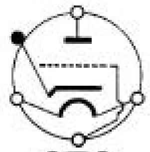
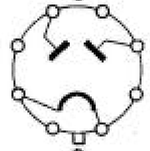
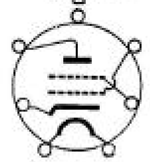
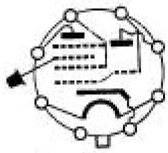
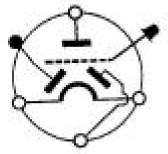
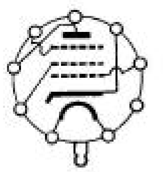
electrodes should be set at O(E). Insert the valve in the appropriate valve holder. With one of the leads provided connect any top cap or side connection on the valve to its appropriately marked socket, on the Socket Panel immediately above the Selector Switch. Note that the loctal valve holder having only eight normal electrodes has its centre lug connected to the ninth roller (corresponding to pin No. 9) to accommodate valves which have a cathode connection made to this lug.

The accompanying examples show how to co-relate the pin basing data and the equivalent set-up combination for a number of valves in common use.

Valve Type	*Set up Number*	*Base Diagram*
1. Osram MH4 indirectly heated triode. British 5-pin base.	6 4 2 3 1 0 0 0 0 A G H— H+ C E E E E	
2. Osram U50 full wave rectifier directly heated. Octal base.	0 2 0 8 0 9 0 3 0 E H— E D1 E D2 E H+ E	
3. Mullard PenA4 indirectly heated output pentode. British 7 pin base.	0 4 5 2 3 1 6 0 0 E G S H— H+ C A E E	
4. American 6K8 indirectly heated frequency changer. Octal base.	0 2 7 5 4 6 3 1 0 E H— A2 S G A H+ C E Top Cap G1.	
5. Mullard TDD2A battery double diode triode. British 5-pin base.	6 8 2 3 9 0 0 0 0 A D1 H— H+ D2 E E E E Top Cap G1.	
6. Mullard EF50 indirectly heated HF pentode. B9G base.	2 5 6 1 0 1 4 0 3 H— S A G3 E C G E H+	

Provision for New Valve Bases

To cover the possibility of the introduction of new valve bases not provided for on the standard panel and also the introduction of valves which may necessitate special conditions associated with standard valve holders, a plug-in adaptor is available which enables any non-standard valve holder to be combined in this adaptor and plugged into the octal or other suitable base on the Valve Characteristic Panel. These adaptors are available for bases not included on the Valve Panel, and also with a blank valve holder mounting panel in which can be mounted the user's own valve holder if he requires any special arrangement for which we have not catered.

The Prevention of Self Oscillation of valves under test

It will be realised that the length of wiring and its associated capacity, connected to the grid and anode pins of any one of the valve holders, can constitute a tuned line corresponding to a high resonant frequency often of the order of 100 megacycles per second or higher. A number of modern valves have sufficiently high slope to overcome the inherent losses associated with such a tuned line, and are, therefore, capable of bursting into oscillation at a frequency determined by the constants of their associated valve holder wiring when being tested at or near their maximum working slope. It is quite obvious that in order to test a valve some wiring must exist between the valve holder and test circuit. Further, since a multiple test panel is desirable to obviate the necessity of a vast number of separate plug-in units, the total amount of wiring associated with any one valve holder must be a considerable number of inches in length. It is almost impossible to increase the effective resonant frequency of the lines thus produced to such a high value that no normal valve will oscillate therewith. The only alternative is to render the line of comparatively high loss and in extreme cases to stopper the valve in question right on top of its anode and/or grid connection. Unfortunately, however, since a very large number of pin combinations have to be accommodated in any one valve holder the presence of such a resistance in say a heater or cathode circuit could give completely erroneous results, and this stoppering system could therefore only be very sparsely used.

In certain circumstances where a newly introduced valve of high efficiency is likely to be tested in any quantity and shows signs of oscillation, the separate valve holder adaptor can be employed with considerable advantage. By this means a valve holder can be stoppered to the maximum extent necessary for the valve in question without reference to any other valves that may be incorporated therein, as when the other types of valves are likely to be used, the adaptor can be set aside and the valve panel used normally. It must be stressed that this oscillation is unlikely to occur where the valve is tested at anode currents lower than normal, or at a point on its curve which renders its mutual conductance low. Were a purely empirical method of testing employed in the Valve Characteristic Meter, therefore, the problem would in all probability not arise, but since every effort has been made to actually test the valve under its correct operating conditions of current and voltage, then it is on this account working at its normal efficiency and can, unless special precautions are taken, give rise to the oscillation troubles to which we have referred.

