SECTION M

ELECTRICAL SYSTEM

Section No. M.1	General description
Section No. M.2	Battery
Section No. M.3	Preparing 'dry charged' batteries for service
Section No. M.4	Preparing new unfilled, uncharged batteries for service
Section No. M.5	Generator
Section No. M.6	Maintenance
Section No. M.7	Testing in position to locate fault in charging circuit
Section No. M.8	Generator assembly
Section No. M.9	Inspection and overhaul
Section No. M.10	Assembling and replacing
Section No. M.11	The starter
Section No. M.12	Servicing the starter
Section No. M.13	Control box
Section No. M.14	Fuse unit
Section No. M.15	Flasher unit
Section No. M.16	Windscreen wipers
Section No. M.17	Ignition switch
Section No. M.18	Direction indicator warning lamp
Section No. M.19	Panel light bulbs
Section No. M.20	Headlamp main beam warning light bulb
Section No. M.21	Ignition warning light bulb
Section No. M.22	Fuel gauge
Section No. M.23	Panel lamps switch
Section No. M.24	Windscreen wiper switch
Section No. M.25	Starter switch
Section No. M.26	Horn-push
Section No. M.27	Horn
Section No. M.28	Headlamp dipping switch
Section No. M.29	Headlamp bulbs
Section No. M.30	Modified European light unit
Section No. M.31	Sealed beam light units
Section No. M.32	Headlamp beam setting
Section No. M.33	Replacing a light unit
Section No. M.34	Combined side and flasher lights bulb
Section No. M.35	Rear flasher light bulb
Section No. M.36	Combined stop and tail light bulb
Section No. M.37	Rear number plate light bulb
Section No. M.38	Fault diagnosis

Section M.1

GENERAL DESCRIPTION

The 12-volt electrical equipment incorporates compensated voltage control for the charging circuit. The positive earth system of wiring is employed.

Battery details may be found in **'General Data'.**

The generator is mounted on the right of the cylinder block and driven by an endless belt from the crankshaft pulley. A rotatable mounting enables the bolt tension to be adjusted.

The voltage control unit adjustment is sealed and should not normally require attention. The fuses are carried in external holders mounted in an accessible position on the right-hand side of the engine compartment together with spare fuses.

The starter motor is mounted on the flywheel housing on the right-hand side of the engine unit and operates on the flywheel through the usual sliding pinion device.

The headlamps employ the double-filament dipping system. Both lamps are fitted with double-filament bulbs, both dipping according to the regulations existing in the countries concerned.

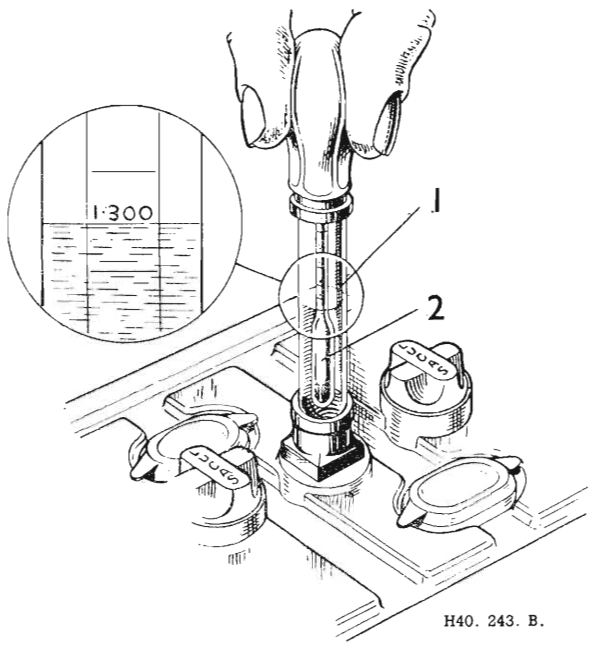


Fig. M.1. Using a hydrometer to test the specific gravity of the battery acid.
1. *Reading.* 2. *Float.*

Section M.2

BATTERY

Description

The battery is a 12-volt lead-acid type, having six cells, each cell consisting of a group of positive and negative plates immersed is a solution of sulphuric acid (electrolyte).

The battery has three functions:

(1) To supply current for starting, ignition and lighting.

(2) To provide a constant supply of current to the electrical equipment under normal operating conditions and when the consumption of the electrical equipment exceeds the output of the generator.

(3) To control the voltage of the electrical supply system.

Adjustments in the Vehicle

The purpose of the following operations is to maintain the performance of the battery at its maximum.

(1) The battery and its surrounding parts should be kept dry and clean, particularly the tops of the cells as any dampness could cause a leakage between the securing strap and the battery negative terminal, resulting in a partially discharged battery. Clean off any corrosion from the battery bolts, strap and tray with diluted ammonia, afterwards painting the affected parts with anti-sulphuric paint.

(2) Remove the vent plugs and check they are not perished or cracked, otherwise leakage of electrolyte will occur. Clean out the vent holes if necessary with a piece of wire.

(3) The electrolyte levels should be maintained just above the tops of the separators by adding distilled water. Never add acid.

(4) Check the terminal posts. If they are corroded remove the cables and clean with diluted ammonia. Smear the posts with petroleum jelly before remaking the connections and ensure that the cable terminal clamp screws are secure.

(5) Test the condition of the battery cells by using a hydrometer (see Fig. M.1.).

The specific gravity readings and their indications are as follows:

Climates below 90° *F.* (32° *C.*)	
1·270 to 1·290	Cell fully charged.
1·190 to 1·210	Cell about half discharged.
1·110 to 1·130	Cell fully discharged.
Climates frequently above 90° *F.* (32° *C.*)	
1·210 to 1·230	Cell fully charged.
1·130 to 1·150	Cell about half discharged.
1·050 to 1·070	Cell fully discharged.

These figures are given assuming an electrolyte temperature of 60° F. (16° C.). If the temperature of the electrolyte exceeds this, ·002 must be added to hydro-

meter readings for each 5° F. rise to give the true specific gravity. Similarly ·002 must be subtracted from hydrometer readings for every 5° F. below 60° F.

To Remove

(1) Raise the bonnet to gain access to the battery.
(2) Disconnect both cables from the battery.
(3) Release the battery clamp and lift out the battery.

To View

(1) Place the battery on a lead-covered bench or on a wooden bench treated with anti-sulphuric paint.
(2) Check the electrolyte levels.
(3) Inspect the container for cracks which may be indicated by external corrosion or extreme variation in the electrolyte levels. A cracked container must be renewed.
(4) Test the condition of the battery cells by using a hydrometer (see Fig. M.1).
All readings should be uniform. The hydrometer values given indicate the state of charge of the battery.
(5) If the electolyte level is below the tops of the separators, it will not be possible to withdraw a sufficient amount to raise the hydrometer float. In such circumstances a high-rate discharge tester should be used
Note: The use of a discharge tester is not recommended for normal testing, but only where a hydrometer reading cannot be obtained due to an excessively low electrolyte level.

Charging from an External Source

The length of time for a used battery to remain on charge before it can be accepted as fully charged depends entirely on the specific gravity before charging commences and the charging rate. The charging should continue until all cells are gassing freely and evenly and the specific gravity in each of the six cells has reached a maximum, i.e. has shown no further rise in four hours. The specific gravity at the end of charging should be within the limits given and should not vary more than ·005 from these values.

Do not allow the temperature of the electrolyte to exceed the maximum permissible temperature, i.e. 100°F (38°C) in climates ordinarily below 90°F (32°C), 120°F (49°C) in climates frequently above 90°F (32°C). If this temperature is reached the charge should be suspended to allow the temperature to fall at least 10° otherwise the life of the battery will tend to be shortened.

To Install

The installation of the battery is a reversal of the procedure 'To remove'. Smear the terminal posts and cable connections with petroleum jelly and tighten the terminal screws sufficiently to prevent the cables from moving on the terminal posts when tested by hand.

Section M.3

PREPARING 'DRY-CHARGED' BATTERIES FOR SERVICE

'Dry-charged' batteries are supplied without electrolyte but with the plates in a charged condition. When they are required for service it is only necessary to fill each cell with sulphuric acid of the correct specific gravity. No initial charging is required. This procedure ensures that there is no deterioration of the efficiency of the battery during the storage period before the battery is required for use.

In these batteries porous rubber is used for the separators between the plates.

Preparation of Electrolyte

Electrolyte is prepared by mixing distilled water and concentrated acid, usually of 1·835 S.G. The mixing must be carried out either in a lead lined tank or in suitable glass or earthenware vessels. 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 specific gravity of the filling electrolyte depends on the climate in which the battery is to be used.

The approximate proportions of acid and water are indicated in the following table:

To obtain specific gravity (corrected to 60°F) of	*Add 1 vol. of acid 1·835 S.G (corrected to 60°F) to*
Climates below 90°F 1·27	2·8 volumes of water
Climates above 90°F 1·21	4·0 volumes of water

Heat is produced by mixing 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 readings as described in Section M.2. To avoid damage to the battery the electrolyte must be cool before filling-in is commenced.

The total volume of electrolyte required can be estimated from the figures quoted under **'General Data'.**

Filling the Battery

Carefully break the seals in the cell filling holes and fill each cell with electrolyte to the top of the separators, **in one operation.** The temperature of the filling room,

battery and electrolyte, should be maintained between 60° and 100°F (15·6° and 37·8°C). If the battery has been stored in a cool place it should be allowed to warm up to room temperature before filling.

Putting into Use

Batteries filled in this way are 90 per cent charged and capable of giving a starting discharge **one hour after filling.** When time permits, however, a freshening charge will ensure the battery is fully charged. Such a freshening charge should last for no more than 4 hours, at the normal recharge rate of the battery (see **'General Data'**).

During the charge the electrolyte must be kept level with the top edge of the separators by addition of distilled water. Check the specific gravity of the acid at the the end of the charge; if 1·27 acid was used to fill the battery, the specific gravity should now be between 1·27 and 1·29; if 1·21, between 1·21 and 1·23. After filling, a dry-charged battery needs only the attention normally given to a lead-acid battery.

Section M.4

PREPARING NEW UNFILLED, UNCHARGED BATTERIES FOR SERVICE

Preparation of Electrolyte

Batteries having dry separators are used. The specific gravity of the filling-in solution should, therefore, be the same as that required at the end of the charge (i.e. their electrolyte requirements are the same as those of 'dry-charged' batteries).

For the precautions to be taken when preparing the electrolyte, the quantity of electrolyte required, and the proportions of acid and water necessary for different ranges of climatic temperature see **'Preparation of Electrolyte'** in Section M.3.

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

Filling the Battery

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

Carefully break the seals in the filling holes and **half-fill** each cell with electrolyte of the appropriate specific gravity. Allow the battery to stand for at least six hours, in order to dissipate the heat generated by the chemical action of the acid on the plates and separators, and then add sufficient electrolyte to fill each cell to the top of the separators. Allow to stand for a further two hours and then proceed with the initial charge.

Initial Charge

The initial charging rate is given under **'General Data'**. Charged at this rate until the voltage and specific gravity readings show no increase over five successive hourly readings. This will take from 40 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 quoted in Section M.2 the charge must be interrupted until the temperature has fallen at least 10°F (5·5°C) below that figure. Throughout the charge, the electrolyte must be kept level with the top of the separators by addition of acid solution of the same specific gravity as the original filling-in acid, until specific gravity and charge readings have remained constant for five successive hourly readings. If the charge is continued beyond that point, top-up with distilled water.

At the end of the charge carefully check the specific gravity in each cell to ensure that, when corrected to 60°F (15·6°C) it lies between the specified limits. If any cell requires adjustment some of the electrolyte must be siphoned off and replaced either by distilled water or by acid of 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 over the tops of the separators.

Section M.5

GENERATOR

Description

The generator is a shunt wound two-pole, two-brush machine, arranged to work in conjunction with a compensated voltage control regulator unit. A fan integral with the driving pulley draws cooling air through the generator, inlet and outlet holes being provided in the end brackets of the unit.

The output of the generator is controlled by the regulator and is dependent on the state of charge of the battery and the loading of the electrical equipment in use. When the battery is in a low state of charge the generator gives a high output, whereas if the battery is fully charged, the generator gives only sufficient output to keep the battery in good condition without any possibility of overcharging. In addition an increase in output is given

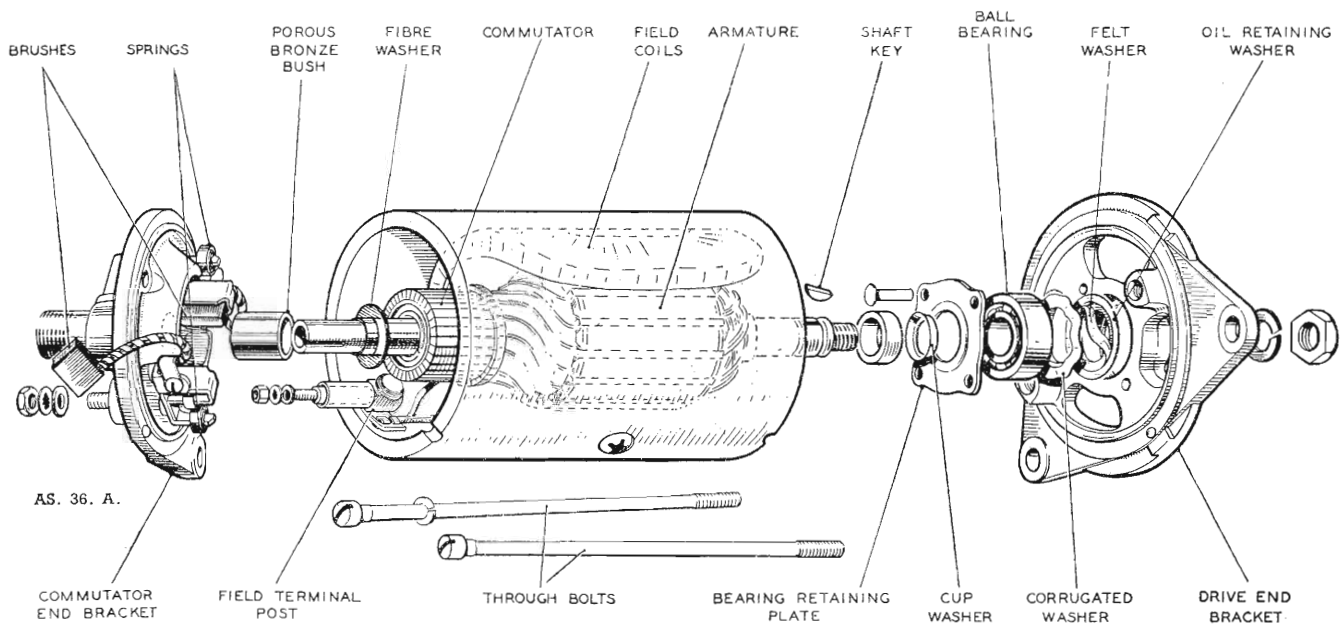


Fig. M.2. The generator exploded.

to balance the current taken by lamps and other accessories when in use. Further, a high boosting charge is given for a few minutes immediately after starting up, thus quickly restoring to the battery the energy taken from it by the electric starting motor.

