






Chapter 5 Engine electrical systems

Contents

Air gap (TCI system) – check and adjustment	11	Ignition sensors (Motronic system) – check and renewal	12
Alternator – removal and refitting	15	Ignition system – check	6
Alternator brushes – check and renewal	17	Ignition system – general information and precautions	5
Battery – emergency jump starting	2	Ignition timing (TCI system) – check and adjustment	7
Battery – removal and refitting	3	Impulse generator and ignition control unit – check and renewal (TCI system)	10
Battery cables – check and renewal	4	Spark plug HT lead check and renewal	See Chapter 1
Battery check and maintenance	See Chapter 1	Spark plug renewal	See Chapter 1
Charging system – check	14	Starter motor – in-vehicle check	19
Charging system – general information and precautions	13	Starter motor – removal and refitting	20
Distributor – removal and refitting	8	Starter solenoid – removal and refitting	21
Drivebelt check, adjustment and renewal	See Chapter 1	Starting system – general information and precautions	18
General information	1	Voltage regulator – renewal	16
Ignition coil – check and renewal	9		

Degrees of difficulty

Easy , suitable for novice with little experience 	Fairly easy , suitable for beginner with some experience 	Fairly difficult , suitable for competent DIY mechanic 	Difficult , suitable for experienced DIY mechanic 	Very difficult , suitable for expert DIY or professional 
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Specifications

General

Application

Models with carburettor or L-Jetronic fuel injection	Transistorised Coil Ignition (TCI) system
Models with Motronic fuel injection	Ignition functions controlled by Motronic system

Ignition coil

Primary resistance

TCI system	0.82 ohms
Motronic system	0.50 ohms

Secondary resistance

TCI system	8250 ohms
Motronic system	5000 to 6000 ohms

Distributor (models with TCI system)

Air gap	0.3 mm to 0.7 mm
Pick-up coil/impulse generator resistance	900 to 1200 ohms

Ignition timing (models with TCI system)

(Vacuum line disconnected at distributor)

316 with M10/B18 engine	25° BTDC at 2500 rpm (2900 rpm from 9/83)
318i with M10/B18 engine	30° BTDC at 3000 rpm
320i with M20/B20 engine	23° BTDC at 5000 ±50 rpm
518 with M10/B18 engine	25° BTDC at 2900 ±50 rpm
518i with M10/B18 engine	30° BTDC at 3000 ±50 rpm
525i with M30/B25 engine (except distributor 237 302 033)	22° BTDC at 1800 ±50 rpm
525i with M30/B25 engine (distributor 237 302 033)	22° BTDC at 2150 ±50 rpm
528i with M30/B28 engine	22° BTDC at 2150 ±50 rpm

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 body-related 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 improperly checked, connected or handled.*
- b) *Never leave the ignition switched on for long periods of time with the engine off.*
- c) *Don't disconnect the battery cables while the engine is running.*
- d) *Observe the rules when jump-starting your vehicle. Read the precautions at the front of this manual.*
- e) *Always disconnect the battery negative cable first, and connect it last, to reduce the risk of accidental short-circuits.*
- f) *Don't charge the battery with the cables connected to the terminals.*

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

Caution: If the radio in your vehicle is equipped with an anti-theft system, make sure you have the correct activation code before disconnecting the battery. Refer to the information on page 0-7 at the front of this manual before detaching the cable.

Note: If, after connecting the battery, the wrong language appears on the instrument panel display, refer to page 0-7 for the language resetting procedure.

2 Battery - emergency jump starting

Refer to the "Jump starting" procedure at the front of this manual.

3 Battery - removal and refitting

Note: Depending on the model, the battery may be located in the engine compartment, in the rear luggage compartment, or under the rear seat. Consult your owners handbook for the location of the battery, if not already known to you.



Caution: If the radio in your vehicle is equipped with an anti-theft system, make sure you have the correct activation code before disconnecting the battery. Refer to the information on page 0-7 at the front of this manual before detaching the cable.

Note: If, after connecting the battery, the wrong language appears on the instrument panel display, refer to page 0-7 for the language resetting procedure.

- 1 Disconnect the battery negative cable.
- 2 Detach the cable from the positive terminal.
- 3 Remove the battery hold-down bracket (see illustrations) and lift out the battery. Be careful - it's heavy. Do not tilt the battery to any extent while it is being removed, and store it upright.
- 4 While the battery is out, inspect the carrier (tray) for corrosion (see Chapter 1).
- 5 If you are renewing the battery, make sure that you get one that's identical, with the same dimensions, amperage rating, cold cranking rating, etc.
- 6 Refitting is the reverse of removal.

4 Battery cables - check and renewal

Check

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.

Caution: If the radio in your vehicle is equipped with an anti-theft system, make sure you have the correct activation code before disconnecting the battery. Refer to the information on page 0-7 at the front of this manual before detaching the cable.

Note: If, after connecting the battery, the wrong language appears on the instrument panel display, refer to page 0-7 for the language resetting procedure.



3.3a Always detach the cable from the battery negative terminal first, then detach the positive cable - to remove the hold-down assembly, remove the nuts (arrowed) or single bolt

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 cleaned or renewed. Check the terminals for distortion, missing mounting bolts, and corrosion.

Renewal

3 When removing the cables, always disconnect the negative cable first and connect it up last. This reduces the risk of accidental short-circuits. Even if only a new positive cable is being fitted, 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 the old cables are to be renewed, 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 terminal 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.



3.3b The battery is mounted under the rear seat on some models

5 Ignition system - general information and precautions

The ignition system includes the ignition switch, the battery, the distributor, the primary (low-voltage/low-tension or LT) and secondary (high-voltage/high-tension or HT) wiring circuits, the spark plugs and the spark plug leads. Models fitted with a carburettor or L-Jetronic fuel injection are equipped with a Transistorised Coil Ignition (TCI) system. Models fitted with the Motronic fuel injection system have the ignition system incorporated within the Motronic system (Digital Motor Electronics or DME).

Transistorised Coil Ignition (TCI) system

This system has four major components: the impulse generator, the ignition control unit, the coil, and the spark plugs. The impulse generator provides a timing signal for the ignition system. Equivalent to cam-actuated breaker points in a standard distributor, the impulse generator creates an A/C voltage signal every time the trigger wheel tabs pass the impulse generator tabs. When the ignition control unit (capacitive discharge unit) receives the voltage signal, it triggers a spark discharge from the coil by interrupting the primary coil circuit. The ignition dwell (coil charging time) is adjusted by the ignition control unit for the most intense spark. **Note:** The air gap (distance between the impulse generator and trigger wheel tabs) can be adjusted (see Section 11).

Ignition timing is mechanically adjusted (see Section 7). A centrifugal advance unit that consists of spring-loaded rotating weights advances ignition timing as engine speed increases. The vacuum advance adjusts ignition timing to compensate for changes in engine load.

Motronic ignition system

This system, also known as Digital Motor Electronics (DME), incorporates all ignition and fuel injection functions into one central control unit or ECU (computer). The ignition timing is based on inputs the ECU receives for engine load, engine speed, coolant temperature and intake air temperature. The only function the distributor performs is the distribution of the high voltage signal to the individual spark plugs. The distributor is attached directly to the cylinder head. There is no mechanical spark advance system used on these systems.

