Engine

Engine Mechanical -6.0L,6.2L,

Specifications

2159264

Fastener Tightening Specifications

Fastener Tightening Specifications:Engine Mechanical

Application	Specification	
	Metric	English
Camshaft Position (CMP) Sensor Bolt	12 N·m	106 lb in
CMP Sensor Wire Harness Bolt	12 N·m	106 lb in
Camshaft Retainer Bolts – TORX® Head Bolts	15 N·m	11 lb ft
Camshaft Sprocket Bolt		
First Pass	75 N·m	55 lb ft
Final Pass	50 degrees	
Clutch Pressure Plate Bolts – Manual Transmission	70 N·m	52 lb ft
Connecting Rod Bolts – First Pass	20 N·m	15 lb ft
Connecting Rod Bolts – Final Pass	85 degrees	
Coolant Air Bleed Pipe Bolts	12 N·m	106 lb in
Coolant Temperature Sensor	20 N·m	15 lb ft
Crankshaft Balancer Bolt – First Pass	150 N·m	111 lb ft
Crankshaft Balancer Bolt – Second Pass – Loosen Bolt	360 degrees	
Crankshaft Balancer Bolt – Third Pass	50 N·m	37 lb ft
Crankshaft Balancer Bolt – Final Pass	230 degrees	
Crankshaft Bearing Cap M8 Bolts	25 N·m	18 lb ft
Crankshaft Bearing Cap M10 Bolts – First Pass in Sequence	20 N·m	15 lb ft
Crankshaft Bearing Cap M10 Bolts – Final Pass in Sequence	80 degrees	
Crankshaft Bearing Cap M10 Studs – First Pass in Sequence	20 N·m	15 lb ft
Crankshaft Bearing Cap M10 Studs – Final Pass in Sequence	51 degrees	
Crankshaft Oil Deflector Nuts	25 N·m	18 lb ft

Application	Specification	
	Metric	English
Crankshaft Position (CKP) Sensor Bolt	25 N·m	18 lb ft
Crankshaft Rear Oil Seal Housing Bolts	30 N·m	22 lb ft
Cylinder Head Coolant Plug	20 N·m	15 lb ft
Cylinder Head M11 Bolts – First Pass in Sequence	50 N·m	37 lb ft
Cylinder Head M11 Bolts – Second Pass in Sequence	80 degrees	
Cylinder Head M11 Bolts – Final Pass in Sequence	55 degrees	
Cylinder Head M8 Bolts – in Sequence	30 N·m	22 lb ft
Drive Belt Tensioner Bolt	50 N·m	37 lb ft
Engine Block Coolant Drain Hole Plug	60 N·m	44 lb ft
Engine Block Oil Gallery Plug	60 N·m	44 lb ft
Engine Mount Bracket to Engine Block Bolts	60 N·m	44 lb ft
Engine Mount Nut to Engine Mount Bracket – Do Not Reuse Nut	100 N·m	74 lb ft
Engine Mount Nut to Frame	100 N·m	74 lb ft
Engine Oil Cooler Coolant Fitting	50 N·m	37 lb ft
Engine Oil Cooler Coolant Hose Connector	35 N·m	26 lb ft
Engine Oil Cooler Core-to-Housing Bolts	25 N·m	18 lb ft
Engine Oil Cooler-to-Oil Pan M6 Bolts	10 N·m	89 lb in
Engine Oil Cooler-to-Oil Pan M8 Bolts	25 N·m	18 lb ft
Engine Oil Cooler Pipe Bolt	25 N·m	18 lb ft
Engine Oil Level Sensor	13 N·m	115 lb in
Engine Oil Pressure Switch	35 N·m	25 lb ft
Engine-to-Transmission or Clutch Housing Bolts	50 N·m	37 lb ft
Evaporative Emission (EVAP) Canister Purge Solenoid Valve Bolt	10 N·m	89 lb in
Exhaust Manifold Bolts – First Pass	15 N·m	11 lb ft
Exhaust Manifold Bolts – Final Pass	20 N·m	15 lb ft
Exhaust Manifold Heat Shield Bolt	12 N·m	106 lb in
Exhaust Manifold Stud	20 N·m	15 lb ft

Application	Specification	
	Metric	English
Flex Plate-to-Torque Converter Bolts	63 N·m	46 lb ft
Flywheel/Flex Plate Bolts – First Pass	20 N·m	15 lb ft
Flywheel/Flex Plate Bolts – Second Pass	50 N·m	37 lb ft
Flywheel/Flex Plate Bolts – Final Pass	100 N·m	74 lb ft
Front Cover Bolts	30 N·m	22 lb ft
Fuel Injection Fuel Rail Bolt	10 N·m	89 lb in
Fuel Injection Fuel Rail Studs	10 N·m	89 lb in
Fuel Injector and Ignition Coil Wire Harness Bracket Bolt	10 N·m	89 lb in
Generator Bracket Bolts	50 N·m	37 lb ft
Ignition Coil -to-Valve Rocker Arm Cover Bolts	12 N·m	106 lb in
Inlet Air Temperature Sensor	20 N·m	15 lb ft
J 41798 M8 Bolt	25 N·m	18 lb ft
J 41798 M10 Bolts	50 N·m	37 lb ft
Knock Sensor Bolts	25 N·m	18 lb ft
Motor Mount Bracket Bolts	50 N·m	37 lb ft
Oil Filter	30 N·m	22 lb ft
Oil Filter Fitting	55 N·m	40 lb ft
Oil Pan Closeout Cover Bolt – Left Side	9 N·m	80 lb in
Oil Pan Closeout Cover Bolt – Right Side	9 N·m	80 lb in
Oil Pan Drain Plug	25 N·m	18 lb ft
Oil Pan M6 Bolts – Oil Pan-to-Rear Oil Seal Housing	12 N·m	106 lb in
Oil Pan M8 Bolts – Oil Pan-to-Engine Block and Oil Pan-to-Front Cover	25 N·m	18 lb ft
Oil Pressure Sensor	35 N·m	26 lb ft
Oil Pump Cover Bolts	12 N·m	106 lb in
Oil Pump-to-Engine Block Bolts	25 N·m	18 lb ft
Oil Pump Relief Valve Plug	12 N·m	106 lb in
Oil Pump Screen-to-Oil Pump Bolt	12 N·m	106 lb in

Application	Specification	
	Metric	English
Piston Oil Nozzle Bolts	20 N·m	15 lb ft
Spark Plugs	20 N·m	15 lb ft
Supercharger Air Outlet Pressure Sensor Bolt	10 N·m	89 lb in
Supercharger Barometric Pressure Sensor Bolt	10 N·m	89 lb in
Supercharger Belt Idler Pulley Bolt	50 N·m	37 lb ft
Supercharger Belt Idler Pulley Bracket Bolt	50 N·m	37 lb ft
Supercharger Belt Tensioner Bolt	50 N·m	37 lb ft
Supercharger Bypass Valve Actuator Bolts	25 N·m	18 lb ft
Supercharger Charge Air Bypass Regulator Solenoid Bolt	10 N·m	89 lb in
Supercharger Inlet Air Pressure Sensor Bolt	10 N·m	89 lb in
Supercharger Charge Air Cooler-to-Cover Bolts	10 N·m	89 lb in
Supercharger Charge Air Cooler Outlet Pipe Bolts	10 N·m	89 lb in
Supercharger Charge Air Cooler Isolator Bolts	5 N·m	44 lb in
Supercharger – Lower – Manifold-to-Cylinder Head Bolts - First Pass in Sequence	5 N·m	44 lb in
Supercharger – Lower – Manifold-to-Cylinder Head Bolts - Final Pass in Sequence	10 N·m	89 lb in
Supercharger – Upper – Charge Air Cooler Cover Bolts – First Pass in Sequence	5 N·m	44 lb in
Supercharger – Upper – Charge Air Cooler Cover Bolts – Final Pass in Sequence	10 N·m	89 lb in
Throttle Body Bolts	10 N·m	89 lb in
Timing Chain Tensioner Bolts	30 N·m	22 lb ft
Valley Cover Bolts	25 N·m	18 lb ft
Valve Lifter Guide Bolts	12 N·m	106 lb in
Valve Rocker Arm Bolts	30 N·m	22 lb ft
Valve Rocker Arm Cover Bolts	12 N·m	106 lb in
Water Inlet Housing Bolts	15 N·m	11 lb ft

Application	Specification	
	Metric	English
Water Pump Bolts – First Pass	15 N·m	11 lb ft
Water Pump Bolts – Final Pass	30 N·m	22 lb ft

Specifications

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Engine Mechanical Specifications

Specifications:Engine Mechanical

Application	Specification	
	Metric	English
General		
Engine Type	V8	
Displacement	6.2L	376 CID
RPO	LSA	
VIN	P	
Bore	103.241–103.259 mm	4.0065–4.0065 in
Stroke	92.0 mm	3.622 in
Compression Ratio	9.1:1	
Supercharger Boost Ratio	10.1 :1	
Firing Order	1–8–7–2–6–5–4–3	
Spark Plug Gap	1.02 mm	0.04 in
Block		
Camshaft Bearing Bore 1 and 5 Diameter	59.58–59.63 mm	2.345–2.347 in
Camshaft Bearing Bore 2 and 4 Diameter	59.08–59.13 mm	2.325–2.327 in
Camshaft Bearing Bore 3 Diameter	58.58–58.63 mm	2.306–2.308 in
Crankshaft Main Bearing Bore Diameter	69.871–69.889 mm	2.75–2.751 in
Crankshaft Main Bearing Bore Out-of-Round	0.006 mm	0.0002 in
Cylinder Bore Diameter	103.241–103.259 mm	4.0065–4.0065 in

Application	Specification	
	Metric	English
Cylinder Head Deck Height – Measuring from the Centerline of Crankshaft to the Deck Face	234.57–234.82 mm	9.235–9.245 in
Cylinder Head Deck Surface Flatness – Measured within a 152.4 mm (6.0 in) Area	0.11 mm	0.004 in
Cylinder Head Deck Surface Flatness – Measuring the Overall Length of the Block Deck	0.22 mm	0.008 in
Valve Lifter Bore Diameter	21.417–21.443 mm	0.843–0.844 in
Camshaft		
Camshaft End Play	0.025–0.305 mm	0.001–0.012 in
Camshaft Journal Diameter	54.990–55.015 mm	2.165–2.166 in
Camshaft Bearing Diameter	55.063–55.088 mm	2.1678–2.1688 in
Camshaft Journal-to-Bearing Clearance	0.048–0.098 mm	0.0002–0.0038 in
Camshaft Journal Out-of-Round	0.025 mm	0.001 in
Camshaft Lobe Lift – Intake	7.2 mm	0.283 in
Camshaft Lobe Lift – Exhaust	7.2 mm	0.283 in
Camshaft Runout – Measured at the Intermediate Journals	0.05 mm	0.002 in
Connecting Rod		
Connecting Rod Bearing Clearance – Production	0.023–0.065 mm	0.0009–0.0025 in
Connecting Rod Bearing Clearance – Service	0.023–0.076 mm	0.0009–0.003 in
Connecting Rod Bore Diameter – Bearing End	56.505–56.525 mm	2.224–2.225 in
Connecting Rod Bore Out-of-Round – Bearing End – Production	0.004–0.008 mm	0.00015–0.0003 in
Connecting Rod Bore Out-of-Round – Bearing End – Service	0.004–0.008 mm	0.00015–0.0003 in
Connecting Rod Side Clearance	0.11–0.51 mm	0.00433–0.02 in
Crankshaft		
Connecting Rod Journal Diameter – Production	53.318–53.338 mm	2.0991–2.0999 in
Connecting Rod Journal Diameter – Service	53.308 mm	2.0987 in
Connecting Rod Journal Out-of-Round – Production	0.005 mm	0.0002 in

Application	Specification	
	Metric	English
Connecting Rod Journal Out-of-Round – Service	0.01 mm	0.0004 in
Connecting Rod Journal Taper – Maximum for 1/2 of Journal Length – Production	0.005 mm	0.0002 in
Connecting Rod Journal Taper – Maximum for 1/2 of Journal Length – Service	0.02 mm	0.00078 in
Crankshaft End Play	0.04–0.2 mm	0.0015–0.0078 in
Crankshaft Main Bearing Clearance – Production	0.02–0.052 mm	0.0008–0.0021 in
Crankshaft Main Bearing Clearance – Service	0.02–0.065 mm	0.0008–0.0025 in
Crankshaft Main Journal Diameter – Production	64.992–65.008 mm	2.558–2.559 in
Crankshaft Main Journal Diameter – Service	64.992 mm	2.558 in
Crankshaft Main Journal Out-of-Round – Production	0.003 mm	0.000118 in
Crankshaft Main Journal Out-of-Round – Service	0.008 mm	0.0003 in
Crankshaft Main Journal Taper – Production	0.01 mm	0.0004 in
Crankshaft Main Journal Taper – Service	0.02 mm	0.00078 in
Crankshaft Rear Flange Runout	0.05 mm	0.002 in
Crankshaft Reluctor Ring Runout – Measured 1.0 mm (0.04 in) Below Tooth Diameter	0.7 mm	0.028 in
Crankshaft Thrust Surface – Production	26.14–26.22 mm	1.029–1.0315 in
Crankshaft Thrust Surface – Service	26.22 mm	1.0315 in
Crankshaft Thrust Surface Runout	0.025 mm	0.001 in
Cylinder Head		
Cylinder Head Height/Thickness – Measured from the Cylinder Head Deck to Machining Pad Locations	6.88–7.12 mm	0.271–0.283 in
Surface Flatness – Block Deck – Measured within a 152.4 mm (6.0 in) Area	0.08 mm	0.003 in
Surface Flatness – Block Deck – Measuring the Overall Length of the Cylinder Head	0.1 mm	0.004 in
Surface Flatness – Exhaust Manifold Deck	0.1 mm	0.004 in
Surface Flatness – Intake Manifold Deck	0.08 mm	0.0031 in

Application	Specification	
	Metric	English
Valve Guide Installed Height – Measured from the Spring Seat Surface to the Top of the Guide	17.08–17.57 mm	0.672–0.692 in
Lubrication System		
Oil Capacity – with Filter	5.7 liters	6.0 quarts
Oil Capacity – without Filter	5.2 liters	5.5 quarts
Oil Pressure – Minimum – Hot	41 kPa at 1,000 engine RPM 124 kPa at 2,000 engine RPM 165 kPa at 4,000 engine RPM	6 psig at 1,000 engine RPM 18 psig at 2,000 engine RPM 24 psig at 4,000 engine RPM
Oil Pan		
Front Cover Alignment – at Oil Pan Surface	+0.0 to −0.5 mm	+0.0 to −0.2 in
Crankshaft Rear Oil Seal Housing Alignment – at Oil Pan Surface	+0.0 to −0.5 mm	+0.0 to −0.2 in
Oil Pan Alignment – to Rear of Engine Block at Transmission Housing Mounting Surface	+0.0 to −0.5 mm	+0.0 to −0.2 in
Piston Rings		
Piston Ring End Gap – First Compression Ring – Measured in Cylinder Bore – Production	0.23–0.44 mm	0.009–0.017 in
Piston Ring End Gap – First Compression Ring – Measured in Cylinder Bore – Service	0.23–0.5 mm	0.009–0.0196 in
Piston Ring End Gap – Second Compression Ring – Measured in Cylinder Bore – Production	0.44–0.7 mm	0.017–0.027 in
Piston Ring End Gap – Second Compression Ring – Measured in Cylinder Bore – Service	0.44–0.76 mm	0.0173–0.03 in
Piston Ring End Gap – Oil Control Ring – Measured in Cylinder Bore – Production	0.18–0.75 mm	0.007–0.029 in
Piston Ring End Gap – Oil Control Ring – Measured in Cylinder Bore – Service	0.18–0.81 mm	0.007–0.032 in
Piston Ring to Groove Clearance – First Compression Ring – Production	0.04–0.085 mm	0.00157–0.00335 in
Piston Ring to Groove Clearance – First Compression Ring – Service	0.04–0.085 mm	0.00157–0.00335 in
Piston Ring to Groove Clearance – Second Compression Ring – Production	0.04–0.078 mm	0.00157–0.0031 in

Application	Specification	
	Metric	English
Piston Ring to Groove Clearance – Second Compression Ring – Service	0.04–0.078 mm	0.00157–0.0031 in
Piston Ring to Groove Clearance – Oil Control Ring – Production	0.012–0.2 mm	0.0005–0.0078 in
Piston Ring to Groove Clearance – Oil Control Ring – Service	0.012–0.2 mm	0.0005–0.0078 in
Pistons and Pins		
Pin – Piston Pin Clearance to Piston Pin Bore – Production	0.003–0.011 mm	0.0001–0.0004 in
Pin – Piston Pin Clearance to Piston Pin Bore – Service	0.002–0.015 mm	0.0008–0.0006 in
Pin – Piston Pin Diameter	24.997–25.0 mm	0.984–0.0984 in
Pin – Piston Pin Fit in Connecting Rod Bore – Production	0.007–0.02 mm	0.00027–0.00078 in
Pin – Piston Pin Fit in Connecting Rod Bore – Service	0.007–0.0022 mm	0.00027–0.00086 in
Piston – Piston Diameter – Measured Over Skirt Coating	103.235–103.258 mm	4.064–4.065 in
Piston – Piston to Bore Clearance – Production	−0.036 to +0.016 mm	−0.0014 to +0.0006 in
Piston – Piston to Bore Clearance – Service Limit with Skirt Coating Worn Off	0.71 mm	0.0028 in
Valve System		
Valves – Valve Face Angle	45 degrees	
Valves – Valve Face Width	1.25 mm	0.05 in
Valves – Valve Lash	Net Lash – No Adjustment	
Valves –Valve Lift – Intake	12.24 mm	0.482 in
Valves – Valve Lift – Exhaust	12.24 mm	0.482 in
Valves – Valve Seat Angle	45 degrees	
Valves – Valve Seat Runout	0.05 mm	0.002 in
Valves – Valve Seat Width – Exhaust	1.78 mm	0.07 in
Valves – Valve Seat Width – Intake	1.02 mm	0.04 in
Valves – Valve Stem Diameter – Production	7.955–7.976 mm	0.313–0.314 in
Valves – Valve Stem Diameter – Service	7.95 mm	0.313 in

Application	Specification	
	Metric	English
Valves – Stem-to-Guide Clearance – Production – Intake	0.025–0.066 mm	0.001–0.0026 in
Valves – Valve Stem-to-Guide Clearance – Service – Intake	0.093 mm	0.0037 in
Valves – Valve Stem-to-Guide Clearance – Production – Exhaust	0.025–0.066 mm	0.001–0.0026 in
Valves – Stem-to-Guide Clearance – Service – Exhaust	0.093 mm	0.0037 in
Rocker Arms – Rocker Arm Ratio	1.70:1	
Valve Springs – Valve Spring Free Length	53.1–53.7 mm	2.09–2.11 in
Valve Springs – Valve Spring Installed Height	45.75 mm	1.8 in
Valve Springs – Valve Spring Load – Closed	400 N at 45.75 mm	90 lb at 1.8 in
Valve Springs – Valve Spring Load – Open	1175 N at 33.05 mm	264 lb at 1.30 in

Specifications

2158463

Engine Content Specifications

Specifications:Engine Content:Engine Mechanical

RPO	VIN	Displacement	Camshaft Position (CMP) Actuator Control System	Active Fuel Management Control System	E85 Capable	Block Material
LSA	P	6.2L	No	No	No	Aluminum

Specifications

2158466

Adhesives, Fluids, Lubricants, and Sealers

Sealers, Adhesives, and Lubricants

Application	Type of Material	GM Part Number	
		United States	Canada
All Purpose Parts Cleaner	Cleaner	12378553	88900920
Coolant Temperature Sensor Threads	Sealant	12346004	10953480
Crankshaft Key	Sealant	9985969	—
Crankshaft Rear Cup Plug	Sealant	89021297	10953488
Engine Block Coolant Drain Hole Plug	Sealant	12346004	10953480

Application	Type of Material	GM Part Number	
		United States	Canada
Engine Block Oil Gallery Plug – Front	Threadlock	12345382	10953489
Engine Block Oil Gallery Plug – Side	Sealant	12346004	10953480
Engine Degreaser	Cleaner	12378482	992878
Engine Oil	5W-30 Oil – Synthetic	12345610	993193
Engine Oil Pressure Sensor Threads	Sealant	12346004	10953480
Engine Oil Supplement	Fluorescent Dye	12345795	10953470
Exhaust Manifold Bolts	Threadlock	12345493	10953488
Flywheel Bolts	Threadlock	12345382	10953489
Fuel Injection Fuel Rail Bolts	Threadlock	12345382	10953489
Ignition Coil-to-Rocker Arm Cover Bolts	Threadlock	12345382	10953489
Intake Air Temperature Sensor Threads	Sealant	12346004	10953480
Intake Manifold Bolts	Threadlock	12345382	10953489
Oil Pan Surface at Front Cover and Rear Housing	Sealant	12378521	88901148
Supercharger Charge Air Cooler-to-Cover Bolts	Threadlock	12345382	10953489
Supercharger-to-Cylinder Head Bolts	Threadlock	12345382	10953489
Thread Repair Component Cleaner	Cleaner	12346139	10953463
Thread Repair Component Cleaner	Cleaner	12377981	10953463
Thread Repair Cutting Oil	Lubricant	1052864	992881

Specifications

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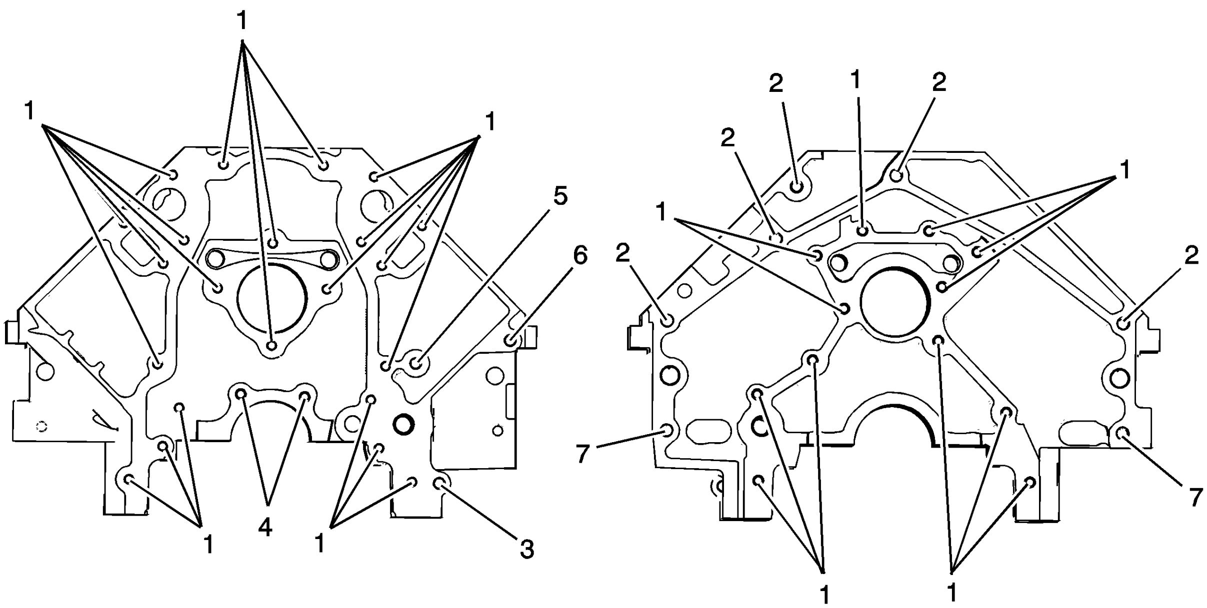
Thread Repair Specifications

Engine Block – Front/Rear Views



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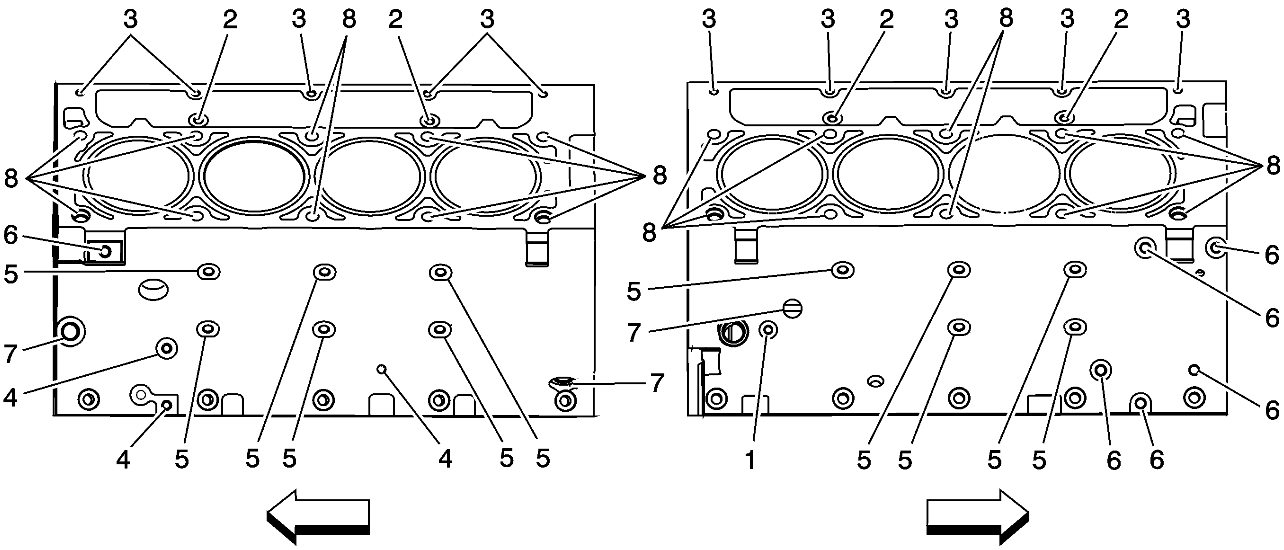
Engine Block – Front/Rear Views

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth – Maximum mm (in)	Tap Depth – Maximum mm (in)
J 42385-								
1	M8 x 1.25	210	206	207	208	209	22.5 (0.885)	17.5 (0.688)
2	M10 x 1.5	215	211	212	213	214	27.5 (1.08)	22.0 (0.866)
3	M10 x 1.5	215	211	212	213	214	Thru	Thru
4	M8 x 1.25	210	206	207	208	209	Thru	Thru
5	M10 x 1.5	215	211	212	213	214	25.0 (0.984)	19.5 (0.767)
6	M10 x 1.5	215	211	212	213	214	32.5 (1.279)	25.0 (0.984)
7	M10 x 1.5	215	211	212	213	214	Thru	Thru
Bolt hole 6 is drilled and tapped for aluminum block applications only.								

Engine Block – Left/Right Side Views



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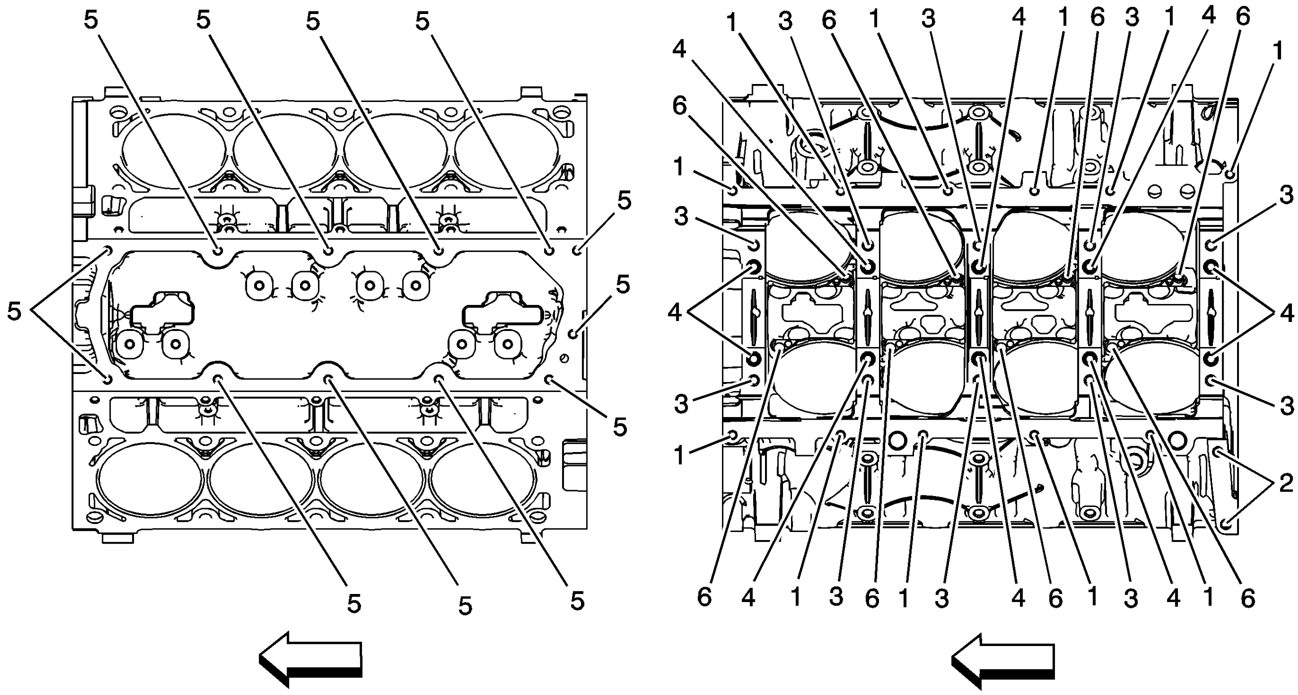
Engine Block – Left/Right Side Views

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth – Maximum mm (in)	Tap Depth – Maximum mm (in)
				J 42385-				
1	M8 x 1.25	210	206	207	208	209	22.5 (0.885)	17.5 (0.688)
2	M6 x 1.0	205	201	202	203	204	22.5 (0.885)	15.0 (0.688)
3	M8 x 1.25	210	206	207	208	209	28.5 (1.122)	23.0 (0.905)
4	M8 x 1.25	210	206	207	208	209	21.5 (0.846)	16.0 (0.629)
5	M10 x 1.25	215	211	212	213	214	29.0 (1.141)	23.0 (0.905)
6	M10 x 1.5	215	211	212	213	214	27.0 (1.062)	21.5 (0.846)
7	M16 x 1.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8	M11 x 2.0	108	105	N/A	106	107	69.0 (2.72)	60.0 (2.36)

Engine Block – Top/Bottom Views



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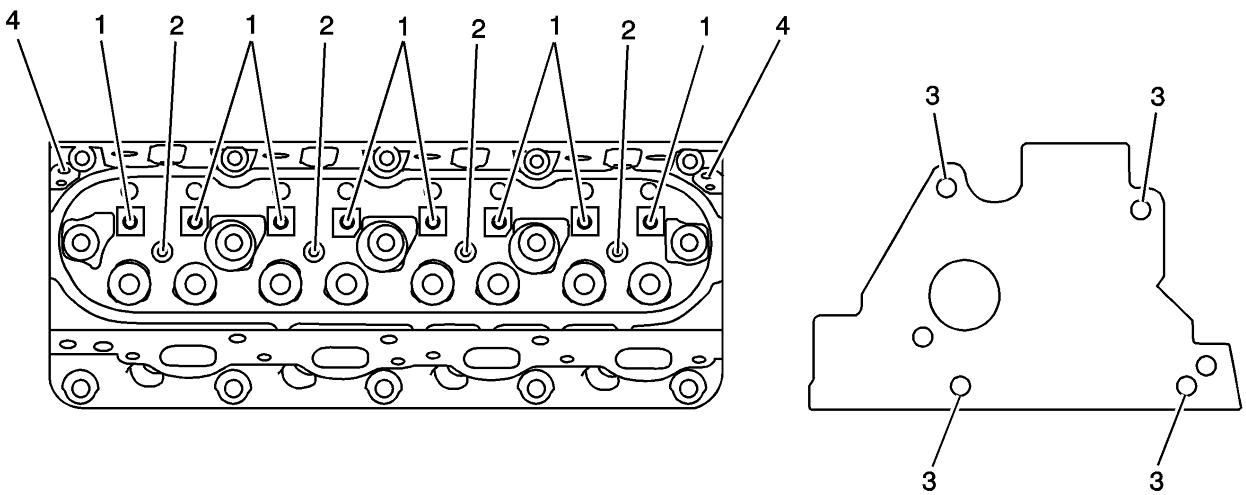
Engine Block – Top/Bottom Views

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth – Maximum mm (in)	Tap Depth – Maximum mm (in)
J 42385-								
1	M8 x 1.25	210	206	207	208	209	22.5 (0.885)	17.5 (0.688)
2	M10 x 1.5	215	211	212	213	214	42.5 (1.67)	37.0 (1.45)
3	M10 x 2.0	104	101	N/A	102	103	31.0 (1.22)	25.5 (1.0)
4	M10 x 2.0	104	101	N/A	102	103	53.5 (2.10)	44.0 (1.73)
5	M8 x 1.25	210	206	207	208	209	26.5 (1.043)	19.0 (0.748)

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth – Maximum mm (in)	Tap Depth – Maximum mm (in)
6	M10 x 1.5	N/A	N/A	N/A	N/A	N/A	61 (2.4)	55 (2.17)

- Bolt hole 2 has an 11.5 mm (0.452 in) counterbore included in the 42.5 mm (1.67 in) drill depth. Use sleeve J 42385-311 with the drill and tap.
- Bolt hole 3 has a 1.5 mm (0.059 in) counterbore included in the 31.0 mm (1.22 in) drill depth. Use sleeve J 42385-316 with the drill and tap.
- Bolt hole 4 has a 20.5 mm (0.807 in) counterbore included in the 53.5 mm (2.10 in) drill depth.
- Piston oil nozzle bolt holes (6) are not serviceable.

Cylinder Head – Top/End Views



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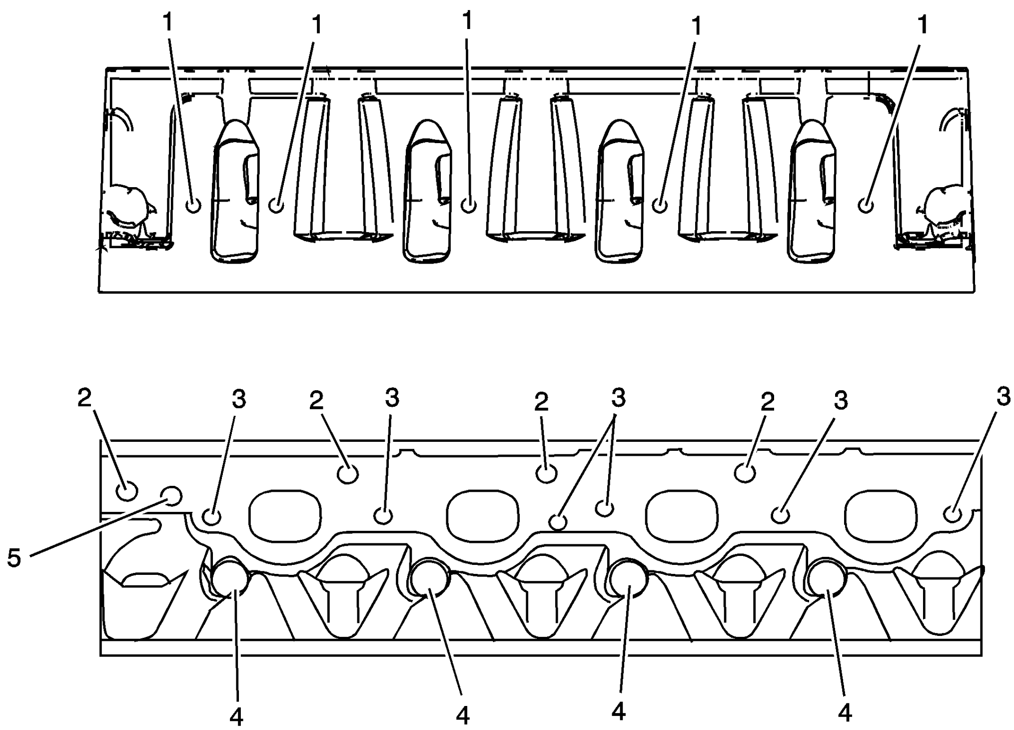
Cylinder Head – Top/End Views

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth – Maximum mm (in)	Tap Depth – Maximum mm (in)
J 42385-								
1	M8 x 1.25	210	206	207	208	209	26.5 (1.04)	19.0 (0.784)
2	M6 x 1.0	205	201	202	203	204	20.05 (0.789)	16.05 (0.632)
3	M10 x 1.5	215	211	212	213	214	28.0 (1.10)	20.0 (0.787)
4	M6 x 1.0	205	201	202	203	204	22.5 (0.885)	15.0 (0.688)

Cylinder Head – Intake/Exhaust Side Views



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Cylinder Head – Intake/Exhaust Side Views

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth – Maximum mm (in)	Tap Depth – Maximum mm (in)
J 42385-								
1	M6 x 1.0	205	201	202	203	204	Thru	Thru
2	M10 x 1.5	215	211	212	213	214	28.0 (1.10)	20.0 (0.787)
3	M8 x 1.25	210	206	207	208	209	21.0 (0.826)	16.0 (0.629)
4	M14 x 1.25	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5	M12 x 1.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Engine

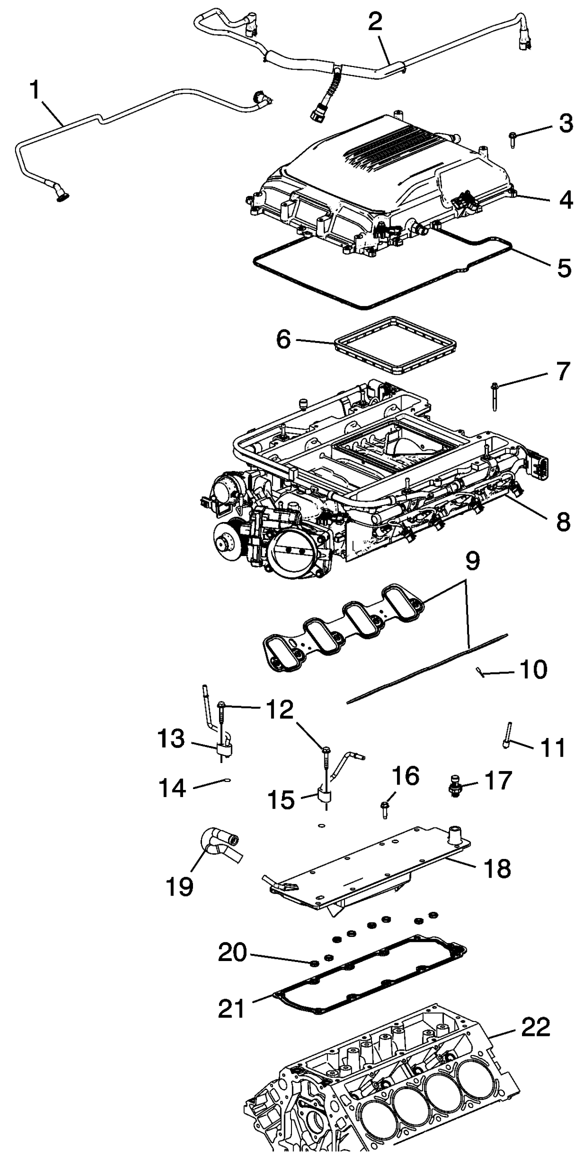
Engine Mechanical -6.0L ,6.2L

Visual Identification

2163510

Disassembled Views

Figure 2163444**Supercharger/Upper Engine**

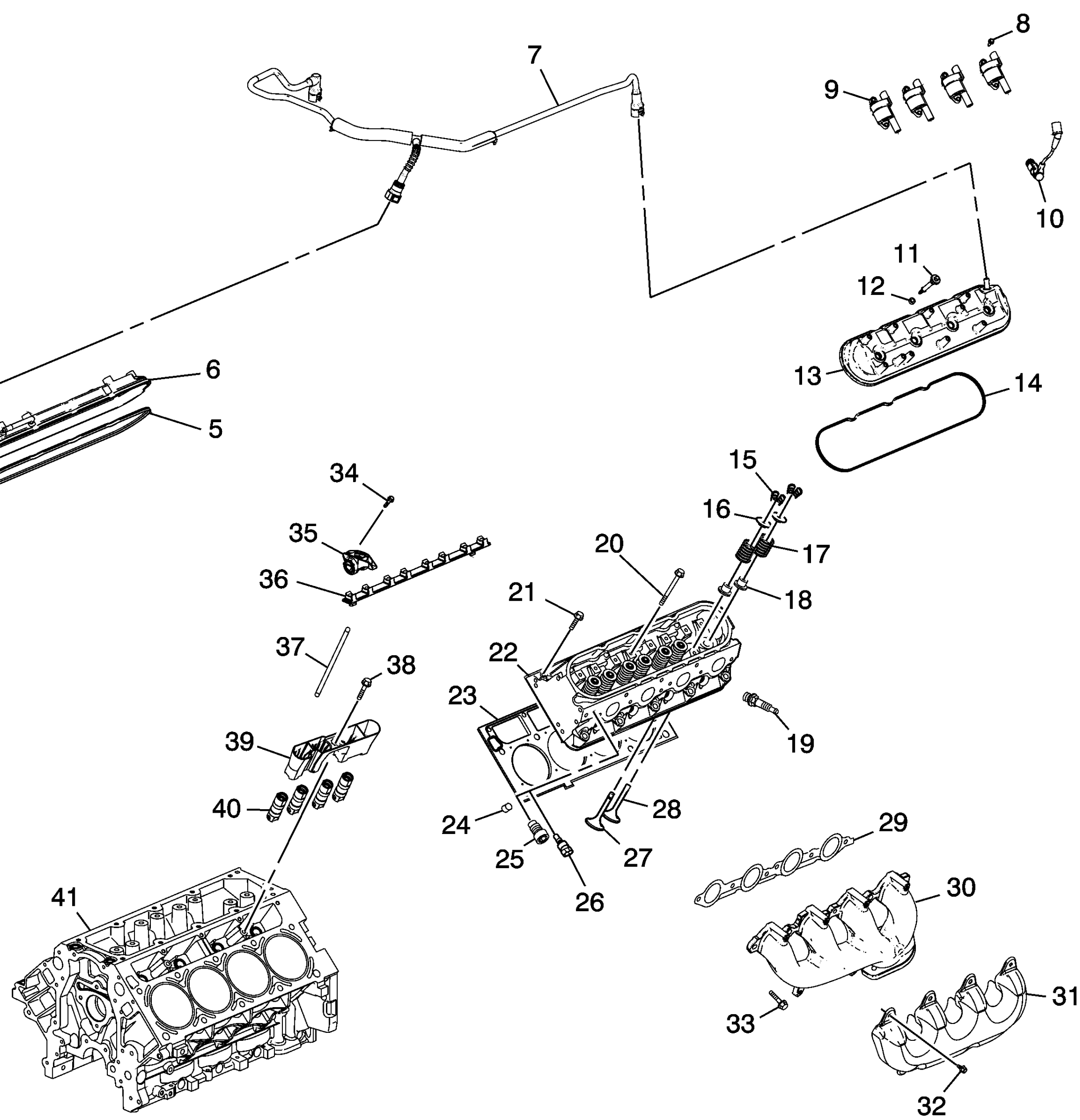


2156290

1. *Evaporative (EVAP) Emission Canister Purge Tube*
2. *Positive Crankcase Ventilation (PCV) Tube – Fresh Air*
3. *Supercharger Cover Bolts*
4. *Supercharger Cover*
5. *Supercharger Cover Seal*
6. *Supercharger Insulator Seal*
7. *Supercharger Bolts*
8. *Supercharger*
9. *Supercharger Gasket*

10. *Supercharger Gasket Rivet*
11. *Engine Coolant Air Bleed Plug*
12. *Engine Coolant Air Bleed Pipe Bolt*
13. *Engine Coolant Air Bleed Pipe*
14. *Engine Coolant Air Bleed Pipe Seal*
15. *Engine Coolant Air Bleed Pipe*
16. *Valley Cover Bolt*
17. *Engine Oil Pressure Sensor*
18. *Valley Cover*
19. *PCV Hose – Dirty Air*
20. *Valley Cover Seal*
21. *Valley Cover Gasket*
22. *Engine Block*

Figure 2177703**Cylinder Head/Upper Engine**

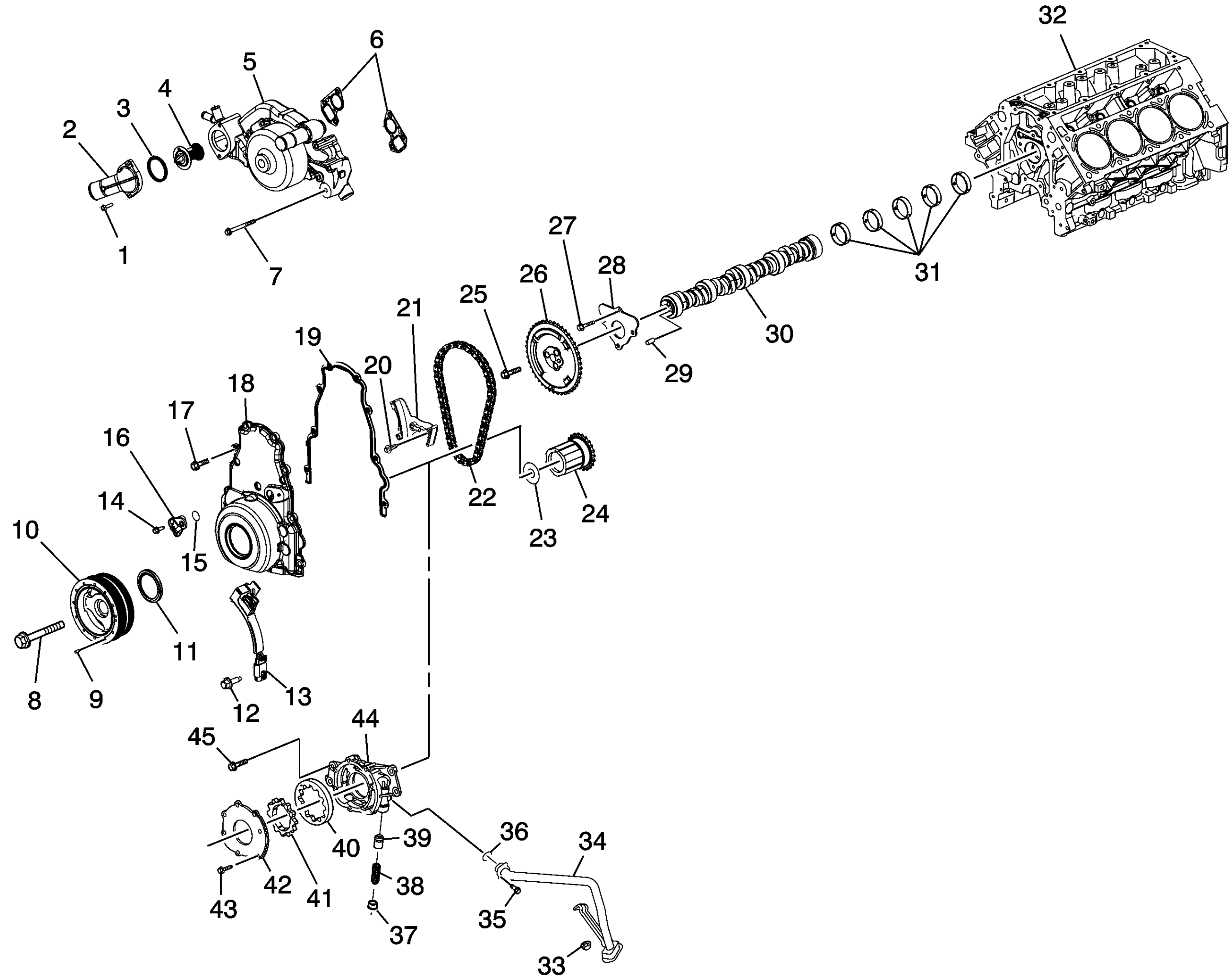


2173541

1. *Oil Cap*
2. *Oil Cap O-ring Seal*
3. *Oil Fill Tube*

4. *Oil Fill Tube O-ring Seal*
5. *Valve Rocker Arm Cover Gasket*
6. *Valve Rocker Arm Cover*
7. *Positive Crankcase Ventilation (PCV) Tube – Fresh Air*
8. *Bolt*
9. *Ignition Coil*
10. *Spark Plug Wire*
11. *Bolt*
12. *Bolt Grommet*
13. *Valve Rocker Arm Cover*
14. *Valve Rocker Arm Cover Gasket*
15. *Valve Stem Key*
16. *Valve Spring Cap*
17. *Valve Spring*
18. *Valve Stem Oil Seal*
19. *Spark Plug*
20. *Cylinder Head Bolt – M11*
21. *Cylinder Head Bolt – M8*
22. *Cylinder Head*
23. *Cylinder Head Gasket*
24. *Cylinder Head Locating Pin*
25. *Cylinder Head Plug*
26. *Coolant Temperature Sensor*
27. *Exhaust Valve*
28. *Intake Valve*
29. *Exhaust Manifold Gasket*
30. *Exhaust Manifold*
31. *Exhaust Manifold Heat Shield*
32. *Exhaust Manifold Heat Shield Bolt*
33. *Exhaust Manifold Bolt*
34. *Bolt*
35. *Valve Rocker Arm*
36. *Valve Rocker Arm Pivot Support*
37. *Valve Pushrod*
38. *Bolt*
39. *Valve Lifter Guide*
40. *Valve Lifter*
41. *Engine Block*

Figure 2177704**Front of Engine**

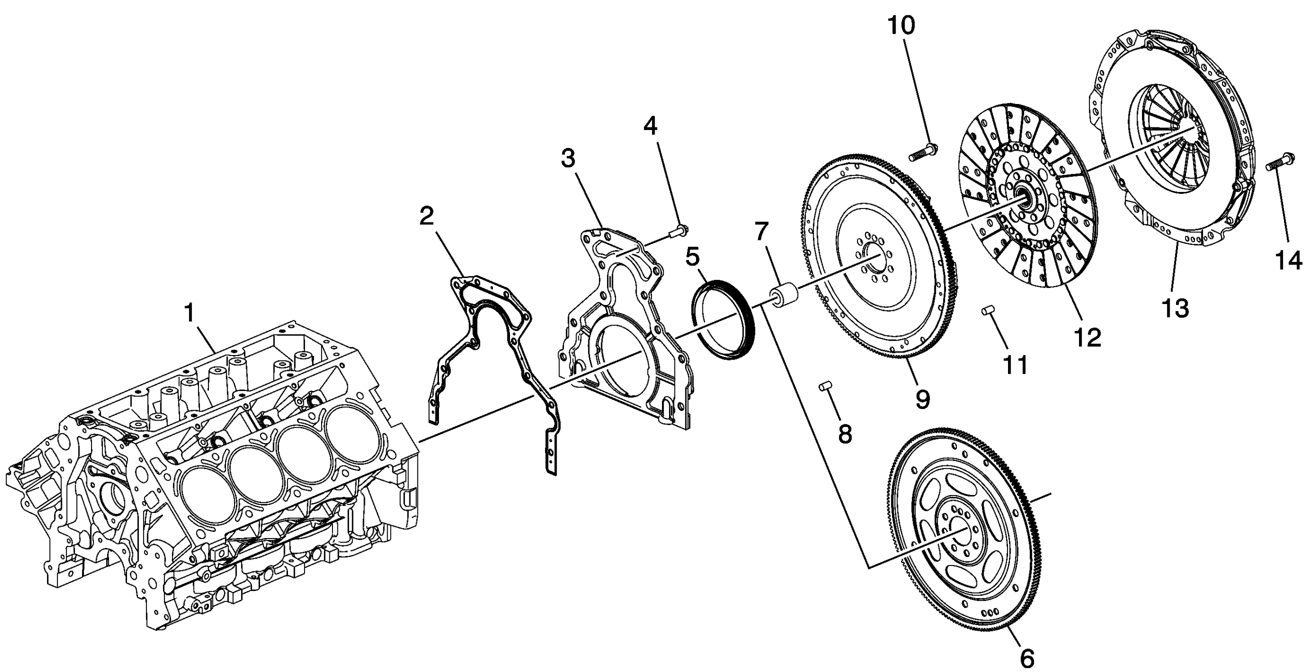


2173543

1. *Bolt*
2. *Water Inlet Housing*
3. *Water Inlet Seal*
4. *Engine Coolant Thermostat*
5. *Water Pump*
6. *Water Pump Gasket*
7. *Bolt*
8. *Bolt*
9. *Balancer Weight – Crankshaft Balancer – Manual Transmission*
10. *Crankshaft Balancer*
11. *Crankshaft Front Oil Seal*
12. *Camshaft Position (CMP) Sensor Wire Harness Bolt*
13. *CMP Sensor Wire Harness*
14. *CMP Sensor Bolt*
15. *CMP Sensor Seal*
16. *CMP Sensor*
17. *Bolt*
18. *Engine Front Cover*
19. *Engine Front Cover Gasket*
20. *Bolt*

21. *Timing Chain Tensioner*
22. *Timing Chain*
23. *Crankshaft Balancer Washer*
24. *Crankshaft Sprocket*
25. *Bolt*
26. *Camshaft Sprocket*
27. *Bolt*
28. *Camshaft Retainer*
29. *Camshaft Sprocket Locating Pin*
30. *Camshaft*
31. *Camshaft Bearings*
32. *Engine Block*
33. *Oil Pump Suction Pipe Nut*
34. *Oil Pump Suction Pipe*
35. *Oil Pump Suction Pipe Bolt*
36. *Oil Pump O-ring Seal*
37. *Oil Pressure Relief Valve Bore Plug*
38. *Oil Pressure Relief Valve Spring*
39. *Oil Pressure Relief Valve*
40. *Oil Pump Driven Gear*
41. *Oil Pump Drive Gear*
42. *Oil Pump Cover*
43. *Oil Pump Cover Bolt*
44. *Oil Pump*
45. *Oil Pump Bolt*

Figure 2056918**Rear of Engine**

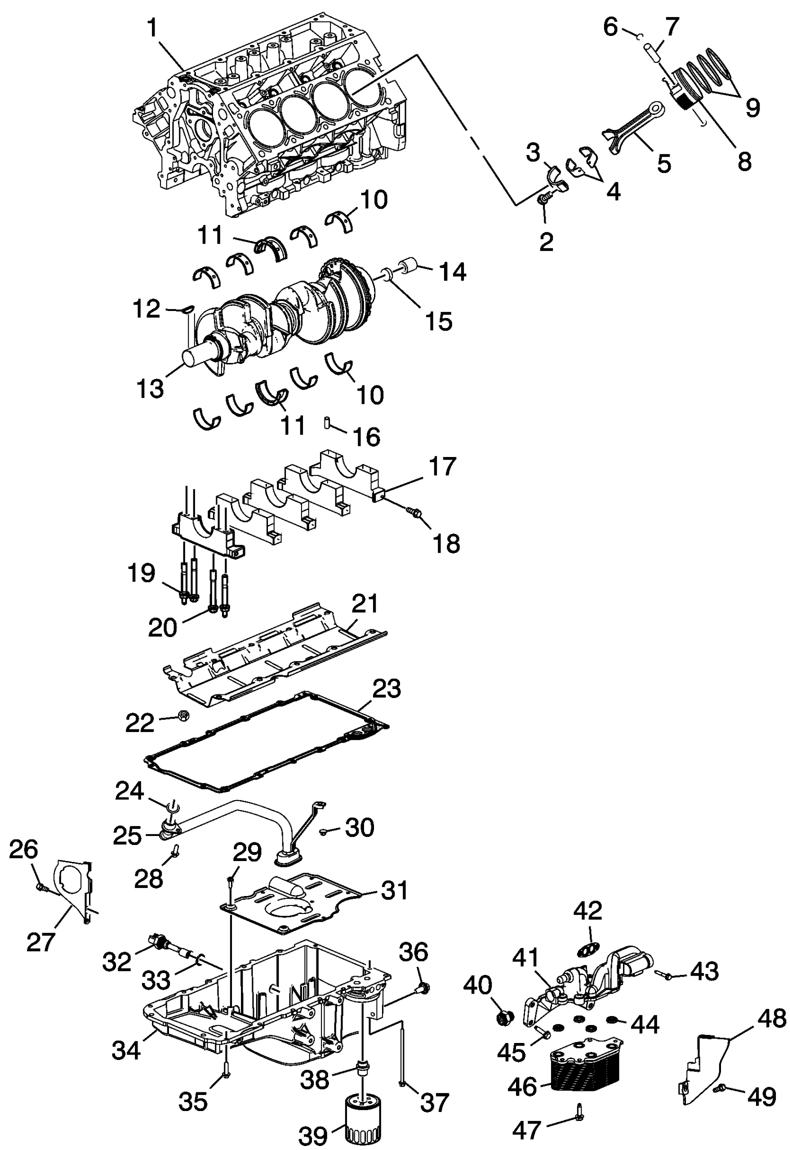


2053958

1. *Engine Block*

2. *Crankshaft Rear Oil Seal Housing Gasket*
3. *Crankshaft Rear Oil Seal Housing*
4. *Bolt*
5. *Crankshaft Rear Oil Seal*
6. *Flexplate – Automatic Transmission*
7. *Transmission Pilot Bearing – Manual Transmission*
8. *Balance Weight – Flywheel – Manual Transmission*
9. *Flywheel – Manual Transmission*
10. *Bolt*
11. *Clutch Pressure Plate Locating Pin – Manual Transmission*
12. *Clutch Drive Plate – Manual Transmission*
13. *Clutch Pressure Plate – Manual Transmission*
14. *Bolt*

Figure 2163503**Lower Engine Assembly**

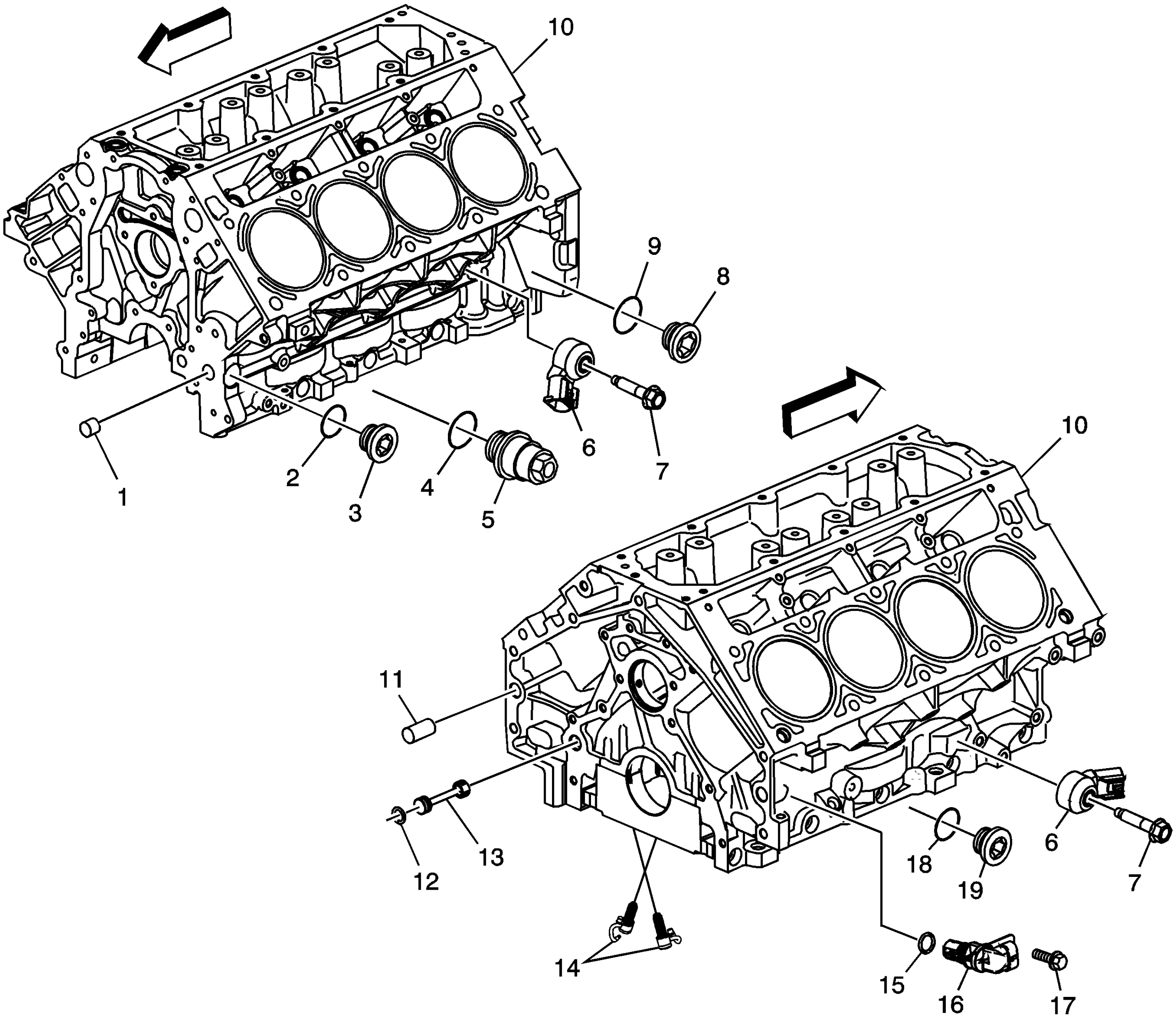


2156292

1. *Engine Block*
2. *Bolt*
3. *Connecting Rod Cap*
4. *Connecting Rod Bearing*

5. *Connecting Rod*
6. *Piston Pin Retainer*
7. *Piston Pin*
8. *Piston*
9. *Piston Ring Set*
10. *Crankshaft Bearing*
11. *Crankshaft Bearing – Thrust*
12. *Crankshaft Sprocket Key*
13. *Crankshaft*
14. *Transmission Pilot Bearing – Manual Transmission*
15. *Crankshaft Hole Plug*
16. *Crankshaft Bearing Cap Locating Pin*
17. *Crankshaft Bearing Cap*
18. *Bolt – M8*
19. *Stud – M10*
20. *Bolt – M10*
21. *Crankshaft Oil Deflector*
22. *Crankshaft Oil Deflector Nut*
23. *Oil Pan Gasket*
24. *Oil Pump Suction Pipe Seal*
25. *Oil Pump Suction Pipe*
26. *Bolt*
27. *Engine Cover – Right*
28. *Oil Pump Suction Pipe Bolt*
29. *Oil Pan Baffle Bolt*
30. *Oil Pump Suction Pipe Nut*
31. *Oil Pan Baffle*
32. *Engine Oil Level Sensor*
33. *Engine Oil Level Sensor Seal*
34. *Oil Pan*
35. *Oil Pan Bolt*
36. *Oil Pan Drain Plug*
37. *Oil Pan Bolt*
38. *Oil Filter Fitting*
39. *Oil Filter*
40. *Engine Oil Cooler Coolant Fitting*
41. *Engine Oil Cooler Housing*
42. *Engine Oil Cooler Gasket*
43. *Engine Oil Cooler-to-Oil Pan Bolt – M6*
44. *Engine Oil Cooler Core Seal*
45. *Engine Oil Cooler-to-Oil Pan Bolt – M8*
46. *Engine Oil Cooler Core*
47. *Engine Oil Cooler Core-to-Housing Bolt*
48. *Oil Pan Cover – Left*
49. *Bolt*

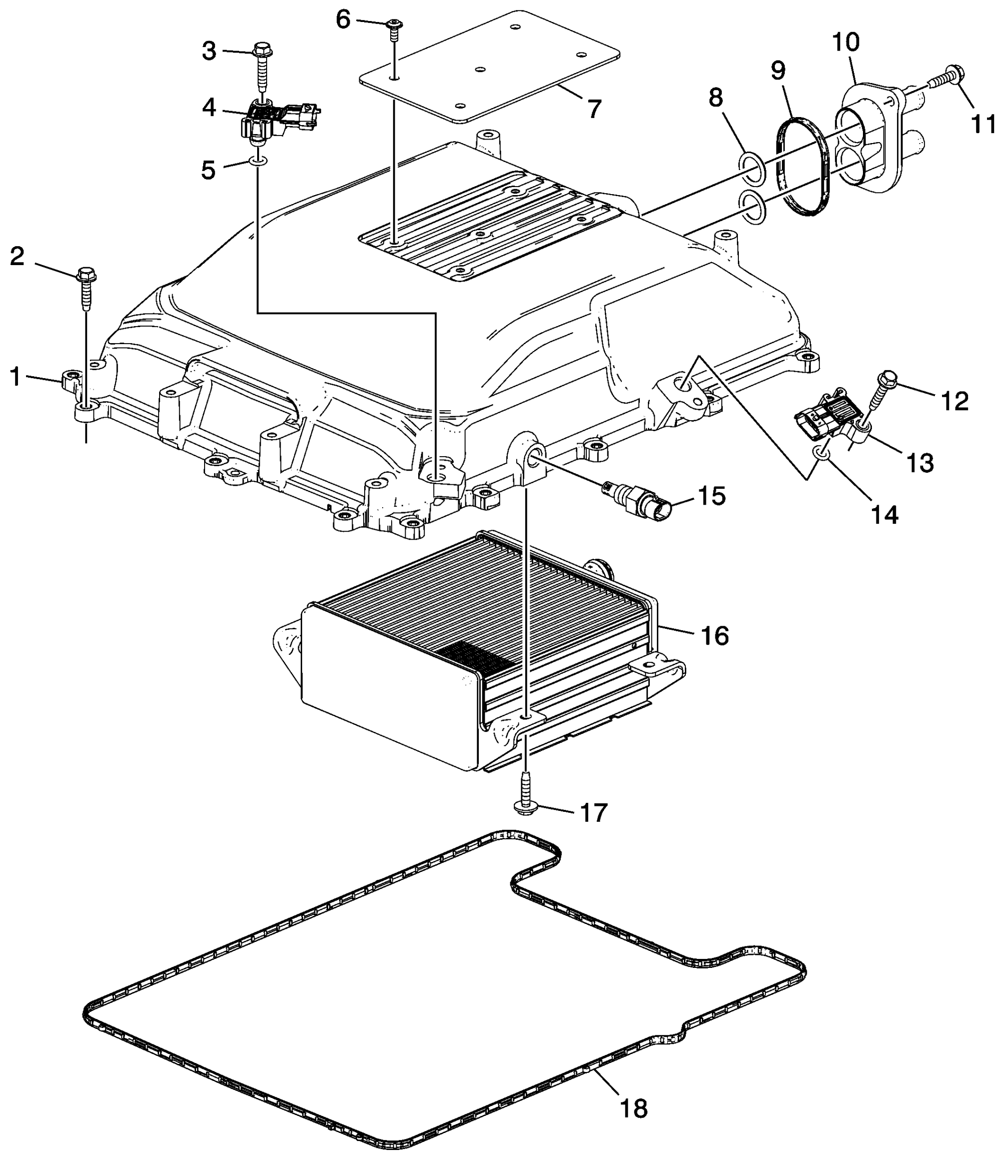
Figure 2108540**Engine Block Plugs/Sensors**



2085637

1. Engine Block Oil Gallery Plug – Front
2. Engine Block Oil Gallery Plug Seal
3. Engine Block Oil Gallery Plug – Side
4. Engine Block Coolant Heater Seal
5. Engine Block Coolant Heater
6. Knock Sensor
7. Bolt
8. Engine Block Oil Gallery Plug – Side
9. Engine Block Oil Gallery Plug Seal
10. Engine Block
11. Transmission Locating Pin
12. Engine Block Oil Gallery Plug Seal
13. Engine Block Oil Gallery Plug – Rear
14. Piston Oil Nozzle
15. Crankshaft Position (CKP) Sensor Seal
16. CKP Sensor
17. CKP Sensor Bolt
18. Engine Block Coolant Drain Hole Plug Seal
19. Engine Block Coolant Drain Hole Plug – Side

Figure 2163446**Supercharger Cover Assembly**

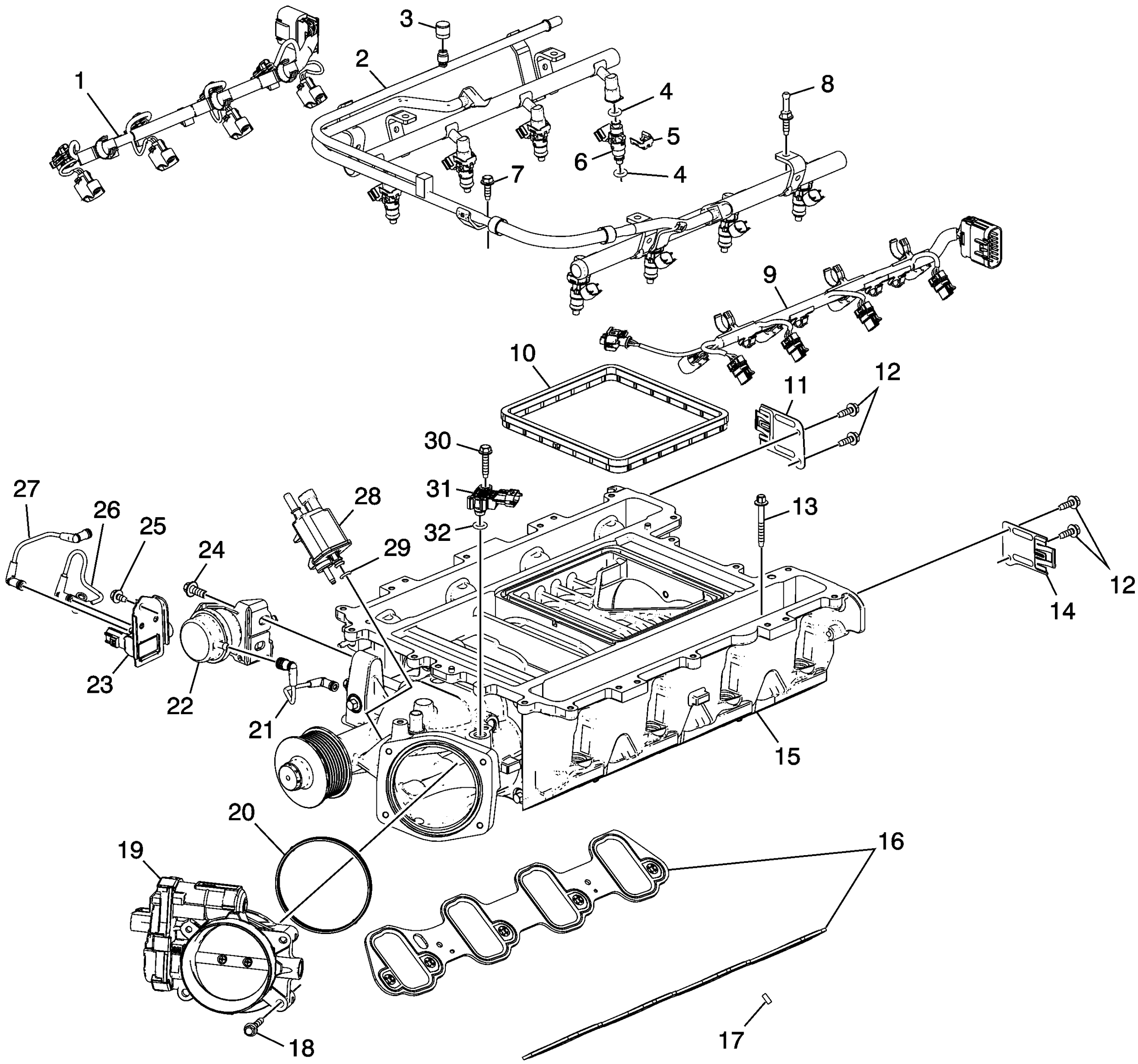


2156295

1. *Charge Air Cooler Cover*
2. *Charge Air Cooler Cover Bolt*
3. *Barometric Pressure Sensor Bolt*
4. *Barometric Pressure Sensor*
5. *Barometric Pressure Sensor Seal*
6. *Isolator Pad Bolt*
7. *Isolator Pad*
8. *Charge Air Cooler Coolant Pipe Seal*
9. *Charge Air Cooler Coolant Outlet Pipe Assembly Seal*
10. *Charge Air Cooler Coolant Outlet Pipe Assembly*
11. *Charge Air Cooler Coolant Outlet Pipe Assembly Bolt*
12. *Supercharger Air Outlet Pressure Sensor Bolt*
13. *Supercharger Air Outlet Pressure Sensor*
14. *Supercharger Air Outlet Pressure Sensor Seal*
15. *Intake Air Temperature Sensor*
16. *Charge Air Cooler*
17. *Charge Air Cooler Bolt*

18. *Charge Air Cooler Cover Seal*

Figure 2163450**Supercharger Assembly**

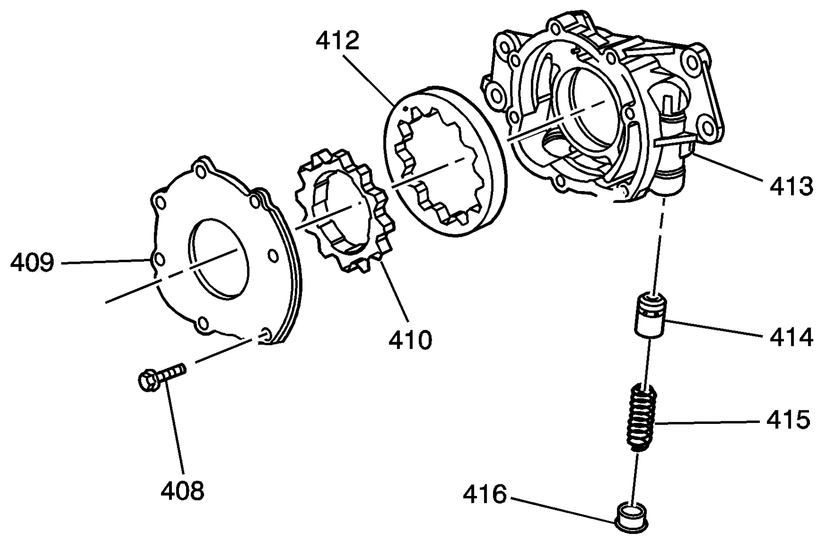


2156297

1. *Fuel Injector Wiring Harness*
2. *Multiport Fuel Injection Fuel Rail*
3. *Fuel Rail Service Port Cap*
4. *Fuel Injector Seal*
5. *Fuel Injector Retainer*
6. *Fuel Injector*
7. *Fuel Injection Fuel Rail Bolt*
8. *Fuel Injector Fuel Rail Stud*
9. *Fuel Injector Wiring Harness*
10. *Charge Air Cooler Insulator*
11. *Fuel Injector Wiring Harness Connector Bracket – Right*
12. *Fuel Injector Wiring Harness Connector Bracket Bolt*
13. *Supercharger Bolt*
14. *Fuel Injector Wiring Harness Connector Bracket – Left*
15. *Supercharger*

16. *Intake Manifold Gasket*
17. *Intake Manifold Gasket Rivet*
18. *Throttle Body Bolt*
19. *Throttle Body*
20. *Throttle Body Seal*
21. *Charge Air Bypass Valve Vacuum Tube*
22. *Supercharger Bypass Actuator*
23. *Charge Air Bypass Valve w/Bracket*
24. *Supercharger Bypass Actuator Bolt*
25. *Charge Air Bypass Valve Bolt*
26. *Charge Air Bypass Valve Tube*
27. *Bypass Valve Actuator Tube*
28. *Evaporative Emission Canister Purge Valve*
29. *Evaporative Emission Canister Purge Valve Seal*
30. *Supercharger Inlet Air Pressure Sensor Bolt*
31. *Supercharger Inlet Air Pressure Sensor*
32. *Supercharger Inlet Air Pressure Sensor Seal*

Figure 1403036**Oil Pump Assembly**



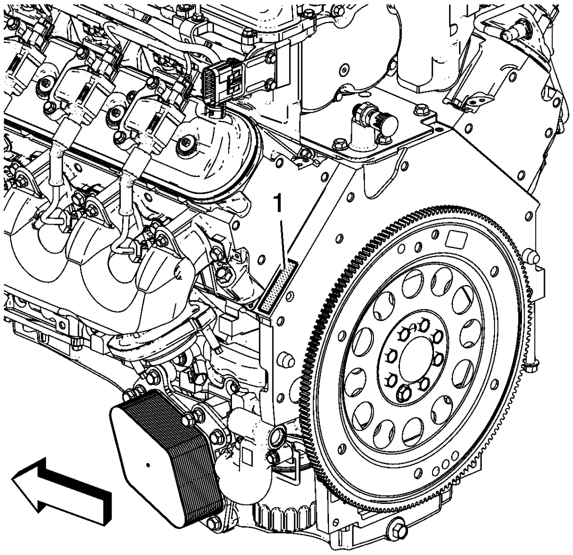
1272779

408. *Bolt*
409. *Oil Pump Housing Cover*
410. *Oil Pump Drive Gear*
412. *Oil Pump Driven Gear*
413. *Oil Pump*
414. *Oil Pump Pressure Relief Valve*
415. *Oil Pump Pressure Relief Valve Spring*
416. *Oil Pump Housing Plug*

Visual Identification

2158481

Engine Identification



2156300

The vehicle identification number (VIN) is located on the left side rear of the engine block (1) and is typically a 9 digit number stamped or laser-etched 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 VIN.

