

Chapter 6

Engine Electrical

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Specifications

BATTERY

Type	12 volt lead acid
Polarity	Negative (-) earth
Specific gravity @ 20° C:	
Fully charged	1.240 – 1.260
Fully discharged	Below 1.130

ALTERNATOR

Make	Nippondenso
Maximum output	80 amps
Regulated voltage	13.7 – 14.8 volts
Brush exposed length:	
Standard	10.5 mm
Minimum	1.5 mm
Slip ring minimum diameter	12.8 mm
Rotor winding resistance @ 20° C	2.1 – 2.5 ohms
Stator winding resistance @ 20° C	Continuity

STARTER MOTOR

Make	Nippondenso
Type	1.4 kW with planetary reduction gears
Number of pinion teeth	9
No load test:	
Current	90 amps or less @ 11.5 V
Rpm	3000
Commutator:	
Maximum out of round	0.05 mm
Diameter—	
Standard	30.0 mm
Minimum	29.0 mm
Mica undercut—	
Standard	0.6 mm
Minimum	0.2 mm
Brush length:	
Standard	15.5 mm
Minimum	10.0 mm
Solenoid contact wear limit	0.9 mm

TORQUE WRENCH SETTINGS

Alternator pulley retaining nut	110 Nm
Alternator pivot bolt	51 Nm
Alternator adjusting bolt locknut	18 Nm
Solenoid contact retaining nut	17 Nm
Starter motor mounting bolts and nut	39 Nm

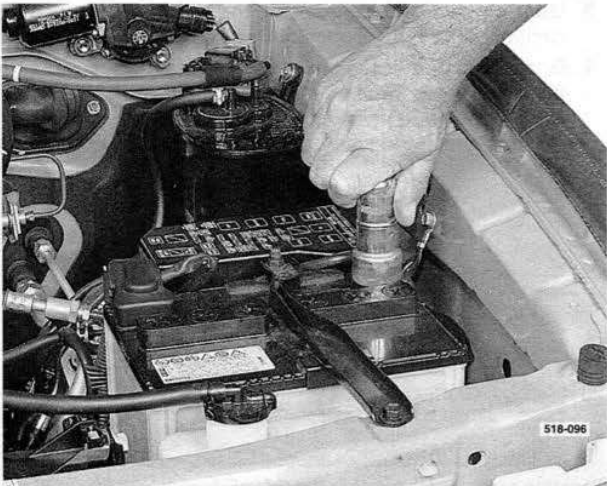
Routine Maintenance

BATTERY



Keep naked flames and sparks away from the battery as the battery gasses are highly explosive.

- 1 Keep the battery and the surrounding area clean and dry. In particular, ensure that the top of the battery is free of dirt and moisture to prevent voltage flow between the terminals. If necessary clean the battery case as follows:
 - a Remove the battery from the vehicle as described later in this chapter.
 - b Pour hot water over the battery being careful not to allow any water to enter the filler cap vent holes.
 - c Wipe the battery case clean.
- 2 Clean the battery terminals and posts using a battery post cleaner or a wire brush. Remove all dirt and corrosion.
- 3 Remove the filler caps and check that the vent holes are clear.



Cleaning the battery terminals with a post cleaner.

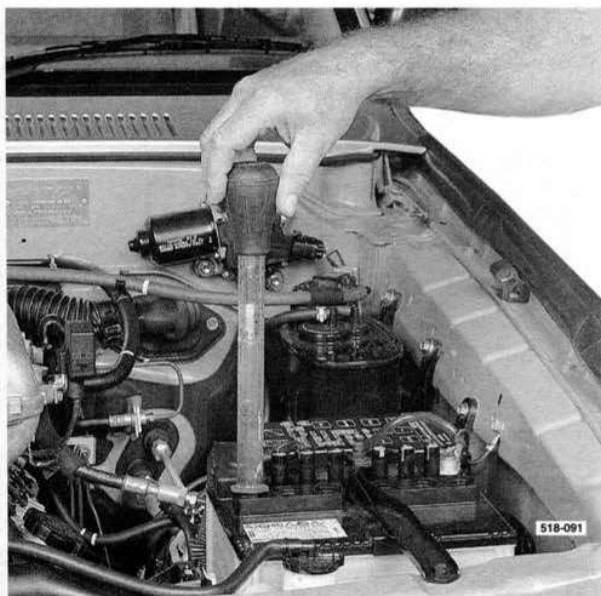
- 4 Check the electrolyte level and replenish with distilled water if necessary. The correct level is marked on the case of some batteries. Alternatively, bring the level to the bottom of the well in the filler hole ensuring that the plates are submerged. Do not overfill the battery.
- 5 If the battery requires frequent replenishing, check for overcharging by measuring the alternator output as described later in this chapter. Check the battery case for cracks. If the case is damaged, renew the battery.
- 6 If the electrolyte has spilled over the battery carrier and surrounding body panels, proceed as follows:
 - a With the battery removed sprinkle bicarbonate of soda over the contaminated area.
 - b Pour hot water over the bicarbonate of soda. The bicarbonate of soda will react with the water and begin to foam.
 - c When the bicarbonate of soda has stopped foaming, rinse the area with clean water and allow to dry.
 - d Remove any blistered paint from the affected area and coat the area with a corrosion inhibiting paint.
- 7 Install the battery as described later in this chapter.

Terminals and Leads

- 1 Clean the battery posts and terminals using a battery post cleaner or a wire brush. Remove all dirt and corrosion.
- 2 Apply petroleum jelly to the battery terminals to prevent corrosion.
- 3 Check the condition of the battery leads and terminals.
- 4 Ensure that the positive lead is securely connected to the positive battery terminal and to the starter motor and that the negative lead is securely connected to the negative battery terminal and to the cylinder block.

