ELECTRICAL AND INSTRUMENTS

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OPTIONAL EXTRAS

ELECTRICAL AND INSTRUMENTS

BATTERY

LUCAS CA9/7
LUCAS CA11/7

DESCRIPTION

The Lucas Model C.A. battery, as listed above, is a new type fitted with an air lock device (Aqualok) which simplifies the topping up procedure. This device consists of a one-piece vent cover and six sliding tubes, perforated to act as air valves and fitted one to each cell aperture.
The tubes are automatically raised when the vent cover is removed and depressed when the cover is refitted.
Air or added water is admitted to the cell venting chamber (via the tube perforations) only while the tubes are in the depressed position.
No provision is provided in the battery top cover for the insertion of the prong of a heavy discharge tester.

DATA

	2.8 Litre	4.2 Litre
Battery type	CA9/7	CA11/7
Voltage	12	12
Number of plates per cell	9	11
Capacity at 10-hour rate	53	53
Capacity at 20-hour rate	60	60

ROUTINE MAINTENANCE

Wipe away any foreign matter or moisture from the top of the battery and ensure that the connections and fixings are clean and tight.
Check the electrolyte level weekly. In extreme cold conditions the battery should be topped up immediately prior to driving the car so that the electrolyte mixing can occur to prevent freezing of the added water.
Topping up the battery should be carried out with the car on a reasonably level surface.
Remove the vent cover. If the acid level is below the bottom of the tubes pour distilled water into the trough until all the tubes are filled.
Replace the vent cover. The electrolyte level is now correct.
DO NOT, under any circumstances, top up the battery by using the normal type of battery filler which incorporates a plunger valve in the filler neck.
The use of this type of filler will depress the sliding tubes and allow the battery to be overfilled.
IMPORTANT: The vent cover must be kept in position at all times except when topping up.
Distilled water should always be used for topping-up. In an emergency, however, clean soft rain water collected in an earthenware container may be used.
Note: Never use a naked light when examining a battery as the mixture of oxygen and hydrogen given off by the battery when on charge and to a lesser extent when standing idle, can be dangerously explosive.
Clean off any corrosion from the battery cable terminals and coat with vaseline before re-connecting.

REMOVAL

Unscrew the two wing nuts retaining the battery strap; remove the fixing rods and strap. Disconnect terminals and lift out the battery from the tray.

WARNING: Rubber sealing plugs are not incorporated in the manifold filler cover.
When removing the battery it is ESSENTIAL that extreme care is taken to ensure that it is NOT tipped to any degree. Failure to ensure this will result in acid spillage which may cause severe acid burning to the Operator and to the car.

REFITTING

Refitting is the reverse of the removal procedure.
Before refitting the cable connectors, clean the terminals and coat with petroleum jelly.

PERSISTENT LOW STATE OF CHARGE

First consider the conditions under which the battery is used. If the battery is subjected to long periods of discharge without suitable opportunities for recharging, a low state of charge can be expected. A fault in the generator or regulator, or neglect of the battery during a period of low or zero mileage may also be responsible for the trouble.

Manifold Vent Cover
See that the ventilating holes in the cover are clear.

Level of Electrolyte
The surface of the electrolyte should be just level with the tops of the separator guards. If necessary, top up with distilled water as detailed on this page. Any loss of acid from spilling or spraying (as opposed to the normal loss of **water** by evaporation) should be made good by dilute acid of the same specific gravity as that already in the cell.

Cleanliness
See that the top of the battery is free from dirt or moisture which might provide a discharge path. Ensure that the battery connections are clean and tight.

Hydrometer Tests
Measure the specific gravity of the acid in each cell in turn with an hydrometer. To avoid misleading readings, do not take hydrometer readings immediately after topping-up.
The readings given by each cell should be approximately the same.
If one cell differs appreciably from the others, an internal fault in the cell is indicated.

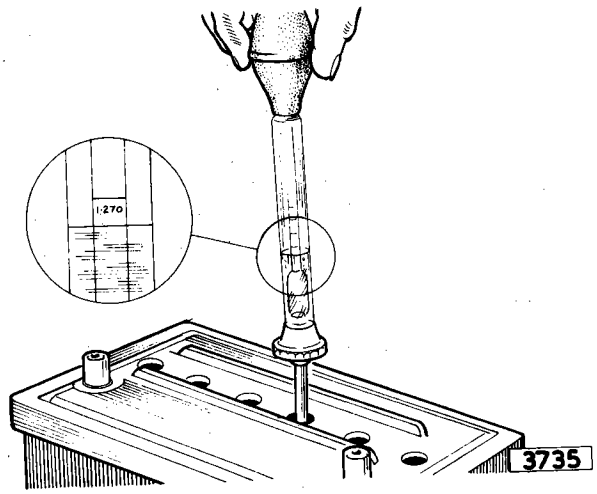


Fig. 1 *Testing with an hydrometer*

The appearance of the electrolyte drawn into the hydrometer when taking a reading gives useful indication of the state of the plates. If the electrolyte is very dirty, or contains small particles in suspension, it is possible that the plates are in a bad condition.

The specific gravity of the electrolyte varies with the temperature, therefore, for convenience in comparing specific gravities, this is always corrected to 60 deg. F (16 deg. C) which is adopted as a reference temperature.

The method of correction is as follows:—

For every 5 deg. F (2.8 deg. C) below 60 deg. F (16 deg. C) deduct 0.002 from the observed reading to obtain the true specific gravity at 60 deg. F (16 deg. C).

For every 5 deg. F (2.8 deg. C) above 60 deg. F (16 deg. C) add 0.002 to the observed reading to obtain the true specific gravity at 60 deg. F (16 deg. C).

The temperature must be that indicated by a thermometer actually immersed in the electrolyte and not the air temperature.

Compare the specific gravity of the electrolyte with the values given in the table and so ascertain the state of charge of the battery.

If the battery is in a discharged state, it should be recharged, either on the vehicle by a period of daytime running or on the bench from an external supply, as described under 'Recharging from an External Supply.'

RECHARGING FROM AN EXTERNAL SUPPLY

If the battery test indicates that the battery is merely discharged and is otherwise in a good condition, it should be re-charged either on the car by a period of day-time running or from an external supply.

Note correct battery polarity (NEGATIVE EARTH) and remove the battery leads when connecting the charging unit cables if charging from an external supply. If the latter, the battery should be charged at 6 amperes until the specific gravity and voltage show no increase over three successive hourly readings.

During the charge the electrolyte must be kept level with the tops of the separator guards by the addition of distilled water.

A battery that shows a general falling-off in efficiency common to all cells will often respond to the process known as 'cycling.' This process consists of fully charging the battery as described above and then discharging it by connecting to a lamp board or other load, taking a current of 5 amperes. The battery should be capable of providing this current for at least 7 hours before it is fully discharged, as indicated by the voltage of each cell falling to 1.8. If the battery discharges in a shorter time, repeat the 'cycle' of charge and discharge.

When using a fast charger to boost the battery, it is ESSENTIAL to check that the ignition switch is in the 'OFF' position. Failure to ensure this will result in damage to the 4TR control unit.

If using the fast charger to start the engine it is **essential** to see that the 4TR control is disconnected by withdrawing the connector plug.

The cable must not be connected to the control unit until the charger has been disconnected and the speed reduced to tick-over.

PREPARING NEW UNFILLED, UNCHARGED BATTERIES FOR SERVICE

Preparation of Electrolyte

Batteries should not be filled with acid until required for initial charging.

Electrolyte of the specific gravity required is prepared by mixing distilled water and concentrated sulphuric acid of 1.835 specific gravity. The mixing must be carried out either in a lead-lined tank or in a suitable glass or earthenware vessel. Slowly add the acid to the water, stirring with a glass rod. **Never add the water to the acid** as the resulting chemical reaction causes violent and dangerous spurting of the concentrated acid. The correct specific gravity for the filling acid and approximate proportions of acid and water are indicated in the table on page P.9.

Heat is produced by the mixture of acid and water, and the electrolyte should be allowed to cool before taking hydrometer readings — unless a thermometer is used to measure the actual temperature and a correction applied to the reading before pouring the electrolyte into the battery.

Filling the Battery

The temperature of the acid, battery and filling-in room must not be below 32 deg. F (0 deg. C).

Carefully break the seals in the filling holes and fill each cell to the level of the separator guard with electrolyte of the approximate specific gravity. Allow the battery to stand 12 hours in order to dissipate the heat generated by the chemical action of the acid on the plates and separators. Restore levels by adding more acid of the same specific gravity and then proceed with the initial charge.

Initial Charge Rate

Charge at the rate of 4 amps until the voltage and specific gravity readings show no increase over five successive hourly readings. This may take up to 80 hours, depending on the length of time the battery has been stored before charging.

Keep the current constant by varying the series resistance of the circuit or the generator output.

This charge should not be broken by long rest periods. If, however, the temperature of any cell rises above the permissible maximum (that is 100 deg. F (38 deg. C) for batteries filled with 1.270 S.G. acids, 120 deg. F (49 deg. C) for those with 1.210 S.G. acid), the charge must be interrupted until the temperature has fallen at least 10 deg. F (–10 deg. C) below that figure. Throughout the charge, the electrolyte must be kept level with the top of the separator guards by the addition of acid solution of the same specific gravity as the original filling-in acid, until the specific gravity and voltage readings have remained constant for five successive hourly readings. If the charge is continued beyond that point, top up with distilled water. At each end of the charge carefully check the specific gravity in each cell to ensure that when corrected to 60 deg. F (16 deg. C) it lies within the specified full-charged limits. If any cell requires adjustment, some of the electrolyte must be siphoned off and replaced by distilled water or by acid of the strength originally used for filling-in, depending on whether the specific gravity is too high or too low. Continue the charge for an hour or so to ensure adequate mixing of the electrolyte and again check the specific gravity readings. If necessary, repeat the adjustment process until the desired reading is obtained in each cell. Finally, allow the battery to cool and siphon off any electrolyte above the tops of the separator guards.

PREPARING NEW "DRY-CHARGED" BATTERIES FOR SERVICE

Filling the Cells

Carefully break the seals in the filling holes and fill each cell with correct specific gravity acid as shown in the table below to the top of the separator guards in one operation. The temperatures of the filling room, battery and acid should be maintained at between 60 deg. F (16 deg. C) and 100 deg. F (38 deg. C). If the battery has been stored in a cool place, it should be allowed to warm up to room temperature before filling.

Freshening Charge

Batteries filled in this way are up to 90% charged and capable of giving a starting discharge one hour after filling. When time permits, however, a short freshening charge will ensure that the battery is fully charged. Such a freshening charge should be 5 amperes for not more than four hours. During the charge the electrolyte must be kept level with the top of the separators by the addition of distilled water. Check the specific gravity of the electrolyte at the end of the charge; if 1.270 acid was used to fill the battery, the specific gravity should now be between 1.270 and 1.290; if 1.210 acid, between 1.210 and 1.230.

Maintenance in Service

After filling, a dry-charged battery needs only the attention normally given to all lead-acid type batteries.

State	Home and climates with shade temperature ordinarily below 80 deg. F (26.6 deg. C). Specific gravity of electrolyte (corrected to 60 deg. F (16 deg. C)).	Climates with shade temperature frequently over 80 deg. F (26.6 deg. C). Specific gravity of electrolyte (corrected to 60 deg. F (16 deg. C)).
Fully charged About half-charged	1.270 – 1.290 1.190 – 1.210	1.210 – 1.230 1.130 – 1.150
Completely discharged	1.110 – 1.130	1.050 – 1.070

Specific Gravity of Filling Acid – corrected to 60 deg. F (16 deg. C)

Home and climates with shade temperature ordinarily below 80 deg. F (26.6 deg. C) 1.260 Add 1 part by volume of acid (1.840 S.G.) to 3.2 parts of distilled water to mix this electrolyte.	Climates with shade temperature frequently above 80 deg. F (26.6 deg. C) 1.210 Add 1 part by volume of acid (1.835 S.G.) to 4 parts of distilled water to mix this electrolyte.
Quantity of electrolyte per cell 1 1/4 pints approximately (720 c.c.)	

DISTRIBUTOR

DESCRIPTION

The Lucas 25D6 distributor is fitted to 2.8 litre engines and the 22D6 model to the 4.2 litre power units.

4.2 litre models fitted with automatic transmission have a speed limiter incorporated in the distributor rotor, the DATA remaining the same irrespective of the type of transmission installed.

The speed limiter is necessary due to the safe maximum speed limitations of the Borg Warner transmission unit, therefore no attempt must be made to fit the standard rotor arm, which will not have the governor plate fitted, as a replacement.

A waterproof cover is incorporated in both distributor assemblies, and is located between the distributor cap and the body. The cover is detachable after removing the cap and disconnecting the cable from the contact breaker spring post.

REMOVAL

Spring back the clips and remove the distributor cap.

Disconnect the low tension wire from the distributor.

Disconnect the vacuum pipe by withdrawing the elbow sleeve junction.

Remove the distributor clamp plate retaining screw and withdraw the distributor.

REFITTING

If the distributor clamping plate pinch bolt has not been slackened during the removal of the distributor, refitting will be the reverse of the removal procedure.

Fit the distributor with the vacuum advance unit facing the cylinder block.

Rotate the rotor arm until the driving dog engages with the distributor drive shaft.

Ignition Timing

If the clamping plate pinch bolt has been slackened during removal of the distributor, it will be necessary to re-set the ignition timing as follows:—

Set the micrometer adjustment in the centre of the scale.

Fit the distributor with the vacuum advance unit facing the cylinder block.

Rotate the rotor arm unit until the driving dog engages with the distributor drive shaft.

Turn the engine until the rotor arm approaches the No. 6 (front) cylinder segment in the distributor cap.

Slowly rotate the engine until the ignition timing scale on the crankshaft damper is the appropriate number of degrees before the pointer (see Fig. 2).

Refer to DATA on page P.14 for the correct degrees of advance.

Connect the low tension wire to the terminal on the distributor body.

Connect a 12 volt test lamp with one lead to the distributor terminal (or the –ve terminal of the ignition coil) and the other to a good earth.

Reconnect the battery and switch on the ignition.

Slowly rotate the distributor body until the points are just breaking, that is, when the lamp lights up.

Tighten the distributor plate clamp bolt to a torque of 30 lb. ins. (0.345 kg/m).

A maximum of six clicks on the vernier adjustment from this setting to either advance or retard, is allowed.

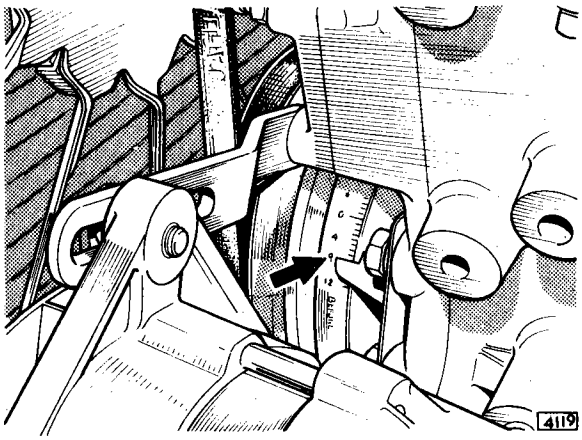


Fig. 2 *Ignition timing scale on crankshaft damper*

ROUTINE MAINTENANCE

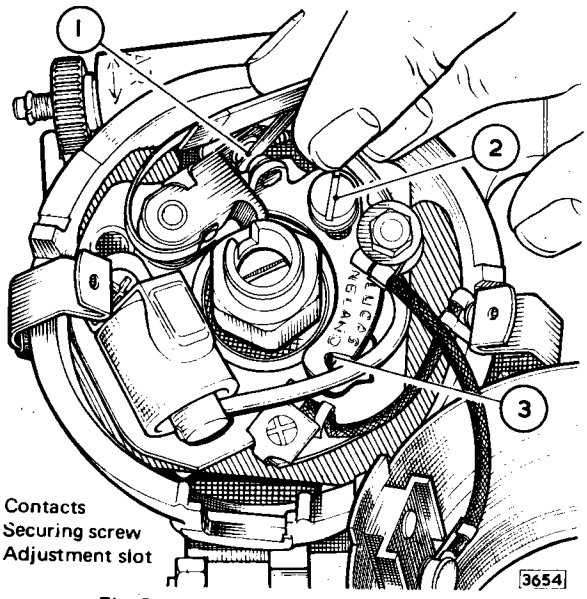
EVERY 12,000 MILES (20,000 KM)

Distributor Contact Breaker Points

Every 12,000 miles (20,000 km) (first 1,000 miles (1,600 km) with new contact set), check the gap between the contact points with feeler gauges when the points are fully opened by one of the cams on the distributor shaft. A combined screwdriver and feeler gauge is provided in the tool kit.

The correct gap is 0.014 – 0.016in. (0.36 – 0.41mm). If the gap is incorrect, slacken (very slightly) the contact plate securing screw and adjust the gap by turning a screwdriver in the nick in the contact plate and the slot in the base plate, clockwise to decrease the gap and anti-clockwise to increase the gap.

Tighten the securing screw and recheck the gap (Fig. 3).
Examine the contact breaker points. If pitted, clean with a fine carborundum stone or very fine emery cloth. Afterwards, wipe away any trace of grease or metal dust with a petrol moistened cloth.
Contact cleaning is facilitated by removing the lever to which the moving contact is attached. To do this, remove the nut, insulating piece and electrical connections from the post to which the contact breaker spring is anchored. The contact breaker lever can then be lifted off the pivot post and the spring from the anchor post.



1 Contacts
2 Securing screw
3 Adjustment slot

Fig. 3 *Checking the contact breaker*

After cleaning and trimming the contacts, smear the pivot post (1, Fig. 4) with Ragosine Molybdenised Non-creep Oil or with Mobilgrease No. 2. Reassemble the contact breaker and check the setting.
Refit the rotor arm, carefully locating its moulded projection in the spindle keyway and pushing it on as far as it will go.
Clean the moulded cover inside and outside with a soft dry cloth. Pay particular attention to spaces between the terminals. If tracking has occurred, indicated by a thin black line between two or more electrodes, or between one of the electrodes and the body, a replacement cover must be fitted.
Check that the small carbon brush inside the moulding can move freely in its holder. Refit the cover and spring the two side clips into position.
Re-check the gap with a dwell angle meter. The dwell angle is measured to verify mechanical condition of the distributor.
The dwell meter registers the average of all dwell angles.
Undue wear of cam lobes, rocker heel, or pivot will result in **incorrect dwell angles** when the contact gap is **correctly adjusted.**
Wear of a spindle or bearing will result in dwell variation with changing speed, producing erratic timing and a poor high-speed performance. The maximum acceptable variation is three degrees.

Note: If correct adjustment of a fully-open gap fails to correct inaccuracy of a dwell, the distributor requires servicing.

LUBRICATION

Remove the moulded cover and withdraw the rotor arm. A tight rotor arm can be withdrawn by using a suitable pair of levers carefully applied at opposite points below the rotor moulding — never against the metal electrode.
IMPORTANT: Do not allow oil or grease on or near the contacts when carrying out the following lubrication.

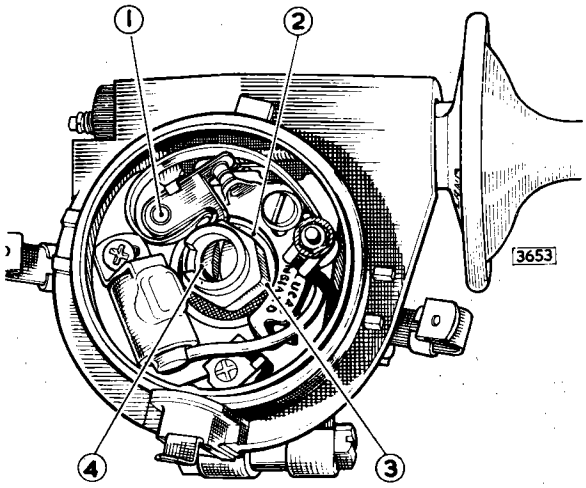


Fig. 4 *Distributor lubrication points*

Cam Bearing

To lubricate the cam bearing, inject a few drops of thin machine oil into the rotor arm spindle (4, Fig. 4). Do not remove or slacken the screw located inside the spindle — a space is provided beneath the screwhead to allow the lubricant to reach the cam bearing.

Pivot Post

Place a drop of clean engine oil on the tip of the pivot post (1, Fig. 4).

Cam

Lightly smear the faces of the cam (3, Fig. 4) with the Mobilgrease No. 2 or with clean engine oil.

Centrifugal Timing Control

Inject a few drops of thin machine oil through a convenient aperture in the contact breaker base plate (2, Fig. 4).

SERVICING

Dismantling

When dismantling, note carefully the position in which the various components are fitted in order to simplify their re-assembly.
Note: The 22D6 distributor embodies a shaft bearing of sintered iron, honed to very fine limits, consequently, fitting a replacement bearing is impracticable. In the case of excessive bush wear the distributor should be replaced with a new or factory re-conditioned unit.
The shaft must be free to rotate with end-play not exceeding 0.006in. (0.15mm). Excessive end-play should be removed by fitting a new thrust washer. After drilling, pinning, and caulking, the shaft assembly should be end tight, but by using a hide mallet, a sharp tap against the end of the shaft will flatten the pips on the washer and permit free rotation of the assembly.

DISTRIBUTOR DATA (4.2 LITRE)

Compression Ratio	'L' or 'S'
Lucas Ignition Distributor Type	22 D 6
Lucas Service	41060A
Cam dwell angle	35 deg. ± 3 deg.
Contact breaker gap	0.014 – 0.016in. (0.36 – 0.41mm)
Contact breaker spring tension measured at free contact	18 – 24 ozs. (512 – 682 gms)

DISTRIBUTOR DATA (2.8 LITRE)

Compression Ratio	8:1 Early cars only 'S' Later cars
Lucas Ignition Distributor Type	25 D 6
Lucas Service	41275
Cam dwell angle	35 deg. ± 3 deg.
Contact breaker gap	0.014in. – 0.016in. (0.36 – 0.41mm)
Contact breaker spring tension measured at free contact	18 – 24 ozs. (515 – 682 gms)

Annotations for Fig. 5 *(opposite)*

1 Rotor arm
2 L.T. terminal
3 Fixed contact plate securing screw
4 Contact breaker base plate
5 Centrifugal timing control weights
6 Vacuum timing control unit
7 Thrust washer
8 C.B. earth connector
9 Capacitor
10 Contacts
11 Contact breaker moving plate
12 Cam
13 Action plate
14 Distance collar
15 Micrometer adjustment nut
16 Oil seal washer
17 Dog and pin

Annotations for Fig. 6 *(opposite)*

1 Rotor arm
2 L.T. terminal
3 Fixed contact plate securing screw
4 Contact breaker base plate
5 Centrifugal timing control weights
6 Vacuum timing control unit
7 Thrust washer
8 C.B. earth connector
9 Capacitor
10 Contacts
11 Contact breaker moving plate
12 Cam
13 Action plate
14 Distance collar
15 Micrometer adjustment nut
16 Dog and pin

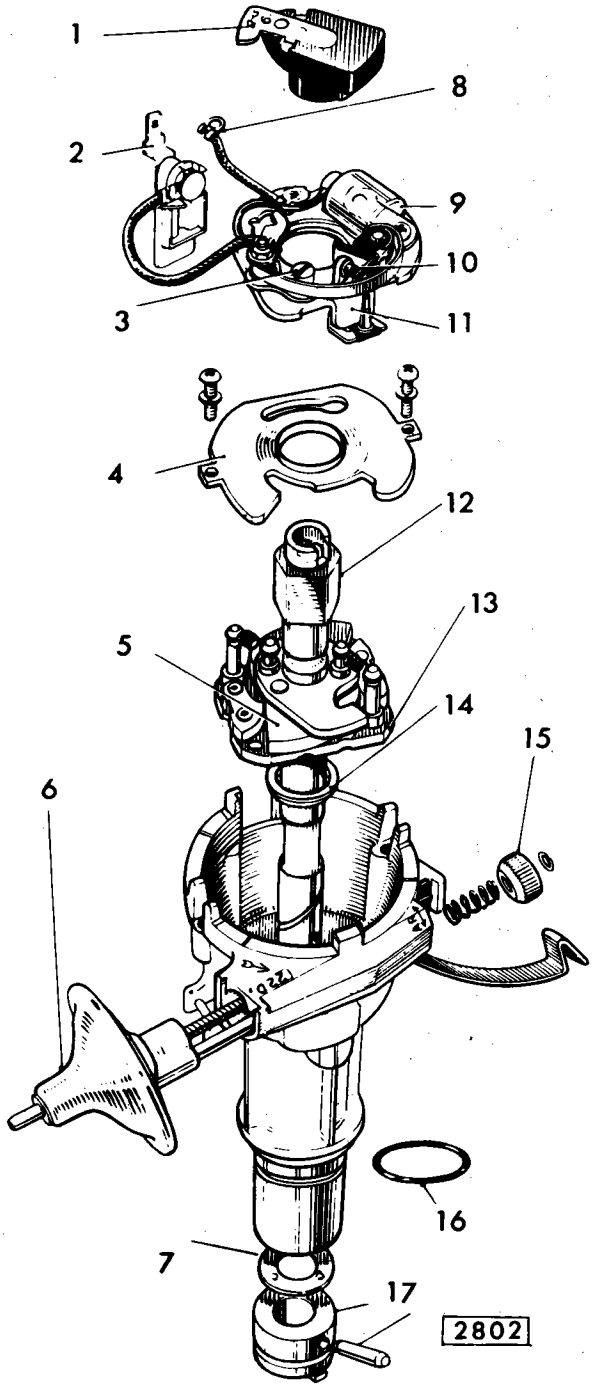


Fig. 5 *The distributor components (4.2 litre)*

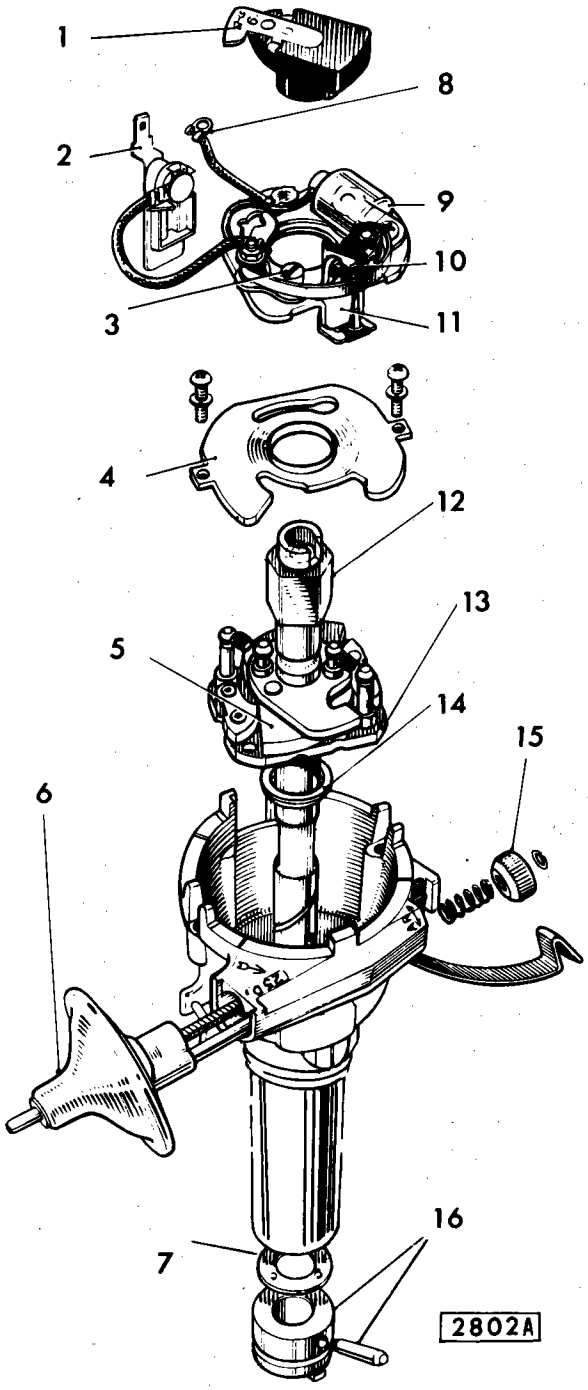


Fig. 6 *The distributor components (2.8 litre)*

IGNITION TIMING (4.2 LITRE)

'L' Compression Ratio . . . . . .8 deg. BTDC*
'S' Compression Ratio . . . . . .8 deg. BTDC

IGNITION TIMING (2.8 LITRE)

8 : 1 Compression Ratio . . 12 deg. BTDC Early cars only
'S' Compression Ratio . . . . . .10 deg. BTDC

* With vacuum retard capsule disconnected.

IGNITION DISTRIBUTOR TEST DATA (4.2 LITRE)

			VACUUM TIMING ADVANCE TESTS. The distributor must be run immediately below the speed at which the centrifugal advance begins to function to obviate the possibility of an incorrect reading being registered				CENTRIFUGAL TIMING ADVANCE TESTS. Mount distributor in centrifugal advance test rig and set to spark at zero degrees at 100 r.p.m.				
			Vacuum in inches of mercury and advance in degrees		No advance timing below-ins. of mercury		Accelerate to-RPM and note advance in degrees		Decelerate to-RPM and note advance in degrees		No advance in timing below-RPM
Distributor Type	Lucas Service Number	Lucas Vacuum Unit Number	Inches	Degrees		Lucas Advance Springs Number	RPM	Degrees	RPM	Degrees	
22D6	41060A (standard) (auto. trans.)	54415894	20 13 9 7½ 6	7–9 6–8½ 2½–5½ 0–3 0–½	4½	55415562	2,300	8½–10½	1,800 1,250 800 650 525	8½–10½ 6½–8½ 5–7 2–4 0–1½	300

Auto advance weights Lucas number 54413073. One inch of mercury = 0.0345 kg/cm^2

IGNITION DISTRIBUTOR TEST DATA (2.8 LITRE)

			VACUUM TIMING ADVANCE TESTS. The distributor must be run immediately below the speed at which the centrifugal advance begins to function to obviate the possibility of an incorrect reading being registered				CENTRIFUGAL TIMING ADVANCE TESTS. Mount distributor in centrifugal advance test rig and set to spark at zero degrees at 100 r.p.m.				
			Vacuum in inches of mercury and advance in degrees		No advance timing below-ins. of mercury		Accelerate to-RPM and note advance in degrees		Decelerate to-RPM and note advance in degrees		No advance in timing below-RPM
Distributor Type	Lucas Service Number	Lucas Vacuum Unit Number	Inches	Degrees		Lucas Advance Springs Number	RPM	Degrees	RPM	Degrees	
25D6	41275	7-14-10	20 13½ 10 8 6	9–11 8½–10½ 4½–7½ 0–5 0–½	5	425305 55415562	2,500	10–12	1,750 1,250 500 400	9–11 7–9 3½–6 1–3½	250

Auto advance weights Lucas number 54413073. One inch of mercury = 0.0345 kg/cm^2

ALTERNATORS

LUCAS 11 AC alternators are fitted to cars as standard equipment, BUTEC alternators being fitted to cars equipped with air-conditioning system.

GENERAL DESCRIPTION (LUCAS 11 AC ALTERNATOR)

The Lucas 11 AC alternator is a lightweight machine designed to give increased output at all engine speeds. Basically the unit consists of a stationary output winding with in-built rectification and a rotating field winding energised from the battery through a pair of slip rings.

The stator consists of a 24 slot, 3 phase star connected winding on a ring shaped lamination pack, housed between the slip ring end cover and the drive end bracket.

The rotor is of 8 pole construction and carries a field winding connected to two face type slip-rings. It is supported by ball bearing in the drive end bracket and a needle roller bearing in the slip-ring end cover.

Two carbon brushes, one positive and the other negative, bear against a pair of concentric brass slip-rings carried on a moulded disc attached to the end of the rotor.

The positive brush is always associated with the inner slip-ring.

The slip-ring end cover also carries six silicon diodes connected in a 3 phase bridge circuit to provide rectification of the generated alternating current output. See Fig. 9. The diodes are cooled by air flow through the alternator induced by a 6in. (152.4mm) ventilating fan at the drive end.

The alternator is matched to an output control unit, Model 4TR, see page P.21 for full details of the control unit. This unit controls the alternator field current and hence the alternator terminal voltage.

A cut-out is not included in the control unit as the diodes in the alternator prevent reverse currents from flowing through the stator when the machine is stationary or is generating less than the battery voltage.

No separate current limiting device is incorporated, the inherent self regulating properties of the alternator effectively limiting the output current to a safe value.

A Lucas 3AW warning light unit is incorporated in the circuit.

The field windings are isolated by means of a relay incorporated in the ignition/switch/steering column lock circuit.

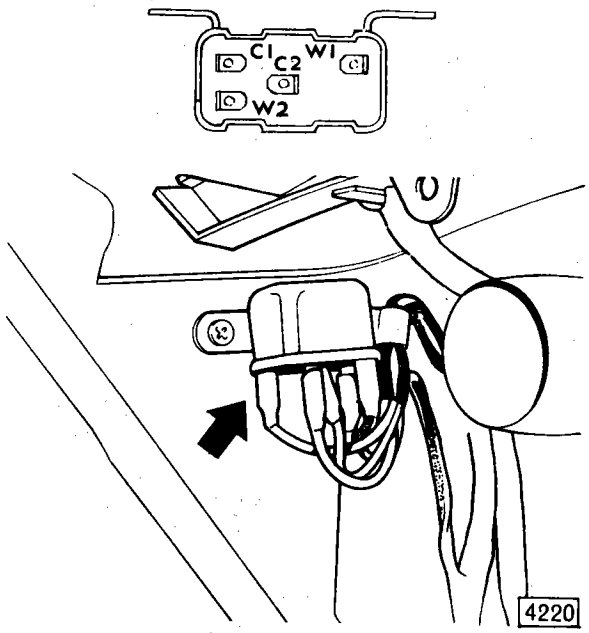


Fig. 7 *Location of alternator relay*

WARNING: When using electric welding equipment for car accident repair, it is advisable to carry out the following precautions:—

1. Disconnect the battery earth cable.
2. Disconnect the main output and AL cables at the alternator.
3. Disconnect all cables at the 4TR control unit.

ROUTINE MAINTENANCE

No routine maintenance is necessary with the alternator and warning light unit.

Occasionally wipe away any dirt or oil which may collect around the slip-ring end cover.

REMOVAL

Disconnect the cables from the terminals on the slip-ring end cover.

Note the colour and the location of the cables for reference when refitting.

PERFORMANCE DATA

Nominal voltage	12 Volts
Nominal d.c. output (hot) in amperes	43 Amperes
Stator phases Phase connection Resistance/phase at 68 deg. F (20 deg. C) ± 5%	3 Star 0.107 ohms
Resistance of rotor winding in ohms at 68 deg.F (20 deg.C)	3.8 ± 5%

Remove the bolts securing the alternator to the mounting bracket and the adjusting link, lift the belt over the pulley and withdraw the alternator.

Note: If air-conditioning equipment is fitted, it will be necessary to remove the compressor unit and the mounting bracket to gain access to the alternator. DO NOT UNDER ANY CIRCUMSTANCE RELEASE OR DISCONNECT THE COMPRESSOR HOSES AT THE UNION.

THIS IS IMPORTANT AS ANY ESCAPING GAS MAY CAUSE BLINDNESS IF IT CONTACTS THE OPERATORS EYES.

Support the compressor in the engine compartment after removing.

REFITTING

Refitting is the reverse of the removal procedure.

Replace the drive belt and adjust to the correct tension by swinging the alternator outwards away from the engine. Tighten the securing bolts.

When correctly adjusted, the belt deflection should be 1/2in. (12.7mm) with pressure applied between the two pulleys.

Important: To avoid bearing damage when adjusting the belt tension, apply leverage ONLY to the drive end bracket and **not** to any other part of the alternator.

SERVICE PRECAUTIONS

Important: The units incorporate transistors in the control box and diode rectifiers in the alternator. The car electrical system must NOT be checked with the ohmmeter incorporating a hand driven generator until these components have been isolated.

REVERSED battery connections will damage the diode rectifiers.

Battery polarity must be checked before connections are made to ensure that the connections to the car battery are NEGATIVE earth. This is most important when using a slave battery to start the engine.

NEVER earth the brown/green cable if it is disconnected at the alternator. If this cable is earthed, with the ignition switched ON, the control unit and wiring may be damaged.

NEVER earth the alternator main output cable or terminal. Earthing at this point will damage the alternator or circuit.

NEVER run the alternator on open circuit with the field windings energised, that is, with the main lead disconnected, or the diodes are likely to be damaged due to peak-inverse voltages.

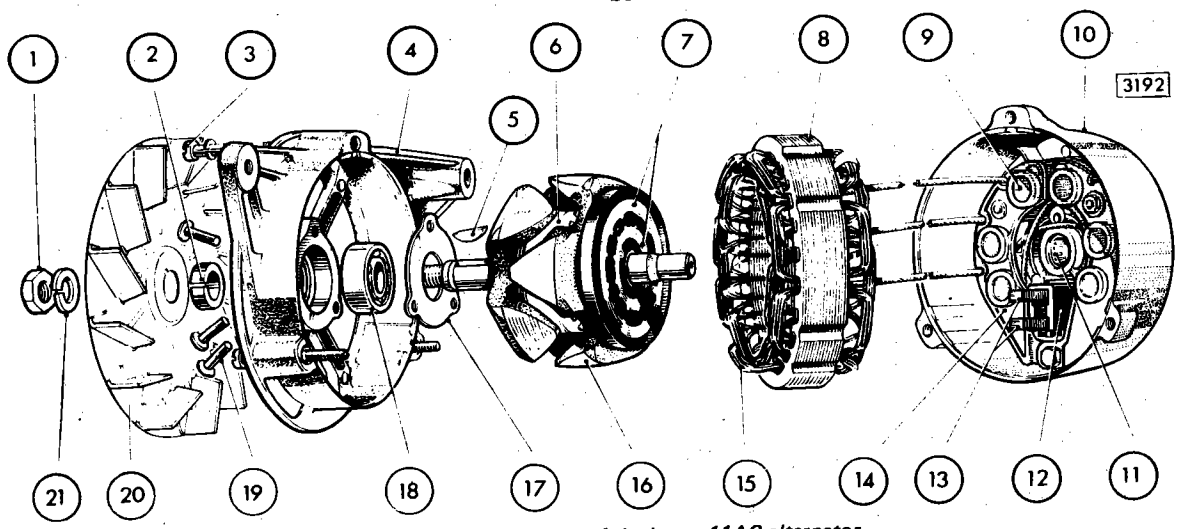


Fig. 8 *Exploded view of the Lucas 11AC alternator*

1 Shaft nut
2 Bearing collar
3 Through fixing bolts (3)
4 Drive end bracket
5 Key
6 Rotor (field) winding
7 Slip rings
8 Stator laminations
9 Silicon diodes (6)
10 Slip ring end bracket
11 Needle roller
12 Brush box moulding
13 Brushes
14 Diode heat sink
15 Stator windings
16 Rotor
17 Bearing retaining plate
18 Ball bearing
19 Bearing retaining plate
20 Fan
21 Spring washer

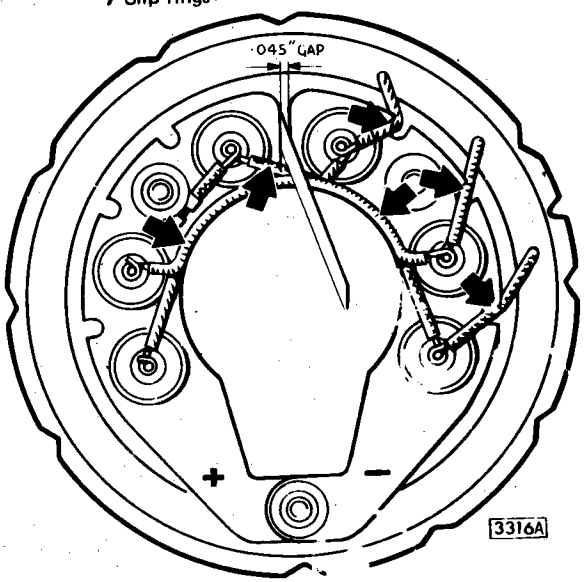


Fig. 9 *Showing the silicon diodes and connections in the slip ring end cover*

SERVICING

Testing the Alternator in position

In the event of a fault developing in the charging circuit, check the following procedure to locate the cause of the trouble.

(a) Disconnect the battery earth cable.

(b) Disconnect the cable from the alternator main output terminal and connect a good quality moving-coil D.C. ammeter, reading up to at least 75 amperes, between the alternator main output terminal and the cable previously disconnected from this terminal.

(c) Detach the terminal connector block from the base of the control unit and connect the black and brown/green cables together by means of a short length of cable with two "Lucar" terminals attached. This operation connects the alternator field winding across the battery terminals and by-passes the output control unit (Fig. 10).

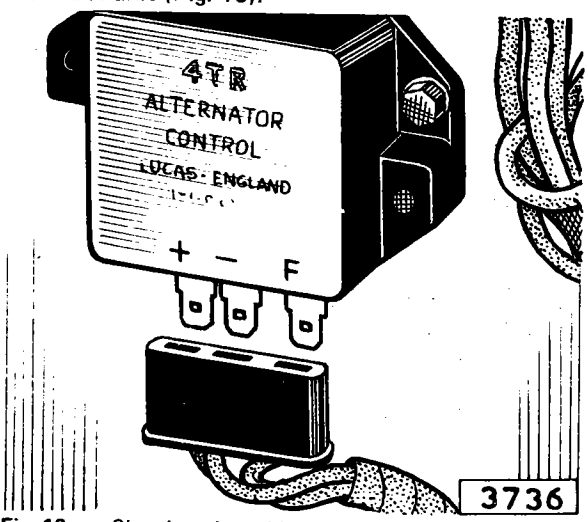


Fig. 10 *Showing the cable terminals disconnected from the base of the control unit*

(d) Reconnect the battery earth lead. Switch on the ignition and start the engine. Slowly increase the engine speed until the alternator is running at approximately 4,000 r.p.m. (2,000 engine r.p.m.).
Check the reading on the ammeter which should be approximately 40 amperes with the machine at ambient temperature.
A low current reading will indicate either a faulty alternator or poor circuit wiring connections.
If, after checking the latter (especially the earth connections), a low reading persists on repeating the test, proceed to paragraph (e).
If, however, a zero reading results, switch on the ignition and check that the battery voltage is being applied to the rotor windings by connecting a voltmeter between the two cable ends normally attached to the alternator field in the field isolating contacts in the ignition switch or the wiring associated with this circuit.
Check each item in turn and rectify as necessary.

(e) If a low output has resulted from the test described in paragraph (d) and the circuit wiring is in order, measure the resistance of the rotor coil (field) by means of a ohmmeter connected between the field

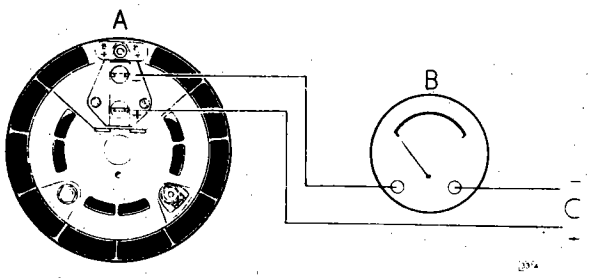


Fig. 11 *Testing the alternator with an ammeter*

terminal blades with the external wiring disconnected. The resistance must approximate to 3.77 ohms.
If an ohmmeter is not available, connect a 12 volt D.C. supply between the field terminals with an ammeter in series. The ammeter reading should be approximately 3.2 amperes (Fig. 11). A zero reading on the ammeter or an 'Infinity' reading on the ohmmeter indicates an open circuit in the field system, that is brushgear, slip-rings, or windings. Conversely, if the current reading is much above, or the ohmmeter is much below the values given above, it is an indication of a short circuit in the rotor winding, in which case the rotor/slip-ring assembly must be changed.

