Service Manual

Section	Group
2	23

LH-Jetronic system B21F

Fault tracing

VOLVO

Contents

TP 30413/1
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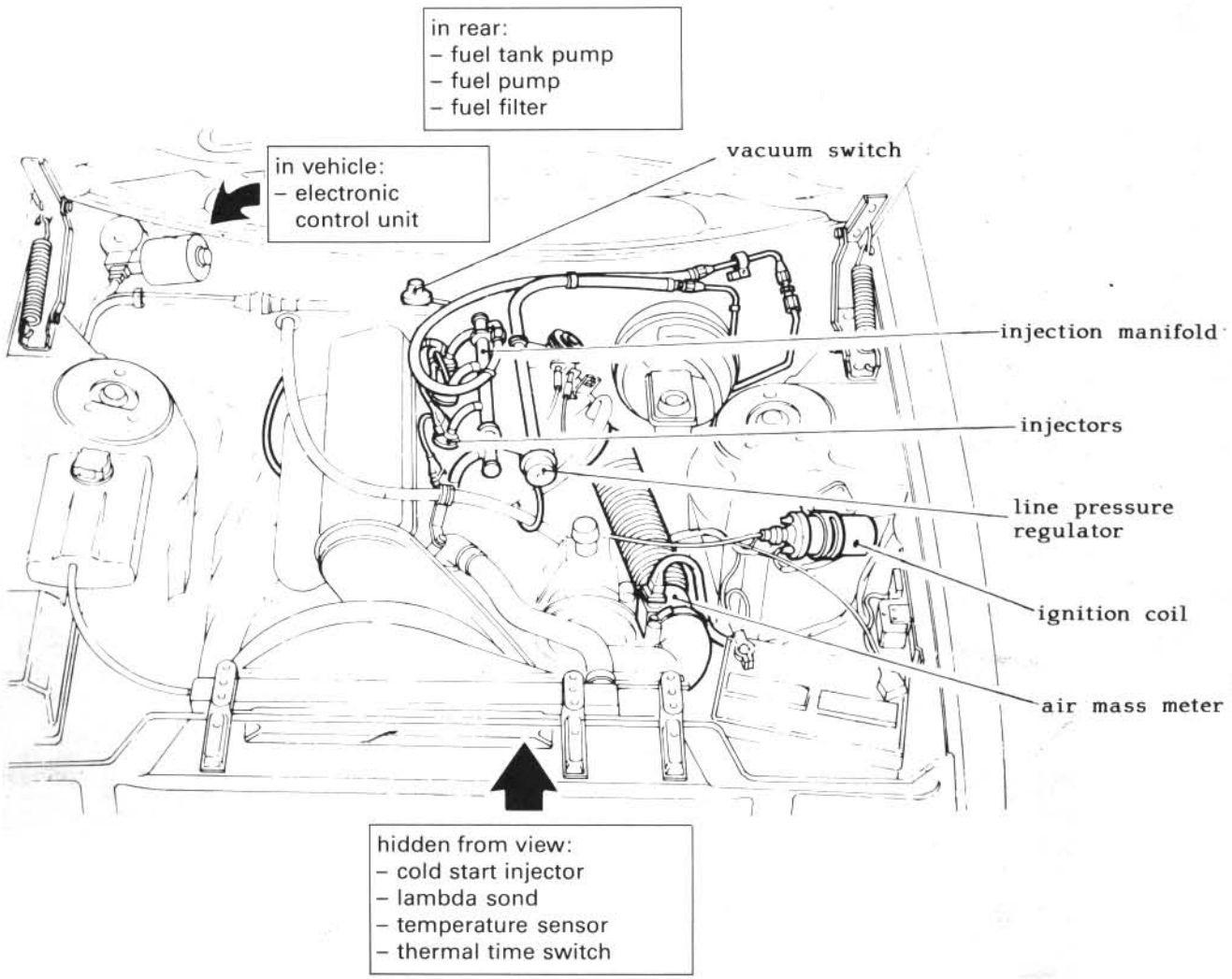
Printed in U.S.A.

LH-Jetronic system

System description

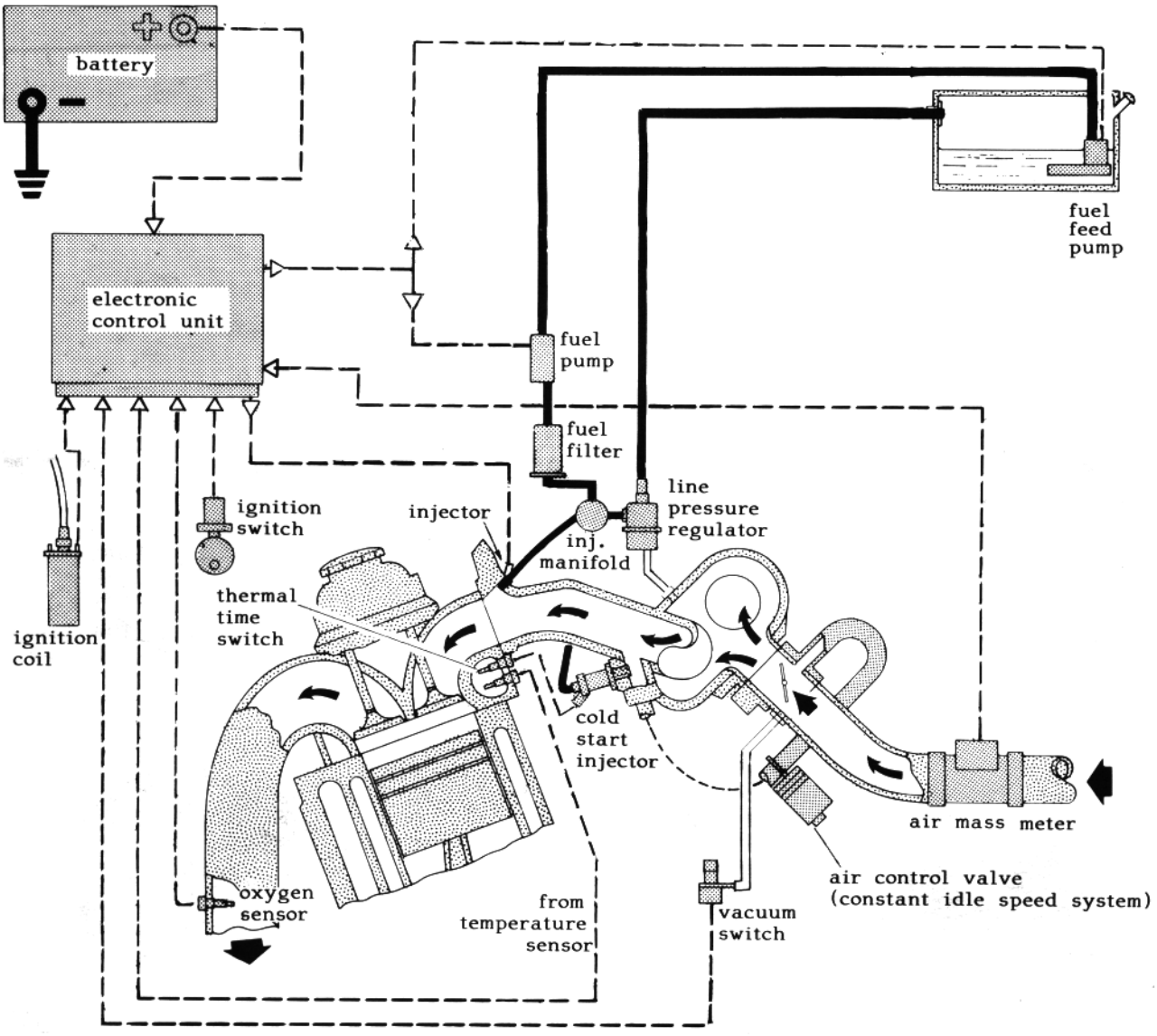


Location of components.

133502

LH-Jetronic is a newly designed fuel injection system. It utilizes a combination of all the best features known today.

It operates with a moderate fuel pressure which is held constant by a line pressure regulator. Injection is by means of electrically controlled solenoid valves in the **injectors** which squirt fuel close to the engine intake valves. The injection duration can be measured in milliseconds and is controlled by an **electronic control unit.** The electronic control unit receives signals on various driving, engine and ambient conditions from a set of **sensors.** Most important is the **air mass meter.** It utilizes a system that continuously measures the **mass** of air entering the induction system. This is accomplished by a platinum wire filament which is located in the intake air stream. It is held at a certain temperature above intake air temperature by a system of amplifiers, resistors and comparators. The current needed to do this is measured and a corresponding signal sent to the electronic control unit. When the engine stops, dirt build-up on the platinum wire filament is burned off by electrically raising the filament temperature to 1050° = 1920°F for less than one second. If dirt was allowed to stay on the filament, false signals would be received and the electronic control unit would order incorrect air/fuel mixture.



133503

The LH-Jetronic system consists of three functional sections:

Electronic Control Unit.

Receives and evaluates readings from the sensors around the engine. It includes a microprocessor and calculates the correct amount of fuel to be injected. It evaluates variations in engine conditions and produces a control signal to the injectors.

Fuel system.

Carries fuel from the tank through a fuel feed pump in the tank, an in-line fuel pump and a fuel filter to the injection manifold.

The line pressure regulator supplies injectors with fuel which is regulated to a constant pressure in relation to the pressure in the intake manifold.

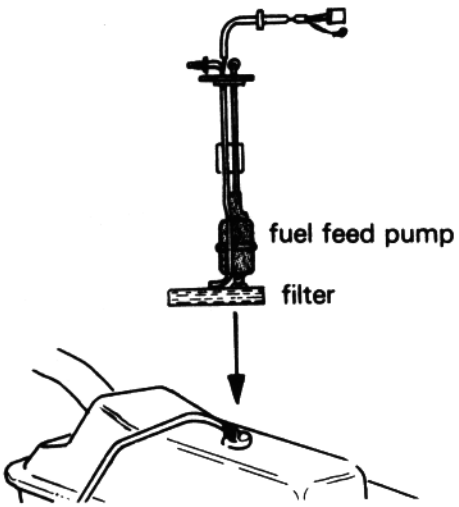
A cold start injector supplies extra fuel to the engine when starting cold. The electrical supply to this injector is controlled by the thermal time switch.

Sensors.

Measure the most important combustion parameters and transmit signals to the Electronic Control Unit.

- **Air mass meter** measures the induction air mass.
- **Vacuum switch,** indicates part load and full load/idle conditions.
- **Engine speed** is monitored by a connection to the ignition coil.
- **Oxygen sensor (Lambda-sond)** checks exhaust gas contents.
- **Coolant temperature sensor** checks engine coolant temperature.
- **During starting** a signal is sent from the ignition switch to the Electronic Control Unit to obtain a start program.

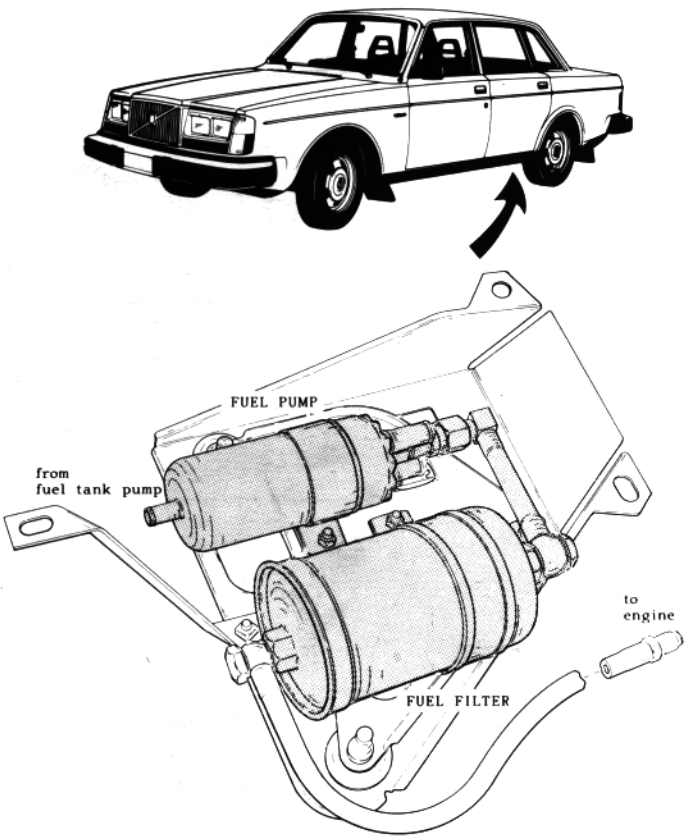
System components and specifications



133175

Fuel feed pump (tank pump).

Electrically operated vane pump, completely immersed in the gasoline in the fuel tank. It feeds fuel to the (main) fuel pump via a mesh screen and a check valve.



133176

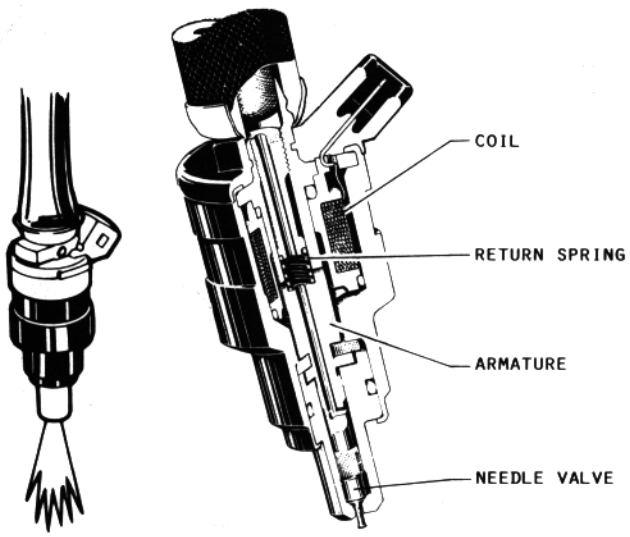
Fuel pump and fuel filter are attached to a bracket underneath the car, under left rear seat.