To Test and Charge

- 1 Using a hydrometer, test the specific gravity of the battery electrolyte. Refer to the following chart which shows conditions for specific gravity readings:



Checking the battery charge condition with a hydrometer.

SPECIFIC GRAVITY	CONDITION
1.110 – 1.130	Fully discharged
1.140 – 1.160	Nearly discharged
1.170 – 1.190	Approximately one quarter charged
1.200 – 1.220	Half charged
1.230 – 1.240	Approximately three quarters charged
1.240 – 1.260	Fully charged

These readings are for electrolyte at a temperature of 20° C. For every 10° above 20° C, add 0.007. For every 10° below 20° C, subtract 0.007.



An accurate specific gravity reading cannot be obtained if distilled water has recently been added to the electrolyte.

If the electrolyte level is below the battery plates, replenish with distilled water and charge the battery before testing the specific gravity. Do not transfer electrolyte from one cell to another.

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- 2 If a hydrometer is not available, the battery condition can be determined using a voltmeter as follows:
 - a Pull the Engine Control relay from the engine compartment fuse and relay box to prevent the engine from starting.
 - b Connect the positive test lead to the positive terminal of the battery and the negative test lead to the negative battery terminal.
 - c Get an assistant to crank the engine for approximately 8 seconds by turning the ignition key to the start position.
 - d If the voltage drops below 9.6 volts, charge the battery as described in this chapter and repeat the test. If the voltage still drops below 9.6 volts while cranking, the battery is suspect. Install the Engine Control relay.
 - e If the voltage stayed above 9.6 volts while cranking, the battery charge condition is good.
- 3 If a low state of charge is indicated, charge the battery, using a commercially available battery charger with attention to the following points:



Specific gravity variations of more than 0.025 between cells indicate defective cells in the battery.

- a Disconnect the negative and positive battery terminals.
- b Remove the filler caps from the battery.
- c Check the battery electrolyte level and replenish as necessary.
- d Follow the battery charger manufacturers instructions.
- e Stop charging the battery when excessive bubbling of the cells is noticed, similar to boiling water.



Where possible, use a slow charge rate in preference to a fast charge rate.

- 4 Should the battery fail to operate satisfactorily after charging, it is recommended that it be taken to an authorised dealer or auto electrician with the necessary equipment to perform a load test. Load testing, when performed in conjunction with the specific gravity tests described above, will give an accurate indication of the serviceability of the battery.

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ALTERNATOR

The alternator itself does not require maintenance under normal conditions, apart from checking that the drive belt is serviceable and correctly tensioned as described in Engine (chapter 4).

Ensure that oil or coolant is not allowed to enter the alternator cooling slots, as both these could cause the alternator to malfunction.

Occasionally check the alternator mounting bolts and wiring to ensure that they are secure.

Battery and Charging System Trouble Shooting

BATTERY UNDERCHARGED

- 1 Loose or broken alternator drive belt: Check the drive belt as described in Engine (chapter 4) and renew as necessary.
- 2 Dirty or loose battery terminals: Clean and check the battery terminals.



Cleaning the battery terminals with a post cleaner.

- 3 Faulty battery: Renew the battery.
- 4 Faulty charge warning lamp bulb or circuit: Renew the bulb or repair the circuit as necessary.
- 5 Fault in the charging circuit wiring or connections: Check and renew or repair as necessary.
- 6 Fusible link blown: Rectify the fault as necessary.
- 7 Faulty alternator or voltage regulator: Overhaul or renew the alternator.



Check the state of charge (specific gravity) of the battery as described under the Battery heading in this chapter. If the battery is undercharged, check the possible causes in the order given.

BATTERY OVERCHARGED

- 1 Faulty alternator or voltage regulator: Overhaul or renew the alternator.
- 2 Faulty battery: Install a new battery of the correct type and capacity.
- 3 Faulty charging circuit wiring or connections: Check and renew any faulty components.



An overcharging battery is indicated by continual loss of water through boiling. This is usually accompanied by discolouration of the electrolyte.

CHARGE INDICATOR LAMP REMAINS ON

- 1 Broken alternator drive belt: Renew the drive belt. Refer to Engine (chapter 4).
- 2 B+ lead from alternator broken: Repair or renew the B+ lead.
- 3 S lead from alternator broken: Repair or renew the S lead.
- 4 Short to earth in the warning lamp circuit: Check and repair the circuit.
- 5 Battery overcharged: Refer to the previous heading.
- 6 Faulty alternator or voltage regulator: Overhaul or renew the alternator.

CHARGE INDICATOR LAMP DOES NOT OPERATE

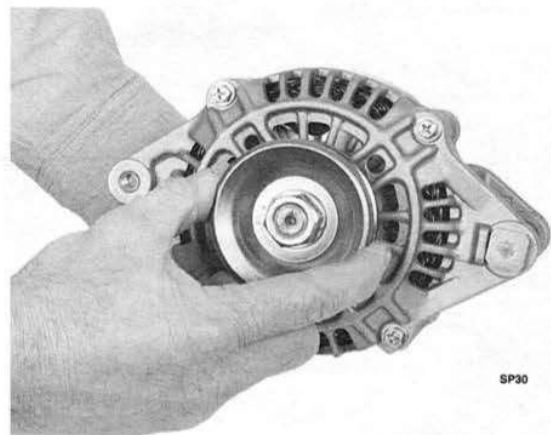
- 1 Faulty voltage regulator or worn alternator brushes: Overhaul or renew the alternator.
- 2 Charge indicator lamp bulb blown: Check and renew the faulty bulb.
- 3 Charge indicator lamp bulb holder faulty: Check the bulb holder and renew if necessary.
- 4 Open circuit in the wiring: Check all the engine bay wiring and rectify the open circuit.
- 5 Open circuit in the rotor windings: Repair or renew the alternator.

