does this apply in the case of valves used either as oscillators or output valves, for in both conditions the valve has to deliver an appreciable power which cannot obviously be up to standard if the emission is low. At the same time care should be taken not to jump to false conclusions on this basis when testing valves of very high slope and short grid base, where it may be possible to double the valve anode current for a change in bias of some ·25V, and a very slight variation in the valve characteristics may give rise to an erroneous impression of the valve's " goodness " on the score of anode current. After having obtained the initial anode current reading and obtained therefrom such information as is desirable, this anode current indication may now be backed off to zero by the **Set Zero** control and the **Meter Selector** switch re-set to a range appropriate to the expected reading of mutual conductance. By pressing the **mA/V** button the mutual conductance of the valve will then be directly indicated on the meter, the reading in milliamps obtained being indicative of the mutual conductance in mA/V.

Alternatively, where it is not necessarily required to obtain a precise reading of mutual conductance, but merely a gauge of the valve's goodness factor on the basis of mutual conductance, then after backing off to zero the **Meter Selector** should be set to position **mA/V** and the **Set mA/V** control set to a value corresponding to the standard mutual conductance reading for the valve. On pressing the **mA/V** button the comparative goodness of the valve will then be shown on the coloured scale which is divided in three coloured bands. All valves coming within the green portion can be taken as satisfactory. Valves in the red portion are suitable for rejection, whilst the small intermediate band between the green and red portions denotes a valve which, whilst not entirely unsatisfactory, is not by any means working at its full rated efficiency. Subsequent action on the valves whose test figures come within this band will obviously have to be related to the particular requirement of the moment.

Where more comprehensive tests of the valve are required, to assist in the solution of development or more intricate test problems, the plotting of one or a family of mutual characteristics can often give a much more complete answer. This may readily be undertaken with the **Valve Characteristic Meter** and is performed with the **Circuit Selector** in its position **Test**. The manipulation of the controls subsequent to the obtaining of the initial anode current readings is not of course required, it being merely necessary to plot the value of the appropriate electrode currents as read from the meter, against the settings of the associated electrode voltage switches. Ia/Vg_1 curves will be taken at a pre-determined setting of anode and/or screen volts, the reading of the anode current obtained being plotted against the settings on the variable grid bias control. Similarly Ia/Va curves will require a fixed setting of grid bias, anode current being plotted against the settings of the anode voltage switch.

Where either mutual conductance characteristic curves are required for the screen or g_2 of the valve in question, then the **Anode Selector** switch should be set to position " S ", the meter current shown will be an indication of the screen (or g_2) current and all the above instructions can be related thereto.

Remarks in relation to the tests described above as applied to multiple or special types of valve, will be found in subsequent test notes.

7. Where a valve is suspected of passing too much grid current, a measure of the magnitude of grid current at the desired conditions of applied electrode voltage may be made after having measured the mutual conductance of the valve in question. After having set the valve up and backed off the anode current to zero as for mA/V test, the button marked **Gas** should be pressed. Any grid current flowing will set up a DC grid voltage across the 100,000 Ω resistance introduced into circuit. This will result in a change in

anode current (usually forward) dependent upon the polarity of the voltage developed across the resistor. The value of the grid current flowing will then be calculated from the formula

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

where $\triangle$Ia is the anode current change, and g is the mutual conductance in mA/V. The direction of anode current change will denote the nature of the grid current flowing.

8. The testing of rectifying valves should really be associated with the requirements of the circuit in which these valves are to work, although in most cases, in the data for the valve in question a figure is quoted denoting the standard emission to be expected for a valve of the type under test. The procedure for carrying out the test is again straightforward. All initial tests should have been carried out as for amplifying valves, but instead of setting **Circuit Selector** to **Test** for the measurement of mutual characteristics, the circuit selector should be set to position **Rec** after having turned the **Meter Selector** to a load current range appropriate to the valve. This load current, it will be realised, applies to one anode only. The setting of load current can either be determined from the tabulated data as already mentioned, or alternatively can be related to the total current that the valve is required to deliver. Thus in a piece of apparatus where the total HT current drawn is say 50mA, then a rectifier load current setting of " 60 " will be an adequate test for the valve emission (assuming half wave rectification.)

