

## BOSCH ELECTRONIC FUEL INJECTION

Mercedes Benz (1968-73)  
 Porsche (1970-73)  
 Renault (1972-73)  
 Saab (1969-73)  
 Volkswagen (1968-73)  
 Volvo (1970-73)

### APPLICATION

Mercedes Benz	
250 E/8.....	1968-70
280 SE 3.5.....	1971
280 SE 4.5, SEL 4.5.....	1971-73
300 SEL 3.5.....	1971-72
300 SEL 4.5.....	1971-73
350 SL.....	1971
450 SL, SLC.....	1973
Porsche	
914.....	1970-73
Renault	
R17.....	1972-73
Saab	
99E.....	1969-73
Volkswagen	
Type 3.....	1968-73
Type 4.....	1971-73
Volvo	
1800 E/ES.....	1970-73
140, 160.....	1972-73

### DESCRIPTION

#### FUEL SYSTEM

An electrically driven fuel pump, forces fuel through a filter, into the main system. Located in this system are, one injector for each cylinder, and a pressure regulator that maintains fuel pressure at 28 psi in the main system. A secondary system carries excess fuel from the pressure regulator back to the fuel tank.

#### AIR SYSTEM

The intake manifolds, connected to an intake air distributor, supply each cylinder with air. A pressure switch, pressure sensor and ignition distributor are also connected to intake air distributor. Pressure switch operates according to difference in pressure in intake air distributor and atmospheric pressure, while pressure sensor measures actual pressure in intake air distributor. A throttle valve, operated by accelerator pedal, is located at the mouth of the intake air distributor. Intake air distributor is connected to air cleaner by a rubber elbow. Idling air system, is in the form of a by-pass system, in intake air distributor, it joins behind throttle valve. Its functional cross section, can be varied, with an idling air adjusting screw. An auxiliary air line, from air cleaner via auxiliary air regulator, to intake air distributor forms the warming-up air system. Its volume is varied, depending on engine temperature, by the auxiliary air regulator.

#### ELECTRONIC CONTROLS

A control unit controls correct amount of fuel, depending on engine speed, pressure in intake system, and engine temperature. When ignition is switched on, control unit receives its operating voltage direct from battery, via a voltage supply relay. It also controls the fuel pump, which normally is provided with current via pump relay only when engine is running. A time switch, in electronic control unit, allows fuel pump to run approximately 1 to 1½ seconds after ignition is turned on. Control unit is connected to all sender units by a special wiring harness coupled to a multiple plug.

#### PRESSURE SENSOR

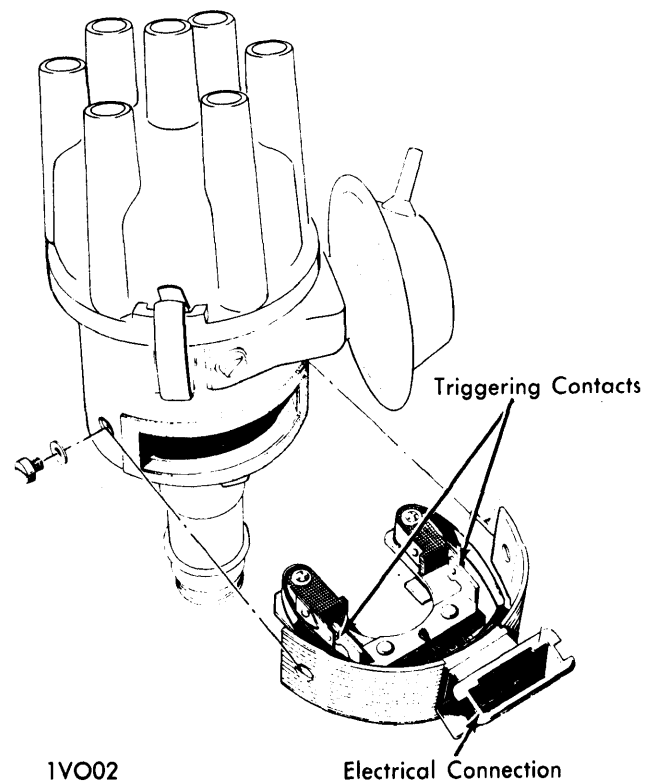
Controls basic amount of fuel, depending on pressure in intake air distributor, and load on engine.

