PORSCHE

928

Air Flow Controlled Fuel Injection

SERVICE INFORMATION

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CONTENTS

1980 Model 928's have A. F. C. electronic fuel injection.

Components of A. F. C. fuel injection:

1 – Fuel pump
2 – Filter
3 – Pressure regulator cyl. 1 – 4
4 – Distribution line cyl. 1 – 4
5 – Air line (central cold idle system)
6 – Cold start valve
7 – Auxiliary air regulator
8 – Temperature sensor II
9 – Pressure damper
10 – Throttle valve housing
11 – Fuel injector
12 – Distribution line cyl. 5 – 8
13 – Air flow sensor
14 – Pressure regulator cyl. 5 – 8
R – Return to tank

a – To manifold vacuum
b – To fuel injection control unit
c – To distributor (retard)
d – To distributor (advance)

Design:

The **basic fuel volume** is determined by the volume of intake air and engine speed.

The **injection timing** depends on ignition pulses, which come from term. 16 of transistor ignition control unit.

The **warm-up enrichment** is provided by way of temperature sensor I in the air flow sensor and temperature sensor II in conjunction with the auxiliary air regulator.

The **full throttle enrichment** is controlled by a microswitch on the throttle valve housing.

Parts of air flow sensor:

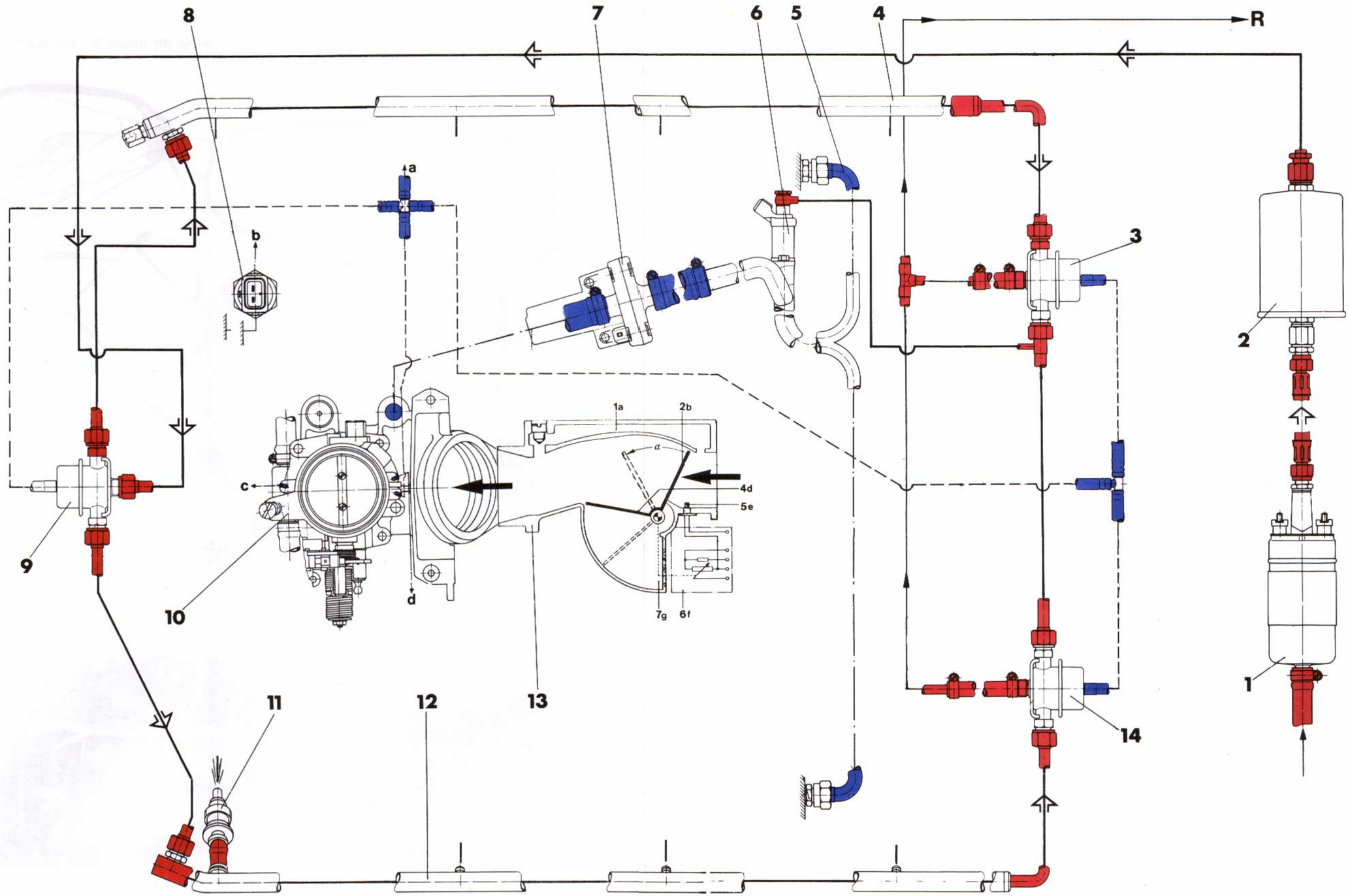
1a – Bypass channel
2b – Sensor flap
4d – Damper flap
5e – Temperature sensor I
6f – Potentiometer
7g – Damping volume

red = Fuel

blue = Air/vacuum

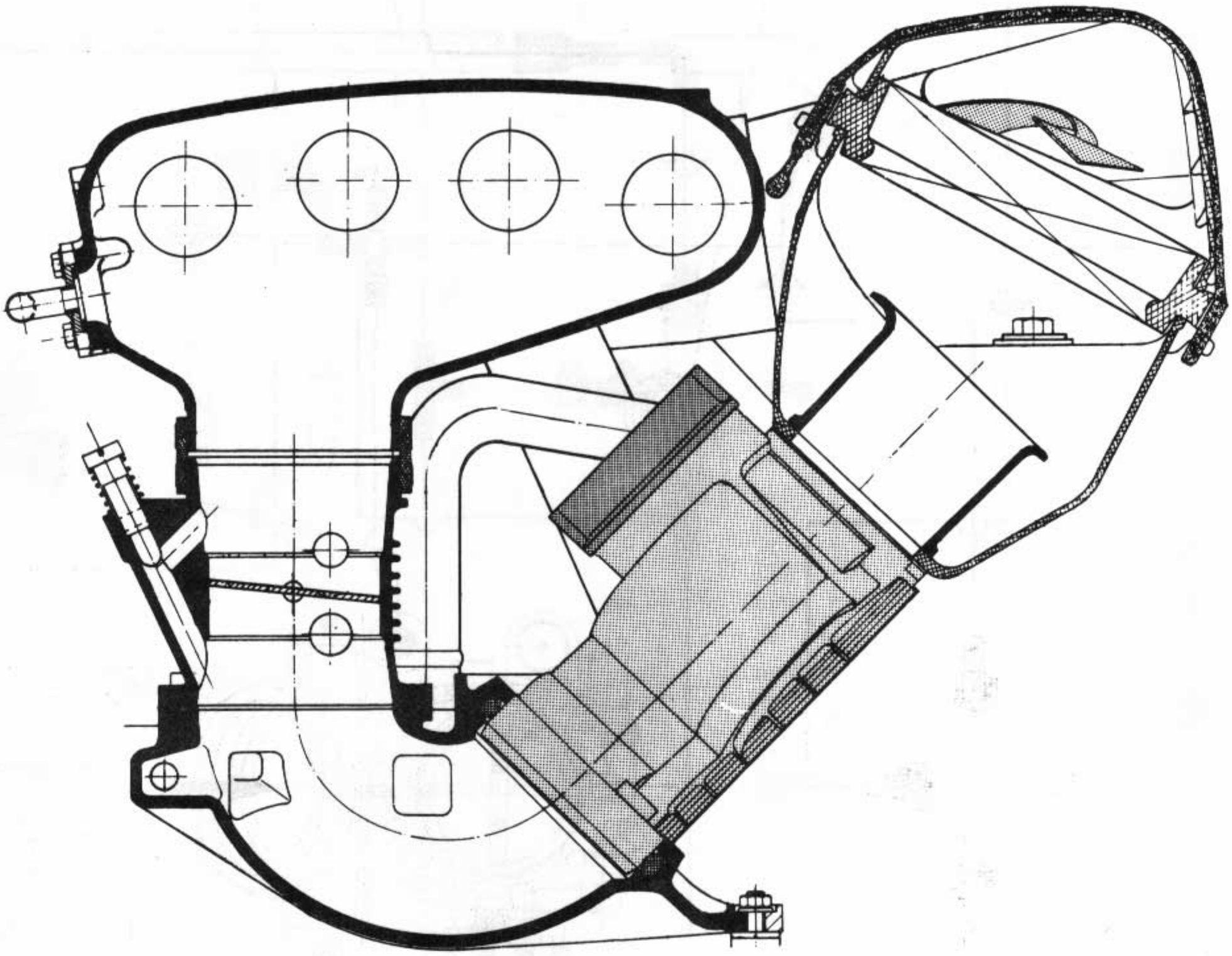
928 Leitungsschema L-Jetronic-Anlage
928 Hose Diagram for L-Jetronic
928 Hose Diagram for Electronic Fuel Injection AFC (air flow controlled)

