ALTERNATOR MODELS 15ACR, 16ACR & 17ACR

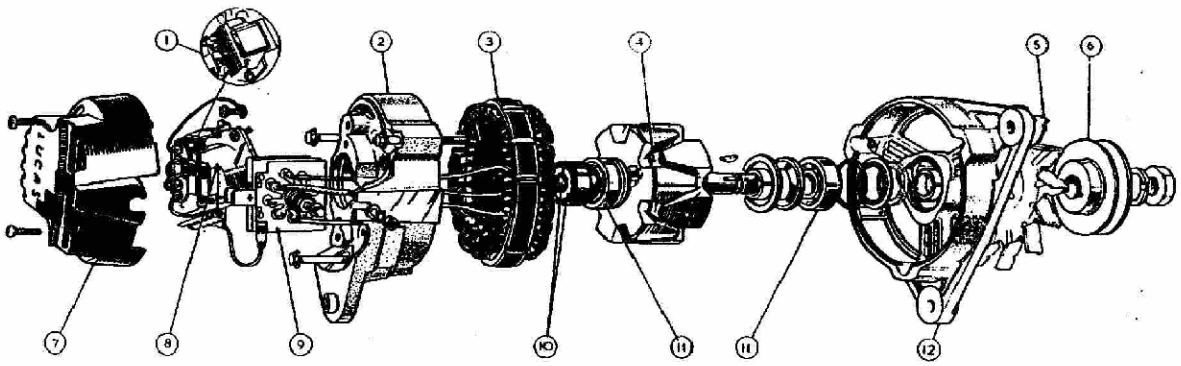


Fig. 1 Alternator Models 15ACR, 16ACR and 17ACR, dismantled

1 Built-in output regulator in heat sink
2 Slip ring end bracket
3 Stator
4 12-pole rotor and field winding assembly
5 Fan
6 Pulley
7 Cover
8 Brushgear and regulator assembly
9 Rectifier pack
10 Slip rings
11 Ball race bearings
12 Drive end bracket

1. DESCRIPTION

These alternators are similar in mechanical construction, 15ACR and 16ACR being dimensionally alike while 17ACR is some ¼" (6.3 mm) longer overall. Differences in the number of turns and the wire gauge on the respective stator windings result in alternative electrical performance characteristics (Fig. 3).

The construction is shown in Fig. 1. The laminated stator carries a 3-phase star-connected output winding. A 12-pole rotor carries the field winding, the rotor shaft running in ball race bearings in die-cast end brackets.

Rectification of alternator output is achieved by six silicon diodes housed in a rectifier pack and connected as a 3-phase full-wave bridge circuit. The rectifier pack is attached to the outer face of the slip-ring end bracket, and contains also three 'field' diodes. At normal operating speeds a small portion of the stator winding current flows through these diodes to provide rectified self-exciting field current. This circuit is taken, via a loop-in cable in the three-way portion of the two-piece terminal connector, to the two brushes which pass current to the field winding by way of face type slip-rings. The latter are carried on a small diameter moulded drum attached to the rotor shaft outboard of the slip-ring end bearing.

A voltage regulator of micro-circuit construction is incorporated on the slip-ring end casting.

System voltage is sensed directly by a permanent connection between the regulator and battery via alternator terminal B+. The battery current drain resulting from this continuous connection is negligible.

Electrical connections to external circuits are brought out to 'Lucar' connector blades, grouped in a manner suitable to accept a two-piece non-reversible moulded connector socket.

Warning Light

The additional 'field' diodes enable a simple charge-indicator warning light to be used (Fig. 2). When the ignition is switched on, the warning light is connected to the battery, the circuit being completed by way of the alternator field winding and the regulator. The bulb is then lit fully. This small current, flowing in the field winding, sets up a flux which supplements the residual flux in the rotor and aids the initial build-up of stator voltage as the rotor begins to rotate when the engine is started.

