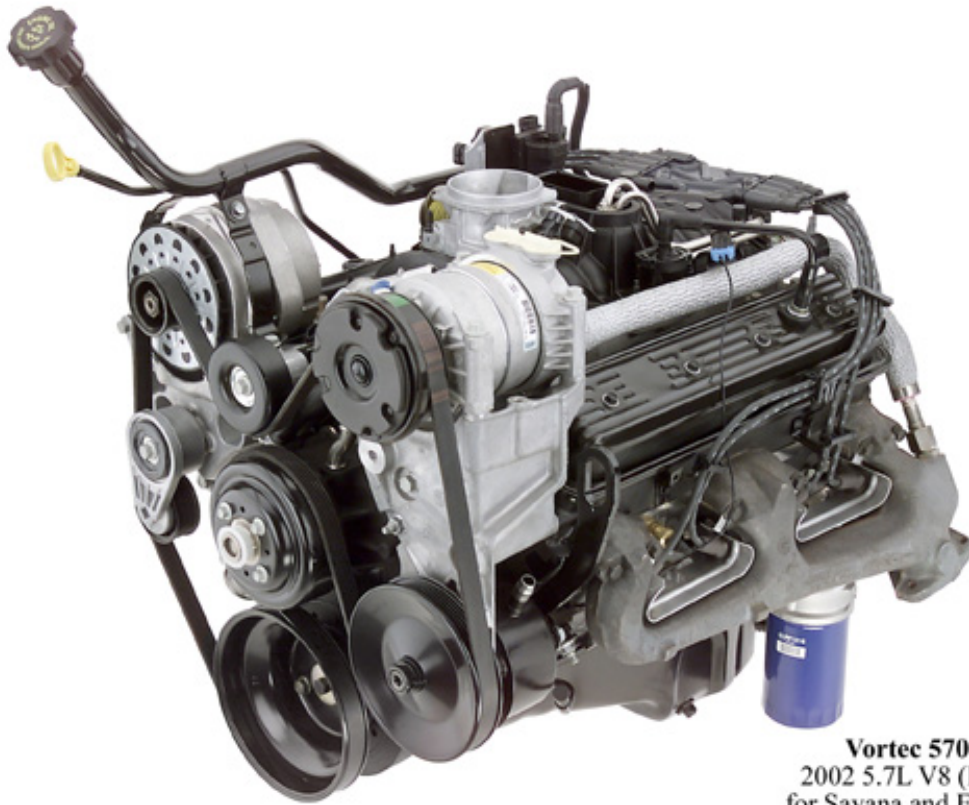


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5.0L/5.7L INDUSTRIAL ENGINE SERVICE MANUAL



Vortec 5700
2002 5.7L V8 (L31)
for Savana and Express



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Engine Mechanical - 5.0L and 5.7L

Specifications

SIE-ID = 784227

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Accelerator Control Cable Bracket Bolt and Nut	12 N·m	106 lb in
Belt Idler Pulley Bolt	50 N·m	37 lb ft
Camshaft Retainer Bolt	21–29 N·m	15–21 lb ft
Camshaft Sprocket Bolt	30–40 N·m	22–30 lb ft
Connecting Rod Nut		
First Pass	27 N·m	20 lb ft
Final Pass	70 degrees	
Crankshaft Balancer Bolt	95 N·m	70 lb ft
Crankshaft Bearing Cap Bolt and Stud – Preferred Method		
First Pass – Two Bolt Type Bearing Cap	20 N·m	15 lb ft
Final Pass – Two Bolt Type Bearing Cap	73 degrees	
First Pass – Four Bolt Type Bearing Cap	20 N·m	15 lb ft
Final Pass Outboard Bolt – Four Bolt Type Bearing Cap	43 degrees	
Final Pass Inboard Bolt and Stud – Four Bolt Type Bearing Cap	73 degrees	
Crankshaft Bearing Cap Bolt and Stud – Optional Strategy		
Two Bolt Type Bearing Cap	105 N·m	77 lb ft
Inboard Bolt and Stud – Four Bolt Type Bearing Cap	105 N·m	77 lb ft
Outboard Bolt – Four Bolt Type Bearing Cap	90 N·m	66 lb ft
Crankshaft Oil Deflector Nut	40 N·m	30 lb ft
Crankshaft Position Sensor Bolt	9 N·m	80 lb in
Crankshaft Pulley Bolt	58 N·m	43 lb ft
Crankshaft Rear Oil Seal Housing Nut and Bolt	12 N·m	106 lb in
Crankshaft Rear Oil Seal Housing Retainer Stud	6 N·m	53 lb in
Cylinder Head Bolt – Preferred Method		
All Bolts First Pass in Sequence	30 N·m	22 lb ft
Long Bolt Final Pass in Sequence	75 degrees	
Medium Bolt Final Pass in Sequence	65 degrees	
Short Bolt Final Pass in Sequence	55 degrees	
Cylinder Head Bolt – Optional On-Vehicle Strategy		
First Pass in Sequence	35 N·m	26 lb ft
Second Pass in Sequence	60 N·m	44 lb ft
Final Pass in Sequence	90 N·m	66 lb ft
Cylinder Head Core Hole Plug	20 N·m	15 lb ft
Distributor Cap Bolt	2.4 N·m	21 lb in
Distributor Clamp Bolt	25 N·m	18 lb ft
Drive Belt Tensioner Bolt	50 N·m	37 lb ft
EGR Valve Bolt		
First Pass	10 N·m	89 lb in
Final Pass	30 N·m	22 lb ft
EGR Valve Pipe Nut at Intake Manifold	25 N·m	18 lb ft
EGR Valve Pipe Nut at Exhaust Manifold	30 N·m	22 lb ft
EGR Valve Pipe Clamp Bracket Bolt	25 N·m	18 lb ft

Fastener Tightening Specifications (cont'd)

Application	Specification	
	Metric	English
Engine Block Coolant Drain Hole Plug	20 N·m	15 lb ft
Engine Block Oil Gallery Plug	20 N·m	15 lb ft
Engine Coolant Temperature (ECT) Gage Sensor	20 N·m	15 lb ft
Engine Flywheel Bolt	100 N·m	74 lb ft
Engine Front Cover Bolt	12 N·m	106 lb in
Engine Lift Front Bracket Stud	35 N·m	26 lb ft
Engine Mount Bolt to Engine Mount Bracket Through-bolt	95 N·m	70 lb ft
Engine Mount Bolt to Engine Mount Frame Bracket	58 N·m	43 lb ft
Engine Mount Bracket Bolt to Engine	54 N·m	40 lb ft
Engine Mount Bracket Bolt to Frame	45 N·m	33 lb ft
Engine Mount Heat Shield to Engine Mount Bracket	6 N·m	53 lb in
Engine Mount Nut Through-bolt	68 N·m	50 lb ft
Engine Oil Pressure Gage Sensor	30 N·m	22 lb ft
Engine Oil Pressure Gage Sensor Fitting – Plus Required Angle	15 N·m	11 lb ft
Engine Wiring Harness Bracket Nut	12 N·m	106 lb in
Evaporative Emission (EVAP) Canister Purge Solenoid Valve Stud	10 N·m	89 lb in
Exhaust Manifold Bolt		
First Pass	15 N·m	11 lb ft
Final Pass	30 N·m	22 lb ft
Fan and Water Pump Pulley Bolt	25 N·m	18 lb ft
Fuel Pipe Bracket Bolt	6 N·m	53 lb in
Fuel Pipe Retainer Nut	3 N·m	27 lb in
Generator and Drive Belt Tensioner Bracket Bolt and Nut to Engine	41 N·m	30 lb ft
Generator and Drive Belt Tensioner Bracket Stud to Engine	20 N·m	15 lb ft
Ignition Coil Stud	12 N·m	106 lb in
Knock Sensor	20 N·m	15 lb ft
Lower Intake Manifold Bolt		
First Pass in Sequence	3 N·m	27 lb in
Second Pass in Sequence	12 N·m	106 lb in
Final Pass in Sequence	15 N·m	11 lb ft
Oil Filter Adapter Bolt	25 N·m	18 lb ft
Oil Filter Fitting	35 N·m	26 lb ft
Oil Level Indicator Tube Bolt	25 N·m	18 lb ft
Oil Pan Drain Plug	25 N·m	18 lb ft
Oil Pan Stud	6 N·m	53 lb in
Oil Pan Stud Nut	25 N·m	18 lb ft
Oil Pan Bolt or Stud	12 N·m	106 lb in
Oil Pump Bolt to Rear Crankshaft Bearing Cap		
First Pass	20 N·m	15 lb ft
Final Pass	65 degrees	
Oil Pump Cover Bolt	12 N·m	106 lb in
Power Steering Pump Bolt	50 N·m	37 lb ft
Power Steering Pump Bracket Bolt to Engine	41 N·m	30 lb ft
Power Steering Pump Bracket Stud to Engine	20 N·m	15 lb ft
Power Steering Pump Bracket Stud Nut	41 N·m	30 lb ft
Power Steering Pump Nut to Engine	41 N·m	30 lb ft
Power Steering Pump Rear Bracket Nut	50 N·m	37 lb ft

Fastener Tightening Specifications (cont'd)

Application	Specification	
	Metric	English
Spark Plug		
Initial Installation – NEW Cylinder Head	30 N·m	22 lb ft
All Subsequent Installations	15 N·m	11 lb ft
Spark Plug Wire Support Bolt	12 N·m	106 lb in
Square Socket Plug – Engine Block Oil Gallery	20 N·m	15 lb ft
Throttle Body Stud	9 N·m	80 lb in
Transmission Cover Bolt	12 N·m	106 lb in
Upper Intake Manifold Stud		
First Pass	5 N·m	44 lb in
Final Pass	10 N·m	89 lb in
Valve Lifter Guide Retainer Bolt	25 N·m	18 lb ft
Valve Rocker Arm Cover Bolt	12 N·m	106 lb in
Water Outlet Stud	25 N·m	18 lb ft
Water Pump Bolt	45 N·m	33 lb ft

SIE-ID = 784228

Engine Mechanical Specifications (5.0 L)

Application	Specification	
	Metric	English
General Data		
Engine Type	V8	
Displacement	5.0 L	305 CID
RPO – VIN Code	L30 (M)	
Bore	94.89 mm	3.737 in
Stroke	88.39 mm	3.480 in
Compression Ratio	9.4:1	
Firing Order	1–8–4–3–6–5–7–2	
Spark Plug Gap	1.52 mm	0.060 in
Oil Pressure – Minimum at Normal Operating Temperature	42 kPa at 1,000 RPM 125 kPa at 2,000 RPM 166 kPa at 4,000 RPM	6 psig at 1,000 RPM 18 psig at 2,000 RPM 24 psig at 4,000 RPM
Camshaft		
End Play	0.05–0.30 mm	0.002–0.012 in
Journal Diameter	47.440–47.490 mm	1.8677–1.8697 in
Journal Diameter Out-of-Round	0.025 mm	0.0010 in
Lobe Lift – Exhaust	7.20–7.30 mm	0.283–0.287 in
Lobe Lift – Intake	6.97–7.07 mm	0.274–0.278 in
Runout	0.065 mm – Maximum	0.0026 in – Maximum
Connecting Rod		
Connecting Rod Bearing Clearance – Production	0.033–0.078 mm	0.0013–0.0031 in
Connecting Rod Bearing Clearance – Service	0.025–0.063 mm	0.0010–0.0025 in
Connecting Rod Journal Diameter	56.505–56.533 mm	2.2246–2.2257 in
Connecting Rod Journal Out-of-Round – Production	0.007 mm – Maximum	0.0003 in – Maximum
Connecting Rod Journal Out-of-Round – Service	0.025 mm – Maximum	0.0010 in – Maximum
Connecting Rod Journal Taper – Production	0.007 mm – Maximum	0.0003 in – Maximum
Connecting Rod Journal Taper – Service	0.025 mm – Maximum	0.0010 in – Maximum
Connecting Rod Side Clearance	0.15–0.61 mm	0.006–0.024 in

Engine Mechanical Specifications (5.0 L) (cont'd)

Application	Specification	
	Metric	English
Crankshaft		
Crankshaft Bearing Clearance – Journal #1 – Production	0.018–0.053 mm	0.0007–0.0021 in
Crankshaft Bearing Clearance – Journal #2, #3, and #4 – Production	0.030–0.068 mm	0.0012–0.0027 in
Crankshaft Bearing Clearance – Journal #5 – Production	0.020–0.060 mm	0.0008–0.0024 in
Crankshaft Bearing Clearance – Journal #1 – Service	0.025–0.051 mm	0.0010–0.0020 in
Crankshaft Bearing Clearance – Journal #2, #3, and #4 – Service	0.025–0.064 mm	0.0010–0.0025 in
Crankshaft Bearing Clearance – Journal #5 – Service	0.038–0.063 mm	0.0015–0.0025 in
Crankshaft End Play	0.05–0.20 mm	0.002–0.008 in
Crankshaft Journal Diameter – Journal #1	62.189–62.212 mm	2.4484–2.4493 in
Crankshaft Journal Diameter – Journal #2, #3, and #4	62.181–62.207 mm	2.4481–2.4491 in
Crankshaft Journal Diameter – Journal #5	62.185–62.207 mm	2.4482–2.4491 in
Crankshaft Journal Out-of-Round – Production	0.005 mm – Maximum	0.0002 in – Maximum
Crankshaft Journal Out-of-Round – Service	0.025 mm – Maximum	0.0010 in – Maximum
Crankshaft Journal Taper – Production	0.005 mm – Maximum	0.0002 in – Maximum
Crankshaft Journal Taper – Service	0.025 mm – Maximum	0.0010 in – Maximum
Crankshaft Runout at Rear Flange	0.038 mm	0.0015 in
Cylinder Bore		
Diameter	94.894–94.947 mm	3.7360–3.7381 in
Out-of-Round – Production	0.025 mm	0.0010 in
Out-of-Round – Service	0.05 mm	0.002 in
Taper – Production – Relief Side	0.025 mm	0.0010 in
Taper – Production – Thrust Side	0.012 mm	0.0005 in
Taper – Service Limit	0.025 mm	0.0010 in
Cylinder Head		
Surface Flatness – Engine Block Deck	0.10 mm	0.004 in
Surface Flatness – Exhaust Manifold Deck	0.05 mm	0.002 in
Surface Flatness – Intake Manifold Deck	0.10 mm	0.004 in
Exhaust Manifold		
Surface Flatness – Flange to Flange	0.25 mm	0.010 in
Surface Flatness – Individual Flange	0.05 mm	0.002 in
Piston		
Piston Bore Clearance – Production	0.018–0.061 mm	0.0007–0.0024 in
Piston Bore Clearance – Service	0.018–0.068 mm	0.0007–0.0026 in
Piston Pin		
Clearance in Piston – Production	0.010–0.020 mm	0.0004–0.0008 in
Clearance in Piston – Service	0.013–0.025 mm	0.0005–0.0010 in
Diameter	23.545–23.548 mm	0.9270–0.9271 in
Interference Fit in Connecting Rod	0.012–0.050 mm	0.0004–0.0019 in
Piston Rings – End Gap Measured in Cylinder Bore		
Piston Compression Ring Gap – Production – Top Groove	0.25–0.51 mm	0.010–0.020 in
Piston Compression Ring Gap – Production – 2nd Groove	0.46–0.66 mm	0.018–0.026 in
Piston Compression Ring Gap – Service – Top Groove	0.25–0.65 mm	0.010–0.025 in
Piston Compression Ring Gap – Service – 2nd Groove	0.46–0.90 mm	0.018–0.035 in
Piston Compression Ring Groove Clearance – Production – Top Groove	0.030–0.070 mm	0.0012–0.0027 in
Piston Compression Ring Groove Clearance – Production – 2nd Groove	0.030–0.074 mm	0.0012–0.003 in

Engine Mechanical Specifications (5.0 L) (cont'd)

Application	Specification	
	Metric	English
Piston Compression Ring Groove Clearance – Service Limit – Top Groove	0.030–0.090 mm	0.0012–0.0035 in
Piston Compression Ring Groove Clearance – Service Limit – 2nd Groove	0.030–0.090 mm	0.0012–0.0040 in
Piston Oil Ring Gap – Production	0.25–0.76 mm	0.010–0.030 in
Piston Oil Ring Gap – Service	0.25–0.89 mm	0.010–0.035 in
Piston Oil Ring Groove Clearance – Production	0.051–0.203 mm	0.002–0.008 in
Piston Oil Ring Groove Clearance – Service	0.051–0.22 mm	0.002–0.009 in
Valve System		
Valve Face Angle	45 degrees	
Valve Head Edge Margin	0.79 mm – Minimum	0.031 in – Minimum
Valve Lash	Rotate the Valve Rocker Arm Nut Clockwise 360 degrees from Zero Lash	
Valve Lifter	Hydraulic Roller	
Valve Rocker Arm Ratio	1.5:1	
Valve Seat Angle	46 degrees	
Valve Seat Runout	0.05 mm – Maximum	0.002 in – Maximum
Valve Seat Width – Exhaust	1.65–2.49 mm	0.065–0.098 in
Valve Seat Width – Intake	1.14–1.78 mm	0.045–0.070 in
Valve Spring Free Length	51.3 mm	2.02 in
Valve Spring Installed Height – Exhaust	42.92–43.43 mm	1.67–1.70 in
Valve Spring Installed Height – Intake	42.92–43.43 mm	1.67–1.70 in
Valve Spring Pressure – Closed	338–374 N at 43.2 mm	76–84 lb at 1.70 in
Valve Spring Pressure – Open	832–903 N at 32.3 mm	187–203 lb at 1.27 in
Valve Stem Clearance – Exhaust – Production	0.025–0.069 mm	0.0010–0.0027 in
Valve Stem Clearance – Intake – Production	0.025–0.069 mm	0.0010–0.0027 in
Valve Stem Clearance – Exhaust – Service	0.025–0.094 mm	0.0010–0.0037 in
Valve Stem Clearance – Intake – Service	0.025–0.094 mm	0.0010–0.0037 in
Valve Stem Diameter	8.661–8.679 mm	0.3410–0.3416 in
Valve Stem Oil Seal Installed Height – Measured from the Top of the Large Diameter Valve Guide Bevel to the Bottom of the Valve Stem Oil Seal	1–2 mm	0.03937–0.07874 in

SIE-ID = 784231

Engine Mechanical Specifications (5.7 L)

Application	Specification	
	Metric	English
General Data		
Engine Type	V8	
Displacement	5.7 L	350 CID
RPO – VIN Code	L31 (R)	
Bore	101.63 mm	4.0012 in
Stroke	88.39 mm	3.480 in
Compression Ratio	9.4:1	
Firing Order	1–8–4–3–6–5–7–2	
Spark Plug Gap	1.52 mm	0.060 in
Oil Pressure – Minimum at Normal Operating Temperature	42 kPa at 1,000 RPM 125 kPa at 2,000 RPM 166 kPa at 4,000 RPM	6 psig at 1,000 RPM 18 psig at 2,000 RPM 24 psig at 4,000 RPM

Engine Mechanical Specifications (5.7 L) (cont'd)

Application	Specification	
	Metric	English
Camshaft		
End Play	0.05–0.30 mm	0.002–0.012 in
Journal Diameter	47.440–47.490 mm	1.8677–1.8697 in
Journal Diameter Out-of-Round	0.025 mm – Maximum	0.0010 in – Maximum
Lobe Lift – Exhaust	7.20–7.30 mm	0.283–0.287 in
Lobe Lift – Intake	6.97–7.07 mm	0.274–0.278 in
Runout	0.065 mm – Maximum	0.0026 in – Maximum
Connecting Rod		
Connecting Rod Bearing Clearance – Production	0.033–0.078 mm	0.0013–0.0031 in
Connecting Rod Bearing Clearance – Service	0.025–0.063 mm	0.0010–0.0025 in
Connecting Rod Journal Diameter	56.505–56.533 mm	2.2246–2.2257 in
Connecting Rod Journal Out-of-Round – Production	0.007 mm – Maximum	0.0003 in – Maximum
Connecting Rod Journal Out-of-Round – Service	0.025 mm – Maximum	0.0010 in – Maximum
Connecting Rod Journal Taper – Production	0.007 mm – Maximum	0.0003 in – Maximum
Connecting Rod Journal Taper – Service	0.025 mm – Maximum	0.0010 in – Maximum
Connecting Rod Side Clearance	0.15–0.61 mm	0.006–0.024 in
Crankshaft		
Crankshaft Bearing Clearance – Journal #1 – Production	0.018–0.053 mm	0.0007–0.0021 in
Crankshaft Bearing Clearance – Journal #2, #3, and #4 – Production	0.030–0.068 mm	0.0012–0.0027 in
Crankshaft Bearing Clearance – Journal #5 – Production	0.020–0.060 mm	0.0008–0.0024 in
Crankshaft Bearing Clearance – Journal #1 – Service	0.025–0.051 mm	0.0010–0.0020 in
Crankshaft Bearing Clearance – Journal #2, #3, and #4 – Service	0.025–0.064 mm	0.0010–0.0025 in
Crankshaft Bearing Clearance Service – Journal #5 – Service	0.038–0.063 mm	0.0015–0.0025 in
Crankshaft End Play	0.05–0.20 mm	0.002–0.008 in
Crankshaft Journal Diameter – Journal #1	62.189–62.212 mm	2.4484–2.4493 in
Crankshaft Journal Diameter – Journal #2, #3, and #4	62.181–62.207 mm	2.4481–2.4491 in
Crankshaft Journal Diameter – Journal #5	62.185–62.207 mm	2.4482–2.4491 in
Crankshaft Journal Out-of-Round – Production	0.005 mm – Maximum	0.0002 in – Maximum
Crankshaft Journal Out-of-Round – Service	0.025 mm – Maximum	0.0010 in – Maximum
Crankshaft Journal Taper – Production	0.005 mm – Maximum	0.0002 in – Maximum
Crankshaft Journal Taper – Service	0.025 mm – Maximum	0.0010 in – Maximum
Crankshaft Runout at Rear Flange	0.038 mm	0.0015 in
Cylinder Bore		
Diameter	101.618–101.643 mm	4.0007–4.0017 in
Out-of-Round – Production	0.025 mm	0.0010 in
Out-of-Round – Service	0.05 mm	0.002 in
Taper – Production – Relief Side	0.025 mm	0.0010 in
Taper – Production – Thrust Side	0.012 mm	0.0005 in
Taper – Service Limit	0.025 mm	0.0010 in
Cylinder Head		
Surface Flatness – Engine Block Deck	0.10 mm	0.004 in
Surface Flatness – Exhaust Manifold Deck	0.05 mm	0.002 in
Surface Flatness – Intake Manifold Deck	0.10 mm	0.004 in
Exhaust Manifold		
Surface Flatness – Flange to Flange	0.25 mm	0.010 in
Surface Flatness – Individual Flange	0.05 mm	0.002 in
Piston		

Engine Mechanical Specifications (5.7 L) (cont'd)

Application	Specification	
	Metric	English
Piston Bore Clearance – Production	0.018–0.053 mm	0.0007–0.002 in
Piston Bore Clearance – Service	0.018–0.061 mm	0.0007–0.0024 in
Piston Pin		
Clearance in Piston – Production	0.013–0.023 mm	0.0005–0.0009 in
Clearance in Piston – Service	0.013–0.025 mm	0.0005–0.0010 in
Diameter	23.545–23.548 mm	0.9270–0.9271 in
Interference Fit in Connecting Rod	0.012–0.050 mm	0.0004–0.0019 in
Piston Rings – End Gap Measured in Cylinder Bore		
Piston Compression Ring Gap – Production – Top Groove	0.25–0.40 mm	0.098–0.015 in
Piston Compression Ring Gap – Production – 2nd Groove	0.038–0.058 mm	0.0015–0.003 in
Piston Compression Ring Gap – Service – Top Groove	0.25–0.50 mm	0.009–0.019 in
Piston Compression Ring Gap – Service – 2nd Groove	0.46–0.80 mm	0.018–0.031 in
Piston Compression Ring Groove Clearance – Production – Top Groove	0.030–0.070 mm	0.0012–0.0027 in
Piston Compression Ring Groove Clearance – Production – 2nd Groove	0.038–0.080 mm	0.0015–0.003 in
Piston Compression Ring Groove Clearance – Service Limit – Top Groove	0.030–0.090 mm	0.0012–0.0035 in
Piston Compression Ring Groove Clearance – Service Limit – 2nd Groove	0.040–0.100 mm	0.0015–0.0040 in
Piston Oil Ring Gap – Production	0.25–0.76 mm	0.009–0.029 in
Piston Oil Ring Gap – Service	0.25–0.90 mm	0.009–0.035 in
Piston Oil Ring Groove Clearance – Production	0.046–0.196 mm	0.0018–0.0077 in
Piston Oil Ring Groove Clearance – Service	0.046–0.200 mm	0.0018–0.0079 in
Valve System		
Valve Face Angle	45 degrees	
Valve Head Edge Margin	0.79 mm – Minimum	0.031 in – Minimum
Valve Lash	Rotate the Valve Rocker Arm Nut Clockwise 360 degrees from Zero Lash	
Valve Lifter	Hydraulic Roller	
Valve Rocker Arm Ratio	1.5:1	
Valve Seat Angle	46 degrees	
Valve Seat Runout	0.05 mm – Maximum	0.002 in – Maximum
Valve Seat Width – Exhaust – Heavy Duty	1.50–2.56 mm	0.059–0.101 in
Valve Seat Width – Exhaust – Light Duty	1.65–2.49 mm	0.065–0.098 in
Valve Seat Width – Intake	1.02–1.65 mm	0.040–0.065 in
Valve Spring Free Length	51.3 mm	2.02 in
Valve Spring Installed Height – Exhaust	42.92–43.43 mm	1.67–1.70 in
Valve Spring Installed Height – Intake	42.92–43.43 mm	1.67–1.70 in
Valve Spring Pressure – Closed	338–374 N at 43.2 mm	76–84 lb at 1.70 in
Valve Spring Pressure – Open	832–903 N at 32.3 mm	187–203 lb at 1.27 in
Valve Stem Clearance – Exhaust – Production	0.025–0.069 mm	0.0010–0.0027 in
Valve Stem Clearance – Intake – Production	0.025–0.069 mm	0.0010–0.0027 in
Valve Stem Clearance – Exhaust – Service	0.025–0.094 mm	0.0010–0.0037 in
Valve Stem Clearance – Intake – Service	0.025–0.094 mm	0.0010–0.0037 in
Valve Stem Diameter	8.661–8.679 mm	0.3410–0.3416 in
Valve Stem Oil Seal Installed Height – Measured from the Top of the Large Valve Guide Bevel to the Bottom of the Valve Stem Oil Seal	1–2 mm	0.03937–0.07874 in

SIE-ID = 378556

Sealers, Adhesives, and Lubricants

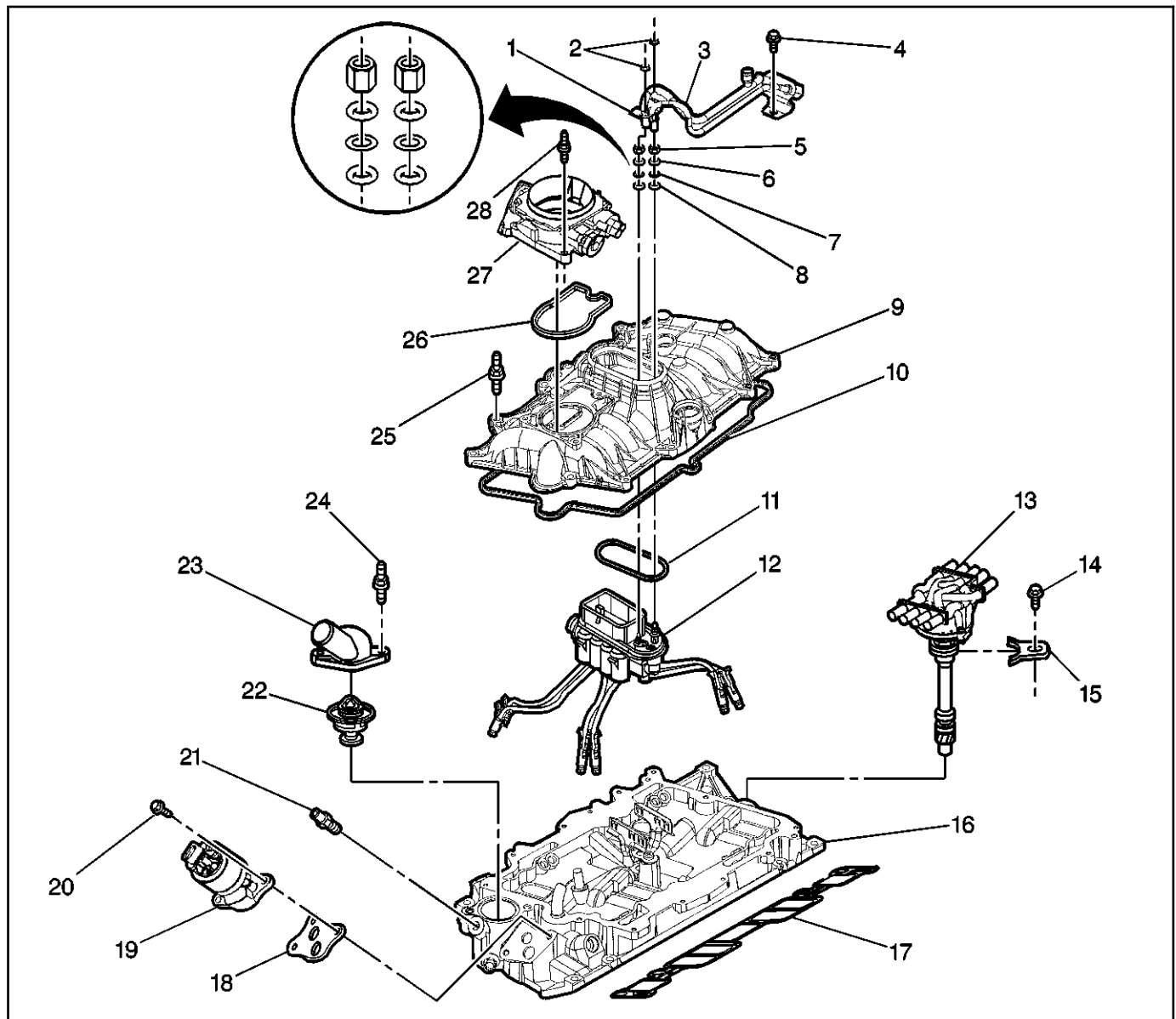
Application	Type of Material	GM Part Number	
		United States	Canada
Camshaft Retainer Bolt	Threadlock	12345382	10953489
Crankshaft Balancer Keyway	Adhesive	12346141	10953433
Cylinder Head Bolt	Sealant	12346004	10953480
Engine Block Core Hole Plug	Threadlock	12345382	10953489
Engine Block Coolant Drain Hole Plug	Sealant	12346004	10953480
Engine Block to the Crankshaft Rear Oil Seal Housing Junction at the Oil Pan Sealing Surfaces	Adhesive	12346141	10953433
Engine Block to the Engine Front Cover Junction at the Oil Pan Sealing Surfaces	Adhesive	12346141	10953433
Engine Block at the Lower Intake Manifold Sealing Surfaces	Adhesive	12346141	10953433
Engine Block Oil Gallery Plug	Sealant	12346004	10953480
Engine Coolant Sensor	Sealant	12346004	10953480
Engine Coolant Temperature (ECT) Gage Sensor	Sealant	12346004	10953480
Engine Oil	SAE 5W-30 Oil	12345610	993193
Engine Oil Pressure Gage Sensor	Sealant	12346004	10953480
Engine Oil Pressure Gage Sensor Fitting	Sealant	12346004	10953480
Engine Oil Supplement	Lubricant	1052367	992367
Evaporative Emission (EVAP) Canister Purge Solenoid Valve Stud	Threadlock	12345382	10953489
Exhaust Manifold Bolt	Threadlock	12345493	10953488
Expansion Cup Plug – Camshaft Rear Bearing Hole	Sealant	12346004	10953480
Expansion Cup Plug – Engine Block Core Hole	Sealant	12346004	10953480
Fuel Meter Body Bracket Bolt	Threadlock	12345382	10953489
Fuel Pipe Bolt	Threadlock	12345382	10953489
Knock Sensor	Sealant	12346004	10953480
Lower Intake Manifold Bolt	Threadlock	12345382	10953489
Oil Level Indicator Tube	Sealant	12346004	10953480
Oil Pump Screen Tube	Sealant	12346004	10953480
Throttle Body Stud	Threadlock	12345382	10953489
Upper Intake Manifold Stud	Threadlock	12345382	10953489
Valve Rocker Arm Ball Stud	Lubricant	1052271	10950849
Valve Train Component Prelube	Lubricant	12345501	992704
Water Pump Bolt	Sealant	12346004	10953480

Component Locator

Disassembled Views

SIE-ID = 348556

Intake Manifolds and Components SIO-ID = 67224



66997

Legend

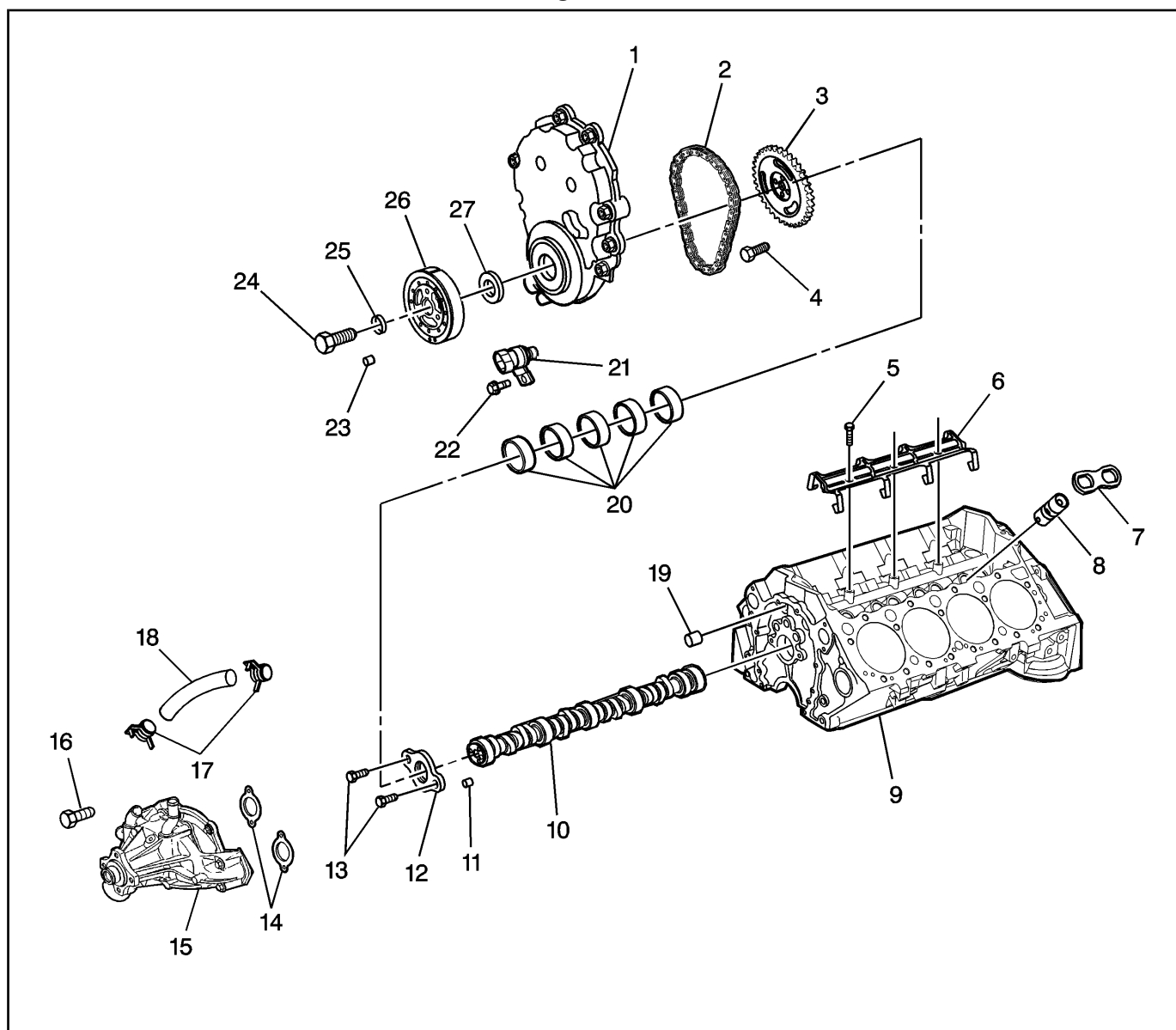
- | | |
|---|-----------------------------------|
| (1) Fuel Pipe Retainer Bracket | (11) Fuel Meter Body Seal |
| (2) Fuel Pipe Retainer Bracket Nuts | (12) Fuel Meter Body |
| (3) Fuel Pipe | (13) Distributor Assembly |
| (4) Fuel Pipe Attachment Screw | (14) Hex Bolt (Distributor Clamp) |
| (5) Fuel Seal Retainer | (15) Distributor Clamp |
| (6) Fuel Seal (Yellow O-ring) | (16) Lower Intake Manifold |
| (7) Spacer Ring (Flat Washer) | (17) Lower Intake Manifold Gasket |
| (8) Fuel Seal (Black O-ring) | (18) EGR Valve Gasket |
| (9) Upper Intake Manifold | (19) EGR Valve |
| (10) Upper Intake Manifold to Lower Intake Gasket | (20) EGR Valve Bolt |
| | (21) Engine Coolant Sensor |

6-10 Engine Mechanical - 5.0L and 5.7L**Engine**

- (22) Engine Coolant Thermostat
- (23) Water Outlet
- (24) Water Outlet Stud
- (25) Upper Intake Manifold Stud

- (26) Throttle Body Gasket
- (27) Throttle Body
- (28) Throttle Body Attaching Stud

Front of Engine SIO-ID = 197523

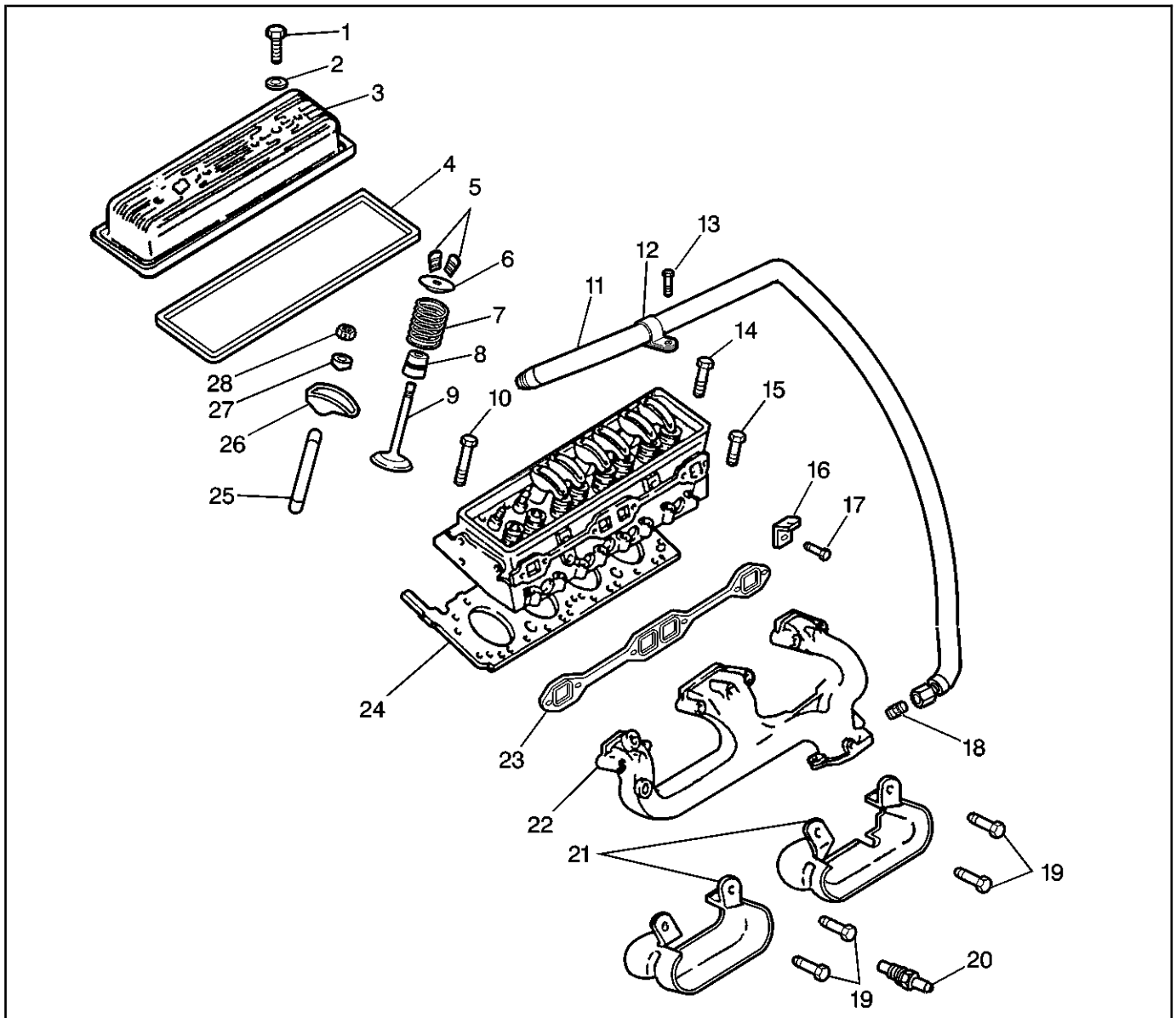


182828

Legend

- | | |
|--------------------------------------|---|
| (1) Engine Front Cover | (15) Water Pump |
| (2) Camshaft Timing Chain | (16) Water Pump Bolt |
| (3) Camshaft Sprocket | (17) Water Pump Inlet Hose Clamp |
| (4) Camshaft Sprocket Bolt | (18) Water Pump Inlet Hose |
| (5) Valve Lifter Guide Retainer Bolt | (19) Engine Block Oil Gallery Plug |
| (6) Valve Lifter Guide Retainer | (20) Camshaft Bearings |
| (7) Valve Lifter Guide | (21) Crankshaft Position Sensor |
| (8) Valve Lifter | (22) Crankshaft Position Sensor Bolt |
| (9) Engine Block | (23) Front Groove Pin (Crankshaft Balancer) |
| (10) Engine Camshaft | (24) Crankshaft Balancer Bolt |
| (11) Camshaft Sprocket Locator Pin | (25) Crankshaft Balancer Bolt Washer |
| (12) Camshaft Retainer | (26) Crankshaft Balancer |
| (13) Camshaft Retainer Bolt | (27) Crankshaft Front Oil Seal |
| (14) Water Pump Gasket | |

Cylinder Head and Exhaust Manifold Area SIO-ID = 197712

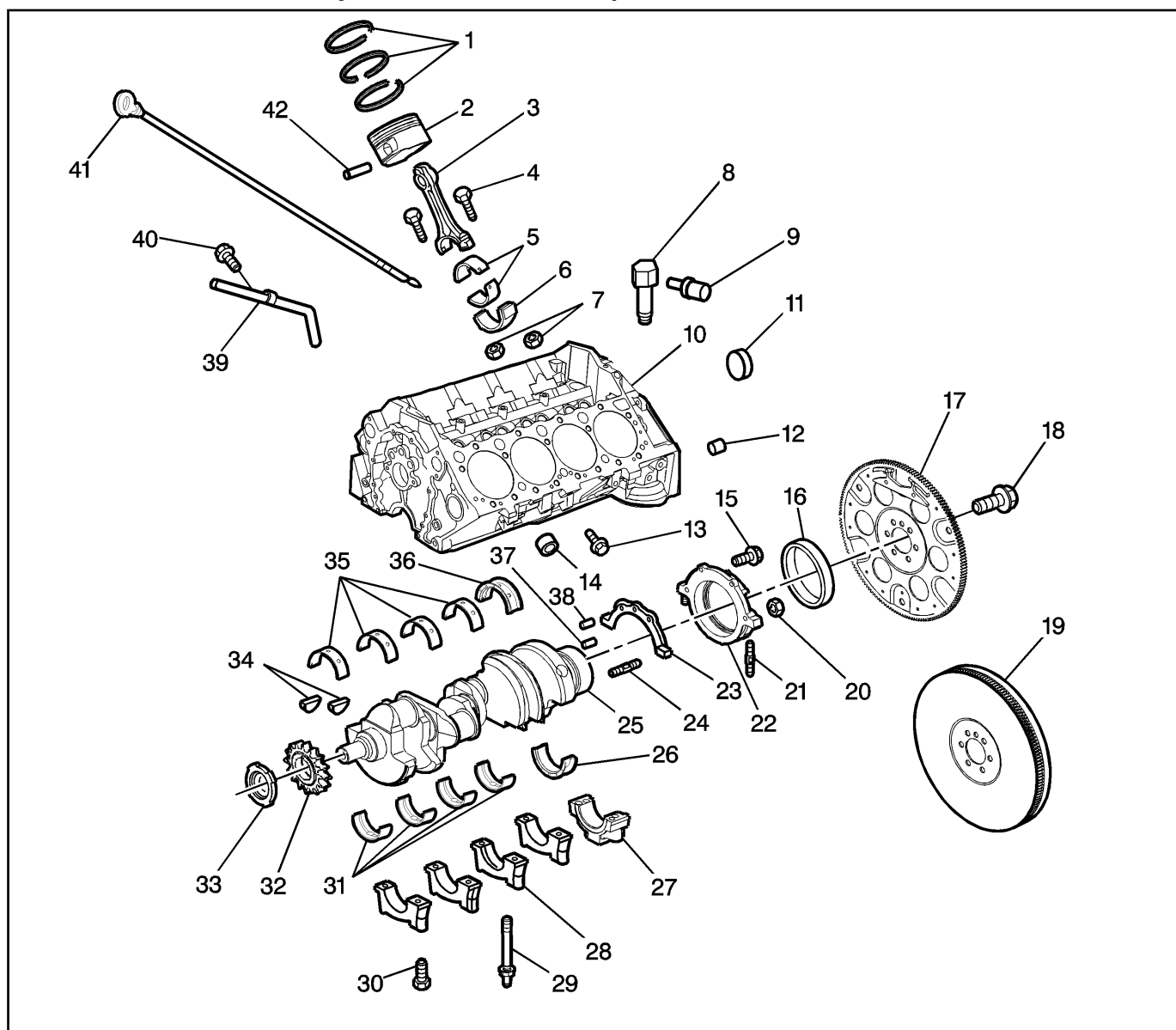


182825

Legend

- | | |
|--|--|
| (1) Valve Rocker Arm Cover Bolt | (16) Spark Plug Wire Support Bracket |
| (2) Valve Rocker Arm Cover Bolt Washer | (17) Spark Plug Wire Support Bracket Bolt |
| (3) Valve Rocker Arm Cover | (18) EGR Valve Pipe Fitting |
| (4) Valve Rocker Arm Cover Gasket | (19) Exhaust Manifold Bolts |
| (5) Valve Stem Keys | (20) Engine Coolant Temperature (ECT) Gauge Sensor |
| (6) Valve Spring Cap | (21) Spark Plug Wire Shields |
| (7) Valve Spring | (22) Exhaust Manifold |
| (8) Valve Stem Oil Seal | (23) Exhaust Manifold Gasket |
| (9) Valve | (24) Cylinder Head Gasket |
| (10) Cylinder Head Bolt (Long) | (25) Valve Pushrod |
| (11) EGR Valve Pipe | (26) Valve Rocker Arm |
| (12) EGR Valve Pipe Clamp | (27) Valve Rocker Arm Ball |
| (13) EGR Valve Pipe Clamp Bracket Bolt | (28) Valve Rocker Arm Nut |
| (14) Cylinder Head Bolt (Medium) | |
| (15) Cylinder Head Bolt (Short) | |

Cylinder Block and Components SIO-ID = 348439



317429

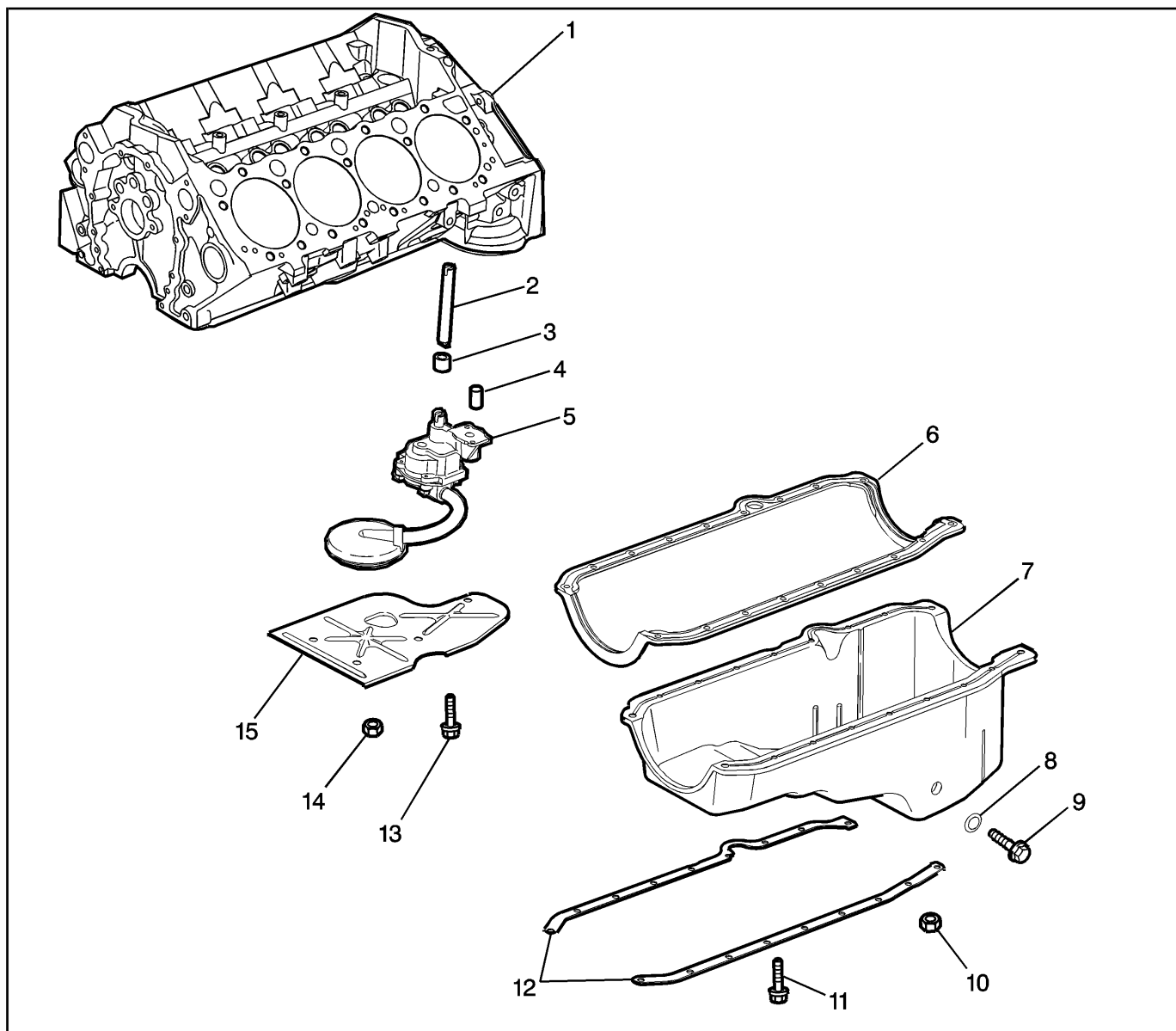
Legend

- | | |
|--|---|
| (1) Piston Ring Kit | (16) Crankshaft Rear Oil Seal |
| (2) Piston | (17) Engine Flywheel (Automatic Transmission) |
| (3) Connecting Rod | (18) Flywheel Bolt |
| (4) Connecting Rod Bolt | (19) Engine Flywheel (Manual Transmission) |
| (5) Connecting Rod Bearings | (20) Crankshaft Rear Oil Seal Housing Nut |
| (6) Connecting Rod Cap | (21) Crankshaft Rear Oil Seal Housing Stud |
| (7) Hex Nut (Connecting Rod) | (22) Crankshaft Rear Oil Seal Housing |
| (8) Engine Oil Pressure Gauge Sensor Fitting | (23) Crankshaft Rear Oil Seal Housing Gasket |
| (9) Engine Oil Pressure Gauge Sensor | (24) Crankshaft Rear Oil Seal Housing Stud |
| (10) Engine Block | (25) Crankshaft |
| (11) Expansion Cup Plug (Camshaft Rear Bearing Hole) | (26) Crankshaft Bearing (Rear Thrust Bearing) |
| (12) Dowel Straight Pin (Transmission Locator) | (27) Crankshaft Bearing Cap (Rear) |
| (13) Engine Block Coolant Drain Hole Plug | (28) Crankshaft Bearing Cap |
| (14) Engine Block Core Hole Plug | (29) Crankshaft Bearing Cap Stud |
| (15) Crankshaft Rear Oil Seal Housing Bolt | (30) Crankshaft Bearing Cap Bolt |
| | (31) Crankshaft Bearings |

6-14 Engine Mechanical - 5.0L and 5.7L**Engine**

-
- | | |
|---|---|
| (32) Crankshaft Sprocket | (38) Spring Type S Pin (Crankshaft Rear Oil Seal Housing Locator) |
| (33) Crankshaft Position Sensor Reluctor Ring | (39) Oil Level Indicator Tube |
| (34) Woodruff Keys (Crankshaft Balancer) | (40) Oil Level Indicator Tube Bolt |
| (35) Crankshaft Bearing | (41) Oil Level Indicator |
| (36) Crankshaft Bearing (Rear Thrust Bearing) | (42) Piston Pin |
| (37) Spring Type S Pin (Flywheel Locator) | |
-

Bottom of Engine SIO-ID = 197524



182829

Legend

- | | |
|--------------------------------------|------------------------------------|
| (1) Engine Block | (9) Oil Pan Drain Plug |
| (2) Oil Pump Driveshaft | (10) Oil Pan Nut |
| (3) Oil Pump Driveshaft Retainer | (11) Oil Pan Bolt |
| (4) Pin (Oil Pump Locator) | (12) Oil Pan Reinforcement |
| (5) Oil Pump | (13) Crankshaft Oil Deflector Bolt |
| (6) Oil Pan Gasket | (14) Crankshaft Oil Deflector Nut |
| (7) Oil Pan | (15) Crankshaft Oil Deflector |
| (8) Oil Pan Drain Plug Seal (O-ring) | |

Engine Identification

SIE-ID = 650058

The Vehicle Identification Number (VIN) is located on the left side rear of the engine block, near the transmission bellhousing, and typically is a 9 digit number stamped onto the engine at the vehicle assembly plant.

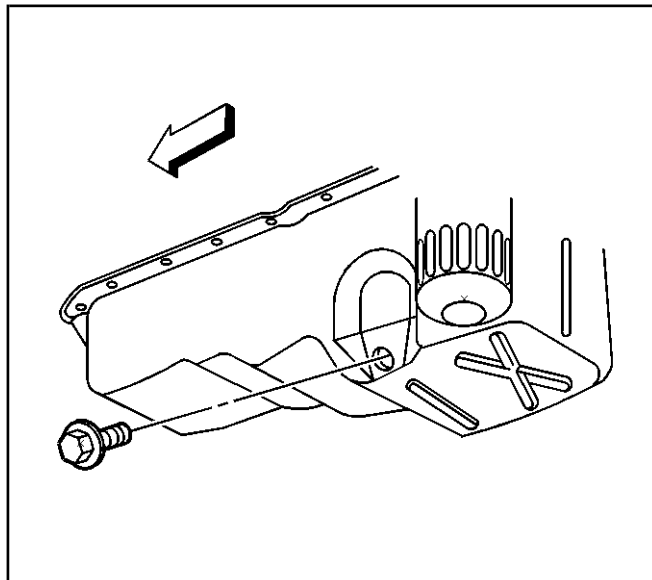
- The first digit identifies the division.
- The second digit identifies the model year.
- The third digit identifies the assembly plant.
- The fourth through ninth digits are the last 6 digits of the Vehicle Identification Number (VIN).

Repair Instructions

Draining Fluids and Oil Filter Removal

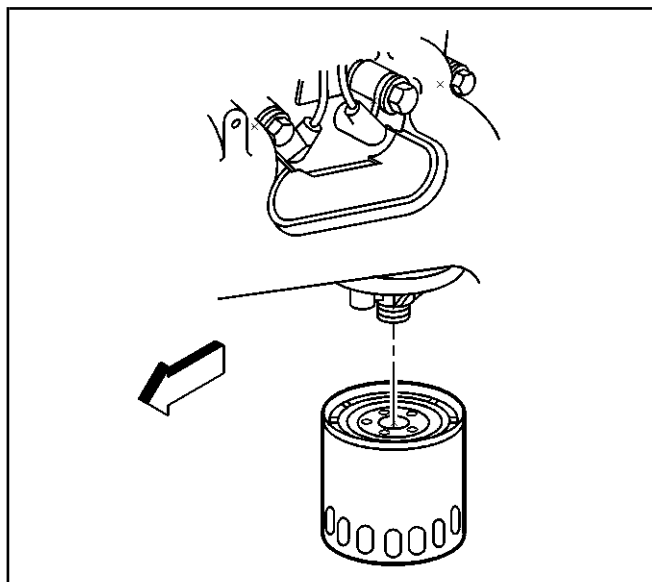
SIE-ID = 194572

1. Remove the oil pan drain plug and allow the engine oil to drain into a suitable container.

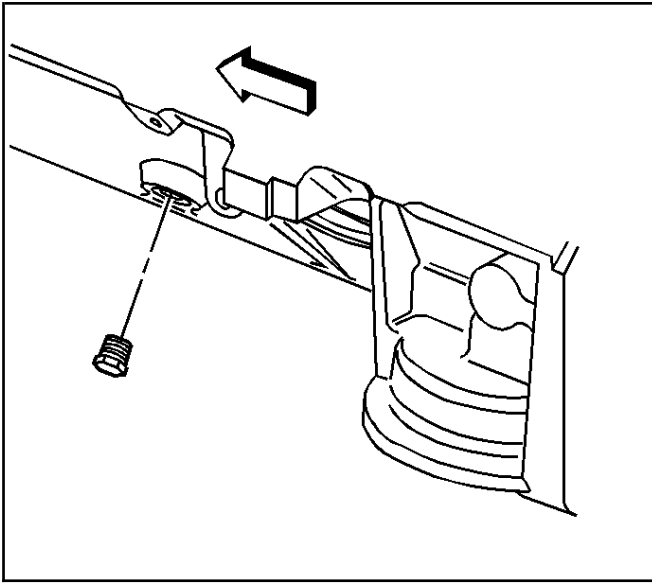


182850

2. Remove the oil filter and discard.

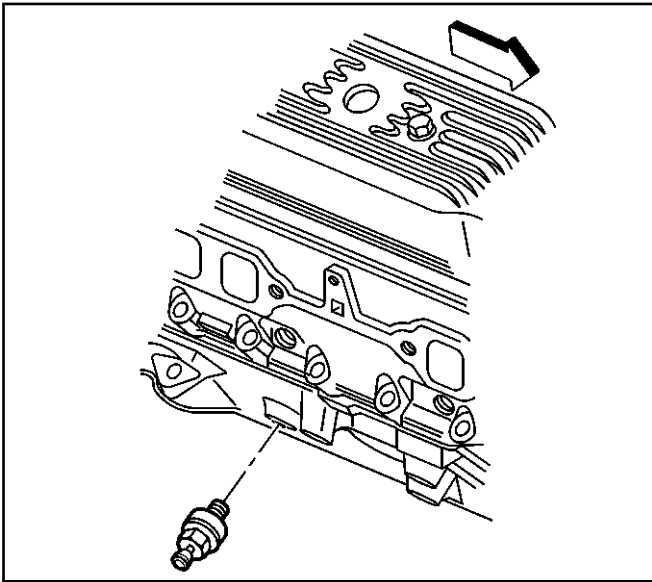


316766



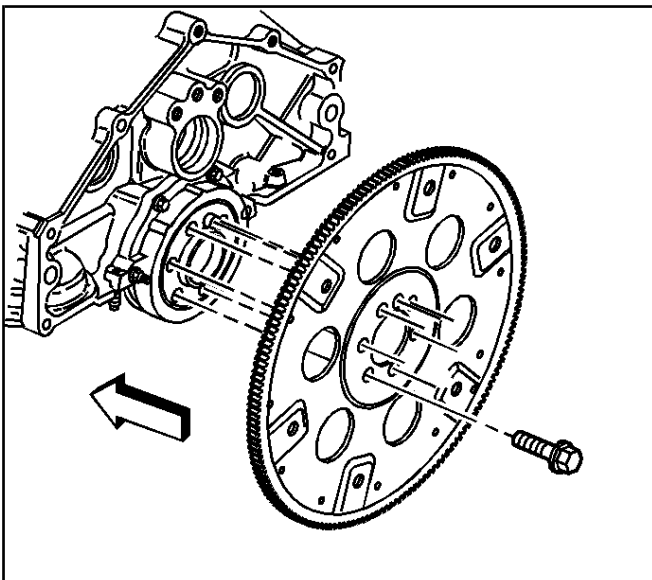
316798

3. Remove the engine block coolant drain hole plug and allow the coolant to drain into a suitable container.



182837

4. Remove the knock sensor and allow the coolant to drain into a suitable container.



522146

Engine Flywheel Removal

SIE-ID = 527623

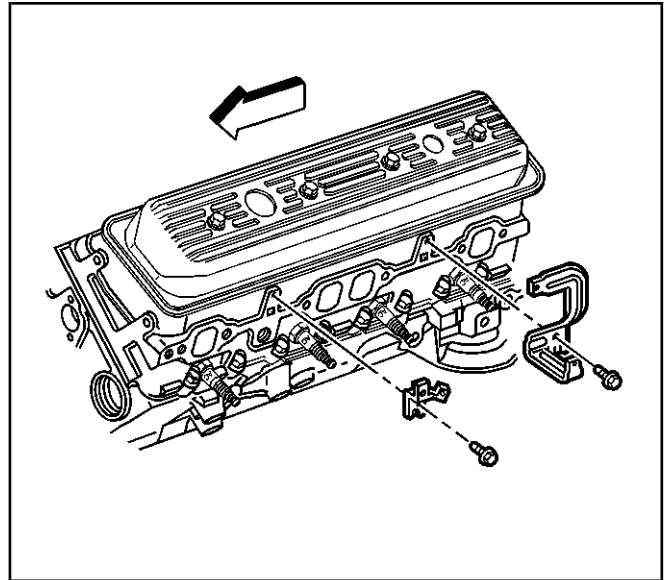
1. Remove the engine flywheel bolts.
2. Remove the engine flywheel.

Exhaust Manifold Removal - Left

SIE-ID = 650059

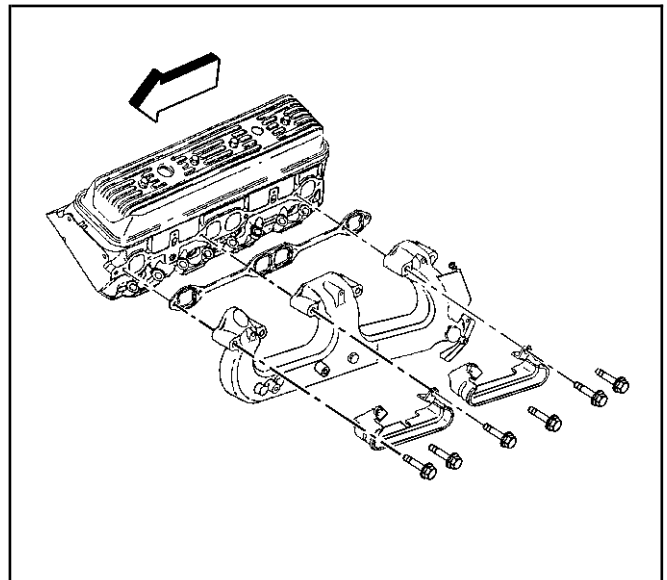
Notice: SIO-ID = 2878 Twist the spark plug boot one-half turn in order to release the boot. Pull on the spark plug boot only. Do not pull on the spark plug wire or the wire could be damaged.

1. Remove the spark plug wires from the spark plugs.
 - 1.1. Rotate the spark plug wire boot one half turn.
 - 1.2. Pull outward on the spark plug wire boot to release from the spark plug.
2. Remove the bolts and the spark plug wire supports.



317185

3. Remove the exhaust manifold bolts.
4. Remove the spark plug wire shields.
5. Remove the exhaust manifold.
6. Remove and discard the exhaust manifold gasket.



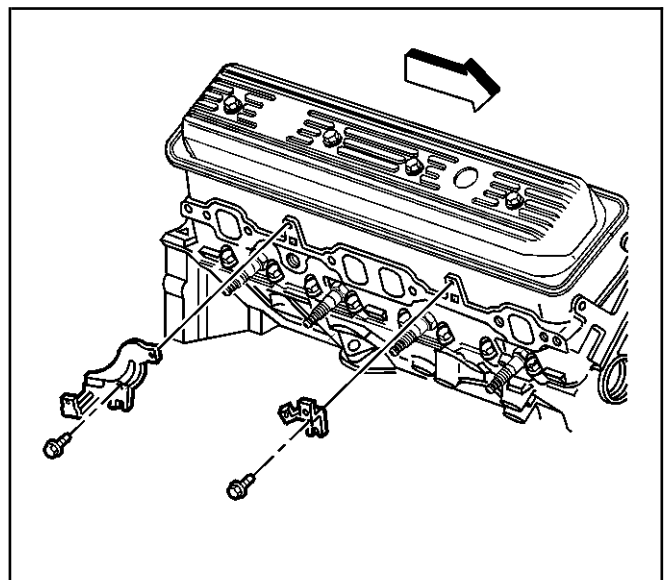
64925

Exhaust Manifold Removal - Right

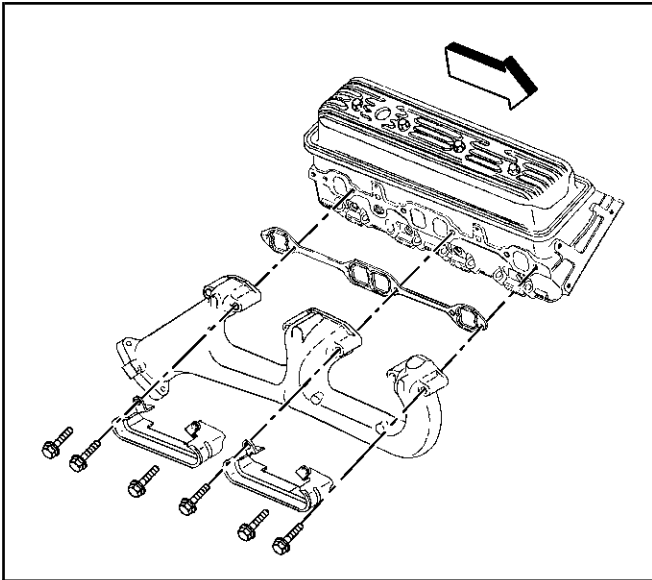
SIE-ID = 650060

Notice: SIO-ID = 2878 Twist the spark plug boot one-half turn in order to release the boot. Pull on the spark plug boot only. Do not pull on the spark plug wire or the wire could be damaged.

1. Remove the spark plug wires from the spark plugs.
 - 1.1. Rotate the spark plug wire boot one half turn.
 - 1.2. Pull outward on the spark plug wire boot to release from the spark plug.
2. Remove the bolts and the spark plug wire supports.

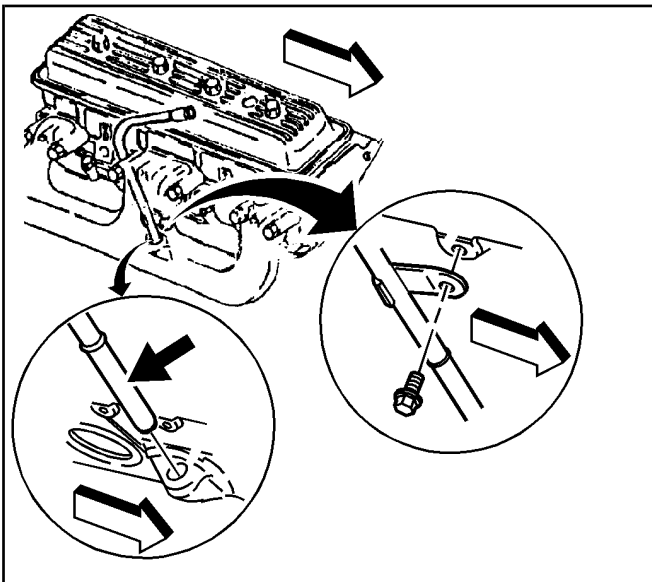


317179



69032

3. Remove the exhaust manifold bolts.
4. Remove the spark plug wire shields.
5. Remove the exhaust manifold.
6. Remove and discard the exhaust manifold gasket.

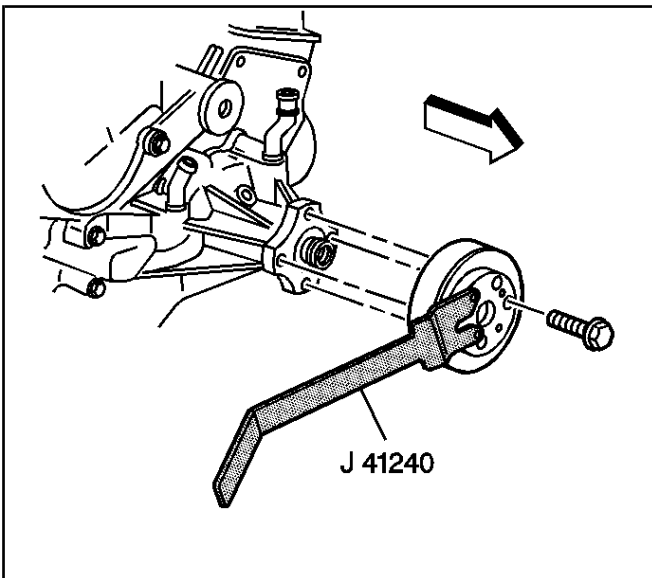


500691

Oil Level Indicator and Tube Removal

SIE-ID = 518523

1. Remove the oil level indicator tube bolt.
2. Remove the oil level indicator tube from the engine block.



317191

Water Pump Removal

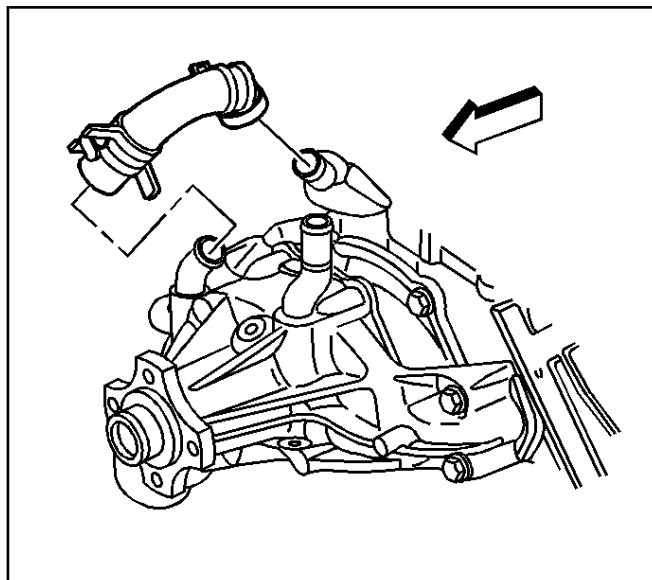
SIE-ID = 69041

Tools Required

J 41240 Fan Clutch Remover and Installer

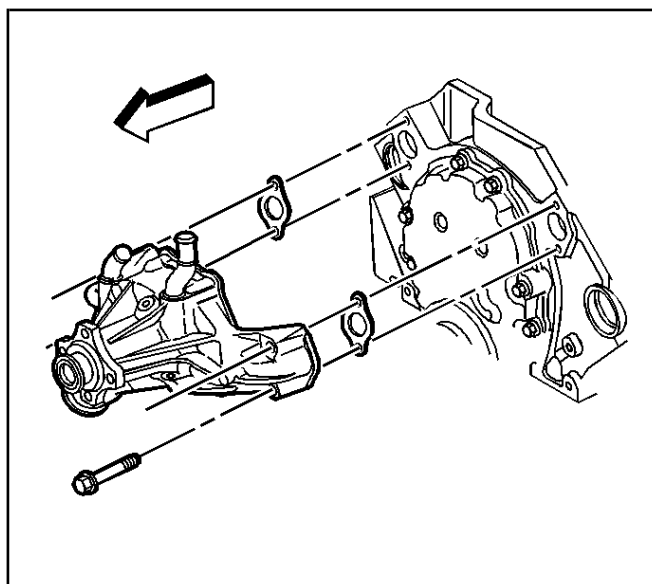
1. Remove the bolts and the fan and water pump pulley using the *J 41240*.

