Mullard

High Speed

VALVE TESTER

OPERATING MANUAL

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ISSUE 4 (1958) TP351

THE MULLARD HIGH SPEED VALVE TESTER

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of the

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. The routine is essential since it is possible to damage the valve under test by, for example, 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 the 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. Such a report safeguards against loss of goodwill by showing whether a valve is likely to require early replacement after the repair has been completed.

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. Although the components are inspected frequently during manufacture, the final works testing can only be performed electrically and therefore 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. off
3 Heater-to-cathode insulation
4 Electrode insulation with h.t. on
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 itself, of the electrodes having been evaporated by the heat developed in 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 caused by the heat developed across a weak part of an electrode or by 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 resulting from gas in the valve or from insulation leaks
  (c) Emission below the manufacturer's limits.

OPERATING CONTROLS

In subsequent sections of this manual, instructions are given for installing, adjusting and operating the valve tester. It will be much easier to follow these instructions if the parts of the equipment and the way in which they work are familiar. Each part as it is described can be identified from Fig. 1, but the controls and switches should not be handled at this stage.

It can perhaps be mentioned at this point that the tester, when it is properly housed in its outer casing—as it would be for normal use—is perfectly safe to handle. But, of course, if the casing is removed for any reason, then many of the electrical components will be exposed and if the tester is connected to the mains, great care should be exercised in touching the inside of the instrument. It will be found that, as a precaution, the outer casing has been designed so that it cannot be removed unless the tester is first disconnected from the mains. The mains plug can be reinserted after the casing has been taken off, but the act of doing so should be sufficient to warn the user that the instrument is 'live', and thus prevent accidents.

Indicator

The indicator, by means of which the results of all the tests performed on a valve are translated into a simple visual form, consists of a small cathode ray tube mounted behind a transparent rectangular mask in the operating panel of the instrument. The position or movement of a green spot on the face of the tube is the indicating device for showing the state of the valve under test.

The face of the indicator is divided into three parts which correspond to coloured sections of the two vertical scales placed on either side of the indicator. The descent of the green spot into the lowest or red zone of the scale indicates in all but one test that the valve is faulty. In the exception mentioned, a downward movement of the spot indicates a serviceable valve. A full description of the test routine and interpretation of the results is given on pages 8, 9 and 10.

Power Switches

Power is supplied to the internal valve circuits of the tester by way of the MAINS ON/OFF SWITCH. The green PILOT LAMP will indicate when the mains voltage has been applied.

The switch does not apply power directly to the valve to be tested. Before the test sockets are made 'live', the wiring connections must correspond to the valve about to be tested. The correct socket connections are made by placing one of the control cards provided in the GATE APERTURE with the lettering on it facing the operator, and pulling the GATE SWITCH LEVER down.

The gate switch consists of a rectangular pattern of pairs of contacts arranged in ten columns and thirteen rows. One of the contacts of each pair is on a fixed panel and the other is on a movable gate which is separated from the fixed panel when the lever is up. Depressing the gate switch lever advances the movable panel until the paired contacts close.

The control card has a pattern of holes in it, and these holes permit electrical connection to be made only between the pairs of contacts which bring into operation the circuitry required for the particular valve to which the card corresponds. The other contacts are prevented from closing by the card.

Two pairs of contacts are provided to close the mains circuit and the h.t. circuit of the cathode ray tube. An interlocking device prevents closure of these contacts on operation of the gate unless a test card has been inserted. To avoid the necessity of having to allow a warming-up period each time the gate is operated, the heater circuits of the tube and internal valves and the negative h.t. circuit are energised by a microswitch when the lever is in the 'off' position.

If the valve under test is faulty, it may cause an unusually large current to be drawn from the h.t. supply. A relay switch, not under the control of the operator, will automatically trip over if this current becomes too great, and the h.t. and mains supplies

will be cut 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. A MAINS FUSE is located beneath the inspection plate at the front of the equipment.

The COARSE TRANSFORMER TAPPING and the MAINS FINE ADJUSTMENT SWITCH will be described later.

Test Switches

The actual tests are applied to the valves 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 the buttons are pressed to test for open-circuited electrodes.

Preset Controls

Six PRESET CONTROLS are situated beneath the inspection plate at the front of the instrument. The plate prevents the controls from being displaced accidentally after they have been adjusted. The controls are labelled A to F.

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

This specific warning for the control A should not be taken to imply that the other controls B to F should be handled 'just to get the feel of the thing'. The controls B and C, for instance, govern the accurate response of the indicator to the information it receives from the test circuits, and any careless alteration of these controls will necessitate readjustments according to the routine laid down in the section dealing with installation (pages 6 and 7).

Of the three remaining preset controls, the brilliance control D alters the brightness of the spot; the focus control E enlarges or diminishes the spot to a suitable definition; and the X-shift control F enables the track of the spot to be moved either to the right or to the left.

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 operating panel of the instrument. The position of the number in the plan corresponds to the position of the socket on the top panel of the tester. Where one of the electrodes has been brought out to a top cap on the valve, the TOP CAP LEAD must be used to include the electrode in the testing circuit.

Many 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 envelope, the sections are tested separately and two or more cards are required. The cards are distinguished by letters A, B, C, etc., placed after the card number, and are used singly and in alphabetical order. Each card shows how many cards will be required to test all sections of the valve.

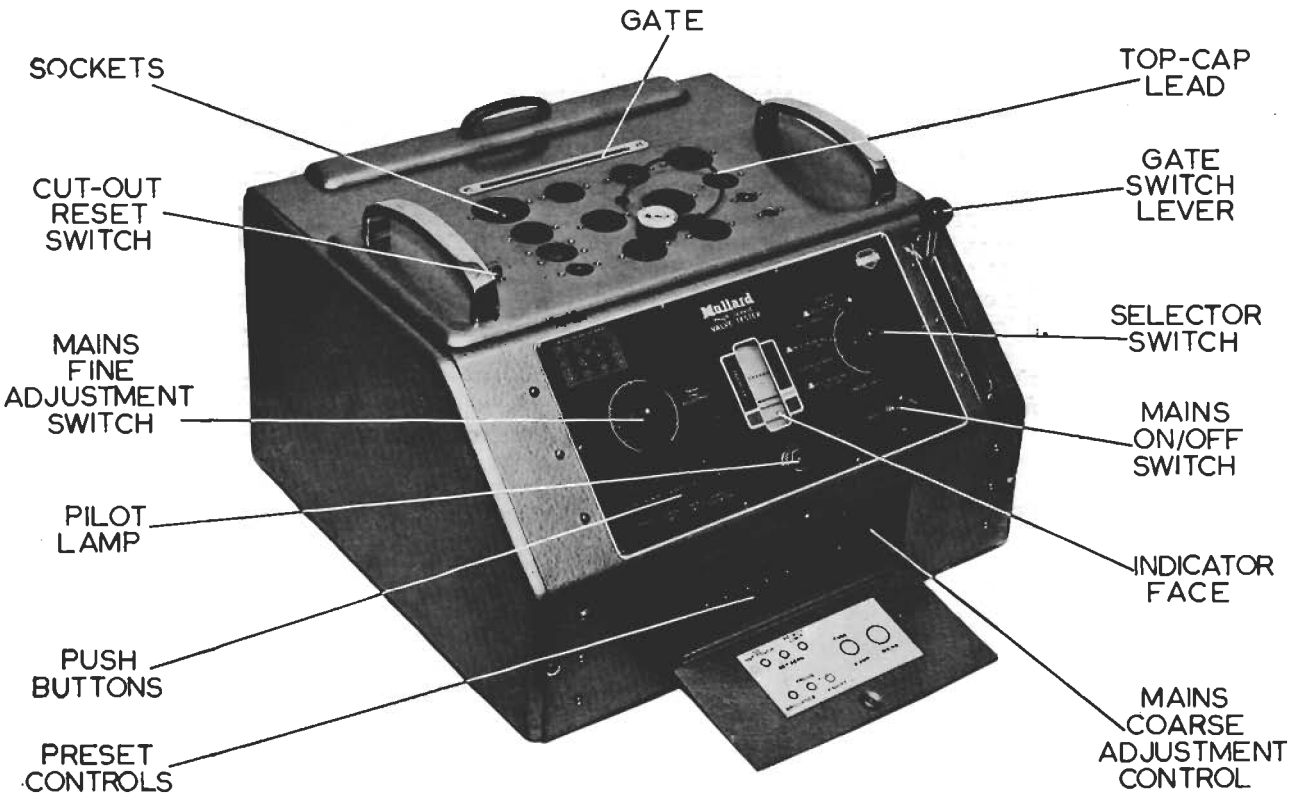


FIG. 1—VALVE TESTER SHOWING CONTROLS

INSTALLATION

In connecting the mains lead provided with the instrument to a mains plug, the red wire should be connected to the 'live' terminal, the black to the 'neutral' pin and the green wire to 'earth'.