#### AIR INTAKE TEMPERATURE SENSOR

Provides control unit with information about air temperature so that control unit can increase the injection quantity somewhat a low intake air temperature. Compensation ceases when intake air is greater than 68°F.

#### COOLANT (EXHAUST PORT ON VW) TEMPERATURE SENSOR

Provides control unit with information about coolant temperature (engine temperature) so that control unit can adapt injection interval and determine how long the cold start valve should open at cold start.



#### TRIGGERING CONTACTS & DISTRIBUTOR

#### TRIGGER CONTACTS

Located in distributor. Provide signals as to when and into which cylinders fuel is to be injected. Also supply information as to engine speed to determine the amount of fuel that needs to be delivered to engine.

#### THROTTLE VALVE SWITCH

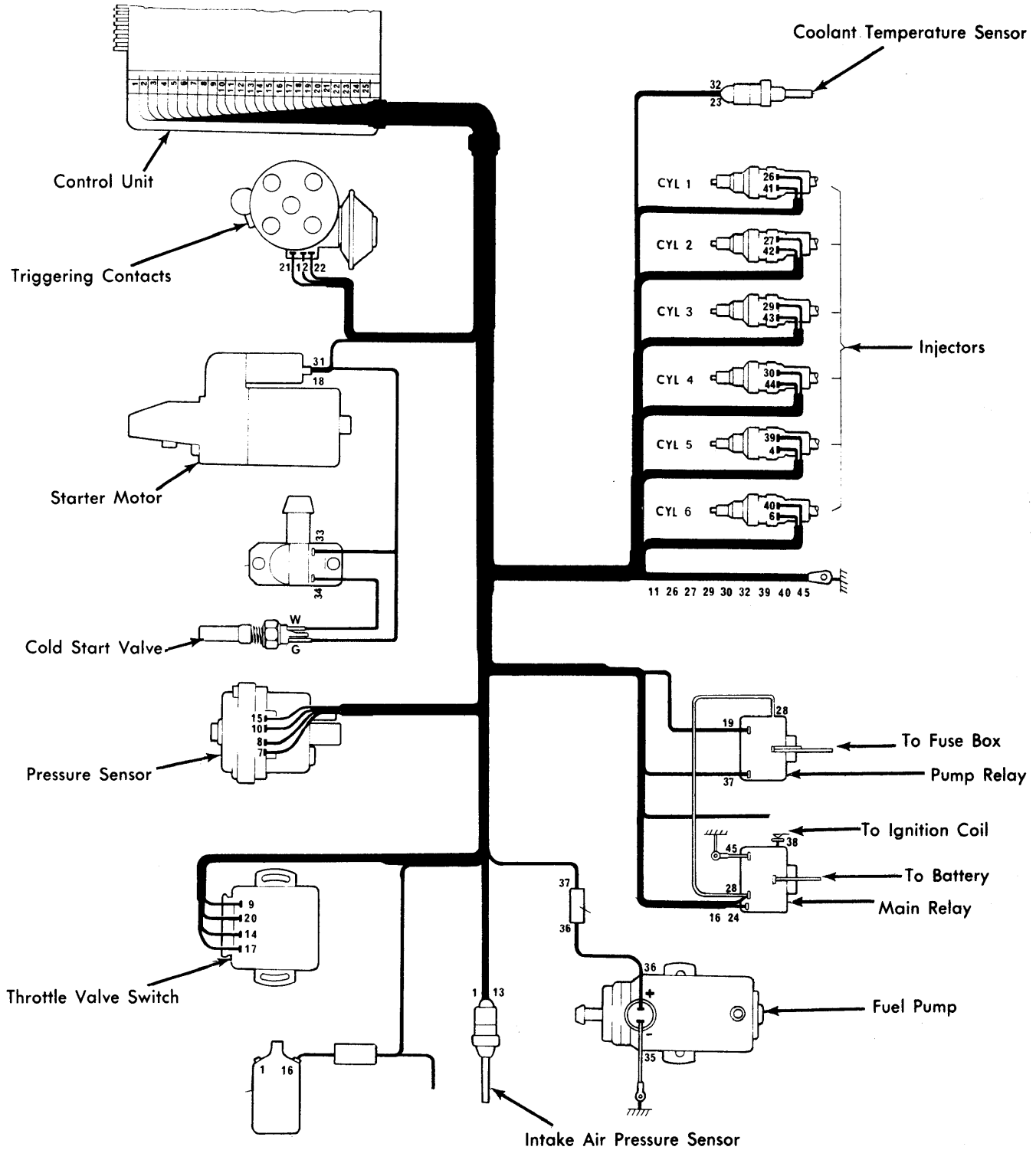
Cuts off fuel supply when vehicle is coasting or decelerating. Also increases fuel supply under acceleration conditions.

