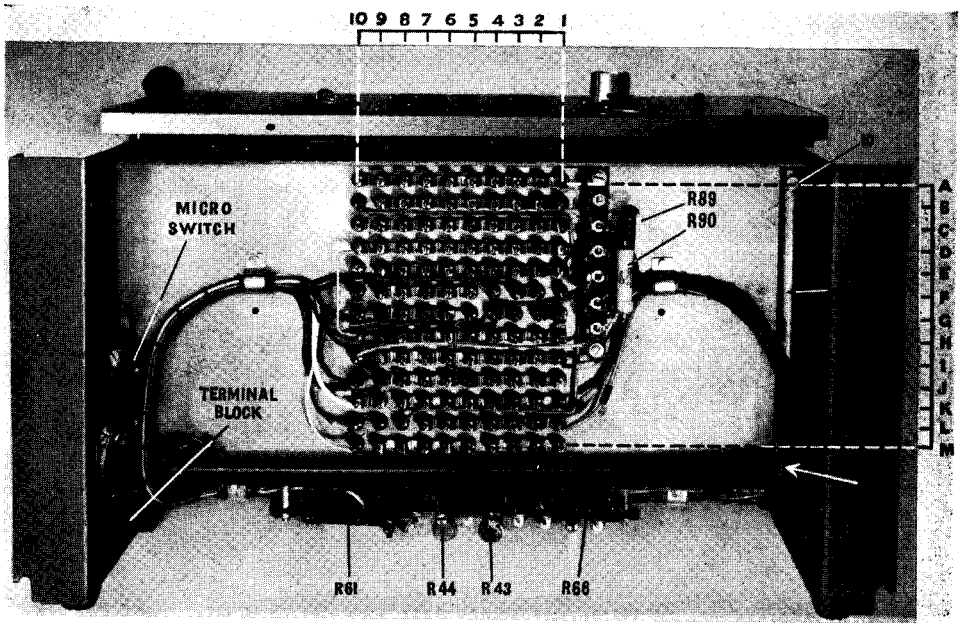


Fig. 6. GATE SWITCH BEFORE DISMANTLING
(Each contact can be referred to by the corresponding letter and number.)

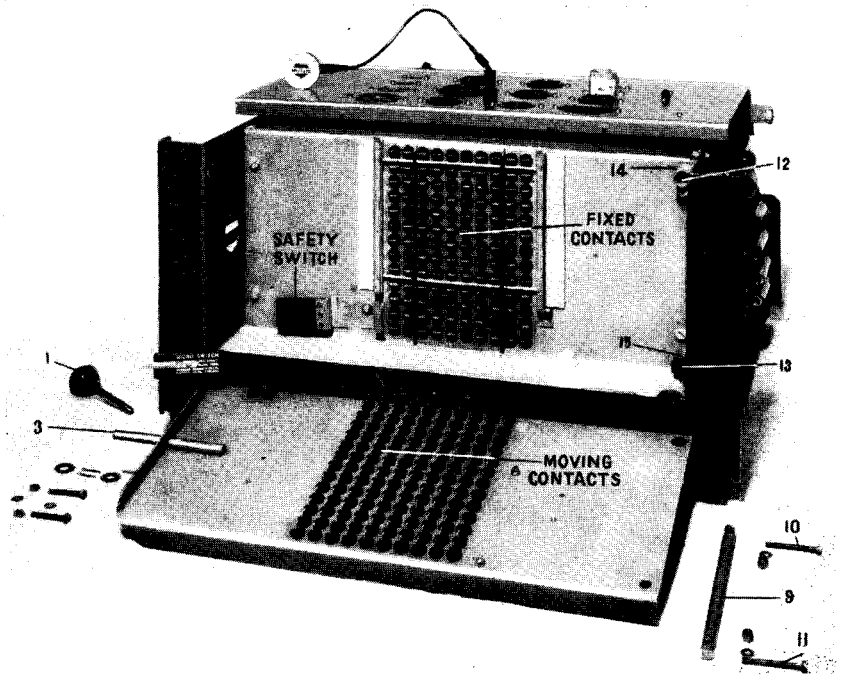


Fig. 7. GATE SWITCH AFTER DISMANTLING

Electrical Replacements

A complete circuit diagram is printed on the folded sheet kept in the pocket at the back of the manual. The gate switch contacts are shown in the bottom left hand corner, and the connections for the selector switch in the bottom right hand corner. The wafer switches forming the selector switch—drawn as if they are transparent in order to show the front and rear connections—are viewed from the front.

Component values have been marked on the diagram, and the parts given reference numbers. Thus a full description of the components can be found in the parts list on pages 19 to 21, and the position of each part in the instrument itself is shown in Figs. 6, 8, 9, 10 and 11.

This information should be sufficient for a faulty component to be replaced, under the guidance of one of the Service Depots.