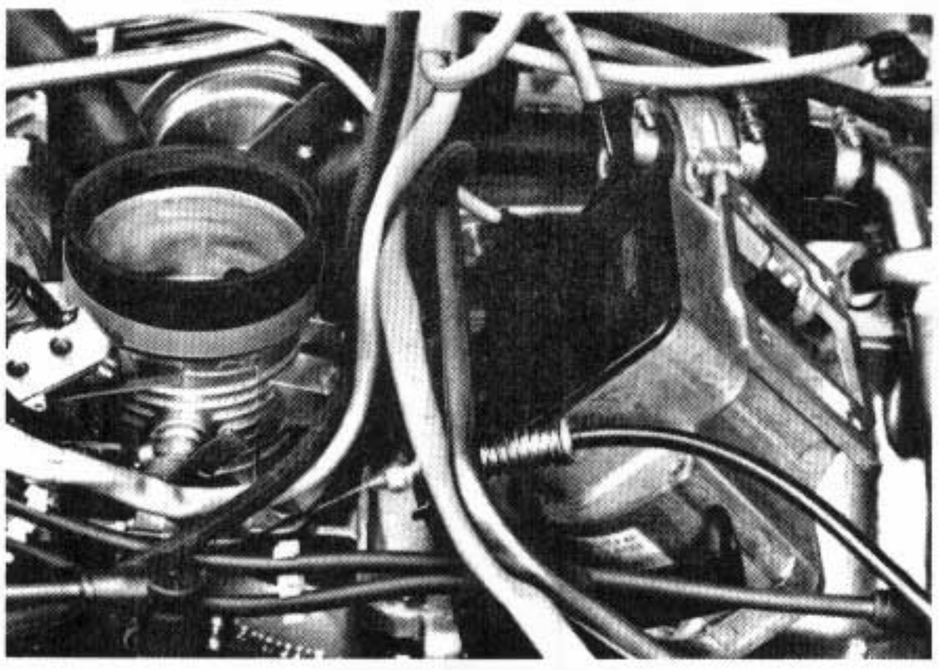
928 Schéma des conduites de l'alimentation L-Jetronic
928 Schema delle tubazioni d'alimentazione L-Jetronic

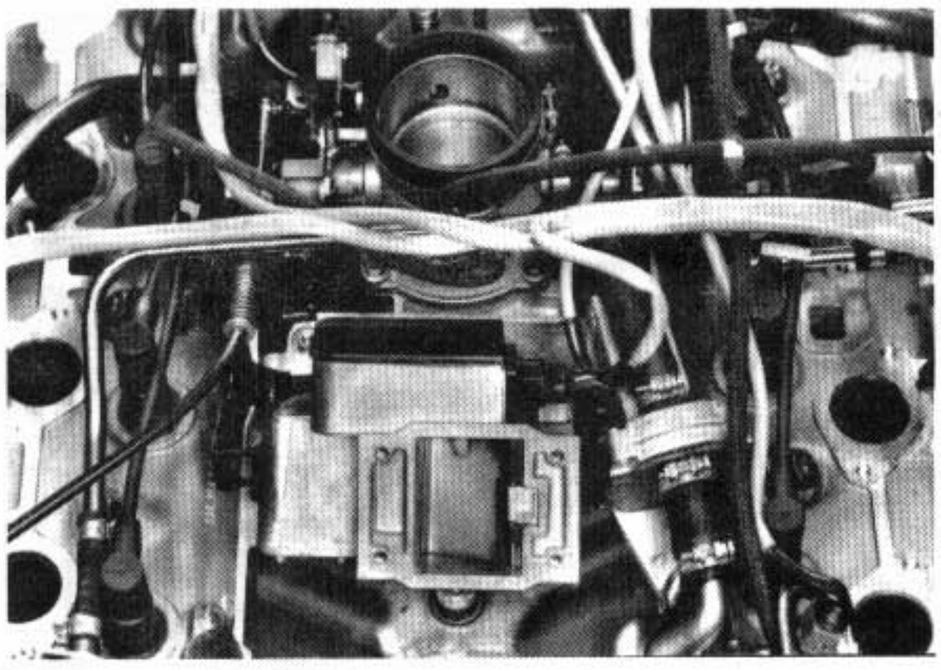


Air Flow Sensor

The air flow sensor is located between the cylinder banks below the intake air distributor.

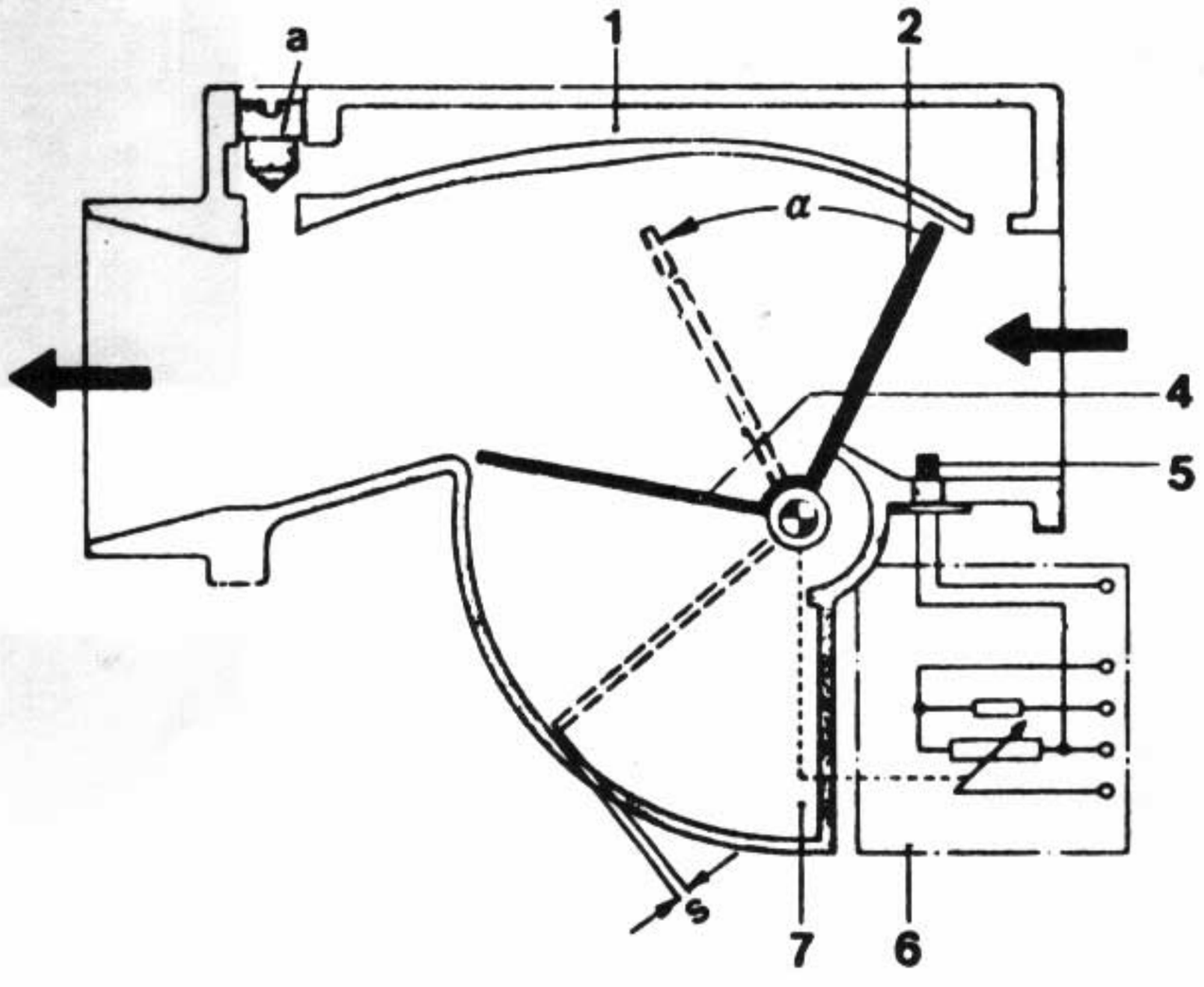






Design

1 – Bypass channel with adjustment screw (a)
2 – Sensor flap
4 – Damper flap
5 – Temperature sensor I
6 – Potentiometer
7 – Damping volume



Description

Depending on the throttle valve position the engine will take in a certain volume of fresh air. This fresh air stream will move the sensor flap against the force of a return spring. The action is transmitted via a pivot shaft to the potentiometer, which sends a voltage signal to the control unit. Temperature sensor I measures the intake air temperature and influences the voltage signal. A pulse goes from the control unit to the fuel injectors and makes sure that the amount of injected fuel is correct for the amount of intake air.

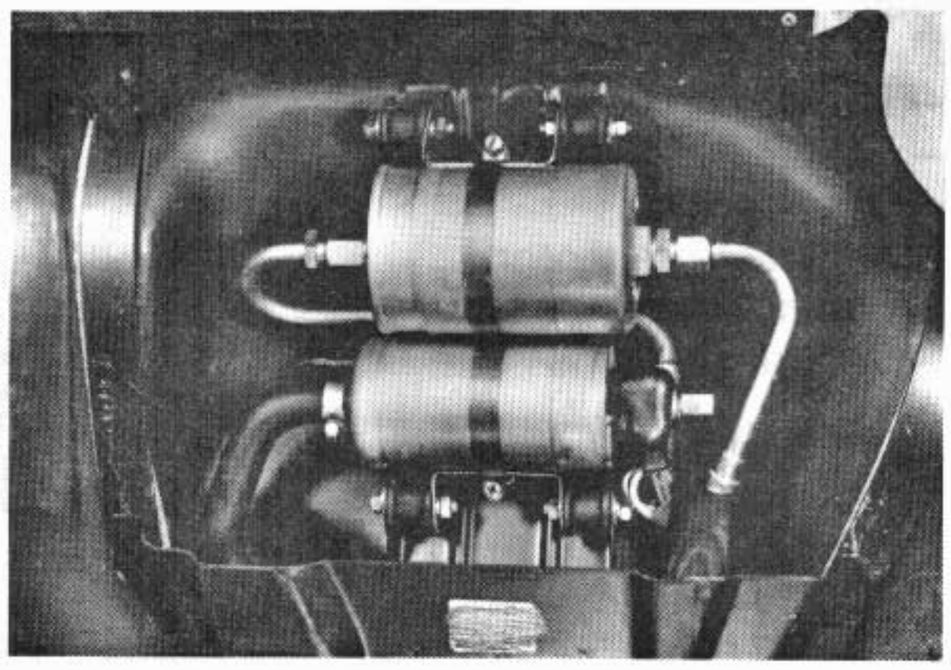
The damper connected with the sensor flap will dampen pulsations of the sensor flap. As the sensor flap opens, the damper flap will move into the dampening chamber. Air in the dampening chamber can only escape via gap "S". Jolts and pulsations are dampened in this manner.

