SECTION Q
Electrical Equipment

ALTERNATOR

Models AC5, 11AC, 15ACR and 17 ACR

1. Precautions

The diodes in the alternator function as one-way valves and the transistors in the regulator/control box operate as fast switches. Both are accurate and sensitive. They do not wear out and seldom require adjustment, but because they are sensitive to voltage changes and high temperature, the following precautions are vital to prevent them from being destroyed.

(a) DO NOT disconnect the battery whilst the engine is running. This will cause a voltage surge in the alternator charging system that will immediately ruin the diodes or transistors.

(b) DO NOT disconnect a lead without first stopping the engine and turning all electrical switches to the off position.

(c) DO NOT cause a short circuit by connecting leads to incorrect terminals. Always identify a lead to its correct terminal. A short circuit or wrong connection giving reverse polarity will immediately and permanently ruin transistors or diodes.

(d) DO NOT connect a battery into the system without checking for correct polarity and voltage.

(e) DO NOT "flash" connections to check for current flow. No matter how brief the contact the transistors may be ruined.

2. Maintenance

The alternator charging system will normally require very little attention, but it should be kept free from build-up of dirt, and a check made if it fails to keep the battery charged.

(a) Regularly inspect the driving belts for wear and correct tension. It is important to ensure that all belts on a multiple belt drive have equal tension and are each carrying their share of the load. Slack belts will wear rapidly and cause slip which will not drive the alternator at the required speed. Drive belts which are too tight impose severe side thrust on the alternator bearings and shorten their life. Periodically ensure that the alternator is correctly aligned to the drive.

(b) Do not replace faulty belts individually in a multi-belt system. A complete matched set of drive belts must always be used.

(c) Keep the alternator clean with a cloth moistened in kerosene or cleaning fluids. Ensure that ventilation slots and air spaces are clear and unobstructed.

(d) Remove any dirt accumulated on the regulator/control box housing, and ensure that cooling air can pass freely over the casing.

3. Fault Finding on AC5

The AC 5 alternator is so designed that a flow of current indicated either by the extinguishing of the warning light, or as shown on the ammeter, is sufficient evidence that the system is in proper working order. Therefore, no open circuit, voltage or current output checks should be performed on the installation UNLESS :—

(a) The warning light fails to illuminate when the generator is stationary, and the switch is closed OR fails to become extinguished when the alternator is running.

(b) No charging current is shown on ammeter.

(c) The battery is flat.

(d) The battery is "boiling", indicating loss of voltage control.

If any of the above symptoms occur, the procedure indicated below should be followed.

(a) Connect a good quality moving coil voltmeter 0—50 volts range across the battery or regulator negative terminal, and one of the three positive terminals marked LO, MED, HI. Disconnect alternator output terminal. Fit a good quality moving coil 0 — 100 amp ammeter in series with the alternator terminal and output lead. **The battery should be in a charged condition.**

(b) Close the warning light switch (master electric switch on dashboard) when the warning lamp should light up.

(c) Switch on a 10—15 amperes load such as lights, etc. for fifteen minutes.

(d) Start engine and run at fast idle speed when fans, etc. for fifteen minutes.

1. The warning light should go out.
2. The ammeter records a small charge dependant on engine speed.

(e) Increase engine speed momentarily to maximum speed, when the charging current should be about 30 Amperes for 24 Volt, and 53 Amperes for 12 volt systems.

(f) With the alternator running at approximately half speed, (engine speed about 1,500 rev/min) switch off electrical load. Depending on the connection selected for the positive sensing wire LO, MED or HI, the voltage should rise to between 26 and 28 volts on 24 volt systems and 13—14 volts on 12 volt systems and then remain constant. At the same time the current reading should drop appreciably.

Any variance in the above data could indicate a fault and the following procedure should be adopted before disconnecting any components.
The regulator is a sealed unit and is non-repairable and if found to be faulty it must be replaced.

Warning Lamp does not light up when switched "On".

Check the bulb.

If no fault

Check all wiring connections at regulator, alternator and battery.

If no fault

Switch off, disconnect 'F' lead at regulator and connect it to the negative terminal.
Switch on. If warning lamp lights up, the regulator is faulty. If lamp fails to light up, the alternator is faulty.