Whilst discussing the problem of oscillation, mention should be made of the rectifier (which will be seen in the circuit diagram) included in the screen circuit of pentode and tetrode valves. This rectifier has been incorporated to obviate a difficulty which can arise in certain circumstances when testing valves of the beam tetrode type with alternating current applied to their electrodes. As the applied electrode voltages approach zero during a portion of their operative cycle, the focusing of the beam of such valves is to some extent upset and the result can be that the screen circuit begins to show an

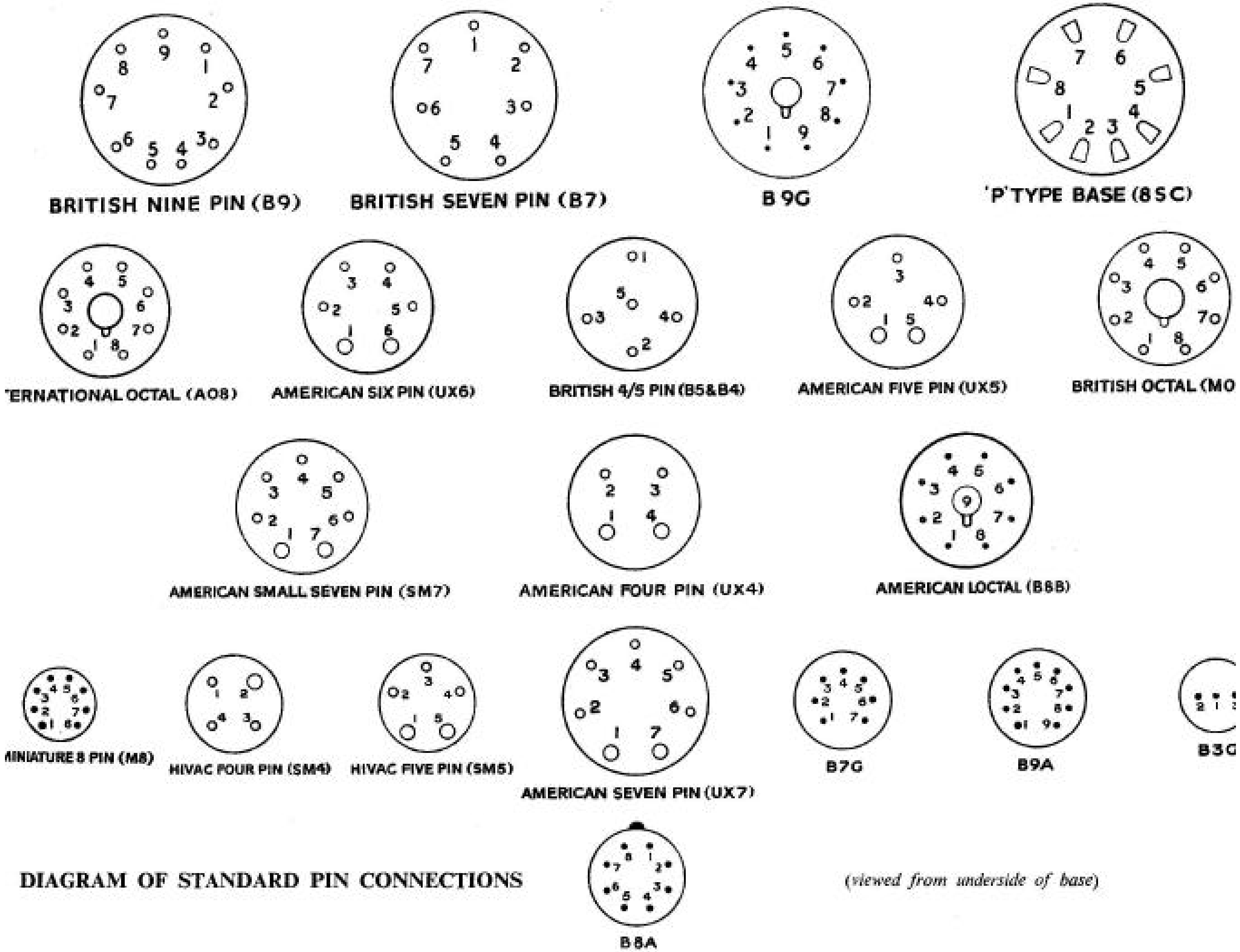


DIAGRAM OF STANDARD PIN CONNECTIONS

(viewed from underside of base)

