MODULAR ENGINE MANAGEMENT SYSTEM

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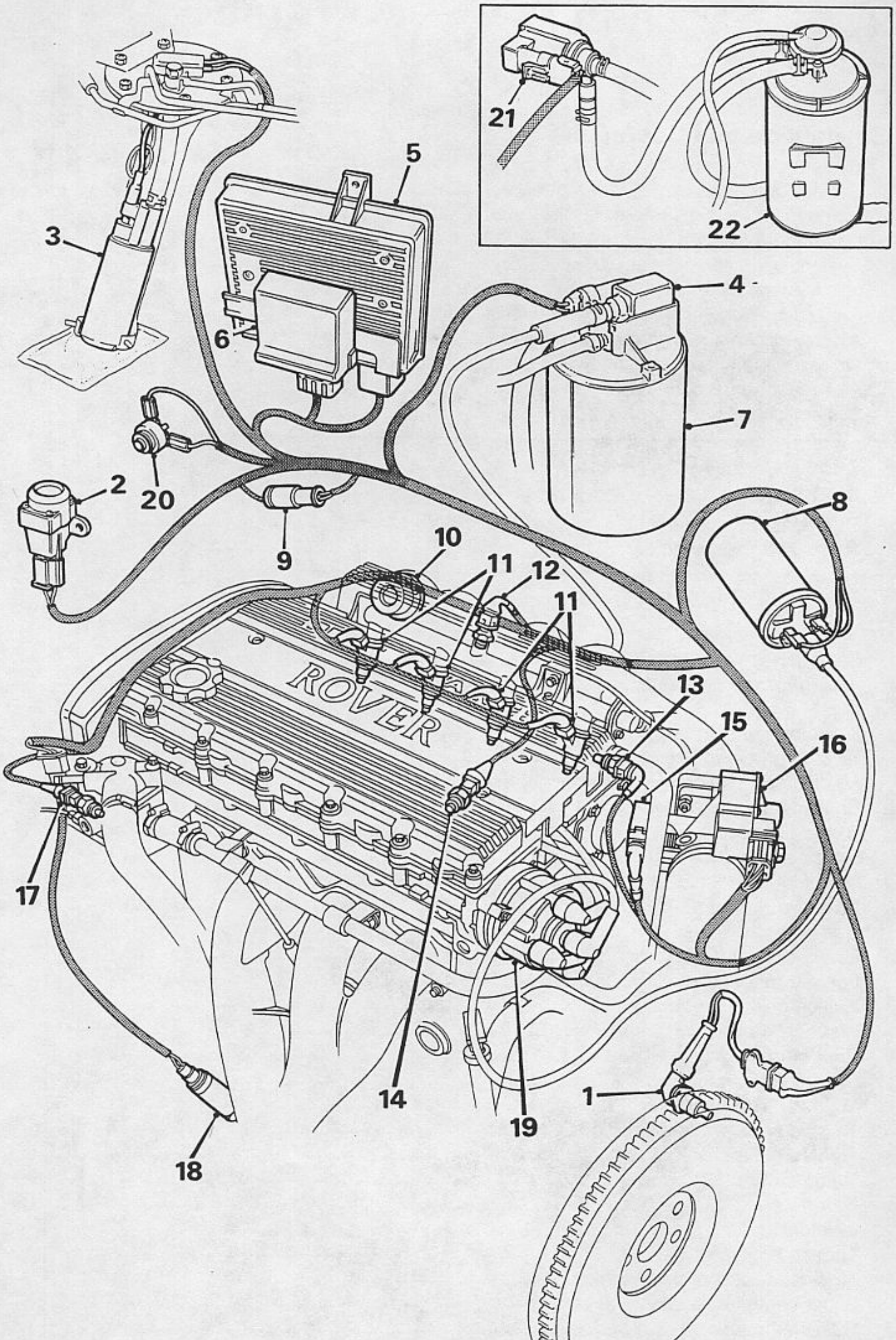
MODULAR ENGINE MANAGEMENT SYSTEM

DESCRIPTION AND OPERATION



19M 0231 A

SYSTEM COMPONENTS – NATURALLY ASPIRATED MODELS

1. Crankshaft sensor
2. Inertia switch
3. Fuel pump
4. Purge control valve – from VIN 152206
5. E.C.U.
6. Relay module
7. Charcoal canister – from VIN 152206
8. Ignition coil
9. Diagnostic connector
10. Fuel pressure regulator
11. Injectors
12. Fuel temperature sensor
13. Intake air temperature sensor
14. Knock sensor
15. Throttle potentiometer
16. Stepper motor
17. Coolant temperature sensor
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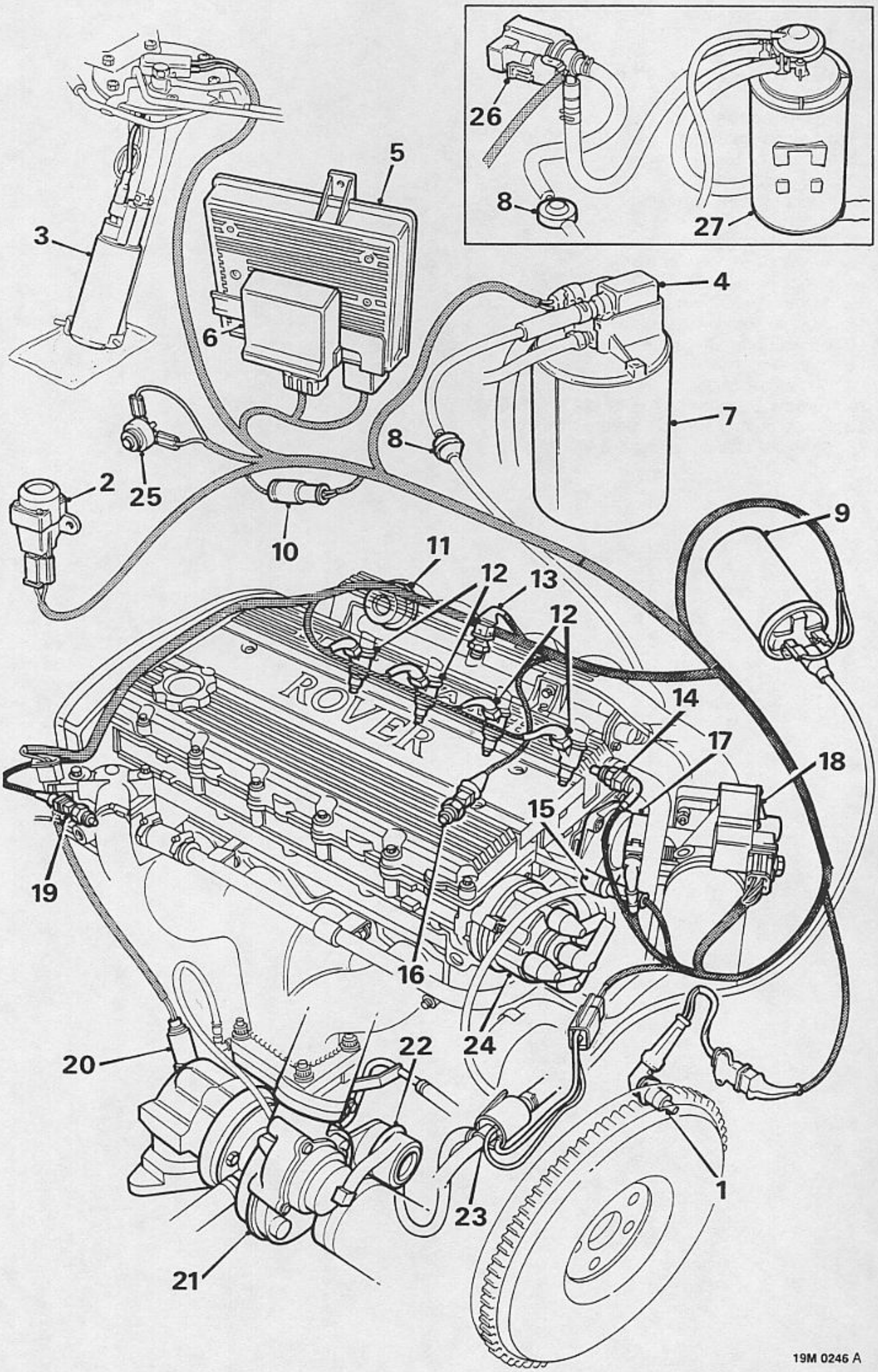
19. Distributor cap
20. Throttle pedal switch – before VIN 152206
21. Purge control valve – before VIN 152206
22. Charcoal canister – before VIN 152206

MODULAR ENGINE MANAGEMENT SYSTEM

DESCRIPTION AND OPERATION

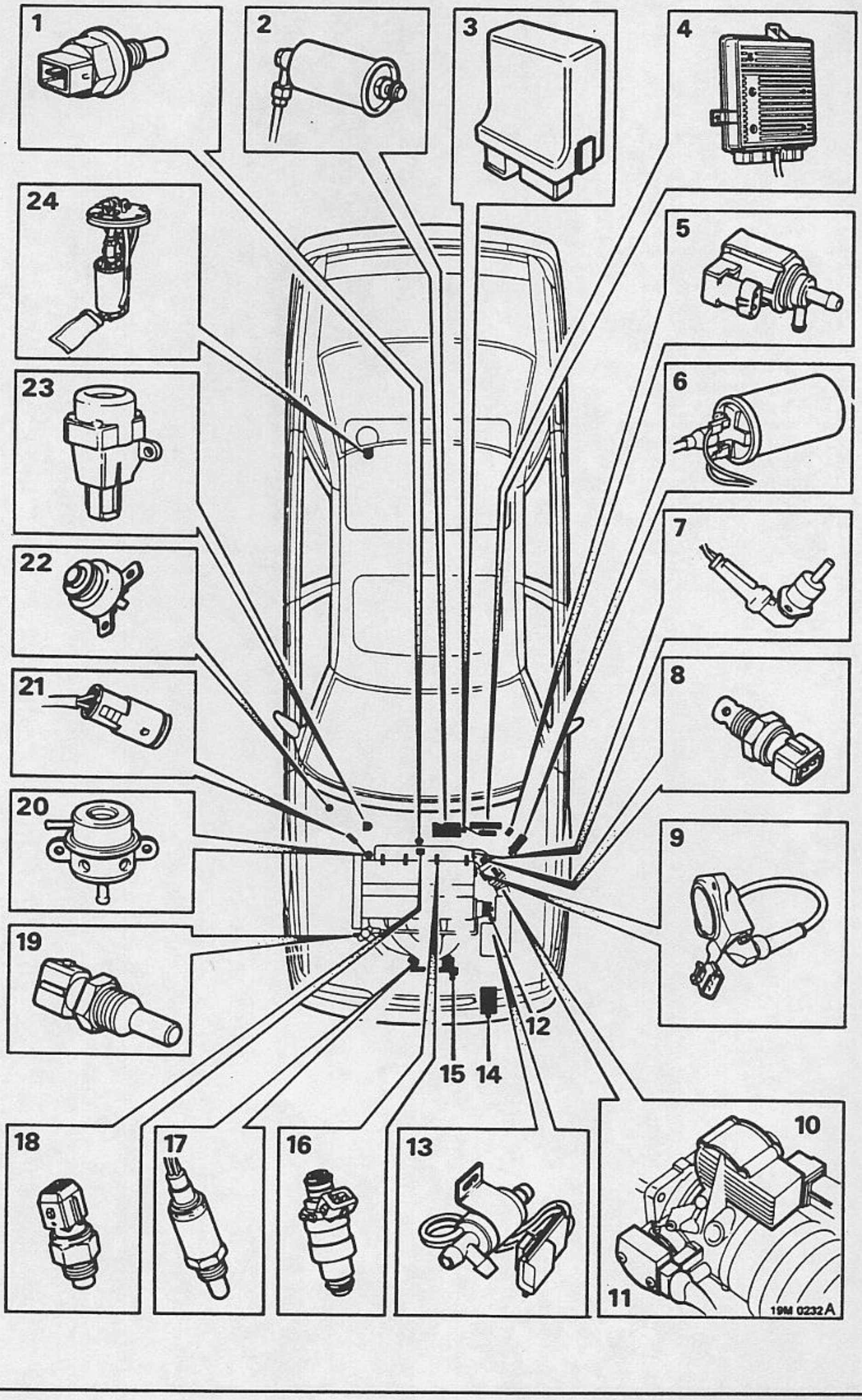


SYSTEM COMPONENTS - TURBO MODELS

1. Crankshaft sensor
2. Inertia switch
3. Fuel pump
4. Purge control valve - from VIN 152206
5. E.C.U.
6. Relay module
7. Charcoal canister - from VIN 152206
8. One way valve
9. Ignition coil
10. Diagnostic connector
11. Fuel pressure regulator
12. Injectors
13. Fuel temperature sensor
14. Intake air temperature sensor
15. Camshaft sensor
16. Knock sensor
17. Throttle potentiometer
18. Stepper motor
19. Coolant temperature sensor
20. Oxygen sensor
21. Turbocharger
22. Pneumatic actuator
23. Boost control solenoid
24. Distributor cap
25. Throttle pedal switch - before VIN 152206
26. Purge control valve - before VIN 152206
27. Charcoal canister - before VIN 152206

MODULAR ENGINE MANAGEMENT SYSTEM

DESCRIPTION AND OPERATION

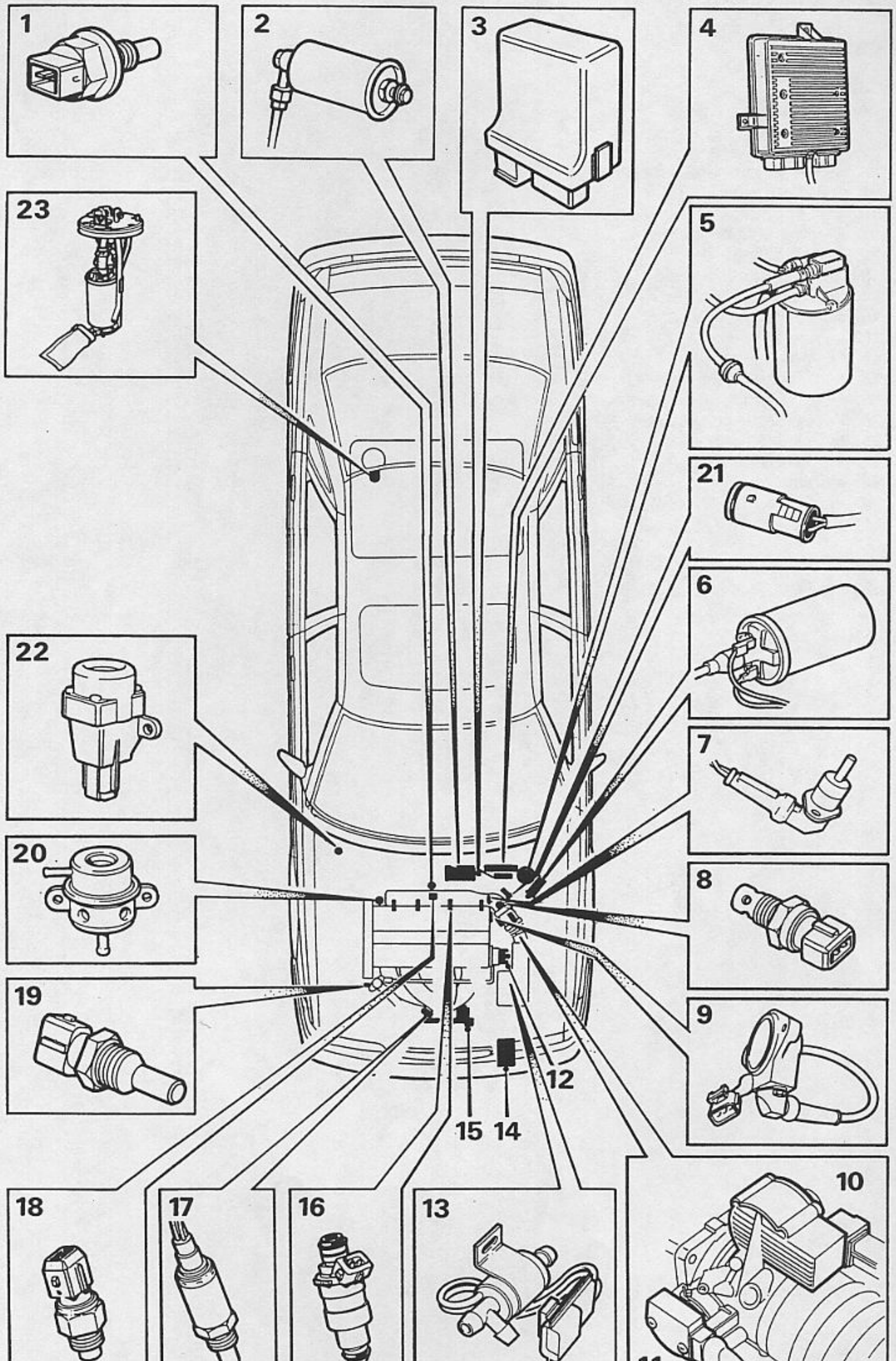


COMPONENT LOCATION – before VIN 152206

1. Knock sensor
2. Fuel filter
3. Relay module
4. E.C.U.
5. Purge control valve
6. Ignition coil
7. Crankshaft sensor
8. Intake air temperature sensor
9. Camshaft sensor (Turbo)
10. Stepper motor
11. Throttle potentiometer
12. Distributor cap
13. Boost control solenoid (Turbo)
14. Intercooler (Turbo)
15. Turbocharger (Turbo)
16. Injectors
17. Oxygen sensor
18. Fuel temperature sensor
19. Coolant temperature sensor
20. Fuel pressure regulator
21. Diagnostic connector
22. Throttle pedal switch
23. Inertia switch
24. Fuel pump

MODULAR ENGINE MANAGEMENT SYSTEM

DESCRIPTION AND OPERATION



COMPONENT LOCATION – from VIN 152206

1. Knock sensor
2. Fuel filter
3. Relay module
4. E.C.U.
5. Charcoal canister and purge control valve
6. Ignition coil
7. Crankshaft sensor
8. Intake air temperature sensor
9. Camshaft sensor (Turbo)
10. Stepper motor
11. Throttle potentiometer
12. Distributor cap
13. Boost control solenoid (Turbo)
14. Intercooler (Turbo)
15. Turbocharger (Turbo)
16. Injectors
17. Oxygen sensor
18. Fuel temperature sensor
19. Coolant temperature sensor
20. Fuel pressure regulator
21. Diagnostic connector
22. Inertia switch
23. Fuel pump

MODULAR ENGINE MANAGEMENT SYSTEM

DESCRIPTION AND OPERATION

SYSTEM OPERATION

The MPi Modular Engine Management System (MEMS) controls the fuel injection and programmed ignition systems.

The main features are as follows:

- One Electronic Control Unit (ECU) controls programmed ignition and fuel injection. The ECU incorporates short circuit protection and can store intermittent faults on certain inputs. Microcheck can interrogate the ECU for these stored faults.
- The ECU uses the speed/density method of air flow measurement to calculate fuel delivery. This method measures the inlet air temperature and inlet manifold pressure and assumes that the engine is a calibrated vacuum pump with its characteristics stored in the ECU
- If certain system inputs fail, the ECU implements a back – up facility to enable the system to continue functioning, although at a reduced level of performance.
- A separate diagnostic connector allows engine tuning or fault diagnosis to be carried out using Microcheck without disconnecting the ECU harness connector.
- The ECU harness multiplug incorporates specially plated pins to minimise oxidation and give improved reliability.
- On models before VIN 152206 the throttle pedal switch triggers the ECU to switch between the main fuelling map and idle speed control in accordance with throttle pedal position. It also triggers over – run fuel cut – off.
- The throttle potentiometer requires no adjustment in service. The following components supply data for both fuelling and ignition:

Ignition system

The ECU determines the optimum ignition timing based on the signals it receives from the following sensors:

1. Crankshaft sensor – Engine speed and crankshaft position.
2. Manifold absolute pressure sensor – Engine load
3. Coolant temperature sensor – Engine temperature.
4. Before VIN 152206: Throttle pedal switch – Throttle pedal released.
   From VIN 152206: Manifold absolute pressure sensor – Throttle closed.
5. Knock sensor – Engine noise and vibration.

MEMS uses no centrifugal or vacuum advance, timing being controlled by the ECU which is energised by the main relay, within the relay module, with spark distribution being achieved by means of a rotor arm and distributor cap mounted at the No.4 cylinder end of the inlet camshaft.

Basic ignition timing

The sensor incorporates an armature which runs adjacent to a reluctor insert in the flywheel, the insert consisting of 34 poles spaced at 10° intervals, with two missing poles 180° apart to identify the T.D.C. positions.

The sensor 'reads' these poles to provide a constant up – date of engine speed and crankshaft position to the ECU

The load signal is provided by the manifold absolute pressure sensor mounted inside the ECU casing which detects manifold pressure via a hose connected to the manifold chamber. The sensor converts pressure variations into graduated electrical signals which can be read by the ECU

Ignition timing compensation

Coolant temperature sensor

When the ECU receives a low engine temperature signal from the coolant sensor, it provides optimum driveability and emissions by advancing or retarding the ignition timing.

Knock sensor

The knock sensor is a capacitive device mounted in the cylinder block between nos. 2 and 3 cylinders below the inlet manifold. The sensor monitors noise and vibration in the engine and passes this information to the ECU which is able to identify the characteristics of the knocking and make the necessary corrections to the ignition timing of individual cylinders.

Idle speed control

When the throttle pedal is released and the engine is at idle, the ECU uses the fast response of ignition timing to assist idle speed control.

When loads are placed on, or removed from the engine the ECU senses the change in engine speed and in conjuction with the opening of the throttle disc by the stepper motor, advances or retards the ignition timing to maintain the specified idle speed. When load is removed from the engine and the stepper motor returns to it's original position, the ignition timing returns to the idle setting.

***Note:** Due to the sensitivity of this system the ignition timing will be constantly changing at idle speed.*

Ignition components

Ignition coil

Though similar in appearance to coils used in conventional ignition systems, the coil used in programmed ignition installations has a lower primary winding resistance (0.71 to 0.81 ohms at 20°C 68°F) than it's conventional counterpart. This allows the full h.t. output to be reached faster and so makes the coil operation more consistent throughout the engine speed range.

Distributor cap and rotor arm.

The distributor cap, carrying a central carbon brush and four h.t. lead pick – ups, is located at the rear of the inlet camshaft and surrounds the rotor arm. The rotor arm is secured by a retaining screw to a 'D' shaped stub shaft, which is press fitted into a vibration absorbing bush at the rear of the inlet camshaft, and is protected from contamination by an anti – flash shield which incorporates an oil drain.

Fuel system

ECU

The MEMS system is controlled by the ECU which is located in the engine compartment.

The ECU is an adaptive unit and can learn the load and wear characteristics of a particular engine.

The ECU remembers and updates two main engine requirements when the engine is fully warm:

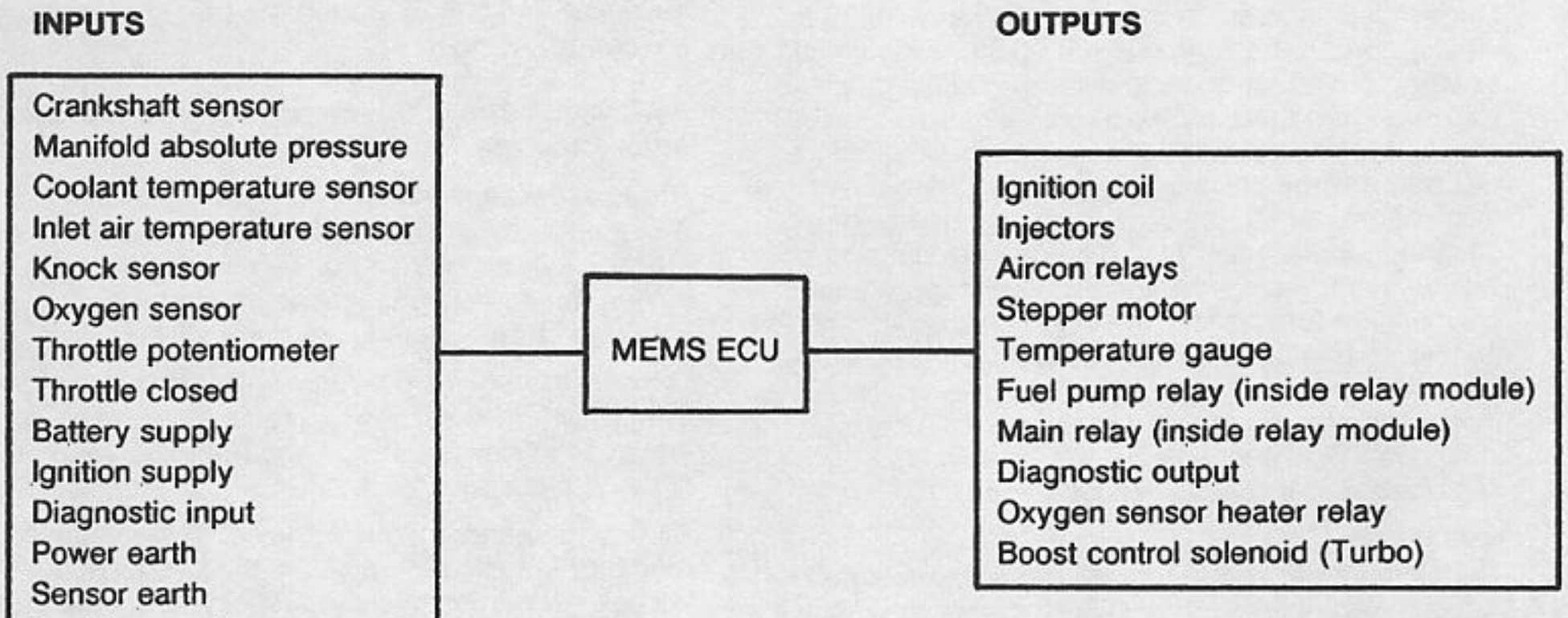
1. The idle stepper position required to achieve the specified idle speed.
2. The fuelling change or offset required to achieve a set oxygen sensor voltage.

The stepper position is used as a reference to update the amount of stepper motor movement required to achieve the specified idle speed under all conditions.

The fuelling offset is required to enable the system when not in closed loop control to provide the correct fuelling and while in closed loop control to prevent having to apply excessive adjustments to the fuelling which can adversely affect the emissions and driveability.

***Note:** After fitting a different ECU, a full tune procedure must be carried out using Microcheck.*

The ECU inputs and outputs are shown in the table.



Injectors

The four fuel injectors are fitted between the pressurised fuel rail and inlet manifold. Each injector comprises of a solenoid operated needle valve and a specially designed nozzle to ensure good fuel atomisation.

Engine coolant temperature sensor

The coolant temperature sensor is mounted in the thermostat housing and is immersed in the engine coolant. The sensor is a resistive device in which the resistance varies with temperature

Throttle housing

The throttle housing is attached to the inlet manifold via a rubber sandwich plate and incorporates a throttle disc which is connected to the throttle pedal via the throttle lever and a cable.

There are two breather pipes; one either side of the throttle disc. When the engine is running with the throttle disc open, both pipes are subject to manifold depression and draw crankcase fumes into the manifold. When the throttle disc is closed, only the pipe on the inlet manifold side of the disc is subject to manifold depression. This pipe incorporates a restrictor to prevent engine oil being drawn into the engine by the substantially greater manifold depression.

Also incorporated in the throttle housing are the throttle potentiometer and stepper motor.

Throttle potentiometer

The throttle potentiometer is mounted in front of the throttle housing and is directly coupled to the throttle disc shaft.

Three wires connect the throttle potentiometer to the ECU; a 5 volt supply to the potentiometer, an earth return to the ECU and an output voltage to the ECU which indicates the rate of throttle disc movement.

Stepper motor
The stepper motor is contained within the throttle housing and operates a cam and push rod via a reduction gear. The push rod is in direct contact with the throttle lever and moves the throttle disc to control idle and fast idle speed. The stepper motor maximum movement is 3.75 revolutions accomplished in steps of 7.5°. The reduction gear converts this into 180° of cam movement.

The throttle lever has a throttle position setting screw which rests on the stepper motor operating pin when the throttle pedal is released and is used to set the relationship between engine speed and stepper motor position.