A small part of the intake air volume is sent past the sensor flap via a bypass bore. Adjusting screw (a) is used to adjust the fuel/air mixture for idling.

Fuel Pump

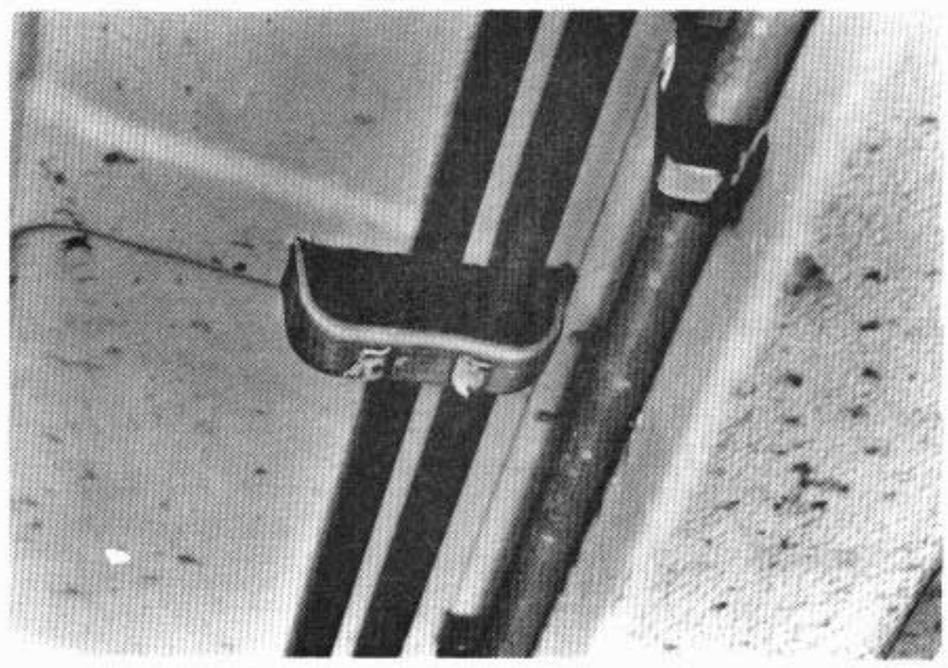
An electric roller-cell pump Type EKP/IV with fuel filter is installed on rubber mounts in a recess below the fuel tank.

The pump receives power and runs as soon as the fuel pump relay receives pulses from the ignition control unit.



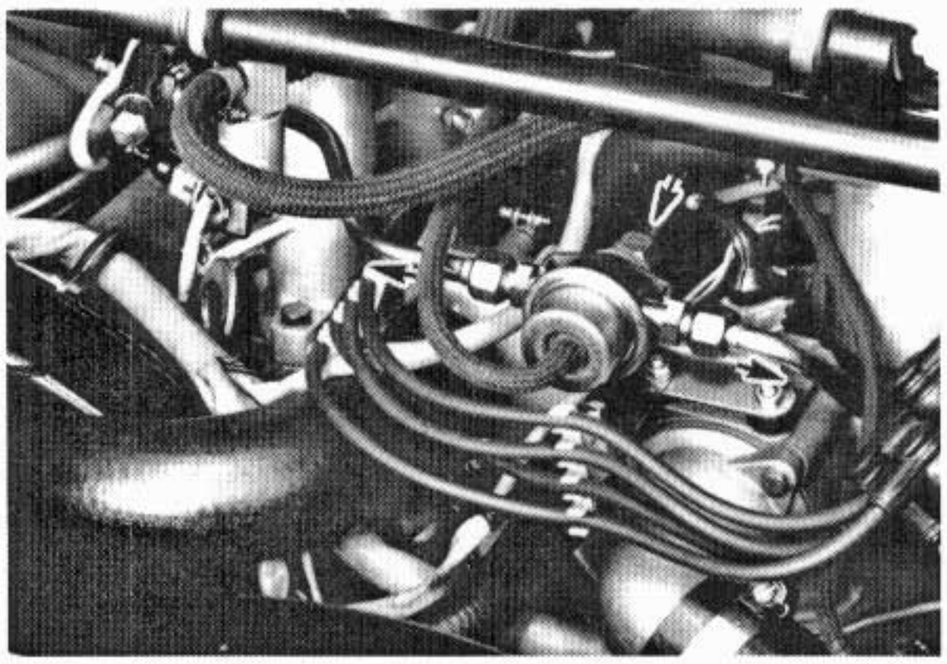
Fuel Lines

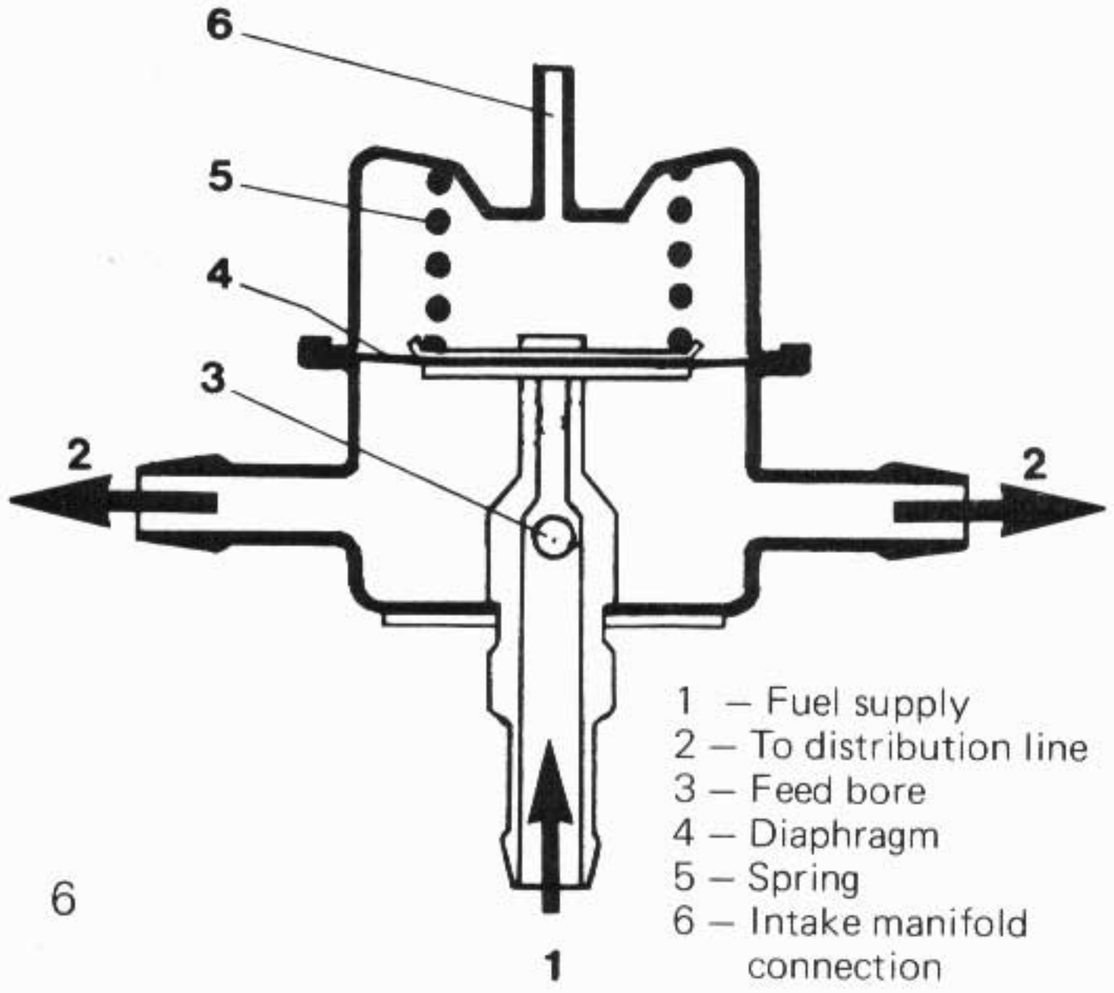
The fuel is pumped via pipes which are mounted in rubber holders on the body floor pan.



Pressure Damper

A pressure damper is installed at the beginning of the fuel supply loop. It must dampen pulsations of the fuel supply pressure.
From the pressure damper the fuel goes to the left and right distribution lines and fuel injectors.





