

# 1974-79 FUEL SYSTEMS

## Bosch AFC/MPC Fuel Injection Systems

### AFC Fuel Injection

Porsche: 1974-76 912 E, 914 (1.8L)

### MPC Fuel Injection

Mercedes-Benz: 1974 450 Series

Porsche: 1974 & 1976 914 (1.7 & 2.0L)

Renault: 1974 R-17 G

Saab: 1974 99E

Volkswagen: 1974 Type 4

Volvo: 1974 164

## DESCRIPTION

The Bosch Air Flow Controlled (AFC) and Manifold Pressure Controlled (MPC) fuel injection systems that are very similar in construction and components. The main difference is that the AFC system uses an air sensor flap with a pickup and a relay set to control the amount of fuel injected into the engine. See Figs. 5 and 6.

The MPC system uses manifold pressure and triggering contacts, in the distributor, to control the amount of fuel injected into the engine. Both systems measure the volume of air going into the engine. The MPC system does this by measuring pressure changes in the manifold while the AFC system measures air flow through the intake manifold.

## OPERATION

### AIRFLOW METER & POTENTIOMETER

The throttle valve housing provides a method for air to enter engine under controlled conditions. Throttle valve sliding switch is a potentiometer which functions as sensor for informing electronic control unit of throttle valve position.

### INTAKE AIR SENSOR

The intake air sensor (temperature sensor I) provides the electronic control unit with voltage signals. The intensity of these signals, depends upon intake air volume and air temperature. The incoming air moves the stator flap against the force of the return spring. As more air is drawn in, stator flap opens even more. See Fig. 1.

This rotary motion of the stator flap actuates a potentiometer and thus varies the signal sent to the electronic control unit. Connected to the stator flap is a dampening flap which prevents rapid oscillations of the stator flap. One of the contacts on the potentiometer operates the fuel pump as the stator flap is opened by air flow.

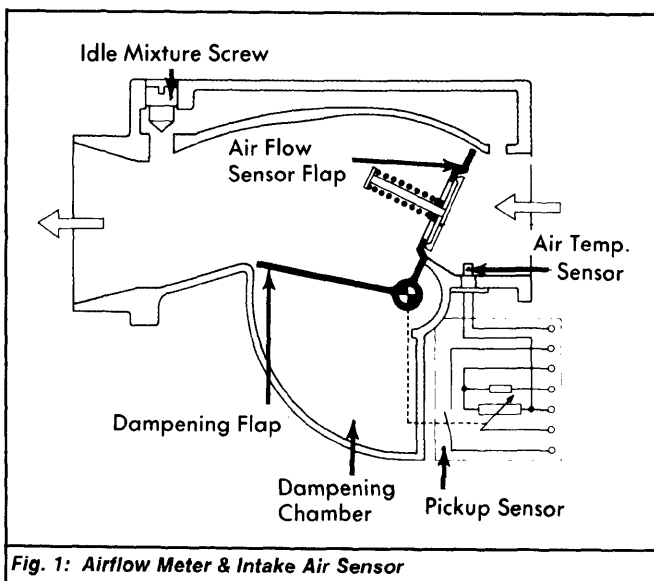


Fig. 1: Airflow Meter & Intake Air Sensor

### MANIFOLD PRESSURE SENSOR

**MPC System** - Manifold pressure sensor is connected to intake manifold between throttle plate and intake valves. Sensor contains a diaphragm with an armature attached. As pressure varies in intake manifold, because of engine load variations, the armature is raised or lowered in a coil. This raising or lowering changes a voltage signal going to the electronic control unit, which in turn controls the amount of fuel injected into the engine.

### ENGINE COOLANT SENSOR

Engine coolant sensor provides the electronic control unit with engine temperature information relating to cold starting and warm-up enrichment.