In the side of the throttle housing is a throttle air bypass bleed screw to provide easier and more sensitive setting of the stepper motor position at idle.

The stepper motor position is checked using Microcheck and should be within the range of 20 to 40 steps when the engine is run in. If it is identified as being outside this range it can be adjusted to within range by turning the throttle air bypass bleed screw. It is important to follow Microcheck setting procedure when adjusting this screw to prevent mismatching of throttle body settings. This ensures that the stepper motor is at the optimum position within its range for providing further movement to compensate for changes in engine load or temperature in accordance with signals from the ECU

***Note:** The stepper motor and throttle position setting screws must only be adjusted when Microcheck identifies the requirement.*

Fuel pump
The electric fuel pump, located inside the fuel tank, is a self – priming centrifugal 'wet' pump, the motor and pump are filled with fuel.

The fuel pump supplies more fuel than the maximum load requirement for the engine, so that pressure in the fuel system can be maintained under all conditions.

Fuel pressure regulator
The pressure regulator is a mechanical device controlled by manifold depression and is mounted in the fuel rail. The regulator ensures that fuel rail pressure is maintained at a constant pressure difference to that in the inlet manifold, as manifold depression increases the regulated fuel pressure is reduced in direct proportion.

When pressure exceeds the regulator setting excess fuel is spill returned to the fuel tank swirl pot which contains the fuel pick – up strainer.

Relay module
The relay module contains the main relay, fuel pump relay, starter relay and oxygen sensor relay and is mounted on the ECU mounting bracket.

The main relay is energised when the ignition is switched on and supplies current to the ECU

The fuel pump relay is energised by the ECU for a short period when the ignition is switched on, during cranking and while the engine is running.

The starter relay is energised by the cranking signal from the ignition switch.

This oxygen sensor relay is energised when the ignition is switched on and supplies current to the ECU

Intake air temperature sensor
The intake air temperature sensor is fitted in the side of the inlet manifold and sends the ECU a signal relating to air temperature. The ECU uses this signal in its calculations on air flow.

Throttle pedal switch – before VIN 152206
When the throttle pedal is at rest, the throttle pedal switch is closed, this informs the ECU that the engine is at idle. The ECU then implements idle speed control.

From VIN 152206 the ECU receives throttle closed information from the manifold absolute pressure sensor.

Inertia switch
The fuel pump circuit incorporates an inertia switch which in the event of sudden deceleration isolates the power supply to the fuel pump. The inertia switch is situated in the engine compartment on the bulkhead and can, if tripped, be reset by depressing the central plunger.

WARNING: Check the integrity of the fuel system before the inertia switch is reset.

Diagnostic connector
A diagnostic connector is provided to enable diagnosis to be carried out without disturbing the system electrical connections and to allow the ECU's ability to store certain faults to be utilised.

Oxygen sensor – Closed – loop emission control
The MEMS MPi system operates a closed loop emission system to ensure the most efficient level of exhaust gas conversion.

An oxygen sensor fitted in the exhaust manifold monitors the exhaust gases. It then supplies a small voltage proportional to exhaust oxygen content to the ECU As the air/fuel mixture weakens, the exhaust oxygen content increases and so the voltage to the ECU decreases. If the mixture becomes richer so the oxygen content decreases and the voltage increases.

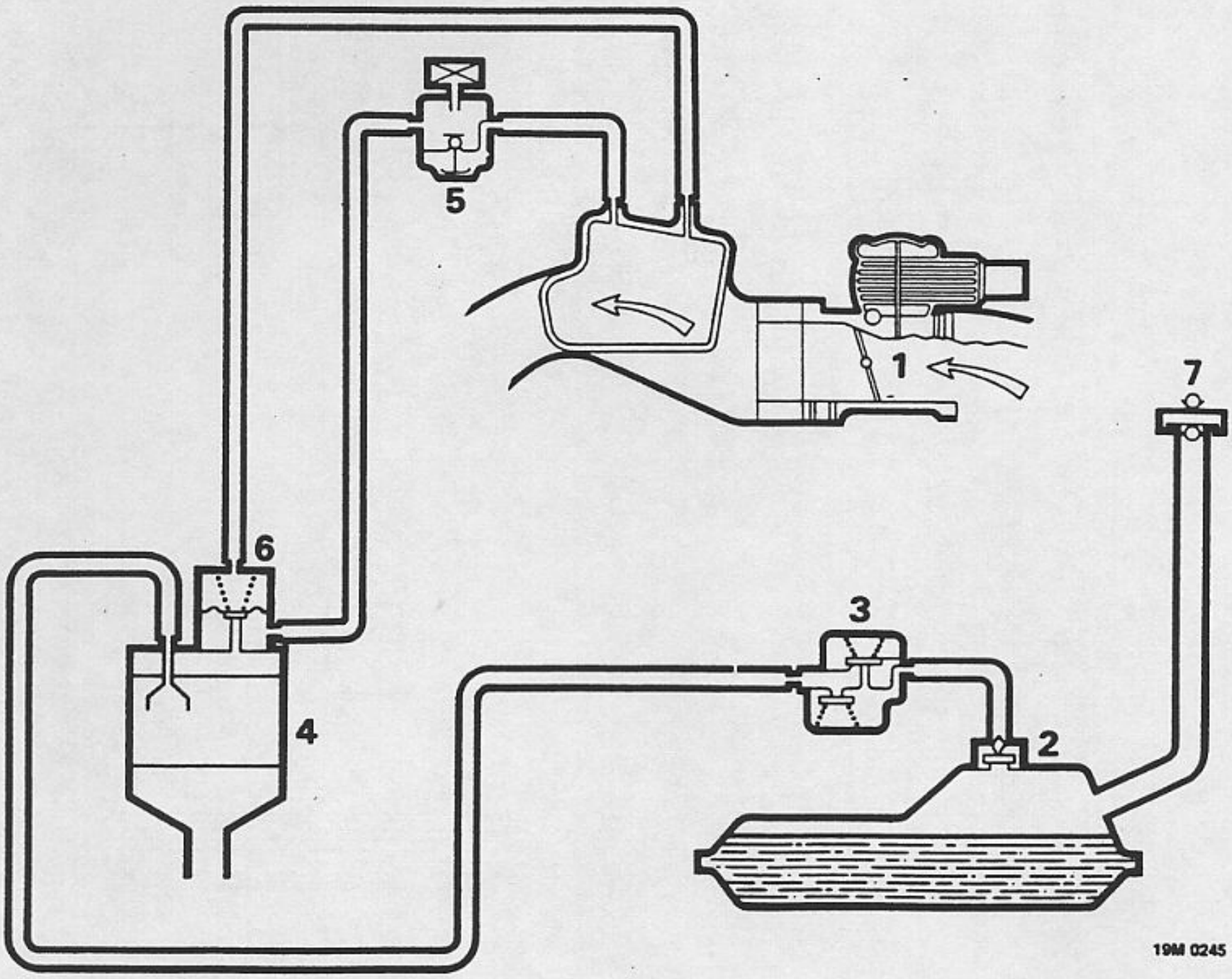
The ECU uses this signal voltage to determine the air/fuel mixture being delivered to the engine, and adjusts the injector duration to maintain the ratio necessary for efficient gas conversion by the catalyst.

The oxygen sensor has an integral heating element to ensure an efficient operating temperature is quickly reached from cold. The electrical supply for the heater element is controlled by the oxygen sensor relay.

Fuel temperature sensor
The fuel temperature sensor is inserted in the fuel rail and measures fuel and fuel rail temperatures. During engine cranking at high temperatures, the ECU increases fuel supply, and opens the throttle disc via the stepper motor to aid hot starting.

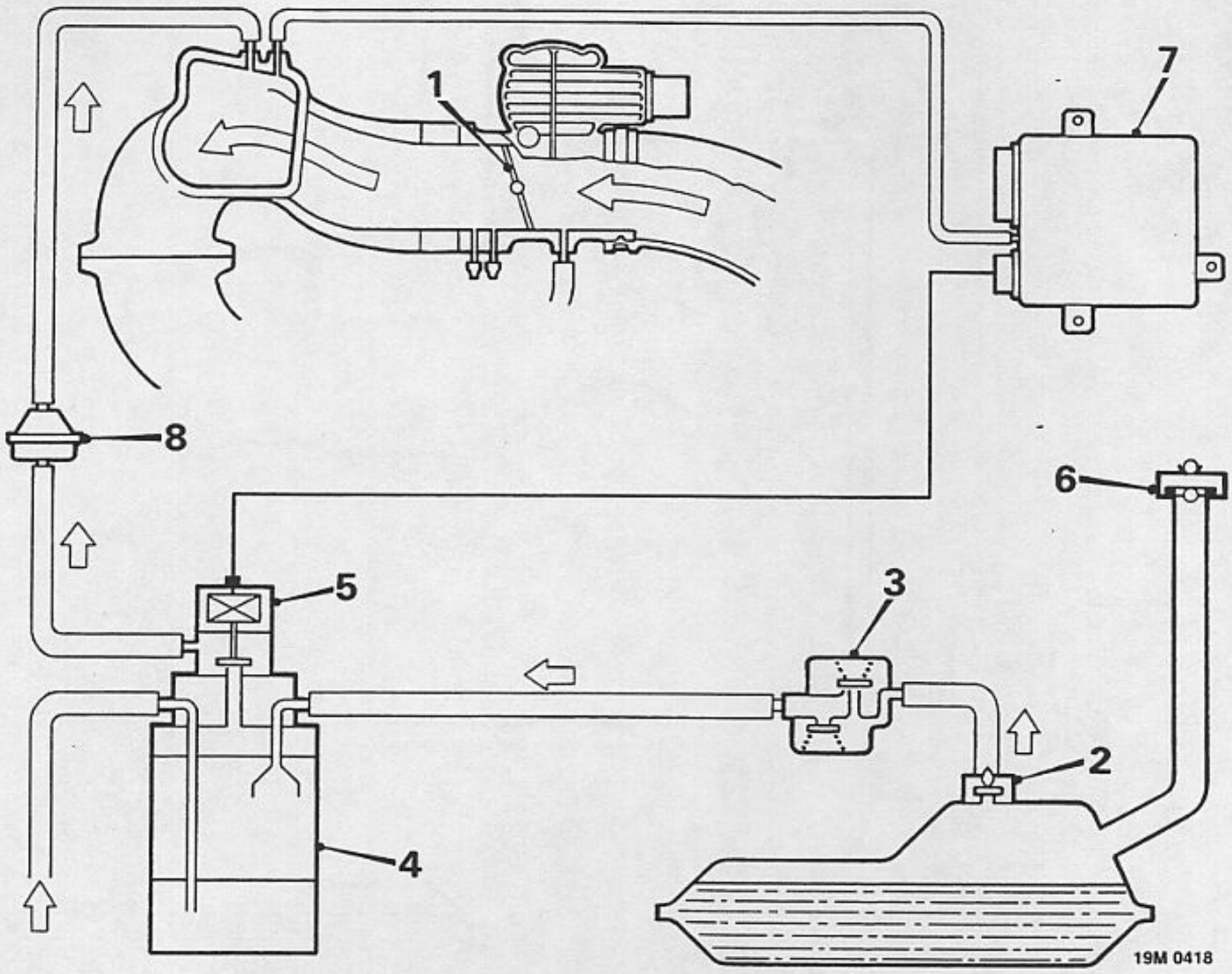
Camshaft sensor (Turbo models)
The camshaft sensor is used in conjunction with the crankshaft sensor to provide the ECU with a basis for sequential fuel injection. The crank sensor detects the position of No. 1 cylinder as a base for injection sequence whereas the camshaft sensor serves to determine the exact injection timing for each cylinder.

The sensor comprises of an armature which runs adjacent to a reluctor attached to the inlet camshaft.



Non – evaporative loss equipment – before VIN 152206

1. Throttle
2. Fuel cut – off valve
3. Two way valve
4. Charcoal canister
5. Purge control valve
6. Diapragm control valve
7. Fuel filler cap



Non – evaporative loss equipment – from VIN 152206

1. Throttle disc
2. Fuel cut – off valve
3. Two way valve
4. Charcoal canister
5. Purge control valve
6. Fuel filler cap
7. E.C.U.
8. One way valve (Turbo)

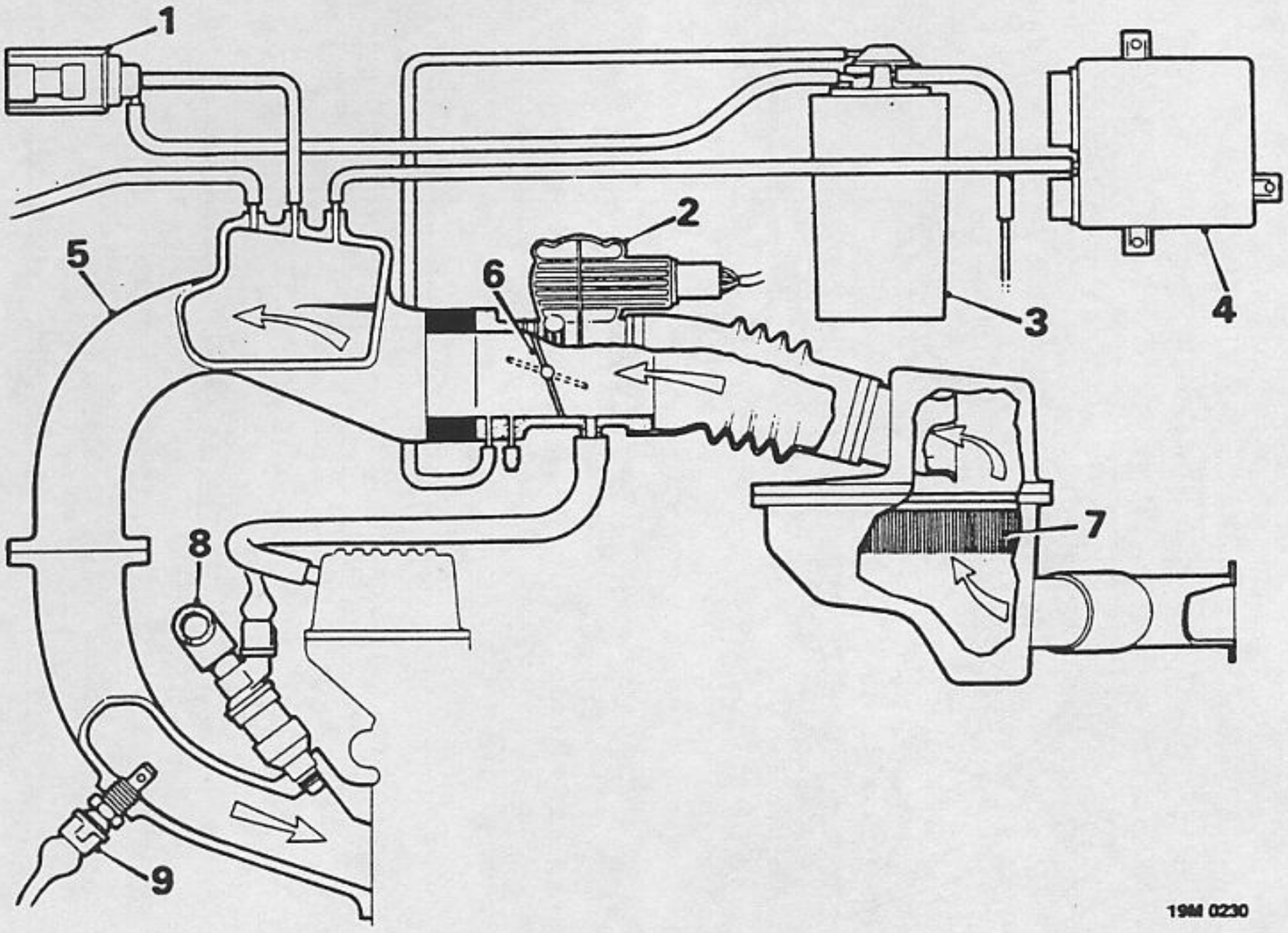
Charcoal canister

A charcoal canister is used for the temporary storage of fuel vapour from the fuel tank until the vapour can be purged from the canister into the engine and burned.

The charcoal canister is purged when the purge control valve is open, fresh air is drawn through the purge air hose, through the charcoal canister and into a port in the inlet manifold.

Purge control valve

A purge control valve is operated by the ECU The valve remains closed when the engine is cold and at idling speed to protect engine tune and catalyst performance. If the charcoal canister was purged during cold running or at idling speed, the additional enrichment in fuel mixture would delay catalyst light off time and cause erratic idle. When the engine temperature is above 75°C, the purge control valve will be operational (modulated ON and OFF) whenever the engine speed is above approximately 1600 rev/min. When the purge valve is opened, fuel vapour from the charcoal canister is drawn into the inlet manifold for combustion.

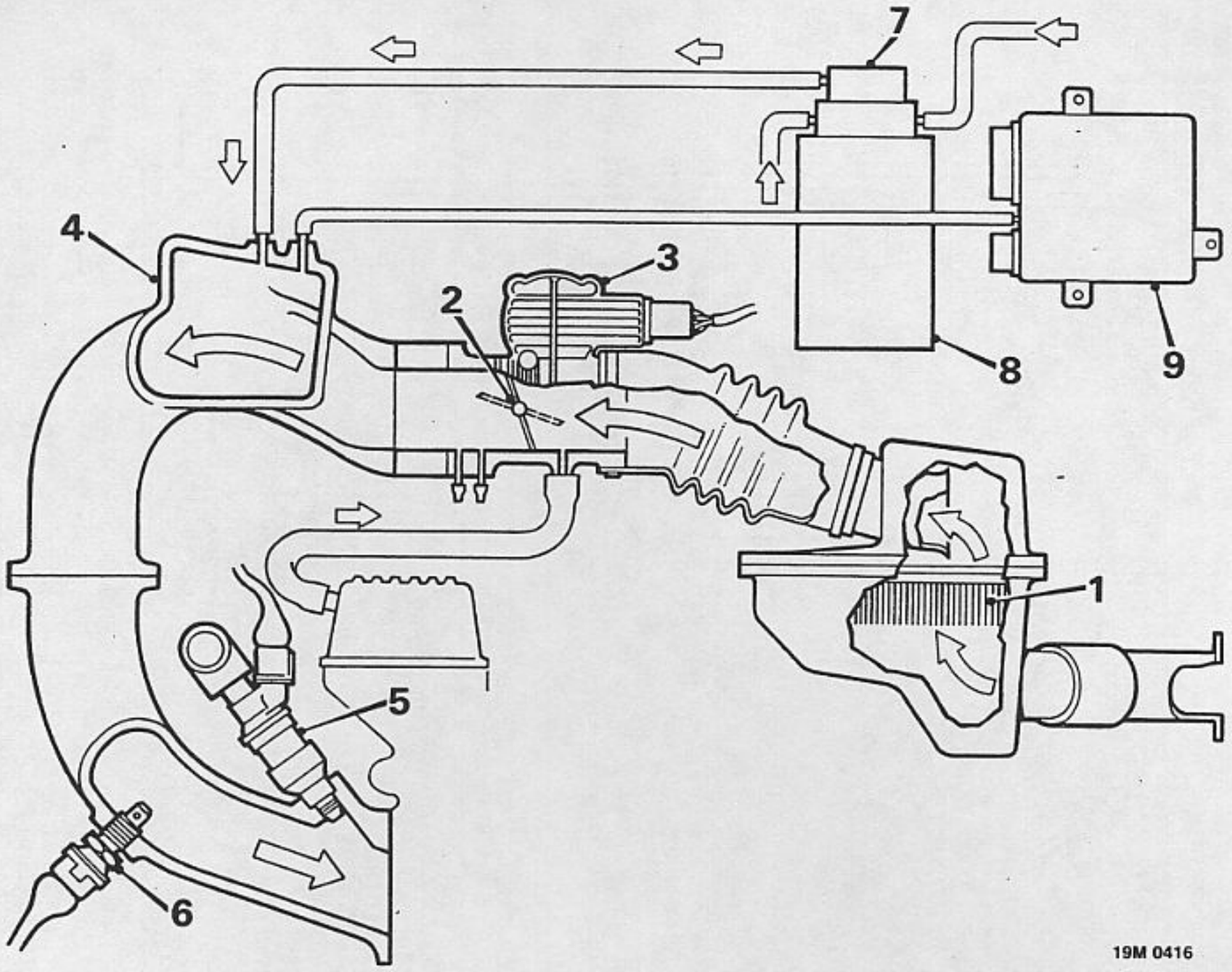


Air flow schematic – naturally aspirated models before VIN 152206

1. Purge control valve
2. Stepper motor
3. Charcoal canister
4. ECU
5. Manifold chamber
6. Throttle
7. Air filter
8. Injector
9. Intake air temperature sensor

MODULAR ENGINE MANAGEMENT SYSTEM

DESCRIPTION AND OPERATION



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Air flow schematic – naturally aspirated models from VIN 152206

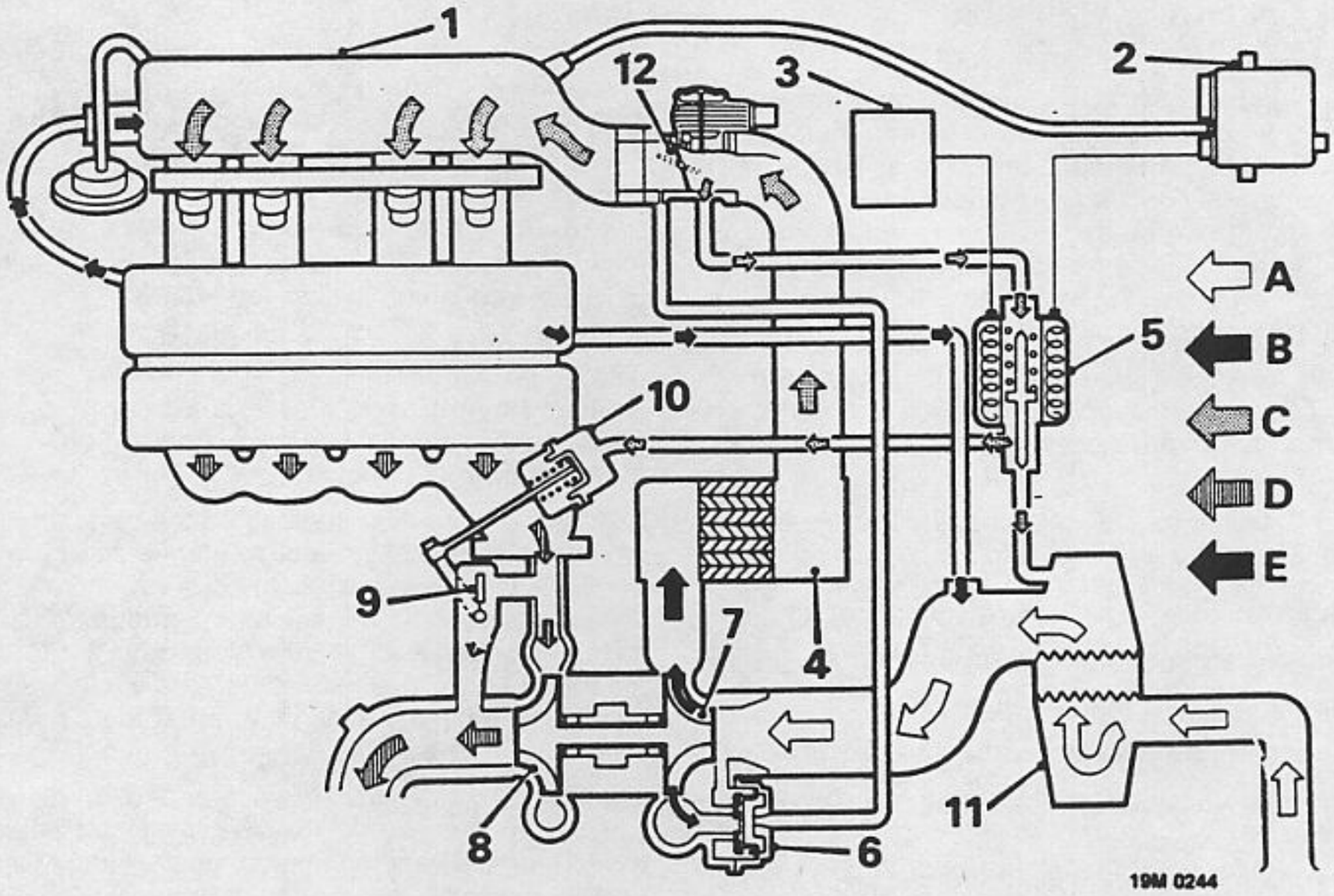
1. Air filter
2. Throttle disc
3. Stepper motor
4. Manifold chamber
5. Injector
6. Intake air temperature sensor
7. Purge control valve
8. Charcoal canister
9. E.C.U.

Air flow system – naturally aspirated models

Intake air is drawn into the throttle housing through an air filter element. Incorporated in the throttle housing are the throttle disc, stepper motor and the throttle potentiometer.

Air is passed from the throttle housing via the manifold chamber to the inlet manifold where the injectors inject the fuel before the mixture passes into the combustion chamber.

A load signal is applied to the ECU from the manifold chamber. This signal along with that supplied by the intake air temperature sensor is used to calculate the fuel delivery to the injectors.



Air flow schematic – Turbo models

1. Inlet manifold
2. ECU
3. Main relay
4. Intercooler
5. Boost control valve
6. Air by – pass valve
7. Impeller
8. Turbine
9. Wastegate valve
10. Pneumatic actuator
11. Air cleaner
12. Throttle disc

A. Intake air
B. Compressed air
C. Intercooled air
D. Exhaust gases
E. Engine breathing gases

Air flow system – turbo models

With the engine running, exhaust gases enter the turbine wheel side of the turbocharger causing the turbine and impeller wheel to rotate as one assembly.

Intake air is drawn through the air cleaner to the impeller wheel, compressed in the compressor housing and directed via the intercooler, through the throttle housing and into the inlet manifold under pressure.

Boost control

Boost control is achieved by a pneumatic actuator operating a mechanical flap situated in the turbocharger, which when operated allows exhaust gases to bypass the turbine side of the turbocharger. So decreasing turbo speeds and boost pressure. The pneumatic actuator is connected to the inlet manifold via a boost control valve which in turn is controlled by the ECU

When the boost control solenoid is energised, all of the boost pressure is applied to the pneumatic actuator diapragm activating the mechanical linkage and so reducing boost pressure.

Alternatively if the boost control solenoid is not energised no boost pressure would be applied to the pneumatic actuator and there would be no boost control.

Air by – pass system

This system is fitted to reduce turbo lag. The air by – pass valve is situated in a by – pass passage in the turbocharger and is connected to the inlet manifold via a sensing pipe. During deceleration, with depression in the inlet manifold, the valve will be pulled off its seat allowing air pressure from the compressor wheel to circulate around the turbocharger housing. This prevents back pressure acting against the impeller wheel slowing down the turbo shaft speed too much and causing turbo lag when the throttle is re – opened.

MODULAR ENGINE MANAGEMENT SYSTEM

DESCRIPTION AND OPERATION

SYSTEM OPERATION

Ignition on

When the ignition is switched on, voltage is applied to ECU pin 11. The ECU then switches on the main relay by supplying an earth path at pin 4. This allows battery voltage to pass to ECU pin 28, to the four injectors and through the ignition coil to ECU pin 25. In addition, the fuel pump relay is switched on by the ECU supplying an earth path on pin 20. Voltage is applied through the inertia switch to the fuel pump.

The pump runs for a short period to pressurise the fuel rail. The fuel pressure regulator will open at its maximum setting and excess fuel is spill returned to the tank.

The ECU determines the amount of stepper motor movement from the following signals:

- Engine coolant temperature data at pin 33.
- Inlet air temperature data at pin 16.
- Throttle potentiometer data at pin 8.
- Engine speed data at pins 31 and 32.
- Manifold absolute pressure data (via pipe from manifold).
- Throttle pedal switch input (before VIN 152206) at pin 13.
- Battery voltage at pin 28.
- Ignition signal at pin 11.

If one or more of the following inputs fail, the ECU will substitute the back – up values shown to maintain driveability.

