1. Description of System

1.1 Fuel System

The fuel is drawn from the tank ① by the fuel pump ②, and is delivered through an expansion vessel ㉞ and a fine filter ③ into the pressure line.

The pressure regulator ④ mounted between the injection valves limits the fuel pressure to 2 kgf/cm². The solenoid-operated injection valves ⑧, as well as the start valve ⑫, are connected to the pressure line by means of a ring main ⑨. Excess fuel flows from the pressure regulator through a return line back to the fuel tank.

An overpressure safety valve connects ("short-circuits") the suction and pressure sides inside the fuel pump if the pressure should rise to an unacceptably high level, for example if a malfunction develops in the pressure system. In addition, the pressure connection at the fuel pump is fitted with a non-return valve which prevents the pressure from dropping completely immediately after the pump is switched off.

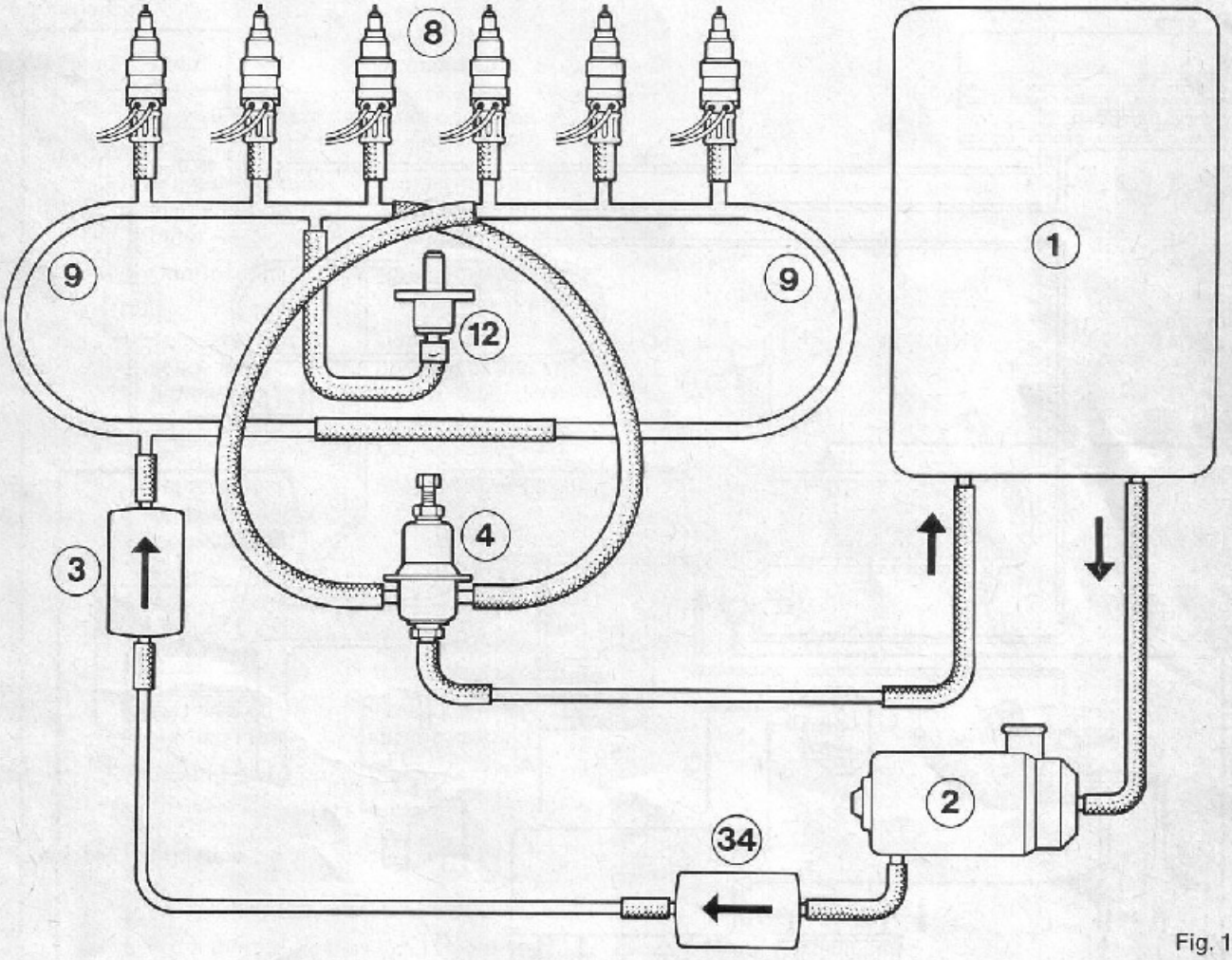


Fig. 1

1.2 Air System

The air required for combustion flows through the air filter and the throttle-valve assembly to the common intake manifold ⑤, whence it flows further through the individual intake manifolds and past the intake valves before finally entering the combustion chamber.

The throttle-valve assembly, together with the throttle valve ㉑, is flanged onto the common intake manifold. The throttle valve is actuated by means of a linkage from the accelerator pedal.

The vacuum prevailing in the common intake manifold acts on the pressure sensor ⑤ (vacuum take-off point on the intake manifold).

The air quantity is dependent on the position of the throttle valve.