Fuel pump.

Electrically operated roller pump. Equipped with check valve and overpressure relief valve, which opens in case the system (particularly the fuel filter) becomes clogged and fuel pressure rises too high.

Fuel filter.

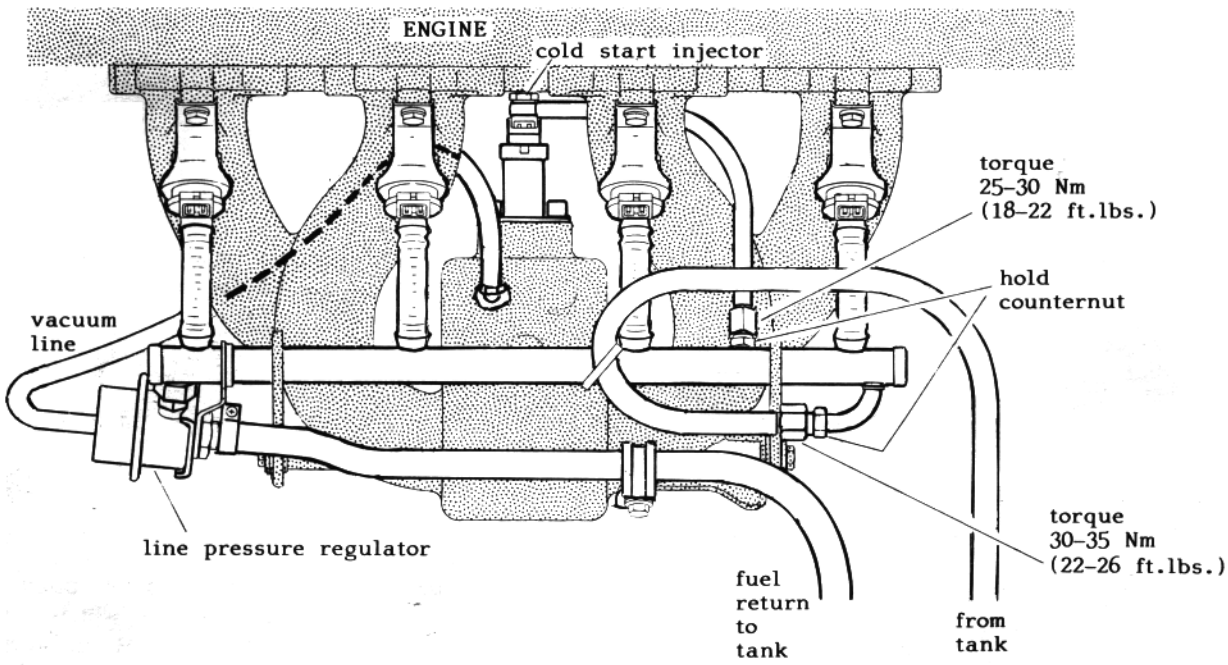
Has a paper element with a very small pore size and a mesh to trap any particles that may fall away from the paper element. The complete filter unit is discarded when replaced.



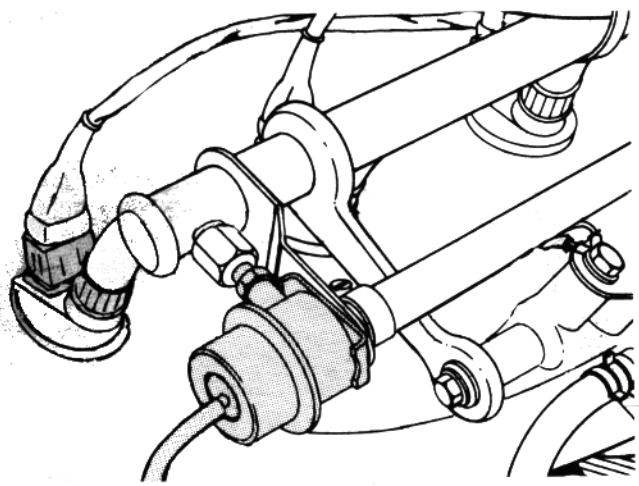
133513

Injectors.

Located on the intake manifold and connected by the injection manifold, which has connectors for the line pressure regulator and the cold start injector.
The injectors are solenoid-operated valves. The electronic Control Unit controls the duration of the injection time.



133178

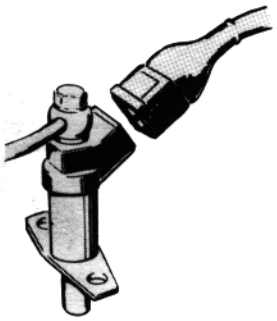


133179

Line pressure regulator.

Maintains a fuel pressure of 43.5 psi (early production vehicles: 35 psi) above intake manifold pressure. Excess fuel is bled off to the fuel tank via a return line.

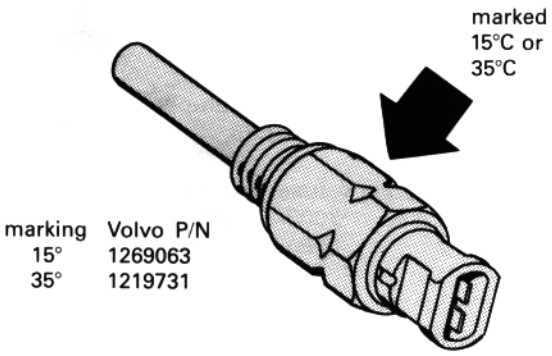
psi	Volvo P/N	Bosch No.
35	1306935	0 280 160 214
43.5	1306965	0 280 160 213



133180

Cold start injector.

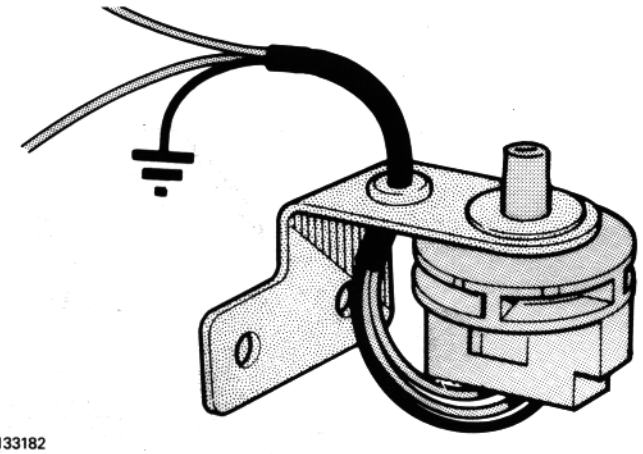
Supplies extra fuel to the engine and is controlled by the thermal time switch. The cold start injector is a solenoid-operated valve and operates when the starter is energized.



133181

Thermal time switch.

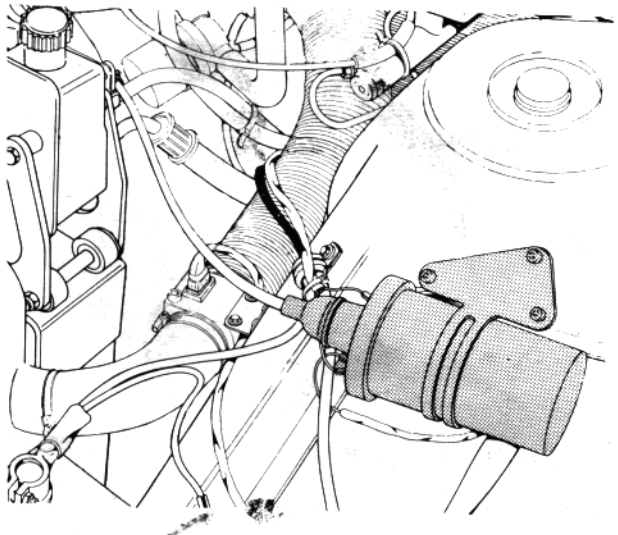
Controls current to the cold start injector and is influenced by engine coolant temperature. It causes termination of cold start fuel injection at engine temperatures above 35 °C =95 °F (early production vehicles: 15 °C =60 °F). A heating coil, acting on a bi-metal strip, provides for maximum injection time at low temperatures. Injection time decreases at higher temperatures.
The thermal time switch and cold start injector only operate while the starter motor is switched on.



133182

Vacuum switch.

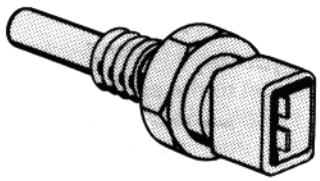
"Used to indicate full load/idle (low ported vacuum) and part load conditions (maximum vacuum)."



133183

Engine speed and injection timing.

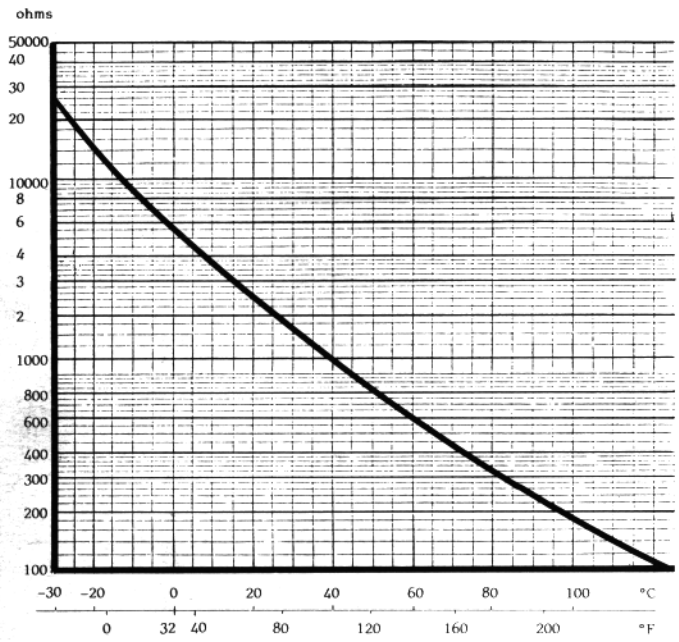
Engine speed pulses are tapped from the low tension side of the ignition coil. Provide both engine speed and injection timing information to the Electronic Control Unit.



133184

Coolant temperature sensor.

Is screwed into the cylinder head. As the engine coolant temperature increases, the resistance in the sensor falls, giving an analog temperature signal to the Electronic Control Unit.

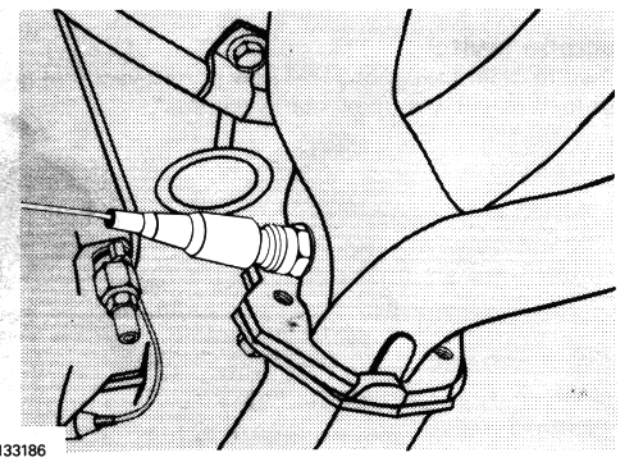


133148

Graph at left shows how coolant temperature sensor resistance changes with temperature.

Below are three test point values, taken from diagram:

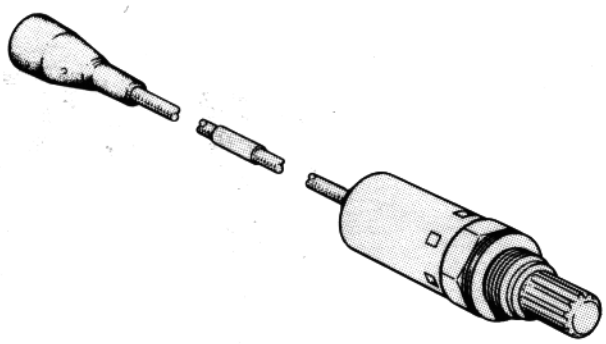
–10°C = 14°F	7000–116000 ohms
20°C = 68°F	2100–2900 ohms
80°C = 175°F	270–390 ohms



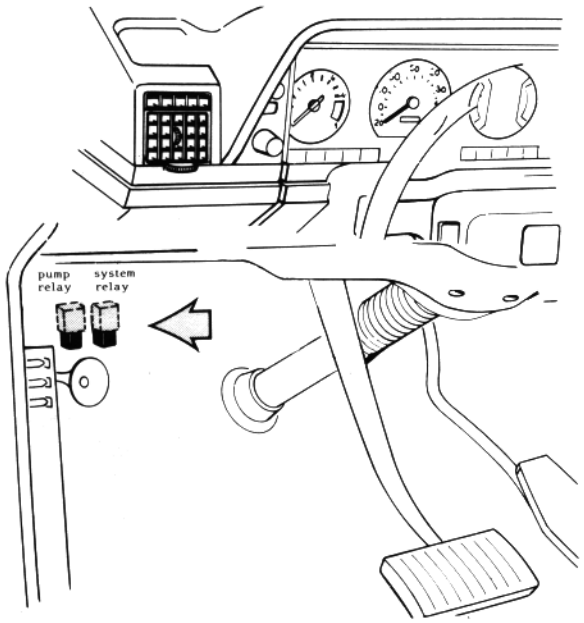
133186

Oxygen sensor (Lambda-sond).