#### AUXILIARY AIR REGULATOR

At cold start, regulator opens to allow additional air into inlet duct. As engine heats up, regulator element expands and presses back regulator. At approximately 140°F the auxiliary air pipe is completely closed by the regulator.

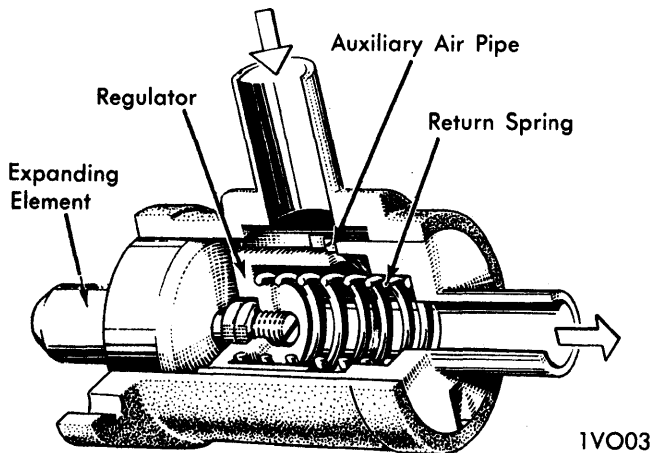
# Bosch Fuel Injection

## BOSCH ELECTRONIC FUEL INJECTION (Cont.)



ELECTRONIC INJECTION CIRCUIT (TYPICAL)

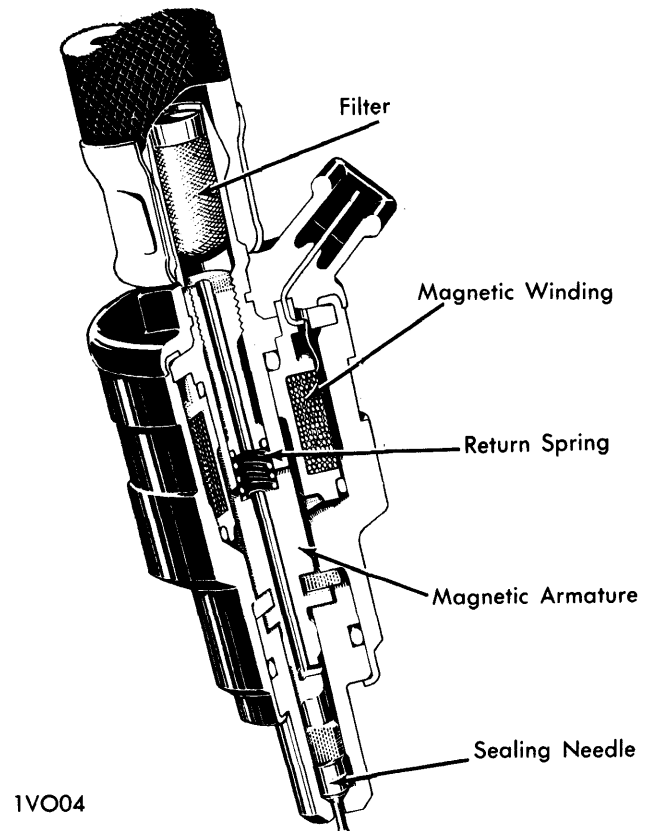
## BOSCH ELECTRONIC FUEL INJECTION (Cont.)