Section M.6

MAINTENANCE

Lubrication

Every 12,000 miles (19200 km.) unscrew the cap of the lubricator on the side of the bearing housing, lift out the felt pad and spring and about half-fill the lubricator cap with high melting point grease. Replace the spring and felt pad and screw the lubricator cap back into position.

Belt Adjustment

Every 3,000 miles (4800 km.) inspect the generator drive belt and adjust if necessary to take up any undue slackness by turning the generator on its mounting. Care should be taken to avoid overtightening the belt which should have sufficient tension to drive without slipping.

See that the generator is properly aligned, otherwise undue strain will be thrown on the bearings.

Section M.7

TESTING IN POSITION TO LOCATE FAULT IN CHARGING CIRCUIT

In the event of a fault in the charging circuit, adopt the following procedure to locate the cause of the trouble:

(1) Inspect the driving belt and adjust if necessary.

(2) Check that the generator and control box are connected correctly. The larger generator terminal must be connected to the control box 'D' terminal, and the smaller generator terminal to control box 'F' terminal. Check the control box terminal 'E' and associated earthing cable for tightness.

(3) Switch off all lights and accessories, disconnect the cables from the generator terminals and connect the two terminals with a short length of wire.

(4) Start the engine and set to run at normal idling speed.

(5) Clip the negative lead of a moving coil voltmeter, calibrated 0 to 20 volts, to one generator terminal, and the other lead to a good earthing point on the yoke.

(6) Gradually increase the engine speed, when the voltmeter reading should rise rapidly without fluctuation. Do not allow the voltmeter reading to reach 20 volts, and do not race the engine in an attempt to increase the voltage. It is sufficient to run the generator up to a speed of 1,000 r.p.m. If there is no reading check the brushgear as described in (7) below.
If there is a low reading of approximately $\frac{1}{2}$ to 1 volt, the field winding may be at fault (see 'Field Coils'). If there is a reading of 4 to 5 volts, the armature winding may be at fault (see 'Armature').

(7) If the generator is in good order, remove the link from between the terminals and restore the original connections, taking care to connect the larger generator terminal to control box terminal 'D', and the smaller terminal to control box terminal 'F'.

(8) Remove the lead from the (D) terminal on the control box and connect the voltmeter between this cable and a good earthing point on the vehicle. Run the engine as before. The reading should be the same as that measured directly at the generator. No reading on the voltmeter indicates a break in the cable to the generator. Carry out the same procedure for the (F) terminal, connecting the voltmeter between cable and earth. Finally remove the link from the generator. If the reading is correct test the control box (Section M.13).

Section M.8

GENERATOR ASSEMBLY

To Remove

(1) Disconnect the two leads to the generator.
(2) Disconnect the high tension lead and the two low tension leads to the coil.
(3) Slacken the nut securing the sliding link and the two hinge bolts holding the generator to the crankcase and water pump.
(4) Push the generator downwards to slacken the fan belt so that the latter can then be removed.
(5) Remove the set pin from the upper end of the sliding link, and take out the two generator hinge bolts, and lift the generator clear of the engine.
(6) Unscrew the nut securing the coil to its bracket on the generator and remove the coil.

To Dismantle

(1) Take off the driving pulley.
(2) Remove the nut, spring washer and flat washer from the smaller terminal (i.e. field terminal).
(3) Unscrew the two through bolts at the commutator end and remove the bracket from the generator yoke. The driving end bracket together with the armature can now be removed from the generator yoke.
(4) The driving end bracket need not be separated from the shaft unless the bearing is suspect and requires examination, or the armature is to be replaced, in this event the armature should be removed from the end bracket by means of a hand press.

Section M.9

INSPECTION AND OVERHAUL

Brushgear

Lift the brushes up into the brush boxes and secure them in that position by positioning the brush spring at the side of the brush. Fit the commutator end bracket over the commutator and release the brushes. 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 its holder and ease the sides by lightly polishing it on a smooth file. Always refit the brushes in their original positions. If the brushes are badly worn, new brushes must be fitted and bedded to the commutator. The minimum permissible length of brush is $\frac{11}{32}$ in.

Test the brush spring tension using a spring scale. The tension of the springs when new is 22 to 25 oz. In service it is permissible for this value to fall to 15 oz. before performance may be affected. Fit new springs if the tension is low.

Commutator

A commutator in good condition will be smooth and free from pits or burnt 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 mount the armature, with or without the drive end bracket, in a lathe, rotate at high speed, then take a light cut with a very sharp tool. Do not remove more metal than is necessary. Polish the commutator with very fine glass

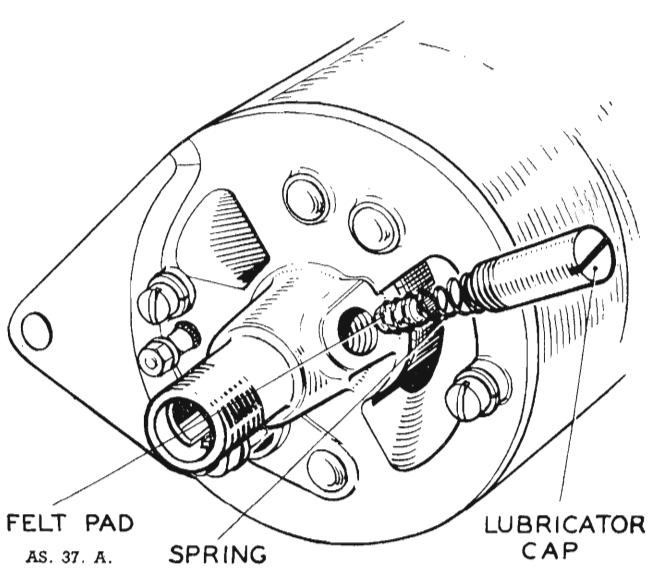


Fig. M.3. Generator lubrication.

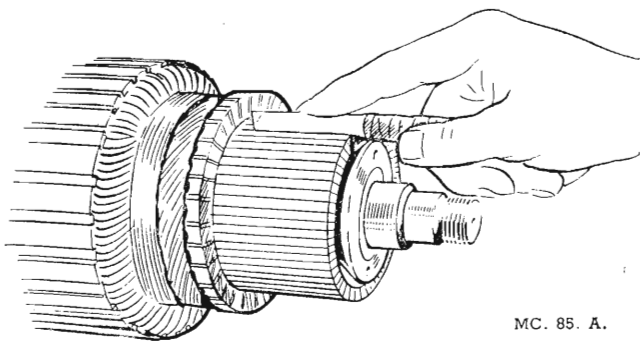


Fig. M.4. Illustrating the operation of undercutting the commutator.

paper. Undercut the insulators between the segments to a depth of $\frac{1}{32}$ in. (·8 mm.) with a hacksaw blade ground to the thickness of the insulator.

The most common armature faults are usually confined to open- or short-circuited windings. Indications of an open-circuited armature winding is given by burnt commutator segments. A short-circuited armature winding is easily identified by discolouration of the overheated windings and badly burnt commutator segments.

If armature testing facilities are not available, an armature can be tested by substitution.

To remove the armature shaft from the drive end bracket and bearing, support the bearing retaining plate firmly and press the shaft out of the drive end bracket. When fitting the new armature, support the inner journal of the ball bearing, using a mild steel tube of suitable diameter while pressing the armature shaft firmly home.

Do not use the drive end bracket as a support for the bearing whilst fitting an armature.

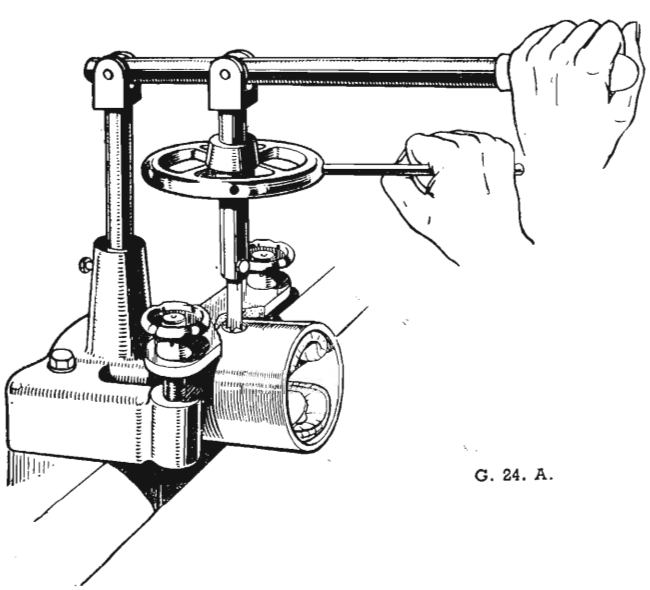


Fig. M.5. Using the wheel operated screwdriver.

Field Coils

Measure the resistance of the field coils, without removing them from the generator yoke, by means of an ohmmeter connected between the field terminal and the yoke.

The ohmmeter should read 6 ohms approximately.

If an ohmmeter is not available connect a 12-volt D.C. supply with an ammeter in series between the field terminal and generator yoke. The ammeter reading should be approximately 2 amperes. Zero on the ammeter or 'Infinity' ohmmeter reading indicates an open-circuit in the field winding.

If the current reading is much more than 2 amperes or the ohmmeter reading much below 6 ohms it is an indication that the insulation of one of the field coils has broken down.

In either case, unless a substitute generator is available, the field coils must be replaced. To do this carry out the procedure outlined below:

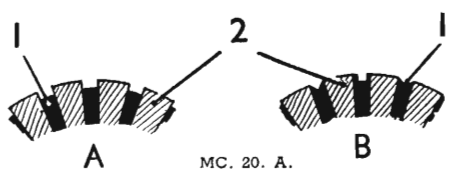


Fig. M.6. Undercutting the commutator.
'A' is the correct and 'B' the incorrect method.
1. *Insulation.* 2. *Segments.*

(1) Drill out the rivet securing the field coil terminal assembly to the yoke and unsolder the field coil connections.
(2) Remove the insulation piece which is provided to prevent the junction of the field coils from contacting with the yoke.
(3) Mark the yoke and pole shoes in order that they can be refitted in their original positions.
(4) Unscrew the two pole shoe retaining screws by means of a wheel-operated screwdriver.
(5) Draw the pole shoes and coils out of the yoke and lift off the coils.
(6) 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 is not trapped between the pole shoes and the yoke.
(7) Locate the pole shoes and field coils by lightly tightening the fixing screw.
(8) Fully tighten the screws by means of a wheel-operated screwdriver and lock them by caulking.
(9) Replace the insulation piece between the field coil connections and the yoke.
(10) Re-solder the field coil connections to the field coil terminal tags and re-rivet the terminal assembly to the yoke.

Bearings

Bearings which have been worn to such an extent that they will allow side movement of the armature shaft must be replaced.

To replace the bearing bush in a commutator end bracket proceed as follows:

(1) Remove the old bearing bush from the end bracket. The bearing can be withdrawn with a suitable extractor or by screwing a $\frac{3}{8}$ in. tap into the bush for a few turns and pulling out the bush with the tap. Screw the tap squarely into the bush to avoid damaging the bracket.

(2) 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 be fitted in the bearing, until the visible end of the bearing is flush with the inner face of the bracket. Porous bronze bushes should not be opened out after fitting or the porosity of the bush may be impaired.

Note: Before fitting the new bearing bush it should be allowed to stand for 24 hours completely immersed in thin (S.A.E. 20) engine oil, this will allow the pores of the bush to be filled with lubricant. In cases of extreme urgency this period may be shortened by heating the oil to 100°C (212°F) for two hours then allowing to cool before removing the bearing bush.

The ball bearing at the driving end is replaced as follows:

(1) Drill out the rivets which secure the bearing retaining plate to the end bracket and remove the plate.

(2) Press the bearing out of the end bracket and remove the corrugated washer, felt washer, and oil retaining washer.

(3) Before fitting the replacement bearing see that it is clean and pack it with high melting point grease.

(4) Place the oil retaining washer, felt washer and corrugated washer in the bearing housing in the end bracket.

