Wide-Range A.C. Valve Voltmeter VM77B

Instruction Manual

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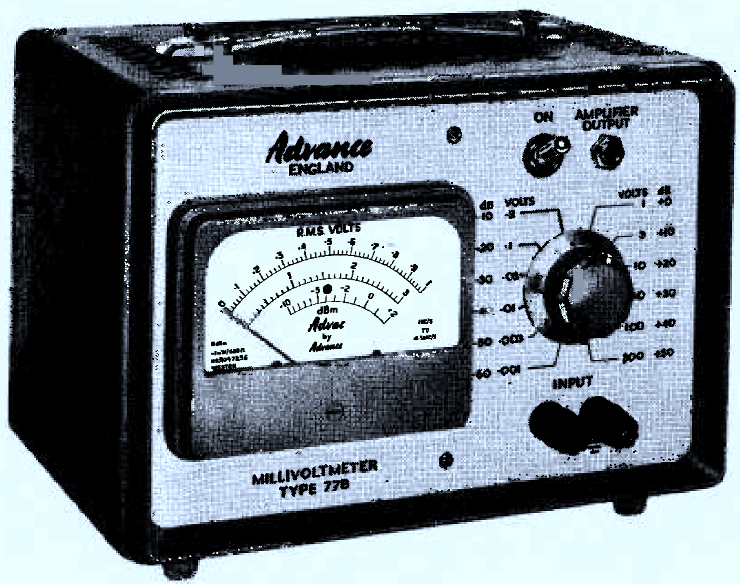
1 Description

The ADVANCE model VM77B Wide-range A.C. Voltmeter consists of a 4-stage amplifier with two attenuators. The output of the amplifier is rectified by a bridge-rectifier across which is connected a meter having a 4-inch scale length.

The amplifier is arranged in two sections each of two stages, negative feed-back being applied over each section. The first attenuator operates between the input and the first section, and has three positions. The second attenuator operates between the first section and the second section, and has four positions, making twelve ranges in all, from 1 millivolt to 300 volts full-scale. Using the screened lead supplied, measurements as low as 100 micro-volts are possible.

The meter is calibrated in three scales:
0—1, Volts, r.m.s.
0—3, Volts, r.m.s. and
decibels, -10, $+2$ (referred to 1 milliwatt into 600 ohms).



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The model VM77B can be used as a sensitive voltmeter for circuit investigation, investigation of erratic operation in amplifier circuits, measurement of circuit voltages (where the input impedance of 10MΩ renders it particularly useful), or in any application where high sensitivity measurements are to be made. There is a 30% overlap between ranges so that the best accuracy of the instrument is always available. It may also be used as an amplifier, the gain of which is adjusted by the range switch in steps of 10 dB from − 60 dBm to + 50 dBm.

The amplifier frequency response, with a 100kΩ resistive load and 40pF capacitative load is within ±2dB from 12c/s to 200kc/s. The response above this range depends upon the capacity of the load. With a load of 40pF and 100kΩ it will rise up to 3Mc/s and fall away thereafter. The harmonic distortion is very low, particularly at low input levels.

Note: When the amplifier jack is inserted, the meter function is inaccurate; the jack plug must be removed for use as a voltmeter.

The instrument is supplied with a low-capacity screened lead, type PL50.

This lead completely screens the input terminal which is necessary in view of the very high sensitivity of the instrument when making measurements on the lower ranges The capacity of the lead is low.

The model VM77B is of compact construction, and operates on either 100 to 125V or 200 to 250V without supply tap adjustment (a stabilised h.t. supply is built-in).

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2 Specification

VOLTAGE RANGES F.S.D.		ATTENUATOR SETTINGS F.S.D.	
0.001 V	1 V	− 60 dBm	0 dBm
0.003 V	3 V	− 50 dBm	+ 10 dBm
0.01 V	10 V	− 40 dBm	+ 20 dBm
0.03 V	30 V	− 30 dBm	+ 30 dBm
0.1 V	100 V	− 20 dBm	+ 40 dBm
0.3 V	300 V	− 10 dBm	+ 50 dBm

FREQUENCY RANGE

15c/s to 2Mc/s, accuracy ±(3% + 3% F.S.D.)
50c/s to 100kc/s, accuracy ±3% F.S.D.
2Mc/s to 4.5Mc/s, accuracy ±2 dB

METER CALIBRATION

The meter reads r.m.s. voltages for sine-wave inputs. There are two voltage scales, 0—1 and 0—3 volts, and a dB scale from − 10 to + 2dB (relative to 1mW in 600Ω).