Input	Back – up value
Coolant temperature	Idle Speed controlled until engine is fully warm. 60°C at speeds above idle.
Inlet air temperature	Derived from engine speed and engine load.
Manifold absolute pressure	Derived from engine speed and throttle position.

Starter operation

Whilst the starter relay is energised, battery voltage is applied to the starter motor solenoid. The solenoid also energises and supplies battery voltage directly to the starter motor.

Ignition is controlled by the ECU switching the low tension circuit via pin 25.

The ECU provides an earth signal on pins 24, 23, 26 and 1 for the period the injectors are required to be open, the injector solenoids are energised (simultaneously on naturally aspirated models) and fuel is sprayed into the manifold onto the back of the inlet valves. The ECU carefully meters the amount of fuel injected by adjusting the injector opening period (pulse width). During cranking, when the engine speed is below approx. 400 rev/min, the ECU increases the injector pulse width to aid starting. The amount of increase depends upon coolant temperature. To prevent flooding, injector pulses are intermittent i.e. 24 on then 8 pulses off.

Idling

After start enrichment is provided at all temperatures immediately cranking ceases. The ECU controls the enrichment by increasing injector pulse width. The enrichment decays in relation to the rising coolant temperature.

Provided the ECU is receiving a signal that the engine speed is close to the idle speed set point, the ECU will implement idle speed control.

The ECU activates a unipolar stepper motor acting directly on the throttle lever. Idle speed response is improved by the ignition system advancing or retarding the timing when load is placed on, or removed from the engine.

If, during engine idle, the load on the engine is increased sufficiently to cause engine speed to fall, the ECU will sense this via the crankshaft sensor and instantly advance the ignition timing to increase idle speed and then energise the stepper motor to open the throttle disc thus maintaining the idle speed. Finally the ignition timing is retarded to its nominal value.

The ECU monitors battery voltage and, if voltage falls sufficiently to cause fluctuations in injector pulse widths, it increases the injector pulse widths to compensate.

On return to idle, the ECU will implement a slightly higher idle speed to prevent the engine stalling.

Driving

When the throttle pedal is depressed, the ECU implements the cruise air/ fuel ratio map. During driving the ECU continually monitors inlet air temperature and engine speed and load for it's air flow calculations, together with coolant temperature for any temperature corrections. Additional inputs are throttle potentiometer for acceleration and throttle pedal switch for cruise/idle fuel map selection and over – run fuel cut – off.

Acceleration enrichment

When the throttle pedal is depressed, the ECU receives a rising voltage from the throttle potentiometer and detects a rise in manifold pressure from the manifold absolute pressure sensor. The ECU provides additional fuel by increasing the normal injector pulse width and also provides a small number of extra injector pulses on rapid throttle openings.

Over – run fuel cut – off

The ECU implements over – run fuel cut – off when the following signals are received.

- Throttle disc closed.
- Engine speed is above 2000 rev/min – engine at normal operating temperature.

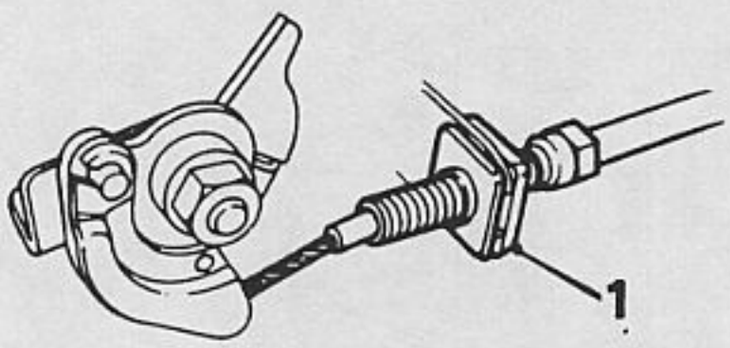
Fuel is reinstated progressively when any of the above signals cease.

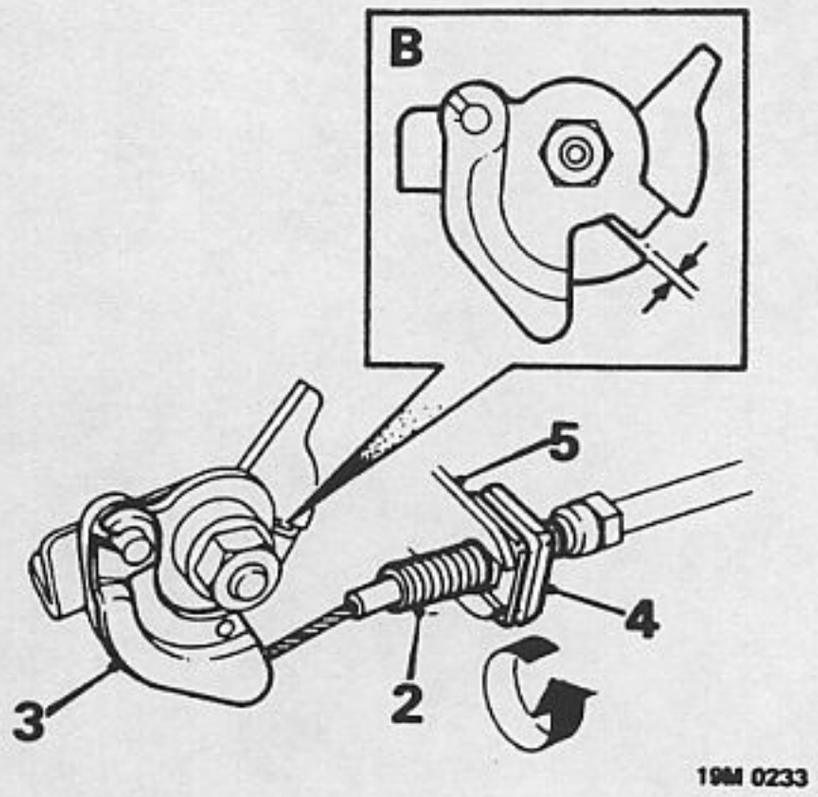
Over – speed fuel cut – off

To prevent damage at high engine speeds the ECU inhibits the earth path for the injectors, cutting off injection. As engine speed falls, injection is reinstated.

Ignition switch off

When the ignition is switched off, the ECU will keep the main relay energised for approx. 30 seconds while it drives the stepper motor to the 35 step position for the next engine start.

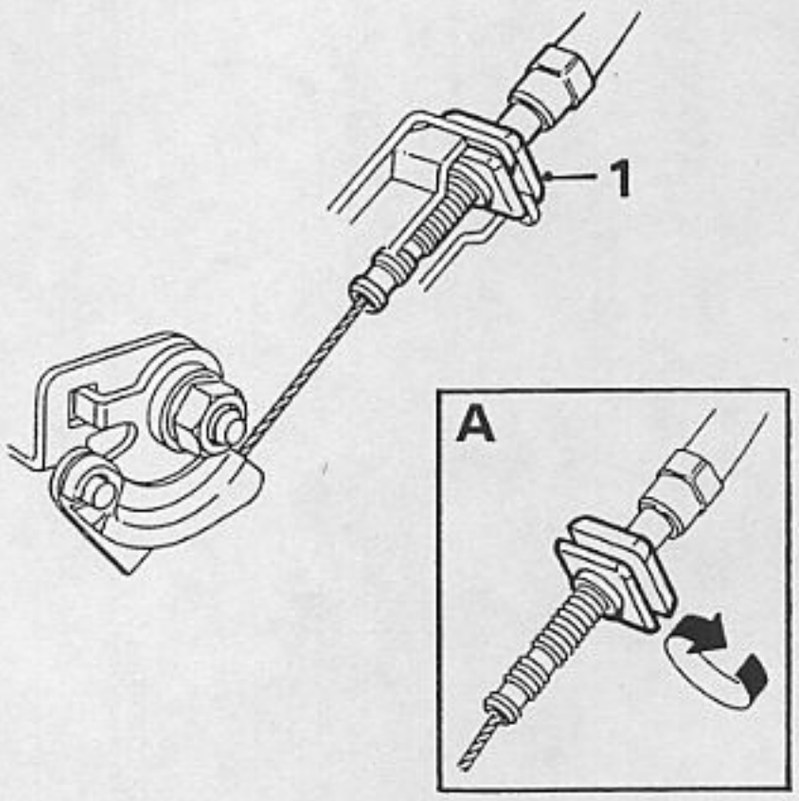


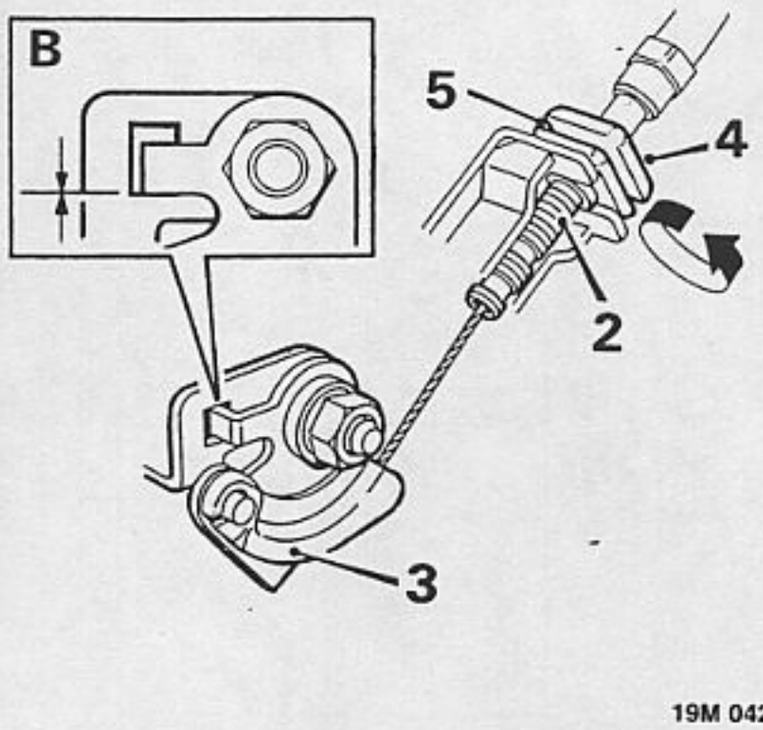


THROTTLE CABLE ADJUSTMENT – before VIN 152206

Action	Ref.	Detail	Special Instructions
Switch on		ignition	Wait 5 seconds and switch ignition off to ensure stepper motor is in setting position.
Release	**1.**	cable adjusting nut from abutment bracket	
Unscrew		cable adjusting nut	Until it is clear of abutment bracket, see inset **A.**
Locate	**2.**	throttle outer cable in abutment bracket	Adjusting nut adjacent to abutment bracket
Hold	**3.**	cam	In throttle closed position
Rotate	**4.**	cable adjusting nut	Until all slack is taken out of inner cable and lost motion gap is taken up without opening throttle, see inset **B.** ***CAUTION:*** *Ensure all free play is removed from outer cable.*
Locate	**5.**	cable adjusting nut groove in abutment bracket	

ADJUSTMENTS





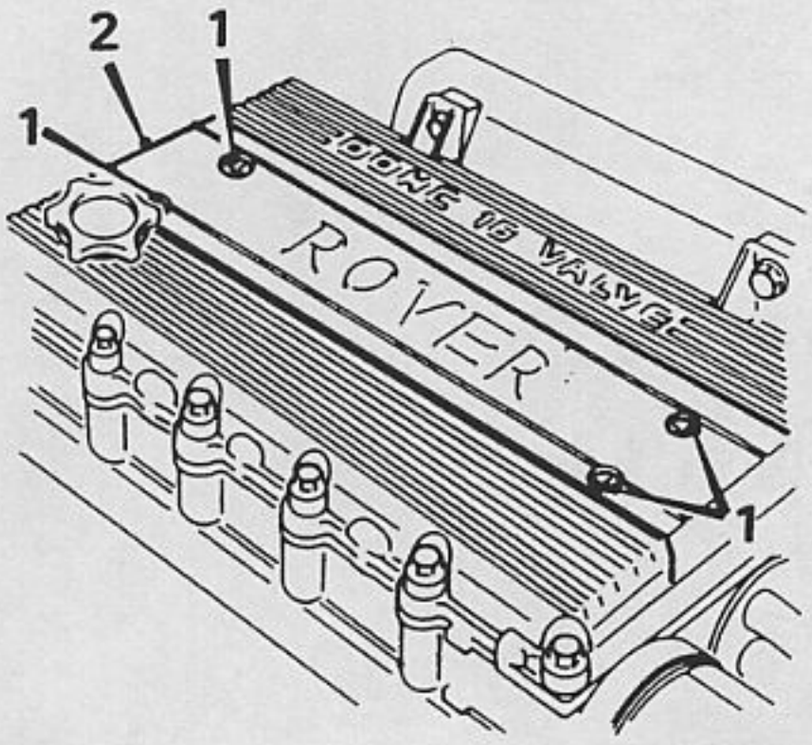
19M 0422

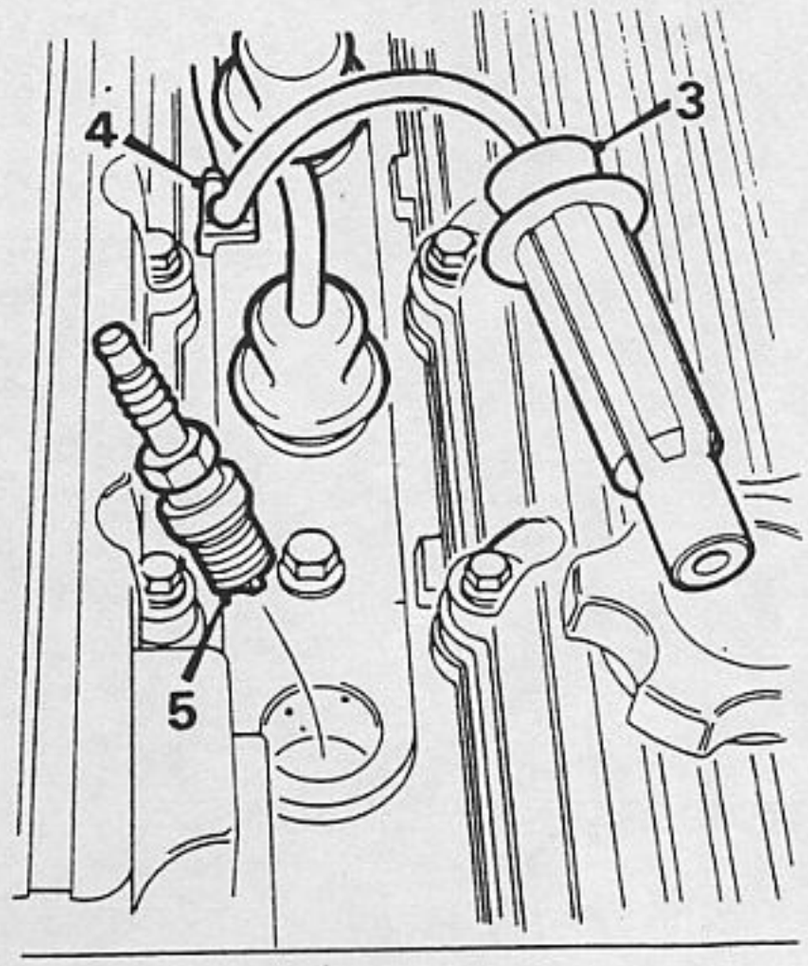
THROTTLE CABLE ADJUSTMENT – from VIN 152206

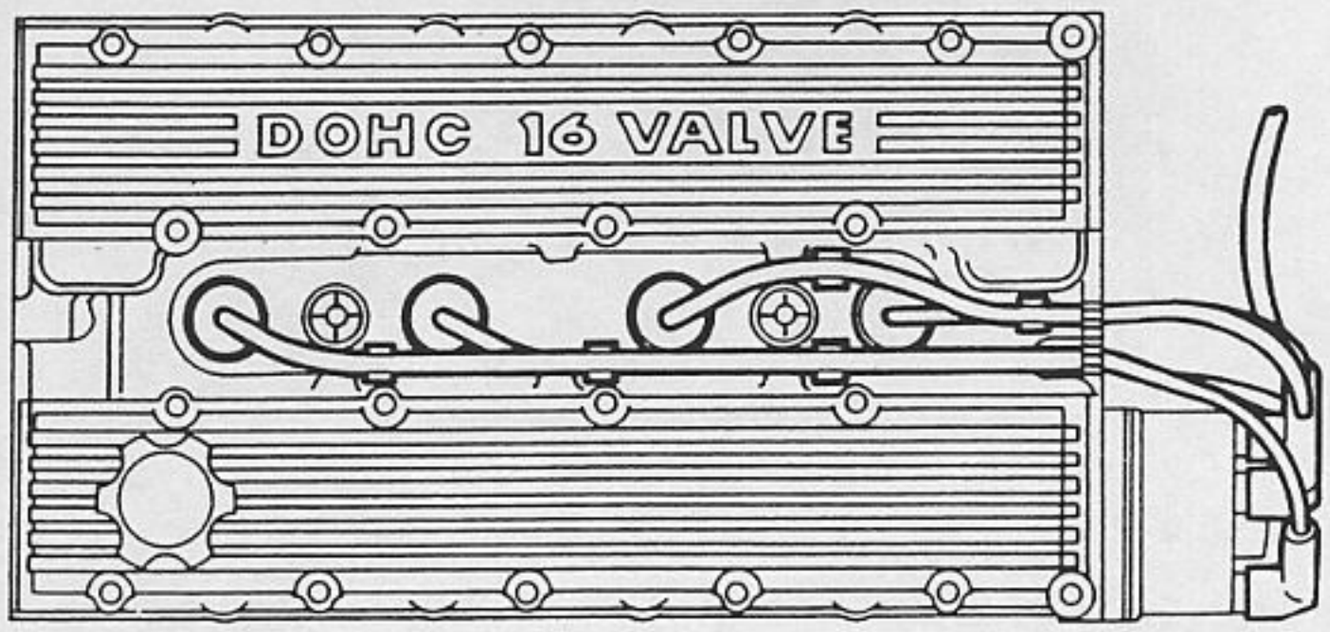
Note: *Before adjusting cable:*

- Use Microcheck to ensure that throttle potentiometer and stepper motor are synchronised.
- Ensure that cable is correctly routed and located.

Action	Ref.	Detail	Special Instructions
Switch on		ignition	Wait 5 seconds and switch ignition off to ensure stepper motor is in setting position.
Release	**1.**	cable adjusting nut from abutment bracket	
Unscrew		cable adjusting nut	Until it is clear of abutment bracket, see inset **A.**
Locate	**2.**	throttle outer cable in abutment bracket	Adjusting nut adjacent to abutment bracket
Hold	**3.**	cam	In throttle closed position and check that throttle position screw is in contact with stepper motor pin.
Rotate	**4.**	cable adjusting nut	Until all slack is taken out of inner cable and any linkage gap is taken up without opening throttle, see inset **B.** ***CAUTION:*** *Ensure all free play is removed from outer cable.*
Locate	**5.**	cable adjusting nut groove in abutment bracket	
Operate		Throttle pedal	Ensure throttle opens fully.



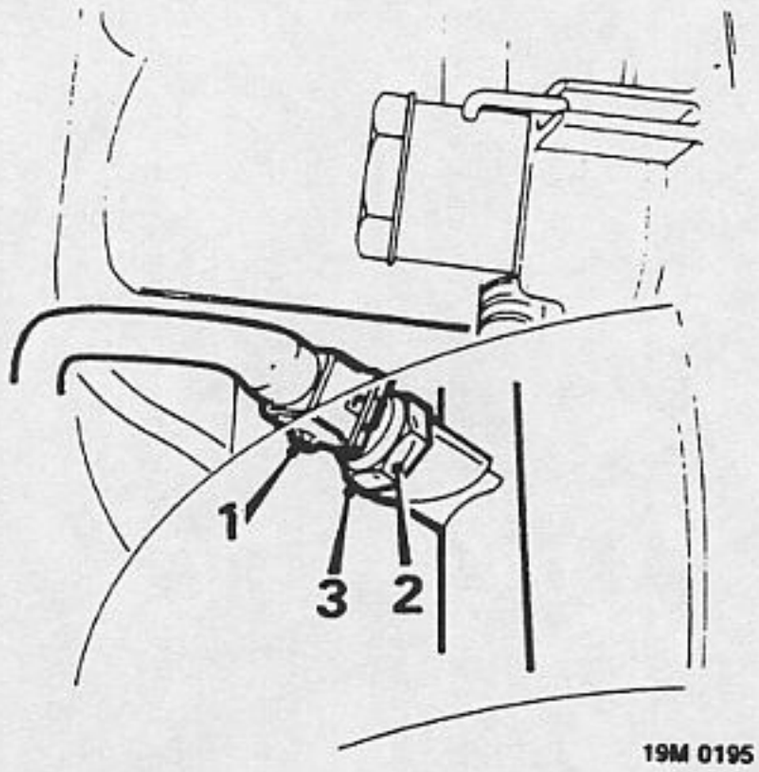




19M 0194

SPARK PLUGS

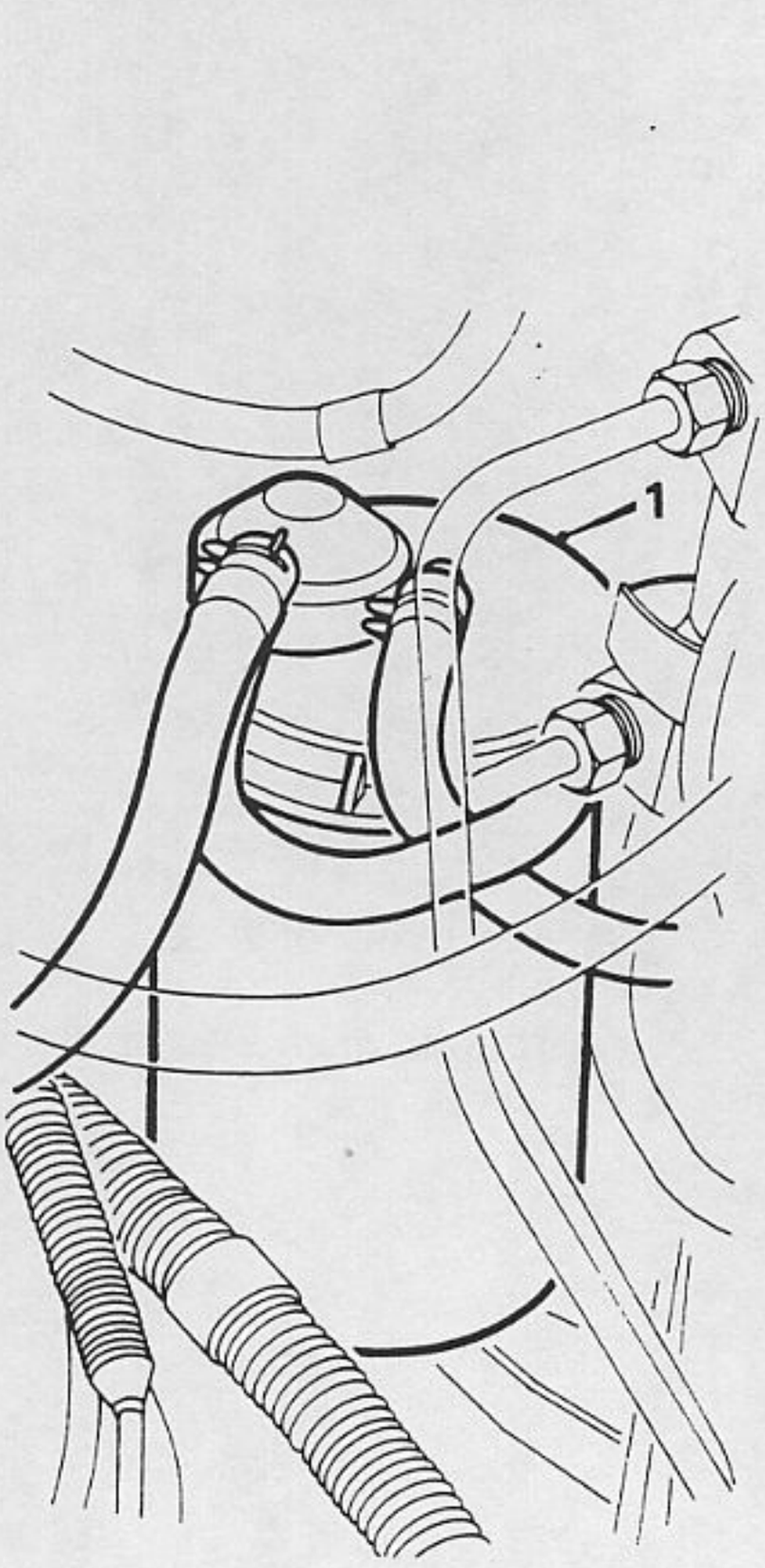
Action	Ref.	Detail	Special Instructions
Remove	**1.**	cover screws	4 off.
"	**2.**	cover	
Disconnect	**3.**	plug leads	4 off.
Release	**4.**	plug leads from clips	
Clean		plug area	
Remove	**5.**	spark plug from cylinder head	4 off.See **TORQUE WRENCH SETTINGS**
Inspect		spark plugs	
Renew		plug leads.	If terminals corroded, damaged or resistance exceeds 25k ohms.
Clean		plug seats	Wipe cylinder head seatings.
Set		plug gaps	See **GENERAL INFORMATION** ***CAUTION:*** *Use correct type and grade of plug.*
Apply		anti – seize to plug threads	
Fit		spark plugs	Finger tight
Tighten		spark plugs	4 off. See **TORQUE WRENCH SETTINGS**
Route		leads	As illustrated
Reassemble		components.	