NOISE IN DRIVE BELT OR ALTERNATOR

- 1 Loose or frayed drive belt: Renew the drive belt, as described in Engine (chapter 4).
- 2 Loose alternator pulley: Tighten the pulley retaining nut to the specified torque.
- 3 Faulty alternator bearings: Overhaul or renew the alternator.
- 4 Faulty drive belt hub pulley bearing: Inspect and repair or renew as necessary.



To check if the noise is in the alternator or drive belt, remove the drive belt and run the engine for a short period. If the noise ceases, check the serviceability of the drive belt and the alternator components. Also, check the bearings of the drive belt hub assembly.

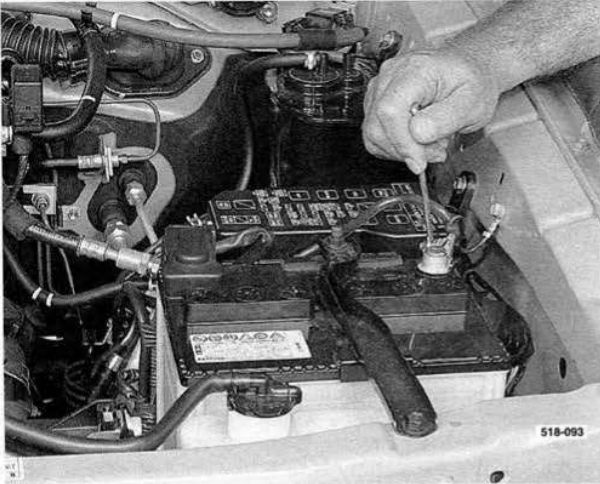


Spin the alternator by hand to check the bearings for noise.

Battery and Starter Trouble Shooting

STARTER LACKS POWER TO CRANK ENGINE

- 1 Battery undercharged: Check the charging system and rectify as necessary.
- 2 Battery terminals loose or corroded: Clean and tighten the terminals.



Check that the battery terminals are clean and tight.

- 3 Battery will not hold charge: Check and renew the battery.
- 4 Faulty or dirty solenoid switch or contacts: Check the solenoid as described later in this chapter.
- 5 Faulty starter motor: Check and overhaul the starter motor.
- 6 Battery fully charged but will not crank engine: Check the starter circuit and starter motor, also check for a locked drive and ring gear or a seized engine.

i Check the state of charge of the battery and check all terminals for cleanliness and security. A terminal, which is not properly crimped on a cable, can give many similar symptoms to a flat battery. Ensure that all earth leads are properly installed.

A battery terminal that is not making good contact will usually become warm when attempting to crank the engine. If necessary, test the starter motor as described later in this chapter.

STARTER WILL NOT ATTEMPT TO CRANK ENGINE

- 1 Battery discharged: Check for a fault or short circuit in the electrical system.
- 2 Faulty automatic transmission inhibitor switch: Check and adjust or renew as necessary. Refer to Automatic Transmission (chapter 11).
- 3 Fusible link blown: Rectify the cause and renew the fusible link.
- 4 Faulty starter motor relay: check and renew the relay if necessary.
- 5 Faulty starter motor: Check and overhaul the starter motor.
- 6 Faulty ignition switch: Renew the ignition switch.
- 7 Open circuit in the starting system: Check for dirty or loose terminals and rectify as necessary.

- 8 Battery fully charged and all components serviceable but engine will not crank: Check for a locked drive pinion and ring gear and/or a seized engine.

i Rotate the engine manually to ensure that the starter motor drive pinion is not locked with the ring gear and that the engine is not seized. Ensure that the ignition is switched Off before rotating the engine.

Battery

TO REMOVE AND INSTALL

Original equipment sound systems are fitted with a security system. Disconnecting the battery terminal(s) will require the operator to enter the security code.

If the number has been lost, it may be obtained by providing proof of ownership and the vehicle identification number (VIN) to an authorised dealer.

Battery packs which plug into the cigarette lighter and maintain security code and radio tuning memory while the battery is disconnected, are commercially available.

- 1 Ensure that the ignition is switched off.
- 2 Disconnect the negative (-) and positive (+) battery terminals in that order.
- 3 Remove the battery clamp retaining bolt, and remove the clamp from above the battery.
- 4 While holding the battery securely, lift it from the engine compartment.

Installation is a reversal of the removal procedure with attention to the following points:

- 1 Prior to installing the battery, check the battery tray for corrosion and repair as necessary.
- 2 Install the battery, ensuring that the terminals are clean.
- 3 When connecting the leads to the battery, ensure that the polarity is correct and connect the positive lead first.



Under no circumstances should the battery terminals be crossed over as severe damage will occur to the electronic circuitry.

- 4 Do not overtighten the terminals.
- 5 Apply petroleum jelly to the terminals to prevent corrosion.

Alternator



To Test — Voltmeter 0 – 20 volts DC, 120 – 0 – 120 ammeter.

DESCRIPTION

The internal fan Nippondenso alternator has an integral brush holder and voltage regulator. The voltage sensitive regulator ensures that the alternator charging rate is directly determined by the condition of the battery.

The alternator consists of a fixed coil winding or stator, a shaft wound coil or rotor, a rectifier or diode pack and an integrated circuit regulator.

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A magnetic field is produced in the rotor by electrical current fed into the rotor windings by brushes bearing on slip rings mounted on the rotor shaft. Three phase alternating current (AC) is produced in the star wound stator by the rotation of the magnetic field.

As it is not possible to charge a storage battery with an alternating current, it is necessary to rectify the output of the stator windings to direct current (DC). This is done using a bank of diodes or diode pack, mounted within the alternator slip ring end bracket.

The voltage output of the alternator is governed by the integrated circuit regulator. The voltage regulator is not adjustable. An electrical cut out unit is not necessary as the diodes prevent a reverse current flow through the alternator.