(5) Locate the bearing in the housing and press it home. The outer bearing journal is a light push-fit in the bearing housing.

(6) Refit the bearing retaining plate using rivets having the same dimensions as those originally fitted.

Note: When fitting a drive end bracket to the armature shaft, the inner journal of the bearing must be supported by a mild steel tube. Do not use the drive end bracket as support for the bearing when fitting an armature.

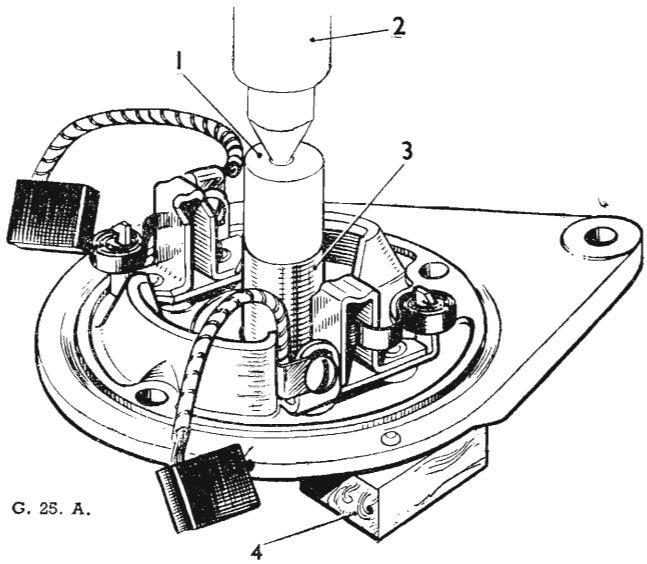


Fig. M.7. Fitting a new bush to the commutator end bracket.
1. *Shouldered mandrel.*
2. *Hand press.*
3. *Bearing Bush.*
4. *Supporting block.*

Section M.10

ASSEMBLING AND REPLACING

In the main the reassembly of the generator is a reversal of the dismantling procedure. Before refitting the generator, however, inject S.A.E. 30 oil into the commutator end bracket as previously described. The replacement is the reverse of the procedure 'To Remove' in Section M.8. Check the fan belt adjustment as described in Section C.

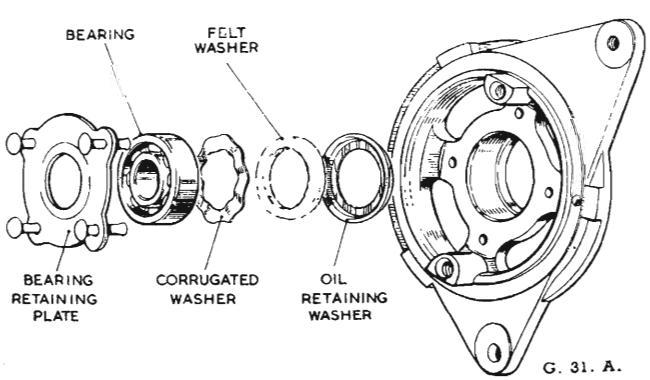


Fig. M.8. Generator drive end bracket.

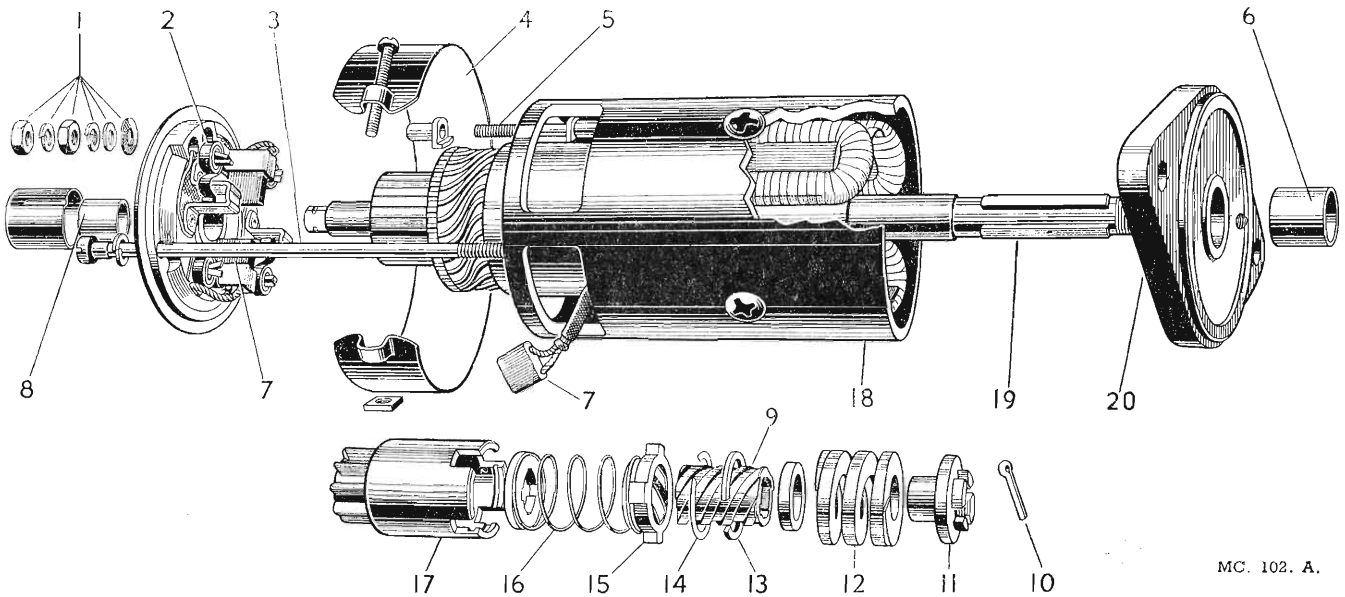


Fig. M.9. The starter in exploded form.

1. *Terminal nuts and washers.*
2. *Brush spring.*
3. *Through bolt.*
4. *Cover band.*
5. *Terminal post.*
6. *Bearing bush.*
7. *Brushes.*
8. *Bearing bush.*
9. *Sleeve.*
10. *Split pin.*
11. *Shaft nut.*
12. *Main spring.*
13. *Retaining ring.*
14. *Corrugated washer.*
15. *Control nut.*
16. *Restraining spring.*
17. *Pinion and barrel.*
18. *Yoke.*
19. *Armature shaft.*
20. *Driving end bracket.*

Section M.11

THE STARTER

Testing on the Vehicle

In the following test it is assumed that the battery is in a charged condition:

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

(2) Should the lamps retain their full brilliance when the starter switch is operated, check that the switch is functioning. Next if the switch is in order, examine the connections at the battery, starter switch, and also examine the wiring joining these units. Continued failure of the starter to operate indicates an internal fault in the starter, which must be removed for examination.

Sluggish or slow action of the starter is usually caused by a poor connection in the wiring which causes a high resistance in the starter circuit. Check the wiring as described above.

Section M.12

SERVICING THE STARTER

To Remove and Replace

(1) Remove the distributor as described in Section B.

(2) Release the starter cable from the terminal and unscrew the top starter securing bolt.

(3) Working beneath the vehicle release and withdraw the dirt deflector situated under the starter motor and unscrew the bottom starter securing bolt.

(4) Manoeuvre the starter forward and lift clear of the engine.

(5) Installation is the reversal of the removal procedure.

Examination of Commutator and Brush Gear

(1) Remove the starter cover band and examine the brushes and commutator.

(2) 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 its holder and ease the sides by lightly polishing with a smooth file. Always replace brushes in their original positions. If the brushes are worn so they no longer bear on the commutator, or if the brush flexible lead has become exposed on the running face, they must be renewed.

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

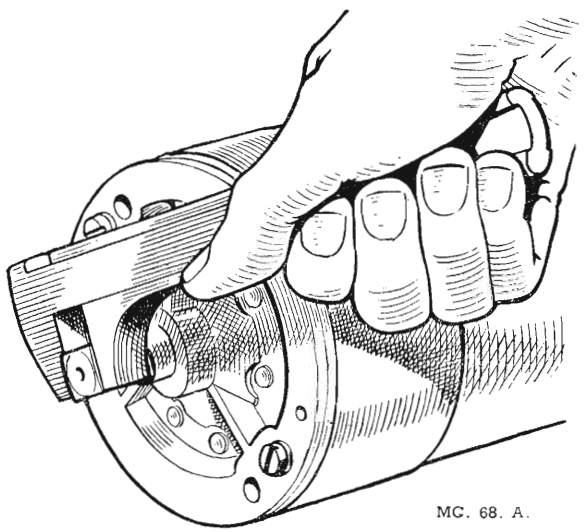


Fig. M.10. Turning the squared end of the armature shaft extension to free a jammed starter.

(4) Secure the body of the starter in a vice and test by connecting it with heavy-gauge cables to a 12-volt battery. One cable must be connected to the starter terminal the other held against the starter body or end bracket. Under these light load conditions the starter should run at a very high speed.

If the operation of the starter is still unsatisfactory, it should be dismantled for detail inspection and testing.

To Dismantle

(1) Take off the cover band at the commutator end, hold back the brush springs and take out the brushes.

(2) Extract the split pin at the driving end.

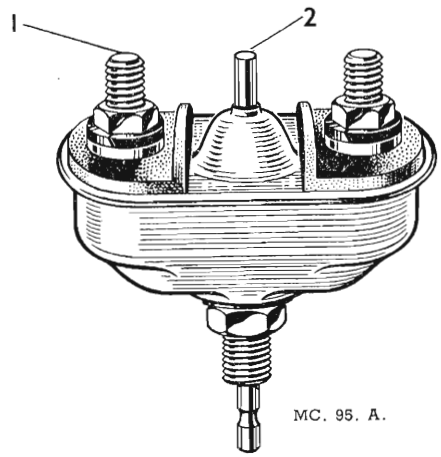


Fig. M.11. The starter switch.
1. *Terminal* 2. *Emergency actuator.*

(3) Unscrew the nut (R.H. thread) and take off the main spring. The complete drive can now be removed from the splined shaft by withdrawing it with a rotary movement.

(4) Remove the terminal nuts and washers from the terminal post on the commutator end bracket. Unscrew and withdraw the two through-bolts and

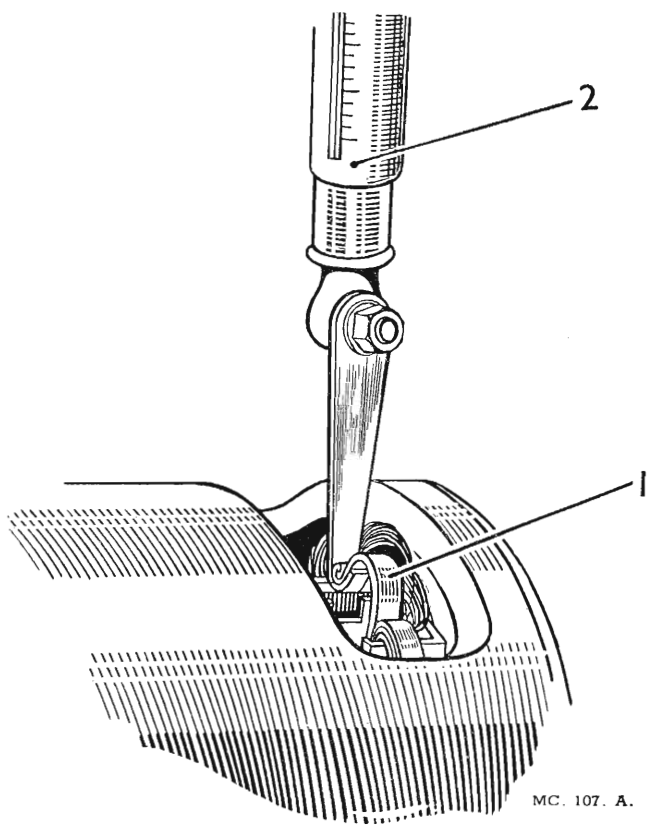


Fig. M.12. Checking the brush spring tension.
1. *Brush spring.* 2. *Spring scale.*

take off the commutator end bracket.

(5) Remove the driving end bracket complete with armature end bracket.

Brushes

(1) Test the brush springs with a spring balance. The Correct tension is 25 to 15 ozs. (·7087 to ·4252 kg.). Fit a new spring if the tension is low.

(2) If the brushes are worn so that they no longer bear on the commutator, or if the flexible connector has become exposed on the running face, they must be renewed. Two of the brushes are connected to terminal eyelets attached to the brush boxes on the commutator end bracket. The other two brushes are connected to tappings on the field coils.

The flexible connectors must be removed by unsoldering and the connectors of the new brushes secured in their place by soldering. The brushes are pre-formed so that bedding of the working face to the commutator is unnecessary.

Drive

(1) If the pinion is tight on the screwed sleeve, wash away any dirt with paraffin (kerosene).

(2) If any parts are worn or damaged they must be replaced.

(3) Unscrew the nut (R.H. thread) and take off the main spring.

(4) The complete drive can now be removed for the splined shaft by pulling it off with a rotary movement. Unscrew the screwed sleeve from the barrel assembly.