Warning Lamp does not go out and Ammeter shows no output when running.

Check all regulator, alternator and battery connections.

If no fault

Switch off, disconnect 'F' lead at regulator and connect to regulator negative terminal.
Switch on, and run at fast idle.
If no output, alternator is faulty.
If output appears, regulator is faulty.

Warning Lamp does not go out when running and Ammeter shows reduced output with full output only at maximum speed or Warning Lamp goes out but Alternator delivers reduced output. Full output only at maximum speed.

Alternator faulty. Remove from installation and apply open circuit diode check.

Warning Lamp flashes intermittently and Ammeter needle oscillates when Battery is fully charged and no loads are switched in.

Check for excessive resistance in regulator negative sensing lead.
If no fault, regulator is faulty.

Batteries overcharging and Ammeter indicates high or full output all the time.

Check regulator positive sensing lead and its connection at regulator.
If no fault, regulator is faulty.

4. Fault Finding on 11 AC

If the alternator does not produce its rated output of 43 amperes for 12 volt and 23 amperes for 24 volt circuit, the failure may be due to any unit or the associated wiring, and the following procedure should be followed.

TEST 1

Checking the Field Isolating Relay

Disconnect the earthed battery terminal and the cable from the alternator main output terminal. Connect a 0—60 DC ammeter between the terminal and disconnected cable. Link terminals 'C1' and 'C2' on the field relay. Reconnect the battery cable. Close the master switch and start engine and run at charging speed. If ammeter shows a charge the relay is faulty. or its wiring and connections.
If ammeter shows no charge, carry on with Test 2.

TEST 2

Checking the Alternator and Control Box
Leave the test ammeter connected, and disconnect cables 'F' and '—' from control unit and join them together. Remove link from field relay terminals and ensure they are connected to 'C1' and 'C2'. Start engine and run at charging speed.
Ammeter should indicate current values of 35 amps or more for 12 volt circuit or 22 amps or more for 24 volt circuit. A zero or low reading indicates a faulty alternator.
If satisfactory output is recorded, a faulty control unit is indicated.

TEST 3

Checking or Adjusting the Voltage Setting

The regulator of the 4 TR control unit must be set on CLOSED CIRCUIT, when the alternator is under load. Also, the system must be stabilised before checking or resetting is carried out, and the battery must be in a well charged condition. Check the battery to control unit wiring, to ensure that the resistance of the complete circuit does not exceed 0.1 ohm. Any high resistance must be traced and remedied. Connect a test DC voltmeter (suppressed zero type) scale 12 — 15 volts for 12 volt installations or 24—30 volts for 24 volt installations, between the battery terminals, and note the reading with no electrical load. Disconnect battery earth cable and connect test ammeter between alternator main terminal and disconnected cable. Reconnect battery earth cable, and switch on an electrical load of approximately two amps, such as, side and tail lights. Start engine and run at about 2000 rev/min for at least eight minutes. If the charging current is still greater than ten amps, continue to run engine until this figure is reached. Then compare the voltmeter reading with the appropriate setting limits, as specified for the particular control unit as follows.

12 V (37423)/(37449)	13.9 — 14.3 volts
24 V (37444)/(37502)	27.9 — 28.3 volts
12 V (37429)	13.7 — 14.1 volts

(Part no. marked on upper edge of the moulded cover of Control Unit).

If reading obtained is stable but outside the appropriate limits the unit can be adjusted as follows.

ADJUSTMENT OF VOLTAGE SETTING
Stop the engine and remove the control unit from its mounting. At the back of the unit is a sealed potentiometer adjuster. Carefully scrape away the sealing compound. Then start the engine, and while running the alternator at charging speed, turn the adjuster slot — CLOCKWISE to INCREASE the setting or ANTI-CLOCKWISE to DECREASE it — until the required setting is obtained.

Recheck the setting by stopping the engine, then start again and slowly "run-up" to charging speed. If setting is now correct, remount the control unit, disconnect test meters and restore original wiring connections. If, after adjustment, the voltmeter reading remains unchanged, or increases in an uncontrolled manner, then the control unit is faulty and a replacement must be fitted.

