GROUP 6

ENGINE

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ENGINE

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DESCRIPTION AND OPERATION

ENGINE CONSTRUCTION

Engine Usage

The 1.9 liter engine is standard equipment on all 1973 Opel 1900, Manta and GT models. This engine has a compression ratio of 7.6:1 and operates on "regular" low lead grade fuel.

Engine Construction

The *cylinder head* is made of high-grade chromium grey cast iron. The valve guides are cast intergal with the head. The overhead camshaft is supported in four bearings in the cylinder head.

Location of the valve seats in ***combustion chamber*** is above the center of cylinder bore. The spark plug is positioned in the center and near the highest point of combustion chamber. This arrangement provides for short flame travel, uniform combustion and **good** cold start prop&ties. ***Exhaust valves*** **have seat** inserts of highly heat and water resisting material. The head surface is alumetized and so are the seats of the *inlet valves* Alumetizing makes the valve heads non- scaling and promotes long life. All engines have "roto-caps".

The forged, five main bearing crankshaft has large-diameter main and connecting rod bearing journals with considerable overlap for vibration-free operation. Tri-metal bearing shells are used for main and connecting rod bearings. The crankshaft end play is controlled by the rear main bearing.

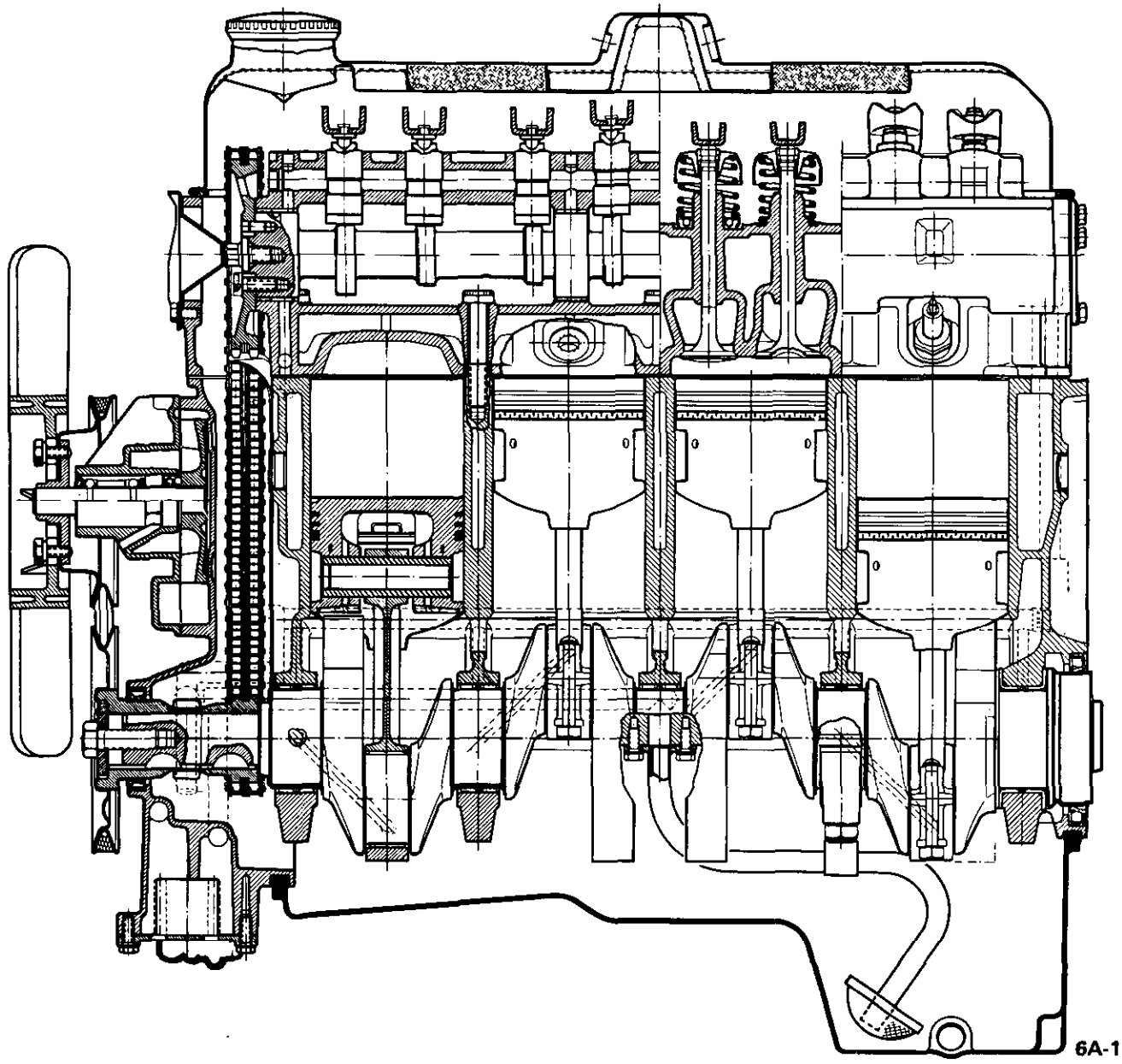


Figure 6A-1 Side Cross Section View of Engine

This engine has full skirt "Autothermic" type pistons with two horizontal slots in oil control ring groove, which partly separate head and skirt to maintain good contact with the cylinder walls throughout the entire temperature range.

The camshaft located in the cylinder head is an important design feature of the new power units. This arrangement permits an extremely rigid valve train which accounts for precise valve timing. The grey cast iron camshaft has induction hardened bearing journals and cams. Installation of camshaft is facilated by each diameter of the four bearings and journals being slightly smaller than the preceding.

Camshaft end play is controlled at forward end by the camshaft front bearing seat outer face in one direction, and by the front bearing cover in the other direction. A nylon bolt in camshaft forward end serves to adjust end clearance.

The camshaft is driven by an endless ***Duplex roller*** chain. The crankshaft double sprocket and pulley arc held by one key. The camshaft sprocket is fixed with a guide pin and attached with 3 bolts.

Inside the timing case, a long damper block is provided on the driving side of the chain and a shorter, curved spring plate tensioner on the non-driving side. Both have wear-resistant and oil-proof synthetic rubber slipper pads. The self adjusting ***chain*** tensioner located on driving side of chain at right

hand side above crankshaft sprocket, has a plunger head with oil- proof and wear-resistant synthetic rubber pad, which is pressed against chain by both spring and oil pressure.

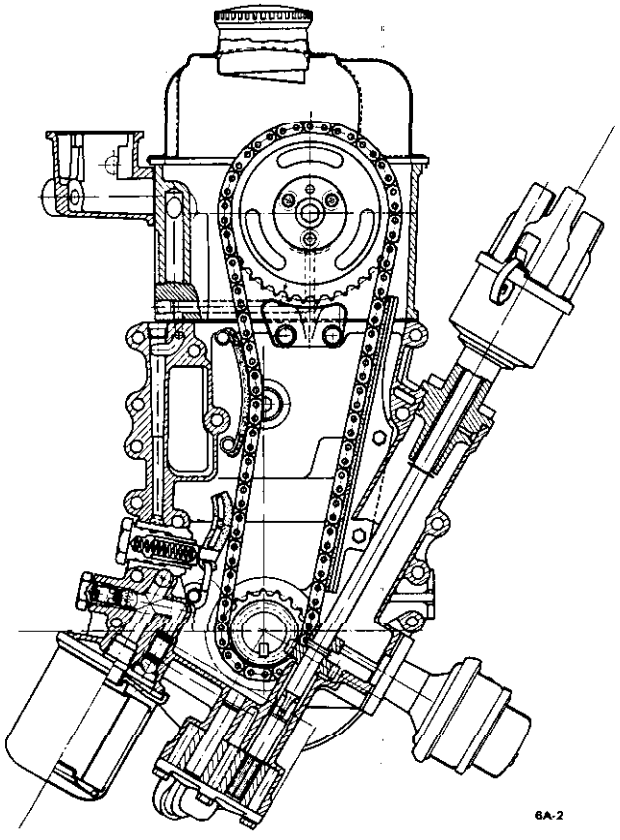


Figure 6A-2 Sectional View. Timing System

The top end of the short, light-weight *hydraulic valve lifters* is provided with a cup in which tits the ball end of a stud engaged in an elongated hole in rocker arm, thus maintaining transverse alignment of the rocker arm.

The ***rocker arm*** is a steel stamping and pivots on a ball secured by a self-locking nut on a stud screwed into the cylinder head. This arrangement permits easy valve clearance adjustment. All valves have oil seals installed between valve spring and cap.

The *fuel pump* is located at bottom left-hand side of timing case and operated by, a cam integral with distributor drive gear riveted to distributor drive shaft.

The aluminum alloy cast ***intake manifold*** with smooth walls provide better charge of cylinders, especially at high engine RPM. It is a four-port manifold, i.e. there are separating walls between all arms, one for each cylinder. An adapter for crankcase ventilation hose leading to rocker arm cover is arranged on front portion of intake manifold.

Hot exhaust gases are used for heating a vaporization plate located at bend of intake manifold below carburetor and communicating with its tinned underside with the interior of the exhaust manifold to ensure that only vaporized fuel reaches the cylinders.

LUBRICATION SYSTEM AND OIL PUMP

The engine is lubricated by a forced feed system

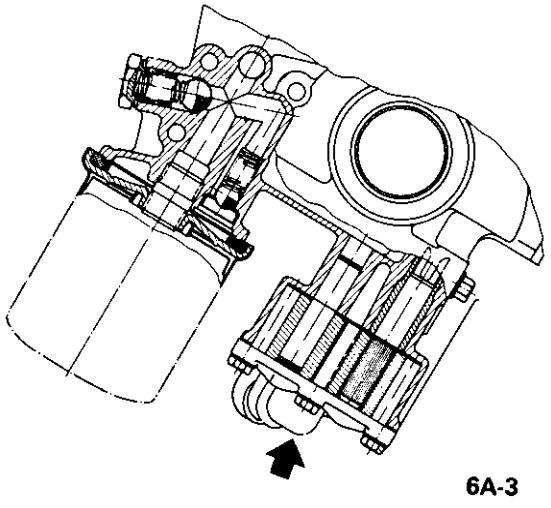


Figure 6A-3 Oil Pump Pressure Relief Valve

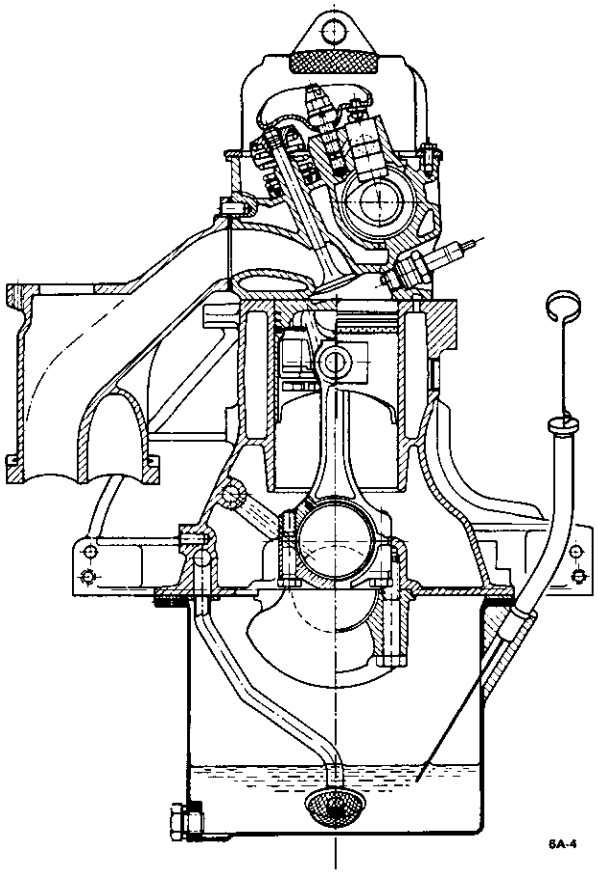


Figure 6A-4 Rear Cross Sectional View

incorporating a gear-type pump driven by the distributor shaft. The pump body forms part of the timing case. A passage cast in cylinder block and a suction pipe connect the pump to the screen cover assembly in the sump of the oil pan.

The oil pump pressure relief valve is located in the engine oil pump cover. See Figure 6A-3. The pressure relief valve serves to feed surplus oil back into the suction passage should the required oil pressure be exceeded. The old oil pressure relief valve which is located above the oil filter is inoperative. A heavier spring has been installed to keep the valve seated at all times.

The oil filter is of the full flow type. With it in parallel is a by-pass system controlled by a valve in the timing chain cover above the oil filter which ensures oil circulation directly to lubrication points if element becomes clogged by dirt or oil is too thick to pass through. Only when oil flow through element is unrestricted the by-pass valve will close and filtered oil is fed to the engine.

Oil flow through the engine is as follows: The oil pump draws oil from the sump through the screen and pumps it through drilled passages in timing case to the full flow filter. From there it passes to the cylinder block main oil gallery with a branch in timing case to no. 1 camshaft bearing. Drilled passages lead from the oil gallery to crankshaft main bearings and in the crankshaft from main bearings to connecting rod bearings. The camshaft front journal has a crescent shaped groove which controls the oil supply to cylinder head oil gallery. The cylinder head oil gallery delivers oil under pressure to all valve lifters, to Nos. 2, 3 and 4 camshaft bearings, and to rocker arm seats. An additionally drilled passage connects the valve lifter circular groove with circular groove of rocker arm stud from where the oil is directed upwards through a drilled passage to the rocker arm seat. The cams are lubricated by oil under pressure.

Surplus oil collects at end of cylinder head and returns through a passage to the crankcase. A calibrated squirt hole in connecting rod big end bearing sprays oil against right-hand side of cylinder wall: Additional cylinder wall and piston pin lubrication is through oil splash from crankshaft. A jet in timing case projects oil against oil pump drive, and the timing chain receives lubrication from above the chain tensioner.

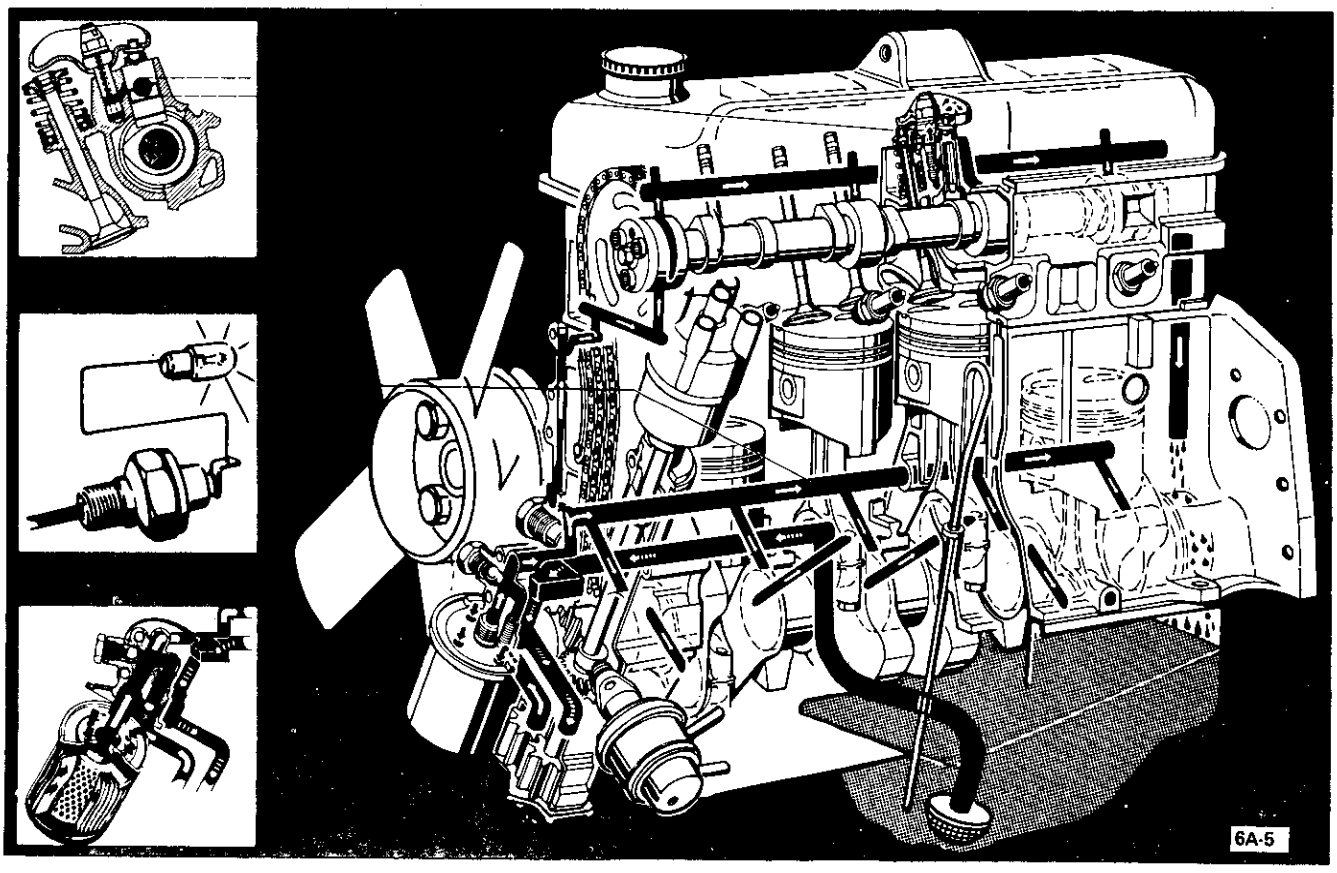


Figure 6A-5 Engine Lubrication System

DIAGNOSIS

EXCESSIVE OIL CONSUMPTION

Condition	Correction
External Oil Leaks at: Rocker Arm Covers Crankcase Front Cover Oil Pan and Gasket	Tighten attaching bolts. If leaks persist, remove cover (or pan), check sealing surfaces for burrs or scoring, replace gasket, and seal bolts with silastic sealer or equivalent. Make sure oil level is not overfull.
Improper Reading of Dip-Stick	Car may not be level when taking r Insufficient oil "drain-back" time after stopping engine (three minutes must be allowed). Dip-stick may not be completely pushed down against stop. Dipstick may be bent.
Oil Viscosity Too Light	Use recommended SAE viscosity for prevailing temperatures.
Continuous High-Speed Driving	At speeds above 60 mph, increased sumption can be expected with any Inform customer of this fact.
High-Speed Driving Following Normal Slow Speed City Driving	When principal use of automobile i city driving, crankcase dilution f condensation occurs. High speed a temperatures will remove water, resulting in what appears to be rapid lowering of oil level. Inform customer of this fact.
Piston Rings Not "Broken In"	Allow engine to accumulate at leas 4,000 miles before attempting any engine disassembly to correct for oil consumption.

NOISY VALVES AND LIFTERS

The noise level of the valve mechanism cannot be properly judged where the engine is below operating temperature when the hood is raised, or when the valve rocker arm covers are removed.

Before attempting to judge valve noise level, the engine must be thoroughly warmed up (at least 20 minutes of operation at 1200 to 1500 RPM) to stabilize oil and coolant temperatures and bring all engine parts to a normal state of expansion. When the engine is warmed up, listen for engine noise while sitting in the driver's seat with the hood closed. Run the engine at idle and at various higher speeds.

If the preceding check indicates valve mechanism is abnormally noisy, remove the rocker arm cover so that the various conditions that cause noise may be checked. A piece of heater hose of convenient length may be used to pick out the particular valves or valve linkages that are causing abnormal noise. With the engine running at a speed where the noise is pronounced; hold the end of hose to an ear and hold other end about 1/2 inch from point of contact between rocker arm and valve stem. Mark or record the noisy valves for investigation of following causes:

1. ***Sticking, Warped, or Eccentric Valves, Worn Guides*** Sticking valves will cause irregular engine operation or missing on a low speed pull and will usually cause intermittent noise.

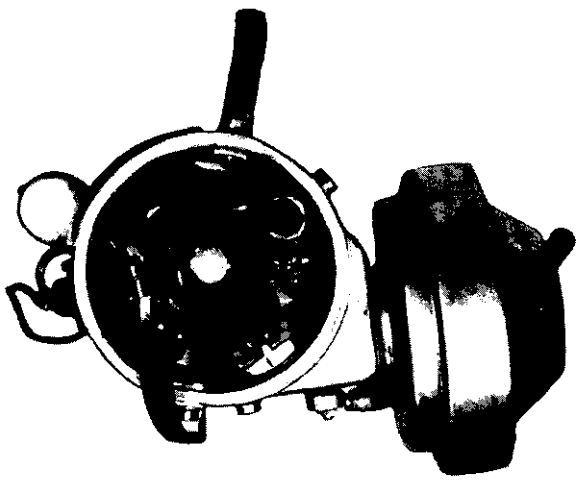
Pour penetrating oil over the valve spring cap and allow it to drain down the valve stem. Apply pressure to the one side of the valve spring and then the other, and then rotate the valve spring about 1/2 turn. If these operations affect the valve noise, it may be assumed that valves should be reconditioned.

2. ***Worn or Scored Parts in the Valve Train*** Inspect rocker arms, push rod ends for scoring. Check push rods for bends, valve lifters, and camshaft surfaces for scoring. Replace faulty parts.

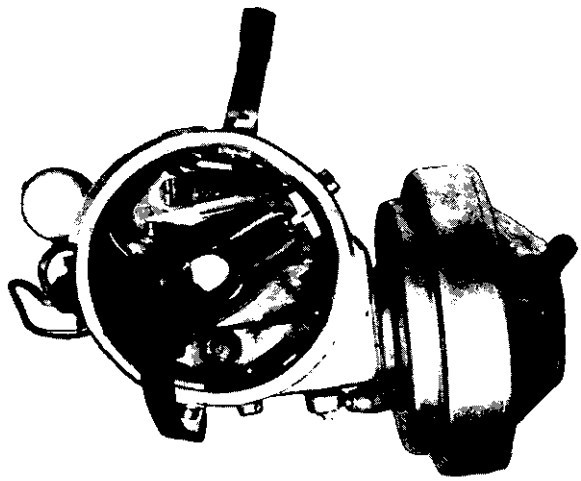
MAINTENANCE AND ADJUSTMENTS

VALVE LIFTER ADJUSTMENT

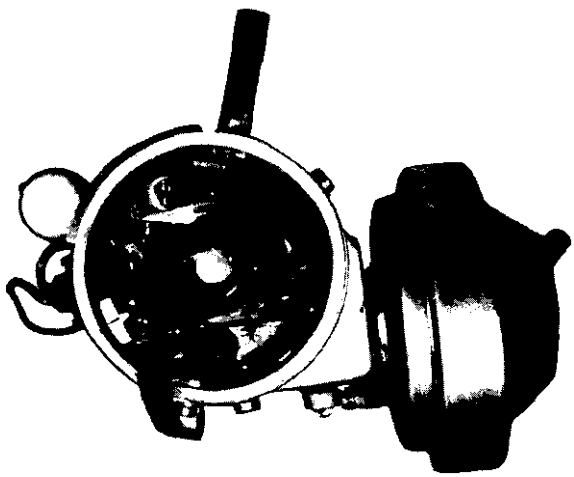
Perform hydraulic valve lifter adjustment with the engine off. It makes no difference whether the engine is cold or is at operating temperature. Set piston of the respective cylinder to upper top center on the firing stroke. This can be accomplished by removing the distributor cap and observing the rotor. Check position of the rotor and follow spark path for the rotor tip through the distributor cap, high tension wire to spark plug. This determines which cylinder is at upper top center on the firing stroke. Adjust the hydraulic lifters of the two valves for that cylinder at this time. When they are adjusted, turn engine so that another cylinder is at upper top center on the firing stroke and adjust the two valve lifters for that cylinder. Repeat process until all valves are adjusted. See Figure 6A-6 for correct rotor position for each cylinder.



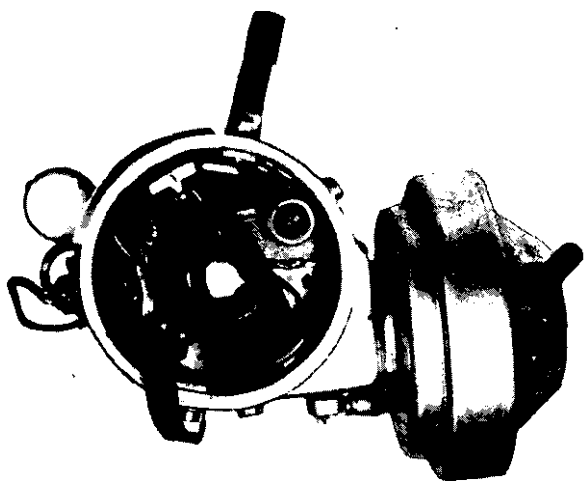
CORRECT ROTOR POSITION TO ADJUST VALVES ON CYLINDER NO. 1



CORRECT ROTOR POSITION TO ADJUST VALVES ON CYLINDER NO. II



CORRECT ROTOR POSITION TO ADJUST VALVES ON CYLINDER NO. III



CORRECT ROTOR POSITION TO ADJUST VALVES ON CYLINDER NO. IV

6A-6

Figure 6A-6 Rotor Positions for Valve Lifter Adjustment

Actual adjustment is made by backing off adjusting nut at the rocker arm until clearance exists between the valve stem, rocker arm, and lifter. Then slowly tighten adjusting nut until clearance is eliminated. When clearance is eliminated, turn adjusting nut one full turn (clockwise). This positions the hydraulic piston of the hydraulic lifter mid-point in its total available travel, and no further adjustment is required.

MAJOR REPAIR

ENGINE ASSEMBLY REMOVAL AND INSTALLATION

Removal (Opel 1900 and Manta)'

The engine assembly on the Opel 1900 and Manta can be removed together with the transmission through the top of the engine compartment.

1. Remove hood (scribe hood hinge to hood mounting location).
2. Disconnect battery negative cable.
3. Drain coolant at lower radiator hose.
4. Remove upper and lower radiator hoses.
5. Remove radiator and fan shroud.
6. Disconnect heater hoses.
7. Disconnect brake booster vacuum hose.
8. Remove air cleaner.
9. Disconnect electrical connections and accelerator linkage.
10. Remove console.
11. Remove shift lever boot, plate, and shift lever.
12. Raise car on hoist.
13. Disconnect fuel line at pump.
14. Remove front stone shield.
15. Disconnect speedo-cable, back-up light switch, and clutch cable.
16. Remove drive shaft.
17. Disconnect exhaust pipe and bell housing support.
18. Disconnect transmission support. See Figure 6A-7.
19. Remove engine mount bolts. See Figure 6A-8.
20. Attach hoist chains.
21. Lift engine and transmission assembly out of car.

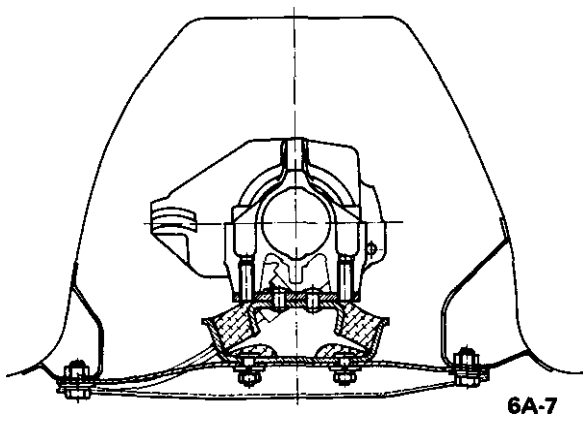


Figure 6A-7 Transmission Support Bolts . Opel 1900 and Manta Series

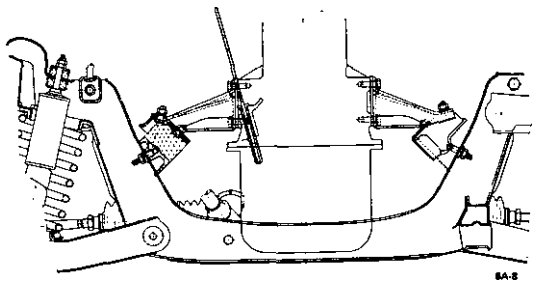
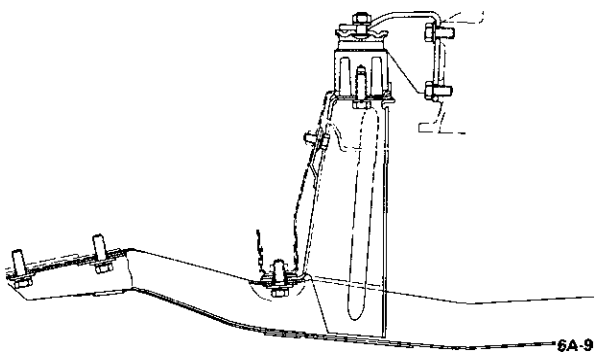


Figure 6A-8 Engine Mount Bolts ▪ Opel 1900 and Manta Series

Removal (GT)

The removal and installation of the 1.9 liter engine is only possible towards the floor and from below respectively.



Fig, 6A-9 Left Front Engine Suspension with Cross Member (GT)

The engine **does not rest on** the front suspension cross member as in the Opel 1900 and Manta but on a separate cross member. On removal and installation of the engine the front suspension cross member need not be detached.

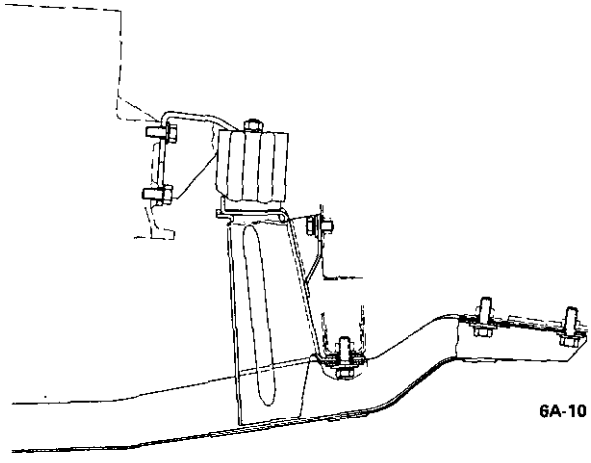


Fig. 6A-10 Right Front Engine Suspension with Cross Member (GT)

1. Disconnect battery negative cable,

2. Remove air cleaner.

3. Drain radiator coolant by disconnecting lower radiator hose. Disconnect upper radiator hose. See Figure 6A-11. Radiator need not be disconnected.

4. Disconnect all electrical connections:

a. Coil wire to distributor.

b. Wires from alternator. Remove unit and bracket.

c. Battery positive cable at starter switch.

d. Oil pressure switch wires at cylinder block.

e. Wires from starter solenoid.

5. Remove vacuum hoses at tee mounted to intake manifold. Remove tee from manifold to avoid interference during engine lowering.