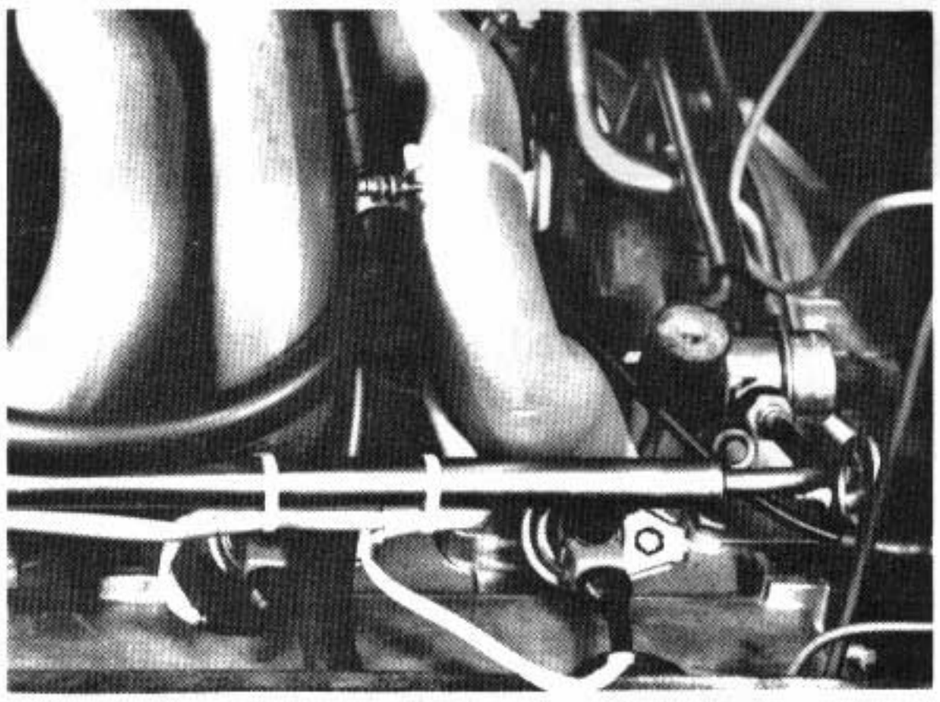
Fuel Injectors

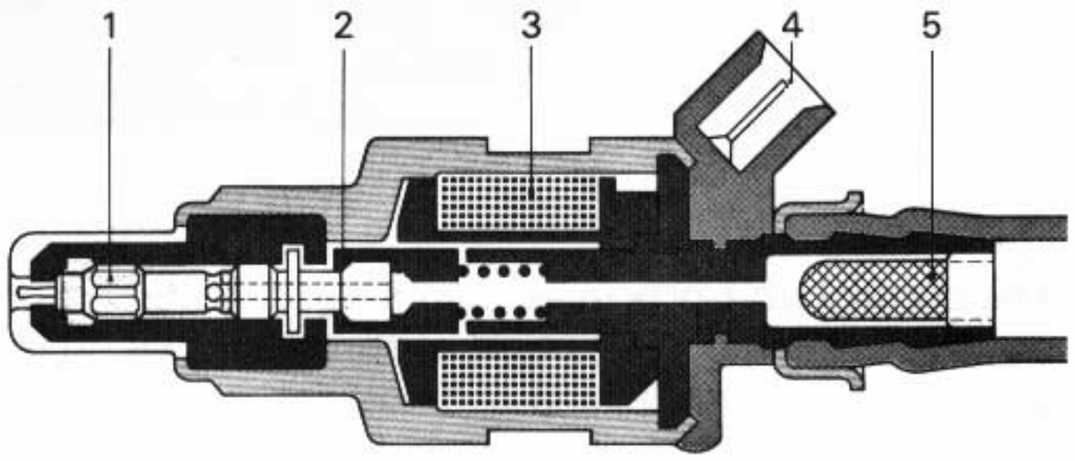
Each cylinder has an electromagnetic fuel injector, which is connected with the fuel distribution line.

The fuel injectors are electrically connected to the control unit. All fuel injectors are connected on the same circuit. When the fuel injectors receive a pulse, they open and fuel is injected into the intake ports.

The amount of fuel injected depends on the length of the pulse from the control unit (opening time of fuel injectors).

All injectors inject simultaneously once per each crankshaft revolution each time injecting half the amount of fuel required for a power cycle.

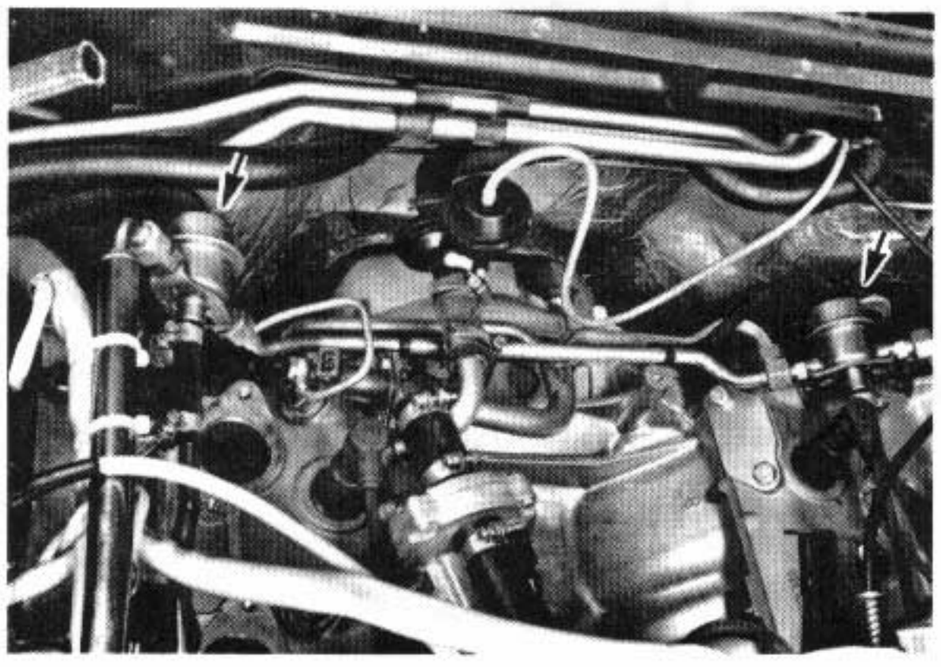


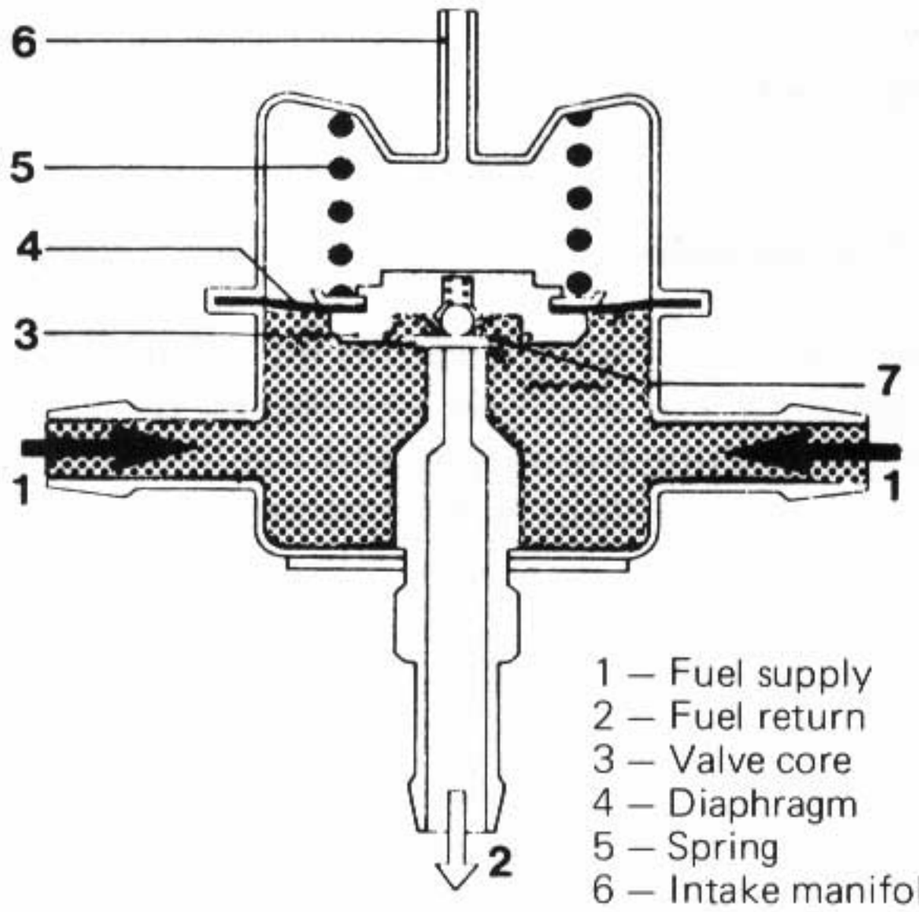


1 – Needle
2 – Armature
3 – Magnetic coil
4 – Electric connection
5 – Filter

Fuel Pressure Regulator

A pressure regulator is installed on the end of each distribution line, to keep the fuel pressure constant. The spring chambers of the pressure regulator are connected to the throttle valve housing. In this manner a constant difference between intake manifold vacuum and fuel pressure is maintained. Consequently the pressure drop via the fuel injectors is identical for all load conditions. The excess fuel is returned to the tank via a return line.