Ignition timing is electronically-controlled, and is not adjustable on Motronic systems. During starting, a crankshaft position sensor (reference sensor) relays the crankshaft position to the ECU, and an initial baseline ignition point is determined. Once the engine

is running, the ignition timing is continually changing, based on the various input signals to the ECU. Engine speed is signalled by a speed sensor. Early Motronic systems have the position reference sensor and the speed sensor mounted on the bellhousing over the flywheel on the left-hand side. Later Motronic systems have a single sensor (pulse sensor) mounted over the crankshaft pulley. This sensor functions as a speed sensor as well as a position reference sensor. Refer to Section 12 for checking and renewing the ignition sensors. **Note:** Some models are equipped with a TDC sensor mounted on the front of the engine. This sensor is strictly for the BMW service test unit, and it is not part of the Motronic ignition system.

Precautions

Certain precautions must be observed when working on a transistorised ignition system.

- Do not disconnect the battery cables when the engine is running
- Make sure the ignition control unit (TCI ignition system) is always well earthed (see Section 10).
- Keep water away from the distributor and HT leads.
- If a tachometer is to be connected to the engine, always connect the tachometer positive (+) lead to the ignition coil negative terminal (-) and never to the distributor.
- Do not allow the coil terminals to be earthed, as the impulse generator or coil could be damaged.
- Do not leave the ignition switch on for more than ten minutes with the engine off, or if the engine will not start.

6 Ignition system - check



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 impulse generator (electronic ignition), coil, distributor and spark plug HT leads, but related components such as spark plug connectors, tachometer and other test equipment.

1 If the engine turns over but will not start, disconnect the spark plug HT lead from any spark plug, and attach it to a calibrated spark tester (available at most car accessory shops).

Note: There are two different types of spark testers. Be sure to specify electronic (breakerless) ignition. Connect the clip on the



6.1 To use a spark tester, simply disconnect a spark plug HT lead, clip the tester to a convenient earth (like a valve cover bolt or nut) and operate the starter – if there is enough power to fire the plug, sparks will be visible between the electrode tip and the tester body

tester to an earth point such as a metal bracket (see illustration).

2 If you are unable to obtain a calibrated spark tester, remove the spark plug HT lead from one of the spark plugs. Using an insulated tool, hold the lead about a quarter-inch from the engine block - make sure the gap is not more than a quarter-inch, or damage may be caused to the electronic components.

3 Crank the engine, and observe the tip of the tester or spark plug HT lead to see if a spark occurs. If bright-blue, well-defined sparks occur, sufficient voltage is reaching the plugs to fire the engine. However, the plugs themselves may be fouled, so remove and check them as described in Chapter 1.

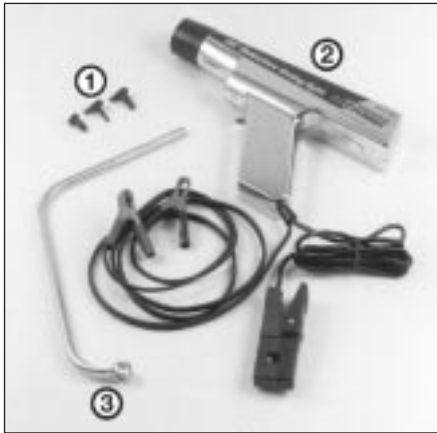
4 If there's no spark, check another HT lead in the same manner. A few sparks followed by no spark is the same condition as no spark at all.

5 If no spark occurs, remove the distributor cap, and check the cap and rotor as described in Chapter 1. If moisture is present, use a water-dispersant aerosol (or something similar) to dry out the cap and rotor, then refit the cap and repeat the spark test.

6 If there's still no spark, disconnect the coil HT lead from the distributor cap, and test this lead as described for the spark plug leads.

7 If no spark occurs, check the primary wire connections at the coil to make sure they're clean and tight. Make any necessary repairs, then repeat the check.

8 If sparks do occur from the coil HT lead, the distributor cap, rotor, plug HT lead(s) or spark plug(s) may be defective. If there's still no spark, the coil-to-cap HT lead may be defective. If a substitute lead doesn't make any difference, check the ignition coil (see Section 9). **Note:** Refer to Sections 10 and 11 for more test procedures on the distributors fitted with the TCI ignition system.



7.1 Tools for checking and adjusting the ignition timing

- 1 **Vacuum plugs** - Vacuum hoses will, in most cases, have to be disconnected and plugged. Moulded plugs in various shapes and sizes can be used for this, if wished
- 2 **Inductive pick-up timing light** - Flashes a bright, concentrated beam of light when No 1 spark plug fires. Connect the leads according to the instructions supplied with the light
- 3 **Distributor spanner** - On some models, the hold-down bolt for the distributor is difficult to reach and turn with conventional spanners or sockets. A special spanner like this must be used

7 Ignition timing (TCI system) - check and adjustment



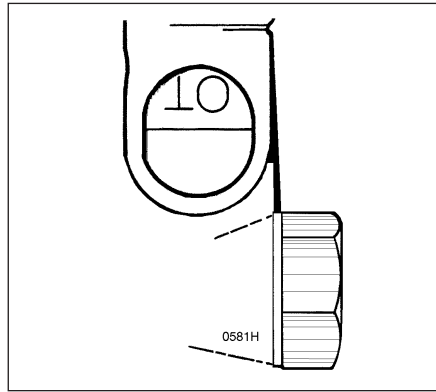
Warning: Keep hands, equipment and wires well clear of the viscous cooling fan during adjustment of the ignition timing.

Note: This Section describes the procedure for checking and adjusting the ignition timing on engines fitted with the TCI system. On engines fitted with the Motronic engine management system, the ignition timing is controlled by the electronic control unit, and no adjustment is possible. The timing can be checked using the following procedure, but no ignition timing values were available at the time of writing. If the timing is thought to be incorrect, refer to a BMW dealer.

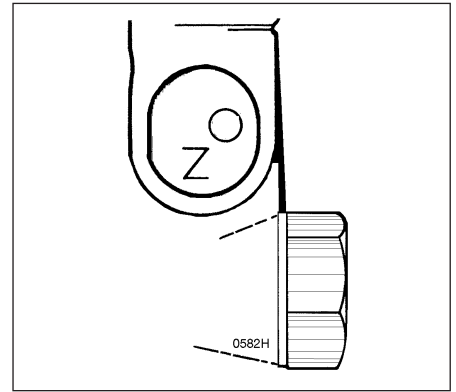
1 Some special tools are required for this procedure (see illustration). The engine must be at normal operating temperature, and the air conditioning (where fitted) must be switched off. Make sure the idle speed is correct.

2 Apply the handbrake, and chock the wheels to prevent movement of the vehicle. The transmission must be in neutral (manual) or Park (automatic).

3 The timing marks are located on the engine flywheel (viewed through the timing check



7.9a Flywheel "OT" timing mark



7.9b Flywheel "OZ" timing mark

hole in the bellhousing) and/or on the vibration damper on the front of the engine.

4 Where applicable, disconnect the vacuum hose from the distributor vacuum advance unit.

5 Connect a tachometer and timing light according to the equipment manufacturer's instructions (an inductive pick-up timing light is preferred). Generally, the power leads for the timing light are attached to the battery terminals, and the pick-up lead is attached to the No 1 spark plug HT lead. The No 1 spark plug is the one at the front of the engine.