TEST 4

Check of Alternator Output

Disconnect battery earth cable, and connect test ammeter between the alternator main terminal and disconnected cables. Reconnect battery earth cable, and switch on the vehicles full electrical load and leave on for 3 or 4 minutes. Leave load on and start engine and run at approximately 2000 rev/min. The alternator output should balance the load, and at the same time show a charge to the battery.

Check Warning Light Control

If warning light does not function either by remaining "on" or "off", but the system is charging satisfactorily, connect voltmeter between the alternator "AL" terminal and earth. Reading should be 7.0—7.5 max (12 volt alternator) or 14.0—15.0 (24 volt alternator). Connect leads 'E' and 'WL' together. If warning lamp lights the warning light control is faulty and should be replaced.

5. Fault Diagnosis Procedure for 11 AC

Alternator Fails to Charge

(a) Check driving belt for correct tension and wear.
(b) Apply Tests 1 and 2.

Low-Unsteady Charging Rate

(a) Check driving belt for correct tension and wear.

(b) Check for high resistance at battery terminals and in the circuit wiring and connection.

(c) Check all connections made to earth.

(d) Apply Test 2.

Flat Battery or Low State of Charge

(a) CHECK condition of battery with hydrometer and high rate discharge tester.

(b) Check driving belt for correct tension and wear.

(c) Check that the field isolating relay contacts open when master switch is off, otherwise battery will discharge through rotor winding.

(d) Check that flat or low battery is not caused by insufficient alternator output caused by abnormal electrical loads by applying Test 4.

Excessive Charge Rate to a Fully Charged Battery

(a) Apply Test 3.

Noisy Alternator

(a) Alternator loose in mounting brackets.

(b) Worn frayed or loose drive belt.

(c) Worn bearings, fully out of alignment.

(d) Rotor damaged or pulley fan loose on shaft.

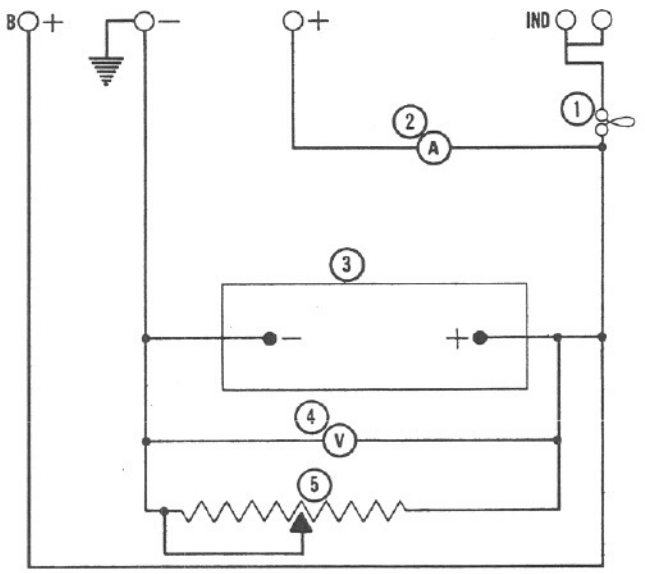
(e) Open circuited, or short circuited rectified diodes, or stator winding open-circuit.

(f) Loose pulley.

6. Testing the 15ACR and 17 ACR Alternator in Position

First check the driving belt for condition and tension. The nominal hot outputs at 6,000 rev/min (alternator speed) are 28 amps and 36 amps for 15ACR and 17ACR alternator respectively. These figures may be exceeded slightly when the alternator is running cold. To avoid misleading results, the following test procedure should therefore be carried out with the alternator running as near as possible to its normal operating temperature.

Connect an external test circuit to the alternator output terminals as shown in Fig. Q.1.



Q1

1. 12 volt 2.2 watt Bulb
2. 0-40 or 0-60 Ammeter
3. 12 volt Battery
4. 0-20 Voltmeter
5. 0-15 ohm 35 amp Variable Resistor

Observe carefully the polarity of battery and alternator terminals — reversed connections will damage the alternator diodes.

The variable resistor across the battery terminals must not be left connected for longer than is necessary to carry out the following test.