Alternatively, if the valve is a new one, the maker's rating for maximum load current can be used as the basis for the setting of the meter range switch. It will be realised that since each half of a full wave valve is tested independently, then the setting of the range switch should indicate half the total value of current that the valve would be expected to deliver in a full wave circuit. For instance a valve rated at a maximum current of 120mA would be tested with each anode at the " 60 " position on the **Meter Selector.** No further manipulation of the electrode voltage controls is required. The heater voltage is already set whilst anode, grid and screen voltage controls are completely dis-associated from the test circuit by the setting of the **Circuit Selector** switch to **Rec,** all appropriate voltage and circuit connections also being automatically made. Having, therefore, correctly set up the valve as explained, the indication of the meter needle on the coloured scale will show the operative goodness of the valve in relation to the standard load current chosen.

Similar remarks apply to the testing of signal diode valves, with the exception that these are always tested with the **Meter Selector** at " 1 " and the **Circuit Selector** at position **Diode.**

INSTRUCTIONS FOR TESTING SPECIFIC VALVE TYPES

The function of a valve, as distinct from its manufacturer's type number is indicated by a symbol in the form of letters appearing at the extreme right of the test data ; thus a half wave rectifier would have the letter " R " in the function column, whilst a full wave rectifier would be designated by " RR ". Similarly, diode valves will be shown by the letter " D " the number of diode elements being indicated by the number of " Ds ", thus " DDD " refer to a triple diode.

The testing of *multiple diodes or rectifiers* is carried out in the manner already explained, the **Anode Selector** switch being used to select the diode or rectifier element, the emission figure for which, being indicated on the meter. It will be realised that when dealing with diodes or rectifiers A_1 and A_2 positions of the selector switch represent diode or rectifier anodes 1 and 2 respectively and correspond to figures 8 and 9 in the set up figure.

In the case of **triple diodes** since only two anode systems are normally catered for, a special procedure is adopted in the set up figure. At the position in the set up number representing the third diode the symbol † is included, the first and second diodes being indicated by 8 and 9 respectively in the normal way. The valve should now be tested normally with the selector switch set to 0 where the † appears in the set up number. This will give emission figures for diodes 1 and 2. Now rotate the **Selector Switch** rollers so that the two rollers originally set at 8 and 9 are now set to 0 and set up the position † as 8 on the selector switch. A further test with the anode selector switch at A_1 will thus give the emission of the third diode, e.g., AAB1 will be indicated in the data as 0231†0980. To test diodes 1 and 2 the set up on the roller switch will be 023100980 and diodes 1 and 2 will be tested in the normal manner. For obtaining the emission figure for the third diode the **Selector Switch** will be altered to 023180000 and the **Anode Selector** to position A_1.

Double Triodes or Double Pentodes will be indicated by the letters "TT" or "PP" in the type column and will be tested in the normal way for each half of the valve, selection being made by the rotation of the **Anode Selector** switch to A_1 or A_2 corresponding to set up figures 6 and 7.

Combined Diode and Amplifying Valves will be represented in the type columns by "DT" and "DDT" for diode triodes and double diode triodes, whilst "DP" and "DDP" indicate diode pentodes and double diode pentodes. The testing of such valves is automatic, the amplifying section being tested first with the **Circuit Selector** switch at position **Test** and the **Anode Selector** at position "A_1" whilst the rotation of the **Circuit Selector** switch to the **Diode** position will automatically set the instrument in readiness for testing one or both the diodes with the anode selector at A_1 or A_2 respectively, with the **Meter Selector** set to "1".

Frequency Changers of the Heptode, Hexode class employing the normal oscillator section as a phantom cathode for the mixer section are not very satisfactorily tested in two Sections, as the nature of the valve construction is such that each section is dependent on the other for its correct operation. For test purposes therefore, this valve is shown connected as an HF pentode for which, where possible, anode current and/or mutual conductance figures are given. Such valves are indicated by the letters "H" in the type column.

An exception to this class of valve is the **Octode** designated by "0" in the type column which, as will be seen from the data, is tested as if it had two separate electrode assemblies, separate data being given for each. In this case the oscillator section is tested with anode selector at A_1 and the mixer section at A_2.