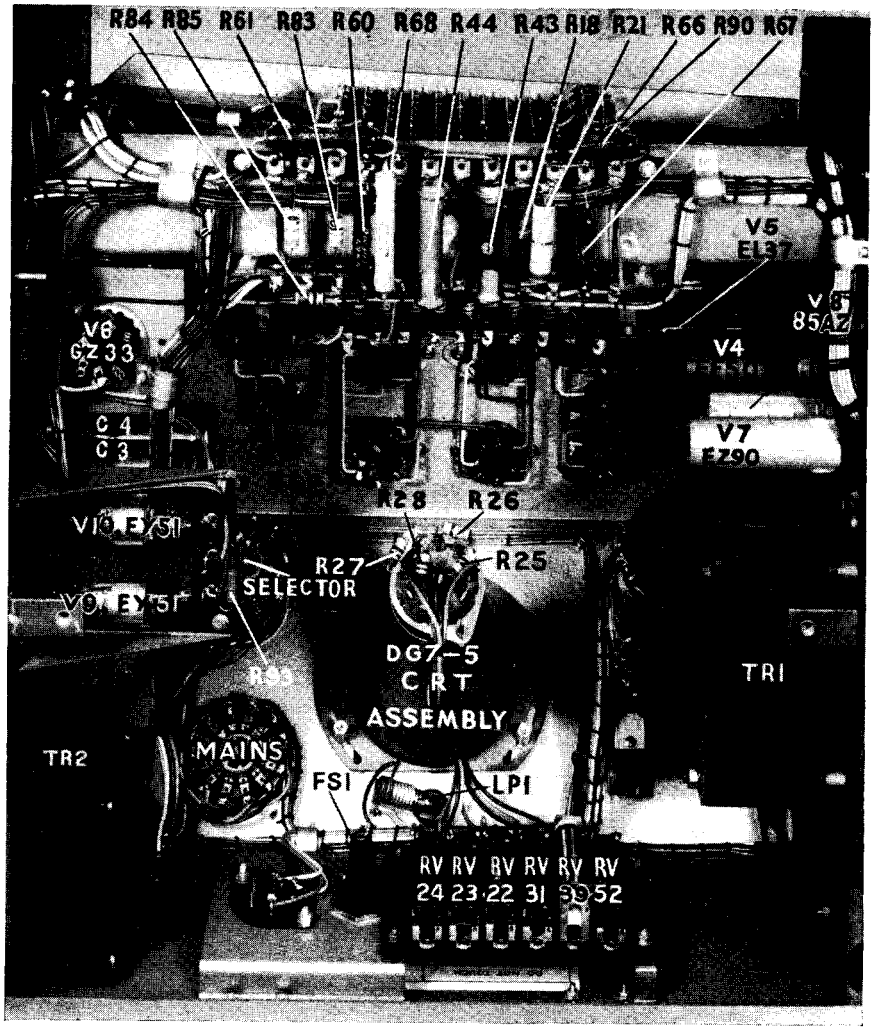


Fig. 8. INTERIOR OF VALVE TESTER SHOWING COMPONENTS

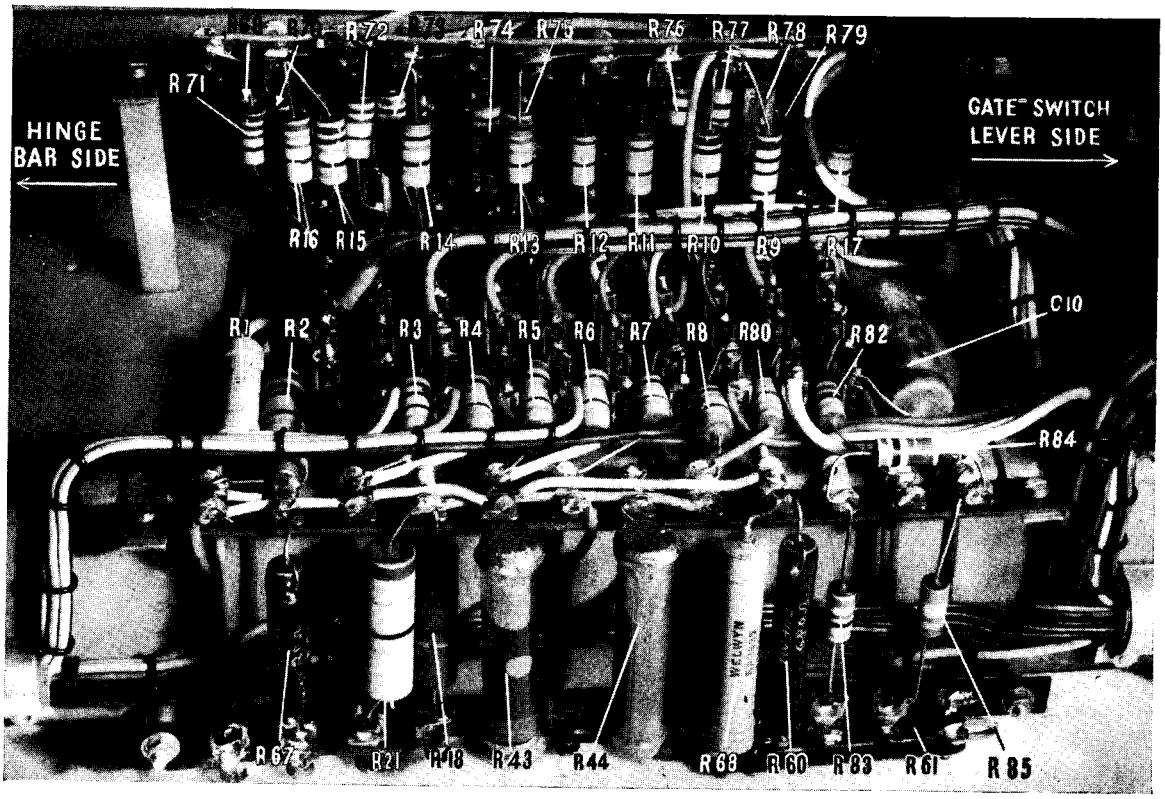


Fig. 9. DETAILED VIEW OF RESISTORS MOUNTED BEHIND THE GATE

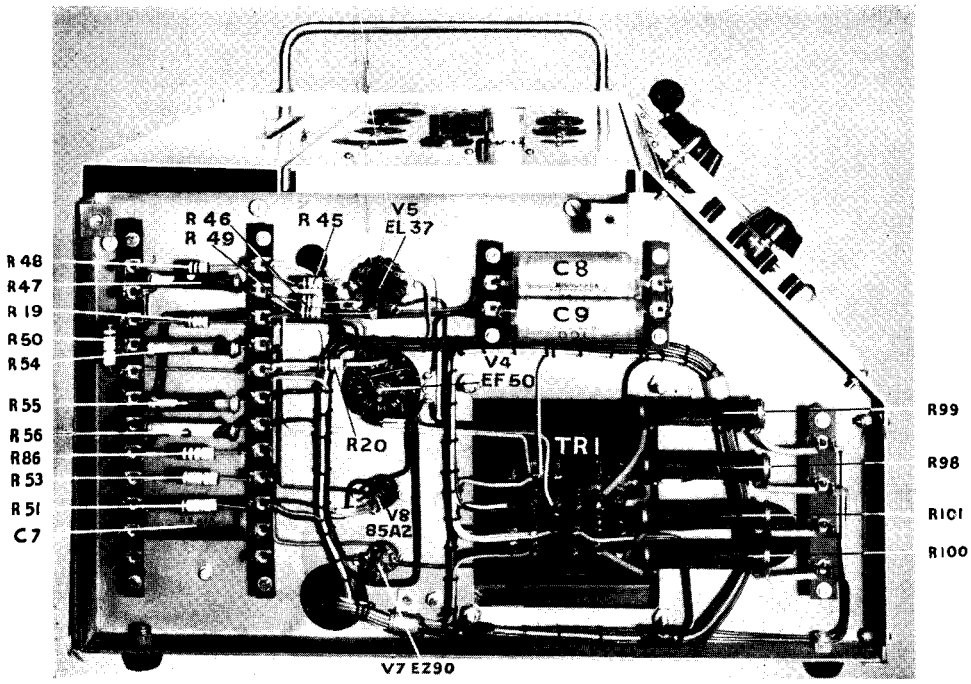


Fig. 10. LEFT-HAND SIDE WITH COVER REMOVED

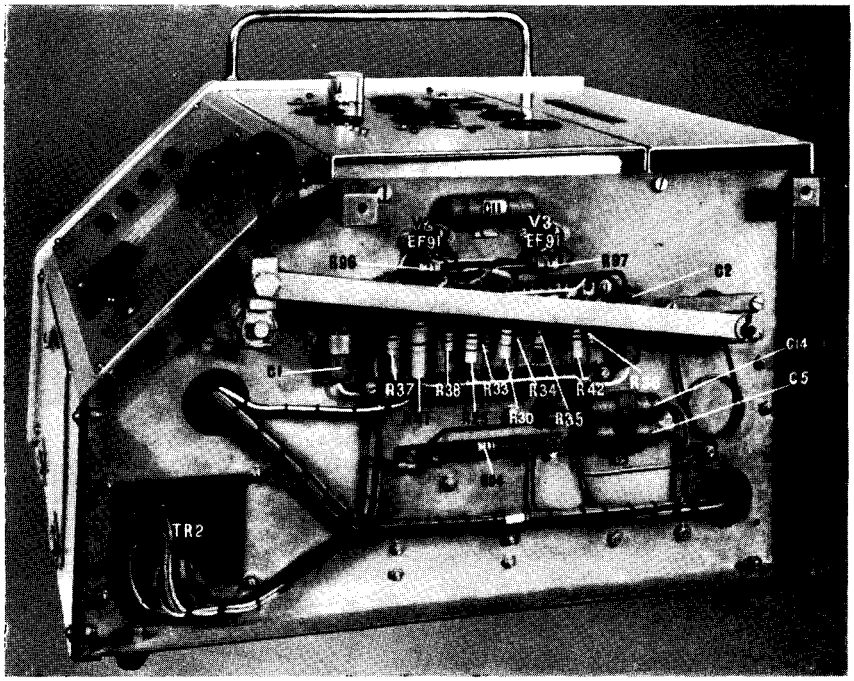


Fig. 11. RIGHT-HAND SIDE WITH COVER REMOVED

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.

Resistors

Circuit Ref.	Value (Ω)	Tolerance (±%)	Description	Make	Code No.	Type No.
R1	4 M	1	High Stability	Welwyn	GH 553 01/4M/WS	SA 3634
R2	2 M	1	High Stability	Erie	GH 552 01/2M/E	100
R3	1 M	1	High Stability	Erie	GH 550 01/1M/E	108
R4	500 k	1	High Stability	Erie	GH 550 01/500K/E	108
R5	250 k	1	High Stability	Erie	GH 550 01/250K/E	108
R6	125 k	1	High Stability	Erie	GH 550 01/125K/E	108
R7	200 k	1	High Stability	Erie	GH 551 01/200K/E	109
R8	51 k	1	High Stability	Erie	GH 551 01/51K/E	109
R9	1 M	1	High Stability	Erie	GH 550 01/1M/E	108
R10	500 k	1	High Stability	Erie	GH 551 01/500K/E	109
R11	250 k	1	High Stability	Erie	GH 551 01/250K/E	109
R12	125 k	1	High Stability	Erie	GH 551 01/125K/E	109
R13	62·5 k	1	High Stability	Erie	GH 550 01/62K5/E	109
R14	31·2 k	1	High Stability	Erie	GH 551 01/31K2/E	109
R15	15·6 k	1	High Stability	Erie	GH 551 01/15K6/E	109
R16	7·8 k	1	High Stability	Erie	GH 551 01/7K8/E	109
