FOCUS

XJ-S
ENGINE
PERFORMANCE

JAGUAR

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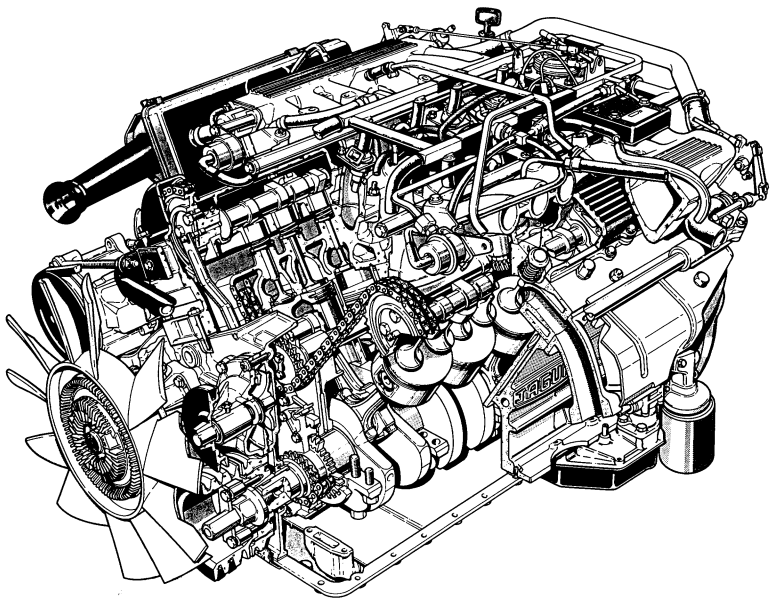


XJ-S
ENGINE PERFORMANCE

Publication number S-58

FOCUS

CONTENTS

The high performance XJ-S V12 engine uses sophisticated fueling, ignition, and emissions control systems to achieve a high level of performance while providing smooth and efficient operation.

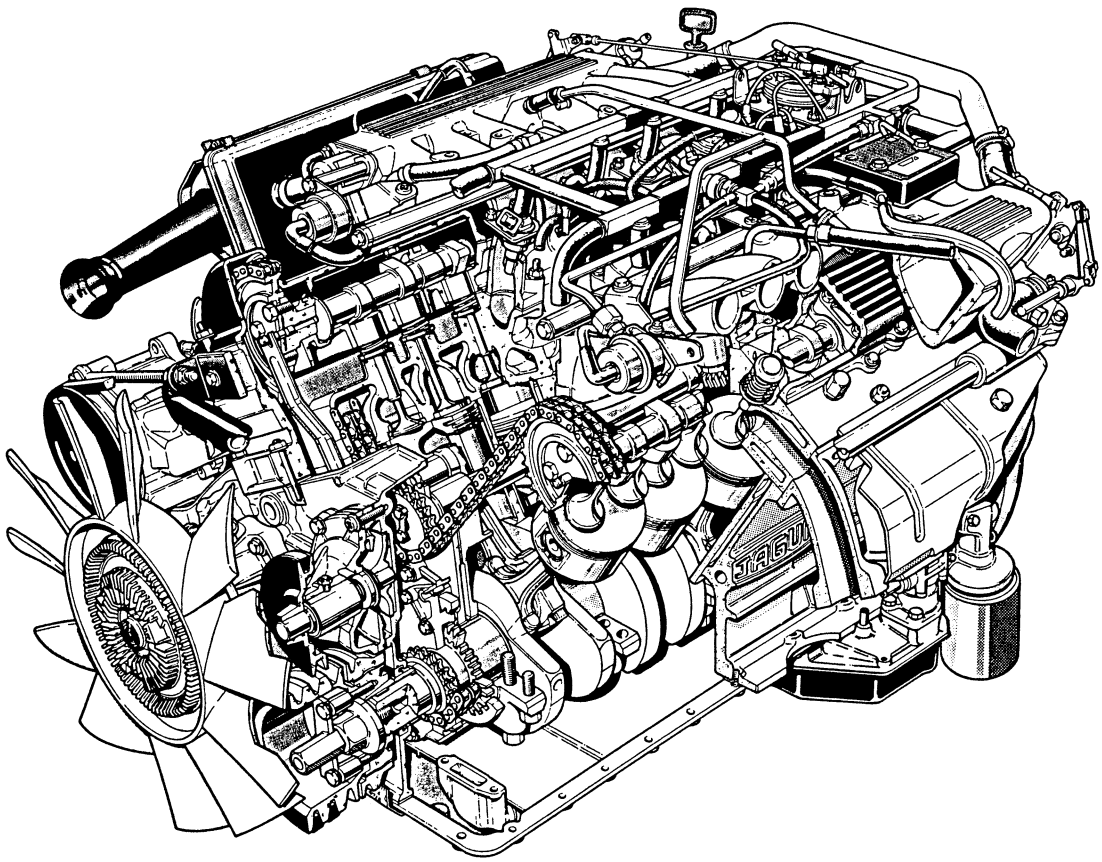
This FOCUS book is to be used as a source document for all current XJ-S engine performance related information and adjustment techniques. These apply to all H.E. and later models with P type fuel injection.

SYSTEM REFINEMENTS

Refinements to the system have been made to enhance reliability and operating characteristics:

Vehicles VIN 104236–125019	RECALL CAMPAIGN D-291
Vehicles VIN 104236–133460	PURGE MODIFICATION AND IDLE STABILIZATION KIT AVAILABLE
Vehicles VIN 133461–ON	PRODUCTION PURGE AND IDLE STABILIZATION MODIFICATIONS INCORPORATED

⚠WARNING: THE OPERATIONS AND PROCEDURES CONTAINED IN THIS PUBLICATION ARE INTENDED FOR USE BY PROFESSIONAL TECHNICIANS WITH KNOWLEDGE OF JAGUAR VEHICLE SYSTEMS. ALL NECESSARY SAFETY PRECAUTIONS MUST BE TAKEN WHEN SERVICING OR TESTING SYSTEMS THAT HAVE THE POTENTIAL FOR CAUSING BODILY INJURY OR DEATH.



The XJ-S V12 engine uses separate systems for fueling, ignition, and emissions control. Although these are independent systems, they are dependent on each other to achieve an overall efficiency of operation while providing precise control over each individual function.

There are some areas of overlap: the EFI system triggers fuel injection pulses from signals provided by the ignition system, the engine idle speed is stabilized during initial warm-up via the emissions control system, and the ignition timing is retarded during initial warm-up by the emissions control system.

The three systems will be discussed separately, but it is important to understand that the operation and performance of the engine is dependent on the three systems acting as one engine control system.

OVERVIEW

Main function

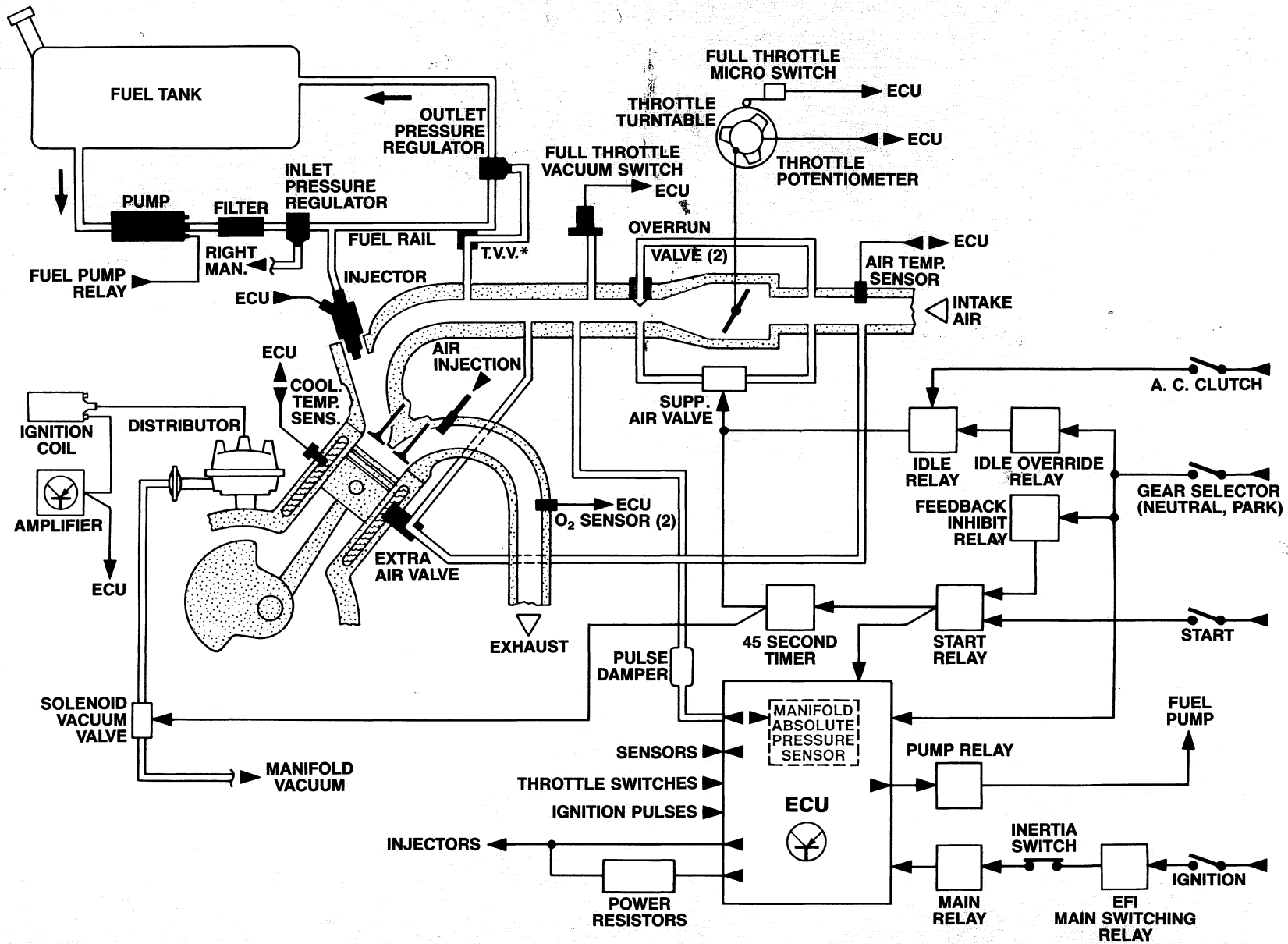
The XJ-S P EFI system maintains optimum fuel control over the entire engine operating range by precisely metering the fuel into each cylinder. The main parameters for determining fuel requirement are engine load and speed. Engine load is determined by sensing intake manifold absolute pressure; engine speed is sensed from the ignition pulses.

The heart of the system is the ECU (Electronic Control Unit), which incorporates a manifold pressure sensor and has a memory with stored fuel quantity requirements for various combinations of engine load and speed. The ECU also receives signals from sensors, switches, and the ignition system that are used for determining the precise amount of fuel required.

Additional functions

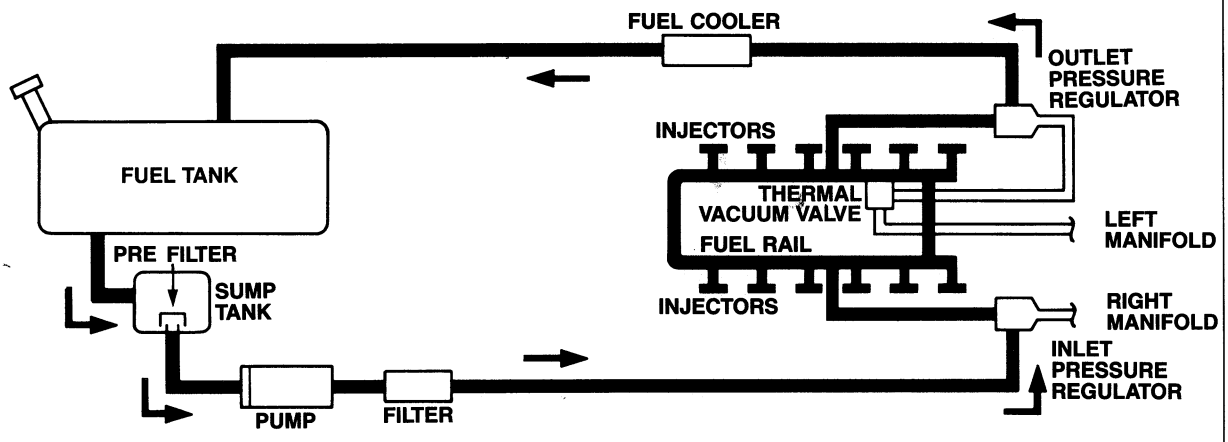
- Fuel pump control
- Warm-up control
- Overrun fuel cutoff
- Emissions control

"P" (PRESSURE SENSING) EFI



* THERMAL VACUUM VALVE

FUEL DELIVERY



FUEL DELIVERY

The XJ-S uses a recirculating fuel system. Fuel is drawn from the small sump tank through a pre filter by the electric pump and delivered to the fuel rail through a renewable filter. The pump incorporates a check valve.

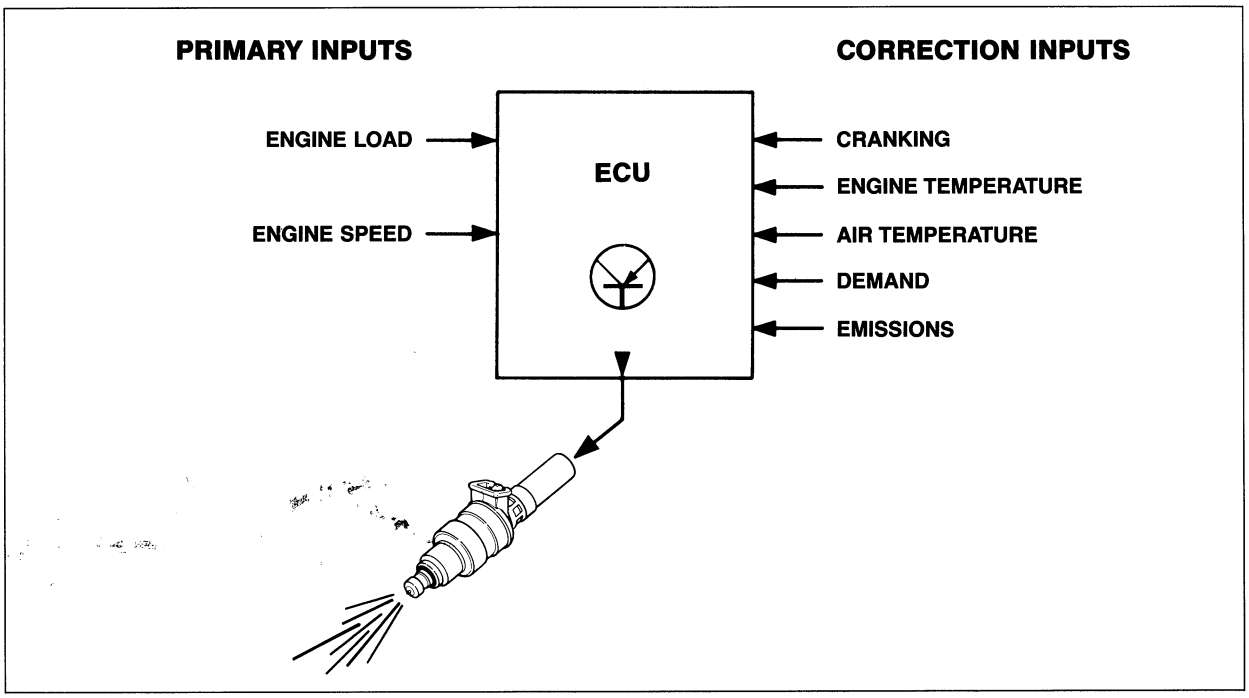
Two pressure regulators are used. The inlet regulator maintains fuel pressure in the delivery line; the outlet regulator controls fuel pressure in the fuel rail. Both regulators sense manifold absolute pressure. Fuel pressure in the rail is controlled so that the pressure drop across the injector nozzles is maintained at approximately 36 psi. The inlet regulator is set at 45 ± 2 psi; the outlet regulator is set at 36 ± 2 psi.

If the fuel temperature in the rail exceeds a specified temperature, the fuel pressure thermal vacuum valve closes the port to the left manifold and applies atmospheric pressure to the outlet regulator, which in turn allows maximum fuel pressure in the rail. The increased fuel pressure prevents vapor formation in the fuel rail at high underhood temperatures and purges the fuel rail for hot starts.

When the air conditioning compressor is operating, unused fuel is cooled by the fuel cooler as it returns to the fuel tank.

FUEL METERING—PRIMARY INPUTS

The fuel injectors are operated by electrical impulses that trigger the injector solenoid valves. The duration (injector "ON TIME") of each pulse (quantity of fuel injected) is determined primarily by engine load and speed that are sensed by the ECU. The timing of each pulse is determined by the ignition pulses that are sensed by the ECU. The ECU triggers the injectors in staggered groups of six every third ignition pulse.



FUEL METERING—CORRECTION INPUTS

Cranking enrichment

The ECU receives a signal via the starter relay each time the engine is started and increases the injector pulse duration while cranking.

Engine temperature correction

During starting and warm-up, the injector pulse duration is increased by the ECU in response to input from the coolant temperature sensor.

Air temperature correction

Intake air density is sensed by temperature measurement and supplied to the ECU, which alters the injector pulse duration to lean or enrich the fueling accordingly.

Demand corrections

During acceleration and full power demands, the injector pulse duration is lengthened by the ECU in response to input received from the throttle potentiometer and the two throttle switches.

Voltage

The EFI system uses voltage stabilized at 5 volts for sensing and injector operation.

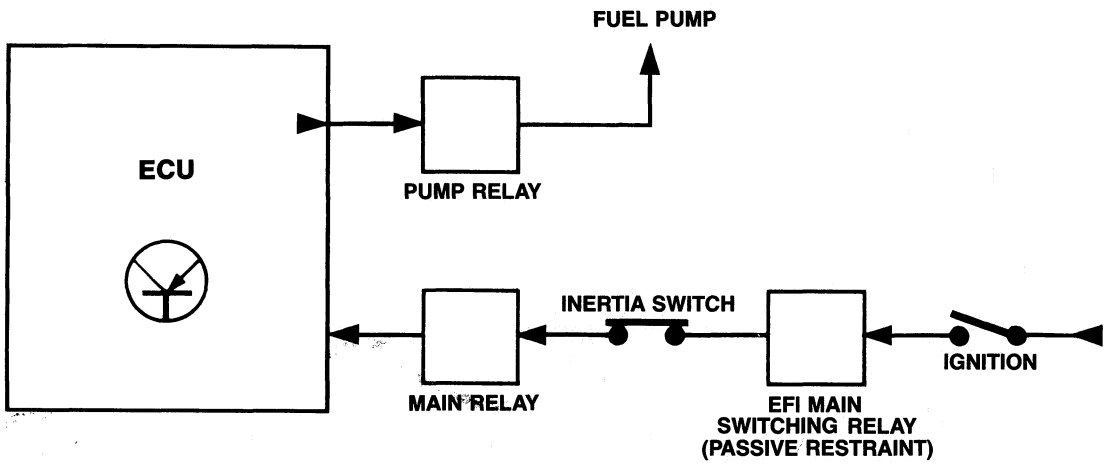
Emissions corrections

"Closed loop" exhaust emission control is provided by inputs from the two heated oxygen sensors to the ECU.

POWER SUPPLY/FUEL PUMP CONTROL

Power supply

Power supply to the system is switched through a series of switches and relays. The ignition switch activates the EFI main switching relay on passive restraint equipped vehicles, which in turn activates the main relay via the inertia switch. When activated, the main relay applies battery voltage to the ECU, which in turn activates the fuel pump relay.



POWER SUPPLY AND FUEL PUMP SWITCHING

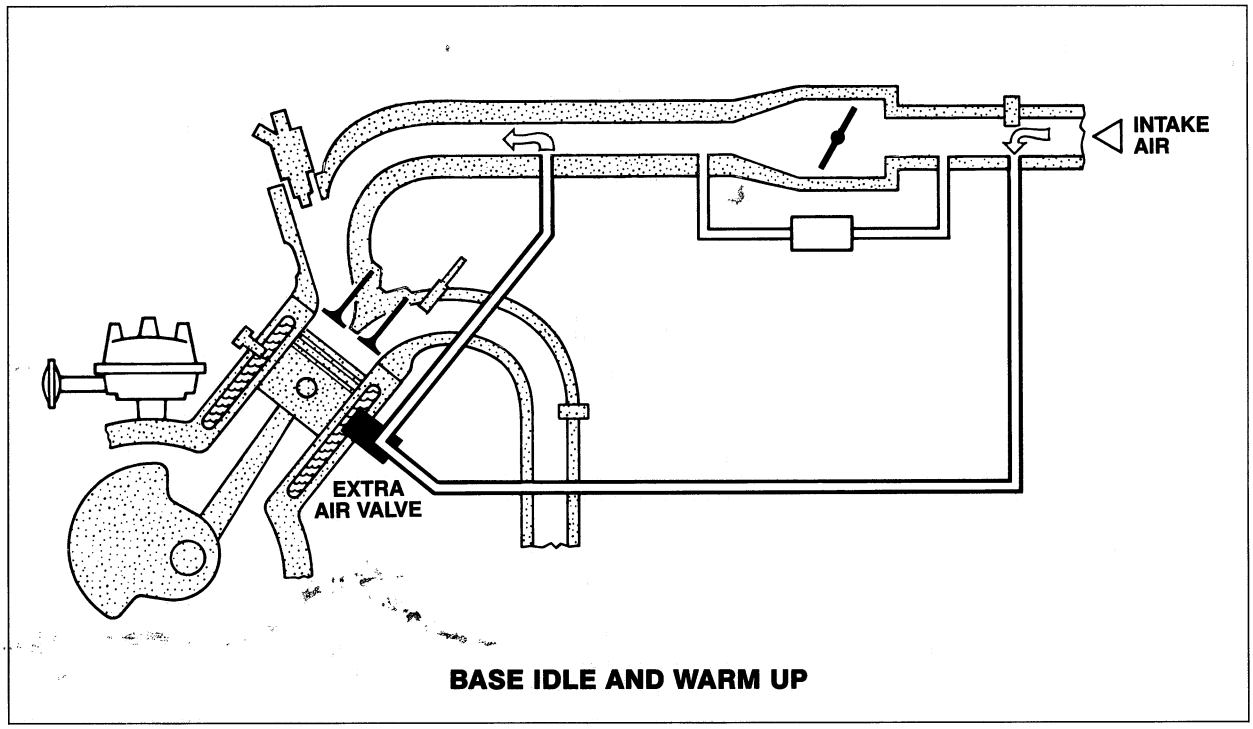
Fuel pump

The fuel pump is energized when the ignition is switched ON. If no immediate cranking occurs, the ECU operates the pump for two seconds only to raise the fuel pressure in the fuel rail and then switches it OFF. This prevents intake "flooding." After cranking has started, the ECU switches ON the pump.