6. Remove throttle linkage and carburetor.

7. Disconnect heater hoses.

8. Disconnect water valve bracket to manifold,

9. Remove gear shift lever.

10. Using suitable equipment lift up engine so that front engine mounts are somewhat relieved.

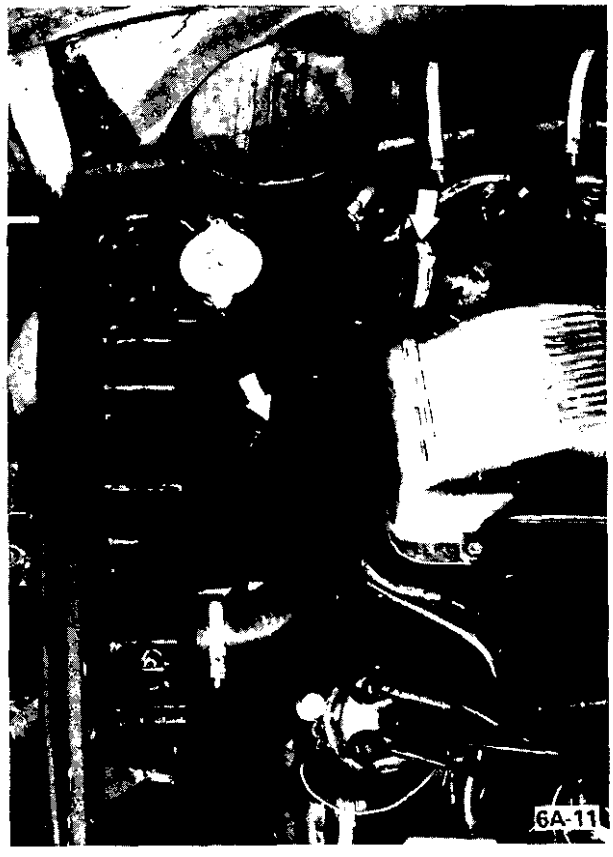


Figure 6A-11 Radiator Hose Clamp Location

11. Raise vehicle, both front and rear end. A two post axle type hoist is recommended for this operation.

12. Disconnect fuel line at fuel pump and plug. Be sure fuel line is disconnected from any engine and transmission clips.

13. Disconnect speedometer cable from transmission.

14. Disconnect clutch cable.

15. Disconnect drive shaft at rear universal joint and remove.

16. Disconnect exhaust at manifold.

17. Remove tailpipe and muffler hangers.

18. Remove ground strap from engine to side rail.

19. Detach transmission cross member from transmission and frame. See Figure 6A-12.

20. Detach engine cross member from engine and frame.

21. Carefully lower engine **and** transmission and remove from underneath vehicle.

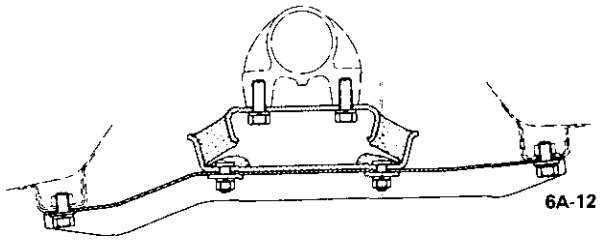


Fig. 6A-12 Transmission Cross Member

Installation (Opel 1900 and Manta)

1. Lower engine and transmission assembly into car.

2. Install components as removed in steps 1 through 19 above.

Installation (GT)

1. Install bell housing, transmission and starter.

2. Using suitable equipment raise assembly into vehicle.

3. Install components as removed in steps 1 thru 21.

ENGINE OIL PAN REMOVAL AND INSTALLATION

Removal (Opel 1900 and Manta)

To remove the engine oil pan, a device similar to the one illustrated in Figure 6A-14 can be made and used to support the front of the engine. This particular device was made up using hardwood, bolts, and chain.

1. Assemble chains to engine.

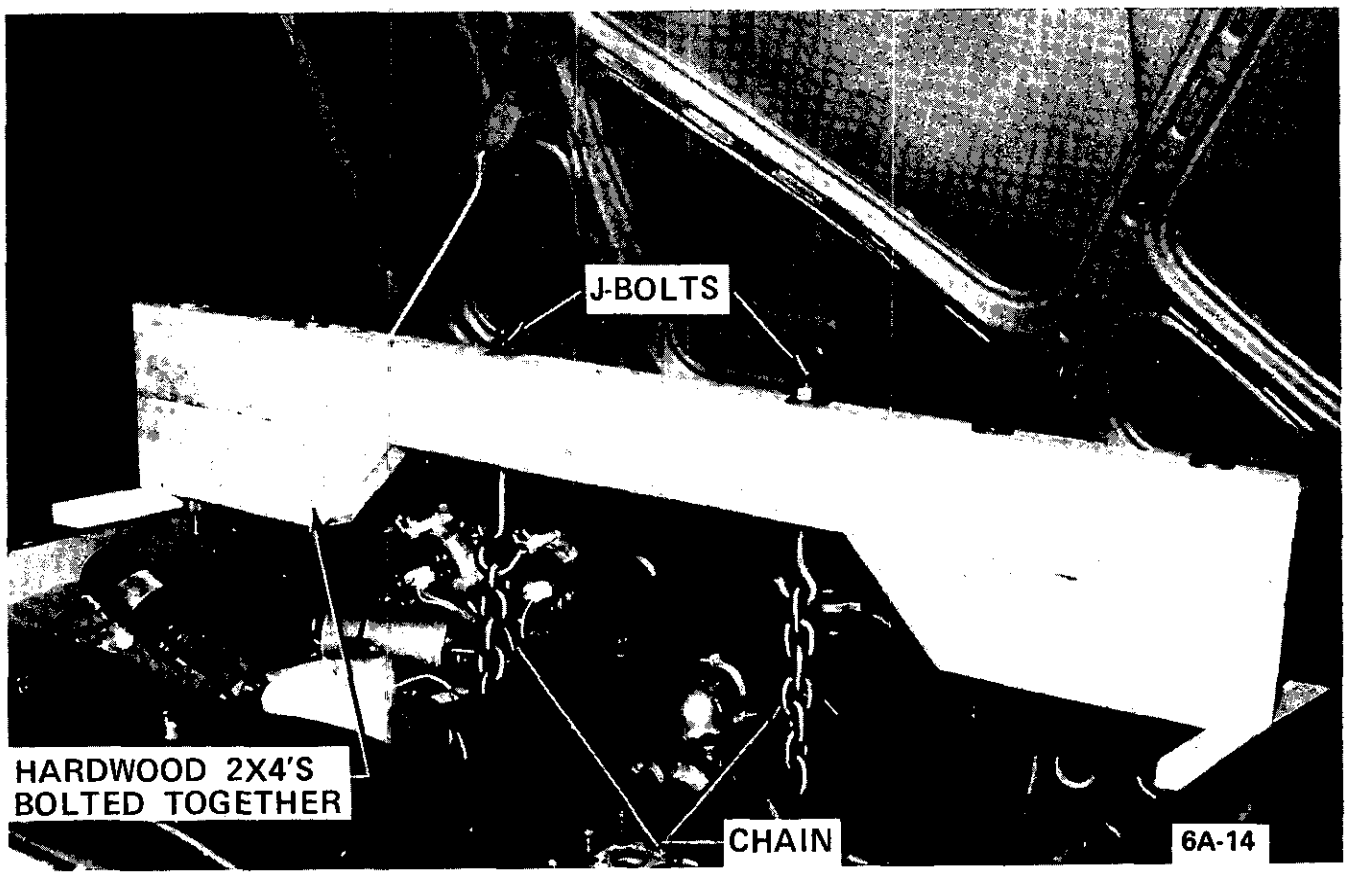


Figure 6A-14 Engine Support Tool - Opel 1900 and Manta.

a. Attach left chain to alternator support rear bolt.

b. Bolt right chain to existing threaded hole at lower right front of engine.

2. Assemble loose ends of chain to support device J- bolts and adjust to remove engine weight from motor mounts.

3. Remove the two motor mount bracket to motor mount retaining nuts.

4. Remove the two front suspension to frame rail bolt retaining nuts.

5. Remove nut and bolt at lower end of steering shaft U-joint.

6. With a floor jack under the center of the front suspension cross member, raise car high enough for wheels and suspension assembly to be rolled from under car.

7. Position jack stands under both front jack brackets on underbody to support car in this position.

8. Remove both front cross member support to frame attaching bolts.

9. Remove brake pipe to brake hose retaining clips at frame rails and disconnect brake hose from brake pipes. Use an absorbent material or suitable container for the brake fluid that will drain out.

10. Lower the front suspension assembly and remove from under car.

11. Drain engine oil and remove oil pan and gasket.

Installation (Opel 1900 and Manta)

1. Apply a light bead of sealer to the clean sealing surfaces of the oil pan and affix a new gasket.

2. Bolt oil pan and gasket assembly to engine block.

3. Roll front suspension and floor jack under car and raise into position careful to pilot the cross member to frame rail attaching bolts and steering shaft to their respective locations.

4. Install cross member support to frame attaching bolts and torque to 22 lb.ft.

5. Connect brake hose to brake pipes and install retaining clips.

6. Bleed front brake system. Maintain brake fluid level.

7. Remove jack stands and lower car.

8. Install suspension to frame rail bolt retaining nuts.

9. Release and remove engine supporting device.

10. Install motor mount bracket to motor mount retaining nuts.

11. Install steering shaft U-joint lower bolt and nut.

12. Replace engine oil.

Removal (GT Series)

1. Support engine in vehicle using Tool J-23375. See Figure 6A- 15.

Figure 6A-15 Engine Holding Fixture

Install tool by removing upper engine mount nut and installing fixture. Replace nut and tighten. The engine will now be supported by the tool, between the frame rails. The front suspension need not be removed on GT Models.

2. Drain oil.

3. Remove oil pan bolts and remove oil.

Installation (GT Series)

1. Replace oil pan and bolts.

2. Remove engine holding fixture and replace engine mounts.

3. Replace engine oil.

INTAKE AND EXHAUST MANIFOLD REMOVAL AND INSTALLATION

Removal

1. Disconnect battery.

2. Remove air cleaner.

3. Disconnect throttle linkage at carburetor.

4. Disconnect vacuum advance line at carburetor.

5. Remove fuel line at carburetor inlet.

6. Remove positive crankcase ventilation hose at rocker arm cover.

7. Disconnect E.G.R. lines from carburetor and intake manifold.

8. Disconnect exhaust pipe.

9. Remove six bolts attaching manifold assembly to cylinder head and remove manifold and carburetor as an assembly. Discard manifold gasket.

To separate intake and exhaust, manifold, remove carburetor and four bolts using Tool J-23016, attaching intake manifold to exhaust manifold. Always install a new manifold intermediate gasket when the manifolds are separated.

Installation

1. Install new manifold gasket and place manifold in position.

2. Install manifold bolts. New manifold to cylinder head gasket must be installed whenever a manifold is removed.

3. When installing the manifold, start with the No. 1 and No. 2 bolts. See Figure 6A-16. Gradually tighten both bolts until snug. Then continue with the rest of the bolts in the sequence illustrated in Figure 6A-16. Torque bolts to 33 lb. ft.

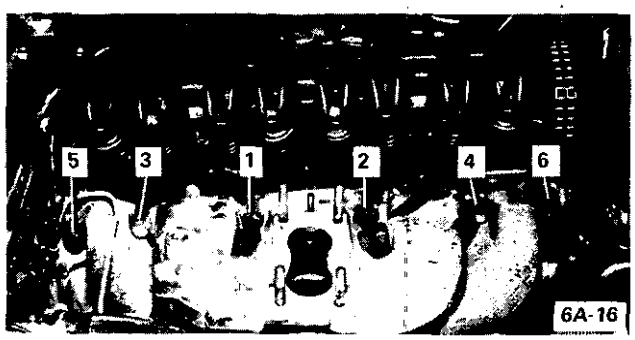


Figure 6A-16 Manifold Bolt Tightening Sequence

4. Connect parts removed in Steps 1 thru 8 above.

CYLINDER HEAD REMOVAL AND INSTALLATION

Removal

1. Drain coolant from radiator and block. Loosen drain plug on right side of engine to avoid coolant entering into cylinder bores. Drain plug is located on the right rear of cylinder block above oil pressure switch.

2. Remove hoses from thermostat housing. Collect coolant as it contains anti-freeze.

3. Remove 6 intake and exhaust manifold attaching bolts and swing assembly aside.

4. Remove spark plug wires from plugs.

5. Remove bracket bolt holding spark plug wires away from cylinder head.

6. Remove rocker arm cover.

7. Remove 10 cylinder head bolts using 12 MM serrated drive J-22915, and 2 cylinder head to timing chain cover bolts with a 6MM hex head wrench. See Figure 6A-17.

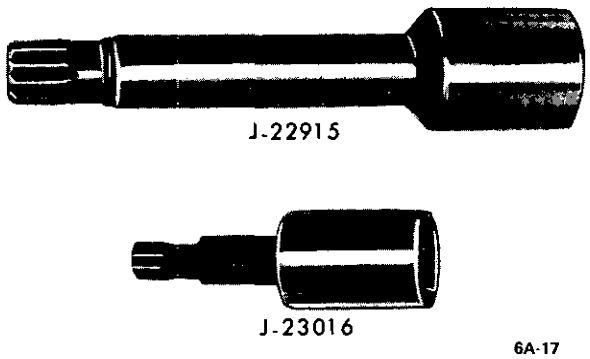


Figure 6A-17 Serrated Bits

8. Remove three bolts attaching plate to front of cylinder head.

9. Remove plastic screw from end of camshaft.

10. Remove 3 bolts attaching camshaft sprocket to cylinder head. Slide sprocket off of camshaft and remove head. Place head on bench supported at each end by a block of wood to prevent damage to valves.

Installation

1. Install in reverse procedure to removal, paying particular attention to the following:

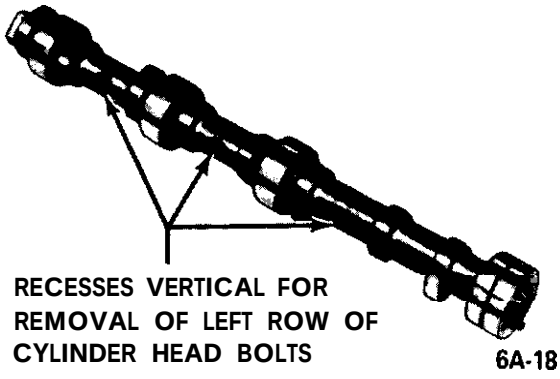
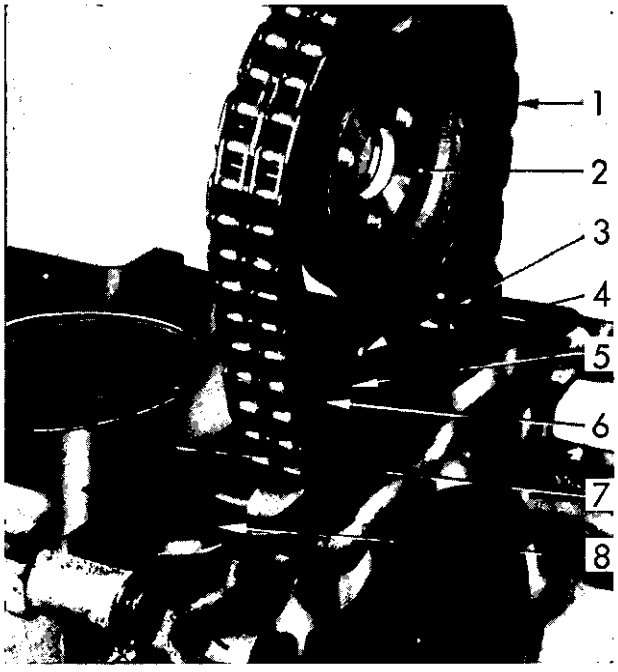


Figure 6A-18 Recesses in Camshaft

2. Clean piston tops and combustion chambers. Thoroughly clean all gasket surfaces on the cylinder block and cylinder head.

3. Lightly lubricate cylinder walls with engine oil. Install coolant passage rubber gasket ring in timing case. See Figure 6A-19.



1. TIMING CHAIN
2. CAMSHAFT SPROCKET
3. SPROCKET TIMING MARK
4. TIMING CASE
5. SUPPORT TIMING MARK
6. SUPPORT
7. CYLINDER BLOCK
6. RUBBER GASKET RING

6A-19

Figure 6A-19 Coolant Passage Rubber Gasket Ring in Timing Case

4. Apply silastic sealer or equivalent to both sides of the cylinder head gasket where the gasket mates with the timing chain cover, place new cylinder head gasket onto cylinder block.

5. Install cylinder head. Be careful to place head squarely over guide pins.

Rotate camshaft so that recesses are in vertical position to allow installation of left row of bolts.

6. Install 10 head bolts. Tighten the bolts a little at a time in the sequence shown in Figure 6A-20. Give bolts a final torque in the same sequence. Torque to 72 lb. ft. (cylinder head cold). Use same procedure for cylinder head to timing chain cover bolts with final torque at 17 lb.ft. See Figure 6A-20. These torques apply to lightly oiled threads.

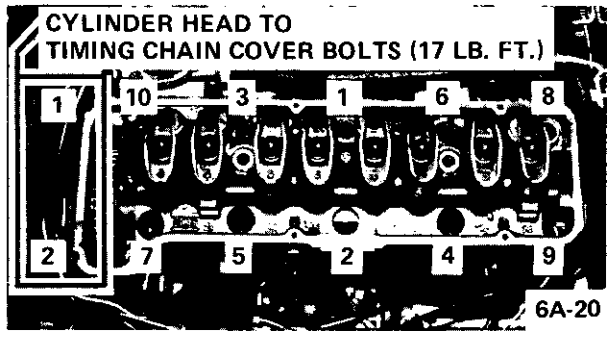


Figure 6A-20 Cylinder Head Bolt Tightening sequence

7. Slide camshaft sprocket with assembled chain onto camshaft and guide pin and fasten with bolts. Install nylon adjusting screw. After sprocket has been attached to camshaft, recheck alignment to see that chain has not slipped. Close front access hole.

8. Check camshaft end clearance between cover and nylon screw with feeler gauge. Clearance should be .004" - .008" Excess clearance can be eliminated by carefully readjusting cover with a suitable drift.

Reconditioning Valves and Guides

1. Remove cylinder head. Place on clean surface. Place head on bench supported at each end by a block of wood to prevent damage to valves.

2. Using suitable spring compressor, such as J-8062, compress valve spring and remove cap retainers. Release tool and remove spring and cap. See Figure 6A-21.

3. Remove valves. Place valves in numerical order so that they can be reinstalled in original location.

4. Remove all carbon from combustion chambers, piston heads, and valves. When using scrapers or

wire brushes for removing carbon, avoid scratching valve seats and valve faces. A soft wire brush such as J-8089 is suitable for this purpose.

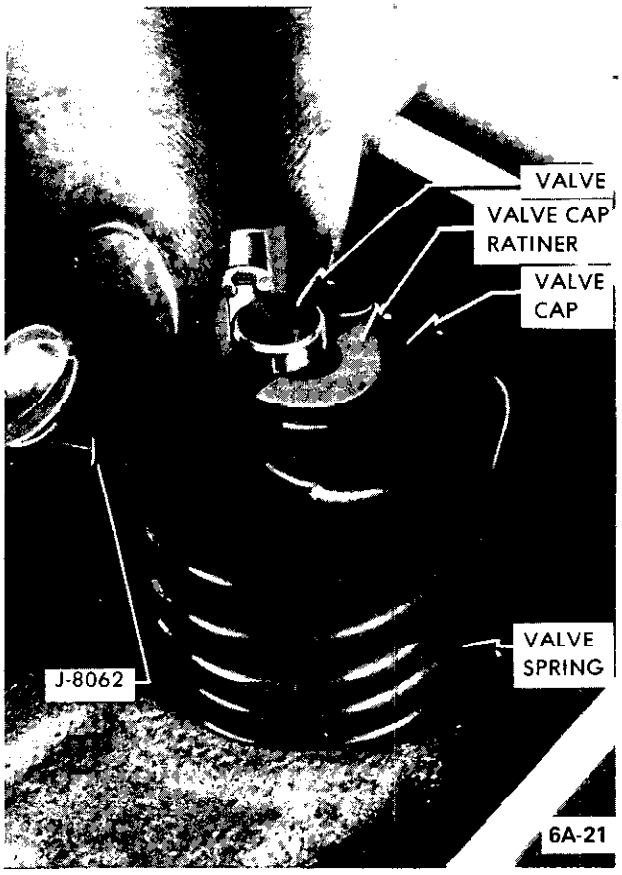


Figure 6A-21 Removing Valve Cap Retainers

5. Clean carbon and gum deposits from valve guide bores.

6. Inspect valve faces and seats for pits, burned spots or other evidences of poor seating. If a valve head must be ground until the outer edge is sharp in order to true up the face,discard the valve because the sharp edge will run too hot.

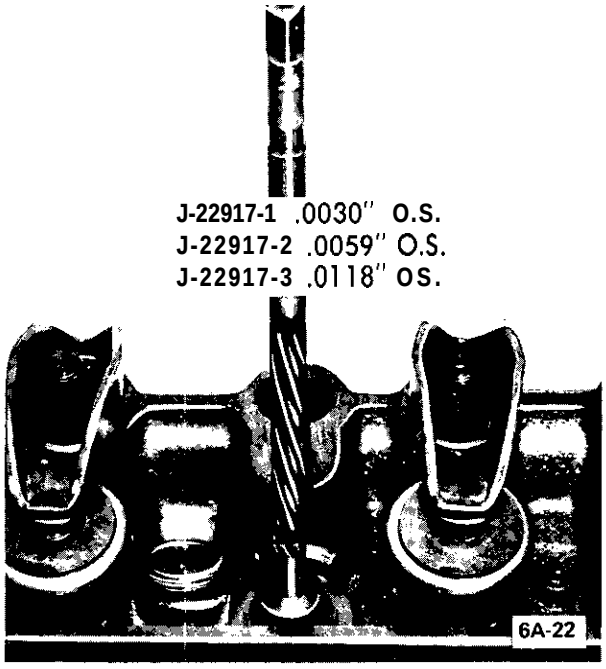


Figure 6A-22 Reaming Valve Guide

SIZE IN.		VALVE GUIDE DIA. IN.	CORRESPONDING VALVE STEM DIA.		OVERSIZE MARK
			INTAKE VALVE IN.	EXHAUST VALVE IN.	
PRODUCTION	STANDARD	.3553 - .3562	.3538 - .3543	.3524 .3528	–
PRODUCTION AND SERVICE	OVERSIZE .0030	.3582 .3592	.3567 .3572	.3553 .3559	1
	OVERSIZE .0059	.3615 - .3622	.3597 .3602	.3583 .3588	2
SERVICE	OVERSIZE .0118	.3671 .3681	.3656 - .3661	.3642 .3647	A

6A-2:

Figure 6A-23 Valve Guides and Corresponding Valves

New inlet valves must not be refaced or lapped with grinding compound. The correct angle for the intake and exhaust valve head is 44 degrees.

7. Inspect valve guides. Worn or pitted guides can be reamed to accept valves with oversize stems. Oversize valves are occasionally used in production. Oversize valves are marked " 1 " "2" or "A" and are stamped into the valve stem end and also stamped near spark plug hole. See Figure 6A-22.

8. Reseat valve seats in cylinder head in the following sequence:

Intake

With 45 degrees cutter, remove burnt structure until a metallic bright seat is obtained. Lightly coat valve head with red lead, insert it into guide and turn it under light pressure several times back and forth. Thereby a contact pattern is obtained and the seat width can be measured. If valve does not seat perfectly all around, lightly recut valve seat to the established seat width of .049" - .059" with 30 degrees correction cutter.

Exhaust

The directions for reconditioning intake valve seats apply in principle also to exhaust valve seat reconditioning with the exception that the valve seat width should be .063-.073 in. and different cutters are employed.

NOTE: *: Use* **new** *valve seals whenever valves are reconditioned.*

9. Lube valves with engine oil and reinstall valves, valve springs, caps and cap retainers using J-8062. Install valve spring with closely wound coils toward cylinder head. See Figure 6A-24.

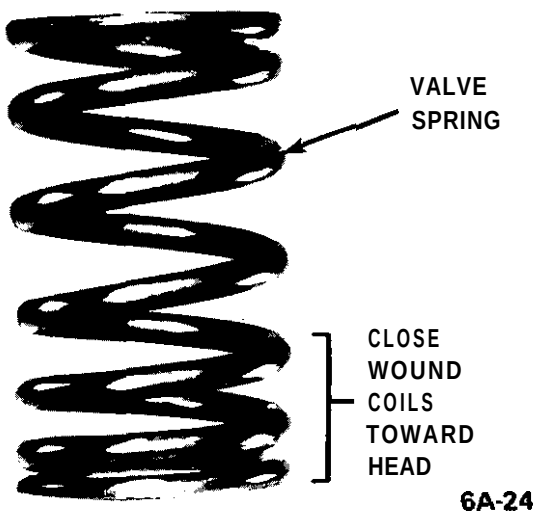


Figure 6A-24 Valve Spring

10. Install cylinder head.

11. Adjust valve clearance. See MAINTENANCE AND ADJUSTMENTS.

Replacing Rocker Arm Studs

1. When replacing rocker arm studs become necessary, remove air cleaner, rocker arm cover and rocker arm.

NOTE: ***The rocker arm studs are screwed into the cylinder head. A tapered part of the stem serves to a void stud loosening.***

2. Attach vise grip pliers to stud being removed and remove from cylinder head.

3. Screw in new stud. Seat tapered part of stud by striking stud end with a rubber hammer.

4. Place two turned down rocker arm nuts on threaded part of stud.

5. Torque stud into cylinder head to 29 lb.ft.

Valve Lifter Service

The valve lifters can be removed after removing rocker arm cover and **rocker arms.**

No oversize lifters have been released due to the insignificant wear of the valve lifters and cylinder head guides.

Amply oil respective parts and install in reverse sequence to removal.

Carry out hydraulic valve lifter adjustment as outlined in MAINTENANCE AND ADJUSTMENTS.

CONNECTING ROD BEARINGS

A connecting rod bearing consists of two halves or shells which are alike and interchangeable in rod and cap. When the shells are placed in rod and cap the ends extend slightly beyond the parting surfaces so that when rod bolts are tightened the shells will be clamped tightly in place to insure positive seating and to prevent turning. The ends of shells must never be tiled flush with parting surface of rod or cap.

If a precision type connecting rod bearing becomes noisy or is worn so that clearance on crankpin is excessive, a new bearing of proper size must be selected and installed since no provision is made for adjustment. Under no circumstances **should the connecting** rod or cap be filed to adjust the bearing clearance.

Inspection of Connecting Rod Bearings and Crankshaft Journals

Remove oil pan.

After removal of oil pan, disconnect two connecting rods at a time from crankshaft and inspect the bearings and crankpin journals. While turning crankshaft it is necessary to temporarily reconnect the rods to crankshaft to avoid possibility of damaging the journals through contact with loose rods.

If connecting rod bearings are chipped or scored they should be replaced. If bearings are in good physical condition check for proper clearance on crankpins as described under, checking clearance and selecting replacement connecting rod bearings.

If crankpin journals are scored or ridged, the crankshaft must be replaced, or reground for undersize bearings, to insure satisfactory life of connecting rod bearings. Slight roughness may be polished out with fine grit polishing cloth thoroughly wetted with engine oil. Burrs may be honed off with a fine oil stone.

Use an outside micrometer to check crankpins for out- of-round. If crankpins are more than .002" out-of- round, satisfactory life of new bearings cannot be expected.

Checking Clearance and Selecting Replacement Connecting Rod Bearings

Service **bearings** are furnished in standard size and several undersizes. The clearance of connecting rod (and crankshaft) bearings may be checked by use of Plastigage, Type PG-1 (green), or equivalent, which is soluble in oil.

1. Remove connecting rod cap with bearing shell. Wipe off oil from bearing and crankpin journal, also blow oil out of hole in crankshaft.

2. Place a piece of the plastic-type gauge material lengthwise along the bottom center of the lower bearing shell (Figure 6A-25, view A), then install cap **with** shell and tighten nuts to 36 lb. ft. Do not turn crankshaft with gauge type material in bearing.

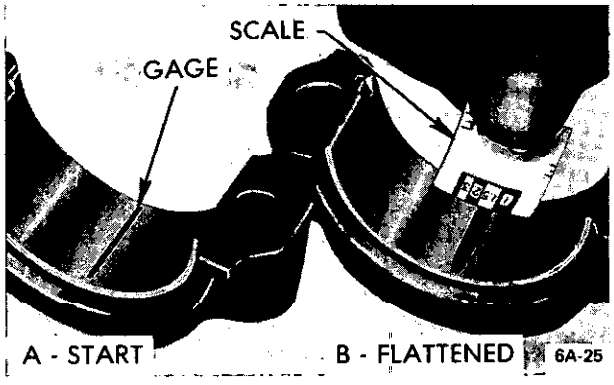


Figure 6A-25 Checking Bearing Clearance With Plastic-Type Gauge

3. Remove bearing cap with bearing shell, the flattened piece of gauge will be found adhering to either the bearing shell or the crankpin. Do not remove it.

4. Using the scale printed on the envelope, measure the flattened piece of gauge at its widest point. The **number** within the graduation which closely corresponds to the width of the gauge, indicates the bearing clearance in thousandths of an inch. See Figure 6A-25, View B.

5. The desired clearance with a new bearing is .0006"- .0025". If bearing has been in service it is advisable to install a new bearing if the clearance exceeds .003", however if bearing is in good condition and is not being checked because of bearing noise, it is not necessary to replace the bearing.

6. After the proper size bearing has been selected, clean off the gauge, oil thoroughly, reinstall cap with bearing shell and tighten nuts to 36 lb. ft.

CRANKSHAFT BEARINGS AND SEALS

Replacement of Crankshaft Bearings

A crankshaft bearing consists of two halves or shells which are identical and are interchangeable in cap and crankcase. All crankshaft bearings except the rear main **bearing** are identical. The crankshaft end **thrust** is taken up the rear (No. 5) main bearing.

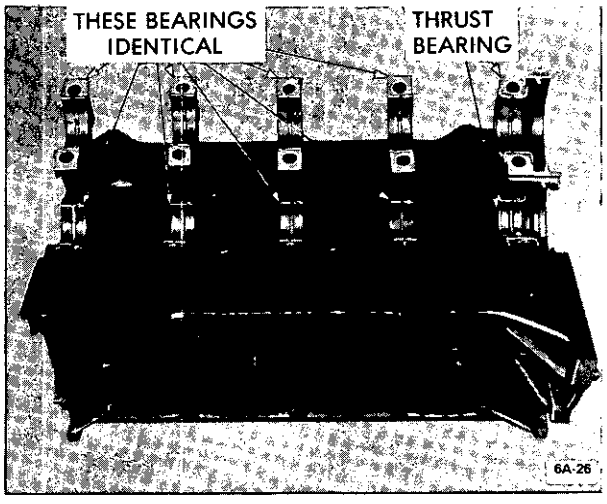


Figure 6A-26 Engine Crankshaft Bearings

When the shells are placed in crankcase and bearing cap, the ends extend slightly beyond the parting **surfaces** so that when cap bolts are tightened the shells will be clamped tightly in place to insure positive

seating and to prevent turning. The ***ends of shells must never be tiled flush with parting surface of crankcase or bearing cap.***

Crankshaft bearings are the precision type which do not require reaming to size. Shims are not provided for adjustment since worn bearings are readily replaced with new bearings of proper size. Bearings for service replacement are furnished in standard size and undersizes. ***Under no circumstances should crankshaft bearing caps be filed to adjust for wear in old bearings.***

After removal of oil pan, pipe and screen assembly, perform the following removal, inspection and installation operations on each crankshaft bearing in turn so that the crankshaft will be well supported by the other bearings.

