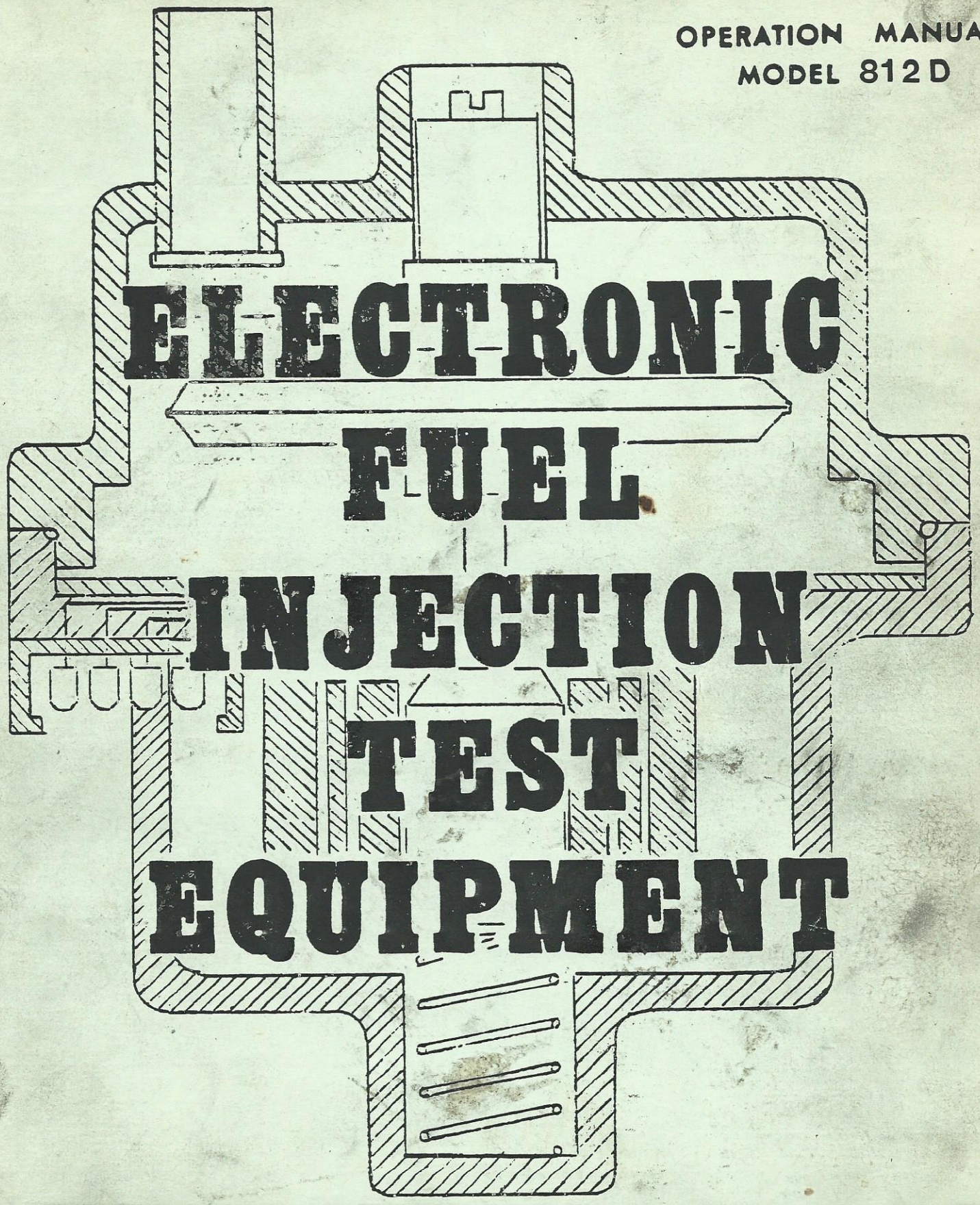
OPERATION MANUAL
MODEL 812D



ELECTRONIC FUEL INJECTION TEST EQUIPMENT

DITRON INDUSTRIES INC.
24911 LIRIO, P O BOX 2460, MISSION VIEJO, CA. 92692

LIMITED WARRANTY

Ditron warrants this analyzer to be free from from defects in material and workmanship for a period of one year from the date of delivery.

This guarantee does not cover damage caused by misuse or repairs attempted by anyone other than Ditron. No other guarantee is expressed or implied.

FOREWARD

This manual is prepared for use with the Ditron Model 812D Electronic Fuel Injection Analyzer. The 812D was designed to test all cars using the Bosch Manifold Pressure, Electronic Fuel Injection system (D-Jetronic). This system is used on VW type 3 and 411 models; Porche 914; Mercedes-Benz; Volvo; Saab; Citroen and, with some modifications, on the Jaguar V-12.

We have attempted to describe the operation of the EFI system as well as the analyzer itself in order to minimize your training burden. Operation of the analyzer for greatest efficiency should be done by performing the tests in a logical sequence. If this is done, the entire system can be checked-out in a matter minutes.

The contents are divided into four sections for convenient reference:

1. Theory, diagrams and descriptions of components

2. Test procedure to be used with the analyzer.

3. Troubleshooting information and service hints

4. Supplemental information

It cannot be emphasized to strongly that the Bosch system is an extremely sophisticated and dependable system. Be sure that the ignition and fuel systems are operating properly before suspecting problems in the EFI area.

The Model 812D is designed to quickly and easily check operation of all sensors associated with the EFI system plus allowing running of the engine with a built-in ECU to verify operation with a faulty Control Unit or for emergency operation.

You have the most complete and modern Electronic Fuel Injection Analyzer on the market today.... use it and enjoy it.

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ELECTRONIC FUEL INJECTION

The Bosch Electronic Fuel Injection system can definitely be considered the fuel system of the future! The heart of the system is a solid state Electronic Control Unit commonly referred to as the "brain", that determines the proper amount of fuel required for optimum engine efficiency. The brain analyzes manifold pressure, engine temperature (inlet air and coolant liquid) and engine RPM. After receiving these inputs, the brain then determines how long the fuel injectors shall remain open for proper and efficient operation. The results are almost complete combustion of the fuel which results in extremely low exhaust emission, fast throttle response, low fuel consumption, excellent torque figures throughout the entire throttle range, high specific power output and elimination of "dieseling".

Good fuel consumption can be attributed to a more complete atomization and equal distribution of the fuel to all cylinders. This is achieved by injecting the fuel at a high pressure (28.6 PSI) through the nozzle of each injector very similar to a diesel injection system. However, the diesel uses a low pressure system and the fuel is injected directly into the cylinder, whereas the electronic fuel injection system injects the fuel behind the intake valve. Another departure from a convential injection system is that the fuel is injected into two cylinders at a time(see inj. data chart). This reduces the cost and complexity of the system with little loss of performance.

ELECTRO MECHANICAL and MECHANICAL COMPONENTS

The DITRON MODEL 812D fuel injection analyzer tests only the electro-mechanical portion of the fuel injection system. If satisfactory conditions exist as verified by the JANBO tester, then it can be safely assumed that the brain or control unit is the problem and must be replaced.

The electro-mechanical components used in the Bosch Electronic Fuel System are as follows:

1. Fuel injectors (one for each cylinder)
2. Pressure sensor
3. Temperature sensor 1, crankase or inlet air (1970 and later)
4. Temperature Sensor 2, cylinderhead or coolant liquid.
5. Trigger points (1 & 2 for four and six cylinders and 1, 2, 3 and 4 for eight cylinders)
6. Pressure switch (1968-69 VW's only)
7. Throttle switch (1968-69 " ")
8. Fuel enrichment switches A & B (1970 and later)
9. Throttle switch (1970 and later)

FUEL INJECTORS

The fuel injectors are solenoid actuated needle valves that inject fuel under pressure into the cylinders in a fine mist condition. The injector is a pintle type needle valve which opens .006" inwardly when the solenoid is actuated. When no signal or current is present the needle valve is pushed closed by a small spring which cuts off the fuel flow. The control unit varies the length of time each injector is open which varies the amount of fuel reaching the engine. (see fig. 1)

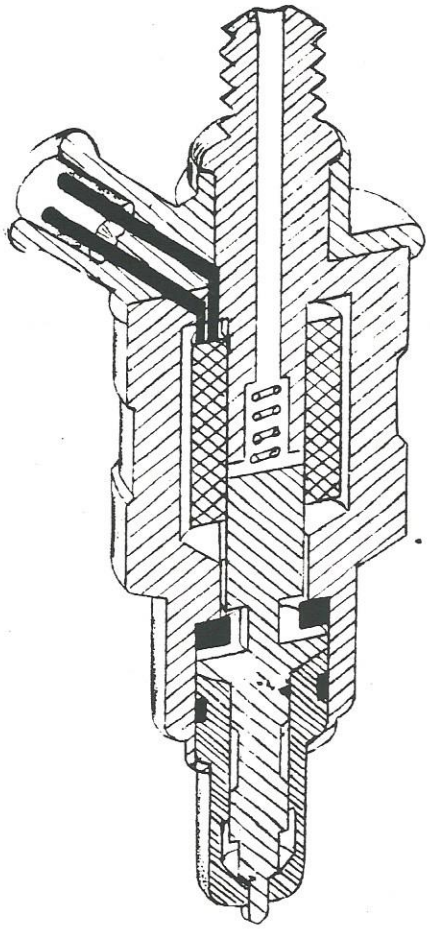


FIG. 1

PRESSURE SENSOR (1968-69) VW's only

The manifold pressure sensor is connected to the intake manifold (air distributor) and senses manifold pressure (vacuum). It consists of a spring-loaded aneroid bellows connected to a transformer core slug. As the vacuum lowers, the bellows expands and moves the slug against the spring, thus changing the voltage going through the sensor. The control unit then regulates the amount of fuel going to the engine as a result of the vacuum level. (see fig. 2)

Added 1970 and later

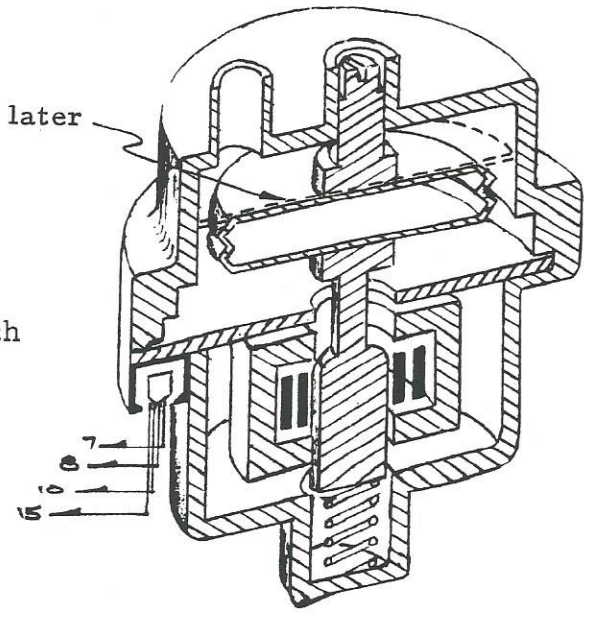


FIG. 2

PRESSURE SENSOR (1970-71)

The new pressure sensor combines the old pressure sensor and pressure switch into one unit. It performs the same functions as the old unit but it responds more positively to engine loading and acceleration, thus eliminating flat spots This type unit is used on all cars, 1970 and later.