IDLE SPEED CONTROL

Base idle

The base idle speed is set with the adjustment screw on the extra air valve. The adjustment regulates throttle-valve-bypass idle air flow.



BASE IDLE AND WARM UP

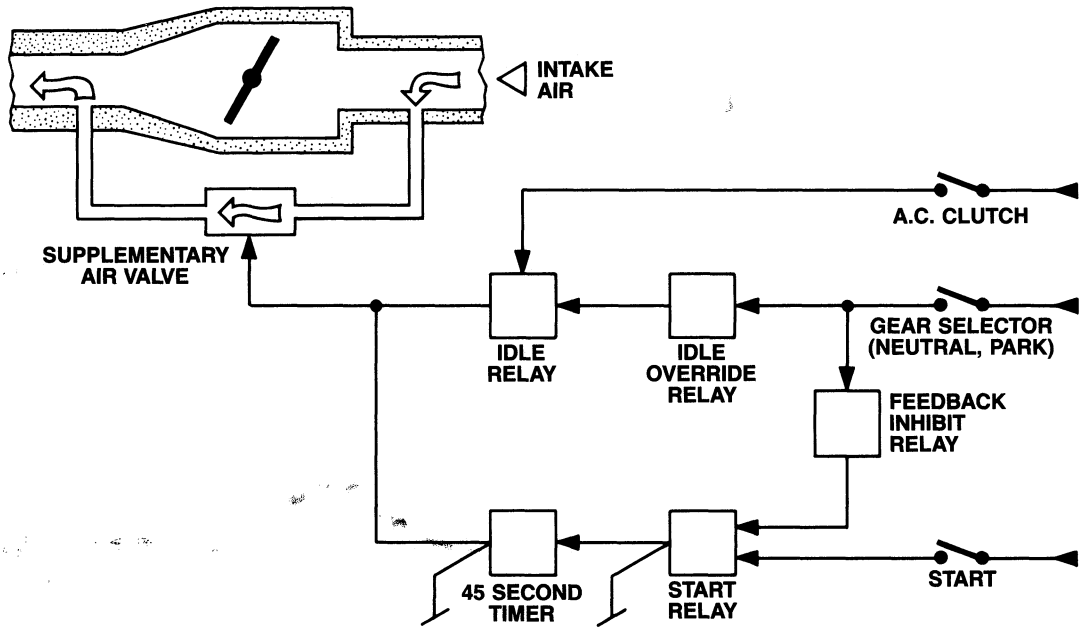
Warm-up

Dependent on engine coolant temperature, the extra air valve allows additional air to bypass the throttle valve to maintain idle speed during warm-up.

IDLE SPEED CONTROL

Initial start up

Each time the engine is started, the starter relay activates the 45-second timer, which opens the supplementary air valve to provide increased bypass air flow for the first 45 seconds of operation.



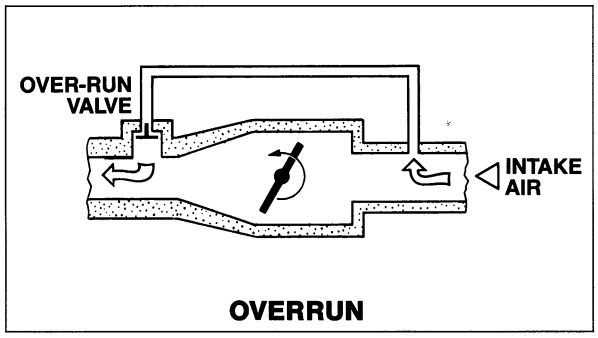
INITIAL START UP AND IDLE STABILIZATION

Idle stabilization

During air conditioning compressor operation, the supplementary air valve is opened via the idle relay to stabilize the idle speed. To prevent excessive idle speed with no engine load, the idle override relay is energized when NEUTRAL or PARK is selected. When energized, the idle override relay switches OFF the idle relay, thereby closing the supplementary air valve.

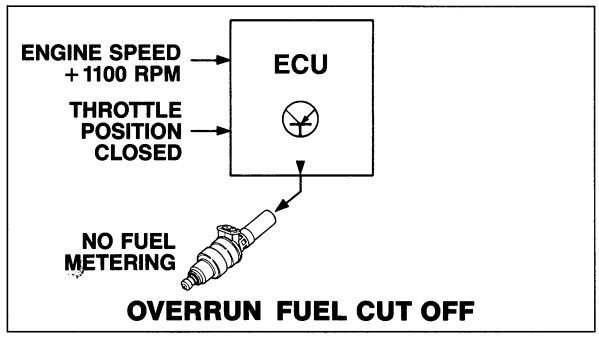
OVERRUN CONTROL

Overrun valves



During deceleration with the throttles closed, the spring loaded overrun valve on each manifold allows air to bypass the throttle valve.

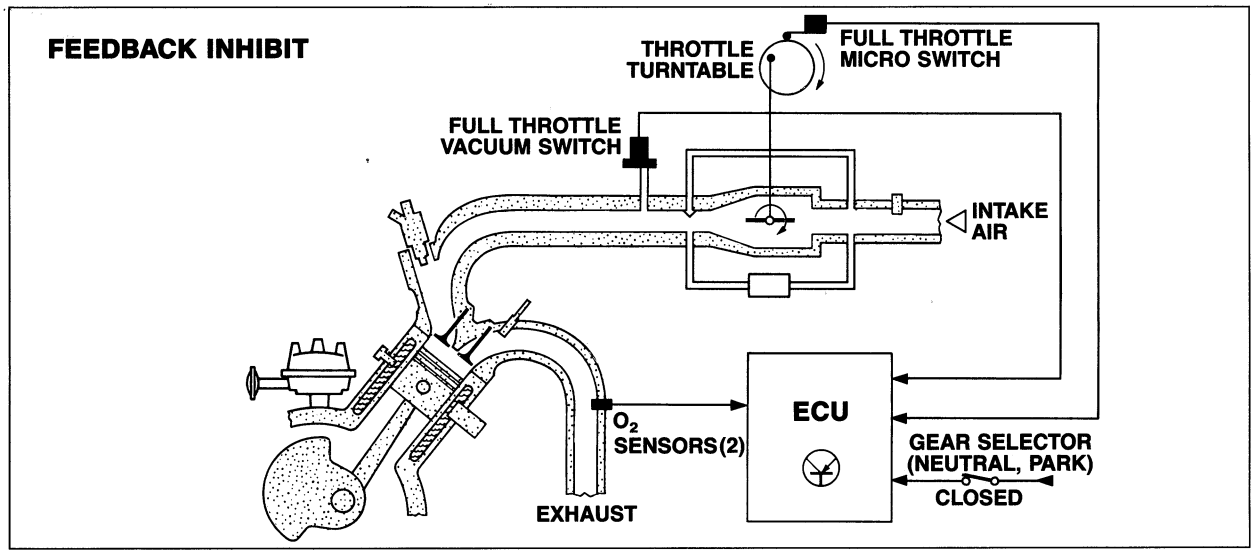
Overrun fuel cutoff



During deceleration with the throttles closed *and* the engine speed above 1100 rpm, the ECU switches off injector fuel flow (early vehicles, 850 rpm).

EMISSIONS CONTROL

During certain phases of engine operation, it is necessary to cancel the "closed loop" feedback from the oxygen sensor.



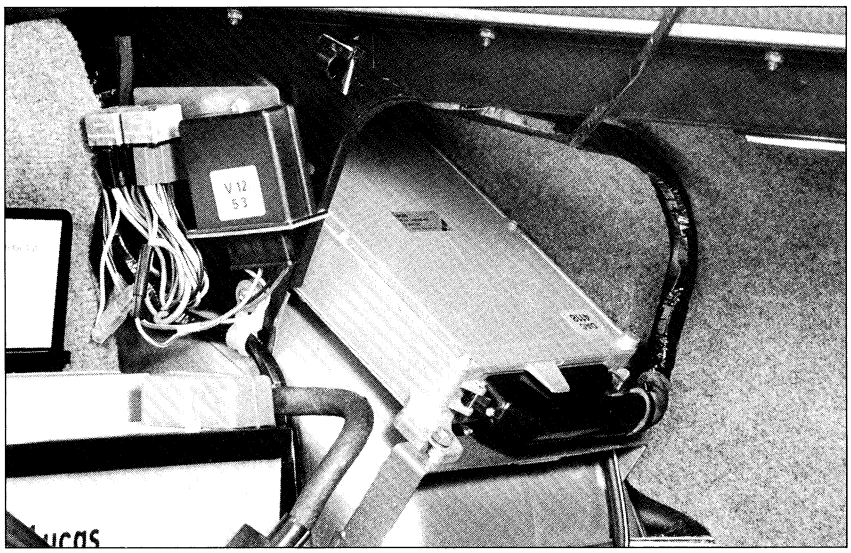
Neutral and Park

When NEUTRAL or PARK is selected, the neutral switch closes and signals the ECU to cancel the oxygen sensor input.

Full load

During acceleration, the engine must produce maximum power. When activated by high manifold pressure (low vacuum) or throttle turntable position, the full throttle vacuum switch and/or the full throttle micro switch signals the ECU to provide additional fuel flow and cancel the oxygen sensor input.

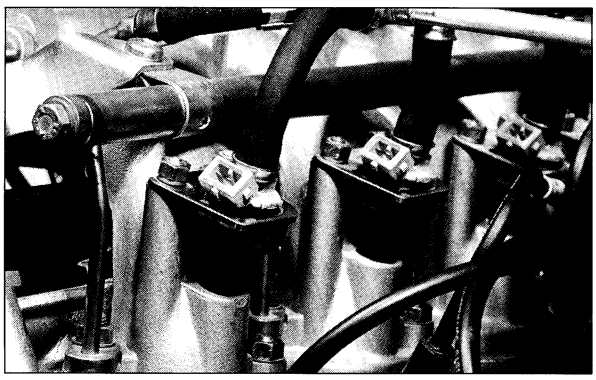
ELECTRONIC CONTROL UNIT



Location Inside right rear fender.

Description The ECU contains an integrated circuit for a dedicated fuel injection control chip and an analog/digital converter for the manifold pressure signal. Integral in the ECU is the manifold absolute pressure sensor. Fueling information is stored in ROM (Read Only Memory) so that for a given combination of manifold pressure and engine speed, the memory assigns a number proportional to the fuel required. The ECU triggers injector pulsing every third ignition pulse. Ignition pulses are sensed from the ignition amplifier.

FUEL INJECTORS



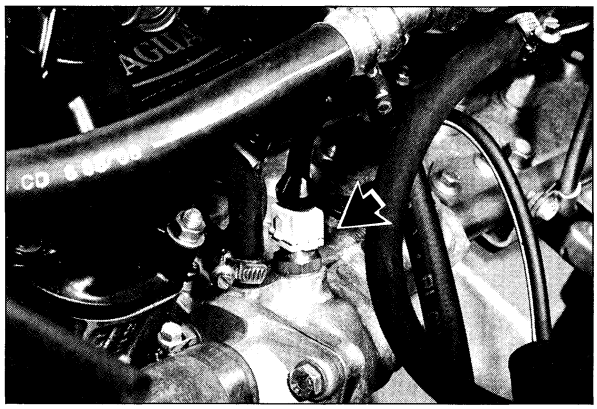
Location Intake manifolds.

Description Each fuel injector contains a solenoid operated needle valve that is held against its seat by spring pressure. When energized by the ECU via the power resistors, the coil moves the needle away from its seat, allowing the pressurized fuel to spray into the manifold. The injectors are pulsed by the ECU in staggered groups of six once every third ignition pulse.

COOLANT TEMPERATURE SENSOR

Location Left thermostat housing.

Description The coolant temperature sensor has a temperature sensitive resistor. As the coolant temperature rises, the electrical resistance decreases providing a coolant temperature parameter to the ECU.

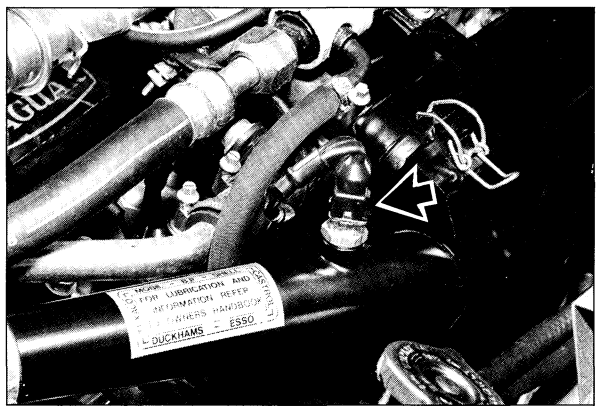


Coolant Temperature (°F)	(°C)	Resistance (kilohms)	Voltage (±10%)
14	−10	9.2	3.27
32	0	5.9	3.11
50	10	3.7	2.91
78	20	2.5	2.66
86	30	1.7	2.38
104	40	1.18	2.07
122	50	0.84	1.76
140	60	0.60	1.48
158	70	0.435	1.22
176	80	0.325	0.99
193	90	0.250	0.80
212	100	0.190	0.65

AIR TEMPERATURE SENSOR

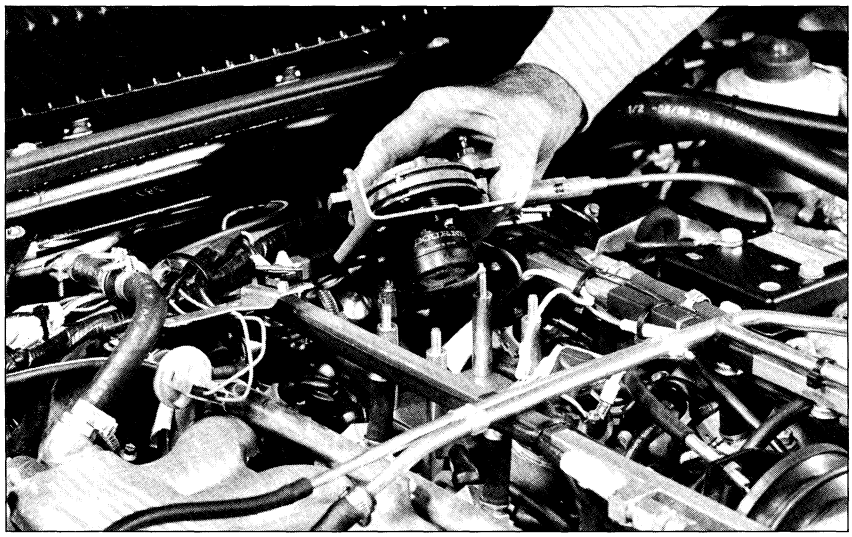
Location Left air cleaner intake.

Description The air temperature sensor has a temperature sensitive resistor that measures intake (ambient) air temperature. As the temperature rises, the electrical resistance decreases. The ECU uses this input as a measure of intake air density (as air temperature rises, its density decreases).



Ambient Air Temperature (°F)	(°C)	Resistance (ohms)
14	−10	960
32	0	640
50	10	435
78	20	300
86	30	210
104	40	150
122	50	108
140	60	80

THROTTLE POTENTIOMETER



Location Under the throttle turntable.

Description The throttle potentiometer is mechanically connected to the throttle turntable and provides a reference voltage to the ECU dependent on throttle position. The ECU uses this input to determine the position of the throttle for correct fueling and the rate of opening for correct enrichment. Sudden throttle opening is sensed by the ECU, which in turn pulses all the injectors once to balance the sudden air intake increase.

FULL LOAD VACUUM SWITCH

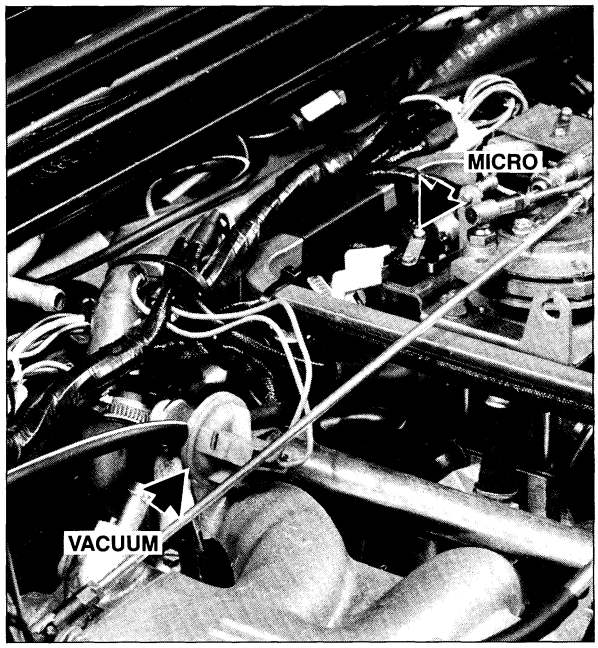
Location Right of throttle turntable.

Description The full load vacuum switch senses intake manifold vacuum and signals the ECU to enrich at low manifold vacuum (high absolute pressure, high engine load).

FULL LOAD MICRO SWITCH

Location On throttle turntable pedestal.

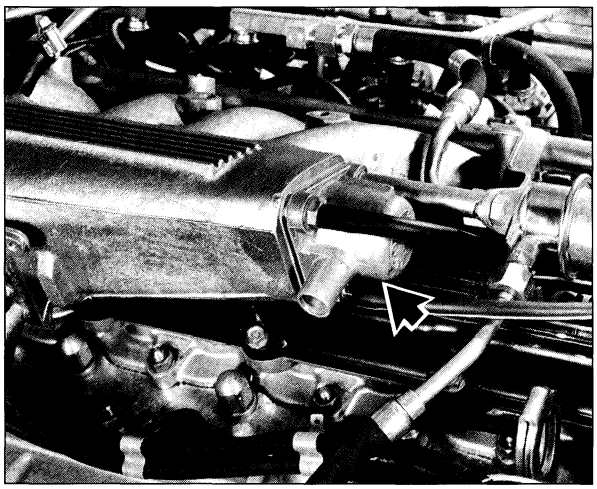
Description The adjustable full load micro switch senses the throttle turntable position. It signals the ECU to enrich at approximately 80% or more throttle opening.

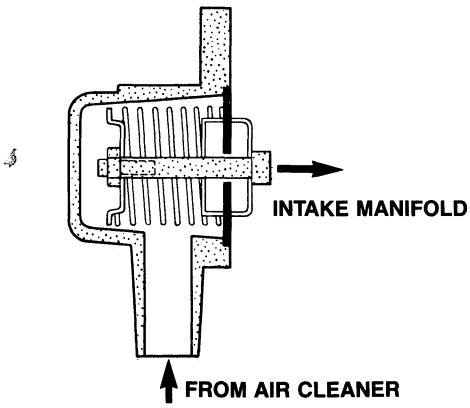


OVERRUN VALVES

Location Front of each intake manifold.

Description The spring loaded overrun valves open at high manifold vacuum (low manifold pressure) created by closed throttle deceleration.



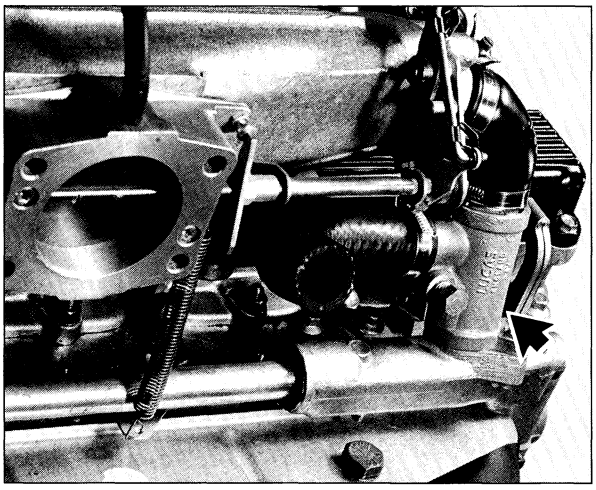


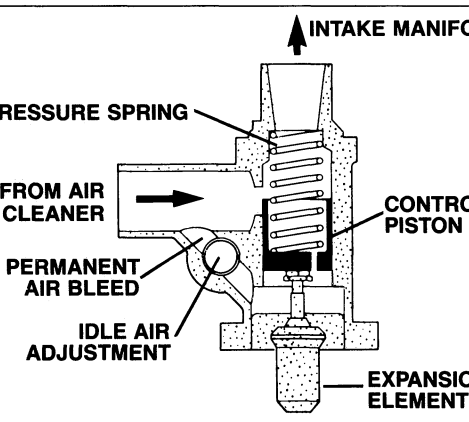
OVERRUN VALVE

EXTRA AIR VALVE

Location Rear of left cylinder head.

