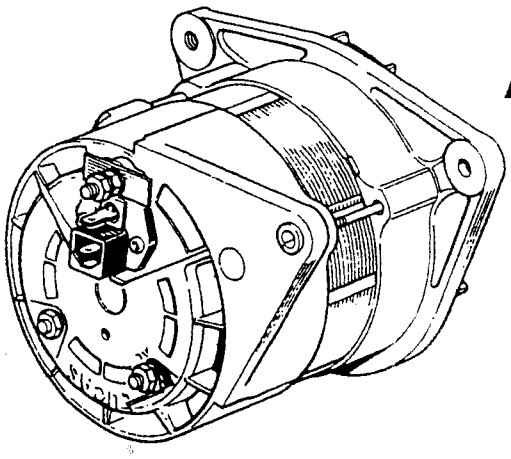
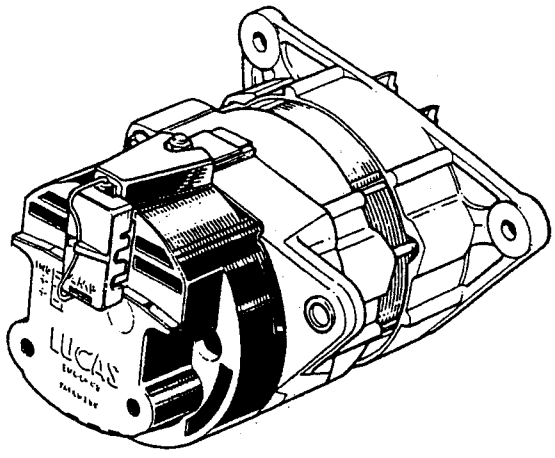
ALTERNATORS





INTRODUCTION

The alternator produces alternating current which is converted to direct current before being connected to the vehicle electrical system. In this respect the alternator and dynamo are similar, since the current generated in the armature windings of the dynamo is also alternating current which has to be converted to direct current before it can be used to charge the vehicle battery.

In the case of the dynamo, the alternating current is rectified by means of a commutator and brush-gear. The output of the alternator is rectified by semi-conductor devices, which allow electricity to flow in one direction only – and so supply uni-directional current to the vehicle electrical system.

The alternator output is controlled by a voltage regulator which is completely electronic, having no vibrating contacts. The use of printed circuits and semi-conductor devices make this type of regulator more reliable and more stable than the conventional type of mechanical regulator used with dynamos.

No cut-out is required with this type of control since the semi-conductor devices prevent reverse currents from flowing. Also, the self-regulating properties of the alternator limit the output current to a safe value so that there is no need for a current regulator.

The latest alternators represent an important development in design, as the alternator and voltage regulator are combined to form a single unit, the regulator being housed within the end cover of the alternator. This simplifies the charging circuit without changing the operating principles.

Alternator design and construction allows a wider speed range and utilisation of higher pulley ratios, which in turn enables the battery to be charged at lower engine speeds. This can be beneficial in high density traffic conditions and on modern vehicles with high electrical loads.