As a further test to ensure the probability of such a valve oscillating satisfactorily, an indication of failing emission will possibly give the most useful results. It will be realised that when a valve is up to standard its cathode will develop its full emission at the rated heater voltage for the valve, and any change in the cathode temperature will not result in a corresponding change in the emission. If, however, the cathode's emission is failing, then an increase or decrease in the cathode temperature will result in a noticeable change in the emission for the valve. When a valve is oscillating it tends to run into the positive grid region, and thus makes use of the full emission capabilities of the cathode. Any failing emission will limit its utility in this respect. As a subsequent test, therefore, on a valve designed to be used as an oscillator, it is helpful to note the anode current at the rated test figures with the normal heater voltage applied and then decrease the heater voltage by about 10 to 15% (the next tapping on the selector switch) for a short period. In the case of a valve with failing emission this will result in an excessive decrease in the anode current considerably greater than the percentage decrease in heater volts. Such a result would suggest that the valve will not oscillate very satisfactorily. A negligible or small decrease in anode current (or of the same order as the heater volts change) will show that the valve is developing its full emission at the rated heater voltage, and provided that the circuit conditions are right it should oscillate normally.

Frequency Changers employing separate electrode assemblies for oscillator and mixer functions are designated by " TH " (Triode Hexode) " TP " (Triode Pentode). The separate sections of this valve are not interdependent, as in the case of the phantom cathode types, and they can thus be tested in two separate sections as a pentode or triode respectively. This arrangement is catered for in the set-up figures given, 6 corresponding to the triode section and tested with the **Anode Selector** at A_1 whilst 7 in the set up figure corresponds to the mixer section which is tested with the **Anode Selector** at A_2. The figures to be expected from both halves of the valve are given in the tables where available, but it is often informative to apply a test for failing cathode emission to the triode or oscillator section in the manner already described.

In the case of normal triodes and pentodes (including beam tetrodes) the test procedure for which has already been fully outlined, the type column will show the symbol " T " and " P " respectively.

THE USE OF THE LINK ON THE BACK PANEL OF THE INSTRUMENT.

This link is to enable a load to be inserted into the anode circuit of the valve under test when an anode current or mutual conductance test is being performed on the electrode circuit in question. It thus enables dynamic figures for the valve or electrode system concerned to be obtained, the procedure being to remove the shorting link and insert across the sockets a resistance or other load which it is desired to include in circuit.

Tuning indicators (Magic Eyes) are tested with the controls set according to the figures given in the separate data table, using the screen switch for obtaining target voltage and inserting the anode load, shown in columns marked " Ra " by means of the link at the rear of the instrument. At the approximate bias given in the table the triode section should be at cut-off and the " eye " fully closed. On varying the grid bias to zero the " eye " should open fully and the value of anode current should be approximately that appearing in the table. In the case of double sensitivity indicators giving multiple images responding to different sensitivities, two sets of data (where possible) are given, the first set referring to the more sensitive indication.

Gaseous Rectifiers

These also necessitate the use of the link, as such valves would normally pass a damaging current if tested without suitable limiting load in the anode circuit. They are, therefore, tested not on the rectifier or diode test circuit, but with the selector switch turned to **Test,** anode voltage and representative anode current figures being given in the Valve Data columns. The value of load resistance (of suitable wattage) which must be included across the link, before the valve is tested, is shown in K Ω in the " mA/V " column (which would not normally apply to a rectifier valve). Full wave examples of this class of valve are of course tested at anode selector switch positions A_1 and A_2.

Cold Cathode Rectifiers designated by the symbol " CCR " can be tested in a similar manner, the anode voltage, approximate anode current, and load resistance being given in the data columns as above.

Thyratrons can be checked by comparison if set up as a normal triode, with a limiting resistance included in the link, the control ratio being indicated by a comparison between the peak value of the applied anode voltage, and the setting of the grid bias control which will prevent the valve striking and passing anode current. It must be emphasised, however, that the main value of such a test is in comparison only, as the hold off grid bias value shown on the grid bias control is only approximately half that of the bias which would normally be required to hold off the anode current of the valve at the peak anode voltage in question.