emission in a reverse direction to normal screen current with the result that the anode current rises and the current taken by the screen decreases rapidly and becomes negative. This can cause screen overheating and besides giving an unstable and erroneous impression of the condition of the valve, can, if allowed to continue, damage the valve. To obviate this condition, therefore, the rectifier is included in such a manner that only its low forward resistance is presented to the screen passing current in the normal direction, thus causing a negligible variation to standard conditions, but the reverse resistance of the rectifier is operative to limit screen current of the opposite direction to negligible proportions and thus prevent the conditions stated above, from coming into effect.

The problem of self oscillation has been almost completely eliminated in the " AVO " Valve Characteristic Meter Mark II by stoppering the Roller Selector Switch, and wiring the Valve Holder Panel in connection loops of predetermined lengths, so that any valve inserted would tend to oscillate at a definite frequency dependent on the loop lengths. These separate inter-connection loops are then loaded so that oscillation cannot occur when testing valves with conventional characteristics, irrespective of the Valve Holder and pin combination used. In earlier models, every attempt has been made to reduce the possibility of oscillation by the discreet use of stoppers wherever possible and the careful lay out of wiring in cases where it is known that high slope valves are likely to give rise to trouble of this nature.

Special procedure for Valves having Internally Connected Pins

> The notes which follow relating to valves having internally connected pins do not apply to the Valve Characteristic Meter Mark II and can be ignored. Here where * appears in the Selector Switch number, denoting an internal connection, it is merely necessary to set the appropriate Roller to $\frac{o}{E}$, e.g. U.81 where the Selector Switch reads **9 **8 230 set the Roller Selector Switch to read 009 008 230 and test as a normal valve.

On certain valves of recent manufacture, particularly the miniature glass type employing B7G, B8A, B9A, etc., bases it has become the practice of manufacturers to connect internally certain of the valve electrodes to pins which would otherwise be blank and free from any connection. Although the manufacturers specify the pins on which this is likely to occur they reserve the right to vary the nature of the internal connections from time to time as prevailing conditions might demand. This in itself prevents the inclusion of the electrode thus internally connected, in the normal selector switch set-up of the valve.

The pins on which this arrangement occurs however, cannot be connected to earth (O) on the roller switch, for this may result in an electrode being shorted to earth with possible damage to the instrument. Therefore, where this possibility is known to exist a symbol " * " appears in place of the relevant pin connection in the valve set up number, (see "AVO" Valve Data Manual) to ensure that the preliminary test for electrode insulation is carefully carried out before normal test procedure is brought into effect.

Where " * " appears in the set up number substitute $\frac{1}{C}$ when setting up the selector switch. Before inserting valve, ensure that **Circuit Selector** switch is in position **Check (C)** and apply the normal Electrode Leakage Test. This will enable the unknown electrode connection to be obtained as follows :—

(1) By rotating the **Electrode Leakage** switch, a " short " will appear at the position " C " in addition to one or more other electrode positions, depending on the number of internal connections. If now the rollers associated with the valve pins designated

by " * " ($\frac{1}{C}$ in the set up) are rotated, the short will be cleared when the roller(s) electrode indication is the same as the electrode to which the pin(s) in question is internally connected. The final set up which clears all shorts will obviously be the correct one for the valves and normal testing can thus proceed.

e.g. if set up reads 41236*100
Set rollers to read 412361100

On proceeding as above, it is found that a short occurs on " C " and " G " positions of **Electrode Leakage** switch : On rotating roller No. 6 to $\frac{4}{G}$, when the set up reads 412364100, the indication of shorts will have been removed and normal test procedure can be followed.

This method will satisfactorily deal with all internal electrode connections (A, S, G, etc.) with the exception of the case where the internal connection is made to a point on the heater (this may be either end or centre tap).