Start the engine. At 1,500 rev/min (alternator speed), the test circuit bulb should be extinguished. Increase engine speed until the alternator is running at 6,000 rev/min approximately, and adjust the variable resistance until the voltmeter reads 14.0 volts. The ammeter reading should then be approximately equal to the rated output (See previous paragraph). Any appreciable deviation from this figure will necessitate the alternator being removed from the engine for further examination.

Failure of one or more of the diodes will be indicated in the above test by effect on alternator output, and also in some instances by abnormally high alternator temperature and noise level.

the alternator output test, start the engine and again run the alternator up to 6,000 rev/min until the ammeter shows an output current of less than 10 amperes. The voltmeter should then give a reading of 14.0 — 14.4 volts. Any appreciable deviation from this (regulating) voltage means that the regulator is not functioning properly and must be replaced.

If the foregoing tests show the alternator and regulator to be satisfactorily performing, disconnect the test circuit and reconnect the alternator terminal connector. Now connect a low-range voltmeter between the positive terminal of the alternator (the moulded terminal connector is open-ended to facilitate this) and the positive terminal of the battery. Switch on battery load (headlights etc.), start the engine and increase speed until the alternator runs at approximately 6,000 rev/min. Note the voltmeter reading.

Transfer the voltmeter connections to the negative terminals of alternator and battery and again note the meter reading.

If the reading exceeds 0.5 volt on the positive side or 0.25 volt on the negative side, there is a high resistance in the charging circuit which must be traced and remedied.

DYNAMO

The following information is concerned with the Lucas C40-1 model. Should information be required in connection with any other type of dynamo then the relevant manufacturer should be contacted.

The C40-1 is of extruded yoke construction and is a ventilated type. Holes in each end bracket allow a pulley mounted fan to draw cooling air through the dynamo.

Description

It is a shunt wound, two pole, two brush machine designed to work in conjunction with a compensated voltage control regulator unit. A ball bearing supports the armature at the driving end and a porous bronze bush at the rear supports the commutator end.

The output of the dynamo is controlled by the regulator unit and is dependent on the state of charge of the battery and the loading of the electrical equipment in use. When the battery is in a low state of charge, the dynamo gives a high output, whereas if the battery is fully charged, the dynamo gives only sufficient output to keep the battery in good condition without any possibility of overcharging. An increase in output is given to balance the current taken by lamps and other accessories when in use.

When fitting a new control box, it is important to use only an authorised replacement. An incorrect replacement can result in damage to the dynamo.

2. Routine Maintenance

(a) Lubrication

Every 4,000 miles (6,000 km) or 150 running hours, inject a few drops of high quality S.A.E.30 engine oil into the hole marked "OIL" at the commutator end bearing housing (Refer to Fig. Q.2).

(b) Inspection of Brushgear

Every 60,000 miles (90,000 km) or 2,400 running hours, the dynamo should be removed from the engine and the brushgear inspected by a competent electrician.

(c) Belt Adjustment

Every 4,000 miles (6,000 km) or 150 running hours, inspect the dynamo driving belt, and if necessary, adjust to take up any slackness by turning the dynamo on its mounting. Care should be taken to avoid overtightening the belt (see Page N.1).

3. Performance Data

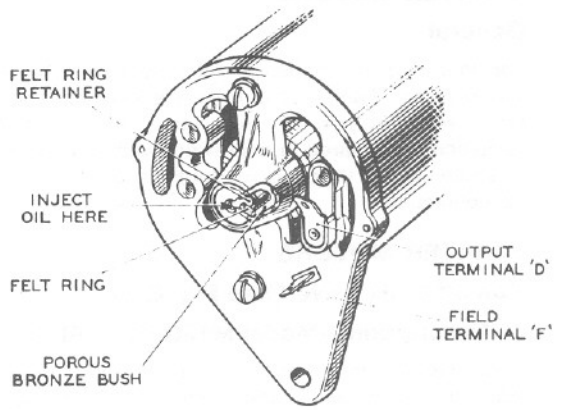
The cutting in and maximum output speeds quoted below are production test figures and refer to cold machines with brushes only partly bedded.
Model C40-1.
Cutting-in Speed.
1450 rev/min (Max.) at 13.0 dynamo volts.
Maximum Output.
22 amp at 2250 rev/min (Max.) at 13.5 dynamo volts and a resistance load of 0.61 ohms.
Field Resistance.
6.0 ohms.