2. Remove the clamps and the water pump inlet hose.



182853

3. Remove the water pump bolts.
4. Remove the water pump.
5. Remove the water pump gaskets.
6. Discard the water pump gaskets.



69011

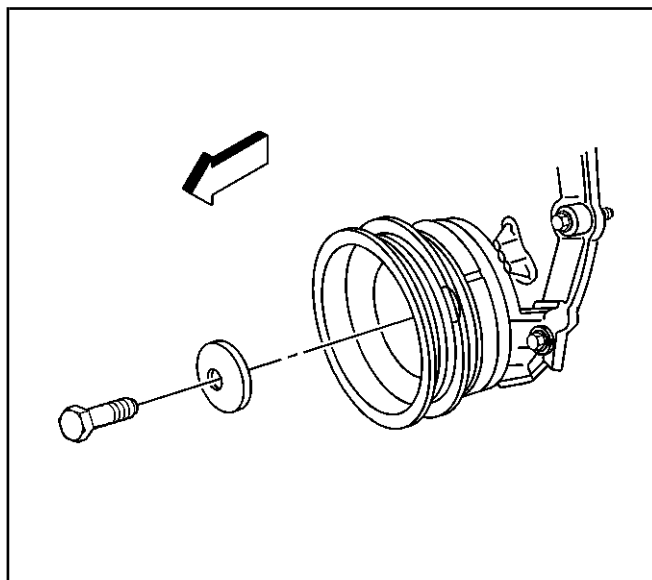
Crankshaft Balancer Removal

SIE-ID = 66682

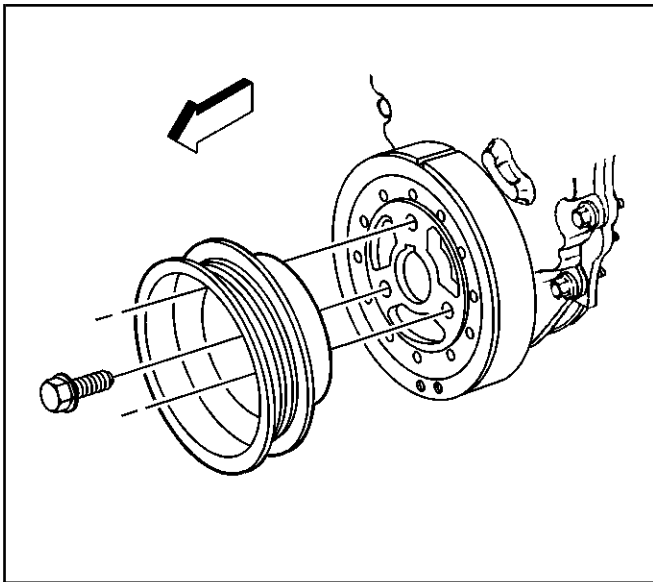
Tools Required

J 23523-F Balancer Remover and Installer

1. Remove the crankshaft balancer bolt and washer.

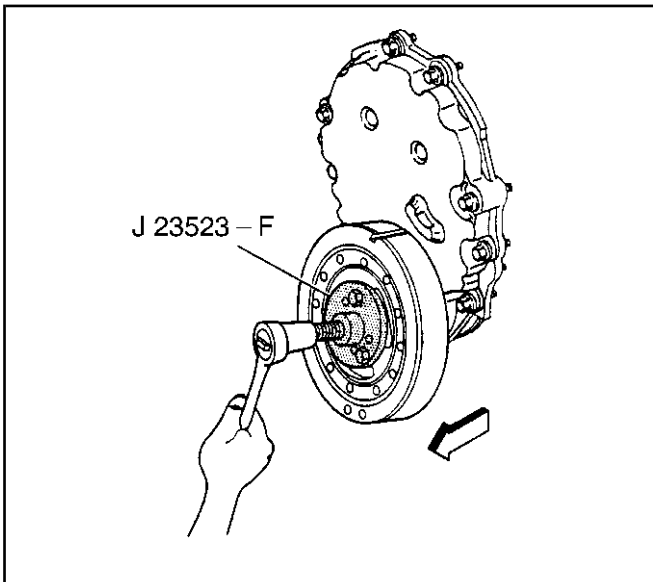


173172



188055

2. Remove the bolts and the crankshaft pulley.

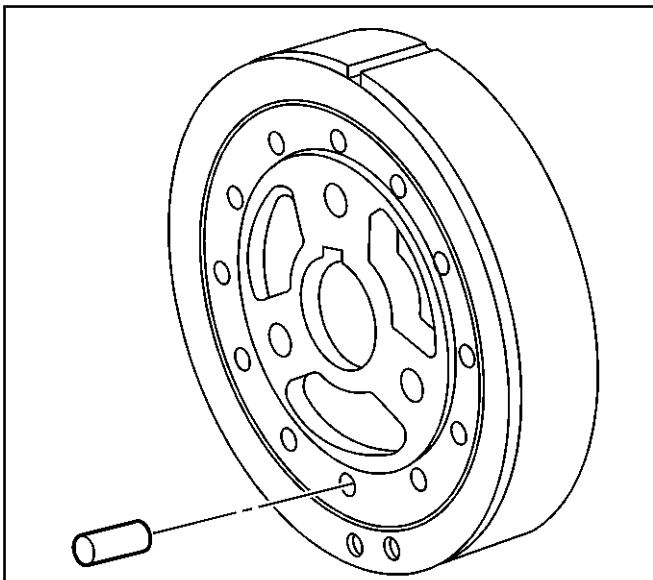


66878

Notice: Refer to *Fastener Notice* in Cautions and Notices.

3. Use the J 23523-F in order to remove the crankshaft balancer.
 - 3.1. Install the J 23523-F plate and bolts onto the crankshaft balancer.

Tighten
Tighten the bolts to 25 N·m (18 lb ft).
 - 3.2. Install the J 23523-F forcing screw into the plate.
 - 3.3. Rotate the J 23523-F forcing screw clockwise in order to remove the crankshaft balancer.
4. Remove the J 23523-F from the crankshaft balancer.



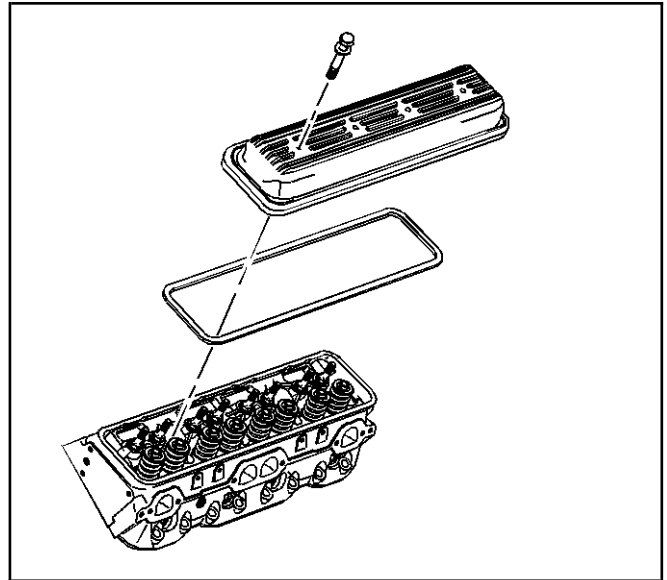
182849

5. Note the position and length of any front groove crankshaft balancer weight pins, if applicable.

Valve Rocker Arm Cover Removal - Left

SIE-ID = 650061

1. Remove the valve rocker arm cover bolts and washers.
2. Remove the valve rocker arm cover.
3. Remove the valve rocker arm cover gasket.
4. Discard the valve rocker arm cover gasket.

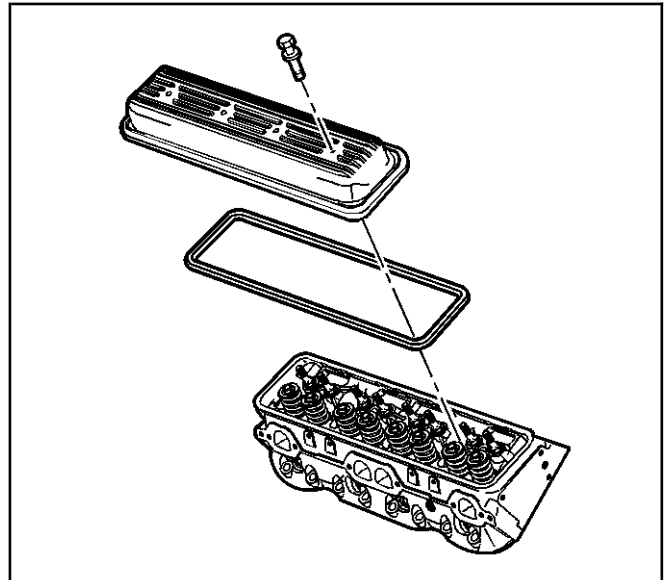


39119

Valve Rocker Arm Cover Removal - Right

SIE-ID = 650062

1. Remove the valve rocker arm cover bolts and washers.
2. Remove the valve rocker arm cover.
3. Remove the valve rocker arm cover gasket.
4. Discard the valve rocker arm cover gasket.

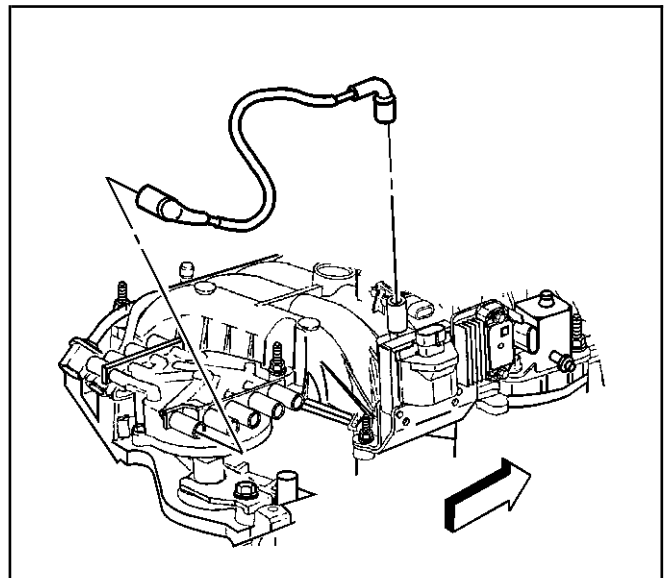


182833

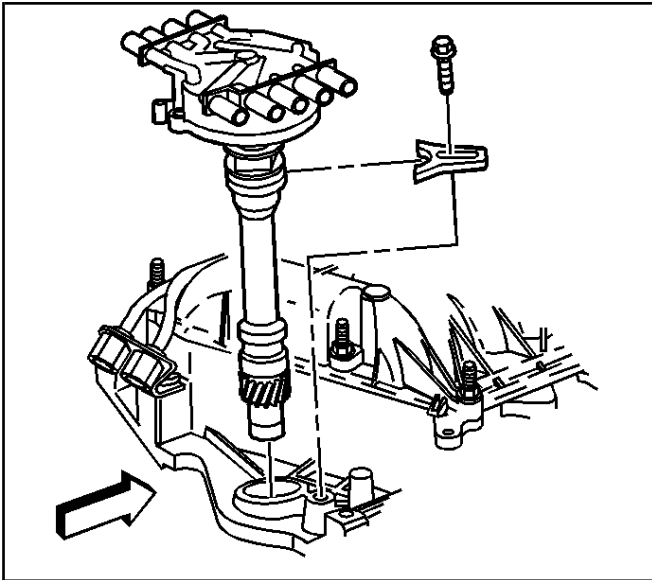
Distributor Removal

SIE-ID = 69504

1. Remove the ignition coil wire harness from the ignition coil and distributor cap.

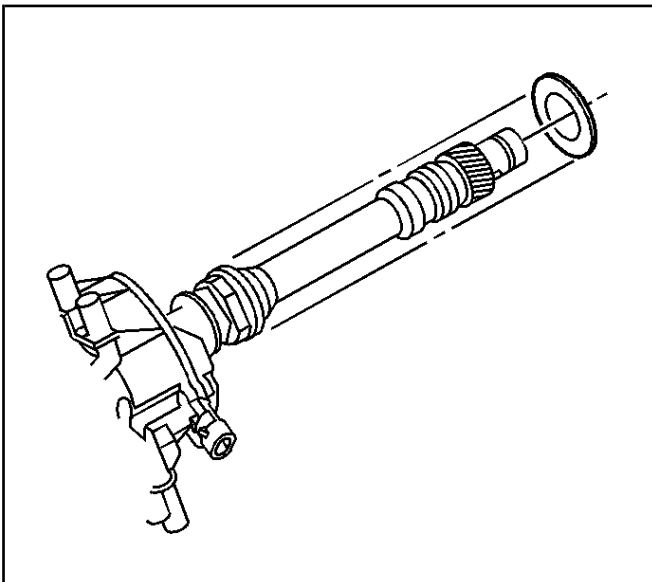


341359



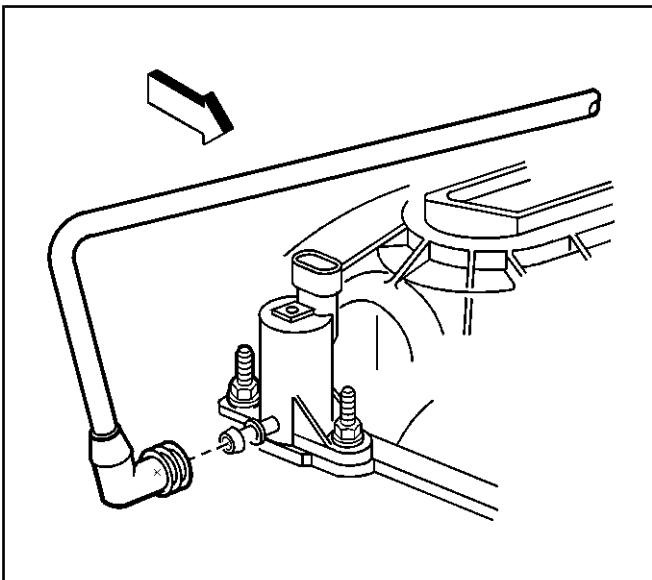
69303

2. Remove the distributor clamp bolt.
3. Remove the distributor and the distributor clamp.



523516

4. Remove the distributor gasket and discard.



317211

Intake Manifold Removal

SIE-ID = 66685

1. Remove the evaporative emission canister purge solenoid valve harness.
 - 1.1. Push the quick disconnect clip and hold in place.
 - 1.2. Pull outward on the harness elbow.

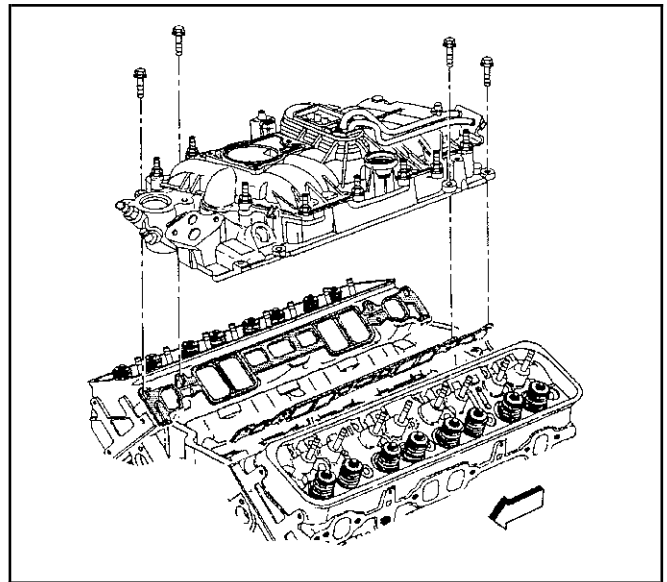
2. Remove the lower intake manifold bolts.

Important: The intake manifold may be removed as an assembly. Do not remove the specific intake manifold components unless component service is required.

Do not allow dirt or debris to enter the fuel system. Ensure that the ends of the fuel system are properly sealed.

Do not disassemble the Central Sequential Fuel Injection (SFI) unit, unless service is required.

3. Remove the intake manifold assembly.
4. Remove and discard the lower intake manifold gaskets.



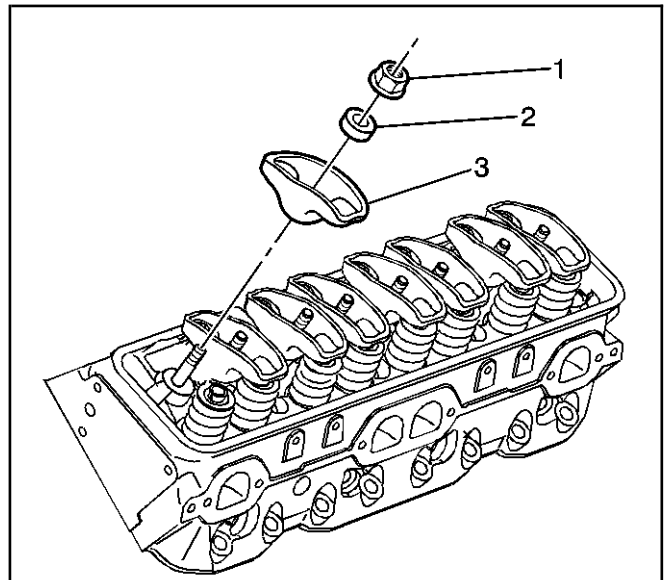
66456

Valve Rocker Arm and Push Rod Removal

SIE-ID = 66690

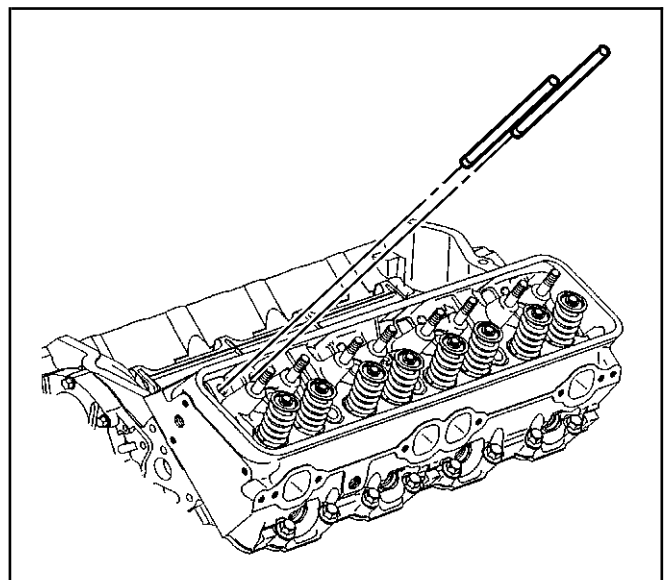
Important: Mark, sort, and organize the components so that the components can be reinstalled to the original location.

1. Remove the following components from the cylinder head:
 - 1.1. The valve rocker arm nuts (1)
 - 1.2. The valve rocker arm balls (2)
 - 1.3. The valve rocker arms (3)



182835

2. Remove the valve pushrods.

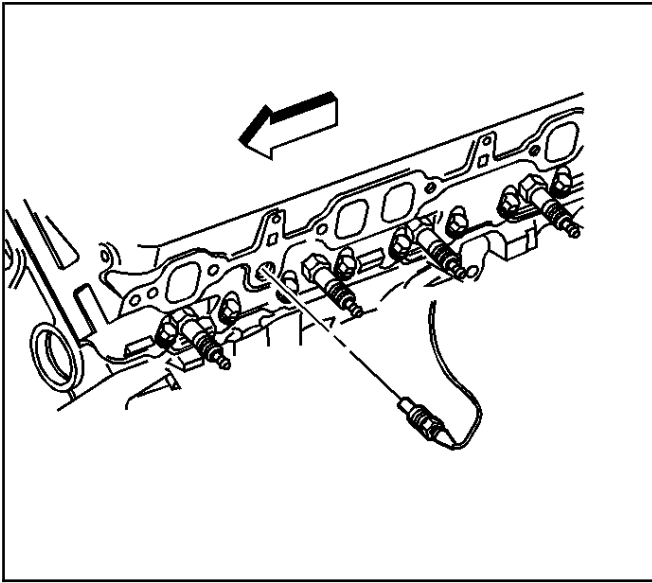


22766

Cylinder Head Removal - Left

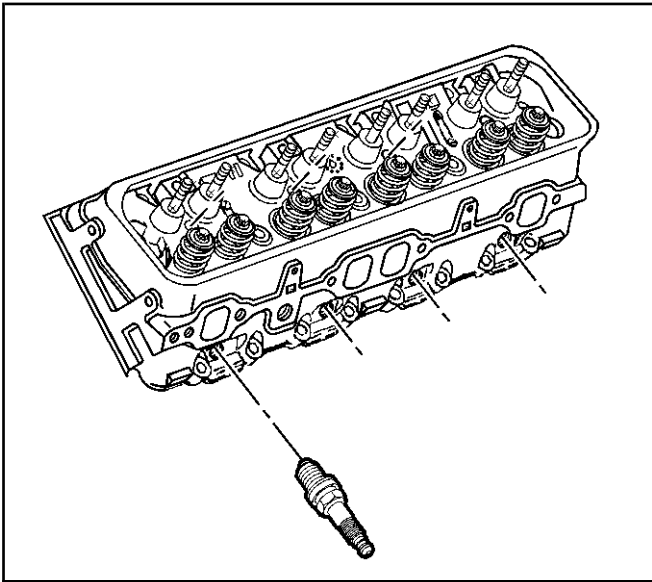
SIE-ID = 650064

1. Remove the engine coolant temperature gage sensor.



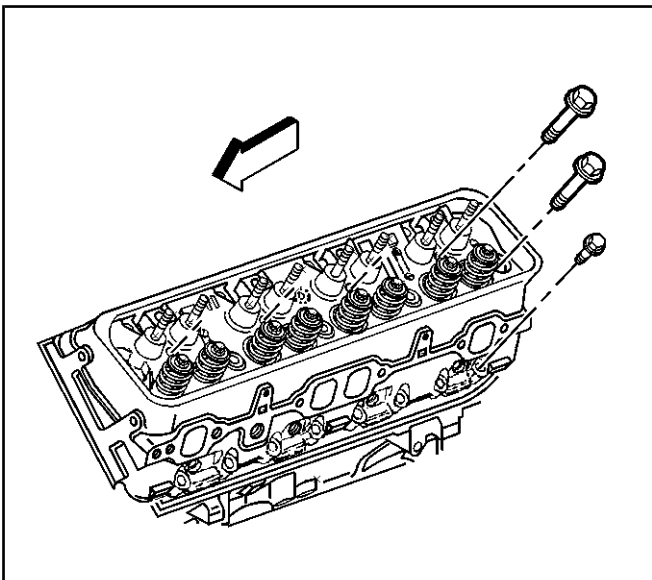
521828

2. Remove and discard the spark plugs.



317307

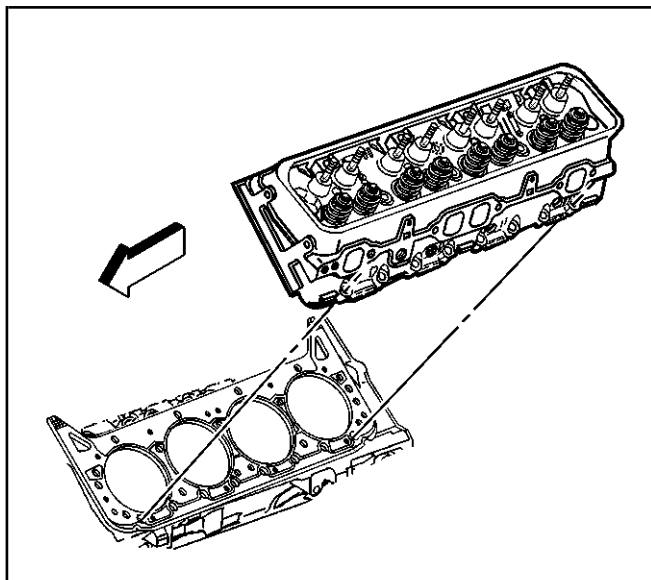
3. Remove the cylinder head bolts.



317217

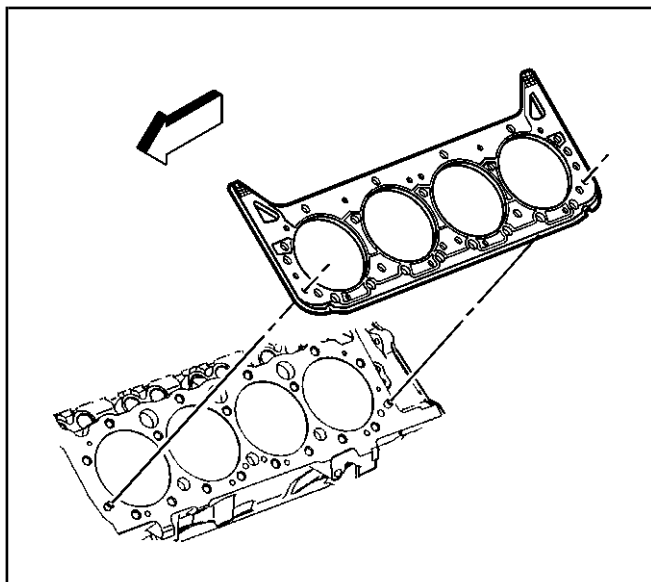
Notice: SIO-ID = 13838 After removal, place the cylinder head on two wood blocks to prevent damage.

4. Remove the cylinder head.



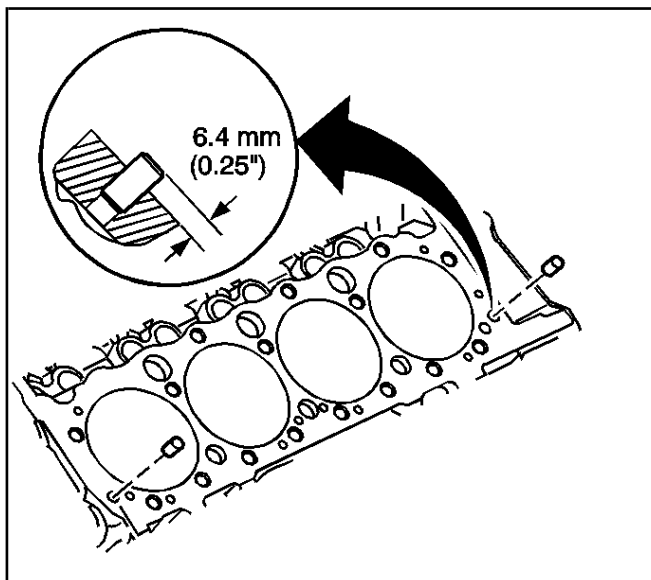
317227

5. Remove and discard the cylinder head gasket.

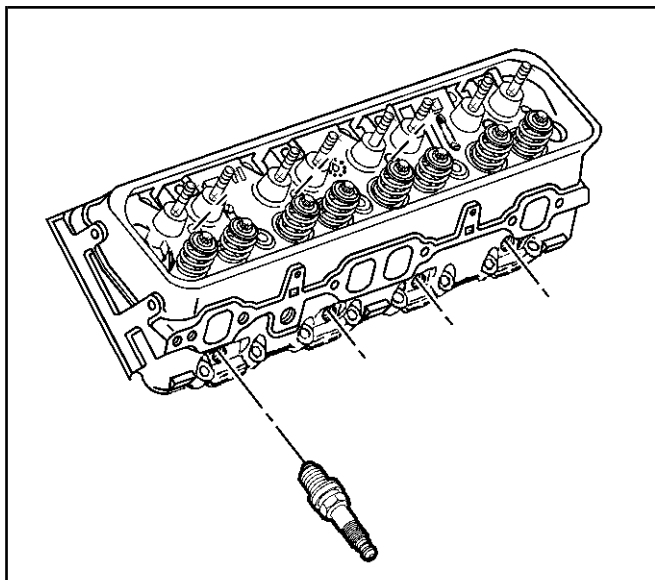


317233

6. Remove the cylinder head locator dowel pin, if required.



182846

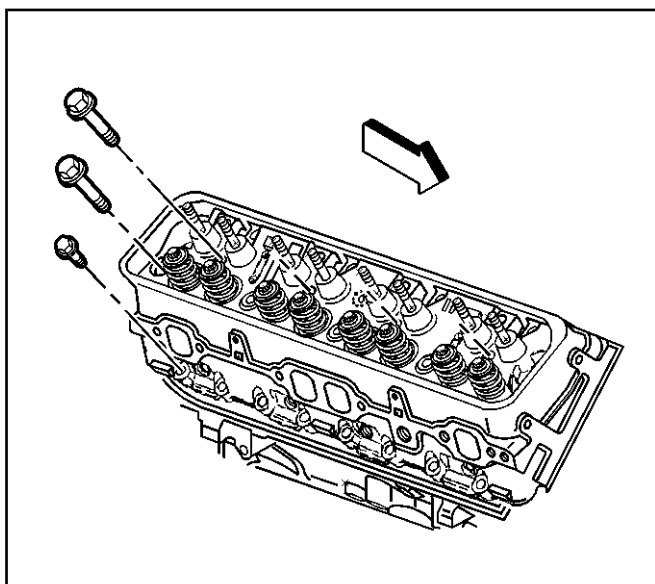


317307

Cylinder Head Removal - Right

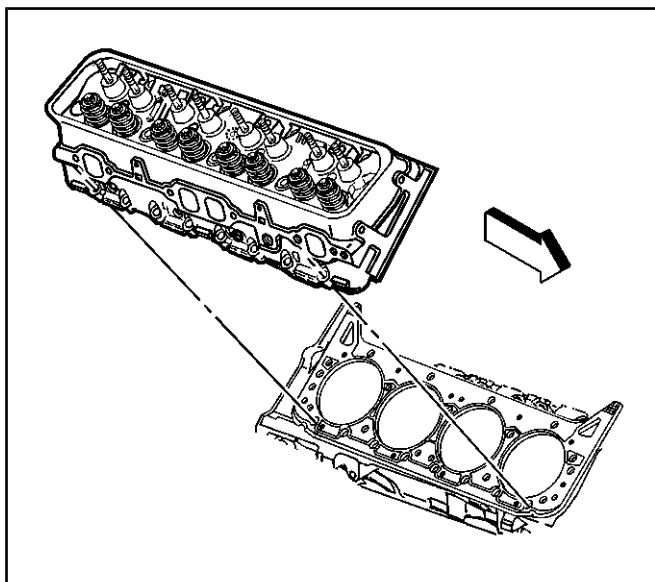
SIE-ID = 650065

1. Remove and discard the spark plugs.



317239

2. Remove the cylinder head bolts.

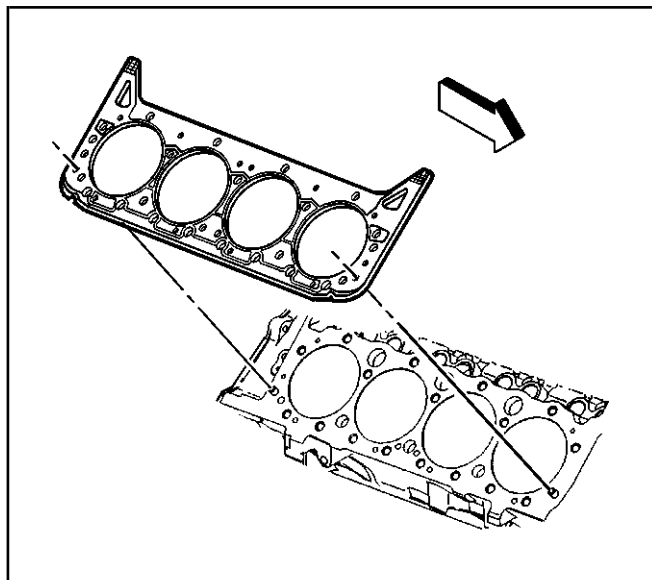


317246

Notice: SIO-ID = 13838 After removal, place the cylinder head on two wood blocks to prevent damage.

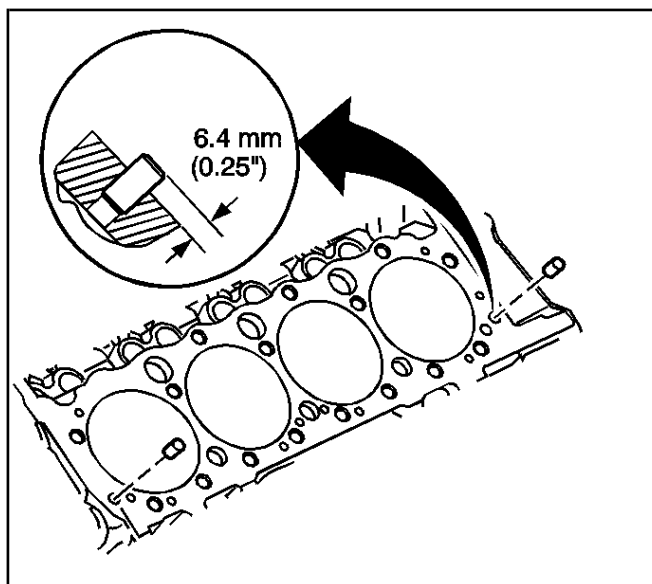
3. Remove the cylinder head.

4. Remove and discard the cylinder head gasket.



317255

5. Remove the cylinder head locator dowel pin, if required.



182846

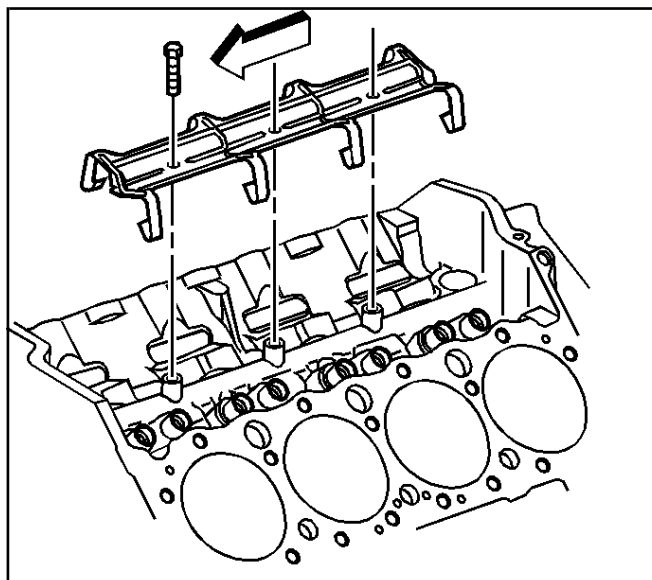
Valve Lifter Removal

SIE-ID = 24119

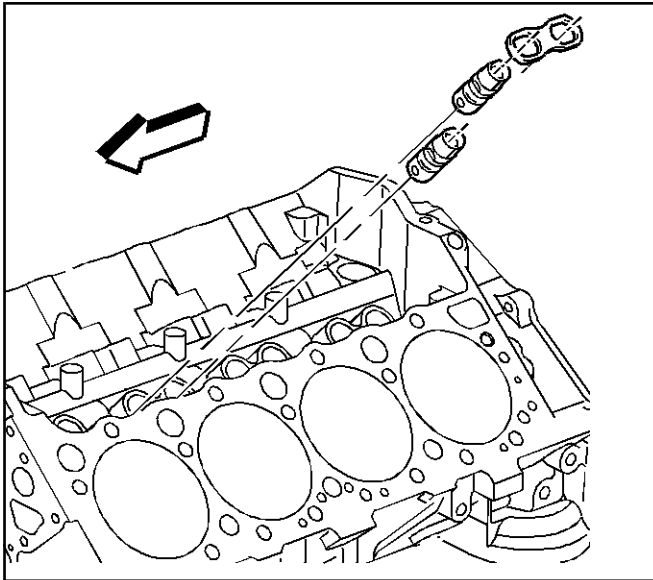
Tools Required

J 3049-A Valve Lifter Remover

1. Remove the bolts and valve lifter guide retainer.



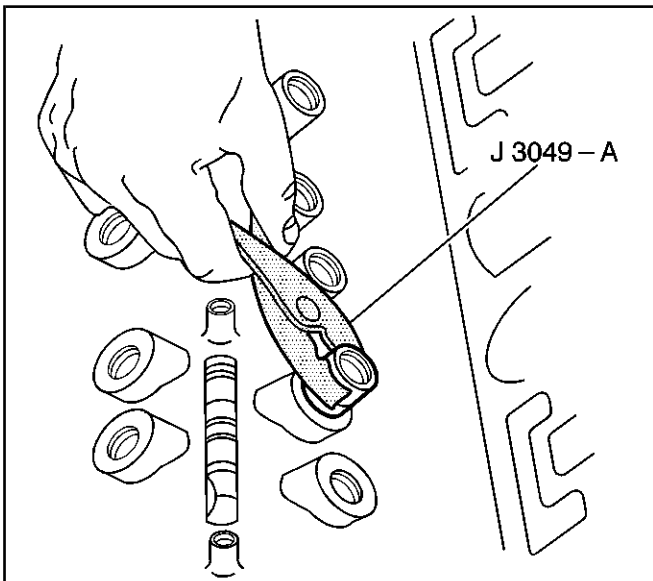
11508



11509

Important: Place the valve lifters in the rack in the upright position in order to maintain the oil inside the valve lifter.

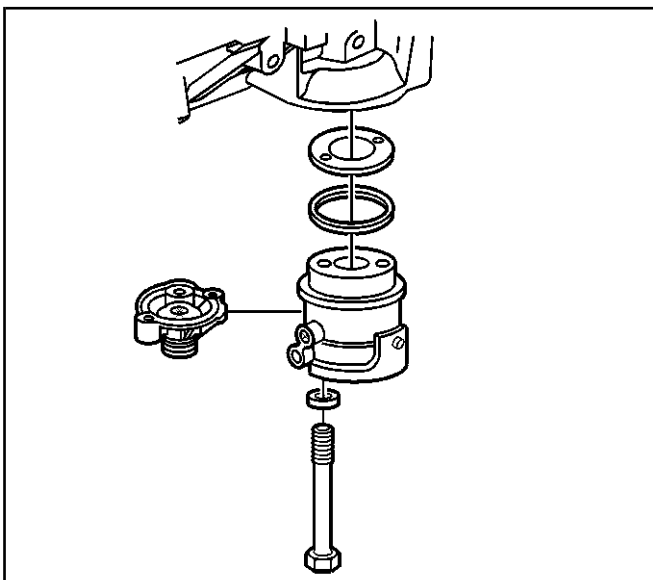
2. Remove the valve lifter guides and valve lifters.
3. Place the components in a rack so that the components can be reinstalled to the original location.



31350

Important: Some valve lifters may be stuck in the valve lifter bores because of gum or varnish deposits.

4. Use the J 3049-A in order to remove the stuck valve lifters.



39122

Oil Filter Adapter Removal

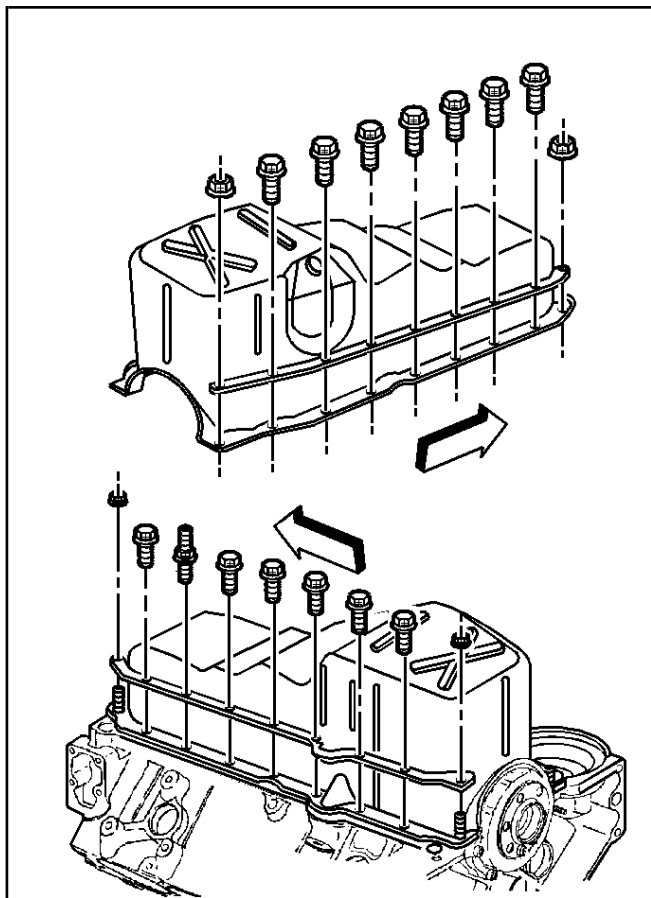
SIE-ID = 69505

1. Remove the oil filter adapter bolts and washers, if applicable.
2. Remove the oil filter adapter.
3. Remove the oil filter adapter seal, O-ring, and the oil filter adapter gasket, if applicable.
4. Discard the oil filter adapter seal, O-ring, and the oil filter adapter gasket, if applicable.

Oil Pan Removal

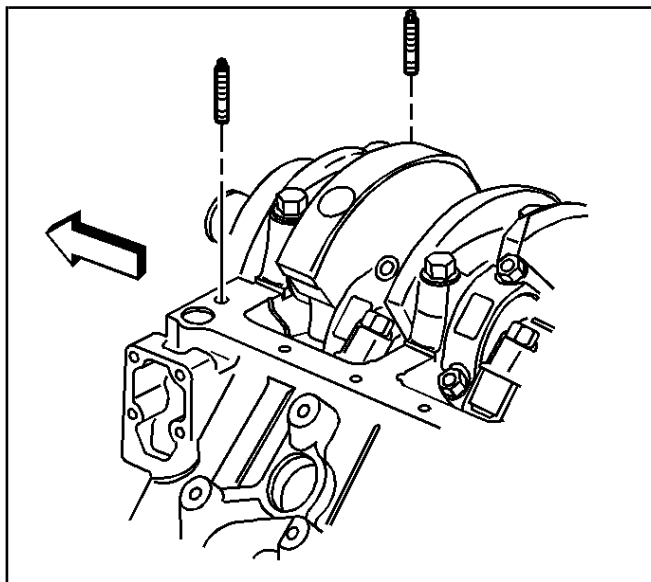
SIE-ID = 66836

1. Remove the oil pan bolts and nuts.
2. Remove the oil pan reinforcements.
3. Remove the oil pan.
4. Remove and discard the oil pan gasket.

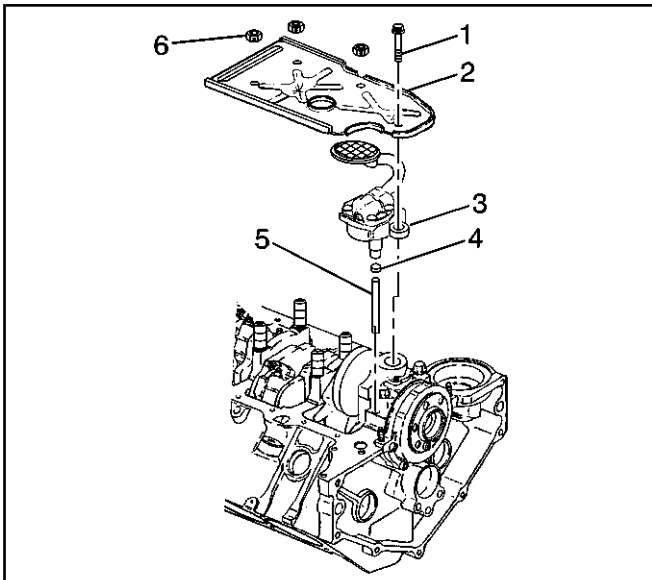


182851

5. Remove the oil pan studs.



521817



11438

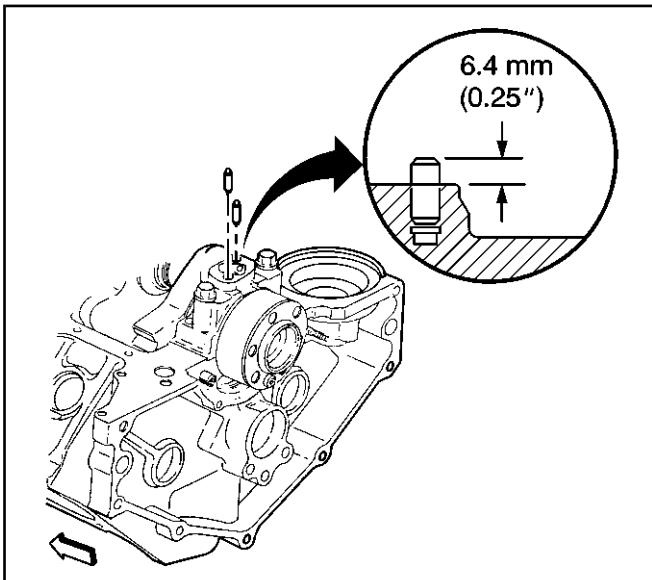
Oil Pump, Pump Screen and Deflector Removal

SIE-ID = 195387

1. Remove the nuts (6) and the crankshaft oil deflector (2).
2. Remove the oil pump bolt (1).
3. Remove the oil pump (3), the oil pump driveshaft (5), and the oil pump driveshaft retainer (4).
4. Separate the oil pump (3), the oil pump driveshaft (5), and the oil pump driveshaft retainer (4).

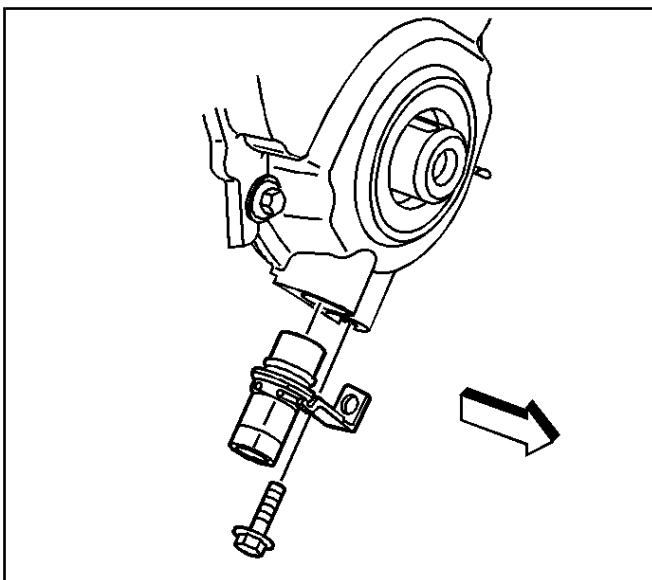
Important: Always install a NEW oil pump driveshaft retainer during assembly.

5. Discard the oil pump driveshaft retainer.



182852

6. Inspect the oil pump locator pins for damage. Replace the pins if required.



11485

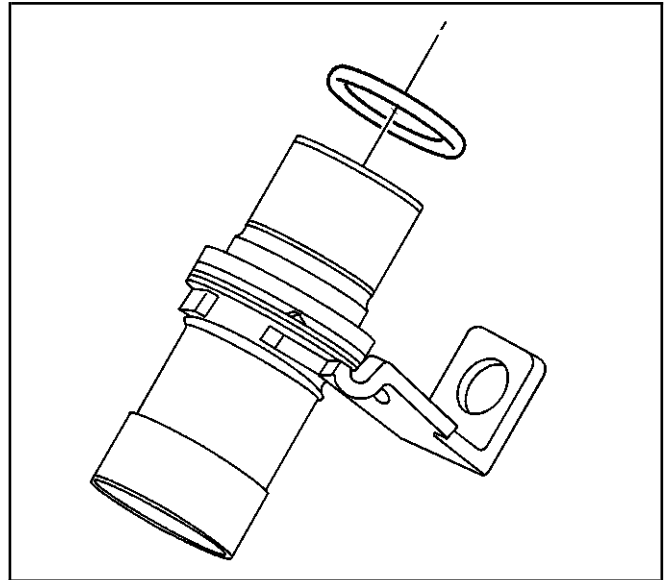
Engine Front Cover Removal

SIE-ID = 195381

1. Remove the crankshaft position sensor bolt.
2. Remove the crankshaft position sensor.

Important: Always install a NEW crankshaft position sensor seal, O-ring, during assembly.

3. Remove the crankshaft position sensor seal, O-ring.
4. Discard the crankshaft position sensor seal, O-ring.

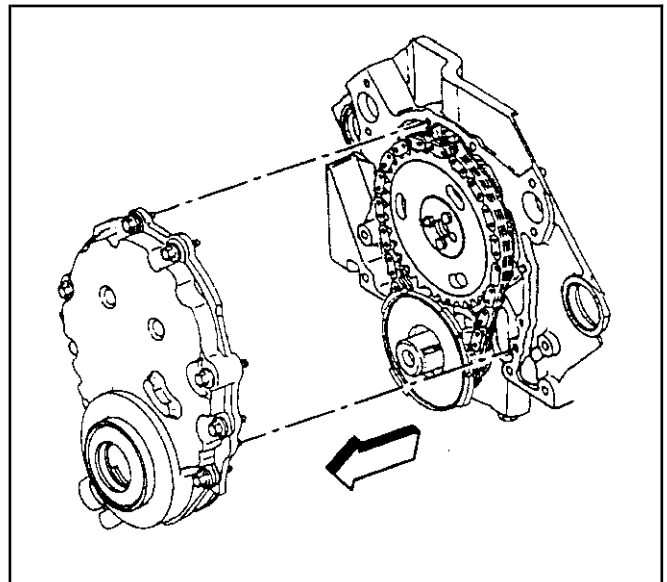


387759

5. Remove the engine front cover bolts.
6. Remove the engine front cover and gasket.

Important: DO NOT reuse the composite engine front cover and gasket. Always install a NEW engine front cover.

7. Discard the engine front cover and gasket.



69010

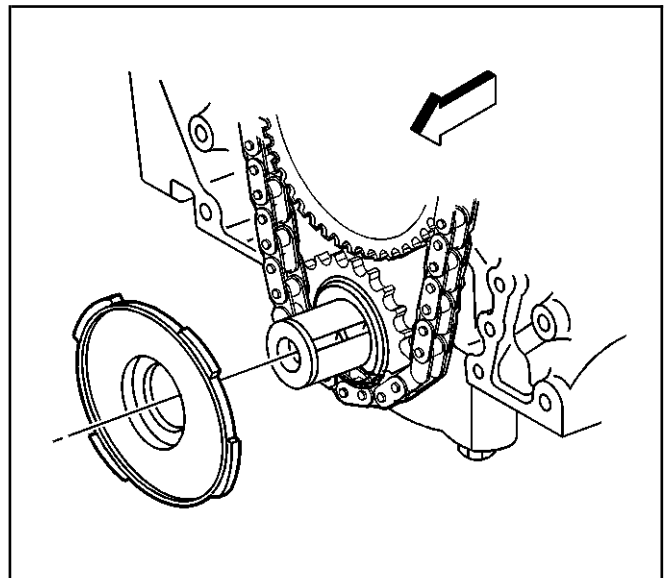
Timing Chain and Sprockets Removal

SIE-ID = 66838

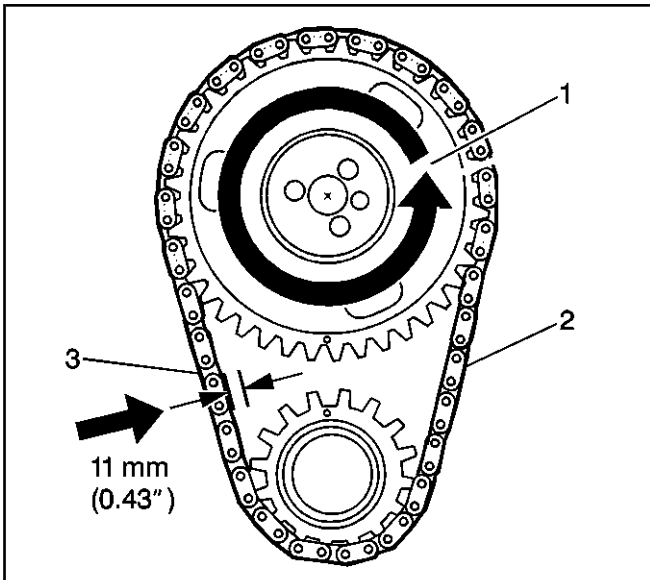
Tools Required

J 5825-A Crankshaft Gear Remover

1. Remove the crankshaft position sensor reluctor ring.



69450

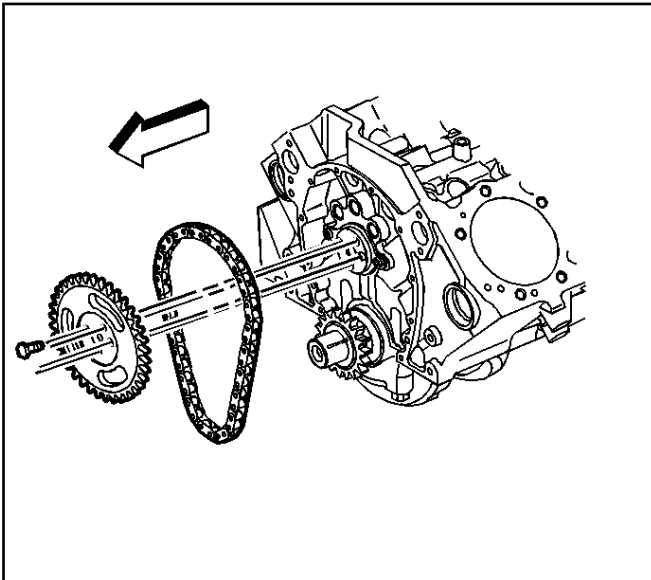


341357

2. Check the camshaft timing chain free play.

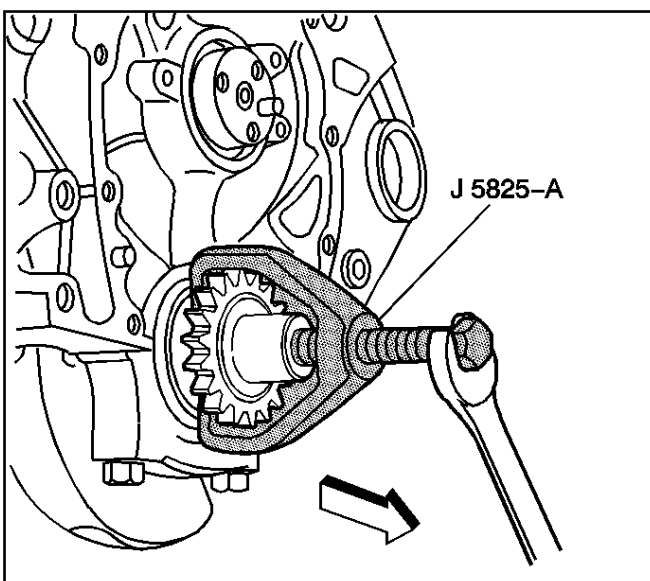
If the camshaft timing chain can be moved in excess of 11 mm (0.43 in), replacement of the camshaft timing chain and the sprockets is recommended during assembly.

- 2.1. Rotate the camshaft sprocket (1) counterclockwise until all slack is removed from the camshaft timing chain (2).
- 2.2. Measure the free play on the slack side (3) of the camshaft timing chain.



500645

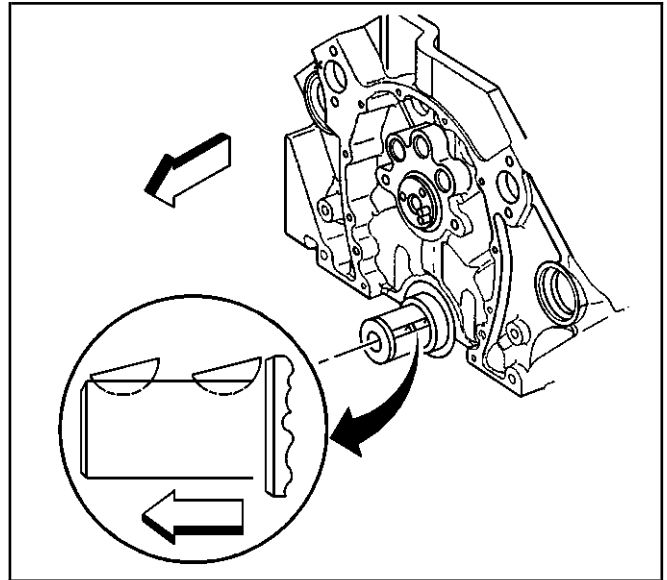
3. Remove the camshaft sprocket bolts.
4. Remove the camshaft sprocket.
5. Remove the camshaft timing chain.



11506

6. Remove the crankshaft sprocket using the J 5825-A.

7. Remove the crankshaft balancer woodruff keys, if required.

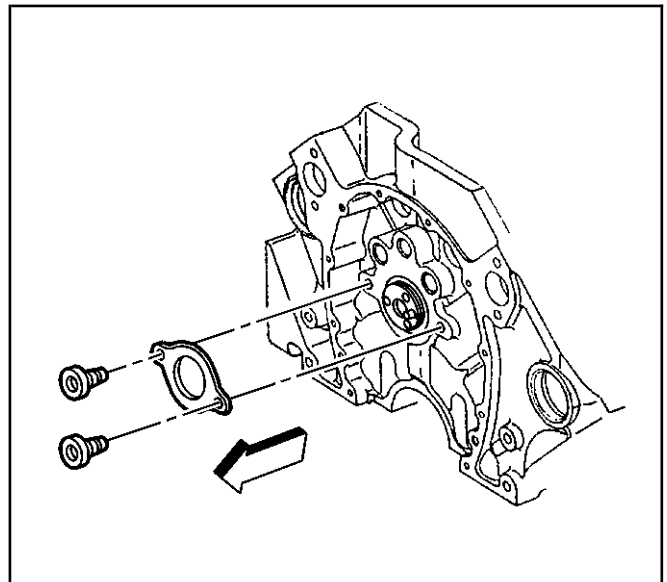


182847

Camshaft Removal

SIE-ID = 69031

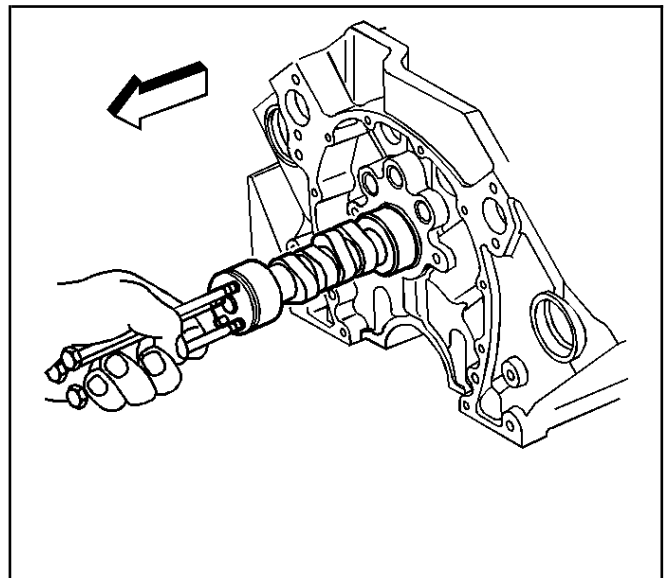
1. Remove the bolts and the camshaft retainer.



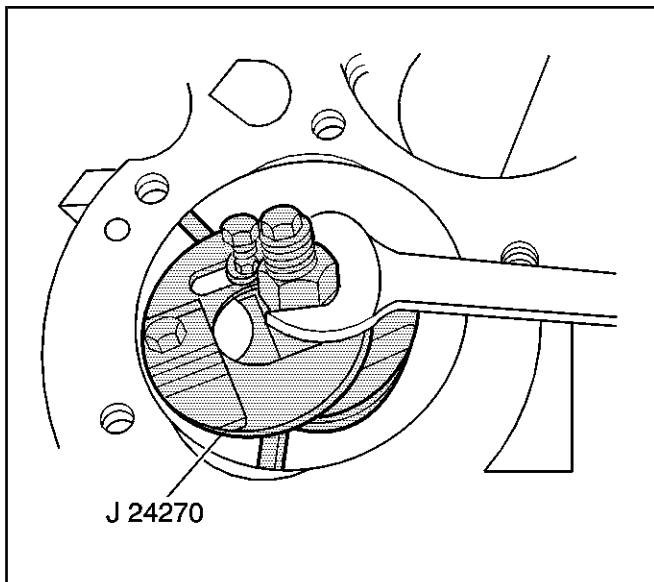
182836

Notice: SIO-ID = 13833 All camshaft journals are the same diameter, so care must be used in removing or installing the camshaft to avoid damage to the camshaft bearings.

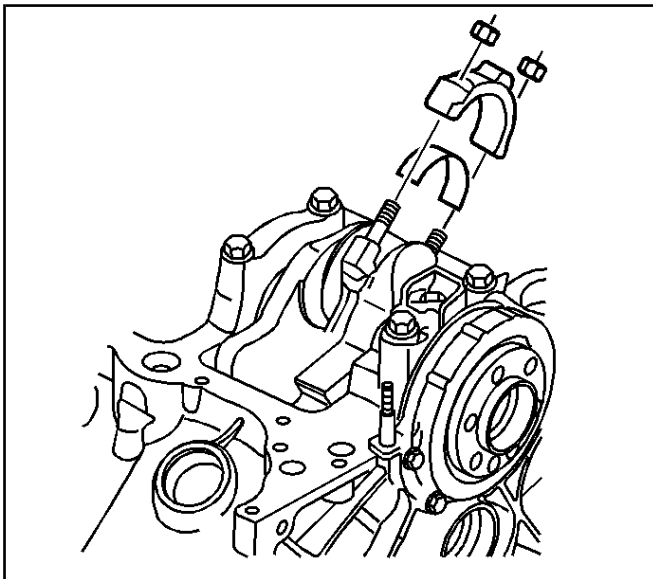
2. Remove the engine camshaft.
 - 2.1. Install the three 5/16–18 x 4.0 inch bolts in the engine camshaft front bolt holes.
 - 2.2. Using the bolts as a handle, carefully rotate and pull the engine camshaft out of the camshaft bearings.
 - 2.3. Remove the bolts from the front of the engine camshaft.



69013



11497



480549

Piston, Connecting Rod, and Bearing Removal

SIE-ID = 24200

Tools Required

- J 5239 Connecting Rod Bolt Guide Set
- J 24270 Cylinder Bore Ridge Reamer

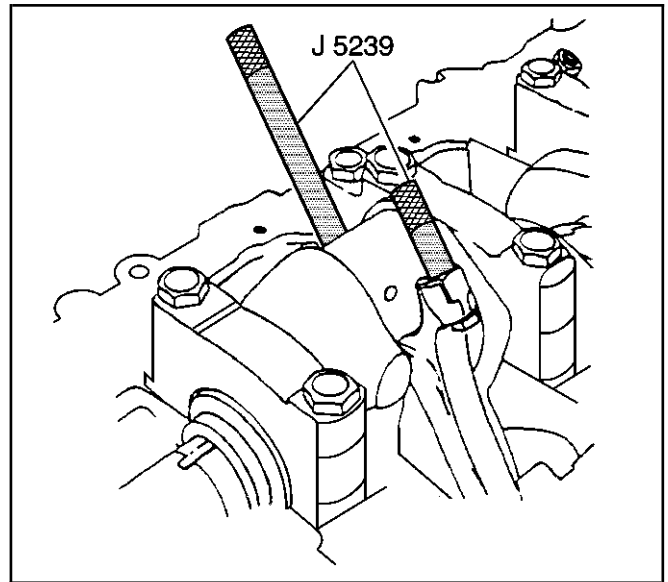
Caution: Refer to Safety Glasses Caution in Cautions and Notices.

1. Remove the ring ridge.
 - 1.1. Turn the crankshaft until the piston is at the bottom of the stroke.
 - 1.2. Place a cloth on the top of the piston.
 - 1.3. Use the J 24270 in order to remove cylinder ring ridge.
 - 1.4. Turn the crankshaft so the piston is at the top of the stroke.
 - 1.5. Remove the cloth.
 - 1.6. Remove the cutting debris.

Important: Place matchmarks or numbers on the connecting rods and the connecting rod caps.

2. Remove the connecting rod nuts.
3. Remove the connecting rod cap.

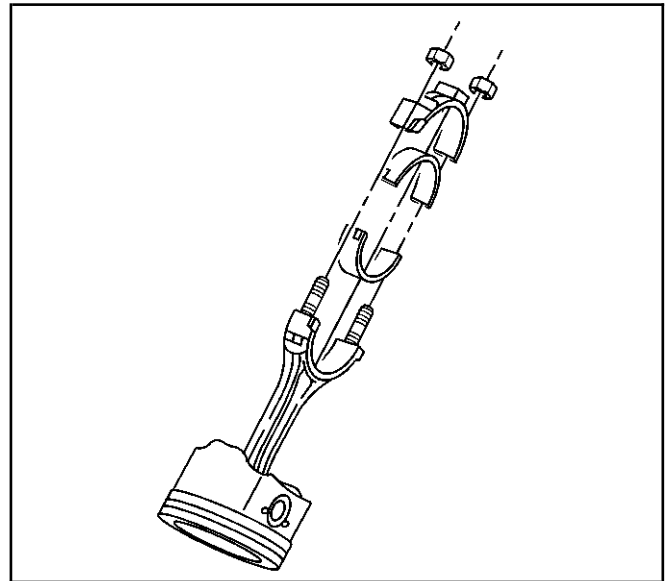
4. Use the *J 5239* in order to protect the crankshaft journals and remove the connecting rod and the piston out of the top of the engine block.



31373

Important: Always assemble the connecting rod caps to the matching connecting rods.

5. Remove the connecting rod bearings.
 - Keep the connecting rod bearings with the original connecting rod and connecting rod cap.
 - Wipe the oil from the connecting bearings.
 - Wipe the oil from the crankpins.

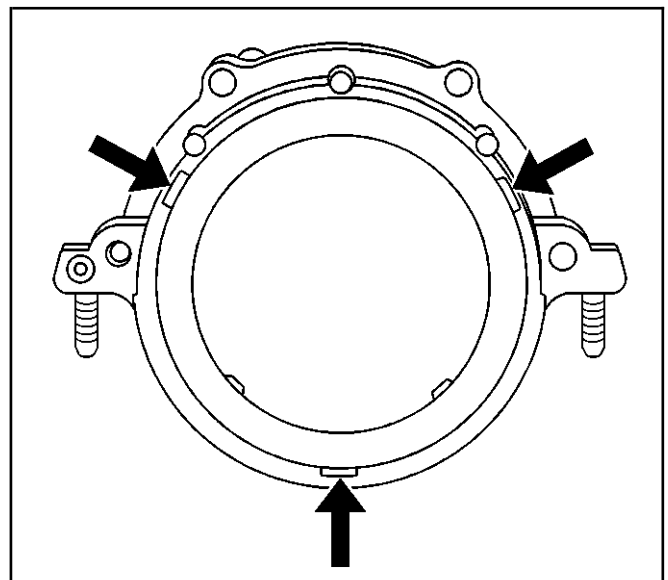


188017

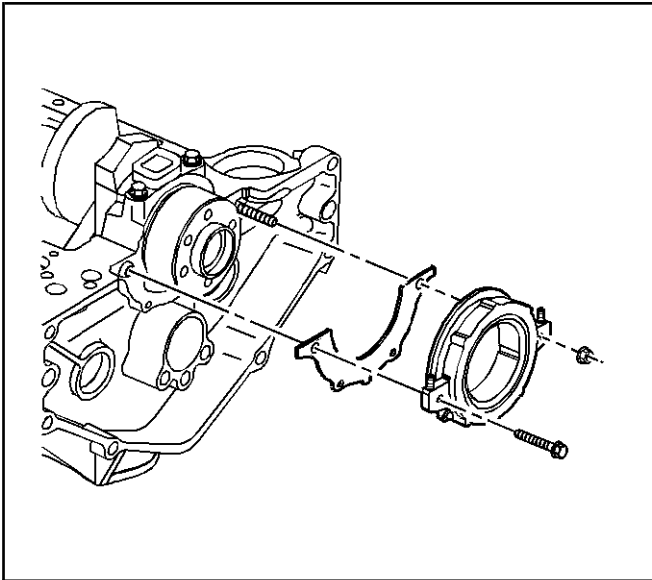
Crankshaft Rear Oil Seal and Housing Removal

SIE-ID = 24222

1. Remove the crankshaft rear oil seal from the crankshaft rear oil seal housing.
Insert a suitable tool into the access notches and then carefully pry the crankshaft rear oil seal from the crankshaft rear oil seal housing.
2. Discard the crankshaft rear oil seal.

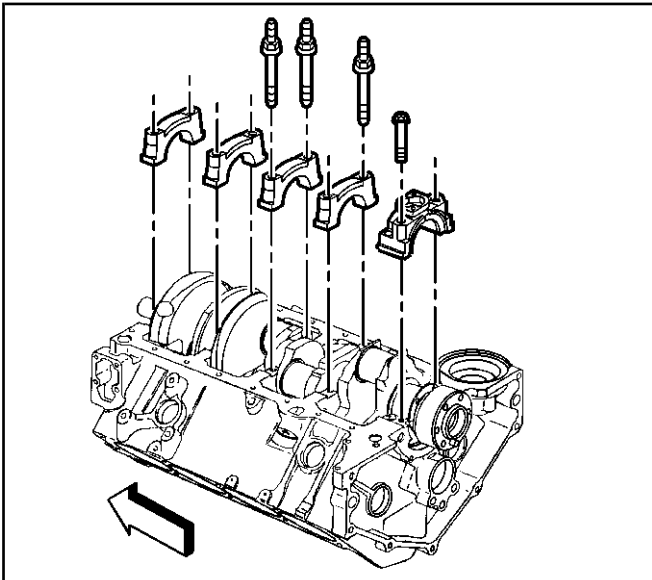


31379



11479

3. Remove the crankshaft rear oil seal housing nut and bolts.
4. Remove the crankshaft rear oil seal housing.
5. Remove the crankshaft rear oil seal housing gasket.
6. Discard the crankshaft rear oil seal housing gasket.
7. Remove the rear oil seal housing retainer stud from the engine block.

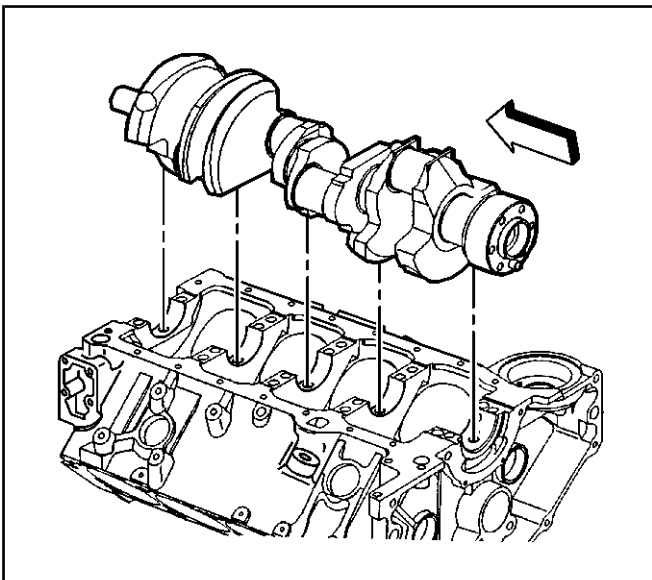


317268

Crankshaft and Bearings Removal

SIE-ID = 69426

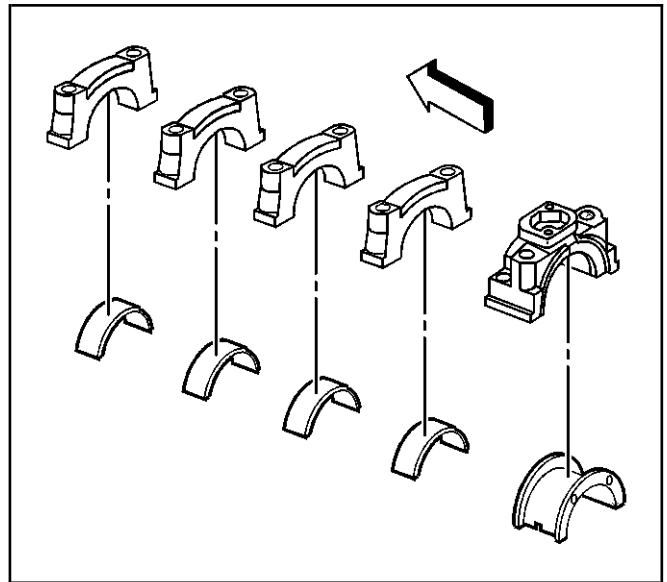
1. Mark or identify the crankshaft bearing cap locations and positions for assembly.
2. Remove the crankshaft bearing cap bolts and studs.
3. Remove the crankshaft bearing caps.