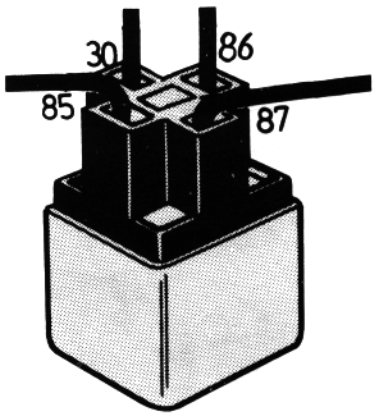
Is located in the exhaust manifold. It measures the oxygen level in the exhaust gases and provides an electrical signal to the Electronic Control Unit.



133185



133188



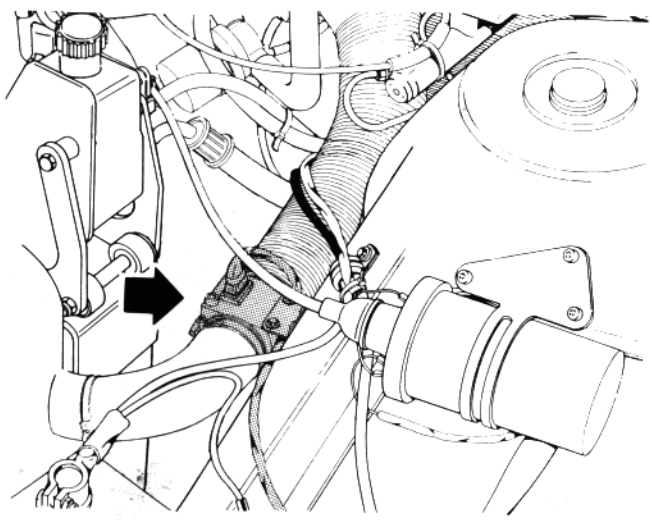
133187

Fuel pump relay.

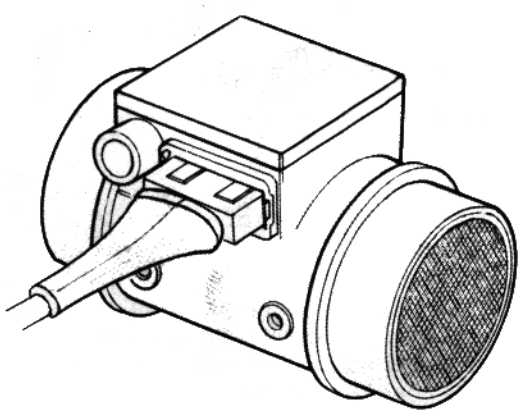
Energizes the fuel feed pump (tank pump) via a separate fuse, and the main fuel pump.

System relay.

Provides current to the Electronic Control Unit. It is energized during filament dirt burn-off after the ignition has been switched off.



133190

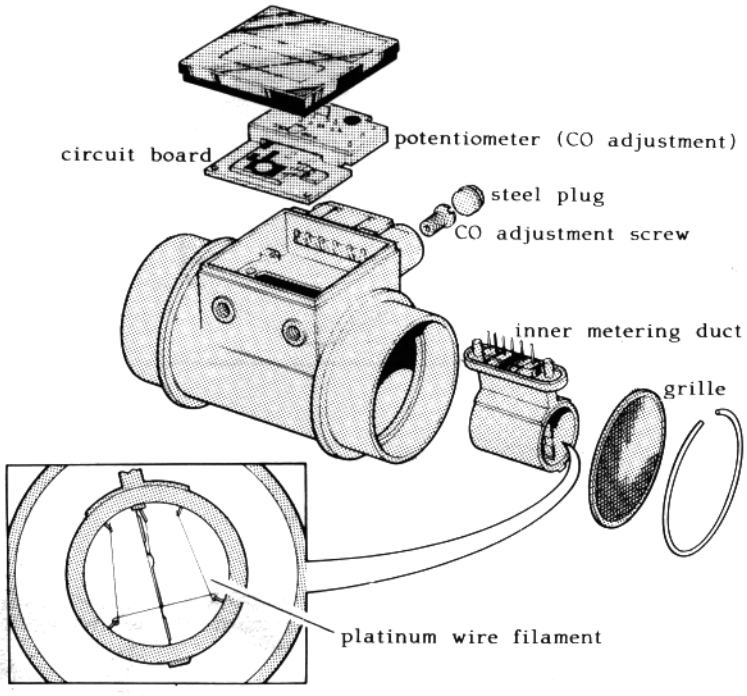


133504

Air mass meter.

Is unique to the LH-Jetronic system. It measures air flow by mass (CI fuel injection system measures by volume). The basic sensing information is provided by a heated platinum wire.

When engine is stopped, dirt build-up on the platinum wire filament is burned off electrically by raising the filament temperature to 1050°C for less than one second.

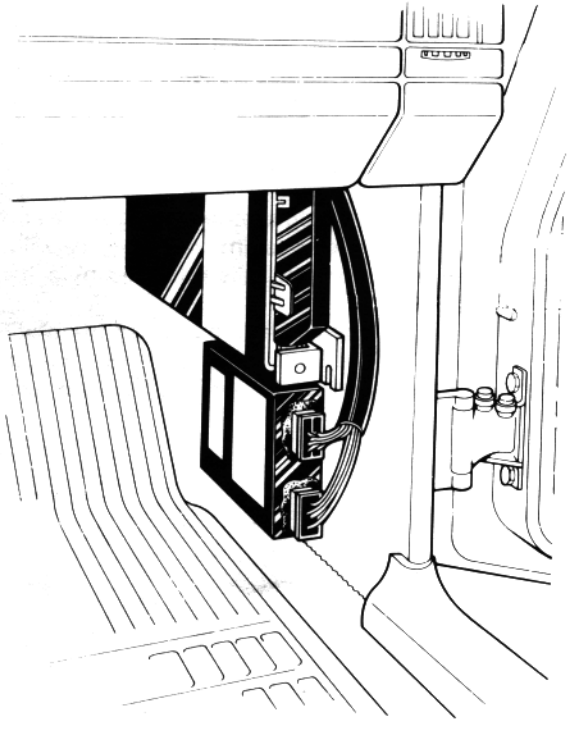


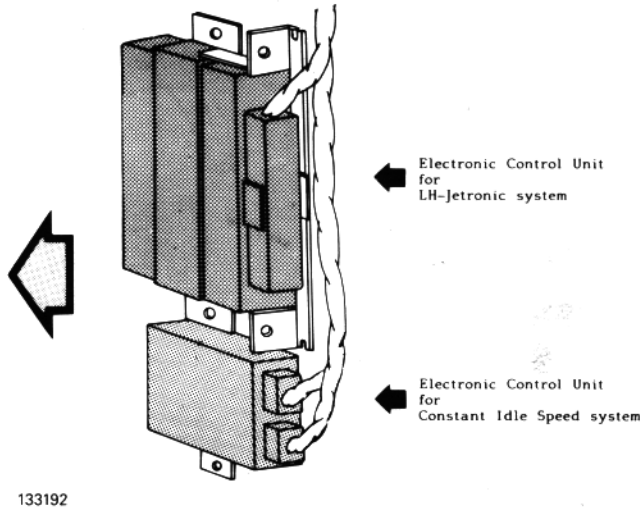
CO adjustment is accomplished by a screw on the air mass meter. The screw is connected by a spring to a linear potentiometer of 1000 ohms. The potentiometer is located on the circuit board inside the air mass meter. It has a range of 15 turns and lacks distinct end stops. The potentiometer adds a voltage to the output signal from the air mass meter. The amount of fuel injected can be changed by 40%. Zero ohms on the potentiometer, measured across terminals 6 and 12, provides maximum lean condition. Turning the screw counter-clockwise makes the idle mixture richer.

Idle CO should be 0.6% (0.4–0.8% permitted) with the oxygen sensor disconnected.

When delivered from factory, the CO adjustment screw is sealed by an aluminium plug with a hardened steel insert.

133501



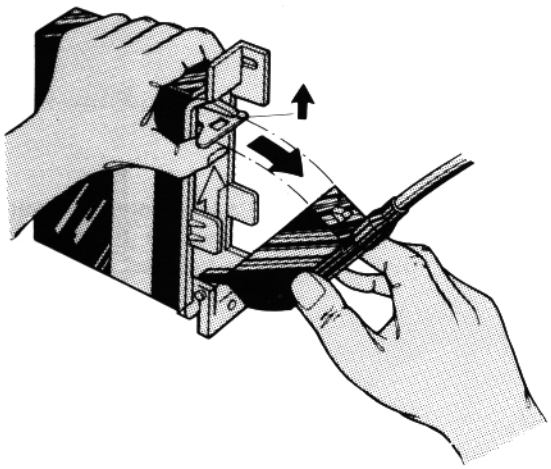


133192

Electronic Control Unit (ECU).

It is the brain of the system. It receives and evaluates readings from the various sensors. It includes a micro-processor which calculates the correct amount of fuel to be injected. The micro-processor is programmed to take account of all possible variations in engine conditions and to produce a control signal to the injectors.

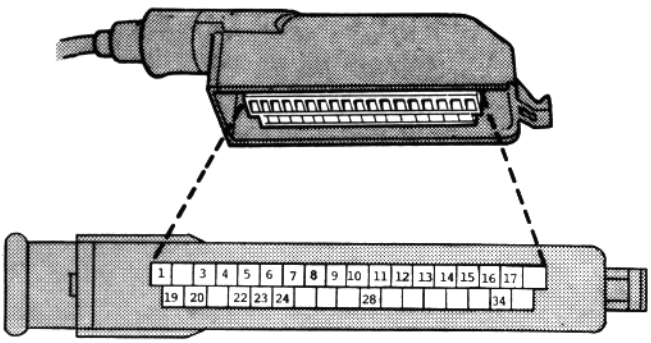
133193



133194

Removing connector on Electronic Control Unit.

Press lock tab UP, then FOLD out connector upper part. DO NOT pull straight out.



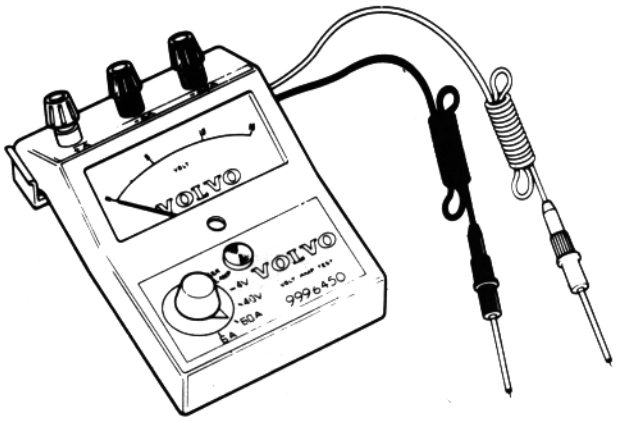
133149

Key to terminals.

Terminal number	
1	Input, engine speed from terminal 1 on ignition coil.
3	Input, from vacuum switch.
4	Input, from terminal 50 on starter motor.
5	Ground, for electronics in Electronic Control Unit.
6	Ground, for electronics in air mass meter.
7	Input, from air mass meter.
8	Control signal, filament burn-off.
9	Output, current to air mass meter.
10	Input, current from system relay.
11	Injector test.
12	Input, CO setting.
13	Input, from coolant temperature sensor.
14	Output, control current to injectors 3+4.

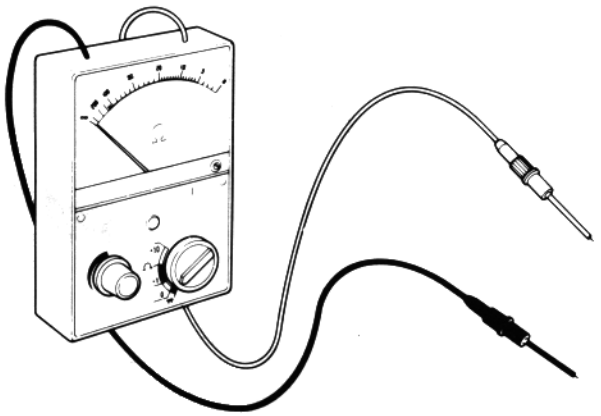
Terminal number	
15	Output, control current to injectors 1+2.
16	Ground, for electronics in Electronic Control Unit.
17	Ground, for electronics in Electronic Control Unit.
19	Shield for wire to terminal 1 on ignition coil.
20	Input, ignition ON, from terminal 15 on ignition coil, or terminal 1 on AC relay.
22	Output, to LH-Jetronic system testing pick-up point.
23	Shield for wire to oxygen sensor.
24	Input, from oxygen sensor.
28	Output, control ground for fuel pump relay.
34	Output, control ground for system relay.

Instruments to use



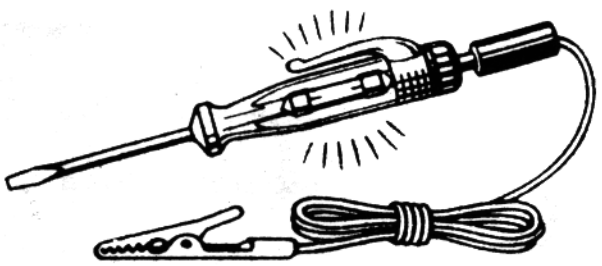
133426

Voltmeter.
Only battery (system) voltage is being measured.
Any ordinary instrument with a measuring range of approx. 0–15 V (0–20 V) can be used.



