

SECTION 55 – ELECTRICAL SYSTEM

Chapter 3 – STARTING SYSTEM

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55 000 TECHNICAL INFORMATION

CHARACTERISTICS	JX60	JX70	JX80	JX90	JX95
Starter motor	BOSCH				
Power (kW)	2.5		3.5		
Maximum current drain without load (Amp)	60 A at 11,6 V and 8600 rev/min		160 at 11.5 V and 8000 rev/min		
Minimum brush length (mm) (in.)	–		7.0 (0.2756)		
Minimum switch diameter (mm) (in.)	42 (1.6535)		42.5 (1.6732)		
Maximum armature shaft end play (mm) (in.)	0.5 – 0.8 (0.0197 – 0.0315)		0.4		

TIGHTENING TORQUES

	Nm
Starter motor and engine block fastening bolts	34 (25.0771)
Box on starter motor/earth (ground) cable side	16 (11.8010)
Solenoid valve wire nuts	7 (5.1629)
Box nuts on starter motor side	10 (7.3756)
Solenoid valve fastening bolts	5 (3.6878)

DESCRIPTION AND OPERATION

The starting system installed depends on the type of gearbox fitted on the tractor. All systems consist of an ignition key switch, heavy-duty wiring, a starter motor with solenoid, a start-up relay and a clutch pedal switch. These are the basic circuit components used on versions with mechanical gearbox. More sophisticated systems include other components, which ensure the engine can be started only under the proper conditions.

There are four types of gearbox: with range reduction gear (synchro command), with range reduction gear and inverter (shuttle command). The starting circuit is illustrated in figure 1.

There are two available types of starter motors: 2.5 kW or 3.5 kW rating. They both have four poles, four brushes with integrated solenoid and positive mesh engagement control.

The solenoid consists of two coils connected in parallel. The low resistance pull-in coil is earthed (grounded) via the engine, while the high resistance hold-in coil is earthed (grounded) via the solenoid body.

When the ignition switch is closed, with the clutch pedal depressed and gear in neutral (except in the case of mechanical gearboxes), the coils are energised and the plunger is magnetically drawn inside the solenoid. This movement, transmitted by

means of an flexible joint mechanism, makes the driving pinion engage the flywheel ring gear. The moment the pinion touches the ring gear, the plunger closes a series of contacts and powers all four field windings directly from the battery, thus giving full power to the starter motor.