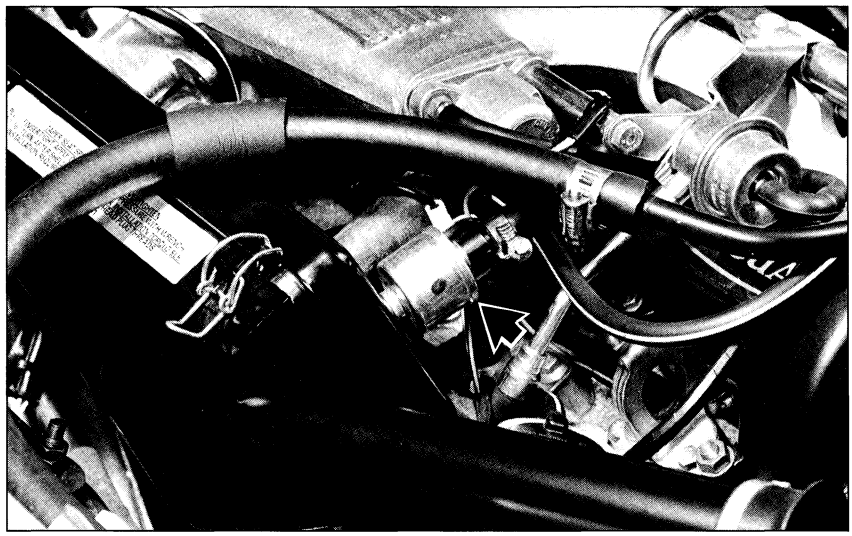
Description The extra air valve has two functions: it provides the engine base idle speed through the adjustable idle air bleed, and it provides warm-up idle speed stabilization through the variable air duct. The air duct area is varied by a temperature sensitive expansion element, in contact with engine coolant, that moves a control piston. As the engine temperature increases, the area of the air duct is gradually reduced until at a coolant temperature of 140° to 158° F (60° to 70° C), it closes completely.





EXTRA AIR VALVE

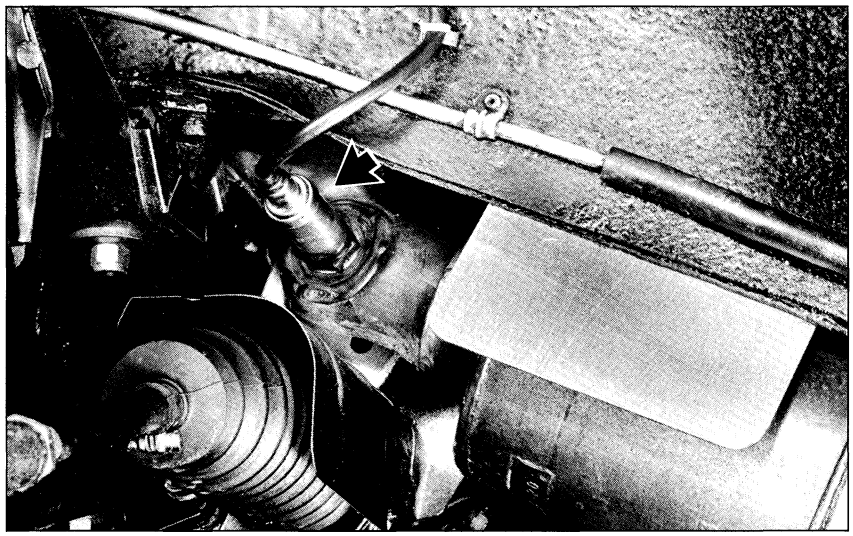
SUPPLEMENTARY AIR VALVE



Location Right air cleaner back plate.

Description The supplementary air valve allows additional throttle bypass air to flow into the right intake manifold during the first 45 seconds of operation after each start up. Additionally, it is activated during air conditioning compressor operation, except when NEUTRAL or PARK is selected.

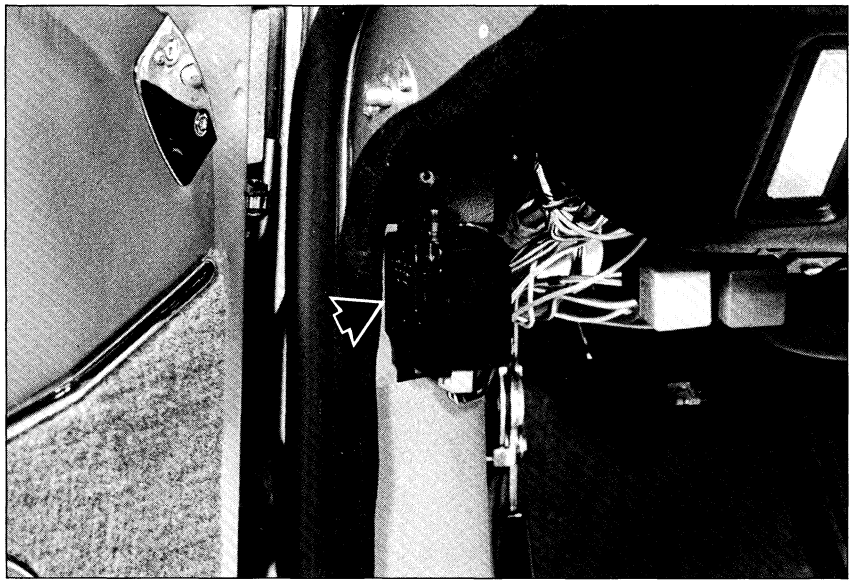
OXYGEN SENSORS



Location Left and right exhaust down pipes.

Description The heated oxygen sensors provide exhaust oxygen content information to the ECU in the form of a voltage signal for continuous fuel metering correction. This "closed loop" system operates in all engine phases except when canceled by the feedback inhibit signal (NEUTRAL or PARK) or the full load signal (throttle switches).

INERTIA SWITCH



Location Left A post.

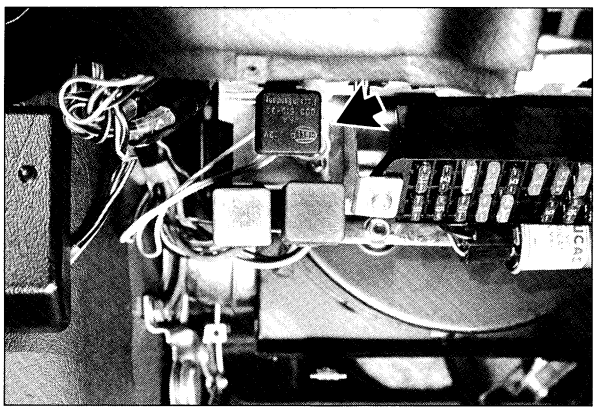
Description The inertia switch turns OFF all power supply to the EFI system in the event of a vehicle impact.

45-SECOND TIMER

Location Right component panel.

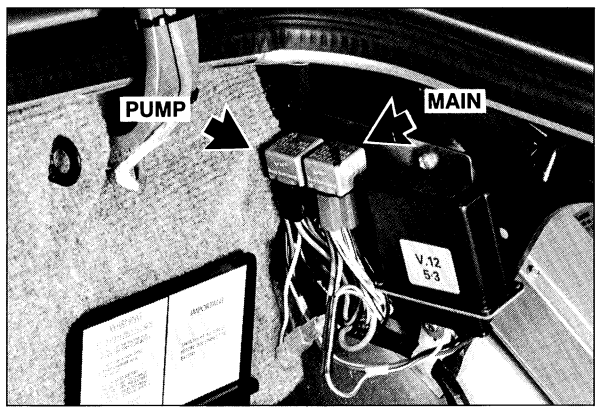
Description The 45-second timer serves both the EFI system and the ignition system. In the EFI system, it switches ON the supplementary air valve for 45 seconds each time the engine is started by a signal from the start switch. Refer to page 21 for additional 45-second timer function.

RELAYS



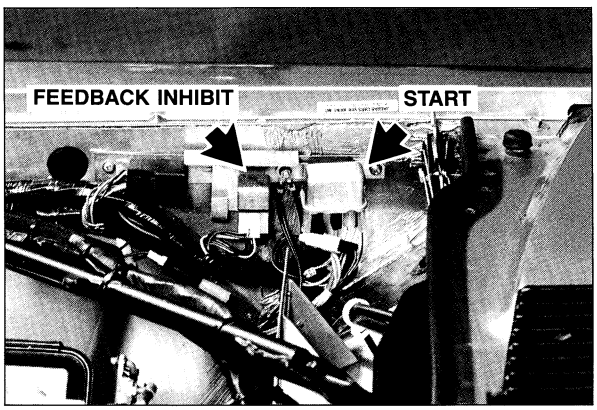
EFI MAIN SWITCHING RELAY

Location Left of main fuse panel.



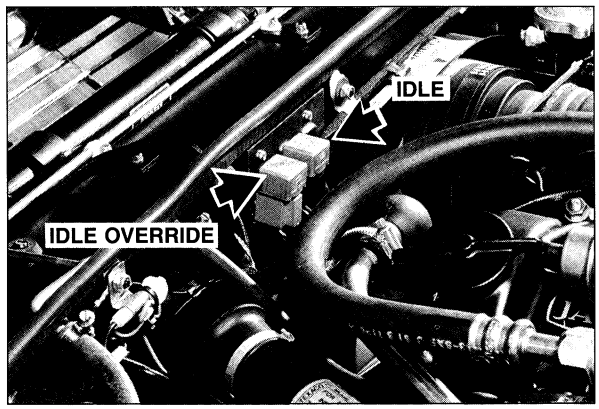
MAIN AND PUMP RELAYS

Location By ECU.



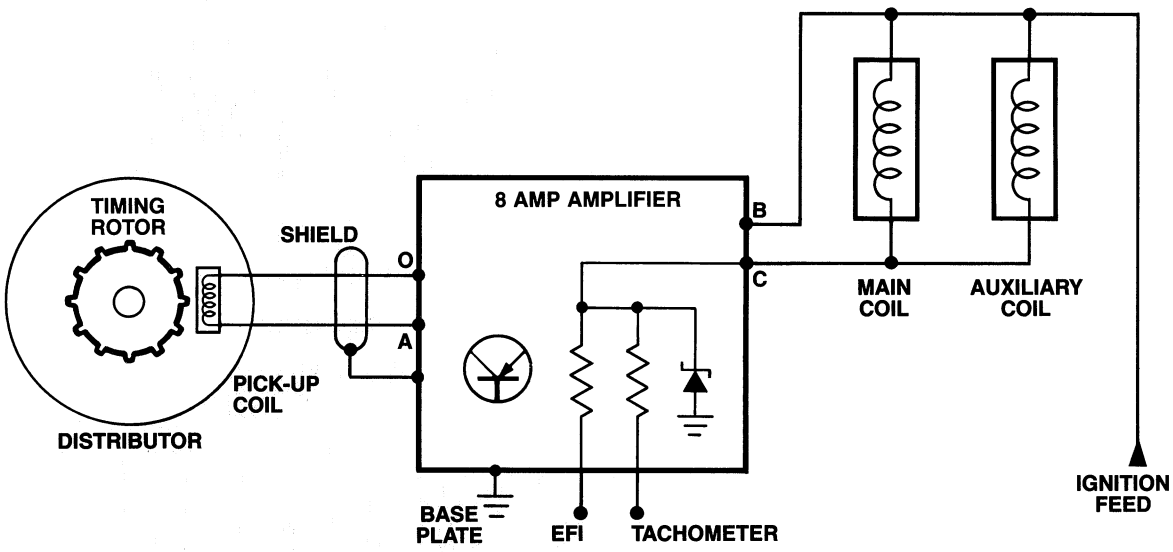
FEEDBACK INHIBIT AND START RELAYS

Location Inside right front fender.



IDLE (BLACK) AND IDLE OVERRIDE (BLUE) RELAYS

Location Radiator support; left side.



IGNITION SYSTEM

A dual coil system is used in the XJ-S. The auxiliary coil is used as a capacitor to increase the output of the main coil and compensate for the very short intervals between cylinder firings. A remote 8-amp amplifier is used to increase the primary amperage (current flow) that must flow through the two coils. The distributor employs a timing rotor with twelve teeth and a pickup module for low tension switching. The external leads to the amplifier are shielded to prevent interference.

Ignition vacuum advance uses a vacuum regulator to limit the amount of advance at idle and then allow further advance above idle operation.

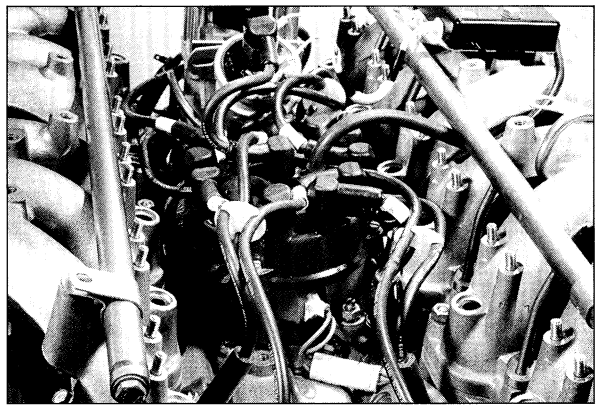
NOTE: Refer to page 21 for complete vacuum advance control details.

Two pulse signals are supplied by the amplifier: one to the EFI system for injector timing and engine speed and one to the tachometer.

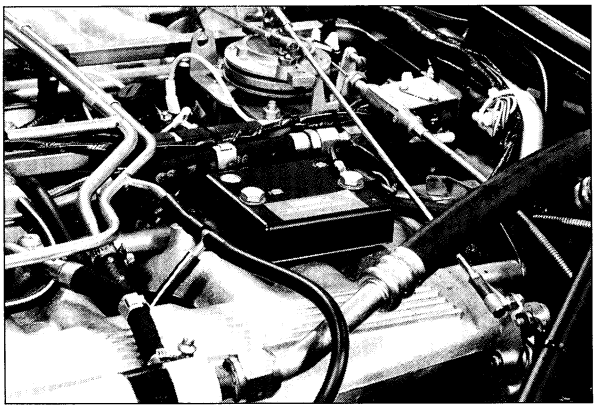
DISTRIBUTOR

Location Engine "vee."

Description The distributor incorporates both vacuum and centrifugal advance mechanisms.



AMPLIFIER



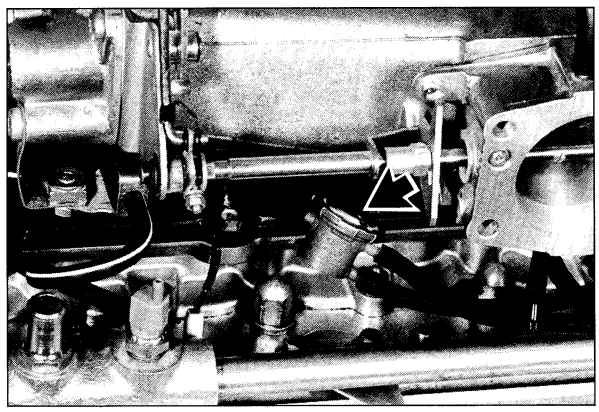
Location Left intake manifold—rear.

Description The 8-amp electronic amplifier provides ignition primary switching via the timing rotor and pickup module in the distributor to generate high energy ignition pulses.

VACUUM REGULATOR

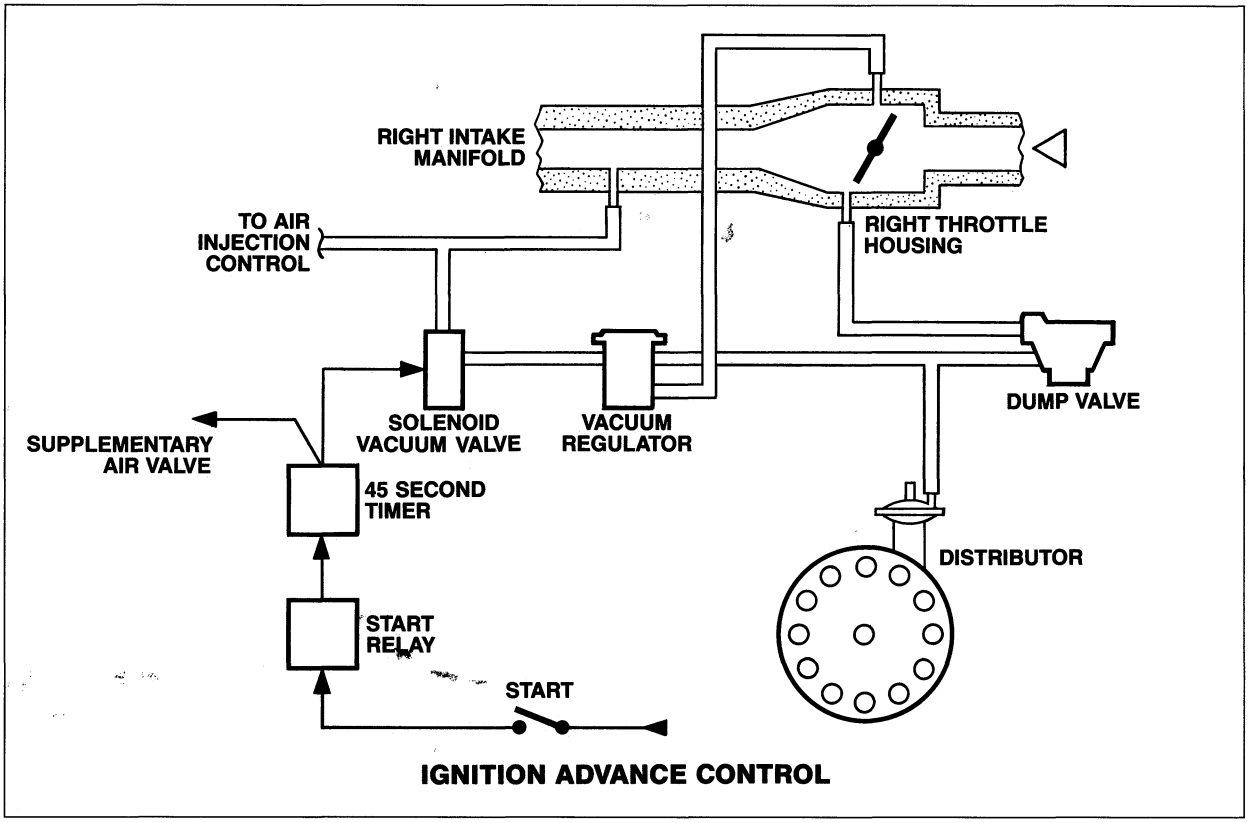
Location Under right intake manifold—rear.

Description The vacuum regulator is ported to both the throttle edge and the intake manifold for sensing of throttle position and engine load respectively.



IGNITION VACUUM ADVANCE

Ignition vacuum advance control is used to control exhaust emissions and to prevent detonation.



IGNITION ADVANCE CONTROL

Normal operation

During normal operation, ignition vacuum advance is controlled through the normally open solenoid valve and the vacuum regulator (refer to pages 19 and 20 for vacuum regulator operation).

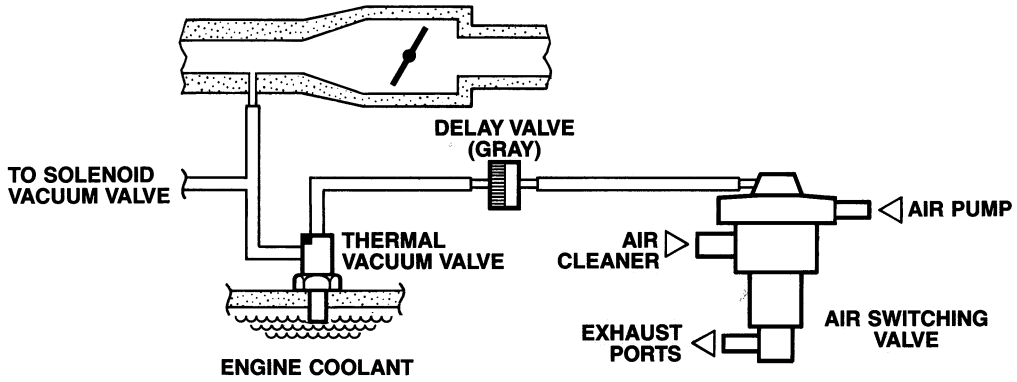
First 45 seconds after start up

When energized via the starter circuit and the 45-second timer, the solenoid valve closes and vents the distributor vacuum capsule to the atmosphere, canceling vacuum advance. The retarded spark provides faster catalytic converter "light off." The cycle is repeated every time the engine is started.

Rapid throttle opening

During normal operation, the dump valve is held closed by the throttle edge vacuum signal. When the throttle is opened suddenly, the signal vacuum is destroyed, causing the dump valve to open. Venting the distributor vacuum capsule to the atmosphere cancels vacuum advance and prevents engine detonation. As the throttle closes, the vacuum signal is reestablished and vacuum control returns to normal.