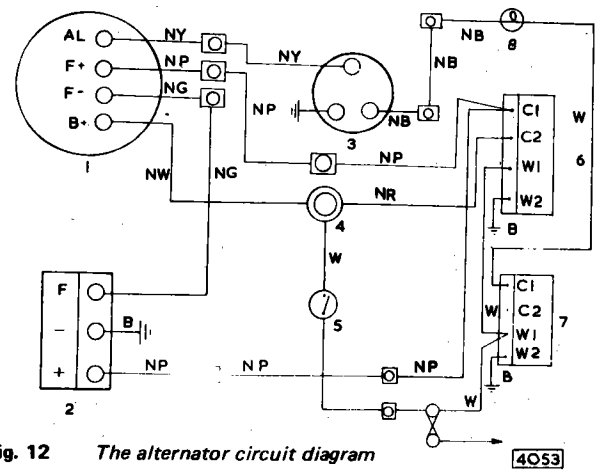


Fig. 12 *The alternator circuit diagram*

1 Alternator	**Colour Code**
2 4TR control unit	**N** Brown
3 3AW warning light unit	**R** Red
4 Main terminal post	**W** White
5 Ignition switch	**Y** Yellow
6 Alternator relay	**B** Black
7 Ignition relay	**P** Purple
8 Ignition warning light	

DISMANTLING

Disconnect the battery and remove the alternator as detailed on page P.15.
Remove the shaft nut and spring washer and withdraw the pulley and fan.
Unscrew the nuts and remove the three through bolts.
Note: The nuts are staked to the three through bolts and the staking must be removed before the nuts are unscrewed. If the threads of the nuts or bolts are damaged, new bolts must be fitted when reassembling.

Mark the drive end bracket, lamination pack and slip-ring end cover so that they may be reassembled in correct angular relation to each other. Care must be taken not to damage the lamination pack when marking.
Withdraw the drive end bracket and rotor from the stator. The drive end bracket and rotor need not be separated unless the bearing requires examination or the rotor is to be replaced, in which case the rotor should be removed from the drive end bracket by means of a hand press, having first removed the shaft key and bearing collar. Remove the terminal nuts, washers, insulating pieces, brush box screws and the 2 BA hexagon headed setscrews and withdraw the stator and heat sink assemblies from the slip-ring end cover. Close up the retaining tongue at the root of each field terminal blade and withdraw the brush spring and terminal assemblies from the moulded brushbox.

REASSEMBLY

Reassembly of the alternator is the reverse of the dismantling procedure. Care must be taken to align the drive end bracket, lamination pack and slip-ring end bracket correctly.
Tighten the three 'through' bolts evenly to a maximum torque of 45–50 lb. in. (0.518 – 0.576 kg.m). Restake the nuts after tightening.
Tighten the brush box fixing screws to a maximum torque of 10 lb. in. (0.115 kg.m).

IMPORTANT

It is important to ensure that a .045in. (1.28mm) gap exists between the non-pivotal end of the heat sinks (see Fig. 9) when reassembling the alternator.
Check by inserting a feeler gauge through the slip-ring and cover aperture.
FAILURE TO ENSURE THIS CLEARANCE WILL RESULT IN A SHORT IN THE AMMETER CIRCUIT BEHIND THE INSTRUMENT PANEL.

INSPECTION OF BRUSH GEAR (EARLY MODELS)

Measure brush length. A new brush is 5/8in. (15.88mm) long; a fully worn brush is 5/32in. (3.97mm) long and must be replaced at, or approaching, this length. The new brush is supplied complete with brush spring and 'Lucar' terminal blade and has merely to be pushed in until the tongue registers.
To ensure that the terminal is properly retained, carefully lever up the retaining tongue with a fine screwdriver blade so that the tongue makes an angle of about 30 deg. with the terminal blade.
The normal brush spring pressures are 4 – 5 oz. (113 – 142 gms) with the spring compressed to 25/32in. (19.84mm) in length and 7 1/2 – 8 1/2 oz. (212 – 242 gms) with the spring compressed to 13/32in. (10.31mm) in length. These pressures should be measured if the necessary equipment is available.

Check that the brushes move freely in their holders. If at all sluggish, clean the brush sides with a petrol moistened cloth, or if this fails to effect a cure, lightly polish the brush sides on a smooth file. Remove all traces of brush dust before re-housing the brushes in their holders.

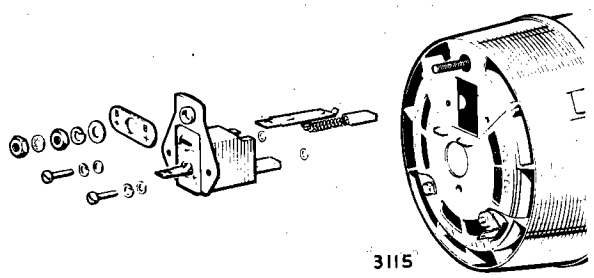


Fig. 13 *Showing the brush removal (early cars)*

INSPECTION OF BRUSHGEAR (LATER MODELS)

Later model alternators will have side entry cables. The characteristics of the alternator remain the same as the previous model (end entry cables) with the exception of the method of inspection and the fixing of the brush gear, detailed as follows:–
The brush length when new is 5/8in. (15.9mm). The serviceability of the brushes may be gauged by measuring the amount by which they protrude beyond the brush box moulding when in the free position. For a brush to remain serviceable this should exceed 0.2in. (5mm).
Renew the brush assemblies if the brushes are worn to or below this length.
The new brush is supplied complete with brush spring and 'Lucar' terminal blade and is retained in position by a plate secured with a single fixing screw.
Check the brush spring pressure using a push type spring gauge.
Push each brush in turn back against its spring until the brush face is flush with the housing. The gauge should then register 8 – 16 ozs. (227 – 454 gms). Replace a brush assembly which gives a reading appreciably outside these limits where this is not due to the brush movement being impeded for any reason.

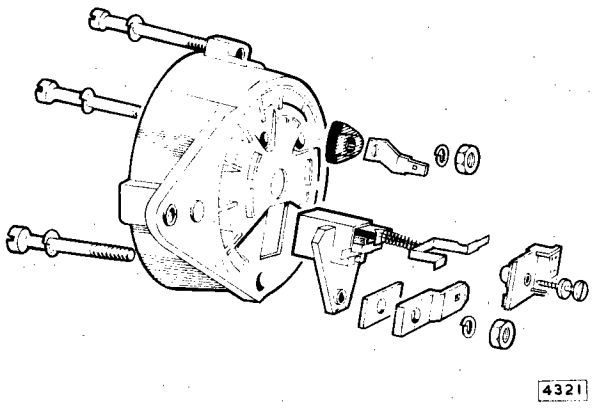


Fig. 14 *Showing brush removal (later cars)*

INSPECTION OF SLIP-RINGS

The surfaces of the slip-rings should be smooth and uncontaminated by oil or other foreign matter. Clean the surfaces using a petrol moistened cloth, or if there is any evidence of burning, very fine glass paper. On no account must emery cloth or similar abrasives be used. No attempt

should be made to machine the slip-rings, as any eccentricity in the machining may adversely affect the high-speed performance of the alternator. The small current carried by the rotor winding and the unbroken surface of the slip-rings means that the likelihood of scored or pitted slip-rings is almost negligible.

Rotor Tests

Note: For clarity, the illustrations of the electrical testing of the rotor and stator show these components isolated from the remainder of the alternator.

Test the rotor by connecting either an ohmmeter (Fig. 15) or a 12 volt battery and ammeter (Fig. 16) between the slip-rings The resistance should be approximately 3.8 ohms, or the value of current approximately 3.2 amperes.

Test for defective insulation between one of the slip-rings and one of the rotor poles, using a 110 volt a.c. mains supply and a 15 watt test lamp (Fig. 17).

If the lamp lights, the coil is earthed to the rotor core and a replacement rotor slip-ring assembly must be fitted.

No attempt must be made to machine the rotor poles or to straighten a distorted shaft.

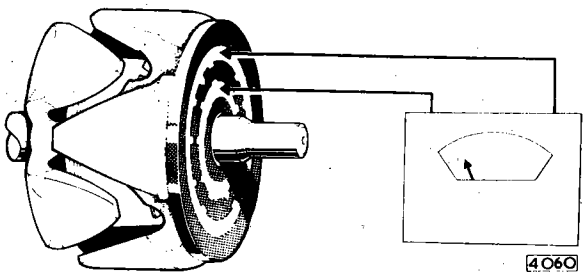


Fig. 15 *Measuring the rotor winding resistance with an ohmmeter*

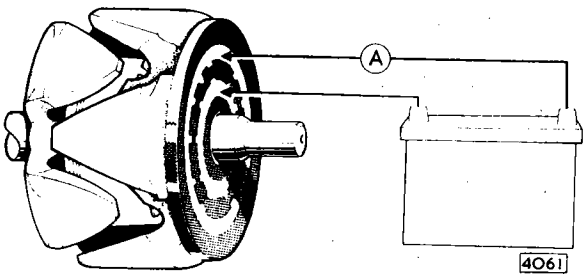


Fig. 16 *Measuring the rotor winding resistance with an ammeter and battery*

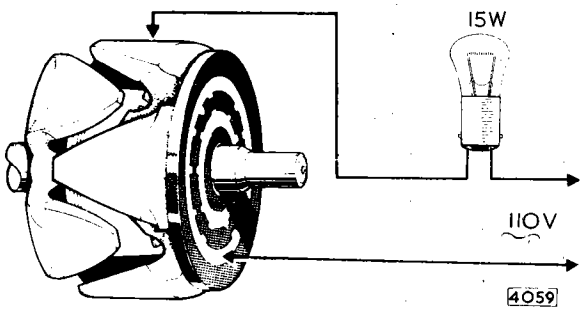


Fig. 17 *Insulation test of rotor winding*

STATOR

Unsolder the three stator cables from the heat sink assembly, taking care not to overheat the diodes. By lettering these cables A, B and C, three pairs of cables – AB, BC, and AC – are available for testing the stator windings. Measure the volt drop across each of these 'pairs' in turn while passing 20 amp between the cable ends. The volt drop should be approximately 4 – 3 volts in each of the three measurements. If any, or all, of the readings are other than these, a replacement stator must be fitted.

Test for defective insulation between stator coils and lamination pack with a mains test lamp. Connect the test probes between any one of the three cable ends and lamination pack. If the lamp lights, the stator coils are earthing and a replacement stator must be fitted.

Before re-soldering the stator cable ends to the diode pins, carry out the following test.

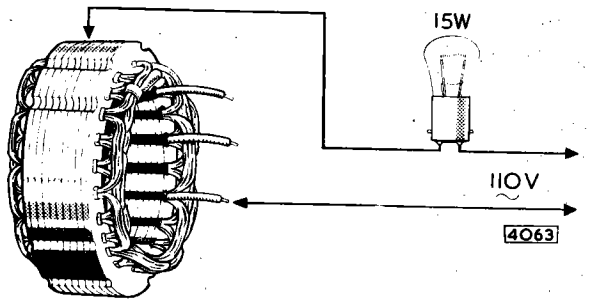


Fig. 18 *Stator winding insulation test*

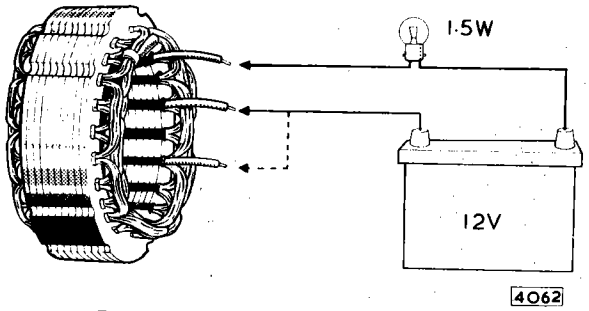


Fig. 19 *Stator winding continuity test*

DIODES

Each diode can be checked by connecting it in series with a 1.5 watt test bulb (Lucas No. 280) across a 12 volt D.C. supply and then reversing the connections.

Current should flow and the bulb light in one direction only. Should the bulb light up in both tests or not light up in either the diode is defective and the appropriate heat sink assembly must be replaced.

The above procedure is adequate for service purposes.

Any accurate measurement of diode resistance requires factory equipment.

Since the forward resistance of a diode varies with the voltage applied, no realistic readings can be obtained with battery-powered ohmmeters. However, should a battery-ohmmeter be used, a good diode will yield 'Infinity' in one direction, and some indefinite but much lower reading in the other.

WARNING: OHMMETERS OF THE TYPE INCORPORATING A HAND-DRIVEN GENERATOR MUST NEVER BE USED FOR CHECKING DIODES.

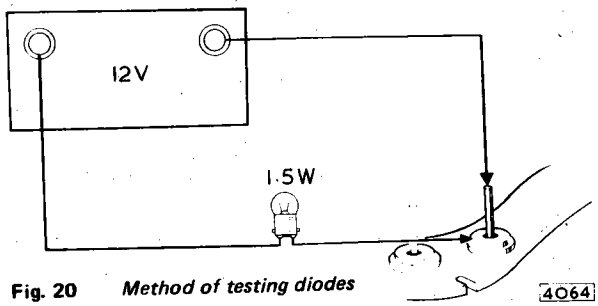


Fig. 20 *Method of testing diodes*

ALTERNATOR DIODE HEAT SINK REPLACEMENT

The alternator heat sink assembly comprises two mutually-insulated portions, one of positive polarity and the other negative. The diodes are not individually replaceable but, for service purposes, are supplied already pressed into the appropriate heat sink portion.

The positive portion carries three cathode base diodes marked red, and the negative portion three anode bas diodes marked black.

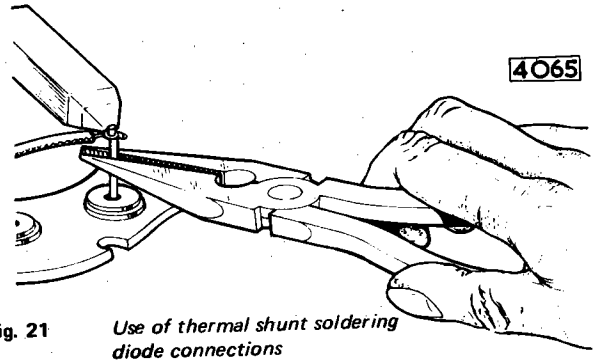


Fig. 21 *Use of thermal shunt soldering diode connections*

When soldering the interconnections, 'M' grade 45 – 55 tin-lead should be used.

Great care must be taken to avoid overheating the diodes or bending the diode pins. The diode pins should be lightly gripped with a pair of suitable long-nosed pliers (which act as a thermal shunt) and the operation of soldering carried out as quickly as possible.

After soldering, the connections must be neatly arranged around the heat sinks to ensure adequate clearance of the rotor and be tacked down with 'MM' EC1022 adhesive where indicated in Fig. 22. The stator connections must pass through the appropriate notches at the edge of the heat sink.

When reassembling the alternator care MUST be taken to ensure that the clearance is maintained between the positive and negative heat sinks as detailed on page P.18.

BEARINGS

Bearings which are worn to the extent that they allow excessive side movement of the rotor shaft must be renewed.

The needle roller bearing in the slip-ring end cover is supplied complete with the end cover.

To renew the drive end ball-bearing (following withdrawal of the rotor shaft from the drive-end bracket) proceed as follows:–

File away the roll-over on each of the three bearing retainer plate rivets and punch out the rivets.

Press the bearing out of the bracket.

Before fitting the replacement bearing see that it is clean and, if necessary, pack it with high-melting point grease such as Shell Alvania No. 3 or an equivalent lubricant.

Locate the bearing in the housing and press it home.

Refit the bearing retaining plate using new rivets.

1 Stator
2 Star point
3 Negative heat sink and anode base (black)
4 Warning light terminal 'AL'
5 Field terminal
6 Slip ring end cover
7 Terminal blade retaining tongue
8 Rotor slip ring brush
9 "Through" bolts
10 Output terminals
11 Positive heat sink and cathode diodes (red)

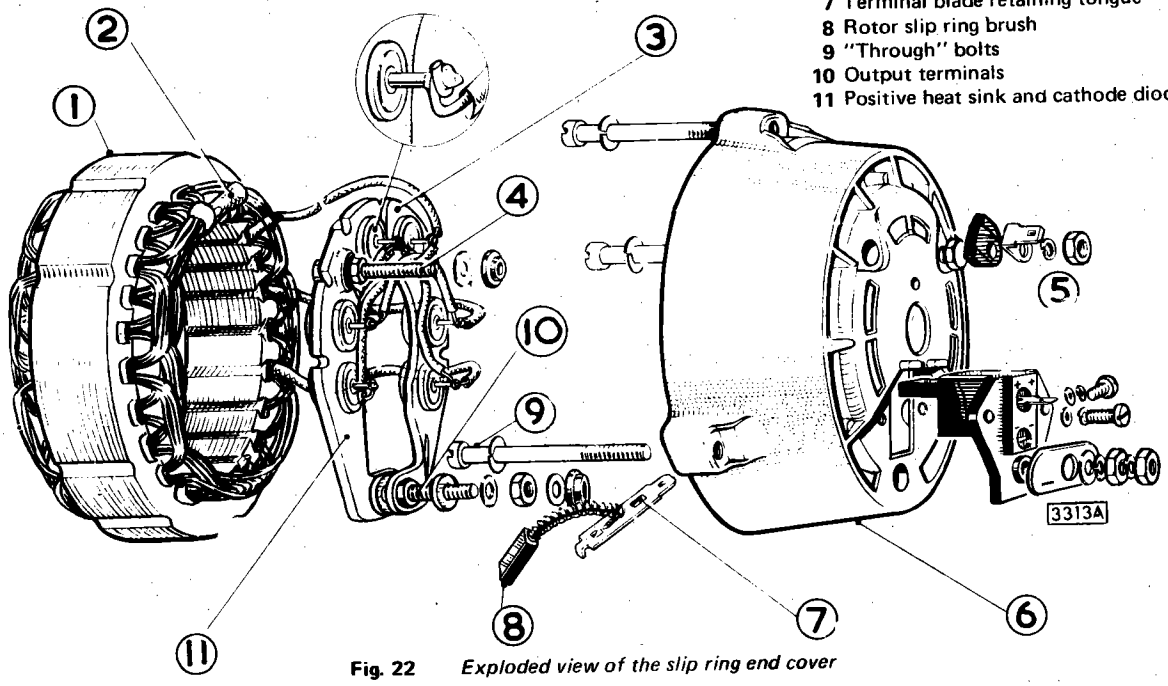


Fig. 22 *Exploded view of the slip ring end cover*

ALTERNATOR OUTPUT CONTROL UNIT

Model 4TR

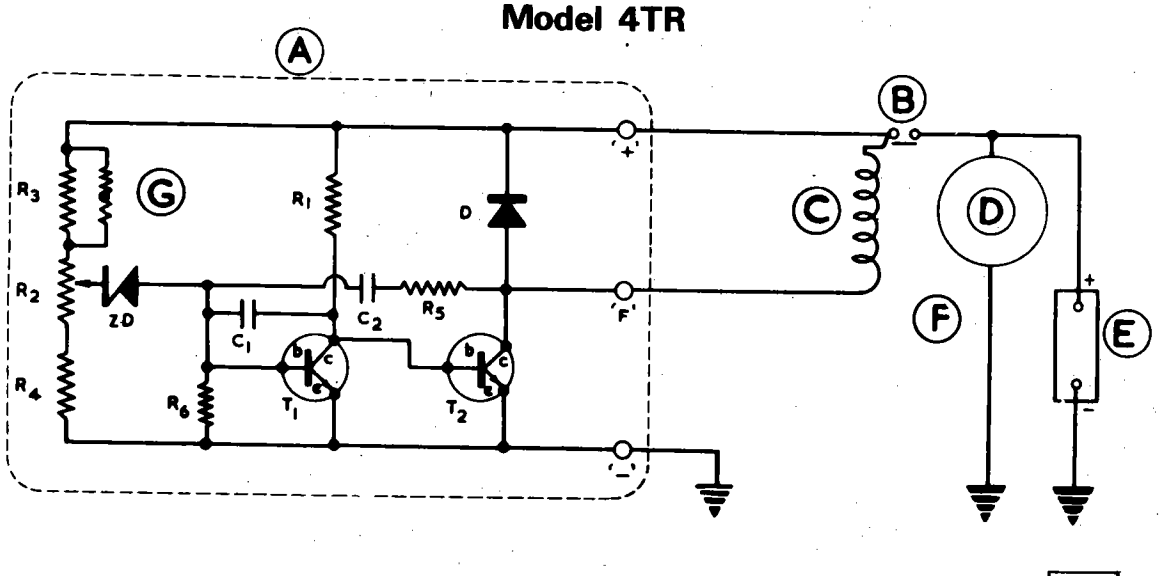


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Fig. 23 *Alternator output control unit circuit diagram*

A Control unit
B Field isolating uevice
C Rotor field winding
D Alternator
E 12 volt battery
F Stator winding (rectified) output
G Thermister

DESCRIPTION

Model 4TR is an electronic control unit. In effect its action is similar to that of the vibrating contact type of voltage control unit, but switching is achieved by transistors instead of vibrating contacts, while a Zener diode provides the voltage reference in place of the voltage coil and tension spring system. No cut-out is required since the diodes incorporated in the alternator prevent currents flowing. No current regulator is required as the inherent self-regulating properties of the alternator effectively limit the output current to a safe value.

Care must be taken at all times to ensure that the battery, alternator and control unit are correctly connected. Reversed connections will damage the semi-conductor devices employed in the alternator and control unit.

OPERATION

When the ignition is switched on, the control unit is connected to the battery through the relay. By virtue of the connection through R1 (see Fig. 23) the base circuit of the power transistor T2 is conducting so that, by normal transistor action, current also flows in the collector-emitter portion of T2 which thus acts as a closed switch to complete the field circuit and battery voltage is applied to the field winding.

As the alternator rotor speed increases, the rising voltage generated across the stator winding is applied to the potential divider consisting of R3, R2 and R4. According to the position of the tapping point on R2, a proportion of this potential is applied to the Zener diode (ZD). This latter is a device which opposes the passage of current through itself until a certain voltage is reached, above which it conducts comparatively freely. The Zener diode can thus be considered as a voltage-conscious switch which closes when the voltage across it reaches 'Breakdown' voltage (about 10 volts) and, since this is a known proportion of the alternator output voltage as determined by the position of the tapping point of R2, the breakdown point therefore reflects the value of the output voltage. Thus at 'breakdown' voltage the Zener diode conducts and current flows in the base-emitter circuit of the driver transistor T1. Again, by transistor action, current will now flow in the collector-emitter portion of T1 so that some of the current which previously passed through R1 and the base circuit of T2 is diverted through T1. Thus the base current of T2 is reduced and, as a result, so also is the alternator field excitation. Consequently, the alternator output voltage will tend to fall – and this in turn will tend to reduce the base current in T1, allowing increased field current to flow in T2. By this means, the field current is continuously varied to keep the output voltage substantially constant at the value determined by the setting of R2.

To prevent overheating of T2 (due to power dissipation) this transistor is operated only either in the fully-on or fully-off condition. This is achieved by the incorporation of the positive feed-back circuit comprising R5 and C2. As the field current in transistor T2 starts to fall, the voltage at 'F' rises and current flows through resistor R5 and capacitor C2, thus adding to the Zener diode current in the base circuit of transistor T1. This has the effect of increasing the current through T1 and decreasing still further through T2 so that the circuit quickly reaches the condition where T1 is fully-on and T2 fully-off. As C2 charges, the feed-back current falls to a degree at which the combination of Zener diode current and feed-back current in the base circuit of T1 is no longer sufficient to keep T1 fully-on.

Current then begins to flow again in the base circuit of T2. The voltage at 'F' now commences to fall, reducing the feed-back current eventually to zero. As T2 becomes yet more conductive and the voltage at 'F' falls further, current in the feed-back circuit reverses in direction, in effect reducing still further the base current in T1. This effect also is cumulative and the circuit reverts to the condition where T1 is fully-off and T2 fully-on.
This condition is only momentary since C2 quickly charges to the opposite polarity, when feed-back current is reduced and current again flows in the base circuit of T1. The circuit thus oscillates, switching the voltage across the alternator field winding rapidly on and off.
Transistor T2 is protected from the high induced voltage surge which results from the collapse of the field current, by the surge quench diode D connected across the field windings. This diode provides a measure of field current smoothing since current continues to flow in the diode after the excitation voltage is removed from the field. The elimination of radio interference is achieved by connecting condenser C1 between the base and collector terminals of T1 to provide negative feed-back. At high temperatures, a small leakage current may flow through the Zener diode even though the latter is in the nominally non-conductive state. Resistor R6 provides a path for this leakage current which otherwise would flow through T1 base circuit and adversely affect the regulator action.
A thermistor is connected in parallel with resistor R3. The thermistor is a device whose resistance increases as the temperature falls and vice versa. Any alteration in its ohmic value will modify the voltage distribution across the potential divider and thus affect the voltage value at which the Zener diode begins to conduct, so matching the changes which take place in battery terminal voltage as the temperature rises.

CHECKING AND ADJUSTING THE CONTROL UNITS

Important: The following voltage checking and setting procedure must be carried out only:—

(a) Providing the alternator and associated wiring circuits have first been tested and found satisfactory, and
(b) in conjunction with a well charged battery, i.e. with the charging current not exceeding 10 amperes.
(c) After running the alternator at charging speed for eight minutes. This operation applies when bench testing or testing on the car.

VOLTAGE CHECKING

Leave the existing connections to the alternator and control unit undisturbed. Connect a high-quality voltmeter between control unit terminals '+' and '—.' If available, use a voltmeter of the suppressed zero type, reading 12-15 volts. Switch on an electrical load of approximately 2 amperes, e.g. side and tail lighting. Start the engine and run the alternator at 3,000 r.p.m. until conditions (b) and (c) above are obtained.
The voltmeter should now show a reading of 13.9 — 14.3 volts at 68-78 deg. F (20-26 deg. C) ambient temperature. If not, but providing the reading obtained has risen to some degree above battery terminal voltage before finally reaching a steady value; the unit can be adjusted to control at the correct voltage (see 'ADJUSTING').
If, however, the voltmeter reading remains unchanged (at battery terminal voltage) or, conversely, increases in an uncontrolled manner, then the control unit is faulty and as its component parts are not serviced individually, a replacement unit must be fitted.

ADJUSTING

Stop the engine and withdraw the control unit mounting screws. Invert the unit and chip away the sealing compound which conceals the potentiometer adjuster (see Fig. 24). Check that the voltmeter is still firmly connected between terminal '+' and '—.' Start the engine and, while running the alternator at 3,000 r.p.m. turn the potentiometer adjuster slot — clockwise to increase the setting or anti-clockwise to decrease it — until the required setting is obtained. Use care in making this adjustment — a small amount of adjuster movement causes an appreciable difference in the voltage reading. Re-check the setting by first stopping the engine then, again, running the alternator at 3,000 r.p.m.
If the control unit regulates satisfactorily after the adjustment has been made, refit the unit.
No attempt should be made to reseal the potentiometer. Any undue heat applied at this point may damage the unit.

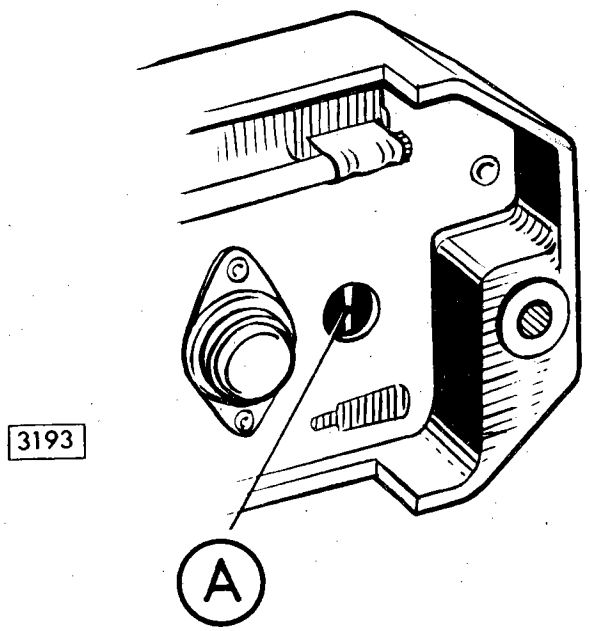


Fig. 24 *4TR control unit. "A" indicates the potentiometer*

WARNING LIGHT CONTROL UNIT
Model 3AW

DESCRIPTION
The Model 3AW warning light unit is a device connected to the centre point of one of the pairs of diodes in the alternator and operates in conjunction with the ignition warning light to give indication that the alternator is charging.
The unit is mounted on the wing valance adjacent to the control box.
The unit is sealed, therefore servicing and adjustment is not possible.
Faulty units must be replaced.

Checking
Check by substitution after ensuring that the remainder of the charging circuit (including the drive belt) is functioning satisfactorily.
Warning: A faulty diode in the alternator or an intermittent or open circuit in the alternator or open circuit in the alternator-to-battery circuit can cause excessive voltages to be applied to the warning light unit. Therefore, to prevent possible damage to a replacement unit, it is important to first check the voltage between the alternator terminal 'AL' and the earth.

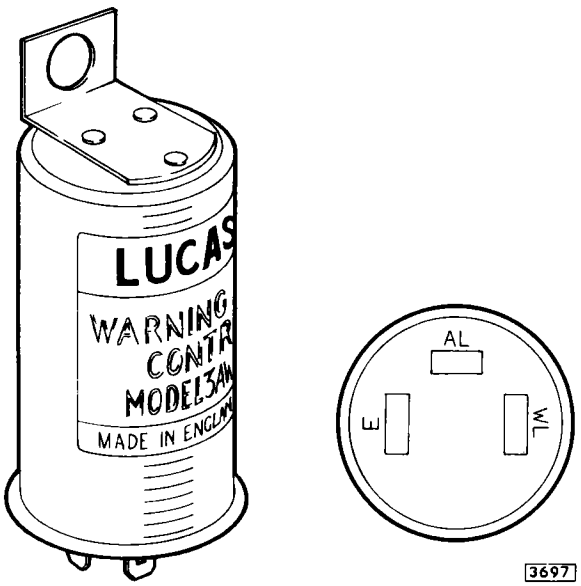


Fig. 25 *The 3AW warning light control unit*

Run the engine at 1,500 r.p.m. when the voltage should be 6-7.5 volts, measured on a good quality moving coil voltmeter.
If a higher voltage is registered, check that all charging circuit connections are clean and tight, then, if necessary, check the alternator rectifier diodes before fitting a replacement 3AW warning light unit.

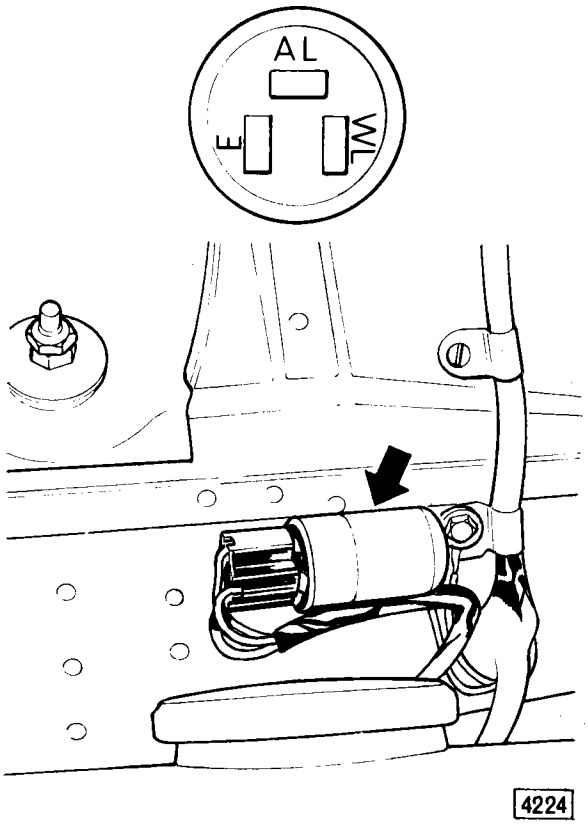


Fig. 26 *Location of warning light unit*

ALTERNATOR
(Air-conditioning System)

GENERAL DESCRIPTION (BUTEC ALTERNATOR)

Cars equipped with the Air-conditioning system will have a 'BUTEC' alternator manufactured by the B.U.T. ELECTRICAL COMPANY Ltd.

This machine gives the higher rated output necessary to compensate for the increased battery load.

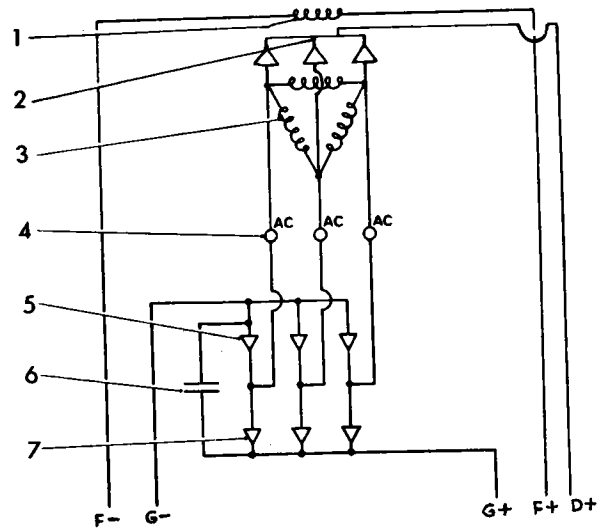
A separate warning light unit (see page P.23) is not required with this machine.

The alternator is a three phase machine cooled by means of a fan carried on the rotor shaft. Six replaceable silicon rectifying diodes are mounted inside the alternator at the slip-ring end and are connected to the stator windings.

A 0.15 micro-farad capacitor is connected to the heat sinks for the purpose of smoothing transients.

The alternator is matched to a regulator unit, detailed on page P.30.

The field windings are isolated by means of a relay in the ignition switch/steering column lock circuit as for the Lucas 11AC alternator.



4323/M2233

Fig. 27 *Butec A7 alternator internal circuit diagram*

1 Rotor (Field) coil
2 Positive (+) sensing diode
3 Stator winding
4 A.C. Terminals
5 Negative (−) diodes
6 Capacitator
7 Positive (+) diodes

WARNING

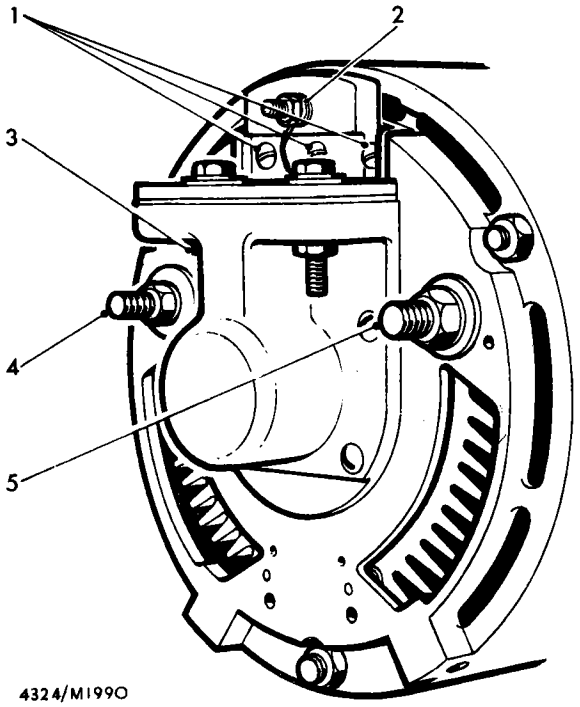
If welding is necessary in the vicinity of the alternator, precautions should be taken to ensure that the heat is not transmitted to the diodes, otherwise irreparable damage will be caused.

When using electric arc welding equipment for car accident repair, it is advisable to carry out the following precautions.

1. Disconnect the battery earth cable.
2. Disconnect the output cables from the alternator.
3. Disconnect the cables from the regulator unit.

PERFORMANCE DATA

Nominal voltage	12 volts.
Maximum output	60 Amperes.
Maximum operating speed	10,000 alternator revs/min. (4,500 engine revs/min.)
Resistance of rotor coil	3.6-4.0 ohms.



4324/M1990

Fig. 28 *Alternator terminals*

1 A.C. Output tappings
2 Sensing diode terminal
3 Field terminal
4 Negative D.C. terminal
5 Positive D.C. terminal

ROUTINE MAINTENANCE

No routine maintenance is necessary with the alternator and the regulator unit, but the following items should be checked occasionally to ensure correct operation:—

1. Check condition of drive belt.
2. Check all connections for tightness and terminal connections for cleanliness.
3. At regular intervals inspect the slip-ring brushes, spring tension, holders and slip-rings. Should the slip-rings and brush holders be fouled with grease or dirt the unit should be removed from the engine and the rings, holders and brushes cleaned.

FAULT FINDING

Should the charging system not function correctly, the following tests may be conducted whilst the alternator is mounted on the engine and should indicate if the unit is defective. Remove sensing diode block from the alternator before making tests.

Stator Earth Test
Check any stator phase for earth to the alternator frame with a 110-230 volt test lamp and leads connected as shown in Fig. 29. No circuit should be indicated.
This is a delta connected stator, therefore if one phase shows earth, all phases will be similarly affected.

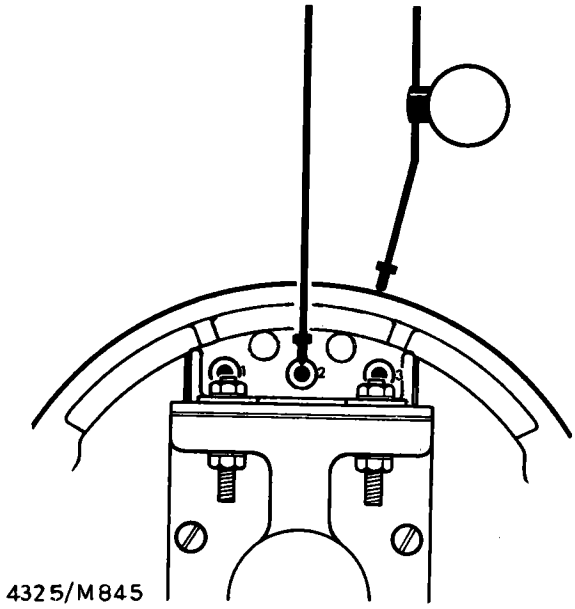


Fig. 29 *Stator earth test*

Stator Winding Continuity Test
With a ohmmeter or test lamp check the continuity of each phase (3) as shown in Fig. 30.
Each phase should be reasonably identical.

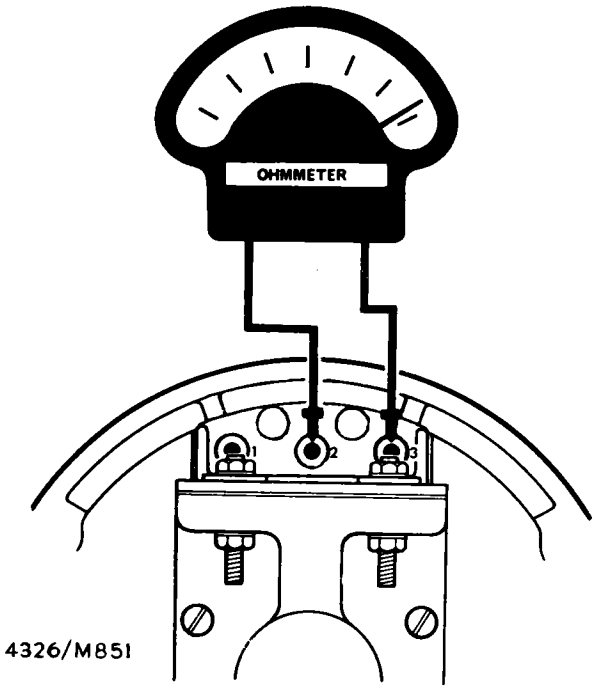


Fig. 30 *Stator continuity test*

Alternator Phase Test
Start the engine and run the alternator at 1,000 revs/min. (460 engine revs/min.). Connect an A.C. voltmeter, or 12 volt test lamp between two of the three A.C. terminals in turn. Voltage or lamp brilliancy should be the same across phases 1-2, 2-3, and 1-3. A pronounced difference in the voltmeter reading or lamp brilliancy indicates shorted or earthed stator terminals (Fig. 31).

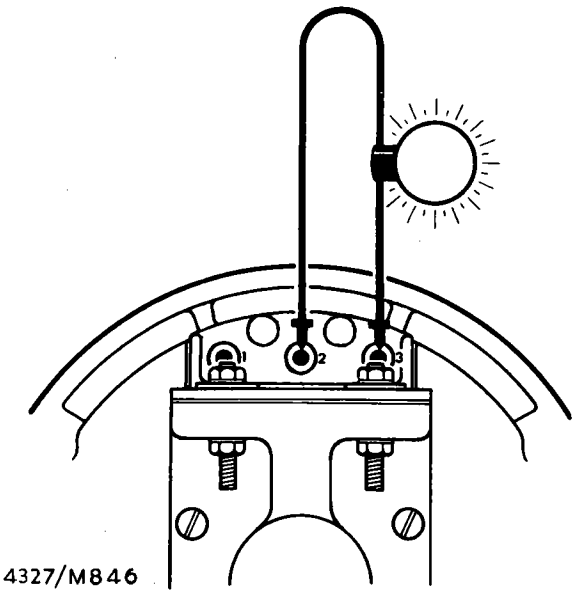


Fig. 31 *Phase test*

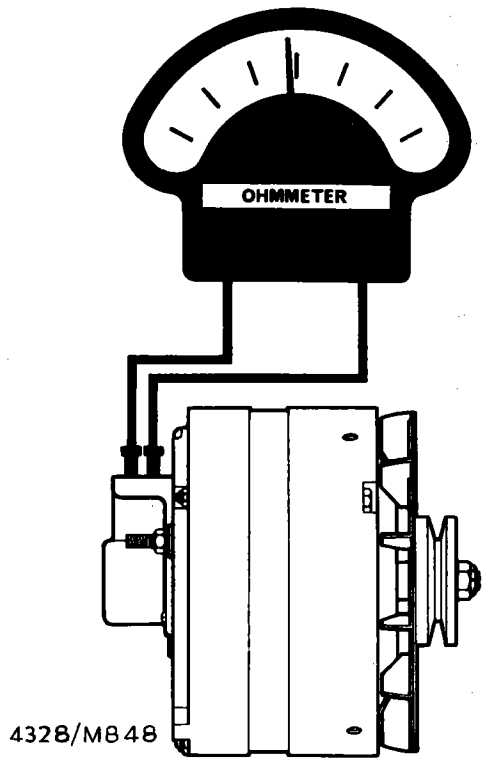


Fig. 32 *Testing rotor winding*

Rotor Coil Resistance Tests
To measure the resistance of the rotor (field) coil winding remove the two brush holders (see dismantling procedure) and insert the ohmmeter test prongs into the brush holder openings and make direct contact with each of the slip rings. The rotor coil resistance should be 3.6 ohms to 4.0 ohms. If there is no resistance it would indicate a possible open circuit in the rotor coil. If on removal of the brushes it is found that the brush springs have collapsed this indicates that the rotor has shorted turns in the coil (Fig. 32).

DISMANTLING
Remove the shaft nut and washer and with a gear puller withdraw the fan assembly. Extract the drive key from the shaft.
Remove the brushes together with washers, insulating cover, cork gasket and jumper leads after removing the two field terminal nuts.
Remove the four screws securing the plastic brush holder housing assembly and detach the assembly from the slip-ring end housing.
Remove three Nyloc nuts and through bolts which hold the unit together. With a brass drift held against the end of the rotor shaft gently tap the drift with a hammer and remove the slip-ring end housing and stator.

To disconnect the stator from the slip-ring end housing, remove the three A.C. terminal nuts and stator connections and separate the stator from the housing with a lead or hide mallet.
Using an arbor type press or gear puller remove the rotor from the drive end housing as shown in Fig. 34.