4. Servicing

Testing in Position

1. Inspect the driving belt and adjust if necessary. (Refer to Page N.1).
2. Check the connections on the commutator end bracket. The larger connector carries the main dynamo output, the smaller connector the field current.
3. Switch off all lights and accessories, take off the cables from the terminals of the dynamo and connect the two terminals with a short length of wire.

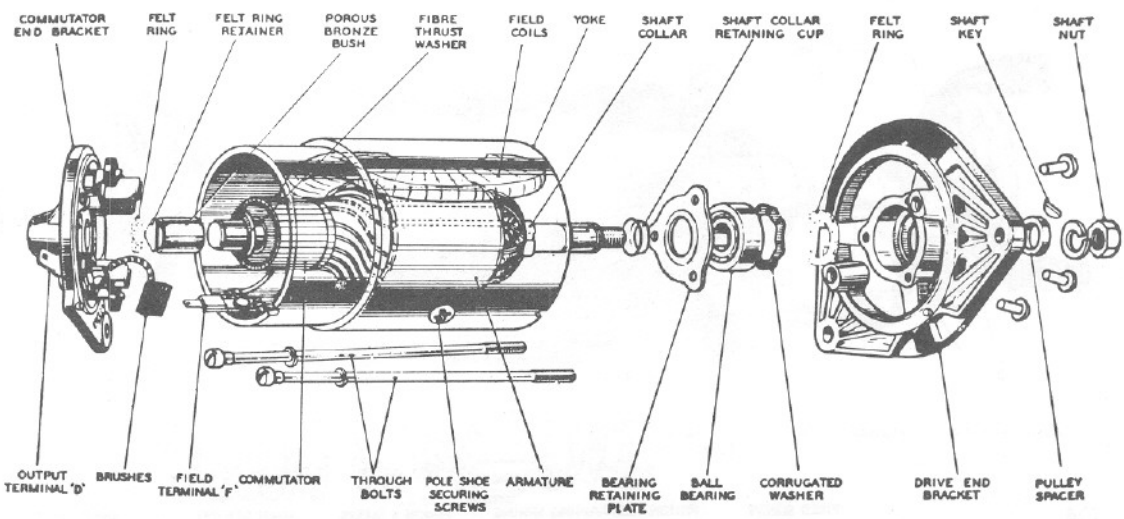
LUBRICATOR IN COMMUTATOR END BRACKET



Q2

4. Start the engine and set to run at normal idling speed.
5. Clip the negative lead of a moving coil type voltmeter, (calibrated 0-20 volts) to one dynamo terminal and the positive lead to a good earthing point on the yoke.
6. Gradually increase the engine speed, when the voltmeter reading should rise rapidly and without fluctuation. Do not allow the volt meter reading to reach 20 volts, and do not race the engine in an attempt to increase the voltage. It is sufficient to run the dynamo up to a speed of 1,000 rev/min. If the voltage does not rise rapidly and without fluctuation the unit must be dismantled for internal examination.
   Excessive sparking at the commutator in the above test indicates a defective armature which should be replaced.
   NOTE: If a radio suppression capacitor is fitted between the output terminal and earth, disconnect this capacitor and re-test the dynamo before dismantling. If a reading is now given on the voltmeter, then the capacitor is defective and must be replaced. If the dynamo is in good order,

MODEL C40-1 GENERATOR DISMANTLED



Q3

remove the link from between the terminals and restore the original connections.

STARTER MOTORS

General

The following information is concerned with the M45G starter motor. Two types of drive are available and both are covered fully in the following section. Should information be required in connection with any other type of starter motor then the relevant manufacturer should be contacted.

STARTER MOTORS

Run-off Helix Drive (See Fig. Q.4)

1. Description—Model M45G Type RF 17

This electric starter motor is a four-pole four-brush machine having an extended shaft which carries the engagement gear, or starter drive as it is more generally known.