Neon Indicators may be tested for striking, by setting up the roller switch so that anode and cathode pins of the tube are set to 6 and 1 respectively, all other rollers being connected to 0. A suitable load resistance (normally between 5,000 and 15,000 ohms) should be included in the anode circuit link and the anode voltage switch should be set to a peak value as near as possible to (and in no cases lower than) the striking voltage of the neon in question. The striking of the neon will, of course, be indicated by a passage of anode current shown on the meter which should be set at a suitably high current range. It should be noted that where the anode voltage refers to the peak applied voltage, as in the case of thyratrons and neons, the actual peak voltage applied to the valve is higher than the indication on the anode voltage switch. To obtain the peak voltage equivalent to a given setting of the anode voltage switch the figure shown on the switch should be *multiplied by approximately 1·5 ; thus with the anode voltage switch set to represent a* DC voltage of 100V. the peak applied voltage is approximately 150V.

GENERAL PRECAUTIONS TO BE OBSERVED WHEN USING THE VALVE CHARACTERISTIC METER

It will be realised that when dealing with an instrument such as the Valve Characteristic Meter with such flexibility of control, it is almost impossible to protect the instrument to such an extent that the operator cannot cause damage to either the valve or the instrument by some combination or wrong setting of the controls or incorrect use of the meter. It is, therefore, important that the correct procedure, as previously outlined, should be used in the sequence of the tests applied. Valves should be tested for insulation or breakdown before full voltages are applied for characteristic tests. Where any doubt whatever exists as to the probable electrode current likely to be passed, the **Meter Selector** switch should always be turned to its highest current range and then gradually reduced in order to facilitate reading of the current.

In experimental work where a variable voltage is required to be supplied to the anode or screen electrodes of the valve, always start with the lower voltage tappings and increase only after correct adjustments have been made to the meter selector circuit to ensure that the meter circuit is not thus overloaded by an unknown current. Always make sure that the selector voltage switches have been correctly set for the valve before the instrument is switched on. In this respect it is a good practice to return the selector voltage switches to zero (particularly Heater Voltage switches) after a test has been applied and before a new valve is inserted.

Take care in setting the selector switch to avoid wrongly connecting the electrodes of the valve under test. In this respect the automatic cut-out is advantageous in that it will usually save a valve if high tension voltage is inadvertently applied to the heater by incorrect setting of the switch, but it must be pointed out that after the switch is correctly set *nothing can save the heater from being burnt out if an overload heater voltage is applied by wrong setting of the heater voltage switches.*

Do not apply test voltages to the valve without ensuring that where necessary top cap connections have been correctly made, as a valve can often be irreparably damaged by running it with its grid or its anode wrongly connected.

Where a valve appears to be performing abnormally, as indicated for instance by a continuously rising or falling anode current which does not attain a condition of stability, do not leave the valve " cooking " for a long period to see what will ultimately happen, as this will in all probability result in the damaging of the valve due to excessive currents in the anode or screen circuits. In general, it is not necessary or helpful to leave a valve on test for a considerably longer period than is necessary to complete the test in question.

Finally, it must be stressed that whilst every care has been taken in the compilation of this publication and the "AVO" Valve Data Manual to ensure that all data given is correct as far as is known at the time of going to press, it is not impossible that with the many thousands of figures involved, errors will have crept in. The manufacturers cannot hold themselves responsible for any damage that might occur to a valve or to the instrument from such a cause.

NOTES ON SIMPLE MAINTENANCE OF INSTRUMENT

If on switching on the instrument and performing the usual test for applied mains voltage, the meter needle does not indicate, and the lamps behind the movement do not light, then it can be assumed that the cut-out has operated. This can have been caused by either an internal or external short circuit that has occurred previously to switching on, or by a sharp mechanical shock that can have jolted the relay. The cut-out is reset by pushing the "reset" button.

Alternatively, the fuse may have blown.

First remove the mains plug and check the fuse for continuity and if necessary replace with Belling Lee type L.562/2·5 rated at 2·5 amps. Then replace the mains plug and re-set the cut-out. If the cut-out again blows, examine for an external short on the top panel. Failure due to an internal short circuit should be reported to the Company.

If the lamps do not light but the test for mains voltage shows a normal deflection, then one or both the lamps (they are in series) may have been blown. They should be removed after having removed the mains plug by withdrawing the mounting bracket through the aperture in the rear of the instrument and faulty lamps replaced with Osram type 6·5 volt 0·3 amp S.E.S. fitting (or equivalent).