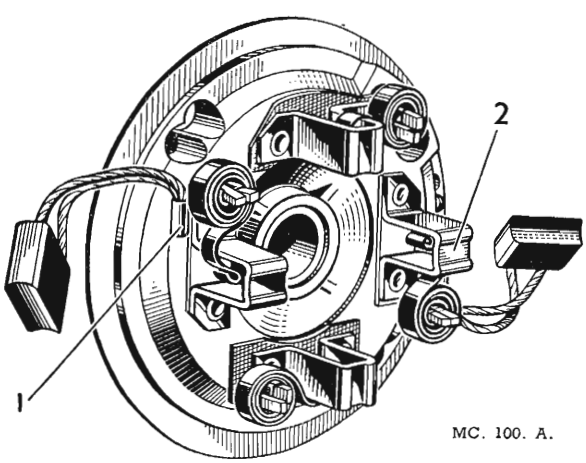


Fig. M.13. Commutator end bracket.
1. *Terminal eyelet.* 2. *Brush holder.*

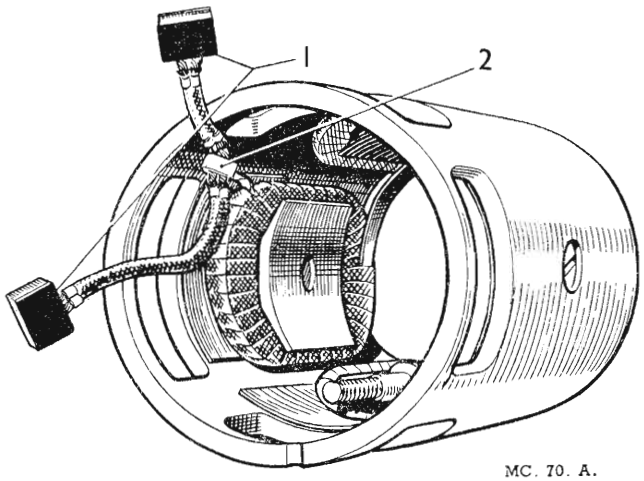


Fig. M.14. Starter yoke.
1. *Brushes.* 2. *Tapping on field coil.*

(5) Further dismantling of the barrel assembly is carried out by removing the large retaining ring.
Note: If the screwed sleeve is worn or damaged it is essential that it is replaced together with the control nut.
Reassemble by reversing the above procedure.

Commutator

A commutator in good condition will be smooth and free from pits and burnt spots. Clean the commutator with a cloth moistened with petrol (gasoline). 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 as described above and remove the armature from the end bracket. Now mount the armature in a lathe, rotate it at high speed and take a light cut with a very sharp tool. Do not remove any more metal than is absolutely necessary, and finally polish with very fine glass-paper.

The mica on the starter commutator **must not be undercut.**

Field Coils

The field coils can be tested for an open circuit by connecting a 12-volt battery having a 12-volt bulb in one of the leads to the tapping point of the field coils to which the brushes are connected and the field terminal post. If the bulb does not light there is an open circuit in the wiring of the field coils.

Lighting of the bulb 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 on to the yoke. This may be checked by removing the lead from the brush connector and holding it on a clean part of the

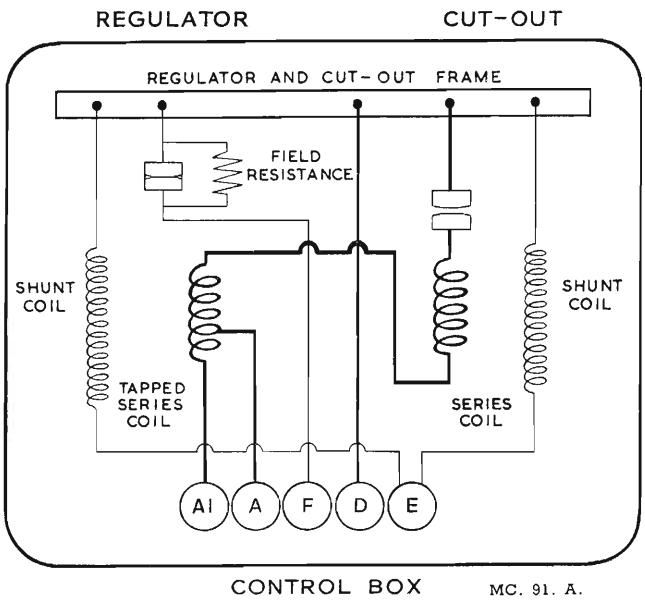


Fig. M.15 Internal connections of control box.

starter yoke. Should the bulb now light it indicates that the field coils are earthed.

Should the above tests indicate that the fault lies in the field coils they must be renewed. When renewing the field coils carry out the procedure detailed in the Generator Section.

Armature

Examination of the armature will in many cases reveal the cause of failure, e.g. conductors lifted from the commutator due to the starter being engaged while the engine is running and causing the armature to be rotated at an excessive speed. A damaged armature must in all cases be renewed—no attempt should be made to machine the armature core or to true a distorted armature shaft.

Bearings (Commutator End)

Bearing which are worn to such an extent that they will allow excessive sideplay of the armature shaft must be renewed. To renew the bearing bush proceed as follows:

Press the new bearing bush into the end bracket, using a shouldered mandrel of the same diameter as the shaft which is to fit into the bearing.

Note: The bearing bush is of the porous phosphor-bronze type, and before fitting, new bushes should be allowed to stand completely immersed for twenty-four hours in thin engine oil in order to fill the pores of the bush with lubricant.

Reassembly

The reassembly of the starter is a reversal of the operations described in this section.

Section M.13

THE CONTROL BOX

This unit contains the cut-out and voltage regulator. The regulator controls the generator output in accordance with the load on the battery and its state of charge. When the battery is discharged, the generator gives a high output, so that the battery receives a quick recharge which brings it back to its normal state in the minimum time.

On the other hand, if the battery is fully charged the generator is arranged to give only a trickle charge, which is sufficient to keep it in good condition without any possibility of causing damage to the battery by overcharging.

The regulator also causes the generator to give a controlled boosting charge immediately after starting up, which quickly restores to the battery the energy taken from it when starting. After about 30 minutes running, the output of the generator has fallen to a steady rate best suited to the particular state of charge of the battery.

The cut-out is an automatic switch for connecting and disconnecting the battery with the generator. This is necessary because the battery would otherwise discharge through the generator when the engine is stopped or running at a low speed.

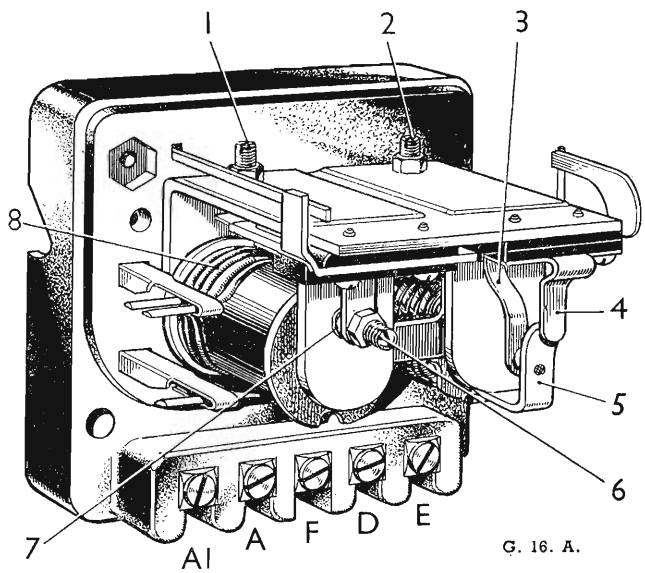


Fig. M.16. Control box.

1. *Regulator adjusting screw.*
2. *Cut-out adjusting screw.*
3. *Fixed contact blade.*
4. *Stop arm.*
5. *Armature tongue and moving contact.*
6. *Regulator moving contact.*
7. *Fixed contact.*
8. *Regulator series windings.*

Regulator Adjustment

The regulator is carefully set before leaving the works to suit the normal requirements of the standard equipment, and in general it should not be necessary to alter it. If, however, the battery does not keep in a charged condition, or if the generator output does not fall when the battery is fully charged, it may be advisable to check the setting and if necessary to readjust.

It is important, before altering the regulator setting when the battery is in a low state of charge, to check that its condition is not due to a battery defect or to the generator belt slipping.

Checking and Adjusting the Electrical Setting

The regulator setting can be checked without removing the cover of the control box.

(1) Withdraw the cables from the terminals marked 'A' and 'A1' at the control box and join them together. Connect the negative lead of a moving coil voltmeter (0 to 20 volts full scale reading) to be 'D' terminal on the generator and connect the other lead from the meter to a convenient chassis earth.

(2) Slowly increase the speed of the engine until the voltmeter needle 'flicks' and then steadies; this should occur at a voltmeter reading between the limits given for the appropriate temperature of the regulator.

If the voltage at which the reading becomes steady occurs outside these limits, the regulator must be adjusted.

(3) Shut off the engine, remove the control box cover, release the locknut (1) Fig. M.16, holding the adjusting screw (2) and turn the screw in a clockwise direction to raise the setting or in an anti-clockwise direction to lower the setting. Turn the adjustment screw a fraction of a turn and then tighten the locknut.

When adjusting, do not run the engine up to more than half throttle because, while the generator is on open circuit, it will build up to a high voltage if run at a high speed and in consequence a false voltmeter reading would be obtained.

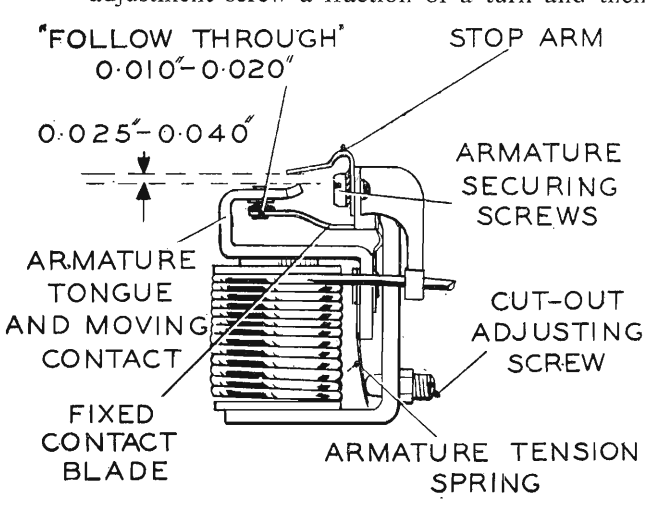


Fig. M.17. Cut-out mechanical settings.

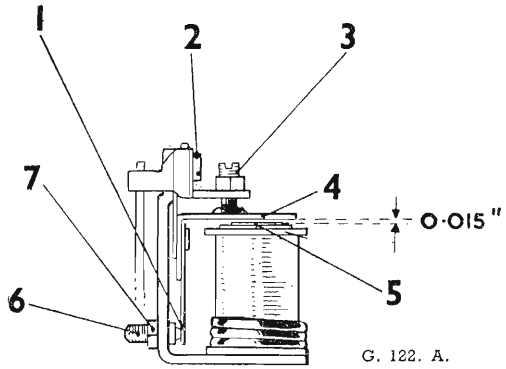


Fig. M.18. Regulator mechanical settings.

1. *Armature tension spring*
2. *Armature securing screws.*
3. *Fixed contact adjustment screw.*
4. *Armature.*
5. *Core face and shim.*
6. *Voltage adjusting screw.*
7. *Locknut.*

Mechanical Setting

The mechanical settings of the regulator are accurately adjusted before leaving the factory and provided that the armature carrying the moving contact is not removed these settings should not be tampered with. If however, the armature has been removed, the regulator will have to be reset. To do this proceed as follows:

(1) Slacken the fixed contact locking nut and unscrew the contact until it is well clear of the armature moving contact. Slacken the two armature assembly securing screws.

Slacken the voltage adjusting screw locking nut and unscrew the adjuster until it is well clear of the armature tension spring. Slacken the two armature assembly securing screws.

(2) Insert a ·015 in. (·381 mm.) feeler gauge between the armature and core shim. Take care not to turn up or damage the edge of the shim. Press the armature squarely down against the gauge and re-tighten the two armature assembly securing screws.

(3) With the gauge still in position, screw the adjustable contact down until it just touches the armature contact. Tighten the locknut and remove the feeler gauge. Reset the voltage adjusting screw as described under 'Electrical Setting'.

Cleaning Regulator Contacts

After periods of long service it may be found necessary to clean the regulator contacts. Fine carborundum stone or fine emery cloth may be used. Carefully wipe away all traces of dust or other foreign matter, using a clean fluffless cloth moistened with methylated spirits.

Cut-Out Electrical Setting

If the regulator is correctly set but the battery is still not being charged, the cut-out may be out of adjustment. To check the voltage at which the cut-out operates remove the control box cover and connect the voltmeter between the terminals 'D' and 'E'. Start the engine and slowly increase its speed until the cut-out contacts are seen to close, noting the voltage at which this occurs. This should be 12·7 to 13·3 volts.

If operation of the cut-out takes place outside these limits, it will be necessary to adjust. To do this, slacken the locknut of (2), Fig. M.16, securing the cut-out adjusting screw and turn the screw in a clockwise direction to raise the voltage setting, or in an anti-clockwise direction to reduce the setting. Turn the screw a fraction at a time and then tighten the locknut. Test after each adjustment by increasing the engine speed and noting the voltmeter readings at the instant of contact closure. Electrical settings of the cut-out, like the regulator, must be made as quickly as possible because of temperature rise effects. Tighten the locknut after making the adjustment.

Adjustment of the drop-off voltage is effected by carefully bending the fixed contact blade. If the cut-out does not operate there may be an open circuit in the wiring of the cut-out and regulator unit, in which case the unit should be removed for examination or renewal.

Cut-out Mechanical Setting

If for any reason the cut-out armature has to be removed from the frame, care must be taken to obtain the correct air gap settings on reassembly. These can be obtained as follows:

(1) Slacken the adjusting screw locking nut and unscrew the adjusting screw until it is well clear of the armature tension spring. Slacken the two armature assembly securing screws. (Fig. M.17).