IT IS ESSENTIAL THAT AN EARTH CONNECTION BE USED

Three adjustments may have to be made to the valve tester before it is ready for use, and the instrument should be checked at regular intervals, these adjustments again being made if they are found to be necessary. Special 'check' test cards, lettered in blue and known as the **mains** card, the **reject** card and the **h.t.** card, are provided for these adjustments.

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

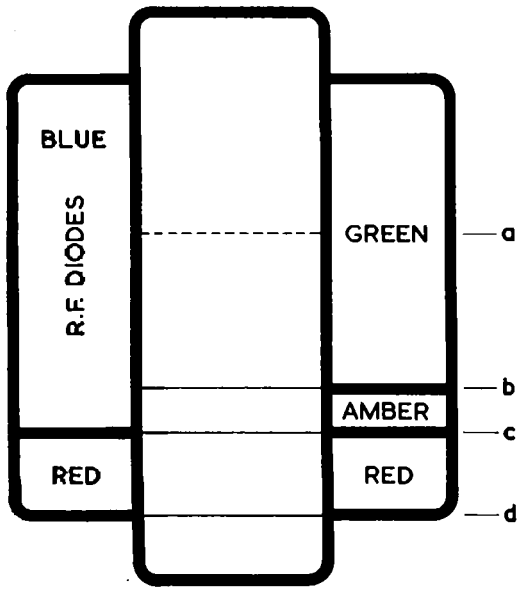


FIG. 2—INDICATOR SCALE

Mains Check and Adjustment

The valve tester can be operated from any 50c/s a.c. supply between 180 and 260 volts. Transformer tappings, controlled by a selector under the inspection plate at the front of the instrument, provide a coarse adjustment of the mains voltage in 20-volt steps between 180 and 240 volts. A fine adjustment, consisting of ten 2-volt tappings, is controlled by the **mains fine adjustment** switch on the operating panel.

It should be noted that the initial settings in the adjustment of the mains voltage should be performed quickly so that the instrument does not run for any length of time on the wrong voltage.

The adjustment is made as follows:

(i) Set the 20-volt coarse transformer tapping to the voltage expected from the mains. (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 beneath the inspection plate, turning it to indicate the voltage required, and pressing the plug home again.

(ii) Switch on the mains. The pilot lamp should light to show that power has been applied. If the pilot lamp does not light, the reset button should be pressed to restore the mains supply.

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

(iv) Turn the selector switch to position 1.

(v) Pull down the gate lever to close the gate switch. A spot should then appear on the indicator.

(vi) Set the instrument to the mains supply by turning the mains fine adjustment switch until the spot on the indicator is as nearly as possible on the dotted line *a* (Fig. 2).

(vii) Raise the lever, and leave the instrument running on the mains for TWO HOURS before proceeding.

(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 fine adjustment switch if necessary (operation vi) to ensure that the spot is as near as possible to the dotted line.

The 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 when it is not in use.

The mains supply 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 and Adjustment

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

With the mains switch closed, the reject card in the gate and the gate lever down, then:

(a) With the selector switch in position 1, the spot should come to rest on the reject upper limit line *c* (Fig. 2); and

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

If these readings are not obtained, adjustments should be made to the preset controls B and C, the procedure being as follows:

(i) Close the mains switch, place the reject card in the gate and depress the gate lever.

(ii) Turn the selector switch to position 1 and adjust the preset control B until the spot rests on the line *c*.

(iii) Turn the selector switch to position 6 and adjust the preset control C until the spot rests on the line *d*.

(iv) Repeat (ii) and (iii) alternately until the location of the spot is correct for either position of the selector switch, that is, on line *c* for position 1 of the switch, and on line *d* for position 6.

Once B and C have been set correctly, the mains adjustment should be repeated.

H.T. Check

After the reject check and adjustments (if any) have been made, the high-tension supply inside the instrument is accurately checked by using the **h.t.** card. The test procedure is:

(i) Warm up the tester and place the h.t. card in the gate aperture.

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

The spot should rest within 3 millimetres ($\frac{1}{8}$-inch) above or below the dotted line *a*. If the spot settles outside this 3mm limit, 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 operating controls (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 the 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 valve 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 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 should 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 are read from the **position** of the green spot on the face of the indicator:

For all valves except signal diodes, the position of the spot with respect to the right-hand or three coloured scale is observed. The meaning of the colours can be remembered perhaps from the 'Stop, Caution, Go' of traffic lights. Thus, as soon as the spot settles in the *red* section 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. For the valve to be in good condition, the spot should be in the *green* section of the scale for all tests 1 to 6.

For signal diodes, the position of the spot in the emission test (test 6) needs a slightly different interpretation. Satisfactory service can be obtained from these diodes even when their emission is relatively low. For this reason, the two-coloured, left-hand scale should be used for this test. Diodes for which the spot remains in the *blue* section of the scale are serviceable. Those for which the spot rests in the *red* section should be replaced. (The blue section of the left-hand scale simply corresponds to the green and amber sections of the right-hand scale.) Tests 1 to 4 are performed for diodes as with other valves; the right-hand scale should be used for each of them.

The result of test 7 is indicated by the **movement** of the green spot on the indicator face. Reference is not made to the coloured scales at all. For this test it should be remembered that the selector switch is in position 6, and the electrode buttons specified on the test card are depressed one at a time. When a button is pressed, a downward movement of the spot indicates that the electrode is not open circuited. To remind the operator that a downward movement of the spot is what is required to indicate a serviceable valve, a

small symbol (a dot over an arrowhead) has been marked on the operating panel of the instrument, corresponding to test 7.

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 either to a filament or heater, according to whether the valve is directly or indirectly heated.

For indirectly heated valves only, a red indication can, under certain conditions, result either from a short circuit between heater and cathode, or from 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 subsequent tests need not 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 towards the red section of the scale shows that the insulation is poor.

If this test indicates poor insulation, no further test 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 the second test with the addition that h.t. is applied to the valve throughout the test except for the periods when the buttons are actually depressed.

When a short-circuited or poorly insulated electrode is tested, the indication is the same as for test 2.

5. *Grid current*

Accurate readings in this and the next test will be obtained with certain types of valve only if they have been allowed to reach their working temperature. Sufficient time, therefore, should be allowed in each case for the valves to warm up, the time required varying considerably from one valve type to another.

A flow of grid current in the valve under test is indicated by a movement of the green spot towards the red section of the indicator.

6. *Emission (anode current)*

Note the steady position of the spot when the selector switch is first moved to position 6. For some valves, particularly small battery diodes, the spot may rise above the green or blue region of the scale and perhaps even right off the face of the indicator. This does not necessarily mean that there is 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 10).

7. *Open-circuited electrodes*

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

The coloured scales are not used to indicate the results 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 movement of the spot will be very slight—the test for earthy electrodes using button 4 with an EL38, for example—and it is essential for a service engineer to realise when this is likely to occur so that he may interpret the results correctly.

Usually this behaviour is found in high-slope pentodes or the types of valve in which a suppressor grid or internal screening are connected to a separate base pin. The construction of the valve may be such that the anode current will not be changed appreciably by the negative voltage which is applied to the electrode when button 4 is pressed. Thus, although the earthy electrode is not open-circuited, there will be very little, or even no, downward movement of the green spot.

