

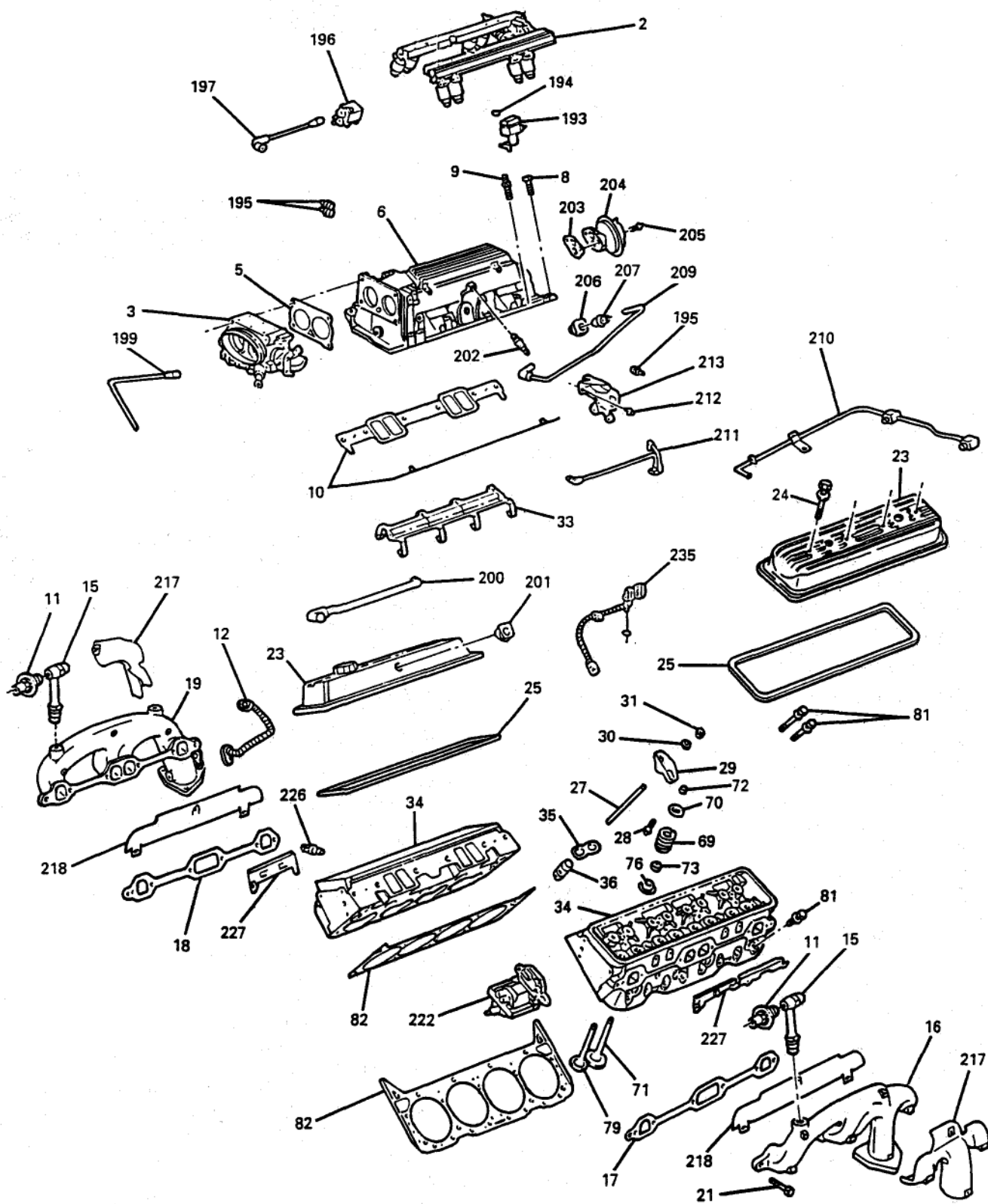
SECTION 6A3B

5.7 LITER V8 ENGINE UNIT REPAIR RPO LT1 – VIN P

NOTICE: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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Figure 1 - Upper Engine Assembly

2 RAIL ASSEMBLY, MULTIPOINT FUEL INJECTION FUEL	79 VALVE, EXHAUST
3 BODY ASSEMBLY, THROTTLE	81 BOLT/SCREW, CYLINDER HEAD
5 GASKET, THROTTLE BODY	82 GASKET, CYLINDER HEAD
6 MANIFOLD ASSEMBLY, INTAKE	193 SOLENOID ASSEMBLY, EGR CONTROL VALVE RELAY
8 BOLT/SCREW, INTAKE MANIFOLD	194 NUT, EGR CONTROL VALVE RELAY
9 STUD, INTAKE MANIFOLD	195 FITTING, INTAKE MANIFOLD VACUUM
10 GASKET, INTAKE MANIFOLD	196 VALVE ASSEMBLY, EVAPORATIVE EMISSION CANISTER PURGE SOLENOID
11 VALVE ASSEMBLY, SECONDARY AIR INJECTION CHECK	197 HOSE, EVAPORATIVE EMISSION CANISTER PURGE SOLENOID VALVE
12 PIPE ASSEMBLY, SECONDARY AIR INJECTION	199 PIPE ASSEMBLY, EVAPORATIVE EMISSION CANISTER PURGE SOLENOID VALVE
15 PIPE ASSEMBLY, SECONDARY AIR INJECTION	200 HOSE, CRANKCASE VENT VALVE
16 MANIFOLD ASSEMBLY, EXHAUST	201 GROMMET, CRANKCASE VENT HOSE CONNECTOR
17 GASKET, EXHAUST MANIFOLD	202 FITTING, POWER BRAKE BOOSTER VACUUM TUBE
18 GASKET, EXHAUST MANIFOLD	203 GASKET, EGR VALVE
19 MANIFOLD ASSEMBLY, EXHAUST	204 VALVE ASSEMBLY, EGR
21 BOLT/SCREW, EXHAUST MANIFOLD	205 BOLT/SCREW, EGR VALVE
23 COVER ASSEMBLY, VALVE ROCKER ARM	206 GROMMET, CRANKCASE VENT VALVE
24 BOLT/SCREW, VALVE ROCKER ARM COVER	207 VALVE ASSEMBLY, CRANKCASE VENT
25 GASKET, VALVE ROCKER ARM COVER	209 HOSE, CRANKCASE VENT VALVE
27 PUSHROD ASSEMBLY, VALVE	210 PIPE, ENGINE COOLANT AIR BLEED
28 STUD, VALVE ROCKER ARM BALL	211 HARNESS ASSEMBLY, EGR VALVE VACUUM
29 ARM, VALVE ROCKER	212 BOLT/SCREW, ACCELERATOR CONTROL CABLE BRACKET
30 BALL, VALVE ROCKER ARM	213 BRACKET, ACCELERATOR CONTROL CABLE
31 NUT, VALVE ROCKER ARM	217 SHIELD, EXHAUST MANIFOLD HEAT OUTER
33 RETAINER, VALVE LIFTER GUIDE	218 SHIELD, EXHAUST MANIFOLD HEAT INNER
34 HEAD ASSEMBLY, CYLINDER	222 COIL ASSEMBLY, IGNITION
35 GUIDE, VALVE LIFTER	226 SPARK PLUG
36 LIFTER ASSEMBLY, VALVE	227 SUPPORT, SPARK PLUG WIRE
69 SPRING, VALVE	235 HARNESS ASSEMBLY, IGNITION DISTRIBUTOR WIRING
70 CAP, VALVE SPRING	
71 VALVE, INTAKE	
72 KEY, VALVE STEM	
73 SEAL, VALVE STEM OIL	

Figure 2 – Upper Engine Assembly – Legend

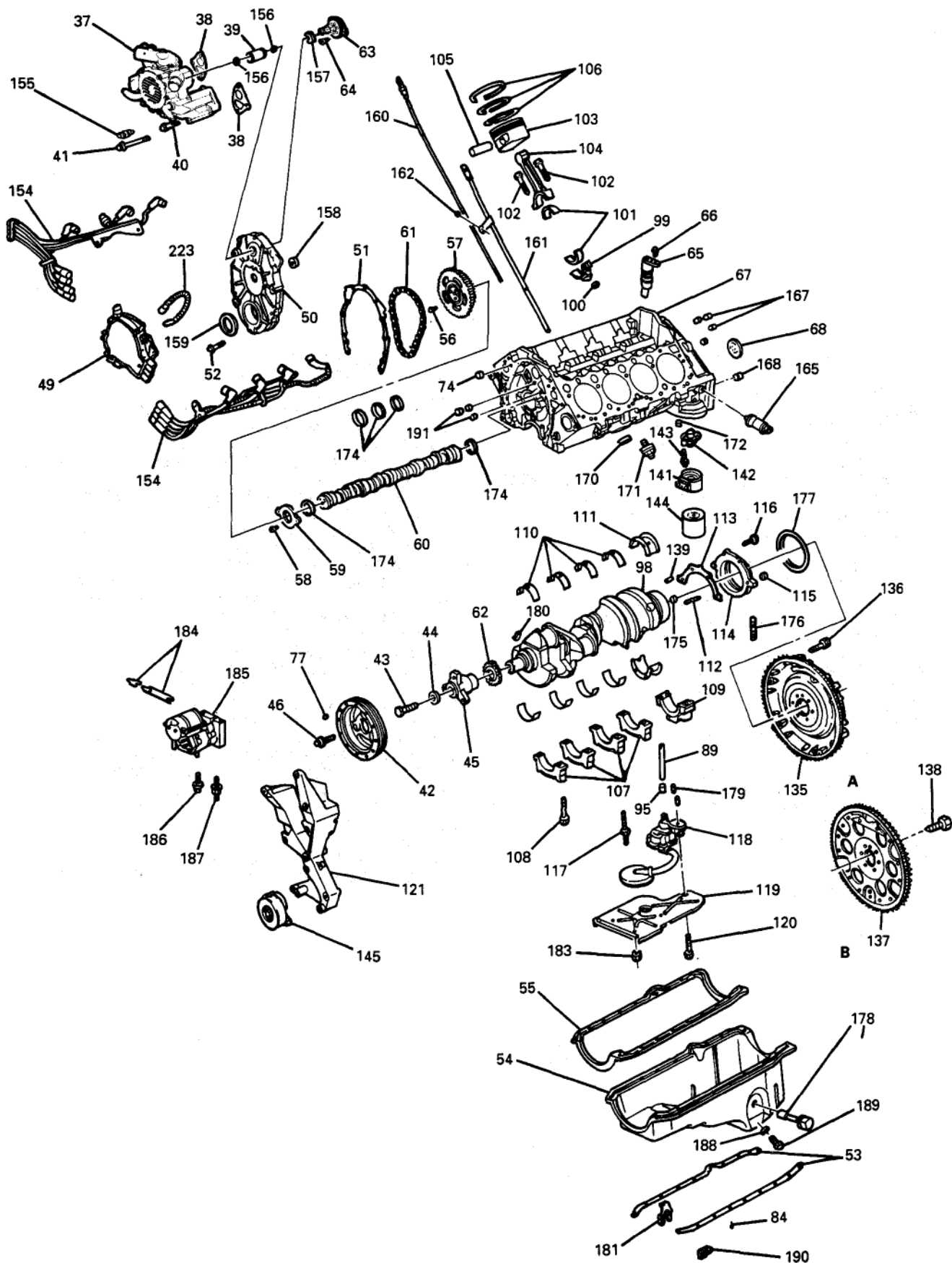


Figure 3 – Lower Engine Assembly

A FOR MANUAL TRANSMISSION	114 HOUSING ASSEMBLY, CRANKSHAFT REAR OIL SEAL
B FOR AUTOMATIC TRANSMISSION	115 NUT, CRANKSHAFT REAR OIL SEAL HOUSING
37 PUMP ASSEMBLY, WATER	116 BOLT/SCREW, CRANKSHAFT REAR OIL SEAL HOUSING
38 GASKET, WATER PUMP	117 STUD, CRANKSHAFT BEARING CAP
39 COUPLING, WATER PUMP DRIVESHAFT	118 PUMP ASSEMBLY, OIL
40 BOLT/SCREW, WATER PUMP	119 BAFFLE, OIL PAN
41 BOLT/SCREW, WATER PUMP	120 BOLT/SCREW, OIL PUMP
42 BALANCER ASSEMBLY, CRANKSHAFT	121 BRACKET ASSEMBLY, GENERATOR AND AIR
43 BOLT/SCREW, CRANKSHAFT BALANCER HUB	CONDITIONING COMPRESSOR AND POWER STEERING
44 WASHER, CRANKSHAFT BALANCER HUB	PUMP
45 HUB, CRANKSHAFT BALANCER	135 FLYWHEEL ASSEMBLY
46 BOLT/SCREW, CRANKSHAFT BALANCER	136 BOLT/SCREW, FLYWHEEL
49 DISTRIBUTOR ASSEMBLY	137 FLYWHEEL ASSEMBLY
50 COVER ASSEMBLY, ENGINE FRONT	138 BOLT/SCREW, FLYWHEEL
51 GASKET, ENGINE FRONT COVER	139 PIN, CRANKSHAFT REAR OIL SEAL HOUSING LOCATOR
52 BOLT/SCREW, ENGINE FRONT COVER	141 COOLER ASSEMBLY, ENGINE OIL
53 REINFORCEMENT, OIL PAN	142 ADAPTER ASSEMBLY, OIL FILTER
54 PAN ASSEMBLY, OIL	143 BOLT/SCREW, OIL FILTER ADAPTER
55 GASKET, OIL PAN	144 FILTER ASSEMBLY, OIL
56 BOLT/SCREW, CAMSHAFT SPROCKET	145 TENSIONER ASSEMBLY, DRIVE BELT
57 SPROCKET, CAMSHAFT	154 HARNESS ASSEMBLY, SPARK PLUG WIRE
58 BOLT/SCREW, CAMSHAFT RETAINER	155 SENSOR ASSEMBLY, ENGINE COOLANT
59 RETAINER, CAMSHAFT	TEMPERATURE
60 CAMSHAFT ASSEMBLY	156 SEAL, WATER PUMP DRIVESHAFT
61 CHAIN ASSEMBLY, TIMING	157 SEAL ASSEMBLY, WATER PUMP BEARING
62 SPROCKET, CRANKSHAFT	158 SEAL, DISTRIBUTOR
63 DRIVESHAFT ASSEMBLY, WATER PUMP	159 SEAL ASSEMBLY, CRANKSHAFT FRONT OIL
64 BOLT/SCREW, WATER PUMP DRIVESHAFT BEARING	160 INDICATOR ASSEMBLY, OIL LEVEL
RETAINER	161 TUBE ASSEMBLY, OIL LEVEL INDICATOR
65 DRIVESHAFT ASSEMBLY, OIL PUMP	162 NUT, OIL LEVEL INDICATOR TUBE
66 BOLT/SCREW, OIL PUMP DRIVESHAFT	165 SENSOR ASSEMBLY, FUEL PUMP AND ENGINE OIL
67 BLOCK, ENGINE	PRESSURE INDICATOR SWITCH
68 PLUG, CAMSHAFT REAR BEARING HOLE	167 PLUG, ENGINE BLOCK OIL GALLERY
74 PIN, ENGINE FRONT COVER LOCATING	168 PIN, TRANSMISSION
77 WEIGHT, CRANKSHAFT BALANCER	170 PLUG, ENGINE BLOCK CORE HOLE
84 BOLT/SCREW, OIL PAN	171 SENSOR ASSEMBLY, KNOCK
89 DRIVESHAFT, OIL PUMP	172 PLUG, OIL FILTER ADAPTER HOLE
95 RETAINER, OIL PUMP DRIVESHAFT	174 BEARING, CAMSHAFT
98 CRANKSHAFT ASSEMBLY	175 BEARING, CLUTCH PILOT
99 CAP, CONNECTING ROD	176 STUD, CRANKSHAFT REAR OIL SEAL RETAINER
100 NUT, CONNECTING ROD	177 SEAL ASSEMBLY, CRANKSHAFT REAR OIL
101 BEARING, CONNECTING ROD	178 SENSOR ASSEMBLY, ENGINE OIL LEVEL SWITCH
102 BOLT/SCREW, CONNECTING ROD	179 PIN, OIL PUMP LOCATOR
103 PISTON ASSEMBLY	180 KEY, CRANKSHAFT BALANCER
104 ROD ASSEMBLY, CONNECTING	181 CLIP, TRANSMISSION OIL COOLER PIPE
105 PIN, PISTON	183 NUT, CRANKSHAFT OIL DEFLECTOR
106 RING, PISTON	184 SHIM, STARTER MOTOR
107 CAP, CRANKSHAFT BEARING	185 MOTOR ASSEMBLY, STARTER
108 BOLT/SCREW, CRANKSHAFT BEARING CAP	186 BOLT/SCREW, STARTER MOTOR
109 CAP, CRANKSHAFT BEARING	187 STUD, STARTER MOTOR
110 BEARING, CRANKSHAFT	188 GASKET, OIL PAN DRAIN PLUG
111 BEARING, CRANKSHAFT	189 PLUG, OIL PAN DRAIN
112 STUD, CRANKSHAFT REAR OIL SEAL RETAINER	190 BRACKET, ENGINE WIRING HARNESS
113 GASKET, CRANKSHAFT REAR OIL SEAL HOUSING	191 PLUG, ENGINE BLOCK OIL GALLERY
	223 HARNESS ASSEMBLY, IGNITION COIL WIRE

Figure 4 – Lower Engine Assembly – Legend

GENERAL DESCRIPTION

CONSTRUCTION

Figures 1 through 4

Engine Block

The engine block is made of cast iron and has eight cylinders arranged in a "V" shape with four cylinders in each bank. It is a one-piece casting with the cylinders encircled by coolant jackets.

Cylinder Head Assemblies

The cylinder head assemblies are cast aluminum and have powdered metal valve guides and valve seats pressed into the intake and exhaust ports. The spark plugs are located between the intake and exhaust ports.

Crankshaft Assembly

The crankshaft assembly is made of cast nodular iron. It is supported by five crankshaft bearings that are retained by bearing caps which are machined with the block for proper alignment and clearances. The bearing caps are retained by two bolts/screws each. The number five bearing at the rear of the engine assembly is the end thrust bearing. Four connecting rod journals (two rods per journal) are spaced 90 degrees apart.

Piston and Connecting Rod Assemblies

The pistons are cast aluminum that use two compression rings and one oil control ring assembly. The piston is a low-friction, lightweight design with a flat top and barrel-shaped skirt. The piston pins are chromium steel. They have a floating fit in the piston and are retained by a press fit in the connecting rod assembly.

The connecting rod assemblies are made of forged steel. They are machined with the rod cap installed for proper clearances and alignment.

Camshaft Assembly

A steel camshaft assembly is supported by five bearings pressed into the engine block. The timing sprocket mounted to the front of the camshaft assembly is driven by the crankshaft sprocket through a timing chain assembly.

The camshaft sprocket also has spur gear teeth which drive a geared shaft assembly to operate the water pump assembly.

A spiral gear machined into the camshaft assembly near the rear journal drives a shaft assembly which operates the oil pump assembly.

The center of the camshaft sprocket has a splined opening with a keyway (missing tooth) that mates with the distributor driveshaft. This provides net build timing, meaning that the ignition timing does not have to be adjusted.

Valve Train

The valve train is a ball pivot type. Motion is transmitted from the camshaft assembly through hydraulic roller lifter and tubular pushrod assemblies to the rocker arms. The rocker arm pivots on a ball to open the valve.

The hydraulic lifter assemblies keep all parts of the valve train in constant contact.

The rocker arm ball is retained on the rocker arm stud with a locking nut. The rocker arm stud is threaded into the cylinder head assembly.

Intake Manifold Assembly

The intake manifold assembly is a one-piece cast aluminum unit. The intake manifold assembly has exhaust gas recirculation and crankcase vent passages cast into it but coolant crossover passages have been eliminated.

Exhaust Manifold Assemblies

The two cast-iron exhaust manifold assemblies direct exhaust gases from the combustion chambers to the exhaust system. The exhaust manifold assemblies each have a port for air injection system pipe fittings.

LUBRICATION

Figures 5 through 7

Engine assembly lubrication is supplied by a gear-type oil pump assembly. The oil pump assembly is driven by an intermediate shaft which is connected to a shaft assembly driven by the camshaft assembly. The pump gears rotate and draw oil from the oil pan sump through a pick-up screen and pipe. The oil is pressurized as it passes through the pump and sent through engine block oil galleries.

Contained within the oil pump assembly is a pressure relief valve that maintains oil pressure within a specified range.

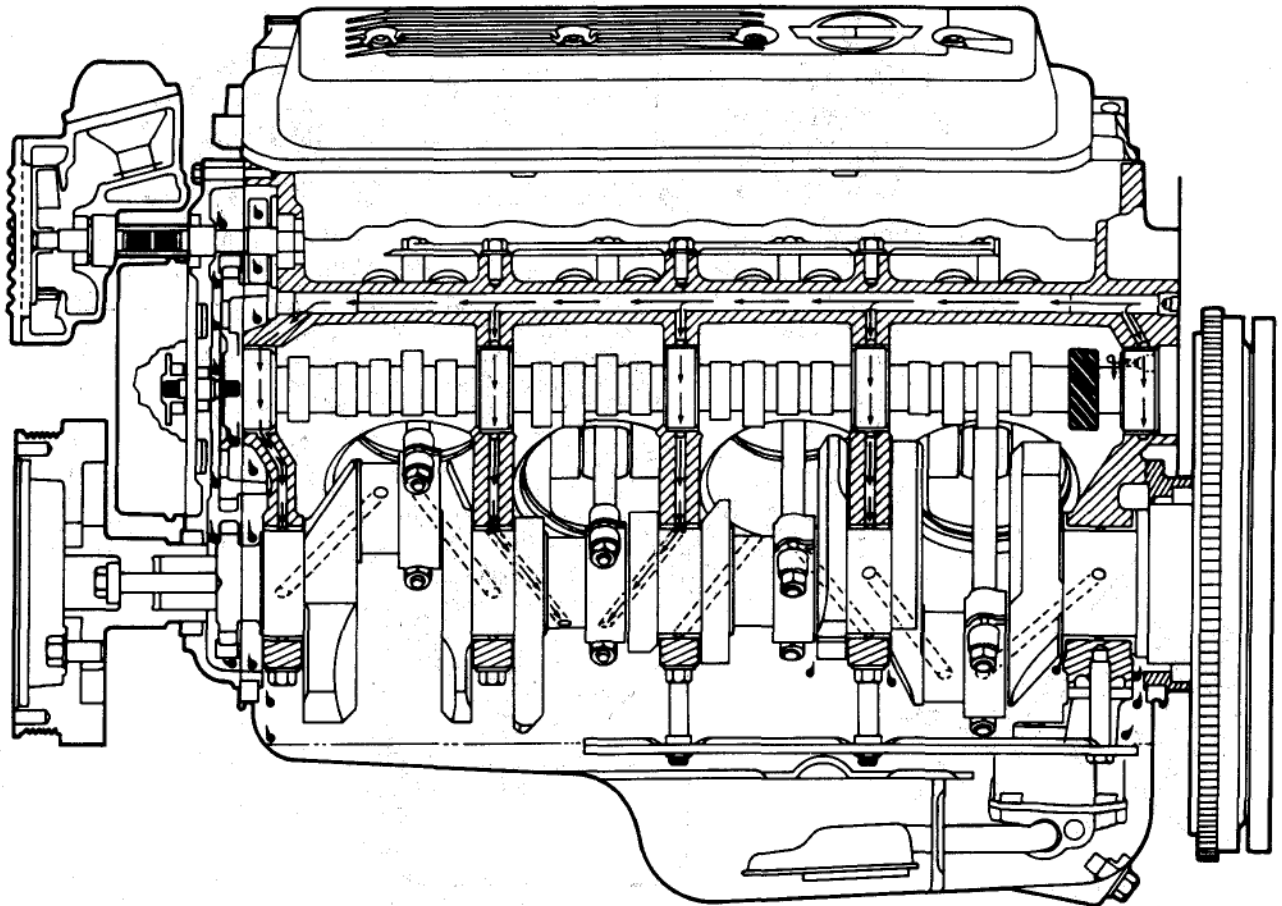
Pressurized oil is directed to the oil filter where harmful contaminants are removed. A bypass valve is also incorporated into the oil filter. The bypass allows oil to bypass the filter and flow to the engine assembly if the filter becomes clogged.

The oil is then pumped to the main oil gallery which is drilled through the length of the engine block just above the camshaft assembly. At the rear of the engine block, oil also flows into the right and left lifter oil galleries. From the main oil gallery, oil is pumped downward to the camshaft bearings, then to the crankshaft bearings. The crankshaft bearing upper inserts are grooved to align with oil passages drilled from the crankshaft bearing journal to the connecting rod journal. After lubricating the connecting rod bearings, the cylinder walls, rings and piston pins are lubricated by oil which is "slung" from the connecting rod bearing journals due to the rotation of the crankshaft assembly. This oil then returns to the oil pan sump. Oil that has entered the left and right lifter oil galleries pressurizes the hydraulic lifter assemblies and is then pumped up through the pushrod assemblies to lubricate the rocker arms and valve stems.