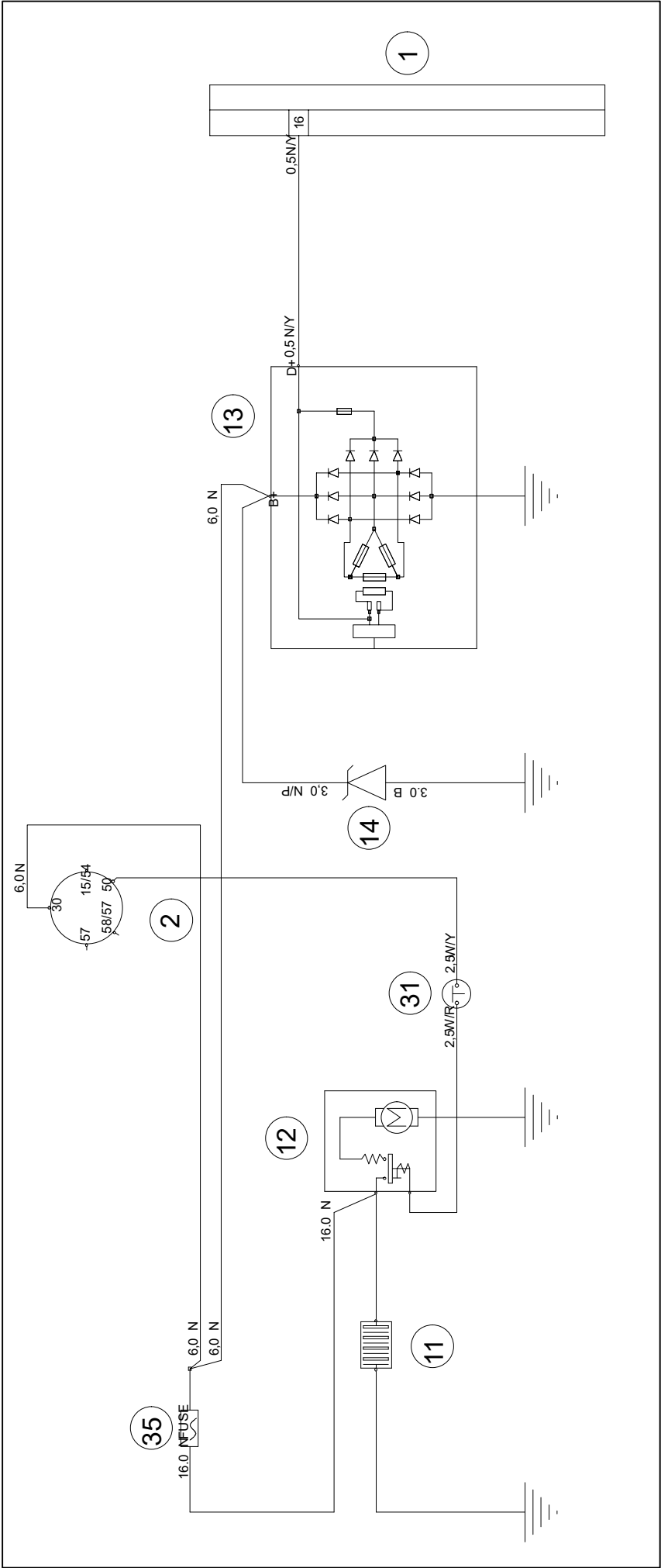
At this stage, one end of the pull-in coil is connected to the positive battery pole through the starter switch, while the other end is connected to the positive pole through the solenoid valve contacts. The pull-in coil is thus bypassed, without absorbing power, and the hold-in coil alone keeps the plunger in position.

The starter motor includes a series of contacts and a two-part solenoid plunger which completely closes the contacts even if the pinion teeth are not perfectly in line with the ring gear. When this happens, a clutch spring compresses the pinion, forcing it to connect completely as soon as the starter motor starts turning.

When the key ignition switch is released, power is taken from both the solenoid and the motor. The solenoid return spring, acting on the flexible joint mechanism, frees the driving pinion from the gear and opens the solenoid valve contacts again.

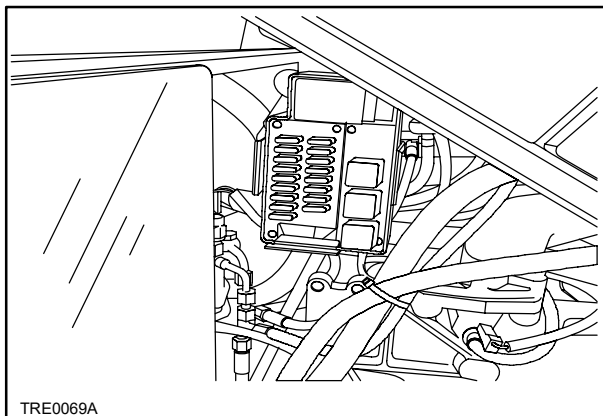
A roller type clutch is incorporated to the driving pinion group. This prevents the pinion from overspeeding if it stays engaged with the flywheel ring gear after the engine has been started.