R17	50 k	1	High Stability	Erie	GH 551 01/50K/E	109
R18	1·5 M	1	High Stability	Erie	GH 552 01/1M5/E	100
R19	22 k	10	Carbon	Erie	GH 422 10/22K/E	9
R20	10 k	5	Carbon	Erie	GH 422 05/10K/E	9
R21	24 k	1	High Stability	Erie	GH 552 01/24K/E	100
RV22	100 k	—	Carbon Variable	Welwyn	MD 790 12	—
RV23	1 M	—	Carbon Variable	Welwyn		
RV24	1 M	—	Carbon Variable	Welwyn		
R25	4·7 M	10	Carbon	Erie	GH 422 10/4M7/E	9
R26	3·3 M	10	Carbon	Erie	GH 422 10/3M3/E	9
R27	1 M	10	Carbon	Erie	GH 422 10/1M/E	9
R28	1 M	10	Carbon	Erie	GH 422 10/1M/E	9
R29	220 k	5	Carbon	Erie	GH 425 05/220K	8
R30	220 k	5	Carbon	Erie	GH 425 05/220K	8
RV31	1 M	—	Carbon Variable	Welwyn	MD 790 12	—
R33	1·5 M	5	Carbon	Erie	GH 422 05/1M5/E	9
R34	3·3 M	5	Carbon	Erie	GH 422 05/3M3/E	9
R35	470 k	5	Carbon	Erie	GH 422 05/470K/E	9
R36	1 k	5	Carbon	Erie	GH 422 05/1K/E	9
R37	220 k	10	Carbon	Erie	GH 422 10/220K/E	9
R38	3·3 k	10	Carbon	Erie	GH 422 10/3K3/E	9
RV39	10 k	—	Wirewound Variable	Welwyn	MD 790 12	—
R41	115 k	1	Carbon High Stability	Erie	GH 552 01/115K/E	100
R42	4·7 k	10	Carbon	Erie	GH 425 10/4K7	8
R43	27 k	5	Carbon	Erie	GH 426 05/27K	1
R44	33 k	5	Carbon	Erie	GH 426 05/33K	1
R45	10 k	10	Carbon	Erie	GH 422 10/10K/E	9
R46	100 k	10	Carbon	Erie	GH 422 10/100E/E	9
R47	560 k	10	Carbon	Erie	GH 423 50/560K	2
R48	1 M	10	Carbon	Erie	GH 422 10/1M/E	9

