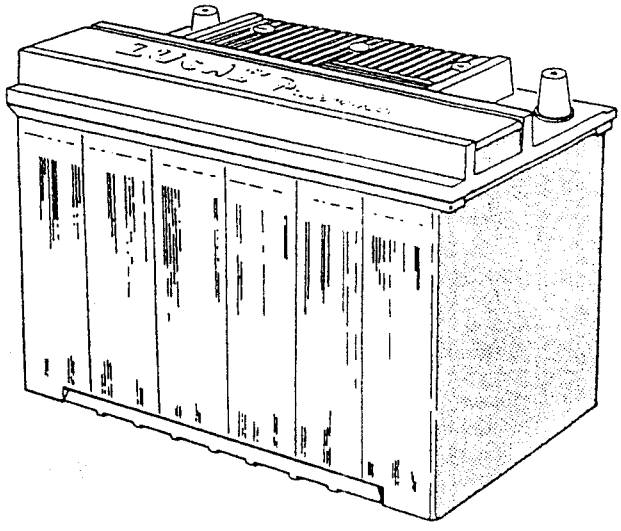

BATTERIES

INTRODUCTION

The lead-acid battery is a device used to convert and store electrical energy in a chemical form and as the name implies the basic active materials are lead and sulphuric acid.

The purpose of the battery on the vehicle is primarily to provide current for the operation of the starter but it also supplies other equipment that may be used whilst the vehicle is stationary, e.g. radio, parking lights, etc.

During the course of normal running, the battery is recharged by the vehicle charging system and provided the vehicle does enough running time, will have stored energy ready for the next start operation.

Note: A vehicle standing idle will *not* maintain a charged battery.

As a battery fault can have adverse effects on the operation of the various systems, particularly the starting and charging system, some knowledge of battery testing is an essential part of fault diagnosis.

BATTERIES IN SERVICE (Fig. 3)

1. CLEAN AND DRY – the battery, particularly the top must be kept clean and dry. Water spillage etc. during topping-up must be immediately wiped away.
2. ELECTROLYTE LEVEL – the electrolyte must be maintained at the correct height which is normally level with the tops of the separators or the splashguard.
3. TOPPING-UP – should be carried out when the electrolyte falls below the correct level. Only distilled water or de-ionised water must be added to replace electrolyte lost by evaporation.
4. STATE OF CHARGE – the battery must never be left in a discharged state. A battery in a poor state of charge i.e. less than 70% should be removed and charged from an independent source at the normal recharge rate. Otherwise the plates may become sulphated (hardened) making it difficult to accept