(2) Press the armature firmly down against the copper sprayed core face and re-tighten the two armature assembly securing screws.

(3) Using a pair of round-nosed pliers, adjust the gap between the armature stop-arm and armature tongue by bending the stop-arm. The gap must be ·025 to ·040 in. (·635 to 1·016 mm.) when the armature is pressed squarely down on the core face.

(4) Similarly the insulated contact blade must be bent so that when the armature is pressed squarely down against the core face there is a 'follow through' or contact deflection of ·010 to ·020 in. (·254 to ·508 mm.). Reset the cut-out adjusting screw as described under 'Cut-out Electrical Setting'.

Cleaning Cut-out Contacts

If the contacts appear rough or burnt place a strip of fine glass paper between, and with them closed by hand draw the paper through. This should be done two or three times with the rough side towards each contact. Wipe away all dust or other foreign matter, using a clean fluffless cloth moistened with methylated spirits.

Do not use emery cloth or carborundum stone for cleaning the cut-out contacts.

Section M.14

FUSE UNIT

Description

The fuse unit which is located on the right-hand side of the engine compartment, is an open insulated moulding carrying two single-pole 35-amp. cartridge-type fuses which are held in spring clips between the grub-screw-type terminal blocks. Two spare fuses are carried in recesses in the fuse unit box and are positioned by retaining springs. The fuse which bridges the terminal blocks (A1—A2) is to protect general auxiliary circuits, e.g. the horn which is independent of the ignition switch. The other fuse, bridging terminal blocks (A3—A4) is to protect the ignition and auxiliary circuits, e.g. the fuel gauge, windscreen wiper motor and flasher indicators which only operate when the ignition is switched on.

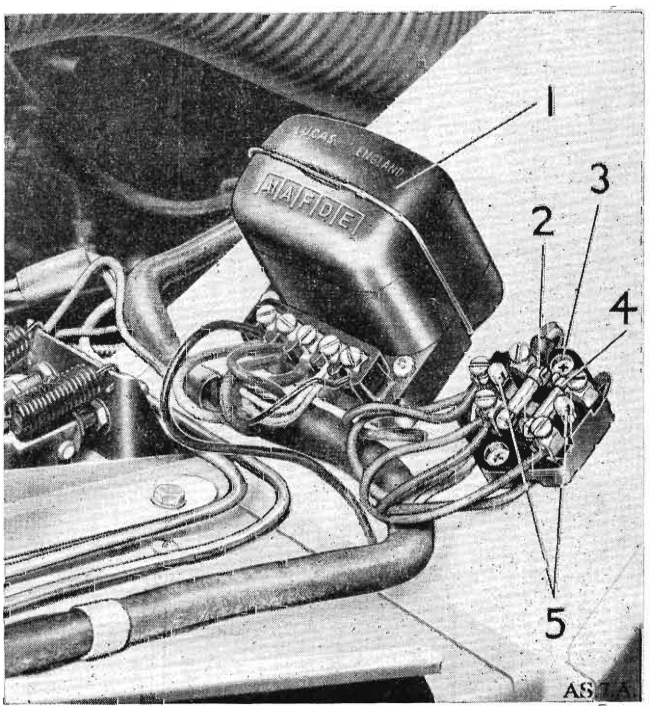


Fig. M.19. Fuse unit and control box.

1. *Control box.*
2. *Auxiliary ignition fuse* (35 *amps.*)
3. *Fuse unit.*
4. *Auxiliary fuse* (50 *amps.*)
5. *Spare fuses.*

Section M.15

THE FLASHER UNIT

Description

The Lucas flasher unit is situated in the engine compartment on the right-hand side, and is operated by a switch centrally mounted on the facia panel, a warning light being provided on the right side of the facia.

The unit is contained in a small cylindrical metal container, one end of which is rolled over on to an insulated plate carrying the mechanism and three terminals. The unit depends for its operation on the linear expansion of a length of wire which becomes heated by an electric current flowing through it. This actuating wire controls the movement of a spring loaded armature attached to a central steel core and carrying a moving contact—the sequence of operation being as follows:

When the direction-indicator switch is turned either to the left or right, current flows through the actuating wire, ballast resistor and coil wound on the central core and hence to earth via the flasher lamp filaments. This current is limited by the ballast resistor to a valve which will ensure that the flasher lamp filaments do not light at this stage. The actuating wire grows in length under the heating influence of the current and allows the armature to move inwards to its alternative position, thereby closing a pair of contacts in the supply circuit to the flasher lamps, and at the same time, short circuiting the actuating wire. The increased electro-magnetic attraction of the armature to the core, due to the full lamp current now flowing through the coils, serves to hold the closed contacts firmly together. At the same time a secondary spring loaded armature is attracted to the core and closes a pilot warning lamp circuit so that now both flasher lamps and warning lamp are illuminated.

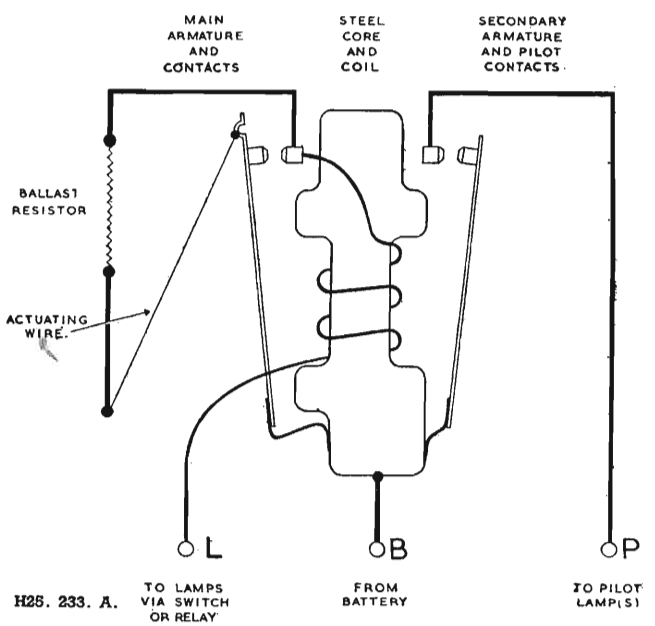


Fig. M.20. Symbolic representation of flasher unit model FL.5

Since, however, heating current no longer flows through the short-circuited actuating wire, the latter cools and consequently contracts in length. The main armature is therefore pulled away from the core, the contacts opened and the light signals extinguished. The consequent reduction of electro-magnetism in the core allows the secondary armature to return to its original position and so extinguish the pilot warning light. The above sequence of operations continues to be repeated until the indicator switch is returned to the off position. A symbolic representation of the flasher unit is shown in Fig. M.20.

Functions of Warning Lamp

The warning lamp not only serves to indicate that the flasher unit is functioning correctly but also gives a warning of any bulb failure occuring in the external direction-indicator lamps—since a reduction in bulb current flowing through the coil reduces the electro-magnetic effect acting on the secondary armature and so prevents closure of the pilot light contacts.

Checking Faulty Operation

In the event of trouble occurring with a flashing light direction-indicator system, the following procedure should be followed:

(1) Check the bulbs for broken filaments.
(2) Refer to the vehicle wiring diagram and check all flasher circuit connections.
(3) Switch on the ignition.
(4) Check with the voltmeter that the flasher unit terminal 'B' is a battery voltage with respect to earth.
(5) Connect together flasher unit terminals 'B' (or 'X') and 'L' and operate the direction-indicator switch. If the flasher lamps now light, the flasher unit is defective and must be replaced.

Maintenance

Flasher units cannot be dismantled for subsequent reassembly. A defective unit must therefore be replaced, care being taken to connect as the original.

Replacement of Flasher Unit

When replacing a flasher unit or installing a flashing light system, it is advisable to test the circuits before connections to flasher terminals are made. When testing join the cables normally connected to those terminals (green, green with brown, and light green) together and operate the direction indicator switch. In the event of a

wrong connection having been made, the ignition auxiliaries fuse will blow but no damage will be done to the flasher unit.

Section M.16

WINDSCREEN WIPERS

Maintenance

(1) Inspection should be made of the rubber wiping elements which after long service become worn and should be renewed.

(3) The rubber grommet or washer around the wheel box spindle should be lubricated with a few drops of glycerine.

(3) Methylated spirits (de-natured alcohol) should be used to remove oil, tar spots and other stains from the windscreen. It has been founded that the use of some silicone and wax-based polishes for this purpose can be detrimental to the rubber wiping elements.

(4) The gearbox and cable rack are packed with grease during manufacture and need no further lubrication.

Checking Switching Mechanism

If the wiper fails to park or parks unsatisfactorily, the limit switch in the gearbox cover should be checked. Unless the limit switch is correctly set, it is possible for the wiper motor to overrun the open circuit position and continue to draw current.

Resetting the Limit Switch

Slacken the four screws securing the gearbox cover and observe the projection near the rim of the limit switch. Position the projection in line with the groove in the gearbox cover. Turn the limit switch 25° in an anti-clockwise direction and tighten the four securing screws. if the wiping blades are required to park on the opposition side of the screen, the limit switch should be turned back 180° in a clockwise direction.

Checking Current Consumption

If the wiper fails to operate, or operates unsatisfactorily, switch on the wiper and note the current being supplied to the motor. The normal running current should be 2·3 to 3·1 amps. Use a 0 to 15 amp. moving coil ammeter connected in the wiper circuit, then proceed as follows:

Wiper takes no Current. Examine the fuse protecting the wiper circuit. If the fuse has 'blown', examine the wiring of the motor circuit and of all other circuits protected by that fuse. Replace any cables which are badly worn or chafed, if necessary fitting protective sleeving over the cables to prevent a recurrence of the fault.

If the external wiring is found to be in order, replace the fuse with one of the recommended size. Then proceed as for wiper taking an abnormally high current.

If the fuse is intact, examine the wiring of the motor circuit for breaks and ensure that the wiper control switch is operating correctly.

When a current-operated thermostat is fitted, test it by connecting an ohmmeter across its terminals in place of the two cables. If closed circuit is indicated, the thermostat is in order, and the cables must be refitted. An open circuit means that the thermostat has operated but not reset. Check the thermostat by substitution. Adjustment of the thermostat must not be attempted.

If the thermostat is in order, proceed as for the wiper taking an abnormally high current.

Wiper takes Abnormally Low Current. Check that the battery is fully charged. The performance of the motor is dependent on the condition of the battery.

Remove the commutator end bracket and examine the brush gear, ensuring that it bears firmly on the commutator. The tension spring must be renewed if the brushes do not bear firmly on the commutator. Brush levers must move freely on the pivots. If these levers are stiff they should be freed by working them backwards and forwards by hand.

Examine the commutator and, if necessary, clean with a petrol-moistened cloth. A suspected armature should be checked by substitution.

Wiper takes Abnormally High Current. If an abnormally high current is shown on the ammeter, this may be due to excessive load on the driving shaft. The stall current of the motor cold is 14 amp., and hot is 8 amp.

If there is no obvious reason for this, such as a sticking wiper blade, a check should be made at the gearbox.

Remove the gearbox cover and examine the gear assembly, checking that a blow on the gearbox end bracket has not reduced the armature end float. The armature end float adjusting screw must be set to give an armature end play of 0·008 in. (·20 mm.) to 0·012 in. (·30 mm.).

Sluggish operation with excessive current consumption may be caused through frictional losses in badly positioned or defective connecting tubes. The connecting tubes can be checked, using a cable gauge. (Details of this gauge can be obtained from any Lucas Agent.) The

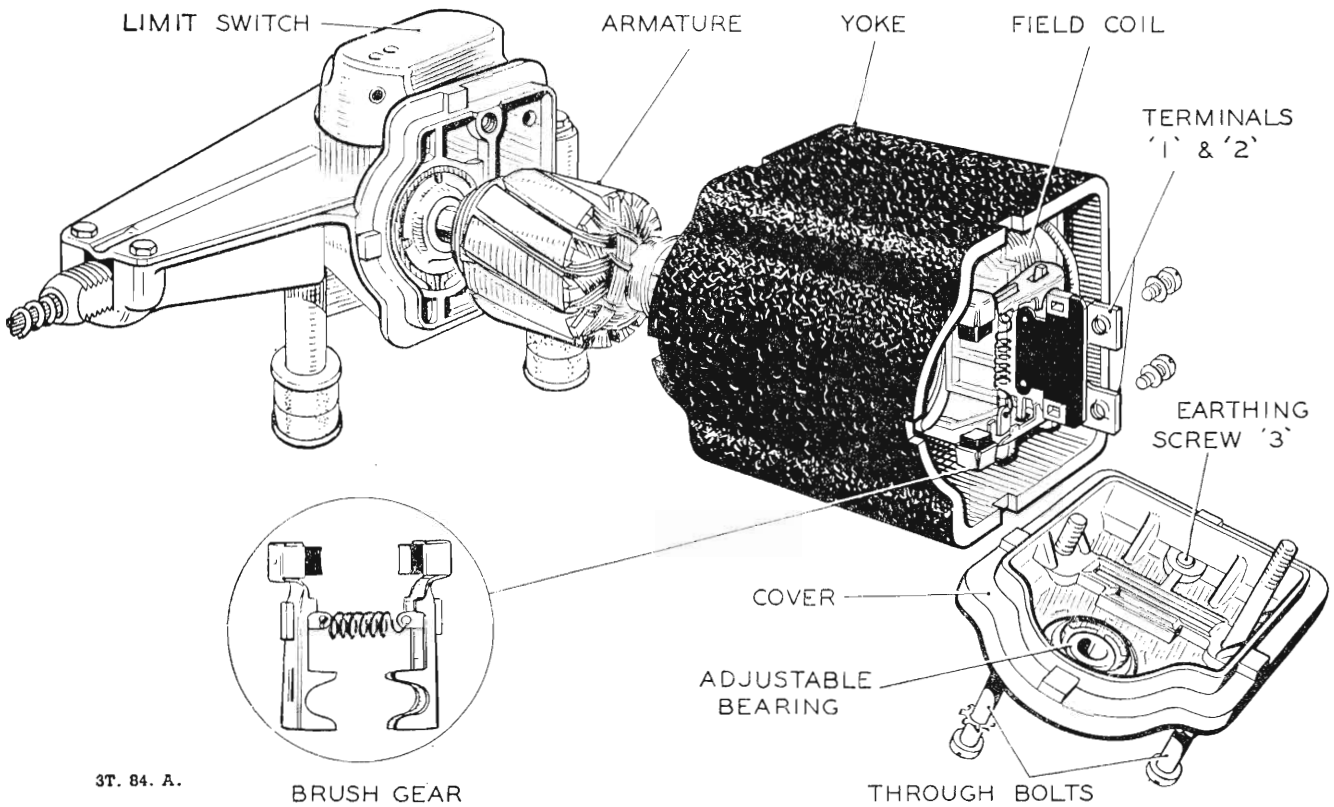


Fig. M.21. Wiper motor exploded.

gauge cable is similar in appearance to the driving rack but is 0·010 in. (·25 mm.) larger in diameter and is less flexible. The gauge will not easily pass through connecting tubes having less than the minimum permissible curvature.

