



GROUP 05

ENGINE ELECTRICAL UNITS

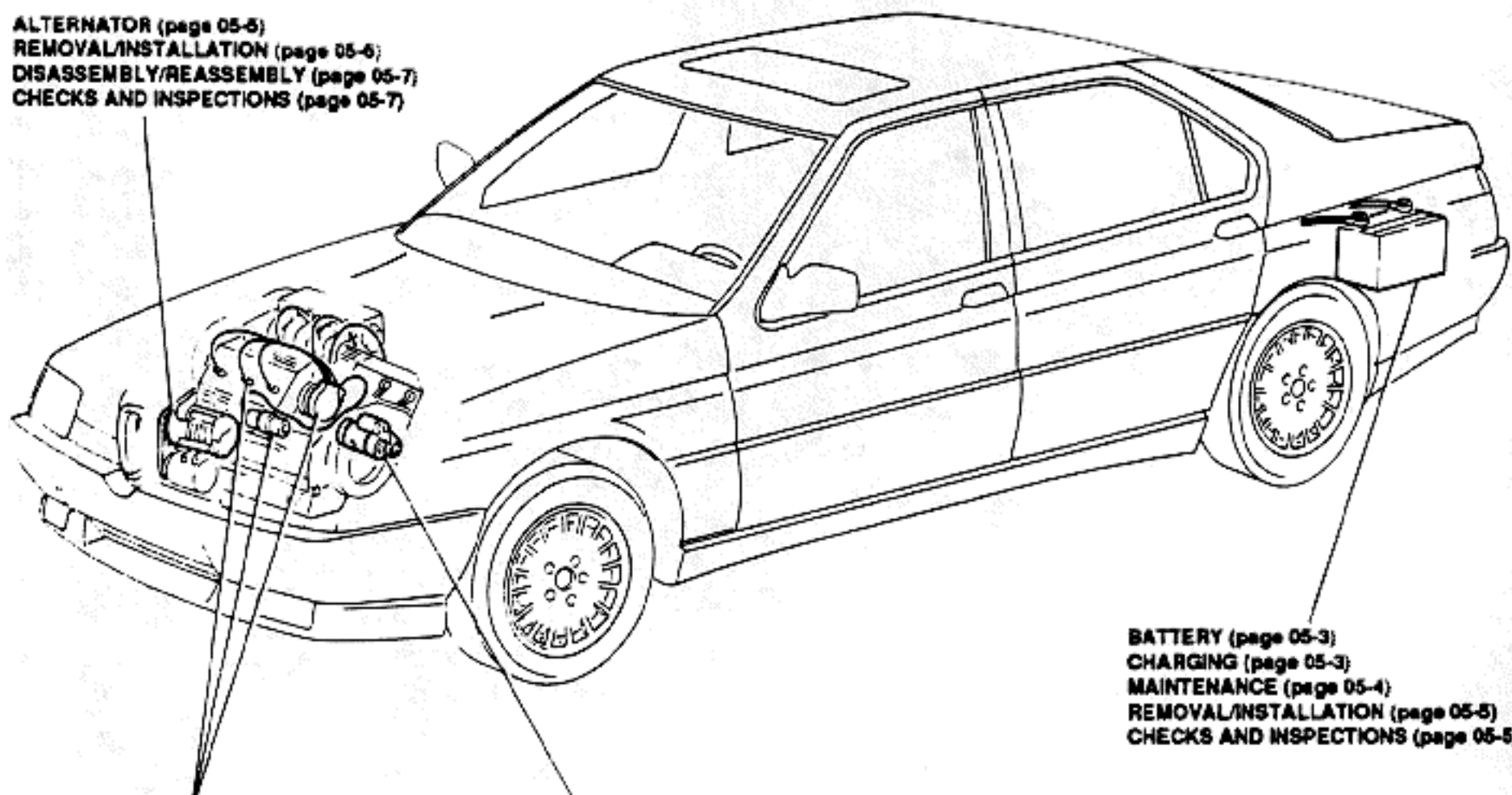
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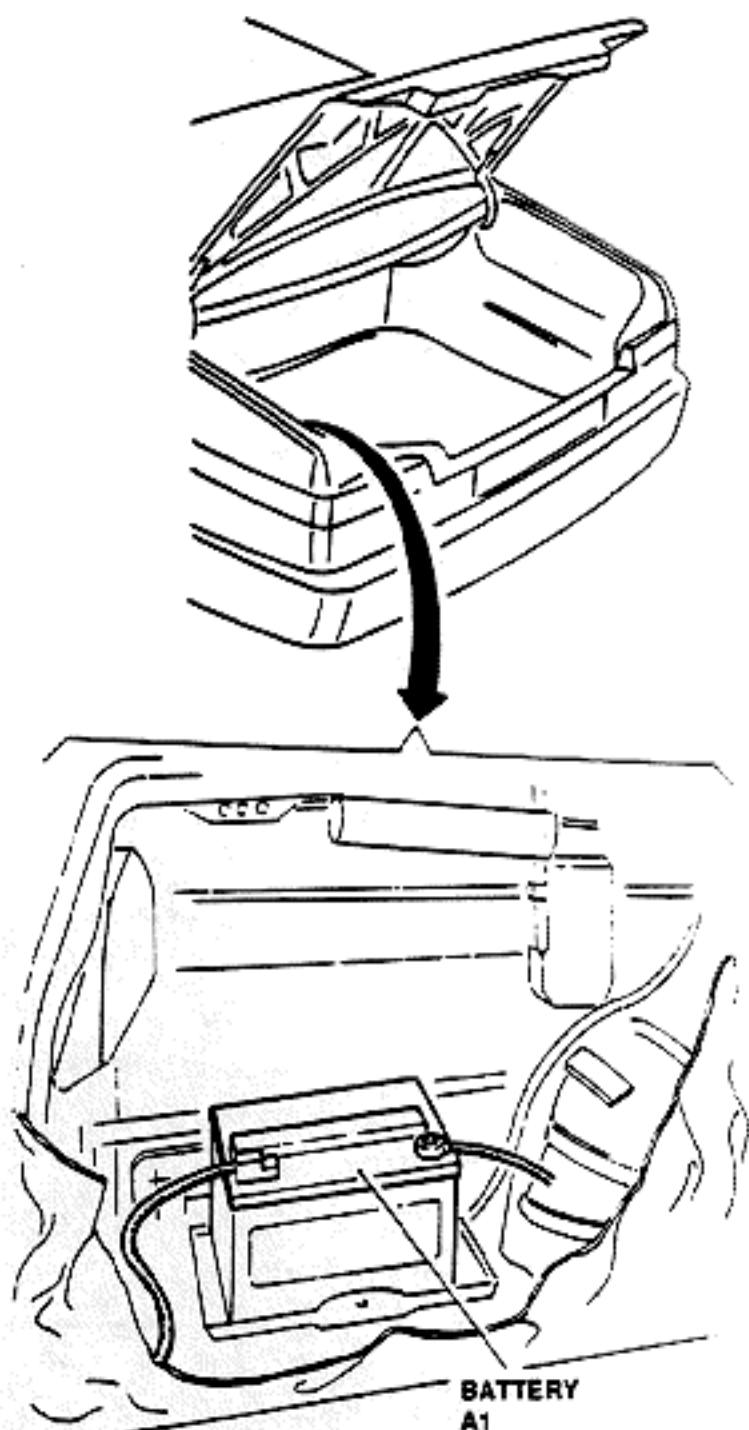
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BATTERY

The battery is located in the left side of trunk.



The battery has been designed according to criteria enabling the engine to be started in the shortest possible time. To this purpose, a high torque and a fixed minimum RPM are required. The above requirements are guaranteed by the optimal sizing of the six battery cells, each one supplying a voltage of about 2V (total voltage 12V).

The battery is of the maintenance-free type; it is substantially identical to conventional batteries, it maintains its charge for a remarkably longer time, and contains diluted sulphoric acid. For this reason it is necessary to maintain the battery in an upright position even when not installed on the vehicle. The battery case is provided with small breathing holes since the formation of gas during the

charging phase is reduced to minimum.

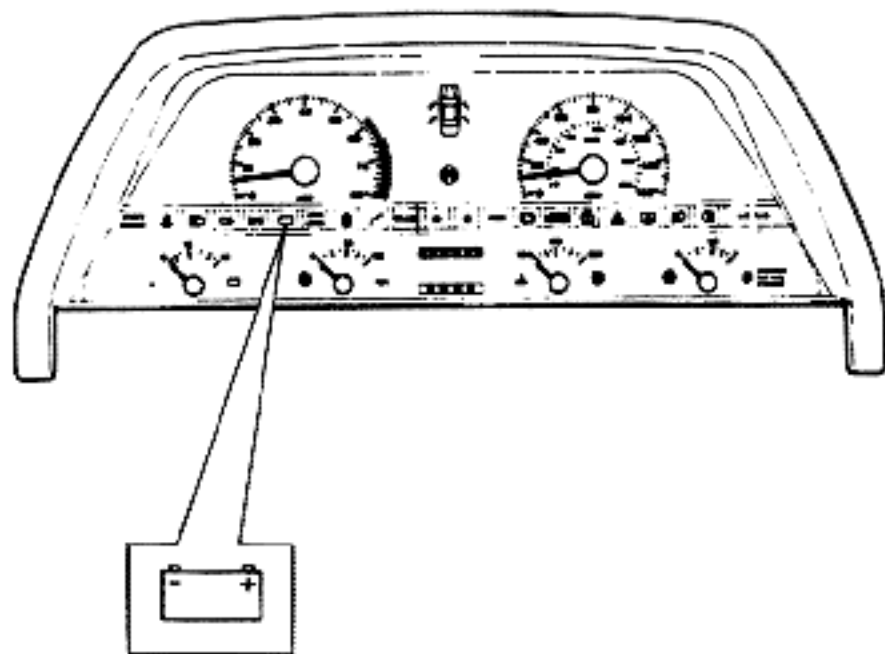
Due to the reduced volume of generated gas, the absence of corrosion and improved electric contact of terminals is assured.

The advantages of a maintenance-free battery are:

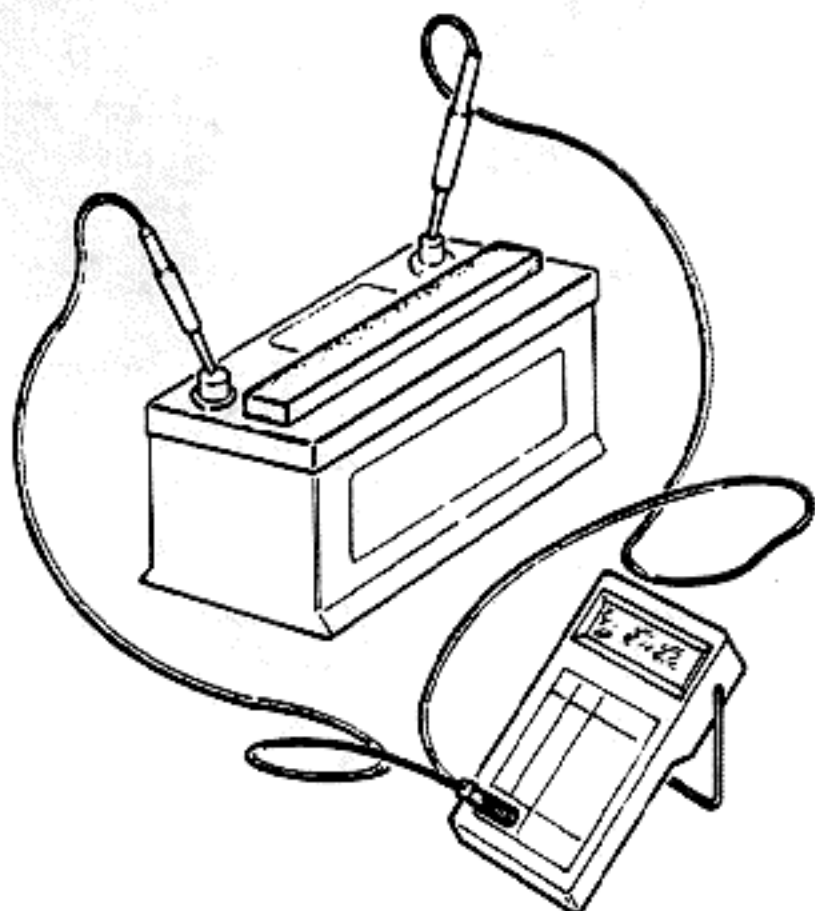
- Maximum reduction of water consumption due to the new type of alloy used for the manufacturing of the grids and plates, and therefore periodic servicing is not required.
- Optimum starting capability due to the highly reduced self-discharging, up to a seven month period, and therefore suitable for long storage (at temperatures below 28°C (82.4°F)).

CHARGING

When the vehicle is running, the alternator recharges the battery; whenever the charging is insufficient or the connection between the alternator and the battery is interrupted, the malfunction is indicated by the illumination of a warning lamp on the instrument panel.



In case of a presumed discharged battery, check the battery charge measuring the loadless voltage at battery terminals using a voltmeter.



If the voltage is lower than 12.30V the battery is charged to 50%; if the voltage reaches 12.48V the charge is at 75%; the battery is fully charged when the voltage reaches 12.66V.

**CAUTION:**

If the level of the electrolyte in one or more cells is below the minimum level mark engraved on the battery plastic case, carefully remove the cover of filling caps row, and add distilled and deionized water as normally done on traditional batteries.

NOTE: You are absolutely advised against quick battery charging with voltage above 15.5V and high current rate. For the charging, use a normal 12V charging equipment and connect positive pole (red) to (+) pole of the battery, and negative pole (black) to (-) pole of the battery. In case of temporary jumping to an auxiliary battery, always connect positive pole to positive pole, and negative pole to negative pole.

**CAUTION:**

- Never disconnect or connect the battery to the vehicle's electrical system when the engine is operating.
- Do not reverse the polarity of connecting cables (even for few instants) to prevent damaging of alternator rectifier.
- During charging operations, always connect first the charging equipment cables to the battery, then switch on the equipment.
- If the conditions require to start the engine using jumper cables and an auxiliary battery, the voltage of the auxiliary battery must not exceed 12V.
- Disconnect negative pole (-) terminal from the battery before charging.
- During charging, check that the electrolyte temperature does not exceed 45°C (113°F).

**WARNING:**

- Never touch with your hands the negative and positive poles of the battery simultaneously.
- During charging, never approach open flames to the battery.

In case the battery is replaced, it is suggested to observe the prescribed operating specifications. If the current capacity of the replacement battery is higher than that of the battery being replaced, a higher output voltage could cause the melting of starter rotor winding, or damages to pinion or crown gear.