The throttle valve is closed during idle. The idle air is sucked in through a bypass air duct. The bypass cross section, and consequently also the idle speed itself, can be altered by turning the idle-speed adjusting screw ⑭. The idle adjustment can only be made when the engine is at normal operating temperature (coolant temperature approx. 80° C). This ensures that the auxiliary-air device ⑰ is closed. It is the function of the auxiliary-air device to provide the engine, during the warm-up phase, with an additional quantity of air; this quantity of air is directly proportional to the additional quantity of fuel established by the ECU based on the engine temperature. The auxiliary-air device accomplishes this task in that the effective cross section of its orifice is altered by a slider. The position of the slider is dictated by an expansion element, which tends to open or close the slider according to the coolant temperature. The slider is fully open at approx. 20° C and fully closed at approx. +70° C.

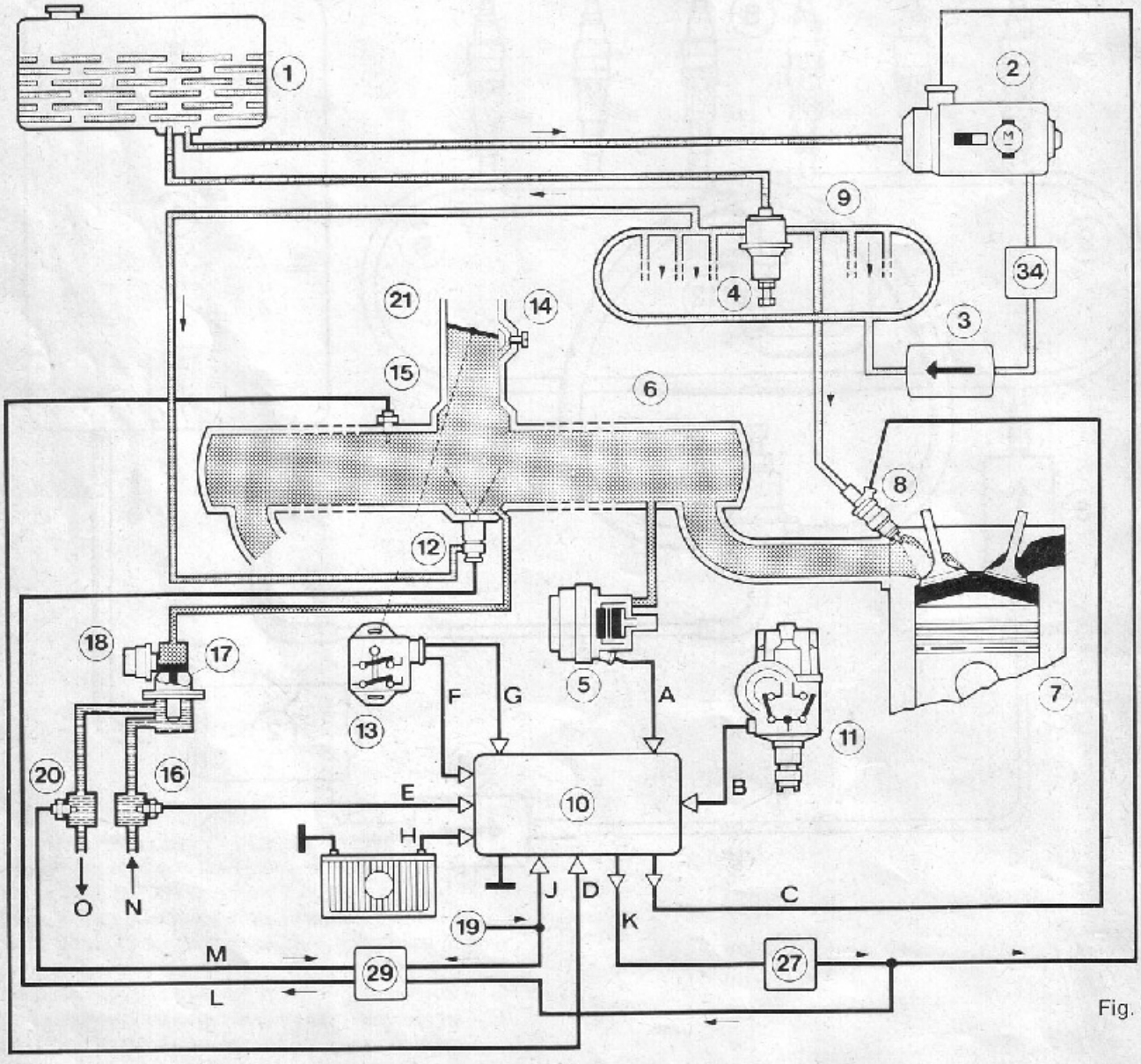


Fig. 2

Identification of Components in Basic System Diagram (Fig. 2)

① Fuel tank
② Fuel pump
③ Fuel filter
④ Pressure regulator
⑤ Pressure sensor
⑥ Common intake manifold
⑦ Cylinder head
⑧ Injection valves
⑨ Fuel-distribution pipe (ring main) leading to the 6 injection valves
⑩ Electronic control unit
⑪ Ignition distributor with trigger contacts
⑫ Start valve
⑬ Throttle-valve switch with acceleration enrichment
⑭ Idle-speed adjusting screw
⑮ Temperature sensor I (intake air)
⑯ Temperature sensor II (coolant)
⑰ Auxiliary-air device
⑱ Air filter for auxiliary-air device
⑲ from terminal 50 on starting motor
⑳ Thermo-time switch
㉑ Throttle valve
㉗ Pump relay
㉙ Post-start relay
㉞ Expansion vessel