STARTING CIRCUIT



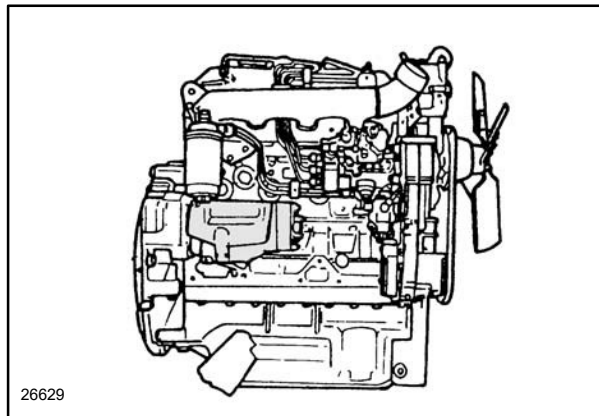
STARTING CIRCUIT

- 1 - Instrument panel
- 2 - Starter switch
- 11 - Battery
- 12 - Starter
- 13 - Alternator
- 14 - Over voltage circuit breaker (DIODE)
- 31 - Starter inhibitor unit
- 35 - Main Fuse



Fuse panel

2



Starter motor

3

SYSTEM TESTS

STARTING SYSTEM ON TRACTOR TEST

To easily and quickly trouble-shoot the starting system problems and reach conclusive results, it is recommended that you use a battery/starting tester (high discharge multimeter) with incorporated 0–20V voltmeter and 0–500 A ammeter.

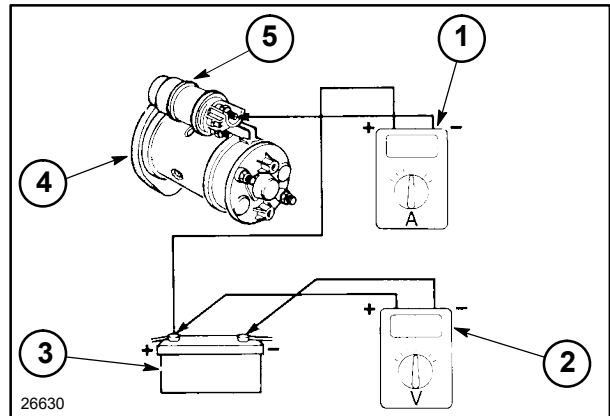
When using testing devices, follow test procedures recommended by the manufacturer. If you do not have access to testing devices, carry out the following test using a normal 0–20V voltmeter and a 0–500 Amp ammeter in order to check correct starter motor functioning without removing it from the engine.

Before carrying out the test:

- check the battery is fully charged;
- check that no wires in the starting system are broken or frayed and that there are no loose connections;
- check the engine is not seized.

POWER ABSORPTION IN STARTER MOTOR CIRCUIT (Fig. 4)

1. Disconnect earth (ground) (negative) battery cable (3).
 2. Disconnect positive battery cable from starter solenoid. Connect the positive ammeter point (1) to the positive battery terminal clamp and the negative point to the solenoid input terminal.
 3. Reconnect earth (ground) (negative) cable to negative battery terminal clamp (3).
 4. Connect the positive voltmeter point (2) to the positive battery terminal clamp and the negative to the negative battery terminal clamp.
 5. Disconnect the wire from the injection pump shut-off solenoid.
 6. Run the engine and note voltmeter and ammeter readings. Voltage must be constantly about 12V and absorption in the range of 250–300 A.
- If absorption corresponds to the readings above, then the starter motor (4) fig. 4, is working correctly. If voltage drops during the test, follow "Resistance in starting system circuit" procedure (see relative paragraph).
 - If absorption is higher than the readings above, check the circuit as follows. If the starting system circuits are in good condition, then the starter motor is malfunctioning and must be removed for further examination.
 - If absorption is lower than the readings above, the starter motor is malfunctioning and must be removed for further examination.



