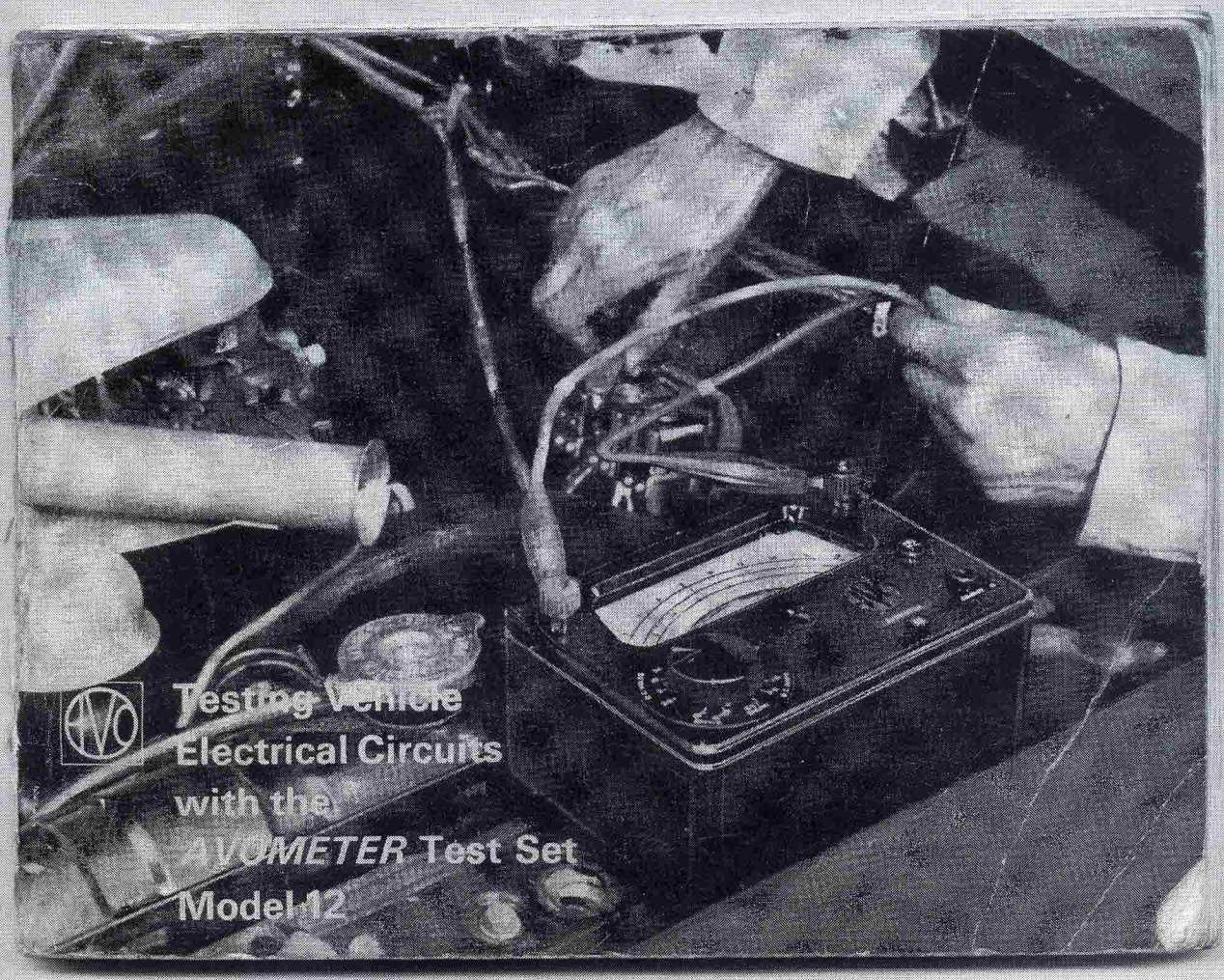


Testing Vehicle Electrical Circuits with the *Avometer* Model 12 Test Set

WARNING
When measuring voltage on live circuits, make sure that the meter is NOT switched to a current (Amps) or resistance (Ohms) range. This mistake can cause injury to the operator.

Contents

Introduction

This booklet has been produced to enable users of the *Avometer* Model 12 Test Set to operate the instrument with confidence on modern car electrical systems.

Within the compass of this publication it is not possible to provide every detail of the many tests that can be made and, where the user is a skilled auto-electrician, such information will not in any case be required. If the subject matter enables mechanics less skilled in electrical testing to benefit from the use of this instrument, the object of the booklet will have been achieved.

DO keep the instrument in its leather case when not in use. Always position it where it cannot be knocked on to the floor or otherwise handle with care. Make sure that the range switch is in the correct position before connecting to the circuit. Always keep the instrument and accessories clean and the latter in their correct positions in the accessory roll. **DO NOT** let the instrument get damp or expose it to dirty conditions. Remember the Model 12 is a highly accurate and sensitive Test Set which will give many years of satisfactory service if it is treated with reasonable care and respect. **Note:** *Although the instrument has been carefully designed for the automobile industry where a considerable amount of rough usage is anticipated, the instrument should be carefully handled and not be subjected to gross overloads.*

Specification

TABLE OF RANGES

D.C. Voltage	D.C. Current	A.C. Voltage
36V	36A	360V
18V	3·6A	90V
9V		18V
3·6V	External Shunt (90A)	9V
External Shunt*	External Shunt (900A)	

Resistance

0-1000 Ω (25 Ω mid scale)
0-10000 Ω (250 Ω mid scale)
*The "Ext. Shunt" position corresponds to 90mV f.s.d.
90A or 900A external shunts (accuracy ± 2%) are available as optional accessories.

Sensitivity

D.C. Voltage Ranges 200Ω/V = 5 mA f.s.d.
A.C. Voltage Ranges 90Ω/V = 11 mA f.s.d.

Weight of Instrument: 8 lb (3.60 kg). *Approx.*

Dimensions: $9\frac{5}{8}$" × $9\frac{1}{4}$" × $5\frac{1}{4}$" (245 × 235 × 125 mm).

Description

THE INSTRUMENT

The instrument is supplied in an ever-ready leather carrying case, complete with accessories. Range switching is accomplished by using a single switch knob, connections to the instrument being made by means of two terminals. Provision is made for polarity reversal without the need for transposing positive and negative leads. A high degree of overload protection is inherent in the circuit itself by the use of generously rated components. Further protection is provided for the movement by the use of silicon diodes which by-pass current during a period of over-load.

DESIGN AND CONSTRUCTION

The moulded front panel is used to support the meter movement, range and "reverse moving coil" switches together with the associated voltage multipliers, shunts, etc. The range switch is of a generous and robust design, the silver-plated contacts being arranged to "make before break" on adjacent positions. The case of the instrument, which is of a similar material to the panel, includes a compartment which houses the 1·5V cell used for continuity and resistance measurements. The "ever-ready" type leather case has been designed to house the instrument, and its accessories together with the instruction book.

ACCURACY

For the greatest accuracy the instrument should be used in a horizontal position.

The accuracy is as follows:—

D.C. Voltage and Current:
± 1% of f.s.d. between 10% and full-scale deflection.

A.C. Voltage:
± 2·25% of f.s.d. between 25% and full-scale deflection.

Owing to the nature of resistance scales, it is not possible to quote percentage accuracy for the whole range. As a guide, however, readings will be within ± 3% of indication around mid-scale, increasing to ± 10% of indication at deflections corresponding to 10% and 90% of the arc traversed by the pointer.

Operating Instructions

SCALING

Three basic scales are provided, each approximately 5" (12·7 cm) in length, the outer one (90 divisions), being for voltage and current measurements and is marked 0–9 and 0–18. The centre scale is also for use on voltage and current, but is scaled with 72 divisions and marked 0–36. The inner scale is for resistance and continuity only, and is scaled 0–1000 Ω, with the first indication being 0·5 Ω.

READING THE SCALEPLATE

Due to limited space available on the scale plate, it is not possible on a multi-range instrument to provide individual scales for every switch position. It is, therefore, necessary for the operator on the 90V a.c. and 360V a.c. ranges to use a basic scale, i.e. 0–9 or 0–36, and multiply his readings by a factor of 10. With the 3·6V d.c. range, the scale marked 0–36 should be used and readings this time divided by a factor of 10. It follows that the remaining ranges (except with the external shunt) may be read directly on the scale appropriate to the range chosen. The ohms range position chosen (× 1 or × 100) indicates the multiplication factor required to the reading indicated on the ohms scale.

OPERATION OF THE INSTRUMENT

The instrument can be used in the leather case after removal of the lid, the latter being so designed that it can be unobtrusively attached to the underside of the case if so desired.

For greater accuracy use the instrument face upward. If necessary, set the pointer to the left-hand zero by means of the screw marked "Z" which is situated on the front panel of the instrument.

The red lead should be attached to the positive (red) terminal, and the black lead to the negative (black) terminal.

Set the range switch to the correct position for the type of measurement to be made before connecting the leads to the circuit. If in doubt as to the magnitude of current or voltage to be measured, switch to the highest range, and then to a lower range, until a suitable meter deflection is obtained. Under these conditions, it is not necessary to break the circuit when switching ranges.

Exercise care before connecting the meter to a circuit or switching on a supply, for although a high degree of protection is inherent in the design, a prolonged heavy overload could cause damage. Severe momentary overloads can be accepted without damage, but care should

Operating Instructions

be taken to avoid such misuse. Should the pointer swing very hard across the scale, remove leads IMMEDIATELY. Never disconnect by turning the range switch to a blank position to disconnect the circuit.

For d.c. measurement, the red terminal is normally positive. Some tests may involve reversing the input polarity, in which case the indication can still be obtained without transposing leads, merely by depressing the reverse moving coil button marked "Rev. M.C."

Warning

Except in the case of low-voltage circuits, it is dangerous to make connections to live apparatus. The user is advised wherever possible to make a habit of connecting the instrument whilst the circuit is dead.

CURRENT MEASUREMENTS

Current measurements up to 36A d.c. are accomplished by connecting the instrument (set to a suitable range) in series with the circuit, i.e. in such a way that the entire current passes through the instrument. For currents in excess of 36A d.c., having first connected a suitable external shunt in series with the circuit under test (with the lead provided if required), connect the instrument (set to the range marked EXT. SHUNT) to the small studs situated at each end of the shunt. The instrument will then take a small fixed proportion of the current flowing in the circuit under test and thus indicate the total current. The 900A shunt is used in exactly the same way as described above, but is not rated for continuous operation at maximum current, and should therefore not be used for periods longer than one minute at maximum current.

RESISTANCE AND CONTINUITY

Before carrying out resistance or continuity measurements, the ohms zero must be checked and adjusted if necessary. This is carried out by setting the range switch to a resistance range and joining the leads together, after which the pointer can be brought to the ohms zero (i.e. full scale), by means of the "ADJUST OHMS" knob.

When the cell voltage has fallen, due to use or age, it may not be possible to adjust the pointer to zero, or even if this

Operating Instructions

can be accomplished the pointer indication may gradually fall. In such a case the 1·5V (SP2 or IEC R20) cell which is housed in a compartment on the under-side of the meter should be removed and replaced by a similar cell inserted in the same direction. After insertion, adjust ohms zero as described above.

