MULTIMETER APPLICATIONS

D.C. VOLTAGE CHECKS

Range	Application	Typical reading
500V	H.T., cathode of rectifier.	200–300V Full-wave. 190–220V Half-wave.
500V	H.T., a/c smoothing capacitor	200–250V Choke-capacitance smoothing. 170–210V Res-cap'y smoothing.
250V	Anode, output stage, at transformer primary.	Full H.T.
250V	Screen grid, output stage.	150–200V.
250V	Anode, driver stage, audio.	50–100V High impedance circuit; meter damps and affects reading.
250V	Anode, i.f. amplifier, mixer and r.f. stages.	150–250V Meter acts as r.f. bypass. Check between 'hot' side of r.f. load and decoupling.
250V	Anode, oscillator.	70–120V Meter damps oscillator circuit. See Fig. 1.
250V	Screen grid, i.f., mixer, r.f. amplifiers. See Fig. 2.	50–120V. Vari-mu valve will have lower voltage on screen than straight amplifier.
50V	Detector, f.m. receiver. See Fig. 3 and Fig. 4.	30–50V varying to zero null point.
50V	A.G.C. See Fig. 5.	0–10V depending on signal strength.
25V	Cathode bias, audio and r.f. stages.	0–10V. Where bias is low, anode and screen volts near normal, suspect low-emission valve.
25V	Battery supply	As appropriate. Check readings on and off load. Wide variation indicates high internal resistance.
25V	Single-ended push-pull transistor output stage.	4·5V at base of upper transistor and at junction of collector of lower with emitter of upper.
25V	Collector of grounded-emitter stages.	5–9V.
25V	Base to emitter of grounded-emitter stage.	3–5V in some audio driver circuits.
2·5V	Across collector load of grounded emitter stage.	0·75–1·5V.
2·5V	Base with respect to chassis	0·75–1·5V Polarity dependent on circuit.

D.C. CURRENT CHECKS

Range	Application	Typical reading
250mA	H.T. line.	100–200mA, depending on number of valves. Examples: EZ40, 90mA; EZ80, 90mA; EZ81, 150mA.
50mA	Anode and screen currents. (Cathode current=sum). Note decoupling, Fig. 2.	Output valves, 30–60mA, screen current, 5–10mA. I.F. and r.f. valves, anode 5–10mA, screen 1–5mA.
50mA	Total consumption, battery operated, transistorised portable.	25–50mA, increasing from quiescent condition to maximum signal output.
50mA	Oscillator anode. See Fig. 1	3–7mA. Damping the oscillator causes change.
2·5mA	Collector current, transistor amplifier stage.	0·5–2·5mA.
50μA	Detector, F.M. radio. See Figs. 3 and 4.	0–30μA.

METER DO'S AND DON'TS

1. Always begin at the highest range when in doubt of the voltage or current.
2. Never insert the meter in a live circuit to read current.
3. Do not apply ohms test to live circuit.
4. Beware of charged electrolytics when making resistance tests.
5. Avoid connecting to a d.c. circuit when testing a.c.
6. Zero ohms before making tests.
7. Check pointer zeroing before each test session.
8. Look after leads, prods and clips—even a poor joint can affect small readings.
9. Keep leads as short as possible when testing r.f. circuits.
10. When testing in high-voltage chain, use meter at low potential end.
11. Do not allow leads to dangle over edge of bench.
12. Keep meter away from strong magnetic fields.
13. View pointer from directly above to avoid 'parallax' effect.
14. When making comparative tests, use the same range.

