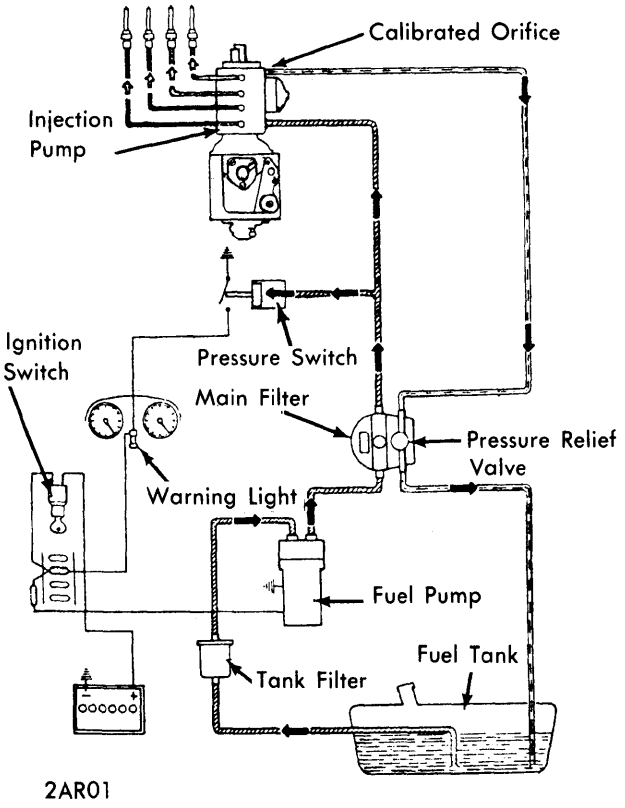
SPICA FUEL INJECTION

Alfa Romeo 1750 (1969-71)
Alfa Romeo 2000 (1972-73)

DESCRIPTION

Fuel is supplied to the engine by injection into the intake port of each cylinder by means of four pumping elements (one per cylinder) whose delivery is controlled by a "control unit". A cam in control unit provides a base delivery according to opening of throttles and RPM. This base delivery is varied by compensating devices giving corrections for atmospheric pressure, engine temperature, cold starting, initial running, and fuel cut off on deceleration.



FUEL FEED SYSTEM

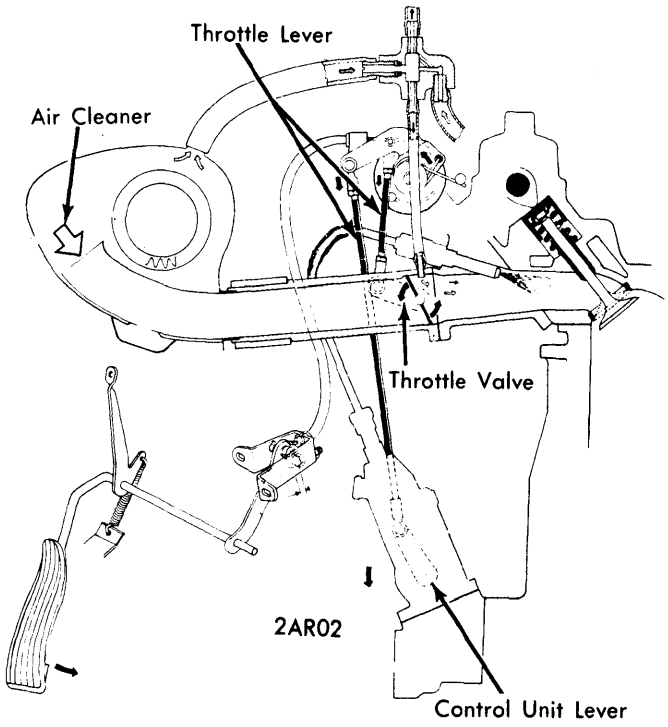
OPERATION

FUEL FEED

When ignition is turned to first position, the electric pump is activated and fuel flows from the tank, through a filter, through the main filter and to the injection pump. A pressure switch inserted in delivery pipe will switch on a warning light on the dash if pressure drops lower than 7.1 psi (.5 kg/sq. cm). A pressure relief valve on main filter limits fuel pump outlet pressure by passing fuel to recovery pipe at 16-18 psi (1.1 - 1.3 kg/sq. cm).