133427

Ohmmeter.
Must be a good instrument, capable of accurately measuring 8–16 ohms and 200–1,200 ohms.



133428

Test lamp.
System voltage and currents are low. Therefore many faults are caused by bad connections in multipin connectors.
In some tests, it is suggested an alternate testing method: using a test lamp. It uses more current than a voltmeter and might in some cases reveal a bad connection better.

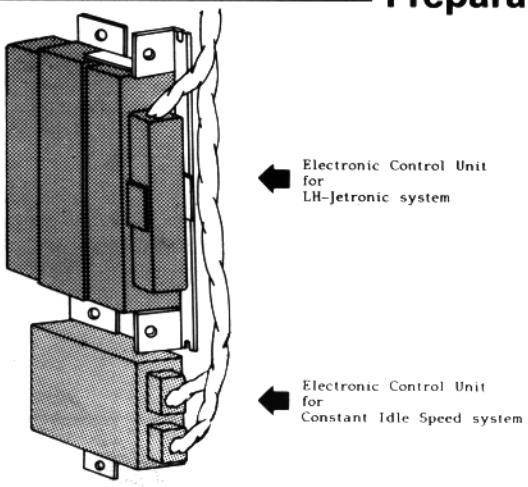
Fault tracing electric circuits

A simple, but very efficient, way to fault trace the LH-Jetronic system is to check all the electric circuits ending at the connector of the Electronic Control Unit. The tests will thus indicate condition of all components and wires leading to the tested terminal.
If there is a problem, yet all tests prove positive, this indicates a fault in the Electronic Control Unit. There are no procedures included on how to test it. Install a correct Electronic Control Unit to see that the problem disappears.

Important!
First test all circuits according to the fault tracing procedures outlined in this manual. If the Electronic Control Unit is replaced first, a faulty circuit may destroy the new Electronic Control Unit the same way as the original one.

Preparations for testing

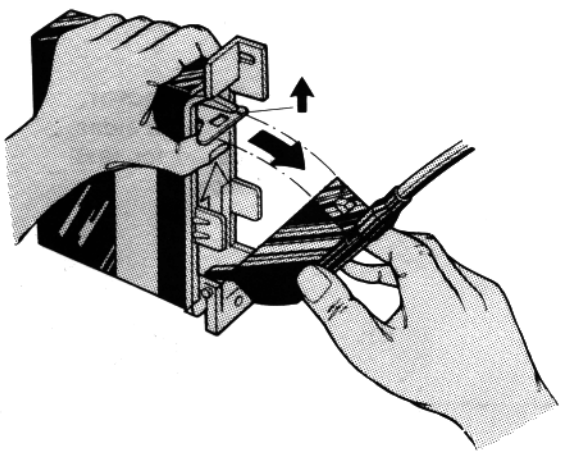
1



133150

Remove panel in front of right front door.
Electronic Control Unit is located behind panel. Under it is the Electronic Control Unit for Constant Idle Speed system.

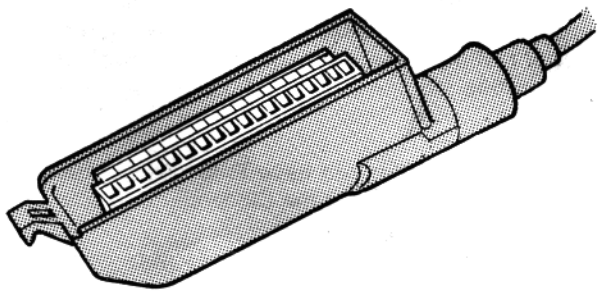
2



133194

Disconnect connector on Electronic Control Unit.
Press lock spring upward and fold connector outward. DO NOT pull straight out.

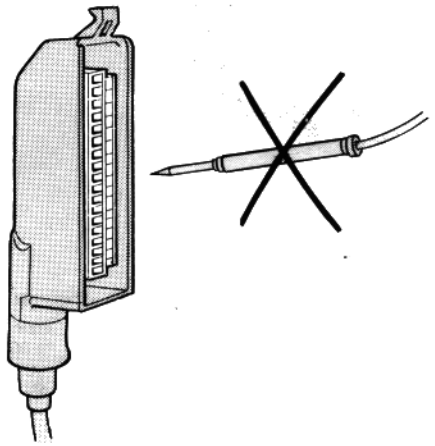
3



133408

Connector terminals.
Connector terminals are now accessible, but should NOT be used as is for **any kind of testing**. See next page.

4

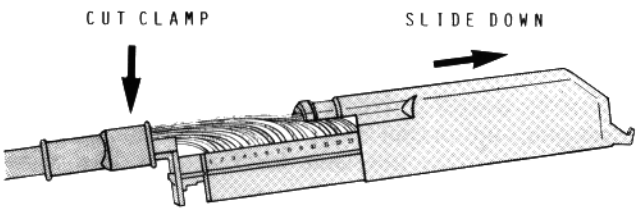


133409

DO NOT test from front.

Experience has shown that connector terminals are easily damaged by test equipment. So what was a small problem before testing can become a big problem after testing.

5

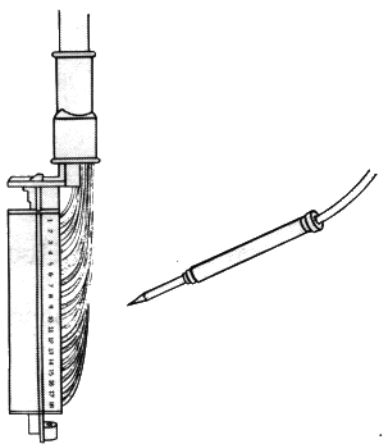


133404

Separate connector assembly.

Cut clamp over rubber boot. Slide down on connector assembly upper part. Remove upper part and gain access to the inside of the connector terminal system.

6

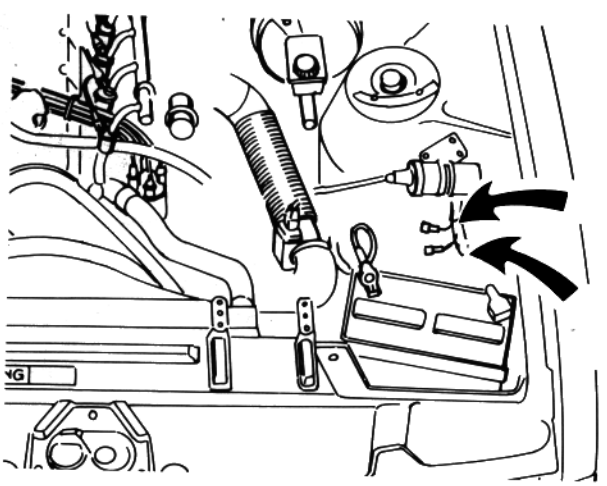


133410

All testing from inside of connector.

Terminal numbers are shown on both sides. Terminals can easily be accessed for testing. DO NOT use excessive force.

7



133423

DO NOT USE TEST POINT!

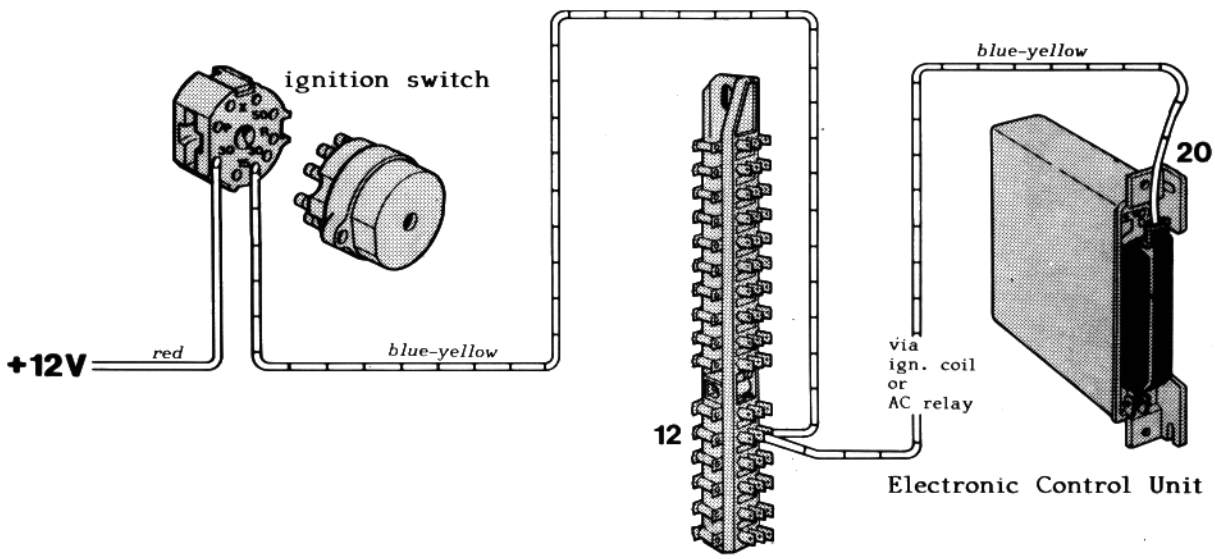
Test connector (see wiring diagram) located behind the battery IS NOT to be used while fault tracing the system. Special test equipment is required. Using this test point without this equipment could cause damage to the Electronic Control Unit.

Later VIN numbers might have TWO test connectors, the second one belonging to the CIS system.

A

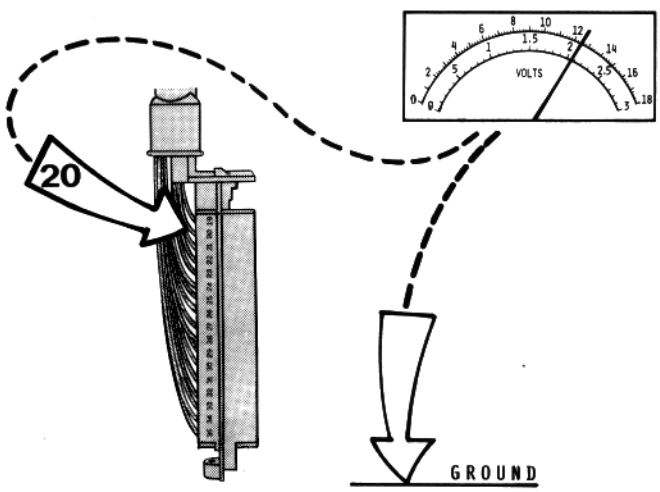
Testing circuit activated by ignition switch

A1



133411

A2

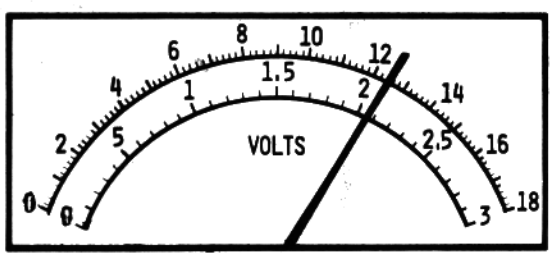


133394

Test voltage across terminal 20 in connector and ground.
Ignition ON.

Alt.
Also a test lamp can be used for this test.

A3



133405

System (battery) voltage.

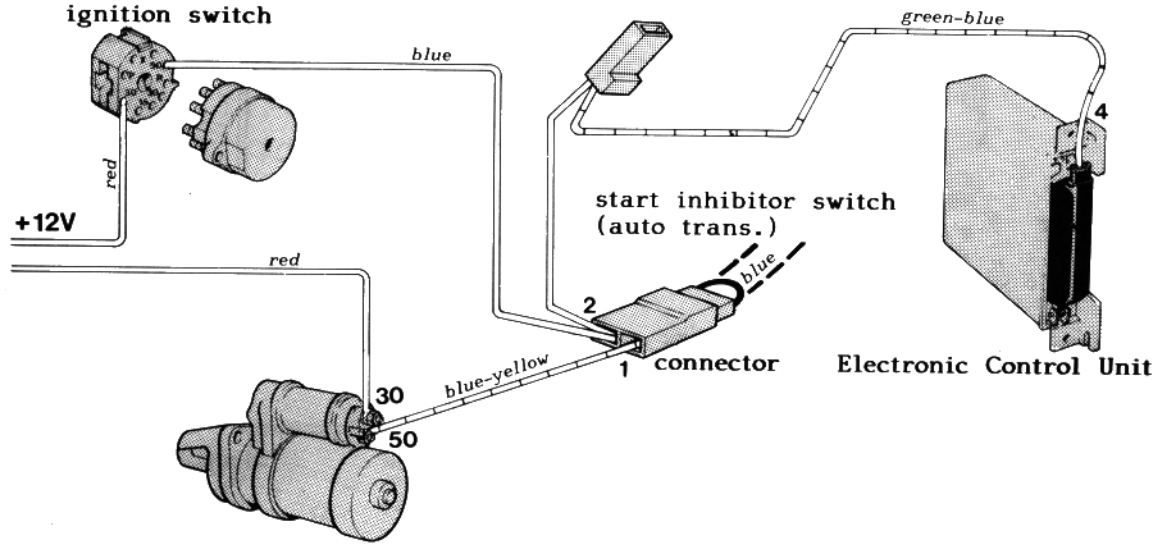
Alt.
Test light illuminates fully.

If not, check:
– Wiring, following wiring harness backward to ignition switch.