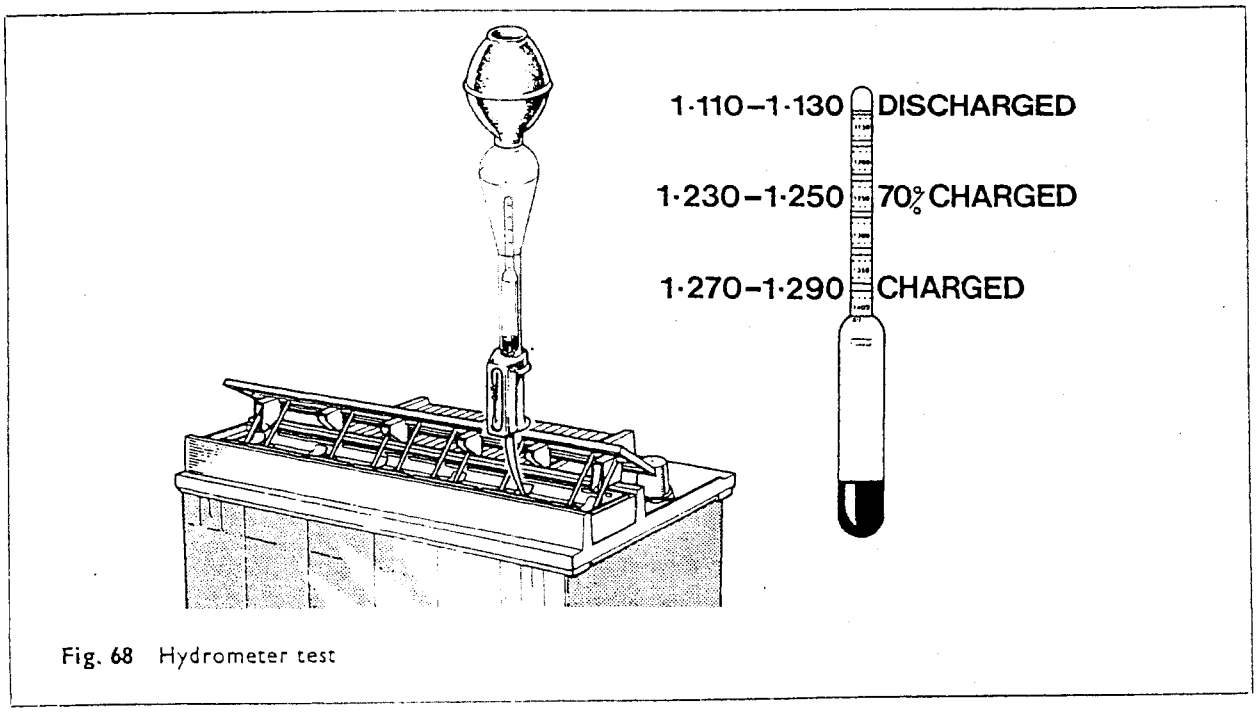


Fig. 68 Hydrometer test

In this section we shall discuss the test procedure for two types of A.C. system:

1. The battery-excited machine (10AC and 11AC), where the alternator field depends on the battery, via a relay, for its initial excitation. Consequently, a flat battery would result in no charge even if the vehicle is started by towing, which is possible with a Diesel engine.
2. The self-excited machine (the AC and ACR range), where, although some excitation is provided from the battery via the warning light this is not essential as the machine is capable of supplying its own field circuit when driven fast enough. The difference between an AC and ACR system is that the former uses an external regulator whilst the ACR has its regulator incorporated in the machine.

TEST 1. Battery Test

Using a hydrometer, check that the battery is at least 70% charged and in good condition, see Fig. 68.

A battery fault can have an adverse effect on the charging system. For example, a sulphated battery will produce a low charge rate while a battery with a shorted cell will produce a high charge rate.

TEST 2. Drive Belt Tension

Allow 13–19 mm (0·5"–0·75") play when moderate finger pressure is applied to the longest run of belt. See Fig. 69.

The alternator will not charge the battery if the drive belt is too slack. On the other hand, an excessively tight belt may damage the bearings.

If the belt is worn or oily, it should be replaced with a premium grade type.

TEST 3. Connections

Ensure that all leads are in position.

TEST 4. Checking 6RA Relay

The purpose of the 6RA relay is to de-energise the alternator field winding, when the engine is stationary.

The relay is connected to the ignition switch so that it operates only when the ignition is switched 'on'. The rotor field is completed by contacts 'C1' and 'C2'. The alternator will not charge the battery if the relay contacts fail to close.

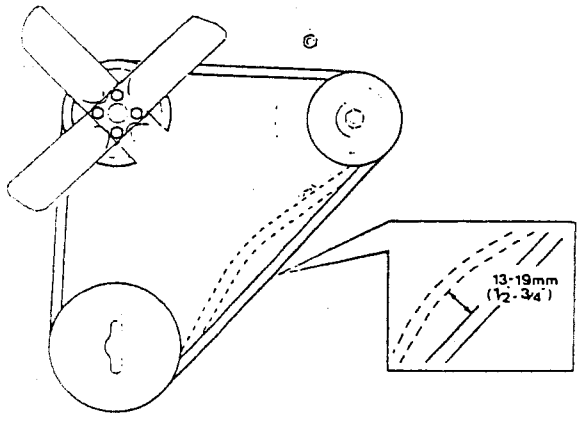


Fig. 69 Drive belt tension

(a) With the engine stationary, disconnect the battery earth cable and connect an ammeter in the alternator main output lead as shown in Fig. 70.

(b) Remove the cables from terminals 'C1' and 'C2' at the relay and link together. Re-connect the battery earth cable, switch on the ignition and run the engine at 1,500 rev/min.

(c) If the ammeter now shows a charge, the previous failure was due to the relay, or its associated wiring, connections etc.

(d) Connect voltmeter across 'W1' and 'W2'. The voltmeter should read battery voltage if the relay has a good earth and supply. If no reading, proceed to (e).

(e) Check relay earth connection by connecting the voltmeter between 'W1' (white lead) and a good earth. The voltmeter should read battery voltage. If not, check that the supply lead (via ignition switch) and its connections are in good condition.