(2) In such a case, a short will appear at the " C " position of the **Electrode Leakage** switch, but at no other electrode position (as " H " position normally shows short circuit denoting heater continuity). Rotating the corresponding roller in this case will merely change the " short " indication to some other electrode designated by the roller position.

Remove the valve from its socket and carry out a continuity test with an ordinary ohmmeter between the pin on which the unknown connection occurs and all standard pins connected to heater. The ohmmeter must be used on a low enough range to distinguish between " short " and the heater resistance. The point on the heater (H —, H+ or CT) showing zero resistance to the pin in question will now determine the set up number, and the roller must be rotated accordingly.

E.g. If set up is 41236*100

and on ohmmeter check, zero resistance is shown between pins 6 and 3, set up for all tests will be 412362100.

It should be noted that if after switching to **Check** (H) the indicator lamps are very dim, and valve heater does not light up, it is probable that the valve filament voltage is being shorted out, due to the wrong side of filament voltage being connected to the internal connection pin, and this fault can be cleared by reversing the heater connection to the pin marked " *. "

(3) When no indication of electrode leakage, other than normal heater continuity, occurs at any position of **Electrode Leakage** switch, the pin(s) marked " * " have not been connected internally and normal procedure can be followed in testing the valve, the roller position marked " * " being set at "$\frac{O}{E}$."

THE CONTROLS ON THE FRONT PANEL THEIR FUNCTIONS AND OPERATIONS

All the controls necessary for carrying out the essential valve testing functions are situated on the front panel of the instrument, and by the manipulation of these controls and the use of the valve panel already described, the following tests can be undertaken.

1. The direct indication of insulation resistance between electrodes with the valve cold. This test will also indicate heater continuity.
2. The direct indication of insulation resistance between specific electrodes with the valve filament hot, including a separate test for the important function of cathode to heater insulation.
3. The measurement of mutual conductance directly in milliamps/volt over a full range of applied high tension and bias voltages.

4. The comparative indication of valve goodness on a coloured scale on the basis of mutual conductance reading.
5. The ability to plot complete sets of mutual characteristics Ia/Vg_1, Ia/Va, I_s/Vg_1, I_s/V_s, etc., with a complete range of applied electrode voltages corresponding to D.C. operating conditions.
6. The testing of rectifiers under reservoir condenser conditions with a full range of D.C. loading.
7. The testing of signal diodes under suitable D.C. load.
8. The testing of the separate sections of multiple valves, the non-operative section of the valve being maintained at reasonable working electrode voltages.
9. The indication of grid current and valve softness.
10. The possibility of testing valves with suitable loads included in the anode or other required electrode circuit, together with the ability to read the required electrode current on a separate meter of greater sensitivity if desirable, thus rendering the instrument suitable for making tests on non-standard and specialised types of valves not catered for in the normal circuit arrangements.

The separate functions of the controls available are as follows :—

The Set ∿ Control.

This control enables minor adjustments to be made to the input tappings on the mains transformer after the coarse mains tapping has been set.

The Electrode Leakage Switch

This switch serves the dual purpose of putting the instrument in a condition for the initial setting of the **Set ∿** control and also indicates the electrodes, if any, between which leakage occurs with the valve in a cold condition. It also serves to indicate heater continuity.

The Circuit Selector Switch

This is a six position switch enabling the instrument to be set up in readiness for the type of test to be undertaken. All the necessary internal circuit connections are made to satisfy the test conditions required, whilst internal test circuits, unnecessary to the measurements in question are automatically removed from the valve.

On position **Check (C)** the instrument is set up for the initial mains voltage adjustment, also on the same position the Tester is suitably connected for the cold electrode leakage test, to which we have already referred.

At the **Check (H)** position of the switch, the valve is automatically tested for electrode leakage, with the heater hot, between the cathode and heater strapped, and all other electrodes.

At position **C/H. ins** the valve is automatically tested for cathode to heater insulation with the valve hot.

With the circuit selector turned to **Test** all normal mutual characteristics are measured in conjunction with the electrode voltage controls, the meter and anode selector switches and other relevant controls. It will be noted that in the case of the insulation tests the meter is automatically shunted to the appropriate sensitivity and the insulation scale can be read directly. On the **Test** position of the **Circuit Selector** switch, however, the meter range selector is brought into circuit, thus enabling the meter range to be suited to the current measurement to be undertaken.