Rectifier Testing – Method 'A'
The following rectifier tests should be made when it is indicated that they are not functioning correctly.
Note: If an ohmmeter is not available see Rectifier Test 'B.'

Test 1 (Positive Terminal Post Diodes)
A – With the negative (–) prod of the ohmmeter on the terminal post of the diode No. 1 and the positive (+) prod on the corresponding heat sink, the meter should indicate a low resistance. (See Fig. 35).
B – With the positive (+) prod of the ohmmeter on the terminal post of the diode terminal No. 1 and the negative (–) prod on the corresponding heat sink, the meter should indicate a very high resistence or infinity. Each of the positive terminal posts should be checked in the above manner (See Fig. 36).

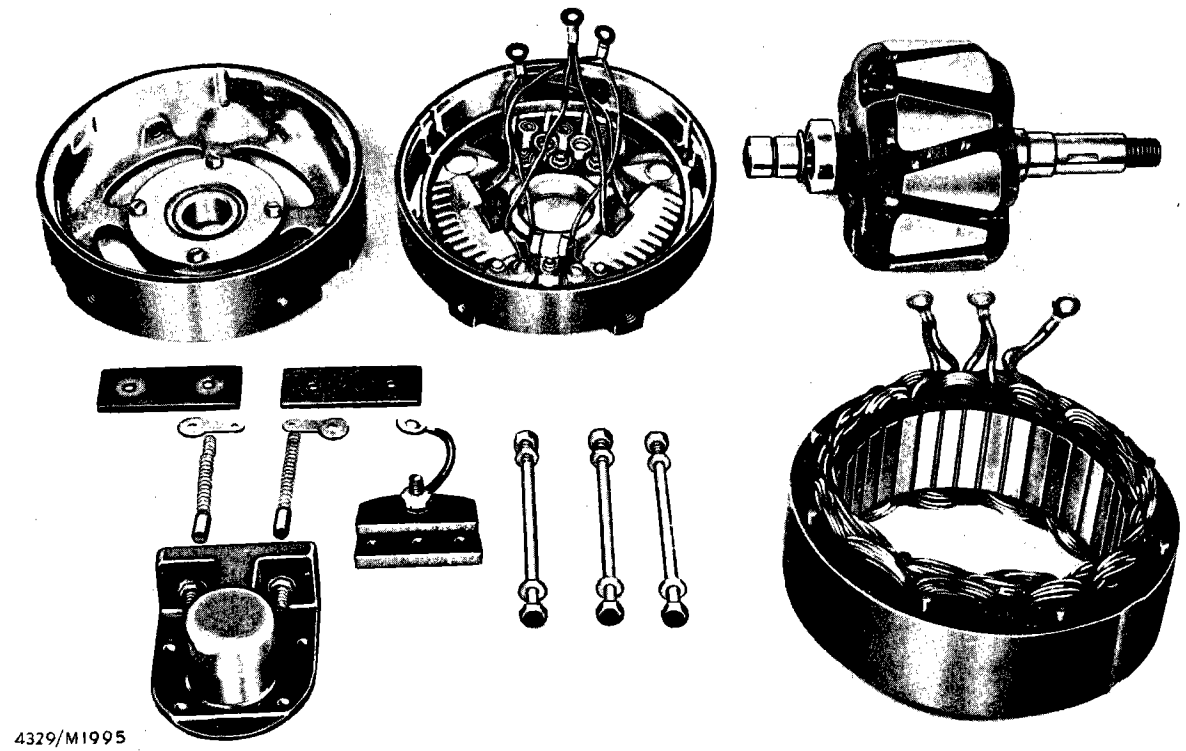


Fig. 33 *Exploded view of alternator*

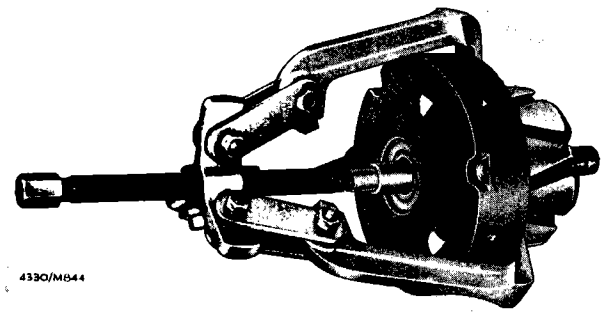


Fig. 34 *Removing rotor*

Test 2 (Negative Terminal Post Diodes)
All three diodes Nos. 4, 5, and 6 should be tested in a similar manner to Test 1.
With the positive prod of the meter on the terminal post of the diode and the negative prod on the corresponding heat sink, the meter should indicate a low resistance. A very high or infinity reading should be indicated when the meter prods are reversed.

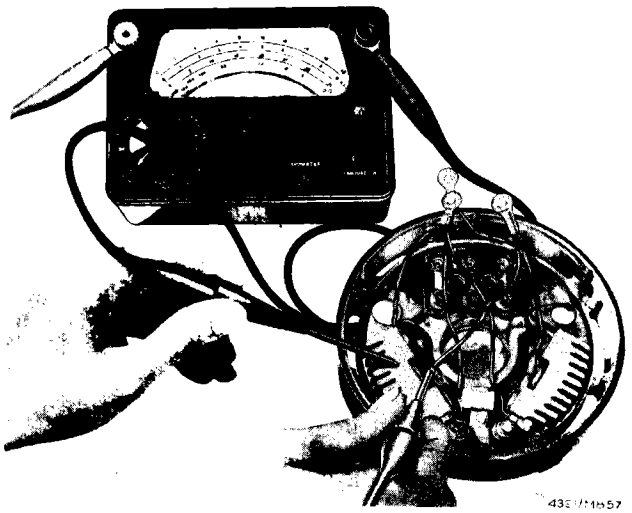


Fig. 35 *Diode test using Avometer*

Rectifier Test 'B' (Alternative)
If an ohmmeter is not available, a 12 volt battery and bulb may be used to test the silicon rectifiers. This test is basically the same as test 'A' with the battery and bulb replacing the ohmmeter.
The results of the preceeding tests can be as follows:—
1. If the bulb lights in one direction only, the rectifier diode is not faulty (Fig. 37).
2. If the bulb lights in both directions the rectifier diode is shorted.
3. If the bulb does not light in either direction, the rectifier diode is open.

Any diode or diodes that the above tests indicate as not operating properly means that the rectifier assembly must be replaced.

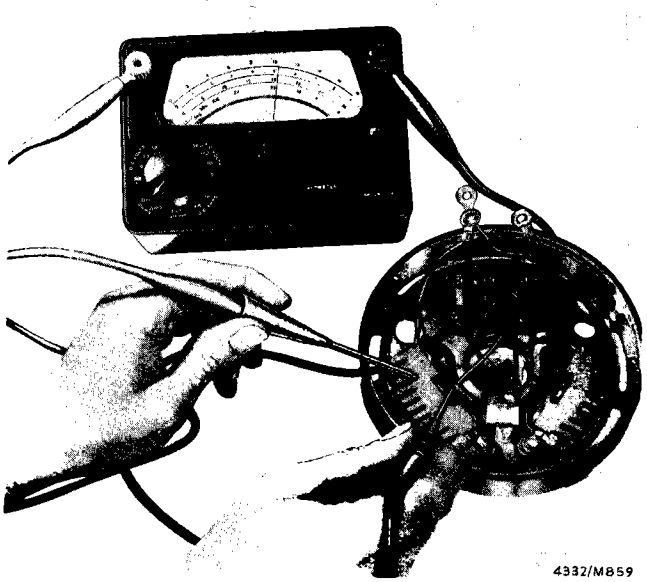


Fig. 36 *Diode test (Prods reversed)*

Rectifier Assembly Replacement
When it is determined which diode or diodes are defective it is recommended that one or both rectifier assemblies are replaced as follows:—
1. Remove the two screws which secure the capacitor leads to the rectifier assemblies.
2. Cut the three flexible leads of one or both rectifier assemblies at the crimped terminals.
3. Remove the screws, nuts, washers and ceramic insulators which secure the rectifier assembly to the end housing.
4. Fit the new rectifier assembly, **ensuring it is of the same polarity, and that both the ceramic insulators and fibre washers are in their correct relative positions.** (See Fig. 38 and 39).
5. Remove the three A.C. terminal nuts and connect the rectifier.
6. Reconnect the capacitor leads

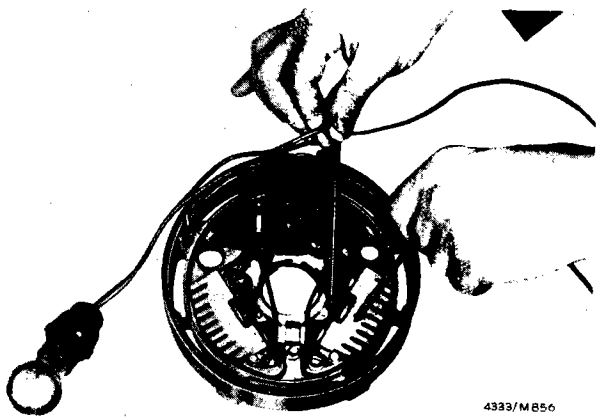


Fig. 37 *Diode test using lamp*

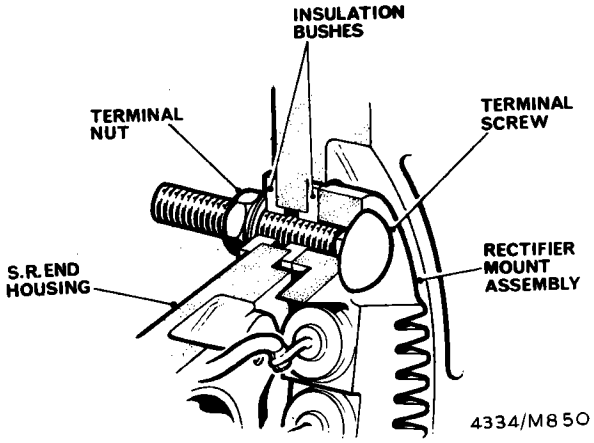


Fig. 38 *Section through slip-ring end housing showing terminal insulation*

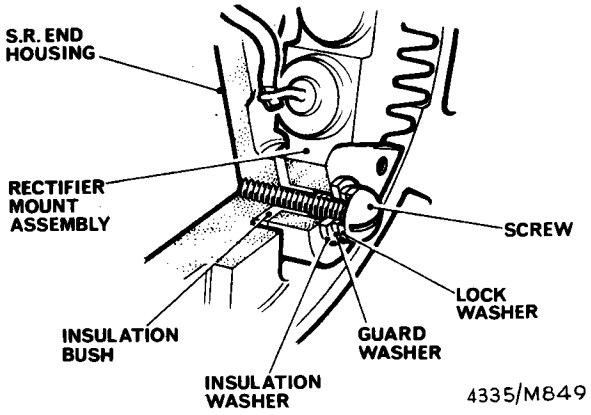


Fig. 39 *Section through slip-ring end housing showing fixing screw*

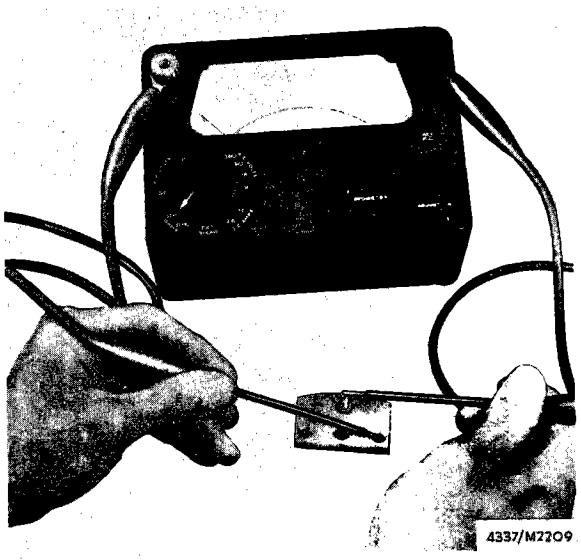


Fig. 40 *Testing field diodes*

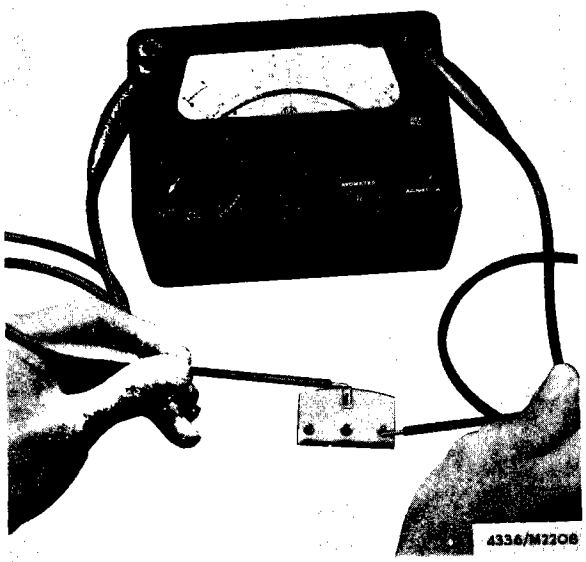


Fig. 41 *Testing field diodes (prods reversed)*

TESTING FIELD DIODES

Diode Block – Positive Sensing

With the negative (–) prod of an ohmmeter on the terminal post and the positive (+) prod on each other terminal in turn, the meter should read a low resistance.

With the positive prod of the ohmmeter on the terminal post and the negative (–) prod on each other terminal in turn, the meter should indicate a high resistance.

Apply test prods between two of the three diodes in turn. No reading should be obtained.

Stator and Housing – Checking

Check the stator windings to ensure that the wires are not burned, broken or insulation damaged (See Fig. 43). If the windings are in good condition use an air hose to blow out

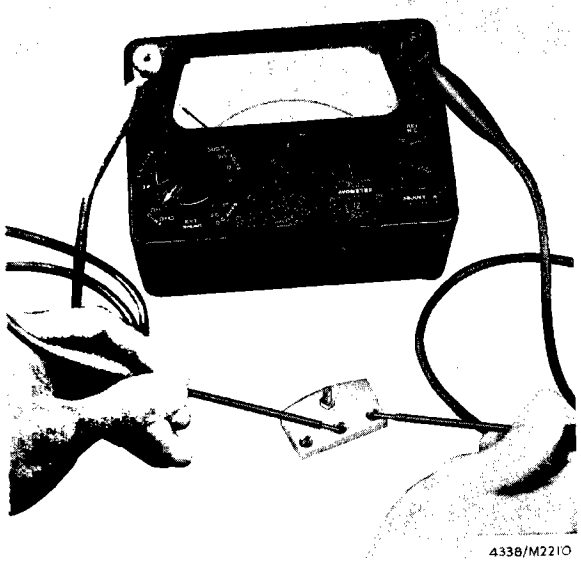


Fig. 42 *Testing between field diodes*

any dust or dirt. Use a cloth soaked in petrol to wipe the stator clean. After the stator has dried check each A.C. terminal to each of the other two terminals; they should all make a complete circuit. (See Fig. 44).
Remove the four screws and the bearing retainer plate from the drive end housing and tap out the old bearing. Press in the new bearing, being sure to apply pressure on the outer race only.

Rotor – Checking
If the rotor bearing, slip-rings and coil are in good condition, further dismantling is unnecessary. If the rotor coil is open circuited, earthed or does not have the correct resistance, the rotor is beyond repair and must be replaced by a new rotor assembly.

Slip-Rings – Replacement
With a soldering iron remove the wire which connects the rotor coil to the outer slip-ring. Bend the wire so that it is parallel to the shaft and unsolder the wire from the inner slip-ring. With a gear puller, pull off the slip-rings and insulating washer. Alternatively an arbor type press may be used, placing suitable fixture plates behind the slip-rings. A new insulating washer should then be fitted.
The new slip-ring assembly should be kept in a warm place so that it will press on the shaft easily without cracking. Ensure that the slots in the slip-ring align with the slot in the shaft carrying the wires from the rotor coil and then press on the slip-ring to the shoulder. Solder the coil leads to the new slip-ring.
Place the rotor assembly in a lathe and take a light smooth cut, preferably with a diamond tool, from the face of the slip-rings to ensure concentricity with the bearing surfaces of the shaft, which should be within 0.002in. (0.050mm) total indicator reading.

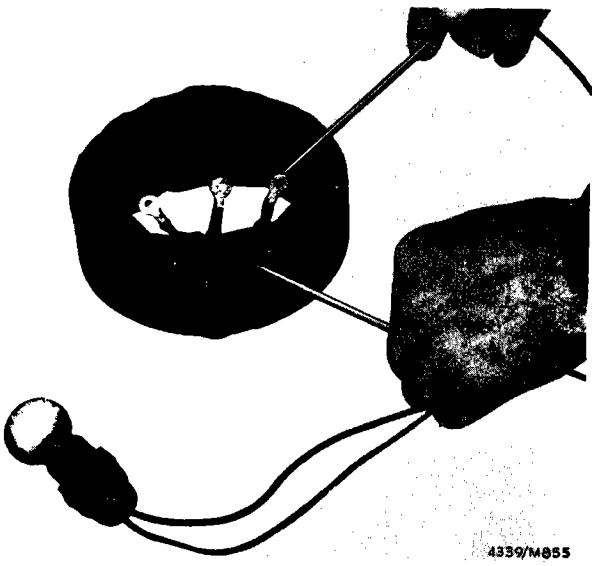


Fig. 43 *Testing stator winding insulation*

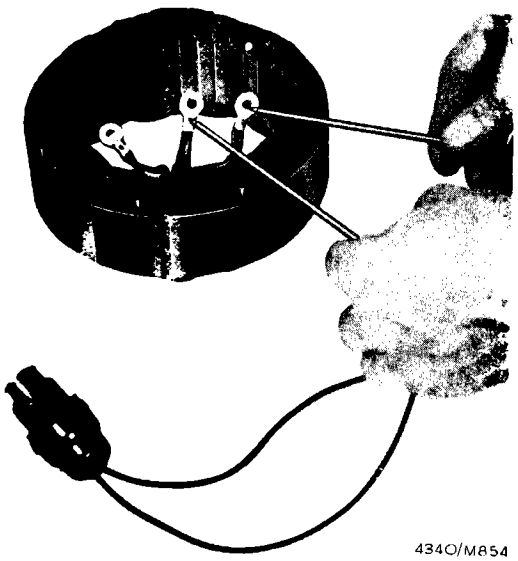


Fig. 44 *Checking stator winding continuity*

Rotor Bearing – Replacement
The rotor bearing may be removed after the slip-rings with the same gear puller (Fig. 45).
An arbor press may be used instead, as previously described for the slip-rings. Press on the new bearing.

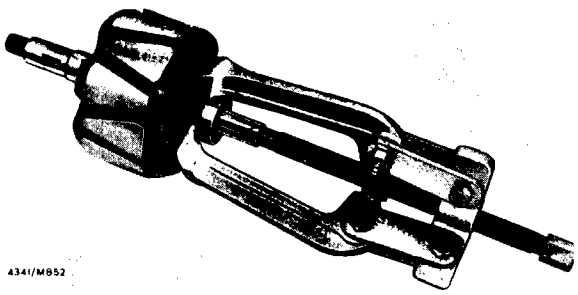


Fig. 45 *Removing rotor bearing*

Reassembly
Place the slip-ring end of the shaft on a flat plate in the arbor press and assemble the rotor and drive end housing, using a tube to press on to the inner race of the bearing only.
Place the stator over the rotor and line up the through bolt holes to match those in the drive end housing. Secure the three stator connections to the insulator block in the slip-ring end housing, then place the housing assembly into position using through bolts to align the housing with the stator. Apply pressure to the top of the slip-ring housing in the arbor press. Tighten the through bolts to a torque loading of 5.5/6.9 lb. ft. (.76/.95 kg.m).
Refit the brush holder housing assembly, renewing if necessary the rubber 'O' ring.
Insert the brushes – if worn below the minimum serviceable length of 0.187in. (4.76mm) they should be replaced – allowing them to rest on the slip-rings, place the tab jumpers over the terminal screws and compressed brush springs and by means of a rule hold the jumpers in position.
Fit a new cork gasket, the insulating cover, washers and nuts.
Fit the shaft key, fan and pulley assembly and finally tighten the shaft nut and washer. Tighten the nut and spin the rotor by hand to ensure free rotation.
Refit the alternator to the engine and test by running the engine.

REGULATOR
BUTEC R2

DESCRIPTION
The BUTEC R2 regulator is a fully transistorised unit with no moving contacts.
The components are fixed upon a printed circuit base in a sealed aluminium case which is suitably finned for heat dissipation.
Output voltage adjustment is by a screw, accessible on removal of a socket plug in the front of the case.

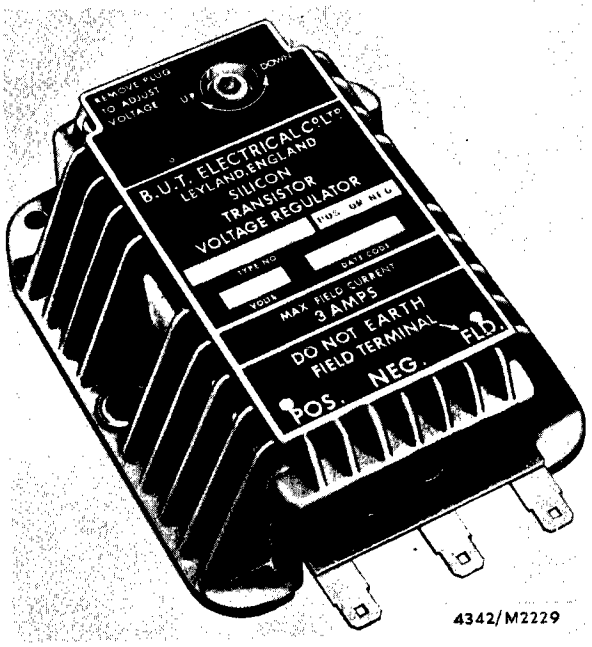


Fig. 46 *The Butec R.2 regulator*

ROUTINE MAINTENANCE
No routine maintenance is necessary.
Faulty components may be replaced as detailed under 'FAULT FINDING.'

FAULT FINDING
The regulator unit is mounted on the left-hand wing valance adjacent to the alternator.
The purpose of this section is to instruct Service personnel in the correct test procedures, which, using common test equipment, quickly diagnose the exact source of the trouble. It is recommended that the following checks be carried out so that only the defective component is repaired or replaced.
It is essential to ensure, that when a fault exists the regulator unit, prior to disconnecting, is faulty and is not due to a wiring error, loose connections or the alternator. **Disconnecting the battery whilst the engine is running or reversing the battery connections will cause damage to the semi-conductors in both regulator and the alternator.**
Before testing the regulator in detail because of low voltage output, first remove the plug from the regulator and join together negative and field leads at connector plug; do not use the regulator terminals to join the leads together as a short may exist inside the unit. This enables the alternator to run full field and should the fault persist, it cannot be the regulator unit.

Test on the Car
Assuming that the fault persists, check the voltage adjustment setting. 1 – On normal load check that a voltage at least equal to the battery voltage exists between the positive (+) and the negative (–) terminals at the regulator. 2 – The control potentiometer may be incorrectly set; adjust to 14 volts on load. 3 – Note setting of control potentiometer, rotate fully clockwise and measure the voltage between the field and negative terminals; this must be less than 1.5 volts. If so the regulator is operating correctly; reset to the original position.
If the above tests confirm that the regulator is faulty, it must be removed for further testing.

Bench Tests
Connect a 12 volt battery to the positive terminals of the regulator and a voltmeter between the positive and field terminals. An Avometer or similar instrument is ideal. (Positive terminal of the meter to positive terminal of regulator).

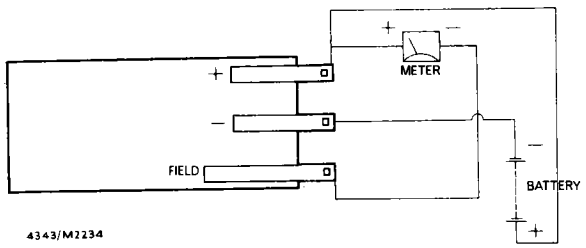


Fig. 47 *Test circuit diagram (showing the underside of the regulator)*

1. Field Discharge Rectifier (1N4003) and Output Transistor (2N3055) Test
With the regulator control at its normal setting the voltmeter will read battery voltage less about 1 volt.
If the reading is near zero rotate the adjustment screw fully anti-clockwise.
The voltmeter should now read battery voltage.
Using a shorting link wire, join the negative terminal of the regulator to the base of the 2N3055 transistor. The voltmeter will now fall to within 1 volt of zero and removal of the link will allow the voltage to rise again.
These tests ensure that the field discharge rectifier is not short-circuited and that the 2N3055 output transistor is switching correctly.

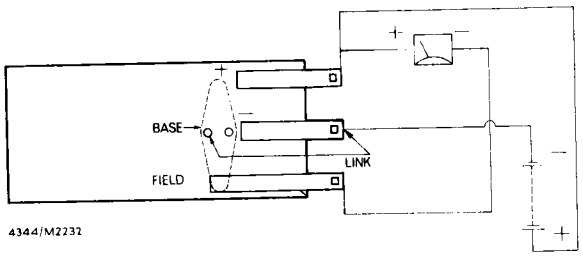


Fig. 48 *Testing output transistor and field discharge rectifier*

2. Driver Transistor

Connect a 100 ohms resistor between the potentiometer slider tag and positive.

The voltmeter should now drop to within 1 volt of zero. Remove the resistor.

This test ascertains correct function of the driver transistor.

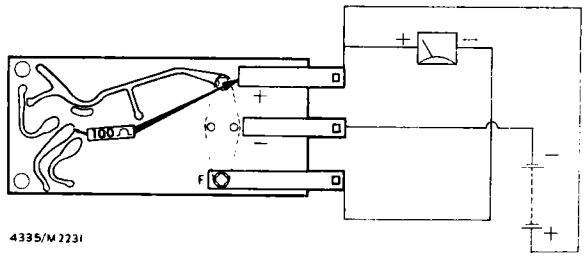


Fig. 49 *Testing driver transistor*

3. Potentiometer and Zener Diode

Connect a fully charged battery (12.4 volts or more) as shown in Fig. 50.

Rotate the potentiometer adjustment screw clockwise. Voltmeter should read 12 volts approximately. Rotate the adjuster screw anti-clockwise; reading obtained should be 1 volt or less.

This check proves correct operation of the potentiometer and the Zener Diode.

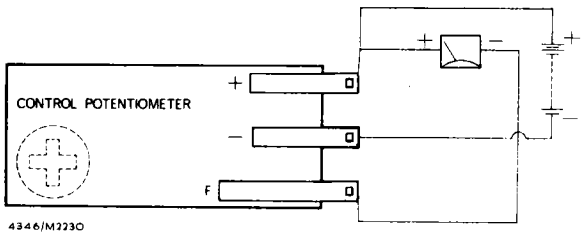


Fig. 50 *Testing potentiometer and Zener diode*

From the foregoing tests 1, 2, 3, it is possible to diagnose any incorrect operation of a stage or component.

Before proceding further it is necessary to remove the printed circuit from the housing and then remove the components from the base.

REMOVAL OF PRINTED CIRCUIT BOARD

Using a box spanner, remove five No. 8 UNF setscrews holding the board, also the nuts and cross headed screws securing the output transistor (2N3055).

A soldering iron not exceeding 25 watts dissipation should be used on all joints, together with solder puller, such as supplied by Sealab Electronics, Havant, Hampshire, England.

Remove solder from around the base and emitter pins of the transistor (2N3055).

The printed circuit board can now be lifted from the housing, care being taken not to lose or damage the mica washer or screw insulating inserts when the output transistor is removed.

COMPONENT TESTING

No attempt should be made to take these measurements whilst the components are attached to the printed circuit base. This would result in false measurements and wrong conclusions due to shunt circuits on the base. Always unsolder the components as detailed above, being careful not to use excessive heat.

Transistor Testing

An ohmmeter is required for the tests described below and it is most important that correct polarities are observed. The polarity of an ohmmeter internal battery can be quickly ascertained and noted for future use.

Connect a 1.5 volt cell as shown in Fig. 51. If the readings are as shown then the ohmmeter battery will be as indicated.

This test is particularly important with combination instruments such as an Avometer, where the positive terminal may well be the negative of an internal battery.

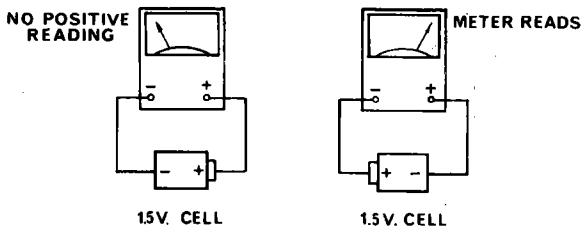


Fig. 51 *Checking ohmmeter polarity*

Method of Testing

(a) Connect the positive terminal of the ohmmeter to the base lead wire. Touch the negative terminal lead to the Emitter and then to the Collector. These readings should be approximately equal and of low resistance.

(b) Connect the negative terminal of the ohmmeter to the Base lead wire. Touch the positive terminal to the Emitter and then to Collector. The readings should be of considerably higher resistance in this case.

Fig. 52 shows the transistor connections viewed from the underside.

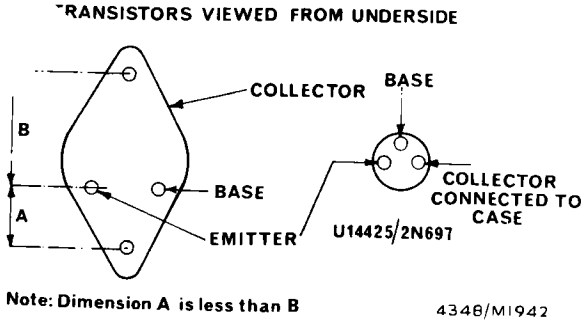


Fig. 52 *Transistor connections*

Note: No specific readings are given for the tests above, only High and Low Resistance. The actual value will depend upon the type of ohmmeter used and its internal battery voltage. Since the tests are essentially PASS/FAIL, if in doubt, replace the transistor.

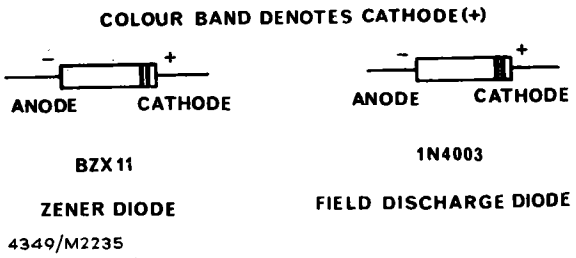


Fig. 53 *Diodes used in Butec regulator*

Diode Testing

The diodes used in the regulator are illustrated in Fig. 53. Again using the ohmmeter, connect the positive of the meter to the diode anode and the negative to the cathode; the meter should read LOW resistance. Negative to anode should obtain a HIGH resistance reading.

It is unimportant if the meter scale will not accommodate the HIGH reading, for the test is aimed to show a large difference when reversing polarity. Differences of at least 100:1 are normal.

Zener Voltage Test

This test allows the Zener diode to be checked for actual breakdown voltage.

Connect a 12 volt battery, the diode and a resistor between 100 and 470 ohms as shown in Fig. 54. Together with a 12 volt D.C. voltmeter.

If the Zener is satisfactory it will read approximately 6.8 volts. However, unless the resistor chosen is of a greater value than 200 ohms, the components should not be left connected for more than a few minutes.

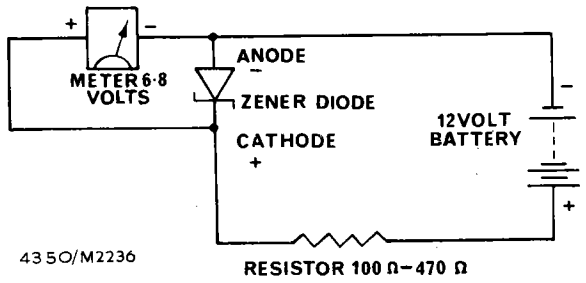


Fig. 54 *Zener voltage test*

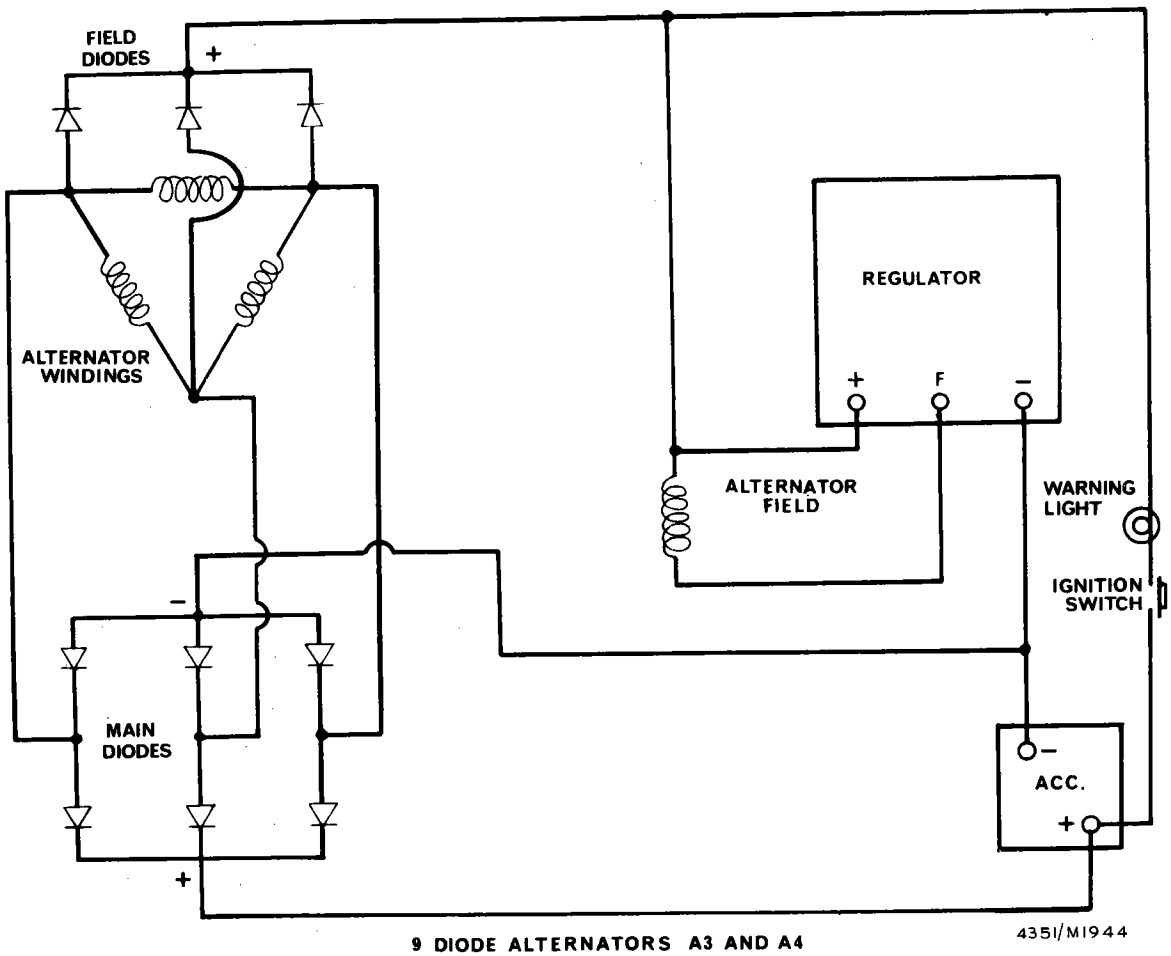


Fig. 55 *Alternator circuit diagram*

Reassembly

The 2N3055 transistor, secured by two screws, is mounted in the housing and insulated by a mica washer and two bushes. Always refit the mica washer and bushes ensuring that the mounting surface is clean and free from burrs.

Since the washer is very thin to obtain maximum heat transfer to the housing, any burrs or metal particles may punch through and cause a short circuit to the mounting surfaces. Silicone grease, applied to both sides of the washer, will improve heat transference.

Use only resin cored solder and ensure that no loose particles of solder are left in the unit on completion of repair.

THE STARTER MOTOR M45G PRE-ENGAGED
(4.2 Litre Engines only)

DESCRIPTION

The purpose of the pre-engaged (or 'positive engagement') starter motor is to prevent premature pinion ejection.

Except on occasions of tooth-to-tooth abutment, for which special provision is made, the starter motor is connected to the battery only after the pinion has been meshed with the flywheel ring gear, through the medium of an electro-magnetically operated linkage mechanism. After the engine has started, the current is automatically switched OFF before the pinion is retracted. On reaching the out-of-mesh position the spinning armature is brought rapidly to rest by a braking device. This device takes the form of a pair of moulded shoes driven by a cross peg in the armature shaft and spring loaded (and centrifuged) against a steel ring inserted in the armature end bracket.

Thus, with the supply switched off and the armature subjected to braking force, the possibility of damaged teeth resulting from attempts being made to re-engage a rotating pinion is minimised.

A bridge shaped bracket is secured to the front end of the machine by the through bolts. This bracket carries the main battery input and solenoid winding terminals, short extension cables being connected between these and the corresponding solenoid terminals.

A Lucas 6RA relay, mounted at the base of the right-hand screen pillar beneath the screen facia, is incorporated in the solenoid circuit to prevent overloading the switch contacts due to initial surge when operating the starter switch.

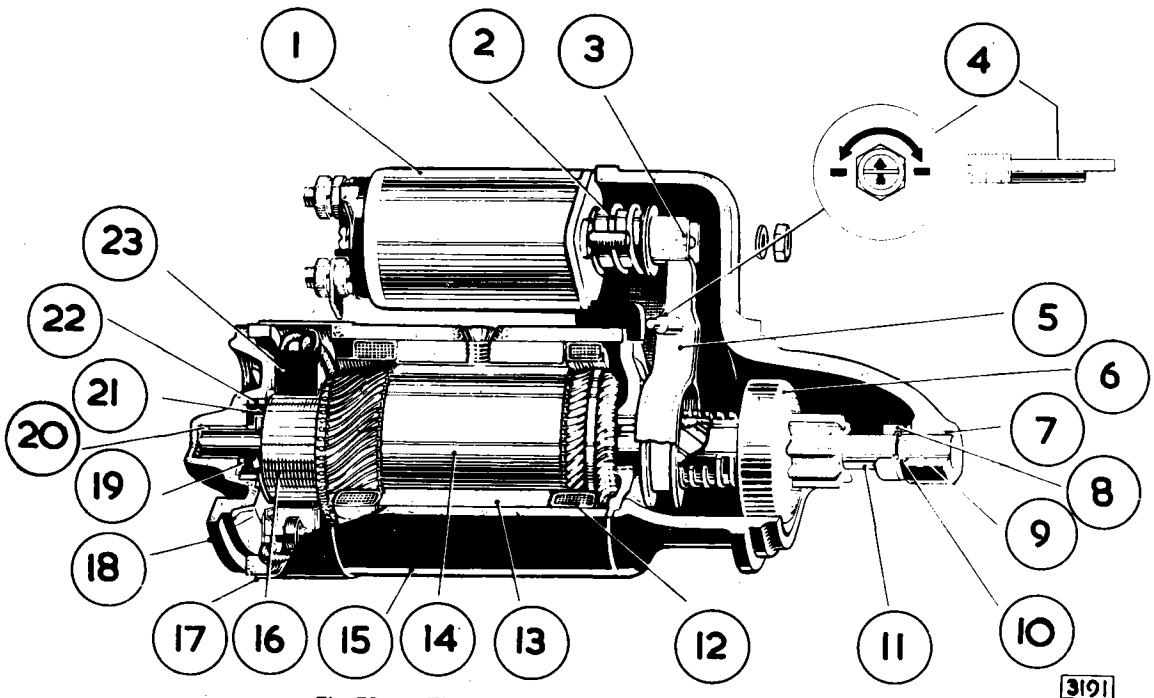


Fig. 56 *The pre-engaged starter motor Model M45G*

1 Actuating solenoid
2 Return spring
3 Clevis pin
4 Eccentric pivot pin
5 Engaging lever
6 Roller clutch
7 Porous bronze bush
8 Thrust collar
9 Jump ring
10 Thrust ring
11 Armature shaft extension
12 Field ring
13 Pole shoes
14 Armature
15 Yoke
16 Commutator
17 Band cover
18 C.E. Bracket
19 Thrust washer
20 Porous bronze bush
21 Brake shoes and cross peg
22 Brake ring
23 Brushes

TOOTH-TO-TOOTH ABUTMENT

The electro-magnetically actuated linkage mechanism consists essentially of a pivoted engaging lever having two hardened steel pegs (or trunnion blocks) which locate with and control the drive through the medium of a groove in an operating bush. This bush is carried, together with the clutch and pinion assembly, on an internally splined out-board driving sleeve – the whole mechanism being housed in a cut-away flange mounting snout-shaped end bracket. This operating bush is spring loaded against a jump ring in the driving sleeve by an engagement spring located between the bush and the clutch outer cover. The system return or drive de-meshing spring is located round the solenoid plunger.

On occasions of tooth-to-tooth abutment (between the ends of the starter pinion teeth and those of the flywheel ring gear), the pegs or trunnion blocks at the 'lower' end of the engaging lever can move forward by causing the operating bush to compress the engagement spring, thus allowing the 'upper' end of the lever to move sufficiently rearwards to close the starter switch contacts. The armature then rotates and the pinion slips into mesh with the flywheel ring gear under pressure of the compressed engagement spring.

THE 'LOST MOTION' (SWITCH-OFF) DEVICE

As it is desirable that the starter switch contacts shall not close until the pinion has meshed with the flywheel ring gear, so it is important that these same contacts should always re-open before the pinion has been retracted – or can be opened in the event of a starter pinion remaining, for some reason, enmeshed with the flywheel ring gear. To ensure this, a measure of 'lost motion' is designed into some part of the engagement mechanism, its effect being to allow the starter switch or solenoid contacts (which are always spring-loaded to the open position) to open before pinion retraction begins.

Several methods of obtaining 'lost motion' have been adopted, but each depends upon the yielding of a weaker spring to the stronger system return (drive de-meshing or disengagement) spring of the solenoid plunger.

The initial yielding results in the switch contacts being fully opened within the first 1/8in. (3.18mm) of plunger return travel – this action being followed by normal drive retraction.

Solenoid model 10S has a weaker ('lost motion') spring located inside the solenoid plunger. Here, enclosed at the outer end by a retaining cup, it forms a plunger-within-a-plunger and is spring-loaded against the tip of the engaging lever inside the plunger clevis link.

THE ROLLER CLUTCH

Torque developed by the starting motor armature must be transmitted to the pinion and flywheel through an over-running or free-wheeling device which will prevent the armature from being rotated at an excessively high speed in the event of the engaged position being held after the engine has been started. The roller clutch performs this function.

The operating principle of the roller clutch is the wedging of several plain cylindrical rollers between converging surfaces. The convergent form is obtained by matching cam tracks to a perfectly circular bore. The rollers, of which there are three, are spring-loaded and, according to the direction of drive, are either free or wedgelocked between the driving and driven members. The clutches are sealed in a rolled over steel outer cover and cannot be dismantled for subsequent re-assembly.

THE STARTER SOLENOID

The starter solenoid is an electro-magnetic actuator mounted pick-a-back fashion on the yoke of the pre-engaged motor. It contains a soft iron plunger (linked to the engaging lever), the starter switch contacts and a coil consisting of two windings, i.e. a heavy gauge pull-in or series winding and a lighter gauge hold-on or shunt winding. Initially, both windings are energised in parallel when the starter device is operated, but the pull-in winding is shorted out by the starter switch contacts at the instant of closure – its duty having been effected.

Magnetically, the windings are mutually assisting.

Like the roller clutch assembly, the starter solenoid is sealed in a rolled-over steel outer case or body and cannot be dismantled for subsequent re-assembly.

STARTER MOTOR

PERFORMANCE DATA

Model	M 45 G Pre-engaged
Lock Torque	22.6 lb. ft. (3.13 kg.m) with 465 amperes at 7.6 terminal volts
Torque at 1,000 r.p.m.	9.6 lb. ft. (1.33 kg.m) with 240 amperes at 9.7 terminal volts
Light running current	70 amperes at 5,800 – 6,500 r.p.m.