Note: Some vehicles are fitted with a pressure switch in the relay earth lead. Connect a temporary

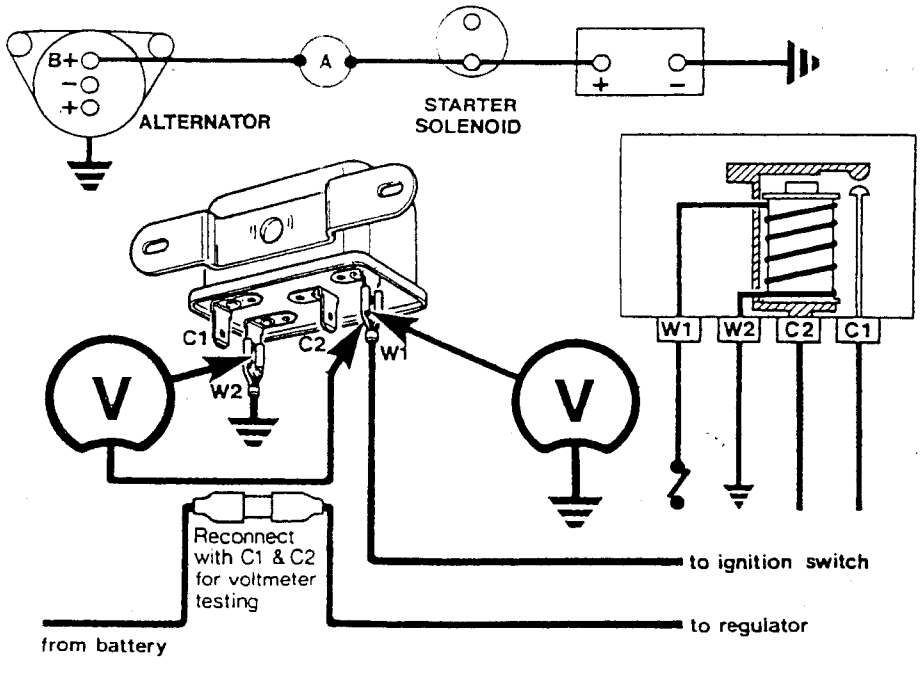


Fig. 70 Checking 6RA relay

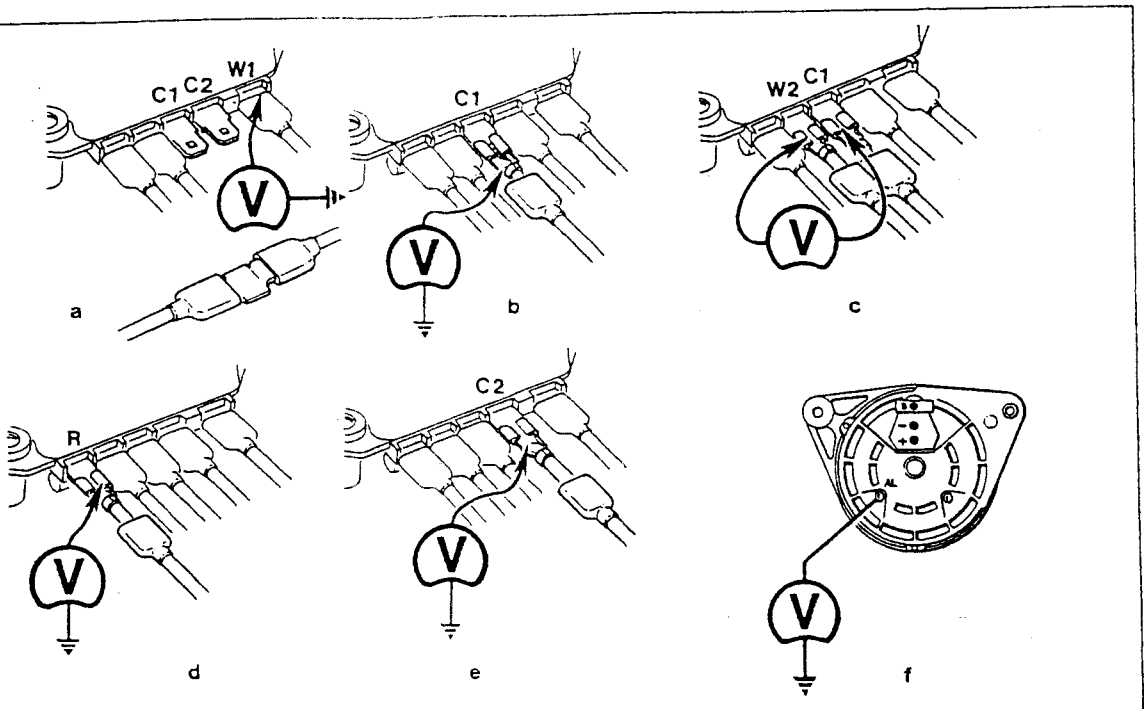


Fig. 71 Checking 16RA relay

lead between terminal 'W2' on the relay and earth. If voltmeter now reads battery voltage, the pressure switch is probably faulty.

TEST 5. Checking 16RA Relay

The 16RA relay is checked in a similar manner to the 6RA. The various checks are shown in Fig. 71.

Connect ammeter in the main charging lead to the battery.

(a) Remove connections 'C1' and 'C2' and link together (Fig. 71a). Connect voltmeter between 'W1' and earth.
Run alternator at charging speed (1,500 engine rev/min).
Ammeter should now show a charge and the voltmeter 6–8V.