Circuit Ref.	Value (Ω)	Tolerance (±%)	Description	Make	Code No.	Type No.
R49	100	10	Carbon	Erie	GH 422 10/100E/E	9
R50	75 k	5	High Stability	Erie	GH 550 05/75K/E	108
R51	560 k	5	High Stability	Erie	GH 550 05/560K	108
RV52	50 k	—	Carbon Variable	Welwyn	MB 790 12	—
R53	180 k	5	High Stability	Erie	GH 550 05/180K/E	108
R54	8·2 k	10	Carbon	Erie	GH 423 50/8K2	2
R55	6·8 k	10	Carbon	Erie	GH 423 50/6K8	2
R56	4·7 k	10	Carbon	Erie	GH 423 50/4K7	2
R57	12 k	5	Carbon	Erie	GH 423 45/12K	2
R58	68	1	High Stability	Erie	GH 550 01/68E/E	108
R59	100 k	10	Carbon	Erie	GH 425 10/100K	8
R60	680	2	Wirewound	Welwyn	GH 031 52/680E	AW 3112
R61	680	2	Wirewound	Welwyn	GH 031 52/680E	AW 3112
R62	10 M	5	Carbon	Erie	GH 422 05/10M/E	9
R64	10 M	5	Carbon	Erie	GH 422 05/10M/E	9
R65	6·8 M	5	Carbon	Erie	GH 422 05/6M8/E	9
R66	20	5	Wirewound	Welwyn	GH 031 25/20E	AW 3111
R67	20	5	Wirewound	Welwyn	GH 031 25/20E	AW 3111
R68	120	2	High Stability	Welwyn	GH 554 02/120E/WS	SA 3635
R69	8·2 k	1	High Stability	Erie	GH 551 01/8K2/E	109
R70	4·3 k	1	High Stability	Erie	GH 551 01/4K3/E	109
R71	2·2 k	1	High Stability	Erie	GH 551 01/2K2/E	109
R72	1·1 k	1	High Stability	Erie	GH 551 01/1K1/E	109
R73	560	1	High Stability	Erie	GH 551 01/560E/E	109
R74	300	1	High Stability	Erie	GH 551 01/300E/E	109
R75	160	1	High Stability	Erie	GH 551 01/160E/E	109
R76	82	1	High Stability	Erie	GH 550 01/82E/E	108
R77	43	1	High Stability	Erie	GH 550 01/43E/E	108
R78	22	1	Wirewound	A. Thomas	GH 435 01/22E	PW 12
R79	11	1	Wirewound	A. Thomas	GH 435 01/11E	AW 12
R80	470 k	5	Carbon	Erie	GH 422 05/470K/E	9
R82	1·2 M	5	Carbon	Erie	GH 422 05/1M2/E	9
R83	3·6 M	5	Carbon	Erie	GH 422 05/3M6/E	9
R84	2·7 M	5	Carbon	Erie	GH 422 05/2M7/E	9
R85	39 k	5	Carbon	Erie	GH 422 05/39K/E	9
R86	1·5 k	10	Carbon	Erie	GH 425 10/1K5	8
R87	150 k	20	Carbon	Erie	GH 425 20/150K	8
R88	150 k	20	Carbon	Erie	GH 425 20/150K	8
R89	100	5	Carbon High Stability	Erie	GH 423 45/100E	2
R90	100	2	High Stability	Welwyn	GH 553 02/100E/WS	SA 3634
R93	18 k	10	Carbon	Erie	GH 425 10/18K	8
R94	2·2 k	10	Carbon	Erie	GH 425 10/2K2	8
R96	470	10	Carbon	Erie	GH 422 10/470E/E	9
R97	470	10	Carbon	Erie	GH 422 10/470E/E	9
R98	600	5	Wirewound	Welwyn	GH 032 05/600E	AW 3192
R99	400	5	Wirewound	Welwyn	GH 032 05/400E	AW 3192
R100	600	5	Wirewound	Welwyn	GH 032 05/600E	AW 3192
R101	400	5	Wirewound	Welwyn	GH 032 05/400E	AW 3192
R102	2·2 M	20	Carbon	Erie	GH 425 20/2M2/E	8
R103	2·2 M	20	Carbon	Erie	GH 425 20/2M2/E	8