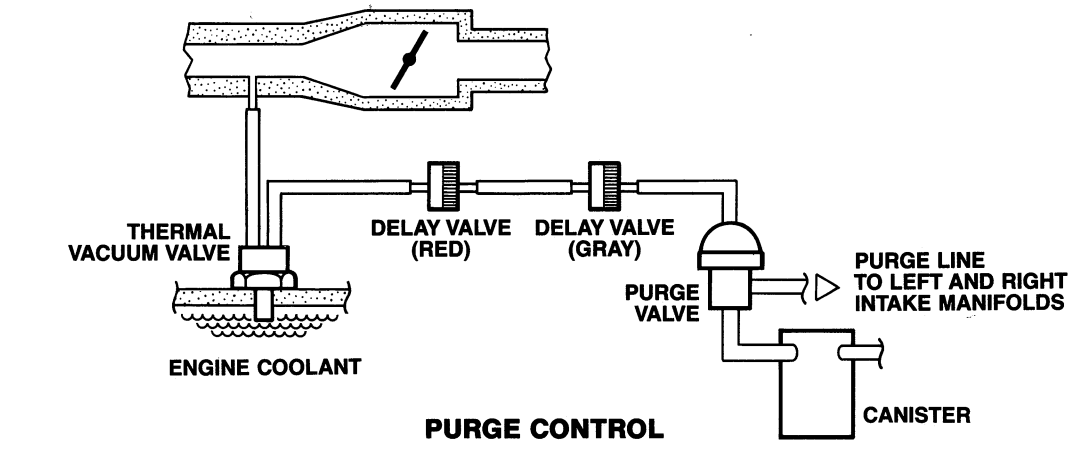
AIR INJECTION CONTROL



AIR INJECTION CONTROL

Exhaust air injection is used to improve emissions control during warm-up only while the oxygen sensor input to the ECU is canceled. The air switching valve is vacuum controlled via a thermal vacuum valve and a delay valve. At coolant temperatures below 95° F (35° C), the thermal vacuum valve applies manifold vacuum to the air switching valve, which in turn routes air injection to the exhaust ports. The delay valve prevents vacuum loss to the air switching valve when the throttle is suddenly opened.

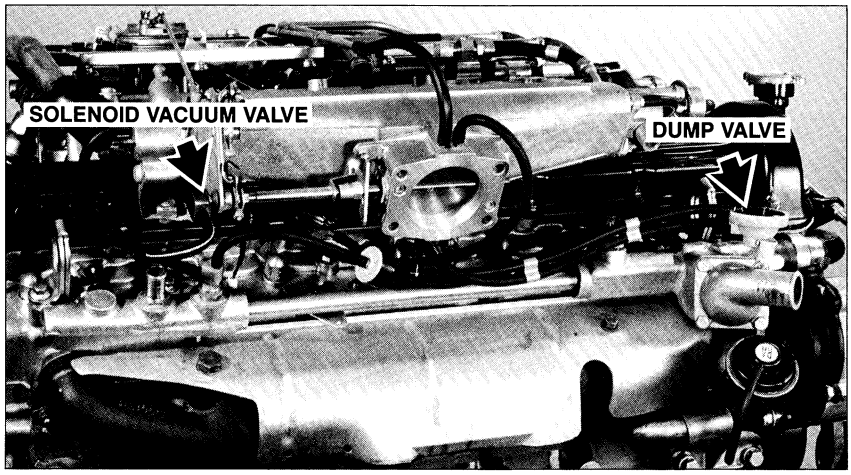
PURGE CONTROL



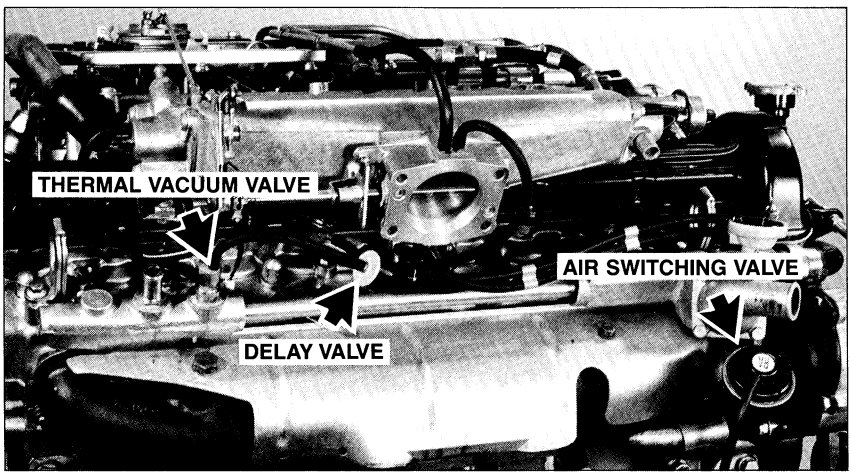
PURGE CONTROL

Canister purging is controlled by a thermal vacuum valve and two delay valves. At engine coolant temperatures below 95° F (35° C) manifold vacuum to the purge valve is switched off by the thermal vacuum valve canceling canister purging. The two delay valves are used to delay canister purging for a few seconds as engine speed increases just off idle, preventing a possible over-rich fuel mixture.

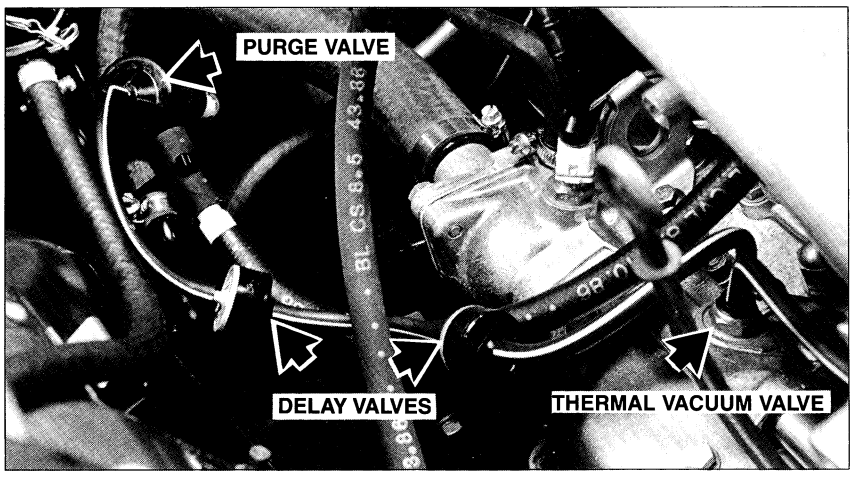
IGNITION

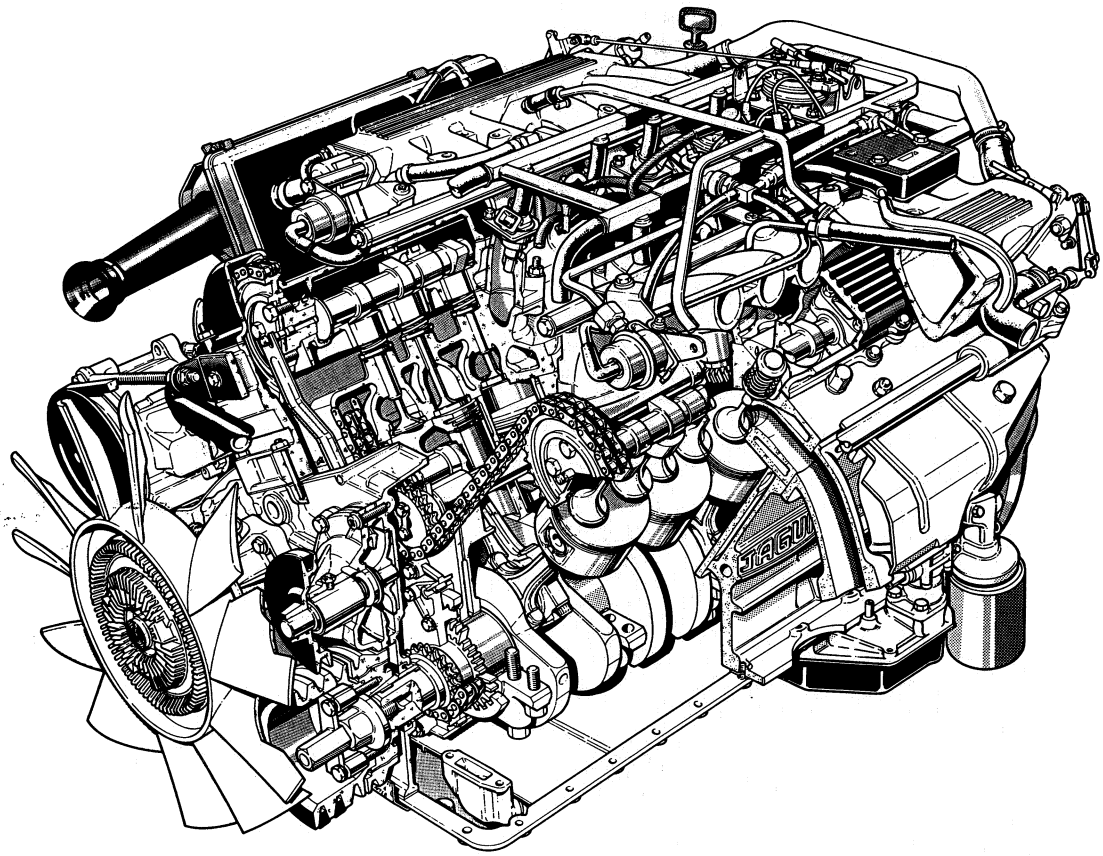


AIR INJECTION



PURGE CONTROL




JAGUAR

To achieve maximum engine performance and smooth operation, fuel and ignition control adjustments must be set to specification. This section will show detailed procedures for each area requiring adjustment or verification to ensure peak performance:

- **Throttle operating adjustments**
- **Vacuum verification**
- **Ignition timing/Idle speed**
- **Fuel flow/Fuel pressure**
- **ECU verification/adjustment**

A summary of engine setup specifications is included in the SPECIFICATIONS section.

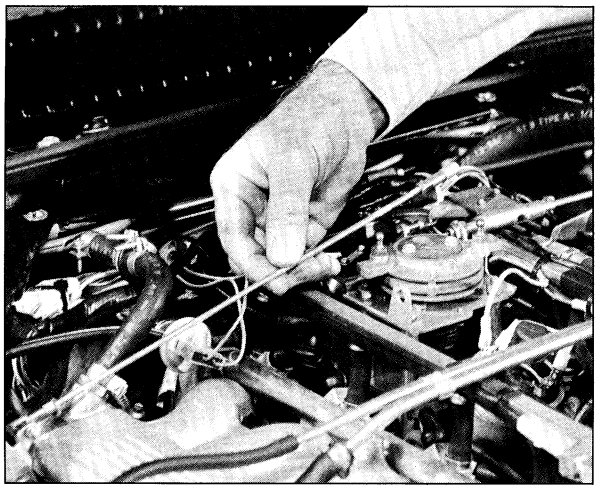


FIG 1

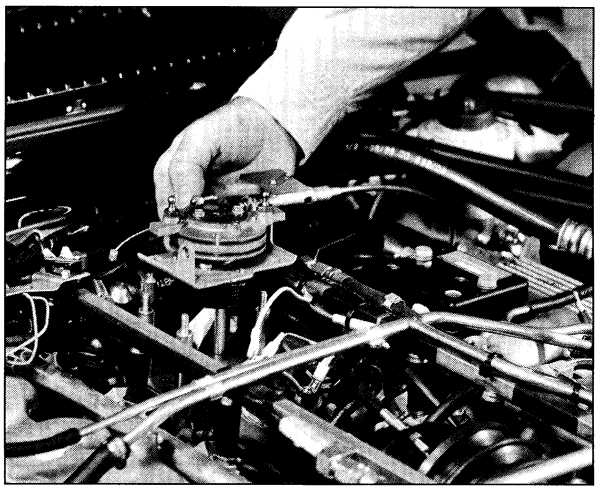


FIG 2

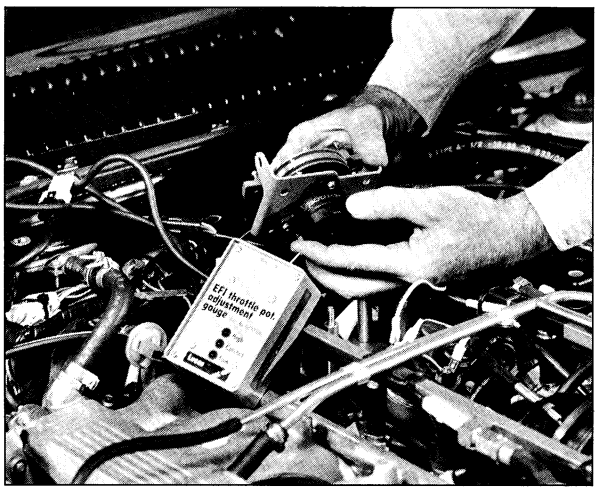


FIG 3

1. Adjust throttle potentiometer

NOTE: The throttle potentiometer adjustment should be made with the engine at normal operating temperature.

Remove both throttle linkage rods (FIG 1).

Disconnect the throttle cable and remove the turntable assembly (FIG 2).

Connect the Throttle Potentiometer Adjustment Gauge YWB 121 to the throttle potentiometer and to a 12-volt power source (FIG 3). Set the gauge switch to T.

Loosen the three screws and slowly rotate the potentiometer (FIG 3) until the "Low" indicator lights. Then slowly rotate in the opposite direction until the "Correct" indicator just lights. Tighten the three screws and recheck the gauge indication. Readjust if necessary.

NOTE: If the potentiometer creeps to its original position when the screws are tightened, place ½ in. O.D. flat washers under the screws and readjust.

Reinstall the turntable assembly and connect the throttle cable only at this time. Back off the throttle cable adjustment.

2. Adjust throttle plate gaps

Remove both air cleaner outer housings and filter elements.

Check the individual throttle operation and condition. Disassemble, clean, and lubricate as necessary. Replace the throttle shaft seals if necessary. Thoroughly clean the throttle housings.

Loosen the lock nut on both sides and adjust the stop screws so that each throttle plate gap is 0.002 in., measured at the top (FIG 4). Be sure the throttle stops are resting on the stop screws during measurement. Tighten the lock nuts and recheck each gap. Readjust if necessary.

NOTE: Ensure that the bellcrank adjustment does not interfere with the throttle gap adjustment.

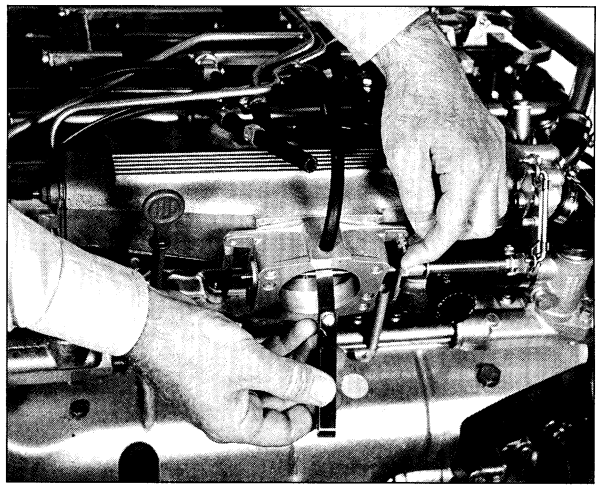


FIG 4

3. Adjust intermediate linkage

Adjust the intermediate linkage (FIG 5) on both sides to meet the following conditions:

Bellcrank on closed stop

No play on opening side of linkage

Throttle stop on stop screw

Adjust by loosening the bellcrank clamp bolt (FIG 6) and repositioning the bellcrank as necessary.

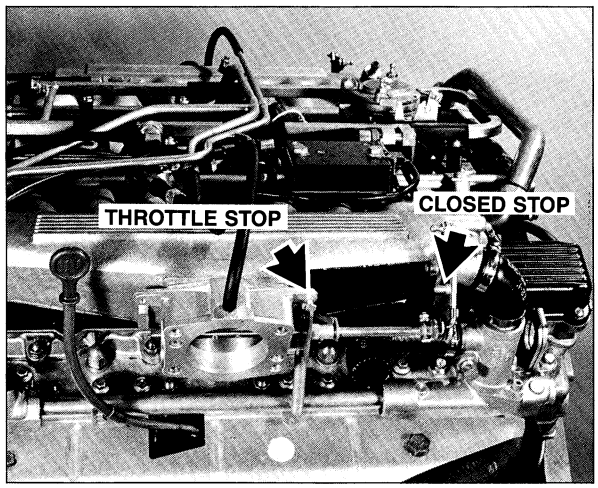


FIG 5

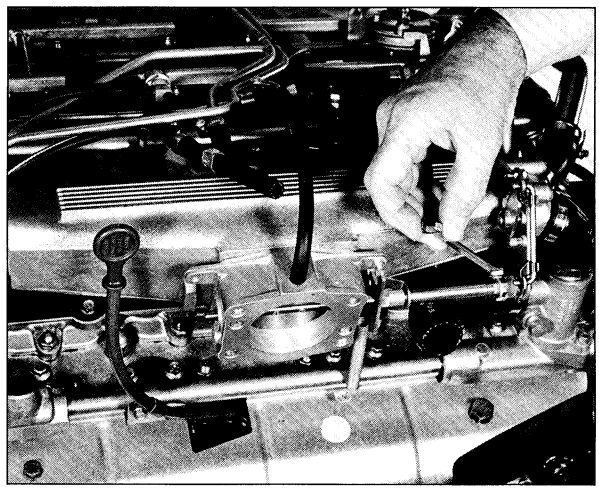


FIG 6

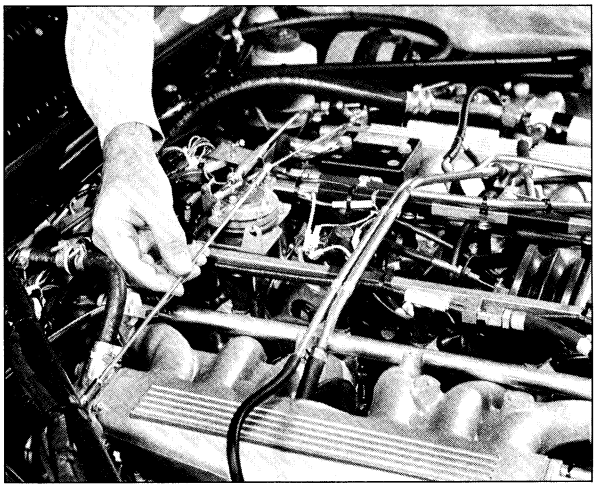


FIG 7

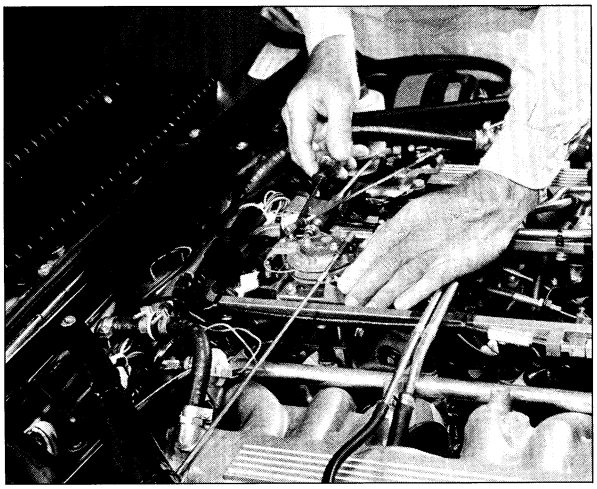


FIG 8

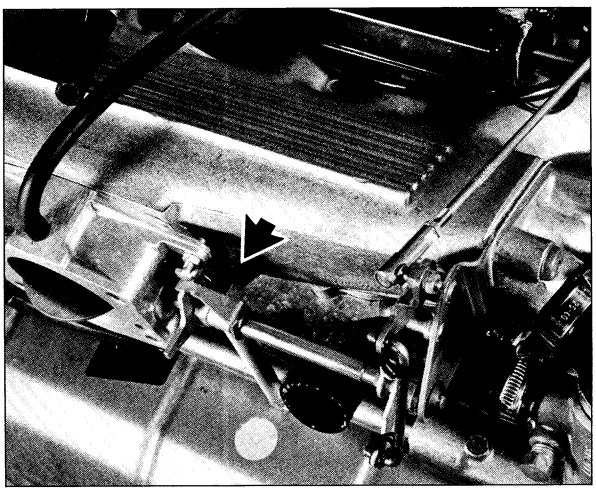


FIG 9

4. Adjust throttle rods

Ensure that the turntable is resting on the closed stop. Adjust the throttle cable if necessary.

Loosen the lock nuts and reinstall the throttle rods.

Adjust each rod to fit with no tension in the idle position (FIG 7).

5. Adjust turntable full throttle stop

Hold the turntable to the full throttle position and adjust the turntable stop screw (FIG 8) so that the individual full throttle stops at each throttle (FIG 9) and the turntable stop are synchronized.

6. Recheck closed and full throttle positions

With the turntable on the closed stop, both throttle stops should rest on the stop screws *and* both intermediate bellcranks should rest on their closed stops.

With the turntable on the full throttle stop, both throttle stops should be resting on their full stops.

Reinstall the filter elements and air cleaners.

7. Adjust the throttle cable

Adjust the throttle cable so that it has slight tension with *no* turntable movement while resting on the closed stop (FIG 10).

8. Adjust the full load micro switch

With the turntable on the full open stop, adjust the micro switch so that the contacts just close (FIG 11).

9. Adjust the transmission kickdown switch

Connect a voltmeter to the green/white connector. Hold the accelerator pedal to full open and adjust the switch so that battery voltage is present at full throttle only (FIG 12).

NOTE: The accelerator pedal travel stop adjustment can affect the kickdown switch adjustment. Ensure that full accelerator travel is available.

10. Recheck the throttle rod adjustment

Because of thermal expansion when the engine warms, the throttle rods may require readjustment. Bring the engine to normal operating temperature and observe the idle speed. Adjust the throttle rods if the idle speed has increased.