Button 4 has been listed on the test cards for these types of valve in order that a complete check on insulation will be made in switch positions 2 and 4, but the operator should be prepared for the results suggested above when button 4 is used for test 7.

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 this 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; thus, half-wave rectifiers require two cards, and full-wave rectifiers usually require three or more.

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, according as the valve is directly or indirectly heated.

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 the gate is closed. The buttons should not be pressed, as only the emission test is to be made.

For the emission test on an indirectly heated rectifier, sufficient 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 the test; severe sputtering in the valve, however, will trip the cut-out and it may be necessary to press the reset button—after removing the faulty valve, of course. DO NOT ATTEMPT TO HOLD THE RESET BUTTON DOWN WITH A FAULTY VALVE ON TEST.

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

Signal Diodes

The tests for these valves have already been discussed. It was stated that the emission requirements for these diodes for satisfactory performance are less exacting than for other types. In fact, indications which for other valves would show them to be borderline samples, probably requiring early replacement, would imply that signal diodes are quite serviceable. In other words, the amber section of the coloured scale can be dispensed with for the emission test on these diodes, and to prevent any misunderstanding with customers, the second, two-coloured scale has been added to the indicator.

Valve Types requiring Special Adaptors

It has been found necessary to use adaptors for testing a few valves, and the diagrams on page 22 show how these adaptors can be made. The 'plug', in fact, is a valve base obtained by dismantling a faulty valve on 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 available on request.

Valve types which require these special adaptors are indicated in the test card index thus: EY51.....579-6. The normal card number (579, for the EY51) is followed by a number (6) indicating which of the adaptors shown on page 22 is required. The diagrams of the adaptors on page 22 show for which types of valve they are required, but the corresponding test card can only be ascertained from the test-card index.

In the diagrams of the adaptors, the valveholders and plugs are viewed from the underside. Where the adaptor shows a connection from the top cap of the valve to one of the pins on the plug, the top cap lead on the tester itself should not be used.

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.

A number of cards are provided for testing cathode ray tubes and they 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 (see page 23) which plugs 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, namely:

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.

Indications in the Green Section of the Scale

It is important to remember that the dotted line *a* (Fig. 2) in the green or blue 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.

SERVICING

It will be appreciated that the number of circuits that can be completed within the valve tester by closing an arbitrary combination of gate contacts is very high. This number is further multiplied by the possible choice of selector-switch and press-button positions. To consider each circuit separately would require a manual of forbidding length and complexity. This section will therefore confine itself to the mechanical rather than the electrical aspects of servicing, giving only a general indication, mainly by means of photographs, of the location of the various electrical components within the instrument.

Before attempting to dismantle the tester, the mains plug should be disconnected. In fact, the casing cannot be removed while the plug is in position. Very great care should be used in handling the tester if, after removing the outer casing, the mains plug is reinserted in its socket. High voltages are developed across many of the components and careless handling of the dismantled instrument when it is 'live' could result in unfortunate accidents.

The removal of the outer casing is straightforward. The two screws to be found on the front panel should be unfastened and the body withdrawn from the casing simply by holding the handles on the top panel and sliding the body forward.

A vertical drawer is incorporated in the outer casing to hold the test card index.

The Valveholder Panel

The top panel of the instrument is hinged and can be opened when the outer casing has been removed to give access to the valveholders. The screws located near the top of each side panel, beneath the edge of the top panel, should be removed, when the panel will pivot upwards to disclose the connections to the underside of the valveholders (see Fig. 8).

The Gate Switch Mechanism

The contacts of the movable gate are mated to the corresponding fixed contacts by a forward motion of the moveable gate along the four guide pins (see Fig. 7). The motion is translated to the gate from the gate switch lever (Fig. 4) by means of the connecting rod and crank (Fig. 4) and the shaft and cams (Fig. 6).

The crank and shaft are riveted together, and the shaft is held in position in the frame of the instrument by the pressure exerted by a spring-loaded plunger resting on the shaft. The crank fits on to a pin on the connecting rod, and to dismantle the gate all that is necessary is to set the gate switch lever to the vertical, or 'off', position and pull the crank and shaft outwards from the instrument until it is clear of the cams. The cams can then be removed, and the moveable gate drawn free of the guide pins. The wiring will allow sufficient freedom of movement for the servicing of the gates, but it should not be unduly strained.

The interlocking shutter S4 which is operated on the insertion of a test card, thus permitting closure of the contacts (see page 3), is shown in Fig. 7. The microswitch S3 which is closed by the lever in its 'off' position is shown in Fig. 4.

Vertical guides for the test cards are indicated in Fig. 7. A small pin inside the card guide directly above the safety switch S4 will only allow cards to be inserted if they are facing the correct way, that is, with the lettering facing the front of the instrument.

To reassemble the gate, the moveable panel should be lifted on to the guide pins, and the shaft should be inserted through the frame of the instrument and through the cams until the crank can be fitted on to the pin at the end of the connecting rod. Marks on the shaft and the cams indicate the position one should have relative to the other for correct reassembly.

A little grease should be applied periodically to the working surface of the cams and to all the bearings.

Cleaning the Gate Switch Contacts

The contacts may be cleaned with a soft tooth-brush using trichlorethylene or a similar cleaning agent. They should not, under any circumstances, be cleaned with an abrasive material.

Care should be taken not to displace the contacts as this may cause a poor connection to be made when the gate 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 link 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 link 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 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 link and reassemble the gate.

Selector Switch and Push Button Contacts

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

The selector switch can be dismantled by unfastening the grub screw in the knob and the locking nut on the spindle. There is sufficient connecting wire for the spindle to be withdrawn from the panel and the switch to be held away from the body of the instrument.

To gain access to the push button unit, two slotted nuts at the back of the unit can be removed to allow the unit to be withdrawn from the tester.

If necessary, the switch assembly may be removed altogether by unsoldering the cable-form leads from the circular tag panels at either end. To ensure correct re-connection, reference should be made to Fig. 3.

Overload Relay

The overload relay is adjusted in the factory to operate when the cathode current of V6 exceeds 180 milliamperes, and it is sealed before despatch. No readjustment should be made without reference to the Mullard Service Organisation.

Indicator Tube

The cathode ray tube unit can be detached from the front panel of the instrument by removing three nuts on the back of the panel. The tube can be removed from this assembly by first detaching the holder and its associated wiring and then loosening the clamp-ring screw.

Pilot Lamp

The green-faced cover of this component and the pilot bulb can be unscrewed and removed from the front of the tester. There is no need to dismantle the instrument at all to replace the bulb.

Mains Fuse

It is unlikely that the mains fuse will need to be replaced, but it is readily accessible beneath the inspection panel at the front of the tester.

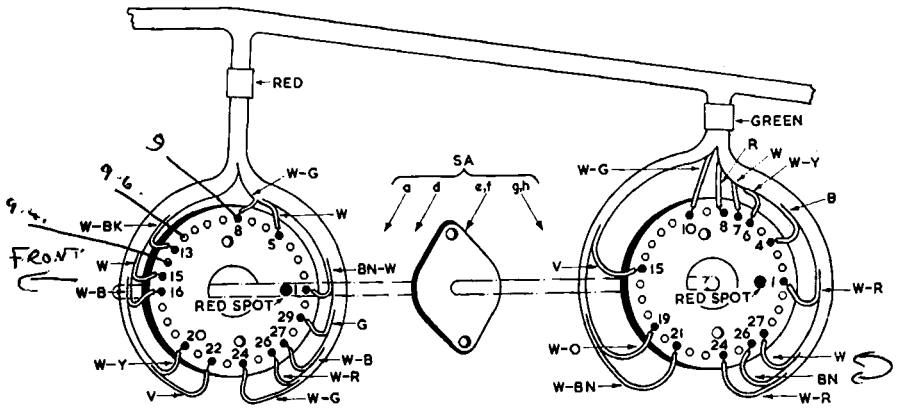


FIG. 3—CABLE-FORM CONNECTIONS TO SELECTOR SWITCH

Electrical Replacements

A complete circuit diagram is printed on the folded sheet kept in the pocket at the back of the manual. The components have been given reference numbers, and a full description of each can be found in the parts list on pages 19 to 21. Also, some of the components shown in the photographs of Figs. 4 to 11 have been marked. This information should be sufficient for a faulty component to be replaced, under the guidance of one of the Service Depots.

