

SECTION 6A

GENERAL ENGINE MECHANICAL

CONTENTS

Cylinder Head	6A-1	Piston Rings	6A-15
Valve, Springs and Rotators	6A-2	Camshaft and Camshaft Bearings	6A-19
Valve Stem Height	6A-5	Camshaft	6A-19
Valve Spring Installed Height	6A-6	Camshaft Bearings	6A-19
Valve Lash Adjustment 2.8L	6A-6	Valve Lifters	6A-20
Oil Pump	6A-7	Leak Down Rate Test	6A-21
Gerotor Oil pump, VIN L, 3	6A-8	Cylinder Block	6A-22
Connecting Rod and Main Bearings	6A-11	Piston Fitting	6A-24
Crankshaft	6A-14	Rear Main Bearing Oil Seal 2.0, 2.5 & 2.8	6A-25
Pistons, Rings and Connecting Rod	6A-14	3.0, 3.8 and 5.0L Rear Main Seal	6A-26
5.0L Piston Pin Retainer	6A-15	Flywheel Balance	6A-26
Piston Pins _Free Floating	6A-15	Thread Repair	6A-27
Piston Pins _Press Fit	6A-15		

CYLINDER HEAD

Important

- o During disassembly, be sure that the valve train components are kept together and identified so that they can be re-installed in their original locations and with the same mating surfaces as when removed.
- o Before removing the cylinder head(s) from the engine and before disassembling the valve mechanism, perform a compression test and record the results.

Disassemble

1. Valve mechanism (refer to specific Engine Section)
2. Oil gallery and water jacket plugs
 - o Threaded plugs
 - o Cup plugs, if damaged or leaking
 - Obtain a suitable self-threading screw.
 - Drill a hole in the plug.
 - Install the self-threading screw.
 - Pry out plug.
3. Spark plugs

important

- o Do not remove spark plugs when hot
- o Clean dirt and debris from spark plug recess area

Inspect

- o Cylinder head gasket and mating surfaces for leaks, corrosion and blow-by. If the gasket has failed, determine the cause:
 - Improper installation
 - Loose or warped cylinder head
 - Missing dowel pins

Clean

- o Cylinder head bolts
- o Cylinder head. Remove all varnish, soot and carbon to the bare metal. **DO NOT** use a motorized wire brush on any gasket sealing surface.
- o Valve guides
- o Threaded holes
- o Remains of sealer from plug holes

CAUTION: Safety glasses must be worn when using a Dower wire brush to avoid injury to the eyes.

Inspect

1. Cylinder head bolts for damaged threads or stretching and damaged heads caused by improper use of tools.

Important

- o Any bolts that are suspected of damage must be replaced.
2. Cylinder head for cracks, especially between valve seats, and in the exhaust ports
 3. Cylinder head deck for corrosion, sand inclusions and blow holes.
 - o Do not attempt to weld the cylinder head, replace it.
 4. Cylinder head deck, intake and exhaust manifold mating surfaces for flatness. These surfaces may be re-conditioned by parallel grinding. If more than .39 mm (.010") V6, or .152 mm (.006") V8 must be removed, replace the head.
 5. All threaded holes for damage. Threads may be re-conditioned with thread inserts (refer to Thread Repair).
 6. Seating surfaces
 - o Water jacket plugs
 7. Valve guides for wear.

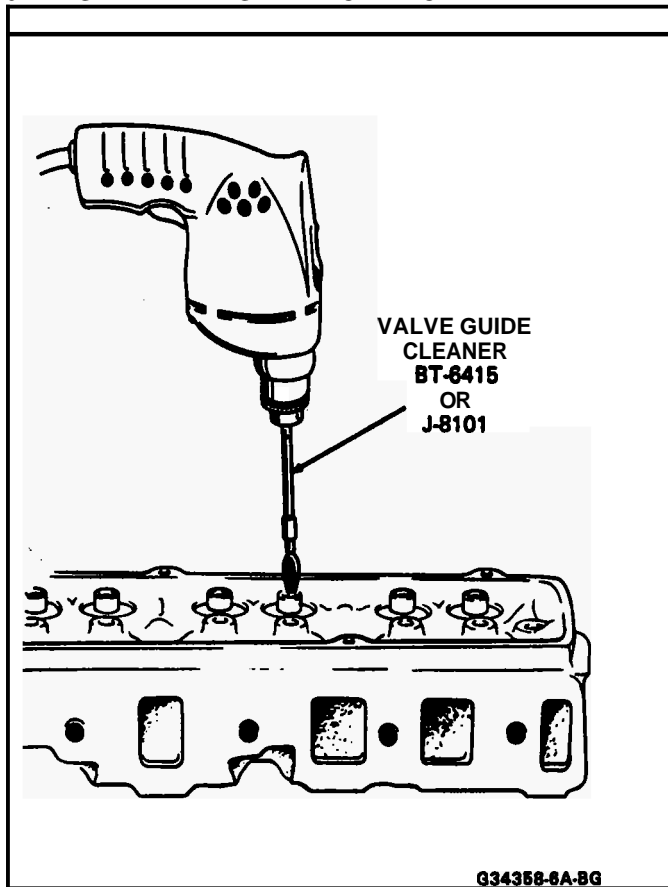


Figure 1 Cleaning Valve Guide

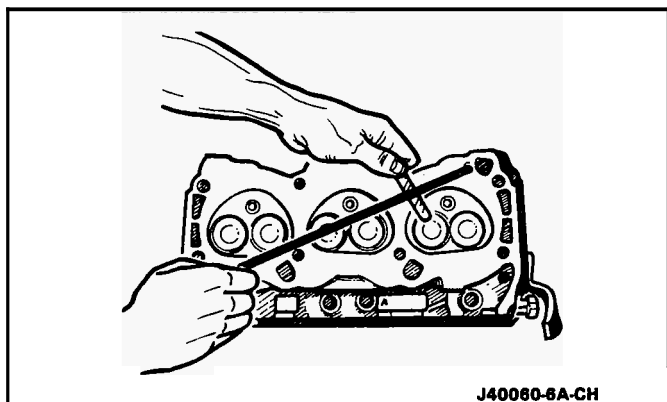


Figure 2 Checking Cylinder Head Flatness

- o Since the valve guide serves to support and center the valve grinder, it is essential that the valve guide is serviced before reconditioning the valve seats. The valve guide must be cleaned properly before any measuring or servicing takes place. If the valve guide requires reaming (refer to Valves, Springs and Rotators), this must be done first.
8. Valve seats for excessive wear and burned spots
- o Valve seats may be re-conditioned by grinding. An oscillating type valve seat grinder is preferred. Follow the grinder manufacturer's instructions. If, after grinding, the new seat is too wide, it may be narrowed by using a 20" or 70" stone. The 20° stone will lower the seat and the 70"

stone will raise the seat. If the seats are re-conditioned, the valves also must be re-conditioned or replaced (refer to Valves, Springs and Rotators).

- o If a burnt valve condition exists, it may be necessary to recondition the valve seat insert. At no time should there be less than 4 mm (2.8L) or 5 mm (2.0L) of valve seat material remaining after reconditioning. When reconditioning a valve seat, it will also be necessary to remove a non-adjustable rocker arm stud and install an adjustable rocker arm stud (2.8L only).

**Assemble**

1. Oil gallery and cooling jacket plugs. Coat plugs with GM 1050026 sealer or equivalent.
2. Valve and spring mechanism. Refer to specific engine section.

VALVES, SPRINGS AND ROTATORS**Disassemble**

- o Valve and spring mechanism (refer to Specific Engine Section)

**Important**

- o Be sure that the valve train components are kept together and identified so that they can be re-installed in their original location and with the same mating surfaces as when removed.

NOTICE: Avoid breaking the valve guide. If the valve stem has mushroomed due to rocker arm wear, remove burrs by chamfering the valve stem with an oil stone or file. Do not remove the valve from the guide using a hammer and drift punch.

**Clean**

1. Valves of carbon, oil and varnish. Carbon can be removed with a wire brush, varnish by soaking in carburetor cleaning fluid

CAUTION: Safety glasses must be worn when using a power wire brush. Avoid inhaling of fumes and exposure of skin to carburetor cleaning fluid, as bodily injury may result.

- o Do not scratch the valve stem with the wire brush.

2. Valve guides

**Inspect**

- o Valve stem tip for wear The valve stem tip may be reconditioned by grinding. If the valve has rotators and the stem tip wear pattern indicates rotator failure or if the rotators bind or stick, they must be replaced.

DISPLACEMENT		2.0	2.0L	2.5L	2.8L	3.0	3.8	3.8	3.8T	5.0	
ENGINE VIN CODE		M, K	#1	R, U	W	L	A	3	7*	Y	
VALVE	INTAKE	FACE ANGLE	46°	45°	45°	45°	45°		45°	44°	
		MARGIN (MIN.)					0.025	0.025	0.025	0.025	0.025
						0.635	0.635	0.635	0.635	0.635	
	SEAT	ANGLE	45°	45°	46°	46°	46°	46°	46°	46°	45°
		IN		.049-.059	0.035-0.075	.061-.073	0.062	0.062	0.062	0.062	0.037-0.075
		WIDTH		1.25-1.50	0.897-1.897	1.55-1.85	1.57	1.57	1.57	1.57	0.94-1.90
		IN	0.002	.002	0.002	.001	0.002	0.002	0.002	0.002	0.002
		RUNOUT	0.05	.05	0.05	.025	0.005	0.05	0.05	0.05	0.05
		STEM CLEARANCE	IN 0.0006-0.002	0.011 0.023	0.0011 0.0026	0.010 0.027	0.0015-0.0035	0.0015-0.0035	0.0015-0.0035	0.0015-0.0035	0.001-0.0027
		MM	0.015-0.042	0.28 0.58	0.025 0.068	0.25 0.68	0.038 0.089	0.038 0.089	0.038 0.089	0.038 0.089	0.026 0.068
EXHAUST	FACE ANGLE	46°	45°	45°	45°	45°	45°	45°	45°	30°	
	MARGIN (MIN.)					0.025	0.025	0.025	0.025	0.025	
						0.635	0.635	0.635	0.635	0.635	
	SEAT	ANGLE	45°	45°	46°	46°	46°	46°	46°	46°	31°
		IN		0.063-0.075	0.058	0.067-0.079	0.075-0.104	0.075-0.104	0.075-0.104	0.075-0.104	0.050-0.100
		WIDTH		1.6-1.91	1.468-2.468	1.7-2.0	1.905-2.642	1.905-2.642	1.905-2.642	1.905-2.642	1.27-2.54
		IN	0.002	0.002	0.002	0.001	0.002	0.002	0.002	0.002	0.004
		RUNOUT	0.05	0.05	0.05	0.025	0.05	0.05	0.05	0.05	0.10
		STEM CLEARANCE	IN 0.001-0.0024	0.0014-.0028	0.0011 0.0020	0.010 0.027	0.0015-0.0032	0.0015-0.0032	0.0015-0.0032	0.0015-0.0032	0.0015-0.0032
		MM	0.030-0.060	0.35-.070	0.025 0.068	0.25 0.68	0.038-0.089	0.038-0.089	0.039-0.089	0.038-0.089	0.038 0.081
SPRING	LOAD	FREE LENGTH	IN 2.06	2.06	1.91	1.91	2.03	2.03	2.03	2.03	1.96
		MM	52.3	52.3	48.5	48.5	51.56	51.56	51.56	51.56	49.78
		LBS @ IN	10591.6	7481.440	9081.701	85951.727	63711.727	85351.721	74821.727	76881.670	
		N @ MM	467940.9	330137	400143	378 422144.0	280 315144.0	378 422144.0	329 365143	338-374142.42	
		OPEN	LBS @ IN 21511.20	21511.20	21511.291	17219211.34	17519511.34	17519511.34	17519511.34	184-19411.27	
	N @ MM	956130.6	730126	956133	778 867134.03	765 854134.0	778 867133.0	778 866134	800-863132.26		
	INSTALLED HEIGHT	IN		1.440		1.697 1.757	1.697 1.757	1.697 1.757	1.697 1.757		
	MM			1440		43 10 44 62	43 10 44 62	43 10 44 62	43 10 44 62		

Figure 3 Valve and Spring Specifications

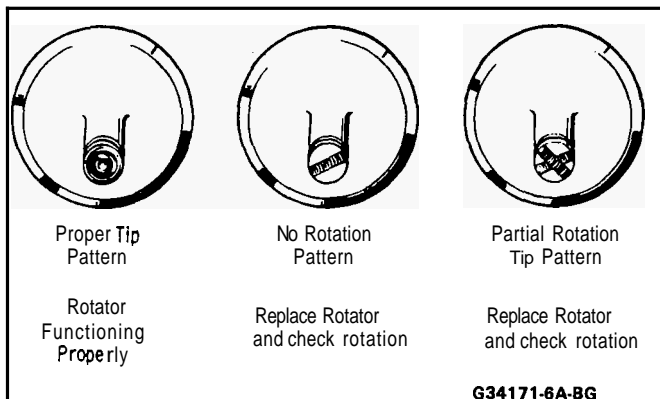


Figure 4 Valve Stem Tip Wear

- Valve face for burning or cracking. If pieces are broken off, inspect the corresponding piston and cylinder head area for damage.
- Valve stem for burrs and scratches. Burrs and **minor** scratches may be removed with an oil stone.
- Valve stem for straightness and valve head for bending or distortion. Use "V" blocks. Bent or distorted valves must be replaced.
- Valve face for grooving. If the groove is so deep that re-facing would result in a knife edge (destroying the margin), the valve must be replaced.
- The valve face may be re-ground to specifications if it is otherwise in good condition (Figure 3). If the valve face cannot be ground within the limits given, it must be replaced.
- Measure valve margin after grinding valves. If the margin is less than the minimum recommended margin, replace the valve.
- Follow the grinder manufacturer's instructions. Make sure the new surface is perpendicular to the valve stem.
- Valve lock (keeper) and oil seal grooves for chipped or worn lands. Replace the valve if chipped or worn.

6A-4 GENERAL ENGINE MECHANICAL

NOTICE: New valves must not be lapped. Lapping destroys the protective coating on the valve face.

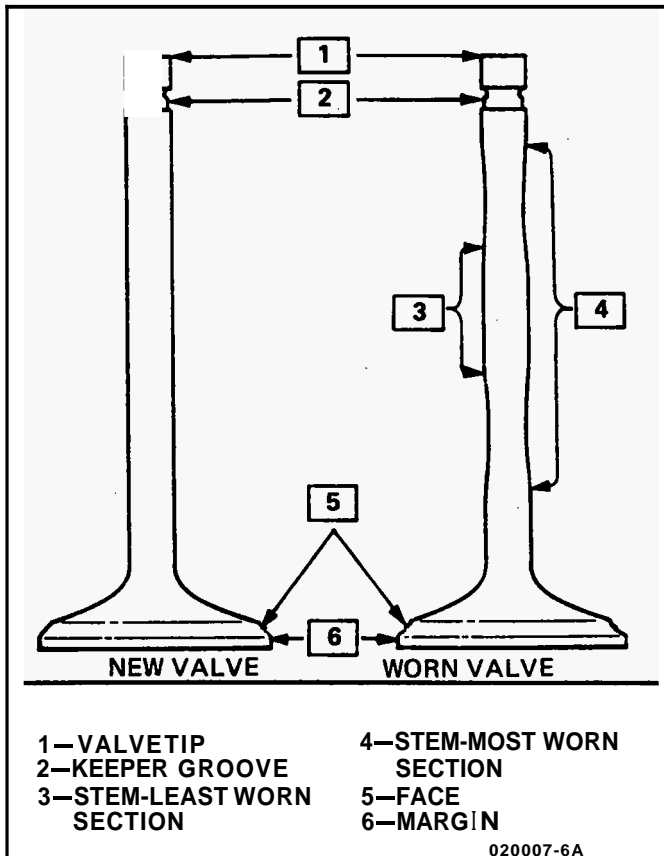


Figure 5 Valve Wear



Measure

- Valve guide clearance
 - Insert the valve into its guide. Lift it 2mm (1/8") off the seat and move it side to side, measuring the amount of movement with a dial indicator, or
 - With a hole gage, measure the valve guide I.D. and measure the valve stem with a micrometer and compare the clearance.
- The valve guides may be reamed to accept an oversized valve

Tools Required

- 2.0L VIN M & K
 J 26590-1 .19mm (.0075") OS
 J 26590-2 .381mm (.015") OS
 J 26590-3 .762mm (.030") OS
- 2.0 and 2.8L VIN #1 & W
 J 5830-1 .089mm (.003") OS
 J 5830-2 .394mm (.015") OS
 J 5830-3 .775mm (.030") OS
- 2.5L VIN R & U
 J 5830-2 .076mm (.003") OS
 J 6621 .127mm (.005") OS
- 3.0 and 3.8L VIN L, 3, A & 7
 J 5830-1 .076mm (.003") OS
 J 5830-6 .1524mm (.006") OS
- 5.0 VIN Y

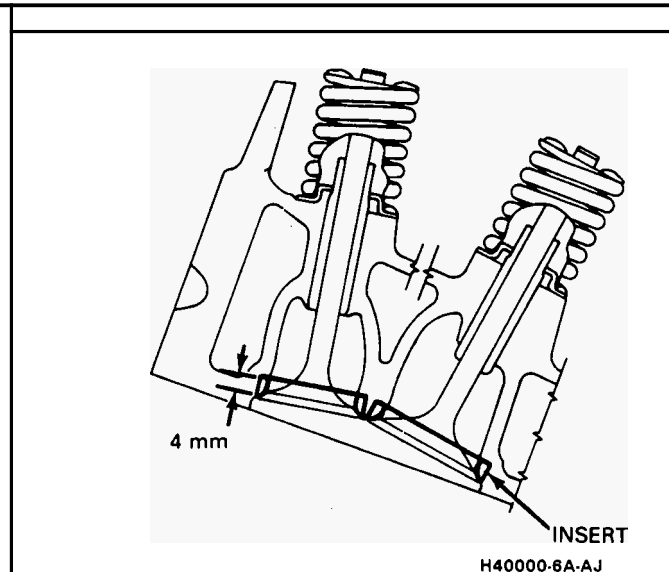


Figure 6 Valve Seat Insert VIN #1 & W

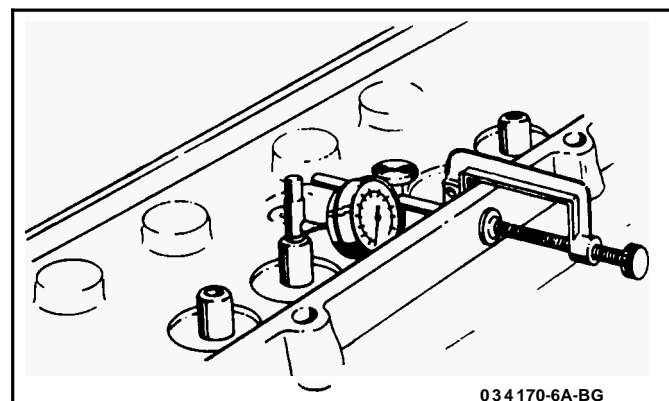


Figure 7 Measuring Valve Guide Clearance

BT-6414-1 or J 5830-2 .076mm (.003") OS

NOTICE: Avoid breaking reamer flutes or jamming the reamer into the valve guide due to packing of chips or carbon. Clean the valve guides before reaming. Do not push down on the reamer.

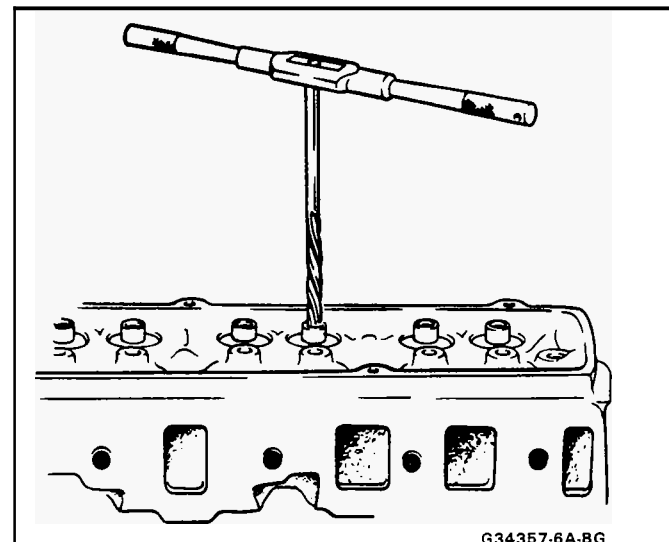


Figure 8 Reaming Valve Guide

Inspect

- o Valve springs (refer to Figure 3 for specifications)
 - Expanded height
 - Spring ends. If they are not parallel, the spring is bent and must be replaced.
 - Spring load. If below specification, replace.
- o Valve spring seating surface of the valve rotators or spring retainers for wear or gouging. Replace as required.

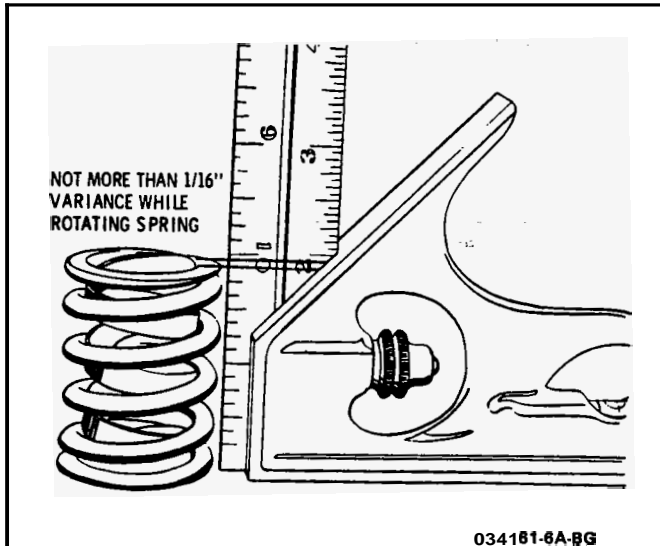


Figure 9 Checking Valve Springs

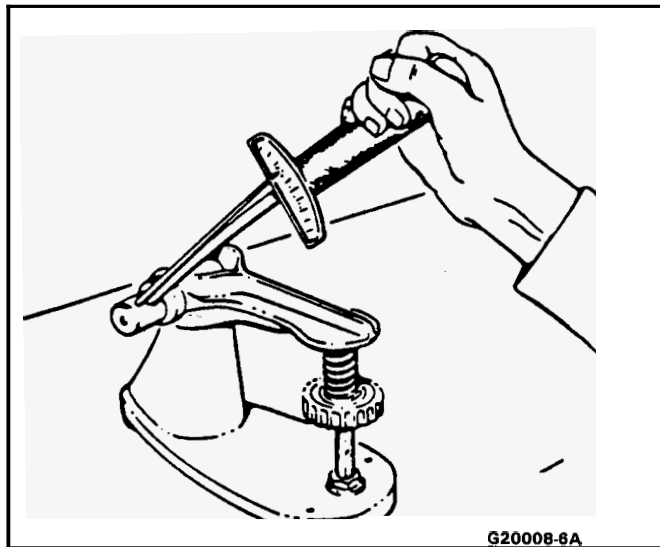


Figure 10 Checking Valve Spring Load

Assemble

1. Valves

Measure

Valve Run-out. Lift the valve off its seat and apply a dab of prussian blue on the valve face. Seat the valve and carefully rotate it. The prussian blue traces transferred to the valve seat are an indication of concentricity of the valve seat.

Clean all traces of prussian blue. Apply a dab of prussian blue on the valve seat and repeat the check. The traces of prussian blue transferred to the valve face indicates valve run-out. Re-condition valve seat/face or replace valves as required.

2. Valve stem oil seals

Important

- If the seals are the **Umbrella type**, push them down as far as they will go. If oversize valves have been installed, oversized valve stem seals must be used. Intake and exhaust valve stem seals may be different.
- If the valve stem seals are the **"O" Ring type** be sure they are properly seated in the groove and not twisted.

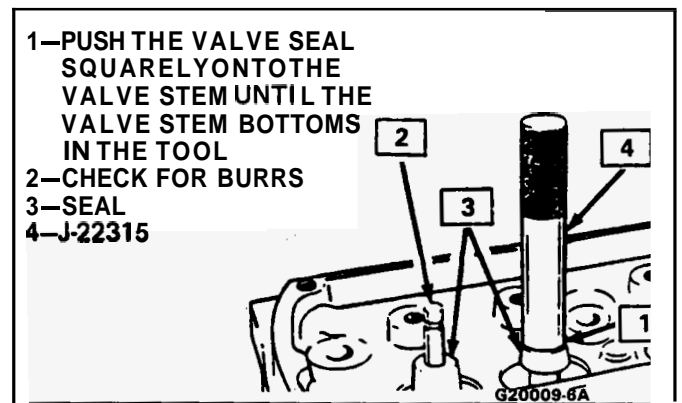


Figure 11 Locating Valve Seal (Typical)

3. Complete assembly of the valve mechanism (refer to specific Engine Section)

VALVE STEM WEIGHT

VIN Y

Measure

Tool Required:

J 25289

- o Installed valve stem height. Excessive valve stem height is caused by lowering of the valve seat and excessive valve face grinding during re-conditioning. To correct, remove the valve and shorten the valve stem by grinding.
- o Valve stem-to-rotator height

NOTICE: If below specification, the valve must be replaced to avoid interference of the rotator with the rocker arms.

