VT MULTIMETER

MODEL VTM

INSTRUCTION MANUAL

PATON ELECTRICAL PTY. LTD.

90 VICTORIA STREET,

ASHFIELD, N.S.W.

Telephone UA 1923, UA 1960, UA 1982

SCHEDULE OF INSTRUCTION

Section 1. – List of Equipment

Item 1. One Palec V.T. Multimeter

Model V.T.M., Complete with valves and battery.

Dimensions:	Length 14 inches. Height: 8 ¾ Inches. Depth 7 ½ inches.
Weight	16 lbs.

Item 2. One A.C. voltage probe and cable complete with valve.

Item 3. One D.C. probe and cable.

Item 4. One pair test leads with clip.

Item 5. One Instruction Manual.

Section 2 **DESCRIPTION .**

2.1 Purpose.

The "PALEC" VT. Multimeter Model V.T.M. is an instrument for measuring D.C. and A.C. voltage and ohms over a wide range. Voltage is measured with a minimum of loading on the circuit. Provision is made for the measurement of high frequency A.C. voltage by locating a diode rectifier assembly in a probe on an extended lead. Effect of line voltage on calibration and zero setting has been reduced to a minimum.

2.2 D.C. Ranges.

The following D.C, ranges are incorporated

D.C. volts	0-2.5
	0-10
	0-25
	0-100
	0-250
	0-1000

The input impedance on all D.C. ranges is 11 megohms shunted by a capacity of less than 1µµf. Accuracy of indication is ±2% of full scale on all ranges.

2.3 A.C. Ranges.

The following A.C. ranges are incorporated

A.C. volts	0-2.5
	0-10
	0-25
	0-100
	0-250
	0-1000

The input impedance is approximately 6 megohms shunted by a capacity of 10 µµf.

The A.C. volts measurement circuit uses a diode rectifier of the peak reading type and the meter scale has been calibrated in R.M.S. values of a sine wave. The frequency response is within ± 6% from 30 cycles to 100 Mc/s., referred to the 50 cycle value, when direct connection is mode to the probe terminals. Accuracy is ± 3% of full scale deflection at 50 cycles

2.4. Ohms Ranges.

The following ohms ranges are included

1 - 1,000
10-10,000
100-1001000
1,000-1 megohm
10,000-10 megohms
1 megohm - 1,000 megohms

Ohms may be measured from 1 ohm to 100 meg ohm- with an accuracy of 15% Values up to 1,000 megohms may be measured with reduced accuracy, which is due principally to the crowding of the scale at the high resistance end.

2.5 Stability.

Particular care has been taken in the design of the instrument to assure stability. Due to the circuit employed, both zero setting and indication are substantially independent of mains voltage fluctuations of 10%. Zero setting is identical on all ranges of volts and ohms, and once set should require no readjustment. On the 2-5 volts A.C. range, however, the variation in contact potential of the diode rectifier causes the zero to change slightly with large mains voltage changes.

The circuit provides that the input tube is operated an a low plate voltage as well as a reduced heater voltage. Under these conditions, anode current in this stage is independent of the resistance connected between the grid and earth, at least up to a resistance value of 10 megohms Zero setting is, therefore. independent of the resistance across which the input of the instrument is connected and zero errors normally introduced by the passage of gas current, etc~, through the input resistance are eliminated.

Section 3 - PRINCIPLES OF OPERATION.

3.1 Figure 1 Is a Schematic Circuit Diagram.

The instrument comprises

(1) a bridge circuit with indicating meter,
(2) a balanced cathode follower stage driving the bridge,
(3) a high resistance voltage divider to provide the various ranges,
(4) a diode rectifier for the measurement of A.C. voltage,
(5) a battery and suitable resistances for the measurement of ohms, and
(6) a power supply.

3.2 Bridge Circuit and Cathode Follower Stage.

The 6SN7GT Valve V3 is used in a bridge circuit and actuates the meter. The meter is connected in series with the calibration resistors and between the cathodes of the two sections of this valve. The anodes at this valve are connected together by the 1,500 ohm zero set potentiometer R.34 and the rotor of this potentiometer is connected to the positive side of the power supply. The potentiometer provides a means of balancing the current through the two sections of the valve, thereby providing zero current through the meter. The 40,000 ohm resistors R.32 and R.33 are connected in the cathode circuits of this stage to provide load resistances, and their junction is returned to the negative of the power supply.