MAINTENANCE

The battery capability of starting the engine depends on the condition of its charge; it is therefore necessary to perform regular checks and maintenance, particularly during the cold season, due to the higher load applied to



the starter and to the reduced capacity of the battery when subject to low temperatures.

Carefully clean the battery case, terminals and cable terminals with a solution of water and sodium bicarbonate. Coat terminals with grease before re-connection.



CAUTION:

Avoid entry of cleaning solution inside the battery to prevent chemical reactions with the electrolyte.



WARNING:

The electrolyte is an acid, and is therefore harmful for your eyes, hands and cloths.

NOTE: The batteries, when stored or left unused on the vehicle for prolonged time are subject to a low self-discharge. It is therefore necessary to re-charge the batteries before their use.

REMOVAL/INSTALLATION

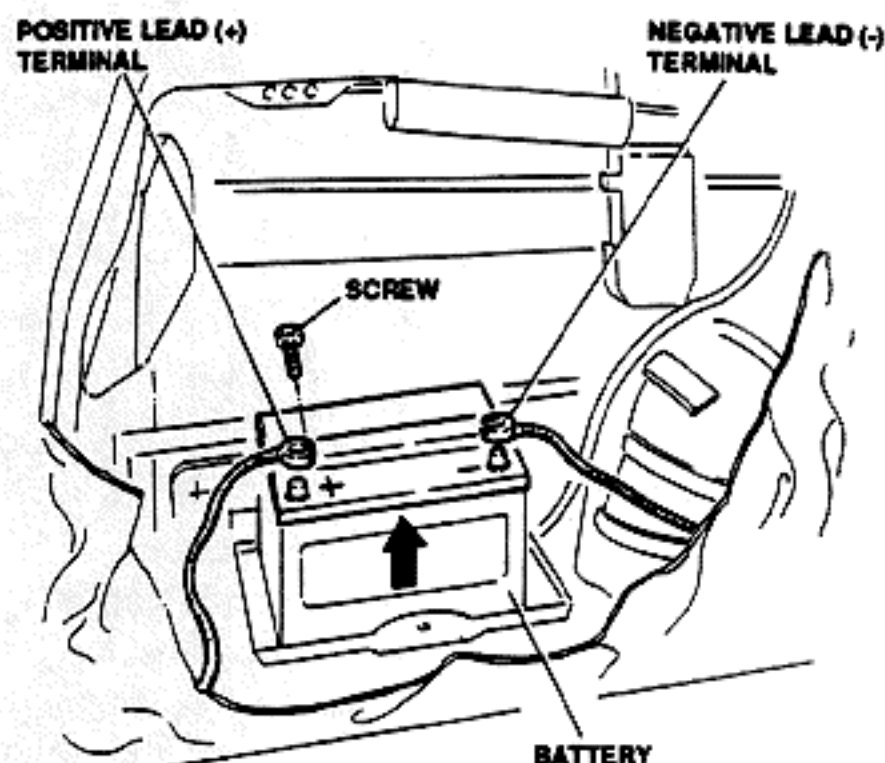
1. Remove the screw securing the lead terminals to battery terminals; disconnect negative (-) lead first, then positive (+) lead.



CAUTION:

When disconnecting the leads from the battery, ensure the engine is not running. On the opposite, serious damage to the alternator will occur.

2. Remove the battery, paying attention to maintain it in upright position.
3. Perform installation in reverse order, and clean and grease the leads and battery terminals with suitable products (REINACH E10 TAC).



CHECKS AND INSPECTIONS

Check the battery case for absence of cracks; checks that level of the electrolyte is about 5 mm (0.2 in) above the upper surface of electrodes. Check the battery top surface for cleanliness, and the terminals for absence of oxidation.

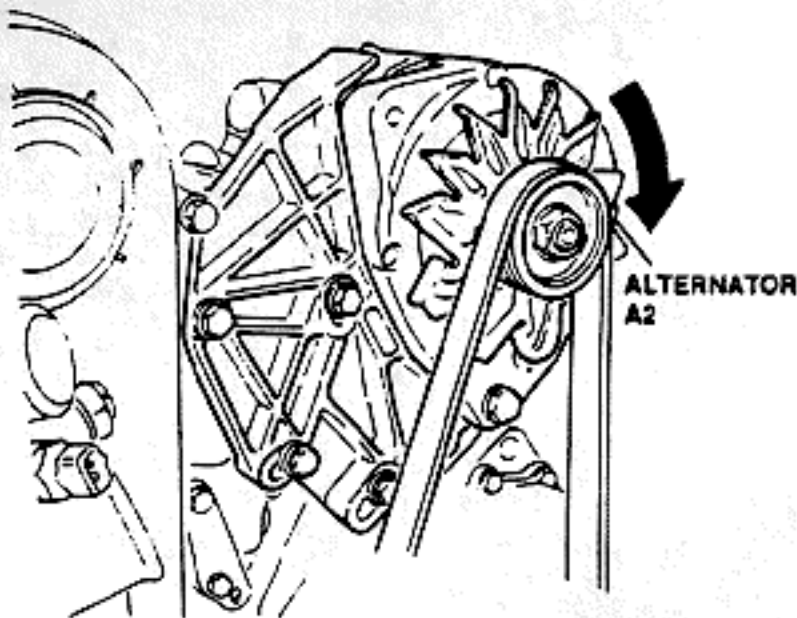
Furthermore, ensure the lead terminals are properly secured to battery terminals to provide a positive electric contact.

TROUBLESHOOTING

A detailed troubleshooting of battery failures and malfunctions is included in the "WIRING DIAGRAMS AND ELECTRICAL DIAGNOSIS" Book - MOTRONIC ON BOARD DIAGNOSIS (TEST A).

ALTERNATOR

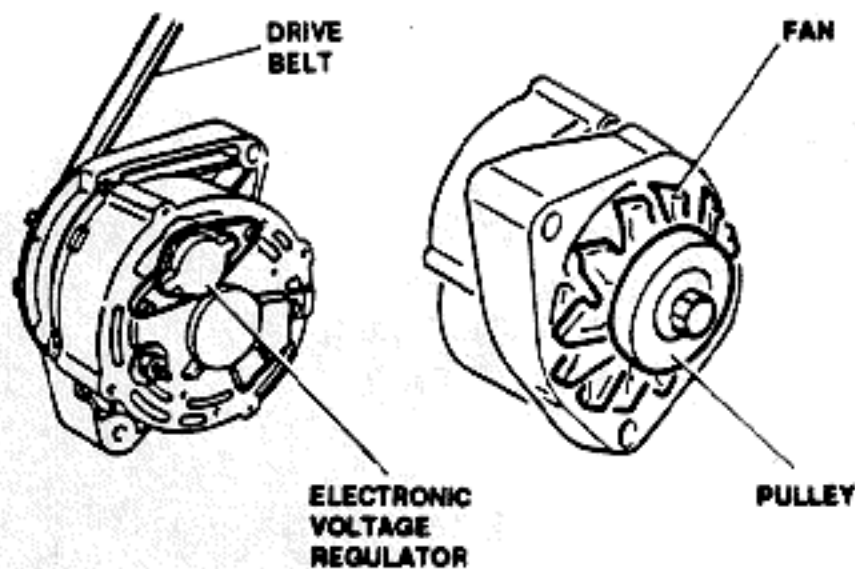
When the engine is operating, the alternator supplies electrical power to the vehicle's monitoring systems (electronic ignition and injection, ABS, air conditioning etc.) and to the various accessories which can be activated in any moment. In addition, the alternator charges the battery that is the only electric power source of the vehicle when the engine is not operating.



The electric power is produced by a rotor that "cuts" the magnetic field generated by a stator winding. The rotor is fixed to a pulley directly connected to the engine crankshaft by means of a belt. Brushes supply the excitation current to the rotor. The alternated voltage generated by the alternator is rectified by diodes and by the voltage regulator located on the alternator body.

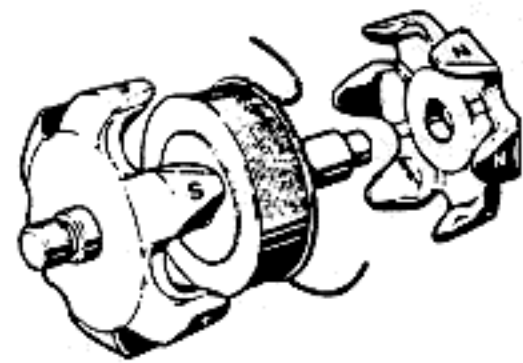
The electronic voltage regulator, not subject to wear and of reduced overall dimensions, supplies a constant voltage at any engine operating range, even with the widest changes of load and range.

A cooling fan rotates together with the drive pulley and prevents reaching of alternator temperatures that could affect its proper operation.



The alternator used on the 164 is of the claw poles and commutator rings type, very compact and of reduced weight.

Attachment of the alternator to the engine is by means of a swinging bracket, thus allowing easy tensioning of the drive belt (refer to Group 00).



CAUTION:

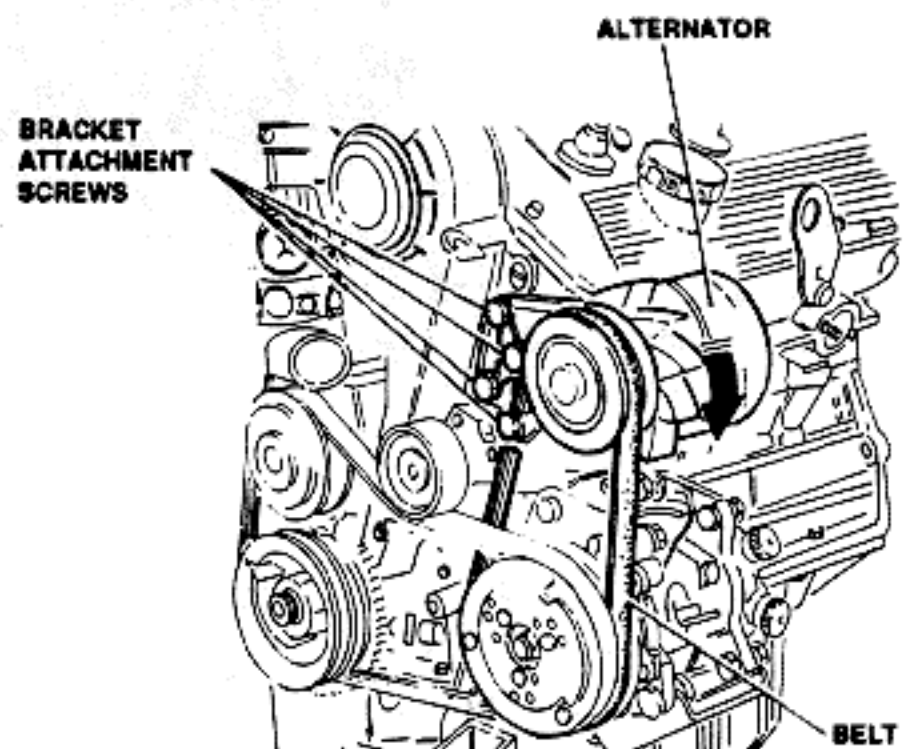
Proper cooling of the alternator is ensured if the fan rotates in the proper direction. **CORRECT ALTERNATOR SENSE OF ROTATION: CLOCKWISE (LOOKING FROM PULLEY SIDE).**

REMOVAL/INSTALLATION

1. Disconnect battery (-) lead.
2. Remove right front headlamp unit (refer to Group 40).
3. Disconnect alternator cables.
4. Loosen the screws securing the alternator bracket and remove drive belt from the pulley.
5. Remove the alternator.



At installation, tighten the drive belt as indicated in Group 00.

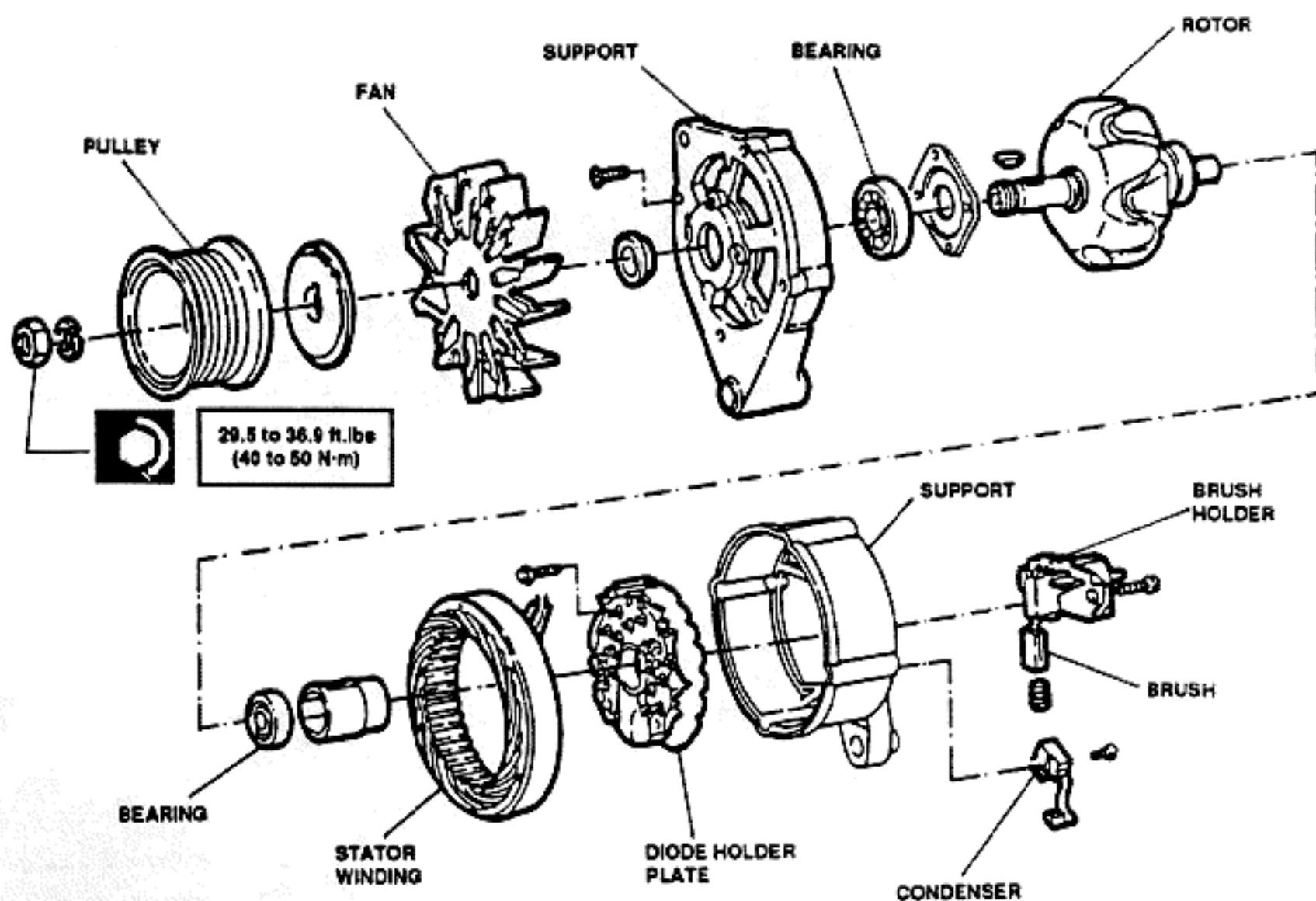




DISASSEMBLY/REASSEMBLY

Disassembly the alternator into its components.