Control unit information or command	From	Content of information or command
A	Pressure sensor	Load condition of engine
B	Trigger contacts in ignition distributor	Triggering start of fuel injection; rotational speed
C	Control unit	Opening period of the injection valves
D	Temperature sensor I (intake air)	Correction of the quantity of fuel injected dependent on the intake-air temperature
E	Temperature sensor II (coolant temperature)	Engine warm-up
F+G	Throttle-valve switch	Idle, acceleration enrichment
H	Battery	Supply voltage for the control unit
J	Terminal 50 on starting motor	Pump control during starting
K	Control unit	Pump control

Additional information

L	From post-start relay to start valve
M	From thermo-time switch to post-start relay
N+O	Coolant circuit leading to auxiliary-air device

1.3 Description of Operation

As a result of the fuel pressure of 2 kgf/cm², fuel is sprayed into the vehicle engine when the injection valve is open. The injection channel in each injection valve is precisely dimensioned. Since the fuel pressure is held constant, the quantity of fuel sprayed depends only on the length of time that the injection valves remain open.

This duration of injection is calculated by the electronic control unit. The information which the electronic control unit processes to make this calculation comes from the various individual information transmitters (sensors) in and on the engine.

Information A and B

The duration of injection (quantity of fuel injected) is determined primarily by two factors, namely the load condition (Information A) and the speed (Information B) of the engine. The intake manifold pressure is a measure for the engine load condition, and after being converted to an electrical signal is fed by the pressure sensor to the control unit. Information on the speed of the engine is determined by ignition distributor contacts I and II (trigger contacts I and II in the distributor).
In addition, these contacts determine the start of injection.

Command C

The electronic control unit processes "Information A and B" above to generate "Command C": the duration of the period during which the solenoid-operated injection valves remain open. In this way, the "basic quantity of fuel" is derived as a function of the engine speed and loading.

The fuel injection valves are actuated electrically by the electronic control unit in two groups (Fig. 3).

Group 1: cylinders 1-5-3;
Group 2: cylinders 6-2-4.

In each group the three fuel injection valves are opened simultaneously.

The fuel is sprayed onto the intake valves while they are still closed, and is "stored" there. When an intake valve is opened, the fuel stored in front of it is then drawn into the combustion chamber together with the air stream.

In order to develop favorable engine running qualities for every operating condition, a precisely metered additional quantity of fuel must be sprayed into the engine when it is started at low temperatures, during the warm-up period of the engine, and when accelerating.

Information D

Temperature sensor I in the common intake manifold corrects the quantity of fuel injected into the engine as a function of the air density, which in turn depends on the temperature of the intake air.

Information E

Temperature sensor II is installed in the coolant circuit leading to the auxiliary-air device and feeds the "warm-up" information to the control unit.

Information F and G

When the driver of the vehicle presses down on the gas pedal (during acceleration), the control unit receives "Information F": "additional fuel" so that a precisely determined additional quantity of fuel will be sprayed into the engine for the so-called "acceleration enrichment". In order to be able to meter the acceleration enrichment exactly, an angular gear is installed between the throttle shaft and the throttle-valve switch.

The second quantum of information, "G", "idle" is used for setting the concentration of CO in the exhaust gas using a potentiometer on the electronic control unit.

Information H

With the ignition switched on, the control unit receives its operating voltage directly from the battery through the main relay. Please see Section 1.4 below, "Cable Layout" for the specific wiring system.