Engine

Engine Mechanical -6.0L,6.2L

Diagnostic Information and Procedures

2137562

Symptoms - Engine Mechanical

Symptoms:Engine Mechanical

Strategy Based Diagnostics

1. Perform the *Diagnostic System Check - Vehicle* before using the symptom tables, if applicable.
2. Review the system operations in order to familiarize yourself with the system functions. Refer to *Disassembled Views* , *Engine Component Description* , *Lubrication Description* , and *Drive Belt System Description* .

All diagnosis on a vehicle should follow a logical process. Strategy based diagnostics is a uniform approach for repairing all systems. The diagnostic flow may always be used in order to resolve a system condition. The diagnostic flow is the place to start when repairs are necessary. For a detailed explanation, refer to *Strategy Based Diagnosis* .

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the engine. Refer to *Checking Aftermarket Accessories* .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Inspect for the correct oil level, proper oil viscosity, and correct oil filter.
- Verify the exact operating conditions under which the concern exists. Note factors such as engine RPM, ambient temperature, engine temperature, amount of engine warm-up time, and other specifics.
- Compare the engine sounds, if applicable, to a known good engine and make sure you are not trying to correct a normal condition.

Intermittent

Test the vehicle under the same conditions that the customer reported in order to verify the system is operating properly.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- *Base Engine Misfire without Internal Engine Noises*
- *Base Engine Misfire with Abnormal Internal Lower Engine Noises*
- *Base Engine Misfire with Abnormal Valve Train Noise*
- *Base Engine Misfire with Coolant Consumption*
- *Base Engine Misfire with Excessive Oil Consumption*
- *Engine Noise on Start-Up, but Only Lasting a Few Seconds (6.2L)*
- *Supercharger Noise Diagnosis*
- *Upper Engine Noise, Regardless of Engine Speed*
- *Lower Engine Noise, Regardless of Engine Speed*
- *Engine Noise Under Load*
- *Engine Will Not Crank - Crankshaft Will Not Rotate*
- *Coolant in Combustion Chamber*
- *Coolant in Engine Oil*
- *Engine Compression Test*
- *Engine Balancing*
- *Cylinder Leakage Test*
- *Oil Consumption Diagnosis*
- *Oil Pressure Diagnosis and Testing*

- *Oil Leak Diagnosis*
- *Crankcase Ventilation System Inspection/Diagnosis*
- *Drive Belt Chirping, Squeal, and Whine Diagnosis*
- *Drive Belt Rumbling and Vibration Diagnosis*
- *Drive Belt Falls Off and Excessive Wear Diagnosis*
- *Drive Belt Tensioner Diagnosis*

Diagnostic Information and Procedures

1877688

Base Engine Misfire without Internal Engine Noises

Base Engine Misfire Without:Internal Engine Noises

Cause	Correction
Fuel injector harness connectors are connected to the incorrect fuel injectors/cylinders	Relocate the fuel injector harness connectors, as necessary.
Abnormalities, such as severe cracking, bumps, or missing areas in the accessory drive belt Abnormalities in the accessory drive system and/or components may cause engine RPM variations and lead to a misfire DTC. A misfire code may be present without an actual misfire condition.	Replace the drive belt. Refer to *Drive Belt Replacement - Accessory* .
Worn, damaged, or mis-aligned accessory drive components or excessive pulley runout May lead to a misfire DTC. A misfire code may be present without an actual misfire condition.	Inspect the components and repair or replace, as required.
Loose or improperly installed engine flywheel or crankshaft balancer A misfire code may be present without an actual misfire condition.	Repair or replace the flywheel and/or balancer, as required. Refer to *Engine Flywheel Replacement* or *Crankshaft Balancer Replacement (LS9)* .
Restricted exhaust system A severe restriction in the exhaust flow can cause significant loss of engine performance and may set a DTC. Possible causes of restrictions include collapsed or dented pipes or plugged mufflers and/or catalytic converters.	Repair or replace, as required.
Improperly installed or damaged vacuum hoses	Repair or replace, as required.
Improper sealing between the intake manifold and cylinder heads or throttle body	Replace the intake manifold, gaskets, cylinder heads, and/or throttle body, as required.
Improperly installed or damaged manifold absolute pressure (MAP) sensor The sealing grommet of the MAP sensor should not be torn or damaged.	Repair or replace the MAP sensor, as required.
Worn or loose rocker arms The rocker arm bearing end caps and/or needle bearings should be intact and the rocker arm in the proper position.	Replace the valve rocker arms, as required.

Cause	Correction
Worn or bent pushrods	• Replace the pushrods. • Inspect the top of the pistons for valve contact. If the top of the piston shows valve contact, replace the piston and pin assembly.
Stuck valves Carbon buildup on the valve stem can cause the valve not to close properly.	Repair or replace, as required.
Excessively worn or mis-aligned timing chain	Replace the timing chain and sprockets, as required.
Worn camshaft lobes	Replace the camshaft and valve lifters.
Excessive oil pressure A lubrication system with excessive oil pressure may lead to excessive valve lifter pump-up and loss of compression.	**1.** Perform an oil pressure test. Refer to *Oil Pressure Diagnosis and Testing* . **2.** Repair or replace the oil pump, as required.
Faulty cylinder head gaskets and/or cracking or other damage to the cylinder heads and engine block cooling system passages Coolant consumption may or may not cause the engine to overheat.	**1.** Inspect for spark plugs saturated by coolant. Refer to *Spark Plug Inspection* . **2.** Inspect the cylinder heads, engine block, and/or head gaskets. Refer to *Coolant in Combustion Chamber* . **3.** Repair or replace, as required.
Worn piston rings Oil consumption may or may not cause the engine to misfire.	**1.** Inspect the spark plugs for oil deposits. Refer to *Spark Plug Inspection* . **2.** Inspect the cylinders for a loss of compression. Refer to *Engine Compression Test* . **3.** Perform cylinder leak down and compression testing to identify the cause. Refer to *Cylinder Leakage Test* . **4.** Repair or replace, as required.
A damaged crankshaft reluctor wheel A damaged crankshaft reluctor wheel can result in different symptoms depending on the severity and location of the damage. • Systems with electronic communications, DIS, or coil per cylinder, and severe reluctor ring damage may exhibit periodic loss of crankshaft position, stop delivering a signal, and then sync the crankshaft position. • Systems with electronic communication, DIS, or coil per cylinder, and slight reluctor ring damage may exhibit no loss of crankshaft position and no misfire may occur. However, a DTC P0300 may be set. • Systems with mechanical communications, high voltage switch, and severe reluctor ring damage may cause additional pulses and affect fuel and spark delivery to the point of generating a DTC P0300 or DTC P0336.	Replace the sensor and/or crankshaft, as required.

Diagnostic Information and Procedures

1877690

Base Engine Misfire with Abnormal Internal Lower Engine Noises

Base Engine Misfire With:Abnormal Internal Lower Engine Noises

Cause	Correction
Abnormalities, such as severe cracking, bumps or missing areas in the accessory drive belt Abnormalities in the accessory drive system and/or components may cause engine RPM variations, noises similar to a faulty lower engine and also lead to a misfire condition. A misfire code may be present without an actual misfire condition.	Replace the drive belt. Refer to *Drive Belt Replacement - Accessory* .
Worn, damaged, or mis-aligned accessory drive components or excessive pulley runout A misfire code may be present without an actual misfire condition.	Inspect the components and repair or replace, as required.
Loose or improperly installed engine flywheel or crankshaft balancer A misfire code may be present without an actual misfire condition.	Repair or replace the flywheel and/or balancer, as required. Refer to *Engine Flywheel Replacement* or *Crankshaft Balancer Replacement (LS9)* .
Worn piston rings Oil consumption may or may not cause the engine to misfire.	**1.** Inspect the spark plugs for oil deposits. Refer to *Spark Plug Inspection* . **2.** Inspect the cylinders for a loss of compression. Refer to *Engine Compression Test* . **3.** Perform cylinder leak down and compression testing to determine the cause. Refer to *Cylinder Leakage Test* . **4.** Repair or replace, as required.
Worn crankshaft thrust bearings Severely worn thrust surfaces on the crankshaft and/or thrust bearing may permit fore and aft movement of the crankshaft and create a DTC without an actual misfire condition.	Replace the crankshaft and bearings, as required.

Diagnostic Information and Procedures

1877691

Base Engine Misfire with Abnormal Valve Train Noise

Base Engine Misfire With:Abnormal Valve Train Noise

Cause	Correction
Worn or loose rocker arms The rocker arm bearing end caps and/or needle bearings should be intact within the rocker arm assembly.	Replace the valve rocker arms, as required.
Worn or bent pushrods	• Replace the pushrods. • Inspect the top of the pistons for valve contact. If the top of the piston shows valve contact, replace the piston and pin assembly.
Stuck valves Carbon buildup on the valve stem can cause the valve not to close properly.	Repair or replace, as required.
Excessively worn or mis-aligned timing chain	Replace the timing chain and sprockets, as required.
Worn camshaft lobes	Replace the camshaft and valve lifters.
Sticking lifters	Replace, as required.

Diagnostic Information and Procedures

2158484

Base Engine Misfire with Coolant Consumption

Base Engine Misfire With:Coolant Consumption

Cause	Correction
Faulty cylinder head gaskets and/or cracking or other damage to the cylinder heads and engine block cooling system passages Coolant consumption may or may not cause the engine to overheat.	**1.** Inspect for spark plugs saturated by coolant. Refer to *Spark Plug Inspection* . **2.** Perform a cylinder leak down test. Refer to *Cylinder Leakage Test* . **3.** Inspect the cylinder heads and engine block for damage to the coolant passages and/or a faulty head gasket. Refer to *Coolant in Combustion Chamber* . **4.** Repair or replace, as required.
Supercharger intercooler – internal coolant leak – 6.2L LSA	**1.** Inspect for a leaking intercooler. Perform a pressure test on the intercooler. Refer to *Supercharger Assemble* . **2.** Repair or replace components as required.

Diagnostic Information and Procedures

1877693

Base Engine Misfire with Excessive Oil Consumption

Base Engine Misfire With:Excessive Oil Consumption

Cause	Correction
Worn valves, valve guides and/or valve stem oil seals	**1.** Inspect the spark plugs for oil deposits. Refer to *Spark Plug Inspection* . **2.** Repair or replace, as required.
Worn piston rings Oil consumption may or may not cause the engine to misfire.	**1.** Inspect the spark plugs for oil deposits. Refer to *Spark Plug Inspection* . **2.** Inspect the cylinders for a loss of compression. Refer to *Engine Compression Test* . **3.** Perform cylinder leak down and compression testing to determine the cause. Refer to *Cylinder Leakage Test* . **4.** Repair or replace, as required.

Diagnostic Information and Procedures

1877695

Engine Noise on Start-Up, but Only Lasting a Few Seconds (6.2L)

Engine Noise:On Start-Up, but Only Lasting a Few Seconds

Cause	Correction
Incorrect oil filter without anti-drainback feature	Install the correct oil filter.
Incorrect oil viscosity	**1.** Drain the oil. **2.** Install the correct viscosity oil.
High valve lifter leak down rate	Replace the lifters as required.

Cause	Correction
Worn crankshaft thrust bearing	**1.** Check the crankshaft end play. **2.** Inspect the thrust bearing and crankshaft. **3.** Repair or replace as required.
Faulty oil filter bypass valve. The valve is now internal to the oil filter.	Replace the oil filter as required.

Diagnostic Information and Procedures

2087620

Supercharger Noise Diagnosis

Supercharger:Noise Diagnosis

Cause	Correction
Whine	**1.** Whine noise is typical of all superchargers and is not a reason to replace the supercharger or other components. **2.** Supercharger whine, inherent to the Roots design, results from eight pulses per engine revolution, 2:1 drive ratio x 4 lobes. Air induction system structure and acoustic resonators are designed to minimize whine.
Whistle	A whistle noise is generated by tooth contact of the spur gears between the rotors. For instance, a low level whistle may occur at 2,300–2,800 RPM at 80 percent load driving up a very long grade. Although most of these conditions are addressed by sound path isolation to the passenger compartment, some can still be heard by a very critical ear.
Supercharger rattle – growl	**1.** Supercharger growl may be heard at low speed or idle, with the engine under light load. **2.** Minuscule crankshaft speed variations, influenced by the torque converter, transmission, drive shaft, differential, and tires, are transmitted through the flexible drive belt to the supercharger. Operating in very thin air, the rotors oscillate and cause the load to alternate from the drive to driven sides of the gear teeth, even precision parts have operating clearances. The entire supercharger drive system is tuned to minimize this noise.
Internal isolator	• The supercharger incorporates an internal isolator between the pulley and the rotor shaft, which has two functions. The first is to minimize a knocking sound when the engine is turned off and the mass of the supercharger rotor set is suddenly jerked to a stop. And second, the isolator is tuned to minimize the normal engine firing pulses passed on to the supercharger rotor drive gears. It is active only in an unloaded condition, low engine speed point where boost is not requested. • If the engine or one of the components in the driveline is not operating to design intent, the isolator may make a harsh intermittent rattle sound that often goes through cycles as the engine speed or other conditions change slightly.

Diagnostic Information and Procedures

2058852

Upper Engine Noise, Regardless of Engine Speed

Upper Engine Noise, Regardless of Engine Speed@Engine Noise:Upper Engine Noise, Regardless of Engine Speed

Cause	Correction
Low oil pressure	**1.** Perform an oil pressure test. Refer to *Oil Pressure Diagnosis and Testing* . **2.** Repair or replace, as required.
Loose and/or worn valve rocker arm attachments	**1.** Inspect the valve rocker arm, bolt, and pedestal. **2.** Repair or replace, as required.
Worn or damaged valve rocker arm	**1.** Inspect the rocker arm for wear or missing needle bearings **2.** Replace the valve rocker arms, as required.
Bent or damaged push rod	Inspect the following components and replace, as required: • The valve rocker arm • The valve push rod • The valve lifter • The valve lifter guide • The piston Inspect the top of the pistons for valve contact. If the top of the piston shows valve contact, replace the piston and pin assembly.
Improper lubrication to the valve rocker arms	Inspect the following components and repair or replace, as required: • The valve rocker arm • The valve push rod • The valve lifter • The oil filter bypass valve The bypass valve is now internal to the oil filter. • The oil pump and pump screen • The engine block oil galleries
Broken valve spring	Replace the valve spring and spring shim.
Worn or dirty valve lifters	Replace the valve lifters.
Stretched or broken timing chain and/or damaged sprocket teeth	Replace the timing chain and sprockets.
Worn engine camshaft lobes	**1.** Inspect the engine camshaft lobes. **2.** Replace the camshaft and valve lifters, as required.
Worn valve guides or valve stems	Inspect the following components and repair, as required: • The valves • The valve guides
Stuck valves Carbon on the valve stem or valve seat may cause the valve to stay open.	Inspect the following components and repair, as required: • The valves • The valve guides

Diagnostic Information and Procedures

2058854

Lower Engine Noise, Regardless of Engine Speed

Lower Engine Noise, Regardless of Engine Speed

Cause	Correction
Low oil pressure	**1.** Perform an oil pressure test. Refer to *Oil Pressure Diagnosis and Testing* . **2.** Repair or replace damaged components, as required.
Worn accessory drive components Abnormalities such as severe cracking, bumps or missing areas in the accessory drive belt and/or misalignment of system components.	**1.** Inspect the accessory drive system. **2.** Repair or replace, as required.
Loose or damaged crankshaft balancer	**1.** Inspect the crankshaft balancer. **2.** Repair or replace, as required.
Detonation or spark knock	Verify the correct operation of the ignition controls system. Refer to *Symptoms - Engine Controls* .
Loose or damaged flywheel	Repair or replace the flywheel.
Oil pump screen loose, damaged, or restricted	**1.** Inspect the oil pump screen. **2.** Repair or replace as required.
Excessive piston-to-cylinder bore clearance	**1.** Inspect the piston and cylinder bore. **2.** Repair, as required.
Excessive piston pin-to-bore clearance	**1.** Inspect the piston, pin, and connecting rod. **2.** Replace the piston and pin as an assembly, as required.
Excessive connecting rod bearing clearance	Inspect the following components, and repair, as required: • The connecting rod bearings • The connecting rods • The crankshaft • The crankshaft journals
Excessive crankshaft bearing clearance	Inspect the following components and repair, as required: • The crankshaft bearings • The crankshaft journals
Incorrect piston, piston pin and connecting rod installation Pistons must be installed with the mark or dimple on the top of the piston facing the front of the engine. Piston pins must be centered in the connecting rod pin bore.	**1.** Verify the pistons, piston pins and connecting rods are installed correctly. Refer to *Piston, Connecting Rod, and Bearing Installation (6.2L)* . **2.** Repair, as required.

Diagnostic Information and Procedures

2214287

Engine Noise Under Load

Engine Noise:Under Load

Cause	Correction
Low oil pressure	**1.** Perform an oil pressure test. Refer to *Oil Pressure Diagnosis and Testing* . **2.** Repair or replace, as required.
Detonation or spark knock	Verify the correct operation of the ignition controls. Refer to *Diagnostic System Check - Vehicle* .
Loose torque converter bolts	**1.** Inspect the torque converter bolts and flex plate. **2.** Repair, as required.
Cracked flex plate – automatic transmission	**1.** Inspect the bolts and flex plate. **2.** Repair, as required.
Excessive connecting rod bearing clearance	Inspect the following components and repair, as required: • The connecting rod bearings • The connecting rods • The crankshaft
Excessive crankshaft bearing clearance	Inspect the following components and repair, as required: • The crankshaft bearings • The crankshaft journals • The cylinder block crankshaft bearing bore

Diagnostic Information and Procedures

2158492

Engine Will Not Crank - Crankshaft Will Not Rotate

Engine Will Not Crank:Crankshaft Will Not Rotate

Cause	Correction
Seized accessory drive system component	**1.** Remove the accessory drive belts. **2.** Confirm that the engine will rotate. Rotate the crankshaft by hand at the crankshaft balancer or flywheel location. **3.** Repair or replace the components, as required.
Seized supercharger – 6.2L LSA	**1.** Remove the accessory drive belt and confirm the pulley of the supercharger will rotate. **2.** Repair or replace components as required.
Broken timing chain	**1.** Inspect the timing chain and sprockets. **2.** Repair or replace the components, as required.
Seized timing chain or timing sprockets	**1.** Inspect the timing chain and sprockets for foreign material or a seized chain. **2.** Repair or replace the components, as required.
Seized or broken camshaft	**1.** Inspect the camshaft and the camshaft bearings. **2.** Repair or replace the components, as required.
Bent valve in the cylinder head	**1.** Inspect the valves and the cylinder heads. **2.** Repair or replace the components, as required.

Cause	Correction
Seized oil pump	**1.** Inspect the oil pump assembly. **2.** Repair or replace, as required.
Hydraulically locked cylinder • Coolant/antifreeze in the cylinder • Oil in the cylinder • Fuel in the cylinder	**1.** Remove spark plugs and inspect for fluid in the cylinder. When rotating the engine with the spark plugs removed, the piston, on compression stroke, will push fluid from the combustion chamber. Refer to *Coolant in Combustion Chamber* . **2.** Inspect for failed/broken head gaskets. **3.** Inspect for a cracked engine block or cylinder head. **4.** Inspect for a sticking fuel injector. **5.** Inspect the supercharger intercooler for an internal coolant leak – 6.2L LS9. Refer to *Supercharger Assemble* . **6.** Repair or replace the components, as required.
Material in the cylinder • Broken valve • Broken piston rings • Piston material • Foreign material	**1.** Inspect the cylinder for damaged components and/or foreign materials. **2.** Repair or replace the components, as required.
Seized crankshaft or connecting rod bearings	**1.** Inspect crankshaft and connecting rod bearings. **2.** Repair or replace the components, as required.
Bent or broken connecting rod	**1.** Inspect the connecting rods. **2.** Replace the components, as required.
Broken crankshaft	**1.** Inspect the crankshaft. **2.** Repair or replace the components, as required.

Diagnostic Information and Procedures

2158497

Coolant in Combustion Chamber

Cause	Correction
DEFINITION: Excessive white smoke and/or coolant type odor coming from the exhaust pipe may indicate coolant in the combustion chamber. Low coolant levels, an inoperative cooling fan, or a faulty thermostat may lead to an overtemperature condition which may cause engine component damage. **1.** A slower than normal cranking speed may indicate coolant entering the combustion chamber. Refer to *Engine Will Not Crank - Crankshaft Will Not Rotate* . **2.** Remove the spark plugs and inspect for spark plugs saturated by coolant or coolant in the cylinder bore. **3.** Inspect by performing a cylinder leak-down test. During this test, excessive air bubbles within the coolant may indicate a faulty gasket or damaged component. **4.** Inspect by performing a cylinder compression test. Two cylinders side-by-side on the engine block, with low compression, may indicate a failed cylinder head gasket. Refer to *Engine Compression Test* .	
Faulty cylinder head gasket	Replace the head gasket and components, as required. Refer to *Cylinder Head Cleaning and Inspection* and *Cylinder Head Replacement - Left Side (LSA)* or *Cylinder Head Replacement - Right Side (LSA)* .
Warped cylinder head	Machine the cylinder head to the proper flatness, if applicable and replace the cylinder head gasket. Refer to *Cylinder Head Cleaning and Inspection* .

Cause	Correction
Cracked cylinder head	Replace the cylinder head and gasket.
Cracked cylinder liner or engine block	Replace the components, as required.
Cylinder head or engine block porosity	Replace the components, as required.
Supercharger intercooler – internal coolant leak – 6.2L LSA	**1.** Inspect for a leaking intercooler. Perform a pressure test on the intercooler. Refer to *Supercharger Assemble* . **2.** Repair or replace components as required.

Diagnostic Information and Procedures

2158500

Coolant in Engine Oil

Cause	Correction
DEFINITION: Foamy or discolored oil or an engine oil overfill condition may indicate coolant entering the engine crankcase. Low coolant levels, an inoperative cooling fan, or a faulty thermostat may lead to an overtemperature condition which may cause engine component damage. Contaminated engine oil and oil filter should be changed. **1.** Inspect the oil for excessive foaming or an overfill condition. Oil diluted by coolant may not properly lubricate the crankshaft bearings and may lead to component damage. Refer to *Lower Engine Noise, Regardless of Engine Speed* . **2.** Inspect by performing a cylinder leak-down test. During this test, excessive air bubbles within the cooling system may indicate a faulty gasket or damaged component. **3.** Inspect by performing a cylinder compression test. Two cylinders side-by-side on the engine block with low compression may indicate a failed cylinder head gasket. Refer to *Engine Compression Test* .	
Supercharger intercooler with an internal coolant leak – 6.2L LSA	Inspect the supercharger intercooler for an internal coolant leak. Refer to *Supercharger Assemble* .
Faulty engine oil cooler – 6.2L LSA	Inspect the engine oil cooler for an internal coolant leak. Refer to *Engine Oil Cooler Cleaning and Inspection* .
Faulty cylinder head gasket	Replace the head gasket and components, as required. Refer to *Cylinder Head Cleaning and Inspection* and *Cylinder Head Replacement - Left Side (LSA)* or *Cylinder Head Replacement - Right Side (LSA)* .
Warped cylinder head	Machine the cylinder head to proper flatness, if applicable, and replace the cylinder head gasket. Refer to *Cylinder Head Cleaning and Inspection* .
Cracked cylinder head	Replace the cylinder head and gasket.
Cracked cylinder liner or engine block	Replace the components, as required.
Cylinder head, block, or manifold porosity	Replace the components, as required.

Diagnostic Information and Procedures

1406807

Engine Compression Test

Engine Compression Test

1. Charge the battery if the battery is not fully charged.
2. Disable the ignition system.
3. Disable the fuel injection system.

4. Remove all spark plugs.
5. Turn the ignition to the ON position.
6. Depress the accelerator pedal to position the throttle plate wide open.
7. Start with the compression gauge at zero and crank the engine through 4 compression strokes, 4 puffs.
8. Measure the compression for each cylinder. Record the readings.
9. If a cylinder has low compression, inject approximately 15 ml (1 tablespoon) of engine oil into the combustion chamber through the spark plug hole. Measure the compression again and record the reading.
10. The minimum compression in any 1 cylinder should not be less than 70 percent of the highest cylinder. No cylinder should read less than 690 kPa (100 psi). For example, if the highest pressure in any 1 cylinder is 1 035 kPa (150 psi), the lowest allowable pressure for any other cylinder would be 725 kPa (105 psi). (1 035 x 70% = 725) (150 x 70% = 105).

- Normal — Compression builds up quickly and evenly to the specified compression for each cylinder.
- Piston Rings Leaking — Compression is low on the first stroke. Compression builds up with the following strokes, but does not reach normal. Compression improves considerably when you add oil.
- Valves Leaking — Compression is low on the first stroke. Compression usually does not build up on the following strokes. Compression does not improve much when you add oil.
- If 2 adjacent cylinders have lower than normal compression, and injecting oil into the cylinders does not increase the compression, the cause may be a head gasket leaking between the cylinders.

Diagnostic Information and Procedures

2173701

Engine Balancing

During the powertrain build process, balance weights may be added to the crankshaft balancer and/or manual transmission flywheel, as required.

In order to maintain engine/clutch assembly balance, it may be necessary to install or remove balance weights as detailed below:

Crankshaft Balancer

- Existing RPO-LSA manual transmission applications, balancer onto existing engine: It is not necessary to mark the balancer prior to removal. The balancer is positioned by a key located in the front of the crankshaft. Refer to *Crankshaft Balancer Removal* .
- New balancer onto an existing engine: Install the same size balance weights into the new balancer in the same location as the old balancer. Refer to *Crankshaft Balancer Cleaning and Inspection* .

Engine Flywheel

- For RPO-LSA manual transmission applications, the flywheel, clutch disc, and pressure plate are each individually balanced components and the clutch and pressure plate are available only as a kit. The pressure plate mounts, or locates, onto the flywheel dowel pins in the flywheel. If the pressure plate is not aligned properly onto the dowel pins and tightened down, the pins may bend and the plate may be incorrectly positioned, which will affect component balance. Refer to *Engine Flywheel Removal* .
- Existing flywheel, clutch, and pressure plate onto the existing engine: Pressure plate position to flywheel must be marked prior to removal and installed to the original position. Flywheel position to crankshaft must also be marked prior to removal and installed to the original position. Refer to *Engine Flywheel Removal* .
- Existing flywheel, clutch, and pressure plate onto a new engine: Pressure plate position to flywheel must be marked prior to removal and installed to the original position. Flywheel position to crankshaft must be marked prior to removal and installed to the similar position on the new engine. Do not remove balance weights from flywheel, if applicable.
- New flywheel onto an existing engine: Install the same size balance weights into the new flywheel in the same location as the old flywheel. Install the new flywheel to a similar position on the new engine.
- New flywheel, clutch, and pressure plate onto a new engine: Do not install balance weights.

Diagnostic Information and Procedures

2134577

Cylinder Leakage Test

Special Tools

J 35667-A Cylinder Head Leakdown Tester, or equivalent

Note

A leakage test may be performed in order to measure cylinder/combustion chamber leakage. High cylinder leakage may indicate one or more of the following conditions:

- Worn or burnt valves
- Broken valve springs
- Stuck valve lifters
- Incorrect valve lash
- Damaged piston
- Worn piston rings
- Worn or scored cylinder bore
- Damaged cylinder head gasket
- Cracked or damaged cylinder head
- Cracked or damaged engine block

Warning **1.** Refer to *Battery Disconnect Warning* . **1.** Disconnect the battery ground negative cable.

2. Remove the spark plugs. Refer to *Spark Plug Replacement* .

3. Rotate the crankshaft to place the piston in the cylinder being tested at top dead center (TDC) of the compression stroke.

4. Install the *J 35667-A* , or equivalent.

Note **5.** It may be necessary to hold the crankshaft balancer bolt to prevent the crankshaft from rotating. **5.** Apply shop air pressure to the *J 35667-A* and adjust according to the manufacturers instructions.

6. Record the cylinder leakage value. Cylinder leakage that exceeds 25 percent is considered excessive and may require component service. In excessive leakage situations, inspect for the following conditions:

  - Air leakage noise at the throttle body or air inlet hose that may indicate a worn or burnt intake valve or a broken valve spring.
  - Air leakage noise at the exhaust system tailpipe that may indicate a worn or burnt exhaust valve or a broken valve spring.
  - Air leakage noise from the crankcase, oil level indicator tube, or oil fill tube that may indicate worn piston rings, a damaged piston, a worn or scored cylinder bore, a damaged engine block or a damaged cylinder head.
  - Air bubbles in the cooling system may indicate a damaged cylinder head or a damaged cylinder head gasket.

7. Perform the leakage test on the remaining cylinders and record the values.

Diagnostic Information and Procedures

1877707

Oil Consumption Diagnosis

Oil Consumption Diagnosis

Checks	Causes
Excessive oil consumption, not due to leaks, is the use of 1 L (1 qt) or more of engine oil within 3 200 kilometers (2,000 miles).	
Preliminary	The causes of excessive oil consumption may include the following conditions: • External oil leaks Refer to *Oil Leak Diagnosis* . • Incorrect oil level or improper reading of the oil level indicator With the vehicle on a level surface, run the engine for a few minutes. Allow adequate drain down time, 2–3 minutes, and inspect for the correct engine oil level. • Improper oil viscosity Refer to the vehicle owners manual and use the recommended SAE grade and viscosity for the prevailing temperatures. • Continuous high speed driving and/or severe usage • Crankcase ventilation system restrictions or malfunctioning components Refer to *Crankcase Ventilation System Inspection/Diagnosis* . • Worn valve guides and/or valve stems • Worn or improperly installed valve stem oil seals Refer to *Spark Plug Inspection* . • Piston rings broken, worn, or not seated properly Allow adequate time for the rings to seat. Replace worn piston rings, as necessary. Refer to *Cylinder Leakage Test* . • Piston and rings improperly installed or not fitted to the cylinder bore Refer to *Lower Engine Noise, Regardless of Engine Speed* .

Diagnostic Information and Procedures

2158506

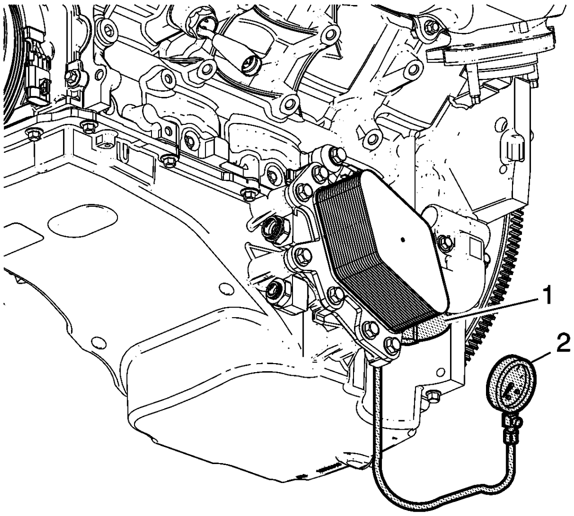
Oil Pressure Diagnosis and Testing

Oil Pressure:Diagnosis and Testing

Special Tools

- EN 47971 Oil Pressure Gauge Adapter
- J 21867 Pressure Gauge

For equivalent regional tools, refer to *Special Tools* .



2156303

1. With the vehicle on a level surface, run the vehicle for a few minutes, allow adequate drain down time, 2–3 minutes, and measure the oil level.

2. If required, add the recommended grade engine oil and fill the crankcase until the oil level measures full on the oil level indicator.

3. Run the engine briefly, 10–15 seconds, and verify low or no oil pressure on the vehicle gauge or light.

4. Listen for a noisy valve train or a knocking noise.

5. Inspect for the following conditions:

- Oil diluted by water or glycol antifreeze
- Foamy oil

6. Remove the oil filter and install the EN 47971 adapter (1) .

7. Install the J 21867 gauge (2), or equivalent to the EN 47971 adapter (1).

8. Run the engine and measure the engine oil pressure.

9. Compare the readings to *Engine Mechanical Specifications* .

10. If the engine oil pressure is below specifications, inspect the engine for 1 or more of the following conditions:

- Oil pump worn or dirty

  Refer to *Oil Pump Cleaning and Inspection (6.2L)* .
- Oil pump-to-engine block bolts loose

  Refer to *Oil Pump, Screen and Crankshaft Oil Deflector Installation (6.2L)* .
- Oil pump screen loose, plugged, or damaged
- Oil pump screen O-ring seal missing or damaged
- Malfunctioning oil pump pressure relief valve
- Excessive bearing clearance
- Cracked, porous, or restricted oil galleries
- Oil gallery plugs missing or incorrectly installed

  Refer to *Engine Block Plug Installation* .
- Broken valve lifters

  Repair, as necessary.

11. If the oil pressure reading on the J 21867 gauge , or equivalent, is within specifications, inspect for the following conditions:

- Plugged or incorrect oil filter and/or malfunctioning oil bypass valve

  The bypass valve is now internal to the oil filter.
- Malfunctioning oil pressure gauge or sensor. Repair as necessary.

Component Connector End Views

Description and Operation

- *Instrument Cluster Description and Operation*
- *Indicator/Warning Message Description and Operation*

Electrical Information Reference

- *Circuit Testing*
- *Connector Repairs*
- *Testing for Intermittent Conditions and Poor Connections*
- *Wiring Repairs*

Scan Tool Reference

Control Module References for scan tool information.

Circuit/System Verification

1. Verify proper engine oil level. Add oil as necessary.

2. Ignition ON, observe the scan tool Engine Oil Level parameter. The reading should be OK and change to Low when the oil level sensor/switch harness connector is disconnected.

Circuit/System Testing

Note

Verify proper engine oil level before continuing with diagnosis.

1. Ignition OFF, disconnect the harness connector at the B35C engine oil level sensor.

2. Ignition OFF for 90 s, test for less than 2 Ω between the ground circuit terminal C and ground.

3. If greater than the specified range, test the ground circuit for an open/high resistance.

4. Ignition ON, verify the scan tool Engine Oil Level Warning parameter reads Low.

5. If the Oil Level Warning parameter reads OK, test the signal circuit terminal A for a short to ground. If the circuit tests normal, replace the ECM.

Note 6. If a short to voltage is found on the signal circuit, the fuse in the 3 A jumper wire will open. **6.** Ignition ON, install a 3 A fused jumper wire between the signal circuit terminal A and the ground circuit terminal C. Verify the scan tool Engine Oil Level Warning parameter reads OK.

7. If the Engine Oil Level parameter reads Low, test the signal circuit terminal A for an open/high resistance. If the circuit tests normal, replace the K20 ECM.

8. If all circuits test normal, test or replace the B35C engine oil level temperature sensor.

Repair Instructions

Perform the *Diagnostic Repair Verification* after completing the diagnostic procedure.

- *Engine Oil Level Sensor and/or Switch Replacement*
- *Engine Control Module Replacement*
- *Control Module References* for the ECM replacement, setup, and programming

Diagnostic Information and Procedures

1406822

Oil Leak Diagnosis

Oil Leak Diagnosis

Step	Action	Yes	No
Important: You can repair most fluid leaks by first visually locating the leak, repairing or replacing the component, or by resealing the gasket surface. Once the leak is identified, determine the cause of the leak. Repair the cause of the leak as well as the leak itself.			

Step	Action	Yes	No
1	**1.** Operate the vehicle until it reaches normal operating temperature. **2.** Park the vehicle on a level surface, over a large sheet of paper or other clean surface. **3.** Wait 15 minutes. **4.** Inspect for drippings. Are drippings present?	Go to Step 2	System OK
2	Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 3
3	**1.** Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. **2.** Inspect for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 4
4	**1.** Completely clean the entire engine and surrounding components. **2.** Operate the vehicle for several kilometers, miles, at normal operating temperature and at varying speeds. **3.** Park the vehicle on a level surface, over a large sheet of paper or other clean surface. **4.** Wait 15 minutes. **5.** Identify the type of fluid, and the approximate location of the leak. Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 5
5	**1.** Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. **2.** Inspect for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 6
6	**1.** Completely clean the entire engine and surrounding components. **2.** Apply an aerosol-type powder, baby powder, foot powder, etc., to the suspected area. **3.** Operate the vehicle for several kilometers, miles, at normal operating temperature and at varying speeds. **4.** Identify the type of fluid, and the approximate location of the leak, from the discolorations in the powder surface. Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 7

Step	Action	Yes	No
7	**1.** Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. **2.** Inspect for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 8
8	Use the *J 28428-E* high-intensity black light kit in order to identify the type of fluid, and the approximate location of the leak. Refer to the manufacturer's instructions when using the tool. Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 9
9	**1.** Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. **2.** Inspect for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	System OK
10	**1.** Inspect the engine for mechanical damage. Special attention should be shown to the following areas: • Higher than recommended fluid levels • Higher than recommended fluid pressures • Plugged or malfunctioning fluid filters or pressure bypass valves • Plugged or malfunctioning engine ventilation system • Improperly tightened or damaged fasteners • Cracked or porous components • Improper sealants or gaskets, where required • Improper sealant or gasket installation • Damaged or worn gaskets or seals • Damaged or worn sealing surfaces **2.** Inspect the engine for customer modifications. Is there mechanical damage, or customer modifications to the engine?	Go to Step 11	System OK
11	Repair or replace all damaged or modified components. Does the engine still leak oil?	Go to Step 1	System OK

Diagnostic Information and Procedures

954724

Crankcase Ventilation System Inspection/Diagnosis

Crankcase Ventilation:System

Concern	Action
External oil leak	Inspect for any of the following conditions: • Plugged positive crankcase ventilation (PCV) • Plugged or kinked PCV hose(s) • Damaged or incorrectly installed PCV or hose(s) • Excessive crankcase pressure
Rough Idle	Inspect for any of the following conditions: • Plugged PCV • Plugged or kinked PCV hose(s) • Leaking (damaged) PCV or hose(s)
Stalling or slow idle speed	Inspect for any of the following conditions: • Plugged PCV • Plugged or kinked PCV hose(s) • Leaking (damaged) PCV or hose(s)
High idle speed	Inspect for a leaking (damaged) PCV or hose(s)
Sludge in the engine	Inspect for any of the following conditions: • Plugged PCV • Plugged or kinked PCV hose(s)

Diagnostic Information and Procedures

2165839

Drive Belt Chirping, Squeal, and Whine Diagnosis

Diagnostic Aids

- A chirping or squealing noise may be intermittent due to moisture on the drive belt(s) or the pulley(s). It may be necessary to spray a small amount of water on the drive belt(s) in order to duplicate the customers concern. If spraying water on the drive belt duplicates the symptom, cleaning the belt pulley(s) may be the probable solution.
- If the noise is intermittent, verify the accessory drive components by varying their loads making sure they are operated to their maximum capacity. An overcharged A/C system, power steering system with a pinched hose or incorrect fluid, or a generator failing are suggested items to inspect.
- A chirping, squeal or whine noise may be caused by a loose or improper installation of a body or suspension component. Other items of the vehicle may also cause the noise.
- The drive belts will not cause a whine noise.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2. The noise may not be engine related. This step is to verify that the engine is making the noise. If the engine is not making the noise do not proceed further with this table.

3. The noise may be an internal engine noise. Removing the drive belts one at a time and operating the engine for a brief period will verify the noise is related to the drive belt. When removing the drive belt the water pump may not be operating and the engine may overheat. Also diagnostic trouble codes (DTCs) may set when the engine is operating with the drive belt(s) removed.

4. Inspect all drive belt pulleys for pilling. Pilling is the small balls or pills or it can be strings in the drive belt grooves from the accumulation of rubber dust.

6. Misalignment of the pulleys may be caused from improper mounting of the accessory drive component, incorrect installation of the accessory drive component pulley, or the pulley bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across two or three pulleys. If a misaligned pulley is found refer to that accessory drive component for the proper installation procedure for that pulley.

10. Inspecting of the fasteners can eliminate the possibility that a wrong bolt, nut, spacer, or washer was installed.

12. Inspecting the pulleys for being bent should include inspecting for a dent or other damage to the pulleys that would prevent the drive belt from not seating properly in all of the pulley grooves or on the smooth surface of a pulley when the back side of the belt is used to drive the pulley.

14. This test is to verify that the drive belt tensioner operates properly. If the drive belt tensioner is not operating properly, proper belt tension may not be achieved to keep the drive belt from slipping which could cause a squeal noise.

15. This test is to verify that the drive belt is not too long, which would prevent the drive belt tensioner from working properly. Also if an incorrect length drive belt was installed, it may not be routed properly and may be turning an accessory drive component in the wrong direction.

16. Misalignment of the pulleys may be caused from improper mounting of the accessory drive component, incorrect installation of the accessory drive component pulley, or the pulley bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across two or three pulleys. If a misaligned pulley is found refer to that accessory drive component for the proper installation procedure for that pulley.

17. This test is to verify that the pulleys are the correct diameter or width. Using a known good vehicle compare the pulley sizes.

19. Replacing the drive belt when it is not damaged or there is not excessive pilling will only be a temporary repair.

Step	Action	Yes	No
Caution: Refer to *Belt Dressing Caution* . DEFINITION: The following items are indications of chirping: • A high pitched noise that is heard once per revolution of the drive belt or pulley. • Chirping may occur on cold damp start-ups and will subside once the vehicle reaches normal operating temperature. DEFINITION: The following items are indications of drive belt squealing: • A loud screeching noise that is caused by a slipping drive belt. This is unusual for a drive belt with multiple ribs. • The noise occurs when a heavy load is applied to the drive belt, such as an air conditioning compressor engagement snapping the throttle, or slipping on a seized pulley or a faulty accessory drive component. DEFINITION: The following items are indications of drive belt whining: • A high pitched continuous noise. • The noise may be caused by an accessory drive component failed bearing.			
1	Did you review the Symptoms—Engine Mechanical operation and perform the necessary inspections?	Go to Step 2	Go to *Symptoms - Engine Mechanical*
2	Verify that there is a chirping, squealing or whining noise. Does the engine make the chirping, squealing or whining noise?	Go to Step 3	Go to Diagnostic Aids
3	**1.** Remove the drive belt. If the engine has multiple drive belts, remove the belts one at a time and perform the test below each time a belt is removed. **2.** Operate the engine for no longer than 30–40 seconds. **3.** Repeat this test if necessary by removing the remaining belt(s). Does the chirping, squealing or whining noise still exist?	Go to *Symptoms - Engine Mechanical*	Go to Step 4
4	If diagnosing a chirping noise, inspect for severe pilling exceeding 1/3 of the belt groove depth. If diagnosing a squealing or whining noise, proceed to step 13. Does the belt grooves have pilling?	Go to Step 5	Go to Step 6

Step	Action	Yes	No
5	Clean the drive belt pulleys with a suitable wire brush. Did you complete the repair?	Go to Step 20	Go to Step 6
6	Inspect for misalignment of the pulleys. Are any of the pulleys misaligned?	Go to Step 7	Go to Step 8
7	Replace or repair any misaligned pulleys. Did you complete the repair?	Go to Step 20	Go to Step 8
8	Inspect for bent or cracked accessory brackets. Did you find any bent or cracked brackets?	Go to Step 9	Go to Step 10
9	Replace any bent or cracked accessory brackets. Did you complete the repair?	Go to Step 20	Go to Step 10
10	Inspect for incorrect, loose, or missing fasteners. Did you find the condition?	Go to Step 11	Go to Step 12
11	**Caution: Refer to *Fastener Caution* .** **1.** Tighten any loose fasteners. Refer to *Fastener Tightening Specifications* . **2.** Replace any incorrect or missing fasteners. Did you complete the repair?	Go to Step 20	Go to Step 12
12	Inspect for a bent pulley. Did you find the condition?	Go to Step 18	Go to Step 19
13	Inspect for an accessory drive component seized bearing or a faulty accessory drive component. If diagnosing a whining noise and the condition still exists, proceed to Diagnostic Aids. Did you find and correct the condition?	Go to Step 20	Go to Step 14
14	Test the drive belt tensioner for correct operation. Refer to *Drive Belt Tensioner Diagnosis* . Did you find and correct the condition?	Go to Step 20	Go to Step 15
15	Inspect for the correct drive belt length. Did you find and correct the condition?	Go to Step 20	Go to Step 16
16	Inspect for misalignment of a pulley. Did you find and correct the condition?	Go to Step 20	Go to Step 17
17	Inspect for the correct pulley size. Did you find and correct the condition?	Go to Step 20	Go to Diagnostic Aids
18	Replace the bent pulley. Did you complete the repair?	Go to Step 20	Go to Step 19

Step	Action	Yes	No
19	Replace the drive belt(s). Did you complete the repair?	Go to Step 20	Go to Diagnostic Aids
20	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

Diagnostic Information and Procedures

2165842

Drive Belt Rumbling and Vibration Diagnosis

Diagnostic Aids

The accessory drive components can have an affect on engine vibration. Vibration from the engine operating may cause a body component or another part of the vehicle to make rumbling noise. Vibration can be caused by, but not limited to the A/C system being over charged, the power steering system being restricted or the incorrect fluid being used, or an extra load on the generator. To help identify an intermittent or an improper condition, vary the loads on the accessory drive components.

The drive belt may have a rumbling condition that can not be seen or felt. Sometimes replacing the drive belt may be the only repair for the symptom.

If replacing the drive belt, completing the diagnostic table, and the noise is only heard when the drive belts are installed, there might be an accessory drive component with a failure. Varying the load on the different accessory drive components may aid in identifying which component is causing the rumbling noise.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2. This test is to verify that the symptom is present during diagnosing. Other vehicle components may cause a similar symptom.

3. This test is to verify that one of the drive belts is causing the rumbling noise or vibration. Rumbling noise may be confused with an internal engine noise due to the similarity in the description. Remove only one drive belt at a time if the vehicle has multiple drive belts. When removing the drive belts the water pump may not be operating and the engine may overheat. Also, diagnostic trouble codes (DTCs) may set when the engine is operating with the drive belt(s) removed.

4. Inspecting the drive belts is to ensure that they are not causing the noise. Small cracks across the ribs of the drive belt will not cause the noise. Belt separation is identified by the plys of the belt separating and may be seen at the edge of the belt our felt as a lump in the belt.

5. Small amounts of pilling is a normal condition and acceptable. When the pilling is severe the drive belt does not have a smooth surface for proper operation.

9. Inspection of the fasteners can eliminate the possibility that the incorrect bolt, nut, spacer, or washer was installed.

11. This step should only be performed if the water pump is driven by the drive belt. Inspect the water pump shaft for being bent. Also inspect the water pump bearings for smooth operation and excessive play. Compare the water pump with a known good water pump.

12. Accessory drive component brackets that are bent, cracked, or loose may put extra strain on that accessory component causing it to vibrate.

Step	Action	Yes	No
Caution: Refer to *Belt Dressing Caution* . DEFINITION: The following items are indications of drive belt rumbling: • A low pitch tapping, knocking, or thumping noise heard at or just above idle. • Heard once per revolution of the drive belt or a pulley. • Rumbling may be caused from: – Pilling, the accumulation of rubber dust that forms small balls (pills) or strings in the drive belt pulley groove – The separation of the drive belt – A damaged drive belt DEFINITION: The following items are indications of drive belt vibration: • The vibration is engine-speed related. • The vibration may be sensitive to accessory load.			
1	Did you review the Symptoms – Engine Mechanical operation and perform the necessary inspections?	Go to Step 2	Go to *Symptoms - Engine Mechanical*
2	Verify that there is a rumbling noise or that the vibration is engine related. Does the engine make the rumbling noise or vibration?	Go to Step 3	Go to Diagnostic Aids
3	**1.** Remove the drive belt(s). If the engine has multiple drive belts, remove the belts one at a time and perform the test below each time a belt is removed. **2.** Operate the engine for no longer than 30–40 seconds. **3.** Repeat this test if necessary by removing the remaining belt(s). Does the rumbling or vibration still exist?	For rumbling diagnosis, go to *Symptoms - Engine Mechanical* . For vibration diagnosis, go to *Vibration Analysis - Engine* .	Go to Step 4
4	Inspect the drive belt(s) for wear, damage, separation, sections of missing ribs, and/or debris build-up. Did you find any of these conditions?	Go to Step 7	Go to Step 5
5	Inspect for severe pilling of more than 1/3 of the drive belt pulley grooves. Did you find severe pilling?	Go to Step 6	Go to Step 7
6	**1.** Clean the drive belt pulleys using a suitable wire brush. **2.** Reinstall the drive belts. Did you correct the condition?	Go to Step 8	Go to Step 7
7	Install a new drive belt. Did you complete the replacement?	Go to Step 8	—
8	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 9
9	Inspect for improper, loose or missing fasteners. Did you find any of these conditions?	Go to Step 10	Go to Step 11

Step	Action	Yes	No
10	**Caution: Refer to *Fastener Caution* .** **1.** Tighten any loose fasteners. Refer to *Fastener Tightening Specifications* . **2.** Replace any improper or missing fasteners. Did you complete the repair?	Go to Step 13	—
11	Inspect for a bent water pump shaft. Did you find and correct the condition?	Go to Step 13	Go to Step 12
12	Inspect for bent or cracked accessory brackets. Did you find and correct the condition?	Go to Step 13	Go to Diagnostic Aids
13	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

Diagnostic Information and Procedures

2165845

Drive Belt Falls Off and Excessive Wear Diagnosis

Diagnostic Aids

If the drive belt repeatedly falls off the drive belt pulleys, this is a result of pulley misalignment.

An extra load that is quickly applied or released by an accessory drive component may cause the drive belt to fall off the pulley. Verify the accessory drive components operate properly.

If the drive belt is the incorrect length, the drive belt tensioner may not apply the proper tension on the drive belt.

Excessive wear on a drive belt is usually caused by an incorrect installation or the incorrect drive belt for the application.

Minor misalignment of the drive belt pulleys will not cause excessive wear, but will probably cause the drive belt to make a noise or to fall off.

Excessive misalignment of the drive belt pulleys will cause excessive wear but may also make the drive belt fall off.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2. This inspection is to verify the condition of the drive belt. Damage may have occurred to the drive belt when the drive belt fell off. The drive belt may be damaged, which caused the drive belt to fall off. Inspect the belt for cuts, tears, sections of ribs missing, or damaged belt plys.

4. Misalignment of the pulleys may be caused from improper mounting of the accessory drive component, incorrect installation of the accessory drive component pulley, or the pulley being bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across 2 or 3 pulleys. If a misaligned pulley is found refer to that accessory drive component for the proper repair procedure of that pulley.

5. Inspecting the pulleys for being bent should include inspecting for a dent or other damage to the pulleys that would prevent the drive belt from not seating properly in all of the pulley grooves or on the smooth surface of a pulley when the back side of the belt is used to drive the pulley.

6. Accessory drive component brackets that are bent or cracked may allow the drive belt to fall off.

7. Inspecting of the fasteners can eliminate the possibility that a incorrect bolt, nut , spacer, or washer was installed. Missing, loose, or an incorrect fastener may cause pulley misalignment from the bracket moving under load. Over tightening of the fasteners may cause misalignment of the accessory component bracket.

13. The inspection is to verify the drive belt is correctly installed on all of the drive belt pulleys. Wear on the drive belt may be caused by mis-positioning the drive belt by one groove on a pulley.

14. The installation of a drive belt that is too wide or too narrow will cause wear on the drive belt. The drive belt ribs should match all of the grooves on all of the pulleys.

15. This inspection is to verify the drive belt is not contacting any component of the engine or body while the engine is operating. There should be sufficient clearance when the drive belt accessory drive components load varies. The drive belt should not come in contact with an engine or a body component when snapping the throttle.

Step	Action	Yes	No
Caution: Refer to *Belt Dressing Caution* . DEFINITION: • The drive belt falls off the pulleys or may not sit correctly on the pulleys. • Wear at the outside ribs of the drive belt may be due to an incorrectly installed drive belt.			
1	Did you review the Symptoms–Engine–Mechanical operation and perform the necessary inspections?	Go to Step 2	Go to *Symptoms - Engine Mechanical*
2	If diagnosing excessive wear, proceed to step 13. If diagnosing a drive belt that falls off, inspect for a damaged drive belt. Did you find the condition?	Go to Step 3	Go to Step 4
3	Install a new drive belt. Does the drive belt continue to fall off?	Go to Step 4	System OK
4	Inspect for pulley misalignment. Did you find and repair the condition?	Go to Step 12	Go to Step 5
5	Inspect for a bent or dented pulley. Did you find and repair the condition?	Go to Step 12	Go to Step 6
6	Inspect for a bent or a cracked accessory bracket. Did you find and repair the condition?	Go to Step 12	Go to Step 7
7	Inspect for improper, loose or missing fasteners. Did you find loose or missing fasteners?	Go to Step 8	Go to Step 9
8	**Caution: Refer to *Fastener Caution* .** **1.** Tighten any loose fasteners. Refer to *Fastener Tightening Specifications* . **2.** Replace any improper or missing fasteners. Does the drive belt continue to fall off?	Go to Step 9	System OK
9	Inspect the drive belt tensioner for proper operation. Refer to *Drive Belt Tensioner Diagnosis* . Does the drive belt tensioner operate properly?	Go to Step 11	Go to Step 10
10	Replace the drive belt tensioner. Does the drive belt continue to fall off?	Go to Step 11	System OK
11	Inspect for failed drive belt idler and/or drive belt tensioner pulley bearings. Did you find and repair the condition?	Go to Step 12	Go to Diagnostic Aids

Step	Action	Yes	No
12	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 2
13	Inspect the drive belt for the proper installation. Did you find this condition?	Go to Step 16	Go to Step 14
14	Inspect for the proper drive belt. Did you find this condition?	Go to Step 16	Go to Step 15
15	Inspect the drive belt for contact against a bracket, hose, or wiring harness. Did you find and repair the condition?	Go to Step 17	Go to Diagnostic Aids
16	Replace the drive belts. Did you complete the replacement?	Go to Step 17	—
17	Operate the system in order to verify the repair. Did you correct the condition?	System OK	—

Diagnostic Information and Procedures

2165846

Drive Belt Tensioner Diagnosis

Drive Belt:Tensioner

Caution: Allowing the drive belt tensioner to snap into the free position may result in damage to the tensioner.

Note

When the engine is operating, the belt tensioner arm will move. Do not replace the belt tensioner because of movement in the belt tensioner arm.

1. Remove the drive belt. Refer to *Drive Belt Replacement - Accessory* or *Air Conditioning Compressor Belt Replacement* .
2. Position a hex-head socket on the belt tensioner pulley bolt.
3. Move the belt tensioner through its full travel.
   - The movement should feel smooth.
   - There should be no binding.
   - The belt tensioner should return freely.
4. If any binding is observed, replace the drive belt tensioner. Refer to *Drive Belt Tensioner Replacement - Accessory*
5. Install the drive belt. Refer to *Drive Belt Replacement - Accessory* or *Air Conditioning Compressor Belt Replacement* .

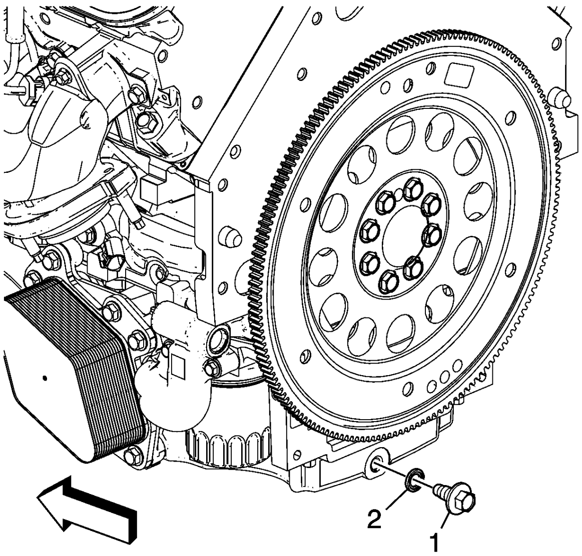
Engine

Engine Mechanical -6.0L,62L

Repair Instructions

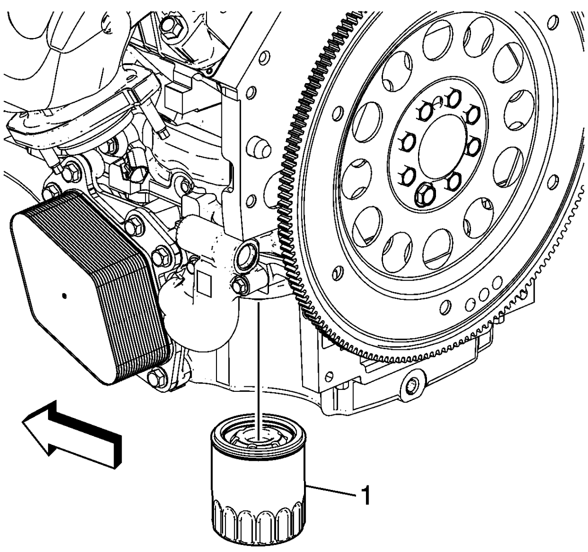
2158520

Draining Fluids and Oil Filter Removal



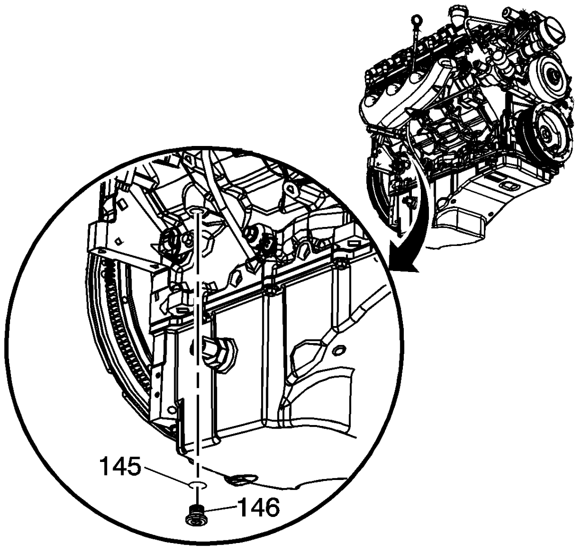
2156307

1. Remove the oil pan drain plug (1) with O-ring (2).



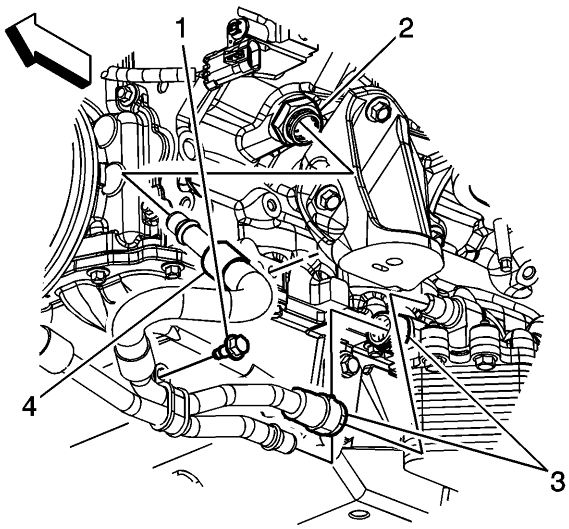
2156311

2. Remove the engine oil filter (1).



1559828

3. Remove the right side rear engine block coolant drain hole plug (146) with washer (145).



2142312

4. Disconnect the engine oil cooler hose/pipe (1) in order to drain coolant from the left side of block.

Repair Instructions

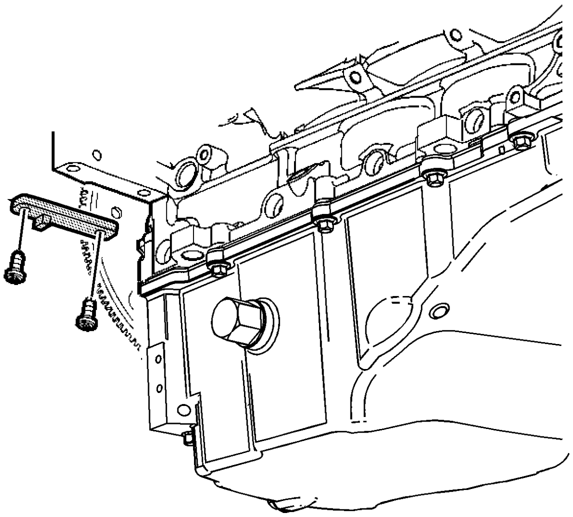
2158548

Crankshaft Balancer Removal

Special Tools

- J 41816-A Crankshaft Balancer Remover
- J 41816-2 Crankshaft End Protector
- J 42386-A Flywheel Holding Tool

For equivalent regional tools, refer to *Special Tools* .



1199283

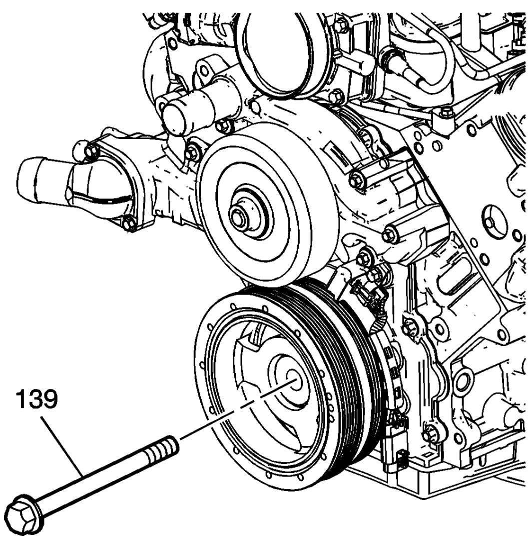
Caution: Refer to *Fastener Caution* .

Note

- If replacing the crankshaft balancer on manual transmission applications, note the location of any existing balance weights, if applicable. Crankshaft balance weights must be installed into the new balancer in the same location as the old balancer. A properly installed balance weight will be either flush or below flush with the face of the balancer. Refer to *Engine Balancing* .
- Do not use the crankshaft balancer bolt again. Install a NEW crankshaft balancer bolt during final assembly.

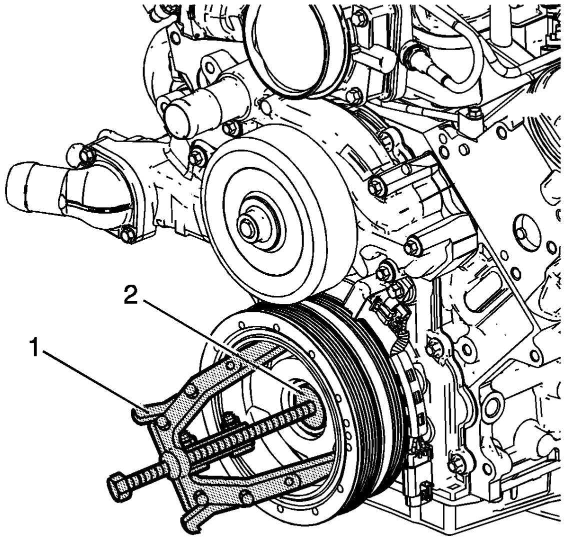
1. Install the J 42386-A tool and bolts.

Use 1 M10 – 1.5 x 120 mm and 1 M10 – 1.5 x 45 mm bolt for proper tool operation and tighten the J 42386-A tool bolts to 50 N·m (37 lb ft) .



1408847

2. Remove the crankshaft balancer bolt (139). Do not discard the crankshaft balancer bolt. The balancer bolt will be used during the balancer installation procedure.



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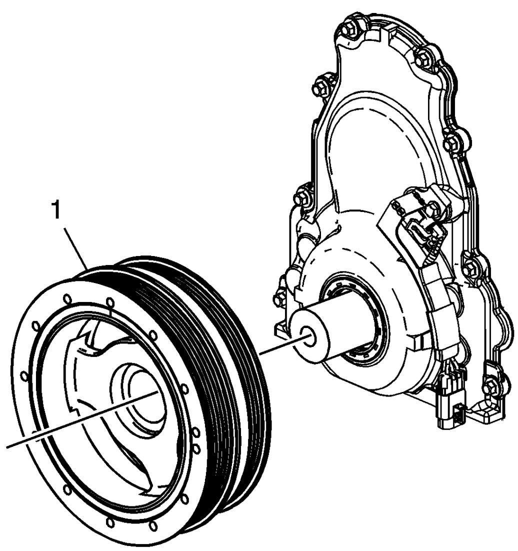
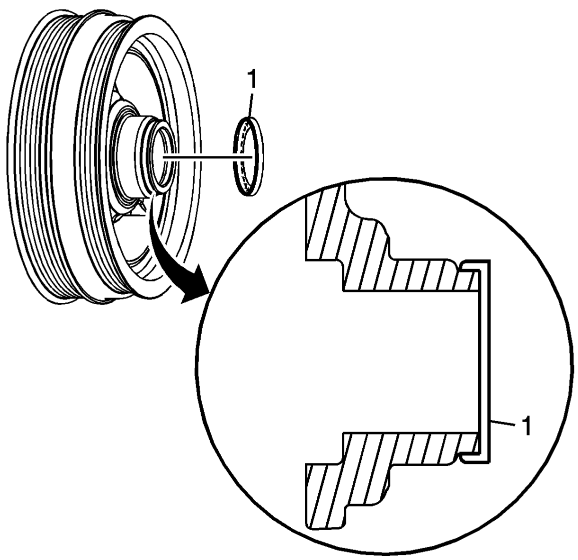
3. Use the J 41816-A remover (1) and the J 41816-2 protector (2) in order to remove the crankshaft balancer.



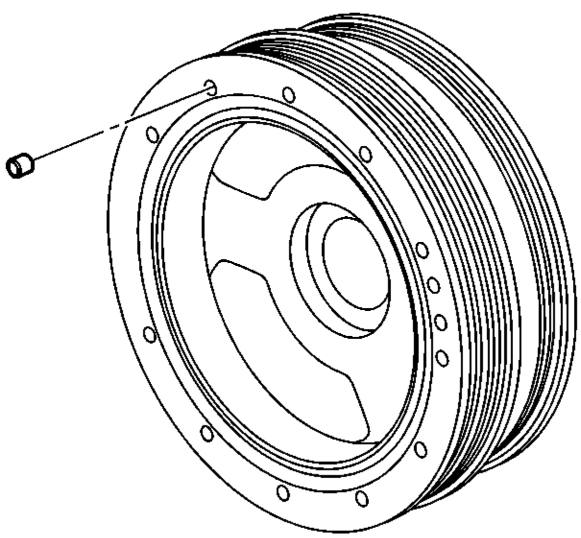
1764786

4. Remove the crankshaft balancer (1).



1759519

5. Remove the crankshaft balancer washer (1) from the balancer, as required.



63153

6. Note the position of the crankshaft balance weights, if applicable for manual transmission applications. Refer to *Engine Balancing* and *Crankshaft Balancer Cleaning and Inspection* .

Repair Instructions

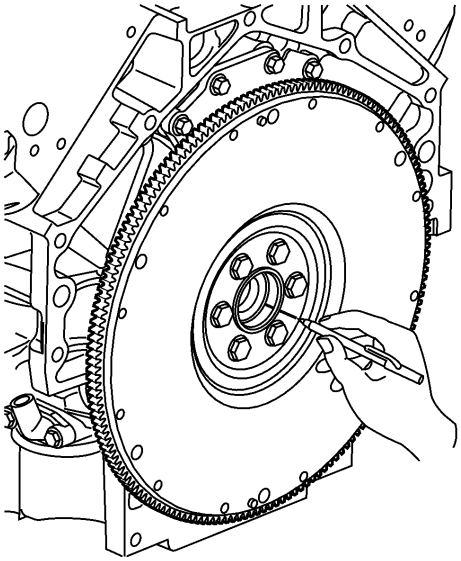
2173728

Engine Flywheel Removal

Special Tools

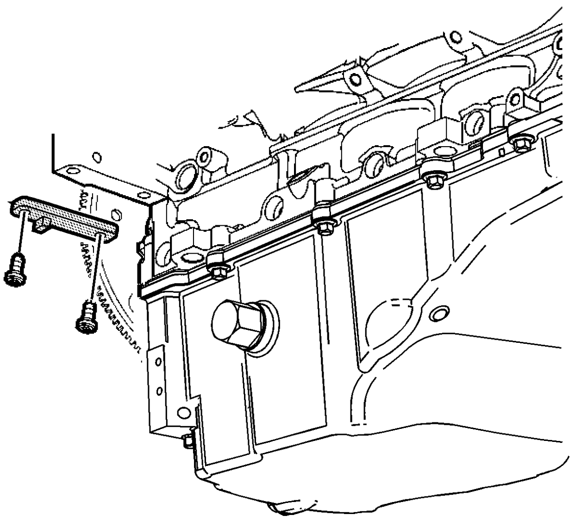
J 42386-A Flywheel Holding Tool

For equivalent regional tools, refer to *Special Tools* .



506140

Note 1. For manual transmission applications, note the position and direction of the engine flywheel before removal. The flywheel do
Mark or scribe the end of the crankshaft and the manual transmission flywheel. Refer to *Engine Balancing* .



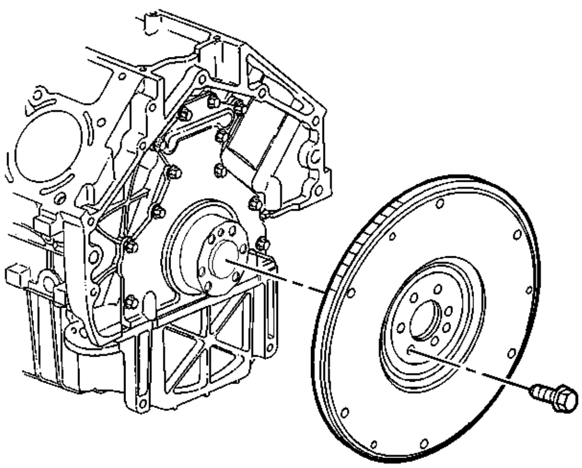
1199283

Caution: Refer to *Fastener Caution* .

2. Install the J 42386-A flywheel holding tool and bolts.

Use 1 M10 –1.5 x 120 mm and 1 M10 –1.5 x 45 mm bolt for proper tool operation.

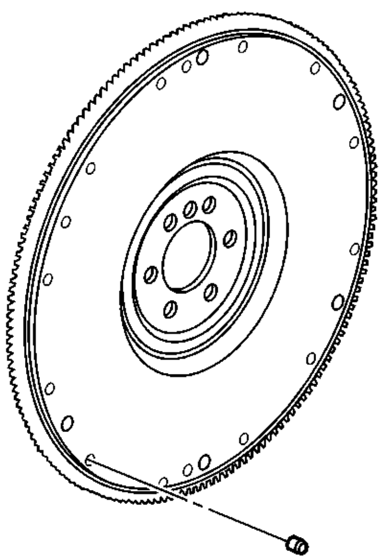
Tighten the J 42386-A flywheel holding tool and bolts to 50 N·m (37 lb ft) .



156166

3. Remove the flywheel bolts.

4. Remove the manual transmission flywheel.



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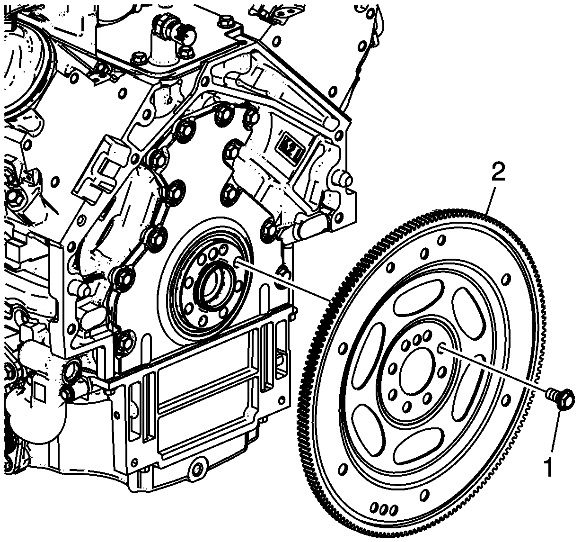
5. Note the location of the manual transmission flywheel balance weights, if applicable. Refer to *Engine Balancing* .



2173548

6. Remove the automatic transmission flex plate bolts (1).
7. Remove the automatic transmission flex plate (2).
8. Remove the J 42386-A flywheel holding tool

Repair Instructions

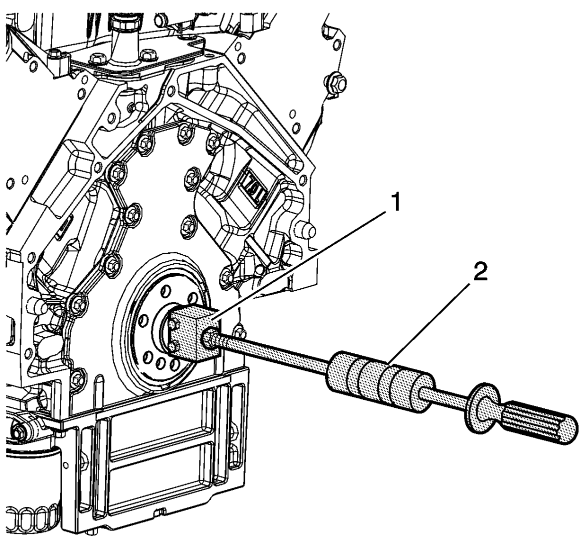
2155666

Clutch Pilot Bearing Removal

Special Tools

- J 2619-01 Slide Hammer
- J 23907 Slide Hammer with Bearing Adapter
- J 23907-1 Slide Hammer

For equivalent regional tools, refer to *Special Tools* .



2187974

Note 1. J 23907-1 slide hammer was part of the J 23907 slide hammer with bearing adapter set. The adapter is still available as J 239
Remove the clutch pilot bearing using the J 23907 adapter (1) and J 23907-1 slide hammer (2).

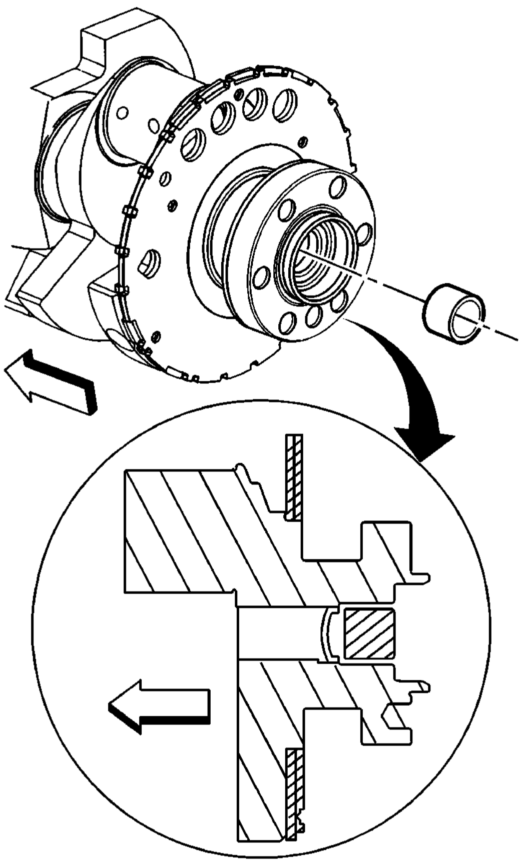
1.1. Install the legs of the J 23907 adapter (1) into the clutch pilot bearing.

1.2. Rotate the shaft of the tool until the legs of the tool are snug and contacting the I.D. surface of the bearing.

1.3. Install the J 23907-1 slide hammer (2) to the J 23907 adapter (1).

1.4. Remove the bearing from the rear of the crankshaft.

1.5. Remove the special tools from the bearing.



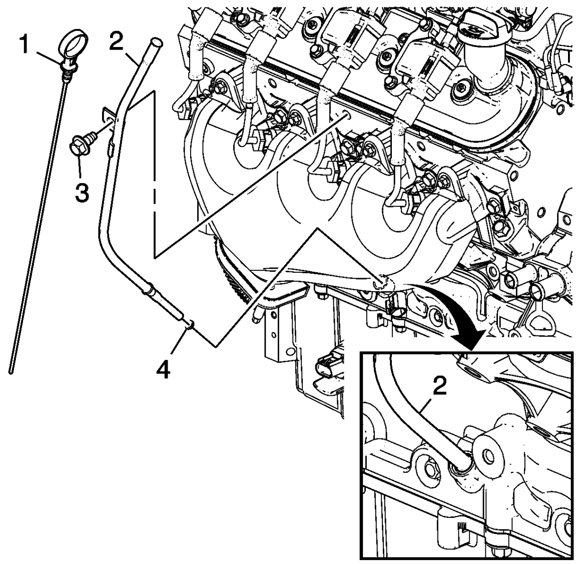
63195

2. Discard the bearing.

Repair Instructions

2158551

Oil Level Indicator and Tube Removal



2156315

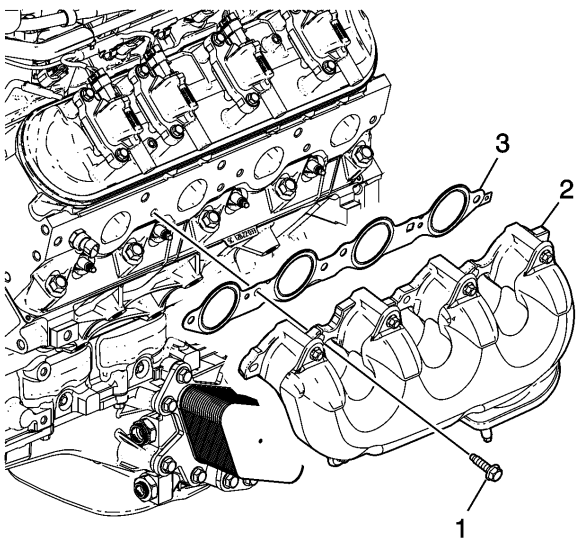
1. Remove the oil level indicator (1) from the tube (2).
2. Remove the oil level indicator tube bolt (3).
3. Remove the oil level indicator tube (2) from the engine block.