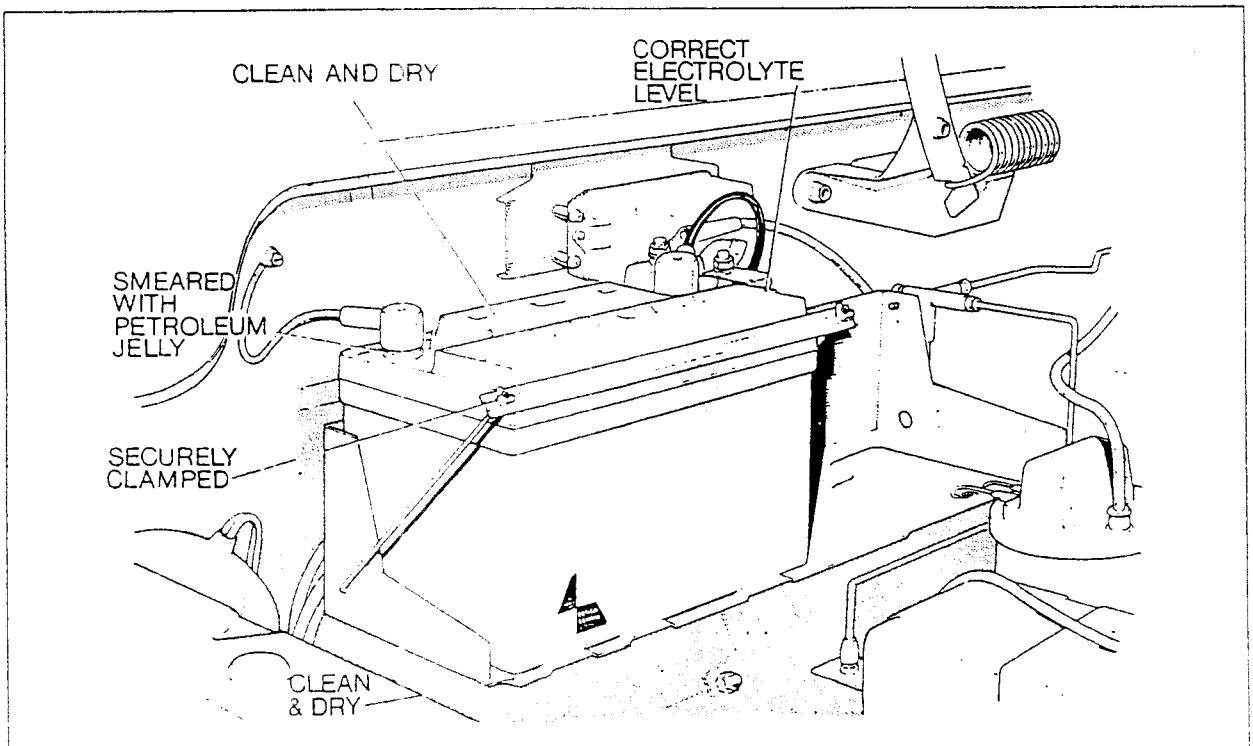

Fig. 3 Batteries in service

a charge, with the consequent early failure of the battery.

Ensure that the generator drive belt is adjusted correctly and that it does not rest on the bottom of the pulleys.

5. INSTALLATION – the battery must be securely clamped (not overtight) to prevent damage from vibration, which may cause shedding of active material from the plates resulting in a loss of capacity or short-circuit between the plates.

   The stowage area must also be kept clean and dry. Any acid spillage should be removed with household ammonia or baking soda and hot water, otherwise the metal will be extensively damaged by corrosion. The metalwork should be repainted with acid-resisting paint after the corrosion has been neutralised.

CARE OF BATTERY LUGS (Fig. 4)

The effect of acid corrosion is far more serious than is generally realised. For example, excessive corrosion of the battery lugs will lead to sluggish operation of the starter. This is due to voltage drop at the battery terminals, when the high starter current is flowing.

The lead die-cast lug is designed to reduce the possibility of corrosion to a minimum and is fitted almost exclusively to British cars today.

The S.M.M.T. lug, clamp type, is used mainly on commercial and passenger vehicles.

In both cases the lug should be cleared of oxidation and the lug and battery post smeared with petroleum jelly as an added precaution against corrosion. When fitting the die-cast lug, ensure that it is in full contact with the terminal post by pressing it down firmly and securing it in position with the self-tapping screw. *Do not* use the screw to pull the lug down on to the terminal post.

Never use force when removing lugs. If, as a result of corrosion, a lug cannot be removed easily, soak a cloth in hot water and apply it to the corroded lug. After freeing the lug, remove all traces of corrosion.

CORRECT CHARGING

The importance of correct charging cannot be overemphasised as far as the life of the battery is concerned.

The battery should not be allowed to stand in a low state of charge especially in the winter when the electrolyte could freeze due to its low specific gravity. If, however, the battery should become fully discharged, it should not be left on the vehicle in the hope that it will become fully recharged by the vehicle's charging system. Unless the battery is charged by an external source it will probably never become more than half-charged, and even though it appears to be working satisfactorily, the plates will harden and the life of the battery will be considerably shortened.

Generally speaking, recharging presents no problems if the recharging rates quoted on the instruction labels are adhered to. The normal charge rate is approximately one-tenth of the A/H capacity of the battery at the 10 hour rate or 20 hour rate.