B

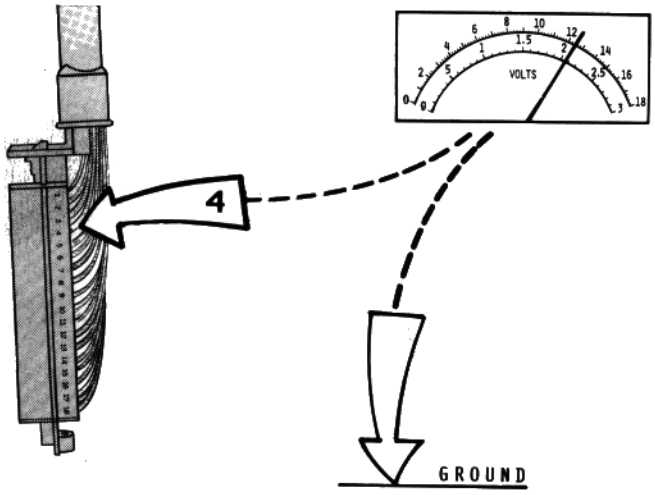
Testing circuit energized when starter motor is operating

B1



133412

B2

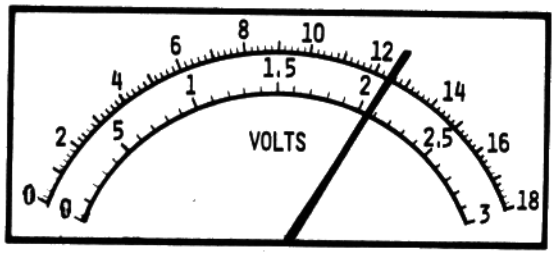


133395

Starter motor operating:
test voltage across terminal 4 in connector and ground.

Alt.
Also a test lamp can be used for this test.

B3



133405

System (battery) voltage.

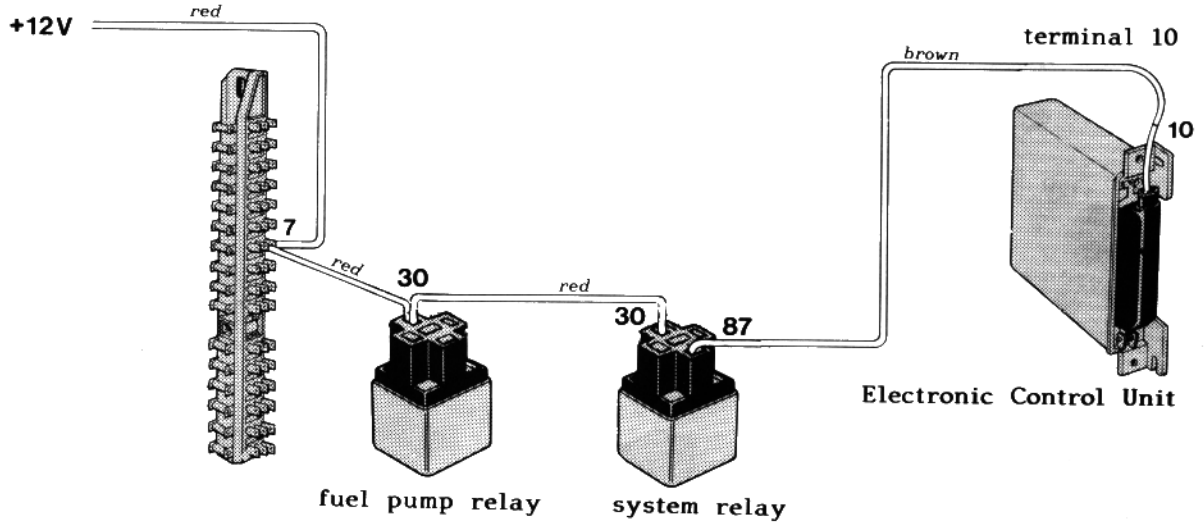
Alt.
Test light illuminates fully.

If not, check:
Wiring and connector, following wiring harness backward to ignition switch.

C

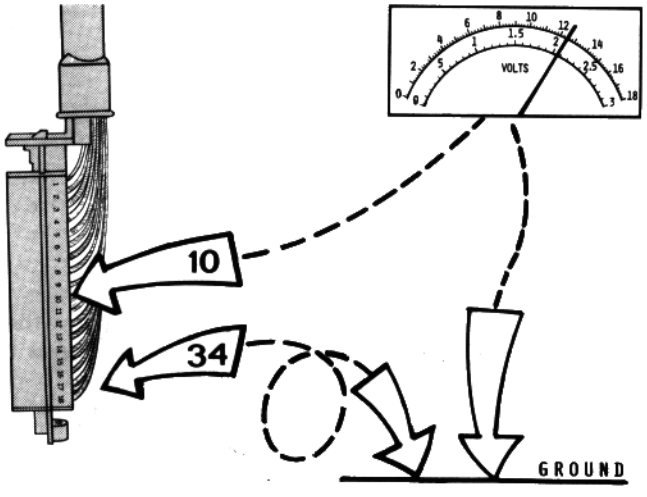
Testing power supply from system relay

C1



133413

C2



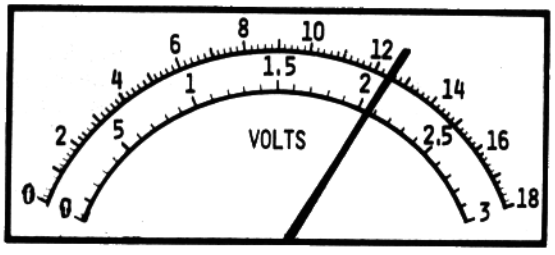
133396

Ground terminal 34.
Use jumper wire.

Test voltage across terminal 10 in connector and ground.

Alt.
Also a test lamp can be used for this test.

C3



133405

System (battery) voltage.

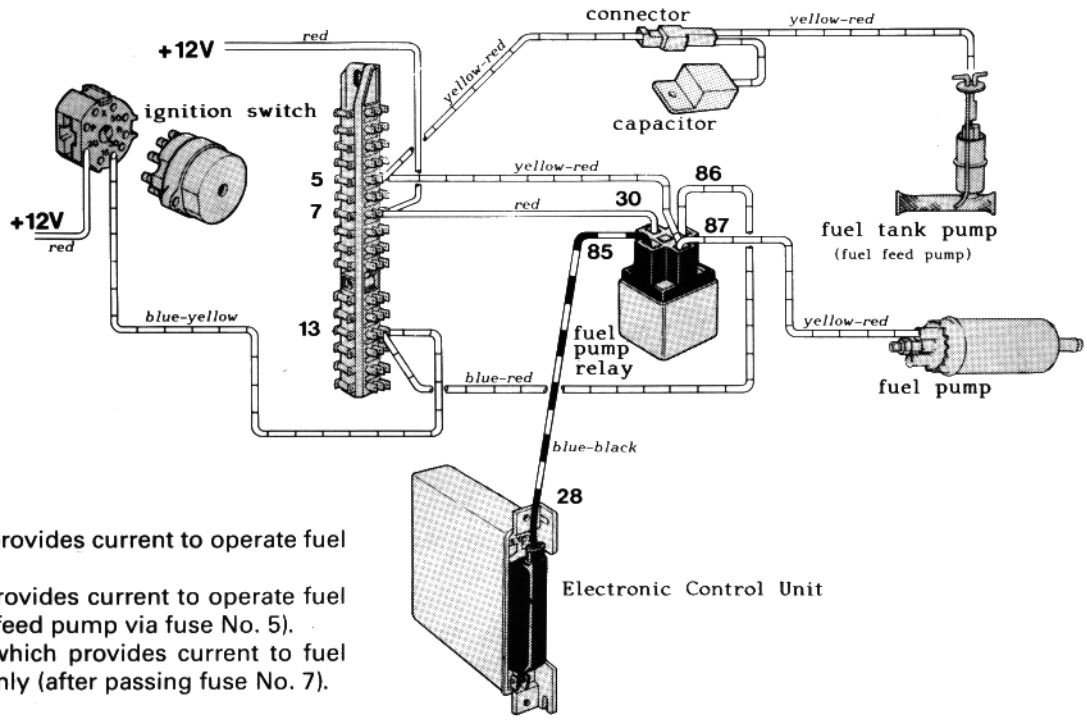
Alt.
Test light illuminates fully.

If not, check:
- That system relay operates (fuse OK?).
- Wiring and connectors, following wiring harness back to system relay.

D

Testing circuit to fuel pumps

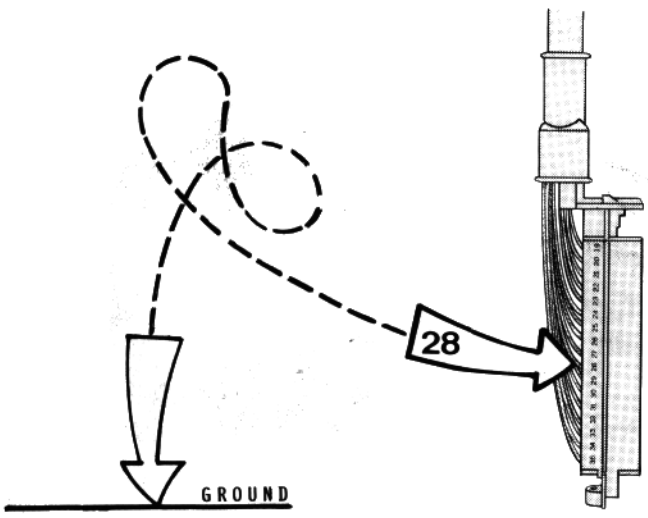
D1



* Fuse No. 13 provides current to operate fuel pump relay.
* Fuse No. 7 provides current to operate fuel pumps (fuel feed pump via fuse No. 5).
* Fuse No. 5 which provides current to fuel feed pump only (after passing fuse No. 7).

133414

D2



133397

Ground terminal 28.
Use jumper wire.
This will enable energizing of fuel pump relay without running starter motor. Electronic Control Unit does not ground terminal 28 at speeds below 200 rpm.

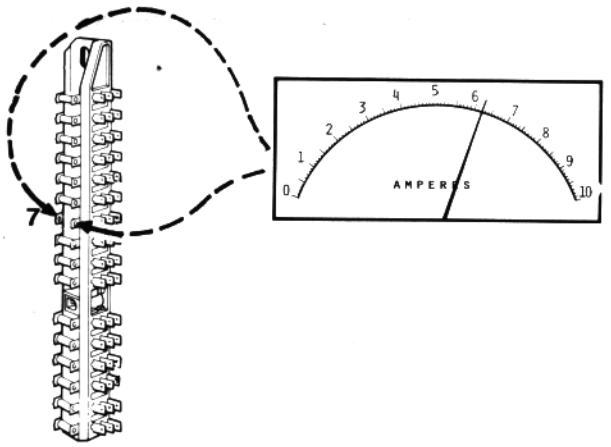
D3

133510

Switch ignition ON.
Check that fuel pumps operate by listening for buzzing sound from rear end of vehicle. This test also confirms proper operation of fuel pump relay.

No fuel pump operation:
- Check fuses 13, 7 and 5.
- Check fuel pump relay.
- Check wiring. Follow wiring harness back from Electronic Control Unit connector.

D4



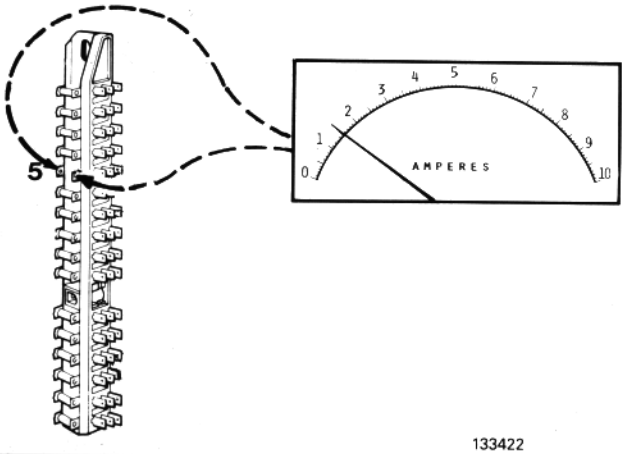
133421

Additional test: fuel pump operation.

Remove fuse No. 5 to prevent fuel feed pump operation from influencing this test.

Remove fuse No. 7. Install amp-meter across fuse terminals. Switch ignition ON. Amp-meter should read 6.2 amps at 12 volts, not to exceed 6.5 amps, indicating proper operation of fuel pump.

D5



133422

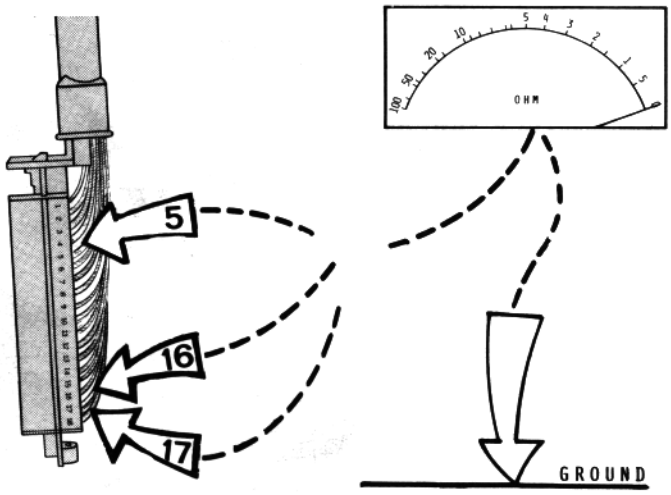
Additional test: fuel feed pump operation.

Remove fuse No. 5. Install amp-meter across fuse terminals. Switch ignition ON. Amp-meter should read 1–2 amps, indicating proper operation of fuel tank pump.