To measure resistance the two leads should be connected across the component under test. It is important that anything being tested is not already carrying current, nor should the leads be connected across any source of voltage, e.g. the battery or dynamo when running.

Although most components are substantially constant as regards resistance, some vary considerably with temperature, e.g. lamps, etc., so that resistance tests only indicate continuity, and the readings obtained cannot be used to calculate wattage. The resistance of other devices, such as rectifiers, varies according to the voltage applied and the direction of current. When such tests have to be made using the resistance ranges, it should be noted that the polarity which appears at the terminals of the meter will be reversed from that shown on the panel (i.e., the positive terminal has a negative potential).

Warning

Under normal conditions the internal cell will operate satisfactorily for a very long period but it should, nevertheless, be examined from time to time, since a discharged cell may develop a leak and thus damage the instrument. If it is anticipated that the instrument will not be used for any length of time it is strongly advised that the cell be removed.

Accessories

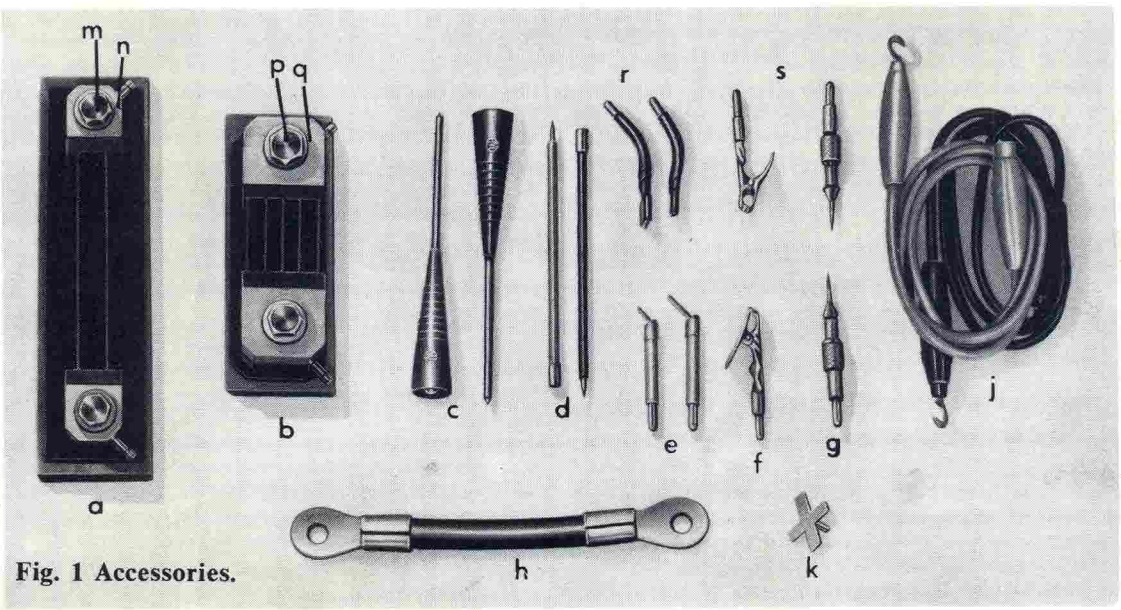


Fig. 1 Accessories.

Accessories

ACCESSORIES AND THEIR USE

In order to ensure the maximum versatility of use for the instrument, Avo Ltd. have included a range of accessories, some of which are to assist in solving special problems encountered when making measurements on automobiles. The description and use of these accessories follows, and should be used in conjunction with Fig. 1 and the appropriate items.

Item a optional extra

90A Shunt: The method of using the shunts has already been described under the paragraph headed "Current Measurements" and, when required, the shunt should be used in conjunction with the extension lead provided (Item *h*).

Item b optional extra

900A Shunt: This is an alternative to the 90A shunt described above and is used in the same manner.

Item c supplied with instrument

Long Reach Safety Clip Mk.2 Supplied in pairs, one black, one red, which can be inserted into the standard test leads (Item *j*) and will be found extremely useful for gaining access to contacts and wires in inaccessible positions. In the closed position 'prod' measurements may be made in the normal manner, a sharp steel point easily pierces varnish on printed circuit boards or soldered joints. By retracting the moulding using thumb and forefinger, a hook end is exposed which may be used as a clip to accommodate conductors up to 0·125" (3·2 mm) in diameter.

Item d supplied with instrument

Test Prods: These are included in addition to the Long Reach Safety Clips where quick measurements may be required with a moderately heavy current consumption and are adequately rated when using the internal ranges of the instrument. They should not, however, be used in conjunction with external shunts.

Items e and r spade terminals and sockets supplied with instruments

These have been specially designed to assist in making connections to spade terminals of the type found on voltage regulators, etc. Where terminals are in very close proximity to one another they reduce the possibility of leads shorting which could, in some cases, produce burning out of the unit under test. These will, no doubt, be found particularly useful when adjusting voltage regulators.

Note: *It is realised that these clips will not fit all makes and types of regulators.*

Accessories

Item f supplied with instrument

Bulldog Clips: These are a pair of moderately heavy duty clips which are capable of carrying heavy currents for sustained periods and should always be used in preference to the Long Reach Safety Clips when making connections for heavy current measurements.

Item g supplied with instrument

Battery Piercing Prods: With current production, manufacturers of motor vehicle batteries are supplying accumulators where the "bus-bars" linking the individual cells are totally enclosed, to reduce the risk of corrosion and sulphation. Cases frequently arise when it is desirable to test individual cells, when it is suspected that they are faulty. With this new type of accumulator, it is often difficult to gain access to the individual "bus-bars" to check each cell in turn. Most batteries do, however, have a small depression over each cell termination and the object of the prods is that they may be pushed into this depression, piercing the material, thus making contact without causing damage to the battery as a whole. A chuck is incorporated to facilitate easy replacement of damaged prod needles, two of which are included. Additional quantities are available, Part No. L/3322—701. To avoid the possibility of corrosion the needles should be wiped after use.

Item h supplied with instrument

Extension Lead: For use with shunts (see Items *a* and *b*).

Item j supplied with instrument

Hook-ended Leads: These are the standard leads provided with the instrument, one end of each providing termination to the meter terminals; the other, a socket, accepts all the various accessories referred to already, with the exception of Items *a, b* and *h*.

Item k supplied with instrument

Harness Connector: An additional accessory adapted for use on various English and continental cars to assist in voltage regulator measurements. When checking a voltage regulator it is necessary to disconnect two connectors from the terminals of the control box and join them together temporarily. The purpose of this accessory is to ensure that these are joined satisfactorily. The two larger contacts should be used for English cars, the other two contacts for continental cars. Care should be taken that the Harness Connector is not inadvertently earthed whilst in use.

INSTRUMENT IN USE

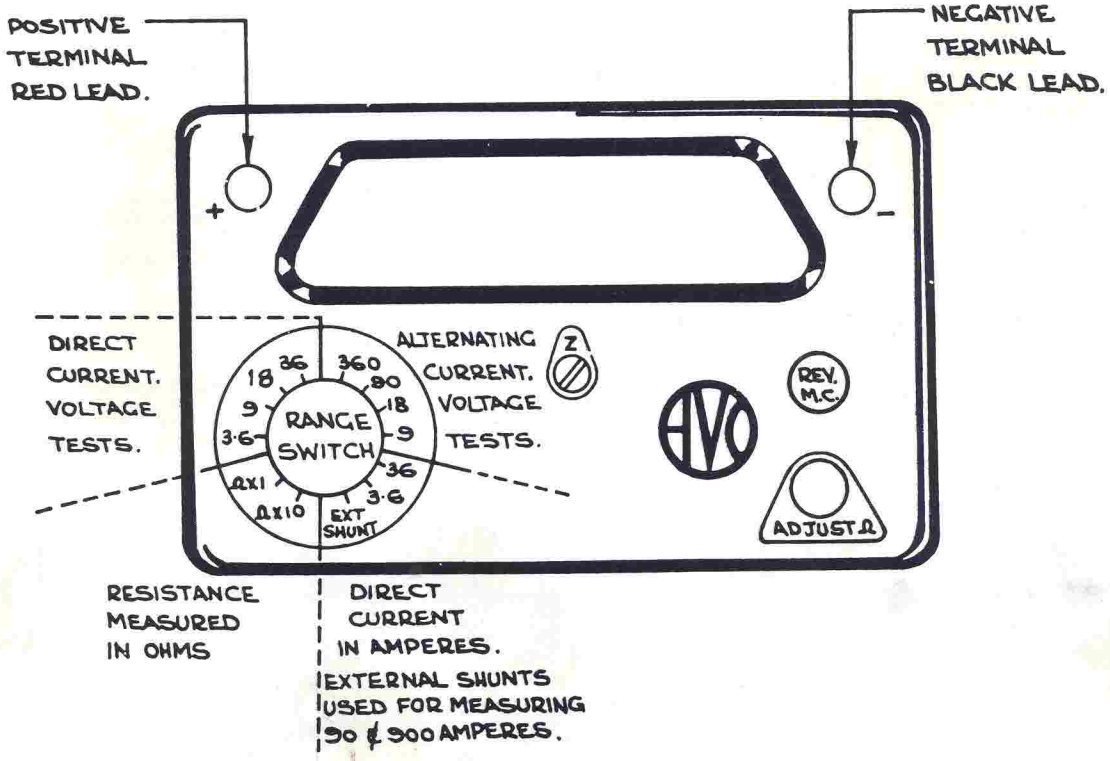
Controls and Connections

To ensure simplicity of operation the number of controls on this instrument has been reduced to a minimum. Only two input terminals are required for all measurements and leads should be connected as indicated on the diagram opposite. The Range switch should be set as required by the instructions for the test to be carried out, the functions of the other controls are as follows:

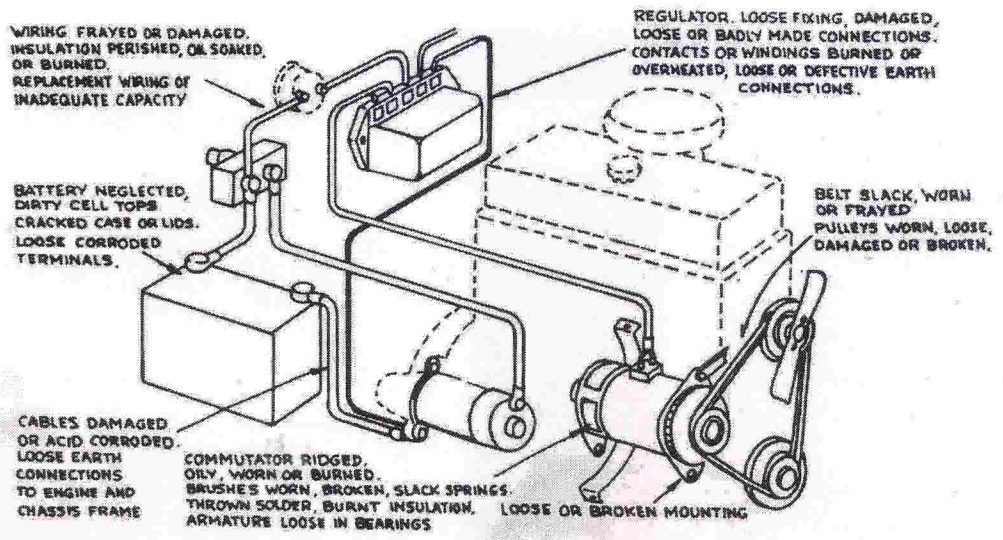
"Z" ADJUSTER — Mechanically sets instrument needle to exact zero.