If crankshaft has been removed to check straightness the following procedure is suggested. Rest crankshaft on "V-blocks" at number one and number live main bearing journals. Check indicator runout at No. 3 main bearing journal. Total indicator reading should not exceed .0012".

1. Since any service condition which affects the crankshaft bearings may also affect the connecting rod bearings, it is advisable to inspect connecting rod bearings first. If crankpins are worn to the extent that crankshaft should be replaced or reground, replacement of crankshaft bearings only will not be satisfactory.

If replacement of cylinder block or crankshaft is required, always check main bearing clearance with plastic-type gauge to obtain specified limits.

2. Remove one bearing cap, then clean and inspect lower bearing shell and the crankshaft journal. If journal surface is scored or ridged, the crankshaft must be replaced or reground to insure satisfactory operation with new bearings. Slight roughness may be polished out with tine grit polishing cloth thoroughly wetted with engine oil, and burrs may be honed off with a tine stone.

3. If condition of lower bearing shell and crankshaft journal is satisfactory, check the bearing clearance with a plastic-type gauge.

4. When checking a crankshaft bearing with plastic-type gauging material, turn crankshaft so that oil hole is up to avoid dripping of oil on the gauge material. Place paper shims in lower halves of adjacent bearings and tighten cap bolts to take the weight of crankshaft off ***the lower shell of beating being checked.***

5. If bearing clearance exceeds .003", it is advisable to install a new bearing; however, if bearing is in good condition and ***is*** not being checked because of bearing noise, it is not necessary to replace the bearing.

6. Loosen all crankshaft bearing cap bolts 1/2 turn, and remove cap of bearing to be replaced.

7. Remove upper bearing shell by inserting Bearing Shell Remover and Installer J-8080 in oil hole in crankshaft, then slowly turning crankshaft so that the tool rotates the shell out of place by pushing against the end without the tang. See Figure 6A-27.

When turning crankshaft with rear bearing cap removed hold oil seal to prevent it from rotating out of position in crankcase.

8. The crankshaft journal cannot be measured with an outside micrometer when shaft is in place; however, when upper bearing shell is removed the journal may be checked for out-of-round by using a special crankshaft caliper and inside micrometer.

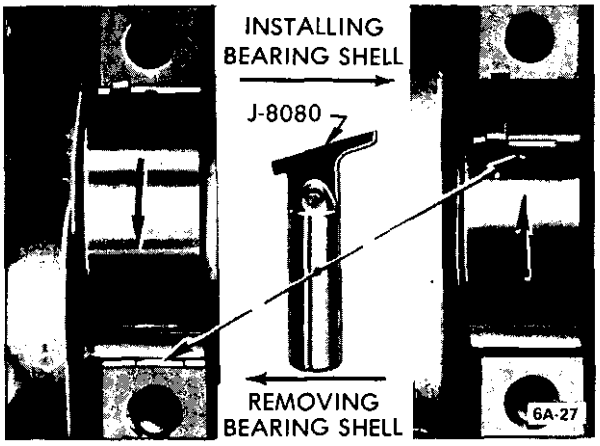


Figure 6A-27 Removing and Installing Crankshaft Bearing Upper Shell

The caliper should not be applied to journal in line with oil hole.

If crankshaft journal is more than .0012" out-of-round, the crankshaft should be replaced since the full mileage cannot be expected from bearings used with an excessively out-of-round crankshaft.

9. Before installation of bearing shells make sure that crankshaft journal and the bearing seats in crankcase and cap are thoroughly cleaned.

10. Coat inside surface of upper bearing shell with engine oil and place shell against crankshaft journal so that tang on shell will engage notch in crankcase when shell is rotated into place.

11. Rotate bearing shell into place as far as possible by hand, then insert Installer J-8080 in crankshaft oil hole and rotate crankshaft to push shell into place. Bearing shell should move into place with very little

pressure. If heavy pressure is required, shell was not started squarely and will be distorted if force into place.

12. Place lower bearing shell in bearing cap, then check clearance with plastic-type gauge, as previously described.

13. The desired clearance with a new bearing is .0009" to .0025". If this clearance cannot be obtained with a standard size bearing, insert an undersize bearing and check again with plastic-type gauge material.

14. When the proper size bearing has been selected, clean out all plastic gauge material, oil the lower shell and reinstall bearing cap. Clean the bolt holes and lube bolts, then torque cap bolts to 72 lb. ft. The crankshaft should turn freely at flywheel rim; however, a very slight drag is permissible if an undersize bearing is used.

15. If the thrust bearing shell is disturbed or replaced it is necessary to line up the thrust surfaces of the bearing shell before the cap bolts are tightened. To do this, move the crankshaft fore and aft the limit of its travel several times (last movement fore) with the thrust bearing cap bolts finger tight.

16. After bearing is installed and tested, loosen all bearing cap bolts 1/2 turn and continue with other bearings. When bearings have been installed and tested, tighten all bearing cap bolts to 72 lb. ft.

17. Replace rear bearing oil seals.

18. Install pipe and screen assembly and oil pan.

Installation of Rear Bearing Oil Seals (Engine in Vehicle)

1. Remove transmission, bell housing and clutch. Refer to appropriate section for removal procedures.

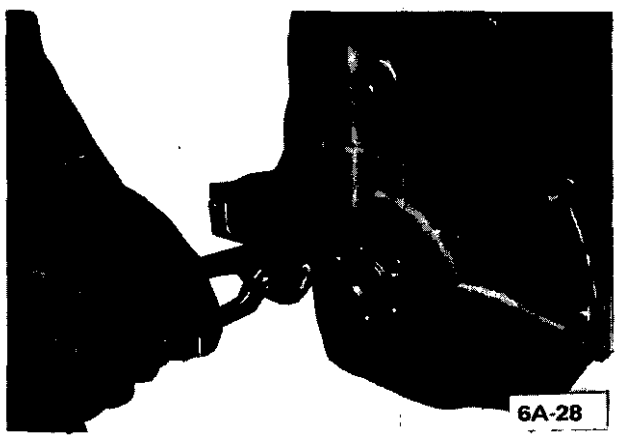


Figure 6A-28 Removing Rear Main Oil Seal

2. Remove flywheel.

3. Punch a hole into oil seal and screw in a sheet metal screw and pull out oil seal. See Figure 6A-28.

4. To insure proper sealing, lubricate seal with a suitable protective grease and install on taper ring J-22928. Turn seal to ensure lip of seal is not turned back. See Figure 6A-27.

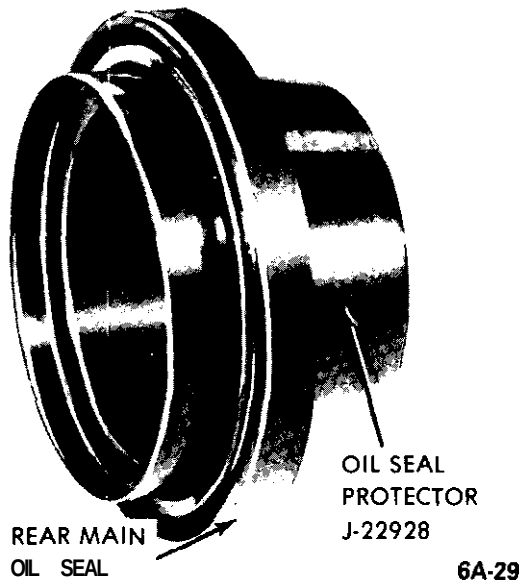


Figure 6A-29 Installing Oil Seal on Tool J-22928

5. Place tapered ring with oil seal on crankshaft flange and move lip of seal over rear of crankshaft. Be careful not to tilt seal.

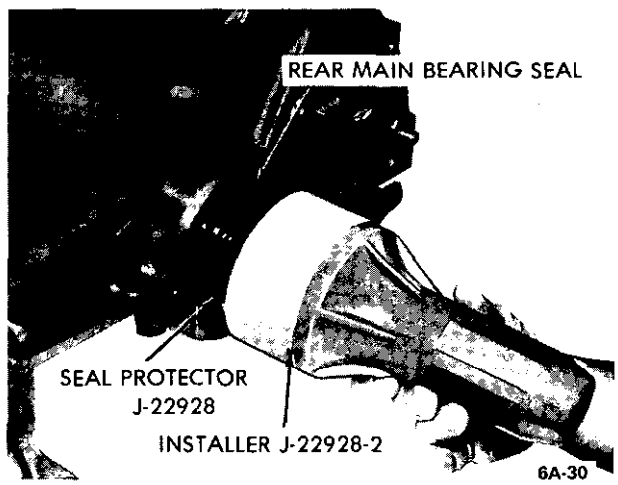


Figure 6A-30 Installing Rear Main Bearing Oil Seal

6. Drive in oil seal using Tool J-22928-2. See Figure 6A-30.

7. Install flywheel, clutch, bell housing and transmis-

sion. When replacing flywheel use new bolts and torque to 43 lb.ft.

PISTON, RINGS AND CONNECTING RODS

Removal and Disassembly of Piston and Rod Assemblies

1. Drain oil.

2. Remove oil pan.

3. Remove cylinder head.

4. Examine the cylinder bores above the ring travel. If bores are worn so a ridge exists, remove the ridges with a ridge reamer to avoid damaging rings or cracking ring lands in pistons during removal.

5. Mark the cylinder number on all pistons, connecting rods and caps. Starting at the front end of the crankcase, the cylinders are numbered l-2-3-4,

6. Remove cap and bearing shell from number 1 connecting rod.

7. Push the piston and rod assembly up and out of top cylinder. Then reinstall cap and bearing shell on rod.

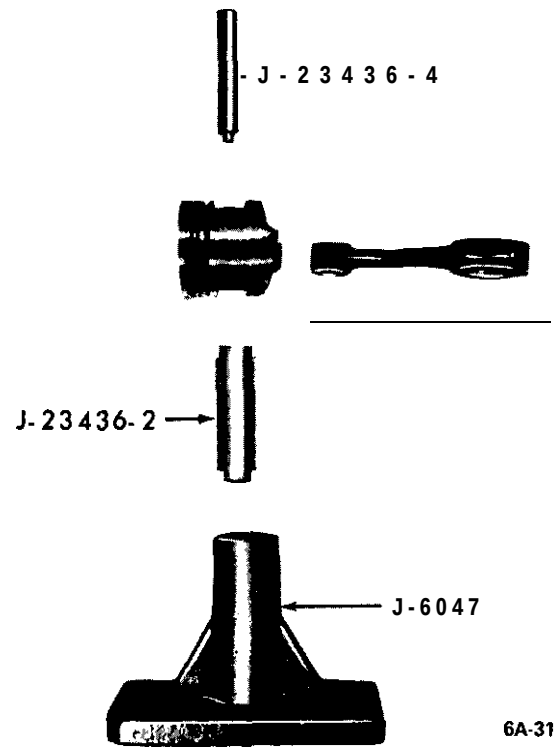


Figure 6A-3 1 Piston Pin Removal Tool Layout - 1 .9 Engine

8. Remove other rod and piston assemblies in the same manner.

9. Remove compression rings and oil rings.

10. Remove piston pin in following manner:

a. Position base support J-6047 on hydraulic press.

b. Place tool J-23436-2 in base support with large diameter bore facing upward. See Figure 6A-31.

c. Position piston and rod assembly on tool J-23436-2 making certain the pin is aligned on tool.

d. Position tool J-23436-4 in opposite end of piston pin and press pin out.

Inspection of Cylinder Bores

Inspect cylinder walls for scoring, roughness, or ridges which indicate excessive wear. Check cylinder bores for taper and out-of-round with an accurate cylinder gage at top, middle and bottom of bore, both parallel and at right angles to the centerline of the engine. The diameter of the cylinder bores at any point may be measured with an inside micrometer or by setting the cylinder gauge dial at "0" and measuring across the gauge contact points with outside micrometer while the gauge is at the same "0" setting.

If a cylinder bore is moderately rough or slightly scored but is not out-of-round or tapered, it is possible to repair the bore by honing to accept a standard service piston. If cylinder bore is very rough or deeply scored, it may be necessary to rebore the cylinder to fit an oversize piston in order to insure satisfactory results.

If a cylinder bore is tapered .0005" or more, or is out-of-round .0005" or more, it is advisable to hone or rebore for the smallest possible oversize piston and rings.

Visual Inspection of Pistons, Rings, and Pins

Clean carbon from piston surfaces and under side of piston heads. Clean carbon from ring grooves with a suitable tool and remove any gum or varnish from piston skirts with suitable solvent.

Carefully examine pistons for rough or scored bearing surfaces, cracks in skirt, head cracked or broken ring lands, and chipping or uneven wear which would cause rings to seat improperly or have excessive clearance in ring grooves. Damaged or faulty pistons should be replaced.

Fitting Pistons to Cylinders

The pistons are cam ground, which means that the

diameter at the right angle to the piston pin is greater than the diameter parallel to the piston pin. When a piston is checked for size, it must be measured with micrometers applied to the skirt at points 90 degrees to the piston pin. See Figure 6A-32. The piston should be measured (for fitting purposes) 2 1/2 inches below the top of piston.

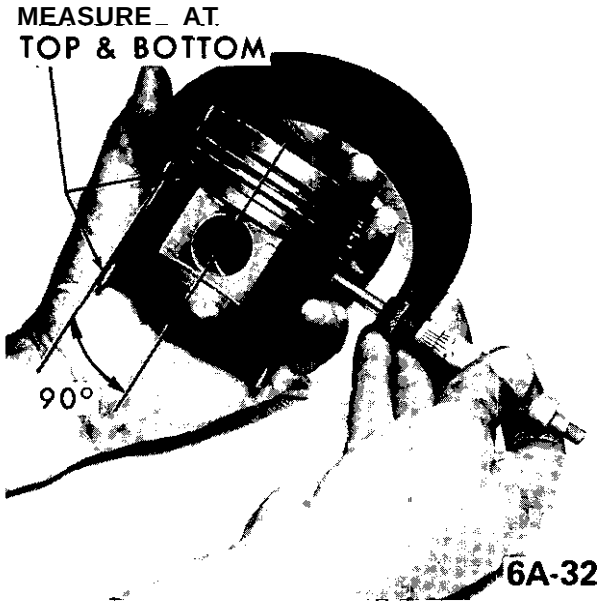


Figure 6A-32 Measuring Piston

Inspect bearing surfaces of piston pins. Check for wear by measuring worn and unworn surfaces with micrometers. Rough or worn pins should be replaced. Check fit of piston pins in piston bosses. Occasionally pins will be found tight due to gum or varnish deposits. This may be corrected by removing the deposit with a suitable solvent. If piston bosses are worn out-of-round or oversize, the piston and pin assembly must be replaced. Oversize pins are not practical because the pin is a press fit *in* the *connecting* rod. Piston pins must tit the piston with .0004" to .0007" clearance.

Examine all piston rings for scores, chips or cracks. Check compression rings for tension by comparing with new rings. Check gap of compression rings by placing rings in bore at bottom of ring travel. Measure gap with feeler gage. Gap should be between .011" and .021". If gaps are excessive (over .021") it indicates the rings have worn considerably and should be replaced.

No attempt should be made to cut down oversize pistons to fit cylinder bores. This practice will destroy the surface treatment and affect the weight. The smallest possible oversize service pistons should be used and the cylinder bores should be honed to size for proper clearance.

1. Before installing piston, piston rings, or reboring cylinders, observe the following:

Cylinder bores may not be the same size. Standard replacement piston sizes are in the midpoint of the cylinder bore size range. Therefore, it may be necessary to hone cylinders for correct piston tit. Out-of-round on cylinder bore must not exceed .0005" maximum with a taper of not over .0005".

Before the honing or reboring operation is started, measure all new pistons with micrometer contacting at points exactly 90 degrees to piston pin (Figure 6A-32) then select the smallest piston for the first fitting. The slight variation usually found between pistons in ***a set*** may provide for correction if the first piston has excessive clearance.

If wear of cylinder does not exceed .005" honing is recommended for truing the bore. If wear or out-of-round exceeds these limits, the bore should be trued up with a fly cutter boring **bar** and then finish honed.

When reboring cylinders, all crankshaft bearing caps must be in place and tightened to proper torque to avoid distortion of bores in final assembly. Always be certain the crankshaft is out of the way of the boring cutter when boring each cylinder. When making the final cut with boring bar, leave .001" on the diameter for finish honing to give the required clearance specified.

When honing cylinders, use clean sharp stones of proper grade for the required amount of metal to be removed, in accordance with instructions of the hone manufacturer. Dull or dirty stones cut unevenly and generate excessive heat. When using coarse or medium grade stones use care to leave sufficient metal so that all stone marks may be removed with the fine stones used for finishing in order to maintain proper clearance.

When finish honing, pass the hone through the entire length of cylinder at the rate of approximately 60 cycles per minute. This should produce the desired 45 degree cross hatch pattern on cylinder walls which will insure maximum ring life and minimum oil consumption.

It is of the greatest importance that refinished cylinder bores have not over .0005" out-of-round or tapered. Each bore must be final honed to remove all stone or cutter marks and provide a smooth surface. During final honing, each piston must be fitted individually to the bore in which it will be installed and should be marked to insure correct installation.

After final honing and before the piston is checked for fit, each cylinder bore must be ***thoroughly*** washed to remove all traces of abrasive and then dried. The dry bore should then be brushed clean with a power-driven fibre brush. If all traces of abrasive are not removed, rapid wear of new pistons and rings will result. Fit new pistons in the following manner:

2.. Expand a telescope gage to fit the cylinder bore at right angles to the piston pin 2-1/2″ from top. See Figure 6A-33.

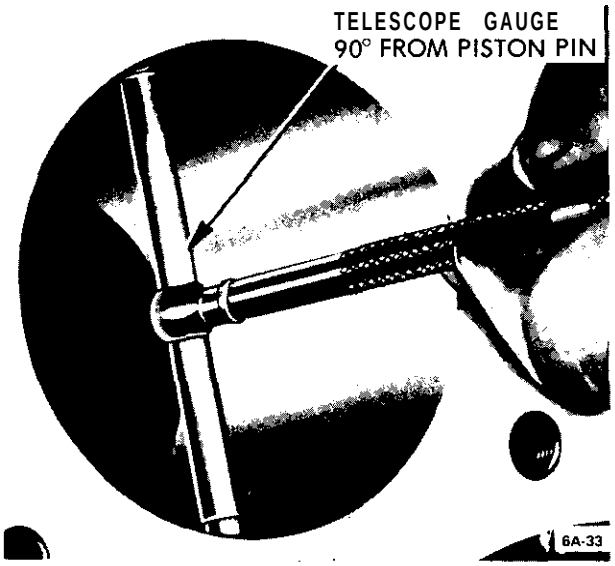


Figure 6A-33 Checking Cylinder Bores

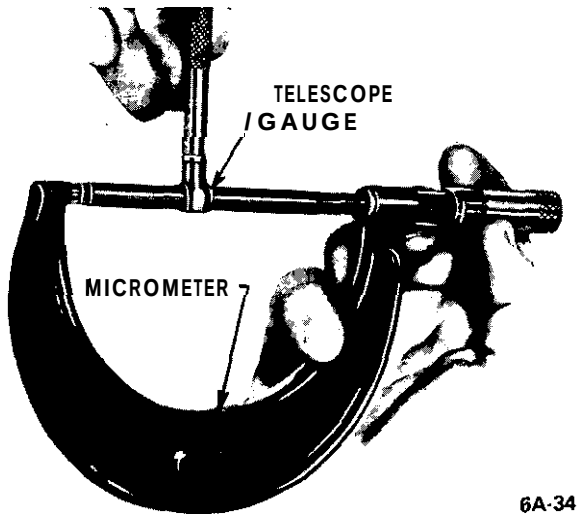


Figure 6A-34 Measuring Telescope Gage

3. Measure the piston to be installed. See Figure 6A-32. The piston must be measured at right angles to the piston pin 2-1/2″ below the top of piston. The piston must be between .0008″ and .0012″ smaller than the cylinder bore.

Both block and piston must be at approximately the same temperature when measurements are made or expansion errors will occur. A dif.ference of 10 degrees F between parts is sufficient to produce a variation of .0005″.

Fitting New Piston Rings

When new piston rings are installed without reboring cylinders, the glazed cylinder walls should be slightly dulled without increasing the bore diameter by means of the finest grade honing stones.

New piston rings must be checked for clearance in piston grooves and for gap in cylinder bores; however, the flexible oil rings are not checked for gap. The cylinder bores and piston grooves must be clean, dry, and free of carbon and burrs.

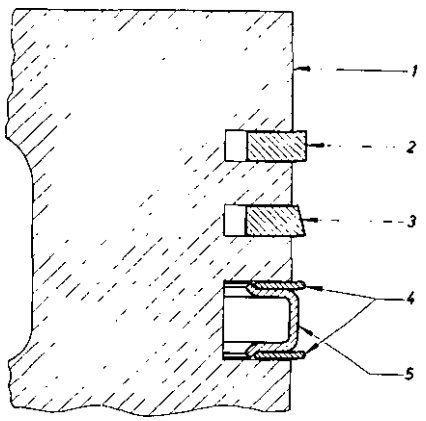
To check the end gap of compression rings, place the ring in the cylinder in which it will be used and square it in the bore by tapping with the lower end of a piston. Measure the gap with feeler gages.

Piston ring end gap should be .014″ - .022″ (top) and .014″ - .022″ (2nd) and the oil ring end gap should be .015″ - .055″.

If gap is less than specified, file the ends of rings carefully with a smooth tile to obtain proper gap.

Install piston rings as follows:

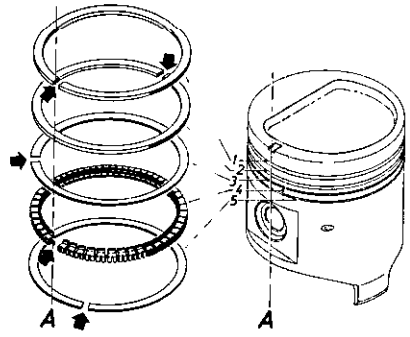
1. Upper ring is chrome plated and can be installed either way up. Number two (2) ring has to be installed with the marking “top” up. Oil ring can be installed either way up. See Figure 6A-35.



1. PISTON
2. NO. 1 COMPRESSION RING - INSTALLED WITH EITHER SIDE UP.
3. NO. 2 COMPRESSION RING - INSTALLED WITH “TOP” MARKING TOWARDS THE TOP.
4. UPPER AND LOWER STEEL BAND RING - INSTALLED WITH EITHER SIDE UP.
5. INTERMEDIATED RING - INSTALLED WITH EITHER SIDE UP.

Figure 6A-35 Arrangement of Piston Rings

2. Install piston rings so gaps are positioned as shown in Figure 6A-36.



1. NO. 1 COMPRESSION - GAP IN FRONT
2. NO. 2 COMPRESSION - GAP IN REAR
3. UPPER STEEL BAND - 1 - 2 IN. TOWARDS THE LEFT OF INTERMEDIATE RING GAP
4. INTERMEDIATE RING - GAP IN FRONT
5. LOWER STEEL BAND - 1 - 2 IN. TOWARDS THE RIGHT OF INTERMEDIATE RING GAP.

"A" VERTICAL LINE FOR PISTON AND RINGS, FRONT

6A-36

Figure 6A-36 Location of Piston Ring Gaps

With rings installed on piston, check clearance in grooves by inserting feeler gages between each ring and its *lower* land. Any wear that occurs forms a step at inner portion of the lower land. If the piston grooves have worn to the extent that relatively high steps exist on the lower lands, the piston should be replaced since steps will interfere with the operation of new rings causing ring clearances to become excessive. Piston rings are not furnished in oversize widths to compensate for ring groove wear.

When fitting new rings to new pistons, the side clearance of the compression rings should be .0024" - .0034" (top) and .0013" - .0024" (2nd), and the oil ring clearance should be .0013" - .0024".

Assembly of Piston and Connecting Rod

*NOTE: **Connecting rods may be out of alignment due to shipping or handling. Always check a new rod before installing piston and pin.***

Inspect piston pin bores and piston pins for wear. Piston pin bores and piston pins must be free of varnish or scuffing when being measured. The piston pin should be measured with a micrometer and the piston pin bore should be measured with a dial bore gage or an inside micrometer. If clearance is in excess of the .001" wear limit, the piston and piston pin assembly should be replaced.

1. Lubricate piston pin holes in piston and connecting rod to facilitate installation of pin.

2. Install pin in following manner:

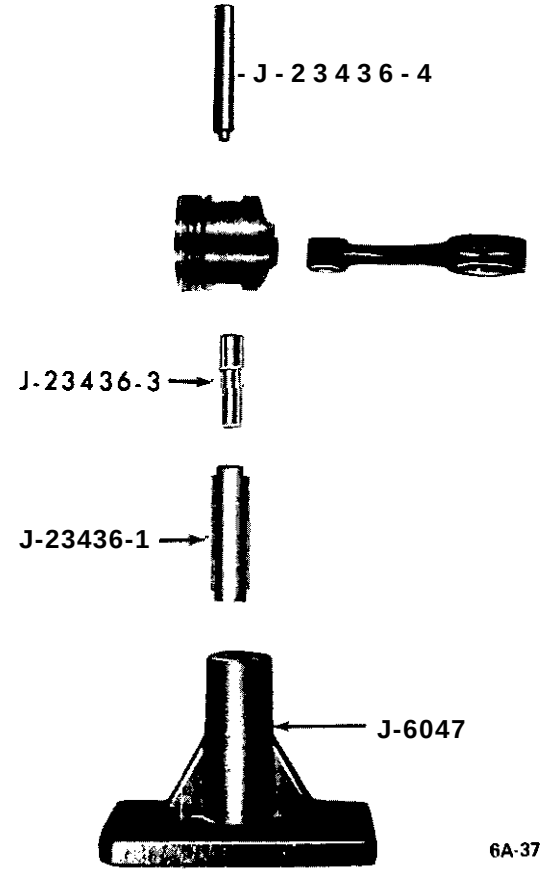
a. Position base support J-6047 on hydraulic press.

b. Place tool J-23436-l in support J-6047 with small diameter bore facing upward.

c. Place small end of tool J-23436-3 in bore of tool J-23436- 1.

d. Position piston, rod, and pin guide J-23436-3.

e. Line up pin on piston, and using tool J-23436-4 press pin into piston. See Figure 6A-37.



6A-37

Figure 6A-37 Piston Pin Installation Tool Layout - 1.9 Engine

3. Remove installer from connecting rod and piston assembly and check piston for freedom of movement on piston pin.

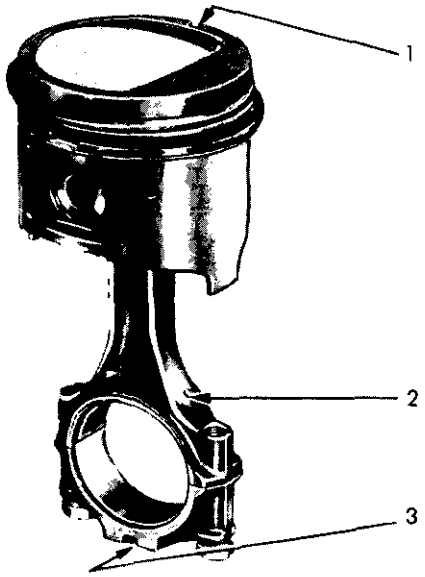
4. Make sure cylinder bores, pistons, connecting rod bearings and crankshaft journals are absolutely clean, then coat all bearing surfaces with engine oil.

5. Before installation of a piston and rod assembly in its bore, position the crankpin straight down.

6. Remove connecting rod cap.

7. Make sure the gap in the oil ring rails and the gaps of the compression rings are positioned correctly.

8. Lubricate the piston and rings and install in bore



1. NOTCH IN PISTON HEAD POINTING TOWARD THE FRONT
2. OIL HOLE IN CONNECTING ROD POINTING TOWARD THE RIGHT (MANIFOLD SIDE)
3. NOTCH IN CONNECTING ROD CAP POINTING TOWARD THE REAR

Figure 6A-38 Piston and Rod Assembly

by compressing the rings with a "wrap around" compressor.

9. Select a new connecting rod bearing, if necessary. Otherwise install cap with bearing lower shell on rod and tighten bolt nuts to 36 lb.ft. torque.

10. Install all other piston and rod assemblies in same manner. When piston and rod assemblies are prop erly installed, the oil spurt holes in the connecting rods will be facing right.

11. Check end clearance between connecting rods in each crankpin using feeler gages. Clearance should be between .0043" and .0095".

12. Install cylinder head. Torque 10 cylinder head bolts to 72 lb.ft (cold), and 2 cylinder head to timing chain cover bolts to 17 lb.ft.

13. Install new oil pan gasket by first installing flange gasket with tabs in slots in rear main bearing cap and engine front cover. Then install rubber strips in grooves in rear main bearing cap and engine front cover. Install oil pan, torquing bolts to 5 lb.ft.

14. Install (Opel 1900 and Manta) front suspension assembly. (GT) Install engine suspension cross member.

After installation of new pistons and rings, care should be used in starting the engine and in running it for the first hour. Avoid high speeds until the parts have had a reasonable amount of break-in so that scuffing will not occur.

TIMING CHAIN COVER AND TIMING CHAIN

Timing Chain Cover Removal

1. Support engine in vehicle as outlined under Engine Oil Pan Removal and Installation.

2. Remove radiator and shroud assembly

3. Remove cylinder head.

4. Remove alternator belt and remove alternator mounting bracket.

5. Remove fuel pump

6. Remove ignition distributor.

7. Remove chain tensioner assembly out of timing cover.

8. Remove crankshaft pulley bolt and remove pulley.

9. Remove water pump assembly.

10. Remove oil pan

11. Remove timing chain cover bolts. One bolt is covered by the water pump. See Figure 6A-39.

12. Pull off sprockets with chain. Put a paint mark

Figure 6A-39 Bolt Behind Water Pump

on front side of timing chain to permit reinstallation in original position.

Timing Chain Cover and Timing Chain installation

Reinstall timing chain cover by reversing removal procedures, pay particular attention to the following points.

1. Clean all parts, check for wear and replace as required. The Parts Department supplies either the two sprockets complete with chain or the chain alone. It is not permissible to replace sprockets alone. The chain tensioner is, with the, exception of the tensioner body, only available as a complete unit.

2. Turn crankshaft so that key for sprocket is on top and vertical. Assemble chain', with camshaft sprocket, then put chain on crankshaft sprocket already installed. Be sure paint dot on chain is in front so that chain moves in same direction as prior to disassembly.

3. Make sure camshaft sprocket mark is in alignment with mark on support and chain in parallel with damper block.

4. To install new timing case oil seal, drive out oil seal from the rear using a drift. Coat circumference of oil seal sparingly with suitable sealer and press seal in, using tool J-22924. Take care not to damage timing case. See Figure 6A-40.