The starter motor is of a similar construction to the dynamo except that heavier copper wire is used in the construction of the armature and field coils. The field coils are series-parallel connected between the field terminal and the insulated pair of brushes.

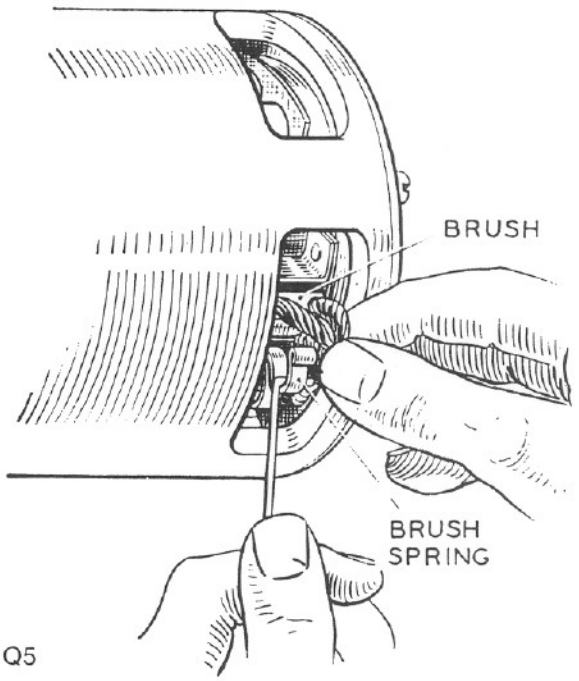
The armature has 23 winding slots. The drive portion incorporates a special overload protective device known as the Run-off Helix.

2. Routine Maintenance

(a) The starter motor requires no routine maintenance beyond the occasional inspection of the electrical connection which must be clean and tight, the brush gear, and the commutator.

(b) After the starter motor has been in service for some time, remove the starter motor from the engine and submit it to a thorough bench inspection.

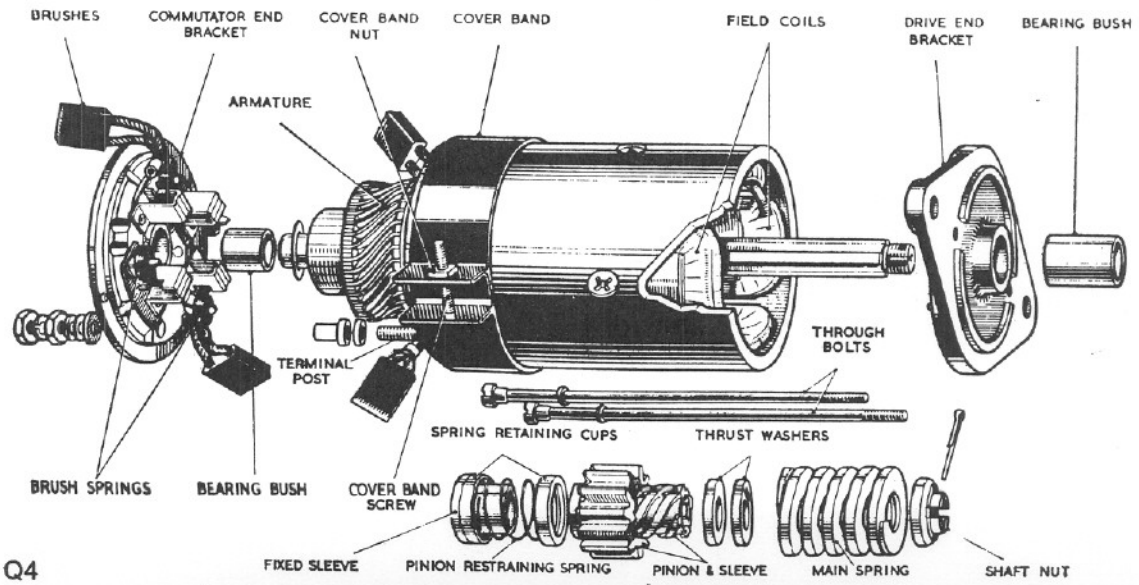
1. Check that the brushes move freely in their holders by holding back the brush springs and pulling gently on the flexible connectors (Refer to Fig. Q.5). If movement is sluggish, remove the brush from its holder and clean its sides with a fluffless petrol moistened cloth. Replace the brush in its original position. Brushes which are worn to less than 9/16 in (14 mm) long must be renewed.
NOTE: This is the length when half the available wearing length has worn away. The time taken to reach this stage normally extends well beyond that to reach the point of major engine overhaul. After this time, the rate of wear accelerates due to re-reducing spring pressure.