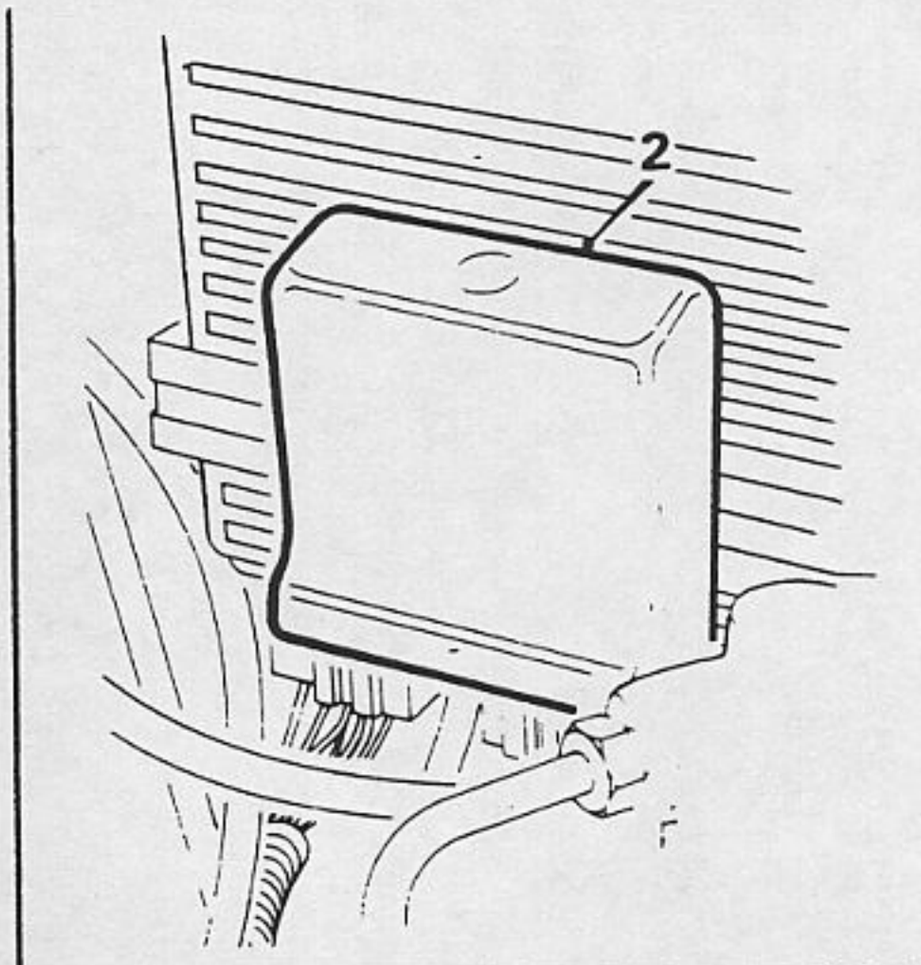


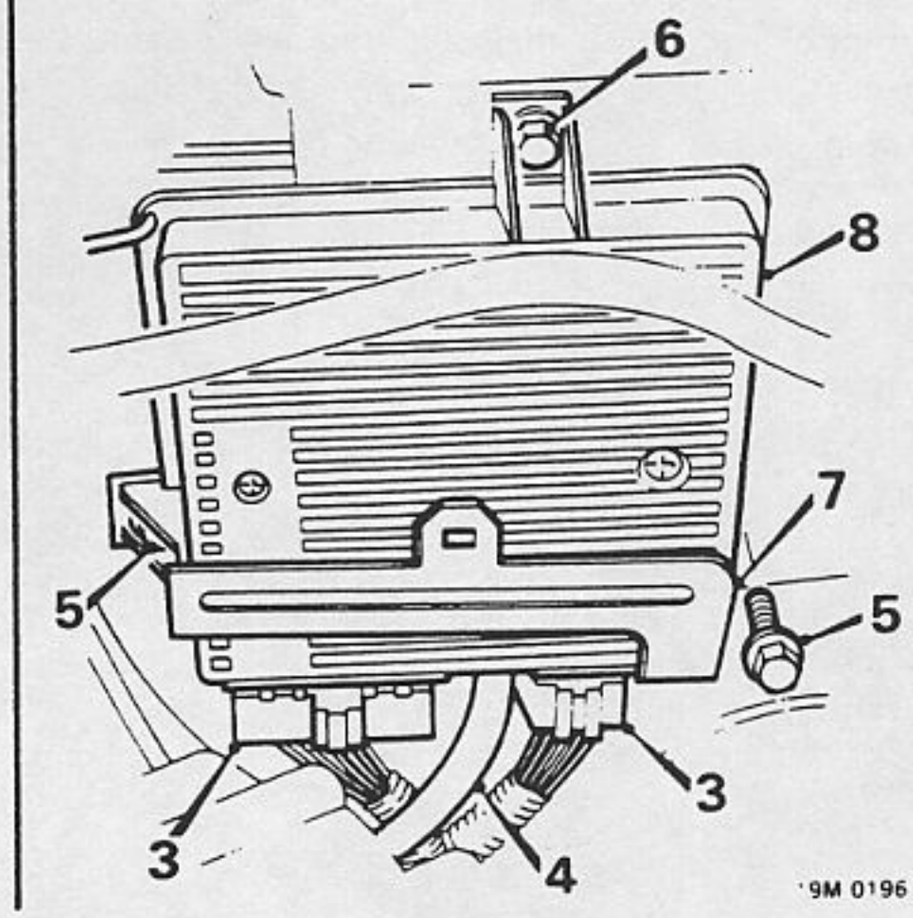
19M 0195

FUEL TEMPERATURE SENSOR

Action	Ref.	Detail	Special Instructions
Disconnect	1.	multiplug from sensor	
Remove	2.	sensor from fuel rail	
"	3.	Sealing washer	Discard
Clean		sensor and mating face	
Reassemble		components	



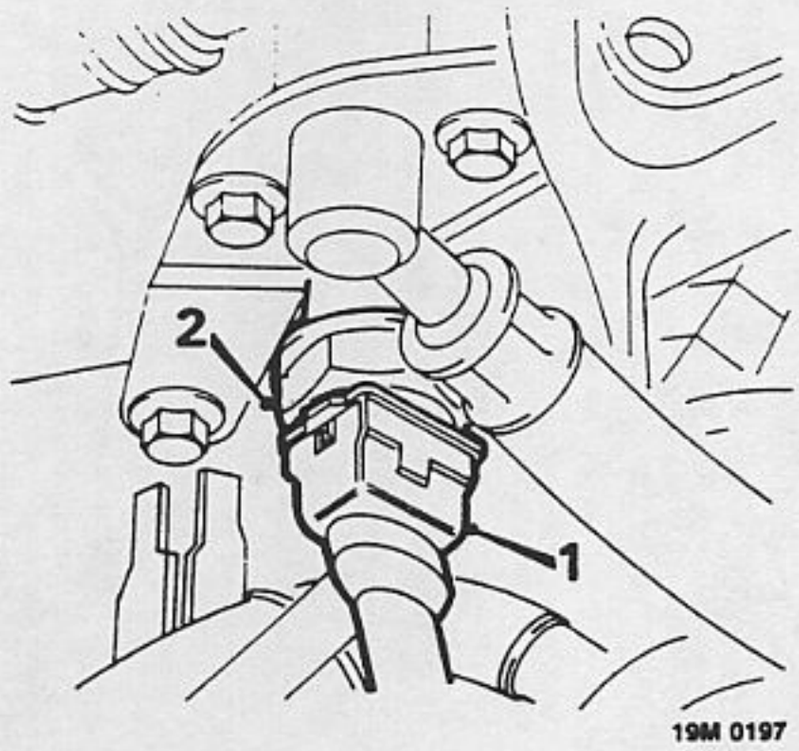




Before VIN 152206 illustrated

M.E.M.S. E.C.U.

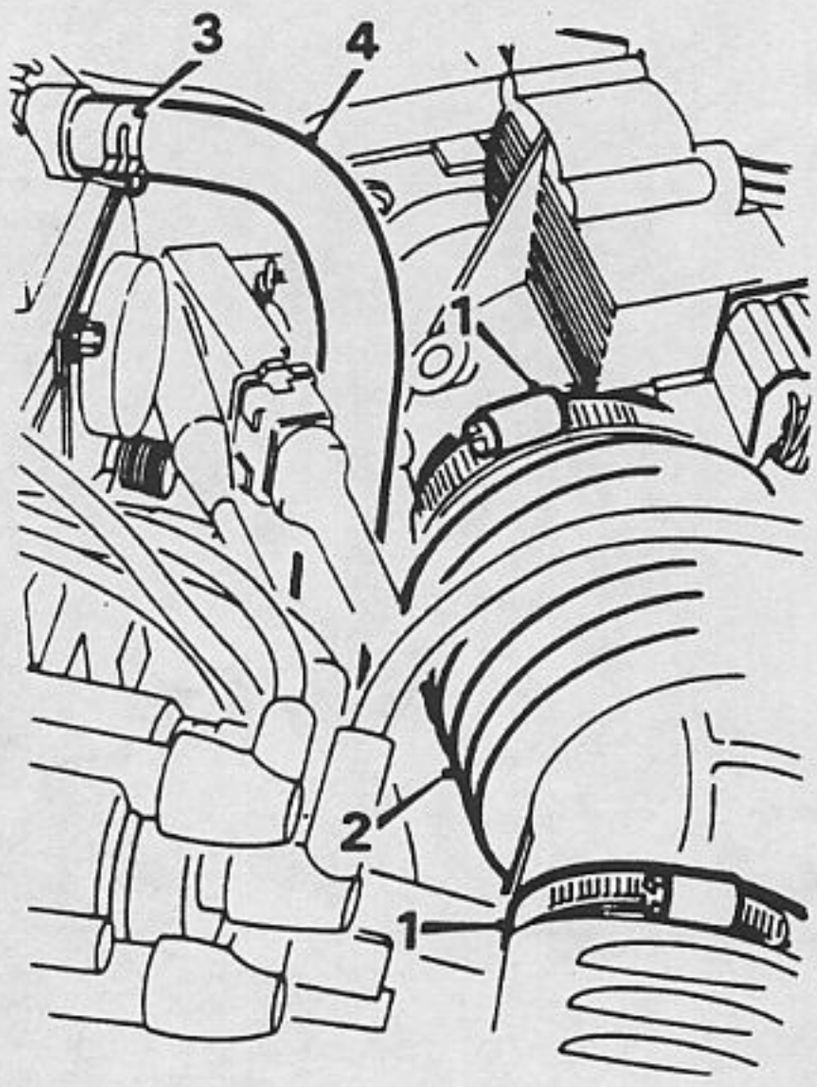
Action	Ref.	Detail	Special Instructions
Release	**1.**	charcoal canister from bracket and move aside	
"	**2.**	M.E.M.S. relay module from bracket on E.C.U.	
Disconnect	**3.**	multiplugs from E.C.U.	2 off.
"	**4.**	vacuum hose from E.C.U.	
Remove	**5.**	lower screws securing E.C.U.	2 off.
"	**6.**	upper screw securing E.C.U.	
"	**7.**	bracket	
"	**8.**	E.C.U.	
Reassemble		components	

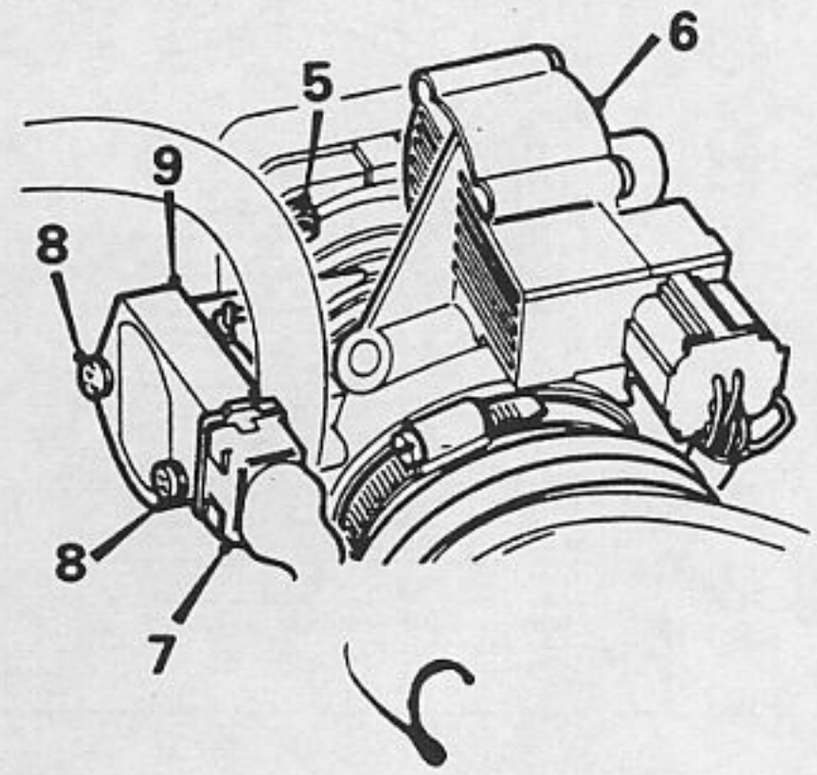


19M 0197

INTAKE AIR SENSOR

Action	Ref.	Detail	Special Instructions
Disconnect	1.	multiplug from temperature sensor	
Unscrew	2.	sensor from inlet manifold	See **TORQUE WRENCH SETTINGS**
Reassemble		components	

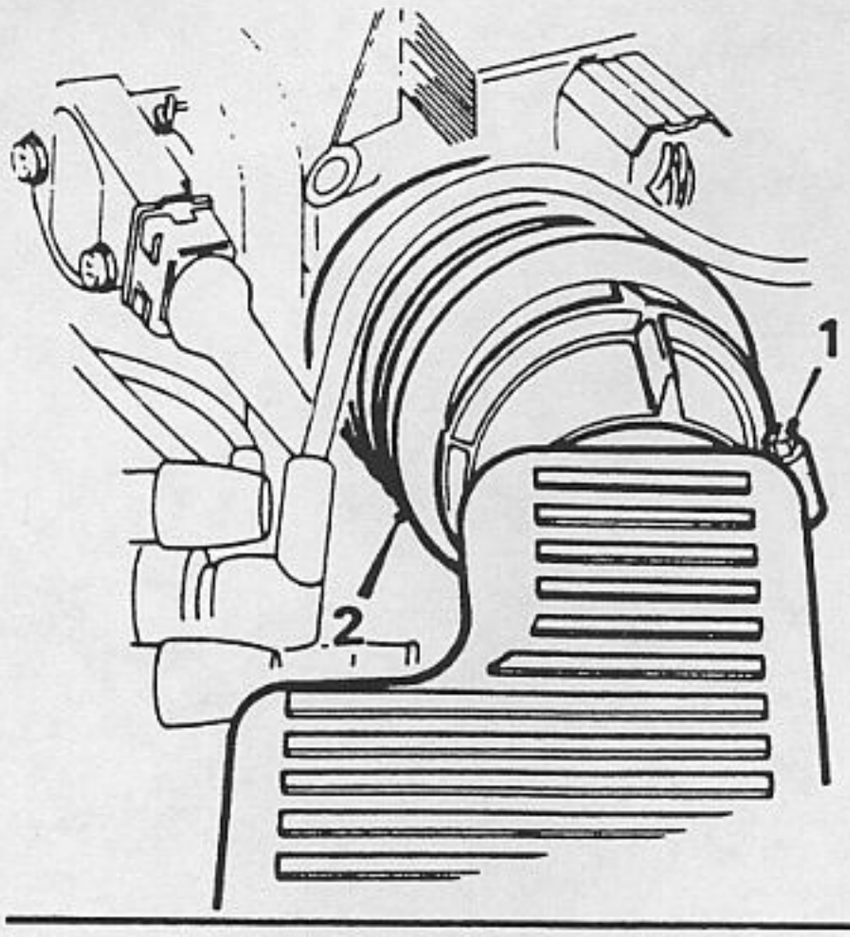


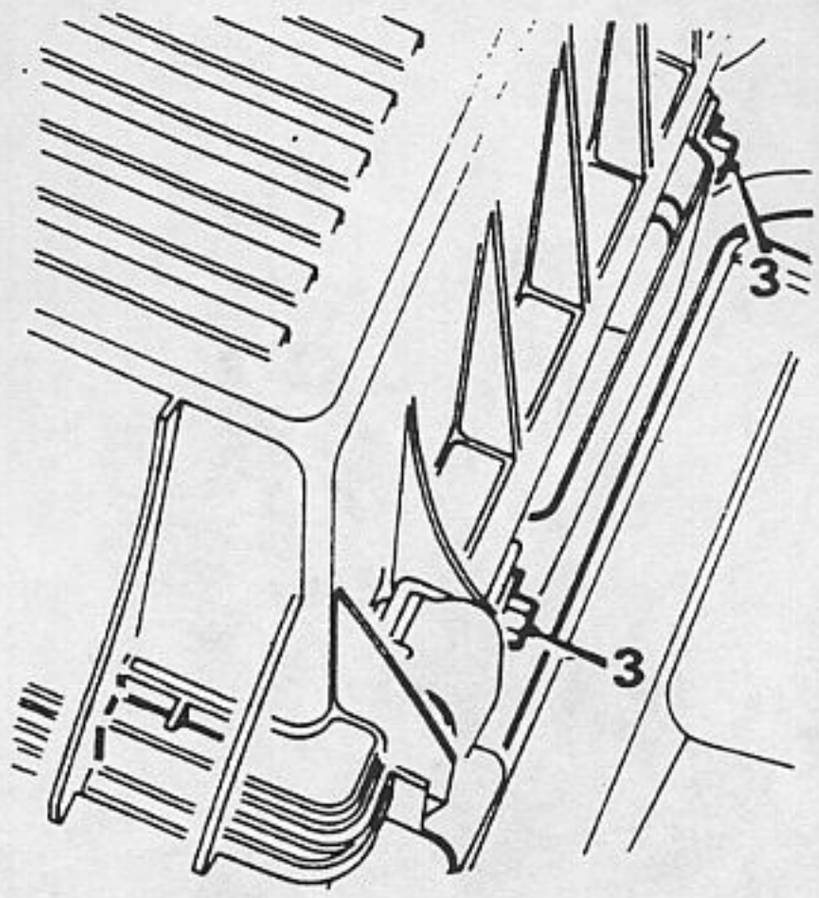


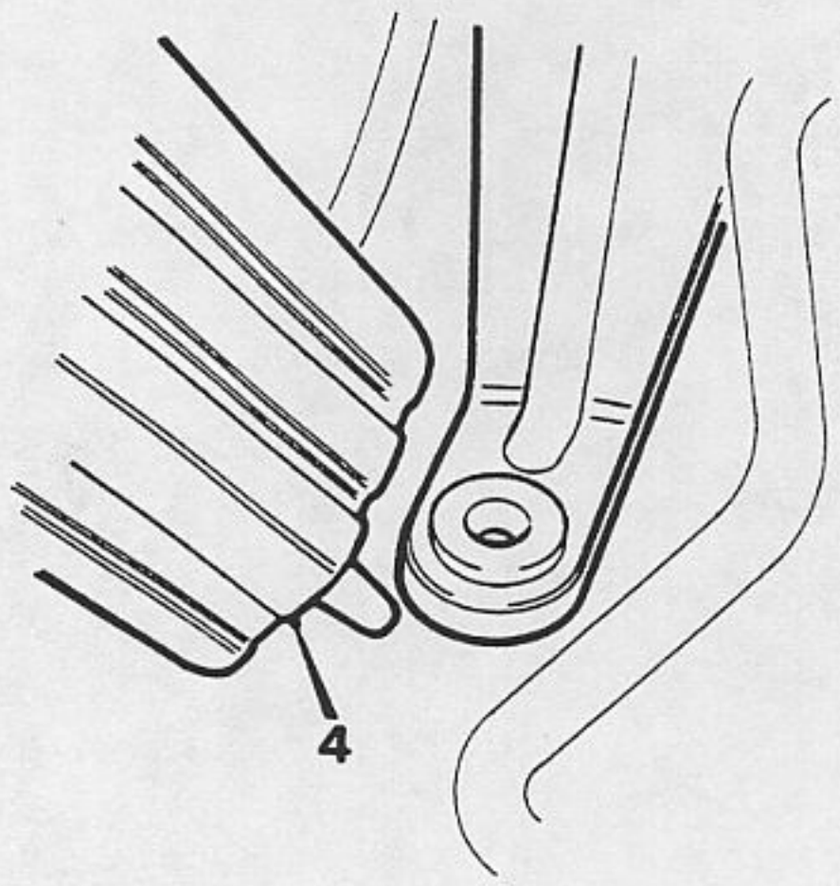
19M 0198

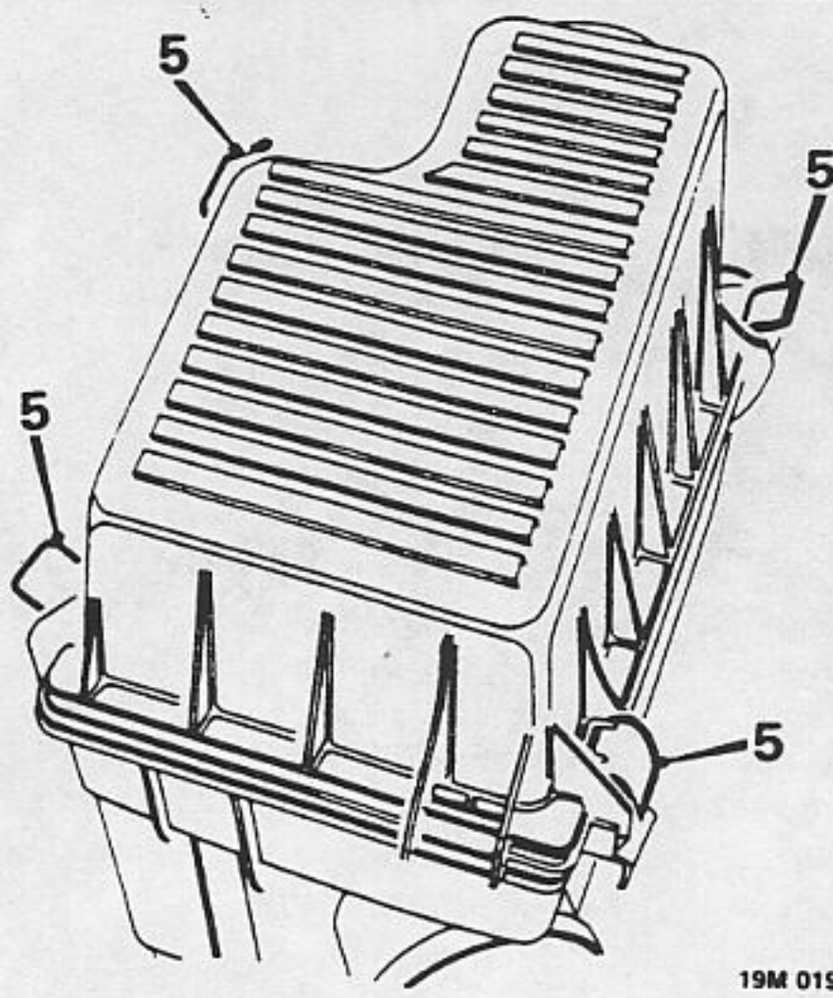
THROTTLE POTENTIOMETER

Action	Ref. Detail	Special Instructions
Slacken	**1.** clips from intake hose	**2 off clips.**
Remove	**2.** intake hose from throttle housing & Air Cleaner assembly	
Release	**3.** clip from camshaft cover breather hose	
Disconnect	**4.** breather hose from camshaft cover	
Remove	**5.** nuts securing throttle housing to rubber mounting on inlet manifold	4 off.
Move	**6.** throttle housing for access	
Disconnect	**7.** multiplug from potentiometer	
Remove	**8.** screws securing potentiometer	2 off.
"	**9.** potentiometer	
Clean	mating faces	
Reassemble	components	***Note:*** *Ensure Potentiometer is correctly adjusted. Using Microcheck or Cobest.*





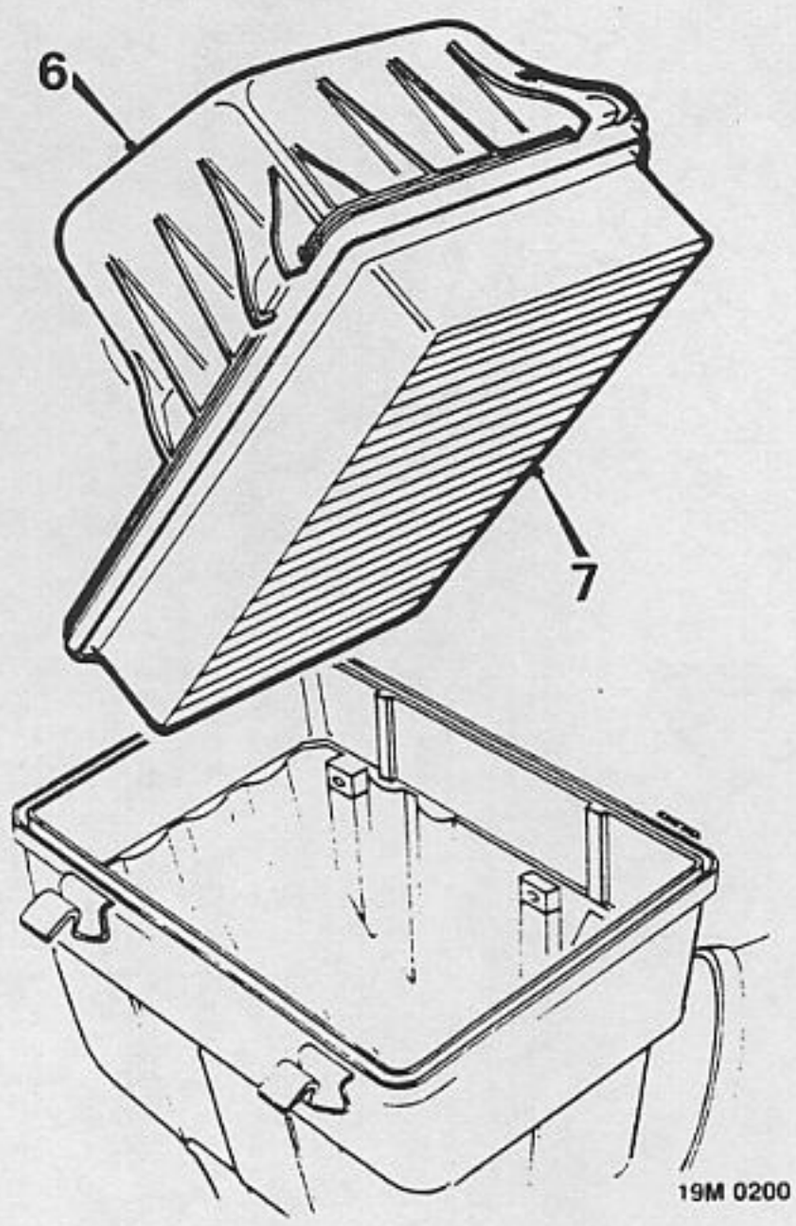




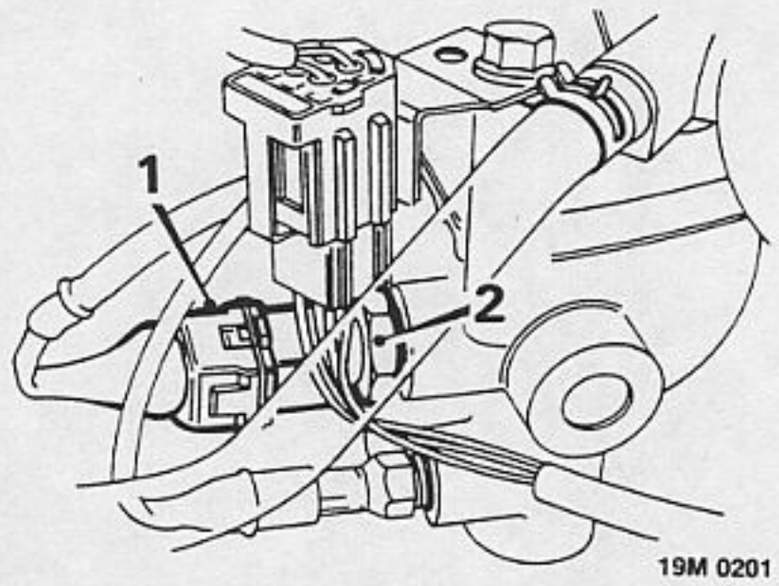
19M 0199

AIR CLEANER ASSEMBLY – NATURALLY ASPIRATED

Action	Ref.	Detail	Special Instructions
Remove		Battery	
Slacken	**1.**	clip from intake hose	
Release	**2.**	hose from air cleaner	
Remove	**3.**	bolts securing air cleaner to bracket	2 off.
"	**4.**	air cleaner from mounting bracket	
Do not carry out further dismantling if component removed for access only.			
Release	**5.**	clips from top cover	4 off.