INPUT IMPEDANCE

10MΩ, 20pF. (+ 60pF when using accessory lead PL50).
Less than 10% change with range switching.

SUPPLY VARIATIONS

Stability ±1% for the line voltage changes from 105 to 125 V, or 210 to 250V (15 c/s to 2 Mc/s). Less than − 1½% at 200V and 100V.

AMPLIFIER GAIN

60 dB maximum. Adjustable in 10 dB steps.

AMPLIFIER FREQUENCY RESPONSE

±2dB from 12c/s to 200kc/s (with 100kΩ, 40pF load). Response rises to 3Mc/s and falls away above this frequency.

AMPLIFIER OUTPUT

Maximum output 1V r.m.s. Output is 0.5V ±2dB when meter reads 0.5 on top scale, up to 200kc/s.

AMPLIFIER OUTPUT IMPEDANCE

Approximately 1,500Ω.

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METER OVERLOAD PROTECTION

It is not possible to permanently damage the meter by applying an input voltage too high for the range selected.

NON-SINUSOIDAL OPERATION

The circuit used gives readings which are close to r.m.s. values even when the harmonic content is comparatively high. Error with

10% second harmonic content is about 0.5%,
20% second harmonic content, −2%,
50% second harmonic content, up to −10%,
10% third harmonic content, ±4%,
50% third harmonic content, −20% to +4%.

MAXIMUM INPUT VOLTAGE

500 volts (d.c. plus peak a.c.).

VALVES

Four 6AK5; one XC12; one 6AQ5; one ECF80; one L.E.S. 5 mm 6.3V indicator lamp.

ACCESSORIES

One jack plug.

One low-capacity lead type PL50, with screened hood for input terminal.

Optional low-capacity probe PL45.

POWER SUPPLY

100 to 125V and 200 to 250V, 50 to 60c/s, 30W.

These two voltage ranges are selected internally by soldered links.

No supply voltage adjustment is necessary between 100 and 125V, or between 200 and 250V.

The valve voltmeter may be used at higher frequency supplies with some deterioration in accuracy.

WEIGHT

$8\frac{1}{2}$lb (3.9kg).

DIMENSIONS

$8\frac{7}{8}$ in. wide × $6\frac{1}{2}$ in. high × $6\frac{3}{4}$ in. deep (23 cm × 17 cm × 17 cm) overall.

PRESENTATION

Dark blue metal case with light grey front panel and medium grey surround. All colours to B.S. 2660; case tint No. 7-086, front panel tint No. 9-093, front panel surround tint No. 9-095.

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3 Controls and Connections

Controls on the front of the instrument are:

3.1 SUPPLY SWITCH

On the right of the instrument. A red indicator light in the centre of the meter indicates when power is on. This light is produced via a perspex lens from a miniature bulb fitted externally to the meter.

3.2 RANGE SWITCH

Located to the right of the meter. The VOLTS indications give the voltage at the input terminals for full-scale deflection; the dB indications are the level in dBm (referred to 1 milliwatt into 600 ohms) which will cause the meter to read zero on the dBm scale.

3.3 INPUT TERMINALS

Two terminals on the bottom right of the instrument panel which will accommodate wires, spade or pin terminals, or 4mm plugs. The right hand terminal is earthed.

3.4 OUTPUT JACK

At the top right-hand side of the panel; the jack ring is earthed to the chassis of the instrument.

3.5 FUSE

A 1 ampere fuse is located in the back of the instrument.

3.6 A.C. BALANCE

This control is accessible through a hole near the centre of the back of the instrument. The setting need only be checked at infrequent intervals when using the more sensitive ranges. It may be quickly set by shorting the input terminals and adjusting for minimum reading on the 0.001 volts range. It may be more accurately set by completely screening, but not short-circuiting, the input terminal. This may be effected by plugging-in the screened lead or probe and placing its tip inside a screened and earthed box or can.

3.7 GAIN SETTING

The gain control, a small flat potentiometer with screwdriver-slot adjustment, is located at the top of the instrument. It should only need adjustment at long intervals, or when very accurate measurements are to be taken, and is located internally to prevent accidental or unnecessary movement. The control is readily