VIN A, L, 3 and 7

1. Place the valve in its guide and hold it in the closed position.
2. With a steel machinists rule, measure from the machined spring seat to the valve tip.
3. The measurement should be **50.29 mm \pm .51 (1.98 in. \pm .020)**

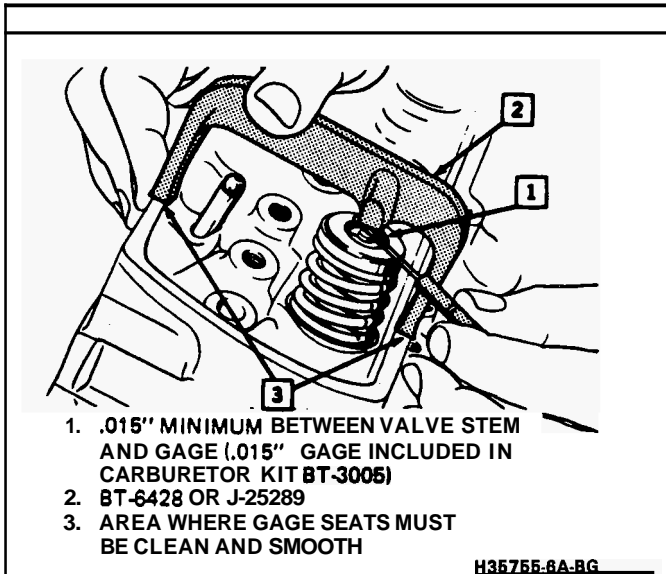


Figure 12 Measuring Valve Stem Height VIN Y

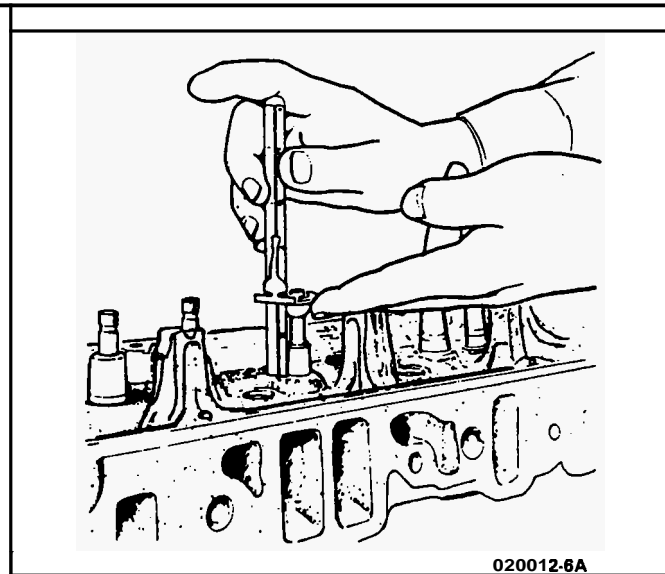


Figure 14 Measuring Valve Spring Installed Height

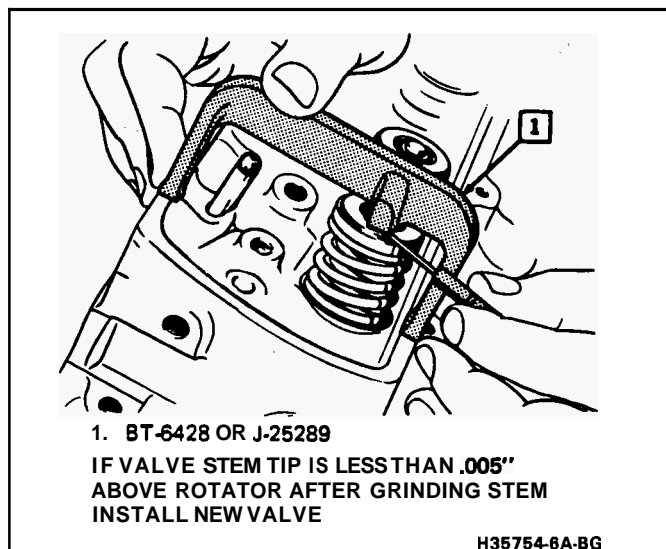


Figure 13 Measuring Valve Rotator Height VIN Y

VALVE SPRING INSTALLED HEIGHT

VIN A, L, 3, 7

Measure

- o Valve spring installed height (Figure 14). Excessive valve spring installed height is caused by the lowering of the valve seat by wear and grinding and valve face grinding during re-conditioning. To correct the valve spring installed height, add shims under the valve spring.
 1. Place the valve in the guide.
 2. Install valve spring retainer and keepers.
 3. Pull up on the valve spring retainer to seat it.
 4. With a steel machinists rule or other suitable measuring device, measure the distance from the machined spring seat to the spring-side of the retainer.
 5. The measurement should be 43.69 \pm .76 mm (1.72 in. \pm .030). If not within specifications, add shims under the valve spring as required.

VALVE LASH ADJUSTMENT (2.8 LITER)

Adjust Rocker Arm Stud

Adjust

- o Valves when lifter is on base circle of camshaft lobe:
 - a. The engine should be in the Number 1 firing position. This may be determined by placing fingers on the Number 1 rocker arms as the engine assembly alignment mark on the front face of the torsional damper aligns with the arrow on the front cover. If the valves are not moving, the engine is in the Number 1 firing position. If the valves move as the mark comes up to the timing tab, the engine is in Number 4 firing position and should be rotated one revolution to reach the Number 1 position.
 - b. With the engine in the Number 1 firing position, the following valves may be adjusted:
 - Exhaust - 1, 2 3
 - Intake - 1, 5 6
 - c. Back out adjusting nut until lash is felt at the push rod, then turn in adjusting nut until all lash is removed.

(This can be determined by rotating push rod while turning adjusting nut.) When lash has been removed, turn adjusting nut in 1-1/2 additional turns (to center lifter plunger).
 - d. Crank the engine one revolution. This is the Number 4 firing position. With the engine in this position, the following valves may be adjusted:
 - Exhaust - 4, 5, 6
 - Intake - 2, 3 4

OIL PUMP

See Figures 15 thru 18

Three types of oil pumps are used. They are located in the engine oil pan or in the front cover.

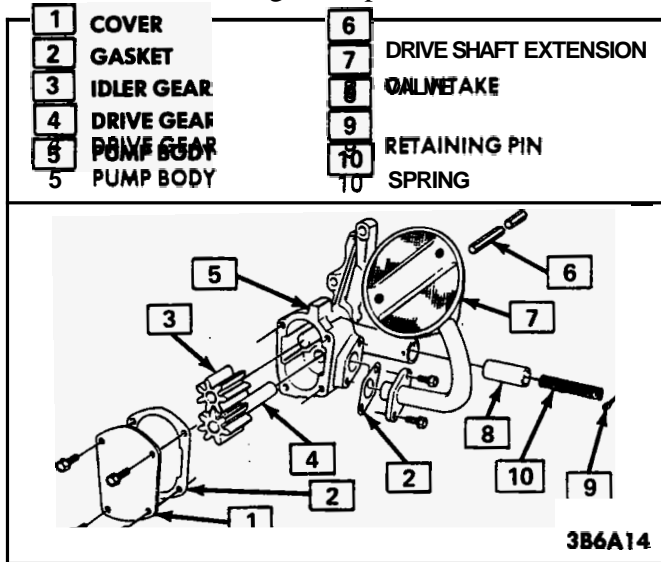


Figure 15 Oil Pump (Gear Type)

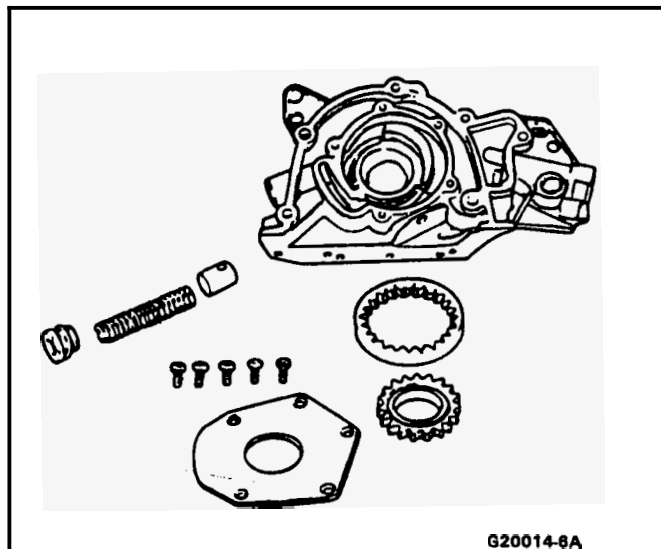


Figure 16 Oil Pump (VIN M & K)



Disassemble

1. Drain oil from pump.
2. Drive shaft and drive shaft extension, if any.
3. Suction pipe and screen assembly (except VIN #1).
4. Pump cover.
5. Pump gears.
6. Pressure regulator valves
 - Plug or cotter pin.
 - Spring.
 - Valve. If the valve is stuck, soak the pump housing in carburetor cleaning solvent.

CAUTION: The pressure regulator valve spring is under pressure. Exercise caution when unscrewing

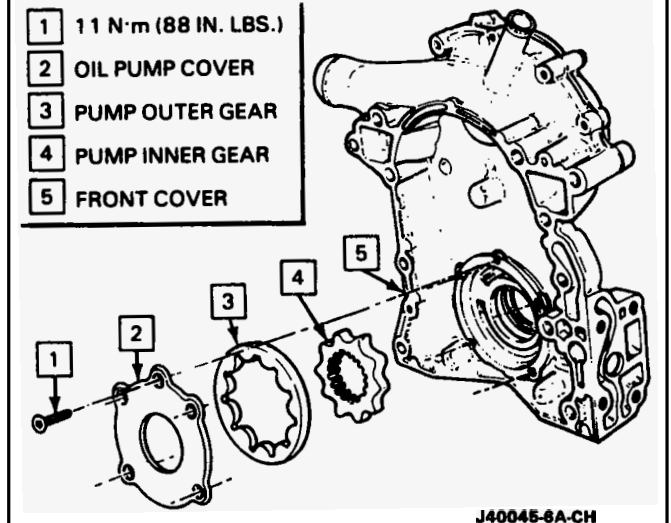


Figure 17 Gerotor Oil Pump (VIN L & 3)

the plug or removing the cotter pin, as bodily injury may result.



Clean

- o All parts of sludge, oil and varnish.
- o Varnish may be removed by soaking in carburetor or cleaning solvent.

CAUTION: Avoid breathing of fumes or exposure of the skin to the cleaning solvent, as bodily injury may result.



Inspect

- o For foreign material and determine its source
- Pump housing and cover for:
 - Cracks
 - Scoring
 - Casting imperfections
 - Damaged threads
 - Do not attempt to repair the pump housing.
 - If in doubt, replace the housing.
- o Idler gear shaft (except VIN M, K, L, 3). If loose in the housing, replace the pump or timing chain cover, depending on model.
- o Pressure regulator valve for:
 - Scoring
 - Sticking. Burrs may be removed with a fine oil stone.
- o Pressure regulator valve spring for:
 - Loss of tension
 - Bending
 - If in doubt, replace the spring.
- o Suction pipe and screen assembly for:
 - Looseness, if permanently pressed into the pump body. If the pipe is loose or has been removed, it must be replaced with a new pump body and screen assembly.
 - Broken wire mesh or screen
- o Gears for:
 - Chipping
 - Galling

- Wear
- o Drive shaft and drive shaft extension, if any, for:
 - Looseness
 - Wear

 **Measure**

- Refer to oil pump specifications
- Gear lash. Install gears, marking toward the timing cover (VIN M, K) and measure in several places
- Pump housing gear pocket
- Gears
- Gear side clearance (Except VIN M, K, L & 3)
- Gear end clearance

 **Important**

- o When deciding pump servicability based on end clearance, consider depth of wear pattern in the pump cover and/or cover plate.

 **Assemble**

1. Lubricate all internal parts with engine oil during assembly.
2. Pump gears. Gear mark facing the timing cover (VIN M & K)

NOTICE: To avoid engine damage, it is essential that **all** pump cavities are packed with petroleum jelly **before** installing the gears to assure priming.

3. Cover and gasket

NOTICE: To avoid engine damage, use **only** original equipment gaskets. The gasket thickness is **critical** to proper functioning of the pump.

4. Pressure regulator valve and spring
5. Cotter pin or plug, depending on model

 **Important**

Plug Type - Coat threads with "Loctite 271" or equivalent.
Cotter Pin Type - Make sure the pin is properly secured.

 **Tighten**

- o Pump cover bolts to **14 N·m (120 lb. in.)** 3.0, 3.8L and **11N·m (132 lb. in.)** 5.0L.
- o Pressure regulating valve plug, if any, to **20 N·m (177 lb. in.)**
- o Suction tube bolts to **10N·m (90 lb. in.)**

 **Install or Connect**

Tool required:

J 8369 Suction Pipe Installer

- o (Except VIN # 1) A new suction pipe "O" ring seal or gasket, depending on model.
- o (VIN #1) Apply GM 1050026 sealer, Fel Pro-Set and Seal or equivalent to a new pipe

and tap into place with a plastic hammer, using installing Tool J 8369.

 **Tighten**

- o (Except VIN #1) Suction tube bolts to **7 N·m (62 lb. in.)**

 **Important**

- o Whenever the oil pump is overhauled, clean the oil pan of oil and sludge, replace the oil filter and fill crankcase with clean oil.

 **Inspect**

1. Remove the oil pressure sending unit and install a pressure gage.
2. Start engine and observe oil pressure

NOTICE: If the oil pressure does not build up almost immediately, remove the oil pan and check oil pump suction pipe attachment to the pump. If necessary, dismantle the oil pump, fill all cavities with petroleum jelly and re-assemble. Running the engine without measurable oil pressure will cause extensive damage.

GEROTOR OIL PUMP (VIN L, 3)

See Figures 24, 25 & 26

 **Disassemble**

1. Remove oil filter adapter, pressure regulator valve and valve spring.
2. Remove oil pump cover attaching screws and cover.
3. Remove pump gears.

 **Clean**

- o All parts in cleaning solvent. Remove varnish, sludge and dirt.
- o All traces of old gasket material.

 **Inspect**

- o Pump cover and housing (crankcase front cover) for:
 - Cracks
 - Scoring
 - Porous or damaged casting
 - Damaged threads
 - Excessive wear or galling.
- o Pressure regulator valve for:
 - Scoring
 - Sticking in the valve bore
 - Burrs
- o Pressure regulator valve spring for:
 - Tension loss
 - Bending
 - If in doubt, replace spring
- Gears for:
 - Chipping
 - Galling

DISPLACEMENT		2.0	2.0L	2.5L	2.8L	3.8L	3.0/3.8L	5.0L		
ENGINE VIN CODE		M, K	1	R, U	W	A, 7	L, 3	Y		
LASH	IN	0.004-0.008	0.009-0.015	0.009-0.015	0.009-0.015	0.0015-0.003	0.006	0.0005-0.0075		
	MM	0.10-0.02	0.23-0.38	0.23-0.38	0.23-0.38	0.038-0.076	0.152	0.013-0.190		
GEAR POCKET	DEPTH	IN	0.395-0.397	1.195-1.198	0.995-0.998	1.95-1.198	0.868-0.870	0.461-0.462	1.500-1.509	
		MM	10.03-10.08	30.36-30.44	25.27-25.35	30.36-30.44	22.04-22.10	11.71-11.73	38.10-38.125	
	DIAMETER	IN	3.230-3.235	1.503-1.506	1.503-1.506	1.503-1.506	1.670-1.675	3.508-3.512	1.534-1.539	
		MM	82.02-82.15	38.10-38.25	38.18-38.25	38.18-38.25	42.4-42.5	89.10-89.20	39.096-38.960	
	LENGTH	IN	3.393-0.394	1.199-1.200	0.999-1.002	1.199-1.200	0.872-0.874	0.459-0.460	1.5075-1.5095	
		MM	9.98-10.0	30.45-30.48	25.37-25.45	30.45-30.48	22.15-22.20	11.66-11.68	38.29-38.341	
GEAR	DIAMETER	DRIVEGEAR (INNER)	IN	2.317-3.319	1.498-1.500	1.496-1.500	1.498-1.500	1.664-1.666	2.839	1.529-1.531
		MM	58.85-58.90	38.05-38.10	38.05-38.10	38.05-38.10	42.26-42.32	72.11	38.887-38.836	
		IDLER GEAR (OUTER)	IN	3.225-3.227	1.498-1.500	-	1.498-1.500	1.665-1.666	3.500-3.497	1.529-1.531
		MM	81.910-81.964	38.05-38.10	-	38.05-38.10	42.26-42.32	88.90-88.82	38.887-38.836	
	SIDE CLEARANCE	DRIVEGEAR	IN	0.014-0.018	0.003-0.004	0.004 MAX	0.003-0.004	0.003-0.005	-	0.0015-0.0045
		MM	0.035-0.45	0.08-0.10	0.10 MAX	0.08-0.10	0.08-0.13	-	0.040-0.120	
		IDLER GEAR	IN	0.004-0.007	0.003-0.004	0.004 MAX	0.003-0.004	0.003-0.005	-	0.0015-0.0045
		MM	0.11-0.19	0.08-0.10	0.10 MAX	0.08-0.10	0.08-0.13	-	0.040-0.120	
END CLEARANCE		IN	0.001-0.004	0.002-0.005	0.002-0.005	0.002-0.005	0.002-0.006	0.001-0.0035	0.0025-0.0065	
MM		0.03-0.10	0.05-0.13	0.05-0.13	0.05-0.13	0.05-0.15	0.025-0.089	0.063-0.165		
INNER GEAR TIP CLEARANCE		IN	-	-	-	-	0.006	-		
MM		-	-	-	-	-	0.152	-		
OUTER GEAR DIAMETER CLEARANCE		IN	-	-	-	-	0.008-0.015	-		
MM		-	-	-	-	-	0.203-0.381	-		
VALVE TO BORE CLEARANCE		IN	-	0.0015-0.0035	0.0015-0.0035	0.0015-0.0035	0.004-0.008	0.0025-0.0050	-	
MM		-	0.038-0.089	0.038-0.089	0.038-0.089	0.102-0.203	0.102-0.203	0.063-0.127		

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Figure 18 Oil Pump Specification

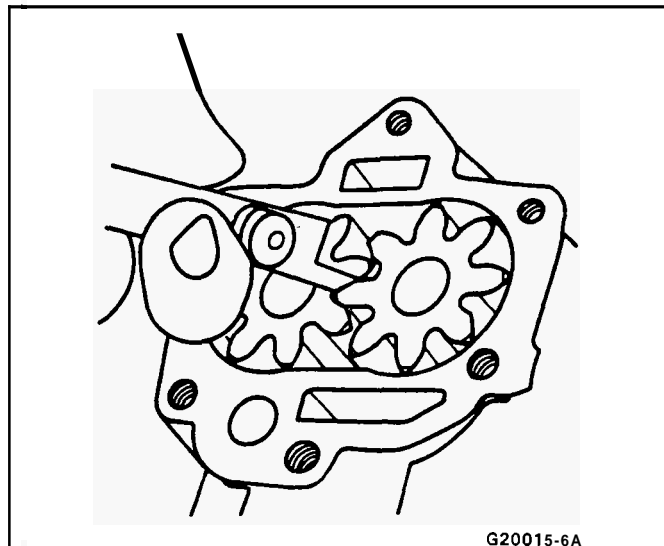


Figure 19 Measuring Oil Pump Gear Lash

Excessive Wear

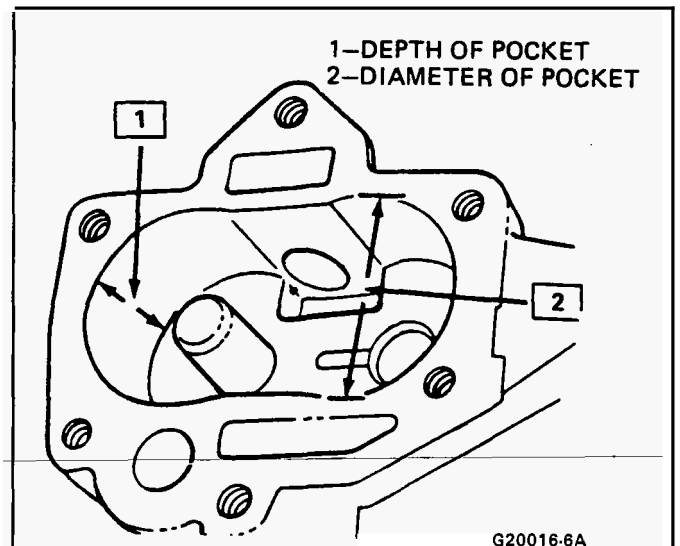


Figure 20 Measuring Oil Pump Gear Pocket

Measure

Oil pump gears for:

DISPLACEMENT		2 0	2 0L	2 5L	2 8L	3 8L	3 013 8L	5 0L		
ENGINE VIN CODE		M. K	1	R, U	W	A. 7	L. 3	Y		
LASH	IN	0.004-0.008	0.009-0.015	0.009-0.015	0.009-0.015	0.0015-0.003	0.006	0.0005-0.0075		
	MM	0.10-0.02	0.23-0.38	0.23-0.38	0.23-0.38	0.038-0.076	0.152	0.013-0.190		
GEAR POCKET	DEPTH	IN	0.395-0.397	1.195-1.198	0.995-0.998	1.95-1.198	0.868-0.870	0.461-0.462	1.500-1.509	
		MM	10.03-10.08	30.36-30.44	25.27-25.35	30.36-30.44	22.04-22.10	11.71-11.73	38.10-38.125	
	DIAMETER	IN	3.230-3.235	1.503-1.506	1.503-1.506	1.503-1.506	1.670-1.675	3.508-3.512	1.534-1.539	
		MM	82.02-82.15	38.10-38.25	38.18-38.25	38.18-38.25	42.4-42.5	89.10-89.20	39.096-38.960	
	LENGTH	IN	3.393-0.394	1.199-1.200	0.999-1.002	1.199-1.200	0.872-0.874	0.459-0.460	1.5075-1.5095	
		MM	9.98-10.0	30.45-30.48	25.37-25.45	30.45-30.48	22.35-22.20	11.66-11.68	38.29-38.341	
GEAR	DIAMETER ^(D)	DRIVE GEAR (INNER)	IN	2.317-3.319	1.498-1.500	1.496-1.500	1.498-1.500	1.664-1.666	2.839	1.529-1.531
			MM	5.885-58.90	38.05-38.10	38.05-38.10	38.05-38.10	42.26-42.32	72.11	38.887-38.836
		IDLER GEAR (OUTER)	IN	3.225-3.227	1.498-1.500		1.498-1.500	1.665-1.666	3.500-3.497	1.529-1.531
			MM	81.910-81.964	38.05-38.10		38.05-38.10	42.26-42.32	88.908-88.82	38.887-38.836
	CL	DRIVE GEAR	IN	0.014-0.018	0.003-0.004	0.004 MAX	0.003-0.004	0.003-0.005		0.0015-0.0045
			MM	0.035-0.45	0.08-0.010	0.10 MAX	0.08-0.10	0.08-0.013	-	0.040-0.120
		IDLER GEAR	IN	0.004-0.007	0.003-0.004	0.004 MAX	0.003-0.004	0.003-0.005		0.0015-0.0045
			MM	0.1-0.19	0.08-0.10	0.10 MAX	0.08-0.10	0.08-0.013	-	0.040-0.120
END CLEARANCE		IN	0.001-0.004	0.002-0.005	0.002-0.005	0.002-0.005	0.002-0.006	0.001-0.0035	0.0025-0.0065	
		MM	0.03-0.10	0.05-0.13	0.05-0.13	0.05-0.13	0.05-0.15	0.025-0.089	0.063-0.165	
INNER GEAR TIP CLEARANCE		IN	-	-	-	-	-	0.006	-	
		MM	-	-	-	-	-	0.152	-	
OUTER GEAR DIAMETER CLEARANCE		IN	-	-	-	-	-	0.008-0.015	-	
		MM	-	-	-	-	-	0.203-0.381	-	
VALVE TO BORE CLEARANCE		IN		0.0015-0.0035	0.0015-0.0035	0.0015-0.0035	0.004-0.008	0.0025-0.0050		
		MM		0.038-0.089	0.038-0.089	0.038-0.089	0.102-0.203	0.102-0.203	0.063-0.127	

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Figure 18 Oil Pump Specification

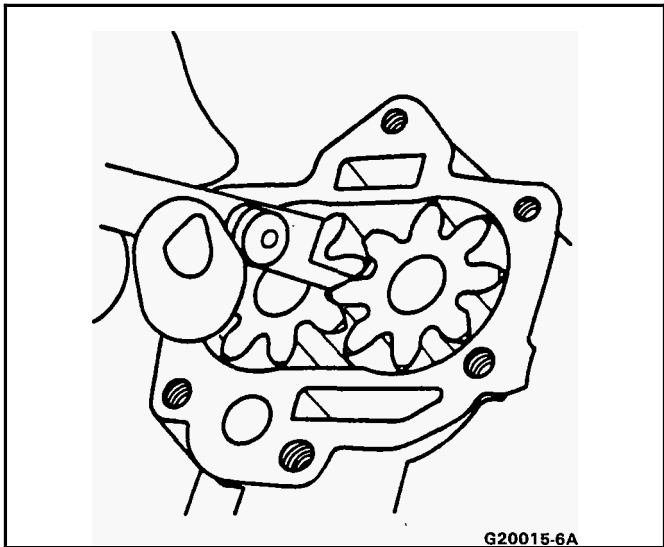


Figure 19 Measuring Oil Pump Gear Lash

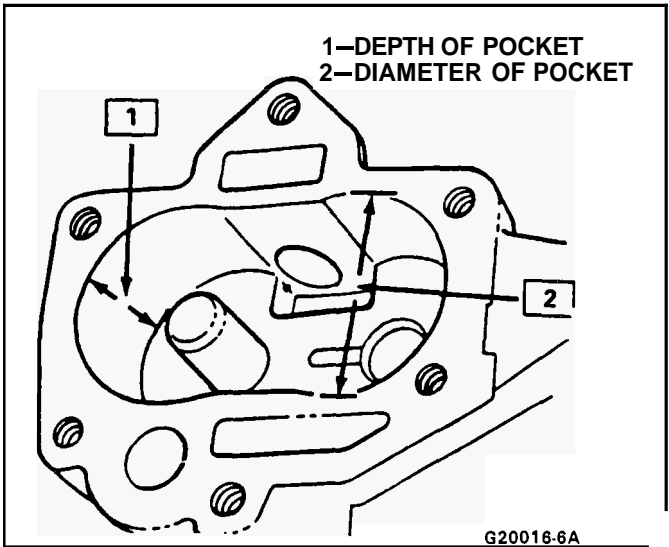


Figure 20 Measuring Oil Pump Gear Pocket

Excessive Wear



Measure

- Oil pump gears for:

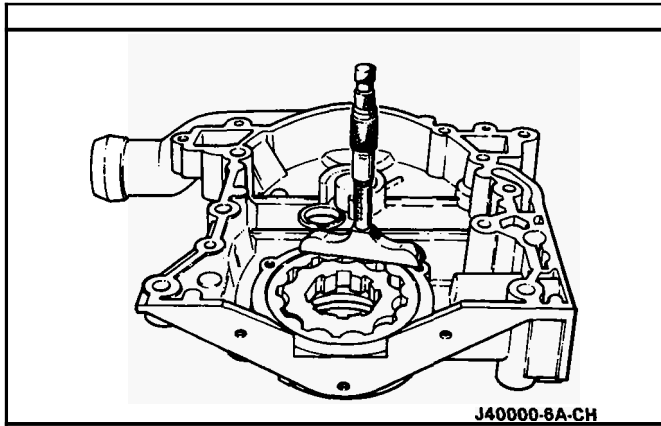


Figure 26 Gear End Clearance (Gear Drop In Housing)
-VIN L, 3

CONNECTING ROD AND MAIN BEARINGS

Engine bearings are of the precision insert type. They are available for service use in standard and various undersizes

See Figures 28 & 29

NOTICE: Bearing inserts must not be shimmed, scraped or filed. Do not touch the bearing surface of the insert with the bare fingers. Skin oil and acids will etch the bearing surface.