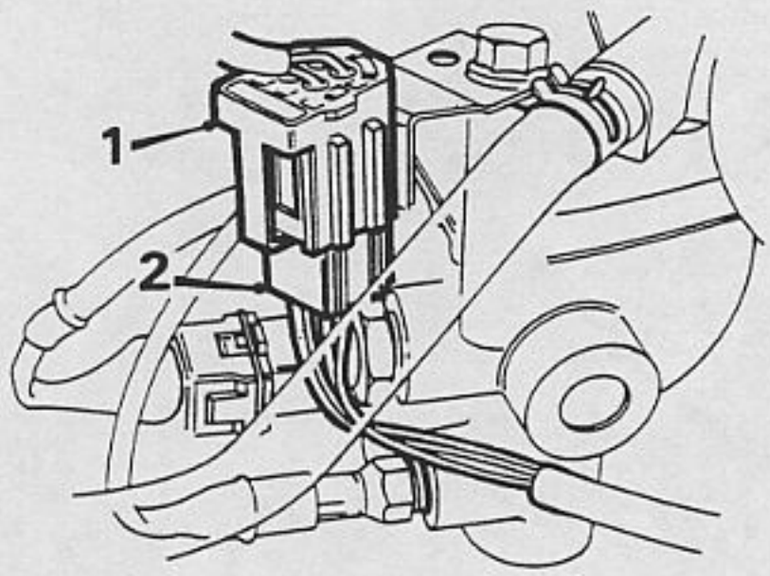


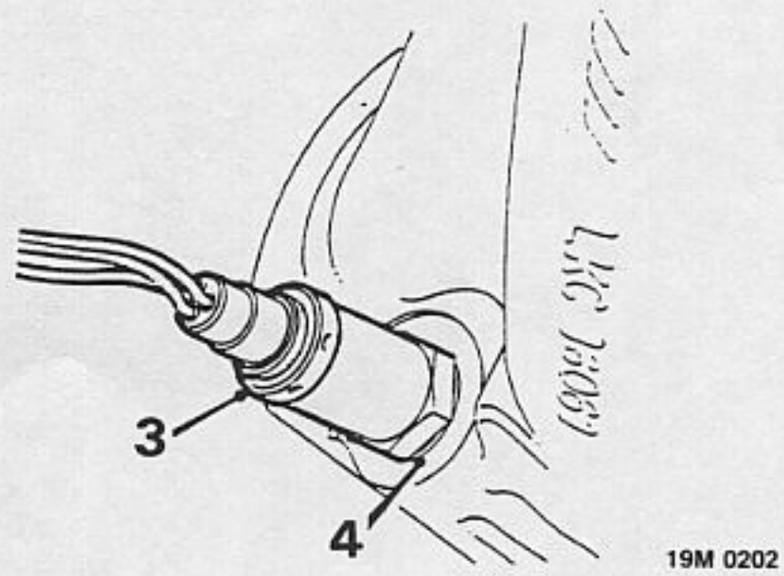
Raise	**6.** top cover	
Remove	**7.** element	Discard
Clean	body and top cover	
Reassemble	components	



COOLANT TEMPERATURE SENSOR

Action	Ref.	Detail	Special Instructions
Position		drain tin	
Disconnect	1.	multiplug from sensor	
Remove	2.	sensor	See **TORQUE WRENCH SETTINGS**
Clean		sensor	
Reassemble		components	***NOTE:*** *Top-up cooling system as required.*

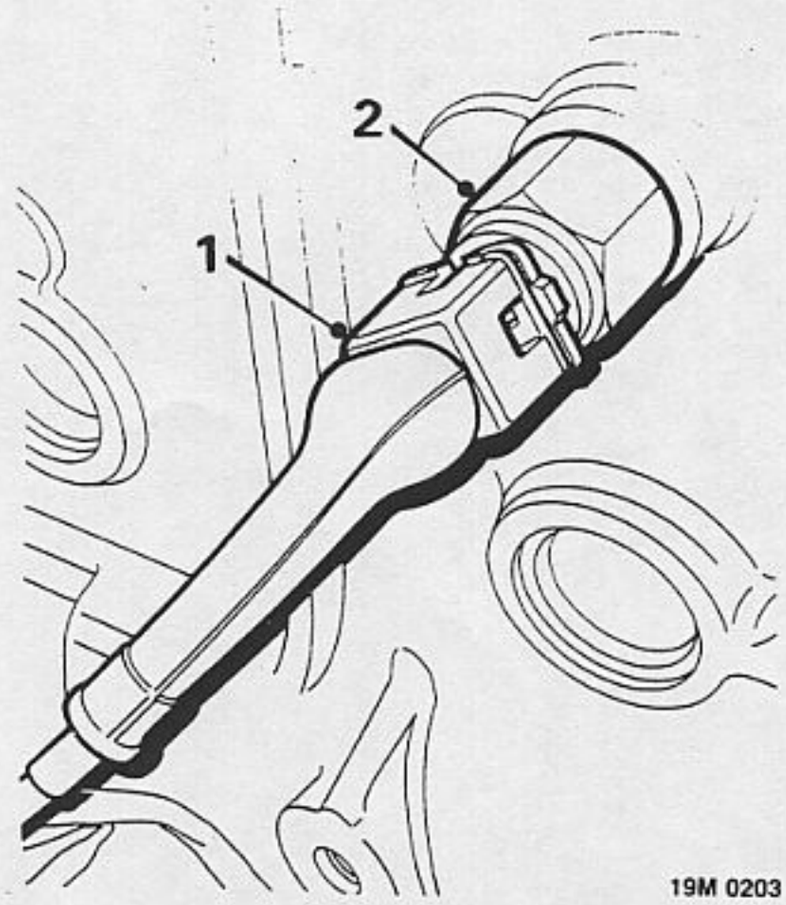




19M 0202

OXYGEN SENSOR

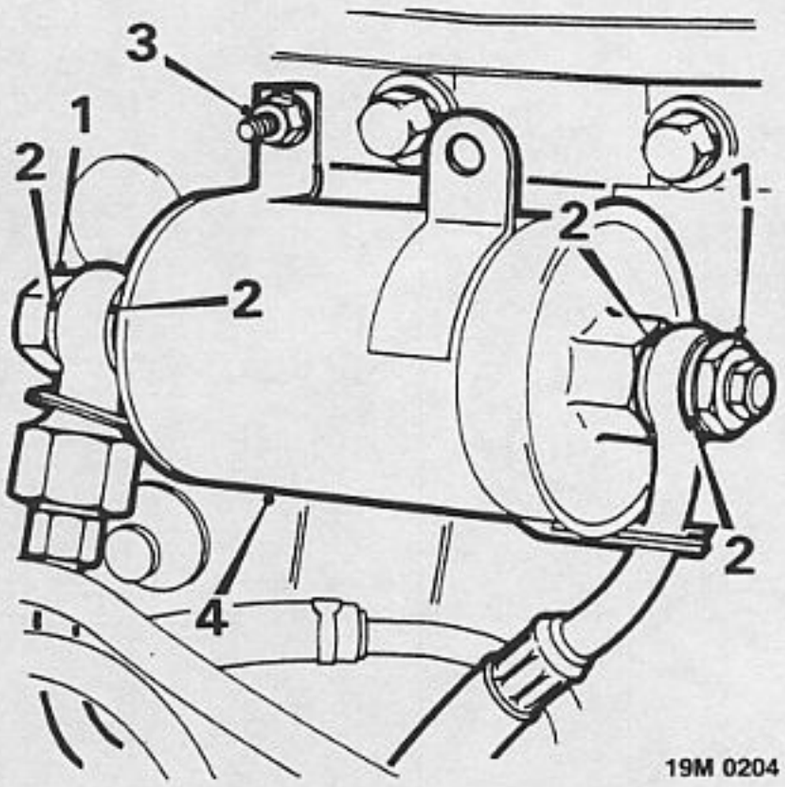
Action	Ref.	Detail	Special Instructions
Release	**1.**	harness from clip	
Disconnect	**2.**	lead from sensor connector	
Unscrew	**3.**	sensor from manifold	
Remove	**4.**	sealing washer	Discard.
Clean		sensor and mating face	
Reassemble		components	



19M 0203

KNOCK SENSOR

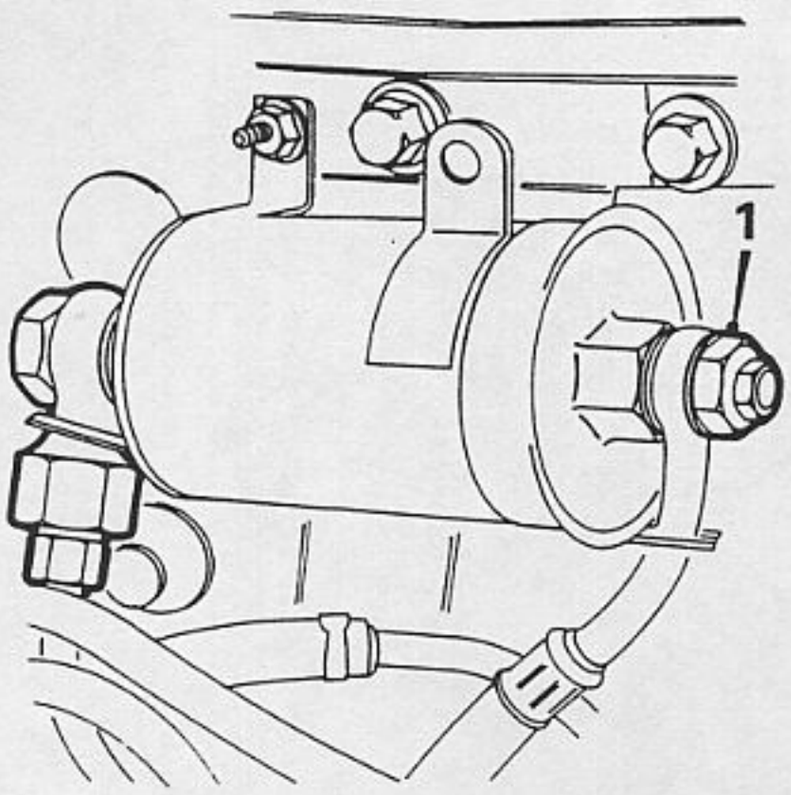
Action	Ref.	Detail	Special Instructions
Raise		front of vehicle	***WARNING:*** *Support on safety stands*
Remove	1.	multiplug from sensor	Access from below engine.
"	2.	sensor from cylinder block	See **TORQUE WRENCH SETTINGS.** Use long reach socket.
Clean		components	
Reassemble		components	

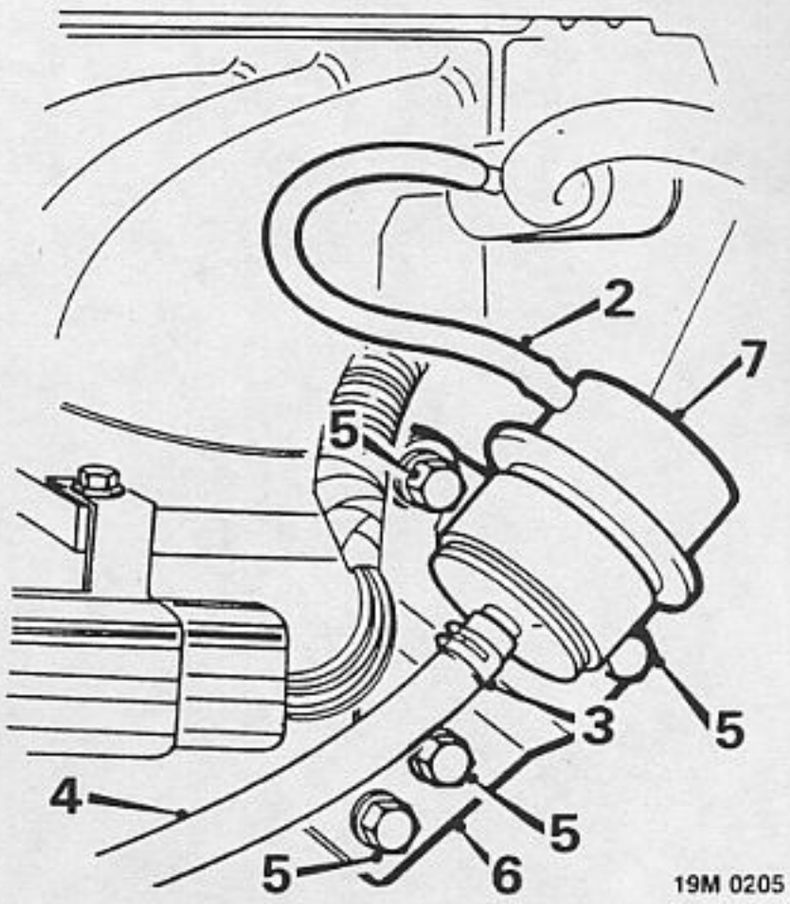


19M 0204

MAIN FUEL FILTER

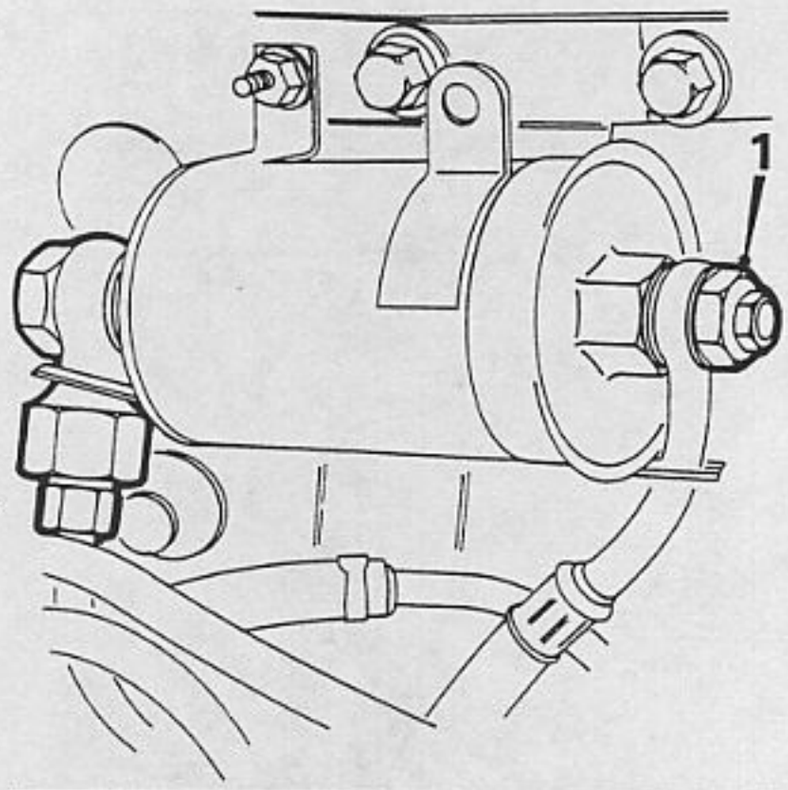
Action	Ref.	Detail	Special Instructions
Slacken	**1.**	unions from banjo bolts	2 off ***CAUTION:*** *Cover bolt with rag to prevent spray when depressurised.*
Remove		banjo bolts	
"	**2.**	sealing washers	4 off. Discard.
Slacken	**3.**	nut from filter clamp	
Remove	**4.**	filter from bracket	
"		plugs from new filter and fit to old	
Clean		sealing surfaces	
Reassemble		components	***WARNING:*** *Ensure banjo bolts are correctly tightened before pressurising system.*

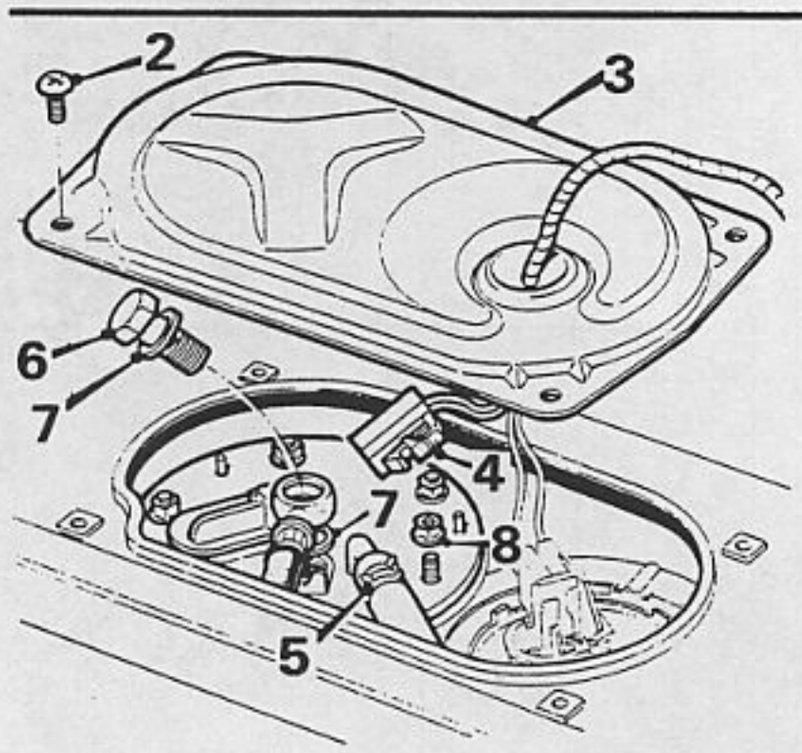


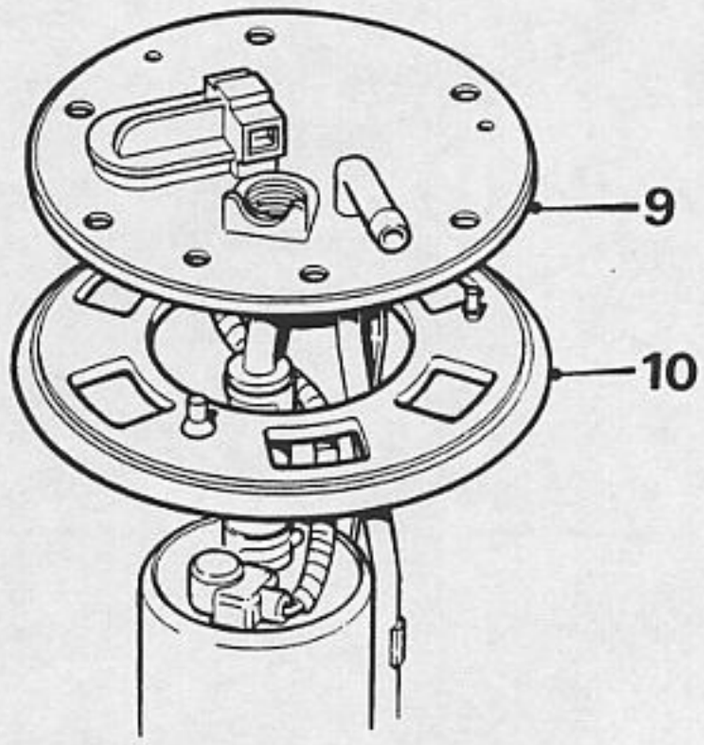


PRESSURE REGULATOR

Action	Ref.	Detail	Special Instructions
Slacken	**1.**	union from banjo bolt	***CAUTION:*** *Cover union with rag to prevent spray when depressurised.* ***WARNING:*** *Tighten up union when system is depressurised.*
Disconnect	**2.**	vacuum hose from regulator	
Release	**3.**	clip	
Remove	**4.**	fuel return hose	
Plug		fuel return hose	
Remove	**5.**	bolts securing regulator and bracket to fuel rail	4 off.
"	**6.**	bracket	
"	**7.**	regulator	
Plug		fuel rail	
Remove		'O' ring seal	Discard.
"		spacer	
Wipe		regulator and all sealing surfaces	
Reassemble		components	



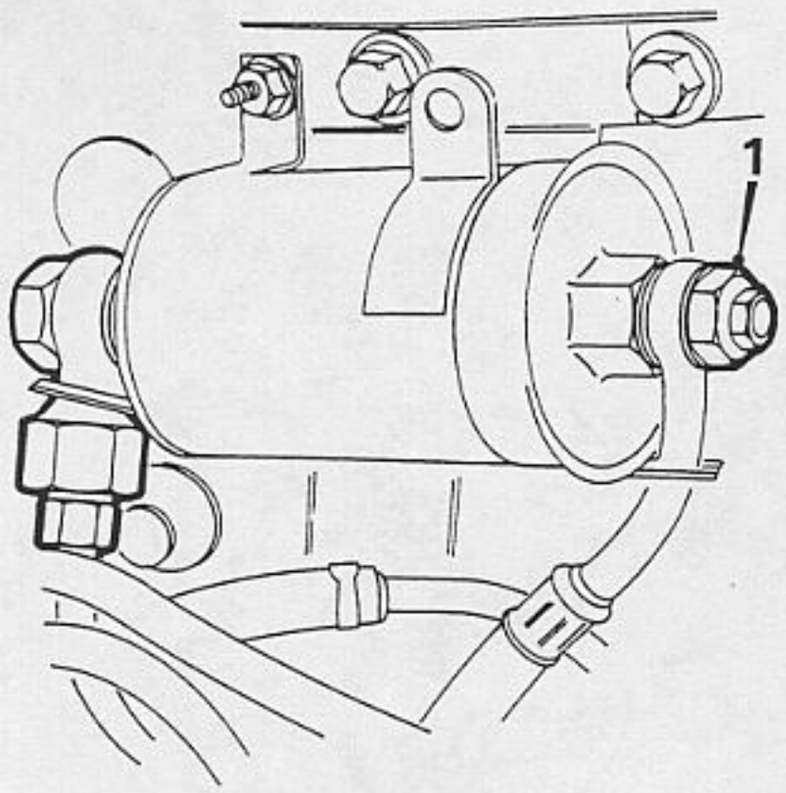


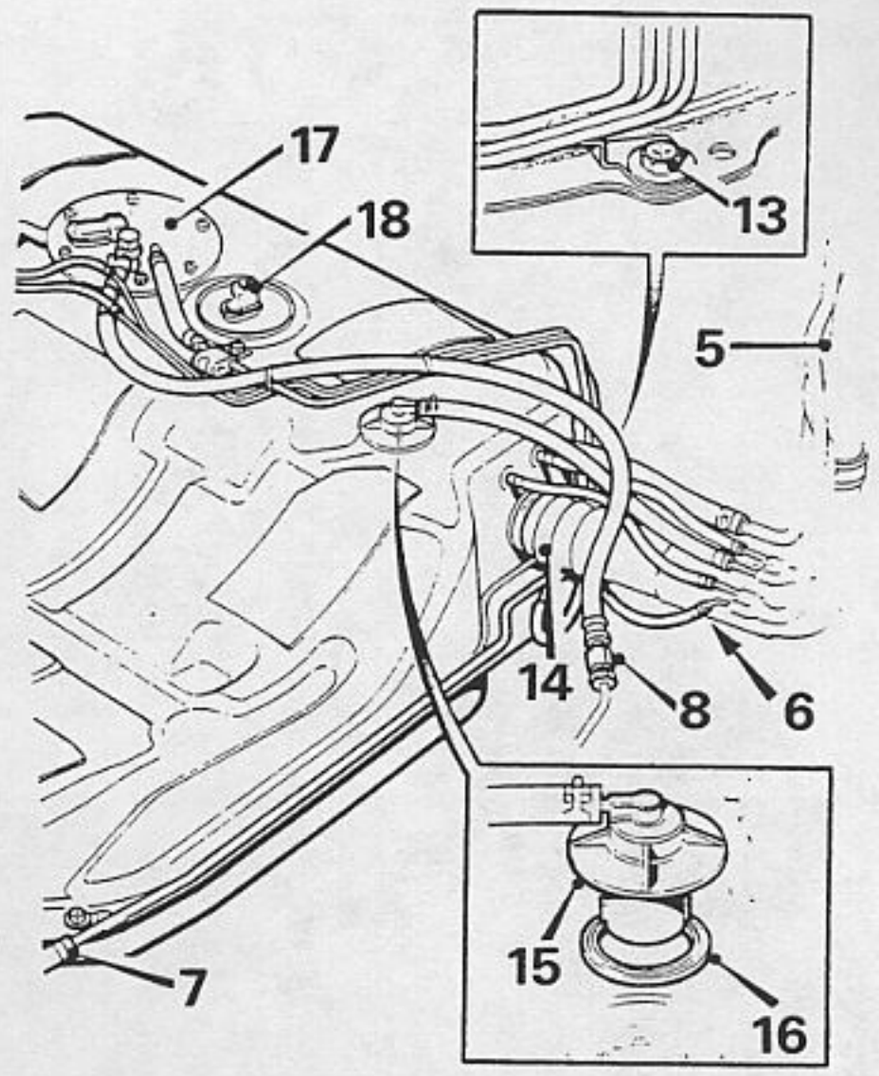


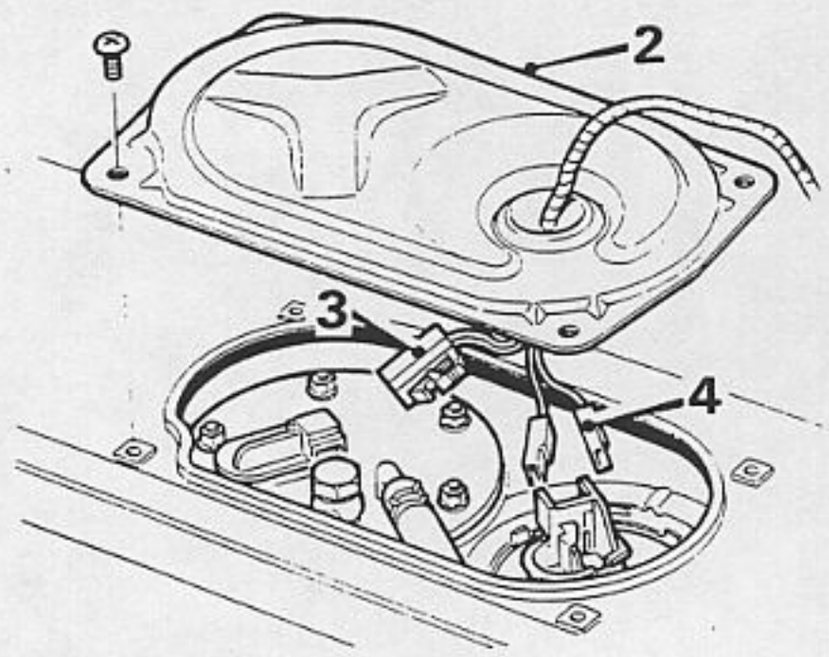
19M 0206

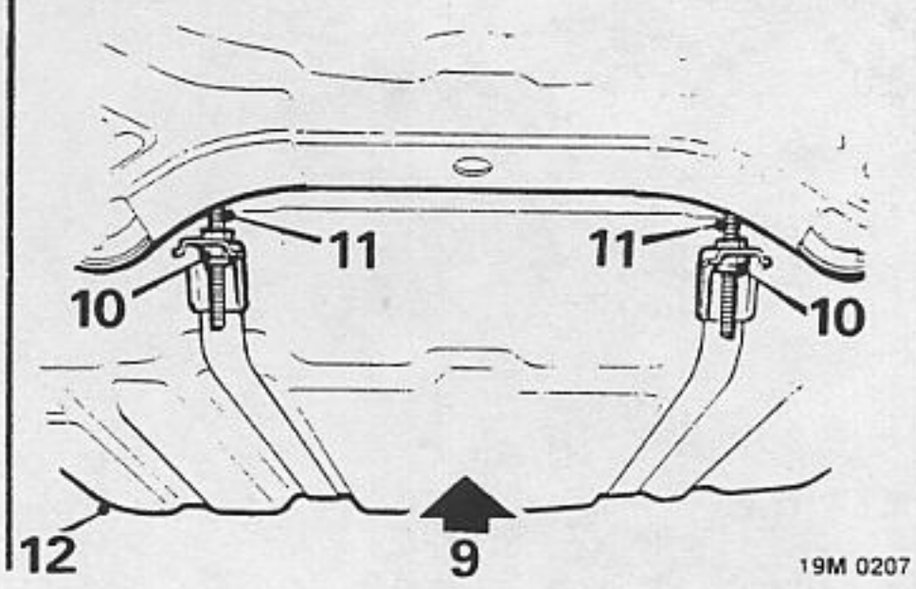
FUEL PUMP

Action	Ref.	Detail	Special Instructions
Slacken	**1.**	union from banjo bolt	***CAUTION:*** *Cover union with rag to prevent spray when system is depressurised.* ***WARNING:*** *Tighten union once system is depressurised.*
Remove		floor carpet from boot	
"		cover board from spare wheel	
Move		tool kit aside	
Fold		rear seats forward	For access
Remove	**2.**	screws from pump access panel	4 off.
Move	**3.**	panel aside	
Clean		around pump location	
Disconnect	**4.**	multiplug from pump	
"	**5.**	hose from pump	Retain clip, plug hose.
Remove	**6.**	banjo bolt from fuel feed hose	See **TORQUE WRENCH SETTINGS**
"	**7.**	sealing washers	2 off. Discard.
"	**8.**	nuts from fuel pump	6 off. See **TORQUE WRENCH SETTINGS**
"	**9.**	fuel pump	
"	**10.**	seal from pump	Check condition, renew if necessary.
Clean		components	
Reassemble		components	