**AUXILIARY AIR REGULATOR**

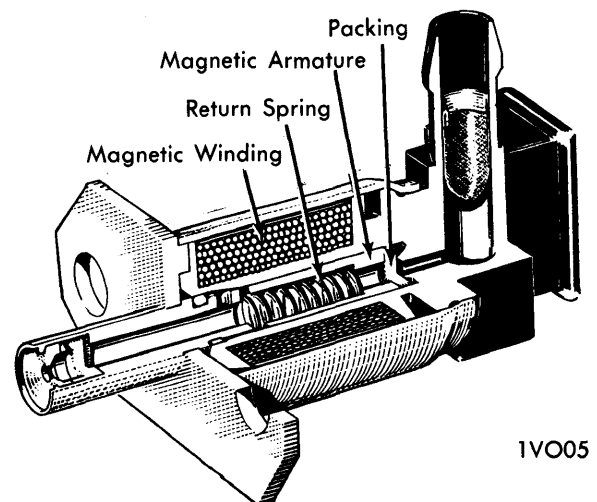
### OPERATION

- 1) Fuel drawn from tank by fuel pump, passes through filter into main fuel supply. Pressure regulator, connected at end of main fuel supply, limits fuel pressure to 28 PSI. The electromagnetic injectors are connected to main fuel supply via fuel distribution pipes.
- 2) Excess fuel from pressure regulator can flow through a second line back to fuel tank. A by-pass return line, coming from fuel pump, leads into this line. A pressure relief valve, in fuel pump, comes into operation when pressure rises considerably above normal (should pressure regulator develop a defect). A check valve in pressure line connection of fuel pump prevents pressure in main fuel supply from dropping immediately when pump is switched off.
- 3) Fuel injectors are opened electrically in pairs by the electronic control unit and, due to pressure, fuel is injected. Injector jet is accurately calibrated and because fuel pressure is constant, amount of fuel injected depends only on length of time injector is kept open.
- 4) Injection time is "computed" by electronic control unit. Information processed by electronics in control unit comes from individual sensors on engine. The moment when fuel is injected is controlled by distributor contacts 1 and 2 according to position of camshaft. These contacts are installed under the centrifugal advance device in distributor and are maintenance free.
- 5) Injection time is governed by two factors, engine speed and load condition of engine. Engine speed is relayed to control unit by distributor contacts 1 and 2. Load condition is indicated by pressure in intake air distributor. Prevailing pressure here is converted to an electrical impulse and relayed to control unit by pressure sensor which is connected to intake air distributor by a hose.
- 6) Electronic control unit processes this information and gives a signal for the injectors to be opened for a longer or shorter period of time. Control unit allows a varying amount of fuel to pass through the electrically operated injectors, depending on engine load and engine speed. This governs "basic amount" of fuel. **NOTE** — *Electronic Control Unit cannot be repaired.*



**INJECTOR**

- 7) In addition to basic amount of fuel, an accurately measured amount of fuel is additionally injected when starting at low outside temperatures, when engine is warming up and at full throttle.
- 8) Enrichment of mixture for starting is dependent on engine temperature. Temperature is relayed from two temperature sensors to the control unit. The information is then sent to the cold start valve which provides extra fuel for approximately 8 seconds. As temperature rises, the injection time reduces, and at approximately 130-140°F the cold start valve stops giving extra fuel at starting. The cold start valve injects only when starter motor is operating to prevent engine flooding.