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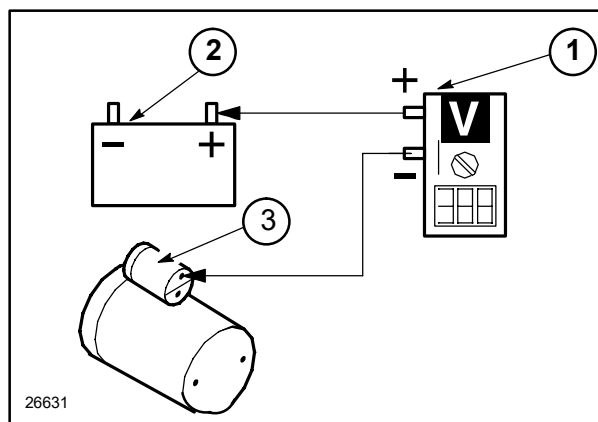
RESISTANCE IN IGNITION SYSTEM CIRCUIT (VOLTAGE DROP) (Fig. 5)

If there is a higher than necessary power absorption, check the circuit to find the cause of the voltage drop occurring within circuit components.

IMPORTANT: Disconnect the injection pump solenoid fuel closing wire.

POSITIVE BATTERY CABLE

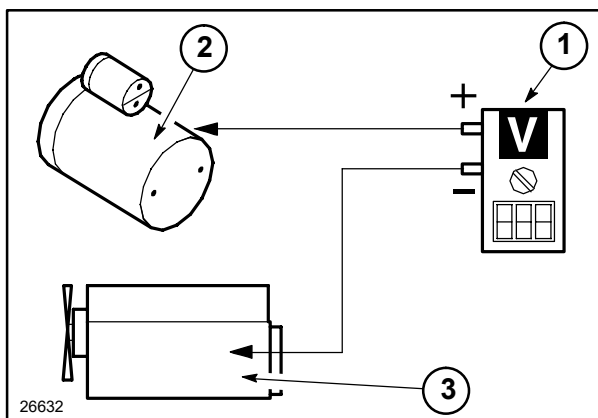
1. Connect the positive voltmeter point (1) to the positive battery terminal clamp (2).
2. Connect the negative voltmeter point to starter motor solenoid terminal (3).
3. Run the engine and check the readings on the voltmeter. If voltage is higher than 0.2 V., check and tighten wire connections. Check voltage again and if it is still high install a new battery cable.



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STARTER MOTOR EARTH (GROUND) (Fig. 6)

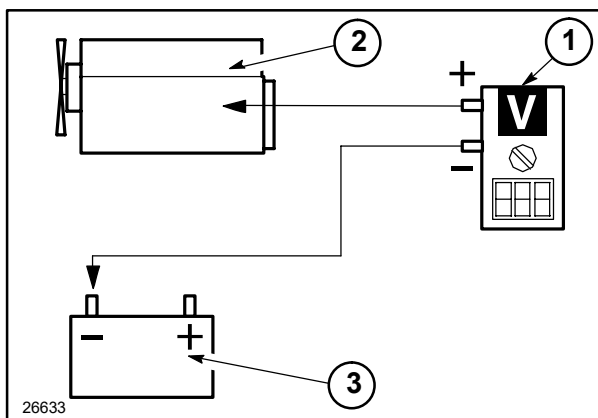
1. Connect the positive voltmeter point (1) to the starter motor casing (2).
2. Connect the negative voltmeter point to the engine block (3).
3. Run the engine and check the readings on the voltmeter. If voltage is higher than 0.2 V., check earth (ground) connections between the starter motor flange and the rear engine cover.



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BATTERY EARTH (GROUND) CABLE (Fig. 7)

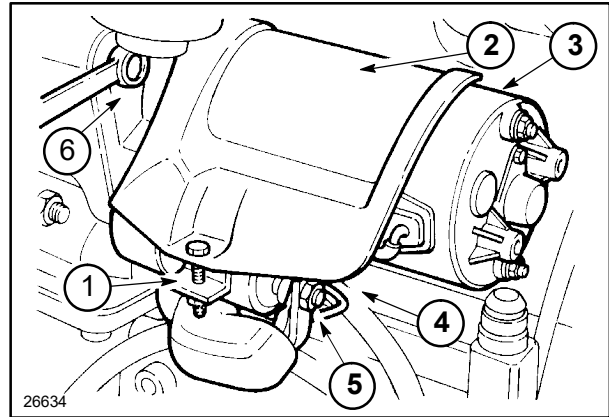
1. Connect the positive voltmeter point (1) to the engine block (2).
2. Connect the negative voltmeter point to the negative battery terminal clamp (3).
3. Run the engine and check the readings on the voltmeter. If voltage is higher than 0.2 V., check and tighten the earth (ground) cable connections. Check the voltage again and if it is still higher, then install a new earth (ground) cable.