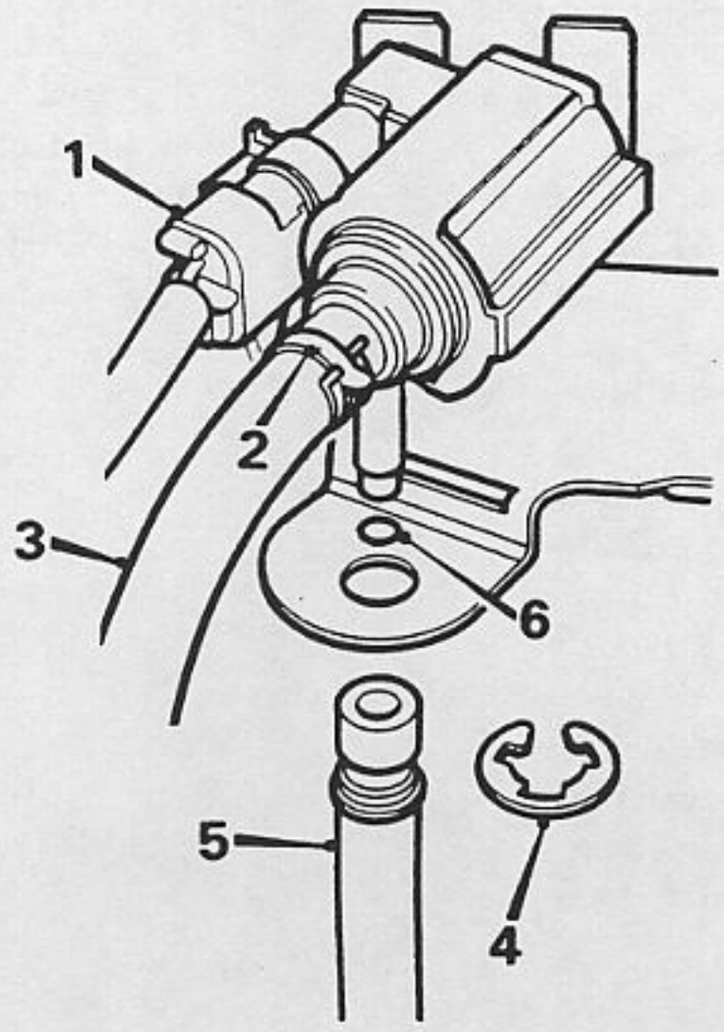


19M 0207

FUEL TANK

Action	Ref.	Detail	Special Instructions
Slacken	**1.**	union from banjo bolt	***CAUTION:*** *Cover union with rag to prevent spray when system is ìdepressurised.* ***WARNING:*** *Tighten union once system is depressurised.* See **FUEL PUMP**
Remove	**2.**	fuel pump access panel	
Disconnect	**3.**	multiplug from pump	
"	**4.**	lucars from tank unit	
Remove		filler cap	
Drain		fuel from tank	***WARNING:*** See **GENERAL INFORMATION** - Fuel handling
Raise		rear of vehicle	***WARNING:*** *Support on safety stands.*
Remove		L.H. rear road wheel	4 off nuts. See **TORQUE WRENCH SETTINGS**
Disconnect	**5.**	filler hose from filler neck	Retain clip.
Move		hose aside	
Disconnect	**6.**	breather hoses from pipes	5 off. Retain clips
Remove		intermediate and tail pipes	See **MANIFOLD AND EXHAUST**
"		bolts from body	2 off.
"		mounting bracket from heat shield	
"		bolts from rear heat shield	2 off. See **TORQUE WRENCH SETTINGS**
"		heat shield from body	

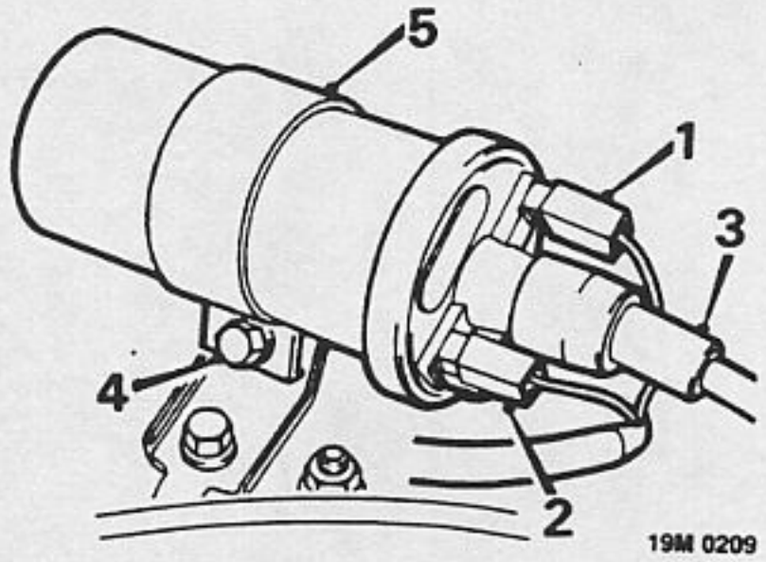
Disconnect	**7.** spill return hose from pipe	Plug hose.
"	**8.** fuel feed hose from union	plug hose.
Support	**9.** fuel tank on a jack	Protect tank.
Slacken	**10.** lock nuts from tank straps	2 off, to thread ends. See **TORQUE WRENCH SETTINGS**
Disconnect	**11.** hook bolts from body slots	2 off.
Lower	tank straps	
Remove	**12.** fuel tank from body	
Clean	components	
Transfer	components to new tank	
Remove	**13.** bolt securing breather pipes to tank	1 off.
"	clip from filler hose	Retain clip.
"	**14.** filler hose from tank	
"	**15.** cut – off valve hose from tank	
"	**16.** seal from tank	Discard.
"	**17.** fuel pump assembly	
"	**18.** fuel guage tank unit	See **INSTRUMENTS**
Reassemble	components	



19M 0208

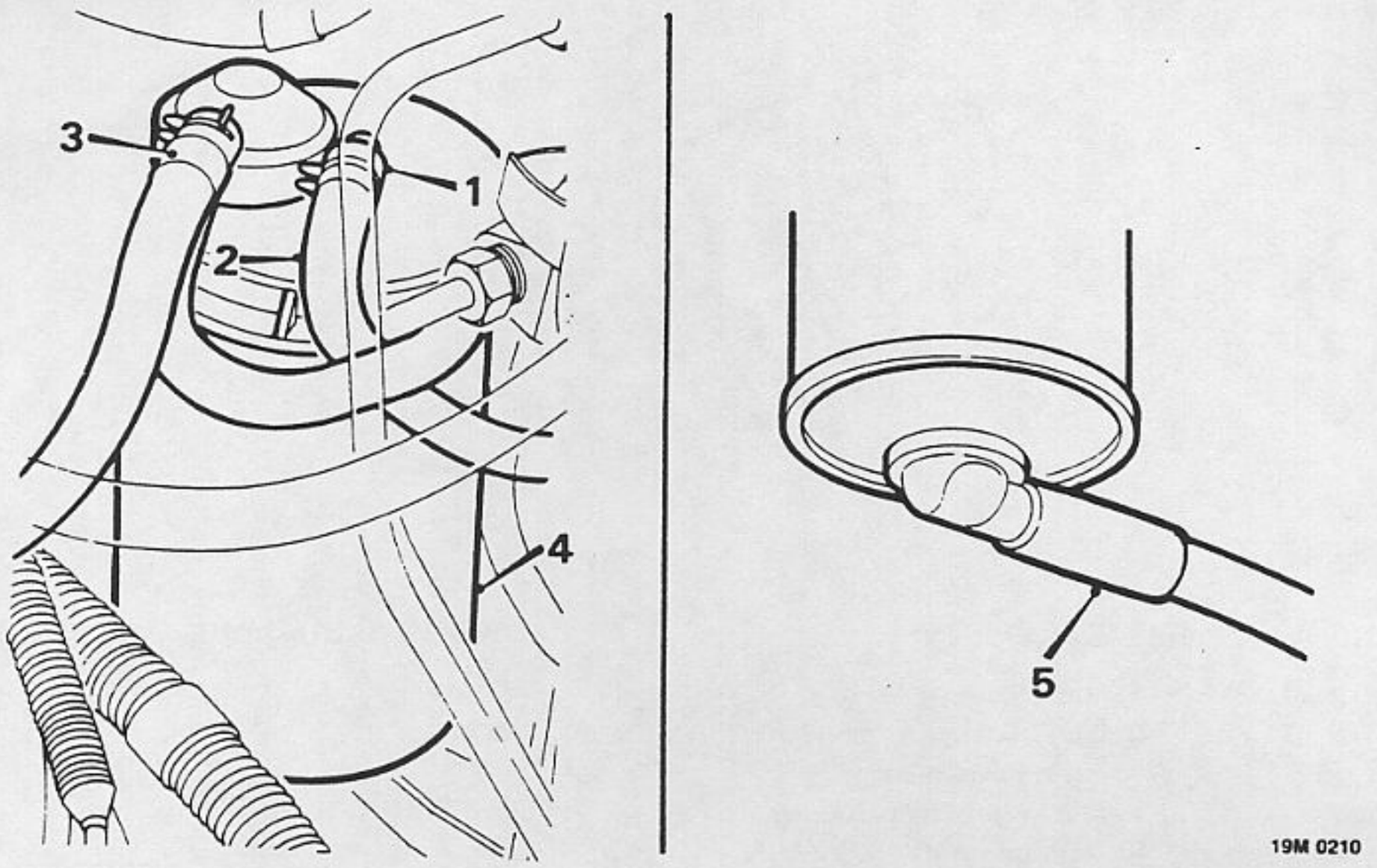
PURGE CONTROL SOLENOID – before VIN 152206

Action	Ref.	Detail	Special Instructions
Disconnect	**1.**	multiplug from solenoid	
Release	**2.**	clip from vacuum hose	
Disconnect	**3.**	vacuum hose from solenoid	***CAUTION:*** *Pull hose straight or pipe may break off inside hose.*
Remove	**4.**	circlip from purge hose	
Disconnect	**5.**	purge hose from solenoid	
Remove	**6.**	'O' ring from solenoid	***CAUTION:*** *Ensure 'O' ring is not left in purge solenoid hose. Discard 'O' ring.*
Slide		solenoid from bracket	
Reassemble		components	***CAUTION:*** *Ensure connections are secure and correct.*



IGNITION COIL

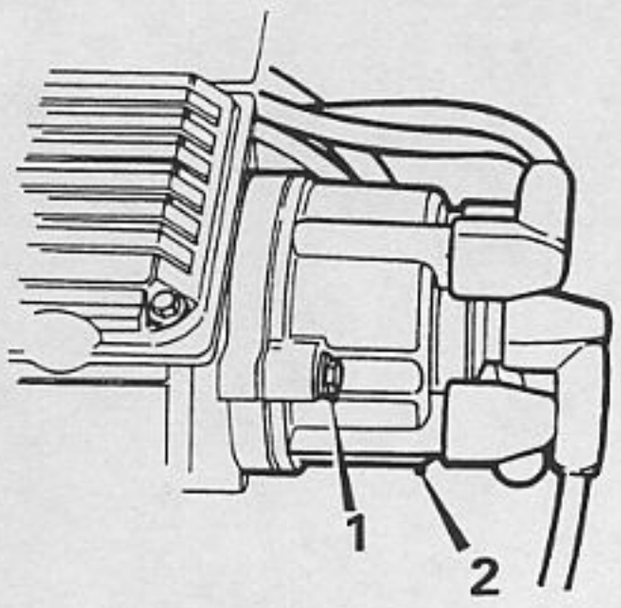
Action	Ref.	Detail	Special Instructions
Disconnect	**1.**	lead from coil	'–' lead.
"	**2.**	lead from coil	'+' lead.
"	**3.**	h.t. lead from coil	
Remove	**4.**	bolt from mounting bracket	See **TORQUE WRENCH SETTINGS**
"	**5.**	coil from bracket	***Note:*** *Fitted position.*
Reassemble		components	

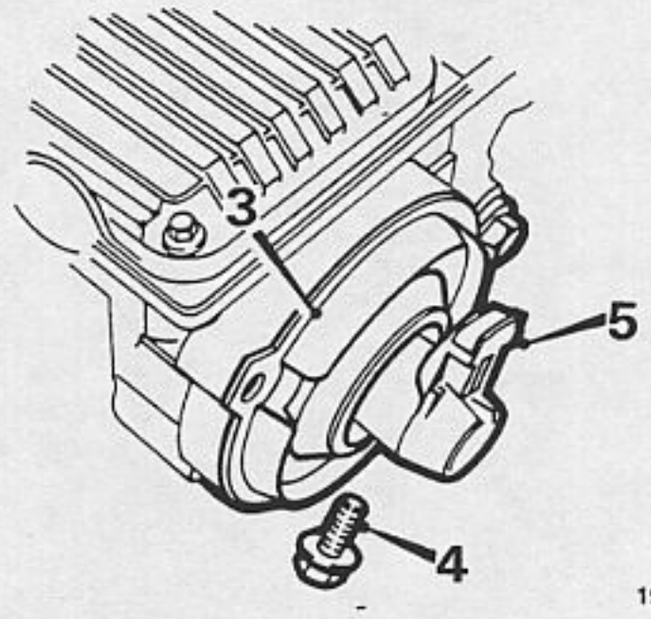


19M 0210

CHARCOAL CANISTER – before VIN 152206

Action	Ref.	Detail	Special Instructions
Release	**1.**	clip from top pipe hose	
Disconnect	**2.**	hose from canister	
"	**3.**	hoses from diaphram valve	2 off. ***CAUTION:*** *Pull hose straight or pipe may break off inside hose.*
Lift	**4.**	canister from bracket	
Disconnect	**5.**	fresh air hose from canister	
Remove		canister	
"		plugs from new canister	***CAUTION:*** *Do not use a new canister which has the plugs missing.*
Fit		plugs to old canister	
Reassemble		components	***CAUTION:*** *Ensure correct location of canister lugs in bracket.*

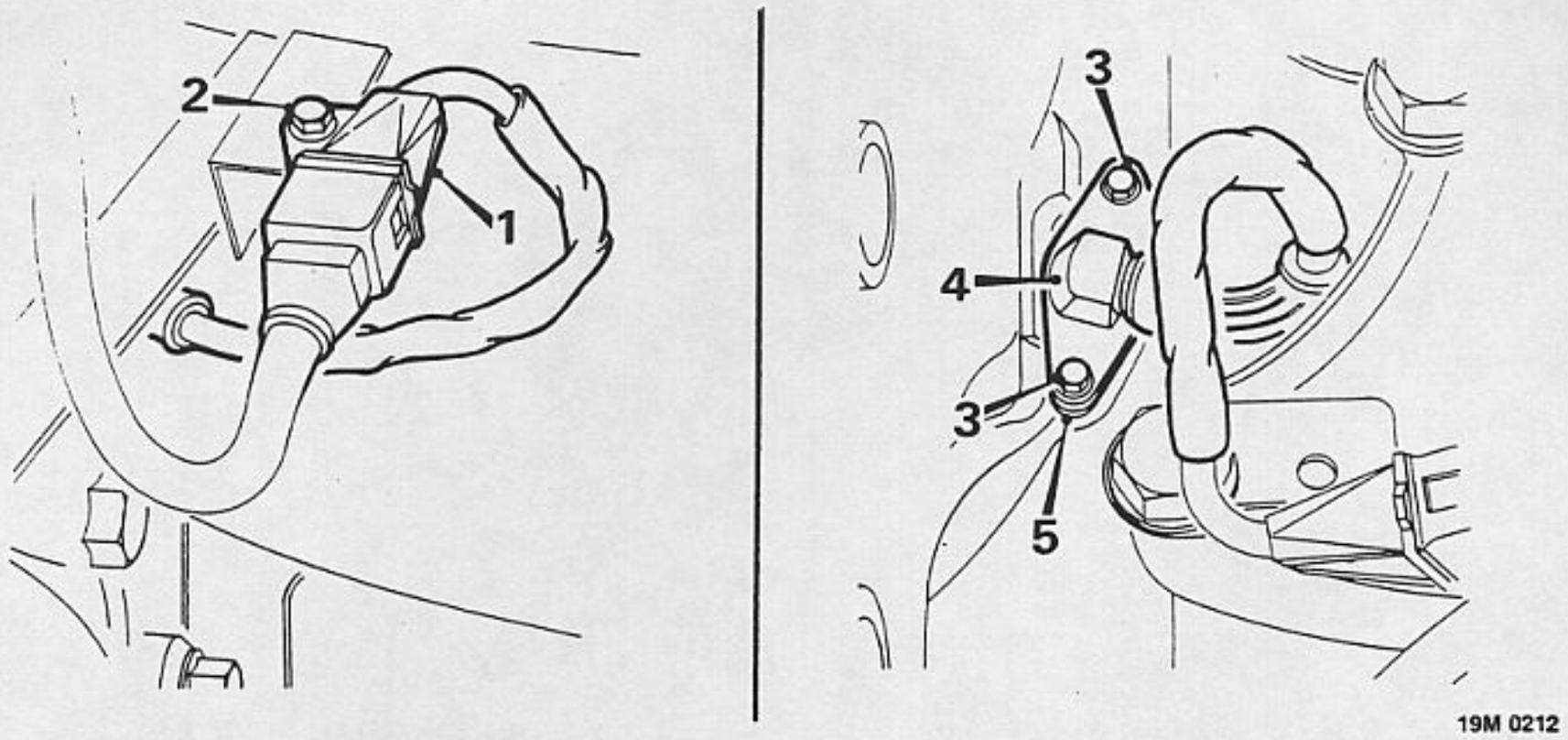




19M 0211

ROTOR ARM

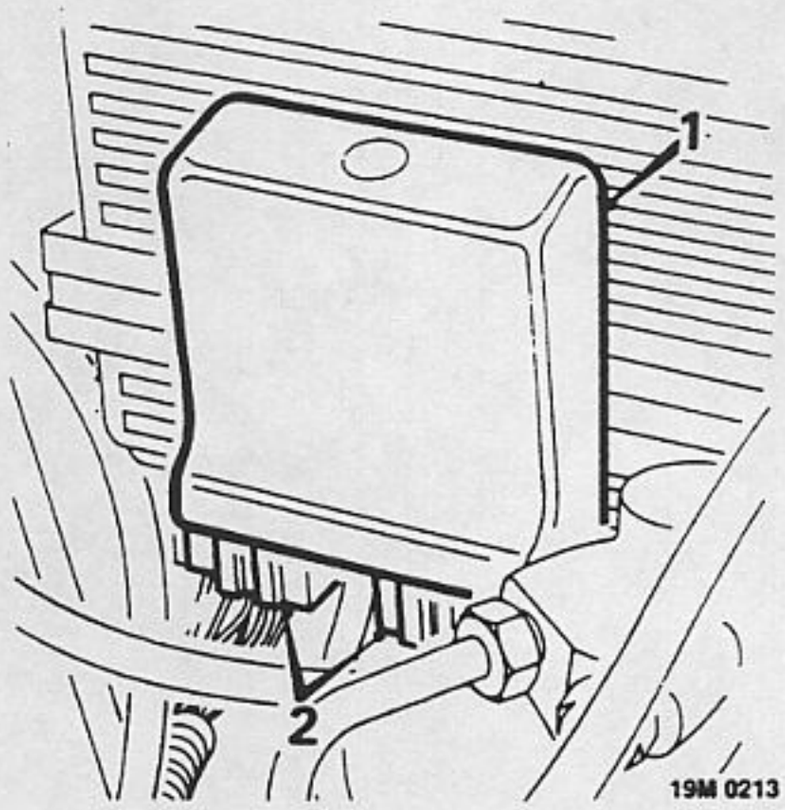
Action	Ref.	Detail	Special Instructions
Remove	1.	bolts from distributor cap	2 off. See **TORQUE WRENCH SETTINGS**
Detach	2.	distributor cap from adaptor	Move aside.
Remove	3.	anti-flash shield from adaptor	
"	4.	bolt from rotor arm	See **TORQUE WRENCH SETTINGS** Apply thread loctite on refitting.
"	5.	rotor arm from spindle	
Clean		components	
"		threads	
Inspect		components	
Renew		components	Showing signs of damage.
Reassemble		components	



19M 0212

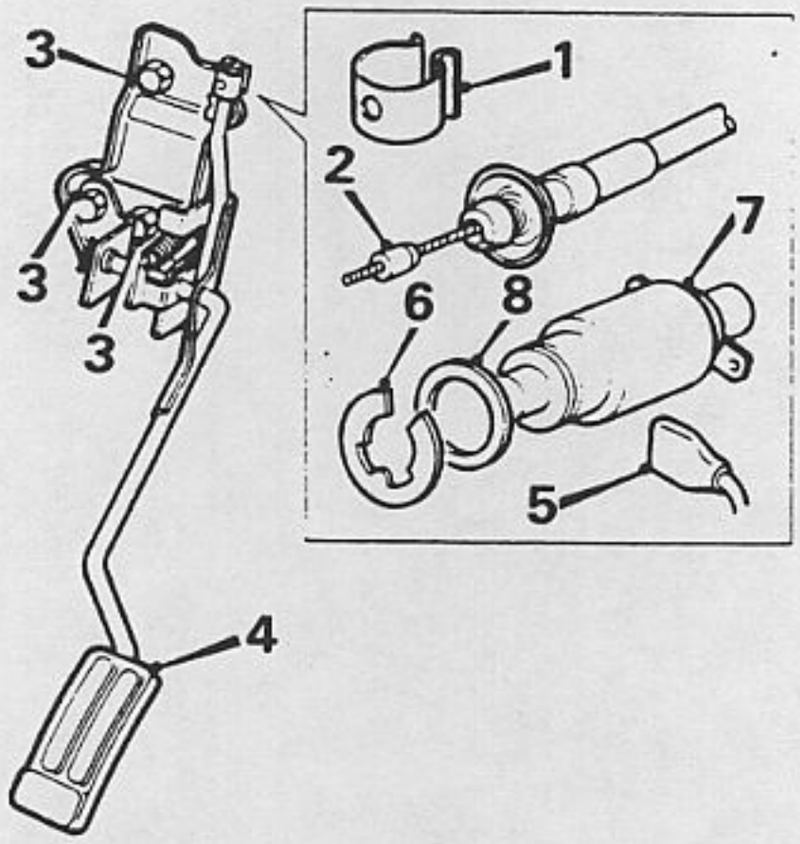
CRANKSHAFT SENSOR

Action	Ref.	Detail	Special Instructions
Raise		front of vehicle	***WARNING:*** *Support on safety stands.*
Disconnect	**1.**	multiplug from sensor	
Remove	**2.**	screw from starter motor bracket	
"	**3.**	bolts from adaptor plate	2 off. See **TORQUE WRENCH SETTINGS**
"	**4.**	sensor from adaptor plate	
"	**5.**	spacer from crankshaft sensor	***CAUTION:*** *Correct spacer must be fitted.*
Clean		components	
Reassemble		components	



M.E.M.S. RELAY MODULE

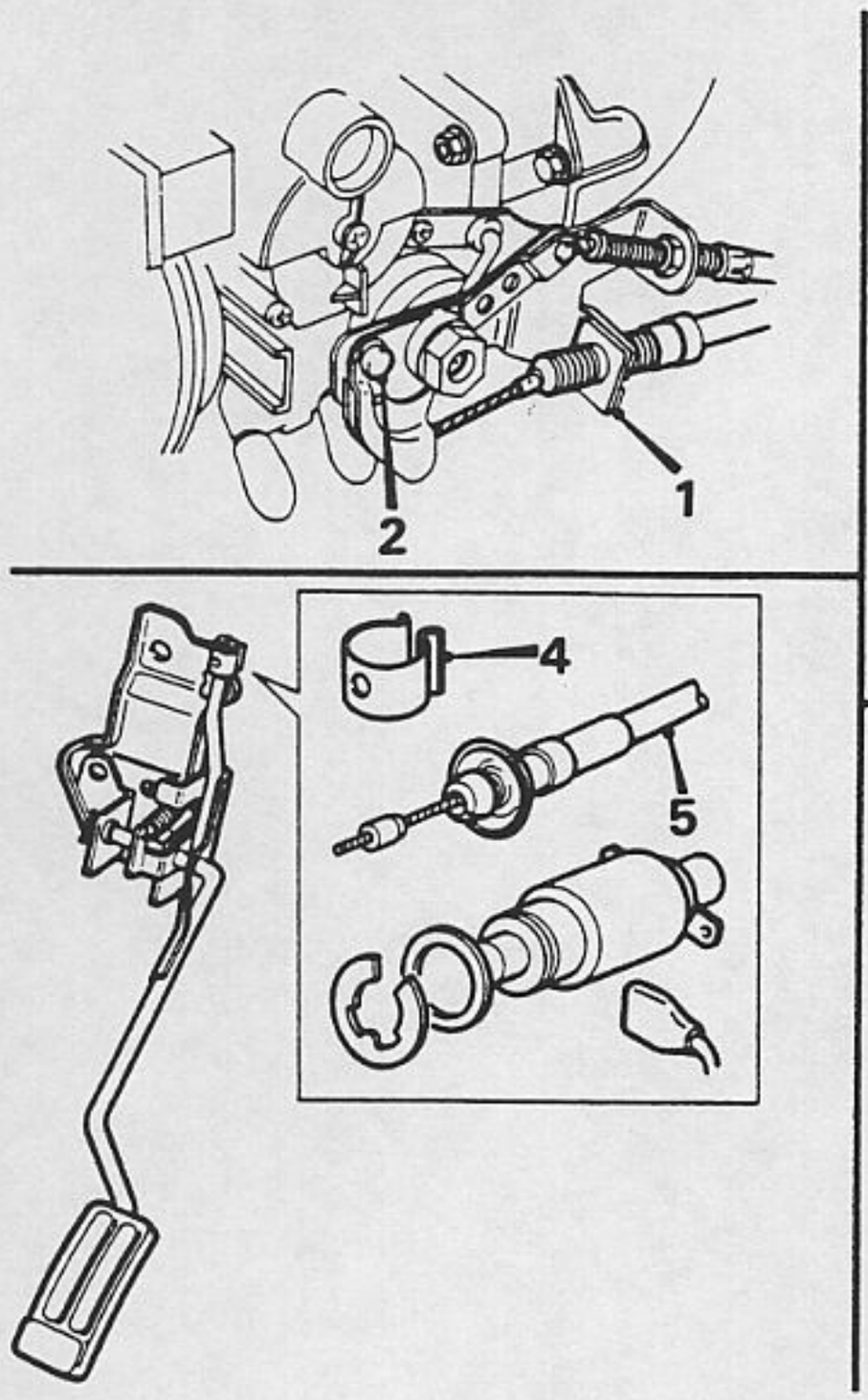
Action	Ref.	Detail	Special Instructions
Release	1.	relay module from clip	
Disconnect	2.	multiplugs	2 off.
Remove		relay module	
Reassemble		components	



19M 0214

THROTTLE PEDAL SWITCH – before VIN 152206

Action	Ref.	Detail	Special Instructions
Remove	**1.**	retaining clip from pedal	
Release	**2.**	cable from pedal	
Remove	**3.**	bolts holding pedal to bulkhead	***Note:*** *3 off on R.H.D., 4 off on L.H.D.*
Release	**4.**	pedal	
Disconnect	**5.**	leads from switch	2 off.
Remove		pedal	
"	**6.**	'C' clip holding switch to pedal	
"	**7.**	switch	
"	**8.**	washer	
Reassemble		components	