INLET AIR (Crankcase temp. sensor on early VW's.)

This sensor causes extra fuel to be supplied when the incomming air is cold. It is located in the air distributor on all cars except the early VW's where is next to the Auxiliary Air Regulator.

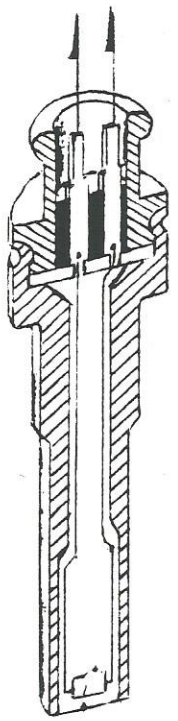


FIG. 3

COOLANT LIQUID TEMPERATURE SENSOR
(Cylinderhead temp. sensor on air cooled engines)

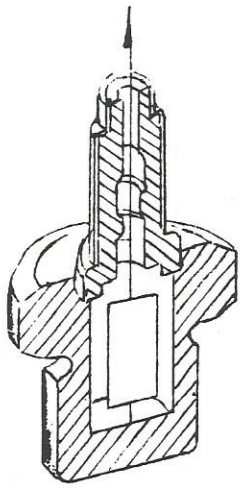


FIG. 4

This sensor changes resistance (moves down) as the engine temperature increases, causing the control unit to supply more fuel to a cold engine (very much like a choke). Then as the temperature goes up, the mixture is leaned out. This sensor is located on VW's between the two left cylinders. (see fig. 4)

TRIGGER POINTS

The trigger points are located in the base of the distributor. They supply the control unit with RPM information. There are 2 points on all cars except the 8 cylinder cars which have 4 points. (See fig. 5)

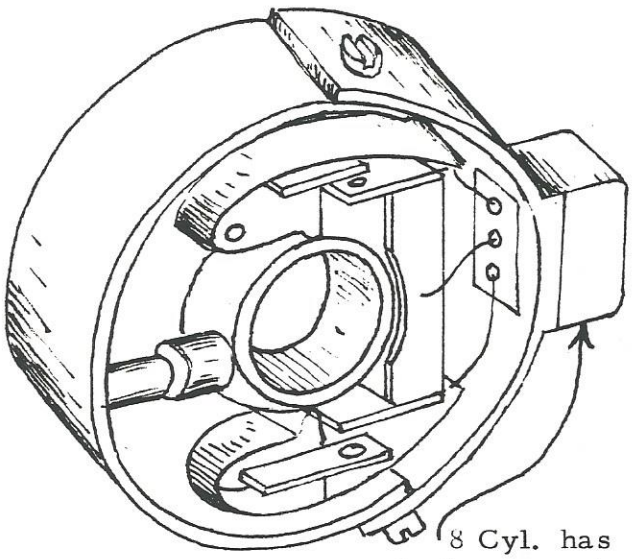


FIG. 5

8 Cyl. has 5 pin connector to accomodate 2 additional points.

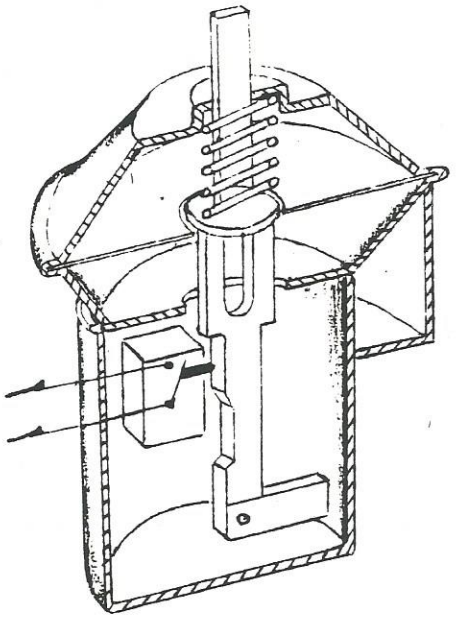


FIG. 6

PRESSURE SWITCH
(1968-69 and some 1970 VW's with auto transmissions)

The pressure switch is located on the right side of the air distributor under the intake pipes. It is connected to the air distributor by a short hose. The pressure switch is made up of a spring loaded diaphragm connected to a micro switch. When absolute manifold pressure (vacuum) approaches atmospheric pressure the switch is closed. The control unit senses this as a need for more fuel. (see fig. 6)

THROTTLE SWITCH & FUEL ENRICHMENT SWITCH (1970 and later)

This is the same as the 1968-69 Throttle switch except additional switches have been added. They transmit a number of pulses (up to 10) to the control unit only when the throttle is being opened. The control unit senses this and causes more fuel to enter the engine. This helps to eliminate flat spots. It cannot be installed on older VW's unless modifications are made to the wiring and a "C" or "D" brain is installed. (see fig. 7) In some 1973 and later cars a "Hi Speed" switch has been added to eliminate flat spots in acceleration at high speed operation.

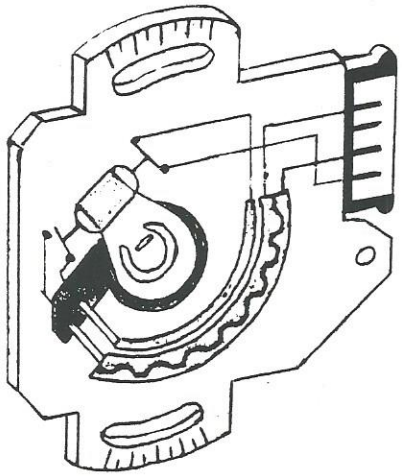


FIG. 7

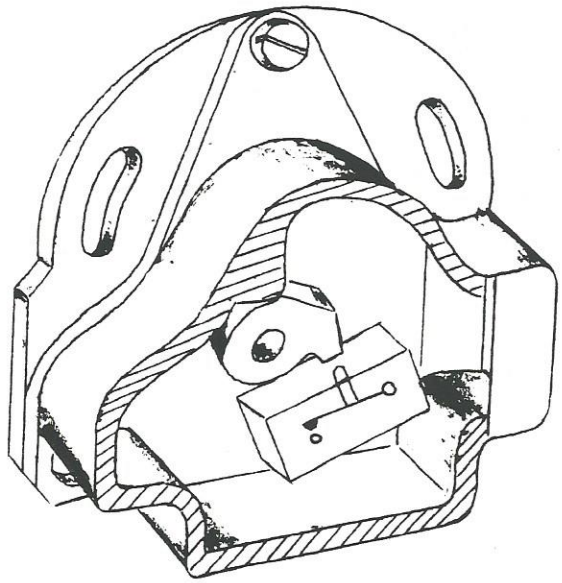


FIG. 8

THROTTLE SWITCH (1968-69 VW's only)

The throttle switch is used to cut off fuel to the engine (when coasting) above approximately 1500 RPM, then gradually increases so that at about 900 RPM a smooth transistion to idle occurs. Proper adjustment is important for good fuel economy. It is located on the air distributor and connects directly to the throttle linkage. (See fig. 8)

AUXILIARY AIR REGULATOR (1968-69 VW's)

This is a purely mechanical device consisting of a rotary valve operated by a bi-metal spring located in the crankcase. It responds to the crankcase temperature and allows additional air to enter the manifold at extremely low temperatures. It opens completely at -30° C and is fully closed at +50° C. The crankcase temperature sensor is mounted on this unit. (see fig. 9)

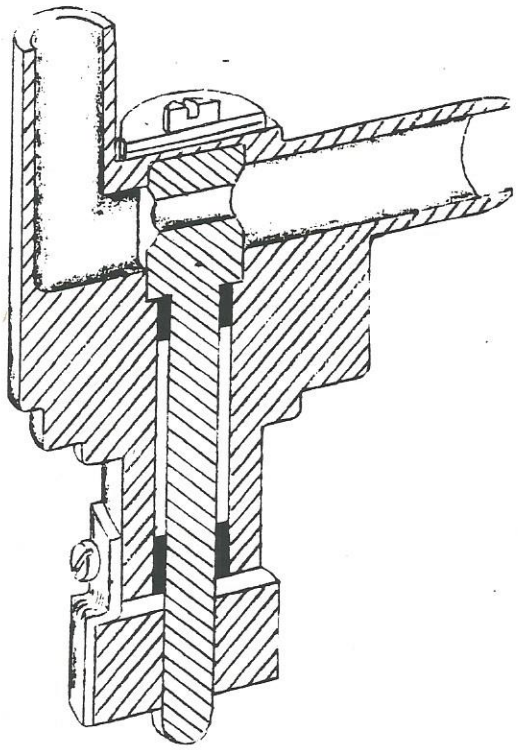


FIG 9

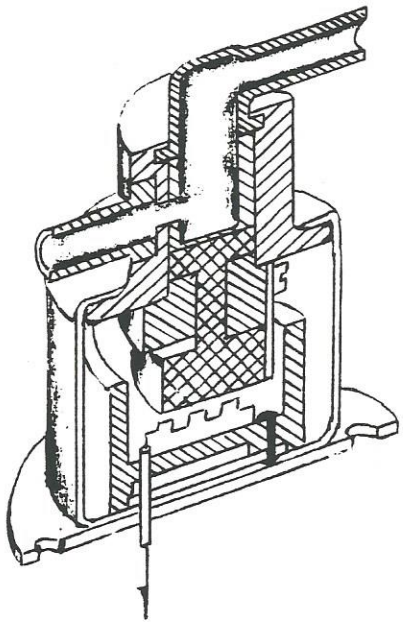


FIG. 10

AUXILIARY AIR REGULATOR

(1970 and later)

This works the same as the old regulator but has an added heater element to make it more responsive. The heater is connected to terminal 15 on the ignition coil. It cannot be installed on earlier models. (see fig. 10)