A further 6SN7GT Valve VZ provides the voltage for the grids of V3, and is used in a balanced cathode follower circuit with 5 megohm resistors as cathode loads. The cathodes arc direct coupled to the grids of V3. Plate voltage for this valve has been reduced to a low value by the use of the voltage divider R.20-R.24 across the power supply. A voltage of 15 is normal applied between cathodes and plates.

One grid of this valve is returned to ground for D.C. and ohms through the switches S56-7, while the other grid is by-passed to ground by a .01µf condenser C2 and coupled to the input circuit through 5 meg-ohms resistor R16. This resistor-condenser circuit provides that any A.C. which may be present with the D.C to be measured will be largely removed.

3.3 Voltage Divider.

As the bridge circuit is adjusted to provide full scale deflection of the meter for 2.27 volts D.C. on the grid of V2 it is necessary that voltages greater than this be reduced in the correct proportion before being applied to the valve. A divider of 10 megohms total resistance and composed of resistors R2 – R7 is used for this purpose.

3.4 D.C. Probe.

When the Instrument is used for the measurement at D C voltage, the voltage to be measured is applied between one end of the divider and ground and switch 5.4 selects a tapping to provide the range required. Connection to the Instrument for D.C. volts measurements is made by a shielded cable to prevent stray pick-up. In the test prod mounted on this cable is a 1megohm non-inductive resistance, across which the capacity is less than 1 µµf. The inclusion of this resistor reduces the voltage input to the bridge by 9%, 50 that 2.5 volts at the test prod provides full scale deflection. The inclusion of the resistor in the probe provides that the capacity of the cable is largely isolated from the circuit under test.

3.5 A.C. Probe.

The Instrument is designed for the accurate measurement of high frequency voltage, and it has been necessary to mount the diode rectifier used for this purpose on an extended cable. The EA50 diode V1 is used in a shunt circuit, the load being composed of the 5 megohm resistor R1 and the voltage divider R2-R7. The A.C. component from the diode is by-passed by .01µf condenser C1. The diode anode is coupled to the probe live terminal through .02µf condenser C5, and care has been taken to provide a low inductance return from the cathode to the earth terminal on the side of the probe. On the lower A.C ranges it is necessary to provide a means of canceling the contact potential present at the anode of the diode. A resistor R22 has been included in series with the negative side of the power supply voltage divider, and the voltage developed across this resistor S applied to the normally earthed grid of valve V2 to return the bridge to balance on these ranges.

3.6 Ohmmeter Circuit.

On the ohms position the bridge is adjusted to provide full scale deflection for 3 volts D.C. between the grid of V2 and ground. Voltage for this Purpose is provided by the battery B1, which is connected to the grid of V2 through appropriate resistors. Potentiometer R26 is used in series with the meter and provides a means of bringing the instrument to zero on the ohms scale as the battery ages. Resistors R8-R12 and R2-R7 have been provided which give centre scale ohm values as under.

R8	10 ohms
R9	100 ohms
R10	1,000 ohms
R11	10,000 ohms
R12	100,000 ohms
R2-7	10 megohms

The ohms scales have adequate overlap and measurement to better than 5% is usual, except where the scale becomes crowded above 100 megohms.

3.7 Power Supply.

The power Supply provides voltages of approximately ±250 volts with respect to ground. A transformer delivering 800 volts centre tapped is used with a 6X5GT rectifier to supply these voltages.

The primary of the transformer is tapped at 220, 240, and 260 volts to provide satisfactory operation over a range of power line voltages.

The instrument may be operated from a 6 volt accumulator by the use of the Palec Vibrator Power Supply.

Section 4 - OPERATING INSTRUCTIONS.

4.1 Installation.

The V.T. Multimeter is supplied with all valves fitted ready for use. Normally the instrument will be supplied with the power cable connected to the 240 volt tapping on the power transformer.