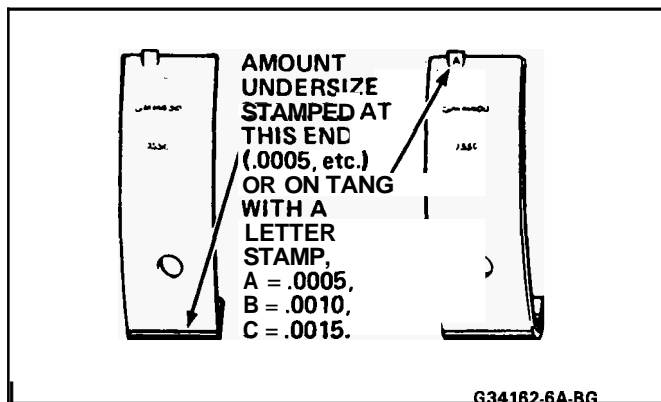


Figure 27 Bearing Insert Markings

Inspect

1. Bearing surfaces for:
 - Wear
 - Gouges
 - Imbedded foreign material. If foreign material is found, determine its nature and source. Inspect oil pan sludge and residue.
 - Uneven side to side wear. If uneven wear is found, check for a bent crankshaft or tapered bearing journals.
2. Outer surfaces for:
 - Wear. Surface wear indicates either movement of the insert or high spots in the surrounding material (spot wear).
 - Overheating (discoloration)
 - Looseness or rotation (flattened tangs and wear grooves)
3. Thrust surfaces (main thrust bearing) for:
 - Wear

- Grooving. Grooves are caused by irregularities of the crankshaft thrust surface. Refer to Crankshaft.

Important

- o Bearing failure, other than normal wear, must be investigated carefully. Inspect the crankshaft or connecting rod and the bearing bores.
 - o To inspect connecting rods or main bearing bores:
 - o Torque the bearing cap to specifications
 - o Measure the bore for taper and out of round
 - o No taper or out of round should exist.
4. Bearing cap bolts. If bolts are stretched, replace them.
- o To determine if a bolt is stretched, compare it to a new bolt.

Measure

- o Bearing clearance. To determine the correct replacement insert size, the bearing clearance must be measured accurately. Either of the following two methods may be used, however, method "A" gives more reliable results and is preferred.

Important

- o Method "A" yields measurements from which the bearing clearance can be **computed**. Method "B" yields the bearing clearance **directly**. Method "B" does **not** give any indication of bearing or journal run-out.
 - o Do not mix inserts of different nominal size in the same bearing bore.
- o Method "A"
- Measure the crankshaft journal diameter with a micrometer in several places, approximately 90° apart, and average the measurements.
 - Taper and run-out.
 - With the bearing inserts installed in the correct bore (cylinder block or connecting rod) and torqued to specification, measure the bearing insert I.D. with **an** inside micrometer. Measure using new inserts if the inserts are being replaced.

Important

- o If the readings are within limits, select a suitable set of inserts. Bearing sets are available in various undersizes in order to keep clearances within limits. If clearances cannot be brought into specifications with selectively fitting bearings, the crankshaft can be refinished and installed with .010 undersize bearings. Rolled fillet crankshafts cannot be refinished and should be replaced.

6A-12 GENERAL ENGINE MECHANICAL

DISPLACEMENT		2.0	2.0L	2.5L	2.8L	3.0, 3.8L	5.0L
VIN CODE		M, K	1	R, U	W	A, L, 3, 7	Y
CONNECTING ROD BEARING	JOURNAL O.D.	IN 1.9278-1.9286 MM 48.971-48.987	1.9983-1.9994 50.758-40.784	2.0 50.8	1.9983-1.9994 50.758-50.784	2.2487-2.2495 57.117-57.137	2.1238-2.1248 53.9445-53.9699
	RUN-OUT	IN .0002 MM .005	.0002 .005	.0005 .013	.0002 .005	.0003 .008	.0002 .0051
	TAPER	IN .0002 MM .005	.0002 .005	.0005 .013	.0002 .005	.0003 .008	.0002 .005
	CLEARANCE	IN .0007-.0024 MM .019-.063	.001-.0031 .025-.079	.0005-.0026 .013-.07	.0013-.0026 .03-.06	.0005-.0026 .013-.06	.0004-.0033 .01-.08
	SIDE CLEARANCE	IN .0027-.0095 MM .070-.242	.004-.015 .10-.38	.006-.022 .15-.6	.006-.017 0.15-.43	.004-.015 .10-.38	.006-.020 .15-.5
	JOURNAL O.D.	Brown: IN 2.280-2.2833 MM 57.988-57.995 Green: IN 2.2827-2.2830 MM 57.982-57.988	2.4945-2.4954 63.360-63.384	2.3 58.42	2.6473-2.6483 67.241-67.265	2.4995 63.487	2.4985-2.4995 63.4619-63.4873 #1: 2.4988-2.4998 63.4695-63.4949
CRANKSHAFT MAIN BEARING	RUN-OUT	IN .0002 MM .005	.0002 .005	.0005 013	.0002 .005	.0003 .008	.0005 Max .013
	TAPER	IN .0002 MM .005	.0002 .005	.0005 .013	.0002 .005	.0003 .008	.0005 .013
	CLEARANCE	IN .0006-.0016 MM .015-.041	.0006-.0019 .015-.048	.0003-.0022 .013-.56	.0016-.0033 .041-.081	.0003-.0018 .008-.045	.0005-.00211 0.127-.053
	ENDPLAY	IN .003-.012 MM .07-.30	.002-.008 .05-.21	.0035-.0085 .09-.20	.008 .06-.21	.003-.009 .08-.23	.0035-.0135 .0889-.3429
NOTE						‡ No. 5: .002-.0034 in. .040-.081 mm	

Figure 28 Connecting Rod and Crankshaft Specifications

- Method "B"
 1. Install bearing inserts and crankshaft into block.
 2. Place a piece of gaging plastic across the **entire** bearing width.
 3. Seat the bearing cap carefully by tapping it lightly with a suitable tool.
 4. Torque bearing cap bolts to specification.

NOTICE: In order to prevent the possibility of cylinder block and/or main bearing cap damage, the main bearing caps are to be tapped into their cylinder block cavity using a brass, lead or leather mallet before attaching bolts are installed. Do not use attaching bolts to pull main bearing caps into their seats. Failure to observe this information may damage a cylinder block or bearing cap.

5. Remove the bearing cap, leaving the gaging plastic in place. It does **not** matter whether the gaging plastic adheres to the journal or to the bearing cap.
6. Measure the flattened gaging plastic at its **widest point** with the scale printed on the gaging plastic package.

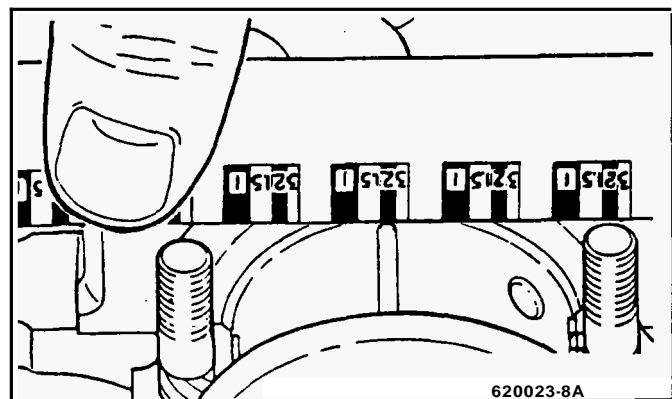


Figure 29 Measuring Bearing Clearance

! Important

- Do not rotate the crankshaft.

7. Remove all traces of the gaging plastic after measuring.
8. Bearing sets are available in various undersizes in order to keep clearances within limits. If clearances cannot be brought into specifications with selectively fitting bearings, the crankshaft can be refinished and installed with .010 undersize bearings. Rolled fillet crankshafts cannot be refinished and should be replaced.

Install or Connect

NOTICE: Bearing inserts must not be shimmed, scraped or filed. Do not touch the bearing surface of the insert with the bare fingers. Skin oil and acids will etch the bearing surface.

Important

- o Make sure the bearing cap bolt holes and the cap mating surfaces are clean and dry. (Refer to Rear Main Bearing for rear main bearing cap sealing procedure.)
1. Dip bearing cap bolts in clean engine oil.
 2. Place inserts into the bearing cap and into the engine block or connecting rod.

NOTICE: Upper and lower inserts may be different. Do not obstruct any oil passages.

Important

- o The inserts will project slightly when put into place. Make sure they project an equal distance on both sides. Make sure the insert tangs are engaged.
3. In the case of a thrust bearing type main bearing insert, coat the thrust surface with GM 1050169 special lubricant or equivalent.
 4. Lubricate the bearing surface with clean engine oil.
 5. Crankshaft or connecting rod.

NOTICE: Avoid damage to the crankshaft journal. Use connecting rod stud protectors or guide pins.

6. Bearing cap. Tap gently into place with a suitable tool.

NOTICE: In order to prevent the possibility of cylinder block and/or main bearing cap damage, the main bearing caps are to be tapped into their cylinder block cavity using a brass, lead or leather mallet before attaching bolts are installed. Do not use attaching bolts to pull main bearing caps into their seats. Failure to observe this information may damage a cylinder block or bearing cap.

7. Seat the crankshaft thrust bearing
8. Bearing cap bolts

Tighten

- o Bolts evenly, then back off one full turn and torque to specification.

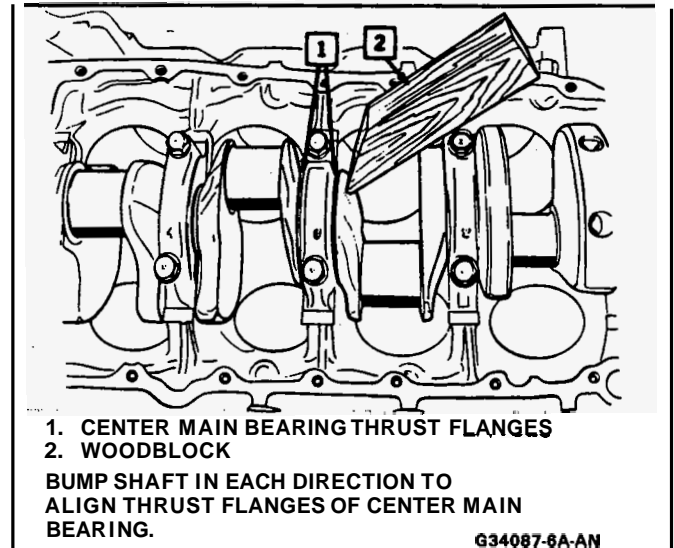


Figure 30 Seating the Crankshaft Thrust Bearing

Inspect

- o Pry the connecting rods back and forth and check for binding. If necessary loosen and re-tighten the bearing cap.

Measure

- o Crankshaft end play
- o Connecting rod side clearance



Figure 31 Measuring Crankshaft End Play

Clean

- o Oil pump intake screen
- o Oil pan

Install or Connect

- o Engine oil filter



Figure 32 Measuring Connecting Rod Side Clearance (Single Rod Journal)

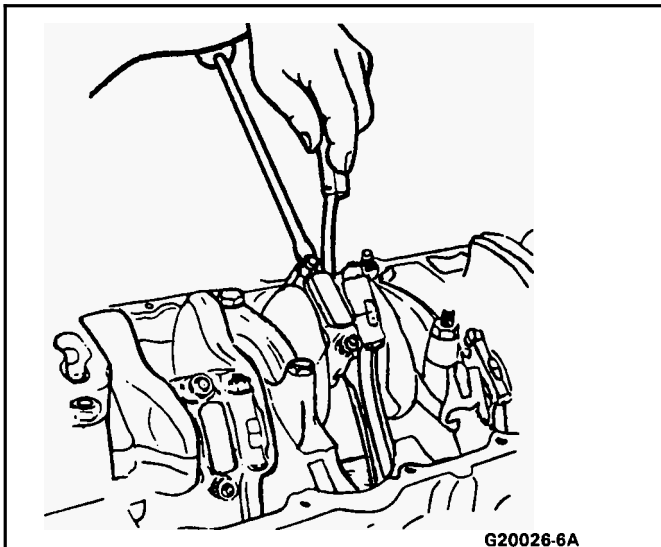


Figure 33 Measuring Connecting Rod Side Clearance (Double Rod Journal)

- o Fill crankcase with clean engine oil

Inspect

1. Remove oil pressure sending unit and install an oil pressure gage.
2. Start engine and observe oil pressure.

NOTICE: If the oil pressure does not build up almost immediately, remove the oil pan and check oil pump suction pipe attachment to the pump. If necessary, dismantle the oil pump, fill all cavities with petroleum jelly and re-assemble. Running the engine without measurable oil pressure will cause extensive damage.

3. Check for bearing knock. If necessary, dismantle and check for adequate oil supply and proper clearances.

CRANKSHAFT

Clean

- o Oil, sludge and carbon
- o Probe oil passages for obstructions

Inspect

- o Keyway
- o Threads
- o Bearing journals and thrust surfaces for:
 - Cracks
 - Chips
 - Gouges
 - Roughness
 - Grooves
 - Overheating (discoloration)

Important

- o Inspect the corresponding bearing inserts for imbedded foreign material and determine its source.
- o If cracks, severe gouges or burned spots are found, the crankshaft must be replaced. **Slight** roughness may be removed with fine polishing cloth soaked in clean engine oil. Burrs may be removed with a fine oil stone.

Measure

- o Crankshaft journals. With a micrometer (or dial indicator in the case of the main bearing journals) measure taper and run-out. If the readings are within specifications, note results for later selection of bearing inserts (refer to Connecting Rod and Main Bearings). If not within limits, the journals may be re-conditioned by grinding (except crankshafts with rolled fillets which must be replaced).

Important

- o Note the location of main bearing high spots. If they are not in line, the crankshaft is bent and must be replaced.

PISTON AND CONNECTING ROD

Remove or Disconnect

1. Mark the piston with the number of the cylinder from which it is being removed.
2. Mark the connecting rod and the rod cap *so* that they can be re-assembled correctly.
3. Turn the crankshaft to bottom dead center.

Clean

- o Carbon from the top end of the cylinder

NOTICE: If there is a pronounced ridge at the top of the piston travel, this ridge must be removed with a ridge reamer before removing piston and connecting rod assembly.

Do not use force. Avoid breaking piston rings and damaging the piston.

Remove or Disconnect

1. Connecting rod cap
2. Connecting rod and piston assembly. Push out with a suitable tool.

NOTICE: Install thread protector to avoid damage to the crankshaft journal

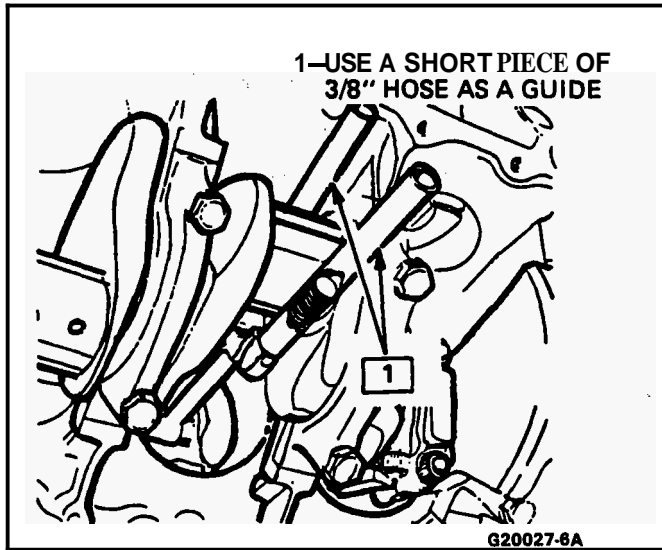


Figure 34 Connecting Rod Protector

Piston Pin Retainers

VIN Y

See Figure 40

Tools Required:

J 34594-1 Installer

J 34594-2 Pilot

Remove or Disconnect

1. Place J 34594-1 installer inside the piston pins inside diameter. Place a shop towel over the installer. Holding the installer and shop towel with one hand will restrain the retainer as it is removed.
2. Place a thin bladed screw driver in the notch and carefully pry the retainer out of the piston. Repeat on the other retainer. Remove all burrs on the piston that resulted when the retainer was removed. **DO NOT** reuse the retainer.

Install or Connect

1. Insert one end of a new retainer into the piston pin retainer bore. Position the retainer so that the gap in the retainer is in the down position (toward the connecting rod).
2. Place Installer J 34594-1 into the piston pin. Rotate the Installer, so that the pin that protrudes from the Installer, pushes the retainer into the piston's groove.

3. Remove the Installer and inspect that the retainer is fully seated and that the gap in the ring is in the **down** position. Correct **as** necessary.
4. If the retainer is not fully seated, insert tool or J 34594-2 into the piston pin. Push down on the tool until the retainer is fully seated.
5. Repeat Steps 1 through 4 to install the opposite retainer.

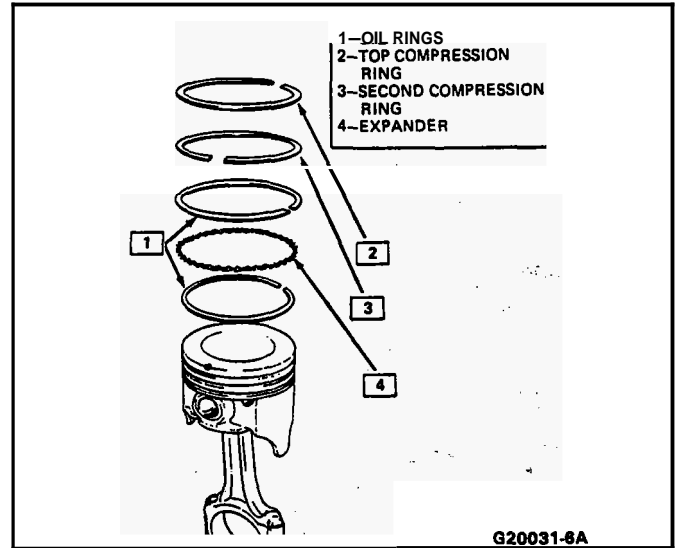


Figure 35 Piston and Rings 5.0 Liter (VIN Y)

**Piston Pins-Free Floating
5.0L VIN Y**

The piston pin is free floating and the correct pin fit in the piston is .0076 - .0127 mm (.0003" to .0005") and rod is .0038 - .0024 (.0015 - .0009) loose. If the pin to piston clearance is to the high limit .0127-.033 mm (.0005" piston or .0013" rod), the pin can be inserted in the piston or rod with very little hand pressure and will fall through the piston or rod by its own weight. If the clearance is .0076 mm (.0003"), the pin will not fall through. It is important that the piston and rod pin hole be clean and free of oil when checking pin fit.

The rod may be installed in the piston with either side facing up.

PISTON PIN-PRESS FIT

Piston Rings

Disassemble

Tool required:

J 24086 Piston Pin Remover/Installer

- o Piston and connecting rod assembly

CAUTION: Use care when handling the piston. Worn piston rings are sharp and may cause bodily injury.

1. Piston rings. Use a suitable tool to expand the rings. Piston rings must not be re-used.
2. Place the piston and connecting rod assembly into Fixture J 24086 and press out the piston pin

Clean

- o Piston, piston pin and connecting rod

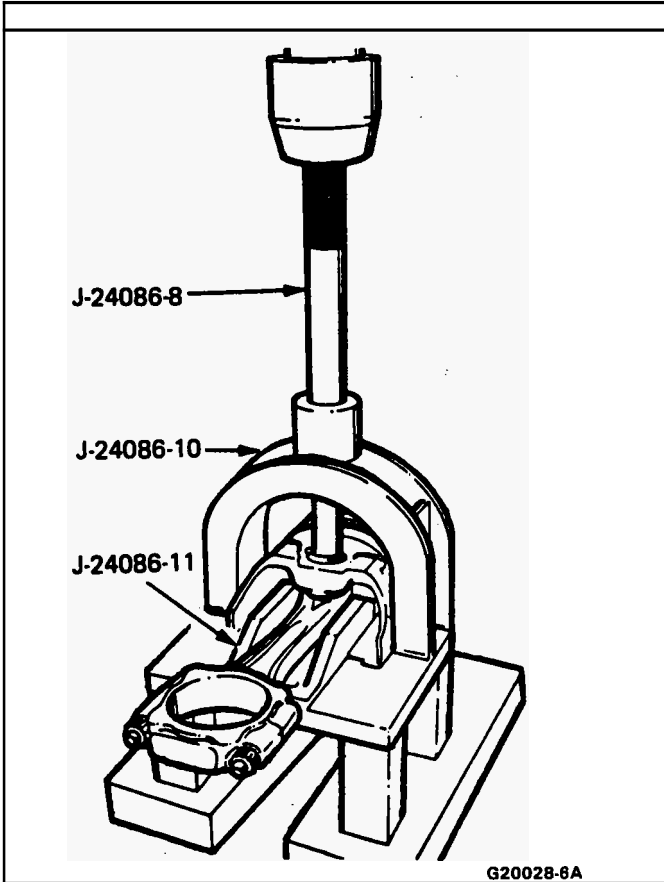


Figure 36 Removing Piston Pin Using Tool J 24086

- Sludge
- Carbon
- It is essential that the piston ring grooves are cleaned of carbon to the bare metal.
- Varnish from the piston pin by soaking in carburetor cleaning solution.

CAUTION: Avoid inhaling fumes or exposure of the skin to carburetor cleaning fluid, as bodily injury may result.

- Do not scrape the piston skirt.

Inspect

1. Connecting rod for:
 - o Bending or twisting
 - Install the connecting rod cap and torque to specifications.
 - Place the connecting rod assembly on a checking fixture and check for bending or twisting.
 - o Do not attempt to straighten the connecting rod. If bent or twisted, replace it. Check new connecting rods before using them.
 - o Outside of the connecting rod bearing and the **I.D.** of the connecting rod lower end for wear indicating high spots in the connecting rod lower end.
 - o Connecting rod bolts for stretching by comparing them with a new bolt.

- o Upper end for scoring
- 2. Piston pin for:
 - o Scoring
 - o Galling caused by improper installation
 - o Fit in connecting rod and piston
- 3. Piston for:
 - o Scoring of the skirt
 - o Cracks.
 - o Broken ring groove lands.
 - o Wear

Measure

- o Piston Rings
 - o Select a set of new piston rings
 - o Piston ring end gap
 - Place piston into the cylinder at the bottom of the ring travel.
 - Place a piston ring on top of the piston.
 - Back off the piston.
 - Measure the ring gap. If the gap is below specification increase the gap by carefully filing off excess material.

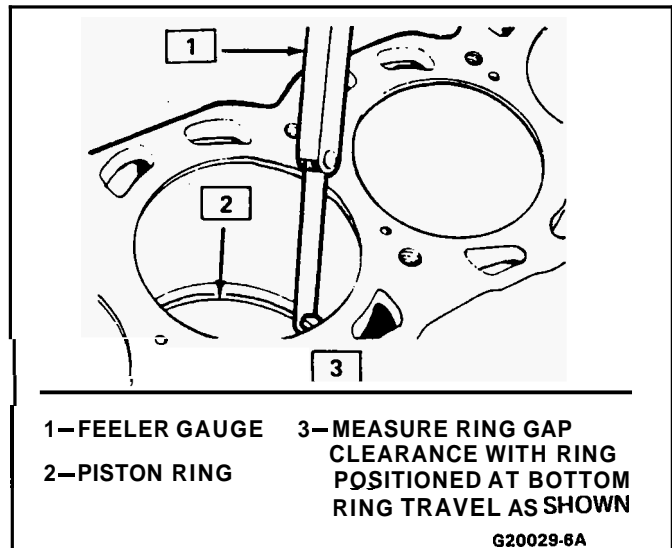


Figure 37 Measuring Piston Ring Gap

1—FEELER GAUGE 3—MEASURE RING GAP CLEARANCE WITH RING POSITIONED AT BOTTOM RING TRAVEL AS SHOWN
2—PISTON RING

- o Piston ring side clearance (compression rings)
 - Roll the piston ring around the groove in which it is to be installed and measure the side clearance. If the ring is too thick, try another ring. If no ring can be found that fits the specifications, the ring may be ground to size with emery paper placed on a plate of glass.