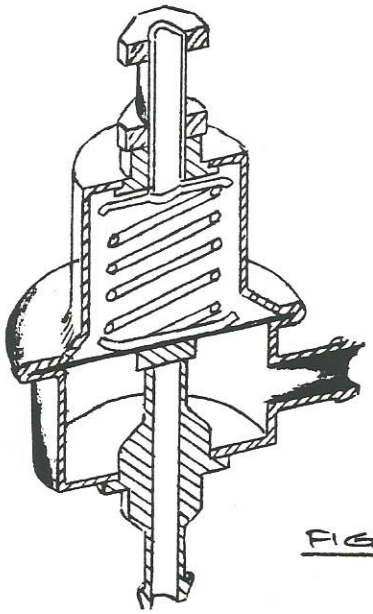


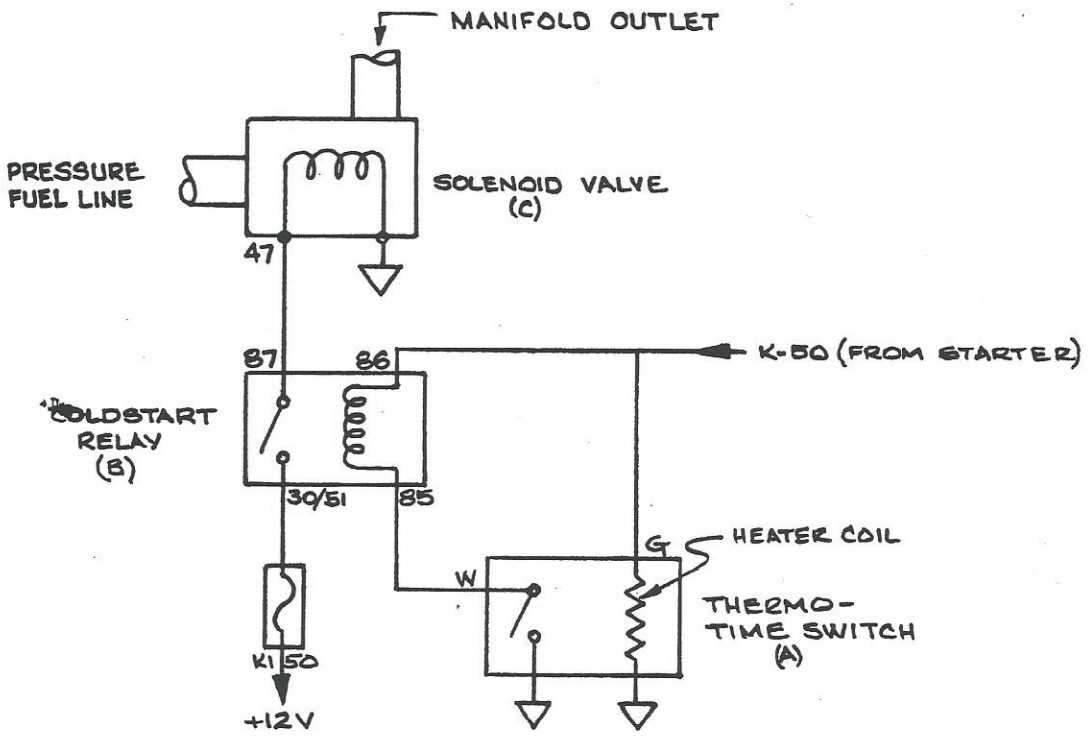
FIG. 11

PRESSURE REGULATOR

The pressure regulator does exactly that... regulates the fuel pressure. It is normally adjusted for a pressure of 28.7 PSI. (see fig 11)

COLD STARTING DEVICE

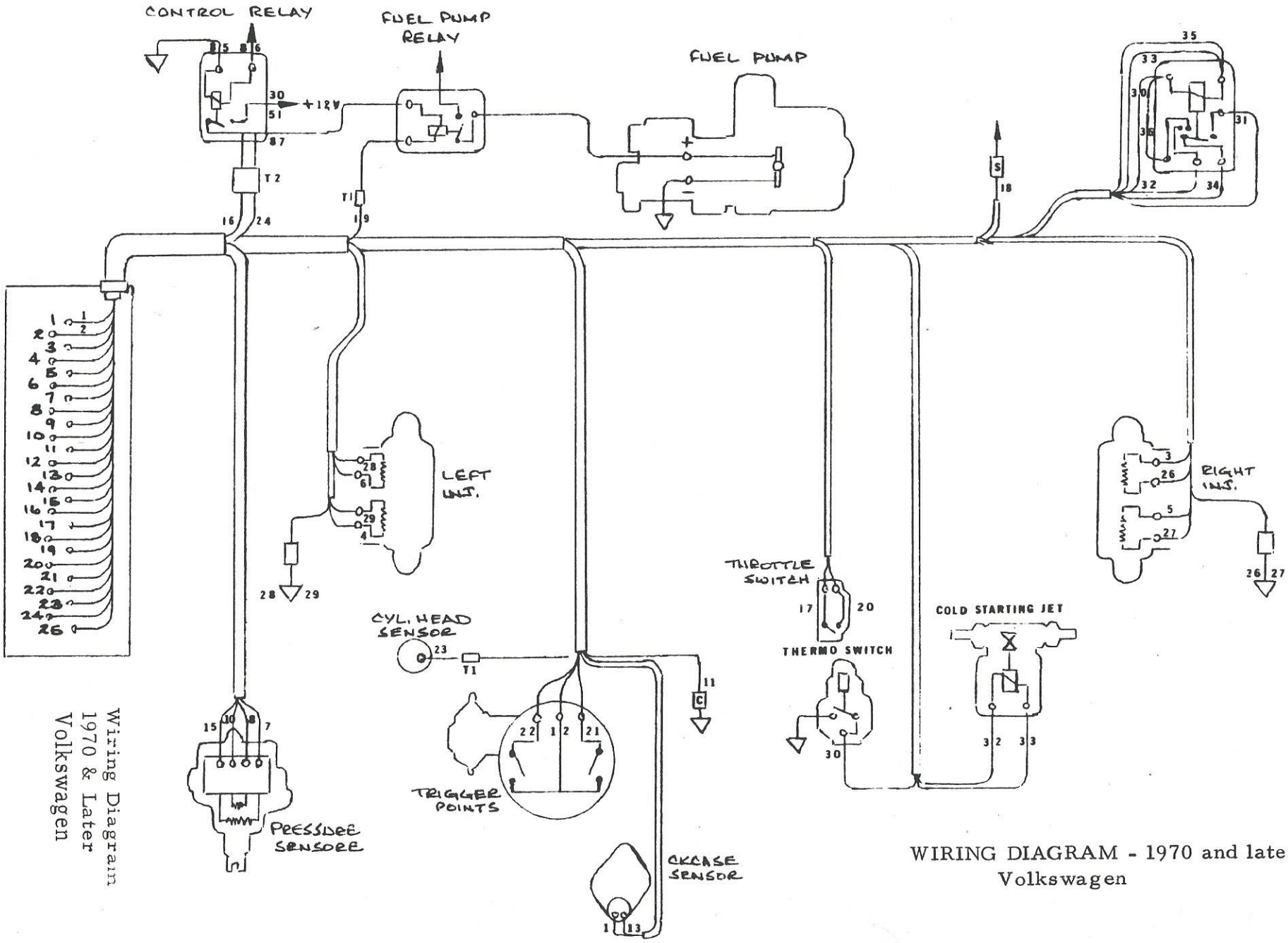
To eliminate difficulties experienced at extremely cold temperatures, a unit called the Cold Starting Device was installed. It consists of a relay, temperature switch, and electro-magnetic fuel valve. A cold starting fuel jet is installed in the air intake distributor and connected by a hose on one side of the fuel valve. The other side of the valve is connected to the pressurized fuel line. When the temperature drops below35°Cthe thermo switch is closed and combined with the cold start relay (closed only when starter motor is energized) injects extra gas into the manifold for easier starting. On 68-69 VW models, the temp. switch responds between 40° and 50° F. This device can be installed on older models.



TYPICAL COLD START CIRCUIT
(Mercedes Benz)

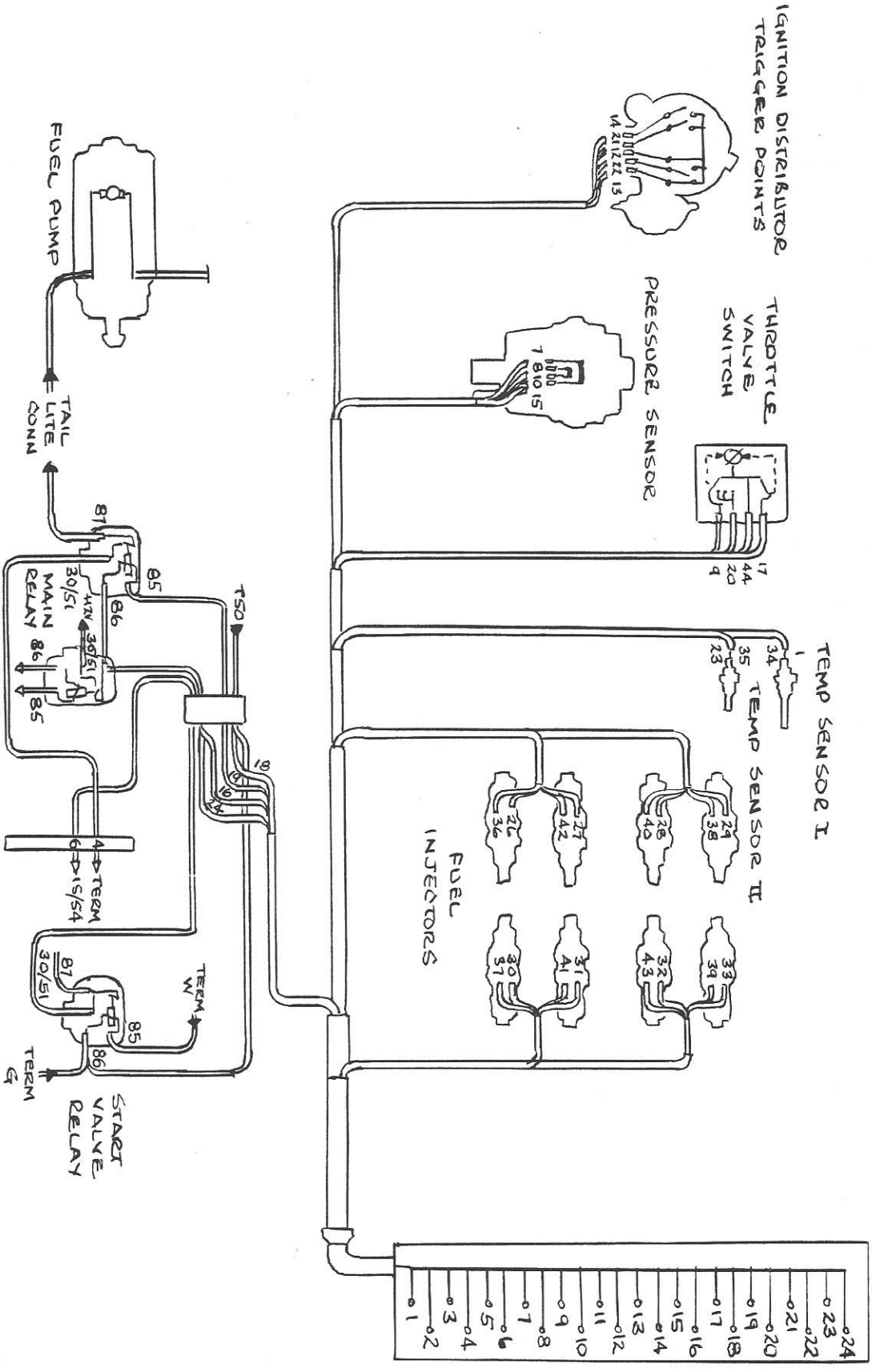
NOTE!

Activation of the starter allows current to flow thru the Thermo-time Sw. -A- heater element (G to Gnd). This heats up causing the contact to close (W to Gnd), which energizes the Cold Start Relay -B-. This causes the Fuel Solenoid Valve -C- to open letting an extra amount of fuel to enter the maniford. The fuel will flow for a short time after the starter is released depending on the outside temperature.