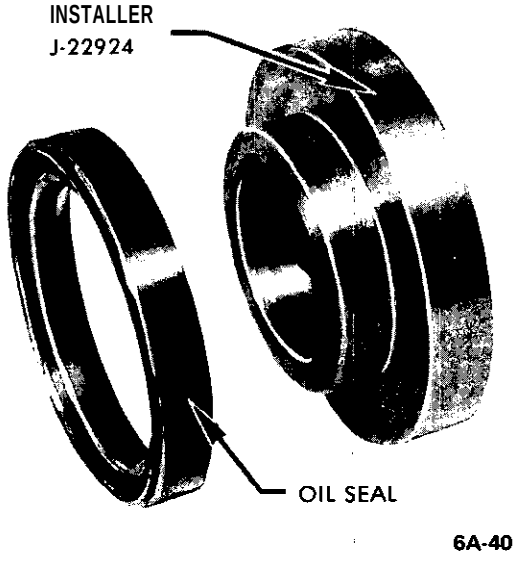


Figure 6A-40 Installing Timing Cover Oil Seal on Protector

It is not necessary to use crankshaft bolt to install seal when cover is off engine.

5. Inspect chain tensioner for proper operation and reusability.

6. Install timing case rubber gaskets to cylinder block. Stick on with grease as necessary. Gaskets will somewhat overlap with oil pan gasket.

7. Position timing cover onto guide pin in upper left corner of cylinder block and insert centering bolt through timing chain cover into lower right corner of cylinder block. See Figure 6A-40A. No sealing is required.

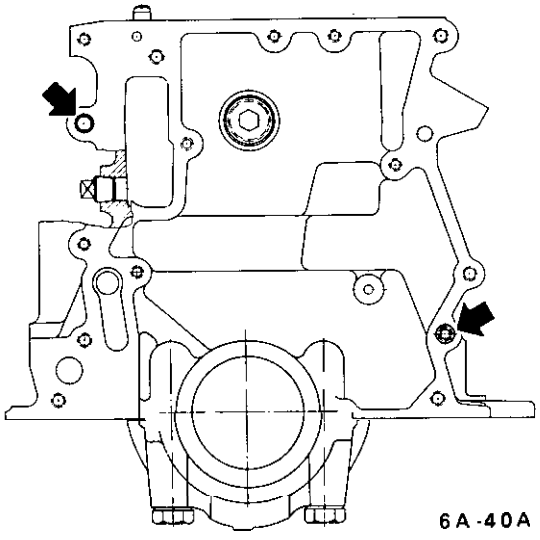


Figure 6A-40A Installing Timing Chain Cover

8. Install cylinder head

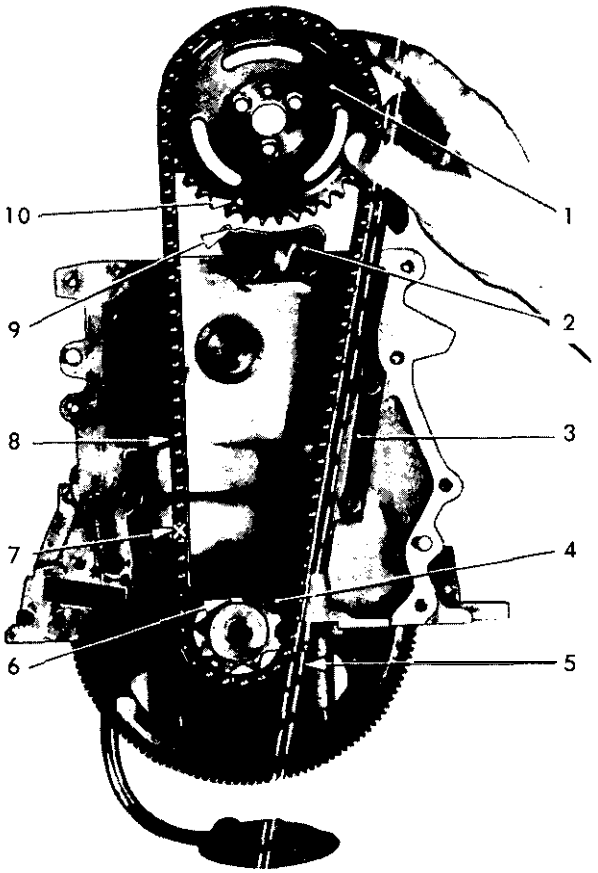
After sprocket has been attached to camshaft, recheck alignment to see that chain has not slipped. At this time both No. 1 and No. 4 pistons will be at TDC position. No. 4 piston will be in tiring position and No. 1 piston up on exhaust stroke. To time engine to fire on No. 1 cylinder, rotate crankshaft 360 degrees. This will position the timing mark 180 degrees from original alignment of camshaft sprocket and support bracket, and will completely close No. 1 intake and exhaust valves. Also, the timing mark on the flywheel (ball) and cylinder block (pointer) will coincide. See Figure 6A-41.

Replacing Timing Cover Oil Seal (Engine Installed)

1. Remove fan belts.

2. Remove crankshaft pulley bolt and remove pulley.

3. Insert screwdriver behind seal and rest screwdriver on crankshaft pin. Pry out oil seal.



1. CAMSHAFT SPROCKET
2. CAMSHAFT SPROCKET SUPPORT
3. LONG DAMPER BLOCK
4. CRANKSHAFT SPROCKET
5. CHAIN AND DAMPER BLOCK IN PARALLEL
6. CRANKSHAFT KEY
7. PAINT MARK ON FRONT
8. TIMING CHAIN
9. MARK ON CAMSHAFT SPROCKET SUPPORT
10. MARK ON CAMSHAFT SPROCKET

6A-41

Figure 6A-4 1 Valve Timing Marks

4. Lubricate new oil seal and place on installer J-22924.

5. Place installer J-22924 on crankshaft. Using crankshaft bolt and washer install seal into cover. See Figure 6A-42.

6. Install crankshaft pulley, bolt and washer. Torque bolt to 72 lb.ft.

7. Install belts and torque to proper tension 45 lb.ft.

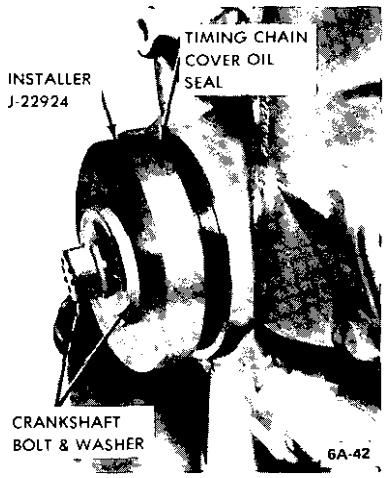


Figure 6A-42 Installing Timing Chain Cover Oil Seal

Replacing Distributor Drive Gear On Crankshaft

1. Remove fan belt.

2. Remove fuel pump. Plug end of fuel line with a suitable stop.

3. Remove spark plug wires, distributor hold down clamp. Remove distributor.

4. Turn crankshaft so key is on top.

5. Pry oil seal out of timing chain cover.

6. Insert a screwdriver through opening for fuel pump and push out distributor drive gear, which has a push tit on crankshaft, through oil seal seat in timing cover.

7. Install new gear. Be sure key tits in keyway. When installing components, use new gaskets as required.

8. Install new oil seal.

9. Connect parts removed in steps 1 thru 3.

CAMSHAFT

Removal

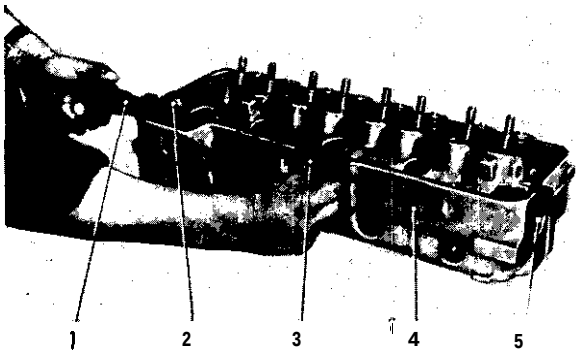
1. Remove cylinder head.

2. Loosen self-locking rocker arm nuts and swing rocker arms off valve lifters.

3. Remove valve lifter. Place lifters in a suitable holding fixture so that they may be reinstalled in original position.

4. Remove cover from access hole on left side and

rear of cylinder head. Remove camshaft toward front, supporting camshaft with one hand through access hole and taking care not to damage bearing surfaces. See Figure 6A-43.



1. CAMSHAFT
2. FRONT ACCESS HOLE
3. LATERAL ACCESS HOLE
4. CYLINDER HEAD
5. REAR ACCESS HOLE

6A-43

Figure 6A-43 Removing Camshaft

Installation

1. Liberally lubricate camshaft journals and install camshaft from front into cylinder head. Support shaft through access hole in left side of head to prevent damaging bearings.

2. Reinstall valve lifters, rocker arms and self- locking rocker arm nuts.

3. Install rear and side access plates.

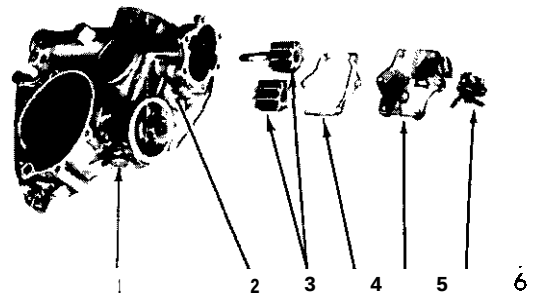
4. Reinstall cylinder head.

OIL PUMP COVER AND GEARS

Removal and Installation of Oil Pump Cover and Gears

1. Remove screws attaching oil pump cover assembly to timing chain cover. Remove cover assembly and slide out oil pump gears. See Figure 6A-44.

2. Wash off gears and inspect for wear, scoring, etc. Replace any gears not found serviceable. Discard pump covers scored by gear action. If pump housing or distributor drive shaft bushing are worn (this is only possible after a long service life), the timing case together with all exchangeable pump parts have to be discarded.



1. OLD PRESSURE RELIEF VALVE ASSEMBLY
2. TIMING CASE
3. OIL PUMP GEARS
4. COVER GASKET
5. COVER & VALVE ASSEMBLY
6. COVER ATTACHING SCREWS

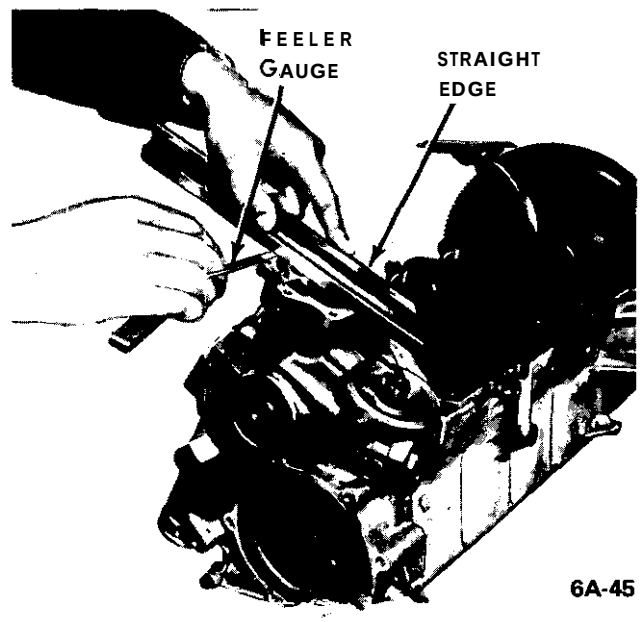
6A-44

Figure 6A-44 Oil Pump Components

In isolated cases, timing cases are installed in production having .008 in. oversize bores for pump gears and shafts. Oversize bores may exist either for one or both gears; these timing cases are identified by the number "0.2" stamped into pump flange on left and-/or right-hand side. Oversize replacement gears should be selected according to Part Catalog specifications.

3. Liberally lubricate spindles and gear teeth and use new cover gasket. Install oil pump cover.

If new gears are installed, their end clearance in a dry pump housing should be checked with a straight edge and a feeler gauge. The gears must not protrude more than .004 in. over pump housing. See Figure 6A-45.



6A-45

Figure 6A-45 Checking Oil Pump Gear End Clearance

With feeler gauge, check gear backlash. It should be between .004 in. and .008 in. See Figure 6A-46.

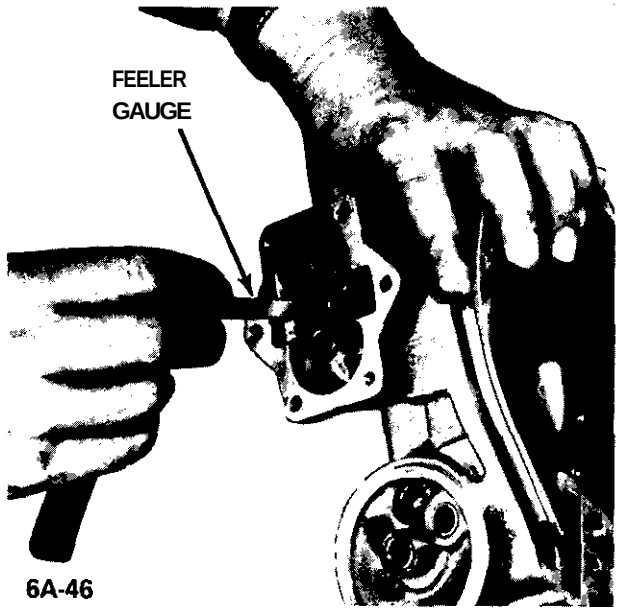


Figure 6A-46 Measuring Oil Pump Gear Backlash

Checking Oil Pump Relief Valve For Proper Functioning

1. Unscrew plug and check spring and relief valve plunger in oil pump cover for dirt particles and free operation. If required, carefully clean plunger and seat. Pressure relief plunger sticking as a result of foreign material or sludge build-up in the oil pump cover can cause loss of oil pressure.

Removal and Inspection of Oil Pump Pipe and Screen Assembly

1. Remove oil pan.

2. Clean oil pan. Make sure the gasket surfaces and pan and block are clean.

3. Remove (2) bolts holding pipe and screen assembly to cylinder block. See Figure 6A-47.

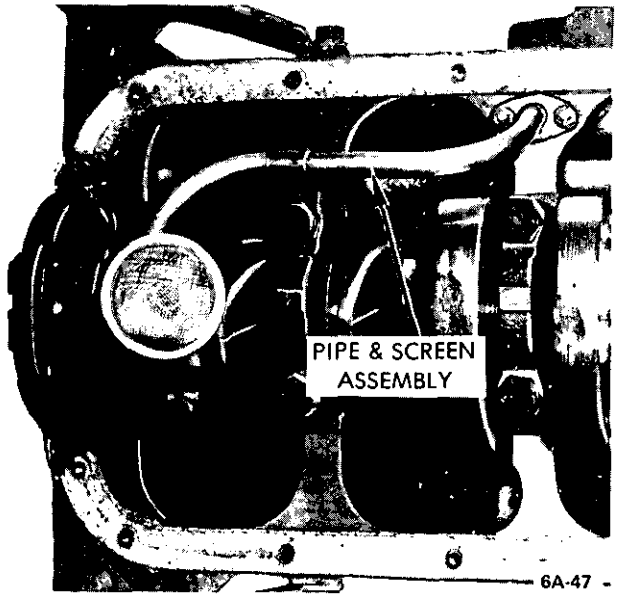


Figure 6A-47 Installation of Pipe and Screen Assembly

4. Clean the screen and housing thoroughly in solvent and blow dry with air stream.

Installation of Oil Pump and Screen Assembly

Install by reversing removal procedures, paying particular attention to the following points.

1. Make sure oil pump pipe flange gasket surface of block is smooth and free of dirt.

2. Use a new gasket and install assembly.

3. Tighten pan bolts evenly. Do not over-tighten. Torque to 5 lb. ft.

SPECIFICATIONS

BOLT TORQUE SPECIFICATIONS

Use a reliable torque wrench to tighten all parts listed, to insure proper tightness without straining or distorting parts. These specifications are for clean and lightly-lubricated threads only; dry or dirty threads produce increased friction which prevents accurate measurement of tightness.

Part	Torque Lb.Ft.
Connecting Rod Bolts	36
Crankshaft Main Bearing Bolts	72
Flywheel to Crankshaft Attaching Bolts	43
Cylinder Head Attaching Bolts	Cold 72 -Warm 58
Camshaft Sprocket Attaching Bolts	18
Generator Bracket to Cylinder Block Attaching Bolts	29
Generator Bracket to Timing Case Attaching Bolts	29
Crankshaft Pulley Attaching Bolts	72
Rocker Arm Stud in Cylinder Head	29
Spark Plugs	30
Clutch Housing to Cylinder Block Attaching Bolts	36
Timing Case to Cylinder Block Attaching Bolts	14
Water Pump to Timing Case Attaching Bolts	11
Engine Support to Cylinder Block Attaching Bolts	40
Rear Engine Suspension to Transmission Rear Bearing Retainer Bolts	22
Transmission to Clutch Housing Attaching Bolts	29
Starter to Clutch Housing Attaching Bolts	40
Support to Starter Attaching Nut	4
Intake and Exhaust Manifold to Cylinder Head Attaching Bolts	33

Unless Otherwise Noted:	
10 MM Bolt (15 MM Head)	30
8 MM Bolt (13 MM Head)	15
6 MM Bolt (10 MM Head)	30 Lb.In.

GENERAL SPECIFICATIONS

Type - No. of Cylinders	In line 4
Valve Arrangement	In head
Bore and Stroke	3.66 x 2.75
Piston Displacement Cu. In.	115.8
Compression Ratio	7.6:1
Octane Requirement	Regular - Low Lead
Firing Order	1-3-4-2
Cylinder Block Material	Cast Iron
Crankshaft Bearings Number and Type In-Metal Babbitts	5 Removable Steel Backed
Bearing Which Takes End Thrust	5
Connecting Rod Bearing Material	Steel Backed Tri-Metal Babbitts
Piston Material and Surface	Aluminum Alloy, Lead Coated
Piston Pin Offset	.031 In. to the Right
Compression Rings Material and Surface Treatment	
No. 1	Chrome-plated, Cast Iron - Rectangular
No. 2	Cast Iron - Tapered
Oil Ring	Chrome-plated, Cast Iron
Location of All Piston Rings	Above Piston Pin
Camshaft Material	Alloy Cast Iron
Camshaft Drive	Chain
Number and Type of Camshaft Bearings	4 Steel-Backed Babbitt
Valve Lifter Type	Hydraulic
Oiling System Type	Circulating High Pressure
Oil supplied to:	
Bearing Surfaces, Crankshaft, Camshaft and Connecting Rods	Pressure
Piston, Pins	Vapor
Cylinder Walls	Nozzle Spray
Rocker Arms	Pressure
Oil Reservoir Capacity - Quarts	3 1/4 With Dry Filter
Oil Filter - Type	Throw Away Element

Cooling System - Type ..... Liquid Cooling With Circulating Pump
Filler Cap Type - Pressure ..... 13.2-15.2 PSI
Water Temperature Control ..... Thermostat and Bypass
Thermostat Open At ..... 189 F.
Cooling System Capacity ..... 6 Qts.
Fan Drive ..... Water Pump Shaft

ENGINE DIMENSIONS AND FITS

Cylinder, Crankcase, Pistons, Cylinder Head, Valves

Cylinder Bore Limits for Standard Size Pistons:
Size 1 ..... 3.659-3.660 In.
Size 2 ..... 3.661-3.663 In.
Size 3 ..... 3.664-3.668 In.
Cylinder Bore Limits for Oversize Pistons, .02 In. Oversize ..... 3.679-3.681 In.
Max. Permissible Cylinder Bore Out-of-Roundness ..... .0005 In.
Max. Permissible Cylinder Bore Taper ..... .0005 In.
Piston Clearance, Nominal (on skirt bottom) ..... .0014 In.
No. 1 Compression Ring Side Clearance in Piston Groove ..... .0024-.0034 In.
No. 2 Compression Ring Side Clearance in Piston Groove ..... .0013-.0024 In.
Oil Control Ring Side Clearance in Piston Groove ..... .0013-.0024 In.
Piston Ring Gap:
No. 1 Compression Ring ..... .014-.022 In.
No. 2 Compression Ring ..... .014-.022 In.
Oil Control Ring ..... .015-.055 In.
Piston Pin in Connecting Rod ..... Press Fit

	Intake	Exhaust
Valve Spring Pressure Valve Closed	1.57 In. at 93 Lbs.	1.36 In. at 97 Lbs.
Valve Open	1.18 In. at 182 Lbs.	.96 In. at 180 Lbs.
Valve Stem Diameters Standard Size	.3538-.3543 In.	.3524-.3528 In.
.003 In. Oversize	.3567-.3572 In.	.3553-.3559 In.
.0059 In. Oversze	.3597-.3602 In.	.3583-.3588 In.
.O 1 18 In. Oversize	.3656-.3661 In.	.3642-.3647 In.
Valve Length, Nominal	4.843 In.	4.92 In.
Valve Head Diameter	1.574 In.	1.34 In.

Valve Guide Bores in Cylinder Head (Intake and Exhaust)
Standard Size ..... .3553-.3562 In.
.003 in Oversize ..... .3582-.3592 In.
.006 in Oversize ..... .3615-.3622 In.
.0118 in Oversize ..... .3671-.3681 In.
Valve Stem Clearance
Intake ..... .001-.0029 In.
Exhaust ..... .0039 In.
Max. Permissible Head to Stem Runout
Intake ..... .0016 In.
Exhaust ..... .0019 In.

Valve Seat and Correction Angle in Cylinder Head
Intake
Valve Seat Angle ..... 45"
Outer Correction ..... 30"
Exhaust
Valve Seat Angle ..... 45"
Outer Correction ..... 30"
Valve Face Angle ..... 44°
Valve Seat Width in Cylinder Head
Intake ..... .049-.059 In.
Exhaust ..... .063-.073 In.
Valve Head Contact Area ..... Aim at Centricity
Valve Clearance at 176°F. Coolant and 140°F. to 176"
Oil Temperature
Intake and Exhaust ..... Zero Plus One Turn

Cranking Mechanism

Max. Permissible Out-of-Roundness of Connecting Rod Bearing Journals	.0002 In.
Max. Permissible Taper of Connecting Rod and Crankshaft Bearing Journals	.0004 In.
Max. Permissible Radial Runout of Center Main Bearing Journals When Supported in End Bearings	.0012 In.
Max. Permissible Unparallelism of Connecting Rod Bearing Journals When Crankshaft is Placed in V-Blocks so That Main Bearing Journals Next to Each Other Are Supported	.0005 In.
Max. Permissible Runout of Crankshaft to Flywheel Contact Area	.0008 In.
Crankshaft End Play	.0017-.0061 In.
Main Bearing Clearance	.0009-.0025 In.
Connecting Rod Bearing Clearance	.0006-.0025 In.
Connecting Rod End Play on Bearing Journal	.0043-.0095 In.
Connecting Rod Bearing Length	.7785-.7992 In.
Crankshaft Thrust Bearing Length	1.08 In.

Valve Mechanism

Camshaft Bearing Clearance	.001-.003 In.
Camshaft End Play	.004-.008 In.
Max. Permissible Radial Runout of Camshaft Center Bearing Camshaft Supported in Outer Bearings	.001 In.
Valve Lifter Clearance in Cylinder Head Bore	.0003-.0013 In.

Engine Lubricating System

Oil Pump Gear Backlash	.004-.008 In.
Oil Pump Gear End Play in Housing	Gears Protruding Over Edge of Housing: Not More Than .004 In.
Clearance of Spindle in Bore of Oil Pump Driven Gear	.0003-.0015 In.
Clearance Between Oil Pump Drive Gear and Bushing	.00035-.0015 In.
Oil Pump Relief Valve Spring Pressure at a Spring Length of .8 In.	.44-.66 Lbs.

	CRANKSHAFT MAIN BEARING JOURNALS			CONNECTING ROD BEARING JOURNALS, (ALL)		CONNECTING ROD WIDTH, (ALL)
	NO. 1, 2, 3 & 4 BEARING DIAMETER	BEARING NO. 5 (PILOT BEARING) WIDTH	BEARING NO. 5 (PILOT BEARING) DIAMETER	WIDTH	DIAMETER	
AVAILABLE SIZES OF CONNECTING ROD AND CRANKSHAFT BEARING SHELLS AS WELL AS CONNECTING RODS.	INCHES	INCHES	INCHES	INCHES	INCHES	INCHES
DIMENSIONS FOR STANDARD (PRODUCTION) SIZE CRANKSHAFT. USE OPEL BEARING PART NOS. 618036, 618710, 622711.	2.2832 ± .003	1.0819 ± .0012	2.2832 ± .0003	.9858 ± .0015	2.0464 ± .0003	.9789 ± .0010
DIMENSIONS FOR GRINDING CRANKSHAFTS FOR USE WITH .010 INCH UNDERSIZE BEARINGS. USE OPEL BEARING PART NOS. 618161, 618735, 622941.	2.2733 ± .0002	1.0898 ± .0012	2.2733 ± .0002	.9858 ± .0015	2.0366 ± .0003	.9789 ± .0010
DIMENSIONS FOR GRINDING CRANKSHAFTS FOR USE WITH .020 INCH UNDERSIZE BEARINGS. USE OPEL BEARING PART NOS. 618310, 618760, 622779.	2.2635 ± 0002	1.0977 ± .0012	2.2635 ± .0002	.9937 ± .0016	2.0267 ± .0003	.9867 ± .0010

6A-48

COOLING SYSTEM

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Conditioning the Cooling System	6B-33
Using and Testing Anti-Freeze Solutions	6B-33
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Radiator Thermostat Inspection and Test	6B-33
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Water Pump Removal	6B-34
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Cooling System Capacities	6B-35

DESCRIPTION AND OPERATION

COOLING SYSTEM AND WATER PUMP

The cooling system is of the conventional pressurized type. A centrifugal pump arranged in timing case serves to circulate the coolant.

When the thermostat is closed, the coolant will return to the pump via a by-pass for swift and uniform warming up of the engine the coolant circulates through the radiator, only when the engine has reached normal operating temperature.

The heater system branches off the cooling system ahead of thermostat in flow direction so that the heater is in operation before engine has reached full operating temperature.

MAINTENANCE AND ADJUSTMENTS

Checking and Filling Cooling System

The coolant level should be checked only when the engine is cold and only enough coolant should be added to bring the level halfway between core and tank top. It is unnecessary and undesirable to remove the radiator cap and check the coolant level each time the car stops at a filling station for gasoline or oil, since the engine is usually hot at such times.

WARNING: ***Never remove the radiator cap quickly when engine is HOT Sudden release of cooling system pressure may cause the coolant to boil and some of it may be ejected from the radiator filler neck, resulting in injury to persons or damage to the car finish.***

If it is necessary at any time to remove the radiator cap when engine is hot, rotate the cap counterclockwise until first stop is reached. Leave cap in this position until all pressure in cooling system has been released, then turn cap past the first stop and remove it.

Draining and Flushing Cooling System

The cooling system should be completely drained and the recommended coolant installed every two (2) years.

To drain the cooling system, remove radiator cap, remove lower radiator hose from the lower tank and

remove drain plug on right side of cylinder block. Set heater temperature control valve at full heat position. After the cooling system is drained, and plugs reinstalled, fill the system with clean water. Run the engine long enough to open the thermostat for complete circulation through the system, then completely drain the cooling system before sediment has a chance to settle.

Conditioning the Cooling System

"Rust Inhibitor and Stop Leak", or equivalent listed under Group 8.800 is recommended for use in the cooling system, particularly when preparing for installation of anti-freeze solution. This material stops small seepage leaks, has rust preventive properties and its soluble oil is effective in eliminating a squealing noise which sometimes develops at the water pump seal washer. Instructions for its application are printed on the conditioner bottle.

It is very important to make certain that the cooling system is properly prepared before an anti-freeze solution is installed, otherwise loss of solution through leakage may occur or seepage may result in damage to the engine. The cooling system should be drained and flushed as described under Draining and Flushing Cooling System. All joints should be checked for leakage and corrected, and the conditioner described above should be added with the anti-freeze solution.

Inspect the water pump, radiator core, heater and defroster cores, water jacket plugs, and edge of cylinder head gaskets for evidence of water leaks. Tighten all hose clamps in the cooling and heating systems and replace any deteriorated hoses.

Using and Testing Anti-Freeze Solutions

Inhibited year around (ethylene glycol type) engine coolant solution which is formulated to withstand two full calendar years of normal operation without draining or adding inhibitors should be used at all times. Freeze protection should be provided to protect against corrosion. When adding solution due to loss of coolant for any reason or in areas where temperatures lower than minus 20 degrees F. may be encountered, a sufficient amount of any of the several brands of year around coolant (Ethylene Glycol base) compatible to GM Specification 1899-M available on the market should be used. Water or alcohol base coolants are not recommended for this vehicle at any time.

If for any reason water only is used as a coolant in an emergency, it is extremely important that Buick Heavy Duty Cooling System Protector and Water Pump Lubricant or equivalent be added to the cooling system as soon as possible. If any other cooling System protector is used, be certain it is labeled to indicate that it meets General Motors Specification GM 1894-M. It should be recognized that this is only a temporary measure. The manufacture intends that permanent type coolant solution be used year around in the cooling system.

The cooling system should be completely drained and the recommended coolant installed every two (2) years.

It is advisable to test the anti-freeze solution at intervals during the winter to make certain that the solution has not been weakened. Use only hydrometers which are calibrated to read both the specific gravity and the temperature, and have a table or other means of converting the freezing point at various temperatures of solution. Disregarding the temperature of the solution when making the test may cause an error as large as 30 degrees F. Care must be exercised to use the correct float or table for the particular type of anti-freeze being tested.

Fan Belt Adjustment or Replacement

A tight fan belt will cause rapid wear of the alternator and water pump bearings. A loose belt will slip and wear excessively and will cause noise, engine over-heating, and unsteady alternator output. A fan belt which is cracked or frayed, or which is worn so that it bottoms in the pulleys should be replaced. The fan belt may be replaced by loosening the alternator brace at alternator, slightly loosening the alternator mounting bolts and moving alternator inward to provide maximum slack in the belt.

The alternator must be moved outward to adjust the fan belt. After the generator brace and mounting bolts are securely tightened, the fan belt tension should be 45 lb. using Tensioner J-23600.

WARNING: ***If a fan blade is bent or damaged in any way, no attempt should be made to repair and reuse the damaged part. A bent or damaged fan assembly should always be replaced with a new fan assembly. It is essential that fan assemblies remain in proper balance and proper balance cannot be assured once a fan assembly has been bent or damaged. A fan assembly that is not in proper balance could fail and fly apart during subsequent use creating an extremely dangerous condition.***

Radiator Thermostat Inspection and Test

A sticking radiator thermostat will prevent the cooling system from functioning properly. If the thermostat sticks in the open position, the engine will warm up very slowly. If the thermostat sticks in the closed position, the engine will overheat.

The thermostat may be removed for inspection and

test by partially draining the cooling system and disconnecting the water outlet housing from the thermostat housing which is mounted on the right front side of cylinder head.

The standard thermostat valve should start to open at 189 degrees F and fully open at approximately 212 degrees F. If thermostat does not operate at specified temperatures, it should be replaced as it cannot be repaired.

MAJOR REPAIR

WATER PUMP REPAIRS

The water pump bearing outer race is shrunk fit into the water pump cover. For this reason the cover, shaft bearing, and hub are not repairable.

Water Pump Removal

Opel radiators do not have a drain plug. Drain radiator by first, loosening radiator cap, then remove lower hose from lower radiator tank.

