

SECTION 55 – ELECTRICAL SYSTEM

Chapter 4 – CHARGING SYSTEM

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55 000 TECHNICAL INFORMATION

CHARACTERISTICS	TYPE OF ALTERNATOR		
	BOSCH 14V-45, 65 and 85A		
Polarity	Negative earth		
Nominal voltage (V)	14		
Max rotation speed (rpm)	15.000		
Maximum output (A)	45	65	85
Regulator controlled voltage (V)	13.6 – 14	13.6 – 14.4	
Rotor field winding resistance (Ω)	3.4– 3.8	2.9	
Stator field winding resistance (Ω)	–	0.2	
New brush length (mm) (in.)	–	20 (0.7874)	
Minimum brush length (mm) (in.)	–	5 (0.1969)	
Brush spring force (N) (lb)	–	1.3–2.7 (0.29–0.60)	

TIGHTENING TORQUE

	Nm (ft lb)
Alternator fastening bolts	5.5 (4.0566)
Pulley fastening nut	70 (51.6293)
Rectifier fastening screws	4.0 (2.9502)
Brush box and regulator screws	2.7 (1.9914)
Terminal nuts	2.7 (1.9914)

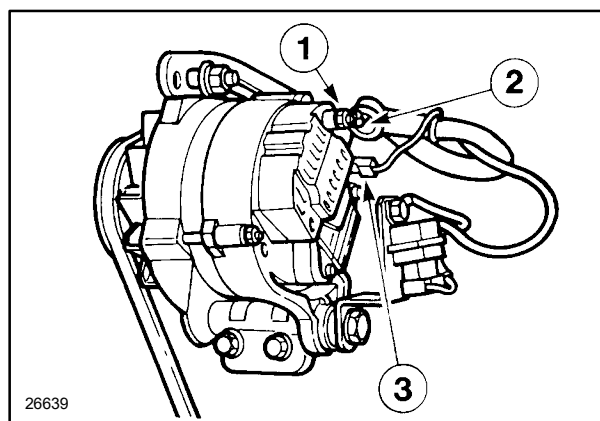
DESCRIPTION AND OPERATION

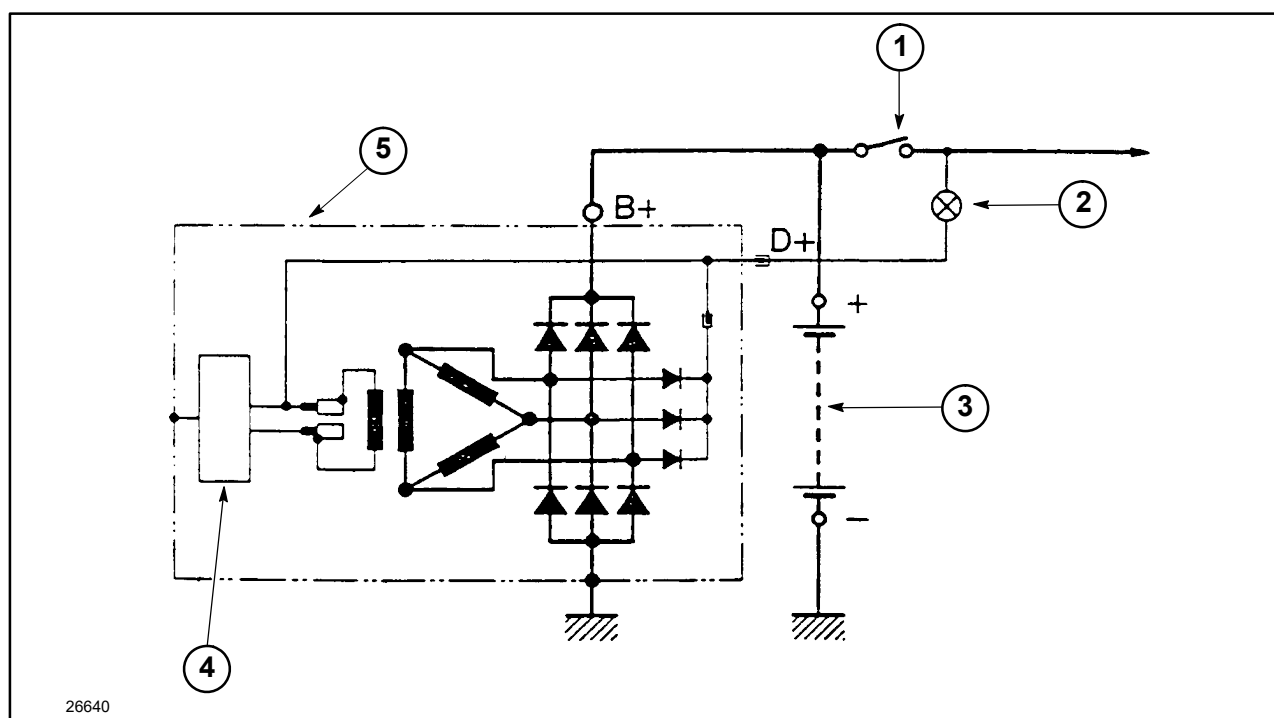
ALTERNATOR DESCRIPTION

Either a Magneti Marelli or a Bosch, 45 or 65 A, alternator, with external cooling fan, is fitted on all models. Stator winding is ventilated with an air conducting diaphragm in the support on the rectifier bridge side and peripheral openings in the support on the control side. The alternator, installed on the left side of the engine, is operated by a pulley and a V-type driving belt. Alternators are fitted with a built-in regulator.

45 or 65 A alternator

1. Battery connection (B+ terminal)
2. Terminal protection sheath
3. Alternator charge indicator connection (D+ terminal)





Alternator charging circuit

2

1. Ignition switch
2. Alternator charge warning light
3. Battery
4. Alternator
5. Alternator electronic voltage regulation circuit

B+ Battery connection
D+ Alternator charge indicator

ALTERNATOR FUNCTIONING

See figure 2.

When the ignition key is turned, a small current passes from the battery through the rotor field winding wiring. The circuit closes powering the charge warning light, the alternator D+ terminal, the rotor field winding, the alternator regulator and earth (ground).

At this stage, the warning light comes on and the rotor is partially magnetised.

When the engine starts and the rotor, partially magnetised, turns inside the stator windings and generates three-phase alternating current. A constant quantity of this current is transformed into direct current by three field diodes built into the rectifier.