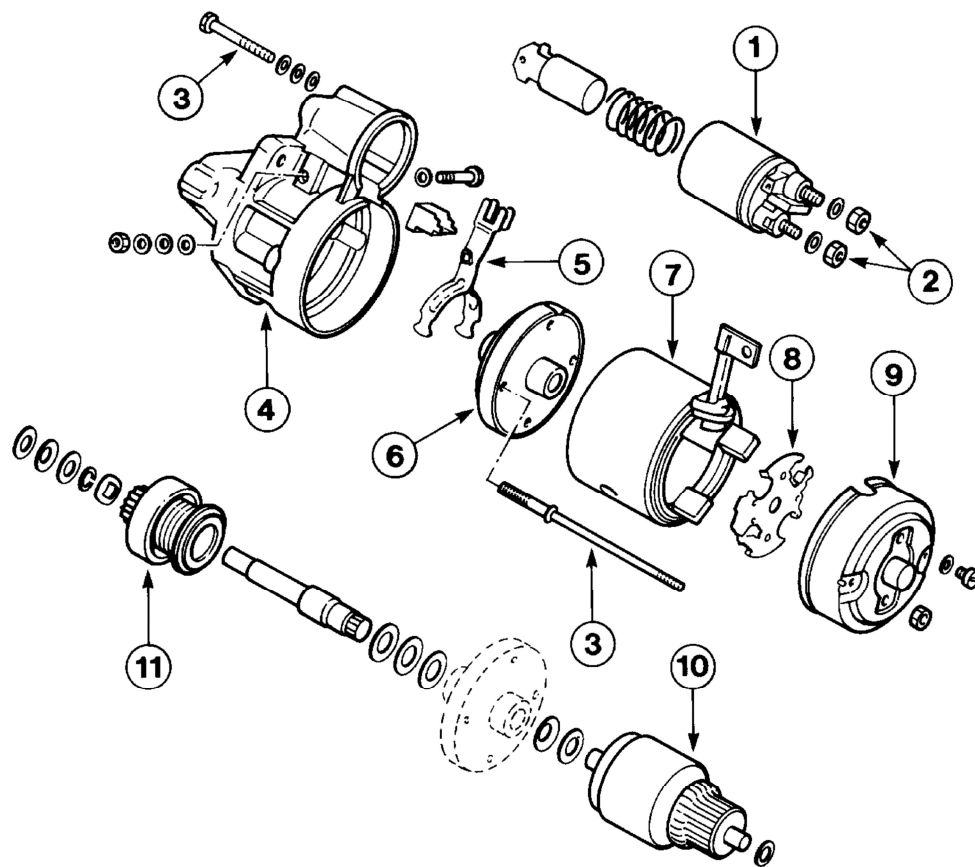
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STARTER MOTOR REMOVAL AND RE-INSTALLATION (Fig. 8) (Op. 55 201 50)

1. Disconnect negative battery cable.
2. Unscrew the nut and bolt (1) and remove the protection cover (2) from starter motor (3).
3. Unscrew the nut and remove power clamp (5) and emergency switch clamp (4).
4. Remove the starter motor securing bolts (6) and remove the starter motor.
5. To re-install the starter motor, reverse the order of removal.