NOTE: Do not unsolder parts unless necessary for parts replacement.



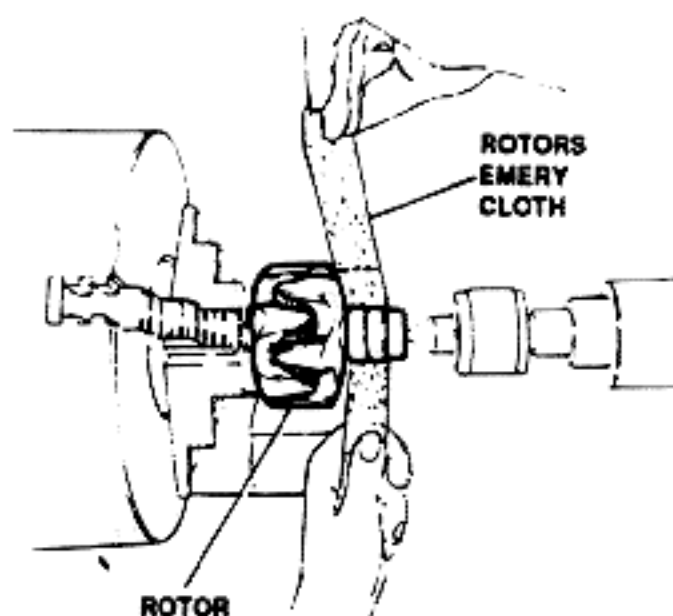
CHECKS AND INSPECTIONS

NOTE: Before proceeding to electrical checks, thoroughly clean the affected parts with compressed air.

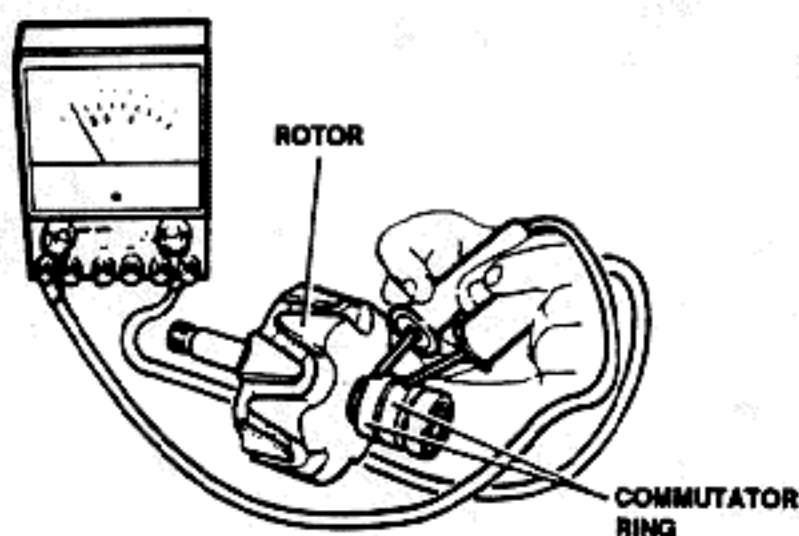
Bearings: check for absence of wear or damages; replace parts if above defects are found.

Commutator rings: check for wear:

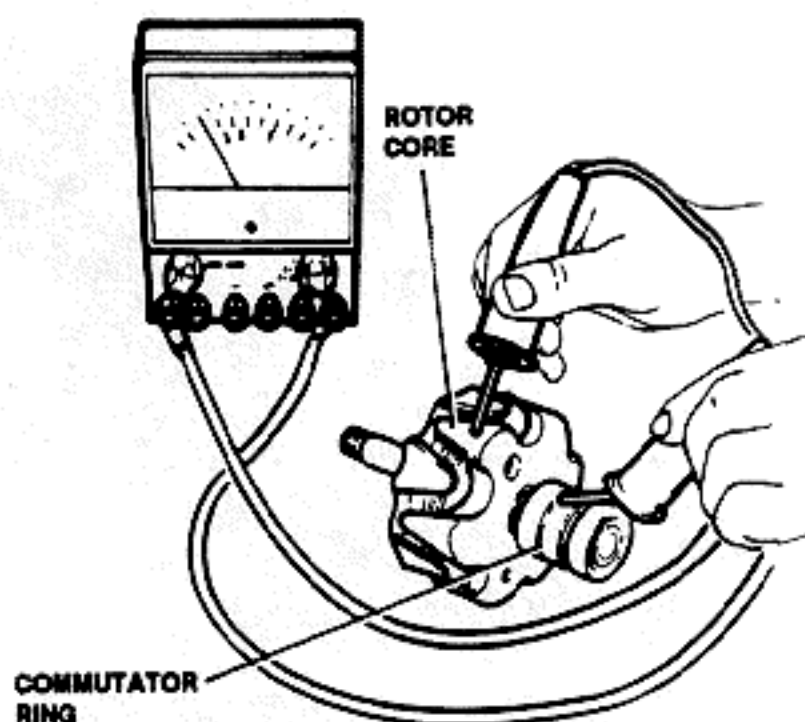
- Minor scoring can be lathe-removed using emery cloth suitable for commutator rings.
- Deeper scoring requires replacement of rotor.



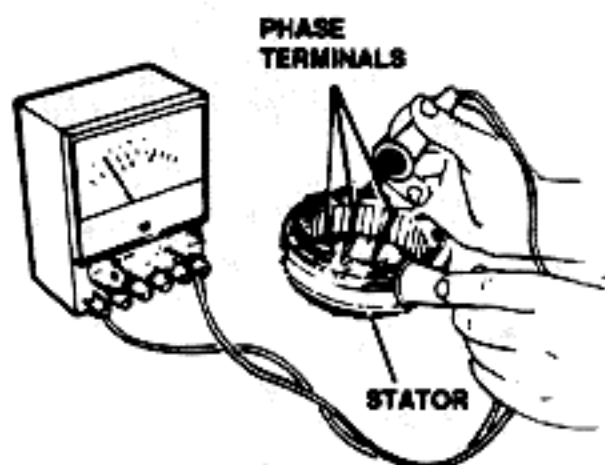
Rotor electric continuity check: check with an ohmmeter for continuity between commutator rings.



Rotor insulation check: using an ohmmeter, check that the electric resistance between one commutator ring and rotor core is infinite (insulation). Replace rotor if required insulation is not met.

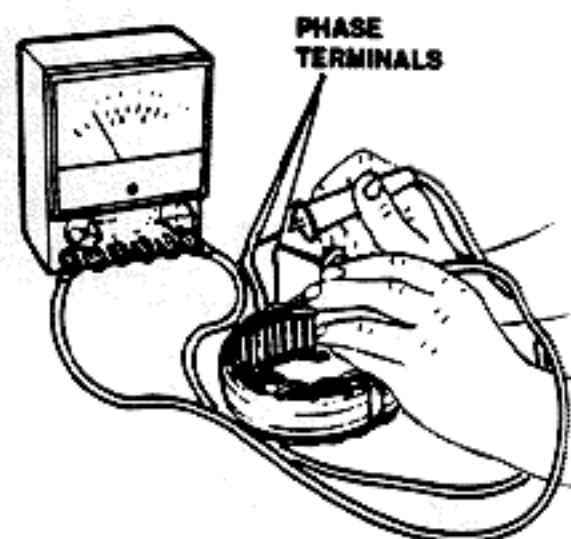


Stator insulation check: using an ohmmeter, check that the electric resistance between the stator pack and phase terminals is infinite (insulation). Replace rotor if insulation is insufficient.



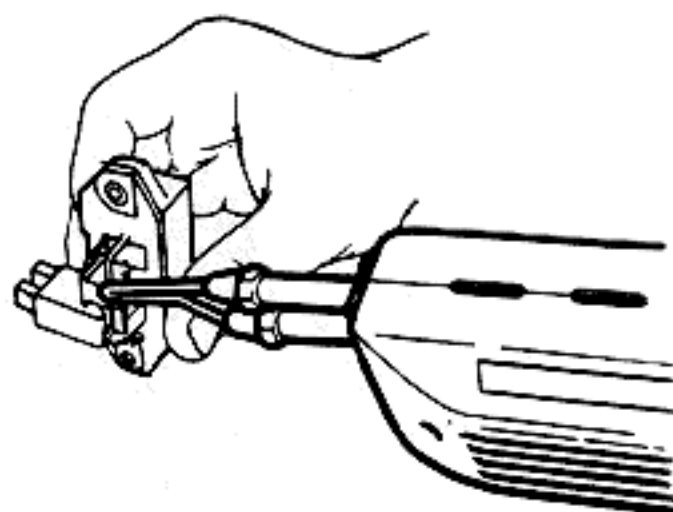
Stator electric continuity check: using an ohmmeter, check for continuity between the various stator phases: 1-2, 1-3, 2-3.

Replace stator if required continuity is not found.



Brushes check: check alternator brushes for absence of chipping and carbon deposits.

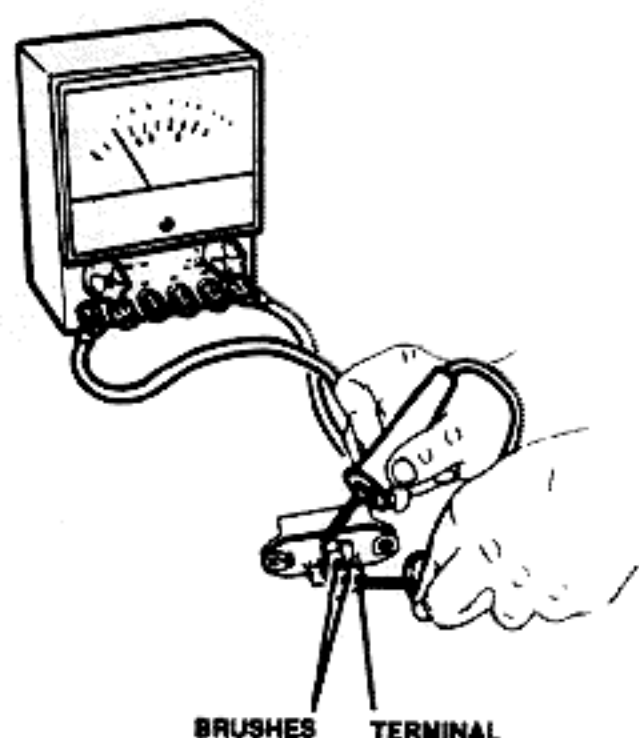
Replace brushes, if excessively worn, by unsoldering as depicted in the illustration below.



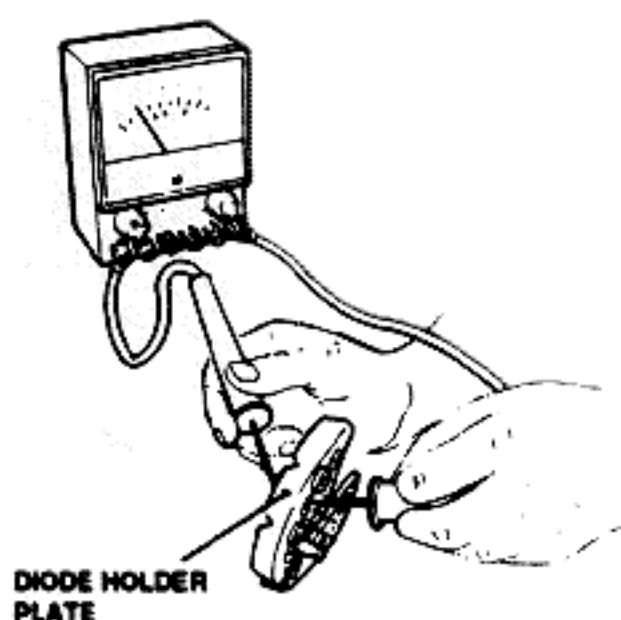
CAUTION:

Reduce to minimum the duration of unsoldering to prevent overheating of diodes.

Brush holder electric continuity check: using an ohmmeter, check for continuity between the brushes and the terminals. In case of lack of continuity, check brush seating and, if necessary, replace the brushes and/or the brush holder.



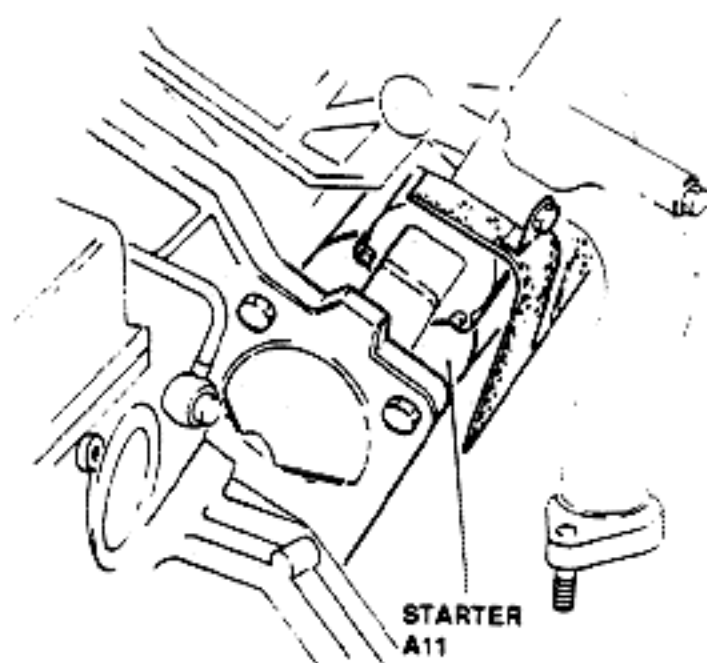
Diodes check: using an ohmmeter, check diodes for continuity in one sense, and insulation in opposite sense (reverse terminals). Replace diode holder plate if proper operation is not found.