AIR INDUCTION

Air coming in through an air filter, enters the engine through four intake ports. Each port has a throttle valve. During idling, air is fed through a separate circuit connecting to intake ports downstream of throttle valves.



AIR INDUCTION SYSTEM WITH THROTTLE LINKAGE

INJECTION PUMP

The pump has four variable displacement plungers which are controlled by the control unit through a rack. Plungers are actuated by connecting rods driven by a crankshaft which revolves at one half of engine speed.

COLD START DEVICE

A solenoid causes additional movement of control unit rack when engine is started. Cold start solenoid device cuts off gradually, according to engine temperature.

INITIAL RUNNING DEVICE

This device provides smooth operation of the engine after a cold start. It consists of a thermostat which senses engine coolant temperature, and acts through linkage on the control unit rack to increase the injection pump delivery The device cuts off automatically and progressively as the engine temperature warms up to operating temperature.

TEMPERATURE SETTING

The temperature compensator lever on the control unit has three settings: N (normal) for temperatures above 59°F; C (cold) for temperatures between 32°F and 59°F; and F (freezing) for temperatures below 32°F. This device deeps a constant air/fuel ratio, even when ambient temperatures vary.

REMOVAL & INSTALLATION

INJECTION PUMP

1) Remove air cleaner, disconnect negative battery terminal and disconnect the lead from cold start device solenoid. Remove two screws on thermostat actuator mounting flange and two screws clamping actuator pipe anchoring grommet. *NOTE – Do not remove thermostat bulb.* Withdraw actuator from control unit. Disconnect fuel lines from injection pump and detach push-pull rod from control unit.

SPICA FUEL INJECTION (Cont.)

2) Bring the number one piston to its injection stroke by aligning "I" mark (70° BTDC) in crankshaft pulley with pointer on front cover. This will facilitate re-installation of injection pump.

3) Unscrew three attaching nuts and remove drive belt cover and take drive belt off pulley. Loosen injection pipe nuts on pump outlet fittings. Using a suitable tool (A.5.0164), unscrew nuts on two bolts attaching pipe cluster plate and injection pump slanting bracket.

4) Loosen two screws attaching control unit to bracket at engine mount. From underside of car, unscrew four nuts attaching injection pump support to engine front cover.

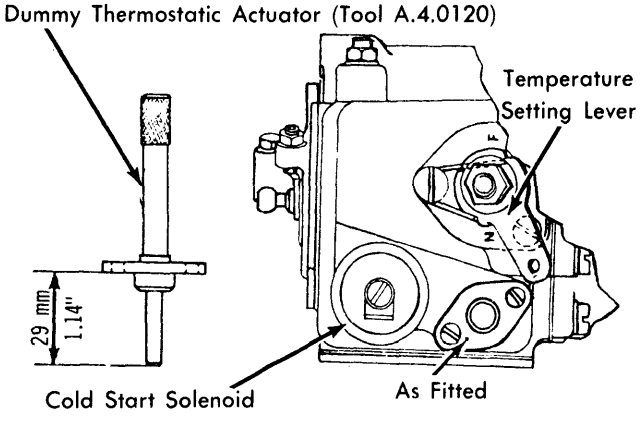
5) Remove injection pump and its support as a unit by tilting it as necessary. To install, reverse removal procedures. *NOTE — When installing, align reference marks on injection pump with mark on drive pulley, then fit drive belt onto pulley. Avoid tools that might damage belt.*

THERMOSTATIC ACTUATOR

1) Remove air cleaner and drain about one gallon of coolant from system. Remove thermostat assembly. *NOTE — Before installing new actuator, check position of screw in control unit upon which the actuator acts. See Testing Procedures.*

2) Install new thermostat assembly, taking care not to distort the small pipe. Replace "O" ring if necessary. After completing installation, refill cooling system.

3) Check that clearance between control unit lever and reference screw is .012-.024" (with .019" preferred) when engine is at normal operating temperature. If not within limits, turn adjuster screw in or out to adjust clearance.