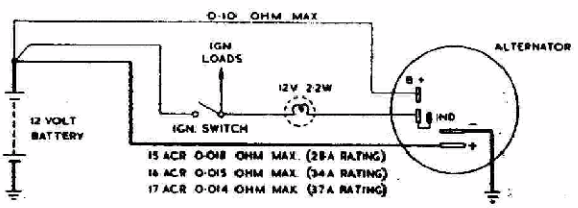


Fig. 2 The charging circuit

As rotor speed and generated voltage increase, the field current supplied by the stator winding through the 'field' diodes increases correspondingly until the alternator becomes fully self-excited. During the rise in stator generated voltage (reflected at terminal IND) the brilliance of the warning light is gradually reduced. At approximately the speed at which the alternator commences to charge, the voltage at the IND terminal equals that at the battery side of the warning light, and the latter is extinguished. Thus, illumination of the warning light under normal running conditions indicates that the alternator is not functioning correctly.

Alternator Models 15ACR, 16ACR & 17ACR

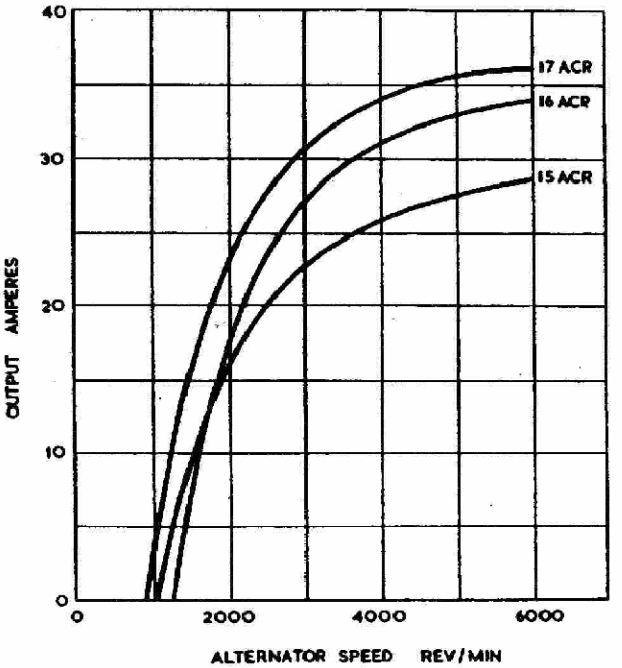


Fig. 3 Typical performance curve (alternator hot)

2. ROUTINE MAINTENANCE

(a) Cleaning

Wipe away any dirt or oil which may have collected around the apertures in the slip-ring end bracket and moulded cover.

(b) Belt Adjustment

Occasionally inspect the driving belt for condition and tension. Refer to the vehicle manufacturer's handbook for the correct method of adjusting belt tension.

IMPORTANT. To avoid bearing damage when adjusting belt tension, apply leverage only on the alternator drive end bracket, not on any other part of the alternator. The lever should be of a soft material, preferably wood.

(c) Lubrication

The bearings are packed with grease during assembly and will normally require no further lubrication during their service life.

(d) Circuit Connections

Care must be taken when connecting the battery, either on the vehicle or in a test circuit, to observe correct polarity matching.

The alternator must only be run either with all charging circuit cables (including the battery) properly connected, or with the two-part connector removed from the alternator terminals.

CAUTION. If electric arc welding is being carried out on any part of the vehicle, the connectors should be removed from the alternator to obviate the slight risk of damage to semiconductor devices.

3. TECHNICAL DATA

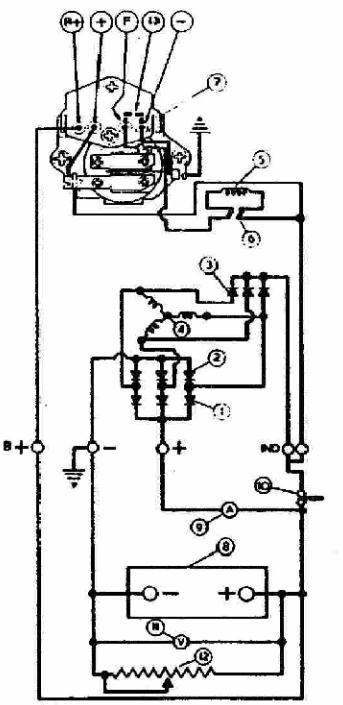
Earth polarity of system:	Negative only	
Nominal voltage:	12	
Nominal d.c. output (hot), at 14.0V and 6,000 rev/min.:	28 amp.	15ACR
	34 amp.	16ACR
	36 amp.	17ACR
Max. permissible rotor speed:	12,500 rev/min.	
Stator phases:	3	
Stator winding connection:	Star	
Number of rotor poles:	12	
Resistance of rotor winding in ohms at 20°C:	4.33 ±5% (15ACR, 16ACR)	
	4.165 ±5% (17ACR)	
Brush spring tension:	9–13 oz (255–368 g) with brush face flush with brush-box housing	