1. Drain coolant into a clean container. Remove radiator and shroud.

2. Remove fan belt.

3. Remove fan blade and pulley on water pump shaft.

4. Disconnect inlet hose and heater hose from water pump. Remove bolts, pump assembly and gasket from timing chain cover.

5. Check pump shaft bearing for end play or roughness in operation. If bearings are not in serviceable condition, the assembly must be replaced.

Water Pump Installation

1. Make sure the gasket surfaces on pump and timing chain covers are clean. Install pump assembly with new gasket. Bolts must be tightened uniformly. Torque to 11 lb. ft.

2. Install radiator and shroud. Connect radiator hose to pump inlet and heater hose to nipple.

3. Install fan pulley and fan blade, tighten attaching bolts securely. Install belts and adjust for proper tension.

4. Fill cooling system and check for leaks at pump and hose joints.

RADIATOR REMOVAL AND INSTALLATION

Removal

I. Loosen radiator cap, then remove lower radiator hose and drain radiator coolant into suitable container.

2. On vehicles with automatic transmission, unscrew oil lines from connectors on lower radiator tank and plug lines. On GT models with automatic transmission the lines have to be disconnected at the coupling before removing from the tank. It is essential that no dirt enters the oil lines. When unscrewing oil lines, hold connectors on lower radiator tank with pliers to avoid leakages. Ensure that no dirt enters oil cooler.

3. Remove lower attaching nut and slide radiator upward and out of engine compartment.

Installation

1. Install radiator into engine compartment and secure lower attaching nut.

2. On vehicles with automatic transmissions, fasten oil cooler lines to lower radiator tank. It is essential that no dirt enters the oil lines. When tightening oil lines, hold connectors on lower radiator tank with pliers to avoid leakages. Ensure that no dirt enters oil cooler. Torque to 1 I-15 lbs.ft.

3. Install lower radiator hose and add collected coolant.

All Opels are provided with a radiator initial fill of an antifreeze solution containing corrosion inhibitor. The antifreeze has either a glycol or glycerin base and protects the engine against freezing, down to minus 22 degrees F. (minus 30 degrees C.). Before the start of the cold season, coolant must be checked with a hydrometer and if necessary, brought to the necessary specific gravity by adding anti-freeze with a glycol or glycerin base. As the specific gravities of all anti- freeze solutions having a glycol or glycerin base are practically the same, the hydrometer can be used for all these types. Because of the tolerances of the hydrometer, or slight differences in specific gravity, variations of plus or minus 5 degrees can be expected. Coolant must be checked at a temperature of plus 68 degrees F. (plus 20 degrees C.)

SPECIFICATIONS

1973 COOLING SYSTEM CAPACITIES

Cooling System - Type	Liquid Cooling With Circulating Pump
Filler Cap Type - Pressure	13.2-15.2 PSI
Water Temperature Control	Thermostat and Bypass
Thermostat Open At	189 F.
Cooling System Capacity	6 Qts.
Fan Drive	Water Pump Shaft

FUEL SYSTEM

ALL MODELS

CONTENTS

Subject	Page No.
DESCRIPTION AND OPERATION:	
Fuel Pump	6C-36
Evaporation Control System	6C-37
DIAGNOSIS: (Not Applicable)	
MAINTENANCE AND ADJUSTMENTS:	
Cleaning Fuel Pump Strainer	6C-37
Evaporation Control System	6C-38
MAJOR REPAIR:	
Fuel Tank	6C-39
Fuel Lines and Fuel Tank Gauge Units	6C-41
SPECIFICATIONS:	
Fuel System Specifications	6C-41

DESCRIPTION AND OPERATION

FUEL PUMP

The 1.9 liter engine uses a push rod type fuel pump.

The push rod is actuated by an eccentric on the distributor shaft. The push rod is held in contact with the eccentric at all times by a push rod spring. Each time the push rod is on the high part of the eccentric, the lighter diaphragm spring will push the diaphragm to replace any fuel used in the carburetor. The diaphragm seldom operates through a full stroke; under normal driving conditions, the diaphragm moves only a few tenths of an inch.

Fuel pump pressure is determined by the compression of the diaphragm spring. Low pressure or pressure leak- down generally indicates a leaky diaphragm or check valves.

Two holes in the lower part of the fuel pump serve to ventilate the space below the diaphragm and to drain any fuel which may have entered. If any fuel comes from these holes, this indicates a defective diaphragm.

When replacing the fuel pump, make sure the asbestos spacer is in place with a gasket on each side. See Figure 6C- 1. Because of the location of the fuel pump eccentric on the distributor shaft, the fuel pump

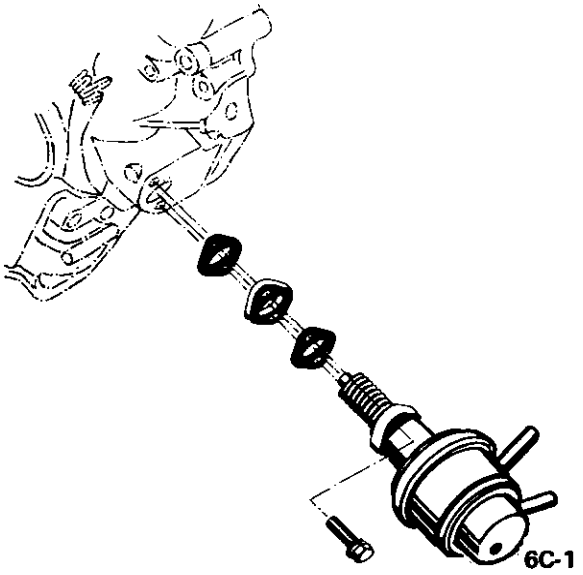


Figure 6C-1 Installing Push Rod Type Fuel Pump

must always be removed before the distributor can be removed.

EVAPORATION CONTROL SYSTEM

1. The function of the fuel evaporation control system is to absorb the fuel vapors developing in the fuel tank, especially when vehicle is parked, due to atmospheric pressure and temperature influences, and to release these fuel vapors during vehicle operation.

2. This system utilizes the property of the activated carbon to absorb and expel fuel vapors. The activated carbon container is installed on the left front side of the engine compartment. The fuel tank has a non-vented tiller cap. Vent hoses are joined in the area of the tank. A plastic evaporation line leads from there along vehicle underbody to the activated carbon container.

3. A small tube above the throttle valve body connects the carburetor to the activated carbon container. In this way, the fuel vapor collected in the activated carbon container is fed through the carburetor into the combustion chambers during engine operation.

4. The carburetor is provided with an internal and outside ventilation, the activated carbon container is also connected to the outside ventilation (only effective when engine is idling). In this way, the fuel vapors escaping to the outside during engine idle are collected by the activated carbon container and fed into the combustion chambers.

5. The vent lines are connected to the upper part of the activated carbon container. Fresh air enters through a foam rubber filter at the lower part and flows, together with the fuel vapor, to the carburetor. Metered bores in the hose fittings of the fuel tank control the air - and fuel vapor flow through the activated carbon container to the carburetor, and the pressure release in the fuel tank and ensure complete purging of the carbon container.

Care must be taken not to mix up lines at the activated carbon container. See Figure 6C-2.

6. The metered bores in the fuel tank fitting and an overflow protection in the fuel tank, which prevents a complete filling of the tank, prevents fuel flows into the activated carbon container rendering it useless.

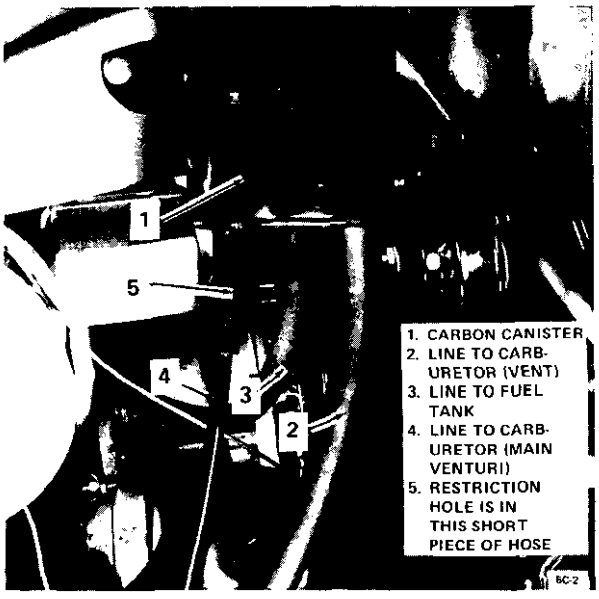


Figure 6C-2 Carbon Canister

FUEL FILTER

An AC fuel filter type (GF 423) is being used on all 1973 Opels. A vapor return line returns vapors in the fuel line back to the fuel tank. Proper installation of the filter is essential. The vapor return line connector must be on top (highest point) for proper operation. See Figure 6C-3.

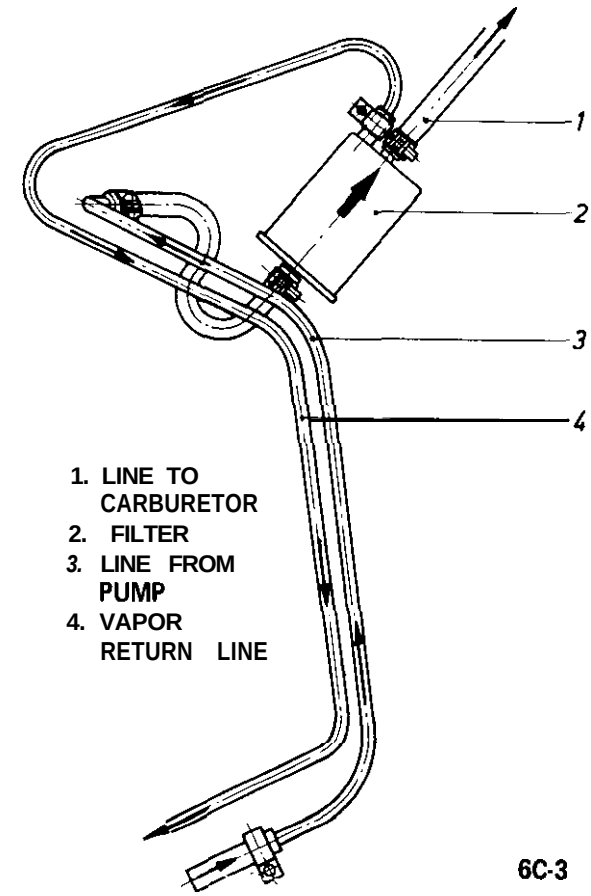


Figure 6C-3 Fuel Filter

MAINTENANCE AND ADJUSTMENTS

CLEANING FUEL PUMP STRAINER

CAUTION: ***Because the fuel pump is below fuel tank level, fuel will drain from the tank. when the supply line is disconnected from the fuel pump.***

1. Pull fuel supply line and rubber connector from fuel pump. Plug rubber connector to prevent fuel loss.

2. Remove fuel pump cap, gasket and plastic strainer.

3. Cover center opening in sediment bowl with finger and blow out sediment bowl with compressed air.

4. Wash plastic strainer in solvent; if strainer does not clean-up or is damaged, replace strainer.

5. Install clean parts, noting the following:

(a) Strainer must be properly seated with projections facing upward.

(b) A new cap gasket must be positioned over strainer.

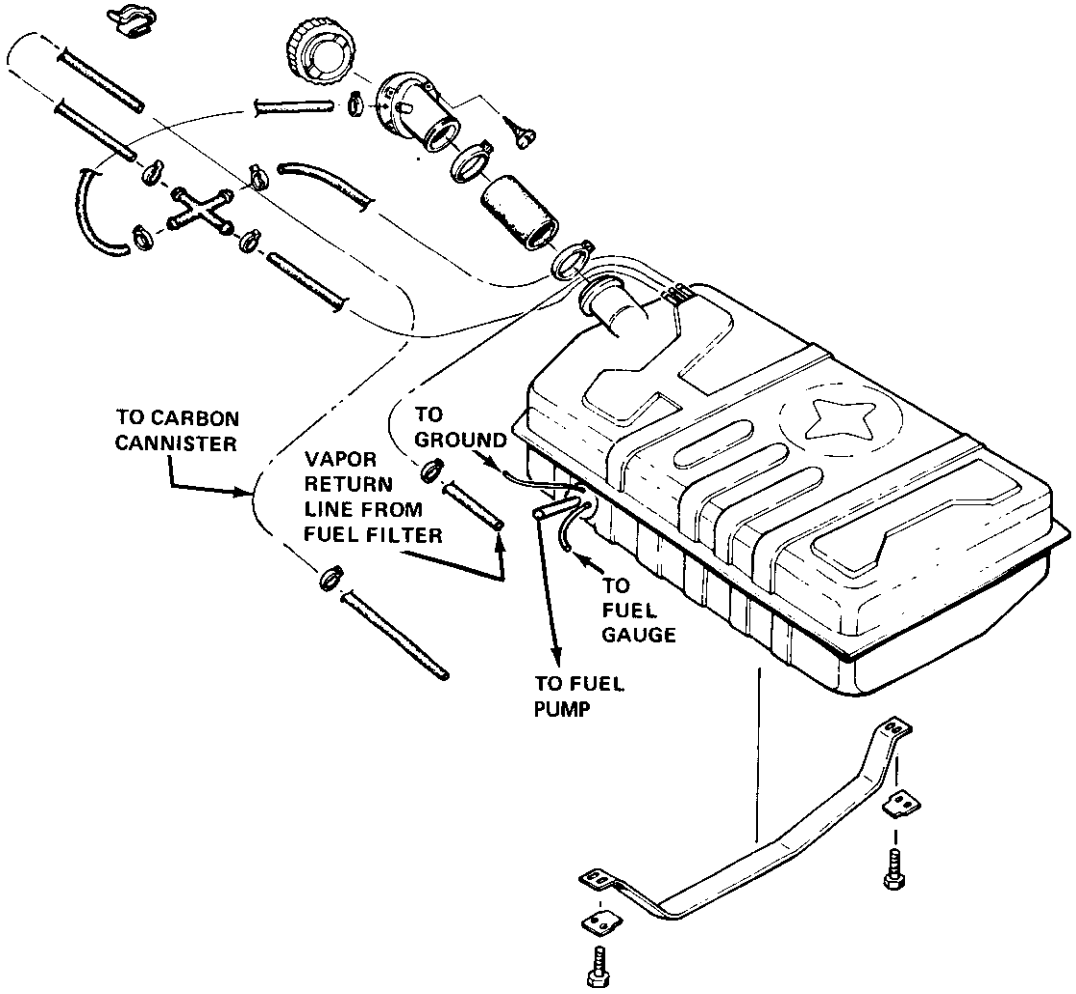
(c) Sealing ring must be in place on cap retaining screw.

6. Reconnect fuel supply line. Start engine and check for leaks.

EVAPORATION CONTROL SYSTEM

Proper performance of the system requires the use of a non-vented fuel tank cap, hose connections be leak-free, and all hoses routed correctly to avoid a pinched or blocked line.

Maintenance requirements demand only that the accumulator purge air filter, an oiled foam filter assembled in the bottom of the canister, be replaced at 12,000 mile intervals. Under extremely dusty conditions, more frequent attention may be required.



6C-4

Figure 6C-4 Exploded View of Opel 1900 and Manta Fuel Tank

MAJOR REPAIR

FUEL TANK OPEL 1900 AND MANTA

The fuel tank is located below the luggage compartment floor panel and is attached with a strap.

The plastic tank vent hoses join in a connector from where the fuel vapors escape through a fourth hose attached to the upper flange of the tank.

On all vehicles, the vent hose is connected to an activated carbon container mounted to the front wheel house panel.

Removal

1. With a pinch clamp, close connecting hose between tank and fuel line. After loosening hose clamp, pull hose off fuel line. See Figure 6C-5.

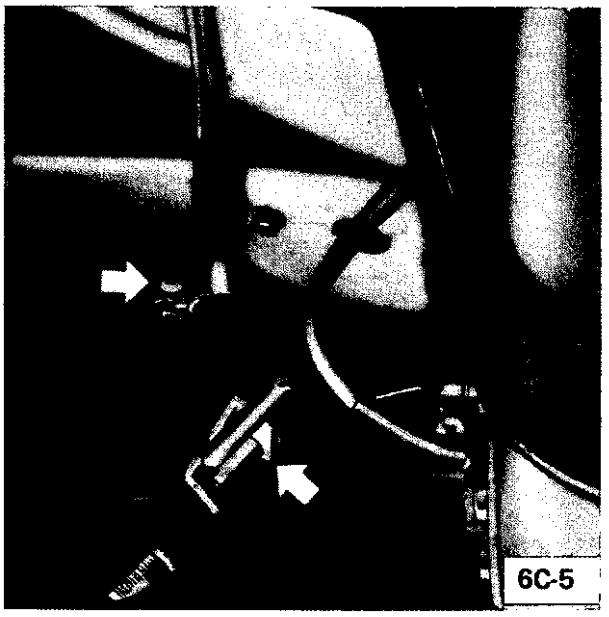


Figure 6C-5

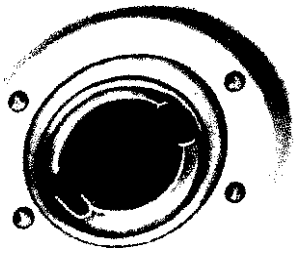
2. Take off tiller cap and unscrew tiller neck from side panel. Pull off fuel tank hose and plug connecting tubes on tank. See Figures 6C-4 and 6C-6.

3. With a jack and suitable support (wooden board 12 x 12"), support fuel tank and unscrew strap. Lower fuel tank. See Figure 6C-7.

Installation

1. Raise tank into position and install strap.

2. Install 4 filler neck to side panel attaching screws and filler cap.



6C-6

Figure 6C-6

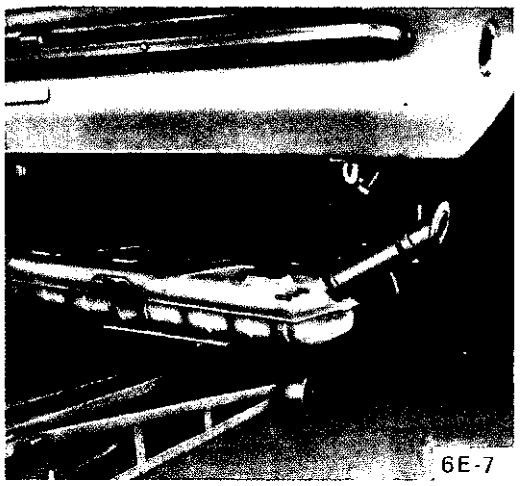


Figure 6C-7

3. Install tank vent hoses and fuel line, taking care not to kink lines.

4. Remove pinch clamp from fuel line.

FUEL TANK (GT MODELS)

Removal

1. Disconnect battery.

2. Remove rubber cap, unscrew fuel line from tank, and drain fuel. See Figure 6C-8.

3. Remove spare tire and jack.

4. Remove spare tire hold-down and brackets. See Figure 6C-9.

5. Remove spare tire support panel.

Figure 6C-8 Fuel Line Attachment at Tank

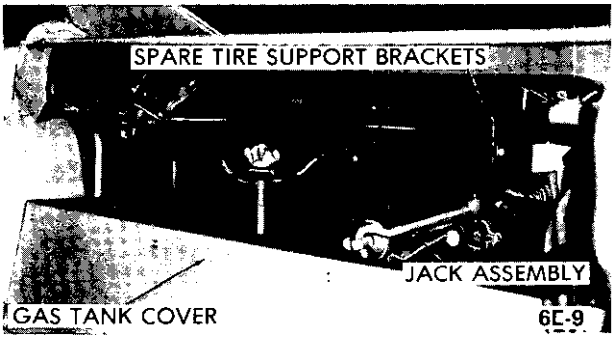


Figure 6C-9 Spare Tire Hold-Down and Brackets

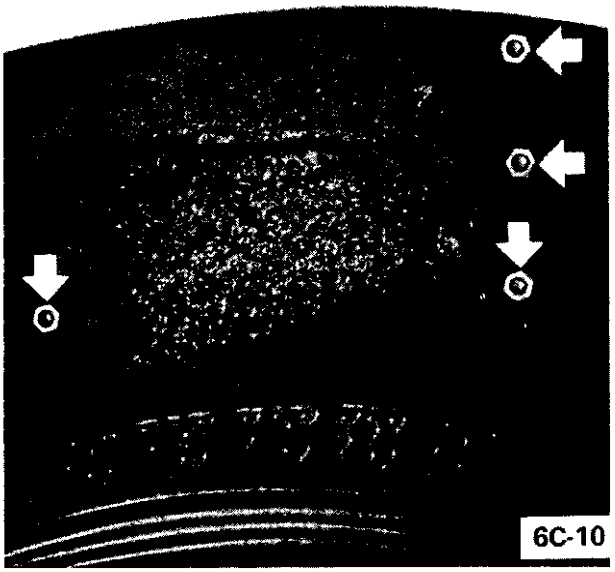


Figure 6C-10 Support Attachments

6. Remove spare tire support attaching brackets. Spare tire hold-down and support attaching brackets are attached to the rear wheel house panel and are

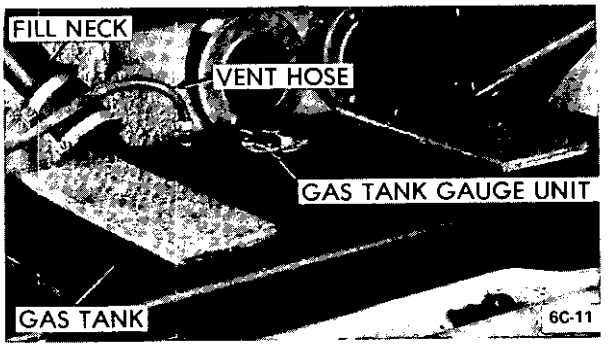
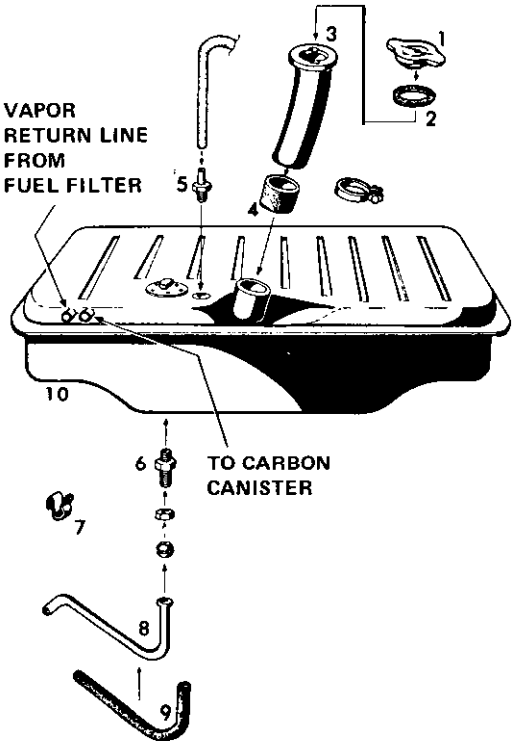


Figure 6C-11 Tank Vent and Filler Hoses



G.T. – FUEL SYSTEM

KEY	DESCRIPTION
1	CAP, FUEL TANK
2	GASKET, FUEL TANK CAP
3	FILLER NECK, FUEL TANK
4	HOSE, FILLER NECK
5	FITTING, FUEL TANK VENT
6	THREADED CONNECTOR, FUEL TANK
7	MOUNTING CLAMP, FUEL VENT HOSE
8	PIPE, FUEL LINE
9	CONNECTING HOSE
10	FUEL TANK, LESS GAUGE

6C-12

Figure 6C-12 Exploded View of GT Gas Tank

covered with sound deadening compound. See Figure 6C-10.

7. Remove fuel tank vent hose and tiller hose. See Figure 6C- 11.

8. Remove fuel tank attaching bolts and gauge wire and remove tank.

Installation

1. Install tank and tighten attaching bolts.

2. Replace gauge wire. Install vent hose, making certain it is not kinked and seal vent hose hole in floor.

3. Install spare tire support attaching brackets, support panel, hold-down, and brackets.

4. Install spare tire and jack.

5. Install fuel line and rubber cap.

6. Connect battery.

FUEL LINES. FUEL GAUGE TANK UNITS

All fuel lines are plastic and have an outside diameter of .240 inches. Unlike metal lines, plastic lines are not flared.

When replacing a plastic line, place the line in hot water to make it flexible. Using the old line as a pattern, form the new line. Let the line cool completely, then route it in the same location as the old line. To prevent chafing against the underbody, nine (9) rubber grommets are placed at points on the line between the fuel tank and the fuel pump. When replacing fuel gauge tank units, coat gasket on both sides and first threads of attaching screws with sealing compound.

CLEANING FUEL TANK

1. Remove fuel tank.

2. Empty fuel tank through filler neck.

3. Remove fuel gauge tank unit, together with suction tube and screen. Clean screen and blow out from cover side. Flush fuel tank.

SPECIFICATIONS

Fuel Tank Capacity (Gallons)	
Opel 1900 and Manta	11.9
GT	13.2
Fuel Gauge Type	Electrical
Fuel Pump Type	Mechanical
Fuel Pump Drive	Eccentric on Camshaft
Fuel Pump Pressure at 1950 (RPM)	3.1 to 3.7 P.S.I.
Fuel Filter	In-Line Filter

EXHAUST SYSTEMS

ALL MODELS

CONTENTS

Subject	Page No.
DESCRIPTION AND OPERATION: (Not Applicable)	
DIAGNOSIS: (Not Applicable)	
MAINTENANCE AND ADJUSTMENTS: (Not Applicable)	
MAJOR REPAIR:	
Exhaust System (All Models)	6D-42
SPECIFICATIONS:	
Torque Specifications	6D-42

MAJOR REPAIR

EXHAUST SYSTEM (ALL MODELS)

Removal

1. Remove exhaust pipe from exhaust manifold.

2. Loosen front exhaust pipe to muffler clamp and pull exhaust pipe out of muffler.

3. Remove muffler damper rings.

4. Remove center exhaust pipe clamp. Remove rear muffler and tail pipe(s) as an assembly. See Figure 6D-1.

5. Remove front exhaust pipe clamp, and remove front muffler and center exhaust pipe as an assembly, then remove center exhaust pipe from front muffler.

The front muffler and center exhaust pipe are one piece on production-built cars but are separate items for service, the tail pipe of the Rallye and GT, has a dual pipe with one resonator.

Installation

Check rubber damper rings for muffler and tail pipe hanger and replace as necessary.

1. Coat I.D. of rear muffler inlet neck and O.D. of center exhaust pipe outlet (rear of pipe) with exhaust sealer compound (several brands are currently available on the market).

2. Insert center exhaust pipe into rear muffler and tighten clamp.

3. Coat I.D. of front muffler outlet neck and O.D. of center exhaust pipe inlet (front of pipe) with exhaust sealer compound.

4. Insert center exhaust pipe into front muffler and tighten clamp.

5. Install muffler and tail pipe assembly on rubber damper rings and tighten hangers. See Figures 6D-1 and 6D-2.

6. Install front exhaust pipe into muffler. Do not tighten clamp.

7. Be sure to install gasket between exhaust manifold and exhaust pipe. Using bolts with washers, attach the exhaust pipe to the exhaust manifold. Torque to 15 lb.ft.

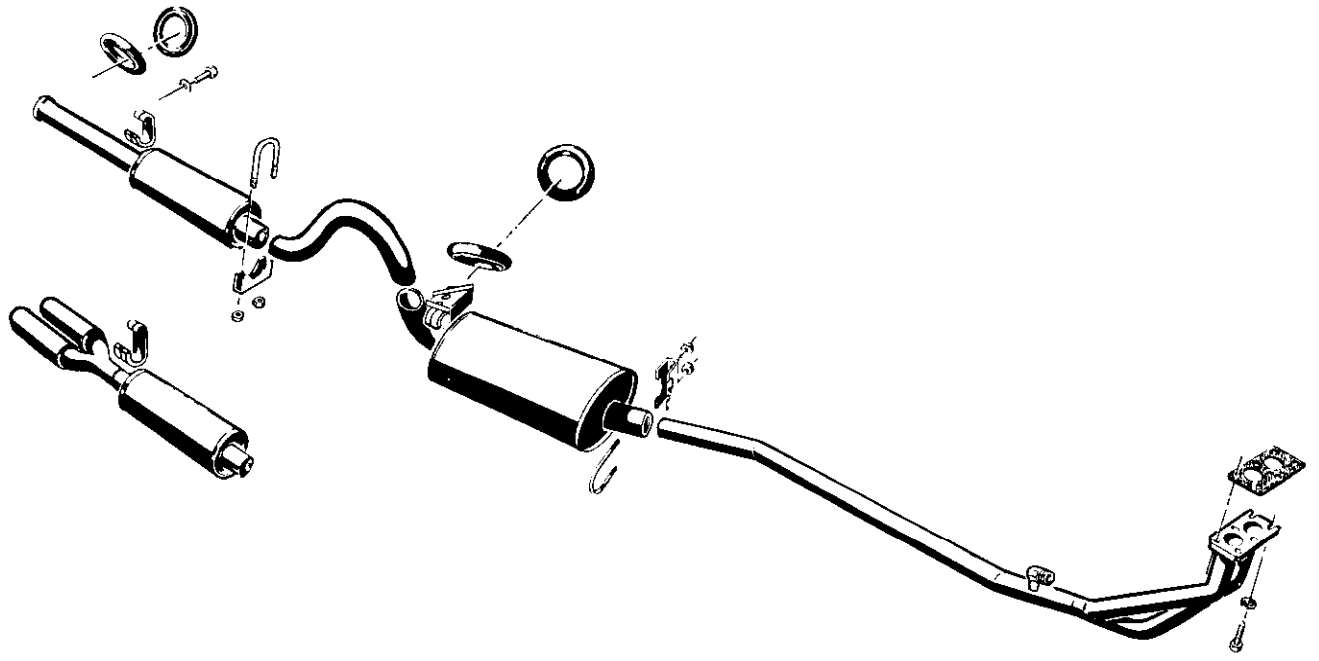
8. Align exhaust system and tighten all clamps.

9. Check alignment of exhaust system; make sure that the exhaust system components have at least 3/4" clearance from the floor pan to avoid possible overheating of the floor pan.

SPECIFICATIONS

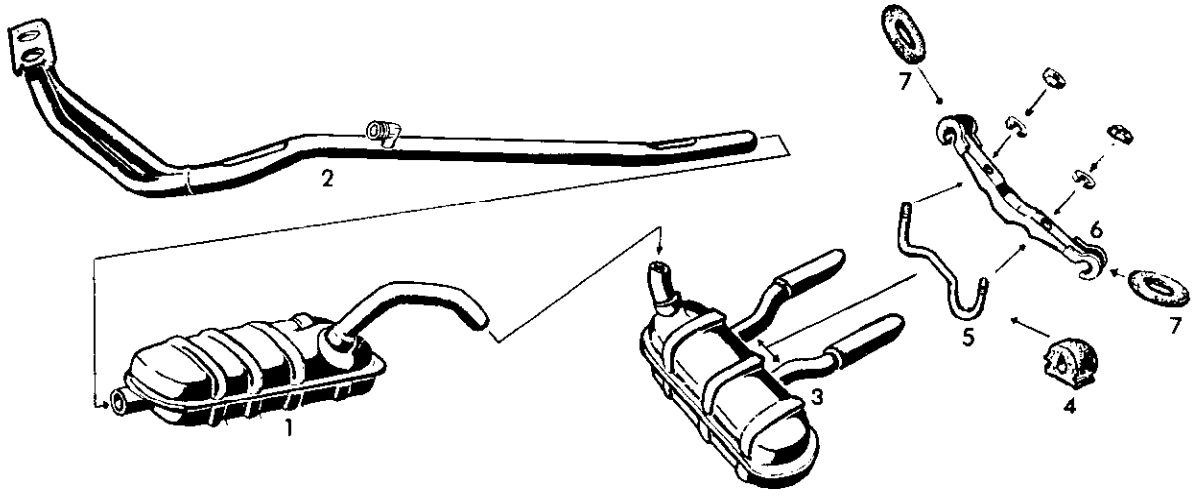
TORQUE SPECIFICATIONS

Exhaust Pipe to Exhaust Manifold - 15 lb.ft.