317351

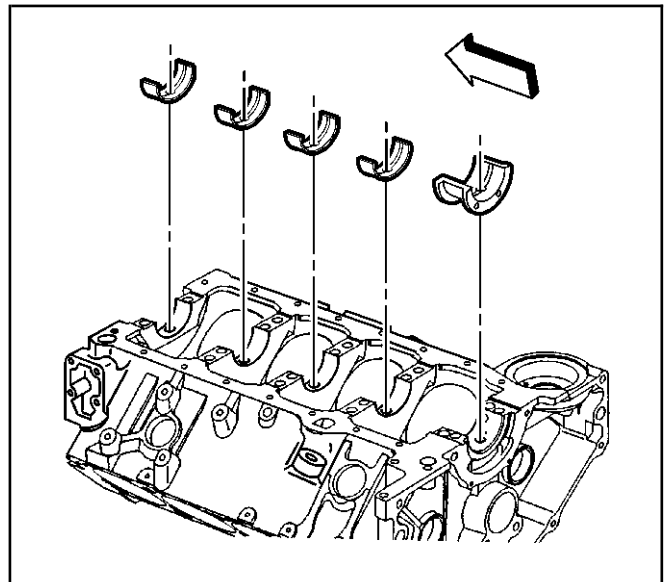
4. Remove the crankshaft.

5. Remove the crankshaft bearings from the crankshaft bearing caps.



317295

6. Remove the crankshaft bearings from the engine block.



317292

Engine Block Plug Removal

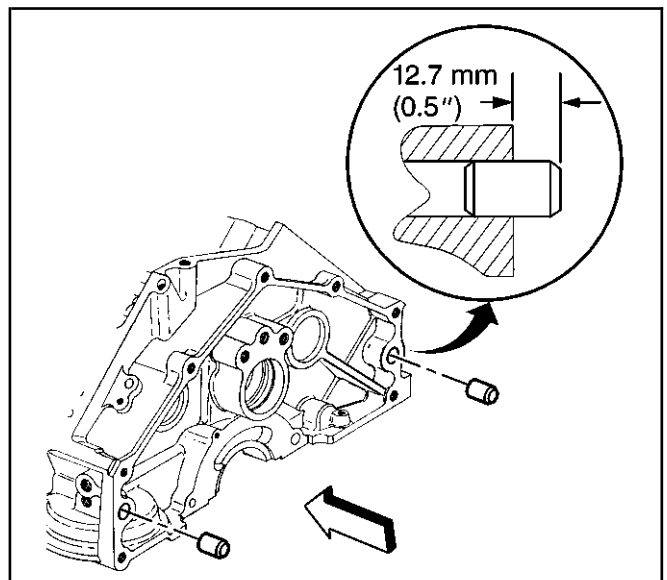
SIE-ID = 348910

Tools Required

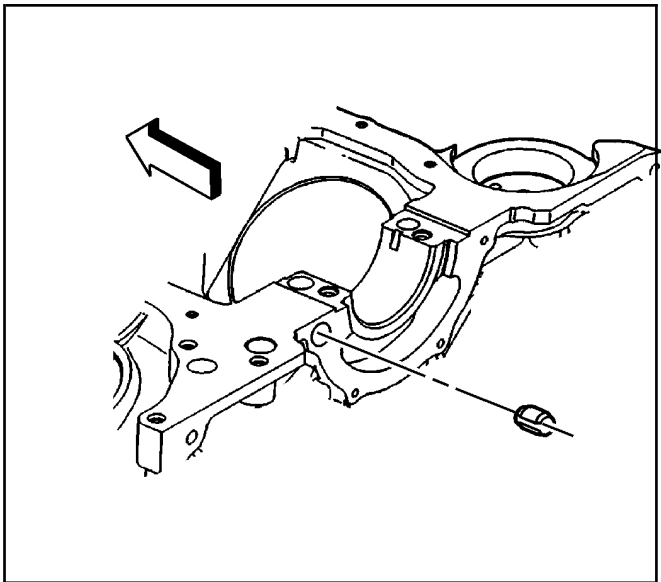
J 41712 Oil Pressure Switch Socket

Caution: Refer to Safety Glasses Caution in Cautions and Notices.

1. Remove the transmission locator pins, if required.

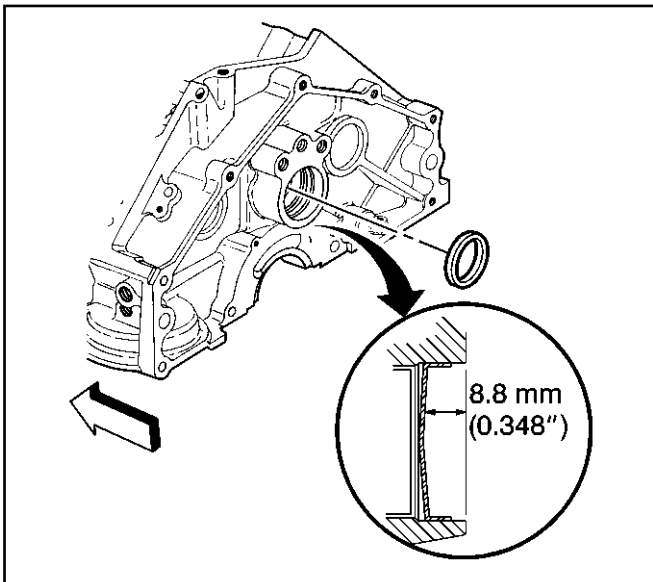


182855



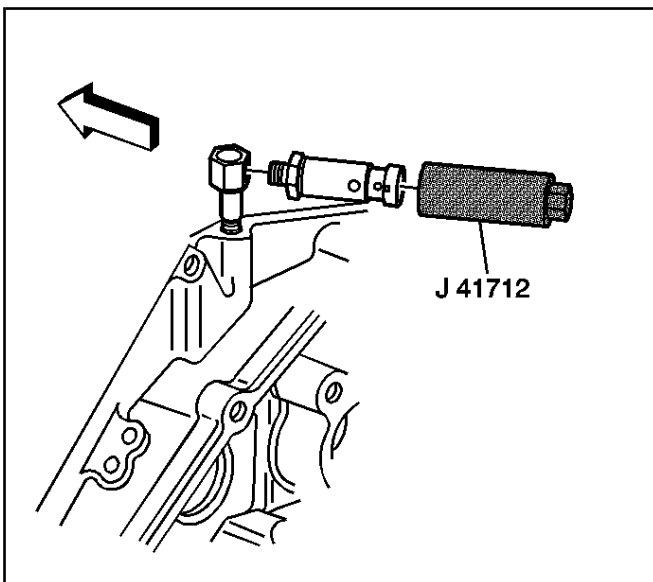
521820

2. Remove the S type pin, and the crankshaft rear oil seal housing, if required.



182854

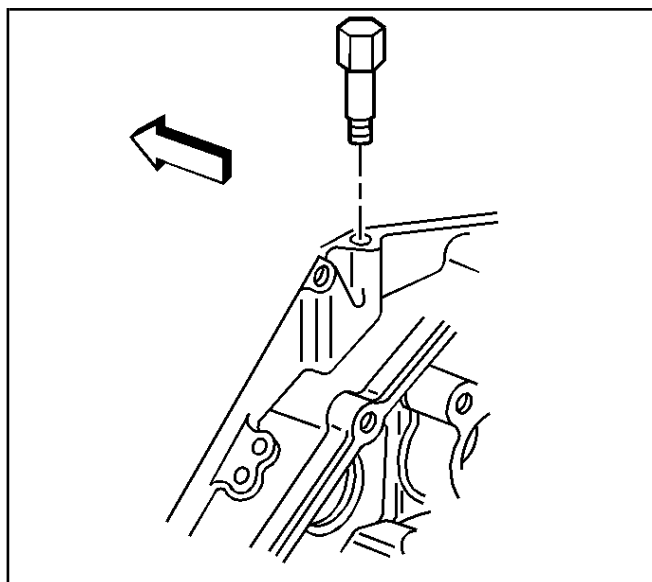
3. Remove the expansion cup plug from the camshaft rear bearing hole.



333649

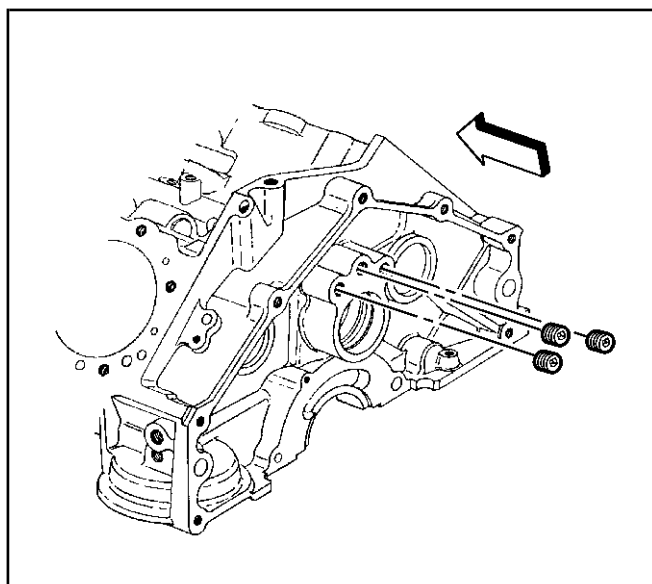
4. Remove the engine oil pressure gage sensor using the J 41712.

5. Remove the engine oil pressure sensor gage sensor fitting.



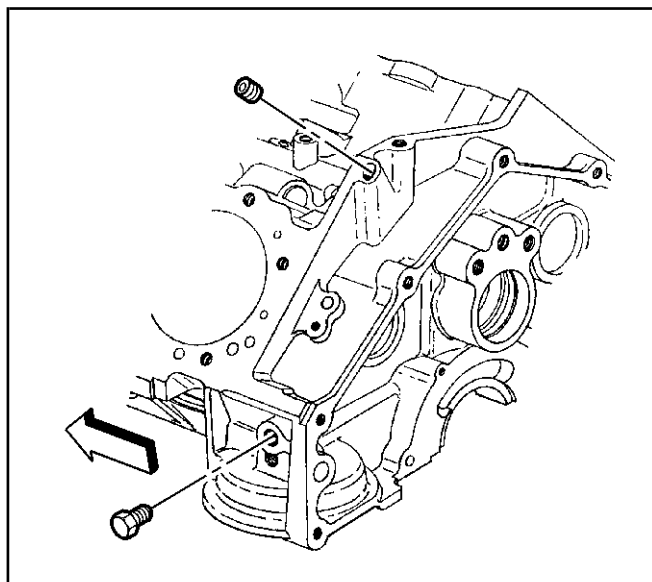
333652

6. Remove the engine block oil gallery plugs from the rear of the engine block and discard.

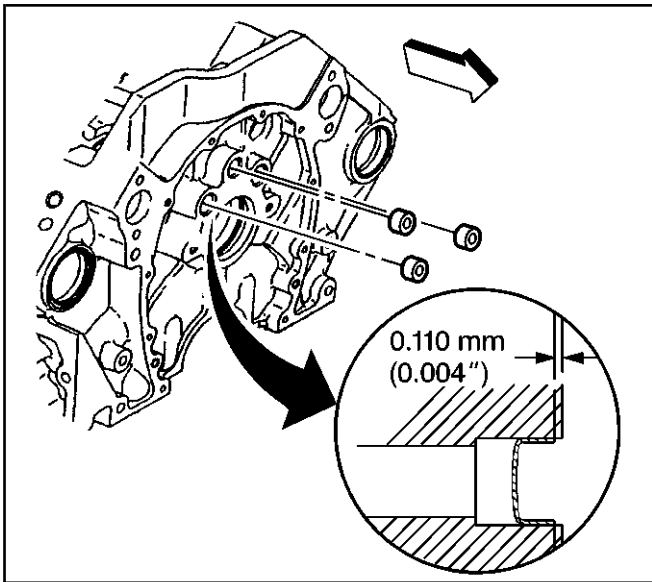


69847

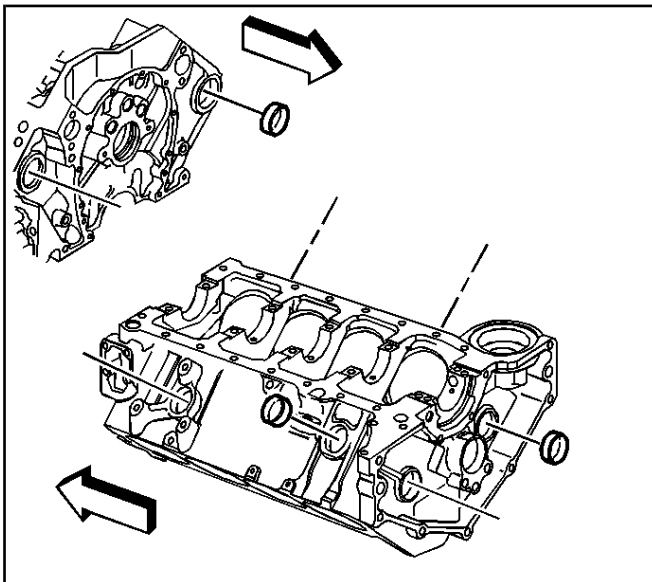
7. Remove the left side rear and left rear top engine block oil gallery plugs.



182841



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8. Remove the engine block oil gallery plugs from the front of the engine block and discard.
Insert a 3/8 x 26 inch rod into the rear oil gallery holes in order to drive out the front engine block oil gallery plugs.

9. Remove the engine block core hole plugs.
 - 9.1. Use a suitable tool in order to drive the engine block core hole plug into the coolant jacket.
 - 9.2. Use a suitable tool in order to pull the engine block core hole plug from the coolant jacket.
 - 9.3. Discard the engine block core hole plug.

Engine Block Cleaning and Inspection

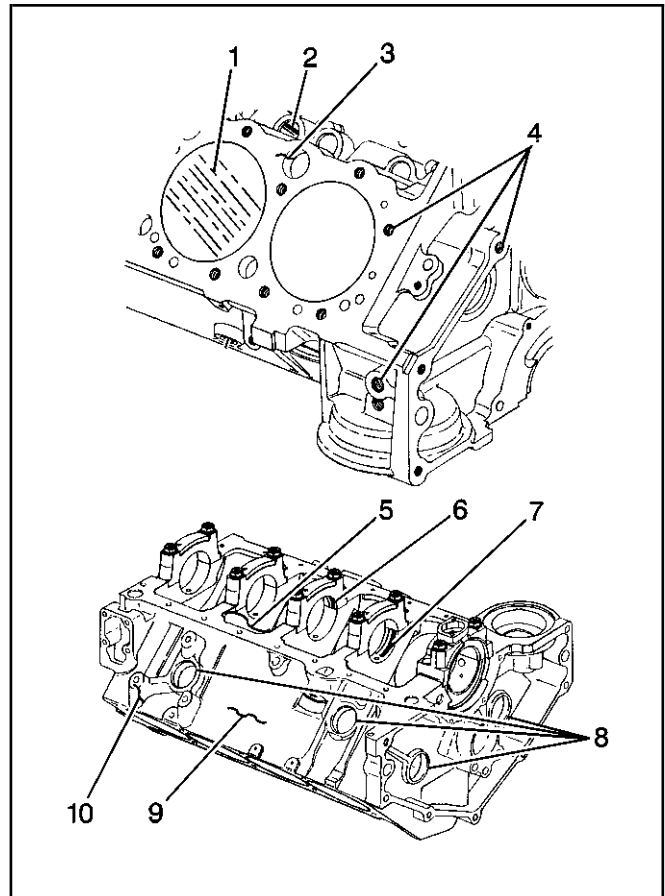
SIE-ID = 784233

Tools Required

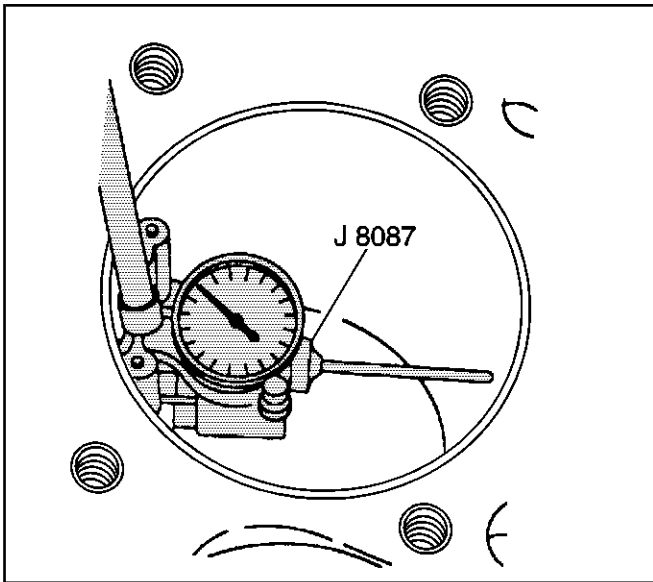
J 8087 Cylinder Bore Gage

Caution: Refer to Safety Glasses Caution in Cautions and Notices.

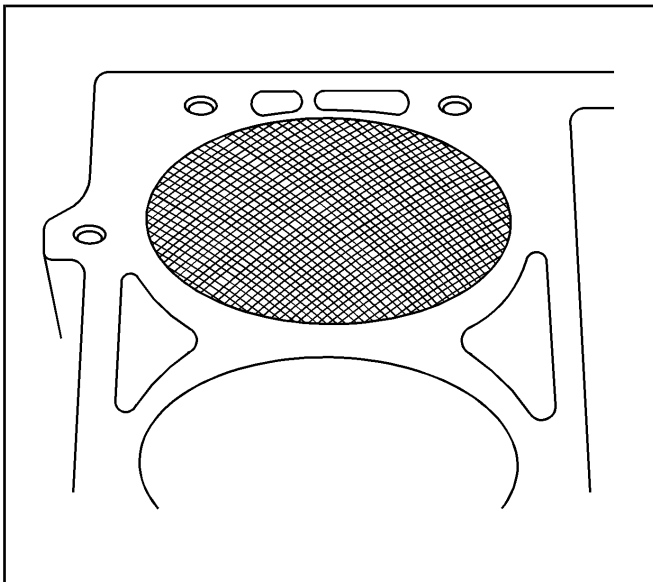
1. Clean all the remaining sealing or gasket material from the sealing surfaces.
2. Clean the engine block in cleaning solvent.
3. Flush the engine block with clean water or steam.
4. Clean the cylinder bores.
5. Clean the oil galleries and the oil passages.
6. Clean the scale and the deposits from the coolant passages.
7. After cleaning the engine block, spray or wipe the cylinder bores and the machined surfaces with clean engine oil.
8. Inspect the following areas:
 - Cylinder bores (1) for scratches or gouging
 - Valve lifter bores (2) for excessive scoring or wear
 - Coolant jackets (3) for cracks
 - Threaded holes (4) for damage
 - Crankshaft bearing webs (5) for cracks
 - Crankshaft bearing caps (6) and the crankshaft bearing bores (7) for damage
 - The crankshaft bearing bores should be round and uniform when measuring the inside diameter (ID).
 - The surface where the crankshaft bearings contact the crankshaft bearing bore should be smooth.
 - If a crankshaft bearing cap is damaged and requires replacement, replace the crankshaft bearing cap first. Then rebore the engine block crankshaft bearing bores and check for the proper alignment. Finally, check the crankshaft bearings for the proper clearances.
 - Expansion cup plug bores (8) for damage
 - Engine block (9) for cracks or damage
 - Engine mount bosses (10) for damage



317297



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9. Measure the cylinder bores for taper and out-of-round.

- 9.1. Depress the plunger on the J 8087 7 mm (0.275 in) or until the J 8087 enters the cylinder bore.
- 9.2. Center the J 8087 in the cylinder bore and turn the indicator dial to 0.
- 9.3. Move the J 8087 up and down the cylinder bore to determine the taper. Refer to *Engine Mechanical Specifications (5.0 L)* or *Engine Mechanical Specifications (5.7 L)*.
- 9.4. Turn the J 8087 to different points around the cylinder bore to determine the out-of-round condition. Refer to *Engine Mechanical Specifications (5.0 L)* or *Engine Mechanical Specifications (5.7 L)*.

Cylinder Boring and Honing

SIE-ID = 784235

Honing Procedure

Caution: Refer to *Safety Glasses Caution in Cautions and Notices*.

1. When honing the cylinder bores, follow the manufacturer's recommendations for equipment use, cleaning, and lubrication.
 - Use only clean sharp stones of the proper grade for the amount of material to be removed.
 - Dull, dirty stones cut unevenly and generate excessive heat.
 - DO NOT hone to a final grade with a coarse or medium-grade stone.
 - Leave sufficient metal so that all the stone marks will be removed with the fine grade stones.
 - Perform the final honing with a fine-grade stone and hone the cylinder bore in a cross hatch pattern at 45–65 degrees to obtain the proper clearance.
2. During the honing operation, thoroughly check the cylinder bore.
 - Repeatedly check the cylinder bore fit with the selected piston.
 - All measurements of the piston or cylinder bore should be made with the components at normal room temperature.
3. When honing to eliminate taper in the cylinder bore, use full strokes the complete length of the cylinder bore.

Repeatedly check the measurement at the top, the middle, and the bottom of the cylinder bore.

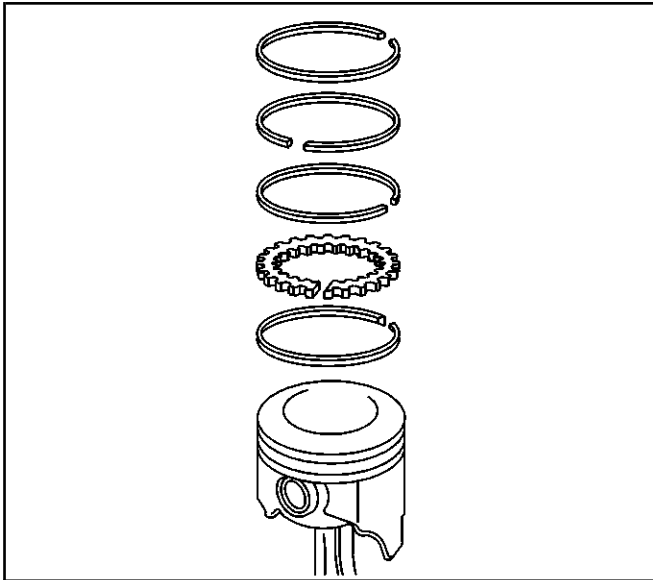
- The finish marks should be clean but not sharp.

- The finish marks should be free from imbedded particles or torn or folded metal.
4. When finished, the reconditioned cylinder bores should have less than or meet the specified out-of-round and taper requirements.
 5. After the final honing and before the piston is checked for fit, clean the cylinder bore with hot water and detergent.
 - 5.1. Scrub the cylinder bores with a stiff bristle brush.
 - 5.2. Rinse the cylinder bores thoroughly with clean hot water.
 - 5.3. Dry the cylinder bores with a clean rag.
 - 5.4. Do not allow any abrasive material to remain in the cylinder bores.
 - Abrasive material may cause premature wear of the new piston rings and the cylinder bores.
 - Abrasive material will contaminate the engine oil and may cause premature wear of the bearings.
 6. Perform final measurements of the piston and the cylinder bore.
 7. Permanently mark the top of the piston for the specified cylinder to which it has been fitted.
 8. Apply clean engine oil to each cylinder bore in order to prevent rusting.

Boring Procedure

Caution: Refer to Safety Glasses Caution in Cautions and Notices.

1. Before starting the honing or reboring operation, measure all the new pistons with the micrometer contacting at points exactly 90 degrees from the piston pin centerline.
2. File the top of the cylinder block in order to remove any dirt or burrs before using any type of boring bar.
3. Follow the instructions furnished by the manufacturer regarding use of the boring equipment.
4. When reboring the cylinders, make sure all the crankshaft bearing caps are installed in the original position and direction.
5. Tighten the crankshaft bearing caps to the proper torque specifications in order to avoid distortion of the cylinder bores in the final assembly.
6. When making the final cut with the boring bar, leave 0.03 mm (0.001 in) on the cylinder bore diameter for finish honing. This gives the required position to the cylinder clearance specifications. Carefully perform the honing and boring operation in order to maintain the specified clearances between the pistons, the piston rings, and the cylinder bores.



4967

Piston and Connecting Rod Disassemble

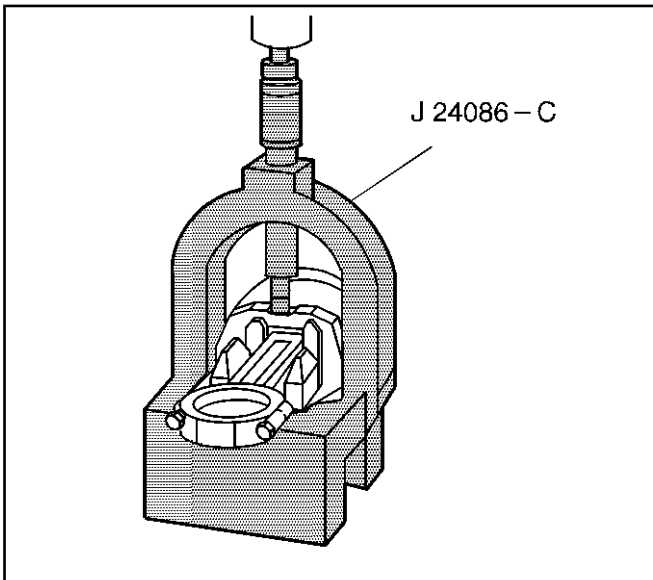
SIE-ID = 195087

Tools Required

J 24086-C Piston Pin Remover/Installer

Caution: Refer to Safety Glasses Caution in Cautions and Notices.

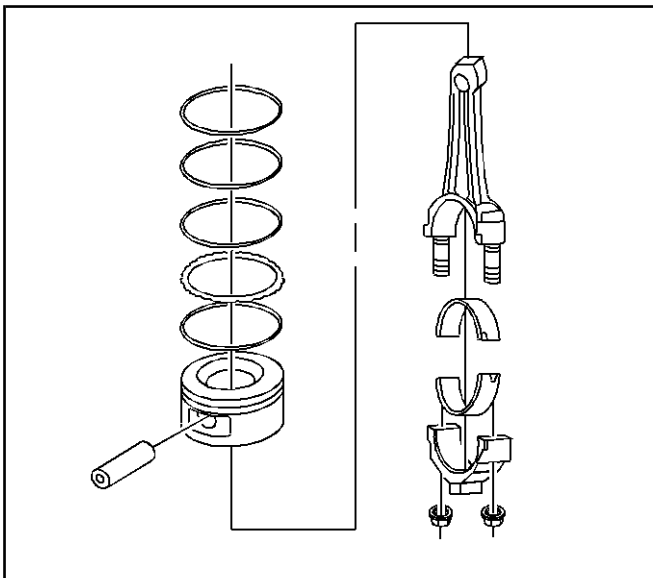
1. Remove the piston rings from the pistons.



4965

2. Press the piston pin from the connecting rod using the J 24086-C.

The piston pin has an interference fit into the connecting rod, and is full floating in the piston.



34671

3. Mark, separate, and organize the parts for assembly.

Piston, Connecting Rod, and Bearings Cleaning and Inspection

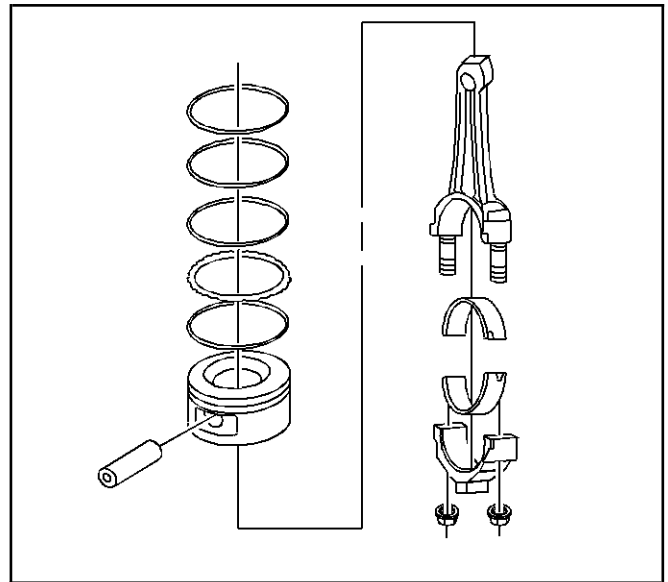
SIE-ID = 784237

Caution: Refer to *Safety Glasses Caution in Cautions and Notices*.

Important: Measurement of all the components should be taken with the components at room temperature.

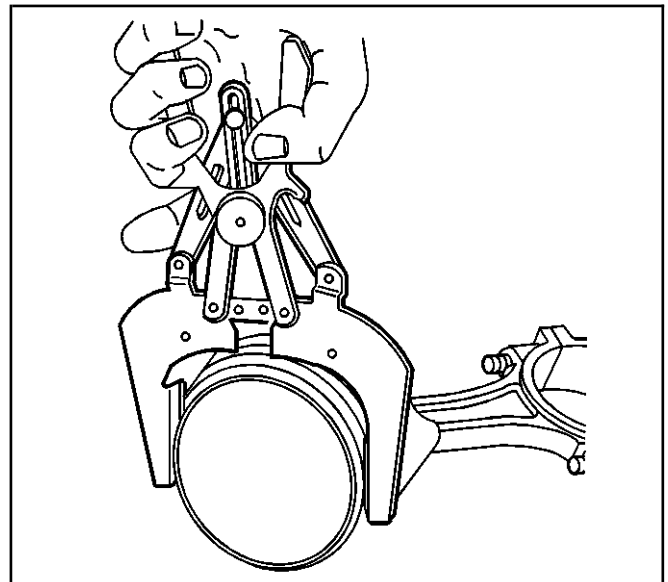
Do not use a wire brush in order to clean any part of the piston.

1. Clean the piston and connecting rod in cleaning solvent.
2. Dry the components with compressed air.



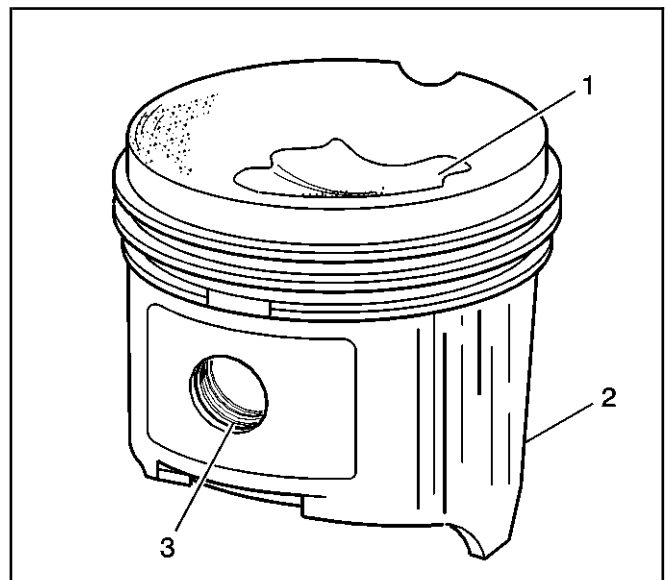
34671

3. Clean the piston ring grooves with a suitable ring groove cleaning tool.

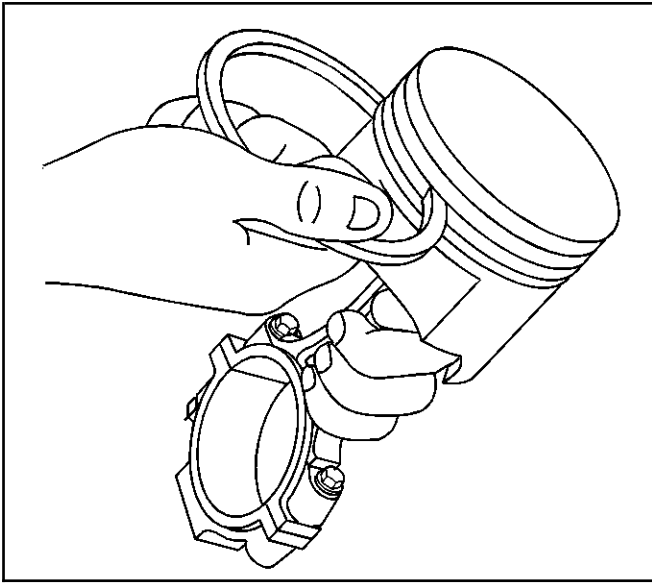


4977

4. Clean the piston oil lubrication holes and slots.
5. Inspect the piston for the following:
 - Eroded areas (1) on the top of the piston
 - Scuffed or damaged skirt (2)
 - Damage to the piston pin bore (3)
 - Cracks in the piston ring lands, the piston skirt, or the piston pin bosses
 - Piston ring grooves for nicks, burrs, or other warpage which may cause the piston ring to bind.
6. Inspect the piston pin for scoring, wear or other damage.

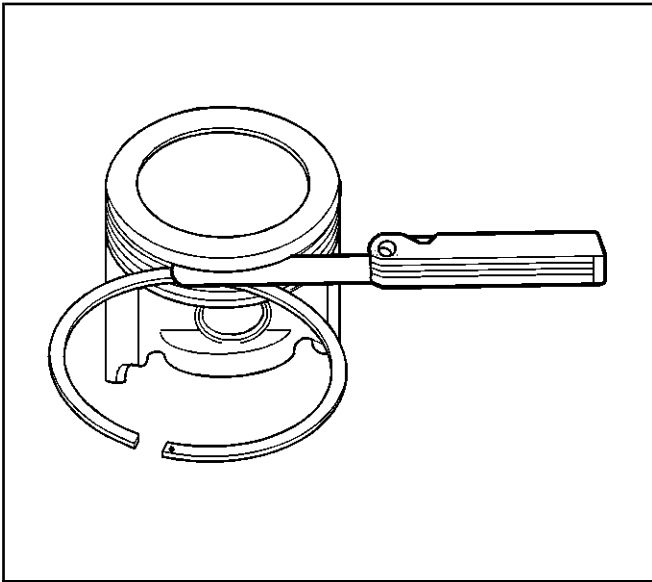


156168



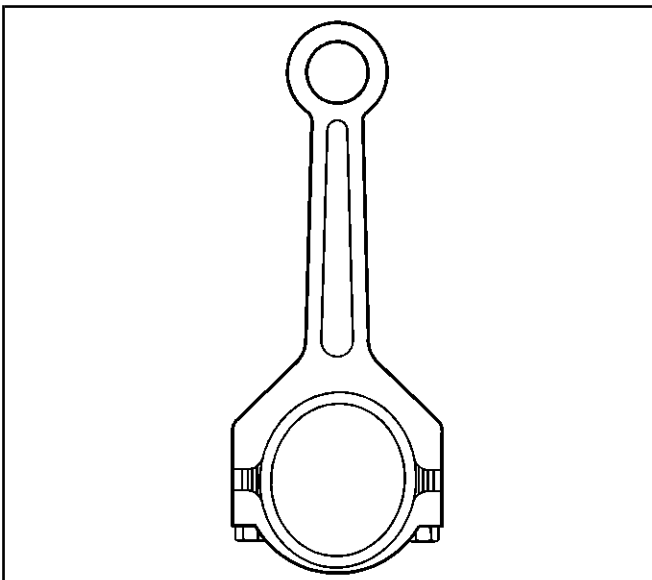
4969

7. Measure the piston ring-to-piston ring groove side clearance.
 - 7.1. Insert the edge of the piston ring into the piston ring groove.
 - 7.2. Roll the piston ring completely around the piston.
 - If binding is caused by a distorted piston ring groove, MINOR imperfections may be removed with a fine file.
 - If binding is caused by a distorted piston ring, then replace the piston ring.



22934

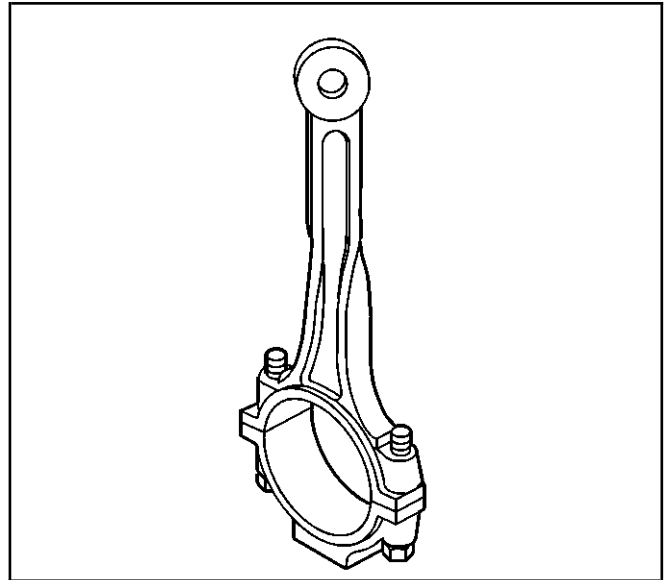
8. Measure the piston ring side clearance with a feeler gage.
 - If the piston ring side clearance is too small, try another piston ring set.
 - If the proper piston ring-to-piston ring groove clearance cannot be achieved, replace the piston and pin assembly.
9. To determine the proper piston ring side clearance, refer to *Engine Mechanical Specifications (5.0 L)* or *Engine Mechanical Specifications (5.7 L)*.



156167

10. Inspect the connecting rod for an out-of-round bearing bore. Refer to *Engine Mechanical Specifications (5.0 L)* or *Engine Mechanical Specifications (5.7 L)*.

11. Inspect the connecting rod for twisting.
12. Inspect the connecting rod for damage to the connecting rod bolt threads.



156169

13. Measure the piston compression ring end gap.

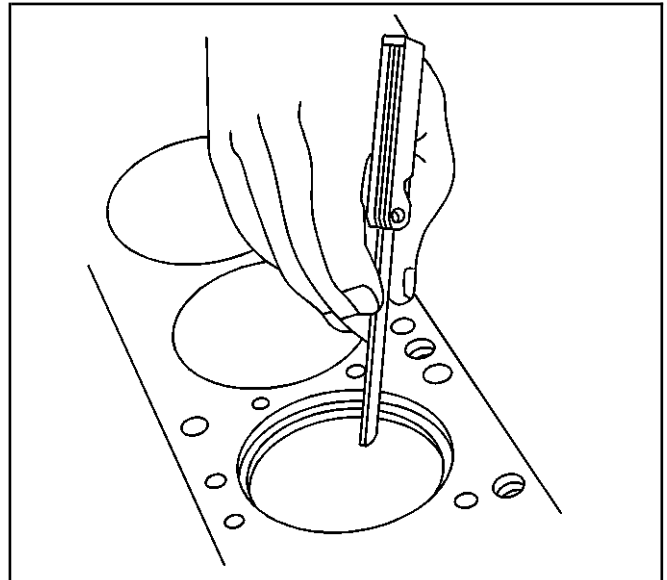
Important: Fit each piston compression ring to the cylinder in which it will be used.

- 13.1. Place the piston compression ring into the cylinder bore.
- 13.2. Push the piston compression ring into the cylinder bore to approximately 6.5 mm (0.25 in) above the piston ring travel.

The piston ring must be square to the cylinder wall.

- 13.3. Use a feeler gage in order to measure the piston ring end gap. Refer to *Engine Mechanical Specifications (5.0 L)* or *Engine Mechanical Specifications (5.7 L)*.

Select another size piston ring set if the piston ring end gap exceeds specifications.



4968

Piston and Connecting Rod Assemble

SIE-ID = 195097

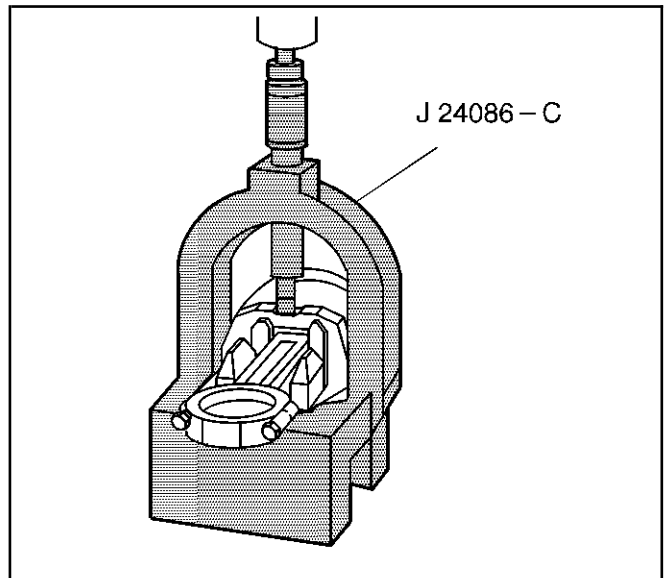
Tools Required

J 24086-C Piston Pin Remover/Installer

Caution: SIO-ID = 71607 **Avoid contact with HOT components. Wear safety glasses and protective gloves to avoid personal injury.**

Notice: SIO-ID = 71608 Applying excessive heat to the connecting rod may damage or distort the rod. Rod temperature SHOULD NOT exceed 315°C (600°F). At this temperature the end of the connecting rod will turn a straw color upon visual inspection.

Notice: SIO-ID = 38775 After the J 24086-C installer hub bottoms on the support assembly, DO NOT exceed 35,000 kPa (5,000 psi) or the tool may be damaged.



4965

Important: When assembling the piston and connecting rod, the mark on the top of the piston must point to the front of the engine block. The left bank connecting rods should have the flange face toward the front of the engine block. The right bank connecting rods should have the flange face toward the rear of the engine block.

The new piston pin has an interference fit into the connecting rod and is full floating in the piston.

1. Install the new piston pin and connecting rod assembly.
 - 1.1. Lubricate the piston pin bores with clean engine oil.
 - 1.2. Use a torch and apply MILD heat to the piston pin end of the connecting rod.
 - 1.3. Use the *J 24086-C* in order to press the new piston pin into the piston and connecting rod assembly.
 - 1.4. Inspect for the proper installation of the piston and piston pin.

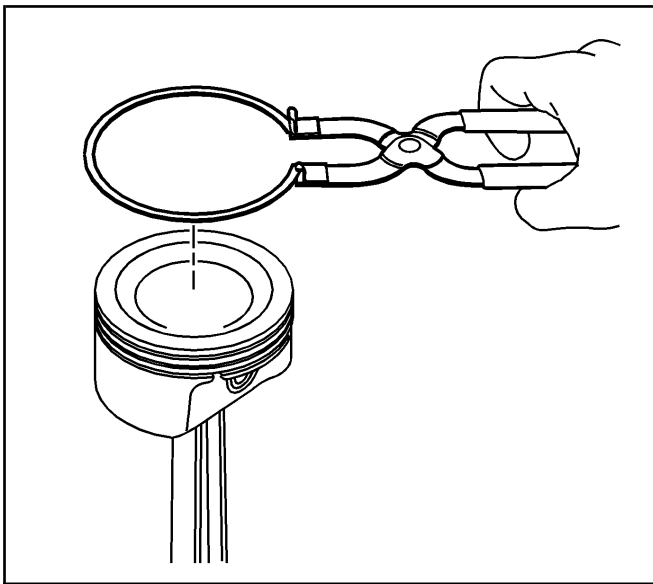
The piston must move freely on the new piston pin with no binding or interference.

Notice: SIO-ID = 16608 Use a piston ring expander to install the piston rings. The rings may be damaged if expanded more than necessary.

2. Install the piston rings onto the piston.
 - 2.1. Install the oil control piston ring spacer.
 - 2.2. Install the lower oil control piston ring.
 - 2.3. Install the upper oil control piston ring.
 - 2.4. Install the lower compression piston ring.

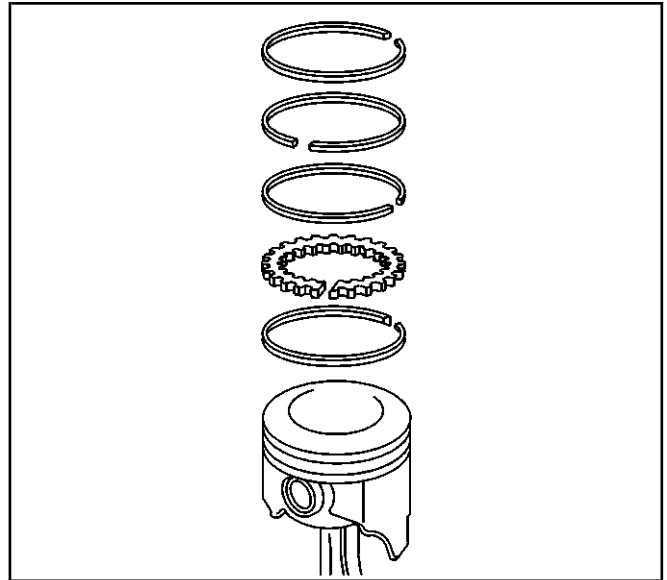
The mark on the side of the piston ring should face the top of the piston.
 - 2.5. Install the upper compression piston ring.

The mark on the side of the piston ring should face the top of the piston.



490763

3. Space the compression piston ring end gaps 120 degrees apart.
4. Space the oil control piston ring end gaps a minimum of 90 degrees apart.



4967

Crankshaft and Bearings Cleaning and Inspection

SIE-ID = 69074

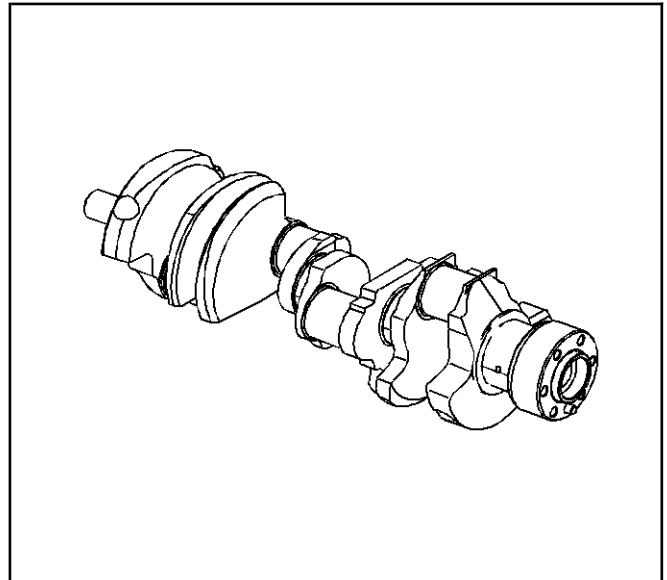
Tools Required

- J 7872 Magnetic Base Dial Indicator
- J 36660-A Torque Angle Meter
- J 43690 Rod Bearing Clearance Checking Tool

Caution: Refer to *Safety Glasses Caution in Cautions and Notices*.

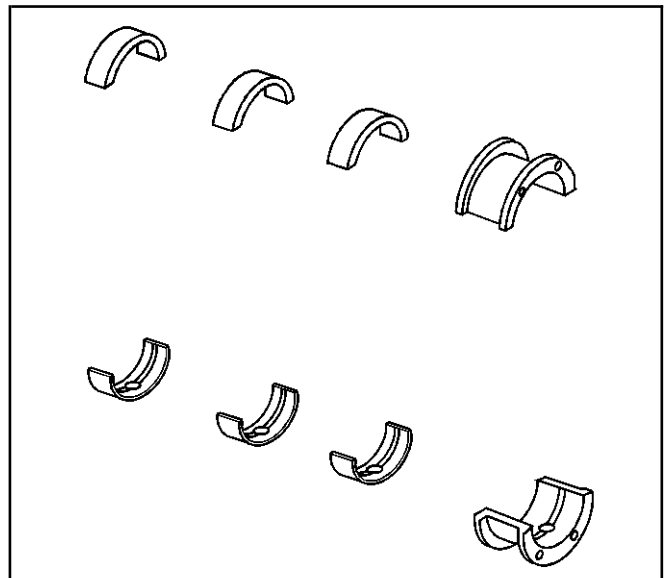
Important: Use care when handling the crankshaft. Avoid damage to the crankshaft bearing surfaces.

1. Clean the crankshaft in cleaning solvent. Remove all sludge or restrictions from the oil passages.
2. Dry the crankshaft with compressed air.

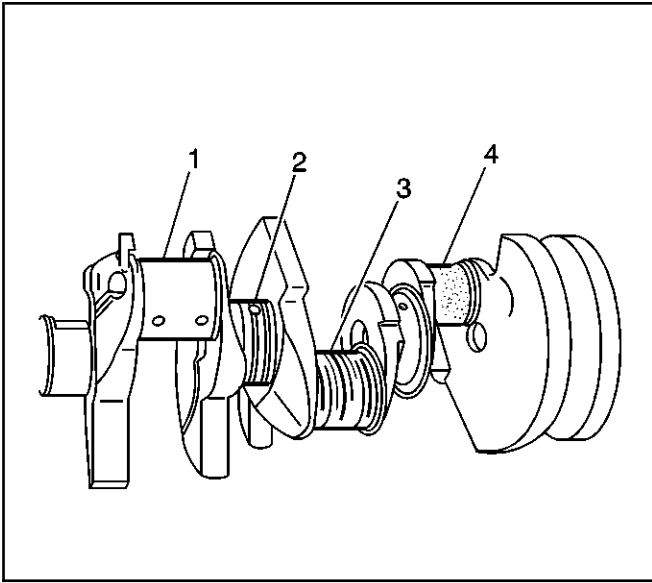


59918

3. Clean the crankshaft bearings in cleaning solvent. Wipe the crankshaft bearings clean with a soft cloth. Do not scratch the crankshaft bearing surfaces.
4. Dry the crankshaft and crankshaft bearings with compressed air.

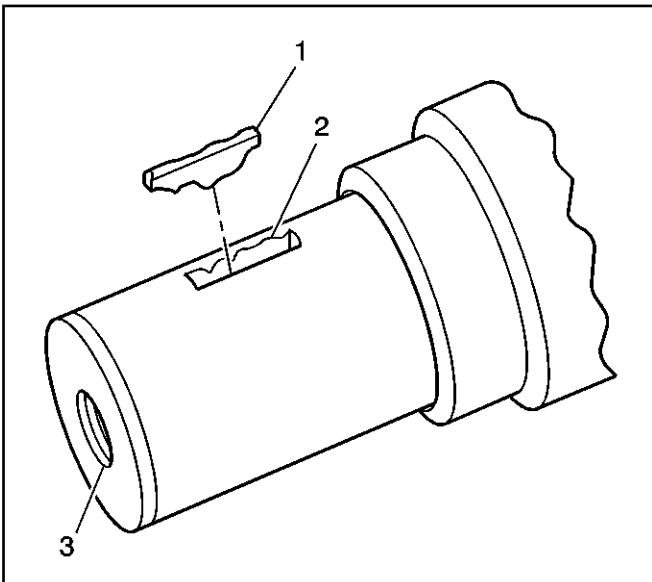


334386



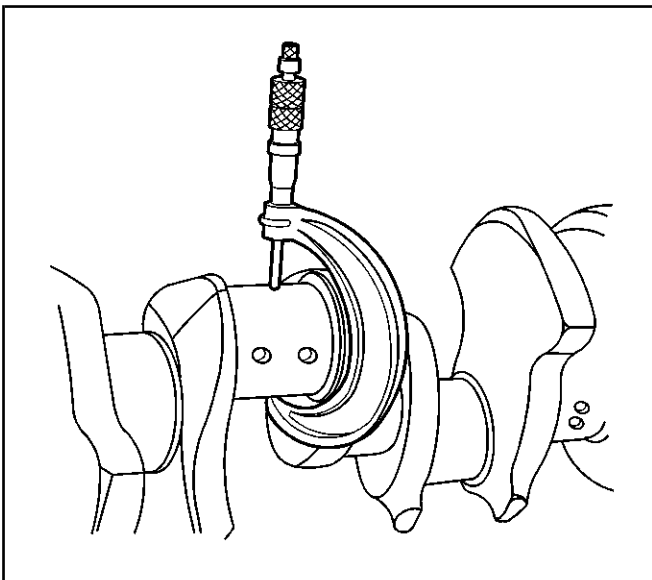
156170

5. Inspect the crankshaft for the following:
- Crankshaft journals (1) should be smooth with no evidence of scoring or damage.
 - Deep grooves (2)
 - Scratches or uneven wear (3)
 - Pitted surfaces (4)
 - Wear or damage to the thrust journal surfaces
 - Scoring or damage to the rear seal surface
 - Restrictions to the oil passages
 - Damage to the threaded bolt holes



188090

6. Inspect the crankshaft balancer woodruff keys (1), the keyway (2), and the threaded hole (3) for damage.

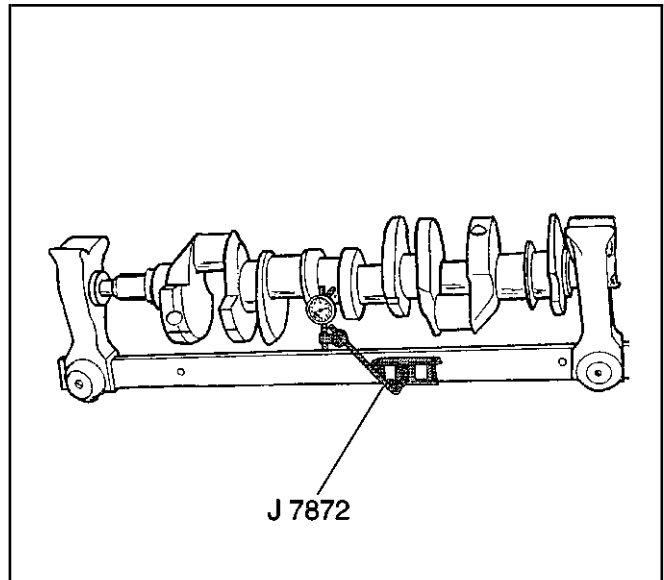


188015

7. Measure the crankpins for out-of-round and taper. Refer to *Engine Mechanical Specifications (5.0 L)* or *Engine Mechanical Specifications (5.7 L)*.

8. Using wooden V-blocks, support the crankshaft on the front and rear journals.
9. Use the J 7872 in order to measure crankshaft journal runout.

Refer to *Engine Mechanical Specifications (5.0 L)* or *Engine Mechanical Specifications (5.7 L)*.



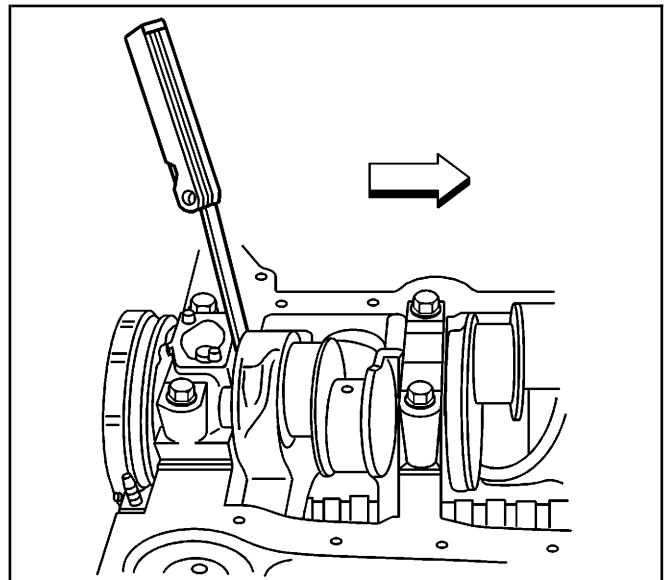
35210

10. Measure the crankshaft end play.

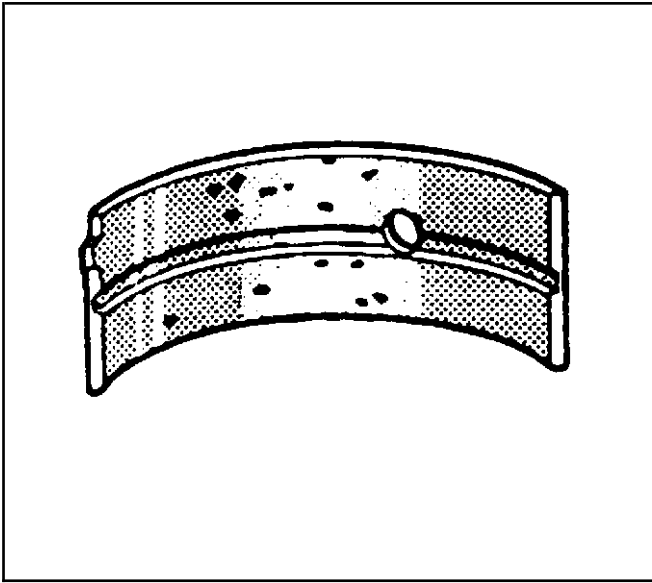
Important: In order to properly measure the crankshaft end play, the crankshaft, the crankshaft bearings, the crankshaft bearing caps, and the fasteners must be installed into the engine block, and the bolts and studs tightened finger tight.

- 10.1. Firmly thrust the end of the crankshaft, first rearward then forward. This will line up the rear crankshaft bearing and the crankshaft thrust surfaces. Tighten the cap bolts and studs. Refer to *Engine Mechanical Specifications (5.0 L)* or *Engine Mechanical Specifications (5.7 L)*.
- 10.2. With the crankshaft pushed forward, insert a feeler gage between the crankshaft and the crankshaft bearing surface, then measure the clearance. Refer to *Engine Mechanical Specifications (5.0 L)* or *Engine Mechanical Specifications (5.7 L)*.
- 10.3. Turn the crankshaft to check for binding. If the crankshaft does not turn freely, loosen the crankshaft bearing bolts and studs, one crankshaft bearing cap at a time, until the tight crankshaft bearing is located.

Burrs on the crankshaft bearing cap or engine block, foreign matter between the crankshaft bearing and the crankshaft bearing cap or the engine block, or a faulty crankshaft bearing could cause a lack of clearance between the crankshaft and crankshaft bearing.

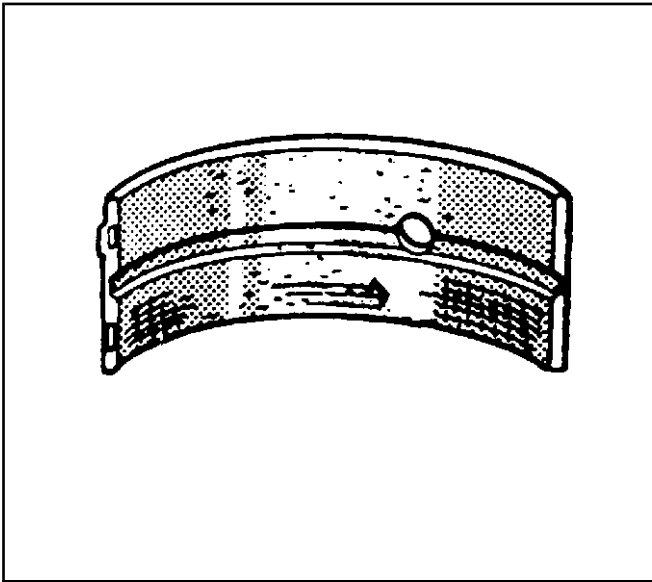


188467



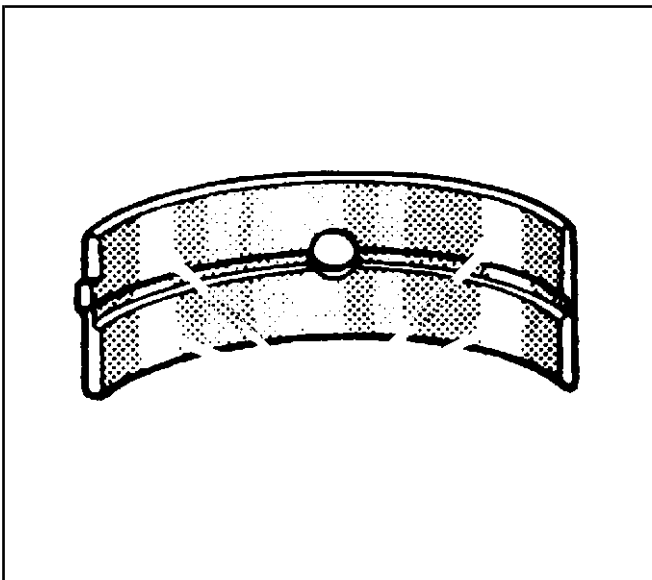
52051

11. Inspect the crankshaft bearings for craters or pockets. Flattened sections on the crankshaft bearing halves also indicate fatigue.



52053

12. Inspect the crankshaft bearings for excessive scoring or discoloration.
13. Inspect the crankshaft bearings for dirt or debris imbedded into the crankshaft bearing material.



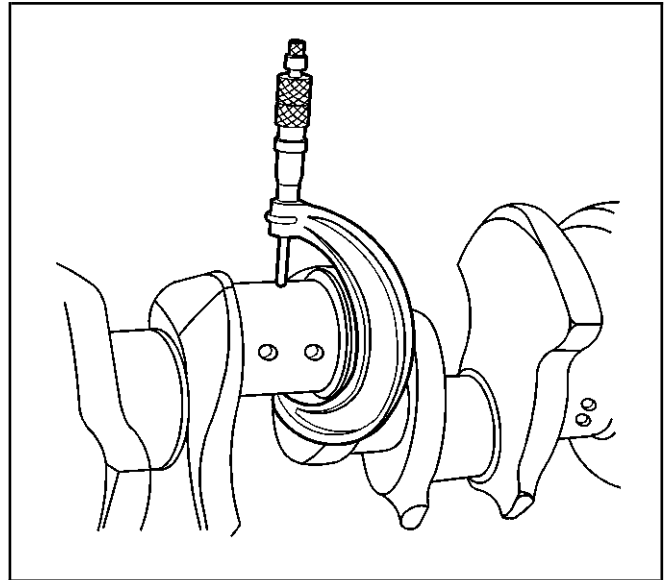
52056

14. Inspect the crankshaft bearings for improper seating indicated by bright, polished sections of the crankshaft bearings.
- If the lower half of the crankshaft bearing is worn or damaged, both the upper and lower halves of the crankshaft bearing should be replaced.
 - Generally, if the lower half of the crankshaft bearing is suitable for use, the upper half of the crankshaft bearing should also be suitable for use.

Measuring Crankshaft Bearing Clearances

Notice: SIO-ID = 5016 Do not shim, scrape, or file bearing inserts. Do not touch the bearing surface of the insert with bare fingers. Skin oil and acids will etch the bearing surface.

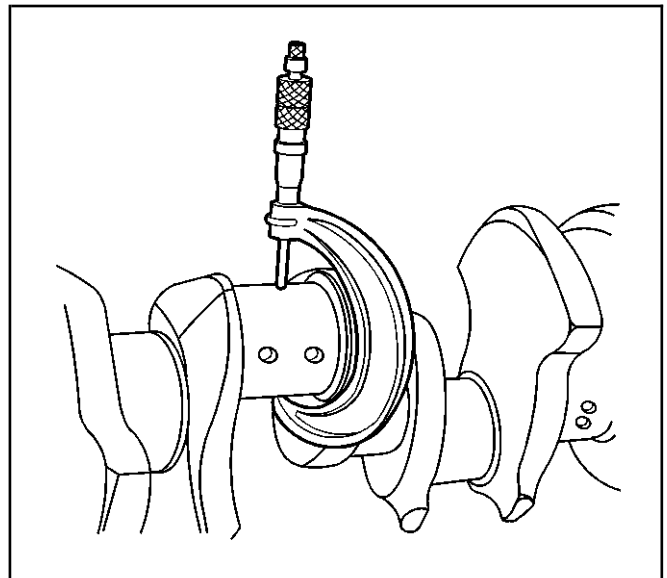
- The crankshaft bearings are precision insert type and do not use shims for adjustment. If the clearances are excessive, then new upper and lower crankshaft bearings will be required. The service crankshaft bearings are available in the standard size and an undersize.
- The selective fitting of the crankshaft bearings are necessary in production in order to obtain close tolerances. For this reason, in one journal bore you may use one-half of a standard crankshaft bearing with one-half of an undersize crankshaft bearing.
- In order to determine the correct replacement bearing size, the bearing clearance must be measured accurately. When checking main bearing clearances, either the micrometer or plastic gage method may be used. The micrometer method gives more reliable results and is preferred. When checking connecting rod bearing clearances, the plastic gage method will result in unreliable measurements. The use of J 43690 is preferred.
- If the crankshaft bearing clearance is within specifications, the crankshaft bearing is satisfactory. If the clearance is not within specifications, replace the crankshaft bearing. Always replace both the upper and lower crankshaft bearings as a unit.
- A standard, or undersize crankshaft bearing combination, may result in the proper clearance. If the proper crankshaft bearing clearance cannot be achieved using the standard or the undersize crankshaft bearings, it may be necessary to repair or replace the crankshaft.



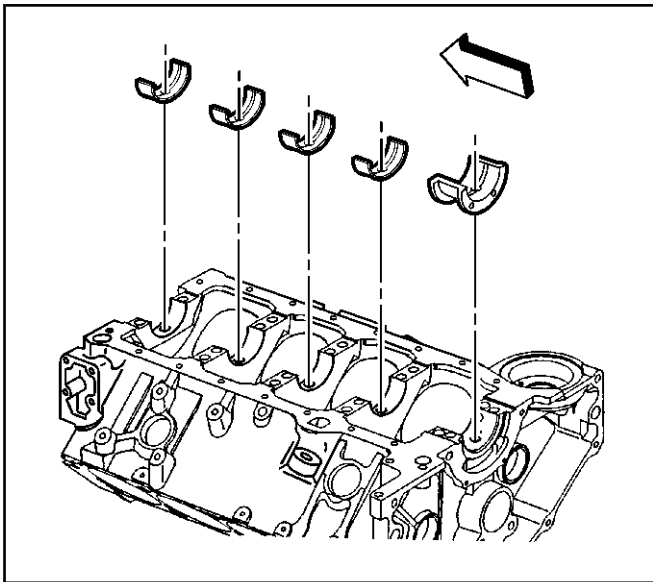
188015

Measuring Crankshaft Bearing Clearances – Micrometer Method

1. Measure the crankshaft journal diameter with a micrometer in several places, approximately 90 degrees apart. Average the measurements.
2. Determine the taper and out-of-round of the journal. Refer to *Engine Mechanical Specifications (5.0 L)* or *Engine Mechanical Specifications (5.7 L)*.

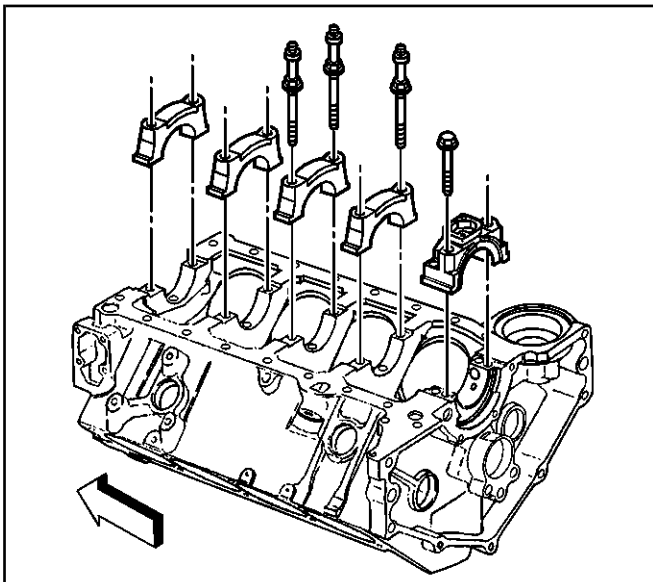


188015



317292

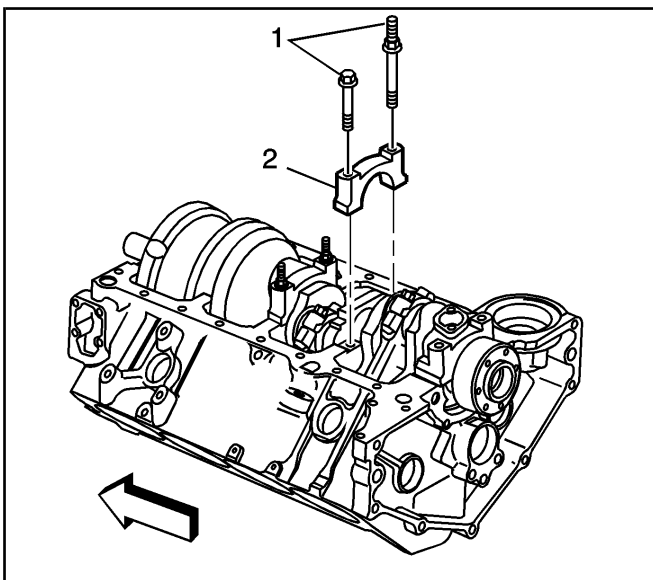
3. Install the bearings into the engine block.



353070

Notice: Refer to *Fastener Notice* in Cautions and Notices.

4. Install the bearing cap bolts and tighten to specifications. Refer to *Fastener Tightening Specifications*.
5. Measure the bearing inside diameter (ID) at the top and bottom.
6. In order to determine the bearing clearance, subtract the average journal diameter from the bearing inside diameter.
7. Compare the readings to specifications. Refer to *Engine Mechanical Specifications (5.0 L)* or *Engine Mechanical Specifications (5.7 L)*.
8. Replace bearing halves as required to obtain the proper bearing clearances.



627138

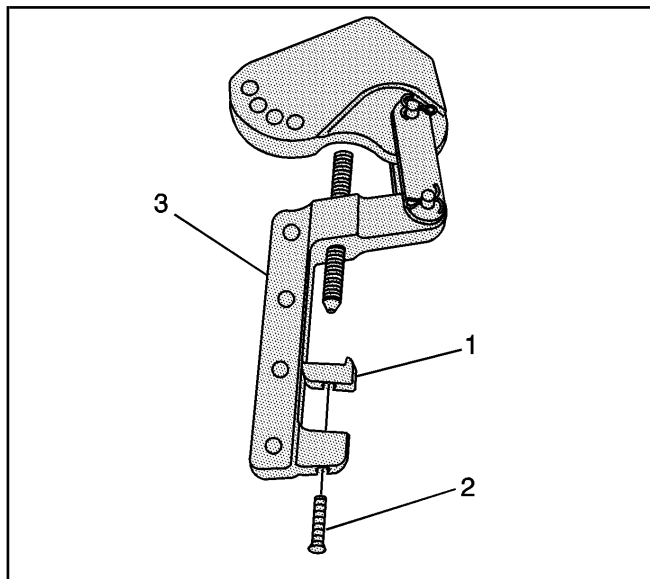
Measuring Connecting Rod Bearing Clearances – J 43690 Method

1. Remove the oil pan and other necessary components to gain access to the connecting rods. Remove the oil pump, screen, and deflector, when applicable.
2. Rotate the crankshaft until the crankshaft journal/connecting rod to be measured is in the 10 o'clock position.

Important: The crankshaft must be secure, with no movement or rotation, in order to obtain an accurate reading. Remove an intermediate bearing cap, as required, in order to secure the crankshaft and allow measurement of connecting rod bearing clearances.

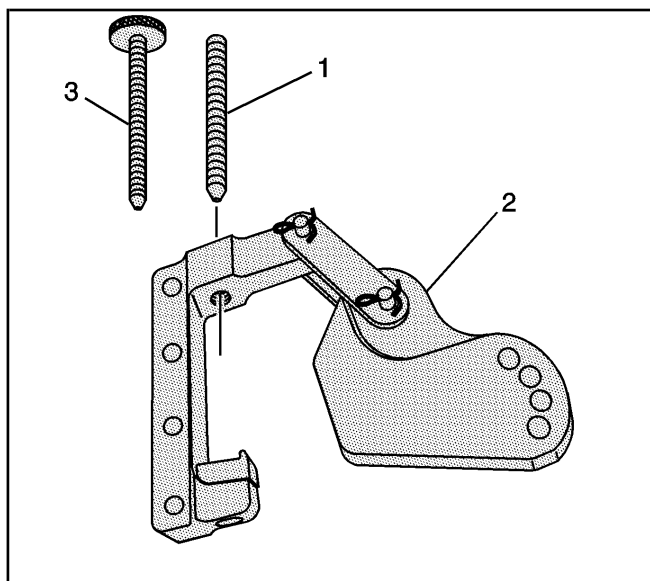
3. Remove the bearing cap bolts (1), cap (2) and bearing half.

4. Insert a piece of paper card stock onto the crankshaft journal. Install the bearing half, bearing cap, and bolts. Refer to *Fastener Tightening Specifications*.
5. Install the foot (1) and bolt (2) to the pivot arm assembly (3).
6. Tighten the bolt until snug.