4.11 Valves.

The following valves are supplied with the instrument, and are fitted in their sockets

Valve Type	Function	Location.
6X5GT.	Power rectifier	On right of power transformer.
6SN7GT	Voltmeter bridge	On left of power transformer at rear of chassis
6SN7GT	Cathode follower	On left of power transformer
EY51	A.C. Voltage rectifier	Within probe housing.

4.2 Operating Controls.

The instrument is simple to operate, the function of all controls and sockets, etc., being clearly marked on the front panel.

4.21 Function Switch.

To the left of the meter a function switch is provided having four positions, viz.: "+ DCV", "- DCV," "ACV" and "Ohms."

When this switch is on the - DCV" position, the meter will read normally, the D-C. probe being positive and the "Common" socket negative. As the "Common" socket of the instrument is normally grounded through the power lead, and as it is often necessary to read negative D.C. volts with respect to ground, provision has been made on the function switch to reverse the connections to the meter by placing the switch on "-DCV." In this position, negative voltage will be indicated normally.

The third position of the function Switch connects the A.C probe to the instrument, and A.C. voltages may now be measured by applying them between the two probe terminals or between the active terminal at the end of the probe and the "Common" socket on the panel.

The fourth function switch position, namely "Ohms" applies the 3 volt battery to the circuit for the measurement of ohms. Measurement of ohms is made between the "Common" and "Ohms" sockets with the leads supplied.

4.22 A.C. Volts Connector.

The probe used for the measurement of A.C. volts may be removed from the instrument by loosening the locking ring and removing the plug from the 2-pin socket on the lower left-hand side of the panel.

4.23 Zero Adjustment.

A knob is provided beneath the left-hand side of the meter for adjustment of zero.

To set up the instrument for operation, the mechanical zero adjustment on the meter itself should be accurately set with the power turned off. The power should then be applied, and after allowing about 30 seconds for the valves to reach operating temperature, the zero adjustment knob may be adjusted to provide zero reading on the meter with the function switch in the "+DCV" position. This setting will be found to hold for all ranges of D.C. and A.C. volts. Care should be taken when making this adjustment that the D.C. and A.C. probes are not in the vicinity of strong fields, otherwise pick-up resulting may cause incorrect zero setting. The input to the respective probes may be short circuited, thus guarding against pickup without effect on the zero settings.

4.24 Ohms Adjustment.

A knob is provided beneath the right-hand side of the meter for the adjustment of ohms zero. When the function switch is placed on the "Ohms" position, it will be found that the meter will read a percentage of full scale, provided that the "Ohms" and "Common" sockets ore not connected together. It is recommended that ohms zero adjustment be made with the test lead removed from the "Ohms" socket to prevent the possibility of stray pick-up. The ohms zero setting will be found to be identical for all ranges of ohms.

4.25 Range Switch.

A six position range switch is provided to the right of the meter, and it is used to select the range required. The voltage ranges provided are clearly marked against the various positions of this switch, as are the multiplying factors which are to be used with the ohm scale on the meter. All zero settings will be found to remain correct, independent of the setting of the range switch, provided that there is no stray pick-up by the respective probes and leads.

4.26 D.C. Volts Connector.

The D.C. volts cable and probe are attached to a co-axial connector at the lower right-hand corner of the panel. This cable may be removed if desired when the measurement of D.C. volts is not being undertaken.

4.27 Precautions.

When measurement of high frequency A.C. voltage is to be undertaken, it is necessary to consider the inductance of the connections to the A.C. probe. It is not satisfactory, if accurate measurement is required, to ground the instrument only by the common lead. A terminal has been provided on the side of the probe, and this is connected by a low reactance path to the cathode of the diode probe rectifier. A short heavy lead should be connected to this terminal and used for grounding purposes when making measurements at radio frequencies.

The probe tip is detachable, and a lead may be held in place beneath the tip if semi-permanent connection to the circuit is required.

The accuracy of measurement of high frequency voltage indicated in Section 2.3 can only be maintained if the shortest possible leads of the lowest inductance are used for connecting the instrument to the voltage to be measured. The accuracy previously indicated refers to the voltage at the actual probe terminals.