E

Testing grounded terminals

E1



133398

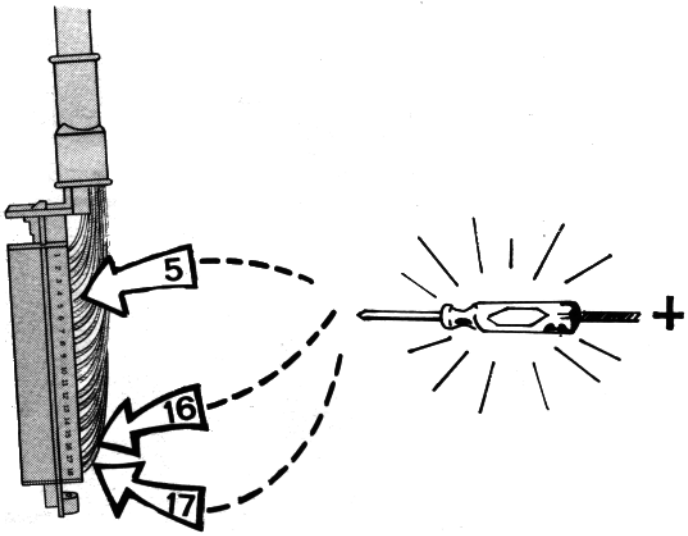
Using ohmmeter.

Connect one ohmmeter test point to ground.

Connect other test point to, in turn:
- Terminal 5.
- Terminal 16.
- Terminal 17.

Resistance should be zero (zero reading on ohmmeter).

E2



133399

Alt.
Using test lamp.

Connect test lamp lead to battery positive terminal (any place with full battery voltage).

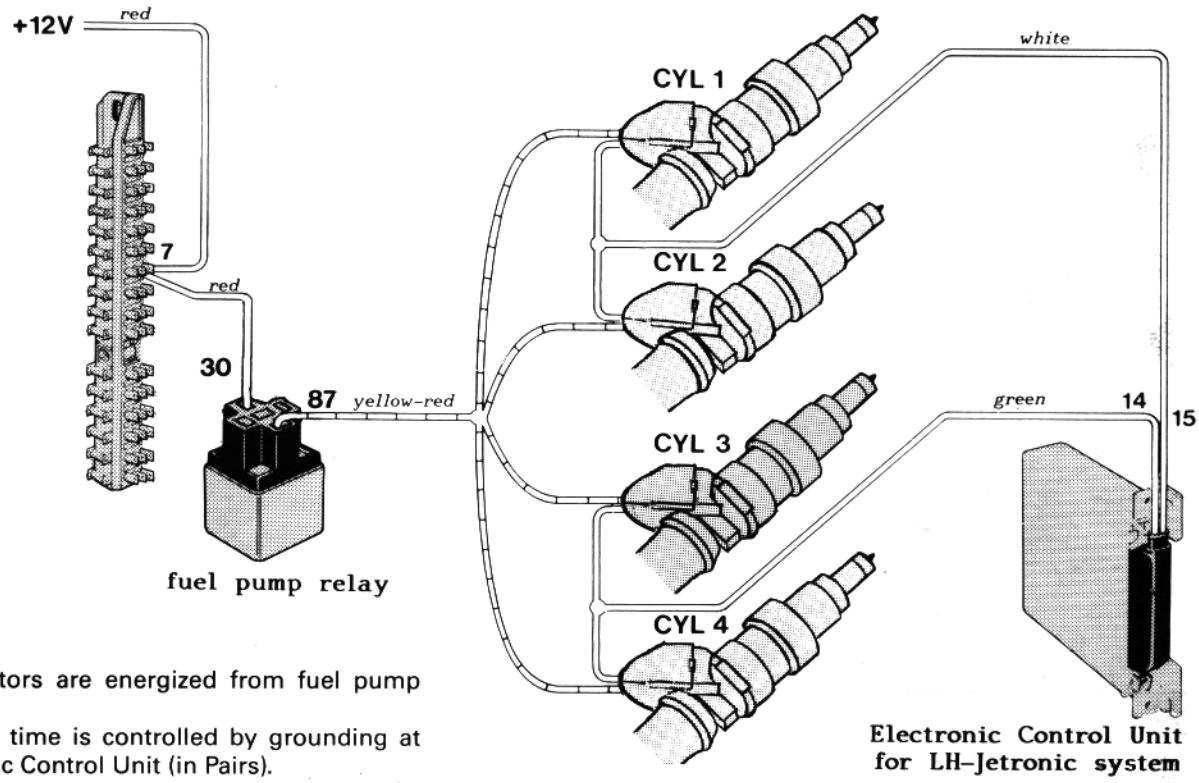
Connect test lamp test point to, in turn:
- Terminal 5.
- Terminal 16.
- Terminal 17.

Test light should illuminate fully at each one of this terminals.

F

Testing injector circuits

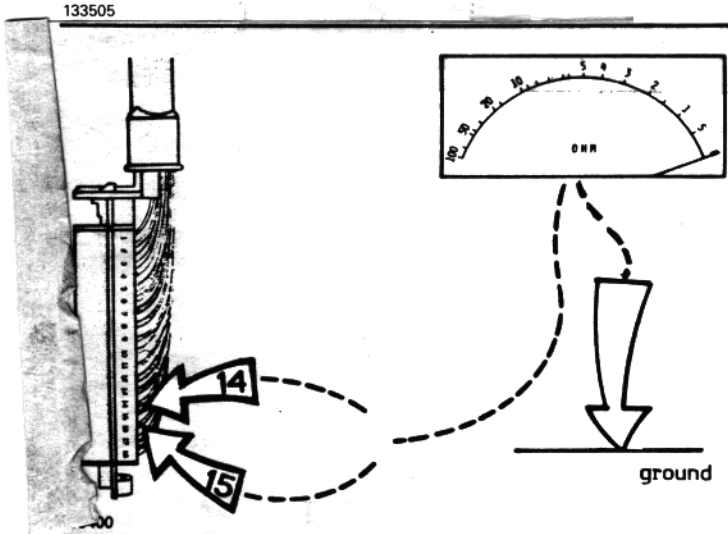
F1



All injectors are energized from fuel pump relay.
Injection time is controlled by grounding at Electronic Control Unit (in Pairs).

133505

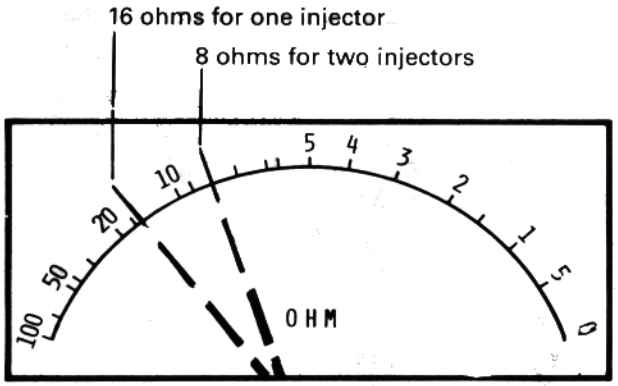
F2



Check resistance.
For this test an ohmmeter capable of accurately measuring resistances of 8-16 ohms must be used.

1. Ignition off
2. Connect ohmmeter across terminal 14 and ground. Read ohmmeter.
3. Connect ohmmeter across terminal 15 and ground. Read ohmmeter.

F3



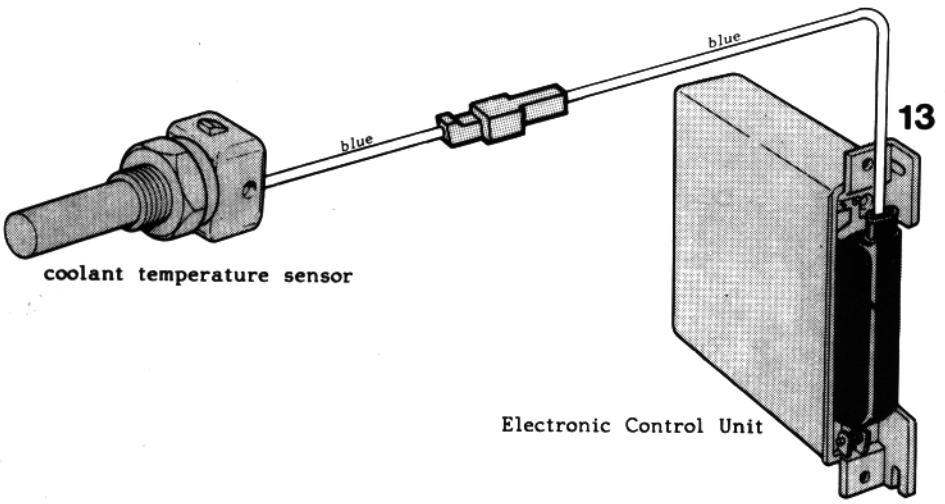
Correct resistance: 8 ohms.
If resistance of 16 ohms is noted, it is likely that one injector is faulty or wiring to it incorrect.
Disconnect connector at each injector and test injector resistance separately.

133406

G

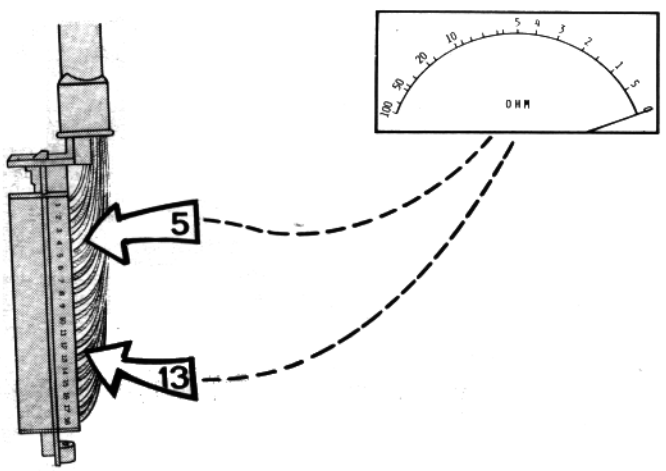
Testing coolant temperature sensor circuit

G1



133416

G2

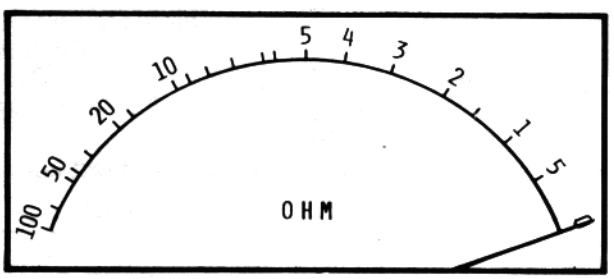


133401

Check resistance.
Connect ohmmeter across terminals 5 and 13. Read resistance. Correct reading depends on coolant temperature. See graph in section on components and specs (page 6).
Values for certain temperatures:

80°C = 175°F	270–390 ohms.
20°C = 68°F	2,100–2,900 ohms.
–10°C = 14°F	7,000–11,600 ohms.

G3



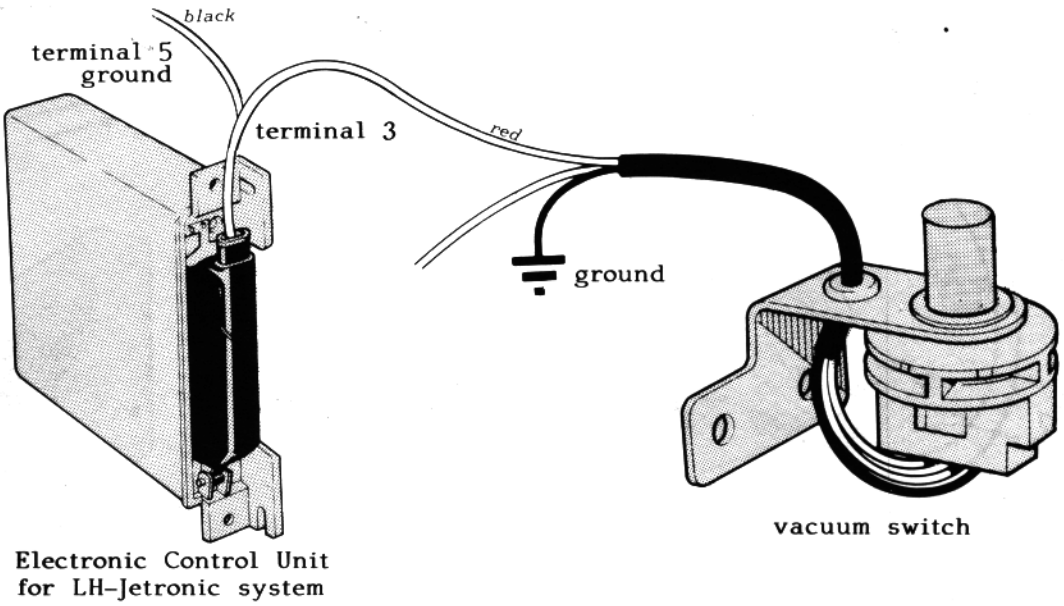
133407

Incorrect readings:
- Slightly incorrect readings indicate faulty coolant temperature sensor.
- Very high resistance indicates open circuit (Wiring or coolant temperature sensor).
- Zero resistance indicates shorted circuit.