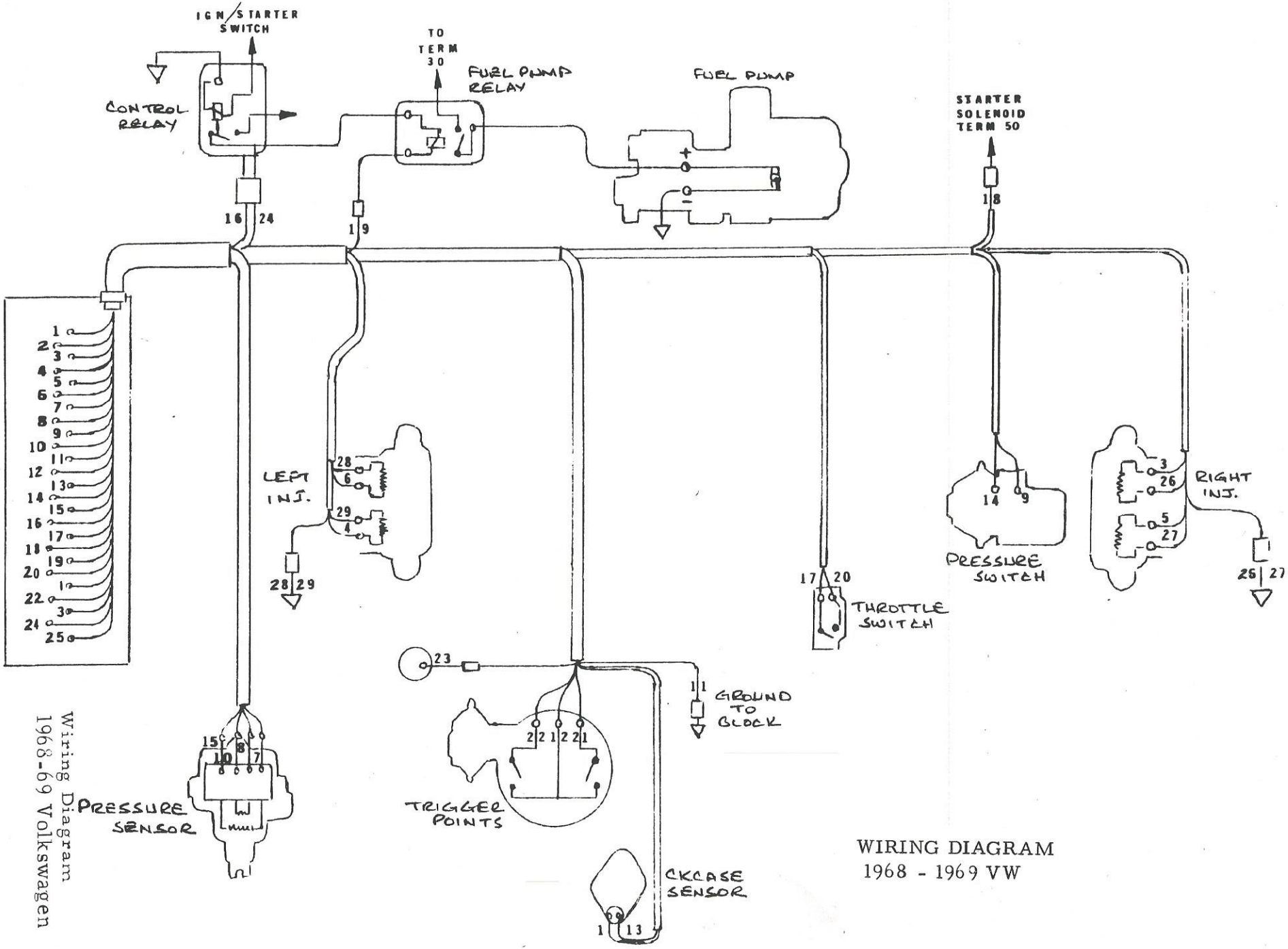


Wiring Diagram
1970 & Later
Volkswagen

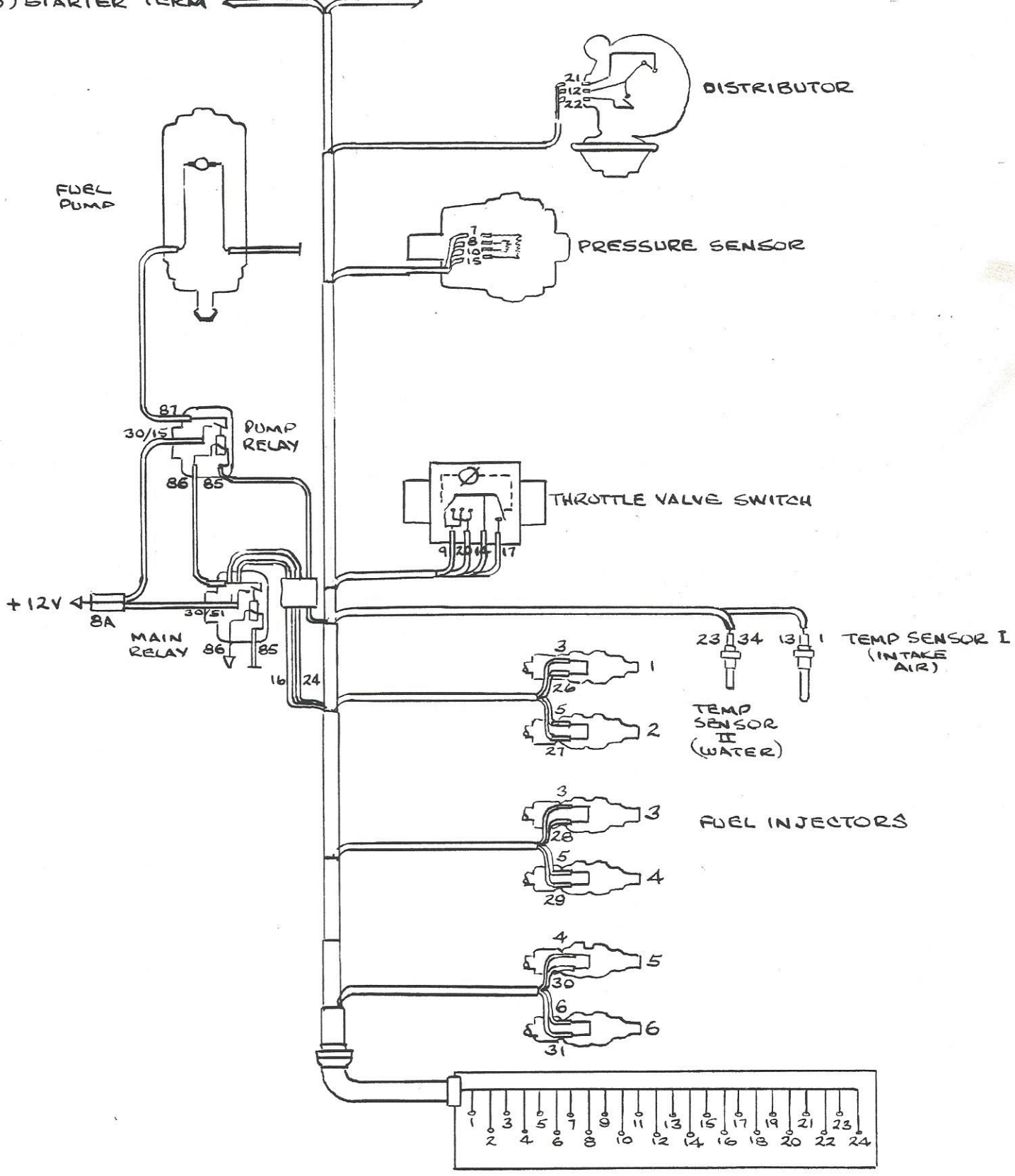
WIRING DIAGRAM - 1970 and later
Volkswagen



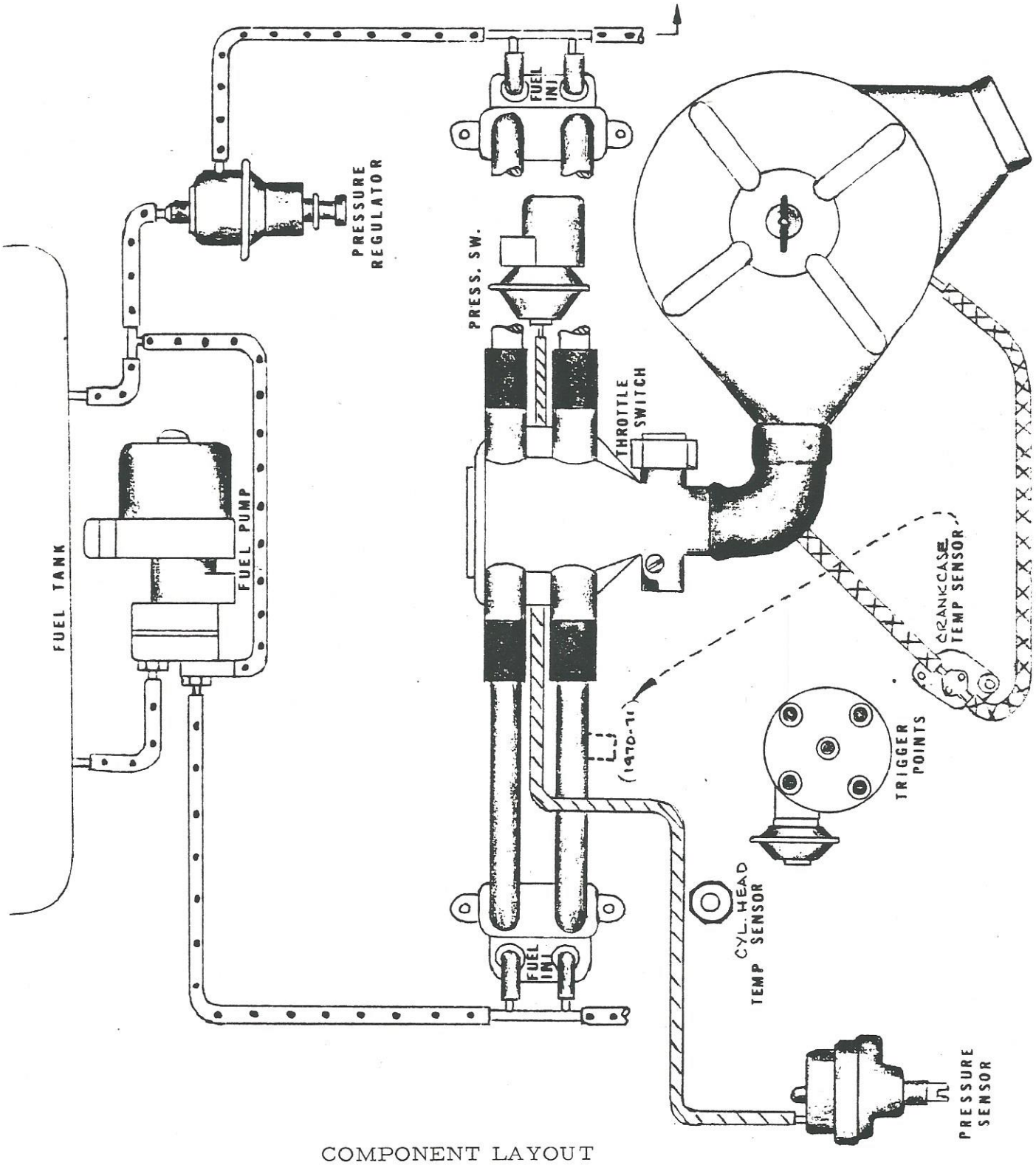
WIRING DIAGRAM - 8 Cyl.
Mercedes-Benz



WIRING DIAGRAM
1968 - 1969 VW



WIRING DIAGRAM - 6 Cyl.
Mercedes-Benz



COMPONENT LAYOUT

1968-69 VW's

COMPONENT LAYOUT
Mercedes - Benz
8 - Cyl.

PREPARATION FOR TEST

1. Place the transmission in NEUTRAL and SET the parking brake.

2. Turn OFF the ignition switch. CAUTION!!! Always make sure that the ignition switch is turned OFF whenever the connector is removed or connected to the computer board. Failure to do so may result in damage to electronic components on the board.