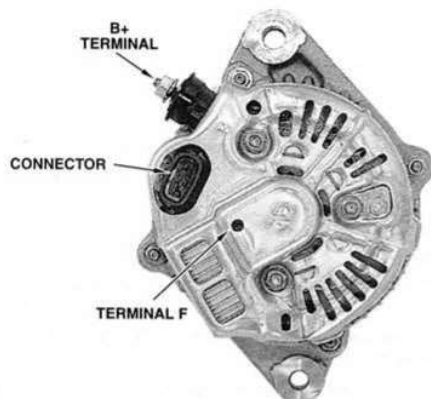
SERVICE PRECAUTIONS

- 1 Ensure that the battery is connected with the negative terminal to earth.
- 2 Do not short circuit or ground any terminals common to the charging circuit.
- 3 Always disconnect the battery before connecting a battery charger.
- 4 If a booster battery is used, always connect it in a parallel circuit, that is positive to positive (+ to +) and negative to negative (- to -) to maintain a 12 volt supply.
- 5 Never disconnect the battery or terminals in the charging circuit while the engine is running.
- 6 Regularly check the drive belt.
- 7 Keep the battery terminals clean and all electrical connections tight.
- 8 Disconnect the battery, alternator and any electronic items when electric welding on the vehicle. Refer to Electronic Components under the Vehicle Safety heading in General Information (chapter 1).

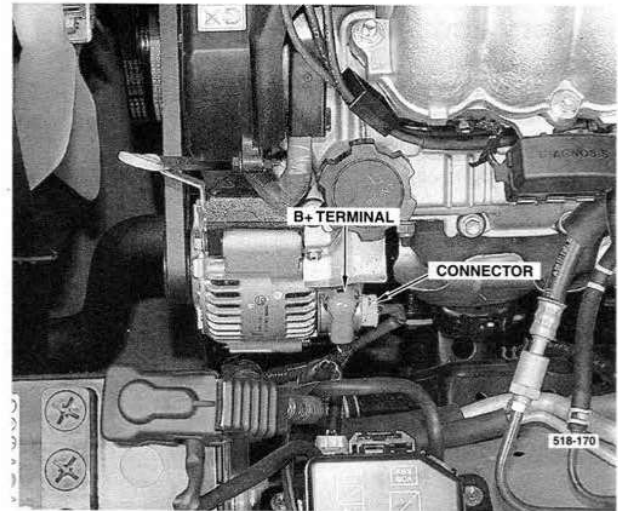
TO TEST ON VEHICLE

If the warning lamp stays on after the engine has been started and run at approximately 1000 rpm or the charge rate is suspected of being outside the specified range, indicated by a discharged or overcharged battery, perform the following tests.

- 1 Stop the engine. Do not open circuit any parts of the charging circuit while the engine is running.



Alternator end view.



Location of the alternator wiring connectors.

- 2 Check the condition and tension of the drive belt.
- 3 Clean the battery terminals and tighten all the electrical connections. Check the wiring for short circuits to earth and/or bridged circuits. Ensure that the battery is fully charged. If the battery is in a low state of charge, either recharge it or replace it with a fully charged battery.
- 4 Start the engine, allow it to run until normal operating temperature is reached and then stop the engine.



While performing the following test on the alternator, avoid attaching the test leads with alligator clips.

All connections should be made with clamp or bolted type connectors. This will prevent leads becoming detached during the test and open circuiting the alternator which would result in failure of the diodes in the alternator.

- 5 Disconnect the negative battery terminal.
- 6 Remove the nut from the alternator output terminal (B+) and disconnect the alternator output lead.
- 7 Connect one lead of a 120 - 0 - 120 ammeter to the output terminal (B+) and the other lead of the ammeter to the lead removed from the output terminal.
- 8 Connect the negative battery terminal and the voltmeter to the battery.
- 9 Switch the headlamps onto high beam. Leave the headlamps On for approximately five minutes to reduce the charge of the battery and to apply a load to the circuit.
- 10 Start the engine and gradually increase the speed to approximately 2 000 rpm. The reading on the ammeter should be approximately 75% of the rated output of the alternator listed in the Specifications.
- 11 Switch off all the lamps and run the engine at 2 000 rpm until the indicated charge is 10 amps or less. The voltage reading should be 13.7-14.8 volts.



Should the alternator fail to reach the specified output, the unit will have to be removed and overhauled, or a replacement unit installed. Should the voltage reading be above or below Specifications, the regulator will have to be renewed.

12 A further test is possible if a low voltage is recorded:

- a Stop the engine and short the alternator terminal F to earth using a metal probe.
- b Start the engine and again check the voltage. If the voltage is now higher than the reading in step 11, renew the voltage regulator in the alternator. If the voltage is still low, overhaul or renew the alternator.

TO REMOVE AND INSTALL

- 1 Disconnect the negative battery terminal.
- 2 Disconnect the wiring from the alternator.
- 3 Remove the adjustment locknut.
- 4 Loosen the pivot bolt and back off the adjusting bolt until the drive belt can be removed from the alternator pulley.
- 5 Remove the pivot bolt and remove the alternator from the vehicle.

Installation is a reversal of the removal procedure with attention to the following points:

- 1 Install the alternator pivot bolt finger tight.
- 2 Install the adjusting bolt and trunnion.
- 3 Install the drive belt and adjust as described under the Routine Maintenance heading in Engine (chapter 4).
- 4 Tighten the pivot bolt to the specified torque.
- 5 Install the B+ terminal wire to the alternator and tighten the nut securely.
- 6 Install the wiring connector securely.