To check the tubing using the gauge, it is necessary to remove the inner rack. Insert the gauge into the connecting tube as far as the first wheel box and then withdraw it. Remove the tubing connecting the wheelboxes. Insert and withdraw the gauge. If the gauge moves freely the tubing is correctly installed. If the gauge does not move freely, the tubing must be checked for sharp bends and obstructions. Check the wheel boxes for alignment and then re-assemble.

Pieces of carbon short-circuiting adjacent segments of the commutator will also cause excessive current consumption. The resistance between adjacent commutator segments should be 0·34 to 0·41 ohms. Cleaning the commutator and brushgear removes this fault. When dismantling, check the internal wiring of the motor for evidence of short-circuiting due to chafed or charred insulation. Slip a new piece of sleeving over any charred connections, and arrange them so that they do not rub against sharp edges.

While the motor is dismantled check the valve of the field resistance. If it is found to be lower than 12·8 to 14 ohms, a short-circuit in the windings is indicated and a new field coil must be fitted. Other evidence of a short-circuit will be given by charred leads from the field coil.

To Remove the Rack and Motor Unit

Release the wiping arms from the spindles, see Fig. M.22, disconnect the union on the Bundy tube at the gearbox, and remove the nuts from the motor mounting bolts. Withdraw the motor and cable rack clear of the Bundy tube.

To Dismantle the Motor

(1) Withdraw the four screws securing the gearbox cover and remove the cover.
(2) Withdraw the terminal screws and through bolts at the commutator end bracket.
(3) Remove the commutator end bracket clear of the yoke.
(4) The brush gear can be removed by lifting it clear of the commutator and withdrawing it as a unit. Care should be taken at this point to note the particular side occupied by each brush so that each may be replaced in its original setting on the commutator.

(5) Access to the armature and field coils can be gained by withdrawing the yoke.
(6) If it is necessary to remove the field coil, unscrew the two screws securing the pole piece to the yoke. These screws should be marked so that they can be returned to their original holes.
(7) Press out the pole pieces complete with field coil, marking the pole piece so that it can be replaced in its correct position inside the yoke. The pole piece can now be pressed out of the field coil.

To Dismantle the Gearbox Unit

Remove the circlip and washer from the crosshead connecting link pin and lift off the crosshead and cable rack assembly. Then remove the circlip and washer from the final gear shaft located underneath the gearbox unit. Remove any burr from the circlip groove before lifting out the final gear. The armature and worm drive can now be withdrawn from the gearbox. All gear teeth should be examined for signs of damage or wear and, if necessary, new gears fitted.

Reassembly

Reassembly is a reversal of the above procedures. When reassembling, the following components should be lubricated, using the lubricants recommended:

(1) **Armature bearings.** These should be lubricated with S.A.E.20 engine oil—the self-aligning bearing being immersed in this for 24 hours before assembly.

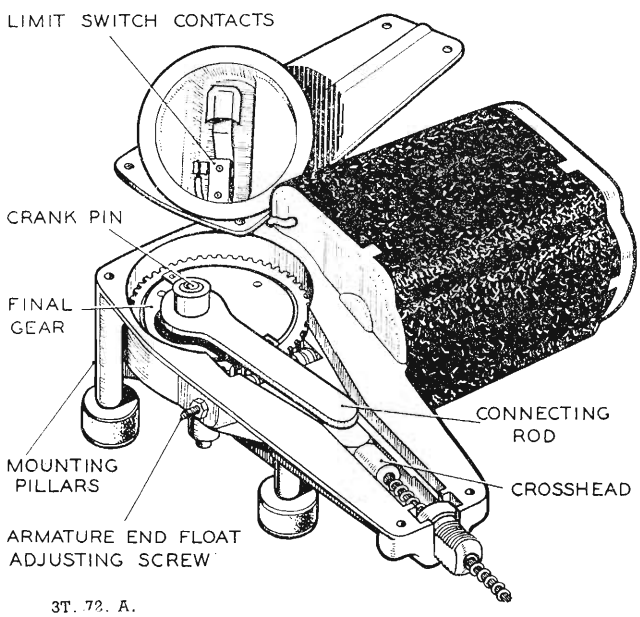


Fig. M.22. Wiper motor gearbox cover removed.

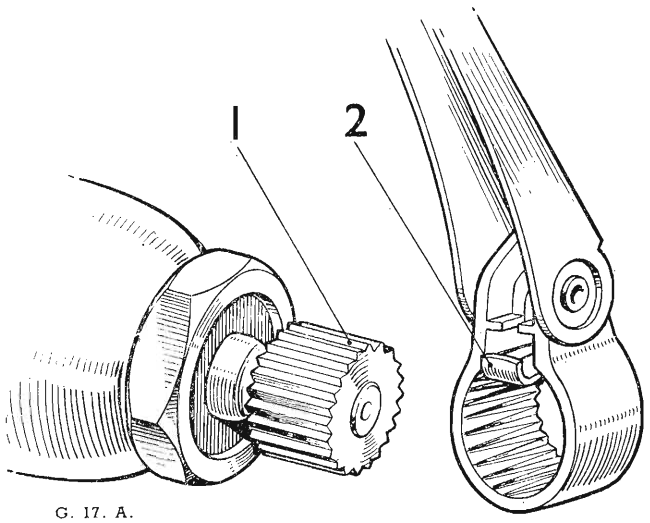


Fig. M.23. Windscreen wiper arm assembly.
1. *Splined driving drum.* 2. *Retaining clip.*

(2) **Armature shaft (commutator end).** Apply S.A.E.20 engine oil sparingly.
(3) **Felt lubricator in gearbox.** Apply S.A.E.20 engine oil carefully.
(4) **Worm wheel bearings, crosshead, guide channel, connecting rod, crank pin, eccentric coupling assembly, worm and final gear shaft.** Grease liberally as for front hubs.
(5) **Cable rack and wheelboxes.** Grease liberally as for front hubs.

Testing

Switch on the ignition and the wiper control. The two wiper areas should be approximately symmetrical on the windscreen.

Fitting a Blade to a Wiper Arm

Pull the wiper arm away from the windscreen and insert the curved 'wrist' of the arm into slotted spring fastening of the blade. Swivel the two components into engagement.

Fitting a Wiper Arm to Driving Spindle

(1) First ensure that the wiper spindles are in the correct parking position by switching on the ignition and turning the wiper control on and then off.
(2) To fit the arms, press the headpieces on to the spindles at the correct parking angle until the retaining clip is heard to snap over the end of the spindle drum.
(3) Switch off the wiper control. The arms should come to rest in the correct parking position.

Adjusting

Correct operation can be obtained by adjusting the position of the arms relative to the spindles. If necessary the position of the arms may be adjusted by removing and re-engaging them with the splined driving spindles, the angular pitch of the splines being 5°.

Do not attempt to turn the arms whilst in position, but press back the retaining clip (Fig. M.23) in the head-pieces and withdraw the arms from the driving spindles. Refit in the desired position. The above adjustment may affect the self-parking position. If so, it may be corrected by adjustment of the limit switch position, as described above.

If the arms and blades are required to come to rest on the opposite side, the limit switch should be turned through 180°. It should be noted that the switch cover is designed for turning through a sector only and not through 360°. This feature prevents unnecessary twisting of the external flexible connections.

Section M.17

IGNITION SWITCH

Description

The ignition switch is of the rotary barrel-type Yale lock located centrally on the facia panel. Operation of the switch is carried out by inserting the ignition key into the lock and turning it in a clockwise direction. In addition to controlling the primary circuit of the ignition coil the switch also operates as a master switch for the ignition, fuel gauge and flashing indicators.

To Test in the Vehicle

Test the ignition switch in the manner described in Section B.

To Remove

(1) Remove the earth lead from the battery.
(2) Disconnect the clip surrounding the switch body behind the facia.
(3) Disconnect the cables from the switch terminals.
(4) Withdraw the switch from the facia.

Section M.18

DIRECTION INDICATOR WARNING LAMP

To Remove and Dismantle

(1) Pull out the bulb holder and bulb from the rear of the warning lamp.
(2) Unscrew the bulb.
(3) To release the red lens unscrew the chrome retaining ring situated on the front of the facia panel.

To Reassemble and Install

The reassembly and installation is the reversal of the procedure 'To Remove and Dismantle'.

Section M.19

PANEL LIGHT BULBS

To Remove

(1) Pull out the bulb holder and bulb from the rear of the facia.
(2) Unscrew the bulb.

To Replace

The replacement of the panel light bulb is a reversal of removal procedure.

Section M.20

HEADLAMP MAIN BEAM WARNING LIGHT BULB

For details see Section M.19.

Section M.21

IGNITION WARNING LIGHT BULB

For details see Section M.19.

Section M.22

FUEL GAUGE SYSTEM

Description

The fuel gauge circuit consists of an instrument panel gauge, a tank unit, and the necessary cables. Its operating current is controlled by the ignition switch.

The gauge is mounted on the facia panel and consists of a metal case and bezel with a dial calibrated to indicate the contents of the fuel tank. Two coils wound on bakelite bobbins with soft iron cores, and shaped pole-pieces, exert a magnetic force on a pivoted soft iron armature, to which is attached the pointer. The magnetic effect of the two coils causes the armature (and therefore the pointer) to be deflected in relation to the amount of fuel in the tank. The voltage across each coil is varied according to the position of the tank unit float arm. The instrument is practically independent of normal variation of battery voltage.

The tank unit is attached by six screws to a flange in the top of the fuel tank, and consists of a float and float arm mounted to a zinc-base die-casting enclosing a

wound resistance. The float arm carries a contact arm which travels over the resistance taking up a position which corresponds to the quantity of fuel in the tank, and this varies the current flowing through the meter.

To Test in the Vehicle

If the gauge fails to register or registers incorrectly, with current available at the (B) terminal of the gauge the fault should be diagnosed by tests as follows:

(1) Disconnect the green with black cable from the fuel gauge terminal marked (T). If the gauge does not register 'FULL' or over with the ignition switched on, then the gauge is faulty. If the gauge registers 'FULL' or over, proceed with test (2) as follows:

(2) With the green with black cable still disconnected, connect a temporary cable between the fuel gauge terminal marked (T) and earth. If the gauge does not register 'EMPTY' or lower with the ignition switched on, then the gauge is faulty. If the gauge registers 'EMPTY' or lower proceed with test (3) as follows:

(3) Disconnect the green with black cable from the fuel tank unit and connect a temporary cable from the fuel gauge terminal marked (T) to the tank unit terminal. If the gauge does not register according to the position of the float in the tank, or registers 'FULL' irrespective of the float position, with the ignition switched on then the tank unit is at fault.
If the contents of the tank are registered correctly with the test cable, but registers 'EMPTY' when in normal circuit, then the cable between the gauge and the tank unit is earthed.
Important: In no circumstances should the battery supply be connected directly to the terminal of the tank unit.

FUEL GAUGE

To Remove

(1) Release the (T) and (B) terminals from behind the gauge.

(2) Free the fuel gauge from the facia by unscrewing the two knurled nuts at the back of the gauge.

(3) Withdraw the gauge forward from the facia panel.

To Replace

The replacement is the reversal of the procedure 'To Remove' noting the following point:

Connect the cables in accordance with the colour code given in the wiring diagram.

TANK UNIT

To Remove

(1) Lower the fuel tank as described in Section D.1.

(2) Remove the six screws securing the tank unit to the fuel tank and withdraw the unit from the tank.

To Replace

The installation of the tank unit is a reversal of the procedure 'To Remove'. Renew the gasket between the unit and the fuel tank flange and tighten the securing screws evenly.

Section M.23

PANEL LAMPS SWITCH

To Remove

(1) Remove the two screws securing the panel lamps switch to the underside of the instrument panel.

(2) Disconnect the cables (red and red with white) from the switch terminals.

(3) Withdraw the switch from the instrument panel.

To Replace

The replacement of the panel lamps switch is the reversal of the procedure 'To Remove', reconnect the cables in accordance with the colour code given in the wiring diagram.