"REV. M.C." — This press-button reverses the instrument without transposing leads. Do NOT press when meter is reading on scale.

"ADJUST Ω" — When measuring resistance, short circuit test leads and use the Adjuster to obtain zero ohms reading before testing commences.



Visual Inspection



DRIVING BELTS

Carefully inspect the generator drive belt and/or fan belt for incorrect tension or poor condition.

PULLEYS

See that the generator and/or fan pulleys are in good condition and not excessively worn, and the whole belt drive is in efficient condition.

GENERATOR

Where access to commutator is possible, remove the cover band and inspect for evidence of thrown solder. Inspect the commutator for dirty, burned, glazed or worn condition and for high micas between commutator bars.

Inspect generator brush gear for loose or frayed leads, worn or sticking brushes and improper brush spring tension.

REGULATOR

Carefully check the regulator and see that all leads are properly connected and that connections are tight.

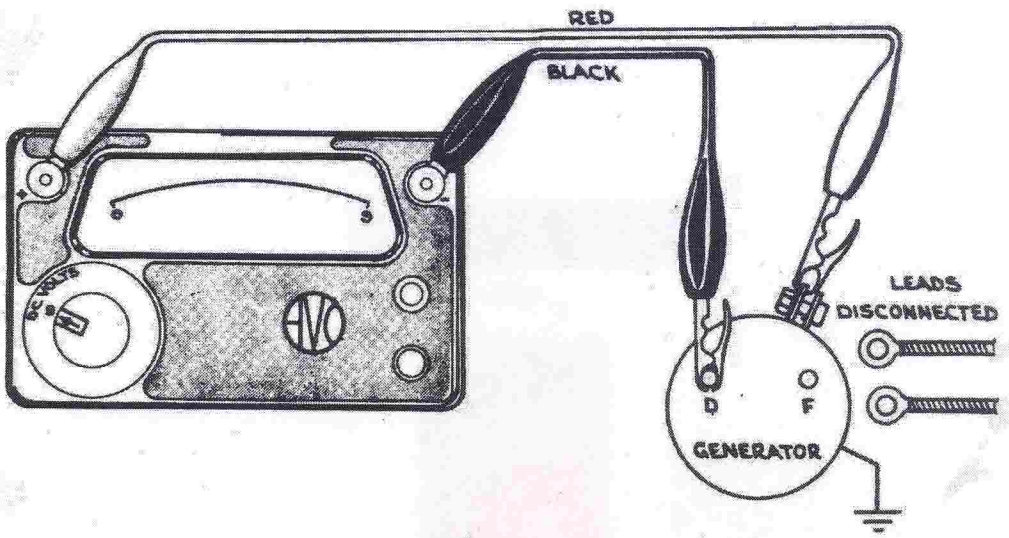
BATTERY

Check the condition and state of charge of the battery, including case and cell cover, terminals, cables and earth connections.

WIRING

Inspect the wiring for broken or partially broken leads, deficient insulation or wrong connections. Examine for oil-soaking, rubbing against sharp edges, undue stretching or other potential causes of breakdown.

Testing Lucas Generators: Test 1

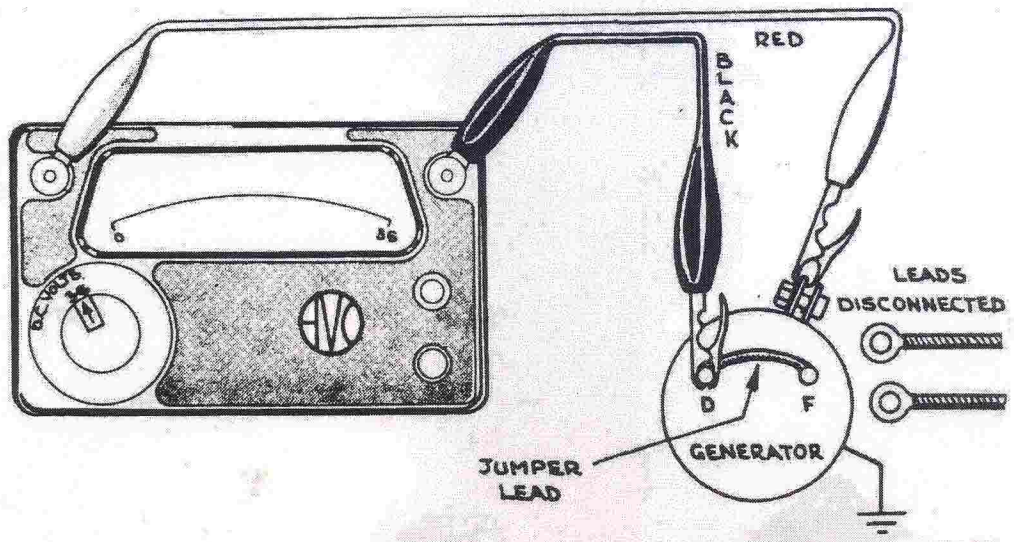


NOTE:

The diagram shows connections for positive earth vehicles. Reverse the tests leads for vehicles where the negative terminal of the battery is connected to the vehicle earth.

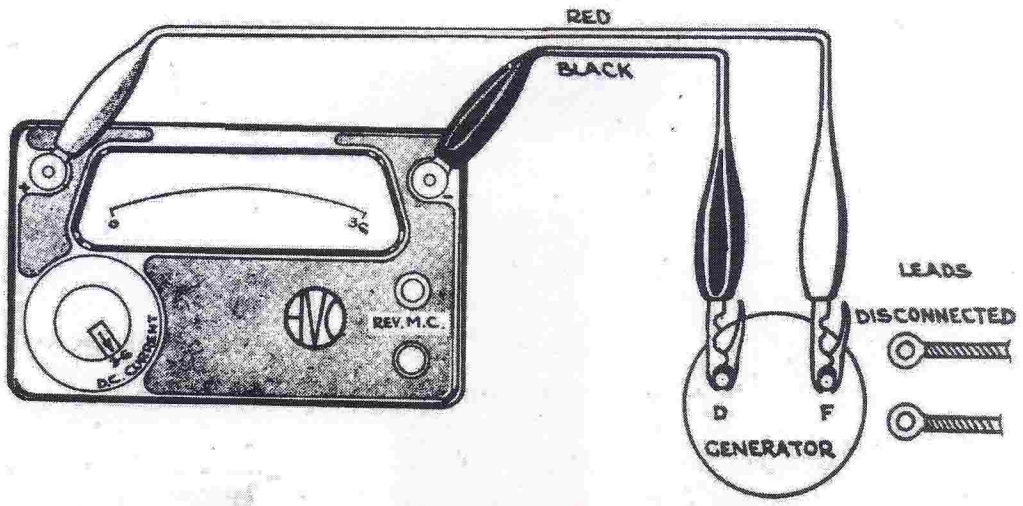
	STEP	READING	ACTION
1	Disconnect leads from generator.		
2	Turn range switch to D.C. "9V".		
3	Connect test leads.		
4	Start engine and speed up to fast idle (1500-2000 r.p.m.) Observe meter response.	(*a*) Up to 4 volts as generator speed increases.	Armature connections and residual magnetism good. Make Test 2 overleaf.
		(*b*) Zero reading.	Re-excite field as on page 54. Repeat test–no reading–generator faulty–replace.
		(*c*) In excess of (*a*) as speed rises.	Check for internal short circuit between "D" and "F" terminals.
5	Stop the engine.		

Testing Lucas Generators: Test 2



	STEP	READING	ACTION
1	Link terminals D and F.		
2	Switch to 36V. D.C. Range.		
3	Reconnect leads as Test 1.		
4	Start engine; accelerate gradually. Observe voltage rise.	(*a*) Steady rise to 30 volts (Hold at this speed to read then decelerate). (*b*) Less than 2V. (*c*) Zero volts.	Generator in order electrically. Open circuit in field coils. Faulty field coils or connections.
5	Stop engine.		

Testing Lucas Generators: Test 3
(field winding test)

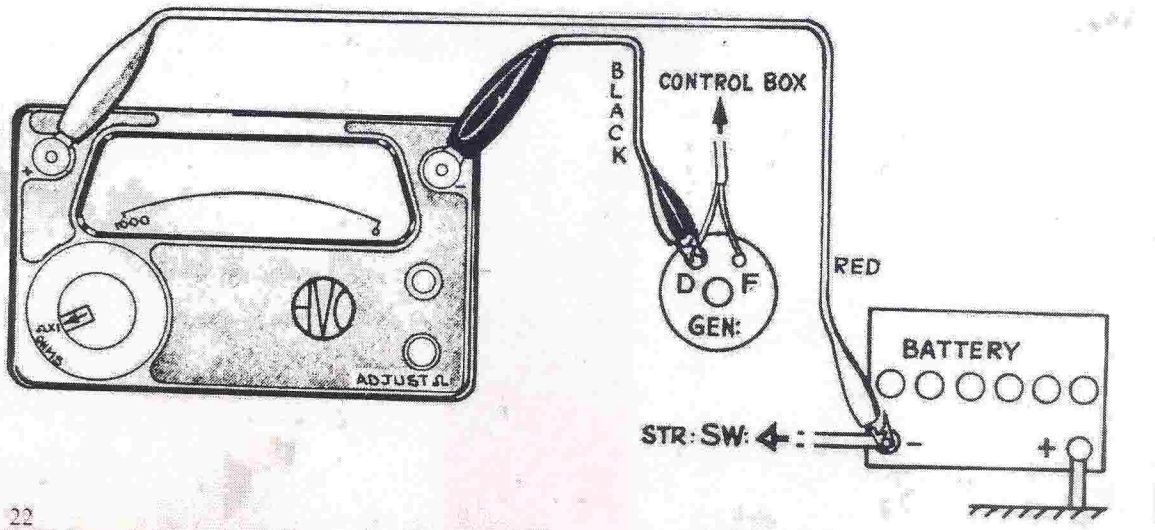


NOTE:

If test meter reads off scale (below zero), reverse test leads, or press "REV. M.C." button.

