Chapter 5
Engine electrical systems

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Specifications

Ignition system (petrol engines)

Ignition timing	See Chapter 1
Ignition coil resistance	
3.0 litre engine	
Primary	0.8 to 1.0 ohm
Secondary	7,600 to 11,400 ohm
4.2 litre engine	
Points ignition	
Primary	1.08 to 1.32 ohms
Secondary	9,000 to 13,400 ohms
Electronic ignition	
Primary	1 ohm
Secondary	10,000 ohms
Distributor air gap (3.0 litre engine)	0.3 to 0.5 mm

Charging system

Charging voltage	13.9 to 15.1 volts
Alternator maximum output	
Type 1	50 amps
Type 2	60 amps
Minimum brush length	6 mm

1 General information

The engine electrical systems include all ignition, charging and starting components. Because of their engine related functions, these components are discussed separately from chassis electrical devices such as the lights, the instruments, etc. (which are included in Chapter 12).

Always observe the following precautions when working on the electrical systems:

a) *Be extremely careful when servicing engine electrical components. They are easily damaged if checked, connected or handled improperly.*
b) *Never leave the ignition switch on for long periods of time (10 minutes maximum) with the engine off.*
c) *Don't disconnect the battery cables while the engine is running.*
d) *Maintain correct polarity when connecting a battery cable from another vehicle during jump starting.*
e) *Always disconnect the negative cable first and hook it up last or the battery may be shorted by the tool being used to loosen the cable clamps.*

It's also a good idea to review the safety-related information regarding the engine electrical systems located in the *Safety first* Section near the front of this manual before beginning any operation included in this Chapter.

2 Battery - emergency jump starting

Refer to the *Booster battery (jump) starting* procedure at the front of this manual.

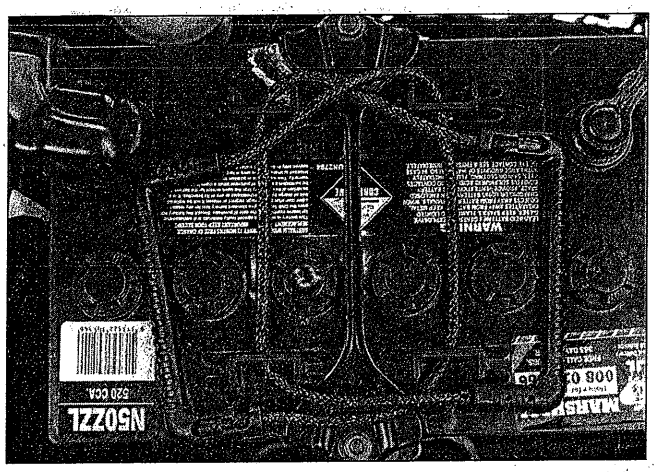
3 Battery - removal and refitting

Refer to illustration 3.1

1 Starting with the negative battery cable, disconnect both cables from the battery terminals **(see illustration)**.
2 Remove the battery hold-down clamp.
3 Lift out the battery. Be careful, it's heavy.
4 While the battery is out, inspect the carrier (tray) for corrosion.
5 If you are renewing the battery, make sure that you get one that's identical, with the same dimensions, terminal locations, amperage rating, cold cranking rating, etc. as the original.
6 Refitting is the reverse of removal.

4 Battery cables - check and renewal

1 Periodically inspect the entire length of each battery cable for damage, cracked or burned insulation and corrosion. Poor battery cable connections can cause starting problems and decreased engine performance.



3.1 The uncovered battery terminal on the right is the negative post. It is important that it be the one disconnected first and connected last when servicing the battery. Damage to expensive electronic components can occur if this is not done

2 Check the cable-to-terminal connections at the ends of the cables for cracks, loose wire strands and corrosion. The presence of white, fluffy deposits under the insulation at the cable terminal connection is a sign that the cable is corroded and should be renewed. Check the terminals for distortion, missing mounting bolts and corrosion.
3 When removing the cables, always disconnect the negative cable first and hook it up last or the battery may be shorted by the tool used to loosen the cable clamps. Even if only the positive cable is being renewed, be sure to disconnect the negative cable from the battery first (see Chapter 1 for further information regarding battery cable removal).
4 Disconnect the old cables from the battery, then trace each of them to their opposite ends and detach them from the starter solenoid and earth terminals. Note the routing of each cable to ensure correct refitting.
5 If you are renewing either or both of the old cables, take them with you when buying new cables. It is vitally important that you renew the cables with identical parts. Cables have characteristics that make them easy to identify: positive cables are usually red, larger in cross-section and have a larger diameter battery post clamp; earth cables are usually black, smaller in cross-section and have a slightly smaller diameter clamp for the negative post.
6 Clean the threads of the solenoid or earth connection with a wire brush to remove rust and corrosion. Apply a light coat of battery terminal corrosion inhibitor, or petroleum jelly, to the threads to prevent future corrosion.
7 Attach the cable to the solenoid or earth connection and tighten the mounting nut/bolt securely.
8 Before connecting a new cable to the battery, make sure that it reaches the battery post without having to be stretched.
9 Connect the positive cable first, followed by the negative cable.
10 If only the terminal at the battery end of a cable is damaged, it can be easily renewed without having to renew the entire cable. Obtain a new battery cable end.
11 Disconnect the negative cable from the battery, then disconnect the positive cable if that is the one being repaired.
12 Cut the old end from the cable and strip back about 25 mm of insulation from the cable. Remove any corrosion at this time.
13 Clamp the new cable end to the cable and attach both cables to the battery terminals, positive first.

5 Ignition system - general information and precautions

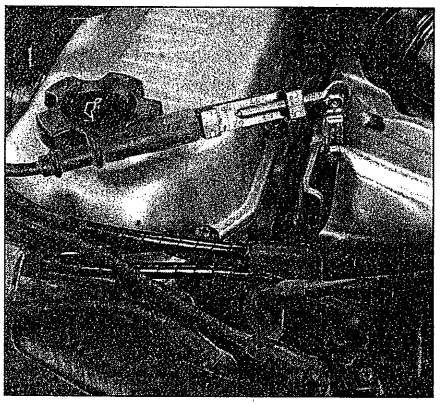
1 The ignition system is designed to ignite the fuel/air charge entering each cylinder at just the right moment. It does this by producing a high voltage spark between the electrodes of each spark plug.
2 The types of ignition systems refitted on these vehicles evolved over the years to accommodate more strict emissions standards adopted by the major automotive manufacturers.

Breaker points type ignition system

3 This system controls the ignition spark using the conventional points and condenser arrangement and timing is controlled by mechanical advance components. This system is refitted on carburetted 4.2 litre engines.