**NOTE:** An exhaust port temperature sensor is used on Volkswagen Type 4.

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### THROTTLE VALVE SWITCH

There are 2 types of throttle valve switches used. The MPC switch has multiple contact points for continuously increasing the amount of injection as throttle plate is opened. See Fig. 2. The AFC switch has only 2 contact points, idle and full load. ECU unit either receives idle or full load signals, from switch, dependent upon position of throttle valve.

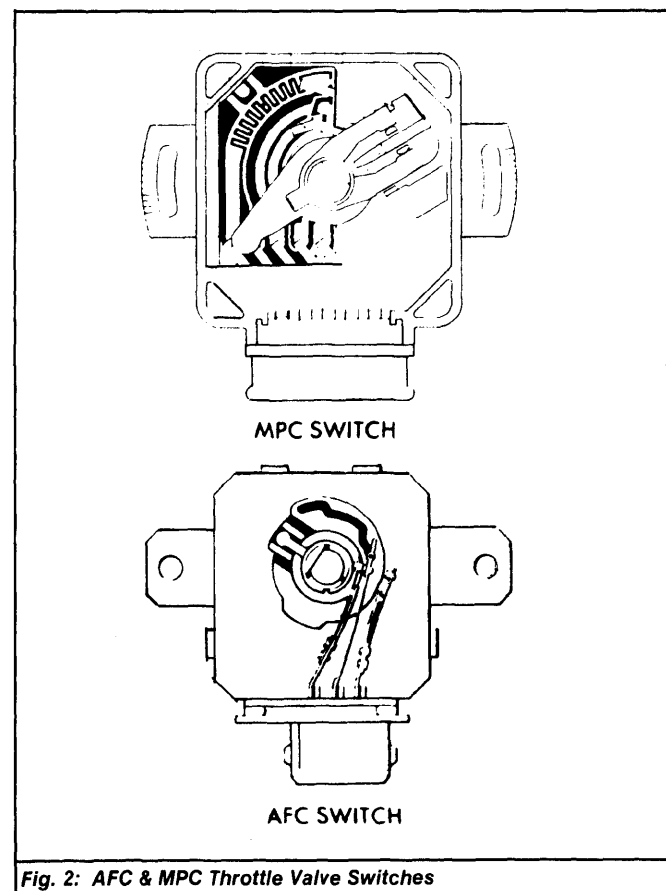


Fig. 2: AFC & MPC Throttle Valve Switches

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## Bosch AFC/MPC Fuel Injection Systems (Cont.)

### ELECTRONIC CONTROL UNIT

The Electronic Control Unit (ECU) is a pre-programmed computer. Its function is to process the incoming signal from each sensor to determine air volume (by airflow sensor on AFC or by manifold pressure on MPC), engine speed, engine temperature, air temperature and throttle position. From this information, ECU determines correct injection time and quantity.

### FUEL PRESSURE REGULATOR

The pressure regulator maintains fuel pressure in relation to intake air pressure. That is, it maintains a specific pressure differential between fuel pressure and intake air pressure.

### AUXILIARY AIR REGULATOR

During cold engine start, the auxiliary air regulator opens to allow additional air into inlet duct. As engine heats up, the regulator element expands and presses back regulator. At about 140°F (60°C), the auxiliary air pipe is completely closed by the regulator. See Fig. 3.