Oil returning to the oil pan assembly from the cylinder head assemblies and the front camshaft bearing, lubricates the timing chain assembly and crankshaft and camshaft sprockets.

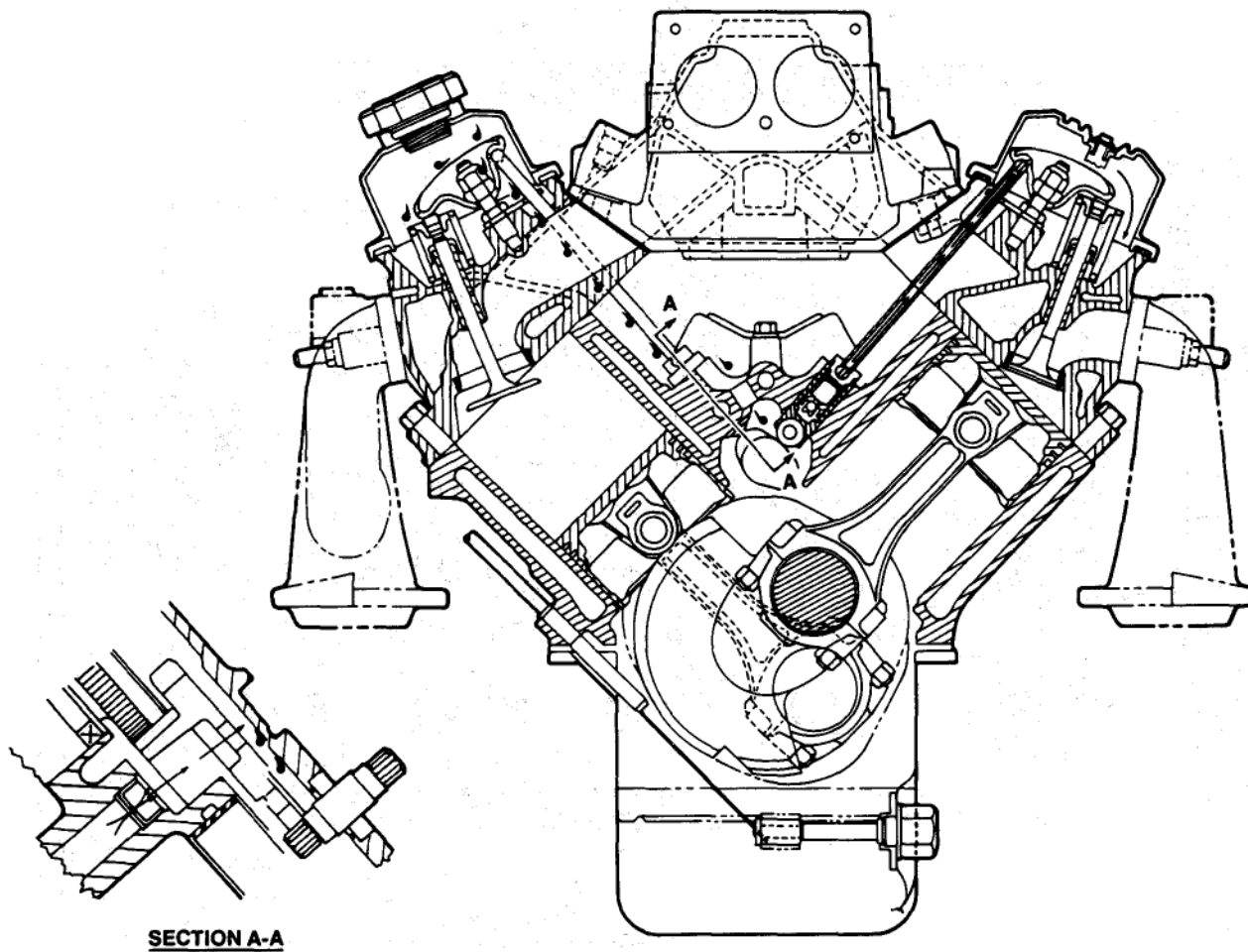
DISASSEMBLY

When beginning the engine assembly unit repair, the belt tensioner, power steering pump, air injection pump, generator, A/C compressor, and generator and A/C com-



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Figure 5 – Engine Assembly Lubrication (Left Side View)



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Figure 6 – Engine Assembly Lubrication (Front View)

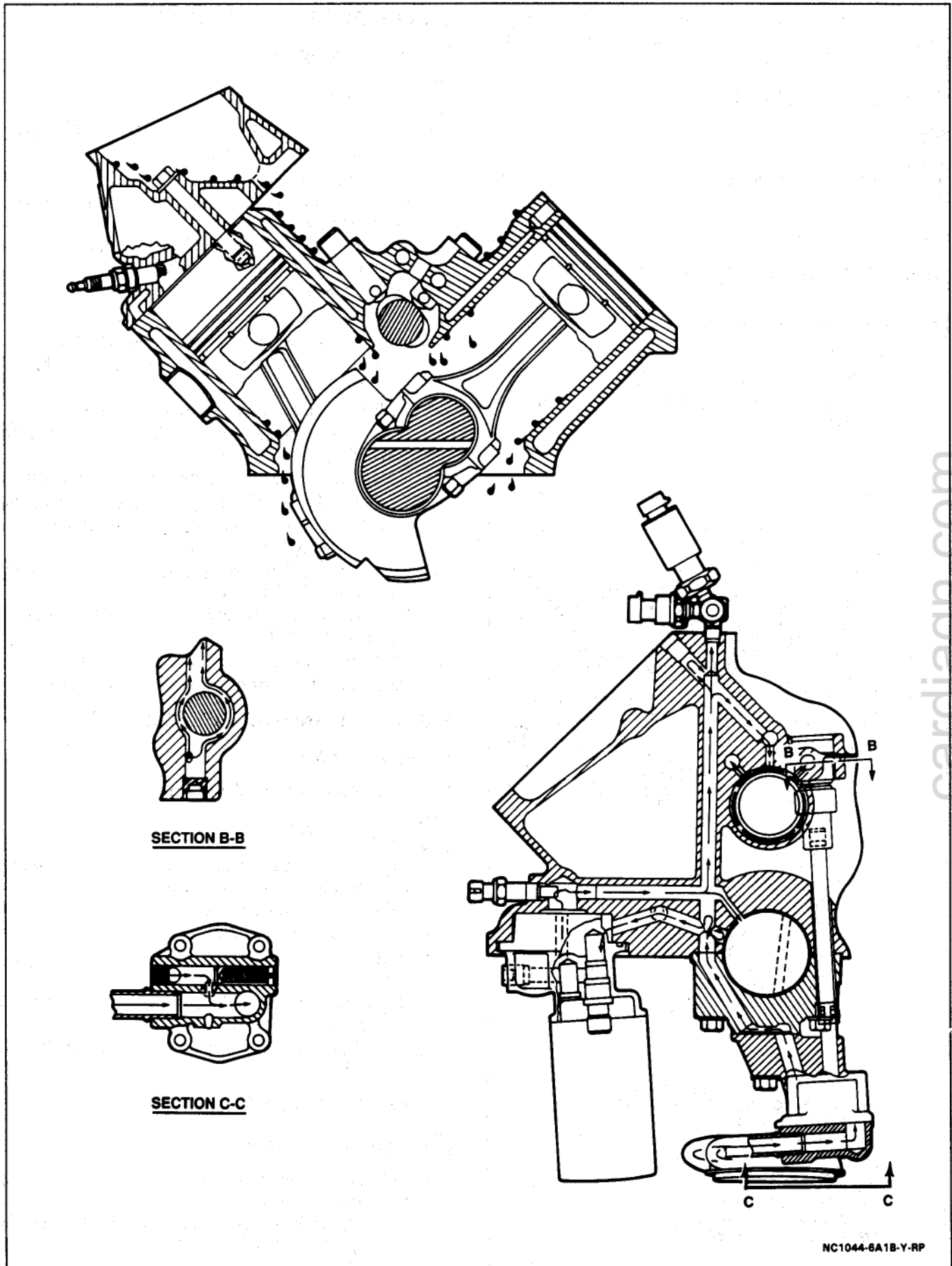


Figure 7 – Engine Assembly Lubrication (Rear Views)

pressor braces should already be removed. For removal procedures, refer to the specific section in the service manual for each component.

FLYWHEEL ASSEMBLY

Figure 8

Remove or Disconnect

1. Flywheel bolts/screws (136 or 138).
2. Flywheel assembly (135 or 137).

DRAINING ENGINE ASSEMBLY

Remove or Disconnect

1. Oil pan plug and drain engine oil.
2. Oil filter assembly.
3. Knock sensor assemblies and drain plug and allow coolant to drain.

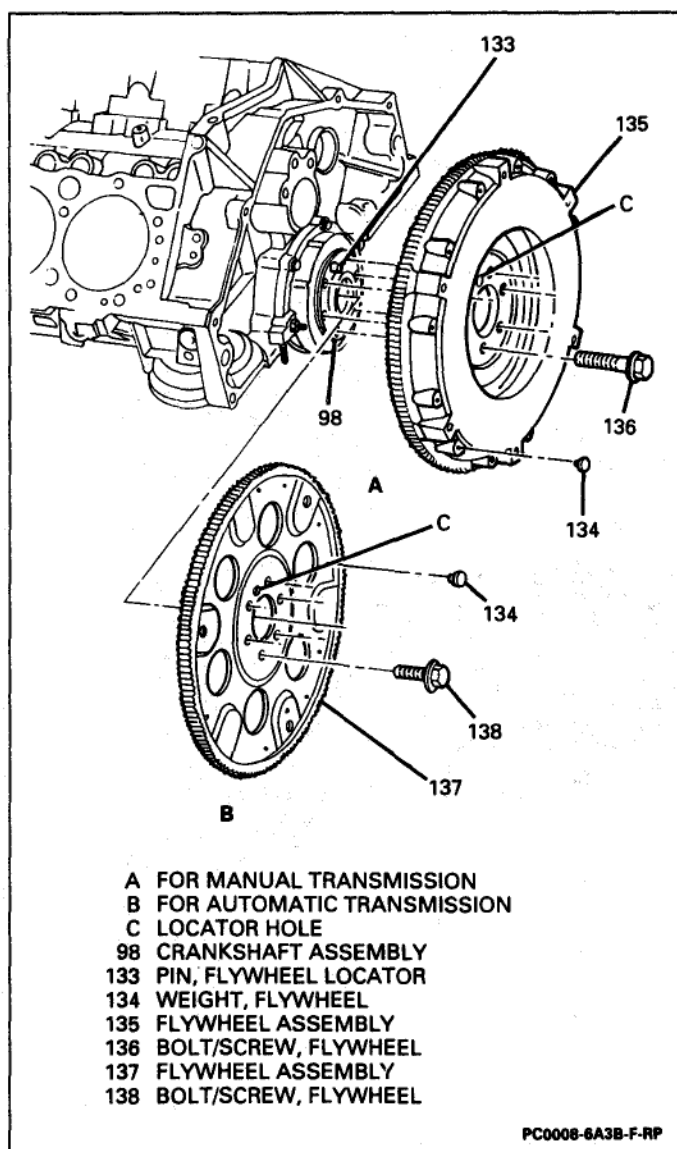


Figure 8 - Flywheel Assembly

INTAKE MANIFOLD ASSEMBLY

Figures 9 through 11

Remove or Disconnect

1. Fuel pressure regulator vacuum tube assembly (7).
2. Fuel rail bolts/screws (1).
3. Canister purge valve vacuum hose.
4. Fuel injectors and fuel rail assembly (2) from intake manifold assembly (6).
5. Exhaust gas recirculation (EGR) vacuum harness assembly and crankcase vent hoses.
6. EGR solenoid assembly and bracket.
7. Canister purge valve assembly and bracket.
8. Move wiring harness assemblies out of area.
9. Disconnect distributor wiring harness assembly, if necessary.
10. EGR valve nuts, valve assembly and gasket.
11. EGR valve pipe bolt/screw (229), nut (14), pipe assembly (12) and gasket (22).
12. Accelerator cable bracket bolt/screw and bracket.
13. Engine coolant air bleed pipe bolts/screws and pipe.
 - Use a backup wrench on pipe fitting when removing bolts/screws.
14. Manifold absolute pressure (MAP) sensor bolts/screws and MAP sensor.
15. Throttle body bolts/screws (4), throttle body assembly (3) and gasket (5).
16. Intake manifold bolts/screws (8) and studs (9).
17. Intake manifold assembly (6) and gaskets (10).

EXHAUST MANIFOLD ASSEMBLIES

Figures 11 and 12

Right Exhaust Manifold Assembly

Remove or Disconnect

1. Right cylinder bank spark plug wire harness assembly from spark plugs and supports.
2. Oil level indicator tube nut.
3. Oil level indicator and tube.
4. Right exhaust manifold air injection pipe assembly (15) and check valve (11).
5. Right exhaust manifold studs (20) and bolts/screws (21) and spacers (245).
6. Right heat shields, exhaust manifold assembly (19) and gasket (18).

Left Exhaust Manifold Assembly

Remove or Disconnect

1. Left exhaust manifold air injection pipe assembly (15) and check valve (11).
2. Left cylinder bank spark plug wire harness assembly from spark plugs and supports.
3. Left exhaust manifold bolts/screws (21) and spacers (245).

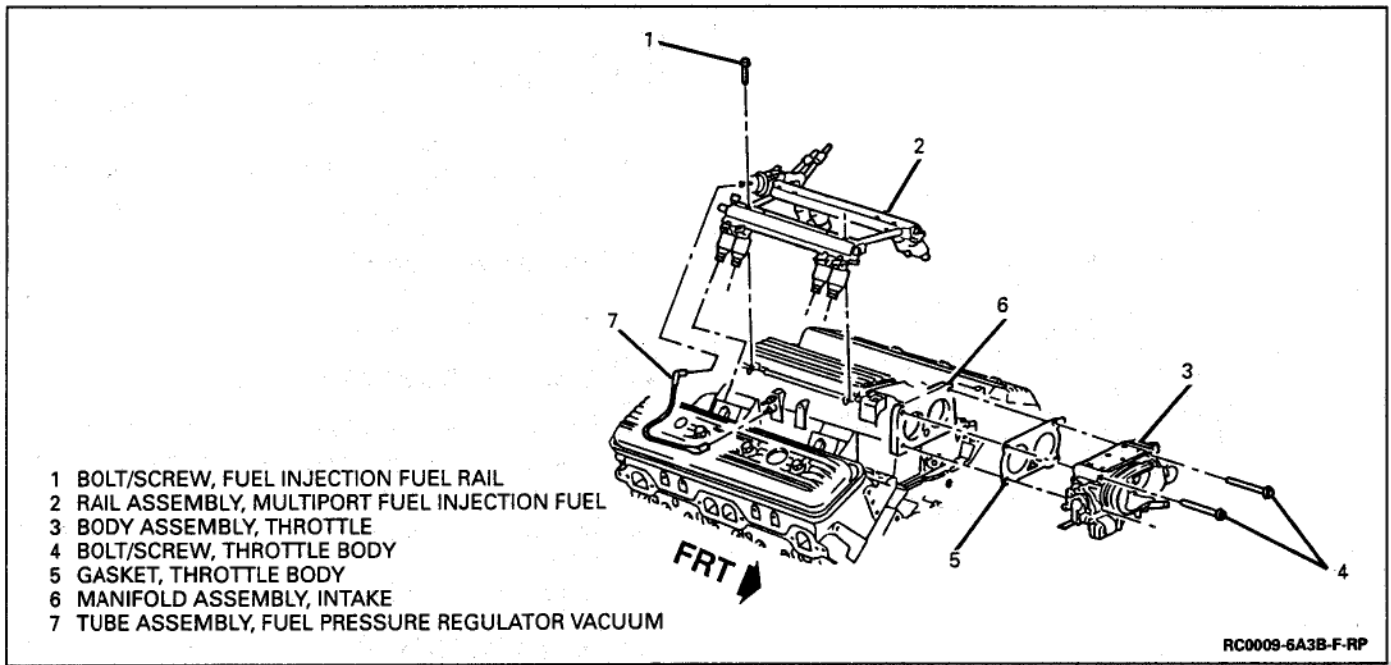


Figure 9 – Fuel Rail and Throttle Body Assemblies

4. Left heat shields, exhaust manifold assembly (16) and gasket (17).

VALVE ROCKER ARM COVER ASSEMBLIES

Figure 13

Right Valve Rocker Arm Cover Assembly

Remove or Disconnect

1. Crankcase vent hose.
2. Right valve rocker arm cover bolts/screws (24).
3. Right valve rocker arm cover assembly (23) and gasket (25).

Left Valve Rocker Arm Cover Assembly

Remove or Disconnect

1. Left valve rocker arm cover bolts/screws (24).
2. Left valve rocker arm cover assembly (23) and gasket (25).

VALVE ROCKER ARMS AND PUSHROD ASSEMBLIES

Figure 14

Remove or Disconnect

1. Rocker arm nuts (31) and balls (30).
2. Rocker arms (29) and pushrod assemblies (27).
 - Place rocker arms (29), rocker arm balls (30) and pushrod assemblies (27) in a rack so that they can be reinstalled in same locations from which they were removed.
3. Rocker arm ball stud (28).

VALVE LIFTER ASSEMBLIES

Figure 15

Remove or Disconnect

1. Valve lifter guide retainer bolts/screws (32) and retainer (33).
2. Valve lifter guides (35) and valve lifter assemblies (36).
 - Some valve lifter assemblies (36) may be stuck in their bores because of gum or varnish deposits. These lifter assemblies (36) can be removed using J 3049 or J 9290-01.

WATER PUMP ASSEMBLY

Figure 16

Remove or Disconnect

1. Air injection pump bracket bolts/screws and bracket.
2. Water pump bolts/screws (40 and 41).

Important

- A. Keep ignition wires connected to distributor assembly until water pump is removed.
- B. Make sure coolant is drained.
3. Water pump assembly (37), coupling (39) and gaskets (38).

CRANKSHAFT BALANCER ASSEMBLY AND HUB

Figure 17

Tool Required:

J 39046 Crankshaft Hub Remover/Installer

↔ Remove or Disconnect

1. Crankshaft balancer bolts/screws (46) and balancer assembly (42).
2. Crankshaft balancer hub bolt/screw and washer.
3. Crankshaft balancer hub (45) using J 39046.

DISTRIBUTOR ASSEMBLY

Figure 18

↔ Remove or Disconnect

1. Ignition harness assembly from coil assembly.
 - Do not remove wires from distributor assembly unless necessary.
2. Distributor bolts/screws (47) and distributor assembly (49).
3. Distributor driveshaft (48).

OIL PAN ASSEMBLY

↔ Remove or Disconnect

1. Oil level sensor assembly.
 - Oil level sensor assembly must be removed to prevent it from being damaged as oil pan assembly is removed.
2. Oil pan bolts/screws, nuts and studs.
3. Oil pan assembly, reinforcements and gasket.

ENGINE FRONT COVER ASSEMBLY

Figure 19

↔ Remove or Disconnect

1. Front cover bolts/screws (52).
2. Front cover assembly (50) and gasket (51).

TIMING CHAIN ASSEMBLY, CRANKSHAFT AND CAMSHAFT SPROCKETS, AND WATER PUMP DRIVESHAFT ASSEMBLY

Figures 20 and 21

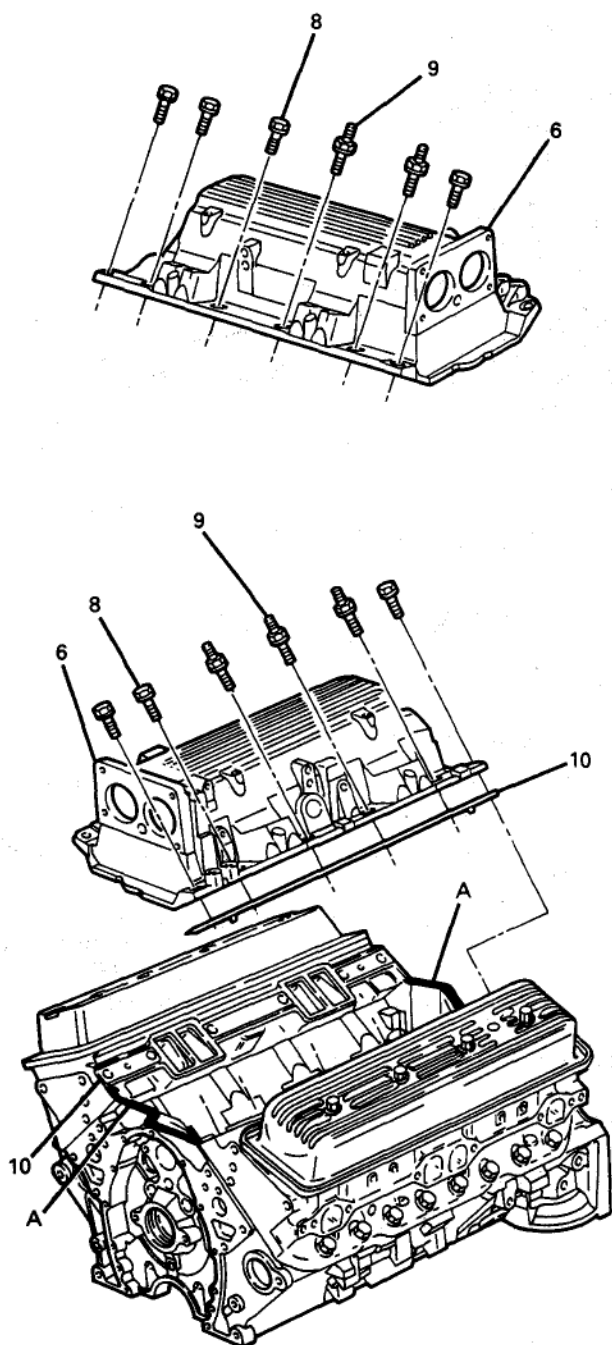
Tools Required:

- J 39243 Driven Gear Assembly Remover
- J 5825-A Crankshaft Gear Remover

↔ Remove or Disconnect

1. Camshaft sprocket bolts/screws (56).

NOTICE: To prevent damage to piston or valve assemblies, do not turn the crankshaft assembly after the timing chain assembly has been removed.
2. Camshaft sprocket (57) and timing chain assembly (61).
3. Water pump driveshaft bolts/screws (64) and drive-shaft assembly (63) using J 39243.
4. Crankshaft sprocket (62) using J 5825-A.
5. Key, if necessary.