Breakerless type ignition systems

4 The electronic ignition system includes the ignition switch, the battery, the power transistor, the control unit (on 3.0 litre engines), the ignition coil, the primary (low voltage) and secondary (high voltage) wiring circuits, the distributor and the spark plugs. On fuel injected 4.2 litre engines the ignition system is controlled by the Electronic Control Unit (ECU). Using data provided by information sensors which monitor various engine functions (such as rpm, intake air volume, engine temperature, etc.), the ECU ensures a perfectly timed spark under all conditions. The ignition coil is mounted externally to the distributor.
5 3.0 litre engines use an electronic ignition system similar to that used on the fuel



6.1 An inexpensive spark tester like this is the proper tool to use when checking for spark - a used spark plug has much too small of a gap to check for full coil output

injected 4.2 litre engine, except that there is no ECU. The distributor has its own vacuum and centrifugal advance mechanisms. Its timing is not ECU-controlled and the distributor has a module and stator.

a) *Do not keep the ignition switch on for more than 10 seconds if the engine will not start.*
b) *Always connect a tachometer in accordance with the manufacturer's instructions. Some tachometers may be incompatible with this ignition system. Consult a dealer service department before buying a tachometer for use with this vehicle.*
c) *Never allow the ignition coil terminals to touch the ground. Earthing the coil could result in damage to the power transistor and/or the ignition coil.*
d) *Do not disconnect the battery when the engine is running.*
e) *Make sure the power transistor is properly earthed.*

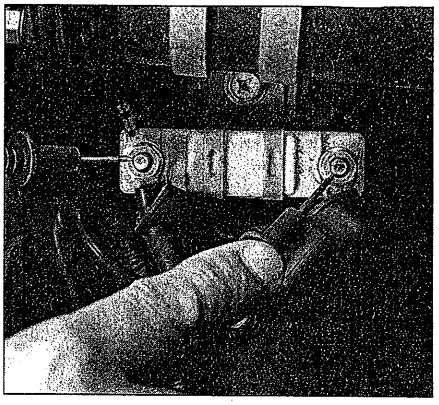
6 Ignition system - check

Refer to illustration 6.1

Warning: *Because of the high voltage generated by the ignition system, extreme care should be taken whenever an operation is performed involving ignition components. This not only includes the power transistor, coil, distributor and spark plug wires, but related components such as plug connectors, tachometer and other test equipment also.*

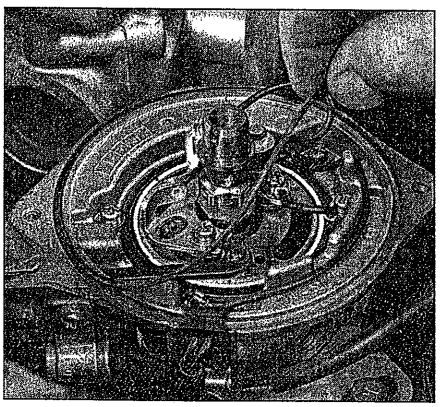
All ignition systems

1 If the engine turns over but won't start, disconnect the spark plug wire from any spark plug and attach it to a calibrated tester (available at most auto parts stores) **(see illustration)**. Connect the clip on the tester to a bolt or metal bracket on the engine. If you're unable to obtain a calibrated ignition tester, remove the wire from one of the spark plugs and using an insulated tool, pull back the boot and hold the end of the wire about 6 mm from a good earth.

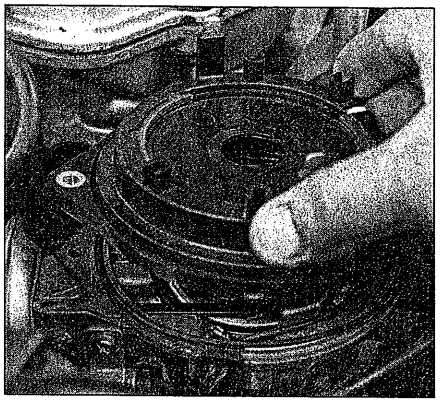


6.10 Test the ballast resistor with an ohmmeter - there must not be infinite resistance across the terminals

2 Crank the engine and watch the end of the tester or spark plug wire to see if a bright blue, well-defined sparks occur.
3 If sparks occur, sufficient voltage is reaching the plug to fire it (repeat the check at the remaining plug wires to verify that the distributor cap and rotor are OK). However, the plugs themselves may be fouled, so remove and check them as described in Chapter 1.
4 If no sparks or intermittent sparks occur, remove the distributor cap and check the cap and rotor as described in Chapter 1. If moisture is present, dry out the cap and rotor, then refit the cap and repeat the spark test.
5 If there's still no spark, detach the coil secondary wire from the distributor cap and hook it up to the tester (reattach the plug wire to the spark plug), then repeat the spark check. Again, if you don't have a tester, hold the end of the wire about 6 mm from a good earth.
6 If sparks now occur, the distributor cap, rotor or plug wire(s) may be defective.
7 If no sparks occur, the coil-to-cap wire may be bad (check the resistance with an ohmmeter and compare it to the spark plug wire resistance Specifications found in Chapter 1).
8 If there's still no spark, check the primary



6.11b The two distributor cover O-rings should be renewed if they appear deteriorated - water can enter the distributor and cause extensive damage



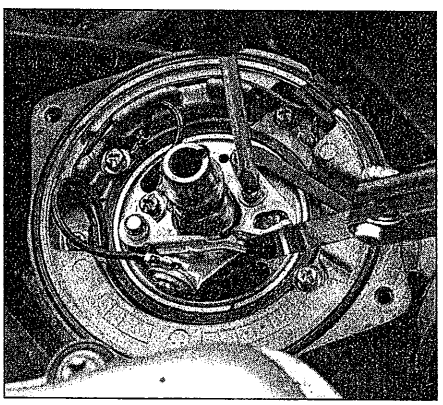
6.11a As you remove the internal distributor cover, check all visible components for signs of damage

wire connections at the coil to make sure they're clean and tight. Check for voltage to the coil on the primary circuit from the ignition switch. On engines equipped with an electronic ignition system, check for battery voltage to the power transistor with the ignition key ON, engine not running; if voltage is present, check the power transistor (see Section 10). Check the ignition coil primary and secondary resistance (see Section 7), the breaker points on 4.2 litre carburetted models (see below), the distributor stator and control unit on 3.0 litre models (see Sections 10 and 11) or the crank angle sensor on 4.2 litre fuel injected models (see Chapter 6).
9 Make any necessary repairs, then repeat the check again.

Breaker points type ignition systems

Refer to illustrations 6.10, 6.11a, 6.11b and 6.11c

10 If no sparks occur, check the ignition ballast resistor. There must be continuity between the two terminals **(see illustration)**.
11 Inspect the ignition points (see Chapter 1). If the points appear to be in good shape (no pitting or burn spots), check the point gap or dwell **(see illustrations)**.



6.11c Use a clean feeler gauge when you are adjusting the points - it is best to use a dwell meter to obtain an exact setting

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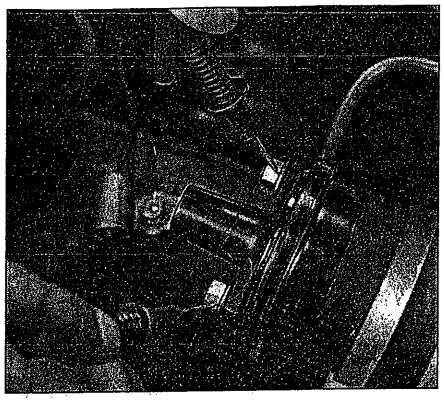
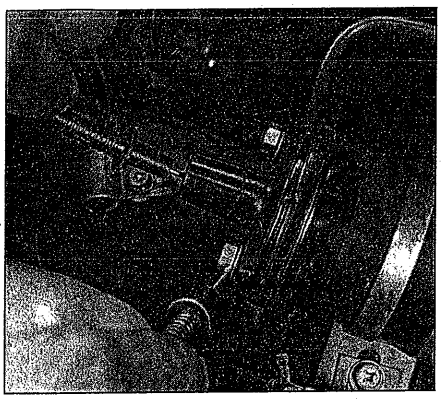
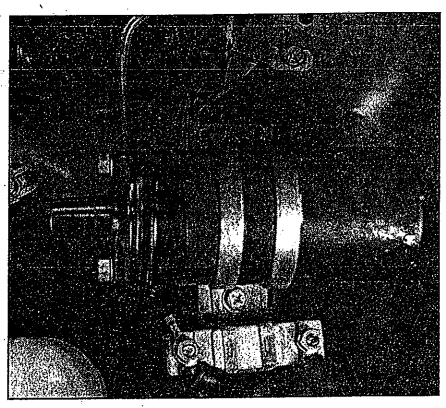


7.2a Connect an ohmmeter to the two primary terminals to measure the coil primary resistance



7.2b The secondary resistance is measured from the secondary terminal to the positive primary terminal - if either of the readings are greatly outside of the specifications, renew the coil



7.4 The coil must be securely mounted in order to resist vibration. Check it closely for indications that the internal oil has begun to leak from a defective housing

12 Measure the voltage at the points with a voltmeter. With the ignition ON (engine not running), the points should produce a voltmeter reading of approximately 10.5 volts. If not, the battery must be recharged or renewed.