SOLENOID SWITCH

Model	
Closing coil resistance (measured between terminal 'STA', copper link removed and 'Lucar' terminal)	0.36 – 0.42 chms
Hold on coil resistance (Measured between 'Lucar' terminal and solenoid outer case)	1.49 – 1.71 ohms

ROUTINE MAINTENANCE

EVERY 24,000 MILES (38,400 KM)

Checking the Brushgear and Commutator

Remove the starter motor (see below) from the engine.

Release the screw and remove the metal band cover and check that the brushes move freely in the brush boxes by holding back the spring and pulling gently on the flexible connection. If a brush is inclined to stick, remove it from its holder and clean its sides with a petrol moistened cloth.

Replace the brushes in their original positions in order to retain 'bedding.' Brushes which will not bed properly or have worn to 5/16in. (7.94mm) in length must be renewed. See page P.37 for method of procedure.

Check the tension of the brush springs with a spring balance. The correct tension should be 52 ozs. (1.47 kg) on a new brush.

Replace each existing brush in turn with a new brush to enable the tension of the brush spring to be tested accurately.

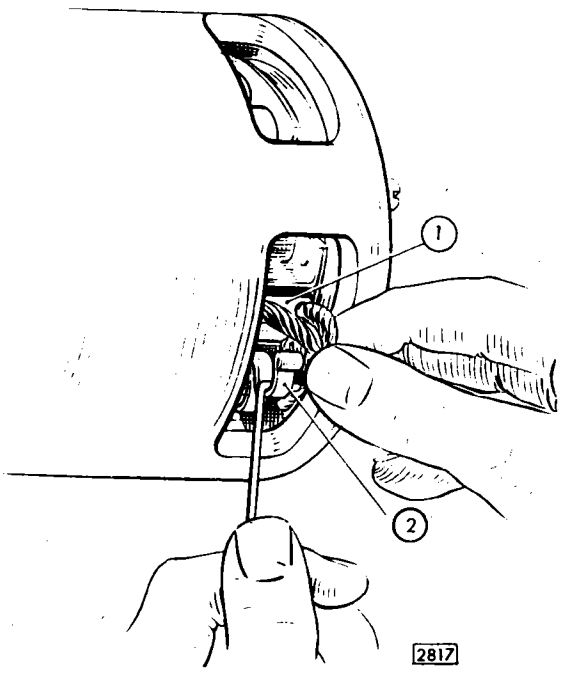


Fig. 57 *Checking the brush gear*

Check that the commutator is clean and free from oil or dirt. If necessary, clean with a petrol moistened cloth. If this is ineffective, rotate the armature and polish the commutator with a fine glass paper. DO NOT use emery cloth. Blow out all abrasive dust with a dry air blast.

A badly worn commutator can be re-skimmed by first rough turning, followed by diamond finishing. DO NOT undercut the insulators.

Armatures must not be skimmed below a minimum diameter of 1.531in. (38.90mm).

Replace the armature if below this limit.

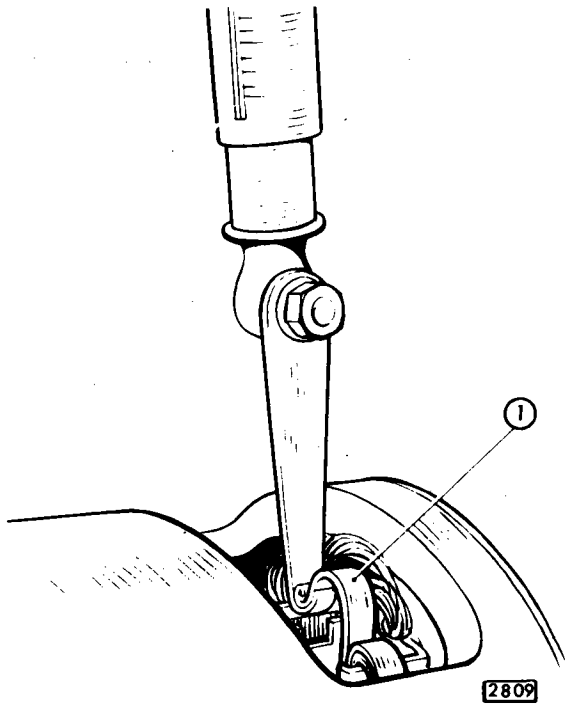


Fig. 58 *Testing the brush spring tension. Brush spring indicated*

REMOVAL

Disconnect the battery.

Detach the cable and remove the oil gauge transmitter unit from the oil filter body.

Disconnect the solenoid and main cables from the starter (cranking) motor.
Remove the two setscrews and washers securing the motor to the crankcase.
Withdraw the motor forward to clear the starter drive and rearwards from the top between the rear of the manifold and the wing valance.

REFITTING
Refitting is the reverse of the removal procedure.
Care must be taken when refitting the two setscrews, which have a fine thread, that they are not cross-threaded.

SERVICING
Testing in Position
Check that the battery is fully charged and the terminals are clean and tight. Recharge if necessary. Switch on the lamps and ignition and operate the starter control. If the lights go dim but the starter does not crank the engine, and indication is given that the current is flowing through the starter motor winding but the armature is not rotating for some reason.
The fault is probably due to high resistance in brush gear or open circuit in armature or field coils.
Remove the starter motor for examination.
If the lights retain their full brilliance when the starter control is operated check:—
(a) the starter motor circuit for continuity,
(b) the solenoid unit for continuity.

If the supply voltage is found to be applied to the starter motor when the control is operated, the unit must be removed from the engine and checked for an internal fault.
Sluggish or slow action of the starter motor is usually due to a loose connection causing a high resistance in the motor circuit. Check as described above.
If the motor is heard to operate but does not crank the engine, indication is given of damage to the drive.

BENCH TESTING
Removing the starter Motor from the Engine
Disconnect the battery. Disconnect and remove the starter motor from the engine. See page P.35 for removal procedure.

MEASURING THE LIGHT RUNNING CURRENT
With the starter motor securely clamped in a vice and using a 12 volt battery, check the light running current and compare with the value given on page P.34.
If there appears to be excessive sparking at the commutator, check that the brushes are clean and free to move in their boxes and the spring pressure is correct. See symptoms 7 and 8, below.

MEASURING LOCK TORQUE AND LOCK CURRENT
Carry out the torque test and compare with the values given on page P.34.
If a constant voltage supply is used, it is important to adjust this to be 7.6 volts at the starter terminal when testing.

FAULT DIAGNOSIS

An indication of the nature of the fault or faults may be deduced from the results of the no-load and lock torque tests.

SYMPTOM	PROBABLE FAULT
1. Speed, torque and current consumption correct	Assume motor to be in normal operating condition
2. Speed, torque and current consumption low	High resistance in brush gear e.g. faulty connections, dirty or burned commutator causing poor brush contact
3. Speed and torque low, current consumption high	Tight or worn bearings, bent shaft, insufficient end play, armature fouling a pole shoe, or a cracked spigot on drive end bracket. Short circuited armature, earthed armature, or field coils
4. Speed and current consumption high, torque low	Short-circuited windings in field coils
5. Armature does not rotate, high current consumption	Open-circuited armature, field coils, or solenoid unit. If the commutator is badly burned, there may be poor contact between brushes and commutator
6. Armature does not rotate, high current consumption	Earthed field winding or short-circuited solenoid unit. Armature physically prevented from rotating
7. Excessive brush movement causing arcing at commutator	Low brush spring tension, worn or out-of-round commutator. 'Thrown' or high segment on commutator
8. Excessive arcing at the commutator	Defective armature windings, sticking brushes or dirty commutator

DISMANTLING

Disconnect the copper link between the lower solenoid terminal and the starter motor yoke.
Remove the two solenoid unit securing nuts. Detach the extension cable and withdraw the solenoid from the drive end bracket casting, carefully disengaging the solenoid plunger from the starter drive engagement lever.
Remove the cover band and lift the brushes from their holders.
Unscrew and withdraw the two through bolts from the commutator end bracket. The commutator end bracket and yoke can now be removed from the intermediate and drive end brackets.
Extract the rubber seal from the drive end bracket.
Slacken the nut securing the eccentric pin on which the starter drive engagement lever pivots and unscrew and withdraw the pin.
Separate the drive end bracket from the armature and intermediate bracket assembly.
Remove the thrust washer from the end of the armature shaft extension, using a mild steel tube of suitable bore.
Prise the jump ring from its groove and slide the drive assembly and intermediate bracket from the shaft.
To dismantle the drive further, prise off the jump ring retaining the operating bush and engagement spring.

BENCH INSPECTION

After dismantling the motor, examine individual items.

Replacement of Brushes (Fig. 59)
The flexible connectors are soldered to terminal tags; two are connected to brush boxes and two are connected to free ends of the field coils. Unsolder these flexible connectors and solder the connectors of the new brush set in their place.
The brushes are pre-formed so that 'bedding' to the commutator is unnecessary. Check that the new brushes can move freely in their boxes.

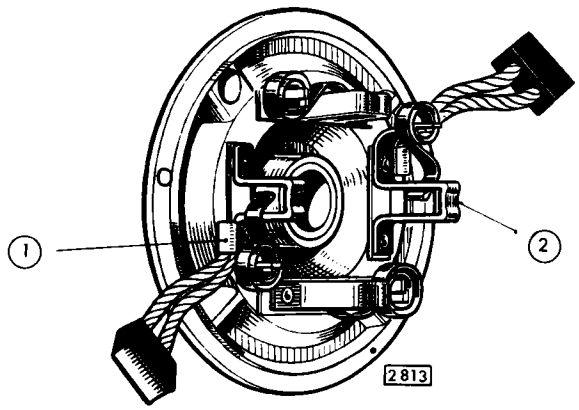


Fig. 59 *Commutator end bracket brush connections*

Commutator
A commutator in good condition, will be burnished and free from pits or burned spots. Clean the commutator with a petrol moistened cloth. Should this be ineffective, spin the armature and polish the commutator with fine glass paper; remove all abrasive dust with a dry air blast. If the commutator is badly worn, mount the armature between centres in a lathe, rotate at a high speed and take a light cut with a very sharp tool. Do not remove more metal than is necessary. Finally polish with very fine glass paper. The INSULATORS between the commutator segments **MUST NOT BE UNDERCUT.**
Armatures must NOT be skimmed below a minimum diameter of 1.531in. (38.90mm). Replace the armature if below this limit.

ARMATURE

Lifted Conductors
If the armature conductors are found to be lifted from the commutator risers, overspeeding is indicated. In this event, check that the clutch assembly is operating correctly.

Fouling of Armature Core against the Pole Faces
This indicates worn bearings or a distorted shaft. A damaged armature must, in all cases, be replaced and no attempt should be made to machine the armature core or to true a distorted armature shaft.

Insulation Test
To check armature insulation, use a 110-volt A.C. test lamp.
The test lamp must not light when connected between any commutator segment and the armature shaft.
If a short circuit is suspected, check the armature on a "growler." Overheating can cause blobs of solder to short circuit the commutator segments.
If the cause of the armature fault cannot be located or remedied, fit a replacement armature.

Field Coils
Continuity Test
Connect a 12-volt test lamp and battery between the terminal on the yoke and each individual brush (with the armature removed from the yoke). Ensure that both brushes and their flexible connectors are clear of the yoke.
If the lamp does not light, an open circuit in the field coils is indicated.
Replace the defective coils.

Insulation Test
Connect a 110-volt A.C. test lamp between the terminal post and a clean part of the yoke. The test lamp lighting indicates that the field coils are earthed to the yoke and must be replaced.
When carrying out this test, check also the insulated pair of brush boxes on the commutator end bracket. Clean off all traces of brush deposit before testing.
Connect the 110-volt test lamp between each insulated brush box and the bracket.
If the lamp lights, this indicates faulty insulation and the end bracket must be replaced.

Replacing the Field Coils
Unscrew the four pole screw retaining screws, using a wheel-operated screwdriver. Remove the insulation piece which is fitted to prevent the inter-coil connectors from contacting the yoke.
Draw the pole shoes and coils out of the yoke and lift off the coils. Fit the new field coils over the pole shoes and place them in position inside the yoke. Ensure that the taping of the field coils is not trapped between the mating surfaces of the pole shoes and the yoke.

Locate the pole shoes and field coils by lightly tightening the retaining screws.
Replace the insulation piece between the field coil connections and the yoke.
Finally, tighten the screws by means of the wheel-operated screwdriver while the pole pieces are held in position by a pole shoe expander or a mandrel of suitable size.

Bearings and Bearing Replacement
The commutator and drive end brackets are each fitted with a porous bronze bush and the intermediate bracket is fitted with an indented bronze bearing.
Replace bearings which are worn to such an extent that they will allow excessive side play of the armature shaft.
The bushes in the intermediate and drive end brackets can be pressed out, whilst that in the commutator end bracket is best removed by inserting a 9/16in. tap squarely into the bearing and withdrawing the bush with the tap. Before fitting a new porous bronze bearing bush, immerse it for 24 hours in clean engine oil (SAE.30–40). In cases of extreme urgency, this period may be shortened by heating the oil to 100 deg. C., for two hours and then **allowing the oil to cool before removing the bush.** Fit new brushes by using a shouldered, highly polished mandrel approximately 0.0005in. greater in diameter than the shaft which is to fit in the bearing. **Porous bronze bushes must not be reamed out after fitting,** as the porosity of the bush will be impaired.
After fitting a new intermediate bearing bush, lubricate the bearing surface with Rocol "Molypad" molybdenised non-creep, or similar oil.

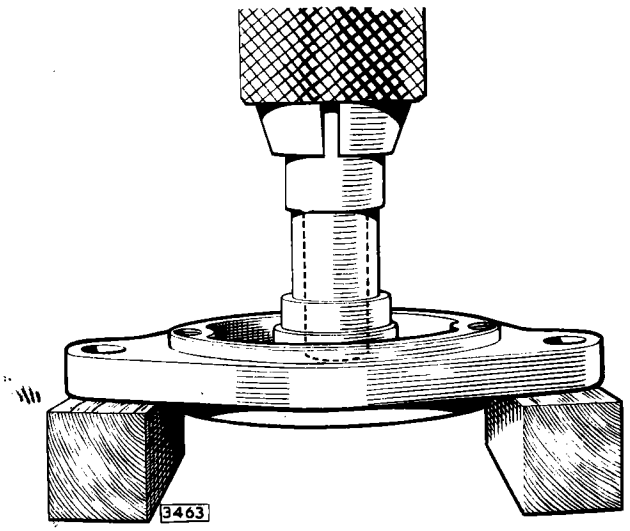


Fig. 60 *Method of fitting the porous bronze bush*

CHECKING THE ROLLER CLUTCH DRIVE

A roller clutch drive assembly in good condition will:–
(1) Provide instantaneous take-up of the drive in the one direction,
(2) Rotate easily and smoothly in the other,
(3) Be free to move round or along the shaft splines without roughness or tendency to bind.

Similarly, the operating bush must be free to slide smoothly along the driving sleeve when the engagement spring is compressed.

Trunnion blocks must pivot freely on the pegs of the engaging lever.
All moving parts should be smeared liberally with Shell Retinax "A" grease, or an equivalent alternative.

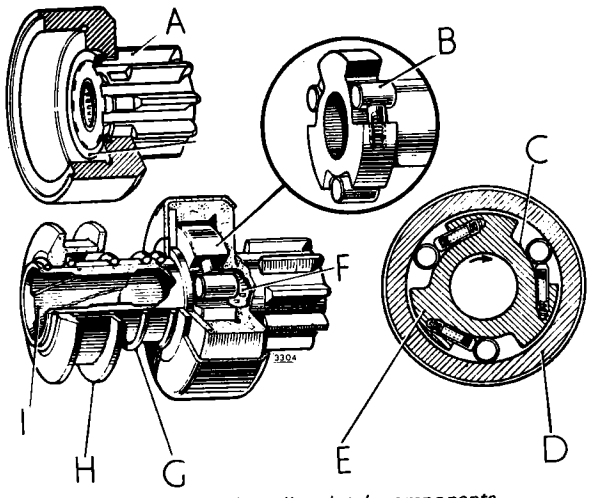


Fig. 61 *The roller clutch components*

A Alternative construction (pinion pressed and clear–ringed into the drive member)
B Spring loaded rollers
C Cam tracks
D Driven member (with pinion)
E Driving member
F Bush
G Engagement spring
H Operating bush
I Driving sleeve

RE-ASSEMBLY

After cleaning all parts, re-assembly of the starter motor is a reversal of the dismantling procedure, but the following special points should be noted.
The following parts should be tightened to the maximum torques indicated:
Nuts on solenoid copper terminals: 20 lb. in. (0.23 kg/m)
Solenoid fixing bolts: 4.5 lb. ft. (0.62 kg/m)
Starter motor through bolts: 8.0 lb. ft. (0.83 kg/m)
When refitting the C.E. bracket, see that the moulded bracket shoes seat squarely and then turn them so that the end of the cross peg in the armature shaft engage correctly with the slots in the shoes.

SETTING PINION MOVEMENT

After complete assembly of the starter motor, connect the "Lucar" solenoid terminal by way of a switch to a 6-volt supply.
Connect the other side of the supply to the starter motor yoke.
Close the switch (this throws the drive assembly forward into the engage position) and measure the distance between the pinion and the thrust washer on the armature shaft extension. Make this measurement with the **pinion pressed lightly towards the armature** to take up any slack in the engagement linkage. For correct setting, this distance should be 0.005in. – 0.015in. (0.127 – 3.81mm). To adjust the setting, slacken the eccentric pivot pin securing nut and turn the pin until the correct setting is obtained. Note that the arc of the adjustment is 180in. and the head of the arrow marked on the pivot pin should be set only

between the arrows on the arc described on the drive end bracket casting.
After setting, tighten the securing nut to retain the pin position.

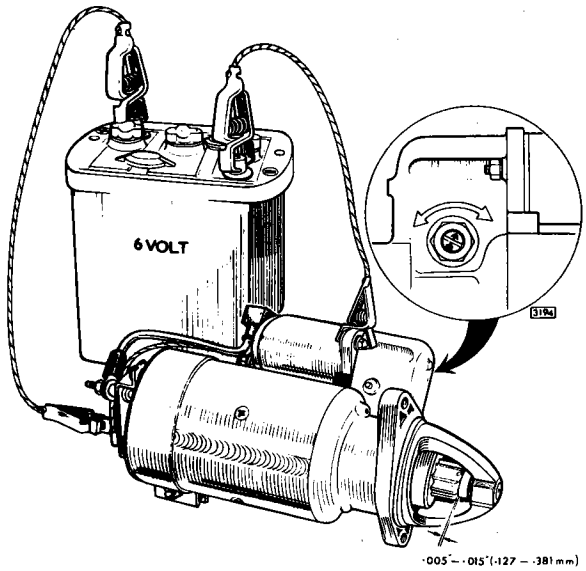


Fig. 62 *Setting pinion movement*

CHECKING OPENING AND CLOSING OF STARTER SWITCH CONTACTS

The following checks assume that pinion travel has been correctly set. Remove the copper link connecting solenoid terminal "STA" with the starter motor terminal.

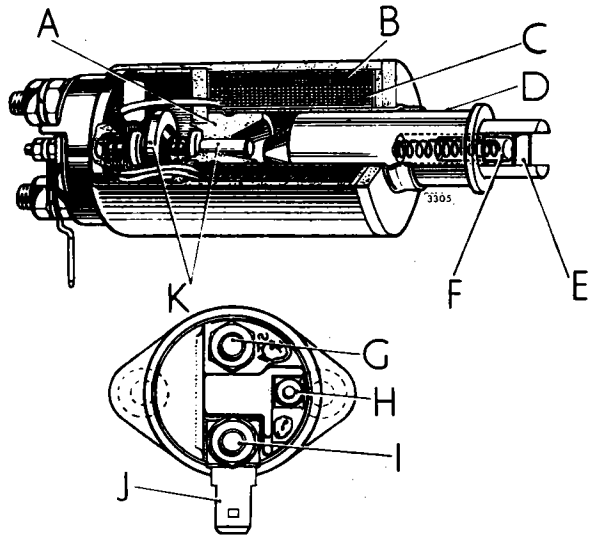


Fig. 63 *Checking the opening and closing of the starter switch contacts*

A Core
B Shunt winding
C Series winding
D Plunger
E Clevis pin
F "Lost motion" device
G Starter terminal
H Solenoid terminal
I Battery terminal
J Accessories terminal
K Spindle and moving contact terminal

Connect, through a switch, a supply of 10-volts D.C., to the series winding, i.e. connecting between the solenoid "Lucar" terminal and large terminal "STA." **DO NOT CLOSE THE SWITCH AT THIS STAGE.**
Connect a separately energised test lamp circuit across the solenoid main terminals.
Insert a stop in the end drive bracket to restrict the pinion travel to that of out-of-mesh clearance – normally a nominal 1/8in. (3.17mm).
An open-ended spanner of appropriate size and thickness can often be utilised for this purpose – its jaws embracing the armature shaft extension.
Energise the shunt winding with a 20-volt D.C. supply and then close the switch in the series winding circuit.
The solenoid contacts should close fully and remain closed, as indicated by the test lamp being switched on and emitting a steady light.
Switch off and remove the stop.
Switch on again and hold the pinion assembly in the fully engaged position.
Switch off and observe the test lamp.
The solenoid contacts should open, as indicated by the test lamp being switched off.

Relay-Checking
Remove the screen rail as detailed in Section N–Body and Exhaust System.
Check by means of a test lamp that current is available at coil terminal W1 when the starter switch is operated. Check that the relay coil is energised and current is available at terminal C1.

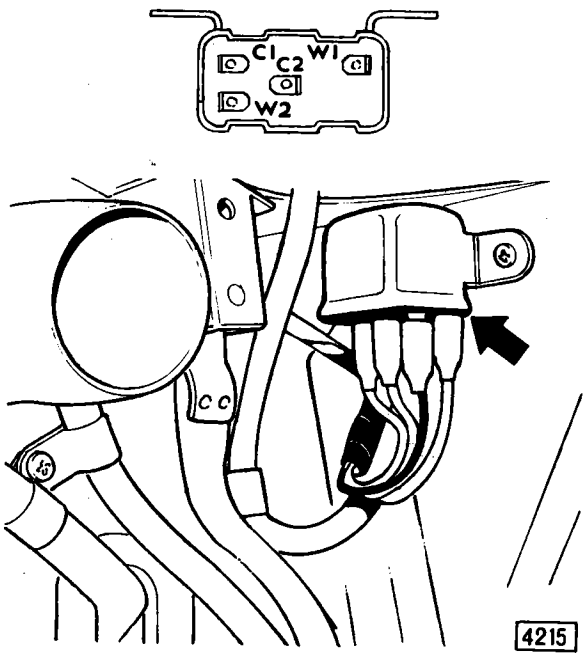


Fig. 64 *Location of starter solenoid relay*

STARTER MOTOR
M45G. INERTIA DRIVE
(2.8 Litre Engines)

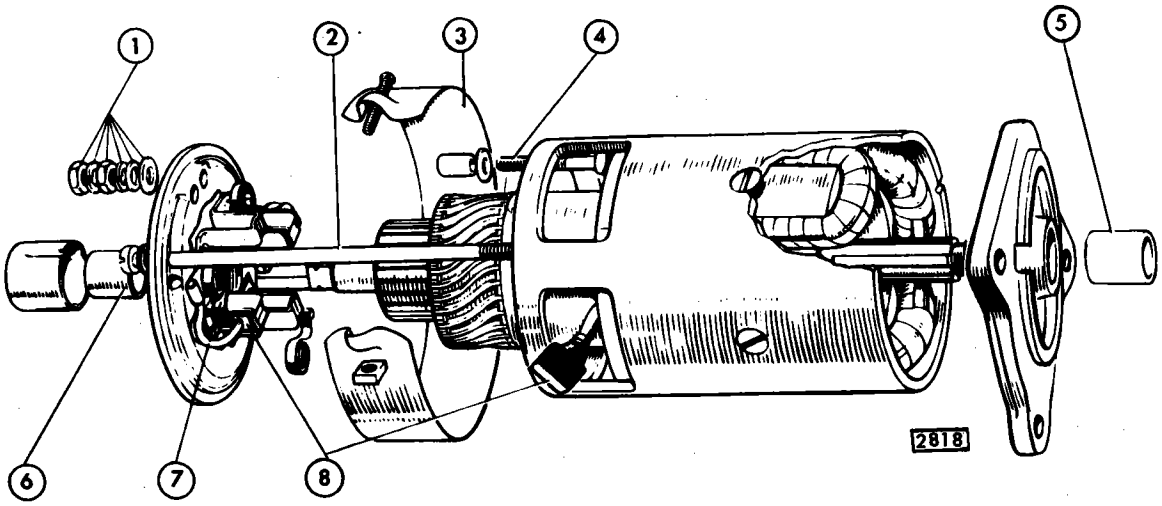


Fig. 65 *Exploded view of the inertia drive starter motor (45G)*

1 Terminal nuts and washers
2 Through bolts
3 Cover band
4 Terminal post
5 Bearing bush
6 Bearing bush
7 Brush spring
8 Brushes

DESCRIPTION

The electric starter motor is a four-pole, four-brush machine having an extended shaft which carries the engine engagement gear, or starter drive as it is more usually named. The diameter of the yoke is 4.5in. (11.4cm).

The starter motor is of similar construction to a generator 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.

A Lucas 6RA relay, mounted at the base of the right hand screen pillar beneath the screen facia, is incorporated in the starter solenoid circuit to prevent overloading the switch contacts due to initial surge when operating the starter switch.

PERFORMANCE DATA

Model	M 45 G
Lock Torque	22 lb./ft. with 430–450 amperes at 7.8–7.4 volts (3.04 kg/m)
Torque at 1,000 r.p.m.	8.3 lb./ft. with 200–220 amperes at 10.2–9.8 volts (1.44 kg/m)
Light running current	45 amperes at 5,800–6,800 r.p.m.

REMOVAL

Disconnect the battery.

Remove the inlet manifold rear starting pipe after withdrawing three union connections from the underside of the manifold and releasing the hose clips at the centre junction.

Disconnect and remove the rear carburetter over-flow pipe.

Remove the two nuts securing the motor to the crankcase and withdraw the linked bolts.

With the car on a ramp or hoist withdraw the motor forward to clear the starter drive and rearwards through the chassis frame.

If the car is fitted with automatic transmission, remove the dipstick tube as follows:—

(1) Withdraw the dipstick.

(2) Unscrew the large nut securing the dipstick tube to the transmission unit. Clean the area around the nut before removing, and cover the aperture to prevent the ingress of dirt.

(3) Remove the nut and lockwasher securing the support bracket to the inlet manifold rear bottom stud.

(4) Withdraw the dipstick tube.

REFITTING

Refitting is the reverse of the removal procedure.

ROUTINE MAINTENANCE

EVERY 24,000 MILES (38,400 KM)

Checking the Brushgear and Commutator.

The only maintenance normally required by the starter motor is the occasional checking of brush-gear and commutator. About every 10,000 miles remove the metal band cover. Check that the brushes move freely in their holders by holding back the brush springs and pulling gently on the flexible connectors. If a brush is inclined to stick, remove it from its holder and clean its sides with a petrol-moistened cloth. Be careful to replace the brushes in their original positions in order to retain 'bedding.'

Brushes which have worn so that they will not 'bed' properly on the commutator or have worn less than 5/16in (7.9mm) in length must be renewed.

The commutator should be clean, free from oil or dirt and should have a polished appearance. If it is dirty, clean by pressing a fine dry cloth against it while the starter is turned by hand by means of a spanner applied to the squared extension of the shaft. Access to the squared shaft is gained by removing the thimble-shaped metal cover. If the commutator is very dirty moisten the cloth with petrol.

SERVICING

Testing in Position

Check that the battery is fully charged and terminals are clean and tight. Recharge if necessary.

(i) Switch on the lamps and operate the starter control. If the lights go dim but the starter motor is not heard to operate, an indication is given that the current is flowing through the starter motor windings but the armature is not rotating for some reason; possibly the pinion is meshing permanently with the geared ring on the flywheel. In this case the starter motor must be removed from the engine for examination.

(ii) Should the lamps retain their full brilliance when the starter switch is operated, check the circuit for continuity from battery to starter motor via the starter switch, and examine the connections at these units. If the supply voltage is found to be applied to the starter motor when the switch is operated, an internal fault in the motor is indicated and the unit must be removed from the engine for examination.

(iii) Sluggish to slow action of the starter motor is usually due to a loose connection causing a high resistance in the motor circuit. Check as described above.

(iv) If the motor is heard to operate, but does not crank the engine, indication is given of damage to the drive.

Bench Testing and Examination of Brushgear and Commutator

(i) Remove the starter motor from the engine.

(ii) After removing the starter motor from the engine secure the body in a vice and test by connecting it with heavy gauge cables to a battery of the appropriate voltage. One cable must be connected to the starter terminal and the other held against the body or end bracket. Under these light road conditions, the starter should run at a very high speed without excessive noise and without excessive sparking at the commutator.

(iii) If the operation of the starter motor is unsatisfactory, remove the cover band and examine the brushes and commutator. Hold back each of the brush springs and move the brush by pulling gently on its flexible connector. If the movement is sluggish, remove the brush from the holder and ease the sides by lightly polishing on a smooth file. Always replace brushes in their original positions. If the brushes are worn so that they will not bear on the commutator, or if the brush flexible is exposed on the running face, they must be replaced. Fig. 57.

Check the tension of the brush springs with a spring scale. The correct tension is 30—40 oz. (850.5 gms — 1134 gms). New springs should be fitted if the tension is low. Fig. 58.

If the commutator is blackened or dirty, clean it by holding a petrol-moistened cloth against it while the armature is rotated.

(iv) Re-test the starter as described under (ii). If the operation is still unsatisfactory, the unit can be dismantled for detailed inspection and testing as follows:—

DISMANTLING

(i) Remove the cover band, hold back the brush springs and lift the brushes from their holders.

(ii) Remove the nuts from the terminal post which protrudes from the commutator end bracket.

(iii) Unscrew the two through bolts from the commutator end bracket. Remove the commutator end bracket from the yoke.

(iv) Remove the driving end bracket complete with armature and drive from the starter motor yoke. If it is necessary to remove the armature from the driving end bracket, it can be done by means of a hand press after the drive has been dismantled.

Commutator
A commutator in good condition will be smooth and free from pits and burned spots.
Clean the commutator with a petrol-moistened cloth. If this is ineffective, carefully polish with a strip of fine glass paper while rotating the armature. To remedy a badly worn commutator, dismantle the starter drive and remove the armature from the end bracket. Now mount the armature in a lathe, rotate at a high speed and take a light cut with a very sharp tool. Do not remove any more metal than is necessary. Finally polish with a very fine glass paper.
The insulators between the commutator segments **MUST NOT BE UNDERCUT.**

Armature
Examination of the armature may reveal the cause of failure, e.g. conductors lifted from the commutator due to the starter motor being engaged while the engine is running and causing the armature to be rotated at excessive speed. A damaged armature must always be replaced – no attempt should be made to machine the armature core or to true a distorted armature shaft.

Replacement of Brushes (Fig. 59)
If the brushes are worn to less than 5/16in. (7.9mm) in length, they must be replaced.
Two of the brushes are connected to terminal eyelets attached to the brush boxes on the commutator end bracket and two are connected to the field coils.
The flexible connectors must be renewed by unsoldering and the connectors of the new brushes secured in their place by soldering. The new brushes are preformed so that the bedding to the commutator is unnecessary.

Field Coils
(i) Test the field coils for continuity by connecting a 12-volt test lamp between the starter motor terminal and to each field brush in turn.
(ii) Lighting of the lamp does not necessarily mean that the field coils are in order, as it is possible that one of them may be earthed to a pole-shoe or to the yoke. This may be checked with a 110-volt test lamp, the test leads being connected between the starter motor terminal and a clean part of the yoke. If the lamp lights, defective insulation of the field coils or of the terminal post is indicated. In this event, see that the insulating band is in position and examine the field coils and terminal connections for any obvious point of contact with the yoke. If, from the above tests, the coils are shown to be open-circuited or earthed and the point of contact cannot be readily located and rectified, either the complete starter motor or the field coils must be replaced. If the field coils are to be replaced, follow the procedure outlined below, using a wheel-operated screwdriver.
Remove the insulation piece which is provided to prevent the intercoil connectors from contacting with the yoke.
Mark the yoke and pole shoes so that the latter can be refitted in their original positions. Unscrew the four-pole shoe retaining screws with the wheel-operated screwdriver.
Draw the pole shoes and coils out of the yoke and lift off the coils. Fit the new field coils over the pole shoes and place them in position inside the yoke.
Take care to ensure that the taping of the field coils in not trapped between the pole shoes and yoke.
Locate the pole shoes and field coils by lightly tightening the fixing screw. Fully ighten the screws with the wheel-operated screwdriver. Replace the insulation piece between the field coil connections and the yoke.

Bearings (Fig. 60)
Bearings which are worn to such an extent that they will allow excessive side-play of the armature shaft must be replaced. To replace the bearing bushes proceed as follows:
(i) Press the bearing bush out of the end bracket.
(ii) Press the new bearing bush into the end bracket using a shouldered, highly polished mandrel of the same diameter as the shaft which is to fit in the bearing. Porous bronze bushes must not be opened out after fitting or the porosity of the bush may be impaired.
Note: Before fitting a new porous bronze bearing bush it must be completely immersed for 24 hours in clean thin engine oil.

REASSEMBLY
The reassembly of the starter motor is a reversal of the dismantling procedure.

STARTER DRIVE

GENERAL DESCRIPTION
The pinion is mounted on a threaded sleeve which is carried on splines on the armature shaft, the sleeve being arranged so that it can move along the shaft against a compression spring so as to reduce the shock loading at the moment engagement takes place.
When the starter switch is operated, the shaft and screwed sleeve rotate, and owing to the inertia of the pinion, the screwed sleeve turns inside the pinion, causing the latter to move along the sleeve into engagement with the flywheel ring. The starter will then turn the engine.

As soon as the engine fires and commences to run under its own power, the flywheel will be driven faster by the engine than by the starter. This will cause the pinion to be screwed back along the sleeve and so thrown out of mesh with the flywheel teeth. In this manner the drive safeguards the starter against damage due to being driven at high speeds by the engine.
A pinion restraining spring is fitted over the starter shaft to prevent the pinion being vibrated into contact with the flywheel when the engine is running.

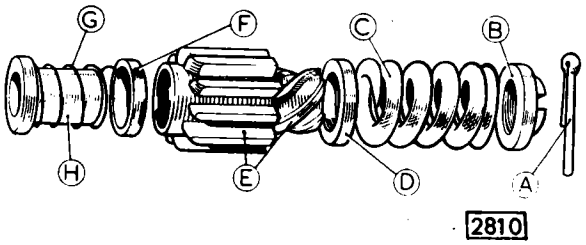


Fig. 66 *Exploded view of the starter drive assembly*

MAINTENANCE

If any difficulty is experienced with the starting 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.
In the event of the pinion becoming jammed in mesh with the flywheel, it can usually be freed by turning the starter motor armature by means of a spanner applied to the shaft extension at the commutator end.
This is accessible by removing the cap which is a push fit.

DISMANTLING AND REASSEMBLY

Having removed the armature as described in the section dealing with starter motors, the drive can be dismantled as follows:–
Remove the split pin (A), (Fig. 66), from the shaft nut (B) at the end of the starter drive. Hold the squared starter shaft extension at the commutator end by means of a spanner and unscrew shaft nut (B). Lift off the main spring (C), washer (D), screwed sleeve with pinion (E), collar (F), pinion restraining spring (G) and restraining spring sleeve (H).
Note: If either the screwed sleeve or pinion are worn or damaged they must be replaced as a pair, not separately.
The reassembly of the drive is a reversal of the dismantling procedure.

Relay-Checking

Remove the screen rail as detailed in Section N-Body and Exhaust system.
Check by means of a test lamp that current is available at the coil terminal W1 when the starter switch is operated. Check that the relay coil is energised and that current is available at terminal C1.

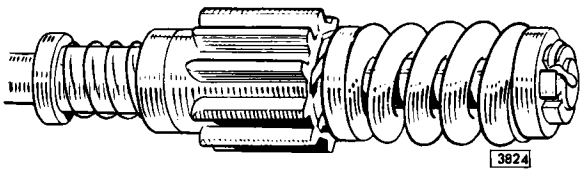


Fig. 67 *Showing the starter drive assembled*

LAMPS

Light Bulbs (Early Cars)

LIGHT	LUCAS BULB NO.	VOLTS	WATTS	APPLICATION
Outer Headlight (Main and dip beams)	Sealed Beam Unit	12	60/45	Home and R.H.D. Export
		12	50/40	S. America & M. East
		12	37.5/50	U.S.A.
	410	12	45/40	Belgium, Holland, Sweden, Austria, Italy & Germany
	411	12	45/40 (Yellow)	France
Inner Headlight (Main Beam Only)	Sealed Beam Unit 410	12	50	Home
		12	37.5	R.H.D. Export
		12	37.5	Austria, U.S.A., Germany
		12	37.5 (Yellow)	France
		12	45	Italy
Side Light	989	12	6	
Front and rear flashing indicators	382	12	21	
Rear brake	380	12	6/21	
Number plate	989	12	6	
Reversing lights	272	12	10	
Interior lights	272	12	10	
Glovebox illumination	254	12	6	
Map light	989	12	6	
Luggage compartment illumination	989	12	6	
Instrument illumination, headlight warning	987	12	2.2	
Switch indicator strip, flasher warning	281	12	2	
Automatic transmission indicator	283	24	3W	
Fog lamp				Optional extra
Ignition warning, Oil pressure warning, Traffic hazard warning, Flasher warning, Handbrake/Brake fluid warning	280	12	1.5	

HEADLIGHTS

DESCRIPTION

The car is fitted with the four headlight system, the standard light units fitted are of the sealed beam type having aiming pads mounted into lenses, These pads are of use with an approved mechanical aimer (such as the Lucas Lev-L-Lite).

To obtain the best possible results from the headlights, it is essential that they are correctly adjusted. The alignment of the headlight beam is set correctly before the car leaves the factory but, if for any reason adjustment becomes necessary and an approved beam setter is not available, the following procedure should be carried out.

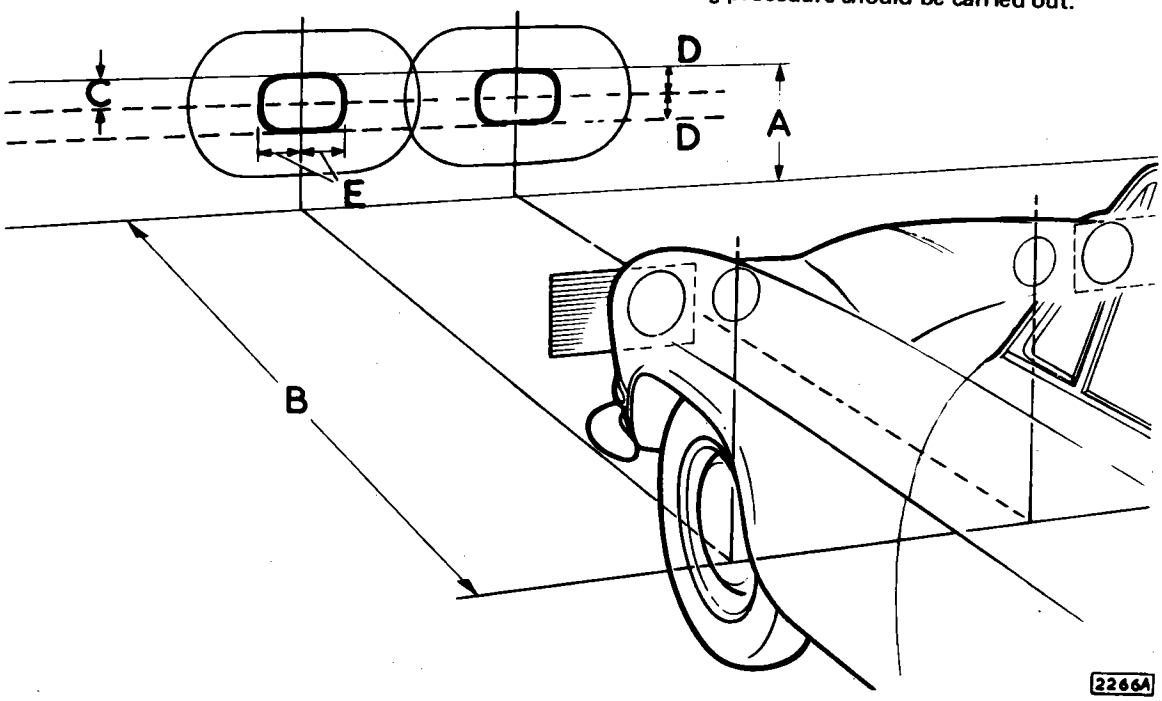


Fig. 68 *Inner headlight beam setting*

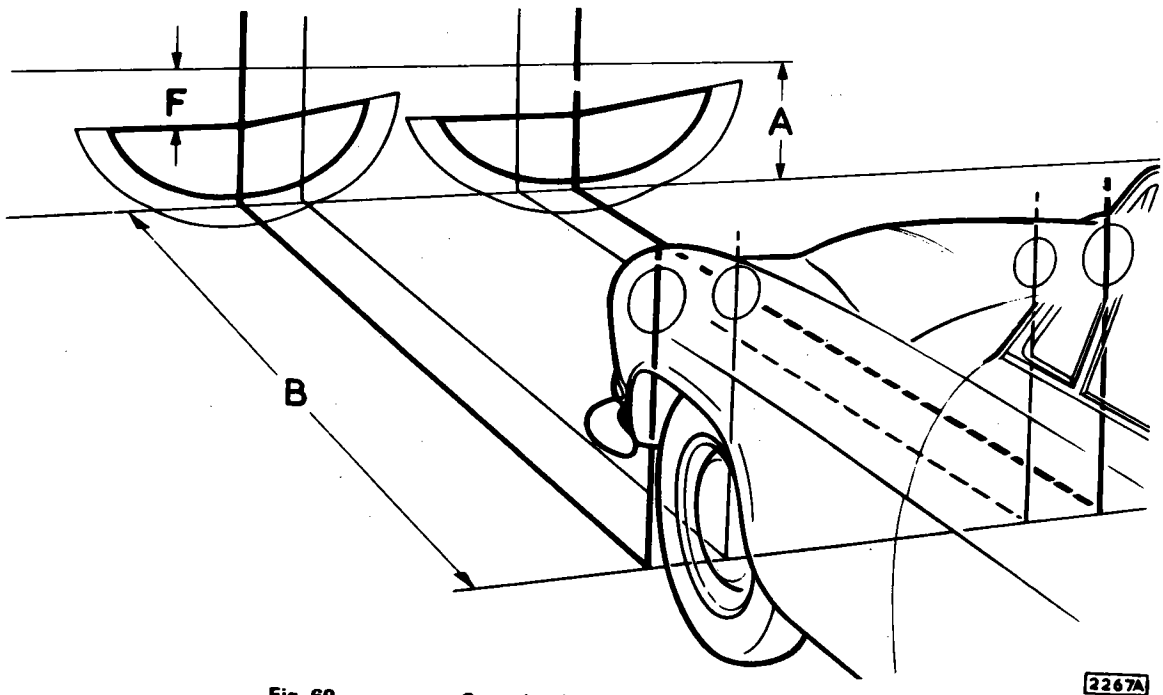


Fig. 69 *Outer headlight beam setting—vertical dip*

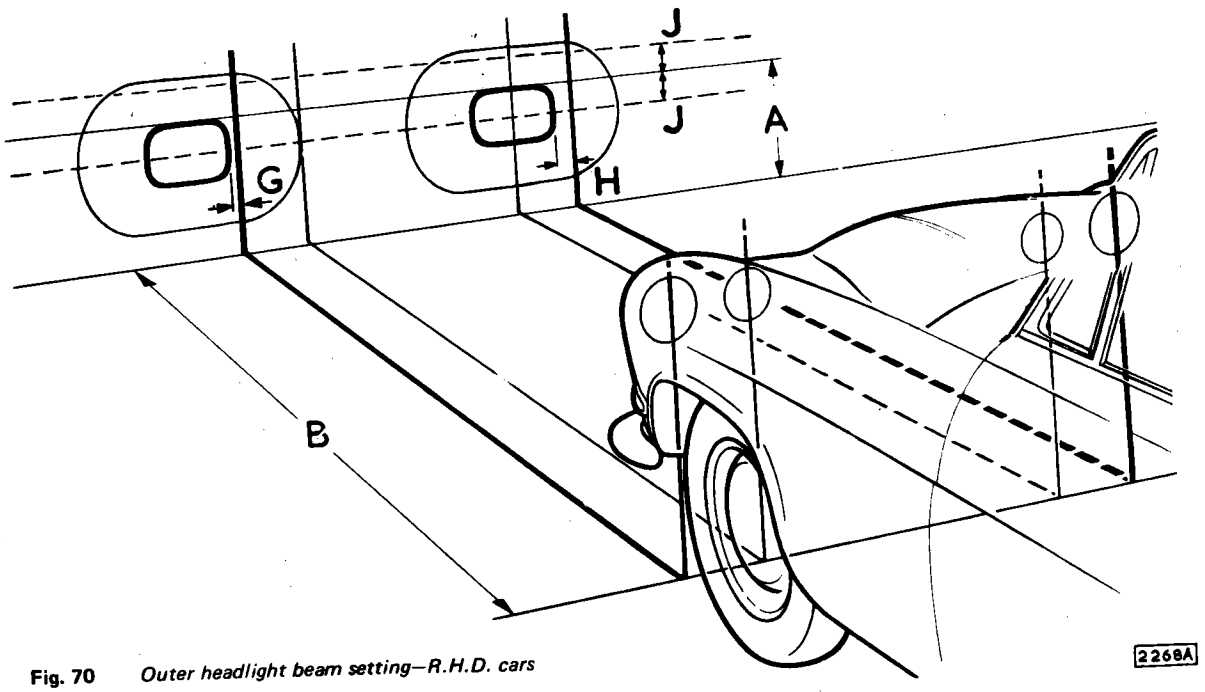


Fig. 70 *Outer headlight beam setting—R.H.D. cars*

ROUTINE MAINTENANCE

Every 12,000 Miles (20,000 KM)

Check the headlamp alignment and adjust as necessary.