Section M.24

WINDSCREEN WIPER SWITCH

Description

The windscreen wiper switch is located on the left-hand side of the facia panel, and consists of a perspex body with two terminal contacts secured at the base. A spring bridge connector attached to the spindle completes the circuit when the switch knob is pulled outwards. The current supply is via the ignition switch and fuse unit to the wiper motor and then to earth at the switch.

To Test in the Vehicle

If the windscreen wiper fails to operate and it is suspected that the switch is at fault check whether the fault lies in the switch in the following manner:

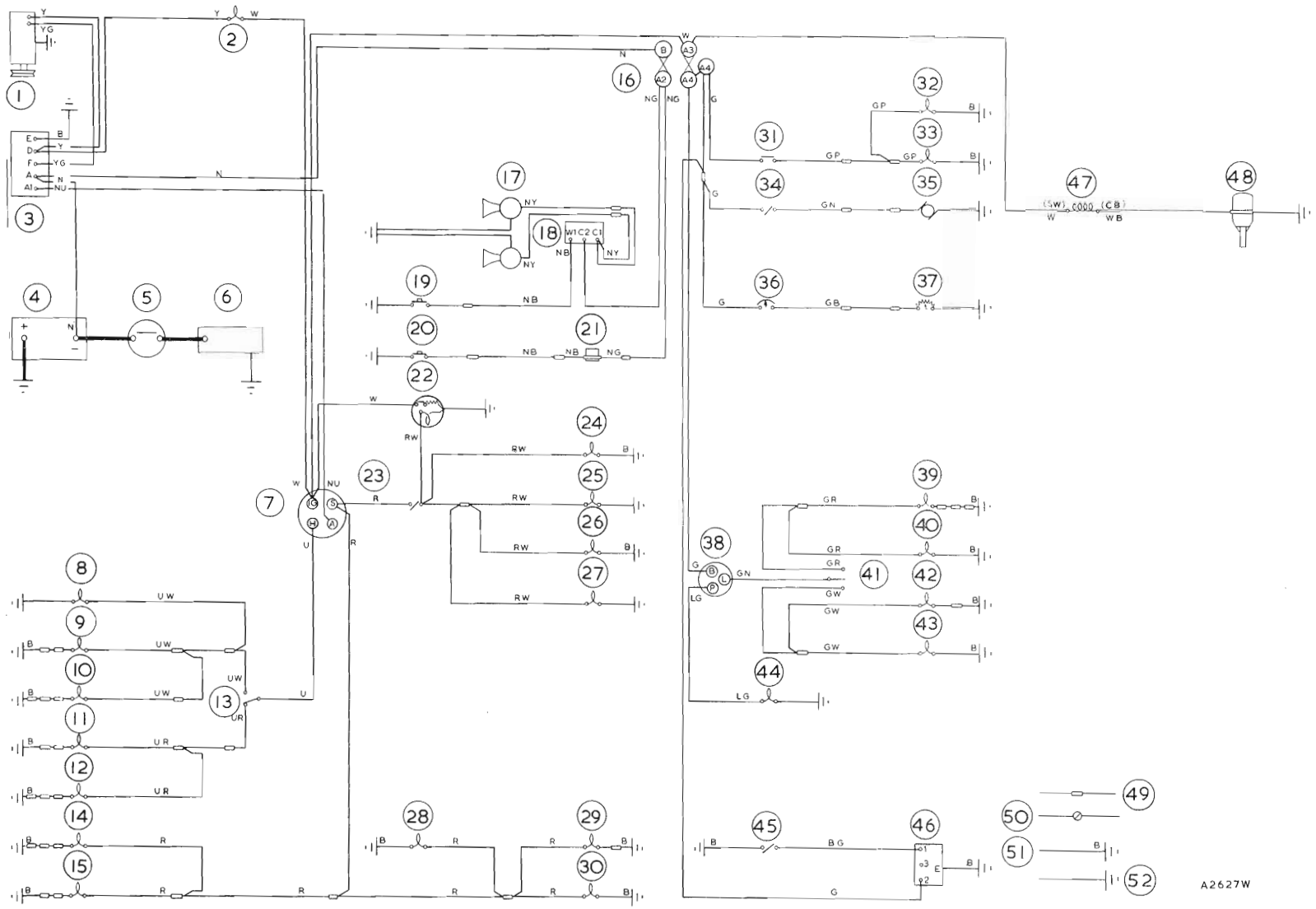
(1) Disconnect the fuse from the terminal (A4) on the fuse unit.

(2) Disconnect the two cables from the switch terminals.

(3) Connect a test lamp in series with a 12-volt battery and the switch. Operate the switch. If the test lamp fails to light then the switch is faulty.

WIRING DIAGRAM

W054 941 00



KEY TO WIRING DIAGRAM (R.H.D. AND L.H.D.)

1. *Generator.*
2. *Ignition Warning Light.*
3. *Control Box.*
4. *12-volt Battery.*
5. *Starter Switch.*
6. *Starter Motor.*
7. *Lighting and Ignition Switch.*
8. *Main Beam Warning Light.*
9. *R/H Headlamp Main Beam.*
10. *L/H Headlamp Main Beam.*
11. *L/H Headlamp Dip Beam.*
12. *R/H Headlamp Dip Beam.*
13. *Dipper Switch.*
14. *L/H Sidelamp.*
15. *R/H Sidelamp.*
16. *Fuse Unit.*
17. *Connections for Twin Windtone Horns (when fitted)*
18. *Horn Relay.*
19. *Horn Push.*
20. *Horn Push.*
21. *Horn.*
22. *Cigar Lighter & Illumination.*
23. *Panel Light Switch*
24. *Panel Light.*
25. *Speedometer Light.*
26. *Panel Light.*
27. *Tachometer Light (when fitted)*
28. *R/H Tail Lamp.*
29. *Number Plate Lamp.*
30. *L/H Tail Lamp.*
31. *Stop Lamp Switch.*
32. *R/H Stop Lamp.*
33. *L/H Stop Lamp.*
34. *Heater Switch* } *when fitted*
35. *Heater Motor* }
36. *Fuel Gauge.*
37. *Fuel Gauge Tank Unit.*
38. *Flasher Unit.*
39. *L/H Front Flasher.*
40. *L/H Rear Flasher.*
41. *Flasher Switch.*
42. *R/H Rear Flasher.*
43. *R/H Front Flasher.*
44. *Flasher Warning Light.*
45. *Windshield Switch.*
46. *Windshield Wipers.*
47. *Ignition Coil.*
48. *Distributor.*
49. *Snap Connectors.*
50. *Terminal Blocks or Junction Box.*
51. *Earth Connections made via Cable or*
52. *Via Fixing Bolts.*

CABLE COLOUR CODE

B	Black	P	Purple	Y	Yellow
U	Blue	R	Red	L	Light
N	Brown	S	Slate	D	Dark
G	Green	W	White	M	Medium

When a cable has two colour code letters the first denotes the main colour and the second denotes the tracer colour.

To Remove

(1) Disconnect the fuse from the terminal (A4) on the fuse unit.
(2) Remove the knob from the switch spindle by unscrewing the grubscrew on the underside of the knob and pulling it off.
(3) Unscrew the front bezel securing the switch to the facia panel.
(4) Disconnect the two cables from the back of the switch, and withdraw the switch through the back of the facia panel.

To Install

The installation is a reversal of the procedure 'To Remove'. Reconnect the cables in accordance with the colour code given in the wiring diagram.

Section M.25

STARTER SWITCH

Description

The starter switch is mounted on the right-hand side of the scuttle within the engine compartment and is operated by a flexible cable attached to a pull knob on the right-hand side of the facia panel. One terminal of the switch is connected to the negative terminal of the battery by a heavy duty cable, and the other terminal is connected by a similar cable to the starter motor.

To Test in the Vehicle

To determine whether the switch will pass current to the starter motor, connect a voltmeter (0 to 20 volts) across the switch terminals, when the voltmeter should register the battery voltage (assuming the starter motor is not defective). Operate the starter switch and note the voltmeter reading: it should fall back to approximately zero. No maintenance is required other than keeping the switch terminals clean and the connections tight. If the switch is found to be faulty it must be renewed as a complete unit.

To Remove

(1) Disconnect the cables from the battery.
(2) Disconnect the switch cable by slackening the locknut on the connecting sleeve, and pulling the wire out of the sleeve.
(3) Remove the locknut from the threaded sleeve of the switch, thus releasing the switch from its mounting bracket.

To Replace

The installation of the switch is the reversal of the procedure 'To Remove'.

Section M.26

HORN-PUSH

Description

The horn-push is located on the steering wheel hub, and comprises an aluminium alloy body containing a brass ring mounted behind an insulating disc in which there are three equally displaced holes. The push-button consists of a steel disc faced with perspex, and is held clear of the cross ring by a helical spring. Current is conducted from the horn via a brown with black wire to an insulated contact ring mounted in the steering column surround. A spring loaded contact plunger mounted in the steering wheel hub connects the contact ring with the brass ring in the horn-push body by passing through one of the holes in the insulating ring.

On pressing the horn-push button the brass ring is connected to earth via the steel disc of the push-button and the helical spring, thus energising the horn circuit.

To Test in the Vehicle

If the horn will not sound when the push-button is depressed remove the horn push, and short the contact plunger direct to earth. If the horn now sounds, the push-button is faulty.

To Remove

The horn-push is held in position by three spring clips, and may be removed by pulling it off the steering wheel hub.

To Replace

When replacing the horn-push align the three spring clips with the depressions in the steering wheel hub so that the contact plunger will pass through one of the holes in the insulating disc.

Section M.27

HORN

Description

The operation of the horn is based on a simple trembler principle. When the horn push is pressed, current flows through the closed contacts of the contact breaker and energises the coil. The coil core is thus magnetised and attracts a leafspring-suspended armature towards an adjustable push rod attached to the diaphragm and tone disc. Movement of the armature opens the contact breaker each time the armature is drawn into the coil, de-energising the magnet system and causing the cycle to be repeated at a frequency determined by the characteristics of the diaphragm and spring leaves

The diaphragm and tone disc are coupled by an adjustable push rod. The vibrating armature impinging on this push rod sets the diaphragm and tone disc into vibration, the diaphragm at a relatively low frequency and the tone disc at a higher frequency. These two sets of vibrations combine together with their various harmonics to give the horn a characteristic note.

To Remove

The horn is located at the front of the vehicle being mounted on the right-hand radiator support bracket.

(1) Disconnect the wires (brown with green and brown with black) at their two snap fasteners.
(2) Unscrew the two cross head bolts and nuts, and remove the horn.

To Replace

Replacement is a reversal of 'To Remove'. Reconnect the wires according to the colour code given in the wiring diagram.

Maintenance

No internal maintenance is required, externally all that is required is an occasional inspection of the horn circuit cables and the fixing bolts.

If the horn fails to operate, or operates unsatisfactorily, first carry out the following external checks.

(1) Examine the cables of the horn circuit, renewing any that are badly worn or chafed. Ensure that all connections are clean and tight and that the connecting nipples are firmly soldered to the cables.
(2) Check that the bolts securing the horn bracket are tight and that the horn body does not foul any other fixture.
(3) Check the current consumption which should be 3 to 3½ amps. when the horn is operating correctly.

After making a thorough external check remove the horn cover, secured by a single screw, and examine the cable connections inside the horn. Examine the contact breaker contacts. If they are burnt or blackened clean them with a fine file, then wipe with a petrol moistened cloth.

Section M.28

HEADLAMP DIPPING SWITCH

To Remove

The switch is foot-operated and is mounted on a bracket welded to the floor assembly.

(1) Remove the two screws securing the switch to the bracket and withdraw the switch.
(2) Disconnect the three cables from the connectors.

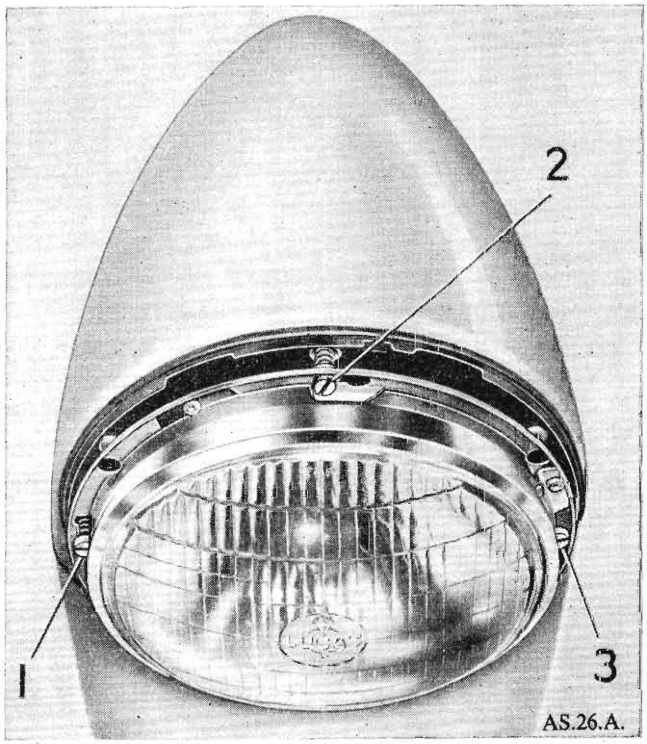


Fig. M.24. Headlamp adjustment.
1. *Horizontal adjustment screw.* 2. *Vertical adjustment screw.* 3. *Horizontal adjustment screw.*

(3) Check the operation of the dip switch. Lightly smear the mechanism with petroleum jelly. A faulty switch must be renewed as a complete unit.