13 Check for an short or open in the distributor points circuit. There may be a damaged points terminal that is causing the ignition voltage to be shorted or diminished.

14 Check the condition of the vacuum advance system (refer to Section 9).

7 Ignition coil - check and renewal

Refer to illustrations 7.2a, 7.2b and 7.4

1 Detach the cable from the negative terminal of the battery.

2 Using an ohmmeter:

a) *Measure the resistance between the positive and negative terminals of the coil* **(see illustration)**. *Compare your reading with the specified coil primary resistance listed in this Chapter's Specifications.*

b) *Measure the resistance between the positive terminal and the high tension terminal* **(see illustration)**. *Compare your reading with the specified coil secondary resistance listed in this Chapter's Specifications.*

3 If either of the above tests yield resistance values outside the specified amount, renew the coil.

4 Carefully inspect the coil housing for signs of leakage or damage. If any abnormality is observed, renew the coil **(see illustration)**.

Renewal

5 Detach the cable from the negative terminal of the battery.

6 Remove the shield from the coil, if equipped.

7 Label and then disconnect the wires from the coil terminals.

8 Remove the coil mounting screws.

9 Refitting is the reverse of removal.

8 Distributor - removal and refitting

Refer to illustrations 8.4, 8.5 and 8.6

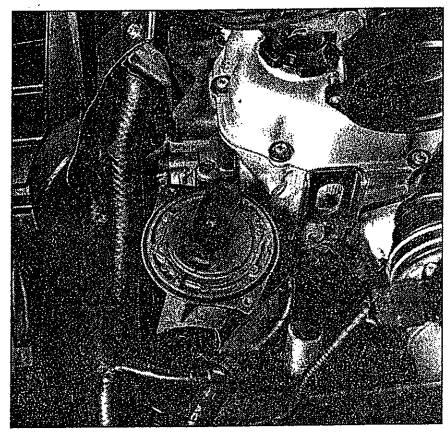
1 Detach the cable from the negative battery terminal.

2 Disconnect the electrical connectors from the distributor.

3 Look for a raised "1" on the distributor cap. This marks the location for the number one cylinder spark plug wire terminal. If the cap does not have a mark for the number one terminal, locate the number one spark plug and trace the wire back to the terminal on the cap.

4 Remove the distributor cap (see Chapter 1) and turn the engine over until the rotor is pointing toward the number one spark plug terminal **(see illustration)**. The timing mark on the crankshaft pulley must be aligned with the zero (see locating TDC procedure in Chapter 2A).

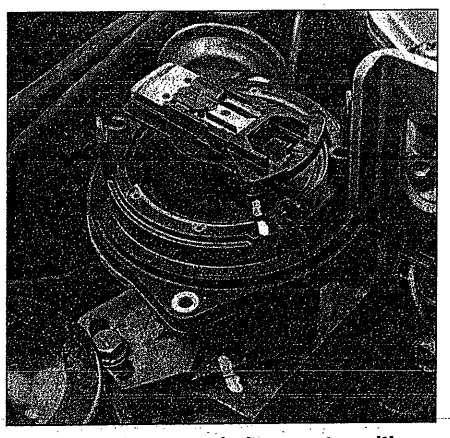
5 Make a mark on the edge of the distributor base directly below the rotor tip and in line with it. Also, make alignment marks on the distributor base and the engine block or



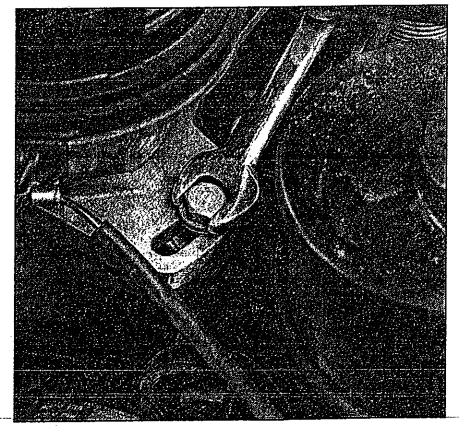
8.4 The rotor must point to the number one spark plug wire before the distributor is removed - it is easiest to operate the starter in bursts to get it close, then turn the engine with a breaker bar on the crankshaft pulley to align the timing marks at zero

hold-down bolt to ensure that the distributor is refitted correctly **(see illustration)**.

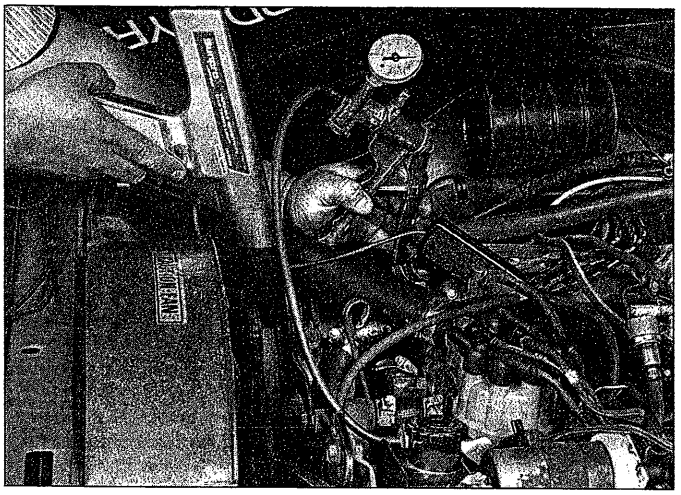
6 Remove the distributor hold-down bolt **(see illustration)**, then pull the distributor



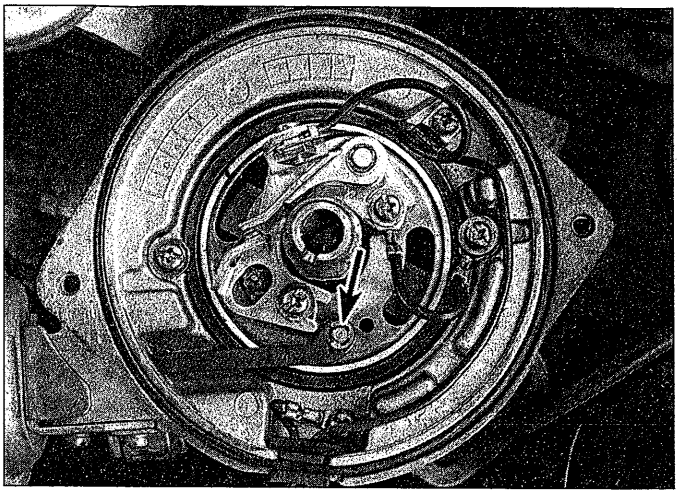
8.5 Use paint to mark the exact positions of the rotor in relation to the distributor housing and the housing in relation to the engine block