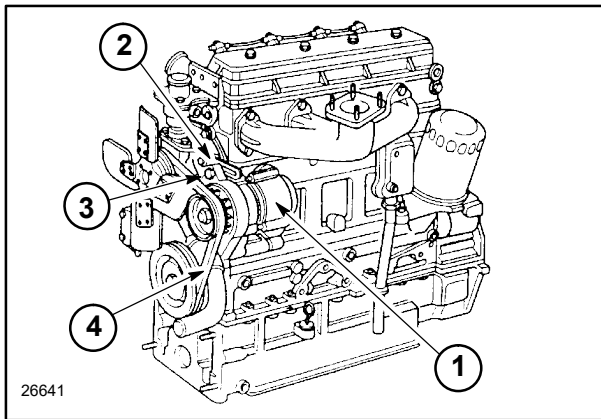
The direct current is then reintroduced into the circuit to increase current flow through the rotor field winding.

This action causes a constant increase in the rotor magnetic field and a fast increase of current and voltage output.

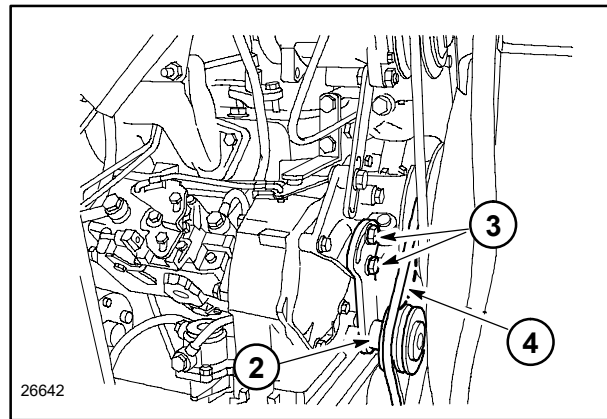
As the generated voltage output (reflected by D+ terminal) increases, the warning light intensity decreases and when the voltage at the D+ terminal equals that on the battery side of the warning light, the light goes out.

Voltage increases until it reaches the pre-set regulated voltage level.

If the driving belt breaks, there will be no voltage accumulation in the alternator. The charge warning light will stay on, thus indicating a fault.



3



4

Fan belt tensioner

Fig. 3. Belt for versions without air conditioning

Fig. 4. Belt for versions with air conditioning

- 1. Alternator
- 2. Belt tensioner

- 3. Belt tensioner securing nut
- 4. Belt

SYSTEM TESTING AND TROUBLE-SHOOTING

PRECAUTIONS

To avoid damaging alternator charging system components, take the following precautions:

- **DO NOT MAKE OR INTERRUPT** any charging circuit connection, including the battery, while the engine is running.
- **NEVER SHORT-CIRCUIT** the alternator positive terminal to check if it is working.
- **ALWAYS DISCONNECT** battery cables when recharging the battery in the tractor with a battery charger.
- **ALWAYS CHECK** battery polarity when installing a battery or using a supplementary battery to start the engine.
- **DO NOT SHORT-CIRCUIT** regulator input/output terminals when the alternator is working.
- **CONNECT POSITIVE TO POSITIVE AND NEGATIVE TO NEGATIVE.**

PRELIMINARY CHECKS

Before carrying out these electrical tests, carefully inspect the charging system and the electrical system in general.

Check continuity in all conductors and connections. Check they are all clean and well fastened.

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1. CHECKING THE BATTERY

Check all battery elements with a densimeter. The battery must be at least 70% charged and efficient.

2. CHECKING THE DRIVING BELT

Inspect the alternator driving belt and pulley, checking that they are both clean, with no traces of oil or lubricant and in good condition.

Check the alternator driving belt tension regularly. If you suspect the belt is not tight, check the tensioner as follows:

Belt for versions without air conditioning (Fig. 3)

- slacken the nut (3) which secures the alternator to the tensioner bracket (2).
- with a lever, move the alternator (1) on the tensioner bracket (2) to reach correct belt tension and tighten the securing nut (3) to 55 Nm (40.5659ft lb).

Belt for versions with air conditioning (Fig. 4)

- slacken the belt tensioner securing nuts (3)
- hold the belt tensioner arm (2) and move it on the bracket to reach the correct belt tension, then tighten the securing nuts (3) to 55 Nm (40.5659ft lb).

Correct deflection values, measured by applying the following loads to the middle of the belt:

	Version with- out cab or with cab with- out air condi- tioning	Version with cab and air conditioning
Load (N) (lb)	78 – 98 (17.20–21.61)	60 – 75 (13.28–16.53)
Deflection (mm) (in.)	10–11 0.3937–0.4331	10 (0.3937)

3. CHECKING THE WARNING LIGHT

Turn the ignition key and check the light is completely lit.

If the warning light does not light completely, check the light bulb. If the light bulb has not blown, carry out the alternator wiring connection tests as described in the paragraph “PRELIMINARY TESTS” in this section.

If the light is on, start the engine and run it above minimum speed. The warning light should go out.

If the warning light does not go out, stop the engine and disconnect the D+ terminal wire. If the warning light goes out now, one of the alternator components is malfunctioning. Carry out “ALTERNATOR COMPONENT TESTS” described in this section.

If the warning light stays on, check there is no short circuit between D+ wire ending and warning light.

PRELIMINARY TESTS

These preliminary tests can be carried out without removing any components from the tractor charging circuit. These tests check:

- the alternator wire connections
- alternator charging current and controlled voltage
- voltage drop in the alternator charging circuit
- maximum alternator output

The following testing devices are required:

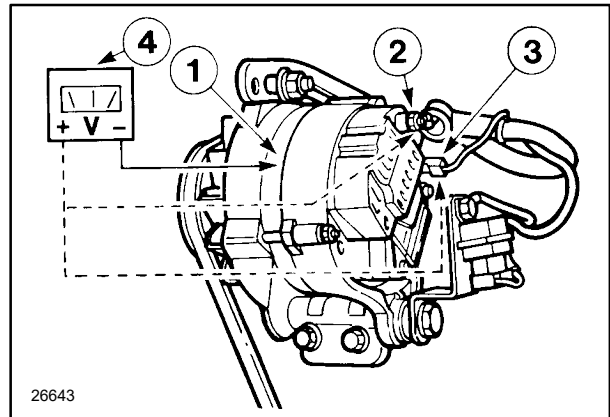
- 0–30V moving coil voltmeter
- 0–1V millivoltmeter
- 0–110 A moving coil ammeter
- 1.5 ohm, 110 A varying load resistance

NOTE: *Most testing devices on the market today combine several electrical test functions (multimeters). When using these devices, follow the manufacturer's instructions.*

1. ALTERNATOR WIRE CONNECTIONS TEST

See figure 5.