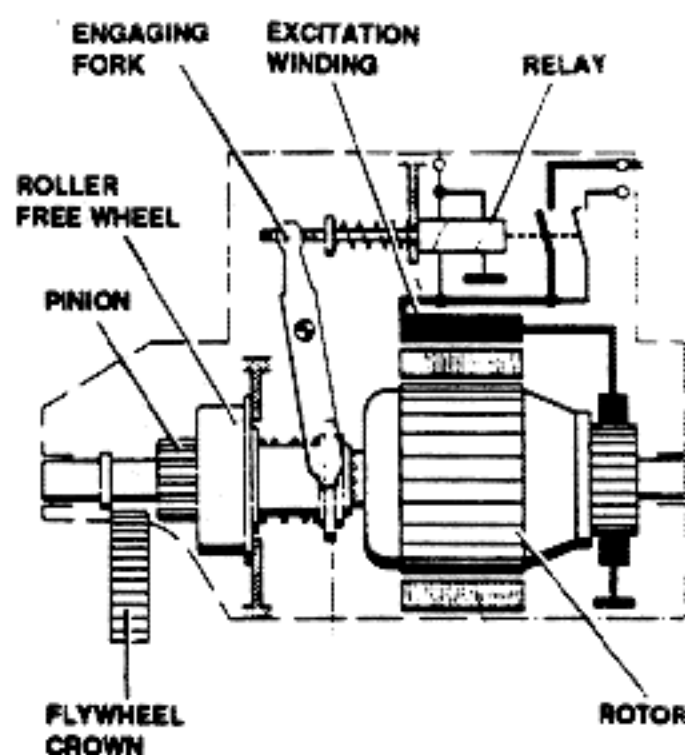
STARTER

The starter cranks the engine, overcoming the inertia and friction forces, and brings it to a rotating range such as to start the formation of the air-fuel mixture necessary to start the combustion and subsequent self-operation of the engine.

The movement is transmitted by a direct current electric motor, powered by the battery, through a drive pinion that engages the teeth of the flywheel crown.

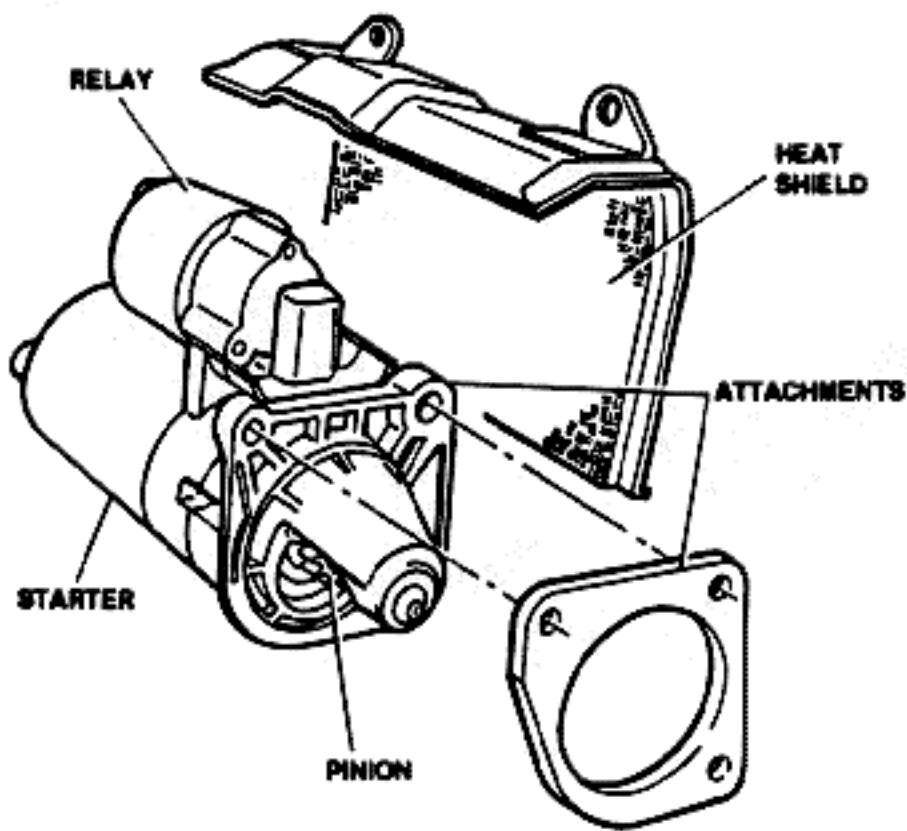


A freewheel disengages the pinion when the crankshaft revolutions exceed the starter revolutions (overrunning). A relay excited by starter current engages the pinion by means of a fork.



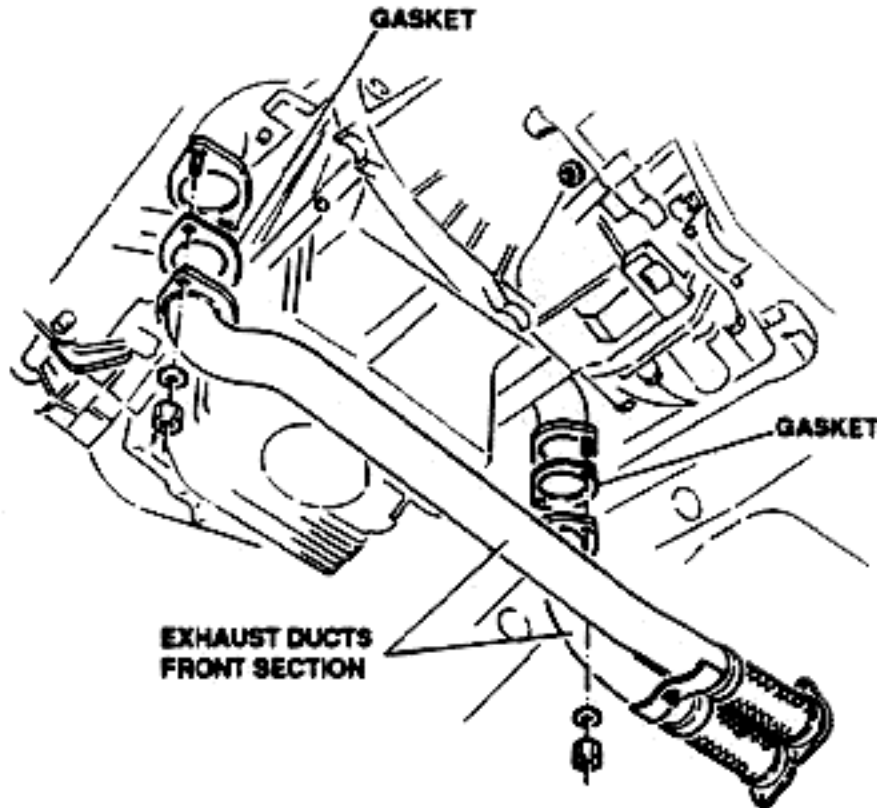
The starter used on the 164 is of the translating and screwing pinion type, with the relay located directly above the starter.

The starter is attached to the engine by means of brackets. A heat shield protects the starter from excessive heating.

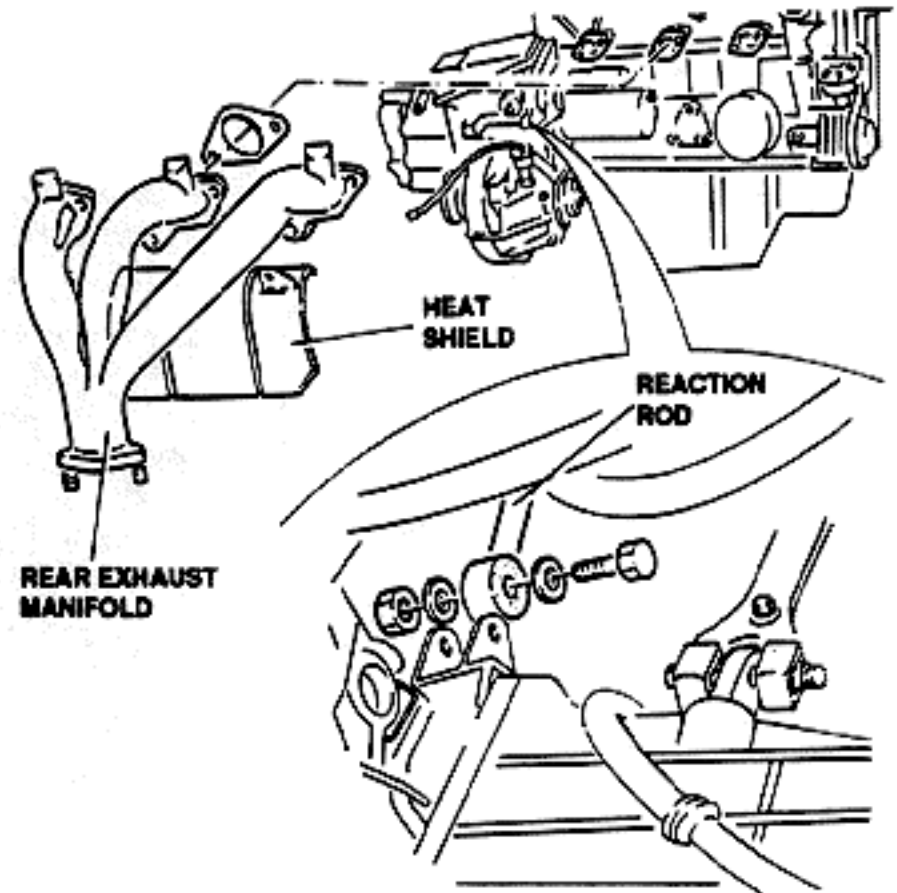


REMOVAL / INSTALLATION

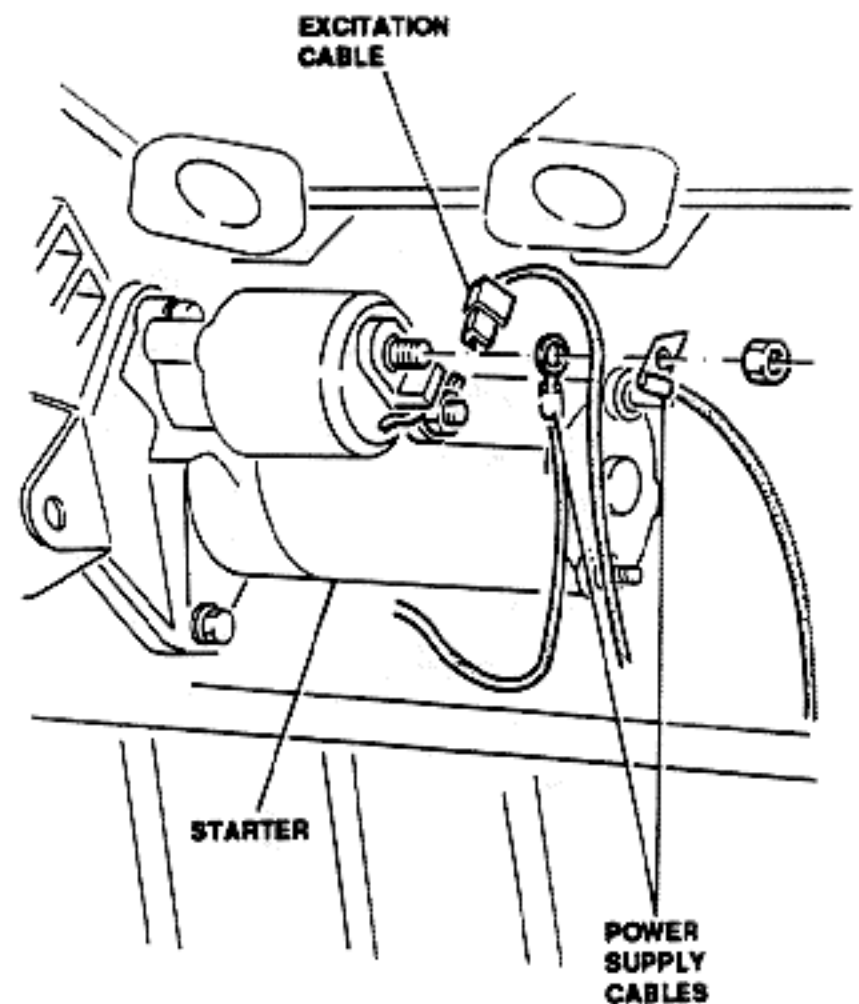
1. Disconnect battery (-) lead.
2. Remove front section of exhaust ducts and relevant gaskets.



3. Remove the rear exhaust manifold and relevant gaskets.
4. Remove the starter heat shield.
5. On vehicles equipped with automatic transmission: disconnect the reaction rod.



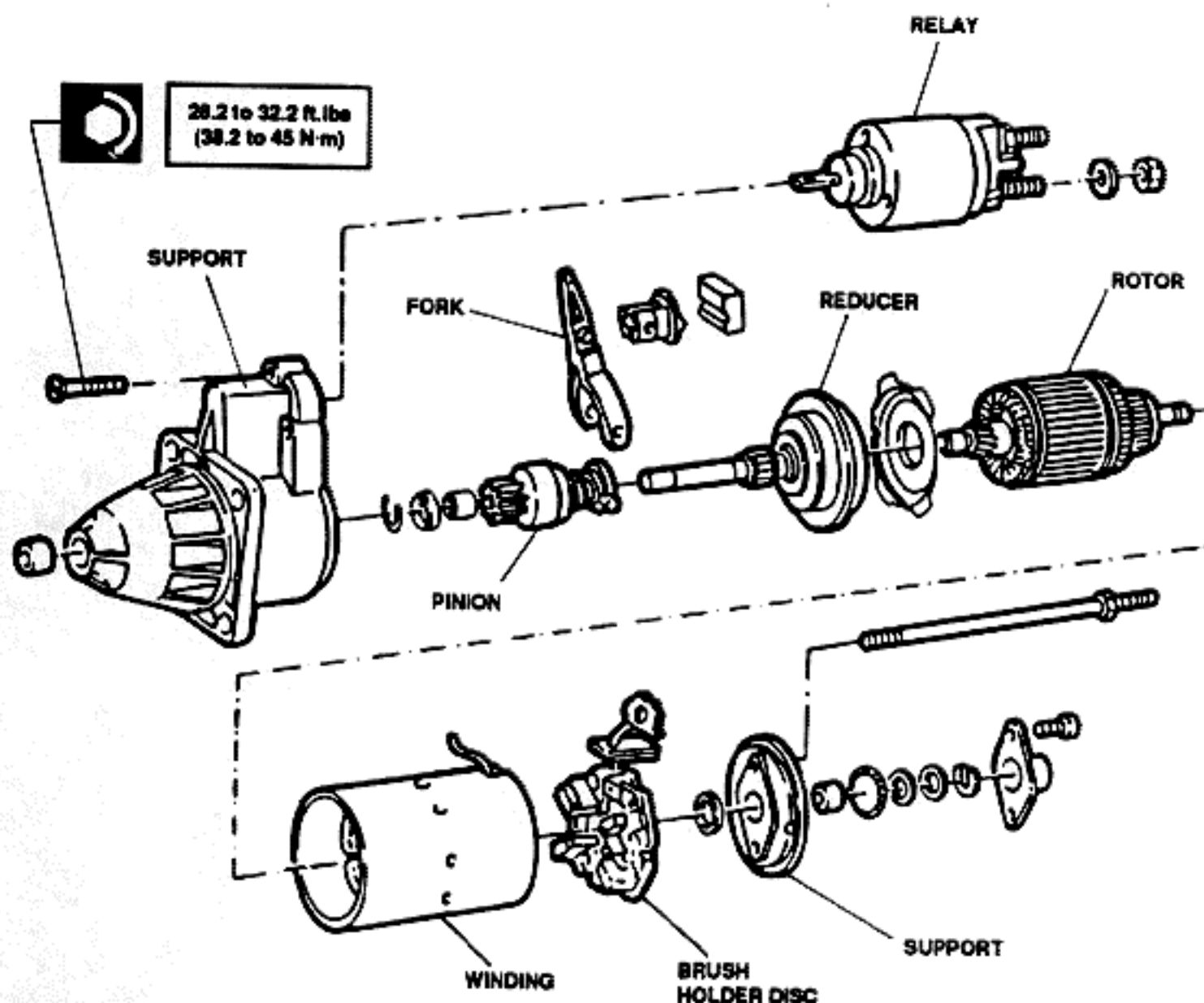
6. Disconnect the starter excitation cable.
7. Disconnect the starter power supply cables.
8. Remove the starter.