Q5

2. Check the tension of the brush springs using a spring scale. (Refer to Fig. Q.6). The minimum tension is 43 ozf (0,61 kgf). New springs should be fitted if the tension is low.

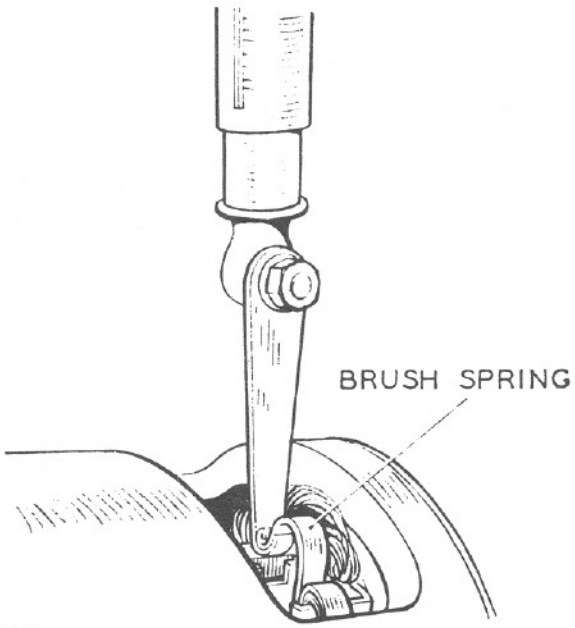
MODEL M45G TYPE RF17



Q4

NOTE : This is applicable to a brush when half the available wearing length has been worn away.

3. The commutator must be clean and have a polished appearance. If necessary, clean it by pressing a fine dry cloth against it whilst the armature is turned by hand. If the commutator is very dirty, moisten the cloth with petrol.
4. Keep all the electrical connections clean and tight. Any which have become dirty should be cleaned and the contacting surfaces lightly smeared with petroleum jelly.



Q6

3. Servicing

(a) Testing in Position

If the starter motor does not operate or fails to crank the engine when the starting button is used, switch on the headlamps. When these are not fitted connect a good quality 0—20 voltmeter across the battery terminals, operate the starter button and watch for the following symptoms :

1. The headlamps dim (or the voltmeter reading falls appreciably) but the motor does not crank the engine.
   This may be caused by the starter drive pinion being jammed in mesh with the engine flywheel. The pinion can usually be freed by engaging a low gear and gently rocking the engine. It is advisable to remove the starter motor from the engine and inspect the starter drive as described later in this section.
   Sluggish action of the starter motor may be due to a discharged battery, check this by disconnecting the existing cables and reconnecting the motor to a battery known to be fully charged. If the starter motor now functions normally then the battery must be examined. Should the starter motor still not function normally then it should be removed from the engine and examined.
2. The headlamps do not dim (or the voltmeter reading remains unaffected) and the motor does not crank the engine.
   Check first that the circuit up to the supply terminal on the starter motor is in order.
   If no voltage is indicated, check the circuit from the battery to the motor via the starter switch. Ensure that all the connections are clean and tight. If the switch is found to be faulty fit a serviceable replacement.
   A normal voltage supply reaching the starter motor terminal indicates that the starter motor has an internal fault and must be removed for examination. If the starter motor operates but does not crank the engine, the starter drive may require cleaning or may have developed some other fault. In either case the starter motor requires removal from the engine for a full examination.