1. Disconnect the battery.
2. Disconnect B+ (2) and D+ (3) alternator terminals.
3. Reconnect the battery and turn the ignition key into position ON but without starting the engine. Connect a voltmeter (4) between each terminal and earth (ground) (1). There must be voltage at the battery.



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If there is no voltage at the battery, check for a continuity fault in the external wiring. See circuit diagram in figure 2.

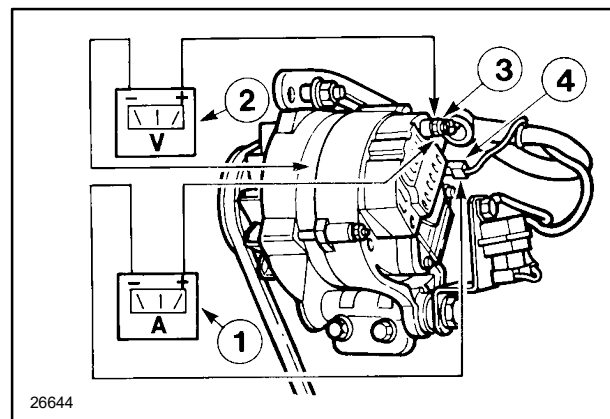
4. Connect D+ terminal, warning light wire (red) and earth (ground). The warning light should illuminate.
5. Disconnect the battery and reconnect the cables to the alternator at (2) and (3) fig. 5.

NOTE: If the warning light does not light up when the wire is connected to the alternator, this means that there is a fault either in the alternator regulator circuit or in the rotor circuit. Check D+ terminal is clean and then test the alternator components as described in this section.

2. CHARGING CURRENT AND REGULATED VOLTAGE TESTS

See figure 6.

1. Check that all tractor electrical devices are switched off and the ignition key is in the OFF position.
2. Disconnect the negative battery terminal clamp and the B+ negative alternator terminal.
3. Connect an ammeter (1) between the disconnected wire (red) (4) and the B+ alternator terminal (3).
4. Connect a voltmeter (2) between the B+ alternator terminal (3) and earth (ground).
5. Reconnect the battery. Start the engine and run it at 2000 rev/min. Note the readings on the voltmeter and the ammeter.



6

The voltmeter reading should be higher than the battery voltage and when the ammeter reading falls below 10 A, the voltmeter reading should stabilise at 13.6 – 14 V (Magneti Marelli alternator) or 13.6 – 14.4 V (Bosch alternator).

If the voltmeter reading is higher than 14 V or 14.4 V, for Magneti Marelli or Bosch alternators respectively, the alternator regulator must be changed, as described in this section. (After installing a new regulator, carry out tests 4 and 5).

If the voltmeter reading is less than 13.6 V, there is either a faulty component in the alternator or a failure due to excessive resistance in the external charging system connections.

If the ammeter reads zero amps, then one of the alternator components is malfunctioning. Turn the engine off and carry out the alternator component test, as described in this chapter.

3. CHARGING CIRCUIT VOLTAGE DROP TESTS

(a) Insulated side voltage drop test

See figure 7.

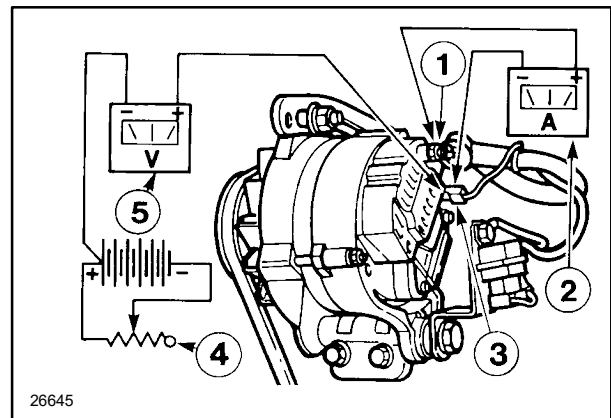
Check the ignition key is in OFF position.

1. Disconnect the negative battery cable and the B+ alternator wire (1).
2. Connect a millivoltmeter (5) between the positive battery terminal clamp and D+ wire (3) (positive side of the wire).
3. Connect an ammeter (2) between the B+ alternator terminal and the D+ wire (negative side of the wire).
4. Reconnect the negative battery cable and connect a varying load resistance (4) with cursor in minimum current absorption position (maximum resistance) through the battery terminal clamps.
5. Start the engine and increase speed to 2000 rev/min.
6. Decrease resistance charging load (decreasing resistance) slowly until the ammeter reads 45 or 65 A, according to the type of alternator.
7. Note the reading on the millivoltmeter. This must not be higher than 400 millivolts.

A reading higher than 400 millivolts indicates malfunctioning due to excessive resistance in the external circuits.

If the alternator does not output required power and the millivoltmeter reading is less than 400 millivolts, there is a malfunctioning component in the alternator. Carry out the alternator component tests, as described in this section.

8. Stop the engine.



(b) Ground side voltage drop test

See figure 8.

1. Check the ignition key is in OFF position.
2. The circuit is the same as that described in the previous test, except that the millivoltmeter (4) is now connected between the negative battery terminal clamp and the alternator casing (negative side of casing).

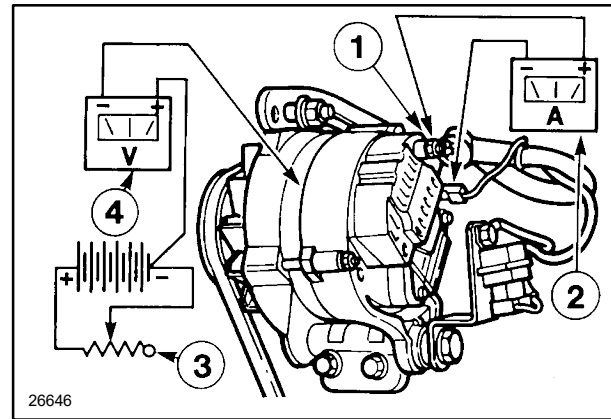
NOTE: Check the varying load resistance (3) is in minimum current absorption position (maximum resistance).

3. Start the engine and increase speed to 2000 rev/min.
4. Increase resistance current load (decreasing resistance itself) slowly until the ammeter (2) reads 45 or 65 A. according to the type of alternator.
5. Note the reading on the voltmeter. This must not be higher than 200 millivolts.