CHARGING METHODS

Either the constant current method, which we advocated for initial charging, or the constant voltage method may be employed for recharging. In either case a DIRECT CURRENT supply must be used. The connections to be made differ with the method and can be seen from the diagram. You will see that, using the constant current method (Fig. 5), the batteries are in series. Thus, a limit is set to the number of batteries that may be charged in series, since the voltage of the batteries when fully charged must not exceed the supply voltage. It is found in practice that the most suitable arrangement is ten 6 volt batteries or five 12 volt batteries when charging from a 110 volt supply.

With the constant voltage system (Fig. 6), the batteries are connected in parallel, usually to a low

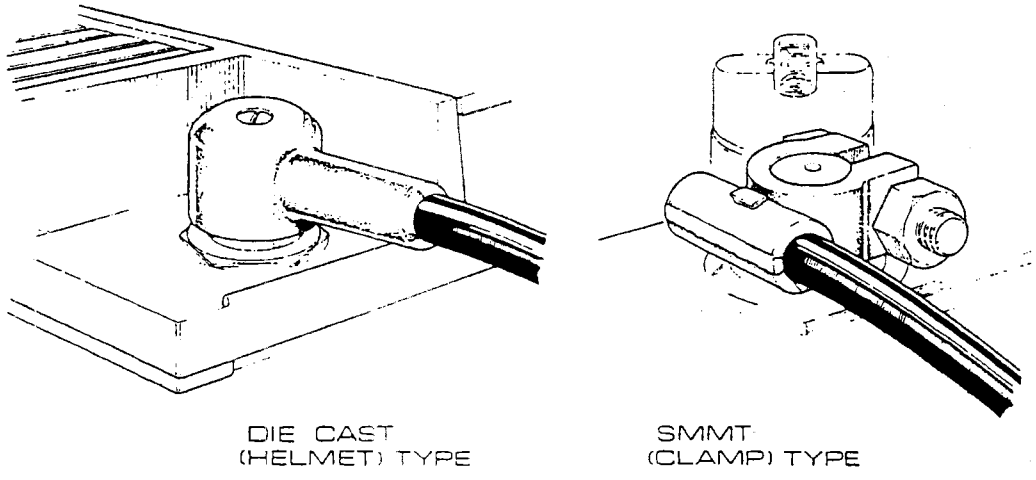

Fig. 4 Types of battery lugs

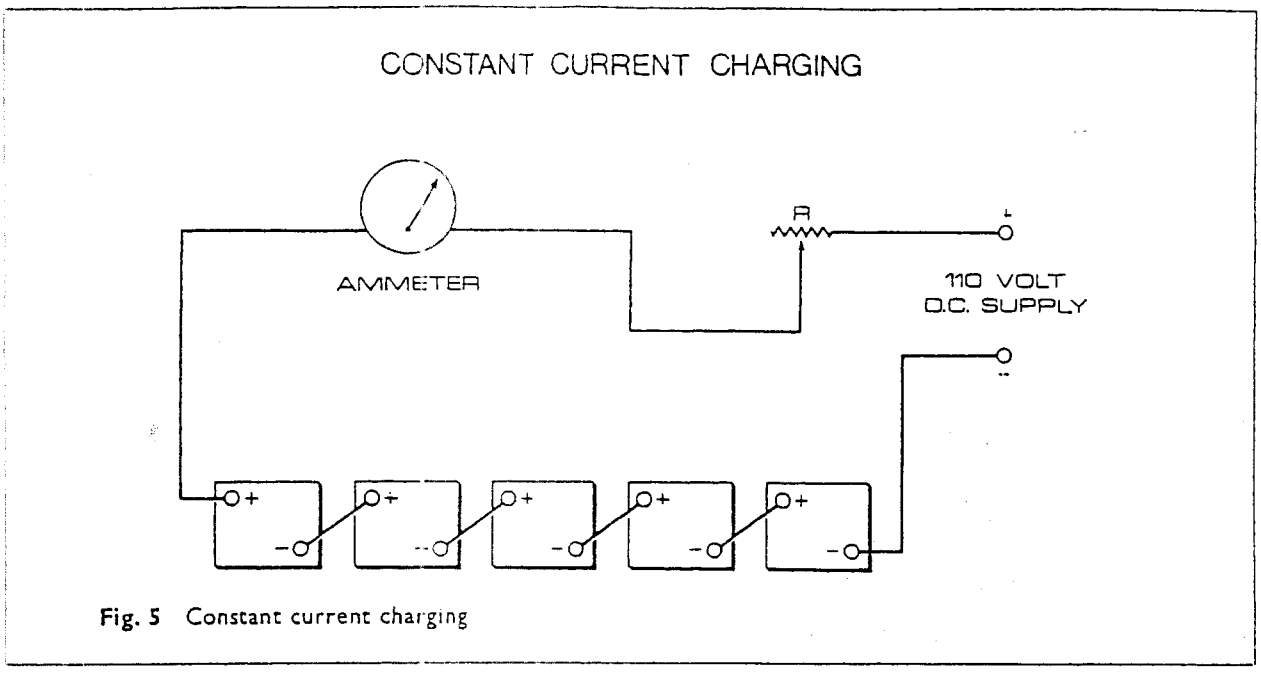

Fig. 5 Constant current charging

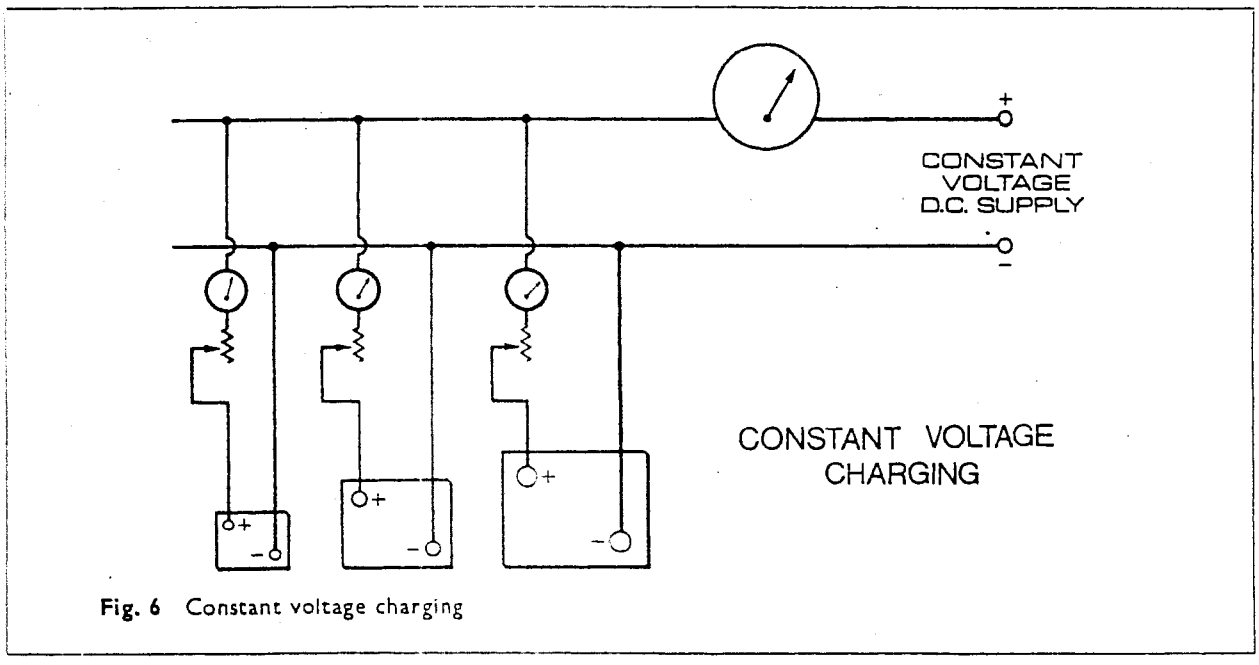

Fig. 6 Constant voltage charging

voltage motor-generator set. The number of batteries that can be charged by one generator is limited by the rated current output of the generator, and the total charging current required for all the batteries must not exceed this output.

The supply voltage can again be regulated by a rheostat, and, if necessary, a rheostat or resistance can be included in the supply line to an individual battery where a lower charging rate is required.