- A SEALER
 6 MANIFOLD ASSEMBLY, INTAKE
 8 BOLT/SCREW, INTAKE MANIFOLD
 9 STUD, INTAKE MANIFOLD
 10 GASKET, INTAKE MANIFOLD

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Figure 10 - Intake Manifold Assembly

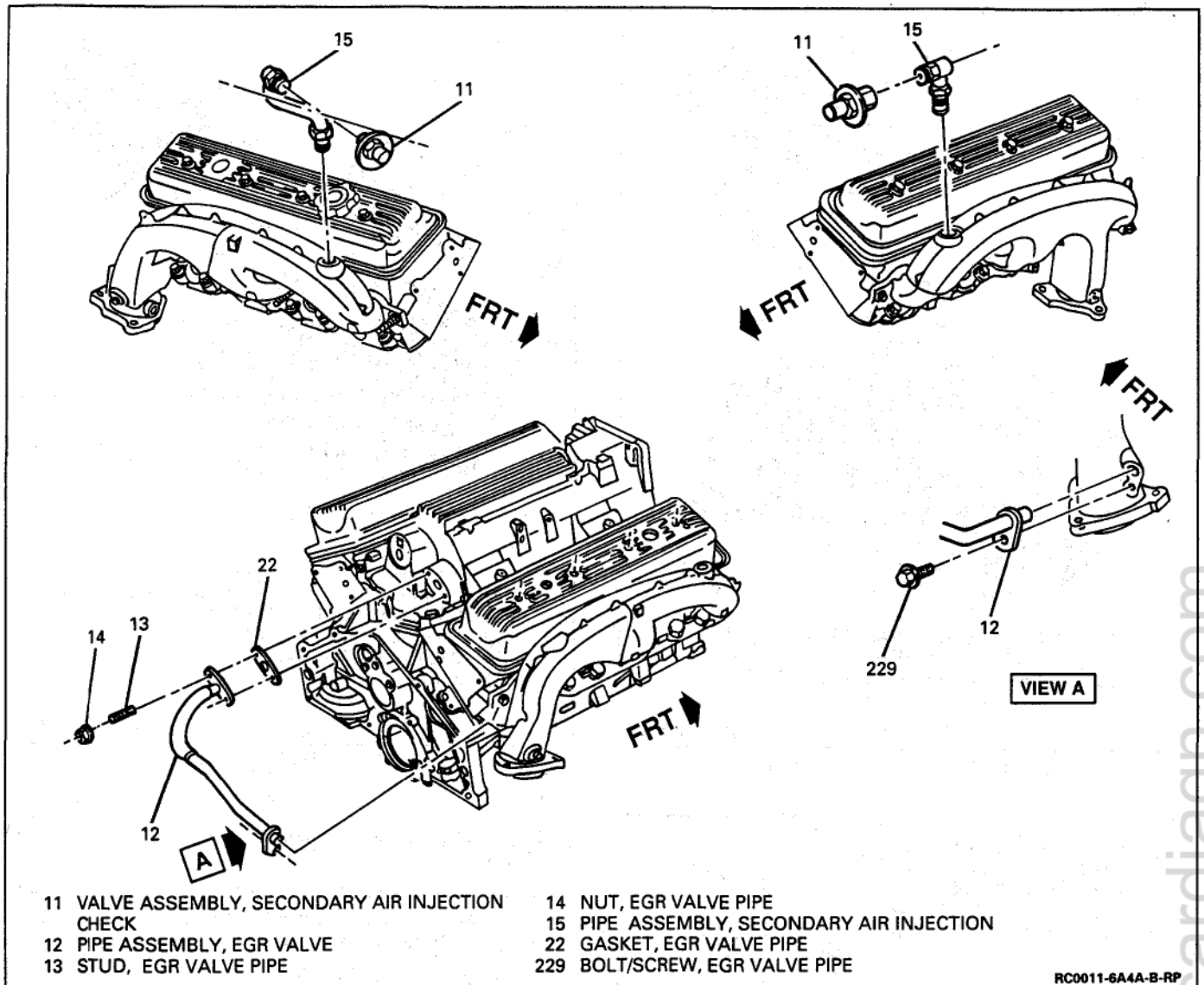


Figure 11 – Secondary Air Injection and EGR Valve Pipe Assemblies

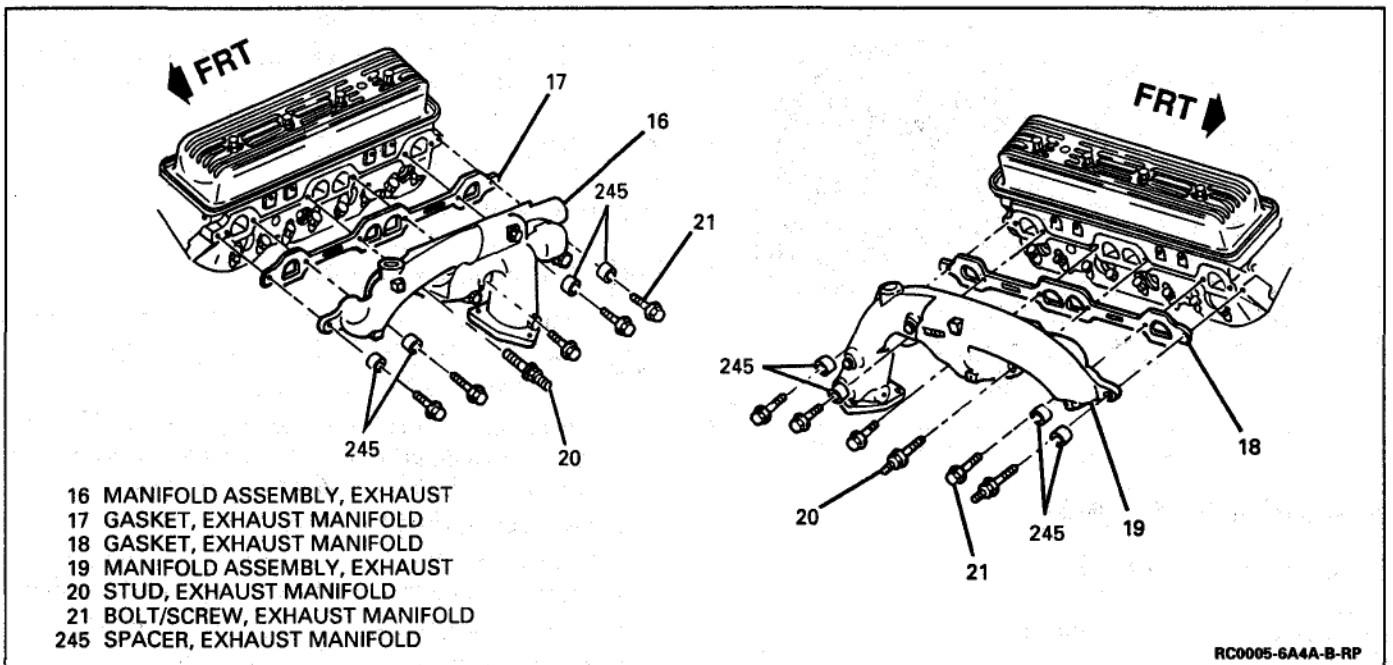


Figure 12 – Exhaust Manifold Assemblies

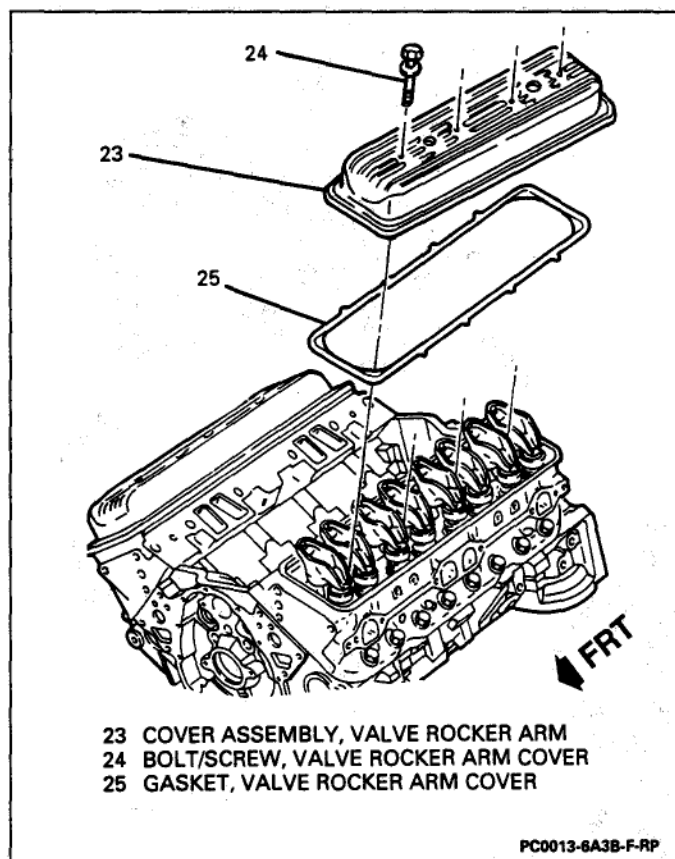


Figure 13 – Valve Rocker Arm Cover Assemblies

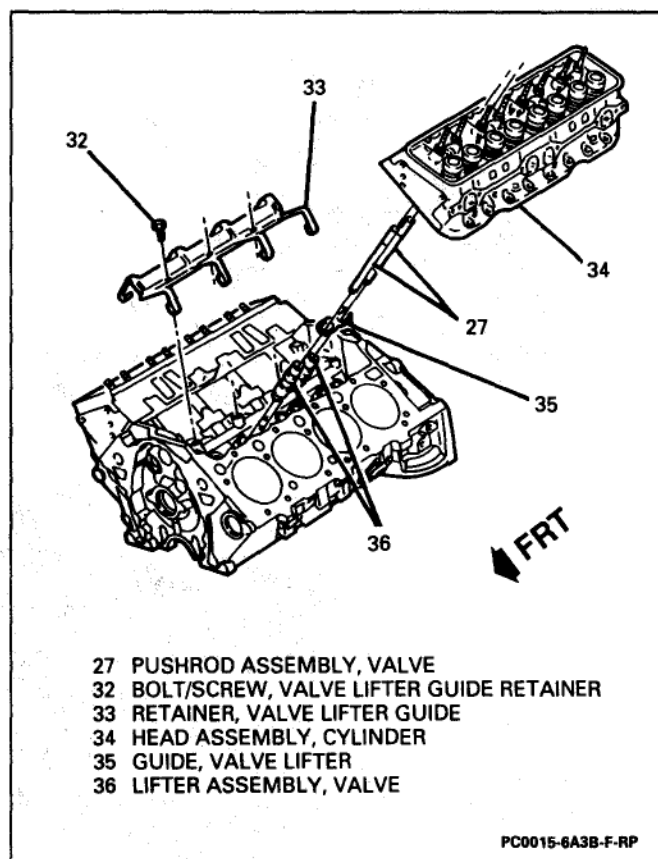


Figure 15 – Valve Lifter Assemblies

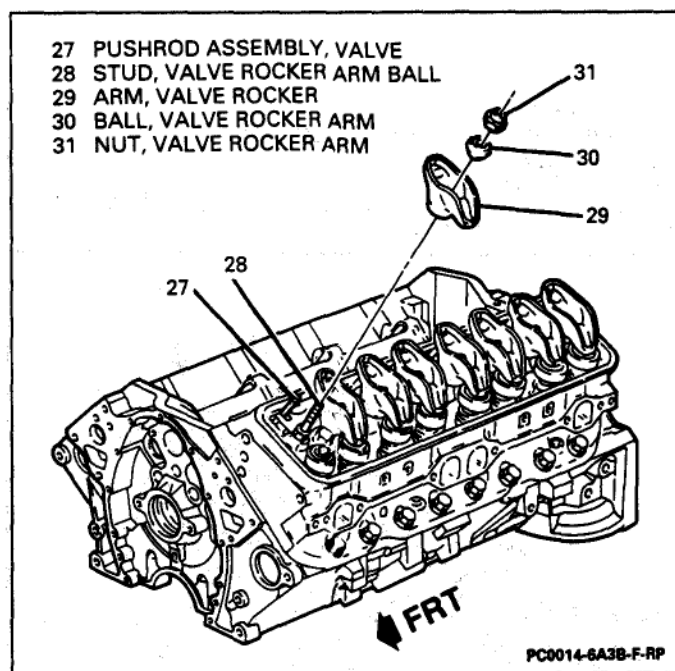


Figure 14 – Valve Rocker Arms and Pushrod Assemblies

CAMSHAFT ASSEMBLY

Figures 20, 22 and 23

Remove or Disconnect

1. Bolt/screw (66) and oil pump driveshaft assembly (65).

2. Camshaft retainer bolts/screws (58) and retainer (59).

NOTICE: All camshaft journals are the same diameter so care must be used in removing the camshaft assembly to avoid damage to the bearings.

3. Camshaft assembly (60).
 - A. Install three 5/16-18 x 4-inch bolts/screws in camshaft bolt holes.
 - B. Carefully rotate and pull camshaft assembly (60) out of bearings.

CYLINDER HEAD ASSEMBLY

Figures 24 and 25

Remove or Disconnect

1. Engine coolant air bleed pipe bolts/screws and pipe.
 - Use a backup wrench on pipe fitting when removing bolts/screws.
2. Generator bracket bolts/screws (122 and 123) spark plug wire support (173) and bracket assembly (121) from right cylinder head assembly (34).
3. Cylinder head bolts/screws (81).

NOTICE: After removal, place the cylinder head assembly on two wood blocks to prevent damage.

4. Cylinder head assembly (34) and gasket (82).
5. Ignition coil studs, coil and bracket assembly from left cylinder head assembly (34).

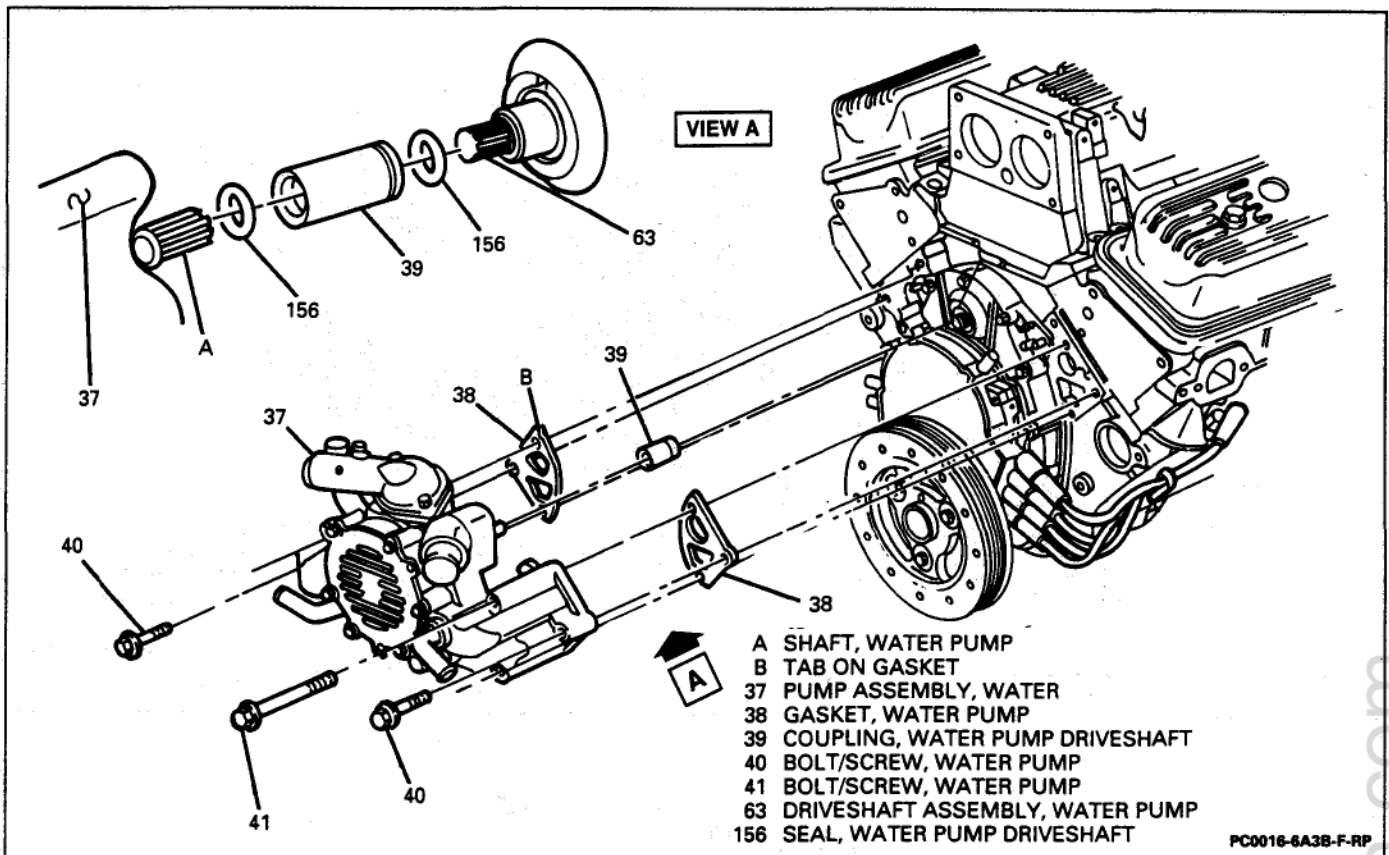


Figure 16 – Water Pump Assembly

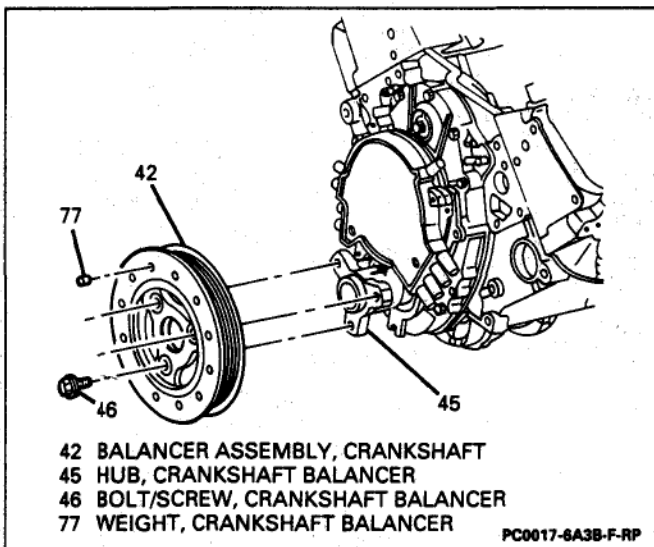


Figure 17 – Crankshaft Balancer Assembly and Hub

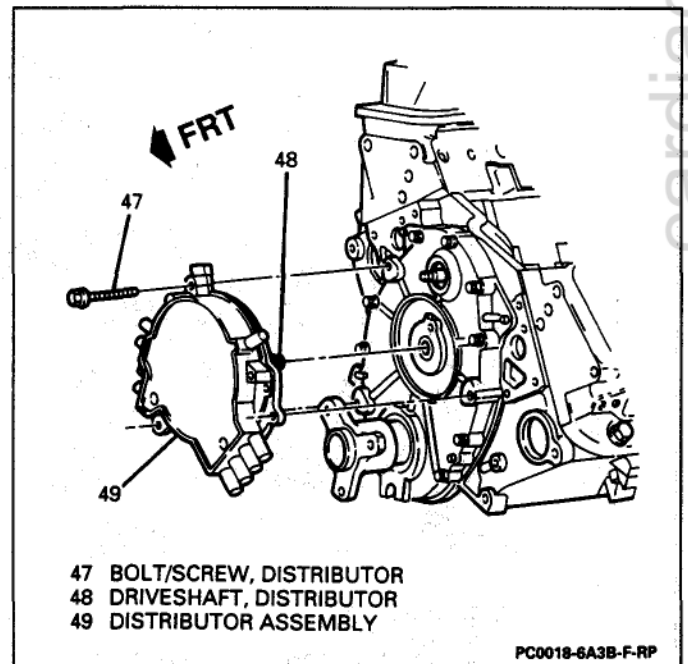


Figure 18 – Distributor Assembly

OIL PUMP ASSEMBLY

Figure 26

Remove or Disconnect

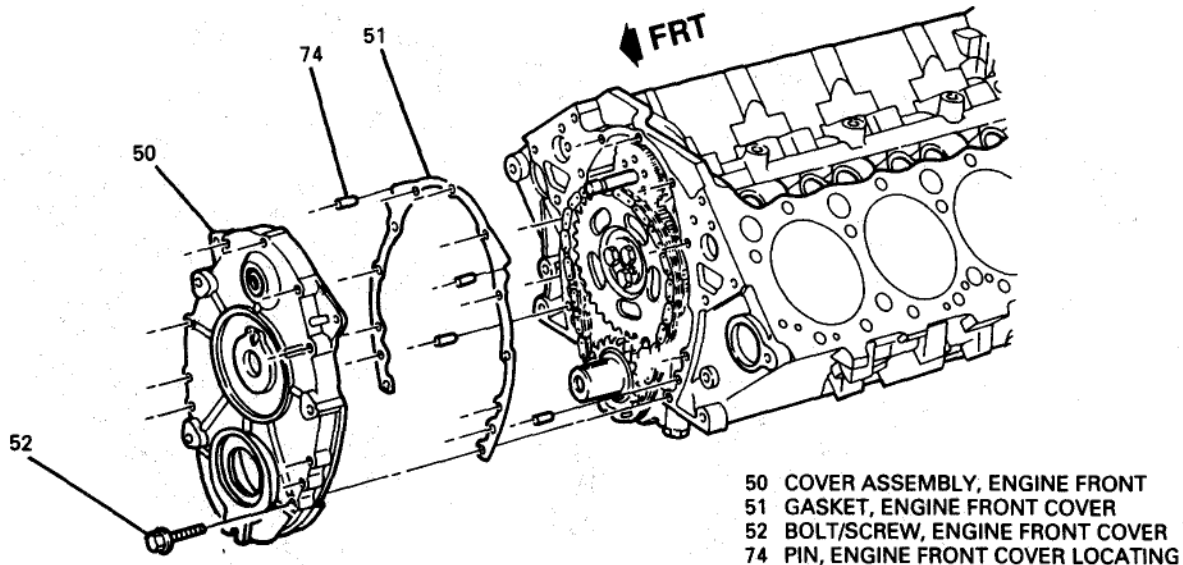
1. Oil pan baffle nuts.
2. Bolt/screw (120) attaching oil pump assembly (118) to rear crankshaft bearing cap.
3. Oil pan baffle (119), oil pump assembly (118), driveshaft (89) and retainer (95).

PISTON AND CONNECTING ROD ASSEMBLY

Figure 27

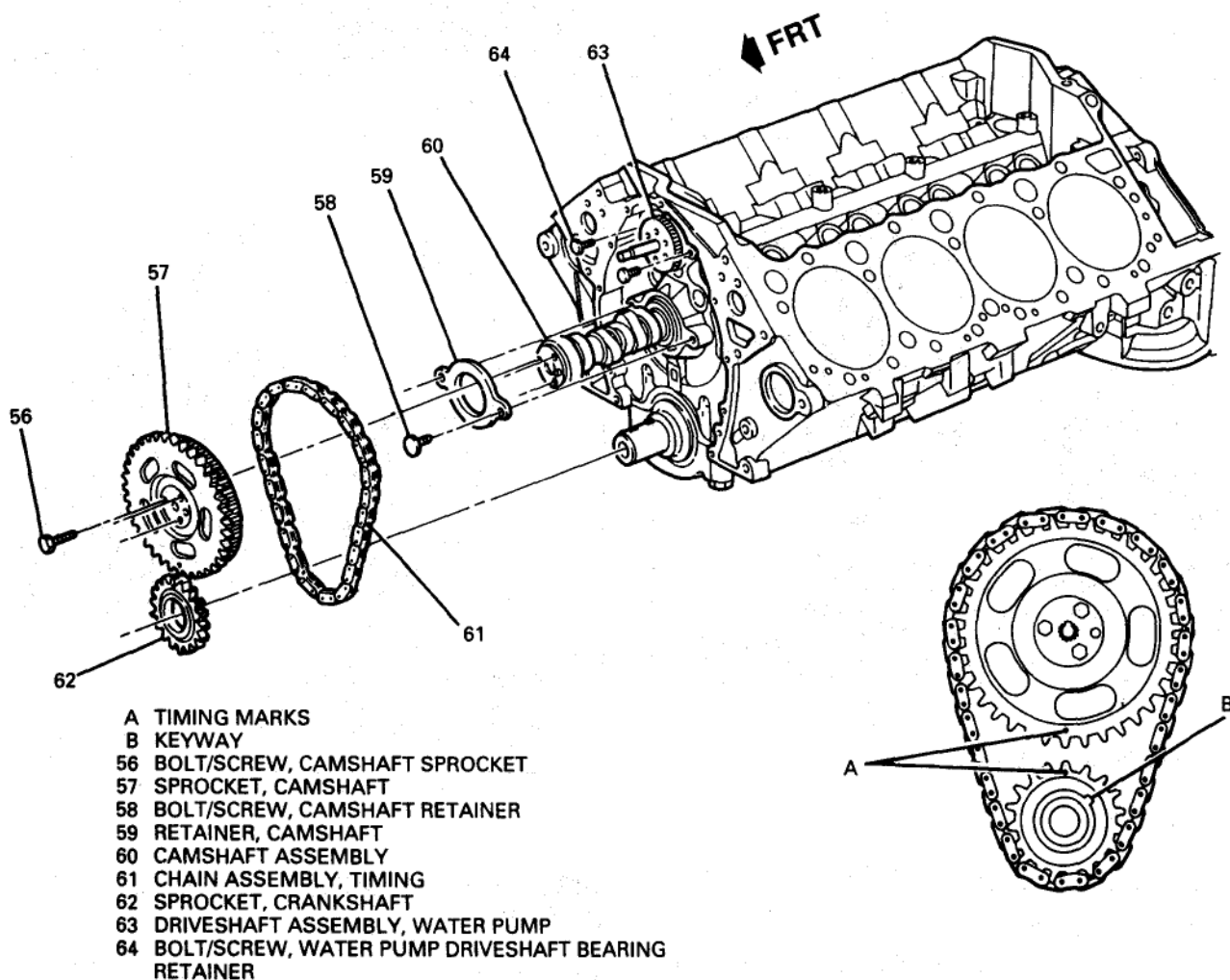
Tool Required:

J 5239 Connecting Rod Bolt Guide Set



PC0019-6A3B-F-RP

Figure 19 – Engine Front Cover Assembly



PC0020-6A3B-F-RP

Figure 20 – Camshaft Assembly, Sprockets and Water Pump Driveshaft Assembly

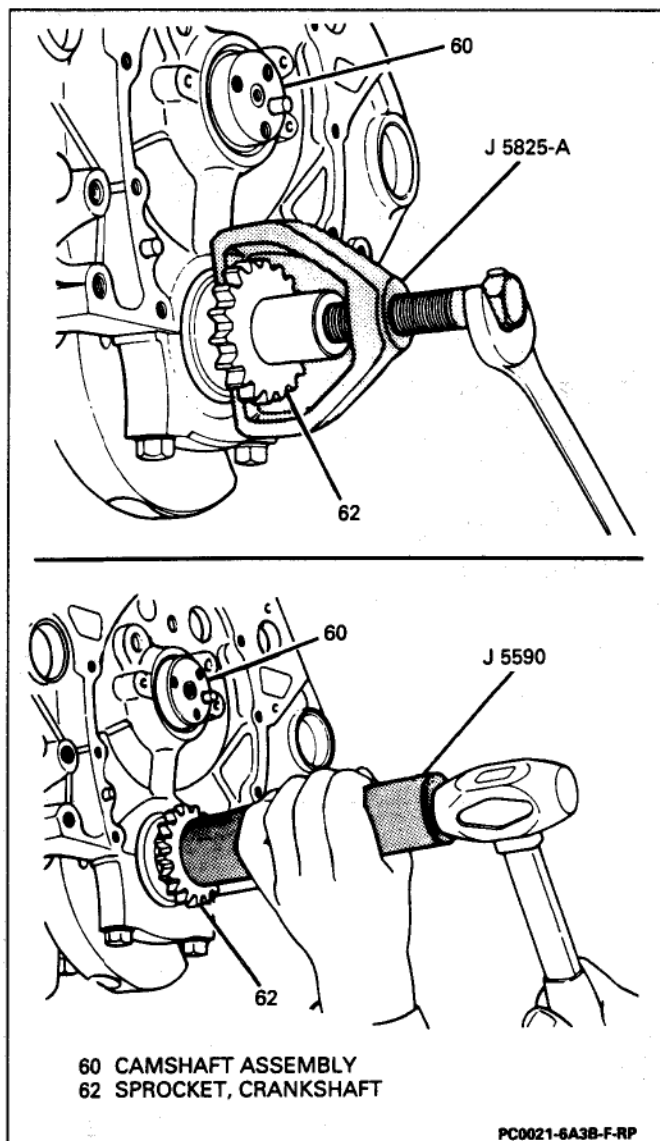


Figure 21 - Crankshaft Sprocket Replacement

Remove or Disconnect

1. Ring ridge.

- Turn crankshaft assembly (98) until piston assembly (103) is at bottom of its stroke.
- Place a cloth on top of piston assembly (103).
- Use a ridge reamer to remove ring ridge.
- Turn crankshaft assembly (98) so piston assembly (103) is at top of its stroke.
- Remove cloth and cutting debris.