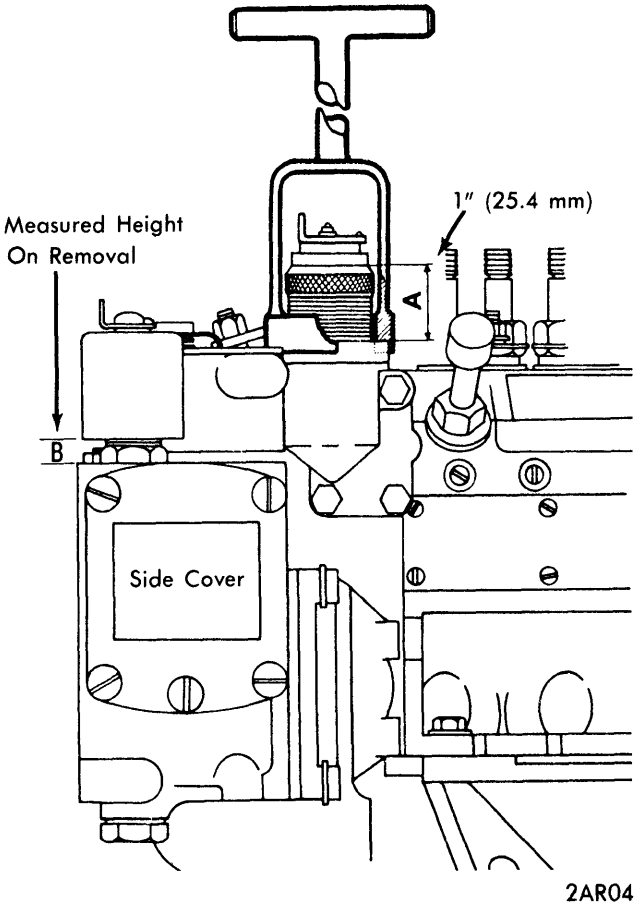


THERMOSTATIC ACTUATOR TOOL

FUEL CUT OFF SOLENOID

1) Remove air cleaner and disconnect terminal of solenoid feed wire. *NOTE — Keep a record of the projection A (see illustration) of solenoid body from ring nut top.*

2) Slacken ring nut with suitable tool (A.5.0177) taking care not to cock solenoid. Unscrew solenoid by hand and remove. Before installing new solenoid it should be checked. *See Testing Procedures.*



COLD START & FUEL CUT OFF SOLENOIDS

COLD START SOLENOID

1) Remove injection pump as previously described. Remove side and rear inspection plates from control unit. Remove cotter key and clevis pin attaching solenoid to plunger shaft. Measure distance from bottom of solenoid to control unit.

2) Loosen solenoid lock nut and unscrew solenoid. Check that plunger moves up and down freely. If necessary to remove plunger shaft, unscrew plug from underneath and withdraw plunger shaft. Check that diameter of plastic plunger is .52" (13.5 mm). Replace or reduce diameter if required.

3) The height of cold start solenoid above control unit housing governs operation of cold start device. *See Adjustment Procedures.*

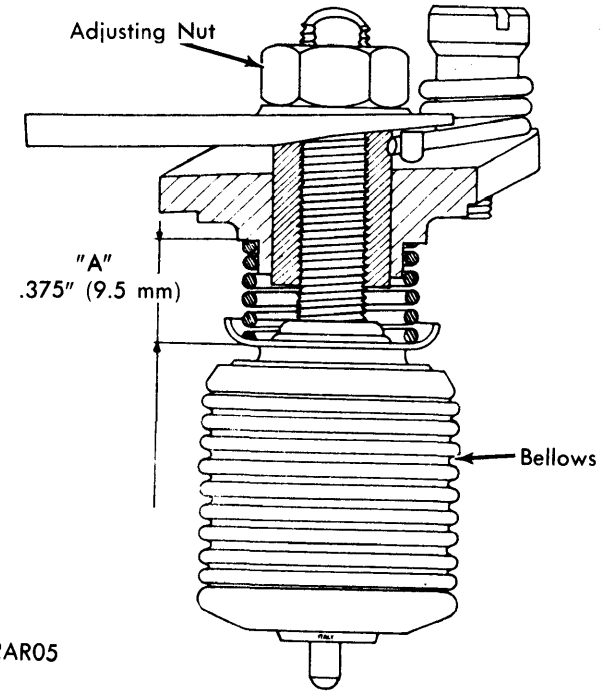
4) Fit plunger, shaft, and plug in reverse order of removal. Install solenoid and lock nut to same height as measured in step 1 above. Connect plunger shaft to solenoid with clevis pin and install cotter key.