A reading higher than 200 millivolts indicates malfunctioning due to excessive resistance in the external circuits.

If the alternator does not output required power and the millivoltmeter reading is less than 200 millivolts, there is a malfunctioning component in the alternator. Carry out the alternator component tests as described in this section.

6. Stop the engine.

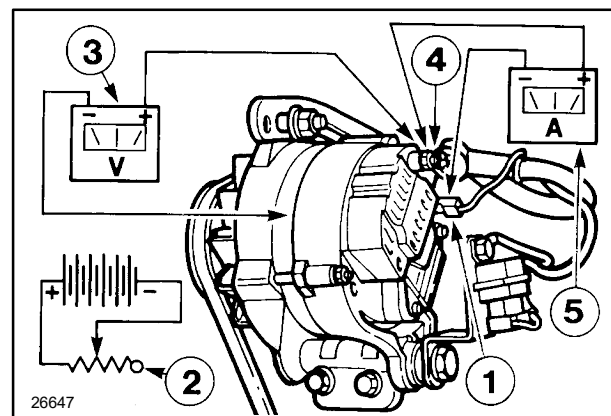


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4. MAXIMUM ALTERNATOR OUTPUT TEST

See figure 9.

1. Check the ignition key is in the OFF position.
2. Disconnect the negative battery cable and the B+ alternator wire (4).
3. Connect an ammeter (5) between B+ alternator terminal (4) and D+ wire (1) (negative side of the wire).
4. Connect a voltmeter (4) between the B+ alternator terminal (5) and earth (ground).
5. Reconnect the negative battery cable. Start the engine and increase speed to 2000 rev/min.



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6. Increase resistance current load (2) (decreasing resistance) slowly until the ammeter reads 45 or 65 A., according to the type of alternator.
7. Note the reading on the voltmeter. This must not be less than 13.6 V.

A reading lower than 13.6 V. shows there is a malfunctioning component in the alternator. Carry out the alternator component tests, as described in this section.

ALTERNATOR COMPONENT TESTS

These alternator tests must be carried out only if the PRELIMINARY TESTS have shown a malfunctioning alternator component. These tests check:

- the regulator,
- rotor field winding continuity,
- rotor brushes, springs and contact rings.

NOTE: *The previously described component tests can be carried out with the alternator installed in the tractor. In order to carry out the other alternator tests, it will be necessary to remove the alternator from the tractor. Refer to the section "FUNCTIONAL TESTS" in this chapter.*

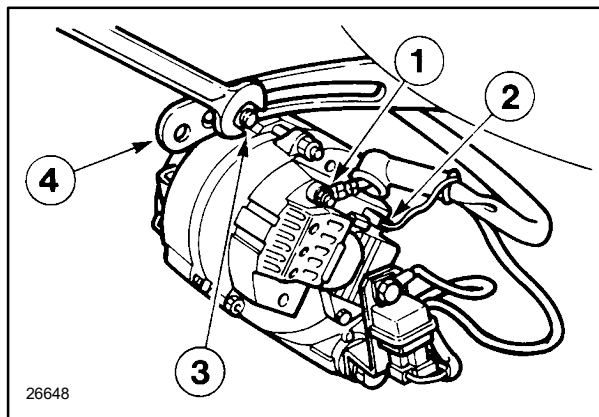
REMOVAL, REASSEMBLY AND SERVICING (Op. 55 301 10)

IMPORTANT NOTE: Before disconnecting the alternator wires, check that the ignition key is in the OFF position.

REMOVING THE ALTERNATOR

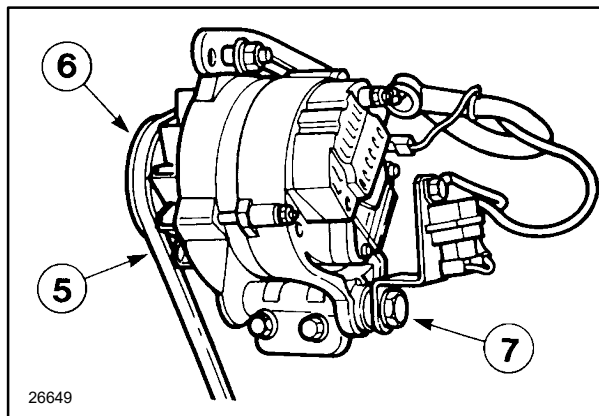
See figures 10 and 11.