A.C. VOLTAGE CHECKS

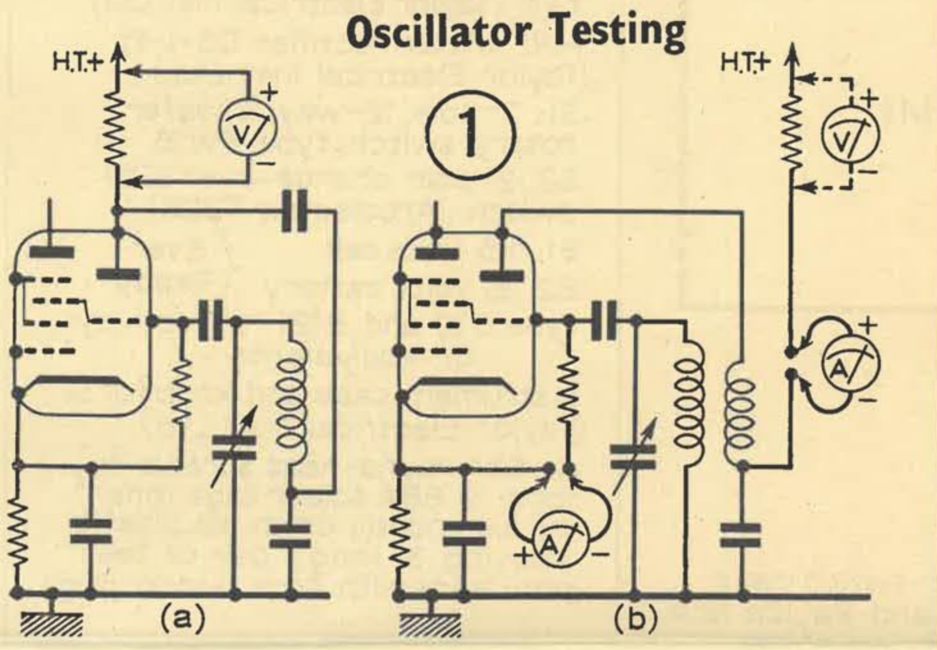
Range	Application	Typical reading
500V	H.T. secondary of c.t. mains transformer.	250–0–250, 350–0–350. Measure at each end with respect to chassis.
250V	Mains input.	200–250V, 110V, as appropriate.
250V	Mains dropper and surge limiter, a.c./d.c.	250–90V, as appropriate. See Fig. 6.
50V	Valve heaters, a.c./d.c.	6–35V, check across valve base.
50V	A.C. bias, tape recorder.	10–40V. At R/P and erase heads with respect to chassis.
25V	A.C. bias, tape recorder.	1–10V across series resistor to avoid damping high impedance head. Also for checking signal voltage, with h.f. oscillator inoperative.
25V	Audio output.	1–10V varying. Meter across output transformer secondary.

RESISTANCE CHECKS

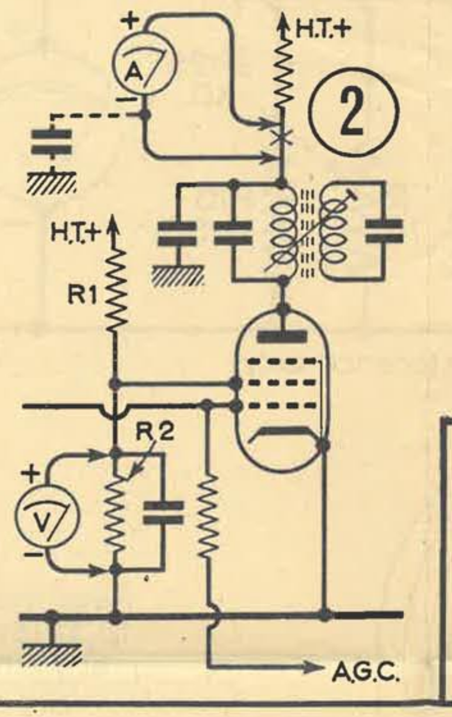
Range	Application	Typical reading
R x 10,000	Component testing.	As appropriate.
R x 10,000	Low-volts leakage testing.	Infinity. Slight kick on connection to higher value capacitors.
R x 100	Component testing.	As appropriate.
R x 100	Electrolytic capacitor testing.	Apply correct polarity, note 'kick' and slow increase. Example: 25μF, kick to 10k, slowly raise to 50k. 100μF, kick to zero, slowly raise to 100k.
R x 100	H.T. line check.	As above, limiting at point depending on total line resistance.
R x 100	Transistor tests.	See Fig. 7.
R	Component testing.	As appropriate.
R	Continuity check.	Zero.
R	Coil d.c. resistance.	0–50 ohms, as appropriate.