RESISTORS

Ref.	DESCRIPTION	Pt. No.
R 1	10K ±1%, ¼W, H.S. RRC	11496
R 2	11K ±1%, ¼W, H.S. RRC	11499
R 3	10M ±2%, ¼W, H.S. RRC	11506
R 4	10M ±1%, ¼W, H.S. RRC	12327
R 5	2.7 Ω ±20%, Erie RMA 9	11512
R 6	2.7 Ω ±20%, Erie RMA 9	11512
R 7	180 Ω ±5%, RRC 5SCD3	11582
R 8	100 Ω ±5%, H.S. RRC 5SCD2	11504
R 9	27K ±5%, Dubilier BTS	405
R10	4.7K ±1%, ¼W, H.S. RRS	11497
R11	1M ±10%, Dubilier BTS	406
R12	22K ±10%, Erie type 8	6706
R13	180 Ω ±5%, RRC 5SCD3	11582
R14	2.7K ±5%, Erie type 8	413
R15	1.2K ±10%, Dubilier BTS	10621
R16	100K ±10%, Erie type 9	1270
R17	1K ±10%, Erie type 9	1175
R18	100 Ω ±5%, H.S. RRC 5SCD2	11504
R19	100 Ω Pot. Egen 170	11518
R20	100 Ω ±5%, H.S. RRC 5SCD2	11504
R21	100 Ω ±10%, Dubilier BTS	10985
R22	51 Ω ±5%, H.S. RRC 5SCD2	11511
R23	4.7K ±1%, ¼W, H.S. RRC	11497
R24	1.5K ±1%, ¼W, H.S. RRC	11498
R25	470 Ω ±1%, ¼W, H.S. RRC	11501
R26	220 Ω ±1%, ¼W, H.S. RRC	11502
R27	1.2K ±10%, Dubilier BTS	10621
R28	820K ±10%, Dubilier BTS	408
R29	27K ±5%, Dubilier BTS	405
R30	15K ±10%, Dubilier BTS	412
R31	1M ±10%, Dubilier BTS	406
R32	470 Ω ±10%, Dubilier BTS	10987
R33	2K Pot. Egan type 123	11309
R34	22K ±5%, H.S. RRC 2HS2	508
R35	470 Ω ±10%, Dubilier BTS	10987
R36	1.2K ±10%, Dubilier BTS	10621
R37	470 Ω ±10%, Dubilier BTS	10987
R38	27K ±5%, Dubilier BTS	405
R39	10K ±5%, Erie type 8	415
R40	180K ±10%, Erie type 9	5080
R41	100Ω Preset pot. Reliance type MW	11534
R42	12 Ω ±10%, Dubilier BTS	409
R43	Selected on test	
R44	18K ±5%, H.S. RRC 2HS2	507
R45	27K ±5%, Dubilier BTS	405
R46	1.5K ±5%, Dubilier BTS	407
R47	33K ±10%, Dubilier BTS	439

CAPACITORS

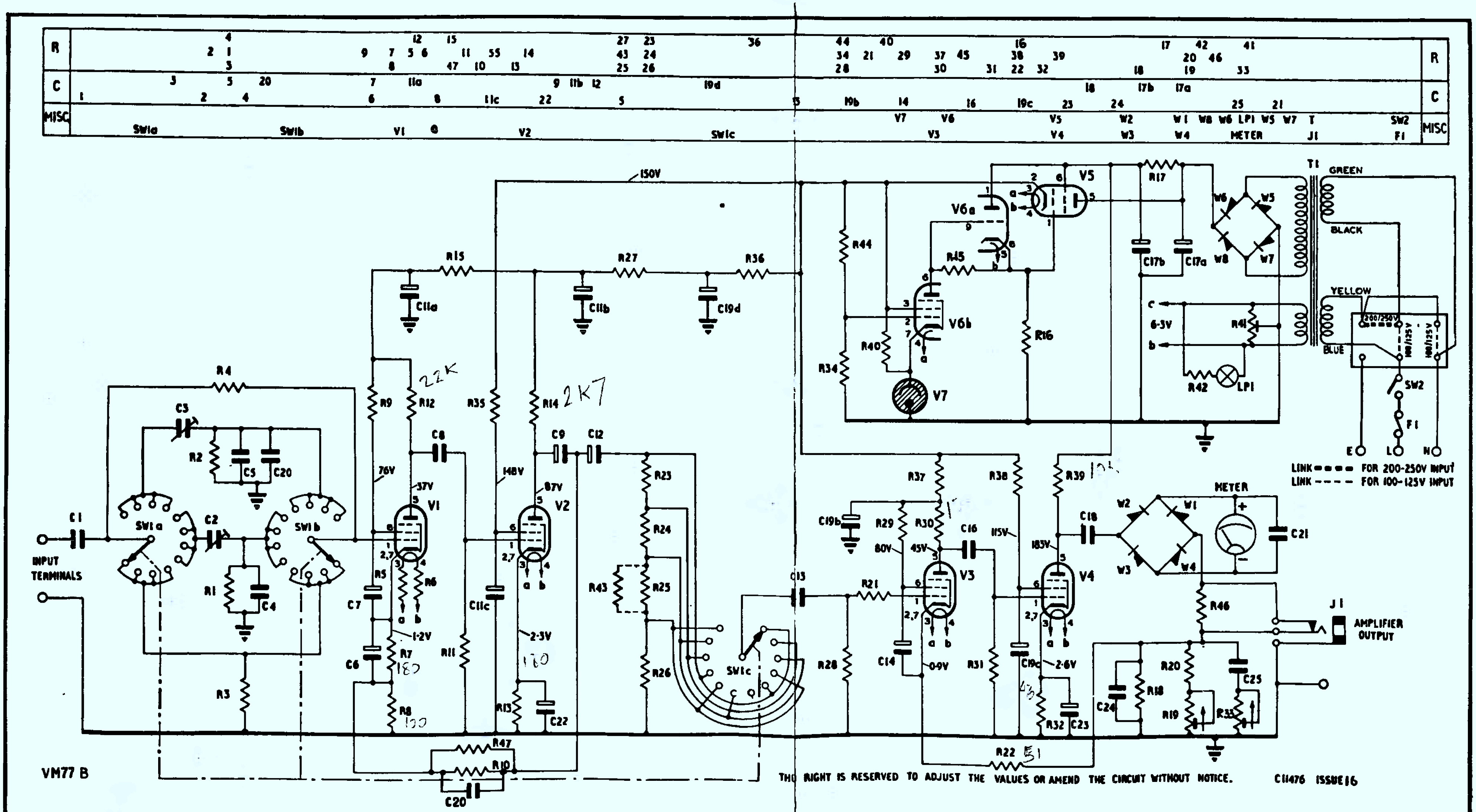
Ref.	DESCRIPTION	Pt. No.
C 1	0.05μF 500V Pleseal	11489
C 2	1.5–7pF Trimmer 004A 10BM. 020 Strico	13110
C 3	1.5–7pF Trimmer 004A 10BM. 020 Strico	13110
C 4	470pF ±10% 350V Polystyrene GEC	11492
C 5	0.01μF 150V Hunts W99	8587