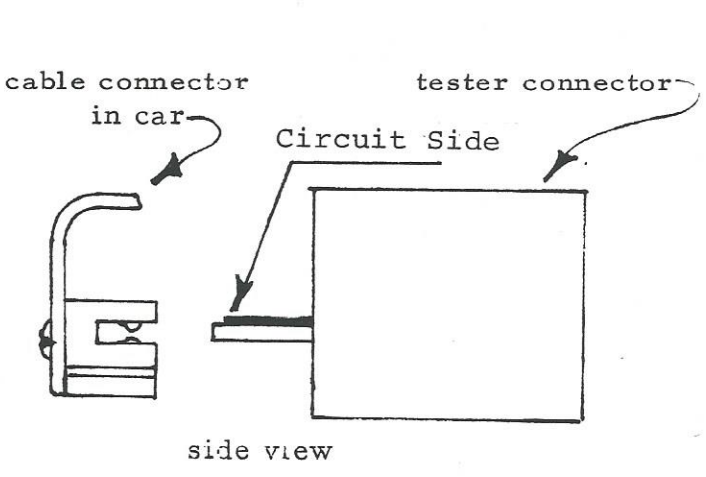
3. Remove the computer board box from its location in the left rear wheel well (VW's), under the drivers seat or dash (Volvo, Saab) or engine compartment (Mercedes-Benz).

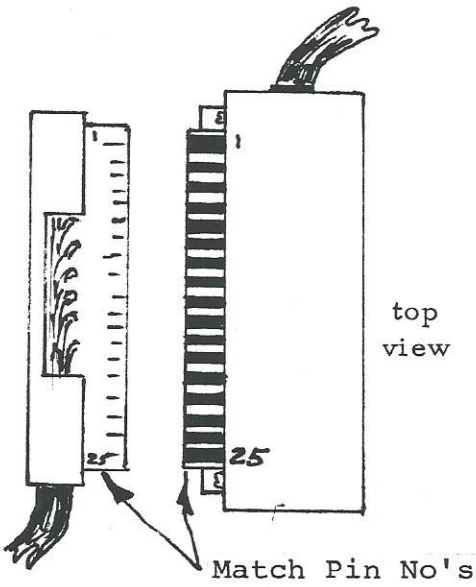
4. Loosen the clamp holding the cable.

5. Grasp the plastic slide covering the cable connector and slide it out of the computer board box. Note! On some cars the slide snaps out after sliding for only about 1/4".

6. Firmly grip the cable connector by the round finger grips and pull the connector STRAIGHT out from the board. CAUTION!!! Do NOT twist or rock the connector in order to remove it as the computer board is fragile and can be broken. Normally a great deal of pressure is required to remove the connector.

7. Push the connector onto the circuit board on the rear of the analyzer cabinet. MAKE SURE THE CONNECTOR PINS LINE UP WITH THE CENTER OF THE METAL STRIPS ON THE CIRCUIT BOARD. Also make certain the connector is oriented as shown below. NOTE! There are at least three different types of connectors. All are similar but be sure the contacts in the plug are on the circuit board by looking in the end of the plug before connecting.





The wires are marked on the connector. Again, push the connector STRAIGHT ON.

8. Turn the TEST SW. on the analyzer to the OFF position. Make sure the CYL SW. is in the proper position for the type car being tested.

9. Remove the vacuum hose from the pressure sensor.

10. Turn the car's ignition sw ON. You are now ready to begin testing.

STANDARD TEST PROCEDURE

This checklist outlines the proper test sequence and operating conditions for quickly checking the EFI system out. Dynamic tests are included whenever possible to simulate actual operating conditions.

Please follow the tests in sequence and pay particular note to the cautions and notes.

Operational tests are broken down into 3 groups:

1. Tests using the test lights (LEDs)
2. Tests using the main tester circuitry and meter
3. Tests not directly connected to the wiring harness but that are still part of the EFI system

Setup the tester controls as follows:

1. Turn the TEST SWITCH to the "AIR TEMP. SENSOR" pos.
2. Turn the TRIGGER POINT SWITCH TO THE "I" pos.
3. Turn the FUEL INJECTOR SWITCH to the "D,H" pos.
4. Turn the MIXTURE CONTROL to "LEAN"

TEST CHECKLIST

USING THE LIGHTS

TEST A BATTERY VOLTAGE/STARTER VOLTAGE (All Cars)

CAUTION!! Make sure transmission in in neutral and the parking brake is on.

1. Turn on the ignition key. Both the 16 and 24 BATTERY lights should come on.
2. Engage the starter. The STARTER light should come on and the BATTERY lights should stay on also.

Failure of the starter light to come on means that the cold start signal is not getting to the control unit.
Failure of the battery lights to come on means that a fuse is blown, a wire is open. or that a connector pin is not making good electrical contact.
Failure of the battery lights to stay on during the starter test indicates that the contacts on the power relay are dirty or that the battery is low (or that the battery cables are corroded).

TEST B THROTTLE SWITCH (1968-69 cars only)

1. The 68-69 THROTTLE light should be on when the throttle is at idle. Slowly depress the accelerator pedal towards the floor. The light should go out just as the throttle leaves the stop and stay off all the way down.

   NOTE! Ignore any other lights that might come on or go off during this test.

TEST C PRESSURE SWITCH (1968-69 cars only)

1. Remove the vacuum hose from the pressure switch and connect a hand vacuum pump to the nib.
2. The PRESSURE SWITCH light should be ON. When more that 5" of vacuum is pulled the light should go out and return to ON as the vacuum is released.

   NOTE! Ignore any other lights that might come on or go off during this test.

When this light is on it causes the control unit to enrichen the mixture. If the light does not go off, the diaphram in the switch could be ruptured. If it does not come on at all the car would not have an acceleration enrichment signal and would be hard to start in cold weather. A bad switch or faulty connections at the harness could be the cause.

TEST D THROTTLE SWITCH (1970 and later cars)

1. The 1970 THROTTLE SWITCH light should be on at IDLE, as above, and go OFF as the pedal is pushed towards the floor.
2. On 8 Cylinder Mercedes-Benz cars, continue to press the pedal to the floor. As you pass the half way point the light should again come on and stay ON until the end.

Failure to pass these tests usually means that the switch contacts are worn or that the switch assembly is not adjusted correctly. Missadjustment can cause abrupt throttle changes around the idle position and hard starting at low temperatures.

TEST E FUEL ENRICHMENT SWITCHES, I & II (1970 and later)

1. Slowly depress the accelerator pedal towards full open.
2. Alternately, F/E I & II lights whould go ON and OFF about 10 times each.
3. Slowly release the pedal and let it return to the IDLE position. As this is being done the LIGHTS should stay OFF. ie. They work going down but should not work coming back up.

Failure of these switches can cause poor acceleration, bucking and uneven firing.

TESTS USING THE MAIN TESTER CIRCUITRY AND THE PANEL METER

TEST 1 AIR TEMPERATURE SENSOR

The meter needle should read with the limits of the lower YELLOW temperature sector. This test measures the resistance of the "Crankcase Sensor" in 1968-69 Type 3 VW's and the "Air Temperature Sensor" resistance in 1970 and later cars. The reading will change not only with the temperature of the air but also the temperature of the engine as well. It has little effect on operation of the car when it is at operating temperature but is necessary during warm-up.

It is necessary only that the reading be approx. as a failure generally will indicate an open or shorted circuit.

TEST 2 ENGINE TEMPERATURE SENSOR

The meter needle should read in the UPPER YELLOW temperature sector at a temperature that approximates the engine temperature.

Failure is as noted above except that an OPEN circuit can keep the engine from running in some cars. Readings out of tolerance on the HOT side, on hot days in Summer, can also cause the engine to die until it cools down enough for the mixture to enrichen.

TEST 3 TRIGGER POINTS

A. Place the TRIGGER POINT SWITCH in pos I. Place the CYLINDER SWITCH in either the 4-6, or the 8 cyl. position.
B. Turn over the engine with the starter and observe the meter needle. It should swing back and forth between OPEN and CLOSED on the TRIGGER POINT scale.

C. Repeat the above for TRIGGER POINT II. If you are testing an 8 cylinder car also repeat for points III and IV.

Ignore the "DWELL" sector at this time.

TEST 4 FUEL INJECTORS/THE FUEL SYSTEM

This test allows you to perform a test on the flow rate of each injector without removing them from the car. You should look for equal and consistient pressure drops at each injector.

CAUTION!! When removing fuel hoses or operating the fuel pump, high pressures can exist in the lines. Excercise caution and wear safety glasses or goggles.

A. Connect a 30PSI fuel pressure gage to the fuel line using a TEE, or the TEE fitting provided on V.W.s (A 60# gage can be used if available)
B. Turn ON the FUEL PUMP momentarily and observe the pressure gage. The pressure should build up to 28.5 PSI in less than one second. Sluggish operation generally means a clogged fuel filter
C. Turn the FUEL PUMP OFF and allow the pressure to drop. It may remain at 28.7 or drop down to 20#. Either is OK but it should stop and stabilize at some value between these limits. Failure to stop indicates a leak or bad check valve in the fuel pump which must be fixed before continuing.

FOR 4 and 6 CYLINDER CARS

D. Rotate the TRIGGER POINT SWITCH to the INJECTOR FLOW position and the FUEL INJECTOR SWITCH to the D,H position
E. Rotate the MIXTURE CONTROL knob to the full RICH position (Clockwise). Do not move this control for the balance of these flow tests.
F. Push the ACT. INJ. SWITCH several times so that the fuel pressure DROPS about 5 PSI, or so. Note both the starting and ending values of pressure. Also note the number of "Pushes" needed to get the lower value.
G. Turn the FUEL INJ. SW. to the C,G position. Momentarily push the FUEL PUMP SWITCH again to build up pressure in the line to the original start value.
Again press the Act. INJ. button the same number of times as before. Note the pressure drop. It

should be the same as before.

H. Repeat for B,F and A,E positions.

I. All pressure drops should be the same if the injectors are working properly.

CAUTION!! You have injected a small amount of fuel into each cylinder. Do not over fill as a hydraulic lock can occur. If you feel that this has happened, remove the spark plugs and purge the engine.

FOR 8 CYLINDER CARS

In these cars the tests are run the same as outlined above except that the injectors are paired in the wiring harness and cannot be separated at the connector. To test them individually, first remove one of each pair by removing its 2 pin connector. Run the tests above and then exchange for the other 4 injectors. See the chart below for the proper cylinders to remove.

Cylinder number vs number on panel

Panel	Mercedes 6	Mercedes 8	VW & Porsche	Saab 4	Volvo 4
A.E	6 *	2.7 *	3	2	2
B,F	2.4 *	3.6 *	2	4	4
C,G	5	4.8 *	4	3	3
D,H	3.1	1.5 *	1	1	1

TEST 5 PRESSURE SENSOR

This position permits the pressure sensor to be checked under simulated operating conditions. A vacuum is drawn against the aneroid bellows. The transformer core-slug will then move a given distance if it is work-properly. The amount of this movement is monitored by the analyzer and displayed on the GREEN scale. It is necessary only to note this movement between 0 and 15"Hg to determine proper operation. These values represent the two edges of the pressure sensor sector.