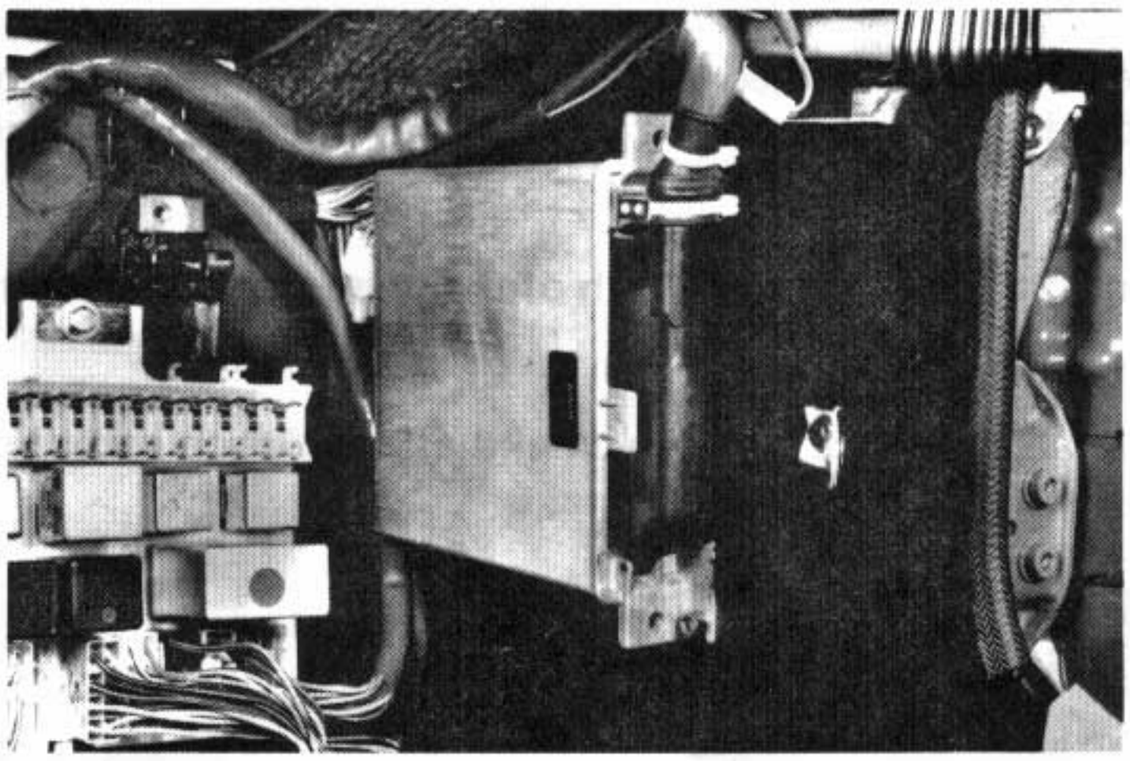




1 – Fuel supply
2 – Fuel return
3 – Valve core
4 – Diaphragm
5 – Spring
6 – Intake manifold connection
7 – Valve

Control Unit

The control unit is mounted on the right side of the passenger's footwell.



The control unit processes incoming information on air volume, engine speed, intake air temperature, engine temperature, position of throttle valve (idle, full throttle), starting, and exhaust (oxygen sensor). It determines and controls the injection time for the fuel injectors.

Speed Sensor/Injection Timing

The fuel injection control unit receives information on engine speed and timing via terminal 16 of the transistor ignition control unit.

Temperature Sensor I

Temperature Sensor I is located in the inlet of the air flow sensor. It measures the intake air temperature and puts out an appropriate signal to the control unit.

Temperature Sensor II

Temperature sensor II supplies information on engine temperature. This information is used to determine the amount of fuel enrichment for engine warm-up.

Control Switches

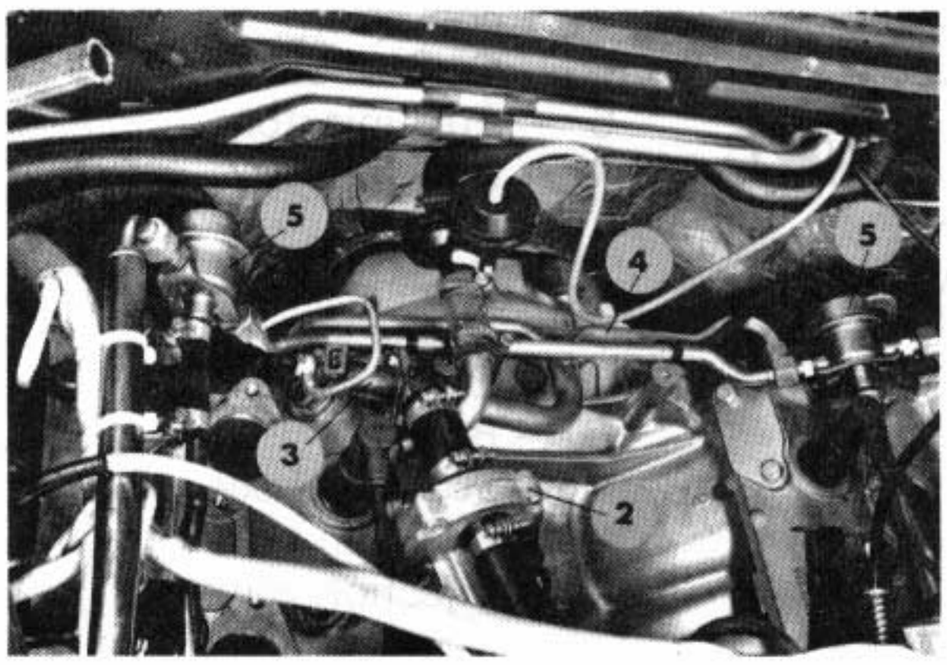
Other control signals are sent to the control unit in addition to those for air volume, speed and temperature. For example, terminal 50 on the starter sends a signal to limit the time of fuel enrichment for starting the engine, and the micro-switches on the throttle valve housing for coasting fuel shut-off and full throttle enrichment.

To compensate for the high friction and condensation loss of a cold engine, there is also a cold start valve and auxiliary regulator.

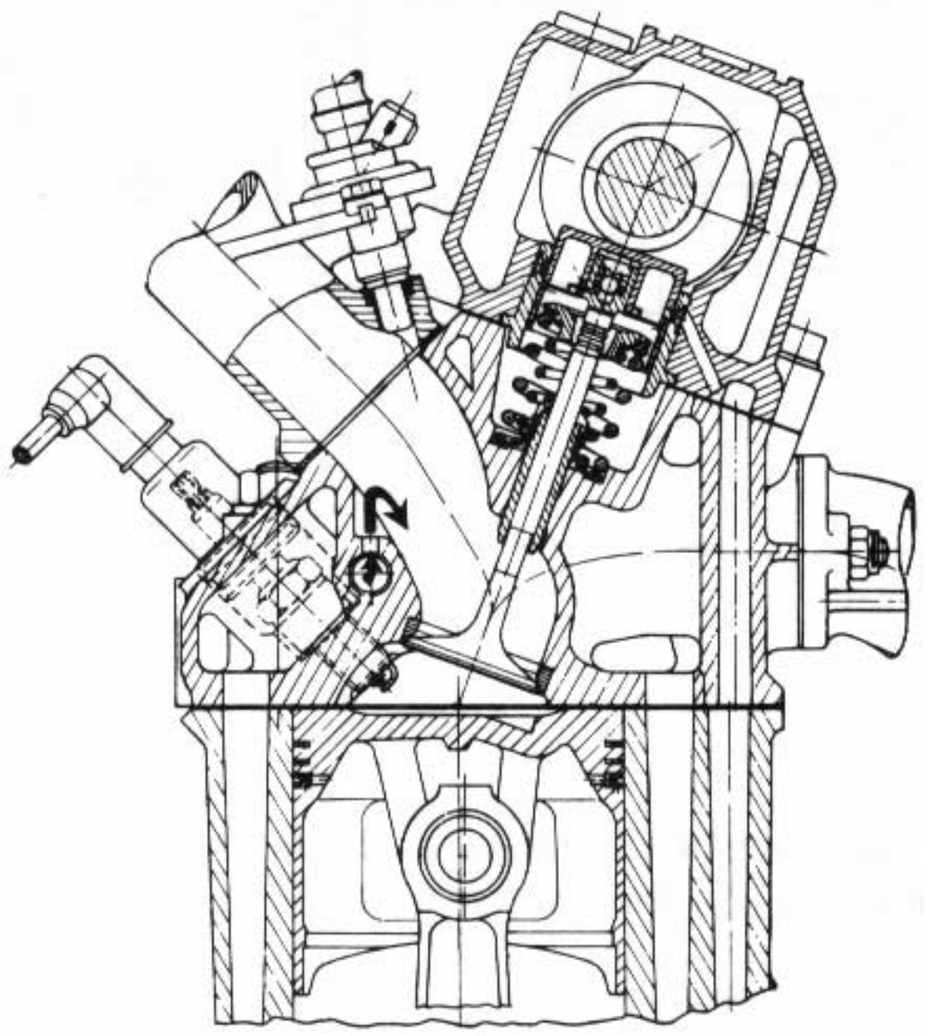
The amount of fuel to be injected by the cold start valve is determined by the thermo time switch, which is bolted in the thermostat housing and measures the engine temperature. The additional air required for cold running is supplied by an auxiliary air regulator.