Caution: If an inductive pick-up timing light isn't available, don't puncture the spark plug HT lead to attach the timing light pick-up lead. Instead, use an adapter between the spark plug and HT lead. If the insulation on the HT lead is damaged, the secondary voltage will jump to earth at the damaged point, and the engine will misfire.

Note: On some models, a TDC transmitter is fitted for checking the ignition system. However, a special BMW tester must be connected to the diagnostic socket to use it, so unless the special tester is available, a conventional timing light should be used. The ignition timing mark may be on the vibration damper, but if not, normally the TDC mark will be. If the timing light is of the adjustable delay type, then the ignition timing may be determined by zeroing the adjustment, then turning the adjustment until the TDC marks are aligned, and then reading off the amount of advance from the timing light. If a standard timing light is being used, make a mark on the vibration damper in accordance with the specified advance, using the following formula to calculate the distance from the TDC mark to the timing mark:

$$\text{Distance} = \frac{2Pr \times \text{advance}}{360}$$

where $P = 3.142$

$r = \text{radius of vibration damper}$
advance = specified advance
BTDC in degrees

6 With the ignition off, loosen the distributor clamp nut just enough to allow the distributor to pivot without any slipping.

7 Make sure the timing light wires are routed away from the drivebelts and fan, then start the engine.

8 Raise the engine rpm to the specified speed, and then point the flashing timing light at the timing marks - be very careful of moving engine components.

9 The mark on the flywheel or vibration damper will appear stationary. If it's aligned with the specified point on the bellhousing or engine front cover, the ignition timing is correct (see illustrations).

10 If the marks aren't aligned, adjustment is required. Turn the distributor very slowly until the marks are aligned, taking care not to touch the HT leads.

11 Tighten the nut on the distributor clamp, and recheck the timing.

12 Switch off the engine, and remove the timing light and tachometer. Reconnect the vacuum hose where applicable.

8 Distributor - removal and refitting



TCI system

Removal

1 After carefully marking them for position, remove the coil HT lead and spark plug HT leads from the distributor cap (see Chapter 1).

2 Remove No 1 spark plug (the one nearest you when you are standing in front of the engine).

3 Manually rotate the engine to Top Dead Centre (TDC) on the compression stroke for No 1 piston (see Chapter 2A)

4 Carefully mark the vacuum hoses, if more than one is present on your distributor.

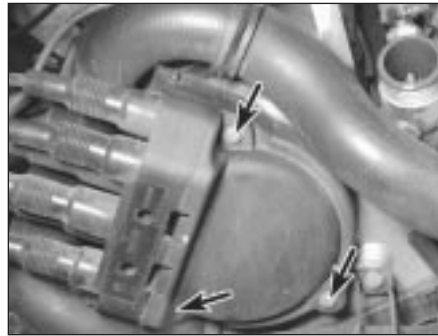
5 Disconnect the vacuum hose(s).

6 Disconnect the primary circuit wires from the distributor.

7 Mark the relationship of the rotor tip to the distributor housing (see illustration). Also mark the relationship of the distributor housing to the engine.



8.7 Mark the relationship of the rotor to the distributor housing (arrowed)



8.18 Remove the three bolts (arrowed) from the distributor cap



8.19 Remove the rotor screws (arrowed) with an Allen key, and pull the rotor off the shaft

8 Remove the hold-down nut or bolt and clamp.

9 Remove the distributor. **Note:** Do not rotate the engine with the distributor out.

Refitting

10 Before refitting the distributor, make certain No 1 piston is still at TDC on the compression stroke.

11 Insert the distributor into the engine, with the adjusting clamp centred over the hold-down hole. Make allowance for the gear to turn as the distributor is inserted.

12 Refit the hold-down nut or bolt. The marks previously made on the distributor housing, and on the rotor and engine, should line up before the nut or bolt is tightened.

13 Refit the distributor cap.

14 Connect the wiring for the distributor.

15 Reconnect the spark plug HT leads.

16 Reconnect the vacuum hoses as previously marked.

17 Check the ignition timing (see Section 7).

Motronic system

Removal

18 Remove the cover from the distributor (see illustration) and remove the distributor cap (see Chapter 1).

19 Using a small Allen key, remove the three screws from the rotor (see illustration).

20 Remove the rotor.

Refitting

21 Refitting is the reverse of removal.

9 Ignition coil - check and renewal



Caution: Do not earth the coil, as the coil and/or impulse generator could be damaged.

Note: On models equipped with the Motronic system, a faulty ECU can cause the ignition coil to become damaged. Be sure to test the ignition coil if the engine will not start and an ECU fault is suspected.

1 Mark the wires and terminals for position, then remove the primary circuit wires and the HT lead from the coil.



9.4a Using an ohmmeter, measure the resistance between the primary terminals of the ignition coil (TCI system shown)



9.4b Some Motronic systems use a different type of coil. First, remove the coil cover and . . .



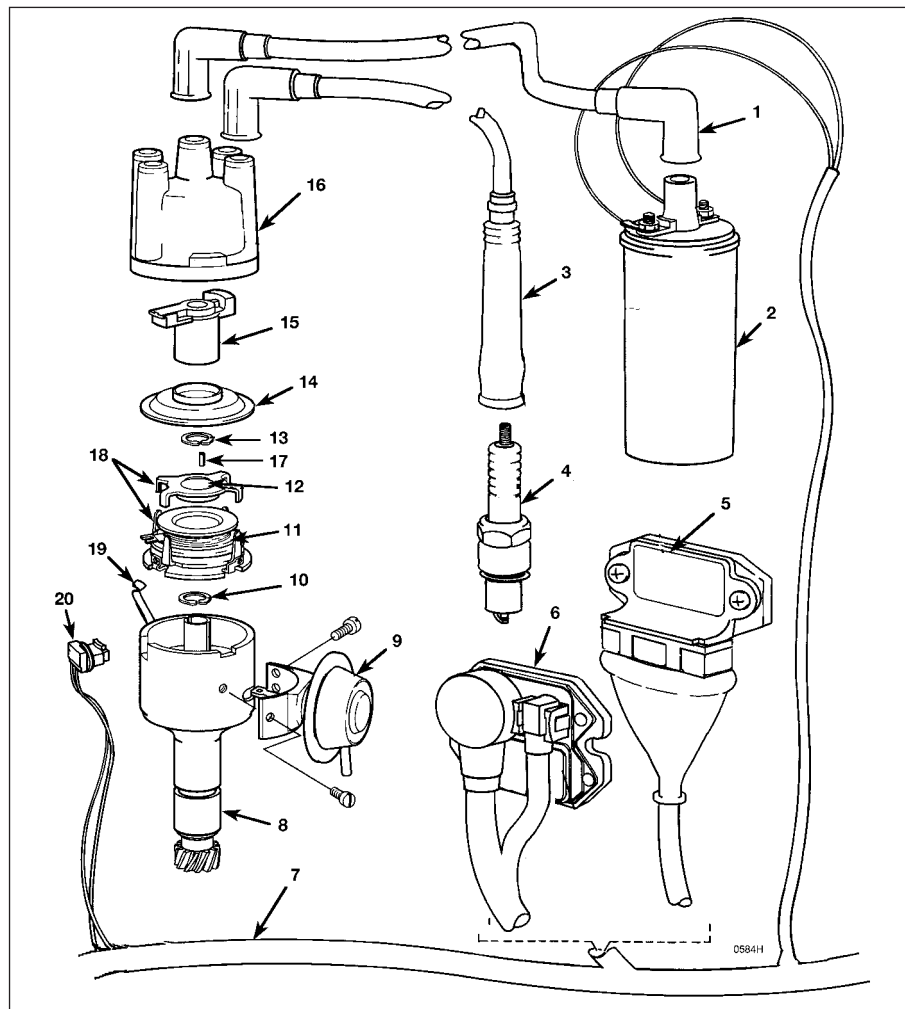
9.4c . . . using an ohmmeter, measure the resistance between the primary terminals of the coil