Note: 1. If the alternator stops charging when 'C1' and 'C2' are re-connected to the relay, proceed to Test (b).
2. If ammeter indicates a charge but voltmeter reads zero, proceed to Test (c).

(b) The following circuit checks *must* be carried out before condemning the relay.
Connect voltmeter between the following points:

	Results
(i) 'C1' and earth (Fig. 71b)	— System voltage
(ii) 'C1' and 'W2' (Fig. 71c)	— System voltage

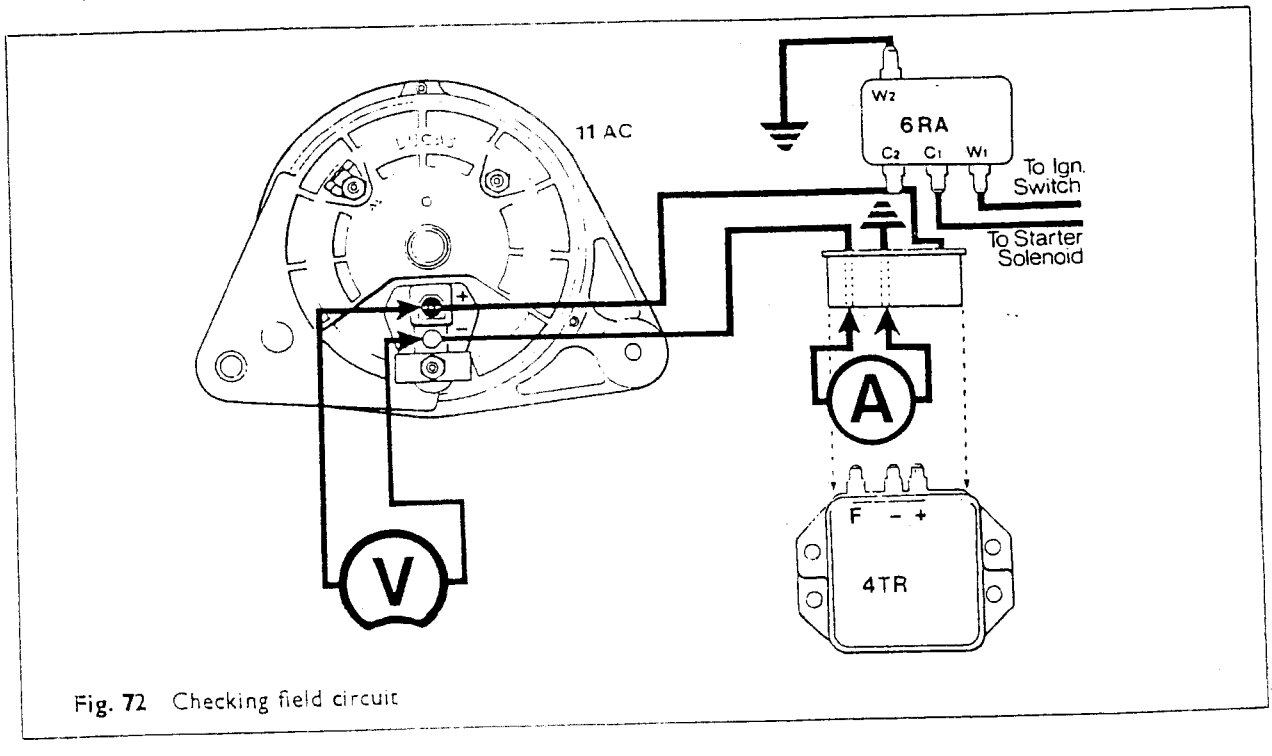


Fig. 72 Checking field circuit

With ignition switched on

(i) 'R' and earth (Fig. 71d) — System voltage

(ii) 'C2' and earth (Fig. 71e) — Approx. 2 volts

(c) Remove 'AL' lead at alternator and connect voltmeter between 'AL' terminal and earth (Fig. 71f). Run engine at charging speed.

Voltmeter should read 6–8V (12V systems) or 14–15V (24V systems).

If meter shows zero reading, replace alternator.

TEST 6. Checking Field Circuit

Disconnect leads from the voltage regulator and link together 'F' and '—' terminals, using an ammeter, Fig. 72. (If 16RA is used, connect terminals 'C1' and 'C2'). With the ignition 'on' the ammeter should read approx. 3A.

Note: If there is no reading, connect a voltmeter across alternator field terminals. Close ignition, if the voltmeter reads battery voltage there is a fault in the alternator field. No reading indicates a wiring fault between the alternator field terminals and the relay or regulator 'F' terminals (on positive earth check earth fly-lead).

TEST 7. Checking Alternator Maximum Output

Short out 'F' and '—' and connect the ammeter in the main output lead at the alternator or starter solenoid, as shown in Fig. 73. Run the engine at approx. 3,000 rev/min. The ammeter reading should be:

Alternator Model	Ammeter Reading
10AC	35A
11AC	45A
11AC (23580)	60A
(23633)	
11AC (24V)	23A

A zero or low reading indicates that the alternator stator and/or diode circuit is faulty.