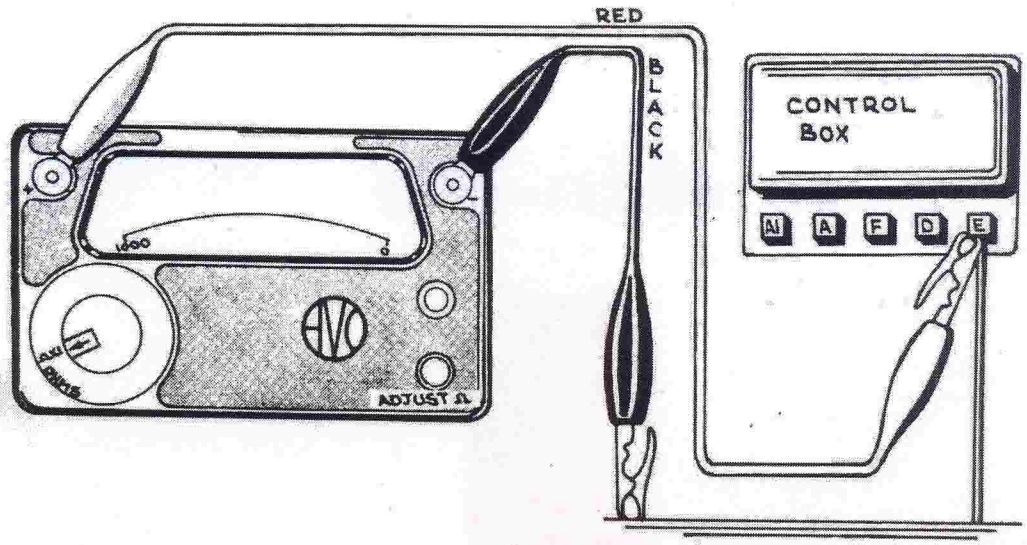
	STEP	READING	ACTION
1	Connect test set as for Test 2. (0–36V. Scale).		**Note:** Test set is connected as for Test 2 during Steps 1, 2 and 3. For Steps 4–8, connections are as illustrated opposite.
2	Run engine and adjust the throttle screw until the test meter reads "6" for 6 volt system or "12" for 12 volt system.		
3	Stop engine, leaving throttle screw adjustment as Step 2.		
4	Remove link between "D" and "F" (Test 2). Re-connect test meter as illustrated opposite.		
5	Turn range switch to D.C. current, 3.6 amps. Start engine.	(*a*) 2 amps. approximately. (*b*) Lower than 2 amps. (*c*) Higher than 2 amps. (*d*) Check with maker's data.	Field windings in order. Excessive resistance in field winding circuit. Short circuit in field winding circuit.
6	Stop engine. Detach Black lead from D. Clip lead to F, with Red lead.		
7	Switch to OMHS × 1. Correct the reading at 0 Ohms. Transfer Black lead to chassis.	Read field resistance and check with maker's data.	Excessive or low resistance— Faulty circuit. Replace generator.
8	Start engine. Re-adjust to correct idling r.p.m. Switch off ignition.		

Charging Circuit Test
(generator control box)



	STEP	READING	ACTION
1	Disconnect test leads. Refit F cable to terminal.		
2	Connect Black lead to terminal D and Red lead to cable D.		
3	Switch to 36 amps. Start engine.	Adjust speed to a reading of 10 amps. charge.	Switch off ignition without altering throttle setting.
4	Disconnect test leads. Refix D cable to terminal. Start engine.		
5	Switch to 3.6V.	(*a*) Hold connections on D terminal and battery negative terminal as shown above. (*b*) Reading not over 0.75V. (*c*) Reading exceeding 0.75V.	 Volt-drop O.K. Excessive resistance. Service needed.
6	Remove test connections, and then re-adjust throttle to idling. Switch off ignition.		

Checking Regulator Earth Connections

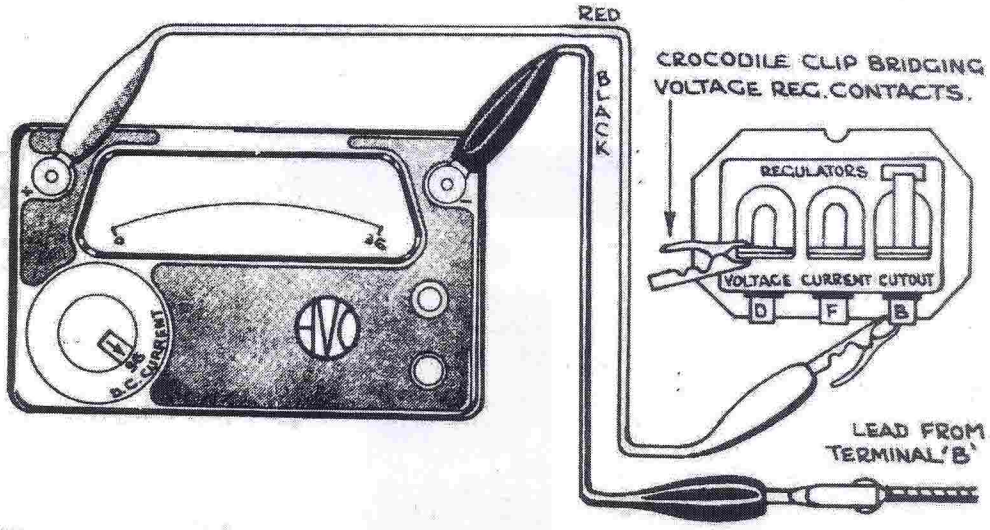


NOTE:

If BLACK lead is connected to engine block, this test will include engine earthing and chassis earth.

	STEP	READING	ACTION
1	Turn range switch to OHMS × 1.		
2	Short circuit test leads together.		
3	Turn "Adjust Ohms" button until needle reads zero ohms.		
4	With engine stationary, connect test leads as shown.	(*a*) Zero ohms.	Earth connections on control box good.
		(*b*) Resistance in circuit.	Check connections and cable.

Checking Current Regulator
(e.g. RB310)

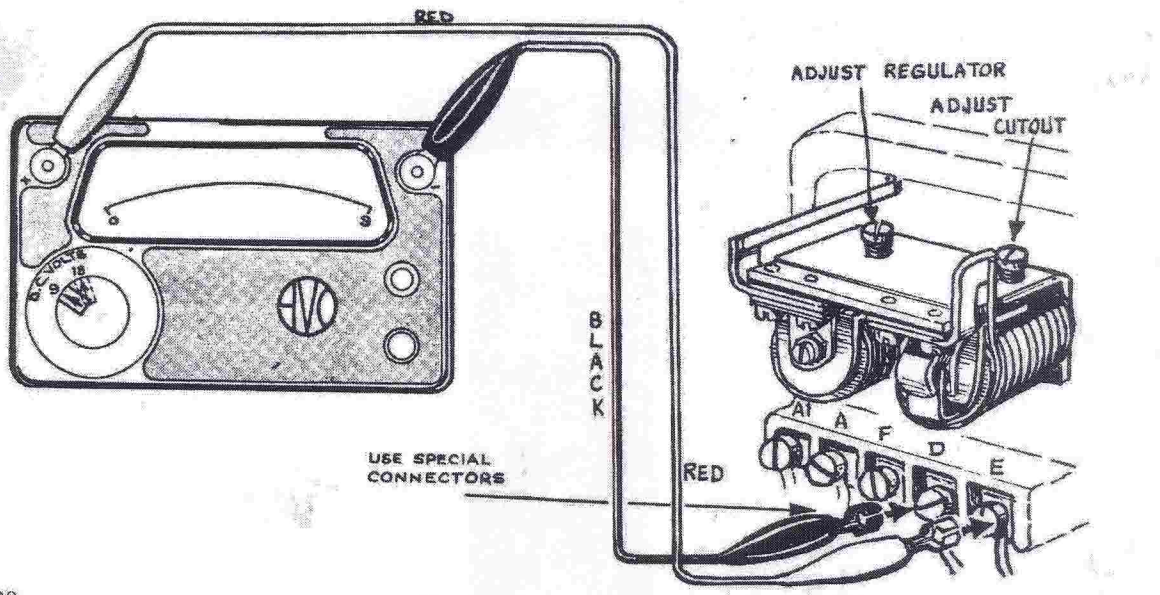


NOTE:

The battery and associated connections must be in good working order before a current regulator can be tested as above.

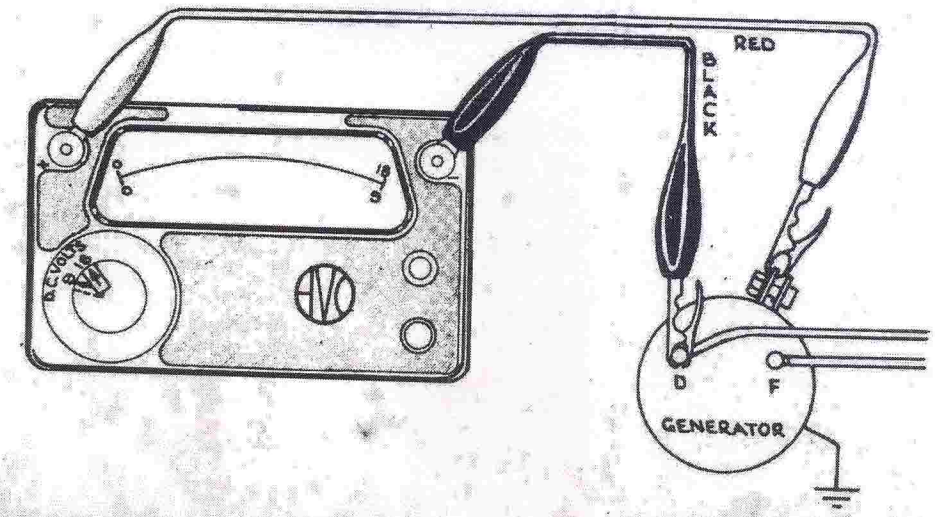
	STEP	READING	ACTION
1	Engine stationary, short circuit voltage regulator contacts with crocodile clip. Connect across contact plate and frame of regulator.		For details see illustration opposite.
2	Turn range switch to D.C. current "36" amps.		
3	Disconnect leads from "B" terminal.		
4	Connect test set between terminal "B" and lead removed as above.		
5	Start engine and run at full charging speed.	(*a*) As maker's specification at full charging speed.	Current regulator setting in order.
		(*b*) Current remains constant but outside maker's limits.	Adjust current regulator.
		(*c*) Current erratic or cannot be adjusted within limits.	Replace regulator.
		(*d*) Current low, cannot be adjusted.	Replace regulator.

Checking Voltage Regulator Setting
(e.g. CVC Unit)



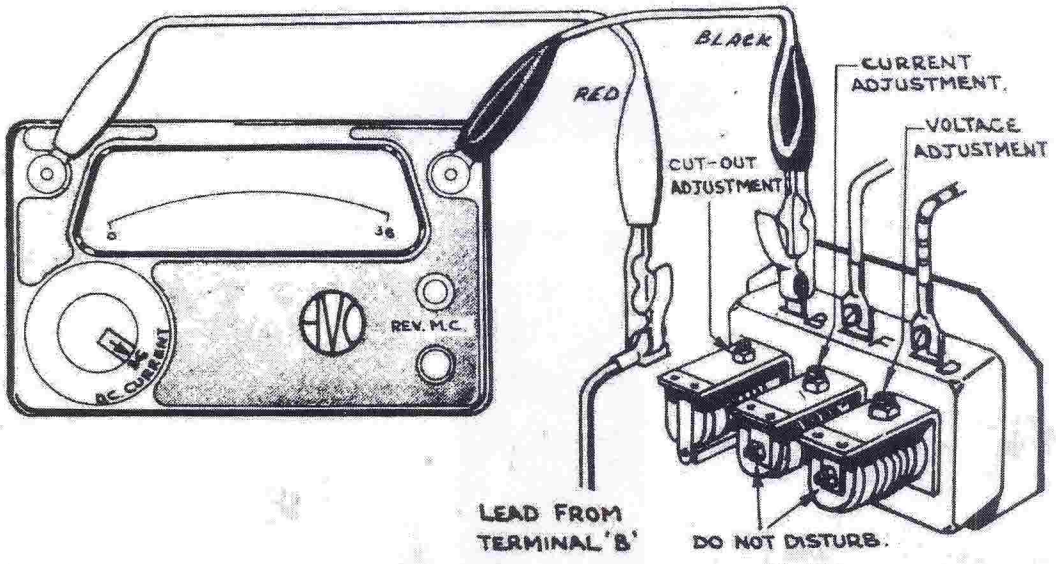
	STEP	READING	ACTION
1	Turn range switch to D.C. volts "9" or "18" (6 or 12 volt systems).		
2	Connect test leads as shown.		(Use special connectors).
3	Disconnect A and A1 cables. Secure in contact by use of clip adapter or harness connector (see operating instructions).		
4	Start engine and accelerate steadily until voltage remains stable.	(*a*) Should be within maker's specification for particular type of equipment. (*b*) Voltage constant but outside maker's limits. (*c*) Voltage rising above limits with change in speed. (*d*) Reading approximately half normal.	Regulator in order. Adjust regulator. Suspect faulty regulator shunt winding, faulty earth on regulator. Check ohms of resistance in regulator and examine regulator contacts.
5	Switch off ignition. Reconnect A and A1 cables to correct terminals.		