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Starter motor components

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- | | |
|-------------------------|------------------------------|
| 1. Solenoid | 7. Field windings and casing |
| 2. Solenoid bolts | 8. Brush holder |
| 3. Bolt and stud group | 9. Brush plate |
| 4. Control side support | 10. Armature |
| 5. Lever | 11. Clutch |
| 6. Reducer | |

SERVICING**DISASSEMBLY (Op.55 201 54)**

Refer to figure 9.

1. Place the starter motor in a vice with protected jaws.
2. Disconnect the biggest braided wire which runs from the field winding casing to the solenoid.
3. Remove the three screws from the front casing and remove the solenoid. Note that the plunger will remain connected to the control lever.
4. Remove solenoid plunger from the control lever by holding and lifting it at the front in order to unclip it from the lever.
5. Remove the two nuts from the rear casing and the two screws which fasten the rear cover and brush plate to the casing. Remove clamp C and armature shaft end play spacers, leaving the brush gear on the commutator. Remove the thin metal washer on the commutator side of the armature.
6. At this stage of the procedure, check the brushes and commutator. Check that the brushes are not sticking and, if necessary, clean the brushes and their respective channels with a rag and solvent. Check the brushes are not worn. If they are worn and minimum length is less than that shown in the technical information table, it will be necessary to change the starter motor.

NOTE: *The brushes are not serviced separately. They are welded to their support and will not be changed for the whole operating life of the starter motor.*

7. Remove the motor casing from the armature and the control side bracket.
8. Remove the control lever knuckle pin from the control side of the casing.
9. Remove the retaining ring which holds the control group and the inner plate from the armature shaft, by first removing the pressure collar perpendicularly from the retaining ring support by means of an appropriately sized tube. Then lever the retaining ring from the groove.
10. Remove armature and control group.

REASSEMBLE

1. To reassemble the starter motor, reverse the removal procedure.

Before reconnecting, test the armature shaft end play and test the starter motor without load.

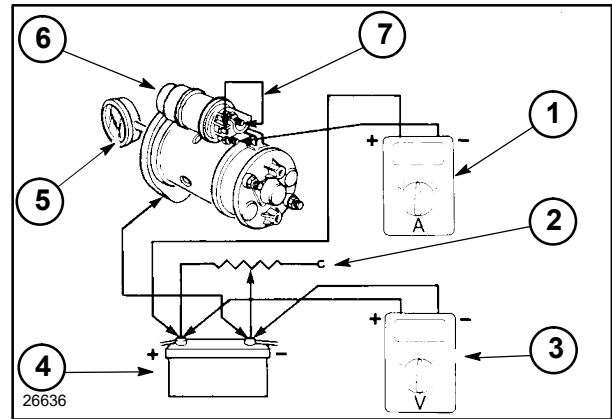
ARMATURE SHAFT END PLAY

1. Place the starter motor in a vice with protected jaws and connect a dial gauge to the flange on the control side of the casing. Position the dial gauge pointer on the end of the armature shaft.
2. Push the armature forward and reset the gauge to zero. Push the armature back as far as it will go and note the gauge reading.
3. Readings must fall within the limits specified in the technical information table. If the value is higher, check that armature and brush plate are not worn. Change the worn components, as necessary, and check end play again.

STARTER MOTOR TEST WITHOUT LOAD (Fig. 10)

NOTE: A fully charged battery and a battery/starting tester (high discharge multimeter) with carbon battery (variable load resistance) are needed to carry out this test.

1. Place the starter motor in a vice with protected jaws.
2. Connect negative battery cable (4) to the starter motor flange.
3. Bridge the solenoid contacts (6) with a short wire (7).
4. Connect the positive voltmeter point (3) to the positive battery terminal clamp and the negative voltmeter point to the negative battery terminal clamp. Connect the ammeter positive point (1) to the positive battery clamp (4) and the negative point to the battery or to the starter motor terminal clamp.
5. Place a manual tachometer (5) on the end of the armature shaft. Check maximum power absorption. This value is specific for each starter motor and must be included in the range of values in the TECHNICAL INFORMATION table. Regulate carbon battery voltage (2) and armature speed according to the information in the technical information table.
6. If the starter motor does not work according to the technical information specification, check if there are earthed (grounded) field windings, if the armature is scuffed or scraped or if the shaft is misshapen or otherwise damaged.