Important

- Place matchmarks or numbers on connecting rod assemblies (104) and connecting rod caps (99). Connecting rod caps (99) must be assembled to their original connecting rod assemblies (104).

2. Connecting rod nuts (100).

3. Connecting rod cap (99) and bearings (101).

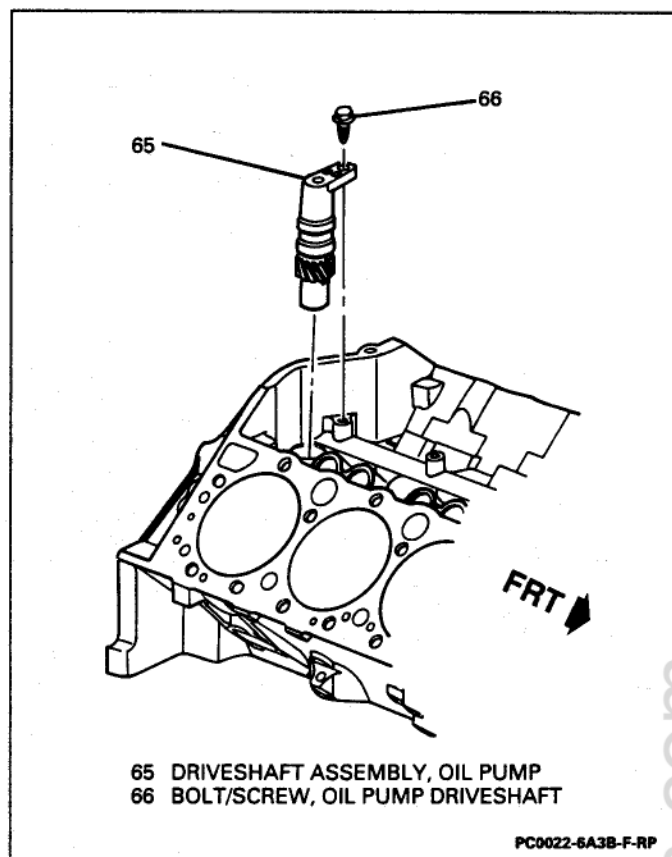


Figure 22 - Oil Pump Driveshaft Assembly

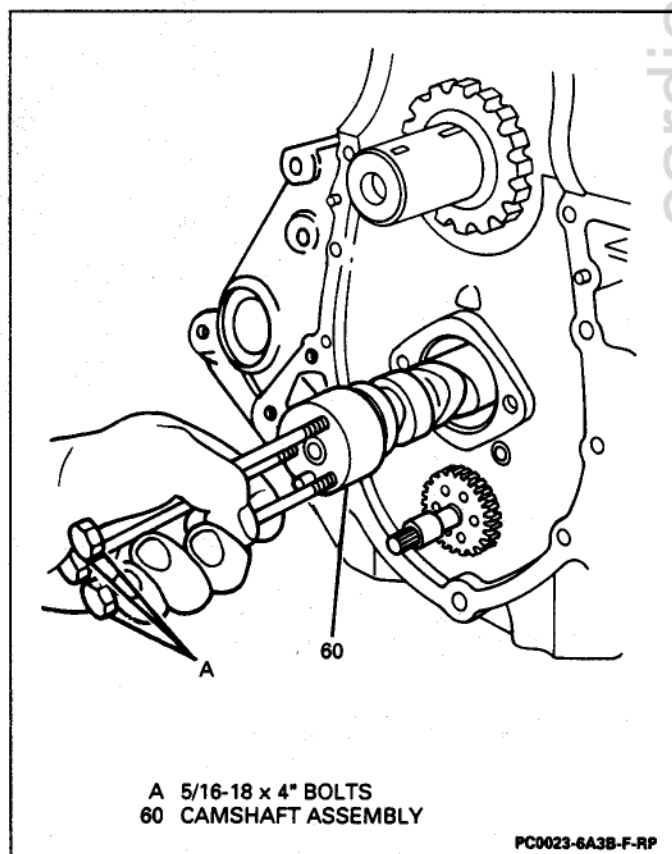


Figure 23 - Removing Camshaft Assembly

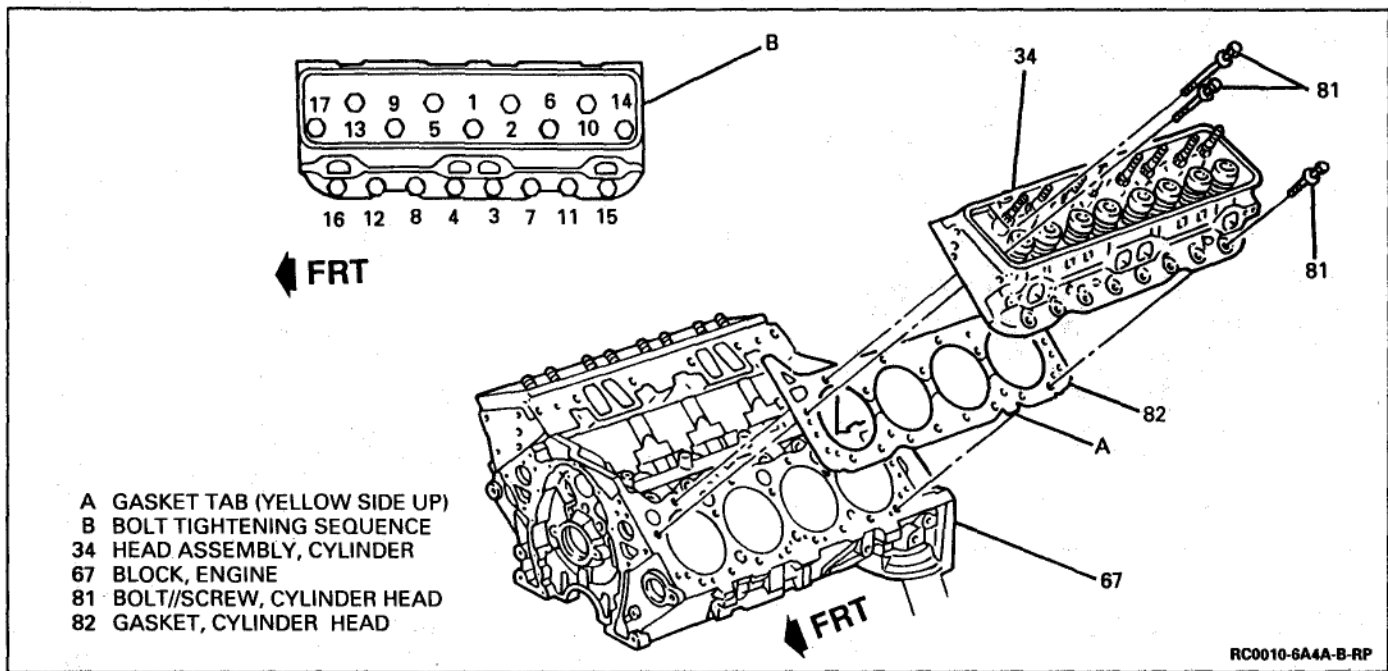


Figure 24 – Cylinder Head Assembly

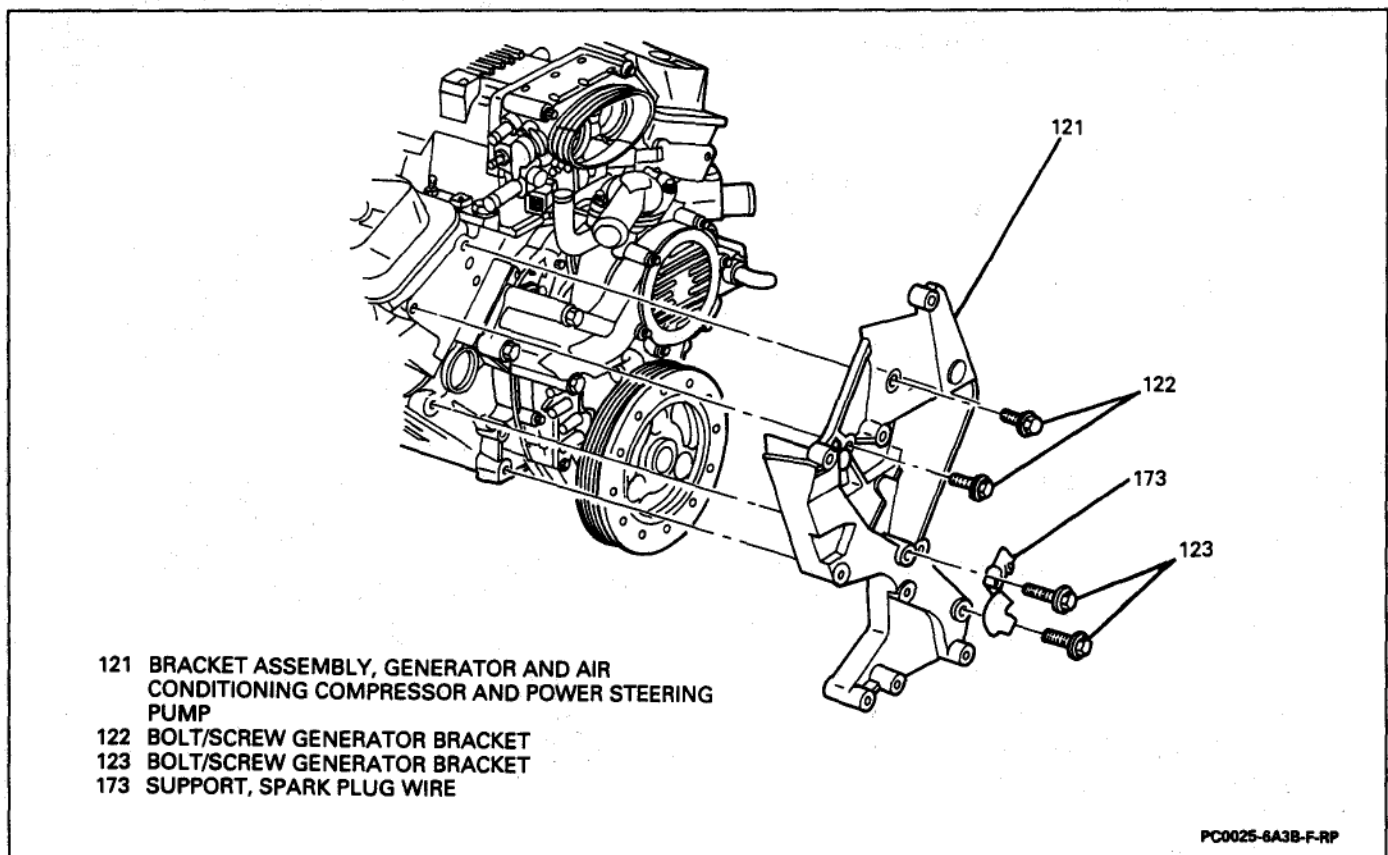


Figure 25 – Generator and Air Conditioning Compressor and Power Steering Pump Bracket Assembly

- Keep bearings (101) with their original connecting rod assembly (104) and connecting rod cap (99) for reassembly if they are being reused.

- Wipe oil from bearings (101) and crankpins.
4. Connecting rod assembly (104) and piston assembly (103) out of top of engine block using J 5239.

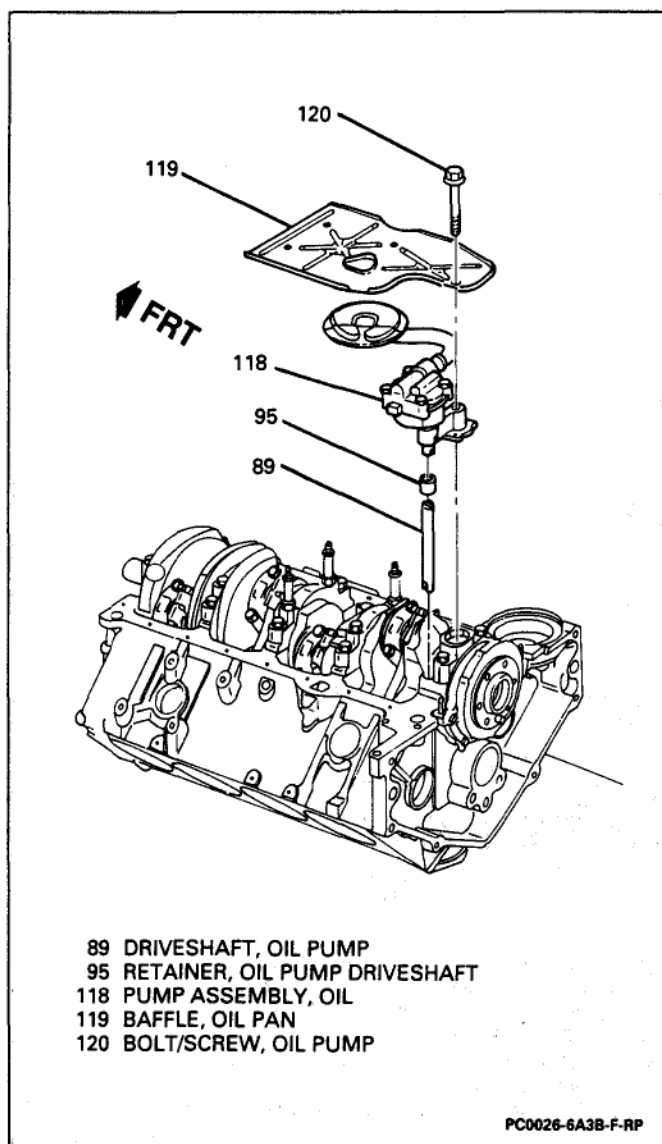


Figure 26 - Oil Pump Assembly

CRANKSHAFT REAR OIL SEAL HOUSING AND CRANKSHAFT ASSEMBLY

Figures 28 and 29

Remove or Disconnect

1. Crankshaft rear oil seal housing nuts (115) and bolts/screws (116).
2. Crankshaft rear oil seal housing assembly (114) with assembled seal, and gasket (113).
3. Crankshaft rear oil seal from crankshaft rear oil seal housing assembly (114).
4. Crankshaft bearing cap bolts/screws (108) and studs.
5. Crankshaft bearing caps (107) and rear crankshaft bearing cap (109).
6. Crankshaft assembly (98).
7. Crankshaft bearings (110 and 111) from engine block (67).

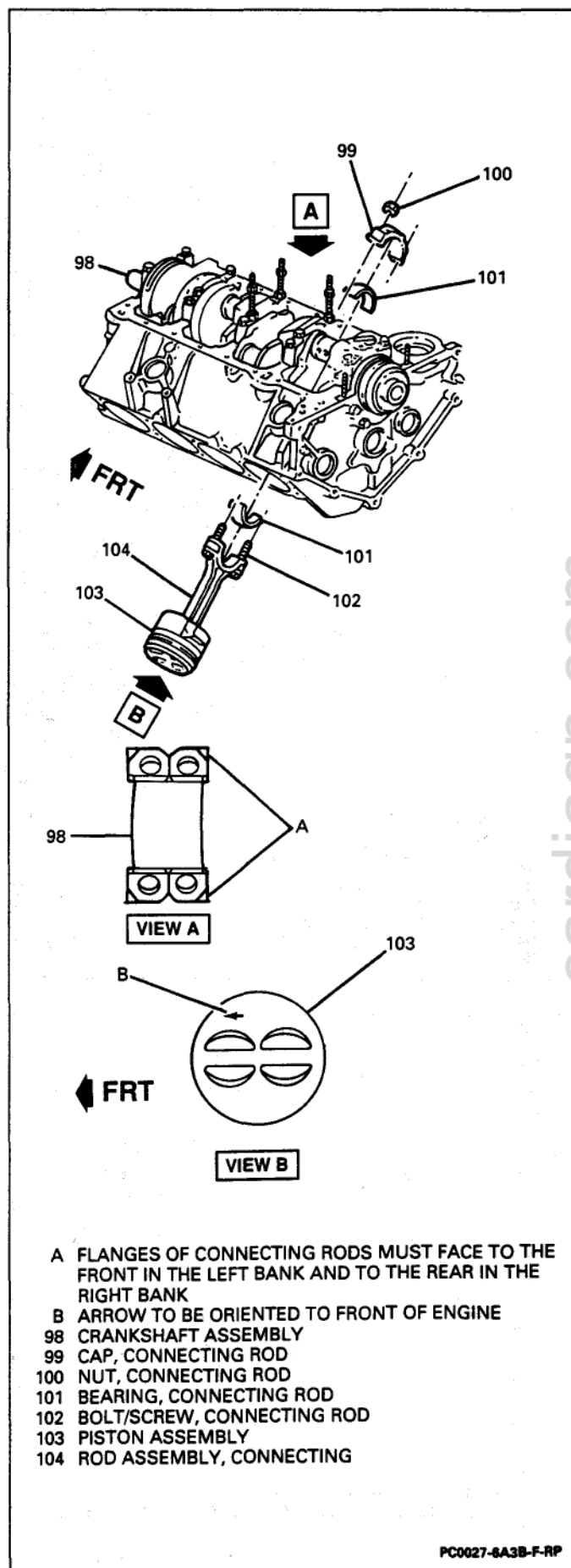
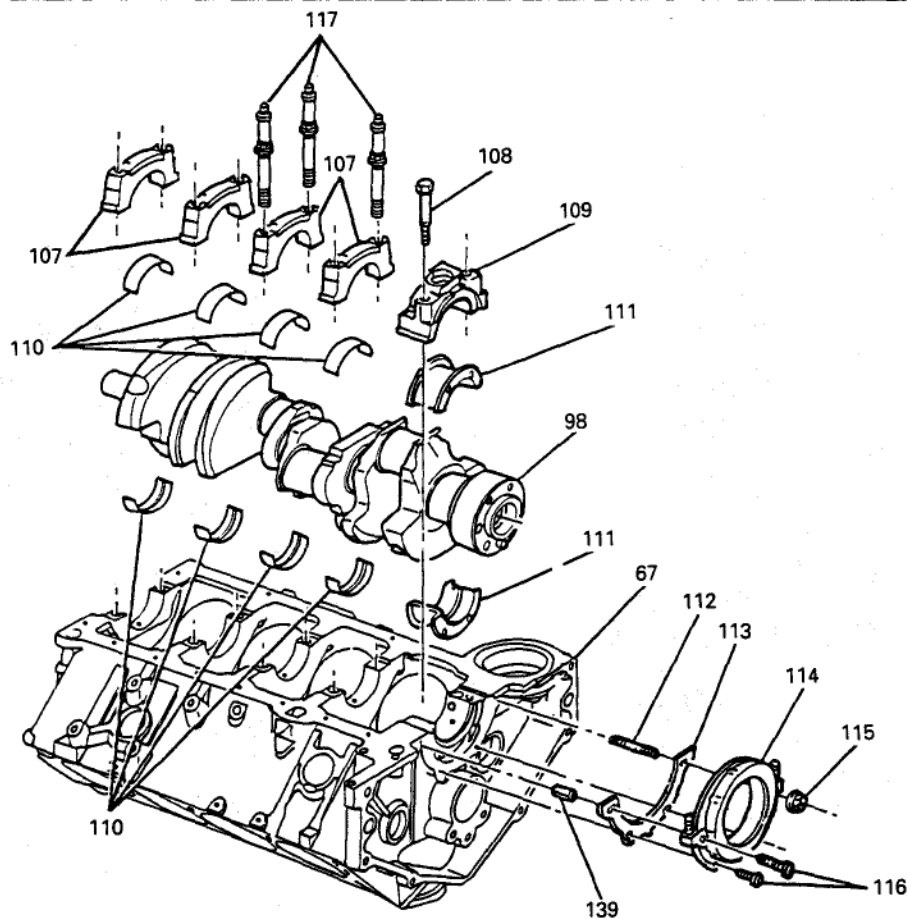


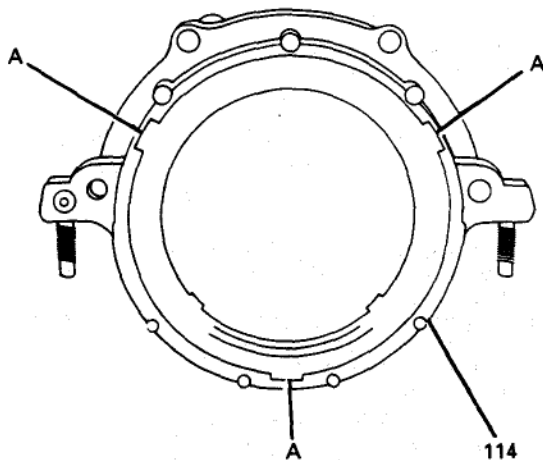
Figure 27 - Piston and Connecting Rod Assemblies



- | | | | |
|-----|------------------------------------|-----|---|
| 67 | BLOCK, ENGINE | 112 | STUD, CRANKSHAFT REAR OIL SEAL RETAINER |
| 98 | CRANKSHAFT ASSEMBLY | 113 | GASKET, CRANKSHAFT REAR OIL SEAL HOUSING |
| 107 | CAP, CRANKSHAFT BEARING | 114 | HOUSING ASSEMBLY, CRANKSHAFT REAR OIL SEAL |
| 108 | BOLT/SCREW, CRANKSHAFT BEARING CAP | 115 | NUT, CRANKSHAFT REAR OIL SEAL HOUSING |
| 109 | CAP, CRANKSHAFT BEARING | 116 | BOLT/SCREW, CRANKSHAFT REAR OIL SEAL HOUSING |
| 110 | BEARING, CRANKSHAFT | 117 | STUD, CRANKSHAFT BEARING CAP |
| 111 | BEARING, CRANKSHAFT | 139 | PIN, CRANKSHAFT REAR OIL SEAL HOUSING LOCATOR |

RC0015-6A4A-B-RP

Figure 28 – Crankshaft Assembly



- A SEAL REMOVAL NOTCHES**
114 HOUSING ASSEMBLY, CRANKSHAFT REAR OIL SEAL

PC0029-6A3B-F-RP

Figure 29 – Removing Crankshaft Rear Oil Seal

8. Crankshaft bearings (110 and 111) from crankshaft bearing caps (107) and rear crankshaft bearing cap (109).

CAMSHAFT BEARINGS

Figures 30 and 31

Tool Required:

J 6098-01 Camshaft Bearing Remover/Installer



Remove or Disconnect

1. Camshaft rear bearing hole plug.
2. Inner camshaft bearings using J 6098-01.
 - A. With nut and thrust washer installed to end of puller screw threads, index pilot in camshaft front bearing and install puller screw through pilot and bearing to be removed.
 - B. Install bearing tool with shoulder toward bearing. Make sure that enough threads are engaged.