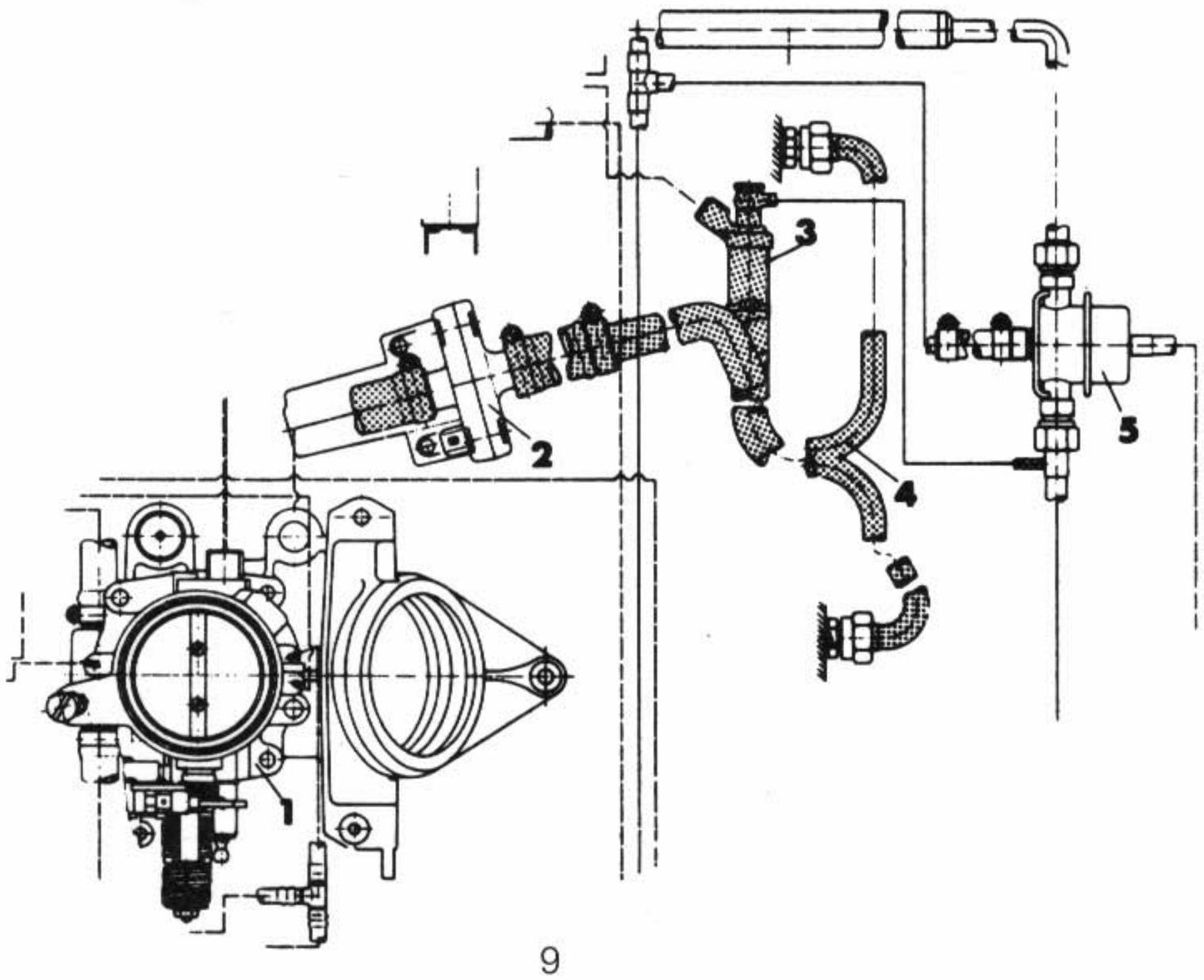
Engines with oxygen sensor do not require air injection. These bores in the cylinder head are used for the central cold idle system, but are connected with the intake ports rather than the exhaust ports.

Fuel from the cold start valve and air from the auxiliary air regulator flow through these bores.



1 – Throttle valve housing
2 – Auxiliary air regulator
3 – Cold start valve
4 – Fuel supply line
5 – Fuel pressure regulator

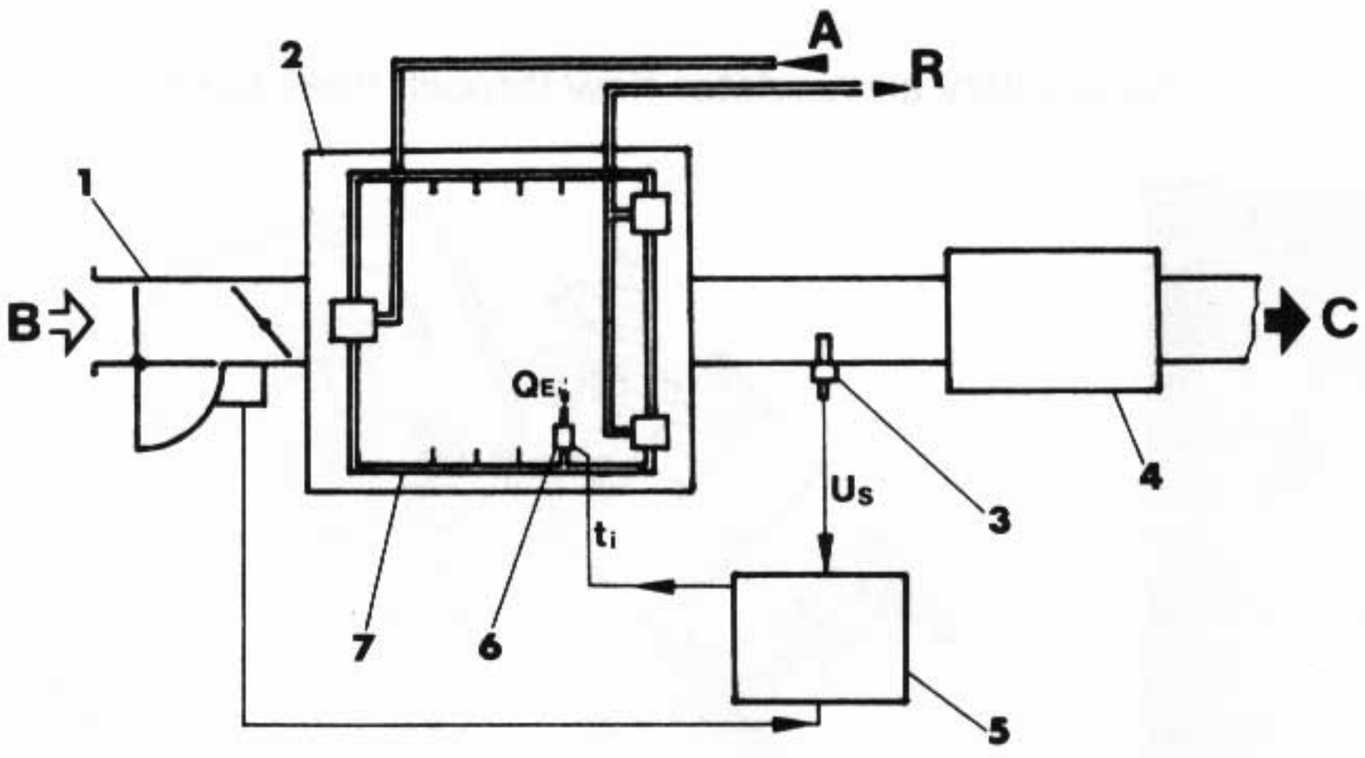




It is less expensive to equip A. F. C. fuel injection with oxygen sensor, than C. I. S. fuel injection.

In addition to the catalytic converter only the oxygen sensor and extra electronic circuit in the control unit are required.

Oxygen Sensor Circuit/Air Flow controlled Fuel Injection



1 – Air flow sensor
2 – Engine
3 – Oxygen sensor
4 – 3-way catalytic converter
5 – Control unit
6 – Fuel injector
7 – Fuel loop

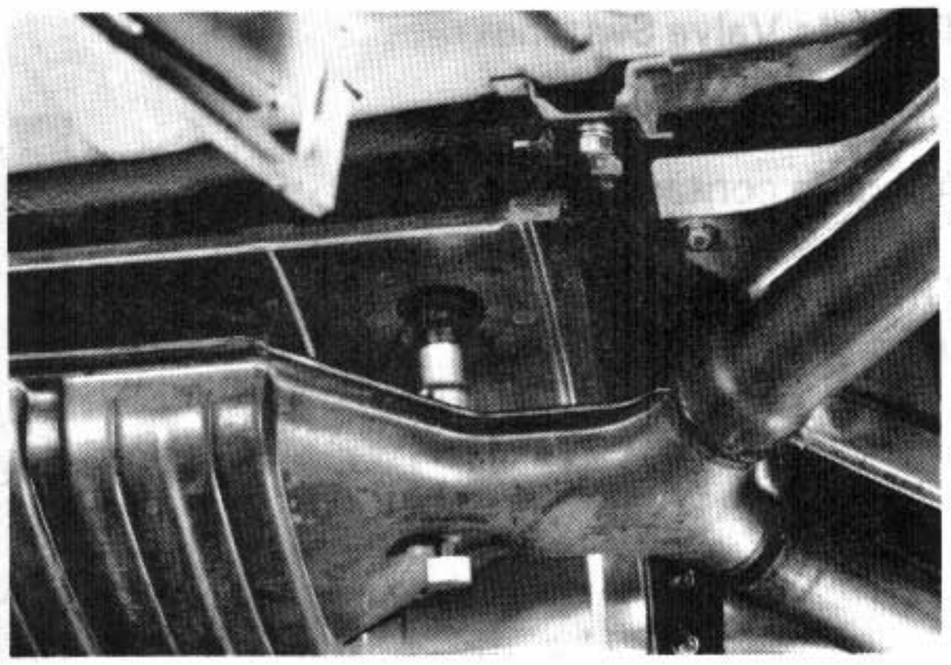
A – Fuel
B – Intake air
C – Exhaust gas
R – Return
U_S – Sensor voltage
t_i – Injection time
Q_E – Injection volume

Oxygen sensor (3) measures the residual oxygen content in the exhaust gas (C) and sends the voltage signal (U_S) to the control unit (5).