TYPICAL TESTS

Oscillator Testing



Meter applied directly to anode will prevent oscillation. With shunt-fed types, measure voltage drop across load resistor, or anode current, short-circuit grid by application of 0·1μF capacitor, note change in anode current or volts drop, indicating that oscillation was taking place. With tuned-anode types (Fig. 1b), insert meter on 'hot' side of tuned circuit, or across decoupling filter resistor, if fitted. Check as before. Where convenient, grid current may be checked directly. Valve not oscillating, about 10μA, rising when oscillations take place.

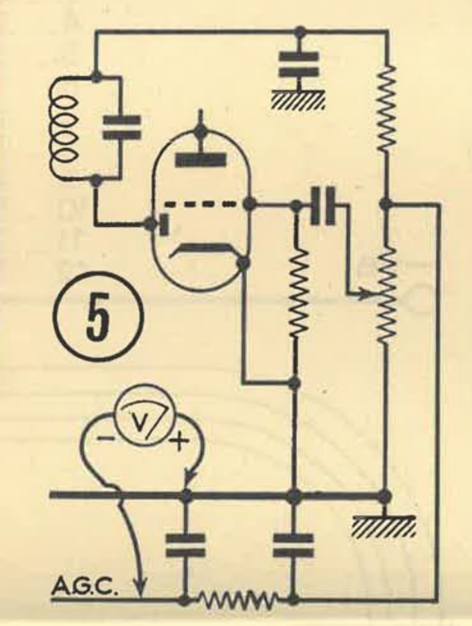


Checking Amplifier Stages

To check anode or screen grid voltages, allowance must be made for current drawn by the meter. For example, if the screen grid potentiometer of V1 was effectively modified by the presence of the meter across R2, the screen grid voltage would tend to drop. This in turn would alter the operating conditions of the valve, reducing the screen current and tending to stabilise. The higher the voltage range used, the more accurate the readings.

When checking anode current, measure at low signal potential side of tuned circuit, as shown, and provide decoupling to avoid feedback, as indicated by dotted capacitor.

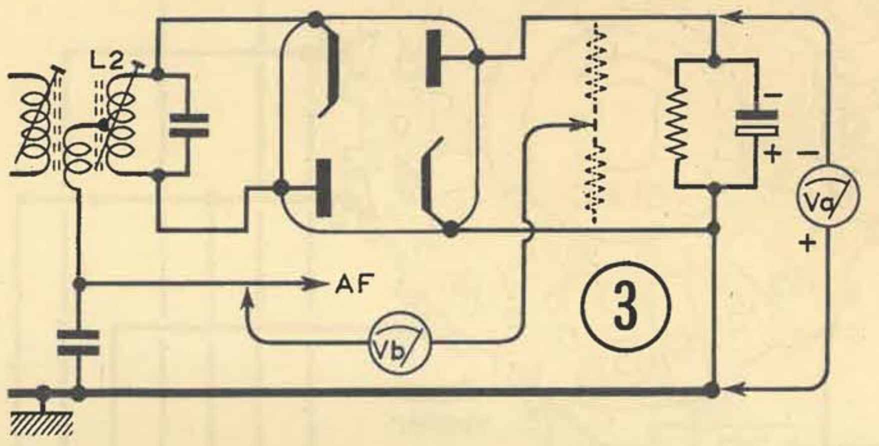
A quick check for a.g.c. operation is to measure the screen grid voltage of a controlled stage (i.f. amplifier), under 'no-signal' conditions, then tune in a strong carrier. An increase from 5 to 15 volts should be noted.