Capacitors

Circuit Ref.	Value (μF)	Rating (V d.c.wkng.)	Description	Make	Code No.	Type No.
C1	0·1	500	Paper Tubular	T.C.C.	GH 382 16/100K	543
C2	0·1	500	Paper Tubular	T.C.C.	GH 382 16/100K	543
C3	4	475	Electrolytic	Daly	GB 204 00	G3/15 R.C.S.
C4	4	475	Electrolytic	Daly	GB 204 00	G3/15 R.C.S.
C5	0·1	500	Paper Tubular	T.C.C.	GH 382 16/100K	543
C6	16	350	Electrolytic	T.C.C.	GH 351 58	CE11 LE
C7	0·5	350	Paper Tubular	T.C.C.	GH 382 16/500K	343
C8	16	350	Electrolytic	T.C.C.	GH 351 58	CE11 LE
C9	16	350	Electrolytic	T.C.C.	GH 351 58	CE11 LE
C10	0·1	500	Paper Tubular	T.C.C.	GH 382 16/100K	543
C11	0·25	350	Paper Tubular	T.C.C.	GH 382 16/250K	343
C12	16	350	Electrolytic	T.C.C.	GH 351 58	CE11 LE
C14	0·1	500	Paper Tubular	T.C.C.	GH 382 16/100K	543

Switches

Circuit Ref.	Description	Make	Code No.	Type No.
SW1–10	Rotary 4-Wafer 6-Way	Oak (N.S.F.)	MD 883 36	H
SW11	On gate assembly	—	MD 885 00	—
SW12	Rotary 11-Way S.P.	Oak (N.S.F.)	MD 883 33	H
SW13	On/Off	Bulgin	GB 201 43	S277
SW14	Micro Switch	Burgess	GB 305 07	BRL2
PB1–4	4-Pole Push Button Unit	Oak (N.S.F.)	MD 930 44	80

Valves

Circuit Ref.	Make	Type No.
V1	Mullard	DG7-5 (CRT)
V2	Mullard	EF91
V3	Mullard	EF91
V4	Mullard	EF50
V5	Mullard	EL37
V6	Mullard	GZ33
V7	Mullard	EZ90
V8	Mullard	85A2
V9	Mullard	EY51
V10	Mullard	EY51

Miscellaneous

Circuit Ref.	Description	Make	Code No.
TR1	High Tension	M.E.L.	MD 510 30
TR2	Heater	M.E.L.	MD 510 28
FS1	2-amp. Cartridge Fuse	Bulgin	MR 079 16
RL1	Cut-out Relay	M.E.L.	MD 881 62
LP1	Pilot Lamp (Round)	Philips	GH 900 08

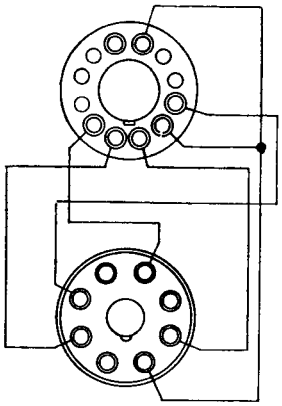
ADAPTORS FOR CATHODE RAY TUBES

The holders and plugs are viewed from beneath.

The B7B base is a modified B8G, the metalwork and one of the pins having been removed.

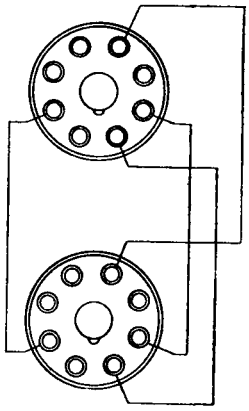
Information on the use of these adaptors is given on page 9.