Note 4. Inspect the O-ring for cuts or damage. The O-ring may be used again if it is not cut or damaged. **4.** Remove the O-ring (4) from the tube, as required.

Repair Instructions

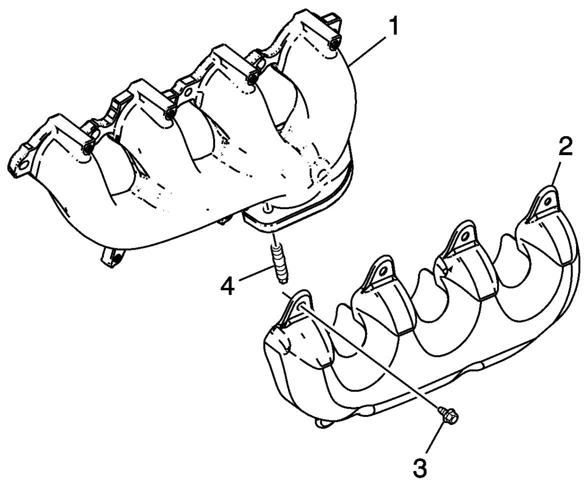
2158555

Exhaust Manifold Removal - Left Side



2156331

1. Remove the spark plug wires from the spark plugs.
2. Remove the exhaust manifold (2), bolts (1), and gasket (3).
3. Discard the gasket.



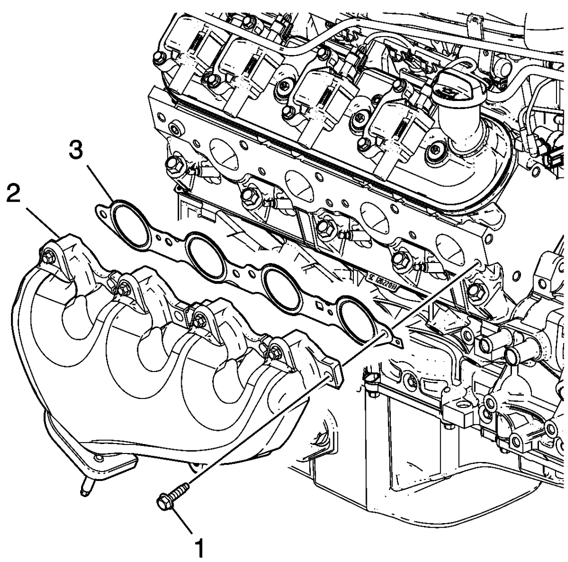
2156337

4. Remove the heat shield (2) and bolts (3) from the manifold (1), as required.
5. Remove the studs (4), as required.

Repair Instructions

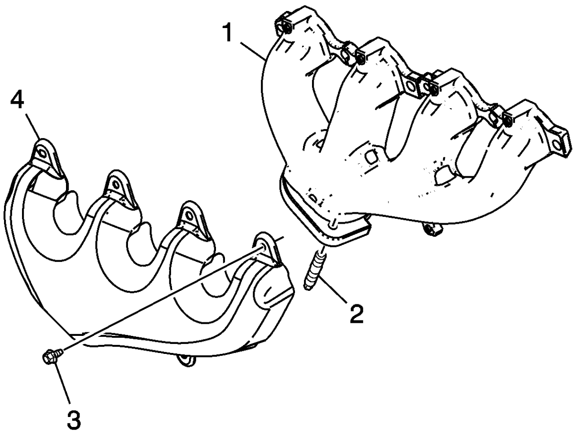
2158558

Exhaust Manifold Removal - Right Side



2156977

1. Remove the spark plug wires from the spark plugs.
2. Remove the exhaust manifold (2), bolts (1), and gasket (3).
3. Discard the gasket.



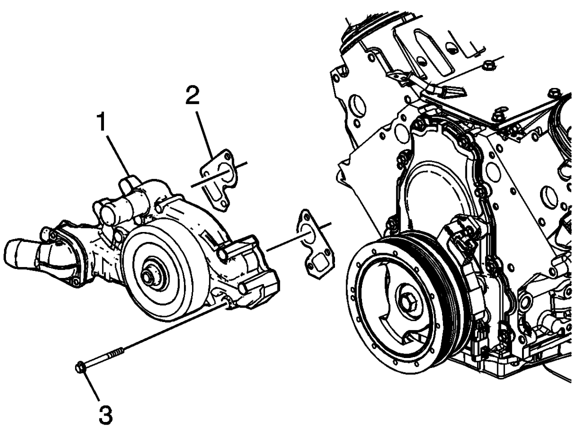
2156341

4. Remove the heat shield (4) and bolts (3) from the manifold (1), as required.
5. Remove the studs (2), as required.

Repair Instructions

2158562

Water Pump Removal



1704622

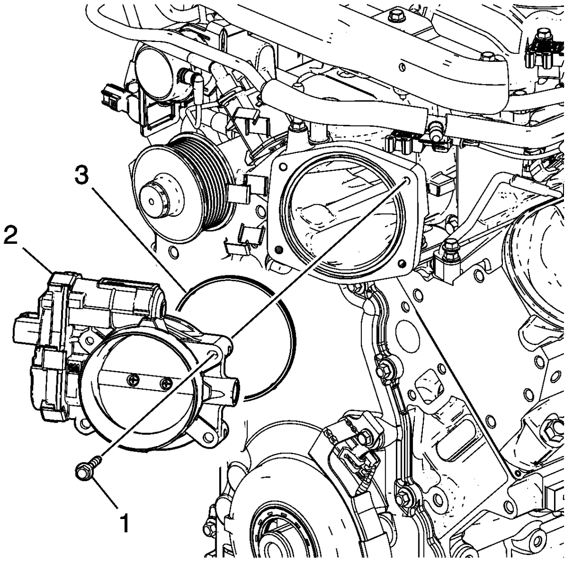
1. Remove the water pump bolts (3).
2. Remove the water pump (1) and gaskets (2).
3. Discard the water pump gaskets.

Repair Instructions

2158771

Throttle Body Assembly Removal

Throttle Body:Assembly Removal



2156351

Caution: Handle the electronic throttle control components carefully. Use cleanliness in order to prevent damage. Do not drop the electronic throttle control components. Do not roughly handle the electronic throttle control components. Do not immerse the electronic throttle control components in cleaning solvents of any type.

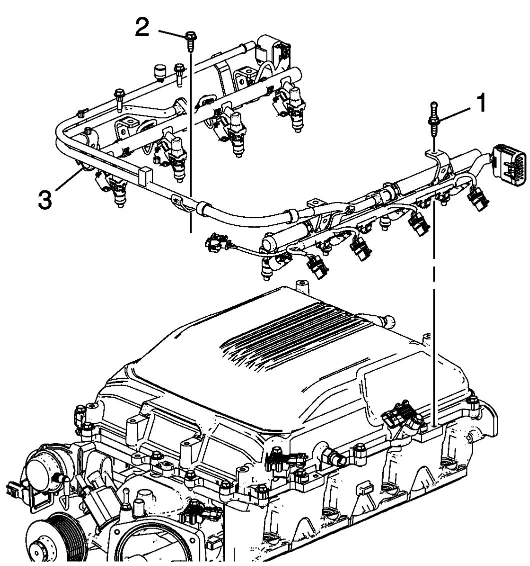
Note 1. The intake manifold, throttle body, fuel injection rail, and fuel injectors may be removed as an assembly. If not servicing the ir
Remove the throttle body bolts (1).

2. Remove the throttle body (2).
3. Remove the throttle body seal (3).
4. Discard the seal.

Repair Instructions

2158773

Fuel Rail and Injectors Removal (6.2L)

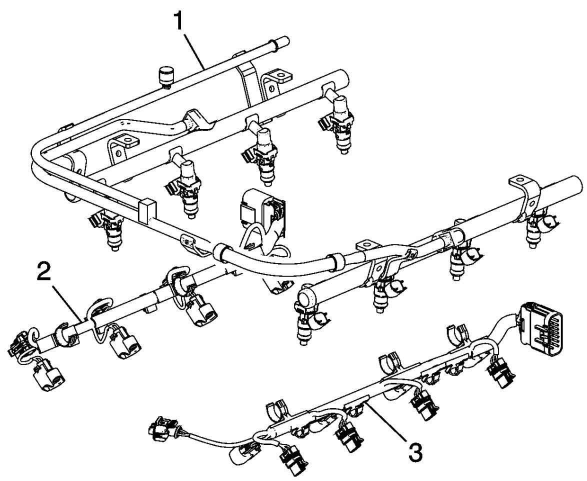


2173554

Note

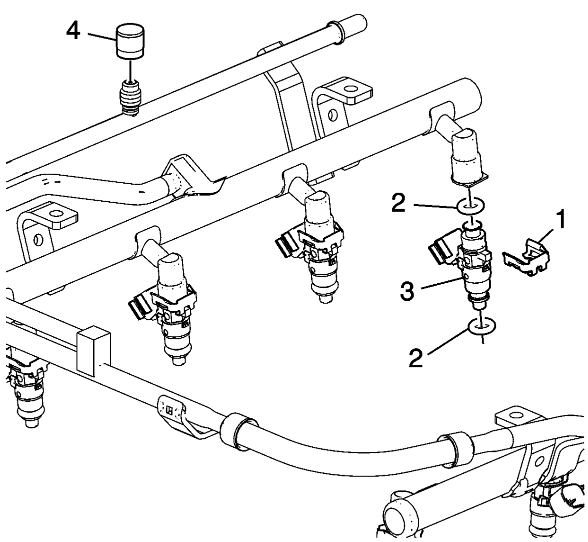
- The supercharger, throttle body, fuel injection rail and fuel injectors may be removed as an assembly. If not servicing the individual components, remove the supercharger as an assembly.
- Do not separate the fuel injectors from the fuel rail, unless component service is required.
- Use cleanliness and care when handling the fuel system components. Do not allow dirt or debris to enter the fuel injectors or fuel rail components. Cap ends as necessary.

1. Remove the studs (1), bolt (2) and fuel rail (3). Remove the left side of the fuel rail with flex-hose first, then remove the right side of the fuel rail until all injectors have left their bores.



2156724

2. Remove the wiring harnesses (2) and (3) from the fuel rail (1).



2156729

3. Remove the retainers (1) and fuel injectors (3).

4. Remove the O-rings (2), as required.

5. Remove the service port cap (4), as required.

Repair Instructions

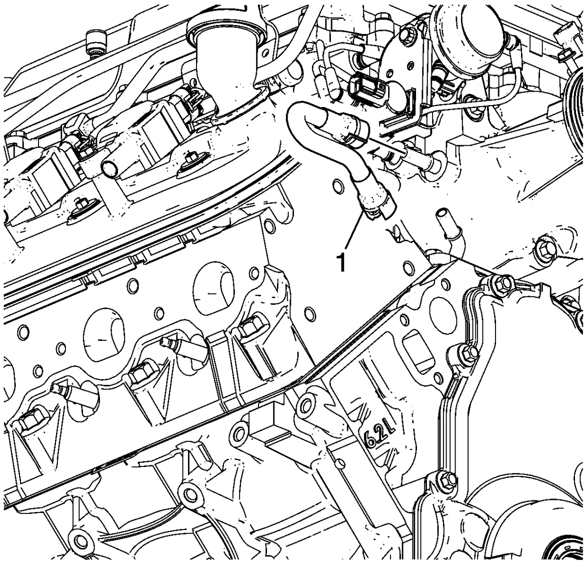
2158567

Supercharger Removal

Special Tools

EN 48898 Supercharger Lift Fixture

For equivalent regional tools, refer to *Special Tools*

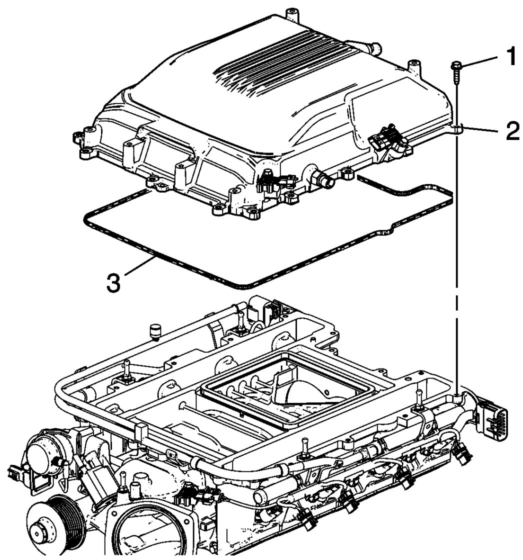


2156737

Note

- The supercharger, throttle body, fuel injection rail and fuel injectors may be removed as an assembly. If not servicing the individual components, remove the supercharger as an assembly.
- Cover the inlet area of the supercharger (1) to prevent dirt or debris contamination onto the rotors.

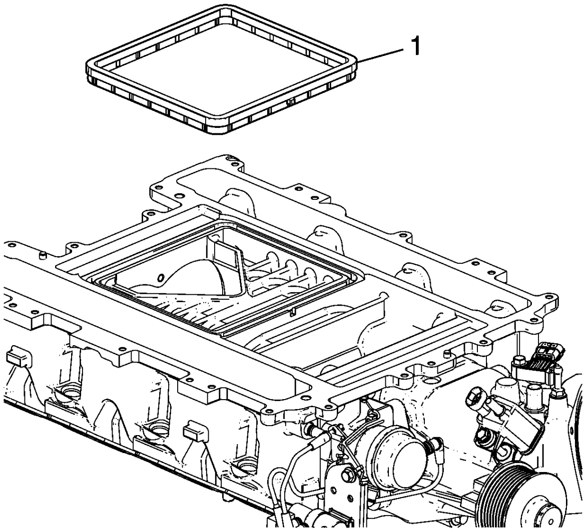
1. Remove the positive crankcase ventilation (PCV) – dirty air hose (1) from the valley cover and supercharger.



2156354

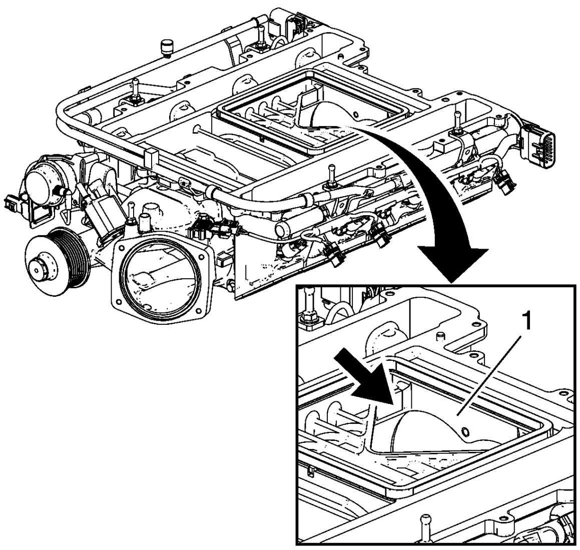
2. Remove the supercharger cover bolts (1) and the supercharger cover (2).

3. Remove the supercharger cover seal (3).



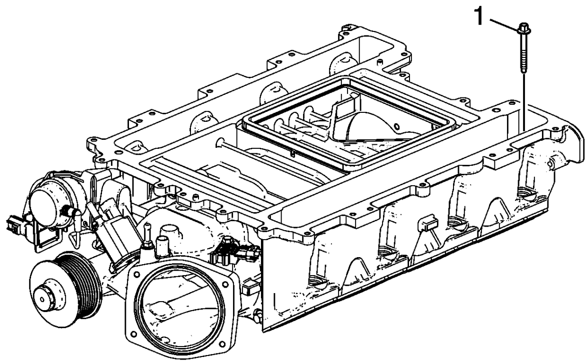
2156823

4. Remove the charge air cooler insulator (1).



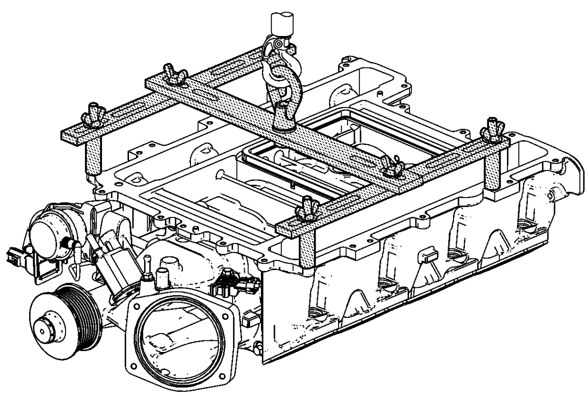
2156357

5. Cover the supercharger rotors area (1) to prevent dirt or debris contamination onto the rotors.



2156748

6. Remove the supercharger bolts (1).



2156758

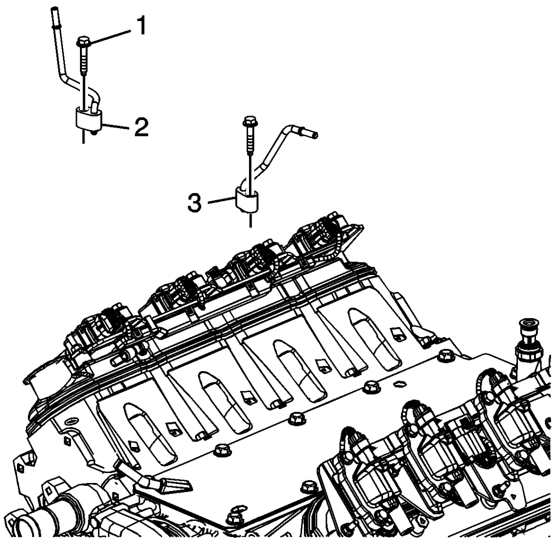
7. Install the EN 48898 fixture to the supercharger and tighten the EN 48898 fixture studs and nuts until snug.

8. Using a lifting device, remove the supercharger from the engine.

Repair Instructions

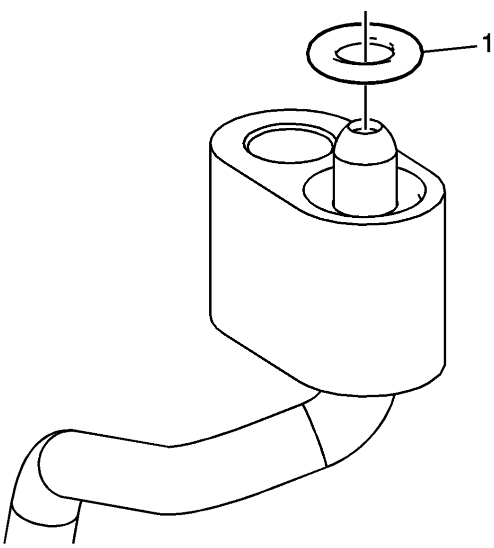
2158570

Engine Coolant Air Bleed Pipe and Hole Cover Removal



2054151

1. Remove the engine coolant air bleed pipe bolts (1).
2. Remove the pipes (2 and 3).



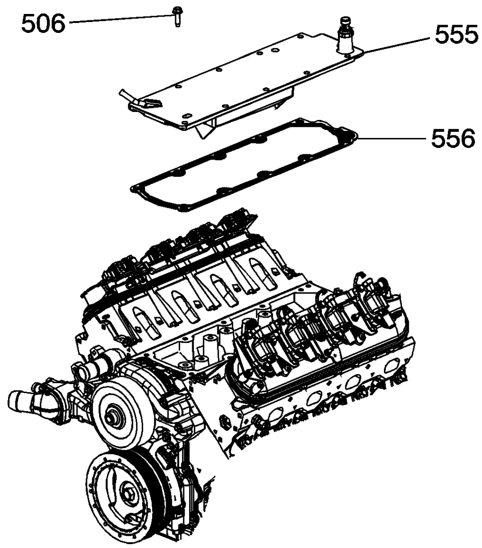
2054156

3. Remove the seals (1) from the pipes.
4. Discard the seals.

Repair Instructions

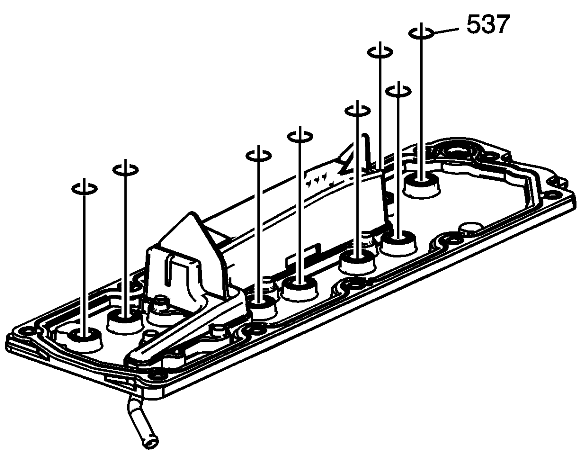
1877722

Engine Block Valley Cover Removal (6.2L)



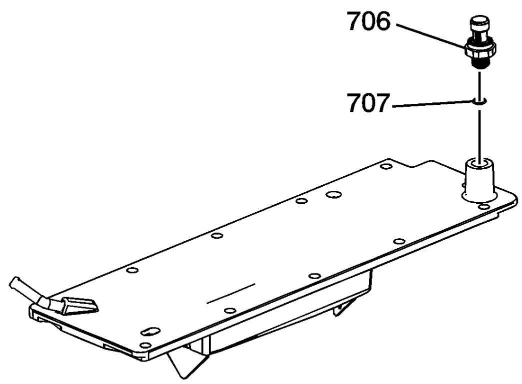
1559856

1. Remove the engine block valley cover bolts (506).
2. Remove the valley cover (555) and gasket (556).



1552536

3. Remove the seals (537) from the cover.



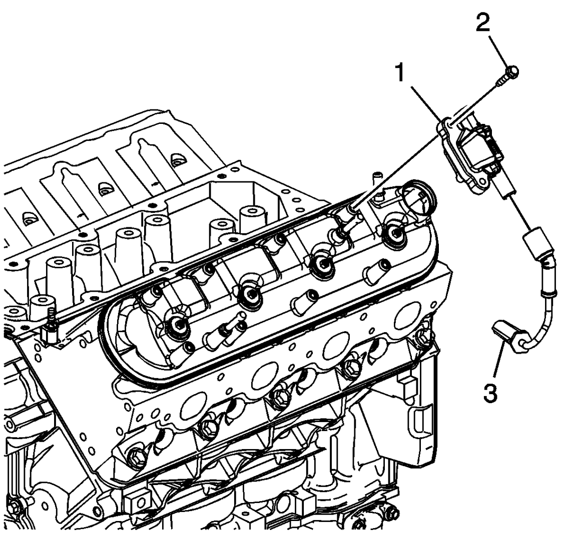
1408864

4. Remove the engine oil pressure sensor (706) and seal (707), as required.

Repair Instructions

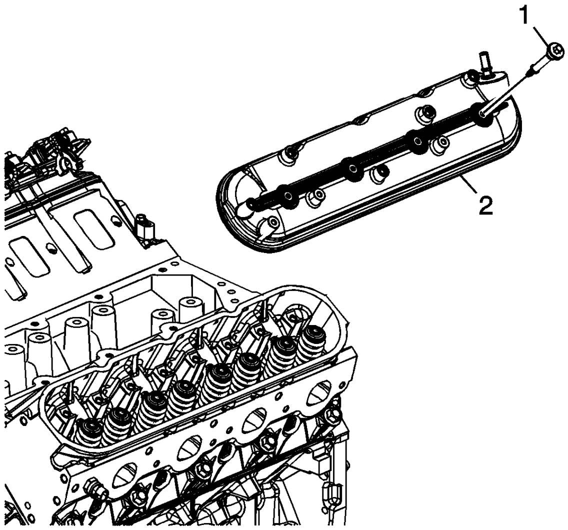
2158575

Valve Rocker Arm Cover Removal - Left Side



2085646

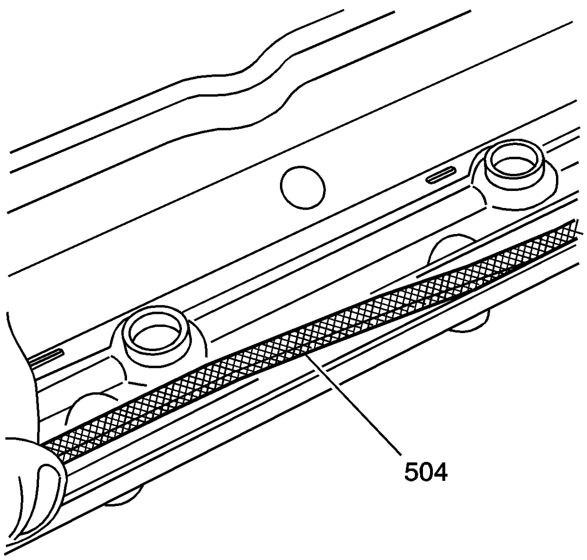
1. Remove the spark plug wires (3), as required.
2. Remove the ignition coil bolts (2) and ignition coils (1).



2054162

3. Remove the valve rocker arm cover bolts (1) and cover (2).

4. Remove and discard the valve rocker arm cover gasket, valve rocker arm cover grommets and valve rocker arm cover bolts if they are serviced with the grommet.



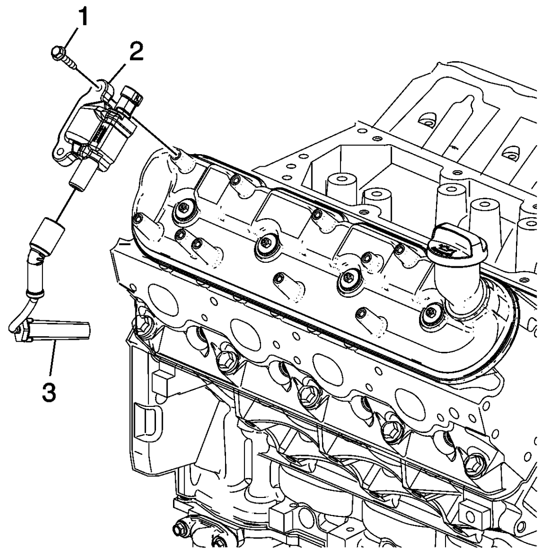
1272820

5. Remove the gasket (504) from the cover.

Repair Instructions

2158579

Valve Rocker Arm Cover Removal - Right Side



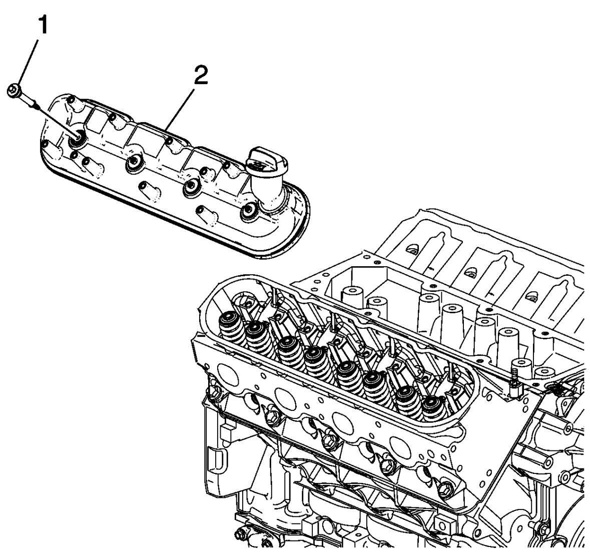
2156766

Note 1. Do not remove the oil cap from the cover, unless service is required. If the oil cap has been removed from the cover, the locking features of the cap will be damaged and no longer functional.

If the cap has been removed, install a NEW cap during assembly.

1. Remove the spark plug wires (3), as required.

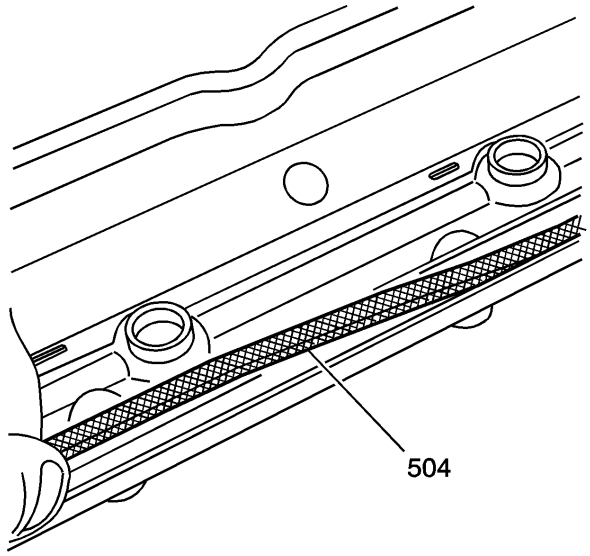
2. Remove the ignition coil bolts (1) and ignition coils (2).



2156771

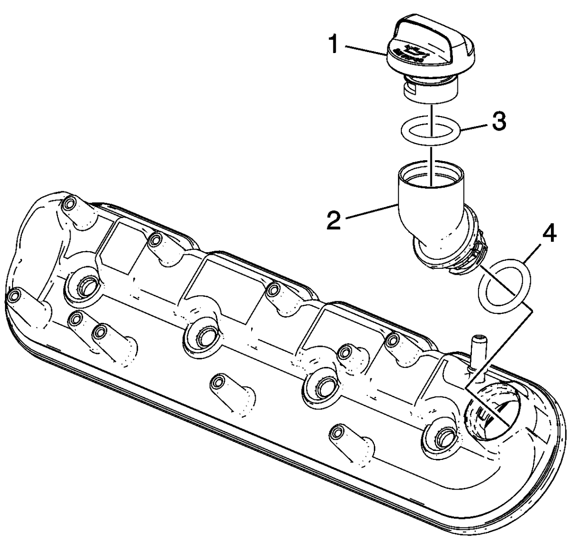
3. Remove the valve rocker arm cover bolts (1) and cover (2).

4. Remove and discard the valve rocker arm cover gasket, valve rocker arm cover grommets and valve rocker arm cover bolts if they are serviced with the grommet.



1272820

5. Remove the gasket (504) from the cover.



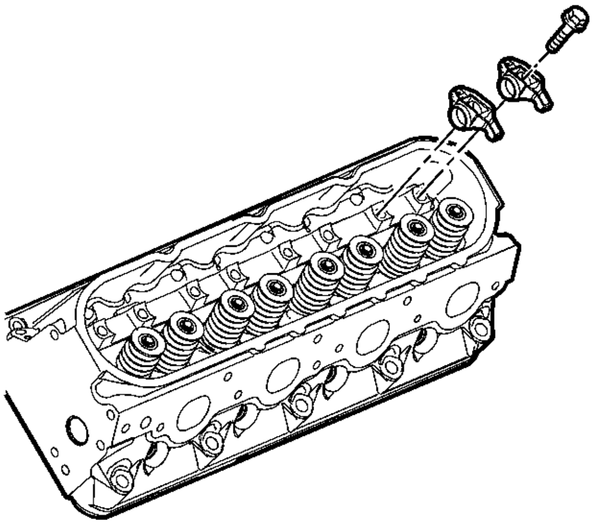
2156776

6. Remove the oil cap (1), oil fill tube (2) and seals (3, 4) from the cover, as required.

Repair Instructions

2158582

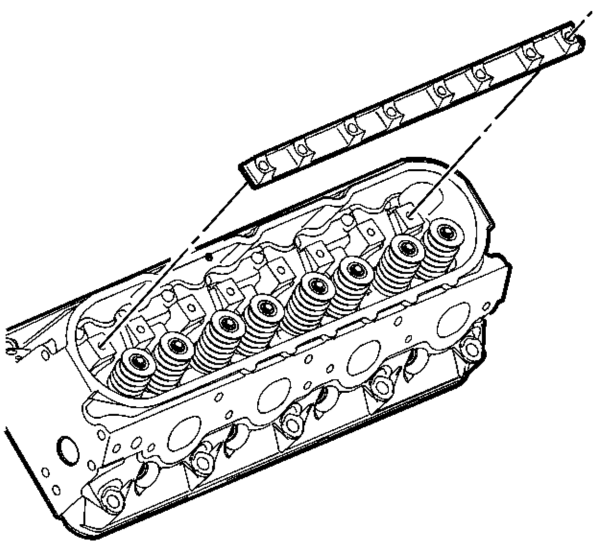
Valve Rocker Arm and Push Rod Removal



260140

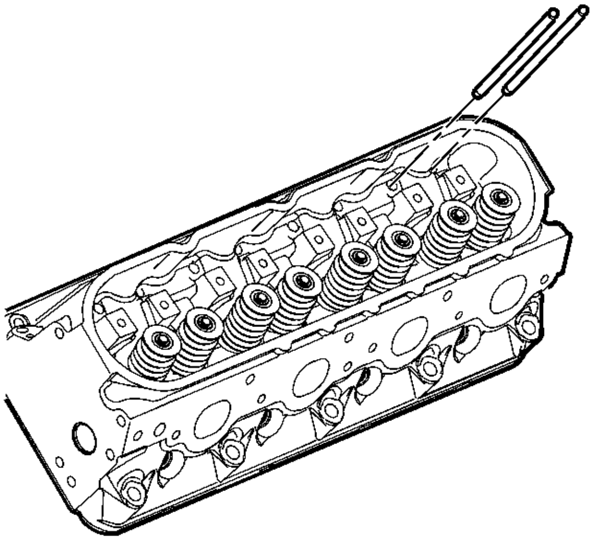
Note 1. Place the valve rocker arms, valve pushrods, and pivot support in a rack so they can be installed in the same location from wh
Remove the valve rocker arm bolts.

2. Remove the valve rocker arms.



260141

3. Remove the valve rocker arm pivot support.



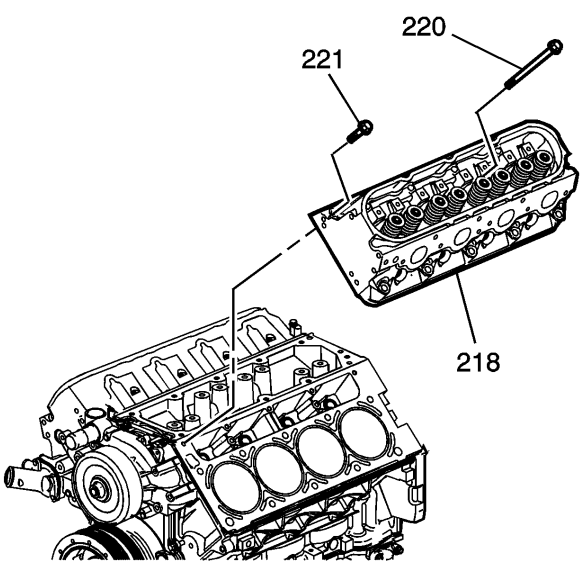
260142

4. Remove the pushrods.

Repair Instructions

2087068

Cylinder Head Removal - Left Side

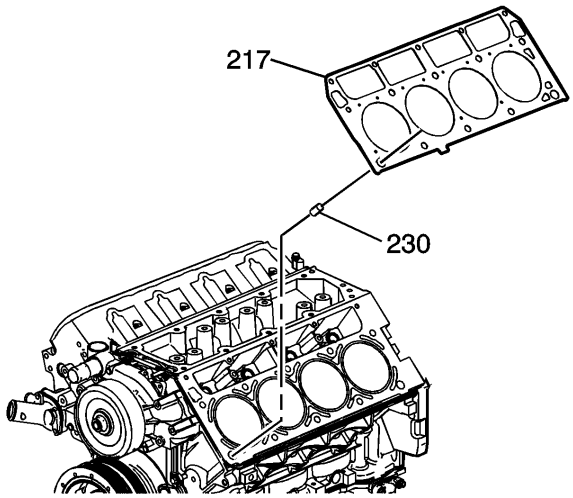


1408868

Note **1.** The cylinder head bolts are of a torque-to-yield design and are NOT to be used again. Install NEW cylinder head bolts during
Remove the cylinder head bolts (220, 221).

Caution: After removal, place the cylinder head on 2 wood blocks in order to prevent damage to the sealing surfaces.

2. Remove the cylinder head (218).



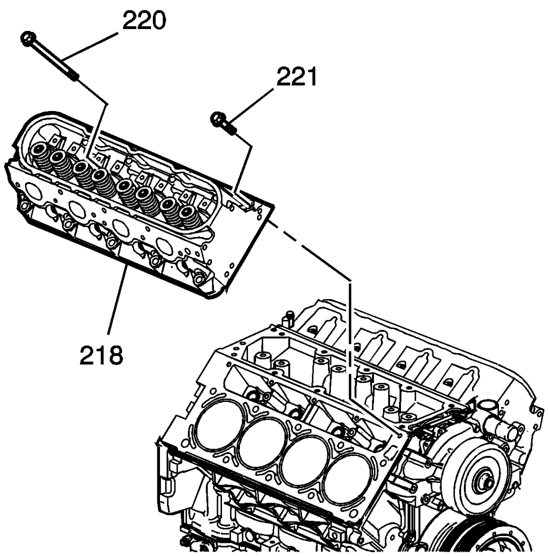
1408869

3. Remove the gasket (217) and locating pins (230).
4. Discard the gasket and cylinder head bolts.

Repair Instructions

2087069

Cylinder Head Removal - Right Side

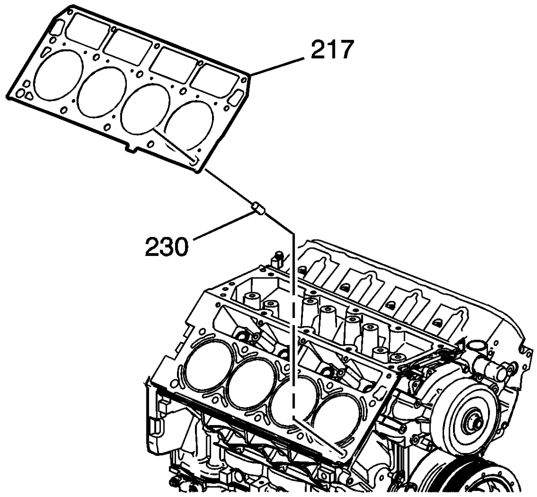


1408870

Note 1. The cylinder head bolts are of a torque-to-yield design and are NOT to be used again. Install NEW cylinder head bolts during
Remove the cylinder head bolts (220, 221).

Caution: After removal, place the cylinder head on 2 wood blocks in order to prevent damage to the sealing surfaces.

2. Remove the cylinder head (218).



1408871

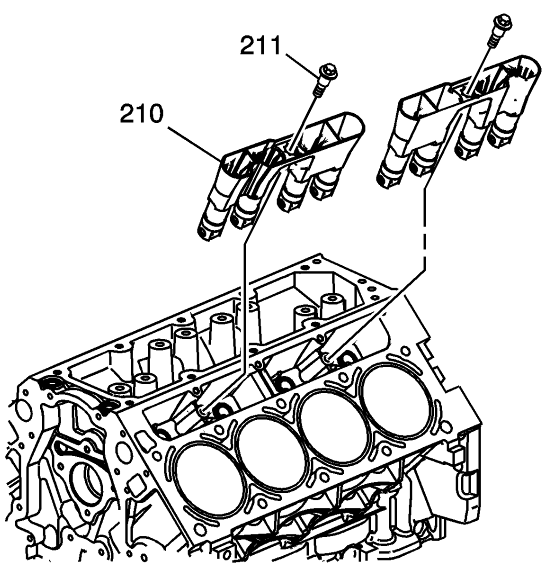
3. Remove the gasket (217) and locating pins (230).

4. Discard the gasket and cylinder head bolts.

Repair Instructions

1877731

Valve Lifter Removal

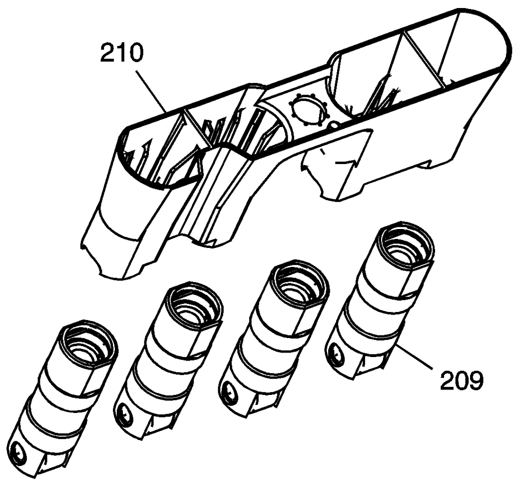


1403318

1. Remove the guide bolts (211).

2. Remove the guides (210) with lifters.

Note the installed position of the guides. The notched area of the guide is to align with the locating tab on the block.



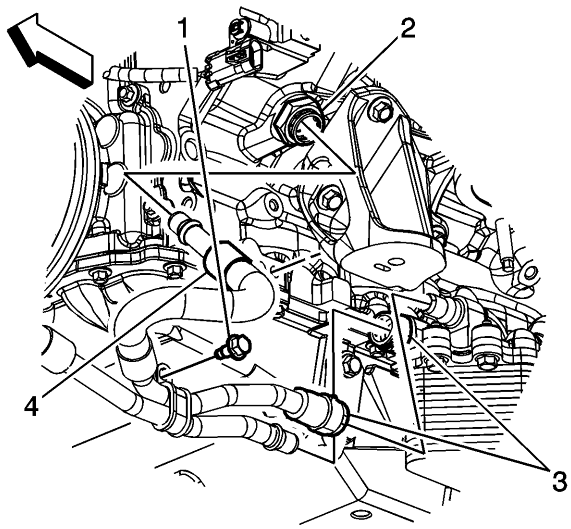
1403319

3. Remove the valve lifters (209) from the guide (210).
4. Organize or mark the components so they can be installed in the same location from which they were removed. Refer to *Separating Parts* .

Repair Instructions

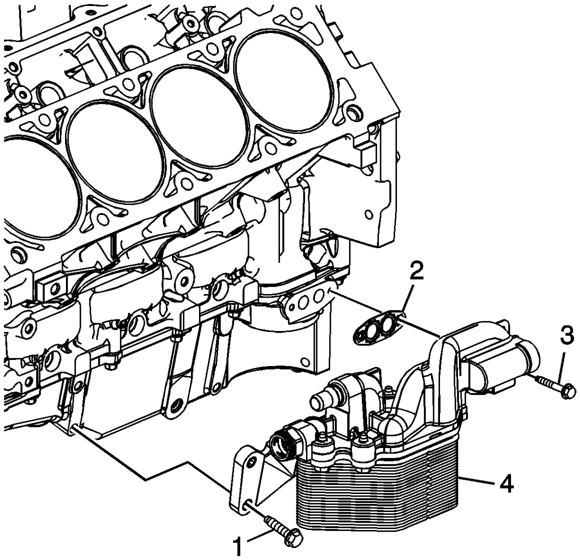
2158586

Engine Oil Cooler Removal



2142312

1. Remove the engine oil cooler coolant hose/pipe bolt (1).
2. Disconnect the hose/pipe (4) from the engine block coolant fitting (2) and oil cooler (3).
3. Remove the hose/pipe.



2054178

4. Remove the oil cooler M8 (1) and M6 (3) bolts.

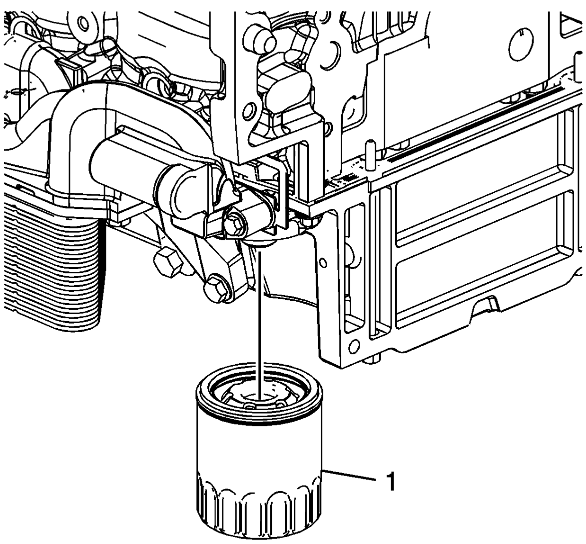
5. Remove the oil cooler (4).

6. Remove the oil cooler gasket (2).

Repair Instructions

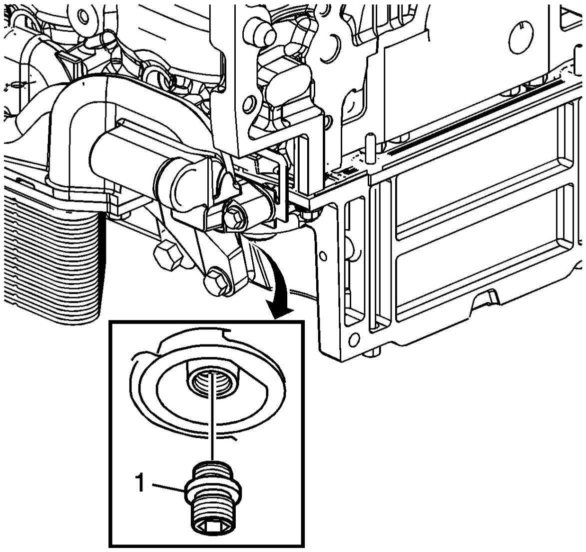
2158591

Oil Filter Removal



2054167

1. Remove the oil filter (1).



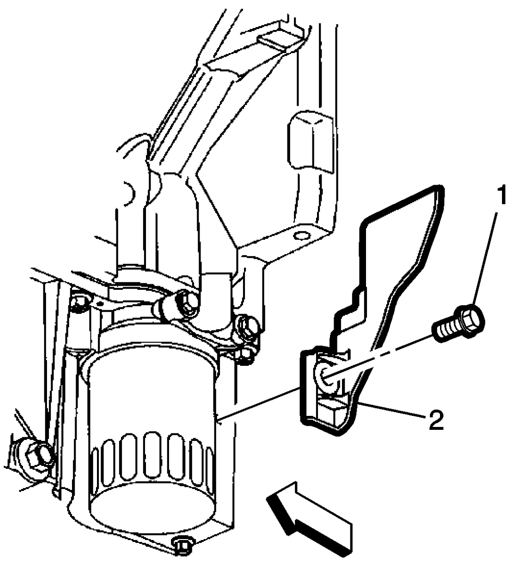
2054171

2. Remove the oil filter fitting (1), as required.

Repair Instructions

2158594

Oil Pan Removal

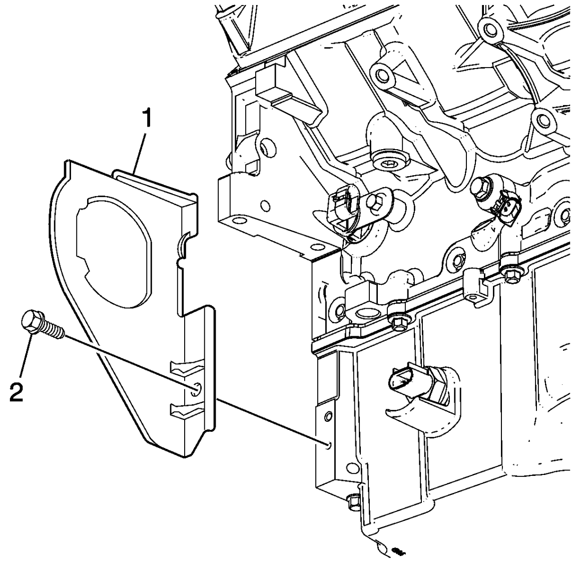


178477

Note

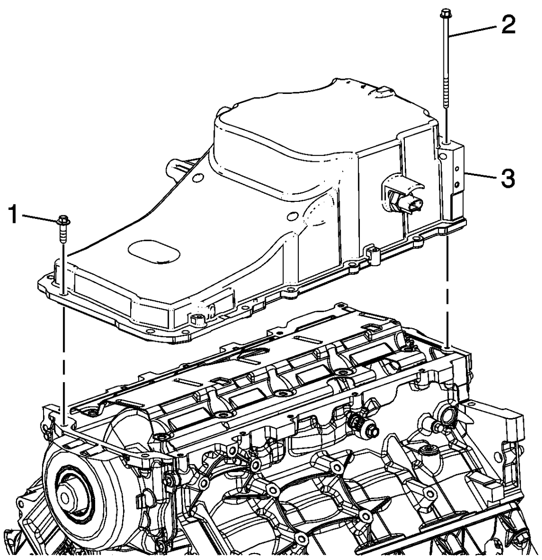
- The original oil pan gasket is retained and aligned to the oil pan by rivets. When installing a new gasket, it is not necessary to install new oil pan gasket rivets.
- DO NOT use the oil pan gasket again. When installing the oil pan, install a NEW oil pan gasket.

1. Remove the left closeout cover (2) and bolt (1).



2157006

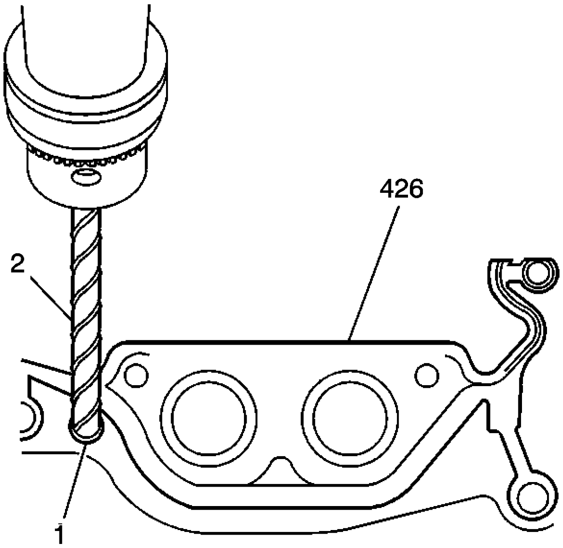
2. Remove the right closeout cover (1) and bolt (2).



2156782

3. Remove the oil pan bolts (1, 2).

4. Remove the oil pan (3).



1272840

Note

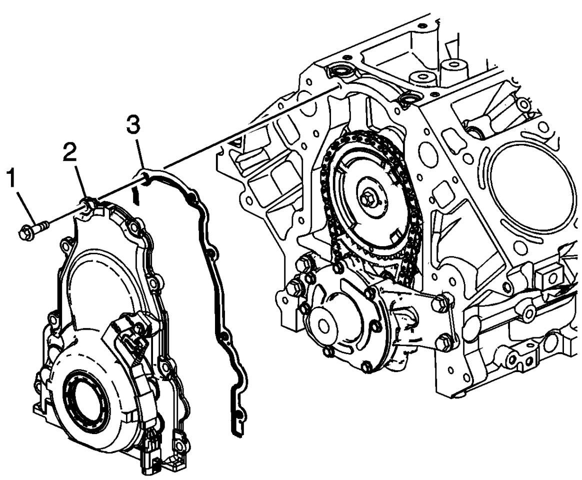
- DO NOT allow foreign material to enter the oil passages of the oil pan. Cap or cover the openings, as required.
- Use care not to gouge, score, or damage the oil pan sealing surface.

5. Drill (2) out the oil pan gasket retaining rivets (1), if required.
6. Remove the gasket (426) from the pan.
7. Discard the gasket and rivets.

Repair Instructions

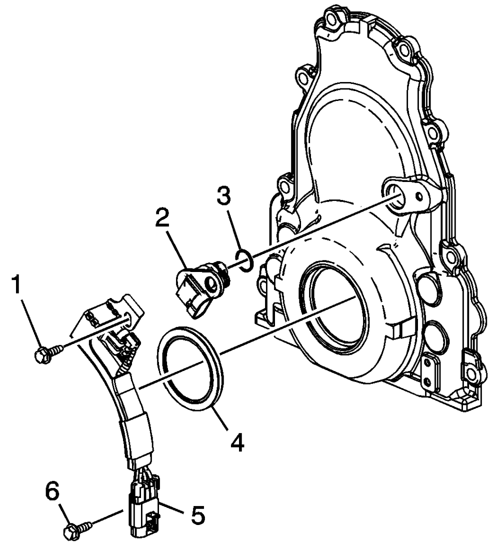
1877734

Engine Front Cover Removal (6.2L)



1704624

1. Remove the front cover bolts (1).
2. Remove the front cover (2) and gasket (3).
3. Discard the front cover gasket.



1704625

4. Remove the oil seal (4).

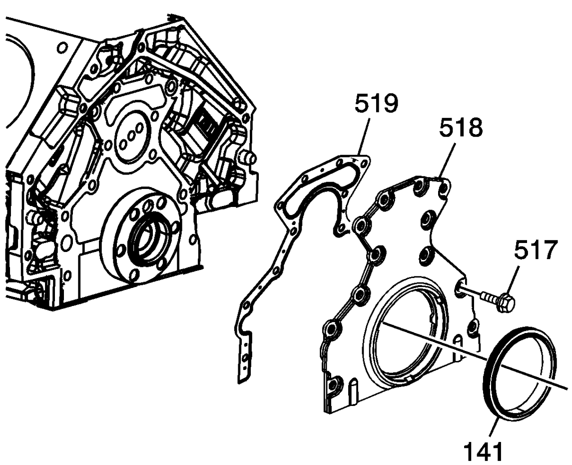
5. Remove the bolts (1, 6), camshaft position (CMP) sensor (2), and wire harness (5).

6. Remove the O-ring (3) from the sensor, as required.

Repair Instructions

1555651

Crankshaft Rear Oil Seal Housing Removal



1552544

1. Remove the rear oil seal housing bolts (517).

2. Remove the housing (518) and gasket (519).

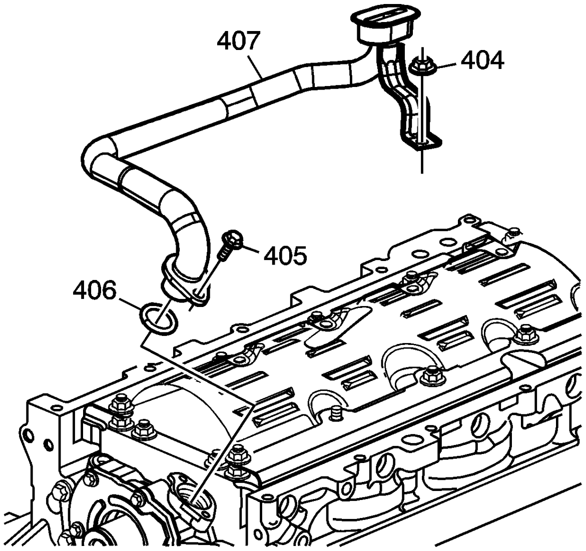
3. Remove the rear oil seal (141).

Repair Instructions

2173742

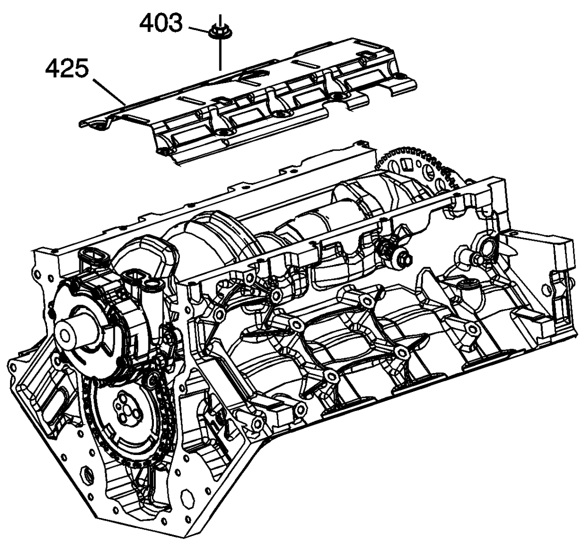
Oil Pump, Screen and Crankshaft Oil Deflector Removal

Oil Pump, Screen and Crankshaft Oil Deflector:Removal



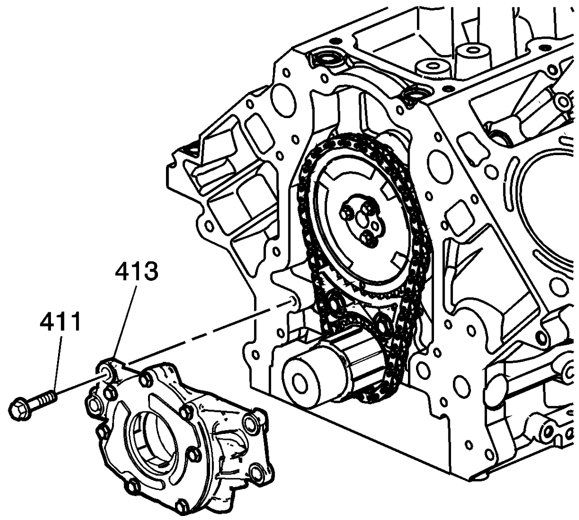
1520947

1. Remove the oil pump screen bolt (405) and nut (404).
2. Remove the oil pump screen (407) with O-ring seal.
3. Remove the O-ring seal (406) from the pump screen.
4. Discard the O-ring seal.



1552545

5. Remove the crankshaft oil deflector nuts (403).
6. Remove the crankshaft oil deflector (425).



1559865

7. Remove the oil pump bolts (411).

Note 8. Do not allow dirt or debris to enter the oil pump assembly. Cap ends, as necessary. **8.** Remove the oil pump (413).

Repair Instructions

2143308

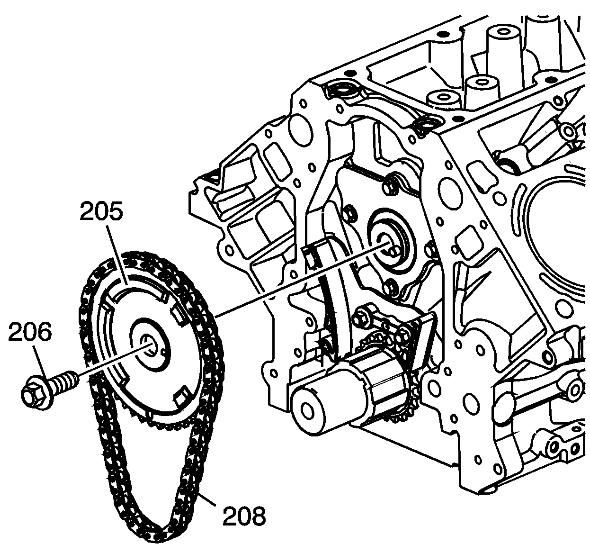
Timing Chain and Sprocket Removal

Timing Chain and Sprockets:Removal

Special Tools

- J 8433 Two Jaw Puller
- J 41558 Crankshaft Sprocket Remover
- J 41816-2 Crankshaft End Protector

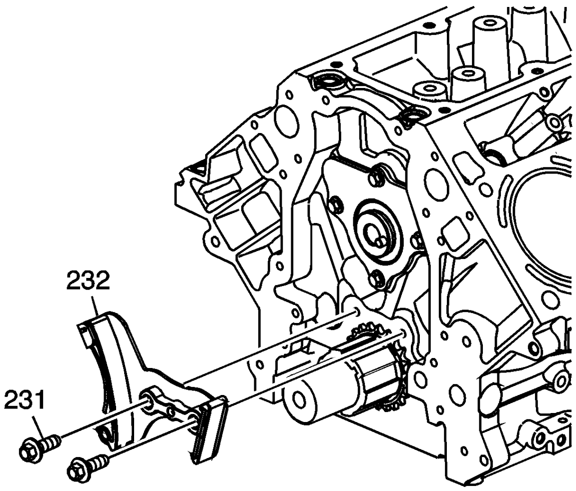
For equivalent regional tools refer to *Special Tools*



1759750

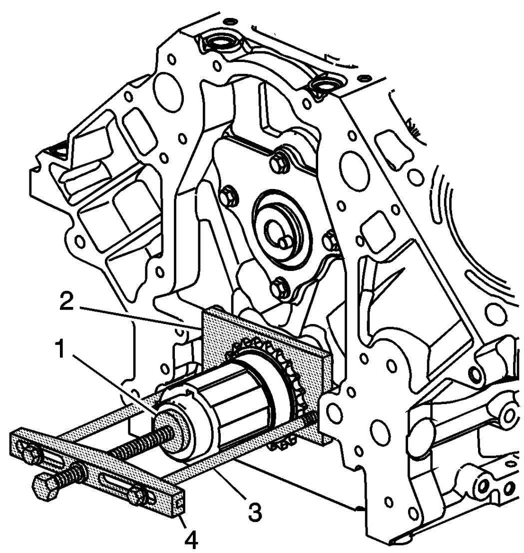
Caution: Do not turn the crankshaft assembly after the timing chain has been removed in order to prevent damage to the piston assemblies or the valves.

1. Remove and discard the camshaft sprocket bolt (206).
2. Remove the camshaft sprocket (205) and timing chain (208).



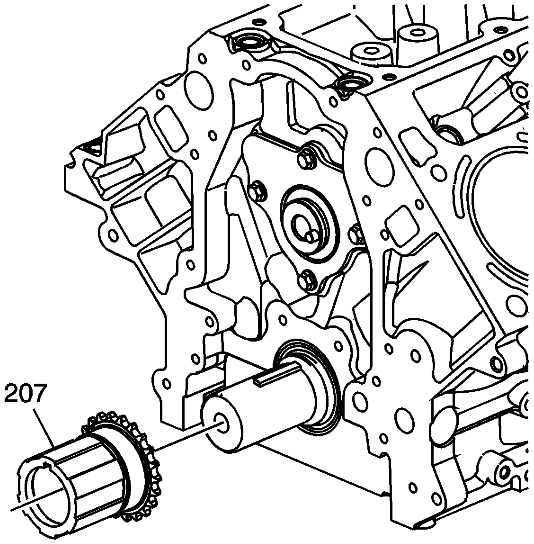
1658178

3. Remove the bolts (231) and timing chain tensioner (232).



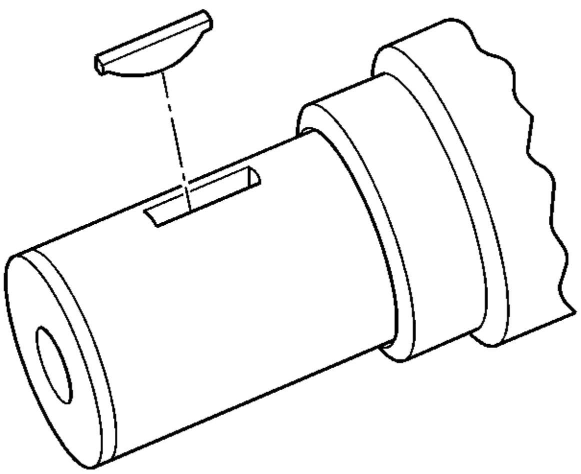
1658180

4. Use the J 41816-2 protector (1), the J 41558 remover (2), bolts (3), and the J 8433 puller (4) in order to remove the crankshaft sprocket.



1658182

5. Remove the crankshaft sprocket (207).



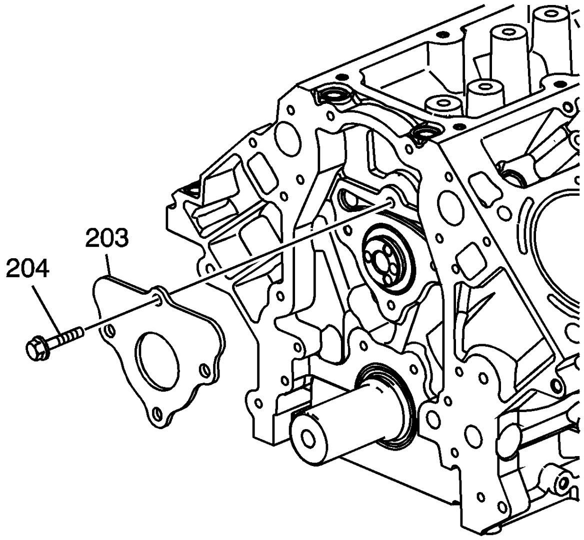
156149

6. Remove the crankshaft sprocket key, as required.

Repair Instructions

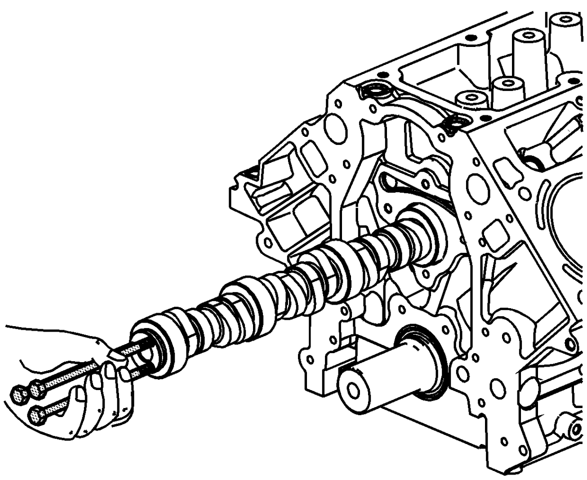
2143316

Camshaft Removal



1552492

1. Remove the camshaft retainer bolts (204) and retainer (203).



1552493

Caution: 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 camshaft.
   - **2.1.** Install the 3 M8-1.25 x 100 mm bolts into the camshaft front bolt holes.
   - **2.2.** Using the bolts as a handle, carefully rotate and pull the camshaft out of the engine block.
   - **2.3.** Remove the bolts from the front of the camshaft.

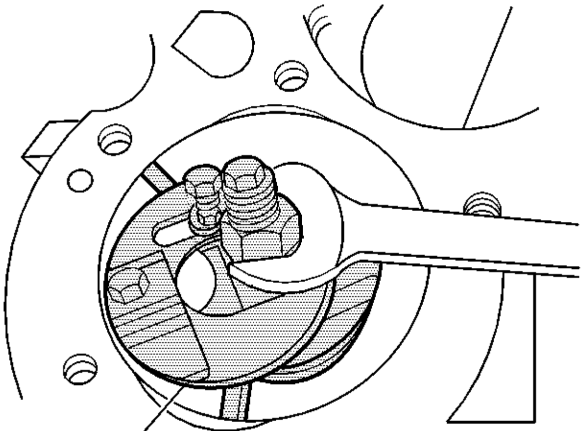
Repair Instructions

1877741

Piston, Connecting Rod, and Bearing Removal

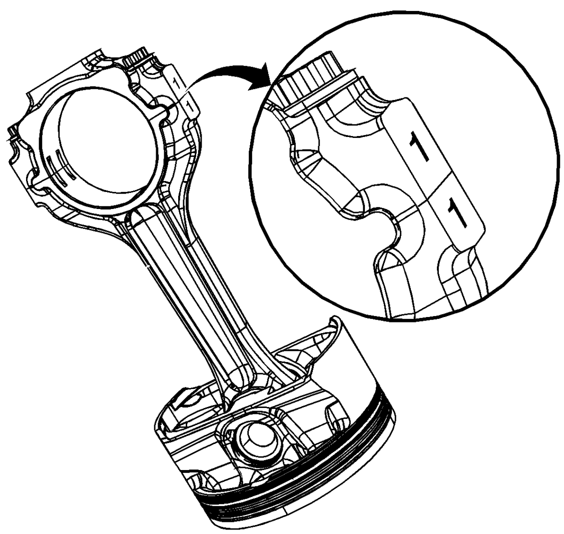
Tools Required

- *J 24270* Cylinder Bore Ridge Reamer
- *J 41556* Connecting Rod Guide



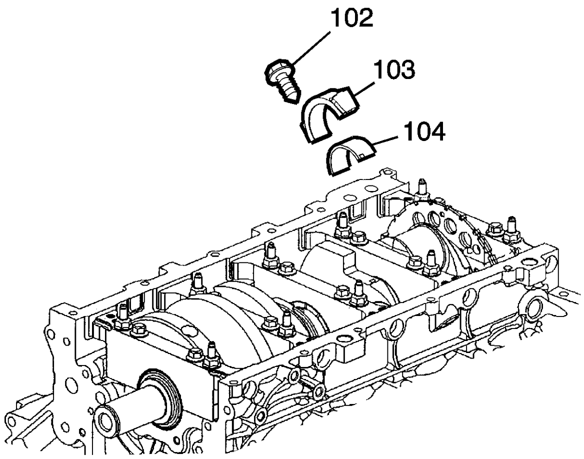
11497

1. Use the *J 24270* in order to remove the cylinder bore ring ridge, if required.
   - **1.1.** Turn the crankshaft until the piston is at the bottom of the stroke.
   - **1.2.** Place a cloth on top of the piston.
   - **1.3.** Use the *J 24270* , or equivalent, in order to remove a 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 from the cylinder and piston.



1552546

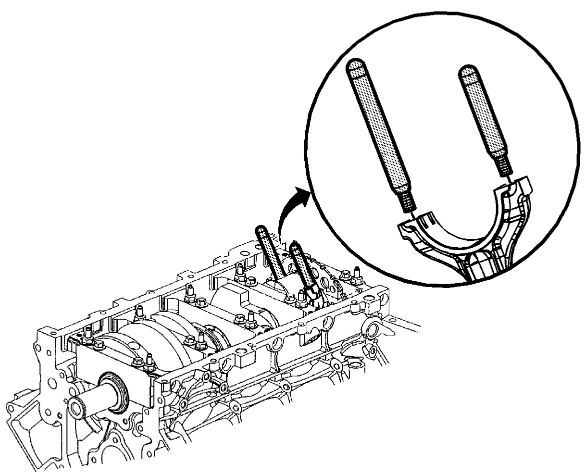
2. Using a paint stick or etching tool, place matchmarks or numbers on the connecting rods and the connecting rod caps. The connecting rods and caps MUST be assembled to their original position and direction.
   - A stamping mark on the side of the connecting rod, at the crankshaft journal, may affect component geometry.
   - Mark the top of the piston to the specific cylinder bore.



1552547

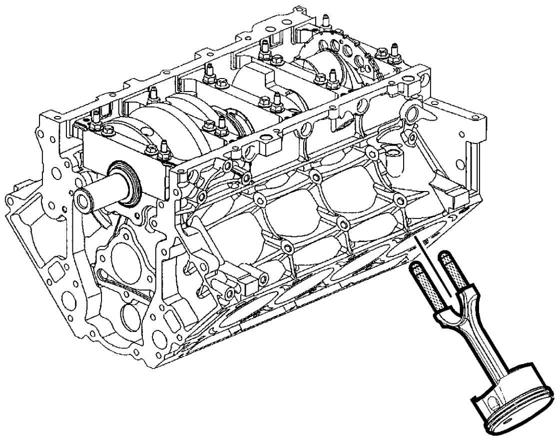
Important: Mark, sort, or organize the connecting rod bearings so they may be installed to their original position and location. The connecting rods and the bearing caps are NOT interchangeable. Refer to *Separating Parts* .

3. Remove the connecting rod bolts (102), cap (103) and bearing (104).



1552499

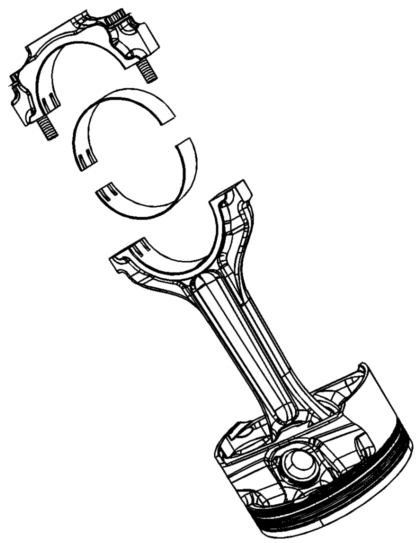
4. Install the *J 41556* to the connecting rod.



1552548

5. Using a hammer, tap lightly on the end of the *J 41556* in order to remove the piston and connecting rod assembly from the cylinder bore.

6. Remove the *J 41556* .



1552501

7. Upon removal of the piston and connecting rod assembly, assemble the connecting rod cap and bolts onto the matching connecting rod.

Repair Instructions

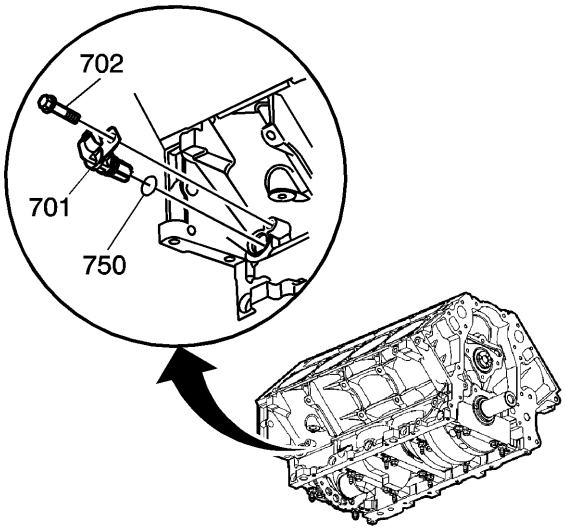
2201750

Crankshaft and Bearing Removal

Special Tools

- J 6125-1B Slide Hammer
- J 41818 Crankshaft Bearing Cap Remover

For equivalent regional tools, refer to *Special Tools*

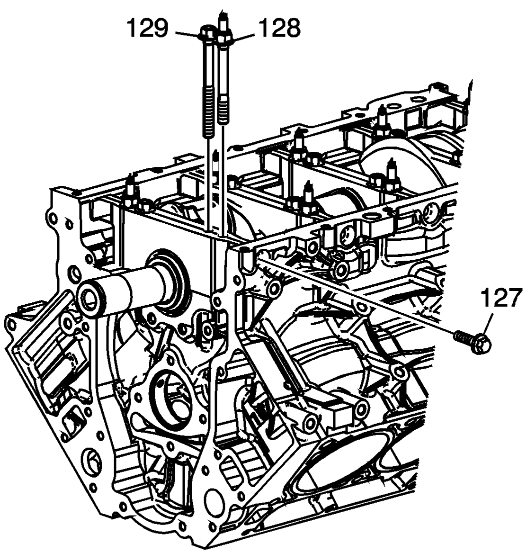


1402083

Note

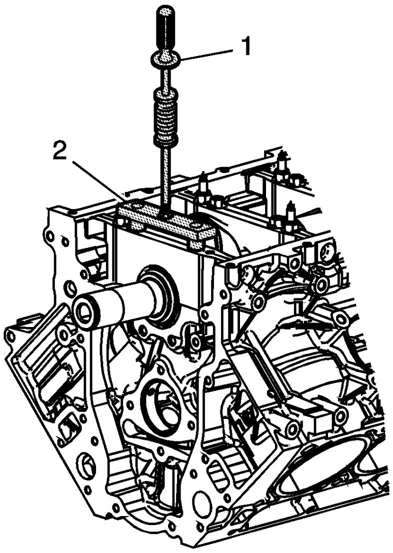
- The crankshaft bearing caps are machined with the engine block, for the proper clearances. Mark or identify each crankshaft bearing cap location and direction before removal. The crankshaft bearing caps MUST be installed to their original position and direction.
- All M8, and M10 bolts are to be discarded and replaced with NEW.

1. Remove the crankshaft position (CKP) sensor bolt (702).
2. Remove the CKP sensor (701).
3. Remove the O-ring (750) from the sensor, as required.



1552494

4. Remove and discard the crankshaft bearing cap M8 bolts (127).
5. Remove and discard the bearing cap M10 bolts (129) and studs (128).

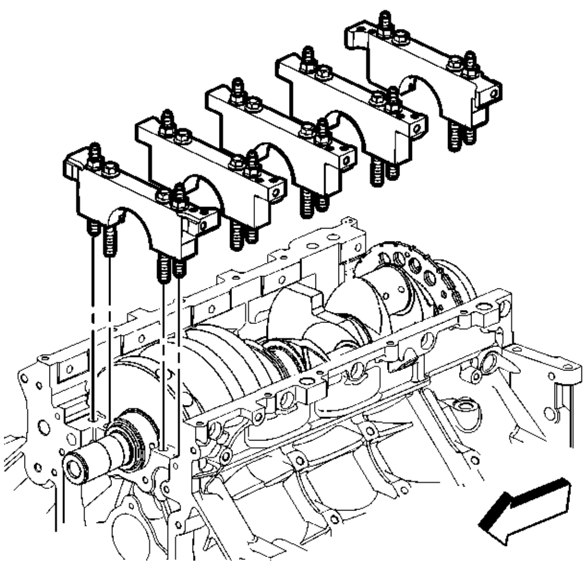


1552495

Caution: Refer to *Fastener Caution* .