TO DISMANTLE

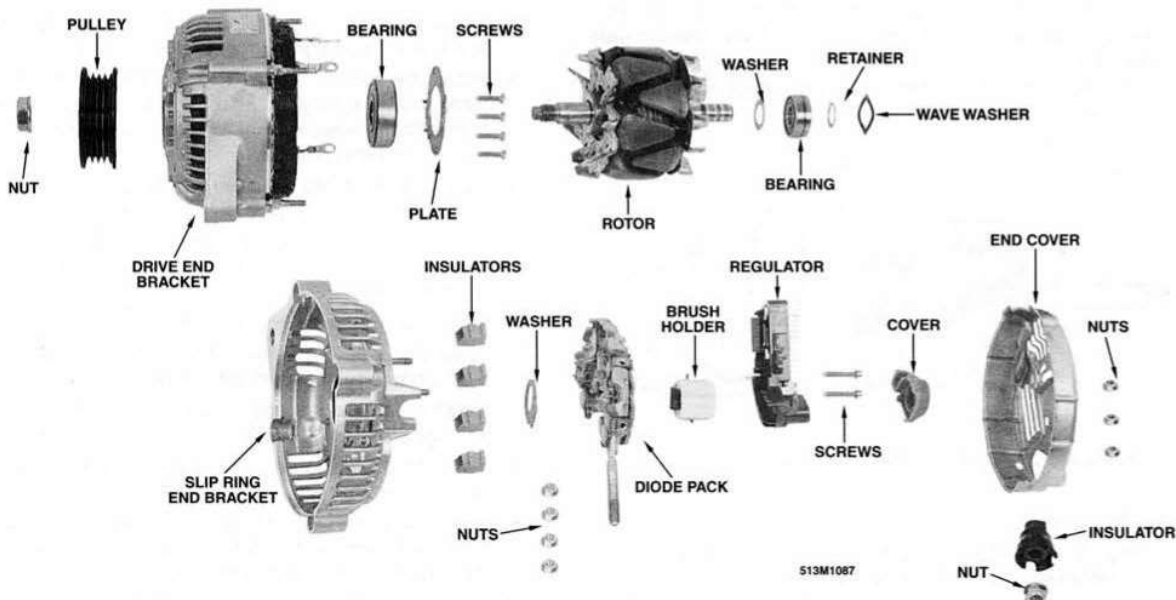
If the alternator is faulty, it is often more economically viable to install an exchange unit rather than overhaul the old one. Check the price of an exchange unit with an auto electrician before proceeding. It is considered standard workshop practice to renew the bearings whenever the alternator is dismantled.

- 1 Remove the alternator from the vehicle as previously described.
- 2 Scribe a mark across the drive end bracket, stator, slip ring end bracket and end cover to facilitate correct alignment during assembly.
- 3 Remove the output terminal retaining nut and insulator from the alternator.
- 4 Remove the alternator end cover retaining nuts and the end cover.
- 5 Remove the brush holder cover.
- 6 Remove the retaining screws and remove the brush holder assembly from the rear of the alternator.
- 7 Remove the regulator retaining screws and remove the regulator.
- 8 Remove the screws retaining the diode pack and remove the insulators.
- 9 Remove the pulley retaining nut by holding the rotor shaft stationary with a single hex 10 mm socket and turning the nut anticlockwise. Withdraw the pulley from the rotor shaft.
- 10 Remove the slip ring end bracket retaining nuts.
- 11 Using a screwdriver carefully separate the slip ring end bracket from the drive end bracket and rotor shaft assembly.
- 12 Remove the rotor shaft from the bracket.
- 13 Remove the wave washer from the rear face of the slip ring end bracket.
- 14 Remove the retainer plate screws and using a suitable drift, drive the bearing from the drive end bracket.



The drive end bracket and the stator are integral. If found to be faulty the drive end bracket and the stator must be renewed as an assembly.

- 15 Remove the rear bearing and slip ring end bracket from the rotor, using a suitable puller, taking care not to damage the fan blades



Alternator components.

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TO CLEAN PARTS

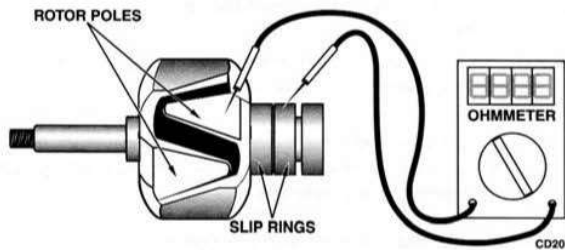
- 1 Do not immerse electrical units of the alternator in cleaning solvents as damage to the windings will result.
- 2 Thoroughly clean all components after they have been completely dismantled from the unit.
- 3 Compressed air can be carefully used to blow the dust from the stator windings and the field winding on the rotor.
- 4 Slip rings that are burned or scored should be machined on a lathe and then polished using very fine emery paper.
- 5 Clean the brushes and the brush holder using a clean rag and or compressed air. Check and remove any burrs from the holder.

TO CHECK AND TEST COMPONENT PARTS

All parts being electrically tested should be resting on a non-conductive pad.

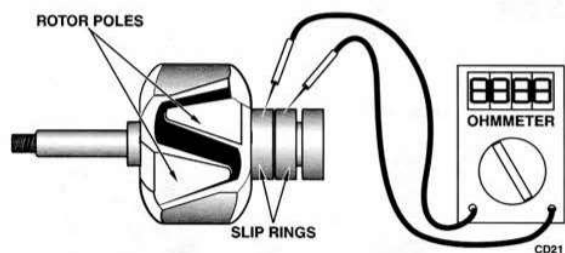
Field Windings and Rotor Assembly

- 1 Using an ohmmeter, check that there is no continuity between the field wires or slip rings and the rotor poles. If there is continuity and no visual earthing can be seen or rectified, renew the rotor assembly.



Checking the rotor windings for shorts to earth.