NOTICE: Do not attempt to cut the ring groove, although high spots in the ring groove may be cleaned up by careful use of a point file.

Assemble

- o Connecting rod and piston assembly

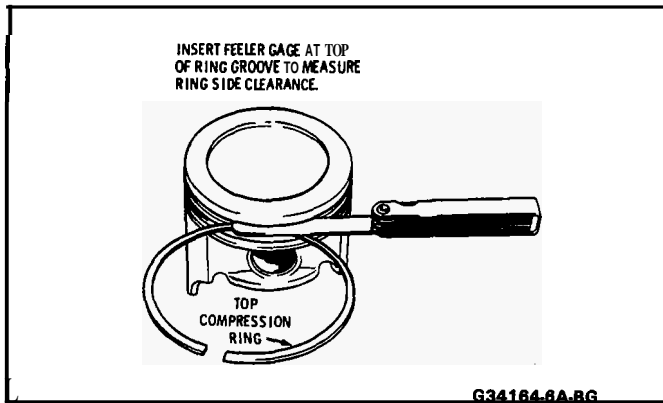


Figure 38 Measuring Piston Ring Side Clearance

Tool required

J 24086 Piston Pin Remover/Installer



Important

- The piston must be mounted on the connecting rod in such a manner that the

mark on the piston lines up with the side of the connecting rod that faces the front of the engine.

1. Place piston and connecting rod into Fixture J 24086 (Figure 41)
2. Adjust plunger of the fixture.
3. Coat the piston pin with clean engine oil.
4. Press the piston pin into place.



Inspect

- Piston for freedom of movement



Install or Connect

1. Oil control ring assembly
 - Expander
 - Lower oil control ring
 - Upper oil control ring
2. Upper and lower compression ring. Manufacturers mark facing up.

		DISPLACEMENT VIN CODE	2 0 M. K	2 0 #1	2 5 R U	2 8 W	3 0 3 8 A L 3 7	5 0 Y
CYLINDER	DIAMETER	IN MM	3 365 3 387 85 97 86 02	3 503 5 350 42 88 991 89 009	4 00 101 6	3 503 3 506 88 99 2 8 9 0 7 0	3 80 96 5	3 80 96 5
	OUT OF ROUND (MAX)	IN MM	005 13	001 02	001 02	0005 013	0005 013	001 025
	TAPER (MAX)	IN MM	005 13	001 02	005 13	0005 013	0005 013	0076 0177 0003 0007
	CLEARANCE	TOP IN MM	0004 0012 010 030	0022 0098 025 055	0014 0022*	002 003 04 06	001 002: 02 05	00075 00175 019 044
	BOTTOM IN MM	-	-		-	0015 00351 04 09	-	
PIS ON	DIAMETER	IN MM		8000 8002 2032 2033	938 942 2382523927	905 906 22 99 23 00	9391 9394 23 85 23 86	9803 9807 24 90 24 91
	FIT IN PISTON	IN MM	0004 0006 011 014	0002 0007 0051 0178	0002 0004 005 010	00026 0007 007 009	0004 0007 010 018	0003 0005 0076 0127
	FIT IN ROO	IN MM		0008 0020 021 051	PRESS FIT	00078 0021 020 053	00075 00125 019 032'	0038 0024 0015 00095
PIS ON RING	TOP COMPRESSION	IN MM	012 020 304 508	010 020 25 50	010 020 25 50	010 020 25 50	013 023 2286 4826	009 019
	2ND COMPRESSION	IN MM	012 020 304 508	010 020 25 50	010 020 25 50	010 020 25 50	013 023 33 58	009 019 2286 4826
	OIL CONTROL	IN MM	016 055 406 140	010 050 25 1 30	020 060 50 1 52	02 055 50 1 40	015 035 38 89	015 055 38 140
	TOP COMPRESSION	IN MM	002 004 05 10	001 003 03 08	002 003 05 08	001 003 03 08	003 005 08 13	0018 0038 0457 0965
	2ND COMPRESSION	IN MM	001 0025 03 06	001 003 03 08	001 003 03 08	001 003 03 08	003 005 08 13	0018 0038 0457 0965
	OIL CONTROL	IN MM	-	008 2	015 055 38 140	008 20	0035 09	001 005 03 13
		†TURBO = TOP 002.0035" .05 09 M M	BTM 001 003" 03 08 MM		*PRESS FIT	‡TURBO 0012 0020 •MEASURED 1 8 INCHES FROM PISTON TOP		

Figure 39 Cylinder and Piston Specifications

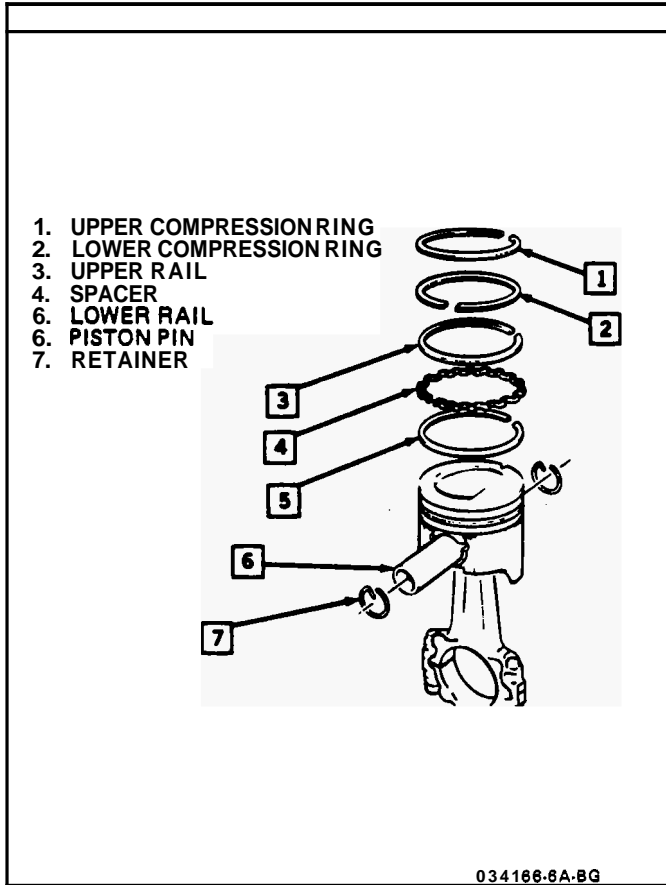


Figure 40 Piston and Rod Assembly VIN Y

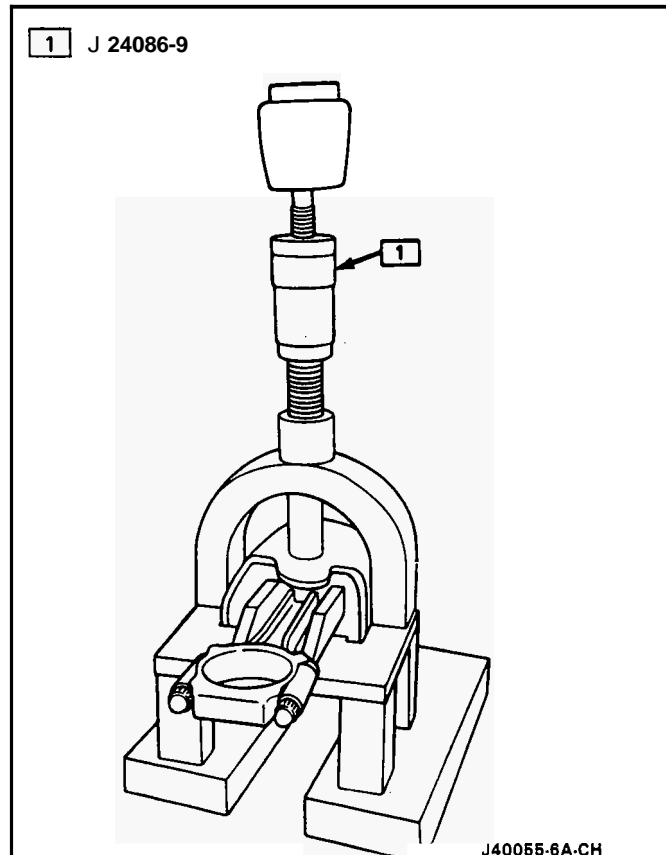


Figure 41 Installing Piston Pin Using Tool J 24086

NOTICE: Use a piston ring expander to install the rings. Avoid expanding the rings more than necessary, which may cause ring damage.

! Important

- In order to provide an effective compression seal, the ring gaps must be staggered

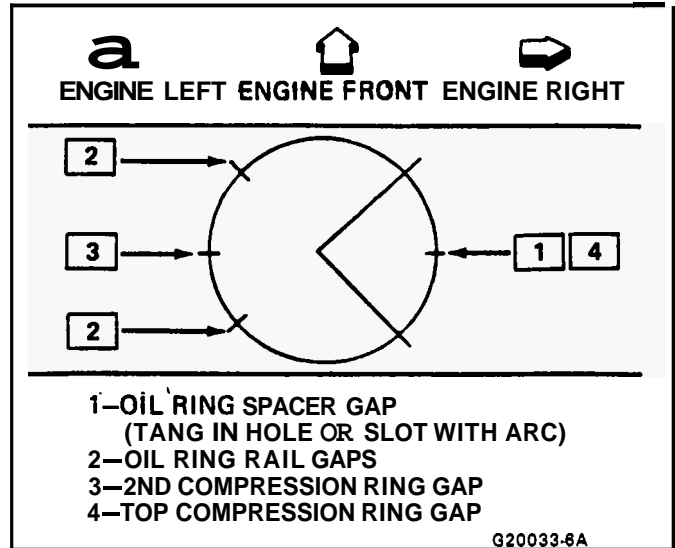


Figure 42 Piston Ring Gap Locations

→ Install or Connect

1. Lubricate cylinder wall and piston rings with clean engine oil.
2. **Turn** crankshaft to bottom dead center.
3. Connecting rod stud thread protector, if required
4. Piston ring compressor

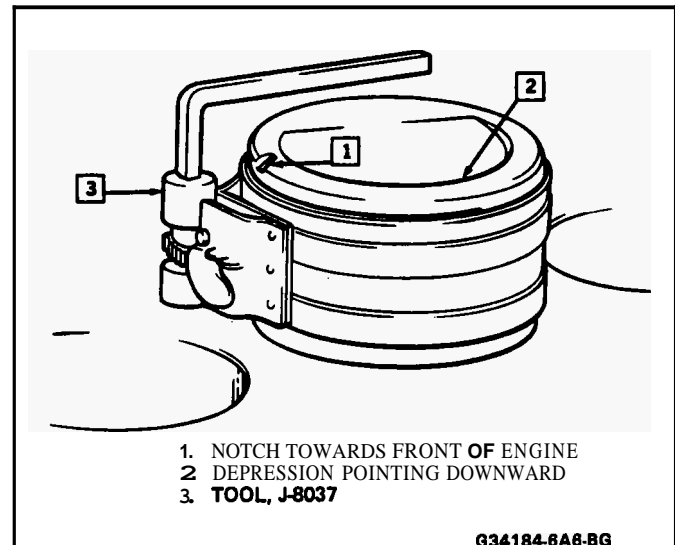


Figure 43 Installing A Piston Using A Piston Ring Compressor

5. Align piston and connecting rod assembly according to the mark on the piston and insert in the cylinder.

NOTICE: Guide the lower connecting rod end carefully to avoid damaging the crankshaft journal.

6. Remove thread protectors.
7. Connecting rod bearing (refer to Connecting Rod and Main Bearing).
8. Bearing cap.

! Important

- o Carefully tap the bearing cap into place. Do not pull the cap down with the cap bolts or nuts.

Tighten

- o Cap bolts or nuts, then loosen one full turn and torque to specification.

L Inspect

- o Pry the connecting **rod** back and forth with a suitable tool and check for binding. If necessary, loosen and re-tighten the bearing cap.

CAMSHAFT AND CAMSHAFT BEARINGS

Camshaft

↔ Remove or Disconnect

- o Refer to specific Engine Mechanical Section

L Inspect

- o Sprocket
- o Keyway and threads
- o Bearing surfaces and lobes for:
 - Wear
 - Galling
 - Gouges
 - Overheating (Discoloration)

T Important

- o Do not attempt to repair the camshaft, replace it if damaged.
- o If a new camshaft is installed, all valve lifters must be replaced (except roller lifters).

T Measure

- o Cam lobe lift
 1. Lubricate the camshaft bearings with 1052365 or equivalent.
 2. Carefully insert the camshaft. If the camshaft bearings are badly worn or damaged, set the camshaft on "V" blocks instead.
 3. Attach a dial indicator with a ball socket attachment and measure the cam lobe lift. If any one cam lobe lift is out of specification, replace the camshaft.
- o Bearing journals

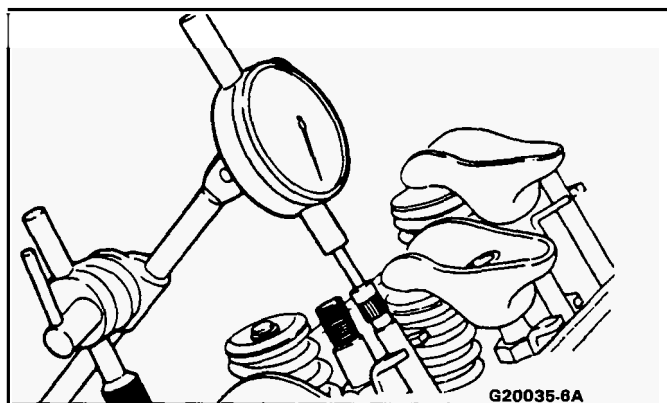


Figure 44 Measuring Cam Lobe Lift

- With a micrometer, measure run-out and diameter. If out of specification, replace the camshaft.

! Important

- o If a new camshaft has been installed, add GM E. O.S. 1052367 or equivalent to the engine oil.
- o Coat cam lobes with 1052365 or equivalent.

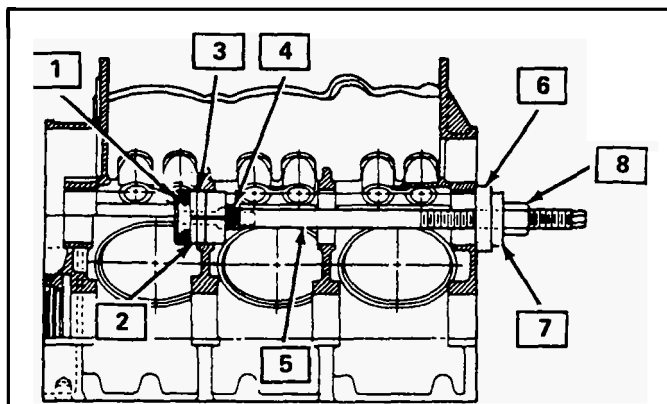
Camshaft Bearings

Tool Required:

J 33049 Camshaft Bearing Remover/Installer

T Remove or Disconnect

1. Camshaft and rear cover (refer to Specific Engine Section)
2. Camshaft Bearings
 - Select the proper pilot, nut and thrust washer
 - Assemble bearing puller Make sure the puller nut engages a sufficient number of threads.
 - Pull out bearings



1-BACK-UP NUT 5-2 PIECE PULLER SCREW
 2-EXPANDING COLLET 6-PULLING PLATE
 3-BEARING 7-THRUST BEARING
 4-EXPANDING MANDREL 8-PULLING NUT

G20036-8A

Figure 45 Removing/Installing Camshaft Bearings

! Important

- o Camshaft bearings must not be re-used once they have been removed.

🧼 Clean

- Sealing surfaces on the camshaft rear cover and on the cylinder block

↔ Install or Connect

1. Camshaft bearings
 - Select front, rear and intermediate camshaft bearings.
 - Select the proper pilot, nut and thrust washer
 - Assemble installing tool.
 - Place bearing onto the tool and index the oil hole(s) of the bearing with the oil passage(s) in the cylinder block. Pull bearing into place.

NOTICE: Proper alignment of the oil holes is critical. Restriction of the oil flow will cause severe engine damage.

👁 Inspect

- o With a piece of 3/32" brass rod with a 90° bend at the end, probe the bearing oil holes and verify that they are properly aligned.

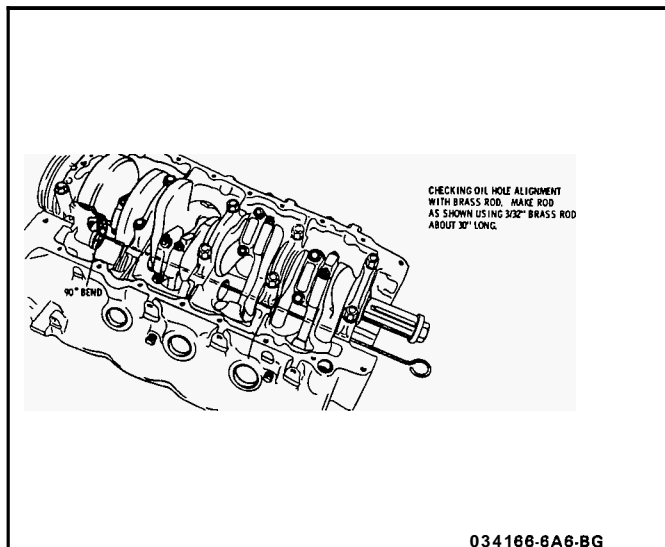


Figure 46 Checking Camshaft Bearing Oil Hole Alignment

2. Camshaft Rear Cover (soft plug)
 - Apply a 3mm (1/8") bead of **GM 1052914** RTV sealer or equivalent to the cover before installing.

VALVE LIFTERS

Operation

Oil is supplied to the lifter through a hole in the side of the lifter body which indexes with a groove and hole in the lifter plunger. Oil is then metered past the

oil metering valve in the lifter, through the push-rods to the rocker arms.

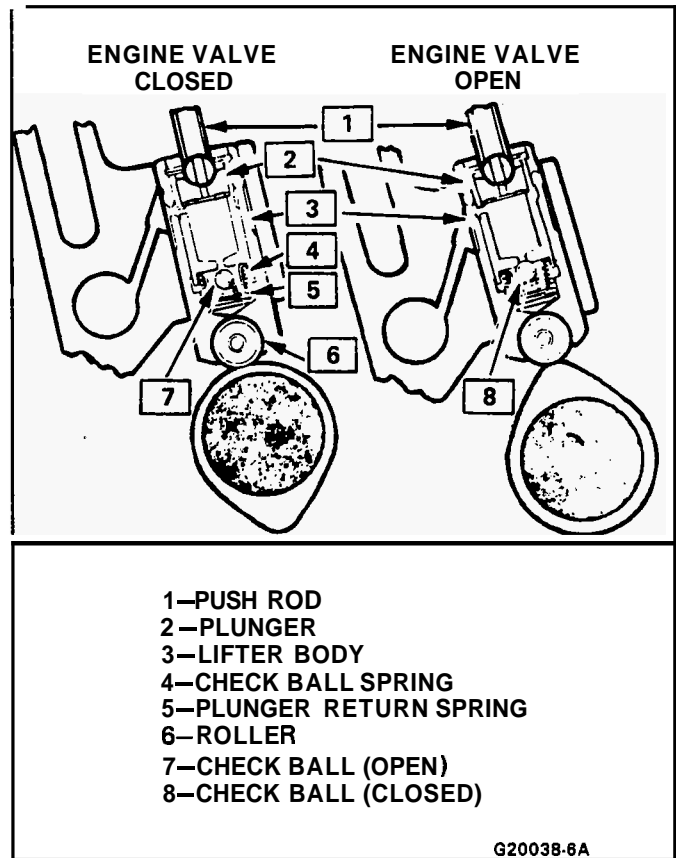


Figure 47 Valve Lifter Operation (Roller Shown)

When the lifter begins to move up the cam lobe, the ball check is held against its seat in the plunger by the ball check spring which traps the oil in the base of the lifter body below the plunger. The plunger and lifter body then raise as a unit, pushing up the push-rod to open the valve. The force of the valve spring which is exerted on the plunger through the rocker arm and push-rod causes a slight amount of leakage between the plunger and lifter body. This "**leak-down**" allows a slow escape of trapped oil in the base of the lifter body. **As** the lifter rolls down the other side of the cam lobe and reaches the base circle or "**valve closed**" position, the plunger spring quickly moves the plunger back (up) to its original position. This movement causes the ball check to open against the ball spring and oil from within the plunger is drawn into the base of the lifter. This restores the lifter to zero lash.

Valve Lifter Diagnosis

1. Momentarily Noisy When Car is Started:

This condition is normal. Oil drains from the lifters which are holding the valves open when the engine is not running. It will take a few seconds for the lifter to fill after the engine is started.
2. Intermittently Noisy On Idle Only, Disappearing When Engine Speed is Increased:

Intermittent clicking may be an indication of a pitted check valve ball, or it may be caused by dirt.

Correction: Clean the lifter and inspect. If check valve ball is damaged, replace lifter.

3. Noisy At Slow Idle Or With Hot Oil, Quiet With Cold Oil Or As Engine Speed Is Increased:
High leak down rate. Replace suspect lifter.

4. Noisy At High Car Speeds And Quiet At Low Speeds:

- a. High oil level - Oil level above the "Full" mark allows crankshaft counterweights to chum the oil into foam. When foam is pumped into the lifters, they will become noisy since a solid column of oil is required for proper operation.

Correction: Drain oil until proper level is obtained. See Section OA.

- b. Low oil level - Oil level below the "Add" mark allows the pump to pump air at high speeds which results in noisy lifters.

Correction: Fill until proper oil level is obtained. See Section OA.

- c. Oil pan bent on bottom or pump screen cocked or loose, replace or repair as necessary.

5. Noisy At Idle Becoming Louder As Engine Speed Is Increased To 1500 rpm:

This noise is not connected with lifter malfunction. It becomes most noticeable in the car at 10 to 15 mph "1" (Low) range, or 30 to 35 mph "D" (Drive) range and is best described as a hashy sound. At slow idle, it may be entirely gone or appear as a light ticking noise in one or more valves. It is caused by one or more of the following:

- a. Badly worn or scuffed valve tip and rocker arm pad.
- b. Excessive valve stem to guide clearance.
- c. Excessive valve seat runout.
- d. Off square valve spring.
- e. Excessive valve face runout.
- f. Valve spring damper clicking on rotator.

To check valve spring and guide clearance, remove the valve covers.

- a. Occasionally this noise can be eliminated by rotating the valve spring and valve. Crank engine until noisy valve is off its seat. Rotate spring. This will also rotate valve. Repeat until valve becomes quiet. If correction is obtained, check for an off square valve spring. If spring is off square more than 1/16" in free position, replace spring.

- b. Check for excessive valve stem to guide clearance. If necessary, correct as required.

6. Valves Noisy Regardless Of Engine Speed:

This condition can be caused by foreign particles or excessive valve lash.

Check for valve lash by turning engine so the piston in that cylinder is on top dead center of firing stroke. If valve lash is present, the push-rod can be freely moved up and down a certain amount with rocker arm held against valve.

Valve lash indicates one of the following:

- a. Worn push-rod.

- b. Worn rocker arm.
- c. Lifter plunger stuck in down position due to dirt or carbon.
- d. Faulty lifter.

Checking of the above four items:

1. Look at the upper end of push-rod. Excessive wear of the spherical surface indicates one of the following conditions.
 - a. Improper hardness of the push-rod ball. The push-rod and rocker arm must be replaced.
 - b. Improper lubrication of the push-rod. The push-rod and rocker arm must be replaced. The oiling system to the push-rod should be checked.
2. If push-rod appears in good condition and has been properly lubricated, replace rocker arm and recheck valve lash.
3. If valve lash exists and push-rod and rocker arm are ok, trouble is in the lifter. Lifter should be replaced.

! Important

- o There are two types of valve lifters: a flat tappet hydraulic type for most engines and a roller tappet type for VIN # 1, 3, Y, R & U They function in a similar manner.
- o If the camshaft was replaced, the lifters must also be replaced (except roller lifter engines).