A.G.C. Circuits

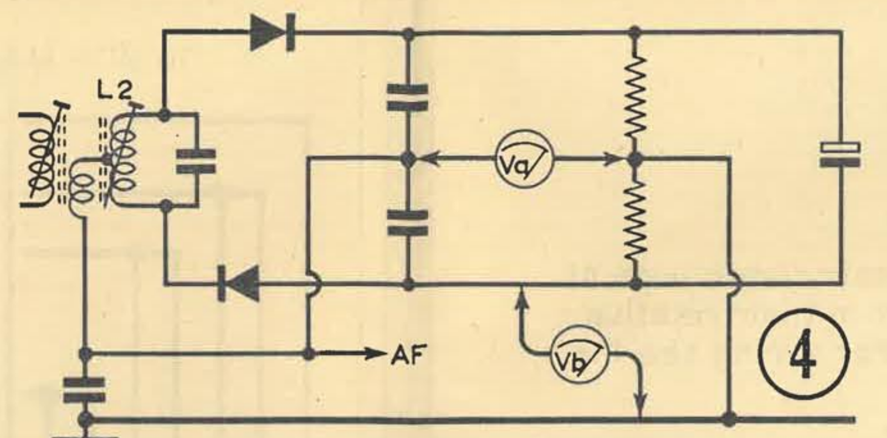
The high impedances present in a.g.c. circuits, and the precise time constants of components, makes measurement misleading in certain cases. Apply the meter to a junction between filter resistors, never across diode or grid circuits.

A method of testing which imposes no load on the a.g.c. line is to measure the screen grid voltage of a controlled stage (see also Fig. 2).



Unbalanced Ratio Detector

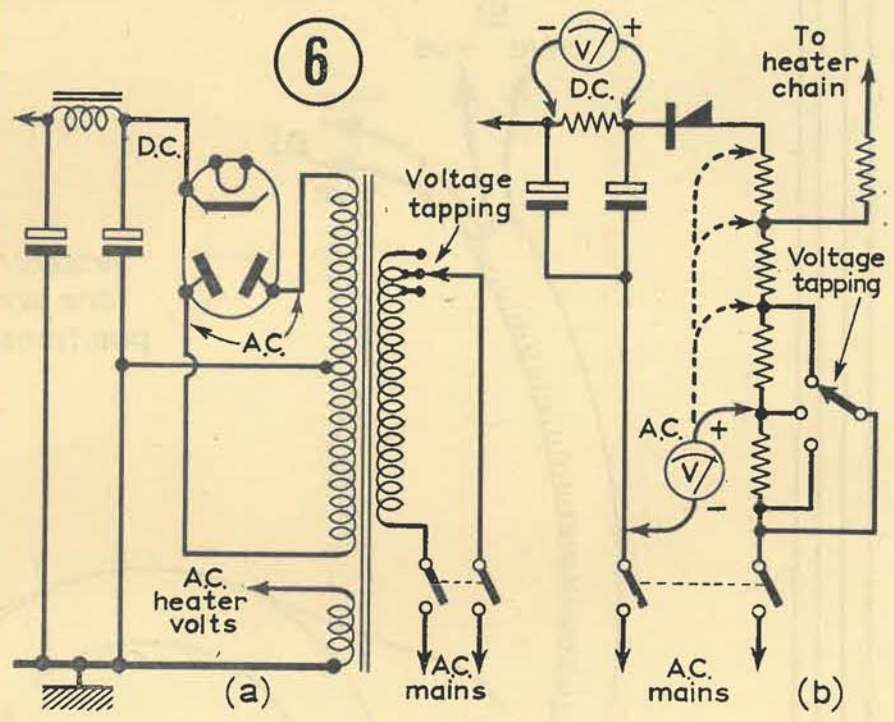
Alignment procedure requires first the detuning of the secondary of the discriminator transformer L2, by unscrewing the core, then tuning other circuits for resonance, measuring the output across the R-C load. The meter, Va, is connected with positive to chassis. Next, the secondary is tuned for correct balance, which can be measured by connecting a matched pair of resistors across the output circuit of the detector (47k each, suggested), and connecting the meter Vb from the centre-tap to the a.f. take-off point. Adjust secondary tuning for null point, zero reading.