Capacitors continued

Ref.	DESCRIPTION	Pt. No.
C 6	200μF 6V Elect. Plessey CE206	12972
C 7	5μF 150V Elect. Plessey CE1348	497
C 8	0.04μF 150V Hunts B858	7485
C 9	5μF 150V Elect. Plessey CE1348	497
C10	Not used	
C11A	60μF	
C11B	40μF } 150V. Elect. Plessey CE17202	11569
C11 C	20μF	
C12	200μF 6V Elect. Plessey CE206	12972
C13	0.05μF 500V Pleseal	11489
C14	16μF 150V. Elect. Plessey CE461/13	11485
C15	Not used	
C16	0.1μF 10% 125V Mullard	804
C17A	20μF } 350V CE, 840	11482
C17B	20μF	
C18	0.5μF ±20% 150V Hunts W48 A308	12056
C19A	60μF	
C19B	40μF } 150V Elect. Plessey CE17202	11569
C19C	20μF	
C20	0.01μF 150V Hunts W99	8587
C21	0.02μF 200V Hunts W94	10604
C22	200μF 6V Elect. Plessey CE206	12972
C23	200μF 6V Elect. Plessey CE206	12972
C24	Selected on test	
C25	0.001μF Hunts type 99	8245
C26	2pF Lemco type 3105	12392

MISCELLANEOUS

Ref.	DESCRIPTION	Pt. No.
W 1	Diode WG5B	11538
W 2	Diode WG5B	11538
W 3	Diode WG5B	11538
W 4	Diode WG5B	11538
W 5	Diode 2E4	500
W 6	Diode 2E4	500
W 7	Diode 2E4	500
W 8	Diode 2E4	500
V 1	6AK5	9064
V 2	6AK5	9064
V 3	6AK5	9064
V 4	6AK5	9064
V 5	6AQ5	498
V 6	6BL8	11005
V 7	XC12 (Hivac)	499
I 1	130 (Bulgin)	449
T 1	Transformer, Power	MT352/2
F 1	Fuse, 1A B/Lee 1055/1	4752
L 1	Lamp, Pilot, LES. 150mA	11547
SW1A		
SW1B	} Plessey	A13397
SW1C		
SW2	Arrow 8040/BT/13 Long/Chrome	12180
	Low-Capacity Connecting Lead	PL50
	Optional Low-Capacity Probe	PL45
	Jack Plug	448
	Instruction Manual	2803



Circuit diagram VM77B

accessible by removing the two screws in the back of the case and sliding out the chassis. Anti-clockwise movement increases the reading. The reading should be set, preferably near full scale, with a known voltage at the input terminals. This voltage being measured with a standard meter.