DISASSEMBLY/REASSEMBLY

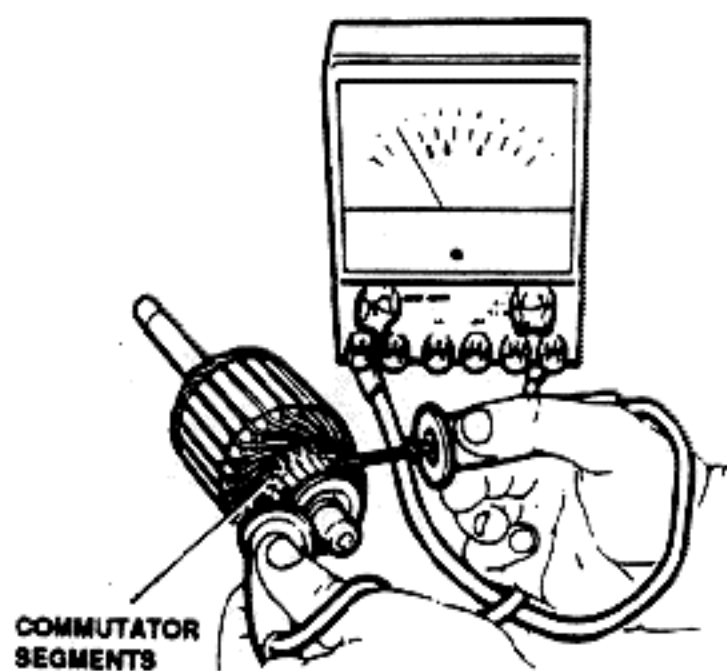
Disassemble the starter into its components.



CHECKS AND INSPECTIONS

NOTE: Before proceeding to electrical checks, thoroughly clean the affected parts with compressed air.

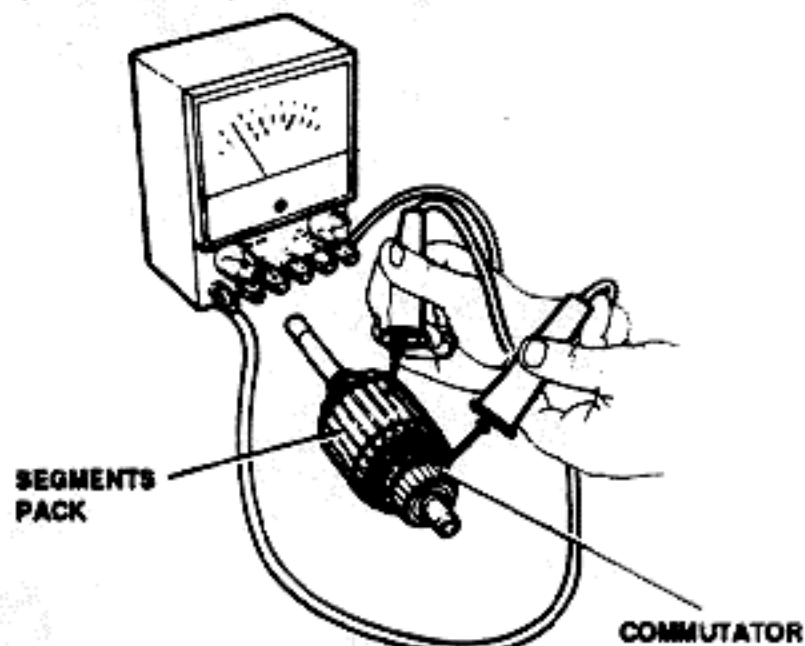
Rotor electrical continuity check: using an ohmmeter, check for electrical continuity between two pairs of adjacent commutator segment packs. Repeat the check on all the corresponding segment pairs. Replace rotor in case of lack of electrical continuity.





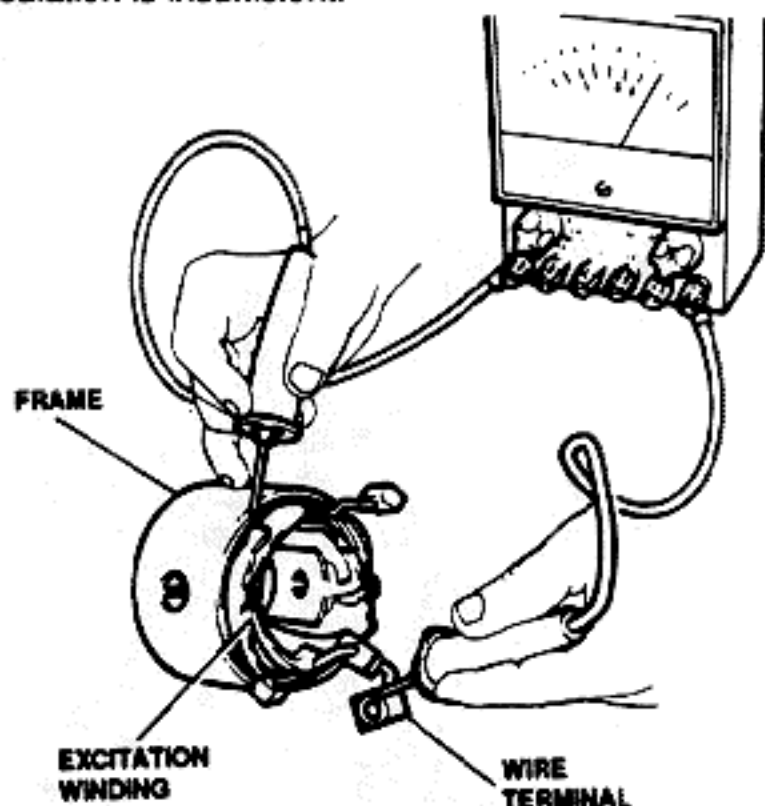
Rotor insulation check: using an ohmmeter, check that the resistance between the commutator and the segment pack is infinite (insulation). Repeat the check on all the corresponding segment pairs.

Replace rotor if proper insulation is not found.



Excitation winding insulation check: using an ohmmeter, check that the resistance between the winding terminals and the frame is infinite (insulation).

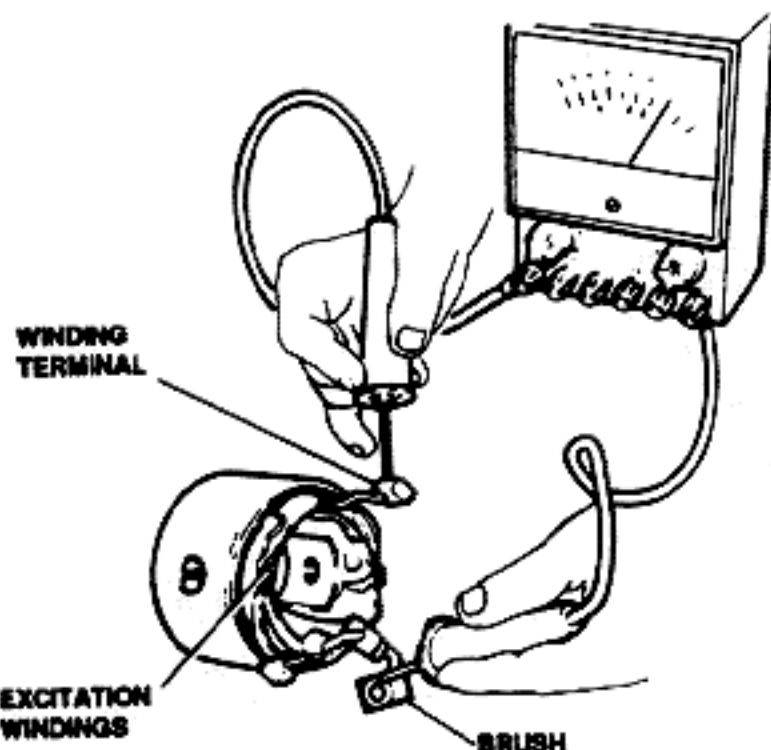
Remove windings from the frame and replace them if insulation is insufficient.



Excitation windings electrical continuity check: using an ohmmeter, check the electric continuity between the winding terminals and one of the brushes.

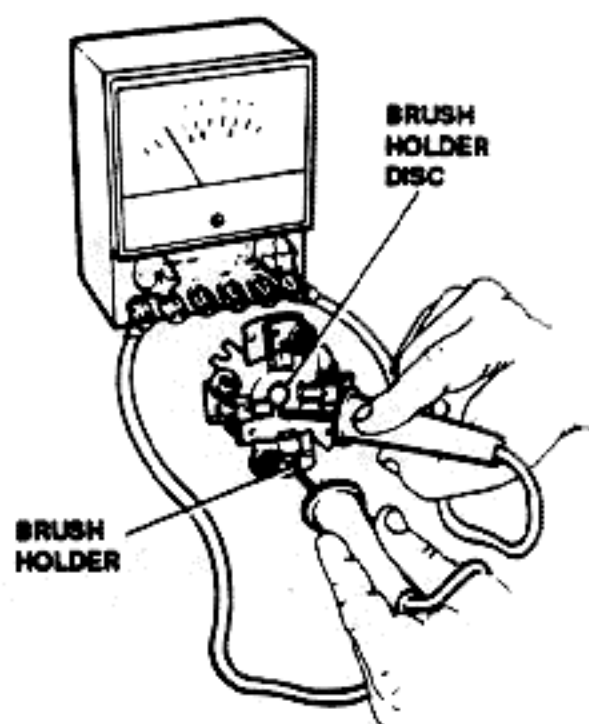
Repeat the check on the other brush.

Remove windings from the frame and replace them if the proper continuity is not found.



Brush holder insulation check: using an ohmmeter, check that the resistance between the brush holder disc and one brush holder is infinite (insulation).

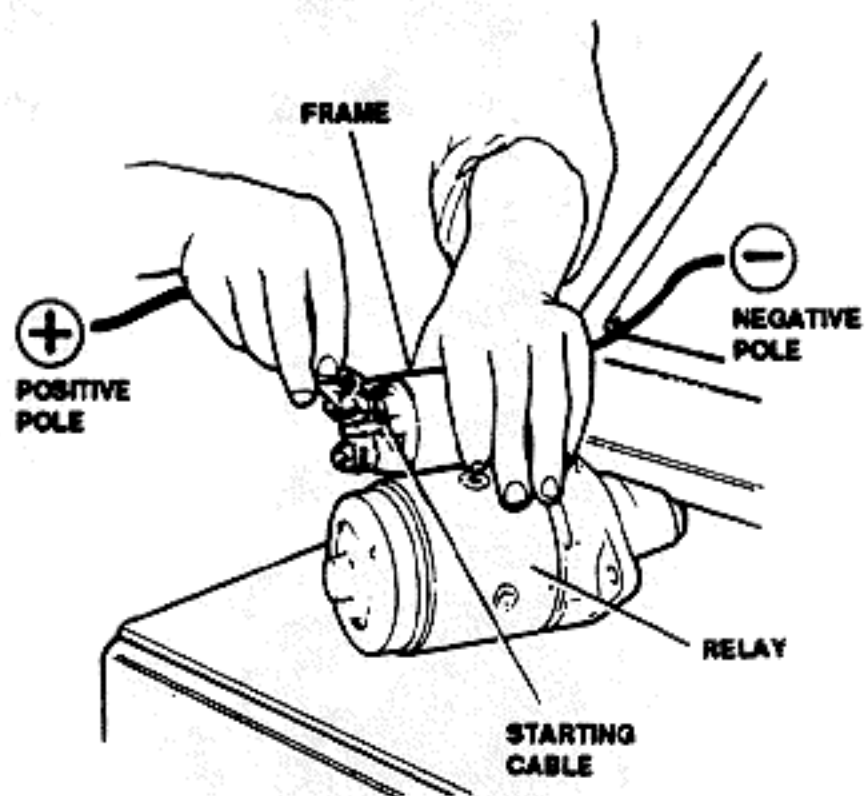
Replace brush holder disc if insulation is insufficient.



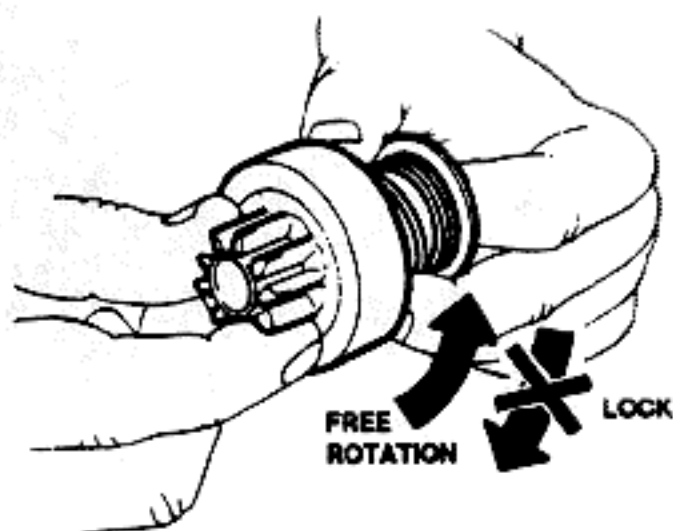
Brushes check: check rotor and stator brushes (excitation windings) for chipping and carbon deposits. Replace affected brushes if excessively worn.