**COLD START VALVE**

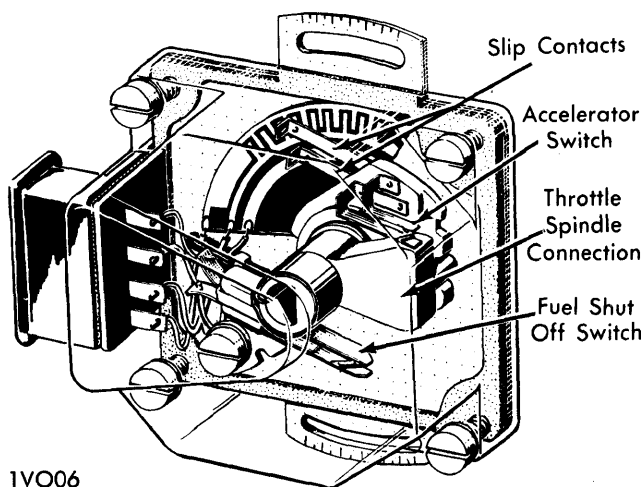
## BOSCH ELECTRONIC FUEL INJECTION (Cont.)

9) This information is processed by the control unit in relation to basic fuel quantity, and impulses are relayed electrically to fuel injectors.

10) During conditions of acceleration, throttle valve closes and engine speed is increased. Throttle valve switch cuts off fuel supply when throttle released for coasting or deceleration above preset RPM. If below a lower preset RPM, fuel supply is switched on again. This allows for smoother return to idle.

11) Injectors of one pair of cylinders, inject fuel past the open intake valves, into combustion chamber during intake stroke, while injectors of other set of cylinders inject, onto the still closed intake valves, while exhaust gases are being forced out. In the latter case, fuel is "stored" at the intake valves.

12) Amount of air is controlled during vehicle operation by a throttle valve in the intake air distributor. When idling, throttle valve is completely closed. Idling air can reach intake air distributor only via by-pass system in intake air distributor. Idling speed is adjusted by altering cross section of by-pass system. Adjustment must be carried out with engine at operating temperature.



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**THROTTLE VALVE SWITCH**

13) Engine, if it has not reached operating temperature, requires an additional amount of air. This is controlled by auxiliary air regulator. It alters functional cross section of auxiliary air line in accordance with temperature. Position of rotary valve is governed by a bi-metal spring which protrudes into crankcase.

### TROUBLE SHOOTING

#### ENGINE CANNOT BE STARTED (PUMP INOPERATIVE)

A) Cables to pump, pump relay or cables on pump relay are defective. Check if pump relay operates (switch ignition on and off, listen for clicking relay sounds).

B) Pump relay has no voltage at terminal 86 (+12 volts), because main relay inoperative or cable defective. Test with voltmeter.

C) Pump relay has +12 volts at terminal 86 but no ground at 85. *NOTE* — Relay operates only approximately 1 to 1½ seconds after switching ignition on. Test with voltmeter. Relay is wired from ground via control unit.

#### ENGINE CANNOT BE STARTED (FUEL PUMP OPERATES)

A) Connection from cable harness (cable 18) to starter terminal 50 defective. Check with tester while operating starter.

B) Cable connector at pressure sensor not pushed on or open circuit (engine floods). Repair.

C) Cable connection has open circuit at temperature sensors. Test cables, replace temperature sensors if necessary.

D) No pressure builds up in main fuel system, cable connector for distributor contacts not pushed on at distributor, or cable has open circuit. Check pressure with gauge (28 PSI with starter operating). If necessary, replace pressure regulator.