The switch setting **Diode** and **Rec** are for carrying out reservoir load tests on diodes and rectifiers, respectively. In the case of the diode test the **Meter Selector** should be set to the 1mA position, whilst when testing rectifiers the Meter Selector is set to a value, on the inner scale, suited to the load on which it is desired the rectifier should be tested.

The Anode and Screen Voltage Switches

As their names imply these switches enable the requisite electrode voltages to be applied to screens and anodes of valves for the purpose of carrying out mutual characteristic measurements. They are normally calibrated in the equivalent DC voltage settings and, therefore, no account need be taken of the actual value of AC voltage which appears at the electrodes of the valve, which, as already explained, will differ from the equivalent DC value marked at the switch position.

The Heater Voltage Switches

This dual switch combination is for adjustment of the heater voltage applied to the valve under test. To enable a very wide range of heater voltages to be obtained the settings of the two switches are arranged to be additive. Thus, with the right hand switch set at 0 all useful voltages between 1.1 and 16 can be applied to the valve by the left hand switch, whilst with the right hand switch at any figure above 0 the value indicated on the right hand switch should be added to the indication of the left hand switch. For example, with the left hand switch set at 5 and the right hand switch at 80, the heater voltage applied to the valve will be 85.

The Negative Grid Voltage Control

A continuously variable control calibrated 0—10 and marked **Neg Grid Volts** enables the initial negative bias at which a test is made, to be set at any value between 0 and — 10 volts, with the bias multiplier switch set at Vg × 1. With this switch set at Vg × 10 the bias range covered by this control is increased to 0—100V negative.

The Press Buttons

Immediately underneath the movement will be found a row of three buttons marked respectively **Gas, Re-Set** and **mA/V.** As their names imply these are for the indication of grid current, the re-setting of the automatic cut-out, and the direct reading of mutual conductance in mA/V after the initial valve test conditions have been set.

The **mA/V** button applies a small supplementary change of grid bias in a positive direction to the grid of the valve after the latter has been correctly set up in accordance with the data given in the "AVO" Valve Data Manual or alternatively, with the maker's characteristic details. The initial anode current having been obtained and the meter indication backed off by the backing off control, the pressing of this button will cause a rise in the anode current which will indicate on the appropriate meter scale the mutual conductance of the valve directly in mA/V. This test also serves as a comparison test of valve goodness in conjunction with the coloured meter scale and **Set mA/V.** control.

A change in anode current consequent upon the pressing of the **Gas** button will indicate the presence of grid current in the valve, the relative magnitude of which can be assessed from a knowledge of the mutual conductance of the valve and the change in current obtained.

When the presence of a damaging short causes the cut-out to operate, the lamps behind the meter will be extinguished and voltages will be removed from anode and screen circuits of the valve. After having investigated and removed the cause of the short the instrument may be put into operation again by the pressing of the **Re-Set** button, the correct condition being shown by the illumination once again appearing behind the meter scale plate.

The Set Zero Control enables an initial anode current reading for the valve to be backed off prior to the taking of mutual conductance readings, the direction of the control being such that an anti-clockwise movement of the knob will cause the meter needle to approach zero.

The Meter Selector Switch is a combination switch serving to shunt the meter suitably to the current measurement to be undertaken and also to insert the right value of load when making tests on rectifiers and diodes. It has two sets of calibrations, the outer ring of figures marked 100, 25, 10, 2·5 and mA/V is for use when the current selector is at position **Test,** and serves to indicate the full scale deflection current for the movement in milliamps when taking anode current figures, and similarly represents full scale reading in mA/V when taking mutual conductance figures. The last position marked **mA/V** indicates that the instrument is correctly switched for the use of the **mA/V Control** in conjunction with the coloured comparison scale on the meter.

The inner ring of figures marked 120, 60, 30, 15, 5, 1 represent the load current associated with the coloured scale when taking rectifier tests with the circuit selector on **Rec** or **Diode.** Thus if the valve is rated at say 60 mA per anode, the **Meter Selector Switch** should be turned to " 60 " on the inner ring of figures and the comparative goodness of the valve with reference to this basic figure will be shown on the coloured scale.