8.6 Remove the distributor hold-down bolt and lift the distributor straight up



9.6 Watch the timing marks using the timing light while applying vacuum to the vacuum advance unit with a hand-held pump. The ignition should advance as vacuum is applied



9.11 Be very careful to not drop the small clip into the distributor or some other inaccessible place when you remove it

straight out to remove it. **Caution:** *DO NOT turn the crankshaft while the distributor is out of the engine, or the alignment marks will be useless.*

Refitting

Note: *If the crankshaft has been moved while the distributor is out, locate Top Dead Centre (TDC) for the number one piston* (see Chapter 2A) *and position the distributor and the rotor accordingly.*

7 Refit a new O-ring onto the distributor housing.

8 Insert the distributor into the engine in exactly the same relationship to the block that it was in when removed. **Note:** *4.2 litre fuel injected engine distributors have alignment marks on the base of the housing and the driven gear. Line up the gear mark with the shorter housing mark prior to refitting. As the distributor is refitted, the shaft will rotate slightly to align the gear mark with the longer housing mark.*

9 If the distributor does not seat completely, recheck the alignment marks between the distributor base and the block to verify that the distributor is in the same position it was in before removal. Also check the rotor to see if it's aligned with the mark you made on the edge of the distributor base.

10 Loosely refit the distributor hold-down bolt.

11 Refitting is the reverse of removal.

12 Check the ignition timing (see Chapter 1) and tighten the distributor hold-down bolt securely.

9 Distributor advance systems - general information, check and renewal

Note: *Vacuum and centrifugal advance systems are used on the 3.0 litre engine and the 4.2 litre breaker-point ignition engine. 4.2 litre fuel injected engines have ECU-controlled ignition timing.*

General information

1 To provide the proper spark timing under all conditions, these distributors are equipped with a vacuum advance and a centrifugal advance mechanism. The vacuum advance controls timing according to engine load (available vacuum), while the centrifugal unit controls timing according to engine speed.

2 The centrifugal advance parts may stick, wear out or become defective after years of service. The vacuum advance diaphragm may rupture, rendering it inoperative. Each mechanism can be checked independent of the other using the procedures below.

Check

Refer to illustrations 9.6 and 9.11

3 Connect a timing light according to the manufacturer's instructions.

4 Connect a hand-held vacuum pump to the vacuum advance unit on the side of the distributor.

5 Apply vacuum to the unit and check that it will hold the vacuum when the pump is stopped. If it will not hold vacuum, it must be renewed.

6 Start the engine and allow it to idle. Apply vacuum while observing the timing marks with the timing light **(see illustration)**. As more vacuum is applied, the timing should advance gradually. If not, disassemble the distributor and repair the mechanism as required. **Note:** *3.0 litre engines are equipped with a vacuum switch which will not allow engine vacuum to reach the vacuum advance unit until the engine is warm.*

7 Remove the vacuum pump and do not reconnect the engine vacuum hose to the unit.

8 Start the engine and observe the timing marks with the timing light. Increase the engine speed gradually to about 3,000 RPM. The timing should advance gradually and smoothly. If it doesn't advance or if it advances in jumps, service the centrifugal advance mechanism or renew the distributor.

Vacuum advance unit renewal

9 Remove the stator (3.0 litre engines) (refer to Section 11) or the points (4.2 litre engines) (refer to Chapter 1).

10 On 3.0 litre engines, mark the top of the reluctor and remove it from the distributor shaft by prising it up carefully with two screwdrivers or by using a battery cable puller. The reluctor is a tight press fit. Do not lose the small roll pin which indexes the reluctor to the shaft.

11 Remove the vacuum advance screws and the clip **(see illustration)**. Remove the vacuum advance unit.

12 Refitting is the reverse of removal.

Centrifugal advance mechanism renewal

13 On 3.0 litre engines remove the control unit (refer to Section 12). On 4.2 litre engines, remove the vacuum advance unit.

14 Remove the base plate.

15 Remove the reluctor shaft or distributor cam retaining screw.

16 Remove the reluctor shaft or distributor cam.

17 Remove the advance springs.

18 Remove the clips and lift off the weights.

19 Carefully inspect all moving parts for wear, binding and elongation of holes. The advance mechanism can be cleaned thoroughly and lubricated with a small amount of high temperature grease. Operate the assembled mechanism by hand to test for free movement.

20 If definite wear is noticed, it is best to renew the complete distributor with a new or rebuilt unit. Refitting is the reverse of removal.

10 Power transistor (electronic ignition models) - check and renewal

Refer to illustration 10.2

1 Disconnect the wiring from the power transistor.

2 Using an ohmmeter, perform the tests as shown **(see illustration)**.

3 If not all of the readings are as indicated, renew the power transistor.

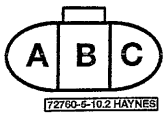
Renewal

4 Detach the cable from the negative terminal of the battery.

5 Disconnect the electrical connector from the power transistor.

6 Remove the screws from the bracket assembly and remove the power transistor/bracket assembly.

7 Refitting is the reverse of removal.



10.2 Perform the following four tests to check the power transistor

1 *Ohmmeter positive lead to A terminal, negative lead to B terminal - continuity should exist.*
2 *Ohmmeter positive lead to B terminal, negative lead to A terminal - continuity should not exist.*
3 *Ohmmeter positive lead to A terminal, negative lead to C terminal - continuity should exist.*
4 *Ohmmeter positive lead to C terminal, negative lead to A terminal - continuity should not exist.*

11 Stator (3.0 litre engines) - renewal and air gap adjustment

1 Remove the distributor cap with the wires attached and set it aside.

2 Loosen the rotor screw and remove the rotor.

3 Remove the inner distributor cover and the O-rings.

4 Disconnect the internal wiring and then remove the wiring harness from the distributor body.

5 Remove the stator.

6 Refitting is the reverse of removal.

Air gap adjustment

7 Detach the cable from the negative terminal of the battery.

8 Using a brass feeler gauge, measure the gap between a tip of the reluctor and the stator. Compare your measurement to the air gap listed in this Chapter's Specifications. If the air gap is not as specified, loosen the stator mounting screws and position it to the correct dimension. Excessive air gap is usually a sign of wear in the distributor shaft bush.

12 Control unit (3.0 litre engines) - removal and refitting

Note: *It is very difficult to verify a defective ignition control unit on a 3.0 litre engine. If there is no spark from the coil and all other components in the system test good, assume that the control unit may be defective.*

1 Remove the stator (refer to Section 10).

2 Mark the top of the reluctor and remove it from the distributor shaft by prising it up carefully with two screwdrivers or by using a battery cable puller. The reluctor is a tight press fit. Do not lose the small roll pin which indexes the reluctor to the shaft.

3 Remove the vacuum advance unit.

4 Remove the two control unit mounting screws and lift it from the distributor.

5 Refitting is the reverse of removal.

13 Charging system - general information and precautions

The charging system includes the alternator, an internal voltage regulator, a charge indicator light, the battery, a fusible link and the wiring between all the components. The charging system supplies electrical power for the ignition system, the lights, the radio, etc. The alternator is driven by a drivebelt at the front of the engine.

The purpose of the voltage regulator is to limit the alternator's voltage to a preset value. This prevents power surges, circuit overloads, etc., during peak voltage output.