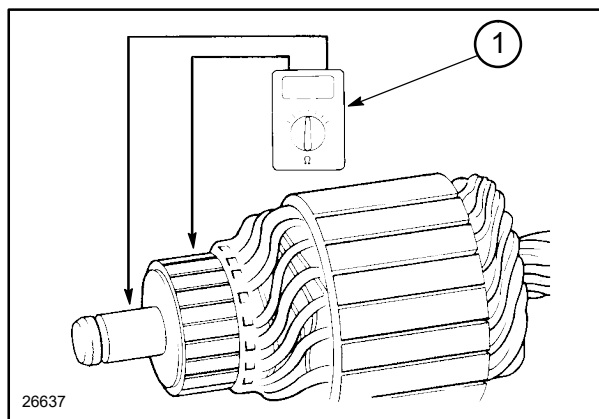
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BENCH TESTS**ARMATURE (Fig. 11)**

1. The commutator surface must be clean and not burnt. If burning needs to be removed, use fine sandpaper and not abrasive fabric (emery cloth). Finally, clean the commutator with a rag and solvent.
2. If the commutator needs refacing, check it is not smaller than the minimum value specified in the TECHNICAL INFORMATION table. After refacing, the commutator must be polished with sandpaper and cleaned with a rag and solvent.

NOTE: Do not cut the armature metal when making insulation slots.

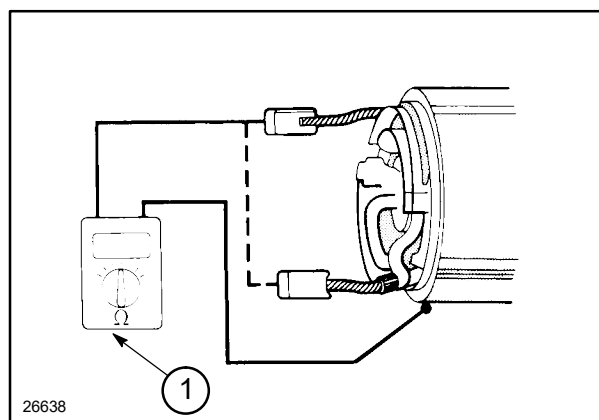
3. Armature insulation can be checked by connecting an ohmmeter (1) between commutator segments and armature shaft. This reading should show infinity, in other words there should be no continuity.
4. To test there are no short circuits, use an appropriate testing device. The only alternative is to try changing the armature.
5. If the armature circumference has obviously been in contact with pole pieces, the pole bearings are probably worn. First check the pole pieces are fixed and that the armature spins well in a lathe. If necessary, change the armature bearing.



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FIELD WINDINGS (Fig. 12)

1. To test field winding insulation, connect an ohmmeter to each of the coil brushes in turn and to a clean and unpainted area of the casing. There should be no readings, that is, there should be no continuity.
2. To test coil continuity, connect an ohmmeter to each of the coil brushes in turn and to the main power clamp (biggest braided wire). The reading should be 1 Ω.
3. If there is a failure in the field windings, then it will be necessary to change the whole box and field winding system.



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BEARING BUSHINGS

1. Check if the bushing on the brush plate and in the box on the pinion side are worn. Assemble the armature shaft and note play. Change the bushing if there is too much play. Check the field poles to see if there are any signs of scraping against the casing. This can also be caused by a worn bushing.

DRIVING PINION

1. Check the roller clutch operation. The pinion must spin clockwise only. If the pinion is either seized or spins in both directions, or if the pinion teeth are damaged, assemble a new control group.

If there is clear evidence of damage to the pinion teeth, check the flywheel ring gear, as described in section 10, Engines.