- 2 Check the resistance between the rotor slip rings. The resistance should be 2.1 – 2.5 ohms at 20°C. A low reading indicates a bridged circuit internally, a high reading indicates an open circuit or high resistance in the windings. In either case, renew the rotor assembly.



Checking the resistance of the rotor windings.

Stator Windings

- 1 Using an ohmmeter, check that there is continuity between the stator leads. Note the resistance.
- 2 Repeat the operation on the remaining leads alternately to check each phase. If there is any variation in resistance between phases, it will be necessary to renew the stator assembly.

- 3 Connect a jumper lead from the negative terminal of a charged 12 volt battery to the stator winding frame. Connect one end of a test lamp to the battery positive terminal and the other end of the test lamp to the stator lead, one at a time. Should the test lamp illuminate, a short circuit is indicated. Renew the stator assembly.

Diodes

- 1 To check positive diodes, using an ohmmeter, place one test probe on the positive terminal and the other probe on each terminal of the diode pack.
- 2 Reverse the probes and repeat the step 1, check that there is continuity one way and not the other way. If continuity exists both ways or if no continuity exists both ways, renew the diode pack.
- 3 To check negative diodes, using an ohmmeter, place one test probe on each diode pack terminal and the other probe on the negative terminal of the diodes.
- 4 Reverse the probes and repeat the step 3. check that there is continuity one way and not the other way. If continuity exists both ways or if no continuity exists both ways, renew the diode pack.

Brush Springs and Brushes

- 1 Check the brush springs for overheating and distortion and check for binding in the brush holders.
- 2 Ensure that the exposed brush length is more than 1.5 mm.
- 3 If necessary, renew the brush holder assembly.

TO ASSEMBLE

Assembly is a reversal of the dismantling procedure with attention to the following points:

i Ensure the fan is not damaged when installing the bearings to the rotor shaft.

- 1 Install a new bearing, retaining plate and screws to the drive end bracket and tighten the screws securely.
- 2 Install the washer, a new bearing and the retainer to the rotor, using a suitable adaptor and a press. Apply some grease to the wave washer to keep it in place and install it to the slip ring end bracket.
- 3 Install the rotor into the drive end bracket.
- 4 Position the slip ring end bracket on the rotor shaft, ensure that the marks made on dismantling are lined up, and using a suitable adaptor, carefully press the bracket on the rotor shaft bearing.
- 5 Install the nuts and tighten securely.
- 6 Install the pulley, hold the nut in a vice and turning the rotor shaft tighten to the specified torque.
- 7 Install the insulators and the diode pack, install the screws and tighten them securely.
- 8 Place the brush holder, and regulator horizontally on the slip ring end bracket.
- 9 Install the screws until there is a clearance of approximately 1 mm between the brush holder and the regulator. Tighten the screws securely and fit the cover.
- 10 Install the end cover and tighten the nuts securely
- 11 Install the insulator and nut to the positive terminal and tighten the nut securely.

- 12 Ensure the alternator spins freely before installing it to the vehicle as previously described.

Starter Motor



To Renew Brushes — Soldering iron

DESCRIPTION

The Nippondenso starter motor is of the induced pole type with four brushes and four pole shoes with field coils. A reduction gear arrangement is used to increase torque delivered from the starter motor.

A solenoid is attached to the starter drive end bracket. When the solenoid windings are energised, the plunger contacts the ball and moves the drive pinion into mesh with the flywheel ring gear. At the same time, the solenoid switch closes, supplying power from the positive battery terminal to the starter motor field coils and to the armature, causing the armature to rotate.

As the engine fires, the overrunning clutch of the drive pinion assembly prevents high speed rotation of, and possible damage to, the starter armature if the solenoid windings are not immediately de-energised by releasing the ignition key.

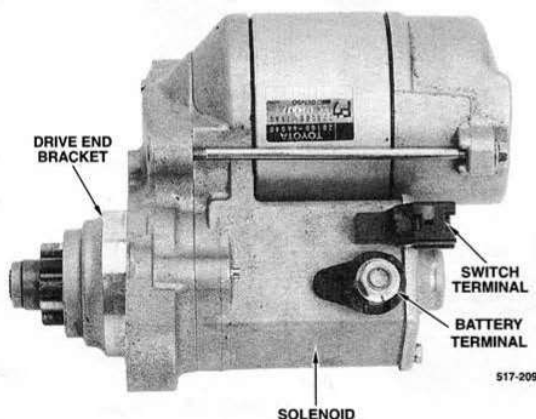
TO TEST ON VEHICLE

Should the starter fail to operate when the ignition switch is moved to the Start position, refer to Roadside Trouble Shooting (chapter 3), to determine if the fault is in the starter motor, starter relay or the battery, fuses and cables.

TO TEST OFF VEHICLE

When testing the starter motor off the vehicle with jumper leads exercise caution not to allow the positive leads to short on the vice or starter motor body.

- 1 Remove the starter motor, as described later in this chapter and secure it in a vice fitted with soft jaws.
- 2 Connect a positive battery jumper lead to the starter motor solenoid B+ terminal.
- 3 Connect the negative jumper lead to the drive end bracket of the starter motor, ensuring it is securely connected.



Starter motor removed from the vehicle.

- 4 Connect the other end of the jumper leads to a fully charged 12 volt battery, ensuring that the positive lead is connected to the positive battery terminal and the negative lead is connected to the negative battery terminal.

- 5 Connect a 4 mm jumper lead from the B+ terminal to the S terminal of the solenoid.

If the starter fails to operate, proceed as follows:

- a Remove the positive jumper leads from the solenoid B+ and S terminals.
 - b Remove the 4 mm jumper lead from the positive jumper lead.
 - c Lift the rubber cover and touch the positive jumper lead to the field core wire terminal on the starter motor solenoid.
- If the starter motor operates, the fault is in the starter motor solenoid. Dismantle and check the solenoid contacts, as described later in this chapter.