#### ENGINE CAN BE STARTED WHEN COLD BUT STALLS

A) Cable connector for distributor contacts not pushed on at distributor, or cable has open circuit. Must be checked with Bosch Tester EFAW 193, EFAW 288, or EFAW 238.

B) Trigger contacts defective. Replace.

#### ENGINE CUTS OUT DURING OPERATION (NORMALLY PRECEDED BY MISFIRING)

A) Distributor contacts have excessive contact resistance or are dirty. Should be checked on Bosch Tester EFAW 193, EFAW 228, or EFAW 238.

B) Push on connections not in order. Check for fault

#### ENGINE RUNS IRREGULARLY, ONE CYLINDER NOT FIRING, EXHAUST GAS WHITE

A) Injector sticking. Replace.

B) Connection to injector windings not in order. Check connections, if necessary replace injectors.

#### ENGINE MISFIRES (NOT CAUSED BY IGNITION SYSTEM)

Loose connections, also ground contact at injectors (if ground defect, two injectors fail to operate). Check connections, tighten ground screw.

#### ENGINE NOT REACHING FULL POWER

Pressure switch not working, or open circuit in pressure switch cable. Check pressure switch with Bosch Tester EFAW 193, EFAW 228 or EFAW 238.

#### FUEL CONSUMPTION TOO HIGH

Sensors not working properly or high contact resistance. Check connecting hoses, check on Bosch Tester EFAW 193, EFAW 228, or EFAW 238.

#### ENGINE IDLES ERRATICALLY (BETWEEN 1000 AND 2000 RPM)

Hose between auxiliary air regulator and intake air distributor disconnected. Reconnect.

### COMPONENT REMOVAL

#### FUEL FILTER

Disconnect both lines to filter together with hose clamp and remove filter. When installing new filter, make sure that new filter is installed with arrow pointing in direction of fuel flow.

#### PRESSURE REGULATOR

Disconnect 3 hose connections to regulator and remove regulator. When installing, use new hose clamps if damaged.

## BOSCH ELECTRONIC FUEL INJECTION (Cont.)

### INJECTOR VALVES

Remove fuel supply pipes from all injectors and disconnect electrical connections. On some models, injectors are held in place by a spring washer (retainer) and nuts or screws. On other models, a locking ring is provided. To remove injector, either remove screws, nuts, and spring washer (retainer) or turn locking ring in counterclockwise direction. Turning locking ring loosens the bayonette fitting. Remove injector by pulling out of holder. *NOTE* — Take note of the positions of the injector bearings so that when installing, parts can be replaced correctly.

### THROTTLE VALVE SWITCH

Remove air filter and/or other components for access to throttle valve switch. Disconnect wiring and remove 2 screws holding switch to intake duct. Remove throttle switch from throttle valve shaft.

### TEMPERATURE SENSORS & TEMPERATURE SWITCH

On water cooled engines it is necessary to drain cooling system before removing these components. Air filter should also be removed, and electrical connectors to each component should be disconnected. On sensors, unscrew using a 1/2 in. (13 mm) wrench. When removing temperature switch, use a 15/16 in. (24 mm) wrench. When replacing, the sealing rings must also be replaced.

### AUXILIARY AIR REGULATOR

On water cooled engines it is necessary to drain cooling system before removing regulator. Air filter should also be removed. Loosen air regulator attaching screws, remove both air hoses and remove air regulator. The sealing ring between regulator and engine block should be renewed when replacing regulator.

### COLD START VALVE

Disconnect fuel hose from fuel distribution manifold and loosen attaching screws and remove valve. Make sure that rubber seal and hose clamps are in good condition.

### IGNITION DISTRIBUTOR TRIGGER CONTACTS

It is necessary to remove the distributor from the engine to service the trigger contacts. Contacts are not adjustable and they are replaced only as a unit with the holder. On some models, distributor advance diaphragm must be removed for access to the attaching screws for trigger contact holder. When access is achieved, remove screws attaching holder to distributor and remove holder complete with trigger contacts.