H

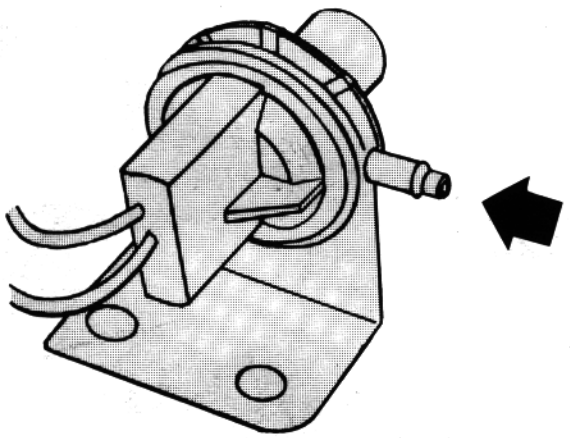
Testing vacuum switch circuit

H1



133506

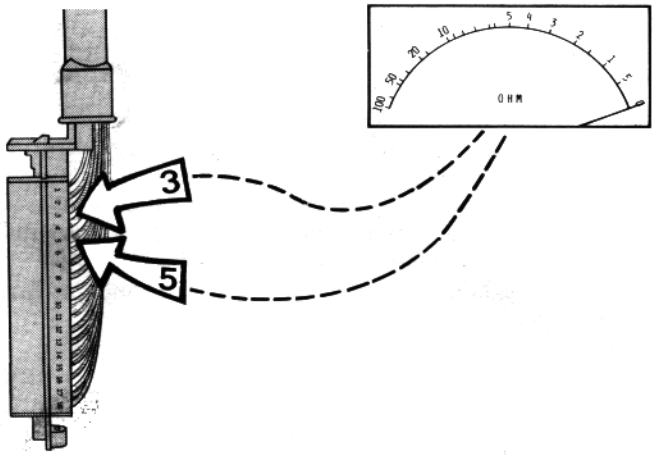
H2



133511

Connect vacuum pump and vacuum gauge to vacuum switch.

H3



133402

Check resistance.

Connect ohmmeter across terminals 3 and 5.

- With no vacuum pumped resistance should be zero.
- Pump vacuum to 4 in. Hg. Resistance very high (infinite).

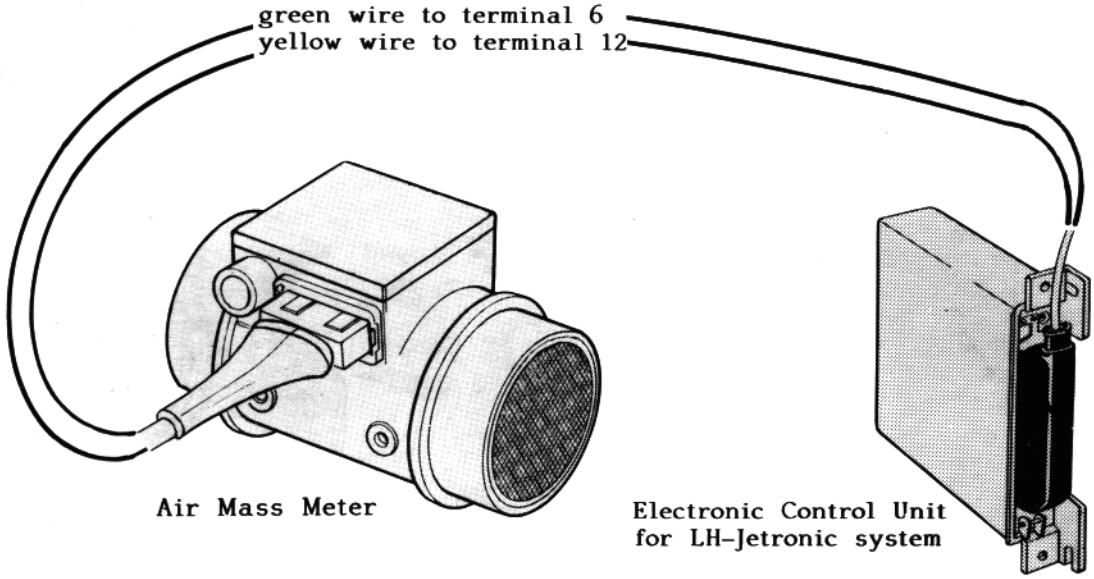
Incorrect readings:

- Very high resistance with no vacuum pumped indicates open circuit.
- Zero resistance when vacuum is pumped indicates shorted circuit.

I

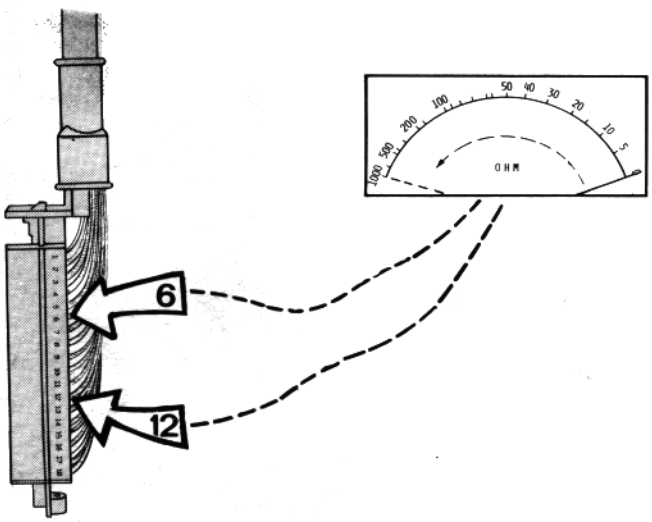
Testing Air Mass Meter circuit

I1



133507

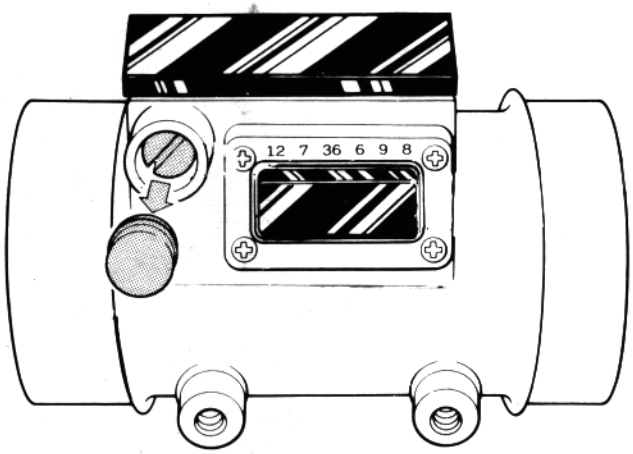
I2



133403

Connect ohmmeter.
Across terminals 6 and 12.

I3

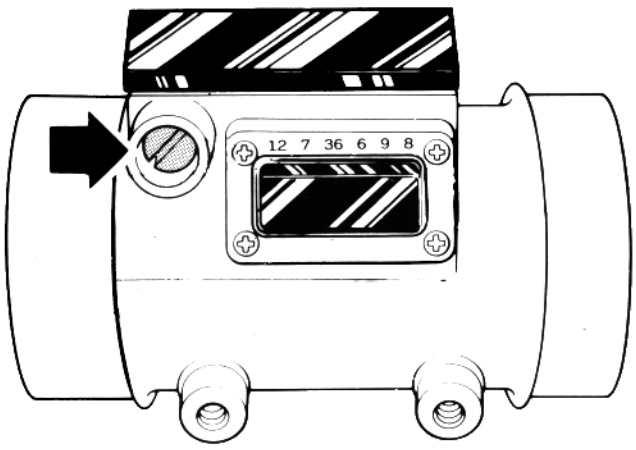


133508

CO adjustment.
CO is set at the factory and the adjustment screw sealed by an aluminium plug, which is reinforced by a hardened steel insert. Adjustments are therefore limited to measurements outside normal resistance range of 0 to 1000 ohms.

Readings outside 0–1000 ohm range:
- Zero resistance **may** indicate shorted circuit.
- Very high resistance indicates open circuit.

I4



133509

Air mass meter with seal removed.

Turn CO adjustment screw on air mass meter. Resistance should vary from 0 ohms at full clockwise position to 1000 ohms at full counterclockwise position.

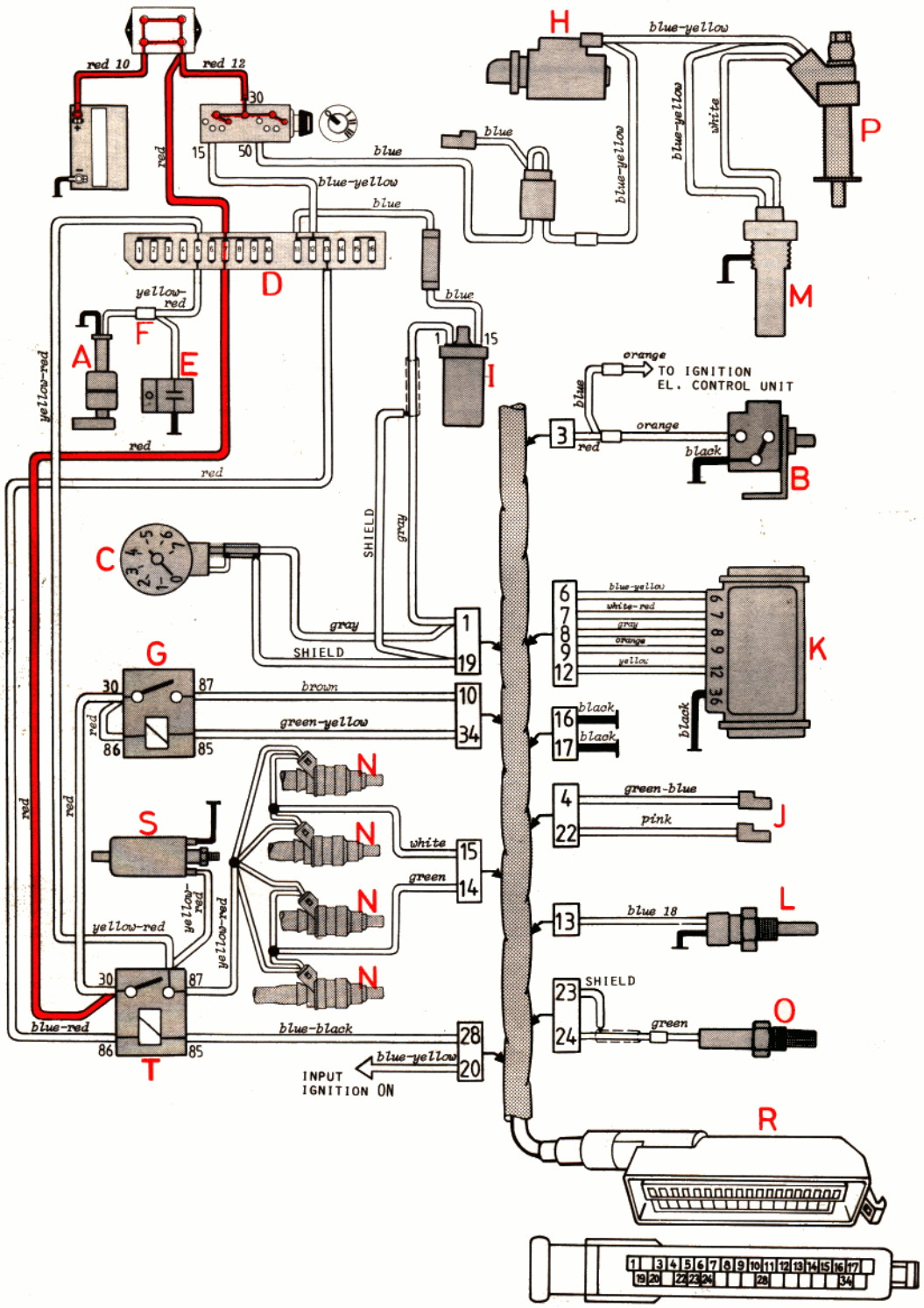
Incorrect readings:

- Slightly incorrect readings indicate incorrectly adjusted air mass meter.
- Zero resistance at full counterclockwise position indicates shorted circuit.
- Very high resistance at full clockwise position indicates open circuit.

LH-Jetronic fuel injection system

Legend:

- A Fuel tank pump
- B Vacuum switch
- C Tachometer
- D Fuse box
- E Capacitor, tank pump
- F Connector, tank pump
- G System relay
- H Starter motor
- I Ignition coil
- J Test pick-up connectors
- K Air mass meter
- L Temperature sensor
- M Thermal time switch
- N Injectors (four)
- O Oxygen sensor
- P Cold start injector
- R Connector, Electronic Control Unit (ECU)
- S Fuel pump (main pump)
- T Fuel pump relay