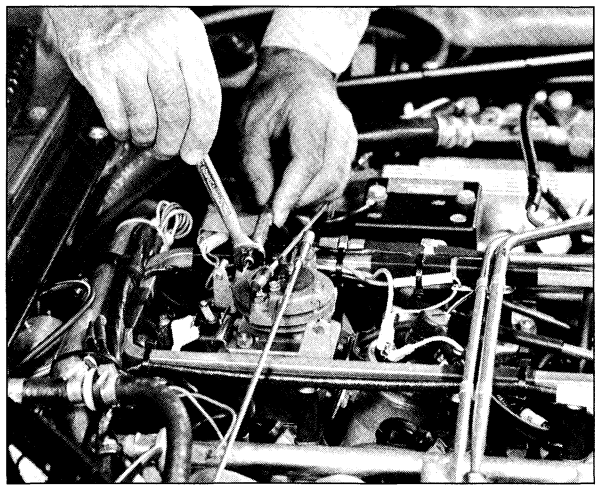


FIG 10

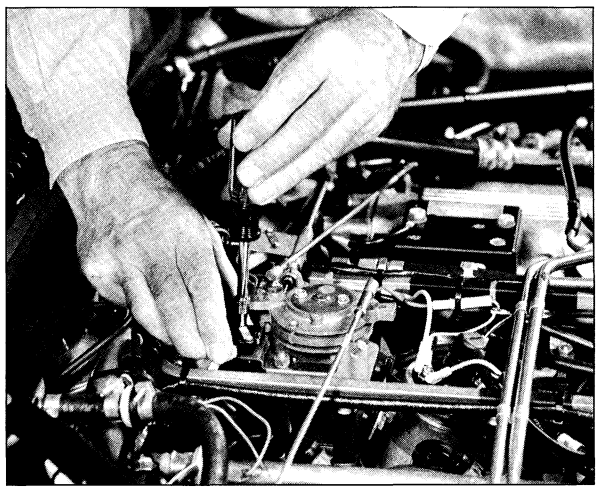


FIG 11

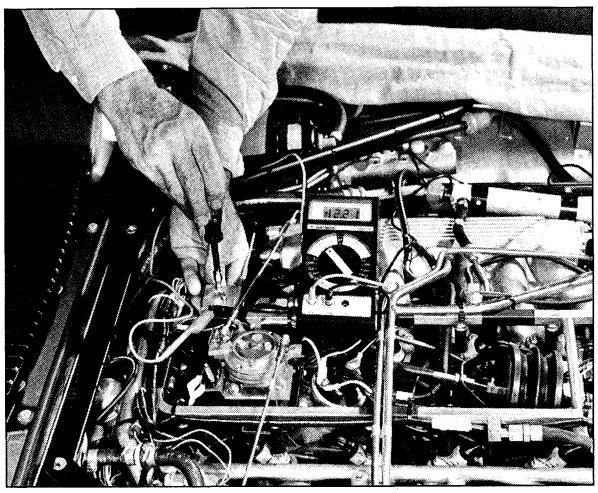


FIG 12

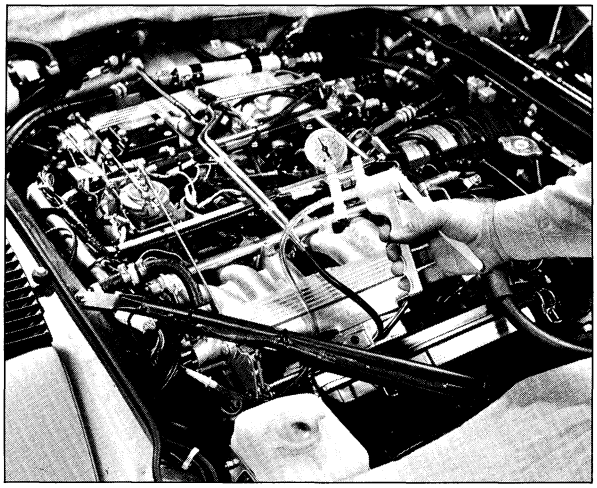


FIG 1

1. Check the integrity of engine vacuum actuated systems

Apply vacuum (FIG 1) to the following supply lines:

- Climate control
- Transmission modulator
- Distributor
- Air injection
- Canister purge
- Brake servo
- Throttle switch
- Fuel pressure thermal valve
- Fuel pressure regulators
- ECU manifold pressure

Each system should hold vacuum. Correct any leaking condition *before proceeding* further. Ensure that all vacuum lines are securely reconnected after checking.

NOTE: Be sure to consider each system and its operation before checking for vacuum leaks.

2. Check distributor vacuum regulator

Tee in two vacuum gauges to the distributor vacuum system (FIG 2)—one to the manifold side and one to the distributor side.

Run the engine with the climate control off and observe the vacuum gauges at the following rpm:

Engine rpm (A/C Off)	Manifold Vacuum (in. Hg)	Distributor Advance (in. Hg)
800	14.5	0.0
800	17.5	10.0
1200	17.5	10.0
1400	18.8	9.5
1600	19.0	9.8
1800	19.2	9.2
2000	19.4	9.2
2200	19.8	11.0
2400	20.0	13.4
2600	20.0	15.0
2800	20.5	17.0
3000	21.0	18.0
3200	21.0	20.0
3400	21.0	20.0

If the specifications are not met, replace the vacuum regulator and recheck the sequence.

NOTE: During cranking for the first two seconds, the distributor vacuum will be 10 in. Hg.

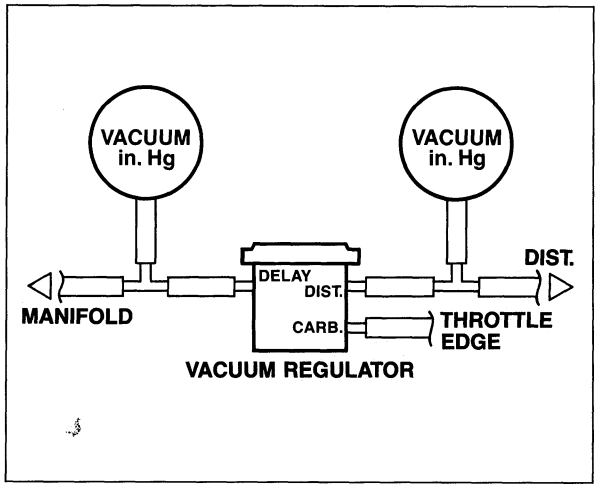


FIG 2

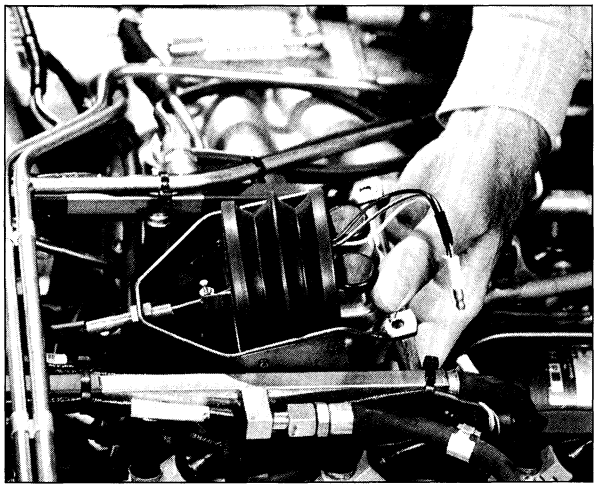


FIG 1

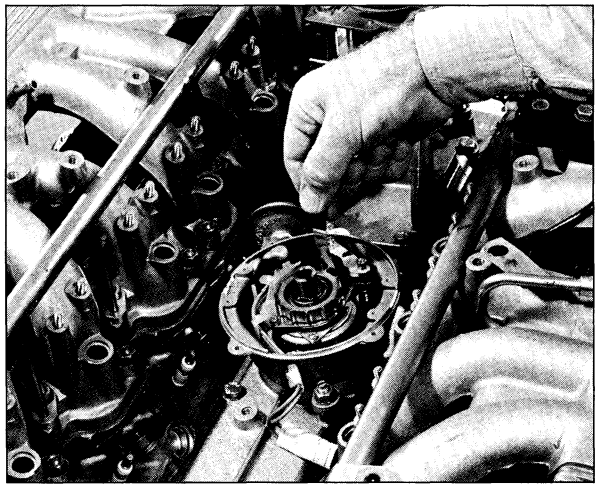


FIG 2

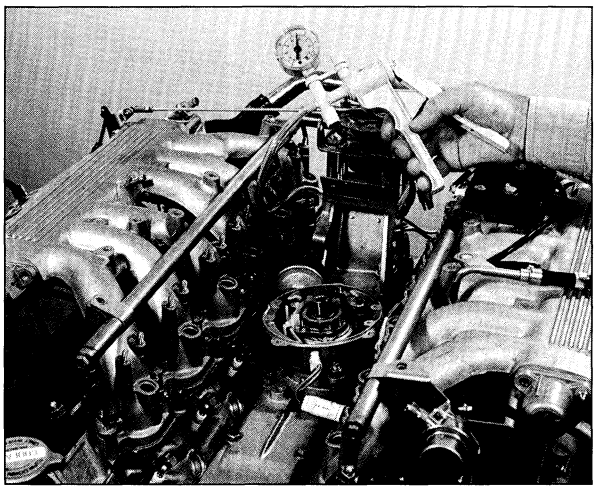


FIG 3

1. Adjust the pickup module air gap

Remove the three bolts; disconnect the cable and remove the cruise control actuator (FIG 1).

After disconnecting the two vent hoses, remove the distributor cap and spark plug leads as a unit.

Remove the rotor and the flash shield. Check the air gap with a nonmagnetic feeler gauge. Adjust to 0.007–0.015 in. (FIG 2).

2. Check vacuum capsule operation

Use a vacuum pump to check the vacuum capsule operation (FIG 3).

Reinstall the flash shield, rotor, cap, and plug leads. Do not connect the leads to the spark plugs.

⚠**CAUTION: ENSURE THAT THE DISTRIBUTOR CAP GASKET IS NOT DISPLACED DURING ASSEMBLY.**

3. Adjust spark plug gaps

Remove the spark plugs and replace if necessary. Set the gaps to 0.025 in. Torque the plugs to 9 lbs. ft. and reconnect the plug leads.

Reinstall the cruise control actuator.

4. Adjust ignition timing

Bring the engine to normal operating temperature and disconnect the lower vacuum hose at the dump valve (FIG 4).

Move the distributor as necessary to obtain the timing specification (FIG 5):

18° BTDC @ 3000 rpm

Reconnect the vacuum hose.

5. Check ignition system condition

Run a complete ignition analysis with ignition scope equipment. Rectify any fault area before proceeding further.

6. Adjust idle speed

With the engine at normal operating temperature, climate control OFF, and PARK selected, adjust the extra air valve idle screw to obtain 750 to 850 rpm (FIG 6).

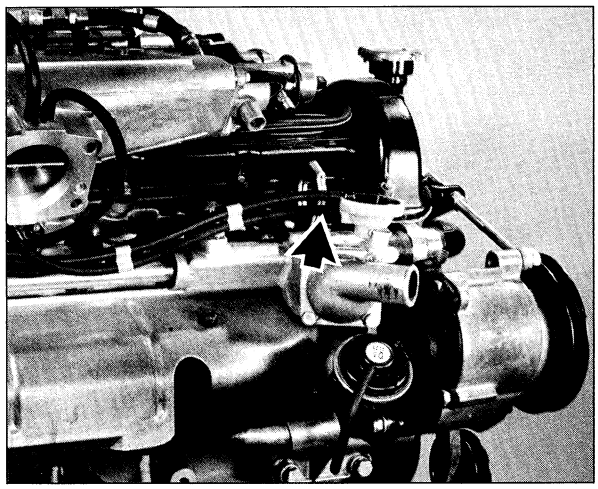


FIG 4

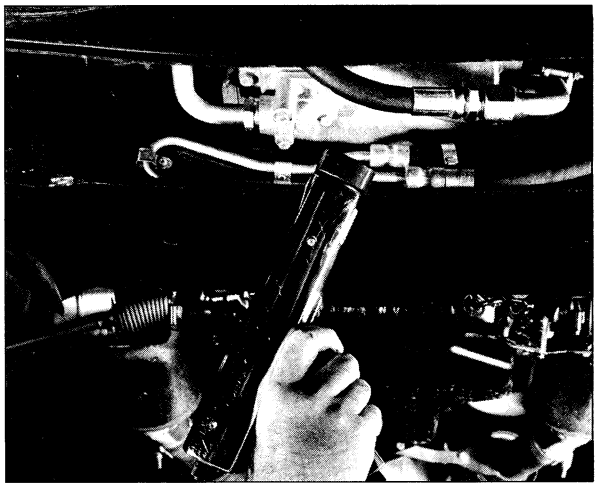


FIG 5

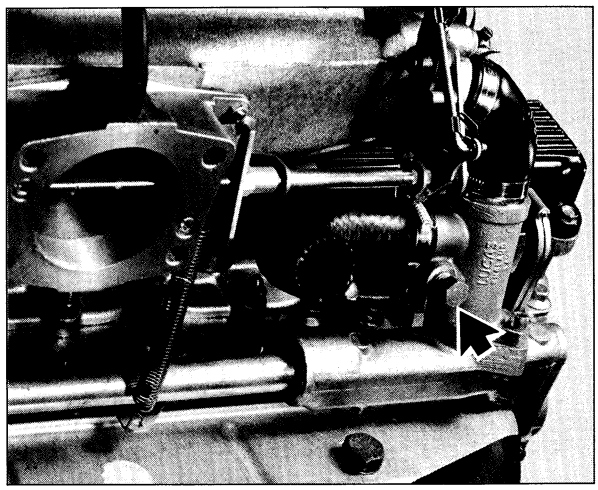


FIG 6

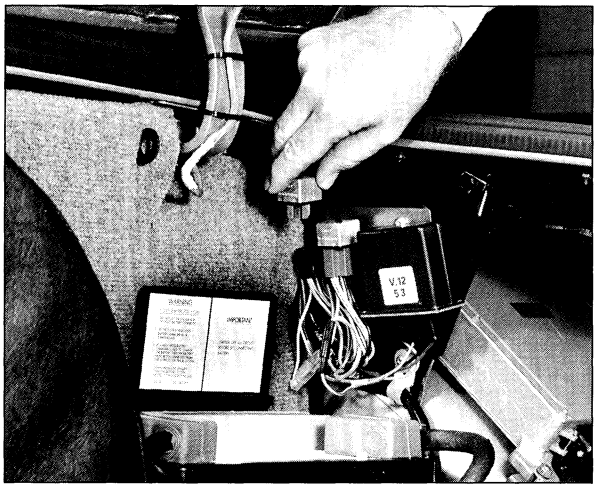


FIG 1

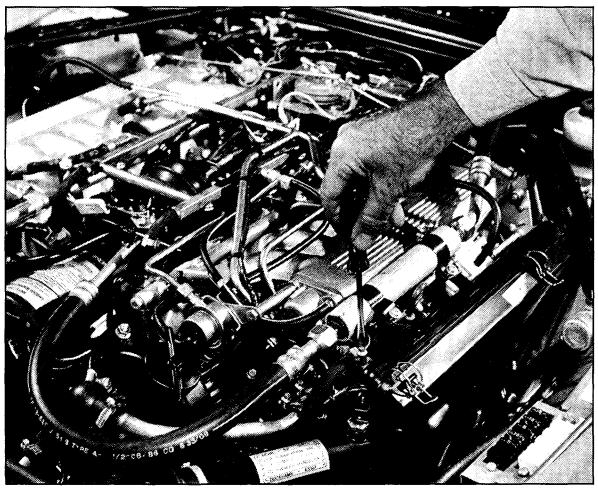


FIG 2

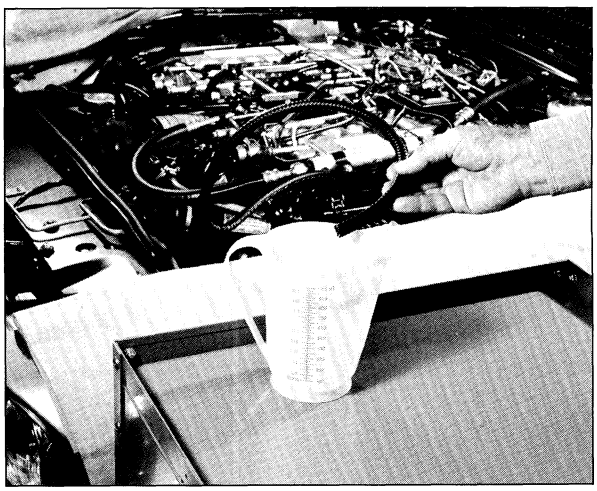


FIG 3

⚠WARNING: DURING FUEL FLOW AND PRESSURE CHECKING PROCEDURES, TAKE ALL NECESSARY PRECAUTIONS TO PREVENT THE POSSIBILITY OF EXPLOSION AND FIRE.

1. Check fuel pump flow

Depressurize the fuel system by removing the fuel pump relay (FIG 1) and running the engine until it stops.

Disconnect the fuel return line at the fuel cooler inlet (FIG 2).

Operate the pump by applying a ground to terminal 85 (orange wire) on the pump relay. Using a graduated beaker, measure the fuel flow for 20 seconds (FIG 3). The minimum flow is 720 ml (milliliters).

If the flow is less than specified, all the fuel delivery components must be checked.

NOTE: Be sure to consider the pre filter in the sump tank.

Securely reconnect the return line when the test is completed.

2. Check fuel pressure

Be certain the fuel system is depressurized (procedure 1).

Using adaptors, tee-in fuel pressure gauge YWB 107 after the inlet pressure regulator on the fuel rail side (FIG 4).

Run the engine at idle and check the fuel pressure in the rail. It should be 28.5–30 psi.

NOTE: If the fuel temperature is high, the fuel pressure thermal vacuum valve (FIG 5) will be activated, causing the pressure to rise to maximum.

If the fuel pressure is less than specification, check the outlet regulator (FIG 5); if more than specified, check the fuel return system.

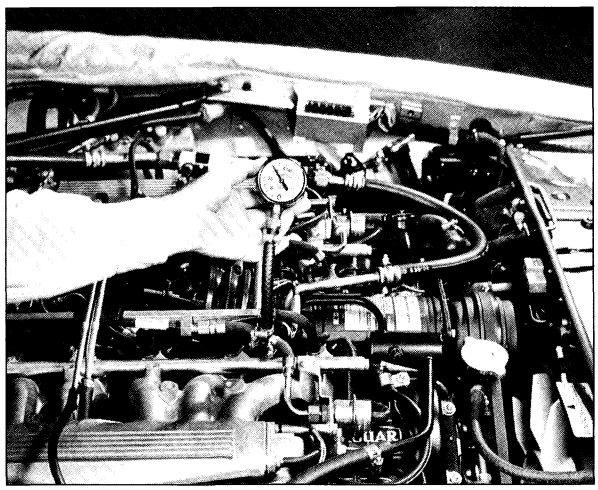


FIG 4

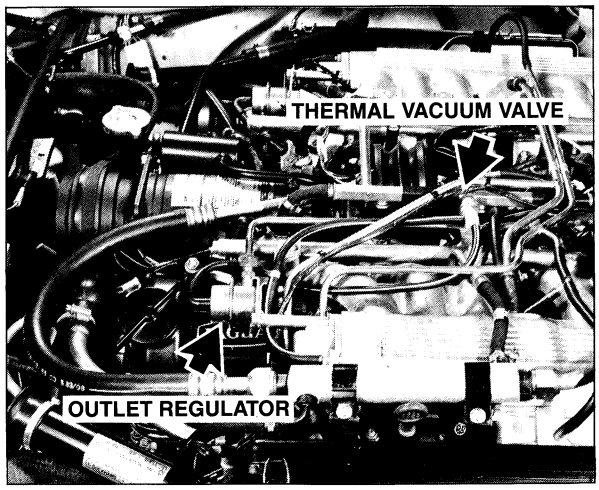


FIG 5

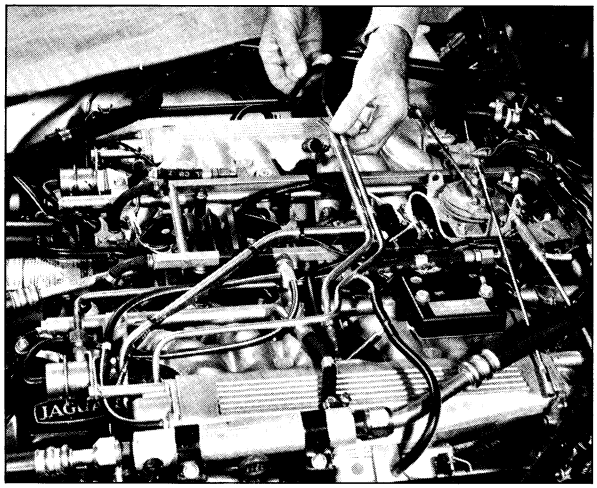


FIG 6

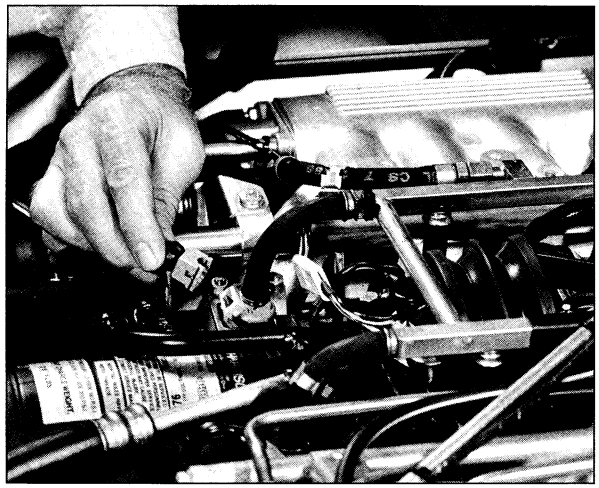


FIG 7

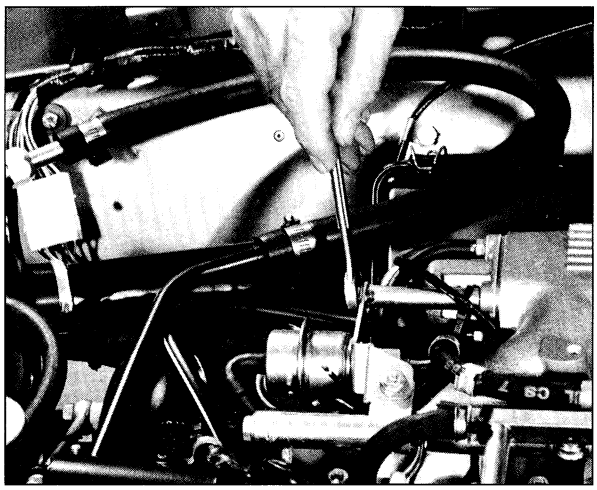


FIG 8

3. Check injector fuel flow

Be certain the fuel system is depressurized (procedure 1).