A B12A (Duodecal) holder



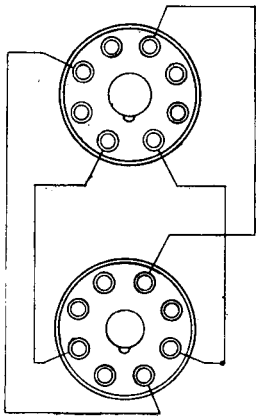
International Octal plug

B International Octal holder



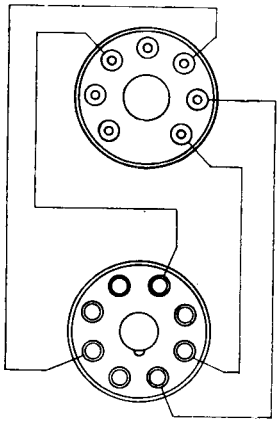
International Octal plug

C Mazda Octal holder



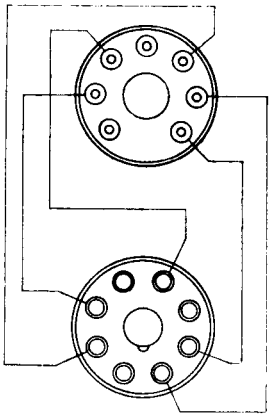
International Octal plug

D B7B holder



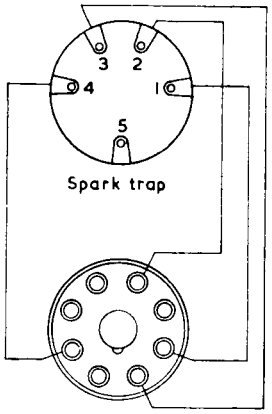
International Octal plug

E B7B holder



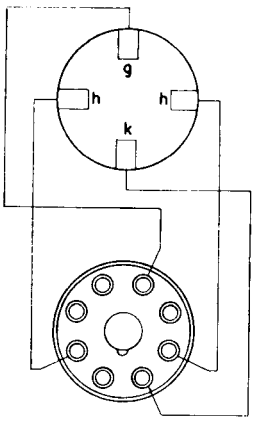
International Octal plug

F 5-Side contact holder



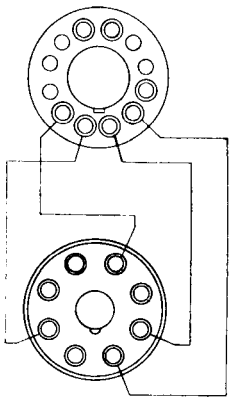
International Octal plug

G B4E 4-clip holder



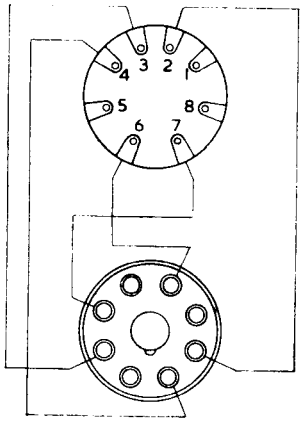
International Octal plug

H B12A (Duodecal) holder



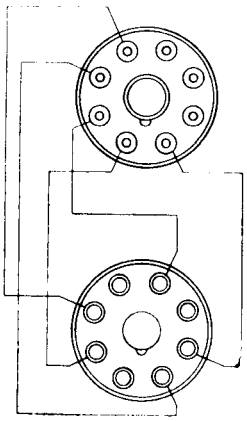
International Octal plug

J 8-Side contact holder



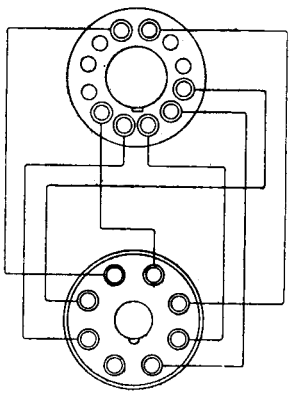
International Octal plug

K B8G (Loctal) holder



International Octal plug

L B12A (Duodecal) holder



International Octal plug

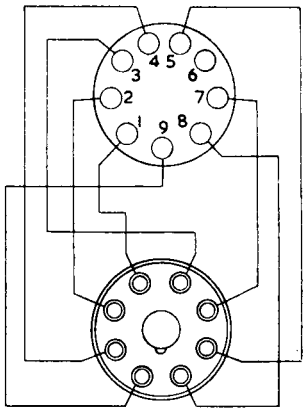
ADAPTORS FOR CERTAIN TYPES OF VALVES

The holders and plugs are viewed from beneath.

Connecting wires should be drawn in to be as short as possible, and should be in good quality insulation sleeving. When making adaptor No. 6, three lengths of 14 gauge T.C. wire covered with sleeving should be used. Bare parts of the wires must not touch each other, or the metal case of the instrument. A spot of red paint may be placed on the anode lead for identification.

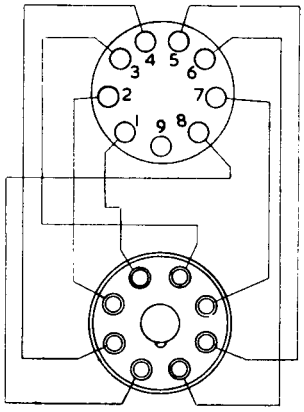
Information on the use of these adaptors is given on page 9.

1 British 9-pin holder
Top cap to top-cap lead



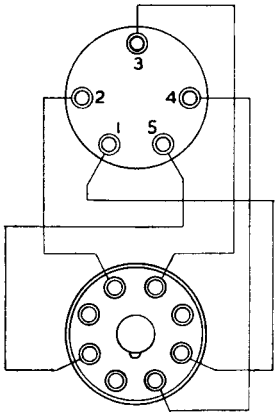
International Octal plug
TP22

2 British 9-pin holder
Top cap to top-cap lead



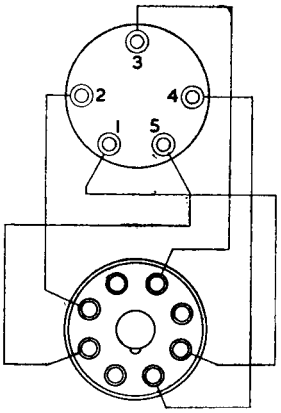
International Octal plug
AC/TP, TP2620

3 UX small 5-pin holder
Top cap to top-cap lead



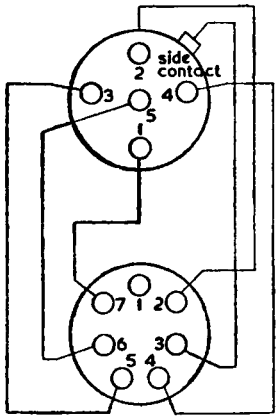
International Octal plug
QV05-25, 807

4 UX 5-pin holder



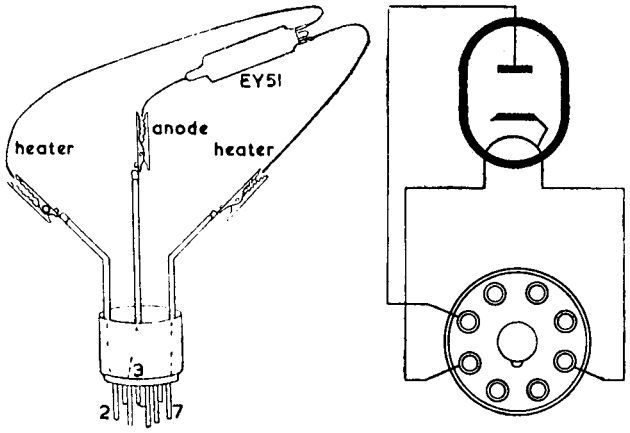
International Octal plug
36, 37, 38, 39/44, 46, 47, 76, 84/6Z4