To Replace

The installation of the switch is a reversal of the procedure 'To Remove'. Reconnect the cables in accordance with the colour code in the wiring diagram.

Section M.29

HEADLAMP BULBS

To Remove

(1) Remove the screw securing the front rim to the headlamp unit. This screw is accessible through a hole in the underside of the bonnet.
(2) Remove the dust excluding cover to expose the three-spring-loaded adjustment screws.
(3) Press the light unit inwards against the tension of the adjusting spring and turn it in an anti-clockwise direction until the heads of the screws can be disengaged through the slotted holes in the light unit rim.
Note: Do not disturb the screws as this will alter the lamp setting.

(4) Twist the adaptor in an anti-clockwise direction and pull it off.

(5) Remove the bulb.

To Replace

(1) Install the replacement bulb in the holder, taking care to locate it correctly.

(2) Engage the projections on the inside of the adaptor with the slots in the holder, press on and secure by twisting in a clockwise direction.

(3) Position the light unit so that the heads of the adjustment screws protrude through the slotted holes in the flange, press the unit in and turn in a clockwise direction.

(4) Replace the dust-excluding cover and refit the front rim.

Section M.30

MODIFIED EUROPEAN LIGHT UNIT

Cars exported to Europe are now fitted with the new European-type headlamps. These lamp units are fitted with special bulbs, and front lenses giving an assymetrical beam to the right-or left-hand side to meet the requirements in the Country to which the car is exported. This modification was introduced on the following cars:

from Car No. 10489 (Europe except France).
from Car No. 7782 (France).
from Car No. 21118 (Sweden).

Access to the bulb is gained in the same way as described in Section M.29. The bulb, however, is released from the reflector by withdrawing the three-pin socket and pinching the two ends of the wire retaining clip to clear the bulb flange (see Fig. M.25).

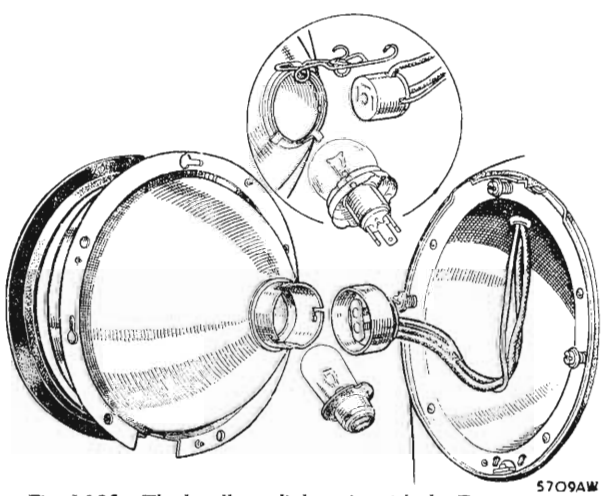


Fig. M.25. The headlamp light unit, with the European-type lamp bulb arrangement inset.

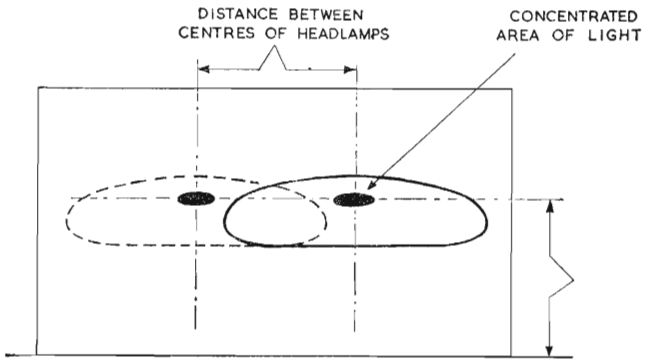


Fig. M.26. Headlamp beam setting.

(a) Front of the vehicle to be square with the wall.

(b) Vehicle to be loaded and on level ground.

(c) Recommended distance for setting is at least 25 feet. (7·6 m.).

When replacing the bulb care must be taken to see that the rectangular pip on the bulb flange engages the slot in the reflector seating for the bulb.

Replace the spring clip with its coils resting in the base of the bulb flange and engaging in the two retaining lugs on the reflector seating.

The appropriate replacement bulbs are listed in **'GENERAL DATA'.** They are not interchangeable with those used in conjunction with the Continental-type headlamps previously fitted.

Section M.31

SEALED BEAM LIGHT UNITS

Cars exported to the U.S.A. are now fitted at the Works with headlamps incorporating sealed beam light units.

To change a sealed beam light unit, remove the headlamp rim and slacken the three retaining screws securing the light unit rim. Rotate the rim anti-clockwise to disengage the slotted holes from the heads of the retaining screws. Pull the light unit forward and disconnect the three-pin socket to release from the backshell.

Section M.32

HEADLAMP BEAM SETTING

The lamps should be set so that the main driving beams are straight ahead and parallel to one another, and parallel to the road surface. If adjustment to the setting is required, first remove the front rim and rubber as previously described. Set each lamp to the correct position in the vertical plane by means of the vertical adjustment screw at the top of the reflector unit. Turn

the screw in a clockwise direction to raise the beam and in an anti-clockwise direction to lower it. Horizontal adjustment can be altered by turning the adjustment screws on each side of the light unit.

The setting of the lamps can best be carried out by placing the car in front of a blank wall at a distance of not less than 25 feet taking care that the surface on which the car is standing is level and not sloping relative to the wall.

It will be found an advantage to cover one lamp while setting the other.

Section M.33

REPLACING A LIGHT UNIT

In the event of damage to either the front lens or reflector, a replacement light unit must be fitted as follows:

(1) Remove the light unit as already described.

(2) Withdraw the three screws from the unit rim and remove the seating rim and unit rim from the light unit.

(3) Position the replacement light unit between the unit rim and setting rim, taking care to see that the die cast projection at the edge of the light unit fits into the slot in the seating rim, and also check that the seating rim is correctly positioned. Finally secure in position by means of the three fixing screws.

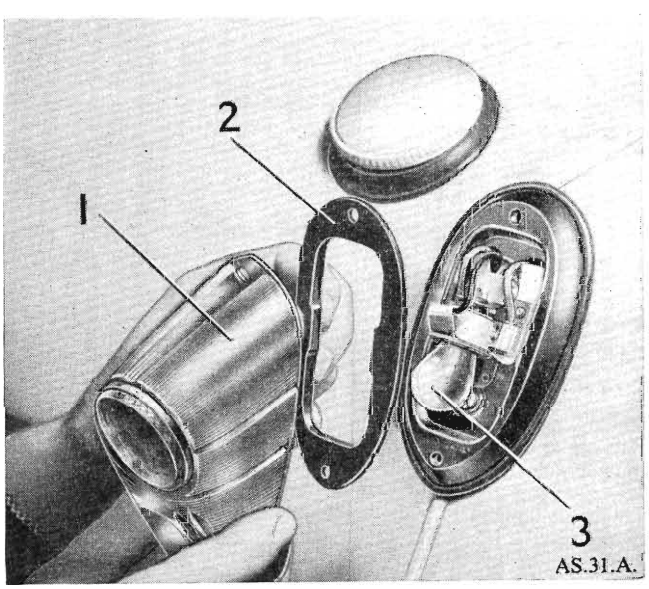


Fig. M.27. Combined stop and tail lamp.
1. *Stop/tail glass.* 2. *Rubber sealing ring.*
3. *Stop/tail bulb.*

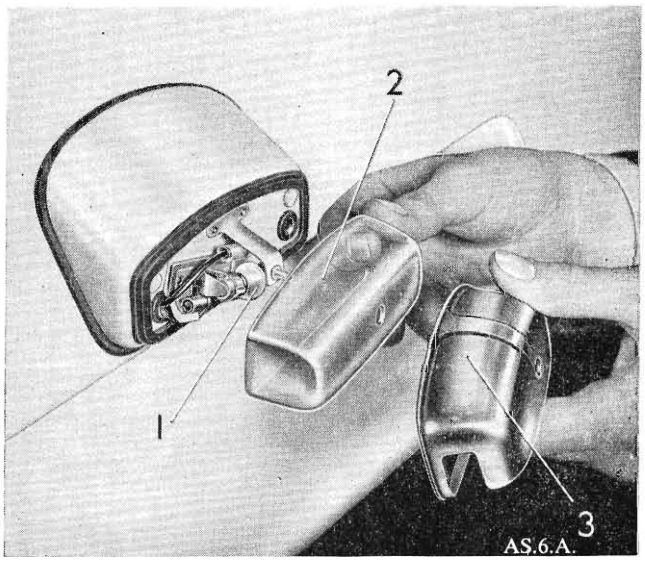


Fig. M.28. Rear number plate light.
1. *Bulb.* 2. *Glass.* 3. *Cover.*

Section M.34

COMBINED SIDE AND FLASHER LIGHTS BULB

To Remove

(1) Prise back the rubber lip and insert a screwdriver blade under the glass retaining collar.
(2) Lever the collar out from the lamp body.
(3) Remove the lamp glass and unscrew the bulb.

To Replace

The installation of a side lamp bulb is a reversal of the procedure 'To Remove'.

Section M.35

REAR FLASHER LIGHT BULB

For details see Section M.34.

Section M.36

COMBINED STOP AND TAIL LIGHT BULB

To Remove

(1) Unscrew the two screws securing the lamp cover glass.
(2) Remove the cover glass.
(3) Unscrew the bulb.

To Replace

The installation of a stop/tail light bulb is a reversal of the procedure "To Remove".

Section M.37

REAR NUMBER PLATE LIGHT BULB

To Remove

(1) Unscrew the screw securing the lamp cover and lift off the cover.
(2) Remove the bulb.

To Replace

The installation of the number plate light bulb is a reversal of the procedure 'To Remove'.

Section M.38 FAULT DIAGNOSIS

Symptom	No.	Possible Fault
(a) Battery discharged	1	Terminals loose or dirty
	2	Lighting circuit shorted
	3	Generator not charging
	4	Regulator unit not operating properly
	5	Battery internally defective
(b) Insufficient current flow to battery	1	Loose or corroded terminal connections
	2	Generator belt slipping
(c) Battery fails to retain charge	1	Electrolyte levels low
	2	Battery plates badly sulphated
	3	Electrolyte leakage due to cracked cell or sealing compound
	4	Plate separators not effective
(d) Battery overcharged	1	Voltage regulator out of adjustment

Symptom	No.	Possible Fault
(e) Generator not charging properly or inoperative	1	Driving belt slipping or broken
	2	Regulator unit not operating properly
	3	Badly worn bearings or pole pieces loose
	4	Short between commutator bars
	5	Armature worn or shaft bent
	6	Commutator out of round
	7	Insulation high between commutator bars
	8	Commutator greasy, glazed or burned
	9	Brush springs weak or broken
	10	Brushes sticking
	11	Field coils shorted, open or burned
(f) Starter motor lacks power or fails to turn the engine	1	Battery in need of attention
	2	Loose or broken connection in starter circuit
	3	Starter motor pinion jammed in mesh with flywheel gear
	4	Starter switch faulty
	5	Brushes worn, sticking or not bedded
	6	Engine abnormally stiff
	7	Commutator dirty or worn
	8	Starter shaft bent
(g) Starter motor operates but does not turn the engine	1	Pinion sticking on the screwed sleeve
	2	Broken pinion or flywheel gear teeth
(h) Noise from starter pinion when engine is running	1	Restraining spring weak or broken
(j) Starter motor inoperative	1	Battery needs attention
	2	Loose or broken connection in starter circuit or switch
	3	Armature faulty
	4	Field coils earthed
(k) Starter motor rough or noisy engagement	1	Starter motor loose on mounting bolts
	2	Damaged pinion and/or flywheel gear teeth
	3	Main spring broken

Symptom	No.	Possible Fault
(l) Lamps inoperative	1 2 3 4	Battery discharged Lamp bulbs burned out Loose or broken connections Lighting switch faulty
(m) Lamps operate when switched on but gradually fade out	1	Battery discharged
(n) Lamps give insufficient illumination	1 2 3 4	Battery in low state of charge Headlamps out of alignment Bulbs discoloured through use Reflector surface deteriorated
(o) Lamps erratic	1 2 3	Lights switch contacts faulty Battery to earth connections faulty Lamp earth faulty
(p) Flashing indicator warning lamp or direction indicator lamp inoperative	1	Check the bulbs and renew if necessary Also see 'Section M.15'
(q) Horn inoperative	1 2 3	Fuse blown Faulty connection Horn faulty internally
(r) Horn operates continuously	1 2	Horn-push stuck or earthed Horn cable (brown with black) to horn-push earthed
(s) Horn note unsatisfactory	1 2	Loose cable connection Horn out of adjustment
(t) Wiper motor inoperative or takes no current	1 2 3 4 5	Fuse blown Battery needs attention Loose or broken connection in the motor circuit Armature faulty Field coils earthed
(u) Wiper motor takes abnormally low current	1 2 3 4	Battery needs attention Armature faulty Commutator dirty Brushes worn or not bedded

Symptom	No.	Possible Fault
(v) Wiper motor sluggish and takes abnormally high current	1 2 3 4	Armature faulty Armature bearings out of alignment Commutator dirty or short-circuited Wheelbox spindle binding or bent
(w) Wiper motor operates but does not drive the wiper arms	1 2 3	Wheelbox gear and spindle worn Driving cable rack faulty Gearbox components worn
(x) Fuel gauge fails to register	1 2 3	Gauge supply interrupted Gauge case not earthed Cable between gauge and tank unit earthed
(y) Fuel gauge registers full	1	Cable between gauge and tank unit broken or disconnected