3.8 A.C. SUPPLY LEAD

The three-wire lead should be connected red to line, black to neutral and green to earth. The earth connection is not essential and may be cut back for connection to two-wire systems. Earthing is preferable when making measurements at very low voltages and may be effected by connecting the black terminal to earth. (See para. 4.2.)

4.1 MAXIMUM INPUT VOLTAGE

CAUTION. The maximum d.c. plus peak a.c. voltage applied to the input terminals should not exceed 500V.

4.2 EARTHING THE INSTRUMENT

The instrument is provided with a 3-core lead, enabling the case and front panel to be earthed. This is desirable, especially when making measurements above a few kc/s.

When making a.c. supply measurements, however, it is preferable not to have the instrument earthed but care must still be taken to avoid connection of the black terminal to the live line.

4.3 VOLTAGE MEASUREMENTS

The instrument normally reads correctly after a few minutes' warming-up period. Set to the range required and apply the voltage to be measured. When the voltage is unknown, set to the highest range (300V) and reduce to a lower range until the meter reads the voltage. Select the range which gives the greatest meter movement. For greatest accuracy, where below one third scale, use the next lower range. (Although it is impossible to over-load the instrument, it is not good practice to allow the meter pointer to go hard over, unnecessarily.)

With the input terminal shorted, the residual noise in the first amplifier stage may give a very small reading. This reading need not be subtracted from the meter reading when the input voltage is greater than the residual noise.

When measuring voltages near supply frequencies, or at harmonics or sub-harmonics of the supply frequency, a small fluctuation in the reading may be noticeable. This is worse if the a.c. balance is incorrectly adjusted. Where possible, avoid measurements at the supply frequency at high impedance (e.g., when measuring the response of an amplifier).

Where the input is other than sinusoidal, a small error in readings may result. The circuit used reads close to the true r.m.s. value even when the harmonic content is comparatively high. (See " Non-sinusoidal Operation " under " Specification ".)

4.4 DB MEASUREMENTS

As with voltage measurements, set to the range required. The range indicates the number of dB to be added to the meter reading, using the dB scale. For example, if the meter reads – 10 dB and the range is − 40 dB, the level is − 50 dB. (Zero dB being 1 milliwatt into 600 ohms.)

Note that the dB relationship to voltages is correct only if the two voltages are measured across equal impedances. The instrument is calibrated in voltage and dB ratios.

4.5 USE AS AN AMPLIFIER

Connect signal to the input terminals and the output load to the output jack, the load should be high-impedance, e.g., oscilloscope, high-impedance headphones, etc. Reactive loads may impair amplifier response. A capacitive load will actually increase response at higher frequencies.

The amplifier is specified ±2dB, 12c/s to 200k/s (with 100kΩ, 40pF load). It will be found that the response rises to 3Mc/s and falls away above this frequency.

The amplifier output, in r.m.s. volts, with 100kΩ, 40pF load, is within 2 dB of meter reading on top scale, at half-scale. This holds on all range settings.

4.6 USE OF SCREENED LEAD, PL50

With open terminals, stray pick-up will cause a meter reading on the most sensitive ranges. Similarly, if measurements are being made across a high-impedance source, hum or other pick-up may add to the voltage being measured. These effects can be avoided by shielding the input lead. Shielding is essential when measuring low voltages at high impedances. Adequate shielding will introduce input capacity which may affect the operation of the circuit being measured, and, at higher frequencies, may affect the reading.

The screened input lead PL50 will add approximately 60pF to the input capacity of 20pF. Where excessive shunt capacity is likely to cause error it will be necessary to add a trimmer capacitor covering 9pF in series with the input to form a capacity divider. This will reduce the input capacity to one tenth and, of course, the sensitivity. The trimmer may be accurately calibrated by noting the reading of a low impedance R.F. signal generator on a given range without the trimmer, and trimming for the same reading with the range switch 20dB more sensitive and the trimmer in circuit.

Alternatively, probe PL45 with a built-in capacity divider may be purchased as an accessory.

4.7 HUM PICK-UP

Under some circumstances, difficulties due to hum pick-up may be reduced by experimenting with the orientation of the power plugs of the voltmeter and other apparatus with which it is in use. Reversal of one or more plugs may reduce the pick-up. When measuring voltages at the supply frequency, hum pick-up may affect the reading, the amount being dependent upon the phase. Adequate screening, the use of the screened lead or optional probe and experimenting with earth connections will minimise the hum. When measuring power supply frequencies, hum pick-up will cause a "beat" and result in a fluctuating reading.