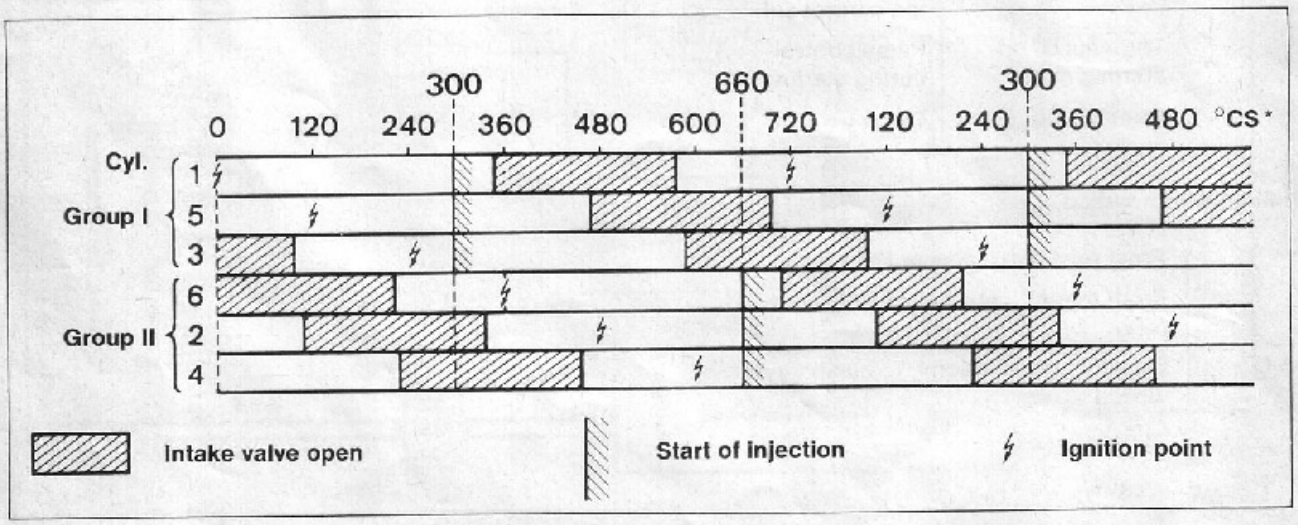


Fig. 3

* °CS = degrees crankshaft

Information J and Command K

The fuel pump is controlled by the pump relay, and this relay in turn is actuated from the electronic control unit (Command K). Also see Section 1.4, "Cable Layout" below. The pump relay operates only when either the starting motor is actuated (Information J) or when the engine speed rises above about 200 rev/min (Information B). This is a form of "cylinder flooding protection" which prevents filling of the combustion chamber with fuel in event of a defective injection valve.
A time-lag relay built into the control unit permits the fuel pump to operate for about 1 s after the ignition is switched on so that the fuel pressure builds up immediately.

Commands L and M:
Post-injection device (Fig. 4)

The start valve ⑫ sprays fuel into the common intake manifold not only during the starting process itself but also after this process until the time required by the thermo-time switch ⑳ to operate has passed – assuming of course that the coolant temperature is under about +35° C so that the contact in the thermo-time switch is initially closed.
During starting, voltage is fed from terminal 50 on the starting motor through cable 44, terminal 86c, and diode D1 to the post-start relay ㉙. When this relay is energized (closed), the start valve receives voltage from terminal 87 on the pump relay through terminals 30/51 and 87 on the post-start relay, and this valve sprays fuel (Command L). When the starting process has ended, the post-start relay holds itself closed through diode D2 until the specified time required by the thermo-time switch has passed, and then its contact interrupts the minus cable No. 40 leading to the post-start relay (Command M). The purpose of D1 is to prevent the starting motor from remaining engaged through terminal 86c after the starting process. As a result of D2, the start valve receives voltage only from the pump relay ㉗, and not from terminal 50 on the starting motor. In the latter case D1 would also be overloaded by the high consumption of current by the start valve.

Identification of parts in Fig. 4:

⑫ Start valve
⑲ from terminal 50 on starting motor
⑳ Thermo-time switch
㉔ Disconnect plug
㉗ from pump relay
㉙ Post-start relay