It is highly probable that due to variations in manufacture, a number of valves will show test figures differing widely from their normal ratings. If, however, all valves appear to be reading consistently low or high by a large percentage then it is probable that either the applied voltages or the movement sensitivity are at fault.

These can be checked without opening the instrument, as follows :—

First check the grid volts between the grid and cathode sockets of a valveholder using an electronic or other D.C. voltmeter imposing negligible load. Then with any given setting of the grid voltage control, the mean D.C. reading obtained between grid and cathode sockets should be $0{\cdot}52 \times$ the nominal setting of the grid control and this should be maintained over the full span of the control.

Thus with the control set at -6 volts, the valve voltmeter reading should be $-3{\cdot}12$V mean D.C., from grid to cathode.

Similarly, the pressing of the button marked mA/V should result in a positive voltage change of 0·52V DC.

Thus with the grid voltage set as above and the button pressed, the valve voltmeter should read $-2{\cdot}6$V i.e. $(-3{\cdot}12 + 0{\cdot}52)$.

Similarly, the applied anode and screen voltages may be checked by taking a reading between anode (or screen) and cathode sockets of a suitably set up valve holder with an ordinary AC voltmeter. These can be compared with the appropriate anode or screen voltage switch setting as follows :—

$$\text{Nominal voltage (D.C.) setting of switch} = \frac{\text{AC voltage apparent at Valve Holder}}{1{\cdot}1}$$

Finally the accuracy of the movement may be checked by inserting a valve in the Valve Characteristic Meter correctly set up for test and introducing a suitable multirange DC milliammeter across the link on the back panel. On switching on, the current reading obtained on the Valve Characteristic movement (read in conjunction with the meter range switch) should be exactly twice the current reading on a suitable range of the milliammeter inserted into the link.

If any or all of the above relationships do not hold good after mains voltage has been correctly set, the following procedure should be adopted.

(*a*) If anode or screen volts do not come within approximately $\pm$ 5% (allowing for any possible error in the meter. N.B.—BS I allows $\pm$ 3½% of f.s.d.) of the required relationship, consult manufacturer.