6D-4

Figure 6D-1 Opel 1900 and Manta Exhaust System



G.T. — EXHAUST SYSTEM

KEY	DESCRIPTION
1	MUFFLER, FRT. W/CTR. EXHAUST
2	PIPE, FRT. EXHAUST
3	MUFFLER, RR. W/TAIL PIPE
4	BUMPER, MUFFLER SUSPENSION — RR.
5	BOW. MUFFLER SUSPENSION — RR.
6	BRACKET, MUFFLER SUSPENSION — RR.
7	DAMPER RING, MUFFLER SUSPENSION — FRONT AND REAR.

6D-5

Figure 6D-2 GT Exhaust System

CARBURETOR AND THROTTLE LINKAGE ALL MODELS

CONTENTS

Subject	Page No.
DESCRIPTION AND OPERATION:	
Carburetor	6E-44
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Carburetor	6E-49
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MAJOR REPAIR:	
Remove and Install Carburetor	6E-52
Throttle Linkage Removal	6E-53
Overhaul Carburetor	6E-53
SPECIFICATIONS:	
Carburetor Specifications	6E-58

DESCRIPTION AND OPERATION

CARBURETOR

The two-barrel carburetor for all 1973 Opel1 1900, Manta and GT models is a down-draft carburetor with two barrels of 1.25 inch diameter each. It has an automatic choke and a secondary valve operated by a vacuum diaphragm, except when installed in an Opel GT. In the GT, the secondary throttle valve is operated by mechanical linkage from the primary throttle valve.

The two-barrel carburetor consists of three main parts - throttle body, float chamber and air horn. Each barrel is a separate system, but both barrels discharge into a common inlet in the intake manifold. The secondary barrel does not have a choke valve or an accelerator pump. See Figure 6E-2.

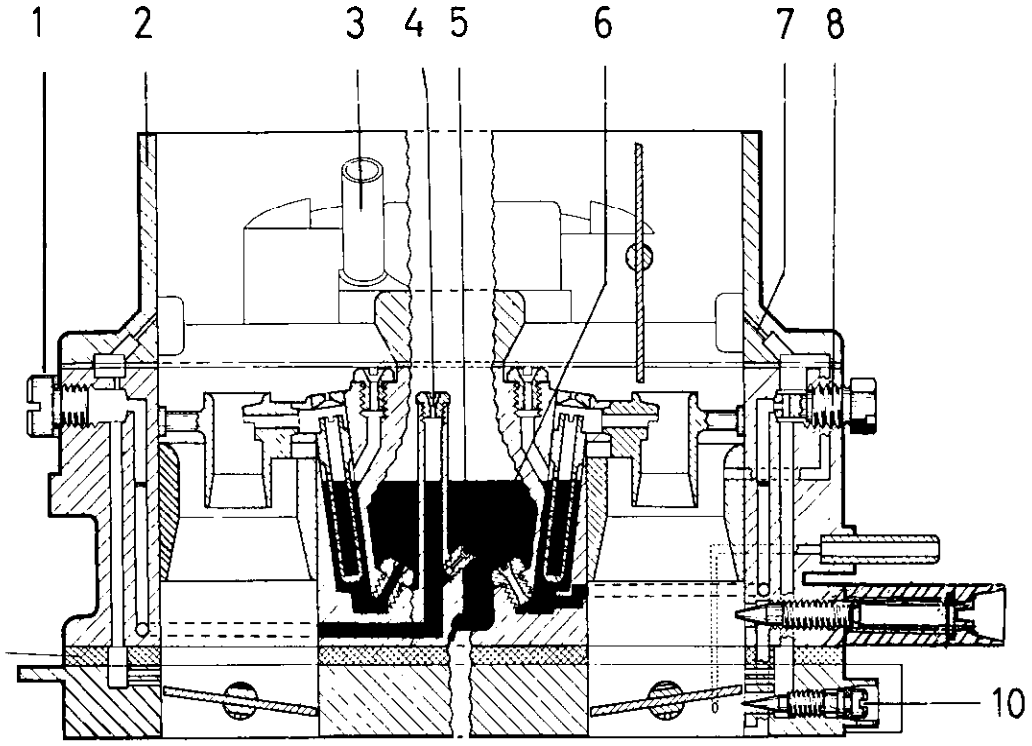
The throttle valve of the primary barrel is opened through the throttle linkage. When the primary throttle valve is almost open, at approximately half of the maximum engine RPM, the secondary throttle valve is opened by vacuum applied through a vacuum diaphragm case. See Figure 6E-3. The secondary throttle valve on the GT model is opened by mechanical linkage from the primary throttle shaft.

Choke System

The automatic choke is operated by a bi-metal spring. The tension of the spring - depending on temperature of the heater coil - decreases with rising temperature and the choke valve opens progressively until it is completely opened at engine operating temperature. The choke valve is off-set so that choke valve opening increases as air flow increases.

If the choke valve is closed, the throttle valve is opened slightly to provide a fast idle speed. This is done through a cam, abutment lever and throttle connecting link. With the throttle valve opened slightly, the vacuum during cranking can take effect up to the choke valve, thereby drawing ample fuel out of the main nozzle. See Figure 6E-4.

With rising temperature of the heater coil, the choke



Sectional View Of 19 US Carburetor (both barrels)

1 Plug (transition channels, secondary barrel)
2 Carburetor cover
3 Vent tube
4 Transition jet
5 Transition air jet
6 Float chamber
7 Idle air passage
8 Idle air jet
9 Idle air adjusting screw
10 Mixture adjusting screw

6E-1

Figure 6E-1 Sectional View of Primary and Secondary Barrels

valve gradually opens and the mixture becomes leaner. During this process, the abutment lever changes position on the fast idle cam, further closing the throttle valve until, the engine is at normal operating temperature, the choke valve is wide open and the throttle valve is in slow idle position.

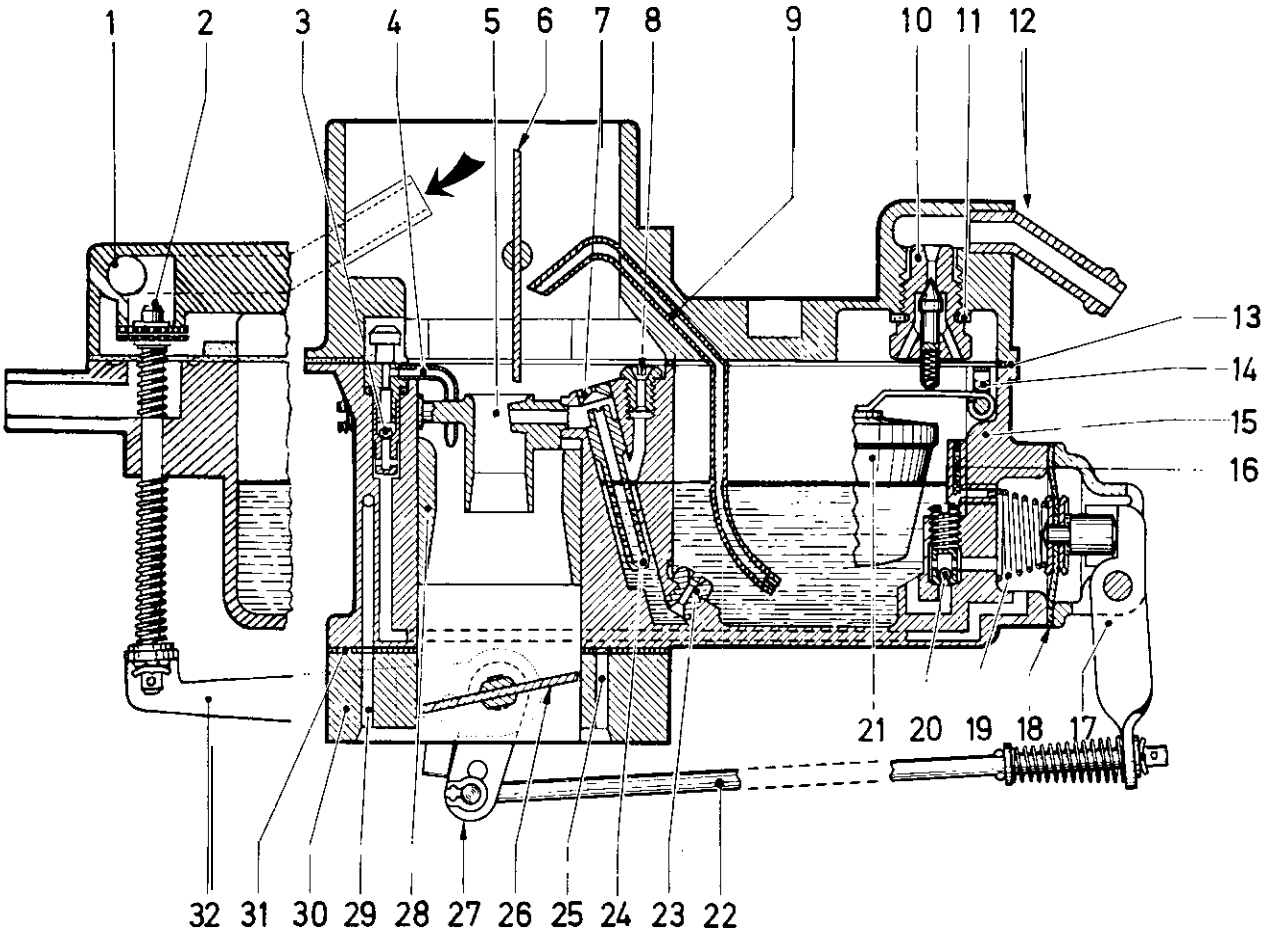
A choke diaphragm is connected to the intermediate lever of the choke valve spindle through a pull rod. The vacuum, which develops below the throttle valve, takes effect on the diaphragm through a vacuum passage. See Figure 6E-4. As soon as the engine starts, this vacuum pulls the choke valve slightly open; the amount of choke valve opening depends on the amount of vacuum, which depends on the engine load. Therefore, with a light engine load, the choke valve will open slightly; with a heavy engine load, the valve will close slightly to give a richer mixture as required for this engine load.

Before starting a cold engine slowly, depress the accelerator pedal three times before engaging the starter.

Idle and Part Throttle System

At engine idle and during low speed (part throttle) operation, fuel is drawn from the emulsion tube bore, controlled by the idle jet and mixed with air entering through idle air bleeds (Figure 6E-1) and ports in the throttle body. This mixture is drawn downward to the three ports near the throttle valve. When the throttle valve is closed, the mixture is drawn from the lowest port and mixed with air by-passing the throttle valve to form the idle mixture.

Turning the idle mixture screw (Figure 6E-1) inward results in a leaner mixture, and turning it out results



Sectional View Of Carburetor

1 Carburetor cover
2 Vent valve
3 Ball valve (pressure valve)
4 Injection tube
5 Primary venturi
6 Choke valve
7 Vent jet
8 Air correction jet
9 Enrichment
10 Float needle valve
11 Float needle valve seal ring
12 Fuel line connecting tube
13 Carburetor cover gasket
14 Leaf spring
15 Float chamber
16 Pressure reduction valve
17 Pump lever
18 Diaphragm
19 D iophragm spring
20 Ball valve (suction valve)
21 Float
22 Pump connecting rod
23 Metering jet
24 Emulsion tube
25 Bore without function
26 Throttle valve
27 Intermediate lever
28 Main venturl
29 Vacuum passage for automatic choke
30 Throttle valve body
31 Gasket
32 Vent valve lever

Figure 6E-2 Sectional View of Carburetor

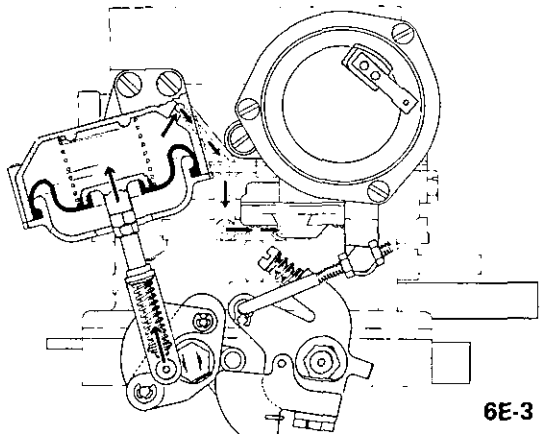


Figure 6E-3 Secondary Vacuum Diaphragm

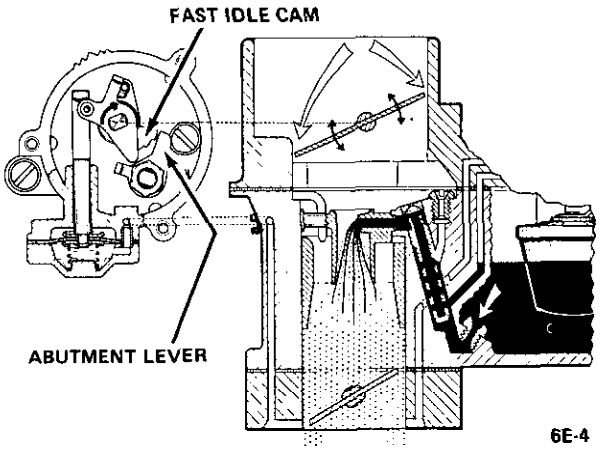


Figure 6E-4 Automatic Choke System

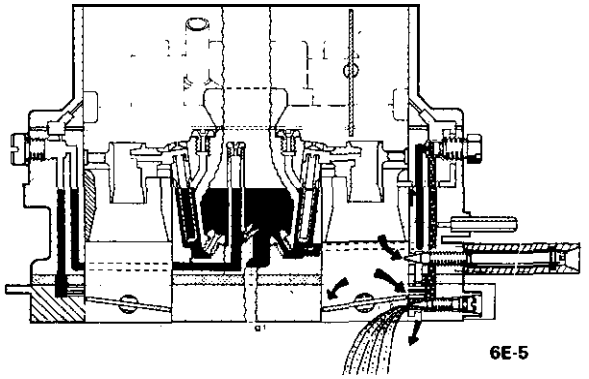


Figure 6E-5 Idle System

in a richer mixture. When the throttle valve is opened, fuel is also drawn from the upper ports, providing a good transfer from the idle system to the main metering jet system. See Figure 6E-5.

Main Metering Jet System

During high-speed operation, fuel is drawn from the float chamber through the main metering jet (Figure 6E-2) into the emulsion tube bore. The emulsion tube, which is provided with transverse bores, is inserted in the emulsion tube bore. Vacuum in the primary venturi (Figure 6E-2) draws fuel from the main nozzle. As the vacuum increases, the tendency is to draw too much fuel from the main nozzle, making the mixture too rich. To compensate for this tendency, the fuel level drops in the emulsion tube bore and more emulsion tube transverse bores are exposed. Air from the high speed air jet (Figure 6E-2) enters the emulsion tube through these transverse bores and mixes with the fuel. The more the fuel level drops, the more the transfer bores are exposed. This causes the air-fuel ratio to remain constant over the whole engine speed range. See Figure 6E-6.

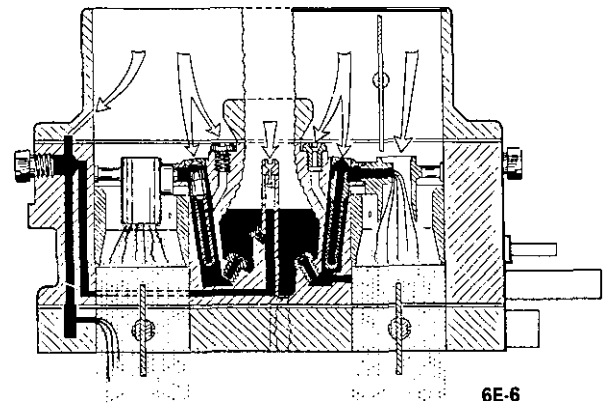


Figure 6E-6 High Speed System

The secondary valve diaphragm is operated by vacuum taken from the mixing chamber of the primary barrel on the Opel 1900 and Manta only. With the primary throttle valve almost open and with engine speed at approximately half of the maximum engine RPM, vacuum increases to such an extent that the secondary throttle valve starts opening from vacuum applied in the vacuum diaphragm case acting through a connecting rod and throttle valve lever. See Figure 6E-3.

Primary to Secondary Transfer System

In order to have a smooth engagement of the second-

ary barrel, it is provided with a transfer system. When the secondary throttle valve starts to open, two ports (which are normally just above the closed valve) are uncovered, causing fuel to feed into the secondary bore just before the secondary nozzle starts feeding. This provides for an additional enrichment of the air-fuel mixture at the beginning of full throttle operation. See Figure 6E-7.

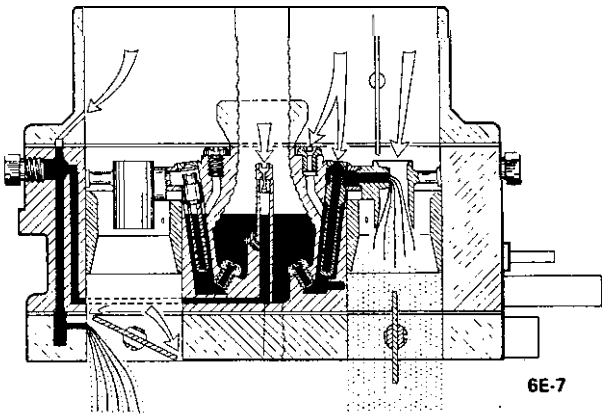


Figure 6E-7 Primary to Secondary Transfer System

Full Throttle Enrichment System

If the secondary throttle valve is fully opened, the vacuum in the throttle valve area is reduced so that the transfer ports (mentioned above) stop feeding. However, the vacuum increases greatly in the secondary venturi area. An enrichment tube which protrudes into the primary venturi area, feeds fuel continuously during full throttle operation. See Figure 6E-2.

Acceleration System

Whenever the throttle is closing, the suction stroke of the diaphragm pump causes fuel to flow from the float chamber through the inlet ball valve into the pump chamber. When the throttle valve is opened the diaphragm is moved inward by the pump connecting rod and the pump lever. Fuel is injected into the primary bore through the injector tube. The amount of fuel is determined by the pump stroke.

The inlet ball valve in the pump chamber prevents fuel from flowing back into the float chamber during the pressure stroke of the pump. The outlet ball valve prevents air from being drawn into the injector tube during the suction stroke of the pump. See Figure 6E-8.

Float Bowl Ventilation

While driving, the float bowl is ventilated from inside the carburetor. That is, the float bowl is connected through the vent valve with the area under the air cleaner.

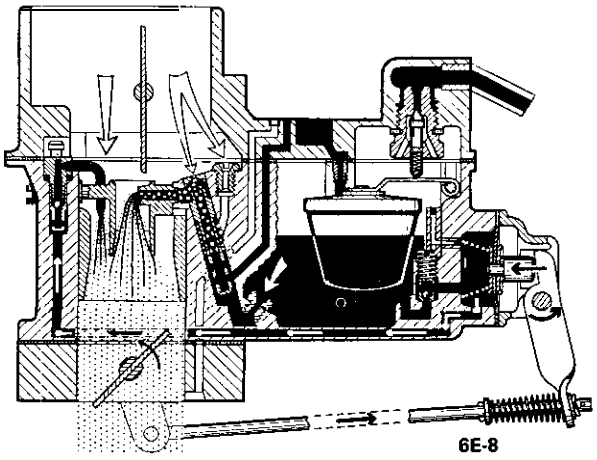


Figure 6E-8 Acceleration System

When the engine is idling or off, the ventilation from inside is cut off and ventilation from the charcoal canister is cut in. The upper spring now seats the valve on the upper seat. See Figure 6E-9.

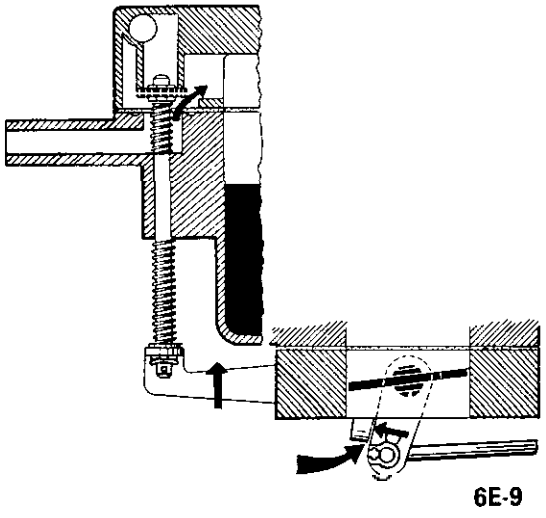


Figure 6E-9 Float Bowl Ventilation

The advantage of an inside vent while driving is that air cleaner restriction does not enrichen the air fuel mixture. The purpose of the charcoal canister vent while idling or after shutting-off a hot engine, is to prevent excess fuel vapors from entering the intake manifold and outside air. Excess fuel vapors may cause an idling engine to stall, or may make it difficult to restart a hot engine.

DIAGNOSIS

CARBURETOR

Condition I

Hesitation or Stall Upon Light Acceleration

Correction

1. Check spark plugs and plug gap. Plug gap should be .030 in.

2. Check dwell and timing.

3. Adjust carburetor.

4. Accelerator pump should discharge fuel between throttle plate and venturi wall with engine off. If aim is not correct, use needlenose pliers to slightly bend nozzle so proper aim is achieved. See Figure 6E- 10.

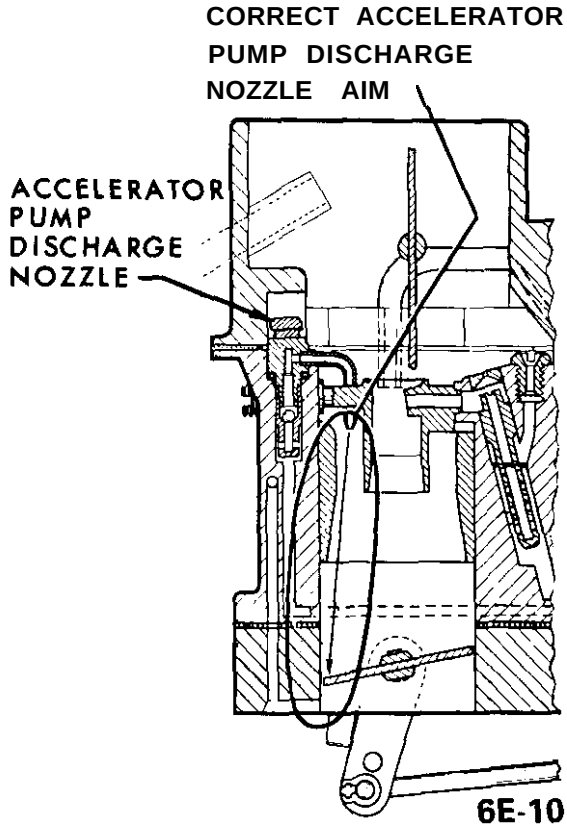


Figure 6E-10 Pump Shot Aim

Road test car. If hesitation still exists, check for the following:

1. Plugged accelerator pump discharge nozzle.

2. Dirt in accelerator pump circuit.

3. Defective inlet check ball.

4. Defective accelerator pump pressure relief valve.

5. Defective accelerator pump diaphragm.

6. Maladjusted accelerator pump linkage.

Condition II

Hard Start After Hot Soak

Correction

Perform Steps 1-4 in Condition I.

Condition III

Hard Start When Engine Is Cold

Correction

1. Align groove on choke cover with pointer on choke housing. See Figure 6E-17.

2. Set fast idle.

3. Replace distributor points if pitted.

4. Check spark plugs and gap at .030.

5. Set dwell and timing.

If above procedure does not correct problem, replace with new automatic choke assembly.

Condition IV

Rough, Erratic, or No Idle

Correction

1. Check spark plugs and gap at .030.

2. Check dwell angle and ignition timing.

3. Clean idle jet and passages with air hose. See Figure 6E-5.

4. Check manifold to head bolt torque. Should be 33 lb.ft.

5. Check automatic choke linkage alignment.

6. Adjust carburetor.

MAINTENANCE AND ADJUSTMENTS

IDLE SPEED ADJUSTMENT

Note: ***Idle speeds of 600 to 800 R.P.M. are normal for engines with less than 3,000 miles.***

Prior to making any adjustment to the carburetor, the following items must be checked for proper operation and/or setting:

1. Valve Adjustment (Hydraulic lifters can be improperly adjusted.)

2. Dwell Angle.

3. Ignition Timing.

4. Spark Plug Gap.

5. Exhaust Gas Recirculation Valve (See "Checking" under EXHAUST GAS RECIRCULATION SYSTEM.)

After it has been ascertained that the above items are properly adjusted and operating correctly and idle R.P.M. is still not within specifications, proceed as follows:

1. With air cleaner installed, run engine until normal operating temperature is reached.

2. Remove plastic caps from the idle mixture screw and air speed screw. See Figure 6E-11.

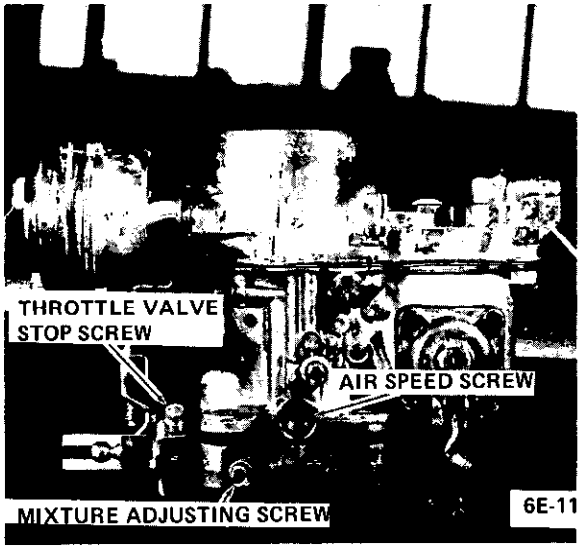


Figure 6E-11 Carburetor Adjusting Screws

3. To raise R.P.M., turn air speed screw counterclockwise. To lower R.P.M., turn air speed screw clockwise, thereby reducing the amount of air going through the system.

4. Adjust idle mixture screw until highest R.P.M. is obtained. Alternately adjust idle mixture screw and air speed screw until R.P.M. is obtained that is 50 R.P.M. higher than the desired final setting. This is to be accomplished with the idle mixture screw at best idle.

5. Turn idle mixture screw clockwise (lean) until a decrease of 50 R.P.M. is obtained. The idle R.P.M. will now be within specifications and proper emission control maintained.

6. Install red plastic caps over the air speed screw and idle mixture screw.

Basic Idle Adjustment

A basic idle adjustment is to be made only if engine idle R.P.M. correction does not result in correct idle R.P.M. setting and engine has more than 3,000 miles of operation. If necessary, proceed as follows:

1. Remove plastic cap from the throttle valve stop screw. See Figure 6E-11.

2. Place the Manometer (J-23951) in a vertical position. Turn the 2 vents on top open to equalize pressure and balance gauge to read zero. With engine idling, unplug the vacuum advance hose from the carburetor and connect the manometer hose in its place. See Figure 6E- 12.

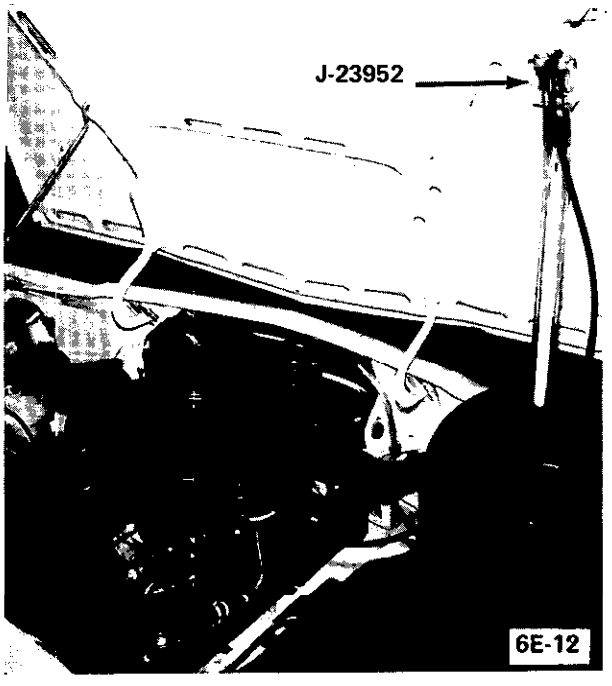


Figure 6E-12 Throttle Plate Calibrator J-23951 Installed

3. If the manometer does not read 1 to 8 inches of

water, adjust the throttle stop screw to read 6 inches of water (3 inches down and 3 inches up).

4. Disconnect manometer and reconnect the vacuum advance hose.

5. Adjust idle air speed screw and mixture screw to obtain maximum idle at 850 to 900 R.P.M. (automatic transmission) or 900 to 950 R.P.M. (manual transmission).

6. Make final adjustment by turning idle mixture screw in to reduce idle speed 50 R.P.M.

7. Install red plastic caps over the air speed screw and idle mixture screw. Replace plastic cap over the throttle valve stop screw and secure in place with Loctite.

Fast Idle Speed Adjustment

1. Remove air cleaner cover.

2. With engine off, open the throttle halfway and close the choke valve, release the throttle, then release the choke.

3. Start engine without moving the throttle. Adjust to 3200 to 3300 R.P.M. using 2 nuts on fast idle rod. See Figures 6E-13 and 6E-14.