- C. Using two wrenches, hold puller screw while turning nut to draw bearing out of bore.
 - When bearing has been pulled from bore, remove bearing tool and bearing from puller screw.
 - D. Repeat above steps for remaining inner camshaft bearings.
 - Index pilot in rear camshaft bearing to remove rear inner bearing.
3. Front and rear camshaft bearings using J 6098-01.
 - A. Assemble bearing tool to driver handle.
 - B. Drive front and rear bearings out, toward center of engine block (67).

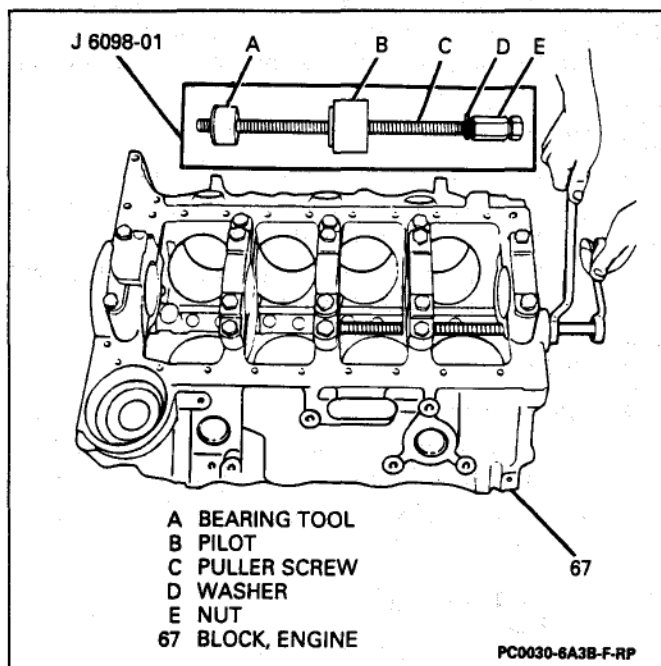


Figure 30 – Removing Camshaft Inner Bearing

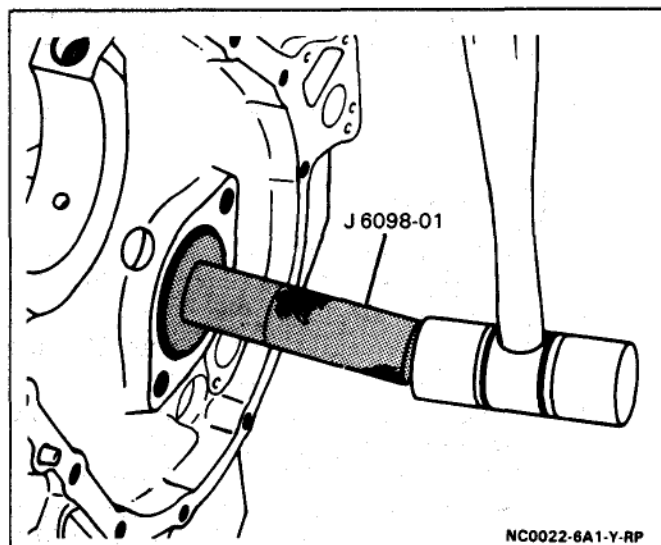


Figure 31 – Replacing Camshaft Front Bearing

CLEANING, INSPECTION AND REPAIR

ENGINE BLOCK

Figure 32

Remove or Disconnect

1. Engine oil cooler assembly (141).
2. Oil filter adapter bolts/screws (143).
3. Oil filter adapter assembly (142).
4. Front and rear oil gallery plugs.
5. Fuel pump and oil pressure sensor assembly.
6. Starter motor assembly. Refer to SECTION 6D2.
7. Engine block core plugs.

Clean

- Engine block in solvent.
- Gasket surfaces.
- Coolant passages.
- Oil passages.

Inspect

- For cracks in cylinder walls, coolant jacket, valve lifter bores and crankshaft bearing webs.

Measure

- Cylinder bores for taper, out-of-round, or excessive ring ridge at top of ring travel. Use a dial indicator. Compare measurements to "Specifications" in this section.
 - Cylinders with less than 0.025 mm (0.0010 inch) of wear or taper may be reconditioned with a hone.
 - Cylinders with more than 0.025 mm (0.0010 inch) of wear or taper must be bored and honed to smallest oversize piston assembly that will permit complete resurfacing of all cylinders.

Boring

1. Draw a flat file across top of engine block several times to remove any burrs or gasket material. If engine block surface is not completely smooth and flat, boring bar may be tilted which would result in cylinder having an incorrect angle to crankshaft assembly.
2. Measure piston assembly to be installed 11.5 mm (0.45 inch) from bottom of piston skirt and at right angles to piston pin.
3. Bore cylinder to same diameter as piston assembly.
4. Hone cylinder as outlined below to provide specified clearance.
 - Follow instructions provided by manufacturer of boring equipment being used.

NOTICE: Handle piston assemblies with care. Do not attempt to force them into the cylinder. The piston assemblies may be easily distorted.

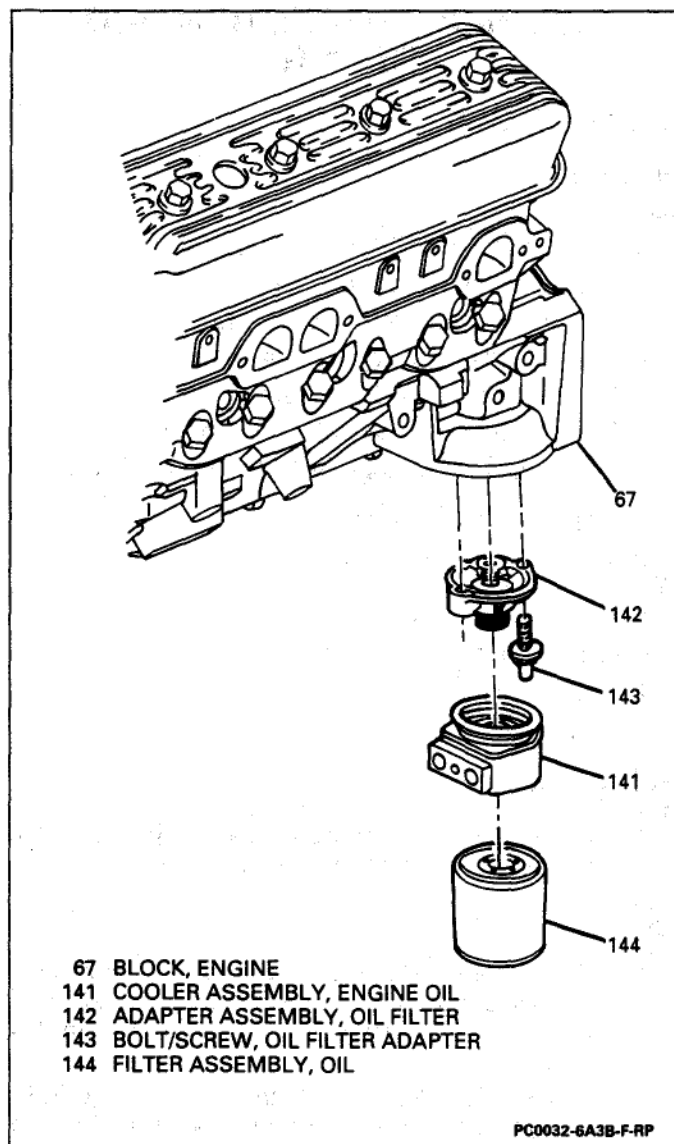


Figure 32 – Oil Cooler and Filter Adapter Assemblies

Honing

- Follow instructions provided by manufacturer of honing equipment being used.
- Occasionally during honing operation:
 - Clean cylinder bore.
 - Measure cylinder bore for proper piston fit.
- Finish operation with a 45 to 65 degree crosshatch pattern on cylinder walls.
 - Finish marks should be clean but not sharp, free from imbedded particles and torn or faded metal.
- Place a permanent mark on each piston assembly to match it to its proper cylinder.



Clean

- Cylinder bores and block with hot water and detergent using a stiff bristle brush. Rinse thoroughly and dry with a clean cloth.

- Any abrasive material left in cylinder bores will cause rapid wear of piston rings, bearings, and other engine assembly parts.
- Do not use kerosene or gasoline for cleaning.
- After cleaning, swab cylinder bores with light engine oil and a clean cloth. Then wipe them out with a clean dry cloth.

CRANKSHAFT BEARING FITTING

Figure 28

If replacing rear crankshaft bearing, check for correct part number. Some rear crankshaft bearings are 0.20 mm (0.008-inch) wider than standard. Crankshaft assembly will be identified by "0.008" stamped on rear counterweight.

It is necessary to measure clearance of each crankshaft bearing to determine proper sizes. Factory installed crankshaft bearings may not be same size for each journal.



Inspect

- Lower half of crankshaft bearing (110 or 111).
 - If lower half is worn or damaged, both upper and lower half should be replaced.
 - If lower half is suitable for use, upper half will also be suitable for use.



Measure

- Crankshaft bearing clearance using gaging plastic.
 - Place a piece of gaging plastic full width of crankshaft bearing (110 or 111) onto journal.
 - Measure all five bearing clearances at same time.



Important

- Do not rotate crankshaft assembly (98) while gaging plastic is between journal and crankshaft bearing (110 or 111).
- Install crankshaft bearing caps (107) and rear crankshaft bearing cap (109) with arrows pointing toward front of engine block assembly.
- Install bearing cap bolts/screws (108) and studs.



Tighten

- Crankshaft bearing cap bolts/screws (108) and studs to 106 N•m (78 lb. ft.).
- Remove crankshaft bearing cap bolts/screws (108), studs, crankshaft bearing caps (107) and rear crankshaft bearing cap (109).
- Measure gaging plastic at its widest using scale provided with gaging plastic. Refer measurements to "Specifications" in this section.
 - If gaging plastic shows an irregularity in journal exceeding 0.025 mm (0.0010 inch), measure journal with a micrometer.

- If clearance is greater than specified, select an undersize bearing and re-measure clearance. Always replace both upper and lower crankshaft bearings (110 and 111) as a unit.
- If clearance cannot be brought to specifications using a standard undersize bearing, regrind crankshaft assembly (98) for use with next undersize bearing.

CRANKSHAFT ASSEMBLY

Figure 28



Clean

- Crankshaft assembly (98) in solvent and dry it with compressed air.



Measure

- Crankpins for out-of-round, taper, or undersize with a micrometer. Refer to "Specifications" in this section.
- Crankshaft run-out at front and rear intermediate journals with a dial indicator. Support crankshaft front and rear journals on V-blocks. Refer to "Specifications" in this section.
- Replace or recondition crankshaft assembly (98) if measurements are outside of specifications.

PISTON AND CONNECTING ROD ASSEMBLY

Figures 27 and 33 through 37

Tool Required:

J 24086-B Piston Pin Remover and Installer Set



Disassemble

1. Piston rings (106) from piston assembly (103).
2. Piston pin (105) from piston assembly (103), using J 24086-B (Figure 33).



Clean

1. Connecting rod assembly (104) in cleaning solvent.
2. Dry connecting rod assembly (104) with compressed air. Do not wire brush any part of piston assembly.
3. Varnish from piston skirts and pins with cleaning solvent.
4. Piston ring grooves with a groove cleaner.
5. Piston oil ring holes and slots.



Inspect

- Connecting rod assembly (104) for twisting, nicks and cracks. Replace any damaged connecting rod assemblies (104).
- Piston assemblies (103) for:

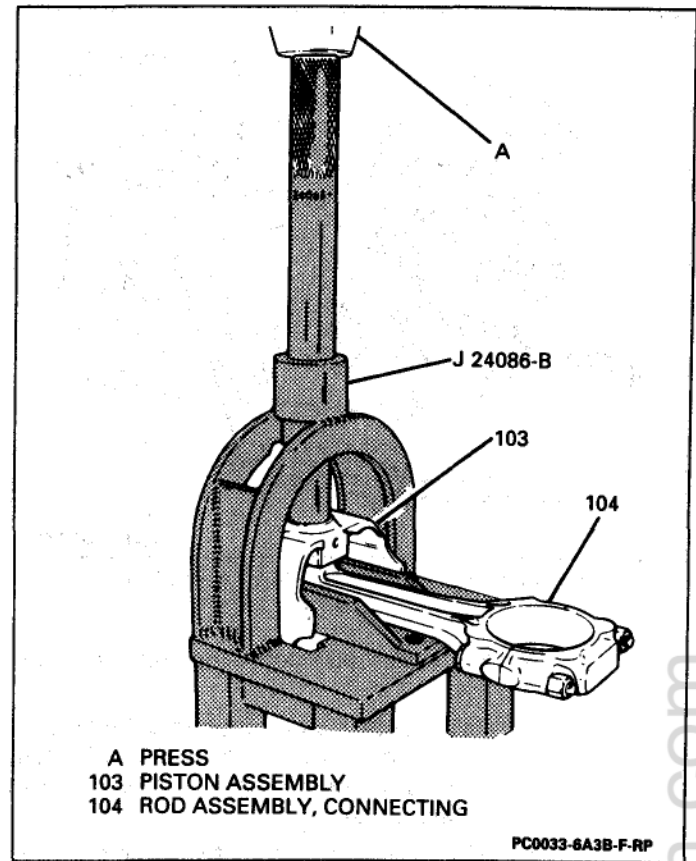


Figure 33 – Removing Piston Pin

- Cracked ring lands, skirts, or pin bosses.
- Grooves for nicks or burrs that may cause binding.
- Warped or worn ring lands.
- Scuffed or damaged skirts.
- Eroded areas at top of piston assembly (103).
- Worn piston bores and piston pins (105).
- Replace piston assemblies (103) that are damaged or show signs of excessive wear.



Measure

1. Piston pin bore-to-piston pin clearance.
 - A. Piston pin bores and piston pins (105) must be free of varnish or scuffing when being measured.
 - B. Use a micrometer to measure piston pin (105) and an inside micrometer to measure piston pin bore.
 - C. If clearance is in excess of 0.025 mm (0.0010 inch), piston assembly (103) and piston pin (105) should be replaced. Piston assembly (103) and piston pin (105) are matched and are not serviced separately.
2. Piston compression ring end gap.



Important

- Fit each compression ring to cylinder in which it will be used.

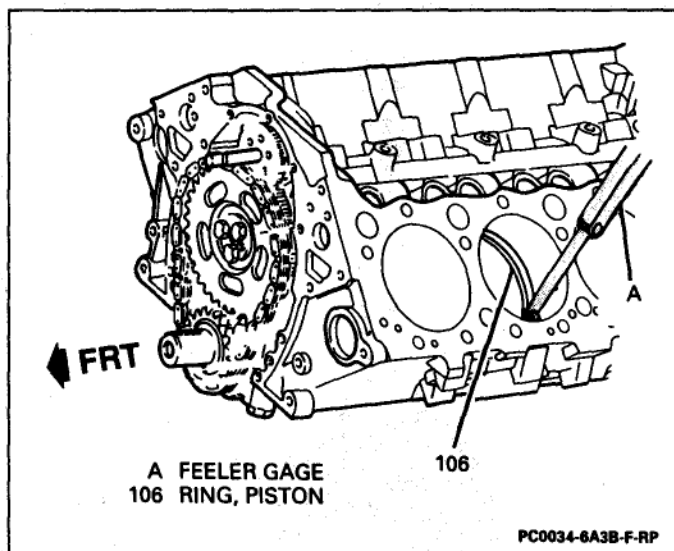


Figure 34 – Measuring Piston Ring End Gap

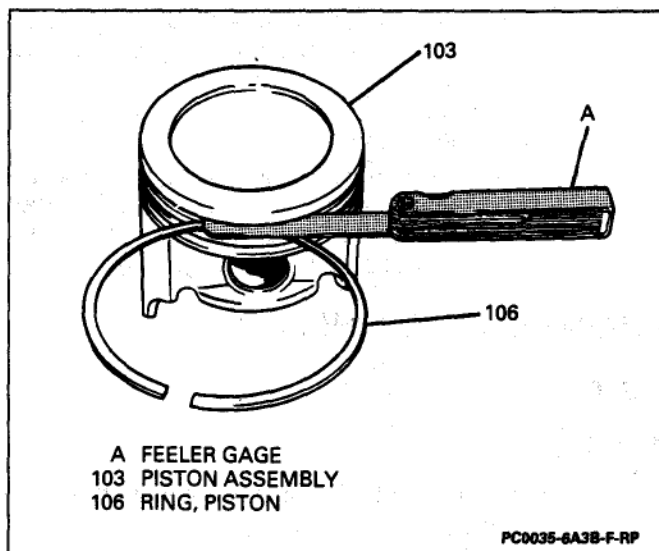


Figure 35 – Measuring Piston Ring Side Clearance

- A. Place compression ring into cylinder bore.
 - B. Push compression ring into cylinder bore to approximately 6.5 mm (1/4 inch) above ring travel. Ring must be square to cylinder wall.
 - C. Measure end gap with a feeler gage. Refer to "Specifications" in this section for acceptable end gaps.
 - D. If end gap exceeds specifications, select another size ring set.
3. Piston ring side clearance.
 - A. Roll piston ring (106) entirely around its ring groove on piston assembly (103).
 - B. If any binding is caused by ring groove, dress groove with a fine cut file.
 - C. If any binding is caused by a distorted piston ring (106), replace piston ring (106).
 - D. Measure side clearance of piston ring (106) and groove with a feeler gage. For acceptable side clearances, refer to "Specifications" in this section.
 - E. If side clearance is too small, try another piston ring (106).
 4. Piston-to-cylinder bore clearance to determine suitability of a used piston assembly (103). Measure piston-to-cylinder bore clearance as follows:
 - A. Measure cylinder bore diameter at a point 64 mm (2 1/2 inches) from top of cylinder bore using a bore gage.
 - B. Measure piston assembly (103) 11.5 mm (0.45 inch) from bottom of skirt at right angles to piston pin (105) using a caliper or micrometer.
 - C. Subtract piston diameter from cylinder bore diameter. This will indicate piston-to-bore clearance.
 - D. Compare measurements to "Specifications" in this section.

- E. If clearance exceeds specifications, subtract size of new piston assembly from cylinder bore diameter previously measured.
- F. If clearance with new piston assembly is within specifications, mark that piston assembly to cylinder to which it is to be installed.
- G. If clearance is within specifications, used piston assembly (103) may be reinstalled.

**Assemble**

Tool Required:

J 24086-B Piston Pin Remover and Installer Set

**Important**

- When assembling piston assembly (103) and connecting rod assembly (104), stamped arrow on piston assembly (103) must point to front of engine block assembly while flange on connecting rod assembly must face toward front of piston assembly on left hand assembly and face toward rear of piston assembly on right hand assembly. Refer to Figure 27.

NOTICE: After J 24086-B installer bottoms on support assembly, do not exceed 34 475 kPa (5000 psi) or the tool may be damaged.

1. Piston assembly (103) and connecting rod assembly (104).
 - A. Lubricate piston pin holes in both piston assembly (103) and connecting rod assembly (104).
 - B. Press piston pin (105) into piston assembly (103) and connecting rod assembly (104) using J 24086-B (Figure 36).

**Inspect**

- For freedom of movement of piston assembly (103) on piston pin (105).
2. Piston rings (106) onto piston assembly (103).

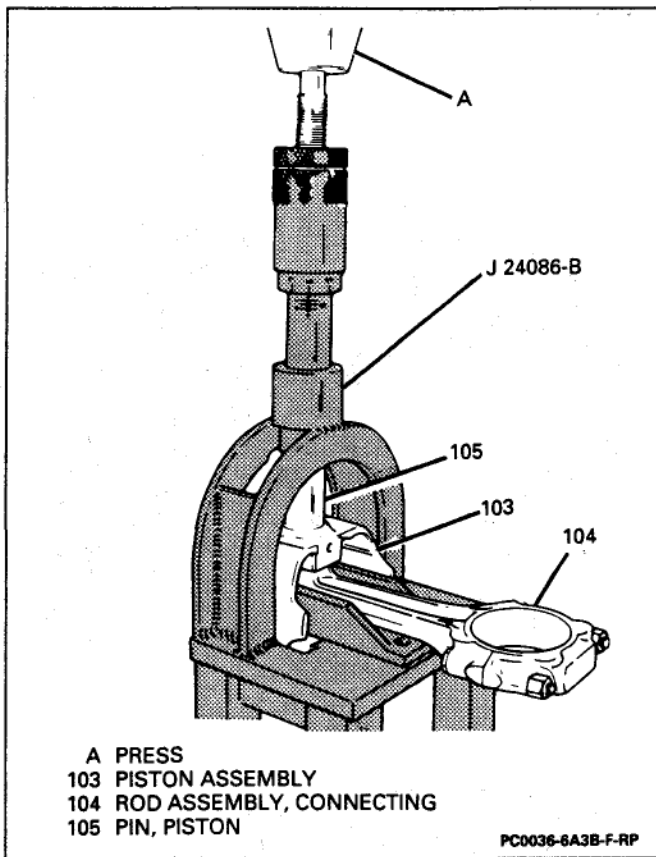


Figure 36 – Installing Piston Pin

- Marked side of piston rings (106) must face toward top of piston assembly (103). Locate piston ring gaps as shown in Figure 37.
- Install oil ring spacer in groove.
 - Hold spacer ends together and install lower oil ring rail with gap properly located.
 - Install upper oil ring rail with gap properly located.
 - Flex oil ring assembly to make sure rings are free.
 - Install lower compression ring with gap properly located.
 - Install upper compression ring with gap properly located.

CONNECTING ROD BEARINGS

Figure 27

Connecting rod bearings are the precision insert type and do not use shims for adjustment. Do not file connecting rod assemblies or rod caps. If clearances are found to be excessive, a new bearing will be required. Service bearings are available in standard size and 0.001 and 0.002-inch undersize for use with new and used standard size crankshaft assemblies, and in 0.010 and 0.020-inch undersize for use with reconditioned crankshaft assemblies.

When removing a connecting rod cap, you may find a 0.010-inch undersize bearing. These are used in manufacturing for selective fitting.

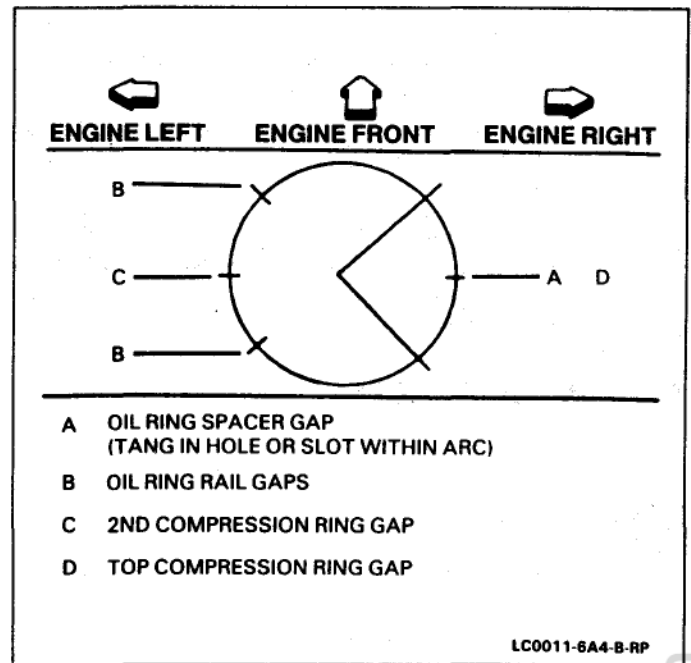


Figure 37 – Piston Ring Gap Locations

Inspect

- Bearings (101) for excessive wear or damage.

Measure

- Crankpin for out-of-round and taper with a micrometer. Refer measurements to "Specifications" in this section.
 - If not within specifications, replace or recondition crankshaft assembly.
 - If installing new bearings (101), determine new bearing size from maximum crankpin diameter.
- Bearing clearances using gaging plastic.
 - Place a piece of gaging plastic full width of bearing (101), (parallel to crankshaft assembly) onto crankpin.
 - Plastic gage should be positioned in middle of bearing (101). Bearing (101) is thickest in center and bearing clearance must be measured at this location.
 - Install connecting rod cap (99) with bearing (101) onto connecting rod assembly (104).
 - Install connecting rod nuts (100).