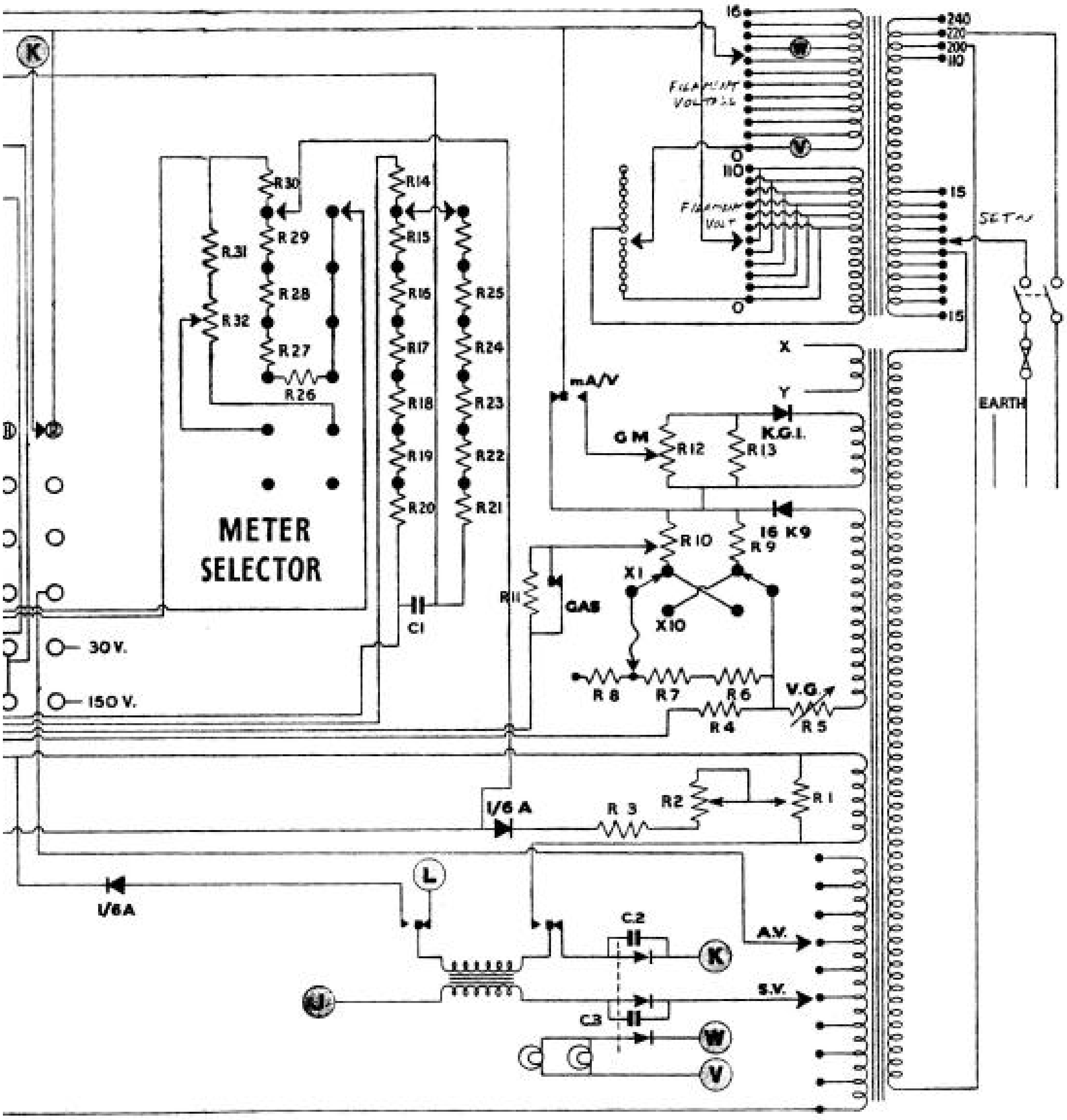
(*b*) If variable grid voltage does not compare with correct V.V. reading :—Remove case of instrument and adjust control marked V.G. on small sub-panel on frame of instrument.

(*c*) If a wrong voltage change is obtained when pressing button marked **mA/V**—adjust pre-set control marked G.M. until correct change obtained.