Note that when the **Circuit Selector** switch is set to **Diode** for testing signal diodes, the **Meter Selector** should always be turned to position " 1 " and the coloured scale then operates with reference to a load current at 1mA, a suitable figure for signal diodes. The 1mA setting of the **Meter Selector** does not apply to rectifier load tests with the **Circuit Selector** switch at **Rec.**

The Set mA/V Control, marked 1—15mA/V is for the rapid checking of the operative goodness of a valve on the basis of mutual conductance, after the valve has been set up for normal test, and the anode current backed off to zero. After the **Meter Selector** is turned to position **mA/V,** the **mA/V Control** should be turned to the rated mutual conductance figure for the valve in question. The pressing of the **mA/V** button will now cause the meter needle to rise and its position on the coloured scale will denote operative valve goodness.

The Anode Selector Switch marked A_1, A_2, S, enables separate tests to be made on multiple valves, and also makes possible the taking of Screen (or g_2) characteristics. With this switch turned to "A_1 ", the figures of anode current and mutual conductance shown on the meter are relevant to the anode designated on the set up roller by $^{6}_{A}$. As such the switch is in position for measurements on all single electrode system valves (triodes, pentodes, etc.). This position also serves for the first half of double valves (double triodes etc.) and for the triode or pentode section of multiple diode valves (double-diode-triode, etc.). A similar setting of this switch serves for the triode or oscillator section of frequency changers.

With the **Anode Selector** switch at position "A_2," the indicator meter will show anode current and mutual conductance associated with the second anode of double valves, the mixer anode of frequency changers and all anode systems associated with the set up figure $^{7}_{A2}$. In this condition the first anode is not left floating, but has the normal anode volts supplied to it via a limiting resistance.

With the **Anode Selector** set to " S ", the current meter is inserted in the screen (g_2) circuit of valves and screen current will thus be indicated. When making this test, anode voltage is automatically applied to all anodes in the valve. Note that in the case of a double pentode valve, the current indicated will be the combined current of both screens.

When the **Circuit Selector** is switched to position **Rec** and **Diode,** then positions "A_1" and "A_2" of the anode selector switch correspond to diode anode 1, and diode anode 2 respectively, i.e. : to the electrodes associated with the selector switch number $^{8}_{D_1}$ and $^{9}_{D_2}$.

The Special Adjustment Panel at the rear of Instrument

This will be uncovered by the removable plate at the back of the instrument and the following will be exposed to view.

(*a*) The coarse setting for the applied 50/60 ∿ mains voltage marked 100/115, 200/215, 220/230, 240/250, the setting being made by means of the plug on this small sub-board, to the tapping most nearly corresponding to the nominal mains voltage.

(*b*) The fuse holder cap which may be unscrewed revealing a small cartridge fuse which may be thus easily replaced if blown. The correct value for this fuse is 2.5 amp.

(*c*) The link shorting out two sockets for the insertion of resistance, meter or other load in the anode circuit.

GENERAL PROCEDURE FOR TESTING A VALVE

1. After having set the coarse mains voltage plug at the rear of the instrument to suit the supply voltage, connect mains lead to supply noting that red and black leads are live and neutral. The green or yellow lead is the Earth connection. Switch on and note that illumination appears behind the transparent meter scale. The valve to be tested should *not* be inserted at this stage.

2. Turn the **Circuit Selector** switch to position **Check (C)** and **Electrode Leakage** switch to position " ∿." The instrument needle should now rise and assume a position near the black region of the insulation scale denoting zero ohms. Rotate the **Set** ∿ control until the meter needle assumes its nearest point to the red line in the middle of this black scale marking. With a correct settings of the initial mains voltage adjustment rotation of the **Set** ∿ control should enable the needle to be moved on either side of the red arrow. If this is not the case and rotation of the **Set** ∿ control does not enable the needle to reach its setting mark from either direction, then the initial mains setting should be moved to the next appropriate tapping. This tapping should be higher than the one chosen if the needle always appears to the right of the red mark and lower if to the left.

3. Having set up the accuracy of the instrument to conform to the applied mains voltage, refer to the "AVO" Valve Data Manual, or alternatively to the maker's characteristic data for the valve and set up the appropriate valve holder connections on the Valve Panel selector switch as already explained.