## ADJUSTMENTS

### PRESSURE REGULATOR

Loosen hose clamp and remove hose at pressure regulator and connect pressure gauge to pressure regulator. Run fuel pump. Pressure should be 28 psi (2.0 kg/sq. cm). Loosen locknut on regulator and adjust. Replace regulator if specified pressure is not achieved.

### THROTTLE VALVE

1) Loosen locknut on stop screw for throttle valve switch and screw out a couple of turns so that it does not touch stop on throttle valve spindle. Check to make sure that switch is fully closed.

2) Screw in stop screw until it touches stop on switch spindle. Turn screw in 1/4-1/3 turn and tighten locknut. Check that throttle valve switch does not jam or seize in closed position.

### THROTTLE VALVE SWITCH

1) Connect Bosch Tester and set switch "A" to "Measuring" position. Set switch "B" to "Throttle Valve Switch III" position.

2) Loosen screws to turn throttle valve switch. Mark intake duct at upper screw and turn throttle valve switch clockwise as far as possible. Then slowly turn it counterclockwise until the pointer on the instrument goes from infinity to zero. Then turn a further 1° (1/2 graduation mark on scale at upper attaching screw). Tighten throttle valve switch.

3) Make sure that instrument pointer goes to infinity when throttle valve opens about 1°. (Place .02 in. feeler gauge between stop screw and stop on throttle valve spindle.) Change to a .012 in. feeler gauge. The pointer should **not** read infinity.

### IDLE ADJUSTMENT

With engine at normal operating temperature and a tachometer and CO meter attached, proceed as follows:

1) Make sure that auxiliary air regulator is completely closed by pulling off hose between intake duct and the regulator and covering the opening with the hand. The speed should not differ to any extent from the previous RPM. If speed does differ significantly, engine is either not warm enough or the air regulator is faulty. Reconnect hose.

#### Idle Adjustment Specifications

Model	CO%	Idle RPM
Mercedes Benz		
1968-69	1.5-3.0	750-800
1970-71	1.0-2.0	750-800
1972-73	.5-2.0	700-800
Porsche 914		
1970-71	.7	850-950
1972	.7	850-900
1973		
1.7 Liter	.7	850-900
2.0 Liter	1.5	850-950
Renault		
1972	2.0-3.0	950-1050
1973		950-1000
Saab		
1972	3.5	800-850
1973	2.5-3.5	800-900
Volkswagen		
Type 3		
1968		
1969-70	2.8-3.1	①850-900
1971		
1972	.7	②800-900
1973		②900-900
Type 4		
1971		
1972	.7	850-900
1973		850-900
Volvo		
1970-72	③1.0-1.5	④900
1973	③1.0-1.5	⑤800

① — Auto. Trans. 1000

④ — Auto. Trans. 800

② — Auto. Trans. 900-1000

⑤ — Auto. Trans. 700

③ — Auto. Trans. .5-1.0

# Bosch Fuel Injection

## BOSCH ELECTRONIC FUEL INJECTION (Cont.)

2) Adjust idle speed to specifications by means of throttle stop screw. Reconnect hose from air cleaner.

3) Adjust CO% to specification using the adjusting screw on the control unit. Turning the adjusting screw clockwise increases the CO content.

### MAINTENANCE

*NOTE — The following operations must be carried out at regular service intervals.*

1) Replace fuel filter, clean or replace spark plugs, and set ignition timing. Timing must be set using stroboscopic light with engine temperature above 50°C.

2) Check operation of throttle valve switch. Run engine and remove hose between auxiliary air regulator and intake air distributor at regulator. Idling speed should change. If no change, throttle valve switch should be replaced.

### Fuel Filter Replacement

Model	Interval (Miles)
Volkswagen.....	6,000
Volvo.....	12,500
Mercedes-Benz .....	24,000
Porsche 914 .....	6,000
Renault.....	6,000
Saab .....	6,000

*NOTE — Use only the manufacturers recommended fuel filter.*