Section 5 - MAINTENANCE.

The only parts of the "Palec" V.T. Multimeter which are subject to wear or deterioration and which require periodical attention are the valves, switches and potentiometers. The valves and potentiometers are standard items and may he replaced by the user. The special switches required may be obtained for replacement from the Manufacturer.

5.1 Disassembly.

To remove the instrument from its case, it should be placed with the panel uppermost and the 14 screws surrounding the front of the case removed. The instrument may then be withdrawn from the case.

5.2 Valves.

The location of the 4 valves used in the instrument are given in paragraph 4.11. Should it become necessary to replace any of these valves, adjustment to the various circuits may be required. Instructions for making these adjustments are giver below.

5.3 A.C. Probe.

Should deterioration of the EY5I valve used for rectification of the A.C. voltages take place, it will be found that the instrument will read low on all A.C. ranges. If the error is peculiar only to the AC. ranges, the EY5l may be suspected, and if the error is not excessive, compensation may be made by -the adjustment of resistors R.28-R.31, on the strip at the rear of the chassis.

R.31	controls the	2.5 volt range
R.30	controls the	10 volt range
R.29	controls the	25 volt range
R.28	controls the	100-1,000 volt ranges

A decrease in the value of these resistances will provide a greater reading on the meter.

Should the EY51 valve deteriorate sufficiently to cause appreciable reading error, it will probably be found that the zero setting is no longer constant with varying range. This is caused by the reduction in the contact potential of the EY5I and will cause, the pointer to indicate below zero on the lower A.C. ranges if the zero adjustment has been set on the higher A.C. or the D.C. ranges. Although the error may be corrected by manipulation of the "Zero Set" control with the range switch set as required, the fault may be corrected by adjustment of R.22 on the strip at the rear of the chassis. A decrease in value of R.22 will cause the meter to read higher on the scale. The adjustment should be undertaken on the 2.5 volts A.C. range at usual line voltage and preferably with the probe input short-circuited to obviate the possibility of stray pick-up.

5.4 Bridge Circuit.

Severe deterioration of the 6SN7GT valves employed as cathode follower and indicator valve will usually only cause minor inaccuracy of reading, due to the large degree of inverse feed-back employed in both stages. The inaccuracy will be evident on both A.C. and D.C. voltage ranges, and may be counteracted on the D.C. ranges by adjustment of resistor R27 mounted on the strip at the rear of the chassis. A decrease in the value of R27 will provide a greater meter reading. Correction for the A.C. ranges is as given in paragraph 5.21 for A.C. probe.

5.5 Voltage Divider.

Should the values of the resistances R2-R7 comprising the voltage divider shift, it will be found that the calibration is inaccurate by varying amounts on the different ranges. The voltage divider resistors are mounted directly on the range switch, and should be checked with a suitable bridge. Each section is composed of two resistors to make up the indicated value, and these should be replaced if necessary with others to provide the correct resistance value.

5.6 Ohms.

After a period of operation, the type 701 battery, which provides current for ohms measurement, will become discharged and as it will then be impossible to set the ohm meter zero, the battery will require replacement. This battery is mounted in a bracket at the left-hand side of the chassis, and may be readily replaced after the instrument has been removed from its case.

5.7 Power Supply.

As the emission of the 6X5GT power rectifier valve decreases the voltage applied to the bridge will decrease. A large decrease in voltage can be tolerated, however, before the accuracy of the instrument suffers. The 6X5GT valve may be replaced without affecting the accuracy of calibration of the instrument.

USE OF THE "PALEC" V.T. MULTIMETER IN RADIO RECEIVER SERVICING.

As the V.T. Multimeter provides a means of measuring D.C. and A.C. voltages over a wide range with very light loading on the circuit under test, as well as the measurement of A.C voltages over a wide frequency range, it allows of many short-cuts in receiver servicing, and permits the operator to make measurements not possible with the D.C. moving coil or rectifier types of voltmeter. An additional advantage is its ability to measure high values of resistance with accuracy.