19 R Designation in cable disconnect plug
19
38
40
43 } Cable numbers
44
62
126

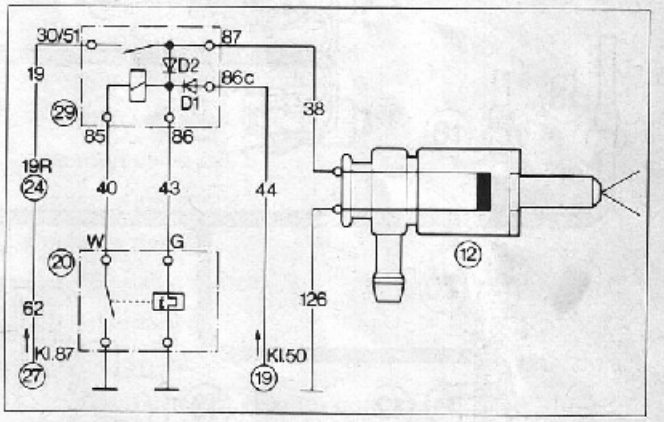


Fig. 4

1.4 Cable Layout

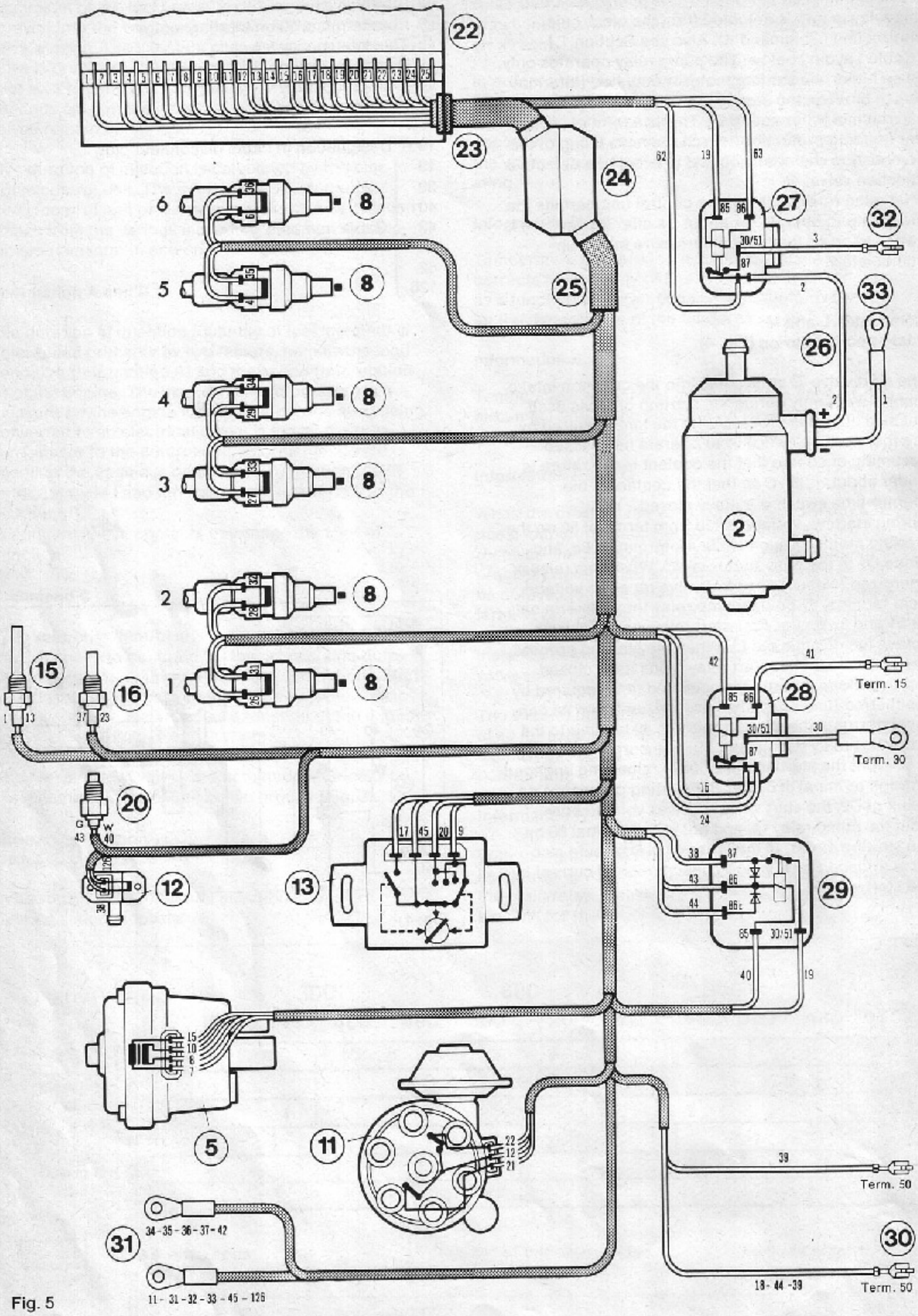


Fig. 5

Identification of parts shown in Cable Layout (Fig. 5)

② Fuel pump
⑤ Pressure sensor
⑧ Injection valves
⑪ Ignition distributor with trigger contacts
⑫ Start valve
⑬ Throttle-valve switch with acceleration enrichment
⑮ Temperature sensor I (intake air)
⑯ Temperature sensor II (coolant)
⑳ Thermo-time switch
㉒ Electronic control unit
㉓ Passenger-compartment cable
㉔ Cable disconnect plug
㉕ Engine wiring harness
㉖ Pump cable
㉗ Pump relay
㉘ Main relay
㉙ Post-start relay
㉚ to terminal 50 on ignition and starting switch through vehicle wiring harness
㉛ Common vehicle ground at the holder for the common intake manifold or cylinder-head cover
㉜ to fuse No. 7 (Coupé) or No. 11 (Limousine)
㉝ Vehicle ground

Cable No.	Designation in cable disconnect plug	From	To	Cable No.
1	A	Electronic control unit (ECU)	Temperature sensor I (air)	1
1		Fuel pump (− connection)	Vehicle ground	1 [2])
2	–	Electronic control unit (ECU)	Not used	–
2		Fuel pump (+ connection)	Pump relay term. 87	2 [2])
3	C	Electronic control unit (ECU)	Injection valve cyl. 1 and	26
			Injection valve cyl. 3	27
3		Pump relay term. 30/51	Fuse No. 7 (coupé) or	3 [2])
			No. 11 (Limousine)	
4	D	Electronic control unit (ECU)	Injection valve cyl. 5	4
5	E	Electronic control unit (ECU)	Injection valve cyl. 2 and	28
			Injection valve cyl. 4	29
6	F	Electronic control unit (ECU)	Injection valve cyl. 6	6
7	I	Electronic control unit (ECU)	Pressure sensor	7
8	H	Electronic control unit (ECU)	Pressure sensor	8
9	K	Electronic control unit (ECU)	Throttle-valve switch	9
10	L	Electronic control unit (ECU)	Pressure sensor	10
11	M	Electronic control unit (ECU)	Vehicle ground	11 [1])
12	N	Electronic control unit (ECU)	Ignition distributor (trigger contacts)	12
13	P	Electronic control unit (ECU)	Temperature sensor I (air)	13
14	–	Electronic control unit (ECU)	Not used	–
15	S	Electronic control unit (ECU)	Pressure sensor	15
16	T	Electronic control unit (ECU)	Main relay term. 87	16
17	U	Electronic control unit (ECU)	Throttle-valve switch	17
18	V	Electronic control unit (ECU)	Vehicle wiring harness term. 50, Starting motor term. 50 and Post-start relay term. 86c	18, 39, 44
19		Electronic control unit (ECU)	Pump relay term. 85	19
19		Post-start relay term. 30/51	Cable disconnect plug term. R	19

[1]) common vehicle ground ㉛
[2]) combined in pump cable ㉖
[3]) cable 24 divides into cables 63 and 64 in the passenger-compartment cable