Checking Cut-out Operation

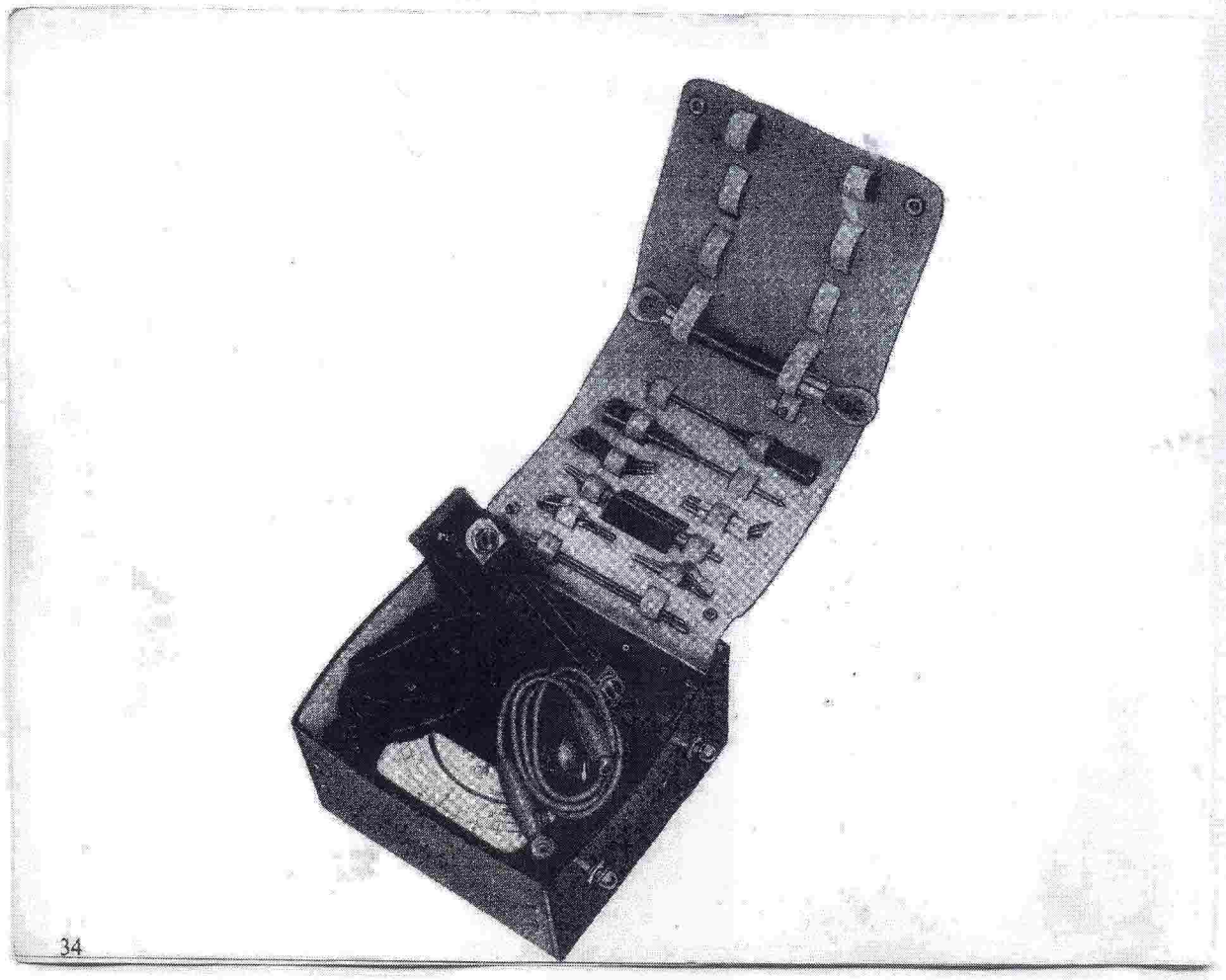


	STEP	READING	ACTION
1	Turn range switch to D.C. volts "9" or "18" (according to voltage of system).		
2	Connect as shown above.		
3	Start engine. (Idle speed).	(*a*) Slowly increase speed and observe increasing voltage. Note the reading at the instant when the pointer flicks back to a steady indication as the cut-out closes.	Closing voltage within data limits —cut-out adjusted correctly.
		(*b*) Cut-out closing at too low or too high a reading.	Adjust armature spring, pole gap, etc., as maker's data.
		(*c*) Cut-out fails to close at a voltage 50% over normal.	Replace control box.

Checking, Charging and Cut-out Reverse Currents



	STEP	READING	ACTION
1	Before changing connections from previous test, decrease speed and note voltage when cut-out opens.	Voltage within limits shown in data. Voltage higher or lower than specified.	Adjustment correct. Adjust according to maker's data.
2	Switch off ignition. Disconnect leads. Switch to 36 amps.		
3	Connect as shown opposite.		
4	Start engine. Adjust speed to maximum charging rate.	Compare reading of car ammeter.	If incorrect, advise new ammeter.
5	Reduce speed gradually and when output falls to zero, press Rev. M.C. button.	Note increasing reverse current and maximum reached as cut-out opens.	Reverse current should be 3–5 amps. Check with data.



34

USA Regulators and Generators

Basic Principle

The standard U.S.A. type regulator consists of three units—(1) a cut-out relay, (2) a voltage regulator and (3) a current regulator. The complete circuit is illustrated in Fig. 12 which shows the basic arrangement and wiring of the complete unit.

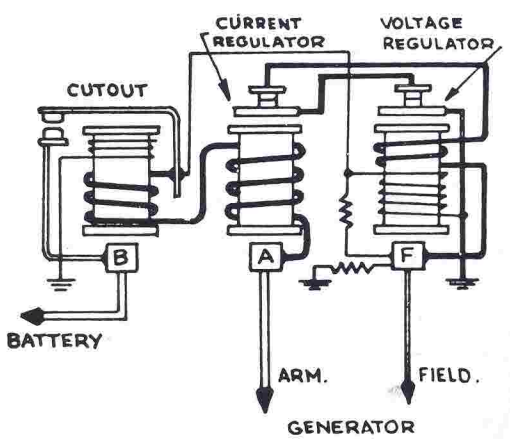


fig. 12. *Basic 3 unit U.S.A. Regulator*

Purpose of the Regulator

The cut-out relay automatically connects the generator to the battery at charging speeds and when the vehicle slows or stops it automatically opens the circuit between the generator and battery to prevent the battery from discharging back through the generator.

Both voltage and current regulators perform the same basic functions of varying the strength of the generator magnetic field to maintain a predetermined output characteristic.

Generator voltage is held at the designed constant level by the vibratory action of voltage regulator contacts—bridged by a resistor—in limiting field current and magnetic excitation.

The difference between battery voltage on charge and the regulator generator voltage determines mean charging current.

As battery voltage increases, the difference diminishes, and the charging rate declines.

The current regulator limits field excitation in a similar manner, by vibration of its resistor-bridged contacts, in series with those of the voltage regulator, but the current regulator is sensitive only to excess

USA Regulators and Generators—*continued*

Purpose of the Regulator—*continued*

current. A heavy charging rate, due to the low back-voltage of a discharged or faulty battery, may well prevent generator voltage reaching regulated level.

The voltage regulator is therefore inoperative, but the action of the current regulator takes over field excitation control, and consequently limits generator output to a safe maximum—holding the output down to a designed level and safeguarding against overload of generator, battery, or circuit.

Types of Generators

Two types of generators are used on U.S.A. vehicles, one referred to as "standard duty" or "type A" generator and the other as "heavy duty" or "type B" generator.

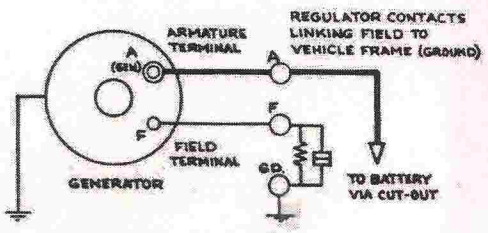


fig. 13. *Type A Generator Circuit*

The type "A" generator is shown in Fig. 13 and has the regulator resistance inserted between the field circuit and earth (ground). The type "B" generator is shown in Fig. 14 and has the regulator resistance inserted between the insulated side of the circuit and

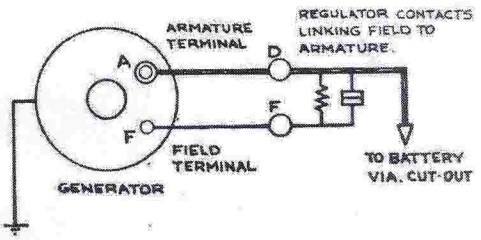


fig. 14. *Type B Generator Circuit*

the generator field. The terms "standard" and "heavy duty" are used only to describe the types of circuit and have no reference to the actual output of the generators. Both circuits are commonly used, standard Delco-Remy and Autolite being generally type "A" and Ford, Lincoln and Mercury type "B".

Basic Tests

An orderly procedure should be followed for testing the vehicle electrical system. The recommended order

is a preliminary visual inspection followed by a test of the battery, generator, charging circuit resistance, regulator visual inspection, regulator voltage testing and regulator current testing. The general visual inspection should include all terminal and earth connections, the condition of contacts and resistors and a careful check for possible maladjustment. Windings and resistors should be checked for signs of overheating and the regulator number and polarity checked with the manufacturer's specifications.

Determination of A type or B type Field Circuit

Before making any tests on American generators (not alternators), the field type and earth polarity should be established, as follows:—

(1) Make connections and switching as in page 30. ("Arm." or "A" terminal is equivalent of "D").

(2) Run engine at fast idle. Bridge F terminal to chassis.

Observe meter reading:

(*a*) Voltage increases, reading on scale—Generator is "A" type with earth polarity as test lead to chassis.(page 30 shows pos. earth).

(*b*) No voltage increase: bridge F terminal to "A" Voltage now increasing proves "B" type field. Earth polarity as earthed test lead.