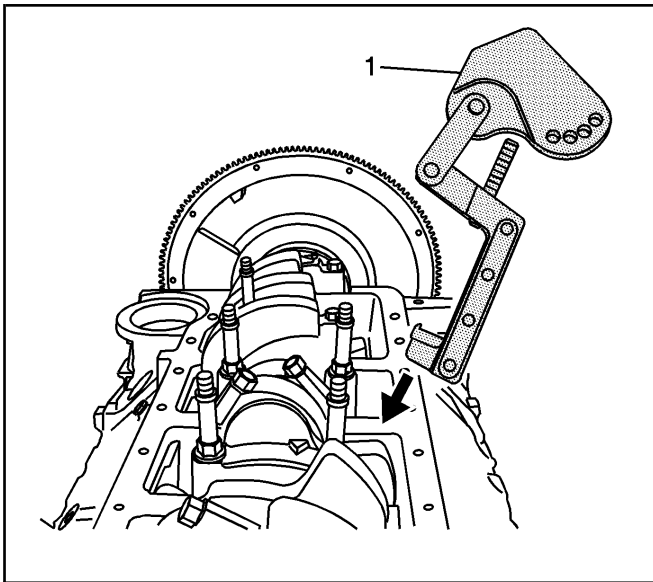


627102

7. Install the screw (1 or 3) to the pivot arm assembly (2).

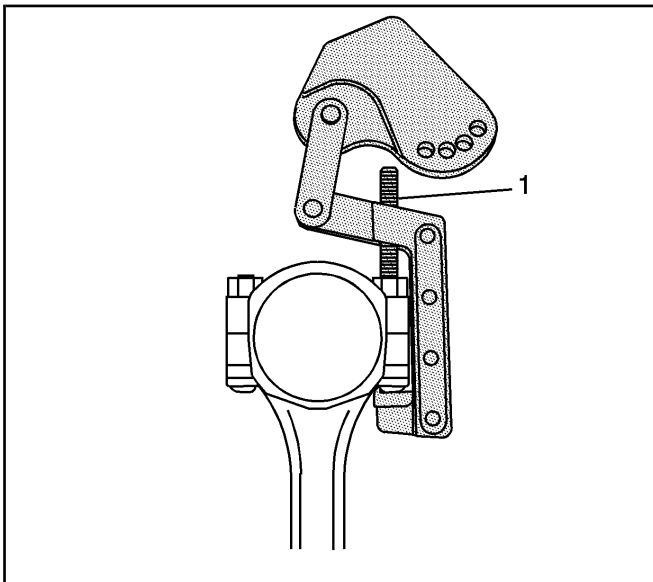


627106



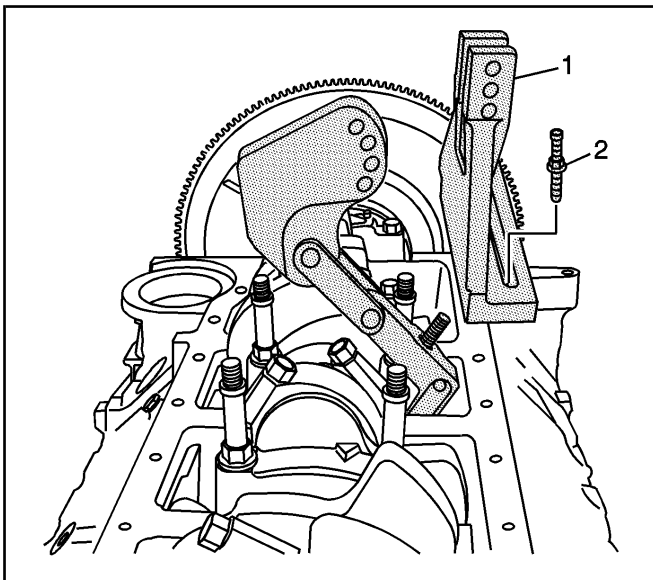
627108

8. Install the pivot arm assembly (1) onto the connecting rod.



627107

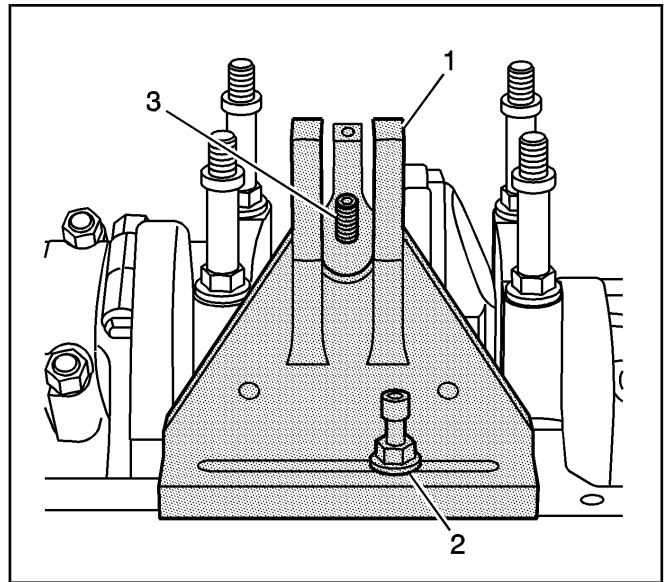
9. Position the foot of the pivot arm assembly over the large end of the connecting rod bolt.
10. Position the screw (1) onto the small end of the connecting rod bolt and tighten securely.



627109

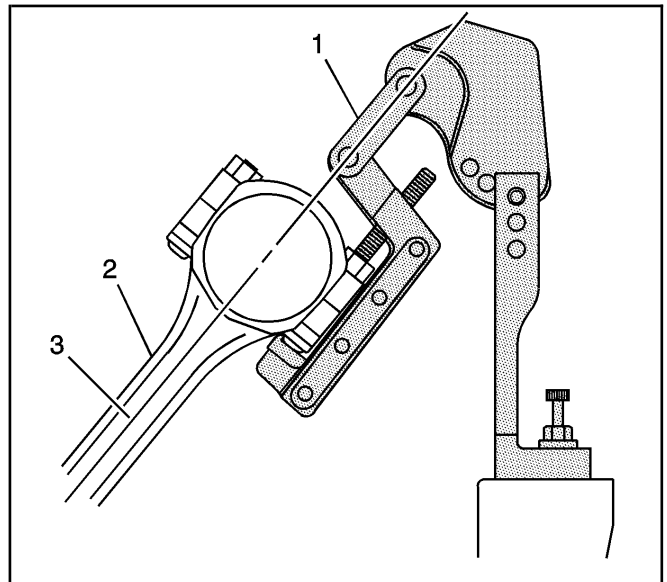
11. Install the base (1) and bolt (2) to the oil pan rail.

12. Align the center of the base (1) with the screw (3) of the pivot arm assembly.
13. Tighten the bolt (2) until snug.



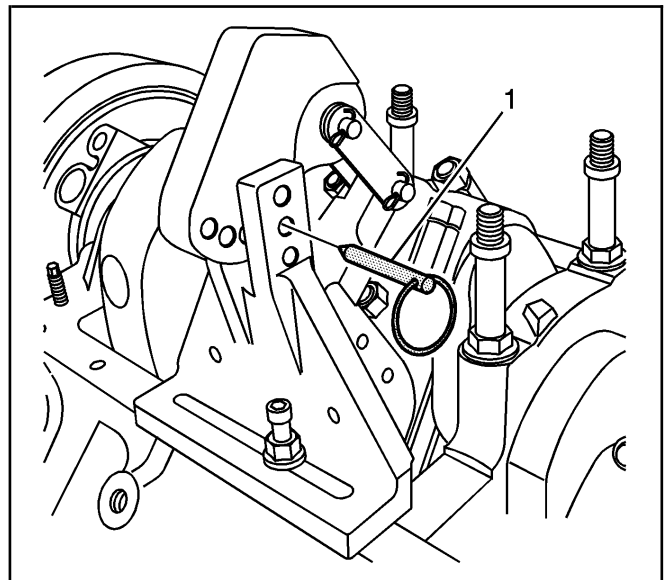
627115

14. Align the link (1) of the pivot arm assembly on a plane (3) equal to that of the connecting rod beam (2).

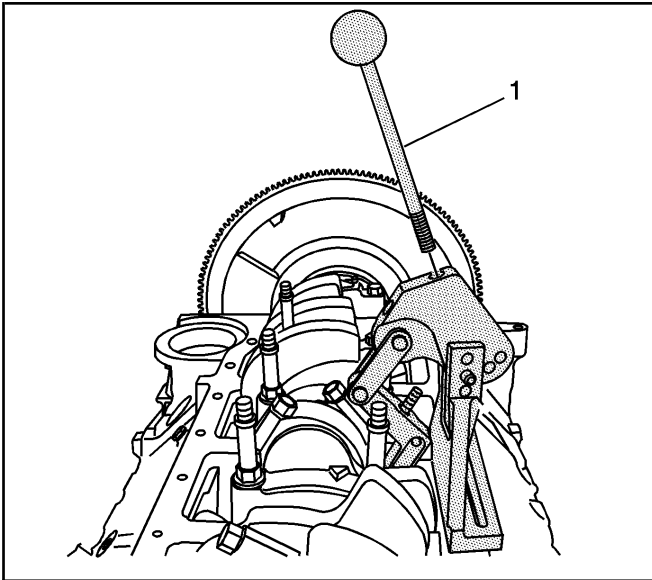


627113

15. With the link of the pivot arm assembly aligned to the beam of the connecting rod, position the pivot arm to the base and insert the pin (1).

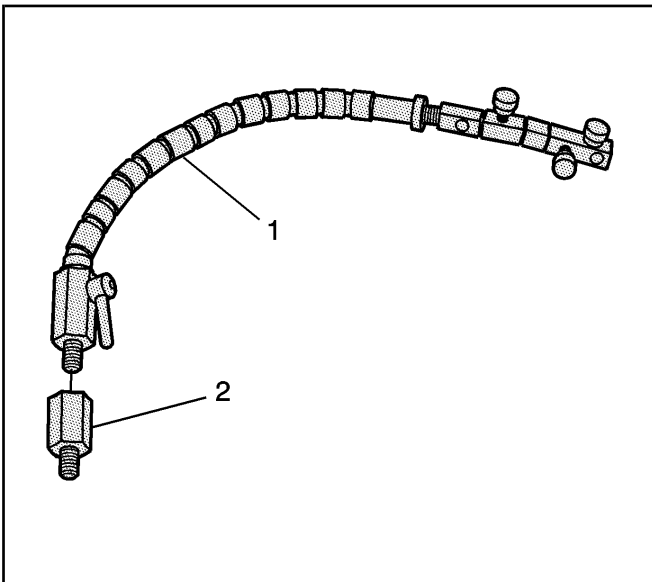


627111



627116

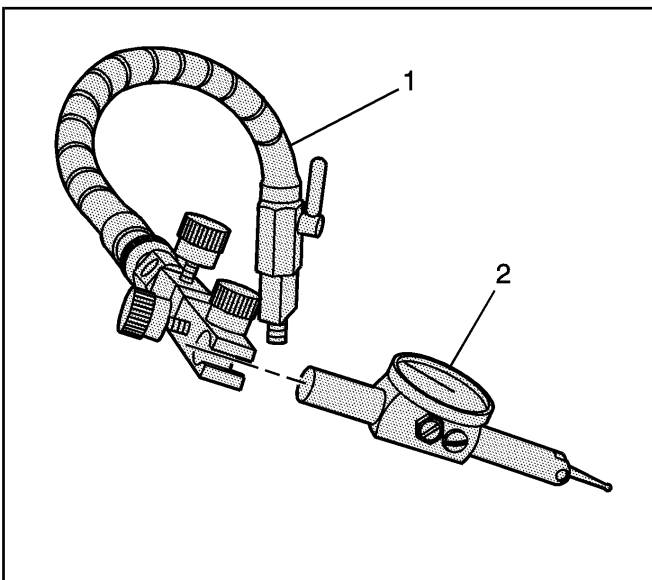
16. Insert the handle (1) to the pivot arm assembly.



627118

17. Select the adapter (2), as required, and install to the swivel base (1).

18. Tighten until snug.



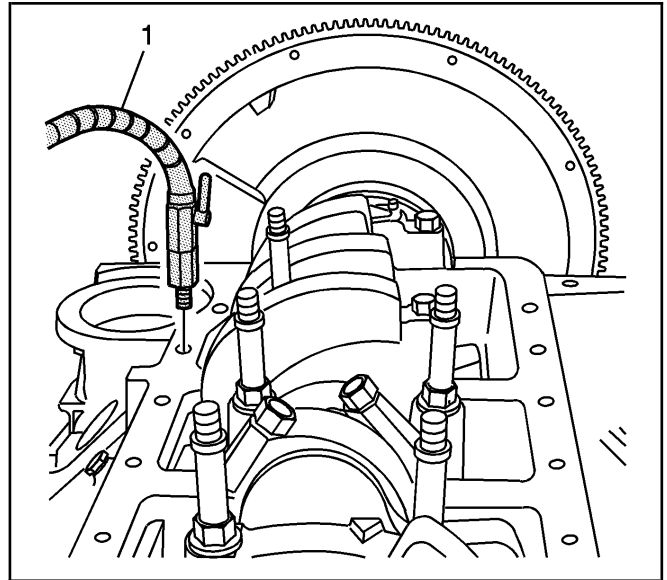
627122

Important: The clamp of the swivel base and the shaft of the indicator should be free of oil or other debris. A loose or improperly clamped indicator may indicate incorrect readings.

19. Install the indicator (2) to the swivel base (1).

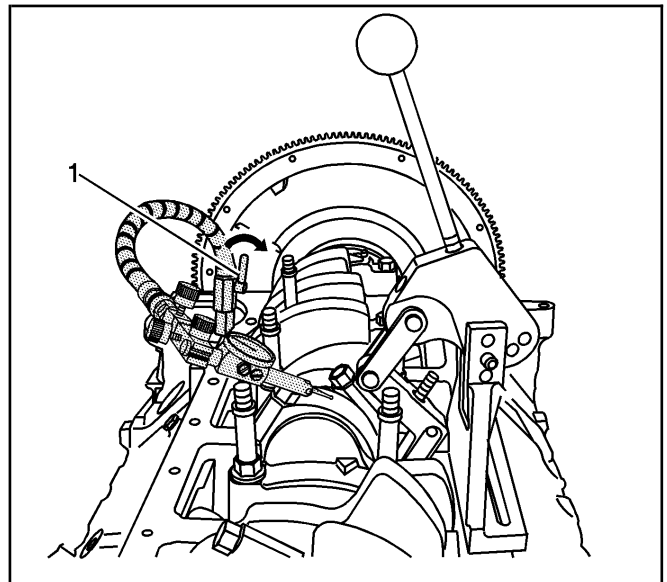
20. Tighten the clamp of the base until snug.

21. Install the swivel base (1) to the oil pan rail of the engine block.
22. Tighten until snug.



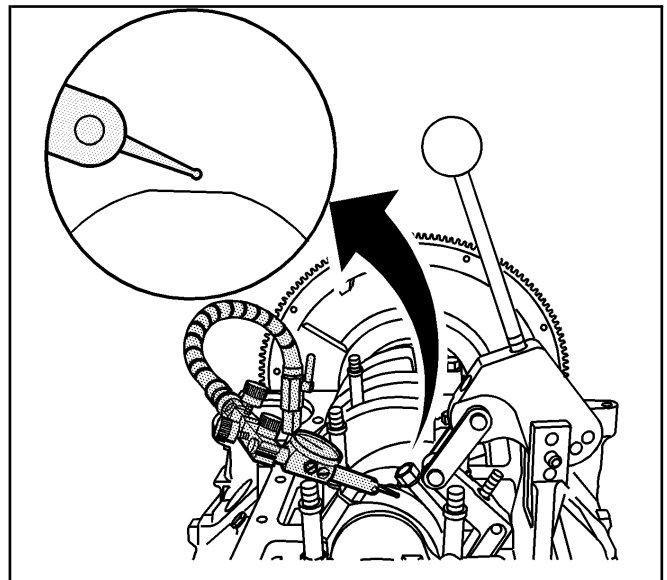
627124

23. Adjust the swivel base as required, and position the indicator tip slightly above the connecting rod cap. Lock the swivel base in position by rotating the locking lever (1). Do not allow the tip of the indicator to contact the connecting rod at this time.

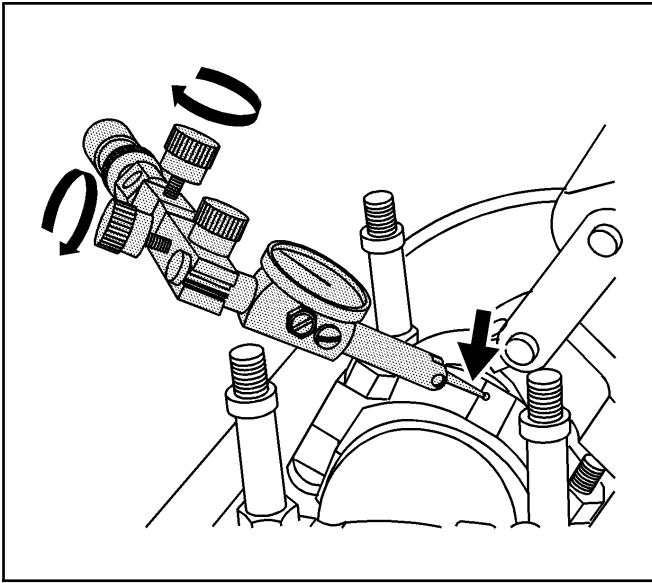


627126

24. The tip of the indicator should be positioned above, and NOT in contact with the cap end of the connecting rod.

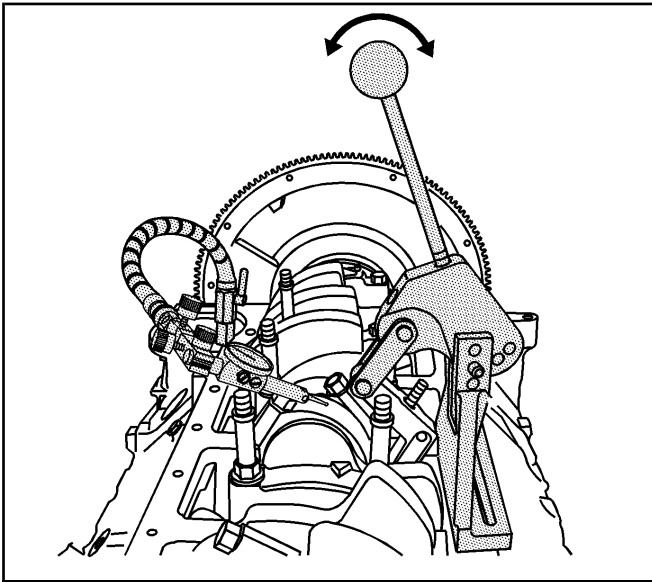


627129



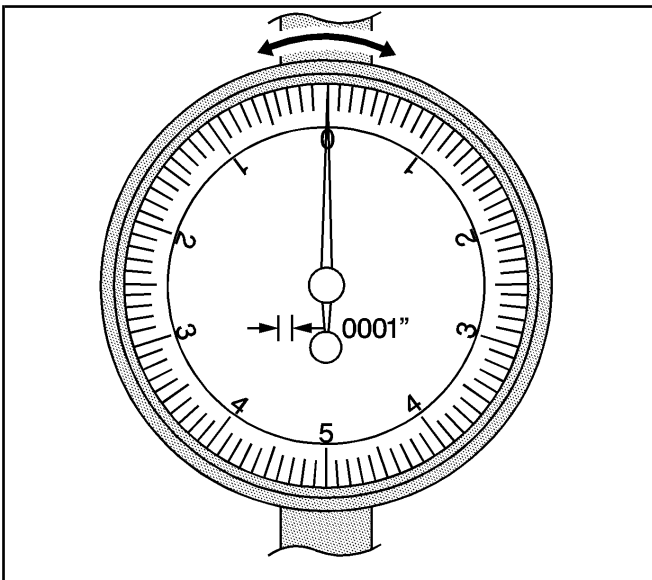
627132

25. Rotate the fine adjustment knobs, on the dial indicator end of the swivel base, to position the tip of the indicator in contact with the connecting rod.



627141

26. Lightly actuate the handle of the pivot arm assembly, multiple times in both directions, to ensure the oil film is removed from the journal.



627135

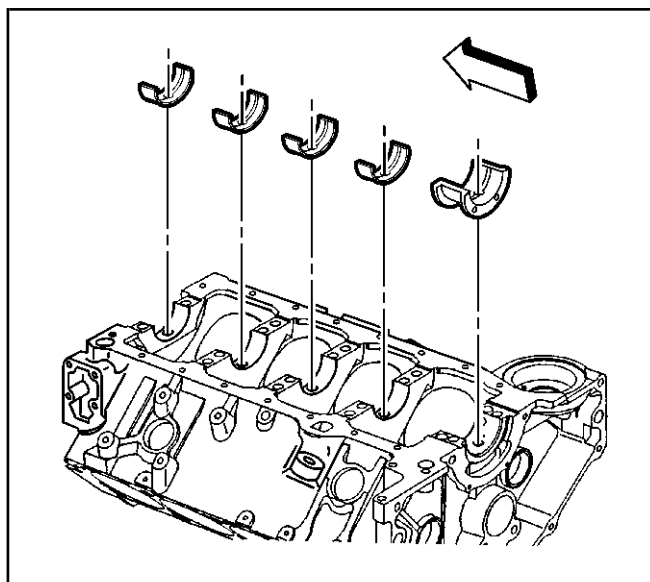
27. Load the handle in the forward position and zero the dial indicator. Load the handle multiple times in both directions and record the reading.

Important: During this procedure, card stock may enter the crankshaft journal oil galleries. Remove all card stock from the bearing journal and oil galleries prior to reassembly.

28. Remove the bearing cap bolts, cap, and paper stock.
29. Replace bearing halves, as required, to obtain the proper bearing clearances.
30. Install the bearings, cap, and bolts. Refer to *Fastener Tightening Specifications*.

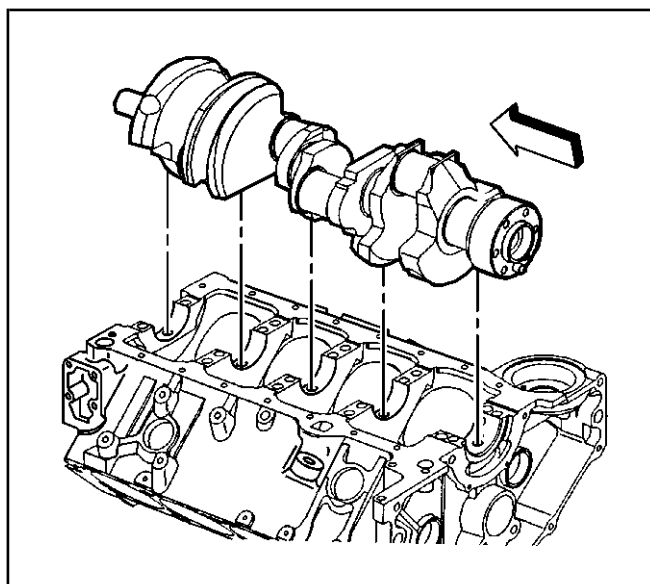
Measuring Crankshaft Bearing Clearances – Plastic Gage Method

1. Install the crankshaft bearings into the engine block.



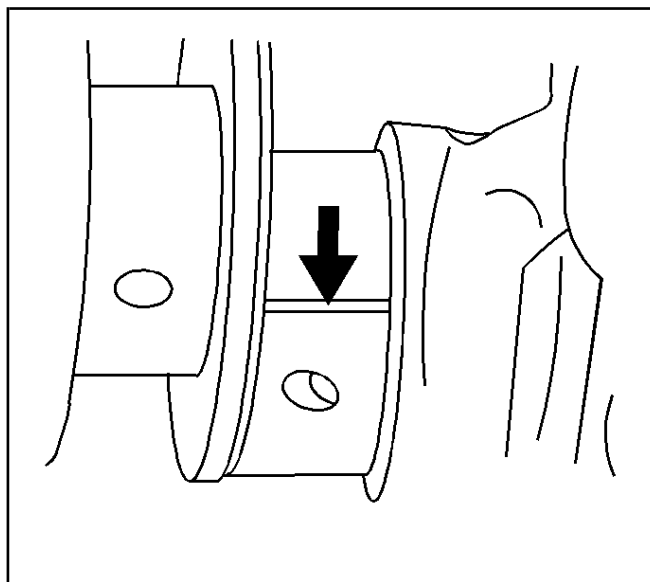
317292

2. Install the crankshaft.

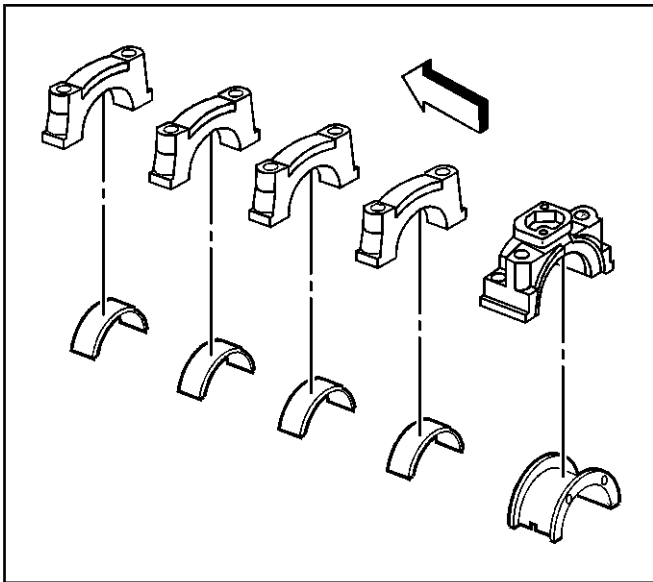


317351

3. Install the gaging plastic the full width of the journal.

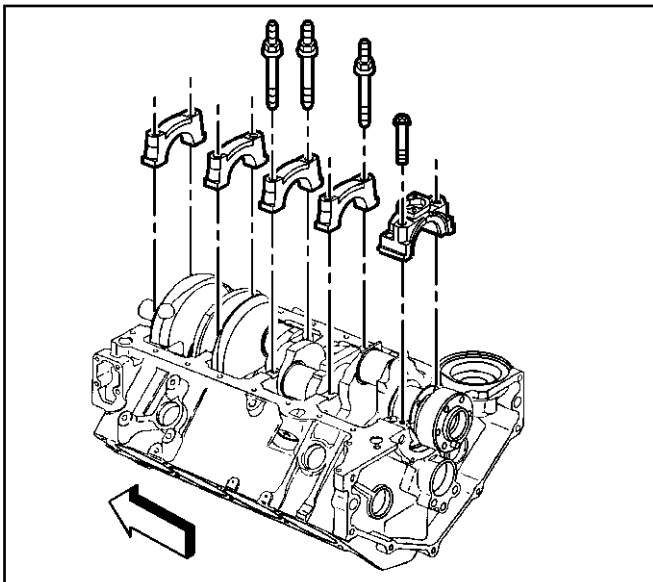


500655



317295

4. Install the crankshaft bearings into the crankshaft bearing caps.

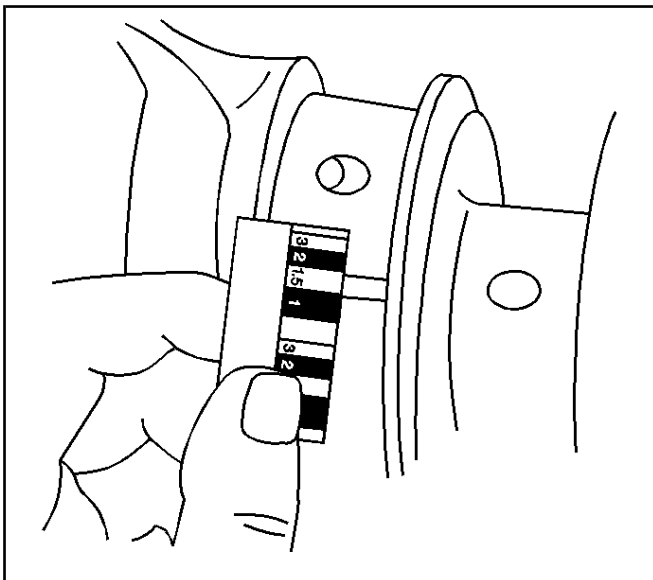


317268

5. Install the crankshaft bearing caps in the original positions, and the arrow on the crankshaft bearing caps in the direction of the front of the engine block.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

6. Install the crankshaft bearing cap bolts and the crankshaft bearing cap studs. Refer to *Fastener Tightening Specifications*.
7. Remove the crankshaft bearing cap bolts and studs.
8. Remove the crankshaft bearing caps. The gaging plastic may adhere to either the crankshaft bearing journal or the crankshaft bearing surface.

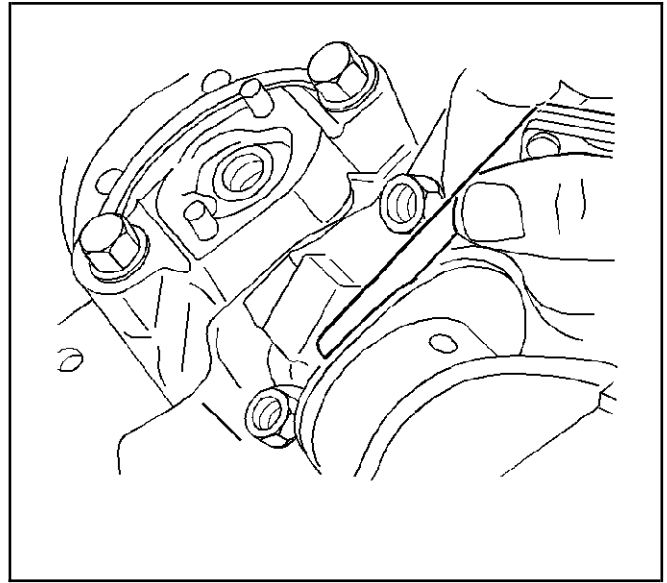


500656

9. Without removing the gaging plastic, measure the compressed width at the widest point, using the graduated scale on the edge of the gaging plastic envelope.
If the flattened gaging plastic tapers toward the middle or the ends, there may be a difference in clearance indicating taper, low spot or other irregularity of the crankshaft bearing or the crankshaft bearing journal.
10. Remove the flattened gaging plastic.
11. Measure the remaining crankshaft bearing journals.

Measuring Connecting Rod Bearing Side Clearance

1. Insert a feeler gage between the connecting rod caps and measure the connecting rod side clearance. Refer to *Engine Mechanical Specifications (5.0 L)* or *Engine Mechanical Specifications (5.7 L)*.
2. The connecting rod side clearances may also be measured with a dial indicator set.



5163

Crankshaft Balancer Cleaning and Inspection

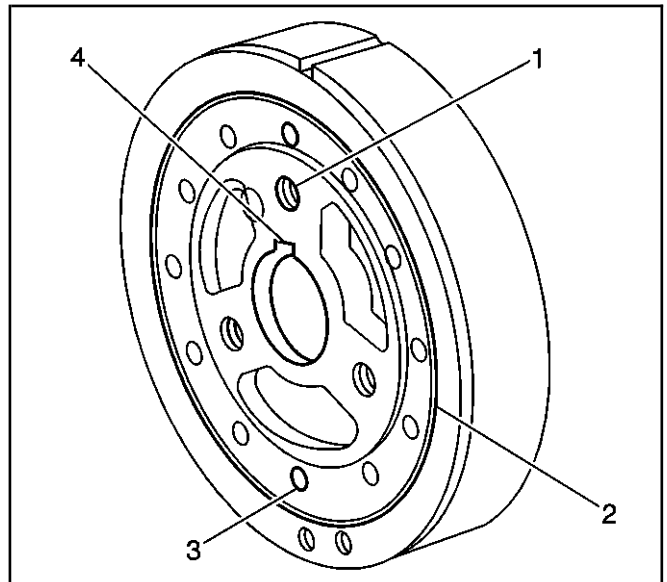
SIE-ID = 194518

Caution: Refer to *Safety Glasses Caution in Cautions and Notices*.

1. Clean the crankshaft balancer in cleaning solvent.
2. Dry the crankshaft balancer with compressed air.
3. Inspect the crankshaft balancer for the following:
 - Worn or damaged bolt hole threads (1)
 - Worn, chunking, or deteriorated rubber (2) between the hub and outer ring
 - Loose or improperly installed balance weights (3)

A properly installed balance weight should be installed until flush or below flush with the face of the crankshaft balancer.

 - Worn or damaged keyway (4)

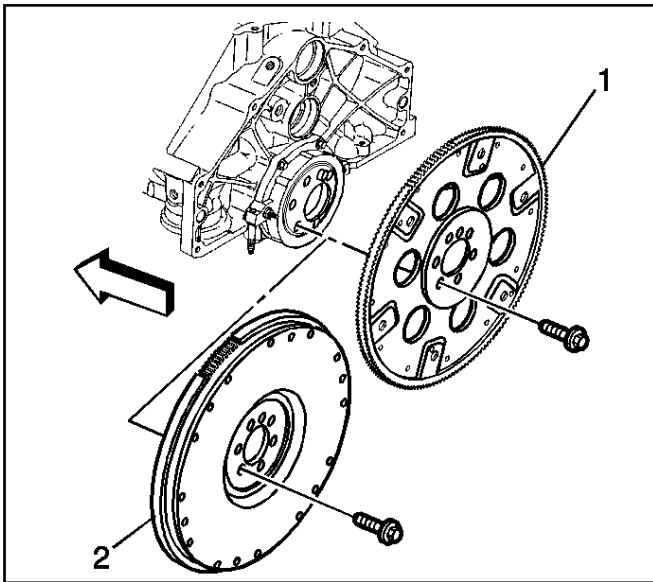


334038

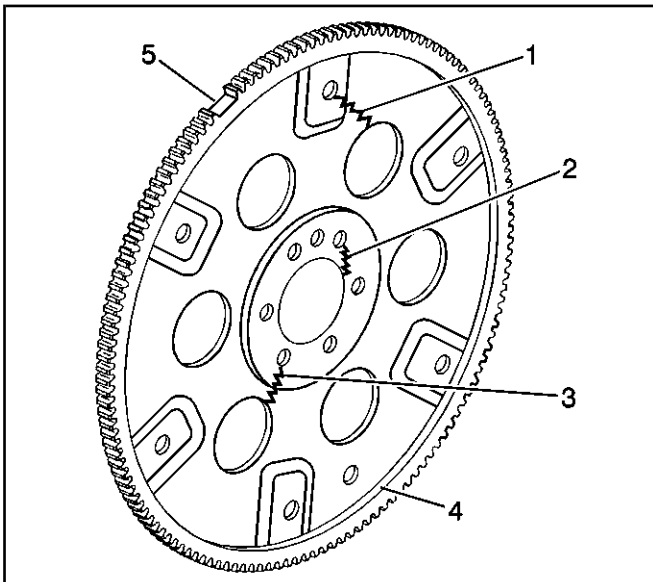
Important: A crankshaft front oil sealing surface with excessive scoring, grooves, rust, or other damage must be replaced.

- Worn, grooved, or damaged crankshaft front oil sealing surface

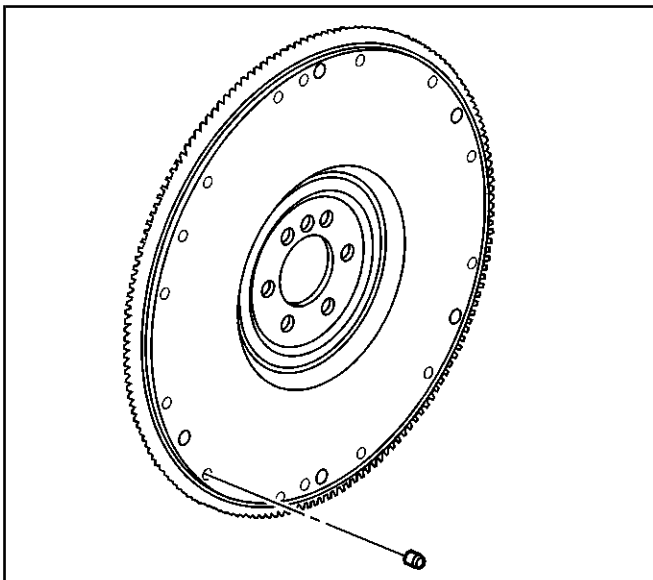
Minor imperfections on the crankshaft balancer crankshaft front oil seal surface may be removed with a polishing compound or fine grade emery cloth.



188129



381965



64126

Engine Flywheel Cleaning and Inspection

SIE-ID = 195065

Caution: Refer to Safety Glasses Caution in Cautions and Notices.

1. Clean the engine flywheel (1 or 2) in cleaning solvent.
2. Dry the engine flywheel with compressed air.

3. Inspect the engine flywheel, automatic transmission, if equipped, for the following:

- Stress cracks around the engine flywheel-to-torque converter bolt hole locations (1)
- Missing balance weights
- Stress cracks around the engine flywheel-to-crankshaft bolt hole locations (2 or 3)

Important: Do not attempt to repair the welded areas that retain the ring gear to the engine flywheel plate. Always install a NEW engine flywheel.

- Welded areas that retain the ring gear onto the engine flywheel for cracking (4)
- Damaged ring gear teeth (5)

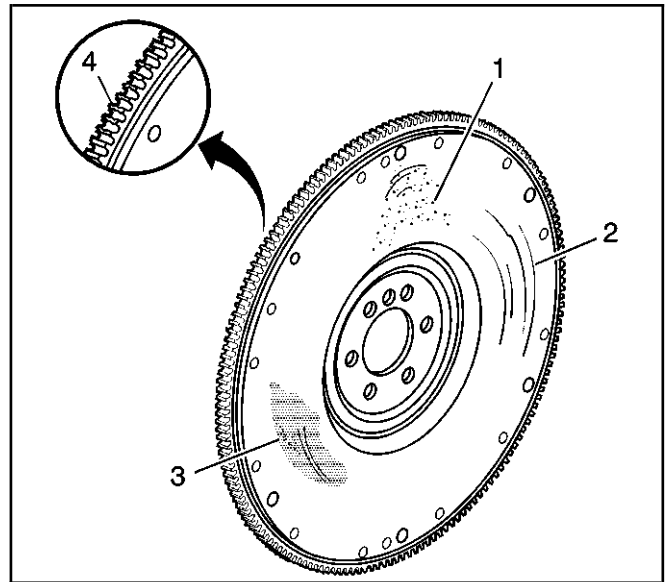
4. Inspect the engine flywheel, manual transmission, if equipped, for loose or improperly installed flywheel weights, if applicable.

A properly installed flywheel weight should be installed until flush or below flush with the face of the engine flywheel.

5. Inspect the engine flywheel, manual transmission, if equipped, for the following:

- Pitted friction surface (1)
- Scoring or grooves (2)
- Rust or other surface damage (3)
- Damaged ring gear teeth (4)
- Loose or improperly positioned ring gear

The ring gear has an interference fit onto the engine flywheel and the ring gear should be positioned completely flat against the flange of the engine flywheel.



188086

Camshaft and Bearings Cleaning and Inspection

SIE-ID = 32312

Tools Required

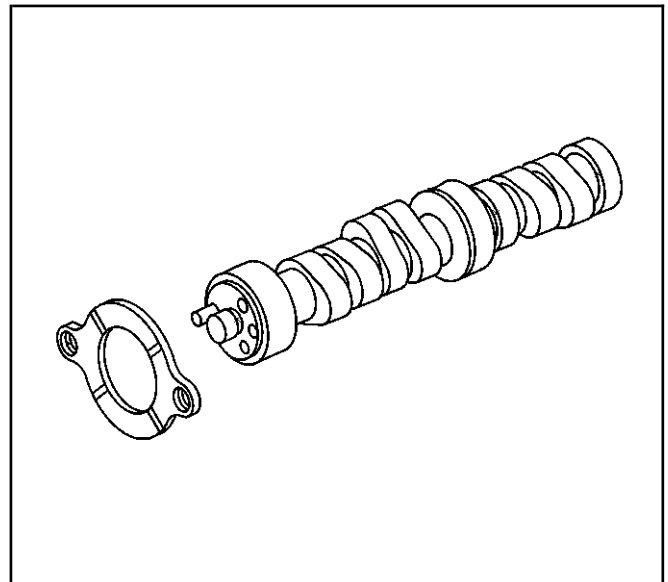
J 7872 Magnetic Base Dial Indicator

Caution: Refer to Safety Glasses Caution in Cautions and Notices.

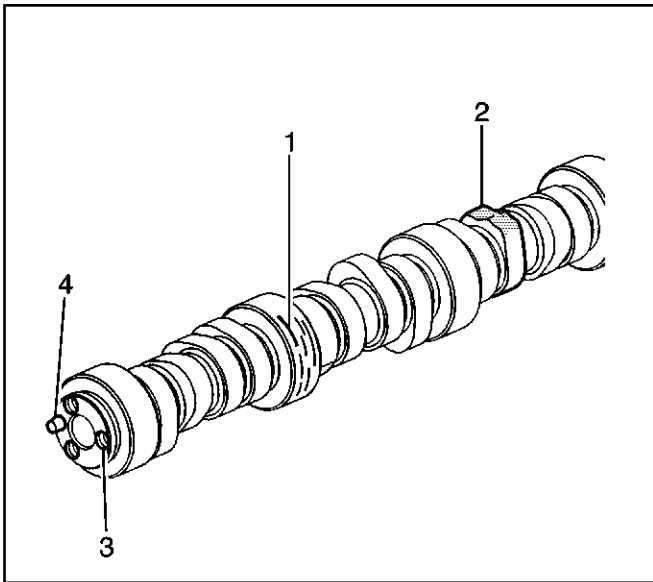
1. Clean the engine camshaft in cleaning solvent.
2. Dry the engine camshaft with compressed air.
3. Inspect the camshaft retainer plate for damage.
If the camshaft retainer plate is damaged, replace as necessary.
4. Inspect the camshaft bearings for correct fit into the engine block camshaft bearing bores.
The camshaft bearings have an interference fit to the engine block camshaft bearing bores and must not be loose in the engine block camshaft bearing bores.

Important: If any camshaft bearing is excessively worn or scored, replace all the camshaft bearings.

5. Inspect the camshaft bearings for excessive wear or scoring.

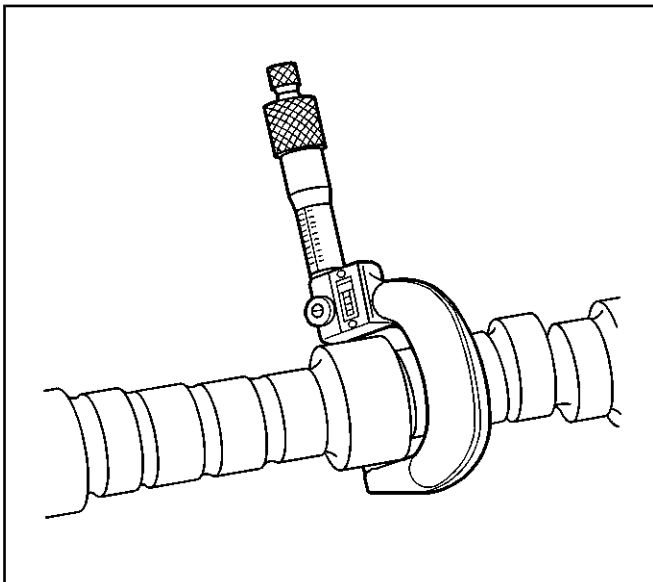


334499



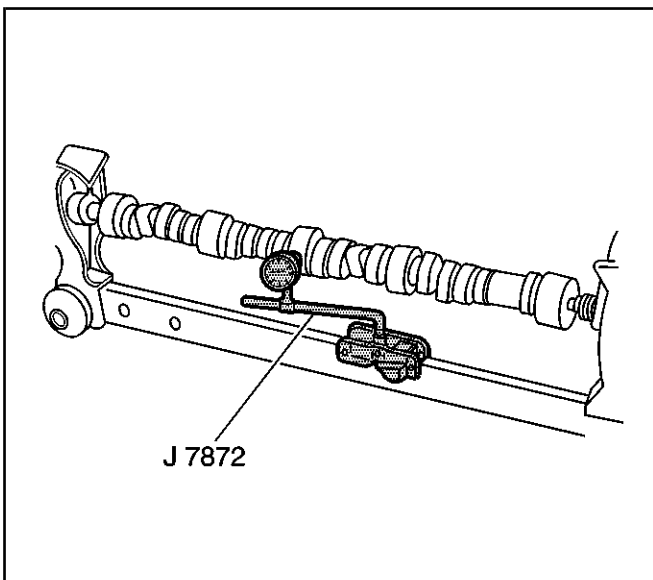
188095

6. Inspect the engine camshaft for the following:
- Worn, scored, or damaged bearing journals (1)
 - Worn engine camshaft lobes (2)
 - Damaged bolt hole threads (3)
 - Damaged camshaft sprocket locator pin (4)



188014

7. Measure the engine camshaft journals with a micrometer.
- If the camshaft journals are more than 0.025 mm (0.0010 in) out-of-round, then replace the engine camshaft.



188012

8. Measure for a bent engine camshaft or excessive engine camshaft runout using the *J 7872*.
- 8.1. Mount the engine camshaft in a suitable stand between centers.
 - 8.2. Use the *J 7872* in order to check the intermediate engine camshaft journals.
- If the runout exceeds 0.065 mm (0.0026 in), the engine camshaft is bent and must be replaced.
9. Measure the engine camshaft lobe lift using the *J 7872*.
- 9.1. Place the engine camshaft on the V-blocks.
 - 9.2. Use the *J 7872* in order to measure the engine camshaft lobe lift.
10. Replace the engine camshaft if the engine camshaft lobe lift is not within specifications.

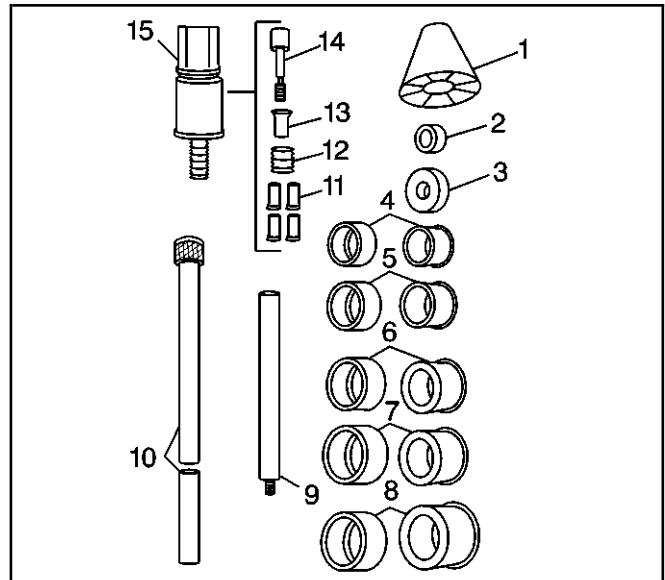
Camshaft Bearing Removal

SIE-ID = 195130

Tools Required

J 33049 Camshaft Bearing Service Kit

1. Select the cone (1), the handle (10), the expanding driver (4–8), the washer (2 or 3), and the expander assembly (15) from the J 33049.
2. Assemble the J 33049.



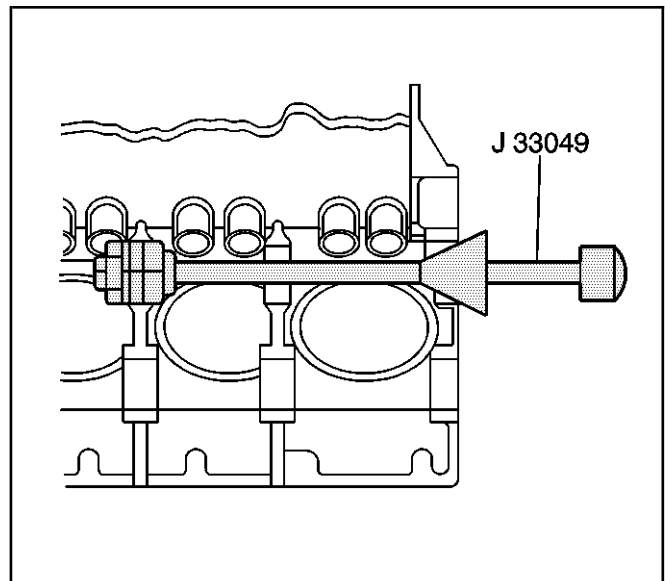
66100

Caution: Refer to Safety Glasses Caution in Cautions and Notices.

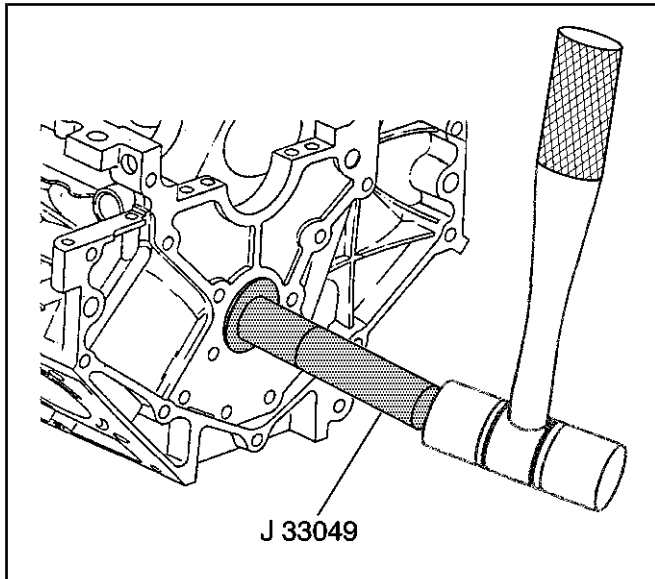
Important: A loose camshaft bearing may be caused by an enlarged, out-of-round, or damaged engine block camshaft bearing bore.

Important: Always remove the camshaft inner bearings #2, #3, and #4 first. The camshaft outer bearings #1 and #5 serve as a guide for the J 33049.

3. Remove the camshaft inner bearings #2, #3, and #4.
 - 3.1. Insert the J 33049 through the front of the engine block and into the camshaft inner bearing #2.
 - 3.2. Tighten the J 33049 expander assembly nut until snug.
 - 3.3. Push the J 33049 guide cone into the camshaft front bearing in order to align the J 33049.
 - 3.4. Drive the camshaft inner bearing #2 from the camshaft inner bearing bore #2.
 - 3.5. Loosen the J 33049 expander assembly nut.
 - 3.6. Remove the camshaft inner bearing #2 from the J 33049 expander assembly.
 - 3.7. Insert the J 33049 expander assembly into the camshaft inner bearing #3.
 - 3.8. Tighten the J 33049 expander assembly nut until snug.
 - 3.9. Push the J 33049 guide cone into the camshaft front bearing in order to align the J 33049.
 - 3.10. Drive the camshaft inner bearing #3 from the camshaft inner bearing bore #3.
 - 3.11. Loosen the J 33049 expander assembly nut.
 - 3.12. Remove the camshaft inner bearing #3 from the J 33049 expander assembly.
 - 3.13. Insert the J 33049 expander assembly into the camshaft inner bearing #4.



4985



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- 3.14. Tighten the *J 33049* expander assembly nut until snug.
- 3.15. Push the *J 33049* guide cone into the camshaft front bearing in order to align the *J 33049*.
- 3.16. Drive the camshaft inner bearing #4 from the camshaft inner bearing bore #4.
- 3.17. Loosen the *J 33049* expander assembly nut.
- 3.18. Remove the camshaft inner bearing #4 from the *J 33049* expander assembly.
4. Remove the *J 33049* from the engine block.
5. Remove the camshaft outer bearings #1 and #5.
 - 5.1. Insert the *J 33049* into the camshaft outer bearing #1.
 - 5.2. Tighten the *J 33049* expander assembly nut until snug.
 - 5.3. Drive the camshaft outer bearing #1 from the camshaft outer bearing bore #1.
 - 5.4. Loosen the *J 33049* expander assembly nut.
 - 5.5. Remove the camshaft outer bearing #1 from the *J 33049* expander assembly.
 - 5.6. Remove the *J 33049* from the engine block.
 - 5.7. Insert the *J 33049* into the camshaft outer bearing #5.
 - 5.8. Tighten the *J 33049* expander assembly nut until snug.
 - 5.9. Drive the camshaft outer bearing #5 from the camshaft outer bearing bore #5.
 - 5.10. Loosen the *J 33049* expander assembly nut.
 - 5.11. Remove the camshaft outer bearing #5 from the *J 33049* expander assembly.
6. Remove the *J 33049* from the engine block.
7. Discard the camshaft bearings.

Camshaft Bearing Installation

SIE-ID = 195136

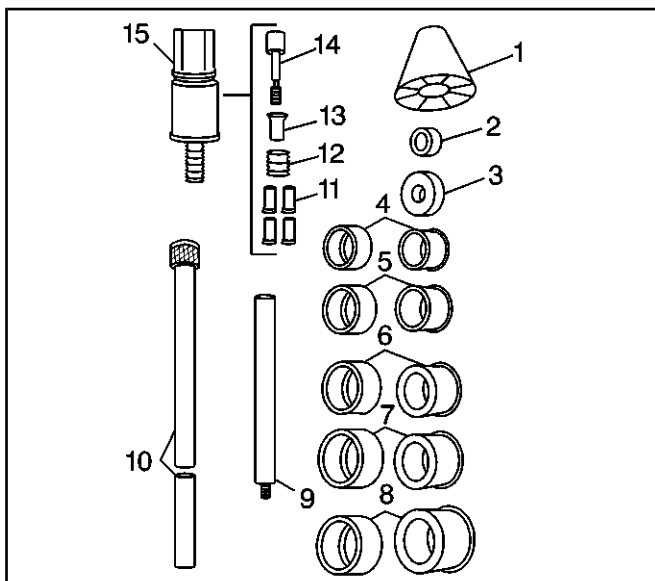
Tools Required

J 33049 Camshaft Bearing Service Kit

Important: Always install the camshaft outer bearings #1 and #5 first. The camshaft outer bearings serve as a guide for the *J 33049* and help center the camshaft inner bearings during the installation process.

Look to ensure that the camshaft bearing lubrication hole or holes align with the oil gallery hole or holes in the engine block. On some engines, the oil gallery holes may be difficult to see. Verify that the camshaft bearing lubrication holes and the oil gallery holes are aligned.

1. Assemble the *J 33049* handle (10), the expanding driver (4–8), the washer (2 or 3), and the expander assembly (15).



66100

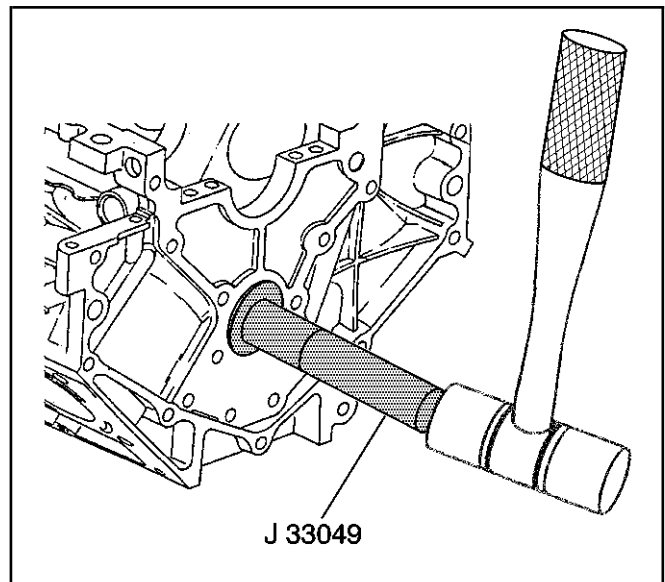
Caution: Refer to Safety Glasses Caution in Cautions and Notices.

Important: The camshaft bearing lubrication holes must align with the oil gallery holes in the engine block.

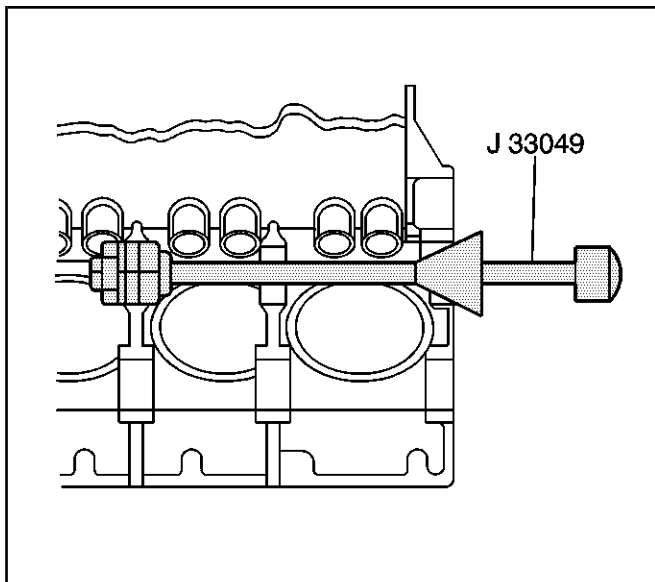
After installation of the camshaft bearings, always inspect the camshaft bearing lubrication holes for proper alignment with the oil gallery holes.

An improperly aligned camshaft bearing lubrication hole and oil gallery hole will restrict oil flow to the camshaft bearing and the camshaft journal.

2. Install the NEW camshaft outer bearings #5 and #1.
 - 2.1. Install the NEW camshaft outer bearing #5 onto the J 33049 expander assembly.
 - 2.2. Tighten the J 33049 expander assembly nut until snug.
 - 2.3. Align the camshaft outer bearing #5 lubrication hole with the oil gallery hole in the camshaft outer bearing bore #5 at the rear of the engine block.
 - 2.4. Drive the camshaft outer bearing #5 into the camshaft outer bearing bore #5 at the rear of the engine block.
 - 2.5. Loosen the J 33049 expander assembly nut.
 - 2.6. Remove the J 33049 expander assembly from the camshaft outer bearing #5.
 - 2.7. Install the NEW camshaft outer bearing #1 onto the J 33049 expander assembly.
 - 2.8. Tighten the J 33049 expander assembly nut until snug.
 - 2.9. Align the camshaft outer bearing #1 lubrication hole with the oil gallery hole in the camshaft outer bearing bore #1 at the front of the engine block.
 - 2.10. Drive the camshaft outer bearing #1 into the camshaft outer bearing bore #1 at the front of the engine block.
 - 2.11. Loosen the J 33049 expander assembly nut.
 - 2.12. Carefully slide the J 33049 into the engine block until the J 33049 expander assembly is positioned between the camshaft inner bearing bores #3 and the camshaft inner bearing bore #4.



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Important: The camshaft bearing lubrication holes must align with the oil gallery holes in the engine block.

After installation of the camshaft bearings, always inspect the camshaft bearing lubrication holes for proper alignment with the oil gallery holes.

An improperly aligned camshaft bearing lubrication hole and oil gallery hole will restrict oil flow to the camshaft bearing and the camshaft journal.

3. Install the NEW camshaft inner bearings #4, #3, and #2.

- 3.1. Install the NEW camshaft inner bearing #4 onto the J 33049 expander assembly.
- 3.2. Tighten the J 33049 expander assembly nut until snug.
- 3.3. Align the camshaft inner bearing #4 lubrication hole with the oil gallery hole in the camshaft inner bearing bore #4 of the engine block.
- 3.4. Push the J 33049 guide cone into the camshaft front bearing bore #1 in order to align the J 33049.
- 3.5. Drive the camshaft inner bearing #4 into the camshaft inner bearing bore #4.
- 3.6. Loosen the J 33049 expander assembly nut.
- 3.7. Carefully slide the J 33049 until the J 33049 expander assembly is positioned between the camshaft inner bearing bore #3 and the camshaft outer bearing bore #2.
- 3.8. Install the NEW camshaft inner bearing #3 onto the J 33049 expander assembly.
- 3.9. Tighten the J 33049 expander assembly nut until snug.
- 3.10. Align the camshaft inner bearing #3 lubrication hole with the oil gallery hole in the camshaft inner bearing bore #3 of the engine block.
- 3.11. Push the J 33049 guide cone into the camshaft front bearing bore #1 in order to align the J 33049.
- 3.12. Drive the camshaft inner bearing #3 into the camshaft inner bearing bore #3.
- 3.13. Loosen the J 33049 expander assembly nut.
- 3.14. Carefully slide the J 33049 until the J 33049 expander assembly is positioned between the camshaft inner bearing bore #2 and the camshaft outer bearing bore #1.
- 3.15. Install the NEW camshaft inner bearing #2 onto the J 33049 expander assembly.
- 3.16. Tighten the J 33049 expander assembly nut until snug.
- 3.17. Align the camshaft inner bearing #2 lubrication hole with the oil gallery hole in the camshaft inner bearing bore #2 of the engine block.
- 3.18. Push the J 33049 guide cone into the camshaft front bearing bore #1 in order to align the J 33049.

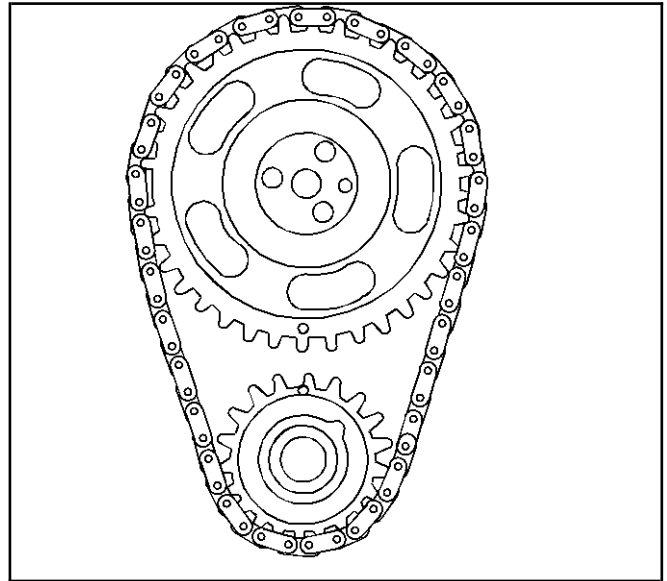
- 3.19. Drive the camshaft inner bearing #2 into the camshaft inner bearing bore #2.
- 3.20. Loosen the *J 33049* expander assembly nut.
4. Carefully remove the *J 33049* from the engine block.

Timing Chain and Sprockets Cleaning and Inspection

SIE-ID = 195154

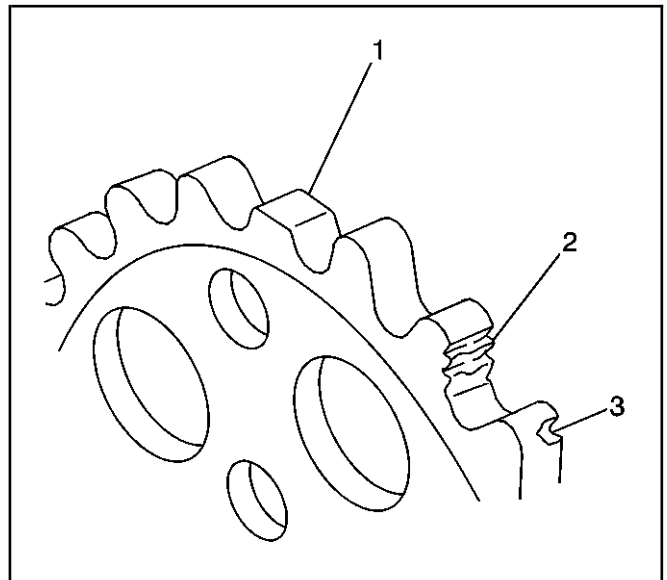
Caution: Refer to *Safety Glasses Caution in Cautions and Notices*.

1. Clean the components in cleaning solvent.
2. Dry the components with compressed air.
3. Inspect the camshaft timing chain for binding or wear.

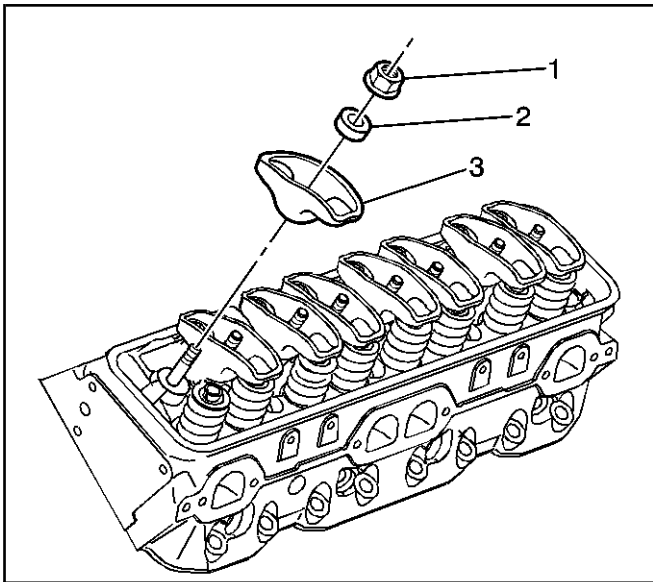


11503

4. Inspect the camshaft and crankshaft sprockets for:
 - Broken teeth (1)
 - Damaged teeth (2)
 - Chipped teeth (3)
 - Worn teeth
 - Uneven wear on one edge of the teeth
 - Worn valleys between the sprocket teeth
 - Crankshaft sprocket keyway for wear
 - Crankshaft sprocket woodruff key for wear or damage



188097



182835

Valve Rocker Arm and Push Rods Cleaning and Inspection

SIE-ID = 195201

Important: Parts that are to be reused must be marked, sorted and organized for assembly.

1. Mark, sort, and organize the components for assembly.

Caution: Refer to Safety Glasses Caution in Cautions and Notices.

2. Clean the components with cleaning solvent.
3. Dry the components with compressed air.
4. Inspect the valve rocker arm components for the following:

- Wear or scoring of the valve rocker arm (3) ball area
- Valve rocker arm (3) pushrod sockets and valve stem contact surfaces

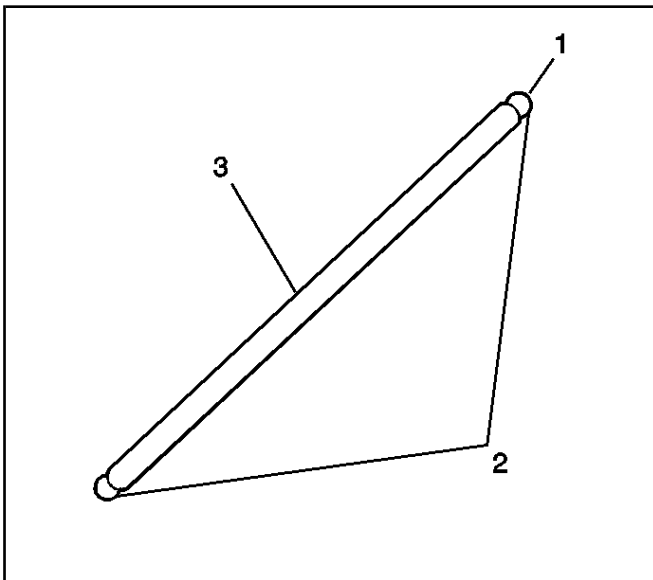
The contact surfaces should be smooth with no scoring or excessive wear.

- Valve rocker arm ball (2) for wear or scoring
The contact surface must be smooth with no scoring or excessive wear.

5. Inspect the valve pushrods for the following:

- Restriction of the oil passage (1)
- Wear or scoring of the end contact surfaces (2)
The end contact surfaces must be smooth with no scoring or excessive wear.
- Shaft for bends (3)

Roll the valve pushrod on a flat surface to determine if the valve pushrod is bent.



488857

Valve Lifters and Guides Cleaning and Inspection

SIE-ID = 195248

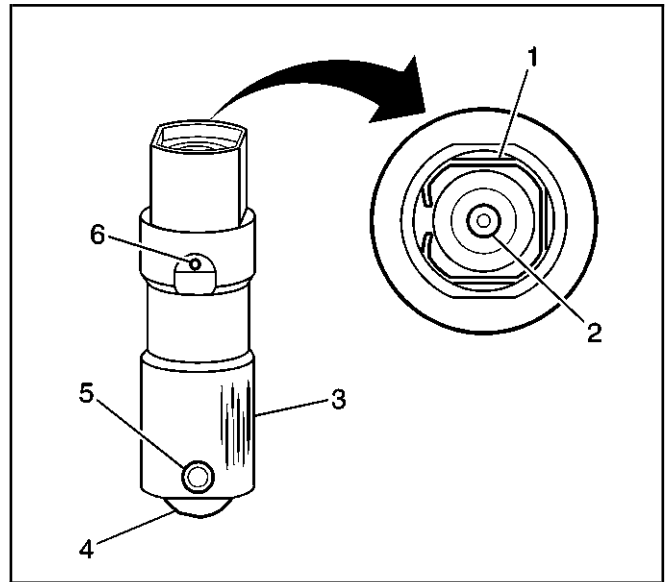
Caution: Refer to Safety Glasses Caution in Cautions and Notices.

Important: Components that are to be reused must be marked, sorted, and organized for assembly.

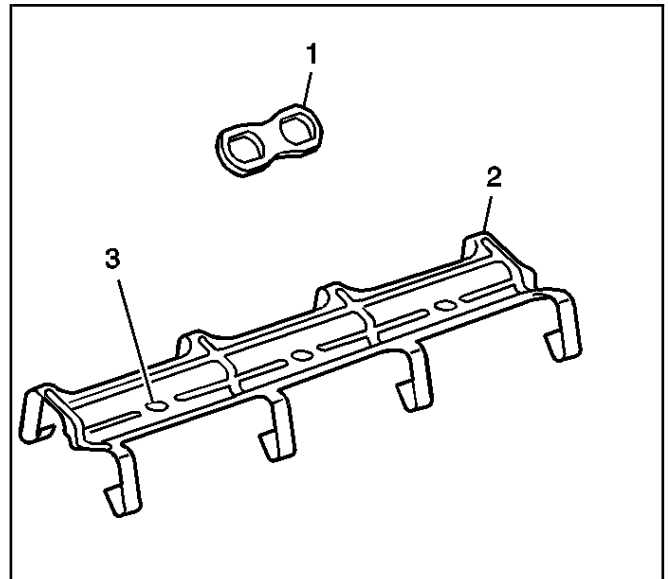
1. Mark, sort, and organize the components for assembly.
2. Clean the components in cleaning solvent.
3. Dry the components with compressed air.
4. Inspect the valve lifter for the following:
 - Broken or damaged clip (1)
 - Worn valve pushrod socket (2)
 - Wear or scuffing (3)

If the valve lifter shows wear or scuffing, inspect the engine block valve lifter bores for wear or damage.

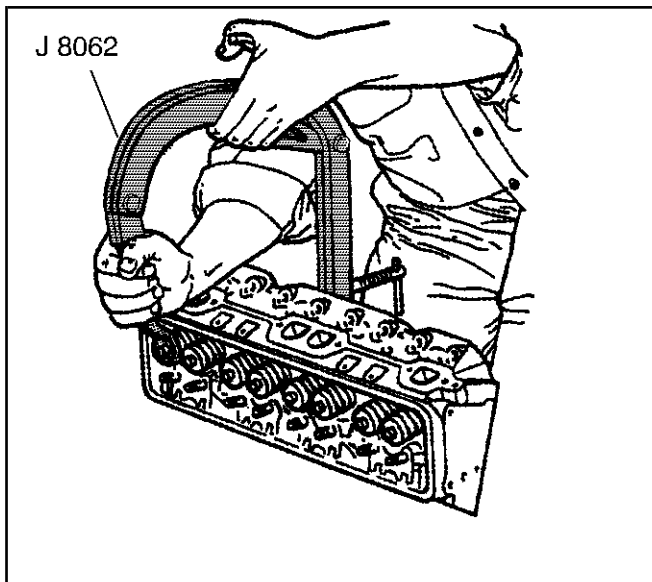
 - Worn roller (4)
 - Loose or damaged pin (5)
 - Plugged oil hole (6)
5. Inspect the valve lifter guides (1) for the following:
 - Excessive wear (1)
 - Cracks or damage
6. Inspect the valve lifter guide retainer for:
 - Wear, damage, or stress cracking in the leg areas (2)
 - Wear or damage in the bolt holes (3)



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34468

Cylinder Head Disassemble

SIE-ID = 195340

Tools Required

J 8062 Valve Spring Compressor

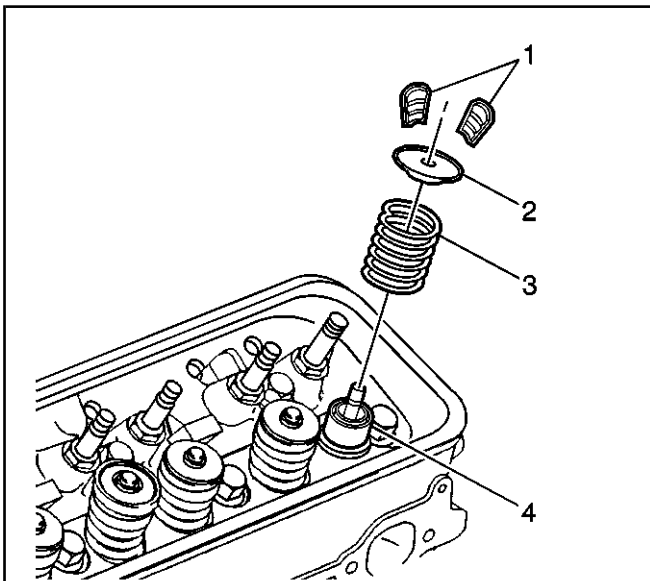
Caution: SIO-ID = 411464 *Compressed valve springs have high tension against the valve spring compressor. Valve springs that are not properly compressed by or released from the valve spring compressor can be ejected from the valve spring compressor with intense force. Use care when compressing or releasing the valve spring with the valve spring compressor and when removing or installing the valve stem keys. Failing to use care may cause personal injury.*

Caution: Refer to Safety Glasses Caution in Cautions and Notices.