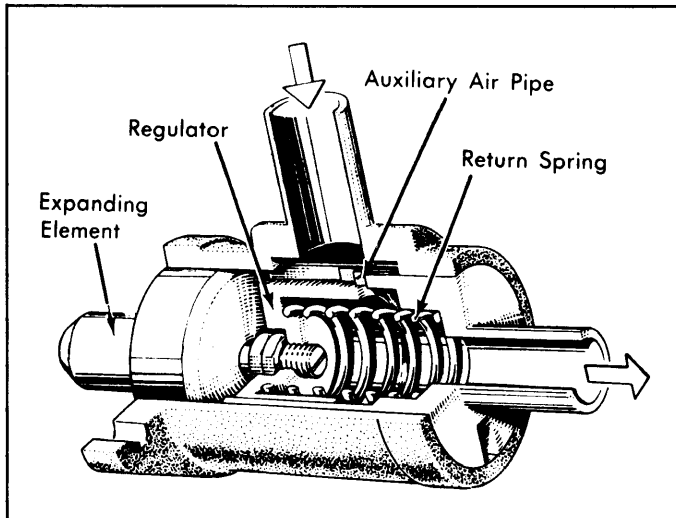


Fig. 3: Auxiliary Air Regulator

### TRIGGERING CONTACTS

The triggering contacts, located in the ignition distributor, inform the ECU when to start injection of fuel. See Fig. 4. The triggering contacts also signal the ECU at what speed the engine is running. These signals only tell the ECU when to start the injection of fuel, the duration of injection is determined by signals from the manifold pressure sensor.

### THERMO-TIME SWITCH

The thermo-time switch controls the time the cold start valve is switched on. This time limit is usually between 5-20 seconds depending upon engine. The time switch has a bimetal contact, surrounded by a heating coil. The heating coil receives current during cranking. The bimetal contact breaks the ground circuit of the cold start valve whenever the heating coil is about 95°F (35°C) or when the delay time is up. Delay time is shortened as temperature raises.

### PRE-RESISTORS

The purpose of the pre-resistor, if used, is mainly to reduce the response time of the injectors. The pre-resistors are connected in series between the injectors and the dual relay.

### DUAL RELAY

The dual relay is composed of 2 relays which control current supply for entire electronic fuel injection system and which disengages system (electrically) from battery when ignition is turned off. When ignition switch is on, the main relay points close, providing voltage to the ECU and pre-resistors (if used) of the electronic fuel injection system.

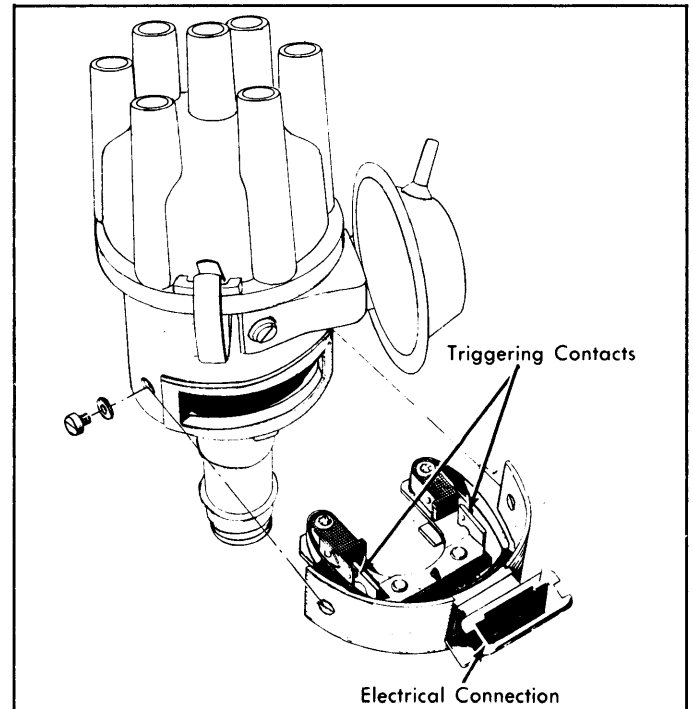


Fig. 4: Distributor & Triggering Contacts

The other relay within the dual relay, controls current to the electric fuel pump. These points close during cranking and when points of air flow valve are closed. This design is to cut off current to fuel pump in the event that engine stops (airflow meter closed).

## ADJUSTMENTS

### FUEL PRESSURE REGULATOR

**MPC System** – Connect pressure gauge to fuel pressure regulator. Turn ignition on to run fuel pump. Fuel pressure should be 28-31 psi (1.97-2.18 kg/cm<sup>2</sup>). If not, loosen lock nut on pressure regulator and turn hex screw to adjust pressure. Turning hex screw clockwise increases pressure and counterclockwise decreases pressure.