4. SERVICING

(a) Testing the Alternator in Position

First check the driving belt for condition and tension.

The nominal hot ratings are given in para. 3. These figures may be exceeded slightly when the



1 Live side output diodes (3)
2 Earth side output diodes (3)
3 Field feed diodes (3)
4 Stator winding
5 Field winding
6 Slip-rings
7 Voltage regulator
8 12-volt battery
9 0–40 or 0–60 ammeter
10 12-volt 2.2-watt bulb
11 0–20 voltmeter
12 0–15 Ω 35-amp variable resistor
13 --- Link bridging regulator terminals 'F' and '—'

Fig. 4 Alternator output test circuit

alternator is running cold. To avoid misleading results, the following test procedure should therefore be carried out with the alternator running as near to its normal operating temperature as possible.

Alternator Output Test with Regulator Inoperative

Withdraw the two-part connector from the alternator, remove the moulded cover (secured by two screws) and link together regulator terminals 'F' and '—'.

Connect an external test circuit as shown in Fig. 4.

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

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

Start the engine. At 1,500 alternator rev/min, the test circuit bulb should be extinguished. Increase engine speed until the alternator is running at 6,000 rev/min approximately, and adjust the variable resistance until the voltmeter reads 14.0 volts. The ammeter reading should then be approximately equal to the rated output (para. 3). Any appreciable deviation from this figure will necessitate the alternator being removed from the engine for further examination (para. 4b).

Failure of one or more of the diodes will be indicated in the above test by the effect on alternator output, and also in some instances by abnormally high alternator temperature and noise level. The table shows how diode failure will influence test results, and para. 4(g) gives information on testing the diodes.

Regulator Test

The following test assumes the alternator to have been tested and found satisfactory.

Disconnect the variable resistor and remove the link bridging regulator terminals 'F' and '—'.

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

SYMPTOMS

Warning Light	Alternator: Temperature	Alternator: Noise	Output	Probable Fault and Associated Damage
Normal at stand-still, goes out at cut-in speed but then glows progressively brighter as speed increases.	High	Normal	Higher than normal at 6,000 rev/min. 15ACR 35 amp approx. 16ACR 40 amp approx. 17ACR 38 amp approx.	Live side output diode open-circuit. (May damage rotor winding and reg: output stage, overheat brushboxes and blow warning light.)
Light out under all conditions.	High	Excessive	Very low at 6,000 rev/-min. 10 amp approx.	Live side output diode short-circuit. (May cause failure of associated 'field' diode).
Normal at stand-still, dims appreciably at cut-in and gets progressively dimmer or may even extinguish at higher speeds.	Normal	Excessive	Poor at low speed. Slightly below normal at 6,000 rev/min. 15ACR 26 amp approx. 16ACR 32 amp approx. 17ACR 30 amp approx.	Earth side output diode open-circuit.
Normal at stand-still, dims at cut-in, remains dim or may extinguish at (much) higher speeds.	Normal	Excessive	Very low at all speeds above cut-in. 7 amp approx.	Earth side output diode short circuit. (The same symptoms would be apparent if one phase winding was shorted to earth).
As for earth side output diode open-circuit.	Normal	Normal	Lower than normal at 6,000 rev/min. 15ACR 23 amp approx. 16ACR 29 amp approx. 17ACR 29 amp approx.	'Field' diode open-circuit.
As for earth side output diode short-circuit.	Normal	Excessive	Very low at 6,000 rev/-min. 7 amp approx.	'Field' diode short-circuit.