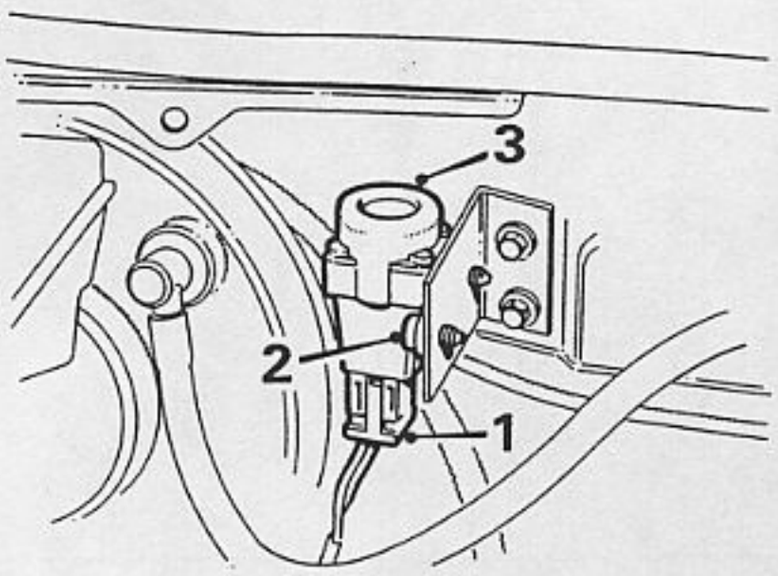


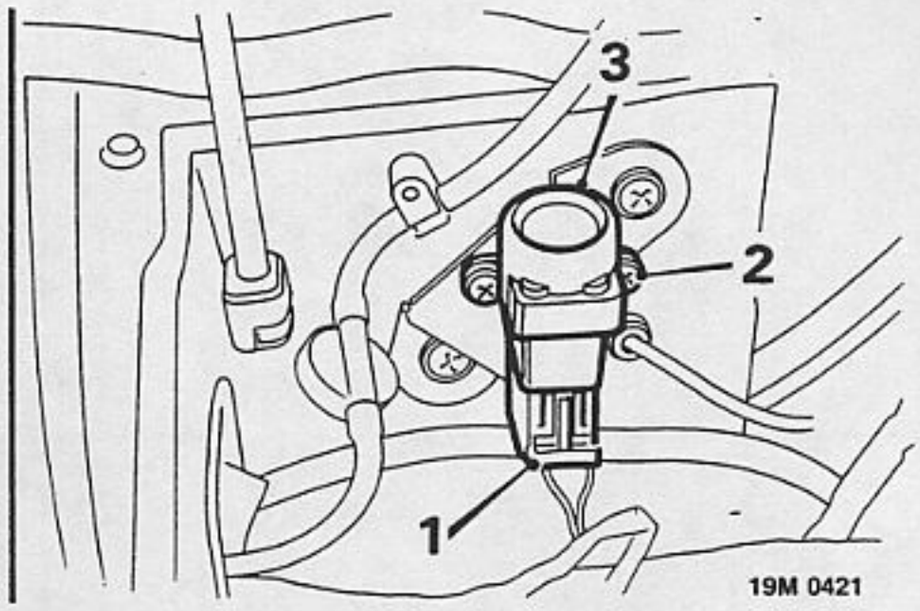
19M 0215

Before VIN 152206 illustrated

THROTTLE CABLE

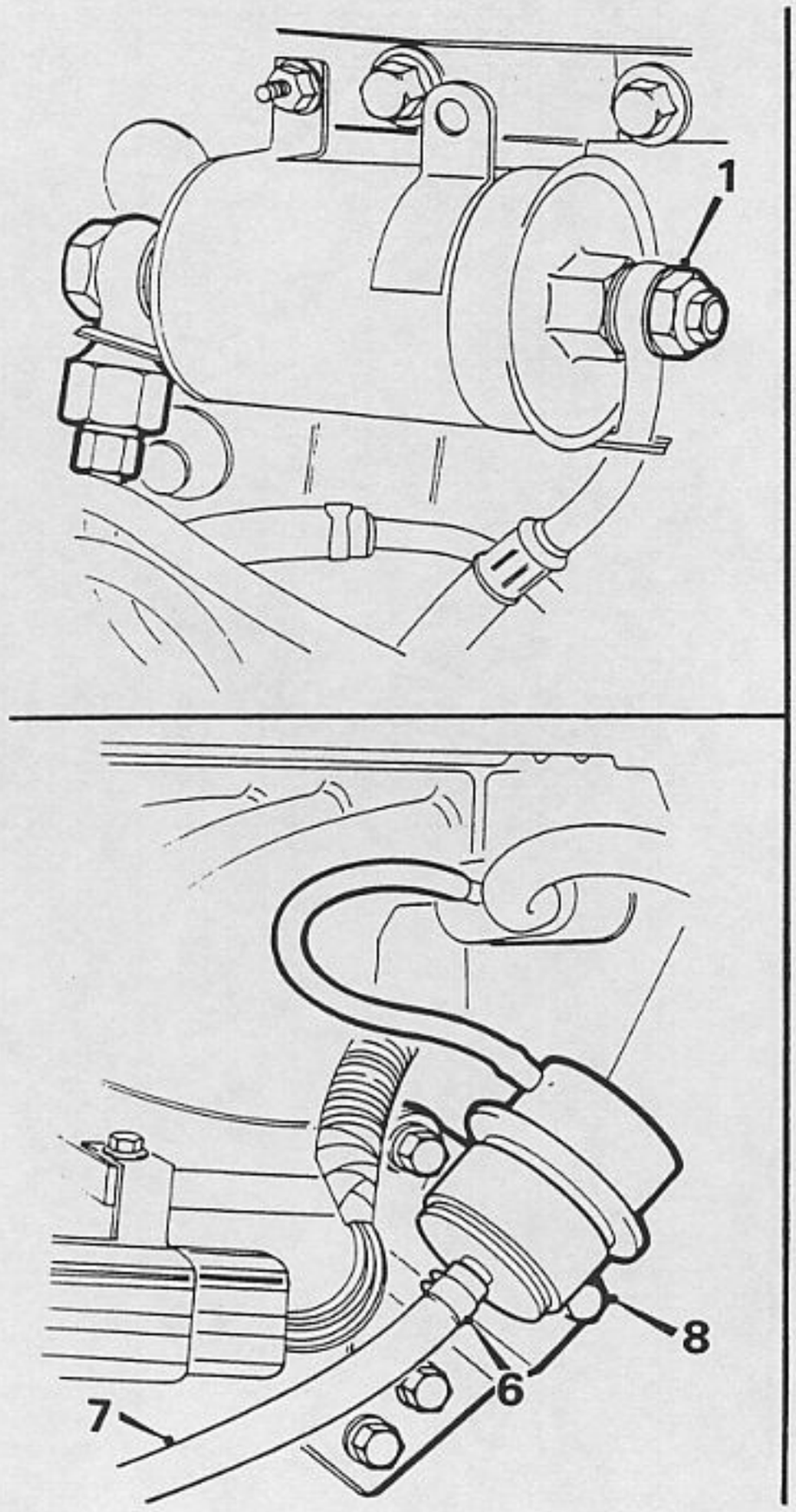
Action	Ref.	Detail	Special Instructions
Release	1.	throttle cable from abutment bracket	
"	2.	inner cable from throttle cam	
"	3.	throttle cable from clip(s)	
Remove	4.	clip securing throttle cable to pedal	
Release	5.	cable from pedal	
"	6	Cable retainer from bulkhead	Rotate through 90°
Remove		cable assembly into engine bay	
Reassemble		components	
Adjust		throttle cable	

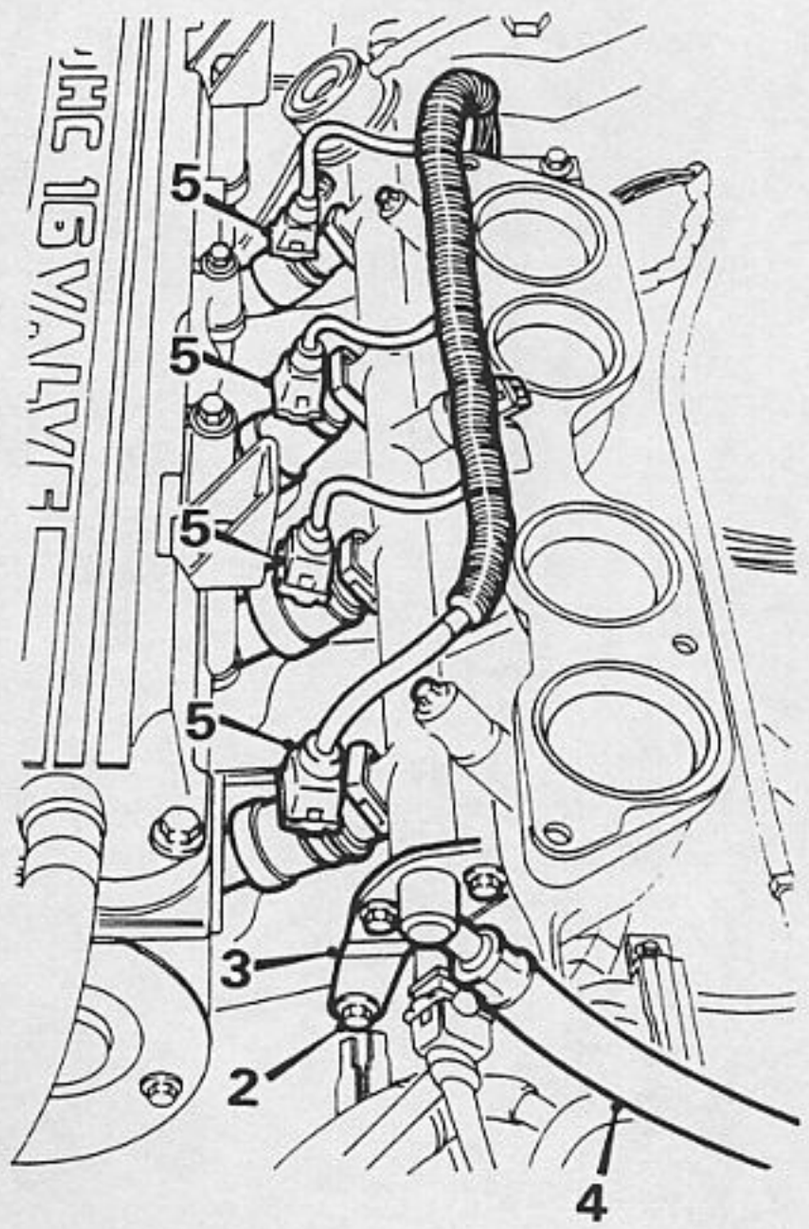




INERTIA SWITCH

Action	Ref.	Detail	Special Instructions
Disconnect	**1.**	multiplug from switch	
Remove	**2.**	screws securing switch	2 off.
"	**3.**	switch	
Reassemble		components	





19M 0217

FUEL RAIL

Action	Ref.	Detail	Special Instructions
Slacken	**1.**	union from banjo bolt	***CAUTION:*** *Cover union with rag to prevent spray when system is depressurised.* ***WARNING:*** *Tighten union once system is depressurised.*
Remove		manifold chamber gasket	See **MANIFOLD & EXHAUST 2.0**
"	**2.**	bolts securing fuel feed hose flange bracket	4 off.
"	**3.**	fuel feed hose flange bracket	
Disconnect	**4.**	fuel feed hose from fuel rail	Plug hose and rail. See **TORQUE WRENCH SETTINGS**
Disconnect	**5.**	multiplugs from injectors	4 off.
Move		injector multiplug harness aside	
Release	**6.**	clip from hose	
Disconnect	**7.**	fuel pipe return hose from pressure regulator valve	Plug pipe and hose.
Slacken	**8.**	bolts securing regulator valve stiffening plate	4 off.

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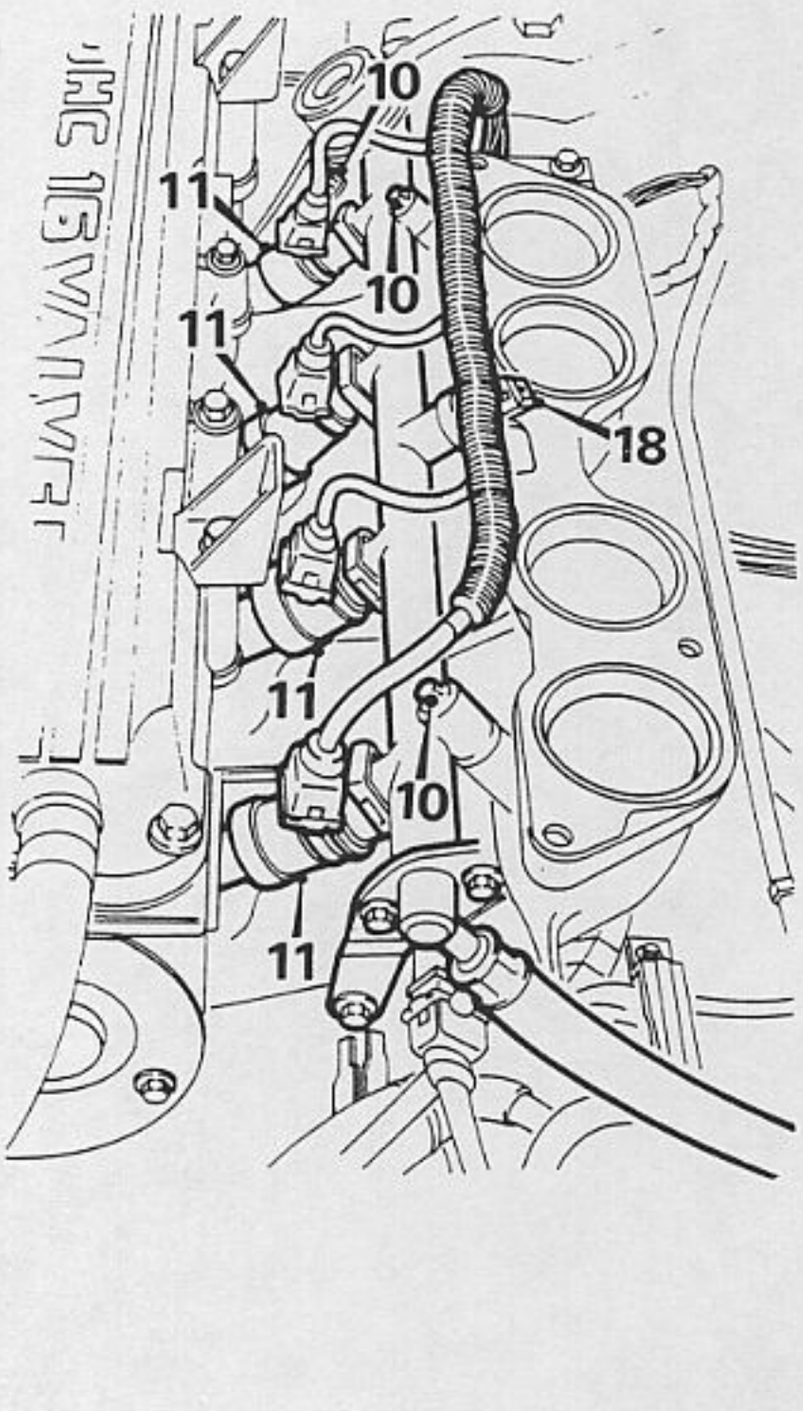
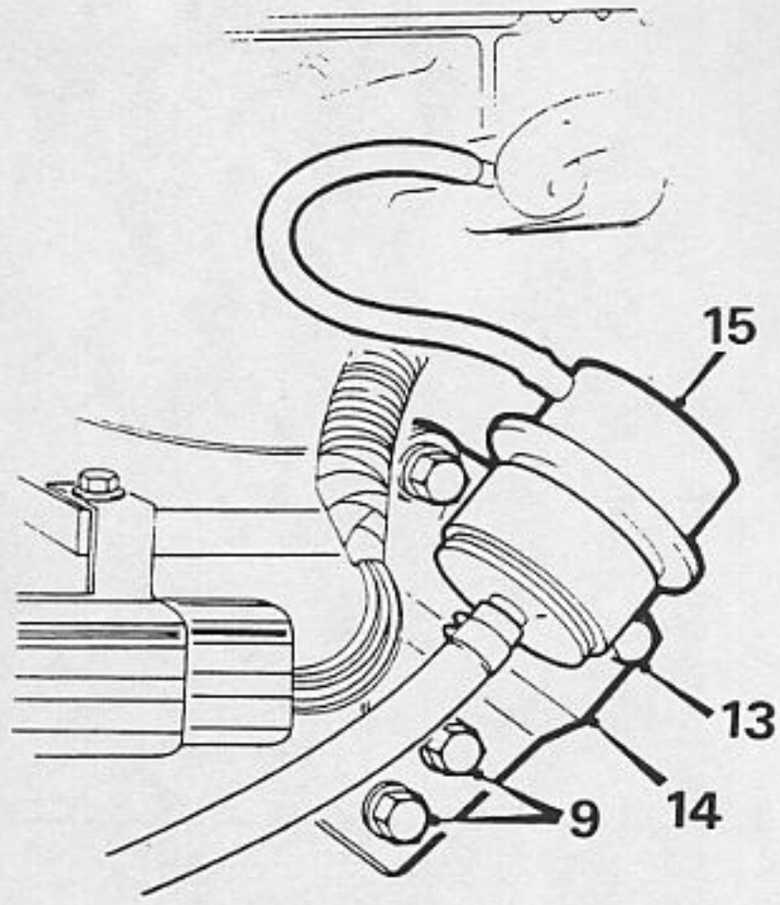
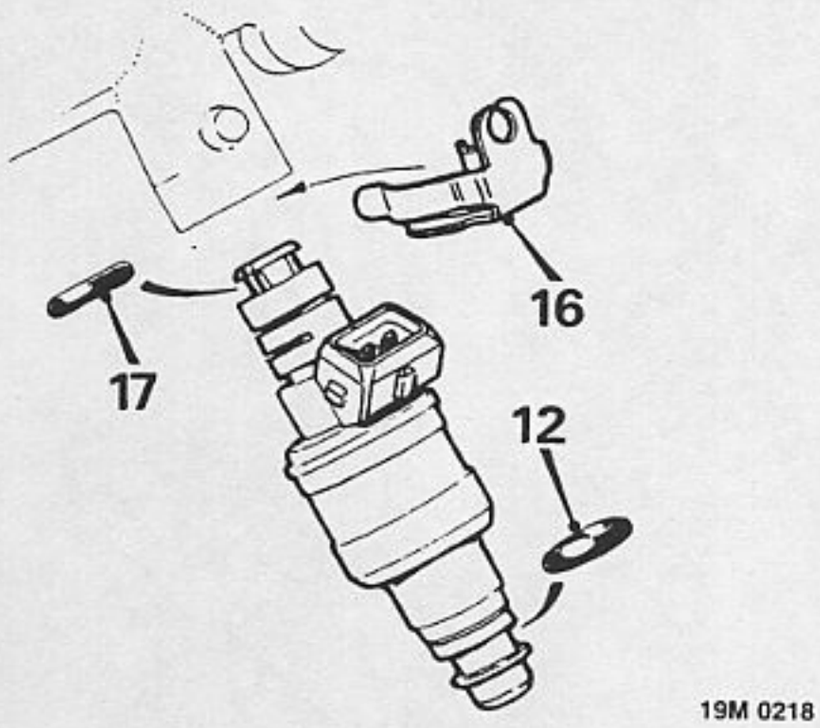


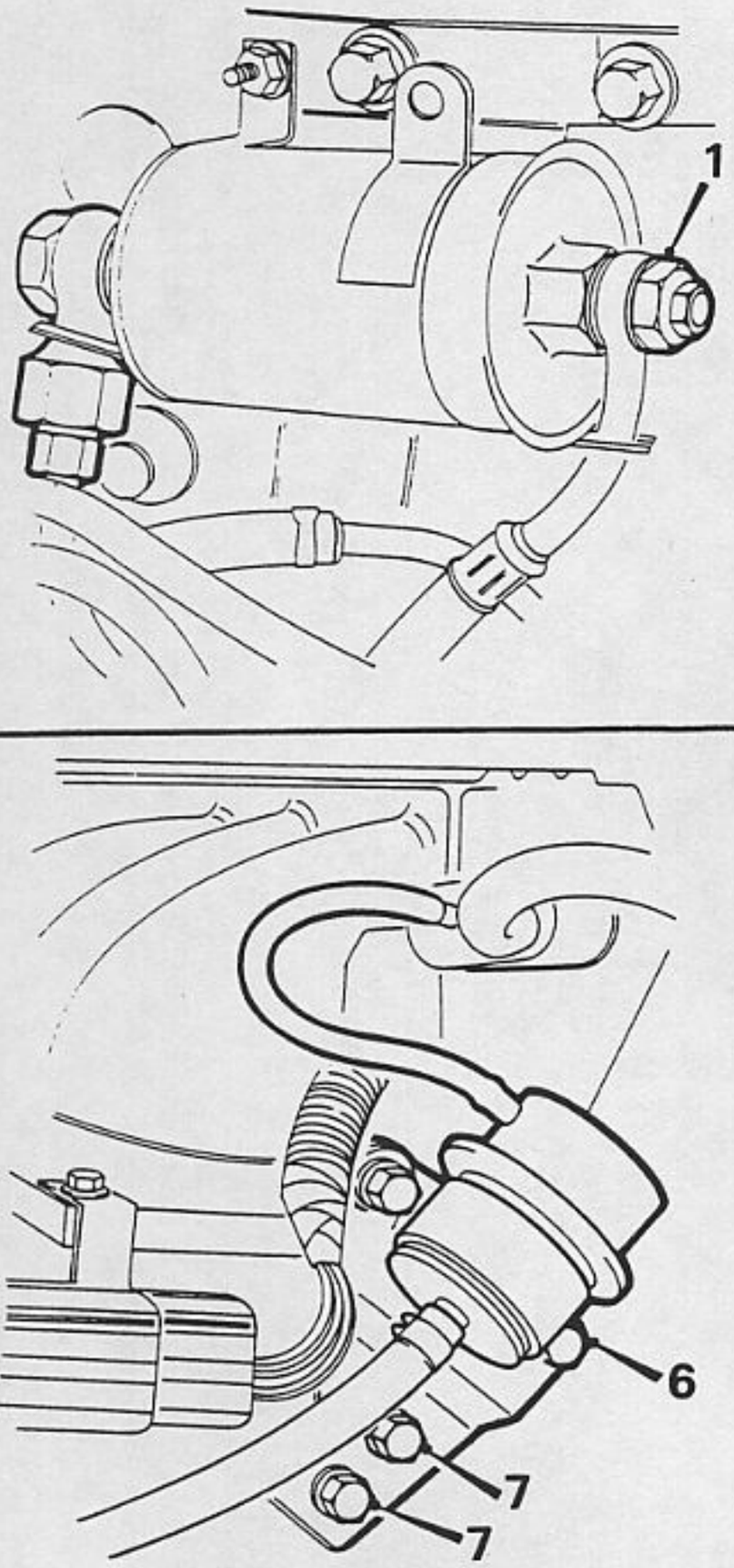


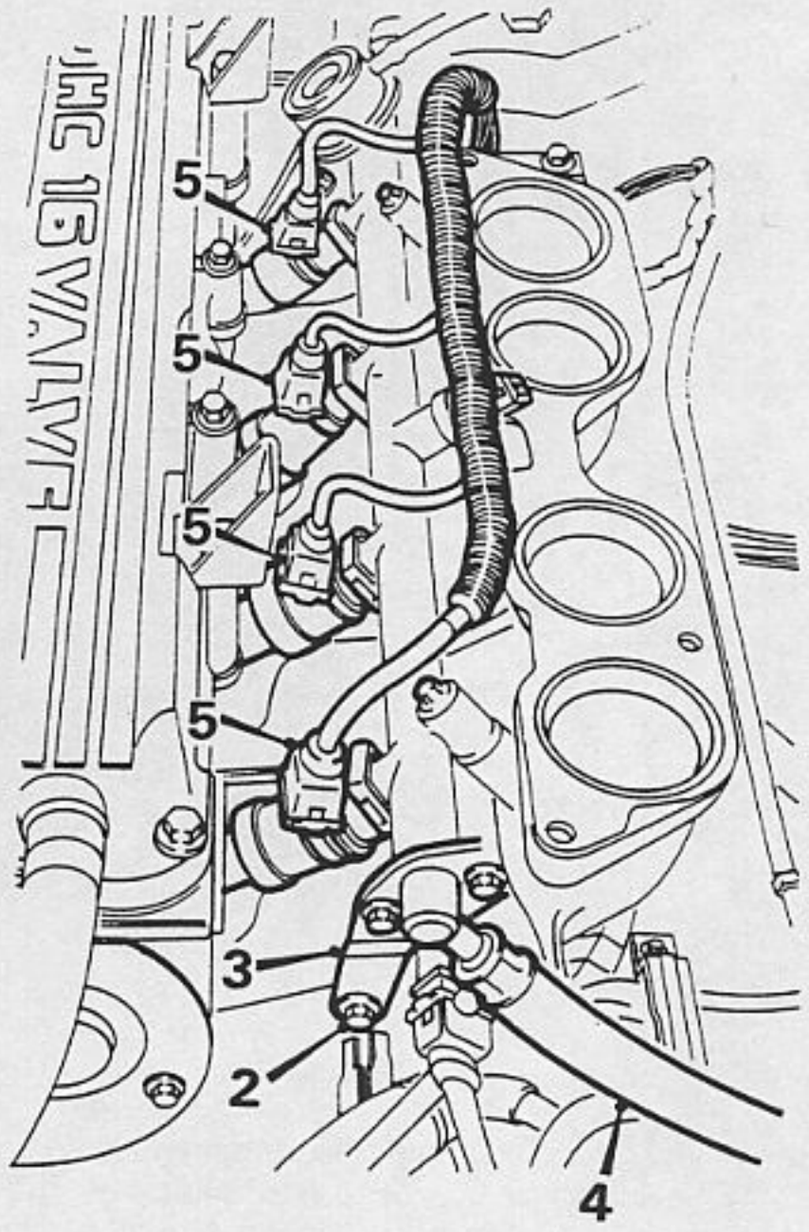


19M 0218

Remove	**9.**	bolts securing stiffening plate to inlet manifold	2 off.
"	**10.**	bolts securing fuel rail to manifold	3 off. See **TORQUE WRENCH SETTINGS**
Release	**11.**	injectors from manifold	4 off.
Remove		fuel rail complete with injectors and pressure regulator	
"	**12.**	'O' ring seals from injectors	4 off. Discard.
"	**13.**	bolts securing pressure regulator to fuel rail	2 off.
"	**14.**	stiffening plate	
"	**15.**	pressure regulator	
"		'O' ring seal	Discard.
"	**16.**	clips securing injectors to fuel rail injectors	4 off.
"	**17.**	'O' ring seals	4 off. Discard.
"	**18.**	fuel temperature sensor	
Clean		components and sealing faces	
Reassemble		components	

Repairs 26

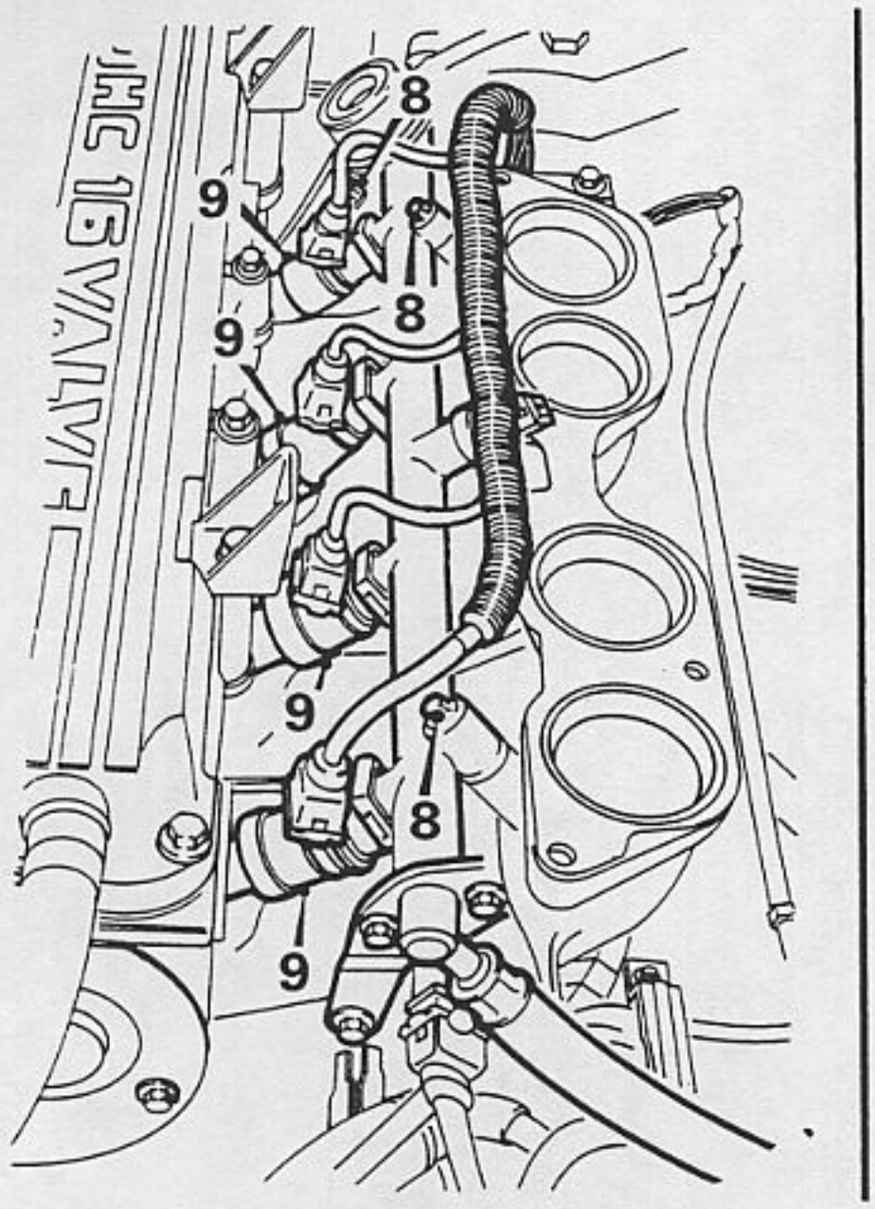


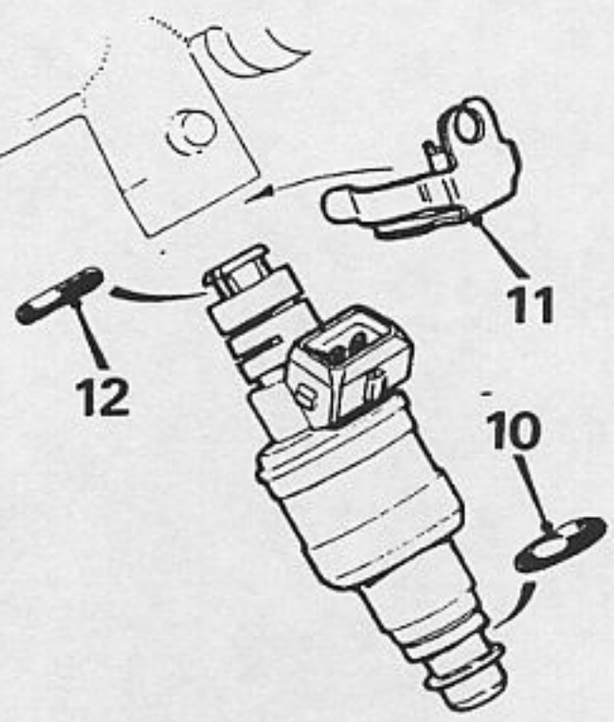


19M 0219

INJECTORS

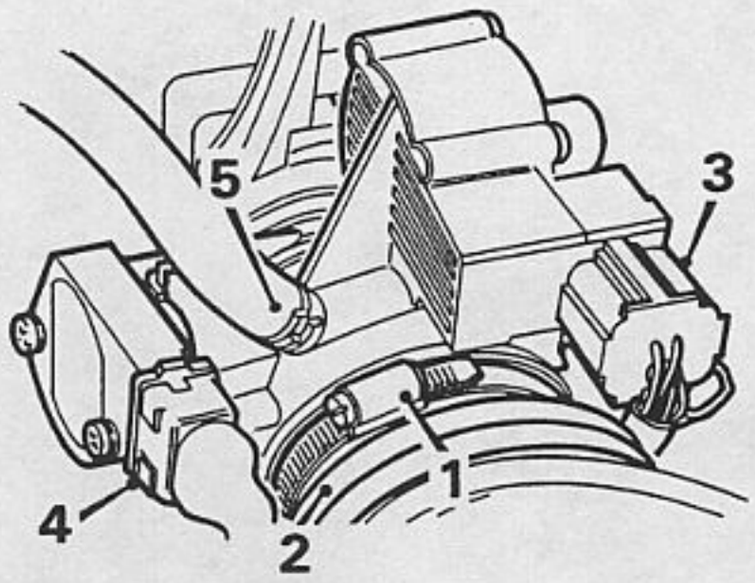
Action	Ref.	Detail	Special Instructions
Slacken	**1.**	union from banjo bolt	***CAUTION:*** *Cover union with rag to prevent spray when system is depressurised.* ***WARNING:*** *Tighten union once system is depressurised.*
Remove	**2.**	bolts securing fuel feed hose flange bracket	4 off. See **TORQUE WRENCH SETTINGS**
"	**3.**	bracket	
Disconnect	**4.**	fuel feed hose from fuel rail	Plug hose and rail.
Disconnect	**5.**	multiplugs from injectors	4 off.
Move		injector multiplug harness aside	
Slacken	**6.**	bolts securing regulator valve to fuel rail	2 off.
Remove	**7.**	bolts securing stiffening plate to inlet manifold	2 off.