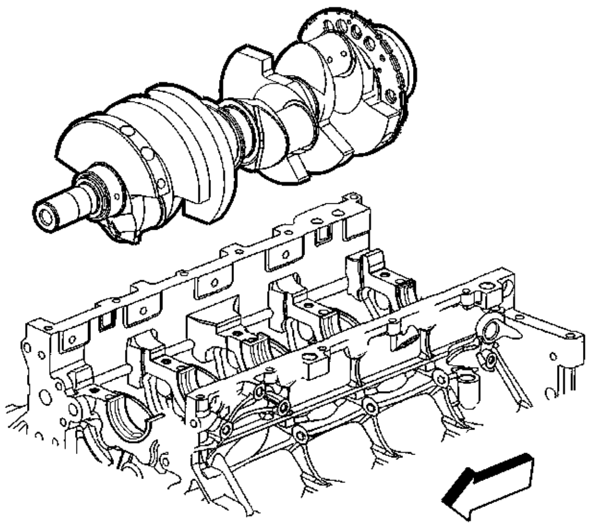
6. Install the J 41818 remover (2) and tighten to 11 N·m (100 lb in) .

7. Install the J 6125-1B hammer (1) to the J 41818 remover (2) in order to remove the crankshaft bearing caps.



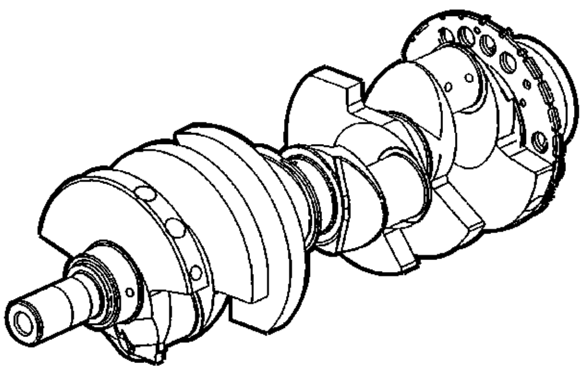
156152

8. Remove the bearing caps.



156151

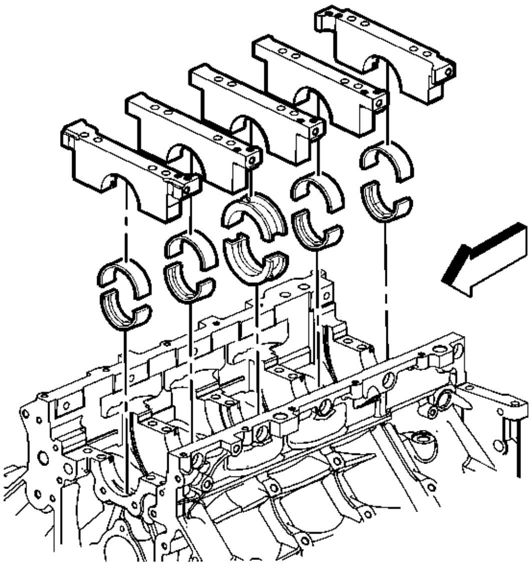
9. Remove the crankshaft.



156153

Note 10. Use care when handling the crankshaft. Avoid damage to the CKP sensor reluctor ring teeth. Nicks, burrs or other damage t

Lay the crankshaft onto 2 wooden V-blocks or other protective surface.



64293

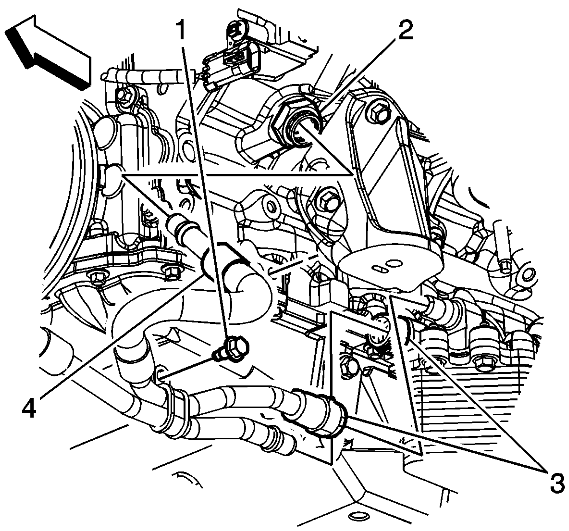
11. Remove the crankshaft bearings from the bearing caps and the engine block.

12. Mark, sort, or organize the crankshaft bearings so they may be installed to their original position and location. Refer to *Separating Parts* .

Repair Instructions

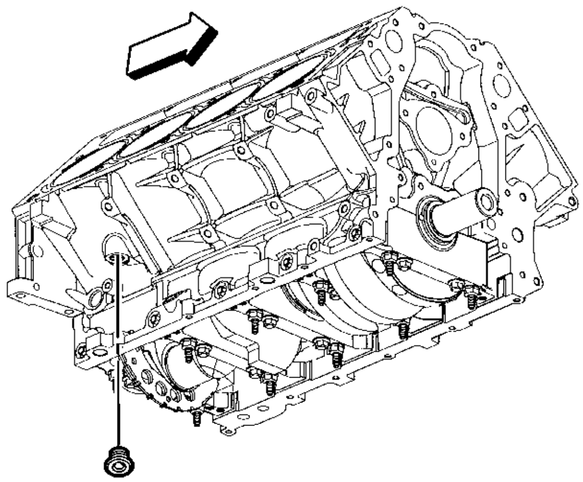
2087100

Engine Block Plug Removal



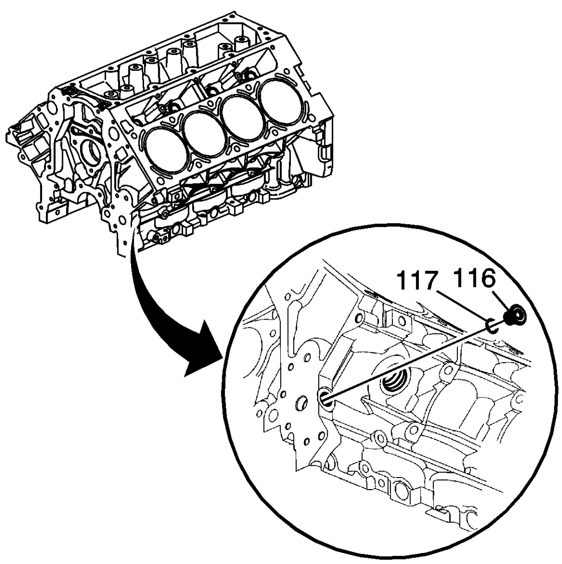
2142312

1. Remove the engine oil cooler coolant fitting (2).



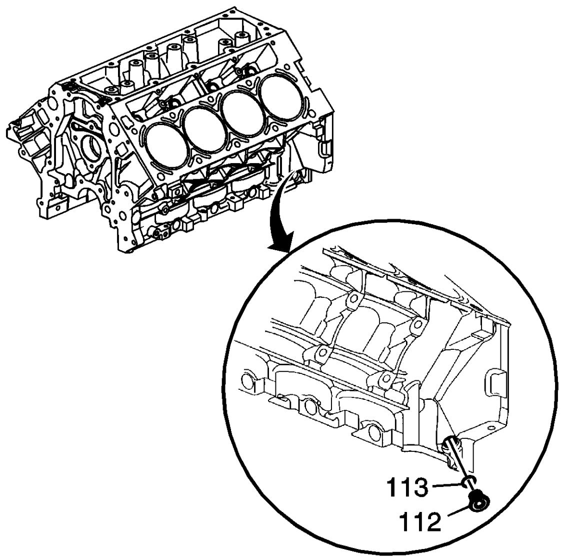
63164

2. Remove the engine block right rear coolant drain hole plug and seal.



1552550

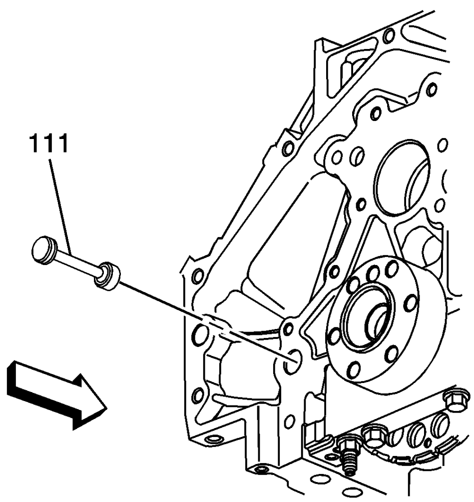
3. Remove the engine block left front oil gallery plug (116) and seal (117).



1552551

4. Remove the engine block left rear oil gallery plug (112) and seal (113).

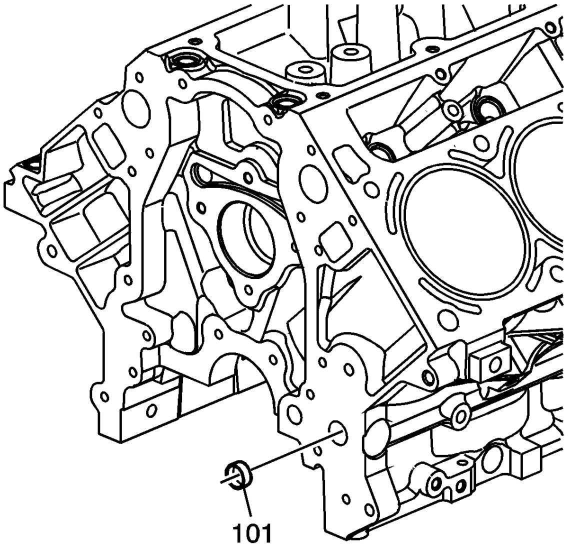
   If the block plug and coolant heater sealing washers are not damaged, they may be used during assembly.



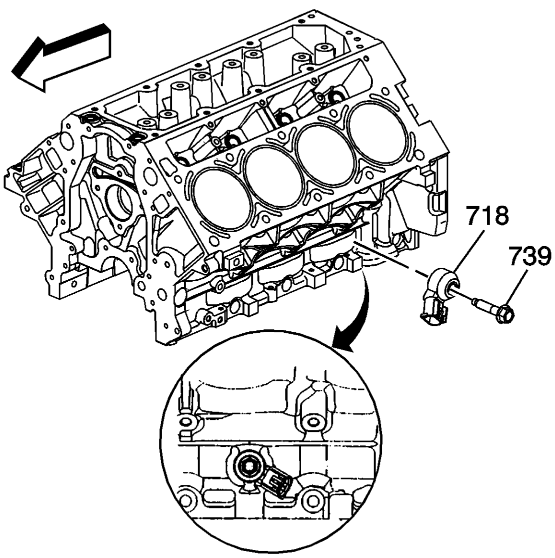
1669843

5. Remove the engine block rear oil gallery plug (111) and seal.
6. Inspect the O-ring seal of the rear oil gallery plug.

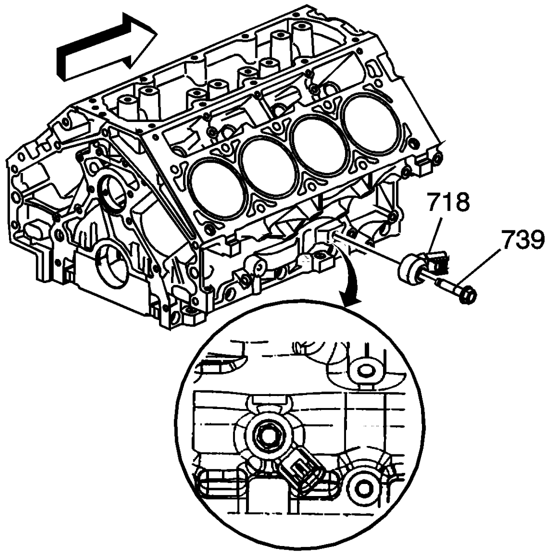
   If the O-ring seal is not cut or damaged, the plug and O-ring seal may be used during assembly.



1552553
Note 7. Remove the front oil gallery plug, only if service is required. If the front oil gallery plug is removed, a NEW oil gallery plug mus
Remove the engine block front oil gallery plug (101).

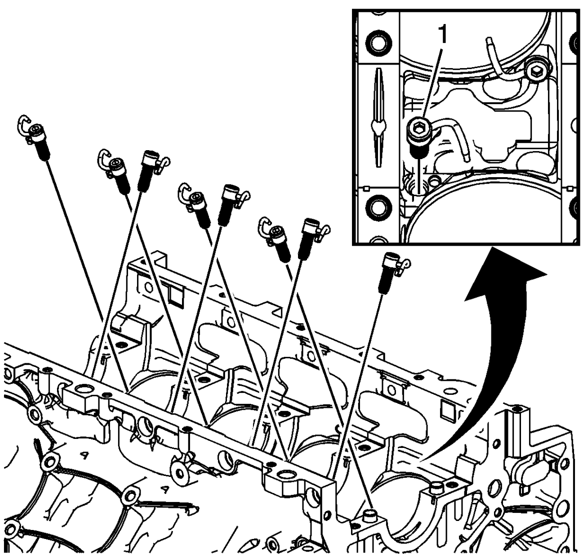


1402136
8. Remove the left side knock sensor (718) and bolt (739).



1402140

9. Remove the right side knock sensor (718) and bolt (739).



2085658

10. Remove the piston oil nozzles (1) from the block – 6.2L LS9/LSA.

Repair Instructions

2143322

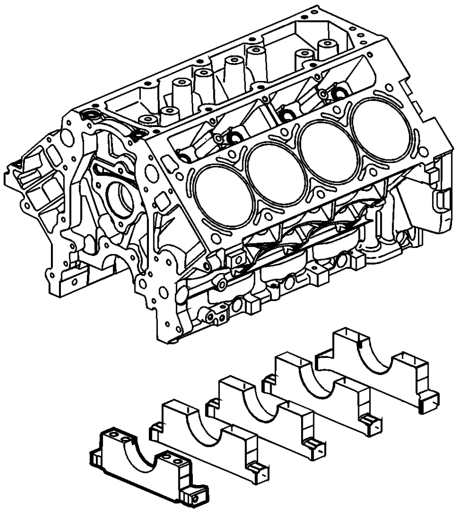
Engine Block Cleaning and Inspection

Special Tools

- J 8087 Cylinder Bore Gauge
- J 42385-100 Head/Main Bolt Thread Repair Kit

For equivalent regional tools, refer to *Special Tools*

Cleaning Procedure



1402142

Caution: Do not use a caustic solution to clean the aluminum engine block.

Note

When cleaning the engine block in a thermal type oven, do not exceed 232°C (450°F).

Clean the following components:

- Remove all sludge, dirt, or debris using a cleaning solvent or thermal type oven. Refer to *Cleanliness and Care* .
- Gasket surfaces

  Refer to *Replacing Engine Gaskets* .
- Coolant passages
- Oil galleries
- Main bearing caps
- Cylinder head bolt holes to remove threadlocking material

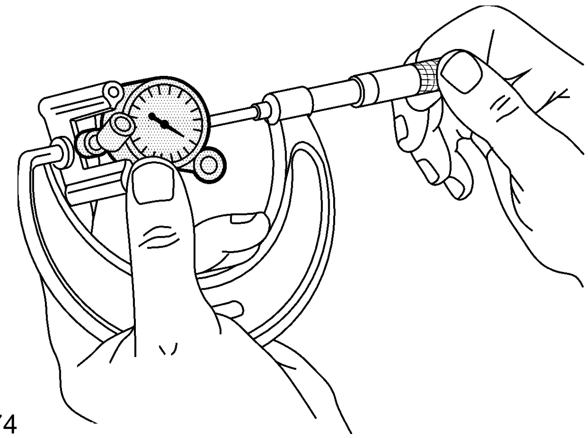
  Thread repair tool J 42385-107 may be used to clean the threads of any residual threadlocking material.

Inspection Procedure

1. Inspect the following components:
   - Cylinder walls for excessive scratches, gouging, or ring ridge
   - Cylinder bores for excessive ring ridge at the top of the cylinder
   - Coolant jacket for cracks
   - Valve lifter bores for excessive scoring or wear
   - Crankshaft bearing webs for cracks
   - Gasket sealing surfaces for excessive scratches or gouging

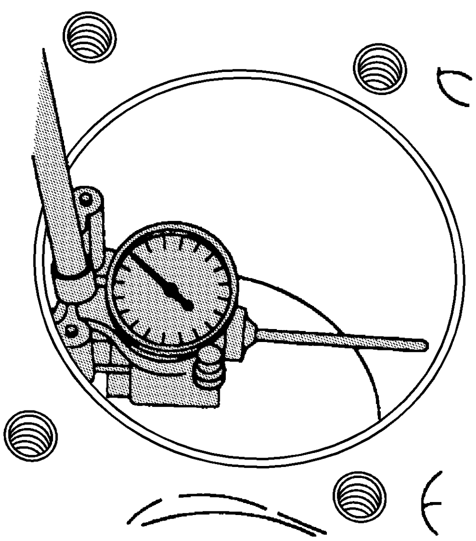
     Refer to *Replacing Engine Gaskets* .
   - Oil galleries for restrictions
   - Threaded bolt holes for damaged threads
   - Cylinder bores for excessive ring ridge at the top of the cylinder
2. Measure the cylinder bores for an oversize condition:

Measuring the Cylinder for Oversize



4974

1. Adjust the micrometer to a dimension slightly smaller than the bore size. Refer to *Engine Mechanical Specifications* .
2. Insert the J 8087 gauge into the micrometer and zero the bore gauge dial.



4972

3. Using the J 8087 gauge , measure the cylinder bore for oversize.

   Slide the bore gauge up and down throughout the length of the cylinder bore. Measure the bore, both parallel and perpendicular to the centerline of the crankshaft, at the top, center, and bottom of the bore. A cylinder bore that exceeds the maximum diameter must be serviced with an oversized piston. Refer to *Engine Mechanical Specifications* .

Repair Instructions

1877748

Cylinder Boring and Honing

Boring Procedure

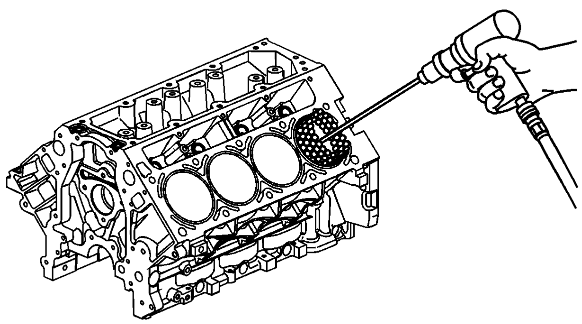
Note 1. A 0.5 mm (0.02 in) oversize service piston and a piston ring set are available. **1.** Measure all pistons with a micrometer to determine the cylinder bore diameter.

2. Before you use any type of boring bar, use a fine file and clean the top of the cylinder block, removing any dirt or burrs. If you do not check the cylinder block, the boring bar may be improperly positioned or tilted and the cylinder bore could be bored at an incorrect angle.
3. Carefully follow the instructions furnished by the manufacturer regarding use of the equipment.

4. When you bore the cylinders, ensure all the crankshaft bearing caps are in place. Tighten the crankshaft bearing caps to the proper torque in order to avoid distortion of the cylinder bores during final assembly.

5. When you take the final cut with a boring bar, leave 0.03 mm (0.001 in) on the cylinder bore diameter for the finish honing and fit of the piston.

Honing Procedure



1552445

1. When honing the cylinders, 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 you remove. Dull, dirty stones cut unevenly and generate excessive heat. Do not hone to final clearance with a coarse or medium-grade stone. Leave sufficient metal so that all stone marks may be removed with fine-grade stones. Perform final honing with a fine-grade stone, honing the cylinder to the proper clearance.

2. During the honing operation, thoroughly clean the cylinder bore. Repeatedly check the cylinder bore for fit with the selected piston.

All measurements of the piston or the cylinder bore should be made with the components at normal room temperature.

3. When honing a cylinder for fit to an oversize piston, first perform the preliminary honing with a 100-grit stone.

4. Perform final cylinder honing with a 240-grit stone and obtain a 45 degree cross hatch pattern.

A 240-grit stone is preferred for final honing. If a 240-grit stone is not available, a 220-grit stone may be used as a substitute.

5. The finish marks should be clean but not sharp. The finish marks should also be free from imbedded particles and torn or folded metal.

6. By measuring the selected piston at the sizing point and by adding the average of the clearance specification, you can determine the final cylinder honing dimension required.

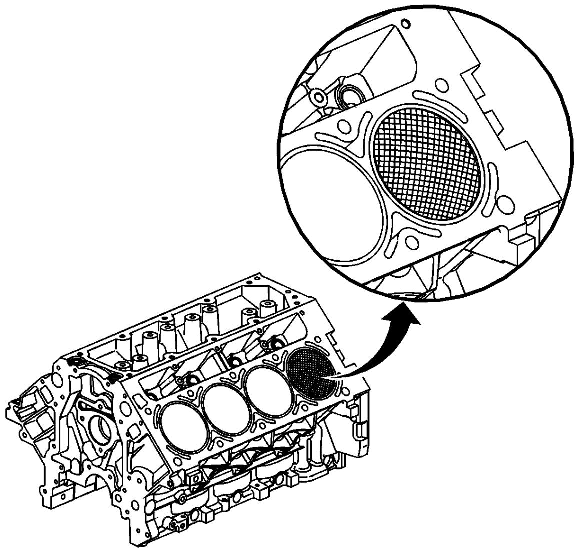
7. After final honing and before the piston is checked for fit, clean the cylinder bores with hot water and detergent. Scrub the bores with a stiff bristle brush and rinse the bores thoroughly with hot water. Do not allow any abrasive material to remain in the cylinder bores. This abrasive material may cause premature wear of the new piston rings and the cylinder bores. Abrasive material will also contaminate the engine oil and may cause premature wear of the bearings. After washing the cylinder bore, dry the bore with a clean rag.

8. Perform final measurements of the piston and the cylinder bore.

9. Permanently mark the top of the piston for the specific cylinder to which it has been fitted.

10. Apply clean engine oil to each cylinder bore in order to prevent rusting.

Deglazing Procedure



1552443

Using a ball type or self centering honing tool, deglaze the cylinder bore lightly. Deglazing should be done only to remove any deposits that may have formed. Use a 240-grit stone of silicone carbide, or equivalent, material when preforming the deglazing procedure.

A 240-grit stone is preferred for final honing. If a 240-grit stone is not available, a 220-grit stone may be used as a substitute.

Repair Instructions

2155706

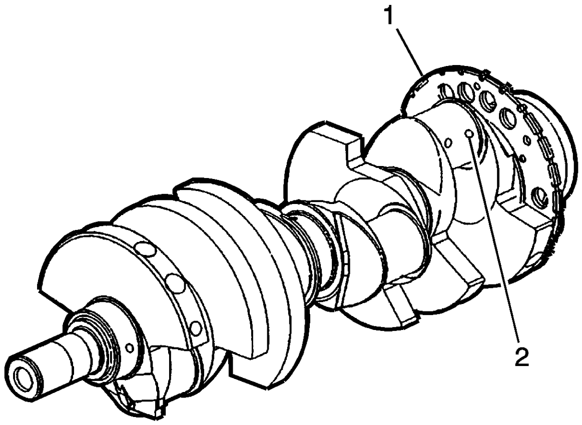
Crankshaft and Bearing Cleaning and Inspection

Special Tools

- J 7872 Magnetic Base Dial Indicator Set
- J 43690 Rod Bearing Checking Tool
- J 43690-100 Rod Bearing Checking Tool – Adapter Kit

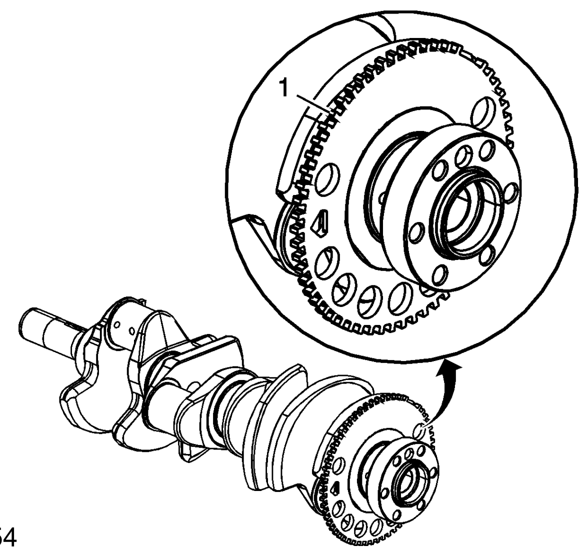
For equivalent regional tools, refer to *Special Tools*

Cleaning Procedure

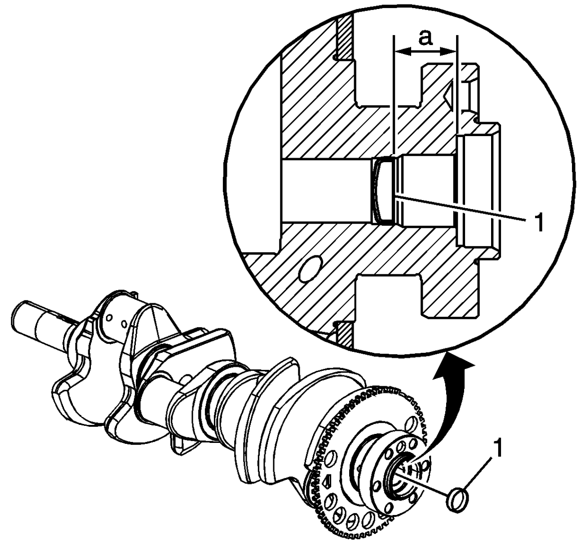


1402145
Note 1. Use care when handling the crankshaft. Avoid damage to the bearing surfaces or the teeth of the crankshaft position (CKP) r
Clean the crankshaft with solvent.
2. Thoroughly clean all oil passages (2) and inspect for restrictions or burrs.
Warning 3. Refer to *Safety Glasses Warning* . **3.** Dry the crankshaft with compressed air.

Inspection Procedure



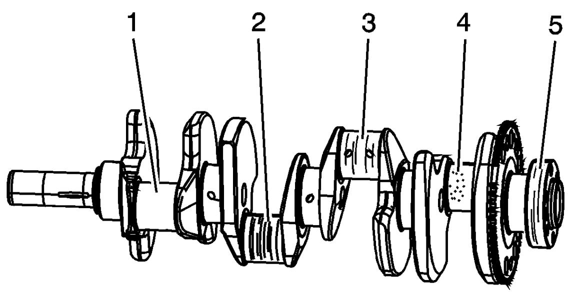
1552554
Note 1. The reluctor ring teeth should not have imperfections on the rising or falling edges. Imperfections of the reluctor ring teeth ma
Inspect the CKP reluctor ring teeth (1) for damage.



2000258

2. Inspect the rear cup plug (1) for leakage, if applicable.

Note 3. If a new plug is required, apply sealant GM P/N 89021297 (Canadian P/N 10953488) to the side of the plug prior to installatio
Install the rear cup plug (1) to a depth of 24.4 mm (0.96 in) (a).



1552446

4. Inspect the crankshaft journals for wear.

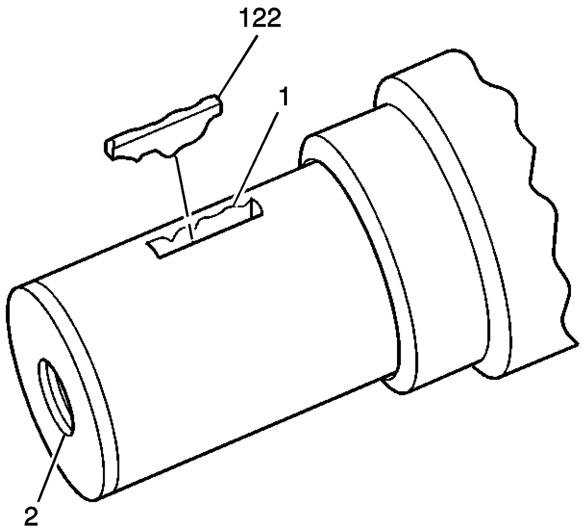
Journals should be smooth (1) with no signs of scoring, wear, or damage.

5. Inspect the crankshaft journals for grooves or scoring (2).

6. Inspect the crankshaft journals for scratches or wear (3).

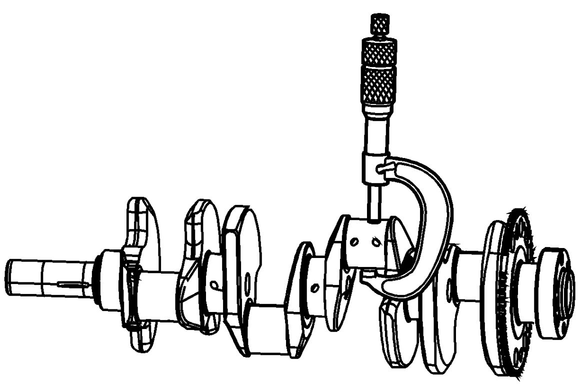
7. Inspect the crankshaft journals for pitting or imbedded bearing material (4).

8. Inspect the crankshaft rear oil seal surface (5) for grooves or scoring.



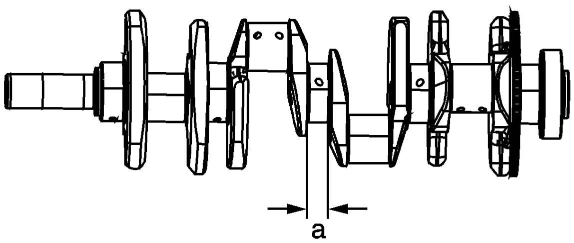
1272849

9. Inspect the crankshaft key (122), keyway (1), and threaded hole (2) for damage.



1552447

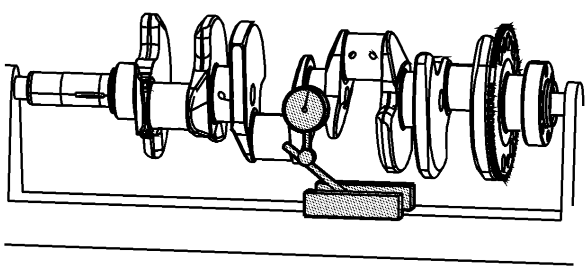
10. Measure the main and connecting rod journals for out-of-round and taper. Replace the crankshaft if all journals are not within specification for diameter, out-of-round, and taper. Refer to *Engine Mechanical Specifications* .



1552449

11. Measure the crankshaft thrust wall width.

A crankshaft with a thrust wall width in excess of 26.22 mm (1.0322 in) (a) must be replaced.



1552450

12. Measure the crankshaft runout. Refer to *Engine Mechanical Specifications* .

Use wooden V-blocks or a fixture to support the crankshaft on the front and rear journals.

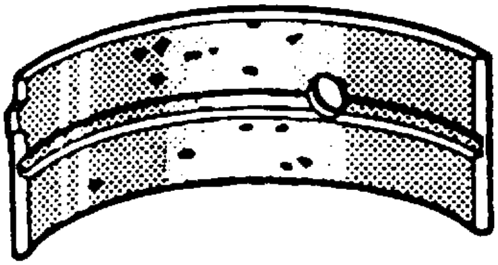
13. Use the J 7872 dial indicator in order to measure the crankshaft runout at the number 3 main journal and the adjacent front and rear intermediate journals.

14. Use the J 7872 dial indicator in order to measure the runout of the crankshaft rear flange.

15. Use the J 7872 dial indicator in order to measure the runout of the crankshaft position reluctor ring. Reluctor ring runout should be measured 1.0 mm (0.04 in) below the ring teeth.

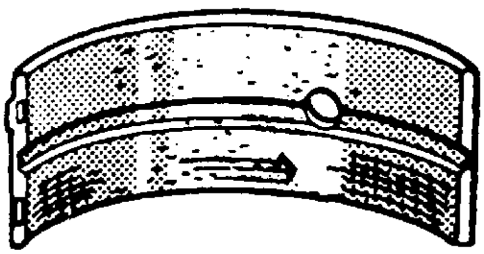
If the reluctor ring has runout in excess of 0.7 mm (0.028 in), replace the crankshaft.

If runout is not within specification for main journals or rear flange, replace the crankshaft.



52051

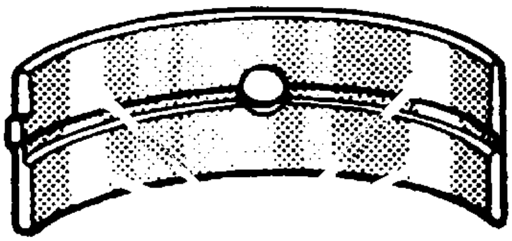
16. Inspect crankshaft bearings for craters or pockets. Flattened sections on the bearing halves also indicate fatigue.



52053

17. Inspect the crankshaft bearings for excessive scoring or discoloration.

18. Inspect the crankshaft bearings for dirt or debris imbedded into the bearing material.



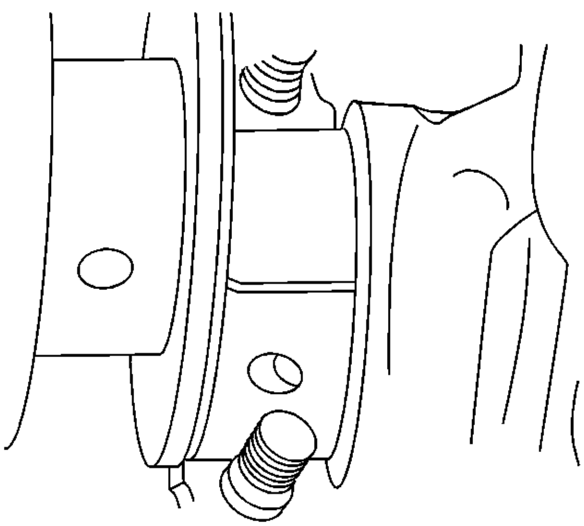
52056

19. Inspect the crankshaft bearings for improper seating, indicated by bright, polished sections of the bearing.

If the lower half of the bearing is worn or damaged, both upper and lower halves should be replaced.

Generally, if the lower half is suitable for use, the upper half should also be suitable for use.

Measuring Main Bearing Clearance – Gaging Plastic Method



4980

Note

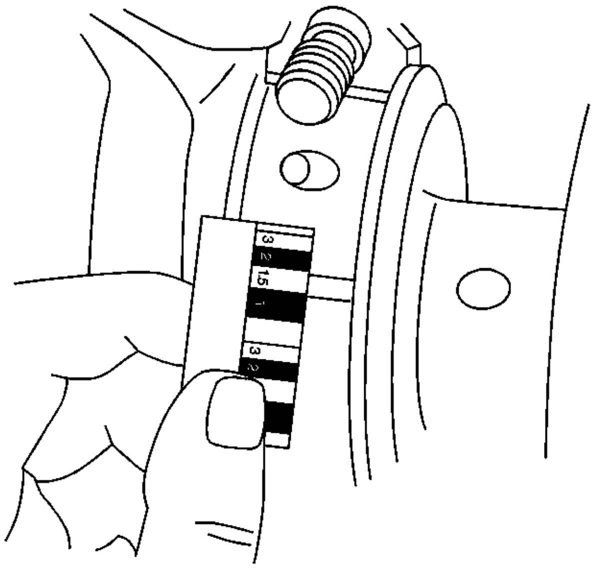
- The crankshaft main bearings are a precision insert type. Main bearing caps are machined with the engine block, for proper clearance, and cannot be shimmed or filed for bearing fit. If the clearances are found to be excessive, new bearings and/or engine block and cap repair or replacement may be required.
- Do not rotate the crankshaft while gaging plastic is between the crankshaft journal and the bearing surface.
- The crankshaft bearing clearances are critical. Excessive bearing clearance may affect crankshaft position sensor signals and may affect on-board diagnostics (OBD) II system operation.
- Remove the bearing cap side bolts prior to cap removal.

1. Remove the bearing caps, bearing half, and bolts. Refer to *Crankshaft and Bearing Removal* .

2. Install gaging plastic onto the crankshaft journal. Install the gaging plastic the full width of the crankshaft bearing journal.

3. Install the bearing caps, bearing half, and bolts. Refer to *Crankshaft and Bearing Installation* .

4. Remove the bearing caps, bearing half, and bolts. Refer to *Crankshaft and Bearing Removal* .

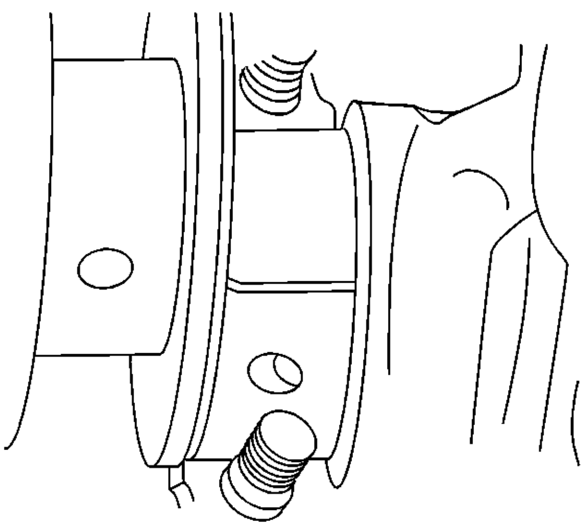


4981

5. Using the scale supplied with the plastic gaging kit, measure the gaging plastic at its widest area.

- If the gaging plastic shows irregularity in the journal, exceeding 0.025 mm (0.001 in), remove the crankshaft and measure the journal with a micrometer.
- If clearance cannot be brought to specifications, replace the crankshaft or engine block as required. Refer to *Engine Mechanical Specifications* .

Measuring Connecting Rod Bearing Clearance – Gaging Plastic Method

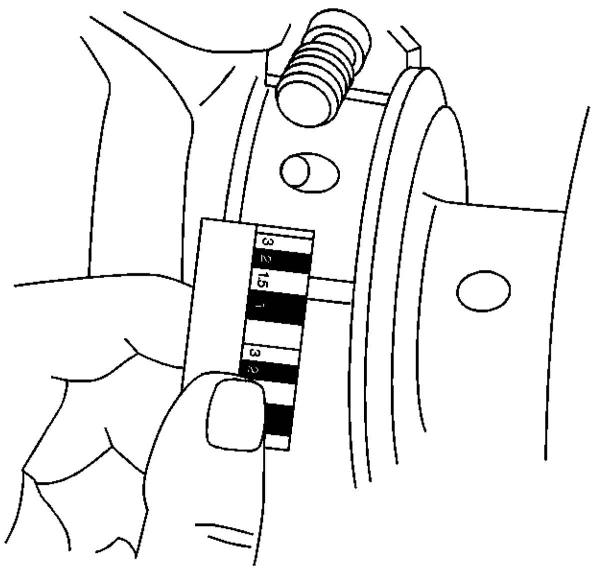


4980

Note

- Connecting rod bearings are a precision insert type. Connecting rods are of a powdered metal design and cannot be shimmed or filed for bearing fit. If clearances are found to be excessive, a new bearing and/or connecting rod is required.
- Do not rotate the crankshaft while gaging plastic is between the crankshaft journal and the bearing surface.

1. Remove the bearing cap, bearing half, and bolts. Refer to *Piston, Connecting Rod, and Bearing Removal* .
2. Install the gaging plastic onto the connecting rod bearing journal. Install the gaging plastic the full width of the journal.
3. Install the bearing cap, bearing half, and bolts. Refer to *Piston, Connecting Rod, and Bearing Installation (6.2L)* .
4. Remove the bearing cap, bearing half, and bolts. Refer to *Piston, Connecting Rod, and Bearing Removal* .

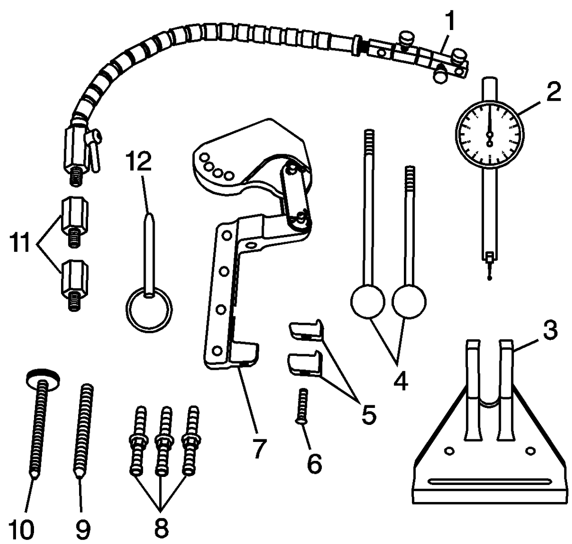


4981

5. Using the scale supplied with the plastic gaging kit, measure the gaging plastic at its widest area. Refer to *Engine Mechanical Specifications* .

Measuring Connecting Rod Bearing Clearance – Using J 43690/J 43690-100

J 43690 checking tool and J 43690-100 adapter kit have been developed as a more accurate method to measure connecting rod bearing clearances. The instructions below provide an overview of tool set-up and usage. For more detailed information, refer to the tool instruction sheets supplied by the tool manufacturer.

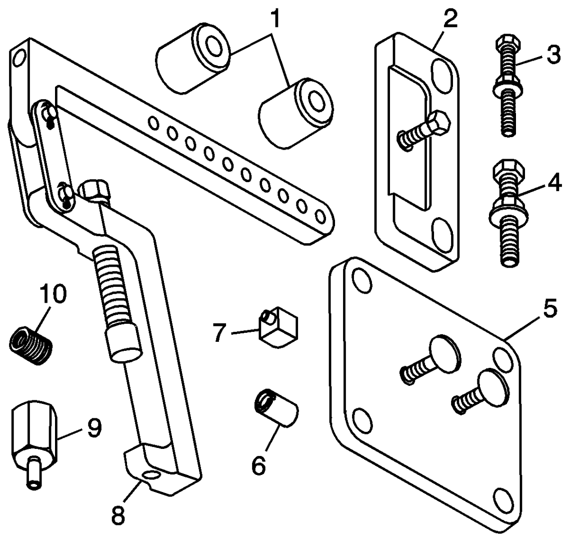


627091

J 43690 Rod Bearing Checking Tool

- J 43690-20 Swivel Base (1)
- J 43690-19 Dial Indicator (2)
- J 43690-2 Base (3)

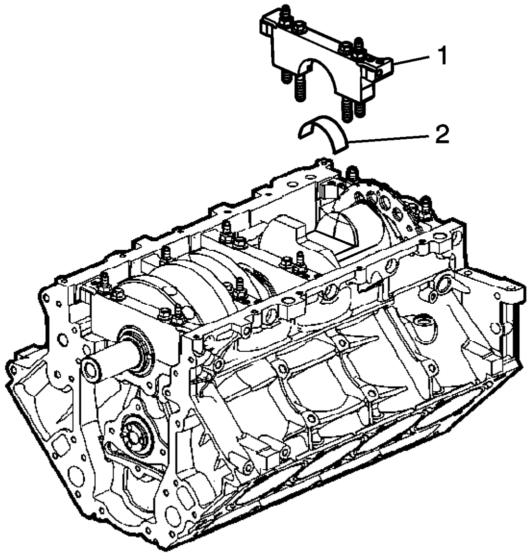
- J 43690-5, J 43690-6 Handle (4)
- J 43690-10, J 43690-11 Foot (5)
- 280307 Screw (6)
- J 43690-1 Pivot Arm Assembly (7)
- J 43690-3, J 43690-7, J 43690-8 Screws (8)
- 280319 Screw (9)
- 280311 Screw (10)
- J 43690-17, J 43690-18 Adapter (11)
- 280310 Pin (12)



836375

J 43690-100 Rod Bearing Checking Tool – Adapter Kit

- J 43690-104 Spacer (1)
- J 43690-105 Retainer Plate (2)
- 505478 Bolt (3)
- 511341 Bolt (4)
- J 43690-106 Retainer Plate (5)
- J 43690-107 Cap (6)
- J 43690-102 Foot (7)
- J 43690-101 Pivot Arm Assembly (8)
- J 43690-103 Adapter (9)
- 505439 Adapter (10)



863074

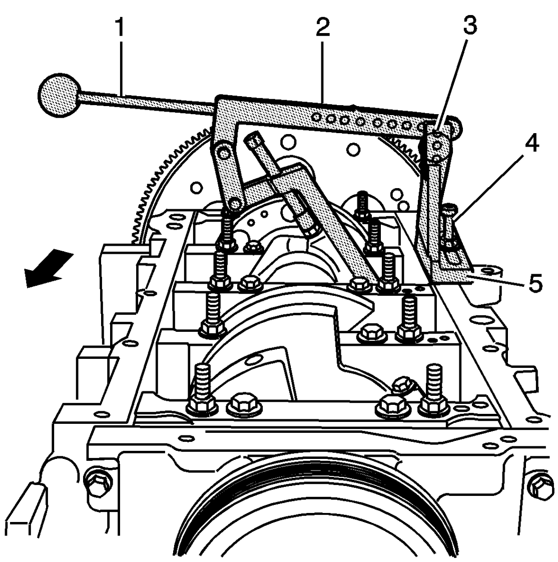
Note 1. The crankshaft must be secure, with no movement or rotation, in order to obtain an accurate reading. **1.** Rotate the crankshaft until the journal/connecting rod to be measured is in the 12 o'clock position.

2. Remove a bearing cap and bolts (1).

3. Remove the bearing half (2).

4. Insert a piece of paper card stock onto the crankshaft journal.

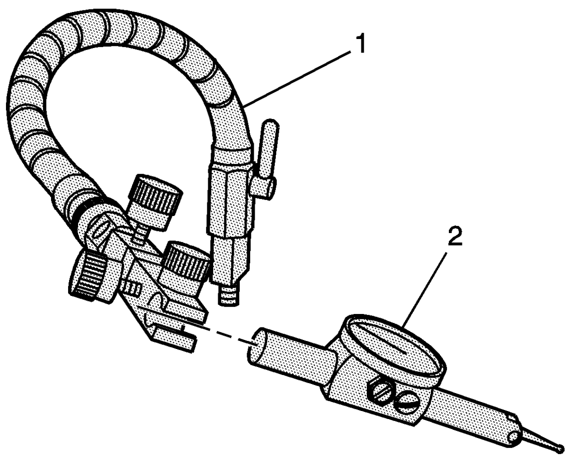
5. Install the bearing half (2) and cap and bolts (1). Refer to *Fastener Tightening Specifications* .



828697

6. Install the following:

- **6.1.** J 43690-2 (5)
- **6.2.** J 43690-3 (4)
- **6.3.** J 43690-101 (2)
- **6.4.** 280310 (3)
- **6.5.** J 43690-5 (1)



627122

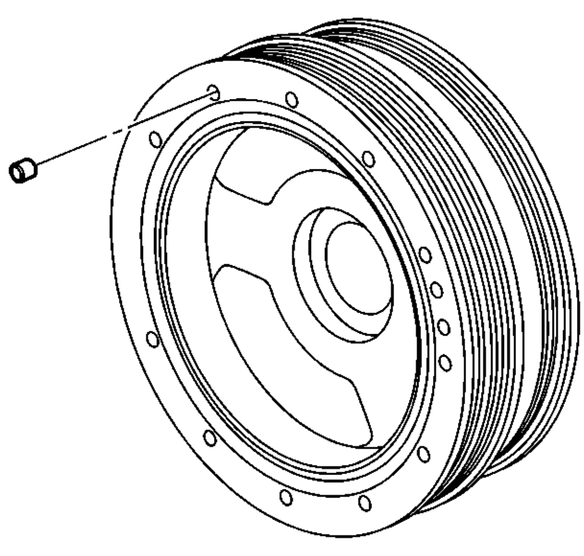
7. Install the swivel base (1) and dial indicator (2).
8. Adjust per the manufacturers instructions and measure the connecting rod bearing clearance.

   The connecting rod side clearance must be within specification. Refer to *Engine Mechanical Specifications* . Service components, as required.

Repair Instructions

2177626

Crankshaft Balancer Cleaning and Inspection



63153

1. Clean the crankshaft balancer in solvent.
2. Using a wire brush, clean the belt grooves of all dirt and debris.
3. Dry the crankshaft balancer with compressed air.
4. Inspect the crankshaft balancer for the following conditions:
   - Loose or improperly installed balance weights – manual transmission applications.

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

- Worn, grooved, or damaged hub seal surface

  A crankshaft balancer hub seal surface with excessive scoring, grooves, rust or other damage must be replaced.

  Minor imperfections on the hub seal surface may be removed with polishing compound or fine grade emery cloth.

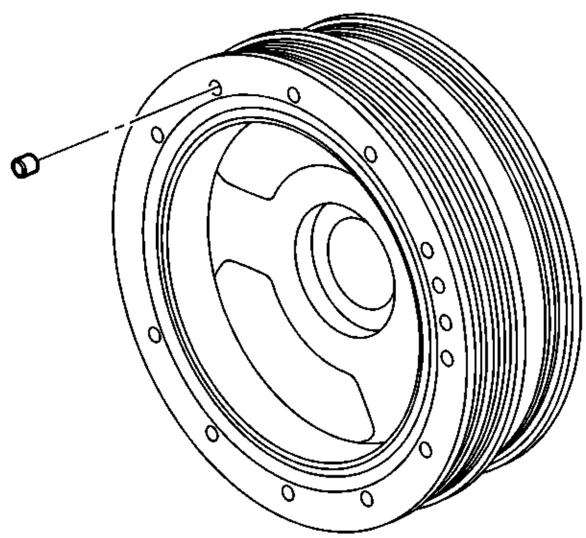
Note • In order for the belt to track properly, the belt grooves should be free of all dirt and debris. • Dirty or damaged belt grooves

  The balancer belt grooves should be free of any nicks, gouges, or other damage that may not allow the belt to track properly.

  Minor imperfections may be removed with a fine file.

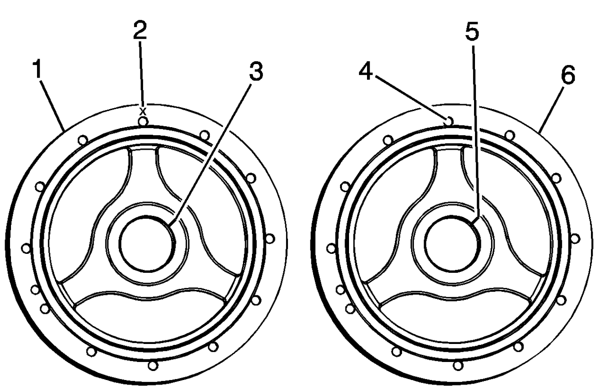
- Worn, chunking or deteriorated rubber between the hub and pulley

Replacing the Crankshaft Balancer and Balance Weights



63153

Note 1. If replacing the crankshaft balancer on manual transmission applications, note the location of any existing balance weights, i
Inspect the crankshaft balancer weight holes for any existing balance weights.



1669848

Warning 2. Refer to *Safety Glasses Warning* . **2.** Using a punch, position the balance weights in the old balancer (1) to the bottom of the weight holes.

3. With a marking crayon, note the weight holes (2) containing balance weights, if applicable.

4. Lay the old crankshaft balancer (1) on a bench or flat table.

Rotate the old balancer until 1 of the marked balance weight holes (2) is in the 12 o'clock position.

5. Lay the new crankshaft balancer (6) on the bench next to the old balancer.

Rotate the new balancer until 1 of the balance weight holes (4) is in the 12 o'clock position.

6. With a marking crayon, mark the new balancer weight hole (4) located in the 12 o'clock position.

7. Viewing the old balancer, note the position of the crankshaft-to-balancer alignment mark (3).

8. Mark the new balancer in the same location (5).

9. Measure the distance from the top of the balance weights to the face of the old crankshaft balancer.

10. Record the readings.

11. Determine the proper balance weight size for the new balancer. Balance weights are available in 3 different sizes.

- A balance weight hole depth that measures 13.0 mm (0.512 in), has a short balance weight in the hole. A short balance weight measures 12.7 mm (0.5 in) in length.
- A balance weight hole depth that measures 6.69 mm (0.263 in), has a medium balance weight in the hole. A medium balance weight measures 19.0 mm (0.75 in) in length.
- A balance weight hole depth that measures 0.29 mm (0.011 in), has a long balance weight in the hole. A long balance weight measures 25.4 mm (1.0 in) in length.

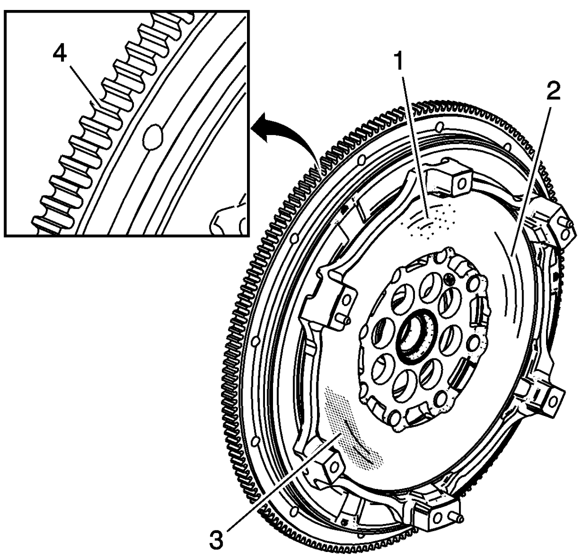
12. Insert new crankshaft balance weights of the proper size into the new balancer in the same location as the old balancer.

A properly installed balance weight is flush or below flush with the face of the balancer.

Repair Instructions

2173789

Engine Flywheel Cleaning and Inspection



2216024

Note

In order to maintain the proper component balance, contact surface taper, and heat transfer, manual transmission flywheels are NOT to be machined.

Inspect the dual-mass manual transmission flywheel for the following conditions:

- Pitted surface (1)
- Grooved or scored surface (2)

- Rusted surface (3)
- Damaged ring gear teeth (4)
- Loose or improperly positioned ring gear

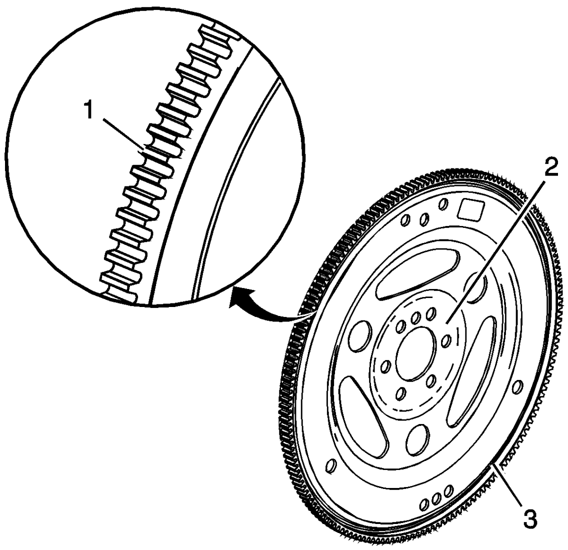
  The ring gear has an interference fit onto the flywheel and should be positioned completely against the flange of the flywheel.

- Missing, bent or damaged pressure plate locating pins
- The flywheel friction disc contact surface is tapered for improved disc contact. If using a straight edge to determine surface wear, the technician may note less material or a taper to the inner or ID area. This condition is considered normal and not a determining factor when replacing the flywheel.

Repair Instructions

2127591

Automatic Transmission Flex Plate Cleaning and Inspection



1658199

1. Clean the flex plate in solvent.

Warning 2. Refer to *Safety Glasses and Compressed Air Warning* . 2. Dry the flex plate with compressed air.

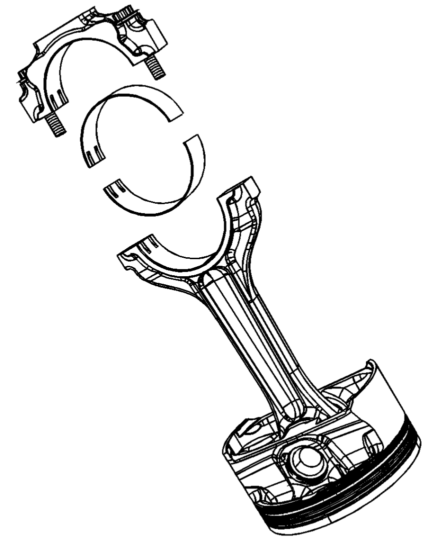
3. Inspect the flex plate for the following conditions:
   - Damaged ring gear teeth (1)
   - Stress cracks around the flex plate-to-crankshaft bolt hole locations (2)

Note • Do not attempt to repair the welded areas that retain the ring gear to the flex plate. Install a new flex plate. • Welded areas (3) that retain the ring gear onto the flex plate for cracking

Repair Instructions

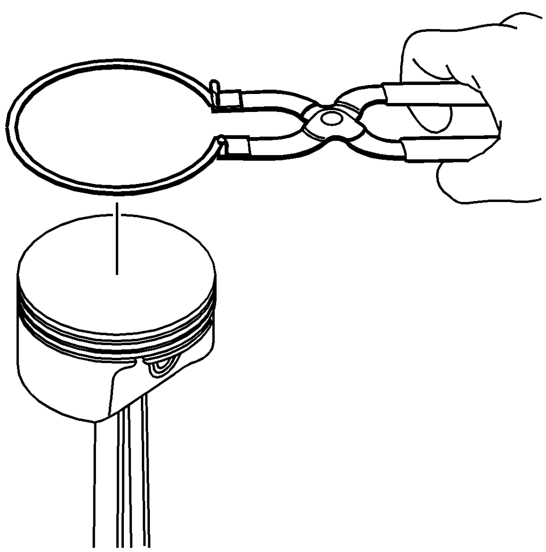
2173790

Piston and Connecting Rod Disassemble



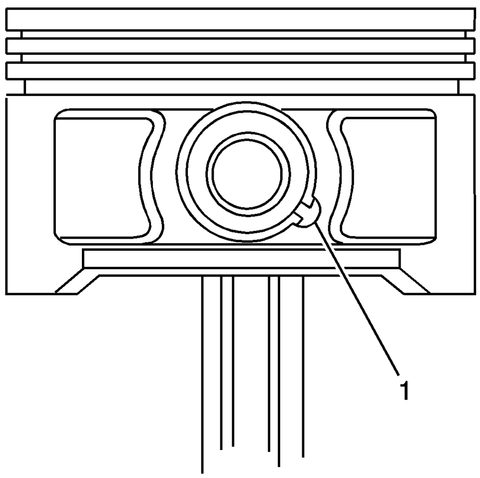
1552501

1. Remove the connecting rod bearings from the rod and cap.



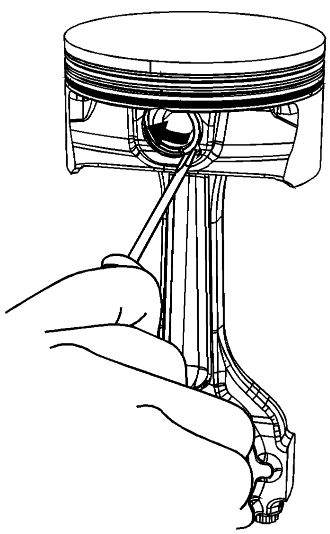
490763

2. Using piston ring pliers, remove the piston rings from the piston.



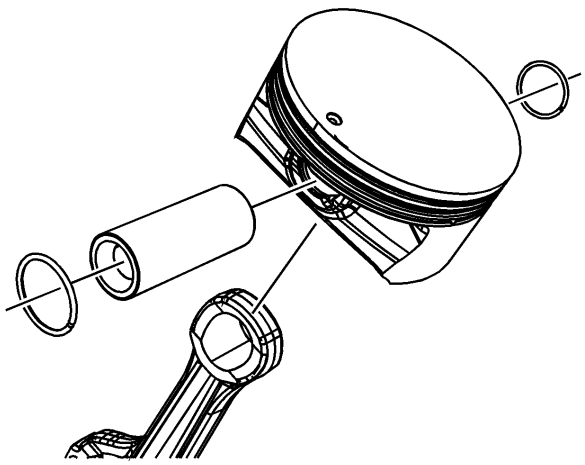
1366364

3. Rotate the piston pin retainers until the ring end gaps are positioned in the cutout area (1) of the pin bore.



1559866

4. Remove the retainers starting in the cutout area of the pin bore.



1559867

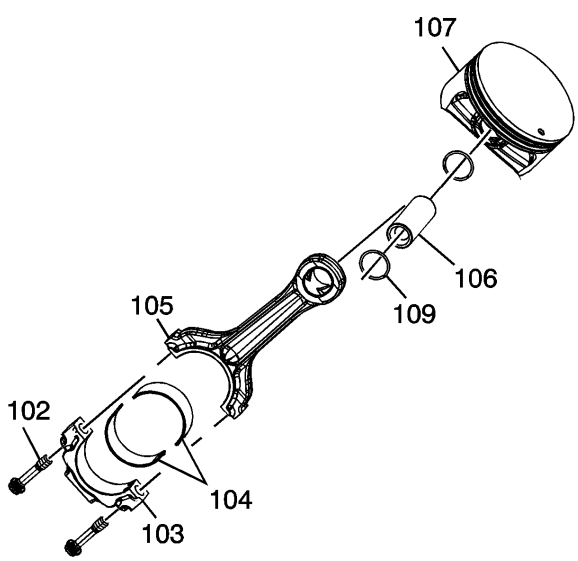
5. Remove the pin from the piston and connecting rod.
6. Mark, sort, or organize the piston and the matching piston pin.

Repair Instructions

2136187

Piston, Connecting Rod, and Bearing Cleaning and Inspection (6.2L)

Piston, Pin, and Piston Rings



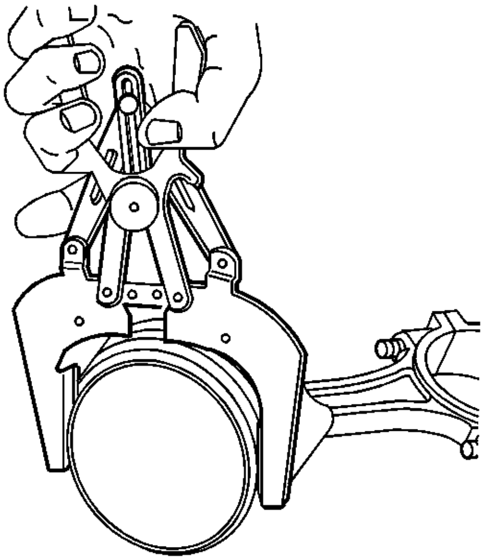
1559868

Note

- Replace pistons, pins, and connecting rods that are damaged or show signs of excessive wear.
- The piston and pin are to be serviced as an assembly.
- Do not wire brush any part of the piston.
- Measurement of the components should be taken with the components at normal room temperature.

1. Clean the varnish and carbon from the piston (107) using cleaning solvent.

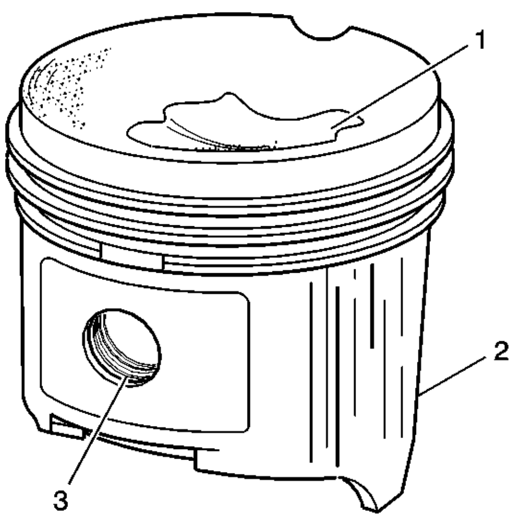
Warning **2.** Refer to *Safety Glasses Warning* . **2.** Dry the components with compressed air.



4977

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

4. Clean the oil lubrication holes and slots.



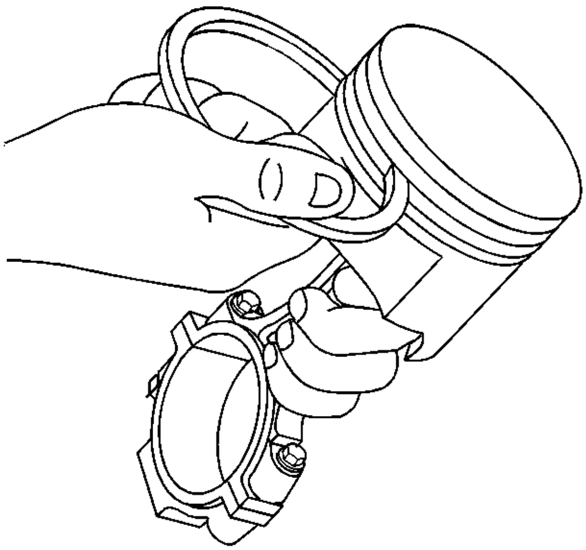
156168

5. Inspect the piston for the following conditions:

- Cracks in the piston ring lands, the piston skirt, or pin bosses
- Piston ring grooves for nicks, burrs, or warpage which may cause the piston ring to bind

  MINOR imperfections may be removed from the piston with a fine file.

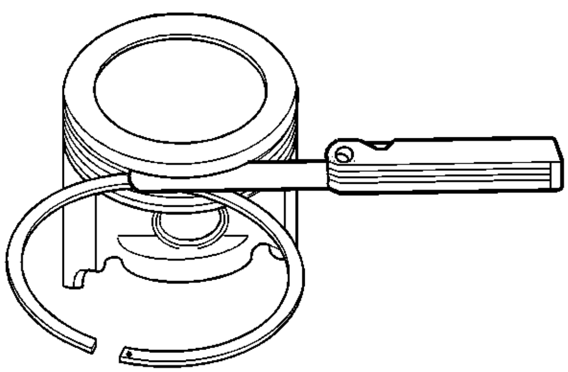
- Eroded areas at the top of the piston (1)
- Scuffed or damaged skirts (2)
- Scoring to the piston pin bore (3) or piston pin



4969

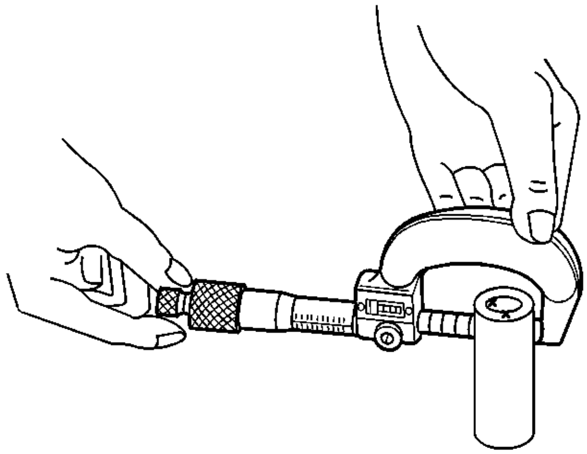
6. Insert the edge of the piston ring into the piston ring groove.

Roll the piston ring completely around the piston. If binding is caused by a distorted ring groove, MINOR imperfections may be removed with a fine file. If binding is caused by a distorted piston ring, replace the rings, as required.



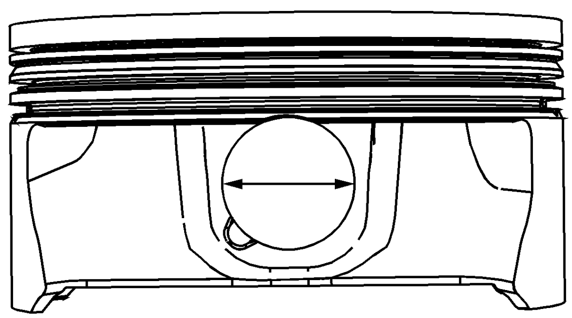
22934

7. Measure the piston ring side clearance with a feeler gauge. If side clearance is not within specifications, try another piston ring. If the proper ring-to-groove clearance cannot be obtained, replace the piston and pin as an assembly. Refer to *Engine Mechanical Specifications* .



4976

8. To determine piston pin-to-bore clearance, use a micrometer and measure the piston pin outside diameter (OD).

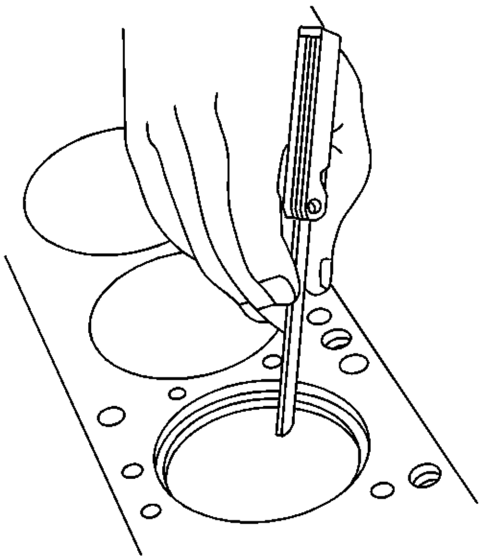


1552429

9. To determine the piston pin-to-bore clearance, use an inside micrometer and measure the piston pin bore inside diameter (ID).

10. Subtract the piston pin OD measurement from the piston pin bore ID measurement to determine pin-to-bore clearance. Refer to *Engine Mechanical Specifications* .

Measuring Piston Ring End Gap



4968

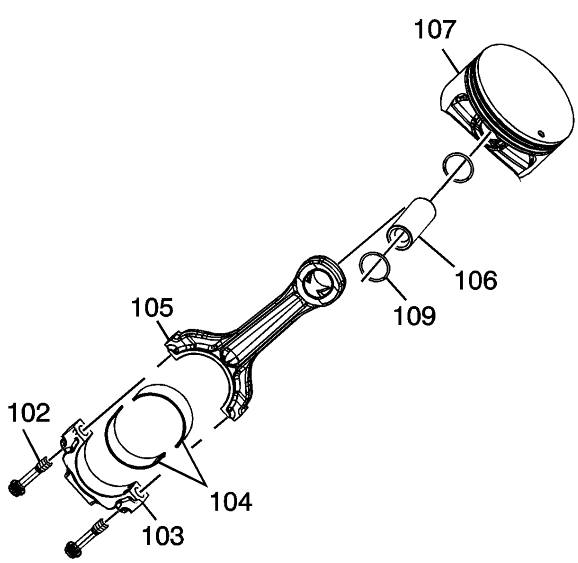
Note

- Do not attempt to file the end of the piston ring to achieve the proper end gap clearance.
- Measure the piston ring in the cylinder in which it will be used.

1. Place the piston ring into the cylinder bore 6.5 mm (0.25 in) below the top of the ring travel area. Both rings should be installed with the orientation marks facing the top of the piston.

2. Insert a feeler gauge and measure the piston ring end gap. Refer to *Engine Mechanical Specifications* .

Connecting Rod and Bearings



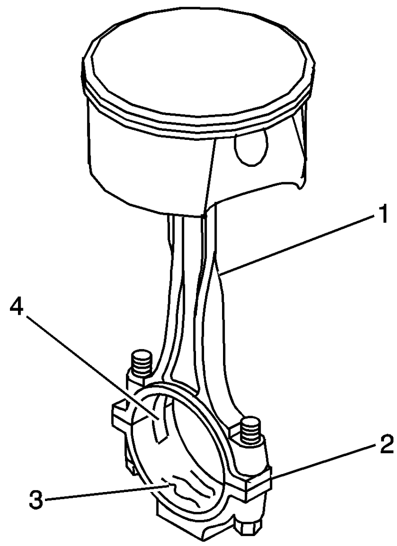
1559868

Note

- The powdered metal connecting rod and cap are machined for proper clearances. The connecting rod and cap must be used as an assembly with no repair or modifications to either mating surface. Do not attempt to repair the rod or cap. If service is required, replace the rod and cap as an assembly.
- Do not attempt to repair the bolt hole threads of the connecting rod.

1. Clean the connecting rod (105) and cap (103) in solvent.

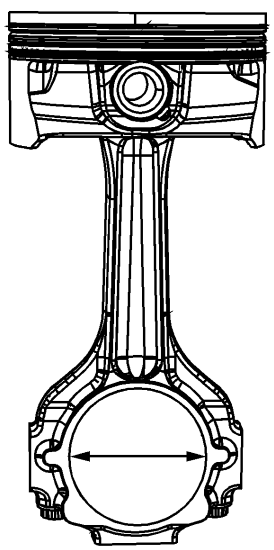
Warning 2. Refer to *Safety Glasses Warning* . **2.** Dry the components with compressed air.



1366360

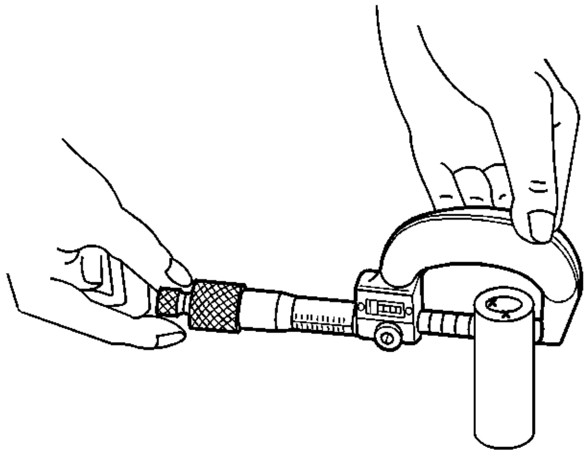
3. Inspect the connecting rod for the following conditions:

- Twisting (1)
- Proper fit of the connecting rod and cap mating surfaces (2)
- Nicks or gouges in the bearing bore (3)
- Damage to the bearing locating slots (4)



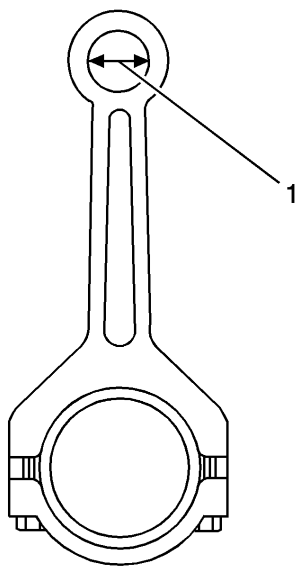
1552442

4. Measure the connecting rod bearing bore for an out-of-round condition. Refer to *Engine Mechanical Specifications* .



4976

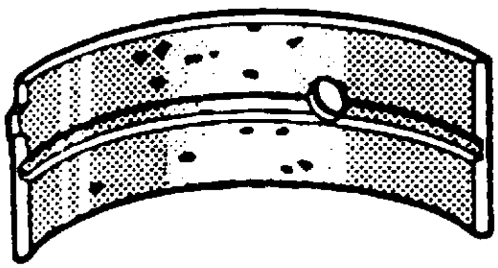
5. To determine piston pin-to-connecting rod bore clearance, use a micrometer and measure the piston pin OD.



1366411

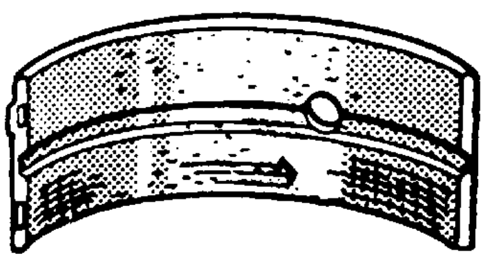
6. To determine the piston pin-to-connecting rod bore clearance, use a micrometer and measure the connecting rod pin bore (1) ID.

7. Subtract the piston pin OD measurement from the connecting rod pin bore ID measurement to determine pin-to-bore clearance. Refer to *Engine Mechanical Specifications* .



52051

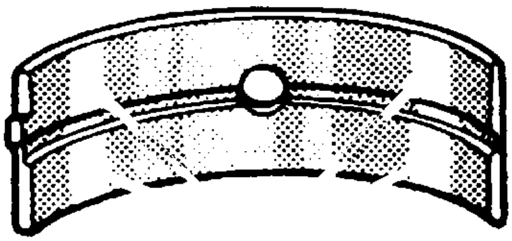
8. Inspect the connecting rod bearings for craters or pockets. Flattened sections on the bearing halves indicate fatigue.



52053

9. Inspect the connecting rod bearings for excessive scoring or discoloration.

10. Inspect the connecting rod bearings for dirt or debris imbedded into the bearing material.



52056

11. Inspect the connecting rod bearings for improper seating indicated by bright, polished sections of the bearing surface.

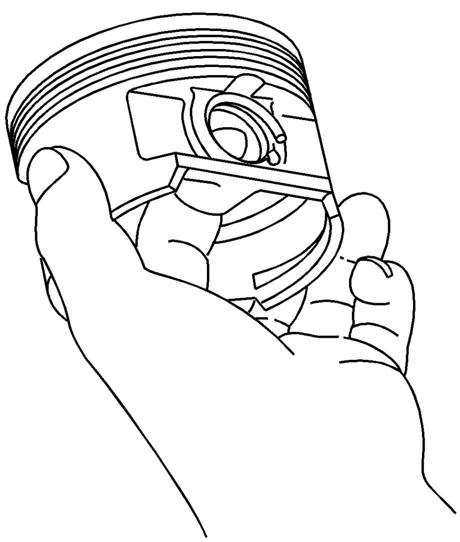
12. To determine the piston pin-to-bore clearance, use an inside micrometer and measure the piston pin bore ID.

13. Subtract the piston pin OD measurement from the piston pin bore ID measurement to determine pin-to-bore clearance. Refer to *Engine Mechanical Specifications* .