TEST 8. Checking Voltage Regulator Setting (4TR)

The 4TR voltage regulator is checked at normal operating temperatures on closed circuit conditions using a well-charged battery.

(Run cold engine at charging speed for at least 8 minutes).

(a) With ammeter in the main output cable, connect a voltmeter across the battery terminals. See Fig. 74.

(b) Switch on side lamps, start and run engine at approx. 3,000 rev/min.

(c) Ensure that the voltage regulator is regulating. (The ammeter must indicate less than 10A and should not increase with speed).

(d) Voltmeter reading should be between the limits:

10/11AC Alternators	Voltage Regulator Setting (Volts)
12V systems	13·9 – 14·4
24V systems	27·9 – 28·3

Note: 1. A low reading indicates a faulty 4TR unit.

2. If the reading is higher than the limits or unstable, the test should be repeated with the voltmeter connected across the '+' and '—' terminals of the 4TR unit.

3. A high reading indicates a faulty 4TR unit. A correct reading denotes a high resistance in the sensing circuit which must be located and remedied.

4. An unstable reading is due either to a high resistance in the circuit (which must be checked) or a faulty 4TR unit.

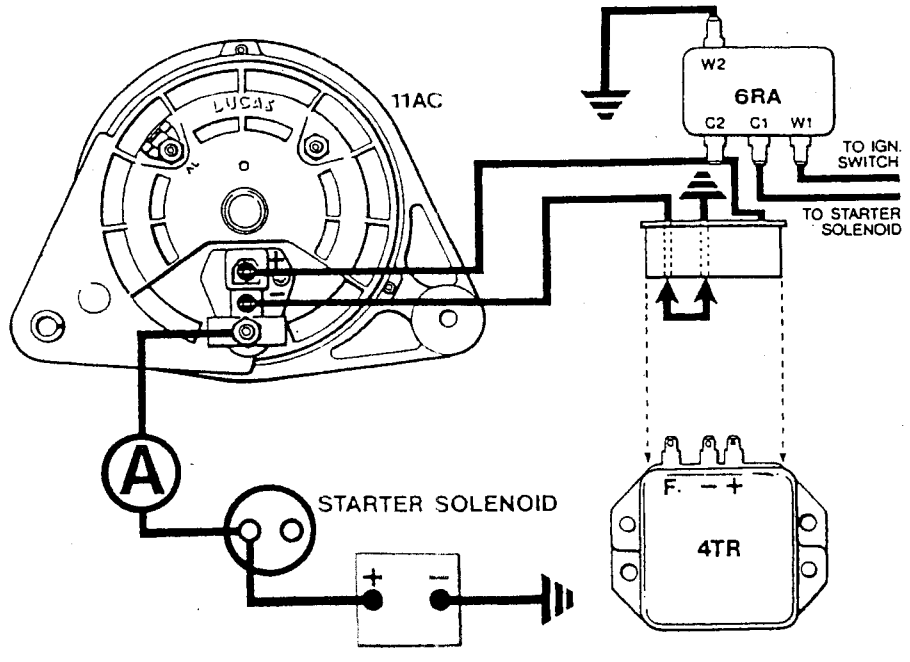


Fig. 73 Checking alternator maximum output

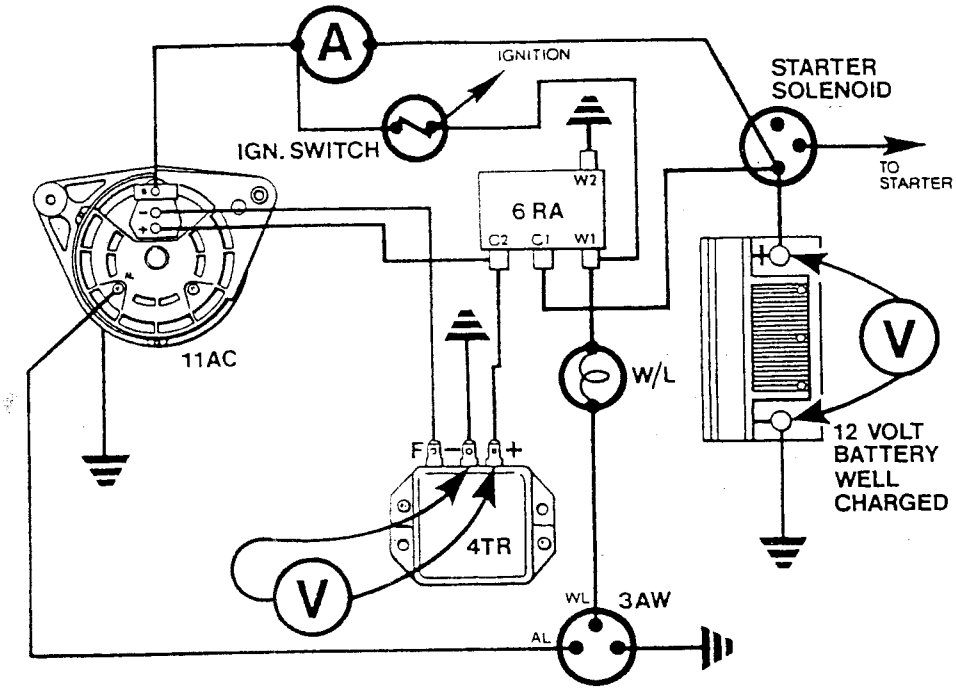


Fig. 74 Checking voltage regulator setting (4TR)