D.C. Voltage Measurements.

With the V.T. Multimeter, the loading on the circuit under test is constant at 11 megohms on all ranges, and the input capacity is less than 1µµf.

In the investigation of faults in audio frequency amplifying stages it has always been difficult to measure with any degree of accuracy the plate and screen voltages of the voltage amplifiers due to the high values of series resistance employed to feed these elements. Plate load resistances are usually of the order .1 to .5 megohms and screen resistances from .1 to 3 megohms. While a shunt of 11 megohms will reduce the voltage measurement quite appreciably in the case of a 3 megohm screen supply, a quick calculation will disclose the actual operating voltage before the application of the instrument. Such calculation is made as follows

$$\text{Actual voltage} = \text{voltage read by Model VTM} \times \frac{11 + \text{series resistance (megohms)}}{11}$$

In the great majority of cases this calculation is unnecessary and the actual reading is sufficiently accurate for practical purposes.

The advantages of the instrument are even more pronounced when it becomes necessary to measure voltages without disturbing the operation of a radio frequency circuit. With the Model V.T.M. it is usual to measure the voltage at the oscillator grid, which gives the peak value of the oscillator A.C. voltage without disturbing the operation of the circuit. In the past it has been necessary to disconnect the grid leak resistor and measure the current flowing therein, after which the bias and peak oscillator voltage was calculated.

It is often necessary to measure negative voltages on the AVC line, and a more complete picture is obtained if these voltages can be measured at the grid of the valves concerned. Such a measurement can be undertaken with the Model V.T.M. without disturbing either the high frequency operation of the circuit or the D.C. voltage at the valve grid. The meter may be left connected while the signal input to the receiver is increased and the AVC characteristic thereby investigated and plotted.

As the Model V T.M. has 11 megohms input resistance on all ranges, it is approximately 4.4 megohms per volt on the 2.5 volt range. It would be impossible to obtain accurate indications of the above voltages even with a 20,000 ohms per volt moving coil meter, which would have a resistance of 50,000 ohms only on the 2.5 volt range.

A.C. Voltage Measurements.

The rectifier type A.C. voltmeter usually has an appreciable frequency error in the audio frequency range, and is useless at radio frequencies. The Model V.T.M., however, makes possible the measurement of voltage from the lowest audio to radio frequencies of 300 Mc/s and higher, and is accurate within 0.5 db to 100 Mc/s. Along with the extreme frequency range, the instrument has a low input capacity 110 µµf and a high input resistance approximately 6 megohms).

With a voltmeter conforming to these specifications, it is obviously possible to undertake measurements on radio receivers which have in the past been outside the scope of the average radio serviceman. Accurate measurements of stage gain in all stages of the receiver are possible when the instrument is used in conjunction with a suitable signal source. The "Palec" Modulated Oscillator Model MO/MOl or Signal Generator Model SGI is recommended for this purpose.

As the input capacity of the instrument is 10 µµf only, the connection of the voltmeter to most circuits will cause only slight detuning and the input resistance of 6 megohms will have little shunting effect an the tuned circuit. Gain measurements may, therefore, be made with high accuracy, and low gain stages, tubes or transformers, etc., rapidly located.

The measurement of stage gain and the investigation at hum in the audio circuits may be undertaken in a similar manner, and the voltmeter will not appreciably shunt the high impedances associated with the voltage amplifier stages.