9.5a Using an ohmmeter, measure the secondary resistance of the coil (TCI system)

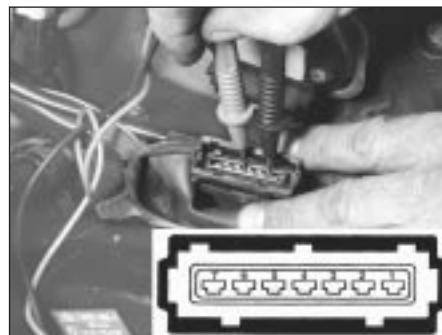


9.5b Using an ohmmeter, measure the secondary resistance of the coil (later Motronic system)

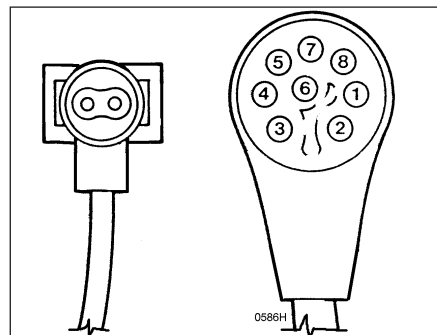


10.1 Schematic of the ignition components used on engines with the TCI system

- | | | |
|--|---|---|
| 1 Coil HT lead | 8 Distributor housing with centrifugal advance counterweights | 15 Ignition rotor |
| 2 Ignition coil | 9 Vacuum diaphragm | 16 Distributor |
| 3 Spark plug HT lead | 10 Circlip | 17 Roll pin |
| 4 Spark plug | 11 Impulse generator | 18 Trigger wheel and impulse generator tabs |
| 5 Ignition control unit (Bosch) | 12 Trigger wheel | 19 Cap retaining clip |
| 6 Ignition control unit (Siemens/Telefunken) | 13 Circlip | 20 Impulse generator connector |
| 7 Wiring harness | 14 Dust shield | |



10.2a Check for voltage at terminals 2 and 4 on the control unit electrical connector (Bosch system shown)



10.2b Check for voltage at terminals 6 and 3 on the control unit electrical connector (Siemens/Telefunken system shown)

connect the ohmmeter to coil terminal 1 (-) and the centre tower. On Motronic systems, connect the ohmmeter to coil terminal 15 (+) and the centre tower. Compare the measured resistance with the values given in the Specifications in this Chapter.

6 If the measured resistances are not close to those specified, the coil is defective and should be renewed. Note that the measured resistance will vary according to the temperature of the coil, so don't rush to condemn the coil if the resistance is only a little way out.

7 It is essential for proper ignition system operation that all coil terminals and wire leads be kept clean and dry.

8 Refit the coil in its mounting, and reconnect the wiring. Refitting is the reverse of removal.

10 Impulse generator and ignition control unit - check and renewal (TCI system)



1 The impulse generator (located in the distributor) and ignition control unit need to be tested in the event there is no spark at the spark plugs. Make sure the plug leads, ignition coil and spark plugs are working properly (see Sections 6 and 9). There are two types of control units; Bosch or Siemens/Telefunken. The two types (see illustration) can be distinguished by their electrical connectors. The Bosch type uses a single, large rectangular connector at the bottom of the unit, while the Siemens/Telefunken control unit uses two round electrical connectors at the front of the unit.

Check

Voltage supply and earth to ignition control unit

2 With the ignition off, remove the harness connectors from the ignition control unit (see illustrations). Connect a voltmeter between connector terminals 2 and 4 on Bosch systems, or between terminals 6 and 3 on Siemens/Telefunken systems.

3 Turn the ignition on. There should be battery voltage on the designated terminals. If there is no voltage, check the wiring harness for an open-circuit (see Chapter 12).

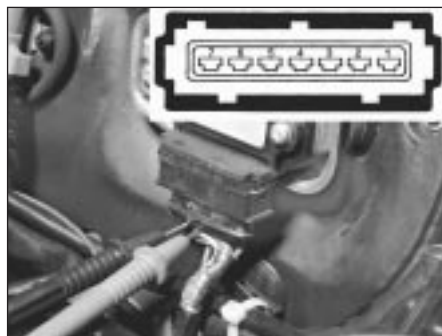
4 Using an ohmmeter, check for continuity between connector terminal 2 (Bosch) or 6 (Siemens/Telefunken) and the earth to the vehicle body. Continuity should exist.

5 Using an ohmmeter, check for continuity between connector terminal 4 (Bosch) or 3 (Siemens/Telefunken) and terminal 15 of the ignition coil. Continuity should exist.

6 If the readings are incorrect, repair the wiring harness.

Impulse generator signal

7 If the ignition control unit is receiving battery voltage, check the A/C signal voltage coming from the impulse generator to the control unit.



10.8 Back-probe the ignition control unit connector, and check for signal voltage on terminals 5 and 6 (Bosch system shown). It is very helpful to use angled probes

8 Use a digital voltmeter for the following tests:

- a) On Bosch systems, connect the positive probe to connector terminal 5, and the negative probe to terminal 6 (see illustration).
- b) On Siemens/Telefunken systems, connect the positive probe to terminal (+) of the smaller connector, and the negative probe to terminal (-).

9 Have an assistant crank the engine over, and check that there is 1 to 2 volts A/C present. If there is no voltage, check the wiring harness between the impulse generator (in the distributor) and the control unit. If the harness is OK, check the impulse generator resistance.



Warning: Do not crank the engine over for an excessive length of time. If necessary, disconnect the cold start injector electrical connector (see Chapter 4) to stop the flow of fuel into the engine.

10 To check the resistance in the impulse generator, proceed as described for your system below:

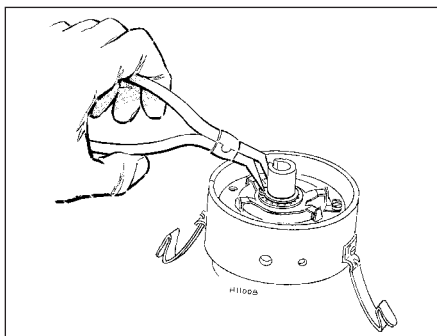
- a) On Bosch units, measure the resistance between connector terminals 5 and 6 (see illustration 10.8). The reading should be 1000 to 1200 ohms.
- b) On Siemens/Telefunken units, measure the resistance between the terminals of the smaller connector. The reading should be 1000 to 1200 ohms.