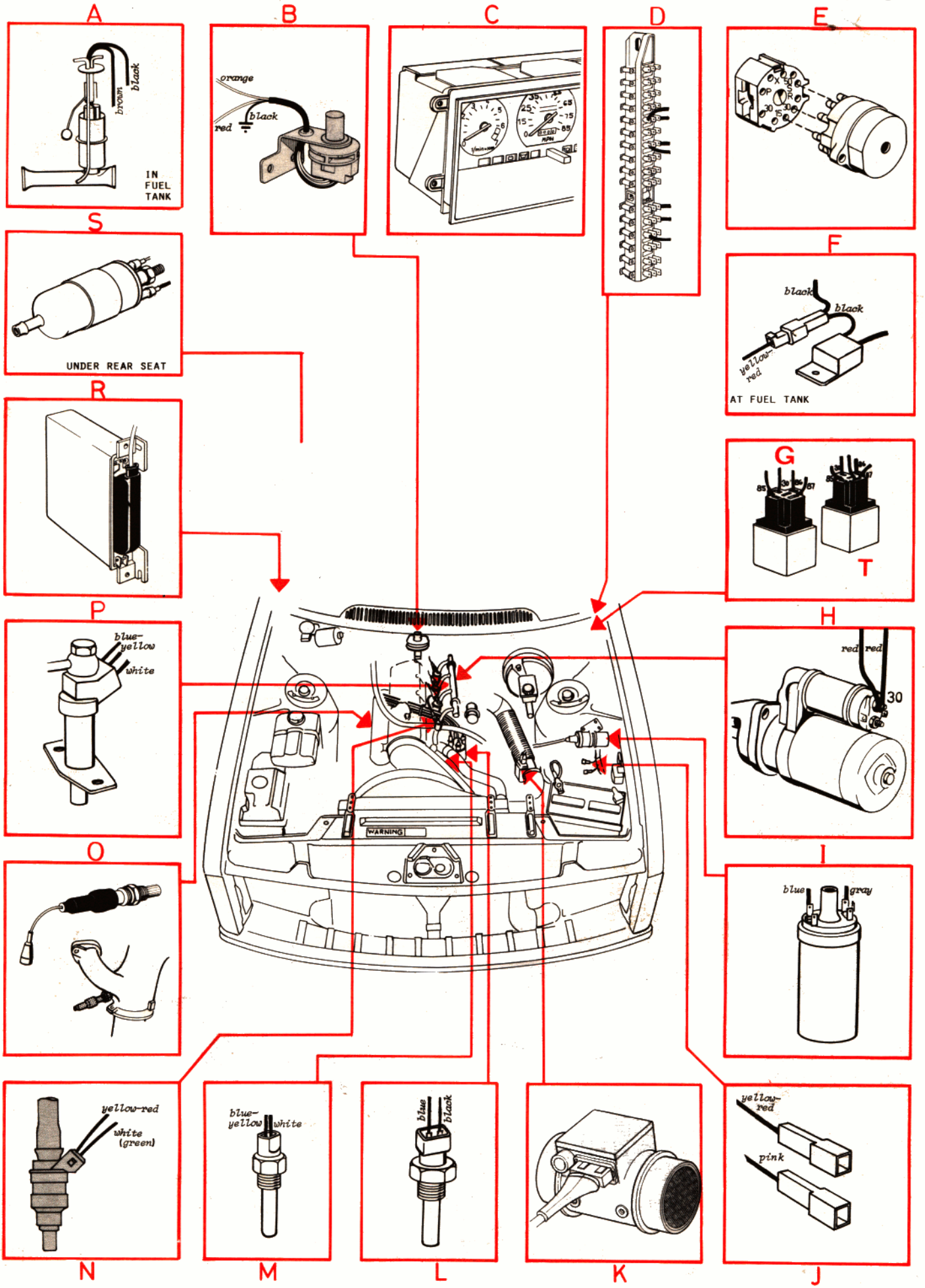


Fuse No. 5:
Fuel feed pump (tank pump)

Fuse No. 7:
Fuel pump (main pump)

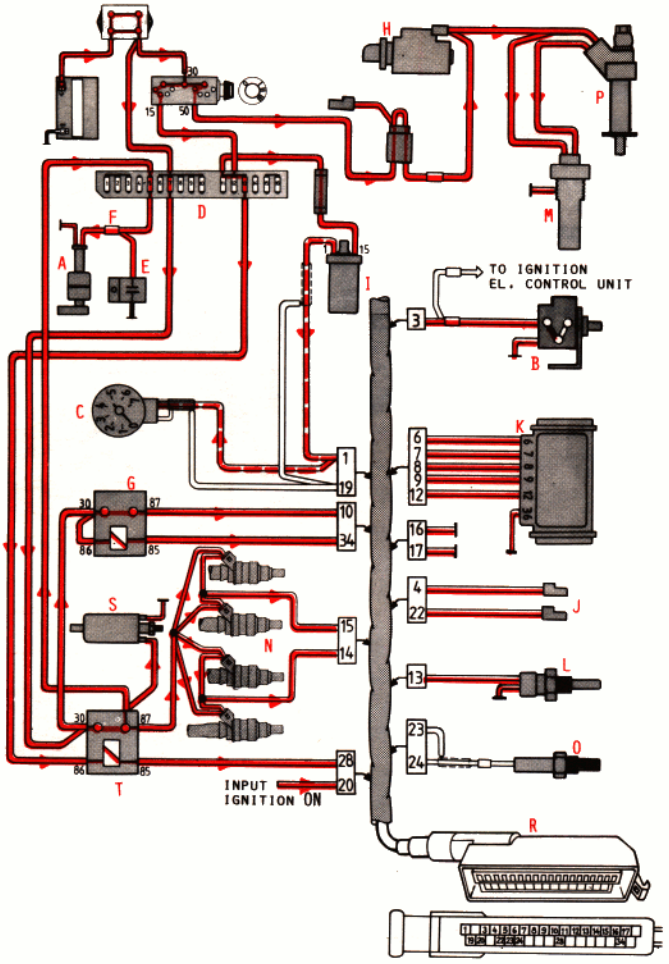
Fuse No. 13:
Instruments
Turn signals
Seat belt warning
System relay

ill. 133444 M


A
brown
black
IN FUEL TANK
B
orange
red
black
C
D
E
S
UNDER REAR SEAT
F
black
black
yellow-red
AT FUEL TANK
R
G
85
30
87
T
P
blue-yellow
white
H
red
red
30
WARNING
O
I
blue
gray
yellow-red
white (green)
blue-yellow
white
blue
black
yellow-red
pink
N
M
L
K
J

ill.
133445 M

LH-Jetronic wiring diagram

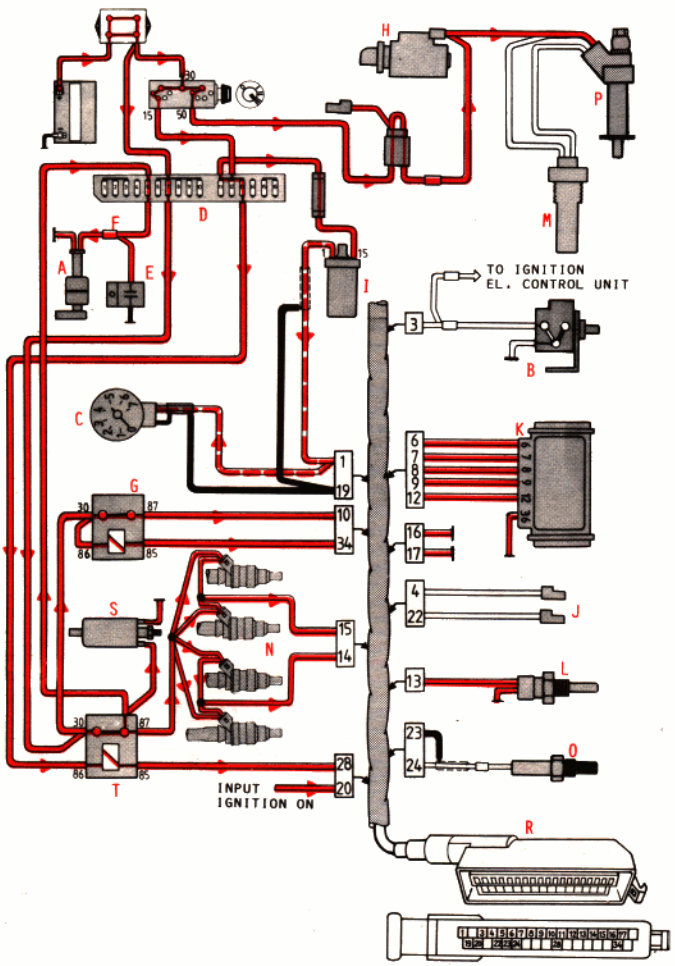


Starting engine cold.

The thermal time switch (M) reduces cold start injector (P) operating time as coolant temperature rises. Injection terminates completely at 15°C = 59°F.
Vacuum switch (B) normally grounds terminal 3 of the ECU.

Legend:

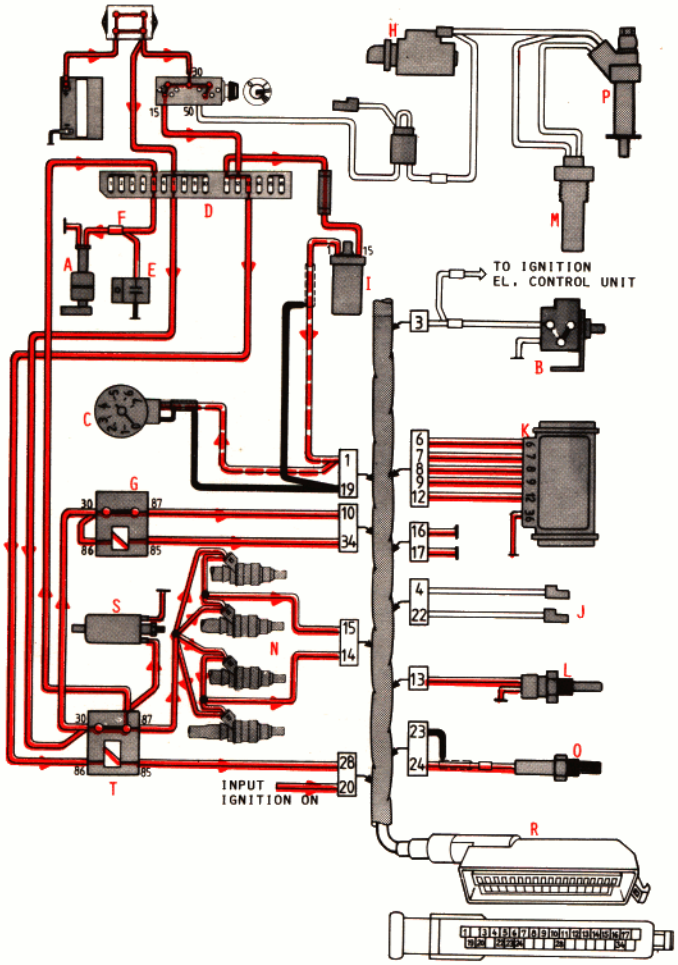
A Fuel tank pump
B Vacuum switch
C Tachometer
D fuse box
E Capacitor, tank pump
F Connector, tank pump
G System relay
H Starter motor
I Ignition coil
J Test pick-up connectors
K Air mass meter
L Temperature sensor
M Thermal time switch
N Injectors (four)
O Oxygen sensor
P Cold start injector
R Connector, Electronic Control Unit
S Fuel pump (main pump)
T Fuel pump relay



Starting engine warm.

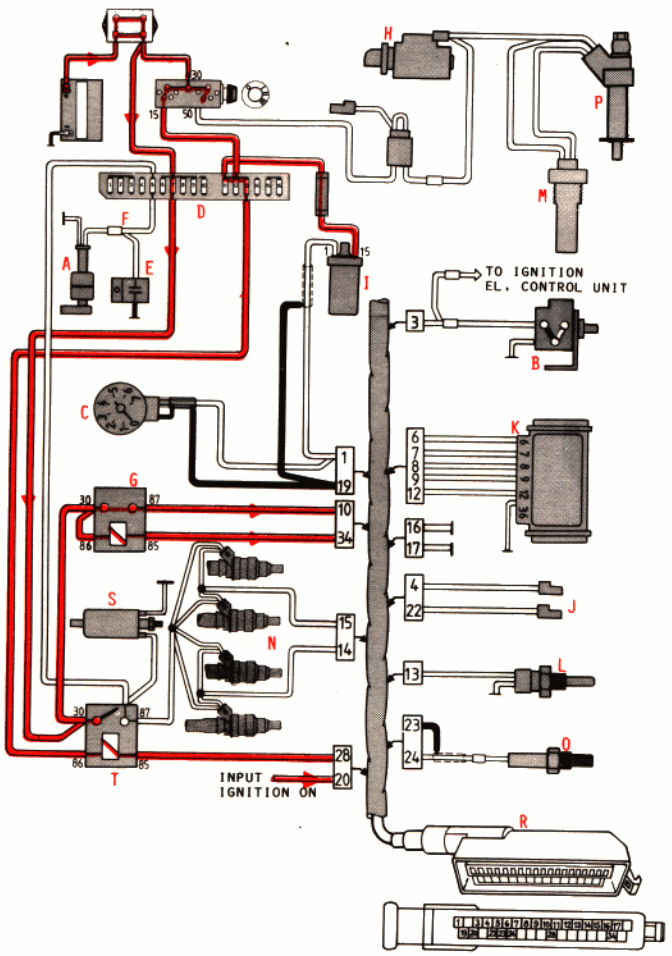
Vacuum switch (B) normally grounds terminal 3 of the ECU.
The ECU receives input signals from the various sensors. Soon after start, the oxygen sensor (O) is heated up by the exhaust gases and starts to signal the ECU.

ill.
133446 M



Engine running.

Various signals are received and processed by the Electronic Control Unit:
The **air mass meter (K)** measures the inducted air mass.
The **temperature sensor (L)** senses coolant temperature.
Terminal 1 receives an **engine speed** signal from the ignition coil.
The **oxygen sensor (O)** checks the exhaust gas contents.



Common conditions.

As soon as the **ignition** is switched ON, voltage is also fed to terminal 20 of the ECU (Electronic Control Unit). This voltage energizes the various circuits of the ECU.
When the ignition switch energizes the **starter** motor, a signal is also sent to terminal 4 of the ECU.
Signals that the engine is **rotating** are fed from the ignition switch to terminal 1 of the ECU. These signals will cause energizing of system relay (G) and fuel pump relay (T) and thereby also energize terminal 10 of the ECU.
The air mass meter (K) measures the **inducted air mass** and provides an input signal to terminal 7 of the ECU.
Under all conditions, the temperature sensor (L) senses **coolant temperature** and sends corresponding signal to the ECU terminal 13.

Engine stalled.

Ignition ON but engine not running.
Engine at normal operating temperature.
There are no speed signals from the ignition coil, so the control ground circuit for the fuel pump relay (T) and system relay (G) is opened. The system becomes inactive and the fuel pumps stop.

ill.
133447 M