'S' TYPE STARTER DRIVE ASSEMBLY

(a) Operation

This drive incorporates a protective feature know as the 'Run-off Helix'. The purpose of this feature is to prevent possible damage occurring to the starter motor through excessive torque being applied while the pinion is in engagement, as would arise for example in the event of an engine back-fire during starting.
Under normal conditions of engagement, axial movement of the pinion is arrested when, in the one direction, the first cup washer has fully compressed the restraining spring and is abutted hard against the second cup washer and, in the opposite direction, the helically screwed sleeve is pressing the thrust washer hard against the main spring.
In the 'Run-off Helix' drive, the main spring is capable of greater compression than is the equivalent standard 'S' pattern drive spring. In addition, the trailing faces of the pinion and helically screwed sleeve are machined to form indented rachet recesses.
In the event of a back-fire occuring during starting, the pinion (being able to rotate but incapable of further axial movement) forces the helically screwed sleeve along the straight-splines of the starter shaft. This further compresses the main spring and permits axial movement of the screwed sleeve to continue until it is clear of the interior of the pinion. At this stage, axial movement of the screwed sleeve ceases and the pinion, now jointly supported by the fixed sleeve and the recessed end of the screwed sleeve, is free to be rotated by the engine ring gear. In this way, excessive torque is harmlessly dissipated by the ratchetting action of the pinion and screwed sleeve against the reaction pressure of the main spring.
The operation of a 'Run-off Helix' drive can be checked by securing the armature and drive assembly in a vice (using wooden vice-clamps) and applying a torque wrench to the pinion. The ratchet action must occur at a torque of not less than 36 lbf ft (5 kgf m).

(b) Routine Maintenance

If any difficulty is experienced with the starter motor not meshing correctly with the flywheel, it may be that the drive requires cleaning.
The pinion should move freely on the screwed sleeve; if there is any dirt or other foreign matter on the sleeve it must be washed off with paraffin.

STARTER MOTOR—PRE-ENGAGED DRIVE (See Fig. Q.7)

1. Description—Model M45G with Model 7S Solenoid

This starter motor is a four-pole, four-brush earth return machine with series-parallel connected field coils. A solenoid-operated pre-engaged drive assembly is carried on an extension of the armature shaft.
The main features of this type of drive are as follows:

(a) Positive pinion engagement preventing the pinion being thrown out of mesh whilst starting.
(b) Dual-purpose plate clutch incorporated in the drive assembly giving over-speed and over-load protection.
(c) Self-indexing pinion to ensure smooth engagement between the pinion and the flywheel teeth before the starter motor begins to rotate.
(d) Armature braking system to ensure rapid return to rest when the starter button is released.

2. Routine Maintenance

(a) The starter motor requires no routine maintenance beyond the occasional inspection of the electrical connection which must be clean and tight, the brush gear, and the commutator.
(b) After the starter motor has been in service for some time, remove the starter motor from the engine and submit it to a thorough bench inspection.

1. Brush wear (this is a fair indication of the amount of work done). Renew brushes worn to, or approaching, 5/16 in (7,9 mm) in length.
2. Brush spring tension. Correct tension is 30 - 40 ozf (0,85-1,13 kgf). Renew springs if tension has dropped below 25 ozf (0,71 kgf).
3. Skim commutator if it is pitted or badly worn.
4. Check bearings for excessive side play of armature shaft.
5. Check pinion movement.
6. Clean and lubricate the indented bearing inside the pinion sleeve using a bentonite based grease for this purpose.
7. Clean and lubricate the indented bronze bearing in the intermediate bracket. Use Ragosine 'Molypad' Molybdenised non-creep oil for this purpose.

3. Servicing

(a) Testing in Position

Switch on the lamps. If the vehicle is not equipped with lighting, then connect a 0-20 voltmeter across the battery terminals before proceeding. Operate the starter control and watch for the following symptoms:—

1. The lamps dim or voltmeter reading drops to about 6 volts, and the motor does not crank the engine. Check battery (must be at least half-charged) and battery lugs, (clean and a good earth connection). Check by hand-cranking that the engine is not abnormally stiff.
2. The lamps do not dim, the voltmeter reading remains steady at about 12 volts, and the motor does not crank the engine.
   Connect voltmeter from solenoid terminal 'BAT', and starter yoke, operate starter :—

No volts indicated

(a) Poor lug connections at battery.
(b) Bad earth connection.
(c) Broken starter lead, battery to starter.

Full volts i.e., 12-14 volts indicated.

(a) Faulty solenoid switch.
(b) Open circuit in starter—check brushes.