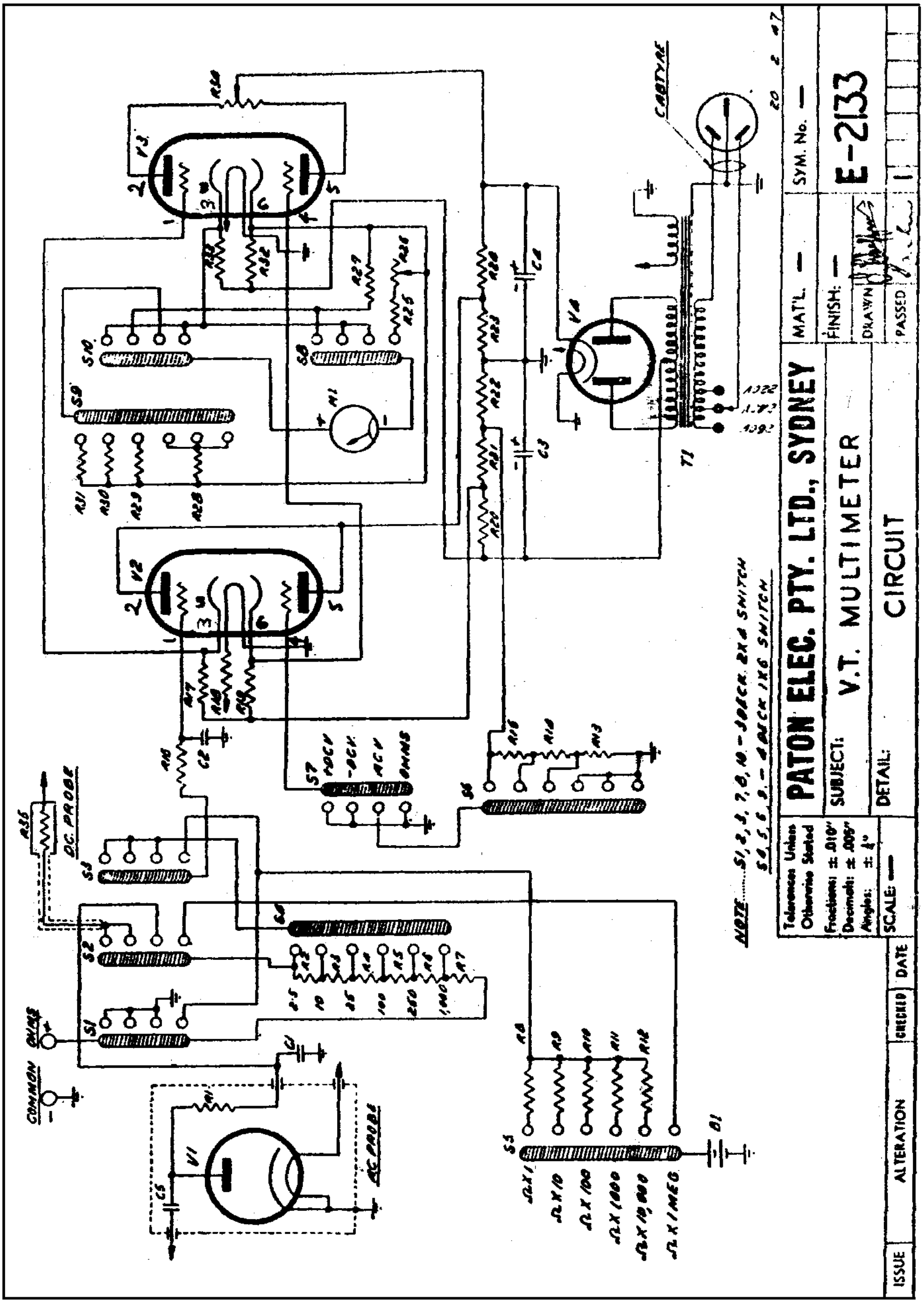
Ohms and Megohms Measurements.

The Model V.T.M. reads ohms and megohms over an extremely wide range, and it is this attribute which makes the ohmmeter section of this instrument so useful. Using the lowest ohms range, it is possible to accurately measure the resistance of coils and transformer windings having resistance values even below 0.5 ohms. On the highest ohms scales it becomes possible to measure leakage from the AVC line to ground, leakage through coupling condensers, leakage between transformer windings, and from windings to ground and leakage through insulating material. These measurements are made possible as the highest megohm range extends beyond 1,000 megohms.

SECTION 6 SCHEDULE OF COMPONENTS.