Balanced Ratio Detector

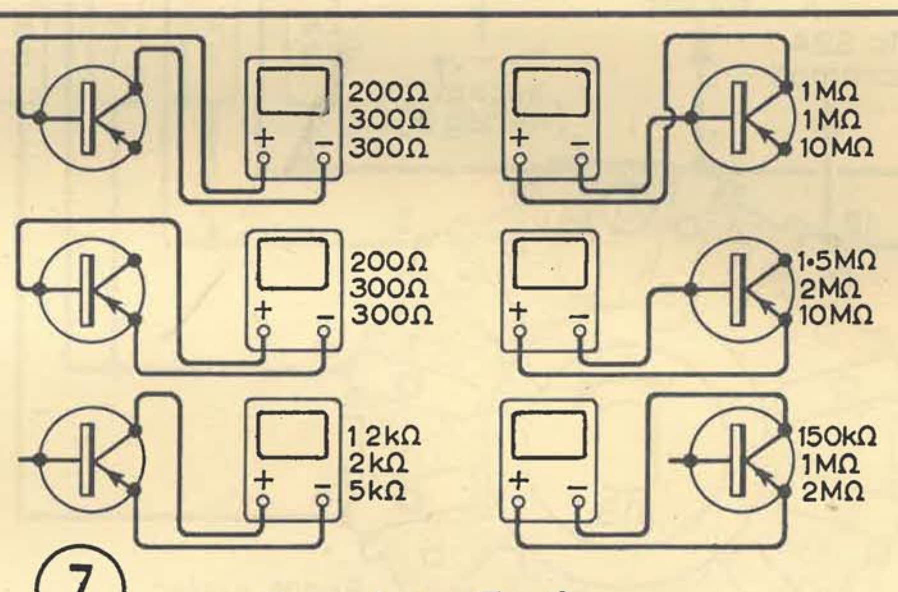
Meter Va is connected across one-half of the resistive load, the secondary L2 detuned and the tuned circuits previous to this adjusted for maximum output. L2 is finally adjusted for balance by applying meter Vb to the centre tap of the load and the centre tap of L2. As the former is at chassis potential and the latter is the a.f. take-off point with respect to d.c., the meter is connected between the a.f. take-off point and chassis. L2 is tuned for null point, zero reading.

An alternative method, stipulated by some manufacturers, is to use a μA-meter with 47k resistor in series, in place of Vb. The high o.p.v. rating of this meter makes it quite suitable for this test, however.



Power Supply Circuits

Always ensure that the meter is switched to the correct range. Avoid application of meter to circuit carrying d.c. when switched to a.c. ranges. Never connect or disconnect current-measuring ranges with the receiver switched on. When testing a.c./d.c. circuits, ensure that the chassis is connected to the neutral pole of the mains input.

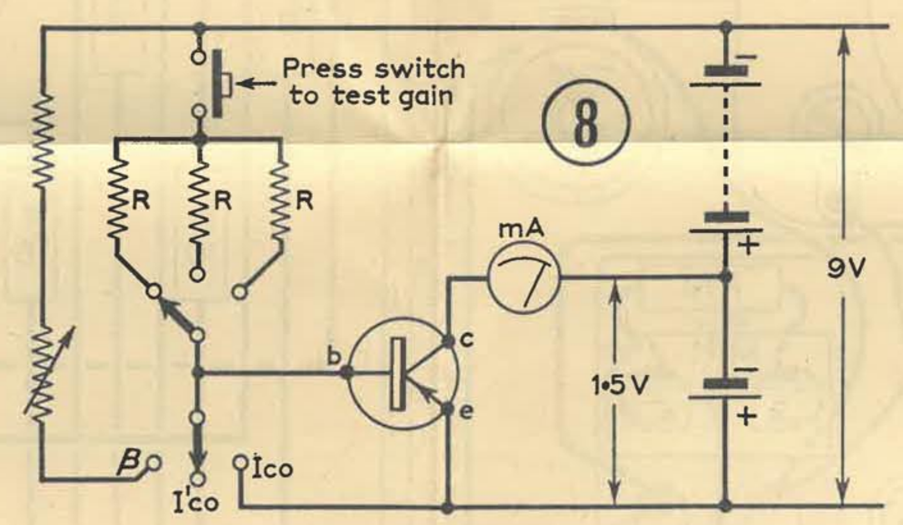


Transistor Testing

Semiconductors can be checked for back and forward resistance by the application of the ohmmeter in the correct sense (polarity). Remember that the positive terminal presents a negative voltage to the external circuit on the ohms ranges, from the internal battery.