Repair Instructions

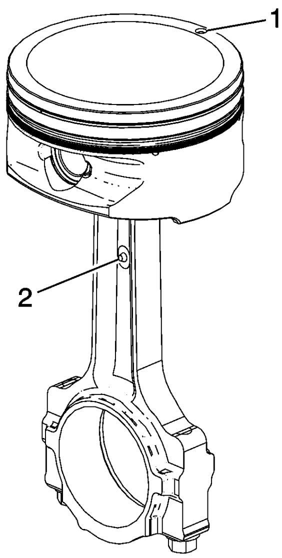
2158603

Piston and Connecting Rod Assemble



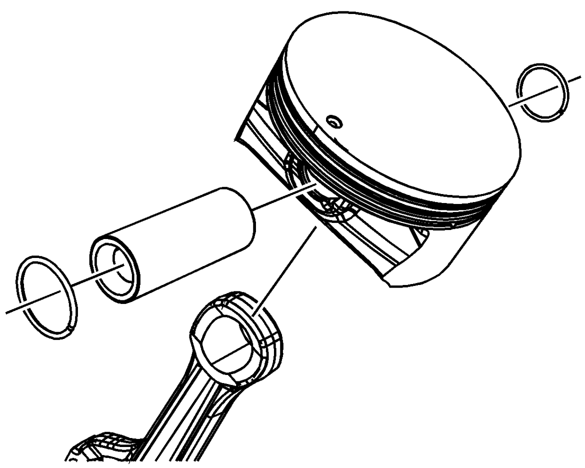
1366372

1. Install the retainer. The retainer should be seated in the groove of the pin bore.



2156785

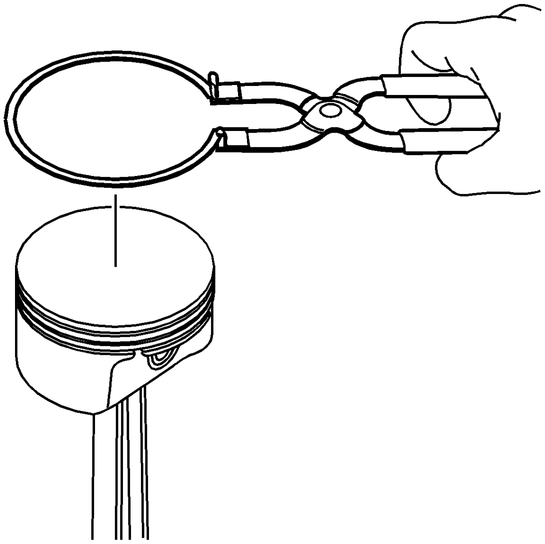
2. Assemble the piston and connecting rod. The mark (1) on the top of the piston and the dimple (2) on the connecting rod should be facing the opposite direction.



1559867

3. Install the piston pin to the piston and connecting rod.

4. Install the retainers. The retainers should be seated in the groove of the pin bore.

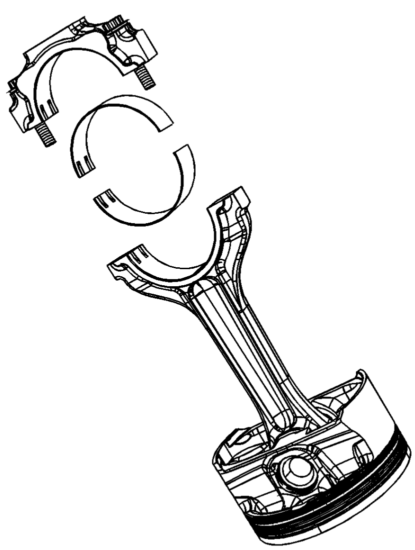


490763

Note 5. When installing piston rings, use a ring expander plier type tool. Do not roll the rings into the grooves of the piston. Use cauti
Using piston ring pliers, install the piston rings onto the piston. The dimple or mark on the piston ring should face the top of the piston. If no dimple or mark can be found on the top compression ring, it may be installed in either direction.

6. Position the oil control ring end gaps a minimum of 25 mm (1.0 in) from each other.

7. Position the compression ring end gaps 180 degrees opposite each other.



1552501

8. Install the connecting rod bearings to the rod and cap.

Repair Instructions

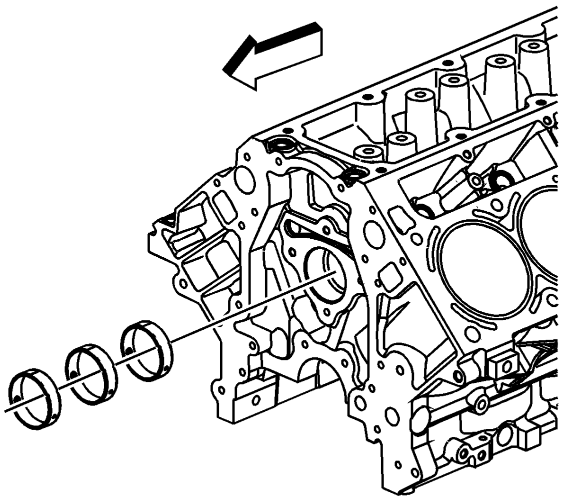
1877762

Camshaft Bearing Removal

Special Tools

J 33049 Camshaft Bearing Service Set

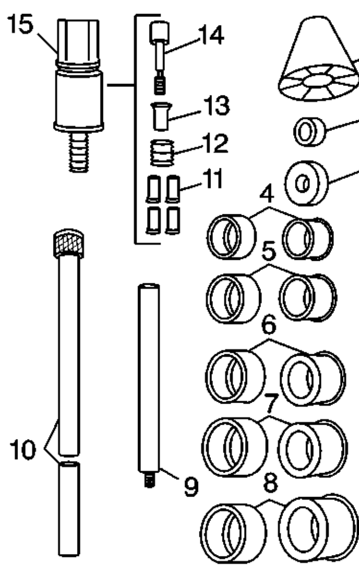
For equivalent regional tools, refer to *Special Tools* .



1552451

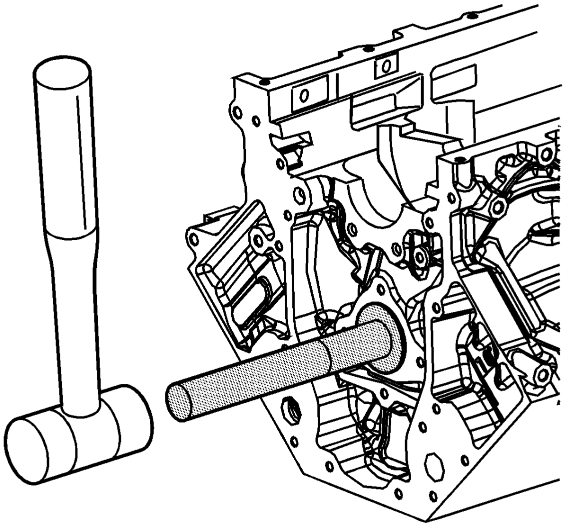
Important: A loose camshaft bearing may be caused by an enlarged, out of round, or damaged engine block bearing bore.

1. Prior to bearing removal, inspect the camshaft bearings for loose fit in the engine block bearing bores. Refer to *Camshaft and Bearings Cleaning and Inspection* .
2. Repair or replace the components, as required.



66100

3. Select the expanding driver (4–8) and washer (2 or 3) from the J 33049 service set .
4. Assemble the tool.
5. Insert the tool through the front of the engine block and into the bearing.
6. Tighten the expander assembly (15) nut until snug.
7. Push the guide cone (1) into the front camshaft bearing in order to align the tool.



1552556

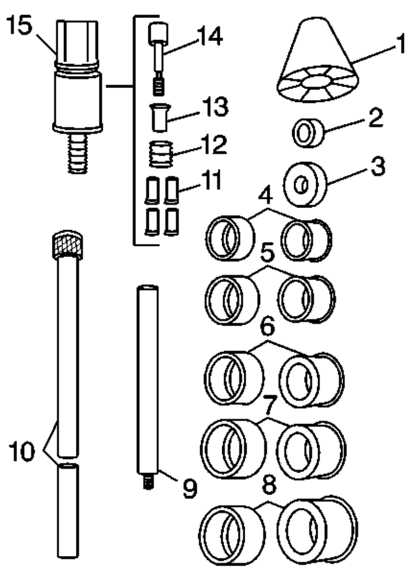
8. Drive the bearing from the block bore.

Important: In order to remove the inner camshaft bearings, operate the tool from either end of the block, using the driver bar extension and the guide cone in the front or rear camshaft bearing bore.

9. Repeat the above procedures in order to remove the remaining bearings.

Tool Usage Information

Bearing, Expander, and Expander Driver Information



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- The tool consists of a guide cone (1), driving washers (2 or 3), expander bearing drivers (4–8), driver bars (9 or 10), expander jaws (11), expander sleeve (12), expander cone (13), expander shaft (14), and expander assembly (15).

Note • The expander bearing drivers (4–8) in the J 33049 service set are stamped with a number (1–5) to assist in identifying the appropriate diameter driver. • Expander assembly (15) is used as a driver for the bearing when inside diameter is 28.575–37.465 mm (1.125–1.475 in) and is used with the small washer.

- Expander bearing driver number 1 inside diameter is 37.465–43.18 mm (1.475–1.7 in) and is used with the expander assembly (15) and the small washer.
- Expander bearing driver number 2 inside diameter is 43.18–48.895 mm (1.7–1.925 in) and is used with the expander assembly (15) and the large washer.

- Expander bearing driver number 3 inside diameter is 48.895–54.61 mm (1.925–2.15 in) and is used with the expander assembly (15) and the large washer.
- Expander bearing driver number 4 inside diameter is 54.61–60.325 mm (2.150–2.375 in) and is used with expander assembly (15) and the large washer.
- Expander bearing driver number 5 inside diameter is 60.325–68.326 mm (2.375–2.69 in) and is used with expander assembly (15) and the large washer.

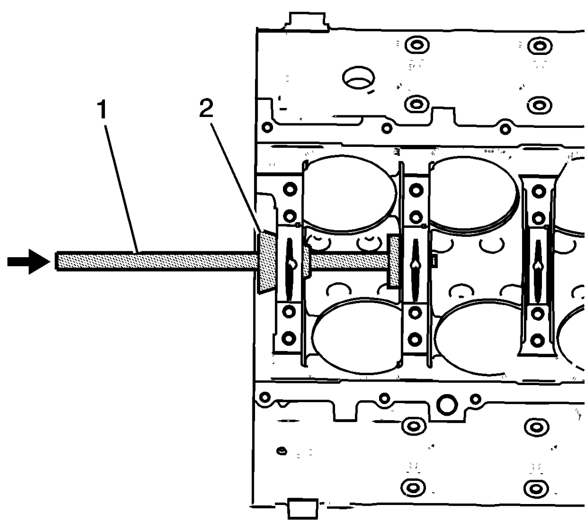
Tool Assembly and Operation

1. Select the proper expanding driver and washer from the expanding driver and washer information.

   Important: To install or remove the expanding driver, always push on or pull from the ends.

   Pressure on the outside diameter may cause a bind against the rubber expanding sleeve.
2. Place the expanding driver onto the expander assembly.
3. Ensure the separation lines between the segments of the expanding driver align with the separation lines of the expander assembly.
4. With the small end of the cone facing the driver assembly, place the guide cone over the driving bar.
5. Place the driving washer over the threaded portion of the expander assembly.
6. Screw the expander assembly, with driving washer, onto the driving bar.

   For removal of the inner bearings, it may be necessary to install the driver bar extension.

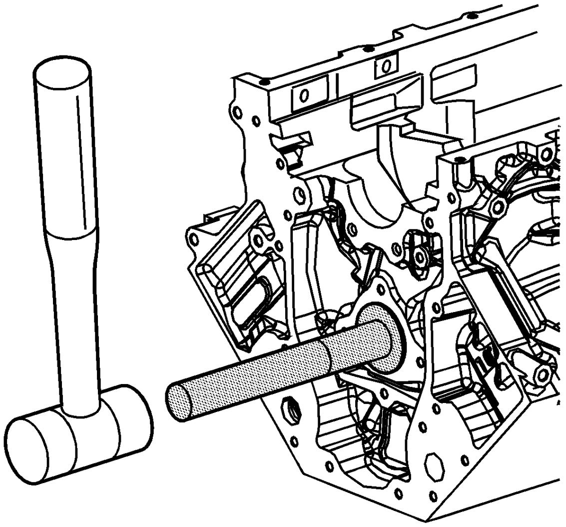


1552557

7. Insert the tool (1) into an inner camshaft bearing and tighten until snug.

   Operate the tool from the front or rear of the engine block.

   On some engine blocks, the nut on the expander assembly is inaccessible, except from either end. In this case, you must use a socket and extension to enlarge and reduce the expander assembly.
8. Slide the nylon cone (2) into the front or rear camshaft bearing. This will properly align the tool.
9. Drive the bearing out of or into the engine block.
10. Repeat the procedure for the additional inner bearings.



1552556

11. For the end bearings, front, position number 1, and the rear, position number 5, remove the nylon cone and driver bar extension.

12. Drive the bearings out of or into the engine block.

Repair Instructions

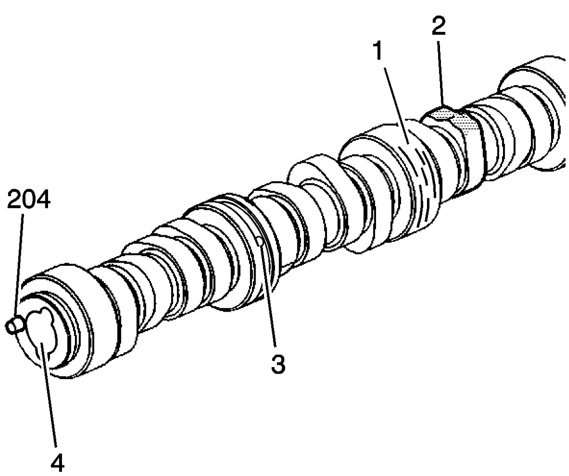
2363140

Camshaft and Bearings Cleaning and Inspection

Special Tools

- J 7872 Magnetic Base Dial Indicator Set
- J 8520 Camshaft Lobe Lift Indicator

For equivalent regional tools, refer to *Special Tools*



1658209

1. Clean the components in solvent.

Warning **2.** Refer to *Safety Glasses and Compressed Air Warning* **2.** Dry the components with compressed air.

3. Inspect the camshaft bearing journals (1) for scoring or excessive wear.

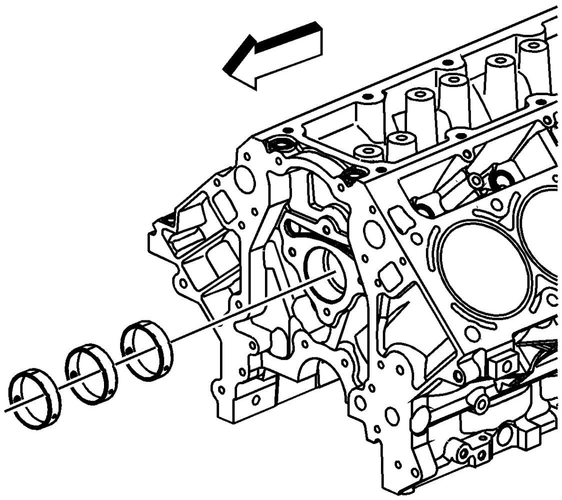
4. Inspect the camshaft valve lifter lobes (2) for scoring or excessive wear.

5. Inspect the threaded bolt hole (4) in the front of the camshaft for damaged threads or debris.

6. Inspect the camshaft sprocket pin (204) for damage.

7. Inspect the camshaft retainer plate for wear or a damaged sealing gasket.

If the camshaft retainer plate sealing gasket is not cut or damaged, it may be used again.



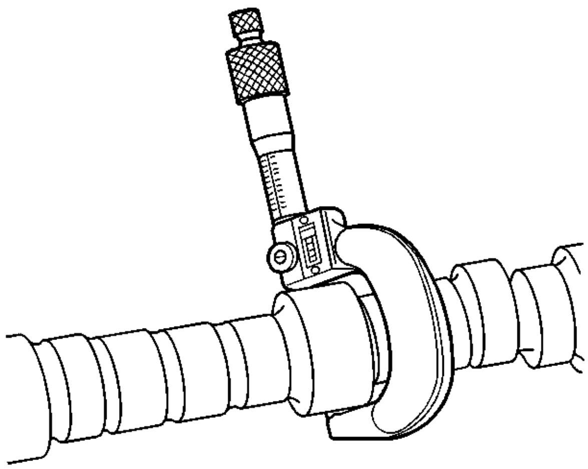
1552451

Note 8. The LSA engine is built with 2 different camshaft bearing designs; the difference is the composition of the bearing lining material.

- The first design camshaft bearing is composed of a lining material that uses a lead babbit with copper matrix backing.
- The second design camshaft bearing is lead-free, the lining is composed of a aluminum-tin material.

8. Inspect the camshaft bearings for the following:

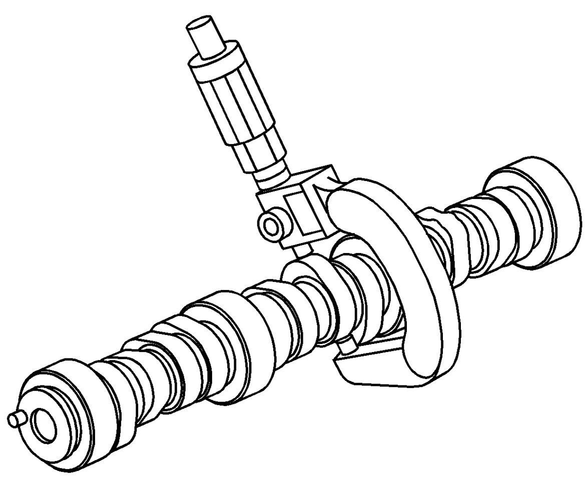
- Excessive wear, evidence of galling, pitting, scoring, or embedded debris. On first design camshaft bearings, the presence of the copper color bearing material should be considered normal, and not a guideline for bearing replacement. On 2nd design camshaft bearings, the appearance of the bearing material being different shades of gray are considered normal, and are not guideline for bearing replacement. Measure the bearing inside diameter (ID) as required for an over-sized condition. Refer to *Engine Mechanical Specifications* .
- Proper fit in the engine block. Camshaft bearings have an interference fit to the engine block and should not be loose in the engine block bearing bores.
- The oil lubrication feed hole in the bearing must be in alignment with the drilled out passage in the block.
- The oil lubrication feed hole is not plugged by debris.
- Bearings with excessive wear or scoring must be replaced.
- Bearings with excessive wear, galling, pitting, scoring, or embedded debris must be replaced.



35212

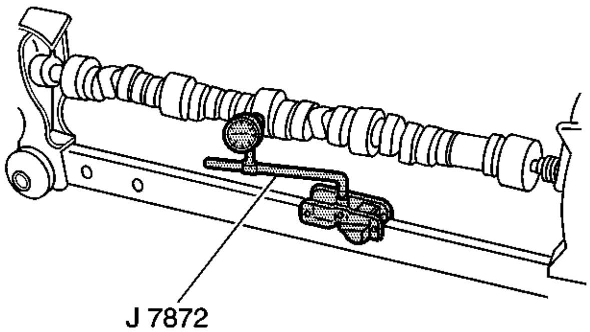
9. Using a micrometer, measure the camshaft journals for wear and out-of-round. Refer to *Engine Mechanical Specifications* .

- If the camshaft bearing journals are out-of-round, replace the camshaft.
- If the camshaft bearing journal diameter is not within specification, replace the camshaft.



1658205

10. Using a micrometer, measure the camshaft lobes for wear. Refer to *Engine Mechanical Specifications* .

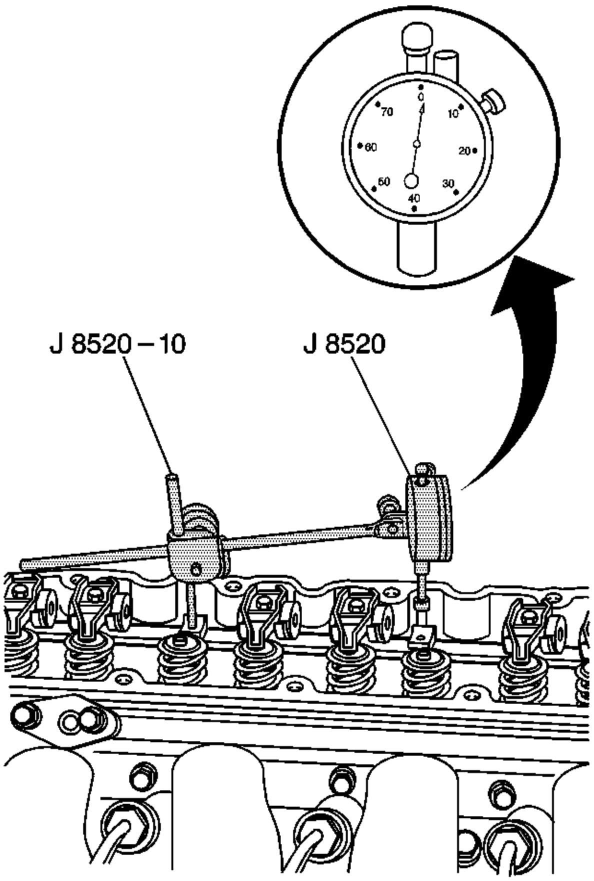


64297

11. Measure the camshaft runout.

- **11.1.** Mount the camshaft in wooden V-blocks or between centers on a fixture.
- **11.2.** Using the J 7872 set , measure the runout of the intermediate camshaft bearing journals.
- **11.3.** If camshaft runout is not within specification, the camshaft is bent and should be replaced. Refer to *Engine Mechanical Specifications* .

Measuring Camshaft Lobe Lift



64967

Note 1. Measuring camshaft lobe lift is a procedure used to determine if the camshaft lobes have worn. This test is to be performed p
Using the J 8520 indicator , measure camshaft lobe lift.

2. Remove the valve rocker arms and bolts.
3. Install the dial indicator mounting stud into the valve rocker arm bolt hole.
4. Assemble the components of the J 8520 indicator and position onto the stud.
5. Position the shaft of the dial indicator onto the end of the pushrod.
6. Rotate the face of the dial indicator to zero.
7. Slowly rotate the crankshaft clockwise, until the dial indicator obtains its highest and lowest readings.
8. Compare the total to specifications. Refer to *Engine Mechanical Specifications* . The total lobe lift is the difference between the highest and lowest reading.

Repair Instructions

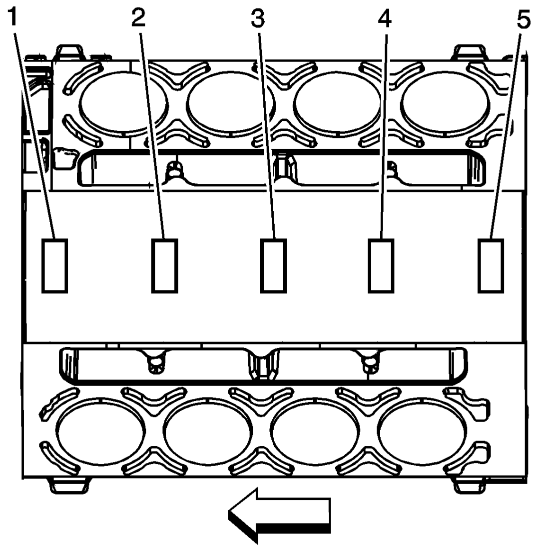
1877764

Camshaft Bearing Installation

Special Tools

J 33049 Camshaft Bearing Service Set

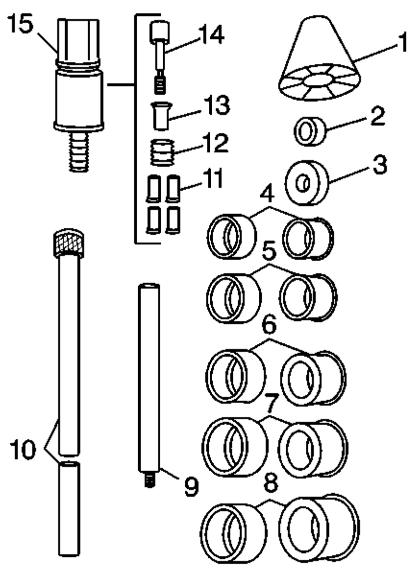
For equivalent regional tools, refer to *Special Tools* .



1332955

Important: The engine block camshaft bearing bores are machined for 3 different outside diameter (OD) size bearings. Position 1 and 5 are the largest diameter bores. Position 3 is the smallest diameter bore. Position 2 and 4 are the intermediate size bores. The inside diameter (ID) for all camshaft bearings is the same size.

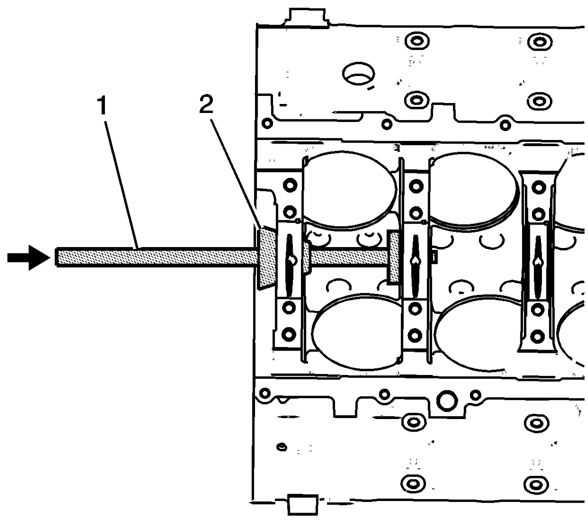
1. Measure the engine block camshaft bearing bores (1–5) in order to identify the correct OD size bearing for each position. Refer to *Engine Mechanical Specifications* .



66100

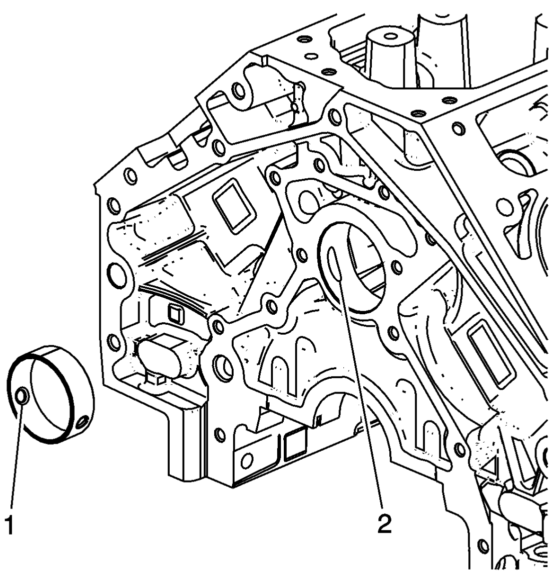
2. Select the expanding driver (4–8) and washer (2 or 3) from the J 33049 service set . Refer to tool usage information in *Camshaft Bearing Removal* .

3. Assemble the tool.



1552557

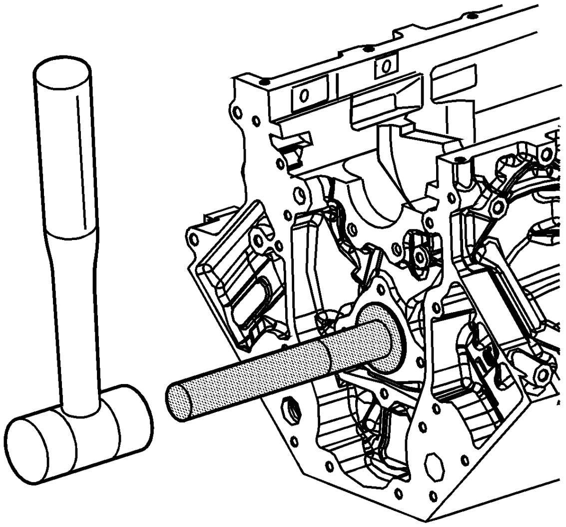
4. Insert the tool (1) through the front or rear of the engine block and into the bearing. For installation of inner bearings, it may be necessary to install the driver bar extension.
5. Tighten the expander assembly nut until snug.
6. Push the guide cone (2) into the front camshaft bearing in order to align the tool.



2275784

Caution: Camshaft bearings must be installed with bearing oil feed hole in alignment with the drilled oil passage in the block bore to ensure proper oil flow to the camshaft. The split seam in the bearing must be installed in the 12 o'clock position towards the top of the block. Improperly installed bearings may restrict oil flow causing engine damage.

7. Position the camshaft bearing with oil feed hole (1) in alignment with drilled oil passage in block bore (2).



1552556

8. Drive the bearing into the block bore. During installation, ensure the bearing is installed straight.

9. Remove J 33049 service set , inspect bearing to confirm the oil hole in the bearing is in alignment with the drilled oil passage in the block bore.

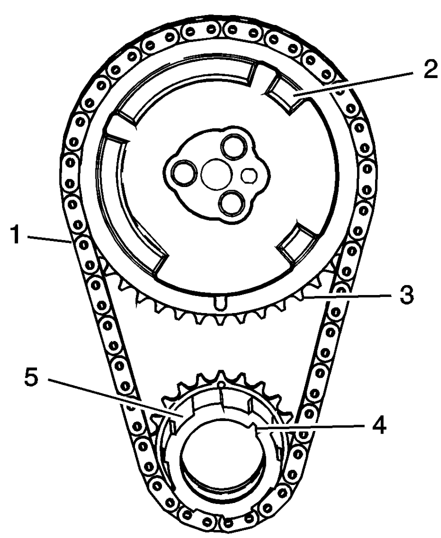
10. Repeat procedure to install the remaining bearings into the block.

Repair Instructions

2177628

Camshaft Timing Chain and Sprocket Cleaning and Inspection

Timing Chain and Sprockets:Cleaning and Inspection



1552452

1. Clean the components with cleaning solvent.

Warning **2.** Refer to *Safety Glasses Warning* . **2.** Dry the components with compressed air.

3. Inspect the timing chain (1) for binding or wear.

4. Inspect the camshaft position (CMP) sensor raised areas (2) for nicks or damage.

5. Inspect for worn, damaged, or chipped teeth (3).

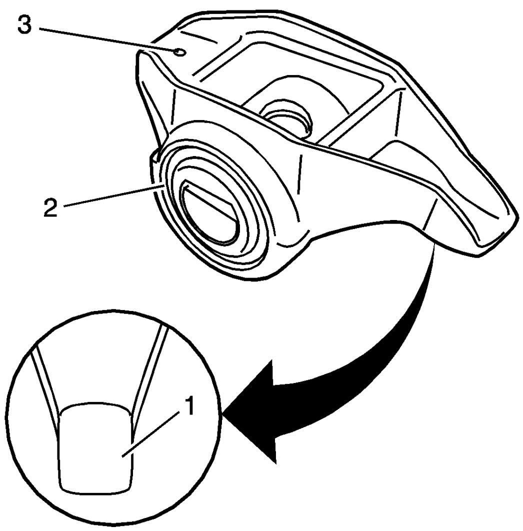
6. Inspect for a damaged keyway (4).

7. Inspect for worn oil pump drive splines (5).

Repair Instructions

2150185

Valve Rocker Arm and Push Rod Cleaning and Inspection



490772

Note 1. Parts that are to be used again must be marked, sorted or organized for assembly. **1.** Mark, sort, or organize the components for assembly. Refer to *Separating Parts* .

2. Clean the components with cleaning solvent.

Warning 3. Refer to *Safety Glasses Warning* . **3.** Dry the components with compressed air.

4. Inspect the valve rocker arms bearings (2) for binding or roughness.
5. Inspect the valve rocker arm pushrod sockets (3) and valve stem mating surfaces (1). These surfaces should be smooth with no scoring or exceptional wear.
6. Inspect the pushrods for worn or scored ends. These surfaces should be smooth with no scoring or exceptional wear.
7. Inspect the pushrods for bends. Roll the pushrod on a flat surface to determine if the pushrod is bent.
8. Inspect the pushrod oil passages for restrictions.
9. Inspect the rocker arm pivot supports for cracks, wear, or other damage.

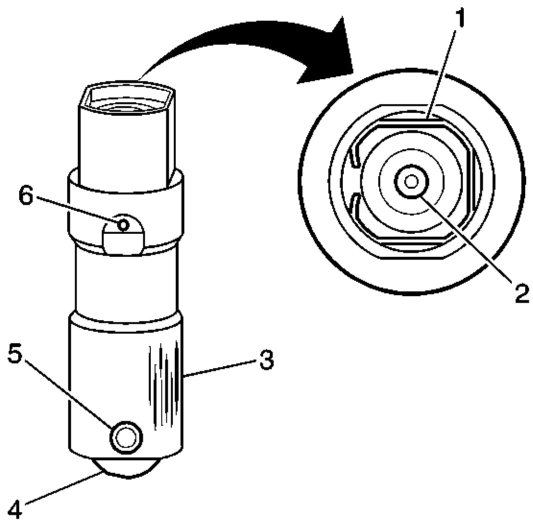
Repair Instructions

2155738

Valve Lifter and Guide Cleaning and Inspection

Valve Lifters and Guides Cleaning and Inspection

Valve Lifters



178485

Note 1. Components that are to be used again must be marked, sorted or organized for assembly. **1.** Clean the components in cleaning solvent.

Warning 2. Refer to *Safety Glasses Warning* . **2.** Dry the components with compressed air.

3. Inspect the valve lifters for the following conditions:

- Bent or broken clip (1)
- Worn pushrod socket (2)
- Scuffed or worn sides (3)

  If the valve lifter shows wear, inspect the engine block lifter bores for wear or damage.
- Flat spots on the roller (4)
- Loose or damaged pin (5)
- Plugged oil hole (6)
- Worn or damaged roller bearing

  The roller should rotate freely with no binding or roughness.

Valve Guides

Inspect the valve lifter guides for the following conditions:

- Cracks or damage
- Excessive wear in the lifter mounting bores

Repair Instructions

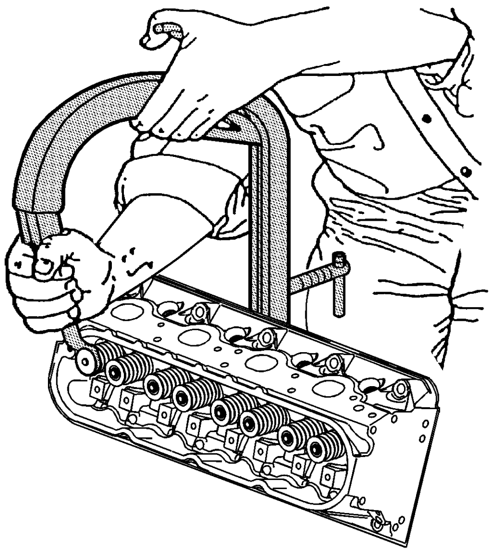
2046645

Cylinder Head Disassemble

Special Tools

J 8062 Valve Spring Compressor – Head Off

For equivalent regional tools, refer to *Special Tools* .

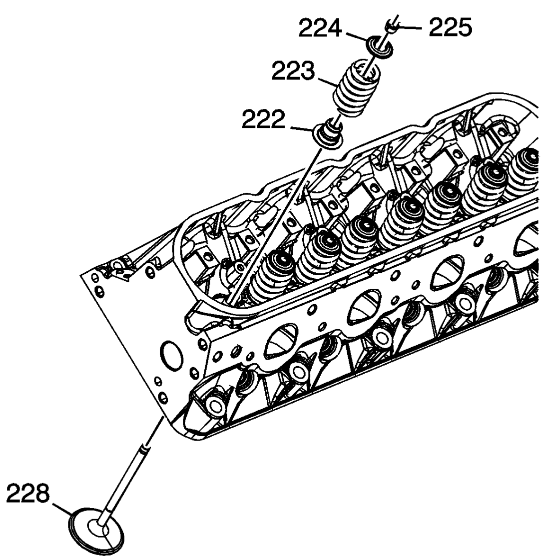


260151

Note

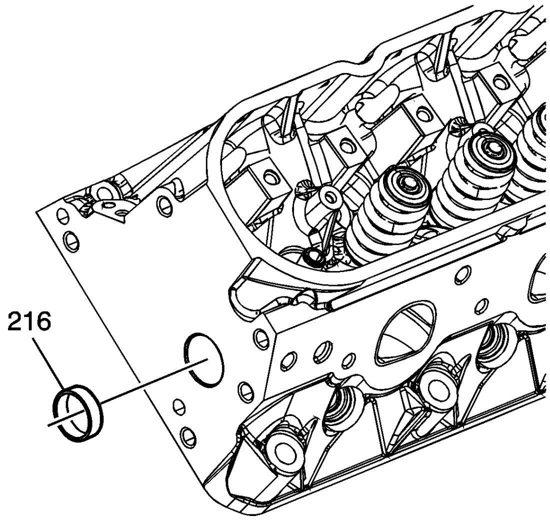
- With the components at room temperature, remove the spark plugs from the cylinder head.
- Mark, organize, or sort the cylinder head components for assembly. Return the components to their original location during assembly.

1. Remove the spark plugs from the cylinder heads.
2. Use the J 8062 valve spring compressor in order to compress the valve spring.



1559870

3. Remove the valve stem keys (225).
4. Remove the valve spring cap (224).
5. Remove the valve spring (223).
6. Remove the valves (228).
7. Remove the valve stem oil seal (222). Refer to *Separating Parts* .



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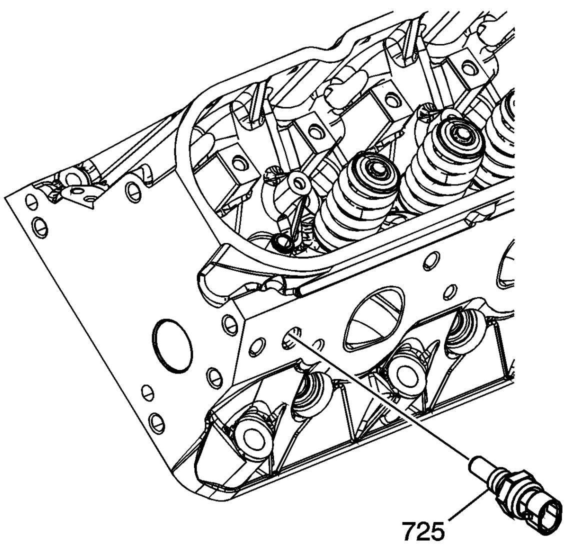
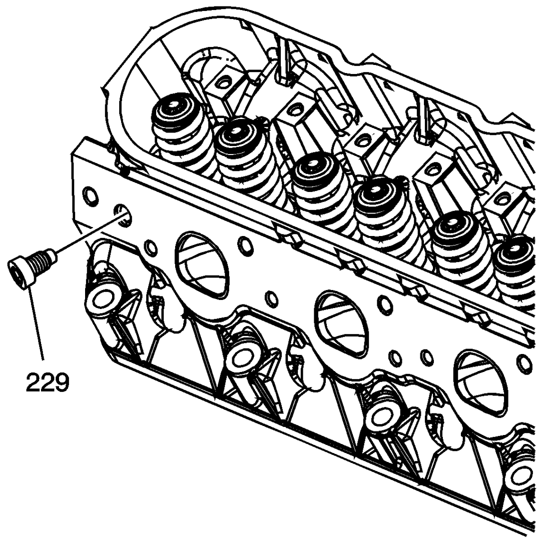
8. Remove the cylinder head core hole plugs (216), as required.



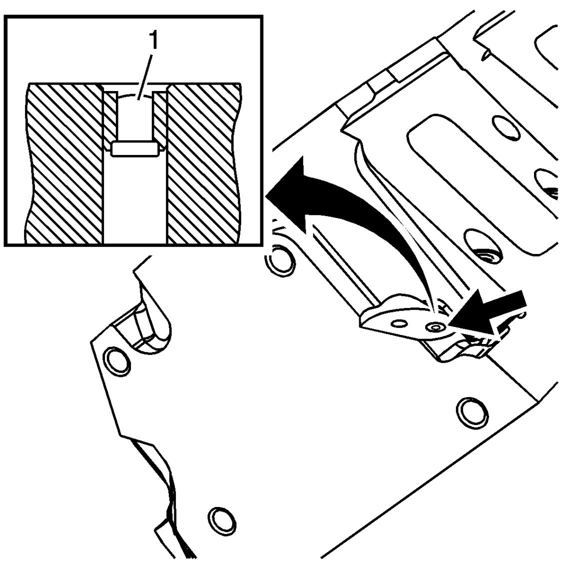
1559875

9. Remove the coolant temperature sensor (725) from the left cylinder head.



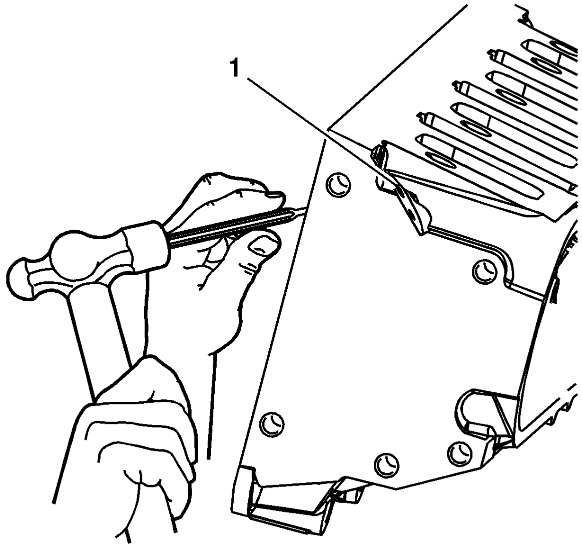
1559878

10. Remove the cylinder head plug (229) from the right cylinder head.

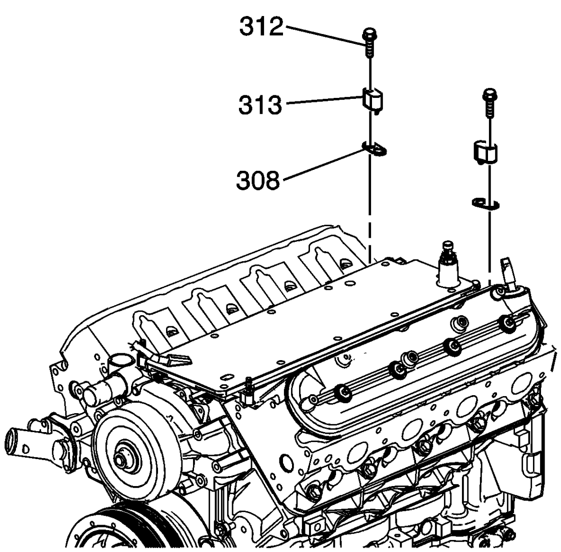


2046466

11. Inspect for a leaking plug (1) at the top rear coolant passage of each cylinder head. If service of a leaking plug is required, it is necessary to remove the cylinder head from the engine to properly remove the plug.



2060115
12. Using a 6.43 mm (0.25 in) or smaller punch, remove the plug assembly (1) from the cylinder head.



1408862
13. If plug removal is required, install either a new plug or a first design coolant air bleed cover (313), seal (308), and bolt (312) to complete the repair. Refer to *Cylinder Head Assemble*

Repair Instructions

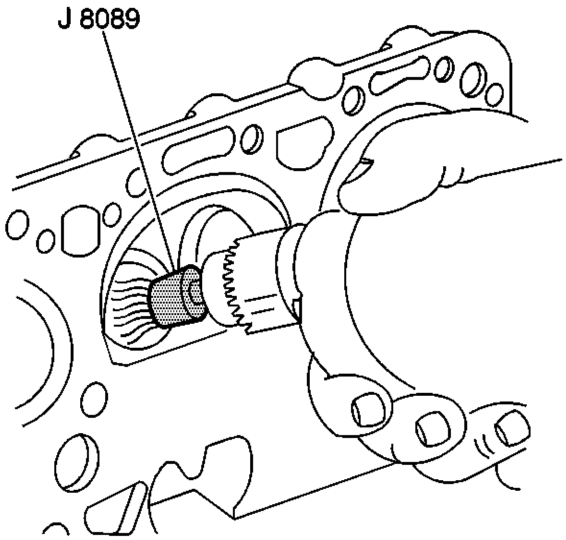
2159109

Cylinder Head Cleaning and Inspection

Special Tools

- J 8089 Carbon Removal Brush
- J 9666 Valve Spring Tester

For equivalent regional tools, refer to *Special Tools*



4957

Warning **1.** Refer to *Safety Glasses Warning* . **Note**

- When cleaning a cylinder head in a thermal type oven, do not exceed 204°C (400°F).
- Be careful not to scuff the chamber.

1. Clean the following components:

- Use the J 8089 Brush in order to remove the carbon from the combustion chambers.
- Gasket surfaces

  Refer to *Replacing Engine Gaskets* .
- Valve stems and heads on a buffing wheel
- Bolt hole threads

  Remove all dirt, debris, or threadlocking material from the bolt holes.

2. Inspect the cylinder head for the following conditions:

2.1. Cracks in the exhaust ports and combustion chambers

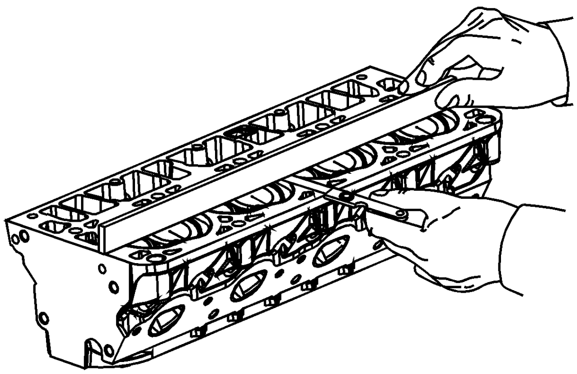
2.2. External cracks in the water chambers

2.3. Gasket surfaces for excessive scratches or gouging

Refer to *Replacing Engine Gaskets* .

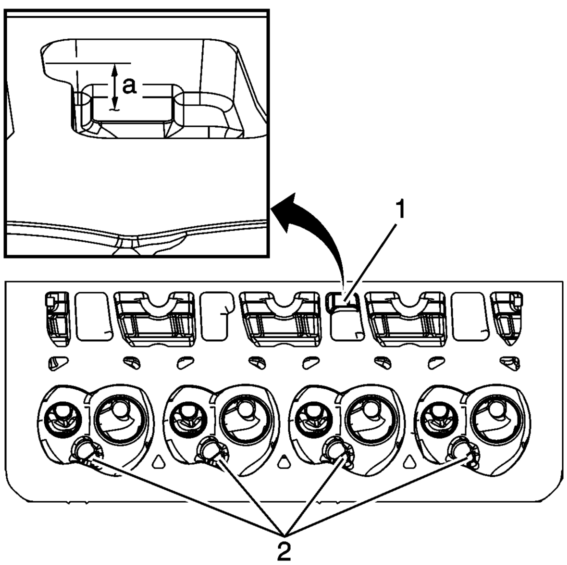
2.4. Bolt hole threads for debris or damaged threads

Refer to *Thread Repair* or *Thread Repair Specifications* .



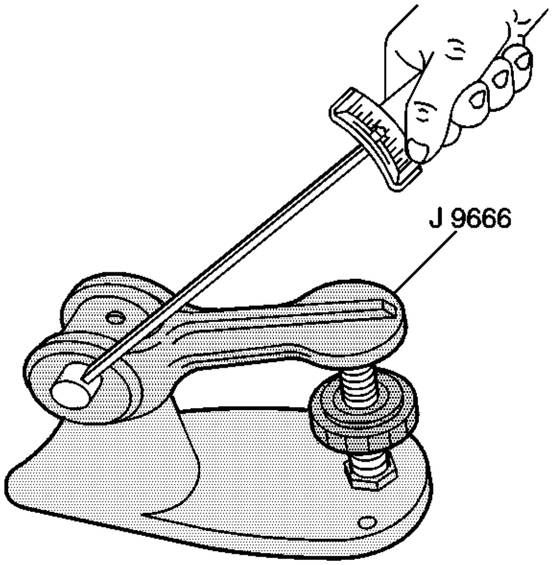
1552456

3. Inspect the cylinder head for warpage. Refer to *Engine Mechanical Specifications* .



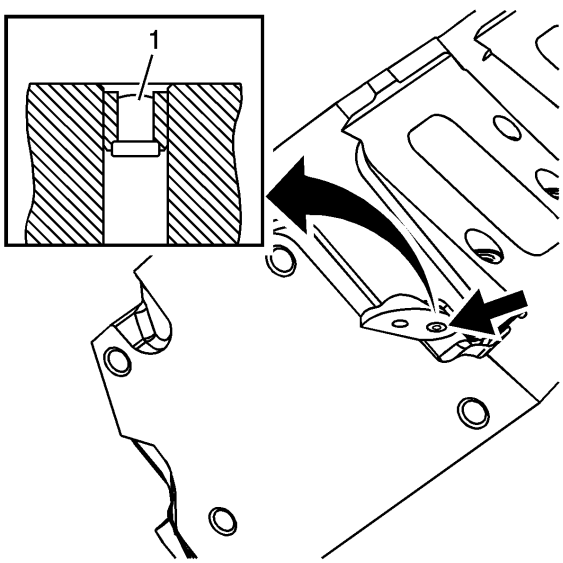
2085664

4. Cylinder heads that have excessive warpage or a damaged sealing surface can be machined as required. Determine the cylinder head thickness as measured from the cast in place machining pads (1 and 2) to the head deck sealing surface. A cylinder head that measures less than 6.88–7.12 mm (0.271–0.283 in) (a) cannot be machined and must be replaced.



4960

5. Use the J 9666 Tester in order to measure the valve spring tension. Refer to *Engine Mechanical Specifications* .



2046466

6. Inspect for a leaking plug. Production applications use a rivet-type plug (1) at the top rear coolant passage of each cylinder head. If service of a leaking plug is required, it is necessary to remove the cylinder head from the engine to properly remove the plug. Refer to *Cylinder Head Disassemble*

Repair Instructions

2143327

Valve Guide Reaming, and Valve and Seat Grinding (6.2L)

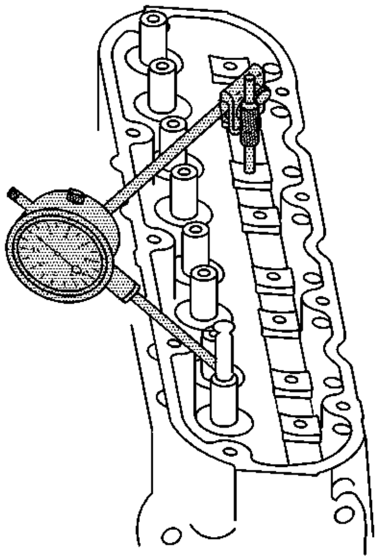
Valve Guide:Reaming/Valve and Seat Grinding

Special Tools

J 8001 Dial Indicator Set

For equivalent regional tools, refer to *Special Tools* .

Valve Guide Reaming



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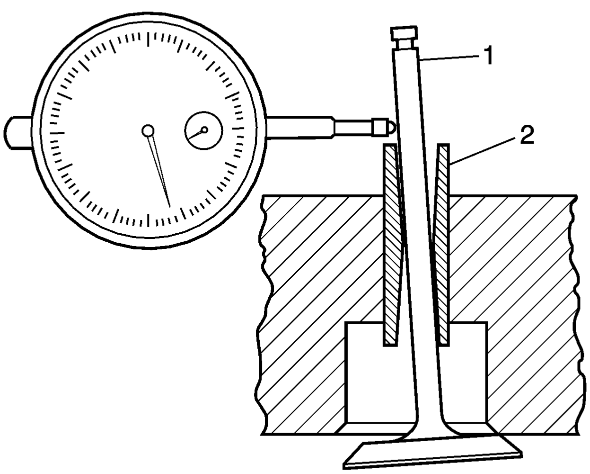
Caution: Excessive valve stem-to-guide clearance may cause a noisy valve train, premature valve stem oil seal wear, component damage, and/or excessive engine oil consumption.

Caution: Insufficient valve stem-to-guide clearance will result in noisy or sticking valves. Valves that are too tight may disturb engine smoothness or lead to component damage.

1. Using the J 8001 dial indicator , measure the valve stem-to-guide clearance. Position the tip of the dial indicator at the top of the valve guide.

Valve stem-to-guide clearance may also be obtained by using a micrometer to measure the valve stem diameter and a ball type measuring gauge to measure the guide bore.



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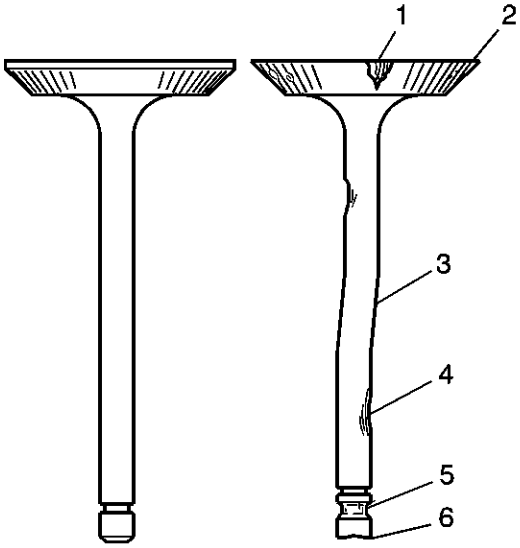
2. If the clearance measurement between the valve stem (1) and guide (2) is not within specification, the valve and/or the cylinder head must be replaced. Refer to *Engine Mechanical Specifications* .



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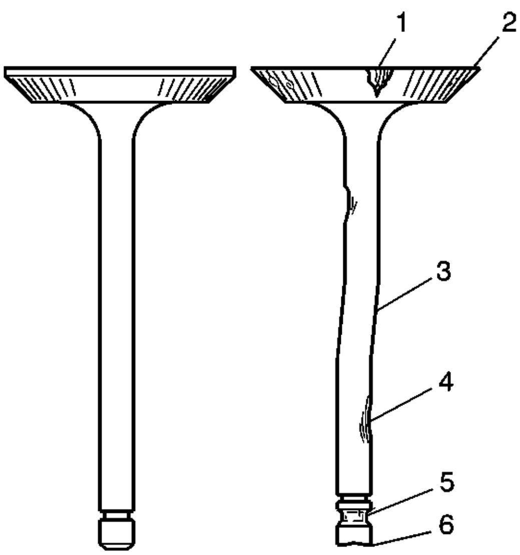
3. Inspect the valve stems for excessive scoring, wear, or warpage.

- A valve stem that has excessive scoring (3 or 4) or wear (4 or 6) must be replaced.
- If a valve guide is worn or has excessive stem-to-guide clearance, the cylinder head should be replaced.

4. Measure the valve stem diameter. If the valve stem diameter is not within specification, the valve must be replaced. Refer to *Engine Mechanical Specifications* .

If the valve stem diameter is within specifications, and the stem-to-guide clearance is excessive, the cylinder head must be replaced.

Valve and Seat Grinding



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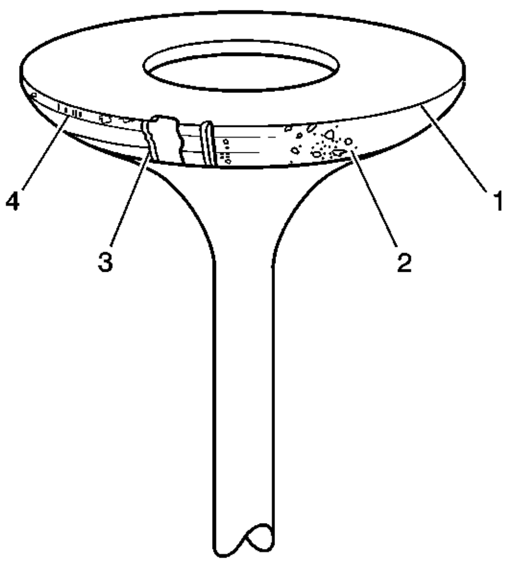
Note

- Reconditioning the valve seats is very important. The seating of the valves must be perfect for the engine to deliver optimum power and performance. Several different types of equipment are available for grinding valve seats.
- Another important factor is the cooling of the valve head. Good contact between the valve and the seat will ensure that heat will be properly dissipated.

- The recommendations of the equipment manufacturer should be followed carefully to obtain the proper results. Regardless of the type of equipment used, it is essential that valve guide bores be free of carbon or dirt to ensure proper centering of the tool pilot in the guide.
- Valves that are pitted must be refaced to the proper angle. Valve stems that show excessive wear, or valves that are warped excessively must be replaced. When a valve head that is warped excessively is refaced, a knife edge may be ground on part or all of the valve head due to the amount of metal that must be removed. Knife edges lead to breakage, burning or pre-ignition due to heat localizing on this knife edge. If the edge of the valve head, margin, is not within specification after grinding, replace the valve.
- Several different types of equipment are available for refacing valves. The recommendation of the equipment manufacturer should be carefully followed to obtain the proper results.
- DO NOT reface intake valves. Intake valves with excessive wear or damage MUST be replaced.

1. Inspect the valve for the following conditions:

- Burnt or eroded areas (1)
- A worn margin (2)
- A bent stem (3)
- A worn or scored stem (4)
- A worn key groove (5)
- A worn stem tip (6)



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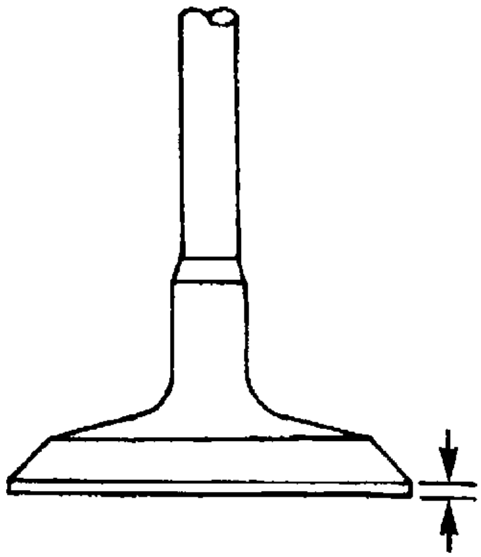
2. Inspect the valve face for the following conditions:

- Worn or no margin (1 or 4)
- Pitted surfaces (2)
- Burnt or eroded areas (3)



4955

3. Inspect the valve margin.

   The exhaust valve may be refaced if the margin is within specification before grinding. Refer to *Engine Mechanical Specifications* .

4. Reface pitted exhaust valves on a suitable valve refacing machine.
5. Replace the valve if the margin is not within specification after grinding. Refer to *Engine Mechanical Specifications* .
6. If the valve face has been ground, measure the valve spring installed height after reassembly of the cylinder head. The valve, and/or cylinder head must be replaced if the valve spring installed height is not within specification. Refer to *Cylinder Head Assemble* .
7. Inspect for a loose valve seat in the cylinder head. The valve seat has an interference fit to the cylinder head.
8. Clean the valve guide bores with a suitable tool. Remove all carbon or dirt from the bores.

   The valve guide must be clean for the seat grinding tool to obtain proper results.

9. Grind the valve seat.

   The recommendations of the equipment manufacturer should be followed carefully to obtain the proper results. Regardless of the type of equipment used, it is essential that valve guide bores be free from carbon or dirt to ensure proper centering of the tool pilot in the guide.

10. Inspect the valve seats.
    - The valve seats should be concentric to the centerline of the guide, measure valve seat runout. The total indicator runout reading must be within specification. Refer to *Engine Mechanical Specifications* .
    - If the valve seat has been ground, measure the valve spring installed height after reassembly of the cylinder head. The cylinder head, and/or valve must be replaced if the valve spring installed height is not within specification after seat grinding. Refer to *Cylinder Head Assemble* .

Repair Instructions

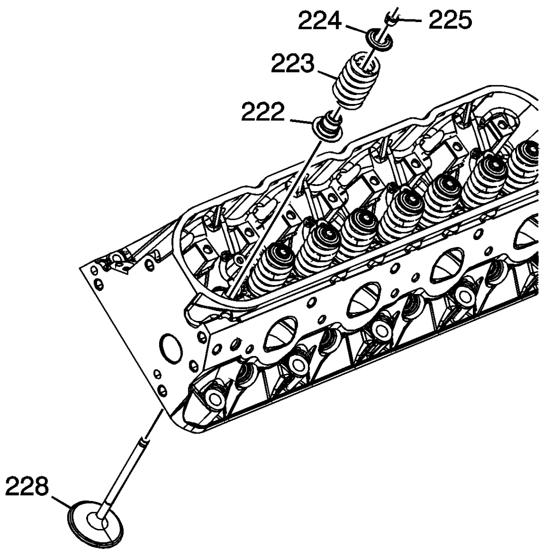
2218224

Cylinder Head Assemble

Special Tools

J 8062 Valve Spring Compressor – Head Off

For equivalent regional tools, refer to *Special Tools*

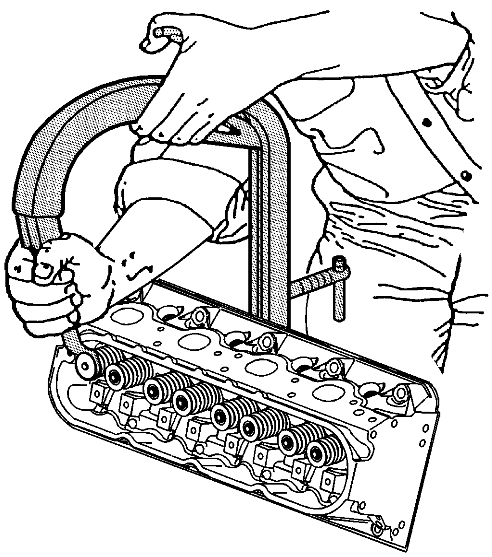


1559870

1. Clean the cylinder head valve spring shim area.

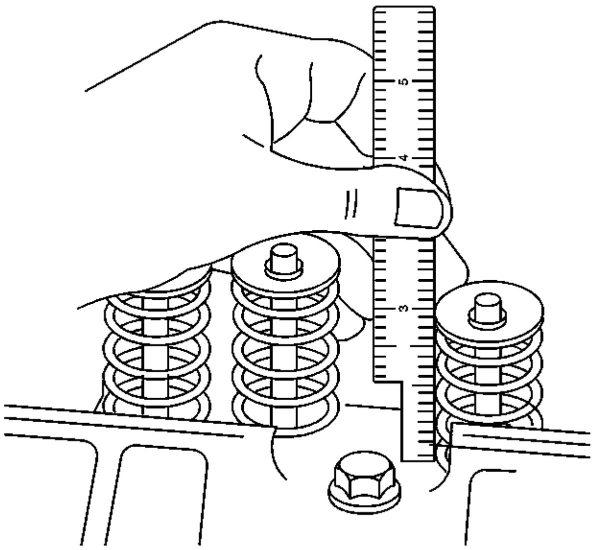
Note 2. When using the valves and related components again, install the parts to their original location. **2.** Install the valves (228) into the proper port. Refer to *Separating Parts*

3. Install a NEW valve stem oil seal (222).
4. Install the valve spring (223).
5. Install the valve spring cap (224).



260151

6. Using the J 8062 spring compressor , compress the valve spring.
7. Install the valve stem keys.
   - **7.1.** Use grease in order to hold the keys in place and remove the J 8062 spring compressor .
   - **7.2.** Ensure the keys seat properly in the groove of the valve stem.
   - **7.3.** Tap the end of the valve stem with a plastic face hammer to seat the keys, if necessary.



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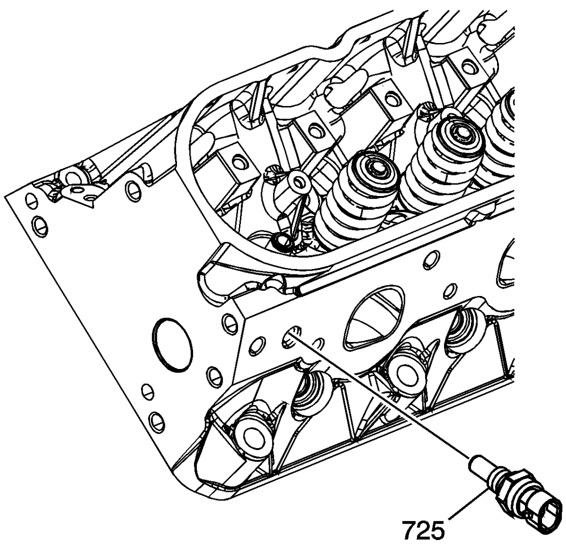
8. After installation, measure the valve spring installed height.

Measure from the base of the valve spring to the top of the valve spring. If the spring installed height is not within specification, the valve and/or cylinder head must be replaced. Refer to *Engine Mechanical Specifications*

9. Install the remaining valves, springs, and other components.



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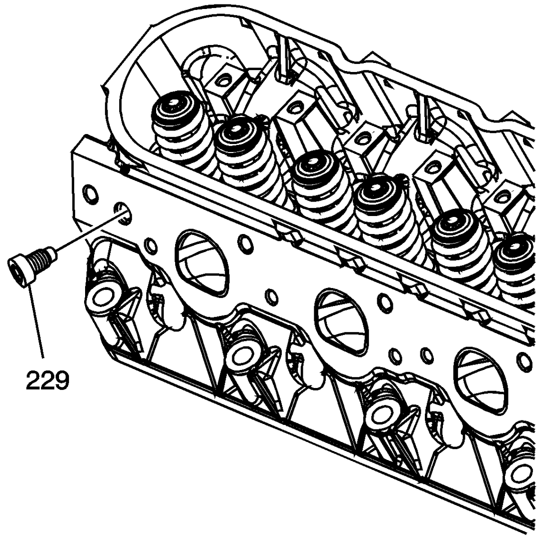
10. Install sealant GM P/N 12346004 (Canadian P/N 10953480), or equivalent, to the threads of the coolant temperature sensor (725).

Caution: Refer to *Fastener Caution*

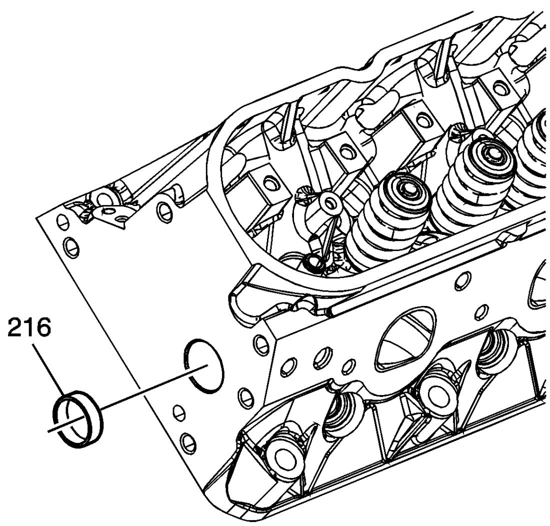
11. Install the coolant temperature sensor into the left cylinder head and tighten to 20 N·m (15 lb ft) .



1559878

12. Install sealant GM P/N 12346004 (Canadian P/N 10953480), or equivalent, to the threads of the cylinder head plug (229).

13. Install the cylinder head plug to the right cylinder head and tighten to 20 N·m (15 lb ft) .

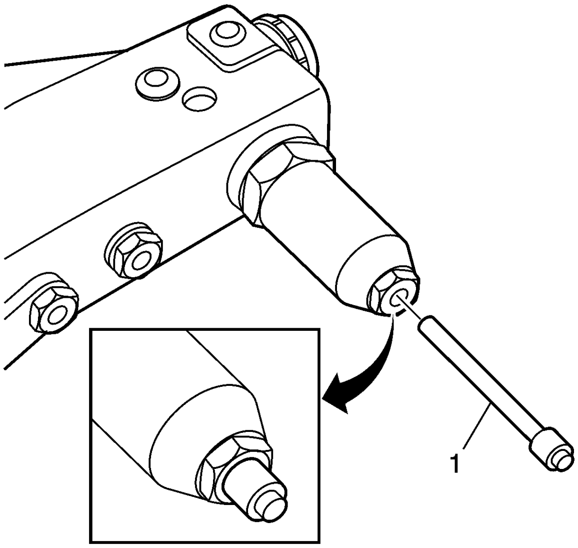


1559873

14. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the sides of the cylinder head plugs (216).

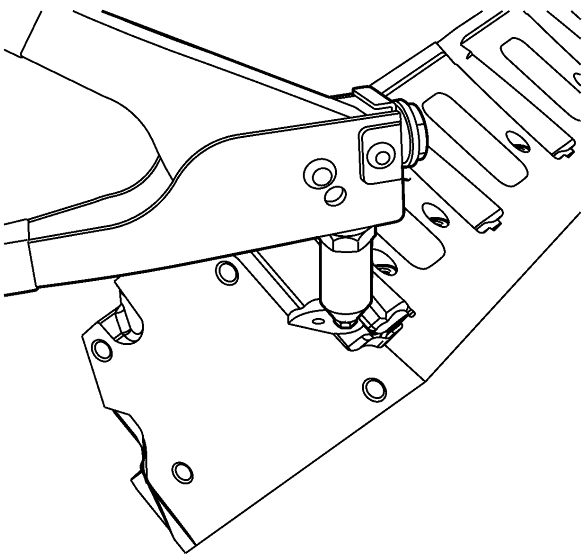
15. Install the cylinder head plugs into the cylinder head.

A properly installed plug should be installed 2.5 mm (0.1 in) below the end face of the head.



2215304

16. Install the rivet plug (1) into a rivet gun.



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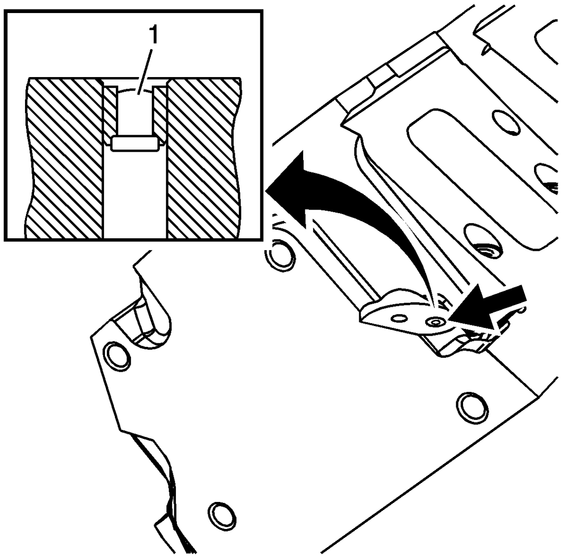
17. Insert the rivet into the coolant passage of the cylinder head.

18. Squeezing the handle of the tool, install the rivet.



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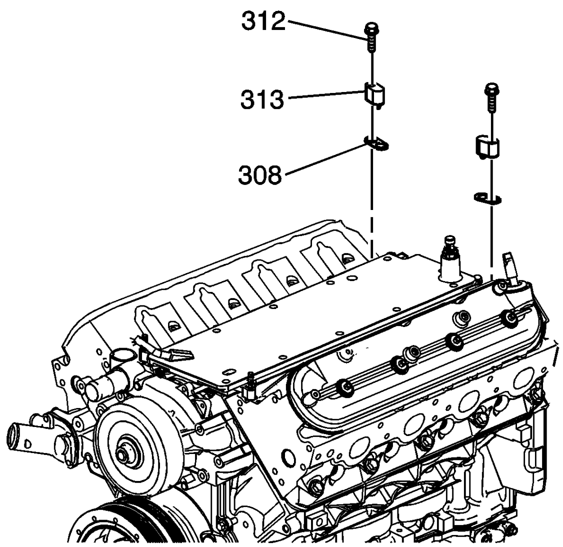
19. Inspect for proper installation of the rivet (1).

A properly installed plug should be installed flush with the surface of the head.



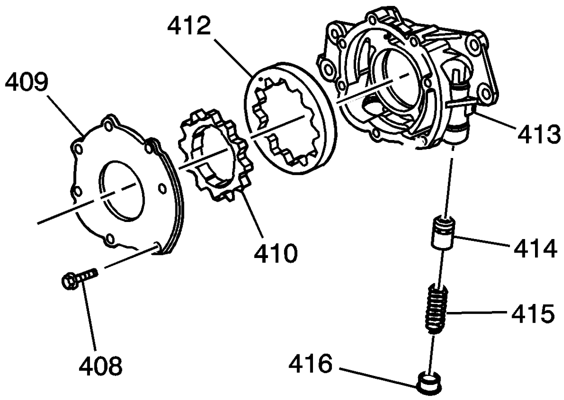
1408862

20. Installation of the first design coolant air bleed cover (313) and bolt (312) may be used instead of the rivet plug to complete the repair. Tighten the coolant air bleed bolts to 12 N·m (106 lb in) .

Repair Instructions

1877773

Oil Pump Disassemble (6.2L)



1402152

Important: The internal parts of the oil pump assembly are not serviced separately, excluding the spring. If the oil pump components are worn or damaged, replace the oil pump as an assembly.

1. Remove the oil pump cover bolts (408).
2. Remove the oil pump cover (409).

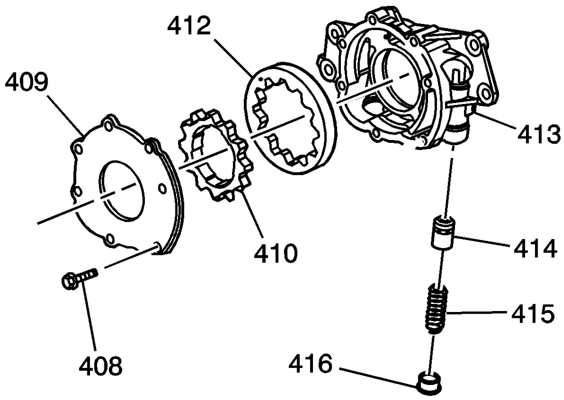
Important: Mark or identify the gears for assembly. Refer to *Separating Parts* .

3. Remove the drive gear (410).
4. Remove the driven gear (412).
5. Remove the pressure relief valve plug (416).
6. Remove the pressure relief valve spring (415).
7. Remove the pressure relief valve (414).
8. Inspect the oil pump components. Refer to *Oil Pump Cleaning and Inspection (6.2L)* .

Repair Instructions

2136204

Oil Pump Cleaning and Inspection (6.2L)



1402152

Note

- The internal parts of the oil pump assembly are not serviced separately, excluding the spring. If the oil pump components are worn or damaged, replace the oil pump as an assembly.
- The oil pump pipe and screen are to be serviced as an assembly. Do not attempt to repair the wire mesh portion of the pump and screen assembly.

1. Clean the parts in solvent.

Warning **2.** Refer to *Safety Glasses Warning* . **2.** Dry the parts with compressed air.

3. Inspect the oil pump housing (413) and the cover (409) for cracks, excessive wear, scoring, or casting imperfections.

4. Inspect the oil pump housing-to-engine block oil gallery surface for scratches or gouging.

5. Inspect the oil pump housing for damaged bolt hole threads.

6. Inspect the relief valve plug (416) and plug bore for damaged threads.

7. Inspect the oil pump internal oil passages for restrictions.

8. Inspect the drive gear (410) and driven gear (412) for chipping, galling, or wear.

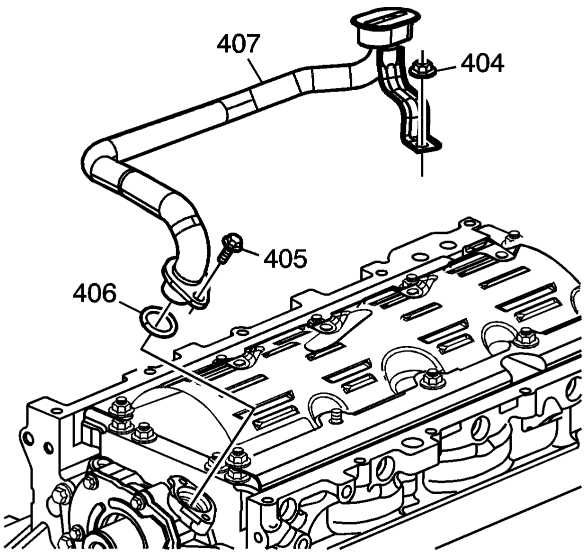
Minor burrs or imperfections on the gears may be removed with a fine oil stone.

9. Inspect the drive gear splines for excessive wear.

10. Inspect the relief valve spring (415) for cracks, scratches, and wear to coils in spring.

11. Inspect the pressure relief valve (414) and bore for scoring or wear.

The valve must move freely in the bore, with no restrictions.



1520947

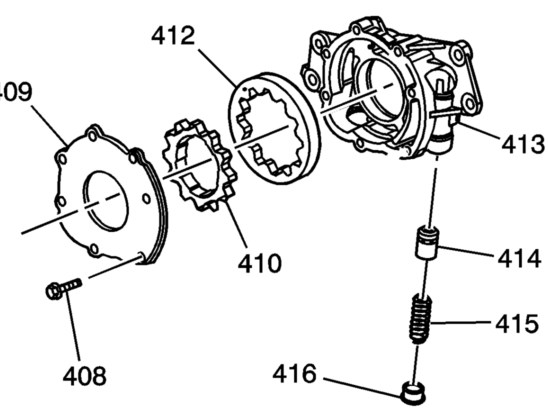
12. Inspect the oil pump screen (407) for debris or restrictions.