The fusible link is a short length of insulated wire integral with the engine compartment wiring harness (see Chapter 12). The fusible link is several wire gauges smaller in diameter than the circuit it protects. See Chapter 12 for additional information regarding fusible links.

The charging system doesn't ordinarily require periodic maintenance. However, the drivebelt, battery and wires and connections should be inspected at the intervals outlined in Chapter 1.

The dashboard warning light should come on when the ignition key is turned to Start, then should go off immediately. If it remains on, there is a malfunction in the charging system. Some vehicles are also equipped with a voltage gauge. If the voltage gauge indicates abnormally high or low voltage, check the charging system (see Section 12).

Be very careful when making electrical circuit connections to a vehicle equipped with an alternator and note the following:

a) *When reconnecting wires to the alternator from the battery, be sure to note the polarity.*
b) *Before using arc welding equipment to repair any part of the vehicle, disconnect the wires from the alternator and the battery terminals.*
c) *Never start the engine with a battery charger connected.*
d) *Always disconnect both battery leads before using a battery charger.*
e) *The alternator is driven by an engine drivebelt which could cause serious injury if your hand, hair or clothes become entangled in it with the engine running.*
f) *Because the alternator is connected directly to the battery, it could arc or cause a fire if overloaded or shorted out.*
g) *Wrap a plastic bag over the alternator and secure it with rubber bands before steam cleaning the engine.*

14 Charging system - check

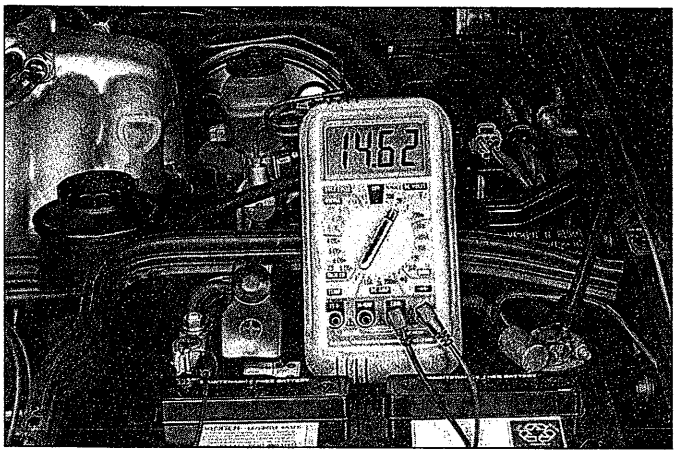
Refer to illustrations 14.3 and 14.9

1 If a malfunction occurs in the charging circuit, don't automatically assume that the alternator is causing the problem. First check the following items:

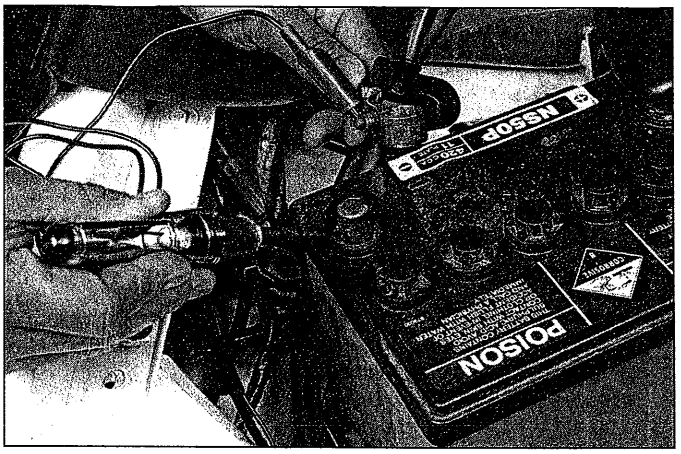
a) *Check the drivebelt tension and its condition. Renew it if worn or deteriorated.*
b) *Make sure the alternator mounting and adjustment bolts are tight.*
c) *Inspect the alternator wiring harness and the electrical connectors at the alternator and voltage regulator. They must be in good condition and tight.*
d) *Check the fusible link located at the positive battery cable or the large main fuses in the engine compartment. If it's burned, determine the cause, repair the circuit and renew the link or fuse (the vehicle won't start and/or the accessories won't work if the fusible link or fuse blows).*
e) *Check all the fuses that are in series with the charging system circuit. The location of these fuses and fusible links may vary from year and model so refer to Chapter 12 and the wiring schematics at the end of Chapter 12 for additional information.*
f) *Start the engine and check the alternator for abnormal noises (a shrieking or squealing sound indicates a bad bush or bearing).*
g) *Check the specific gravity of the battery electrolyte. If it's low, charge the battery (doesn't apply to maintenance free batteries).*
h) *Make sure that the battery is fully charged (one bad cell in a battery can cause overcharging by the alternator).*
i) *Disconnect the battery cables (negative first, then positive. Inspect the battery posts and the cable clamps for corrosion. Clean them thoroughly if necessary* (see Section 4 and Chapter 1)*. Reconnect the positive cable, then the negative cable.*

2 Using a voltmeter, check the battery voltage with the engine off. It should be approximately 12 volts.

3 Start the engine and check the battery



14.3 Battery voltage should increase to approximately 14.5 volts after the engine has been started



14.9 Checking for a key-off battery drain can be easily done by disconnecting the negative battery cable and bridging it to the battery terminal with a test light. Make sure that all power such as the interior lights are turned off first

voltage again. It should now be approximately 13.5 to 15.1 volts **(see illustration)**.

4 Turn on the headlights. The voltage should drop and then come back up, if the charging system is working properly.

5 If the voltage reading is greater than the specified charging voltage, renew the alternator (see Section 15). The internal voltage regulator is malfunctioning.

6 If you have an ammeter, hook it up to the charging system as shown. If you don't have an ammeter, you can also use an inductive-type current indicator (clamp-on ammeter). This device is inexpensive, readily available at auto parts stores and accurate enough to perform simple amperage checks like the following test.

7 With the engine running at 2,000 rpm, check the reading on the ammeter with all accessories and lights off, then again with the high-beam headlights on and the heater blower switch turned to the HI position. Compare your readings to the standard amperage listed in this Chapter's Specifications.

8 If the ammeter reading is much less than the standard amperage, renew the alternator.

Note: *This manual does not recommend that the owner attempt to disassemble and repair an alternator. If the alternator has developed a problem with a particular component, then it is very likely that it has neared the end of its service life as far as its other components are concerned also. Since rebuilt alternators are relatively inexpensive, it is not usually worth the effort and time to overhaul an alternator at home.*

9 If the battery is discharging due to a current drain with the ignition turned off, check for a draw as follows:

Disconnect both battery cable (negative cable first). Inspect the battery posts and the cable clamps for corrosion. Clean them thoroughly if necessary (refer to Chapter 1).

Reconnect the positive terminal to its post. Remove the fuse for the clock, if so equipped. With the key off and the doors closed, insert a test light between the negative battery post and the disconnected negative battery cable **(see illustration)**.

If the test light does not glow, then there is no key-off battery drain.

If the test light glows, then remove one fuse at a time from the fuse panel until the light goes out. The circuit for the fuse is causing the draw. Investigate the circuit and correct the problem.

If the light will not go out with all the fuses removed, then disconnect the wiring from the alternator. If the light goes out, the alternator is bad.