Cable No.	Designation in cable disconnect plug	From	To	Cable No.
20	W	Electronic control unit (ECU)	Throttle-valve switch	20
21	X	Electronic control unit (ECU)	Ignition distributor (trigger contact)	21
22	Y	Electronic control unit (ECU)	Ignition distributor (trigger contact)	22
23	Z	Electronic control unit (ECU)	Temperature sensor II (Coolant)	23
24	a	Electronic control unit (ECU)	Main relay term. 87 and Pump relay term. 86	24 [3]) 63
25		Electronic control unit (ECU)	Not used	–
26		Injection valve cyl. 1	Electronic control unit (ECU) and Injection valve cyl. 3	3 27
27		Injection valve cyl. 3	Electronic control unit (ECU) and Injection valve cyl. 1	3 26
28		Injection valve cyl. 2	Electronic control unit (ECU) and Injection valve cyl. 4	5 29
29		Injection valve cyl. 4	Electronic control unit (ECU) and Injection valve cyl. 2	5 28
30		Main relay term. 30/51	Starting motor term. 30	30
31		Injection valve cyl. 1	Vehicle ground	31 [1])
32		Injection valve cyl. 2	Vehicle ground	32 [1])
33		Injection valve cyl. 3	Vehicle ground	33 [1])
34		Injection valve cyl. 4	Vehicle ground	34 [1])
35		Injection valve cyl. 5	Vehicle ground	35 [1])
36		Injection valve cyl. 6	Vehicle ground	36 [1])
37		Temperature sensor II (Coolant)	Vehicle ground	37 [1])
38		Start valve	Post-start relay term. 87	38
39		Starting motor term. 50	Electronic control unit (ECU) term. 18, Vehicle wiring harness term. 50 and Post-start relay term. 86c	18, 39, 44
40		Post-start relay term. 85	Thermo-time switch term. W	40
41		Main relay term. 86	Ignition coil term. 15	41
42		Main relay term. 85	Vehicle ground	42 [1])
43		Thermo-time switch term. G	Post-start relay term. 86	38
44		Post-start relay term. 86c	Starting motor term. 50, Vehicle wiring harness term. 50 and Electronic control unit (ECU) term. 18	18, 39, 44
45		Throttle-valve switch	Vehicle ground	45 [1])
62		Pump relay term. 87	Cable disconnect plug term. R	62
63		Pump relay term. 86	Electronic control unit (ECU) term. 24 and Cable disconnect plug term. a	24, 64 [3])
64		Soldering point in passenger-compartment wiring harness	Cable disconnect plug term. a	64 [3])
126		Start valve	Vehicle ground	126 [1])

[1]) common vehicle ground ⑬

[2]) combined in pump cable ⑯

[3]) cable 24 divides into cables 63 and 64 in the passenger-compartment cable

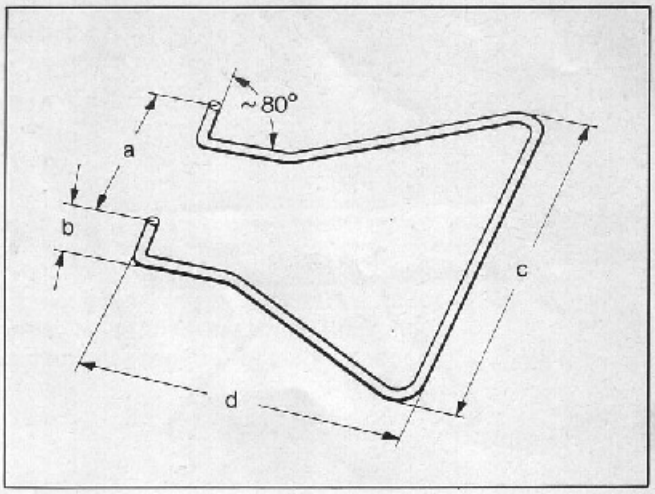
2. Testing Equipment and Tools Required

Tester EFAW 228 (A) **0 681 500 000**
for testing the system in the vehicle (0 681 500 008)
Dwell-tach tester
Timing light

CO analyzer
Mobile stand to hold testing equipment,
for example EFAW 172 A **0 681 169 084**
Extractor hook (to be user-fabricated)
to pull the wiring-harness plug out of the control unit (Fig. 6).

Dimensions:
a = 45 mm
b = 12 mm
c and d = about 100 mm
Material: welding rod, dia. 3 mm.

3 hose clamps to pinch off the fuel hoses; obtainable, for example, from Matra Werke GmbH, Diesel-strasse 30, 6000 Frankfurt/Main, West Germany, under part number **W 157.**



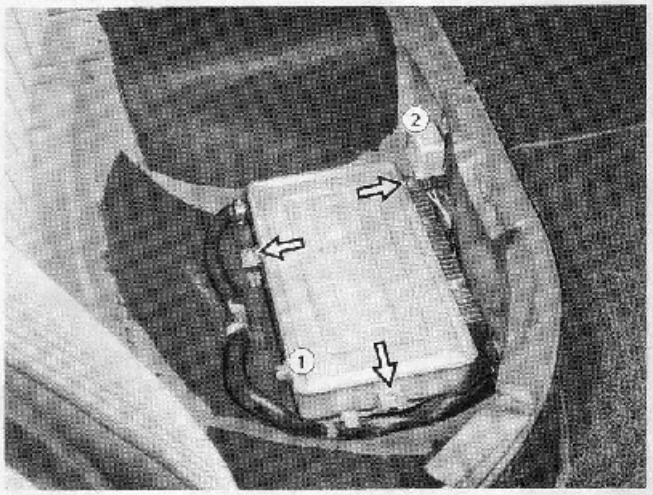
6

3. Removal and Installation of the Electronic Control Unit and Preparations for Testing the System Using Tester EFAW 228 (A)

Carry out all working steps described below only with the ignition switched off!