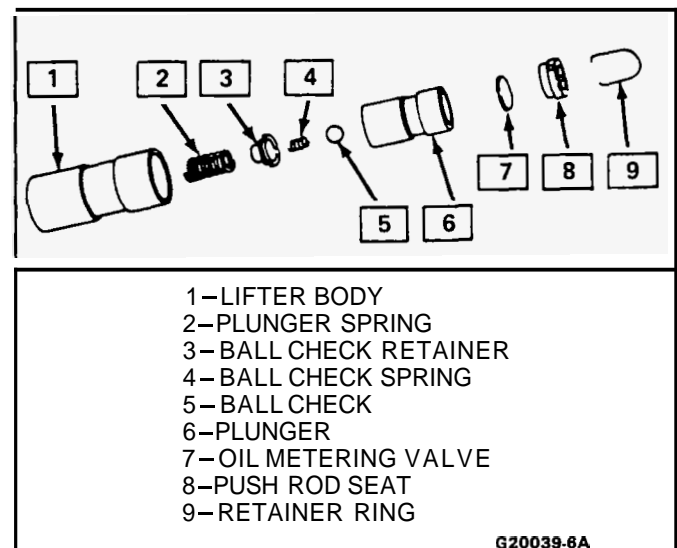


Figure 48 Valve Lifter-Flat Tappet

VALVE LIFTER LEAK-DOWN RATE TEST (FLAT TAPPET LIFTERS ONLY)

Tool Required:

J 5790 Tester

With J 5790-01 test the valve lifter leak-down rate:

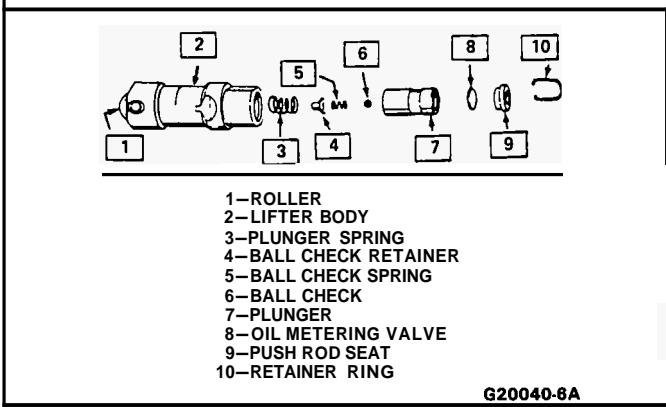


Figure 49 Valve Lifter-Roller Tappet

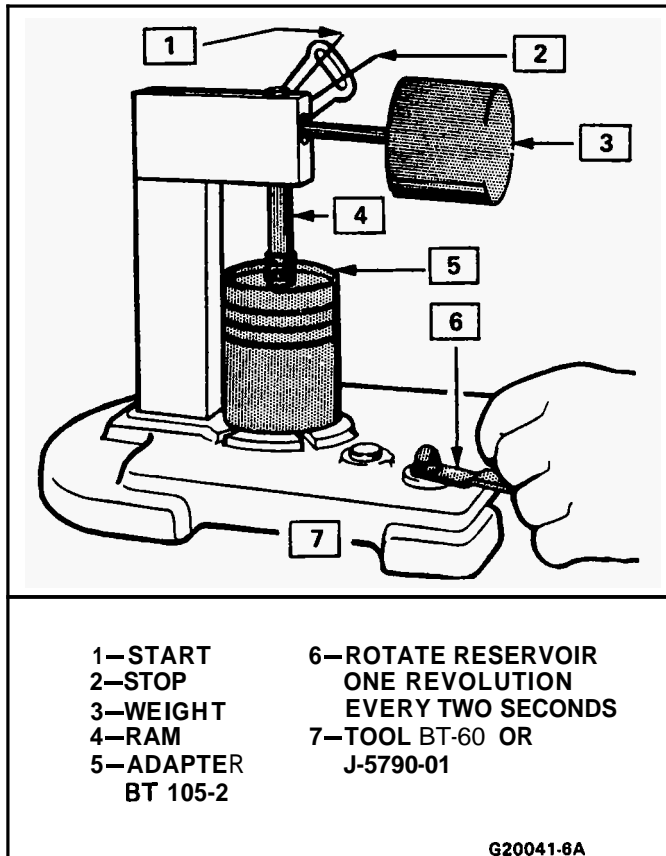


Figure 50 Measuring Valve Lifter Leak-Down Rate

1. Fill tester cup to approximately one inch from top with the special fluid which is available from tester manufacturer.
2. Swing weight arm out-of-the-way, raise ram, and position lifter into boss in center of tester cup.
3. Adjust ram (with weight arm clear of ram) so that the point is positioned on the set line (marked "S"). Tighten jam nut to maintain setting.
4. Operate lifter through full travel of plunger by pumping weight arm to fill lifter with test fluid and force out air.

! Important

- o Lifter must be completely submerged at all times.
- o Continue pumping for several strokes after definite resistance is felt.

5. Raise weight arm to allow plunger spring to expand fully; lower arm onto ram and commence turning crank slowly (1 revolution every 2 seconds).
6. Time indicator travel from lower line (first line above set line) to line marked .094 or 3/32", while rotating cup with crank. Lifter is satisfactory if rate between 12 and 90 seconds.

CYLINDER BLOCK

✦ Disassemble

- o Cooling jacket plugs
 - Obtain a suitable self-threading screw
 - **Drill** a hole into the plug
 - Install the self-threading screw
 - Pry out plug
- o Oil gallery screw plugs

! Important

- o Some plugs have holes drilled to spray oil on the timing chain and the distributor gear. Note the position of these plugs to aid in re-assembly.
- o Camshaft bearings
Refer to Camshaft and Camshaft Bearing.

! Important

- o Caustic cleaning solution destroys the bearing material. All bearings must be replaced after cleaning with a caustic solution. Do not clean bearing material or aluminum parts with caustic solutions.

🧼 Clean

- o Sealing material from mating surfaces
- o Boil in caustic solution
 - Flush with clean water or steam
- o Oil passages
- o All blind holes
- o Spray or wipe cylinder bores and machined surfaces with engine oil

🔍 Inspect

- o Deck surface for flatness. Use a straight edge and a feeler gage. Minor irregularities may be carefully machined. If more than .25 mm (.010") V6, .127 mm (.005") V8 must be removed, replace the block.
- o Oil pan rail and timing cover attaching area for nicks. **Minor** irregularities may be cleaned up with a flat mill file.
- o Transmission case mating surface

NOTICE: If this surface is not flat, a broken flexplate may result.

- o Temporarily install the crankshaft. Measure crankshaft flange run-out (refer to Crankshaft).

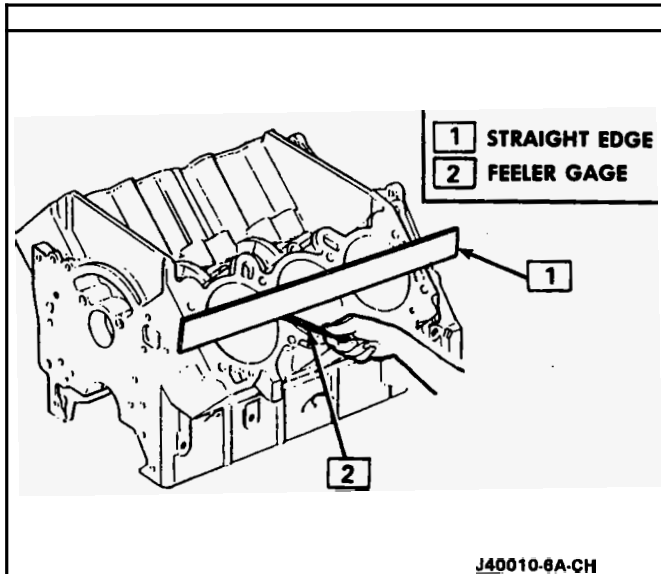


Figure 51 Checking Cylinder Block for Flatness

Measure

- o Six mounting hole bosses
 1. Hold gage plate flat against the crankshaft flange
 2. Place dial indicator stem on the transmission mounting bolt hole boss and set indicator to 0.
 3. Record the readings obtained on the remaining transmission mounting bolt hole bosses. Measurements should not vary more than .203 mm (.008").
 4. If the readings vary more than .203 mm (.008"), recheck crankshaft flange run-out. If the run-out is excessive, replace the crankshaft.

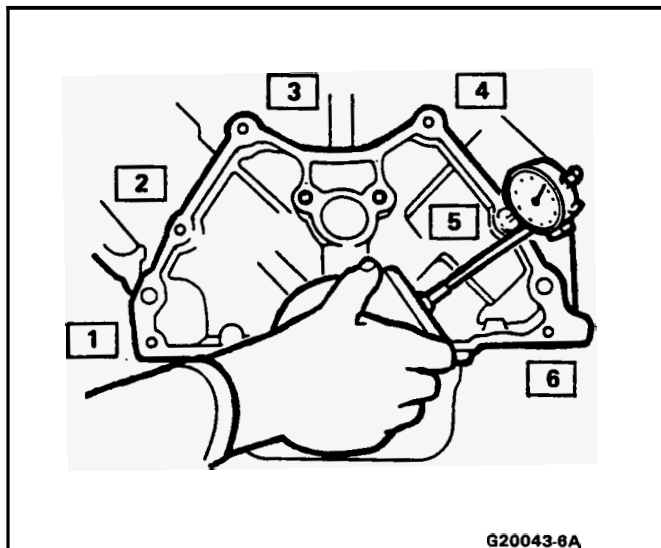


Figure 52 Measuring Transmission Mounting Surface Runout

- o Threaded holes. If necessary, clean with a tap or drill out and install thread inserts (refer to Thread Insert Repair).

! Important

- o The following inspections as well as re-conditioning, if necessary, must be carried out with the main bearing caps installed and torqued to specification.
- o Make sure main bearing caps are installed correctly, with the arrows pointing toward the front of the engine.
- o Bearing bores, with a bore gage, measure concentricity and alignment
 - Camshaft
 - Crankshaft
 - If outside specification, replace the block.
 - If an examination of the outside of the bearing inserts indicates minor high spots, they may be carefully removed.

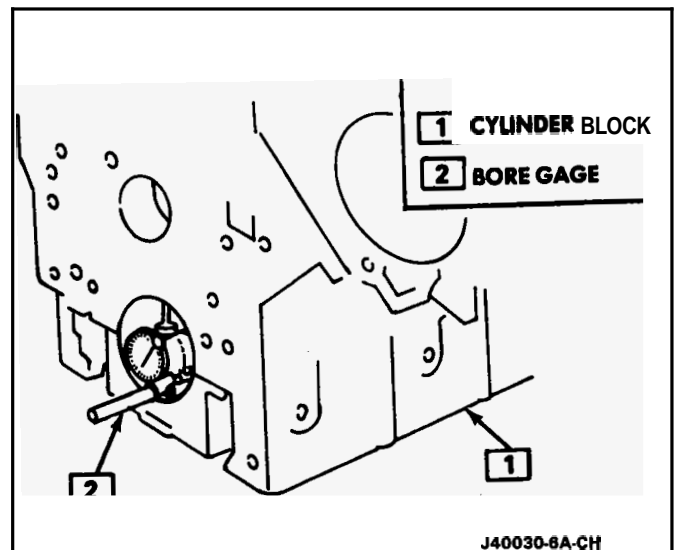


Figure 53 Measuring Bearing Bore

- Cylinder bore, with bore gage J 8087 measure for wear, taper, run-out and ridging
- o If the bore is worn beyond limits, it may be re-bored, honed and fitted with oversize pistons. The smallest available oversize should be selected (refer to Piston Fitting).

! Important

- o Leave sufficient material to allow finish honing in conjunction with fitting the piston.
- If the bore is glazed but otherwise serviceable, break the glaze lightly with a hone and replace the piston rings.
- o Make sure the honing stones are clean, sharp and straight. Move the hone slowly up and down to produce a 45" cross-hatch pattern. Clean bore thoroughly with soap and water. Dry and rub in clean engine oil, re-measure.

➔ Assemble

- o Coolingjacket plugs. Apply GM 1050026 sealer, or equivalent.

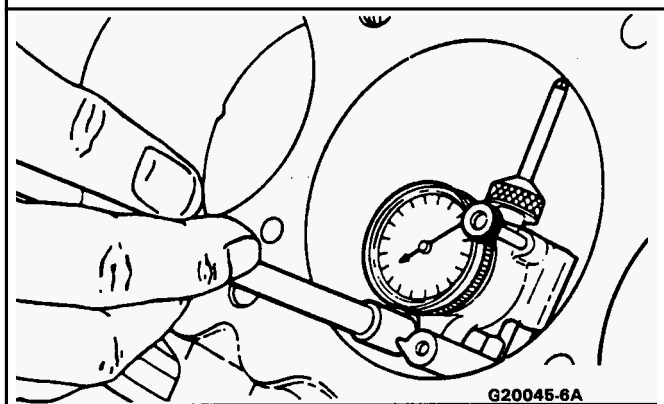


Figure 54 Measuring Cylinder Bore For Taper And Out-of-Round

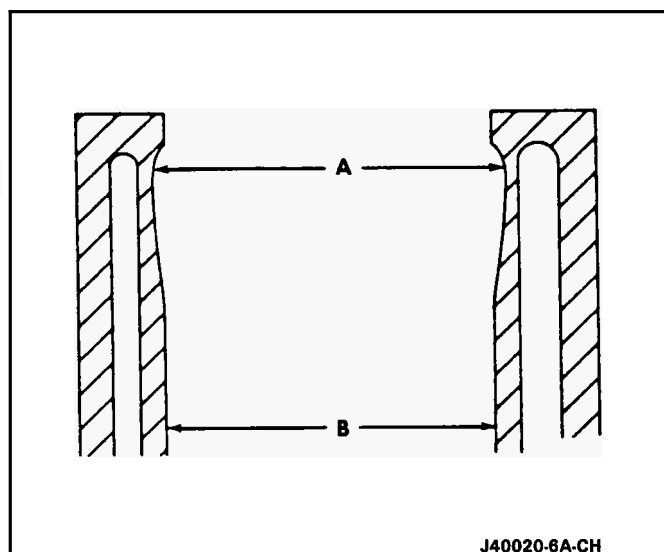


Figure 55 Cylinder Wear Pattern

- Oil gallery screw plug

! Important

- o Make sure plugs with oil holes are re-installed in their original position to provide lubrication to the timing chain and to the distributor Refer to Specific Engine Section.

- o Camshaft bearings (refer to Camshaft and Camshaft Bearings)

PISTON FITTING

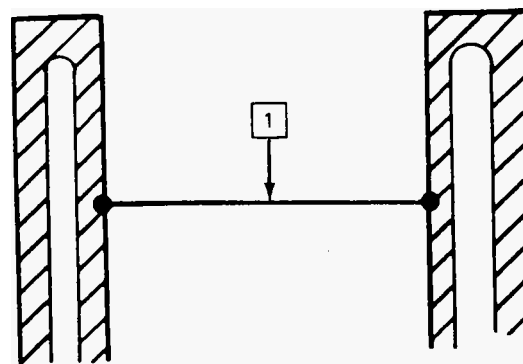
! Important

- o When fitting pistons, both piston and cylinder bore condition must be considered together. Production and service pistons have the same nominal weight and can be intermixed without affecting engine balance. If necessary, used pistons may be fitted selectively to any cylinder of the engine, providing they are in good condition.
- o Do not cut oversize pistons down or engine balance will be affected.

! Measure

1. Piston. If worn or damaged, replace with a standard or oversize piston.
2. Cylinder bore, refer to Cylinder Block. If worn beyond specifications, rebore and hone to size.

1 GAGING POINT



BORE GAGING POINTS J40025-6A-CH

Figure 56 Cylinder Bore Gaging Point

! important

- o Finish hone when selecting piston.

3. Fit piston to cylinder.

! Important

- o Both piston and cylinder bore must be dry.

! Clean

- o Scrub the cylinder bore and the piston with soap and water and remove all foreign material. Dry and rub in clean engine oil.

! Measure

1. Check piston to cylinder bore clearance as follows:
 - a. Measure the cylinder bore diameter with a telescope gage.
 - b. Measure the cylinder bore diameter. When measuring piston for size or taper, measurement must be made as shown in Figure 55.
 - c. Subtract piston diameter from cylinder bore diameter to determine piston-to-bore clearance.
 - d. Compare piston-to-bore clearance obtained with specifications.
 - e. Determine if piston-to-bore clearance is in acceptable range.
2. If a used piston is not acceptable, check service piston sizes and determine if a new piston can be selected. (Service pistons are available in standard and several oversizes.

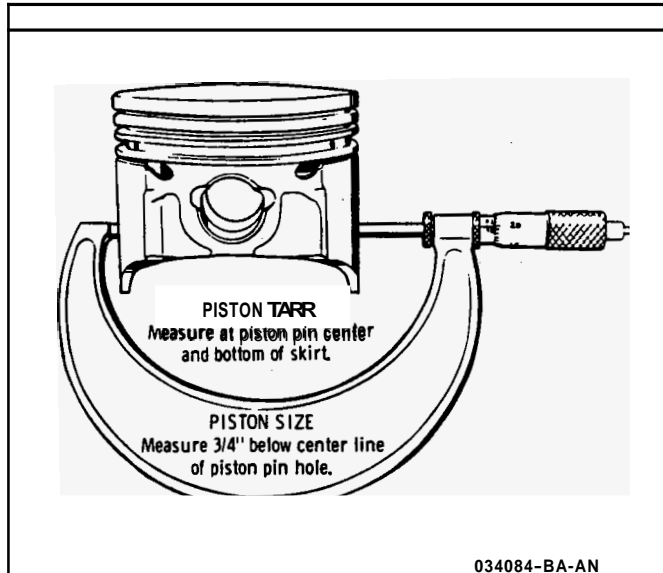


Figure 57 Measuring Piston

3. If cylinder bore must be reconditioned, measure new piston diameter then hone cylinder bore to obtain preferable clearance.
4. Select new piston and mark piston to identify the cylinder for which it was fitted. (On some cars oversize pistons may be found. These pistons will be .010" oversize.)



Clean

- o Scrub the cylinder bore and the piston with soap and water and remove all foreign material. Dry and rub in clean engine oil.

**REAR MAIN BEARING OIL SEAL-
2.0, 2.5 & 2.8L**

VIN M, K, #1, R, U & W

Figures 58 and 59

Tool Required:

J 34686 VIN 1 & W

J 36227 VIN M & K

J 34924 VIN R & U



Remove or Disconnect

1. Support engine.
2. Transaxle. See Section 7A1.
3. Flywheel
 - o At this time, confirm seal leak.
4. Seal by inserting a screwdriver or similar tool through the dust lip. Pry out seal, by moving tool around seal as required.



important

- o Do not damage seal bore or crankshaft with pry tool.



Inspect

- o Cylinder block seal bore for nicks or burrs. Correct as necessary.

- o Crankshaft for nicks or burrs on seal contact surface. Correct as necessary.

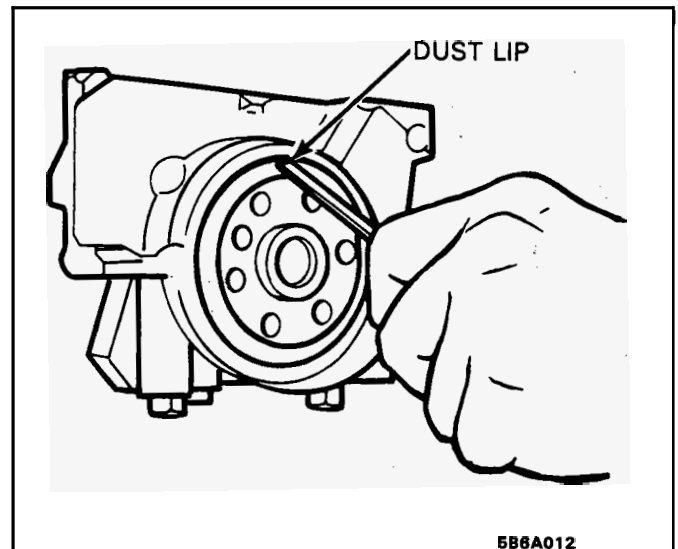


Figure 58 Removing Seal

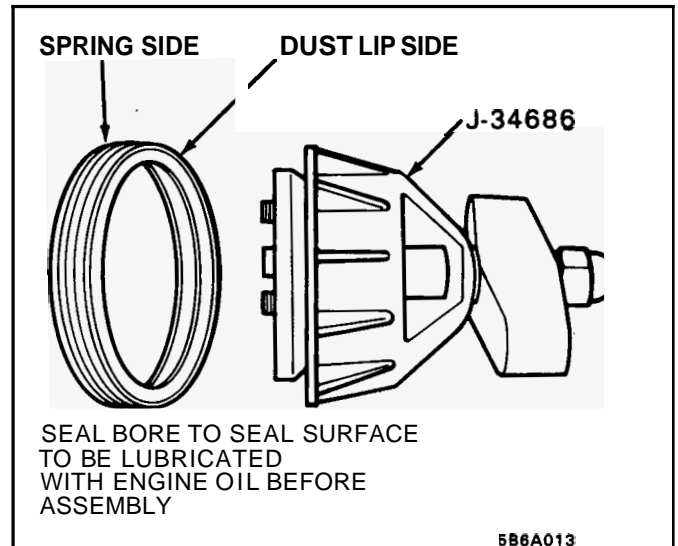


Figure 59 Installing Rear Main Bearing Oil Seal (typical)



Install or Connect

1. Lubricate seal bore surface of seal with engine oil.
2. New seal using correct tool.
 - a. Slide new seal over mandril until dust lip bottoms squarely against tool collar.
 - b. Align dowel pin of tool with dowel pin hole in crankshaft and attach tool to crankshaft. Tighten attaching screws to 5 N·m (48 lb. in.).
 - c. Tighten "T" handle completely. Remove attaching screws and tool.
 - o Check to be sure seal is seated squarely in bore.
3. Flywheel
4. Transaxle. See Section 7A1.

**REAR MAIN BEARING OIL SEAL-
3.0, 3.8, 5.0L**

VIN A, 7, L, 3 & Y

See Figures 60 thru 63

Tools Required:
J 25285A or BT-7923A Seal Installer

 **Clean**

- Remains of sealer from:
 - Upper and lower bearing groove
 - Mating surface of the bearing cap

 **Install or Connect**

- A. Rope seal
1. Apply GM 1052621 sealer, Loctite 414 or equivalent to the seal groove.
 2. Within one (1) minute, insert seal into the groove and roll into place with a tool as listed.
 3. 3.0 and 3.8L roll into place with a suitable tool until seal projects above groove no more than 1.59 mm (1/16").
 4. Seat the seal with a suitable tool.

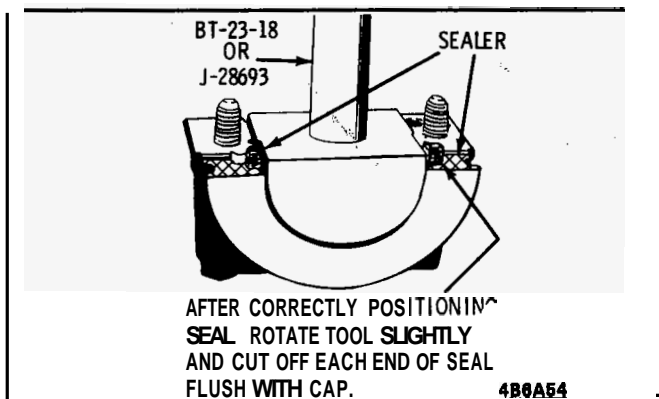


Figure 60 Installing Rear Main Bearing Oil Seal In Cap

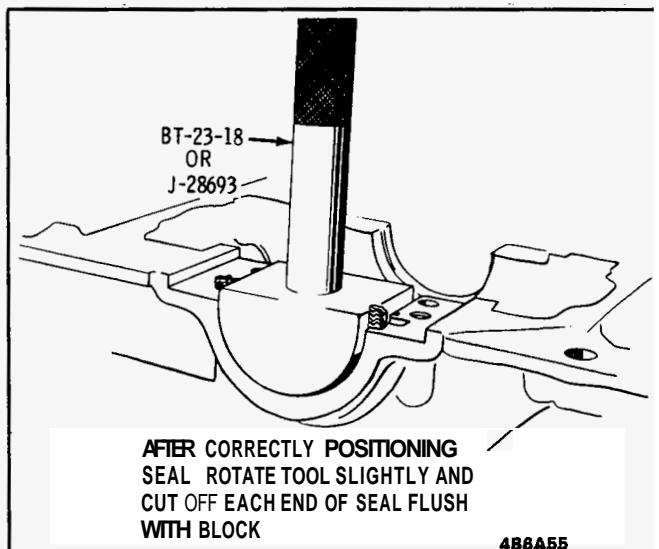


Figure 61 Installing Rear Main Bearing Oil Seal In Block

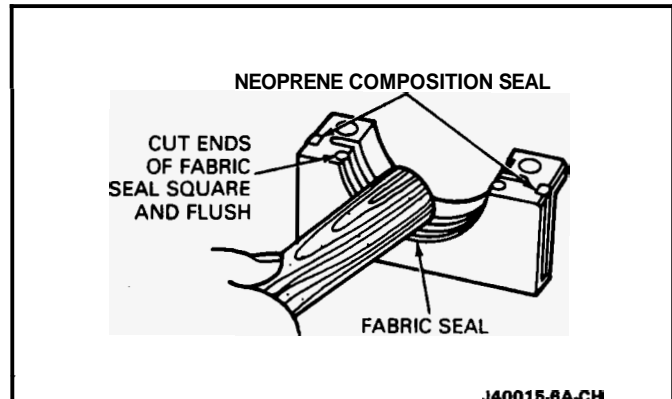


Figure 62 Installing Rear Main Bearing Oil Seals 3.0 and 3.8L)

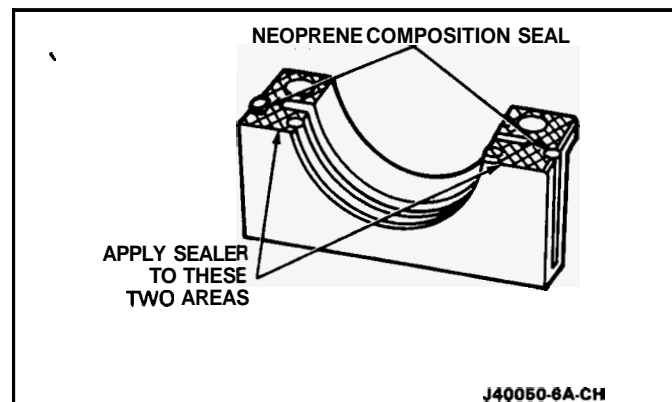


Figure 63 Sealer Application on Rear Main Bearing Cap 3.0 and 3.8L Shown

 **Important**

- o Use sealer sparingly. Keep sealer out of bolt threads (VIN A, L, 3, 7). Soak sealing strips in light oil or kerosene for 5 minutes before installing.
- 8. (VIN A, L, 3, 7) Place composition strips into grooves along the sides of the main bearing cap.
- 9. Re-install the rear main bearing cap.

FLYWHEEL BALANCE

See Figure 64

Flywheel imbalance can be corrected by the use of balance weights clipped to the flexplate.

1. Mark the flywheel in four locations, 90° apart.
2. Install one clip at one of the marked locations.

 **Inspect**

- o Start engine and, with transmission/transaxle in "Neutral", note the vibration.
 - If vibration has increased, re-locate clip 180° from its present position.

- If vibration has decreased, install an additional clip next to the first clip.
- If no change is noticed, re-locate the clip 90° from its present location.
- o Continue until vibration is reduced. Fine adjustments may be made by moving the clips in small increments.

NOTICE: Make sure the clips are properly secured to avoid shifting at high engine speed.