5) Tighten solenoid lock nut and install inspection plates. Assemble pump to engine as previously described.

SPICA FUEL INJECTION (Cont.)

ALTITUDE COMPENSATOR (IF EQUIPPED)

1) Remove in this sequence: air cleaner, relay crank-to-control unit rod rear inspection cover from control unit, and altitude compensator with its mounting flange. *NOTE — Do not move control unit input lever (tape it in place), or disturb the inside devices of control unit or serious damage and out-of-adjustment may result.*



ALTITUDE COMPENSATOR

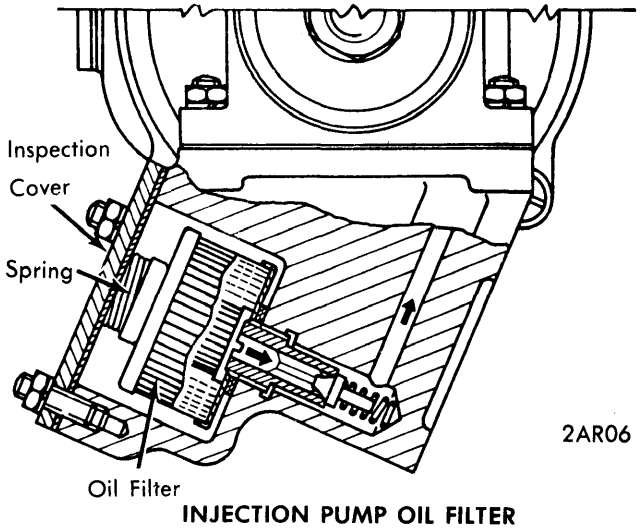
2) Measure dimension "A" (see illustration). Loosen lock nut and unscrew capsule, taking care not to rotate setting lever with respect to mounting flange. Screw in new capsule until dimensions previously taken are obtained, and lightly tighten lock nut.

3) Install capsule and mounting flange on control unit, making sure setting lever spring is properly positioned and setting lever itself is in "N" position. Replace rear inspection cover and rod.

REPLACING OIL FILTER IN INJECTION PUMP

1) Clean around filter housing and surrounding area, to prevent foreign matter from entering filter housing when filter is removed.

2) Remove cover and filter; insert new filter so that spring faces cover, and renew gasket. To facilitate air bleed and quick filling of oil filter, slightly tighten two upper cover retaining nuts, crank engine a few seconds (until oil comes out), then lock nuts fully.



INJECTION PUMP OIL FILTER

CHECKS & ADJUSTMENTS

NOTE — Some checks and or adjustments are covered under "Testing & Trouble Shooting" Section.

COLD START SOLENOID

1) After installation, if operation is improper, adjustment may be necessary. To adjust solenoid, a suitable dummy thermostat tool (A.4.0120 for 1969-72 models, or A.4.0159 for 1973 models) must be used. *NOTE — On 1969-72 models, standard dummy is 29 mm and it must be shortened 10 mm (to 19mm) for this operation.*

2) With dummy thermostat installed, measure clearance between pin (on lever actuated by solenoid) and arm which it actuates. Correct clearance for 1969-72 models is .010", and clearance for 1973 models should be .008-.012". Screw solenoid in or out to obtain correct clearance. Tighten lock nut, install side cover and install pump on engine.

THROTTLE CONTROL UNIT LINKAGE

1) Disconnect both throttle rods, accelerator cable, and negative battery cable. With suitable tool (A.4.0121), attached to clamp studs, adjust idle stop screw until ball joint just touches reference plane of tool and set lock nut.

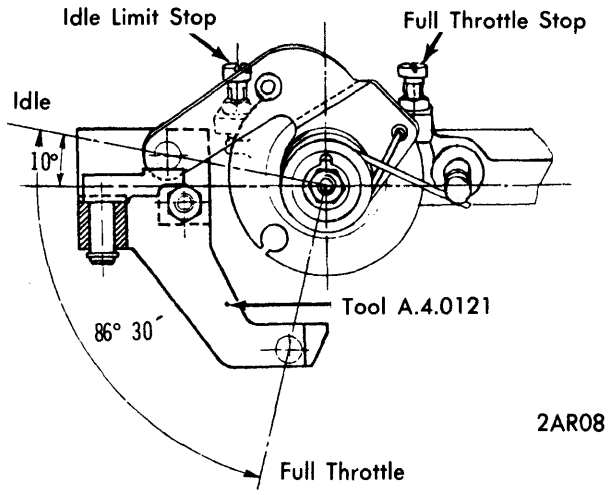
2) Adjust full throttle stop screw in same manner. Remove tool and replace throttle cable. Check that clearance between accelerator arm (see illustration) and limit bolt is .040-.060" with pedal at rest. Adjust limit bolt if necessary.