If the starter motor does not operate, dismantle and check as described later in this chapter.

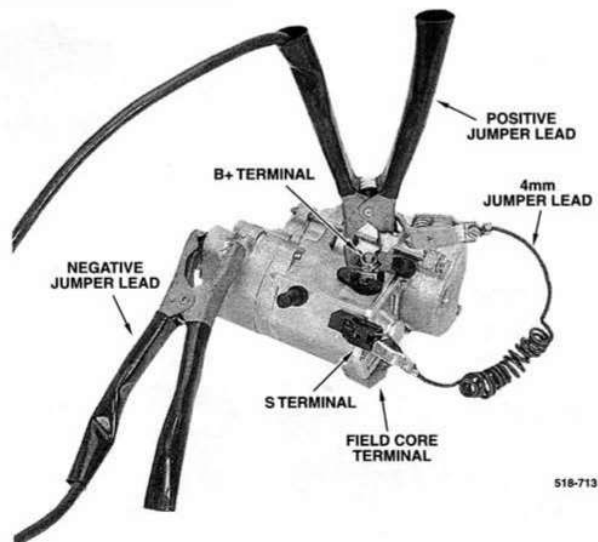
TO REMOVE AND INSTALL

- 1 Disconnect the negative battery terminal.
- 2 Raise the front of the vehicle and support on chassis stands. Refer to General Information (chapter 1) for the positions of the jacking points.
- 3 Slide back the rubber cover, remove the nut and disconnect the B+ cable from the starter motor solenoid.
- 4 Disconnect the wiring connector from the switch terminal on the solenoid.
- 5 Remove the starter motor retaining bolts and withdraw the starter from the vehicle.



It may be necessary to remove the heat shield from the right hand exhaust manifold and then manoeuvre the starter motor from the vehicle. If difficulty is experienced removing the starter motor; remove the right hand exhaust engine pipe from the exhaust manifold back to the muffler.

Installation is a reversal of the removal procedure with attention to the following points:



Testing the starter motor off the vehicle.

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- 1 Ensure that the wiring is securely connected to the starter motor and that it is well clear of the exhaust system.
- 2 Tighten the bolts and nut to the specified torque.

TO DISMANTLE

If the starter motor is faulty, it is often more economically viable to install an exchange unit rather than overhaul the old one. Check the price of an exchange unit with an auto electrician before proceeding.

- 1 Remove the starter motor as previously described.
- 2 Slide back the rubber cover and remove the field core wire from the terminal on the solenoid.
- 3 Place matchmarks between the solenoid housing, yoke and commutator end cover. Remove the two through bolts from the rear of the commutator end cover.
- 4 Remove the commutator end cover, armature and yoke from the drive end bracket as an assembly. Remove the O ring.
- 5 Remove the retaining screws and the dust cover from the brush holder. Remove the O ring.
- 6 Using a small hook, lift the springs and remove the brushes from the brush holder.
- 7 Remove the brush holder and the armature from the yoke.
- 8 Remove the screws retaining the drive end bracket to the solenoid housing.



It may be necessary to use an impact driver to loosen the screws.

- 9 Remove the drive end bracket from the solenoid housing, collecting the spring and using a magnet, the steel ball from the drive pinion.
- 10 Remove the pinion with the planetary gear assembly, idler gear and bearing from the drive end bracket.
- 11 Clean all parts thoroughly but do not immerse the yoke, armature, drive clutch or bearings in cleaning solvent.



Do not remove the field coils from the yoke. If the field coils are found to be faulty, the field coils and yoke must be renewed as a complete assembly.

- 12 Remove the screws retaining the end cover to the solenoid housing. Remove the cover and gasket and pull the plunger from the housing.

TO CHECK AND INSPECT

- 1 With the starter motor dismantled check the brush holder insulation using an ohmmeter.

Connect one test probe to the brush holder positive side and the other probe to the negative side. If the ohmmeter reading is other than infinity, renew the brush holder.

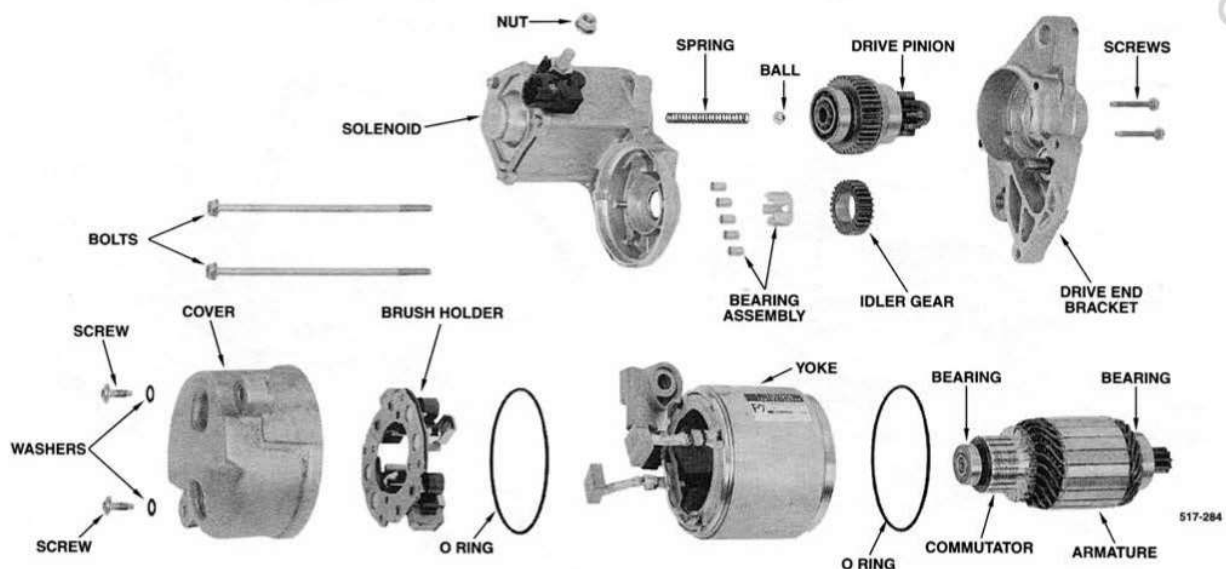
- 2 Check the length of the brushes. If the length of the brushes is less than Specifications, renew the brush holder and the yoke.
- 3 Check that the commutator is free from pitting and burning. Clean the commutator with a petrol moistened cloth and polish with a strip of fine emery paper.