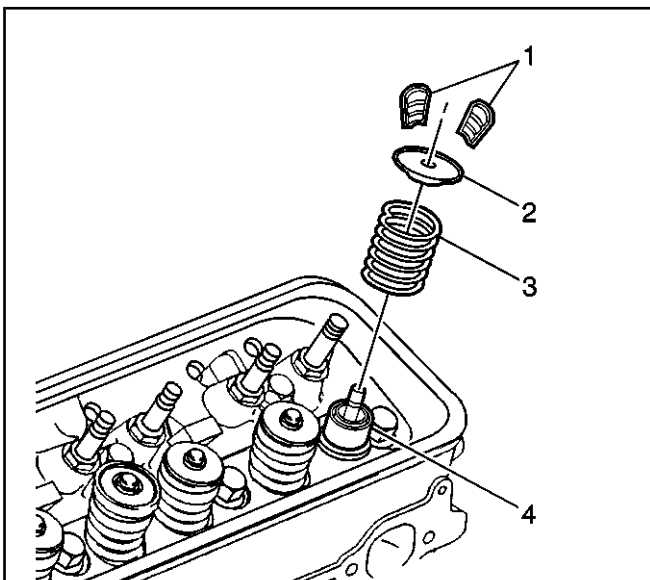
1. Use the J 8062 in order to compress the valve springs.

Important: Place the valves in a rack, in the proper sequence, so that the valves can be installed in the same order as the valve were removed.

2. Remove the valve stem keys (1).
3. Remove the J 8062 from the cylinder head.
4. Remove the valve spring cap (2).
5. Remove the valve spring (3).
6. Remove the valve stem oil seal (4).
7. Discard the valve stem oil seal (4).
8. Remove the valve.



334505



334505

Cylinder Head Cleaning and Inspection

SIE-ID = 799092

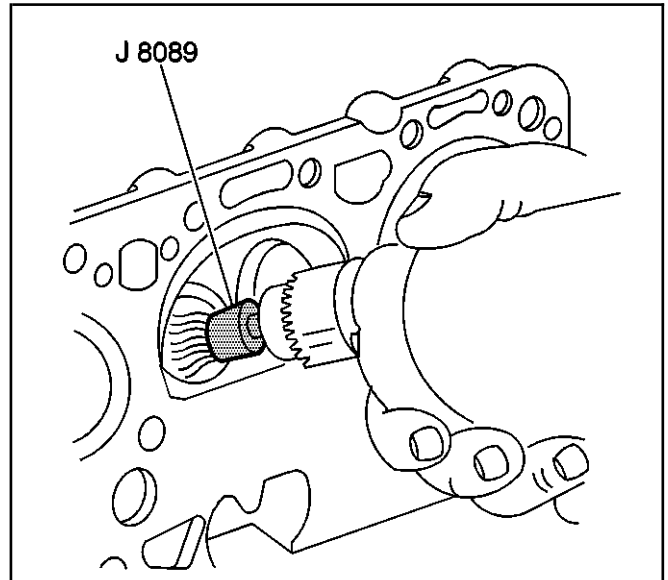
Tools Required

- J 8001 Dial Indicator Set
- J 8089 Carbon Removing Brush
- J 9666 Valve Spring Tester

Caution: Refer to Safety Glasses Caution in Cautions and Notices.

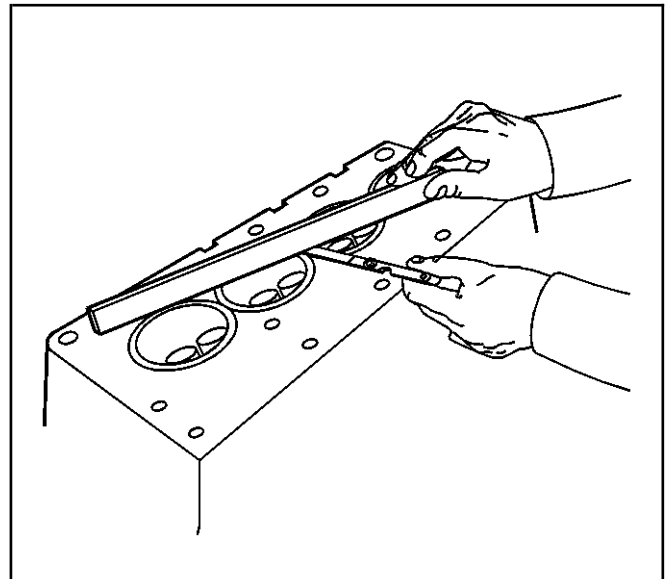
1. Clean the valve stems and cylinder heads on a buffing wheel.
2. Clean the following components in cleaning solvent:
 - Valve stem keys (1)
 - Valve spring cap (2)
 - Valve spring (3)
 - Cylinder head

3. Dry the components with compressed air.
4. Use the *J 8089* to clean the carbon from the cylinder head combustion chambers.
Be careful not to scuff the combustion chambers.
5. Inspect the cylinder head for the following:
 - Damage to the gasket surfaces
 - Damage to the threaded bolt holes
 - Burnt or eroded areas in the combustion chamber
 - Cracks in the exhaust ports and combustion chambers
 - External cracks in the water chamber
 - Restrictions in the intake or exhaust passages
 - Restrictions in the cooling system passages
 - Rusted, damaged, or leaking core plugs

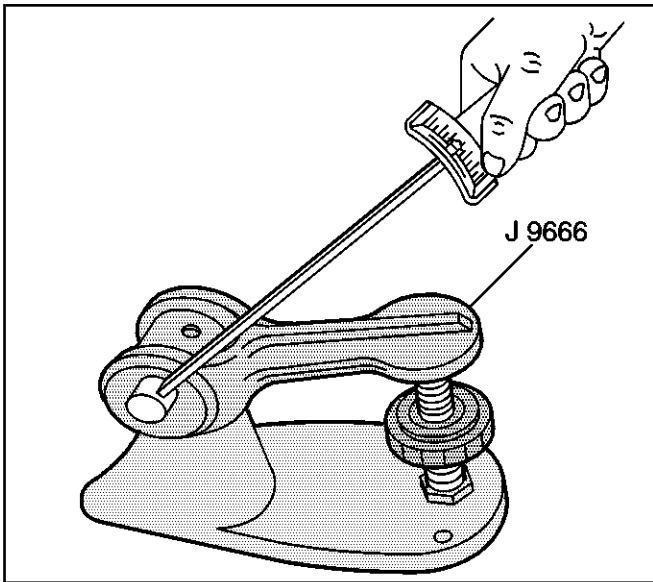


4957

6. Measure the cylinder head for warpage with a straight edge and feeler gage.
 - A cylinder head block deck with warpage in excess of 0.10 mm (0.004 in) within a 152.4 mm (6.0 in) area must be repaired or replaced.
 - A cylinder head exhaust manifold deck with warpage in excess of 0.05 mm (0.002 in) must be repaired or replaced.
 - A cylinder head intake manifold deck with warpage in excess of 0.10 mm (0.004 in) must be repaired or replaced.



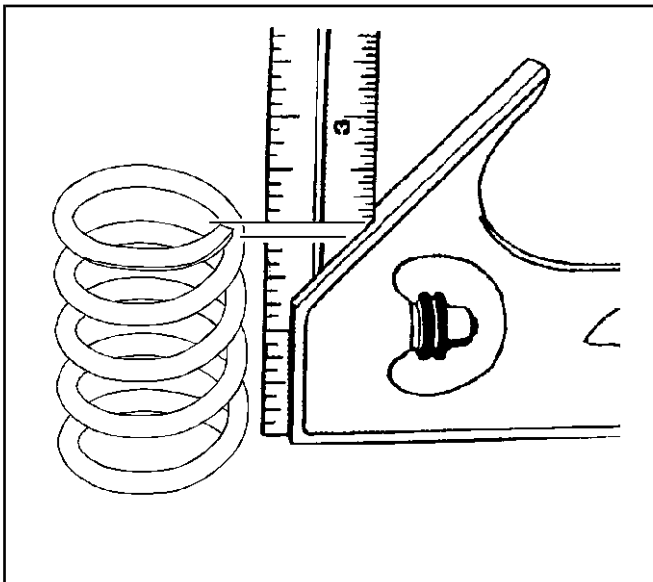
64318



4960

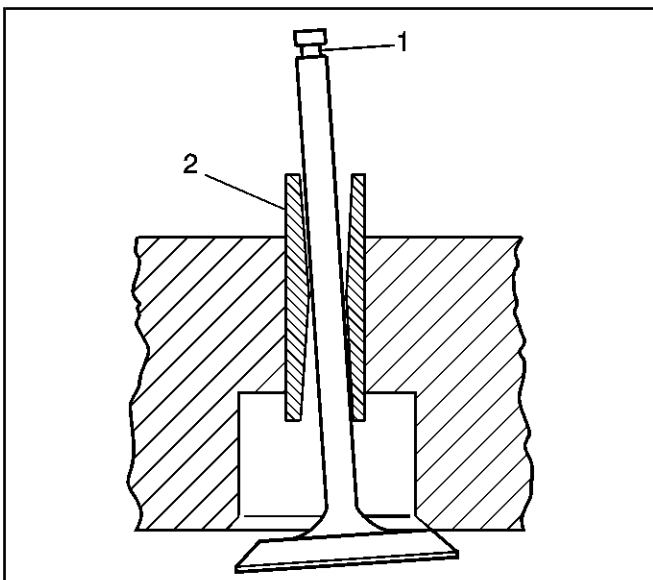
7. Use the *J 9666* in order to measure the valve spring.

Replace the valve spring if the valve spring tension is less than 338 N (76 lb) at 43.2 mm (1.70 in).



40075

8. Inspect the valve springs for squareness.



156172

9. Valve stems (1) with excessive guide (2) clearance must be repaired or replaced.

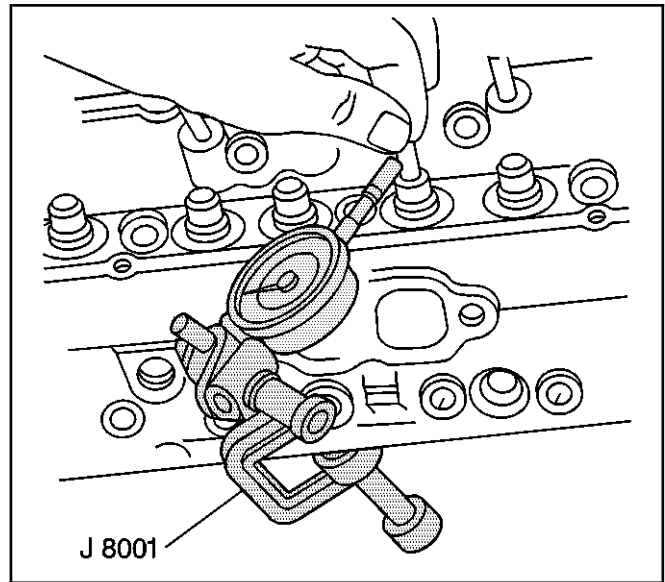
10. Measure the valve stem-to-guide clearance.

Excessive valve stem-to-guide clearance may cause an excessive oil consumption and may also cause a valve to break. Insufficient clearance will result in noisy and sticky functioning of the valve and will disturb the engine assembly smoothness.

- 10.1. Clamp the *J 8001* on the exhaust port side of the cylinder head.
- 10.2. Locate the dial indicator so that the movement of the valve stem from side to side, crosswise to the cylinder head, will cause a direct movement of the dial indicator stem.

The dial indicator stem must contact the side of the valve stem just above the valve guide.

- 10.3. Drop the valve head about 1.6 mm (0.063 in) off the valve seat.
- 10.4. Use light pressure and then move the valve stem from side to side in order to obtain a clearance reading. Refer to *Engine Mechanical Specifications (5.0 L)* or *Engine Mechanical Specifications (5.7 L)*.



35214

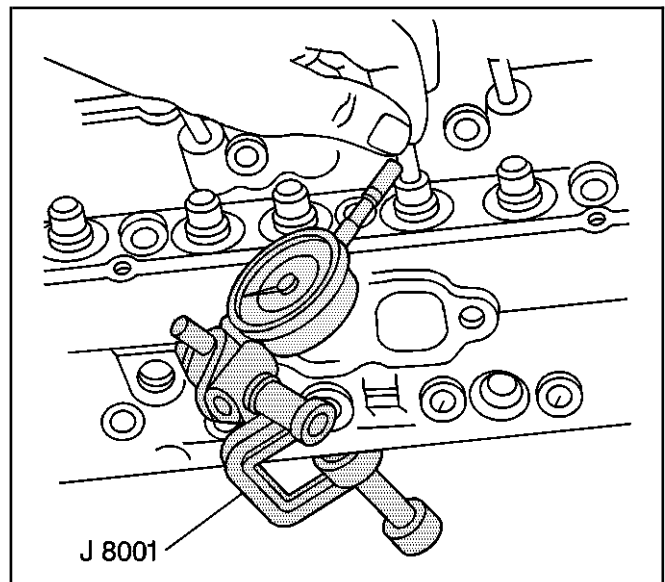
Valve Guide Reaming/Valve and Seat Grinding

SIE-ID = 784242

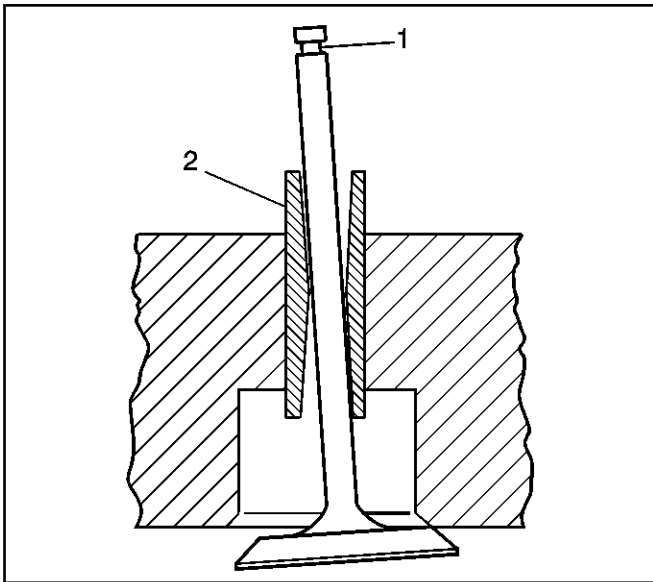
Tools Required

- *J 5830-02* Valve Guide Reamer Set
- *J 8001* Dial Indicator Set

1. Measure the valve stem-to-guide clearance.
Refer to *Cylinder Head Cleaning and Inspection*.

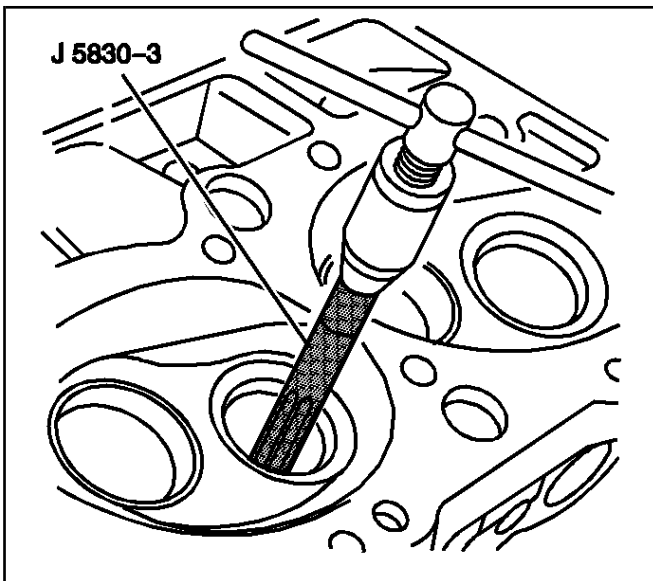


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2. Improper valve stem (1) to valve guide (2) clearance may cause excessive oil consumption.

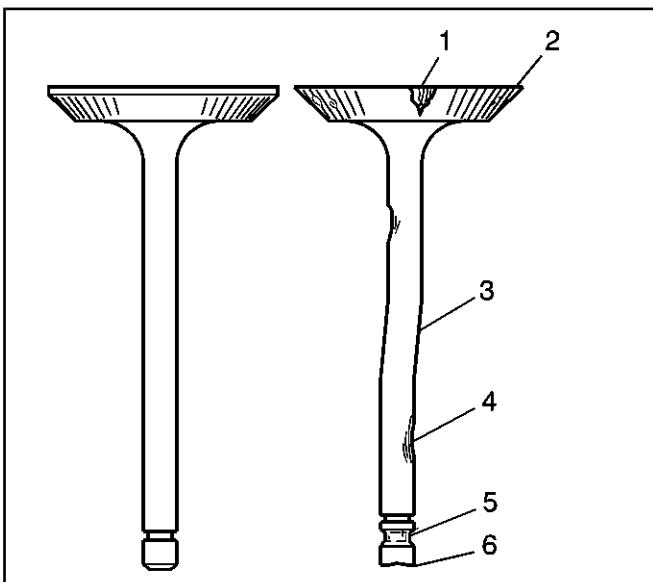


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Caution: Refer to Safety Glasses Caution in Cautions and Notices.

Important: Exhaust valves with excessive valve stem-to-guide clearance must be replaced with the available service valve that has an 0.774 mm (0.0305 in) oversize valve stem. The intake valves are NOT available with oversize valve stems. Replace the cylinder head if after using a NEW intake valve in order to measure the valve stem-to-guide clearance, the valve stem-to-guide clearance is not within specifications.

3. Use the J 5830-3 in order to ream the exhaust valve guide in order to achieve the correct valve stem-to-guide clearance.
4. Always recondition the exhaust valve seat after reaming the exhaust valve guide bores and installing new exhaust valves.



156174

5. Inspect the valves for the following:
 - Burnt or damaged areas (1)
 - Undersized margin (2)
 - Bent stem (3)
 - Scoring or other damage to the stem (4)
 - Worn key groove (5)
 - Worn stem tip (6)

6. Inspect the valve contact surface for the following:

- Undersized margin (1)
- Pitted surface (2)
- Burnt or eroded areas (3)
- Acceptable edge (margin) (4)

Valves with excessive damage must be replaced.

Minor imperfections of the valve or valve seat may be repaired.

7. Reconditioning of the valves and valve seats:

- The valves must seat perfectly for the engine to deliver optimum power and performance.
- Cooling the valve heads is another important factor. Good contact between each valve and valve seat in the cylinder head is necessary to insure that the heat in the valve head is properly carried away.

- Regardless of what type of equipment is used, it is essential that the valve guide bores are free from carbon or dirt in order to ensure the proper centering of the pilot in the valve guide.

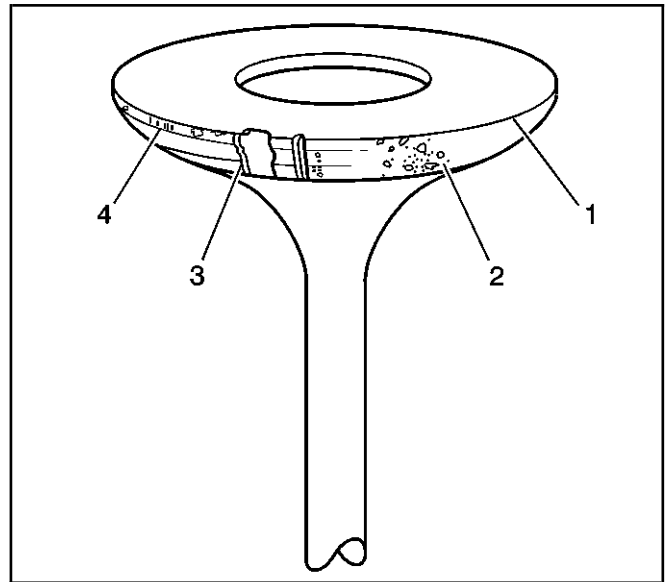
The valve seats should be concentric to within 0.05 mm (0.002 in) total indicator reading.

- Reface pitted valves on a valve refacing machine in order to ensure the correct relationship between the valve head and the valve stem.

Replace the valve if the valve stem is excessively worn or warped.

Replace the valve if the edge of the valve head is less than 0.79 mm (0.031 in) thick after grinding.

- Several different types of equipment are available for reconditioning valves and valve seats. Follow the equipment manufacturer's recommendations for equipment use to attain the proper results.



156173

Valve Rocker Arm Stud Removal

SIE-ID = 195352

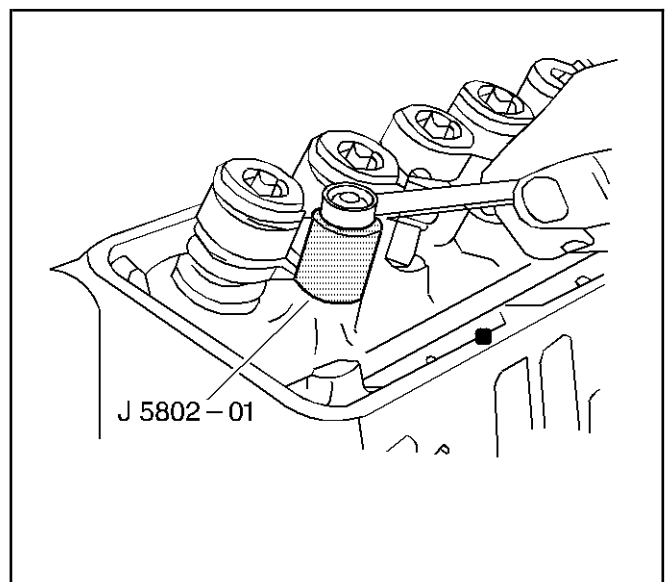
Tools Required

J 5802-01 Rocker Arm Stud Remover

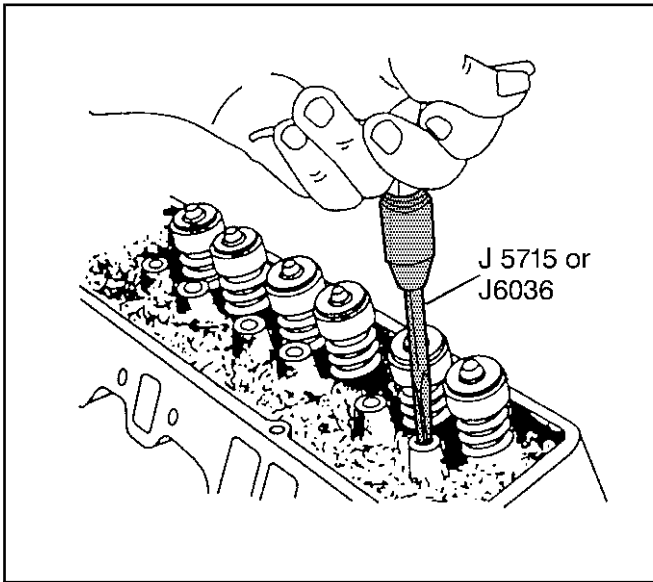
Important:

- Valve rocker arm ball studs that have damaged threads, or are loose in cylinder heads, should be replaced.
- Valve rocker arm ball studs are pressed into the cylinder head.
- New valve rocker arm ball studs are available in 0.0762 mm (0.003 in) and 0.3302 mm (0.013 in) oversize.

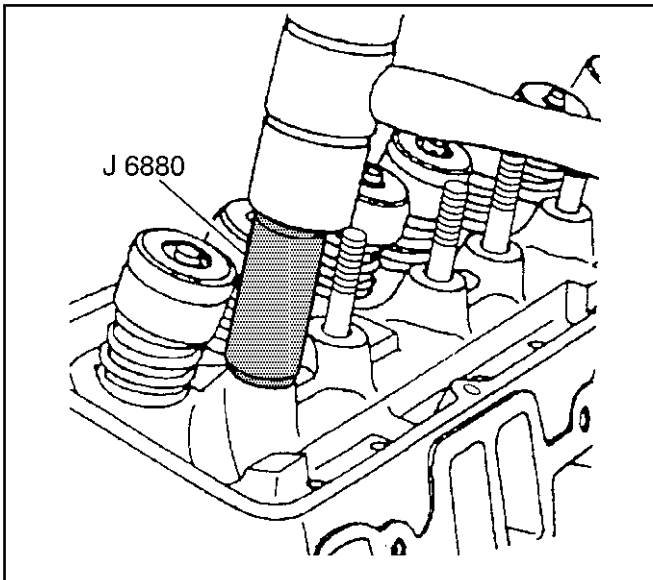
1. Place the J 5802-01 over the valve rocker arm ball stud to be removed.
2. Install a nut and a flat washer.



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66509



66504

3. Rotate the nut clockwise to remove the valve rocker arm ball stud.

Valve Rocker Arm Stud Installation

SIE-ID = 195354

Tools Required

- J 5715 Reamer (0.0762 mm (0.003 in)
- J 6036 Reamer (0.03302 mm (0.013 in)
- J 6880 Rocker Arm Stud Installer

Caution: Refer to Safety Glasses Caution in Cautions and Notices.

Important: Valve rocker arm ball studs that have damaged threads or are loose in cylinder heads should be replaced. New valve rocker arm ball studs are available in 0.0762 mm (0.003 in) and 0.3302 mm (0.013 in) oversize.

1. Ream the hole to the proper size for the replacement oversize valve rocker arm ball stud.
Use J 5715 for 0.0762 mm (0.003 in) oversize valve rocker arm ball studs, or J 6036 for 0.3302 mm (0.013 in) oversize valve rocker arm ball studs.
2. Apply lubricant GM P/N United States 1052271, GM P/N Canada 10950849, or equivalent, the lower end, press-fit end, of the valve rocker arm ball stud.
3. Use the J 6880 and a hammer to install the valve rocker arm ball stud into place.
The valve rocker arm ball stud is installed to proper depth when the J 6880 bottoms onto the cylinder head.

Cylinder Head Assemble

SIE-ID = 195342

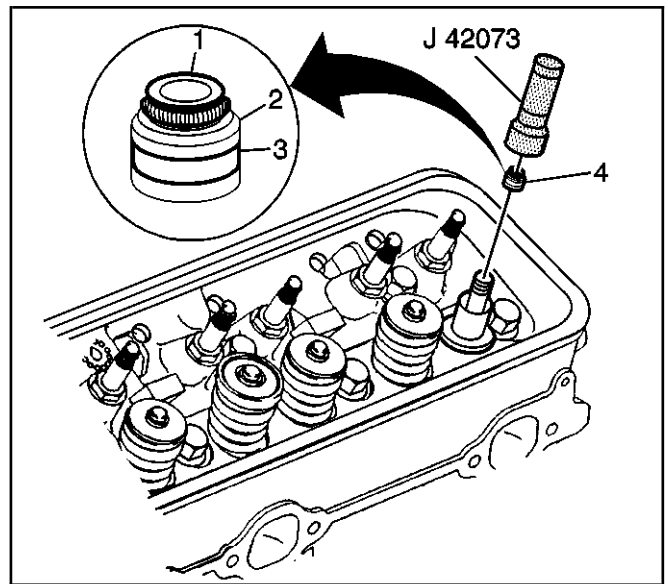
Tools Required

- J 8062 Valve Spring Compressor
- J 42073 Valve Stem Seal Installer

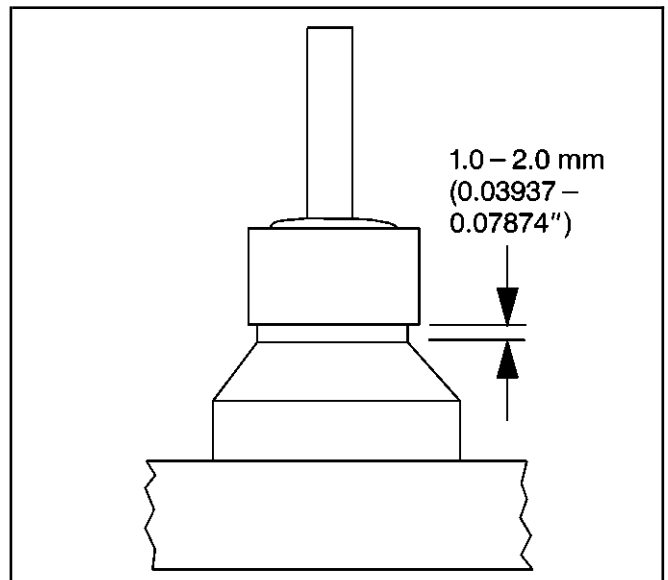
Caution: Refer to Safety Glasses Caution in Cautions and Notices.

Important: The exhaust valve oil stem seal has the letters EX (1) molded into the top of the seal. The exhaust valve oil stem seal material is brown in color (2) with a white stripe (3) painted onto the outside diameter of the seal, or the material may be red in color (2) with no paint stripe. The intake valve stem oil seal is black in color.

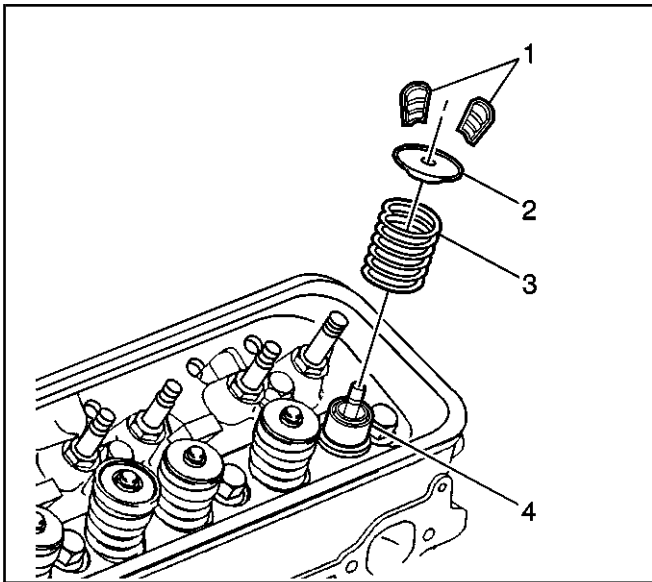
1. Lubricate the valve stem and assemble the valve into the proper valve guide.
2. Select the proper valve stem oil seal for the specific valve guide.
3. Lubricate the valve stem oil seal and guide with clean engine oil.
4. Assemble the valve stem oil seal onto the valve stem.
5. Using the J 42073, install the valve stem oil seal onto the valve guide.
 - 5.1. Tap the valve stem oil seal onto the valve guide until the J 42073 bottoms against the valve spring seat.
 - 5.2. Inspect the valve stem oil seal. The valve stem oil seal should not be bottomed against the valve guide.
There should be a 1–2 mm (0.03937–0.07874 in) gap between the bottom edge of the valve stem oil seal and the valve guide.



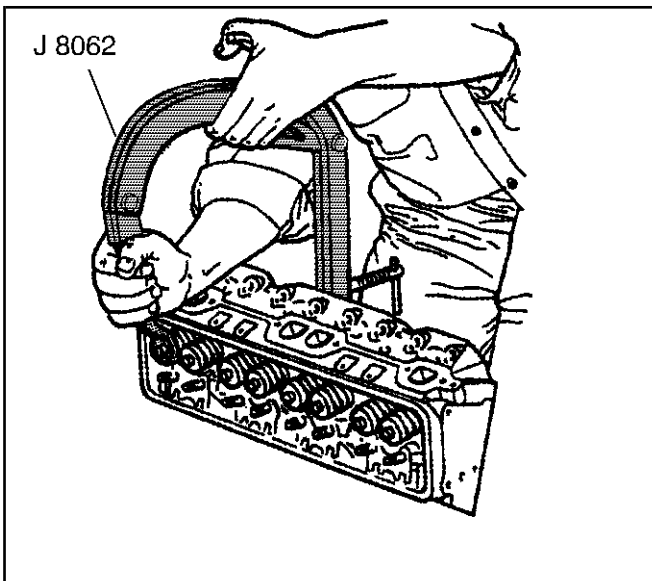
200320



36373



334505



34468

6. Install the valve spring (3).
7. Install the valve spring cap (2) onto the valve spring (3), over the valve stem.

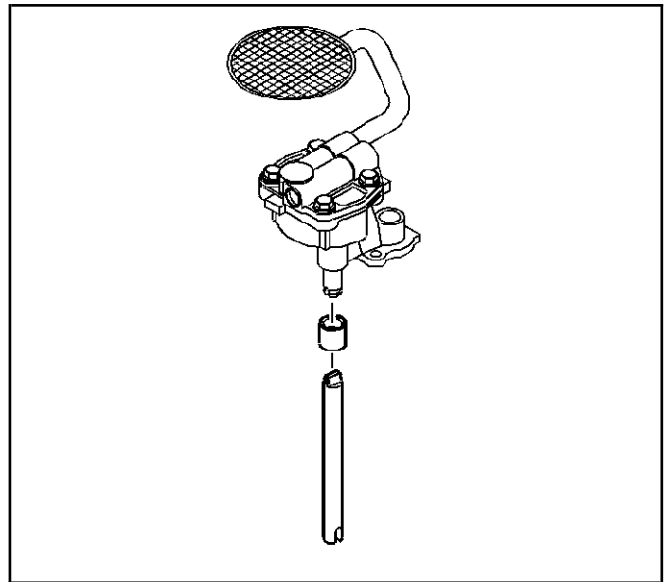
Caution: SIO-ID = 411464 *Compressed valve springs have high tension against the valve spring compressor. Valve springs that are not properly compressed by or released from the valve spring compressor can be ejected from the valve spring compressor with intense force. Use care when compressing or releasing the valve spring with the valve spring compressor and when removing or installing the valve stem keys. Failing to use care may cause personal injury.*

8. Use the J 8062 to compress the valve spring.
9. Install the valve stem O-ring seal.
10. Install the valve stem keys.
 - 10.1. Use grease to hold the valve stem keys in place while disconnecting the J 8062.
 - 10.2. Tap the end of the valve stem with a plastic-faced hammer to seat the valve stem keys.
 - 10.3. Inspect the valve stem keys to ensure that they are seated in the upper groove of the valve stem.

Oil Pump Disassemble

SIE-ID = 195049

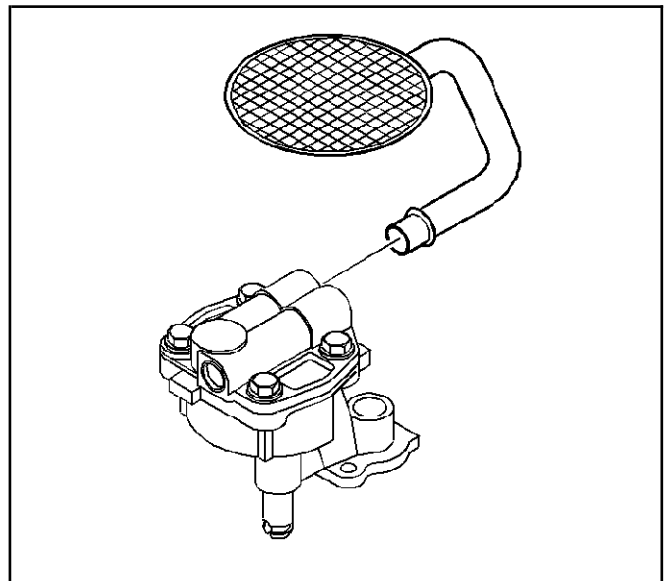
1. Remove the oil pump driveshaft and oil pump driveshaft retainer.



5274

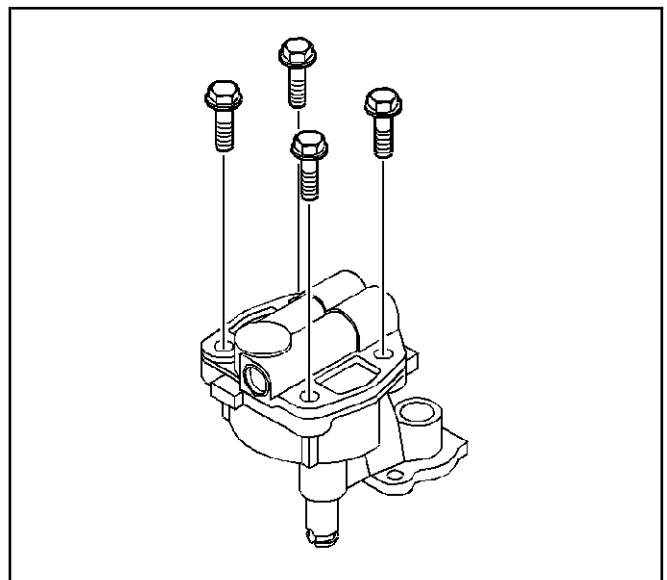
Important: Do not remove the oil pump screen from the pipe. The pipe and oil pump screen are serviced as a complete assembly.

2. Remove the oil pump screen, if necessary. The oil pump screen has a press fit into the oil pump cover.

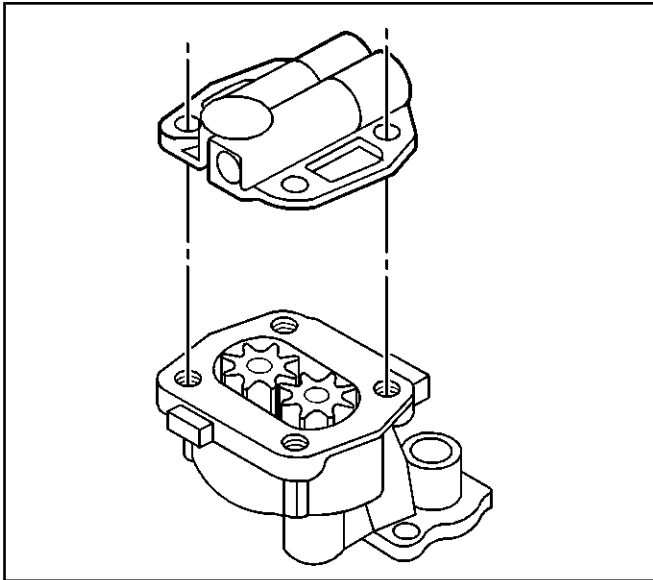


5275

3. Remove the oil pump cover bolts.

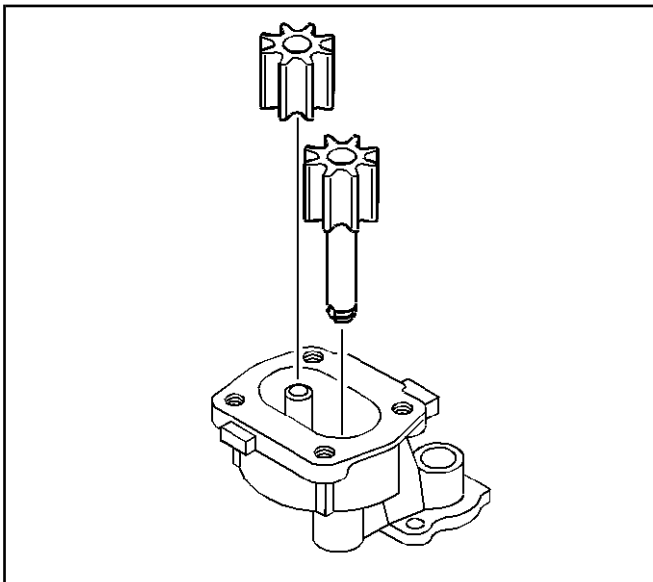


5276



5277

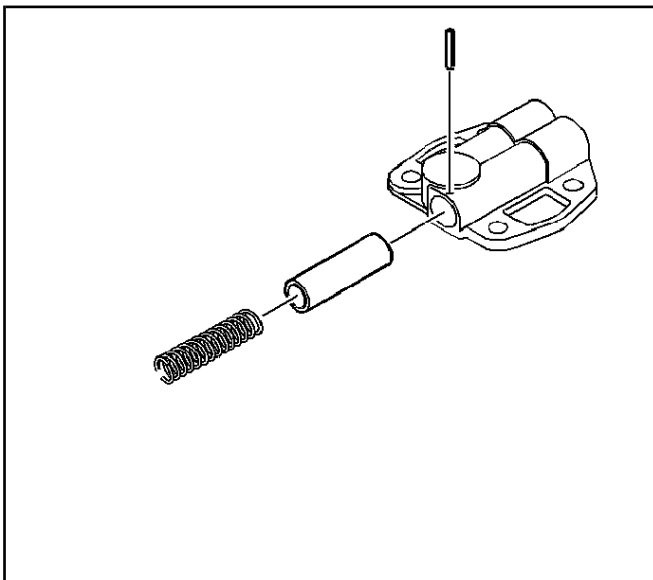
4. Remove the oil pump cover.



5278

5. Remove the oil pump drive gear and the oil pump driven gear.

6. Matchmark the gear teeth for assembly.



30401

Caution: Refer to Safety Glasses Caution in Cautions and Notices.

7. Remove the following items:

- 7.1. The oil pump pressure relief valve spring straight pin
- 7.2. The oil pump pressure relief spring
- 7.3. The oil pump pressure relief valve

Oil Pump Cleaning and Inspection

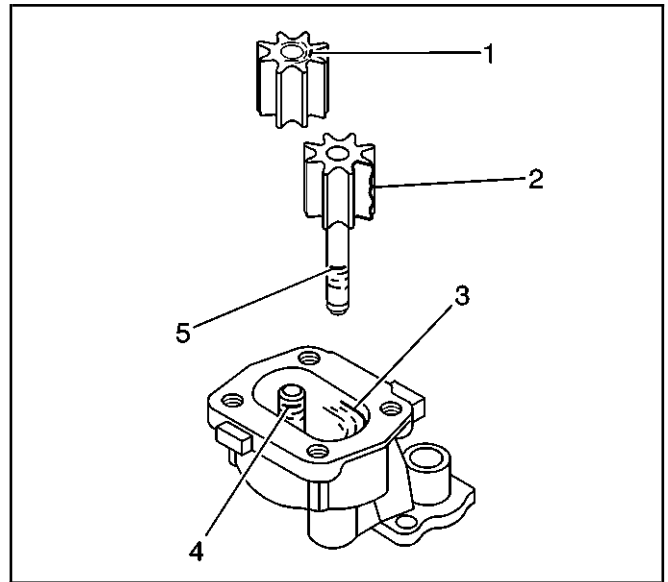
SIE-ID = 35473

Caution: Refer to Safety Glasses Caution in Cautions and Notices.

1. Clean the oil pump components in cleaning solvent.
2. Dry the components with compressed air.
3. Inspect the oil pump for the following conditions:
 - Scoring on the top of the gears (1)
 - Damaged gears (2) for the following:
 - Chipping
 - Galling
 - Wear
 - Scoring, damage or casting imperfections to the body (3)
 - Damaged or scored gear shaft (4)
 - Damaged or scored gear shaft (5)
 - Damaged bolt hole threads
 - Worn oil pump driveshaft bore
 - Damaged or sticking oil pump pressure relief valve

Minor imperfections may be removed with a fine oil stone.

 - Collapsed or broken oil pump pressure relief valve spring
4. If the oil pump is to be reused, install a NEW oil pump pressure relief valve spring.
5. During oil pump installation, install a NEW oil pump driveshaft retainer.



186750

Oil Pump Assemble

SIE-ID = 389671

Tools Required

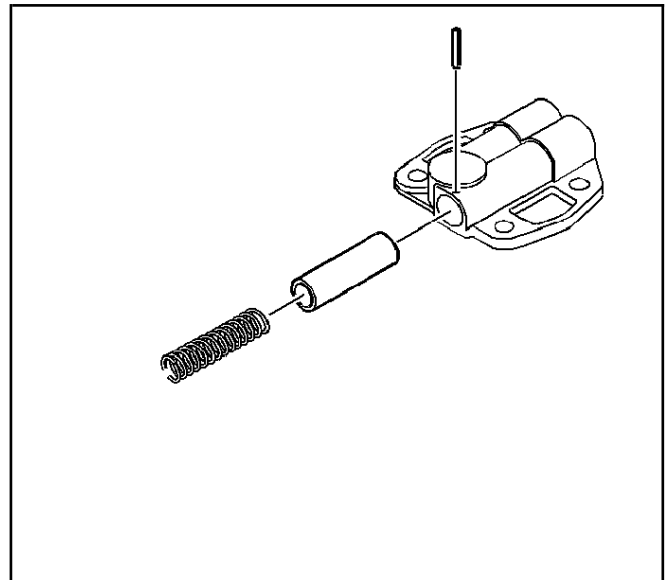
J 21882 Oil Suction Pipe Installer

1. Apply clean engine oil GM P/N United States 12345610, GM P/N Canada 993193, or equivalent, to the oil pump pressure relief valve, oil pump pressure relief valve spring, and oil pump body.

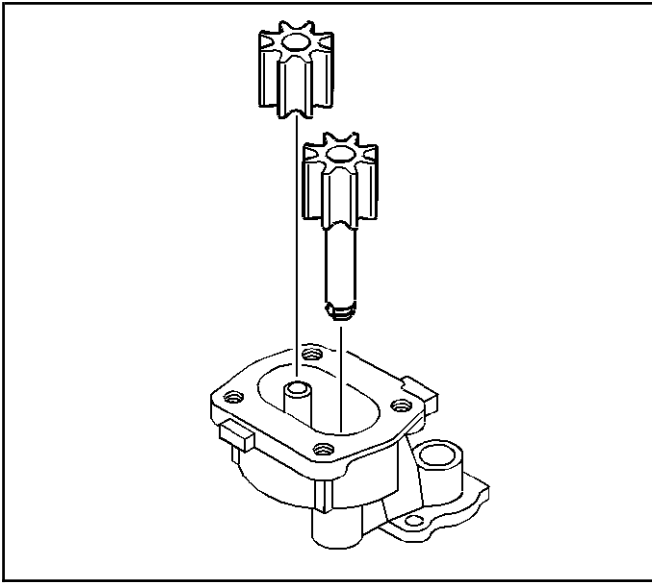
Caution: Refer to Safety Glasses Caution in Cautions and Notices.

Important: Replace the oil pump pressure relief valve spring when you reuse the oil pump.

2. Install the following items:
 - 2.1. The oil pump pressure relief valve
 - 2.2. The oil pump pressure relief valve spring
 - 2.3. The oil pump pressure relief valve spring straight pin

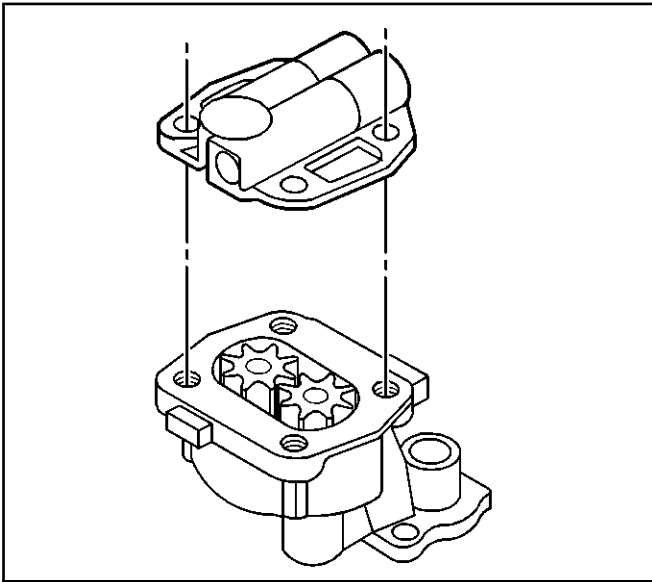


30401



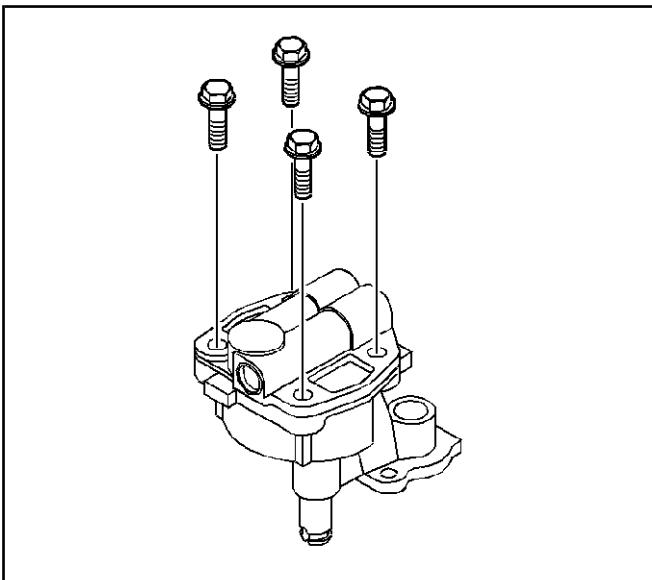
5278

3. Apply clean engine oil GM P/N United States 12345610, GM P/N Canada 993193, or equivalent, to the oil pump drive gear, the oil pump driven gear, and the oil pump body internal surfaces.
4. Install the oil pump drive gear and the oil pump driven gear into the oil pump body.
 - 4.1. Align the matchmarks on the oil pump drive and driven gears.
 - 4.2. Install the smooth side of the oil pump drive and driven gears toward the oil pump cover.



5277

5. Install the oil pump cover.



5276

Notice: Refer to *Fastener Notice* in Caution and Notices.

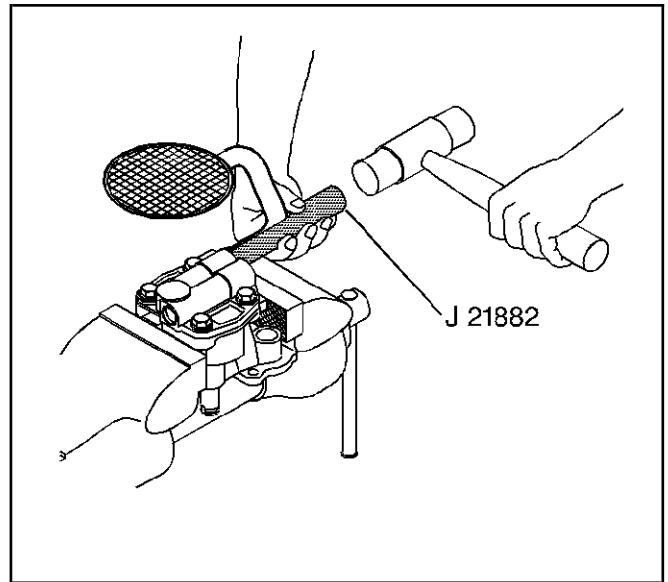
6. Install the oil pump cover bolts.

Tighten

Tighten the bolts to 12 N·m (106 lb in).

7. Inspect the oil pump for smoothness of operation by turning the oil pump driveshaft by hand.

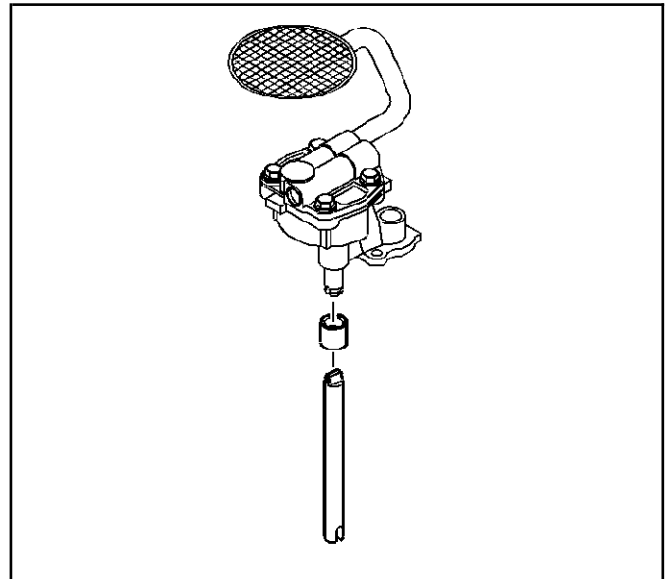
8. Install the oil pump screen.
 - 8.1. If removed, replace the oil pump screen. The oil pump screen must have a good press fit into the oil pump body.
 - 8.2. Mount the oil pump in a soft jawed vise.
 - 8.3. Apply sealant GM P/N United States 12346004, GM P/N Canada 10953480, or equivalent, to the end of the oil pump screen pipe.
 - 8.4. Use the *J 21882* and a soft-faced hammer in order to tap the oil pump screen into the pump body.
The oil pump screen must align parallel with the bottom of the oil pan when the oil pan is installed.



5280

Important: Install a NEW oil pump driveshaft retainer during assembly.

9. Install the oil pump driveshaft and the NEW oil pump driveshaft retainer.



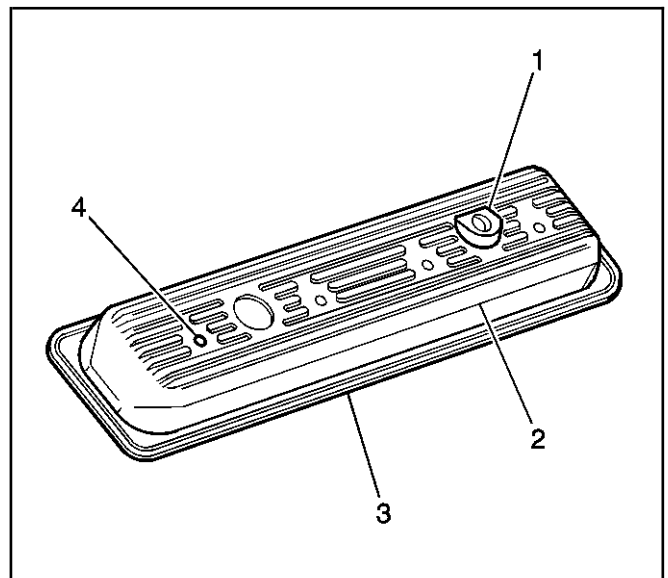
5274

Valve Rocker Arm Cover Cleaning and Inspection

SIE-ID = 195020

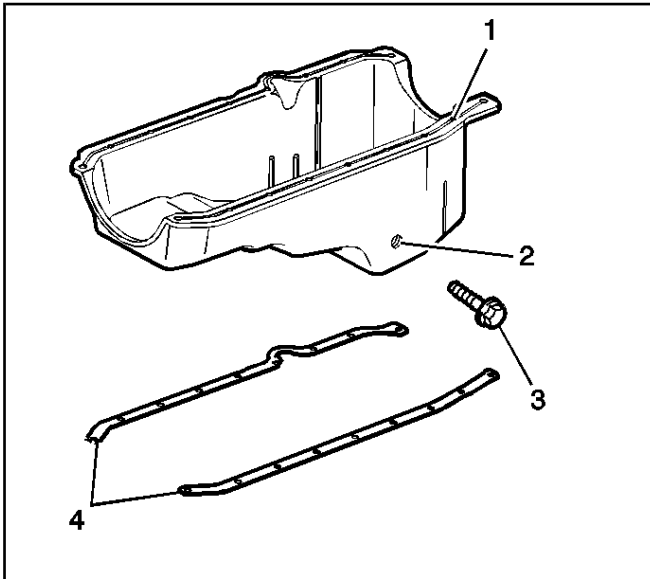
Caution: Refer to Safety Glasses Caution in Cautions and Notices.

1. Clean the valve rocker arm cover in cleaning solvent.
2. Dry the valve rocker arm cover with compressed air.
3. Inspect the valve rocker arm cover for the following:
 - Damage to the PCV valve grommet (1)
 - Dents or damage to the exterior of the valve rocker arm cover (2)
 - A dented or damaged cover may interfere with the valve rocker arms.
 - Gouges or damage to the sealing surface (3)



333657

- Damage to the bolt holes (4)
- Restrictions to the ventilation system passages



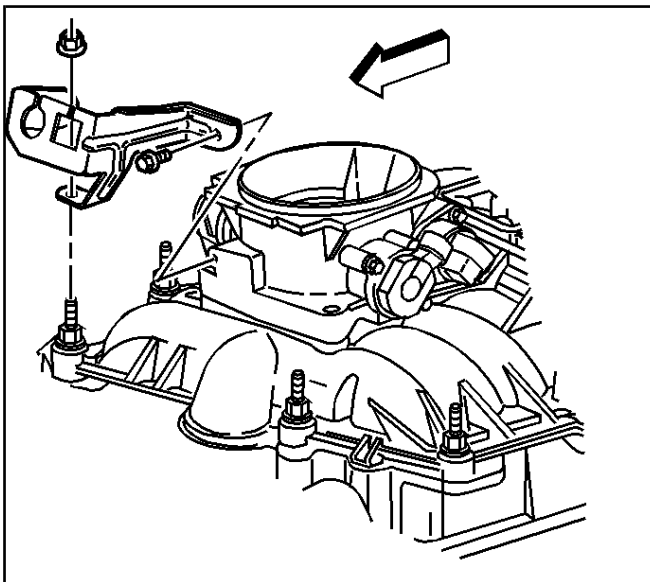
521835

Oil Pan Cleaning and Inspection

SIE-ID = 194998

Caution: Refer to Safety Glasses Caution in Cautions and Notices.

1. Clean the oil pan in cleaning solvent.
 2. Dry the oil pan with compressed air.
 3. Inspect the oil pan for the following:
 - Gouges or damage to the oil pan sealing surfaces (1)
 - The oil pan drain plug hole for damaged threads (2)
 - Damage to oil pan drain plug threads (3)
 - Damage to the oil pan reinforcements (4)
 - Damage to the oil pan baffle
 - Dents or damage to the exterior of the oil pan
- An oil pan that is dented may interfere with the position of the oil pump screen or not distribute oil properly in the oil pan sump area.



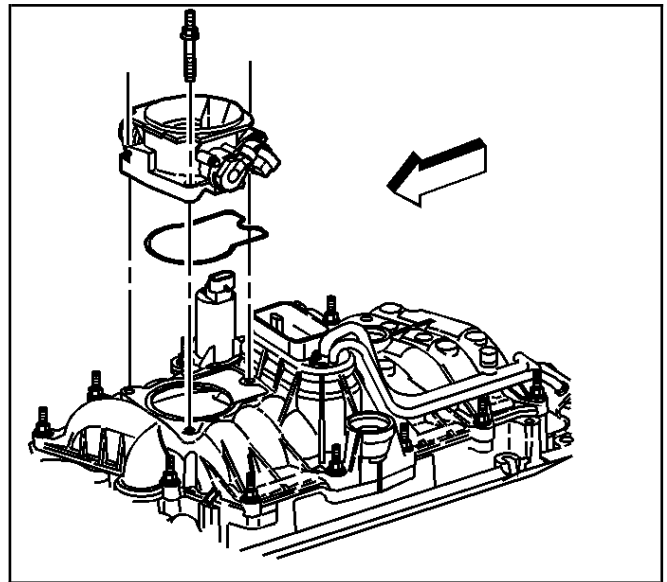
500661

Intake Manifold Disassemble

SIE-ID = 193478

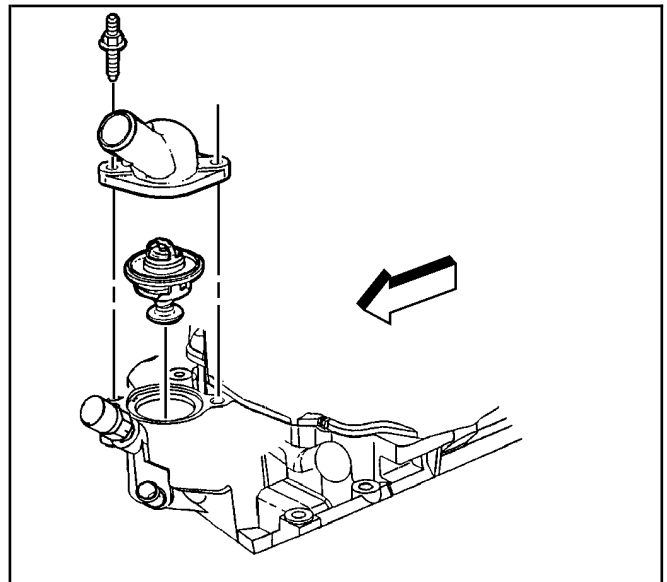
1. Remove the bolt, the nut, and the accelerator control cable bracket.

2. Remove the throttle body attaching studs.
3. Remove the throttle body.
4. Remove the throttle body to upper intake manifold gasket.
5. Discard the throttle body to upper intake manifold gasket.



500667

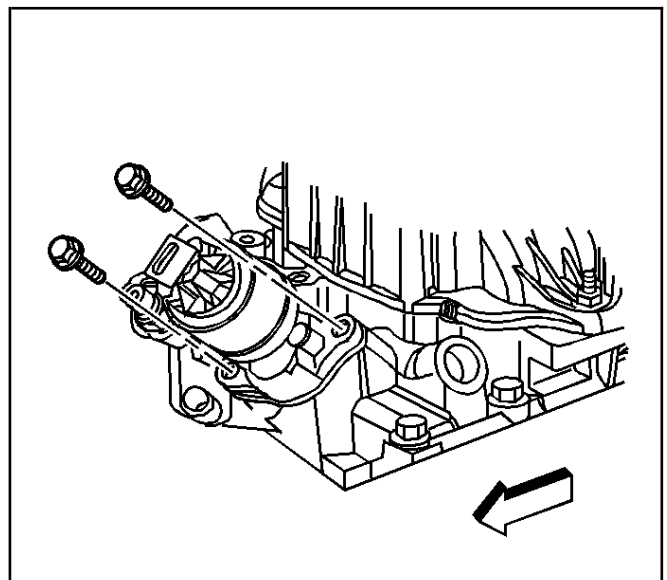
6. Remove the water outlet studs.
7. Remove the water outlet.
8. Remove the engine coolant thermostat.



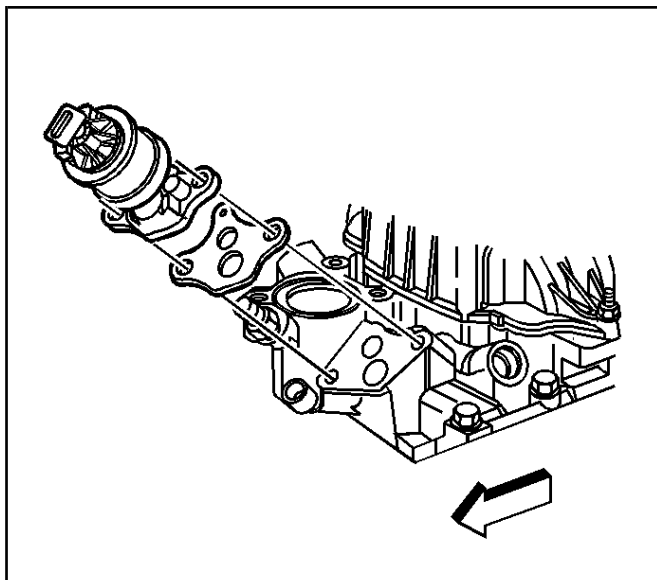
500671

Important: Note the position and direction of the exhaust gas recirculation (EGR) valve before removal. It is possible to improperly install the EGR valve 180 degrees from the original position.

9. Remove the exhaust gas recirculation (EGR) valve bolts.



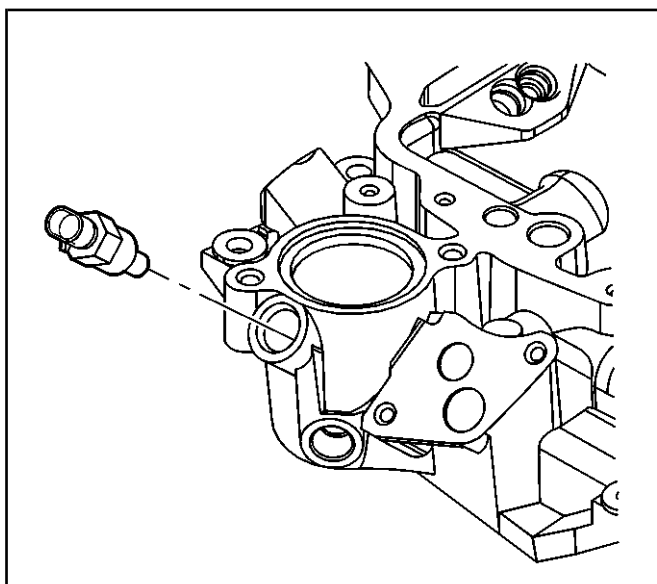
480563



480565

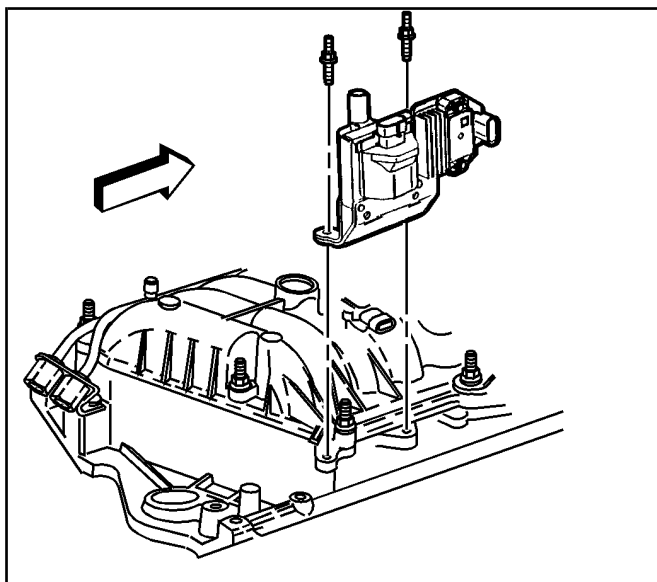
Notice: SIO-ID = 5005 The Linear EGR valve is an electrical component. DO NOT soak in any liquid cleaner or solvent because damage may result.

10. Remove the EGR valve and EGR valve gasket from the lower intake manifold.
11. Discard the EGR valve gasket.



10932

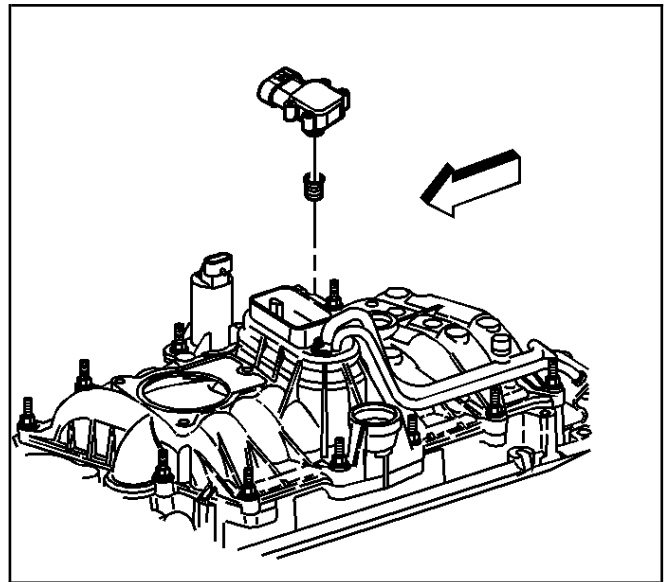
12. Remove the engine coolant temperature (ECT) sensor from the lower intake manifold.



500674

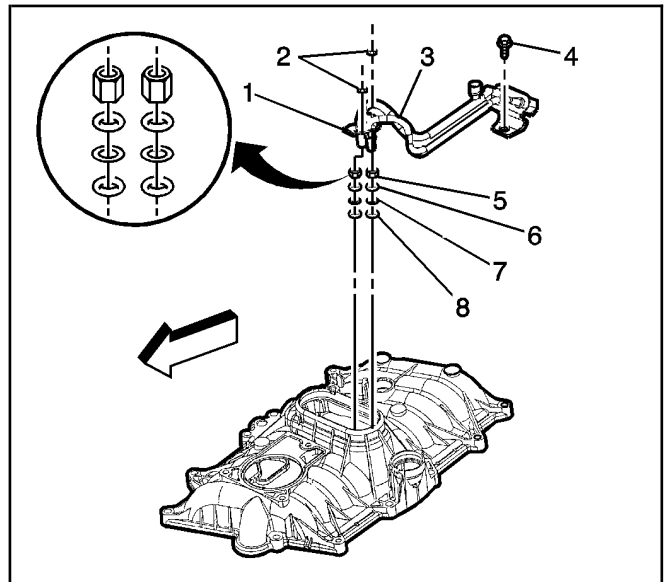
13. Remove the studs and the ignition coil.

14. Remove the manifold absolute pressure (MAP) sensor from the upper intake manifold.
15. Remove the MAP sensor seal from the MAP sensor.
16. Discard the MAP sensor seal.



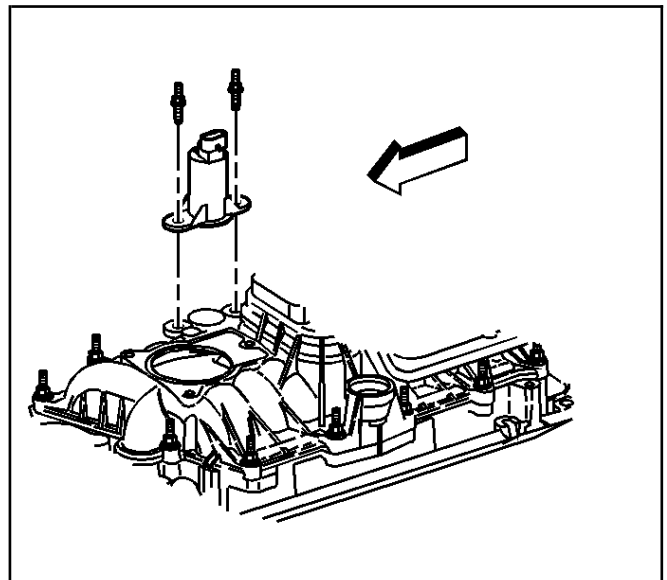
500677

17. Remove the fuel pipe bolt (4).
18. Remove the nuts (2) and the fuel pipe retainer (1).
19. Remove the fuel pipe (3).
20. Remove and discard the fuel seal retainers (5).
21. Remove and discard the fuel seals (6) (yellow O-rings).
22. Remove and discard the spacer rings (7) (flat washers).
23. Remove and discard the fuel seals (8) (black O-rings).

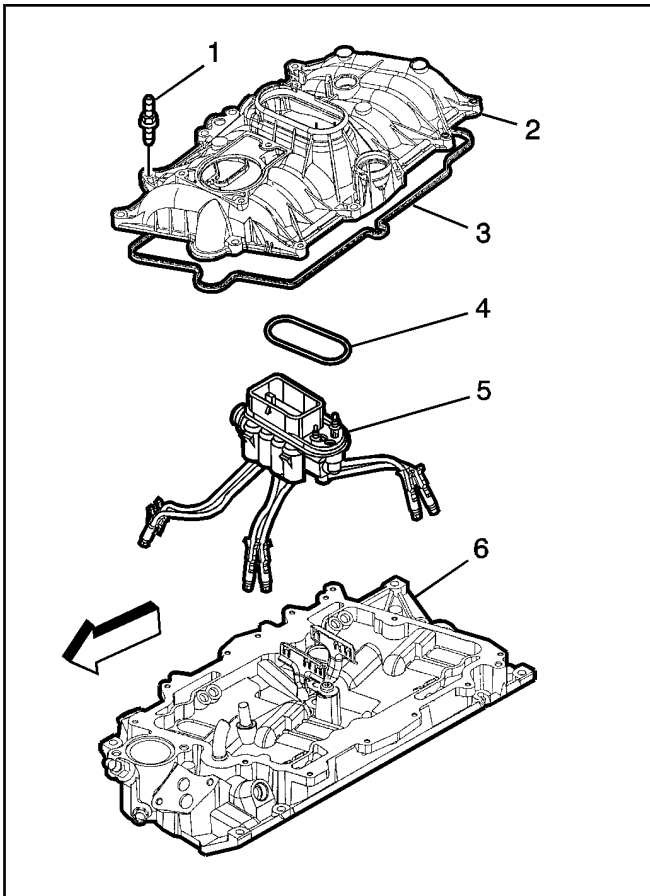


500679

24. Remove the studs and the evaporative emission (EVAP) canister purge solenoid valve.
25. Remove the nut and the engine wiring harness bracket.

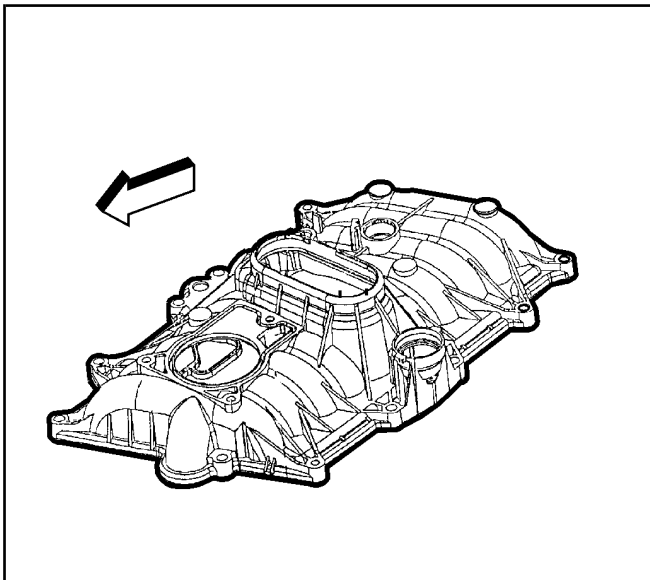


500680



500681

26. Remove the upper intake manifold studs (1).
27. Remove the upper intake manifold (2).
28. Remove the upper intake manifold to lower intake manifold gasket (3).
29. Discard the upper intake manifold to lower intake manifold gasket (3).
30. Remove the fuel meter body seal (4).
31. Discard the fuel meter body seal (4).
32. Remove the 8 poppet nozzles from the lower intake manifold bores.
33. Remove the fuel meter body (5) from the lower intake manifold (6).