The electronic control unit is installed in the passenger compartment under the right rear seat (Fig. 7).

Removal:
Remove the rear seat and unscrew the 3 recessed-head screws (arrows); bend the cable clip open and tilt the control unit forward.



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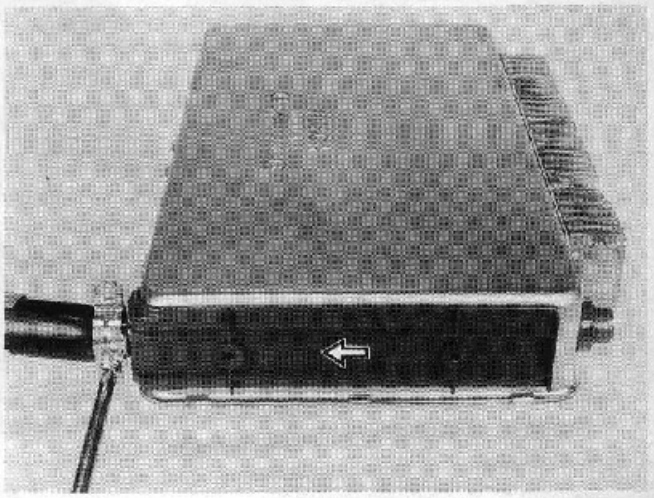
Open the strain-relief clamp with a Phillips-head screwdriver and pull the cover slider out to the left (Fig. 8).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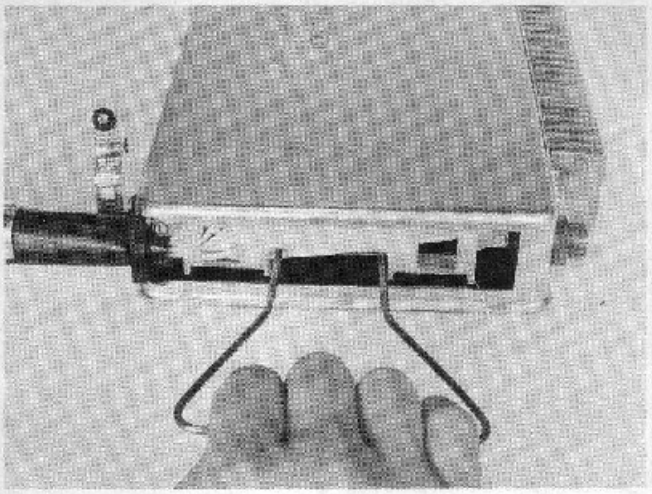

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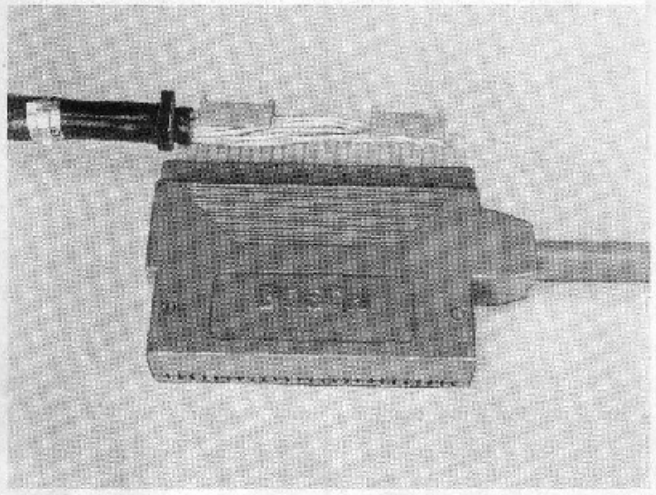
Pull the wiring-harness plug carefully out of the control unit (Fig. 9) using the extractor hook (to be user-fabricated as per Fig. 6).



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In order to test the information transmitters as well as the fuel pump and the injection valves, the wiring-harness plug should be inserted into the multiple plug on Tester EFAW 228 (A). The control unit is not connected here (Fig. 10).

Testing of the system is carried out according to the Test Specifications, VDT-W-280/1010 B.

Installation

Insert the wiring-harness plug carefully into the control unit (this plug can be inserted in only one position). Place the rubber sleeve on the wiring harness properly in the opening in the control unit. Move the cover slider into place and reattach the strain-relief clamp.

4. Trouble-Shooting Chart

referring to malfunctions which can possibly occur in the injection system. Prerequisites are that the ignition system and engine are in proper condition.