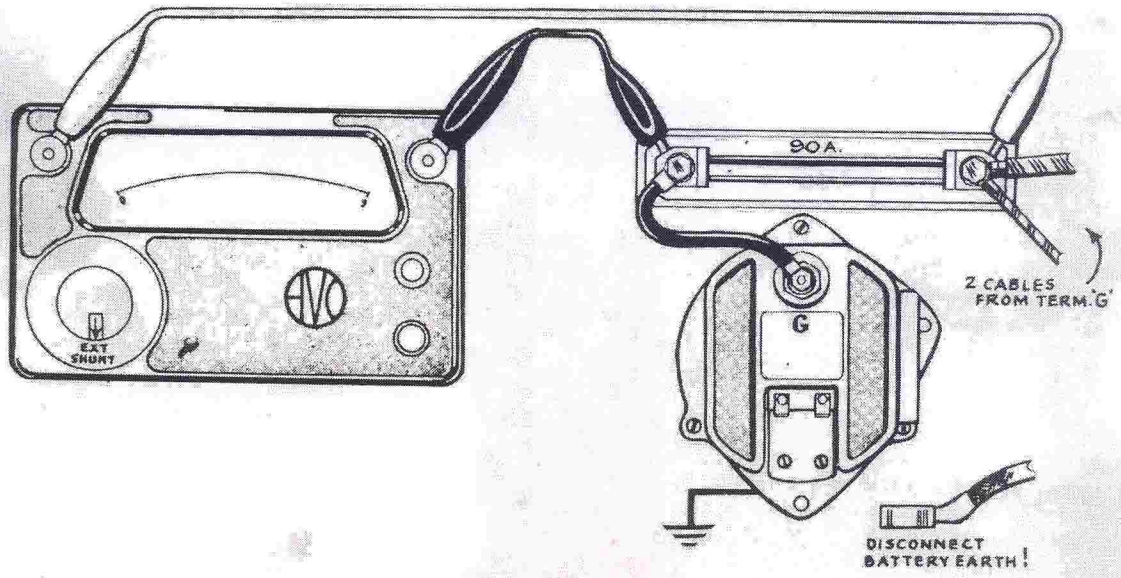
(3) Where meter pointer moves towards left of zero, test connections are reversed. Exchange Red and Black leads on terminal and chassis. Readings will now be on-scale and earth polarity as earthed test lead.

There is a wide variation in test procedure and in methods of adjustment, etc., in American equipment, so that detailed instructions must be sought in the Service Data and Workshop Manuals of relative makers. The same general principles govern application of the *Avometer* to test procedures as has already been outlined for Lucas equipment, using the 3.6V. D.C. range for volt-drop measurements, or the 9V., 18V. or 36V. D.C. ranges for generator and line voltage checks.

The external shunt, connected in series with the charging circuit, enables currents up to the maximum rating of the shunt to be measured and read on the appropriate meter scale.

In a generator control box application, the shunt should be connected between "B" terminal and the cable previously detached from it, in order to measure charging current.

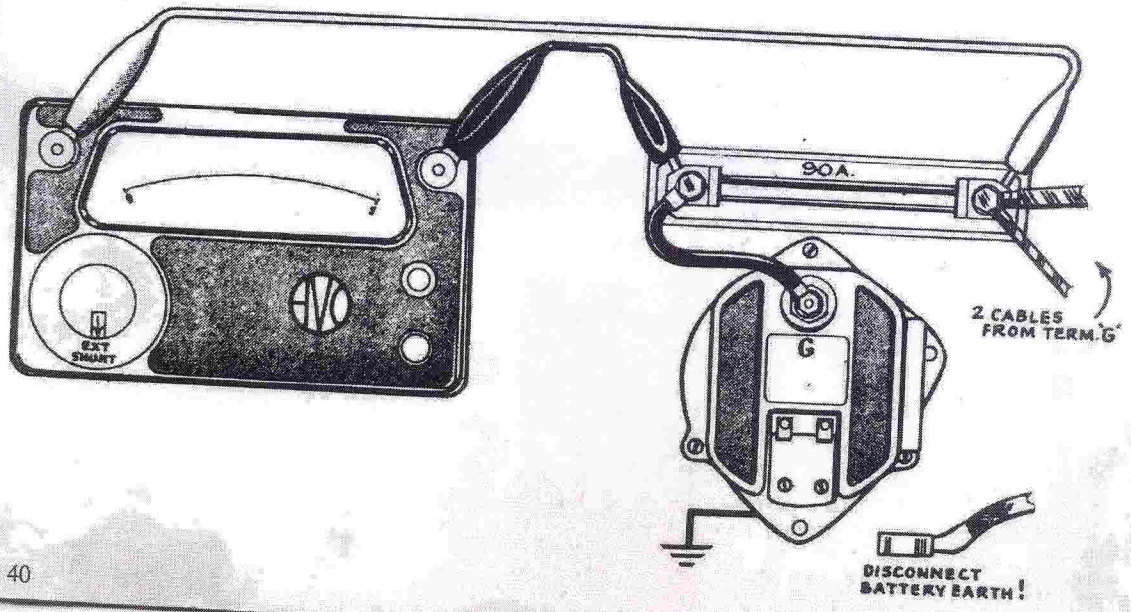
Testing Lucas Alternators Type 2AC: Test 1



NOTE: Use special shunt leads for connecting *Avometer*.

	STEP	RESULT	ACTION
1	Disconnect vehicle battery earth lead.		
2	Disconnect both cables from alternator output terminal "G".		If in excess of 45 amps.—satisfactory.
3	Connect 90 amp. *Avo* shunt between "G" and two cables disconnected in Step 2.		A low reading at 2,500 r.p.m. indicates faulty alternator, bad earth, or poor wiring connections.
4	Disconnect BROWN-GREEN cable from control box terminal "F" and temporarily connect it to chassis earth.		Zero amps. indicate faulty alternator, field isolating relay, or associated circuit.
5	Re-connect battery earth lead. Turn range switch to "EXT. Shunt". Connect test leads to shunt.		If relay fails to close, rotor field is open circuit at terminals C1 to C2 in the relay. Make Test 2.
6	Start engine. Increase speed slowly to approximately 2,500 r.p.m.	Reading should be in excess of 45 amps., with alternator at ambient temperature.	

Testing Lucas Alternators Type 2AC: Test 2

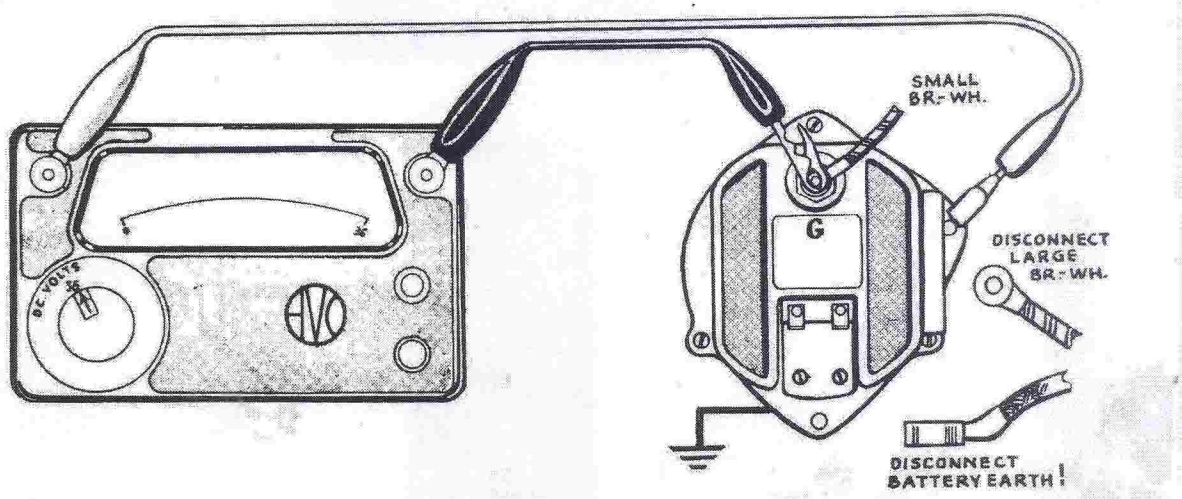


	STEP	RESULT	ACTION
1	With connections as for 1st Test, connect Jumper across "C1" and "C2" on relay.		
2	Run engine at 2,500 r.p.m.	Reading in excess of 45 amps.	Relay faulty. Check windings, wiring, earth connections.

NOTE:

If after making Tests 1 and 2 the output is unsatisfactory, if the 2TR control box earth is satisfactory and previous wiring checks have been made, the fault lies in the control unit. The manufacturer recommends a replacement unit. The open circuit voltage can, however, be checked as outlined overleaf.

Testing Lucas Alternator Control Box Type 2TR
(open circuit voltage)



42

	STEP	RESULT	ACTION
1	Disconnect vehicle battery earth lead.		
2	Disconnect thick BROWN-WHITE cable from alternator "G" terminal, leaving smaller BROWN-WHITE — (connecting to relay "C1"), in position.	Take care **NOT** to short circuit battery lead to earth.	
3	Turn range switch to D.C. volts "36" connect as shown.		
4	Re-connect battery earth lead. Start engine.		
5	Raise engine speed to half throttle, slowly reduce until alternator speed is approximately 3,000 r.p.m.	Voltage should be 14.4 to 14.8 at 20°C. (68°F.).	Note: *Add* 0.1 volts to these figures for every 10°C. or 18°F. *below* 20°C. *Subtract* 0.1 volts for every 10°C. above 20°C. Adjust if necessary as shown on page 44.

Testing Control Box Type 2TR—*continued*
(adjustment)

If necessary, adjust the setting by continuing as follows:

	STEP
6	Remove regulator cover.
7	Alter setting screw (*clockwise to increase, anti-clockwise to decrease*) on regulator voltage setting, whilst maintaining alternator speed at approximately 3,000 r.p.m. Make adjustments as quickly as possible.
8	Increase alternator speed to 4,500 r.p.m. Open circuit voltage MUST NOT exceed 15.8V.
9	Stop engine. Remove vehicle battery earth lead.
10	Replace BROWN-WHITE lead on "G" terminal.
11	Re-connect battery earth lead.

Fault Diagnosis of Type 2AC Alternator Circuit

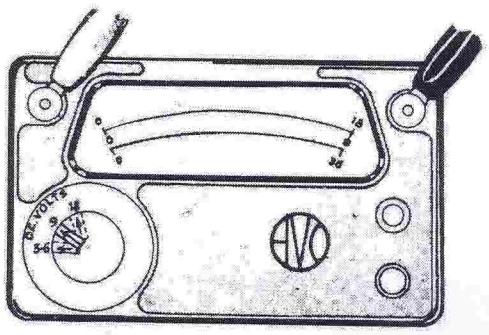
IMPORTANT POINTS TO WATCH:

The following points should be checked: Belt tension, pulley condition, earth and wiring connections, correct opening of relay contacts. The control box is polarised to suit vehicle earth. *If wrong battery terminal is earthed, regulator and alternator rectifiers will be damaged.*

CHARGING FAULTS

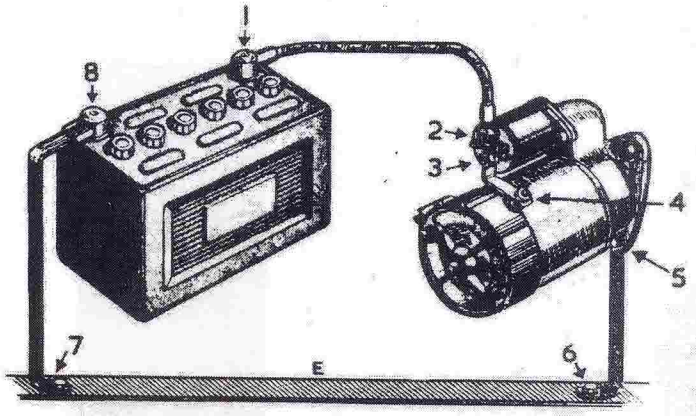
1	**Vehicle battery in low state of charge** Check battery. Check alternator belt tension. Make preceding tests as necessary. Check field isolating relay releases when ignition switch is open.
2	**Battery overcharged** Make test shown on page 43. Check battery.
3	**No charge or intermittent charge** Check driving belt. Make tests as necessary (pages 38 to 43).