13. Inspect the oil pump screen for broken or loose wire mesh.

Repair Instructions

2136206

Oil Pump Assemble (6.2L)



1402152

Note 1. Prior to assembling the oil pump, coat all wear or internal surfaces with clean engine oil. **1.** Install the driven gear (412) into the pump housing (413).

Install the driven gear with the orientation mark facing the pump cover.

2. Install the drive gear (410) into the pump housing.

3. Install the oil pump cover (409).

Caution: Refer to *Fastener Caution* .

4. Install the oil pump cover bolts (408) and tighten to 12 N·m (106 lb in) .

5. Install the relief valve (414).

6. Install the relief valve spring (415).

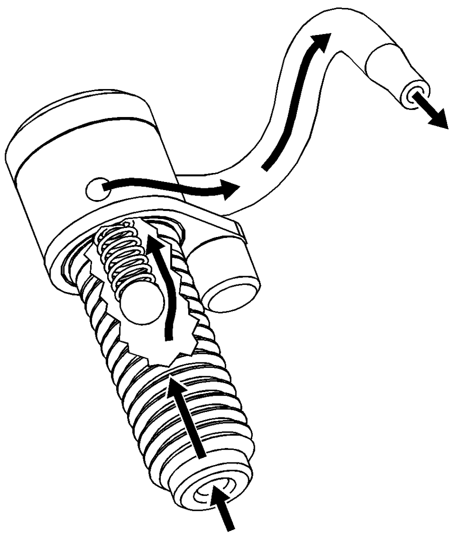
7. Install the relief valve plug (416) and tighten to 12 N·m (106 lb in) .
8. Inspect the oil pump for smooth operation by rotating the drive gear.

Repair Instructions

2093912

Piston Oil Nozzle Cleaning and Inspection

Note 1. The piston oil nozzle assembly is designed to provide oil to the bottom side of the piston for cooling purposes. The internal check ball is held in the normally closed position by the spring until system oil pressure exceeds 20.7 kPa (43.5 psi).



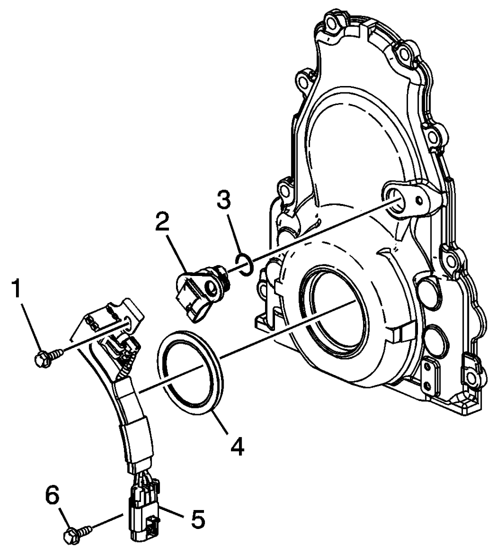
2093885

1. Clean the nozzle assembly in solution.
2. Inspect the nozzle assembly for the following:
   - damaged bolt threads
   - damaged or cut O-ring seal
   - bent nozzle
   - A restricted or stuck-open nozzle assembly
3. With no oil pressure, the check ball should be seated and not permit flow through the nozzle tube. Using a blow gun, apply air pressure to the inlet portion of the bolt. Air pressure should unseat the check ball and permit flow through and out of the nozzle tube.

Repair Instructions

2136209

Engine Front Cover Cleaning and Inspection (6.2L)



1704625

Note

- Do not use the crankshaft oil seal again. Install a NEW crankshaft oil seal during assembly.
- Do not use the front cover-to-engine block gasket again. Install a NEW gasket during assembly.

1. Remove the crankshaft oil seal (4) from the front cover.

2. Clean the cover in solvent. Remove the sealant from the cover oil pan surface. Refer to *Replacing Engine Gaskets* .

Warning **3.** Refer to *Safety Glasses Warning* . **3.** Dry the cover with compressed air.

4. Inspect the gasket sealing surfaces for excessive scratches or gouging.

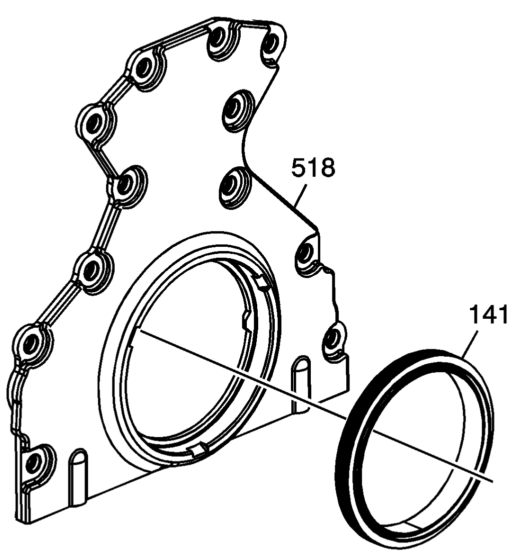
5. Inspect the threaded bolt holes for damaged threads or debris.

6. Inspect the crankshaft oil seal and camshaft position (CMP) sensor mounting bores for damage.

Repair Instructions

2155757

Crankshaft Rear Oil Seal Housing Cleaning and Inspection



1552461

Note

- Do not use the crankshaft rear oil seal again. Install a NEW crankshaft oil seal during assembly.
- Do not use the rear housing-to-engine block gasket again. Install a NEW gasket during assembly.

1. Remove the crankshaft oil seal (141) from the rear housing.

2. Clean the housing in solvent. Remove the sealant from the housing oil pan surface. Refer to *Replacing Engine Gaskets* .

Warning **3.** Refer to *Safety Glasses Warning* . **3.** Dry the housing with compressed air.

4. Inspect the gasket sealing surfaces for excessive scratches or gouging.

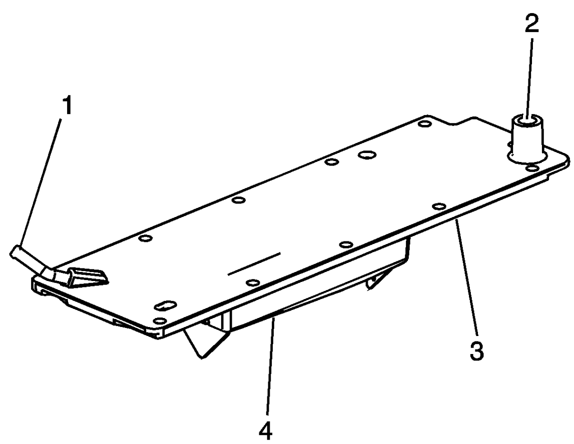
5. Inspect the housing-to-oil pan threaded bolt holes for damaged threads or debris.

6. Inspect the crankshaft oil seal mounting bore for damage.

Repair Instructions

2155758

Engine Block Valley Cover Cleaning and Inspection



1408874

1. Clean the valley cover in solvent.

Warning **2.** Refer to *Safety Glasses Warning* . **2.** Dry with compressed air.

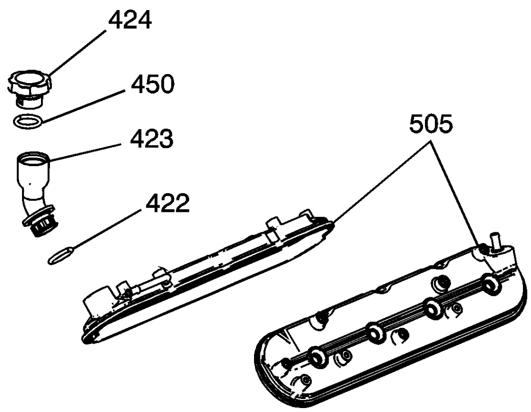
3. Inspect for restrictions within the positive crankcase ventilation (PCV) passages (1, 4).

4. Inspect for damaged threads (2) and damaged sealing surfaces (3).

Repair Instructions

1877780

Valve Rocker Arm Cover Cleaning and Inspection (6.2L)



1559813

Important:

- Do not use the valve rocker arm cover gasket again. Install a NEW gasket during assembly.
- Remove the ignition coils before cleaning the cover in solvent. Do not submerge the ignition coils in solvent.
- Do not remove the oil fill tube from the covers unless service is required. If the tube is removed from the cover, install a NEW tube (423) and seal (422) during assembly.

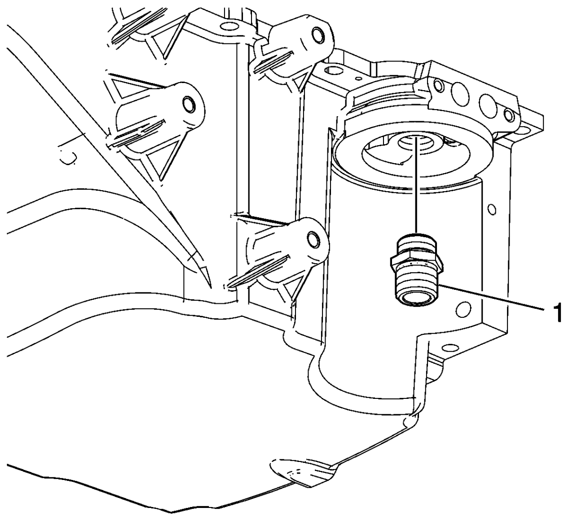
1. Inspect the oil fill tube (423) for a loose fit or damage.
2. Inspect the covers (505) for the following conditions:

- Scoring or damage to the gasket surfaces
- Ventilation system passages for restrictions
- Threaded bolt holes for damage or debris

Repair Instructions

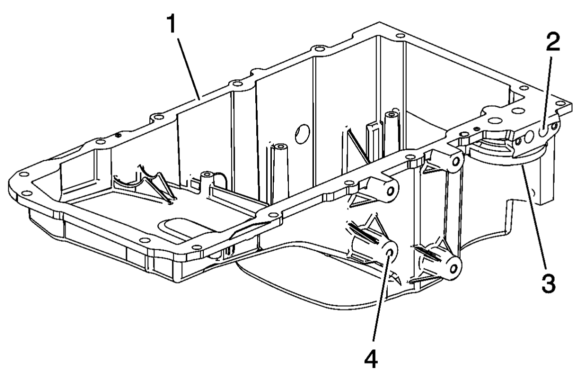
2159111

Oil Pan Cleaning and Inspection



2156810

1. Remove the oil filter fitting (1), as required.



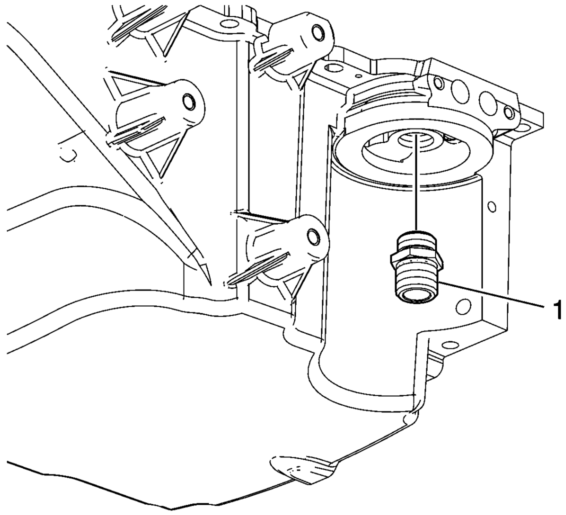
2156813

2. Clean the oil pan in solvent.

Warning **3.** Refer to *Safety Glasses Warning* . **3.** Dry the oil pan with compressed air.

4. Inspect the oil pan for the following conditions:

- Damaged gasket surfaces (1)
- Restrictions within the oil passages (2) of the pan
- Damaged oil filter seal surface (3)
- Threaded bolt holes (4) for damage



2156810

Caution: Refer to *Fastener Caution* .

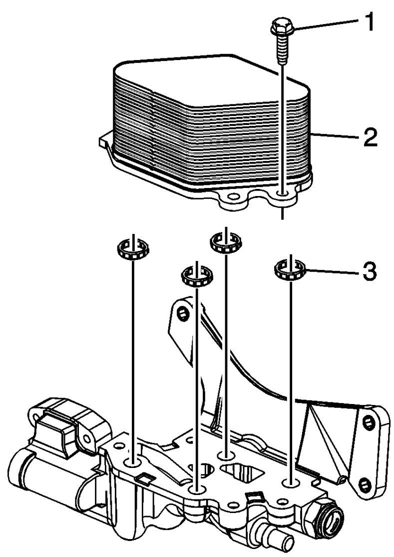
5. Install the oil filter fitting (1), as required, and tighten to 55 N·m (40 lb ft) .

Repair Instructions

2058829

Engine Oil Cooler Disassemble

Oil Cooler:Disassemble



2054197

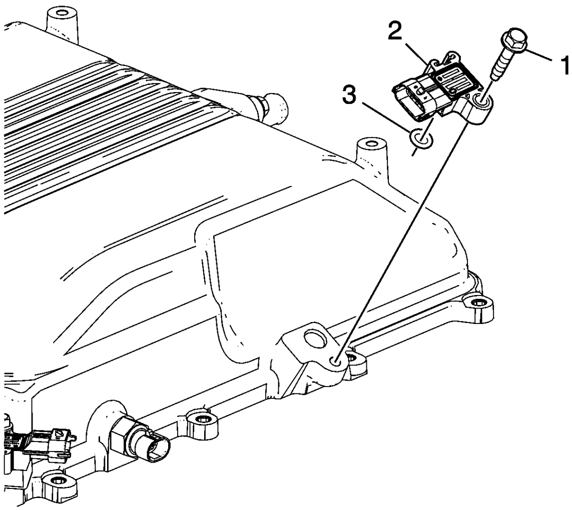
Caution: Refer to *Engine Oil Cooler Debris Caution* .

1. Remove the oil cooler core bolts (1).
2. Remove the oil cooler core (2).
3. Remove the oil cooler core seals (3).

2158626

Supercharger Disassemble

Supercharger:Disassemble

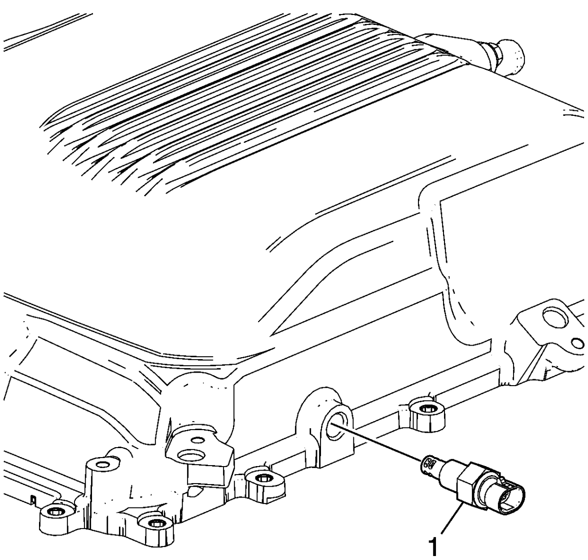


2156817

1. Remove the air outlet pressure sensor bolt (1).

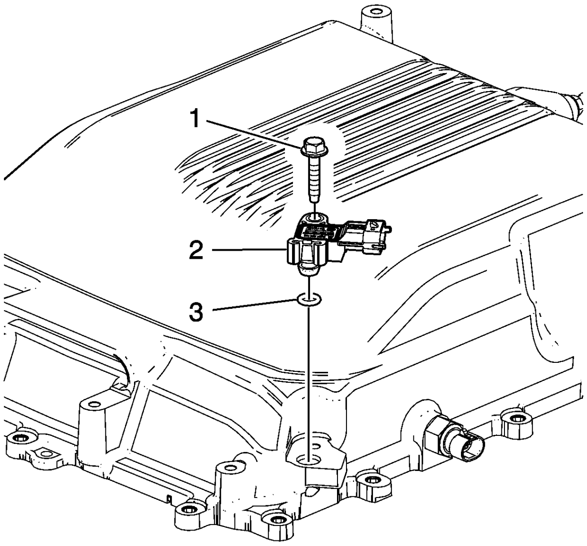
2. Remove the sensor (2).

3. Inspect the sensor seal (3) for damage, do not remove the seal from the sensor. If the seal is damaged, replace the sensor. The seal is serviced with the sensor.



2156820

4. Remove the inlet air temperature sensor (1).

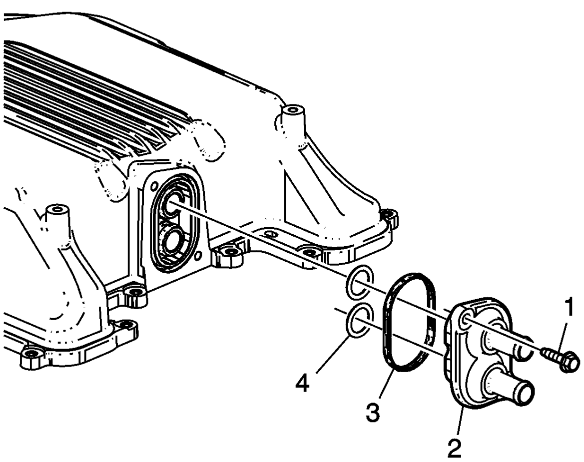


2156822

5. Remove the barometric pressure (BARO) sensor bolt (1).

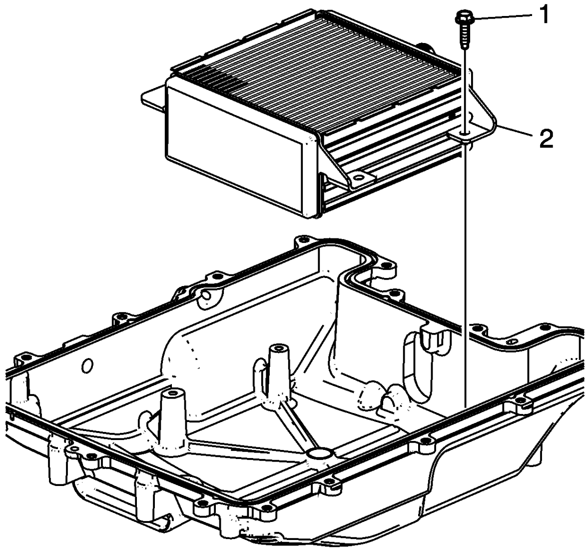
6. Remove the BARO sensor (2).

7. Inspect the BARO sensor seal (3) for damage, do not remove the seal from the sensor. If the seal is damaged, do not remove the seal from the sensor. If the seal is damaged replace the sensor. The seal is serviced with the sensor.



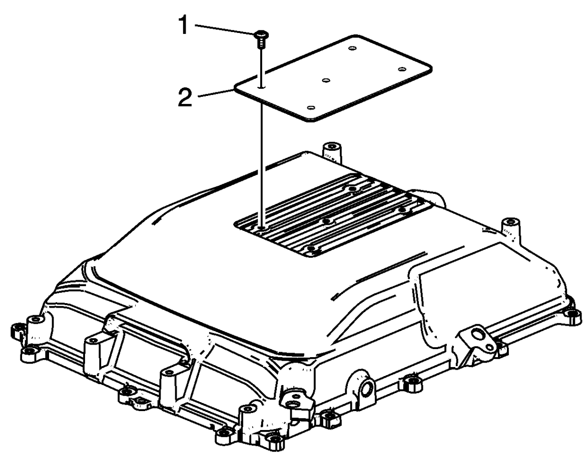
2173558

8. Remove the bolts (1), plate (2), seal (3), seals (4) from the cooler. Discard the seals.



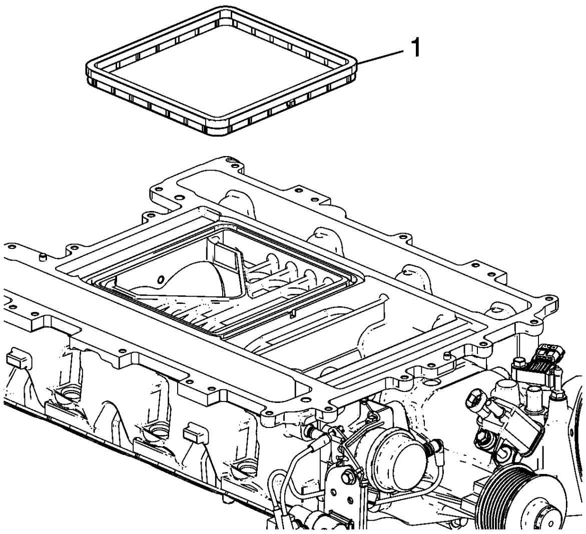
2173565

9. Remove the charge air cooler (2) and bolts (1).



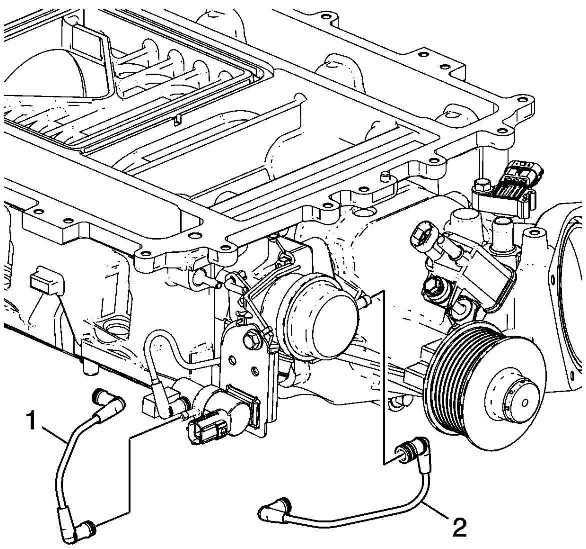
2173566

10. Remove the isolator pad (2) and bolts (1), as required.



2156823

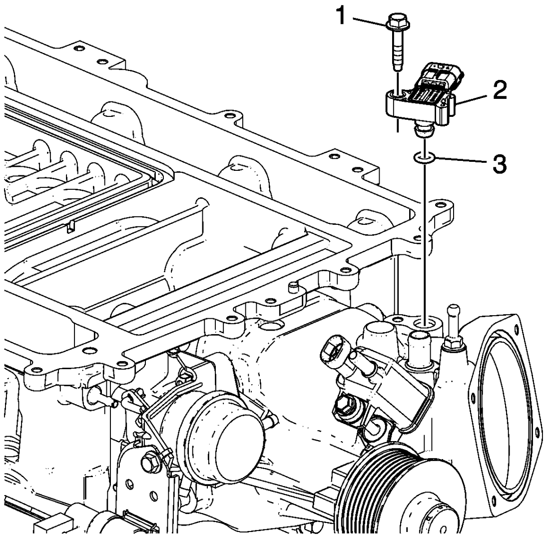
11. Remove and discard the insulator seal (1).



2156826

12. Remove the charge air bypass valve tube (1).

13. Remove the charge air bypass valve vacuum tube (2).

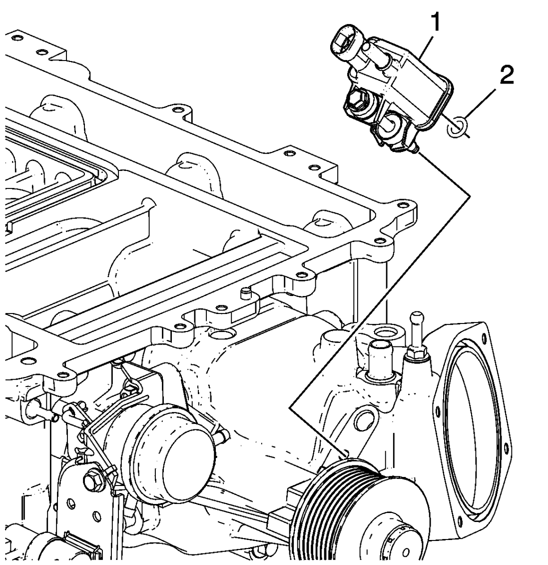


2156827

14. Remove the inlet air pressure sensor bolt (1).

15. Remove the inlet air pressure sensor (2).

16. Inspect the sensor seal (3) for damage, do not remove the seal from the sensor. If the seal is damaged, replace the sensor. The seal is serviced with the sensor.

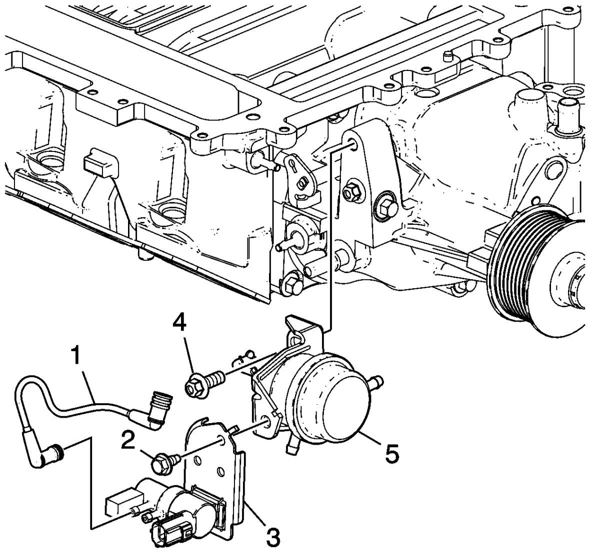


2156828

17. Loosen the evaporative emissions (EVAP) bolt.

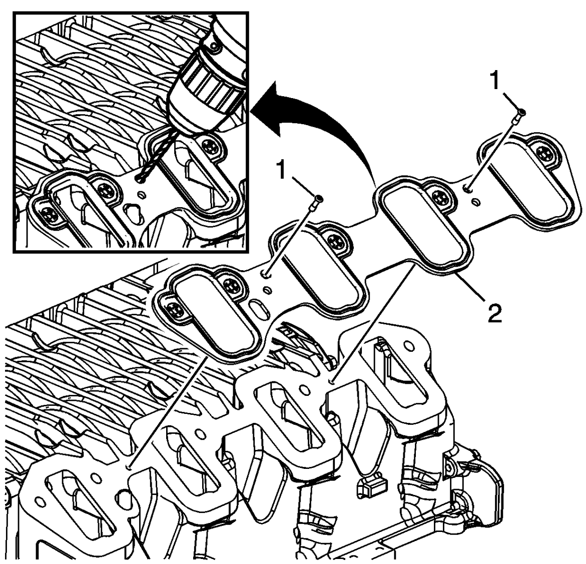
18. Remove the EVAP valve (1).

19. Inspect the sensor seal (2) for damage, do not remove the seal from the sensor. If the seal is damaged, replace the sensor. The seal is serviced with the sensor.



2156830

20. Remove the bypass actuator tube (1).
21. Remove the charge air bypass valve bolt (2).
22. Remove the charge air bypass valve (3).
23. Remove the bypass actuator bolts (4).
24. Rotate the actuator upward and remove the rod from the lever of the supercharger.
25. Remove the bypass actuator (5).



2054342

Note

- Do not allow dirt or debris to enter the passages of the supercharger. Cover the intake ports as required.
- With the manifold positioned upside down on a bench, the lower assembly may be positioned onto the intercooler cover dowel pins. Use care not to reposition or bend the dowel pins.

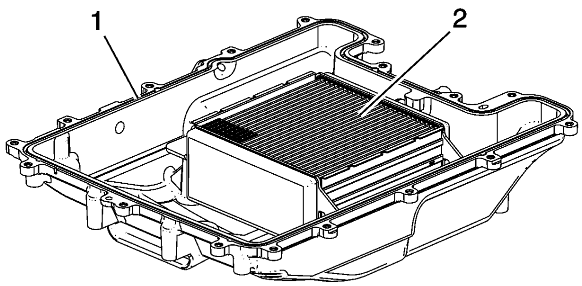
26. Drill out the gasket rivets (1) using a drill bit with an outside diameter (OD) no larger than 3.2 mm (0.125 in).
27. Remove the gaskets (2).

Repair Instructions

2158631

Supercharger Cleaning and Inspection

Charge Air Cooler Cover Cleaning and Inspection

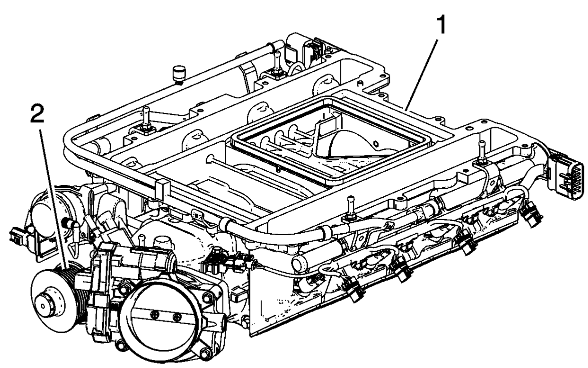


2156831

Inspect the cover for the following:

- Damaged seal surfaces (1)
- Leaking, restricted, or damaged charge air cooler (2). Refer to *Supercharger Assemble* .

Supercharger Cleaning and Inspection



2156832

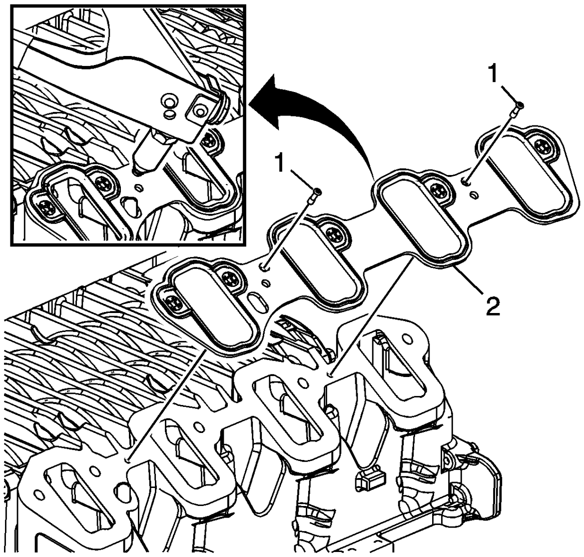
1. Inspect the supercharger for the following:
   - Damaged seal surfaces (1)
   - Worn or damaged belt pulley grooves (2)
2. Rotate the pulley of the supercharger by hand. The pulley and rotors should rotate freely with no binding.
3. Operate the boost bypass valve by hand. The bypass valve should operate within the full range of motion with no sticking or binding.

Repair Instructions

2158633

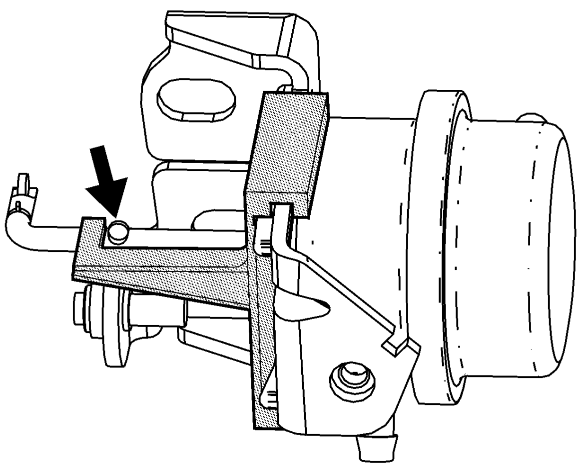
Supercharger Assemble

Supercharger:Assemble



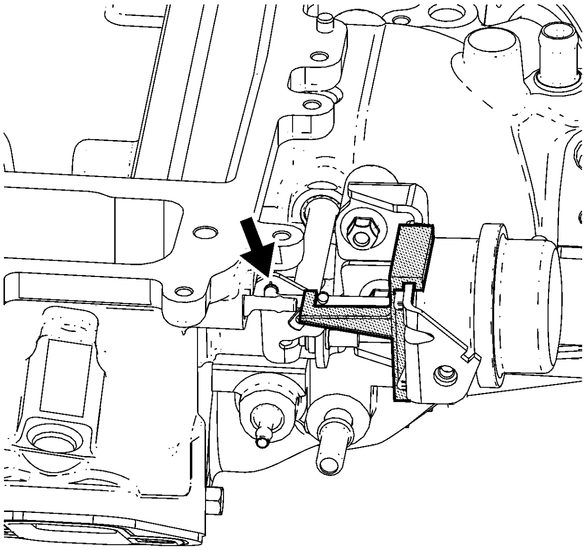
2054458

1. Install the NEW gaskets (2).
2. Install NEW gasket rivets (1).



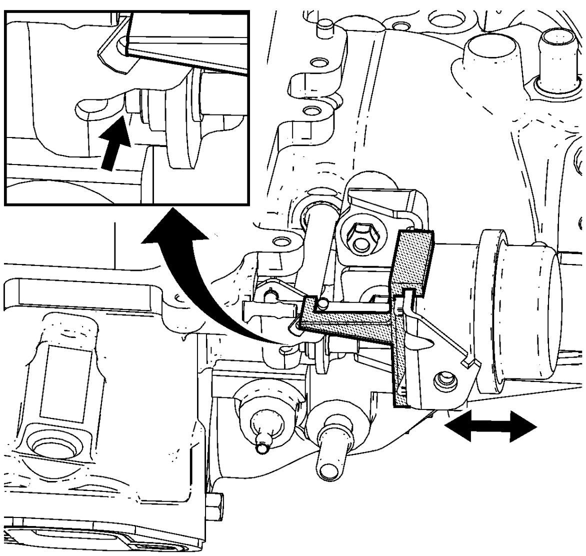
2156834

Note 3. The actuator adjustment tool is provided within the actuator parts kit. **3.** Install the actuator adjustment tool onto the actuator. Position the raised portion of the rod in the proper position.



2156835

4. Install the rod of the actuator into the lever of the supercharger.
5. Rotate the actuator and install the bolts. Do not tighten the bolts at this time.

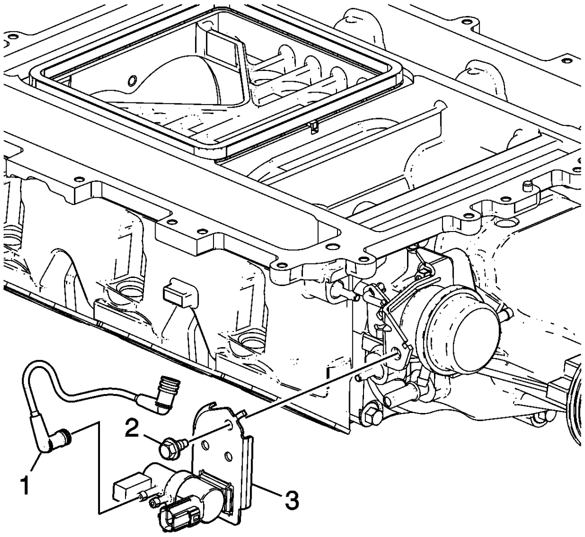


2156836

6. Moving the actuator forward or rearward as required, ensure that the supercharger lever is in contact with the adjustment screw on the actuator and that the lever is rotated to the fully closed position.

Caution: Refer to *Fastener Caution* .

7. Tighten the actuator bolts to 25 N·m (18 lb ft) .
8. Remove the adjustment tool from the actuator.
9. Rotate the adjustment screw on the actuator clockwise $\frac{1}{4}$ turn.

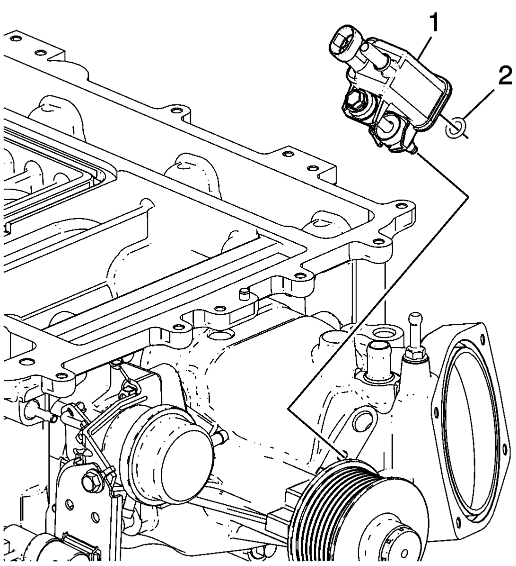


2156838

10. Install the charge air bypass valve (3).

11. Install the charge air bypass valve bolt (2) and tighten to 12 N·m (108 lb ft) .

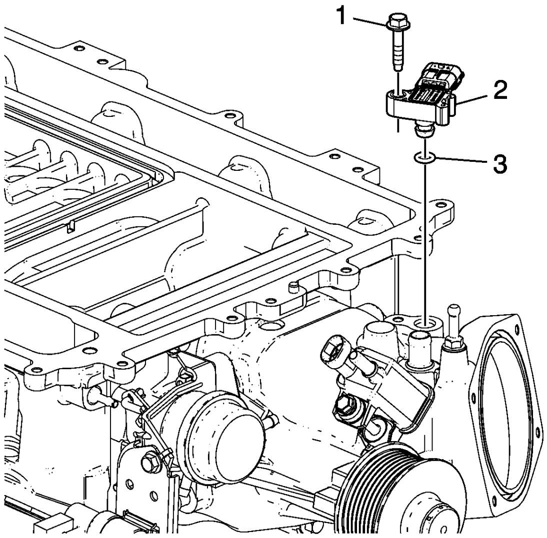
12. Install the bypass actuator tube (1).



2156828

13. Confirm that the evaporative emission (EVAP) valve seal (2) is installed on the EVAP valve (1).

14. Install the EVAP valve (1) and tighten to 10 N·m (89 lb in) .

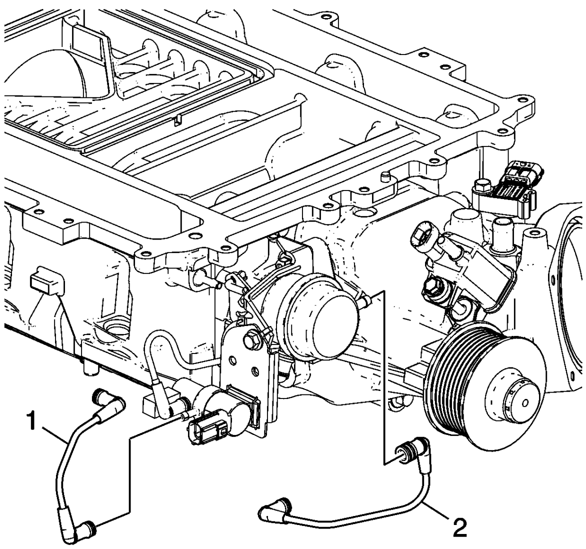


2156827

15. Confirm that the inlet air pressure sensor seal (3) is installed on the sensor (2).

16. Install the inlet air pressure sensor (2).

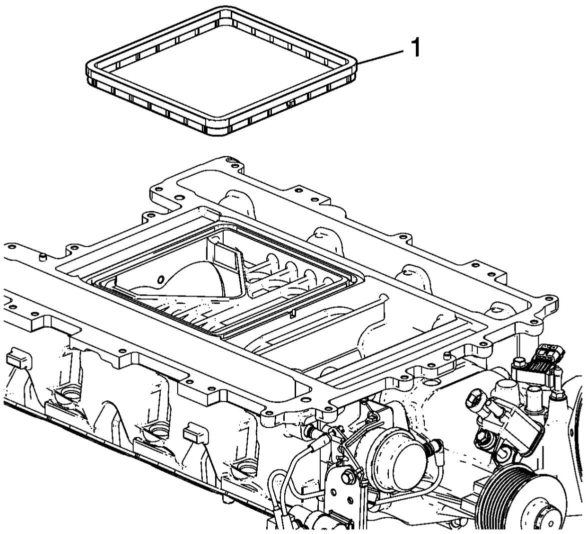
17. Install the inlet air pressure sensor bolt (1) and tighten to 10 N·m (89 lb in) .



2156826

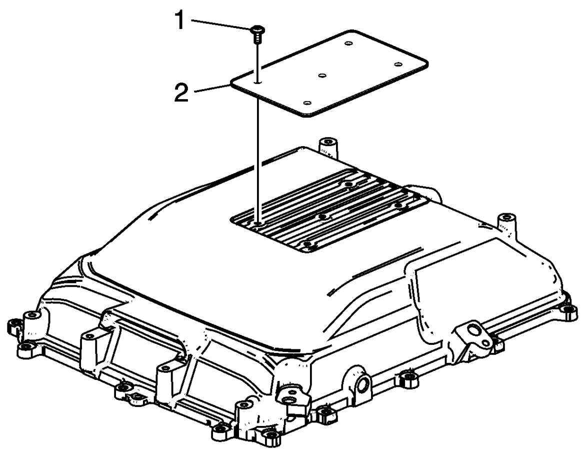
18. Install the bypass valve vacuum tube (2).

19. Install the bypass valve tube (1).



2156823

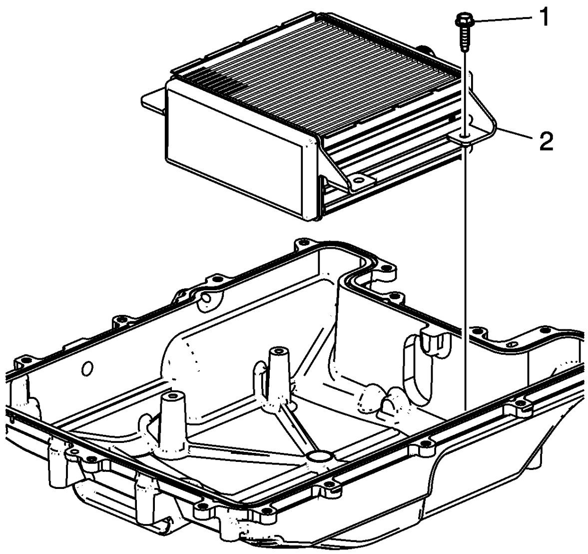
20. Install the NEW insulator seals (1).



2173566

21. Apply a 5 mm (0.2 in) band of threadlocker GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the threads of the bolts (1).

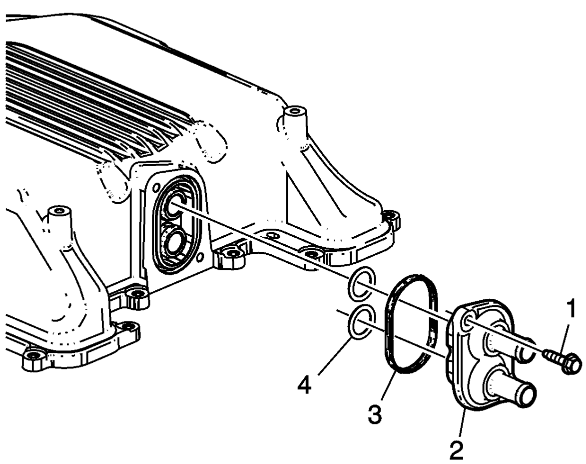
22. Install the isolator pad (2) and bolts (1) and tighten to 5 N·m (44 lb in) .



2173565

23. Apply a 5 mm (0.2 in) band of threadlocker GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the threads of the bolts.

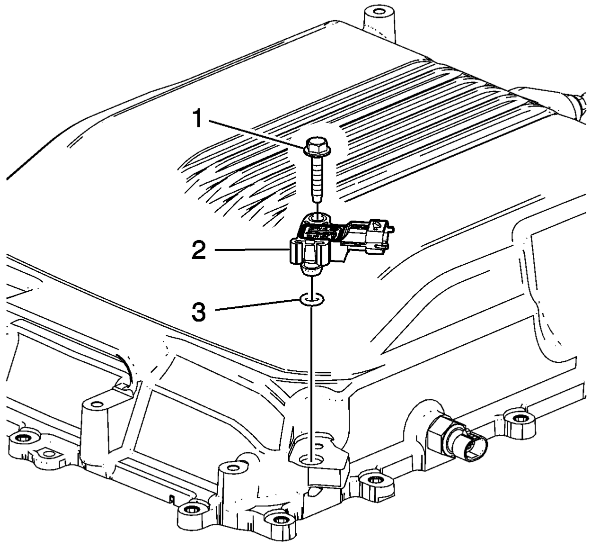
24. Install the charger air cooler (2) and bolts (1) and tighten to 10 N·m (89 lb in) .



2173558

25. Lubricate the seals with clean engine oil.

26. Install NEW O-ring seals (4), NEW seal (3), the plate (2), the bolts (1) and tighten to 10 N·m (89 lb in) .

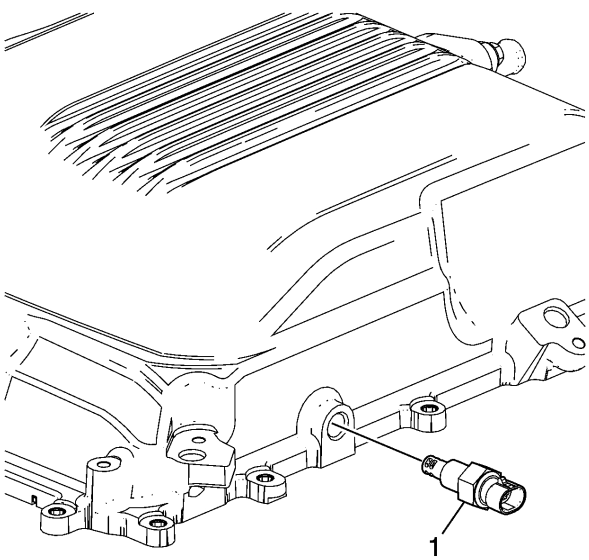


2156822

27. Confirm that the BARO sensor seal (3) is installed on the BARO sensor (2).

28. Install the BARO sensor (2).

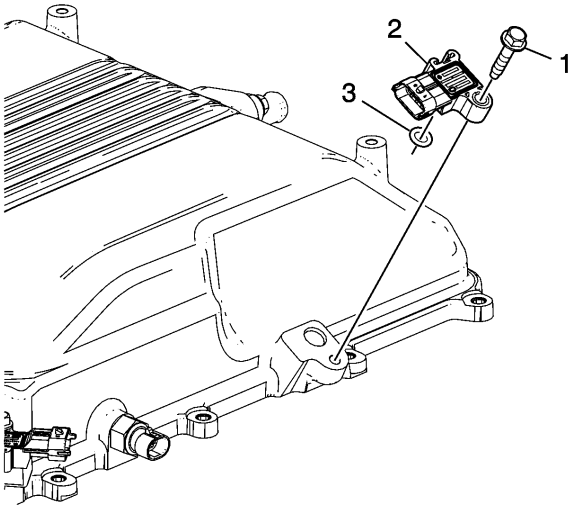
29. Install the BARO sensor bolt (1) and tighten to 10 N·m (89 lb in) .



2156820

30. Install sealant GM P/N 12346004 (Canadian P/N 10953480), or equivalent, to the threads of the sensor (1).

31. Install the IAT sensor (1) and tighten to 20 N·m (15 lb ft) .



2156817

32. Confirm that the manifold absolute pressure (MAP) sensor seal (3) is installed on the MAP sensor (2).

33. Install the MAP sensor (2).

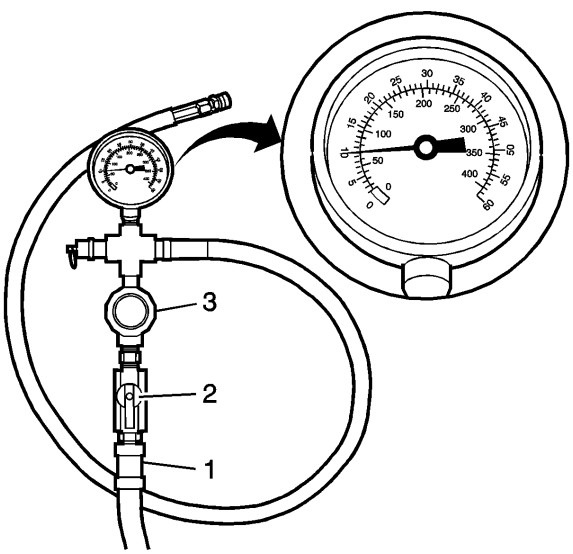
34. Install the MAP sensor bolt (1) and tighten to 10 N·m (89 lb in) .

Supercharger Intercooler Pressure Testing

Special Tools

- EN-48974 Adapter Kit
- J 46091 Charge Air Cooler Tester

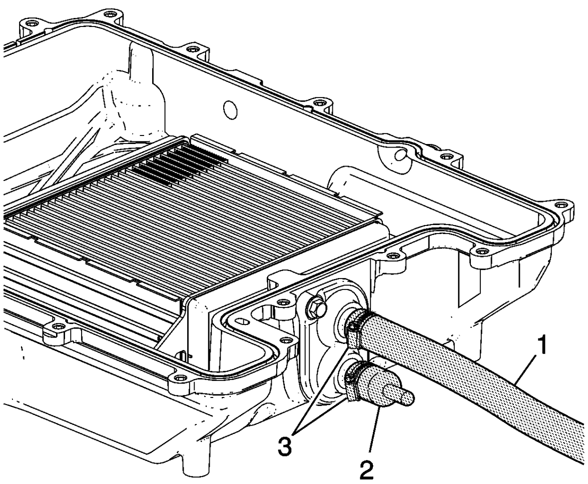
For equivalent regional tools, refer to *Special Tools* .



2054358

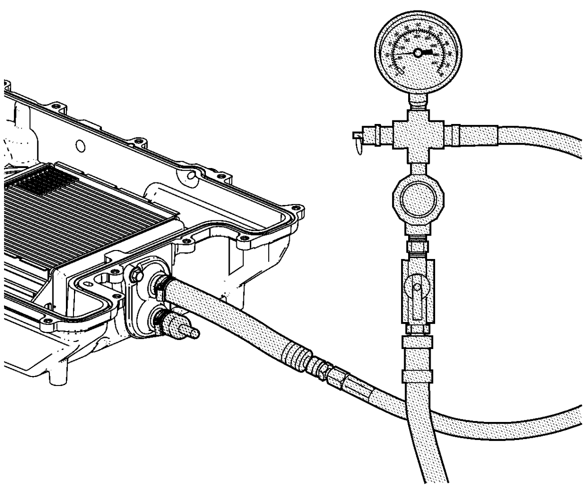
Warning **1.** Do not apply greater than 69 kPa (10 psi) to the supercharger intercooler, this may damage the charge air cooler and other
Rotate the regulator knob (3) counterclockwise until stop to reduce pressure to 0 kPa (0 psi).

2. Connect the J 46091-1 to a shop air source (1).



2156841

3. Install the EN-48974 kit adapter hose (1), cap (2) and clamps (3) to the coolant inlet and outlet connections of the intercooler water manifold. Tighten the clamps until snug.



2156845

4. Install the J 46091-1 to the EN-48974 kit adapter hose.

5. Rotate the knob of the regulator slowly clockwise to increase pressure.

Note 6. The gauge value should not exceed 69 kPa (10 psi). Adjust the pressure regulator as required. **6.** With the intercooler pressurized to 69 kPa (10 psi) maximum, close the air inlet valve of the J 46091-1.

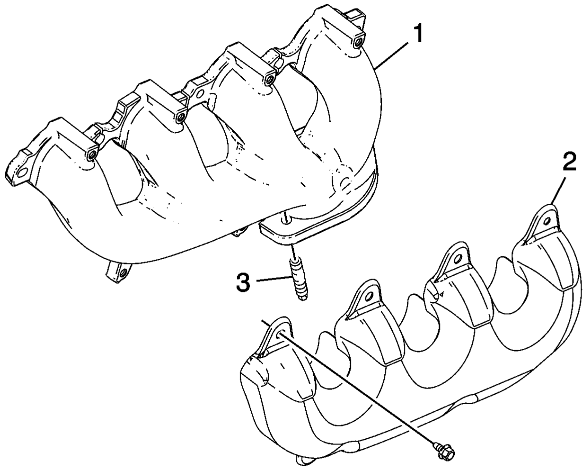
7. Inspect for a drop in air pressure on the gauge.

- If a drop in pressure is noted, inspect for leaks at the tool connections, the charge air coolers, service bleed ports, assembly plant fill port, and water manifold-to-charge air cooler seal locations.
- If no drop in pressure is noted, the intercooler can be installed onto the engine assembly.

Repair Instructions

2159112

Exhaust Manifold Cleaning and Inspection

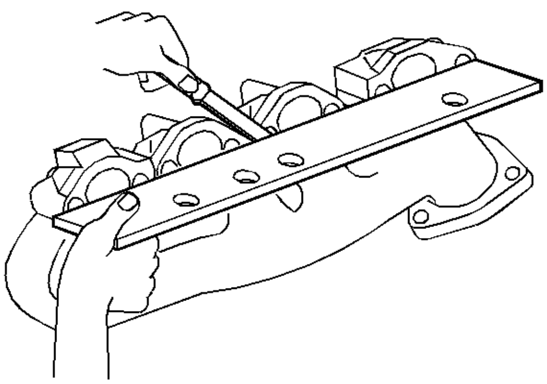


2156850

Note 1. Do not use the exhaust manifold-to-cylinder head gaskets again. Upon installation of the exhaust manifold, install a NEW ga
Clean the exhaust manifold (1) and heat shield (2) in solvent.

Warning 2. Refer to *Safety Glasses Warning* . **2.** Dry the exhaust manifold with compressed air.

3. Inspect the exhaust manifold-to-cylinder head gasket surface for excessive scratches or gouging.
4. Inspect for a loose, damaged, or cracked heat shield (2).
5. Inspect the exhaust pipe studs (3) for damaged threads.



66607

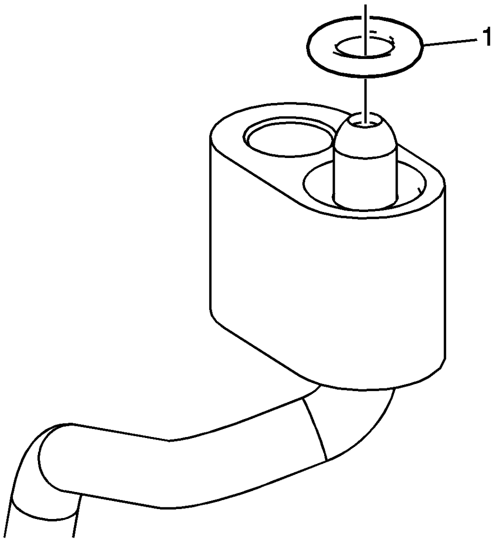
6. Use a straight edge and a feeler gauge to measure the exhaust manifold cylinder head deck for warpage.

   An exhaust manifold deck with warpage in excess of 0.25 mm (0.01 in) within the 2 front or 2 rear runners or 0.5 mm (0.02 in) overall, may cause an exhaust leak and may effect OBD II system performance. Exhaust manifolds not within specifications must be replaced.

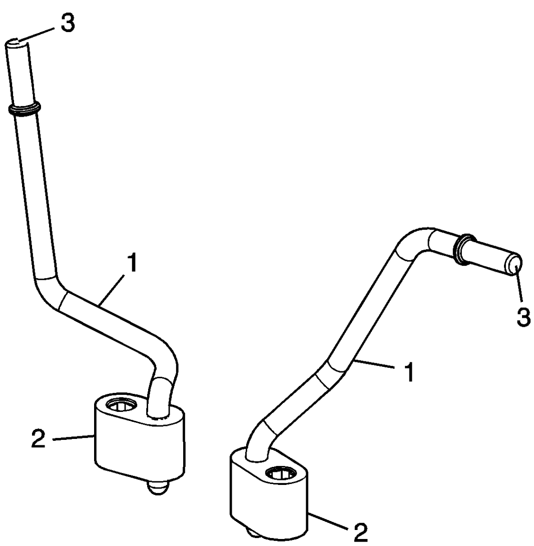
Repair Instructions

2159113

Engine Coolant Air Bleed Pipe and Hole Cover Cleaning and Inspection



2054370
Note 1. Do not use the engine coolant air bleed pipe seals again. Upon installation of the pipes, install NEW seals. **1.** Remove the seals (1) from the pipes.

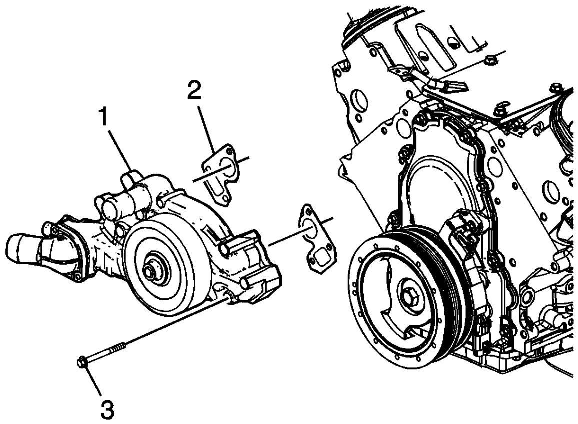


2054371
2. Clean the pipes in solvent.
Warning 3. Refer to *Safety Glasses Warning* . **3.** Dry the pipes with compressed air.
4. Inspect the pipes for damaged sealing surfaces (1, 2) or restrictions within the pipe (3).

Repair Instructions

1877788

Water Pump Cleaning and Inspection (6.2L)



1704622

1. Remove the old gasket from the water pump sealing surfaces. Refer to *Replacing Engine Gaskets* .
2. Clean all excess dirt and debris from the water pump housing.
3. Inspect the water pump (1) for the following conditions:
   - Gasket and hose sealing surfaces for excessive scratches or gouging
   - Restrictions within the internal coolant passages
   - Excessive side-to-side play in the pulley shaft
   - Leakage at the water outlet housing or rear cover gasket
   - Leakage at the water pump vent hole

     A stain around the vent hole is acceptable. If leakage, dripping, occurs with the engine running and the cooling system pressurized, replace the water pump.
   - Wear or damage in the belt tracking area of the pulley

Repair Instructions

2154710

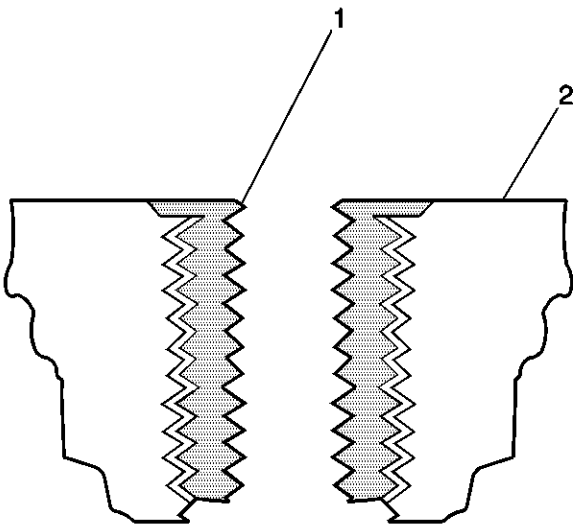
Thread Repair

Special Tools

- J 42385-100 Head/Main Bolt Thread Repair Kit
- J 42385-300 Fixtures and Hardware Kit

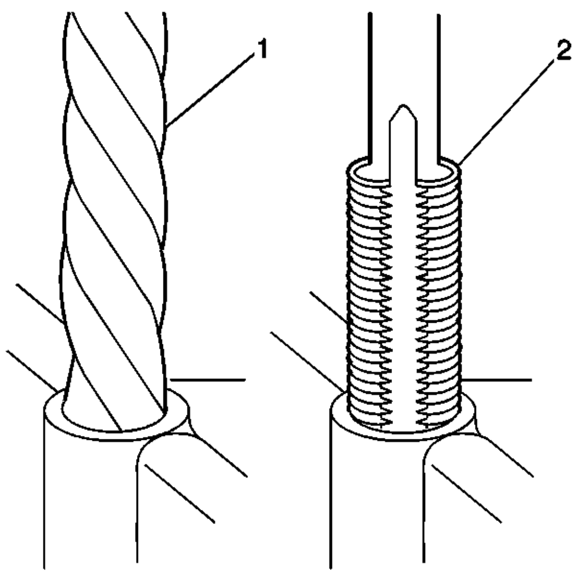
For equivalent regional tools, refer to *Special Tools*

General Thread Repair



320675

The thread repair process involves a solid, thin walled, self-locking, carbon steel, bushing type insert (1). During the bushing installation process, the driver tool expands the bottom external threads of the insert into the base material (2). This action mechanically locks the insert in place. Also, when installed to the proper depth, the flange of the insert will be seated against the counterbore of the repaired hole.



320670

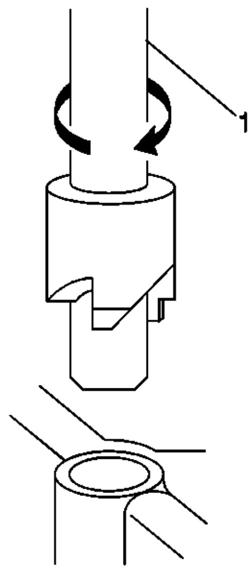
Warning 1. Refer to *Safety Glasses Warning* . **Note**

- The use of a cutting type fluid GM P/N 1052864 (Canadian P/N 992881), WD 40®, or equivalent, is recommended when performing the drilling, counterboring, and tapping procedures.
- Driver oil MUST be used on the installer driver tool.
- The tool kits are designed for use with either a suitable tap wrench or drill motor.

1. Drill out the threads of the damaged hole (1).

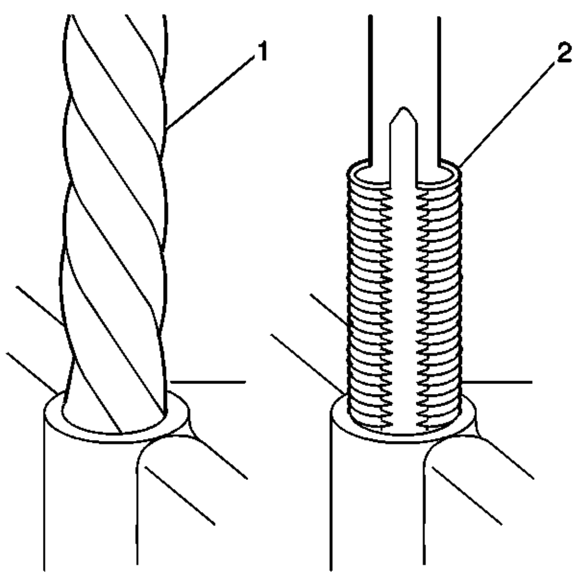
  - M6 inserts require a minimum drill depth of 15 mm (0.59 in).
  - M8 inserts require a minimum drill depth of 20 mm (0.79 in).
  - M10 inserts require a minimum drill depth of 23.5 mm (0.93 in).

2. Using compressed air, clean out any chips.



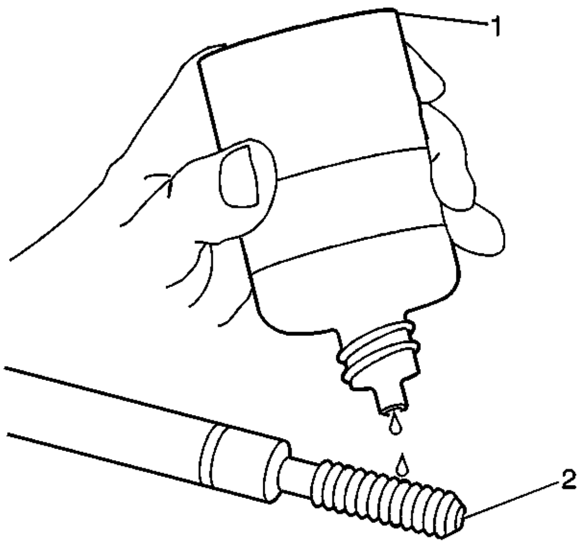
320672

3. Counterbore the hole to the full depth permitted by the tool (1).
4. Using compressed air, clean out any chips.



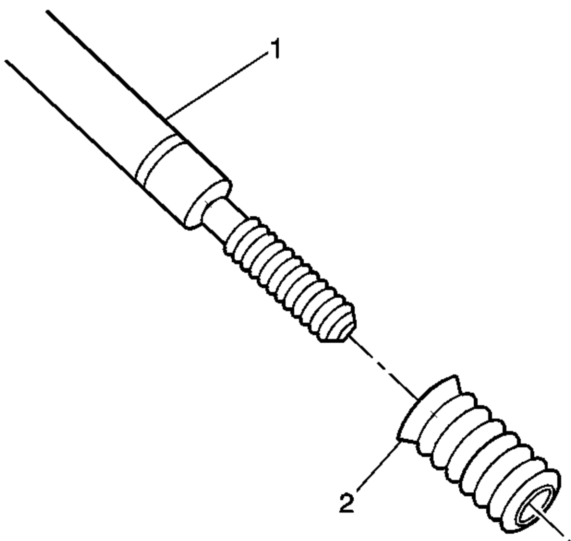
320670

5. Using a tap wrench (2), tap the threads of the drilled hole.
   - M6 inserts require a minimum tap depth of 15 mm (0.59 in).
   - M8 inserts require a minimum tap depth of 20 mm (0.79 in).
   - M10 inserts require a minimum tap depth of 23.5 mm (0.93 in).
6. Using compressed air, clean out any chips.
7. Spray cleaner GM P/N 12346139, GM P/N 12377981 (Canadian P/N 10953463), or equivalent, into the hole.
8. Using compressed air, clean any cutting oil and chips out of the hole.



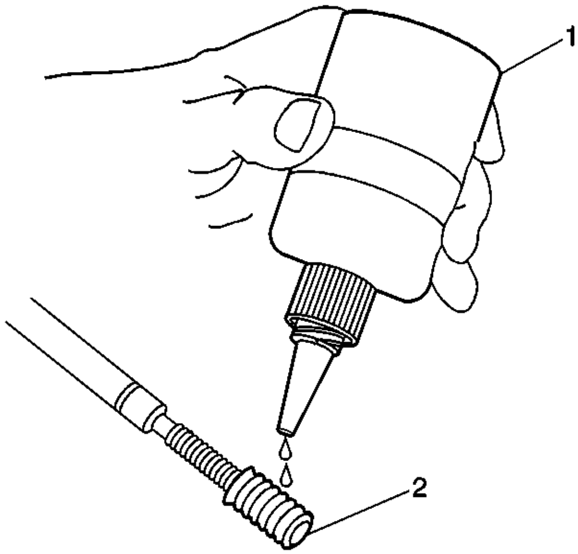
313562

Note 9. Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert. **9.** Lubricate the threads of the installer tool (2) with the driver oil (1).



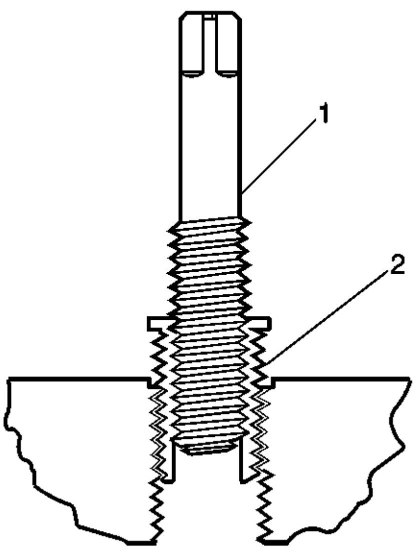
313567

10. Install the insert (2) onto the driver tool (1).



313572

11. Apply threadlock LOCTITE™ 277, J 42385-109 (1), or equivalent, to the insert OD threads (2).

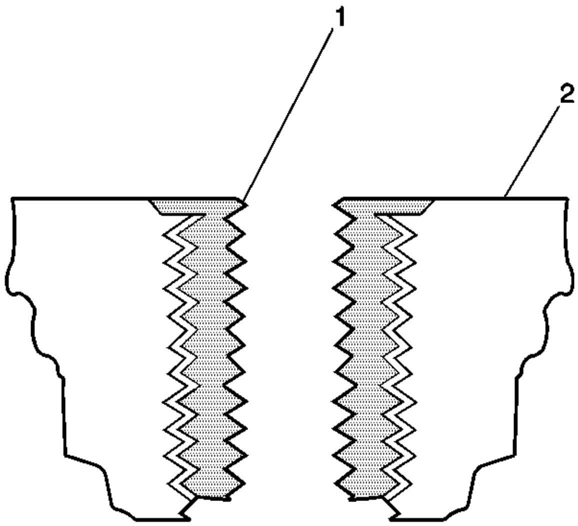


320673

12. Install the insert (2) into the hole.

Install the insert until the flange of the insert contacts the counterbored surface. Continue to rotate the installer tool (1) through the insert.

The installer tool will tighten up before screwing completely through the insert. This is acceptable. You are forming the bottom threads of the insert and mechanically locking the insert to the base material threads.

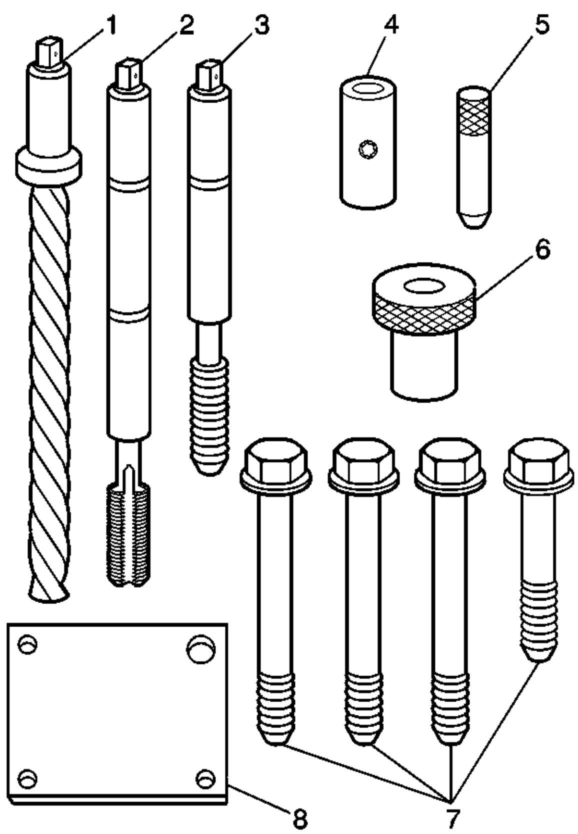


320675

13. Inspect the insert for proper installation into the hole.

A properly installed insert (1) will be either flush or slightly below flush with the surface of the base material (2).

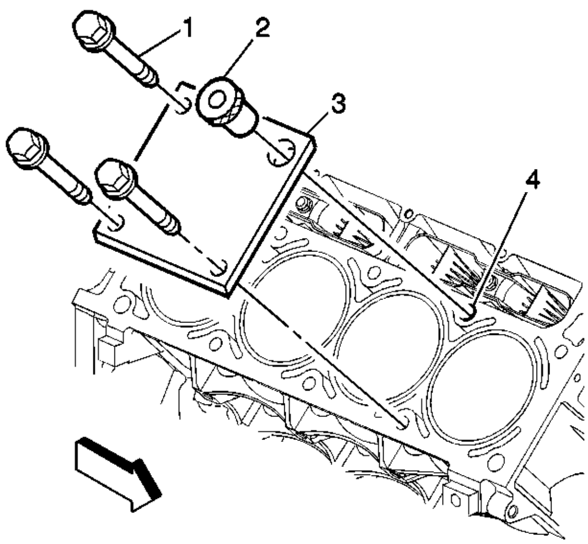
Cylinder Head Bolt Hole Thread Repair



313560

1. The cylinder head bolt hole thread repair kit consists of the following items:

- The drill (1)
- The tap (2)
- The installer (3)
- The sleeve (4)
- The alignment pin (5)
- The bushing (6)
- The bolts (7)
- The fixture plate (8)

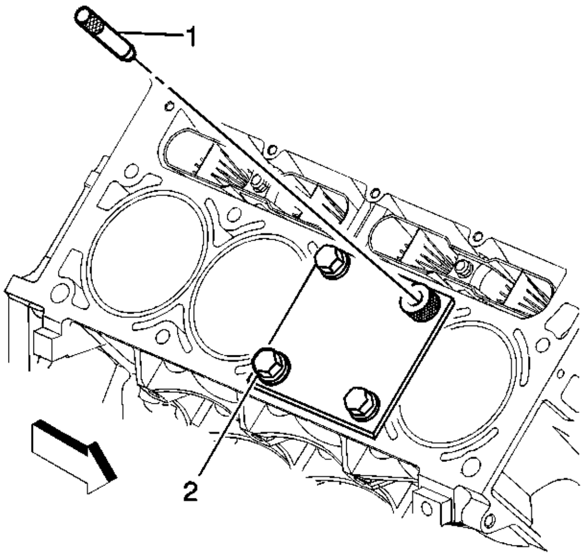


313574
Warning 2. Refer to *Safety Glasses Warning* . **Note**

- The use of a cutting type fluid GM P/N 1052864 (Canadian P/N 992881), WD 40®, or equivalent, is recommended when performing the drilling and tapping procedures.
- Driver oil MUST be used on the installer driver tool.
- The tool kits are designed for use with either a suitable tap wrench or drill motor.

2. Install the fixture plate (3), bolts (1), and bushing (2) onto the engine block deck.

Position the fixture plate and bushing over the hole that is to be repaired (4).

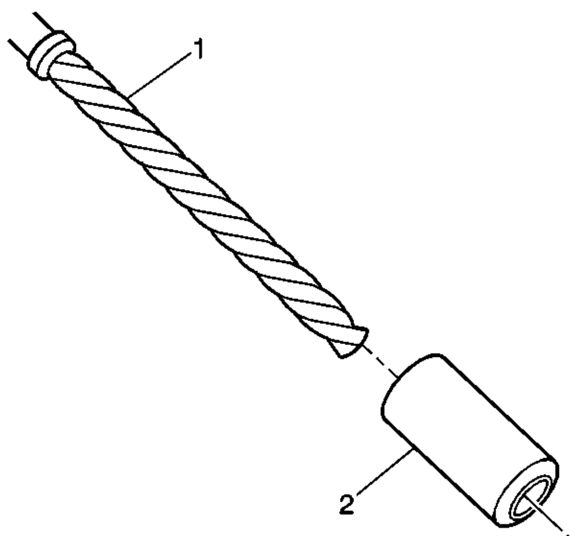


313577

3. Position the alignment pin (1) through the bushing and into the hole.

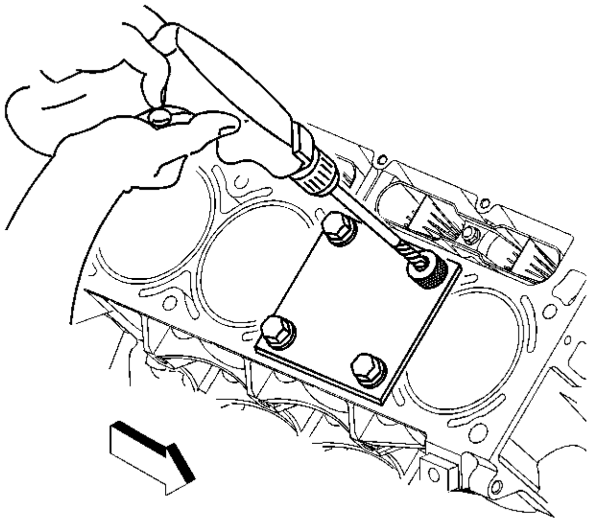
4. With the alignment pin in the desired hole, tighten the fixture retaining bolts (2).

5. Remove the alignment pin from the hole.



313570

6. Install the sleeve (2) onto the drill (1).

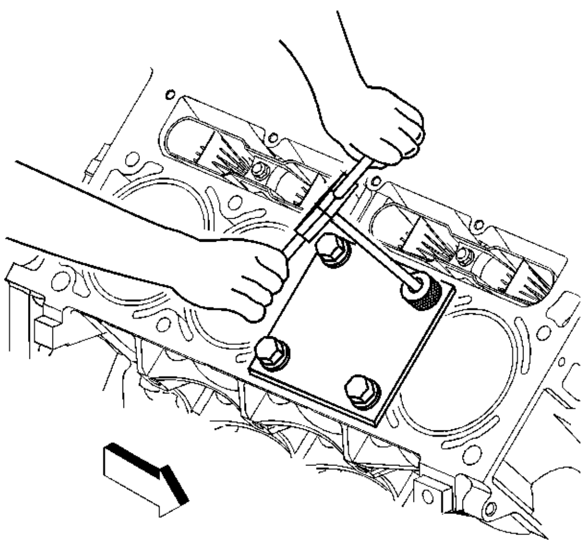


309861

Note 7. During the reaming process, it is necessary to repeatedly remove the drill and clean the chips from the hole. **7.** Drill out the threads of the damaged hole.

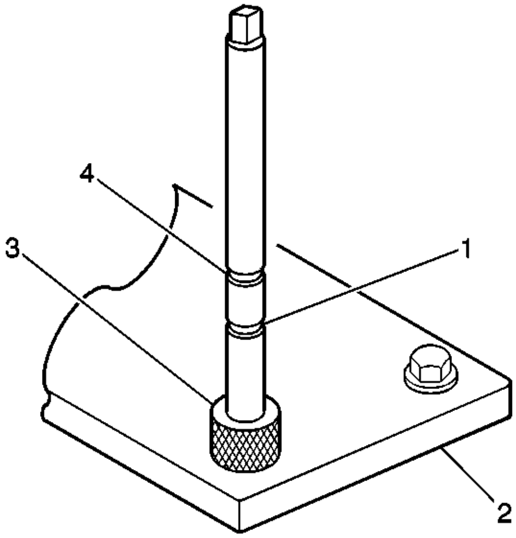
Drill the hole until the stop collar of the drill bit or the sleeve contacts the bushing.