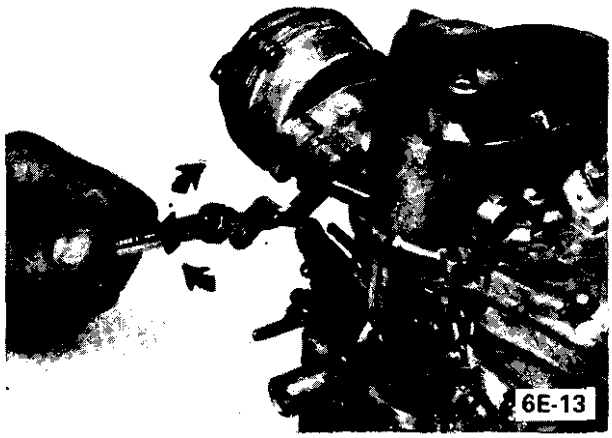


Figure 6E-13 Decreasing Fast Idle Speed

CARBURETOR LINKAGE ADJUSTMENT

GT Series

1. Remove air cleaner.

2. Have helper depress accelerator pedal to floor and check to see if wide open throttle is reached at carburetor.

3. If adjustment is necessary, proceed as follows:

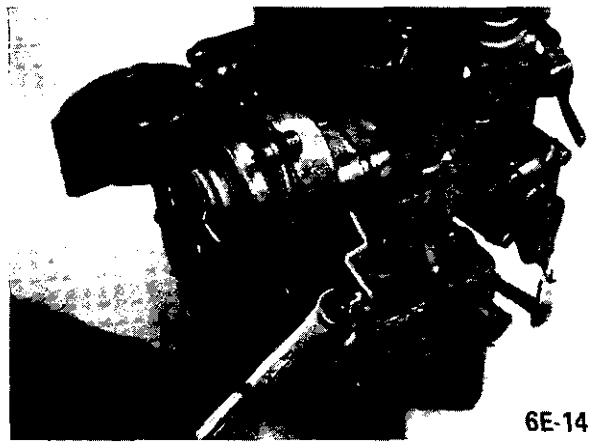


Figure 6E-14 Increasing Fast Idle Speed

(a) Unhook accelerator pedal return spring.

(b) Remove lock spring at upper end of vertical control rod and detach rod.

(c) Lengthen or shorten control rod so that wide open throttle is obtained at the carburetor when accelerator pedal is 1/4" - 1/2" from floor mat.

(d) Reinstall rod, lock spring and pedal return spring.

Opel 1900 and Manta Series

The carburetor bowden control wire is properly adjusted if, with correctly-adjusted engine idle speed, engine at operating temperature and accelerator pedal at an angle of 25 degrees to the vertical plane, the ball (A) of the carburetor bowden control wire rests against the accelerator pedal lever. See Figure 6E-15.

1. Position accelerator pedal at an angle of 25 degrees to the vertical plane. To do this, loosen lock nut of adjusting bolt (c) and unscrew adjusting bolt a few turns.

Squeeze a 1 3/8" wood block (D) between accelerator pedal and dash panel. See Figure 6E-15.

Screw in adjusting bolt until the accelerator pedal lever releases the wood block (D). Tighten lock nut.

2. Adjust bowden control wire at adjuster. See Figure 6E-16. Prior to doing this, adjust engine idle speed with engine at operating temperature.

Set carburetor bowden control wire adjuster at the bracket so that the ball (A) of the control wire rests against part (B) of the accelerator pedal lever and the wire core between bracket and segmental disc is not sagging.

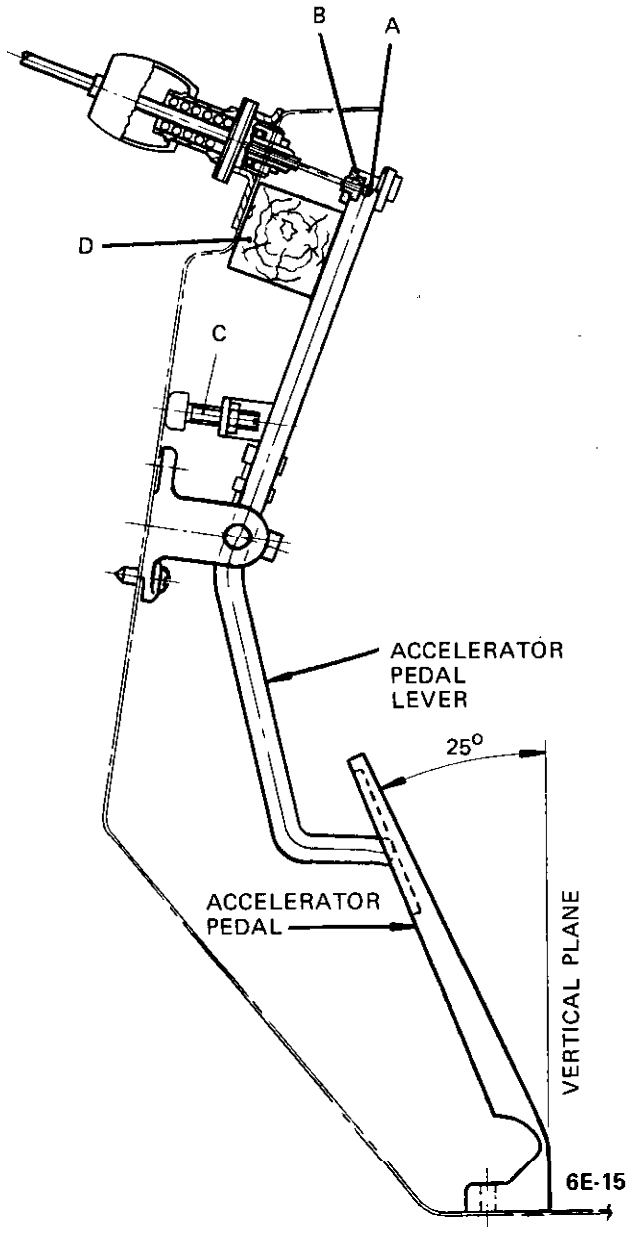


Figure 6E-15 Adjusting Accelerator Cable

Depress accelerator pedal until pedal lever touches floor mat. The carburetor throttle valve must now be completely opened.

MAJOR REPAIR

REMOVE AND INSTALL CARBURETOR

1. Remove air cleaner.

2. Remove fuel and vacuum hoses from carburetor fittings.

3. Remove choke wire.

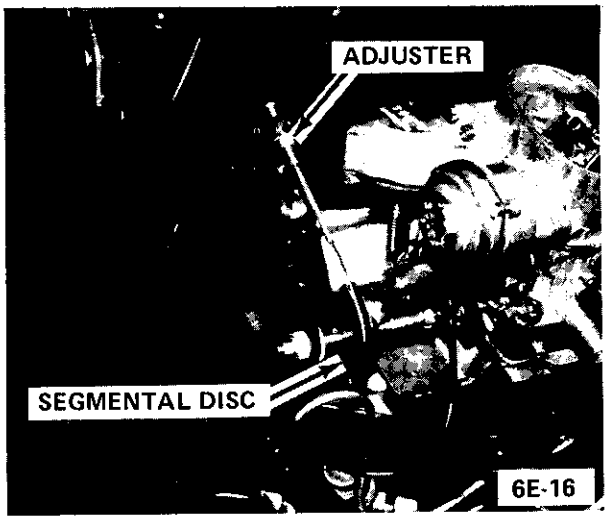


Figure 6E-16 Bowden Control Wire Adjuster and Segmental Disc

4. Disconnect throttle linkage by removing lock pin and unsnapping ball socket from ball on end of throttle shaft.

5. Remove carburetor by removing four nuts and lockwashers.

Install in reverse order, noting the following:

1. Prior to carburetor installation, place a new gasket on intake manifold.

2. Make certain that all nuts and screws on the carburetor are securely tightened.

3. Make sure that choke housing is set on index and that choke valve is nearly closed at room temperature. See Figure 6E-17. Make sure choke valve is free in all positions.

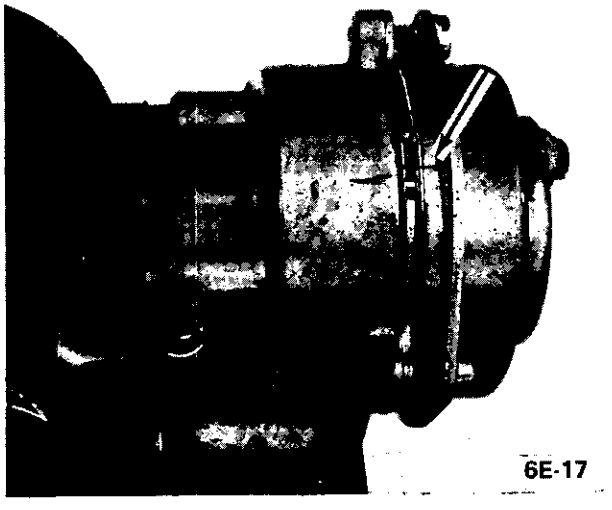


Figure 6E-17 Choke Housing Set on Index

4. Adjust engine idle speed and mixture

CAUTION: : ***Make sure choke valve opens fully before starting idle adjustment.***

THROTTLE LINKAGE REMOVAL

Removal

Opel 1900 and Manta Series

1. Remove control wire from bracket and unhook it from segmental disc. See Figure 6E-16.

2. In passenger compartment, unhook wire with ball **and** plastic bushing from accelerator pedal lever. See arrow in Figure 6E- 18.

Figure 6E-18 Unhook Wire in Passenger Compartment

3. In engine compartment, pull bowden control wire out of bracket on dash panel.

If bowden control wire is kinked or damaged in any way, it must be replaced.

Installation

1. Feed ball and plastic bushing from engine compartment through opening in dash panel and hook in accelerator pedal lever. See Figure 6E-19.

2. Lightly pull wire core so that the plastic bushing slips into bore of accelerator pedal lever.

3. Hook bowden control wire in segmental disc and attach control wire to bracket.

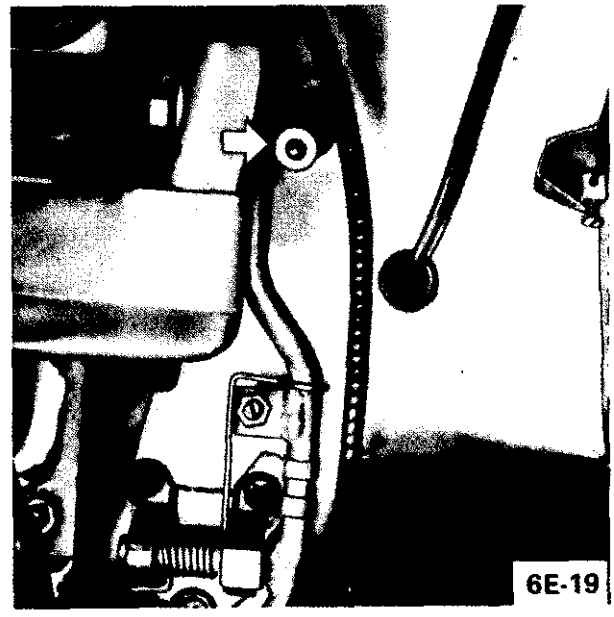


Figure 6E-19 Installing Ball and Plastic Bushing

4. Adjust control wire.

OVERHAUL CARBURETOR

Disassembly

1. Remove outer nut from end of throttle lever to choke link. See Figure 6E-20.

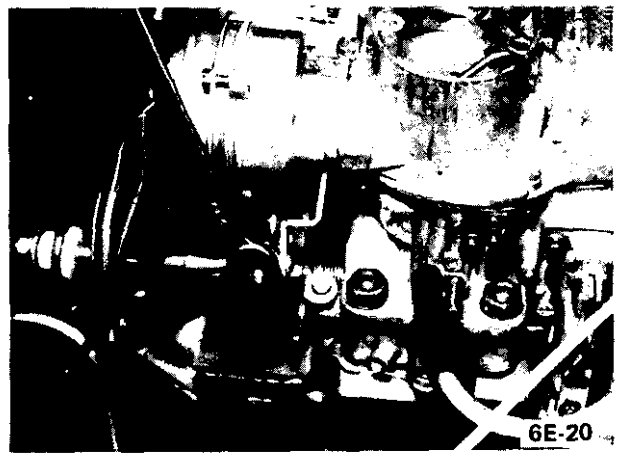


Figure 6E-20 Removing Choke Link

2. Pry off vacuum case connecting lever. See Figure 6E-21.

3. Unscrew carburetor cover.

4. Screw float needle valve out of carburetor cover and take off copper seal ring.

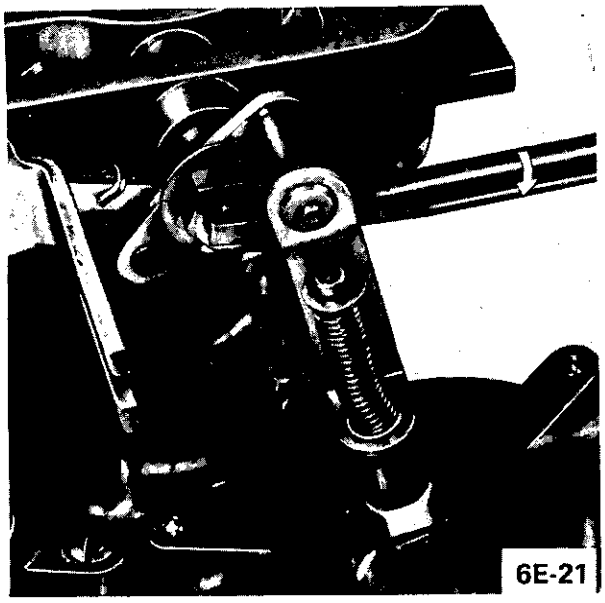


Figure 6E-21 Removing Vacuum Case Lever

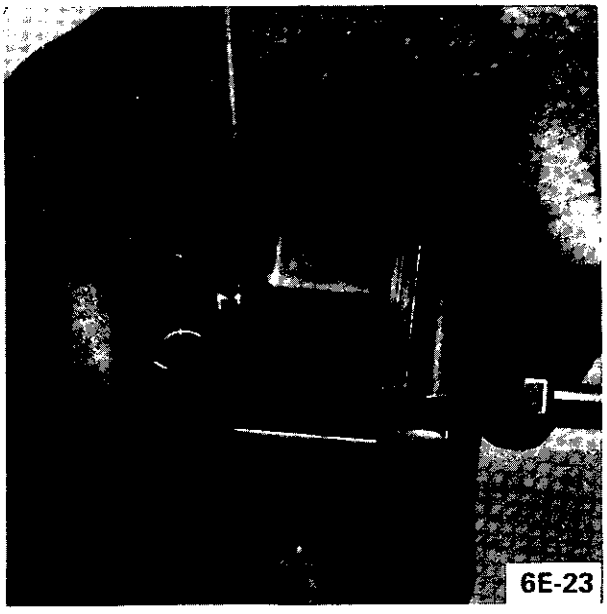


Figure 6E-23 Removing Vacuum Case Reduction Jet

5. Unscrew vacuum diaphragm cover from choke housing. See Figure 6E-22.

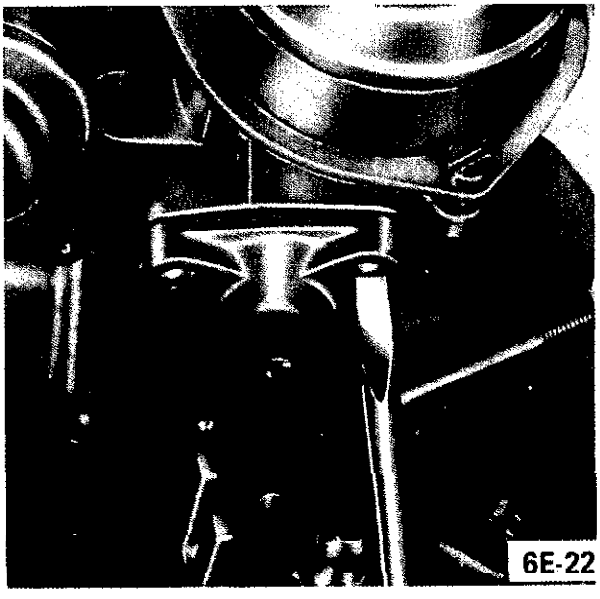


Figure 6E-22 Removing Vacuum Diaphragm Cover

6. Unscrew retaining ring from automatic choke body and take off cover.

7. Unscrew vacuum diaphragm case from carburetor cover. Remove reduction jet. See Figure 6E-23.

8. Take float together with spindle and leaf spring from float chamber.

9. Pull accelerator pump discharge nozzle assembly out of carburetor housing. Nozzle is press fitted. See Figure 6E-24.

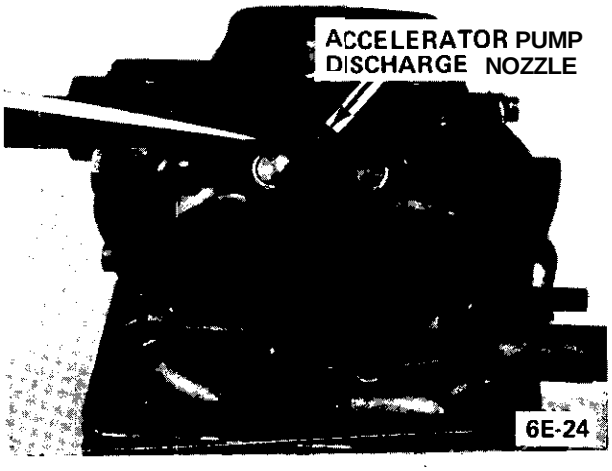


Figure 6E-24 Removing Accelerator Pump Discharge Nozzle

10. Remove primary idle jets and secondary idle plug. Remove primary and secondary high-speed air jets.

11. Remove primary and secondary main metering jets.

12. Remove cotter pin from pump connecting rod. Remove accelerator pump.

13. Remove idle mixture adjusting screw from throttle valve body. Remove idle air adjusting screw from

float chamber. Clean all parts and blow out with compressed air. Replace gaskets and seal rings.

14. Check actuating parts in automatic choke body, including diaphragm, for wear. Check pull rod for free operation. See Figure 6E-25.

15. Remove choke assembly by removing choke valve and 2 choke housing - to - carburetor screws.

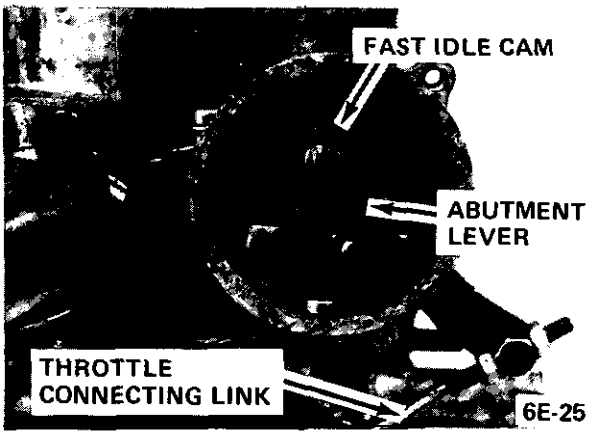


Figure 6E-25 Checking Automatic Choke Parts

16. Check vacuum case assembly. If bushing is worn, replace vacuum case assembly. See Figure 6E-27.

Figure 6E-27 Checking Vacuum Case Brass Bushings

17. Install secondary vacuum diaphragm case assembly. See Figure 6E-28.

18. Install gasket and shield between automatic choke cover and automatic choke body.

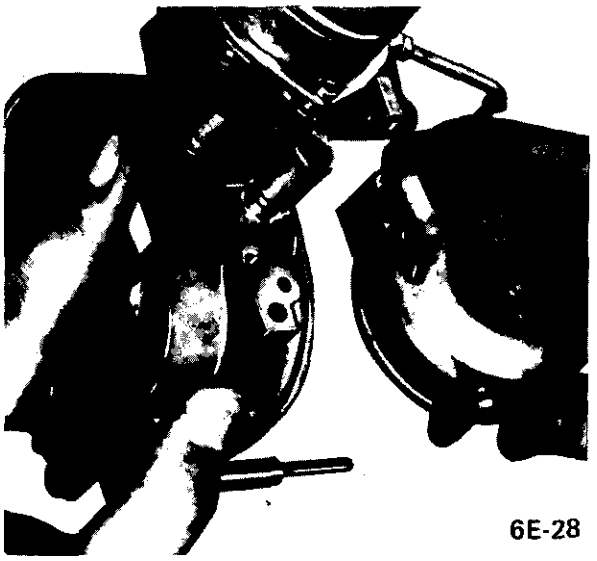


Figure 6E-28 Installing Vacuum Case Assembly

19. Install automatic choke cover so that the catch of the bi-metal spring is positioned onto bent end of the intermediate lever. See Figure 6E-29.

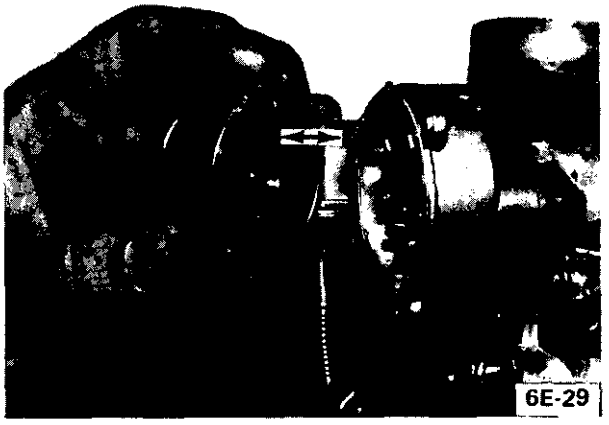


Figure 6E-29 Installing Automatic Choke Cover

20. Align and tighten automatic choke cover. Choke valve should be nearly closed at room temperature.

21. Check vent valve for free operation. Valve rod must not be bent.

22. Screw in jets according to calibration table. Never interchange parts of the primary and secondary barrel. See Figure 6E-37.

23. Install the throttle body to the bowl, using new throttle body gasket. Adjust secondary throttle valve gap by loosening lock nut on the secondary throttle

valve stop screw. Loosen the stop screw until the valve is completely closed. Turn the screw in 1/4 turn from **closed** position, hold, and tighten lock nut. This is done to insure that the throttle blade will not stick closed. See Figure 6E-30.

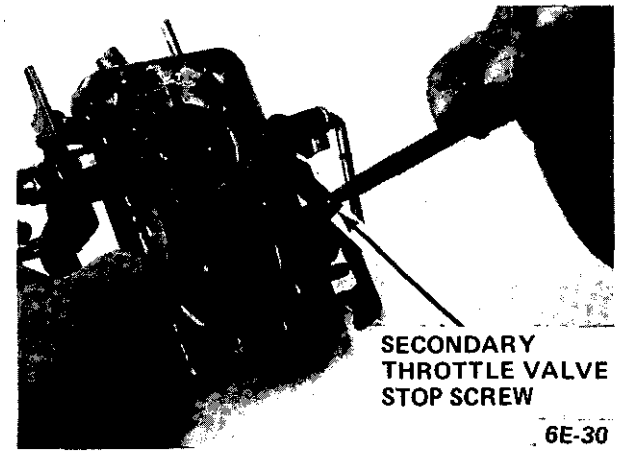


Figure 6E-30 Adjusting Secondary Throttle Valve Gap

24. Install accelerator pump connecting rod in lower hole of primary throttle shaft lever and cotter pin in outboard hole at accelerator pump actuating lever end. Paying attention to proper arrangement of cotter pin and washers. See Figure 6E-2.

25. With throttle plate completely closed, there should be no clearance between the pump lever and the pump plunger rod.

26. If a clearance is present, loosen 4 accelerator

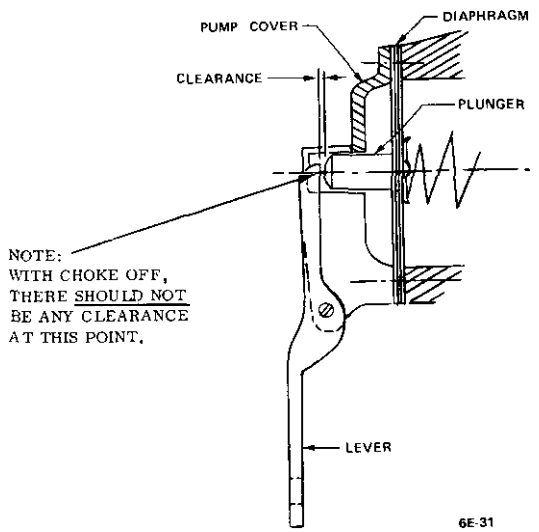


Figure 6E-31 Accelerator Pump Cover

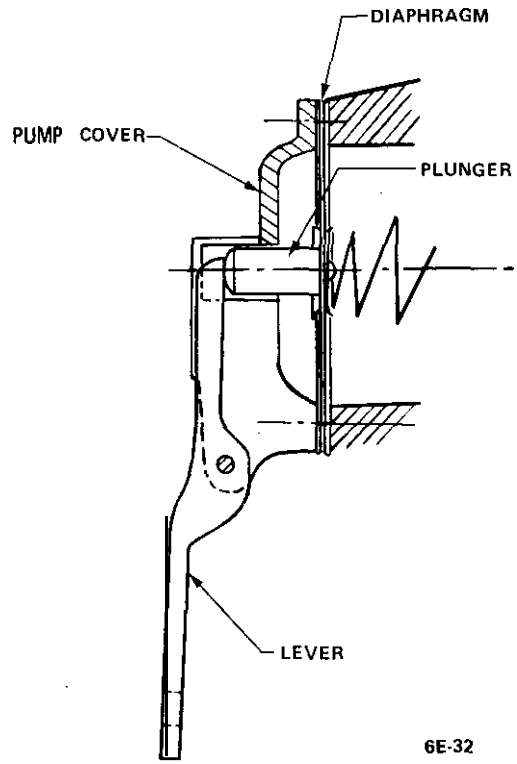


Figure 6E-32 Accelerator Pump Cover

pump cover retaining screws and allow the diaphragm spring to push plunger against lever so that a zero clearance exists. Then retighten the screws. See Figures 6E-3 1 and 6E-32.

27. Insert accelerator pump discharge nozzle so that the bent tube end points into suction channel of the primary barrel.

28. Fill the bowl with fuel.

29. With fuel in bowl, slowly open the throttle and observe the accelerator pump pressure relief valve exhaust ports and where it seats into the bowl. See Figure 6E-33. Fuel should not be bleeding back into the bowl from the exhaust ports or where the relief valve seats, but a steady stream of fuel should discharge from the discharge nozzle.

30. With fuel in bowl, rapidly open the throttle and observe the exhaust ports of the pressure relief valve. See Figure 6E-33. Fuel should exhaust from the accelerator pump pressure relief valve exhaust ports.

3 1. If the pressure relief valve malfunctions, remove it and replace with a new one.

32. No float adjustment is possible, so check position of float arm by comparing with a new float of the same carburetor type. If float arm is bent, replace float.

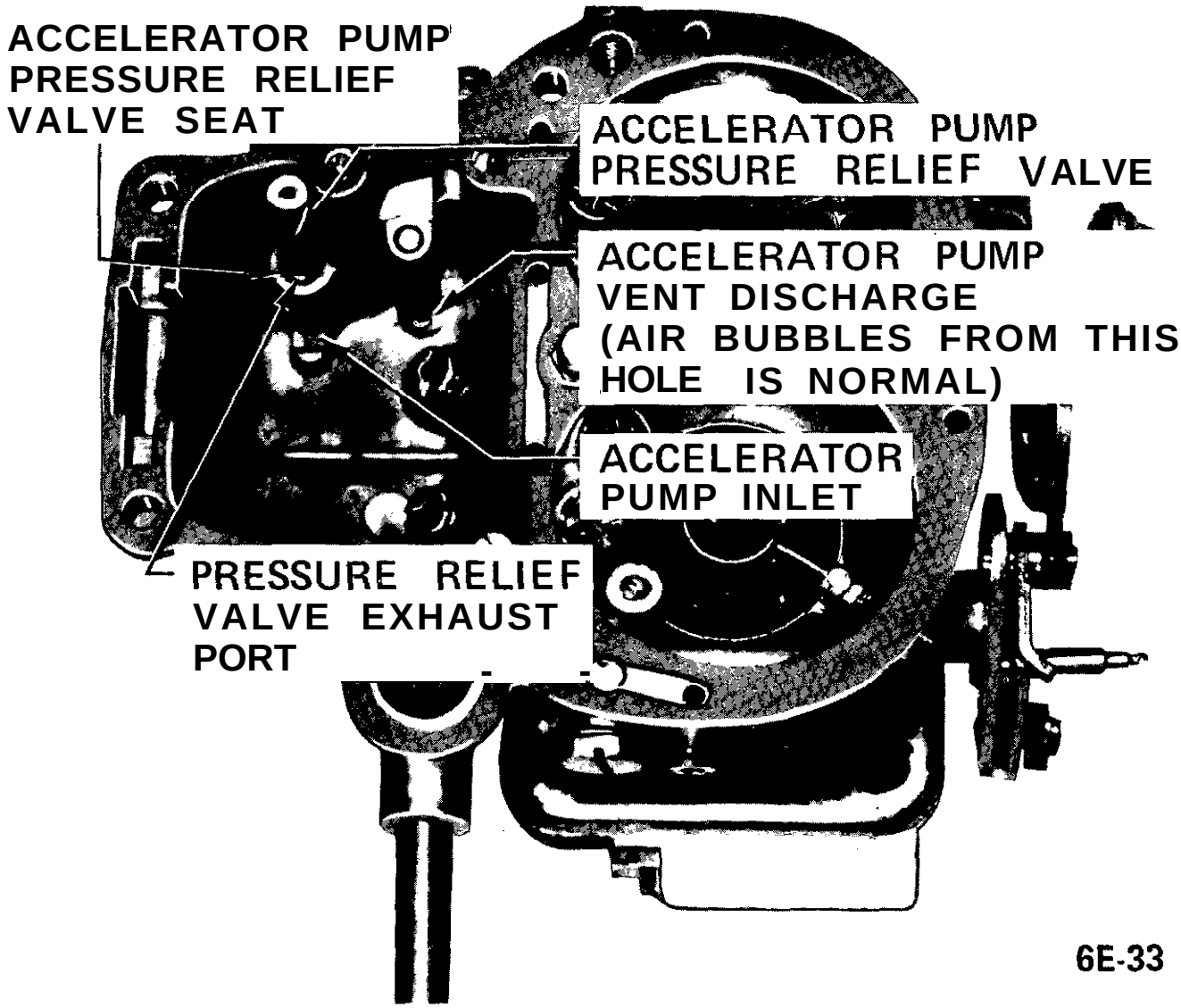


Figure 6E-33 Carburetor Fuel Bowl

33. Install float and pivot rod making sure rod is seated in casting.

34. Install leaf spring so that spring ends rest on float spindle. See Figure 6E-34.

3.5. Screw in float needle valve together with copper seal ring (.08 in. thick).

36. Install new air horn gasket so that the holes in the gasket coincide with the screw holes in carburetor housing. See Figure 6E-35.