TEST 1. Battery Testing – Hydrometer

Testing should commence at the source of supply; the battery itself. If the battery is discharged or unserviceable, the readings in the other tests will be affected.

There is a relationship between the state of battery charge and the strength of the electrolyte. As the battery becomes discharged, the specific gravity (S.G.) of the electrolyte becomes lower. The S.G. of the electrolyte is measured by means of a hydrometer. This instrument consists of a glass tube, with a rubber bulb fitted on one end. Inside the tube, there is a float, which is calibrated from 1.130 to 1.300.

When the end of the hydrometer is inserted in the battery cell, as shown in Fig. 7, and the rubber bulb is pressed and then released, a small quantity of the electrolyte is drawn into the tube. The position of the float is determined by the specific gravity of the electrolyte. When the specific gravity is high, the float maintains a high position inside the tube, and if the specific gravity is low the float sinks to a lower position.

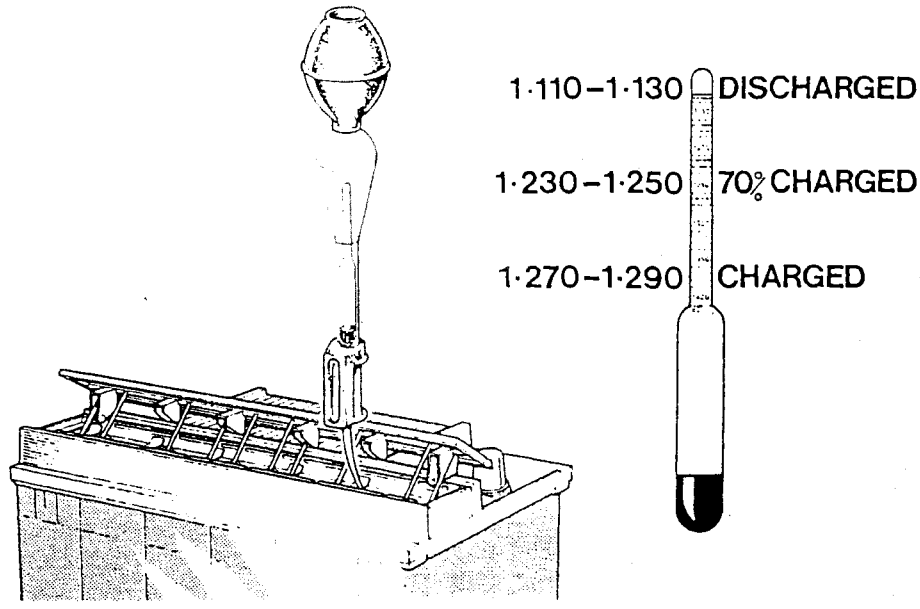

Fig. 7 Hydrometer test

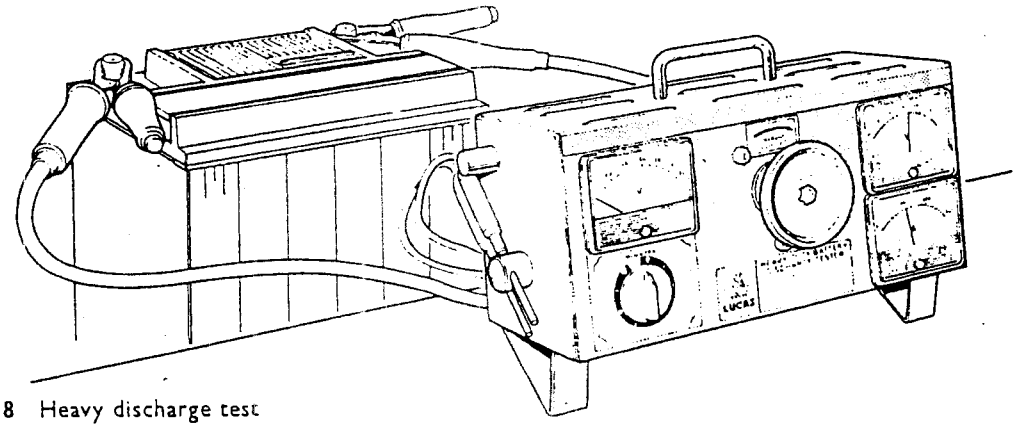

Fig. 8 Heavy discharge test

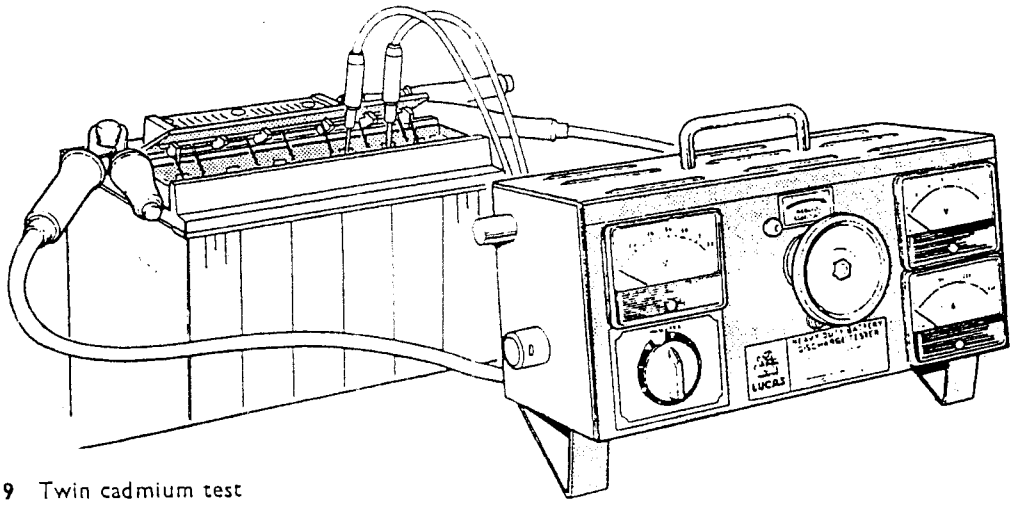

Fig. 9 Twin cadmium test

From the specific gravity (S.G.) readings, a fairly accurate indication of the battery state of charge can be obtained.

State of Charge	Specific Gravity Readings	
	Climates normally below 25°C (77°F)	Climates normally above 25°C (77°F)
Fully charged	1.270–1.290	1.210–1.230
70% charged	1.230–1.250	1.170–1.190
Discharged	1.110–1.130	1.050–1.070

Note: The hydrometer readings should not be taken if the battery has only just been topped up. It should be charged for 1 to 2 hours before taking any readings.