A. Disconnect the vacuum hose from the pressure sensor. Attatch a hand vacuum pump to the sensor.
B. Squeeze the handle on the hand pump until its gage indicates 15" of vacuum. The needle on the meter should be "AT LEAST" to the edge of the sector or beyond.
C. Now release the vacuum. The needle should return to the RIGHT side of the sector. Repeat the above several times to see if the readings repeat.
D. Hold a value of 15" of vacuum for several seconds to see if there is a leak. The value should re-main steady.

Each pressure part number will have slightly differ-ent readings depending upon their individual calib-ration points. But each should approximate the limits of the meter sector and hold a value of vacuum with-out leaking.
The pressure sensor is probably the most troublesome device in the system but it generally does not give give trouble for several years. The normal failure is to fracture and develop a slow (several seconds) leak. Backfiring will "Bloat" the aneroid and shift readings significantly. After several years use the aneroid will begin to work harden and its flexibility is reduced and is noted by readings that do not run the full span of the meter sector.
In emergencies, resetting of the pressure sensor can be accomplished in the field, but are not reccommended. (see supplemental information section)

TEST 6 RUN/DWELL

RUN

A. Position the trigger point sw. at the "I" pos.
B. Position the fuel injector sw. at the "RUN/DWELL" pos.
C. Remove the vacuum hose from the pressure sensor
D. Insure that the engine is somewhat near normal temperatures. If left outside during freezing temperatures, pull inside the shop for a time before attempting to start the engine.

NOTE! The built-in ECU, in the 812D is designed to start and run the car under normal temperatures and for test purposes only. Fuel/air mixture is controlled manually by the mixture control knob and will generally make the engine run rich.

E. Position the MIXTURE CONTROL at its mid point.

NOTE! Make sure that the transmission is in NEUTRAL and that the PARKING BRAKE IS ON.

F. Turn ON the fuel pump. Press the starter and as the engine fires, rotate the MIXTURE CONTROL back towards the LEAN position until it idles smoothly.

If the remainder of the engine systems are operating properly, the engine should run normally, but at a slightly high idle RPM. If the engine cannot be started, look elsewhere for a problem. If the engine does run, even roughly, continue.

DWELL

In this position, the dwell of each trigger point is measured and the engine is run on each trigger point individually so that differences in dwell as well as contact resistance can be detected under actual operating conditions. This is a much more meaningful test than the trigger point test run previously.

A. Start with the TRIGGER POINT SWITCH in the I pos. Then, in turn, go to the II,III and IV positions (The III and IV are only for 8 cyl cars). The engine should run smoothly, and the same, in each position. If one position makes the car run rough, or the RPM changes significaltly the points are bad.

ADDITIONAL TESTS

Several components in the fuel injection system do not connect to the computer board directly and therefore must be checked separately. These items can be checked by following these procedures.

THE COLD STARTING CIRCUIT

The cold starting feature operates separately from the computer. It consists of a TEMPERATURE SW, a SOLENOID FUEL VALVE, and a RELAY. When the engine reaches the temperatures specified in table 5, the TEMPERATURE SW closes and energizes the SOLENOID VALVE only when the starter is energized. At all other times the circuit is inactive.

NOTE ! Some cars may not be equipped with this feature as it was initially offered only as an option on early VW's.

CHECKING THE COLD START SWITCH

Remove the lead from the COLD START TEMP SW. Turn the analyzer TEST SW to the EXT OHMMETER position. Insert the leads into the tester. Touch one test lead to a clean spot on the chassis or engine block. Touch the other lead to the TEMP SW pin. The meter should read in the WHITE (open) area if the engine temperature is ABOVE the temperatures listed above or in the BLACK (closed) area if the temperature is lower.

CHECKING THE COLD START SOLENOID

Touch the pin on the end of the cable plug going to the COLD START SW to a clean spot on the engine block or car chassis. Momentarily press the FUEL PUMP switch on the analyzer to build up pressure in the fuel line if actual fuel flow chick is to be made. Briefly press the STARTER button and listen for a click indicating that the solenoid valve is being actuated.

CAUTION!! Fuel will also spray into the intake manifold. Hold the STARTER button down only momentarily or the engine will become flooded.

Replace wires to their original positions.

RELAY OPERATION

A relay is an electrically operated switch. Two relays are directly associated with the fuel injection system. They are the PUMP RELAY and the COMPUTER POWER RELAY. The PUMP RELAY is energized only by the computer board. It is turned on for only 1 or 2 seconds when the ignition switch is turned ON, or as long as it is held in the START position. Thereafter, the engine must be running to keep the PUMP RELAY energized and the fuel pump running. The COMPUTER POWER RELAY is energized whenever the ignition switch is turned on. It supplys 12V DC to the control box.

CHECKING OPERATION OF THE FUEL PUMP RELAY

Proper operation of this relay is determined during the FUEL PUMP and FUEL INJ. tests.

CHECKING OPERATION OF THE POWER RELAY.

Proper operation of this relay is automatically checked during the BATTERY VOLTAGE AND STARTER tests.

RECONNECTING THE COMPUTER

Turn OFF the ignition sw. in the car. Examine the contacts on the computer to insure that they are not damaged or burned. Take a PENCIL ERASER (or RUBY RED) and rub the contacts until they shine. This will remove the oxide accumulation that can contribute to bad connections. (Bad electrical connections are the biggest trouble spot in the system).
Check the contacts on the harness connector as well. The contacts should not be spread apart so as not to contact the fingers in the control unit. Carefully push the contacts together slightly with a small awl or screwdriver. Lay a hack saw blade in the contacts to insure they are not closed too much.
Carefully reinstall the connector and boots into the computer case. Make sure the guides are engaged.

CONDITION	FUEL INJECTION	ELECTRICAL/IGNITION	MECHANICAL
FLAT SPOTS NOTE! FLAT SPOTS TO SOME EXTENT ARE NORMAL IN THE '68 & '69 MODELS DUE TO OLD PRESSURE SENSOR & PRESSURE SWITCH DESIGN	Open circuit in pressure switch cable and/or defective pressure switch	Points improperly adjusted	Valves too tight
		Improperly timed	Timing off
	Throttle switch improperly adjusted	Weak coil	
		Defective plug wires	
	Pressure sensor full of oil or slug sticking	Polarity reversed on coil	
		Defective condenser	
		Defective plugs	
		Defective or cracked distributor cap	
		Defective vacuum advance	
		Resistance in rotor in error	
		Bent or worn distributor plate	
HIGH FUEL CONSUMPTION	High contact resistance at sensors	Timing incorrect	Restricted muffler
		Plug gaps too wide	Low compression
	Pressure sensor vacuum hose cracked or off	Weak coil	Heater flap
	Fuel pressure set too high		
	Pressure switch diaphragm ruptured or vacuum disconnected 68 - 69 VW		
ENGINE FLOODS	Brain (especially 2 cylinders only)	Cracked distributor cap	
	Injectors sticking if only one cylinder		
"POPPING" DURING ACCELERATION	Pressure sensor full of oil	Timing off (critical)	
LOW VACUUM	Auxiliary air regulator valve open		
	Lean mixture or mixture leaning out		

CONDITION	FUEL INJECTION	ELECTRICAL/IGNITION	MECHANICAL	FUEL SYSTEM
ROUGH IDLE	Metallic spring in auxiliary air regulator bad	Timing incorrect	Excessive carbon build up	Air leaks
	Press sensor sw binding	Points improperly adjusted		Wrong air/fuel ratio
	Pressure sensor hose cracked, loose or off	Excessive resistance in secondary		Cross induction
	Air regulator or vacuum hose between regulator & air distributor leaking	Leaking high tension wires		
	Pressure switch open or hose loose			
	Brain			
ENGINE STALLS AFTER STARTING WHEN COLD	Pressure sensor full of oil	Distributor contacts		Low fuel pressure
	Loose connector pins on brain connector			Air/fuel ratio improperly adjusted
	Brain			
	Restricted fuel filter			
	Trigger points			
ENGINE HUNTS BETWEEN 500 TO 1200 RPM (IDLE SPEED)	Hose between intake air distributor and auxiliary air regulator leaking or disconnected			
ENGINE CUTS OUT OR MISFIRES DURING OPERATION... (MISFIRES PRECEDES CUTTING)	Restricted fuel filter or lines if engine misfires at high speeds	Bad plugs		
	Excessive contact resistance at trigger points	Distributor points improperly adjusted		
	Trigger points dirty			
	Connector improperly connected or faulty contact at ground (both injectors fail to operate if this condition exists)			

CONDITION	FUEL INJECTION	ELECTRICAL/IGNITION	MECHANICAL	FUEL SYSTEM
ONE CYLINDER NOT FIRING OR ENGINE RUNS EXTREMELY ROUGH	Sticking injector	Defective plugs		Leaking fuel line to injectors
	Poor connections	Defective distributor cap		
		Faulty rotor		
		High tension wires leaking		
		Timing incorrect		
ENGINE NOT FIRING ON ALL CYLINDERS (NO FUEL)	Brain			
	Ground connections at injectors			
	Connector loose on brain			
	Injector if only one cylinder			
	Poor injector plug connections			
ENGINE RUNS LEAN	Replace cylinder head temperature sensor			
	pressure sensor out of adjustment			
	Burnt valves			
	Low fuel pressure or restricted flow (filter)			
ENGINE QUITS @ HIGH TEMPERATURE BUT OTHERWISE RUNS OK	Replace cylinder temperature sensor			
	Restricted fuel line or filter			
	Brain			
	Loose contact pins on brain connector			
FUEL PRESSURE INCREASES SLOWLY (MORE THAN 1 OR 2 SECONDS TO REACH 28.7 POUNDS	Fuel filter restricted			
	Fuel lines restricted			
	Poor pump ground connection			

CONDITION	FUEL INJECTION	ELECTRICAL/IGNITION	MECHANICAL	FUEL SYSTEM
FUEL PRESSURE DROPS AFTER FUEL PUMP IS TURNED OFF (ENGINE OFF)	Fuel pressure regulator			
	Leak in fuel lines (check fuel lines around injector)			
FUEL INJECTORS HIGH BUT CAR RUNS OK	Check all connectors to injectors for loose, dirty contacts and ground connections to block			
UNABLE TO START (FUEL PUMP INOPERATIVE)	Brain			
	Power relay (under rear seat)			
	Battery connection at battery (small red wire)			
	Connector pins @ brain loose			
	Fuel pump relay inoperative (under dash)			
	Wire 19 disconnected			
	Check cables to pump and pump relay			
	No voltage at pump relay (terminals 86 + 12 V) due to inoperative main relay or defective cable (check ground at terminal 85)			
TESTER BLOWS FUSES WHEN STARTER SWITCH PUSHED	Engine has automatic transmission (use ignition switch)			
	Starter solenoid stiff or high resistance (use ignition switch or jumper starter switch)			
	Low battery voltage			
	Disconnect cold start solenoid during tests			

CONDITION	FUEL INJECTION	ELECTRICAL/IGNITION	MECHANICAL	FUEL SYSTEM
UNABLE TO START (FUEL PUMP OPERATING)	Bad battery connection	Points	Valves too tight (critical on fuel injection systems)	
	Cable from starter terminal 50 to cable 18 (cable tree) defective	Plugs		
		Coil wire		
		Rotor		
	Open circuit at temperature sensor in cable connection (check connection or temperature sensor for open condition)	Bad coil		
		Secondary resistance high		
		Primary voltage low		
		Weak battery		
	Low fuel pressure or no pressure caused by defective pressure regulator, restricted fuel filter, leak or pinched line	Excessive starter amperage draw		
	T-11 off (ground)			
	T-23 off (cylinder head sensor wire)			
	Ground at computer relay (T-85, relay 1)			
	Defective cylinder head sensor			
	Control relay inoperative (under rear seat)			
	Pressure sensor stuck in lean position			
	Brain			
	Connector pins at brain loose			

ADDITIONAL SERVICE NOTES

PRESSURE SENSOR OPERATION

The PRESSURE SENSOR is the most critical component in the BOSCH Electronic Fuel Injection system (EFI). Its purpose is to sense the vacuum level in the air distributor. This information tells the control unit the loading condition of the engine. It can then change the fuel/air mixture quantity to meet the demands of the engine.