### THROTTLE VALVE

**1974 (MPC System)** – 1) Loosen lock nut on stop screw for throttle valve switch. Turn screw out a couple of turns so that it does not touch stop on throttle valve spindle. Make sure that throttle valve switch is fully closed.

2) Turn in stop screw until it touches stop on switch spindle. Turn screw in an additional 1/4 turn and tighten lock nut. Make sure that throttle valve switch does not jam or seize in closed position.

### THROTTLE VALVE SWITCH

**1974 (MPC System)** – 1) Connect Bosch Tester (EFAW 238) and set switch "A" to "MEASURING" position. Set switch "B" to "THROTTLE VALVE SWITCH III" position. Mark intake duct at upper screw. Loosen throttle valve switch screws.

2) Turn throttle valve switch clockwise as far as possible, then slowly turn switch counterclockwise until tester needle goes from infinity to zero ohms. Now turn switch an additional one degree (1/2 graduation mark on scale at upper attaching screw) and tighten throttle valve switch screws.

3) Ensure that tester needle goes to infinity when throttle valve opens one degree. Place a .020" (.51 mm) feeler gauge between stop screw and stop on throttle valve spindle. Change feeler gauge to .012" (.30 mm). Tester needle should NOT read infinity.

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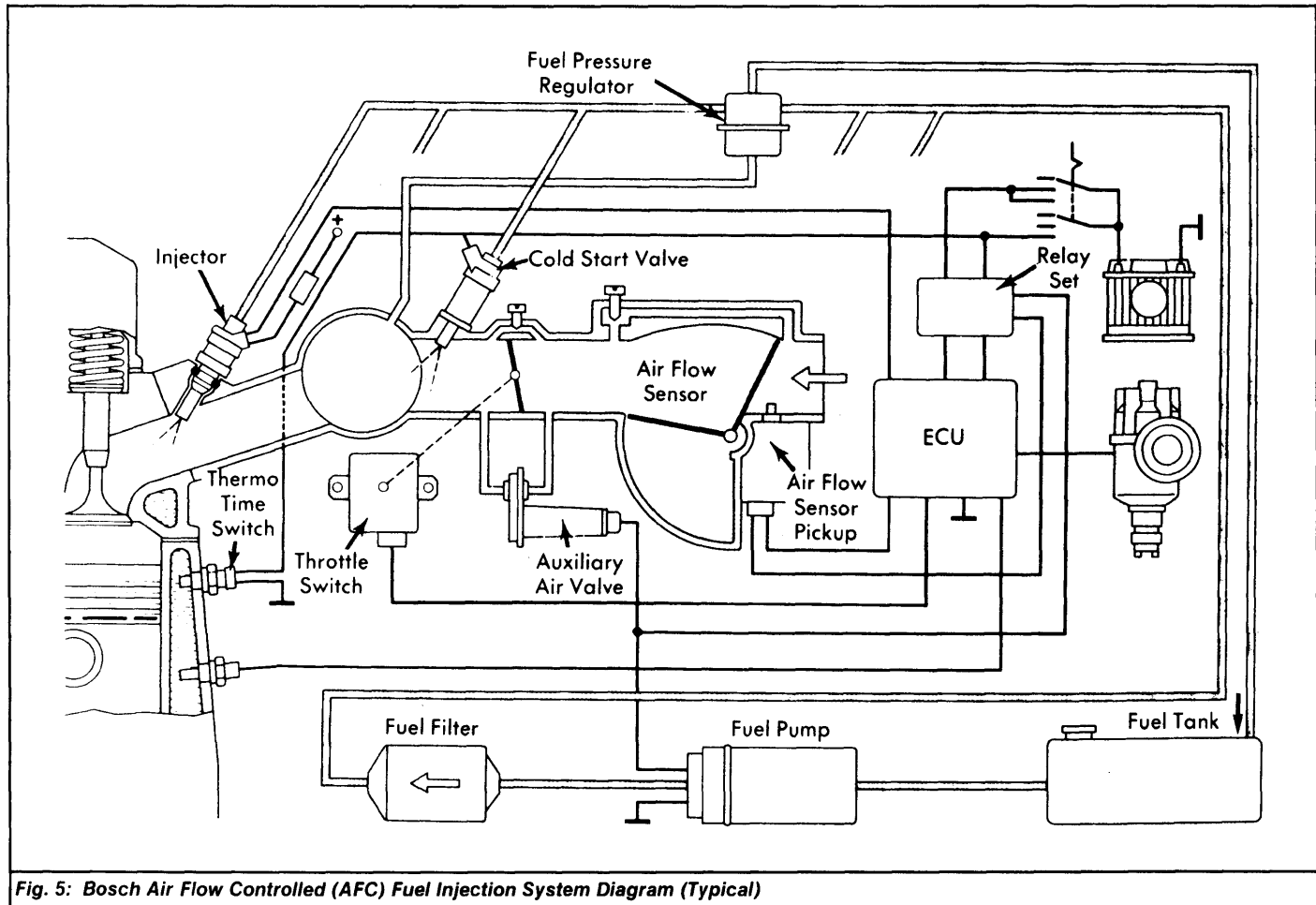