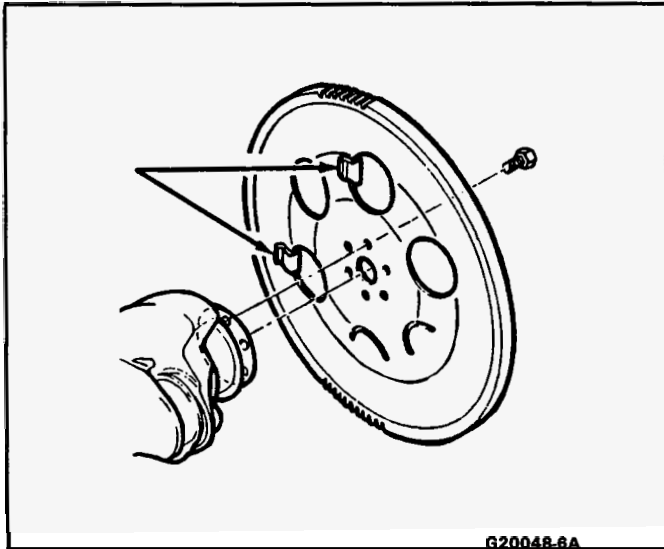


Figure 64 Flywheel Balance Clip Location (Typical)

THREAD REPAIR

See Figure 65

Damaged threads may be re-conditioned by drilling out, re-threading and installing a suitable thread insert.

Tools Required:

General purpose thread repair kits are available commercially. J 33425 is recommended for spark plug threads.

CAUTION: Wear safety glasses to avoid eye damage.

1. Determine size, pitch and depth of damaged thread. If necessary, adjust stop collars on cutting tool and tap to the required depth.

! Important

- o Refer to the kit manufacturer's instructions regarding the size of drill and tap to be used.
2. Drill out damaged thread. Clean out chips.
 3. Tap hole. Lubricate tap with light engine oil (except when tapping into aluminum). Clean the thread.

□ Important

- o Avoid build-up of chips. Back out the tap every few turns and remove chips.
4. Thread the thread insert onto the mandrel of the installer. Engage the tang of the insert onto the end of the mandrel.
 5. Lubricate the insert with light engine oil (except when installing in aluminum) and install.

! Important

- o When correctly installed, the insert should be flush to one turn below the surface.
6. If the tang of the insert does not break off when backing out the installer, break the tang off with a drift punch.

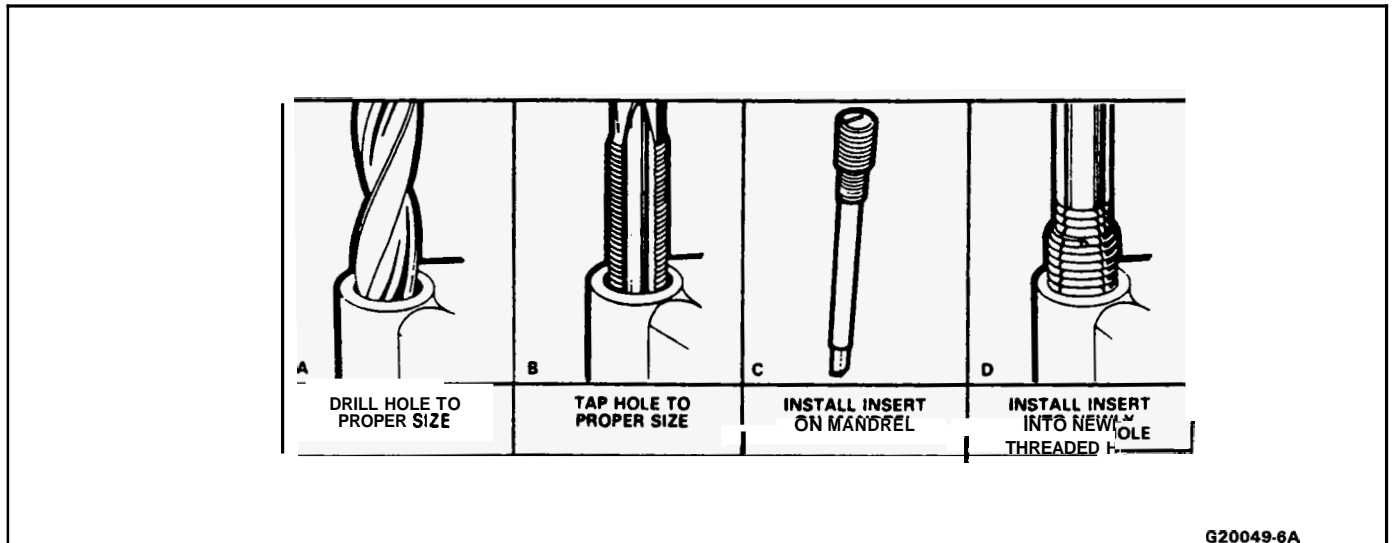


Figure 65 Repairing Threaded Holes



SECTION 6A5

3.8L ENGINE

VIN CODES A, 7

CONTENTS

General Description	6A5-1	Timing Chain and Sprocket	6A5-10
Engine Identification	6A5-1	Camshaft	6A5-10
Engine Construction	6A5-1	Oil Pan	6A5-11
Lubrication System	6A5-2	Oil Pump Pipe and Screen Assembly	6A5-11
On-Car Service	6A5-2	Testing Oil Pressure	6A5-12
Engine Assembly	6A5-2	Priming the Oil Pump	6A5-12
Engine Mounts	6A5-3	Oil Pump and Relief Valve	6A5-12
Intake Manifold or Gasket	6A5-5	Oil Pump Cover and Gears	6A5-12
Exhaust Manifold	6A5-6	Piston and Connecting Rod	6A5-13
Valve Cover	6A5-6	Crankshaft	6A5-13
Rocker Arm and/or Shaft	6A5-6	Rear Main Bearing Oil Seal Repair	6A5-14
Valve Lifters	6A5-7	Flywheel	6A5-15
Cylinder Head	6A5-7	Bolt Torque Specifications	6A5-16
Crankshaft Balancer	6A5-8	Engine Specifications	6A5-17
Timing Chain Cover	6A5-9	Special Tools	6A5-18
Front Crankshaft Oil Seal	6A5-10		

For Canadian vehicles equipped with non-closed loop engines refer to the appropriate Canadian Service Manual Supplement.

GENERAL DESCRIPTION

ENGINE IDENTIFICATION

The 3.8L engine may be identified from the vehicle identification number. The code letter in the eighth digit location identifies the type and cubic inch displacement of the engine. Refer to Section OA for additional information on identification of engine codes.

ENGINE CONSTRUCTION

The left bank of cylinders (as viewed from rear) is set slightly forward of the right bank. Starting at the front of the engine, cylinders in the left bank are numbered 1-3-5 and cylinders in the right bank are numbered 2-4-6. The crankshaft is supported in the crankcase by four bearings which are all specific.

The crankshaft is counterbalanced by weights cast integral with the crankshaft. Additional counterbalancing is obtained from the flywheel and balancer.

These engines are even-firing in that the cylinders fire at equal 120° intervals of crankshaft rotation. The location of the crankpins has been offset by 30° in order to fire the cylinders at equal 120° intervals of crankshaft rotation.

The firing order of the V-6 is 1-6-5-4-3-2.

The camshaft lobes and timing also reflect 120° spacing.

The tin plated aluminum alloy pistons have full skirts and are cam ground or cam turned. Two

transverse slots in the oil ring grooves extend through the piston wall and permit drain back of oil collected by the oil ring. Turbocharged engines do not incorporate these slots into the pistons.

The camshaft is supported in the crankcase by four steel-backed babbitt-lined bearings. It is driven from the crankshaft by sprockets and chain.

The cylinder heads are cast iron and incorporate integral valve stem guides and rocker arm shaft pedestals. Right and left cylinder heads are identical and interchangeable, although in service it is good practice to reinstall the cylinder heads on the side from which they are removed.

The intake manifold is bolted to the inner faces of both cylinder heads so that it connects with all inlet ports.

Each exhaust and intake Valve has a spring of ample capacity to insure positive seating throughout the operating speed range.

The valve rocker arms for each bank of cylinders are mounted on a tubular steel shaft supported on the cylinder head by three pedestals. The rocker arms are stamped steel.

Hydraulic valve lifters and tubular pushrods are used to operate overhead rocker arms and valves of both banks of cylinders from a single camshaft. Operation of hydraulic valve lifters is described below.

In addition to its normal function of a cam follower, each hydraulic valve lifter also serves as an automatic adjuster which maintains zero lash in the valve train under all operating conditions. By

eliminating all lash in the valve train and also providing a cushion of oil to absorb operating shocks, the hydraulic valve lifter promotes quiet valve operation. It also eliminates the need for periodic valve adjustment to compensate for wear of parts.

Oil is fed to all lifters through galleries in the crankcase. The first few cycles of operation after the engine is started forces out all air and completely fills the plunger and lower chamber of each lifter with oil.

LUBRICATION SYSTEM

See Figure 1

The engine lubrication system is of the force-feed type in which oil is supplied under full pressure to the crankshaft, connecting rods, camshaft bearings, valve lifters, and a controlled volume is supplied to the rocker arms and push rods. All other moving parts are lubricated by gravity flow or splash.

The supply of oil is carried in the lower crankcase (oil pan) which is filled through a filler opening in the rocker arm cover. A removable oil level indicator (dip stick) rod on the left side of the crankcase is provided to check oil level.

The oil pump is located in the timing chain cover where it is connected by a passage in the cylinder crankcase to an oil screen housing and pipe assembly. The screen is submerged in the oil sump and has ample supply for all operating conditions. If the screen should become clogged for any reason, oil may be drawn into the system through the by-pass valve in the screen.

Oil is drawn into the pump through the screen and pipe assembly and a passage in the crankcase which connects to passages in the timing chain cover. All oil is discharged from the pump to the oil pump cover assembly. The cover assembly consists of an oil pressure relief valve, an oil filter by-pass valve, and a nipple for installation of an oil filter. The spring loaded oil pressure relief valve limits the oil pressure. The oil filter by-pass valve opens when the filter has become clogged, to the extent that when approximately 69 kPa (10 psi) difference exists between the filter inlet and discharge, to by-pass the oil filter and channel unfiltered oil directly to the main oil galleries of the engine.

A full flow oil filter is externally mounted to the oil filter cover nipple on the lower right front side of the engine. Normally, all engine oil passes through the filter element, however, if the element becomes restricted, a spring loaded by-pass valve opens as mentioned above.

The main oil galleries run the full length of the crankcase and cut into the valve lifter guide holes to supply oil at full pressure to the lifters. Holes drilled from the crankshaft bearings to the main gallery intersect the cam bearing bores to supply oil to the cam bearings.

Holes drilled in the crankshaft carry oil from the crankshaft bearings to the connecting rod bearings. Pistons and cylinder walls are lubricated by oil thrown off the crankshaft and connecting rod splash. Piston pins are lubricated by splash.

A drilled hole in the camshaft allows oil to flow from the front camshaft bearing journal to the front

camshaft sprocket and distributor gear. The oil stream strikes the distributor gear and provides ample lubrication of the timing chain and sprockets by splash.

Each rocker arm and valve is supplied with oil through the tubular push rod. This oil comes from the inside of the lifter, passing around the metering valve and through a hole in the lifter push rod seat. Oil from the push rod passes through a hole in the rocker arm push rod seat, and emerges on top of the push rod seat boss.

ON-CAR SERVICE

ENGINE ASSEMBLY

Remove or Disconnect

1. Hood

Important

- o For easier installation, scribe marks should be made at hood hinge to hood mating surface.

2. Negative battery cable
3. Engine coolant
4. Air cleaner
5. Fan blade, pulleys and belts
6. A/C compressor from mounting bracket, if equipped
7. Radiator and heater hoses from engine
8. Fan shroud assembly
9. Power steering pump to mounting bracket bolts and position out of the way
10. Fuel line
11. Battery ground cable from engine
12. Vacuum hosing to all non-engine mounted components
13. Accelerator cable at carburetor
14. Engine wiring harness connector
15. Generator
16. Engine to body ground strap(s) at engine
17. Raise car and suitably support. See Section OA.
18. Crossover pipe from exhaust manifolds
19. Flywheel cover and torque converter bolts

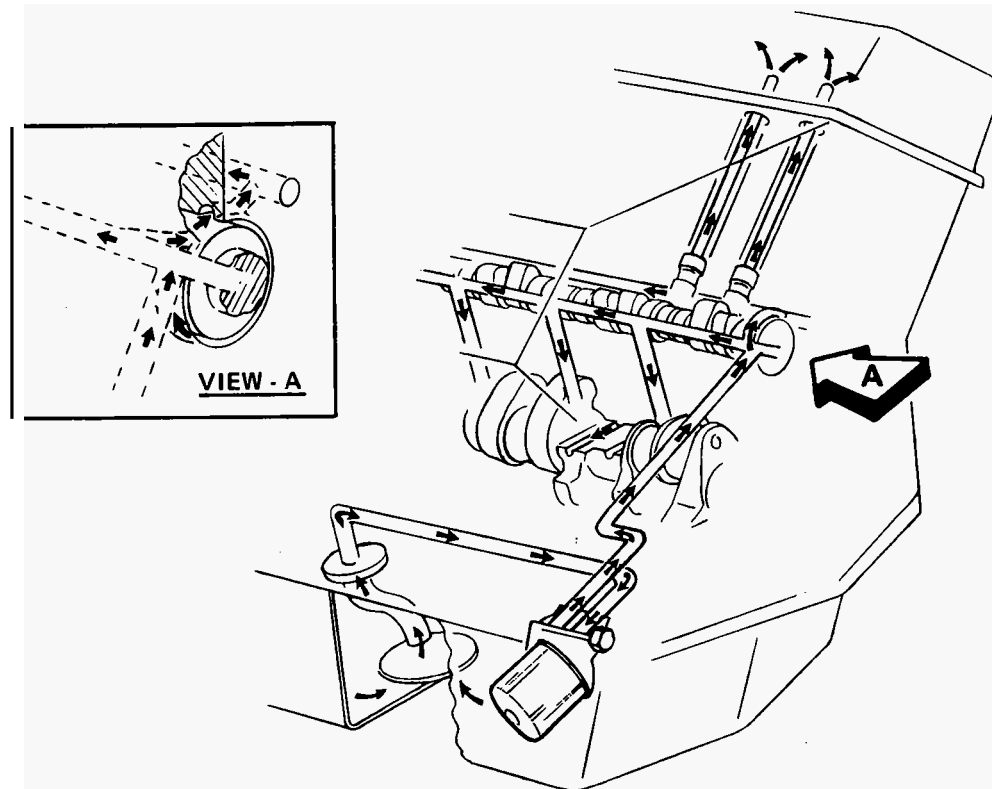
Important

- o Use a scribe to mark relationship of torque converter to flywheel.

20. Wiring at starter motor.
21. Transmission to cylinder block attaching bolts
22. Front motor mount to frame bracket attaching bolts
23. Lower car and support the transmission
24. Install engine lift fixture
25. Engine Assembly

Inspect

- For inspection and overhaul procedures, refer to Section 6A, General Engine Mechanical.



5B 6A501

Figure 1 Engine Lubrication

↔ Install or Connect

1. Lower engine into car.
2. Transmission to cylinder block attaching bolts
3. Raise car and suitably support. See Section OA.
4. Front motor to frame bracket attaching bolts
5. Torque converter bolts and flywheel cover, making sure to align marks.
6. Wiring at starter motor
7. Crossover pipe to exhaust manifold
8. Lower car.
9. Engine to body ground straps at engine
10. Generator
11. Engine wiring harness connector
12. Accelerator cable at carburetor
13. Vacuum hosing to all non-engine mounted components
14. Battery ground cable from engine
15. Fuel pump hoses
16. Power steering pump to mounting bracket bolts and secure.
17. Fan shroud assembly
18. Radiator and heater hoses to engine
19. A/C compressor to mounting bracket, if equipped
20. Fan blade, pulleys and belts and adjust to proper tension
21. Engine oil as needed
22. Engine coolant
23. Air cleaner
24. Negative battery cable

👁 Inspect

- For proper completion of repair
- Proper fluid levels
- For fluid and exhaust leaks

ENGINE MOUNTS

See Figure 3

↔ Remove or Disconnect

1. Raise car and suitably support. See Section OA.
2. Support weight of engine at forward edge of oil pan.
3. Mount to cylinder block bolts
4. Raise engine slightly.
5. Mount to mount bracket bolt and nut
6. Mount

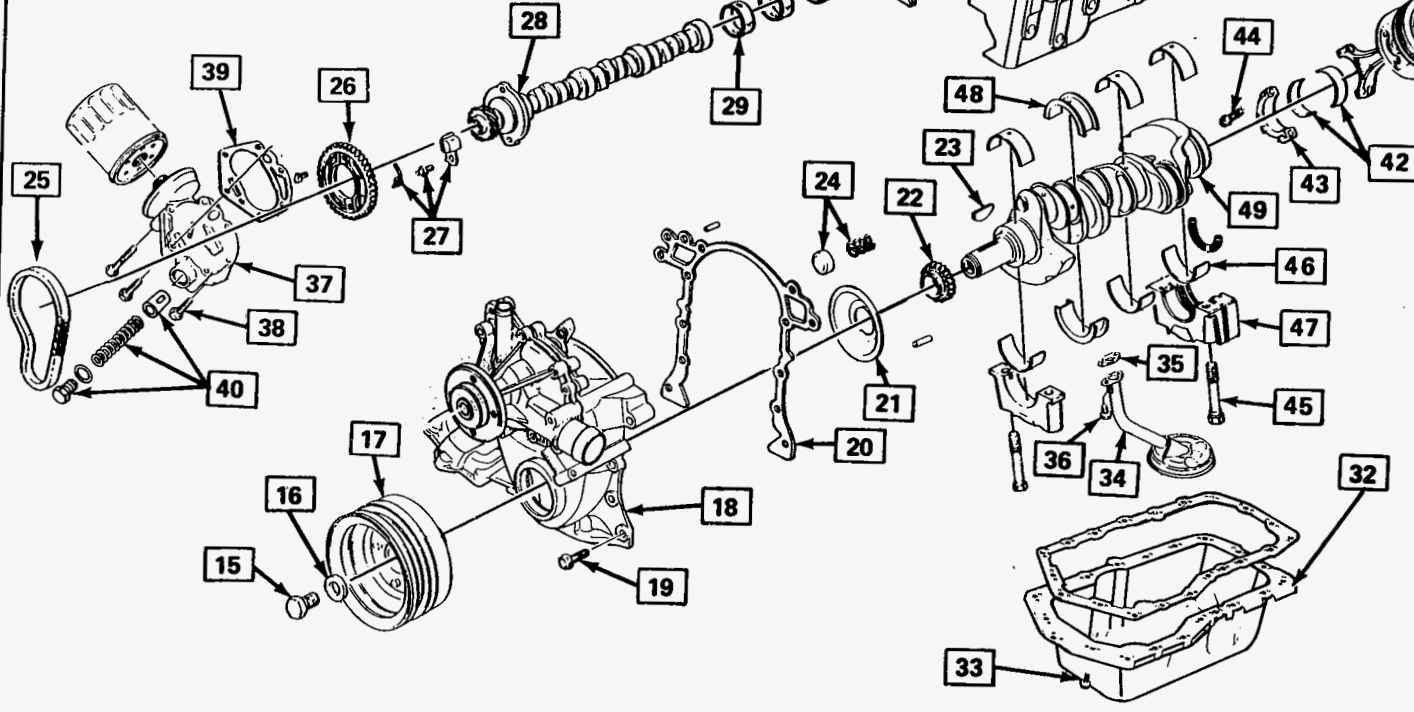
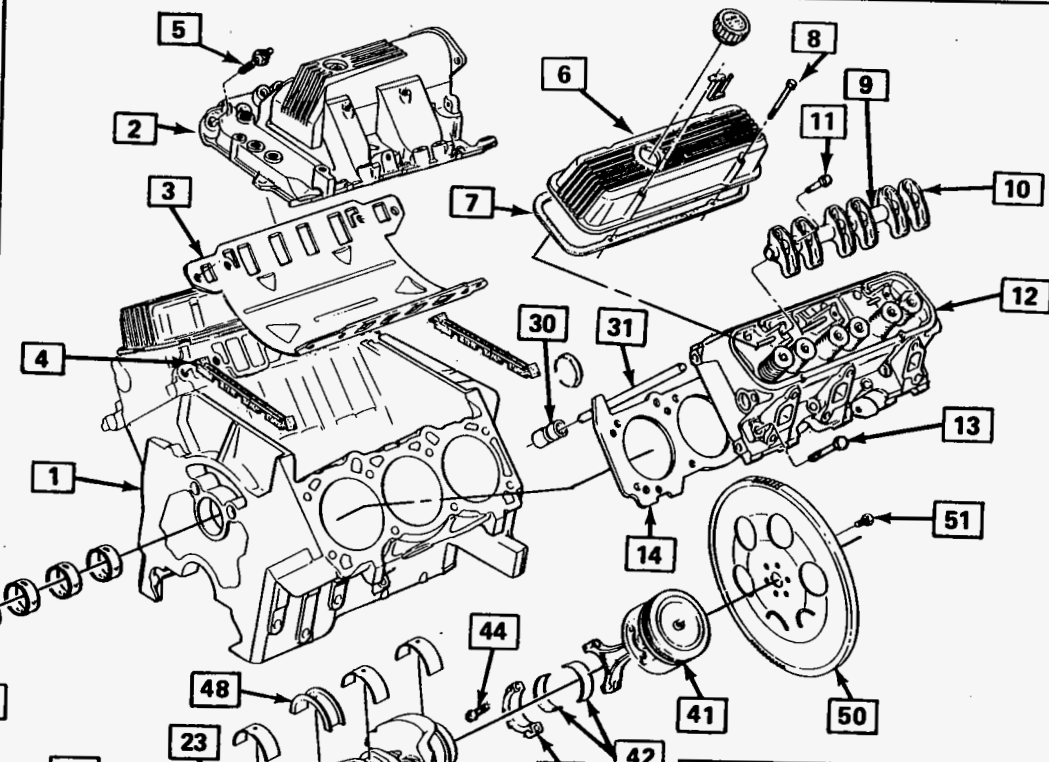
↔ Install or Connect

1. Mount to cylinder block bolts and tighten to specification
2. Lower engine.
3. Mount to mount bracket bolt and tighten to specification
4. Remove frame support and lower car.

👁 Inspect

- For proper completion of repair
- For mount alignment

- | | | | |
|----|-----------------|----|----------------------------|
| 1 | CYLINDER BLOCK | 18 | TIMING CHAIN COVER |
| 2 | INTAKE MANIFOLD | 19 | BOLT |
| 3 | GASKET | 20 | GASKET |
| 4 | SEAL | 21 | SLINGER |
| 5 | BOLT | 22 | CRANKSHAFT SPROCKET |
| 6 | VALVE COVER | 23 | KEY |
| 7 | GASKET | 24 | CAMSHAFT BUTTON AND SPRING |
| 8 | BOLT | 25 | TIMING CHAIN |
| 9 | SHAFT | 26 | CAMSHAFT SPROCKET |
| 10 | ROCKER ARM | 27 | TIMING CHAIN TENSIONER |
| 11 | BOLT | 28 | CAMSHAFT |
| 12 | CYLINDER HEAD | 29 | CAMSHAFT BEARING |
| 13 | BOLT | 30 | LIFTER |
| 14 | GASKET | 31 | PUSH ROD |
| 15 | BOLT | 32 | OIL PAN |
| 16 | WASHER | 33 | BOLT |
| 17 | BALANCER | 34 | OIL PUMP PIPE AND SCREEN |



- | | |
|----|--|
| 35 | GASKET |
| 36 | BOLT |
| 37 | OIL PUMP COVER |
| 38 | BOLT |
| 39 | OIL PUMP COVER GASKET |
| 40 | PRESSURE RELIEF VALVE, SPRING AND PLUG |
| 41 | PISTON AND CONNECTING ROD ASSEMBLY |
| 42 | ROD BEARING |
| 43 | ROD CAP |
| 44 | BOLT |
| 45 | BOLT |
| 46 | MAIN BEARING |
| 47 | MAIN BEARING CAP |
| 48 | THRUST MAIN BEA |
| 49 | CRANKSHAFT |
| 50 | FLEXI |
| 51 | BOLT |

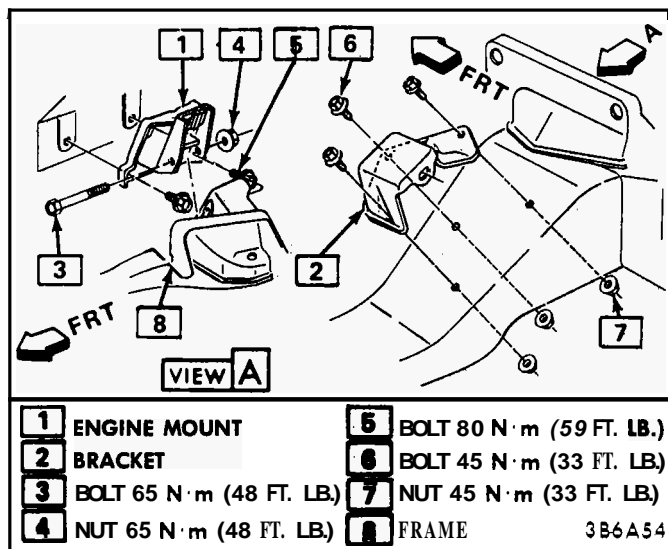


Figure 3 Engine Mounting

INTAKE MANIFOLD

See Figure 4

Tool required:
J 24394 Bolt Wrench

Remove or Disconnect

1. Negative battery cable
2. Fuel System:
 - o Air cleaner
 - o Accelerator linkage, springs and bracket
 - o Fuel line at carburetor
 - o Cruise control if equipped
3. Cooling System:
 - o Engine coolant
 - o Upper radiator hose
 - o Heater hose
 - o Coolant by pass hose
4. Brake booster vacuum pipe at manifold
5. Vacuum hoses at carburetor
6. Wires or cables:
 - Distributor
 - Temperature sending unit
 - CCC harness as required
8. Distributor cap and rotor to access bolt
Use J 24394 to remove bolt.
9. Accessory mounting brackets as required
10. Intake manifold bolts
11. Intake manifold

Clean

- o All gasket surfaces on the intake manifold and cylinder heads.