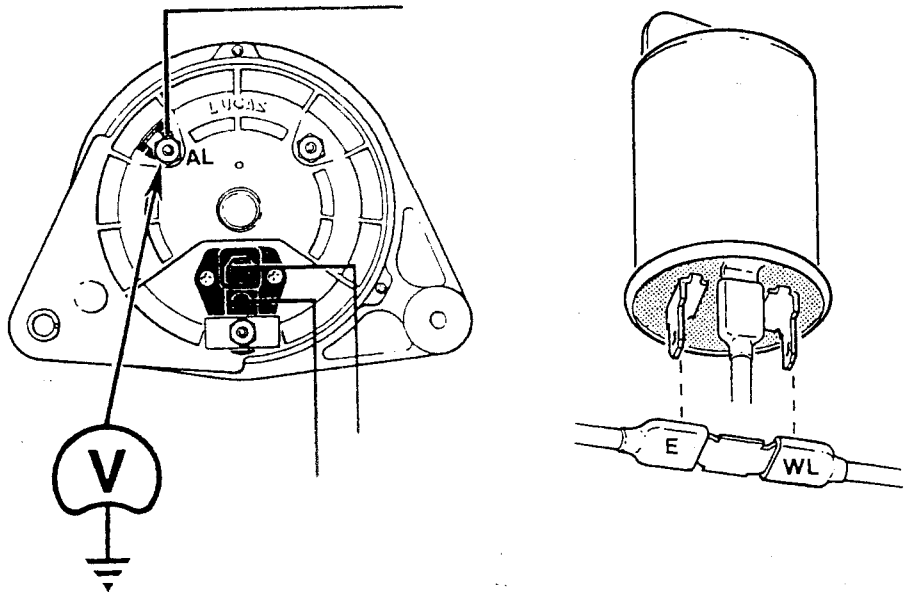


Fig. 75 Checking 3AW warning light control

TEST 9. Checking 3AW Warning Light Control

The 10AC and 11AC alternator systems normally incorporate a 3AW charge warning light control.

If the charging system is operating satisfactorily, but the warning light does not function correctly (either by remaining 'on' or 'off'), it indicates that the 3AW or the connecting wire is faulty.

(a) Connect a voltmeter between the 'AL' terminal of the alternator and earth. (Fig. 75a).

(b) Start and run the engine at approx. 1,500 rev/min. The voltmeter should read between 6–8V (12V systems) or 14–15V (24V systems). A high voltage or no reading at the 'AL' terminal indicates faulty rectifier diode.

(c) Remove the leads from terminals 'E' and 'WL' on the 3AW, and link them together (Fig. 75b). When the ignition is switched 'on', the warning lamp should be illuminated.

Note: 1. If the bulb now lights, the 3AW control is probably faulty.

2. Should the warning light remain out, the bulb and circuit should be checked.

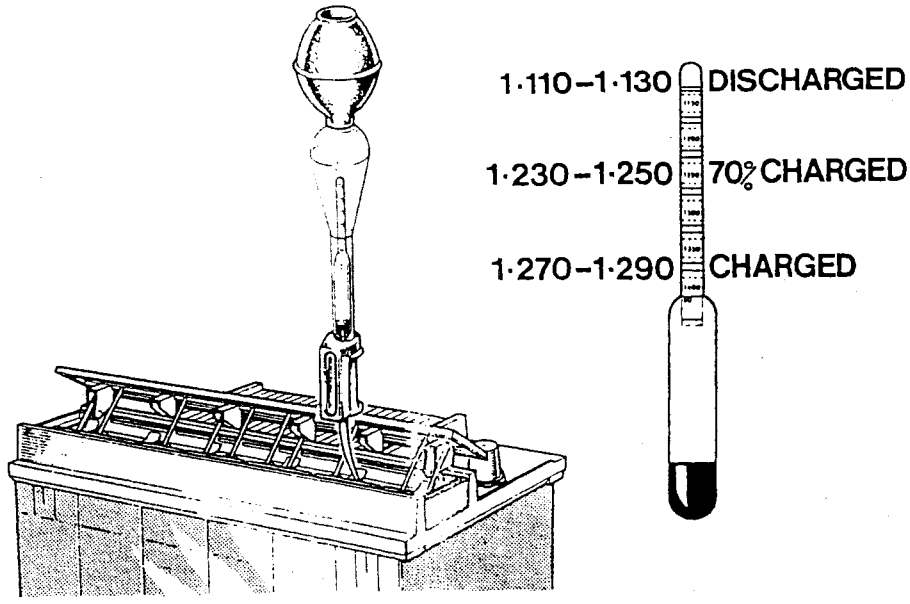


Fig. 76 Hydrometer test

15/16/17/18/20ACR SYSTEMS

TEST 1. Battery Test

Using a hydrometer, check that the battery is at least 70% charged and in good condition, see Fig. 76.