Tighten

- Connecting rod nuts (100), evenly, to 64 N•m (47 lb. ft.).

Important

- Do not turn crankshaft assembly with gaging plastic installed or accuracy of measurement will be affected.
- D. Remove connecting rod nuts (100) and cap.

- E. Measure gaging plastic at its widest using scale provided with gaging plastic. Refer measurements to "Specifications" in this section.
- F. If clearance is greater than specified, select an undersize bearing (101) and re-measure clearance.
- G. If clearance cannot be brought to specifications, regrind crankpin. If crankpin is already at maximum undersize, replace crankshaft assembly (98).

OIL PUMP ASSEMBLY

Figure 38

Disassemble

1. Oil pump cover bolts/screws (97) and pump cover (96).
 - Matchmark gear teeth for reassembly.
2. Driven gear (86), drive gear (94), driveshaft (89) and retainer (95) from housing assembly (87).
3. Oil pressure relief valve pin (90), relief valve (92), spring (91) and plug (93).
4. Screen assembly (88) from housing assembly (87), if replacement is necessary.
 - Mount housing assembly (87) in a soft-jaw vise and extract screen assembly (88).
 - Screen assembly (88) is serviced as a unit. Do not disturb pipe on screen.

Clean

1. All parts in cleaning solvent.
2. Dry parts with compressed air.

Inspect

- Housing assembly (87) and cover (96) for cracks, scoring, casting imperfections, and damaged threads.
- Drive gear shaft. If loose in housing assembly (87), replace oil pump.
- Pressure relief valve (92) for scoring and sticking.
 - Burrs may be removed with a fine oil stone.
- Relief valve spring (91) for loss of tension.
- Screen assembly (88) for broken wire mesh or screen, or looseness.
 - If pipe is loose or has been removed from screen, screen assembly (88) must be replaced.
- Gears for chipping, galling, and wear.
- Drive gear (94) and driveshaft (89) for looseness and wear.

Important

- If wear is noted, replace entire pump assembly.

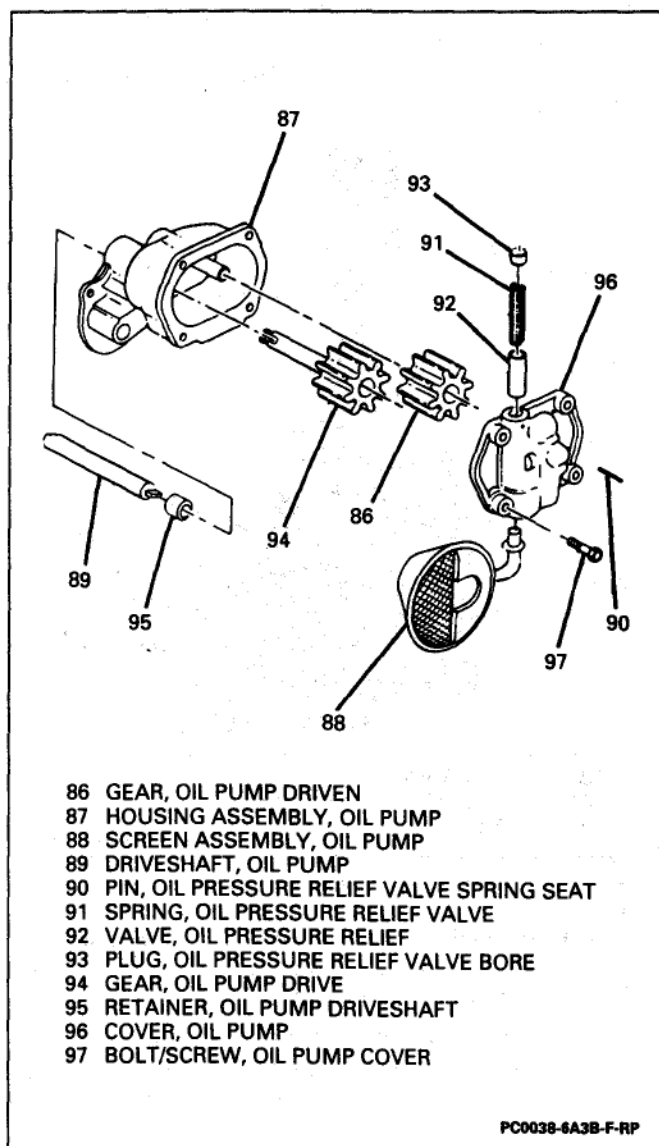


Figure 38 – Oil Pump Components

Assemble

Tool Required:

J 21882 Oil Suction Pipe Installer

NOTICE: See "Notice" on page 6A3B-1 of this section.

Important

- Be careful not to twist, shear, or collapse screen assembly while installing it to oil pump assembly.
1. A new screen assembly (88), if previously disassembled, to housing assembly (87).
 - A. Mount housing assembly (87) in a soft-jaw vise.
 - B. Apply sealer to end of pipe.
 - C. Tap pipe into place using J 21882 and a plastic-faced hammer.
 2. Relief valve (92), spring (91), plug (93) and pin (90).

3. Drive gear (94), driveshaft (89) and retainer (95) to housing assembly (87).
4. Driven gear (86) to housing assembly (87) with smooth side of gear toward pump cover (96).
5. Pump cover (96).
6. Oil pump cover bolts/screws (97).

**Tighten**

- Oil pump cover bolts/screws (97) to 9 N•m (80 lb. in.).

**Inspect**

- For smoothness of operation by turning pump drive-shaft (89) by hand.

CYLINDER HEAD ASSEMBLY**Figures 24 and 39 through 45****Tools Required:**

- J 8001 Dial Indicator Set
- J 9666 Valve Spring Tester
- J 8062 Valve Spring Compressor
- J 8358 Carbon Removing Brush
- J 8101 Valve Guide Cleaner

**Disassemble**

1. Spark plugs from cylinder head assembly.
 2. Compress valve springs (69) using J 8062.
 3. Valve stem keys (72).
 4. Cap (70) from valve.
 5. Valve spring (69).
 6. Valve seal (73).
 7. Valve.
- Place valves in a rack in proper sequence so they can be assembled in their original order.

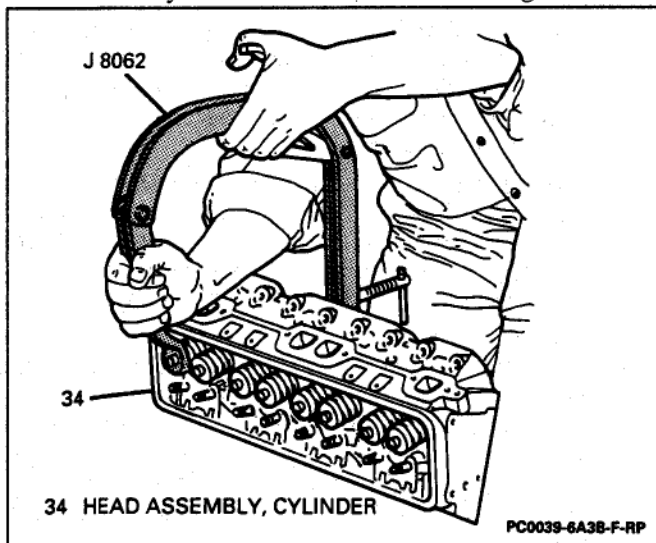
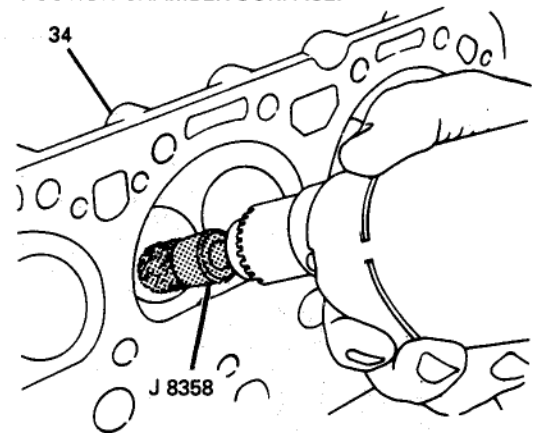


Figure 39 – Compressing Valve Spring

**Clean**

1. Carbon from combustion chambers and valve parts using J 8358.
2. Valve guides using J 8101 (Figure 41).
3. Carbon and sludge from pushrod assemblies and rocker arms.
4. Valve stems and heads on a buffing wheel.
5. Cylinder head assembly and engine block gasket surfaces.
6. Bolt/screw hole threads in cylinder head assembly (34) and engine block (67).

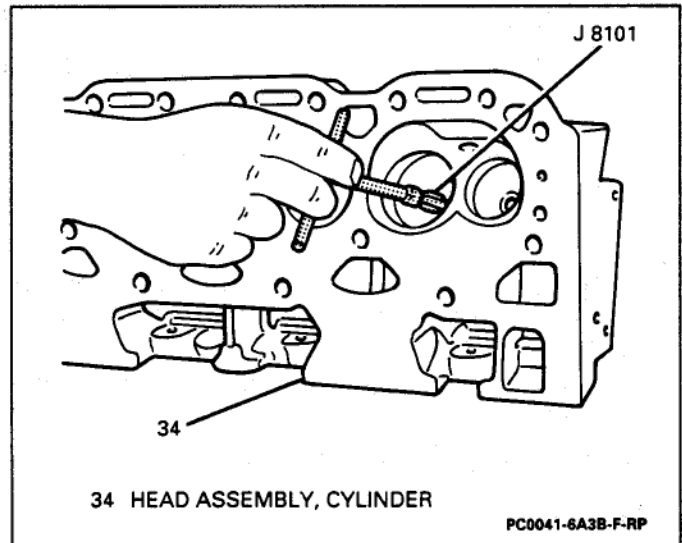
NOTE: DO NOT ALLOW WIRE WHEEL TO CONTACT CYLINDER HEAD DECK. USE ONLY ON COMBUSTION CHAMBER SURFACE.



34 HEAD ASSEMBLY, CYLINDER

PC0040-6A3B-F-RP

Figure 40 – Cleaning Combustion Chamber



34 HEAD ASSEMBLY, CYLINDER

PC0041-6A3B-F-RP

Figure 41 – Cleaning Valve Guide

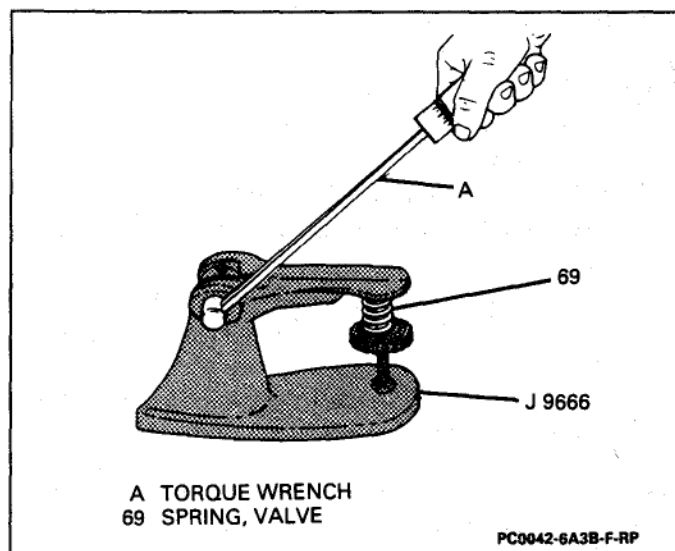


Figure 42 – Checking Valve Spring Tension

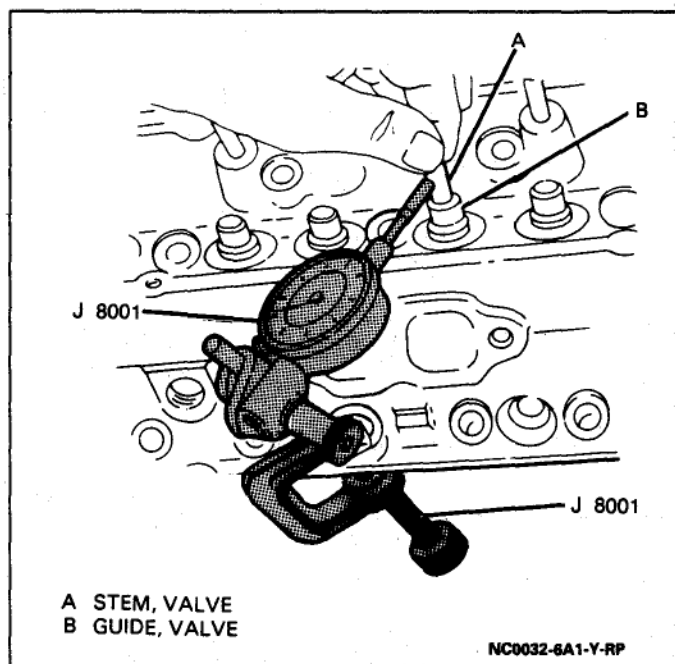


Figure 43 – Measuring Valve Stem Clearance

- A. Excessive valve stem-to-bore clearance will cause excessive oil consumption and may cause a valve to break. Insufficient clearance will result in noisy and sticky functioning of valve and disturb engine assembly smoothness.
- B. Clamp J 8001 on exhaust port side of cylinder head assembly.
- C. Locate indicator so movement of valve stem from side to side (crosswise to cylinder head assembly) will cause a direct movement of indicator stem. Indicator stem must contact side of valve stem just above valve guide.
- D. Drop valve head about 1.6 mm (1/16 inch) off valve seat.
- E. Move stem of valve from side to side using light pressure to obtain a clearance reading. If clearance exceeds specifications, it will be necessary to ream valve guides for oversize valves. Refer to "Specifications" in this section.
- F. Service valves are available in standard, 0.003, 0.015, 0.030 inch oversize.

Recondition

1. Valves with oversize stems are available as outlined above. Ream valve guide bores for oversize valves as necessary.
2. Reconditioning valve seats is very important. Valve seat reconditioning must be done after reaming valve guide bores or installing new valve guides.
 - Seating of valves must be perfect for engine assembly to deliver optimum power and performance.
 - Another important factor is cooling of valve heads. Good contact between each valve and its seat in cylinder head assembly is necessary to insure that heat in valve head will be properly carried away.
 - Several different types of equipment are available for reconditioning valve seats. Recommendations of manufacturer of equipment being used should be carefully followed to attain proper results.
 - Regardless of what type of equipment is used, it is essential that valve guide bores be free from carbon or dirt to ensure proper centering of pilot in guide. Valve seats should be concentric to within 0.05 mm (0.002 inch) total indicator reading.
3. Valves that are pitted can be refaced to proper angle, insuring correct relation between head and stem, on a valve refacing mechanism. Valve stems which show excessive wear, or valves that are warped excessively should be replaced. If edge of valve head is less than 0.79 mm (1/32 inch) thick after grinding, replace valve.
 - Several different types of equipment are available for refacing valves. Recommendation of manufacturer of equipment being used should be carefully followed to attain proper results.



Inspect

1. Cylinder head assembly (34) for cracks in exhaust ports, combustion chambers, or external cracks to water chamber.
2. Valves for burned heads, cracked faces, or damaged stems.
3. Valve springs (69) for squareness.



Measure

1. Valve spring tension using J 9666 (Figure 42).
 - If spring tension is less than 360 N (81 lb.) at 45.2 mm (1.78 inch), replace spring.
2. Valve stem-to-bore clearance.

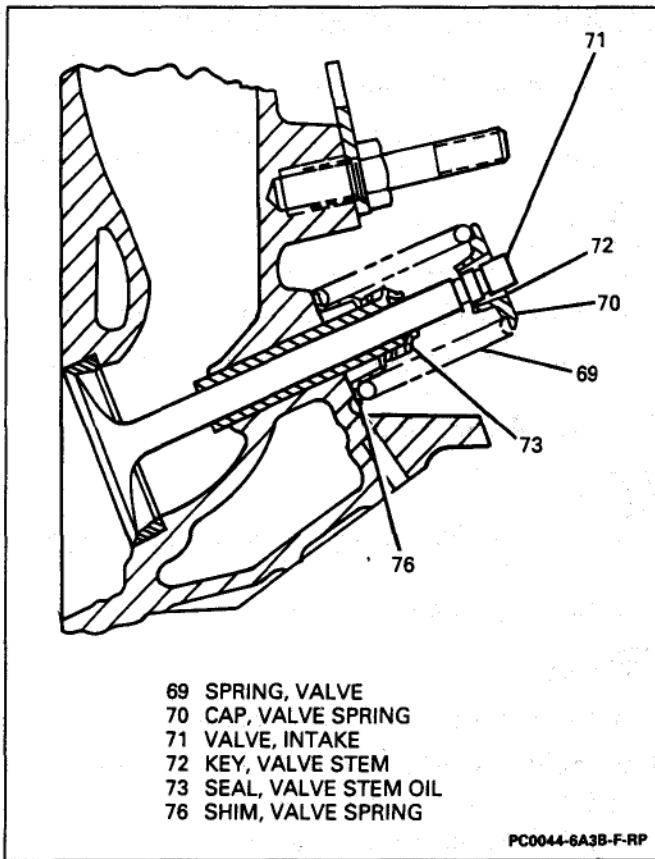


Figure 44 – Valve Assembly
(Intake Shown, Exhaust Similar)

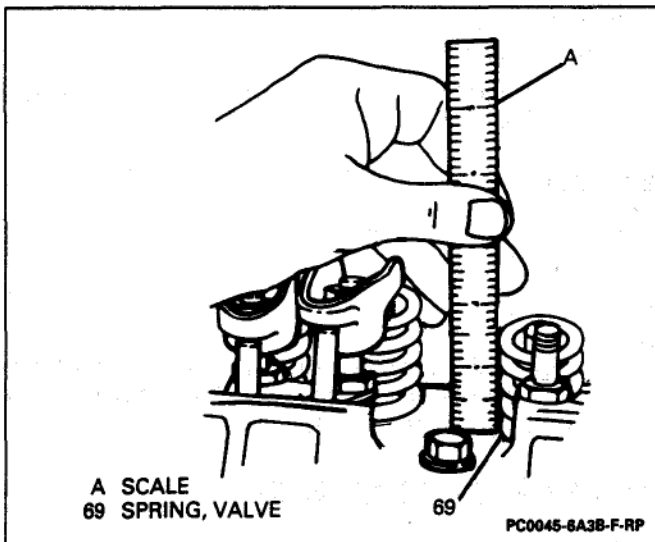


Figure 45 – Measuring Valve Spring Installation Height

Assemble

1. Shim (76) to cylinder head assembly.
2. Valve into proper port.
3. Valve seal (73) and seat seal (73) against shim (76).
4. Valve spring (69).
5. Cap (70) on valve stem.

6. Compress valve spring (69) using J 8062 (Figure 39).
7. Valve stem keys (72).
 - A. Use grease to hold keys (72) in place while disconnecting J 8062.
 - B. Make sure keys (72) seat properly in upper groove of valve stem.
 - C. Tap end of stem with a plastic-faced hammer to seat keys (72), if necessary.
8. Remaining valves.



Measure

- Valve spring installed height from valve spring seat to top of cap (Figure 45).
 - If installed height exceeds 45.2 mm (1.78 inch), install a valve spring seat shim approximately 1.6 mm (1/16 inch) thick.
 - Do not shim a valve spring to obtain a less than specified installed height.

CAMSHAFT ASSEMBLY

Figures 46 and 47

Tool Required:

J 7872 Magnetic Base Indicator Set



Measure

1. Camshaft journals with a micrometer.
 - If journals are more than 0.025 mm (0.0010 inch) out-of-round, replace with a new camshaft assembly.
2. Camshaft runout using J 7872.
 - Mount camshaft assembly in V-blocks or between centers. Using J 7872, check intermediate camshaft journal. If runout exceeds 0.038 mm (0.0015 inch) camshaft assembly is excessively bent and should be replaced.

TIMING CHAIN ASSEMBLY, CRANKSHAFT AND CAMSHAFT SPROCKETS, AND WATER PUMP DRIVESHAFT ASSEMBLY

Figures 20 and 21



Inspect

- Camshaft and crankshaft sprockets (57 and 62) and water pump driveshaft assembly (63) for wear.
- One edge of teeth worn or teeth no longer concentric.
- Valley between teeth worn.
- Key and crankshaft keyway for wear.
- Timing chain assembly for binding.

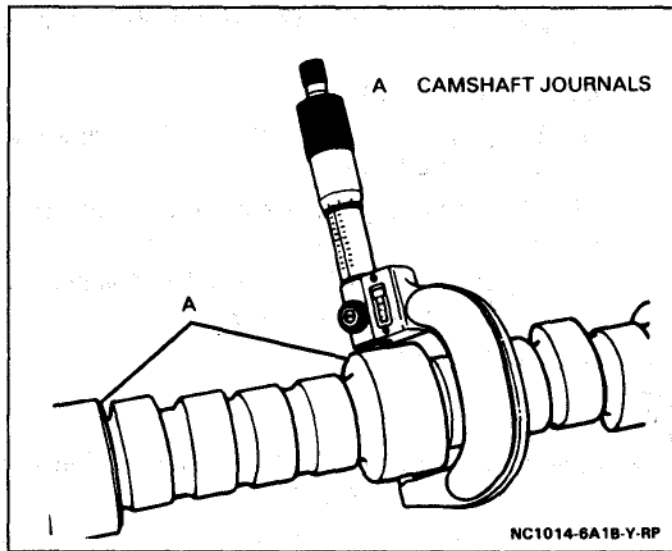


Figure 46 – Measuring Camshaft Journals

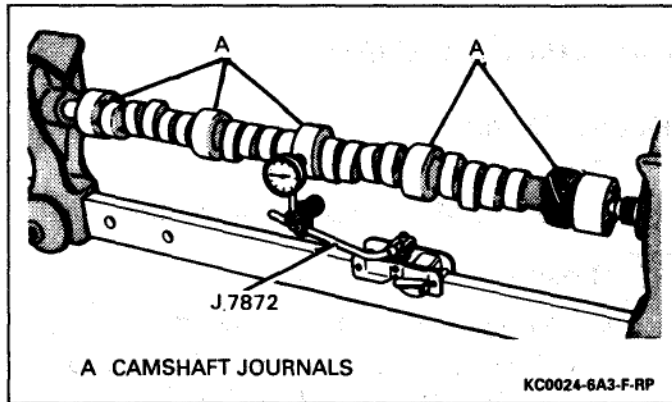


Figure 47 – Measuring Camshaft Runout

ENGINE FRONT COVER ASSEMBLY

Figure 19

Tools Required:

J 35468 Front Cover Aligner and Oil Seal Installer

J 39090 Distributor Driveshaft Front Cover Seal Installer

J 39088 Driven Gear Shaft Front Cover Seal Installer



Clean

- Front cover assembly and engine block gasket surfaces.



Inspect

- Front cover assembly (50) for damage to seals or gasket surface.

ENGINE FRONT COVER OIL SEALS



Remove or Disconnect

- Front cover oil seals for crankshaft assembly, distributor shaft and water pump driveshaft assembly.



Install or Connect

1. Crankshaft seal using J 35468.
2. Distributor driveshaft seal using J 39090.
3. Water pump driveshaft seal using J 39088.

OIL PAN ASSEMBLY



Clean

- Oil pan assembly in solvent. Remove all sludge and varnish.
- Gasket surfaces.



Inspect

- Gasket flanges for bending or damage.
- Oil pan assembly for rock damage or cracks.
- Oil pan baffle for lack of fit.
- Drain plug threads for stripping.

WATER PUMP ASSEMBLY

Figure 16

Tool Required:

J 39089 Driven Gear/Water Pump Shaft Seal Installer



Clean

- Water pump assembly (37) and engine block gasket surfaces.



Inspect

- O-ring seals (156) on water pump driveshaft assembly (63) and water pump shaft. Replace seals (156), if necessary, using J 39089.

VALVE LIFTER ASSEMBLIES

Figure 15



Inspect

- Lifter body for wear and scuffing. Also inspect bore in engine block for scuffing.
- Lifter roller for:
 - Binding or roughness.
 - Excessive looseness in roller bearings.
 - Flat spots.
 - Pitting.

- Lifter pushrod seat and pushrod end for wear or scoring.

VALVE ROCKER ARMS AND PUSHROD ASSEMBLIES

Figures 14 and 15

Inspect

- Rocker arms (29) and balls (30) at their mating surfaces. These surfaces should be smooth and free of scoring or other damage.
- Rocker arm pushrod sockets and valve stem mating surfaces. These surfaces should be smooth with no scoring or exceptional wear.
- Pushrod assemblies (27) for scored ends or bends.

VALVE ROCKER ARM COVER ASSEMBLIES

Figure 13

Clean

- Valve rocker arm cover and cylinder head gasket surfaces.

Inspect

- Gasket flanges for damage.
- Rubber grommets for deterioration.