Install or Connect

1. Intake manifold gasket and rubber manifold seals

Important

- o Be sure pointed end of seal fits snugly against block and heads.

- o Before installing intake manifold seals, apply GM 1052366 sealer, Fel Pro-RTV Black or equivalent to ends of seals.
- o New intake manifold gasket and seals must be used whenever a manifold is removed.

2. Intake manifold bolts

Tighten

- o Start with one and two
- o Gradually until both are snug.
- o Continue in sequence shown on Figure 4.

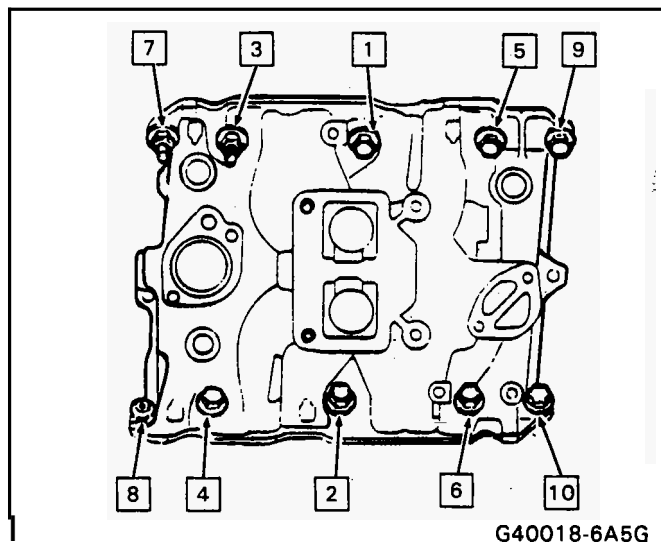


Figure 4 Intake Manifold Bolt Tightening Sequence

Install or Connect

1. Accessory mounting brackets as needed
2. Distributor cap and rotor
3. Wiring/cables at:
 - Distributor
 - Temperature sending unit
 - CCC harness
4. Brake booster vacuum pipe at manifold
5. Vacuum hoses at carburetor
6. Cooling System:
 - o Upper radiator hose
 - o Heater hose
 - o Coolant bypass hose
 - o Engine coolant
7. Fuel System:
 - o Accelerator linkage, springs and bracket
 - o Fuel line at carburetor
 - o Cruise control chain if equipped
 - o Air Cleaner
8. Negative battery cable

Inspect

- o For proper completion of repair
- o Fluid leaks
- o Vacuum leaks

EXHAUST MANIFOLD

Remove or Disconnect

1. Negative battery cable
2. Right side - oxygen sensor lead
3. Raise car and suitably support. See Section OA.
4. Exhaust pipe at manifold
5. Six bolts attaching manifold to cylinder head
6. Exhaust manifold

Important

- o TO REPLACE EXHAUST MANIFOLD, transfer the following items to the new manifold:
 - o Oxygen sensor
 - o Exhaust pipe seal

Clean

- o Sealing surfaces of manifold and cylinder head

Install or Connect

1. Manifold to cylinder head with six bolts and tighten to specification
2. Exhaust pipe at manifold
3. Right side - oxygen sensor lead
4. Negative battery cable

Inspect

- o For proper completion of repair
- o For exhaust leaks

VALVE COVER

See Figure 5

Remove or Disconnect

1. Negative battery cable
2. Right side:
 - o PCV pipe to air cleaner
 - o Necessary Computer Command Control hoses and leads.
 - o Hot air tube
3. Spark plug wires
4. Accessory mounting brackets, as required
5. Valve cover to cylinder head attaching bolts
6. Valve cover

Clean

- o All gasket surfaces on the valve cover and cylinder head

Install or Connect

1. Valve cover gasket in valve cover
2. Valve cover
3. Valve cover to cylinder head attaching screws and tighten to specifications
4. Spark plug wires
6. Right side:
 - o PCV pipe to air cleaner
 - o Hot air tube

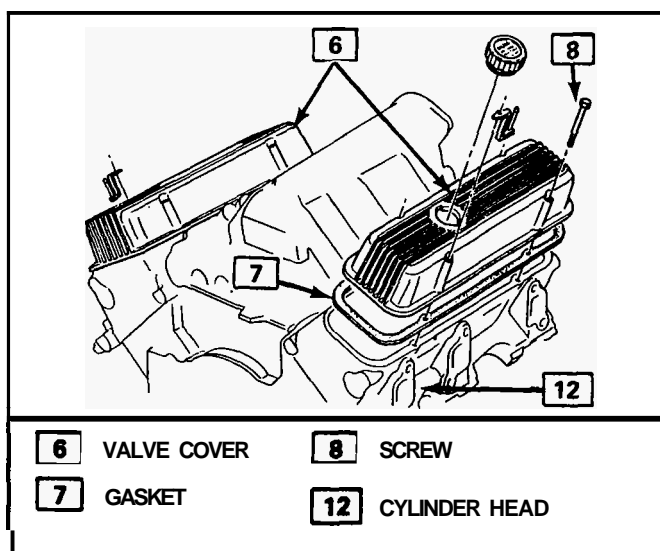


Figure 5 Valve Covers

- o Necessary Computer Command Control hoses and leads

7. Negative battery cable

Inspect

- o For proper completion of repair
- o Oil leaks

ROCKER ARM AND/OR SHAFT

See Figures 6 and 7

Remove or Disconnect

1. Valve cover
2. Rocker arm shaft retaining bolts
3. Shaft assembly

Important

- o Place assembly on a clean surface.
 - o Store components in order so they can be reassembled in the same location.
4. Nylon rocker arm retainers (not reusable)
 5. Rocker arms from shaft

Clean

- o Rocker arms and shaft in suitable solution and inspect for wear
- o Retainer pieces from inside shaft

Install or Connect

1. Rocker arms on shaft

Important

- o Should it become necessary to replace one or more rocker arms, it must be noted that all service rocker arms are stamped (R) right (L) left. Be sure rocker arms are installed on the rocker arm shaft in the correct sequence (Figure 7).
2. New nylon retainers using a drift of at least 12.7 mm (1/2") diameter

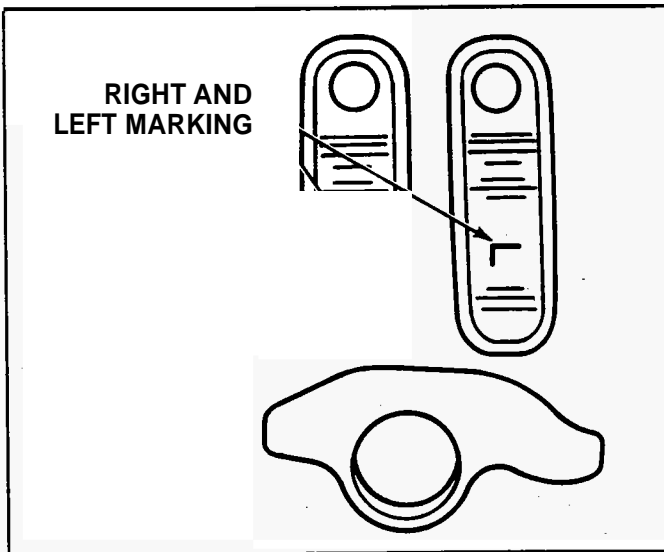


Figure 6 Service Rocker Arm Identification

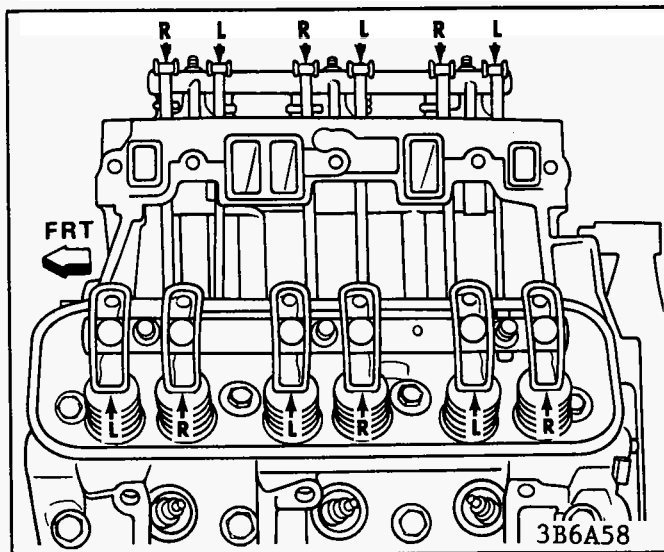


Figure 7-Position of Service Rocker Arms on Shaft

3. Rocker arm shaft assembly and tighten to specification
4. Valve cover and gasket

Inspect

- o For proper completion of repair
- o For valve train noise

VALVE LIFTERS

Remove or Disconnect

1. Negative battery cable
2. Drain coolant.
3. Rocker arm covers
4. Intake manifold
5. Rocker arm shaft and rockers
 - o Be sure to keep all valve train parts in order so they may be reinstalled in their original locations and with the same mating surfaces as when removed.
6. Pushrods

7. Valve lifters
 - o If lifters are to be reused, be sure to keep them in order so they may be reinstalled in their original locations and with the same mating surfaces as when removed.

Clean

- o All gasket surfaces with degreaser
- o Valve train parts

Inspect

- o Valve train parts
- o Lifters for wear
- o Cam lobes for wear

Install or Connect

1. Lifters

Important

- o Before installation, coat the bottoms of the lifters with GM E.O.S., part no. 1052367 or equivalent

2. Pushrods
3. Rocker arms and shaft. Tighten to specifications.
4. Intake manifold and gaskets
5. Rocker arm covers and gaskets
6. Refill coolant.
7. Negative battery cable

Inspect

- o Proper fluid levels
- o Fluid leaks

CYLINDER HEAD

See Figures 8 and 9

Remove or Disconnect

1. Negative battery cable
2. Belt(s)
3. Right cylinder head
 - o A/C compressor, if equipped, with hoses attached.
 - o Generator
 - o Mounting bracket
4. Left Cylinder Head
 - o Oil level indicator
 - o Power steering pump, if equipped, with hoses connected
 - o Mounting bracket
5. Spark plug wires
6. Exhaust manifold bolts

Clean

With air hose and cloths, dirt from head and adjacent areas. Avoid getting DIRT into engine.

7. Intake manifold
8. Valve cover

6A5-8 3.8L ENGINE

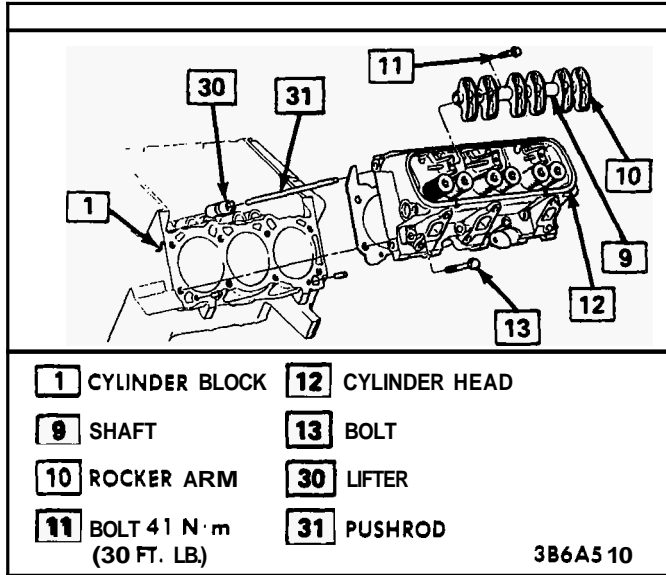


Figure 8 Cylinder Head Installation

9. Rocker arm shaft assembly
10. Pushrods

Important

- o During disassembly of the engine, all parts must be marked as to their proper location.

11. Cylinder head bolts
12. Cylinder head

Inspect

- o For inspection and overhaul procedures, refer to Section 6A, General Engine Mechanical.

Clean

- o Engine block and cylinder head mating surfaces.

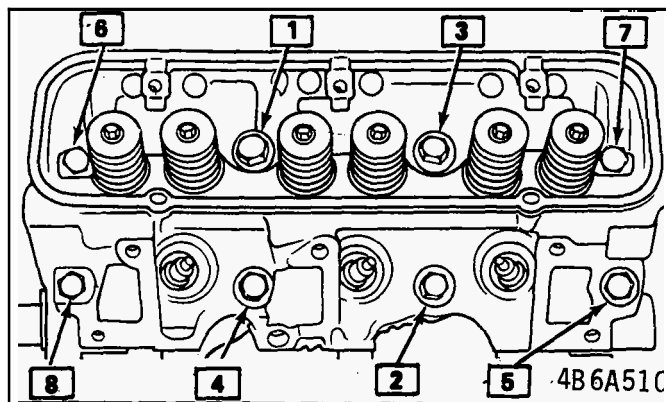


Figure 9 Cylinder Head Torque Sequence

Install or Connect

1. Clean threads in cylinder block using appropriate tap.
2. Cylinder head gasket on block.
3. Cylinder head.
4. Apply a heavy body thread sealer on bolt threads.
5. Cylinder head bolts.

NOTICE: This engine uses special torque to yield head bolts. This design bolt requires a special tightening procedure. Failure to follow the given procedure will cause head gasket failure and possible engine damage.

6. Torque cylinder head bolts to 34 N·m (25 lbs. ft.) per sequence shown in Figure 9.

Important

- o Should you reach 81 N·m (60 lbs. ft.) at any time in Steps 7 & 8, you should stop at this point. Do not complete the balance of the 90° turn.

7. Tighten each bolt 1/4 turn (90°) in sequence.
8. Tighten each bolt an additional 1/4 (90°) in sequence.
9. Exhaust manifold to cylinder head
10. Pushrods
11. Rocker arm shaft assembly
12. Intake manifold
13. Valve cover
14. Spark plug wires
15. Right cylinder head
 - o Mounting bracket
 - o Generator
 - o A/C Compressor if equipped
16. Left cylinder head
 - o Mounting bracket
 - o Power steering pump
 - Oil level indicator
17. Belts
18. Negative battery cable

Inspect

- o For proper completion of repair
- o Oil and coolant level
- o For external fluid leaks

CRANKSHAFT BALANCER

Remove or Disconnect

See Figure 10

1. Negative battery cable
2. Crankshaft pulley and belts
3. Balancer retaining bolt and washer
4. Balancer

Install or Connect

1. Balancer
2. Balancer retaining bolt and washer and tighten to specification.
3. Crankshaft pulley
4. Belts to proper tension
5. Negative battery cable

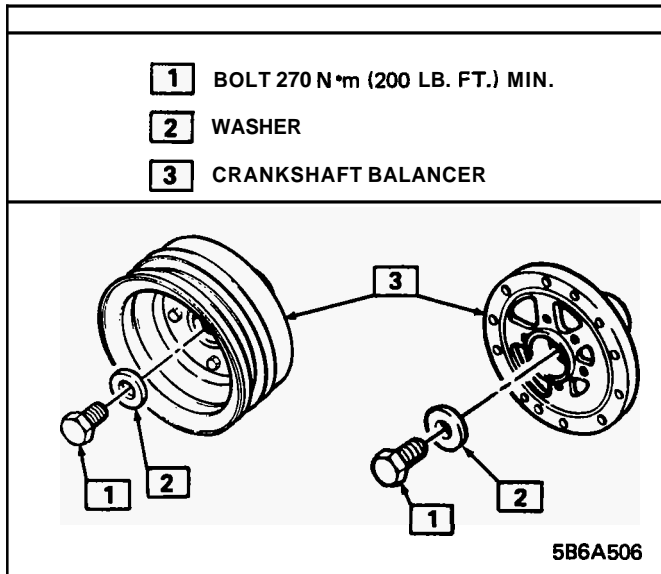


Figure 10 Crankshaft Balancer & Pulley

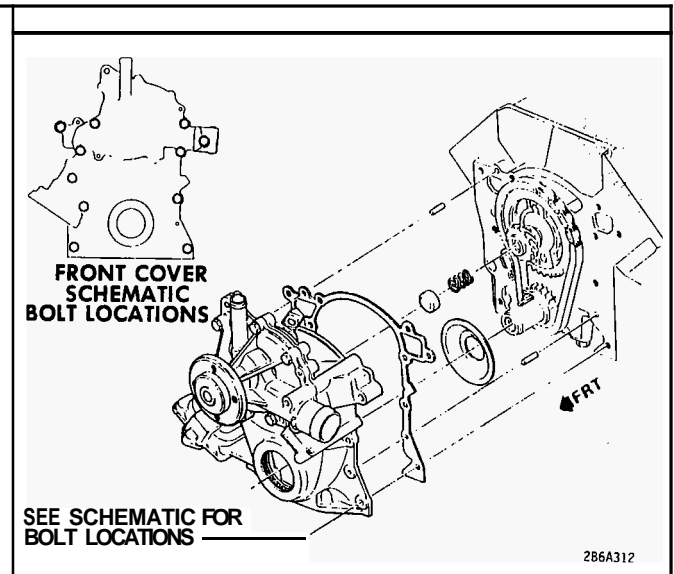


Figure 11 Timing Chain Cover

Inspect

- o For proper completion of repair
- o For pulley alignment
- o For oil leaks at front crankshaft seal

TIMING CHAIN COVER

See Figure 11

Remove or Disconnect

1. Negative battery cable
2. Engine coolant
3. Upper and lower radiator hoses
4. Heater return hose
5. Fan, fan pulley and belts
6. Crankshaft pulley
7. Fuel pump and lines
8. Two nuts from front engine mount at cradle and raise engine using suitable lifting device.
9. Water pump pulley and belts
10. Generator and mounting bracket
11. Distributor

Important

- o If timing chain and sprockets are not going to be disturbed, note position of distributor rotor for reinstallation in same position.
12. Front clamp on coolant bypass hose
 13. Balancer bolt, washer and balancer
 14. Timing chain cover to cylinder block attaching bolts
 15. Timing chain cover to oil pan bolts
 16. Timing chain cover
 17. Oil pan and gasket

Inspect

- Timing chain for overall “in and out” movement. Should not exceed 25.4mm (one inch).
- Sprockets for wear

Clean

- o Gasket mating surfaces at oil pan, timing chain cover, and cylinder block.

Important

- o Remove oil pump cover and pack space around the oil pump gears completely full of petroleum jelly. There must be no air space left inside the pump. Reinstall cover using new gasket.

NOTICE: This step is very important as the oil pump may “lose its prime” whenever the pump, pump cover or timing chain cover is disturbed. If the pump is not packed, it may not begin to pump oil as soon as the engine is started, and engine damage may result.

Install or Connect

1. Gaskets at oil pan and cylinder block
2. Timing chain cover
3. Timing chain cover bolts with sealer applied to threads and tighten to specification
4. Balancer, bolt and washer, and tighten to specification
5. Oil pan and gasket
6. Lower engine and connect two nuts to front engine mount at cradle.
7. Front clamp on coolant by-pass hose
8. Distributor
9. Generator and mounting bracket
10. Fuel pump and lines
11. Crankshaft pulley
12. Fan, fan pulley and belts to proper tension, see “Belt Tension Chart,” in Section OA.
13. Water pump pulley and belts to proper tension see “Belt Tension Chart,” in Section OA.
14. Heater return hose
15. Upper and lower radiator hoses
16. Engine coolant

6A5-10 3.8L ENGINE

17. Oil pan and gasket
18. Negative battery cable

Inspect

- o For correct completion of repair
- o For external fluid leaks

FRONT CRANKSHAFT OIL SEAL

With Timing Chain Cover Removed

Remove or Disconnect

1. Timing chain cover
2. Use a drift to drive out old seal and shedder from front toward the rear of the cover.

Install or Connect

1. Coil new packing around opening so ends of packing are at top.
2. Drive in shedder using suitable punch and stake shedder in place at three locations.
3. Size the packing by rotating a hammer handle or suitable tool around the packing until the balancer hub can be inserted through the opening.

TIMING CHAIN AND SPROCKETS

See Figure 12

Remove or Disconnect

1. With timing chain cover removed, align timing marks on sprockets so that they are as close together as possible.
2. Front crankshaft oil slinger
3. Camshaft sprocket bolts
4. Camshaft sprocket and chain
5. Crankshaft sprocket

Clean

- o Timing chain
- o Sprockets
- o Distributor drive gear
- o Fuel pump eccentric
- o Crankshaft oil slinger

Inspect

All components for wear and/or damage.

Important

If the pistons have not been moved in the engine, go to Step 3, otherwise Step 1.

1. Turn crankshaft so that number one piston is at top dead center.
2. Turn camshaft so, with sprocket temporarily installed, timing mark is straight down.
3. Assemble timing chain on sprockets with timing marks in their closest together position.

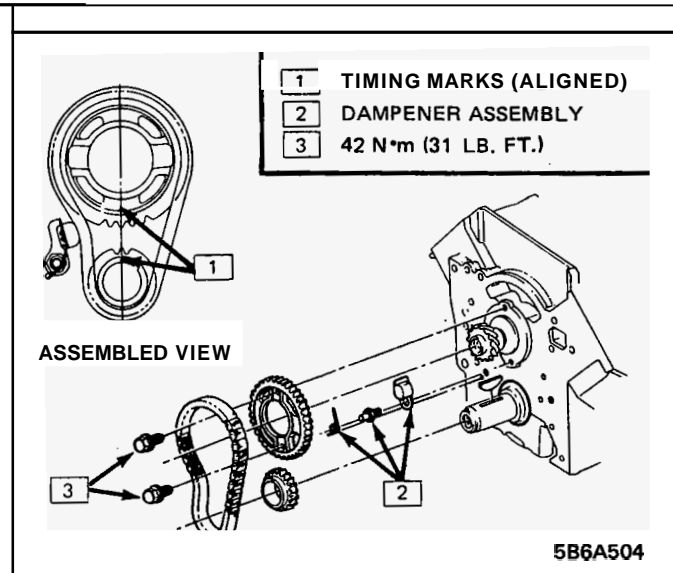


Figure 12 Timing Chain and Sprockets

Install or Connect

1. Timing chain and sprocket
2. Oil slinger with large part of cone to front of engine
3. Camshaft sprocket bolts and tighten to specification
4. Camshaft thrust button and spring
5. Timing chain dampener
6. Timing chain cover

Inspect

- o For proper completion of repair
- o For fluid leaks
- o For pulley alignment

CAMSHAFT

See Figure 13

Remove or Disconnect

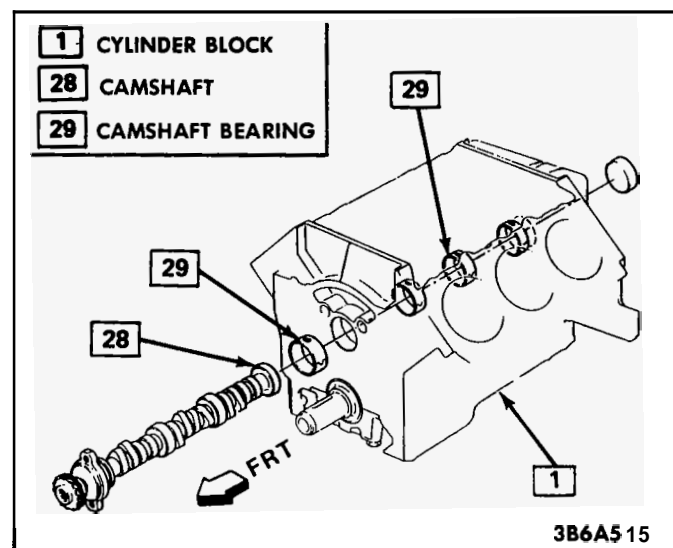


Figure 13 Camshaft Disassembled View

1. Negative battery cable
2. Intake manifold
3. Valve covers
4. Rocker arm shaft assemblies
5. Pushrods
6. Valve lifters
7. Radiator
8. A/C condenser, if equipped
9. Crankshaft pulley and balancer as an assembly
10. Timing chain cover

! Important

- o Align the timing marks of camshaft and crankshaft sprockets to avoid marring the bearing surfaces.

11. Timing chain and sprocket
12. Camshaft

! Important

- o When removing or installing camshaft, avoid marring the bearing surfaces.

L Inspect

- o For inspection of camshaft, overhaul of lifters, and replacement of camshaft bearings, refer to Section 6A, General Engine Mechanical.

↔ Install or Connect

1. Camshaft
2. Timing chain and sprockets
3. Timing chain cover
4. Crankshaft pulley and balancer as an assembly
5. A/C condenser if equipped
6. Radiator
7. Valve lifters
8. Pushrods
9. Rocker arm shaft assemblies
10. Valve covers
11. Intake manifold
12. Negative battery cable

L Inspect

- o For proper completion of repair
- o For fluid leaks

OIL PAN

See Figure 14

↔ Remove or Disconnect

1. Negative battery cable
2. Raise car and suitably support. See Section OA.
3. Engine oil
4. Flywheel cover
5. Crossover pipe
6. Engine mounts from frame brackets
7. Raise and suitably support engine.
8. Oil pan retaining bolts

9. Oil pan
10. Old oil pan gasket
 - o The formed rubber oil pan gasket cannot be re-used.

C Clean

- o Oil pan and cylinder block mating surfaces

↔ Install or Connect

1. New formed rubber oil pan gasket to oil pan flange

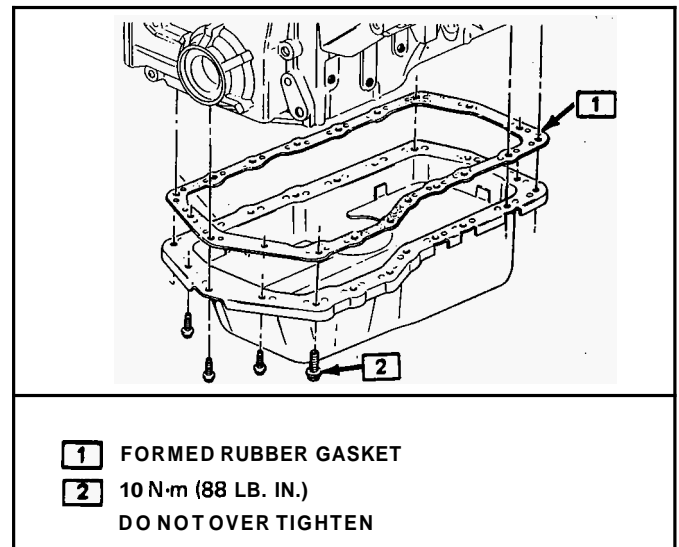


Figure 14 Oil Pan & Gasket

2. Oil pan and tighten bolts to specification

! Important

- o Do not over-tighten bolts or damage to the oil pan will occur. Resulting in an oil leak.