1. Disconnect the negative battery cable.
2. Disconnect B+ (1) and D+ (2) wires from the alternator.

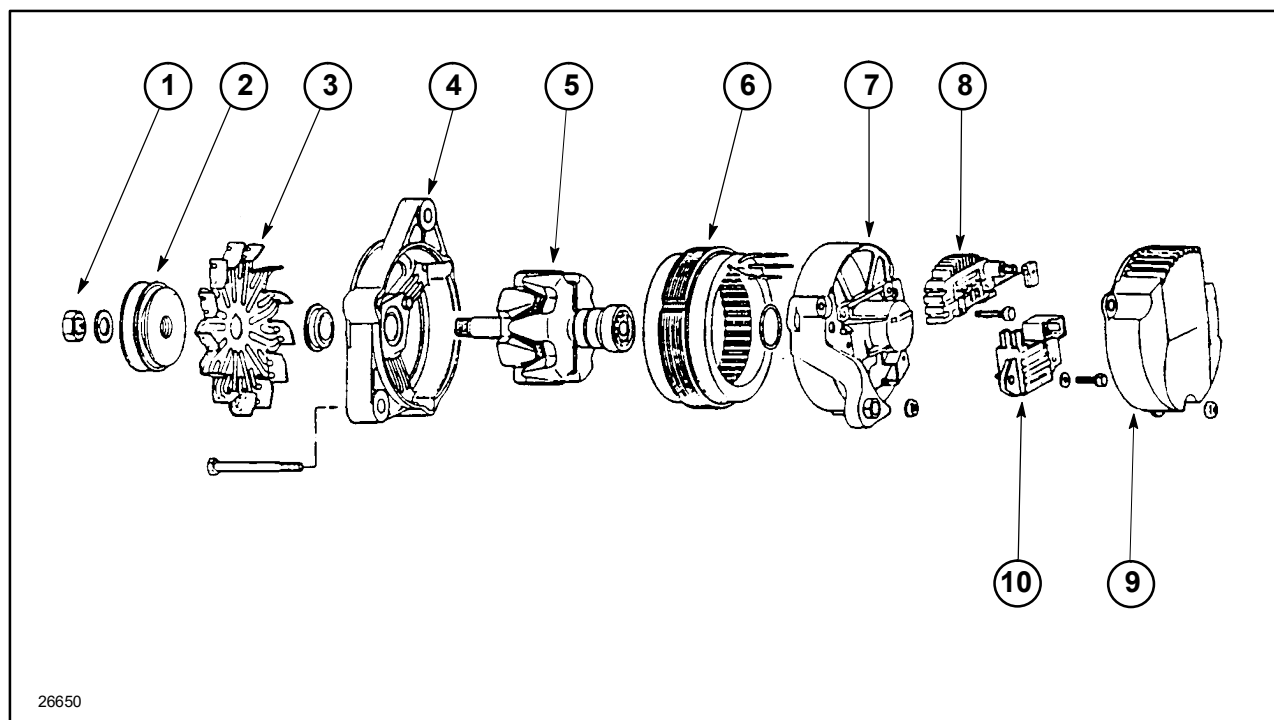


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1. Slacken and remove the nut and bolt (3) securing the alternator to the belt tensioner (4).
2. Move the alternator to reduce belt tension (5) and remove it from the alternator pulley (6).
3. Unscrew and remove the nut and bolt (7). Remove the alternator.



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Alternator components

12

1. Pulley retaining nut
2. Pulley
3. Cooling fan
4. Front support plate
5. Rotor

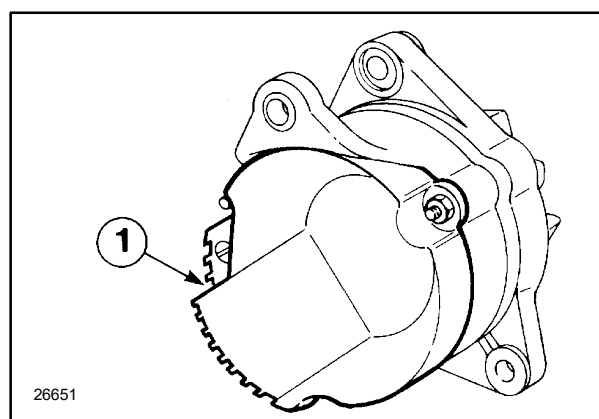
6. Stator
7. Rear support plate
8. Rectifier bridge
9. Protection guard

10. Electronic voltage regulator with built-in brushes

Firmly fix the alternator horizontally to an appropriate holder with internal surfaces protected with soft material.

Remove the guard (1) after unscrewing the nuts which fasten it to the alternator (Fig. 13)

Before dismantling the alternator completely, carry out the operations and tests described on the following pages.



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ROTOR AND REGULATOR FIELD CIRCUIT TEST

The following testing devices are required:

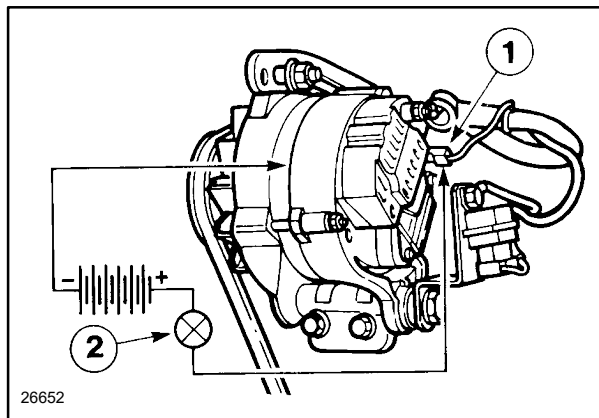
- 12 volt battery
- multimeter
- 2 watt test lamp.

See figure 14.

1. Disconnect all alternator wires.
2. Connect a 12 V. battery and a 2.2 watt test lamp (2) in series to D+ (1) and alternator casing (negative side of the casing).
3. The test lamp should light up.

If the test lamp does not light up, then the rotor circuit is faulty. Check brushes, contact rings and rotor field winding continuity.

If the test shows these components are satisfactory, then the regulator may be faulty.

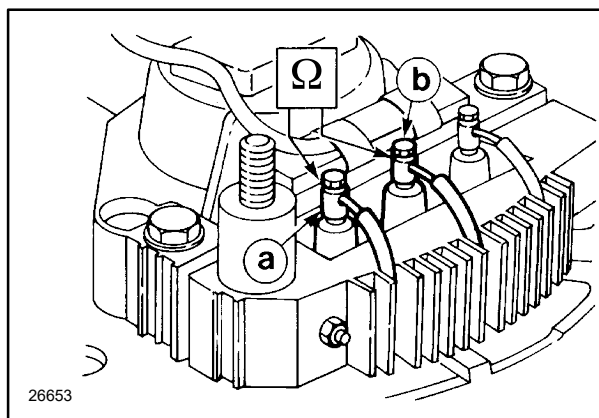


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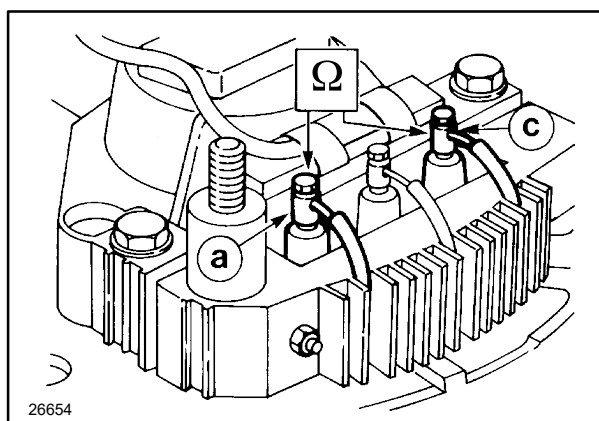
CHECKING THE CONTINUITY OF THREE STATOR WINDINGS

Position the points of an ohmmeter (regulated on Ω x1 scale) so that they touch the stator phase ends (a – b – c) in the three possible ways shown in figures 15, 16 and 17. Each reading should show a certain resistance value which should be the same for all three readings.