If the foregoing tests show the alternator and regulator to be satisfactorily performing, disconnect the test circuit and reconnect the alternator terminal connector.

Now connect a low-range voltmeter (Fig. 5) between the positive terminal of the alternator (the moulded terminal connector is open-ended to facilitate this) and the positive terminal of the battery. Switch on the headlamps, start the engine and increase speed until the alternator runs at approximately 6,000 rev/min. Note the voltmeter reading.

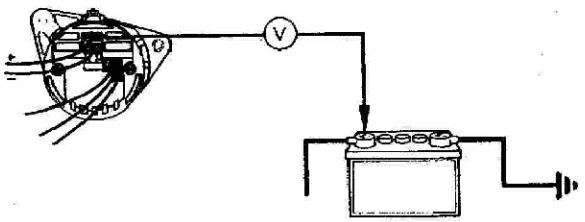


Fig. 5 Charging circuit voltage drop testing — insulated side

Transfer the voltmeter connections to the negative terminals (Fig. 6) of alternator and battery, and again note the meter reading.

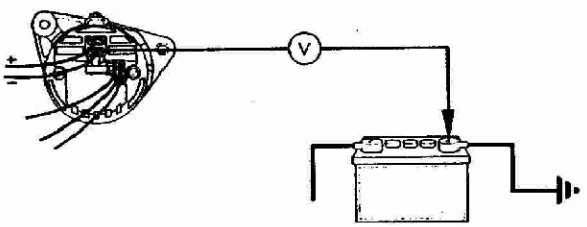


Fig. 6 Charging circuit voltage drop testing — earth side

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

(b) Electrical Test Procedure

The following instructions cover the dismantling required to enable the alternator to be tested electrically. If, as a result of these tests (or because the rotor bearings are to be replaced) further dismantling becomes necessary, proceed as described in 4(h).

Disconnect the battery and alternator cables and remove the alternator from the vehicle.

Withdraw the two moulded cover securing screws and remove the cover.

Unsolder the three stator connections to the rectifier assembly noting the order of connection. (See para. 4(g) for soldering procedure).

Withdraw the two brush moulding securing screws, slacken the nut on the rectifier assembly bolt, remove the screw securing the regulator to the slip-ring end bracket and (when fitted) detach the suppressor cable at the rectifier. Withdraw the brush moulding and rectifier assembly together with the short cable which joins them.

(c) Inspection of Brushgear

The brush length when new is ½" (12.6 mm). The serviceability of a brush may be gauged by measuring the amount by which it protrudes beyond the brush-box moulding when in the free position. For a brush to remain serviceable the amount protruding should exceed 0.2" (5 mm). Renew the brush assemblies if the brushes are worn to or below this amount. If brush renewal is necessary, take care not to lose the leaf spring fitted at the side of the inner brush.

Check the brush spring pressure using a push-type spring gauge. This should indicate 9–13 oz (255–368 g) when the brush is pushed back against the spring until the brush face is flush with the housing. 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. Clean a sticking brush with a petrol-moistened cloth or, if necessary, by lightly polishing the brush sides on a smooth file.

(d) 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 evidence of burning, very fine glass paper. On no account must emery cloth or similar abrasive be used. No attempt must be made to machine the slip-rings as any eccentricity in the machining may adversely affect the high-speed performance of the alternator.

(e) Rotor

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

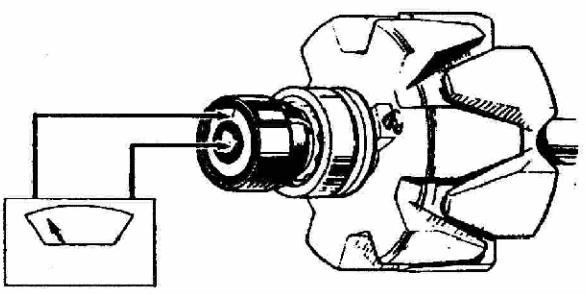


Fig. 7 Measuring rotor winding resistance with ohmmeter

Test the rotor winding by connecting either an ohmmeter (Fig. 7) or a 12-volt battery and ammeter

(Fig. 8) between the slip-rings. The resistance should be as given in 'Technical Data' or the value of current approximately 3 amperes.