TEST 2. Battery Testing – Heavy Discharge Test

This test should be carried out as a further check of the battery condition. A heavy discharge tester should be applied to the battery terminals as shown in Fig. 8. The test ensures that the battery is capable of supplying the heavy currents required by the starter at the moment of starting the engine.

The tester should be set to discharge the battery at three times the ampere hour capacity (20 hr rate) for 15 seconds. (*Example:* If the battery has a capacity of 50 Ah (20 hr rate), the tester should be set to 150 amps on the ammeter). Observe the voltmeter during the battery discharge. If the voltmeter reading is 9·6V or above, the battery is considered satisfactory. If the voltage falls below 9·6V, the battery is suspect and should be removed for further testing.

TEST 3. Battery Testing – Twin Cadmium Test

Charge a 12 volt battery at 40 amps (or at the 20 hour rate, whichever is the lower) for 3 minutes. At the end of three minutes and with the battery still on charge (Fig. 9), record the overall voltage and the 5 intercell readings (i.e. 1 and 2, 2 and 3, 3 and 4, 4 and 5, 5 and 6) using cadmium sticks. Subtract the lowest intercell voltage readings from the highest.

CONCLUSION

(a) If the variation is 0·15 volts or more, the battery needs replacing.

(b) If the variation is less than 0·15 volts and the battery voltage is less than 15·5 for a 12 volt battery or 7·75 for a 6 volt battery, the battery is satisfactory but discharged and only in need of a fast charge.

(c) If the variation is less than 0·15 volts and the battery voltage is 15·5 or over for a 12 volt battery (7·75 for a 6 volt battery) the battery is discharged (and may be sulphated).