15 Alternator - removal and refitting

Refer to illustrations 15.3 and 15.4

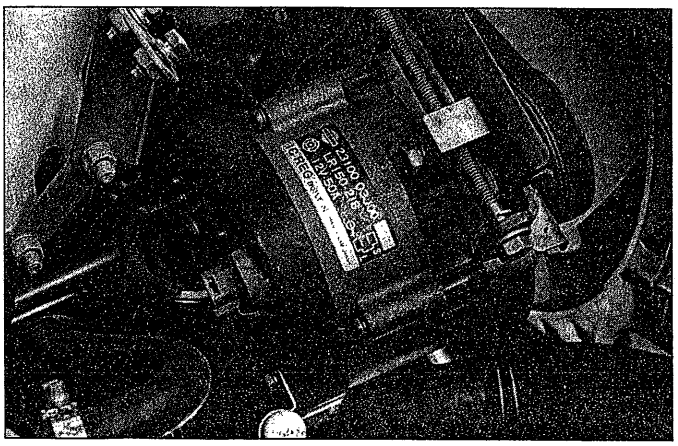
1 Detach the cable from the negative terminal of the battery.

2 Detach all of the electrical connectors from the alternator.

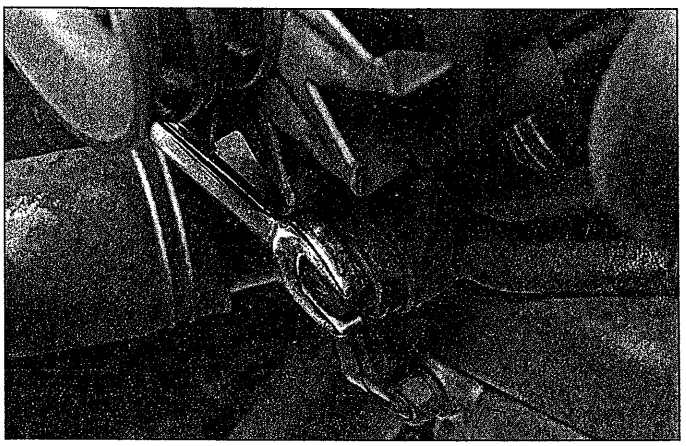
3 On diesel models. disconnect both vacuum hoses from the alternator and move them out of the way.

4 Place some rags beneath the rear of the alternator and disconnect the oil supply and return lines on diesel models.

5 Loosen the alternator adjustment, then remove the adjustment assembly **(see illustration)** and detach the drivebelts.

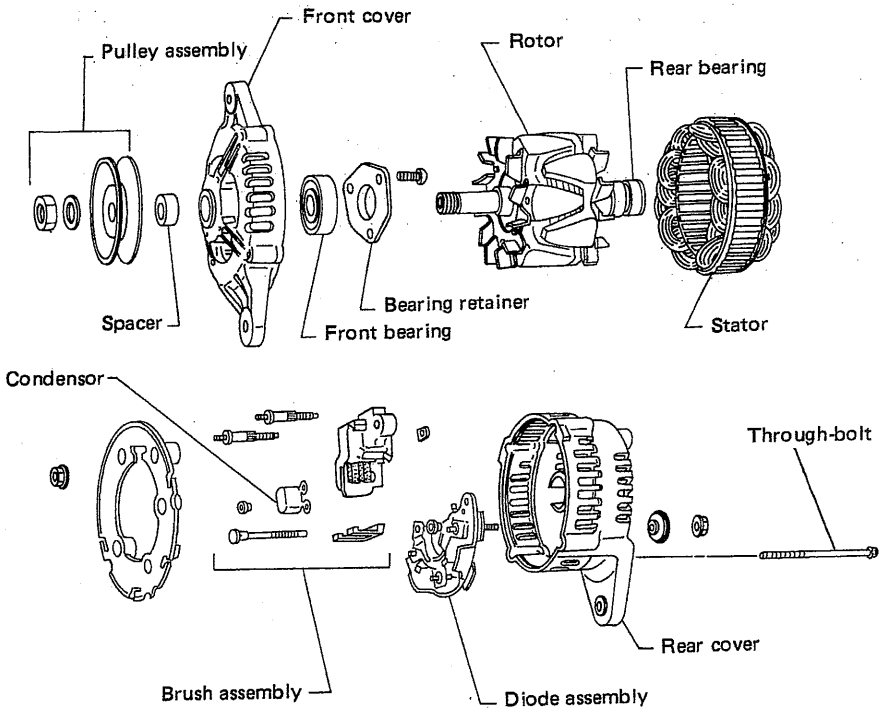


15.5 Be certain to disconnect the negative battery cable before you attempt to disconnect the wiring from the alternator. The adjustment mechanism will have to be removed also



15.6 Get a firm hold of the alternator as you remove the mounting bolt - it is heavy and should not be dropped

6 Remove the mounting bolt(s) while holding the weight of the unit **(see illustration)**.
7 Remove the alternator from the engine compartment.
8 If you are renewing the alternator, take the old alternator with you when purchasing a renewal unit. Make sure that the new/rebuilt unit is identical to the old alternator. Look at the terminals - they should be the same in number, size and locations as the terminals on the old alternator. Finally, look at the identification markings - they will be stamped in the housing or printed on a tag or plaque affixed to the housing. Make sure that these numbers are the same on both alternators.
9 Many new/rebuilt alternators do not have a pulley refitted, so you may have to switch the pulley from the old unit to the new/rebuilt one. When buying an alternator, find out the shop's policy regarding refitting of pulleys - some shops will perform this service free of charge.
10 Refitting is the reverse of removal.
11 After the alternator is refitted, adjust the drivebelt tension (see Chapter 1).
12 Check the charging voltage to verify proper operation of the alternator (see Section 14).



16.2 Exploded view of a typical Hitachi alternator

16 Alternator - overhaul

Disassembly

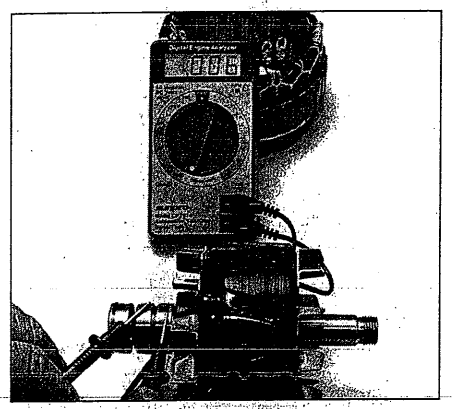
Refer to illustration 16.2

1 Remove the alternator (refer to Section 15). Remove the vacuum pump from the rear housing of the alternator on diesel models.
2 Scribe or paint alignment marks on the end frame housings to ease reassembly **(see illustration)**.
3 Remove the nut retaining the fan pulley to the rotor shaft and remove the pulley.
4 Remove the four through-bolts holding the front and rear covers together, then separate the rear cover assembly from the front cover. Remove the rotor.
5 Remove the nuts securing the stator and separate the stator and diode assembly from the rear end frame.
6 Remove the screws attaching the regulator and the brush holder to the diode assembly and remove the brush holder and regulator.
7 Remove the diode assembly from the stator. If necessary, use a solder gun and a heat sink to melt the solder joints that connect the stator leads to the diode assembly.