Typical readings for specimen p-n-p transistors are given beside each meter illustration. The specimens were OC81, OC71, OC44.

A simple circuit can be set up, using the meter switched to the 2·5mA range, and a few components from the spares box. In the circuit, the transistor

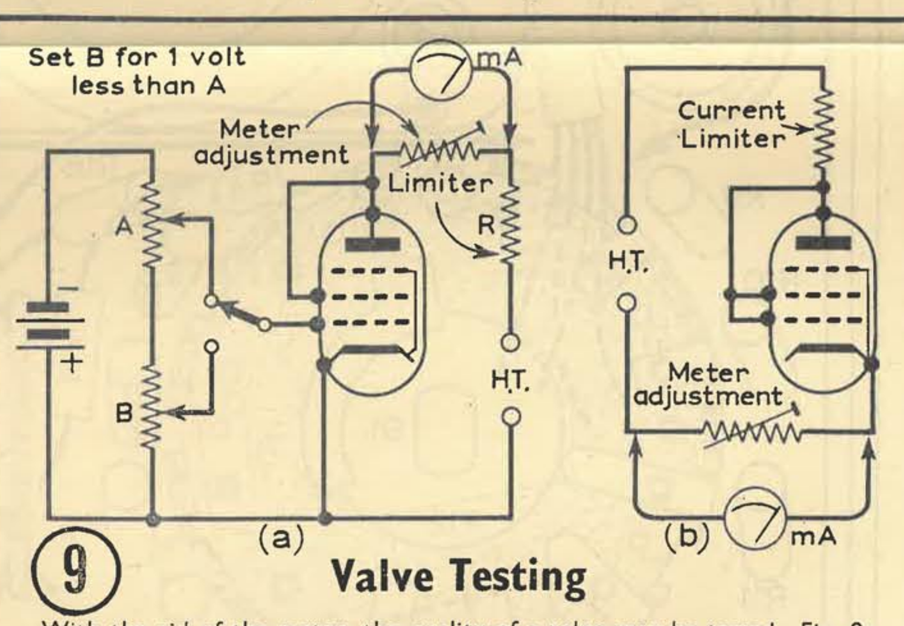


under test is a p-n-p type, connected in the grounded-emitter mode. N-P-N types require potentials of opposite polarity. The three switch positions select collector leakage current (I'co) with base open-circuited, collector current (I'co) at cut-off, with base connected to emitter, and β, current gain.

Note that the milliameter is fed from a tapping on the supply. Current gain measures the test current (collector) caused by change in base current. First, adjust the base current for normal bias conditions by varying the potentiometer. Set for a 1mA reading. The press-switch S2 allows the base current to be increased by an amount governed by R.

This resistor must be calculated for the appropriate transistor. If a transistor with, for example, a current gain of 100 is chosen, R is calculated to provide a 2mA deflection. Thus a change of 1mA results from an increase in base current of $\frac{1}{100}$mA. So R must feed an extra 0·01mA to the base when S2 is pressed, which works out to be 900k. Gains of other values can be calculated by the same method and several preset resistors fitted in the R positions.

$$\text{Current gain } \beta = \frac{\text{change in collector current}}{\text{change in base current}}$$



Valve Testing

With the aid of the meter, the quality of a valve may be tested. Fig. 9a shows the arrangement for testing mutual conductance. The meter is switched to a suitable current range and indicates anode current. A voltage is applied to the grid, and varied by 1 volt (this can be done by first measuring the applied voltage, resetting the potentiometer for a 1-volt change, and re-connecting the meter to measure anode current).

The mutual conductance $g_m = \mu / r_a$, where μ is the amplification factor and r_a the anode impedance. As a valve ages, its r_a increases, and consequently the gm decreases. Mutual conductance can be calculated by dividing the change in anode current by the change in grid voltage, in units of amps and volts. The g_m is generally stated in mA/V.

Another test of 'goodness' is a measurement of emission. As shown in Fig. 9b, the total valve current is measured by the milliameter.