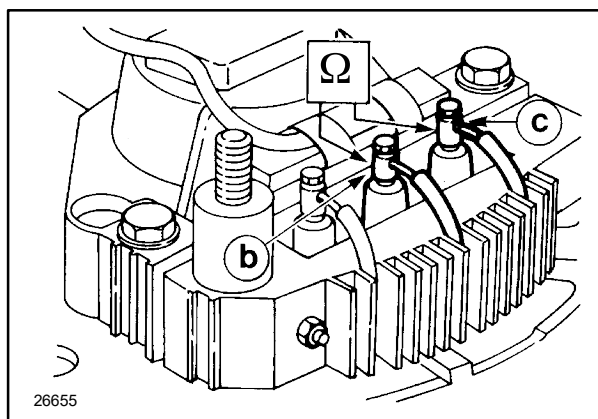
If resistance shows infinity or zero, the measured phase is either interrupted or short-circuited and the stator needs to be changed.



15



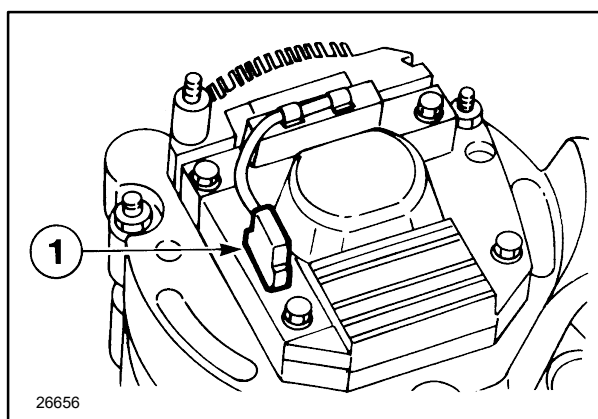
16



17

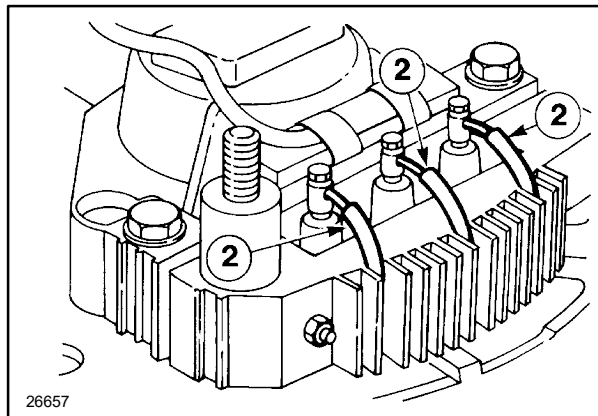
CHECKING THE DIODES

Disconnect the terminal wire connector (1) of the excitation diodes from the positive brush pin (Fig. 18).



18

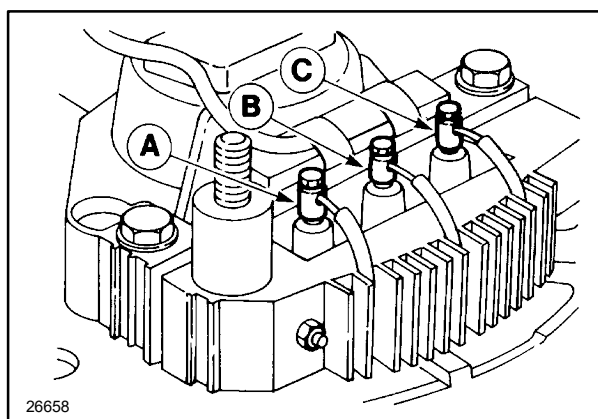
Unweld stator winding terminals (2) from the rectifier bridge (Fig. 19).



19

EXCITATION DIODES TEST

Insert an ohmmeter point in the connector mentioned above (1) (Fig. 18). The second point must be put in contact successively with each of the three terminals (A–B–C): Repeat the three measurements after reversing the instrument points (Fig. 20).

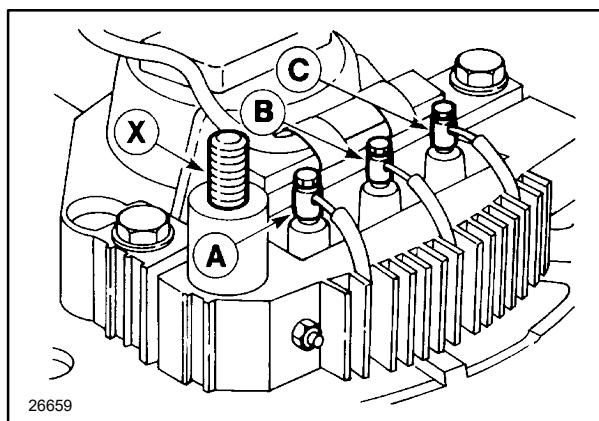


20

POSITIVE POWER DIODES TEST

Put an ohmmeter point in contact with the positive (X) alternator terminal and the other successively with each of the three terminals (A–B–C) (Fig. 21).

Repeat the three measurements after reversing the instrument point connections.

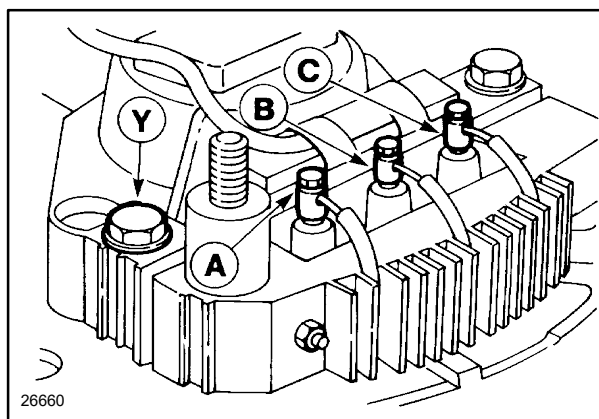


21

NEGATIVE POWER DIODES TEST

Put an ohmmeter point in contact with the negative (Y) diodes plate and the other successively with each of the three terminals (A–B–C) (Fig. 22).

Repeat the three measurements after reversing the instrument point connections.



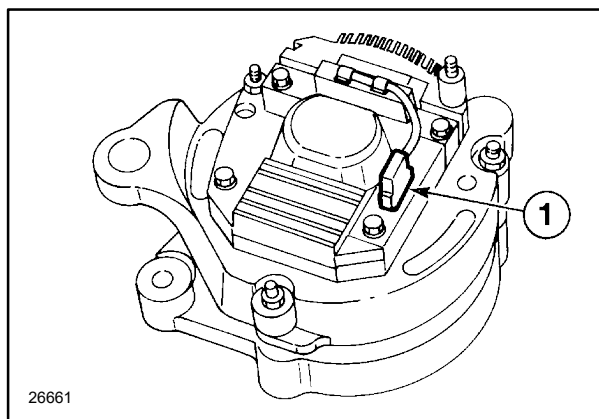
22

In the three tests described above, the instrument should show resistance at each terminal (A–B–C). Reversing the instrument point connection, there should be no resistance (Fig. 22). If there is resistance in both cases, this means short-circuited diodes. Otherwise, with a $R=0$ value (interrupted diode), change the whole rectifier bridge.