INTAKE MANIFOLD ASSEMBLY

Figure 10

Clean

- Intake manifold bolts/screws (8) and studs (9).
- Cylinder head assembly, engine block and intake manifold sealing surfaces.

ASSEMBLY

ENGINE BLOCK

Figure 32

Install or Connect

NOTICE: See "Notice" on page 6A3B-1 of this section.

1. Engine block core plugs.
2. Front and rear oil gallery plugs.

Tighten

- Rear engine block oil gallery plugs to 24 N•m (18 lb. ft.).

Inspect

- Oil filter adapter bypass valve and spring for operation.

- For cracked or broken bypass valve.
 - Oil filter adapter and bypass valve assembly must be replaced as a unit.

3. Oil filter adapter assembly (142).
4. Oil filter adapter bolts/screws (143).

Tighten

- Oil filter adapter bolts/screws (143) to 23 N•m (17 lb. ft.).
5. Engine oil cooler assembly (141).
 6. Oil filter assembly (144).
 7. Fuel pump and oil pressure sensor assembly.
 8. Knock sensor assemblies.
 9. Starter motor assembly and bolts/screws.

Tighten

- Knock sensor assemblies to 19 N•m (14 lb. ft.).
- Starter motor bolts/screws to 46 N•m (34 lb. ft.).
- Fuel pump switch and oil pressure gage sensor assembly to 12 N•m (108 lb. in.).

CAMSHAFT BEARINGS

Figures 30, 31 and 48

Tool Required:

J 6098-01 Camshaft Bearing Remover/Installer

Outer front and rear camshaft bearings must be installed first. These bearings serve as guides for tool pilot, and help center inner bearings during installation process.

Install or Connect

Important

- Align camshaft bearing oil holes properly during installation.
 - Number one (front) camshaft bearing oil holes must be positioned so that they are at 1 o'clock and 5 o'clock positions.
 - Number two through number four inner camshaft bearing oil holes must be positioned at 5 o'clock toward left side of engine block and even with bottom of cylinder bore.
 - Number five (rear) camshaft bearing oil hole must be positioned at 12 o'clock.
1. Front and rear camshaft bearings using J 6098-01.
 - A. Assemble bearing tool to driver handle.
 - B. Align oil holes as outlined above.
 - C. Drive front and rear bearings in, toward center of engine block.
 2. Inner camshaft bearings using J 6098-01.
 - A. With nut and thrust washer assembled to end of puller screw threads, index pilot in camshaft

front bearing and install puller screw through pilot.

- B. Index camshaft bearing in bore, aligning oil hole as outlined above.
 - C. Install puller screw through bearing bore and bearing to be installed and assemble bearing tool to puller screw with shoulder toward bearing. Make sure that enough threads are engaged.
 - D. Using two wrenches, hold puller screw while turning nut to draw bearing into bore.
 - When bearing has been pulled into bore, remove bearing tool and puller screw and check alignment of bearing oil hole to bore oil hole.
 - E. Repeat above steps for remaining inner camshaft bearings.
 - Index pilot in rear camshaft bearing to install rear inner bearing.
3. New camshaft rear bearing hole plug (68).
- A. Coat plug outside diameter with GM P/N 1052080 sealant, or equivalent.
 - B. Install camshaft rear bearing hole plug (68) as shown in Figure 48.

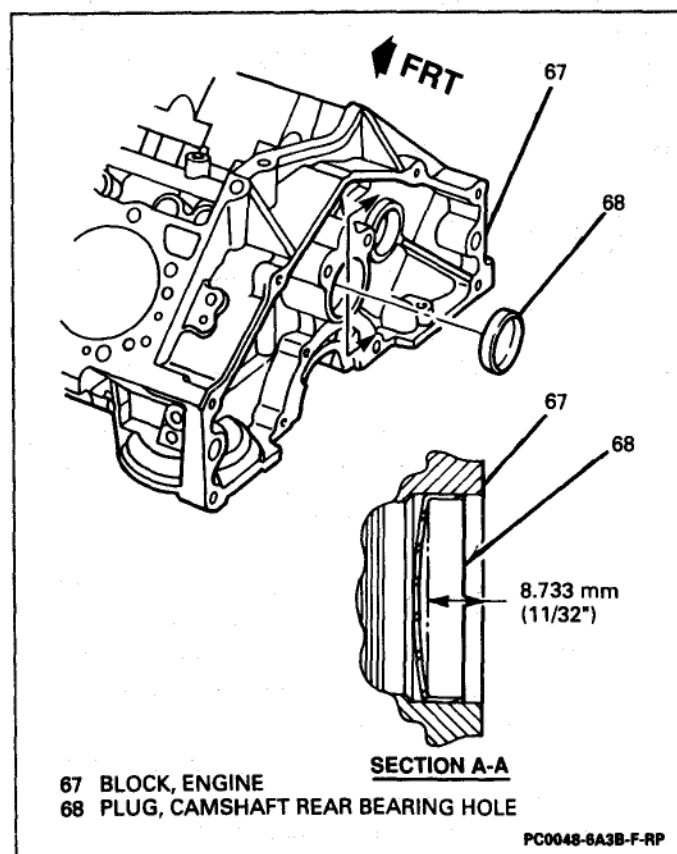


Figure 48 - Camshaft Rear Bearing Hole Plug

CRANKSHAFT ASSEMBLY

Figure 28

Install or Connect

NOTICE: See "Notice" on page 6A3B-1 of this section.

1. Crankshaft bearings (110 and 111) into engine block (67) and crankshaft bearing caps (107) and rear crankshaft bearing cap (109).
 - Coat crankshaft bearings (110 and 111) with oil.
2. Crankshaft assembly (98).
3. Crankshaft bearing caps (107) and rear crankshaft bearing cap (109) with assembled crankshaft bearings (110 and 111) with arrows pointing toward front of engine block.
4. Crankshaft bearing cap bolts/screws (108) and studs.
 - With crankshaft assembly (98), crankshaft bearings (110 and 111) and crankshaft bearing caps (107) and rear crankshaft bearing cap (109) installed and bolts/screws (108) and studs started, thrust crankshaft assembly (98) rearward to set and align bearing caps (107 and 109). Then thrust crankshaft assembly forward to align rear faces of rear crankshaft bearings (111).

Tighten

- Crankshaft bearing cap bolts/screws (108) and studs to 106 N•m (78 lb. ft.).

Measure

- Crankshaft end play using a dial indicator or feeler gage. Refer to "Specifications" in this section.
 - If using a feeler gage, measure between front of rear crankshaft bearing cap (109) and crankshaft thrust surface.

CRANKSHAFT REAR OIL SEAL HOUSING

Figure 28

Clean

- Gasket surfaces.

Install or Connect

NOTICE: See "Notice" on page 6A3B-1 of this section.

Important

- Always use new crankshaft rear oil seal and new housing gasket (113) during installation of crankshaft rear oil seal housing assembly (114).

1. New gasket (113) and crankshaft rear oil seal housing assembly (114) on studs (112).

- It is not necessary to use any type of sealant to hold gasket (113) in place.
2. Crankshaft rear oil seal housing nuts (115) and bolts/screws (116).

Tighten

- Crankshaft rear oil seal housing nuts (115) and bolts/screws (116) to 15 N•m (11 lb. ft.).

CRANKSHAFT REAR OIL SEAL

Figures 28 and 49

Tool Required:

J 35621 Rear Main Seal Installer

Install or Connect

1. Coat new seal entirely with engine oil.
2. Seal onto J 35621.
3. J 35621 onto rear of crankshaft assembly (98). Tighten screws snugly to ensure seal will be installed squarely over crankshaft assembly (98).
4. Crankshaft rear oil seal to crankshaft assembly (98) and crankshaft rear oil seal housing (114).
 - Tighten wing nut on J 35621 until it bottoms.
5. Remove J 35621 from crankshaft rear oil seal housing (114).

PISTON AND CONNECTING ROD ASSEMBLY

Figures 27 and 50

Install or Connect

Tool Required:

J 8037 Piston Ring Compressor

J 5239 Connecting Rod Bolt Guide Set

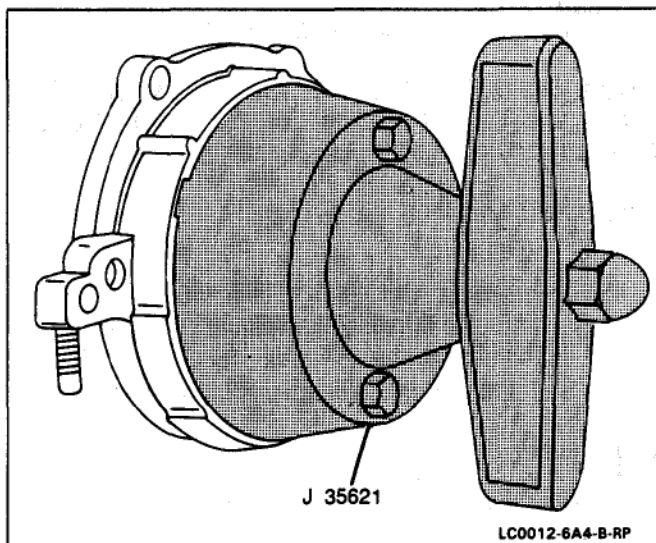


Figure 49 – Installing Crankshaft Rear Oil Seal

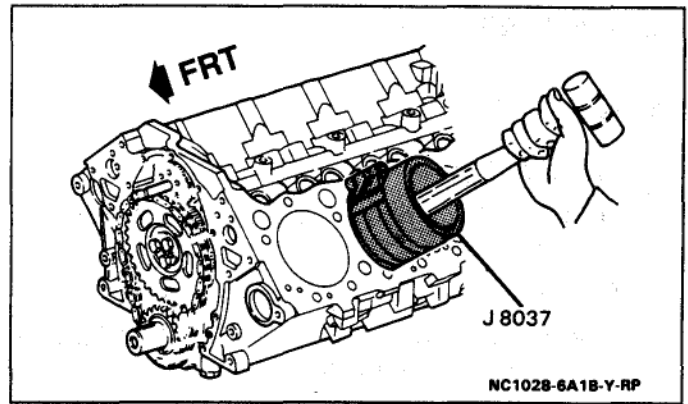


Figure 50 – Installing Piston Assembly

1. Coat piston assembly (103), piston rings, cylinder bore, and bearing surfaces with engine oil.
2. Piston assembly (103) with stamped arrow facing forward into its matched bore using J 8037 and J 5239 and lightly tapping top of piston assembly (103) with wooden hammer handle.
 - Hold J 8037 firmly against engine block until all piston rings have entered cylinder bore.
 - Guide connecting rod using J 5239.
 - Remove J 5239.

CONNECTING ROD BEARINGS

Figure 27

Install or Connect

NOTICE: See "Notice" on page 6A3B-1 of this section.

1. Coat inside surface of bearings (101) with engine oil.

Important

- When assembled, flanges on connecting rod assembly and cap should face to front in left bank and to rear in right bank.
2. Connecting rod cap (99) and bearings (101).
 3. Connecting rod nuts (100).

Tighten

- Connecting rod nuts (100), evenly, to 64 N•m (47 lb. ft.).

Measure

1. When all connecting rod bearings (101) have been installed, tap each connecting rod assembly lightly parallel to crankpin to make sure they have clearance.
2. Side clearance between connecting rod caps (99) using a feeler gage or dial indicator.
 - Rod side clearance should be 0.16 to 0.35 mm (0.006 to 0.014 inch).

OIL PUMP ASSEMBLY

Figure 26

 Install or Connect

NOTICE: See "Notice" on page 6A3B-1 of this section.

1. Oil pump assembly (118) and driveshaft (89).
 - Align slot on end of driveshaft (89) with drive tang on oil pump shaft.
2. Oil pan baffle (119).
3. Bolt/screw (120) attaching oil pump assembly (118) to rear crankshaft bearing cap.
4. Oil pan baffle nuts.

 Tighten

- Oil pump bolt/screw (120) to 88 N•m (65 lb. ft.).
- Oil pan baffle nuts to 34 N•m (25 lb. ft.).

CYLINDER HEAD ASSEMBLY

Figures 24 and 51

 Install or Connect

NOTICE: See "Notice" on page 6A3B-1 of this section.

1. New cylinder head gasket (82).
2. Gasket (82) over locating pins, with yellow side of tab on outboard side facing up.
3. Cylinder head assembly (34) over locating pins and gasket (82).
 - Coat threads of cylinder head bolts/screws (81) with sealing compound, GM P/N 1052080 or equivalent.
4. Cylinder head bolts/screws (81) finger tight.

 Tighten

- Cylinder head bolts/screws (81) in sequence and in three passes to 88 N•m (65 lb. ft.) (Figure 51).
5. Spark plugs.
 6. Engine coolant air bleed pipe and bolts/screws.
 - Use a backup wrench on pipe fittings when installing bolts/screws.

 Tighten

- Engine coolant air bleed pipe bolts/screws to 41 N•m (30 lb. ft.).
- Spark plugs to 15 N•m (11 lb. ft.).

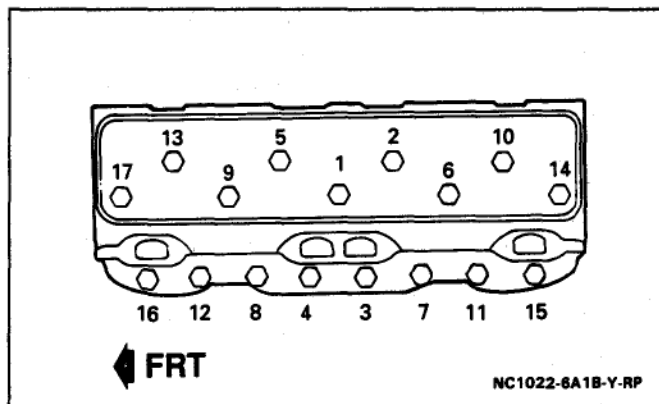


Figure 51 – Cylinder Head Tightening Sequence

CAMSHAFT ASSEMBLY

Figures 20, 22 and 23

When installing new camshaft assembly, coat camshaft lobes and journals with engine oil. Also, inspect all valve lifter assemblies and replace as necessary to ensure durability of camshaft lobes and lifter rollers.

 Install or Connect

NOTICE: See "Notice" on page 6A3B-1 of this section.

1. Camshaft assembly (60).
2. Camshaft retainer (59) and camshaft retainer bolts/screws (58).

 Tighten

- Camshaft retainer bolts/screws (58) to 12 N•m (108 lb. in.).
3. Oil pump driveshaft assembly (65) and bolt/screw (66).
 - Bolt/screw hole "ear" must be seated on boss before tightening bolt/screw (66).

 Tighten

- Bolt/screw (66) to 18 N•m (13 lb. ft.).

TIMING CHAIN ASSEMBLY, CRANKSHAFT AND CAMSHAFT SPROCKETS, AND WATER PUMP DRIVESHAFT ASSEMBLY

Figures 20 and 21

Tools Required:

- J 5590 Crankshaft Gear Installer
- J 39089 Driven Gear/Water Pump Shaft Seal Installer
- J 39092 Driven Gear Assembly Installer

 Install or Connect

NOTICE: See "Notice" on page 6A3B-1 of this section.

1. Key, if previously removed.
2. Crankshaft sprocket (62) using J 5590.

3. Water pump driveshaft assembly (63) using J 39092.
4. Water pump driveshaft bearing retainer bolts/screws (64).

Tighten

- Water pump driveshaft bearing retainer bolts/screws (64) to 12 N•m (108 lb. in.).
5. Camshaft sprocket (57) and timing chain assembly (61).
 - Gears must mesh, or damage to camshaft retainer could occur.
 6. Camshaft sprocket bolts/screws (56).
 - Make sure that camshaft and crankshaft timing marks align as shown in Figure 20.

Tighten

- Camshaft sprocket bolts/screws (56) to 28 N•m (21 lb. ft.).
7. New O-ring seal to water pump driveshaft assembly (63) using J 39089.

ENGINE FRONT COVER ASSEMBLY

Figure 19

Tool Required:

J 39087 Driven Gear Shaft Front Cover Seal Protector

Install or Connect

NOTICE: See "Notice" on page 6A3B-1 of this section.

NOTICE: Be careful not to damage seal when installing front cover assembly over water pump driveshaft assembly.

1. Gasket (51) and front cover assembly (50) using J 39087 on water pump driveshaft assembly.
2. Front cover bolts/screws (52).

Tighten

- Front cover bolts/screws (52) to 11 N•m (100 lb. in.).

DISTRIBUTOR ASSEMBLY

Figure 18

Important

- Distributor driveshaft (48) has a keyway (missing spline) on both ends that positively locates distributor assembly (49) to camshaft sprocket.
- Install distributor driveshaft (48) to camshaft sprocket. Rotate crankshaft assembly until keyway on driveshaft distributor end is near 12 o'clock position. Remove distributor driveshaft (48), install in distributor assembly (49) and turn until keyway on camshaft sprocket end is in same position (12

o'clock) when crankshaft assembly was turned. This will help make installation of distributor assembly (49) easier.

Install or Connect

NOTICE: See "Notice" on page 6A3B-1 of this section.

1. Distributor assembly (49) and distributor driveshaft (48).
2. Before torquing bolts/screws, make sure distributor assembly is properly seated. If it is difficult to seat, check shaft alignment.
3. Distributor bolts/screws (47).

Tighten

- Distributor bolts/screws (47) to 12 N•m (106 lb. in.).
4. Ignition coil and bracket assembly and studs.
- ### Tighten
- Ignition coil studs to 34 N•m (25 lb. ft.).
5. Spark plug and ignition harness assemblies to distributor assembly (49) if removed.

OIL PAN ASSEMBLY

Figures 52 and 53

Install or Connect

1. Apply a small amount of sealer, GM P/N 1052914 or equivalent, to front cover assembly and engine block junction and to rear seal housing and engine block junction. Apply sealer 25 mm (1 inch) in either direction of radius cavity of junctions. See Figure 52.
2. Oil pan gasket (55), oil pan assembly (54) and reinforcements (53).
3. Oil pan nuts (85), bolts/screws (84) and studs (83).

Tighten

- Corner bolts/screws (84) or stud (83), and nuts (85) to 20 N•m (15 lb. ft.).
 - Remainder of bolts/screws (84) and studs (83) to 11 N•m (100 lb. in.).
4. Oil level sensor assembly (178).

Tighten

- Oil level sensor assembly (178) to 35 N•m (26 lb. ft.).

CRANKSHAFT BALANCER ASSEMBLY AND HUB

Figure 17

Tool Required:

J 39046 Crankshaft Hub Remover/Installer

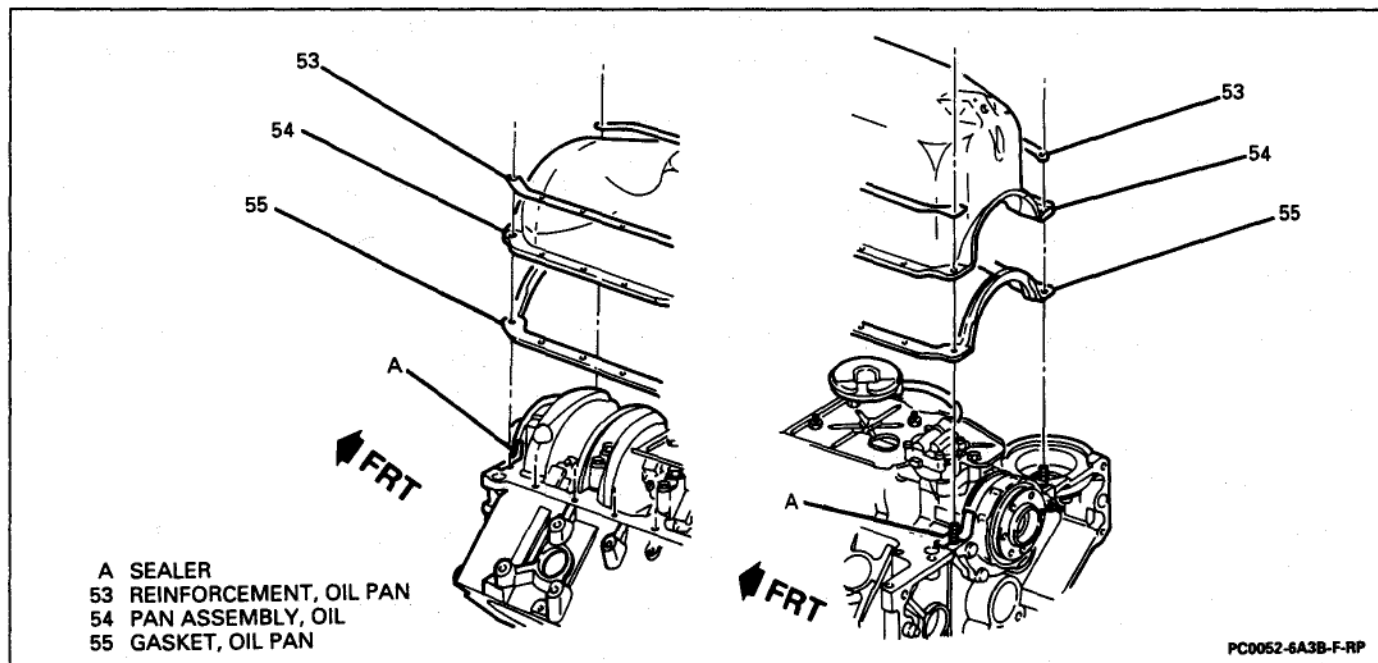


Figure 52 - Oil Pan Seal

Install or Connect

NOTICE: See "Notice" on page 6A3B-1 of this section.

1. Crankshaft balancer hub (45) must be installed by following procedure:
 - A. Set number 1 piston assembly to top dead center.
 - B. Install crankshaft balancer hub with cast arrow on hub in 12 o'clock position.
2. Crankshaft balancer hub (45) using J 39046.
3. Crankshaft balancer hub washer and bolt/screw.
4. Crankshaft balancer assembly (42) and bolts/screws (46).

Important

- If crankshaft balancer assembly is replaced, new balancer weights of same size must be installed on new balancer assembly in same location as old balancer assembly.
 - A. Measure depth of empty balancer weight hole. Record measurement.
 - B. Drive weights in old balancer to bottom of hole then measure depth of hole. Record measurement.
 - C. Subtract measurement of hole with weight from measurement of empty hole. Difference will be the length of the balancer weight that must be installed in the new balancer assembly in the same location.

Tighten

- Crankshaft balancer hub bolt/screw to 102 N•m (75 lb. ft.).
- Crankshaft balancer bolts/screws (46) to 81 N•m (60 lb. ft.).

WATER PUMP ASSEMBLY

Figure 16

Install or Connect

NOTICE: See "Notice" on page 6A3B-1 of this section.

1. Coupling (39) to water pump shaft with groove on coupling toward engine block.
 - Apply a light coat of grease to O-ring seals and grease to coupling.
2. Position water pump assembly (37) and gaskets (38), with tabs straight up, to engine block and rotate coupling (39), if necessary, to align it to water pump driveshaft splines and then seat water pump assembly (37).
3. Water pump bolts/screws (40 and 41).

Tighten

- Water pump bolts/screws (40 and 41) to 41 N•m (30 lb. ft.).
4. Air injection pump bracket and bolts/screws.

Tighten

- Air injection pump bracket bolts/screws to 25 N•m (18 lb. ft.).

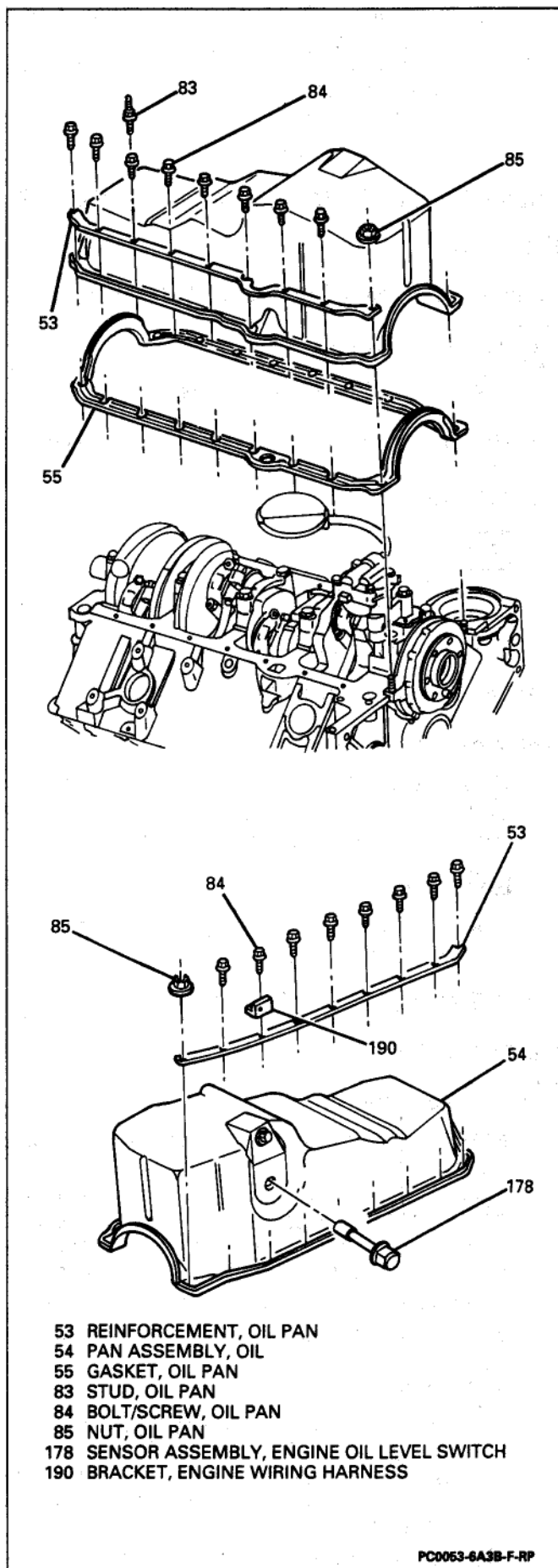


Figure 53 - Oil Pan Assembly

VALVE LIFTER ASSEMBLIES

Figure 15

Install or Connect

NOTICE: See "Notice" on page 6A3B-1 of this section.