Relay check: connect relay body to (-) pole of the battery, and (+) pole of relay to (+) pole of the battery, shorted with the starting cable: the relay must actuate the fork control pin.

Replace the relay if the above condition is not met.



Pinion efficiency check: check the pinion for freedom of rotation in counterclockwise direction, and that it locks when rotated in clockwise direction (engagement direction). Furtherly, visually check the pinion for integrity of teeth. Replace the pinion complete of engagement mechanism if operation is not satisfactory.





IGNITION SYSTEM

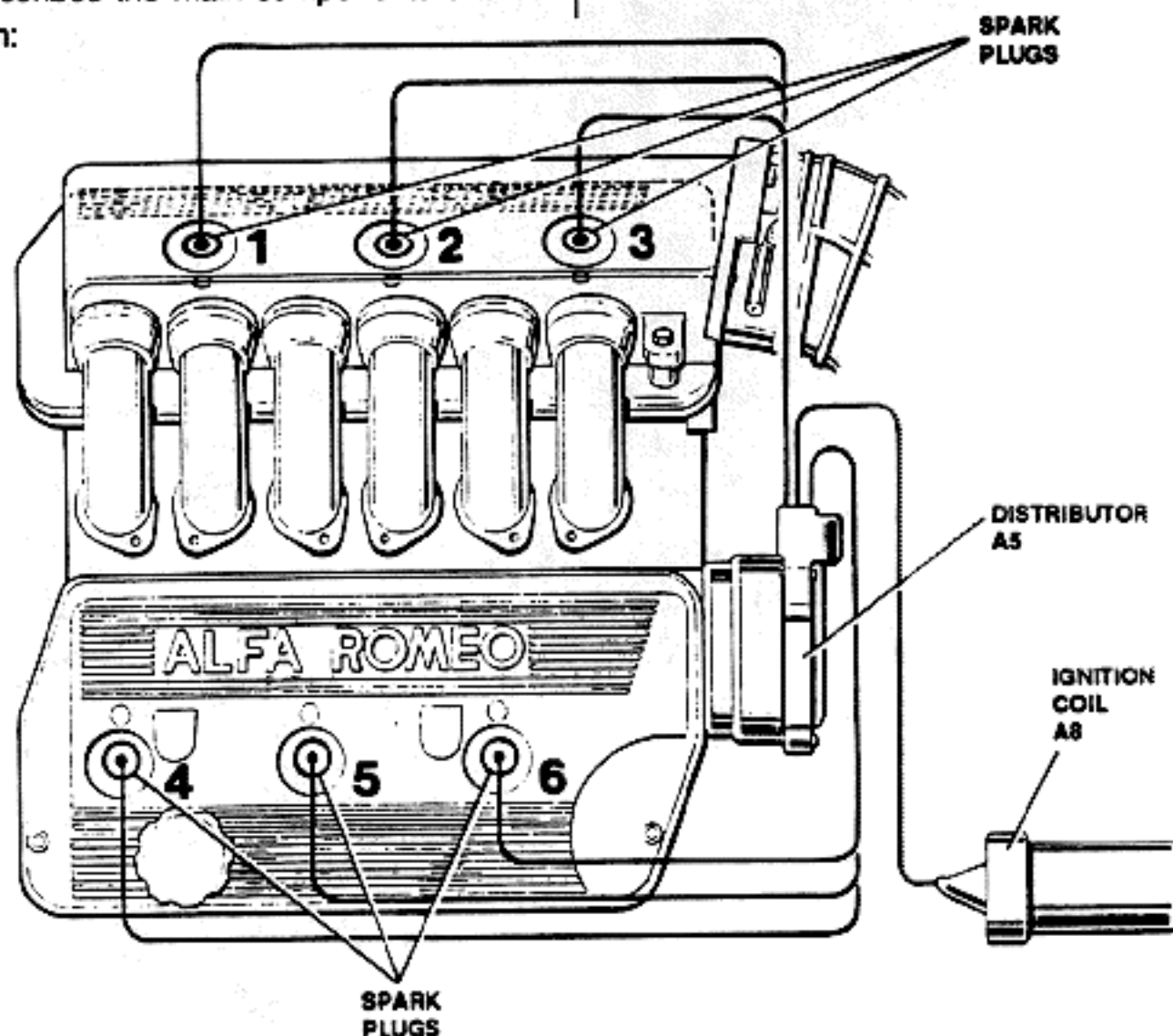
The ignition system is integrated with the injection system in the Motronic system.

This paragraph describes the main components of the ignition sub-system:

- Distributor

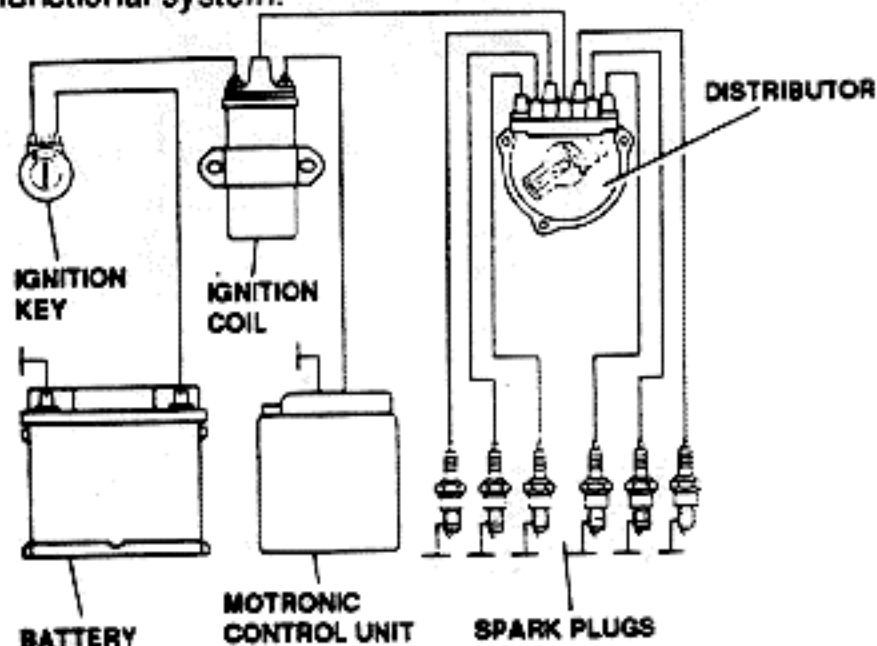
- Ignition coil
- Spark plugs

For the information concerning the remaining component of this sub-system refer to Group 04 - MOTRONIC ML 4.1 IGNITION AND INJECTION SYSTEM.



ELECTRONIC IGNITION

The adjustment of the spark plug advance is realized using the Motronic control unit memory maps, that supply a signal directly to the ignition coil, and from there to the distributor. This enabled to set-up a simple and very functional system.



WARNING:

INCREASED CAPACITY IGNITION SYSTEM. DANGEROUS LOW AND HIGH VOLTAGES.

The electronic ignition system operates in a dangerous voltage range, in both the low voltage range, and even more in the high voltage range.

Before performing any activity on the ignition system, assure the ignition is disconnected or disconnect the power supply source.

Never connect test equipment, stroboscopic guns, etc. to the ignition system; always connect the above equipment to the battery.

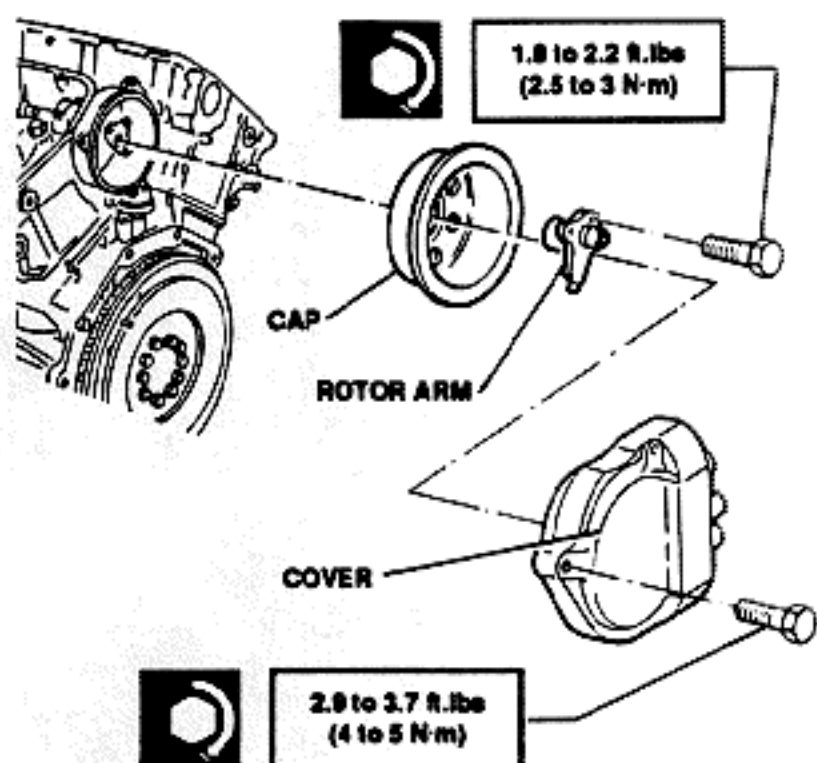


DISTRIBUTOR

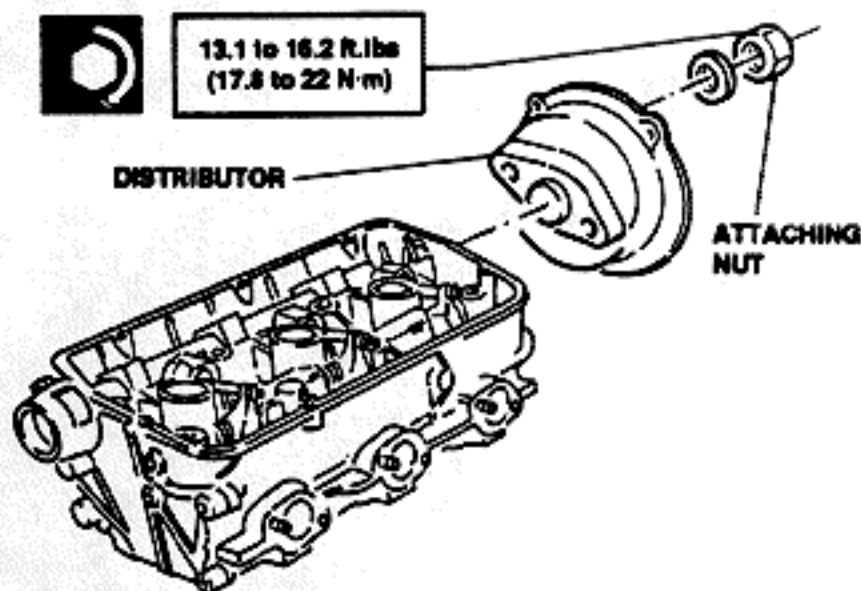
The distributor used in the electronic ignition system has the only purpose of delivering to the spark plugs the high voltage supplied by the ignition coil: this function is performed by means of a rotor arm connected by a shaft to the left cylinder's camshaft. A plastic cap protects the rotor arm, and also assures isolation and radio noise suppression.

REMOVAL / INSTALLATION

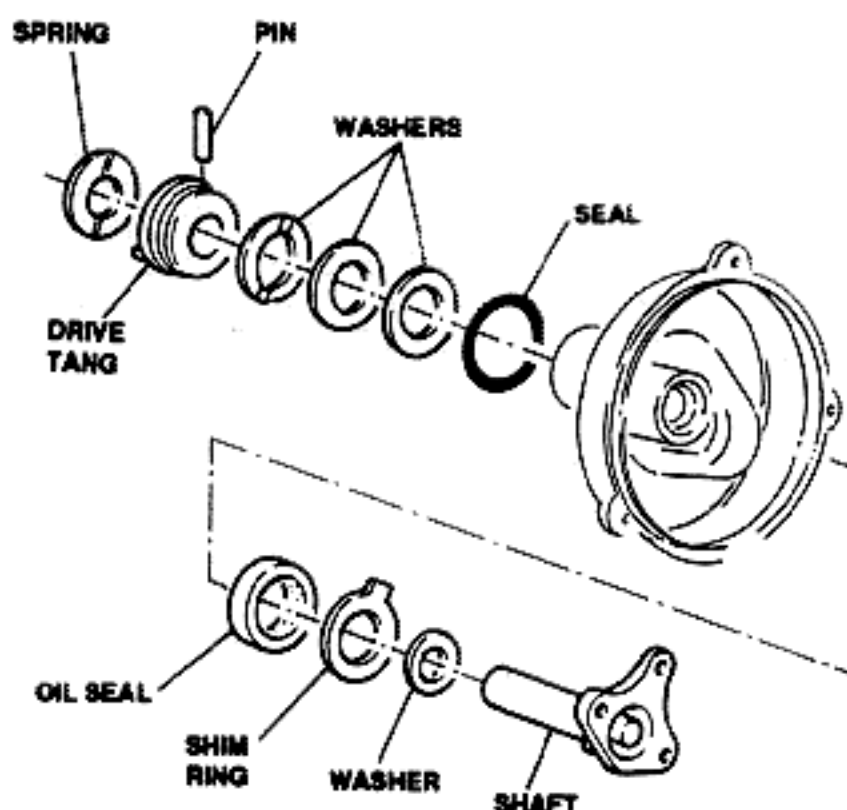
1. Remove protective cover
2. Remove rotor arm and cap.



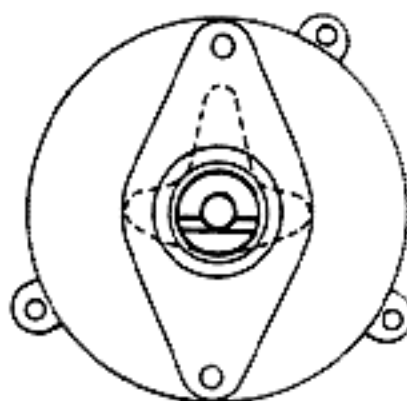
3. Remove two screws and remove distributor from cylinder head.