Set the heater voltage switch to its correct value for the valve and insert it in the appropriate valve holder, without moving the **Circuit Selector** switch from its position **Check (C).** Rotate the **Electrode Leakage** switch through its various electrode positions starting with the extreme counter clockwise position marked " H ". At position " H " the meter should show a short, thus indicating heater continuity. Thereafter any reading obtained on the insulation scale of the meter will show an electrode insulation breakdown corresponding to the electrode indicated by the Electrode leakage switch setting. (Thus a reading on the meter of 1 megohm when the **Electrode Leakage** switch is set to position " G_1 " and position " S " will indicate that a cold insulation breakdown of 1 megohm is occurring between the grid and screen electrodes of the valve.) It will be noted that wherever electrode leakage occurs, indication of this will be shown at two positions of the **Electrode Leakage** switch, because, obviously, leakage must occur between two points. In the case of breakdown to heater from any other electrode, such leakage indication will only occur at one switch setting subsequent to the initial selector setting, which should automatically show zero ohms to denote heater continuity.

4. Having ensured that no cold leakage path of any magnitude is present in the valve to be tested turn the **Circuit Selector** switch to **Check (H).** Allow a few moments for the valve

heater to warm up and note if any meter deflection occurs. Such a deflection would denote in megohms the amount of insulation breakdown that occurs between cathode and heater strapped and all other electrodes of the valve when heater voltage is applied. Note that if, for any reason, the **Circuit Selector** switch is turned back to **Check (C)** there will, in all probability, be an indication of an apparent cold electrode insulation breakdown between a number of the valve electrodes. This need not be the cause and the reading will be found generally to disappear after a few moments. The reason for such an indication is obvious when it is realised that the valve cathode has been heated during the **Check (H)** test. When returning to the **Check (C)** position, therefore, the cathode is hot and still emitting. What appears to be a temporary electrode breakdown, therefore, is in fact the indication of emission which disappears as the heater or cathode cools.

5. Turn **Circuit Selector** switch to **C/H. ins** when any cathode to heater insulation breakdown which occurs with the heater hot will be shown on the insulation resistance scale of the meter. No set rule for the rejection of a valve on this score can be laid down, but it will be realised that in many circuits where an appreciable potential exists between heater and cathode such as, for instance, in cathode follower circuits or DC valve amplifiers, the presence of a heater to cathode breakdown of the order of megohms can often give rise to quite serious trouble. Heater to cathode insulation breakdown, either permanent or variable, can also give rise to noise in valve amplifier circuits. If, on the other hand, the value of cathode to heater circuit resistance is only of the order of a few hundred ohms, as for instance where cathode biasing is used with high slope valves, then a cathode to heater insulation breakdown of the order of fractions of a megohm need not give rise to any serious trouble.

6. The next test normally to be made upon the valve is the measurement of some or all of its mutual characteristics. This may take the form of the complete plotting of one or all of its characteristics, or the measurement of its mutual conductance, or the comparative testing of the valve on the basis of its mutual conductance. All these require the manipulation of the main voltage and meter controls and, before such a test is undertaken and the **Circuit Selector** switch turned to position **Test,** one should be assured that all the requisite controls are correctly set. This applies to the setting of the anode, screen and grid voltage controls, the **Meter Selector** and the **Anode Selector** switches. *In particular, where the probable anode current of the valve is unknown, the* **Meter Selector** *should be set to 100mA to avoid damage to the movement, if the current flowing is such as to be considerably higher than that catered for by the lower meter range positions.* It is always perfectly simple and safe to set the **Meter Selector** at successively lower full scale current deflections to cater for a valve, the anode current of which is less than that which can be appropriately read on a higher range. If the reverse procedure is adopted, however, then it is quite possible that a damaging current may have passed through the meter circuit before the latter is set to a suitable high range. The procedure for taking the necessary valve measurements is then almost self explanatory.

Where only a measurement of mutual conductance is required then the data for this can be taken from the "AVO" Valve Data Manual. The electrode voltage settings should be made as indicated and consequent upon such settings an initial anode current will be shown on the meter which has been finally set to a suitable range. This anode current reading should normally be compared with the anode current reading shown in the tables, as it will give an initial indication of the valve " goodness ". Quite obviously if a valve shows an anode current reading considerably below that which is appropriate for the applied electrode voltages, then its emission is much lower than would normally be expected and in normal circumstances the valve will not function at full efficiency. More particularly