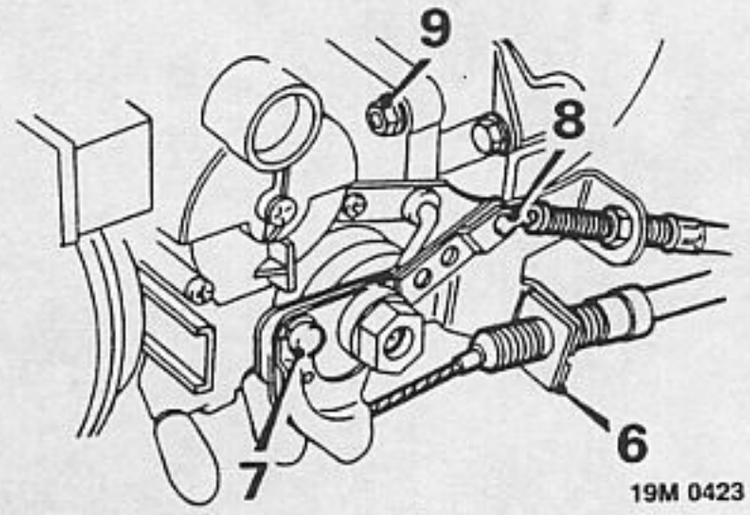




19M 0220

Remove	**8.**	bolts securing fuel rail to manifold	3 off. See **TORQUE WRENCH SETTINGS**
Release	**9.**	injectors from manifold	4 off.
Remove		fuel rail complete with injectors and pressure regulator	
"	**10.**	'O' ring seals from injectors	4 off. Discard.
"	**11.**	clips securing injectors to fuel rail	4 off.
"		injectors	
"	**12.**	'O' ring seals	4 off. Discard.
Clean		components and sealing faces	
Reassemble		components	

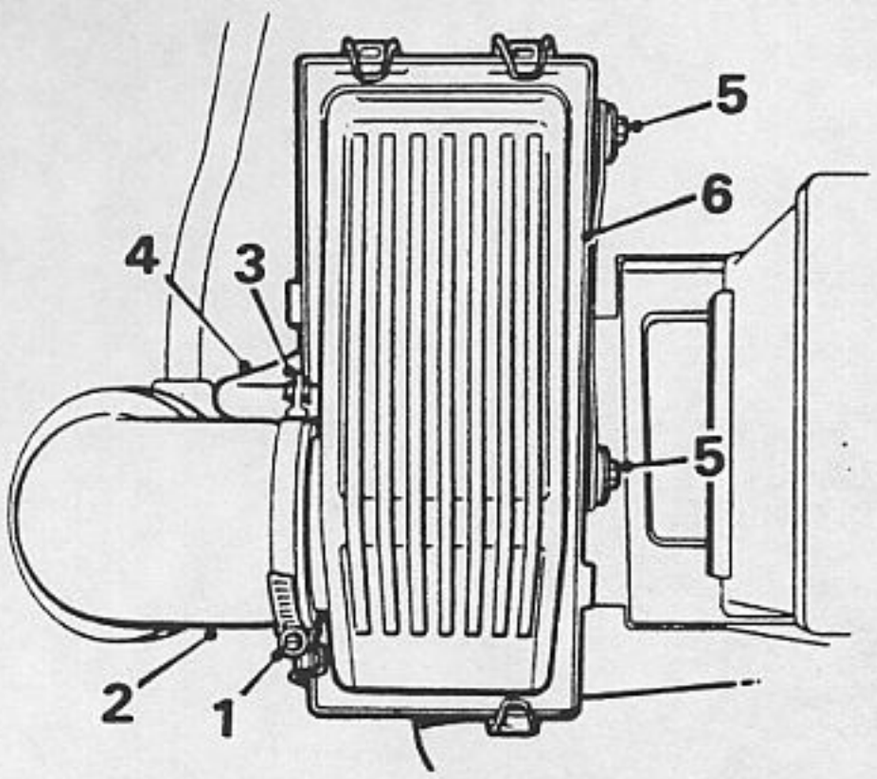


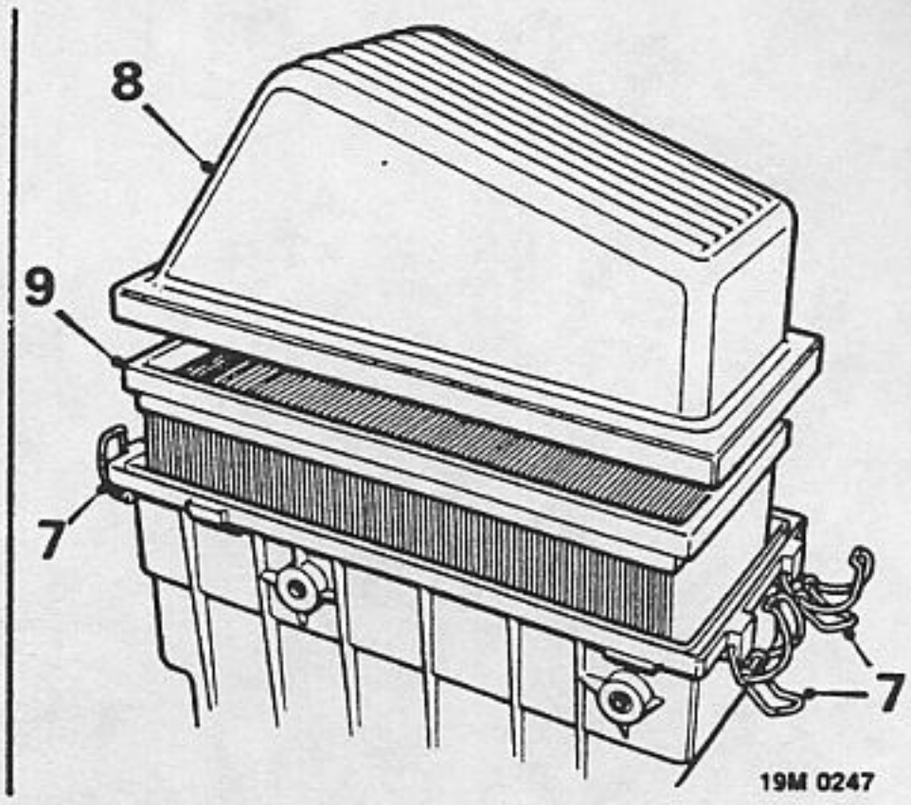


19M 0423

THROTTLE HOUSING

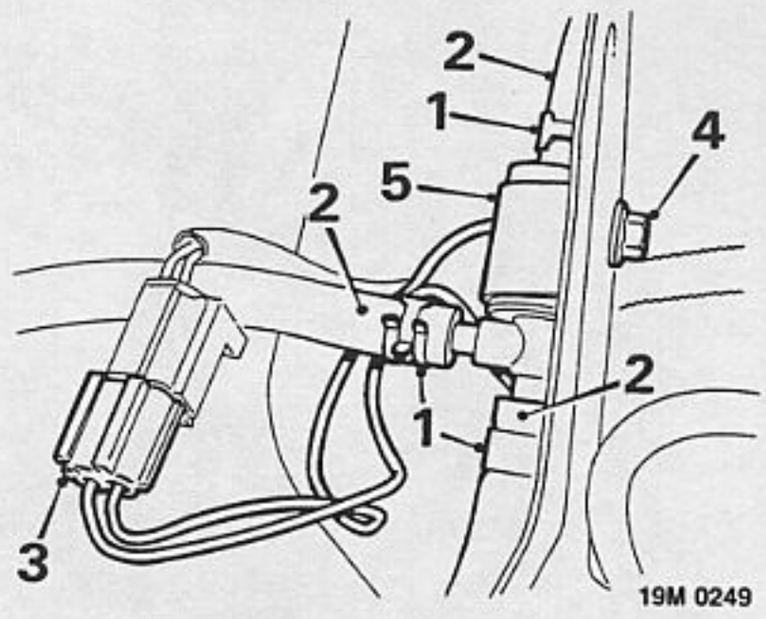
Action	Ref.	Detail	Special Instructions
Slacken	**1.**	clip from intake hose	2 off.
Remove	**2.**	intake hose from throttle housing	
Disconnect	**3.**	multiplug from stepper motor	
"	**4.**	multiplug from potentiometer	
"	**5.**	breather hose(s) from throttle housing	2 off on some models.
Release	**6.**	throttle cable from abutment bracket	
"	**7.**	inner cable from cam lever	
Disconnect	**8.**	kick – down cable from cam lever	Automatic only
Remove	**9.**	nuts from throttle housing	4 off. See **TORQUE WRENCH SETTINGS**
"		throttle housing from mounting	
Clean		components	
Reassemble		components	
Adjust		throttle cable	





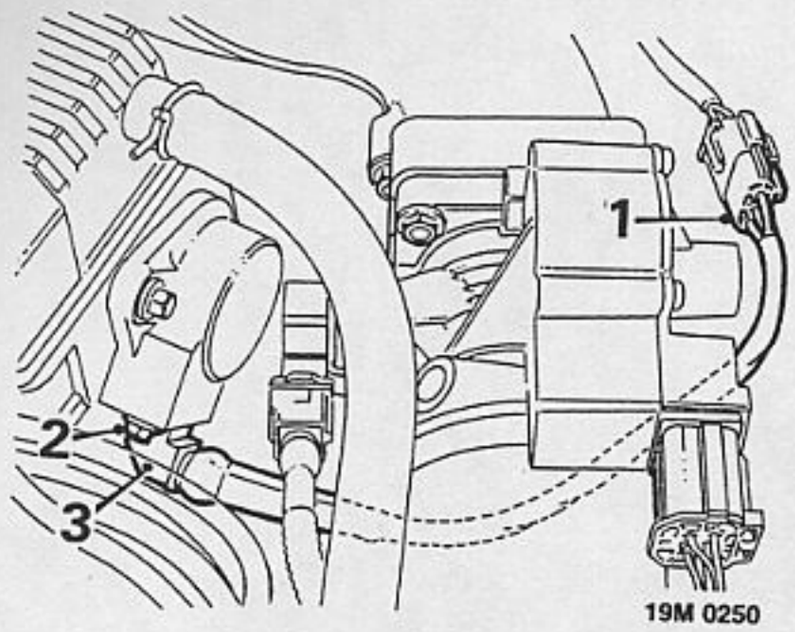
AIR CLEANER ASSEMBLY – TURBO

Action	Ref.	Detail	Special Instructions
Slacken	1.	clip from air cleaner hose	
Release	2.	hose from air cleaner	
"	3.	clip from boost control solenoid valve hose	
"	4.	hose from air cleaner	
Remove	5.	bolts securing air cleaner to bracket	2 off.
"	6.	air cleaner from mounting bracket	
Do not carry out further dismantling if component removed for access only.			
Release	7.	clips from top cover	4 off.
Raise	8.	top cover	
Remove	9.	element	Discard
Clean		body and top cover	
Reassemble		components	



BOOST CONTROL SOLENOID - TURBO

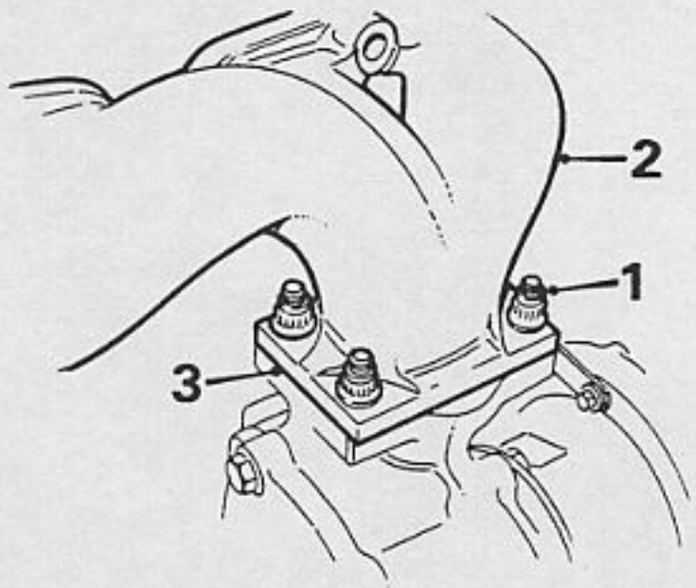
Action	Ref.	Detail	Special Instructions
Disconnect		both battery leads.	'–' lead first.
Remove		bolt and battery clamp	
"		battery	
"		air cleaner assembly	
Release	1.	clips from solenoid hoses	3 off.
"	2.	hoses from solenoid	3 off.
Disconnect	3.	multiplug from solenoid	
Remove	4.	bolt securing solenoid to battery tray	
Remove	5.	solenoid	
Clean		components	
Renew		components	If damaged.
Reassemble		components	

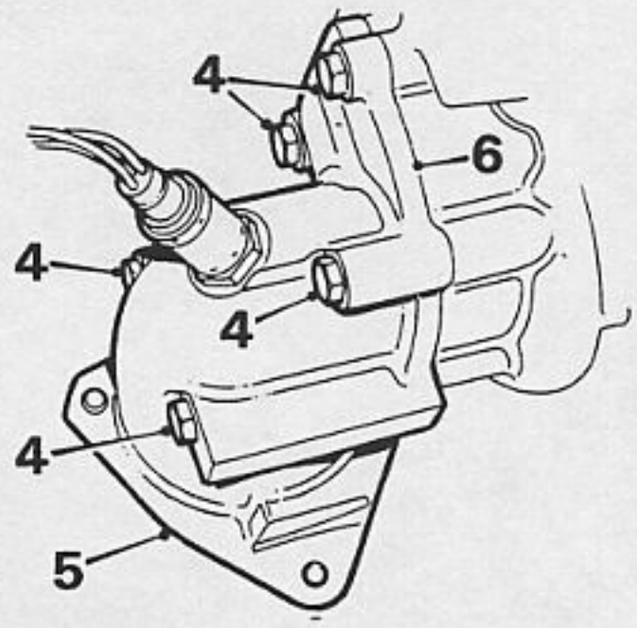


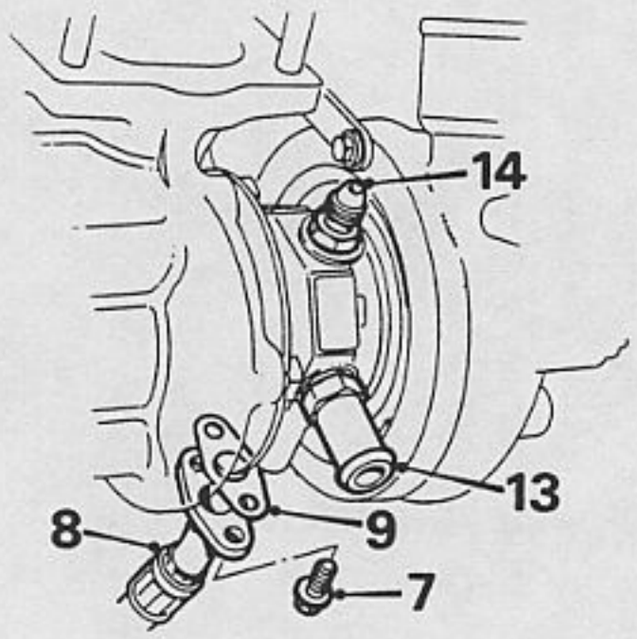
19M 0250

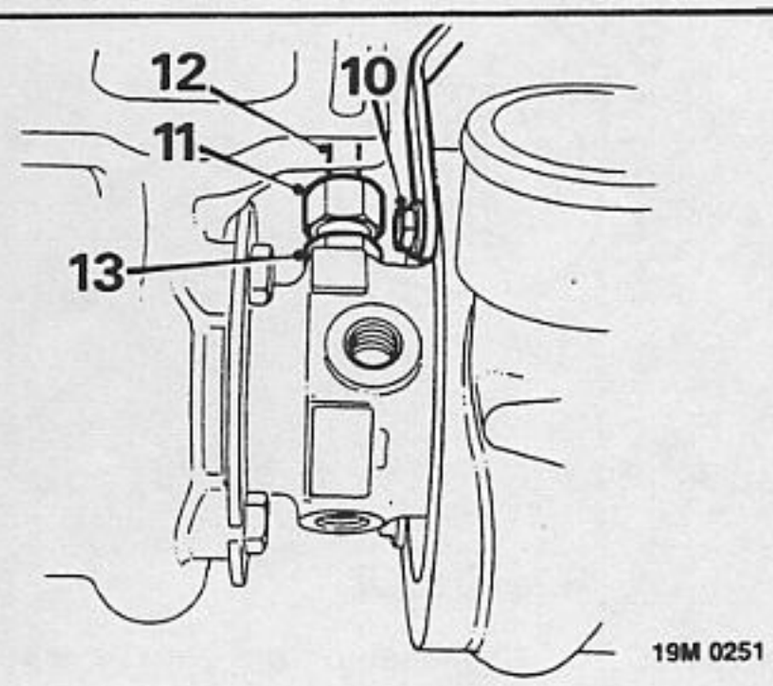
CAMSHAFT SENSOR - TURBO

Action	Ref.	Detail	Special Instructions
Disconnect	1.	sensor multiplug from engine harness	
Remove	2.	bolt from sensor	
"	3.	sensor	
Clean		components	
Renew		components	If damaged.
Reassemble		components	



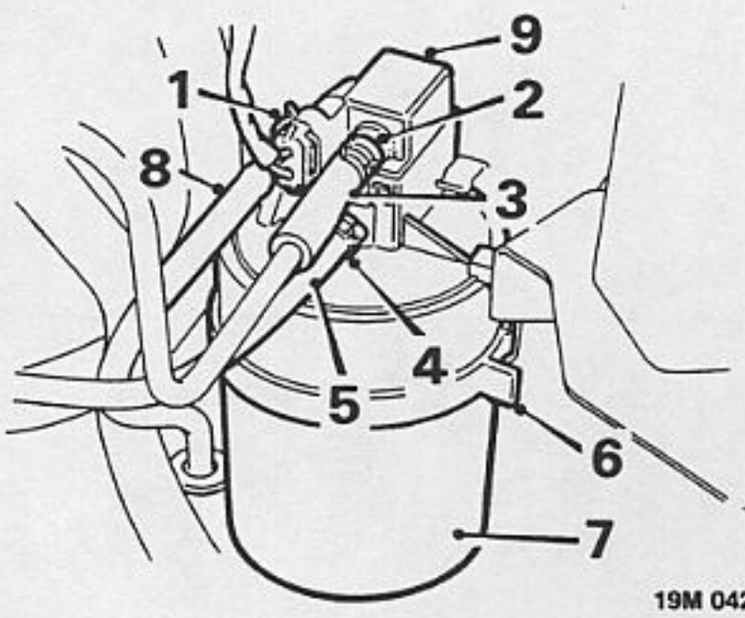






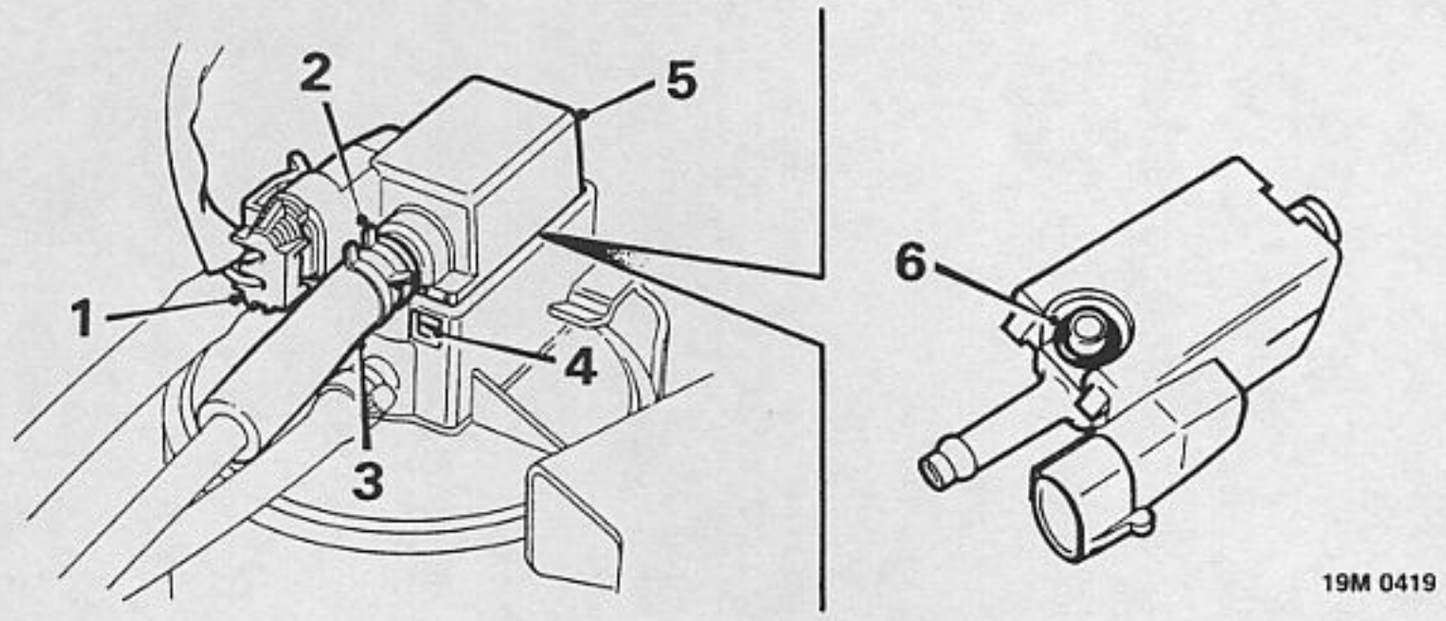
TURBOCHARGER

Action	Ref.	Detail	Special Instructions
Remove		exhaust manifold	See **MANIFOLD & EXHAUST 2.0**
"	**1.**	nuts securing turbocharger to exhaust manifold	4 off. See **MANIFOLD & EXHAUST**
"	**2.**	exhaust manifold from turbocharger	
"	**3.**	gasket	Discard and replace with new
"	**4.**	bolts from exhaust elbow	5 off. See **TORQUE WRENCH SETTINGS**
"	**5.**	exhaust elbow from turbocharger	
"	**6.**	gasket	Discard and replace with new
"	**7.**	bolts from oil return pipe	2 off.
"	**8.**	oil return pipe	
"	**9.**	gasket	Discard and replace with new
"	**10.**	bolt from coolant return pipe bracket	
Undo	**11.**	coolant return pipe union	
Remove	**12.**	coolant return pipe	
"	**13.**	coolant feed and return pipe adapters from turbocharger	Discard and replace with new
"	**14.**	oil feed pipe adapter from turbocharger	Discard and replace with new
Clean		components	***WARNING: Do not use an air line to blow gasket dust, asbestos dust can be a serious health hazard if inhaled. Use Methylated spirit or denatured alcohol to wash dust from components. Do not use any petroleum based fluids***
Renew		components	If damaged.
Reassemble		components	
Fill		cooling system	See **COOLING SYSTEM 2.0**
Renew		engine oil and filter	



CHARCOAL CANISTER – from VIN 152206

Action	Ref.	Detail	Special Instructions
Disconnect	**1.**	multiplug from purge control valve	
Release	**2.**	clip from purge control valve hose	
Disconnect	**3.**	hose from purge control valve	
Release	**4.**	Clip from fuel tank hose on charcoal canister	
Disconnect	**5.**	fuel tank hose from charcoal canister	
Release	**6.**	securing strap on canister	
Remove	**7.**	charcoal canister	
Disconnect	**8.**	vent hose from charcoal canister	
Remove	**9.**	purge control valve	Discard O ring.
Reassemble		components	***CAUTION:*** *Ensure correct location and security of connections.*



19M 0419

PURGE CONTROL VALVE - from VIN 152206

Action	Ref.	Detail	Special Instructions
Disconnect	**1.**	multiplug from purge control valve	
Release	**2.**	clip from hose	
Disconnect	**3.**	hose from purge control valve	
Release	**4.**	purge control valve from charcoal canister	
Remove	**5.**	purge control valve	
"	**6.**	'O' ring from purge control valve	Discard 'O' ring.
Reassemble		components	***CAUTION:*** *Ensure connections are secure and correct.*