3) Depress accelerator to floor and check that clearance between relay crank lug and full throttle stop screw is .080". Adjust pedal stop on floor if necessary.

4) Reconnect relay crank-to-throttle rod and adjust length so throttles are just closed when relay crank is resting on idle limit stop. "Just Closed" can be varified by opening and closing throttles by hand (very slowly). Throttle plates will be felt touching their bores as they close. When relay crank is opened slightly and allowed to close under its own spring pressure there will be a click as the crank hits the limit stop.

5) Reconnect crank-to-control unit rod, battery cable, and start engine, warming it to 170°F. Check that clearance between control unit arm and its reference screw is .012-.024" (as close to .019" as possible). Adjust length of rod as required. Twisting rod ends to 30° off a common plane is permitted to obtain desired clearance. *NOTE — Never tamper with sealed reference screw on control unit.*

SPICA FUEL INJECTION (Cont.)



THROTTLE CONTROL UNIT LINKAGE

IDLE & MIXTURE

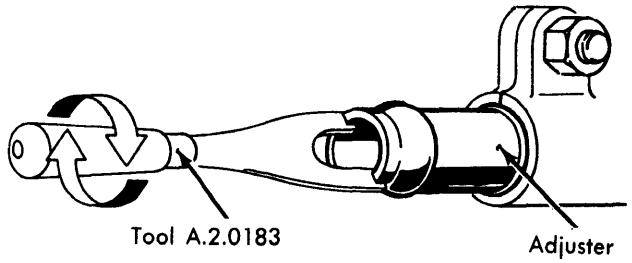
To insure proper control of exhaust emissions and proper driveability, it is necessary to adjust idle and operating mixture correctly. To obtain proper CO percentage at idle, operating mixture must be set properly. Operating mixture can only be set by road test or on engine dyno. To make necessary adjustment proceed as follows:

Idle – 1) With engine at normal operating temperature (170°F), remove air cleaner-to-equalizer block, and loosen tube and adjuster lock screw. Connect an accurate tachometer.

2) Using a suitable tool (A.2.0183), set idle speed on 1969-72 models to 650 RPM by turning adjuster. On 1973 models, set idle to highest RPM without engine running rough, but no less than 600 RPM. Screw adjuster in to reduce speed, out to increase speed. Tighten lock screw and replace tube.

3) With engine at normal operating temperature, road test car. Drive vehicle at a high RPM in low gears to burn deposits off spark plugs, then drive at constant speeds of 20-35 MPH in third gear. Next, accelerate very slowly from 30-35 MPH.

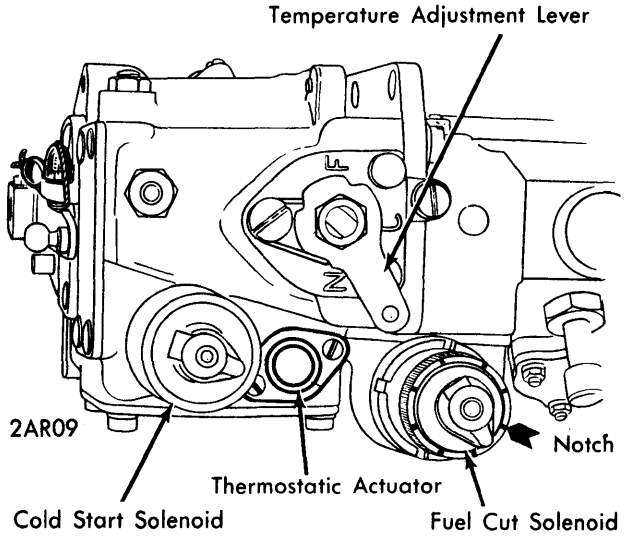
4) If a hesitation is felt, air/fuel mixture is too lean. In this case, fuel cut off solenoid must be backed out to obtain correct air/fuel mixture. If acceleration is sluggish, mileage is poor, spark plugs foul easily, or other over rich conditions exist, the air/fuel mixture must be leaned. Screw solenoid in until a lean mixture is obtained, then back out until lean hesitation no longer exists.