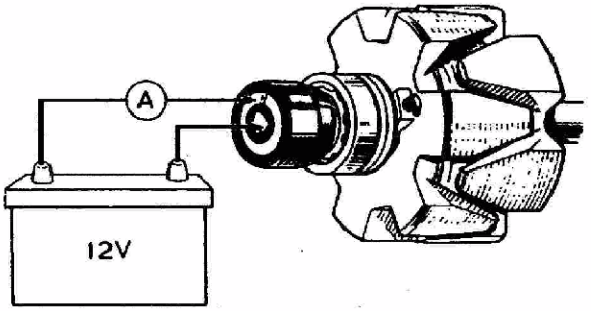


Fig. 8 Measuring rotor winding resistance with battery and ammeter

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. 9). 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.

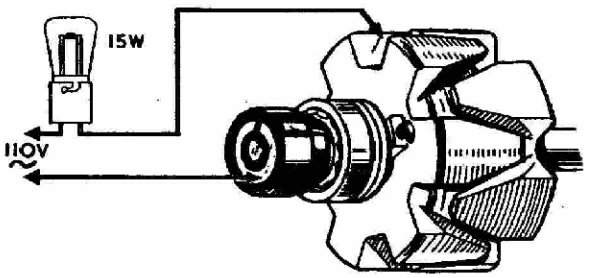


Fig. 9 Insulation test of rotor winding

(f) Stator

Check the continuity of the stator windings by first connecting any two of the three stator cables in series with a 12-volt battery and test lamp of not less than 36-watts (Fig. 10). Repeat the test, replacing one of the two cables by the third cable. Failure of the test lamp to light on either occasion means that part of the stator winding is open-circuit and a replacement stator must be fitted.

Test for defective insulation between stator coils and the lamination pack with the mains test lamp (Fig. 11). Connect the test probes between any one of the three cable ends and the lamination pack. If the lamp lights, the stator coils are earthing and a replacement stator must be fitted.

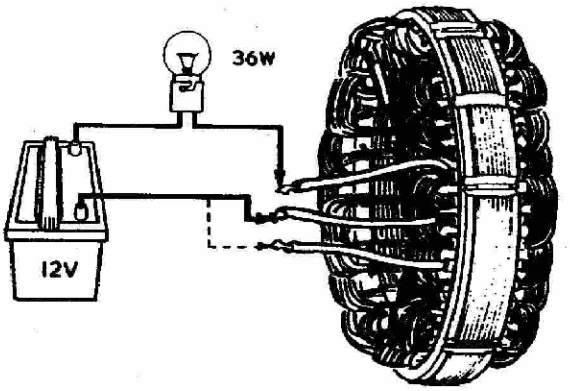


Fig. 10 Stator winding continuity test

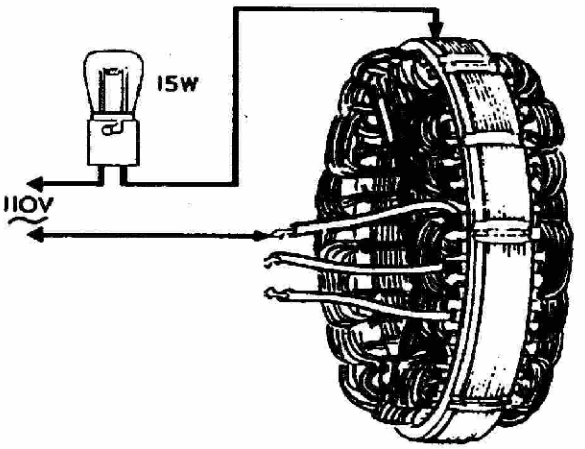


Fig. 11 Insulation test of stator windings

(g) Diodes

In the event of a fault in one or more of the diodes being indicated by the alternator output test (para. 4a), the stator winding connections to the rectifier pack must be unsoldered (para. 4b).