3. Lower engine.
4. Engine mounts
5. Crossover pipe
6. Flywheel cover
7. Lower car.
8. Engine oil
9. Negative battery cable

L Inspect

- o For proper completion of repair
- o For fluid leaks

OIL PUMP PIPE AND SCREEN ASSEMBLY

↔ Remove or Disconnect

See Figure 14

1. Oil pan
2. Oil pump pipe and screen assembly attaching bolts



Clean

- o Screen and housing with solvent and blow dry.
- o Gasket mating surfaces on pipe flange and cylinder block.



Install or Connect

1. Oil pump pipe and screen with new gasket and tighten bolts to specification.
2. Oil pan using new gasket



Inspect

- o For proper completion of repair
- o For fluid leaks

TESTING OIL PRESSURE

Tool required:

J 25087 Oil Pressure Test Kit

- o If low oil pressure is suspected, the pressure can be checked on the car.
1. Check oil level.
 2. Raise car and remove oil filter.
 3. Assemble plunger valve in the large hole of the tester base and the hose in the small hole of the tester base. Connect gage to the end of the hose.
 4. Insert the flat side of the rubber plug, for ease of installation, in the by-pass valve without depressing the by-pass valve itself.
 5. Install the tester on filter mounting pad.
 6. Start engine to check overall pressure, sender switch, or noisy lifters. Engine should be at operating temperature before checking oil pressure. Pressure should be 255 kPa (37 psi) @ 2400 rpm.
 7. If adequate oil pressure is indicated, check pressure sending switch.
 8. If a low reading is indicated, depress the valve on tester base to isolate the oil pump and/or its components from the lubricating system. An adequate reading at this time would indicate a good pump and the previous low pressure was due to worn bearings etc. A low reading while depressing the valve would indicate a faulty pump.

PRIMING THE OIL PUMP

Tool Required:

J 25087 Oil Pressure Test Kit

1. Assemble plunger valve in the large hole of the tester base and the hose in the small hole of the tester base. Connect gage to the end of the hose.
2. Insert the flat side of the rubber plug, for ease of installation, in the by-pass valve without depressing the by-pass valve.
3. Install the tool on filter mounting pad.
4. Connect a pressurized air supply to the primer attachment.
5. Depress lever on primer attachment while at the same time holding valve on tester base down to assure that oil will be lifted instead of air being

drawn from bearings etc. Hold these positions until a light spray of oil comes from the nozzle verifying that the oil pump has been primed.

6. Remove primer assembly, install filter, and start engine.
- o In the event of failure to raise oil during priming operation, check for vented system, such as a cracked or broken pump body or relief valve in open position.
- o If oil can be lifted during priming operation, but pump fails to function, check for worn or broken pump drives. A broken or twisted pump drive may indicate a lock-up (frozen) oil pump. Inspect and replace as necessary.

OIL PUMP AND RELIEF VALVE



Clean

- At times an oil pump or oil pump relief valve may be stuck due to the presence of foreign particles. They may be cleaned in the following manner:
1. Blow compressed air through the oil channel (between the pump and filter pad), with short blasts, this will further open the relief valve allowing these particles to be forced from the pump. If this operation is successful, the oil pump will once again be able to deliver pressure.
 2. Follow procedure for priming oil pump.

NOTICE: This step is very important as the oil pump may “lose its prime” whenever the pump, pump cover or timing chain cover is disturbed. If the pump is not packed, it may not begin to pump oil as soon as the engine is started, and engine damage may result.

OIL PUMP COVER AND GEARS

See Figure 15



Remove or Disconnect

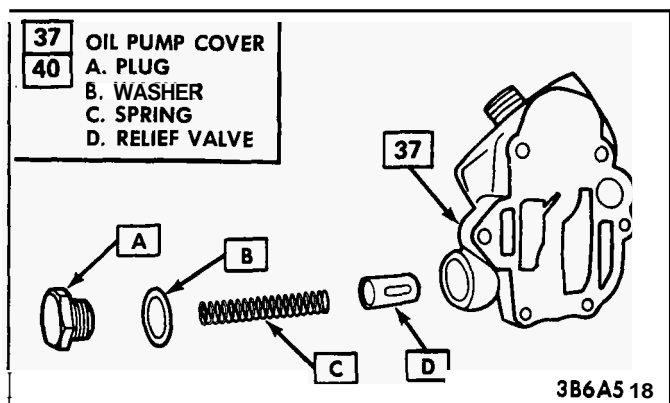


Figure 15 Oil Pump Cover - Disassembled View

1. Oil filter
2. Oil pump cover to timing chain cover attaching screws
3. Cover assembly, oil pump drive and driven gears
4. Oil pressure relief valve cap, spring and valve

 **important**

- o Oil filter by-pass valve and spring are staked in place and should not be removed.

 **Clean**

- o All parts in solvent and blow dry

 **Inspect**

- o All parts for wear or scoring
- Bypass valve for cracks, nicks or warping
- o For inspection and overhaul procedures, refer to Section 6A, General Engine Mechanical.

 **install or Connect**

1. Pressure relief valve and spring in bore of oil pump cover after lubricating.
2. Relief valve spring retaining cap and gasket an tighten to specification.
3. Oil pump drive and driven gears and pack gear pockets full of petroleum jelly.

NOTICE: This step is very important as the oil pump may lose its prime whenever the pump, pump cover or timing chain cover is disturbed. If the pump is not packed, it may not begin to pump oil as soon as the engine is started, and severe engine damage may result.


4. Cover assembly screws and tighten alternately and evenly to specifications
5. Filter nipple

 **inspect**

- o For proper completion of repair
- o For oil leaks

PISTON AND CONNECTING ROD ASSEMBLY

See Figure 16

 **Remove or Disconnect**


1. Cylinder head
2. Oil pan
3. Connecting rod bolts
4. Connecting rod cap
5. Piston and connecting rod assembly

 **Clean**

- o Cylinder bore
- o Crankshaft rod journal

 **Inspect**

- o For inspection, fitting of piston rings and connecting rod bearings refer to Section 6A, General Engine Mechanical.

 **Install or Connect**

1. Piston rings to piston

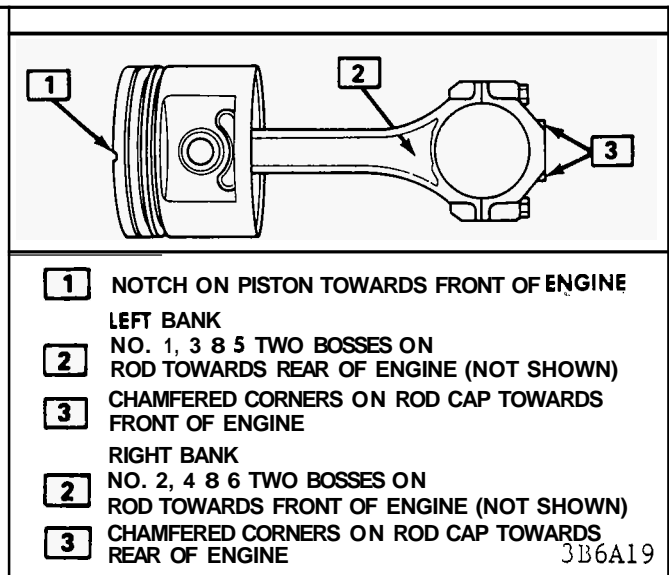


Figure 16 Piston and Connecting Rod Assembly

2. Piston and connecting rod bearing assembly
3. Rod bearing inserts
4. Connecting rod cap
5. Connecting rod bolts

 **Tighten**

- o Connecting rod bolts alternately to specifications.
6. Oil pan
 7. Cylinder head

 **Inspect**

- o For proper completion of repair
- o For proper oil pressure
- o For exhaust smoke indicating poor ring seal

CRANKSHAFT

See Figure 17

 **Remove or Disconnect**

1. Engine
2. Timing chain cover
3. Timing chain
4. Oil pan
5. Oil pump pipe and screen assembly
6. Connecting rod caps and push piston and connecting rod assemblies to top of cylinder bores.
7. Secure connecting rods to outside of cylinder block using rubber bands attached to oil pan rail bolts.
8. Main bearing cap attaching bolts
9. Main bearing caps
10. Crankshaft

NOTICE: To avoid damaging crankshaft journals, rod or main bearing inserts, or connecting rods, use extreme care when removing or installing crankshaft.

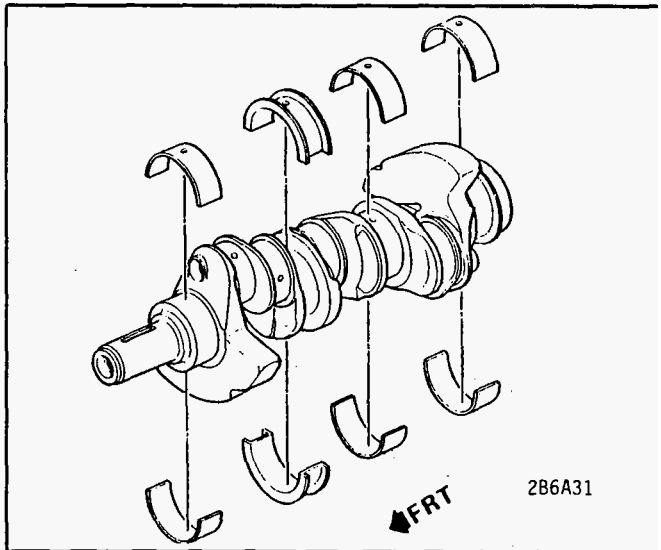


Figure 17 Crankshaft and Bearings

**Clean**

- o Crankshaft journals
- o Connecting rods
- o Main bearing bores

**Inspect**

- o For inspection and fitting procedures, refer to Group 6A General Engine Mechanical.

**Install or Connect**

1. Crankshaft
2. Main bearing caps
3. Main bearing cap attaching bolts

**Tighten**

- o Main bearing cap bolts alternately to 135 N·m (100 lbs. ft.).
4. Connecting rod bearing inserts
 5. Connecting rod cap bolts

**Tighten**

- o Rod bearing cap bolts to 54 N·m (40 lbs. ft.)
6. Oil pump pipe and screen
 7. Oil pan
 8. Timing chain
 9. Timing chain cover
 10. Engine

**Inspect**

- o For proper completion of repair
- o For proper oil pressure

REAR MAIN BEARING UPPER OIL SEAL REPAIR (ENGINE IN CAR)

See Figures 18, 19, 20

Tools Required

J 21526-1 and 2

**Remove or Disconnect**

1. Drain oil
2. Oil Pan
3. Rear main bearing cap

**Assemble**

1. Insert packing tool against one end of the seal in the cylinder block. Drive the old seal gently into the groove until it is packed tight. This varies from 1/4" to 3/4" depending on the amount of pack required.

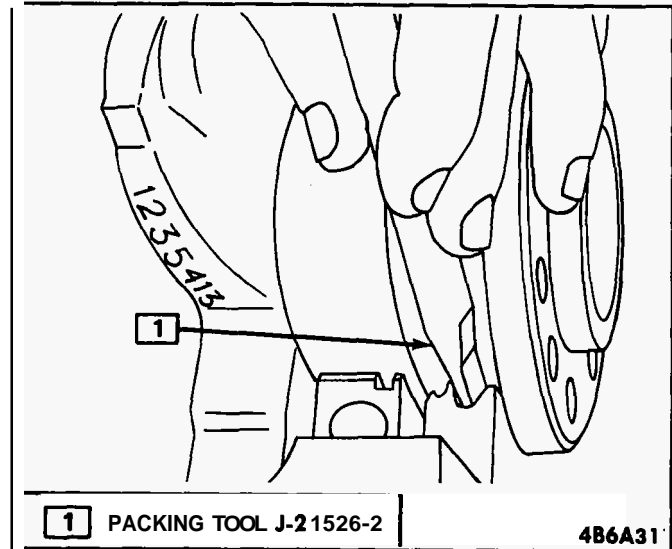


Figure 18 Packing Seal Into Cylinder Block

2. Repeat step 1 on the other end of the cylinder block.
3. Measure the amount the seal was driven up on one side and add 1/16" using a single edge razor blade cut that length from the old seal removed from the rear main bearing cap. Repeat the procedure for the other side. Use the rear main bearing cap as a holding fixture when cutting the seal.
4. Install Guide (J 21526-1) onto cylinder block.
5. Using packing tool, work the short pieces cut in Step 4 into the guide tool and then pack into cylinder block. The guide tool and packing tool have been machined to provide a built-in stop. Use this procedure for both sides.

It may help to use oil on the short pieces of the rope seal when packing into the cylinder block.
6. Remove the guide tool
7. Form a new rope seal in the rear main bearing cap. See Section 6A. General Engine Mechanical
8. Install main bearing cap
9. Add oil.

**Inspect**

- o Proper Assembly
- o Leaks

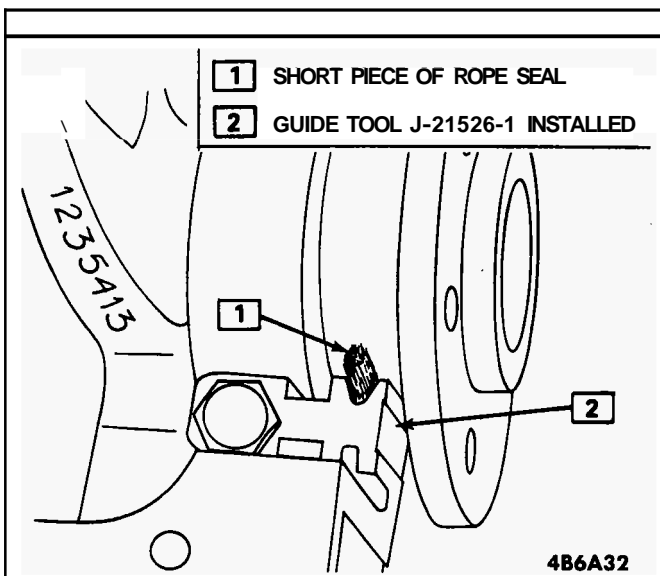


Figure 19 Guide Tool Installed

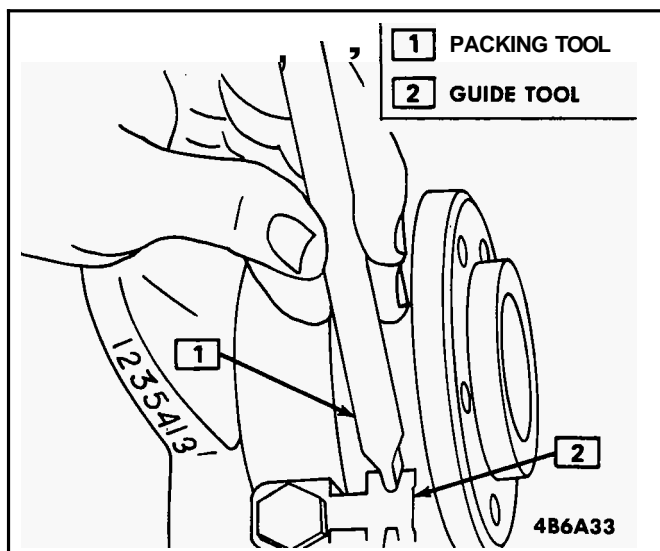


Figure 20 Packing Short Pieces of Rope Seal Into Guide Tool and Cylinder Block

FLYWHEEL

↔ Remove or Disconnect

1. Transmission (refer to Section 7A2)
2. Six bolts attaching flywheel to crankshaft flange

🔍 Inspect

- o Flywheel, if cracked, badly worn or broken teeth, replace flywheel
- o Crankshaft and flywheel mating surfaces for burrs. Remove as required.

→← Install or Connect

1. Flywheel
2. Flywheel attaching bolts and tighten to specification
3. Dial indicator on engine block and check flywheel runout at three attaching bosses.

⚠ Important

- o The crankshaft end-play must be held in one direction during this check. Runout should not exceed .381 mm (.015 in.).
4. If runout exceeds .381 mm (.015 in.), attempt to correct by tapping high side with mallet.
 5. If condition cannot be corrected, replace flywheel.
 6. Transmission (refer to Section 7A2)

🔍 Inspect

- o For proper completion of repair
- o For vibration

SPECIFICATIONS

BOLT TORQUE SPECIFICATIONS

Use a reliable torque wrench to obtain the figures listed below. This will prevent straining or distorting the parts, as well as preventing thread damage. These specifications are for clean and lightly-lubricated threads only. Dry or dirty threads produce friction which prevents accurate measurements of the actual torque. It is important that these specifications be strictly observed. Overtightening can damage threads. This will prevent attainment of the proper torque and will require replacement of the damaged part.

Area

N·m (Lbs. Ft.)

Spark Plugs	28 (20)
Crankshaft Bearing Caps to cylinder Block	135 (100)
Connecting Rods	54 (40)
Cylinder Head to Cylinder Block	See Assembly Procedure
Balancer Assembly to Crankshaft (Min)	297 (219)
Fan Driving Pulley to Harmonic Balancer	33 (25)
Flywheel to Crankshaft	81 (60)
Oil Pan to Cylinder Block	10 (88)*
Oil Pan Drain Plug	41 (30)
Oil Pump Cover to Timing Chain Cover	16 (141)*
Oil Pump Pressure Regulator Retainer	48 (35)
Oil Screen Housing to Cylinder Block	11 (96)*
Oil Gallery Plugs	34 (25)
Oil Pressure Switch to Cylinder Block	32 (24)
Filter Assembly to Pump Cover	24 (18)
Timing Chain Cover to Block	30 (22)
Water Pump Cover to Timing Chain Cover	13 (115)*
Fan Driven Pulley	29 (21)
Thermostat Housing to Intake Manifold	18 (13)
Intake Manifold to Cylinder Head	66 (45)
Exhaust Manifold to Cylinder Head	50 (37)
Carburetor to Intake Manifold	17 (15)*
Fuel Pump to Cylinder Block	30 (22)
Engine Mount to Cylinder Block	80 (59)
Timing Chain Sprocket	42 (31)
Rocker Arm Cover to Cylinder Head	5 (44)*
Rocker Arm Shaft to Cylinder Head	35 (25)
Generator Bracket to Cylinder Head	50 (37)
Generator Adjusting Bracket to Water Pump	27 (20)
Generator Mounting Bracket Through Generator to Cylinder Head at Pivot Location	60 (44)
Starting Motor to Block	48 (35)
Distributor Hold-Down Clamp	27 (20)
Lower Flywheel Cover	6 (48)*
Automatic Transmission to Cylinder Block	48 (35)
Bolt - Special Movable Timing Chain Dampener	19 (14)

* = (Lbs. In.)

ENGINE	3.8	3.8 TURBO
ENGINE TYPE	90° V-6	90° V-6
BORE AND STROKE	3.800 x 3.400	3.800 x 3.400
DISPLACEMENT	231 CU. IN.	231 CU. IN.
FUEL SYSTEM TYPE	2BBL	SFI
COMPRESSION RATIO	8.0:1	8.0:1
FUEL REQUIREMENTS	UNLEADED	UNLEADED
OCTANE REQUIREMENTS—MOTOR.,	82	82
OCTANE REQUIREMENTS—RESEARCH	91	91
CYLINDER NUMBERS—FRONT TO REAR—RIGHT BANK	2-4-6	2-4-6
CYLINDER NUMBERS—FRONT TO REAR—LEFT BANK	1-3-5	1-3-5
FIRING ORDER	1-6-5-4-3-2	1-6-5-4-3-2
		G40017-6A5G



*When changing oil filter, add as necessary to bring to full mark.

ENGINE DIMENSIONS AND FITS

General

Piston Clearance Limits	
Top Land	1.168 mm - 1.422 mm (.046 in.-.056 in.)
Skirt Top .....	.0203 mm - .0508 mm (.0008 in.-.0020 in.)
Skirt Bottom .....	.033 mm - .0889 mm (.0013 in.-.0035 in.)
Ring Groove Depth	
#1 - Compression Ring	4.674 mm - 4.928 mm (.184 in.-.194 in.)
#2 - Compression Ring	4.724 mm - 4.928 mm (.186 in.-.194 in.)
#3 - Oil Ring	4.7752 mm - 4.978 (.188 in.-.196 in.)
Ring Width	
#1 - Compression Ring	1.956 mm - 1.981 mm (.077 in.-.078 in.)
#2 - Compression Ring	1.956 mm - 1.981 mm (.077 in.-.078 in.)
#3 - Oil Ring	4.648 mm - 4.80 mm (.183 in.-.189 in.)
Ring Gap	
#1 - Compression Ring .....	.254 mm - .508 mm (.010 in.-.020 in.)
#2 - Compression Ring .....	.254 mm - .508 mm (.010 in.-.020 in.)
#3 - Oil Ring .....	.381 mm - 1.397 mm (.015 in.-.055 in.)
Piston Pin Length	73.66 mm (2.900 in.)
Diameter of Pin	23.853 mm - 23.86 mm (.9391 in.-.9394 in.)
Pin Clearance In Piston .....	.01 mm - .0177 mm (.0004 in.-.0007 in.)
Pin Press Fit in Rod .....	.0177 mm - .0432 mm (.0007 in.-.0017 in.)
Pin Direction and Amount Offset in Piston	1.016 mm (.040 in.) Major Thrust Side

Connecting Rod Specifications

Bearing Length	16.611 mm (.654 in.)
Bearing Clearance (Limits) .....	.0127 mm - .066 mm (.0005 in.-.0026 in.)
End Play .....	.0762 mm - .381 mm (.003 in. - .015 in.)

Crankshaft Specifications

End Play at Thrust Bearing .....	.0762 mm - .2794 mm (.003 in.-.011 in.)
Main Bearing Journal Diameter	63.4873 mm (2.4995 in.)
Crankpin Journal Diameter	57.1169 mm - 57.1373 mm (2.2487 in.-2.2495 in.)
Main Bearing Overall Length	
# 1	21.9456 mm (.864 in.)
# 2	26.8478 mm (1.057 in.)
# 3	21.9456 mm (.864 in.)
# 4	21.9456 mm (.864 in.)
Main Bearing to Journal Clearance .....	.0076 mm - .0457 mm (.0003 in.-.0018 in.)

Camshaft Specifications

Bearing Journal Diameter .....	.. All 45.339 - 45.364 mm (1.785 in.-1.786 in.)
Journal Clearance in Bearings .....	.0127 - .0635 mm (.0005 in.-.0025 in.) (#1)
Journal Clearance in Bearing .....	.0127 - .0889 mm (.0005 in.-.0035 in.) (#2, #3 and #4)

Valve System Specifications

Rocker Arm Ratio	1.55 to 1
Valve Lifter Diameter	21.3868 mm - 21.4046 mm (.8420 in. - .8427 in.)
Valve Lifter Clearance in Crankcase .....	.0203 mm - .0635 mm (.0008 in. - .0025 in.)
Minimum Valve Margin .....	.635 mm (.025")
Intake Valve	
Head Diameter	43.561 mm - 43.307 mm (1.715 in. - 1.705 in.)
Seat Angle	45°
Stem Diameter	8.666 mm - 8.639 mm (.3412 in. - .3401 in.)
Clearance in Guide .....	.038 mm - .089 mm (.0015 in. - .0035 in.)
Exhaust Valve	
Head Diameter	38.227 mm - 37.973 mm (1.505 in. - 1.495 in.)
Seat Angle	45°
Stem Diameter	8.6665 mm - 8.6487 mm (.3412 in. - .3405 in.)
Clearance in Guide .....	.0381 mm - .0813 mm (.0015 in. - .0032 in.)
Valve Spring VIN A	
Valve Closed @ Length Not Including Dampener	298 N ± 22.2 @ 43.866 mm (67 lbs. ± 5 @ 1.727 in.)
Valve Open @ Length Not Including Dampener	809.5 N ± 35.6 @ 34.036 mm (182 lbs. ± 8 @ 1.340 in.)
Valve Spring VIN 7	
Valve Closed @ Length Not Including Dampener	347 N ± 18 N @ 43 mm (78 lbs. ± 4 @ 1.727)
Valve Open @ Length Not Including Dampener	823 N ± 45 @ 44 mm (185 lbs. ± 10 @ 1.340)

SPECIAL TOOLS

BT-60 or J-5790	Hydraulic Valve Lifter Tester
BT-6407 or J-3049	Valve Lifter Remover
BT-6413 or J-8062	Valve Spring Compressor
BT-6415	Valve Guide Cleaning Tool
BT-6428 or 5-4160A	Valve Lifter Plunger Remover
BT-6501	Engine Lifting Fixture Set
BT-7109	Support Bar Adapter
BT-7203	Adapter (Use with BT-6501)

BT-7825 or J-2300	Belt Tension Gage
J-5830-4	Valve Guide Reamer - .010" O.S.
J-8037	Piston Ring Compressor
J-21526-1 and 2	Upper Rear Main Bearing Oil Seal Repair Tools
J-24394	Front Intake Manifold Bolt Wrench
J-25087	Oil Pressure Test Kit