11 If the resistance readings are incorrect, renew the impulse generator. If the resistance readings for the impulse generator are correct and the control unit voltages (supply voltage [paragraphs 1 to 6] and signal voltage [paragraphs 7 to 9]) are incorrect, renew the control unit.

Renewal

Ignition control unit

- 12** Make sure the ignition is switched off.
- 13** Disconnect the electrical connector(s) from the control unit.
- 14** Remove the mounting screws from the control unit, and lift it from the engine compartment.



10.18 Use circlip pliers and remove the circlip from the distributor shaft

15 Refitting is the reverse of removal. **Note:** On Bosch control units, a special dielectric grease is used between the heat sink and the back of the control unit. In the event the two are separated (renewal or testing) the old grease must be removed, and the heat sink cleaned off using 180-grit sandpaper. Apply Curil K2 (Bosch part number 81 22 9 243). A silicon dielectric compound can be used as a substitute. This treatment is very important for the long life of these expensive ignition parts.

Impulse generator



Caution: If the radio in your vehicle is equipped with an anti-theft system, make sure you have the correct activation code before disconnecting the battery. Refer to the information on page 0-7 at the front of this manual before detaching the cable.

Note: If, after connecting the battery, the wrong language appears on the instrument panel display, refer to page 0-7 for the language resetting procedure.

16 Disconnect the battery negative cable.

17 Remove the distributor from the engine (see Section 8).

18 Using a pair of circlip pliers, remove the circlip retaining the trigger wheel (see illustration).

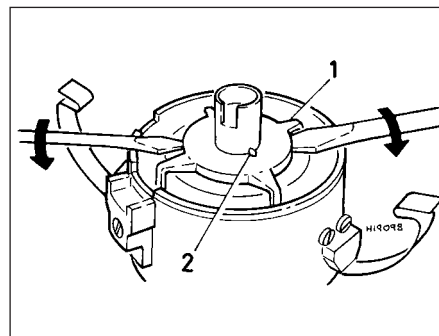
19 Use two flat-bladed screwdrivers positioned at opposite sides of the trigger wheel, and carefully prise it up (see illustration). **Note:** Push the screwdrivers in as far as possible without bending the trigger wheel. Prise only on the strongest, centre portion of the trigger wheel. In the event the trigger wheel is bent, it must be replaced with a new one. **Note:** Be sure not to lose the roll pin when lifting out the trigger wheel.

20 Remove the mounting screws from the impulse generator electrical connector, the vacuum diaphragm and the baseplate.

21 Remove the two screws from the vacuum advance unit, and separate it from the distributor by moving the assembly down while unhooking it from the baseplate pin.

22 Use circlip pliers to remove the circlip that retains the impulse generator and the baseplate assembly.

23 Carefully remove the impulse generator and the baseplate assembly as a single unit.



10.19 Carefully prise the trigger wheel off the distributor shaft

24 Remove the three screws, and separate the baseplate assembly from the impulse generator.

25 Refitting is the reverse of removal. **Note:** Be sure to position the insulating ring between the generator coil and the baseplate. It must be centred before tightening the mounting screws. Also, it will be necessary to check/adjust the air gap if the trigger wheel has been removed, or tampered with to the point that the clearance is incorrect (see Section 11).

11 Air gap (TCI system) - check and adjustment



Caution: If the radio in your vehicle is equipped with an anti-theft system, make sure you have the correct activation code before disconnecting the battery. Refer to the information on page 0-7 at the front of this manual before detaching the cable.

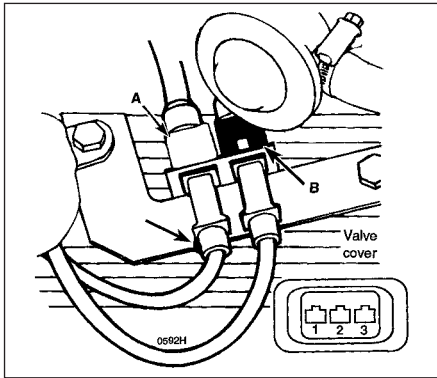
Note: If, after connecting the battery, the wrong language appears on the instrument panel display, refer to page 0-7 for the language resetting procedure.

1 Disconnect the battery negative cable.

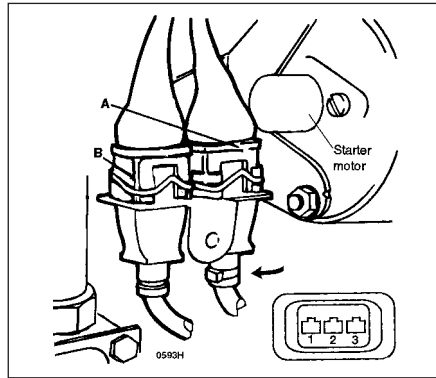
2 Insert a brass feeler gauge between the trigger wheel tab and the impulse generator (see illustration). Slide the feeler gauge up



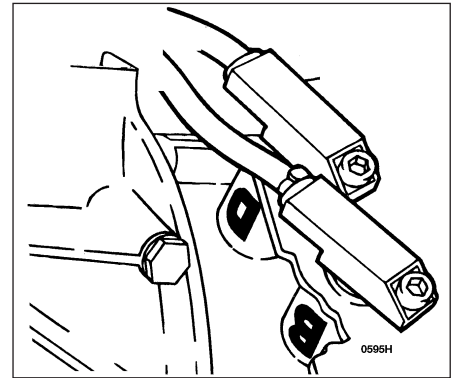
11.2 Use a brass feeler gauge to check the air gap (be sure the gauge rubs lightly against the trigger wheel as well as the locating pin for the correct adjustment)



12.1a Location of the position sensor (grey connector) (A) and the speed sensor (black connector) (B) on Motronic systems (early models)



12.1b Location of the position sensor (grey connector) (A) and the speed sensor (black connector) (B) on Motronic systems (later models)



12.5 Location of the position sensor (B) and speed sensor (D) on the bellhousing on all Motronic systems – do not interchange the sensors, or the engine will not start

and down - you should feel a slight drag on the feeler gauge as it is moved if the gap is correct. The gap must be as given in this Chapter's Specifications.

3 To adjust the gap, it is necessary to remove the impulse generator and the baseplate assembly from the distributor (see illustration 10.1).

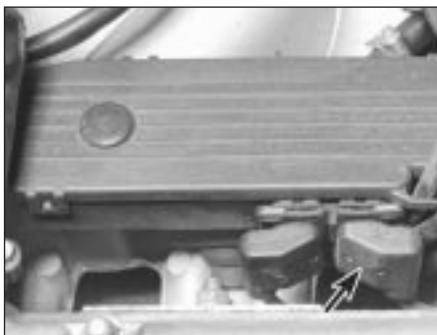
4 Follow paragraphs 17 to 24 in Section 10 and loosen the screws that retain the impulse generator to the baseplate assembly.

5 Carefully insert the feeler gauge and tighten the screws.

6 Refit the assembly back into the distributor and recheck the adjustment.



12.7a On later 3-Series models, the pulse sensor connector (arrowed) is located next to the 20-pin diagnostic connector



12.7b On later 5-Series models, the pulse sensor connector (arrowed) is located next to the valve cover

12 Ignition sensors (Motronic system) - check and renewal

Note: Some models are equipped with a TDC sensor mounted on the front of the engine. This sensor is strictly for the BMW service test unit, and is not part of the Motronic ignition system.