A badly worn commutator may be cleaned by mounting it in a lathe and, while spinning at high speed, taking a light cut with a very sharp tool. After turning, undercut the insulation between the segments to Specifications. Measure the diameter of the commutator, if less than specified renew the armature.

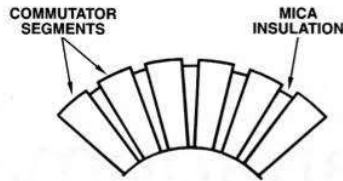
- 4 Using an ohmmeter, check the armature for a short circuit by placing one of the test probes on the armature shaft or core and moving the other probe around the circumference of the commutator. If the ohmmeter shows continuity at any point, the armature is faulty and must be renewed.

- 5 Check the field coils for serviceability as follows:

- a Check the field coil for ground by placing one test probe on the field coil lead and the other probe on the yoke. If the ohmmeter shows a reading, the field coils and yoke assembly are faulty and will have to be renewed as an assembly.



Starter motor components.



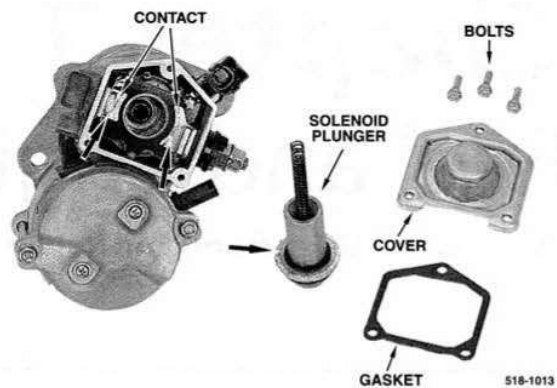
After machining check that the mica undercut is to specifications. If necessary undercut using a hacksaw blade.

- b Test the field coils for continuity by connecting the test probes in series with the field windings.
Failure of the ohmmeter to show a reading indicates an open circuit in the wiring of the field coils. Renew the field coils and yoke as a complete assembly.
- 6 Check the drive pinion clutch assembly pinion teeth for wear, scoring or chipping. A clutch in good condition should rotate in one direction only. It should rotate easily and smoothly in the non-drive direction and the assembly should move smoothly along the helical splines. If necessary, renew the drive clutch assembly.
- 7 Check the reduction gears for wear and renew if necessary.
- 8 Install the plunger and spring into the solenoid. Push the plunger into the solenoid and ensure that it releases freely. If any binding occurs, renew the solenoid.
- 9 Check the solenoid contacts for damage. If necessary, renew the contacts and insulators as described later in this chapter.

TO ASSEMBLE

Assembly is a reversal of the dismantling procedure with attention to the following points:

- 1 Install the plunger to the solenoid housing. Install the cover and gasket and tighten the screws securely.
- 2 Lightly coat the drive pinion and idler gear teeth, steel ball, gear roller bearing with high temperature grease.
- 3 Install the bearing, idler gear and drive pinion assembly into the drive end bracket. Install the steel ball to the drive pinion.
- 4 Install the spring to the solenoid and install the solenoid housing to the drive end bracket. Tighten the retaining screws securely.
- 5 Position the armature into the yoke and with the brushes installed in the brush holder and the brush retaining springs held back, install the brush holder assembly to the armature. Ensure that the springs are seated correctly and that the brushes move freely in the brush holders.
- 6 Install the O ring to the yoke and ensuring that the match marks are lined up, install the dust cover. Tighten the retaining screws securely.
- 7 Install the O ring to the solenoid housing and ensuring that the match marks are lined up, install the yoke to the solenoid. Install and tighten the through bolts securely.
- 8 Install the field core wire to the solenoid and tighten the retaining nut securely. Slide the rubber cover over the terminal.
- 9 Test the starter motor before installing it to the vehicle as previously described.



Cover removed from the starter motor solenoid showing the plunger and contacts. The large arrows indicate a common place for wear and burning which can result in sluggish operation of the starter motor.

TO CHECK AND RENEW SOLENOID CONTACTS

- 1 Remove the solenoid end cover.
- 2 Check the contacts for wear and burning. If the wear is greater than the specified maximum, renew the contacts as follows:
 - a Holding the head of the contact retaining bolt steady, remove the retaining nut.
 - b Noting the installed position withdraw a wave washer, insulator, insulator packing and O ring from outside the solenoid housing.
 - c From inside the housing withdraw the terminal bolt, contact, insulator and insulation paper.
- 3 Clean the contacts and the plunger contact area and if necessary renew the contacts and the solenoid plunger.
- 4 Install the contacts in the position noted on dismantling.

i Ensure that the insulator protrusion locates in the indentation in the housing.

- 5 Using a wooden block, put a reasonable load on the contacts.

i The contacts are pressed down to prevent them tilting when tightening the retaining nuts.

- 6 Tighten the retaining nuts to the specified torque. Check that the contacts are square and level.

Ignition System

The ignition system is part of the engine management system. Specifications, testing and the overhaul procedures for the ignition system are covered in Fuel and Engine Management (chapter 7).