Checking Battery, Starter and Starter Circuit



Using 3.6, 9 or 18 volt ranges according to tables opposite, make voltage checks as indicated, by connecting RED and BLACK leads to numbered positions.

Fit fused jumper lead to earth the distributor terminal. This prevents engine starting.

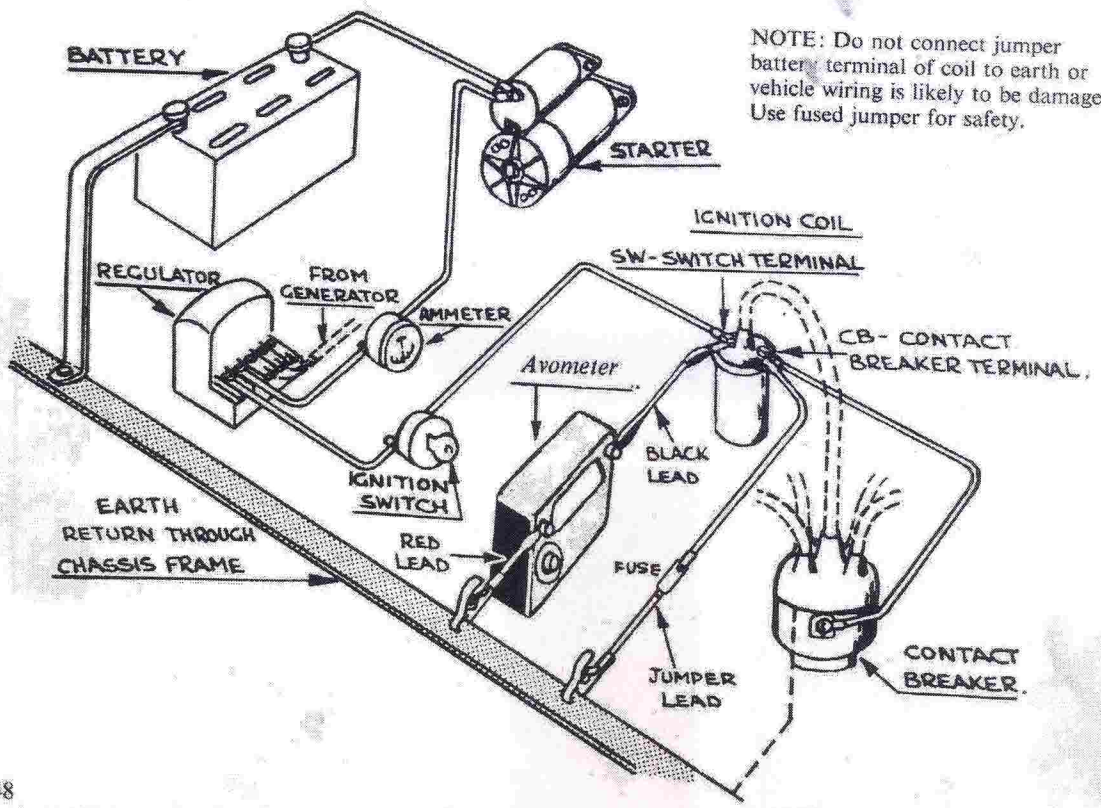


TEST	METER RANGE	CONNECTIONS BLACK	CONNECTIONS RED	MAXIMUM PERMISSIBLE VOLTS READING	CIRCUIT TESTED
1	D.C. 3.6	1	2	0.2 Maximum	Battery to Starter switch (Solenoid).
2	D.C. 3.6	3	4	0.2 Maximum	Starter switch (Solenoid) to starter.
3	D.C. 3.6	5	6	0.1 Maximum	Starter to chassis
4	D.C. 3.6	7	8	0.1 Maximum	Chassis to battery
5	D.C. 9 or 18	1	8	4.5 or 9.0 *Minimum*	Battery
6*	D.C. 9 or 18	2	3	0.5 Maximum	Switch contacts and connections

*The voltage will read approximately full battery volts until starter is operated and then the voltage must be no greater than 0.5 volts maximum.

REMEMBER: ALL TESTS ARE MADE WITH STARTER OPERATING

Testing Ignition Primary Circuit

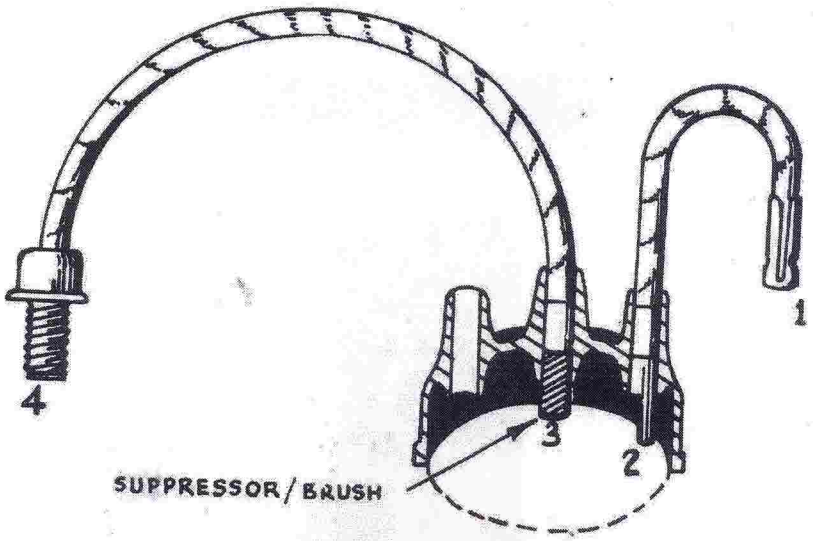


NOTE: Do not connect jumper battery terminal of coil to earth or vehicle wiring is likely to be damaged. Use fused jumper for safety.

STEP	
1	Turn range switch to "9" volts or "18" volts. D.C., depending if 6 volt or 12 volt system.
2	Connect instrument and fused jumper as opposite.
3	Switch on ignition. Reading should not be more than half a volt less than the battery voltage.

STEP		READING	ACTION
4	Check reading.	If Voltmeter reads less than 11½ or 5½, it indicates that there is high resistance between battery and coil or a weak battery.	Test battery voltage drop throughout circuit with test voltmeter.
5	Operate Starter.	If volts fall below 4.5 or 9 volts. (*a*) Battery weak or defective. (*b*) Connections corroded. (*c*) Poor battery cables. (*d*) Defective starter switch or starter.	 Test, charge and re-test battery. Clean or replace battery cable. Replace battery cables. Recondition or replace starter switch or starter.
6	Cranking speed uneven.	(*a*) Cylinder compression uneven. (*b*) Starter drive defective.	Test cylinder compression. Test starter and drive.

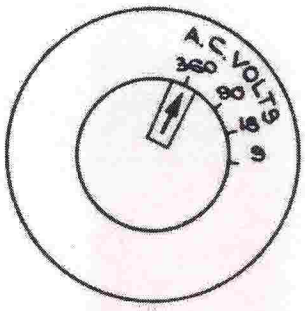
Testing Radio Suppressors in Ignition System



50

	STEP	READING	ACTION
1	Range switch to "Ohms × 10".		
2	Adjust needle to zero on ohms scale using "Adjust Ohms" button.		See page 25 Steps 2 and 3.
3	Remove distributor cap. Connect instrument at points 1 and 2 (Polarity of leads immaterial).	Special suppressed leads will have resistance to 3,000 ohms per inch.	If reading is excessive, remove and test leads separately.
4	To test coil lead and suppressed brush, connect across 3 and 4.	Suppressed lead may be as above, alternatively, long pick-up brushes will be 12,000 ohms approx.	If the reading is excessive, change brush and re-test.
5	Re-fit distributor cap.		

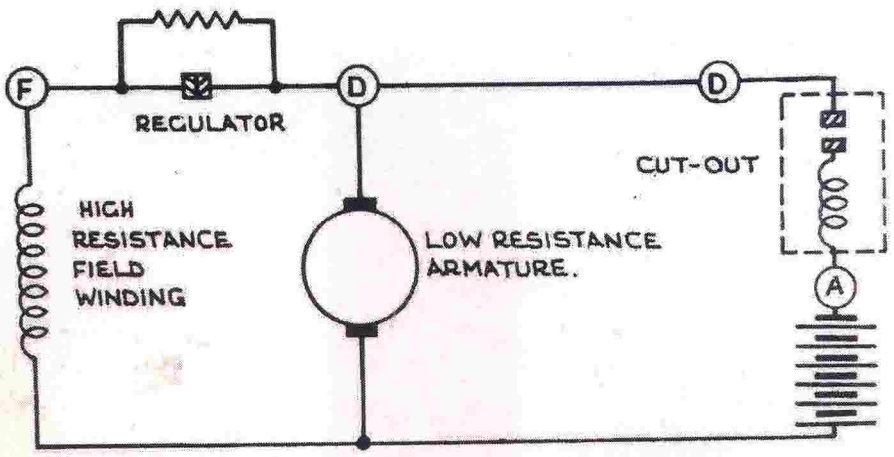
Testing Mains, Power Supplies and AC Circuits



To test A.C. supplies, use one of the A.C. ranges and the special pair of prodclips to prevent danger from electrical shock.

USES	*AVO* A.C. VOLTS RANGE
Heater supplies to radio valves. Low voltage, A.C. systems on scooters, etc.	**9**
Motorcycle and car alternators, tachometer transmitters. Low voltage lighting systems.	**18**
A.C. circuits on battery chargers (excluding Mains input side).	**90**
General—single phase A.C. mains supplies—A.C. supplies on car radios.	**360**

Checking Generator for residual magnetism



A generator will only excite if a small amount of residual magnetism has been left in the iron from a previous excitation.

It is harmful to press in the cut-out armature on the vehicle to re-magnetise the iron in the generator, since a heavy current may take the low resistance path through the commutator and armature (see illustration opposite) causing damage. Further, the cut-out contacts will be burnt.

To re-magnetise, proceed as follows:—

	STEP
1	Disconnect the cable from the field terminal on the dynamo
2	Momentarily, "Flash" the "F" terminal with a short length of cable connected to the "A" or live battery terminal. Repeat Test on page 17.