Speed and position sensors

Check

1 Locate the two electrical connectors for the sensors (see illustrations). The grey connector is for the position sensor, and the white connector is for the speed sensor.

2 Using an ohmmeter, check the resistance between terminal 1 (yellow wire) and terminal 2 (black wire) on the sensor side of each connector. The resistance should be 860 to 1,060 ohms.

3 Also check the resistance between terminal 3 and either terminal 1 or terminal 2. The resistance should be approximately 100 000 ohms.

4 If the reading(s) are incorrect, renew the sensor(s).

Renewal

5 Remove the sensor mounting screw(s),

using an Allen key where necessary, and pull the sensor(s) from the sockets. Disconnect the wiring from one sensor at a time - be sure the connectors are not interchanged when fitting new sensors. The bellhousing is marked with a B for the position sensor (grey connector) and D for the speed sensor (black connector) (see illustration). **Note:** It is a good idea to check the condition of the raised pin on the flywheel while the sensors are out of the sockets. Turn the engine by hand as necessary to bring the pin into view.

6 Tighten the sensor mounting screw(s) securely, but be careful not to overtighten.

Pulse sensor (later models)

Check

7 Locate the two electrical connectors for the sensor (see illustrations). Disconnect the electrical connector from the front.

8 Using an ohmmeter, check resistance between terminal 1 (yellow wire) and terminal 2 (black wire) on the sensor side of each connector (see illustration). The resistance should be 500 to 600 ohms.

9 If the reading is incorrect, renew the sensor.

Renewal

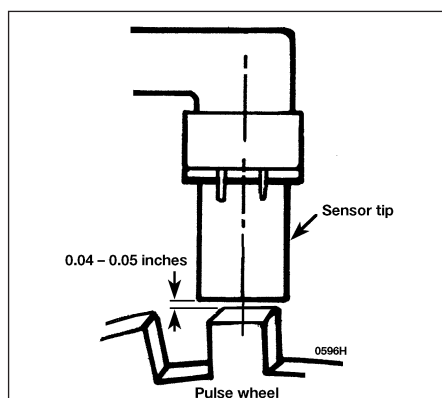
10 Remove the pulse sensor mounting bolt using a 5 mm hex spanner (see illustration).



12.8 The resistance of the pulse sensor should be 500 to 600 ohms (later models)



12.10 The pulse sensor itself (arrowed) is located on the timing belt cover, to one side of the pulley (later models)



12.11 The sensor tip should be set at 1.0 ± 0.3 mm from the pulse wheel

Withdraw the sensor from its bracket and remove it.

11 When fitting the new sensor, use a brass feeler gauge to position the tip of the sensor the correct distance from the pulse wheel (see illustration).

12 Tighten the mounting bolt, but be careful not to overtighten it.

13 Charging system - general information and precautions

There are two different types of alternator fitted on these models; Bosch and Motorola. Also, there are three different amperage ratings available; 65A, 80A or 90A. A stamped serial number on the rear of the alternator will identify the type and amperage rating. Perform the charging system checks (see Section 14) to diagnose any problems with the alternator.

The voltage regulator and the alternator brushes are mounted as a single assembly. On Bosch alternators, this unit can be removed from the alternator (see Section 16) and the components serviced individually.

The alternator on all models is mounted on the left front of the engine, and utilises a V-belt and pulley drive system. Drivebelt tension and battery servicing are the two primary maintenance requirements for these systems. See Chapter 1 for the procedures regarding engine drivebelt checking and battery servicing.

The ignition/no-charge warning light should come on when the ignition key is turned to Start, then go off immediately the engine starts. If it remains on, there is a malfunction in the charging system (see Section 14). Some vehicles are also equipped with a voltmeter. If the voltmeter indicates abnormally high or low voltage, check the charging system (see Section 14). **Note:** On models up to 1986, a blown ignition/no-charge warning light will prevent the alternator from charging. After 1987, a resistor is wired in parallel with the warning light in order to allow current to

bypass the light in the event of a broken circuit (blown warning light).

Precautions

Be very careful when making electrical circuit connections to the alternator, and note the following:

- When reconnecting wires to the alternator from the battery, be sure to note the polarity.
- Before using arc-welding equipment to repair any part of the vehicle, disconnect the wires from the battery terminals and from the alternator.



Caution: If the radio in your vehicle is equipped with an anti-theft system, make sure you have the correct activation code before disconnecting the battery. Refer to the information on page 0-7 at the front of this manual before detaching the cable.

Note: If, after connecting the battery, the wrong language appears on the instrument panel display, refer to page 0-7 for the language resetting procedure.

- Never start the engine with a battery charger connected. Always disconnect both battery cables before using a battery charger.
- Never disconnect cables from the battery or from the alternator while the engine is running.
- The alternator is turned by an engine drivebelt. Serious injury could result if your hands, hair or clothes become entangled in the belt with the engine running.
- Because the alternator is connected directly to the battery, take care not to short out the main terminal to earth.
- Wrap a plastic bag over the alternator, and secure it with rubber bands, before steam-cleaning the engine.

14 Charging system - check



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:

- Check the drivebelt tension and condition (see Chapter 1). Renew the drivebelt if it's worn or deteriorated.
- Make sure the alternator mounting and adjustment bolts are tight.
- Inspect the alternator wiring harness and the connectors at the alternator and voltage regulator. They must be in good condition and tight.
- Check the fuses.
- Start the engine and check the alternator for abnormal noises (a shrieking or squealing sound indicates a worn bearing, but could also be due to a slipping drivebelt - see a) above).

- Check the specific gravity of the battery electrolyte. If it's low, charge the battery (doesn't apply to maintenance-free batteries).
- Make sure the battery is fully-charged (one bad cell in a battery can cause overcharging by the alternator).
- Disconnect the battery cables (negative first, then positive). Inspect the battery posts and the cable clamps for corrosion. Clean them thoroughly if necessary (see Chapter 1).



Caution: If the radio in your vehicle is equipped with an anti-theft system, make sure you have the correct activation code before disconnecting the battery. Refer to the information on page 0-7 at the front of this manual before detaching the cable.

Note: If, after connecting the battery, the wrong language appears on the instrument panel display, refer to page 0-7 for the language resetting procedure.

2 With the ignition off, connect a 12 volt test light between the battery negative post and the disconnected negative cable clamp. If the test light does not come on, refit the cable and proceed to paragraph 4. If the test light comes on, there is a short (drain) in the electrical system of the vehicle. The short must be repaired before the charging system can be checked. **Note:** Accessories which are always on (such as the clock or the radio station memory) must be disconnected before performing this check.

3 Disconnect the alternator wiring harness. If the test light now goes out, the alternator is faulty. If the light stays on, remove each fuse in turn until the light goes out (this will tell you which component is shorting out).

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

5 Start the engine and check the battery voltage again. It should now be approximately 14 to 15 volts.

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

7 If the voltage reading is more than the specified charging voltage, renew the voltage regulator (refer to Section 16). If the voltage is less, the alternator diode(s), stator or rotor may be faulty, or the voltage regulator may be malfunctioning.