Because of the critical nature of the mixture ratio, the Pressure Sensor must be accurate throughout the range from idle to full speed conditions. It must maintain this ratio very accurately to insure optimum operation of the engine and to reduce the exhaust emmissions to the required level.

At 0" of vacuum (engine not running or wide open throttle) the pressure sensor tells the control unit to supply a large amount of properly mixed fuel. When the vacuum is maximum (about 15"), which occurs at or slightly above idle, the sensor commands the computer to supply a small amount of fuel mixture. Figure #1 shows a cut-away view of the original pressure sensor and its internal parts.

Since 1970 all cars have used a modified unit which adds the compartment contained within the dotted lines on the figure. This compartment contains an additional bellows which permits, among other things, more rapid response to engine loading conditions.

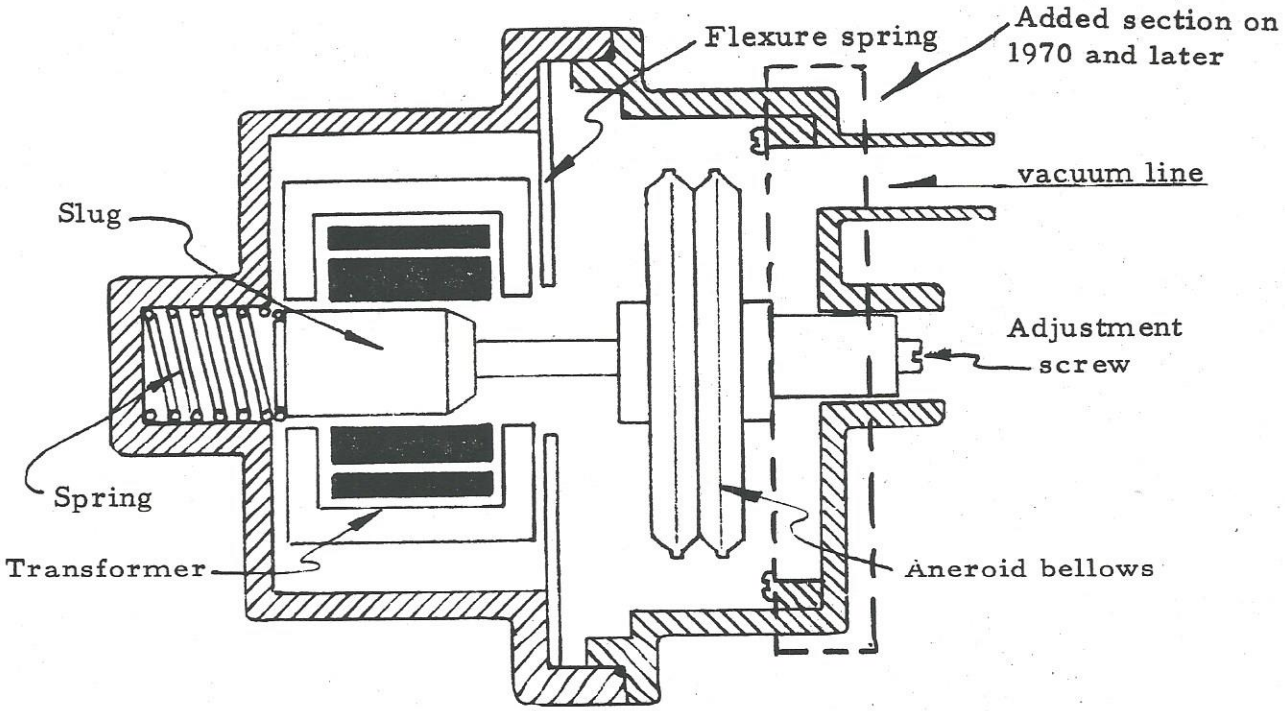


Figure 1

In figure #1 it can be seen that the two transformer windings are fixed but an iron slug is made to move back and forth between them. As the slug moves it varies the output voltage going to the control unit (brain). This is the fuel quantity signal. The slug, in turn, is attached to a spring, (on the left) and an aneroid bellows (on the right). The interior of the pressure sensor case is sealed to the atmosphere but connected to the vacuum level by a hose from the air distributor.

As the engine starts air is pulled out of the sensor housing. Since the aneroid is sealed to normal air pressure, it begins to expand as the air is removed around it, this moves the slug to the left against the force of the spring and the voltage going to the control unit is changed. The control unit interprets this as a decreased load condition and reduces the amount of fuel.

You can see that all the parts must be able to move freely and quickly so they are able to respond to the acceleration needs of the engine. By introducing a known amount of vacuum at the inlet to the pressure sensor housing and monitoring the amount of change in the output voltage coming from the sensor, we can simulate the actual operation of the unit in the car and tell from the outside, if the parts are operating as they should.

Again referring to figure #1 you can see how the sensor can have many symptoms of failure that are radically different from each other. For example:

1. FILLED WITH OIL (Characteristic of VW's)
   This makes the operation sluggish, expecially in cold weather when the oil congeals and causes the slug to move slowly or not at all. This causes hard starting, poor acceleration, flat spots or sometimes "popping".
2. SLUG STUCK TO THE RIGHT
   This is the rich condition. This would cause the engine to flood, run very rich, load up at idle, or have very poor mileage.
3. SLUG STUCK TO THE LEFT
   This is the lean position. It would cause the engine not to start or be very hard to start or if it did start it would probably starve out and die.
4. SLUG RUBBING THE SIDE OF THE TRANSFORMER
   This would cause varing amounts of response problems depending on how bad the slug was rubbing. It would cause bad flat spots or even coughing and spitting.
5. ANEROID BELLOWS HAS LEAK
   This would cause the engine to run very rich and appear as if the the accelerator linkage was loose near idle or act in an off/on manner with abrupt action.
6. OPEN WINDINGS
   Unable to start
7. LEAKY OR LOOSE VACUUM HOSE
   Although not part of the sensor itself, it is frequently blamed on a bad unit. A leaky hose will reduce the vacuum level which will cause the engine to run richer than normal which can cause a variety of problems such as rough idle when warm, poor mileage, etc.

With the hose removed from the sensor the engine will, of course, run very rich. This can sometimes give a clue to proper operation. If the hose is removed and the engine does not run excessively rich chances the problem is in the sensor itself (if the vacuum level is correct).

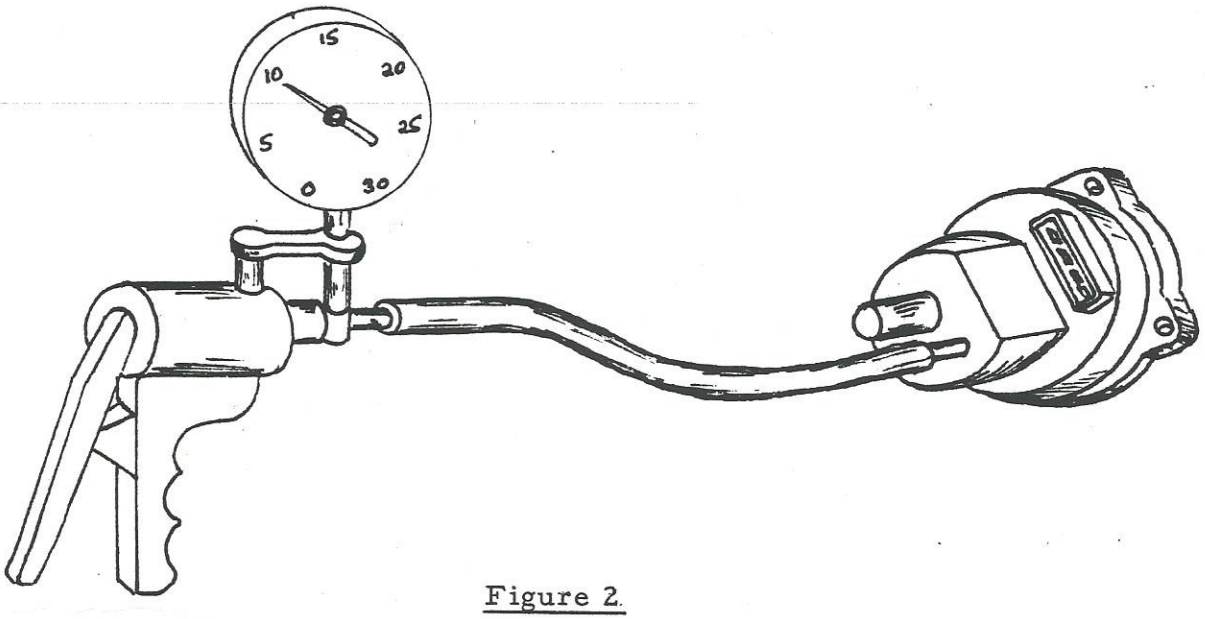


Figure 2.

Proper operation of the sensor is indicated by proper operation and movement of the tester meter. No movement or sluggish readings indicate problems within the sensor itself. However, it;should be remembered that operation of the sensor is very critical and only slight variations from the normal operating range can cause problems. Even so, most of the problems can be cured by a simple overhaul and cleaning. Also, some of the problems might only occur under specific conditions such as extreme cold (hard or not starting) which are not present when the test is made . Filling with oil and cracked vacuum lines cause the most problems.

Considerable history can be gathered by keeping a separate notebook on pressure sensor problems and how they relate to the readings and symptoms obtained at the time of repair. These will be invaluable as reference material.

It may also be desireable to maintain an extra sensor in the shop to compare against operation of a suspected bad unit. Readings can be obtained and compared directly without removing the unit from the car by interchanging vacuum and electrical connections. NOTE: The Pressure Sensor is position sensitive and must be oriented as it is in the car for proper operation.

TROUBLESHOOTING CHART

SYMPTOM	PROBABLE CAUSES
Will not start	Slug stuck in lean position Full of oil Open winding
Starts but will not catch	Slug stuck near lean position Slug not moving freely Full of oil
Starts but will not idle (floods)	Slug stuck in extreme rich position Aneroid cracked and leaking
Runs very rich (black smoke)	Slug stuck in extreme rich position Aneroid cracked and leaking Vacuum hose disconnected
Loads up at idle (smoke)	Slug stuck in extreme rich position Aneroid cracked and leaking Vacuum hose disconnected
Flat spots (poor acceleration)	Full of oil Slug rubbing Leaky or cracked vacuum hose Low vacuum (vacuum should be about 12" to 15".
Will not start when cold or very hard to start but OK when warm	Full of oil Slug rubbing slightly
Runs slightly rich	Leaky vacuum hose

REMEMBER: These symptoms can also be caused by other components in the Electronic Fuel Injection System. The above symptoms are listed because they pertain only to the Pressure Sensor itself. As you may note, one of the major problems is the Pressure Sensor becoming full of oil. (VW's)

OVERHAULING THE PRESSURE SENSOR

In order for the Pressure Sensor to operate properly the following conditions must exist.