A battery fault can have an adverse effect on the charging system. For example, a sulphated battery will produce a low charge rate, whereas a battery with a shorted cell will produce a high charge rate

TEST 2. Drive Belt Tension

Allow 13–19 mm (0·5"–0·75") play when moderate finger pressure is applied to the longest run of the belt, see Fig. 77.

The alternator will not charge the battery if the drive belt is too slack. On the other hand, an excessively tight belt may damage the bearings.

If the belt is worn or oily, it should be replaced with a premium grade type.

TEST 3. Connections

Ensure that all leads are in position.

TEST 4. Cable Continuity

(a) Remove all the connections from the alternator terminals.

(b) Switch on the ignition.

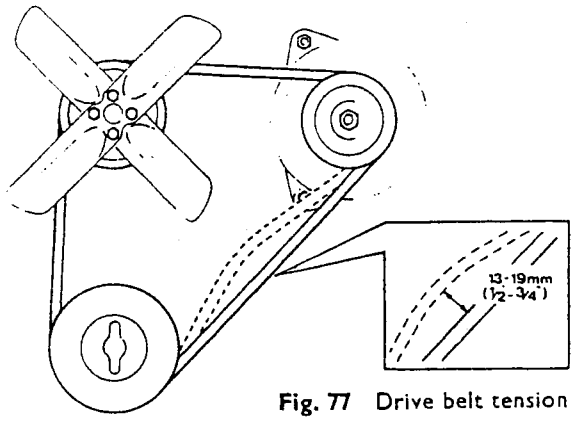


Fig. 77 Drive belt tension

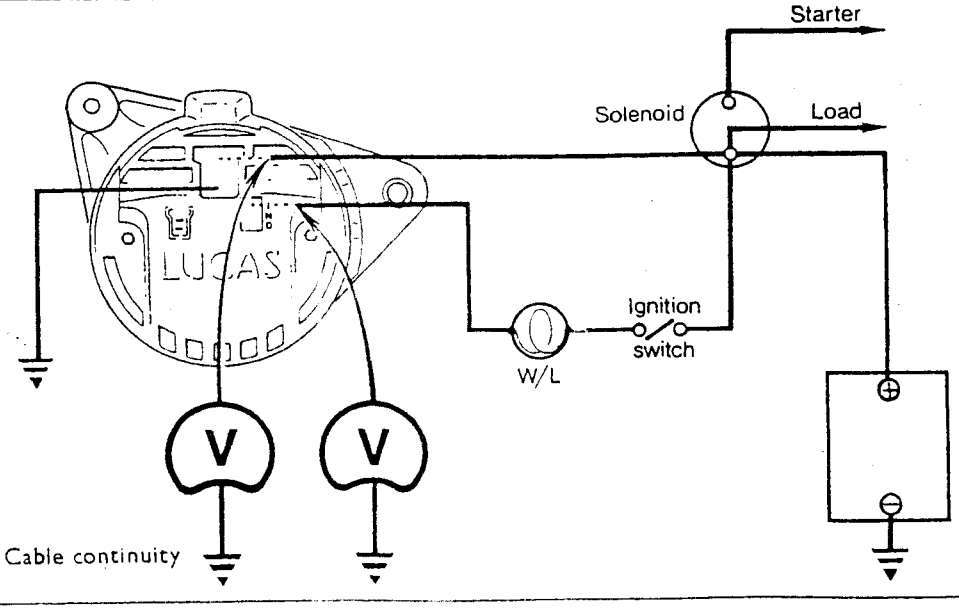


Fig. 78 Cable continuity

(c) Connect the voltmeter between a good earth and each of the disconnected leads in turn. Fig. 78. The voltmeter should indicate battery voltage.

Note: 1. A zero reading indicates open-circuit leads (or faulty bulb if 'IND' lead).
2. Where the additional earth terminal is used on the alternator, the voltmeter reading for that connection will be zero.
4. On replacing the connections, failure of the warning light indicates a faulty alternator field circuit or regulator. If the warning light is illuminated, proceed to Test 5.

TEST 5. Checking Alternator Maximum Output

The alternator should be run for a few minutes to ensure that the tests are carried out at the normal operating temperature. Then, stop the engine.