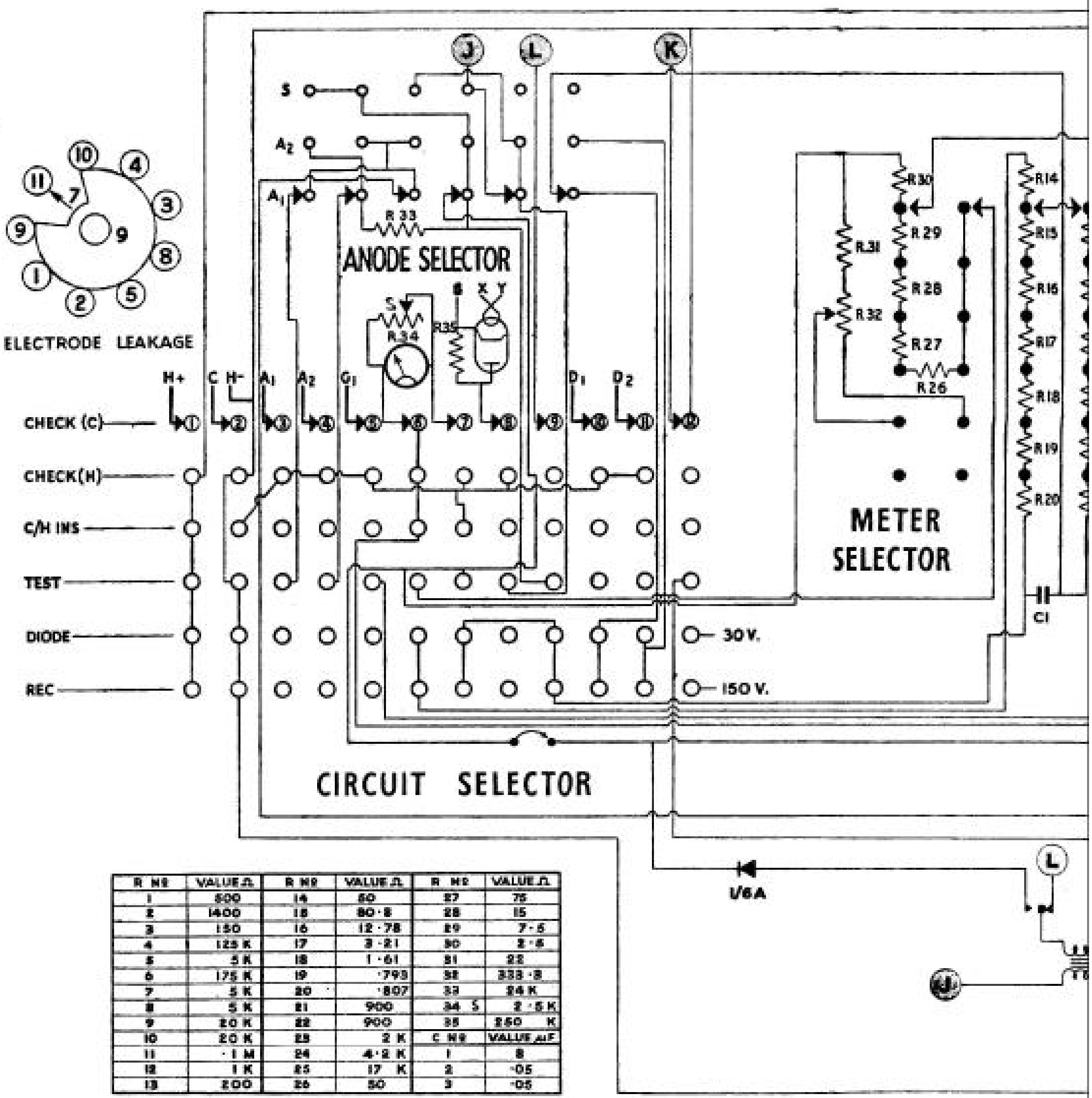
(*d*) Wrong relationship between panel movement and external milliammeter—adjust pre-set control marked " S ", and then recheck mains setting, electrode voltages and meter sensitivity.

When making test measurements as described above, it is of course essential for the user to assure himself that he is not misinformed as to the accuracy of his Valve Characteristic Meter by the use of unsuitable or inaccurate external test instruments. Thus when measuring grid volts, the DC Valve Voltmeter used should have an input resistance of at least 100 times the internal resistance of the grid voltage circuit (which is 20,000Ω), whilst when checking for accuracy of screen voltages, it must be remembered that a subsidiary rectifier (see page 12) is always in circuit, and thus an AC Voltmeter having a resistance not less than 1,000 Ω per volt should be used. The accuracy of all similar measurements should be related to the probable error in the measuring instrument which should of course always be high grade.

Enclosed within this publication will be found a quick reference guide to the operation of the Valve Characteristic Meter which is intended only to be used once the instructions within this book have been assimilated.



K
16
W
FILAMENT VOLTAGE
O
V
110
15
FILAMENT VOLT
SET V
O
15
240
220
200
110
X
Y
EARTH
R30
R29
R28
R27
R26
R31
R32
R14
R15
R16
R17
R18
R19
R20
R25
R24
R23
R22
R21
METER SELECTOR
C1
30 V.
150 V.
mA/V
GM
R12
R13
K.G.I.
16 K9
R10
R9
R11
GAS
X1
X10
R8
R7
R6
V.G.
R4
R5
I/6 A
R 3
R2
R 1
I/6A
L
C.2
K
A.V.
S.V.
C.3
W
V



R Nº	VALUE Ω	R Nº	VALUE Ω	R Nº	VALUE Ω
1	500	14	50	27	75
2	1400	15	80·8	28	15
3	150	16	12·78	29	7·5
4	125 K	17	3·21	30	2·5
5	5 K	18	1·61	31	22
6	175 K	19	·793	32	333·3
7	5 K	20	·807	33	24 K
8	5 K	21	900	34 S	2·5 K
9	20 K	22	900	35	250 K
10	20 K	23	2 K	C Nº	VALUE µF
11	·1 M	24	4·2 K	1	8
12	1 K	25	17 K	2	·05
13	200	26	50	3	·05