Remove both air cleaner covers and filters.

Disconnect the canister purge and crankcase breather hoses from the manifolds (FIG 6).

Disconnect the throttle cable and the throttle rods from the turntable.

Disconnect the throttle cable assembly and remove from the turntable pedestal.

Electrically disconnect all injectors by removing the plug connectors (FIG 7). Cut the tie wraps to free the harnesses from the fuel rail.

Remove the hardware mounting both pressure regulators to the manifolds (FIG 8).

Carefully lift the fuel rail with all the injectors from the manifolds.

Connect the EPITEST unit to the ECU harness plug and switch ON the ignition. Set the EPITEST switches as follows:

A to 12

B to 5

C to 1

Pol. to +ve.

3. Check injector fuel flow *(cont'd)*

Place a 250-ml graduated beaker beside the car ensuring that the top is below the injectors. Cut a 5/16 in. plastic hose to run from the injectors to the beaker (FIG 9).

Check the flow of each injector *one at a time* starting at injector 1A (injector numbering, FIG 10).

After electrically connecting *only* the injector to be tested, hold ON the EPITEST PUMP switch while holding ON the correct EPITEST INJECTOR switch for exactly ONE MINUTE.

Groups of three injectors are operated by the four INJECTOR switches (FIG 11).

⚠CAUTION: ELECTRICALLY CONNECT ONLY THE INJECTOR BEING TESTED.

Measure the amount of fuel flow in one minute from each injector. If necessary, repeat the test to confirm the results. The minimum flow is 170 ml per minute.

Before reassembling the injectors and the fuel rail, check the condition of the injector seals and replace them if necessary. Ensure that the seals are positioned correctly during reassembly.

Check the adjustment of the throttle rods, throttle cable, full throttle micro switch, and the kickdown switch (see Throttle Operating Adjustments, pages 26–29).

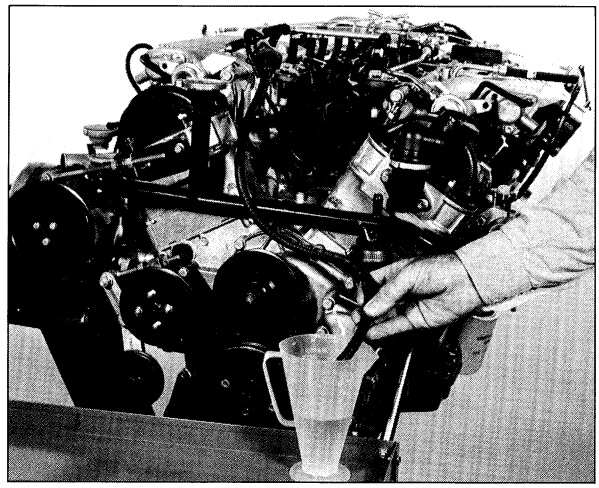


FIG 9

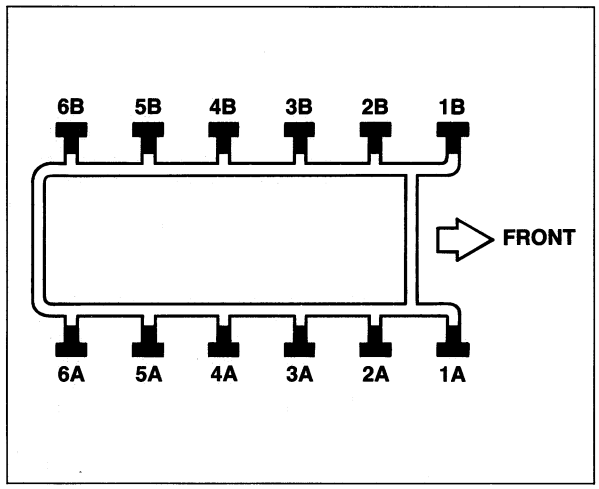


FIG 10

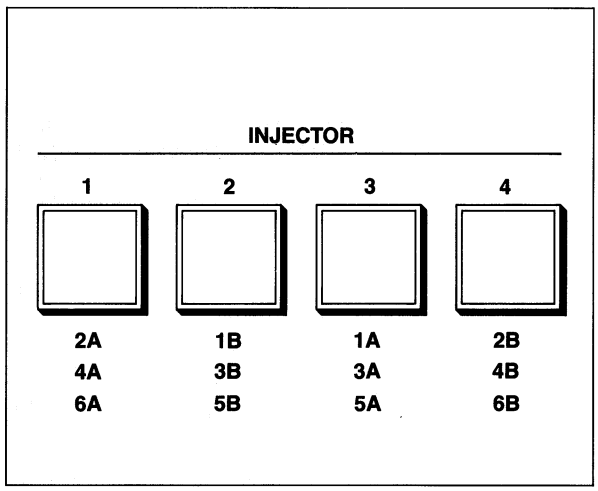


FIG 11

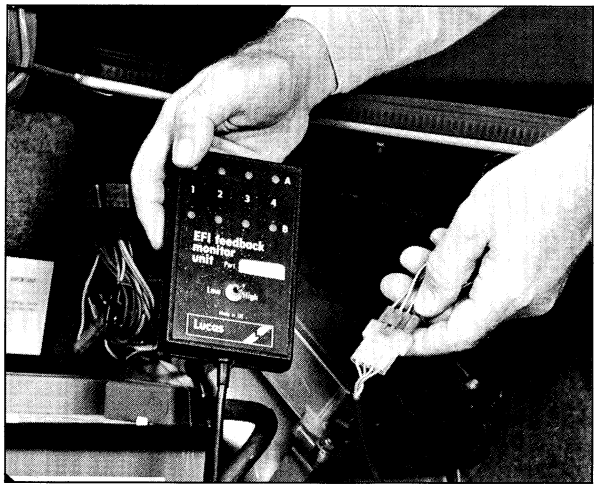


FIG 1

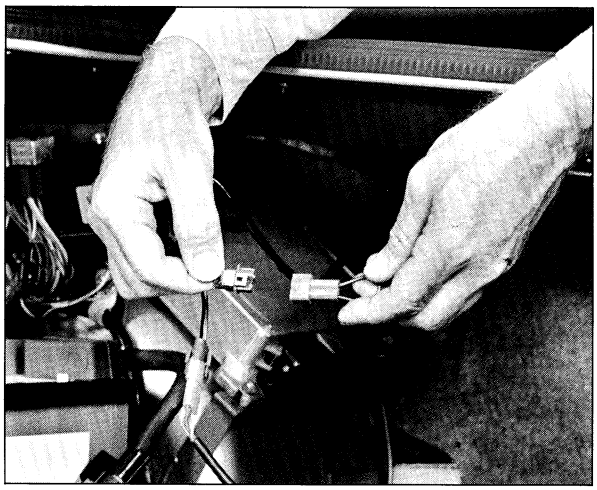


FIG 2

1. ECU verification

If the ECU requires replacement, the idle exhaust emissions level must be adjusted. The "verification" portion of this procedure can be used for checking correct ECU operation.

2. Adjust idle emissions level

Connect the Feedback Monitor YWB 130 into the fuel injection harness plug near the ECU (FIG 1).

Remove the feedback inhibit plug (FIG 2)

Check the part number on the ECU and set the feedback monitor switch as follows:

LOW position	HIGH position
DAC1926	DAC4118
DAC2597	
DAC3586	

Bring the engine to normal operating temperature. Select PARK. Turn off the climate control system. Verify that the idle speed is 750 to 850 rpm.

2. Adjust idle emissions level *(cont'd)*

Three correct indications are possible: A-2 and B-2, or A-3 and B-2, or A-2 and B-3 (FIG 3). Any one of the three combinations indicates correct ECU operation and idle emissions level.

On new ECUs, adjust the ECU with the fuel adjuster 60730551 to obtain a correct reading (FIG 4).

NOTE: Follow these precautions to ensure accurate results:

Be sure the engine is completely warmed up before checking.

Do not operate the engine at idle for an extended period of time. If necessary, drive the car on the highway for ten minutes to clear the oxygen sensors.

Wait at least 45 seconds before observing the feedback monitor if the engine is switched OFF and then restarted.

Make the observation before the engine requires the auxiliary fan operation. If the radiator auxiliary fan cycles ON/OFF, switch OFF the engine and allow it to cool.

After completing the adjustment, install the adjustment blanking plug, disconnect the feedback monitor, and reinstall the feedback inhibit plug.

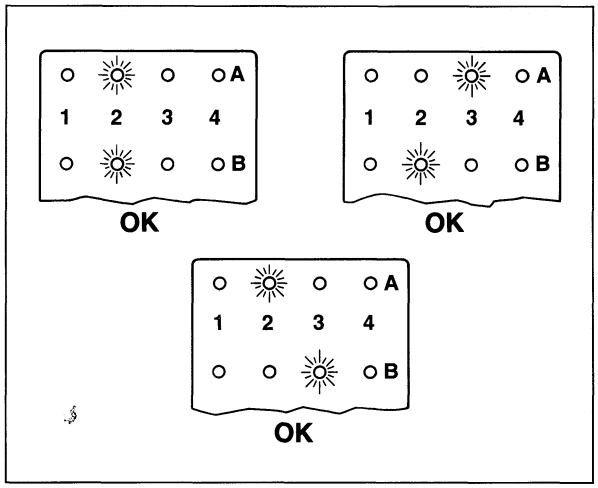


FIG 3

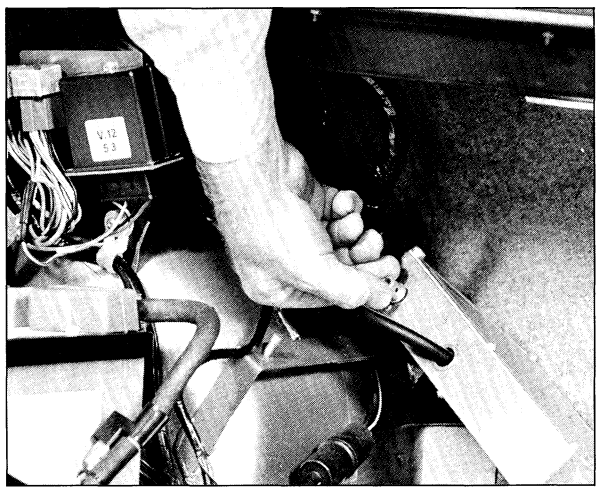
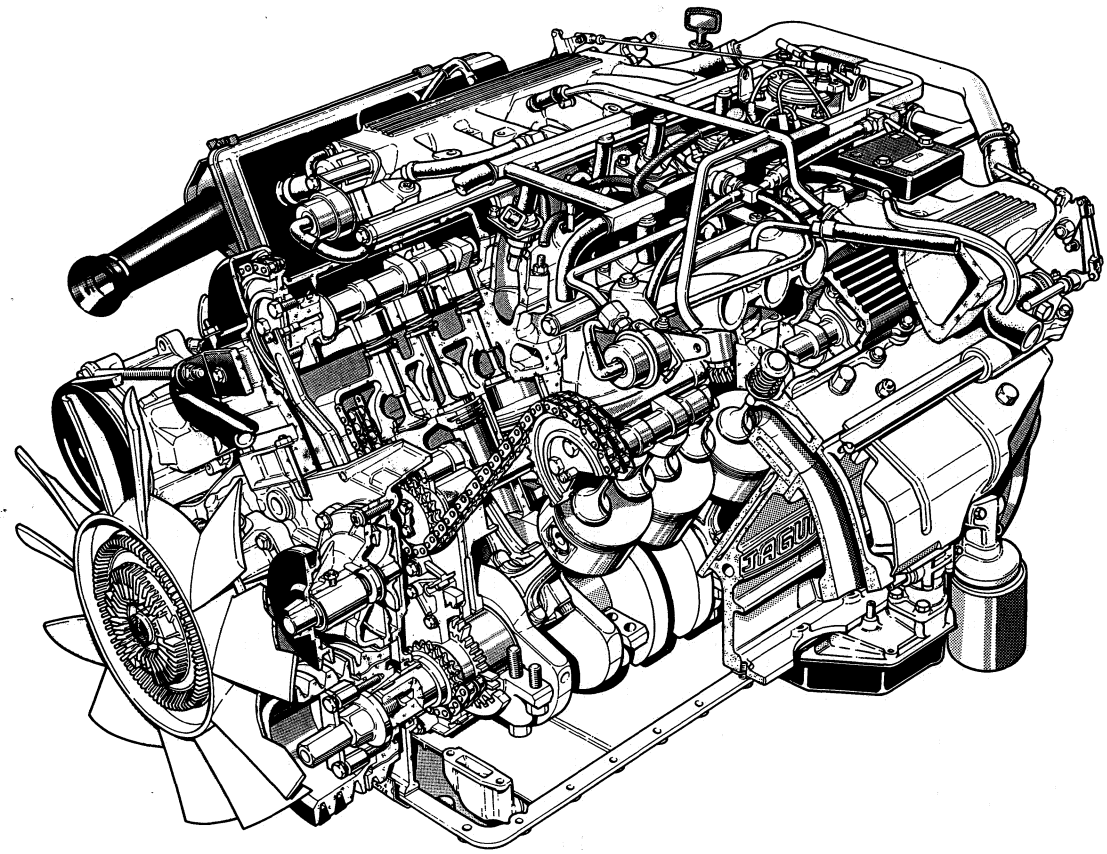


FIG 4


JAGUAR

Engine performance is dependent on many factors other than the correct operation of the fuel injection, ignition, and emissions control systems. When diagnosing a performance problem, consider all performance factors:

- **Engine mechanical condition**
- **Engine sealing**
- **Engine intake**
- **Basic engine setup**
- **Engine oil and coolant**
- **Engine electrical system**
- **Emissions components**
- **Battery and charging system**
- **Accessory drives**
- **Drive train**
- **Exhaust system**

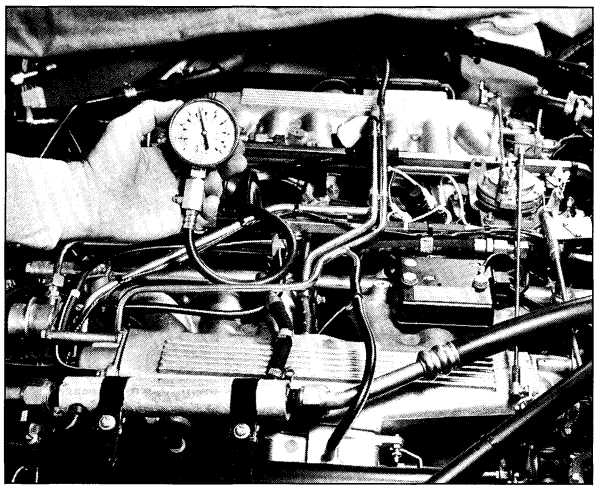


FIG 1

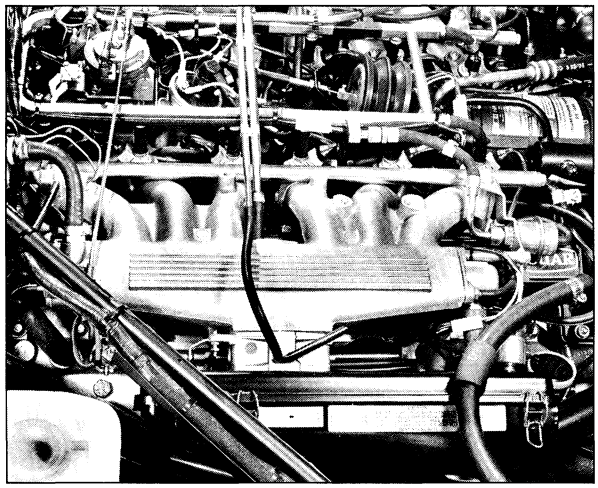


FIG 2

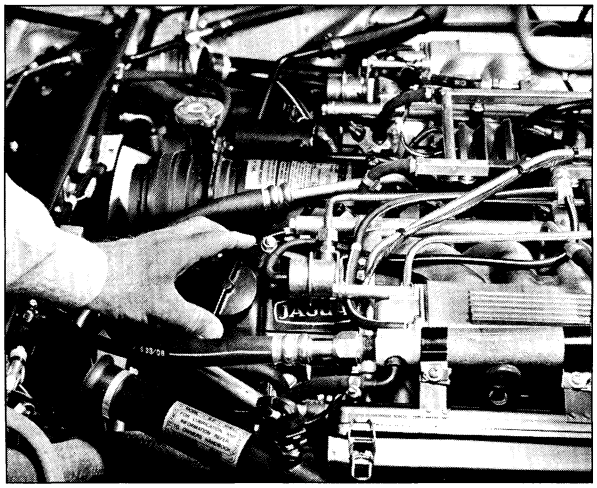


FIG 3

1. Engine mechanical condition

The mechanical condition of the engine is verified by checking cylinder compression pressures (FIG 1).

Specification

Engine at normal operating temperature

200–240 psi

Maximum 10% difference between cylinders (20–24 psi)

2. Engine sealing

Sealing of the intake manifolds (FIG 2) and the cylinder head gaskets must be ensured.

The oil filler cap (FIG 3) and the engine dipstick must be sealed correctly to allow effective emissions control operation (also check the transmission dipstick sealing).

3. Engine intake

The air filter(s) condition (FIG 4) must be ensured to prevent intake restriction.

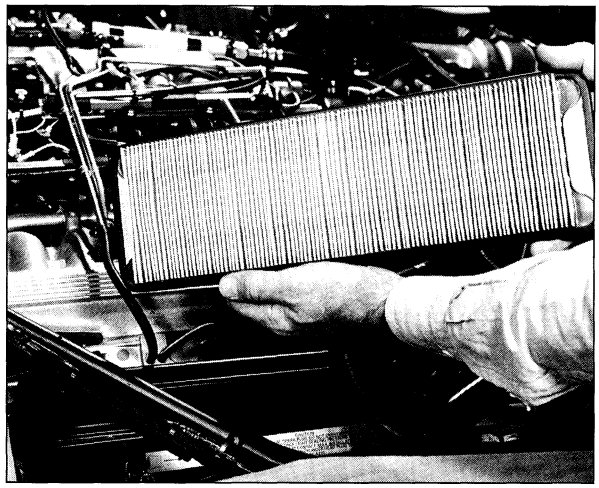


FIG 4

4. Engine basic setup

Valve clearance (FIG 5) is adjusted by substituting tappet shims of varying thickness.

Specification

Engine cold

Intake and Exhaust 0.010–0.012 in.

Camshaft timing is set with timing tool C3993 (FIG 6).