Connect each of the nine diode pins in turn in series with a 1.5 watt test bulb and one terminal of a 12-volt battery (Fig. 12). Connect the other battery terminal to the particular heat sink on the rectifier pack into which the diode under test is soldered. Next, reverse the connections to diode pin and heat sink. The bulb should light in one direction only. Should the bulb light in both tests, or not light in either, the diode is defective and a new rectifier pack must be fitted.

When re-soldering the stator cables to the diode pins use only 'M' grade 45-55 tin-lead solder. Take great care to avoid overheating the diodes or bending the diode pins. The diode pins should be lightly

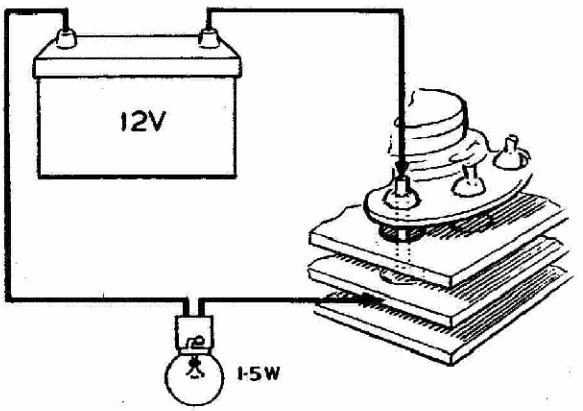


Fig. 12 Simple test for diodes

gripped with a pair of long-nosed pliers (which act as a thermal shunt) and soldering must be carried out as quickly as possible. The operation is shown in Fig. 13.

Fig. 13 Use of thermal shunt when soldering diode connections

(h) Further Dismantling

If as a result of the foregoing electrical tests further dismantling is necessary proceed as follows:

Withdraw the three through bolts. Separate the slip-ring end bracket and stator assembly from the rotor and drive-end bracket — preferably by sleeving a metal tube about 3" long over the slip-ring moulding so as to engage with the outer ring of the slip-ring end bearing and then carefully drive the bearing from its housing with the alternator positioned vertically, fan lowermost. The tube should be 1.320" (33.53 mm) outside diameter and bored out to 1.240" (31.5 mm) for about half of its length. Carefully file away any surplus solder from the field winding terminals which may prevent the tubing from sleeving over the slip-ring moulding. The less preferred method of separating the slip-ring end bracket and stator assembly from the rotor and drive-end bracket is to insert a lever between the stator and the drive-end bracket and carefully prise the two apart until the slip-ring end bearing is clear of its housing.

If necessary, the rotor shaft can be pressed out from the drive end bracket having first removed the shaft nut, washers, pulley, fan and shaft key.

(j) Bearings

The need for bearing replacement during the service life of the alternator is extremely unlikely provided the alternator is mounted correctly and belt tension maintained as recommended. However, should bearing replacement become necessary, proceed as follows:

Drive-end Bearing

Dismantle the alternator as described in 4(b) (i), (ii) and (iv), (it is not necessary to unsolder the rectifier assembly) and also as in 4(h) including the separation of the rotor from the drive end bracket.

The drive-end bearing assembly can be withdrawn following removal of the circlip — see Fig. 1 for details of the bearing assembly.

Slip-ring End Bearing

Dismantle the alternator as described for the drive end bearing. Unsolder the field winding connections to the slip-ring moulding assembly which can then be withdrawn from the rotor shaft. Extract the bearing from the shaft, noting that the shielded side of the bearing faces the slip-ring end moulding. Fit the new bearing and re-engage the slip-ring moulding with the slot in the rotor shaft. Finally, remake the field-to-slip-ring connections using Fry's H.T.3 solder.

When required, the correct lubricant for the alternator bearings is Shell Alvania 'RA'.

(k) Reassembly

Reassembly of the alternator is a reversal of the dismantling procedure given in 4(b) and (h). Ensure that the slip-ring end bearing is positioned as far as it will go along the rotor shaft in the direction of the field assembly. Ensure that the brushes are entered in their housing before refitting the brush moulding. Tighten the through bolts evenly. If the rotor and drive-end bracket have been separated, support the inner ring of the drive-end bearing with the distance collar for the re-assembling operation. Do not use the drive-end as a support for the bearing while fitting the rotor.