ADJUSTING IDLE SPEED

Mixture – 1) On top of fuel cut off solenoid are eight notches. Mark one of them with respect to a fixed point on control unit housing (for reference).

2) Disconnect solenoid feed wire. Loosen ring nut at bottom of solenoid, using a suitable tool (A.5.0177). *NOTE – Do not rotate solenoid.*



FUEL CUT SOLENOID & TEMPERATURE ADJUSTMENTS

3) Move solenoid one notch (1/8 turn) in or out, depending on whether mixture is lean or rich.

4) Retighten ring nut and connect feed wire. Check reference to be sure that solenoid had been moved one notch. Install air cleaner, idle air tubes, crankcase breather tubes, air inlet and road test (as described above).

CO Adjustment – 1) Attach a tachometer and a suitable exhaust gas analyzer to engine. On 1969-72 models, with engine speed at 650 RPM, CO reading must be between .8 and 2.2%. On 1973 models, with engine idle speed adjusted to 600-700 RPM, CO level should be .8-2.0%.

2) If CO level is not within specifications, remove air cleaner-to-equalizer block hose and loosen adjuster lock screw. Screw equalizer adjustment screw in to decrease RPM and increase CO level, and screw adjustment screw out to increase RPM and decrease CO level. Tighten lock screw and replace hose.

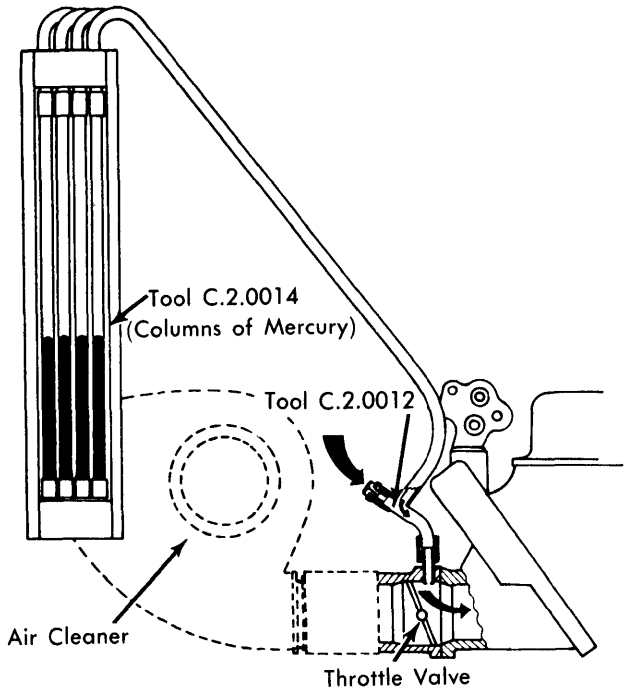
POSITIONING & ALIGNMENT OF THROTTLES

1) To perform this check, remove air cleaner and hoses to inlet port of each cylinder. Using a suitable tool (C.2.0012), in place of hoses, attach four columns of mercury (tool C.2.0014).

2) Start engine and warm it up until coolant temperature is at least 158°F (70°C); first check that clearance between control unit lever and its reference screw is .012-.024" (as close to .019" as possible) with thermostat actuator fitted.

3) Now check that readings on mercury columns are much the same (maximum difference: .4"); if this is not the setting proceed as follows:

SPICA FUEL INJECTION (Cont.)



CHECKING THROTTLE ALIGNMENT WITH MANOMETER

4) If reading in front pair of cylinders is **higher**, unscrew throttle coupling adjusting screw so as to close rear pair of throttles.