37. On vent valve, pay attention to cotter pin position and arrangement of washers.

38. Basic adjustment of idle mixture adjusting screw is 5 turns open.

Figure 6E-34 Leaf Spring Installed

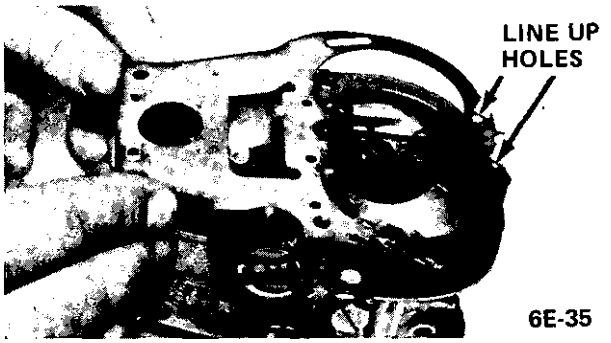


Figure 6E-35 Installing Cover Gasket

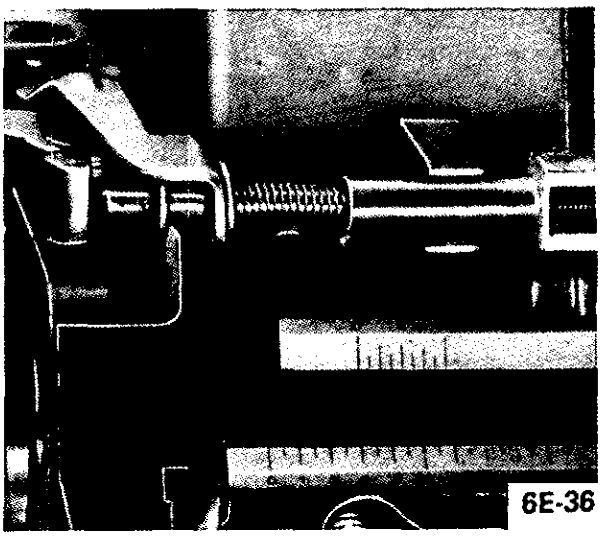


Figure 6E-36 Checking Vent Valve Adjustment

39. Check compression of vent valve lower spring. It should be compressed 1/4 inch with throttle valve completely closed. See Figure 6E-36.

40. Correct by bending valve lever.

SPECIFICATIONS

GENERAL SPECIFICATIONS

Compression Ratio	7.6 to 1
Fuel Required	Low Lead
Fuel Tank Capacity (Gallons)	
Opel 1900 and Manta..	11.9
GT..	13.2
Fuel Gauge Type	Electrical
Fuel Pump Type	Mechanical
Fuel Pump Drive	Eccentric on Camshaft
Fuel Pump Pressure at 1950 RPM	3.1 to 3.7 psi
Fuel Filter	In-Line Filter
Carburetor Make and Type	1-Solex 2 BBL Automatic Choke
Air Cleaner Element Type	Fiber Mesh - Paper

1973 OPEL CARBURETION SPECIFICATIONS

	Manta & 1900 Manual Transmission	Manta & 1900 Automatic Transmission	G. T. Manual Transmission	G. T. Automatic Transmission
Carburetor Tag No.	3441825	3441596	3441826	3441827
Primary Main Metering Jet	X122.5	X122.5	X120	X120
Secondary Main Metering Jet	X155	X155	X137.5	X137.5
Primary Air Correction Jet	120	120	110	110
Secondary Air Correction Jet	80	80	120	120
Idle Jet	47.5	47.5	45	45
Accelerator Pump Discharge Nozzle	50	50	50	50
Fast Idle Setting	3200-3300 R.P.M.	3200-3300 R.P.M.	3200-3300 R.P.M.	3200-3300 R.P.M.
Primary Venturi	.94 (24)	.94 (24)	.94 (24)	.94 (24)
Secondary Venturi	1.10 (28)	1.10 (28)	1.10 (28)	1.10 (28)

6E-37

Figure 6E-37 Carburetor Specifications

EMISSION CONTROL SYSTEMS

ALL MODELS

CONTENTS

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Exhaust Gas Recirculation System	6F-63
MAINTENANCE AND ADJUSTMENTS:	
Exhaust GAS Recirculation System	6F-63
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DESCRIPTION AND OPERATION

OPEL EMISSION CONTROL SYSTEM (O.E.C.S.)

All 1973 cars must be capable of passing certain tests which measure the quantity of unburned impurities in the exhaust system. Federal law places a limit on the hydrocarbon and carbon monoxide emissions from the exhaust system. The purpose of this law is to keep the atmosphere cleaner, particularly in populous areas where these impurities add to the smog problem. Basically, excessive exhaust emissions are caused by incomplete combustion of the air-fuel mixture in the cylinders.

The basic components of the OECS on the 1.9 liter engines are (1) leaned out carburetion, (2) heated air (except GT), and (3) tuned spark timing.

(1) The carburetor idle system is leaned out and special features are incorporated into the carburetors to make possible additional idle mixture adjustments over and above those manufactured into the carburetors.

(2) The heated air package consists of a heat stove, a corrugated paper heated air pipe, and an air cleaner containing a temperature controlled door operated by vacuum through a temperature sensor. See Figure 6F-1.

The heat stove is a sheet metal cover, shaped to and bolted onto the exhaust manifold. Air drawn in along

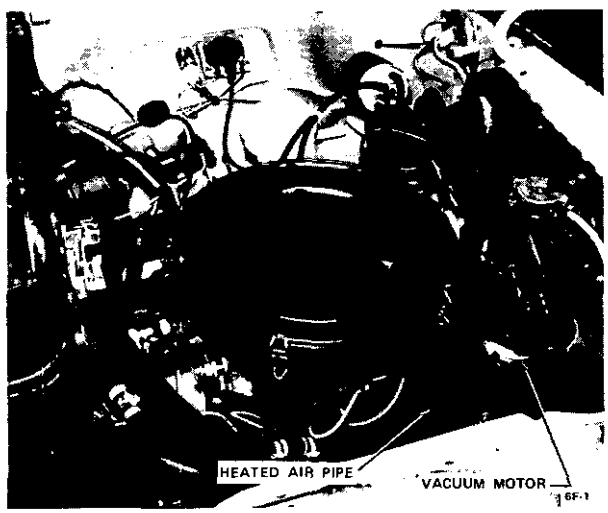

Figure 6F-1 Heated Air System Installed

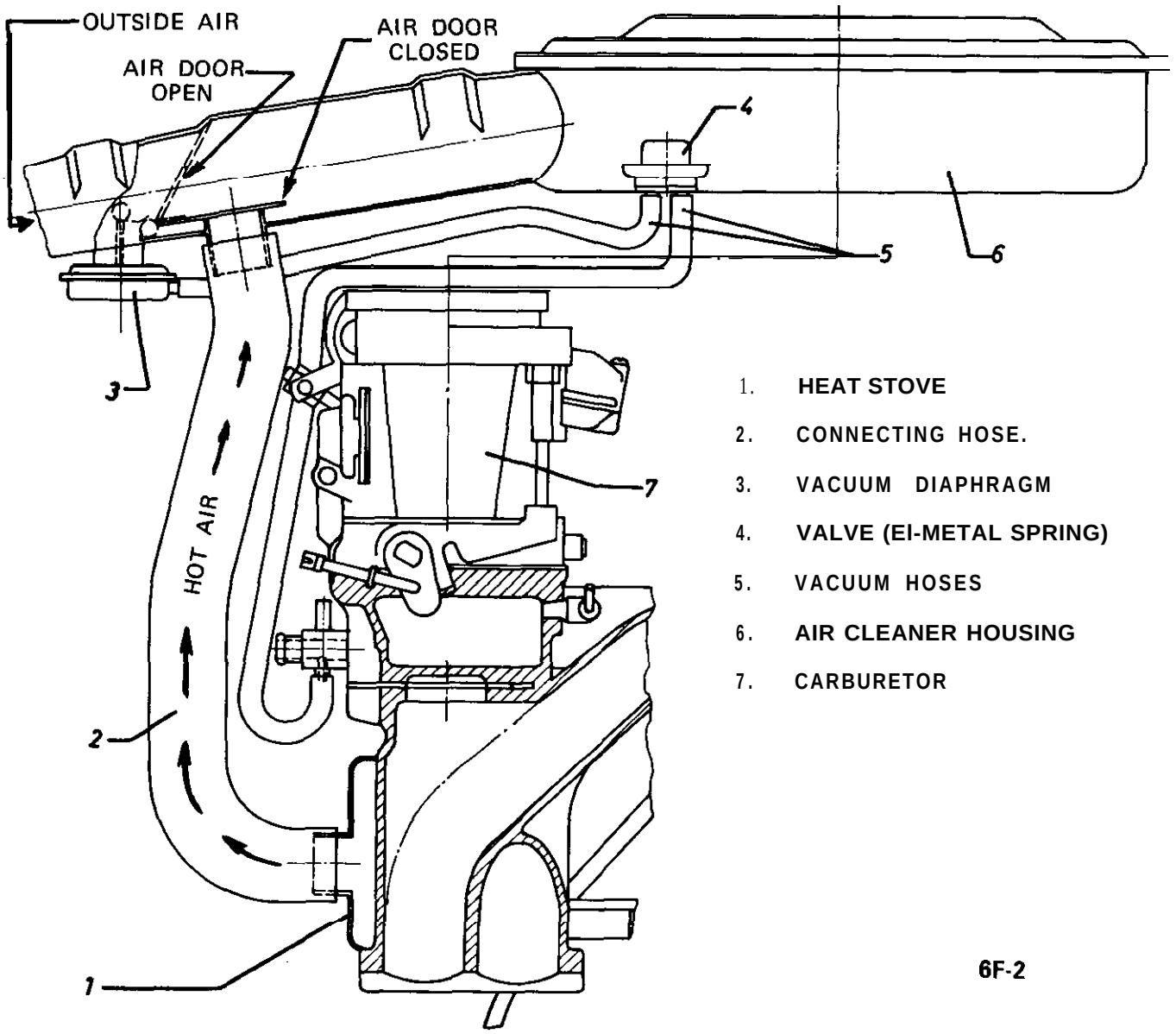

Figure 6F-2 Heated Air System

the lower edge of the stove passes across the manifold surface, picking up heat. The heated air is drawn out from the upper end of the manifold, through the heated air pipe into the snorkel of the air cleaner. See Figure 6F-2.

The temperature control air cleaner is designed to mix this heated air with cold air from under the hood so that carburetor inlet air temperature averages about 115 degrees. This mixing is done by an air door located in the air cleaner snorkel. Most of the time, the door will be partially open, as required, to control the temperature. When the underhood temperature reaches about 135 degrees, the door will close tight, not allowing any more warm air from the mainifold to enter the snorkel of the air cleaner. Obviously, if underhood temperatures rise above 135 degrees, the air cleaner will no longer be able to control temperature and the inlet air temperature will rise with underhood temperature.

The temperature door is moved by a diaphragm type vacuum motor. When there is no vacuum present in the motor, the diaphragm spring forces the door closed. Whenever the engine is running, the amount of vacuum present in the vacuum motor depends on the temperature sensor in the air cleaner which is located in the vacuum line between the intake manifold and the vacuum motor. In the sensor, a bi-metal temperature sensing spring starts to open a valve to bleed more air into the vacuum line whenever the temperature in the air cleaner rises above about 115 degrees. Whenever the temperature falls below about 115 degrees, the sensing spring starts to close the air

bleed into the vacuum line, allowing more manifold vacuum to reach the vacuum motor. Whenever there is nine inches or more of vacuum in the vacuum motor, the diaphragm spring is compressed, the door is opened.

When the engine is not running, the diaphragm spring will always hold the door closed. However, when the engine is running, the position of the door depends on the air temperature in the air cleaner.

When starting a cold engine (air cleaner temperature under 85 degrees), the air door will open immediately. This is because the air bleed valve in the sensor is closed so that full manifold vacuum, is applied in the vacuum motor. As soon as the air cleaner starts receiving hot air from the heat stove, the sensor will cause the air door to close partially, mixing cold air with the hot air as necessary to regulate air cleaner temperature within 20 degrees of the ideal 115 degrees air inlet temperature.

If underhood air temperature rises to 135 degrees, the air bleed valve in the sensor will be wide open so that vacuum to the vacuum motor approaches zero. The diaphragm spring in the vacuum motor will hold the air door closed tightly. If underhood temperature rises above 135 degrees, carburetor inlet air temperature will also rise above 135 degrees.

While air cleaner temperature is being regulated, accelerating the engine hard will cause the vacuum level in the intake manifold and in the vacuum motor to drop. Whenever vacuum drops below 5 inches, the diaphragm spring will close the air door in order to get the maxumum outside air flow required for maximum acceleration.

The carburetor is set by the manufacturer for 800-850 RPM (automatic transmission) or 850-900 RPM (manual transmission) and 1.5 to 2.5 percent CO.

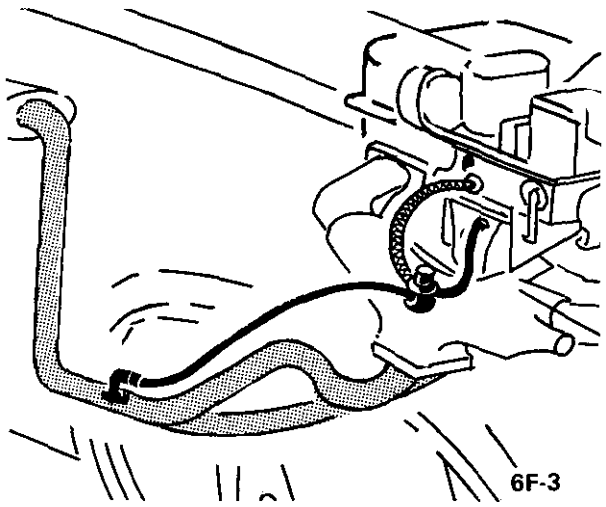

Figure 6F-3 E.G.R. System

EXHAUST GAS RECIRCULATION SYSTEM

All 1973 Opel 1900's, Manta's and GT's are equipped with an exhaust gas recirculation (E.G.R.) system. See Figure 6F-3.

The E.G.R. system consists of a pipe connected to the center of the front exhaust pipe, an E.G.R. valve, a short pipe from the valve to the intake manifold and a short vacuum hose from the E.G.R. valve to the base of the carburetor. See Figure 6F-4.

The system does not receive sufficient vacuum at idle to operate, but will operate during acceleration and part throttle providing sufficient intake manifold vacuum is present.

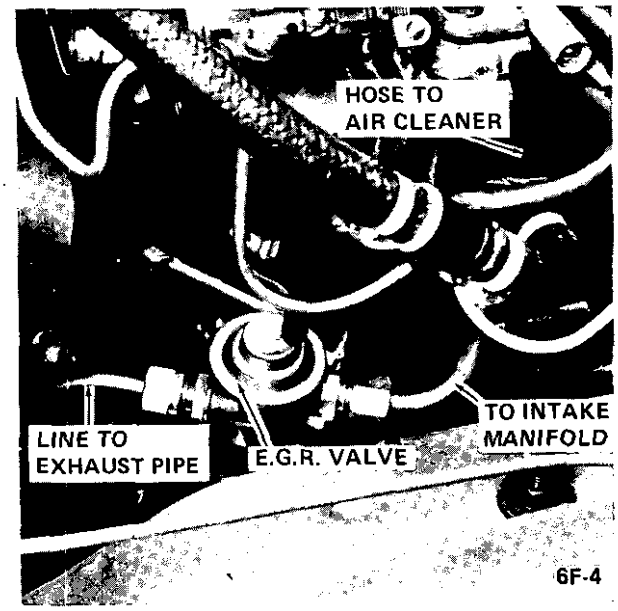

Figure 6F-4 E.G.R. Valve Location

DIAGNOSIS

TESTING THERMO AIR CLEANER OPERATION

Since failure of the thermo air cleaner will generally result in the snorkel air door staying open, failure will probably go unnoticed in warm or hot weather. In cold weather, however, owners will complain of leaness, hesitation, sag, surge, or stalling. When any type of lean operation complaint is received, always test the thermo air cleaner for proper functioning before doing any work on the carburetor.

Always perform checks in the same order as listed below.

Vacuum Motor Check

1. Check all hoses for proper hookup. Check for kinked, plugged, or damaged hoses.

2. With the engine "OFF", observe damper door position through snorkel opening. If position of snorkel makes observation difficult "se the aid of a mirror. At this point damper door should be in such a position that the heat stove passage is covered (snorkel passage open). If not, check for binds in linkage.

3. Apply at least nine in. Hg. of vacuum to diaphragm assembly through hose disconnected at sensor "nit. This can be done by mouth. Damper door should completely close snorkel passage when vacuum is applied. If not, check to see if linkage is hooked up correctly and for a vacuum leak.

4. With vacuum applied, bend or clamp hose to trap vacuum in diaphragm assembly. Damper door should remain in position (closed snorkel passage). If it does not, there is a vacuum leak in diaphragm assembly. Replace diaphragm assembly.

Sensor Check

Quick Check of System:

1. Start test with engine cold, air cleaner at a temperature below 85 degrees. If the engine has been in recent "se, allow it to cool.

2. Observe the air door before starting the engine: it should be closed.

3. Start the engine and allow it to idle. Immediately after starting the engine, the air door should open.

4. As the engine warms up, the air door should start to close, and the air cleaner should become warm to the hand.

5. The system is operating normally as described above. If the air cleaner fails to operate as above or if correct operation of the air cleaner is still in doubt, proceed to the thermometer check.

Thermometer Check of Sensor:

1. Start test with air cleaner temperature below 85 degrees. IF ENGINE HAS BEEN RUN RECENTLY, ALLOW IT TO COOL DOWN. While engine is cooling, remove air cleaner cover and install a temperature gage such as J- 22973 as close as possible to sensor. Reinstall air cleaner cover. Let car stand idle for 1/2 hour or more before proceeding to step 2.

2. Start the engine. Air door should open immediately if engine is cool enough. When air door starts to close (in a few minutes), remove air cleaner cover and read temperature gage. It must read 115 degrees plus or minus 20 degrees.

3. If air door does not start to close at temperature indicated, temperature sensor is defective and must be replaced.

EXHAUST GAS RECIRCULATION SYSTEM

Testing

The exhaust gas recirculation valve is to be checked at 12,000 mile intervals "sing the following procedure:

1. With engine at operating temperature, connect a tachometer to engine and note R.P.M. at idle.

2. Disconnect vacuum hose at the intake manifold that goes to the air cleaner.

3. Disconnect vacuum hose for exhaust gas recirculation valve from the throttle valve and connect it to the intake manifold where vacuum hose to air cleaner was connected.

4. Engine speed should decrease between 100-240 R.P.M. from previously noted R.P.M.

5. If the R.P.M. decrease is less than 100 R.P.M., the exhaust gas recirculation valve and fitting going into the intake manifold must be removed, cleaned, and' reinstalled.

MAINTENANCE AND ADJUSTMENTS

EXHAUST GAS RECIRCULATION SYSTEM

Cleaning

Clean the exhaust gas recirculation valve and fitting with a piece of stiff wire removing all exhaust deposits.

> CAUTION: ***Do not soak in solvent. After reinstalling the valve and fitting, check operation as outlined under "Testing". If valve does not operate properly after a thorough cleaning, replace it.***

MAJOR REPAIR

REMOVAL AND REPLACEMENT OECS UNITS

The damper door is not serviceable. The air cleaner assembly must be replaced if the damper door is defective.

R And R Vacuum Motor

1. Remove vacuum motor retainer spring. See Figure 6F-5.

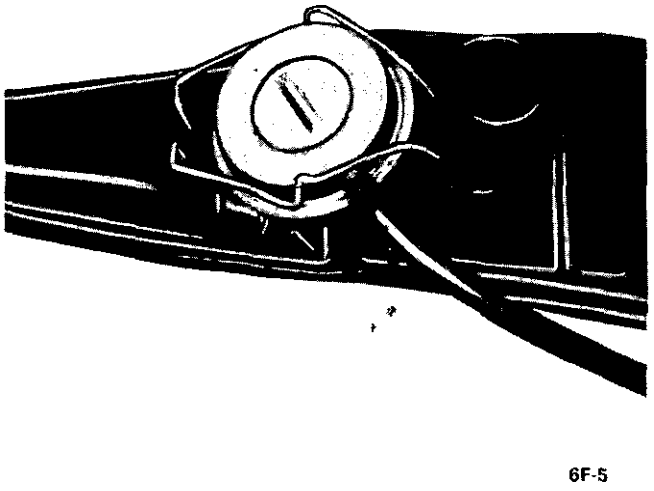

Figure 6F-5 Replacing Vacuum Motor Assembly

2. Lift vacuum motor, cocking it to one side to unhook motor linkage at the control door.

3. Install in reverse sequence.

R And R Air Cleaner Sensor

1. Remove sensor retaining clips by prying. See Figure 6F-6.

2. Pull vacuum hoses from sensor.

3. Note carefully the installed position of the sensor

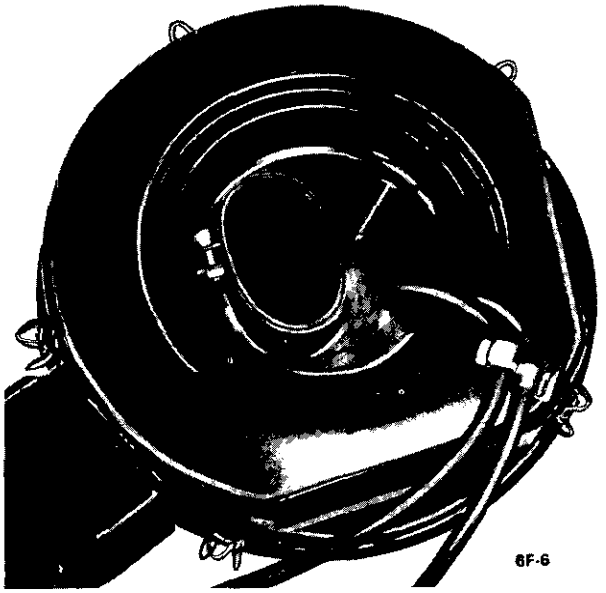

Figure 6F-6 Replacing Sensor Assembly

so that you can install new sensor in same position. Then remove sensor.

4. Install sensor and gasket assembly in air cleaner in same position as noted in Step 3. This is to eliminate the possibility of interference with the air filter element. See Figure 6F-4.

5. Install sensor retaining clip. Meanwhile supporting sensor around the outside rim to prevent damage to the temperature sensing spring.

6. Reinstall vacuum hoses.

SPECIFICATIONS

EMISSION CONTROL SYSTEM SPECIFICATIONS

Carburetor Inlet Air Regulated Temperature	115" ± 20
Idle Mixture Setting (Lean From Best Idle)	50 RPM
Thermo Vacuum Switch Operating Temperature	220
Engine Thermostat Operating Temperature	189

TUNE-UP

ALL MODELS

CONTENTS

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DIAGNOSIS: (Not Applicable)	
MAINTENANCE AND ADJUSTMENTS:	
Engine Tune-Up Mechanical Operations	6G-65
Engine Tune-Up Instrument Checks	6G-67
MAJOR REPAIR: (Not Applicable)	
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Tune-Uo Specifications and Adjustments	6G-68

DESCRIPTION AND OPERATION

PURPOSE OF TUNE-UP

The purpose of an engine tune-up is to restore power and performance that may have been lost through, loss of adjustment, wear, corrosion, or deterioration of one or more parts or units. In the normal operation of an engine, these changes take place gradually at quite a number of points so that it is seldom advisable to attempt an improvement in performance by correcting one or two items only. Time will be saved and more lasting results will be assured by following a definite and thorough procedure of analysis and correction of all items affecting power and performance. Because of Federal laws, limiting exhaust emissions, it is even more important that the engines tune-up is done accurately, using the specifications listed and the tune-up sticker found in each engine compartment.

Economical, trouble free operation can better be assured if a complete tune-up is performed at first 4 months or 6,000 miles of operation - then at 12 month or 12,000 mile intervals.

The parts or units which affect power and performance may be divided, into three groups (1) compression, (2) ignition and (3) carburetion. The tune-up procedure should cover these groups in the order given. While the items affecting compression and ignition may be handled according to individual preference, correction of items in the carburetion group should not be attempted until all items in compression and ignition have been satisfactorily corrected.

MAINTENANCE AND ADJUSTMENTS

ENGINE TUNE-UP OPERATIONS

Compression

To make sure hydrocarbon and carbon monoxide emissions will be within limits, it is very important that the adjustments be followed exactly.

The suggested procedure for engine tune-up *is as* follows:

1. Remove all spark plugs.

2. Position throttle and choke valve in full open position.

3. Connect jumper wire between distributor terminal of coil and ground on engine to avoid high tension sparking while cranking engine.

4. Hook up starter remote control cable and turn ignition switch to "on" position.

5. Firmly insert compression gage in spark plug port. Crank engine to obtain highest possible reading.

6. Check compression of each cylinder. ***Repeat*** compression check and record highest reading obtained on each cylinder during the two pressure checks.

The recorded compression pressures are to be considered normal if the lowest reading cylinder is more than 75 percent of the highest reading cylinder. See the following example and the "Compression Pressure Limit Chart." See Figure 6G-2.

Seventy-five percent of 140 (highest) is 105. Thus, cylinder No. 4 is less than 75 percent of No. 3. This condition, accompanied by low speed missing, indicates an improperly seated valve or worn or broken piston ring. See Figure 6G-1.

CYLINDER NO.	PRESSURE (PSI)
2	129
3	135
4	140
	100

6G-1

Figure 6G-1 Example of Compression Check

7. If one or more cylinders read low, inject about a tablespoon of engine oil on top of pistons in low reading cylinders through spark plug port. Repeat compression check on these cylinders.

a. If compression improves considerably, rings are worn.

b. If compression does not improve, valves are sticking or seating poorly.

c. If two adjacent cylinders indicate low compression and injecting oil does not increase compression, the cause may be the head gasket leaking between the cylinders. Engine coolant **and/or oil** in cylinders could result from this defect.

Compression Pressure Limit Chart

This chart may be used when checking cylinder compression pressures. It has been calculated so that the lowest reading number is 75 percent of the highest reading number. See Figure 6G-2.

EXAMPLE: ***After checking the compression pressures in all cylinders, it was found that the highest pressure obtained was 182 psi The lowest pressure reading was 145 psi. By locating 182 in the maximum column, it is seen that the minimum allowable pressure is 136 psi. Since the lowest reading obtained was 145 psi, the car is within limits and the compression is considered satisfactory.***

MAXIMUM PRESSURE POUNDS/ SQ. INCH	MINIMUM PRESSURE POUNDS/ SQ. INCH	MAXIMUM PRESSURE POUNDS/ SQ. INCH	MINIMUM PRESSURE POUNDS/ SQ. INCH
134	101	188	141
136	102	190	142
138	104	192	144
140	105	194	145
142	107	196	147
146	110	198	148
148	111	200	150
150	113	202	151
152	114	204	153
154	115	206	154
156	117	208	156
158	118	210	157
160	120	212	158
162	121	214	160
164	123	216	162
166	124	218	163
168	126	220	165
170	127	222	166
172	129	224	168
174	131	226	169
176	132	228	171
178	133	230	172
180	135	232	174
182	136	234	175
184	138	236	177
186	140	238	178

6G-2

Figure 6G-2 Compression Pressure Limit Chart

Spark Plugs

1. Inspect, clean and regap or replace spark plugs as required. Correct gap is .030.

2. Install spark plugs. Tighten to 30 lb.ft.

Secondary Ignition System

1. Inspect ignition cables for broken, swollen or deteriorated insulation.

2. Check terminal ends and condition of rubber boots. Replace as required.

3. Inspect the condition of the distributor cap and rotor.

4. Clean the ignition coil and inspect for cracks or carbon paths which could cause high voltage leakage.

Distributor Contact Points

1. Inspect distributor contact points and replace or adjust as necessary (.016 gap).

2. If inspection of contact points indicates excessive burning, pitting or wear, check condenser and replace if necessary.

3. Inspect all connections and wires in the primary ignition circuit. Correct any abnormal conditions found.

Carburetor

1. Clean fuel strainer in fuel pump. To prevent fuel leakage in pump, disconnect "IN" line from pump and raise end above fuel level. The in-line fuel filter should be replaced every 12,000 miles or every 12 months.

2. Check for freedom of choke valve operation and clean shaft if necessary, with suitable solvent.

3. Inspect throttle cable or linkage bracket and return spring for wear. With helper depressing accelerator pedal to floor, check for wide open throttle. Adjust accelerator pedal height so wide open throttle is obtained when pedal is within 1/2 inch from floor. Lubricate linkage pivot points with engine oil.

Air Cleaner

Check paper element every 6,000 miles and replace every 24,000 miles. If a vehicle is operated in dusty territory, check condition of air cleaner element more frequently and replace if necessary.

Fan Belt

1. Inspect belt for wear, cracks or frayed points. Replace and/or adjust as necessary. Specified tension for belt using Gauge J-23600 is 45 lbs.

Cooling System

1. Inspect the radiator, water pump, cylinder head areas and all radiator and heater hose connections for evidence of engine coolant leaks.

2. Inspect all hoses for deterioration from gas and oil contact. Correct as required.

Inspection should be made with engine operating at normal temperature, cooling system completely filled, temperature control lever fully open and normal pressure in the system. Normal pressure should be 13.2 to 15.2 psi.

Engine Lubrication System

Inspect engine for evidence of oil leakage. Correct any abnormal condition with sealastic or new seals and gaskets.

Battery

1. Inspect battery, battery mount and cables and check electrolyte level. Proper level should be just above the cell plates.

CAUTION: *Do not over fill.*

2. Determine the serviceability of the battery by applying the 421 Battery Test.

Positive Crankcase Ventilation

Clean crankcase ventilator metered orifice in the intake manifold fitting every 6,000 miles. Also all hoses and fittings should be inspected, cleaned and replaced, if necessary.

To clean, remove rubber hose from metered orifice and apply air pressure to orifice to remove any foreign particles that may be trapped.

Valve Lifter Adjustment

Refer to Engine Mechanical and Mounts section for valve lifter adjustment procedure.

Engine Tune-Up Instrument Checks

The following instrument checks and adjustments serve as a final check on engine condition. These checks may discover some new problems that may not have been obvious before. The engine is also given its final adjustments that will assure maximum performance, reliability, and proper emission control.

Refer to Electrical Group for checking procedures of the following:

Cranking Voltage Check

Ignition Timing

Distributor Advance

Ignition Output

Secondary Resistance

Current Output and Voltage Setting

Idle Speed and Mixture Adjustments

Refer to carburetor section.

SPECIFICATIONS

TUNE-UP SPECIFICATIONS AND ADJUSTMENTS

Voltage Regulator

Voltage Regulator Setting in Volts at 2500 Engine RPM	14 ± .5

Ignition Coil

Ignition Coil Current Draw, Amperes at 12.5 Volts	
Engine Stopped	3.8
Engine Idling	2.3

Distributor

Total Advance (Centrifugal and Vacuum), Engine Degrees at 3600 Engine RPM	29-38
Centrifugal Advance, Engine Degrees and RPM	
Start Advance, at RPM	1000-1200
Medium Advance, Degrees at RPM	7.5-15 at 1400
Maximum Advance, Degrees at RPM	28-32 at 3600
Vacuum Advance, Engine Degrees and In. of Vacuum	
Start Advance..	- 5 at 2.9-4.1 In.
Maximum Advance..	1-5 at 4.5-5.0 In.
Vacuum Retard, Engine Degrees at Closed Throttle	- 5
Condenser Capacity in MicroFarads	.23-.32
Breaker Spring Tension in Ounces	14 to 19
Breaker Point Gap in Inches	.016
Dwell Angle in Engine Degrees	50 ± 3
Firing Order	1-3-4-2
Spark Plug or Coil Cable, Max. Resistance in Ohms	10,000

Spark Plugs

Make and Model Production	AC42FS
Make and Model - Replacement	AC42FS
If carbon fouling occurs, use	AC43FS
Spark Plug Torque in Lb.Ft.	.30
Spark Plug Gap in Inches	.030

Valve Lifter Adjustment

One full turn (clockwise) after zero clearance is obtained - refer to Valve Adjustment Procedure

Ignition Timing

Align timing marks with distributor retard hose disconnected and plugged