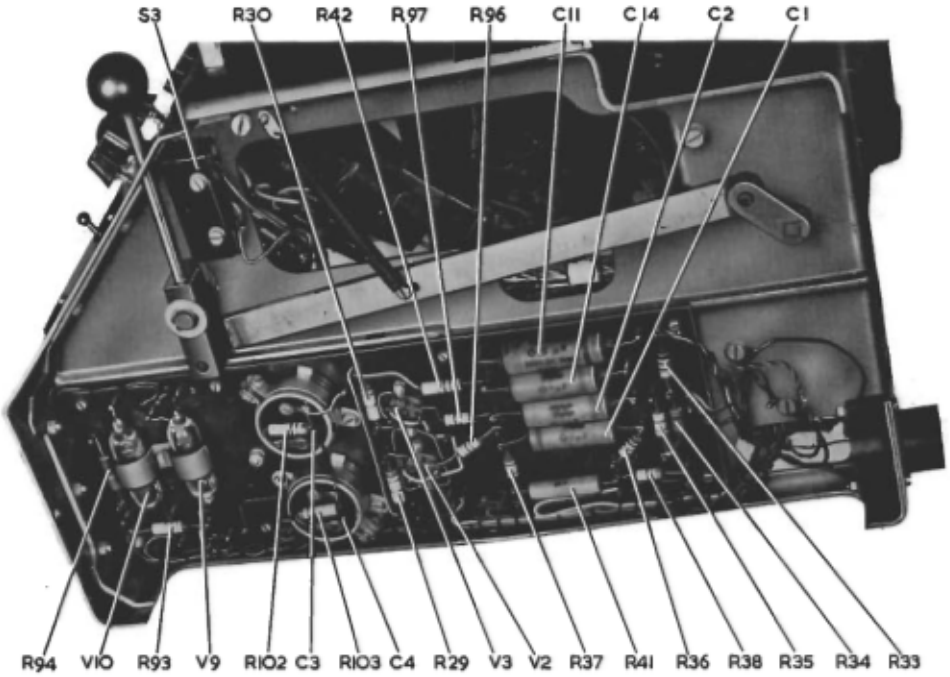


FIG. 4—SIDE PANEL SHOWING GATE SWITCH LEVER

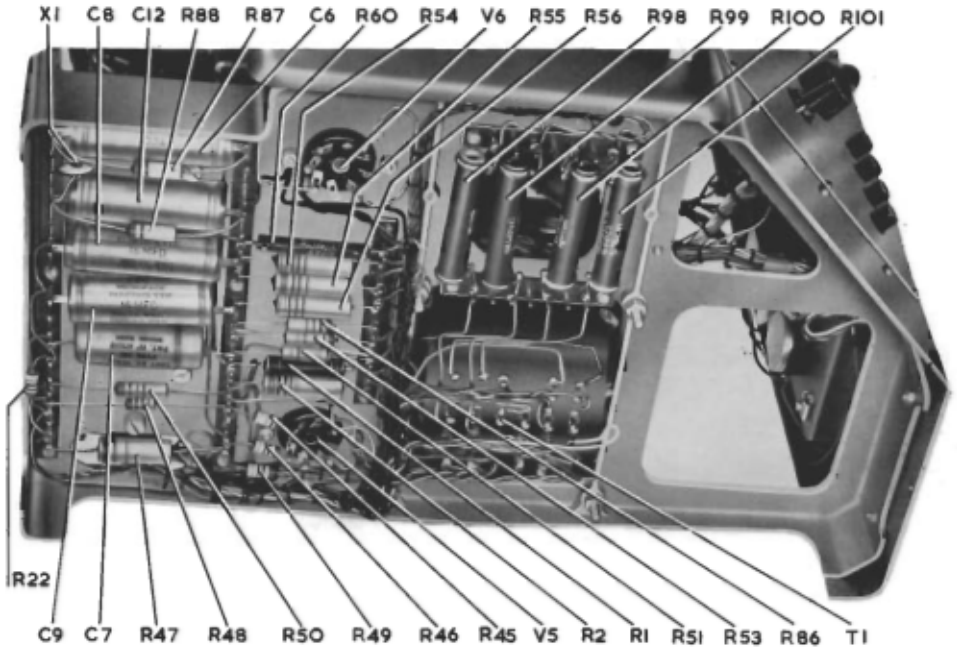


FIG. 5—SIDE PANEL SHOWING MAINS TRANSFORMER

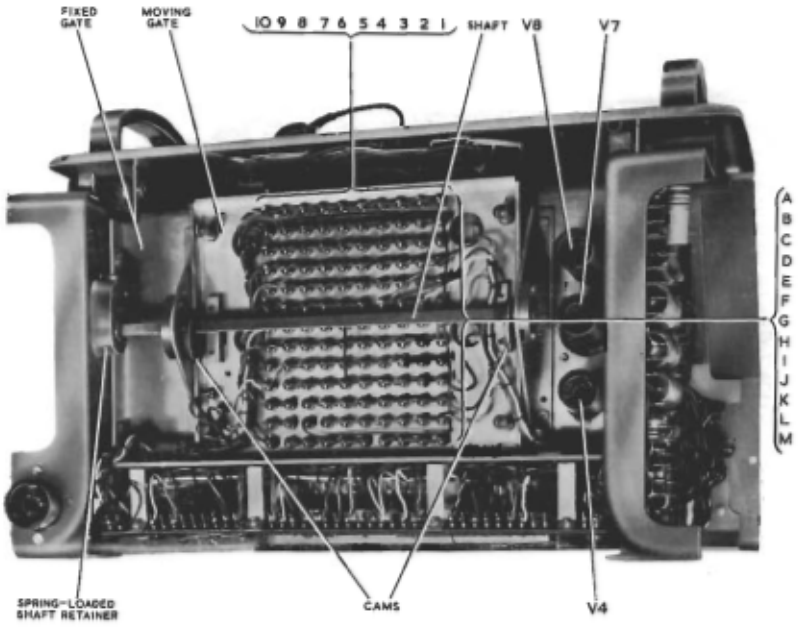


FIG. 6—GATE SWITCH BEFORE DISMANTLING

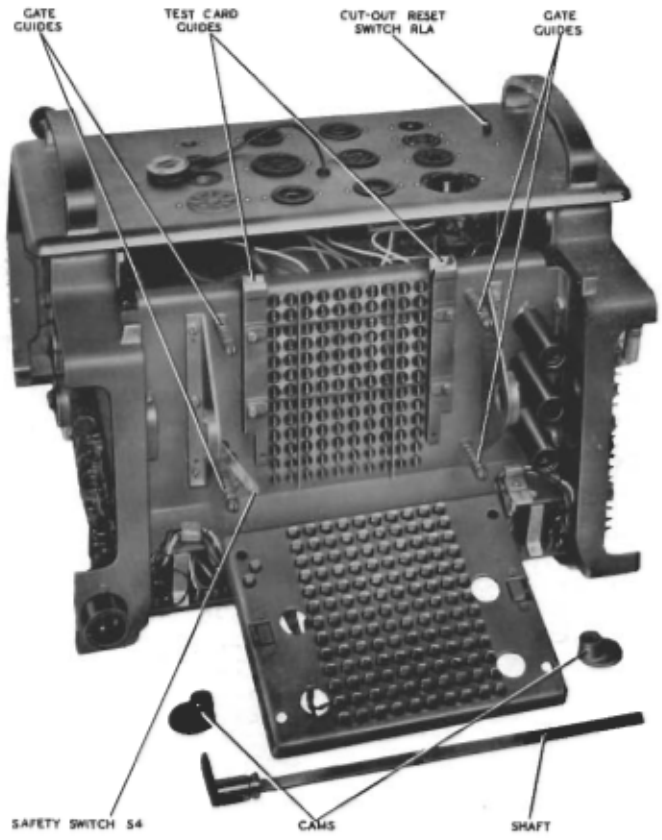


FIG. 7—GATE SWITCH AFTER DISMANTLING

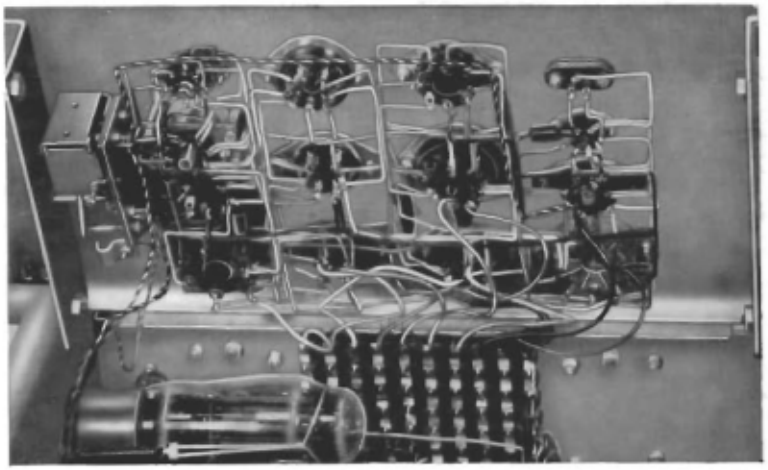


FIG. 8—UNDERSIDE VIEW OF VALVEHOLDER PANEL

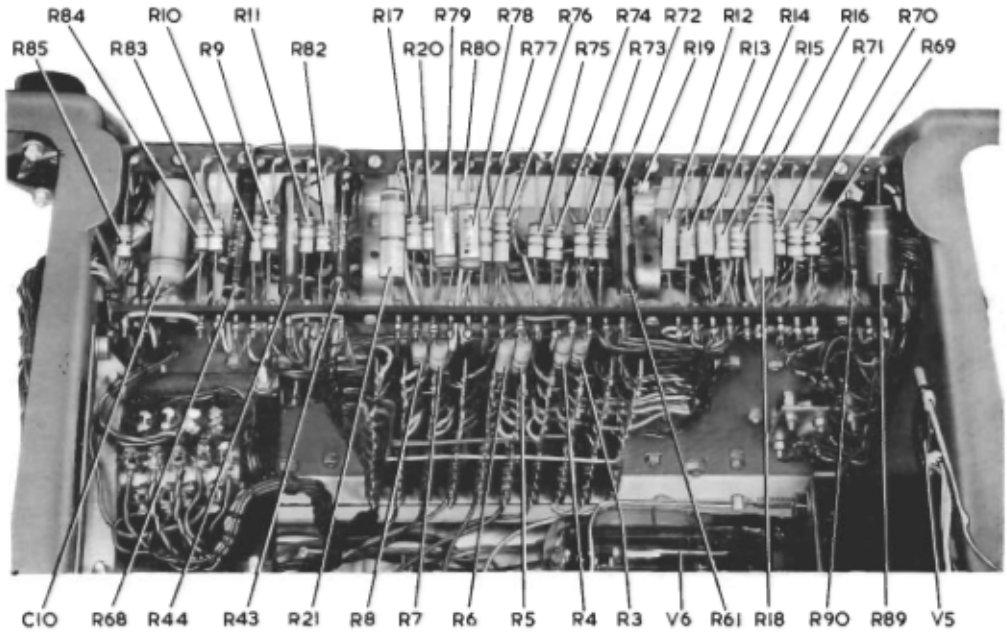


FIG. 9—REAR VIEW OF FIXED GATE

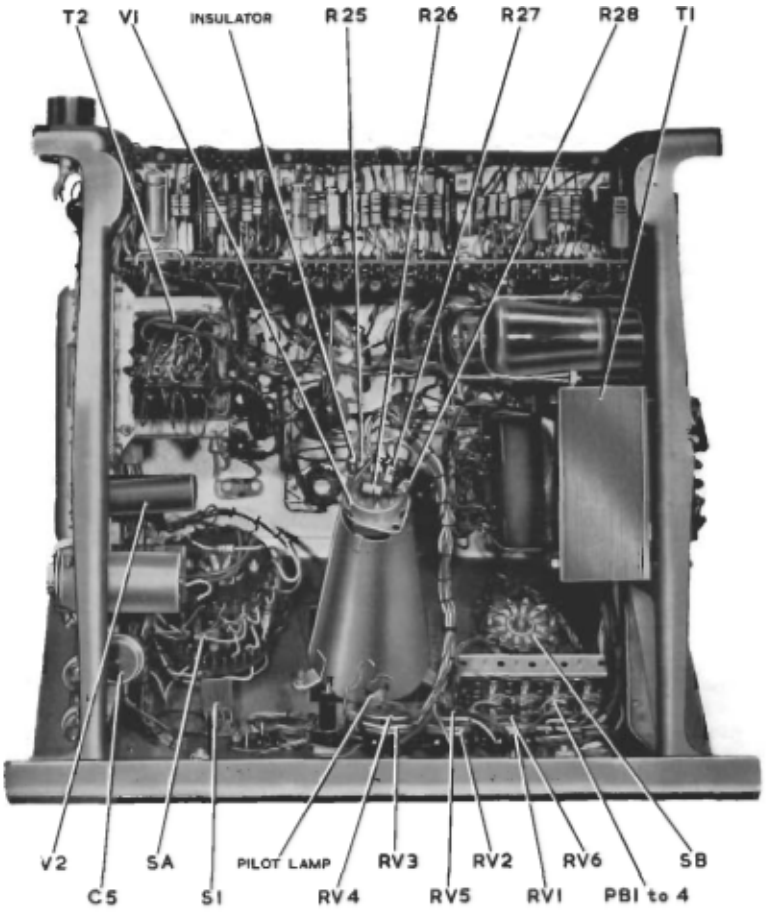


FIG. 10—GENERAL UNDERSIDE VIEW OF TESTER