HEADLAMP BEAM SETTING

Place the car on a level surface in front of a wall or board. Mark out the vertical and horizontal centre lines of both inner and outer headlight units on the wall or board and position the car 25 feet (7.6m) away from, and square to, the surface.

Inner Headlamp Beam Setting (All Cars)

Switch off the headlights in the full beam position and blank off the outer headlights. Set the inner headlights to the position shown in Fig. 68.

Outer Headlight Beam Setting (Vertical Dip Units)

With the headlights switched on in the dip position, set the outer headlight beams to the position shown in Fig. 69.

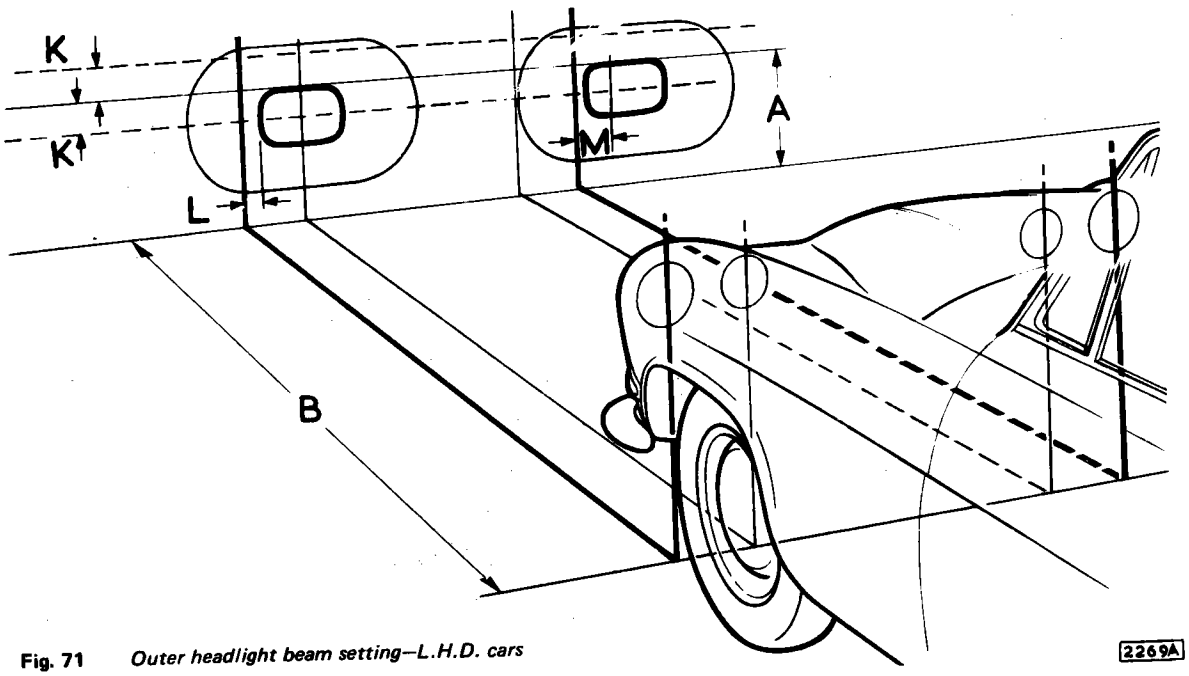


Fig. 71 *Outer headlight beam setting—L.H.D. cars*

Outer Headlight Beam Setting (Excluding Vertical Dip Units)
With the headlights switched on in the dip position, set the outer headlight beams to the position shown in Fig. 70–71.

Adjusting the Headlight Beam
Remove the headlight surround by unscrewing the retaining screw and springing the surround away from the bottom clip fixings.
The setting of the outer beams is adjusted by two screws, one being located at the top centre and the other at the centre left-hand side. The top screw is for vertical adjustment, that is, to raise or lower the beam; turn the screw anti-clockwise to lower the beam and clockwise to raise the beam. The side screw is for lateral adjustment, that is, to turn the beam to left or right. To move the beam to the right, turn the screw clockwise and to move the beam to the left, turn the screw anti-clockwise.

The setting of the two inner beams is adjusted by two screws diagonally opposite each other. The upper screw is for vertical adjustment, turn the screw clockwise to move the beam to the right and anti-clockwise to move the beam to the left.

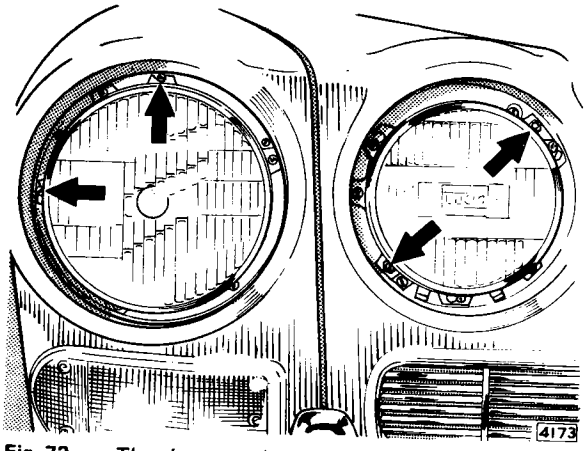


Fig. 72 *The inner and outer headlight beam setting screws*

Note: Cars for some countries are fitted with similar light units in the inner and outer positions. The adjustment of the beam on these outer lights is the same as that described above for the inner headlights.

LIGHT BULB REPLACEMENT

OUTER HEADLAMP REPLACEMENT

Remove the top retainer screw and withdraw the headlamp embellisher noting the two retaining lugs at the lower edge. Remove the three cross headed screws and the headlight retaining rim. Withdraw the headlight unit and detach the socket from the rear of the unit. The headlight may now be replaced with a unit of the correct type.
On cars fitted with non-sealed beam headlights proceed as described above until the headlight unit is withdrawn, release the bulb retaining spring clips and withdraw the bulb. Replace with a bulb of the correct type (see page P.44). When reassembling, note that a groove in the bulb plate must register with a raised portion of the bulb retainer.
Note: Do not turn the two slotted screws or the setting of the headlights will be upset.

INNER HEADLIGHT – REPLACEMENT

The procedure for replacing the inner headlight unit or bulb is the same as that described in 'Outer Headlight –

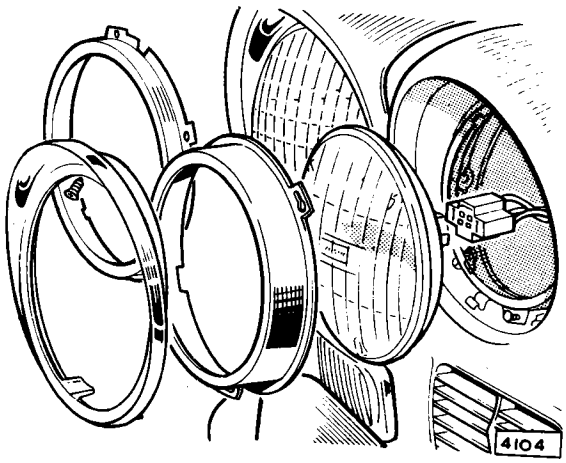
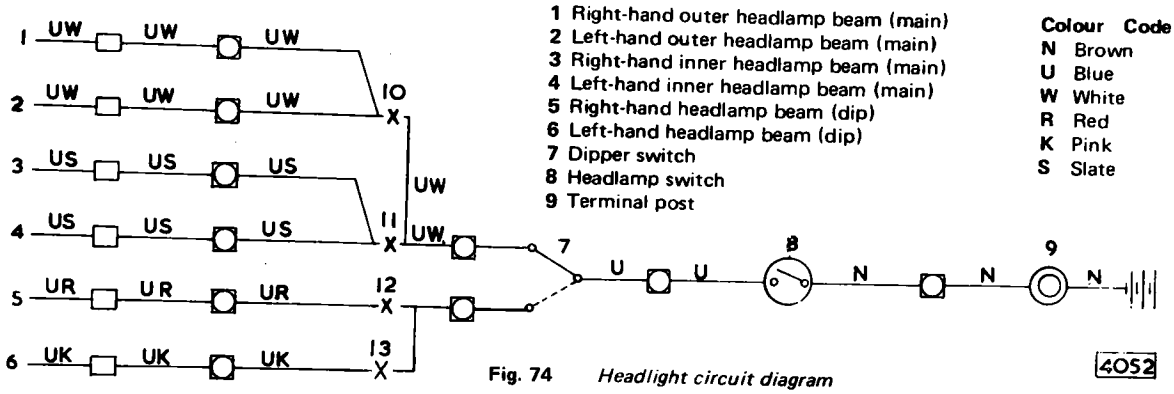


Fig. 73 *The outer and inner headlight unit removal (sealed beam)*



1 Right-hand outer headlamp beam (main)
2 Left-hand outer headlamp beam (main)
3 Right-hand inner headlamp beam (main)
4 Left-hand inner headlamp beam (main)
5 Right-hand headlamp beam (dip)
6 Left-hand headlamp beam (dip)
7 Dipper switch
8 Headlamp switch
9 Terminal post

Colour Code
N Brown
U Blue
W White
R Red
K Pink
S Slate

Fig. 74 *Headlight circuit diagram*

Replacement.' However, when removing the headlight unit retaining rim, it is not necessary to remove the three cross headed screws, these should be slackened and the rim turned anti-clockwise until it can be withdrawn.
Note: Do not turn the two slotted screws or the setting of the headlamp will be upset.

SIDELAMP BULB – REPLACEMENT
Withdraw three screws, detach the lens cover and remove the bulb. Check the condition of the lens seal when refitting.

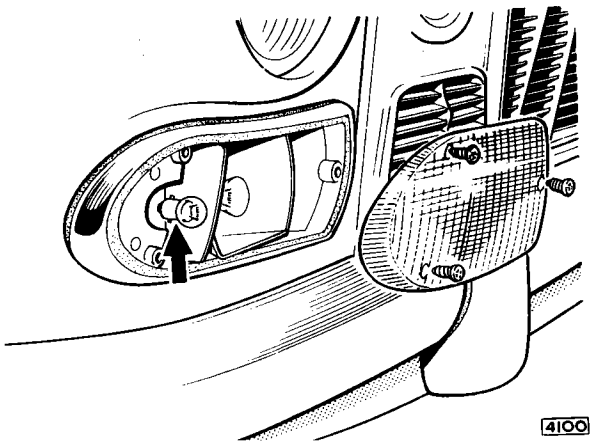


Fig. 75 *Side lamp bulb removal*

FRONT FLASHER BULB – REPLACEMENT
Proceed as detailed for 'Sidelamp bulb – replacement.'

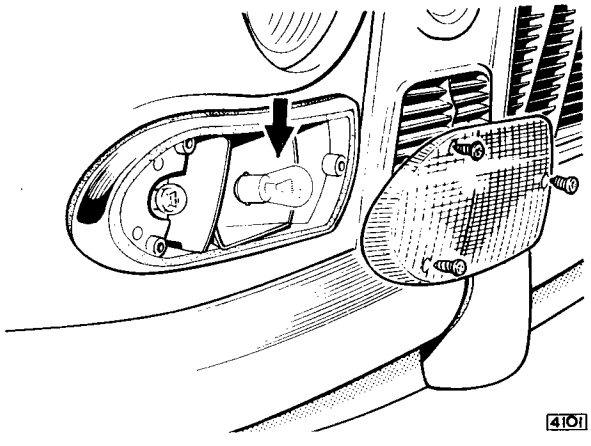


Fig. 76 *Front flasher bulb removal*

REAR FLASHER BULB – REPLACEMENT
Remove three screws retaining the glass. Detach the glass and withdraw the upper bulb.
Check the condition of the lens seal when refitting.

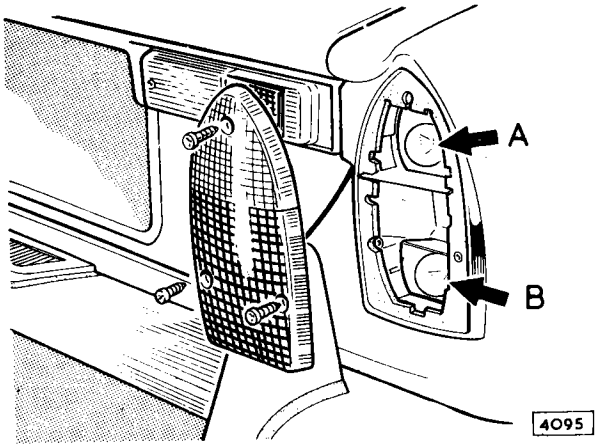


Fig. 77 *Rear flasher/rear light/brake light bulb removal*

REAR/BRAKE LIGHT BULB – REPLACEMENT
Proceed as for Rear Flasher Bulb, but withdraw the lower bulb. When refitting a replacement bulb note that the pins are offset.

REVERSE LIGHT BULB – REPLACEMENT
Remove two screws and detach the lens cover. Withdraw the festoon bulb from between the contacts.

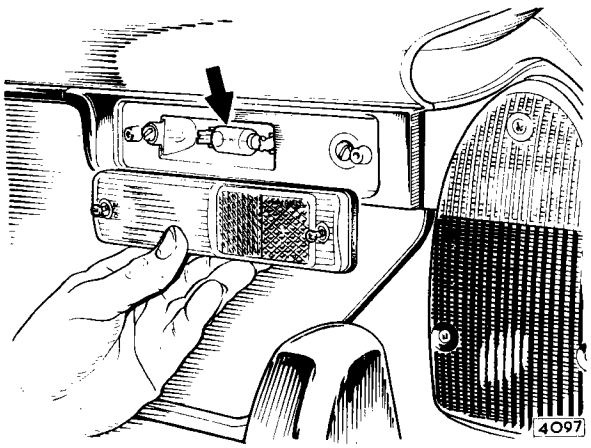


Fig. 78 *Reverse light bulb removal*

NUMBER PLATE LIGHT BULB –REPLACEMENT
Remove the two cross-headed screws located in the centre section of the rear bumper, and detach the lens cover.
Remove the faulty bulb by pressing in and turning anti-clockwise.
Check the condition of the lens seal when refitting.

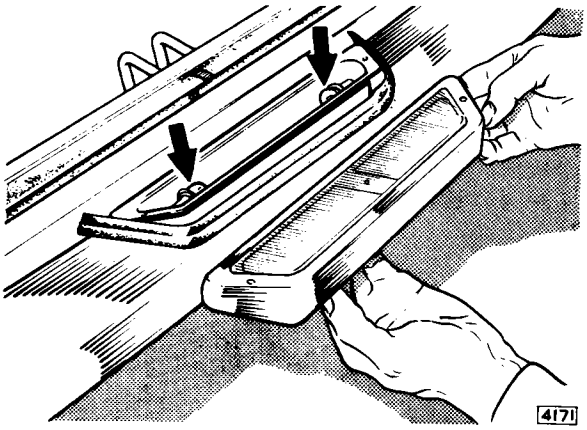


Fig. 79 *Number plate lamp bulb removal*

IGNITION WARNING LIGHT BULB – REPLACEMENT
The ignition warning light bulb is contained in a cluster unit located between the speedometer and the revolution counter.
To remove, detach the cover retained by spring clips to the unit base and withdraw the bulb from the holder.

BRAKE FLUID AND HANDBRAKE WARNING LIGHT BULB – REPLACEMENT
Proceed as for Ignition warning light bulb.

OIL PRESSURE WARNING LIGHT BULB – REPLACEMENT
Proceed as for Ignition warning light bulb.

TRAFFIC HAZARD WARNING LIGHT BULB – REPLACEMENT
Proceed as for Ignition warning light bulb.

DIRECTION INDICATOR WARNING LIGHT BULBS – REPLACEMENT
Proceed as for Ignition warning light bulbs.

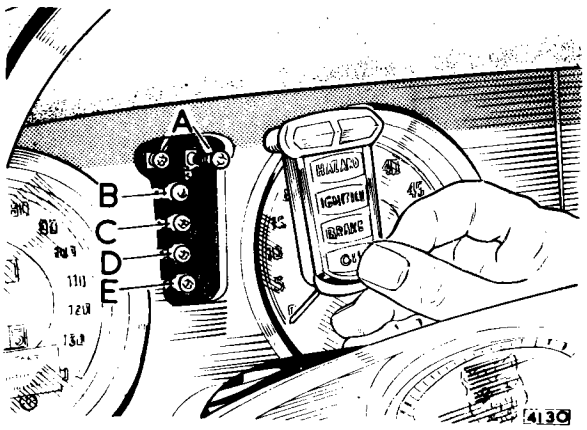


Fig. 80 *The warning light cluster–with cover removed*

- **A** Flasher bulbs
- **B** Hazard warning
- **C** Ignition warning
- **D** Brake light warning
- **E** Oil warning

INTERIOR LIGHT BULB – REPLACEMENT
Using care to avoid breakages, insert a screwdriver under the chromium plated portion of the lens cover and lever away from the lamp base.
Remove the festoon bulb from between the contacts and replace with one of the correct value (12v 10w).
To replace the glass fit the top first and snap the bottom edge into position.

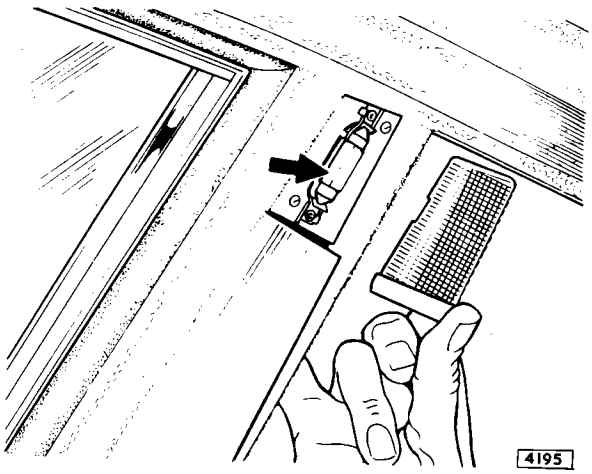


Fig. 81 *Interior light bulb removal*

MAP LIGHT BULB – REPLACEMENT
Press in the side clips of the bulb holder, located under the centre of the screen rail above the instrument panel, and withdraw the holder downwards. Access to the bulb for removal is gained through the hole in the base.

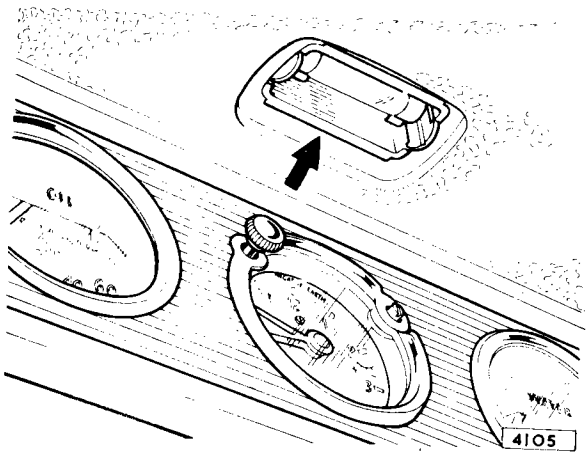


Fig. 82 *Map light bulb removal*

INDICATOR STRIP BULBS – REPLACEMENT
Three bulbs are provided along the bottom rear edge of the instrument panel. Withdraw the bulbs by pulling out from the sockets provided in the panel.
Replace the appropriate bulb with one of the correct value.

AUTOMATIC TRANSMISSION INDICATOR BULB – REMOVAL

Remove the securing screws and detach the transmission unit cover.
Remove the gear control lever knob.
Withdraw two screws and detach the gear indicator cover.
Remove the bulb cover and withdraw the bulb.
Replace the bulb with one of the correct type and voltage (24 volts).

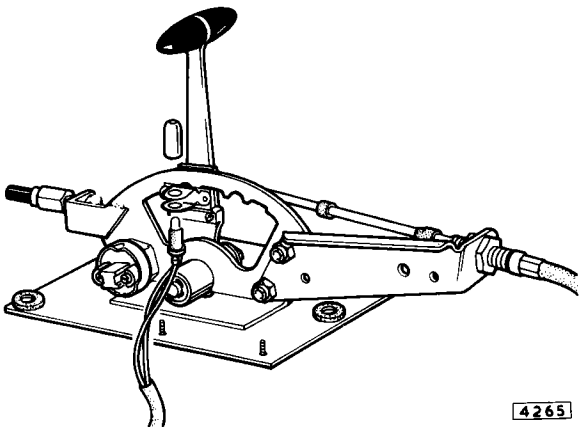


Fig. 83 *Automatic transmission indicator bulb removal*

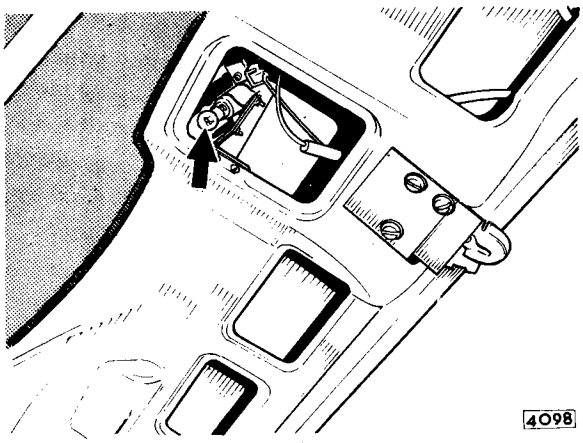


Fig. 84 *Luggage compartment light bulb removal*

LUGGAGE COMPARTMENT LIGHT BULB – REPLACEMENT

The bulb is accessible through an aperture in the luggage compartment lid inner panel. Remove the bulb by pressing in and turning anti-clockwise.

FLASHER UNIT (Lucas Model 8FL)

DESCRIPTION

The Lucas 8FL flasher unit consists of a moulded base which carries a snap-action metal vane held in tension by a metal ribbon and a pair of normally closed contacts.
Two 'Lucar' blade terminals are provided on the opposite side of the base, the input terminal 'L' to the direction (turn) indicator switch.
The action assembly is housed within an aluminium cover.

Operation

With the direction indicator switch in the 'OFF' position, the snap-action metal vane is held in tension by the unheated metal ribbon. Mounted midway along the ribbon is the moveable portion of a pair of normally closed contacts. When R.H. or L.H. signal lamps are selected, the signal lamp load current flows through the ribbon via terminal 'B' and the contacts, causing the appropriate signal lamps to be illuminated.
The current flowing through the ribbon causes the latter to heat and expand, allowing the vane to relax and so open the contacts.
The signal lamps are now extinguished, the ribbon cools, re-tensions the vane, and the contacts close for the cycle to be repeated.
Should one of the signal bulb filaments fail, the reduced load will be insufficient to heat the metal ribbon to operating temperature and the contacts will remain closed. The remaining signal lamp and the pilot lamp will remain on **but will not flash.** An occasional unit may, however, continue to operate, but at a significantly different rate. The distinctive click of the vane will not be heard, and the difference of any sound which may take place will be immediately obvious.

Servicing

The flasher unit is a sealed component, and no service or repair is possible. Faulty units must be replaced.

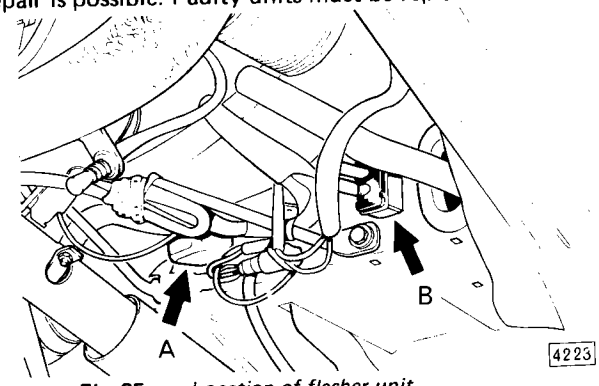


Fig. 85 *Location of flasher unit*
'A'–Hazard warning. 'B'–Flasher unit

Should it become necessary to renew the flasher unit, care must be taken to fit only the correct replacement unit. The current rating is marked on the cover. This number MUST correspond on both components.
To avoid possible damage or unsatisfactory operation of the replacement unit always ensure that the lamps are equipped with bulbs of the correct type, and that a fault in the wiring does not exist.
A simple check of the vehicle flasher system after the removal of the old flasher unit, can be made by carrying out the following checks (1 and 2). Lamp load current may then be checked as detailed under 3 and 4.

(1) Use a temporary link to connect together the cables removed from terminals 'B' and 'L' of the flasher unit.

(2) With the ignition switch turned 'ON' operate the direction (turn) indicator switch to the left and right and check the appropriate front and rear bulbs.

(3) Remove the temporary link described in (1) and substitute a good quality ammeter having a range of 0-10 amperes. Connect the meter positive (+) lead to the cable terminal originally connected to connection 'B' of the 8FL unit.

(4) With the ignition switched 'ON' operate the direction (turn) indicator switch to the left and right and check that the two readings obtained are equal and also approximately the same as the current rating on the 8FL unit case.

The operating speed of the unit when fitted to the car can be checked by counting the number of flashes given by one of the indicator lamps over a timed period.

FUSE UNIT

Two Lucas fuse units each carrying four live glass cartridge type fuses and one spare are incorporated in the electrical system and are located behind the instrument panel.

Access to the fuses is obtained by removing the two instrument panel retaining screws (top left-hand and top right-hand corners). The instrument panel will then hinge downwards exposing the fuses and the fuse indicator panel.

The circuits controlled by individual fuses are shown on the indicator panel and it is essential that the blown fuse is replaced by one of the correct value.

The spare fuses are retained in position by small plastic clips. Always replace the spare fuse as soon as possible.

On cars exported to Germany the tail lamps and number plate lamps are not fused.

The fuses for the heated backlight and the air-conditioning equipment, both available as optional extras, are located in plastic fuse holders behind the instrument panel.

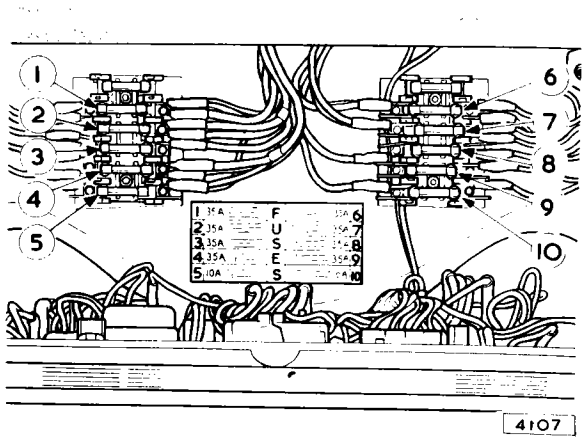


Fig. 86 *Location of fuses*

Fuse No.	Cable Colour	Circuit	Fuse
1	Green	Screen Washer, Instruments, Horn Relay, Tachometer	35
2	Purple	Map/Interior Lights, Cigar Lighter, Air-Conditioning Relay (when fitted)	35
3	Green	Windscreen Wiper, Flasher, Heater Motor, Stop Lights	35
4	Purple/Brown	Horns	50
5	Red	Side/Tail Lamps (Left-hand)	10
6	Blue/White	Outer Headlamp (Main)	35
7	Blue/Slate	Inner Head Lamps	35
8	Blue/Purple	Outer Headlamp (Left-hand Dip)	35
9	Blue/Red	Outer Headlamp (Right-hand Dip)	35
10	Red	Side/Tail Lamps (Right-hand)	10
–	–	Traffic Hazard Warning	35
–	–	Electrically Heated Backlight	15
–	–	Overdrive Solenoid/Reverse Light	8

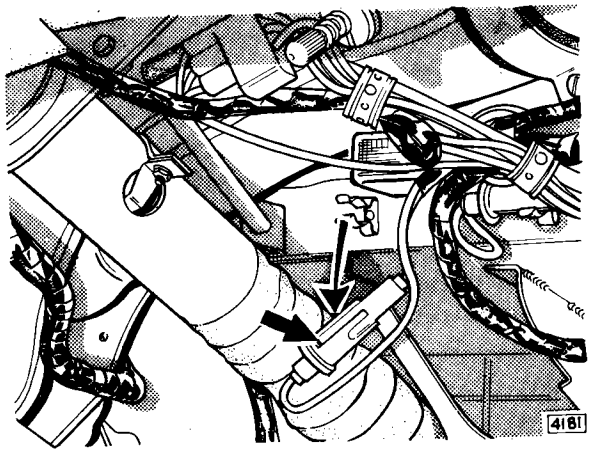


Fig. 87 *Location of overdrive fuse*

TRAFFIC HAZARD WARNING DEVICE

Description

This system operates in conjunction with the four flashing (turn) indicator lamps fitted to the car.

The operation of a rocker switch in the panel will cause the four flashing (turn) indicator lamps to flash simultaneously.

A red warning lamp, located in the warning light cluster, is incorporated in the circuit to indicate that the hazard warning system is in operation.

The flasher unit is attached to the bulkhead behind the right-hand facia panel.

A correct replacement unit must be fitted in the event of failure.

The pilot lamp bulb is accessible after removing the warning light cluster located between the speedometer and revolution counter.

Failure of one or more of the bulbs due to accident or other causes will not prevent the system from operating on other lamps.

See Fig. 88 (A) for the location of the hazard warning unit.

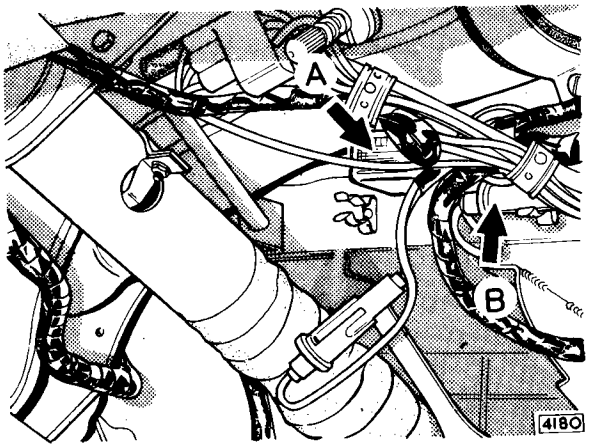


Fig. 88 *Hazard warning light unit 'A' and in-line fuse 'B'*

HORNS
(Model 9H)

DESCRIPTION

The Lucas 9H horns are mounted at the front end on either side of the engine compartment immediately below the radiator. The horn circuit operates through a Lucas 6 RA relay, the contacts C1 and C2 closing when the relay coil is energised by depressing the semi-circular ring attached to the steering wheel or by pressing the centre button.

Maintenance

In the event of the horn(s) failing to sound or performance becoming uncertain, check that the fault is not due to external causes before any adjustments are made.

Check as follows and rectify as necessary:—

(i) Battery condition.

(ii) Loose or broken connections in the horn circuit. Test with voltmeter at cable terminals.

(iii) Loose fixing bolts. It is important to keep the horn mountings tight and to maintain rigid the mountings of any unit fitted near the horns.

(iv) Faulty relay. Check by substitution after verifying that current is available at terminal C2 (cable colour — brown and blue) and terminal W1 (green).

(v) Check that fuse 3 (35 amperes) and fuse 5 (50 amperes) have not blown.

Note: Horns will not operate until the ignition is switched on.

Adjustment

The horns cannot be conveniently adjusted in position. Remove and securely mount on the test fixture.

A small serrated adjusting screw is provided to take up wear of moving parts only in the horn and it is located adjacent to the horn terminals. Turning this screw does not alter the pitch of the note.

Connect an 0-25 moving coil ammeter in series with the horn supply feed. The ammeter should be protected from overload by connecting an ON-OFF switch in parallel with its terminals.

Keep this switch ON except while taking the readings, that is, when the horn is sounding.

Turn the adjustment screw anti-clockwise until the horn just fails to sound.

Turn the screw clockwise until the horn operates within the specified current limits of 6.5 — 7.0 amperes.

Service Replacements

When fitting replacement horns it is essential that the following procedure be carried out:—

(i) Refit the lockwashers in their correct positions, one on each side of the mounting bracket centre fixing.

(ii) Ensure, after positioning the horn, that the 5/16in. centre fixing bolt is secure but not overtightened. Overtightening of this bolt will damage the horn.

(iii) Ensure that, when a centre fixing bolt or washers other than the originals are used, the bolt is not screwed into the horn to a depth greater than 11/16in. (17.5mm).

Muted Horns (Holland only)
Special horns are fitted to cars exported to Holland.
These horns are muted to comply with the Traffic Regulations of that country and incorporates a rubber plug inserted in the trumpet.

Horn Relay – Checking
If the horn relay is suspected, check for the fault by substitution or by the following method:–

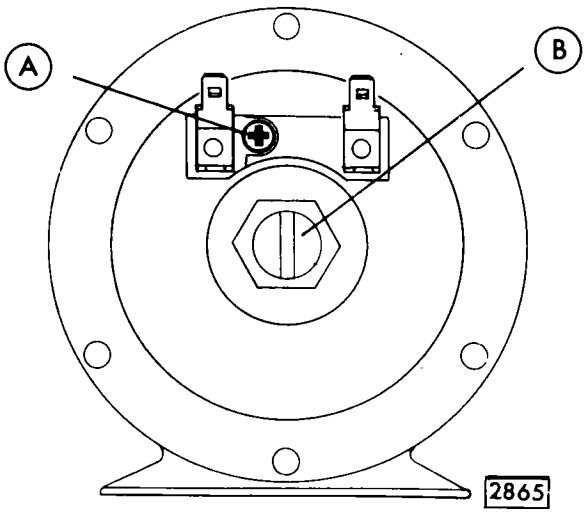


Fig. 89 *The Lucas 9H horn*
A – To adjust for wear
B – To adjust current

(i) Check that the fuses No. 3 and No. 5 have not blown. Replace if necessary.
(ii) Check with a test lamp that current is present at relay terminals W1 (green) and C2 (brown and purple). Switch on ignition before checking terminal W1.
(iii) Remove cable from terminal W2 (purple and black) and earth the terminal to a clean part of the frame. Relay coils should now operate and close contacts. Reconnect cable.
(iv) Remove cables from terminal C2 (brown and purple). Check for continuity by means of an earthed test lamp, the horn button or ring is depressed with the ignition ON. Replace relay if faulty.

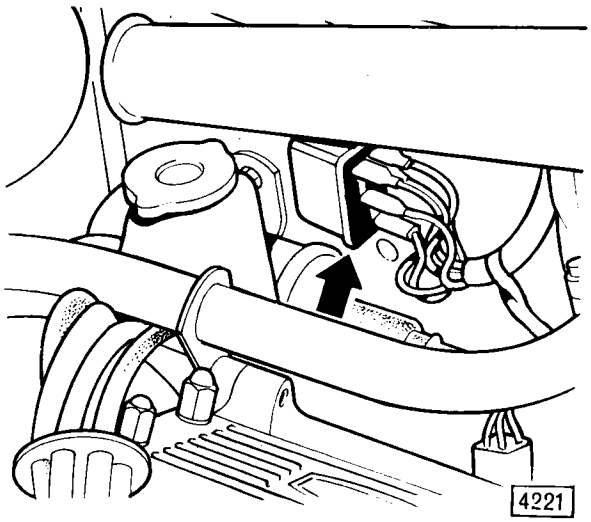


Fig. 90 *The 6RA relay, arrow shows connections*

WINDSCREEN WIPER

DESCRIPTION
The windscreen wiper consists of a two-speed self-parking power unit coupled by a cable rack drive to two scuttle mounted wheel boxes.
The two-pole motor has a permanent magnet field consisting of two ceramic magnets housed in a cylindrical yoke.
A worm gear formed on the extended armature shaft drives a moulded gear wheel within the die-cast gearbox.
The cable rack consists of a flexible inner core of steel wire wound with a wire helix. A reciprocating motion is imparted to the cable rack by a connecting rod and crosshead actuated by a crank pin carried on the gear wheel and is transmitted to the wiper arm spindles by the engagement of the rack with a gear in each wheel box.
The gearbox incorporates the self-parking mechanism which automatically parks the wiper blades in the correct position irrespective of the moment when the motor is switched off.
When the switch is operated to 'Park', contacts inside the switch automatically change over the external circuits to reverse the polarity of the supply connections to the motor.
This results in the motor commencing to operate in the opposite direction to normal rotation. The reversing action of the motor causes an eccentric cam in the crank pin bearing part of the connecting rod to rotate independently, enabling the connecting rod movement to be extended beyond its normal travel.
This extended movement of the connecting rod is used to move a moulded slider-block into a position where a cam on its underside strikes the operating plunger of a limit switch (part of the terminal assembly) and the first stage contacts inside the switch are opened to switch off the motor.
Following a momentary period during which no contact is made by the limit switch, continued momentum of the motor and further movement of the switch operating plunger closes the second stage contacts inside the switch which causes regenerative braking of the armature and maintains consistent parking of the wiper blades
Two speed operation is obtained by switching the positive feed to the third brush (with a stepped contact face) when the second (fast) speed is selected by the switch.

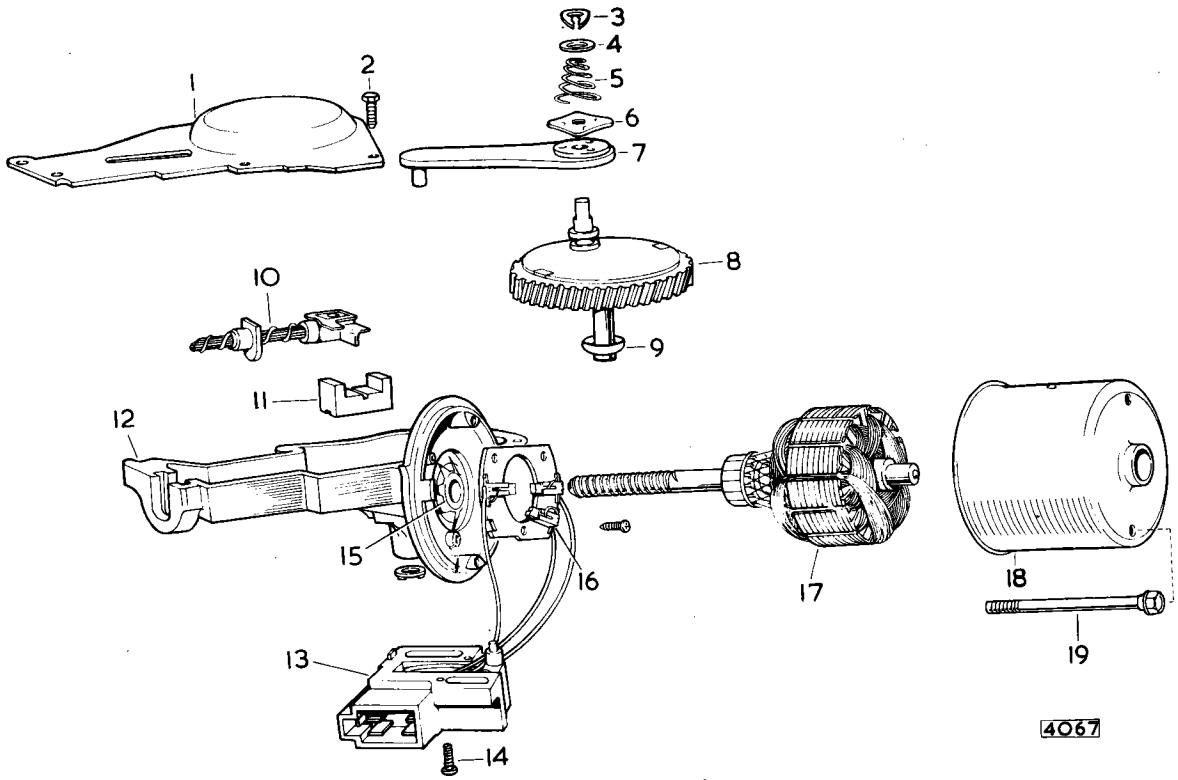


Fig. 91 *Exploded view of the windscreen wiper*

1 Gearbox cover
2 Screw (gearbox cover fixing)
3 Circlip
4 Washer
5 Conical spring
6 Friction plate
7 Connecting rod assembly
8 Moulded gearwheel
9 Dished washer
10 Cable rack
11 Moulded slider block
12 Gearbox
13 Limit switch
14 Screws
15 Self-aligning bush
16 Brush gear
17 Armature
18 Yoke assembly
19 Bolts (yoke fixing)

DATA

Light running speed (with rack disconnected) after 60 seconds from cold Normal High	 46-52 revolutions/minute 60-70 revolutions/minute
Light running current after 60 seconds from cold Normal High	 1.5 amperes 2.0 amperes
Pressure of blades against windscreen	11-13 ounces (312-369 gms)
Maximum permissible force to move cable rack in protective tubing with motor, arms, and blades disconnected.	6.0 lb. (2.72 kilograms)

ROUTINE MAINTENANCE

All bearings are adequately lubricated during manufacture and require no maintenance.

Use methylated spirits (denatured alcohol) to remove oil, tar spots or other stains from the windscreen.

Silicone or wax polishes must not be used for this purpose.

Efficient wiping is dependent upon having a clean windscreen and wiper blades in good condition.

Note: The wiper blades are manufactured with special anti-smear properties.

Renew only with genuine Jaguar replacement parts.

Worn or perished blades are readily removed for replacement.

The self-parking mechanism is pre-set during assembly and should not need any further adjustment.

If the arms of the blades are removed for any purpose, care must be taken to ensure that they are replaced in the same position relative to the spindles.

WIPER MOTOR

Removal

Withdraw the wiper arms from the spindles.

Disconnect and remove the battery.

Unscrew the large nut connecting the cable conduit to the wiper motor.

Withdraw the cable connector plug from the socket in the motor.