(a) Disconnect the battery earth cable.
(b) Connect an ammeter between the starter solenoid terminal and the alternator main output cable, Fig. 79.
(c) Remove the connections at the alternator and the moulded cover. Then re-make the connections. Use a jumper lead to short together the 'F' and '—' connections of the voltage regulator unit.
8TR — Green lead and black lead (i.e. earth).
8TRD — Green lead and earth.
11TR/14TR — Regulator frame and earth.
(d) Re-connect the battery earth cable.
(e) Switch on the ignition (or auxiliary switch for diesel vehicles) and check that the warning light comes on.
(f) Start the engine and slowly increase speed. At approx. 3,000 engine rev/min, the ammeter reading should equal the maximum rated output of the alternator.

Alternator Model	Ammeter Reading
15ACR	28A
16ACR	34A
17ACR	36A
17ACR (De-rated)	25A
18ACR	43A
20ACR	66A

Note: If the ammeter reading is low, the alternator is at fault.

TEST 6. Checking Voltage Drop in Charging Circuit

Use a voltmeter to check for high resistance in the charging circuit, see Fig. 80.

(a) Connect a voltmeter between the battery insulated terminal and the alternator main output terminal.
(b) Switch on the vehicle lighting load (headlamps on main beam). Start and run engine at approx. 3,000 rev/min. The voltmeter reading should not exceed 0·5V.
(c) Transfer the voltmeter connections to the battery earth terminal and the alternator body.
(d) Start and run the engine as in (b). The voltmeter reading should not exceed 0·25V.

Note: If the readings are higher, then there is a high resistance in the circuit which must be located and rectified.

TEST 7. Checking Voltage Regulator Setting

Before checking the voltage regulator setting, it is essential that a battery in a well-charged condition is fitted to the vehicle.

(a) Disconnect the battery earth cable.
(b) Connect an ammeter between the starter solenoid terminal and the alternator main output cable. Connect a voltmeter across the battery terminals, Fig. 81.

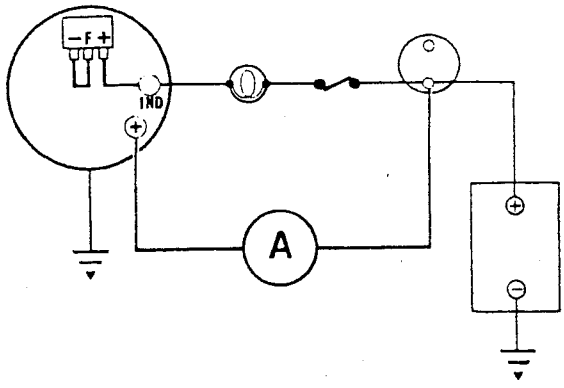


Fig. 79 Checking alternator maximum output

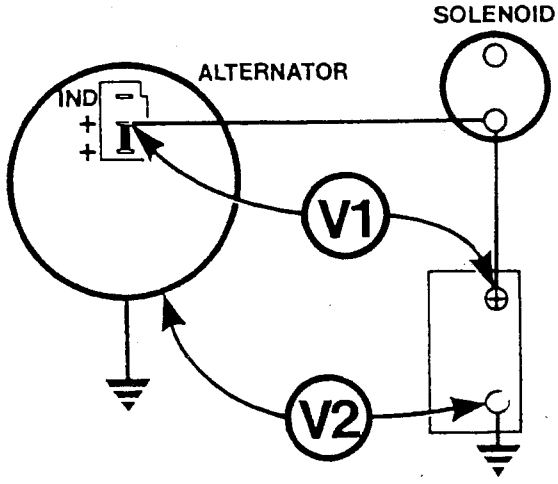


Fig. 80 Checking voltage drop in charging circuit

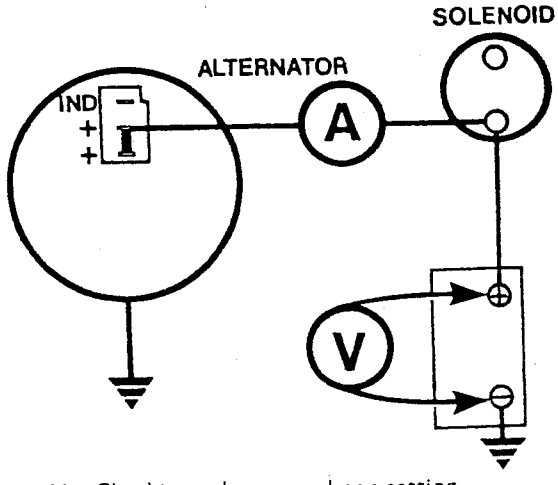


Fig. 81 Checking voltage regulator setting

(c) Re-connect the battery earth cable.
(d) Start and run the engine at approx. 3,000 rev/min until the ammeter reading is less than 10 amperes.

The voltmeter reading should be within the limits 13·6–14·4V.

If the reading is unstable or outside the specified limits, the voltage regulator is faulty and should be replaced.

Note: When checking battery-sensed alternators, first check for high resistance in sensing lead. Connect known good lead between battery '+ve' terminal and alternator terminal 'B+' and repeat TEST 7.