8. Using compressed air, clean out any chips.



320667

9. Using a tap wrench, tap the threads of the drilled hole.



377637

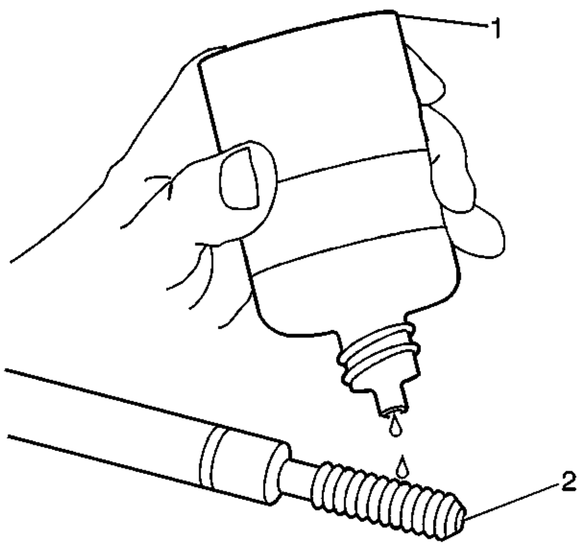
10. In order to tap the new threads to the proper depth, rotate the tap into the hole until the mark (1) on the tap aligns with the top of the drill bushing (3).

11. Remove the fixture plate (2), bushing (3), and bolts.

12. Using compressed air, clean out any chips.

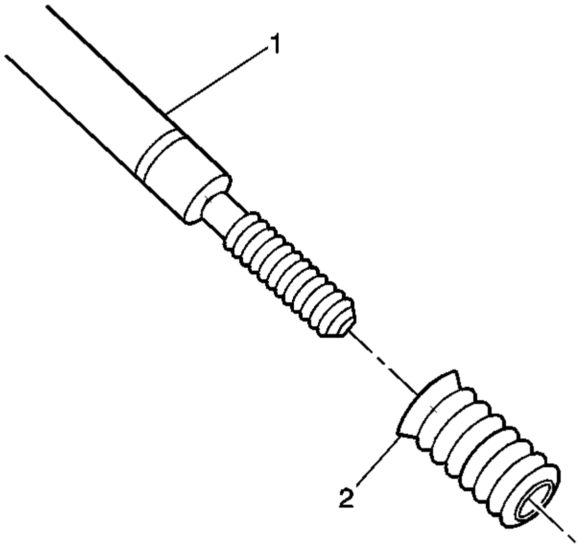
13. Spray cleaner GM P/N 12346139, GM P/N 12377981 (Canadian P/N 10953463), or equivalent, into the hole.

14. Using compressed air, clean any cutting oil and chips out of the hole.



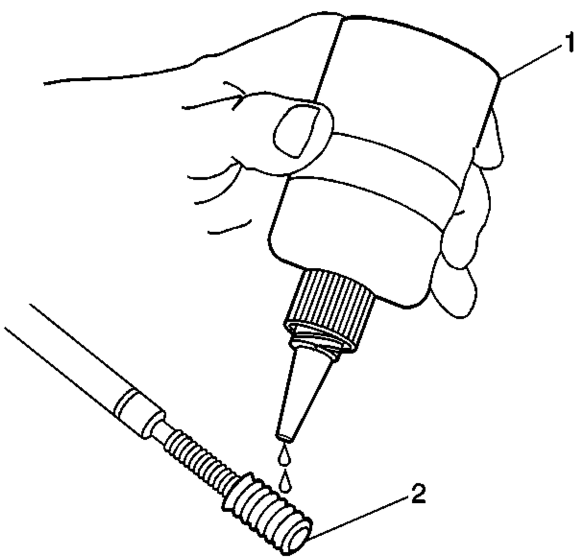
313562

Note 15. Do not allow oil or foreign material to contact the OD of the insert. **15.** Lubricate the threads of the installer tool (2) with the driver oil (1).



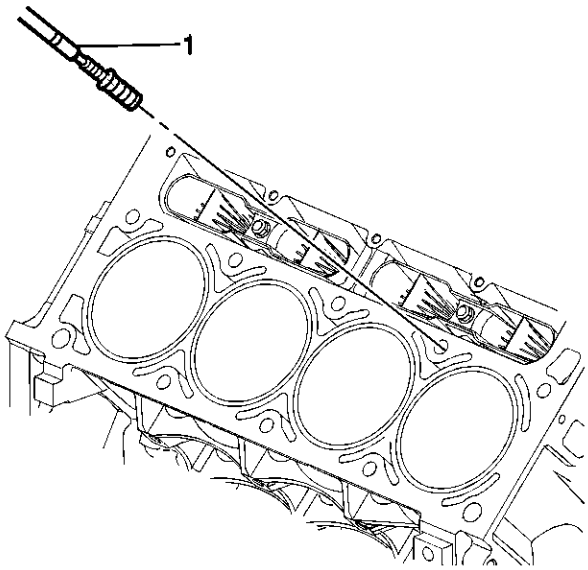
313567

16. Install the insert (2) onto the driver tool (1).



313572

17. Apply threadlock LOCTITE™ 277, J 42385-109 (1), or equivalent, to the insert OD threads (2).



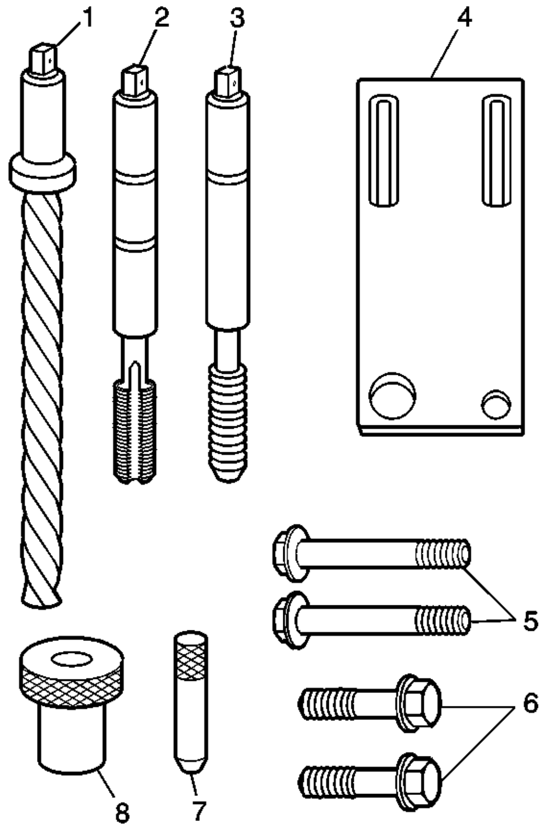
320669

18. Install the insert and driver (1) into the hole.

Rotate the driver tool until the mark on the tool aligns with the deck surface of the engine block.

The installer tool will tighten up before screwing completely through the insert. This is acceptable. You are forming the bottom threads of the insert and mechanically locking the insert to the base material threads.

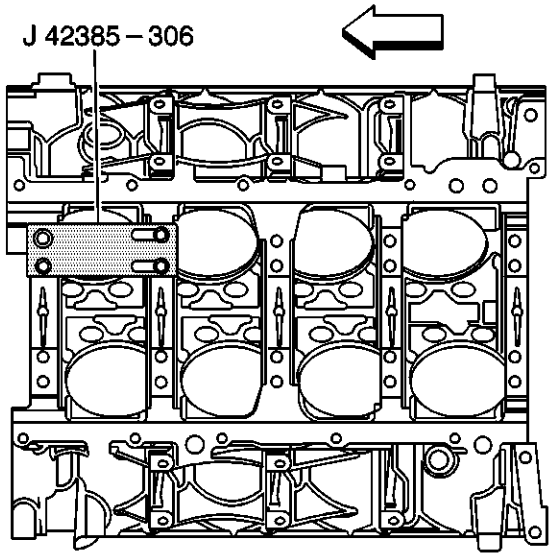
Main Cap Bolt Hole Thread Repair



313556

1. The main cap bolt hole thread repair kit consists of the following items:

- The drill (1)
- The tap (2)
- The installer (3)
- The fixture plate (4)
- The long bolts (5)
- The short bolts (6)
- The alignment pin (7)
- The bushing (8)

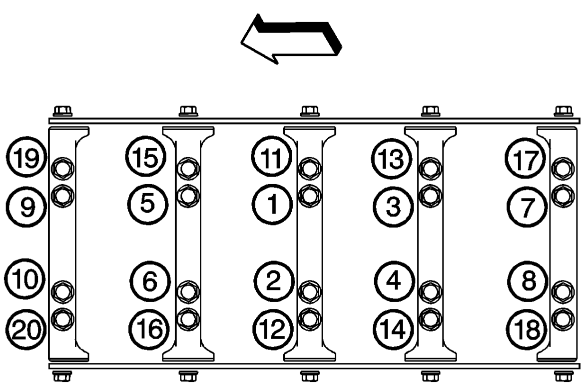


377630

2. Install the fixture plate, bolt, and bushing onto the engine block.

   Position the fixture plate and bushing over the hole that is to be repaired.

3. Position the alignment pin in the desired hole and tighten the fixture retaining bolts.



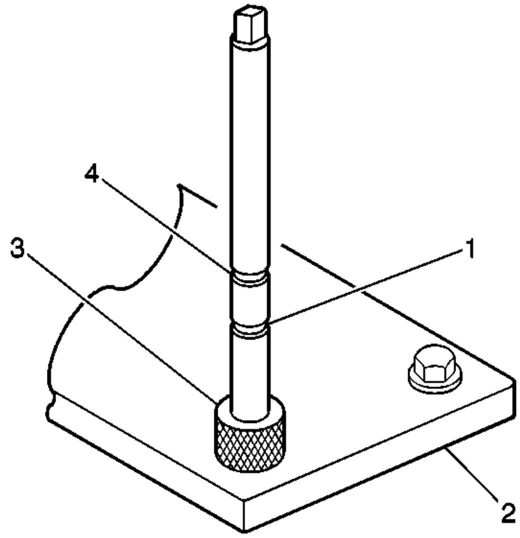
63214

4. Drill out the damaged hole.

   The outer bolt hole locations 11–20 have the shallower counterbores. Use sleeve J 42385-316 with the drill.

   Drill until the stop collar of the drill bit or the sleeve contacts the bushing.

5. Using compressed air, clean out any chips.



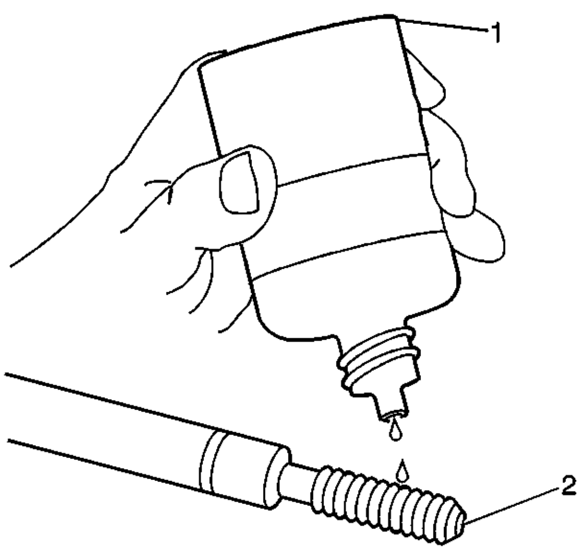
377637

6. Using a tap wrench, tap the threads of the drilled hole.

   In order to tap the new threads to the proper depth, rotate the tap into the hole until the mark on the tap aligns with the top of the bushing.

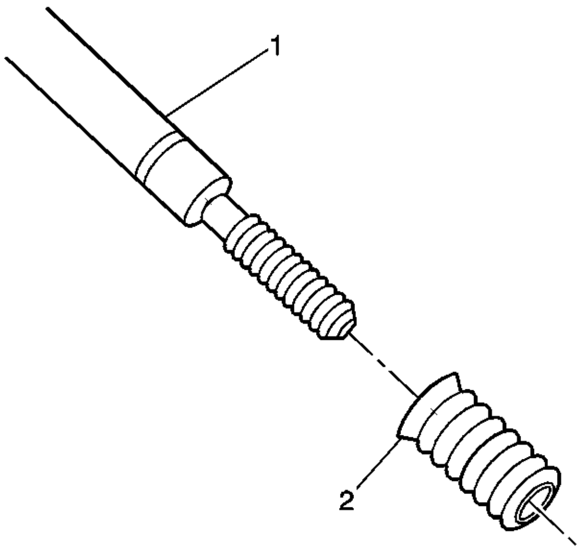
   For the deeper main cap holes 1–10, rotate the tap until the upper mark (4) on the tap aligns with the top of the bushing (3).

   For the shallower main cap holes 11–20, rotate the tap until the lower mark (1) on the tap aligns with top of the bushing (3).
7. Using compressed air, clean out any chips.
8. Spray cleaner GM P/N 12346139 (Canadian P/N 10953463), or equivalent, into the hole.
9. Using compressed air, clean any cutting oil and chips out of the hole.



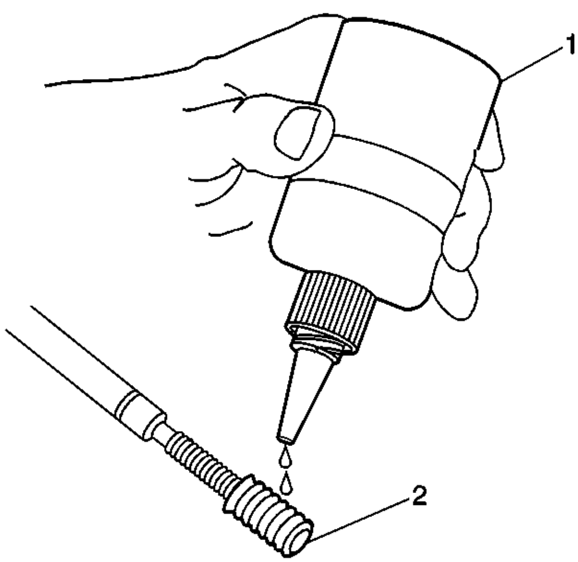
313562

Note 10. Do not allow oil or foreign material to contact the OD of the insert. **10.** Lubricate the threads of the installer tool (2) with the driver oil (1).



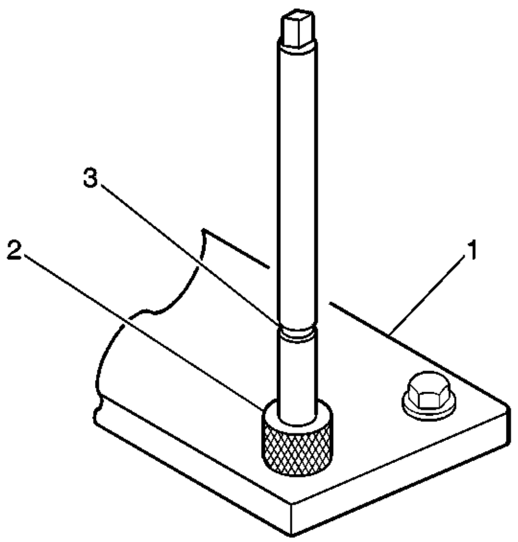
313567

11. Install the insert (2) onto the driver tool (1).



313572

12. Apply threadlock LOCTITE™ 277, J 42385-109 (1), or equivalent, to the insert OD threads (2).



377635

Note 13. The fixture plate and bushing remains installed onto the engine block during the insert installation procedure. **13.** Install the insert and driver (1) through the fixture plate and bushing and into the hole.

Rotate the driver tool until the mark on the tool (3) aligns with the top of the bushing (2).

The installer tool will tighten up before screwing completely through the insert. This is acceptable. You are forming the bottom threads of the insert and mechanically locking the insert to the base material threads.

Repair Instructions

1877790

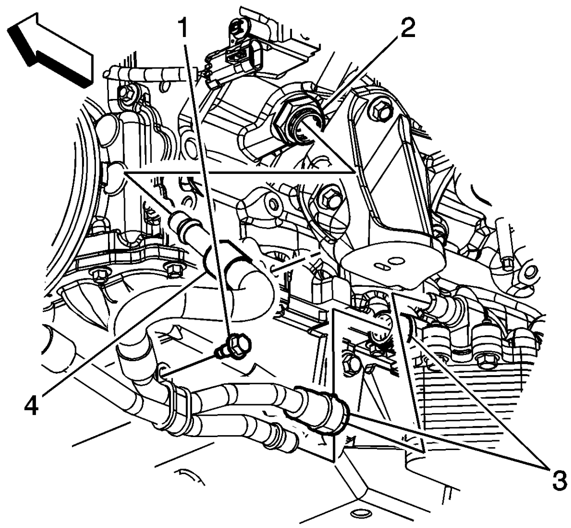
Service Prior to Assembly

- Dirt or debris causes premature wear of the rebuilt engine. Clean all components. Refer to *Cleanliness and Care* .
- Use the proper tools to measure components when inspecting for excessive wear. Components that are not within the manufacturers specifications must be repaired or replaced.
- When the components are installed into an engine, return the components to their original location, position and direction. Refer to *Separating Parts* .
- During assembly, lubricate all moving parts with clean engine oil. This provides initial lubrication when the engine is first started.

Repair Instructions

2088513

Engine Block Plug Installation

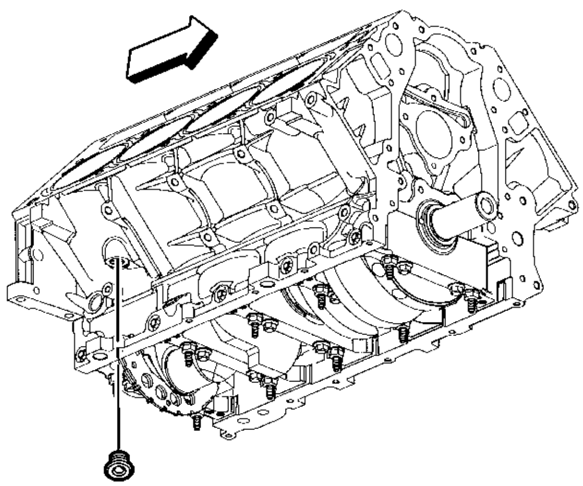


2142312

Note 1. Engine block plug, oil gallery, and coolant sealing washers may be used again if not bent, scored or otherwise damaged. **1.** Apply a 3.175 mm (0.125 in) bead of sealant GM P/N 12346004 (Canadian P/N 10953480) to the threads of the engine oil cooler coolant fitting (2). Refer to *Adhesives, Fluids, Lubricants, and Sealers* .

Caution: Refer to *Fastener Caution* .

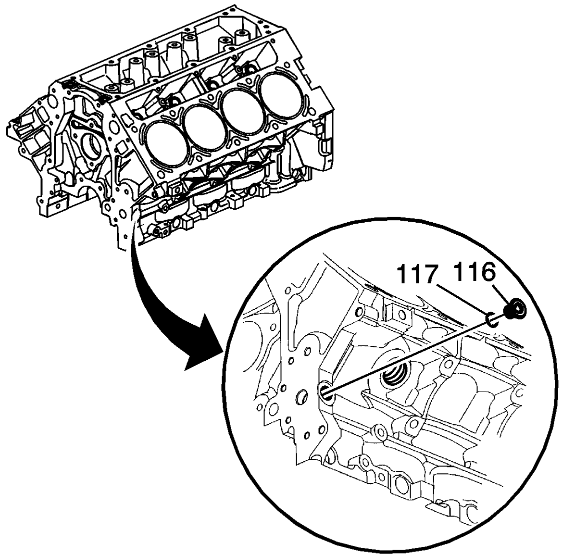
2. Install the engine oil cooler coolant fitting (2) and tighten to 50 N·m (37 lb ft) .



63164

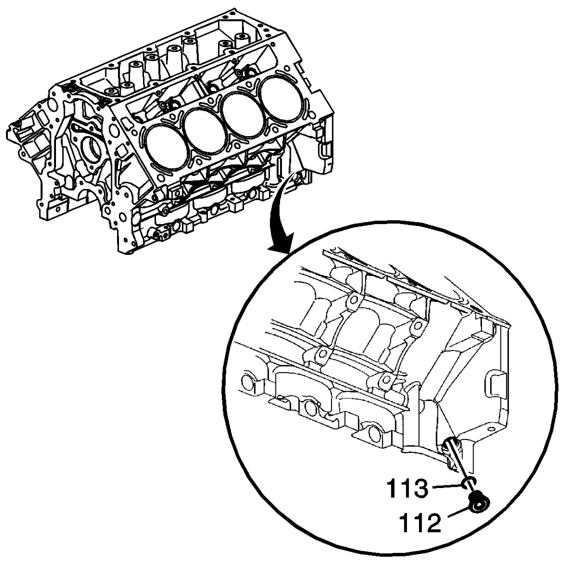
3. Apply a 3.175 mm (0.125 in) bead of sealant GM P/N 12346004 (Canadian P/N 10953480) to the engine block right rear coolant drain hole plug sealing washer.

4. Install the engine block right rear coolant drain hole plug and tighten to 60 N·m (44 lb ft) .



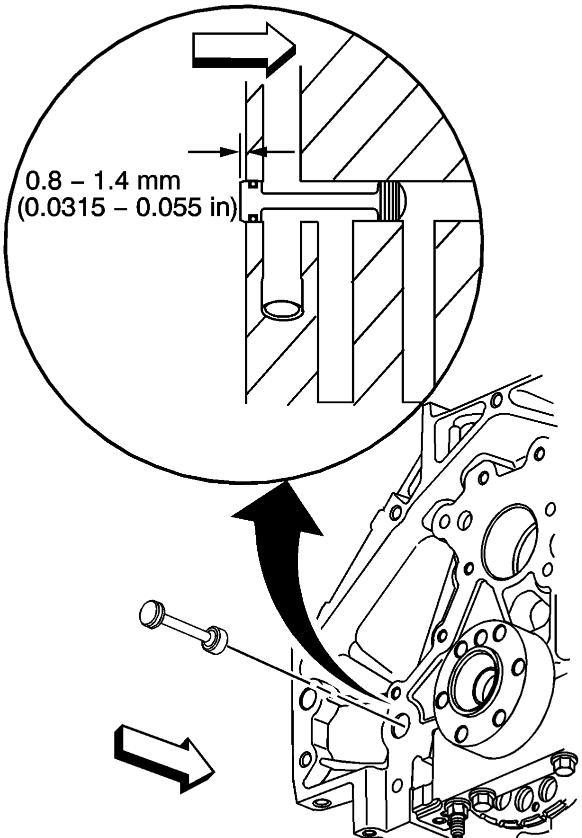
1552550

5. Apply a 3.175 mm (0.125 in) bead of sealant GM P/N 12346004 (Canadian P/N 10953480) to the engine block left front oil gallery plug sealing washer (117).
6. Install the engine block left front oil gallery plug (116) and tighten to 60 N·m (44 lb ft) .



1552551

7. Apply a 3.175 mm (0.125 in) bead of sealant GM P/N 12346004 (Canadian P/N 10953480) to the engine block left rear oil gallery plug sealing washer (113).
8. Install the engine block left rear oil gallery plug (112) and tighten to 60 N·m (44 lb ft) .



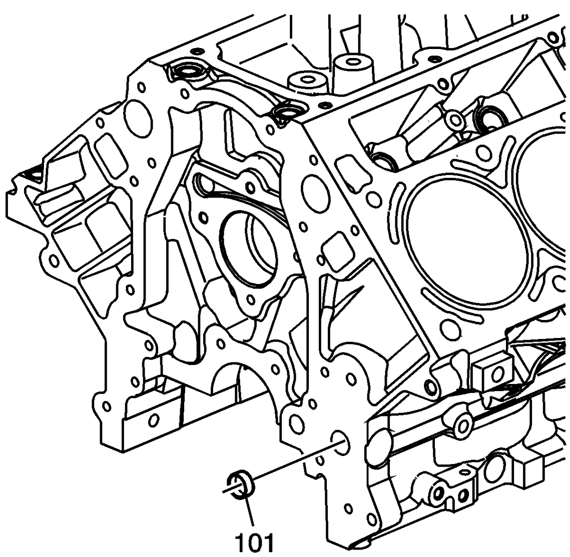
63228

9. Inspect the engine block rear oil gallery plug and O-ring seal. If the O-ring seal on the plug is not cut or damaged, the rear oil gallery plug may be used again.

10. Lubricate the O-ring seal with clean engine oil.

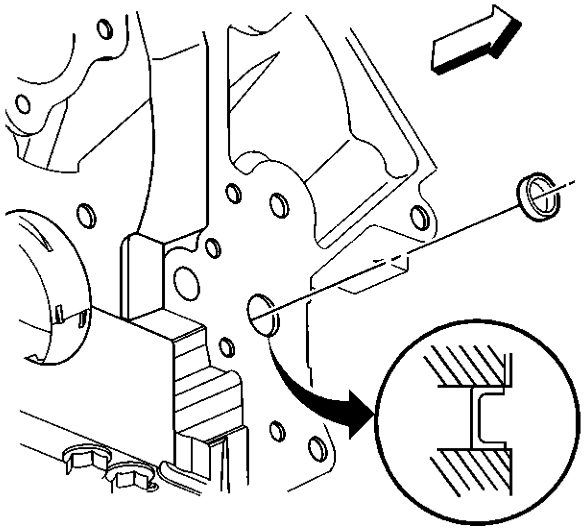
11. Install the O-ring seal onto the plug.

12. Install the engine block rear oil gallery plug into the oil gallery bore. A properly installed block plug will protrude 0.8–1.4 mm (0.0315–0.055 in) beyond the rear face of the block.



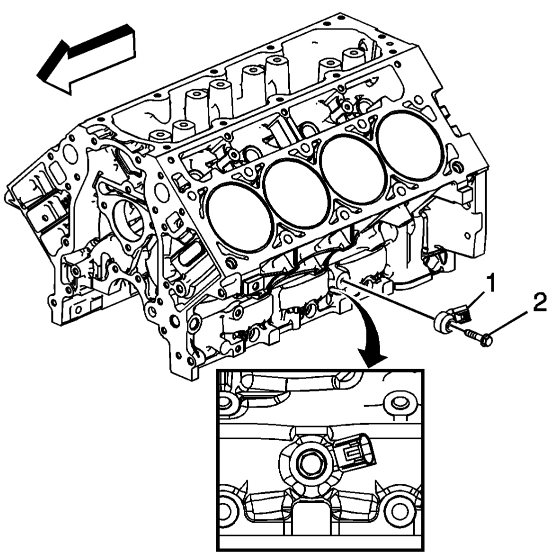
1552553

13. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489) to the sides of the NEW front oil gallery plug (101).



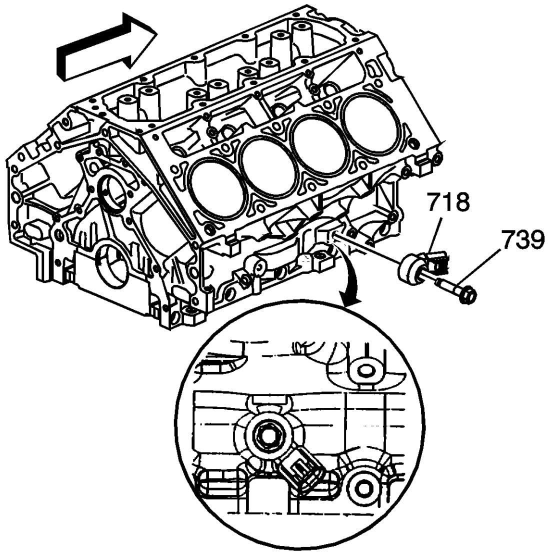
64295

14. Install a NEW engine block front oil gallery plug. Install the plug into the oil gallery bore 2.2–2.8 mm (0.0086–0.011 in) below flush.



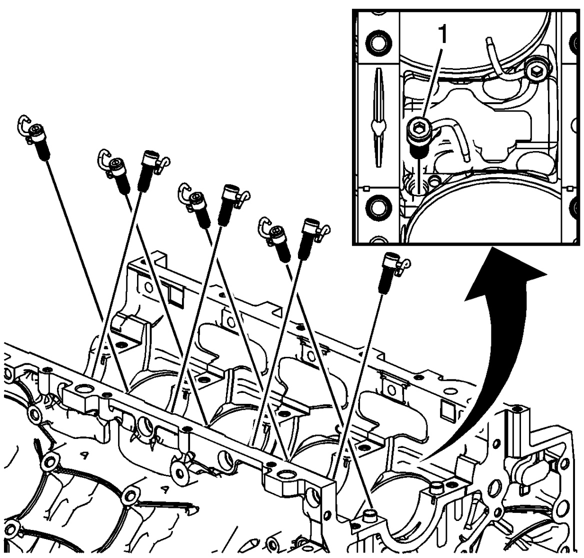
2085694

15. Install the left side knock sensor (1) and bolt (2) and tighten to 25 N·m (18 lb ft) .



1402140

16. Install the right side knock sensor (718) and bolt (739) and tighten to 25 N·m (18 lb ft) .



2085658

17. Install the piston oil nozzles (1) to the block – 6.2L LS9/LSA.

18. Tighten the bolts to 20 N·m (15 lb ft) .

Repair Instructions

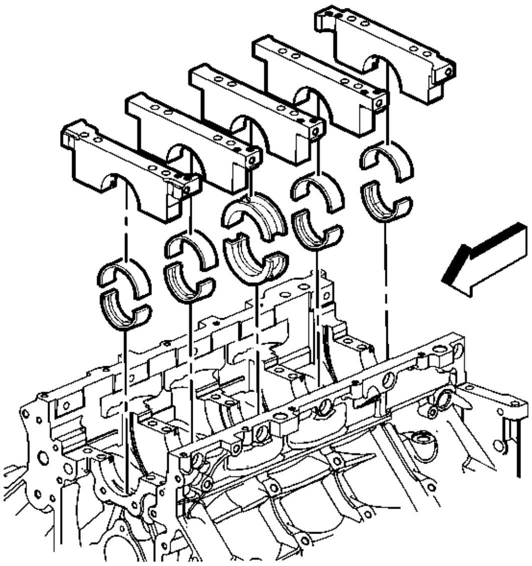
2155771

Crankshaft and Bearing Installation

Special Tools

J 45059 Angle Meter

For equivalent regional tools, refer to *Special Tools*



64293

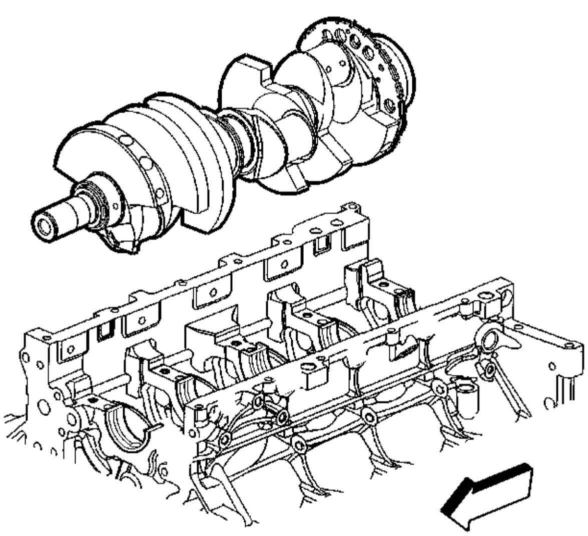
Note

- Crankshaft bearing clearances are critical. Excessive crankshaft bearing clearance may affect crankshaft position (CKP) sensor signals and/or on-board diagnostic (OBD) II system performance.
- Crankshaft bearing caps must be installed to the proper location and direction.
- When installing the crankshaft bearings, align the locating tabs on the bearings with the locating notches in the engine block journal bore and the bearing cap.
- Always install crankshaft bearings with their machined partner. Do not file bearings or mix bearing halves.
- In order to prevent engine block oil leakage, install NEW M8 crankshaft bearing cap side bolts.

The crankshaft bearing cap M8 side bolts have a pre-applied sealant patch applied to the bolt flange.

1. Install the crankshaft bearings to the engine block and bearing caps. The thrust bearings are to be installed into center journal.

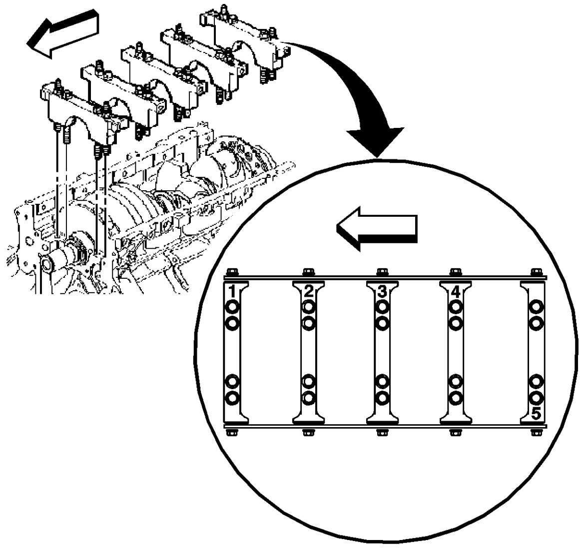
2. Lubricate the bearing surfaces and crankshaft journals with clean engine oil.



156151

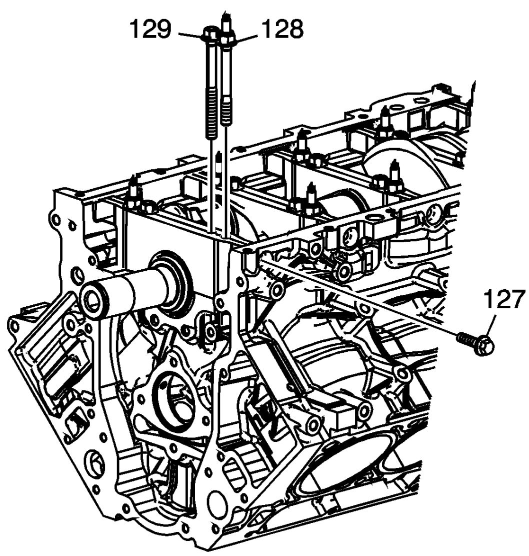
Caution: To maintain proper crankshaft end play, use extreme care during crankshaft installation. Avoid scoring or damaging the thrust bearing.

3. Install the crankshaft.



1870578

Note 4. The bearing caps must be installed in the proper location and direction. **4.** Install the crankshaft bearing caps, with bearings, into the engine block.

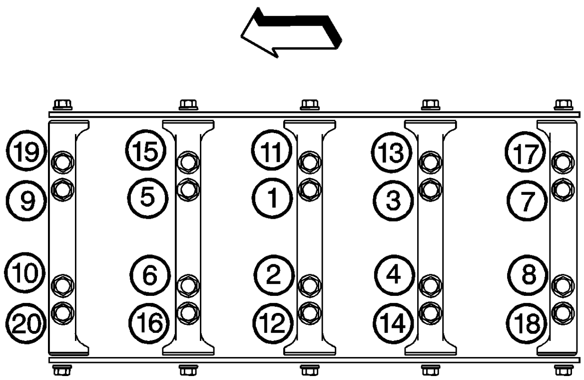


1552494

5. Install NEW M10 bolts (129) and NEW studs (128).

6. Using a plastic-face hammer, tap the bearing caps into place.

7. Install the NEW M8 bearing cap side bolts (127).



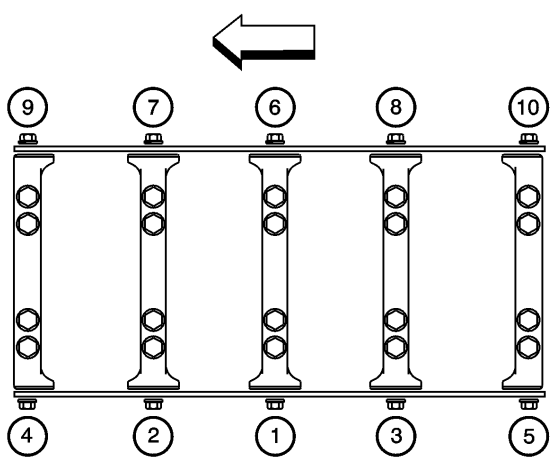
63214

Caution: Refer to *Fastener Caution* .

8. Tighten the M10 bearing cap bolts (1–10) a first pass in sequence to 20 N·m (15 lb ft) .

Note 9. To properly align the crankshaft thrust bearings, the final thrust of the crankshaft MUST be in the forward direction. **9.** Using a plastic-face hammer, tap the crankshaft rearward, then forward in order to align the thrust bearings.

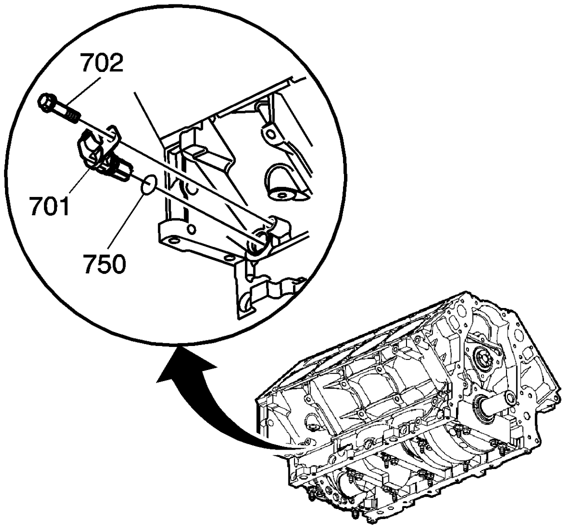
- Tighten the M10 bolts (1–10) a final pass in sequence 80 degrees using the J 45059 meter .
- Tighten the M10 studs (11–20) a first pass in sequence to 20 N·m (15 lb ft) .
- Tighten the M10 studs (11–20) a final pass in sequence 51 degrees using the J 45059 meter .



2275797

10. Tighten the M8 main bearing cap side bolts (1–10).

- Tighten the M8 bolts (1–5) a first pass in sequence to 20 N·m (15 lb ft) .
- Tighten the M8 bolts (1–5) a final pass in sequence to 30 N·m (22 lb ft) .
- Tighten the M8 bolts (6–10) a first pass in sequence to 20 N·m (15 lb ft) .
- Tighten the M8 bolts (6–10) a final pass in sequence to 30 N·m (22 lb ft) .



1402083

11. Install the CKP sensor.

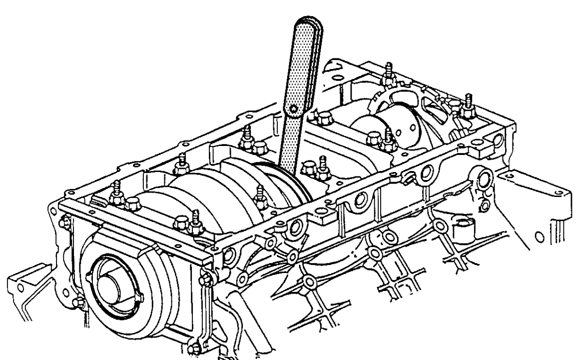
11.1. Inspect the CKP sensor O-ring seal (750). If the O-ring seal is not cut or damaged, it may be used again.

11.2. Coat the O-ring seal with clean engine oil.

11.3. Install the O-ring onto the sensor.

11.4. Install the sensor (701). Rotate the sensor until the locating hole in the bracket aligns with the bolt hole in the block.

11.5. Install the sensor bolt (702) and tighten to 25 N·m (18 lb ft) .



64316

12. Measure the crankshaft end play.

12.1. Thrust the crankshaft forward or rearward.

12.2. Insert a feeler gauge between the center crankshaft bearing and the bearing surface of the crankshaft and measure the bearing clearance.

The proper crankshaft end play clearance is 0.04–0.2 mm (0.0015–0.0078 in).

12.3. If the bearing clearance is not within specifications, inspect the thrust surfaces for nicks, gouges or raised metal. Minor imperfections may be removed with a fine stone.

Repair Instructions

2136230

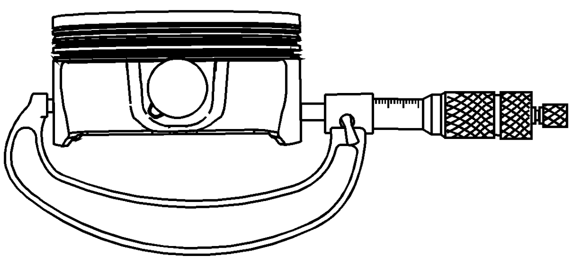
Piston, Connecting Rod, and Bearing Installation (6.2L)

Special Tools

- J 8037 Piston Ring Compressor
- J 8087 Cylinder Bore Gauge
- J 41556 Connecting Rod Guide
- J 45059 Angle Meter

For equivalent regional tools, refer to *Special Tools* .

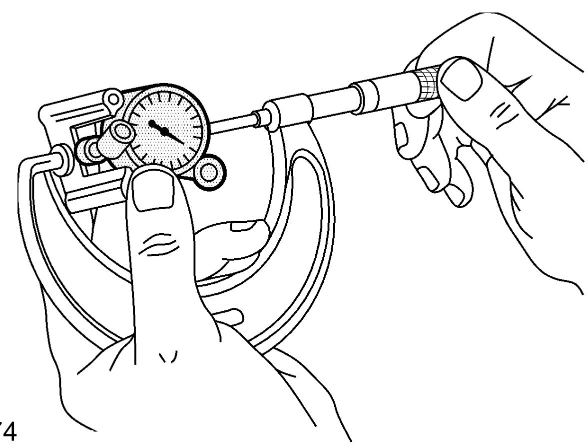
Piston Selection



1552496

Note 1. Measurements of all components should be taken with the components at normal room temperature. For proper piston fit, th
With a micrometer at a right angle, measure the piston outside diameter (OD). Measure the diameter 43 mm (1.69 in) from the top of the piston. Refer to *Engine Mechanical Specifications* .

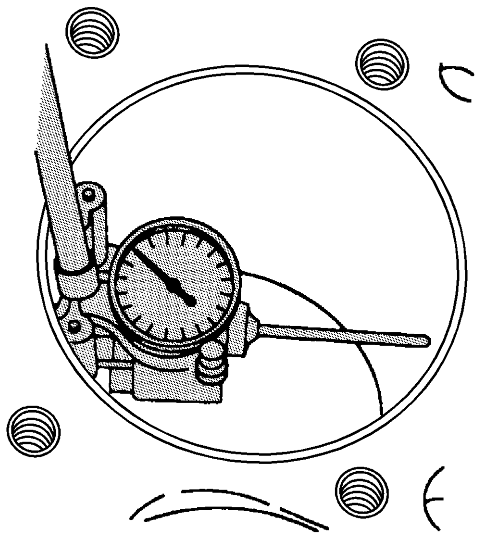
2. Record the piston OD.



4974

3. Adjust the micrometer to the recorded piston OD.

4. Insert the J 8087 bore gauge into the micrometer and zero the gauge dial.



4972

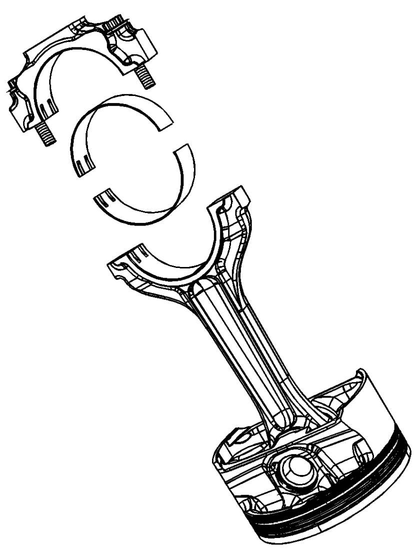
5. Using the J 8087 bore gauge , measure the cylinder bore inside diameter (ID). Measure at a point 64 mm (2.5 in) from the top of the cylinder.

6. Record the cylinder bore ID.

7. Subtract the piston OD from the cylinder bore ID in order to determine the piston-to-bore clearance. Refer to *Engine Mechanical Specifications* .

8. If the proper clearance cannot be obtained, select another piston and pin assembly and measure the clearances again. If the proper fit cannot be obtained, the cylinder bore may require honing for an oversize piston.

Piston, Pin, and Connecting Rod Installation



1552501

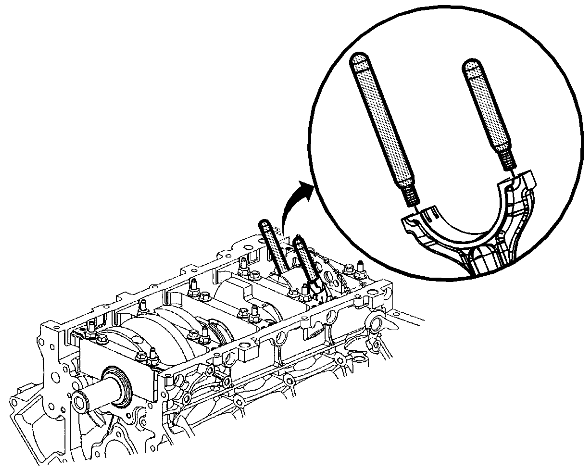
1. Lubricate the following components with clean engine oil:

- Piston
- Piston rings
- Cylinder bore
- Bearings and bearing surfaces

2. Install the bearings to the connecting rod and cap.

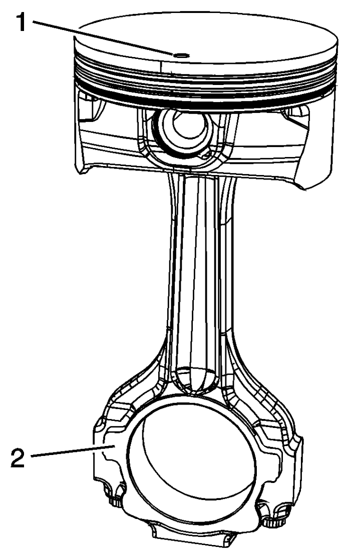
3. Position the oil control ring end gaps a minimum of 25 mm (1.0 in) from each other.

4. Position the compression ring end gaps 180 degrees opposite each other.



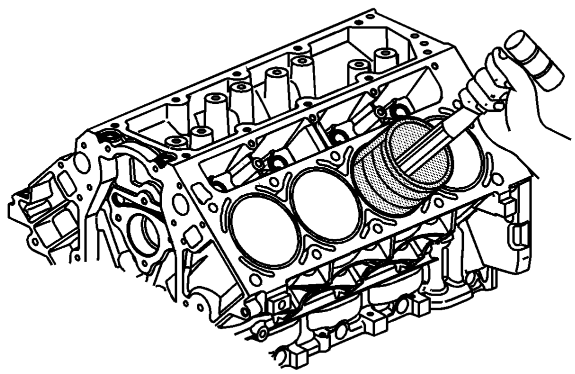
1552499

5. Install the J 41556 rod guide to the connecting rod.



1768708

6. Identify the proper installation direction of the piston and connecting rod assembly. When installing the piston and connecting rod assembly, the mark on the top of the piston (1) and the tab (2) on the side of the connecting rod should face the front of the engine.



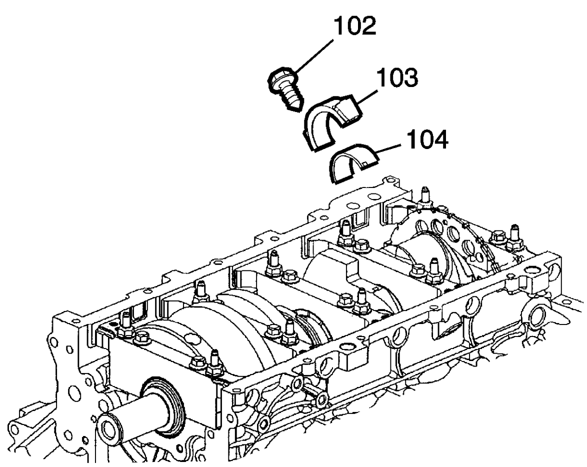
1552497

7. Install the J 8037 ring compressor onto the piston and compress the piston rings.

Note 8. The piston alignment mark MUST face the front of the engine block. **8.** Install the piston, pin, and connecting rod assembly into the cylinder bore. Hold the piston ring compressor firmly against the engine block. Using a wooden hammer handle, lightly tap the top of the piston until all piston rings have entered the cylinder bore.

9. Use the J 41556 rod guide to guide the connecting rod onto the crankshaft journal.

10. Remove the J 41556 rod guide from the connecting rod.



1552547

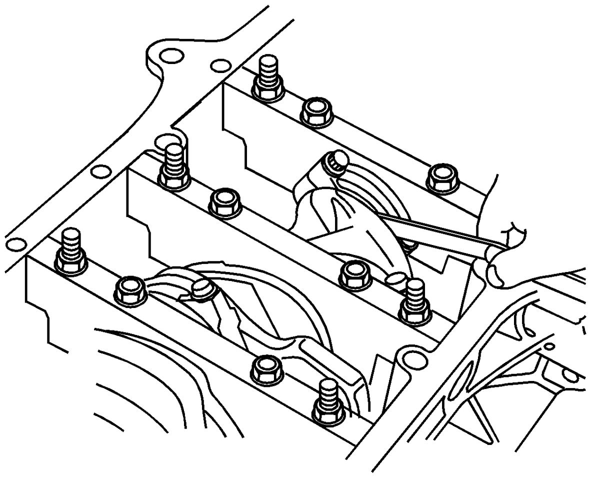
Caution: Refer to *Fastener Caution* .

Note

- The connecting rod and cap must be assembled with the mating surfaces properly aligned.
- If re-using connecting rods, DO NOT re-use connecting rod fasteners. During an installation procedure, the new connecting rod bolts can be re-tightened a maximum of 3 times.

11. Install the bearing cap (103), bearing (104), and bolts (102).

- **11.1.** Tighten the bolts a first pass to 20 N·m (15 lb ft) .
- **11.2.** Tighten the bolts a final pass to 85 degrees using the J 45059 angle meter .



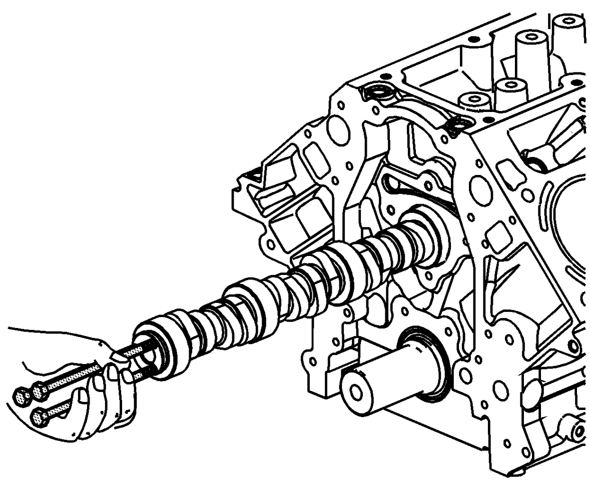
1366378

12. Measure the connecting rods for the proper side clearance. Refer to *Engine Mechanical Specifications* .

Repair Instructions

2136231

Camshaft Installation (6.2L)



1552493

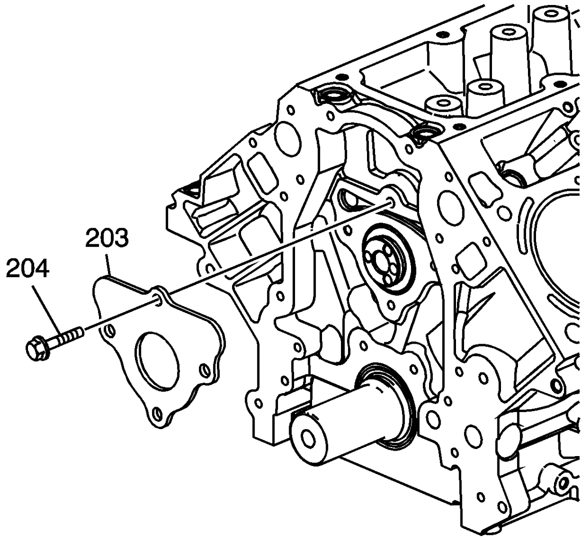
Note 1. If camshaft replacement is required, the valve lifters must also be replaced. **1.** Lubricate the camshaft journals and the bearings with clean engine oil.

2. Install 3 M8 – 1.25 x 100 mm (M8 – 1.25 x 4.0 in) bolts into the camshaft front bolt holes.

Caution: 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.

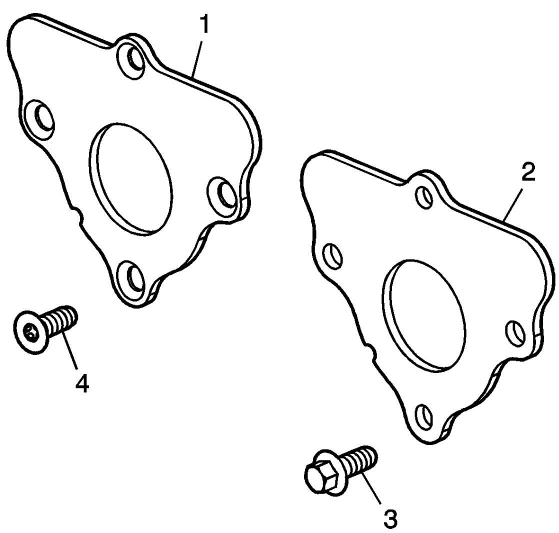
3. Using the bolts as a handle, carefully install the camshaft into the engine block.

4. Remove the 3 bolts from the front of the camshaft.



1552492

Note 5. The gasket surface on the engine block should be clean and free of dirt or debris. **5.** Install the camshaft retainer (203) and the bolts (204). Install the retainer with the sealing gasket facing the front of the engine block.



1665445

Caution: Refer to *Fastener Caution* .

6. Tighten the camshaft retainer bolts.

- Tighten the first design hex head bolts (3) to 25 N·m (18 lb ft) .
- Tighten the second design TORX® head bolts (4) to 15 N·m (11 lb ft) .

Repair Instructions

2136232

Timing Chain and Sprocket Installation

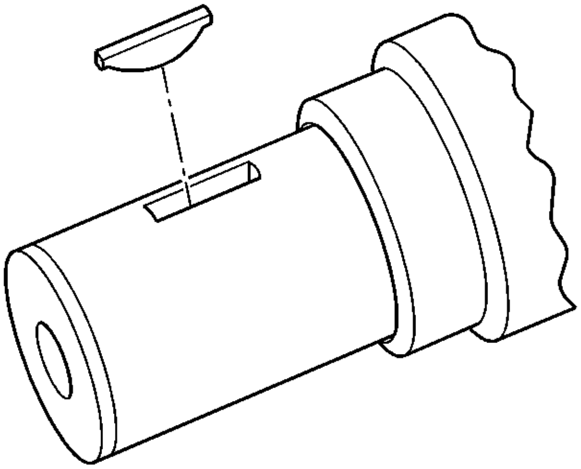
Timing Chain and Sprockets:Installation

Special Tools

- EN 46330 Timing Belt Tensioner Retaining Pin
- J 41478 Crankshaft Front Oil Seal Installer

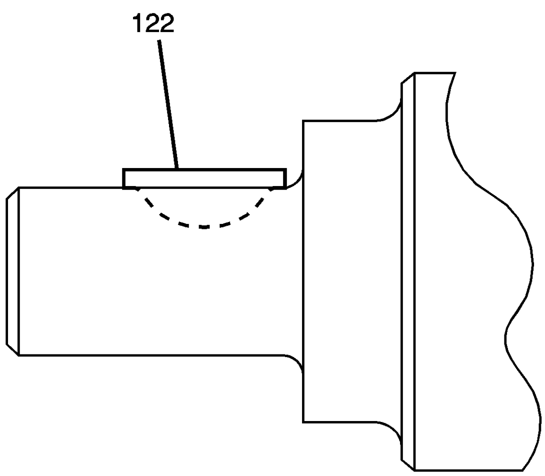
- J 41665-A Crankshaft Balancer and Sprocket Installer
- J 42386-A Flywheel Holding Tool
- J 45059 Angle Meter

For equivalent regional tools, refer to *Special Tools*



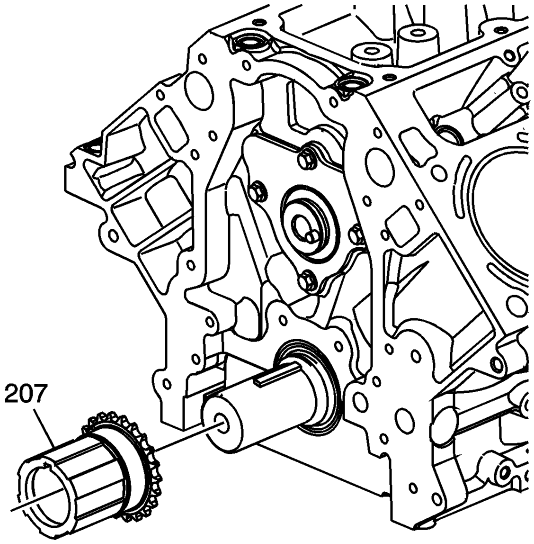
156149

1. Install the key into the crankshaft keyway, if previously removed.



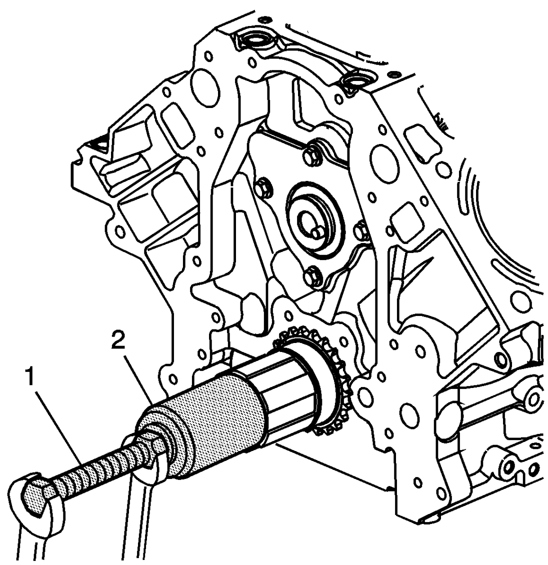
1272887

2. Tap the key (122) into the keyway until both ends of the key bottom onto the crankshaft.



1658182

3. Install the crankshaft sprocket (207) onto the front of the crankshaft. Align the crankshaft key with the crankshaft sprocket keyway.

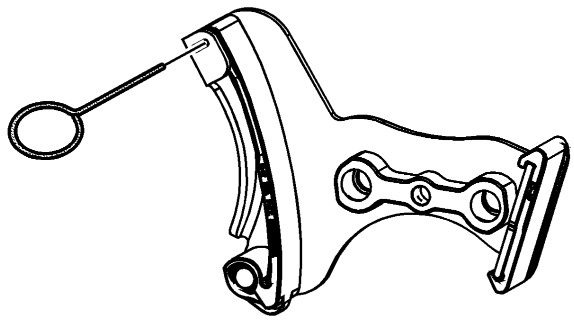


1658237

4. Use the J 41478 installer (1) and the J 41665-A installer (2) in order to install the crankshaft sprocket.

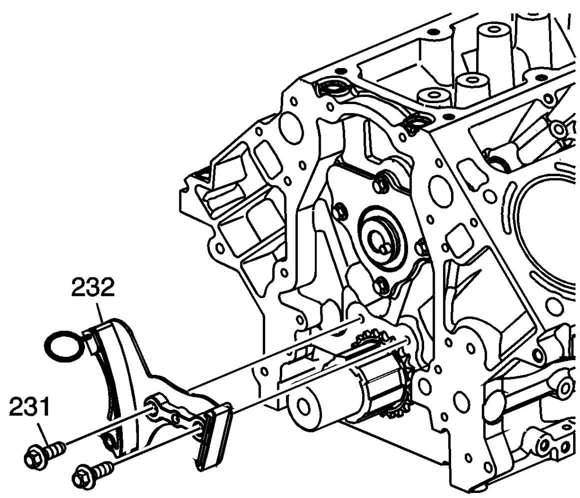
Install the sprocket onto the crankshaft until fully seated against the crankshaft flange.

5. Rotate the crankshaft sprocket until the alignment mark is in the 12 o’clock position.



1658249

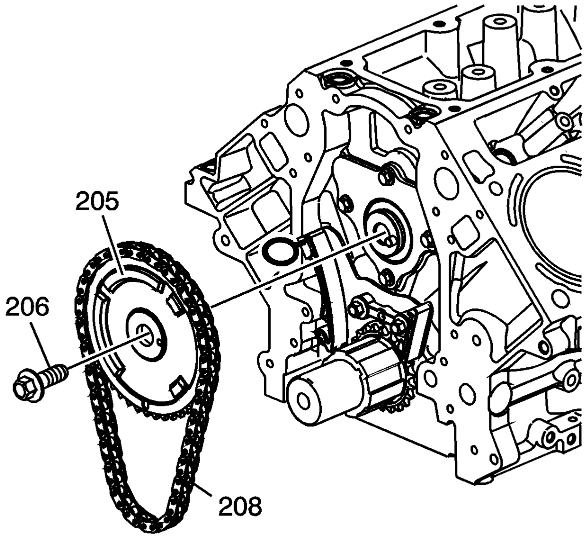
6. Compress the timing chain tensioner guide and install the EN 46330 pin .



1658251

Caution: Refer to *Fastener Caution* .

7. Install the timing chain tensioner (232) and bolts (231) and tighten to 30 N·m (22 lb ft) .

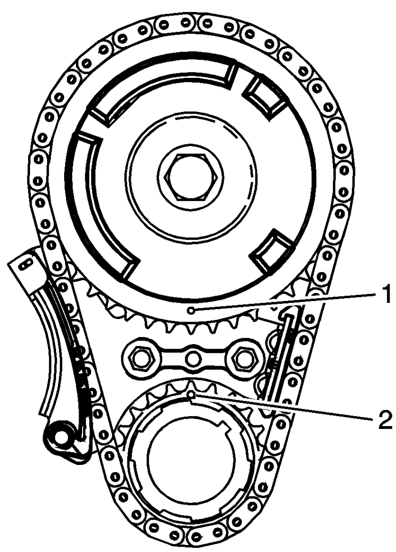


1658265

Note

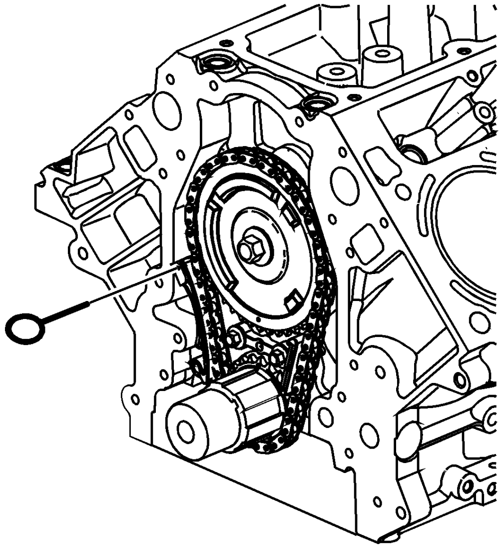
- The sprocket teeth and timing chain must mesh.
- The camshaft and the crankshaft sprocket alignment marks MUST be aligned properly.
- Do not use the camshaft sprocket bolt again. Install a NEW bolt during assembly.

8. Install the camshaft sprocket (205), timing chain (208), and a NEW bolt (206).



1658268

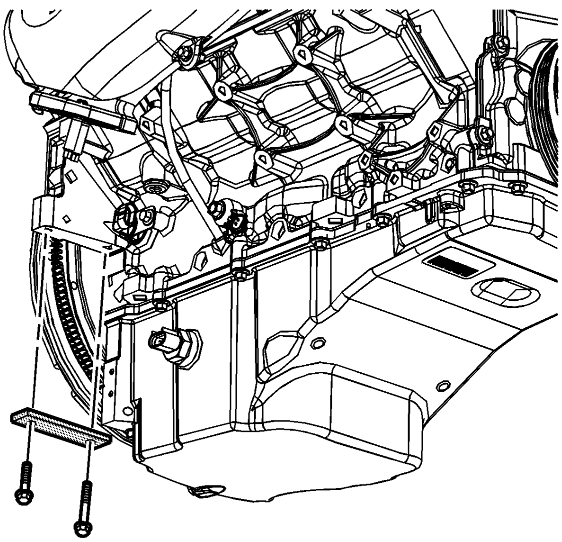
9. Inspect the sprockets for proper alignment. The mark on the camshaft sprocket (1) should be located in the 6 o'clock position and the mark on the crankshaft sprocket (2) should be located in the 12 o'clock position.



1658271

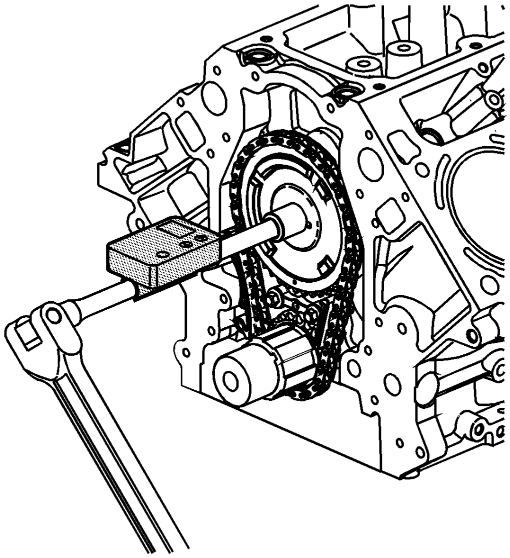
10. Remove the EN 46330 pin .

Note 11. Do not apply threadlock to the flex plate bolts at this time. **11.** Temporarily install the automatic transmission flex plate or manual transmission flywheel and bolts. Refer to *Engine Flywheel Installation (6.2L)* .



1559840

12. Install the J 42386-A tool and bolts. Use 1 M10–1.5 x 120 mm bolt and 1 M10–1.5 x 45 mm bolt for proper tool operation. Tighten the J 42386-A tool bolts to 50 N·m (37 lb ft) .



1658274

13. Tighten the camshaft sprocket bolt.

- Tighten the camshaft sprocket bolt a first pass to 75 N·m (55 lb ft)
- Tighten the camshaft sprocket bolt a final pass an additional 50 degrees using J 45059 meter .

14. Remove the J 42386-A tool and bolts.

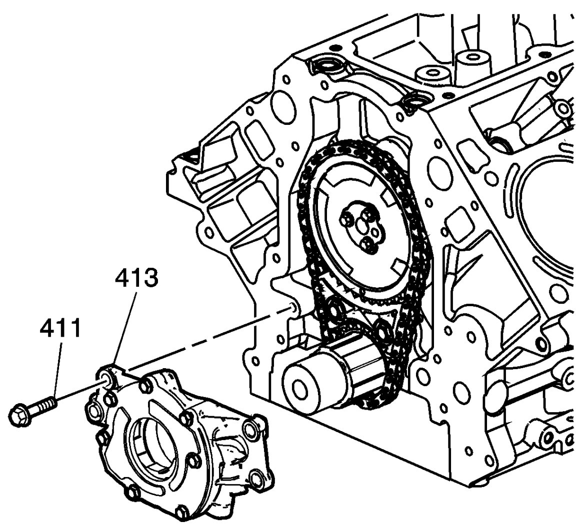
15. Remove the automatic transmission flex plate or manual transmission flywheel and bolts. Refer to *Engine Flywheel Removal* .

Repair Instructions

2136233

Oil Pump, Screen and Crankshaft Oil Deflector Installation (6.2L)

Oil Pump, Screen and Crankshaft Oil Deflector:Installation



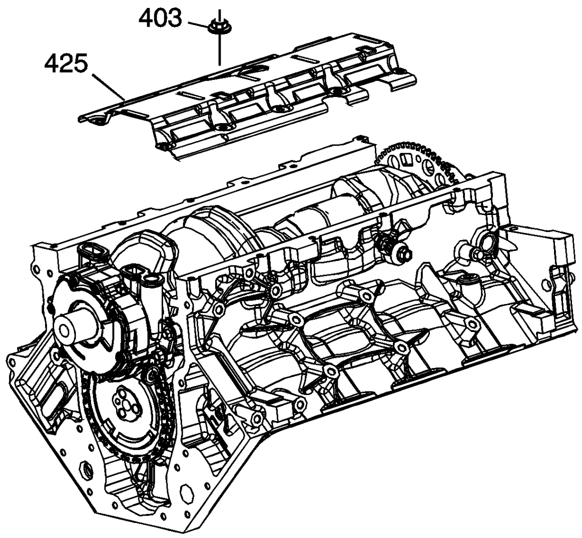
1559865

Note 1. Inspect the oil pump and engine block oil gallery passages. These surfaces must be clear and free of debris or restrictions. Align the splined surfaces of the crankshaft sprocket and the oil pump drive gear and install the oil pump (413).

2. Install the oil pump onto the crankshaft sprocket until the pump housing contacts the face of the engine block.

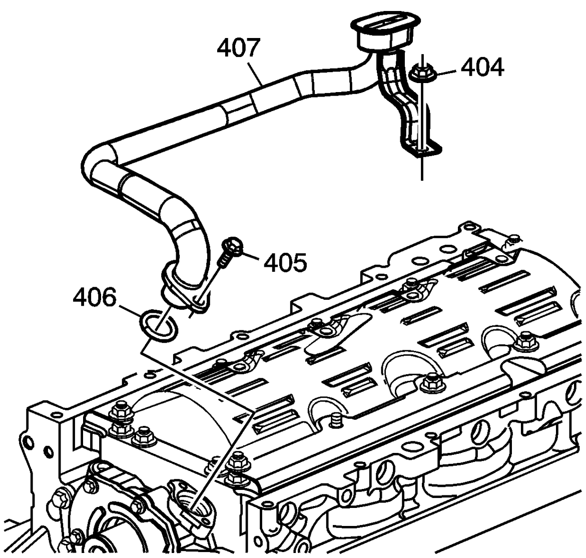
Caution: Refer to *Fastener Caution* .

3. Install the oil pump bolts (411) and tighten to 25 N·m (18 lb ft) .



1552545

4. Install the crankshaft oil deflector (425).



1520947

5. Lubricate a NEW oil pump screen O-ring seal (406) with clean engine oil.

6. Install the NEW O-ring seal onto the oil pump screen.

Note

- Push the oil pump screen tube completely into the oil pump prior to tightening the bolt. Do not allow the bolt to pull the tube into the pump.
- Align the oil pump screen mounting brackets with the correct crankshaft bearing cap bolt/studs.

7. Install the oil pump screen (407).

8. Install the oil pump screen bolt (405) and the deflector nut (404).

- **8.1.** Tighten the oil pump screen bolt to 12 N·m (106 lb in) .
- **8.2.** Tighten the crankshaft oil deflector nut to 25 N·m (18 lb ft) .

Repair Instructions

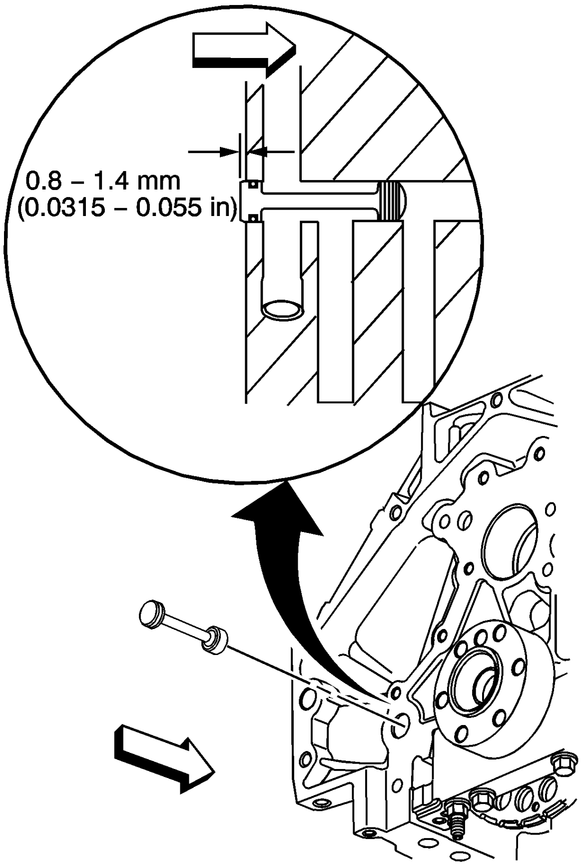
2150246

Crankshaft Rear Oil Seal Housing Installation (Without Seal in Housing)

Special Tools

- J 41476 Front and Rear Cover Alignment Tool
- J 41480 Front and Rear Cover Alignment

For equivalent regional tools, refer to *Special Tools* .

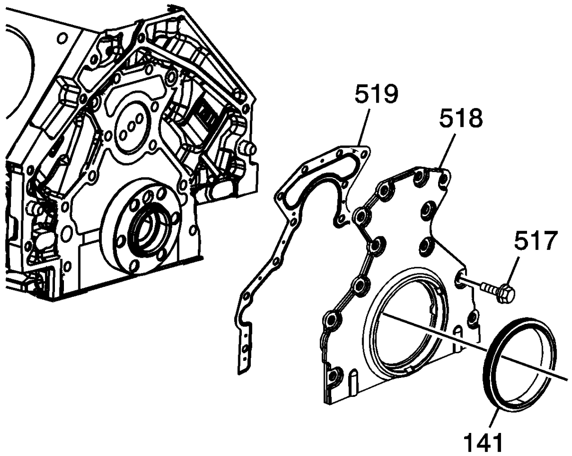


63228

Note

- Do not use the crankshaft rear oil seal or the engine rear housing gasket again.
- Do not apply any type of sealant to the rear housing gasket, unless specified.
- The special tools in this procedure are used to properly align the engine rear housing at the oil pan surface and to center the crankshaft rear oil seal.
- The crankshaft rear oil seal will be installed after the rear housing has been installed and aligned. Install the rear housing without the crankshaft oil seal.
  - The crankshaft rear oil seal MUST be centered in relation to the crankshaft.
  - The oil pan sealing surface at the rear housing, and the engine block, MUST be aligned within specifications.
  - An improperly aligned rear housing may cause premature rear oil seal wear and/or engine assembly oil leaks.

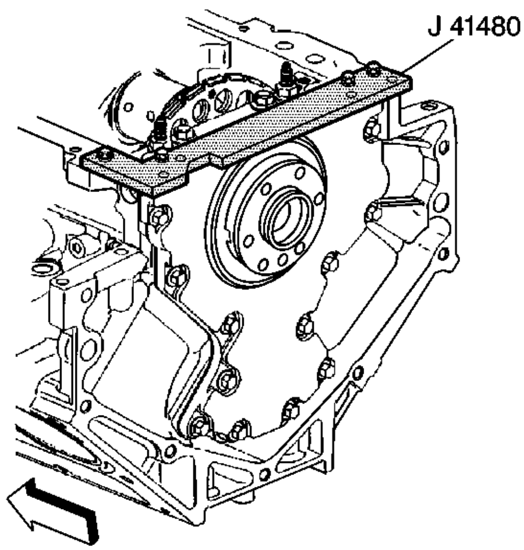
1. Inspect the rear oil gallery plug for proper installation.



1552544

2. Install the rear housing gasket (519), rear housing (518), and bolts (517).

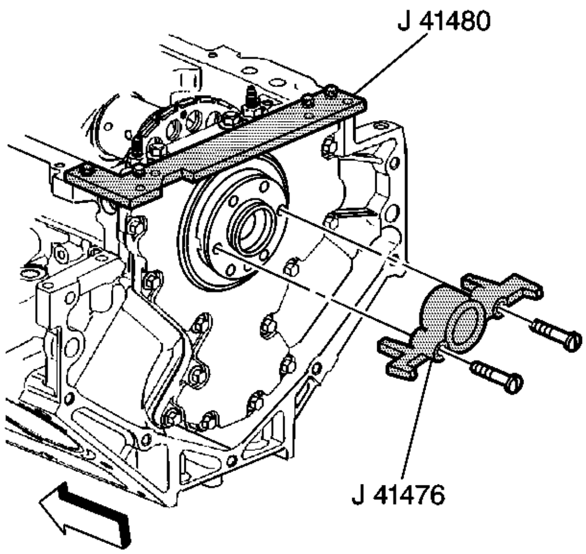
3. Tighten the bolts finger tight. Do not overtighten.



64204

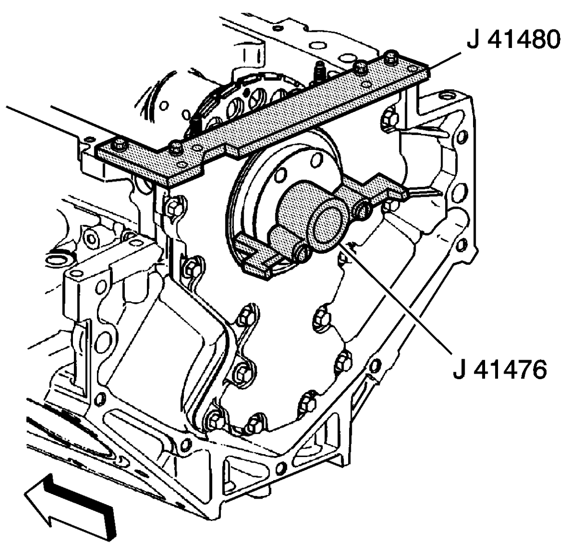
Caution: Refer to *Fastener Caution* .