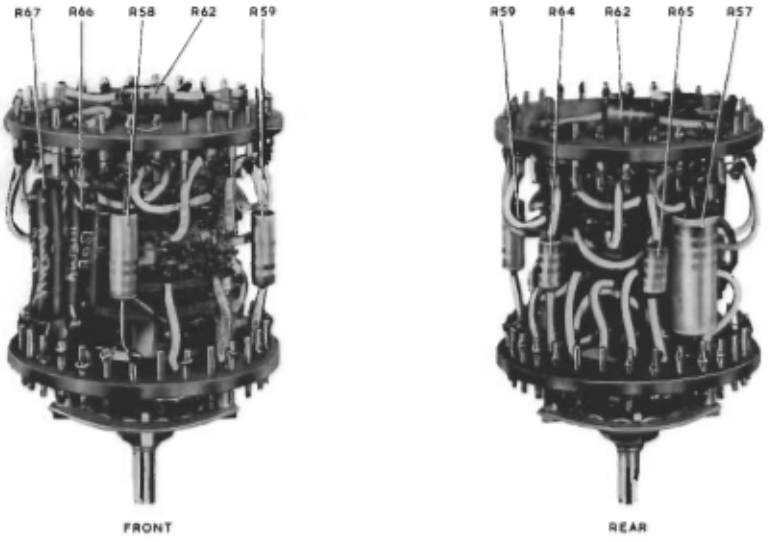


FIG. 11—SELECTOR SWITCH

SERVICING FACILITIES

The Valve Service Depots listed below are equipped to render assistance on testers for members of the Mullard High Speed Valve Tester Maintenance Plan and if any difficulty is found in setting up or maintaining the equipment members should write or telephone, in the first instance, to the nearest Depot. (Details of the maintenance plan, which carries many advantages, can be obtained on application to the Valve Sales Department, Mullard Limited, Mullard House, Torrington Place, London, W.C.1.)