500682

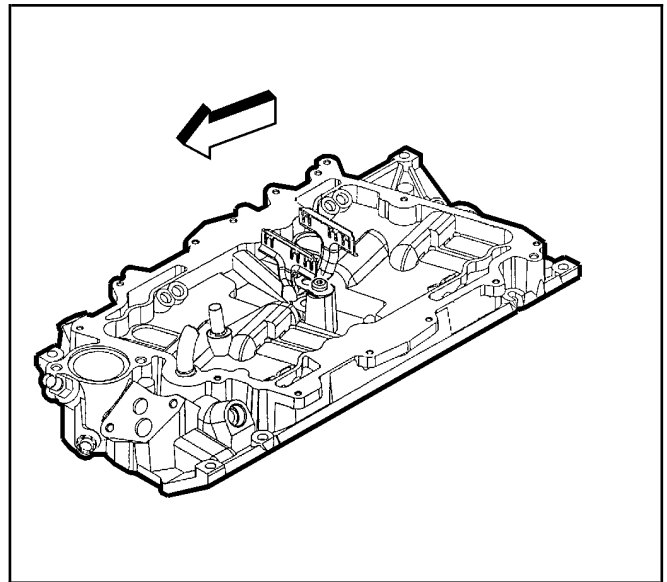
Intake Manifold Cleaning and Inspection

SIE-ID = 66845

Caution: Refer to Safety Glasses Caution in Cautions and Notices.

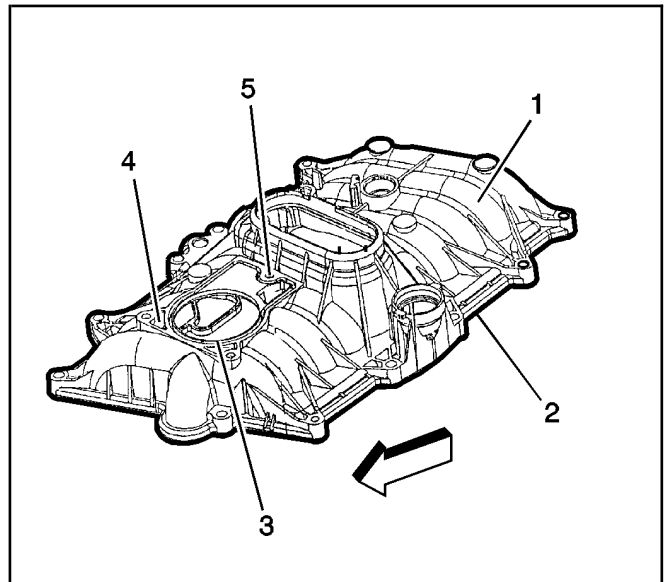
1. Clean the upper intake manifold in cleaning solvent.
2. Dry the upper intake manifold with compressed air.

3. Clean the lower intake manifold in cleaning solvent.
4. Dry the lower intake manifold with compressed air.



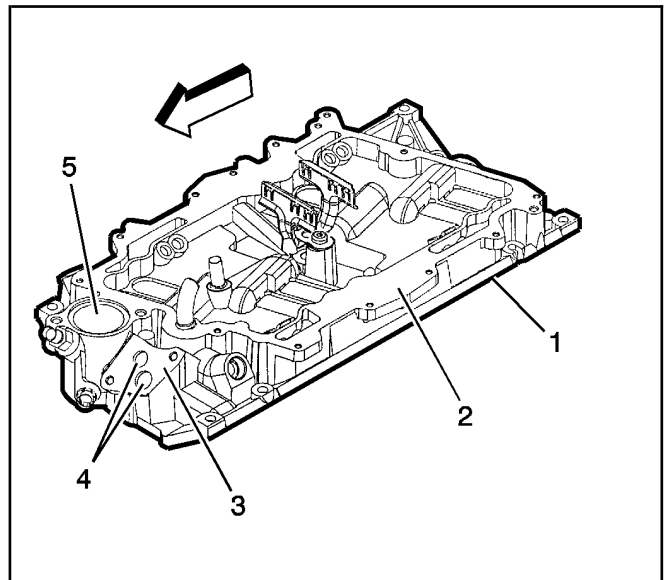
500684

5. Inspect the upper intake manifold for the following:
 - Cracks or other damage to the exterior (1)
 - Cracking or damage in the gasket grooves (2 and 3)
 - Damage to the throttle body mounting surface (4)
 - Loose or damaged bolt hole thread inserts (5)

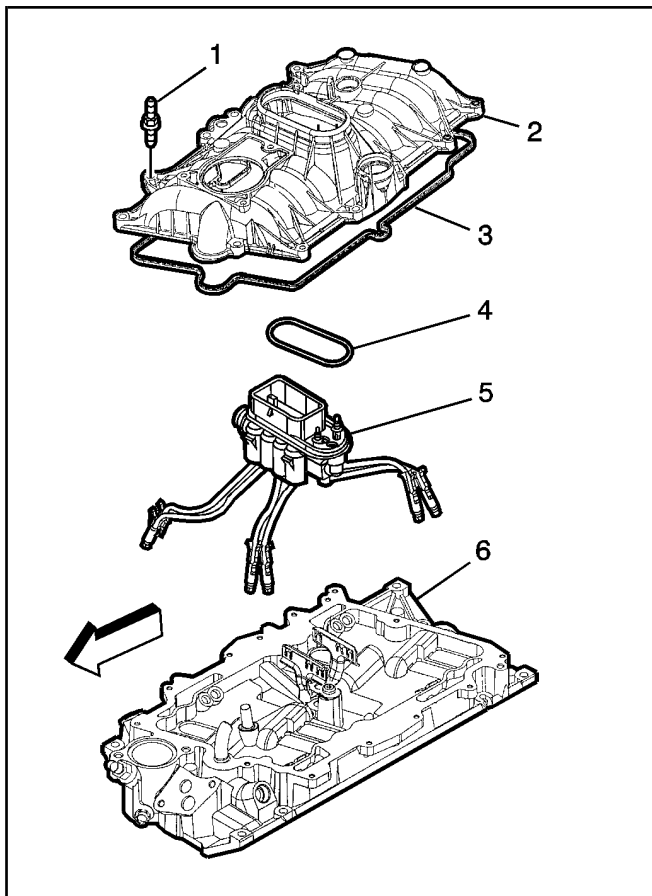


500685

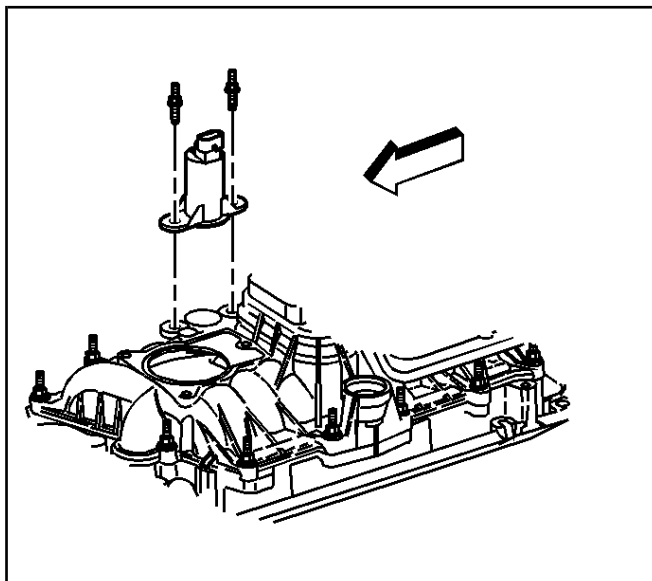
6. Inspect the lower intake manifold for the following:
 - Damage to the gasket sealing surfaces (1, 2 and 3)
 - Restricted exhaust gas recirculation (EGR) system passages (4)
 - Restricted cooling system passages (5)
 - Cracks or damage
 - Damage to the threaded bolt holes



500686



500681



500680

Intake Manifold Assemble

SIE-ID = 194513

1. Install the fuel meter body (5) into the lower intake manifold (6).
2. Install the 8 poppet nozzles into the lower intake manifold (6).
3. Inspect the poppet nozzles in order to ensure that the poppet nozzles are firmly seated and locked in the lower intake manifold bores.
4. Install the NEW fuel meter body seal (4) into the groove on the fuel meter body (5).
5. Install the NEW upper intake manifold to lower intake manifold gasket (3) into the groove of the upper intake manifold (2).
6. Install the upper intake manifold (2) onto the lower intake manifold (6).
7. If reusing the fasteners, apply threadlock GM P/N United States 12345382, GM P/N Canada 10953489, or equivalent, to the threads of the upper intake manifold attaching studs (1).

Notice: Refer to *Fastener Notice* in Cautions and Notices.

8. Install the upper intake manifold studs (1).

Tighten

- 8.1. Tighten the upper intake manifold studs on the first pass to 5 N·m (44 lb in).
- 8.2. Tighten the upper intake manifold studs on the second pass to 10 N·m (89 lb in).
9. If reusing the fasteners, apply threadlock GM P/N United States 12345382, GM P/N Canada 10953489, or equivalent, to the threads of the evaporative emission (EVAP) canister purge solenoid valve studs.
10. Install the EVAP canister purge solenoid valve and studs.

Tighten

Tighten the EVAP canister purge solenoid valve studs to 10 N·m (89 lb in).

11. Install the engine wiring harness bracket and nut.

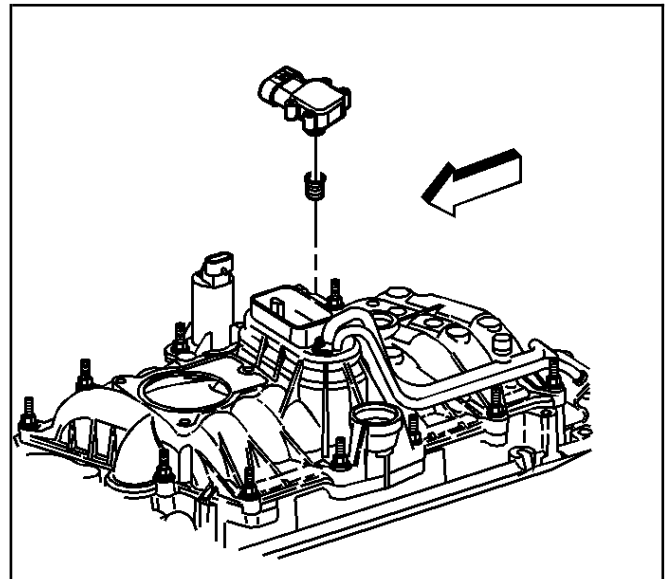
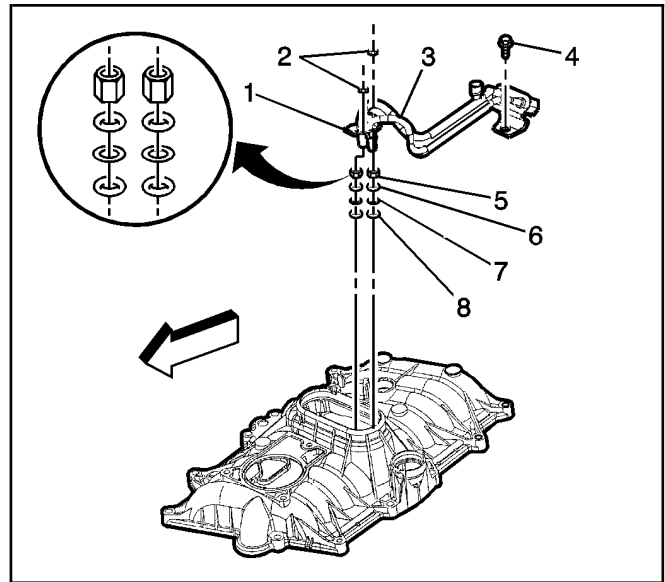
Tighten

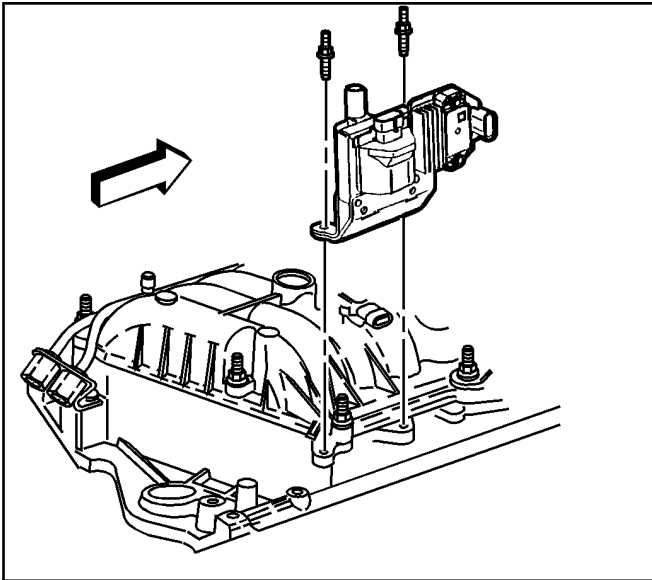
Tighten the engine wiring harness bracket nut to 12 N·m (106 lb in).

12. Install the NEW fuel seals (8), black O-rings, into the fuel meter body.
13. Install the NEW spacer rings (7), flat washers, into the fuel meter body.
14. Install the NEW fuel seals (6), yellow O-rings, into the fuel meter body.
15. Install the NEW fuel seal retainers (5) into the fuel meter body.
16. Install the fuel pipe (3) into the fuel meter body.
17. Install the fuel pipe retainer (1) and the nuts (2).
18. If reusing the fastener, apply threadlock GM P/N United States 12345382, GM P/N Canada 10953489, or equivalent, to the threads of the fuel pipe bolt (4).
19. Install the fuel pipe bolt (4).

Tighten

- 19.1. Tighten the fuel pipe retainer nuts (2) to 3 N·m (27 lb in).
 - 19.2. Tighten the fuel pipe bolt (4) to 6 N·m (53 lb in).
20. Install a NEW manifold absolute pressure (MAP) sensor seal onto the MAP sensor.
 21. Apply a small amount, approximately 1 drop, of clean engine oil to the MAP sensor seal.
 22. Install the MAP sensor into the upper intake manifold.



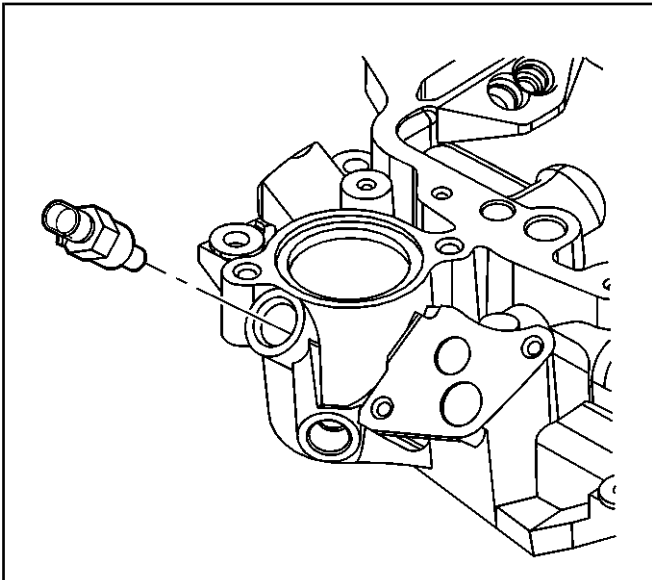


500674

23. Install the ignition coil and studs.

Tighten

Tighten the ignition coil studs to 12 N·m (106 lb in).



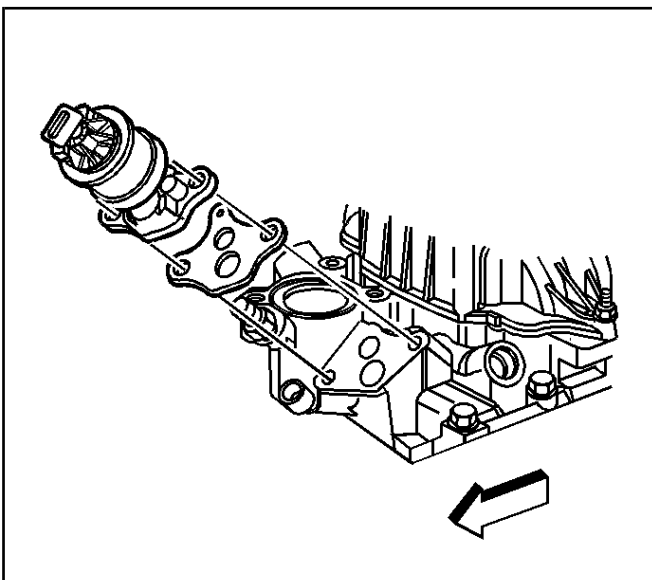
10932

24. If reusing the engine coolant temperature (ECT) sensor, apply sealant GM P/N United States 12346004, GM P/N Canada 10953480, or equivalent, to the threads of the ECT sensor.

25. Install the ECT sensor into the front of the lower intake manifold.

Tighten

Tighten the ECT sensor to 20 N·m (15 lb ft).



480565

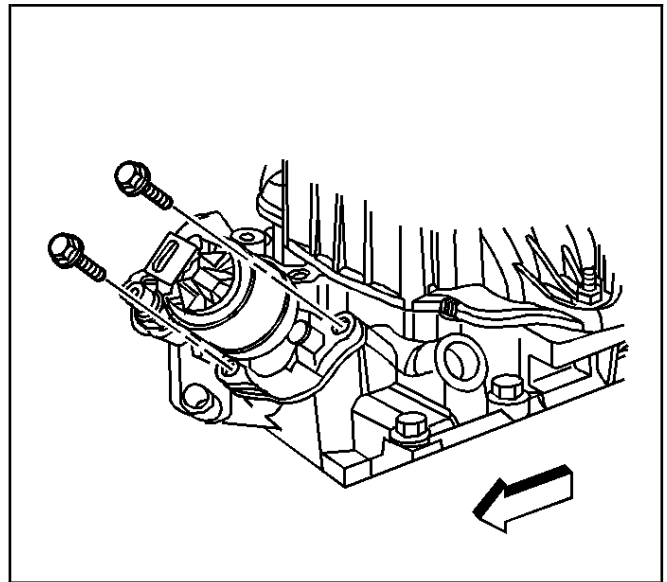
Important: The EGR valve must be installed in the original orientation.

26. Install a NEW exhaust gas recirculation (EGR) valve gasket and the EGR valve.

27. Install the EGR valve bolts.

Tighten

- 27.1. Tighten the EGR valve bolts on the first pass to 10 N·m (88 lb in).
- 27.2. Tighten the EGR valve bolts on the final pass to 30 N·m (22 lb ft).

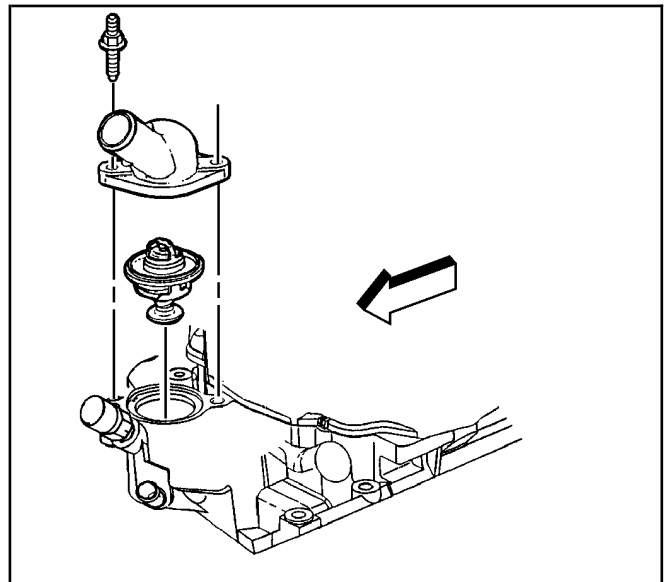


480563

28. Install the engine coolant thermostat.
29. Install the water outlet.
30. Install the water outlet studs.

Tighten

Tighten the water outlet studs to 25 N·m (18 lb ft).

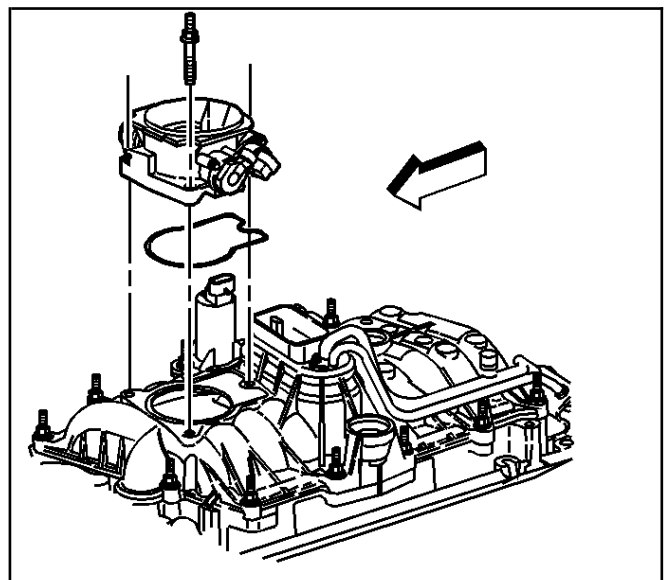


500671

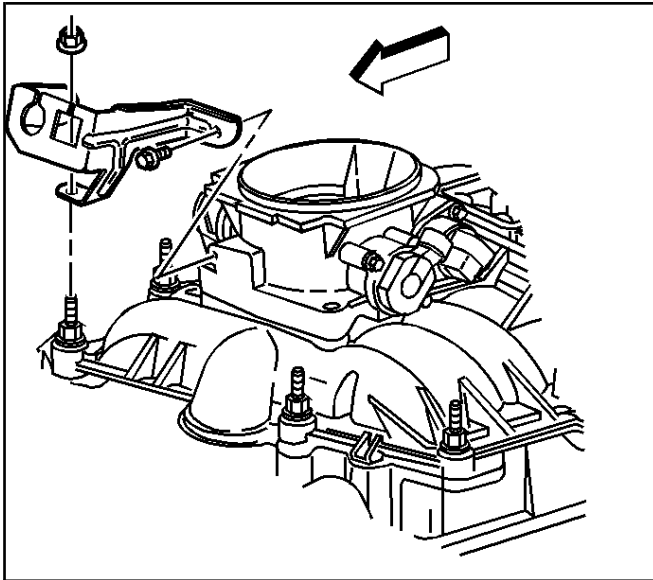
31. Install a NEW throttle body gasket into the groove in the upper intake manifold.
32. Install the throttle body onto the upper intake manifold.
33. If reusing the fasteners, apply threadlock GM P/N United States 12345382, GM P/N Canada 10953489, or equivalent, to the threads of the throttle body attaching studs.
34. Install the throttle body attaching studs.

Tighten

Tighten the throttle body attaching studs to 9 N·m (80 lb in).



500667

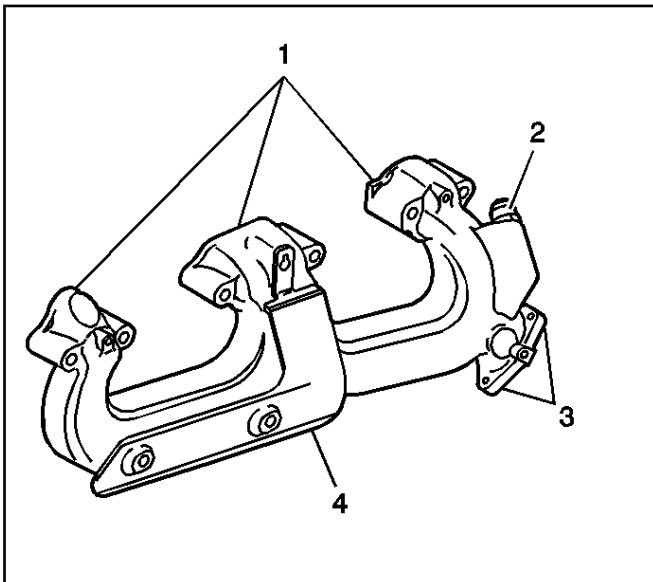


500661

35. Install the accelerator control bracket, the bolt, and the nut.

Tighten

Tighten the accelerator control bracket bolt and the nut to 12 N·m (106 lb in).



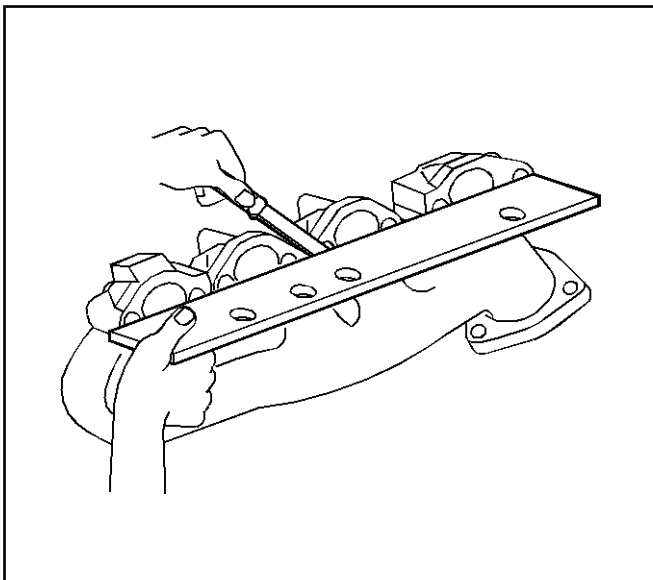
521830

Exhaust Manifold Cleaning and Inspection

SIE-ID = 784240

Caution: Refer to *Safety Glasses Caution in Cautions and Notices*.

1. Clean the exhaust manifolds in cleaning solvent.
2. Dry the components with compressed air.
3. Inspect the exhaust manifolds for the following:
 - Damage to the gasket sealing surfaces (1)
 - Damage to the exhaust gas recirculation (EGR) pipe fitting (2) (left manifold)
 - Damage to the take down bolt hole threads (3)
 - Broken or damaged exhaust manifold heat shields (4), if applicable
 - Restrictions within exhaust passages
 - Damaged or cracked exhaust manifold



66607

4. Measure the alignment or surface flatness of the exhaust manifold flanges, using a straight edge and a feeler gauge. Refer to *Engine Mechanical Specifications (5.0 L)* or *Engine Mechanical Specifications (5.7 L)*.

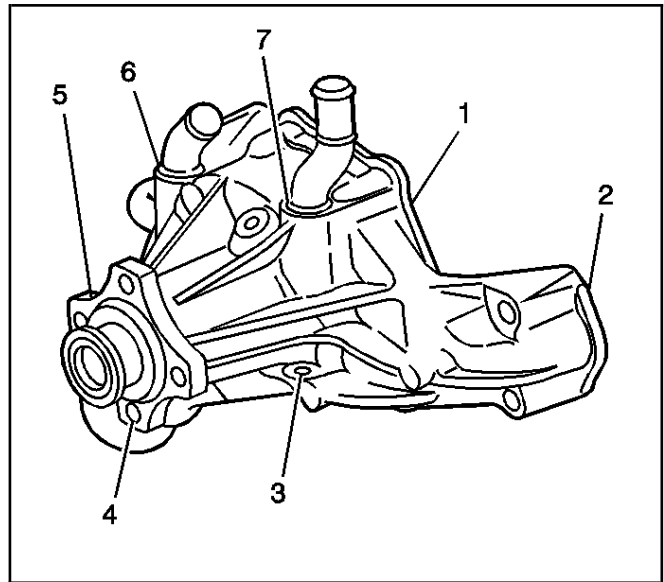
If the surface flatness is not within specifications, the exhaust manifold is warped and must be replaced.

Water Pump Cleaning and Inspection

SIE-ID = 194965

Caution: Refer to Safety Glasses Caution in Cautions and Notices.

1. Remove the old gasket material from the water pump sealing surfaces.
2. Clean all the dirt and any debris from the water pump.
3. Inspect the water pump for the following:
 - Leakage or damage to the housing cover or gasket (1)
 - Excessive scratches or gouging to the gasket sealing surfaces (2)
 - Leakage from the water pump vent hole (3)
A stain around the vent hole is acceptable. If leakage occurred (dripping) with the engine operating and the cooling system pressurized, then replace the water pump.
 - Damaged bolt hole threads (4)
 - Excessive side-to-side movement of the water pump shaft (5)
 - Leakage around the water inlet pipe (6)
 - Leakage around the heater hose pipe (7)
 - Restrictions within the internal coolant passages



480571

Thread Repair

SIE-ID = 43119

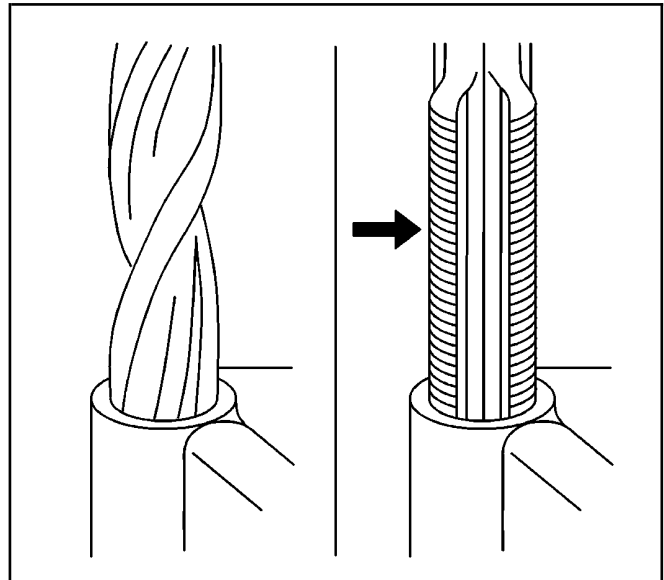
General purpose thread repair kits are available commercially.

Caution: Refer to Safety Glasses Caution in Cautions and Notices.

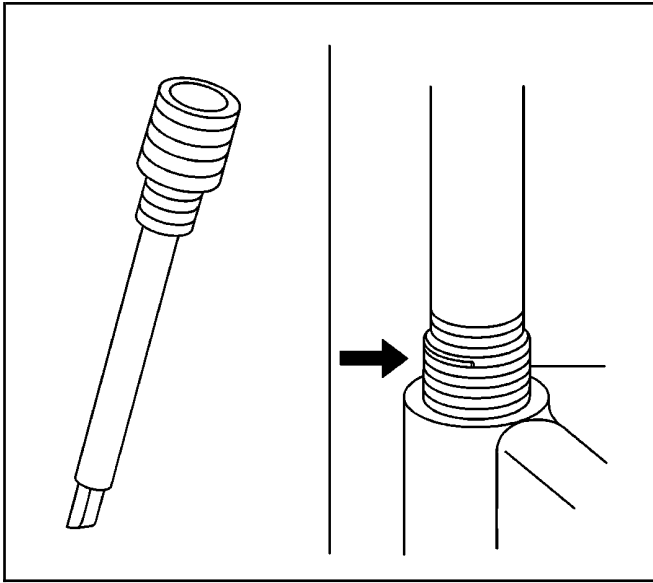
Important: Refer to the thread repair kit manufacturer's instructions regarding the size of the drill and which tap to use.

Always avoid any buildup of chips. Back out the tap every few turns and remove the chips.

1. Determine the size, the pitch, and the depth of the damaged thread.
2. Adjust the stop collars on the cutting tool as needed. Tap the stop collars to the required depth.
3. Drill out the damaged thread.
4. Remove the chips.
5. Apply clean engine oil to the top thread.
6. Use the tap in order to cut new thread.
7. Clean the thread.



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8. Screw the thread insert onto the mandrel of the thread insert installer. Engage the tang of the thread insert onto the end of the mandrel.

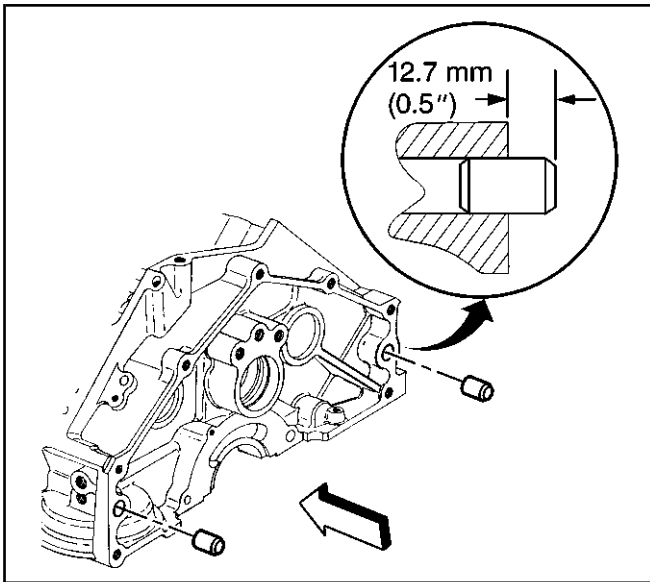
Important: The thread insert should be flush to 1 turn below the surface.

9. Lubricate the thread insert with clean engine oil (except when installing in aluminum) and install the thread insert.
10. If the tang of the thread insert does not break off when backing out the thread insert installer, break off the tang using a drift punch.

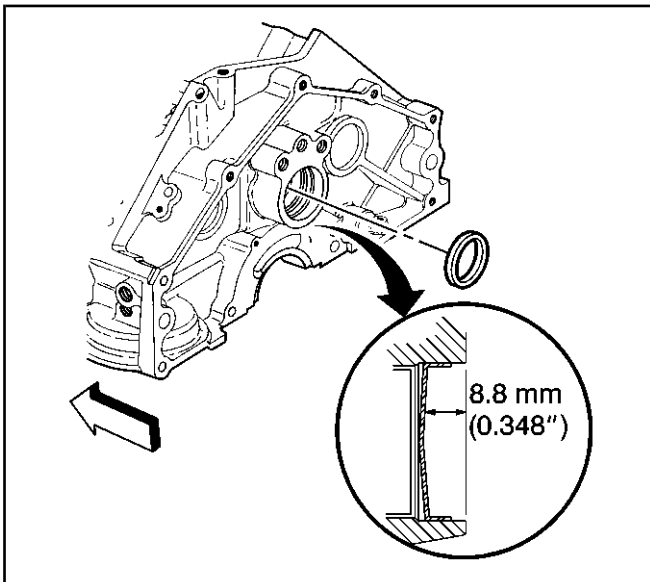
Service Prior to Assembly

SIE-ID = 43122

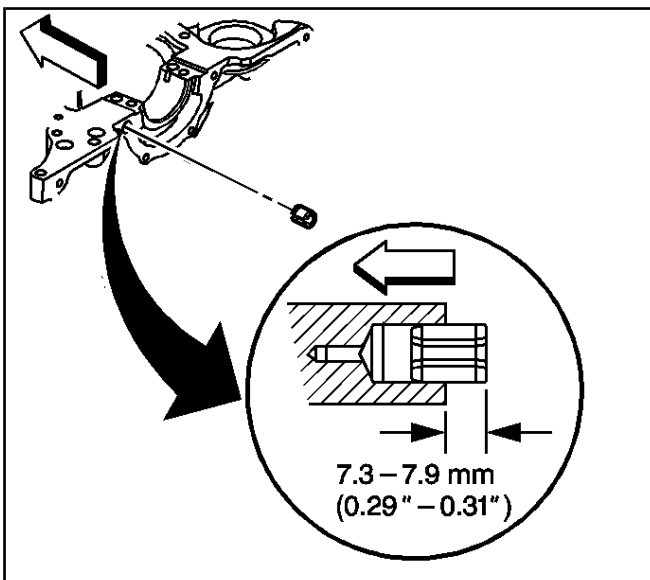
- Dirt will cause premature wear of the rebuilt engine. Clean all the components.
 - Use the proper tools to measure the components when checking for excessive wear. Components not within the manufacturer's specification must be repaired or replaced.
- When the components are re-installed into an engine, return the components to the original location, position, and direction.
 - During assembly, lubricate all the moving parts with clean engine oil (unless otherwise specified). The engine oil will provide the initial lubrication when the engine is first started.



182855



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521836

Engine Block Plug Installation

SIE-ID = 348917

Tools Required

J 41712 Oil Pressure Switch Socket

Caution: Refer to Safety Glasses Caution in Cautions and Notices.

1. Install the transmission locator pins, if required.
A properly installed transmission locator pin will protrude 12.7 mm (0.5 in) from the rear face of the engine block.

2. Apply sealant GM P/N United States 12346004, GM P/N Canada 10953480, or equivalent, to the outside diameter of the NEW camshaft rear bearing hole expansion cup plug.
3. Install the NEW camshaft rear bearing hole expansion cup plug.

4. Install the crankshaft rear oil seal housing locator S type pin.

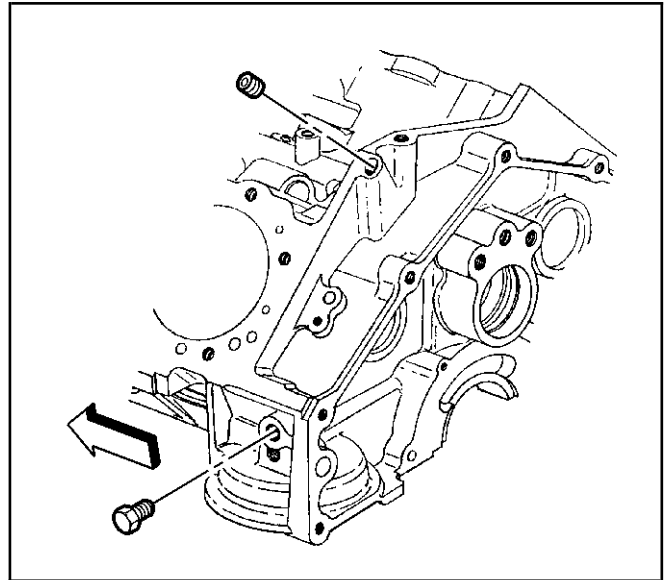
5. Apply sealant GM P/N United States 12346004, GM P/N Canada 10953480, or equivalent, to the threads of the left side rear and left rear top engine oil gallery plugs.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

6. Install the left side rear and left rear top oil engine gallery plugs.

Tighten

Tighten the left side rear and left rear top engine oil gallery plugs to 20 N·m (15 lb ft).



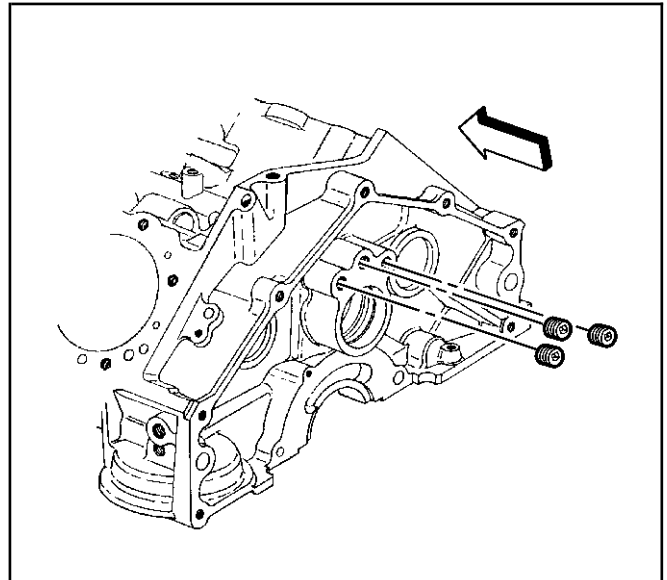
182841

7. Apply sealant GM P/N United States 12346004, GM P/N Canada 10953480, or equivalent, to the threads of the square socket engine block oil gallery plugs.

8. Install the square socket plugs.

Tighten

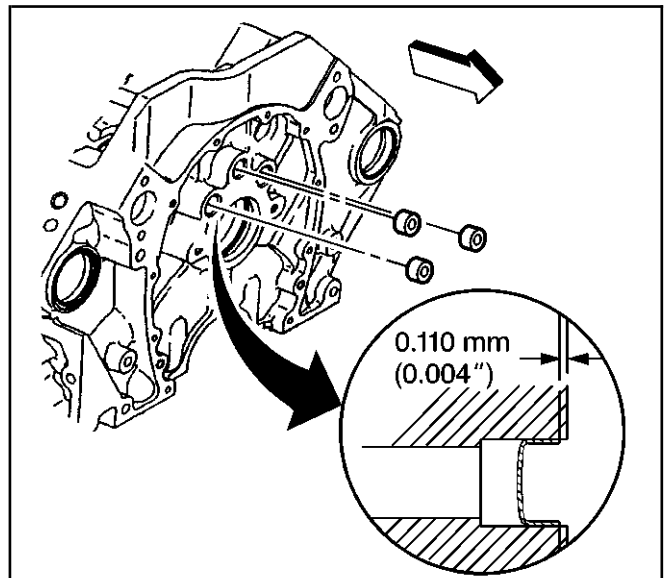
Tighten the square socket plugs to 20 N·m (15 lb ft).



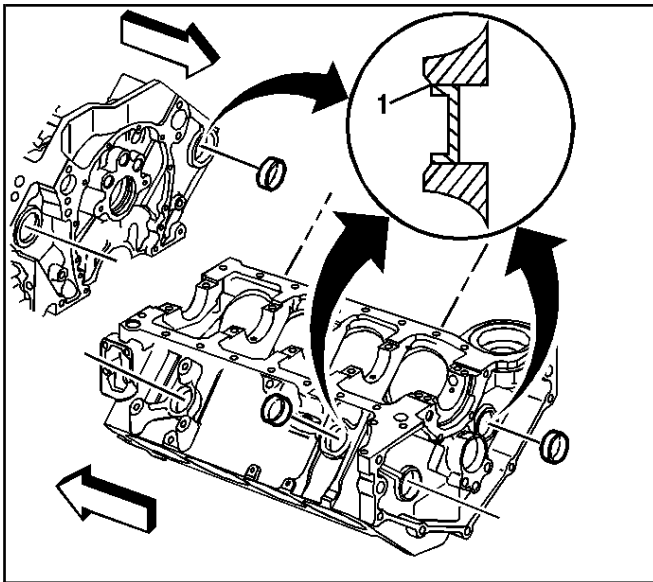
69847

9. Apply sealant GM P/N United States 12346004, GM P/N Canada 10953480, or equivalent to the outside diameter of the NEW engine oil gallery plugs.

10. Install the NEW engine block oil gallery plugs.
A properly installed engine oil gallery plug must be installed below flush with the front face of the engine block.

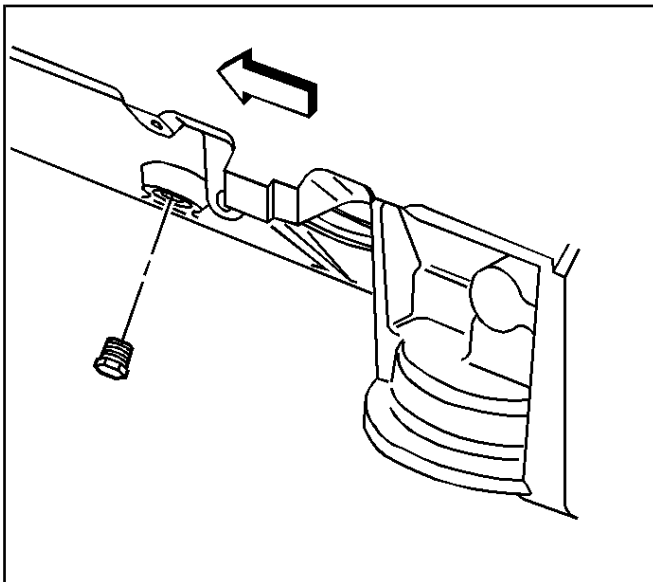


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11. Apply threadlock GM P/N United States 12345382, GM P/N Canada 10953489, or equivalent, to the outside diameter of the NEW engine block core hole plugs.
12. Install the NEW engine block core hole plugs.
A properly installed engine block core hole plug must be installed flush or below the bottom of the chamfer (1) of the engine block core hole.

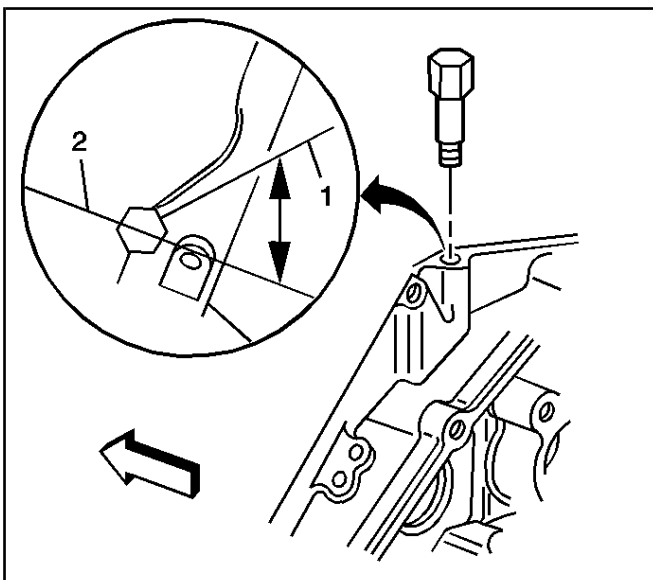


316798

13. Apply sealant GM P/N United States 12346004, GM P/N Canada 10953480, or equivalent, to the threads of the engine block coolant drain hole plug.
14. Install the engine block coolant drain hole plug.

Tighten

Tighten the engine block coolant drain hole plug to 20 N·m (15 lb ft).



333659

15. Apply sealant GM P/N United States 12346004, GM P/N Canada 10953480, or equivalent, to the threads of the engine oil pressure sensor fitting.

Important: Do not loosen the oil pressure sensor fitting after the initial torque has been obtained.

16. Install the engine oil pressure sensor fitting.

Tighten

Tighten the engine oil pressure sensor fitting to 15 N·m (11 lb ft).

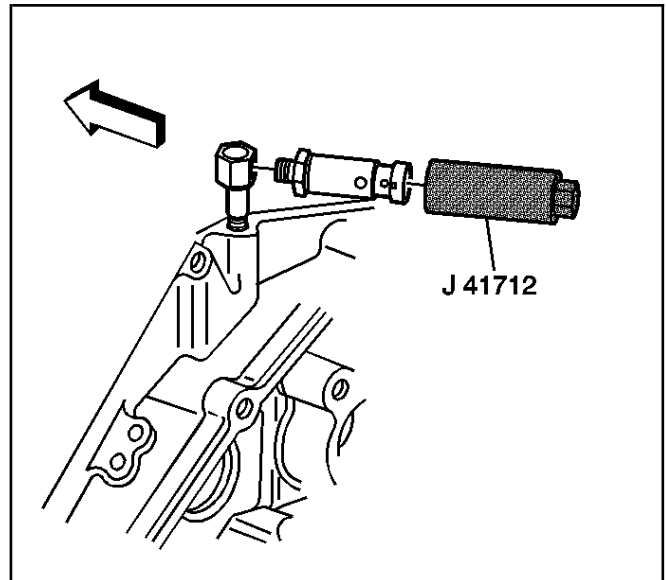
Important: Do not rotate the engine oil pressure sensor fitting more than 359 degrees after the initial torque has been obtained.

17. Rotate the engine oil pressure sensor fitting clockwise to the proper position (1), 50 degrees from the centerline (2).

18. Apply sealant GM P/N United States 12346004, GM P/N Canada 10953480, or equivalent, to the threads of the engine oil pressure gage sensor.
19. Install the engine oil pressure gage sensor using the *J 41712*.

Tighten

Tighten the engine oil pressure gage sensor to 30 N·m (22 lb ft).

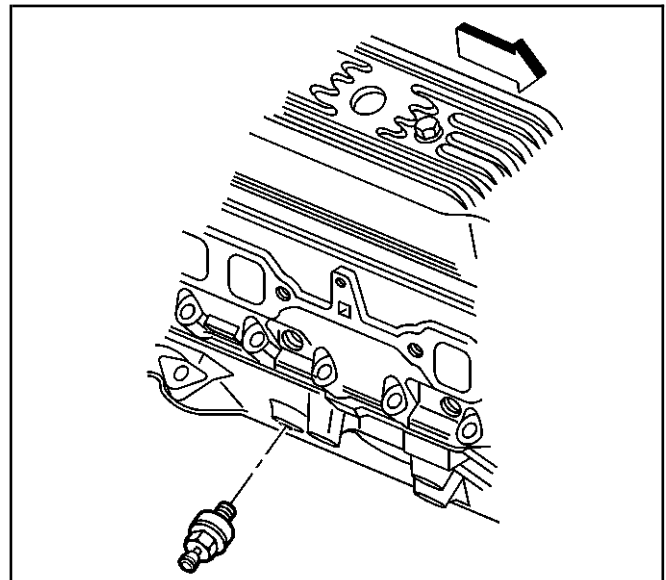


333649

20. Apply sealant GM P/N United States 12346004, GM P/N Canada 10953480, or equivalent, to the threads of the knock sensor.
21. Install the knock sensor.

Tighten

Tighten the knock sensor to 19 N·m (14 lb ft).



182837

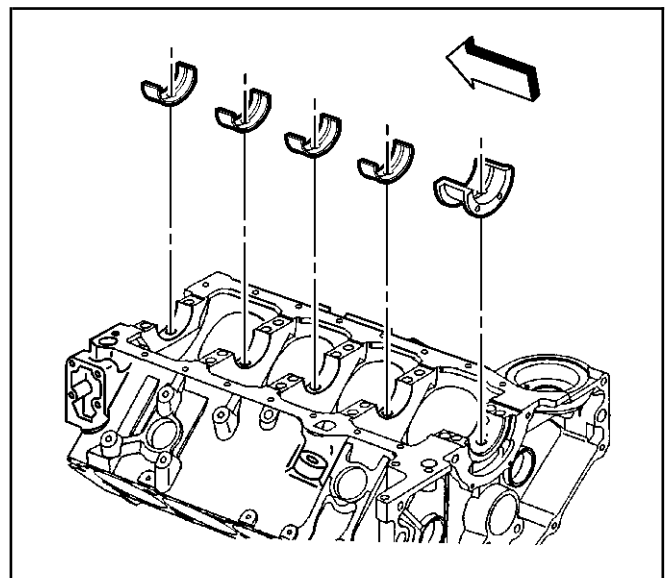
Crankshaft and Bearings Installation

SIE-ID = 66853

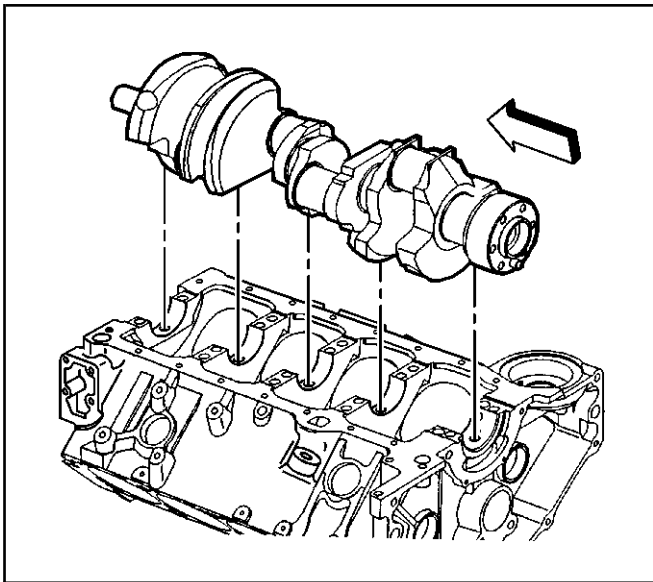
Tools Required

J 36660-A Electronic Torque Angle Meter

1. Install the crankshaft bearings into the engine block.
2. Apply clean engine oil to the crankshaft bearings.

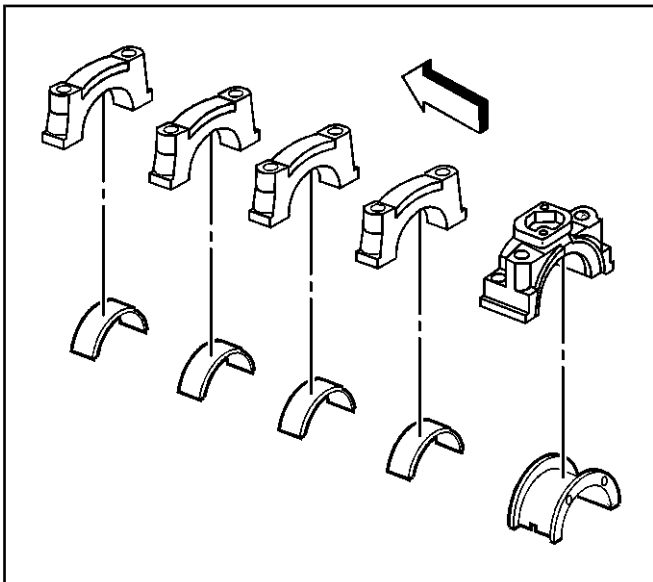


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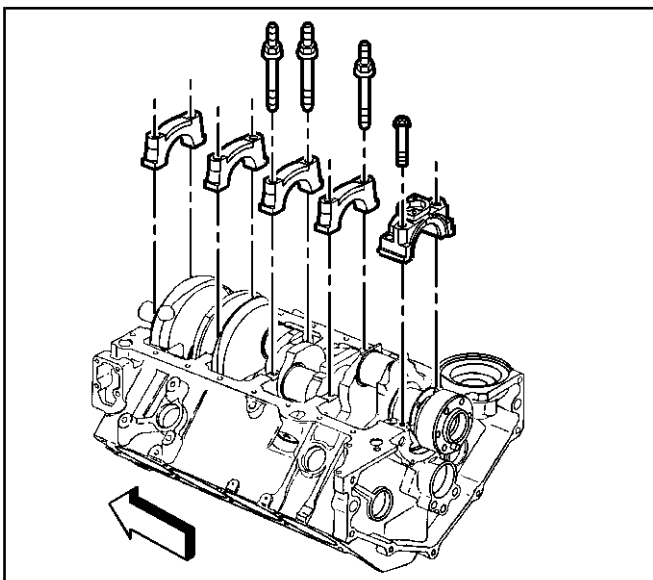
317351

3. Apply clean engine oil to the crankshaft bearing journals.
4. Install the crankshaft.



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5. Install the crankshaft bearings into the crankshaft bearing caps.
6. Apply clean engine oil to the crankshaft bearings.



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Important: Ensure that the crankshaft bearing cap directional arrow points toward the front of the engine block, and the crankshaft bearing cap is in the original location and position.

7. Install the crankshaft bearing caps in the original positions and with the arrow on the crankshaft bearing caps in the direction of the front of the engine block.
8. Install the crankshaft bearing cap bolts and the crankshaft bearing cap studs.
9. Thrust the crankshaft rearward in order to set and align the crankshaft thrust bearings and the crankshaft bearing caps.
10. Thrust the crankshaft forward in order to align the rear faces of the crankshaft thrust bearings.

11. Ensure that the crankshaft bearing caps are fully seated in the engine block crankshaft bearing cap channel, and that the crankshaft bearing caps are centered on the engine block bulkheads.
12. Measure the crankshaft end play.
 - 12.1. Tighten the crankshaft bearing cap bolts and the crankshaft bearing cap studs finger tight.
 - 12.2. Firmly thrust the crankshaft rearward, and then forward.

This will align the crankshaft rear bearing thrust surfaces.
 - 12.3. With the crankshaft pushed forward, insert a feeler gauge between the crankshaft and the crankshaft rear bearing thrust surface to measure the clearance.

Specification

Crankshaft end play 0.05–0.20 mm (0.002–0.008 in)

Notice: Refer to *Fastener Notice* in Cautions and Notices.

13. Tighten the crankshaft bearing cap bolts and the crankshaft bearing cap studs.

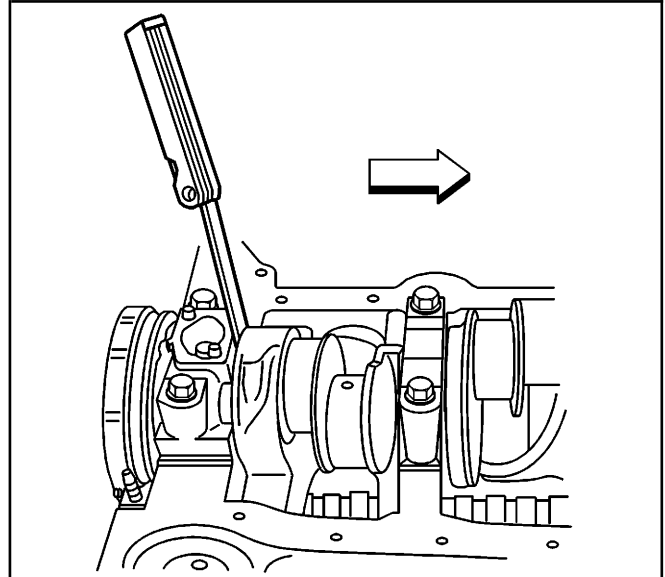
Tighten

- 13.1. Tighten the crankshaft bearing cap bolts and the crankshaft bearing cap studs on the first pass to 20 N·m (15 lb ft).
 - 13.2. Tighten the crankshaft bearing cap bolts and the crankshaft bearing cap studs (2 bolt caps) on the final pass to 73 degrees using the *J 36660-A*.
 - 13.3. Tighten the bearing cap outboard bolts (4 bolt caps) on the final pass to 43 degrees using the *J 36660-A*.
 - 13.4. Tighten the bearing cap inboard bolts and the bearing cap inboard studs (4 bolt caps) on the final pass to 73 degrees using the *J 36660-A*.
14. Rotate the crankshaft in order to check for binding.

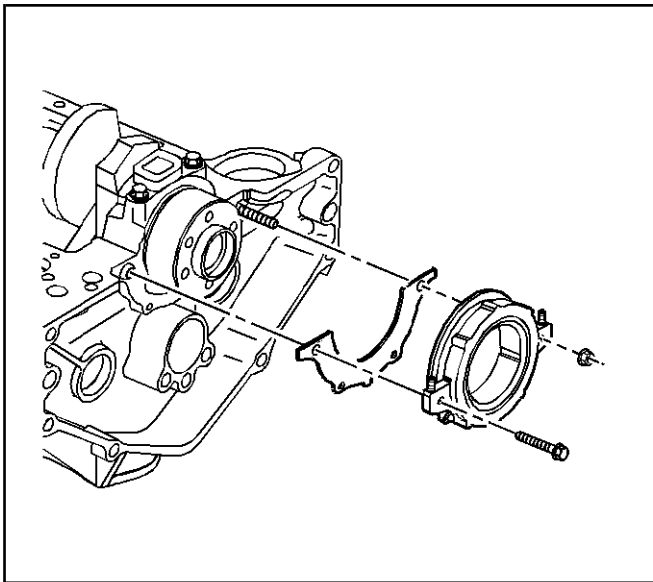
A bent crankshaft, or lack of proper crankshaft bearing clearance, may cause binding.
 15. If the crankshaft does not turn freely, loosen the crankshaft bearing cap bolts on 1 crankshaft bearing cap at a time in order to determine the location of the binding.

A lack of proper crankshaft bearing clearance may be caused by the following:

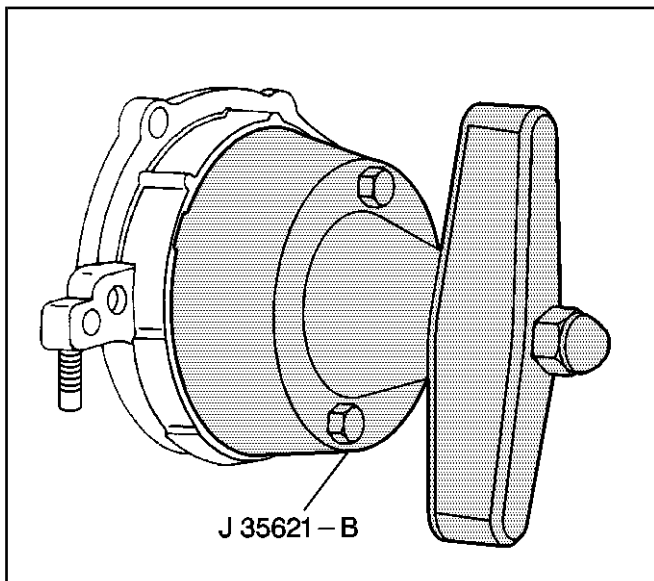
 - Burrs on the crankshaft bearing cap
 - Foreign material between the crankshaft bearing and the engine block
 - Foreign material between the crankshaft bearing and the crankshaft bearing cap
 - Damaged crankshaft bearing
 - Improper size crankshaft bearing



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Crankshaft Rear Oil Seal and Housing Installation

SIE-ID = 348923

Tools Required

J 35621-B Rear Main Seal Installer

Notice: Refer to *Fastener Notice* in Cautions and Notices.

1. Install the crankshaft rear oil seal housing retainer stud.

Tighten

Tighten the crankshaft rear oil seal housing retainer stud to 6 N·m (53 lb in).

Important: Always use a NEW crankshaft rear oil seal housing gasket when installing the crankshaft rear oil seal housing.

2. Install the NEW crankshaft rear oil seal housing gasket and the crankshaft rear oil housing onto the crankshaft rear oil seal housing retainer stud.
3. Install the crankshaft rear oil seal housing nut and bolts.

Tighten

Tighten the crankshaft rear oil seal housing nut and bolts to 12 N·m (106 lb in).

4. Apply a small amount, approximately 2–3 drops, of clean engine GM P/N United States 12345610, GM P/N Canada 993193, or equivalent, oil to the bore of the crankshaft rear oil seal housing.
5. Inspect the outside diameter of the engine flywheel pilot flange for imperfections or rust.
Minor imperfections and/or rust may be removed with a fine grade emery cloth.
6. Apply a small amount, approximately 2–3 drops, of clean engine GM P/N United States 12345610, GM P/N Canada 993193, or equivalent, oil to the outside diameter of the engine flywheel pilot flange.
7. Apply a small amount, approximately 1 drop, of clean engine oil GM P/N United States 12345610, GM P/N Canada 993193, or equivalent, to the outside diameter of the flywheel locator pin.
8. Apply a small amount of clean engine GM P/N United States 12345610, GM P/N Canada 993193, or equivalent, oil to the crankshaft seal surface.
9. Inspect the J 35621-B flange for imperfections that may damage the crankshaft rear oil seal.
Minor imperfections may be removed with a fine grade emery cloth.

Important: DO NOT allow oil or any other lubricants to contact the seal lip surface of the crankshaft rear oil seal.

10. Remove the installation guide from the NEW crankshaft rear oil seal.

11. Apply a small amount, approximately 2–3 drops, of clean engine oil GM P/N United States 12345610, GM P/N Canada 993193, or equivalent, to the outside diameter of the NEW crankshaft rear oil seal.
12. Install the NEW crankshaft rear oil seal onto the *J 35621-B*.
13. Install the *J 35621-B* onto the rear of the crankshaft and hand tighten the tool bolts until snug.

Notice: SIO-ID = 348112 Proper alignment of the crankshaft rear oil seal is critical. Install the crankshaft rear oil seal near to flush and square to the crankshaft rear oil seal housing. Failing to do so may cause the crankshaft rear oil seal or the crankshaft rear oil seal installation tool to fail.

Important: A properly installed crankshaft rear oil seal will be near to flush and square to the crankshaft rear oil seal housing.

14. Install the crankshaft rear oil seal onto the crankshaft and into the crankshaft rear oil seal housing.
 - 14.1. Turn the *J 35621-B* wing nut clockwise until the crankshaft rear oil seal is installed near to flush and square to the crankshaft rear oil seal housing.

Increased resistance will be felt when the crankshaft rear oil seal has reached the bottom of the crankshaft rear oil seal housing bore.
 - 14.2. Turn the *J 35621-B* wing nut counter clockwise to release the *J 35621-B* from the crankshaft rear oil seal.
15. Remove the *J 35621-B* from the crankshaft.
16. Wipe off any excess engine oil with a clean rag.

Piston, Connecting Rod, and Bearing Installation

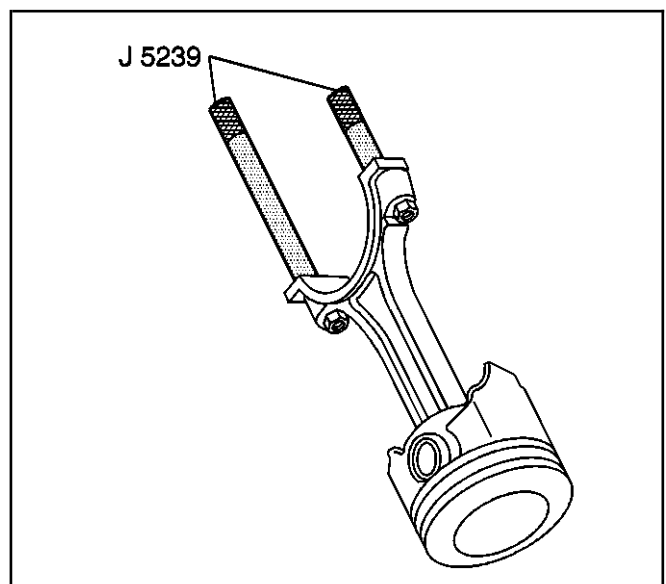
SIE-ID = 650066

Tools Required

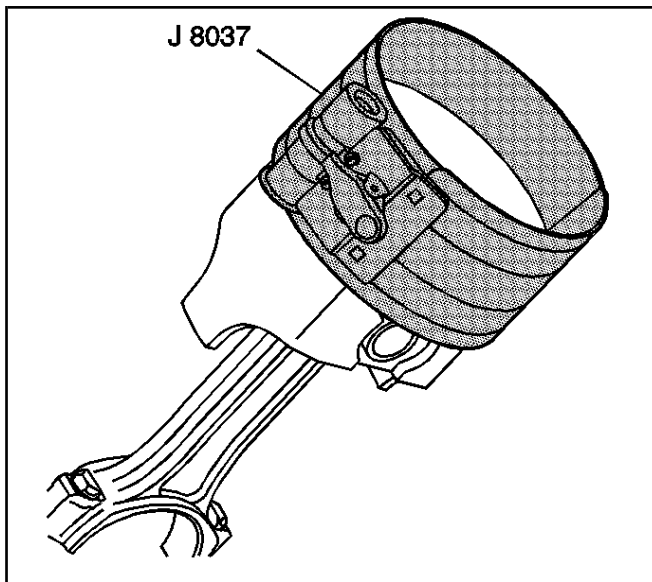
- *J 5239* Connecting Rod Bolt Guide Set
- *J 8037* Ring Compressor
- *J 36660-A* Torque Angle Meter

Important: The piston and cylinder bore have been measured and the bore has been sized for the proper clearance. Install the piston and connecting rod assembly into the proper cylinder bore. The piston alignment mark **MUST** face the front of the engine block.

1. Apply clean engine oil to the following components:
 - The piston
 - The piston rings
 - The cylinder bore
 - The connecting rod bearing surfaces
2. Install the *J 5239* onto the connecting rod bolts.

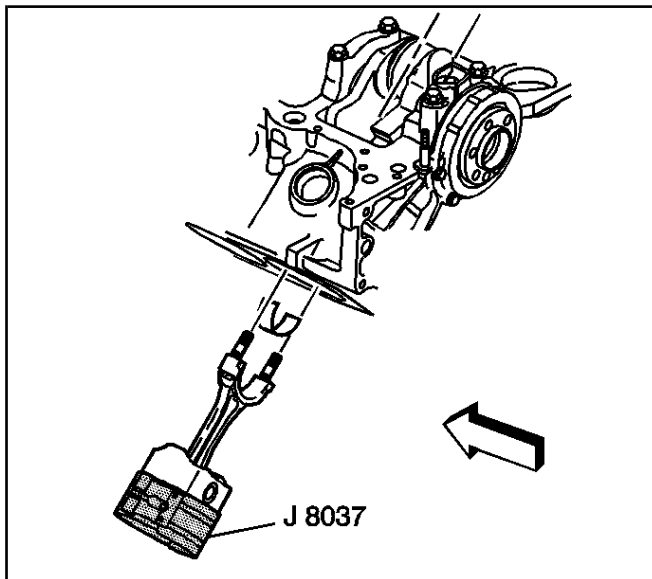


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3. Install the *J 8037* onto the piston and compress the piston rings.

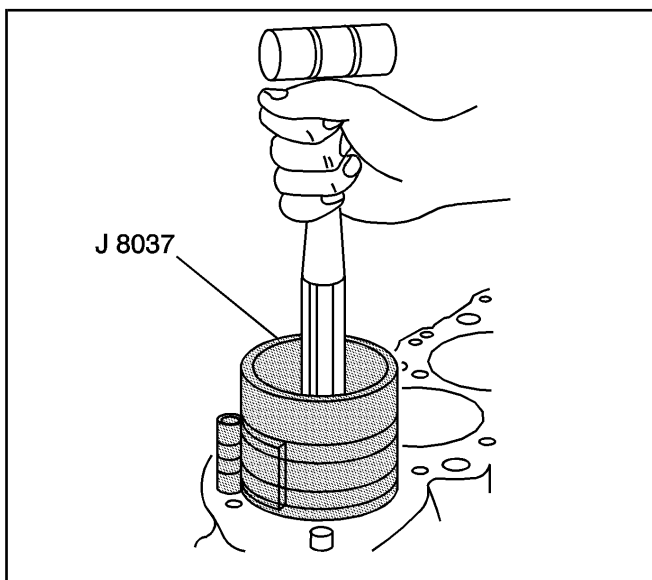


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Important: The mark on the top of the piston must face the front of the engine block.

When assembled, the flanges on the connecting rod and connecting rod cap should point to the front of the engine block on the left bank and point to the rear of the engine block on the right bank.

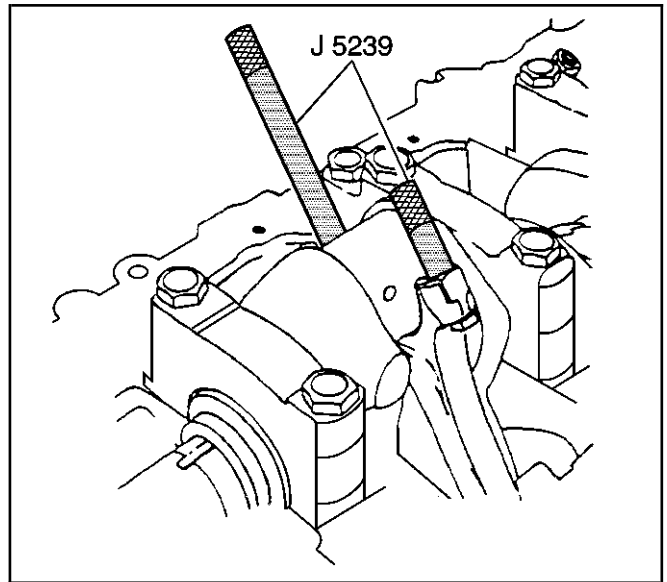
4. Install the connecting rod bearing.
5. Install the piston and connecting rod assembly, and the *J 8037* into the proper cylinder bore.



5159

6. Use the *J 8037* and the *J 5239* and lightly tap the top of the piston with a wooden hammer handle.
 - 6.1. Hold the *J 8037* firmly against the engine block until all of the piston rings have entered the cylinder bore.
 - 6.2. Use the *J 5239* in order to guide the connecting rod onto the crankshaft journal.

7. Remove the *J 5239* from the connecting rod bolts.



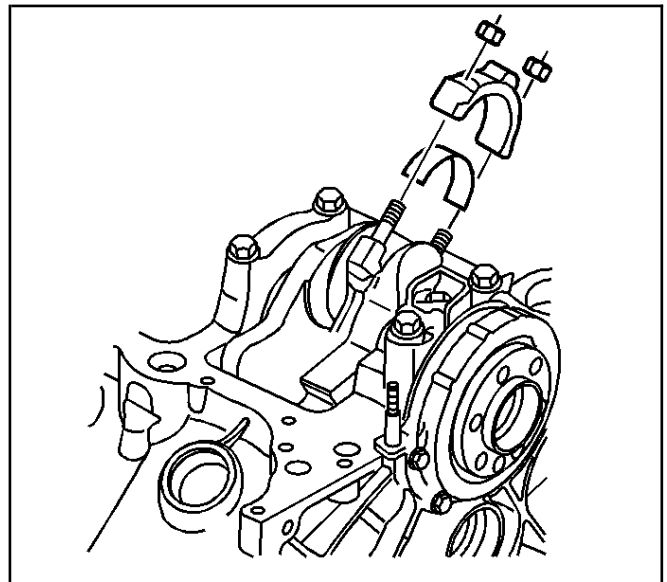
31373

Notice: Refer to *Fastener Notice* in Cautions and Notices.