8 If there is no short-circuit causing battery drain but the battery is constantly discharging, then either the battery itself is defective, the alternator drivebelt is loose (see Chapter 1), the alternator brushes are worn, dirty or disconnected (see Section 17), the voltage regulator is malfunctioning (see Section 16) or the diodes, stator coil or rotor coil are defective. Repairing or renewing the diodes, stator coil or rotor coil is beyond the scope of the home mechanic. Either renew



15.2 Depending on how many accessories the vehicle has, sometimes it's easier to remove the alternator from the brackets first, and then turn it sideways to gain access to the connections (arrowed) on the rear of the alternator body

the alternator complete, or take it to an automotive electrician, who may be able to overhaul it. **Note:** On models up to 1986, a blown ignition/no-charge warning light bulb will prevent the alternator from charging. After 1987, a resistor is wired in parallel with the warning light, in order to allow current to bypass the light in the event of a broken circuit (blown warning light).

15 Alternator - removal and refitting



Caution: If the radio in your vehicle is equipped with an anti-theft system, make sure you have the correct activation code

before disconnecting the battery. Refer to the information on page 0-7 at the front of this manual before detaching the cable.

Note: If, after connecting the battery, the wrong language appears on the instrument panel display, refer to page 0-7 for the language resetting procedure.

Removal

1 Detach the battery negative cable.



16.4a Remove the nuts and lift off the small terminal protector from the alternator cover, then remove the nuts and the cover

2 Detach the electrical connectors from the alternator, noting their locations for refitting (see illustration). **Note:** On some models, it may be necessary to remove the air cleaner assembly and airflow meter to gain access to the alternator.

3 Loosen the alternator adjustment and pivot bolts, and slip off the drivebelt (see Chapter 1).

4 Remove the adjustment and pivot bolts, and separate the alternator from the engine.

Refitting

5 If you are renewing the alternator, take the old one with you when purchasing a new or reconditioned unit. Make sure the new unit looks identical to the old alternator. Look at the terminals - they should be the same in number, size and location as the terminals on the old alternator. Finally, look at the identification numbers - they will be stamped into the housing, or printed on a tag attached to the housing. Make sure the numbers are the same on both alternators.

6 Many new alternators do not come with a pulley fitted, so you may have to transfer the pulley from the old unit to the new one.

7 Refitting is the reverse of removal.

8 After the alternator is fitted, adjust the drivebelt tension (see Chapter 1).

9 Check the charging voltage to verify proper operation of the alternator (see Section 14).

16 Voltage regulator - renewal



1 The voltage regulator controls the charging system voltage by limiting the alternator output. The regulator is a sealed unit, and isn't adjustable.

2 If the voltmeter indicates that the alternator is not charging (or if the ignition/no-charge warning light comes on) and the alternator, battery, drivebelt tension and electrical connections seem to be fine, have the



16.4b The regulator can be withdrawn easily on Bosch alternators. This type of regulator is integral with the brush assembly

regulator checked by a dealer service department or electrical specialist.

3 Disconnect the battery negative cable.



Caution: If the radio in your vehicle is equipped with an anti-theft system, make sure you have the correct activation code

before disconnecting the battery. Refer to the information on page 0-7 at the front of this manual before detaching the cable.

Note: If, after connecting the battery, the wrong language appears on the instrument panel display, refer to page 0-7 for the language resetting procedure.

Bosch alternator

4 The voltage regulator is mounted externally on the alternator housing. To renew the regulator, remove the mounting screws (see illustration) and lift it off the alternator (see illustration). **Note:** Some Bosch alternators have an integral voltage regulator which is part of the brush assembly.

5 Refitting is the reverse of removal. **Note:** Before refitting the regulator, check the condition of the slip rings (see illustration). Use a torch and check for any scoring or deep wear grooves. Renew the alternator if necessary.

Motorola alternator

6 Remove the alternator from the engine compartment (see Section 15).

7 Remove the rear cover and diode carrier, remove the voltage regulator mounting screws (see illustration) and lift the regulator off the alternator body.

8 Refitting is the reverse of removal.

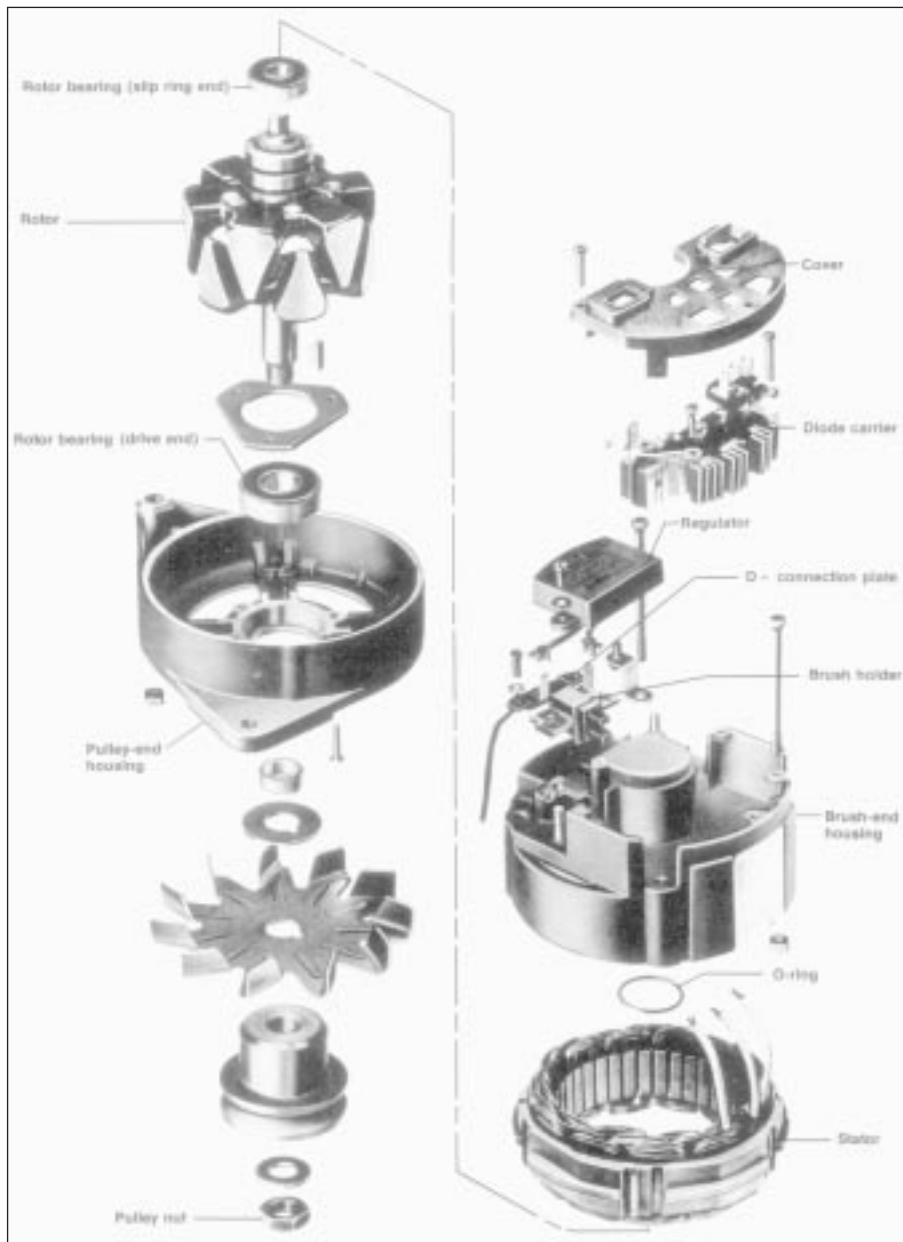
17 Alternator brushes - check and renewal



Caution: If the radio in your vehicle is equipped with an anti-theft system, make sure you have the correct activation code before disconnecting the battery.