London and the Home Counties

MULLARD LIMITED
Service Department
Purley Way
Croydon, Surrey
Telephone No. Croydon 3881

Provinces

MULLARD LIMITED
Valve Service Depot
108 Dale End
Birmingham
Telephone No. Central 0413

MULLARD LIMITED
Valve Service Depot
Renfrew Chambers
20 Renfrew Street
Glasgow, C.2
Telephone No. Douglas 7772

MULLARD LIMITED
Valve Service Depot
Brunel House
St. George's Road
Bristol
Telephone No. Bristol 27235

MULLARD LIMITED
Valve Service Depot
Berry Lane
Halifax
Yorks
Telephone No. Halifax 5722

The Service Depots will require the following information:

1. With the **mains** card in the gate, can the spot be adjusted normally to the dotted line *a* when the mains coarse adjustment switch is in a position corresponding approximately to the mains voltage?

2. (a) With the **reject** card in the gate, what are the positions of the spot when the selector switch is turned to positions 1 and 6?

   (b) Can the spot be adjusted normally by the preset control B?

3. With the **h.t.** card in the gate, what is the position of the spot in relation to the dotted line when the selector switch is in position 6?

If the above check correctly, please indicate whether or not the fault is restricted to a particular type, or group, of valves: i.e., does the fault occur only on rectifiers, or only on pentodes, etc?

In the event of a fault developing in a valve tester belonging to a dealer who is not a member of the Maintenance Plan, he should communicate with the nearest service depot (See page 17). If it is necessary to return the instrument for servicing, it is essential that it is correctly packed. Suitable packing will be forwarded on application to the nearest service depot. Instruments still under guarantee can be collected from most areas. Instruments which cannot be collected by our own transport should be packed in our approved packing and forwarded by passenger train. All correspondence concerning service matters should be addressed to the nearest service depot.

All other correspondence, including enquiries regarding test cards, should be addressed to:

MULLARD LIMITED
Valve Sales Department
Mullard House, Torrington Place, London, W.C.1

If the cathode ray tube or a valve used in the tester becomes faulty within the guarantee period, it should be returned with the appropriate B.V.A. form to the nearest service depot.

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	Tolerance (±%)	Rating (W)	Description	Make	Code No.	Type No.
R1	4MΩ	1	1	High Stability	Welwyn	GH 553 01/4M/WS	SA 3634
R2	2MΩ	1	1	High Stability	Erie	GH 553 01/2M/E	100
R3	1MΩ	1	½	High Stability	Erie	GH 552 01/1M/E	108
R4	500kΩ	1	½	High Stability	Erie	GH 552 01/500K/E	108
R5	250kΩ	1	½	High Stability	Erie	GH 552 01/250K/E	108
R6	125kΩ	1	½	High Stability	Erie	GH 552 01/125K/E	108
R7	200kΩ	1	¼	High Stability	Erie	GH 550 01/200K/E	109
R8	51kΩ	1	¼	High Stability	Erie	GH 550 01/51K/E	109
R9	1MΩ	1	½	High Stability	Erie	GH 552 01/1M/E	108
R10	500kΩ	1	¼	High Stability	Erie	GH 550 01/500K/E	109
R11	250kΩ	1	¼	High Stability	Erie	GH 550 01/250K/E	109
R12	125kΩ	1	¼	High Stability	Erie	GH 550 01/125K/E	109
R13	62·5kΩ	1	¼	High Stability	Erie	GH 550 01/62K5/E	109
R14	31·2kΩ	1	¼	High Stability	Erie	GH 550 01/31K2/E	109
R15	15·6kΩ	1	¼	High Stability	Erie	GH 550 01/15K6/E	109
R16	7·8kΩ	1	¼	High Stability	Erie	GH 550 01/7K8/E	109
R17	50kΩ	1	¼	High Stability	Erie	GH 550 01/50K/E	109
R18	1·5MΩ	1	1	High Stability	Erie	GH 553 01/1M5/E	100
R19	22kΩ	10	½	Carbon	Erie	GH 422 10/22K/E	9
R20	10kΩ	5	½	Carbon	Erie	GH 422 05/10K/E	9
R21	24kΩ	1	1	High Stability	Erie	GH 553 01/24K/E	100
R22	10Ω	10	½	Carbon	Erie	GH 422 10/10E	9
R25	4·7MΩ	10	½	Carbon	Erie	GH 422 10/4M7/E	9
R26	3·3MΩ	10	½	Carbon	Erie	GH 422 10/3M3/E	9
R27	1MΩ	10	½	Carbon	Erie	GH 422 10/1M/E	9
R28	1MΩ	10	½	Carbon	Erie	GH 422 10/1M/E	9
R29	220kΩ	5	1	Carbon	Erie	GH 425 05/220K	8
R30	220kΩ	5	1	Carbon	Erie	GH 425 05/220K	8
R33	1·5MΩ	5	½	Carbon	Erie	GH 422 05/1M5/E	9
R34	3·3MΩ	5	½	Carbon	Erie	GH 422 05/3M3/E	9
R35	470kΩ	5	½	Carbon	Erie	GH 422 05/470K/E	9
R36	1kΩ	5	½	Carbon	Erie	GH 422 05/1K/E	9
R37	220kΩ	10	½	Carbon	Erie	GH 422 10/220K/E	9
R38	3·3kΩ	10	½	Carbon	Erie	GH 422 10/3K3/E	9
R41	115kΩ	1	1	High Stability	Erie	GH 553 01/115K/E	100
R42	4·7kΩ	10	1	Carbon	Erie	GH 425 10/4K7/E	8
R43	27kΩ	5	14	Wirewound	Welwyn	GH 031 45/27K	AW 3112
R44	33kΩ	5	14	Wirewound	Welwyn	GH 031 45/33K	AW 3112
R45	10kΩ	10	½	Carbon	Erie	GH 422 10/10K/E	9
R46	100Ω	10	½	Carbon	Erie	GH 422 10/100E/E	9
R47	560kΩ	10	2	Carbon	Erie	GH 429 10/560K/E	10
R48	1MΩ	10	½	Carbon	Erie	GH 422 10/1M/E	9
R49	100Ω	10	½	Carbon	Erie	GH 422 10/100E/E	9
R50	75kΩ	5	½	High Stability	Erie	GH 552 05/75K/E	108
R51	560kΩ	5	½	High Stability	Erie	GH 552 05/560K/E	108
R53	180kΩ	5	½	High Stability	Erie	GH 552 05/180K/E	108