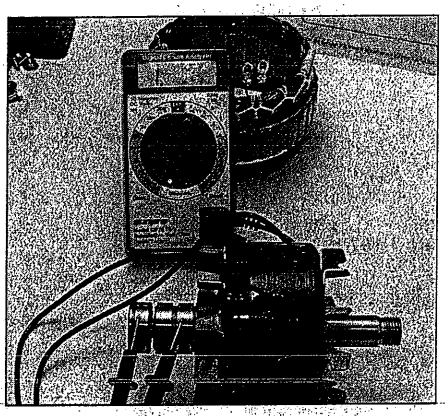
Component checks

Refer to illustrations 16.8a, 16.8b, 16.9 and 16.10

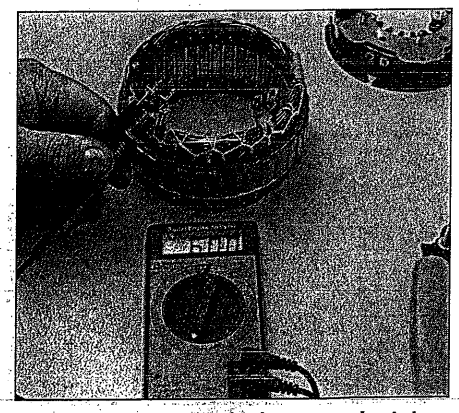
8 Check the rotor for an open between the two slip rings **(see illustration)**. There should be continuity between the slip rings. Check for earths between each slip ring and the rotor shaft **(see illustration)**. There should be no continuity (infinite resistance) between the rotor shaft and either slip ring. If the rotor fails either test or if the slip rings are worn, the rotor is defective.
9 Check for opens between the center terminal of the stator and each end terminal of the stator windings **(see illustration)**. If either reading is high (infinite resistance), the stator is defective. Check for an earthed stator winding between each stator terminal and the frame. If there is continuity between any stator winding and the frame, then the stator is defective.
10 Start the checks on the diode assembly by touching one probe of the ohmmeter to the diode plate and the other to one of the other designated diode terminals **(see illustration)**. Then reverse the probes and check again. Follow the chart carefully. The diode should have continuity with the ohmmeter one way and no continuity when the probes are reversed. Check each of the terminals in



16.8a Continuity should exist between the rotor slip rings



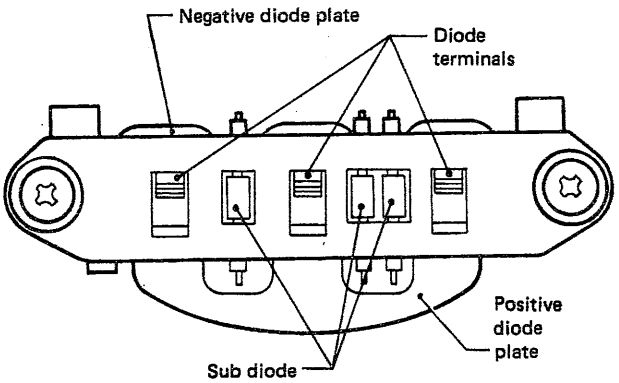
16.8b No continuity should exist between the slip ring(s) and the rotor shaft



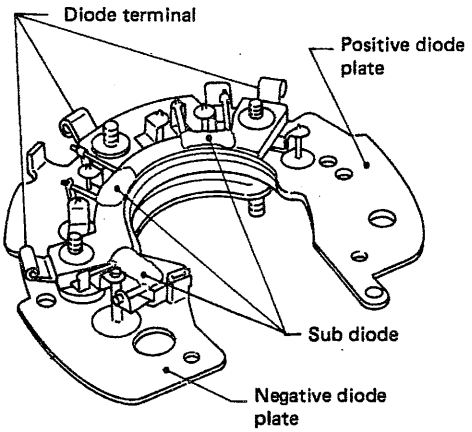
16.9 Check for continuity on each stator lead. There should be no breaks in the windings, therefore continuity should exist between each terminal

	Ohmmeter probes		Continuity
	Positive ⊕	Negative ⊖	
Diodes check (Positive side)	Positive diode plate	Diode terminals	Yes
	Diode terminals	Positive diode plate	No
Diodes check (Negative side)	Negative diode plate	Diode terminals	No
	Diode terminals	Negative diode plate	Yes

[MITSUBISHI make]



[HITACHI make]

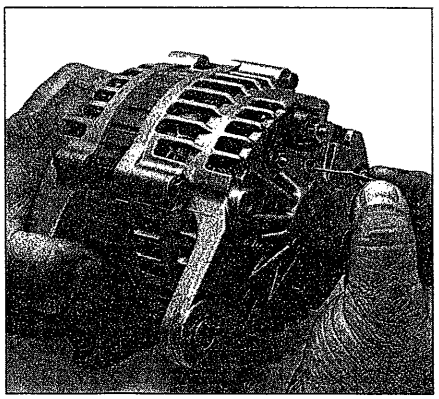


16.10 Check each diode to make sure continuity exists only in ONE direction

this manner. If any of the diodes fails the test, the diode assembly is defective.

11 To check the sub diodes, refit the probes of the ammeter into the sub diode terminals and check for continuity in the same way as the previous diode checks. Be sure to probe only the sub diode terminals. If any sub diode fails the test, the diode assembly is defective.

12 Measure the lengths of the brushes and renew them if they are at or near the minimum brush length found in this Chapter's Specifications. **Note:** *On some models, the brush leads are soldered onto the voltage regulator assembly.*



16.14 Fit a paper clip into the rear of the alternator to hold the brushes in place during refitting – after refitting, simply pull the paper clip out

Reassembly

Refer to illustration 16.14

13 Refit the components in the reverse order of removal, noting the following:

14 Before refitting the brush holder, push the brushes into the holder and slip a straightened paper clip into the hole in the brush holder to hold them in retracted position. After the end frames have been bolted together, remove the paper clip **(see illustration)**.

17 Starting system - general information and precautions

The sole function of the starting system is to turn over the engine quickly enough to allow it to start.

The starting system consists of the battery, the starter motor, the starter solenoid and the electrical circuit connecting the components. The solenoid is mounted directly on the starter motor.

The solenoid/starter motor assembly is refitted on the upper part of the engine, next to the transmission bellhousing.

When the ignition key is turned to the START position, the starter solenoid is actuated through the starter control circuit. The starter solenoid then connects the battery to the starter. The battery supplies the electrical energy to the starter motor, which does the actual work of cranking the engine.

The starter motor on a vehicle equipped with a manual transmission can be operated only when the clutch pedal is depressed; the starter on a vehicle equipped with an automatic transmission can be operated only when the transmission selector lever is in Park or Neutral.

Always observe the following precautions when working on the starting system:

a) *Excessive cranking of the starter motor can overheat it and cause serious damage. Never operate the starter motor for more than 15 seconds at a time without pausing to allow it to cool for at least two minutes.*

b) *The starter is connected directly to the battery and could arc or cause a fire if mishandled, overloaded or short circuited.*

c) *Always detach the cable from the negative terminal of the battery before working on the starting system.* **Caution:** *If the stereo in your vehicle is equipped with an anti-theft system, make sure you have the correct activation code before disconnecting the battery.*

18 Starter motor - testing in vehicle

Note: *Before diagnosing starter problems, make sure the battery is fully charged.*

1 If the starter motor does not turn at all when the switch is operated, make sure that the shift lever is in Neutral or Park (automatic