16.5 Use a torch to check the slip rings for scoring or deep grooves



16.7 Exploded view of the Motorola alternator

Refer to the information on page 0-7 at the front of this manual before detaching the cable.

Note: If, after connecting the battery, the wrong language appears on the instrument panel display, refer to page 0-7 for the language resetting procedure.

1 Disconnect the battery negative cable.

Bosch alternator

2 Remove the voltage regulator from the back of the alternator (see Section 16).

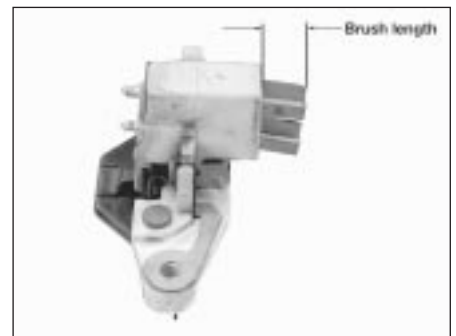
3 Measure the length of the brushes (see illustration). They should not be less than 6.0 mm. If any are worn past this point, renew them all as a set.

4 Also check for excessively worn slip rings (see illustration 16.5).

5 The brushes are retained either by set screws or by solder. If you are not skilled at soldering, it may be best to have an auto electrician fit the new brushes. **Note:** Be careful not to apply heat to the solder joint for more than 5 seconds. If necessary, use a heat sink to capture the excess heat. This can be accomplished by clamping a pair of needle-nose pliers next to the solder joint.

6 On the screw type, hold the assembly in place and refit the screws. Tighten them evenly, a little at a time, so the holder isn't distorted.

7 Refit the regulator assembly to the alternator.



17.3 Check the brush length in the normal rest position (spring uncoiled)

8 Reconnect the battery negative cable.

Motorola alternator

9 Remove the alternator.

10 The brushes are mounted under the regulator on the rear of the alternator (see illustration 16.7).

11 Remove the mounting screws and insulating washers, and separate the voltage regulator and brush holder from the brush end housing.

12 Measure the length of the brushes (see illustration 17.3). If any brush is less than 6.0 mm long, renew them all as a set.

13 Make sure the brushes move smoothly in the holder.

14 Refit the brush holder/regulator. Tighten the screws securely. Make sure the brushes aren't earthed.

15 Refitting is the reverse of removal.

18 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, the ignition switch, and the wires connecting them. The solenoid is mounted directly on the starter motor. The starter/solenoid motor assembly is fitted on the lower 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, and moves the starter pinion into mesh with the flywheel ring gear. The battery supplies the electrical energy to the starter motor, which does the actual work of cranking the engine.

The starter motor on some manual transmission vehicles can only be operated when the clutch pedal is depressed. On a vehicle equipped with automatic transmission, the starter can only be operated

when the transmission selector lever is in Park or Neutral.

Always detach the battery negative cable before working on the starting system.

19 Starter motor - in-vehicle check



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 gear lever is in Neutral or Park (automatic transmission) or, where applicable, 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 overrun 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 either in the battery, the main solenoid contacts, or the starter motor itself (or the engine is seized).

5 If the solenoid plunger cannot be heard when the switch is actuated, the battery is faulty, the switch is defective, the fusible link is burned-out (the circuit is open), or the solenoid itself is defective.

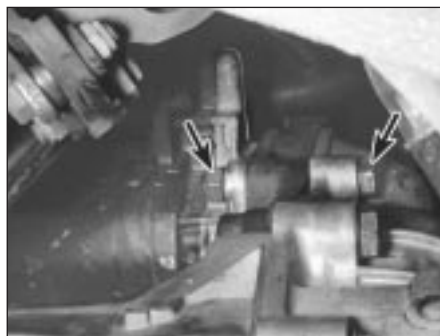
6 To check the solenoid, connect a jumper lead between the battery (+) and the ignition switch wire terminal (the small terminal) on the solenoid. If the starter motor now operates, the solenoid is OK and the problem is in the ignition switch, starter inhibitor switch (automatic transmission models), clutch switch (some manual transmission models), or the wiring.

7 If the starter motor still does not operate, remove the starter/solenoid assembly for dismantling, 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, or has the wrong viscosity oil in it, it will crank slowly.

9 Run the engine until normal operating temperature is reached, then disconnect the coil HT lead 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.



20.4a Working under the vehicle, remove the starter lower mounting bolt and nut (arrowed)



20.4b Withdrawing the starter motor from the M40 engine

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 10 seconds at a time. A reading of 9 volts or more, with the starter motor turning at normal cranking speed, is normal. If the reading is 9 volts or more but the cranking speed is slow, the solenoid contacts are burned, there is a bad connection, or the starter motor itself is faulty. If the reading is less than 9 volts and the cranking speed is slow, the starter motor is faulty or the battery is responsible (defective or discharged).

20 Starter motor - removal and refitting



Note: If the starter motor is defective, it should be renewed, or taken to an auto electrical specialist for repair. Overhaul of the starter motor is unlikely to be a practical proposition for the home mechanic, even if spare parts are available. However, the solenoid can be renewed separately (see Section 21).

Removal



Caution: If the radio in your vehicle is equipped with an anti-theft system, make sure you have the correct activation code before disconnecting the battery. Refer to the information on page 0-7 at the front of this manual before detaching the cable.

Note: If, after connecting the battery, the wrong language appears on the instrument panel display, refer to page 0-7 for the language resetting procedure.

- 1 Detach the battery negative cable.
- 2 Raise the vehicle and support it securely on axle stands.
- 3 Clearly label the wires from the terminals on

the starter motor and solenoid, then disconnect them. **Note:** On some models, it may be necessary to remove the air cleaner (see Chapter 4), coolant expansion tank (see Chapter 3) and the heater hoses to gain access to the top of the starter. Carefully label any hoses or components that need to be removed from the engine compartment, to avoid confusion when reassembling.

4 Unscrew the mounting bolts and detach the starter (see illustrations).

Refitting

5 Refitting is the reverse of removal.

21 Starter solenoid - removal and refitting



Removal



Caution: If the radio in your vehicle is equipped with an anti-theft system, make sure you have the correct activation code before disconnecting the battery. Refer to the information on page 0-7 at the front of this manual before detaching the cable.

Note: If, after connecting the battery, the wrong language appears on the instrument panel display, refer to page 0-7 for the language resetting procedure.

- 1 Disconnect the battery negative cable.
- 2 Remove the starter motor (see Section 20).
- 3 Disconnect the cable from the solenoid to the starter motor terminal.
- 4 Remove the screws which secure the solenoid to the starter motor.
- 5 Detach the solenoid from the starter body.
- 6 Remove the plunger and plunger spring.

Refitting

7 Refitting is the reverse of removal.