ROTOR

CHECK ON ROTOR WINDING RESISTANCE MEASURED BETWEEN PINS CONNECTED TO BRUSHES

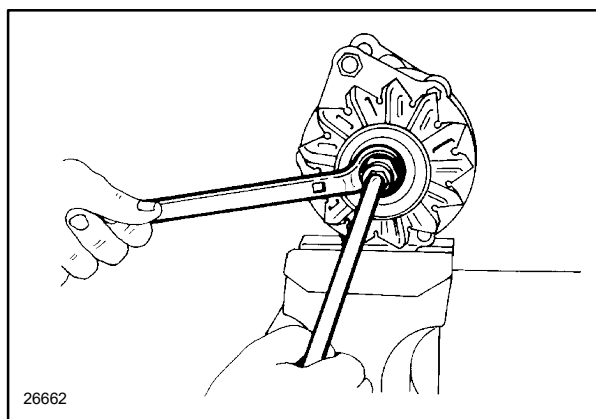
Disconnect the excitation diode terminal wire connector (1) from the pin connected to the positive brush. Put both points of an ohmmeter (regulated on $\Omega \times 1$ scale) in contact with the two voltage regulator–brush holder pins. If resistance reading is different from the indicated value or if it shows infinity (interrupted circuit), check and, if necessary, change the rotor (Fig. 23).



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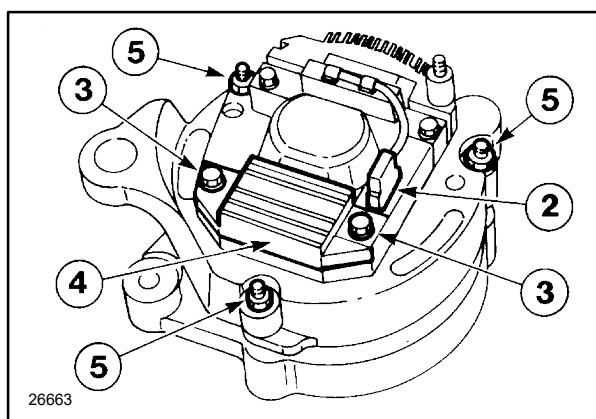
DISASSEMBLY (Op. 55 301 12)

Place a suitable Allen wrench in the hexagonal hole in the alternator shaft to prevent the alternator shaft from turning. With another wrench, unscrew the fan and rotor pulley fastening nut. Draw out the above mentioned parts, spacing collars and alternator washers (Fig. 24).



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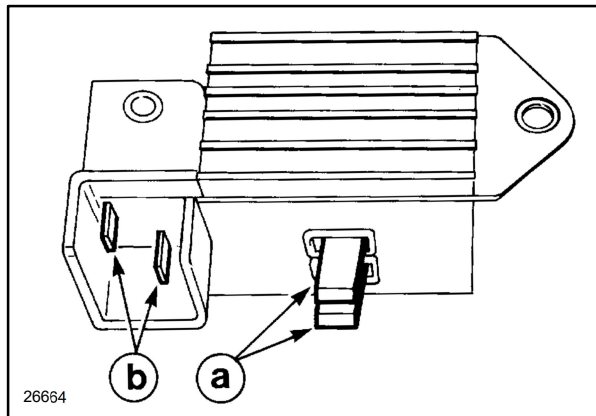
Disconnect the excitation diode terminal wire connector (2) from the pin connected to the positive brush. Unscrew and remove the screws (3) securing the electronic voltage regulator (4), complete with brushes, to the rear alternator support. Unscrew nuts (5) and remove the screws fastening the alternator main external parts (Fig. 25).



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ELECTRONIC VOLTAGE REGULATOR (Fig. 26)

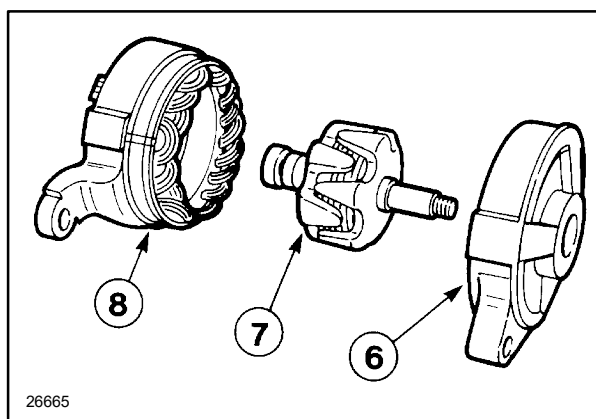
- a. Brushes
- b. Pins



26

Separate the parts (as illustrated) bearing in mind that it is necessary to apply a considerable degree of pressure on the rotor shaft to free the front support plate (6) and the rotor (7) (Fig. 27).

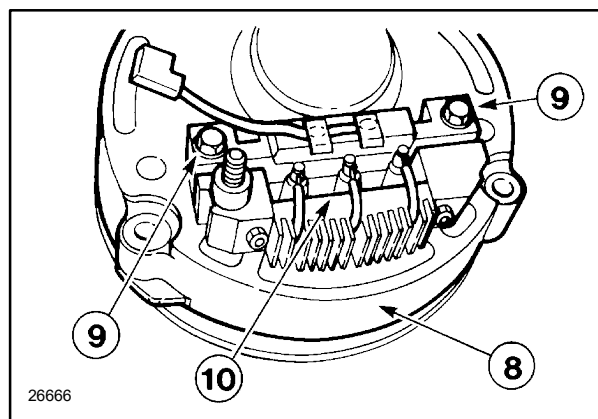
If you do not have a press, use a brass drift, to avoid damaging the thread.



27

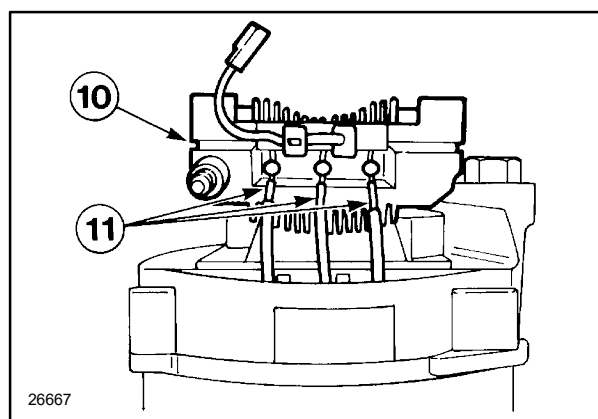
Unscrew the screws (9) which fasten the rectifier bridge (10) to the rear support plate (8) (Fig. 28).