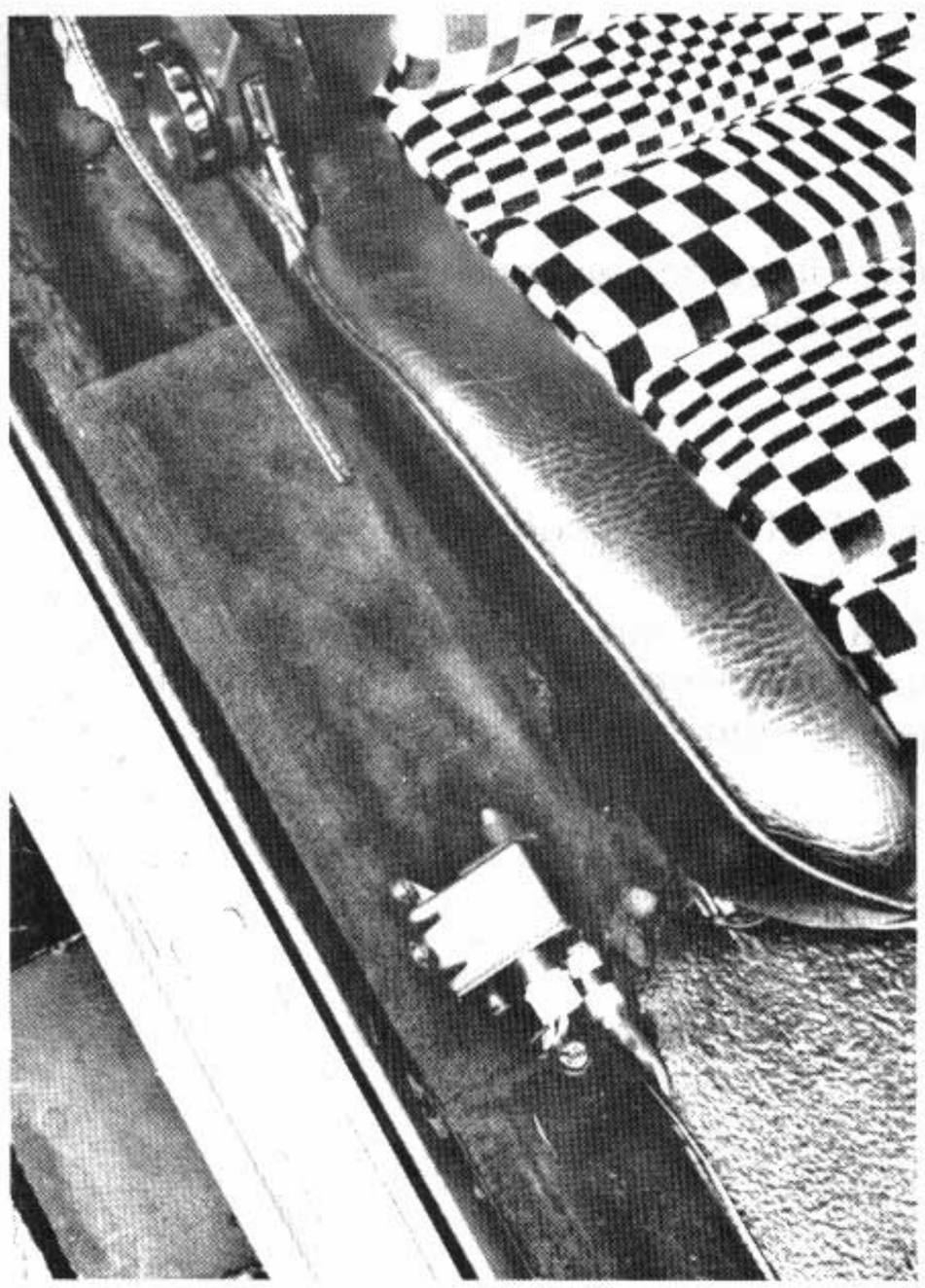
The existing injection signal is corrected with this signal and forwarded to the fuel injectors (6). The opening time (t_i) of the fuel injectors and also the injection volume (Q_E) are changed.

The fuel mixture is very close to lambda = 1.

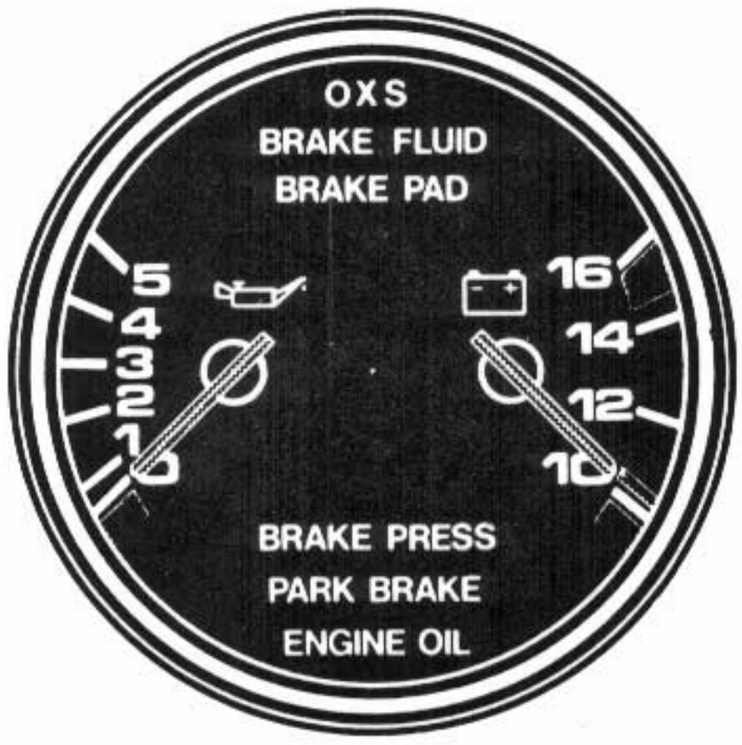
The oxygen sensor must be surrounded by exhaust gas from all cylinders. Consequently it is located after the exhaust manifold junction before the catalytic converter.



A mileage counter is located to the right of the passenger's seat underneath a cover.



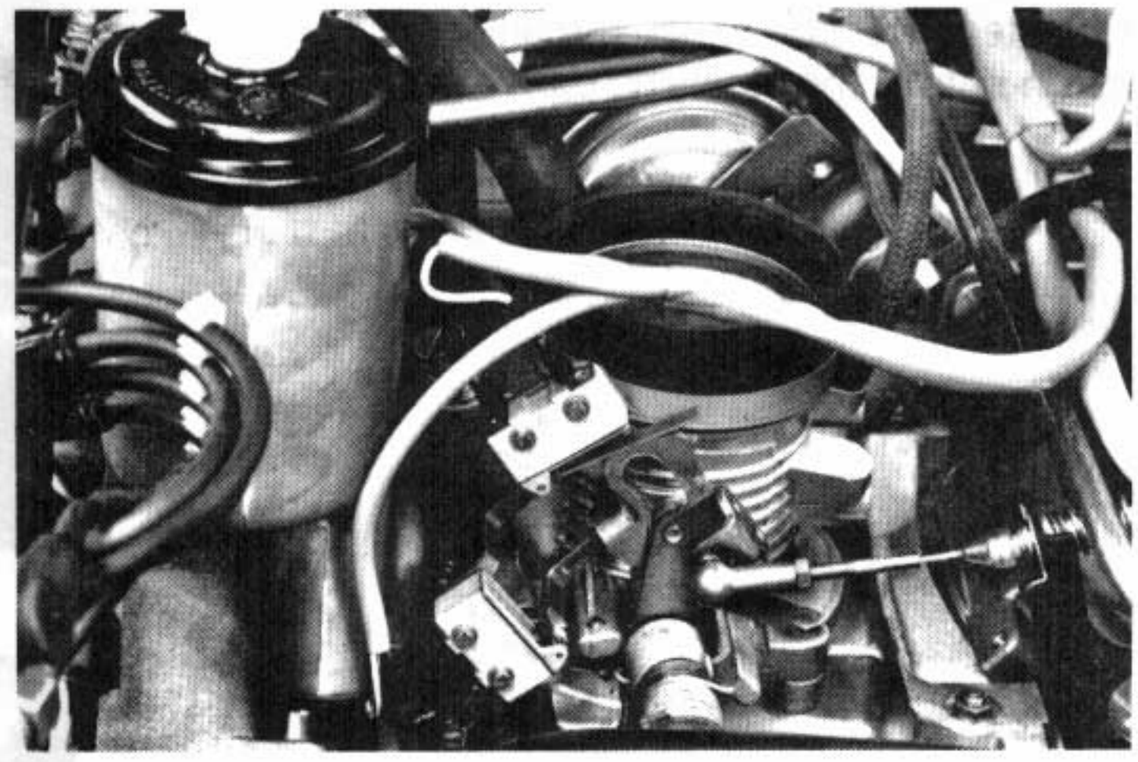
After a distance of 30,000 miles (48,000 km) the OXS indicator light in the instrument panel will come on to remind the driver to have the oxygen sensor replaced and the counter reset.



Throttle Valve Switches

A – Idle contact

This contact is used to shut off the fuel supply when coasting.

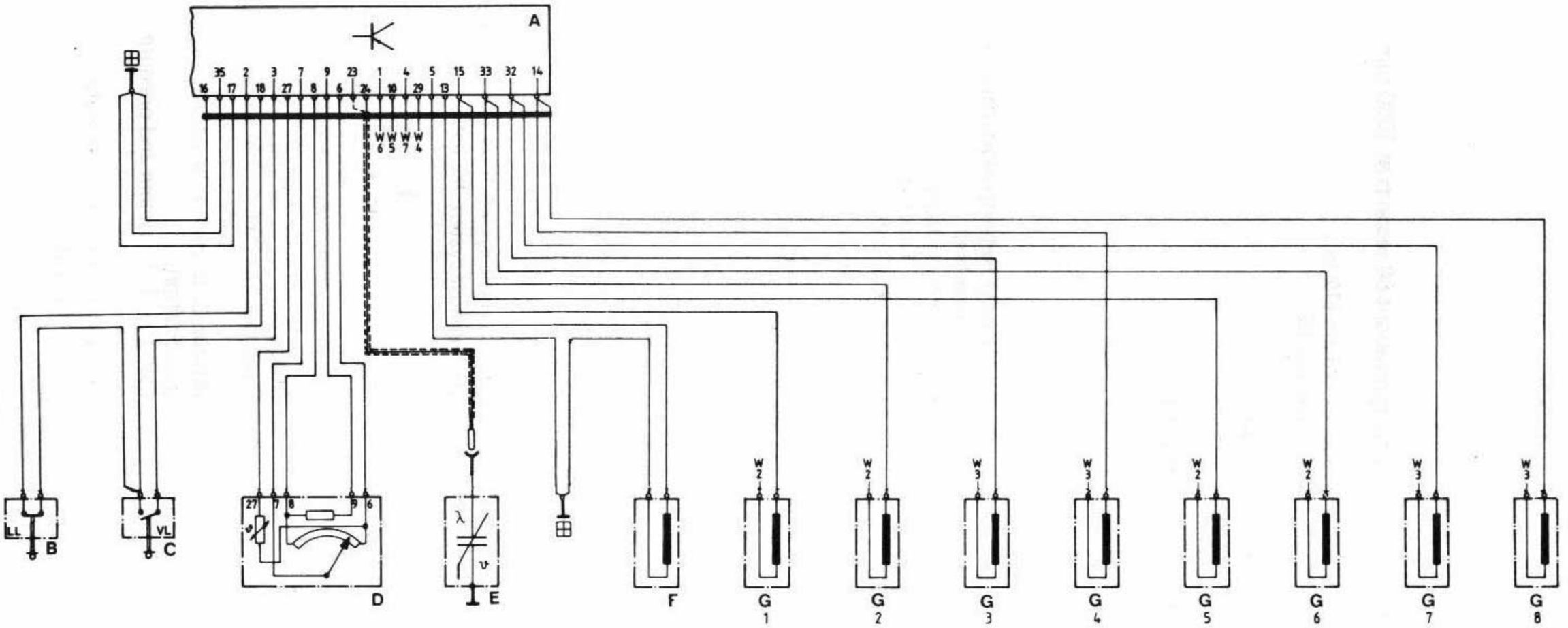


The idle switch will open when the accelerator linkage play is eliminated, before the throttle valve is opened.