8. Install the connecting rod bearing, cap, and nuts.

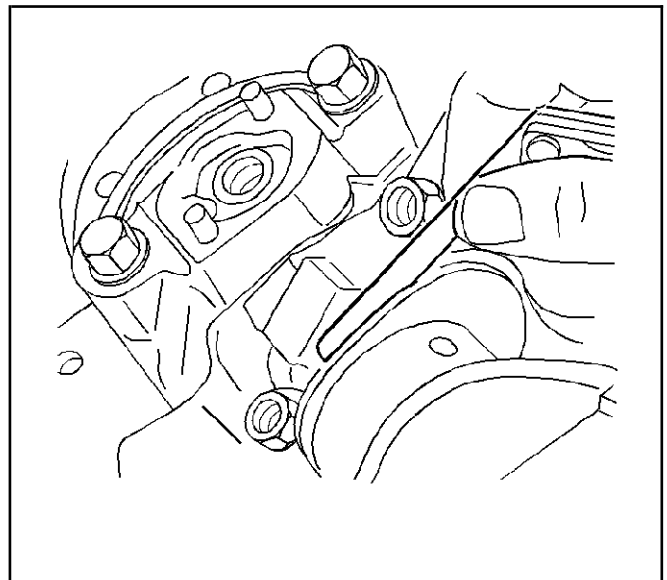
Tighten

- 8.1. Tighten the nuts on the first pass evenly to 27 N·m (20 lb ft).
- 8.2. Tighten the nuts on the final pass to 55 degrees using the *J 36660-A*.

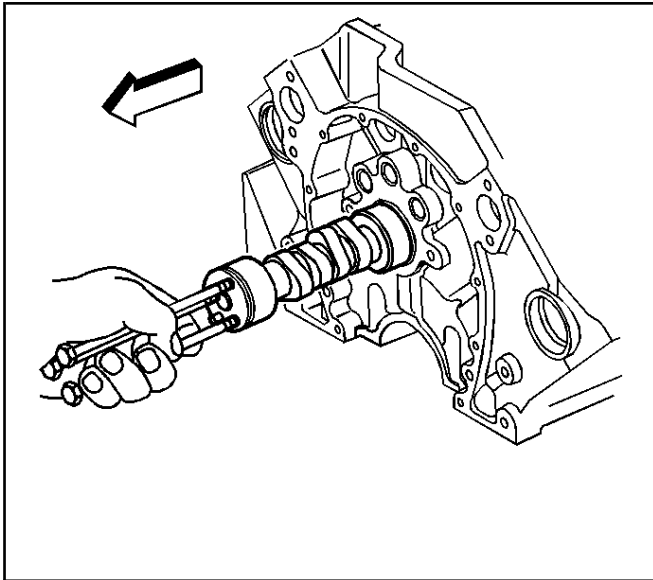


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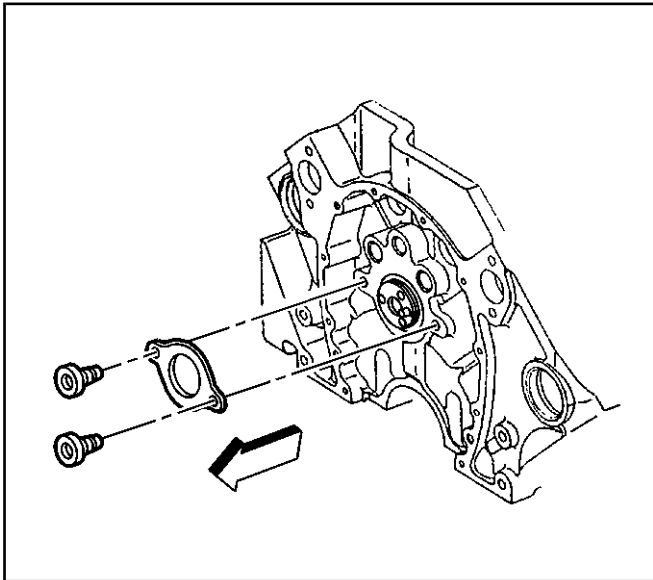
9. Once the piston and connecting rod assemblies have been installed, lightly tap each connecting rod assembly, parallel to the crankpin, in order to make sure that the connecting rods have the proper side clearance.
10. Use a feeler gage or a dial indicator to measure the side clearance between the connecting rod caps. The connecting rod side clearance measurement should be 0.15–0.68 mm (0.006–0.027 in).



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Camshaft Installation

SIE-ID = 66855

Notice: SIO-ID = 13833 All camshaft journals are the same diameter, so care must be used in removing or installing the camshaft to avoid damage to the camshaft bearings.

1. Lubricate the following components with clean engine oil GM P/N United States 12345610, GM P/N Canada 993193, or equivalent, or engine oil supplement GM P/N United States 1052367, GM P/N Canada 992367, or equivalent:
 - The engine camshaft lobes
 - The camshaft bearing journals
 - The camshaft bearings
 - The distributor drive gear
2. Install the 3 5/16–18 x 4.0 inch bolts in the engine camshaft bolt holes.
3. Install the engine camshaft using the bolts as a handle.
4. Remove the 3 bolts from the engine camshaft.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

5. Install the camshaft retainer and bolts.

Tighten

Tighten the camshaft retainer bolts to 12 N·m (106 lb in).

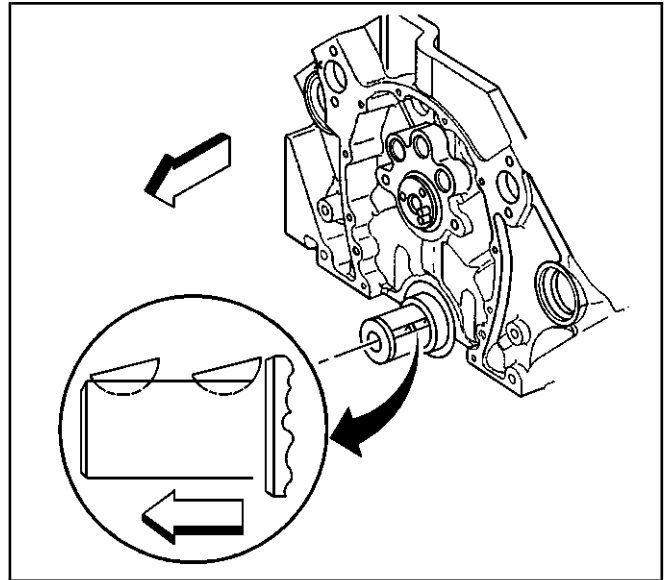
Timing Chain and Sprockets Installation

SIE-ID = 69464

Tools Required

J 5590 Installer

1. Install the crankshaft balancer woodruff keys into the crankshaft keyway.

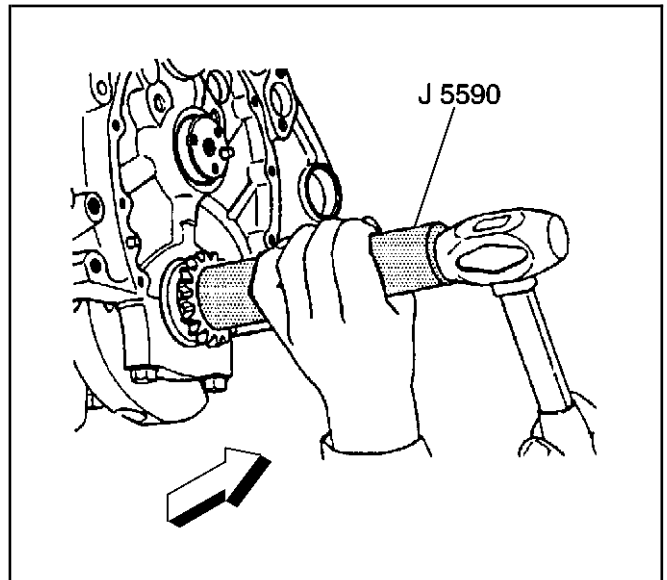


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2. Align the keyway of the crankshaft sprocket with the crankshaft balancer woodruff key.

Caution: Refer to Safety Glasses Caution in Cautions and Notices.

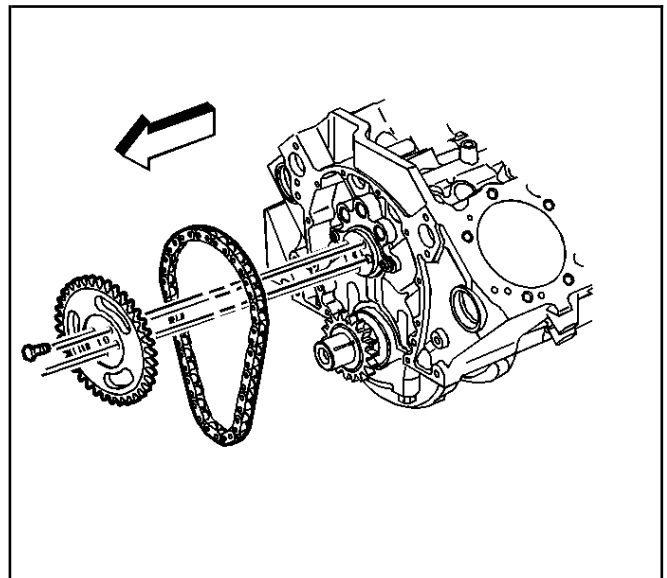
3. Use the J 5590 in order to install the crankshaft sprocket.
4. Rotate the crankshaft until the crankshaft sprocket alignment mark is in the 12 o'clock position.



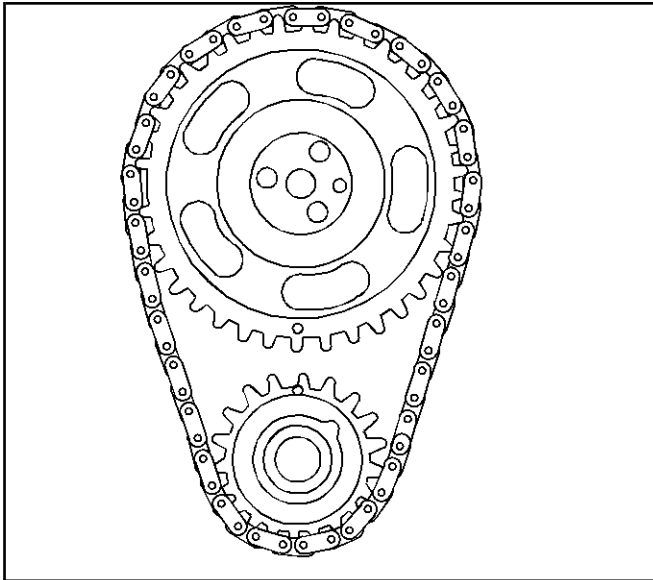
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5. Install the camshaft sprocket and the camshaft timing chain.

Install the camshaft sprocket with the alignment mark in the 6 o'clock position.



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Notice: SIO-ID = 788777 Do not use tools to force the camshaft sprocket onto the camshaft. The camshaft sprocket is a slip fit onto the camshaft and does not require tools to install. Using force against the camshaft can cause component damage and cause the expansion plug at the rear of the block to move out of position. The expansion plug out of position can leak engine oil or fall out. A missing or leaking expansion plug at the rear of the camshaft bearings can cause a loss of oil and oil pressure leading to extensive engine damage.

6. Rotate the camshaft until the camshaft and crankshaft sprocket alignment marks are in the proper position.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

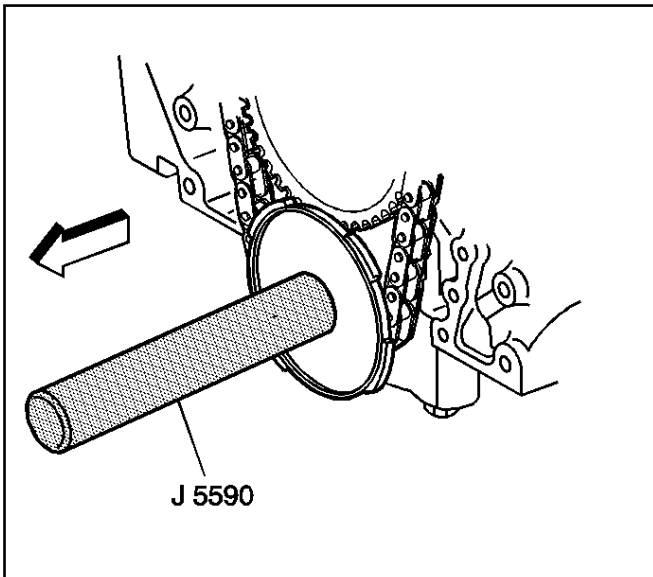
7. Install camshaft sprocket bolts.

Tighten

Tighten the camshaft sprocket bolts to 25 N·m (18 lb ft).

Important: Align the keyway on the crankshaft position sensor reluctor ring with the crankshaft balancer woodruff key in the crankshaft. Install the crankshaft position sensor reluctor ring onto the crankshaft until completely seated against the crankshaft sprocket.

8. Install the crankshaft position sensor reluctor ring.
 - 8.1. Align the keyway on the crankshaft position sensor reluctor ring with the crankshaft balancer woodruff key in the crankshaft.
 - 8.2. Use the J 5590 in order to push the crankshaft position sensor reluctor ring onto the crankshaft until completely seated against the crankshaft sprocket.



521825

Engine Front Cover Installation

SIE-ID = 194773

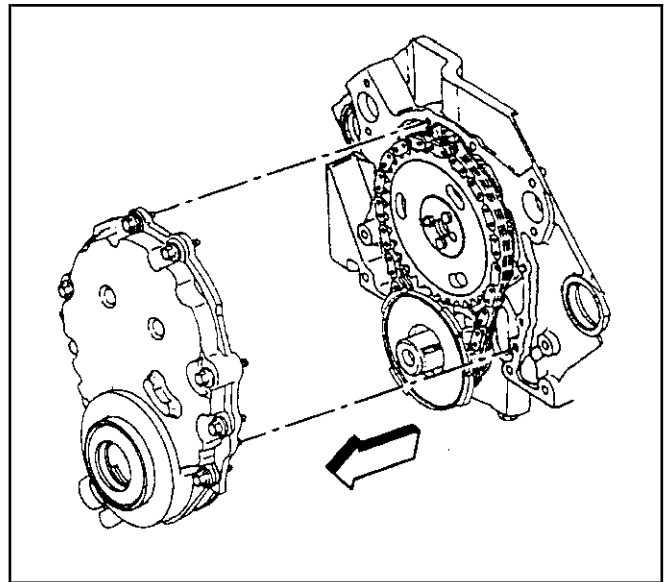
Notice: Refer to *Fastener Notice* in Cautions and Notices.

Important: Do not reuse the composite type engine front cover and seal. Always install a NEW engine cover, which includes a new seal.

1. Install the NEW engine front cover and bolts.

Tighten

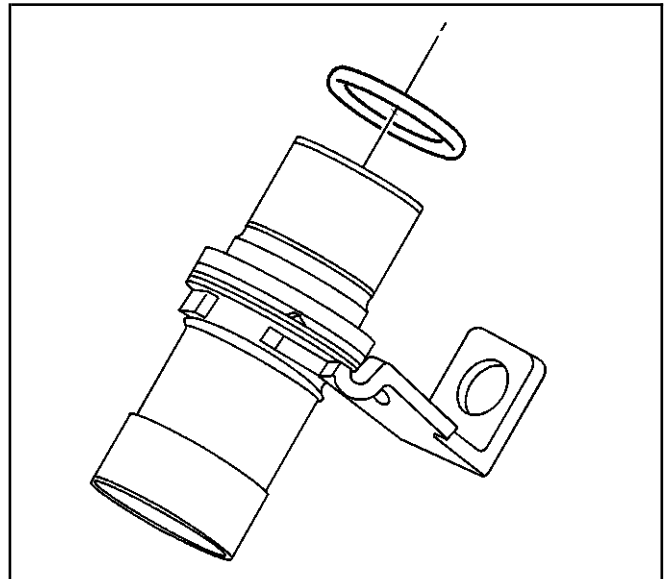
Tighten the engine front cover bolts to 12 N·m (106 lb in).



69010

Important: DO NOT reuse the original crankshaft position sensor seal, O-ring. When installing the crankshaft position sensor be sure the crankshaft position sensor is fully seated and held stationary in the engine front cover crankshaft position sensor bore. A crankshaft position sensor that is not completely seated will cock in the engine front cover and may result in erratic engine operation.

2. Lubricate the NEW crankshaft position sensor seal, O-ring, with clean engine oil.
3. Install the NEW crankshaft position sensor seal, O-ring, onto the crankshaft position sensor.

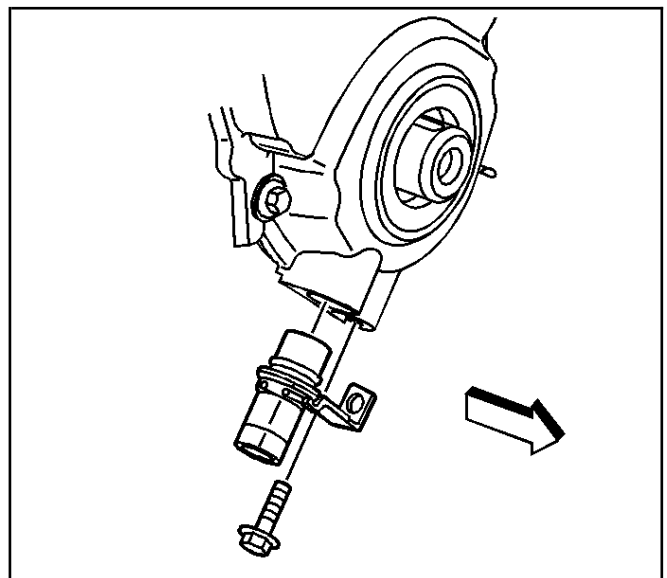


387759

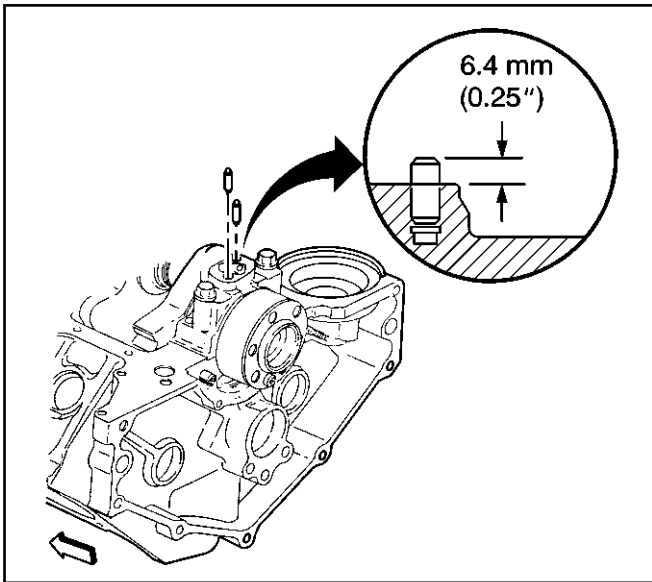
4. Install the crankshaft position sensor.
5. Install the crankshaft position sensor bolt.

Tighten

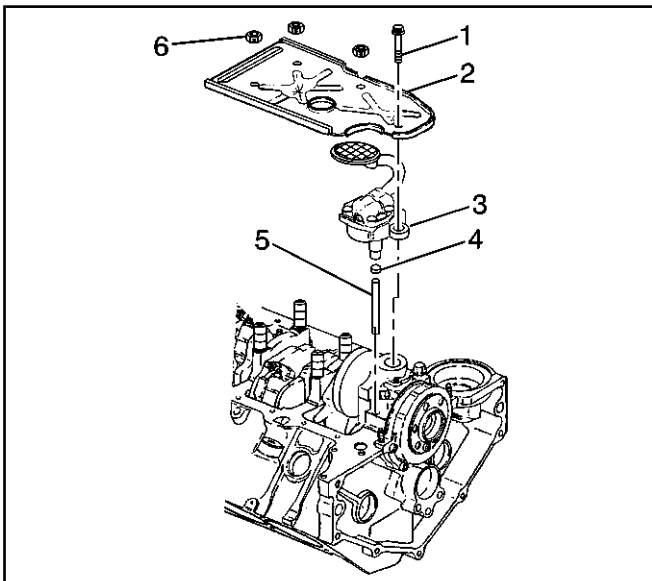
Tighten the crankshaft position sensor bolt to 9 N·m (80 lb in).



11485



182852



11438

Oil Pump, Pump Screen and Deflector Installation

SIE-ID = 194869

Tools Required

J 36660-A Torque Angle Meter

1. Inspect for properly installed oil pump locator pins.

Important: Do not reuse the oil pump driveshaft retainer (4).

During assembly, install a NEW oil pump driveshaft retainer.

2. Assemble the oil pump (3), the oil pump driveshaft (5), and a NEW oil pump driveshaft retainer (4).

3. Install the oil pump (3).

Position the oil pump onto the pins.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

4. Install the crankshaft oil deflector (2) and the nuts (6).
5. Install the bolt (1) attaching the oil pump to the rear crankshaft bearing cap.

Tighten

- Tighten the oil pump bolt on the first pass to 20 N·m (15 lb ft).
- Tighten the oil pump bolt on the final pass to 65 degrees using the J 36660-A.
- Tighten the crankshaft oil deflector nuts to 40 N·m (30 lb ft).

Oil Pan Installation

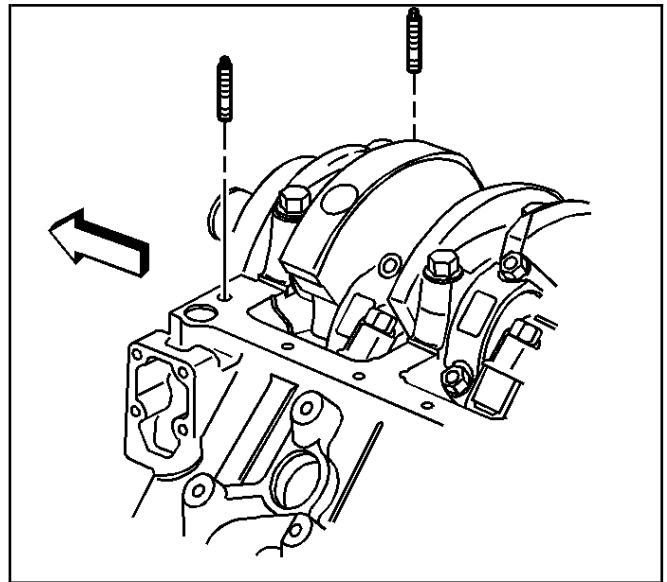
SIE-ID = 66859

Notice: Refer to *Fastener Notice* in Cautions and Notices.

1. Install the oil pan studs into the engine block.

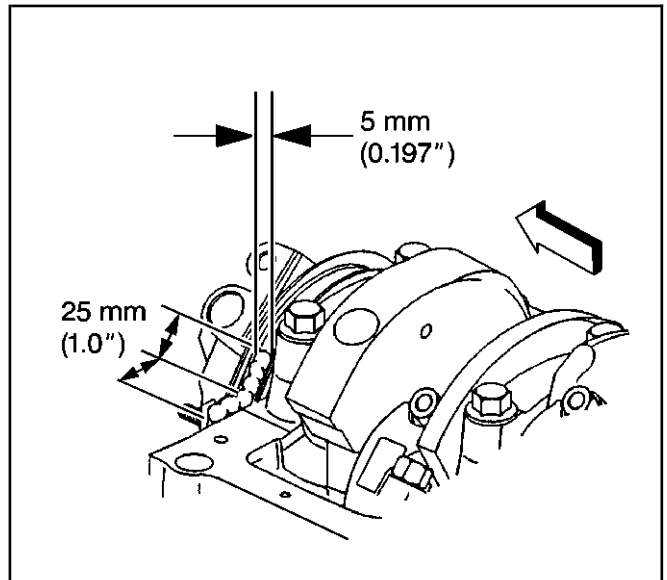
Tighten

Tighten the oil pan studs to 6 N·m (53 lb in).



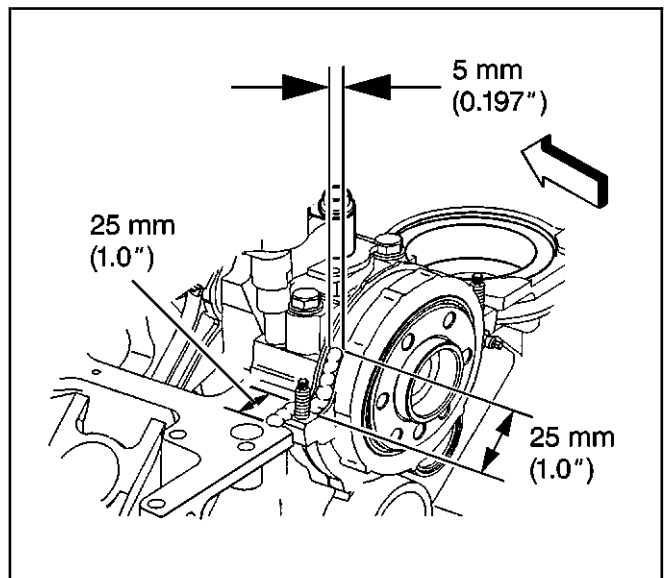
521817

2. Apply a 5 mm (0.197 in) wide and 25 mm (1.0 in) long bead of adhesive GM P/N United States 12346141, GM P/N Canada 10953433, or equivalent, to the engine front cover to engine block junction at the oil pan sealing surfaces.

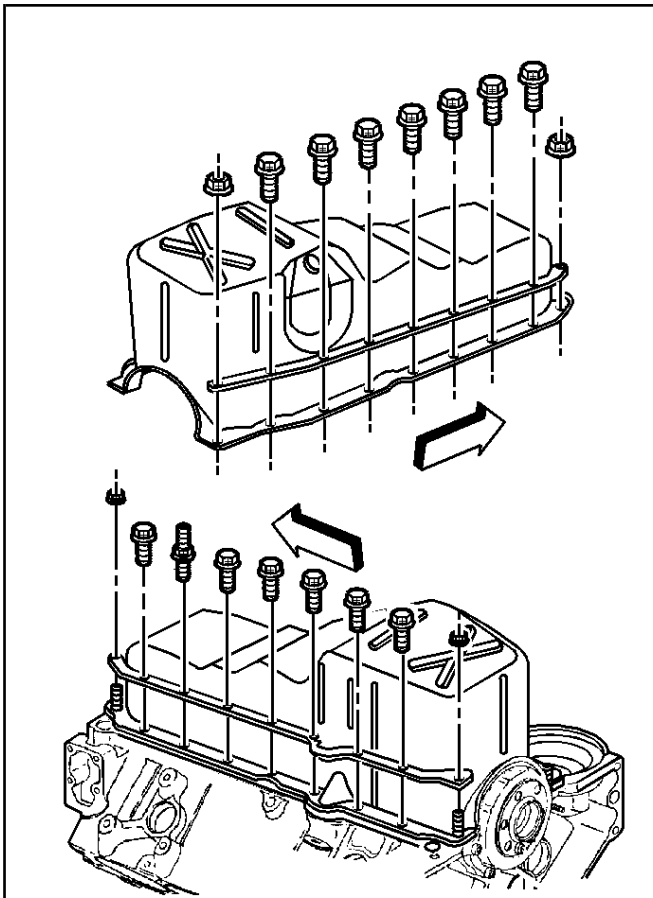


317310

3. Apply a 5 mm (0.197 in) wide and 25 mm (1.0 in) long bead of adhesive GM P/N United States 12346141, GM P/N Canada 10953433, or equivalent, to the crankshaft rear oil seal housing to engine block junction at the oil pan sealing surfaces.



317313



182851

Important: Always install a NEW oil pan gasket.

The oil pan gasket and oil pan must be installed and the fasteners tightened while the adhesive is still wet to the touch.

4. Install the NEW oil pan gasket.

5. Install the oil pan.

Press the oil pan gasket into the grooves of the engine front cover and crankshaft rear oil seal housing.

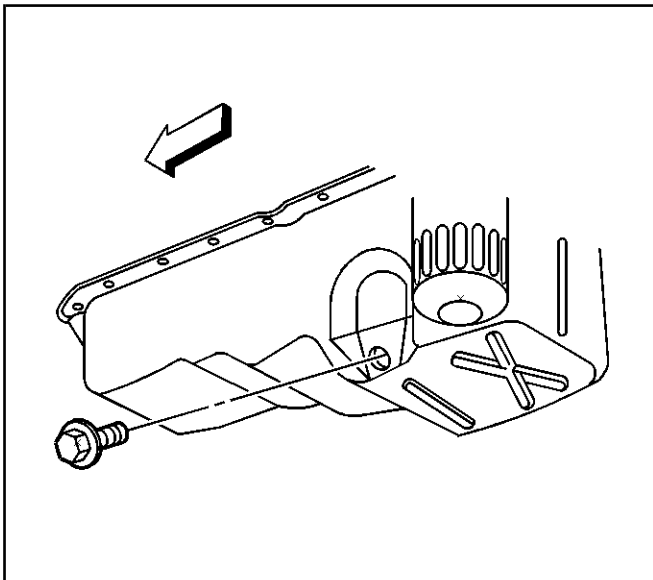
6. Install the oil pan reinforcements.

7. Install the nuts and the bolts.

Tighten

7.1. Tighten the oil pan bolts to 12 N·m (106 lb in).

7.2. Tighten the oil pan nuts to 25 N·m (18 lb ft).



182850

8. Install a NEW oil pan drain plug seal, O-ring, onto the oil pan drain plug.

9. Install the oil pan drain plug into the oil pan.

Tighten

Tighten the oil pan drain plug to 25 N·m (18 lb ft).

Oil Filter Adapter Installation

SIE-ID = 69508

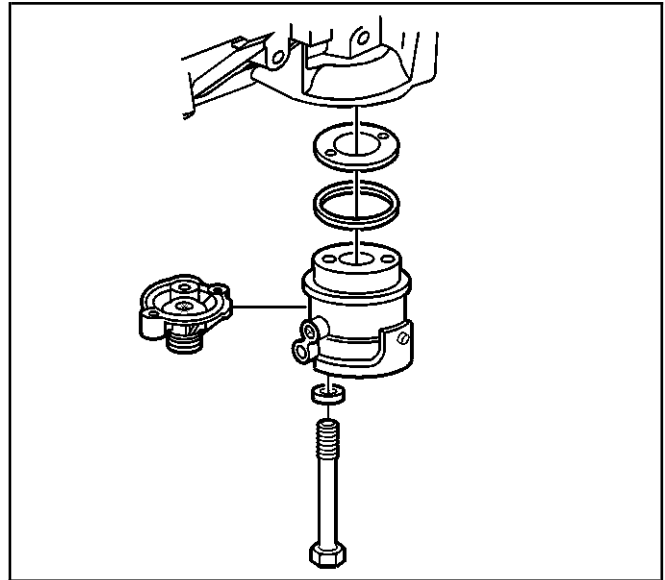
1. Apply clean engine oil GM P/N United States 12345610, GM P/N Canada 993193, or equivalent, to the NEW oil filter adapter seal, O-ring, if applicable.
2. Install the NEW oil filter adapter seal into the groove in the oil filter adapter, if applicable.
3. Install the NEW oil filter adapter gasket, if applicable, and the oil filter adapter.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

4. Install the oil filter adapter flat washers, if applicable, and the oil filter adapter bolts.

Tighten

Tighten the oil filter adapter bolts to 25 N·m (18 lb ft).



39122

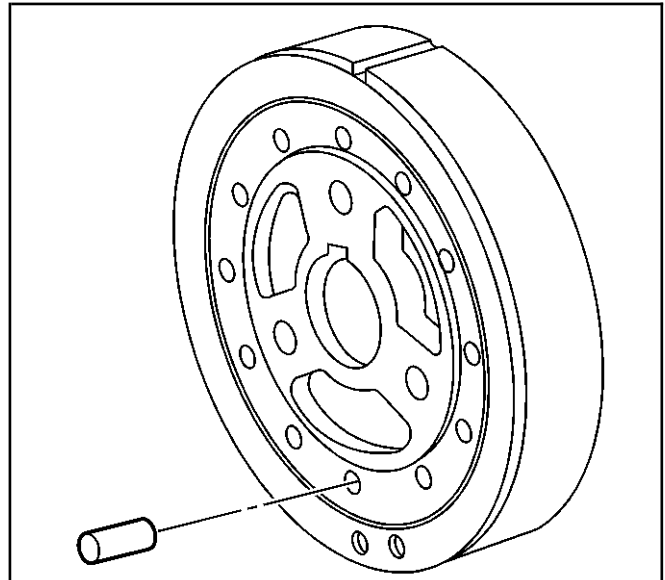
Crankshaft Balancer Installation

SIE-ID = 66868

Tools Required

J 23523-F Balancer Remover and Installer

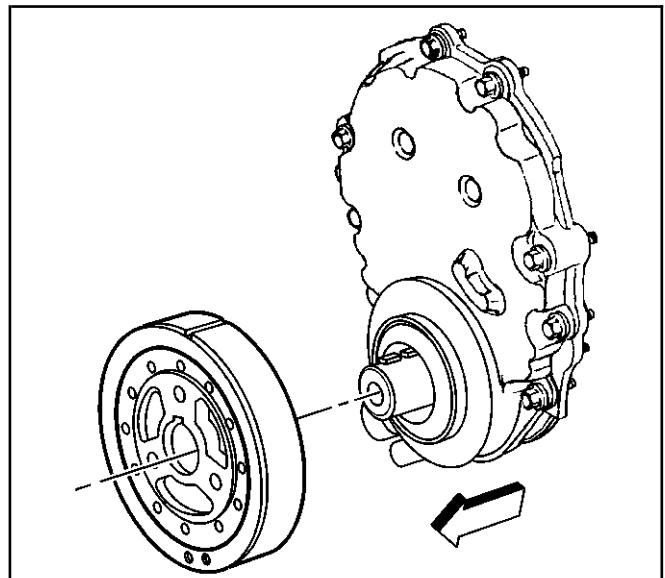
1. Ensure that the crankshaft balancer front groove pin is the proper length and installed in the proper location, if applicable.



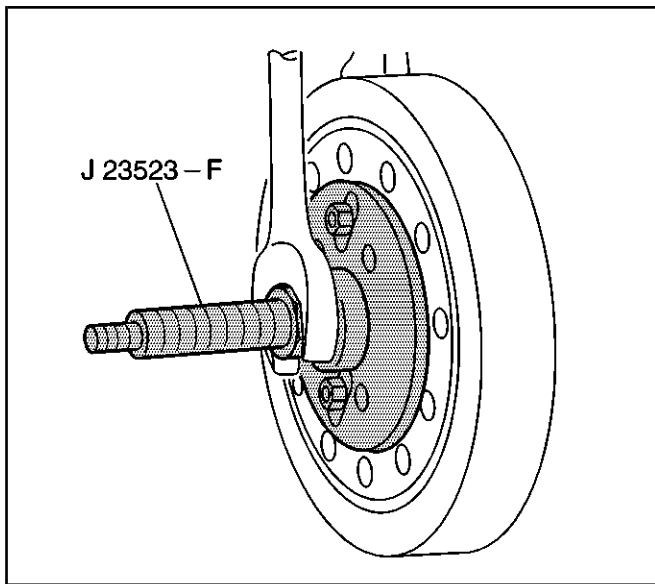
182849

Notice: SIO-ID = 16580 The inertial weight section of the crankshaft balancer is assembled to the hub with a rubber type material. The correct installation procedures (with the proper tool) must be followed or movement of the inertial weight section of the hub will destroy the tuning of the crankshaft balancer.

2. Apply a small amount of adhesive GM P/N United States 12346141, GM P/N Canada 10953433, or equivalent, onto the crankshaft balancer keyway in order to seal the crankshaft balancer keyway and crankshaft joint.
3. Install the crankshaft balancer onto the end of the crankshaft.
Align the keyway of the crankshaft balancer with the crankshaft balancer woodruff key.
4. Install the crankshaft balancer onto the end of the crankshaft.



182832



4065

Notice: Refer to *Fastener Notice* in Cautions and Notices.

5. Use the *J 23523-F* in order to press the crankshaft balancer onto the crankshaft.

- 5.1. Install the *J 23523-F* plate and bolts onto the front of the crankshaft balancer.

Tighten

Tighten the *J 23523-F* plate bolts to 25 N·m (18 lb ft).

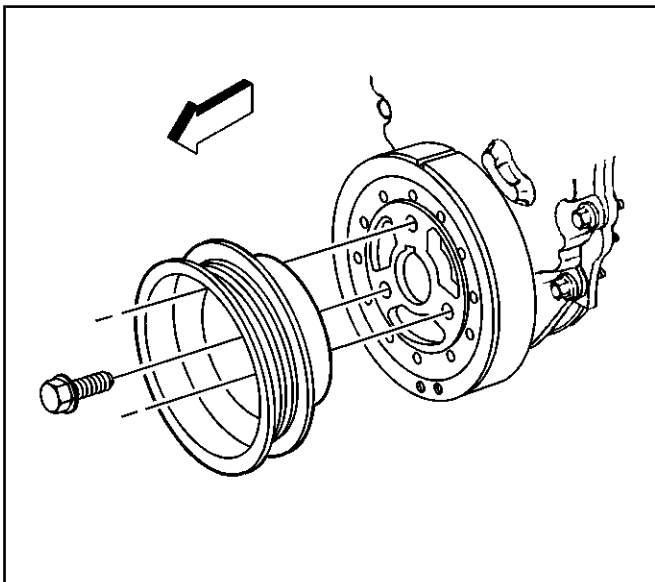
- 5.2. Install the *J 23523-F* screw into the end for the crankshaft.
- 5.3. Install the *J 23523-F* bearing, the washer, and the nut onto the *J 23523-F* screw.
- 5.4. Rotate the *J 23523-F* nut clockwise until the crankshaft balancer hub is completely seated against the crankshaft position sensor reluctor ring.

6. Remove the *J 23523-F*.

7. Install the crankshaft pulley and bolts.

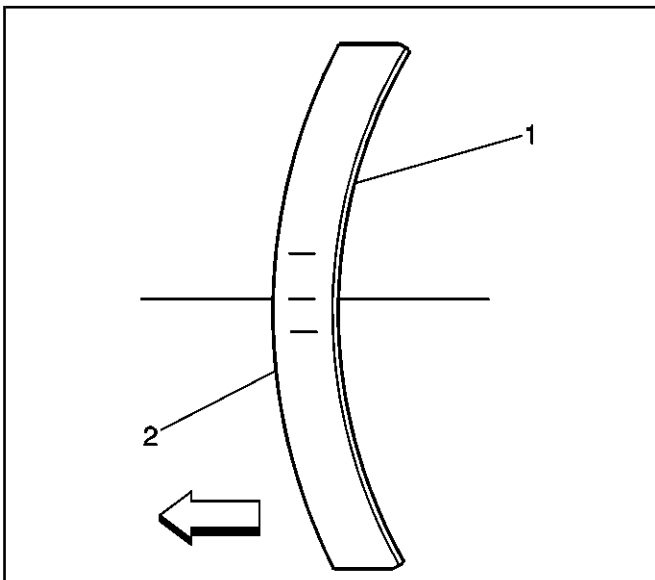
Tighten

Tighten the crankshaft pulley bolts to 58 N·m (43 lb ft).



188055

8. Ensure that the crown of the crankshaft balancer washer (2) is faced away from the engine.

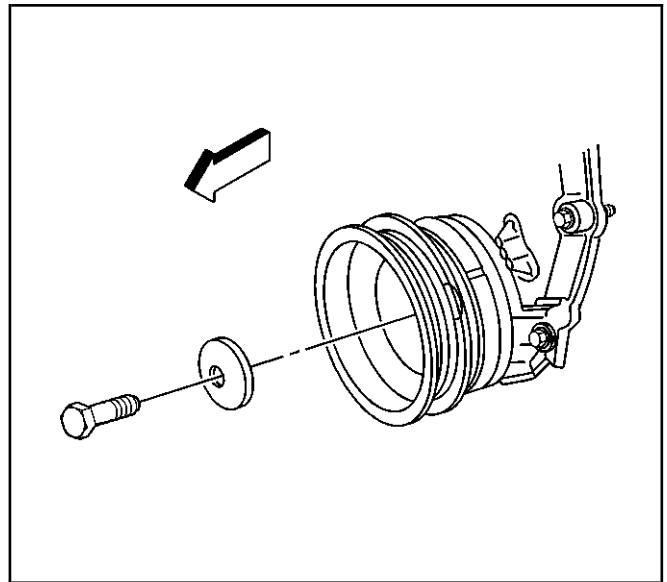


342203

9. Install the crankshaft balancer washer and the bolt.

Tighten

Tighten the crankshaft balancer bolt to 95 N·m (70 lb ft).



173172

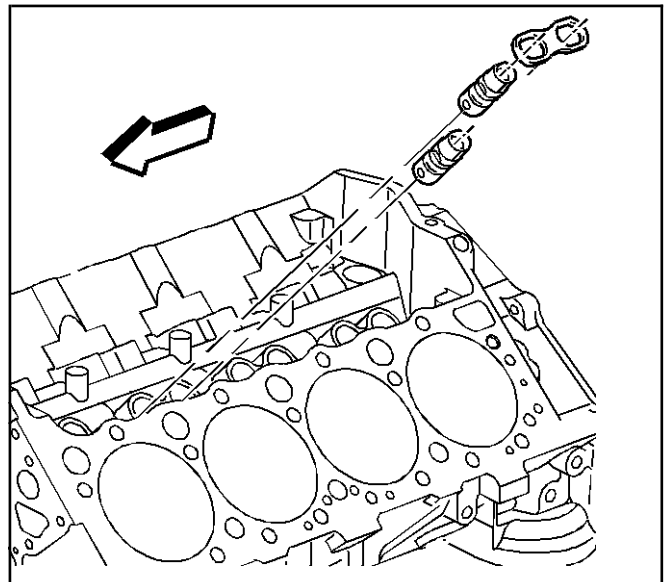
Valve Lifter Installation

SIE-ID = 69825

1. Apply lubricant GM P/N United States 12345501, GM P/N Canada 992704, or equivalent, to the valve lifter rollers.

Important: If reusing the valve lifters, install the valve lifters in the original positions.

2. Install the valve lifters.



11509

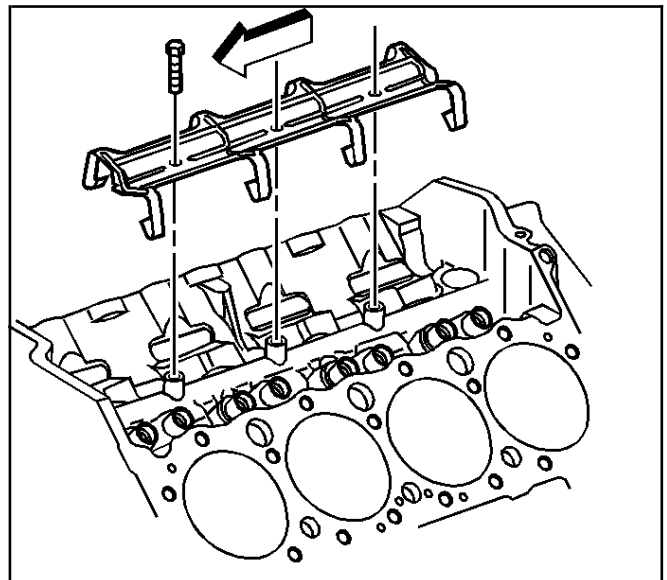
3. Install the valve lifter guides.
4. Install the valve lifter guide retainer.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

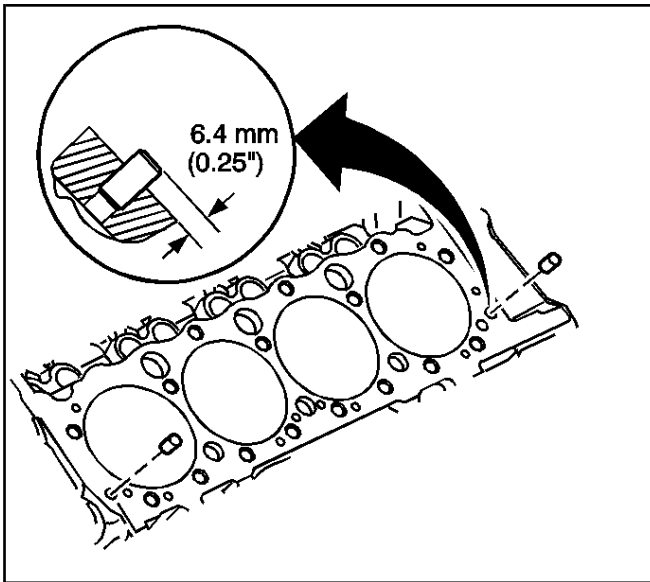
5. Install the valve lifter guide retainer bolts.

Tighten

Tighten the valve lifter guide retainer bolts to 25 N·m (18 lb ft).



11508



182846

Cylinder Head Installation - Left

SIE-ID = 650067

Tools Required

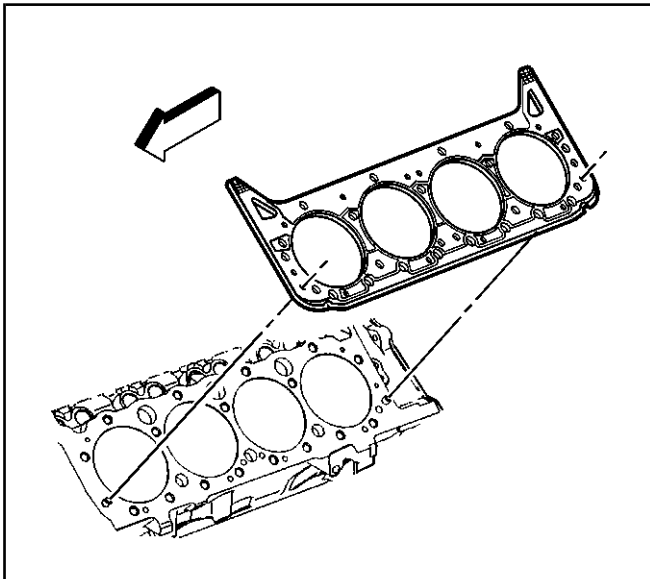
J 36660-A Torque Angle Meter

1. Clean the cylinder gasket surfaces on the engine block.
2. Inspect the cylinder head locator dowel pins for proper installation.
3. Clean the cylinder head gasket surfaces on the cylinder head.

Important: Do not use any type sealer on the cylinder head gasket, unless specified.

4. Place the NEW cylinder head gasket in position over the cylinder head locator dowel pins.

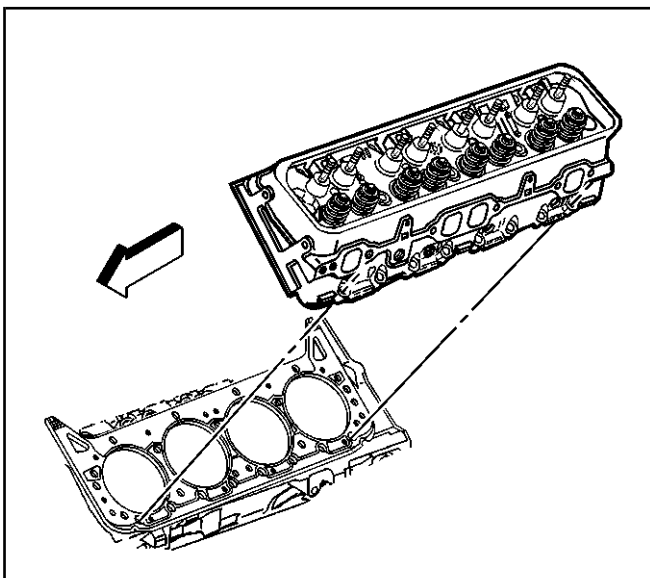
The cylinder head gasket is not directional and may be installed using either side facing the engine block.



317233

5. Install the cylinder head to the engine block.

Guide the cylinder head carefully into place over the dowel pins and the cylinder head gasket.



317227

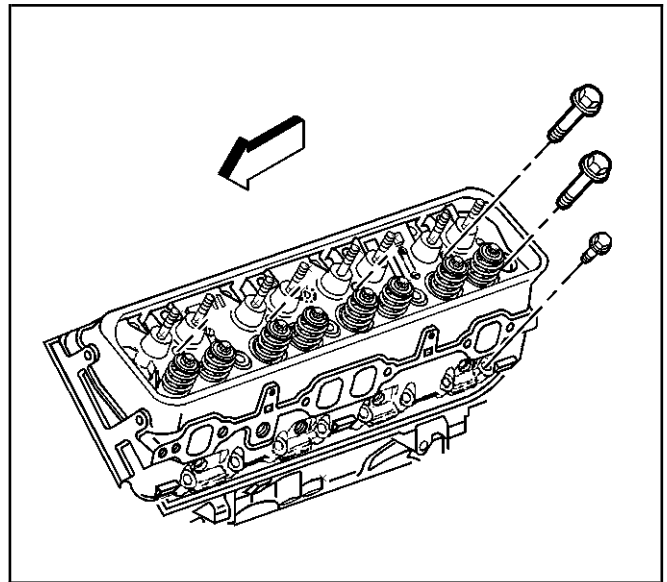
6. Apply sealant GM P/N United States 12346004, GM P/N Canada 10953480, or equivalent, to the threads of the cylinder head bolts.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

7. Install the cylinder head bolts.

Tighten

Tighten the bolts in sequence on the first pass to 30 N·m (22 lb ft).

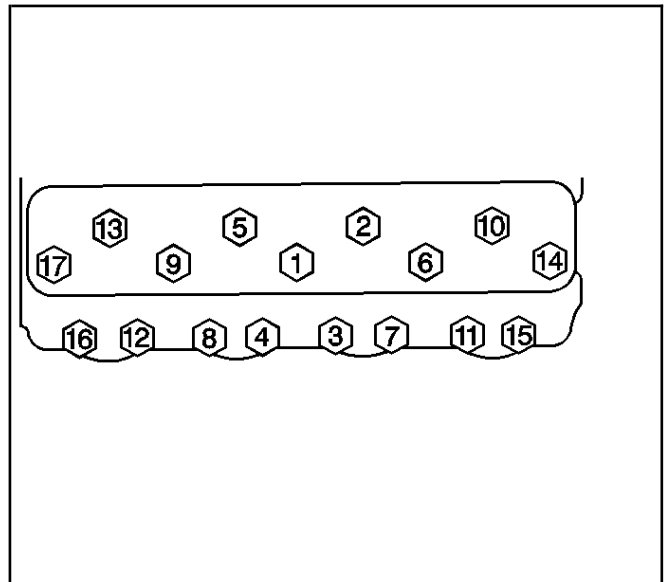


317217

8. Use the J 36660-A in order to tighten the cylinder head bolts in sequence on the final pass.

Tighten

- Tighten the long bolts (1, 2, 5, 6, 9, 10, and 13) on the final pass in sequence to 75 degrees.
- Tighten the medium bolts (14 and 17) on the final pass in sequence to 65 degrees.
- Tighten the short bolts (3, 4, 7, 8, 11, 12, 15, and 16) on the final pass in sequence to 55 degrees.



500687

9. Measure the NEW spark plugs for the proper gap. Adjust the spark plug gap if necessary.

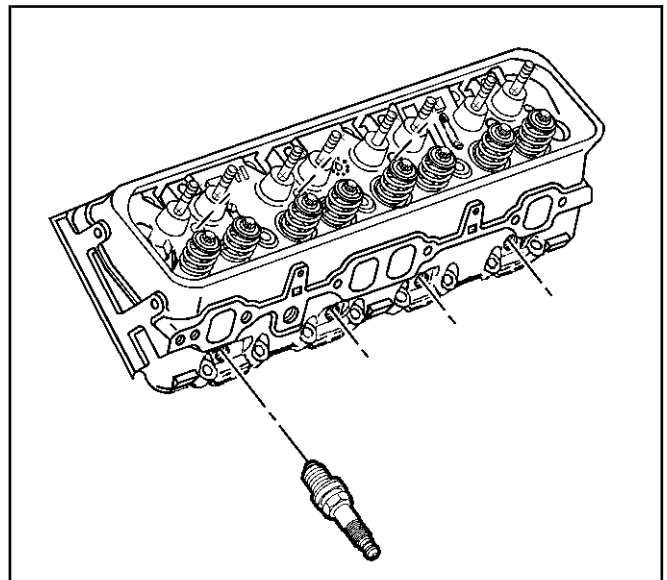
Specification

Spark plug gap to 1.52 mm (0.060 in)

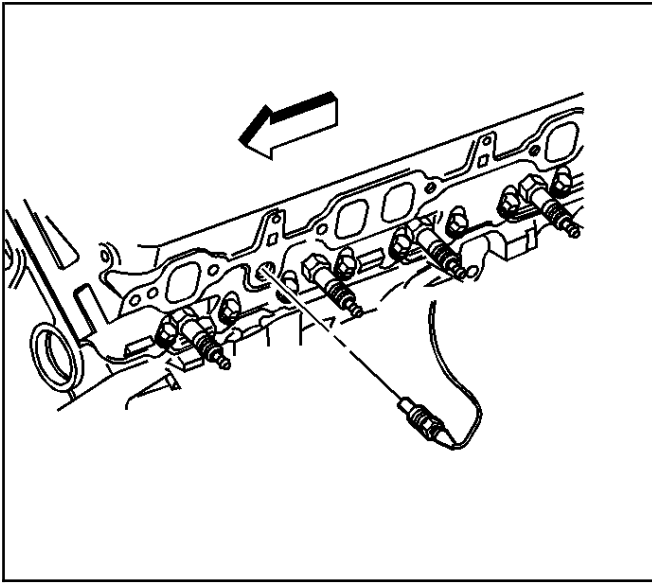
10. Install the NEW spark plugs.

Tighten

- Tighten the spark plugs for a USED cylinder head to 15 N·m (11 lb ft).
- Tighten the spark plugs for the initial installation of a NEW cylinder head to 30 N·m (22 lb ft).



317307

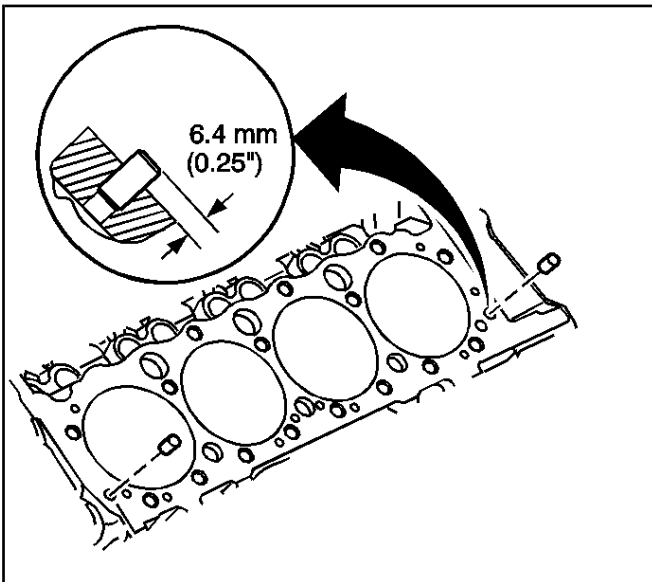


521828

11. If reusing the engine coolant temperature (ECT) gage sensor, apply sealant GM P/N United States 12346004, GM P/N Canada 10953480 to the threads of the ECT gage sensor.
12. Install the ECT gage sensor.

Tighten

Tighten the ECT gage sensor to 20 N·m (15 lb ft).



182846

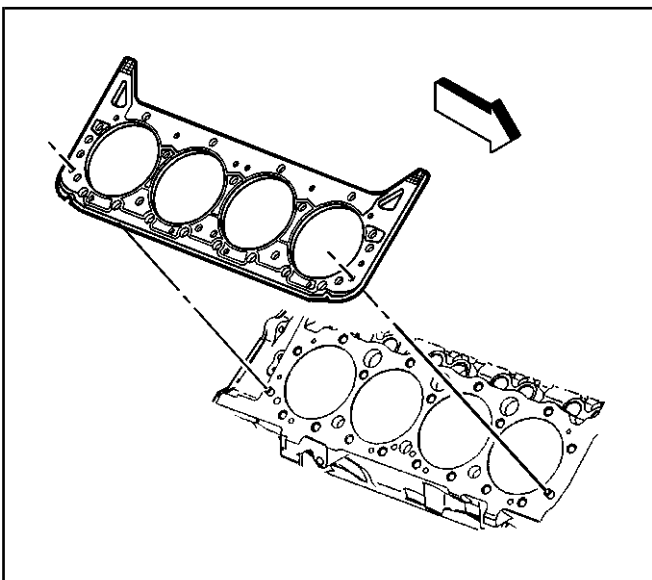
Cylinder Head Installation - Right

SIE-ID = 650068

Tools Required

J 36660-A Torque Angle Meter

1. Clean the cylinder gasket surfaces on the engine block.
2. Inspect the cylinder head locator dowel pins for proper installation.
3. Clean the cylinder head gasket surfaces on the cylinder head.

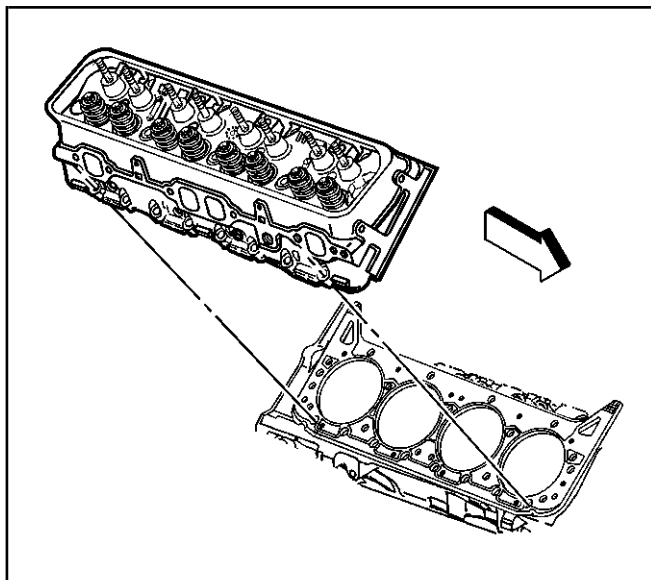


317255

Important: Do not use any type sealer on the cylinder head gasket, unless specified.

4. Place the NEW cylinder head gasket in position over the cylinder head locator dowel pins.
The cylinder head gasket is not directional and may be installed using either side facing the engine block.

5. Install the cylinder head to the engine block.
Guide the cylinder head carefully into place over the dowel pins and the head gasket.



317246

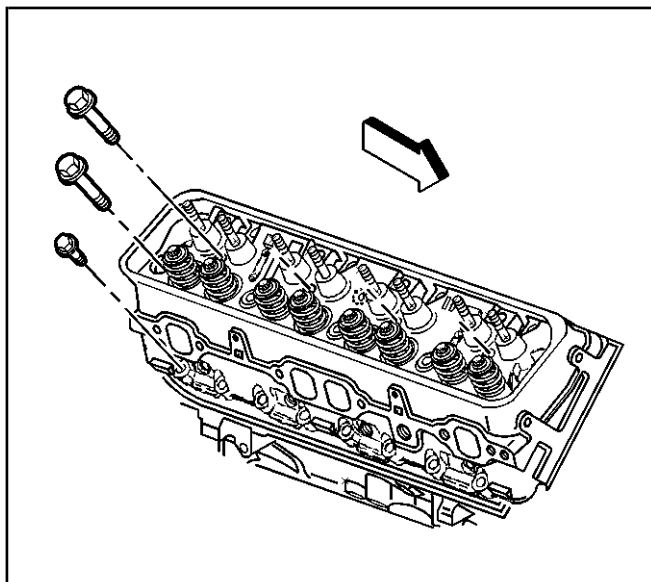
6. Apply sealant GM P/N United States 12346004, GM P/N Canada 10953480, or equivalent, to the threads of the cylinder head bolts.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

7. Install the cylinder head bolts.

Tighten

Tighten the bolts in sequence on the first pass to 30 N·m (22 lb ft).

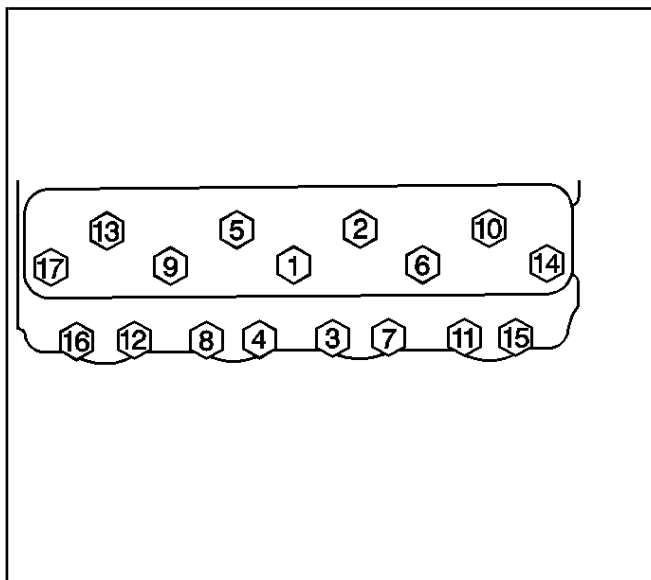


317239

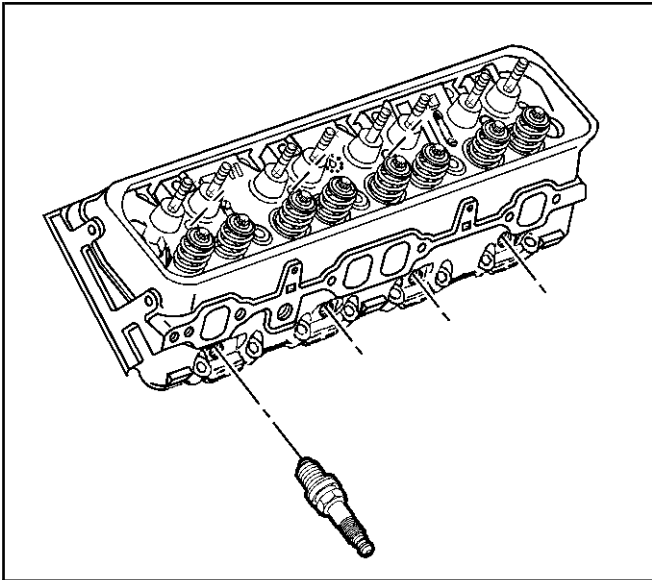
8. Use the J 36660-A in order to tighten the cylinder head bolts in sequence on the second pass.

Tighten

- Tighten the long bolts (1, 2, 5, 6, 9, 10, and 13) on the second pass in sequence to 75 degrees.
- Tighten the medium bolts (14 and 17) on the second pass in sequence to 65 degrees.
- Tighten the short bolts (3, 4, 7, 8, 11, 12, 15, and 16) on the second pass in sequence to 55 degrees.



500687



317307

9. Measure the NEW spark plugs for the proper gap. Adjust the spark plug gap, if necessary.

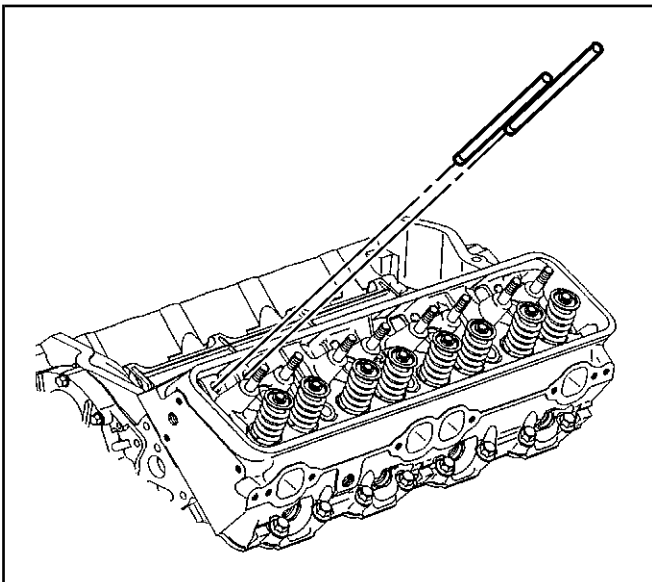
Specifications

Spark plug gap to 1.52 mm (0.060 in).

10. Install the NEW spark plugs.

Tighten

- Tighten the spark plugs for a USED cylinder head to 15 N·m (11 lb ft).
- Tighten the spark plugs for the initial installation of a NEW cylinder head to 30 N·m (22 lb ft).



22766

Valve Rocker Arm and Push Rod Installation

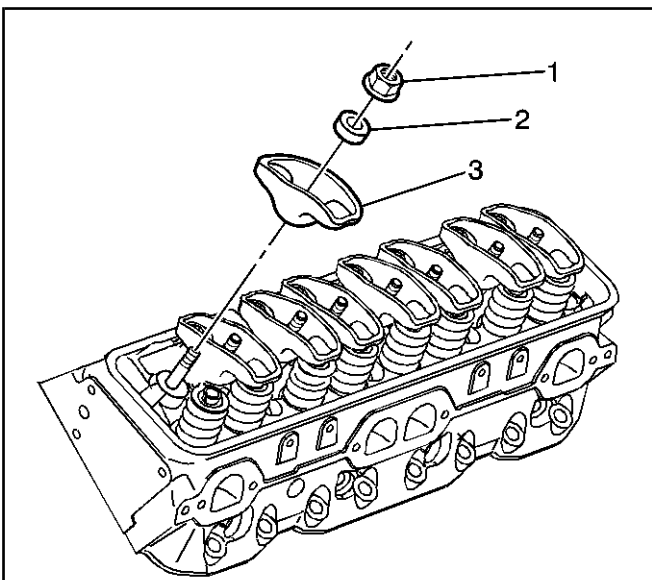
SIE-ID = 194762

Important: Be sure to keep parts in order. Parts must be put back from where they were removed.

1. Apply prelube GM P/N United States 12345501, GM P/N Canada 942704, or equivalent, to the valve rocker arm and the valve rocker arm ball bearing surfaces.

Important: Be sure that the valve pushrods seat in the valve lifter sockets.

2. Install the valve pushrods.



182835

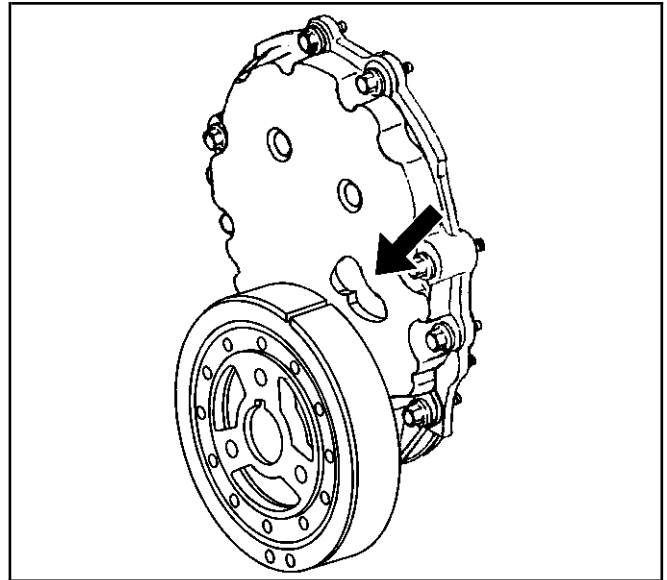
3. Install the following parts:

- 3.1. The valve rocker arm nuts (1)
- 3.2. The valve rocker arm balls (2)
- 3.3. The valve rocker arms (3)

Valve Lash Adjustment

SIE-ID = 194734

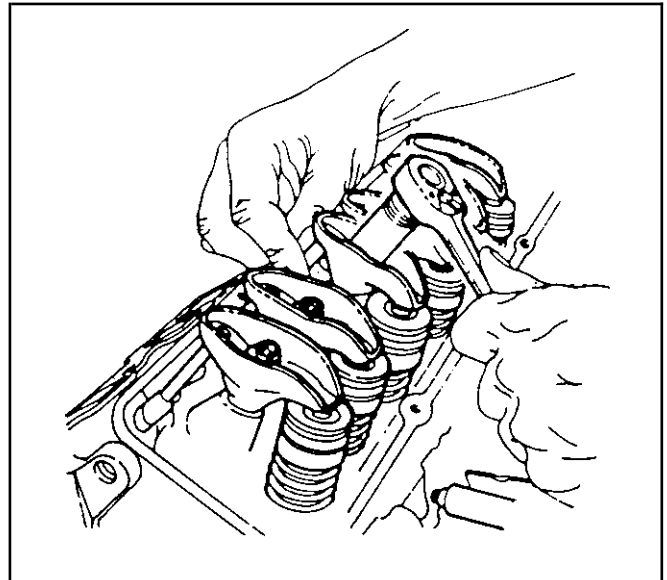
1. Turn the valve rocker arm nuts clockwise until all of the valve lash is removed.
2. Turn the crankshaft clockwise until the alignment mark on the crankshaft balancer is aligned with the notch in the engine front cover tab.
3. Look at the number 1 cylinder valves as the crankshaft balancer alignment mark approaches the notch in the engine front cover tab. If a valve moves as the alignment mark moves into position, the engine is in the number 6 firing position. If this happens, turn the crankshaft clockwise 1 revolution in order to reach the number 1 cylinder firing position.



195336

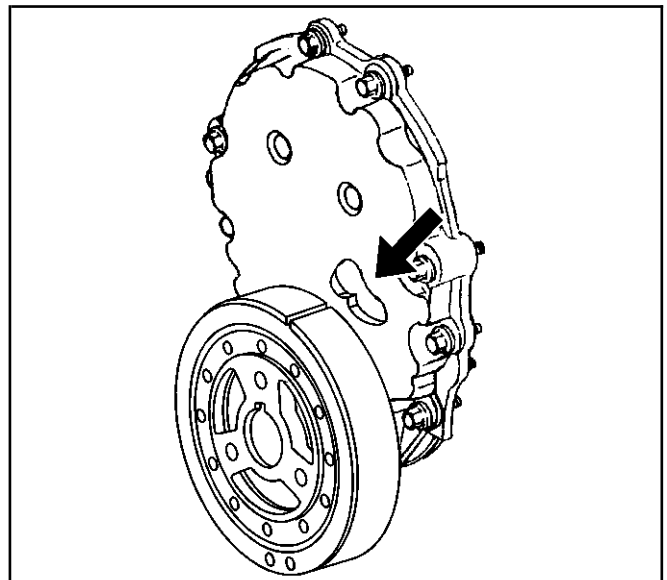
4. With the engine in the number 1 firing position, adjust the exhaust valves for cylinders number 1, 3, 4, and 8 and the intake valves for cylinders number 1, 2, 5, and 7.
 - 4.1. Turn the valve rocker arm nut counter clockwise until the valve lash is felt in the valve pushrod.
 - 4.2. Turn the valve rocker arm nut clockwise until all the valve lash is removed.

Zero valve lash can be felt by moving the valve pushrod up and down between your thumb and forefinger until there is no more up and down movement of the valve push rod.
 - 4.3. When all the valve lash is removed, then turn the valve rocker arm nut clockwise 1 additional turn (360 degrees).

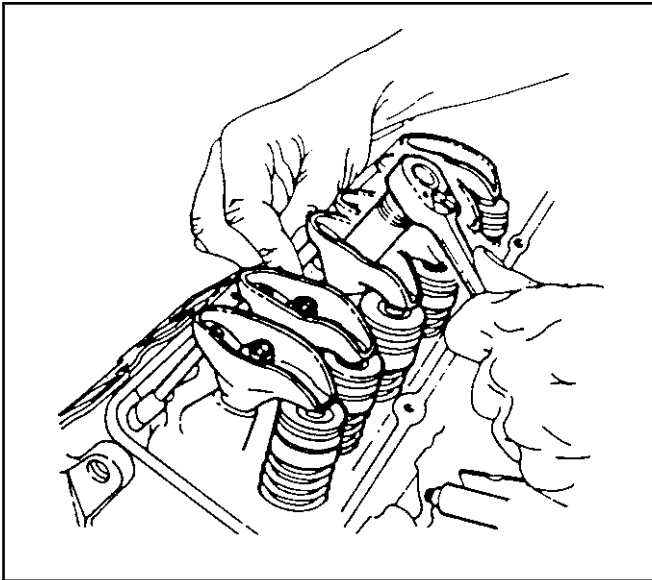


22759

5. Turn the crankshaft clockwise 1 revolution until the alignment mark on the crankshaft balancer is aligned with the notch in the engine front cover tab.