Specification

Cylinder 1A at Top Dead Center

Tool C3993 aligned with camshaft and housing

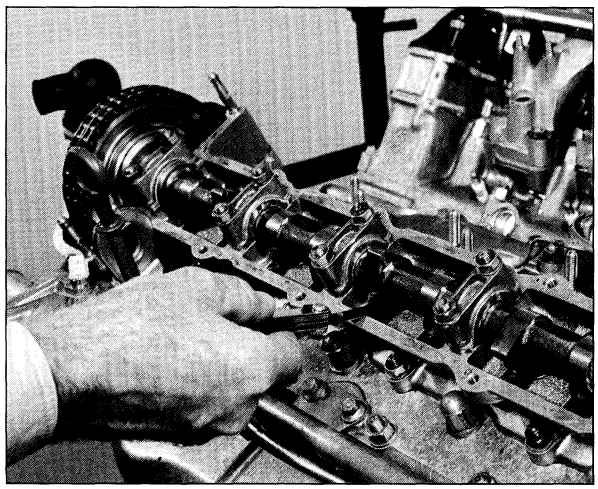


FIG 5

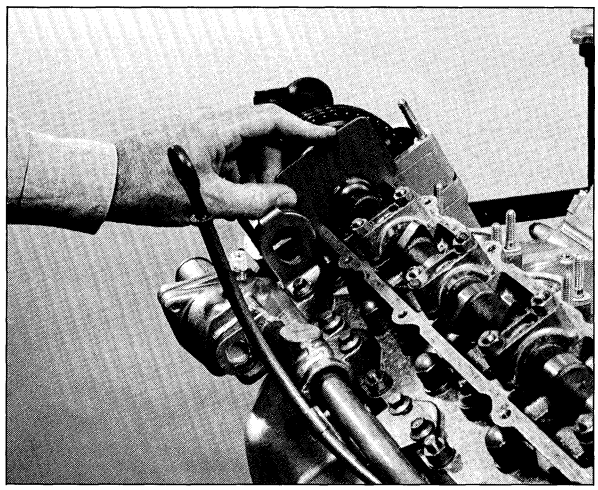


FIG 6

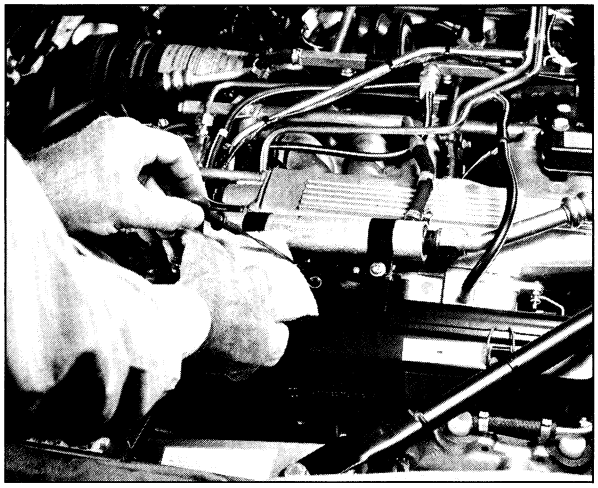


FIG 7

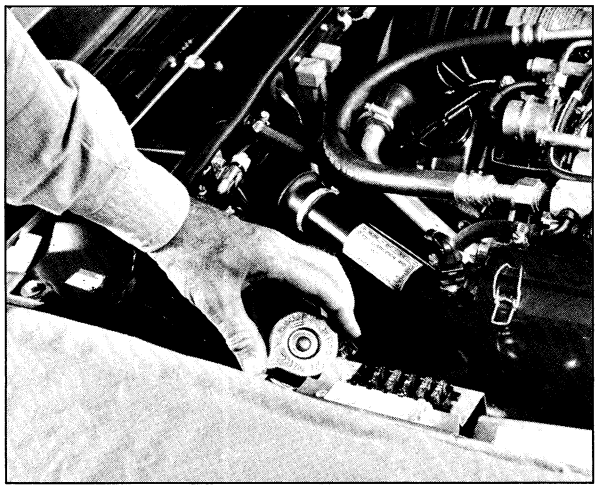


FIG 8

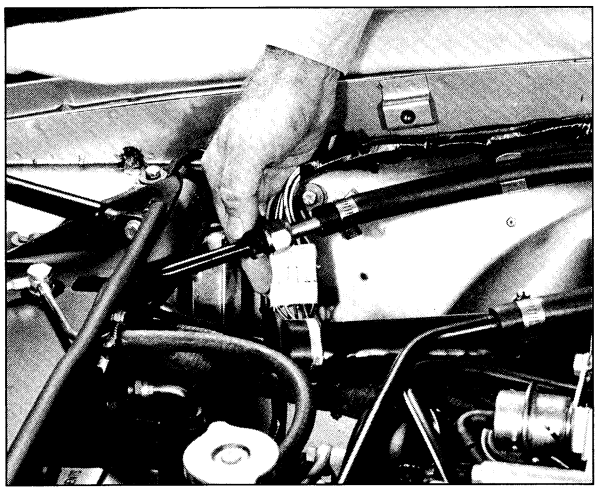


FIG 9

5. Engine oil and coolant

Engine oil condition, level, and specification (FIG 7) must be verified.

Coolant condition, level (FIG 8), and specification must be verified.

Specification

Minimum 55% solution

Phosphate free antifreeze

NOTE: The coolant level is critical to coolant temperature sensor operation.

6. Engine electrical system

The integrity of all engine electrical connections (FIG 9) must be ensured.

ECU connector

EFI connections

Ground connections

Engine/chassis ground cable

All connections corrosion free

All connections securely made

7. Emissions components

The engine breathing system (FIG 10) must be free from restriction.

The charcoal canister (FIG 11) must be free from restriction.

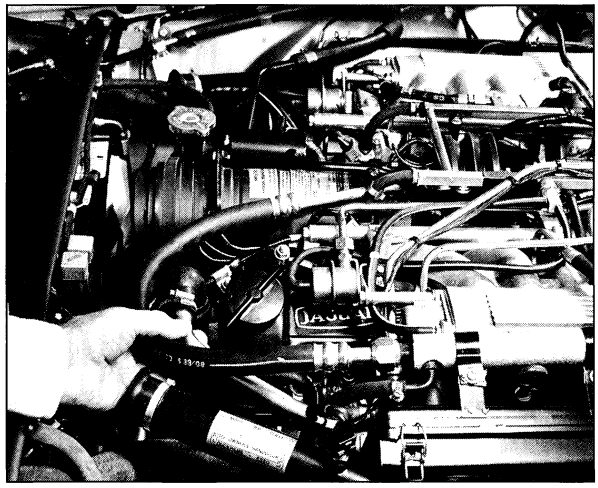


FIG 10

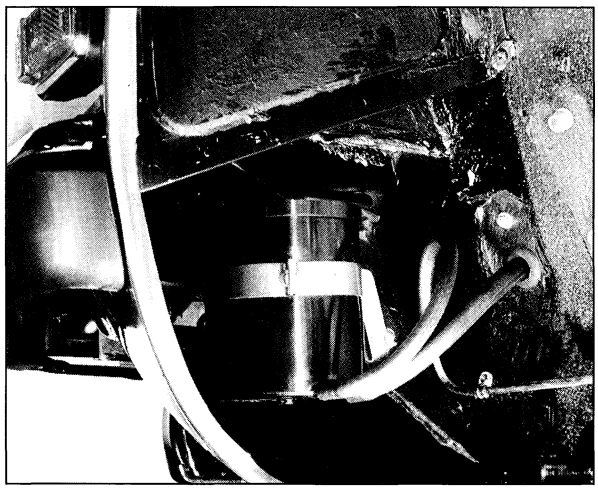


FIG 11

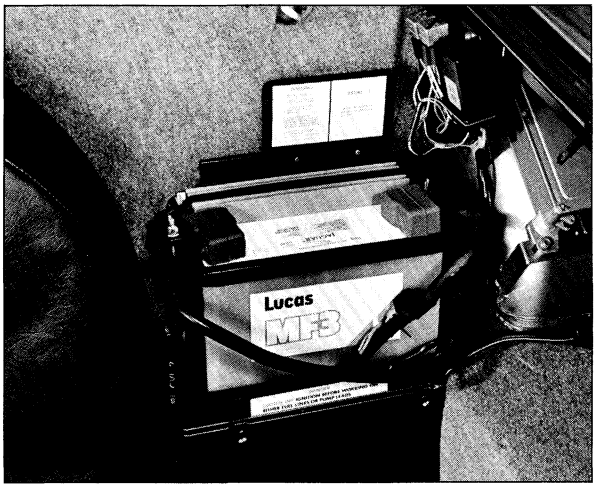


FIG 12

FIG 13

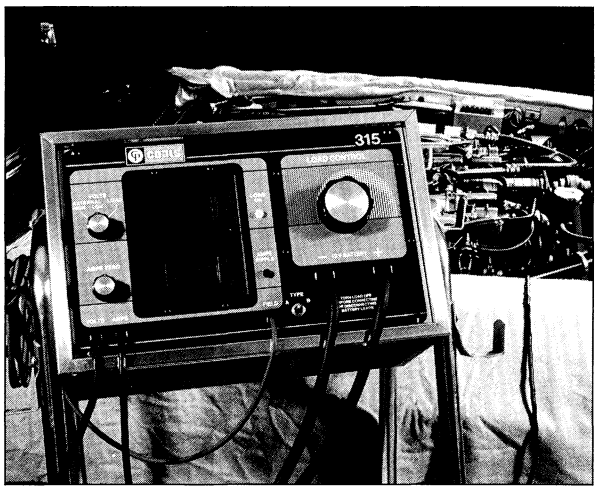


FIG 14

8. Battery and charging system

The battery condition (FIG 12) can be verified by visual inspection, electrolyte level and specific gravity checks, and conducting a load test.

The alternator and drive belt condition should be verified. The drive belt tension (FIG 13) is adjusted by the jack screw.

Specification

Alternator belt tension—
120 lbs. initial tension load
100 lbs. retension load

Alternator output can be checked with test equipment (FIG 14).

Specification

Alternator maximum output—75 amp (current production vehicles)

9. Accessory drive

The condition of all engine driven accessories and their drive belts should be verified. Drive belt tension (FIG 13) should also be verified.

Specification

⅜ in. belt tension—
60 lbs. initial tension load
50 lbs. retension load

½ in. belt tension—
120 lbs. initial tension load
100 lbs. retension load

10. Drive train

The transmission mechanical condition, fluid condition, and fluid level (FIG 15) must be to specification. The mechanical condition can be verified by conducting a stall test and a pressure test. Both tests should be made with the transmission at normal operating temperature.

Specification (stall test)

1950–2150 rpm DRIVE and REVERSE

⚠WARNING: TAKE ALL NECESSARY PRECAUTIONS TO PREVENT VEHICLE MOVEMENT DURING THE STALL TEST.

Specification (pressure test)

Gear	rpm	psi
N	1000	55–70
D (brakes applied)	IDLE	60–85
D (brakes applied)	1000	60–90
D (brakes applied, manually activate kickdown switch)	1000	90–100

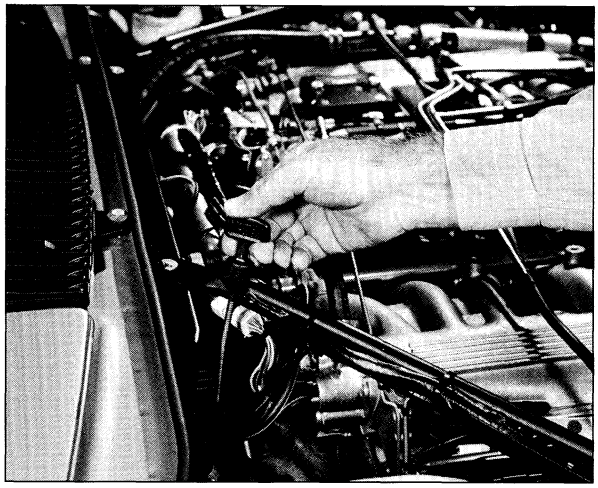


FIG 15

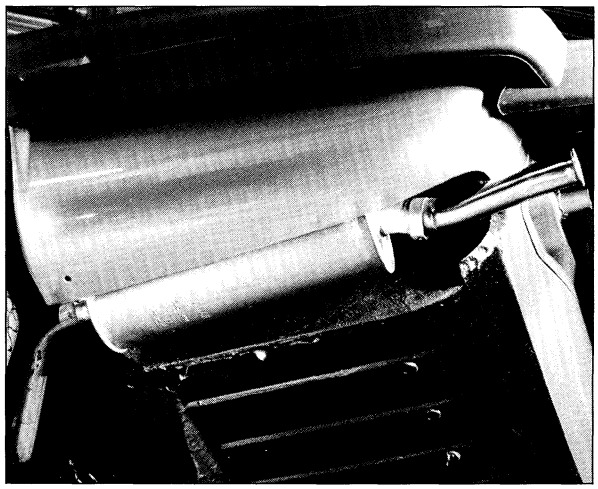
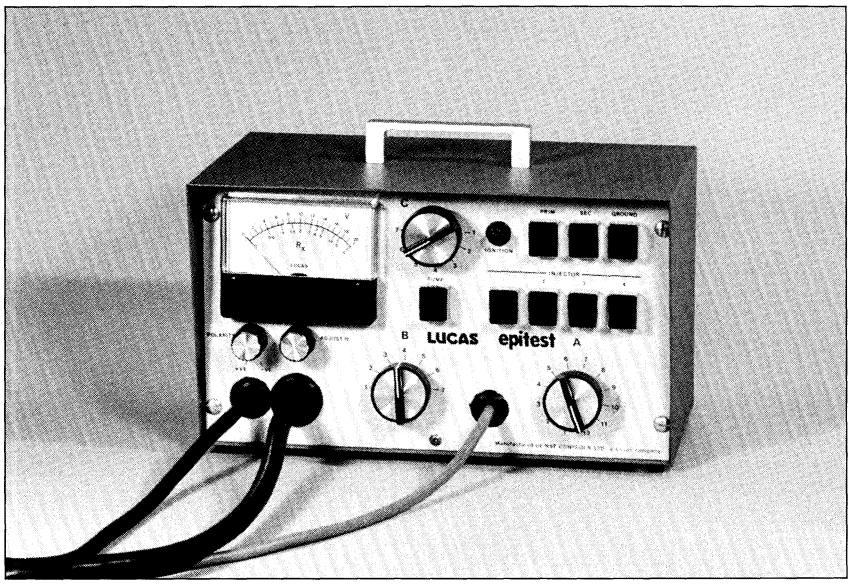


FIG 16

11. Exhaust system

The exhaust system (FIG 16) must be original equipment and free from obstructions.

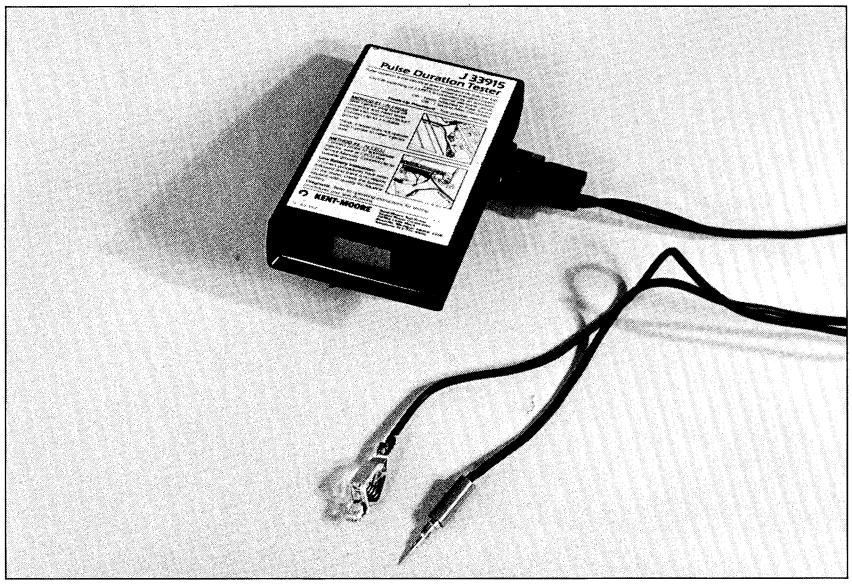


The EPITEST equipment is the Jaguar approved equipment used for checking the EFI system. It has several important unique features that should be understood when it is used:

- EPITEST guides the technician to the fault area.
- EPITEST provides static component testing.
- EPITEST provides a simple and quick way for checking the EFI wiring harness.
- EPITEST provides manual control for the pump and the injectors.
- EPITEST requires only battery voltage for operation.

EPITEST operation

The EPITEST equipment is supplied with an instruction manual for the various Jaguar systems. The EPITEST information sheet is used for recording test data.



The pulse duration tester can be a valuable diagnostic tool if used by a technician with a thorough understanding of the XJ-S fuel injection system. This tester has the following features:

- The pulse duration tester is compact, easy to read, and easily connected.
- The pulse duration tester measures the output pulse signal (pulse duration) to the injectors.
- The pulse duration tester is used for dynamic testing—engine running and/or driving on the road.
- The pulse duration tester can confirm if further diagnosis with EPITEST is necessary.

Connection

Connection is made at the power resistors on the ECU side. The four groups of three injectors are identified by the wire color code:

pink/slate	1B	3B	5B
pink/green	2B	4B	6B
pink/blue	1A	3A	5A
pink/white	2A	4A	6A

Readings

With the engine at normal operating temperature and the air conditioning compressor ON, the following approximate values can be expected:

IDLE	NEUTRAL	2.6–3.1 milliseconds
IDLE	DRIVE	2.9–3.1 milliseconds
FULL THROTTLE (MAXIMUM LOAD)		10–11.6 milliseconds

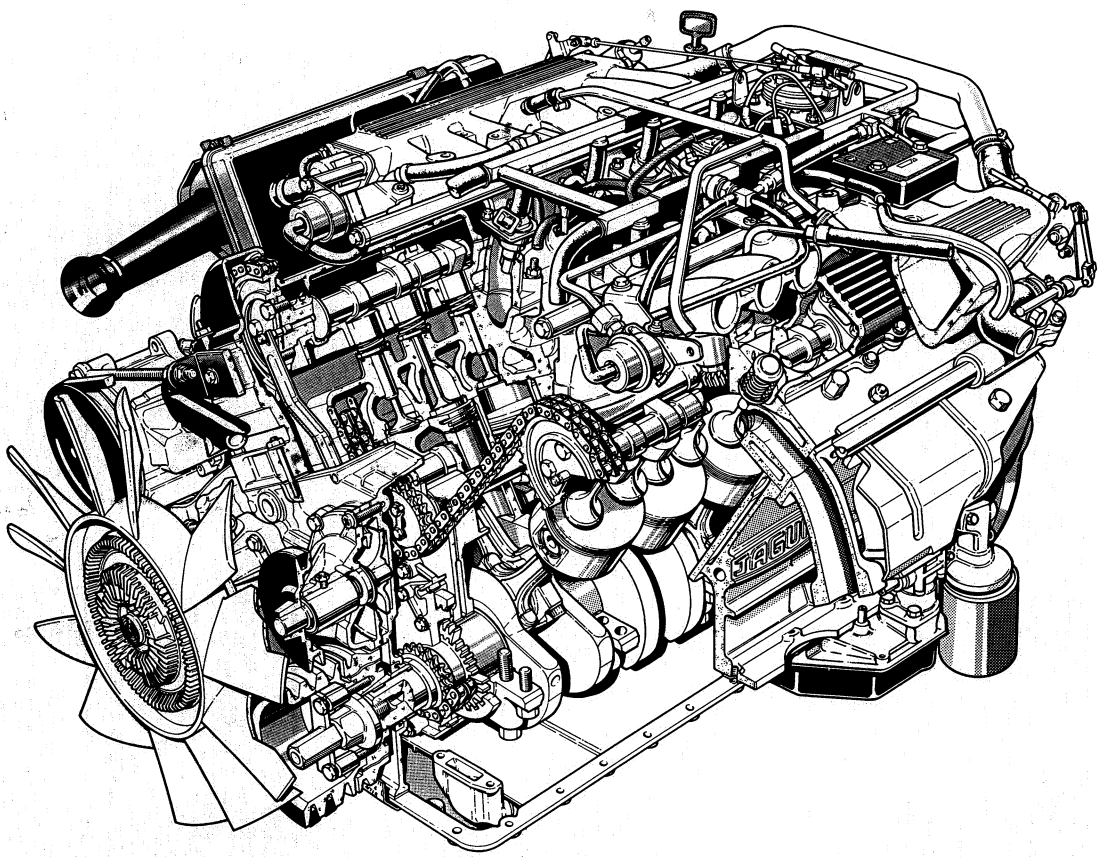
SYSTEMS ANALYSIS fault guide

Use this chart as a guide for a sequence of engine performance checks.

Refer to ENGINE SETUP and SYSTEMS ANALYSIS Performance Factors for details of each check. Check the condition and/or the operation of the items listed as OTHER.