4. Disassemble the distributor into its components, if necessary.
5. When installing, torque hardware to the specified values.



NOTE: On reassembly, pay due attention that shaft is positioned as depicted in the illustration below: improper positioning of shaft could lead to 180 degrees phase displacement.

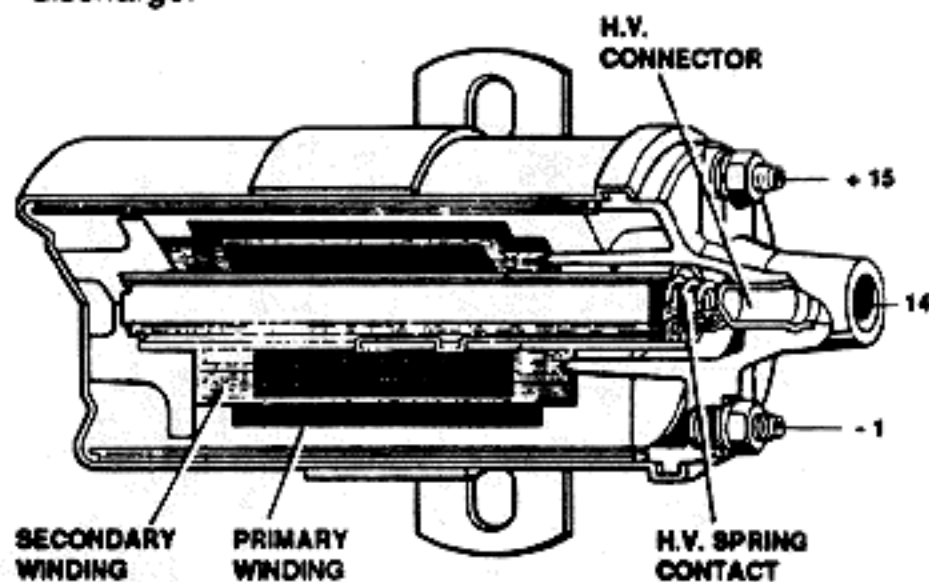


On reassembly, lubricate distributor seal with grease (ISECO Molycote BR2).

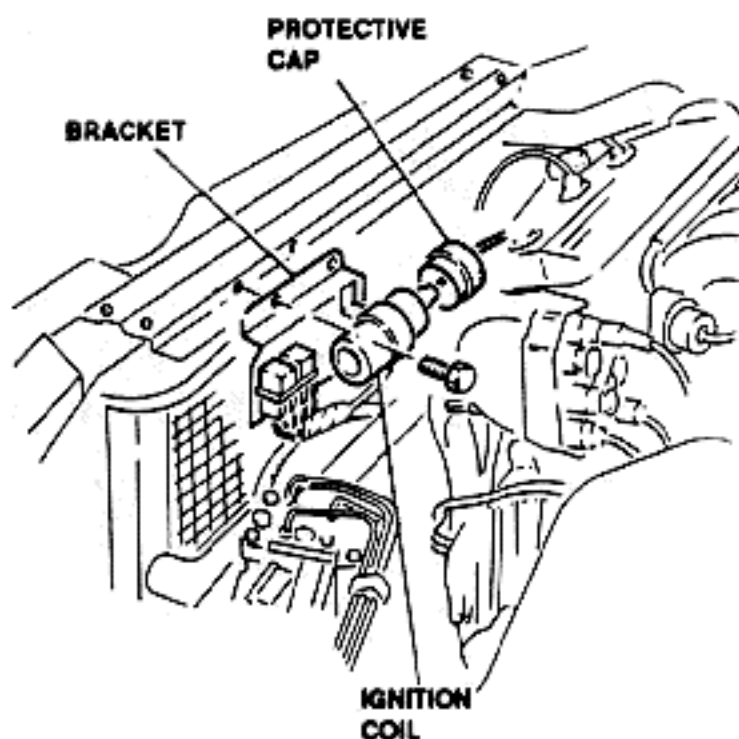


IGNITION COIL

The ignition coil accumulates the energy required to produce a high voltage capable of providing duration and intensity of required sparks. The energy stored through the primary winding is then delivered to the distributor through the secondary winding in the form of high voltage discharge.



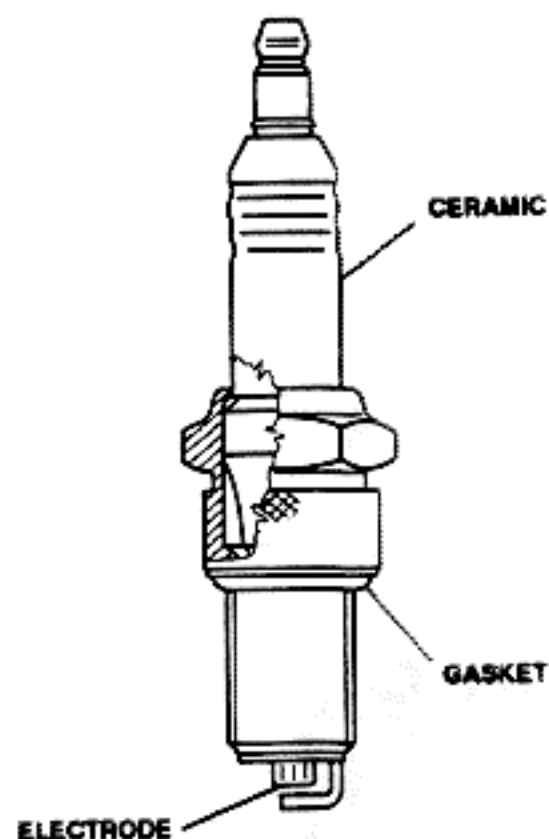
The ignition coil is located inside the engine compartment, and is installed on a bracket near the coolant radiator.



SPARK PLUG

The adopted spark plug types are:

- Champion RN7YC (164 - 164L)
- NGK PGR6A (164S) Gap .024 - .028 in



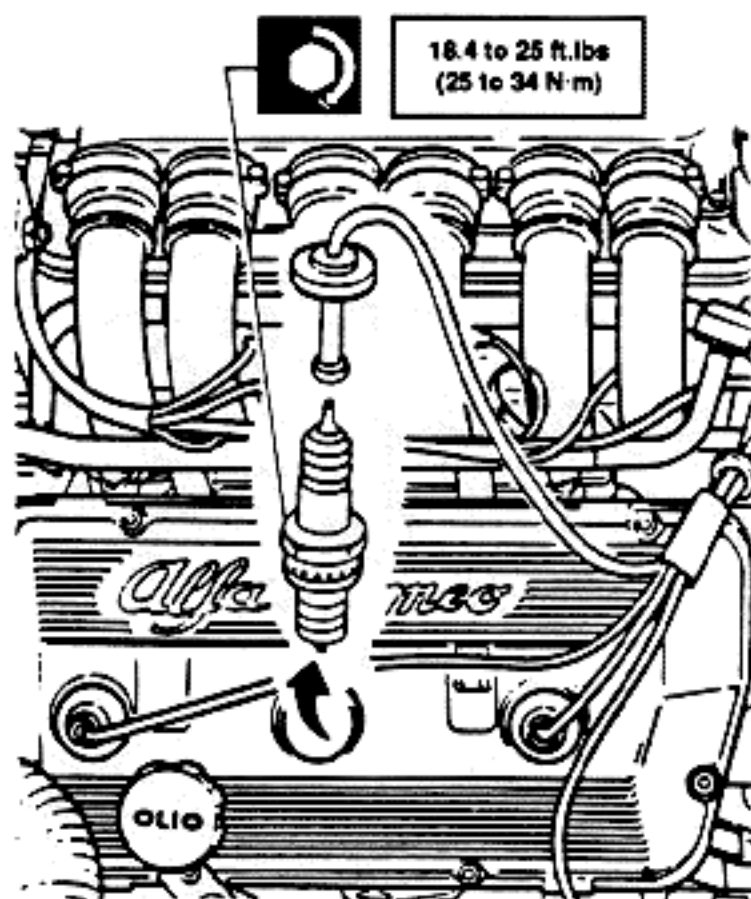
MAINTENANCE

Periodically check the electrode for cleanliness.

Also check the electrode for wear, and the ceramic for breakage.

Replace the spark plugs if damaged or worn.

At installation, lubricate spark plug thread (ISECO Moly-cote A) and torque to specified value.



**CAUTION:**

Use of spark plugs having specifications and dimensions different from those specified could cause severe engine damage, and alter the level of harmful exhaust emissions.

**CAUTION:**

A fouled or burnt spark plug is always a symptom of abnormal operation of the engine supply system.

For example:

- Traces of carbon deposits: improper fuel-air mixture. Air cleaner very dirty.
- Oil stains: oil seepage through piston rings
- Ash deposits: presence of aluminum particles, particularly in the lubricating oil.
- Melted electrodes: overheating due to use of improper fuel, defective valves, defective distributor, etc.
- Excessive electrode wear: presence of harmful additives in the fuel or oil knocking, overheating.
- Etc.

Refer to troubleshooting procedure in Groups 01 and 04 for further details concerning the above malfunctions.

TROUBLESHOOTING

The troubleshooting contained in Group 04 also includes the troubleshooting of the ignition system components.



TECHNICAL CHARACTERISTICS AND SPECIFICATIONS

BATTERY

Type		DELCO 1980775
Voltage	V	12
Capacity (20 hours)	Ah	102
Cold discharge current (at -18°C/0°F)	A	400

ALTERNATOR

Type		BOSCH N1-> 14V 40/115A
Rated voltage	V	14
Current output	A	115
- Rated current		
- Minimum speed (0A speed)	RPM	950
- 40 A speed	RPM	1500
- Rated current speed	RPM	6000

STARTER

Type		BOSCH 12V 1.4 kW
Rated voltage	V	12
Rated power	kW (HP)	1.4 (1.9)
Full load test		
- Voltage	V	9
- Current	A	350 max
- Speed	RPM	1500 min
- Torque	ft.lbs (Nm)	6.3 (8.5)
Short circuit test		
- Voltage	V	4
- Current	A	750 max
- Torque	ft.lbs (Nm)	11 (15)
Flywheel overrunning torque	ft.lbs (Nm)	0.09 to 0.013 (0.12 to 0.18)
Pinion teeth module	mm (in)	2.1167 (0.08333)



IGNITION COIL

Primary winding resistance	Ω	0.45 to 0.55
Secondary winding resistance	k Ω	5400 to 6600

SPARK PLUGS

	164 - 164L	164S GAP .024 - .028
Type	Champion RN7YC	NGK PGR6A
	GOLDEN LODGE 2 HL	

FLUIDS AND LUBRICANTS

Application	Type	Name	Quantity
Battery leads	GREASE	Reinach E10 TAC	—
Distributor ring seal	GREASE	ISECO Molycote BR2	—
Spark plug threads	OIL	ISECO Molycote A	—

TIGHTENING TORQUES

Alternator pulley nut	29.5 to 36.9 ft.lbs	40 to 50 Nm
Starter attachment	28.2 to 32.2 ft.lbs	38.2 to 45 Nm
Distributor rotor arm attachment	1.8 to 2.2 ft.lbs	2.5 to 3 Nm
Distributor cover attachment	2.9 to 3.7 ft.lbs	4 to 5 Nm
Distributor to cylinder head attaching screws	13.1 to 16.2 ft.lbs	17.8 to 22 Nm
Spark plugs (with oil)	18.4 to 25 ft.lbs	25 to 34 Nm



TROUBLESHOOTING PROCEDURE: IGNITION

TROUBLES AND SYMPTOMS	TEST REFERENCE
WITH THE ENGINE RUNNING, IGNITION IS IRREGULAR	A
AT HIGH SPEEDS, IGNITION IS IRREGULAR	B
WITH THE IGNITION KEY SET TO "START", THE STARTER RUNS BUT THE ENGINE DOES NOT START	C
ENGINE DIAGNOSIS ACCORDING TO THE SPARK PLUG CONDITIONS	D



TROUBLESHOOTING PROCEDURE: START-UP

TROUBLES AND SYMPTOMS	TEST REFERENCE
WITH THE IGNITION KEY SET TO "START", THE STARTER DOES NOT RUN AND THERE IS NO CURRENT ABSORPTION	E
WITH THE IGNITION KEY SET TO "START", THE STARTER ABSORBS CURRENT BUT DOES NOT RUN, OR RUNS SLOWLY, OR DOES NOT START THE ENGINE	F
WITH THE IGNITION KEY SET TO "START", THE STARTER RUNS BUT DOES NOT START THE ENGINE	G
WITH THE IGNITION KEY SET TO "START", THE STARTER RUNS NORMALLY BUT EXCESSIVE OR UNUSUAL NOISE IS HEARD	H
WITH THE IGNITION KEY SET TO "START", THE STARTER DOES NOT DEVELOPE ITS MAXIMUM POWER	I
EXCESSIVE WEAR OF STARTER BRUSHES	J
SPARKING AT THE STARTER COMMUTATOR	K



TROUBLESHOOTING PROCEDURE: RECHARGE

TROUBLES AND SYMPTOMS	TEST REFERENCE
THE ALTERNATOR DOES NOT CHARGE	L
THE ALTERNATOR IS NOISY	M
DURING THE ALTERNATOR NORMAL OPERATION, THERE IS AN INSUFFICIENT OR IRREGULAR CURRENT SUPPLY	N
DURING THE ALTERNATOR NORMAL OPERATION, THERE IS AN EXCESSIVE CURRENT SUPPLY	O



WITH THE ENGINE RUNNING, IGNITION IS IRREGULAR

TEST A

TEST STEPS		RESULTS	REMEDY
A1	HIGH VOLTAGE CONNECTION CHECK		
- Check that the ignition coil protective cap is free from burning		OK ►	Carry-out step A2
		~~OK~~ ►	Replace the ignition coil
A2	WIRING CHECK		
- Check that the distributor cap is free from burning		OK ►	Carry-out step A3
		~~OK~~ ►	Replace the distributor cap
A3	DISTRIBUTOR CHECK		
- Check that the distributor rotor is free from burning		OK ►	Carry-out step A4
		~~OK~~ ►	Replace the distributor rotor
A4	COIL WINDING CHECK		
- Check that the spark plug spark is not of weak intensity (which is due to a broken coil secondary winding or in short circuit)		OK ►	Carry-out step A5
		~~OK~~ ►	Replace the ignition coil

(Cont.d)



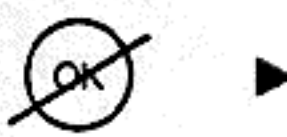
WITH THE ENGINE RUNNING, IGNITION IS IRREGULAR