The rectifier bridge must not be dismantled: the spare part is supplied as a complete unit.



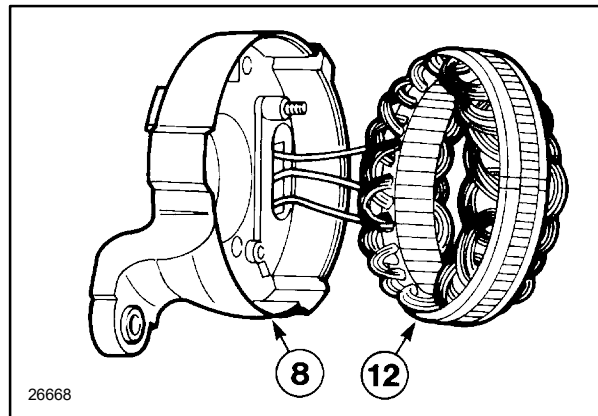
28

Separate the rectifier bridge (10) from the rear support plate. Unweld the stator winding terminals (11) (Fig. 29).



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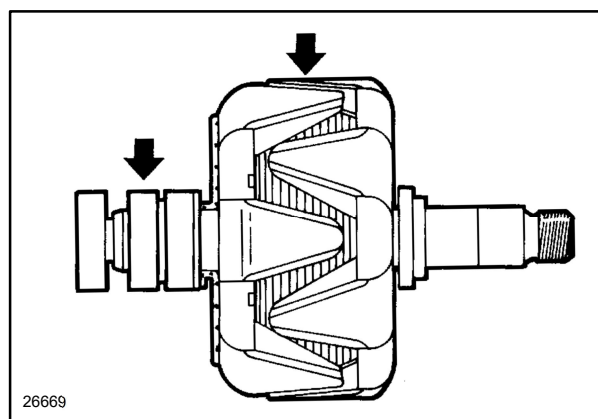
Separate the stator (12) and the terminals (11) from the rear support plate (8) (Fig. 30).



30

INDUCTOR COIL INSULATION TEST

Put both ohmmeter points (fixed at $\Omega \times 1$ scale) in contact respectively with a slip ring and the rotor casing (see arrows). The instrument should show infinity resistance. If this is not the case, change the rotor (Fig. 31).

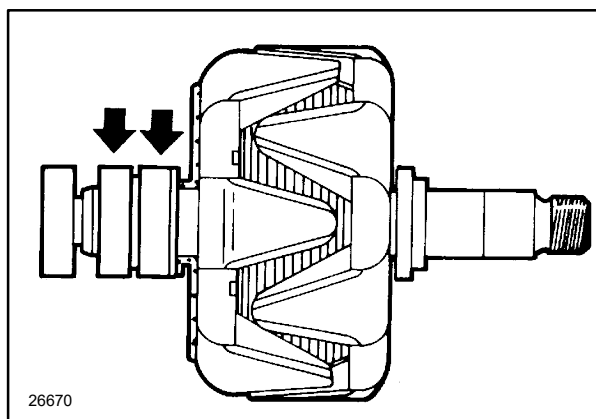


31

Check rotor inductor resistance on slip rings

Put both ohmmeter points (fixed at $\Omega \times 1$ scale) in contact respectively with the slip rings (see arrows). The instrument should show a certain degree of resistance (Fig. 32).

If the instrument reading is different from the prescribed value or shows infinity (interrupted circuit), change the rotor.



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Check the ball bearing moves freely, without sticking or noise. Check the collectors have not been damaged by the brushes. If this is the case, change the whole rotor.

REASSEMBLY

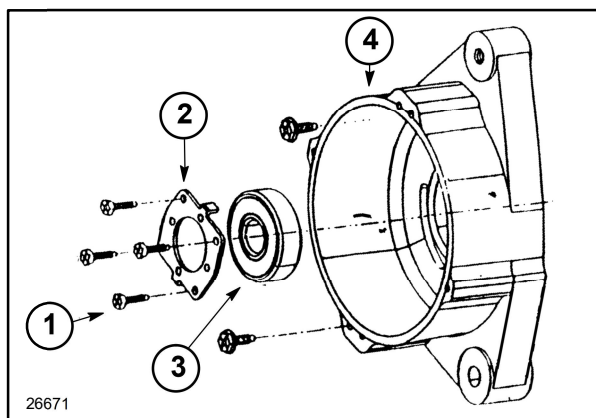
To reassemble, reverse the order of the operations described.

SERVICING

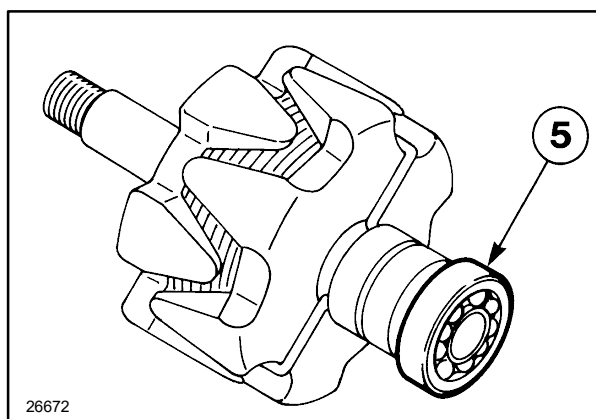
1. Check the rotor and stator poles are not worn. If this is the case, it means the ball bearings are worn, the casings are not in line or the rotor shaft is misshapen.

NOTE: *alternator ball bearings cannot be serviced separately. When necessary, therefore, both must be changed.*

2. Unscrew the screws (1) securing plate (2) that locks bearing (3). Remove it from the front support plate (4) (Fig. 33). Check if it is worn or damaged; if so, change it. Before installing the ball bearing, check the front support plate holder and clean it carefully.
3. Installation of bearing (5) on support plate side is different from the one described above. A new rotor complete with bearing must be installed (Fig. 34).



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RE-INSTALLATION

1. Re-install the alternator by reversing the removal procedure.

During re-installation, remember to:

- Check the negative (ground) battery cable is disconnected from the battery while re-installing the alternator.
- Adjust the alternator drive belt, as described previously in this chapter.