SYMPTOM	ENGINE SETUP: THROTTLE OPERATING ADJUSTMENT	VACUUM VERIFICATION	IGNITION TIMING	IDLE SPEED	FUEL PUMP FLOW	FUEL PRESSURE	FUEL INJECTOR FLOW	ECU VERIFICATION
ENGINE CRANKS BUT WILL NOT START			7		4	5	10	11
DIFFICULT COLD START			3		6	4	5	
DIFFICULT HOT START			4		3	1		11
ENGINE STARTS BUT WILL NOT RUN		9	2		5	1		6
HESITATION AND FLAT SPOTS	12	6	2		4	5	10	11
ENGINE RUNS ROUGH	10	11	6		3	7	4	8
IDLE TOO FAST	5	8		1		9		
HUNTING AT IDLE	1				2	3	5	6
LOW POWER AND TOP SPEED		9	3		4	5	7	8
HIGH FUEL CONSUMPTION			2			4	5	7
LACK OF ENGINE BRAKING	3	4	2					7
ENGINE DETONATION (PING)		3	1		2			

PERFORMANCE FACTORS											OTHER			
ENGINE MECHANICAL	ENGINE SEALING	ENGINE INTAKE	BASIC ENGINE SETUP	ENGINE OIL AND COOLANT	ENGINE ELECTRICAL SYSTEM	EMISSIONS COMPONENTS	BATTERY AND CHARGING SYSTEM	ACCESSORY DRIVES	DRIVE TRAIN	EXHAUST SYSTEM	MANIFOLD PRESSURE SENSOR LINE	EXTRA AIR VALVE	IDLE STABILIZATION	EPITEST
6			12		2		1			8	3			9
					2		1							7
		8	7		6		5			9			2	10
					3					8		4		7
	8	7			1	3							13	9
12			2		1						13		9	5
7	4		10				12				6	2	3	11
														4
10	11	2	17	12	1	13		14	15	16				6
		8			1	3								6
	5								1				6	8
5		4												6



ENGINE SETUP

Throttle potentiometer	(refer to page 26)
Throttle plate gap	0.002 in.
Distributor vacuum regulator	(refer to page 31)
Pickup module air gap	0.007–0.015 in.
Spark plug gap	0.025 in.
Ignition timing	18° BTDC @ 3000 rpm (vacuum disconnected)
Idle speed	750–850 rpm
Fuel flow (pump)	minimum 720 ml/20 sec. (at return)
Fuel pressure (in rail)	28.5–30 psi (idle, vacuum connected)
Fuel flow (injectors)	minimum 170 ml/60 sec.
ECU adjustment	(refer to page 38)

PERFORMANCE FACTORS

Cylinder compression pressures	200–240 psi (maximum 10% difference between cylinders)
Valve clearance (intake and exhaust)	0.010–0.012 in.
Camshaft timing	cylinder 1A @ TDC (tool C3993)
Drive belt tension (⅜ in. belts)	60 lbs. initial load 50 lbs. retension load
Drive belt tension (½ in. belts)	120 lbs. initial load 100 lbs. retension load
Transmission stall test	1950–2150 rpm

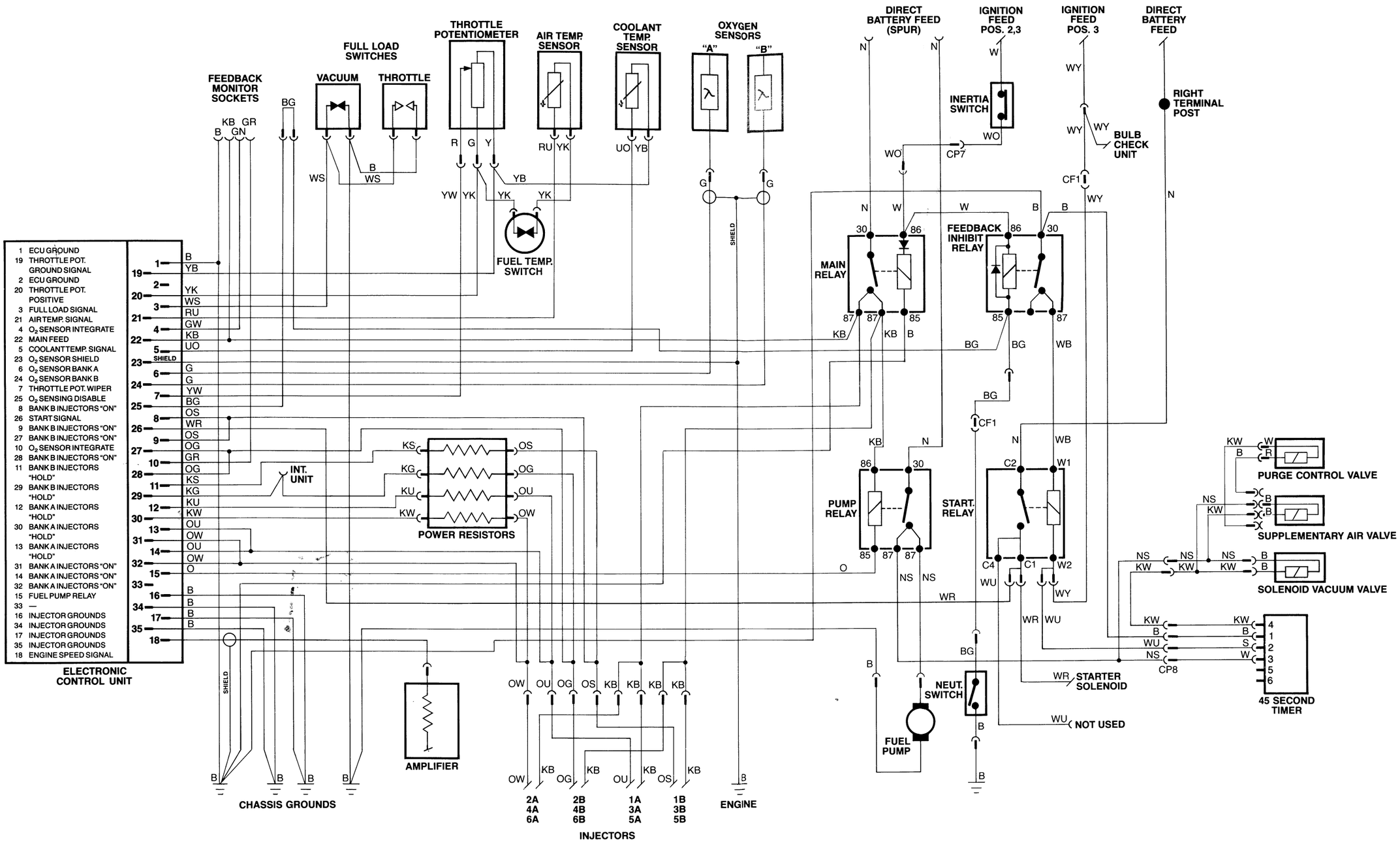
Transmission pressures

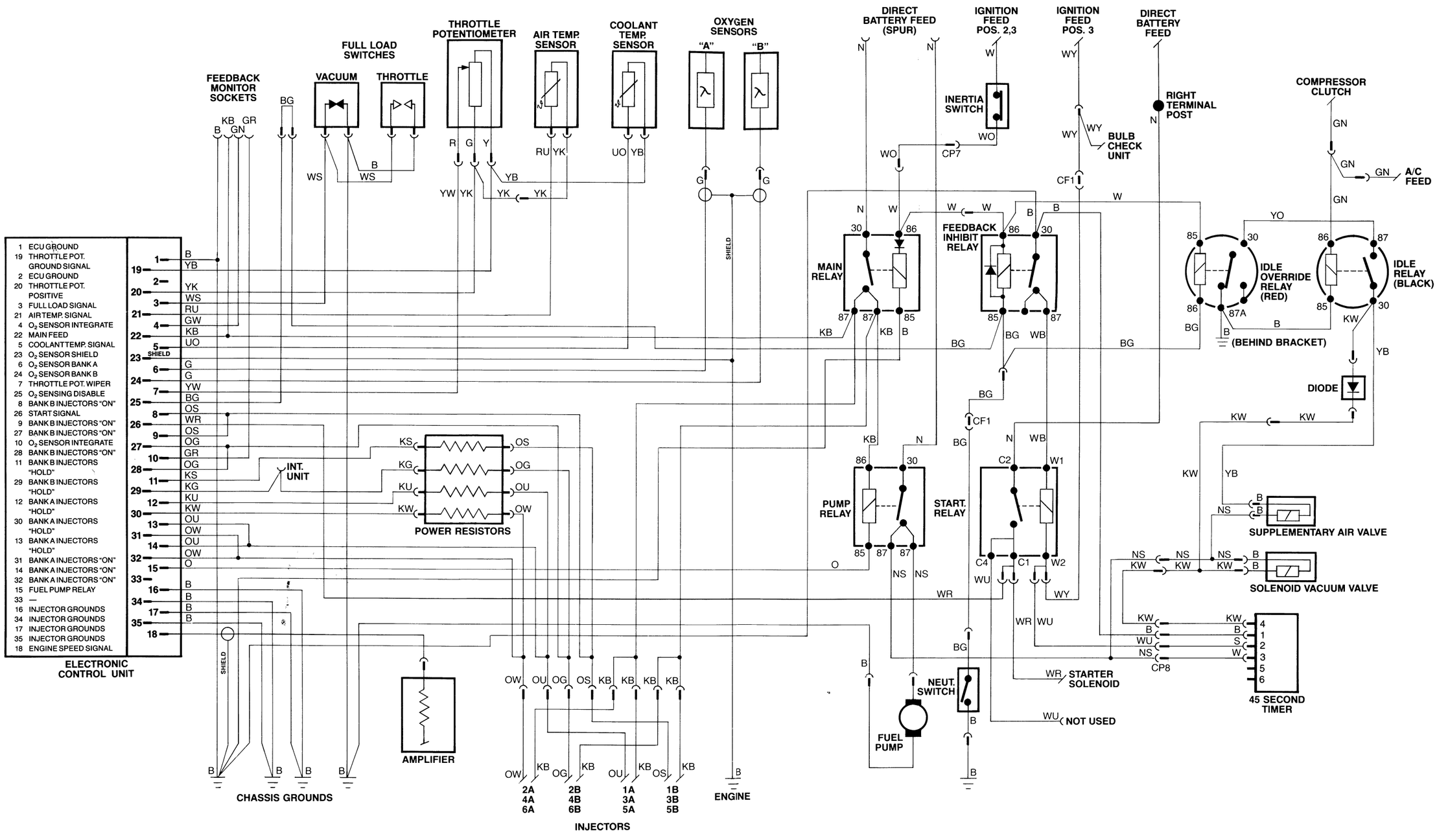
Gear	rpm	psi
N	1000	55–70
D (brakes applied)	IDLE	60–85
D (brakes applied)	1000	60–90
D (brakes applied, manually activate kickdown switch	1000	90–100

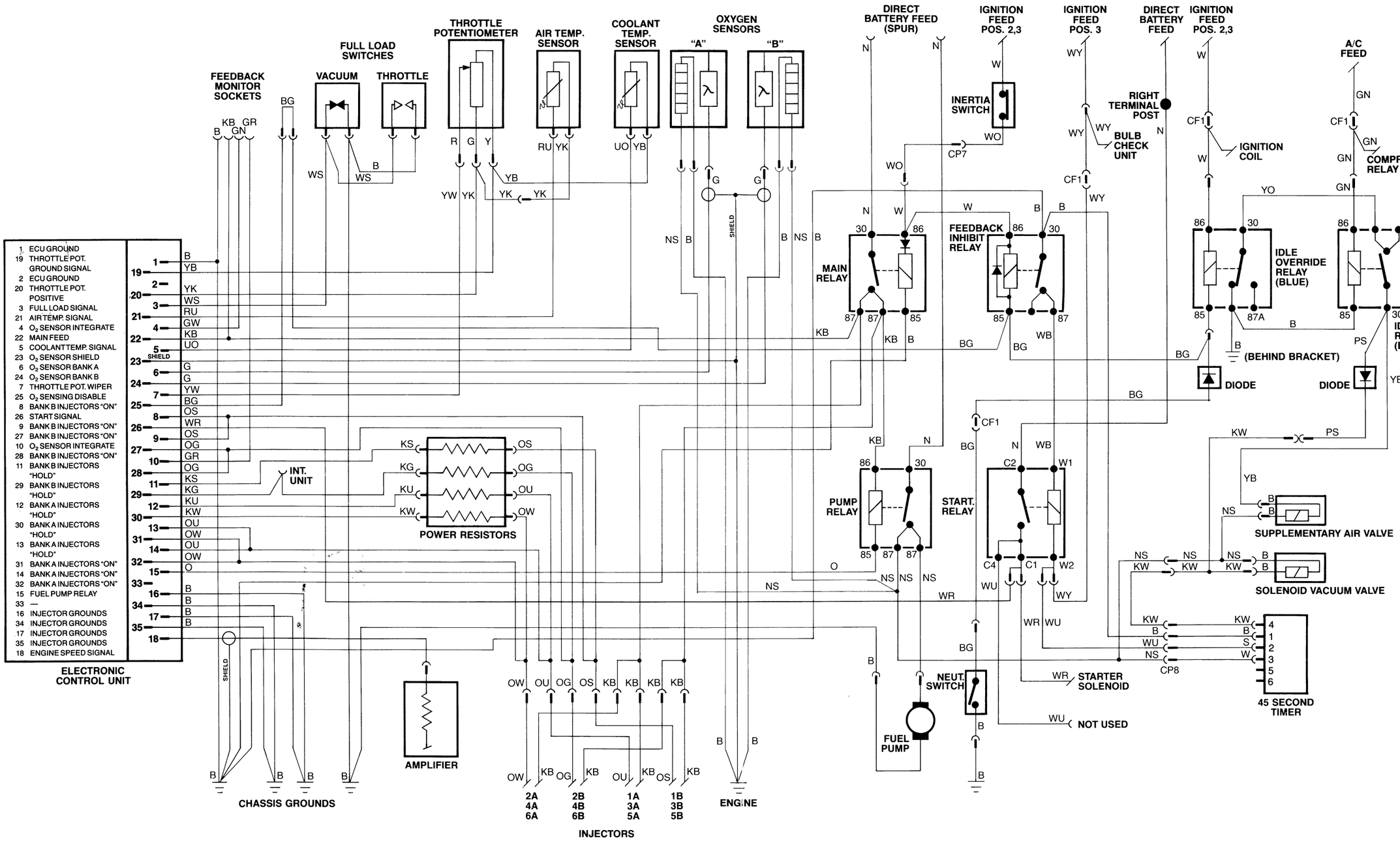
WIRING COLOR CODE

N	Brown	**Y**	Yellow
B	Black	**O**	Orange
W	White	**S**	Slate (gray)
K	Pink	**L**	Light
G	Green	**U**	Blue
R	Red	**P**	Purple

When a wire has two color code letters, the first letter indicates the main color and the second letter indicates the tracer color; for example, WK = white with pink tracer and PGS = purple with a green and slate tracer.


1 ECU GROUND
19 THROTTLE POT. GROUND SIGNAL
2 ECU GROUND
20 THROTTLE POT. POSITIVE
3 FULL LOAD SIGNAL
21 AIR TEMP. SIGNAL
4 O2 SENSOR INTEGRATE
22 MAIN FEED
5 COOLANT TEMP. SIGNAL
23 O2 SENSOR SHIELD
6 O2 SENSOR BANK A
24 O2 SENSOR BANK B
7 THROTTLE POT. WIPER
25 O2 SENSING DISABLE
8 BANK B INJECTORS "ON"
26 START SIGNAL
9 BANK B INJECTORS "ON"
27 BANK B INJECTORS "ON"
10 O2 SENSOR INTEGRATE
28 BANK B INJECTORS "ON"
11 BANK B INJECTORS "HOLD"
29 BANK B INJECTORS "HOLD"
12 BANK A INJECTORS "HOLD"
30 BANK A INJECTORS "HOLD"
13 BANK A INJECTORS "HOLD"
31 BANK A INJECTORS "ON"
14 BANK A INJECTORS "ON"
32 BANK A INJECTORS "ON"
15 FUEL PUMP RELAY
33 —
16 INJECTOR GROUNDS
34 INJECTOR GROUNDS
17 INJECTOR GROUNDS
35 INJECTOR GROUNDS
18 ENGINE SPEED SIGNAL
ELECTRONIC CONTROL UNIT
FEEDBACK MONITOR SOCKETS
FULL LOAD SWITCHES
VACUUM
THROTTLE
THROTTLE POTENTIOMETER
AIR TEMP. SENSOR
COOLANT TEMP. SENSOR
OXYGEN SENSORS
"A"
"B"
FUEL TEMP. SWITCH
SHIELD
INT. UNIT
POWER RESISTORS
AMPLIFIER
CHASSIS GROUNDS
ENGINE
INJECTORS
2A 4A 6A
2B 4B 6B
1A 3A 5A
1B 3B 5B
DIRECT BATTERY FEED (SPUR)
IGNITION FEED POS. 2,3
IGNITION FEED POS. 3
DIRECT BATTERY FEED
INERTIA SWITCH
BULB CHECK UNIT
RIGHT TERMINAL POST
MAIN RELAY
FEEDBACK INHIBIT RELAY
PUMP RELAY
START. RELAY
FUEL PUMP
NEUT. SWITCH
STARTER SOLENOID
NOT USED
PURGE CONTROL VALVE
SUPPLEMENTARY AIR VALVE
SOLENOID VACUUM VALVE
45 SECOND TIMER
CP7
CP8
CF1


FEEDBACK MONITOR SOCKETS
KB GR
B GN
BG
FULL LOAD SWITCHES
VACUUM
THROTTLE
WS
B
WS
THROTTLE POTENTIOMETER
R G Y
YW YK
YB
YK
AIR TEMP. SENSOR
RU YK
COOLANT TEMP. SENSOR
UO YB
OXYGEN SENSORS
"A"
"B"
G
G
SHIELD
DIRECT BATTERY FEED (SPUR)
N
N
WO
IGNITION FEED POS. 2,3
W
INERTIA SWITCH
WO
CP7
IGNITION FEED POS. 3
WY
WY
WY
BULB CHECK UNIT
CF1
W
DIRECT BATTERY FEED
N
RIGHT TERMINAL POST
COMPRESSOR CLUTCH
GN
GN
GN
A/C FEED
GN
YO
MAIN RELAY
30
86
87
87
85
KB
KB
B
N
W
FEEDBACK INHIBIT RELAY
86
30
85
87
W
W
B
B
BG
BG
WB
BG
85
30
86
87A
IDLE OVERRIDE RELAY (RED)
B
(BEHIND BRACKET)
BG
86
87
85
30
IDLE RELAY (BLACK)
KW
YB
DIODE
KW
KW
KW
YB
B
B
NS
SUPPLEMENTARY AIR VALVE
NS
NS
NS
B
B
KW
KW
KW
SOLENOID VACUUM VALVE
KW
B
WU
NS
CP8
KW
B
S
W
4
1
2
3
5
6
45 SECOND TIMER
BG
CF1
KB
N
86
30
PUMP RELAY
85
87
87
O
NS
NS
WR
N
WB
C2
W1
START RELAY
C4
C1
W2
WU
WY
WR
WU
WR
STARTER SOLENOID
WU
NOT USED
B
NEUT. SWITCH
B
FUEL PUMP
B
B
1 ECU GROUND
19 THROTTLE POT. GROUND SIGNAL
2 ECU GROUND
20 THROTTLE POT. POSITIVE
3 FULL LOAD SIGNAL
21 AIR TEMP. SIGNAL
4 O2 SENSOR INTEGRATE
22 MAIN FEED
5 COOLANT TEMP. SIGNAL
23 O2 SENSOR SHIELD
6 O2 SENSOR BANK A
24 O2 SENSOR BANK B
7 THROTTLE POT. WIPER
25 O2 SENSING DISABLE
8 BANK B INJECTORS "ON"
26 START SIGNAL
9 BANK B INJECTORS "ON"
27 BANK B INJECTORS "ON"
10 O2 SENSOR INTEGRATE
28 BANK B INJECTORS "ON"
11 BANK B INJECTORS "HOLD"
29 BANK B INJECTORS "HOLD"
12 BANK A INJECTORS "HOLD"
30 BANK A INJECTORS "HOLD"
13 BANK A INJECTORS "HOLD"
31 BANK A INJECTORS "ON"
14 BANK A INJECTORS "ON"
32 BANK A INJECTORS "ON"
15 FUEL PUMP RELAY
33 —
16 INJECTOR GROUNDS
34 INJECTOR GROUNDS
17 INJECTOR GROUNDS
35 INJECTOR GROUNDS
18 ENGINE SPEED SIGNAL
1 B
19 YB
2
20 YK
3 WS
21 RU
4 GW
22 KB
5 UO
23 SHIELD
6 G
24 G
7 YW
25 BG
8 OS
26 WR
9 OG
27 OG
10 GR
28 OG
11 KS
29 KG
12 KU
30 KW
13 OU
31 OW
14 OU
32 OW
15 O
33
16 B
34 B
17 B
35 B
18
ELECTRONIC CONTROL UNIT
INT. UNIT
KS
KG
KU
KW
OS
OG
OU
OW
POWER RESISTORS
SHIELD
B
B
B
B
CHASSIS GROUNDS
AMPLIFIER
OW
OU
OG
OS
KB
KB
KB
KB
OW
KB
OG
KB
OU
KB
OS
KB
2A
4A
6A
2B
4B
6B
1A
3A
5A
1B
3B
5B
INJECTORS
B
ENGINE


1 ECU GROUND
19 THROTTLE POT. GROUND SIGNAL
2 ECU GROUND
20 THROTTLE POT. POSITIVE
3 FULL LOAD SIGNAL
21 AIR TEMP. SIGNAL
4 O2 SENSOR INTEGRATE
22 MAIN FEED
5 COOLANT TEMP. SIGNAL
23 O2 SENSOR SHIELD
6 O2 SENSOR BANK A
24 O2 SENSOR BANK B
7 THROTTLE POT. WIPER
25 O2 SENSING DISABLE
8 BANK B INJECTORS "ON"
26 START SIGNAL
9 BANK B INJECTORS "ON"
27 BANK B INJECTORS "ON"
10 O2 SENSOR INTEGRATE
28 BANK B INJECTORS "ON"
11 BANK B INJECTORS "HOLD"
29 BANK B INJECTORS "HOLD"
12 BANK A INJECTORS "HOLD"
30 BANK A INJECTORS "HOLD"
13 BANK A INJECTORS "HOLD"
31 BANK A INJECTORS "ON"
14 BANK A INJECTORS "ON"
32 BANK A INJECTORS "ON"
15 FUEL PUMP RELAY
33 —
16 INJECTOR GROUNDS
34 INJECTOR GROUNDS
17 INJECTOR GROUNDS
35 INJECTOR GROUNDS
18 ENGINE SPEED SIGNAL
ELECTRONIC CONTROL UNIT
FEEDBACK MONITOR SOCKETS
FULL LOAD SWITCHES
VACUUM
THROTTLE
THROTTLE POTENTIOMETER
AIR TEMP. SENSOR
COOLANT TEMP. SENSOR
OXYGEN SENSORS
"A"
"B"
INT. UNIT
POWER RESISTORS
AMPLIFIER
CHASSIS GROUNDS
INJECTORS
2A 4A 6A
2B 4B 6B
1A 3A 5A
1B 3B 5B
ENGINE
DIRECT BATTERY FEED (SPUR)
IGNITION FEED POS. 2,3
IGNITION FEED POS. 3
DIRECT BATTERY FEED
IGNITION FEED POS. 2,3
A/C FEED
INERTIA SWITCH
CP7
RIGHT TERMINAL POST
BULB CHECK UNIT
IGNITION COIL
COMPRESSOR RELAY
MAIN RELAY
FEEDBACK INHIBIT RELAY
IDLE OVERRIDE RELAY (BLUE)
IDLE RELAY (BLACK)
(BEHIND BRACKET)
DIODE
DIODE
PUMP RELAY
START. RELAY
SUPPLEMENTARY AIR VALVE
SOLENOID VACUUM VALVE
NEUT. SWITCH
FUEL PUMP
STARTER SOLENOID
NOT USED
CP8
45 SECOND TIMER

JAGUAR

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