B – Full throttle contact

At a throttle valve opening of approx. 30°, the full throttle switch is tripped. The control unit turns the oxygen sensor off and enriches the fuel mixture by about 12 %. This lowers the exhaust temperature in order to protect the oxygen sensor and catalytic converter.

928 A. F. C. Wiring Diagram



A — Control unit
B — Idle micro-switch
C — Full throttle micro-switch
D — Air flow sensor
E — Oxygen sensor
F — Temperature sensor II
G — Fuel injectors 1 — 8

W 2, W 3, W 4, W 5 — Power supply relay XVI 87

⊞ — Valve cover ground
W 6 — Fuel pump relay XVII 31b
W 7 — Power from starter term. 50

Checking Engine Idle Speed, CO Level and Oxygen Sensor Control – Type 928

Requirements:

Engine warm
Run engine about 60 seconds at 3000 rpm.
If test is not finished in about 5 minutes, run engine again about 60 seconds at 3000 rpm.
(air conditioner switched off).
If a test connection is not available, connect an approx. 20 cm (12 in.)
piece of wire fitted with a proper flat male plug on terminal 22
of the control unit multiple-pin plug.
Connect voltmeter on other end of wire (terminal 22).
A. F. C. system O. K.
Battery fully charged
Full throttle and idle microswitched correctly adjusted

1. Run engine at idle speed
Engine speed: 750 ± 50 rpm.

Read voltage.
Voltage should vary back and forth
between 2 values.

— no — Sensor hot? Refer to requirements.
Sensor defective.
Break in wire harness.
Control unit defective.
Check A. F. C. system (basic C. O. setting)

|

yes

|

Record voltage values
from ..... V to V
Find mean value.
U_R V

|

yes

|

Disconnect oxygen sensor at
connection point (passenger's
footwell).

— no — Check intake system with pressure regulator
and exhaust system for leaks.

|

O. K.

|

Steady control voltage (U_S) V

$U_R = U_S$

|

yes

|

Connect sensor line again.

Check basic C. O. setting
Reconnect oxygen sensor

If basic C. O. cannot be adjusted to
specification:
Check A. F. C. system and pressure
regulator.
Check cold start valve for leaks.
Check fuel injectors.

2. Test: Other controls
Run engine at idle speed

Check rich stop:
Disconnect sensor at connection point and hold sensor line (coming from control unit) against ground.

Voltage rises slowly in direction of 12 V (rich)

— no — Pull plug off of full throttle microswitch and repeat test.

Okay – switch defective.
Not okay – Check wire from control unit terminal 24 to sensor.
Control unit defective.

yes

Check lean stop:
Connect sensor wire (coming from control unit) on 1.5 V battery, " – " side of battery to ground.
Voltage drops slowly in direction of 0 V (lean).

— no — Check test battery (min. IV).
Check terminal 24 wire to sensor.
Control unit defective.

yes

Connect sensor.
Check full throttle microswitch.
Operate (close) microswitch by hand.
Read voltage.
Should be control voltage U_S.

— no — Full throttle microswitch defective.
Check wires to control unit term. 3 and 18.
Control unit defective.

yes

Run engine at about 2000 rpm/
Operate (close) idle microswitch by hand.
Engine should "hunt" between 1000 and 1500 rpm.

— no — Check microswitch
Check wires leading to control unit terminals 18 and 2
Control unit defective

|

yes

|

Run engine to 4000 rpm (no load)
Voltmeter reading varies
Release accelerator pedal suddenly
Voltmeter momentarily goes to control voltage U_S ..... V then begins varying again when engine returns to idle speed

— no — Check adjustment of idle microswitch
Control unit defective

|

yes

|

Test finished.
Reconnect all wires.

Adjustment of microswitches:

Full throttle microswitch
"Off" with accelerator pedal released
"on" with throttle valve open more than 30°

Idle microswitch
"on" with accelerator pedal released
"off" with accelerator pedal depressed enough to eliminate throttle linkage play but without opening throttle plate

Refer to Group 24 of Type 928 Repair Manual for other tests and adjustments on A. F. C. Fuel Injection System.

Checking Engine Idle Speed, CO Level and Oxygen Sensor Control – Type 928

Engine fully warmed up.
Run engine about 60 seconds at 3000 rpm prior to checking.
If test is not finished in about 5 minutes, run engine about 60 seconds at 3000 rpm.

Connect CO tester on test adapter ahead of catalytic converter.
Run engine at idle speed.
Air conditioner switched off.

Nominal value for idle speed: 750 ± 50 rpm.
— no — Correct idle speed with idle air control screw (throttle bypass).

yes

Disconnect oxygen sensor.
Note! Don't hold wire from control unit against ground!
Read CO level, nominal value: 0.6 ± 0.2 %.
— no — Adjust CO level to specified value with mixture control screw in air flow sensor (sensor plate bypass).

yes

Hold sensor wire (coming from control unit) against ground. Read CO level.
CO level rises (rich).
— no —
1. Check wire to control unit term. 24 for breaks.
2. Control unit defective.

yes

Connect sensor wire (coming from control unit) on 1.5 volt battery, " – " side of battery to ground. Read CO level.
CO level drops (lean).
— no —
1. Check test battery (min. 1 volt).
2. Check wire to control unit term. 24.
3. Control unit defective.

yes

Connect sensor again (regulating operation). Read CO level. Range: 0.4 to 0.8 %.
— no —
1. Sensor defective.
2. Control unit defective.

yes

Open plate of air flow sensor slightly with a screwdriver (air cleaner upper section removed).
CO level rises then is regulated to 0.4 to 0.8 %.
— no — Sensor defective.

yes

Keep engine running at idle speed.
Operate (close) full throttle contact (microswitch B) by hand.
CO level rises.
— no —
1. Full throttle switch defective.
2. Check wires to control unit term. 3 and 18.
3. Control unit defective.

Refer to Group 24 of Type 928 Repair Manual for other tests and adjustments on A. F. C. Fuel Injection System.

Test Values for A. F. C. Fuel Injection System – Type 928

Test performed on disconnected control unit multiple-pin plug.
Testing equipment: high quality voltmeter and ohmmeter.

All resistance test values apply at 20 °C (68 °F) ambient temperature.

Ohmmeter at Terminals	Test Values	Components
Term. 5 + term. 13	2–3 k-ohms	Temperature sensor II
Term. 2 + term. 18	0 ohms[1]	Idle microswitch A
Term. 2 + term. 18	ohms[2]	Idle microswitch A
Term. 3 + term. 18	ohms[3]	Full throttle microswitch B
Term. 3 + term. 18	0 ohms[4]	Full throttle microswitch B
Term. 6 + term. 9	200–400 ohms	Air flow sensor
Term. 6 + term. 8	130–260 ohms	Air flow sensor
Term. 8 + term. 9	70–140 ohms	Air flow sensor
Term. 6 + term. 7	40–300 ohms	Air flow sensor
Term. 7 + term. 8	100–500 ohms	Air flow sensor
Term. 27 + term. 6	2–3 k-ohms	Air flow sensor/temp. sensor I
Term. 10 + term. 15	1–1.5 ohms[5]	Fuel injectors 1 + 5
Term. 10 + term. 14	1–1.5 ohms[5]	Fuel injectors 4 + 8
Term. 10 + term. 32	1–1.5 ohms[5]	Fuel injectors 3 + 7
Term. 10 + term. 33	1–1.5 ohms[5]	Fuel injectors 2 + 6
Term. 16 + ground	0 ohms	Ground (camshaft housing)
Term. 17 + ground	0 ohms	Ground (camshaft housing)
Term. 35 + ground	0 ohms	Ground (camshaft housing)
Term. 5 + ground	0 ohms	Ground (camshaft housing)

Voltmeter at Terminals	Test Values	Comments
Term. 1 + ground	ca. 1 volt	Ignition turned on
Term. 10 + ground	ca. 12 volts	Ignition turned on
Term. 29 + ground	ca. 12 volts	Ignition turned on
Term. 4 + ground	min. 8 volts	Starter activated
Term. 1 + ground	ca. 2.5 volts (reading varies)	Starter activated

1) Accelerator pedal released.
2) Accelerator pedal slightly depressed (throttle linkage play eliminated).
3) Accelerator pedal released.
4) Accelerator pedal depressed (until throttle open more than 30°).
5) 2–3 ohms for each fuel injector when checked separately.

Refer to Group 24 of Type 928 Repair Manual for other tests and adjustments on A. F. C. Fuel Injection System.

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