CIRCUIT SYMBOL	DESCRIPTION	ITEM NUMBER
	RESISTORS	
R1	Resistor, 5 Megohms, 1 Watt, Carbon	
R2	Resistor, 7.5 Megohms, 1 Watt, Carbon	
R3	Resistor, 1 .5 Megohms, 1 Watt, Carbon	
R4	Resistor, 750,000 Ohms, 1 Watt, Carbon	
R5	Resistor, 150,000 Ohm.,, 1 Watt, Carbon	
R6	Resistor, 75,~O0 Ohms, I Watt, Carbon	
R7	Resistor, 25,000 Ohms, 1 Watt, Carbon	
R8	Resistor, 10 Ohms, Wire Wound	
R9	Resistor, 100 Ohms, Wire Wound	
R10	Resistor, 1,000 Ohms, Wire Wound	
R11	Resistor, 10,000 Ohms, 1 Watt, Carbon	
R12	Resistor, 1 00,000 Ohms, 1 Watt Carbon	
R13	Resistor, 1 60 Ohms, Wire Wound	
R14	Resistor, 240 Ohms, Wire Wound	
R15	Resistor, 1 ,200 Ohms, Wire Wound	
R16	Resistor, 5 Megohms, 1 Watt, Carbon	
R17	Resistor, 5 Megohms, 1 Watt, Carbon	
R18	Resistor, 4 Ohms, Wire Wound	
R19	Resistor, 5 Megohms, 1 Watt, Carbon	
R20	Resistor, 40,000 Ohms, Wire Wound	
R21	Resistor, 4,000 Ohms, 1 Watt, Carbon	
R22	Resistor, Approx. 1 00 Ohms, Carbon	
R23	Resistor, 4,000 Ohms, 1 Watt, Carbon	
R24	Resistor, 40,000 Ohms, Wire Wound	
R25	Resistor, 1,000 Ohms, 1 Watt, Carbon	
R26	Potentiometer, 1500 Ohms, Wire Wound	OT-15
R27	Resistor, Approx.1 ,000 Ohms, I Watt, Carbon	
R28	Resistor, Approx.1,000 Ohms, 1 Watt, Carbon	
R29	Resistor, Approx.1 ,000 Ohms, 1 Watt, Carbon	
R30	Resistor, Approx.1,000 Ohms, 1 Watt, Carbon	
R31	Resistor, Approx. 1 ,000 Ohms, 1 Watt, Carbon	
R32	Resistor, 40,000 Ohms, Wire Wound	

CIRCUIT SYMBOL	DESCRIPTION	ITEM NUMBER
R33	Resistor, 40,000 Ohms, Wire Wound	
R34	Resistor, 1,500 Ohms, Wire Wound	OT-15
R35	Resistor, 1 Megohm, 1 Watt, Carbon	
	CONDENSERS.	
C1	Condenser, .01 µfd, 1,000 Volt, Mica	CD-5
C2	Condenser, .01 µfd, 1,000 Volt, Mica	CD-5
C3	Condenser, 8 µfd, 525 Volt, Electrolytic	CD-50
C4	Condenser, 8 µfd, 525 Volt, Electrolytic	CD-50
C5	Condenser, .02 µfd, 1,000 Volt Mica	CD-5
	METER	
M1	Meter, K.475, 0-1 mA, 100 Ohms	
	VALVES	
V1	Type EY51 Valve	VL19
V2	Type 6SN7GT Valve	RK19
V3	Type 6SN7GT Valve	RK19
V4	Type, 6X5GT Valve	VL2
	TRANSFORMER	
T1	Power Transformer	RG516
	SWITCHES	
S1		
S2		
S3	Function Switch	
S7	6 Pole, 4 Position	
S8		
S10		
S4	Range Switch	
S5	4 Pole, 6 Position	
S6		


PATON ELEC. PTY. LTD., SYDNEY
SUBJECT:
V.T. MULTIMETER
DETAIL:
CIRCUIT
MAT'L. —
SYM. No. —
FINISH: —
DRAWN
PASSED
E-2133
Tolerances Unless Otherwise Stated
Fractions: ± .010"
Decimals: ± .005"
Angles: ± ½°
SCALE: —
ISSUE
ALTERATION
CHECKED
DATE
COMMON
OHMS
DC PROBE
AC PROBE
CABTYRE

PALEC VT MULTIMETER MODEL VTM.

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