Fig. 5: Bosch Air Flow Controlled (AFC) Fuel Injection System Diagram (Typical)

**1976 Porsche (MPC System)** – 1) Throttle valve switch should start to operate when throttle valve is opened 2 degrees from its normally closed position. To adjust throttle valve switch, use Bosch Tester (EFAW 238).

2) Use tester manufacturer's instructions for switch positions on tester. Readings on tester should indicate zero resistance at idle, infinity at part throttle, and zero resistance for full throttle.

3) If not, loosen throttle switch screws. Rotate throttle valve switch clockwise until needle on tester moves from an infinity reading to a zero reading, then rotate throttle switch counterclockwise one graduation (2 degrees). Tighten throttle valve switch screws and check switch for proper operation.

## TESTING

### FUEL PRESSURE REGULATOR

1) Remove intake air sensor and air cleaner assembly. Connect Fuel Pressure Gauge (P378) to injector supply line. Detach vacuum hose which connects air distributor and pressure regulator. Connect plug to removed intake air sensor.

2) Turn on ignition. Slightly open stator flap by hand until pump contacts close and read fuel pressure shown on pressure gauge. If pressure is not 28-31 psi (1.97-2.18 kg/cm<sup>2</sup>), replace fuel pump.

### INTAKE AIR SENSOR

Disconnect plug from intake air sensor. Connect ohmmeter to terminals No. 6 and 9. Ohmmeter reading should be 200-800 ohms. Now connect ohmmeter between terminals No. 7 and 8. Ohmmeter reading should be 120-200 ohms. If readings are incorrect, replace air sensor.

### THROTTLE VALVE SLIDING SWITCH

Disconnect plug from throttle switch (on throttle body) and connect ohmmeter between middle contact and rear contact. Slowly open throttle by hand. Ohmmeter should move from infinity to zero ohms. If not, replace throttle sliding switch.

### AUXILIARY AIR REGULATOR

Remove auxiliary air regulator and connect ohmmeter leads to regulator terminals. Ohmmeter reading should be 30-33 ohms. Blow through regulator with compressed air; passage must be open when engine is cold. Connect battery voltage to both terminals. As temperature increases, opening in regulator should become smaller. If ohmmeter reading is incorrect or if regulator fails to close with voltage applied, replace auxiliary air regulator.

### THERMO-TIME SWITCH

Disconnect plug from cold start valve and connect ohmmeter between terminals. If engine temperature is below 59°F (15°C), ohmmeter should indicate zero ohms. If engine temperature is above 72°F (22°C), ohmmeter reading should indicate infinity.

### COLD START VALVE

Connect pressure gauge to injector supply line. Operate starter, to build up fuel pressure. Disconnect plug from cold start valve. Connect wires from negative terminal of coil to cold start valve. Observe fuel pressure reading, it should slowly decrease. If pressure does not drop, replace cold start valve.