TEST A

TEST STEPS		RESULTS	REMEDY
A5	ROTOR - STATOR AIR GAP CHECK		
- Check that there is no air gap between the ignition distributor rotor and stator		 	See "WIRING DIAGRAMS AND ELECTRICAL DIAGNOSIS"
		 	Replace the involved components inside the Ignition distributor

End of test A

**AT HIGH SPEEDS, IGNITION IS IRREGULAR****TEST B**

TEST STEPS		RESULTS	REMEDY
B1	LOW VOLTAGE CONNECTION CHECK		Fully tighten the fixing points, check the electric connections for integrity, perform beading on the contacts
- Check the low voltage connections for integrity			

End of test B

**WITH THE IGNITION KEY SET TO "START", THE STARTER RUNS BUT THE ENGINE DOES NOT START****TEST C**

TEST STEPS		RESULTS	REMEDY
C1	COIL PROTECTIVE CAP CHECK		
- Check that the ignition coil protective cap is not perforated by high voltage or connected to ground		 ►	Carry-out step C2
		 ►	Replace the Ignition coil
C2	DISTRIBUTOR CAP CHECK		
- Check that the distributor cap is not perforated by high voltage or connected to ground		 ►	Carry-out step C3
		 ►	Replace the distributor cap
C3	DISTRIBUTOR ROTOR CHECK		
- Check that the distributor rotor is not perforated by high voltage or connected to ground		 ►	Carry-out step C4
		 ►	Replace the distributor rotor
C4	COIL WINDING CHECK		
- Check that the coil secondary winding is not broke, in short circuit, or connected to ground		 ►	Carry-out step C5
		 ►	Replace the Ignition coil

(Cont.d)



WITH THE IGNITION KEY SET TO "START", THE STARTER RUNS BUT THE ENGINE DOES NOT START

TEST C

TEST STEPS		RESULTS	REMEDY
C5	SECONDARY WINDING CHECK		
Check that the dary winding of the Ignition coil is not broken		 	See "WIRING DIAGRAMS AND ELECTRICAL DIAGNOSIS" or "TROUBLESHOOTING PROCEDURE" Group 04
		 	Replace the Ignition coil

End of test C

**ENGINE DIAGNOSIS ACCORDING TO THE SPARK PLUG CONDITIONS****TEST D****Normal condition**

Insulator noses grayish-white or grayish-yellow to brown. Engine is in order. Heat range of plug correct. Mixture setting and ignition timing are correct, no misfiring. Cold-starting device functioning. No deposits from fuel additives containing lead or from alloying constituents in the engine oil. No overheating.

Sooted-carbon-fouled

Insulator nose, electrodes and spark-plug shell covered with velvet-like, dull black soot deposits. Cause: incorrect mixture setting (fuel injection); mixture too rich, air filter very dirty, automatic choke not in order. Spark plug too cold, heat range code number too low.

Oil-fouled

Insulator nose, electrodes and spark-plug shell covered with shiny soot or carbon residues. Cause: too much oil in combustion chamber. Oil level too high, badly worn piston rings, cylinders and valve guides.

Formation of ash

Heavy ash deposits from oil and fuel additives on the insulator nose, in the scavenging area and on the ground electrode. The structure of the ash is loose to cinder-like.

Cause: Alloying constituents, in particular from oil, can deposit this ash in the combustion chamber and on the spark-plug face.

Partially melted electrodes

Cauliflower-like appearance of the electrodes. Possible deposits of materials not originating from the plug. Cause: overheating due to autoignition, e.g. due to over-advanced ignition timing, combustion deposits in combustion chamber, defective valves, defective ignition distributor or insufficient fuel quantity.

Heavy wear on ground electrode

Excessively large electrode gap owing to excessive wear. Cause: aggressive fuel and oil additives. Unfavorable influences of gas turbulence in the combustion chamber, possibly caused by deposits. Knocking. No overheating.

End of test D



WITH THE IGNITION KEY SET TO "START", THE STARTER DOES NOT RUN AND THERE IS NO CURRENT ABSORPTION

TEST E

TEST STEPS		RESULTS	REMEDY
E1	WIRING CHECK		
- Check that no breaks are present on the electric circuit between battery and starter		OK ► ~~OK~~ ►	Carry-out step E2 Locate and repair the break (see: WIRING DIAGRAMS AND ELECTRICAL DIAGNOSIS). Also check battery terminals, cranking cable ferules, by fully tightening the fixing nuts
E2	WIRING CHECK		
- Check that no breaks are present on the electric circuit between the ignition switch and the starter		OK ► ~~OK~~ ►	Carry-out step E3 Locate and repair the break (see: WIRING DIAGRAMS AND ELECTRICAL DIAGNOSIS). Also check the conditions of the ignition switch contacts, replace it if necessary
E3	BATTERY TERMINAL CHECK		
- Check that the battery terminals are not oxydated and the post clamps are not slackened		OK ► ~~OK~~ ►	Carry-out step E4 Clean the battery terminals and fully tighten the post clamps

(Cont.d)



WITH THE IGNITION KEY SET TO "START", THE STARTER DOES NOT RUN
AND THERE IS NO CURRENT ABSORPTION

TEST E

TEST STEPS		RESULTS	REMEDY
E4	BRUSH CHECK		Replace the brushes and check the commutator for integrity
- Check that the brushes are not excessively worn and the contact with the commutator is correct			

End of test E



WITH IGNITION KEY TO "START", THE STARTER ABSORBS CURRENT BUT DOES NOT RUN, RUNS SLOWLY OR DOES NOT START THE ENGINE

TEST F

TEST STEPS		RESULTS	REMEDY
F1	ROTOR CHECK		
- Check that the rotor rotates freely and is not stuck against the pole shoes		OK ► ~~OK~~ ►	Carry-out step F2 Should bearings be excessively worn, replace the complete bearing assy. Also check bearings for correct alignment and rotor shaft for integrity; check that pole shoes are correctly positioned and tightened
F2	ROTOR SHAFT CHECK		
- Check that the rotor shaft is not sized		OK ► ~~OK~~ ►	Carry-out step F3 Replace the sized rotor and bearing
F3	EXCITATION COIL CHECK		
- Check that the excitation winding of the coils is not short-circuited or connected to ground		OK ► ~~OK~~ ►	Carry-out step F4 Replace the excitation coils
F4	ROTOR CHECK		
- Check that the rotor is not broken or connected to ground		OK ► ~~OK~~ ►	Carry-out step F5 Replace the rotor

(Cont.d)



WITH IGNITION KEY TO "START", THE STARTER ABSORBS CURRENT BUT DOES NOT RUN, RUNS SLOWLY OR DOES NOT START THE ENGINE

TEST F

TEST STEPS		RESULTS	REMEDY
F5	ROTOR CHECK		Clean the commutator and the brush holders from copper and carbon residues. Also check the rotor for integrity and replace it if necessary
- Check that the rotor is not short-circuited			

End of test F



WITH THE IGNITION KEY SET TO "START", THE STARTER RUNS BUT DOES NOT START THE ENGINE

TEST G

TEST STEPS		RESULTS	REMEDY
G1	FLYWHEEL CROWN TOOTH CHECK		
THE PINION DOES NOT ENGAGE: Check that the flywheel teeth are not worn		OK ► ~~OK~~ ►	Carry-out step G2 Replace the flywheel crown
G2	PINION INSTALLATION CHECK		
THE PINION ENGAGES ONLY PARTIALLY: Check the pinion for correct installation		OK ► ~~OK~~ ►	Carry-out step G3 Restore the alignment between pinion and flywheel crown
G3	ENGAGEMENT FORK CHECK		
Check that the engagement fork slides freely on the rotor shaft		OK ► ~~OK~~ ►	Carry-out step G4 Clean and lubricate the engagement fork
G4	PINION FREE WHEEL CHECK		
Check the pinion free wheel for correct operation		OK ► ~~OK~~ ►	Carry-out step G5 Replace the pinion complete assy
G5	ELECTROMAGNET CHECK		
Check the electromagnet for correct operation		~~OK~~ ►	Replace the electro-magnet

End of test G



WITH THE IGNITION KEY SET TO "START", THE STARTER RUNS NORMALLY BUT EXCESSIVE OR UNUSUAL NOISE IS HEARD

TEST H

TEST STEPS		RESULTS	REMEDY
H1	MECHANICAL COMPONENT CHECK		
- Check that the mechanical components inside the starter are not defective		 	Carry-out step H2
		 	Replace the defective components
H2	FOREIGN BODY PRESENCE CHECK		
- Check for presence of foreign bodies inside the starter		 	Eliminate any foreign body

End of test H



WITH THE IGNITION KEY SET TO "START", THE STARTER DOES NOT DEVELOPE ITS MAXIMUM POWER

TEST I

TEST STEPS		RESULTS	REMEDY
I1	BRUSH CHECK		
- Check that the contact between brushes and commutator is uniform		OK ► ~~OK~~ ►	Carry-out step I2 Adapt the brushes to the commutator by rotating the motor loadless; replace the brushes if necessary
I2	FOREIGN BODY PRESENCE CHECK		
- Check that the brush pressure spring are not yielded or broken		OK ► ~~OK~~ ►	Carry-out Step I3 Replace the brushes
I3	BRUSH GUIDE CHECK		
- Check that the brushes slide freely along the guides		~~OK~~ ►	Clean the guides of the brushes, if necessary, replace the brushes

End of test I

**EXCESSIVE WEAR OF STARTER BRUSHES****TEST J**

TEST STEPS		RESULTS	REMEDY
J1	COMMUTATOR CHECK	OK ~~OK~~	Carry-out step J2
- Check the commutator for ovality			Grind the commutator within the prescribed limits and carefully clean it
J2	MICA CHECK	OK ~~OK~~	Carry-out step J3
- Check that the mica does not protrude from the commutator copper blades			Remove excess of mica and clean the commutator
J3	BRUSH CHECK	~~OK~~	Replace the brushes with the prescribed type
- Check that the brushes correspond to the original type			

End of test J



SPARKING AT THE STARTER COMMUTATOR

TEST K

TEST STEPS		RESULTS	REMEDY
K1	ELECTRIC LOAD CHECK	OK	Carry-out step K2
- Check that no electric overload occurs			Proceed to overhauling operations of the motor of the starter
K2	BRUSH PRESSURE SPRING CHECK	OK	Carry-out Step K3
- Check that the brush pressure spring are not yielded			Replace the brushes
K3	MICA CHECK		Remove excess of mica and clean the commutator
- Check that the mica does not protrude from the commutator copper blades			

End of test K



THE ALTERNATOR DOES NOT CHARGE

TEST L

TEST STEPS		RESULTS	REMEDY
L1	BELT TENSIONING CHECK	OK ▶ ~~OK~~ ▶	Carry-out step L2
- Check the belt for correct tensioning			Proceed to the correct belt tensioning
L2	WIRING CHECK	OK ▶ ~~OK~~ ▶	Carry-out step L3
- Check that the charging circuit and the return-to-ground circuit are not broken			Check the circuit (see WIRING DIAGRAMS AND ELECTRICAL DIAGNOSIS)
L3	BRUSH CHECK	OK ▶ ~~OK~~ ▶	Carry-out step L4
- Check the brushes for integrity			Replace the brushes
L4	DIODE CHECK	OK ▶ ~~OK~~ ▶	Carry-out step L5
- Check that the excitation diodes are not short-circuited			Replace the diode holder plate

(Cont.d)



THE ALTERNATOR DOES NOT CHARGE

TEST L

TEST STEPS		RESULTS	REMEDY
L5	EXCITATION CIRCUIT CHECK		
- Check that the excitation circuit is not broken		OK ►	Carry-out step L6
		~~OK~~ ►	Check the circuit
L6	ROTOR CHECK		
- Check that the rotor winding is not broken		OK ►	Carry-out step L7
		~~OK~~ ►	Replace the rotor
L7	VOLTAGE REGULATOR CHECK		
- Check that the voltage regulator is correctly operating		OK ►	Carry-out step L8
		~~OK~~ ►	Replace the voltage regulator
L8	STATOR CHECK		
- Check that the stator winding is insulated from ground		~~OK~~ ►	Replace the stator

End of test L



THE ALTERNATOR IS NOISY

TEST M

TEST STEPS		RESULTS	REMEDY
M1	BELT CHECK		
- Check that the alternator driving belt is not worn		 ►	Carry-out step M2
		 ►	Replace the belt
M2	PULLEY CHECK		
- Check that the alternator pulley fixing nut is not slackened		 ►	Carry-out step M3
		 ►	Tighten the pulley fixing nut
M3	BEARING CHECK		
- Check that the alternator bearing are not worn		 ►	Carry-out step M4
		 ►	Replace the defective bearings
M4	DIODE CHECK		
- Check the excitation diodes for integrity		 ►	Carry-out step M5
		 ►	Replace the diode holder plate
M5	ALTERNATOR FIXING POINT CHECK		
- Check that the alternator fixing points are not slackened		 ►	Tighten the alternator fixing screws

End of test M


DURING THE ALTERNATOR NORMAL OPERATION, THERE IS AN INSUFFICIENT OR IRREGULAR CURRENT SUPPLY
TEST N

TEST STEPS		RESULTS	REMEDY
N1	BELT TENSIONING CHECK		
	Check the alternator driving belt tensioning	OK ► ~~OK~~ ►	Carry-out step N2 Proceed to the correct belt tensioning
N2	BRUSH CHECK		
	Check that the alternator brushes are not worn	OK ► ~~OK~~ ►	Carry-out step N3 Replace the brushes
N3	VOLTAGE REGULATOR CHECK		
	Check that the voltage regulator is correctly operating	OK ► ~~OK~~ ►	Carry-out step N4 Replace the voltage regulator
N4	DIODE CHECK		
	Check the excitation diodes are not broken or short-circuited	OK ► ~~OK~~ ►	Carry-out step N5 Replace the diode holder plate

(Cont.d)



DURING THE ALTERNATOR NORMAL OPERATION, THERE IS AN INSUFFICIENT OR IRREGULAR CURRENT SUPPLY

TEST N

TEST STEPS		RESULTS	REMEDY
N5	ROTOR CHECK		
- Check that the rotor suitably insulated		 ►	Carry-out step N6
		 ►	Replace the rotor
N6	STATOR CHECK		
- Check that the stator is not broken, or connected to ground, or partially short-circuited		 ►	Replace the stator

End of test N



DURING THE ALTERNATOR NORMAL OPERATION, THERE IS AN EXCESSIVE CURRENT SUPPLY

TEST O

TEST STEPS		RESULTS	REMEDY
O1	VOLTAGE REGULATOR CHECK		Replace the voltage regulator
- Check that the voltage regulator is correctly operating			

End of test O