Circuit Ref.	Value	Tolerance (±%)	Rating (W)	Description	Make	Code No.	Type No.
R54	8·2kΩ	10	2	Carbon	Erie	GH 429 10/8K2/E	10
R55	6·8kΩ	10	2	Carbon	Erie	GH 429 10/6K8/E	10
R56	4·7kΩ	10	2	Carbon	Erie	GH 429 10/4K7/E	10
R57	12kΩ	5	2	Carbon	Erie	GH 429 05/12K	10
R58	68Ω	1	½	High Stability	Erie	GH 552 01/68E/E	108
R59	100kΩ	10	1	Carbon	Erie	GH 425 10/100K/E	8
R60	680Ω	2	14	Wirewound	Welwyn	GH 031 52/680E	AW 3112
R61	680Ω	2	14	Wirewound	Welwyn	GH 031 52/680E	AW 3112
R62	10MΩ	5	½	Carbon	Erie	GH 422 05/10M/E	9
R64	10MΩ	5	½	Carbon	Erie	GH 422 05/10M/E	9
R65	6·8MΩ	5	½	Carbon	Erie	GH 422 05/6M8/E	9
R66	20Ω	5	10	Wirewound	Welwyn	GH 031 25/20E	AW 3111
R67	20Ω	5	10	Wirewound	Welwyn	GH 031 25/20E	AW 3111
R68	120Ω	2	2	High Stability	Welwyn	GH 554 02/120E/WS	SA 3635
R69	8·2kΩ	1	¼	High Stability	Erie	GH 550 01/8K2/E	109
R70	4·3kΩ	1	¼	High Stability	Erie	GH 550 01/4K3/E	109
R71	2·2kΩ	1	¼	High Stability	Erie	GH 550 01/2K2/E	109
R72	1·1kΩ	1	¼	High Stability	Erie	GH 550 01/1K1/E	109
R73	560Ω	1	¼	High Stability	Erie	GH 550 01/560E/E	109
R74	300Ω	1	¼	High Stability	Erie	GH 550 01/300E/E	109
R75	160Ω	1	¼	High Stability	Erie	GH 550 01/160E/E	109
R76	82Ω	1	½	High Stability	Erie	GH 552 01/82E/E	108
R77	43Ω	1	½	High Stability	Erie	GH 552 01/43E/E	108
R78	22Ω	1	½	Wirewound	Adco	GH 435 00/22E	PW 3
R79	11Ω	1	½	Wirewound	Adco	GH 435 00/11E	PW 3
R80	470kΩ	5	½	Carbon	Erie	GH 422 05/470K/E	9
R82	1·2MΩ	5	½	Carbon	Erie	GH 422 05/1M2/E	9
R83	3·6MΩ	5	½	Carbon	Erie	GH 422 05/3M6/E	9
R84	2·7MΩ	5	½	Carbon	Erie	GH 422 05/2M7/E	9
R85	39kΩ	5	½	Carbon	Erie	GH 422 05/39K/E	9
R86	1·5kΩ	10	1	Carbon	Erie	GH 425 10/1K5/E	8
R87	150kΩ	20	1	Carbon	Erie	GH 425 20/150K/E	8
R88	150kΩ	20	1	Carbon	Erie	GH 425 20/150K/E	8
R89	100Ω	5	2	Carbon	Erie	GH 429 05/100E/E	10
R90	100Ω	2	1	High Stability	Welwyn	GH 553 02/100E/WS	SA 3634
R93	18kΩ	10	1	Carbon	Erie	GH 425 10/18K/E	8
R94	2·2kΩ	10	1	Carbon	Erie	GH 425 10/2K2/E	8
R96	470Ω	10	½	Carbon	Erie	GH 422 10/470E/E	9
R97	470Ω	10	½	Carbon	Erie	GH 422 10/470E/E	9
R98	600Ω	5	30	Wirewound	Welwyn	GH 032 05/600E	AW 3192
R99	400Ω	5	30	Wirewound	Welwyn	GH 032 05/400E	AW 3192
R100	600Ω	5	30	Wirewound	Welwyn	GH 032 05/600E	AW 3192
R101	400Ω	5	30	Wirewound	Welwyn	GH 032 05/400E	AW 3192
R102	2·2MΩ	20	1	Carbon	Erie	GH 425 20/2M2/E	8
R103	2·2MΩ	20	1	Carbon	Erie	GH 425 20/2M2/E	8
RV1	100kΩ	20	¼	Carbon Variable	Welwyn	GH 063 10/100K	A 7353
RV2	1MΩ	20	¼	Carbon Variable	Welwyn	GH 063 10/1M	A 7353
RV3	1MΩ	20	¼	Carbon Variable	Welwyn	GH 063 10/1M	A 7353
RV4	1MΩ	20	¼	Carbon Variable	Welwyn	GH 063 10/1M	A 7353
RV5	10kΩ	20	1½	Wirewound Variable	Welwyn	GH 075 60/10K	A 7253
RV6	50kΩ	20	¼	Carbon Variable	Welwyn	GH 063 10/50K	A 7353
X1				Varite Thermistor	Mullard		VA 1038

Capacitors

Circuit Ref.	Value (μF)	Tolerance (%)	Rating (V d.c.wkng.)	Description	Make	Code No.	Type No.
C1	0·1	±20	500	Paper Tubular	T.C.C.	GH 382 16/100K	543
C2	0·1	±20	500	Paper Tubular	T.C.C.	GH 382 16/100K	543
C3	4	+50; −10	475	Electrolytic	Daly	GB 204 00	G3/15 R.C.S.
C4	4	+50; −10	475	Electrolytic	Daly	GB 204 00	G3/15 R.C.S.
C5	0·5	±20	500	Paper Tubular	Dubilier	GH 381 26	4706B
C6	16	+50; −20	350	Electrolytic	T.C.C.	GH 351 58	CE11 LE
C7	0·5	±20	350	Paper Tubular	T.C.C.	GH 382 10/500K	343
C8	16	+50; −20	350	Electrolytic	T.C.C.	GH 351 58	CE11 LE
C9	16	+50; −20	350	Electrolytic	T.C.C.	GH 351 58	CE11 LE
C10	0·1	±20	500	Paper Tubular	T.C.C.	GH 382 16/100K	543
C11	0·25	±20	350	Paper Tubular	T.C.C.	GH 382 10/250K	343
C12	16	+50; −20	350	Electrolytic	T.C.C.	GH 351 58	CE11 LE
C14	0·1	±20	500	Paper Tubular	T.C.C.	GH 382 16/100K	543

Switches

Circuit Ref.	Description	Make	Code No.	Type No.
SA	Rotary, 4-Wafer, 6-Way	Oak (N.S.F.)	MD 937 40	H
SB	Rotary, 11-Way, S.P.	Oak (N.S.F.)	MD 883 33	H
S1	On/Off	Bulgin	GB201 43	S277
S2	4-Way	Philips	MD852 18	
S3	Micro Switch	Burgess	GB 305 02	BRL2
S4	Lever Assy (Safety Switch)		MD 860 49	
PB1-4	4-Pole Push Button Unit	Oak (N.S.F.)	MD 930 44	80

Miscellaneous

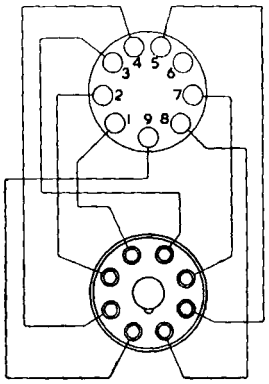
Circuit Ref.	Description	Make	Code No.	Type No.
T1	H.T. Transformer	M.E.L.	MD 510 29	
T2	Heater Transformer	M.E.L.	MD 511 29	
FS1	2-Amp. Cartridge Fuse	Bell	GB 141 56	L1055/2
RLA	Cut-out Relay	M.E.L.	MD 881 82	
LP1	Pilot Lamp 6·5V, 0·3A	Philips	GH 900 23	Tubular
	Plug	Bulgin	MD 930 91	P73-BB
	Socket	Bulgin	MD 930 92	P73-BB

Valves

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

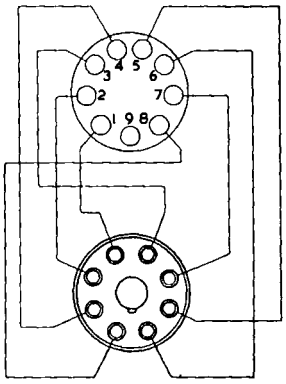
FIG. 12—ADAPTORS FOR CERTAIN TYPES OF VALVE

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



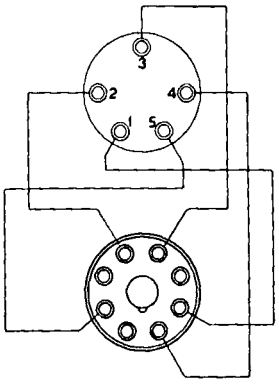
International Octal plug
TP22

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



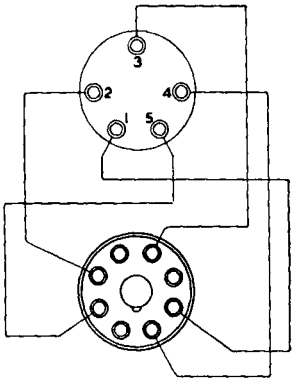
International Octal plug
AC/TP, TP2620

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



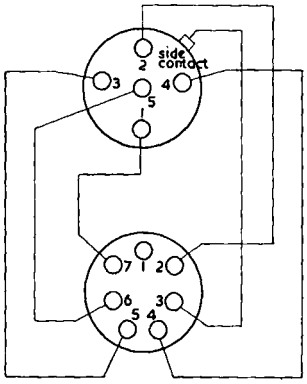
International Octal plug
QV05-25, 807

4 UX 5-pin holder



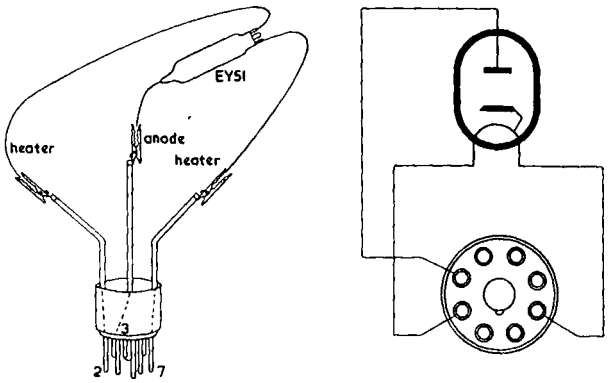
International Octal plug
36, 37, 38, 39/44, 46, 47, 76, 84/6Z4