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## Bosch AFC/MPC Fuel Injection Systems (Cont.)

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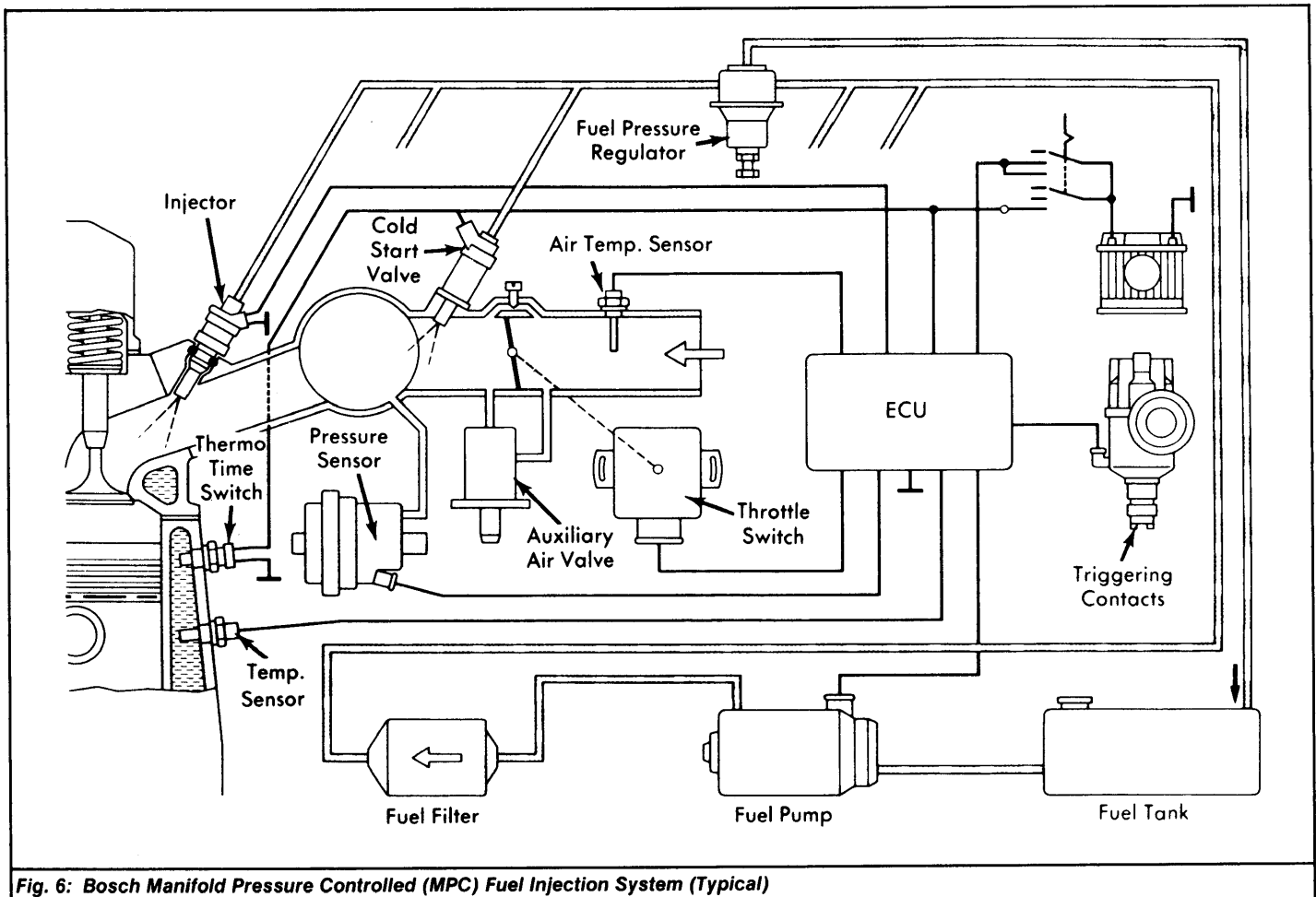


Fig. 6: Bosch Manifold Pressure Controlled (MPC) Fuel Injection System (Typical)

### ENGINE COOLANT SENSOR

Locate sensor in cylinder head and disconnect sensor lead. Connect ohmmeter between temperature sensor and ground. Reading should be between 500-2500 ohms. As point of reference, ohmmeter reading should be about 2500 ohms with engine coolant at 68°F (20°C). As temperature increases, resistance reading will decrease.