Remove two setscrews and washers, detach the clamp strap, and remove the motor and drive cable as an assembly by drawing the cable through the conduit.

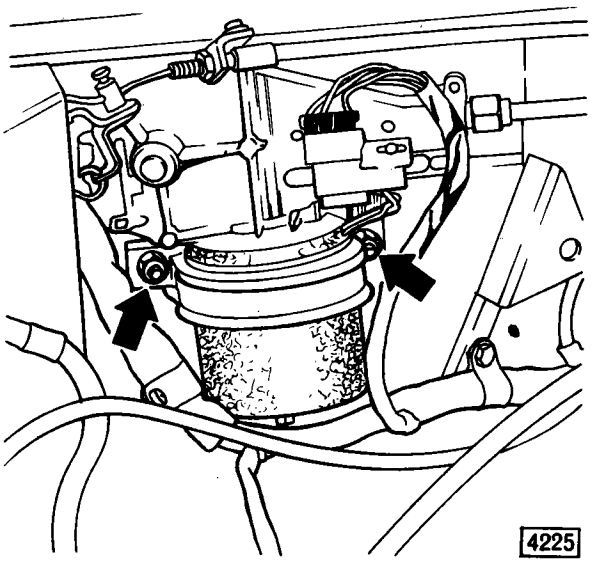


Fig. 92 *Showing wiper motor securing screws*

Refitting

Refitting is the reverse of the removal procedure.

Refit the wiper arms and blades as follows:—

(a) Switch on the ignition.

(b) Switch on the windscreen wipers to slow speed and note the arc of rotation of the wheel box spindles.

(c) Switch off the ignition when the spindles have reached the left-hand limit of travel.

(d) Fit the arms to the spindles in the approximate left-hand position and switch on the ignition. Adjust the position of the arms to give equal movement either side of the arc central line. Lift the spindle locking catch before withdrawing the arms from the spindles.

(e) Switch off the wiper switch.

Fault Diagnosis

Poor performance can be electrical or mechanical in origin, and not necessarily due to a faulty motor, for example:—

Low voltage at the motor due to poor connections or to a discharged battery.

Cable rack binding in conduit tubing.

Excessive loading on the blades.

Wheelboxes loose, out of alignment, or spindles binding in the bearing housing.

TESTING

Unless the origin of the fault is apparent, proceed as follows to determine the cause of the failure:—

Note: Since the motor is of permanent magnet design, the direction of rotation of the armature depends on the polarity of the supply to its terminals. If it is necessary to run the motor while it is removed from the vehicle, the negative supply cable should be connected to motor terminal number (1) and the positive supply cable to terminal number (5) for normal speed, or terminal number (3) for high speed (see Fig. 93).

Measuring Supply Voltage

Using a first grade moving coil voltmeter, measure the voltage between the motor supply terminal (cable colour — red/light green) and a good earthing point. This should be 11.5 volts with the wiper working on slow speed. If the reading is low, check the battery, switch (by substitution) cabling and connections.

To Check the 'Fast' Speed

Disconnect the cable rack from the motor as detailed under 'Dismantling', page P.56.

Using a fully charged battery connect motor terminal number (1) (See Fig. 93) to the negative supply and terminal number (5) to positive supply.

Check the speed of rotation of the moulded gear with the figures given under 'Data', page P.54.

If the speed is not as stated, an internal fault is indicated and the motor should be removed for detailed examination, or a replacement unit fitted.

To Check the 'Slow' Speed

Proceed as directed above, but connect the negative supply to motor terminal number (1) and positive supply to terminal number (3).

Measuring Light Running Current

Disconnect the cable rack from the motor as detailed above.

Connect a first grade moving coil ammeter in series with the motor supply cables for 'Fast' and 'Slow' speeds.

Check the figures obtained with those given under 'DATA' on page P.54.

If the figure is not stated, check for internal fault or fit replacement unit.

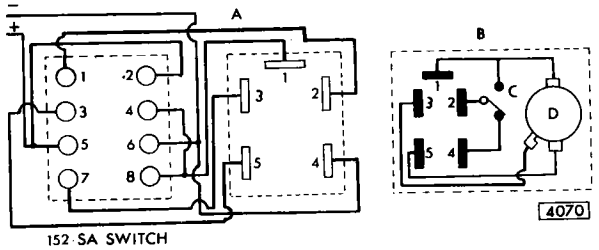


Fig. 93 *The windscreen wiper circuit*

A Moulded terminal connector on cable harness
B Terminal connector on wiper motor
C Limit switch
D Armature

Switch internal connections

OFF	NORMAL	HIGH SPEED
(1-3) (2-4)	(3-5) (4-6)	(5-7) (6-8)

Checking Cable Rack and Tubing

The maximum permissible force to move the cable rack in its protective tubing is 6 pounds with the wiper arms, blades and motor disconnected. The measurement can be made by hooking a spring balance in the hole in the crosshead (into which a pin on the connecting rod is normally located) and withdrawing the rack with the balance.

Before checking, disconnect the cable rack from the motor, remove the motor, wiper arms and blades.

When refitting the tubing, check that they do not foul the body at any point. Failure to ensure this may result in the transmission of cable rack noise.

Binding of the rack can be due to kinked or flattened tubing or to a faulty installation.

Minor faults can be cleared with a suitable testing mandrel sold specifically for checking wiper installations. Badly kinked or flattened tubing must be renewed. Any bends of less than 9in. radius must be reformed.

It is ESSENTIAL that all flared ends of the tubing are registered in the slots provided in the wheelbox plates before tightening the wheelbox cover plate securing nuts.

DISMANTLING (Fig. 91)

Remove the motor as detailed on page P.55

Withdraw the gearbox cover fixing screws (2) and lift off the cover (1).

Prise off the circlip (3) from the groove in the gear wheel crankpin and remove the flat washer (4), conical spring (5), friction plate (6), connecting rod assembly (7) and the flat washer located beneath the connecting rod.

Remove the circlip and washer securing the shaft to the gearbox.

With a fine file remove any fraze from the gearshaft, and remove the gear. Collect the dished washer (9) from the underside of the gearwheel.

Note: Location marks between the gearbox and yoke, withdraw the two fixing bolts (19) and detach the yoke assembly (18) and armature (17) from the gearbox (12).

Note: When removed, the yoke must be kept well clear of swarf and iron filings which may be attracted by the pole pieces.

Mark the location of the moulded slider block in relation to the terminal assembly. **THIS IS ESSENTIAL** to ensure the correct parking position when reassembling.

Remove the screws securing the brushgear (16) and the terminal and limit switch assembly (13) and detach both assemblies.

Bench Inspection

(1) Brush Replacement

The original specified length of the brushes is sufficient to last the life of the motor. If, due to accidental damage to the brushes or faulty commutator action, it becomes necessary to renew the brushes, the complete brushgear service assembly must be fitted. The brushgear assembly must be renewed if the main (diametrically opposed) brushes are worn to 3/16in. (4.8mm) or if the narrow section of the third brush is worn to the full width of the brush.

Check that the brushes move freely in the boxes.

(2) Armature Testing

Check the armature windings for open or short circuit with normal testing equipment.

Check armature insulation by using a mains test lamp, as shown in Fig. 94.

Lighting of the lamp indicates faulty insulation.

If worn, the armature can be lightly skimmed while mounted in a lathe. Clear the inter-segment spaces of copper swarf after skimming.

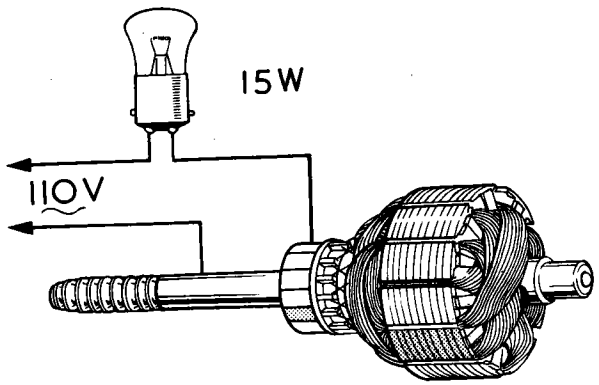


Fig. 94 *Armature insulation test*

(3) Inspection of Moulded Gear

Examine the gearwheel, especially the teeth, for signs of wear or damage. Fit replacement if necessary.

REASSEMBLING

Reassembling is the reverse of the removal procedure.

Check that the slide block and terminal assembly are fitted exactly as noted during dismantling.

Before refitting the armature to the yoke, check that the thrust disc and felt oiler washer are in place in the yoke bearing. The correct method of assembly is with the thrust disc flat against the end face of the bearing, followed by the felt oil washer which must have a hole in the centre to allow the captive ball bearing in the end of the armature shaft to contact the thrust disc.

If the felt oiler is renewed, check that the replacement is provided with the necessary hole. If not, make 1/8in. (3mm) hole in the centre of the felt.

Soak the felt oiler in Shell Turbo 41 Oil.

Tighten the yoke fixing bolts to a torque of 12-16 lb, in. (0.138-0.184 kg.m).

If a service replacement armature has been fitted, slacken the thrust screw before tightening the yoke fixing bolts.
Lubricate all moving parts liberally in the gearbox with Ragosine Listate grease. Minimum quantity of grease – 15cc.
Apply Shell Turbo 41 Oil sparingly to the bearing bushes, armature shaft surfaces and gearwheel shaft.

Armature End-Float Adjustment
Armature end-float is 0.002 – 0.008in. (0.05 – 0.2mm).
To obtain a satisfactory end-float adjustment with the motor and gearbox completely assembled, position the unit with the thrust screw uppermost, tighten the thrust screw until abutment takes place and then slacken it off one quarter turn and secure it in this position by tightening the locknut.

WHEELBOXES
Removal
Disconnect the battery.
Remove the screen rail facia as detailed in Section N. Body and Exhaust System, page N.6.
Withdraw the wiper blades and arms.
Remove the wiper motor and drive cable as detailed previously.
Remove two nuts, detach the back plate from the wheelbox(es) and withdraw the conduit tubing.
Unscrew the nuts securing the wheelbox(es) to the scuttle and remove the chrome distance pieces and sealing washers. Withdraw the wheelbox(es).

Refitting
Refitting is the reverse of the removal procedure.
When refitting, ensure that the flared ends of the tubes register with the narrow slots in the cover plate.
Wheelboxes with seized spindles or with excessive spindle end play should be replaced.

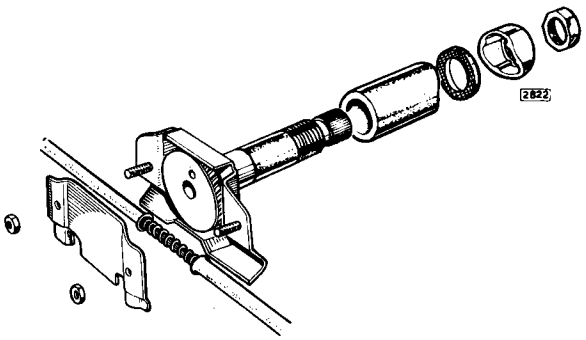


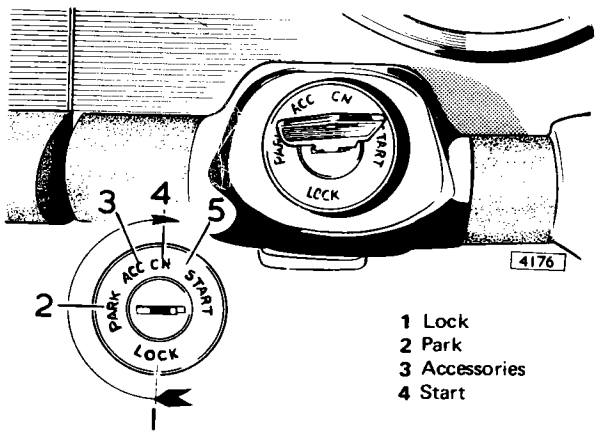
Fig. 95 *Wheel box exploded*

STEERING COLUMN LOCK

DESCRIPTION
A steering column lock is fitted as standard equipment.
The switch/lock unit is mounted on a bracket attached to the steering column and has five operative positions, (1) Lock, (2) Park, (3) Accessories, (4) Ignition, (5) Start.
During the assembly of the switch to the column the hexagon portion of the lock securing bolt, which is of the necked type, is sheared when fully tightened and cannot subsequently be easily removed, thus preventing unauthorised removal of the switch.

IMPORTANT
The steering column lock fitted to Jaguar XJ6 cars is brought into action when the key is turned to the 'LOCK' position and then removed.
IMMEDIATELY THIS IS DONE IT BECOMES IMPOSSIBLE TO STEER THE CAR.
It is therefore important to remember that if the ignition is switched off whilst the car is in motion the key should not be turned past the 'park' position. The ignition key should NEVER be removed from the lock whist the car is moving.

OPERATION
(1) Lock
This is the locked stop position. The key can be removed leaving the steering locked by engagement of the lock bolt with the register in the inner steering column.
(2) Park
This is the normal stop position. The key can be removed leaving the car capable of being steered with the ignition 'OFF.'
(3) Accessories
This position will allow the operation of accessories such as Radio and Electric Window Lift control (when either is fitted) with the ignition 'OFF.'
The key cannot be removed.
(4) ON
This is normal driving position. The key cannot be withdrawn and the ignition is 'ON.'
(5) START
This is the normal starting position. On release, the key will automatically return to the ignition 'ON' position.



1 Lock
2 Park
3 Accessories
4 Start

Fig. 96 *The ignition/starter/steering column lock control*

IMPORTANT
Re-engagement of the starter (cranking) motor will not be possible until the key is returned to the 'Park' position. This is a safety device introduced to prevent damage to the starter drive through accidental engagement when the engine is running.

MAINTENANCE
No maintenance is necessary or provided for.

SERVICING
No servicing is possible with the exception of the switch carrier contact plate which can be replaced if faulty as follows:–
(1) Disconnect the cables at the connectors.
(2) Remove two hexagon headed screws and plain washers and withdraw the contact plate with attached harness.
(3) Refit by reversing the removal procedure.
Note: The contact plate is indexed and cannot be fitted incorrectly.

Two Lucas 6RA relays are incorporated in the circuits controlled by the ignition switch to prevent overloading of the switch contacts.

Both units are located under the screen rail facia.
Operation of individual relays should be checked when testing for a fault in the ignition/starter switch circuits.

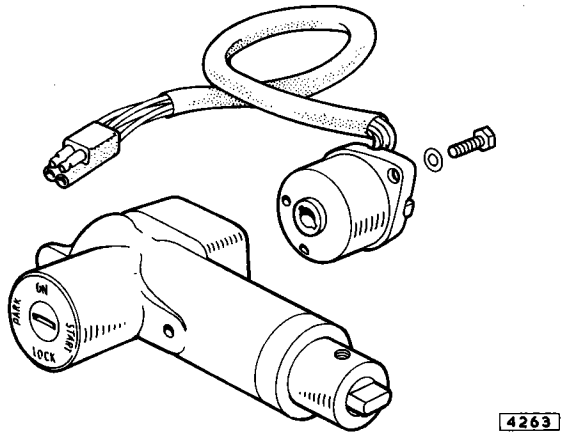


Fig. 97 *The steering column lock dismantled*

WIRING HARNESS REPLACEMENT AND CIRCUIT DIAGRAMS

GENERAL
The wiring harness consists of six main items, namely right and left-hand forward, right and left-hand rearward, panel and bulkhead harness. Small individual harnesses connect the engine and accessory components and automatic or overdrive unit switches into the main harness.
Connection between the various harnesses is by plug and socket, the pins being offset to prevent incorrect connection.

The main junctions are behind the side facia panel and the glove box adjacent to the screen pillars.
When replacing harness, all items must be secured in the clips provided and all grommets must be renewed if worn or damaged.
The body harnesses are routed over the door sills.
The rear harnesses are routed over the door sills.
Always refer to the main wiring diagram, page P.79, and the individual circuit diagrams when making connections.

4317

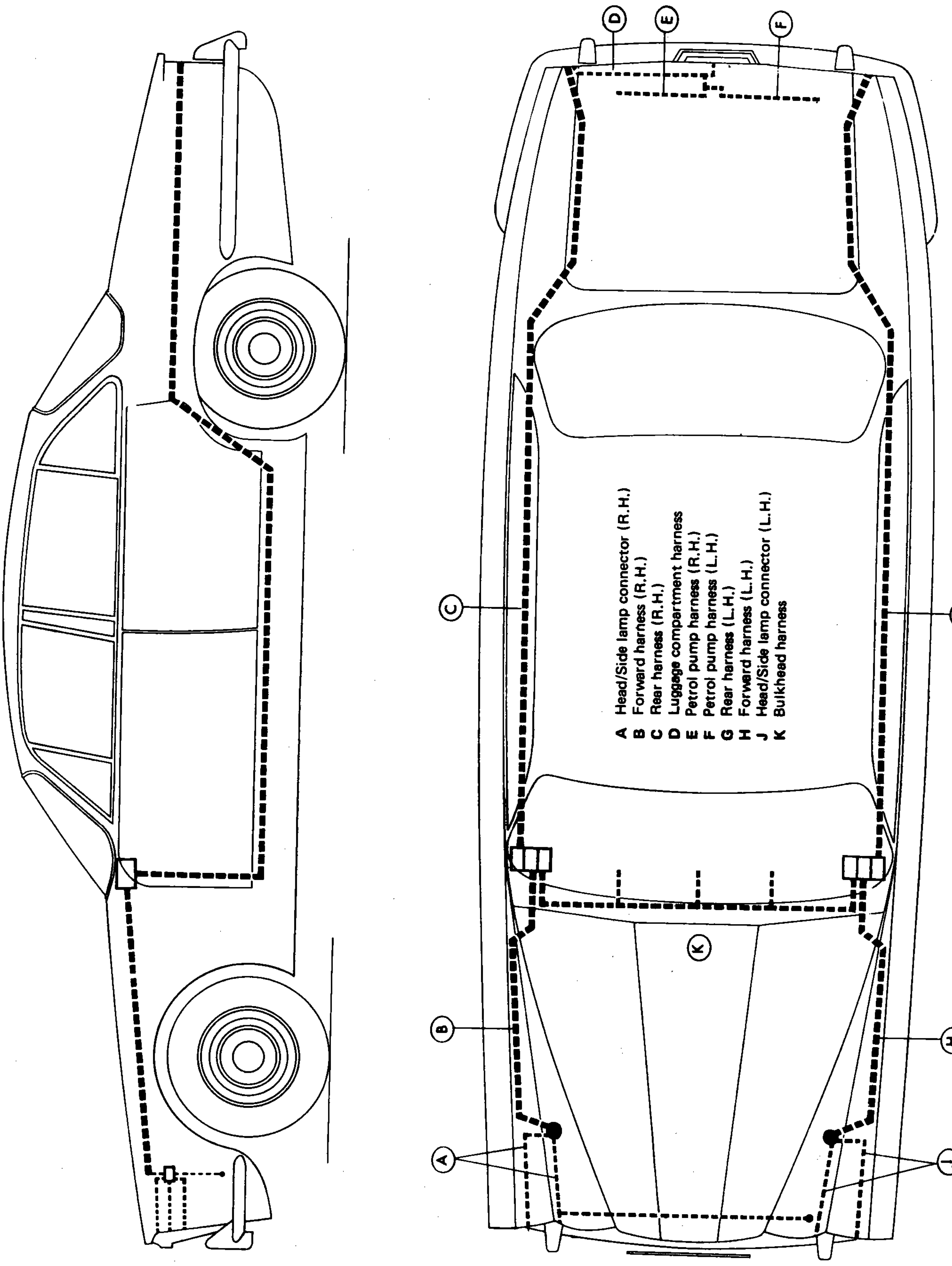
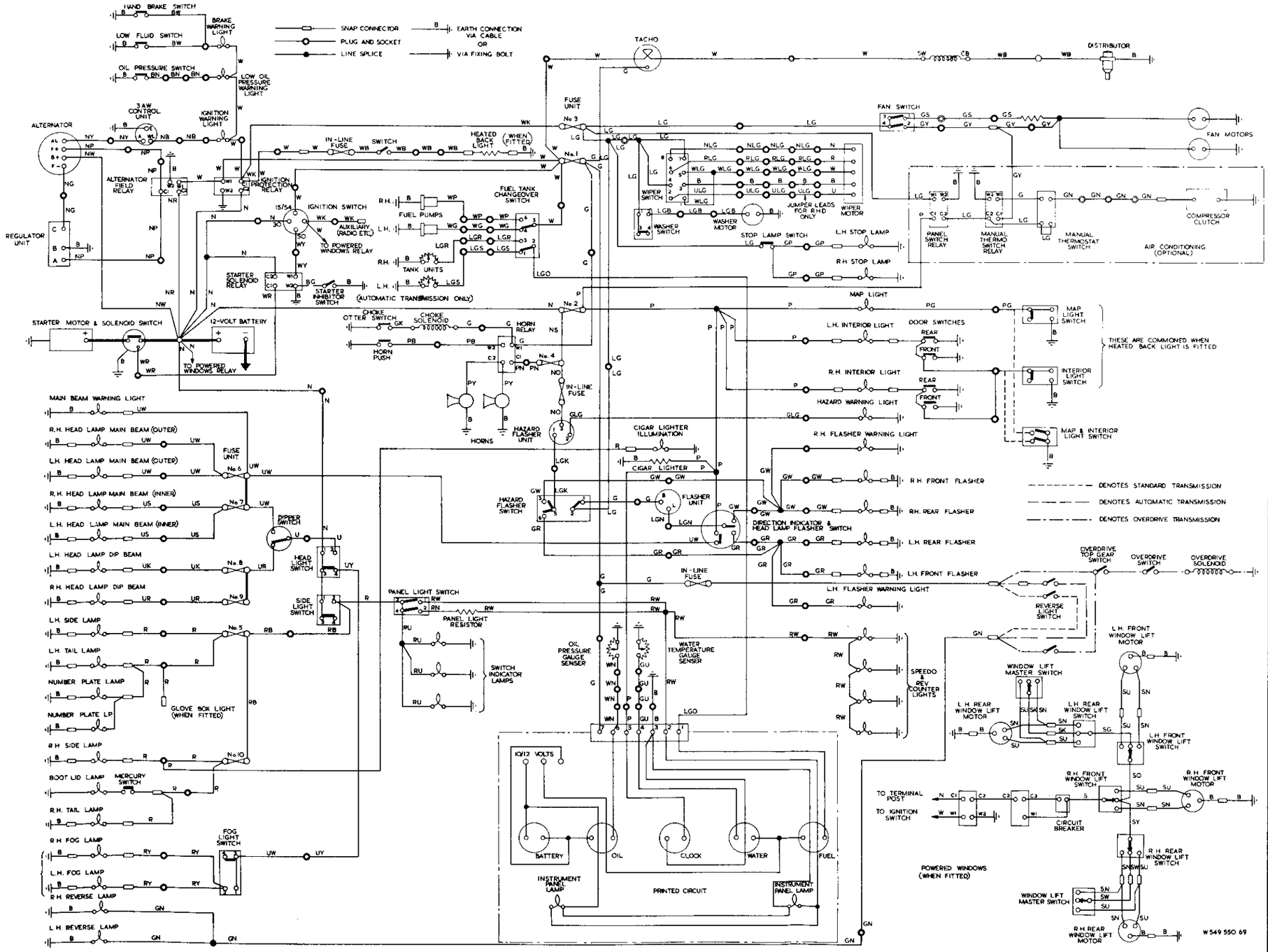


Fig. 98 *Layout of wiring harness*

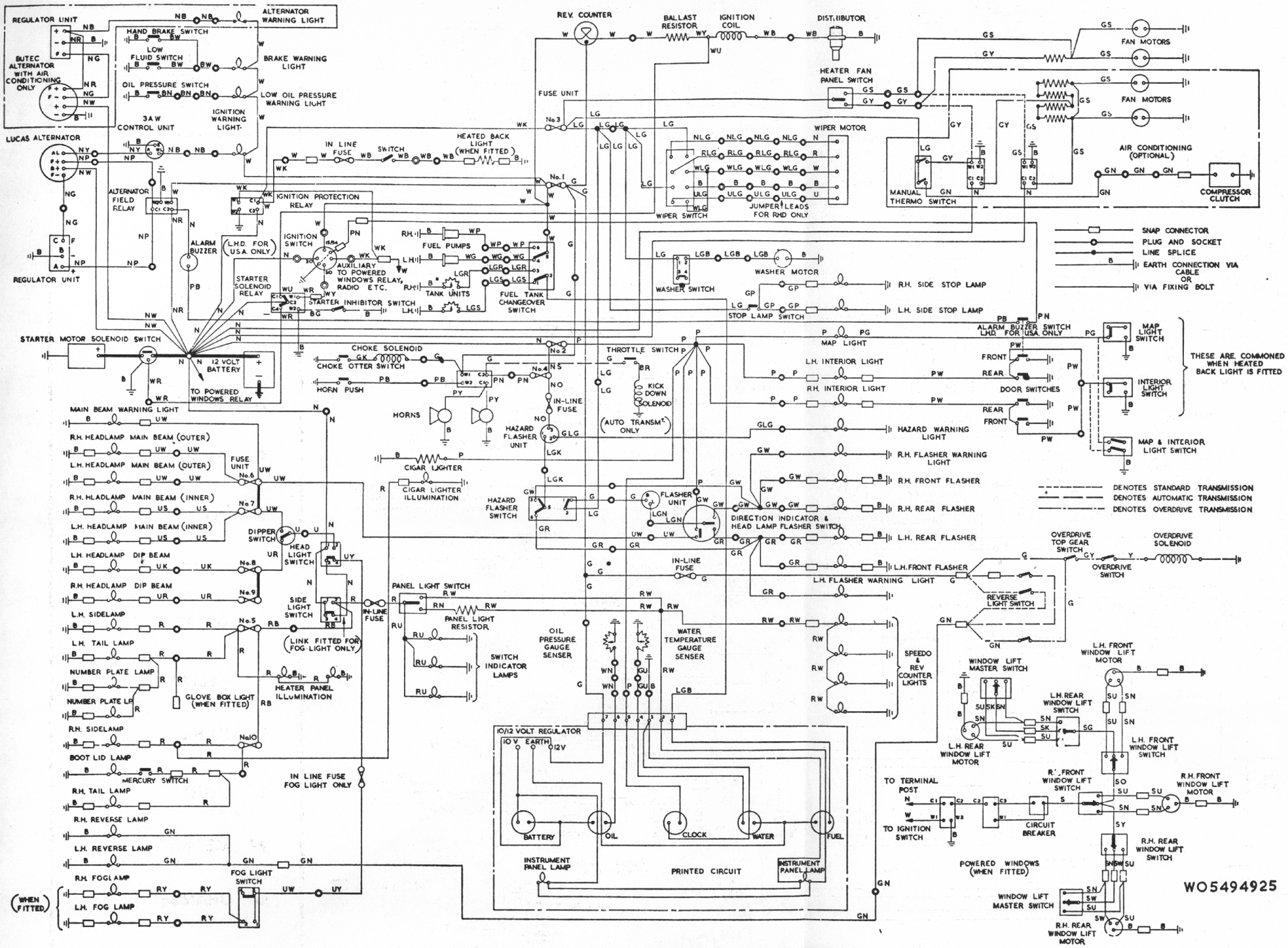


CABLE COLOUR CODE

B	BLACK
U	BLUE
N	BROWN
G	GREEN
K	PINK
P	PURPLE
R	RED
S	SLATE
W	WHITE
Y	YELLOW
D	DARK
L	LIGHT
M	MEDIUM
O	ORANGE

JAGUAR XJ.6 WIRING DIAGRAM (W.54955069)

Up to Chassis No. 1G.4158 – 2.8 litre R.H. DRIVE
1G.52012 – 2.8 litre L.H. DRIVE
1L.5561 – 4.2 litre R.H. DRIVE
1L.53096 – 4.2 litre L.H. DRIVE



JAGUAR XJ.6 WIRING DIAGRAM (W.05494925)

For Chassis No. 1G.4159 onwards—2.8 litre R.H. DRIVE
1G.52013 onwards—2·8 litre L.H. DRIVE
1L.5562 onwards—4.2 litre R.H. DRIVE
1L.53097 onwards—4.2 litre L.H. DRIVE

CABLE COLOUR CODE

B	BLACK
U	BLUE
N	BROWN
G	GREEN
K	PINK
P	PURPLE
R	RED
S	SLATE
W	WHITE
Y	YELLOW
D	DARK
L	LIGHT
M	MEDIUM
O	ORANGE

THE INSTRUMENTS

SPEEDOMETER

Removal

Disconnect the battery.
Unscrew the knurled nut from the right-angled drive at the rear of the instrument and disconnect the cable.
Unscrew the knurled nut and withdraw the odometer setting control cable.
Apply hand pressure against the speedometer bezel, rotate anti-clockwise to the stop in the bayonet fixing and withdraw the instrument.
Remove the headlamp warning light and the two illumination lamps.
Remove the right-angled drive gearbox from the instrument after unscrewing the captive knurled ring nut.

Refitting

Refitting is the reverse of the removal procedure.
The right-angled drive gearbox is a sealed unit and must be replaced if faulty.

THE SPEEDOMETER DRIVE CABLE

Removal

Disconnect the drive cable from the speedometer by unscrewing the knurled nut. Detach the opposite end of the cable from the gearbox and release from the retaining clips.

Refitting

Refitting is the reverse of the removal procedure.
Sharp bends must be avoided when installing the cable, and securing clips must retain the cable without crushing.
The original run of the cable must be maintained and the clips should **not** be re-positioned.

SPEEDOMETER CABLE – GENERAL INSTRUCTIONS

Flexible cable condition to a great extent affects the performance of speedometers. Poor installation or damage to the flexible drive will show up as apparent faults. It is most important that the flexible drive should be correctly fitted and maintained as illustrated in the following diagrams.

Connection

Ensure tightness of outer flex connections. They should be finger tight only. It may be necessary to clean thoroughly the point of the drive before the connection can be screwed completely home.

Lubrication

Withdraw inner flexible drive (see below).
Place a blob of grease on end of outer cable and insert flex through it, carrying grease inside. Use Esso T.S.D.119 or equivalent. Do NOT use oil. Avoid excessive lubrication. If oil appears in flexible drive, suspect faulty oil-seal at point of drive.

Connection of Inner Flexible Shaft to Gearbox

Where possible, slightly withdraw inner flex and connect outer first. Then slide inner into engagement.

Removal of Inner Shaft

Inner flexes can be removed by disconnecting the instrument end and pulling out flex. Broken inner flex will have to be withdrawn from both ends.

Examination of Inner Flexible Shaft

Check for kinked inner flexible shaft by rolling on clean flat surface. Kinks will be seen and felt.

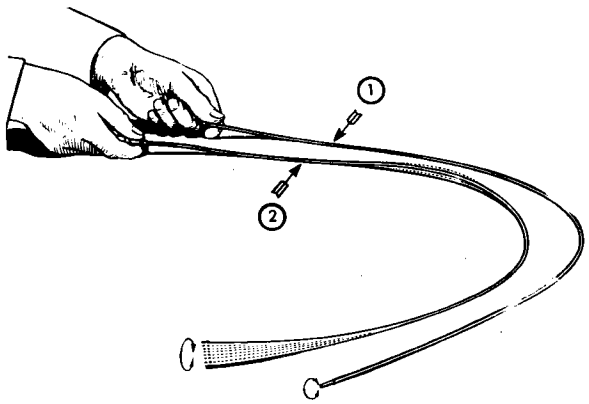


Fig. 99 *Checking the inner flex for kinks* 2825

Inner Shaft Projection

Check 3/8in projection of inner flex beyond outer casing at instrument end. This ensures correct engagement in instrument and point of drive.

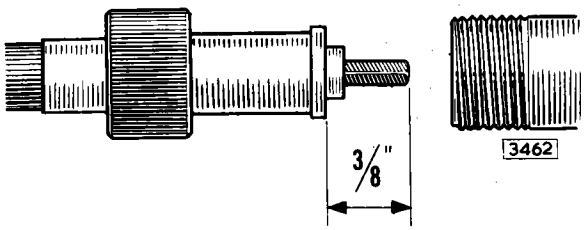


Fig. 100 *Showing the amount of inner flex which should protrude*

Concentric Rotation

Check that the inner flex rotates in centre of outer cable.

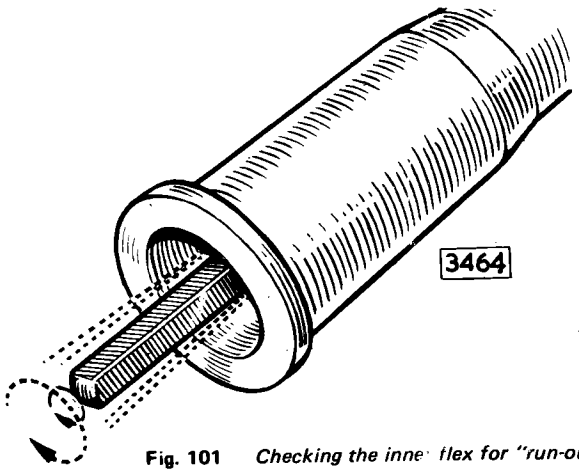


Fig. 101 *Checking the inner flex for "run-out"*

Damaged Inner Shaft
Examine inner flex ends for wear and other damage. Before fitting new flex ensure instrument main spindle is free.

SPEEDOMETERS – GENERAL INSTRUCTIONS

Speedometer performance is dependent on the flexible drive, and apparent faults in the instrument may be due to some failure of the drive. Before returning a speedometer for service, the flexible drive should be checked, as described in the previous paragraphs. The following paragraphs show how to check the instrument performance.

Instrument Operating
(1) Flexible cable broken/damaged – renew.
(2) Defective instrument – return for service.

Speedometer Inaccurate
Check tyre pressures. Inaccuracy can be caused by badly worn tyres. If non-standard tyres are fitted, apply to Smiths for specially calibrated instrument.
Check that the code number on the face of the instrument (Fig. 102) is correct for the final drive unit ratio as stated in the Spare Parts Catalogue.

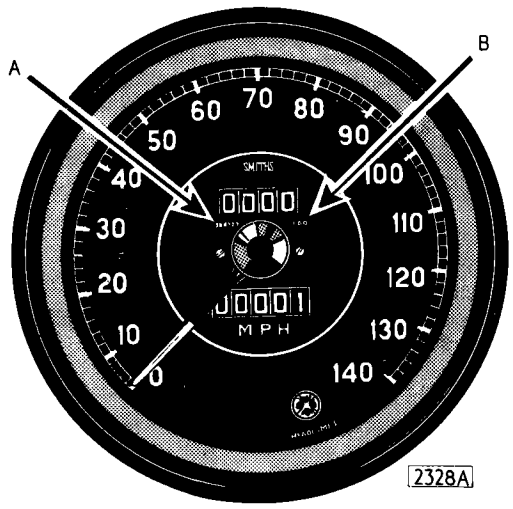


Fig. 102 *Showing the code numbers on the face of the instrument*
'A'–code number. 'B'–turns per mile

Pointer Waver
Pointer waver may be due to one or more of the following causes:–
1. Oiled up instrument. Replace the oil seal if necessary; clean the flexible drive and re-lubricate.
2. Inner shaft not engaging fully. Check the inner shaft projection.
3. Kinked or crushed flexible drive. Remove and examine inner cable.
4. Instrument defective. Return for replacement.

Noisy Installation
1. Inner flex damaged. Remove and check, replace if necessary. Check for lack of lubrication.
2. General high noise level. Withdraw the inner flex and reconnect the outer flex. If the noise continues at a lower level then the source of the noise is at the point of drive.
3. Regular ticking in time with speedometer distance counter. Return instrument for replacement.
4. Loud screeching, more prevalent in cold weather. Return the instrument for replacement.

THE REVOLUTION COUNTER (TACHOMETER)

DESCRIPTION
The revolution counter is an impulse tachometer instrument with transistors and a printed circuit, the pulse lead (coloured white) being wired in circuit with the S/W terminal on the ignition coil and the ignition switch.
Mechanical drive cables or an engine driven generator are not required with this type of instrument.
The performance of the instrument is not affected by distributor contacts setting, by corrosion of the sparking plug points or by differences in the gap setting.
Connections to the back of the tachometer is by means of a locked plug and socket, the contacts being offset to prevent incorrect coupling.

Removal
Apply hand pressure against the instrument bezel, rotate anti-clockwise to the stop in the bayonet fixing and withdraw.
Disconnect the plug and socket as follows:–
Pinch together the prongs of the plastic retainer clip and withdraw from the plug and socket assembly (Fig. 103).
Detach the plug from the socket and complete the removal of the tachometer.

IMPORTANT
Do not detach the green and the white cables connected to the plug from the instrument.

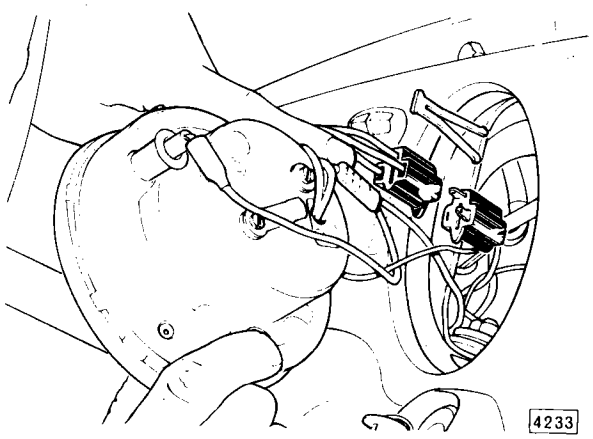


Fig. 103 *The tachometer plug and socket assembly*

Refitting
Refitting is the reverse of the removal procedure. Re-connect the plug and socket assembly and lock with the retaining clip.

DIRECTION (TURN) INDICATOR SWITCH

Removal
Disconnect the battery.

Remove the steering wheel and steering wheel shaft as detailed in Section H – Power Assisted Steering – page H.14.
Remove the three pan-headed screws securing the direction (turn) indicator switch and cowl to the outer column.
Disconnect the cables attached to the switch at the plug and socket connector.
Note: The connectors are indexed to prevent incorrect assembly when re-connecting.

REFITTING
Refitting is the reverse of the removal procedure.

OVERDRIVE SWITCH
The overdrive control switch is mounted in the gear lever knob. Overdrive is engaged by sliding the serrated button in the centre of the switch rearwards.

Removal
Disconnect the battery.
Insert a knife blade or similar tool between the switch cover and the gear lever knob. Gently prise away the cover with attached switch from the snap ring retainer.
Detach the two cables from the connectors on the switch to complete the removal.
The switch can be removed from the cover, if required, after withdrawing the two cross-headed screws.

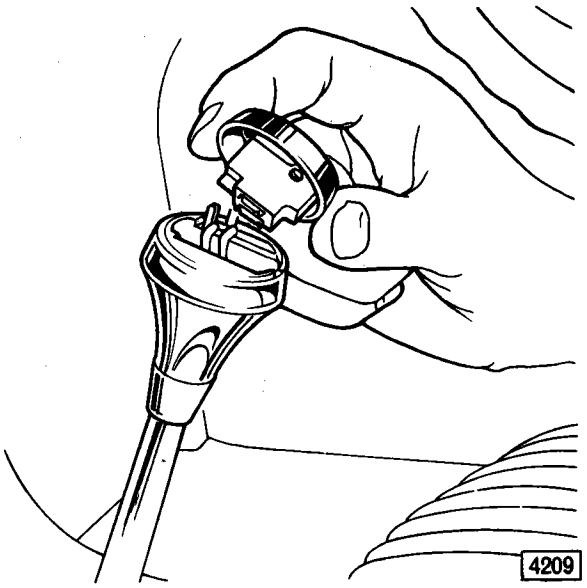


Fig. 104 *The overdrive switch removal*

Refitting
Refitting is the reverse of the removal procedure.
Ensure that the cable connectors are pushed fully home on to the switch terminals before refitting the cover.
No repairs are possible on the switch which must be replaced if faulty.

STARTER SOLENOID SWITCH RELAY
A relay is incorporated in the starter solenoid/ignition switch circuit to prevent overloading of the ignition switch contacts, due to initial surge, when operating the starter (cranking) motor.
The relay is located under the screen rail facia at the base of the right-hand screen pillar.
In operation, turning the ignition switch key to 'START' will energise the relay coil windings (W1–W2) causing the relay main contacts to close and allow solenoid operation through the ignition switch control. (See Fig. 105).

Removal
Disconnect the battery.
Remove the screen rail facia as detailed in Section N – Body and Exhaust System – page N.6.
Withdraw the cables from the relay terminals, note the location for reference when refitting.
Withdraw two drive screws and detach the relay from the mounting bracket.

Refitting
Refitting is the reverse of the removal procedure.

INHIBITOR SWITCH (AUTOMATIC TRANSMISSION)
On cars equipped with automatic transmission, an inhibitor switch mounted on the gear control quadrant is provided to prevent the starter motor solenoid operation unless the gear lever is in the 'N' or 'P' positions.
Operation of the inhibitor switch will energise the starter solenoid switch Relay coil.

Removal
Remove the console as detailed in Section N – Body and Exhaust System – page N.5.
Withdraw the cable, release the locknut, and unscrew the switch from the quadrant.

Refitting
Refitting is the reverse of the removal procedure.
Adjust the position of the switch to ensure that the contacts are closed when the control is in 'N' or 'P' and secure with the locknut.

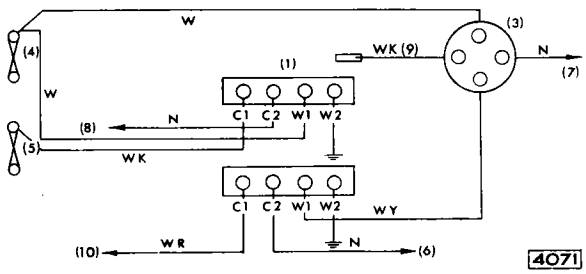


Fig. 105 *The ignition switch and starter solenoid relay circuit*

1 Ignition switch relay
2 Starter solenoid relay
3 Ignition/starter switch
4 Fuse No. 1
5 Fuse No. 2
6 To battery
7 To battery
8 To battery
9 Auxiliary (radio)
10 Starter solenoid

INSTRUMENT PANEL COMPONENTS

GENERAL DESCRIPTION

The battery indicator, oil gauge, water temperature gauge, fuel gauge and electric clock are mounted in a sub-panel which is attached to the main instrument panel by four screws and lockwashers.

The instruments are connected to the main electrical circuits via a printed circuit panel attached to the back face of the sub-panel and a seven pin harness plug.

The voltage regulator for the instruments is of the plug-in type, the socket being contained in the back panel.

The panel swiches are also contained in a removable sub-panel.

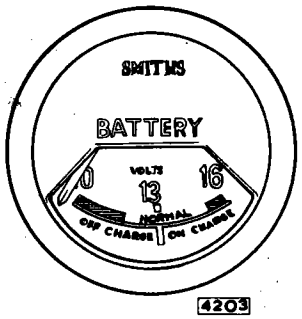


Fig. 106 *The battery indicator*

Battery Indicator

This is an instrument with a specially calibrated dial which indicates the condition of the battery. The position of the needle with a charged battery will be central within the area marked 'Normal.'

The instrument does NOT indicate the charging rate in amperes of the alternator.

Full instructions for reading the battery voltage by means of the meter are given below.

Check the condition of the battery by means of the table below.

RED (Off Charge)		NORMAL			RED (On Charge)
BATTERY CHARGE EXTREMELY LOW	BATTERY CHARGE LOW	WELL CHARGED BATTERY	CHARGING VOLTAGE LOW	CHARGING VOLTAGE SATISFACTORY	CHARGING VOLTAGE TOO HIGH
If with the ignition and electrical equipment e.g. headlamps etc., switched on, but with the engine not running the indicator settles in this section—your battery requires attention.		Ideally the indicator should settle in this section when the ignition and electrical equipment e.g. headlamps etc., are switched on and the engine is not running.	This condition may be indicated when the headlights and other equipment are in use.	The indicator should point to this section when the engine is running above idle.	If the indicator continues to point to this section after 10 minutes running, either your voltage regulator requires adjustment or some other fault has developed.