Instrument Repairs and Spares

The manufacturers service and spares organisation for AVO instruments:—

AVO LIMITED
Parts and Service Centre
Archcliffe Road,
Dover,
Kent CT17 9EN,
England
Tel. Dover (0304) 202620
Telex: 96283 Avomeg G

Approved Repair Companies
A number of independent instrument repair companies in the UK have been approved for repair work on AVOMETER instruments, using genuine AVO spares. Their names and addresses are listed in the AVO Warranty Booklet supplied with each new instrument.

Overseas
Instrument owners outside Great Britain should consult the Appointed AVO Distributor/Agent for their country regarding spares and repair facilities. The Distributor/Agent will advise on the best course of action to take. Names and addresses of Overseas Distributors/Agents are given in the AVO Warranty Booklet supplied with each new instrument.

If returning the instrument to Britain for repair, it should be sent, freight pre-paid, to the Parts and Service Centre at the address shown opposite. A copy of the Invoice and of the Packing Note should be sent simultaneously by airmail to expedite clearance through the UK Customs.

A repair estimate showing freight return and other charges will be submitted to the sender, if required, before work on the instrument commences.

NEW AVO INSTRUMENTS ARE GUARANTEED FOR 12 MONTHS FROM THE DATE OF PURCHASE BY THE USER.

Schedule of Spare Parts

FRONT PANEL ASSEMBLY 50127/A

Item	*Quantity*	*Part No.*	*Description*
1	1	3876-422	Front Panel Bare
2	1	6120-478	Movement Assembly (See next page for breakdown details)
3	1	3876-405	Window Glass
4	1	21321/A	Leaf Switch Assembly
5	1	B45633	Resistor Board Assembly (See next page for breakdown details)
6	1	6120-017	Red Terminal Complete
7	1	6120-016	Black Terminal Complete
8	1	6120-048	Black Terminal Cap
9	1	6120-047	Red Terminal Cap
10	1	6140-002	Ohms Zero Knob
11	1	3674-105	Ohms Zero Brush Arm
12	1	16113/A	Ohms Zero Resistance Strip (RV1)
13	1	21428/A	Shunt Strip (R1)
14	1	11577/13	Window Clip, left hand*
15	1	11577/14	Window Clip, right hand* **Secures Window to Panels*
16	4	3552-403	Brass Spacer for Scale Plate
17	4	3823-613	Rubber Sleeve for Item 16
18	4	14941/34	Spacing Pillar for Items 17 and 18
19	1	6150-024	Contact (Located on Panel under Item 4)
20	1	3627-109	Spring Contact between Items 10 and 11
21	2	3344-504	Contact Pillar
22	1	3828-302	Movement Zero Screw
23	1	3177-207	Spiral Spring for Item 22
24	1	3155-517	Switch Knob
25	1	23148-306	Click Ball for Item 24
26	1	3672-707	Contact Spring for Switch Ring
27	1	3672-706	Contact Spring for Switch Ring
28	1	6120-071	Switch Ring
29	2	3634-709	Switch Contact
30	1	3218-202	Selector Switch Plate
31	1	3675-502	Selector Switch Contact Arm
32	1	3873-104	Selector Switch Cap
33	1	3527-301	Movement Mounting Plate
34	1	3828-314	Rev. Moving Coil Button
35	1	3258-706	Model Button

Schedule of Spare Parts

***MOVEMENT ASSEMBLY 6120-478 (CALIBRATED)**

Item	*Quantity*	*Part No.*	*Description*
1	1	3557-107	Scale Plate
2	1	30006/AC	Movement Bobbin (R16) (adjust to suit movement)
3	1	5390-018	Movement Frame
4	1	6230-010	Jewel Screw Top
5	1	6230-012	Jewel Screw Bottom
6	1	20672/G	Moving Coil Assembly
7	2	28468/511	Rectifier, type 10D8 (MR2 MR3)

***IMPORTANT NOTE:**
Unless facilities are available for *expert* repair it is considered advisable to return this complete assembly to our works for servicing.

RESISTOR BOARD ASSEMBLY 6220-178

Item	*Quantity*	*Part No.*	*Description*	*Circuit Reference*
1	1	21320/A	Board with Tag	
2	1	3645-311	Support Bracket, left hand	
3	1	3645-309	Support Bracket, right hand	
4	1	26448-336	Resistor 600 Ω	R12 †
5	1	26448-958	Resistor 810 Ω	R13
6	1	26834-339	Resistor 700 Ω	R8 *
7	1	26451-554	Resistor 1080 Ω	R9
8	1	26454-016	Resistor 3600 Ω	R11
9	1	26452-616	Resistor 1800 Ω	R10
10	1	30006/YH	1·02 Ω Bobbin	R4
11	1	26455-321	Resistor 6500 Ω	R14
12	3	26455-764	Resistor 8·1k Ω	R15
13	1	30006/BJ	13·97 Ω Bobbin	R3
14	1	30006/CJ	8 Ω Bobbin	R7
15	1	26446-406	Resistor 240 Ω	R6
16	1	30006/EJ	23·5 Ω Bobbin	R5
17	4	28413-211	Diode OA95	MR1
18	1	27215-502	Potentiometer 150 Ω	RV2

† was 740 Ω * was 710 Ω

Schedule of Spare Parts

CASE ASSEMBLY 40599D

Item	*Quantity*	*Part No.*	*Description*
1	1	3883-304	Case Bare
2	1	3876-204	Battery Cover
3	4	22316-839	Rubber Foot
4	2	21151-645	Rivet (Secures Item 3 & 8 to case)
5	2	3666-108	Shaped Battery Contact
6	2	3513-426	Flat Contact (Fixed to Battery Box)
7	1	3271-139	Instruction Plate
8	1	25511-013	Battery SP2 1·5V (BY1)
9	2	21151-558	Rivet (Secures Item 1 & 8)

ACCESSORIES (See Illustration Page 9)

Item	*Quantity*	*Part No.*	*Description*
a	1	6220-256	90A Shunt
b	1	6220-251	900A Shunt
		also available	
		6220-257	180A Shunt
		6220-258	360A Shunt
c	1	6220-008	Long Reach Safety Clip Mark 2 (Black)
c	1	6220-009	Long Reach Safety Clip Mark 2 (Red)
d	1	6120-012	Red Prod
d	1	6120-013	Black Prod
e	1	6150-042	Large Spade Connector
	1	6150-043	Small Spade Connector
f	2	6120-003	Bulldog Clip
g	2	16192/A	Battery Piercing Prod Assembly (complete)
h	1	21341-2	Shunt Ext. Lead
j	1	6220-001	Meter Lead Black
j	1	6220-002	Meter Lead Red
k	1	3331-711	Harness Connector
m	2	21463-089	Hex. Hd. screw for (a)
n	2	21172-782	Washers for (a)
p	2	21464-731	Hex. Hd. screw for (b)
q	2	21172-383	Washers for (b)
r	1	6130-065	Large Spade Socket
		6130-064	Small Spade Socket
s	2	3322-701	Prod needles for (g)
—	1	6320-146	Instrument Case Leather
—	1	6170-082	Instrument Book

Components List

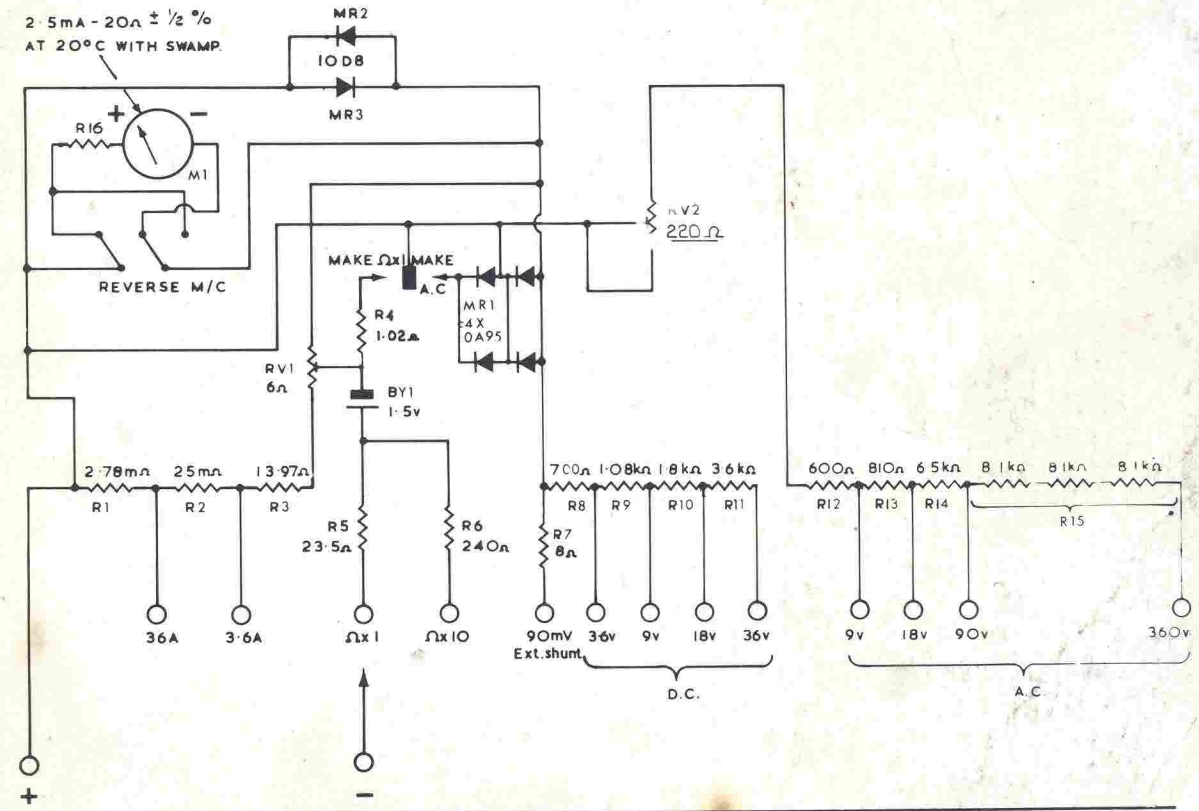
See circuit diagram of instrument on facing page.

CCT Ref.	*Description*	*Remarks*
R1	2·78 milli-ohms	
R2	25 milli-ohms	
R3	13·97 Ω	±0·25%
R4	1·02 Ω	
R5	23·5 Ω	±0·5%
R6	240 Ω	±0·5%
R7	8 Ω	±0·25%
R8 *	700 Ω	±0·3%
R9	1080 Ω	±0·3%
R10	1800 Ω	±0·3%
R11	3600 Ω	±0·3%
R12 *	600 Ω	±1·0%
R13	810 Ω	±0·5%
R14	6500 Ω	±0·5%
R15	3x8·1k Ω	±0·5%
R16	Swamp Bobbin	Adjust to suit Mvt.
RV1	6 Ω	
RV2	150 Ω	
MR1	4xOA95	
MR2	10 D8	Internl. Rectifier
MR3	10 D8	Internl. Rectifier
M1	Meter Movement 2·5mA f.s.d.	
BY1	Battery 1·5V	Ever-Ready SP2

* was 710 Ω † was 740 Ω

Circuit Diagram

Avometer Model 12



Avo Limited

Archcliffe Road
Dover, Kent, England
Tel : Dover (0304) 202620

Telegrams & Cables :
AVOMEG Dover
Telex : 96283 AVOMEG G

Part No. 6170-082 Edition 2

Printed in England BP/0,4M/7L