### DECELERATION VALVE

Disconnect and plug intake air sensor hose to deceleration valve. Start engine and accelerate throttle to 3000 RPM. With finger placed over hose connection on deceleration valve opening, release throttle quickly. When throttle is released, no vacuum should be felt. If vacuum is detected on deceleration, replace valve.

### REMOVAL & INSTALLATION

#### AIRFLOW METER & AIR CLEANER

**Removal & Installation (AFC System)** - Detach hose clamp, air cleaner retaining clips, electrical plug, and vent hose. Loosen retaining screws from intake air sensor. Remove air sensor from air cleaner upper bracket assembly. To install, reverse removal procedure.

#### MANIFOLD PRESSURE SENSOR

**Removal & Installation (MPC System)** - 1) Disconnect battery. Disconnect electrical connector and vacuum hose from sensor. Remove attaching screws and remove pressure sensor.

2) To install, reverse removal procedure. Make sure replacement part has same part number as removed part. Different part numbers reflect higher or lower pressure adjustments.

### THROTTLE VALVE HOUSING

**Removal & Installation (AFC System)** - Disconnect and remove hose which connects intake air sensor with throttle valve housing. Disconnect return spring, throttle linkage, vacuum hoses and electrical plugs. Remove retaining screws and remove throttle valve housing. To install, reverse removal procedure.

**Removal & Installation (MPC System)** - Disconnect air cleaner and ducting, return spring, throttle linkage, vacuum hoses and electrical connections from throttle valve housing. Remove screws attaching throttle valve housing to intake manifold and remove throttle valve housing. To install, reverse removal procedure.

### ELECTRONIC CONTROL UNIT

**Removal & Installation (AFC System)** - Locate electronic control unit on passenger's side of engine compartment. Disconnect cable by pushing back spring and pulling out plug at same time. Remove screws and remove electronic control unit. To install, reverse removal procedure.

**Removal & Installation (MPC System)** - 1) Locate electronic control unit in engine compartment, behind battery. Remove hot air hose and bracket screws. Pull electronic control unit from behind battery. 2) Remove angle bracket. Open cable clamp and pull valve for electronic control unit out. Disconnect electronic control unit and remove from vehicle. To install, reverse removal procedure.

### COLD START VALVE

**Removal & Installation** - Disconnect electrical plug, fuel lines and retaining screws. Remove cold start valve together with its gasket. To install, reverse removal procedure.

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## Bosch AFC/MPC Fuel Injection Systems (Cont.)

### AUXILIARY AIR REGULATOR

**Removal & Installation** - Disconnect hoses and electrical plug. Remove screws and auxiliary air regulator. To install, reverse removal procedure.