5 British 5-pin holder



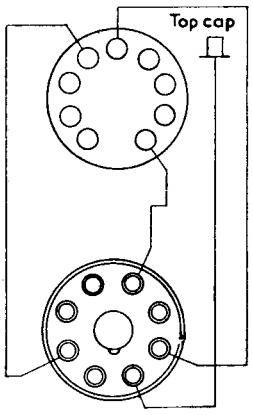
British 7-pin plug
MKT4,PEN4VA (5-pin using 7-pin card), APP4A

6 Wire-in EY51 Valve



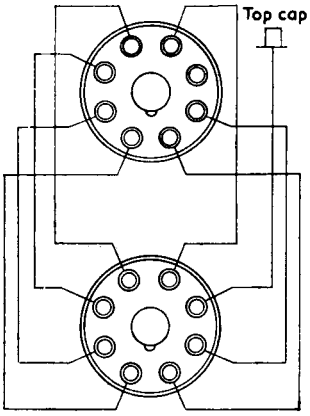
International Octal plug
R16, R12, EY51, SU61, U43, U151, U25, U37, IT2, 6W2, 6X2

7 B9A (Noval) holder
Top cap to plug pin 8



International Octal plug
PY81, U153, U329, 17Z3, EY81, PY83

8 International Octal holder
Top cap to plug pin 6



International Octal plug
U282, U301

FACILITIES FOR TESTING CONTINENTAL (Y8A) BASED VALVES ON YOUR MULLARD HIGH-SPEED VALVE TESTER

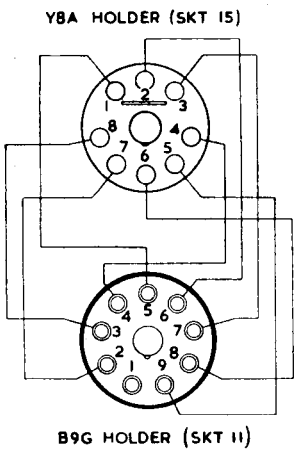
Test cards for some of the range of Continental valve types listed below are available on demand from Valve Sales Dept., Century House, Shaftesbury Avenue, London, W.C.2. Price 1*s* per type to members of the Maintenance Plan, or 1*s* 6*d* per type to non-members.

EF12	.. ..	722
ECL11	.. ..	729AB
UCL11	.. ..	730AB
UF11	.. ..	734
EF11	.. ..	739
EBF11	.. ..	742ABC
UBF11	.. ..	743ABC
ECH11	.. ..	747AB
UY11	.. ..	751AB

holder on the top, or test panel of the valve tester. This wiring should be carried out in P.V.C. wire and the leads made as short as possible consistent with neatness. Care should be taken to keep the wiring clear of fixing bolts and soldering tags. Instructions for dismantling the valve tester will be found on Page 11 of this Operating Manual.

Valve holders only may be obtained from Mullard Ltd., Service Dept., Brathway Road, Wandsworth, London, S.W.18 (telephone PUTney 7872). Price 2*s* 6*d*.

Should you not wish to carry out the modification yourself, the Service Dept. will undertake the work for a price of £1 1*s* 0*d* to subscribers, or £1 5*s* 0*d* to non-subscribers, provided the instrument is sent carriage paid to the above address.



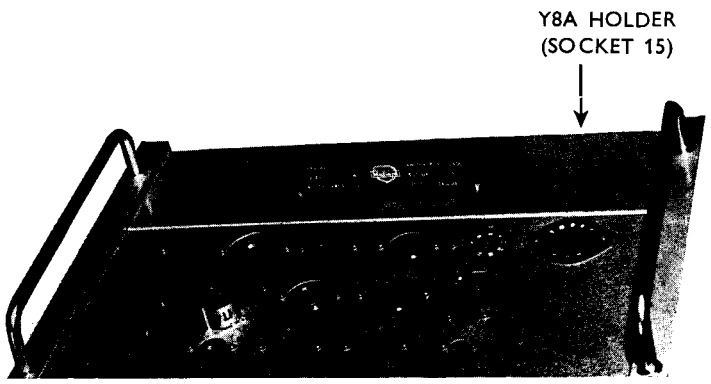
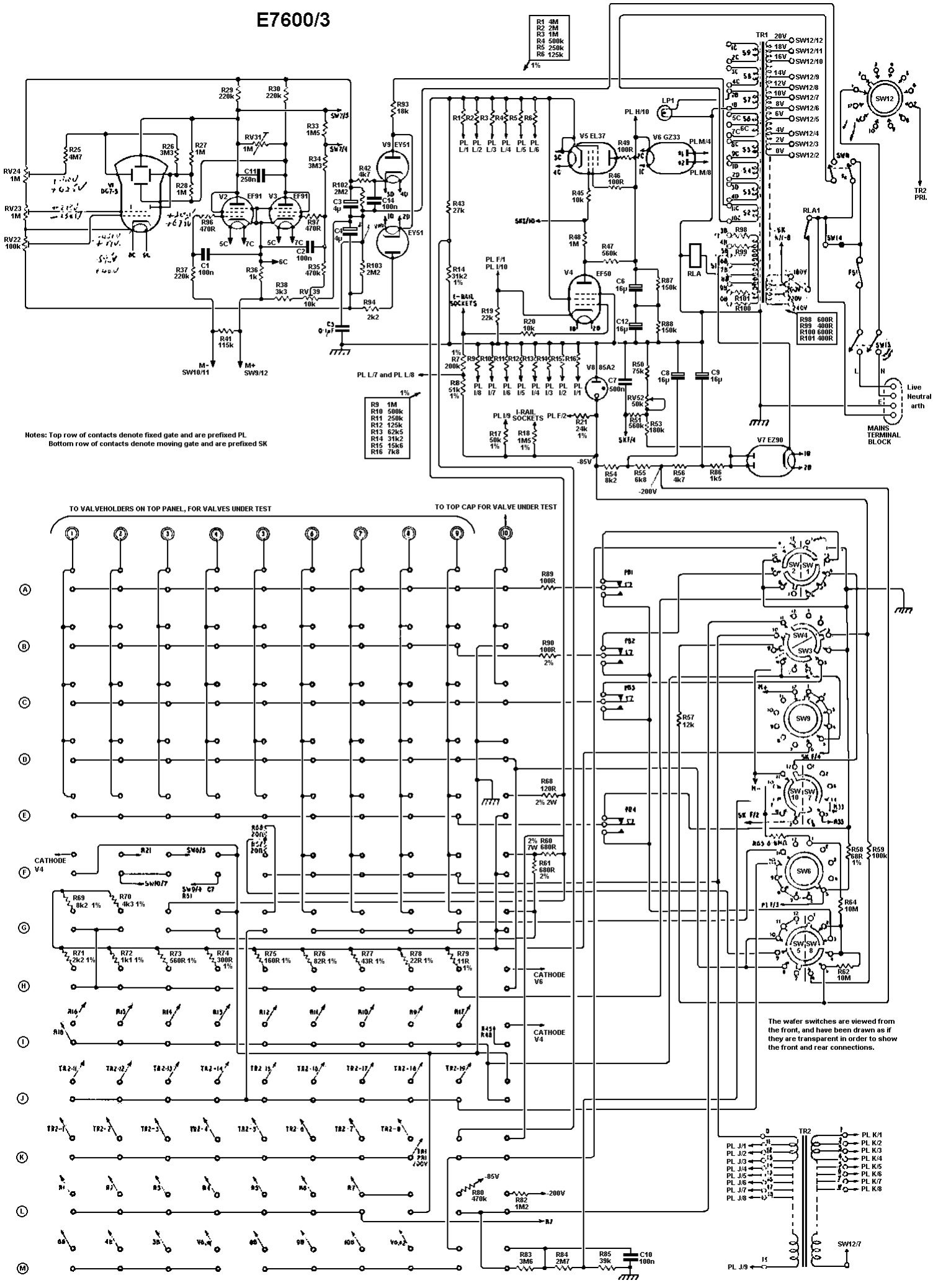