5) If front pair of cylinders is **lower** than rear pair, disconnect relay crank-to-throttle rod and set throttle coupling screw in such a way as to close front pair of throttles (screw in adjusting screw). Then reconnect relay crank-to-throttle rod and adjust its length so that throttle valves are in "just closed" position. *NOTE — Avoid sudden revving of engine, since too great a vacuum will suck the mercury out of gauge columns.*

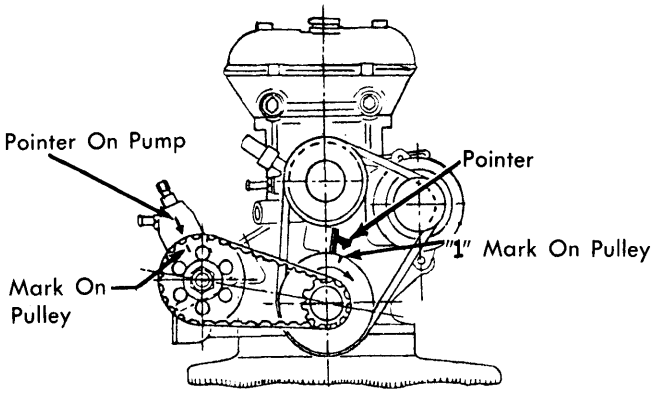
6) Disconnect adaptors and install air cleaner, blow-by tube, four idle air tubes, and air cleaner-to-equalizer tube.

TIMING INJECTION PUMP

1) Rotate crankshaft until mark "I" is aligned with pointer on crankshaft front cover, corresponding to 70° BTDC on induction stroke.

2) Now check that mark on injection pump pulley is aligned with reference on injection pump itself (to gain access to reference on injection pump remove protective cover). *NOTE — Reference marks can be out of alignment within a tolerance of about ± .2" (5 mm) corresponding to half pitch of pulley splines.*

3) If pump is out of alignment, remove drive belt and line up reference marks of injection pump and refit drive belt by rotating pulley in either direction to engage nearest spline. On completion of alignment replace protective cover.



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INJECTION PUMP TIMING

TESTING & TROUBLE SHOOTING

NOTE — Some tests are included under "Checks & Adjustments" Section.

TESTING INJECTORS

1) Use handpump, like that for testing Diesel injectors, but supplied with gasoline and provided with a pressure gauge with a top reading of 700-1000 psi (50-70 kg/sq. cm).

2) Disconnect test pump pipe to injector inlet fitting and **pump quickly** to prime pump and injector. **Pump slowly** until injector nozzle opens. This must take place at 360-400 psi (25-28 kg/sq. cm) for new injector, and at no less than 260 psi (18 kg/sq. cm) for used injectors.

3) Again pump slowly to bring pressure to 15-30 psi (1-2 kg/sq. cm) below rating pressure above. Make sure that there is no drip from nozzle within five seconds.

4) Pump quickly and check that spray is narrow, deep plunging and has good vaporization even at minimum delivery. At a distance of four inches from nozzle orifice, the spray cone delivery should be about .8" (20 mm). If injector does not meet these requirements, replace it with a new one.

5) Use a suitable tool (A.5.0165) to remove injectors. *NOTE — Before testing or removing injectors, the cause of malfunction should unquestionably be attributed to injectors themselves.*

TROUBLE SHOOTING INJECTOR SYSTEM

Engine Misfires; Rough Idle — Injector defective, injector pipe fitting leak, injection pipes cracked.

Rough Idle — Lean mixture, idle adjuster out of adjustment.

Fast Idle & Smokey Exhaust — Faulty thermostatic actuator.

Idle Too Fast — Accelerator linkage failing to return properly.

Unsatisfactory Performance; Hesitation — Control linkage out of adjustment, fuel pump outlet pressure too low, defective injector, defective injection pump or control, temperature setting improper, fuel outlet pressure too low (warning light on at high speed).

SPICA FUEL INJECTION (Cont.)

Excessive fuel Consumption – Fuel feed circuit leaks, thermostatic actuator defective, out of adjustment on injector pump, accelerator linkage failing to return properly.

Engine Stalls In Positions Other Than Idle – Defective altitude compensator, injection pump vibrating excessively.

Noisy Fuel Pump – Line between pump and main filter distorted or forced in rubber mounting or against recovery pipe. Tank filter and hoses improperly fitted.

Detonations In Tail Pipe On Deceleration – Fuse #6 blown, feed wire disconnected from fuel cut off solenoid, defective fuel cut off solenoid, defective fuel cut off devise micro switch.

Engine Stops – Fuel cut off solenoid stuck in cut off position or sluggish in operation.

Noisy Electric Fuel Pump – Line between pump and main filter distorted or forced in rubber mounting or against recovery pipe, tank filter and hoses improperly fitted.