195336



22759

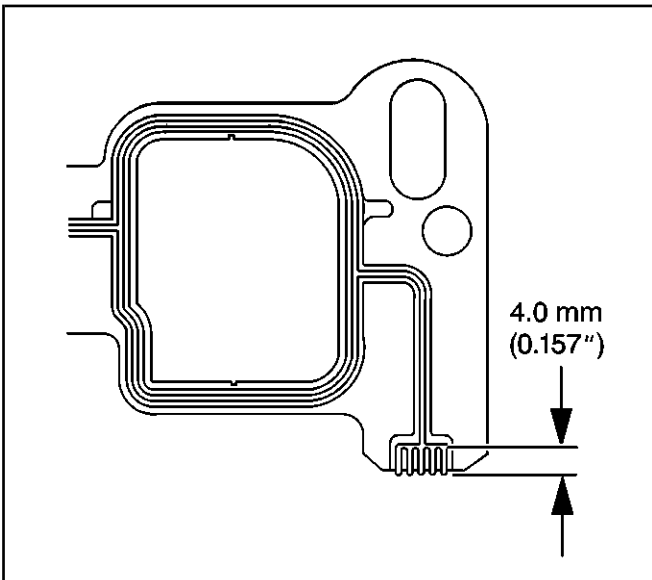
6. With the engine in the number 6 firing position, adjust the exhaust valves for cylinders number 2, 5, 6, and 7 and the intake valves for cylinders number 3, 4, 6, and 8.

6.1. Turn the valve rocker arm nut counter clockwise until the valve lash is felt in the valve pushrod.

6.2. Turn the valve rocker arm nut clockwise until all the valve lash is removed.

Zero valve lash can be felt by moving the valve pushrod up and down between your thumb and forefinger until there is no more up and down movement of the valve push rod.

6.3. When all the valve lash is removed, then turn the valve rocker arm nut clockwise 1 additional turn (360 degrees).



38512

Intake Manifold Installation

SIE-ID = 66866

Notice: SIO-ID = 16302 Apply the proper amount of the sealant when assembling this component. Excessive use of the sealant can prohibit the component from sealing properly. A component that is not sealed properly can leak leading to extensive engine damage.

Important: The lower intake manifold must be installed and the fasteners tightened while the adhesive is still wet to the touch.

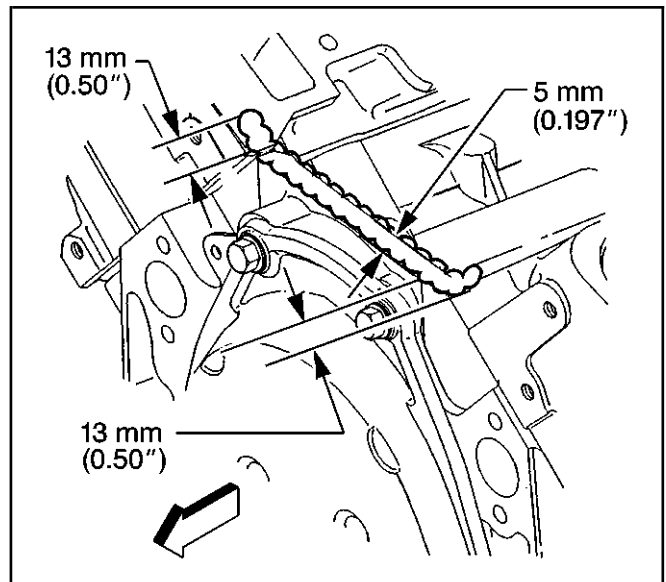
1. Apply a 4.0 mm (0.157 in) patch of adhesive GM P/N United States 12346141, GM P/N Canada 10953433, or equivalent, to the cylinder head side of the lower intake manifold gasket at each end.
2. Install the lower intake manifold gasket onto the cylinder head.

Use the gasket locator pins in order to properly seat the lower intake manifold gasket onto the cylinder head.

Notice: SIO-ID = 41431 Apply the proper amount of the sealant when assembling this component. Excessive use of the sealant can prohibit the component from sealing properly. A component that is not sealed properly can leak leading to extensive engine damage.

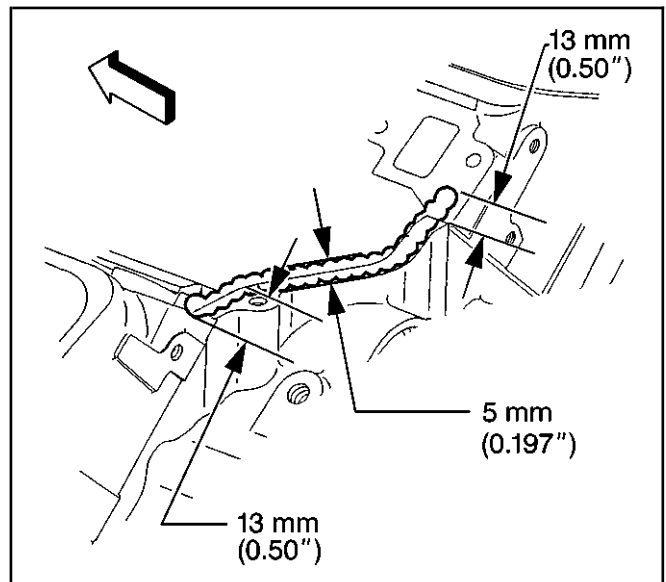
Important: All sealing surfaces must be clean, free of oil, dirt, or any other foreign material.

3. Apply a 5 mm (0.197 in) bead of adhesive GM P/N United States 12346141, GM P/N Canada 10953433, or equivalent, to the front top of the engine block.
4. Extend the adhesive bead 13 mm (0.50 in) onto the each lower intake manifold gasket.



26744

5. Apply a 5 mm (0.197 in) bead of adhesive GM P/N United States 12346141, GM P/N Canada 10953433, or equivalent, to the rear top of the engine block.
6. Extend the adhesive bead 13 mm (0.50 in) onto each lower intake manifold gasket.

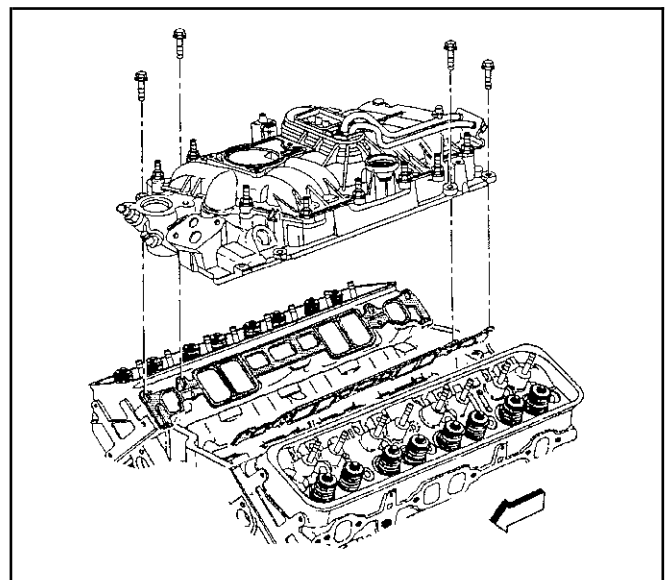


26743

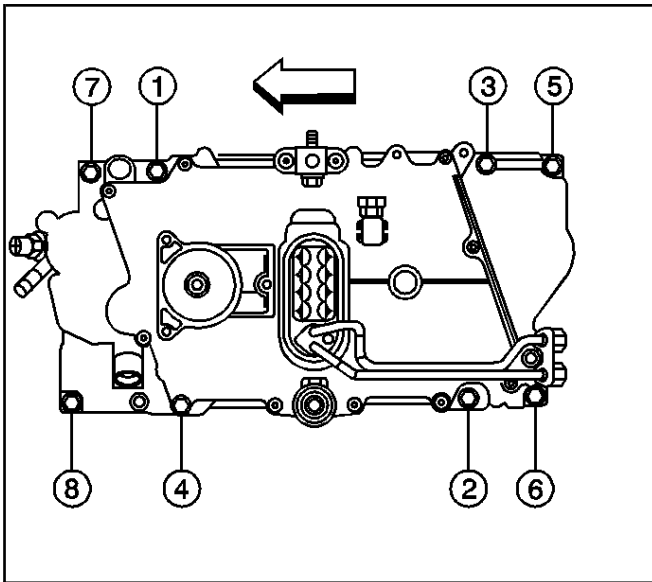
7. Install the lower intake manifold onto the engine block and the cylinder heads.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

8. Apply threadlock GM P/N United States 12345382, GM P/N Canada 10953489, or equivalent, to the threads of the lower intake manifold bolts.



66456



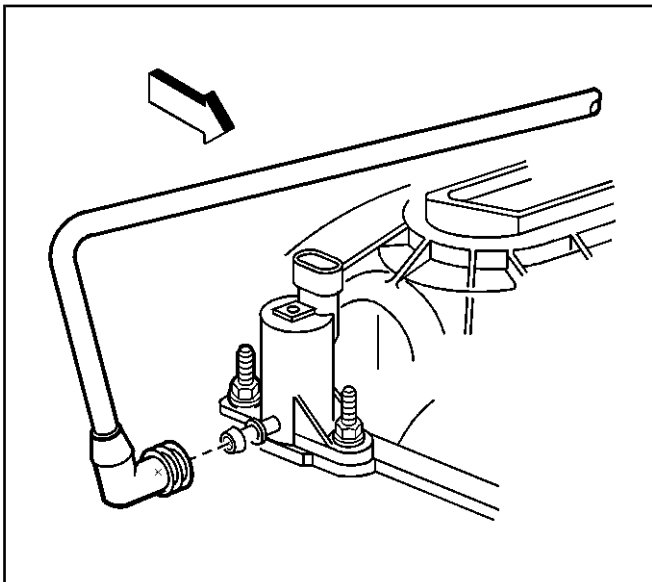
500689

Notice: SIO-ID = 382467 Proper lower intake manifold fastener tightening sequence and torque is critical. Always follow the tightening sequence, and torque the intake manifold bolts using the 3 step method. Failing to do so may distort the crankshaft bearing bore alignment and cause damage to the crankshaft bearings.

9. Install the lower intake manifold bolts.

Tighten

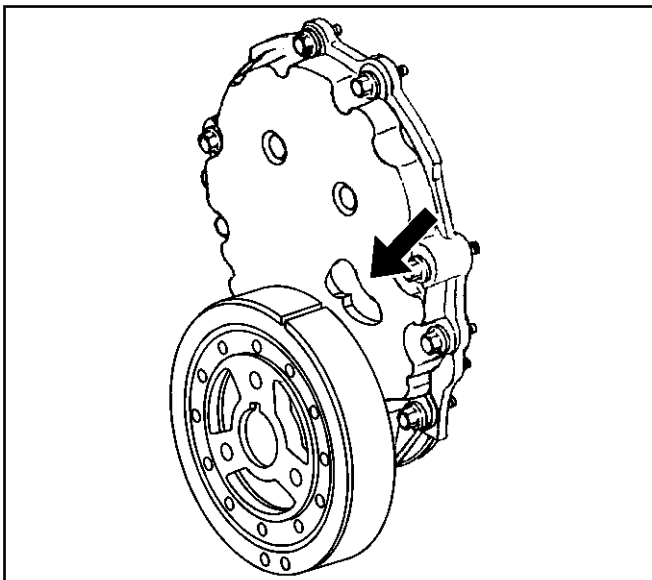
- 9.1. Tighten the bolts on the first pass in sequence (1–8) to 3 N·m (27 lb in).
- 9.2. Tighten the bolts on the second pass in sequence (1–8) to 12 N·m (106 lb in).
- 9.3. Tighten the bolts on the final pass in sequence (1–8) to 15 N·m (11 lb ft).



317211

10. Connect the evaporative emission (EVAP) canister purge solenoid valve harness.

- 10.1. Push the elbow inward until the quick connect snaps into place.
- 10.2. Pull the elbow outward in order to ensure proper connection.



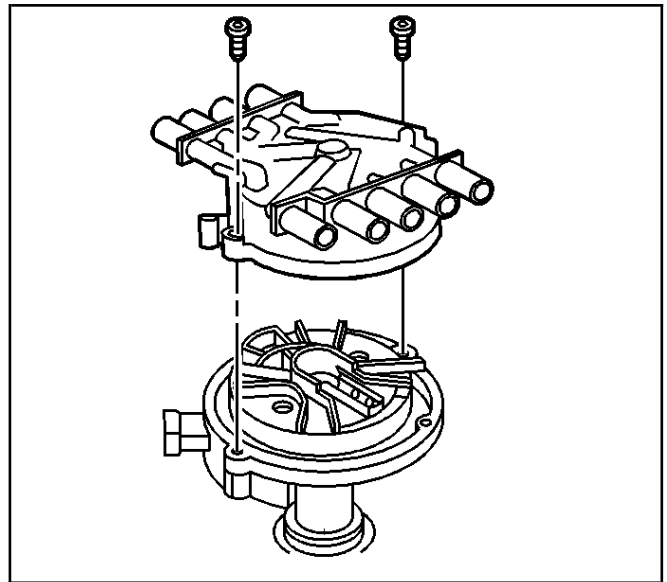
195336

Distributor Installation

SIE-ID = 69509

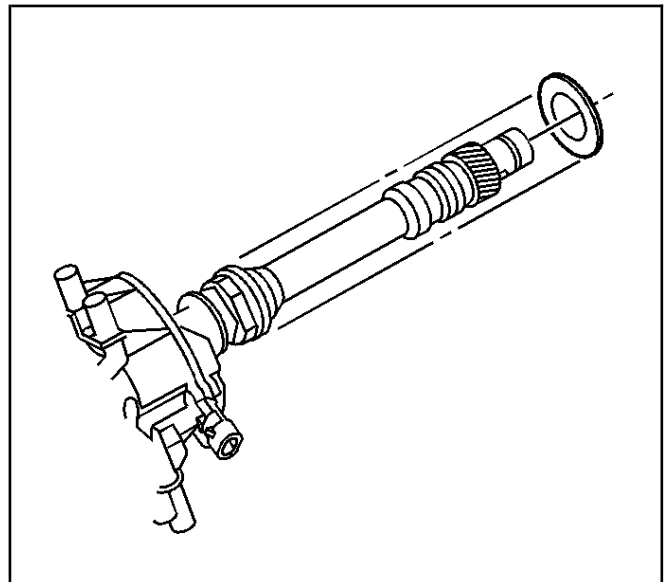
1. Bring cylinder number one piston to Top Dead Center (TDC) of compression stroke.

2. Remove the distributor cap bolts and discard.
3. Remove the distributor cap.



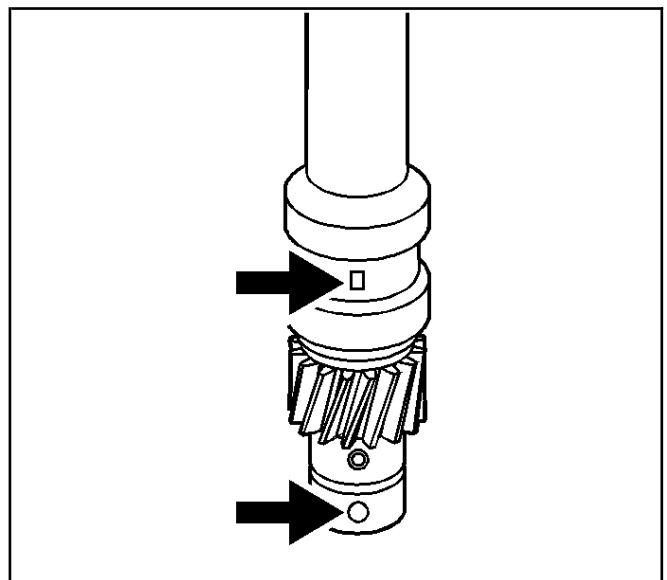
500690

4. Install a NEW distributor gasket onto the distributor.

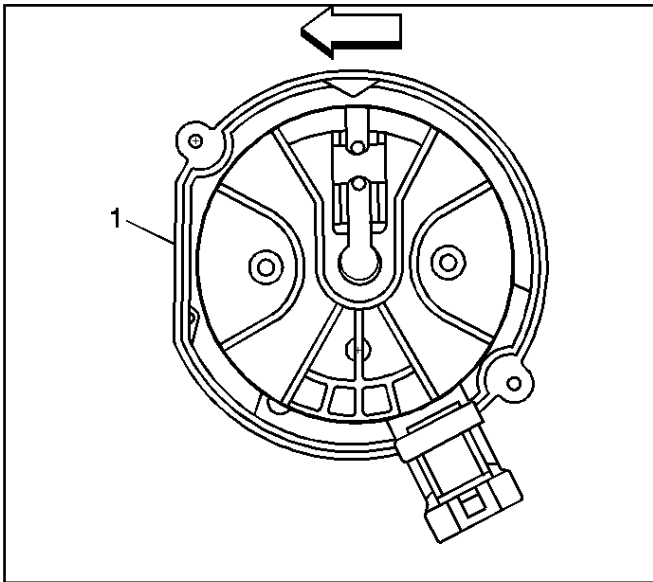


523516

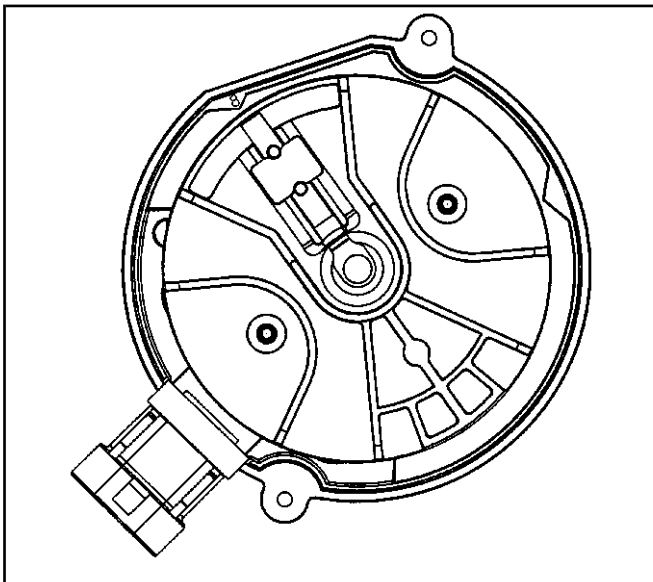
5. Align the indent hole on the driven gear with the paint mark on the distributor housing.
6. Ensure that the distributor rotor segment points to the cap hold area.



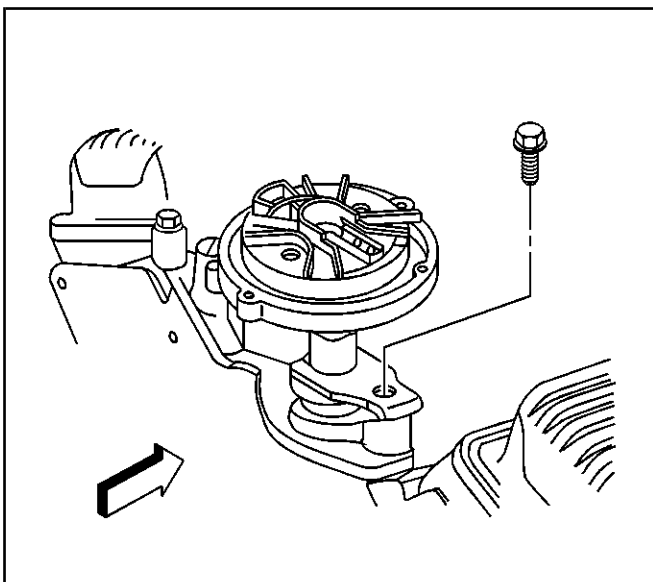
492137



523746



68505



366609

7. Align the slotted tang in the oil pump driveshaft with the distributor driveshaft. Rotate the oil pump driveshaft with a screwdriver if necessary.
8. Align the flat (1) in the distributor housing toward the front of the engine.
9. Install the distributor and distributor clamp.

10. Once the distributor is fully seated, align the distributor rotor segment with the number 8 pointer that is cast into the distributor base.
11. If the distributor rotor segment does not come within a few degrees of the number 8 pointer, the gear mesh between the distributor and camshaft may be off a tooth or more. Repeat the procedure in order to achieve proper alignment.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

12. Install the distributor clamp bolt.

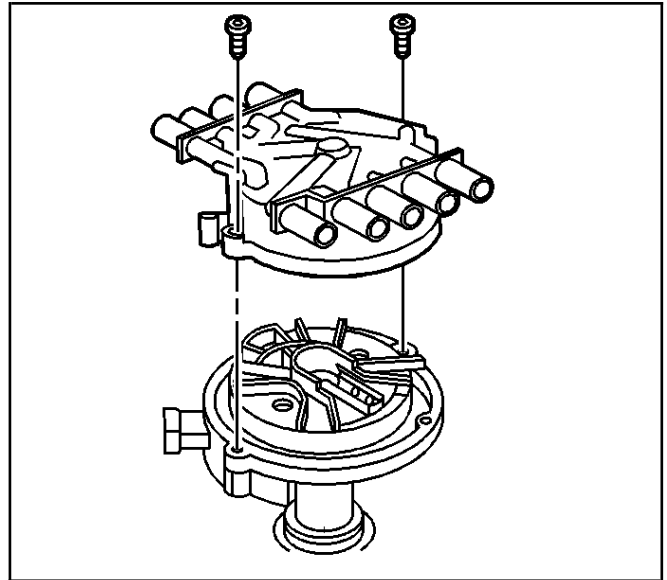
Tighten

Tighten the distributor clamp bolt to 25 N·m (18 lb ft).

13. Install the distributor cap onto the distributor.
14. Install the NEW distributor cap bolts.
Do not overtighten the NEW distributor cap bolts.

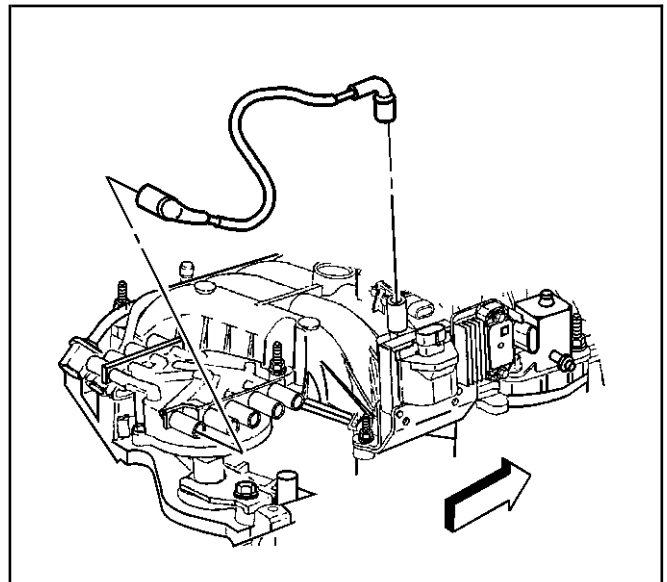
Tighten

Tighten the distributor cap bolts to 2.4 N·m (21 lb in).



500690

15. Install the ignition coil wire harness.



341359

Valve Rocker Arm Cover Installation - Left

SIE-ID = 650069

Important: Always install a NEW valve rocker arm cover gasket.

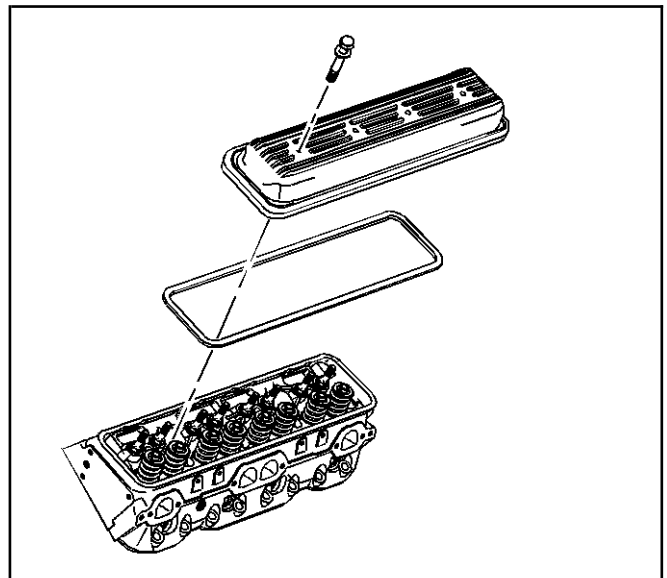
1. Install the NEW valve rocker arm cover gasket.
2. Install the valve rocker arm cover.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

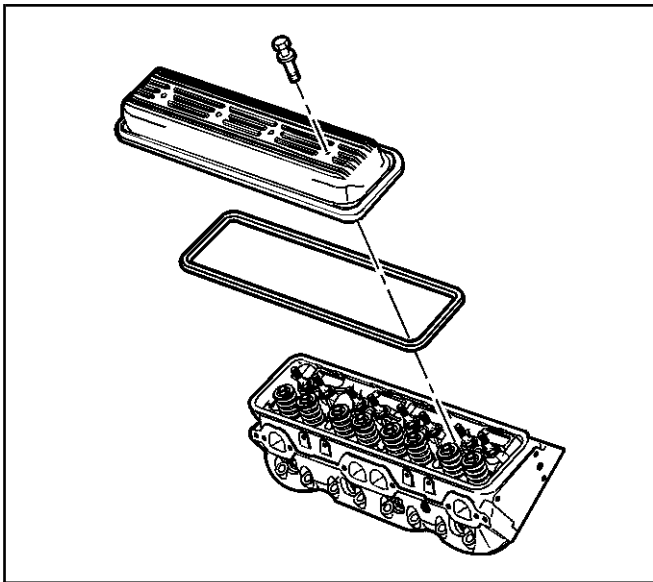
3. Install the valve rocker arm cover washers and bolts.

Tighten

Tighten the bolts to 12 N·m (106 lb in).



39119



182833

Valve Rocker Arm Cover Installation - Right

SIE-ID = 650070

Important: Always install a NEW valve rocker arm cover gasket.

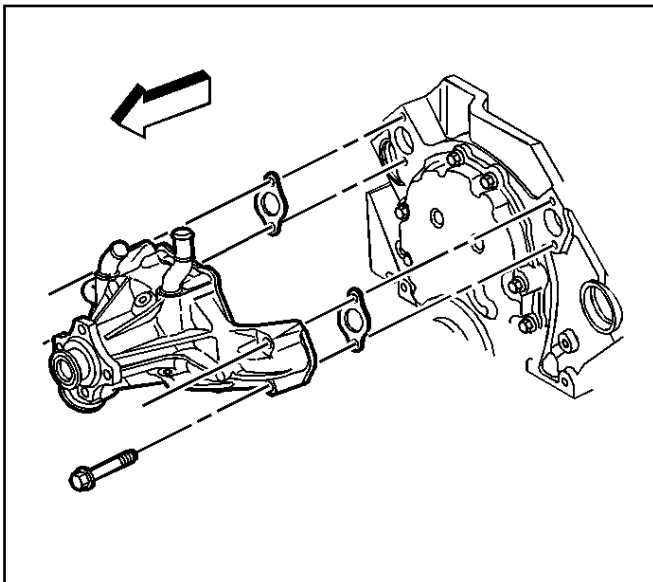
1. Install the NEW valve rocker arm cover gasket.
2. Install the valve rocker arm cover.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

3. Install the valve rocker arm cover washers and bolts.

Tighten

Tighten the bolts to 12 N·m (106 lb in).



69011

Water Pump Installation

SIE-ID = 69040

Tools Required

J 41240 Fan Clutch Remover and Installer

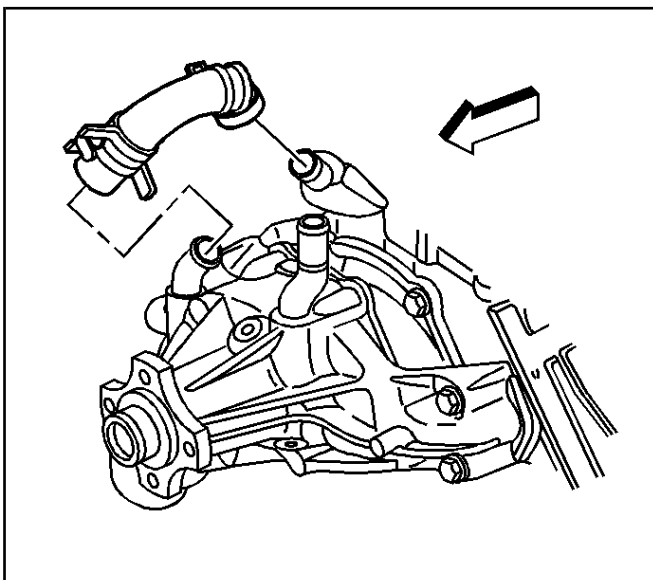
1. Apply sealant GM P/N United States 12346004, GM P/N Canada 10953480, or equivalent, to the threads of the water pump bolts.
2. Install NEW water pump gaskets.
3. Install the water pump.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

4. Install the water pump bolts.

Tighten

Tighten the water pump bolts to 45 N·m (33 lb ft).



182853

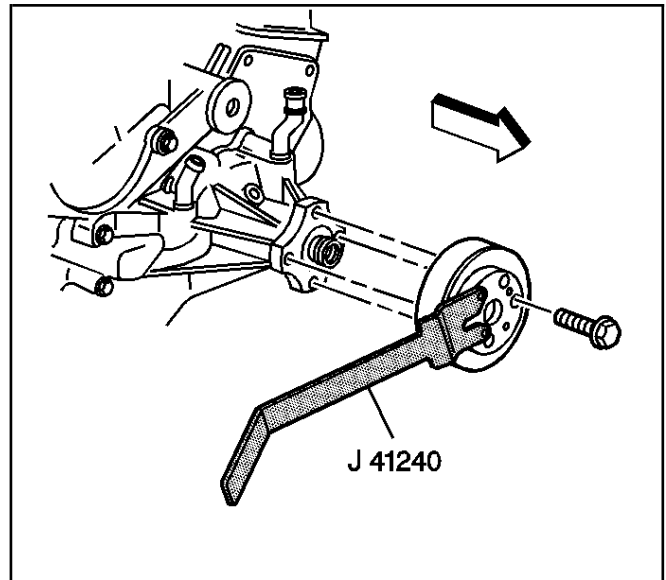
Important: After final assembly, the water pump inlet hose clamp tangs, water pump end, must point forward and the upper tang should be level with the outside diameter of the water pump inlet hose.

5. Install the water pump inlet hose and the water pump inlet hose clamps.

6. Install the fan and water pump pulley and bolts using the *J 41240*.

Tighten

Tighten the fan and water pump pulley bolts to 25 N·m (18 lb ft).



317191

Oil Level Indicator and Tube Installation

SIE-ID = 349357

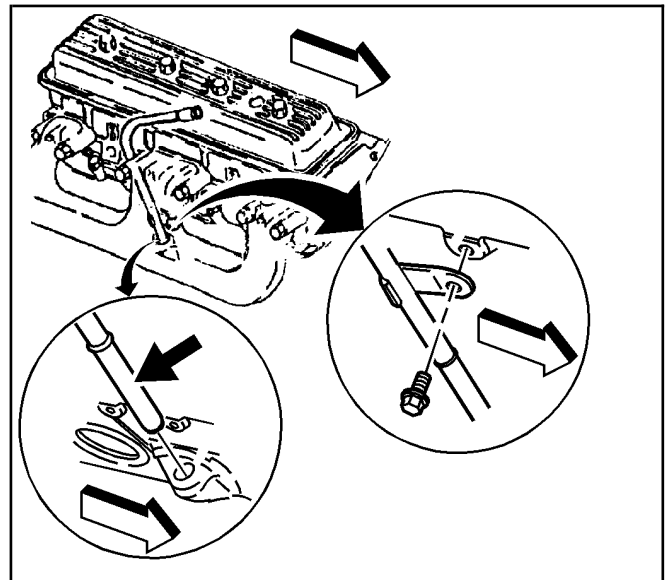
1. Apply sealant GM P/N United States 12346004, GM P/N Canada 10953480, or equivalent, around the oil level indicator tube 13 mm (0.5 in) below the tube bead.
2. Install the oil level indicator tube into the engine block. Rotate the oil level indicator tube into position.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

3. Install the oil level indicator tube bolt.

Tighten

Tighten the oil level indicator tube bolt to 25 N·m (18 lb ft).



500691

Exhaust Manifold Installation - Left

SIE-ID = 650071

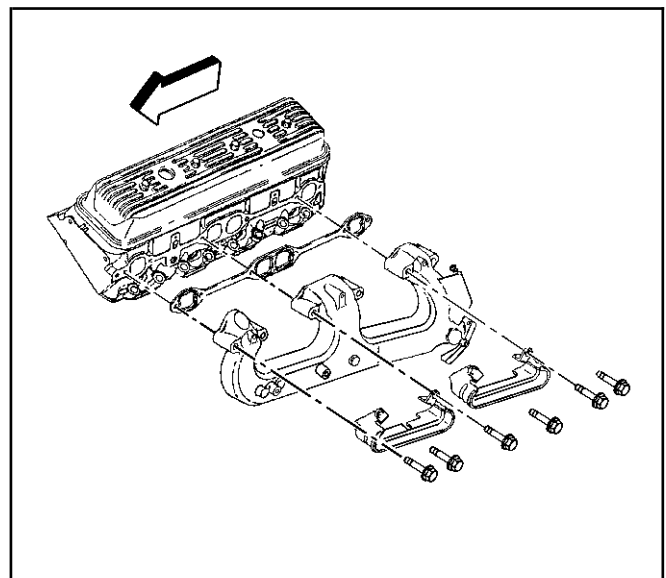
1. Install the NEW exhaust manifold gasket.
2. Install the exhaust manifold.
3. Install the spark plug wire shields.
4. Apply threadlock GM P/N United States 12345493, GM P/N Canada 10953488, or equivalent, to the threads of the exhaust manifold bolts.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

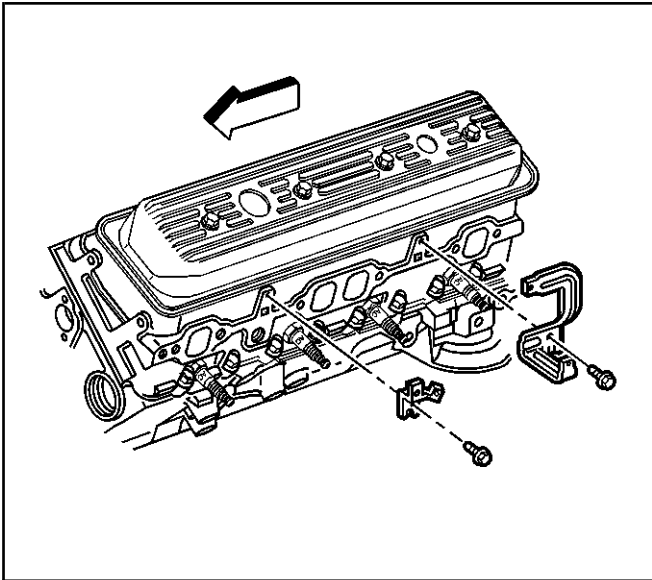
5. Install the exhaust manifold bolts.

Tighten

- 5.1. Tighten the exhaust manifold bolts on the first pass to 15 N·m (11 lb ft).
- 5.2. Tighten the exhaust manifold bolts on the final pass to 30 N·m (22 lb ft).



64925



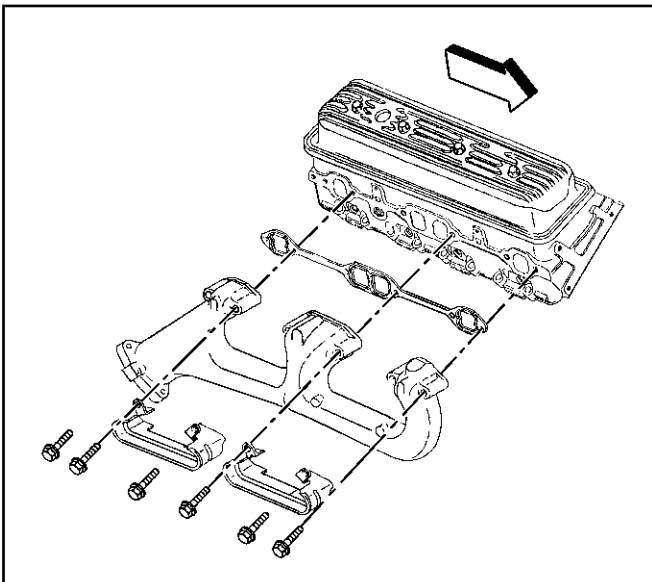
317185

6. Install the spark plug wire supports and bolts.

Tighten

Tighten the bolts to 12 N·m (106 lb in).

7. Install the spark plug wires onto the spark plugs.



69032

Exhaust Manifold Installation - Right

SIE-ID = 650072

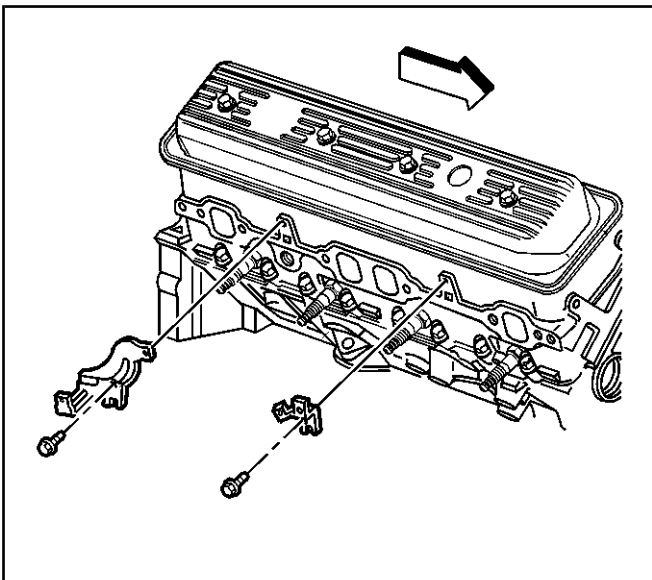
1. Install the NEW exhaust manifold gasket.
2. Install the exhaust manifold.
3. Install the spark plug heat shields.
4. Apply threadlock GM P/N United States 12345493, GM P/N Canada 10953488, or equivalent, to the threads of the exhaust manifold bolts.

Notice: Refer to *Fastener Notice* in Cautions and Notices.

5. Install the exhaust manifold bolts.

Tighten

- 5.1. Tighten the exhaust manifold bolts on the first pass to 15 N·m (11 lb ft).
- 5.2. Tighten the exhaust manifold bolts on the final pass to 30 N·m (22 lb ft).



317179

6. Install the spark plug wire supports and bolts.

Tighten

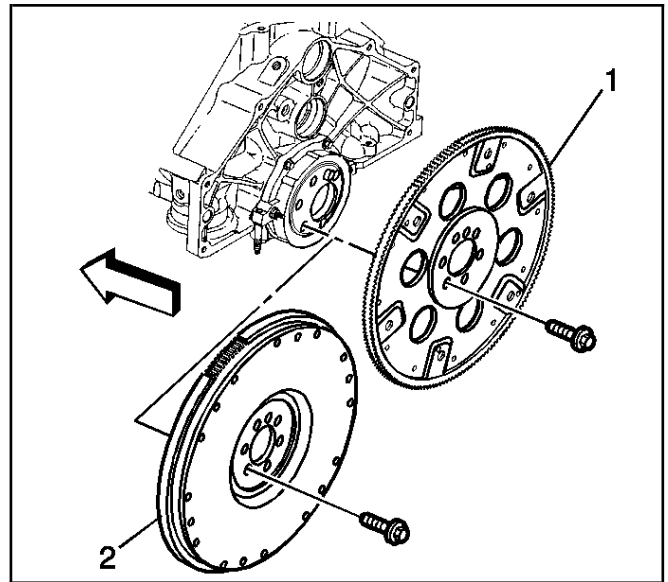
Tighten the bolts to 12 N·m (106 lb in).

7. Install the spark plug wires onto the spark plugs.

Engine Flywheel Installation

SIE-ID = 784241

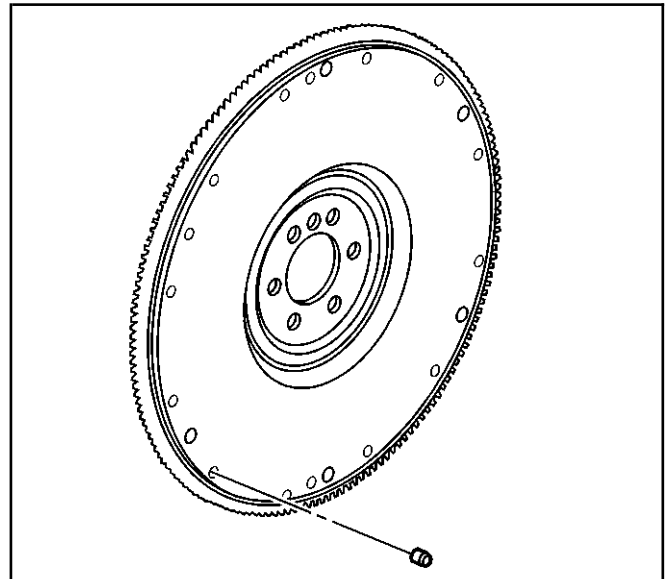
1. Install the engine flywheel (1 or 2) to the crankshaft.
Align the engine flywheel locator hole to the flywheel locator pin.



188129

Important: If replacing the engine flywheel (manual transmission), note the position and length of the original flywheel weights, if applicable. Flywheel weights of the same length must be installed into the new engine flywheel in the same location as the flywheel weights were in the old engine flywheel.

2. Note the position of the flywheel weights and install the NEW flywheel weights as required.
A properly installed flywheel weight will be flush or slightly below flush with the face of the engine flywheel.



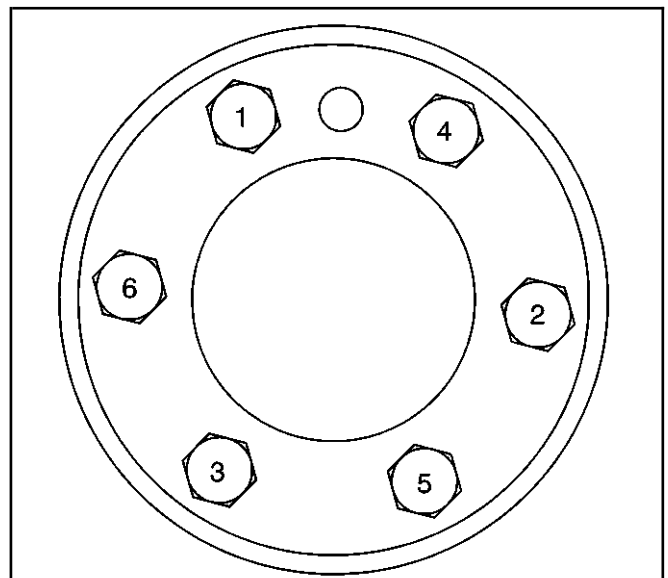
64126

Notice: Refer to *Fastener Notice* in Cautions and Notices.

3. Install the engine flywheel bolts.

Tighten

Tighten the engine flywheel bolts in sequence (1–6) to 100 N·m (74 lb ft).

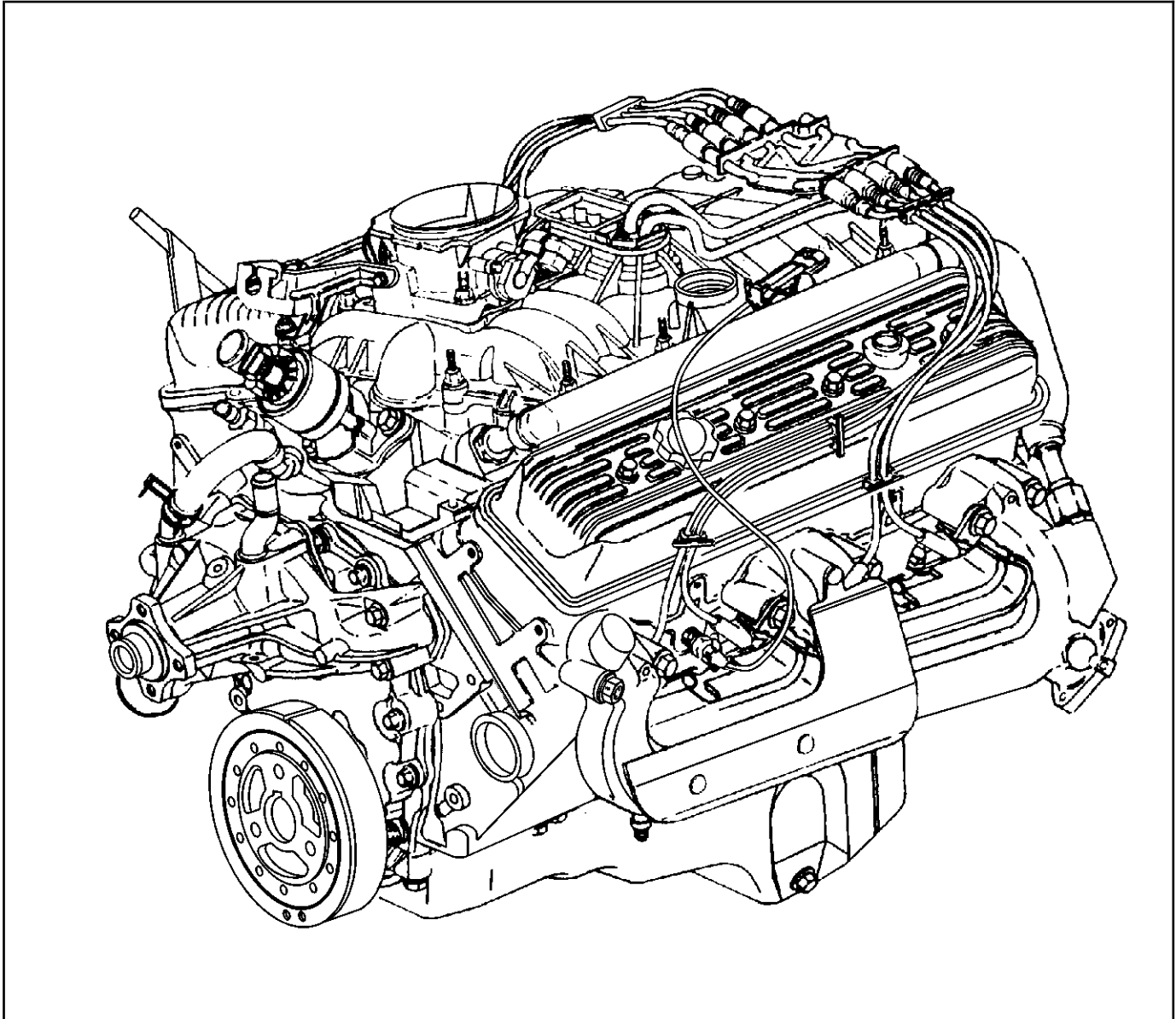


63174

Description and Operation

Engine Component Description

SIE-ID = 69042



182830

Cylinder Block

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

Cylinder Head

The cylinder heads are made of cast iron. The valve guides and valve seats are machined surfaces integral to the cylinder head. The 5.7L heavy duty applications have pressed in exhaust valve seats. The spark plugs are located between the intake and exhaust ports.

Camshaft

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

Motion from the engine camshaft is transmitted to the valves by hydraulic roller valve lifters, valve pushrods, and ball-pivot type valve rocker arms.

Crankshaft

The crankshaft is made of cast nodular iron. The crankshaft is supported by five crankshaft bearings. The crankshaft bearings are retained by the crankshaft bearing caps, which are machined with the engine block for proper alignment and clearances. Light duty

5.0L and 5.7L engines have two bolts per crankshaft bearing cap. The heavy duty 5.7L engines have four bolts per crankshaft bearing cap, on bearing caps 2, 3, and 4. The number 5 crankshaft bearing cap at the rear of the engine is the end thrust bearing cap. The four connecting rod journals (two connecting rods per journal) are spaced 90 degrees apart. The crankshaft position sensor reluctor ring is pushed onto the front of the crankshaft. The crankshaft position sensor reluctor ring has four lugs used for crankshaft timing and it is constructed of powdered metal. The reluctor ring has an interference fit onto the crankshaft and an internal keyway for correct positioning.

Pistons and Connecting Rods

The pistons are made of 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. The piston pins have a floating fit in the piston and are retained by a press fit in the connecting rod assembly. The connecting rods are made out of either forged powdered metal or forged steel. The connecting rods are machined with the connecting rod cap installed for proper clearances and alignment.

Valve Train

The valve train is a ball pivot type. Motion is transmitted from the camshaft through the hydraulic roller valve lifters and tubular valve pushrods to the valve rocker arms. The valve rocker arm pivots on a ball in order to open the valve. The hydraulic roller valve lifters keep all parts of the valve train in constant contact. The valve rocker arm ball is retained on the valve rocker arm ball stud with a locking nut. The valve rocker arm ball studs are pressed into the cylinder head.

Intake Manifold

The intake manifold is a two piece design. The upper intake manifold portion is made from a composite material and the lower intake manifold portion is cast-aluminum. The throttle body mounts to the upper intake manifold. The lower intake manifold has an exhaust gas recirculation (EGR) port cast into the manifold for mixture of exhaust gases with the fuel and air mixture. The EGR valve mounts to the lower intake manifold.

The Central Sequential Multiport Fuel Injection, Central (SFI) system uses multiple injectors to meter and distribute fuel to each engine cylinder. The Central (SFI) unit is retained by a bracket bolted to the lower intake manifold. The TBI fuel meter also houses the pressure regulator. Metal inlet and outlet

fuel lines and nylon delivery tubes independently distribute fuel to each cylinder through nozzles located at the port entrance of each manifold runner where the fuel is atomized.

New Product Information

SIE-ID = 512775

The purpose of New Product Information is to highlight or indicate important product changes from the previous model year.

Changes may include one or more of the following items:

- Torque values and/or fastener tightening strategies
- Changed engine specifications
- New sealants and/or adhesives
- Disassembly and assembly procedure revisions
- Engine mechanical diagnostic procedure revisions
- New special tools required
- A component comparison from the previous year

Torque Values and/or Fastener Tightening Strategies

- Cylinder head bolts, crankshaft bearing cap bolts, and connecting rod bolts apply a torque angle strategy.
In an on-vehicle situation where a torque angle meter may not fit into the vehicle packaging, a three step tightening process may be used with a torque wrench.
- Certain fasteners should not be reused. Bolts, studs, or other fasteners that must be replaced will be called out in the specific service procedure.

Changed Engine Specifications

Engine specifications remain the same as the 1999 products.

Disassembly and Assembly Procedure Revisions and Additions

No revisions or additions.

Engine Mechanical Diagnostic Procedure Revisions

- Valve Train diagnostic information is now provided in table form. Potential or probable causes are supplied for each specific concern.
- Engine Noise diagnostic information is now provided in table form. Potential or probable causes are supplied for each specific concern.

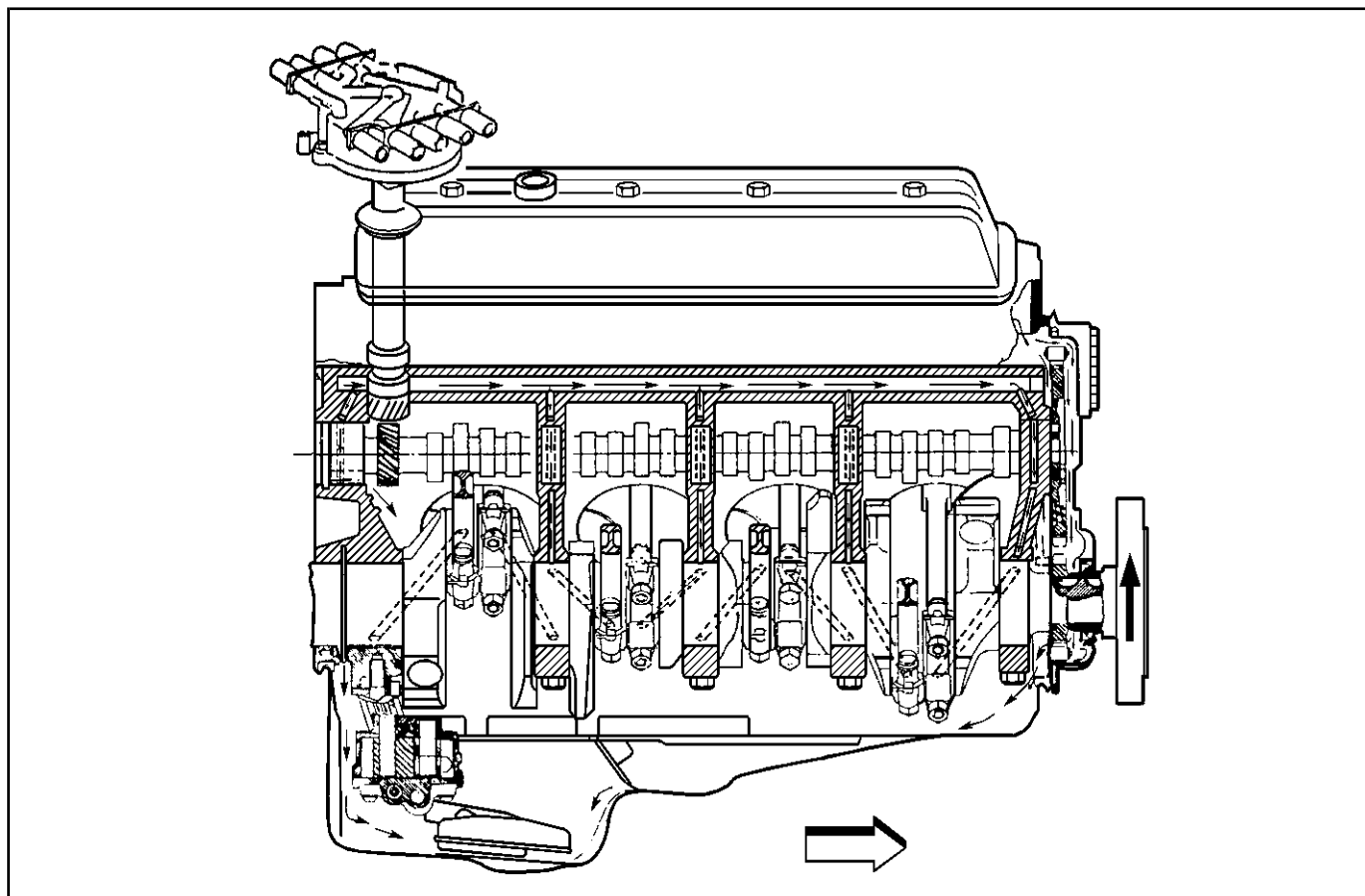
New Special Tools Required

No new special tools are required.

Lubrication Description

SIE-ID = 650073

Right Side View SIO-ID = 71039

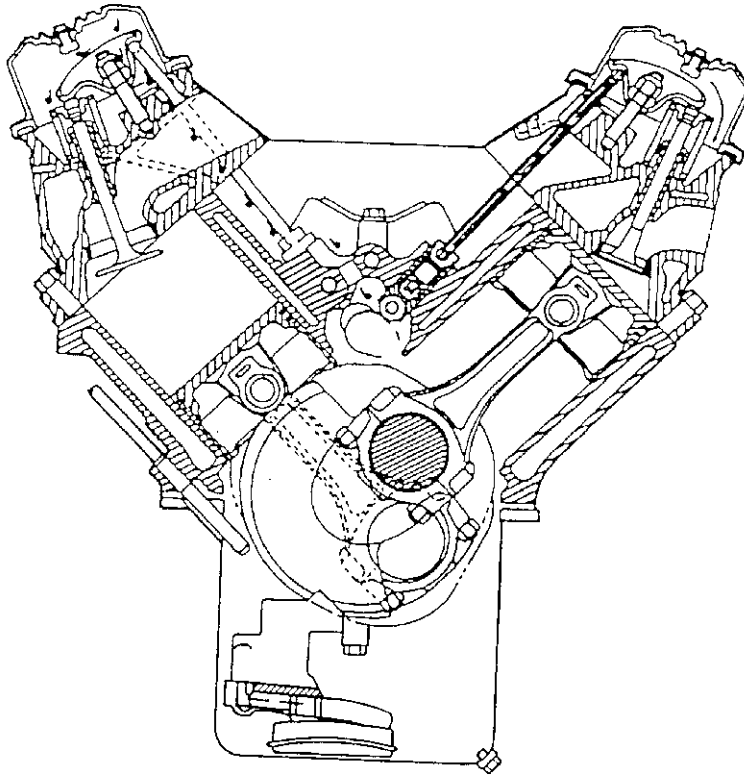


67757

The gear-type oil pump is driven through an extension driveshaft. The extension driveshaft is driven by the distributor which is gear driven by the camshaft. The oil is drawn from the oil pan through a pickup screen and tube. Pressurized oil is delivered through internal passages in order to lubricate the camshaft and the crankshaft bearings and to provide lash control in

the hydraulic valve lifters. Oil is metered from the valve lifters through the valve pushrods in order to lubricate the valve rocker arms and valve rocker arm ball pivots. Oil returning to the oil pan from the cylinder heads and the camshaft front bearing, lubricates the camshaft timing chain and the crankshaft and the camshaft sprockets.

Front View SIO-ID = 71037



67753

Cleanliness and Care

SIE-ID = 19007

- Throughout this section, it should be understood that proper cleaning and protection of machined surfaces and friction areas is part of the repair procedure. This is considered standard shop practice even if not specifically stated.
- When any internal engine parts are serviced, care and cleanliness is important.
- When components are removed for service, the components should be marked, organized or retained in a specific order for re-assembly.
- At the time of installation, the components should be installed in the same location and with the same mating surface as when removed.
- An automobile engine is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in millimeters or thousandths of an inch. The surfaces should be protected to avoid component damage.
- Apply a liberal amount of clean engine oil to friction areas during assembly.
- Proper lubrication will protect and lubricate friction areas during initial operation.

Replacing Engine Gaskets

SIE-ID = 66654

Gasket Reuse and Applying Sealant

- Do not reuse any gasket unless specified.
- Gaskets that can be reused will be identified in the service procedure.
- Do not apply sealant to any gasket or sealing surface unless specified in the service procedure.

Separating Components

- Use a rubber mallet in order to separate the components.
- Bump the part sideways in order to loosen the components.
- Bumping of the component should be done at bends or reinforced areas of the component to prevent distortion of the components.

Cleaning Gasket Surfaces

- Use care to avoid gouging or scraping the sealing surfaces.
- Use a plastic or wood scraper in order to remove all the sealant from the components.
Do not use any other method or technique to remove the sealant or the gasket material from a part.
- Do not use abrasive pads, sand paper, or power tools to clean the gasket surfaces.
 - These methods of cleaning can cause damage to the component sealing surfaces.

- Abrasive pads also produce a fine grit that the oil filter cannot remove from the engine oil.

This fine grit is an abrasive and can cause internal engine damage.

Assembling Components

- Assemble components using only the sealant (or equivalent) that is specified in the service procedure.
- Sealing surfaces must be clean and free of debris or oil.
- Specific components such as crankshaft oil seals or valve stem oil seals may require lubrication during assembly.
- Components requiring lubrication will be identified in the service procedure.
- Apply only the amount of sealant specified in the service procedure to a component.
- Do not allow the sealant to enter into any blind threaded holes, as the sealant may prevent the fastener from clamping properly or cause component damage when tightened.

Important: Do not overtighten the fasteners.

- Tighten the fasteners to the proper specifications.

Use of RTV and Anaerobic Sealer

SIE-ID = 411537

Sealant Types

Important: The correct sealant and amount of sealant must be used in the proper location to prevent oil leaks, coolant leaks, or the loosening of the fasteners. DO NOT interchange the sealants. Use only the sealant, or equivalent, as specified in the service procedure.

The following 2 major types of sealant are commonly used in engines:

- Aerobic sealant Room Temperature Vulcanizing (RTV)
- Anaerobic sealant, which include the following:
 - Gasket eliminator
 - Pipe
 - Threadlock

Aerobic Type Room Temperature Vulcanizing (RTV) Sealant

Aerobic type Room Temperature Vulcanizing (RTV) sealant cures when exposed to air. This type of sealant is used where 2 components, such as the intake manifold and the engine block, are assembled together.

Use the following information when using RTV sealant:

- Do not use RTV sealant in areas where extreme temperatures are expected. These areas include:
 - The exhaust manifold
 - The head gasket

- Any other surfaces where a different type of sealant is specified in the service procedure

- Always follow all the safety recommendations and the directions that are on the RTV sealant container.
- Use a plastic or wood scraper in order to remove all the RTV sealant from the components.

Notice: SIO-ID = 68592 Do not allow the RTV sealant to enter any blind threaded hole. RTV sealant that is allowed to enter a blind threaded hole can cause hydraulic lock of the fastener when the fastener is tightened. Hydraulic lock of a fastener can lead to damage to the fastener and/or the components. Hydraulic lock of a fastener can also prevent the proper clamping loads to be obtained when the fastener is tightened. Improper clamping loads can prevent proper sealing of the components allowing leakage to occur. Preventing proper fastener tightening can allow the components to loosen or separate leading to extensive engine damage.

- The surfaces to be sealed must be clean and dry.
- Use a RTV sealant bead size as specified in the service procedure.
- Apply the RTV sealant bead to the inside of any bolt holes areas.

Important: Do not wait for the RTV sealant to skin over.

- Assemble the components while the RTV sealant is still wet to the touch, within 3 minutes.

Important: Do not overtighten the fasteners.

- Tighten the fasteners in sequence, if specified, and to the proper torque specifications.

Anaerobic Type Gasket Eliminator Sealant

Anaerobic type gasket eliminator sealant cures in the absence of air. This type of sealant is used where 2 rigid parts, such as castings, are assembled together. When 2 rigid parts are disassembled and no sealant or gasket is readily noticeable, then the 2 parts were probably assembled using an anaerobic type gasket eliminator sealant.

Use the following information when using gasket eliminator sealant:

- Always follow all the safety recommendations and directions that are on the gasket eliminator sealant container.
- Apply a continuous bead of gasket eliminator sealant to one flange.

The surfaces to be sealed must be clean and dry.

Important:

- Do not allow the gasket eliminator sealant to enter any blind threaded holes, as the gasket eliminator sealant may prevent the fasteners from clamping properly, seating properly, or cause damage when the fastener tightened.
- Gasket eliminator sealed joint fasteners that are partially torqued and the gasket eliminator sealant allowed to cure more than five minutes, may result in incorrect shimming and sealing of the joint.

- Do not overtighten the fasteners.
 - Apply the gasket eliminator sealant evenly to get a uniform thickness of the gasket eliminator sealant on the sealing surface.
 - Tighten the fasteners in sequence, if specified, and to the proper torque specifications.
 - After properly tightening the fasteners, remove the excess gasket eliminator sealant from the outside of the joint.

Anaerobic Type Threadlock Sealant

Anaerobic type threadlock sealant cures in the absence of air. This type of sealant is used for threadlocking and sealing of bolts, fittings, nuts, and studs. This type of sealant cures only when confined between 2 close fitting metal surfaces.

Use the following information when using threadlock sealant:

- Always follow all safety recommendations and directions that are on the threadlock sealant container.
- The threaded surfaces to be sealed must be clean and dry.
- Apply the threadlock sealant as specified on the threadlock sealant container.

Important:

- Fasteners that are partially torqued and then the threadlock sealant allowed to cure more than five minutes, may result in incorrect clamp load of assembled components.
- Do not overtighten the fasteners.
- Tighten the fasteners in sequence, if specified, and to the proper torque specifications.

Anaerobic Type Pipe Sealant

Anaerobic type pipe sealant cures in the absence of air and remains pliable when cured. This type of sealant is used where 2 parts are assembled together and require a leak proof joint.

Use the following information when using pipe sealant:

- Do not use pipe sealant in areas where extreme temperatures are expected. These areas include:
 - The exhaust manifold
 - The head gasket
 - Surfaces where a different sealant is specified
- Always follow all the safety recommendations and the directions that are on the pipe sealant container.
- The surfaces to be sealed must be clean and dry.
- Use a pipe sealant bead of the size or quantity as specified in the service procedure.

Notice: SIO-ID = 768432 Do not allow the pipe sealant to enter a blind hole. The pipe sealant may prevent the fastener from achieving proper clamp load, cause component damage when the fastener is tightened, or lead to component failure.

- Apply the pipe sealant bead to the inside of any bolt hole areas.
- Apply a continuous bead of pipe sealant to 1 sealing surface.

Important: Do not overtighten the fasteners.

- Tighten the fasteners in sequence, if specified, and to the proper torque specifications.

Separating Parts

SIE-ID = 194497

Important: Many internal engine components will develop specific wear patterns on their friction surfaces.

When disassembling the engine, internal components **MUST** be separated, marked and organized in a way to ensure reinstallation to original location and position.

Mark or identify the following components:

- Piston and the piston pin
- Piston to the specific cylinder bore
- Piston rings to the specific cylinder bore
- Connecting rod to the crankshaft journal
- Connecting rod to connecting rod cap
- Crankshaft bearings and connecting rod bearings
- Engine camshaft and valve lifters
- Valve lifters and valve rocker arms
- Valve to the valve guide
- Valve spring to cylinder head location
- Engine block bearing cap location and direction
- Oil pump drive and driven gears

Tools and Equipment

SIE-ID = 507215

Special tools are listed and illustrated throughout this section with a complete listing at the end of the section. The tools (or the equivalents) are specially designed to quickly and safely accomplish the operations for which the tools are intended. The use of special tools will also minimize possible damage to engine components. Some precision measuring tools are required for inspection of certain critical components. Torque wrenches and a torque angle meter are necessary for the proper tightening of various fasteners.

To properly service the engine assembly, the following items should be readily available:

- Approved eye protection and safety gloves
- A clean, well-lit, work area
- A suitable parts cleaning tank
- A compressed air supply
- Trays or storage containers to keep parts and fasteners organized
- An adequate set of hand tools
- Approved engine repair stand
- An approved engine lifting device that will adequately support the weight of the components

Special Tools and Equipment

SIE-ID = 690690

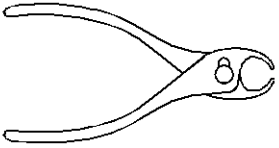
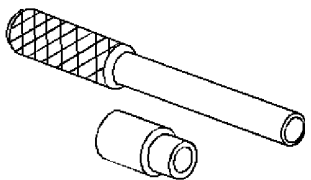
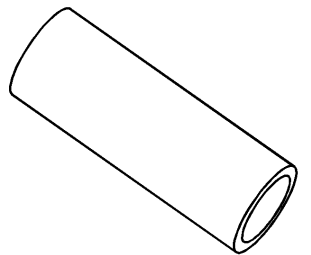
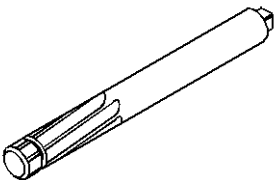
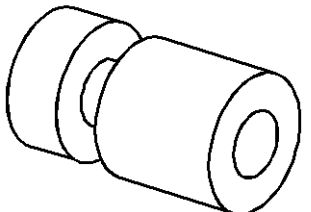
Illustration	Tool Number/ Description
 14487	J 3049-A Valve Lifter Remover
 3404	J 5239 Connecting Rod Bolt Guide Set
 3407	J 5590 Installer
 69826	J 5715 Rocker Stud Hole Reamer 0.0762 mm (0.003 in) oversized
 35460	J 5802-01 Rocker Arm Stud Remover

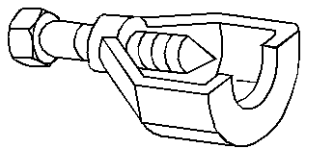
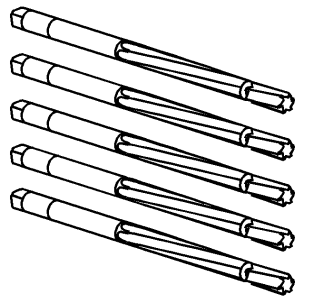
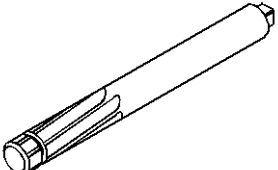
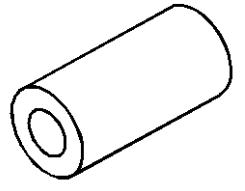
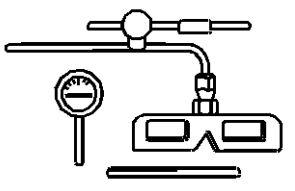
Illustration	Tool Number/ Description
 3406	J 5825-A Crankshaft Gear Remover
 4999	J 5830-02 Valve Guide Reamer Set
 14492	J 6036 Rocker Stud Hole Reamer 0.33 mm (0.013 in) oversized
 35461	J 6880 Rocker Arm Stud Installer
 35463	J 7872 Magnetic Base Dial Indicator

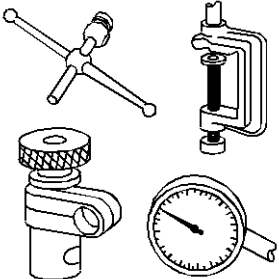
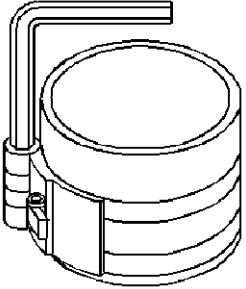
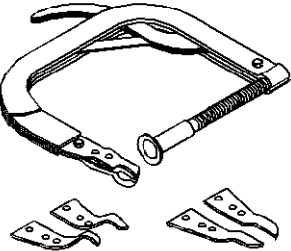
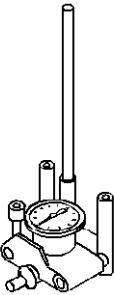
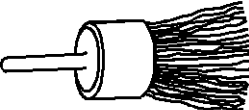
Illustration	Tool Number/ Description
 2014	J 8001 Dial Indicator Set
 3403	J 8037 Ring Compressor
 3414	J 8062 Valve Spring Compressor
 5110	J 8087 Cylinder Bore Gage
 35464	J 8089 Carbon Removing Brush

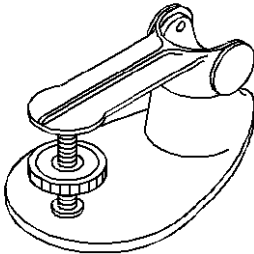
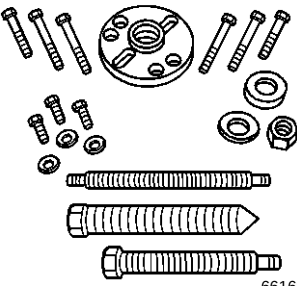
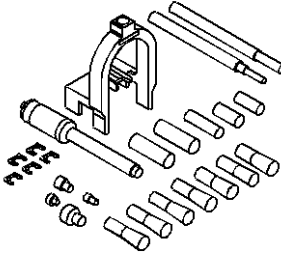
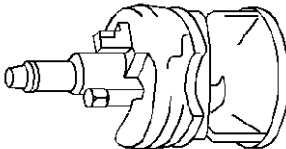
Illustration	Tool Number/ Description
 5112	J 9666 Valve Spring Tester
 3416	J 21882 Oil Suction Pipe Installer
 66168	J 23523-F Balancer Remover and Installer
 14495	J 24086-C Piston Pin Remover/Installer Set
 3412	J 24270 Cylinder Bore Ridge Reamer

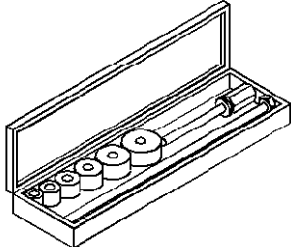
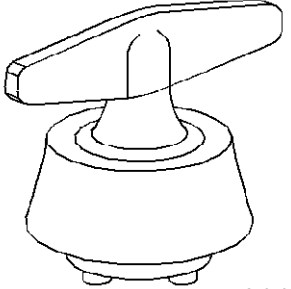
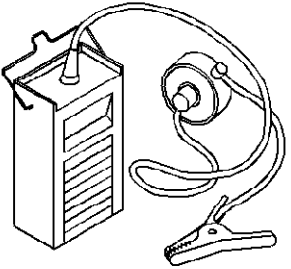
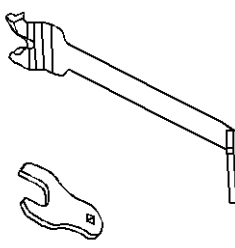
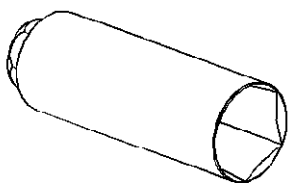
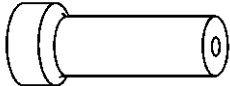
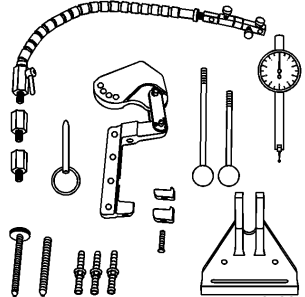
Illustration	Tool Number/ Description
 5118	J 33049 Camshaft Bearing Service Set
 350498	J 35621-B Rear Main Seal Installer
 3413	J 36660-A Electronic Torque Angle Meter
 48304	J 41240 Fan Clutch Remover and Installer
 67136	J 41712 Oil Pressure Switch Socket

Illustration	Tool Number/ Description
 38509	J 42073 Valve Stem Seal Installer
 650651	J 43690 Rod Bearing Clearance Checking Tool