1. Case must be properly sealed
2. The hose from the air distributor must not leak
3. The aneroid (bellows) must be properly sealed
4. The slug must move freely from end to end. (1/4" total movement)
5. The slug positions at idle (maximum vacuum) and full throttle (near minimum vacuum) must be correct. This is a factory setting and should not be changed in the field (sealed screw at end of housing).
6. The electrical connections and the transformer windings must be intact and not open or shorted.

The most common problems with the sensor are as follows:

1. Filled with oil from the air cleaner (VW's)
2. Loose, leaky or disconnected vacuum hose between the air distributor and the pressure sensor or in some other parts of the vacuum system. (Low vacuum)
3. Slug is rubbing on the sides of the transformer within the pressure sensor.
4. Aneroid bellows has developed a leak and is unable to expand and reduce the amount of fuel.
5. External adjustment screw has been tampered with.

Of all the above defects only correction of items 1 and 2 should be attempted in the field until considerable experience is gained. Fortunately these two problems account for the majority of the field failures.

After a years operation very pressure sensor will have a certain amount of oil in it and should be cleaned. (VW's)

TAKING THE SENSOR APART (for cleaning and oil removal)

1. Remove the 4 screws that hold the two halves of the sensor case together. Note: Perform this operation over an empty can or some receptical as considerable oil may drip out (see figure #1).
2. Carefully mark and take the two sections apart as the aneroid bellows is not held rigidly in and will be loose. Take out the bellows and mark the end that faces towards the end of the housing so that it can be properly reinstalled.
3. Immerse the entire sensor into a container of solvent and thoroughly rinse out the oil. Blow out solvent and dry all the parts. Clean the O-ring by hand so as not to damage it.
4. Push the end of the slug inwardly to see if it moves freely and does not rub. The spring is fairly strong but it should move about 1/4" from end to end. The movement should be free and the slug should quickly return to its normal position when released.

NOTE: If the slug is not moving freely, loosen the 2 screws holding the flat spring to the housing and move the slug around a little and see see if you can get it to move freely. Then retighten the screws. If possible, you should practice on a shop unit before attempting this adjustment on a customers car.

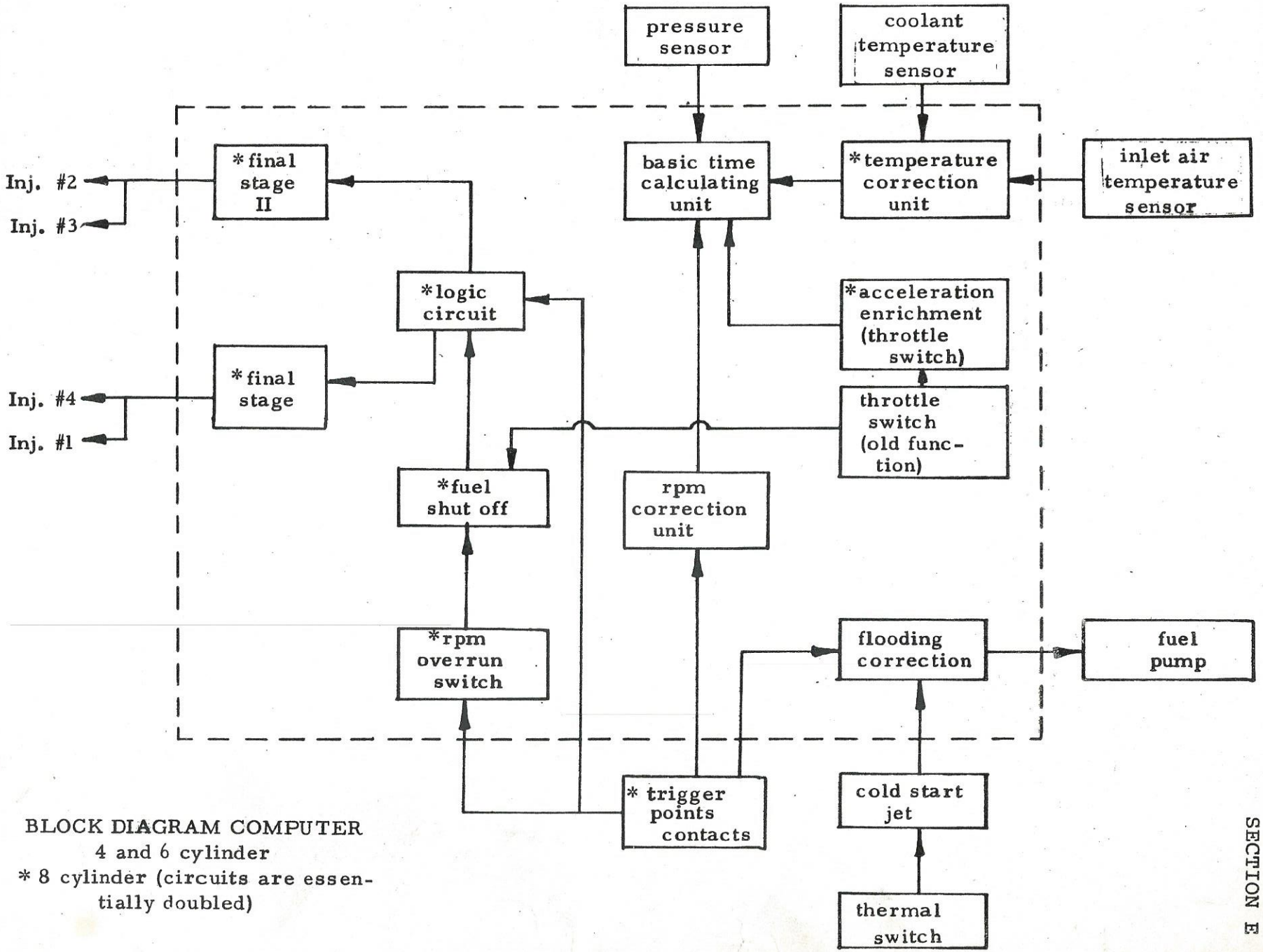
5. If the slug is free replace the O-ring and the aneroid bellows (make sure that it is oriented properly and that it is riding evenly on the ends of the slug and adjustment screw.) Place the two halves of the case together in the same fashion as they were before and secure with the 4 screws.
6. Plug the electrical connector from the car into the sensor and connect the hose from the hand vacuum pump to the sensor inlet. Run through the test as outlined before and see if the slug is operating properly.
7. Reinstall in the car.

ADDITIONAL NOTES

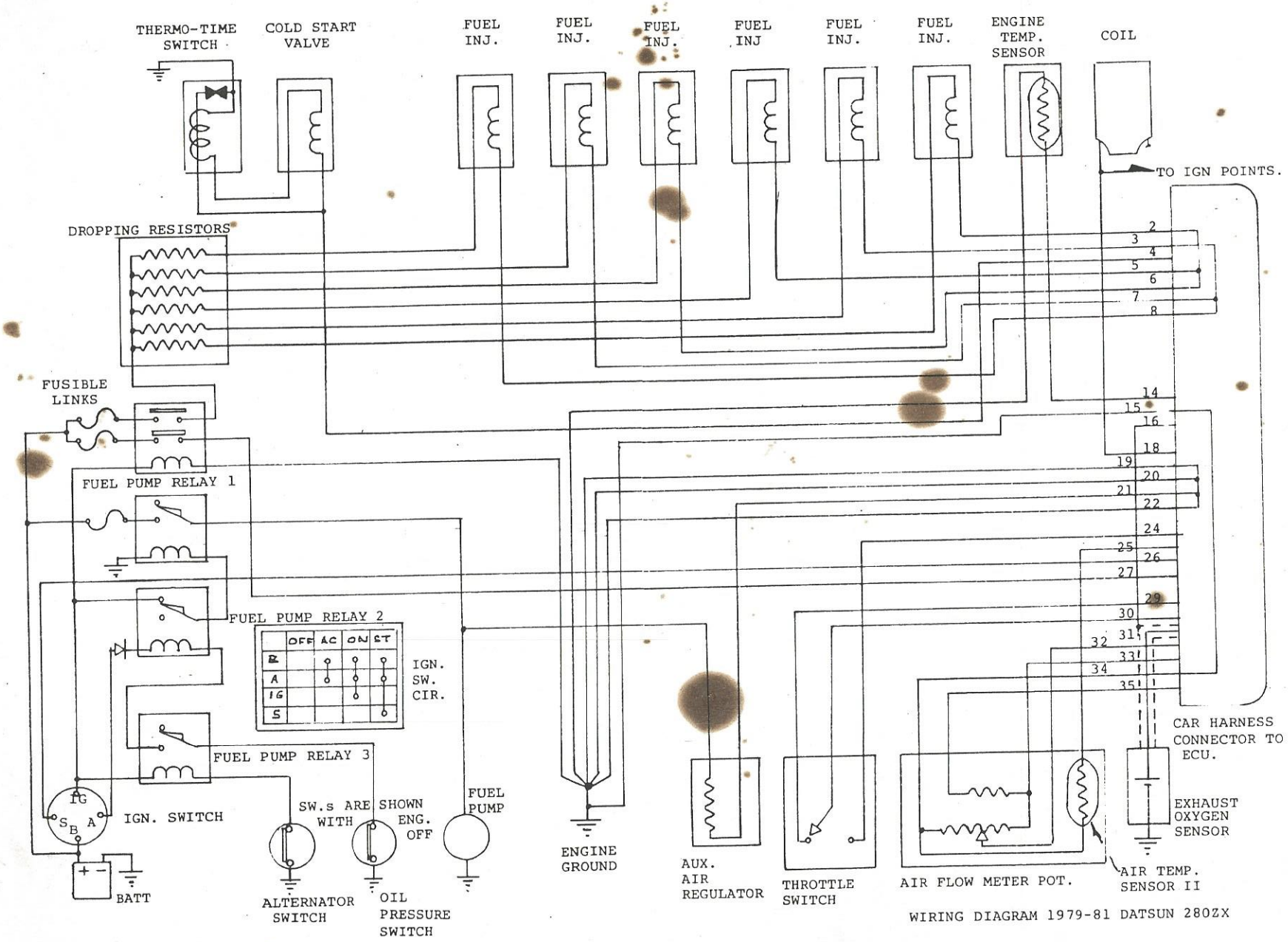
A. While apart, you may wish to check the aneroid billows for leaks. To do this hold the ends of the bellows between your thumb and forefinger. Hold it next to your ear and squeeze. As the bellows expands and contracts a "Swishing" sound will be heard if it is leaking. It is normal for it to move stiffly. If there is a hole it may be filled with solder for a temporary fix.

B. Occationally pin holes will be found in the pressure sensor hose. This has been done in an attempt to "Enrichen" the mixture and improve response. This will be found in a number of the 1968-69 VW's as a cure for flat spots.

C. In the 1970, and later, Pressure Sensors, the added barometric section can be removed by loosening 2 additional screws inside the smaller of the two housing sections. However, this must be done carefully as it must be resealed to insure proper operation.



BLOCK DIAGRAM COMPUTER
4 and 6 cylinder
* 8 cylinder (circuits are essentially doubled)



WIRING DIAGRAM 1979-81 DATSUN 280ZX