Fig. 12

The wiring diagram shows the connections for the additional Y8A valve holder (Socket 15) which can be mounted to the right of the B9G valve

E7600/3


R1 4M
R2 2M
R3 1M
R4 500k
R5 250k
R6 125k
1%
TR1
20V
18V
16V
14V
12V
10V
8V
6V
4V
2V
0V
SW12/12
SW12/11
SW12/10
SW12/9
SW12/8
SW12/7
SW12/6
SW12/5
SW12/4
SW12/3
SW12/2
SW12
TR2 PRI.
RLA1
SW14
SW13
L
N
Live
Neutral
arth
MAINS TERMINAL BLOCK
R98 600R
R99 400R
R100 600R
R101 400R
RLA
V5 EL37
V6 GZ33
PL H/10
PL M/4
PL M/8
LP1
V4 EF50
V7 EZ90
V8 85A2
V9 EY51
V1 DG7-5
V2 EF91
V3 EF91
EY51
R25 4M7
R26 3M3
R27 1M
R28 1M
RV24 1M
RV23 1M
RV22 100k
RV31 1M
R29 220k
R30 220k
R33 1M5
R34 3M3
C11 250n
C1 100n
C2 100n
R36 470R
R37 220k
R38 3k3
R39 10k
R35 470R
R41 115k
M- SW10/11
M+ SW9/12
R42 4k7
R102 2M2
C3 4µ
C4 4µ
C14 100n
R103 2M2
R94 2k2
C5 0·1µF
R93 18k
R43 27k
R14 31k2 1%
R19 22k
R20 10k
R45 10k
R46 100R
R47 560k
R48 1M
R49 100R
C6 16µ
C12 16µ
R87 150k
R88 150k
R50 75k
C8 16µ
C9 16µ
RV52 50k
R51 560k
R53 180k
R21 24k 1%
R17 50k 1%
R18 1M5 1%
R54 8k2
R55 6k8
R56 4k7
R86 1k5
-85V
-200V
PL L/7 and PL L/8
PL I/9
PL F/2
PL F/1
PL I/10
I-RAIL SOCKETS
R7 200k 1%
R8 51k 1%
R9 1M
R10 500k
R11 250k
R12 125k
R13 62k5
R14 31k2
R15 15k6
R16 7k8
1%
Notes: Top row of contacts denote fixed gate and are prefixed PL
Bottom row of contacts denote moving gate and are prefixed SK
TO VALVEHOLDERS ON TOP PANEL, FOR VALVES UNDER TEST
TO TOP CAP FOR VALVE UNDER TEST
R89 100R
R90 100R 2%
R68 120R 2% 2W
2% R60 7W 680R
R61 680R 2%
R57 12k
R58 68R 1%
R59 100k
R64 10M
R62 10M
CATHODE V4
CATHODE V6
CATHODE V4
R69 8k2 1%
R70 4k3 1%
R71 2k2 1%
R72 1k1 1%
R73 560R 1%
R74 300R 1%
R75 160R 1%
R76 82R 1%
R77 43R 1%
R78 22R 1%
R79 11R 1%
R80 470k
R82 1M2
R83 3M6
R84 2M7
R85 39k
C10 100n
TR2
PL J/1
PL J/2
PL J/3
PL J/4
PL J/5
PL J/6
PL J/7
PL J/8
PL J/9
PL K/1
PL K/2
PL K/3
PL K/4
PL K/5
PL K/6
PL K/7
PL K/8
SW12/7
The wafer switches are viewed from the front, and have been drawn as if they are transparent in order to show the front and rear connections.