5 British 5-pin holder



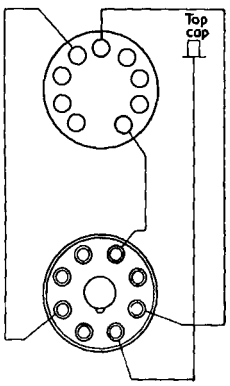
British 7-pin plug
MKT4, PEN4VA (5-pin using 7-pin card), APP4A

6 Wire-in EY51 Valve



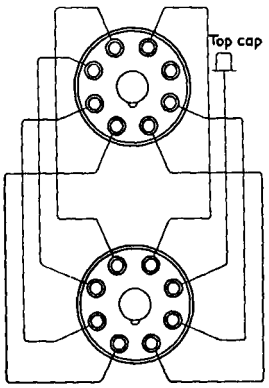
International Octal plug
R16, R12, EY51, SU61, U43, U151, U25, U37, IT2, 6W2, 6X2

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



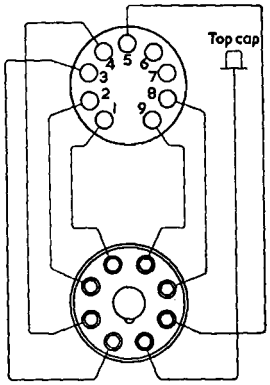
International Octal plug
PY81, U153, U329, 17Z3, EY81, PY83

8 International Octal holder
Top cap to plug pin 6



International Octal plug
U282, U301

9 Noval holder
Top cap to plug pin 8



International Octal plug

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 s.w.g. 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.

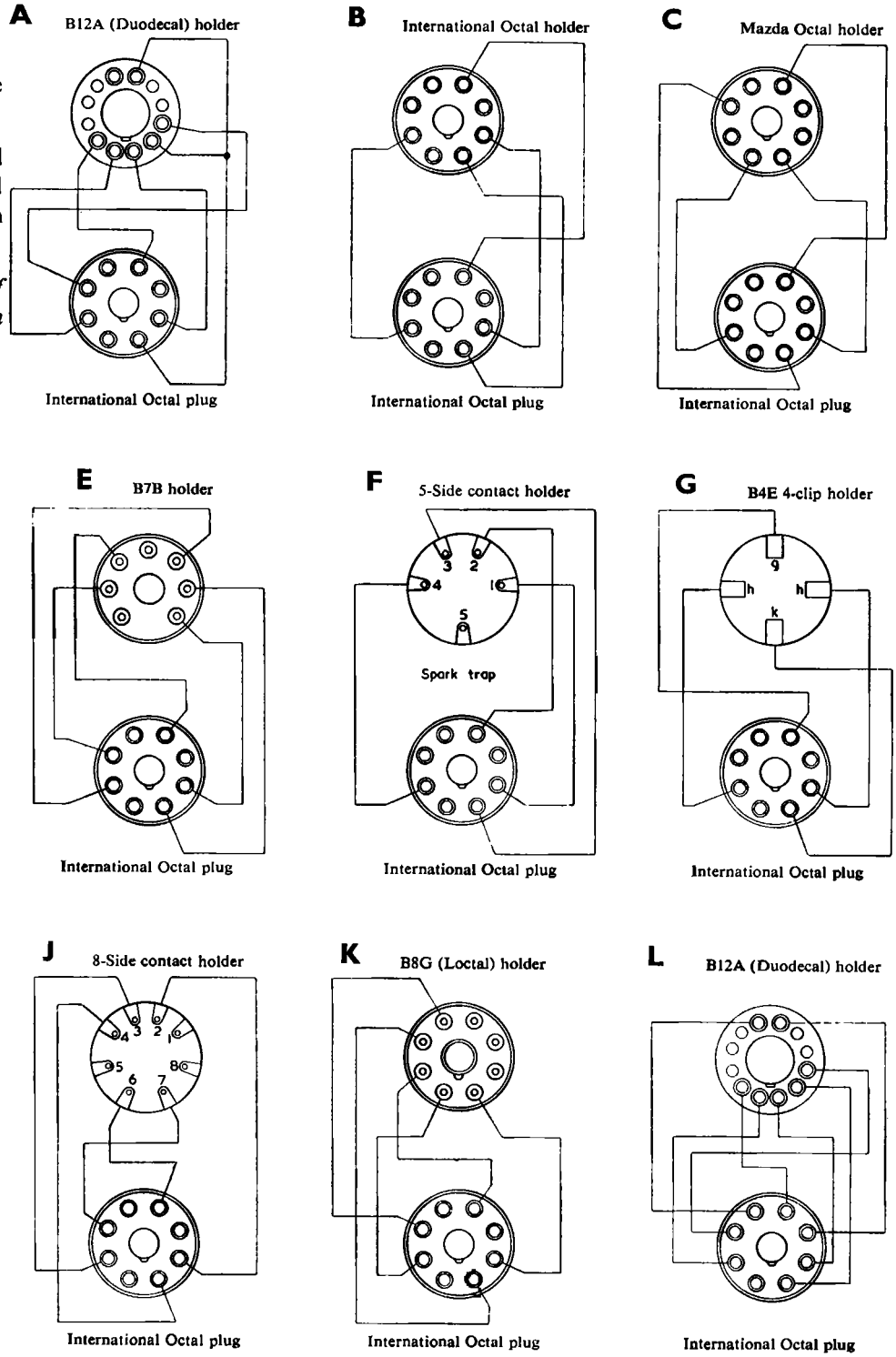
Information on the use of these adaptors is given on page 10.

FIG. 13—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 10.



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

Test cards for the Continental valve types listed below are available on demand from Valve Sales Dept., Mullard House, Torrington Place, London, W.C.1. 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

The wiring diagram shows the connections for the additional Y8A valveholder (Socket 15) which can be mounted to the right of the B9G valveholder on the top, or test panel of the valve tester. This wiring should be carried out in p.v.c. covered 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.

Valveholders only may be obtained from Mullard Ltd., Service Department, Purley Way, Croydon, Surrey (Telephone Croydon 3881) 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.

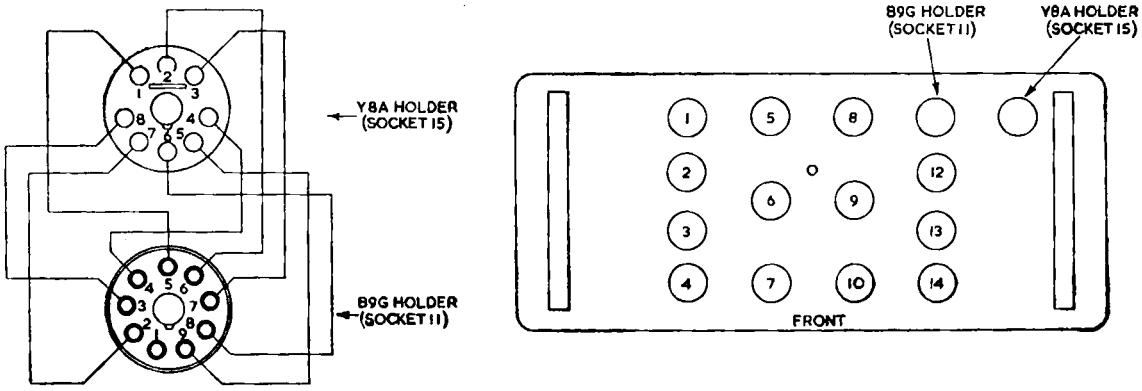


FIG. 14—TOP PANEL MODIFIED WITH Y8A BASE