5

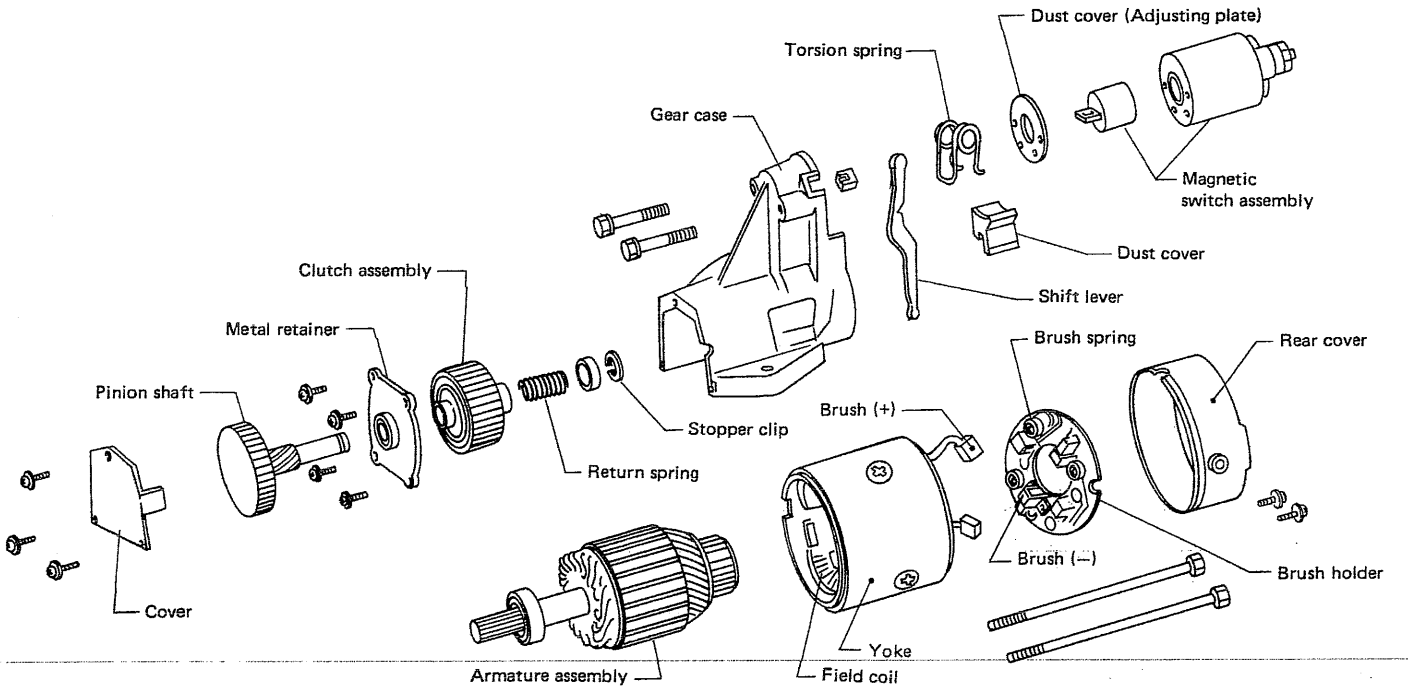
transmission) or that the clutch pedal is depressed (manual transmission).
2 Make sure that the battery is charged and that all cables, both at the battery and starter solenoid terminals, are clean and secure.
3 If the starter motor spins but the engine is not cranking, the overrunning clutch in the starter motor is slipping and the starter motor must be renewed.
4 If, when the switch is actuated, the starter motor does not operate at all but the solenoid clicks, then the problem lies with either the battery, the main solenoid contacts or the starter motor itself (or the engine is seized).
5 If the solenoid lever and pinion gear cannot be heard when the switch is actuated, the battery is bad, the fusible link is burned (the circuit is open), the starter relay is defective or the starter solenoid itself is defective. **Note:** *Follow the relay testing procedure in Chapter 12 to diagnose a defective relay.*
6 To check the solenoid, connect a jumper lead between the battery (+) and the ignition switch terminal (the small terminal) on the solenoid. If the starter motor now operates, the solenoid is OK and the problem is in the ignition switch, Neutral start switch or in the wiring.
7 If the starter motor still does not operate, remove the starter/solenoid assembly for disassembly, testing and repair.
8 If the starter motor cranks the engine at an abnormally slow speed, first make sure that the battery is charged and that all terminal connections are tight. If the engine is partially seized, then it will crank slowly.
9 Run the engine until normal operating temperature is reached, then disconnect the coil wire from the distributor cap and earth it on the engine.
10 Connect a voltmeter positive lead to the battery positive post and connect the negative lead to the negative post.
11 Crank the engine and take the voltmeter readings as soon as a steady figure is indicated. Do not allow the starter motor to turn for more than 15 seconds at a time. A reading of nine volts or more, with the starter motor turning at normal cranking speed, is normal. If the reading is nine volts or more but the cranking speed is slow, the motor is faulty. If the reading is less than nine volts and the cranking speed is slow, the solenoid contacts are probably burned, the starter motor is bad, the battery is discharged or there is a bad connection.

19 Starter motor - removal and refitting

1 Detach the cable from the negative terminal of the battery.
2 Raise the vehicle and support if securely with jackstands.
3 Disconnect all of the wiring from the solenoid. Label the smaller wires if necessary.
4 Remove the starter motor mounting bolts.
5 Use a sharp screwdriver to carefully prise the starter out. It may be sealed to the bellhousing with RTV silicone sealer.
6 Refitting is the reverse of removal. Apply a 3 mm bead of RTV silicone sealer to the sealing surface of the starter before refitting it.

20 Starter motor - overhaul

Refer to illustration 20.3
1 Remove the starter motor from the vehicle (refer to Section 19).
2 Disconnect the cable from the solenoid terminal.
3 Use dabs of paint to make alignment marks on all housing components including the solenoid **(see illustration)**. This is required for correct reassembly.
4 Remove the end housing.
5 Remove the yoke and the brush holder as a unit.
6 Pull back the brushes and then remove the yoke from the brush holder.
7 Remove the armature from the drive housing.
8 Disassemble all of the solenoid components and lay them out carefully in order.
9 Remove the mounting screws, then lift the pinion gear housing and the gear assembly from the end of the drive housing.
10 Mount the pinion gear assembly in a solid vice and remove the clip or cap from the end of the pinion shaft.
11 Remove the small bearing behind the clip or cap.
12 Remove the snap-ring or retainer from the pinion shaft. Lift off the return spring and then remove the pinion gear from the opposite end of the clutch assembly.
13 The bearings on the clutch assembly



20.3 Typical exploded view Hitachi starter motor

and the armature can be removed with a puller (armature)or by prising carefully with screwdrivers (clutch assembly).
14 Renew all components which are found to be defective. Check the brush length. They must be at least 10mm long. Check the price and availability of a new or remanufactured unit if yours has several worn components.
15 During assembly, apply wheel bearing grease to the armature bearings only. Other areas of wear such as gears, splines on shafts and bearing cavities should also receive grease.
16 Assembly of the unit is the reverse of disassembly.
17 After assembly, check the pinion gear endplay by first energising the solenoid very briefly with 12 volts. Measure the distance the pinion gear protrudes from the housing.
18 Disconnect the 12 volts as soon as possible and then pull the gear out manually. Measure the same distance. The difference should be from 0.2mm to 1.7mm. The endplay can be adjusted, if necessary, by adding or removing shims from the end of the solenoid.

21 Starter solenoid - removal and refitting

1 Remove the solenoid mounting screws.
2 Slide the solenoid rearward and disconnect the fork.
3 Remove the solenoid.
4 Refitting is the reverse of removal.

4.2 litre engines

5 Make an alignment mark on the solenoid housing and the starter so that it can be refitted in the same position.
6 Remove the mounting bolts and remove the solenoid with its plunger.
7 Remove the spring and lever along with the seal.
8 Refitting is the reverse of removal.

Notes