1. Coat valve lifter rollers with prelube, GM P/N 1052365 or equivalent.
2. Valve lifter assemblies (36) in same location from which they were removed.
3. Valve lifter guides (35), retainer (33) and valve lifter guide retainer bolts/screws (32).

Tighten

- Valve lifter guide retainer bolts/screws (32) to 20 N•m (15 lb. ft.).

VALVE ROCKER ARM BALL STUDS

Figure 14

Install or Connect

NOTICE: See "Notice" on page 6A3B-1 of this section.

1. Apply sealer, GM P/N 1052080 or equivalent, to threads of new rocker arm ball stud.
2. Rocker arm ball stud (28).

Tighten

- Valve rocker arm ball stud (28) to 68 N•m (50 lb. ft.).

VALVE ROCKER ARMS AND PUSHROD ASSEMBLIES

Figures 14 and 54

Tool Required:

J 8520 Cam Lobe Lift Indicator

Install or Connect

1. Coat rocker arm and rocker arm ball bearing surfaces with prelube, GM P/N 1052365 or equivalent, when installing. Install these components and pushrod assemblies (27) in locations from which they were removed.
2. Pushrod assemblies (27). Make sure pushrod assemblies (27) seat in lifter sockets.

Measure

- Camshaft lobe lift.
 - A. Position J 8520 with ball socket adapter on pushrod assembly. Make sure pushrod assembly is in lifter socket.
 - B. Rotate crankshaft assembly slowly in direction of rotation until lifter roller is on heel of cam lobe. At this point, pushrod assembly will be in its lowest position.

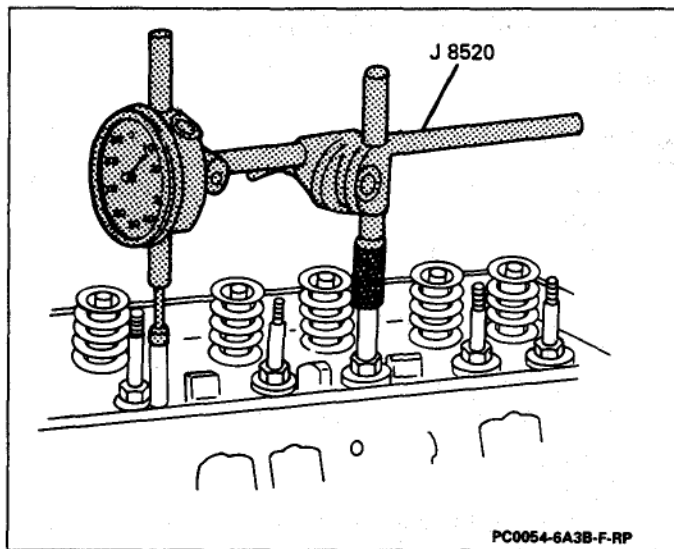


Figure 54 – Measuring Camshaft Lobe Lift

- C. Set J 8520 on zero.
- D. Rotate crankshaft assembly slowly until pushrod assembly is in fully raised position.
- E. Compare total lift shown on J 8520 with specifications. Refer to "Specifications" in this section.
- F. Remove J-8520.

3. Rocker arms (29).
4. Rocker arm balls (30) and nuts (31).

**Adjust**

- Rocker arm nuts until all lash is eliminated.
 - A. Turn crankshaft assembly until cast arrow on crankshaft balancer hub is in 12 o'clock position and number 1 cylinder is in firing position (top dead center).
 - Watch number 1 cylinder valves as crankshaft balancer hub arrow approaches 12 o'clock position. If a valve moves as arrow moves to position, engine assembly is in number 6 cylinder firing position. Crankshaft assembly must then be turned one more time to reach number 1 cylinder firing position.
 - B. With engine assembly in number 1 cylinder firing position, following valves can be adjusted:
 - Exhaust 1, 3, 4, 8
 - Intake 1, 2, 5, 7
 - C. Back off rocker arm nut (31) until lash is felt in pushrod assembly (27). Then tighten rocker arm nut (31) until all lash is removed. Zero lash can be felt by moving pushrod assembly (27) up and down using thumb and forefinger until there is no more movement.
 - D. When all free play has been removed, tighten rocker arm nut (31) one additional turn (360 degrees).

E. Turn crankshaft assembly one revolution until hub arrow is again at 12 o'clock position. This is number 6 cylinder firing position. Following valves can now be adjusted:

- Exhaust 2, 5, 6, 7
- Intake 3, 4, 6, 8

VALVE ROCKER ARM COVER ASSEMBLIES*Figure 13***Right Valve Rocker Arm Cover Assembly****Install or Connect**

NOTICE: See "Notice" on page 6A3B-1 of this section.

1. Gasket (25) and valve rocker arm cover assembly (23).
2. Valve rocker arm cover bolts/screws (24).

**Tighten**

- Valve rocker arm cover bolts/screws (24) to 11 N•m (100 lb. in.).
3. Crankcase vent hose.

Left Valve Rocker Arm Cover Assembly**Install or Connect**

1. Gasket (25) and valve rocker arm cover assembly (23).
2. Valve rocker arm cover bolts/screws (24).

**Tighten**

- Valve rocker arm cover bolts/screws (24) to 11 N•m (100 lb. in.).

INTAKE MANIFOLD ASSEMBLY*Figures 9, 10 and 55***Install or Connect**

NOTICE: See "Notice" on page 6A3B-1 of this section.

1. Apply a 5 mm (3/16-inch) bead of RTV sealer, GM P/N 1052366 or equivalent, to front and rear of engine block. Extend bead 13 mm (1/2 inch) up each cylinder head assembly to seal and retain gaskets.
2. Intake manifold assembly (6) with new gaskets (10).
3. Intake manifold bolts/screws (8) and studs (9).

**Tighten**

- Intake manifold bolts/screws (8) and studs (9) in a first pass to 8 N•m (71 lb. in.) in sequence as shown in Figure 55. Tighten in sequence in a second pass to final specifications of 48 N•m (35 lb. ft.).
4. Throttle body assembly (3), gasket (5) and bolts/screws (4).

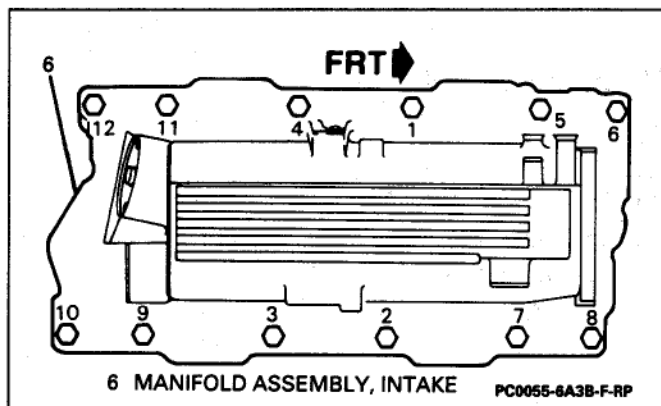


Figure 55 - Intake Manifold Tightening Sequence

Tighten

- Throttle body bolts/screws (4) to 26 N•m (19 lb. ft.).
5. Accelerator cable bracket.
 6. Engine coolant air bleed pipe and bolts/screws.

Tighten

- Accelerator control cable bracket bolts/screws to 10 N•m (90 lb. in.).
 - Engine coolant air bleed pipe bolts/screws to 41 N•m (30 lb. ft.).
 - Use a backup wrench when tightening engine coolant air bleed pipe bolts/screws.
7. EGR valve assembly and nuts.
 8. EGR solenoid assembly and nut.

Tighten

- EGR valve nuts and EGR control valve relay nut to 22 N•m (16 lb. ft.).
9. Canister purge valve assembly bracket and bolt/screw.

Tighten

- Evaporative emission canister purge solenoid valve bracket bolt/screw to 6 N•m (53 lb. in.).
10. EGR vacuum harness assembly and crankcase vent hoses.
 11. Generator bracket assembly, spark plug wire support and bolts/screws.

Tighten

- Generator bracket bolts/screws to 42 N•m (31 lb. ft.).
12. Canister purger valve vacuum hose.
 13. Fuel injectors with fuel rail assembly (2) to intake manifold assembly (6).
 14. Fuel pressure regulator vacuum tube assembly (7).
 15. Fuel rail bolts/screws (1).

Tighten

- Fuel injection fuel rail bolts/screws (1) to 10 N•m (89 lb. in.).
16. Wiring harness assemblies if moved or disconnected.
 17. MAP sensor and bolts/screws.

Tighten

- Map sensor bolts/screws to 6 N•m (53 lb. in.).

EXHAUST MANIFOLD ASSEMBLIES

Figures 11 and 12

Right Exhaust Manifold Assembly

Install or Connect

NOTICE: See “Notice” on page 6A3B-1 of this section.

1. Exhaust manifold gasket (18), manifold assembly (19) and heat shields.
2. Exhaust manifold studs (20) and bolts/screws (21) and spacers (245).

Tighten

- Exhaust manifold studs (20) and bolts/screws (21) to 47 N•m (35 lb. ft.).
3. Air injection pipe assembly (15) and check valve (11).

Tighten

- Secondary air injection pipe fitting-to-exhaust manifold assembly to 34 N•m (25 lb. ft.).
4. Apply sealer, GM P/N 1052080 or equivalent, around oil level indicator tube 13 mm (1/2 inch) below bead.
 5. Oil level indicator, tube and bolt/screw to engine block.

Tighten

- Oil level indicator bolt/screw to 11 N•m (100 lb. in.).
6. Spark plug wire harness assembly.
 7. EGR valve pipe gasket (22), pipe assembly (12), nut (14) and bolt/screw (229).

Tighten

- EGR valve pipe nuts (14) and bolt/screw (229) to 25 N•m (18 lb. ft.).

Left Exhaust Manifold Assembly

Install or Connect

NOTICE: See “Notice” on page 6A3B-1 of this section.

1. Exhaust manifold gasket (17), manifold assembly (16) and heat shields.
2. Exhaust manifold stud (20) and bolts/screws (21) and spacers (245).

**Tighten**

- Exhaust manifold stud (20) and bolts/screws (21) to 47 N•m (35 lb. ft.).
3. Spark plug wire harness assembly.
 4. Secondary air injection pipe assembly (15), and check valve (11).

**Tighten**

- Secondary air injection pipe fitting-to-exhaust

manifold assembly to 34 N•m (25 lb. ft.).

FLYWHEEL ASSEMBLY**Figure 8****Install or Connect**

1. Flywheel assembly (135 or 137) to crankshaft assembly (98).
 - Align locator hole to pin (133).
2. Flywheel bolts/screws (136 or 138).

**Tighten**

- Flywheel bolts/screws (136 or 138) to 100 N•m (74 lb. ft.).

SPECIFICATIONS**FASTENER TIGHTENING SPECIFICATIONS**

Accelerator Control Cable Bracket Bolt/Screw	10 N•m (90 lb. in.)
Camshaft Retainer Bolt/Screw	12 N•m (108 lb. in.)
Camshaft Sprocket Bolt/Screw	28 N•m (21 lb. ft.)
Connecting Rod Nut	64 N•m (47 lb. ft.)
Coolant Air Bleed Pipe Bolt/Screw	41 N•m (30 lb. ft.)
Crankshaft Balancer Bolt/Screw	81 N•m (60 lb. ft.)
Crankshaft Balancer Hub Bolt/Screw	102 N•m (75 lb. ft.)
Crankshaft Bearing Cap Bolt/Screw and Stud	106 N•m (78 lb. ft.)
Crankshaft Rear Oil Seal Housing Nut and Bolt/Screw	15 N•m (11 lb. ft.)
Cylinder Head Bolt/Screw	88 N•m (65 lb. ft.)
Distributor Bolt/Screw	12 N•m (106 lb. in.)
Drain Plug	14 N•m (10 lb. ft.)
EGR Control Valve Relay Nut	22 N•m (16 lb. ft.)
EGR Valve Nut	22 N•m (16 lb. ft.)
EGR Valve Pipe Bolt/Screw and Nut	25 N•m (18 lb. ft.)
Engine Block Oil Gallery Plug	24 N•m (18 lb. ft.)
Engine Front Cover Bolt/Screw	11 N•m (100 lb. in.)
Engine Oil Level Sensor Assembly	35 N•m (26 lb. ft.)
Evaporative Emission Canister Purge Solenoid Valve Bracket Bolt/Screw	6 N•m (53 lb. in.)
Exhaust Manifold Stud and Bolt/Screw	47 N•m (35 lb. ft.)
Flywheel Bolt/Screw	100 N•m (74 lb. ft.)
Fuel Injection Fuel Rail Bolt/Screw	10 N•m (89 lb. in.)
Fuel Pump Switch and Oil Pressure Gage Sensor Assembly	12 N•m (108 lb. in.)
Generator Bracket Bolt/Screw	42 N•m (31 lb. ft.)
Ignition Coil Stud	34 N•m (25 lb. ft.)
Intake Manifold Bolt/Screw and Stud	
First Pass	8 N•m (71 lb. in.)
Final Pass	48 N•m (35 lb. ft.)
Knock Sensor Assembly	19 N•m (14 lb. ft.)
MAP Sensor Bolt/Screw	6 N•m (53 lb. in.)
Oil Filter Adapter Bolt/Screw	23 N•m (17 lb. ft.)
Oil Level Indicator Tube Bolt/Screw	11 N•m (100 lb. in.)
Oil Pan Assembly	
Corner Bolt/Screw and Nut	20 N•m (15 lb. ft.)
Side Rail Bolt/Screw	11 N•m (100 lb. in.)
Oil Pan Baffle Nut	34 N•m (25 lb. ft.)
Oil Pan Drain Plug	22 N•m (16 lb. ft.)
Oil Pump Bolt/Screw-to-Rear Crankshaft Bearing Cap	88 N•m (65 lb. ft.)
Oil Pump Cover Bolt/Screw	9 N•m (80 lb. in.)
Oil Pump Driveshaft Bolt/Screw	18 N•m (13 lb. ft.)
Secondary Air Injection Pipe Fitting-to-Exhaust Manifold Assembly	34 N•m (25 lb. ft.)
Secondary Air Injection Pump Bracket Bolt/Screw	25 N•m (18 lb. ft.)

Starter Motor Bolt/Screw	46 N•m (34 lb. ft.)
Throttle Body Bolt/Screw	26 N•m (19 lb. ft.)
Valve Lifter Guide Retainer Bolt/Screw	20 N•m (15 lb. ft.)
Valve Rocker Arm Ball Stud	68 N•m (50 lb. ft.)
Valve Rocker Arm Cover Bolt/Screw	11 N•m (100 lb. in.)
Water Pump Bolt/Screw and Stud	41 N•m (30 lb. ft.)
Water Pump Driveshaft Bearing Retainer Bolt/Screw	12 N•m (108 lb. in.)

ENGINE ASSEMBLY SPECIFICATIONS 5.7L (LT1)

GENERAL

Type	V8
Displacement	5.7L (350 CID)
Bore	101.60 mm (4.000")
Stroke	88.39 mm (3.480")
Compression Ratio	10.5:1
Firing Order	1-8-4-3-6-5-7-2
Spark Plugs	
Type	AC41-906
Gap	1.27 mm (0.050")
Torque	15 N•m (11 lb. ft.)
Oil Pressure (Minimum)	41.4 kPa (6.0 psig) at 1,000 engine rpm
	124.1 kPa (18.0 psig) at 2,000 engine rpm
	165.5 kPa (24.0 psig) at 4,000 engine rpm
Oil Filter Torque	19 N•m (14 lb. ft.)

CYLINDER BORE

Diameter	101.618 – 101.643 mm (4.0007 – 4.0017")
Out-of-Round	
Production	0.02 mm (0.001") MAX.
Service Limit	0.05 mm (0.002") MAX.
Taper	
Production	
Thrust Side	0.012 mm (0.0005") MAX.
Relief Side	0.025 mm (0.0010") MAX.
Service Limit	0.025 mm (0.0010") MAX.

PISTON ASSEMBLY

Piston Bore Clearance	
Production	0.025 – 0.068 mm (0.0010 – 0.0027")
Service Limit	0.068 mm (0.0027") MAX.

PISTON RINGS

Piston Compression Ring	
Groove Clearance	
Production Top	0.030 – 0.068 mm (0.0012 – 0.0027")
Production 2nd	0.038 – 0.078 mm (0.0015 – 0.0031")
Service Limit	0.107 mm (0.0042") MAX.
Gap	
Production Upper	0.25 – 0.50 mm (0.010 – 0.020")
Production Lower	0.46 – 0.66 mm (0.018 – 0.026") MAX.
Service Limit	0.88 mm (0.035") MAX.
Piston Oil Ring	
Groove Clearance	
Production	0.051 – 0.17 mm (0.002 – 0.007")
Service Limit	0.20 mm (0.008") MAX.
Gap	
Production	0.25 – 0.76 mm (0.010 – 0.030")
Service Limit	1.65 mm (0.065") MAX.

PISTON PIN

Diameter	23.546 – 23.548 mm (0.9270 – 0.9271")
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Clearance in Piston Assembly

Production	0.0127 – 0.0203 mm (0.0005 – 0.0008")
Service Limit	0.025 mm (0.0010") MAX.
Fit In Connecting Rod Assembly	0.013 – 0.050 mm (0.0005 – 0.0020") Interference

CRANKSHAFT ASSEMBLY

Main Journal

Diameter #162	.189 – 62.212 mm (2.4484 – 2.4493")
Diameter #2, #3, #462	.182 – 62.205 mm (2.4481 – 2.4490")
Diameter #562	.177 – 62.120 mm (2.4479 – 2.4488")

Taper

Production	0.005 mm (0.0002") MAX.
Service Limit	0.025 mm (0.0010") MAX.

Out-of-Round

Production	0.005 mm (0.0002") MAX.
Service Limit	0.025 mm (0.0010") MAX.

Crankshaft Bearing Clearance

Production #10	.020 – 0.051 mm (0.0008 – 0.0020")
Production #2, #3, #40	.028 – 0.051 mm (0.0011 – 0.0020")
Production #50	.043 – 0.081 mm (0.0017 – 0.0032")
Service Limit #10	.025 – 0.038 mm (0.0010 – 0.0015")
Service Limit #2, #3, #40	.025 – 0.064 mm (0.0010 – 0.0025")
Service Limit #50	.064 – 0.089 mm (0.0025 – 0.0035")

Crankshaft Assembly End Play 0.03 – 0.17 mm (0.001 – 0.007")

Crankshaft Assembly Runout (at rear flange) 0.038 mm (0.0015")

CONNECTING ROD ASSEMBLY

Connecting Rod Journal

Diameter	53.284 – 53.334 mm (2.0978 – 2.0998")
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Taper

Production	0.007 mm (0.0003") MAX.
Service Limit	0.025 mm (0.0010") MAX.

Out-of-Round

Production	0.007 mm (0.0003") MAX.
Service Limit	0.025 mm (0.0010") MAX.

Rod Bearing Clearance

Production	0.033 – 0.088 mm (0.0013 – 0.0035")
Service Limit	0.076 mm (0.0030") MAX.

Rod Side Clearance 0.16 – 0.35 mm (0.006 – 0.014")

CAMSHAFT ASSEMBLY

Journal Diameter 47.440 – 47.490 mm (1.8677 – 1.8697")

End Play 0.11 – 0.30 mm (0.004 – 0.012")

Lobe Lift ± 0.050 mm (0.002")

Intake 7.62 mm (0.300")

Exhaust 7.80 mm (0.307")

VALVE SYSTEM

Lifter Assembly Hydraulic

Rocker Arm Ratio 1.50:1

Valve Lash $1 \pm 1/4$ turn down from zero lash

Face Angle 45°

Seat Angle 46°

Seat Runout 0.05 mm (0.002") MAX.

Seat Width

Intake 0.76 – 1.27 mm (0.030 – 0.050")

Exhaust 1.52 – 2.03 mm (0.060 – 0.080")

Stem Clearance

Production

Intake	0.023 – 0.069 mm (0.0009 – 0.0027")
Exhaust	0.023 – 0.069 mm (0.0009 – 0.0027")

Service

Intake	0.093 mm (0.0037") MAX.
Exhaust	0.119 mm (0.0047") MAX.

Valve Spring

Free Length 51.1 mm (2.01")

Pressure	
Closed	360 – 395 N at 45.2 mm (81 – 89 lb. at 1.78")
Open	1121 – 1208 N at 33.1 mm (252 – 272 lb. at 1.305")
Installed Height	
Intake	45.2 mm (1.78")
Exhaust	45.2 mm (1.78")
Valve Lift	
Intake	11.43 mm (0.450")
Exhaust	11.68 mm (0.460")

SPECIAL TOOLS



1. J 5590



2. J 39087



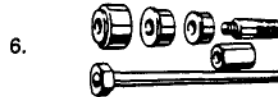
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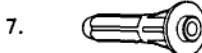
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5. J 39089



6. J 6098-01



7. J 39088



8. J 8037



9. J 9666



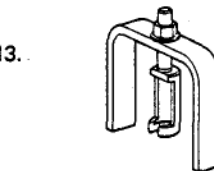
10. J 8062



11. J 5239

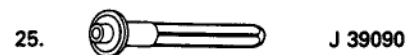
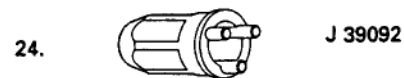
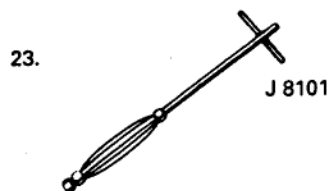
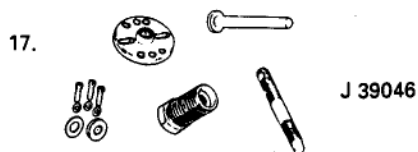


12. J 9290-01



13. J 39243

1. CRANKSHAFT GEAR INSTALLER
2. DRIVEN GEAR SHAFT FRONT COVER SEAL PROTECTOR
3. CRANKSHAFT GEAR REMOVER
4. HYDRAULIC VALVE LIFTER REMOVER (PLIER TYPE)
5. DRIVE GEAR/WATER PUMP SHAFT SEAL INSTALLER
6. CAMSHAFT BEARING REMOVER AND INSTALLER
7. DRIVEN GEAR SHAFT FRONT COVER SEAL INSTALLER
8. PISTON RING COMPRESSOR
9. VALVE SPRING TESTER
10. VALVE SPRING COMPRESSOR (HEAD-OFF)
11. CONNECTING ROD BOLT GUIDE SET
12. HYDRAULIC VALVE LIFTER REMOVER (SLIDE HAMMER TYPE)
13. DRIVEN GEAR ASSEMBLY REMOVER



- 14. CARBON REMOVING BRUSH
- 15. CAM LOBE LIFT INDICATOR
- 16. OIL SUCTION PIPE INSTALLER
- 17. CRANKSHAFT HUB REMOVER AND INSTALLER
- 18. SPARK PLUG PORT ADAPTOR (14 mm TAPERED SEAT)
- 19. MAGNETIC BASE INDICATOR SET
- 20. PISTON PIN REMOVER AND INSTALLER SET
- 21. FRONT COVER ALIGNER AND OIL SEAL INSTALLER
- 22. REAR MAIN SEAL INSTALLER
- 23. VALVE GUIDE CLEANER
- 24. DRIVEN GEAR ASSEMBLY INSTALLER
- 25. DISTRIBUTOR DRIVESHAFT FRONT COVER SEAL INSTALLER
- 26. DIAL INDICATOR SET