IMPORTANT All readings on the indicator should be ignored when the engine is idling, since readings may vary at very slow engine speeds due solely to operation of the voltage regulator.

OFF CHARGE

This means more energy is being used from your battery than is being replaced by the alternator on your car. This condition is satisfactory provided it does not persist for long periods, when the engine is running above idle or at speed. If the indicator remains in the section, it may mean that you have a broken or slipping fan belt, a faulty alternator, a badly adjusted voltage regulator or some other fault.

ON CHARGE

This means your battery is having more energy put into it then is being taken out of it. In the ordinary way this condition predominates and your battery is continuously being recharged by the alternator whenever the engine is running above idle. If however the engine is continually running slowly as may be the case in traffic—or when, in winter, lights and cold starting make extra demands on the battery—you may find the rate of discharge exceeds the rate of charge—that is to say the battery is running down, as will be indicated on your Battery Condition Indicator and you may need an extra charge if 'battery charge low or extremely low' is indicated by the instrument.

SUB-PANEL (Instruments)

Removal

Disconnect the battery, lower the instrument panel and withdraw the harness plug.

Remove four setscrews and washers and withdraw the panel as a unit.

Refitting

Refitting is the reverse of the removal procedure.

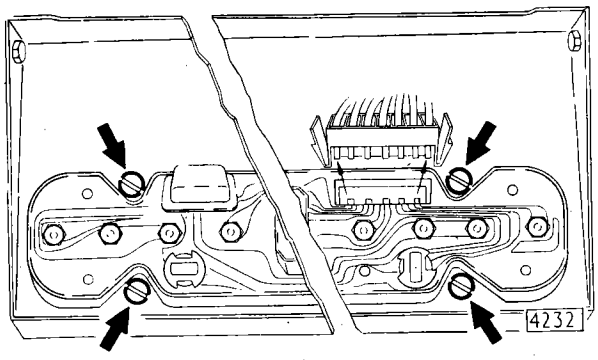


Fig. 107 *The instrument sub-panel removal*

THE INSTRUMENTS (FUEL, WATER, OIL AND BATTERY GAUGES)

Removal

Removal of the fuel, water temperature, oil pressure and battery indicator gauges is identical as follows:—

Remove the sub-panel as described previously.

Remove the voltage regulator.

Withdraw six cross-headed screws, disconnect the two leads from the clock and remove the back panel complete with the instruments.

To remove the individual instruments, remove the two securing nuts and wave washers and detach the faulty unit. EXTREME CARE MUST BE TAKEN NOT TO SCORE THE PRINTED CIRCUIT.

Refitting

Refitting is the reverse of the removal procedure.

Care must be taken to ensure that the instrument needles are not damaged when inserting the back panel.

Check that the plastic insulator is attached to the back cover of the voltage regulator when refitting.

IMPORTANT

It is ESSENTIAL that 'Lucar' blade connector (20) is refitted to the correct battery indicator terminal as shown in Fig. 108.

This connector is for radio suppression only.

UNDER NO CIRCUMSTANCES MUST THE CONNECTOR BE USED AS A POWER TAKE-OFF POINT. SEVERE DAMAGE WILL BE CAUSED TO THE INSTRUMENT IF THIS IS NOT ADHERED TO.

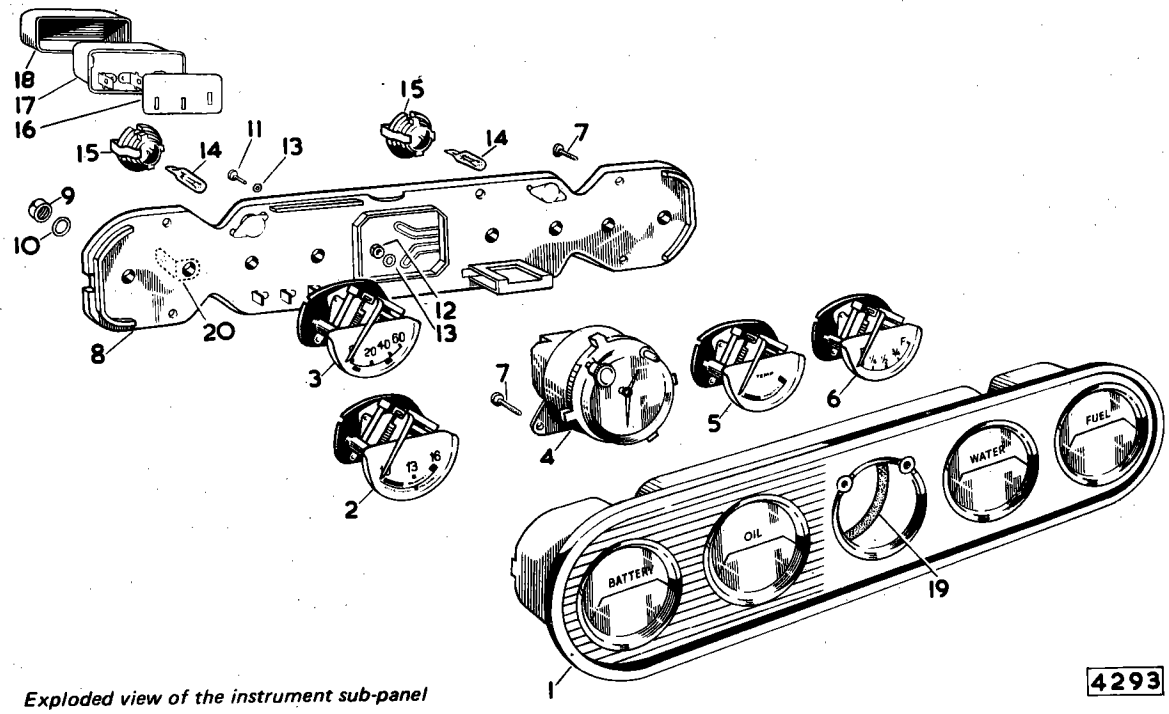


Fig. 108 *Exploded view of the instrument sub-panel*

1 Front case
2 Battery condition indicator
3 Oil pressure indicator
4 Clock
5 Water temperature indicator
6 Fuel contents indicator
7 Screw
8 Printed circuit and backplate
9 4BA Nut
10 Washer
11 8BA screw
12 8BA nut
13 Washer
14 Bulb (capless 12v 2.2w)
15 Bulb holder
16 Dust cover
17 Voltage stabiliser
18 Voltage stabiliser cover
19 Washer
20 Blade connector

THE ELECTRIC CLOCK

Removal

Remove the back panel as detailed previously. Remove the securing screws and withdraw the clock from the instrument panel case.

Refitting

Refitting is the reverse of the removal procedure.

IMPORTANT

The transistorised clock is car battery fed, the 12 volt nominal voltage being reduced to 1.35 volts through a rectifier incorporated in the instrument. If, at any time, the instrument is removed for servicing and subsequent testing on the bench, IT IS MOST IMPORTANT that the connections are not reversed.

The clock is of NEGATIVE EARTH POLARITY and if incorrectly connected will not start.

After refitting it is ESSENTIAL to restart the movement IMMEDIATELY THE BATTERY IS RECONNECTED.

Failure to ensure this will inevitably result in irreparable damage to the timepiece.

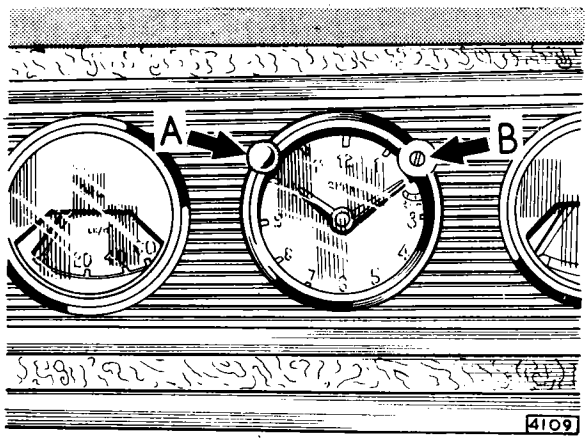


Fig. 109 *Clock controls*
'A'—hand setting. 'B'—Timekeeping

Adjustment

Frontal adjustment is provided for starting and resetting the hands and for timekeeping adjustment.

To start the clock or to re-set the hands, pull out the knob, turn to adjust and release.

To adjust the timekeeping, turn the small slotted screw anti-clockwise if losing and clockwise if gaining.

SUB-PANEL (Switches)

Removal

Disconnect the battery.

Hinge the instrument panel downwards.

Disconnect the cables from the switches, note location of cables for reference when refitting.

Remove four securing screws and washers, and detach the sub-panel.

Note: Individual switches may be removed without detaching the panel, as follows:—

Hinge the panel down and disconnect the cables from the switch to be removed, noting location for reference when refitting. Press in the two nylon locking tabs located at the top and bottom faces of the switch body and push forward through the aperture.

Refitting

Refitting is the reverse of the removal procedure.

Reconnect the cables as noted on removal.

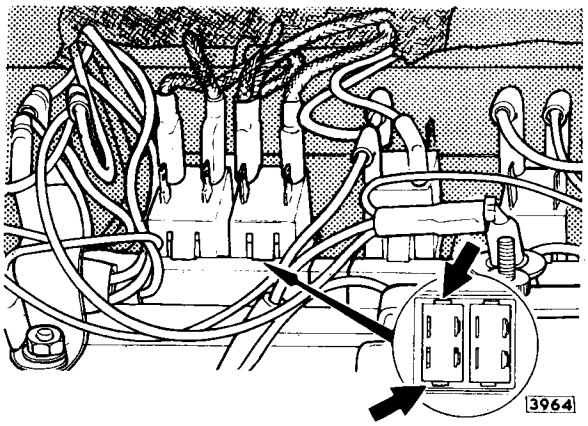


Fig. 110 *Instrument panel rocker switch removal*
(Inset shows the nylon locking tabs arrowed)

THE BI-METAL RESISTANCE INSTRUMENTATION

Engine Temperature, Fuel Tank and Oil Pressure Gauge

DESCRIPTION

The Bi-metal Resistance Instrumentation for engine temperature, petrol tank contents and engine oil pressure consists of a gauge unit fitted in the instrument panel, a transmitter unit fitted in the engine or the petrol tanks and connected together to the battery, the oil pressure gauge being an exception, through a common voltage regulator.
The purpose of the latter is to ensure a constant supply of predetermined voltage, thus avoiding errors due to a low battery voltage. In the instance of the oil pressure gauge this is not quite so critical to supply voltage.
In all systems the gauge unit operates on the thermal principle utilizing a heater winding round on a bi-metal strip, whilst the transmitter units of the engine temperature and petrol tank contents gauge are of the resistance type, but in both instances the system is voltage sensitive. The transmitter unit of the oil pressure gauge is of the thermal pressure principle utilizing a heater winding wound on a bi-metal strip, having contact at one end with the second contact mounted on a diaphragm which is sensitive to engine oil pressure.

OPERATION OF THE ENGINE TEMPERATURE GAUGE

The transmitter unit of the engine temperature gauge is fitted in the water outlet pipe of the engine unit and is a variable resistance and consists of a temperature sensitive resistance element contained in a brass bulb.
The resistance element is a semi-conductor which has a high negative temperature co-efficient of resistance and its electrical resistance decreases rapidly with an increase in its temperature. As the temperature of the engine unit rises, the resistance of the semi-conductor decreases and increases the flow of current through the transmitter, similarly a decrease in engine temperature reduces the flow of current.
The gauge unit fitted in the instrument panel consists of a heater winding, connected at one end to the transmitter unit and at the second end to the voltage regulator, wound on a bi-metal strip which is linked to the indicator needle. The heater winding and bi-metal strip assembly is sensitive to the changes in voltage received from the transmitter unit causing the heater winding to heat or cool in the bi-metal strip, resulting in the deflection of the indicator needle over the scale provided. The calibration of the scale is such that the movement of the indicator needle over it is relative to the temperature of the transmitter unit bulb and therefore the temperature of the engine unit.

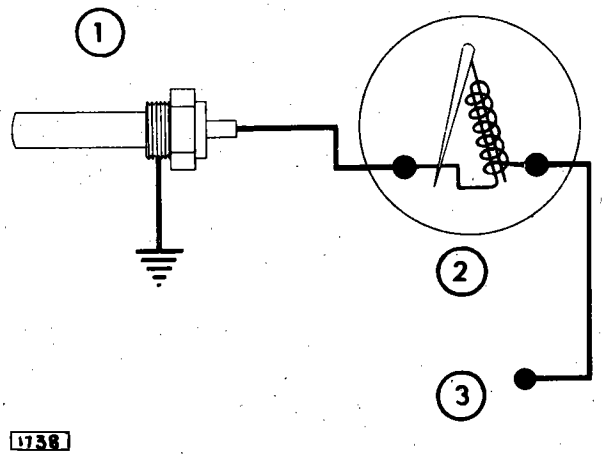


Fig. 111 *The engine gauge temperature circuit*

OPERATION OF THE FUEL TANK GAUGE

The transmitter units of the petrol gauge are fitted in the petrol tanks and each is a variable resistance actuated by a float, the arm of which carries a contact travelling across a resistance housed in the transmitter body. The float arm takes up a position relative to the level of petrol in the tank being used, and thus varies the amount of current passing through the indicator unit.
The gauge unit in the instrument panel consists of a heater winding, connected at one end of the transmitter units and at the other to the voltage regulator, wound on a bi-metal strip which is linked to the indicator needle. The heater winding and bi-metal strip assembly is sensitive to the changes in voltage received from the position of the transmitter float, causing the heater winding to heat or cool the bi-metal strip, resulting in the deflection of the indicator needle over the scale provided. The calibration of the scale is such that the movement of the indicator needle over it is relative to the position of the transmitter float actuated by the level of the contents in the petrol tank.
Exaggerated indicator needle movement due to petrol swirl in either tank is considerably reduced as there is a delay before current changes from the transmitter can heat or cool the bi-metal and heating winding assembly in the indicator unit, which causes the deflection of the needle.
Similarly the indicator needle will take a few moments to register the contents of the petrol tank being used when the ignition is switched on.

OPERATION OF THE OIL PRESSURE GAUGE

The transmitter unit of the oil pressure gauge, fitted in the head of the engine oil filter, is a voltage compensated pressure unit and consists of a diaphragm, a bi-metal strip with a heater winding wound thereon, a resistance and a pair of contacts. One contact is attached to the diaphragm, while the second is mounted on one end of the bi-metal strip, the second end of which is connected through the resistance and the gauge unit to the battery supply; the heater winding is also connected to the battery supply but not through the resistance. Engine oil pressure will close the contacts causing current to flow through the gauge unit, bi-metal strip and contacts to earth resulting in the heating of the heater winding which will, after a time, open the contacts.
The gauge unit fitted in the instrument panel consists of a winding, connected at one end to the battery supply and at the second to the transmitter unit wound onto a bi-metal strip which is linked to an indicating needle. The heater winding and bi-metal strip assembly is sensitive to the continuity changes received from the thermal pressure unit, fitted in the oil filter, causing the heater winding to heat or

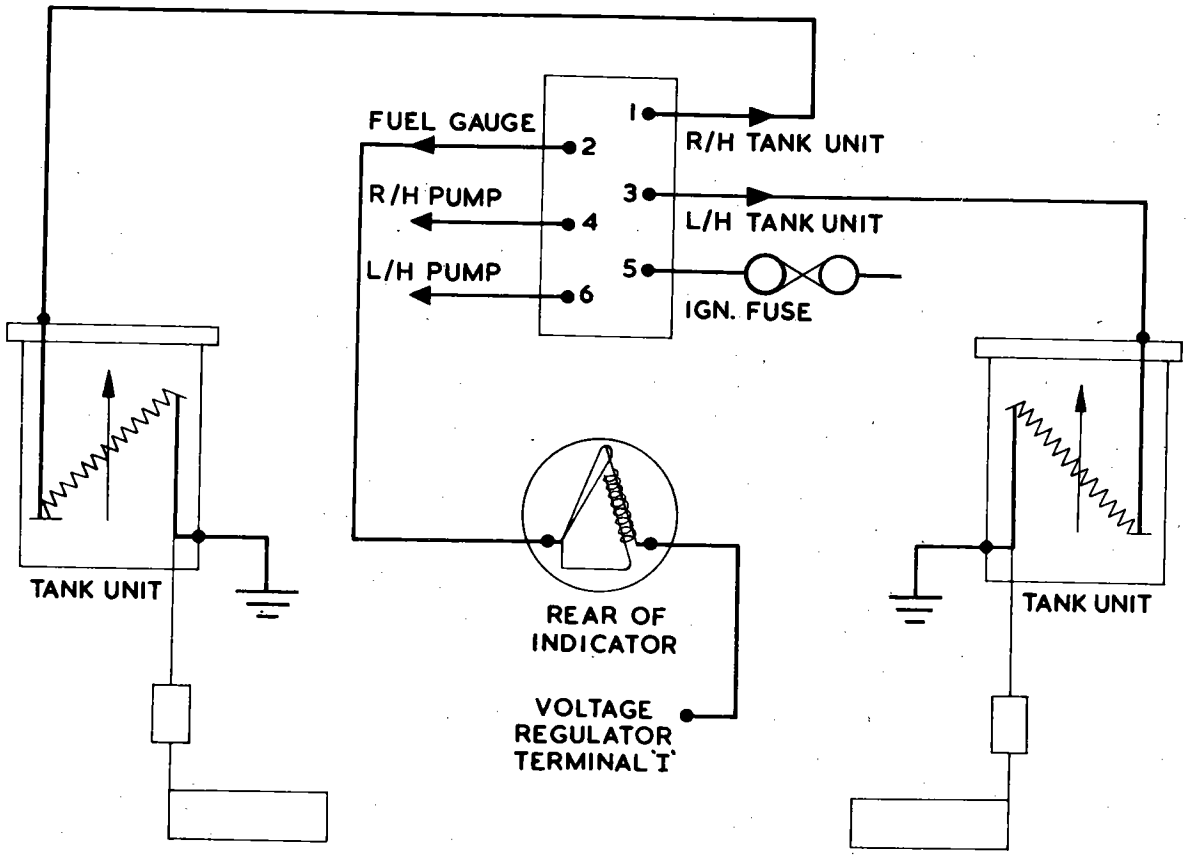


Fig. 112 *The fuel tank gauge circuit*

cool the bi-metal strip, resulting in the deflection of the indicating needle over the scale provided.

The changes in continuity of current from the transmitter unit will vary according to the amount of oil pressure, for as the latter rises the outward moving diaphragm contact limits the return travel of the bi-metal strip contact, thus allowing a longer continuity period.

This results in a greater heating of the heater winding in the gauge unit and increased deflection of the indicating needle over the scale showing a greater oil pressure.

The opening and closing of the transmitter unit contacts is continuous, thus the temperature of the heater winding in the gauge unit is kept within close limits and the calibration of the scale is such that the movement of the indicating needle over it is relative to the opening of the transmitter unit contacts and therefore the oil pressure of the engine is recorded.

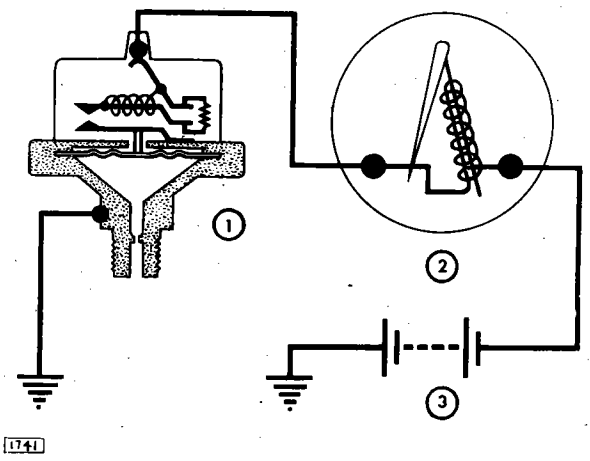


Fig. 113 *The engine oil pressure gauge circuit*

INSTRUMENT TESTING

INSTRUMENT GAUGE TEST EQUIPMENT

In order to facilitate the testing of the electrical gauges and indicators fitted to Jaguar cars, Messrs. SMITHS Motor Accessories have now produced a compact test unit which will quickly determine whether the fault is in the indicator transmitter or bi-metal stabiliser.

Apart from tracing the fault easily, it will be appreciated that time will be saved, thereby reducing labour costs, and will also avoid components in good working order being unnecessarily returned for replacement.

The unit is known as the 'Automatic Electrical Testing Instrument', and is available at reasonable cost from the Manufacturers, SMITHS MOTOR ACCESSORIES, OXGATE LANE, CRICKLEWOOD, LONDON, N.W.2., under Part No. SR/D.380.

The test procedure detailed below is based on this instrument.

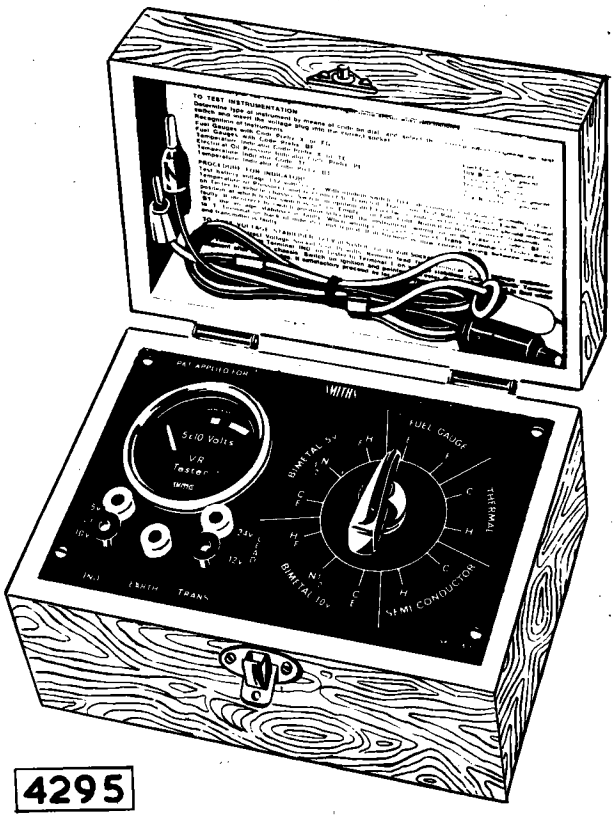


Fig. 114 *The SMITHS SR/D380 instrument tester*

TEST PROCEDURE

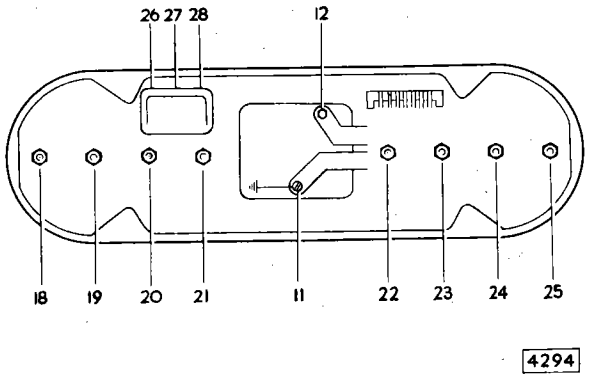


Fig. 115 *Test points for checking sub-panel instruments*

Remove the two knurled thumbscrews from the top right and left-hand corners of the instrument panel and lower the panel to the horizontal position.

The position of the indicator pointer of the Fuel, Temperature and Oil Pressure Gauges is checked in relation to calibration dots, e.g. Fuel Indicator – left of 'E', under 1/2, and right of 'F.'

A stabilising period of 2 minutes is necessary for each positional check.

Check that a good earth is available.

For all test procedure refer to Fig. No. 115.

Voltage Stabiliser

Connect the test leads supplied in the case to the 10 VOLT and EARTH terminals on the Testing Instrument and the corresponding free ends to points 24 and 18 indicated on Fig. 115 by means of the crocodile terminals.

Return the panel to the upright position and switch on the ignition.

The test indicator pointer should assume a position in the first bar sector or vertical position.

Fuel Indicator

Connect the test leads to a 12V Trans: and EARTH terminals on Testing Instrument and corresponding free ends to points 25 and 18 (Fig. 115).

Switch to L.H. fuel tank.

Turn Tester switch to Bi-Metal 10V 'E' and switch on ignition. The fuel indicator pointer should rise to the 1st set of calibration dots below 'Empty' mark on car instrument. Continue check by rotating tester switch to the '1/2' and 'F' positions.

Temperature Indicator

Connect Tester leads to EARTH and 12V TRANS: terminals on Testing Instrument. Remove the supply lead from the temperature transmitter, (cable colour – Green and Blue).

Connect free ends of Test leads to earth and to lead removed from the transmitter.
Rotate Tester switch to Bi-Metal 10V 'C' and switch on ignition.
The temperature indicator needle should rise to the 1st set of dots.
Repeat procedure by rotating tester switch to 'N' and 'H' positions.
If doubt exists on supply lead, check at panel on points Nos. 18 – 22.

Clock
Available voltage can be checked by using Tester leads on 10V IND and EARTH with free ends connected to points 11 (earth) and other lead to 12 (Fig. 115). Test indicator will show pointer in second sector.

Oil Pressure Indicator
Connect Tester leads to EARTH and 12V TRANS.

Remove the supply lead from the oil pressure transmitter and connect to one free end of the tester lead.
Connect remaining free end of tester lead to EARTH.
Rotate Tester switch to Bi-metal 10V 'C' and switch on ignition.
Panel instrument pointer should rise to 1st service test line (between 1 and 5 lb.).
Continue test by rotating switch to 'N.' Pointer should rise to 2nd service line (between 34 and 38 lb.).

WARNING: DO NOT SELECT 'H'
If doubt exists on supply lead, check at instrument panel using points 18 and 21, leaving transmitter lead disconnected.

Battery Condition Indicator
Carry out normal check for continuity between terminals or independent volt check.

OPTIONAL EXTRAS

This section covers the equipment available as optional extras

ELECTRICALLY OPERATED WINDOWS

GENERAL

This system (fitted as an optional extra to 2.8 litre De Luxe and 4.2 litre Models) enables the window regulators to be operated by means of push button switches which control reversable motors mounted in each door panel and actuate the lifting and lowering mechanism.

Six control switches are incorporated in the circuit, two for the use of the passengers in the rear of the car controlling the rear windows and four for the driver's use giving control over all four windows and over-riding the rear passengers' switches.

Operation of the driver's control switches will open a pair of normally closed contacts (Relay 'A') and isolate the power supply to the window switches in the rear arm rests. This operates fractionally ahead of a single pole change-over switch controlling the direction of motor rotation.

The driver's front window switch also operates as a master control switch.

The system is operative only when the ignition is switched on, when the closing of a relay connects the window lift circuit to the battery (via the terminal post). Refer to wiring diagram page P.79.

A thermostatic circuit breaker protects the motor windings from damage should the motors be stalled with the current on as, for example, with the control switch not fully released although the window is fully open or closed, or if the regulating mechanism is out of adjustment or requires lubrication. It also protects the wiring should fault current be flowing for any reason in any part of the circuit.

A second relay ('B') having normally closed contacts is used in circuit with the circuit breaker.

In the event of a stall or fault, current flowing in the circumstances described above, the circuit breaker will operate and current will then flow through the relay winding and thus opening the relay contacts.

As long as the switch remains closed or the fault exists, the relay will be energised and the contacts will remain open preventing further operation of the motors. When the switch is released or the fault rectified, the relay coil is de-energised and the contacts closed, so restoring the system to normal. It should be noted, however, that by operating the driver's window control switch the remainder of the circuit is isolated, the driver may still use the system to control his own window providing that the cause of the trouble is in one or all of the passengers' window.

The relay 'A' and 'C' and circuit breaker 'B' are incorporated in a control box unit located behind the left-hand front kick panel.

Relays are not replaceable as individual items. Faulty units must be replaced as complete control box assemblies.

DATA

Relay ('A')	
Cut-in Voltage	8 Volts
Drop-off Voltage	2.0 Volts
Coil Resistance	76.0 Ohms
Relay ('C')	
Cut-in Voltage	12 Volts
Drop-off Voltage	10.5 Volts
Coil Resistance	76.0 Ohms
Circuit Breakers ('B')	
Operating Current	14 – 16 Amps
Stall Conditions	20/30 Seconds at 20 Amps
	6 Seconds at 25 Amps
	3/4 Seconds at 30 Amps

Circuit Breaker must be re-set within 30 Seconds.

DRIVER'S CONTROL SWITCHES

Removal

Disconnect the battery.

Lift the centre arm rest lid and remove the drive screws securing the arm rest lid and pocket to the console.

Remove the nylon locking catch and withdraw the pocket.

Remove the switch escutcheon panel by pressing out from the rear, accessible through the aperture in the armrest.

Remove the control button from the faulty switch(es).

Withdraw the three screws securing the console panel to the console, two are located at the front and one at the rear.

Remove the four screws securing the switch carrier plate to the console panel and move the panel to one side.

Remove the two screws and washers securing each faulty switch to the carrier plate, disconnect the cables, noting the location for reference when refitting and withdraw the switch(es).

Switches cannot be serviced and must be replaced if faulty.

Refitting

Refitting is the reverse of the removal procedure.

Care must be taken to ensure that the cables are re-connected correctly as noted on removal, or by reference to the circuit diagram.

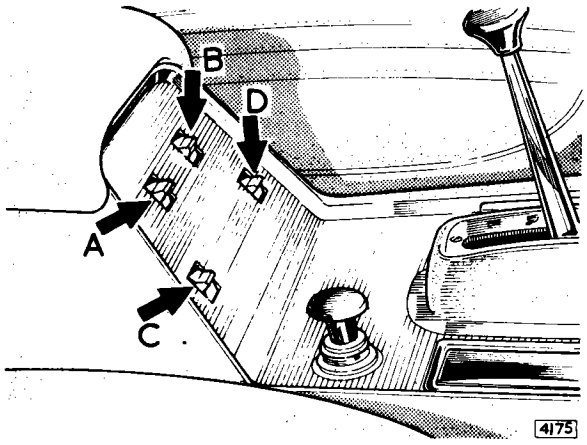


Fig. 116 *The driver's control panel (electric windows)*

A Rear window switch (right-hand)
B Rear window switch (left-hand)
C Front window (master) switch (right-hand)
D Front window switch (left-hand)

REAR PASSENGERS' CONTROL SWITCHES

Removal

Remove the armrest from the door after withdrawing the screws from the bottom edge and lifting away from the top keyhole fixing.
Disconnect the cables from the switch, noting the location for reference when refitting.
Remove the switch escutcheon plate and detach the switch from the armrest.

Refitting

Refitting is the reverse of the removal procedure.
Care must be taken to ensure that the cables are re-connected as noted on removal or by reference to the circuit diagram.

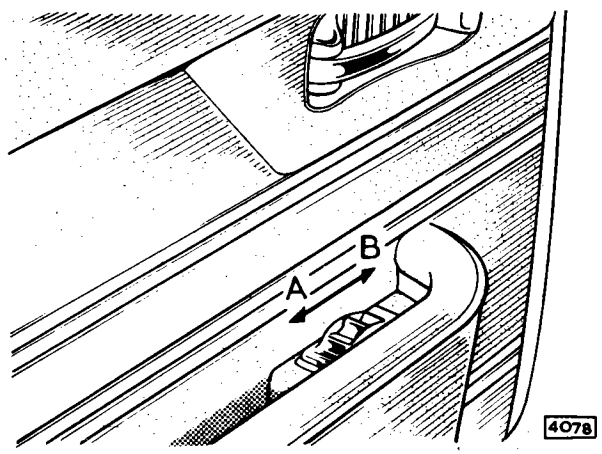


Fig. 117 *The passenger's electric window switch*

REAR WINDOW MOTORS

Removal

Remove the door casing and arm rest as detailed in Section N, page N.11.
Disconnect the battery.
Disconnect the cables from the motor at the plug and socket connection.
Remove four pan-headed setscrews and detach the regulator mechanism from the door panel.
Adjust the position of the door until the regulator arm can be removed from the channel. Withdraw the regulator through the aperture in the door.
If it is necessary to remove the glass in order to withdraw the regulator refer to Section N, page N.13.
Withdraw three setscrews and washers and detach the motor from the regulator.
The motor is sealed during manufacture. Faulty units must be replaced, no service repair being possible.

Refitting

Refitting is the reverse of the removal procedure.

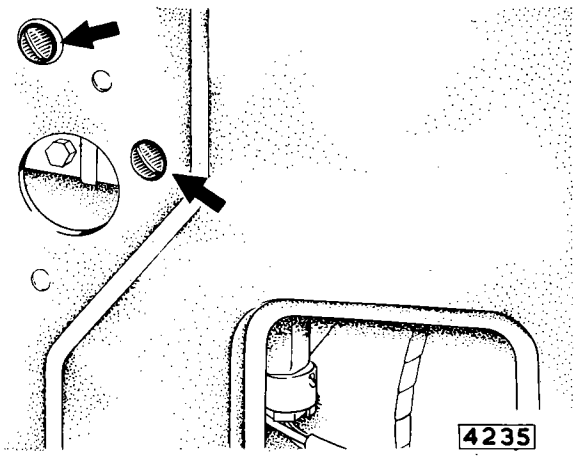


Fig. 118 *Location of the rear window motor*

FRONT WINDOW MOTORS

Removal

Disconnect the battery.
Remove the door casing and arm rest as detailed in Section N, page N.11.
Disconnect the cables from the motor at the plug and socket connection.
Remove two setscrews and detach the N.D.V. light gearbox.
Remove the top bolt securing the glass channel to the door inner panel.
Remove four pan-headed setscrews and detach the regulator mechanism from the door panel.
Slide the mechanism towards the hinge face of the door to clear the regulator arm roller from the channel.
Lift the regulator arm to pass on the opposite (outer) side of the glass channel.
Remove the assembly through the aperture in the door inner panel.
Withdraw three setscrews and washers and detach the motor from the regulator.

The motor is sealed during manufacture. Faulty units must be replaced, no service repair being possible.

Refitting
Refitting is the reverse of the removal procedure.

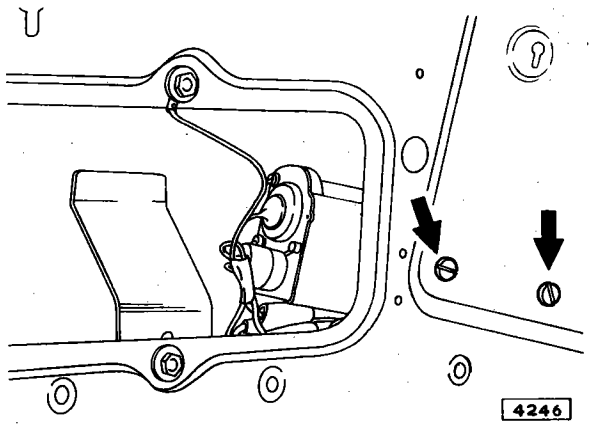


Fig. 119 *Location of the front window motor*

Relay Control Box
Removal
Disconnect the battery.
Remove the left-hand front kick panel.
Remove two securing screws and detach the control box from the mounting bracket.
Disconnect the cables from the terminal blades, note the location of the cables for reference when refitting.

Refitting
Refitting is the reverse of the removal procedure.

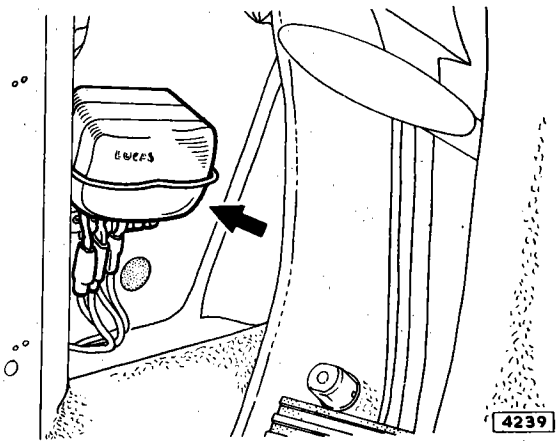


Fig. 120 *Location of the control box (electric windows)*

FAULT LOCATION

In the event of the system not operating satisfactorily it will be necessary - because of the interdependability of the mechanisms associated with each window – to note the symptoms and locate the source of the trouble by a process of elimination with the aid of the wiring diagram.
It is important that the supply voltage for testing must be a minimum of 12 volts.

Complete Failure of System
This will usually indicate that the battery or ignition switch supply is not connected or a fault in the control box components.

Checking
1. Check that the battery current is available at control box terminal C1 by means of a voltmeter.
2. Check that ignition switch current is available at control box terminal W2 with ignition 'ON.'
3. Check control box earth at terminals W1.

If any of the above checks prove negative, locate fault in wiring or connections and rectify as necessary.

4. With the ignition 'ON', check that battery current is available at control box terminal C2.
   If test proves negative, check that the relay contacts are closed, also that the circuit breaker contacts have closed.
   If faulty, fit replacement control box.
   If normal supply voltage is available at terminal C2 check for loose, broken, or earth fault, cable connections between terminal C2 and driver's switch – cable colour Slate (S). Check driver's window switch by substitution. Refer to wiring diagram when checking.

Driver's Window Operates Normally, but None or One of the Remainder Operates
If operation of the driver's control switch causes the driver's window to operate normally, but none or only one of the remainder do so, the cause of the trouble may be due to a sticking switch or an earth fault in the rest of the circuit causing the protective circuit to function. Operation of the driver's window control switch has the effect of isolating the remainder of the system, allowing the driver's window motor to operate individually.
Depending upon the situation of the fault, however, it might be possible to localise it more closely. With the driver's window control switch off, operate the rear window master control switch on the same side. By doing so, the corresponding rear passenger control switch will be isolated, and if the rear window now operates normally a faulty rear passenger switch or feed wire can be suspected. Such a fault will also prevent both windows on the opposite side from operating.
If no operation results, next operate the switch controlling the front window on the opposite side. If this window now operates, an indication is given that the fault is associated with the rear window circuit on that side which has now been isolated by the front control switch. Release the front control switch and operate the rear window master control switch, thereby isolating the rear passenger control switch. If the rear window operates normally, a faulty rear passenger switch or feed wire can be suspected. Such a fault will prevent the front window and the rear window on the opposite side from operating.

Failure of One Window Only
Check if the voltage appears at the switch terminal connection to the motor when the switch is operated. If not, make a point-to-point check with the voltmeter along circuit to non-operative mechanism, paying particular attention to snap connectors. If voltage is present at switch

terminal, check wiring from switch to motor and motor to earth. Provided that the window mechanism is free to operate, an open circuit in the motor itself is indicated in these circumstances and a replacement unit should be fitted.
If voltage is present at the switch input terminal but not at the appropriate switch output terminal when the switch is operated, check switch by substitution.
If voltage is present at the motor switch terminal when the ignition is first switched on, but falls to zero after a few seconds, and the window does not move, this indicates that stall current is being drawn by the motor causing the cir uit breaker to open. Check window mechanism for freenes in operation.

Failure Due to Sticking Windows
Failure of window operation may be due to sticking windows causing the circuit breaker to operate and opening the contacts of relay.
Check that the windows are not sticking and that the window lift mechanism is not damaged and working freely. Rectify or replace as necessary.

ELECTRICALLY HEATED BACKLIGHT

DESCRIPTION
An electrically heated backlight provides demisting or defrosting to the rear view window.

OPERATION
The heating element, consisting of a fine wire mesh, is connected to the main wiring harness.

NOTE: On later cars, element is on inside of glass and care must be taken when wiping or cleaning glass that element is not damaged.

The operation is controlled by a switch mounted in the switch cluster with the ignition 'ON.'
The current consumption is approximately 5 amperes and a 15 ampere fuse, contained in a plastic holder, located in a clip behind the instrument panel is provided as a safety precaution.

FITTING INSTRUCTIONS
Remove the backlight as detailed in Section N, page N.9 (Body and Exhaust System).
Remove the rear seat and squab as detailed in Section N, page N.13 and detach the rear parcel tray trim board.
Drill two holes 1/4in. (6.4mm) diameter in the parcel tray 17 1/2in. (44.45cm) from either side of the centre line of the tray and 1/4in. (6.4mm) from the rear edge, drill also through the drip tray beneath the parcel tray.
Remove the drip tray, secured by four nuts and lockwashers to the underside of the parcel tray and accessible from inside the luggage compartment.
Enlarge the two holes previously drilled to 3/8in. (9.5mm) diameter and refit the drip tray. Renew the rubber seal if worn or damaged when refitting.
Fit the two grommets supplied to the holes in the parcel tray.
Fit the heated backlight as detailed in Section N, page N.10.
Free the two cables attached to the backlight through the grommets and connect to the Black and Black/white cables incorporated in the main harness in the luggage compartment beneath the parcel tray.
Clip the cables securely with the main harness.
Refit the parcel tray trim board, squab and seat cushion.
Disconnect the battery.
Remove the two thumb screws and lower the instrument panel.
Disconnect the cables from the map and interior light switches.
Remove both switches by pressing in the nylon tongues and withdrawing the switches through the panel front face.
Fit the three position Map/interior light switch to the original interior light switch position.
Fit the two position switch supplied to the original map light switch location.

Note: The switches are not indexed to prevent incorrect fitting. Check with a test lamp and battery to determine the 'OFF' position before inserting in the panel. To fit both switches press in from the front of the panel until locked by the nylon tongues.
Fit the spring clip supplied to the back face of the instrument panel with the small drive screw. The hole for the screw is pre-drilled in the panel above the fuel change-over switch.
Remove four cross-headed drive screws from the back face of the panel and withdraw the switch cluster, it is not necessary to disconnect the cables from the remaining switches.
Detach four spring clips and remove the switch indicator strip. Replace with the new strip supplied.
Check that the fuse holder contains a 15 ampere fuse and insert in the clip.
Route the fuse connector harness underneath the panel switch leads and connect to the panel harness cables and switches as follows:—

1. Fuse connector cable (White/black) to the switch lower right hand terminal.
2. Fuse connector cable (White) to the panel harness cable (White with black ident).
3. Panel harness cable (White/black) to the switch lower left-hand terminal.

Reconnect the map/interior light switch cables as follows:—

1. Purple/white and black cables to the switch right-hand terminals.
2. Purple/green cables to the switch left-hand terminals.
   Reconnect the battery and test through.
   Close the instrument panel and secure with the thumb screws.

FAULT DIAGNOSIS
Check that the fuse has not blown. Replace if necessary with one of the correct value.
Check that the backlight element is intact by disconnecting the cables at the connectors in the luggage compartment and reconnecting the backlight cables to a 12 volt battery with a 0-12 volt moving coil ammeter in series.
If no reading is apparent on the meter check the feed cable connections in the luggage compartment for continuity with a voltmeter. Insert the fuse and switch on the ignition before checking.

RADIO

GENERAL

Smiths 'Radiomobile' radio sets are available in the following models to suit the broadcasting requirements of different countries. Rear extension speakers are also available if required.

980T – Long and medium wave band.
982T – Medium wave band.
930T – Medium and short wave band.

This instruction covers both left-hand and right-hand drive cars.

WARNING

Before connection to the battery supply is made, ensure the polarity of the radio is made for NEGATIVE GROUND. DAMAGE TO TRANSISTORS IS INEVITABLE IF POLARITY IS INCORRECT.

The radio is mounted in the prepared position in the console situated centrally below the glove tray.

The speaker is mounted in the prepared position in the console situated centrally on the top facia roll.

A second speaker may be fitted beneath the rear parcel tray on the right-hand side. (Additional kit LK/55 required).

The aerial is fitted on the drive side front wing (ONLY AW 97 can be fitted due to steep wing angle condition).