### THERMO-TIME SWITCH

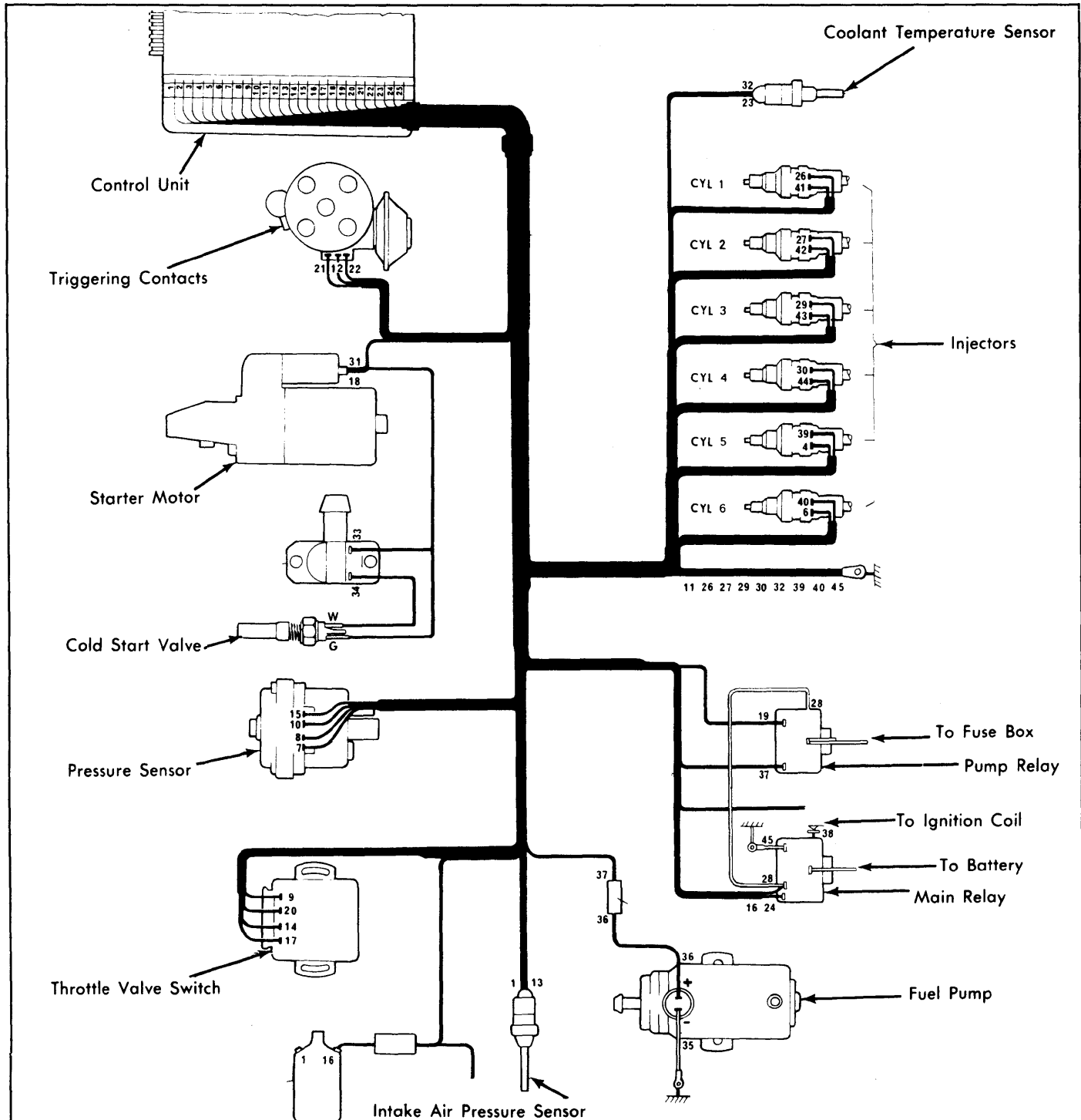
**Removal & Installation** - Remove cold start valve and set aside. Disconnect electrical connector from switch. Remove screws and thermo-time switch. To install, reverse removal procedure.

### FUEL PRESSURE REGULATOR

**Removal & Installation** - Disconnect fuel hoses, vacuum hose, and retaining nut. Remove pressure regulator from holder, being careful not to damage holder when loosening or tightening retaining nut. To install, reverse removal procedure.

### INJECTORS

**Removal & Installation** - Disconnect battery and relieve pressure in fuel system. Disconnect and plug fuel lines to injectors to be removed. Disconnect electrical connection from injectors. Remove retaining nuts and remove injectors with retaining clips and washers. To install, reverse removal procedure.



**Fig. 7: Bosch Manifold Pressure Controlled (MPC) Fuel Injection System Wiring Schematic (Typical)**