Malfunction	Cause	Remedy	Additional information given in
Engine cannot be started. Fuel pump does not operate.	1. Fuse No. 7 (Coupé) or No. 11 (Limousine) in the cable leading to terminal 30/51 on the pump relay is defective. Cables leading to the fuel pump or the pump relay, or cables at the pump relay, are defective. 2. Check the plug at the fuel pump for a proper connection.	Replace the fuse (8 A). Check whether the pump relay is energized. Listen for relay noise when switching the ignition on and off; use the voltmeter if necessary.	Section 1.4; Test Specifications VDT-W-280/1010 B
	No voltage (12 V) at terminal 86 on the pump relay because the main relay is not energized or the cable is defective.	Test the cables leading to the main relay, the cable leading from terminal 87 on the main relay to terminal 86 on the pump relay, and the main relay; if any part is found to be defective, replace it.	
	The pump relay has voltage at terminal 86 but terminal 85 is not grounded.	The fuel pump operates about 1–2 seconds after the ignition is switched on! Check with the voltmeter that terminal 85 is switched to ground by the control unit! Replace the control unit.	
	Cable from terminal 87 on the pump relay to the pump plug has an open circuit.	Repair the open circuit (Check the plug connections.)	
Engine cannot be started. Fuel pump operates.	Cable connector not plugged in at pressure sensor or has an open circuit.	Plug cable into pressure sensor or repair the cable.	Section 5.1; Test Specifications VDT-W-280/1010 B
	Cable connector at temperature sensor II has an open circuit. Engine floods.	Check cables, replace temperature sensor II if necessary.	Section 5.5; Test Specifications VDT-W-280/1010 B
	Pressure is not built up in the fuel line (line pinched, defective pressure regulator).	Test the pressure with a pressure gauge, replace the pressure regulator if necessary.	Section 5.3; Test Specifications VDT-W-280/1010 B
Cold engine cannot be started. Fuel pump operates.	Post-injection device defective: start valve, thermo-time switch, or post-start relay defective.	Check parts according to Test Specifications VDT-W-280/1010 B.	Section 5.7
	Auxiliary-air device defective (does not open).	Make the following test: the engine can be started with the throttle valve open, but dies with the throttle valve closed; replace the auxiliary-air device.	
Cold engine can be started but then it stops.	Cable connector for the trigger contacts is not plugged in at the ignition distributor or cable has open circuit.	If necessary, connect Tester EFAW 228 (A) and localize the defect; replace the trigger contacts or the wiring harness.	Test Specifications VDT-W-280/1010 B
	Trigger contacts defective.	Test the trigger contacts with EFAW 228 (A) and replace them if necessary.	
	Pressure sensor defective (for example aneroid capsule).	Replace pressure sensor.	Section 5.1; Test Specifications VDT-W-280/1010 B

Malfunction	Cause	Remedy	Additional information given in
Engine stops whilst being driven (usually preceded by misfiring).	1. Trigger contacts have too high a contact resistance or are dirty. 2. Plug connections are loose. 3. No fuel pressure.	1. Replace the trigger contacts. 2. Check the plug connections. 3. Test pressure. Determine cause of problem.	Test Specifications VDT-W-280/1010 B Section 5.3
Engine misfires, not caused by the ignition system.	An injection valve is stuck.	Test with EFAW 228 (A), replace if necessary.	Test Specifications VDT-W-280/1010 B Section 5.8
	Valve connection or valve coil not in proper condition.	Check connections. Check injection valves with EFAW 228 (A) and replace if necessary.	Test Specifications VDT-W-280/1010 B
	Loose connections, the common ground cable makes poor contact with the holder for the common intake manifold or cylinder-head cover.	Check connections, polish ground connection	Section 5
Engine does not develop its full power.	Fuel pressure too low.	Check pressure and pressure regulator.	Section 5.3
	Pressure sensor defective.	Replace.	Test Specifications VDT-W-280/1010 B
	Throttle valve does not open far enough.	Check throttle valve.	Section 5.2.1
Fuel consumption too high.	Information transmitters not operating properly, or high contact resistance at the electrical connections.	Test the system according to Test Specifications VDT-W-280/1010 B.	
	Throttle valve switch not set correctly.	Set the throttle-valve switch with Tester EFAW 228 (A).	Test Specifications VDT-W-280/1010 B
	Fuel pressure not correct.	Check the pressure and the pressure regulator, replace the pressure regulator if necessary.	Section 5.3
Idle speed too high (warm engine).	Throttle-valve stop set poorly (throttle valve opens too far).	Readjust the throttle-valve stop.	Section 5.2.1
	Idle speed set too high.	Set idle speed correctly.	Section 5.13
	Hose between auxiliary-air device and common intake manifold has become detached or is defective.	Attach hose or replace it.	Section 5.7
	Auxiliary-air device defective (does not close).	Make the following test: clamp off the hose between the auxiliary-air device and the intake manifold; if the speed drops, the auxiliary-air device is defective and must be replaced.	Section 5.7
Idle speed too high – cannot be adjusted.	Leaks in idle-air system.	Check idle-air system.	Section 1.2
	Small rubber seal ring (Service Parts List Item 14) under the injection valves is leaky.	Replace rubber seal ring.	Section 6, Item 14
Engine misfires ("burbles") during acceleration.	Acceleration enrichment mechanism in throttle-valve switch does not operate.	Check throttle-valve switch (Tester EFAW 228 (A)).	Test Specifications VDT-W-280/1010 B
Entire system fails, pump relay opens for short periods of time.	Voltage supply for the pump relay or ground connection for the control unit has a loose contact.	Check the pump relay and associated cables with a voltmeter.	Section 5.14; Test Specifications VDT-W-280/1010 B