AERIAL MOUNTING (AW 97)

1. Disconnect battery
2. Remove parcel tray on drive side secured by two P.K. screws into side scuttle trim and by knurled headed nut on stud in side of console unit.
3. Ease draught excluder away from door opening on drive side to expose edge of side scuttle trim pad adhered to body of car.
4. With extreme care, break adhesive bond securing pad to body of car.
   Remove the two P.K. screws securing pad to body of car and ease trim away to expose grommetted hole in side of metal scuttle panel through which the aerial lead-in is to be routed.
5. Mark and drill 1in. dia. hole in drive side front wing to dimensions shown in Fig. 121.
6. Pass aerial lead-in through drilled hole in wing and using fish wire, route lead-in via hole provided in side of metal scuttle panel.
7. Fit aerial to drive side front wing in accordance with Aerial General Fitting Instructions.
8. Route aerial lead-in to radio location and grommet hole in side of metal scuttle panel through which it passes using grommet provided.
9. Replace side scuttle trim pad, draught excluder and parcel tray.

FRONT LOUDSPEAKER MOUNTING

1. With exteme care, remove speaker grille, secured by four studs, situated centrally in top of facia roll.
2. Secure the two clip nuts (provided in loudspeaker fixings in kit) to speaker fixing holes in trimmed metal surrounding the aperture in which the speaker is located.

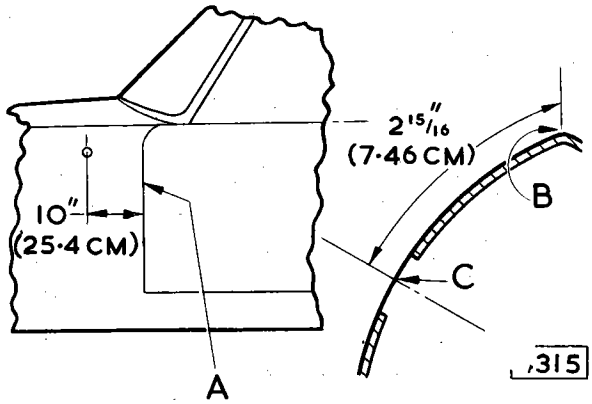


Fig. 121 *Drilling instructions for radio aerial*
'A' Door shut face
'B' Crown of wing
'C' Centre line of aerial hole

3. Connect speaker lead to speaker.
4. Pass speaker lead through aperture and route to radio location. Locate speaker from the top, in aperture and secure to metal panel by lipping the forward edge of the speaker under the clip provided on the front edge of the speaker aperture and affixing the rear edge of the speaker by two P.K. screws (provided in loudspeaker fixings in kit) into the two clip nuts.
5. Replace speaker grille.

RADIO UNIT MOUNTING

1. Pull off the three small control knobs from the air control quadrants.
   Pull off large control knob from heater control.
2. With extreme care pull off the three air control quadrant escutcheons from finisher panel.

Note:
To facilitate the removal of these escutcheons without damaging the finisher panel, it will be found advisable to exert the required pressure on the inside face of the escutcheon accessible via the slot through which the quadrant passes. A small screwdriver with the end bent at right angles will be found suitable for this purpose.

3. Remove finisher panel complete with radio aperture blanking panel to expose front face of bracket in which the radio is mounted.
4. Remove radio blanking panel secured to finisher by two 10 UNF nuts and discard.
5. Remove four P.K. screws accessible on front face of radio mounting bracket which secures the bracket to the console. Withdraw bracket from console ensuring flexible pipes to the air controls do not become disconnected.
6. Remove knobs, nuts, trim pieces and escutcheon from radio. Discard trim pieces and escutcheon.
7. Affix radio to mounting bracket (using fixings provided in radio fixings in kit), utilising front side or front and rear side fixings depending which radio is being fitted.

8. Attach one end of long insulated bond provided to underside rear fixing on radio. Secure other end under nut which retains console to bracket attached to gear box tunnel i.e. earth radio to body of car.
9. Connect speaker, aerial and battery jumper leads to radio with battery lead choke (supplied with suppression parts) connected between battery lead from radio and battery jumper lead.
10. Connect battery jumper lead to fuse lead and connect fuse lead into two way snap connector (terminating white/pink) supply lead located above fuses behind centre instrument panel.
11. Replace radio assembly into console and secure with P.K. screws previously removed. Ensure pipes connected to controls do not become disconnected or trapped.

Note:

On early production cars it may be found necessary to relieve the centre bottom edge of the radio mounting bracket to allow it to pass over the gear lever escutcheon on cars fitted with automatic gearboxes.

12. Re-connect battery, ensuring there are no electrical short circuits.
13. Switch on radio and tune to a weak signal on approximately 250 metres (1.2 MHz) and adjust aerial trimmer for maximum volume. Access to trimmer is via hole alongside tuning spindle.
14. Replace front finisher panel, quadrant escutcheons and control knobs.
15. Replace nuts and knobs on radio.

Note:

It is not necessary to replace the trim pieces and escutcheon discarded from the radio as it is intended that the finisher panel in the console should form the escutcheon for the radio.

Caution

When installing a Philips Stereo radio into a car fitted with power operated windows, it is necessary to make the following modifications to the motor/regulator units in both front doors.

The regulator motors normally hang downwards and to avoid fouling between the speakers and the motors it is necessary to remove the regulator from the right hand regulator and fit it to the left hand regulator and vice versa.

Care must be taken when removing the motors from the regulator mechanism that the tension is taken from the spring by operating the motor whilst removing the mounting screws.

SUPPRESSION

It is important to scrape to bare metal all points at which an earth connection is made.

1. Connect a 1 mfd. suppressor capacitor to the +ve terminal on the coil.
   Secure capacitor mounting clip under coil mounting bolt.
2. Connect a 1 mfd. suppressor capacitor to the output terminal of the alternator. Secure capacitor mounting clip under alternator fixing bolt.
3. Connect a 1 mfd. suppressor capacitor to each petrol pump feed. Secure capacitor mounting clips under pump fixings. (Pumps located behind boxed floor trim at rear in spare wheel compartment).
4. Connect a .25 mfd. suppressor capacitor to oil pressure transmitter. Secure capacitor mounting clip under sump bolt which retains breather pipe bracket. Ensure bolt is fully re-tightened.
5. Connect a 1 mfd. suppressor, with short flexible leads, to small 'LUCAR' type blade at rear of battery condition indicator on printed circuit behind centre instrument panel. Connect other end of suppressor capacitor to a 'LUCAR' type connector terminating on earthing blade on metal panel in which the centre instrument cluster is mounted.
6. Secure short insulated bonding strip provided under bolt on coil mounting bracket and under bolt on steering reservoir mounting bracket.
7. Secure other insulated bond provided under the P.K. screw which retains the label on the alternator back plate. Secure other end under P.K. screw which secures brake pipe clip to body of car located beneath windscreen washer bottle.

LOUDSPEAKER MOUNTING REAR (Additional kit LK/55 required)

1. From inside luggage boot, remove felt pad and blanking panel on right-hand side of metal parcel shelf to expose aperture to which the rear speaker assembly is mounted.
2. Remove semi-pierced aperture in right-hand side of rear trimmed parcel shelf and fit speaker bezel and grille with masking cloth interposed between underside of grille and top of shelf using 4BA nuts and washers (provided in loudspeaker fixings in kit).
3. Assemble speaker to speaker mounting board (using fixings provided in loudspeaker fixings in kit) and connect short speaker lead to speaker.
4. Affix clip nuts (provided together with fixing screws in loudspeaker fixings in kit) to fixing holes in metal parcel tray in area of speaker aperture.
5. Secure speaker assembly to underside of metal parcel shelf using fixing screws provided.
6. Locate clear plastic covered twin lead in loom in boot, bare ends, and connect to speaker lead from speaker assembly (using two way terminal block provided in speaker fixings in kit).
7. Locate clear plastic covered twin lead in loom near fuses behind centre instrument panel. Bare ends and together with speaker lead from front speaker and output leads from radio, connect to balance control as shown on label attached to control.
8. Mount balance control in console in the circular indicated position opposite the cigar lighter. If a cigar lighter is not fitted then mount the control convenient for operation by the driver.

SUPPLEMENTARY INFORMATION

SEAT BELT WARNING SYSTEM – U.S.A./CANADA ONLY

Commencing chassis number at 1L.64775 a seat belt warning system was introduced to comply with U.S.A. federal safety regulations. The system is associated with the ignition key alarm buzzer and gives audio and visual indication when seat belts are not fastened. Warning signals comprise a buzzer alarm and an illuminated warning sign to 'FASTEN BELTS'. The warning sign is located immediately below the warning light cluster on the facia. The alarms are initiated if a drive selection is made on auto or manual selector levers with belts unfastened.

Occupied front seats must have seat belts fastened to cancel warnings. The passenger seat section of the system is inhibited if the seat is not occupied.

1. Battery feed line fuse.
2. Buzzer door switch.
   A – Door closed.
   B – Door open.
3. Buzzer.
4. Ignition key switch.
   A – Key out.
   B – Key in.
5. Blocking Diode.
6. Seat belt warning light.
7. Passenger seat switch.
   A – Seat empty.
   B – Seat occupied.
8. Passenger belt switch.
   A – Belt fastened.
   B – Belt loose.
9. Driver's belt switch.
   A – Belt fastened.
   B – Belt loose.
10. Gear switch.
    A – Neutral selected.
    B – Forward or Reverse selected.
11. Seat Belt circuit line fuse. (Ignition controlled).

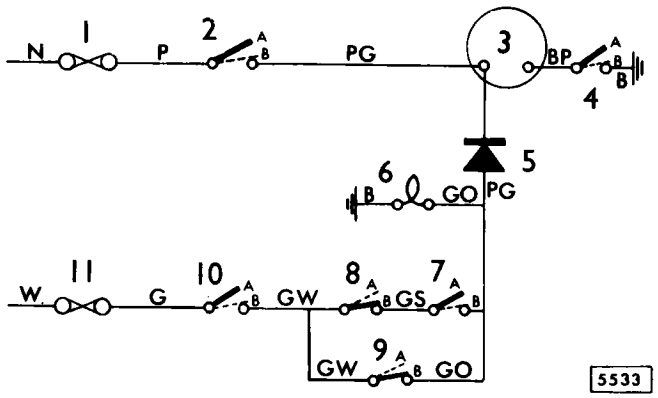


Fig. 121a *Circuit Diagram for Seat Belt Warning*

BATTERY – Later Cars
Type – Lucas Pacemaker CP11/8
Voltage – 12
Capacity at 20 hour rate – 66
No. of plates – 11.

Topping up procedure
Under extreme cold conditions, the battery should be topped up immediately prior to driving the vehicle so that electrolyte mixing can occur to prevent freezing of the added water.
This battery is fitted with an air lock device. When topping up, the vehicle should be on a reasonably level surface.
Remove the vent cover.
If the acid level is below the bottom of the tubes, pour distilled water into the trough until all tubes are filled. Replace the vent cover. The electrolyte level is now correct.

Important: The vent cover must be kept in position at all times except when topping up. Never examine battery or electrolyte with a naked light.

DISTRIBUTORS

Distributors now fitted to 2.8 litre and 4.2 litre cars have various centrifugal advance curves and vacuum advance/retard arrangements, depending upon type and year of engine. It is essential, therefore, that the engine number is quoted when ordering replacements.

BALLAST RESISTOR IGNITION SYSTEM

Later 2.8 litre and 4.2 litre cars are fitted with a ballast resistor ignition system replacing the basic (non-ballast) system previously fitted.

Description

The purpose of a ballast ignition system is to provide maximum efficiency at high engine speed and to facilitate engine starting in very cold conditions.

The ballast resistor and coil primary winding are of similar resistance values and because the resistor and coil are separate units connected in series they share the system voltage.

Because the resistor, which has no inductive resistance, is connected in series with the coil primary winding, a coil with an operating voltage lower than the system voltage can be used and this reduces the inductive resistance in the coil primary winding circuit, resulting in a better high-speed performance of the ignition coil than is normally possible with basic ignition systems.

When the starter cranks the engine, it is normal for the system voltage to fall below its rated value, due to the starter motor load conditions. Under these conditions a lower-than-normal voltage is applied to the ignition coil primary winding of basic (non-ballast) ignition systems and this can sometimes adversely affect engine starting in very cold conditions.

In the case of a ballast ignition system, however, the ballast resistor is short circuited during the period of starter motor operation, and the whole of the voltage available is applied direct to the ignition coil primary winding. Providing the battery and starter are satisfactory, the voltage applied direct to the primary winding of the coil during starter motor operation will always be slightly higher than normal operating voltage of the coil and this, for a limited period of time, ensures that the coil performance will be adequate during the engine starting period.

The ballast resistor is short-circuited by the closing of normally open contacts of a double-contact type relay (Model 6RA, LUCAS No. 33231).

This relay is situated on the engine side of the bulkhead, the coil and ballast resistor being mounted on the right-hand side wing valance at the forward end of the engine compartment. The additional pair of contacts in the relay close simultaneously with the ballast resistor contacts to provide a direct battery voltage supply to the solenoid operating windings, so ensuring satisfactory solenoid operation.

One end of the operating winding (terminal marked W1) of the dual-purpose relay is connected to the ignition-and-start position of the starter control switch and the other end of the operating winding is connected to earth (vehicle frame).

When the starter control switch is operated and the relay is automatically energised, battery voltage, permanently connected to the relay terminal marked 'C2' is transferred to the relay terminals marked 'C1' and 'C4', which are connected to one end of the ignition coil primary winding and ballast resistor, and the starter solenoid operating windings respectively. Battery voltage (or system voltage) available at the relay terminal 'C1' short-circuits the ballast resistor and the full available voltage is applied direct to the ignition coil primary winding (see illustration).

TEST DATA

The Model 16c6 ignition coil primary winding resistance is 1.43 – 1.58 ohm, and the Model 3 BR ballast resistor resistance is 1.3 – 1.4 ohm.

Note: Performance testing of the ballast-ignition type coil must always be carried out in conjunction with the ballast resistor (or an equivalent resistance) in circuit.

The special coil fitted with the ballast resistor ignition system is **NOT** interchangeable with a normal 6 or 12 volt coil used in conjunction with the basic ignition system.

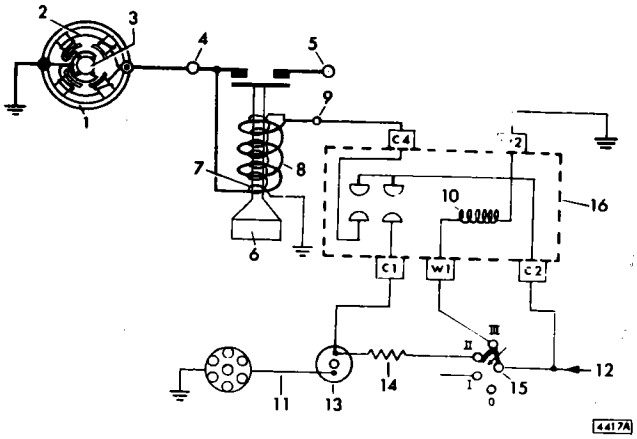


Fig. 122 *Ballast ignition system circuit diagram*

1. Starter Motor
2. Field Windings
3. Armature
4. Solenoid Terminal "STA"
5. Battery Supply Terminal
6. Solenoid Core
7. Solenoid Shunt Winding
8. Solenoid Series Winding
9. Solenoid Terminal
10. Relay Coil
11. L.T. Lead
12. Ignition Supply Lead
13. Coil
14. Ballast Resistor
15. Ignition/Starter Switch
16. Relay

STARTER MOTOR RELAY – CHECKING

The ballast ignition relay is mounted on the engine compartment rear bulkhead beneath the brace/tie rod centre bracket.

If starter motor does not operate when ignition key is turned, initially check as follows:-

Pull cable from C2 and C4 connectors on relay and short together. Starter motor should operate showing relay at fault. If starter does not operate, there is either no supply on C2 cable or the starter motor is at fault.

ALTERNATOR

Information given on Page P.20 relating to BEARINGS is superseded by the following procedure.

BEARINGS

Bearings which are worn to the extent of allowing excessive side-movement of the rotor shaft must be renewed (Service replacement bearings are pre-packed with grease ready for use).

During reconditioning of the alternator, check the bearing lubricant and if necessary re-pack the original bearings with Shell Alvania 'RA' grease, or an equivalent lubricant.

Renewing the Bearings

The drive end ball-bearing is a press fit in the bracket and can be renewed by means of a wheel-operated, or power assisted press. To renew the bearing, it will first be necessary to dismantle the bearing retaining plate which will be secured by screws, a circlip, or rivets. According to the method of fixing, remove the screws, file away the rivet heads, or insert the tip of a small screwdriver in the extractor notch and prise free the circlip from its groove. Assembling a new bearing into the bracket is simply a reversal of the dismantling procedure involved in removing the original bearing.

If the needle roller bearing in the slip ring end bracket needs to be renewed, first inspect the inside of the bracket and determine whether the bearing-housing incorporates a felt seal. If not, it is advisable to renew the bracket complete with bearing so that a bracket of improved design incorporating a felt seal is fitted. If the original bracket incorporates a felt seal, either the bracket complete with bearing can be renewed, or the bearing can be serviced separately. The bearing can be serviced by using a needle roller bearing kit (Lucas Part No. 54219553) comprising bearing, felt seal and associated assembly washers, as illustrated in Fig. 123.

In the case of brackets incorporating a felt seal, renewing the needle roller bearing is facilitated by using a specially designed and recommended jig and tool (Hartridge Cat. No. 99-70), manufactured and supplied by Leslie Hartridge Ltd., Buckingham, Bucks, England. The jig and tool is used in conjunction with a wheel-operated, or power-assisted, press.

With the stator and heat sinks removed from the bracket, and using the recommended jig and tool, procedure for renewing the bearing is as follows:-

1. Place the new felt seal in light oil and leave to soak.
2. Press out the old bearing assembly, using the smaller diameter of the punch supplied with the jig.
3. Locate the bracket on the jig and fit the new bearing on the spring loaded insert.
4. Using the larger diameter of the punch, press the bearing into the housing. Ensure that the bearing is inserted to the full depth allowed by the jig, but avoid excessive pressure.
5. Invert the bracket and place on the jig, using the two small lugs for locating.
6. Remove the felt seal from the oil.
7. Place felt seal and washers on bracket.
8. Press the retaining washer into the housing, using the smaller diameter of the punch.

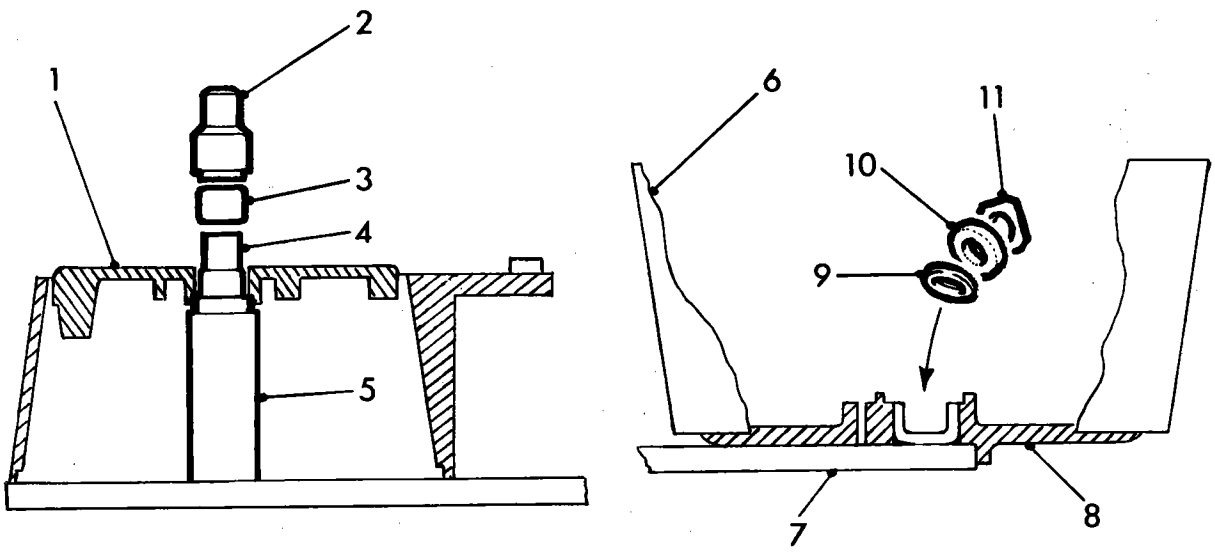


Fig. 123 *Bearing renewal* 5451

1. Slip ring end Bracket
2. Punch
3. Needle Roller Bearing
4. Spring loaded insert
5. Post
6. Slip ring end bracket
7. Jig base plate
8. Locating lugs
9. Steel washer
10. Felt seal
11. Retaining washer

ALTERNATORS (Later Cars)

Later cars equipped with air conditioning are fitted with a LUCAS 20 ACR alternator in place of the BUTEC alternator previously used. The LUCAS 20 ACR alternator differs from previous models in that the voltage regulation facility is built into the machine and not supplied as a separate unit.

GENERAL DESCRIPTION

The Lucas type 20 ACR alternator is a high output three phase machine which produces current at idling speed.

The heatsink – rectifier, terminal block assembly can be removed complete after removing five screws. There are six silicon diodes connected to form a full wave rectifier bridge circuit, and three silicon diodes which supply current to the rotor winding. Individual diodes cannot be removed from the heatsink assemblies.

Regulation is by a Lucas type 11 TR control unit mounted in the slip ring end bracket. There is no provision for adjustment in service.

Individual snap connectors are used to connect external wiring to the alternator. The alternator's main negative terminals are connected internally to the body of the machine. Provision is made for the connection of external negative wiring if required.

It should be noted that 20 ACR alternator, because of regulator electronics configuration, permits a permanent drain on the battery. This drain is of extremely small proportions, 10 milliamps maximum. No harmful effects will result from this drain unless the vehicle is stored for periods exceeding one month, in which case the battery leads should be disconnected.

Caution: No part of the charging circuit should be connected or disconnected while the engine is running.

When using electric-arc welding equipment in the vicinity of the engine take the following precautions to avoid damage to the semi-conductor devices used in the alternator and control box, and also the ignition system.
Disconnect battery earth lead.
Disconnect alternator output cables.
Disconnect ignition and amplifier unit.

ALTERNATOR

Removing

1. Disconnect battery.
2. Drain coolant as detailed in radiator removal Page C.5 and remove expansion tank.
3. Slacken air conditioning compressor mounting bolts.
4. Slacken compressor drive belt adjuster trunnion retaining nut.
5. Slacken compressor drive belt adjustment and locknuts.
6. Adjust compressor as near to engine block as practicable without kinking air conditioning hoses.
7. Withdraw adjusting arm securing bolt from alternator end frame.
8. Disconnect alternator cables from lucar connections.
9. Withdraw alternator mounting bolts.
10. Ease alternator past compressor and clear of engine compartment, taking great care not to damage or disturb air conditioning pipes.

Refitting

11. Reverse operations 7 – 10.
12. Tighten adjusting nut to obtain an alternator belt tension as follows:-

    A load of 1.0 kg (2.2 lb) applied at midpoint of lower portion of belt will give a deflection of 4.0 mm (.15 ins).

13. Tighten adjuster locknut and alternator securing bolts.
14. Reverse operations 1 – 6.

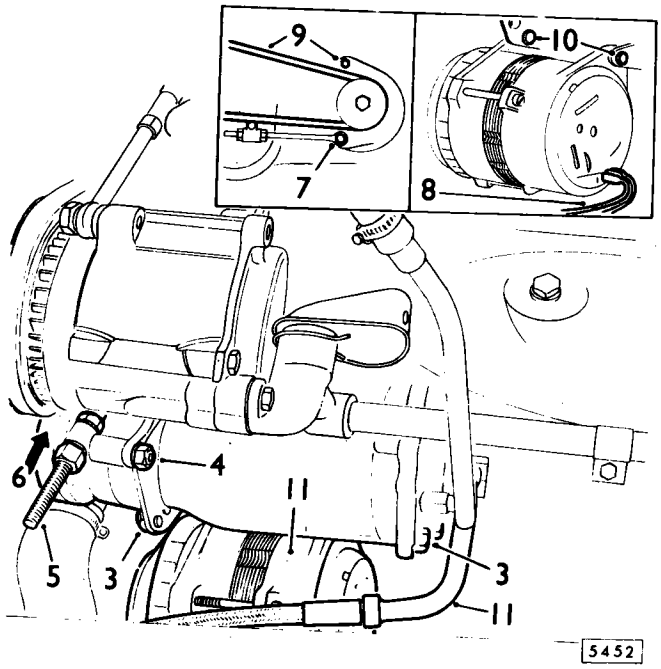


Fig. 124 *Alternator removing and refitting*

Output Test (In Situ)
Equipment required:-
A moving coil ammeter or multi-range test meter on range 0—75 amperes.
This test should be carried out with the alternator at normal temperature. Run cold engine at 3000 rev/min for 3-4 minutes.

1. Disconnect battery earth lead.
2. Connect ammeter in series with alternator main output cable and starter solenoid.
3. Remove connectors from alternator. Remove moulded end cover and re-make connectors.
4. Connect jump lead to short out the 'F' and '—' terminals of the control unit.
5. Re-connect battery earth lead.
6. Switch on all vehicle lighting, headlights on main beam. Switch on ignition and check warning light is on.
7. Start engine, slowly increase speed to 3000 rev/min. Ammeter reading should equal maximum rated output of 66 amperes.

Voltage Drop Test (In Situ)
Equipment required:-
A moving coil voltmeter or multi-range test meter on 0—30 volt range.
To check for high resistance in the charging circuit.

1. Connect voltmeter between battery end terminal and alternator main output terminal.

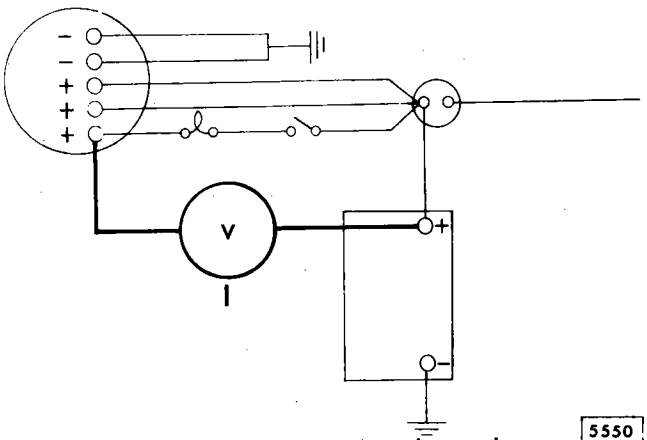


Fig. 126 *Circuit for voltage drop testing*

Control Unit Test
Equipment required:-
A moving coil ammeter and moving coil voltmeter or multi-range test meters.
Circuit wiring must be in good condition, and all connections clean and secure. The battery must be in a well charged condition or be temporarily replaced by a charged unit.

1. Connect ammeter in series with starter solenoid and alternator main output cable.
2. Connect voltmeter between battery terminals.
3. Start engine and run at 3000 rev/min until the ammeter reads less than 10 amperes. Voltmeter reading should be between 13.6 volts and 14.4 volts.
4. An unstable reading or a reading outside the specified limits indicates a faulty control unit.

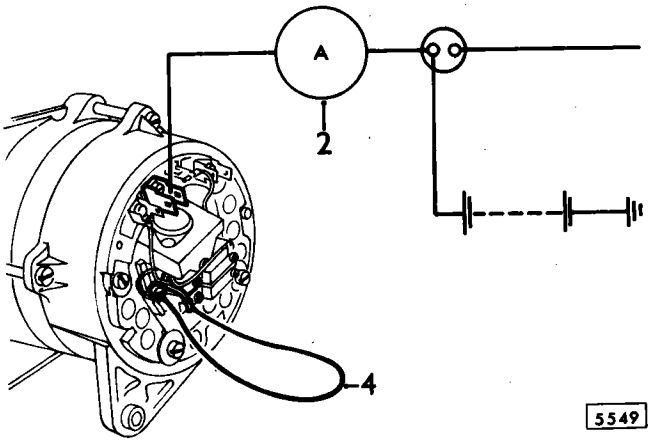


Fig. 125 *Alternator output test*

2. Switch on all vehicle lighting, headlights on main beam. Start engine and run at 3000 rev/min.
   Note voltmeter reading. Stop engine.
3. Transfer voltmeter connections to battery earth and alternator negative terminals.
4. Repeat operation 2. Note voltmeter reading.
5. Voltage should not exceed 0.5 volts for positive side. Higher readings indicate high resistance in the circuit.

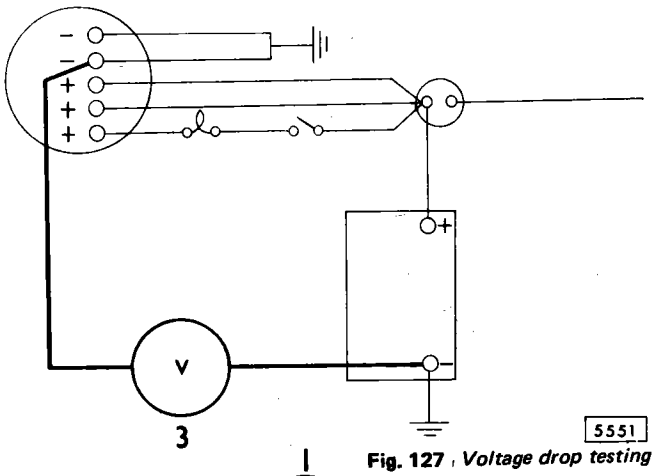


Fig. 127 *Voltage drop testing*

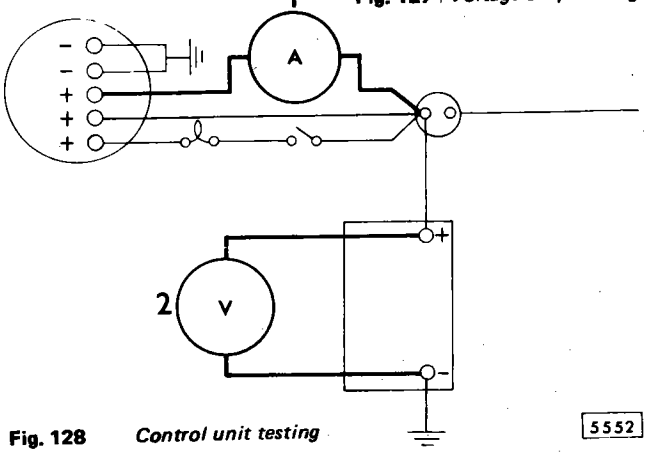


Fig. 128 *Control unit testing*

DISMANTLING AND REASSEMBLING

Dismantling

1. Remove pulley retaining nut and washer.
2. Withdraw pulley from shaft.
3. Remove fan, spacer and shaft key.
4. Remove moulded cover plate.
5. Remove brush moulding fixing screws, which also secure the radio suppression capacitor and black earth cable. (Retain insulation piece for replacement on reassembly).
6. Disconnect red leads from 'IND' and '+' terminals.
7. Withdraw brush moulding complete with control box.
8. Disconnect the three stator windings from their respective heatsinks.
9. Remove the four screws securing the heatsink/terminal block assembly and the small screw connecting the earth strap to the alternator frame.
10. Withdraw the three through bolts from the alternator frame.
11. Separate the slip ring end bracket and stator assembly from the rotor and drive end bracket by inserting a lever and prising them apart. Care must be taken to prevent damage to the stator and drive end casing.

Reassembling

12. Reverse operations 1 to 11.

Note: If the rotor and drive end bracket have been separated support the inner ring of the drive end bearing with the distance collar for reassembly. Do not use the drive end as a support for the bearing while fitting the rotor.
Tighten through bolts evenly.
Ensure that brushes are housed correctly before re-fitting the brush moulding.

13. Remove brush gear moulding.
14. Disconnect control unit cables from brush retaining plates and '+' output terminals.
15. Withdraw single screw from unit retaining flange. Retain keyed insulation spacer.
16. Reverse operations 13 to 15.

Note: The aluminium casing of the control unit must not make direct contact with the alternator body, this would cause the field circuit to be fully switched on, and the alternator to supply maximum output regardless of battery condition.

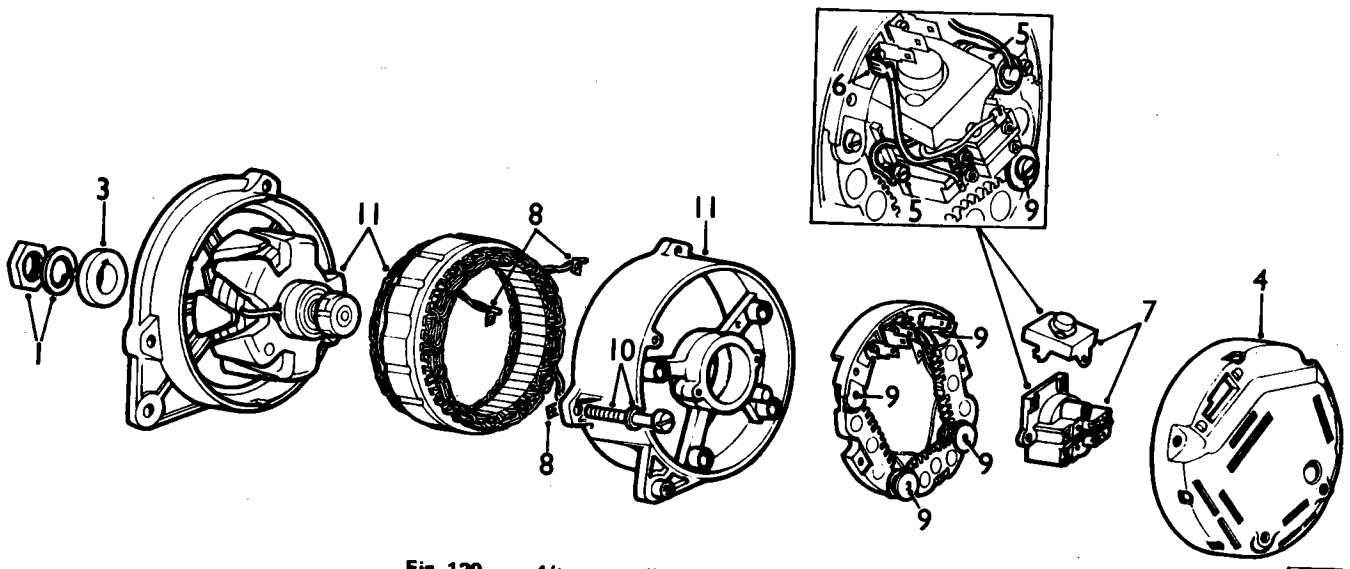


Fig. 129 *Alternator dismantling and reassembling* 5553

Brush Gear and Slip Ring Inspection

The serviceability of the brushes is gauged by the length protruding beyond the brush moulding in the free position. This amount should exceed 5mm (0.02"). If renewal is necessary care must be taken to replace the leaf spring at the side of the inner brush.
The surface of the slip rings should be smooth and free from grease or dirt. Servicing is confined to cleaning with a petrol moistened cloth or finest grade glass-paper.

Note: Emery cloth or similar abrasive must not be used. The slip rings cannot be machined.

Brush Replacement

1. Remove the small screws securing the brush retaining plates and regulator cables.
2. Replace brushes with new units and refit brush retaining plates and regulator cables.
3. Brush spring pressure should be checked with a push type spring tension gauge. This should indicate 235-368 grammes (9-13 cms) when brush face is flush with the moulding.

Rotor Testing
Equipment required:-
An ohmeter, or a 12 volt battery and ammeter. A 110 volt A.C. supply and a 15 watt test lamp.

1. Connect the ohmeter between the slip rings. Resistance should be 3.6 ohms at 20°C.
2. Alternatively connect ammeter and battery between slip rings, the ammeter should react approximately 3 amperes.
3. To test for defective insulation between slip rings and rotor poles connect the 110 volt supply and 15 watt test lamp between slip rings and rotor poles in turn. If the lamp lights, the coil is earthed to the rotor core. A replacement rotor, slip ring assembly should be fitted.

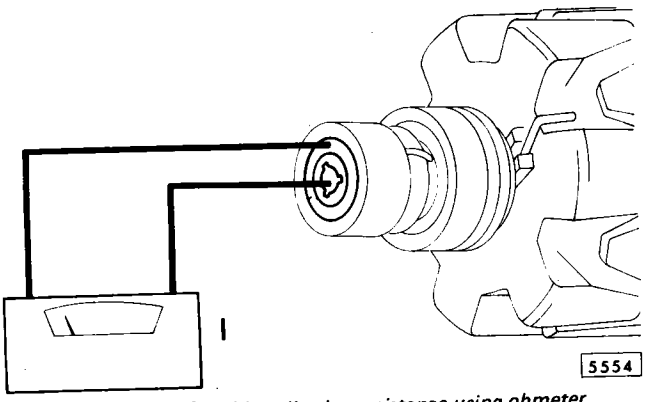


Fig. 130 *Checking slip ring resistance using ohmeter*

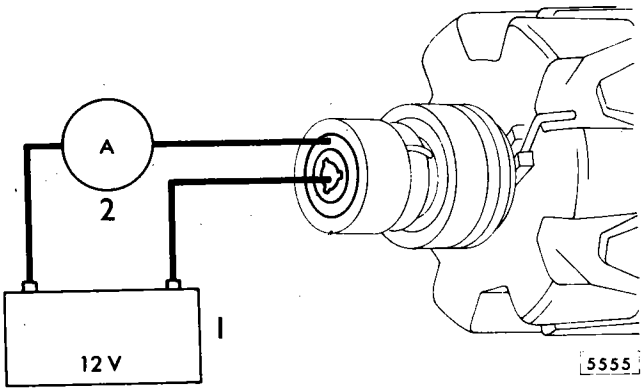


Fig. 31 *Checking slip ring resistance using ammeter and battery*

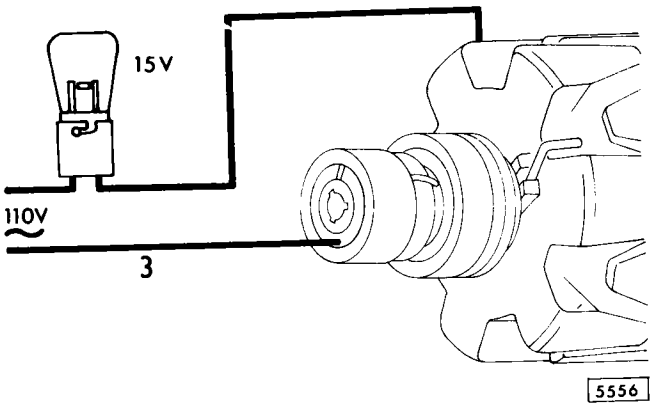


Fig. 132 *Checking slip ring and rotor insulation*

Stator Testing
Equipment required:-
A 12 volt battery and 36 watt test lamp. A 110 volt A.C. supply and 15 watt test lamp.

1. Check continuity by connecting any two of three stator cables in series with the 12 volt battery and 36 watt test lamp. Lamp should light.
2. Repeat test after replacing one of the cables under test with the remaining stator cable. Failure of the lamp to light on either test indicates an open circuit. A replacement stator is required.
3. Test stator insulation with 110 volt test lamp. Connect test leads to laminated yoke and any one of the three stator cables. If the lamp lights, the stator coils are earthed. A replacement stator must be fitted.

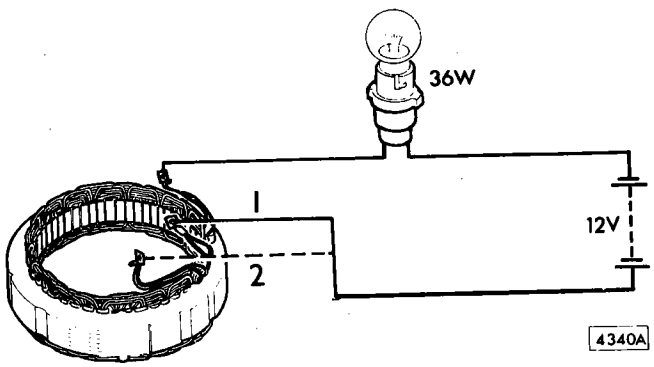


Fig. 133 *Stator continuity check*

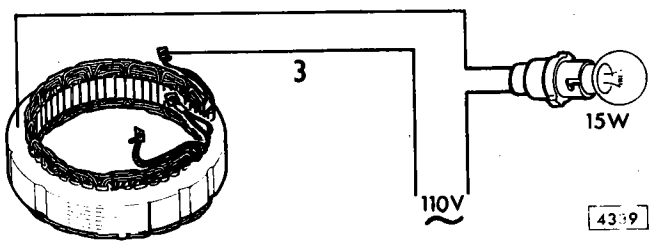


Fig. 134 *Stator insulation test*

Diodes Testing
Equipment required:-
A 12 volt battery and a 1.5 volt test lamp.

1. Connect one battery terminal to the heatsink under test.
2. Connect the other battery terminal in series with the test lamp and each diode pin in turn.
3. Reverse connections to heatsinks and diode pins. The lamp should light in one direction only. Should the lamp light in both tests, or not light at all the diode is defective and a new rectifier heatsink assembly must be fitted.
4. To prevent damage to diode assemblies during soldering operations it is important that a thermal shunt is used.

Note: Only 'M' grade 45-55 tin lead solder should be used.

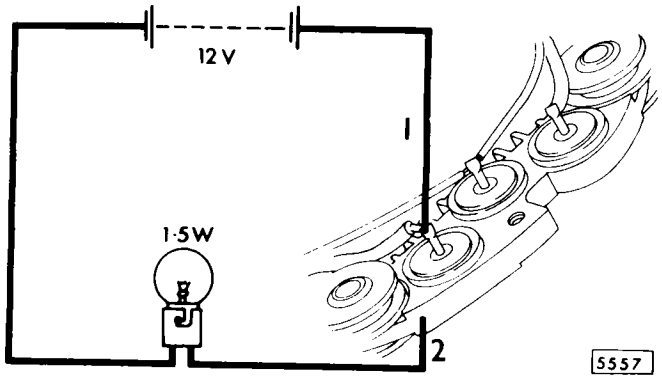


Fig. 135 *Method of diode testing*

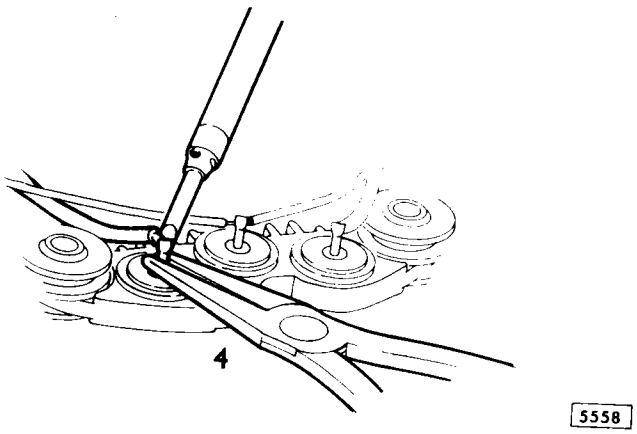


Fig. 136 *Suitable method of using a thermal shunt*

Lamp Bulb Application Chart (Later Cars)

LAMP	LUCAS BULB No.	VOLTS	WATTS	APPLICATION
Outer Headlight (main and dip beams)	Sealed Beam Unit	12 12 12 12	60/45 50/37.5 37.5/50 60/50	Home, R.H.D. Export Japan U.S.A. All other countries
	411	12	45/50 (Yellow)	France
Inner Headlight (Main beams only)	Sealed Beam Unit	12 12 12	50 37.5 37.5 (Yellow)	Home and all other countries U.S.A. France
Side/Front Flasher Side light Front and Rear Flashing Indicators Rear/Brake Number Plate Reversing lights Interior lights Map light Luggage compartment illumination	380 989 382 380 989 273 272 989 989	12 12 12 12 12 12 12 12 12	6/21W 6W 21W 6/21W 6W 21W 10W 6W 6W	Italy – Greece
Instrument illumination Headlight Warning Safety Belt Warning	987	12	2.2W	
Ignition Warning Handbrake/Brake Fluid Warning Flasher Warning Oil Pressure Warning Heater control panel illumination	280	12	1.5W	
Switch indicator strip	281	12	2W	
Auto Transmission Indicator	281	12	2W	