Note 4. Start the J 41480 alignment tool-to-rear housing bolts. Do not tighten the bolts at this time. **4.** Install the J 41480 alignment and bolts. Tighten the tool-to-engine block bolts to 25 N·m (18 lb ft) .



63243

Note 5. To properly align the rear housing, the J 41476 tool must be installed onto the rear of the crankshaft with the tool mounting bo
Rotate the crankshaft until 2 opposing flywheel bolt holes are parallel to the oil pan surface.

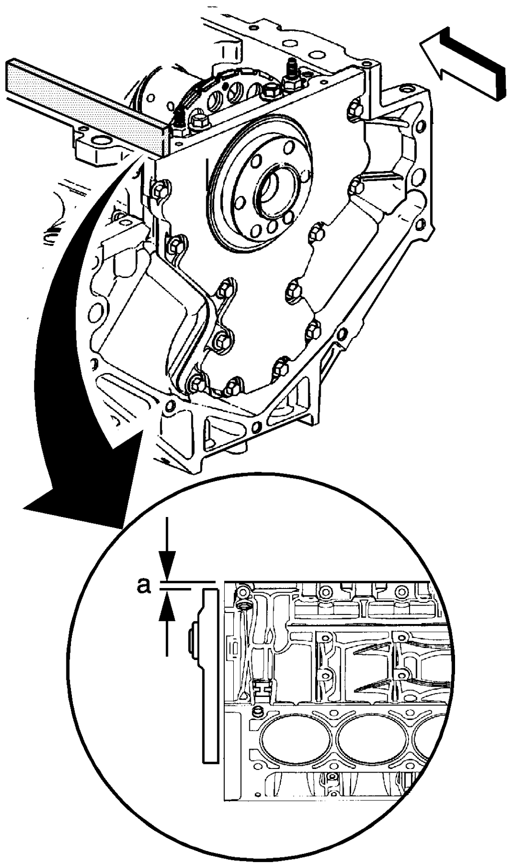


65286

Note 6. The tapered legs of the alignment tool must enter the rear housing oil seal bore. **6.** Install the J 41476 tool and bolts onto the rear of the crankshaft.

- **6.1.** Tighten the tool mounting bolts until snug. Do not overtighten.
- **6.2.** Tighten the J 41480 alignment tool-to-rear housing bolts evenly to 12 N·m (106 lb in) .
- **6.3.** Tighten the rear housing bolts to 30 N·m (22 lb ft) .

7. Remove the tools.



63240

8. Measure the rear housing-to-engine block oil pan surface for flatness.

8.1. Place a straight edge onto the engine block and rear housing oil pan sealing surfaces.

Avoid contact with the portion of the gasket that protrudes into the oil pan surface.

8.2. Insert a feeler gauge between the rear housing and the straight edge. The housing must be flush with the oil pan or no greater than 0.5 mm (0.02 in) below flush (a).

9. If the rear housing-to-engine block oil pan surface alignment is not within specifications, repeat the housing alignment procedure.

10. If the correct rear housing-to-engine block alignment at the oil pan surface cannot be obtained, replace the rear housing.

Repair Instructions

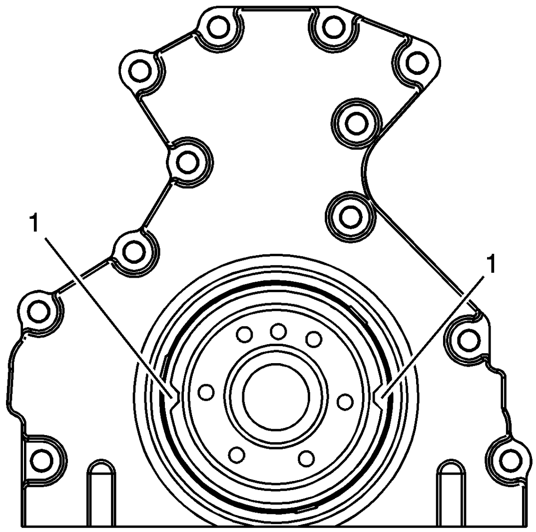
2150248

Crankshaft Rear Oil Seal Housing Installation (With Seal in Housing)

Special Tools

- J 41479-2A Crankshaft Rear Oil Seal Installation Guide
- J 41480 Front and Rear Cover Alignment

For equivalent regional tools, refer to *Special Tools*

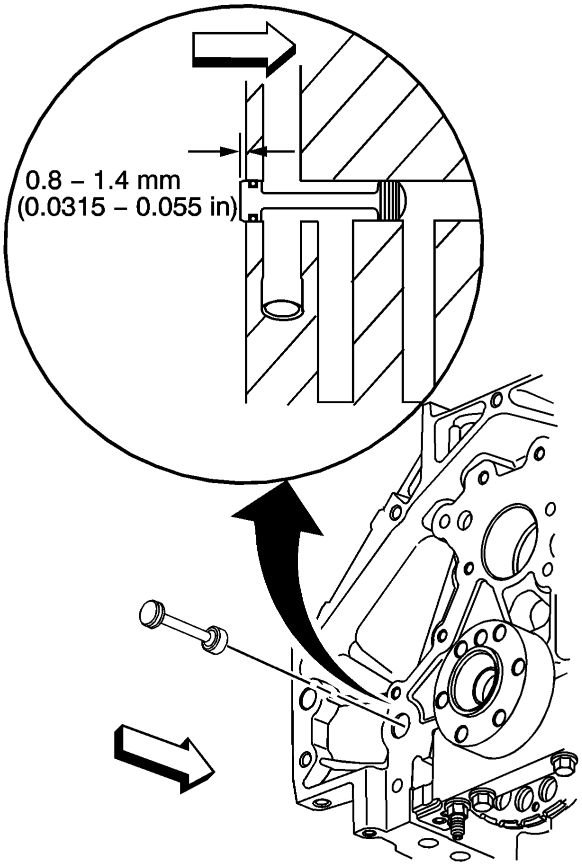


1977797

Note

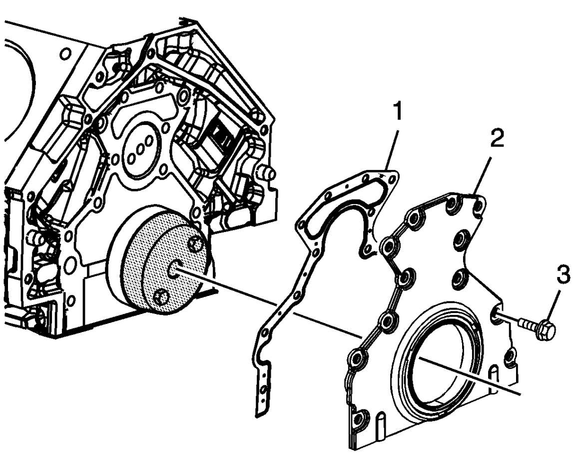
- Do not use the crankshaft rear oil seal or the engine rear housing gasket again.
- Do not apply any type of sealant to the rear housing gasket, unless specified.
- The special tool in this procedure is used to properly align the engine rear housing at the oil pan surface.
- First design rear housings do not have alignment tabs for alignment of the housing horizontally. J 41476 tool is required to properly align first design rear housings. The rear oil seal must be removed from the housing for proper use of the tool.
- Second design rear housings have alignment tabs for alignment of the housing horizontally. J 41476 tool is not required for proper alignment of second design rear housings. The housing may be installed and aligned with the seal already installed into the housing.

1. Inspect the rear housing to identify for alignment tabs (1).



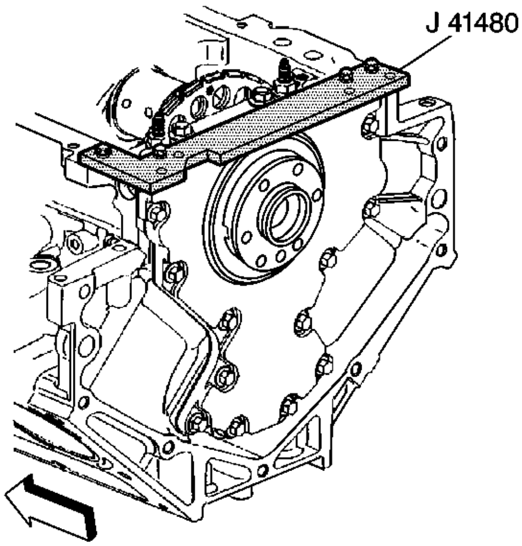
63228

2. Inspect the rear oil gallery plug for proper installation.



1977798

3. Install the J 41479-2A guide cone and bolts onto the rear of the crankshaft.
4. Tighten the bolts until snug. Do not overtighten.
5. Install the rear housing gasket (1), rear housing with seal (2), and bolts (3).
6. Tighten the bolts finger tight. Do not overtighten.
7. Remove the J 41479-2A guide and bolts.



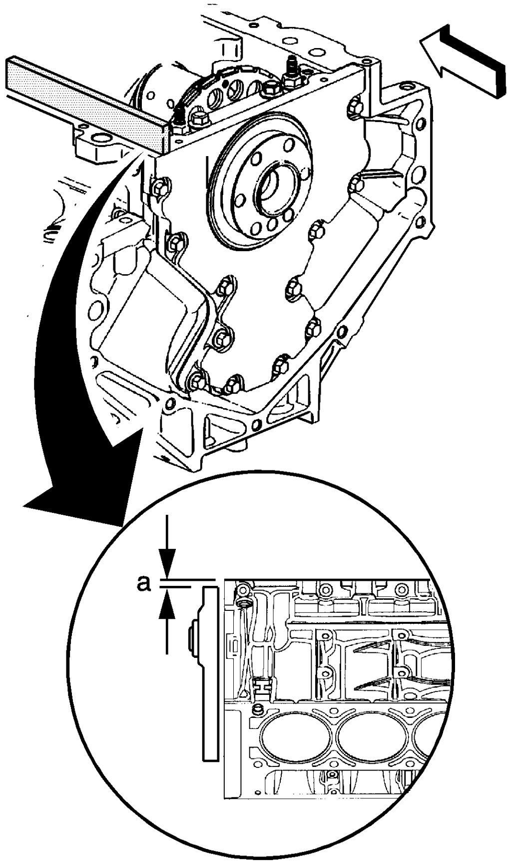
64204

Caution: Refer to *Fastener Caution* .

8. Install the J 41480 alignment and bolts.

- **8.1.** Tighten the tool-to-engine block bolts to 25 N·m (18 lb ft) .
- **8.2.** Tighten the J 41480 alignment tool-to-rear housing bolts evenly to 12 N·m (106 lb in) .
- **8.3.** Tighten the rear housing-to-engine block bolts to 30 N·m (22 lb ft) .

9. Remove the J 41480 alignment and bolts.



63240

10. Measure the rear housing-to-engine block oil pan surface for flatness.

10.1. Place a straight edge onto the engine block and rear housing oil pan sealing surfaces.

Avoid contact with the portion of the gasket that protrudes into the oil pan surface.

10.2. Insert a feeler gauge between the rear housing and the straight edge. The housing must be flush with the oil pan or no greater than 0.5 mm (0.02 in) (a) below flush.

11. If the rear housing-to-engine block oil pan surface alignment is not within specifications, repeat the housing alignment procedure.

12. If the correct rear housing-to-engine block alignment at the oil pan surface cannot be obtained, replace the rear housing.

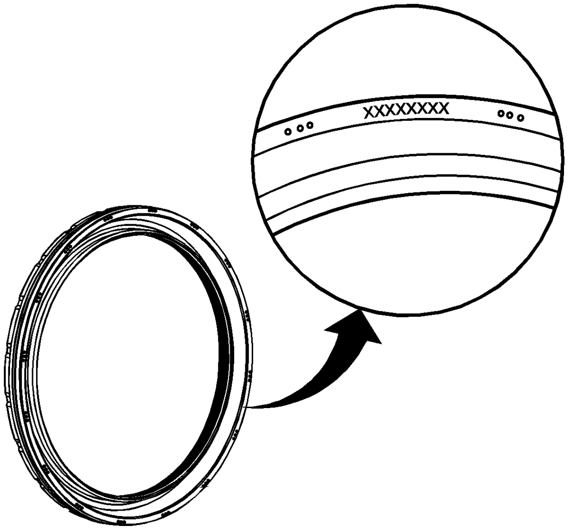
Repair Instructions

1765631

Crankshaft Rear Oil Seal Installation

Special Tools

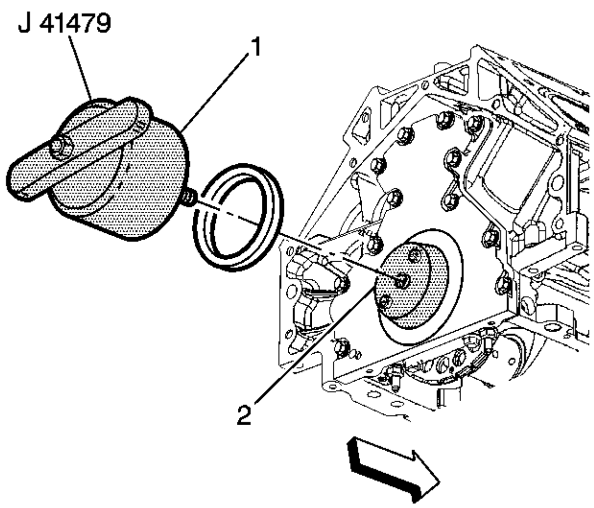
- *J 41479* Crankshaft Rear Oil Seal Installer
- *J 41479-2A* Crankshaft Rear Oil Seal Installation Guide



1699207

Important: For proper orientation, note the installation direction of the oil seal. The oil seal is a reverse-lip design. The part number is applied to the outside face of the seal, as shown.

1. Inspect the seal and identify the part number markings for proper orientation.



63200

2. Install the *J 41479* or the *J 41479-2A* cone (2) and bolts onto the rear of the crankshaft. The *J 41479-2A* may be required for manual transmission or 5.3L LS4 applications.

3. Tighten the bolts until snug. Do not overtighten.

4. Install the rear oil seal onto the tapered cone (2) and push the seal to the rear seal bore. Install the oil seal with the part number markings facing away from the engine.

5. Thread the *J 41479* threaded rod into the tapered cone until the tool (1) contacts the oil seal.

6. Align the oil seal onto the tool (1).

7. Rotate the handle of the tool (1) clockwise until the seal enters the rear housing and bottoms into the seal bore.

8. Remove the tool.

Repair Instructions

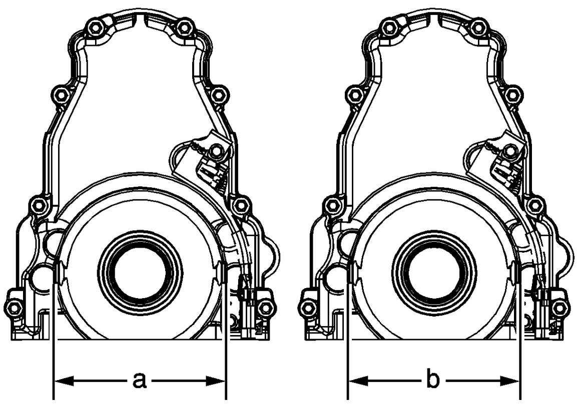
2363144

Engine Front Cover Installation

Special Tools

- EN-48853 Front Cover Alignment Tool
- J 41480 Front and Rear Cover Alignment

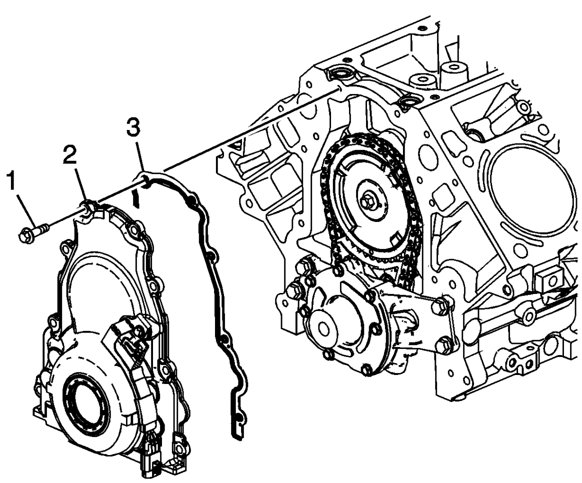
For equivalent regional tools, refer to *Special Tools* .



2038350

1. Measure the alignment tab distance on the front cover.

The engine front cover may have either a 141 mm (5.55 in) dimension (a) or 159 mm (6.26 in) dimension (b) alignment tab distance. Front cover alignment tool EN-48853 alignment tool is designed to properly align both front covers. For the 141 mm (5.55 in) cover, adapters EN-48853-2 must be used.



1704624

Caution: Refer to *Fastener Caution* .

Note

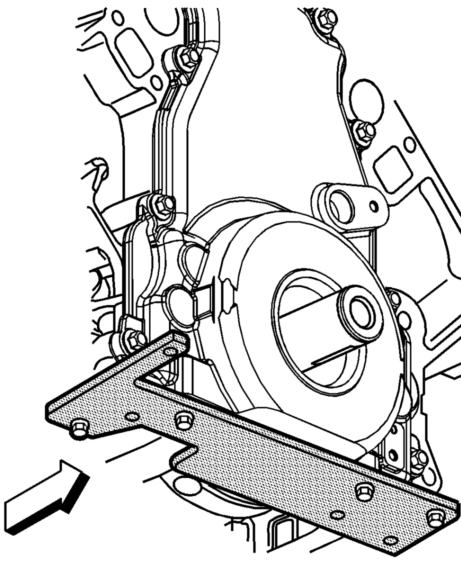
- Do not use the crankshaft oil seal or the engine front cover gasket again.
- Do not apply any type of sealant to the front cover gasket, unless specified.

- The special tools in this procedure are used to properly align the engine front cover at the oil pan surface and to center the crankshaft front oil seal.
  - All gasket surfaces should be free of oil or other foreign material during assembly.

    The crankshaft front oil seal MUST be centered in relation to the crankshaft.
  - The oil pan sealing surface at the front cover and engine block MUST be aligned within specifications.
  - An improperly aligned front cover may cause premature front oil seal wear and/or engine assembly oil leaks.

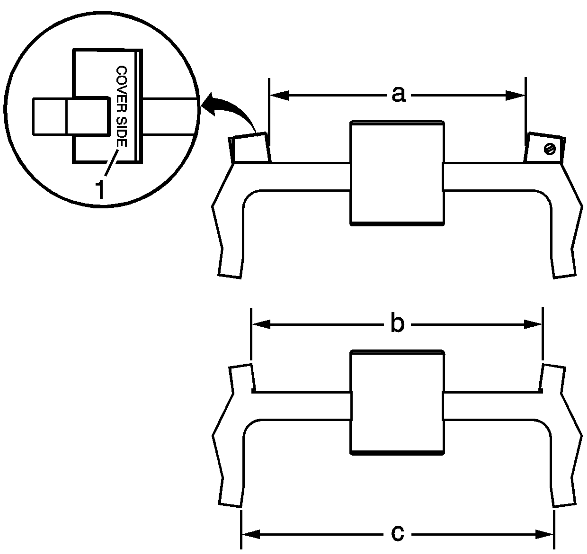
2. Install the front cover gasket (3), front cover (2), and bolts (1).

3. Tighten the cover bolts finger tight. Do not overtighten.



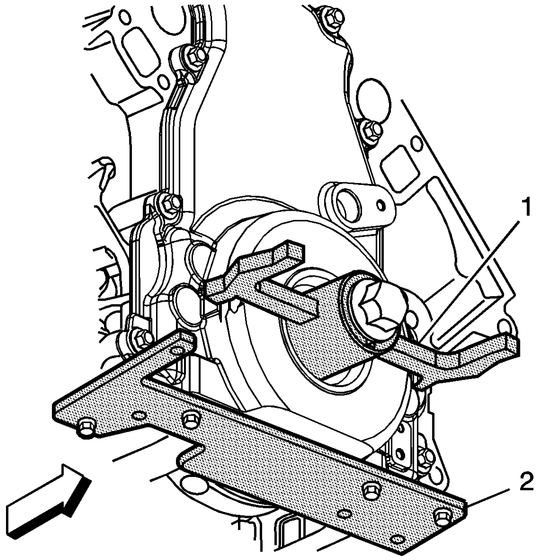
2038351

Note 4. Start the tool-to-front cover bolts. Do not tighten the bolts at this time. **4.** Install the J 41480 cover alignment and tighten the tool-to-engine block bolts to 25 N·m (18 lb ft) .



2037005

5. Install the EN-48853-2 adapters as required for usage on the 141 mm (5.55 in) dimension (a) front cover. Position the adapters against the legs of the EN-48853 tool with the words “cover side” (1) facing away from the tool.



2038352

Note 6. Align the tapered legs of the tool with the machined alignment surfaces on the front cover. **6.** Install the EN-48853 alignment tool (1).

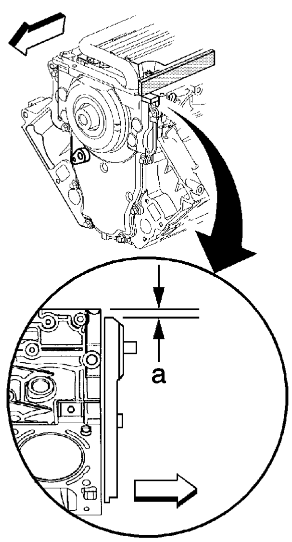
7. Install the crankshaft balancer bolt.

8. Tighten the crankshaft balancer bolt by hand until snug. Do not overtighten.

9. Tighten the J 41480 cover alignment (2).

10. Tighten the engine front cover bolts to 25 N·m (18 lb ft) .

11. Remove the tools.



1402104

12. Measure the oil pan surface flatness, front cover-to-engine block.

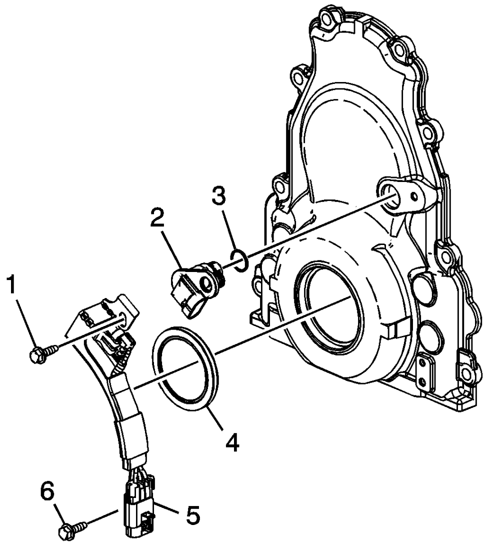
12.1. Place a straight edge across the engine block and front cover oil pan sealing surfaces.

Avoid contact with the portion of the gasket that protrudes into the oil pan surface.

12.2. Insert a feeler gauge between the front cover and the straight edge tool. The cover must be flush with the oil pan surface or no greater than 0.3 mm (0.0118 in) (a) below flush.

13. If the front cover-to-engine block oil pan surface alignment is not within specifications, repeat the cover alignment procedure.

14. If the correct front cover-to-engine block alignment cannot be obtained, replace the front cover.



1704625

15. Inspect the camshaft position (CMP) sensor O-ring seal (3) for cuts or damage. If the seal is not cut or damaged, it may be used again.

16. Lubricate the O-ring seal with clean engine oil.

17. Install the O-ring seal onto the sensor (2).

18. Install the sensor to the cover.

19. Install the CMP sensor wire harness (5) and bolts (1, 6). Tighten the bolts to 12 N·m (106 lb in) .

Repair Instructions

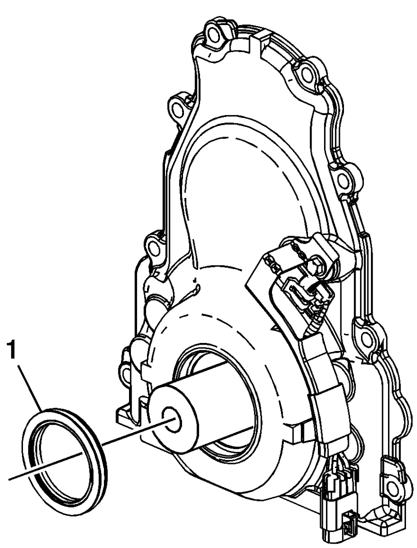
2158650

Crankshaft Front Oil Seal Installation

Special Tools

- EN-47812 Installer Bolt
- J 41478 Crankshaft Front Oil Seal Installer
- J 41478-1A Crankshaft Front Oil Seal Installer Cone

For equivalent regional tools, refer to *Special Tools*



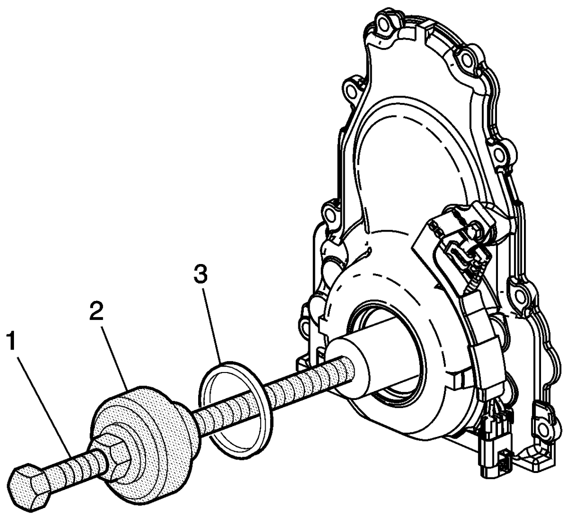
1704631

Note

- Do not lubricate the oil seal sealing surface.
- Do not use the crankshaft front oil seal again.

1. Lubricate the outer edge of the oil seal (1) with clean engine oil.

2. Lubricate the front cover oil seal bore with clean engine oil.



2174069

3. Using the EN-47812 bolt and the J 41478 installer , install the crankshaft front oil seal.

4. Install the EN-47812 bolt threaded rod (1), nut, washer, the J 41478-1A installer cone (2), and oil seal (3) into the end of the crankshaft.

5. Use the J 41478 installer in order to install the oil seal into the cover bore.

  5.1. Use a wrench and hold the hex on the installer bolt.

  5.2. Use a second wrench and rotate the installer nut clockwise until the seal bottoms in the cover bore.

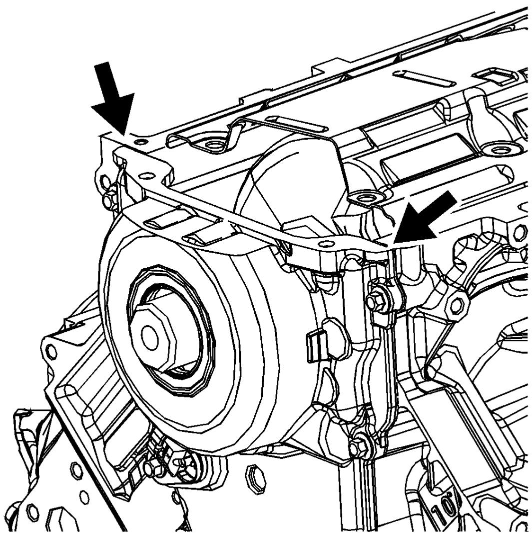
  5.3. Remove the tool.

  5.4. Inspect the oil seal for proper installation. The oil seal should be installed evenly and completely into the front cover bore.

Repair Instructions

2159114

Oil Pan Installation

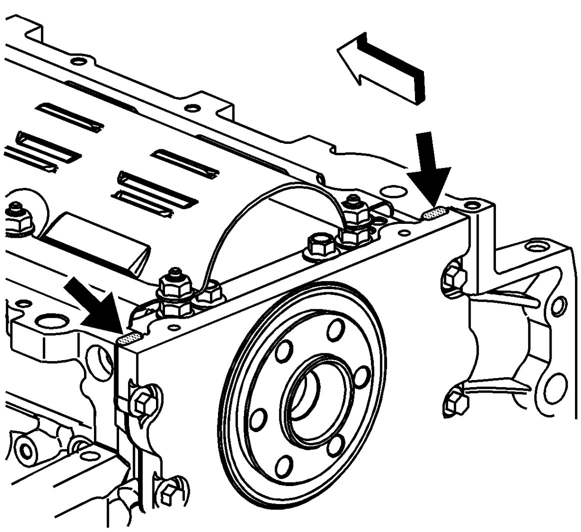


1669850

Note

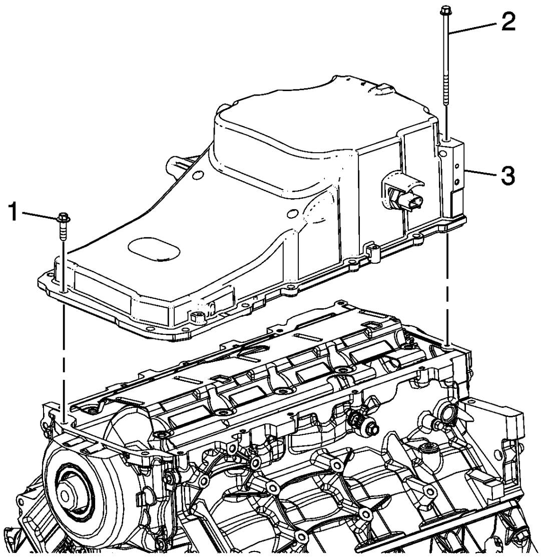
- The alignment of the structural oil pan is critical. The rear bolt hole locations of the oil pan provide mounting points for the transmission housing. To ensure the rigidity of the powertrain and correct transmission alignment, it is important that the rear of the block and the rear of the oil pan are flush, or even. The rear of the oil pan must NEVER protrude beyond the engine block and transmission housing plane.
- Do not use the oil pan gasket again.
- It is not necessary to rivet the NEW gasket to the oil pan.

1. Apply a 5 mm (0.2 in) bead of sealant GM P/N 12378521 (Canadian P/N 88901148), or equivalent, 20 mm (0.8 in) long to the engine block. Apply the sealant directly onto the tabs of the front cover gasket that protrude into the oil pan surface. Refer to *Adhesives, Fluids, Lubricants, and Sealers* .



63175

2. Apply a 5 mm (0.2 in) bead of sealant GM P/N 12378521 (Canadian P/N 88901148), or equivalent, 20 mm (0.8 in) long to the engine block. Apply the sealant directly onto the tabs of the rear housing gasket that protrude into the oil pan surface.



2156782

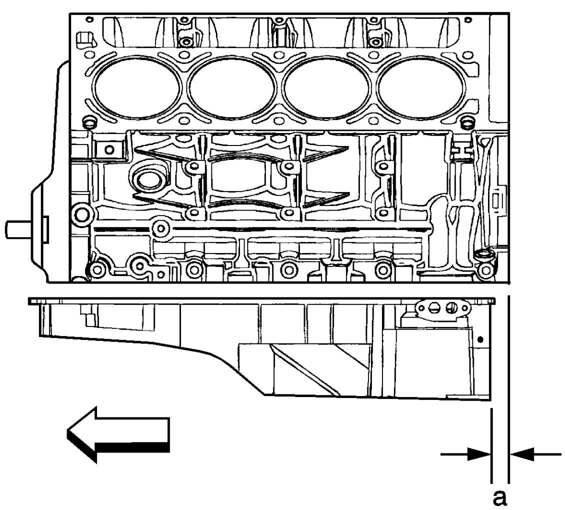
3. Pre-assemble the oil pan gasket to the pan.

3.1. Install the gasket onto the oil pan.

3.2. Install the oil pan bolts (1, 2) to the pan and through the gasket.

4. Install the oil pan (3), gasket and bolt to the engine block.

5. Tighten the bolts finger tight. Do not overtighten.



1552565

6. Place a straight edge across the rear of the engine block and the rear of the oil pan at the transmission housing mounting surfaces.

Caution: Refer to *Fastener Caution* .

7. Align the oil pan until the rear of the engine block and the rear of the oil pan are flush, or even.

8. Tighten the oil pan-to-block and oil pan-to-front cover bolts to 25 N·m (18 lb ft) .

9. Tighten the oil pan-to-rear cover bolts to 12 N·m (106 lb in) .

10. Measure the oil pan-to-engine block alignment.

10.1. Place a straight edge across the rear of the engine block and rear of oil pan at the transmission housing mounting surfaces.

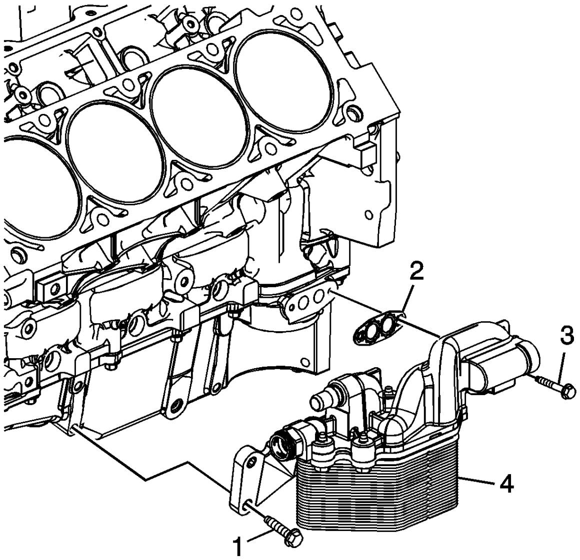
Note **10.2.** The rear of the oil pan must NEVER protrude beyond the engine block and transmission housing mounting s
Insert a feeler gauge between the straight edge and the oil pan transmission housing mounting surface. The rear of oil pan must be flush with the rear face of block or no greater than 0.5 mm (0.02 in) below flush (a).

10.4. If the oil pan alignment is not within specifications, remove the oil pan and repeat the above procedure.

Repair Instructions

2158656

Engine Oil Cooler Installation

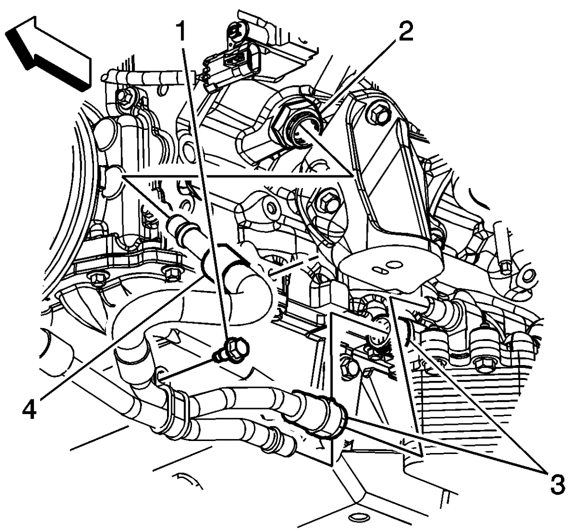


2054178

1. Install the oil cooler gasket (2).
2. Install the oil cooler (4).

Caution: Refer to *Fastener Caution* .

3. Install the oil cooler M8 (1) and M6 (3) bolts.
   - Tighten the M6 bolts to 10 N·m (89 lb in) .
   - Tighten the M8 bolts to 25 N·m (18 lb ft) .



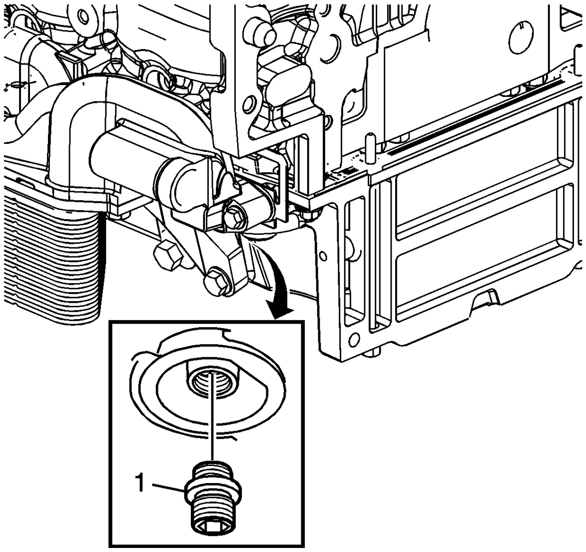
2142312

4. Install the engine oil cooler coolant fitting (2) to the block, as required and tighten to 50 N·m (37 lb ft) .
5. Install the hose/pipe (4) to the fitting (2) and cooler (3).
6. Install the bolt and tighten to 25 N·m (18 lb ft) .

Repair Instructions

2159115

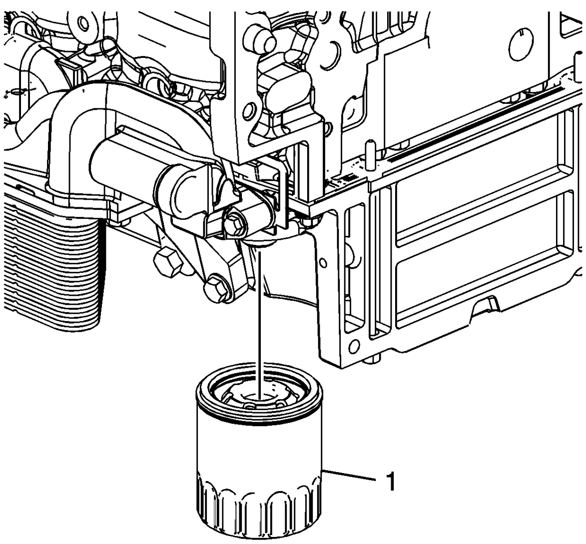
Oil Filter Installation



2054171

Caution: Refer to *Fastener Caution* .

1. Install the oil filter fitting (1) and tighten to 55 N·m (40 lb ft) .



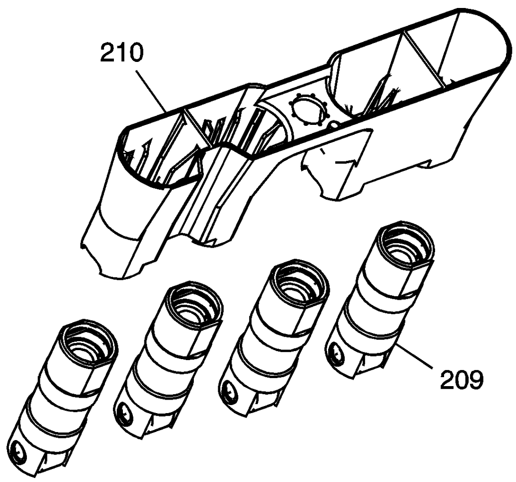
2054167

2. Lubricate the oil filter seal with clean engine oil.
3. Install the oil filter (1) and tighten to 30 N·m (22 lb ft) .

Repair Instructions

2136240

Valve Lifter Installation



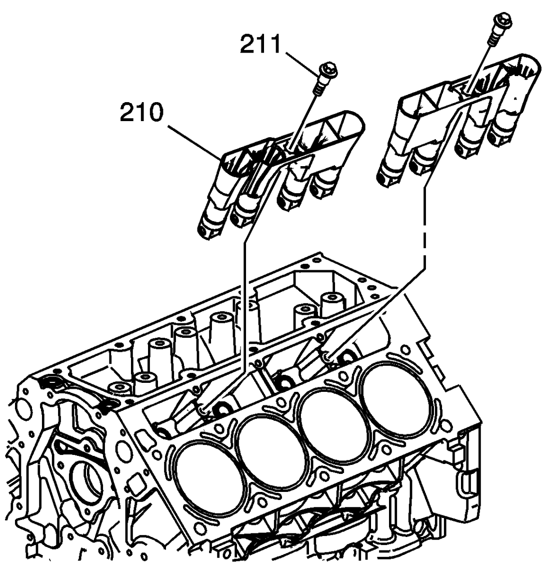
1403319

Note

- When using the valve lifters again, install the lifters to their original locations.
- If camshaft replacement is required, the valve lifters must also be replaced.

1. Lubricate the valve lifters (209) and engine block valve lifter bores with clean engine oil.
2. Insert the valve lifters into the lifter guides (210).

   Align the flat area on the top of the lifter with the flat area in the lifter guide bore. Push the lifter completely into the guide bore.



1403318

3. Install the valve lifters and guide assembly (210) to the engine block.

Caution: Refer to *Fastener Caution* .

4. Install the valve lifter guide bolts (211).

   Tighten: Tighten the valve lifter guide bolts to 12 N·m (106 lb in).

Repair Instructions

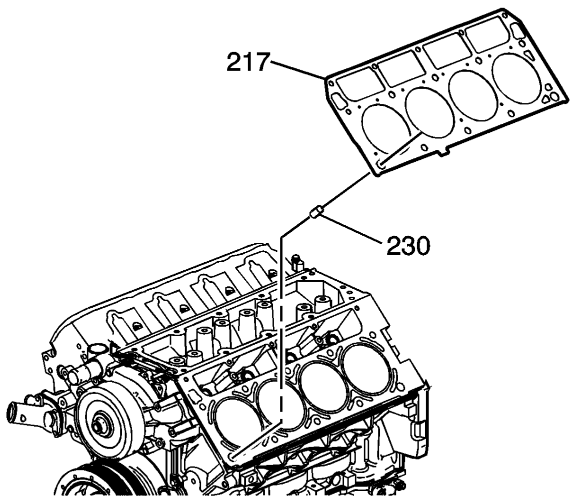
2159116

Cylinder Head Installation - Left Side

Special Tools

- J 42385-100 Thread Repair Kit
- J 45059 Angle Meter

For equivalent regional tools, refer to *Special Tools*



1408869

Warning **1.** Refer to *Safety Glasses Warning* .

Caution: Clean all dirt, debris, and coolant from the engine block cylinder head bolt holes. Failure to remove all foreign material may result in damaged threads, improperly tightened fasteners or damage to components.

Note

- Do not use the cylinder head bolts again. Install NEW cylinder head bolts during assembly.
- Do not use any type of sealant on the cylinder head gasket, unless specified.
- The cylinder head gaskets must be installed in the proper direction and position.

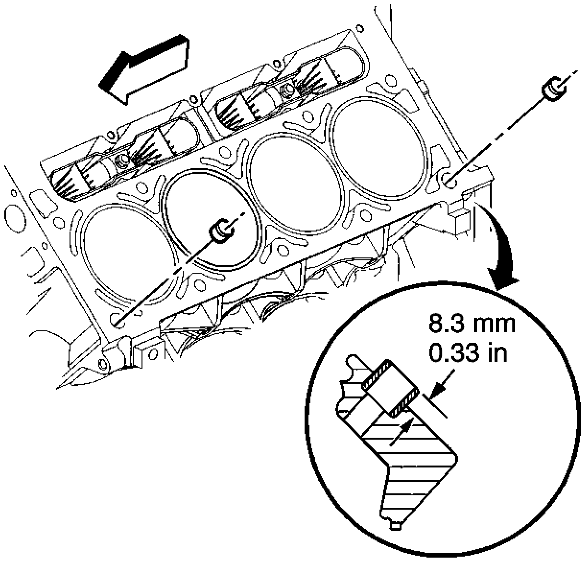
1. Clean the engine block cylinder head bolt holes, if required.

Thread repair tool J 42385-107 may be used to clean the threads of old threadlocking material.

2. Spray cleaner GM P/N 12346139 (Canadian P/N 10953463), GM P/N 12377981 (Canadian P/N 10953463), or equivalent, into the hole.

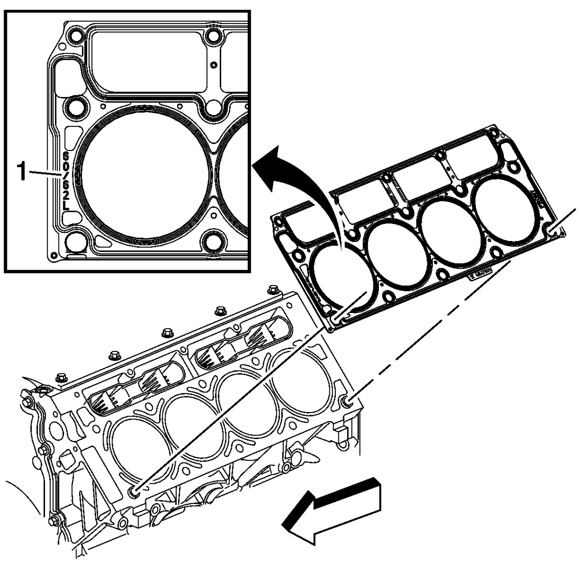
3. Clean the cylinder head bolt holes with compressed air.

4. Install the cylinder head locating pins (230).



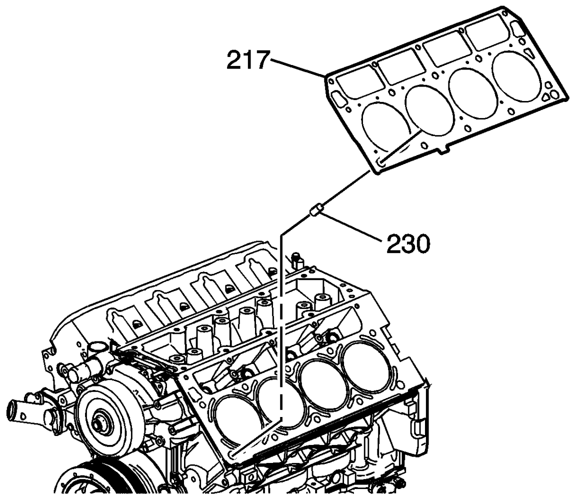
1481465

5. Inspect the locating pins for proper installation.



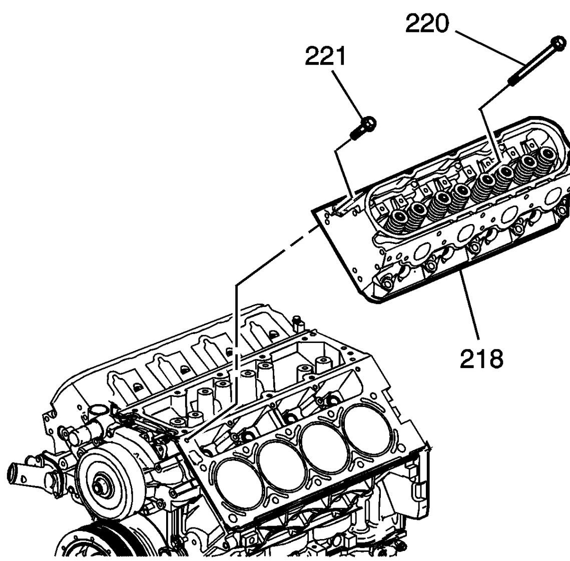
2156855

6. Inspect the displacement markings (1) on the gasket for proper usage.



1408869

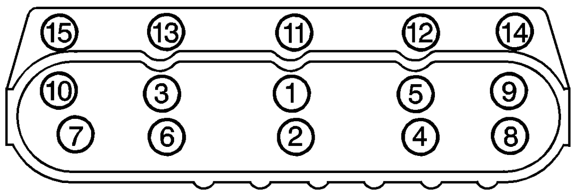
7. Install the NEW cylinder head gasket (217) onto the locating pins.



1408868

8. Install the cylinder head (218) onto the locating pins and the gasket.

9. Install the NEW cylinder head bolts (220, 221).



260150

Caution: Refer to *Fastener Caution* .

10. Tighten the cylinder head bolts.

10.1. Tighten the M11 cylinder head bolts (1–10) a first pass in sequence to 50 N·m (37 lb ft) .

10.2. Tighten the M11 cylinder head bolts (1–10) a second pass in sequence to 80 degrees using the J 45059 meter .

10.3. Tighten the M11 cylinder head bolts (1–10) a final pass in sequence to 55 degrees using the J 45059 meter .

10.4. Tighten the M8 cylinder head bolts (11–15) to 30 N·m (22 lb ft) . Begin with the center bolt (11) and alternating side-to-side, work outward tightening all of the bolts.

Repair Instructions

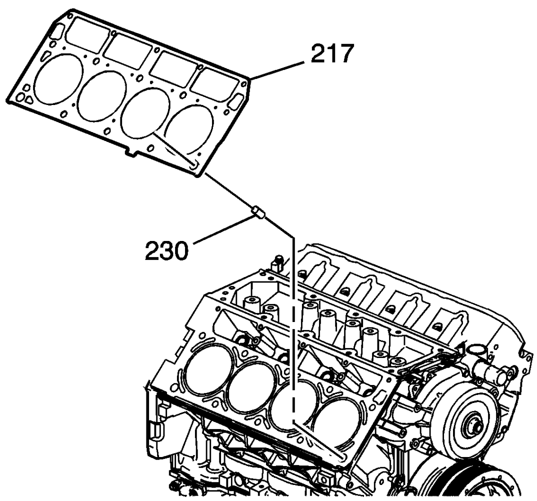
2159117

Cylinder Head Installation - Right Side

Special Tools

- J 42385-100 Thread Repair Kit
- J 45059 Angle Meter

For equivalent regional tools, refer to *Special Tools*



1408871

Warning **1.** Refer to *Safety Glasses Warning* .

Caution: Clean all dirt, debris, and coolant from the engine block cylinder head bolt holes. Failure to remove all foreign material may result in damaged threads, improperly tightened fasteners or damage to components.

Note

- Do not use the cylinder head bolts again. Install NEW cylinder head bolts during assembly.
- Do not use any type of sealant on the cylinder head gasket, unless specified.
- The cylinder head gaskets must be installed in the proper direction and position.

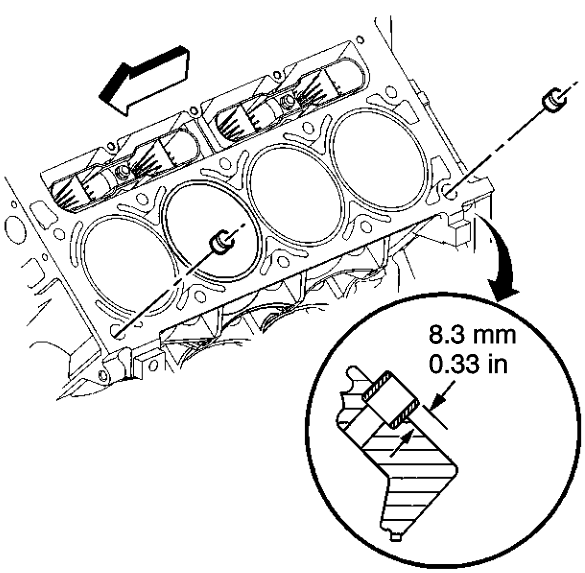
1. Clean the engine block cylinder head bolt holes, if required.

Thread repair tool J 42385-107 may be used to clean the threads of old threadlocking material.

2. Spray cleaner GM P/N 12346139 (Canadian P/N 10953463), GM P/N 12377981 (Canadian P/N 10953463), or equivalent, into the hole.

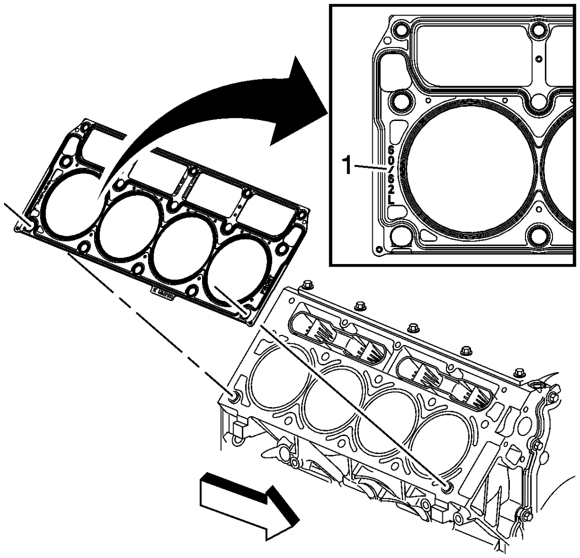
3. Clean the cylinder head bolt holes with compressed air.

4. Install the cylinder head locating pins (230).



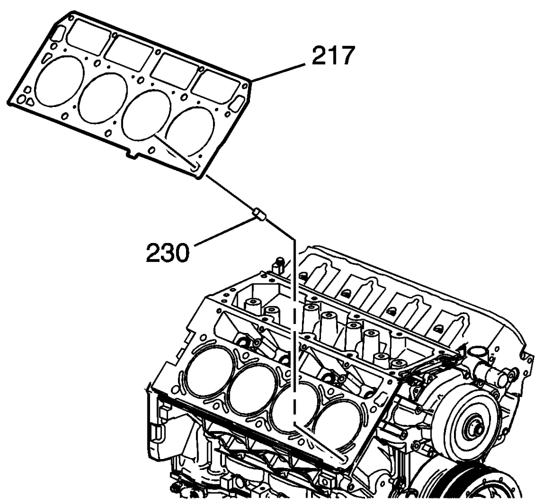
1481465

5. Inspect the locating pins for proper installation.



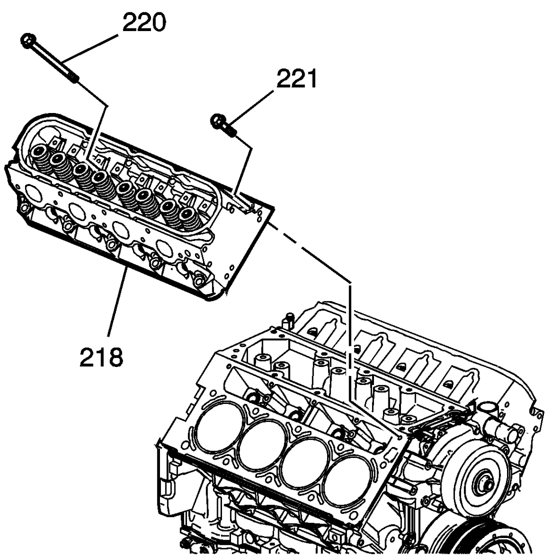
2156862

6. Inspect the displacement markings (1) on the gasket for proper usage.



1408871

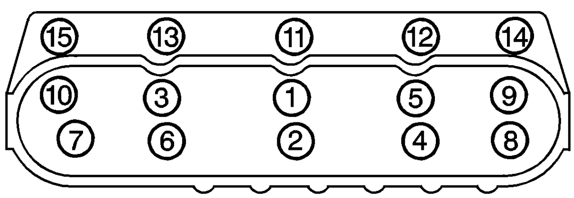
7. Install the NEW cylinder head gasket (217) onto the locating pins.



1408870

8. Install the cylinder head (218) onto the locating pins and the gasket.

9. Install the NEW cylinder head bolts (220, 221).



260150

Caution: Refer to *Fastener Caution* .

10. Tighten the cylinder head bolts.

10.1. Tighten the M11 cylinder head bolts (1–10) a first pass in sequence to 50 N·m (37 lb ft) .

10.2. Tighten the M11 cylinder head bolts (1–10) a second pass in sequence to 80 degrees using the J 45059 meter .

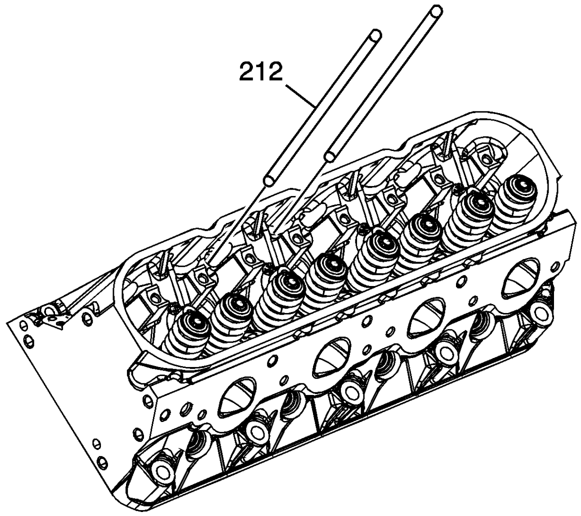
10.3. Tighten the M11 cylinder head bolts (1–10) a final pass in sequence to 55 degrees using the J 45059 meter .

10.4. Tighten the M8 cylinder head bolts (11–15) to 30 N·m (22 lb ft) . Begin with the center bolt (11) and alternating side-to-side, work outward tightening all of the bolts.

Repair Instructions

2159118

Valve Rocker Arm and Push Rod Installation



1552510

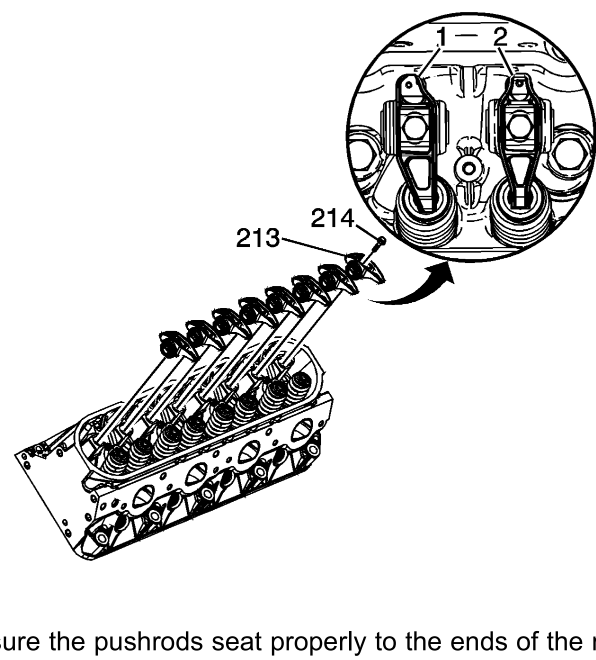
Note

- When using the valve train components again, always install the components to the original location and position.
- Valve lash is net build, no valve adjustment is required.

1. Lubricate the valve rocker arms and pushrods with clean engine oil.

2. Lubricate the flange of the valve rocker arm bolts with clean engine oil.

Note **3.** Ensure the pushrods seat properly to the valve lifter sockets. **3.** Install the pushrods (212).

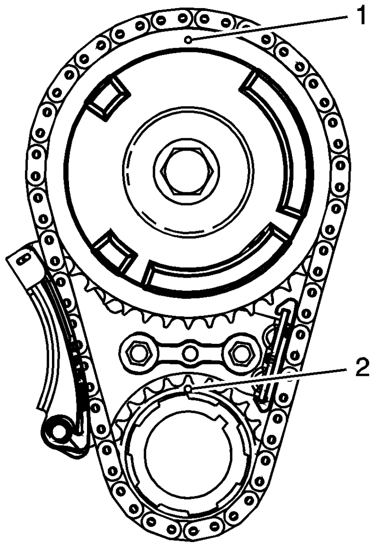


1552511

Note

- Ensure the pushrods seat properly to the ends of the rocker arms.
- DO NOT tighten the rocker arm bolt at this time.

4. Install the rocker arms (213) and bolts (214). Note the locations of the intake (1) and exhaust (2) valve rocker arms. The intake rocker arms (1) have an offset design.



1658282

5. Rotate the crankshaft until number 1 piston is at top dead center of compression stroke.

In this position, cylinder number 1 rocker arms will be off lobe lift, and the crankshaft sprocket key will be at the 1:30 position. The camshaft and crankshaft sprocket alignment marks (1, 2) will be in the 12 o'clock positions. If viewing from the rear of the engine, the additional crankshaft pilot hole, non-threaded, will be in the 10:30 position.

The engine firing order is 1, 8, 7, 2, 6, 5, 4, 3.

Cylinders 1, 3, 5 and 7 are left bank.

Cylinders 2, 4, 6, and 8 are right bank.

Caution: Refer to *Fastener Caution* .

6. With the engine in the number 1 firing position, tighten the following valve rocker arm bolts:

- Tighten exhaust valve rocker arm bolts 1, 2, 7, and 8 to 30 N·m (22 lb ft) .
- Tighten intake valve rocker arm bolts 1, 3, 4, and 5 to 30 N·m (22 lb ft) .

7. Rotate the crankshaft 360 degrees.

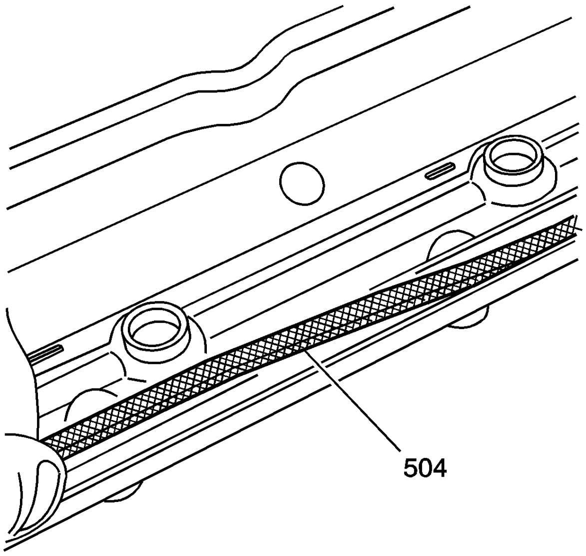
8. Tighten the following valve rocker arm bolts:

- Tighten exhaust valve rocker arm bolts 3, 4, 5, and 6 to 30 N·m (22 lb ft) .
- Tighten intake valve rocker arm bolts 2, 6, 7, and 8 to 30 N·m (22 lb ft) .

Repair Instructions

2159119

Valve Rocker Arm Cover Installation - Left Side



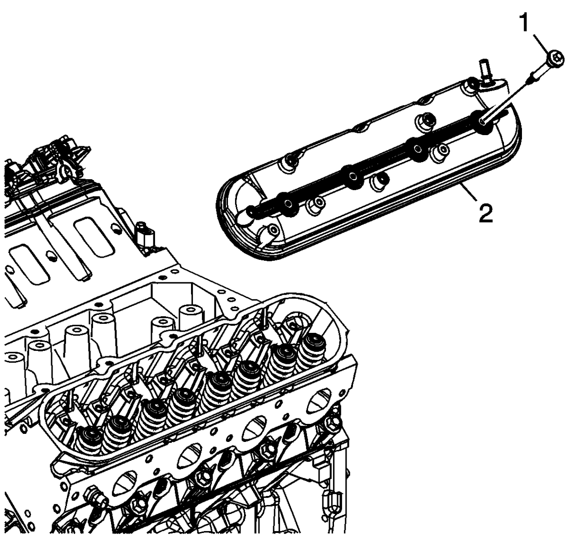
1272820

Note

- All gasket surfaces should be free of oil or other foreign material during assembly.
- DO NOT use the valve rocker arm cover gasket again.

1. Install NEW valve rocker arm cover grommets and use NEW valve rocker arm cover bolts if they are serviced with the grommet.

2. Install a NEW gasket (504) into the valve rocker arm cover.

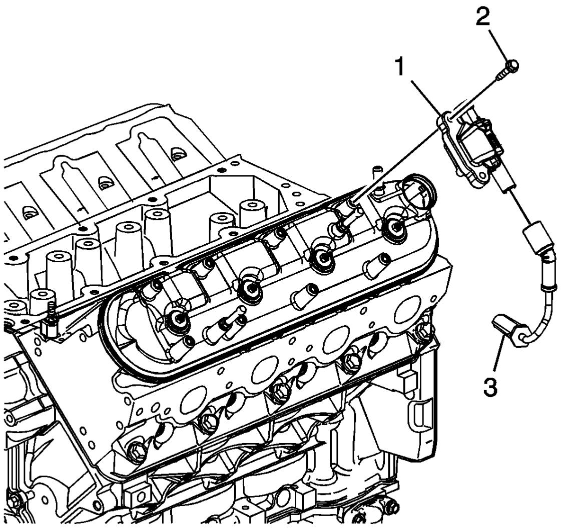


2054162

3. Install the valve rocker arm cover (2) onto the cylinder head.

Caution: Refer to *Fastener Caution* .

4. Install the cover bolts (1) with grommets and tighten to 12 N·m (106 lb in) .



2085646

5. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the threads of the ignition coil bolts (2).

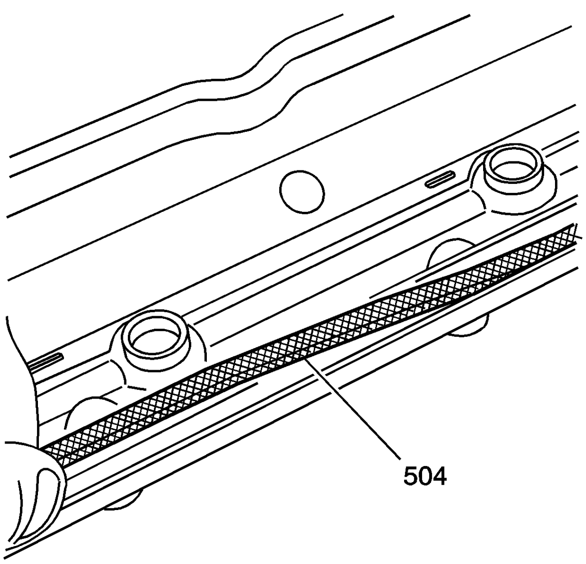
6. Install the ignition coils (1) and bolts (2) and tighten to 12 N·m (106 lb in) .

7. Install the spark plug wires (3).

Repair Instructions

2159120

Valve Rocker Arm Cover Installation - Right Side



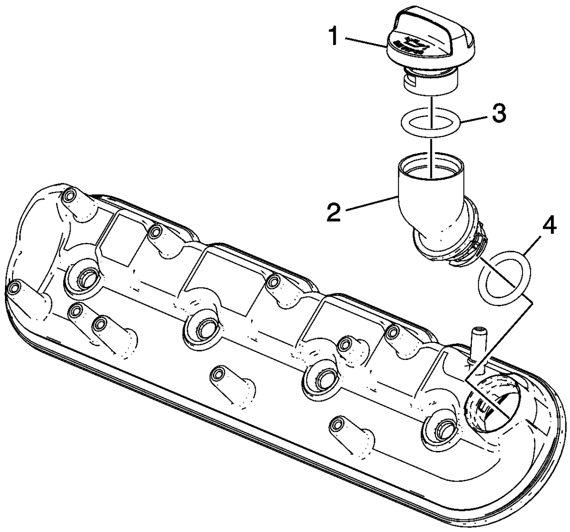
1272820

Note

- All gasket surfaces should be free of oil or other foreign material during assembly.
- DO NOT use the valve rocker arm cover gasket again.

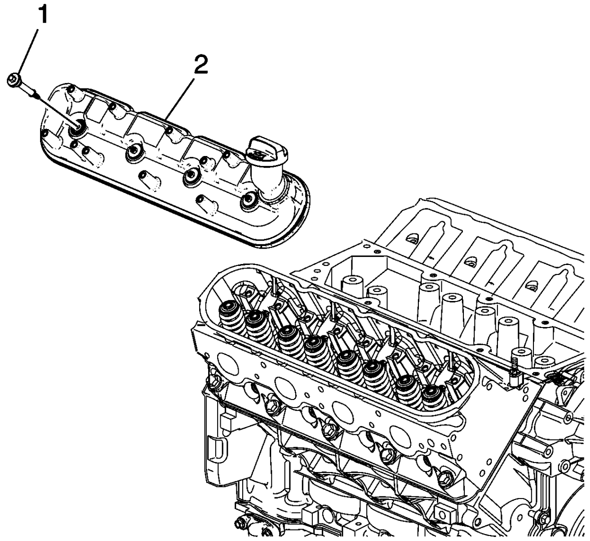
1. Install NEW valve rocker arm cover grommets and use NEW valve rocker arm cover bolts if they are serviced with the grommet.

2. Install a NEW gasket (504) into the valve rocker arm cover.



2156776

3. Install a NEW oil cap (1), oil fill tube (2) and seals (3, 4) to the valve rocker arm cover, as required.

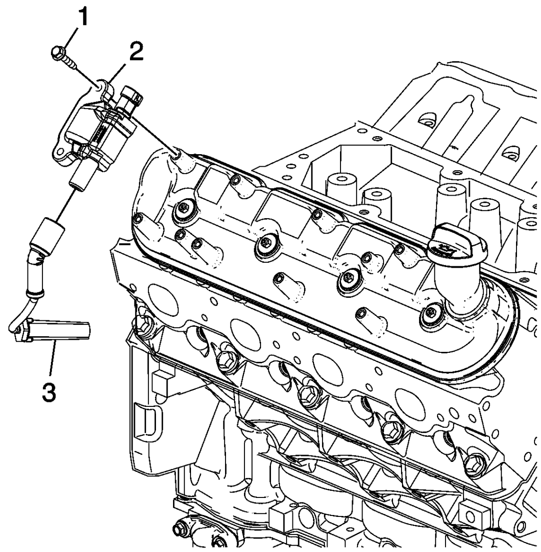


2156771

4. Install the valve rocker arm cover (2) onto the cylinder head.

Caution: Refer to *Fastener Caution* .

5. Install the cover bolts (1) with NEW grommets and tighten to 12 N·m (106 lb in) .



2156766

6. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the threads of the ignition coil bolts (1).

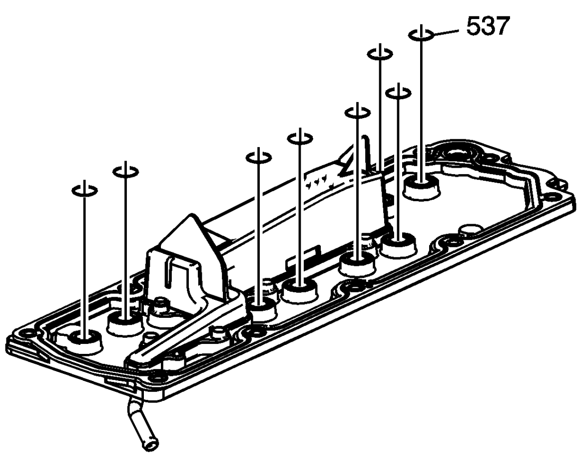
7. Install the ignition coils (2) and bolts (1) and tighten to 12 N·m (106 lb in) .

8. Install the spark plug wires (3).

Repair Instructions

2136259

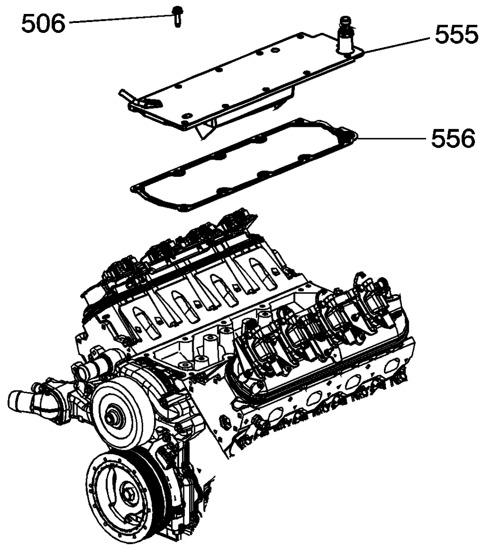
Engine Block Valley Cover Installation (6.2L)



1552536

Note 1. All gasket surfaces should be free of oil or other foreign material during assembly. **1.** Lubricate the O-ring seals (537) with clean engine oil.

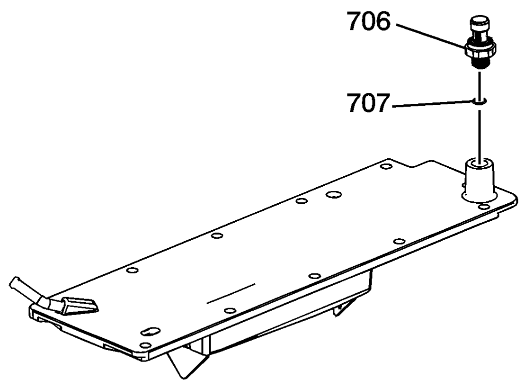
2. Install the O-ring seals (537) to the cover.



1559897

Caution: Refer to *Fastener Caution* .

3. Install the cover (555), gasket (556), and bolts (506) and tighten the cover bolts to 25 N·m (18 lb ft) .



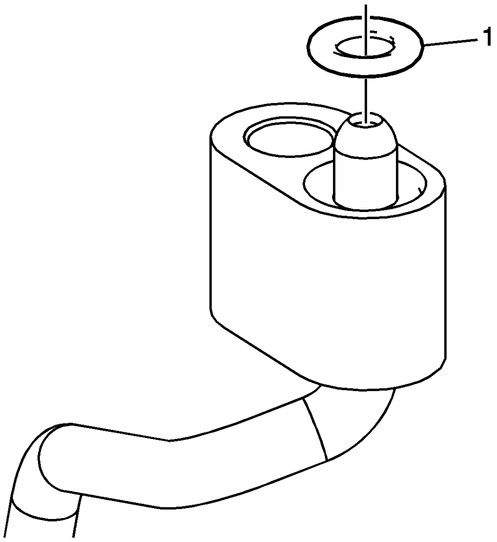
1408864

4. Apply sealant GM P/N 12346004 (Canadian P/N 10953480), or equivalent, to the threads of the sensor.
5. Install the oil pressure sensor (706) and sealing washer (707) and tighten the sensor to 35 N·m (26 lb ft) .

Repair Instructions

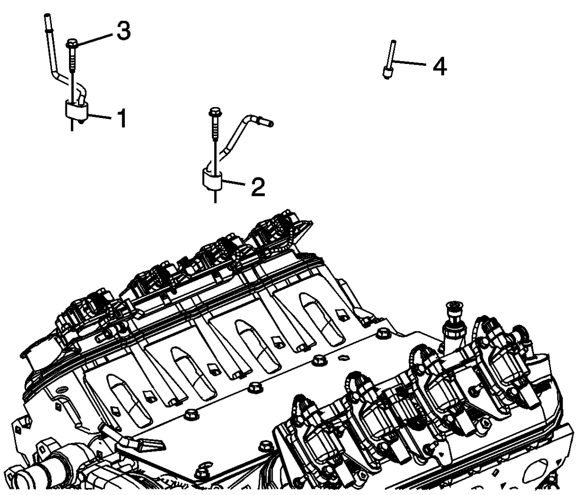
2159121

Engine Coolant Air Bleed Pipe and Hole Cover Installation



2054156

1. Install the seals (1) onto the engine coolant air bleed pipe.



2054452

Caution: Refer to *Fastener Caution* .

Note 2. Production engines use a rivet-type plug at the top rear coolant passage of each cylinder head. If service of a leaking plug is
Install the pipes (1 and 2) and bolts (3) and tighten to 12 N·m (106 lb in) .

3. As required, install either a NEW plug (4), or the earlier design coolant air bleed covers, bolts and gaskets. Refer to *Cylinder Head Assemble* . If required, tighten the cover bolts to 12 N·m (106 lb in) .

Repair Instructions

2158668

Supercharger Installation

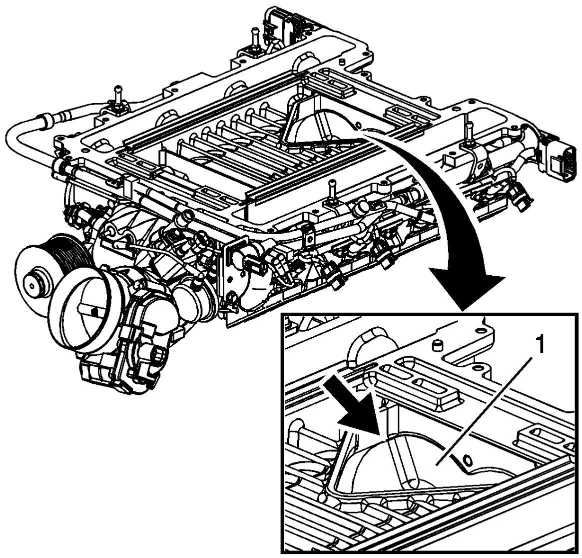
Special Tools

EN 48898 Supercharger Lift Fixture

For equivalent regional tools, refer to *Special Tools*

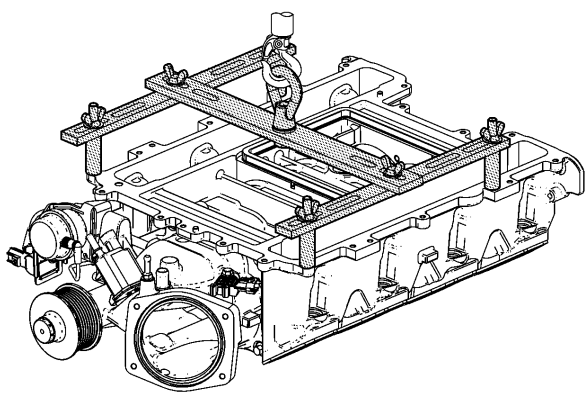
Note

- The supercharger, throttle body, fuel injection rail and fuel injectors may be removed as an assembly. If not servicing the individual components, remove the supercharger as an assembly.
- Cover the rotors area of the supercharger to prevent dirt or debris contamination onto the rotors.



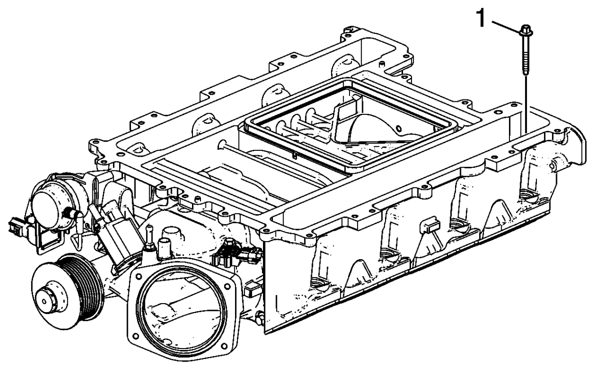
2156983

1. Cover the inlet area of the supercharger (1) to prevent dirt or debris contamination onto the rotors.



2156758

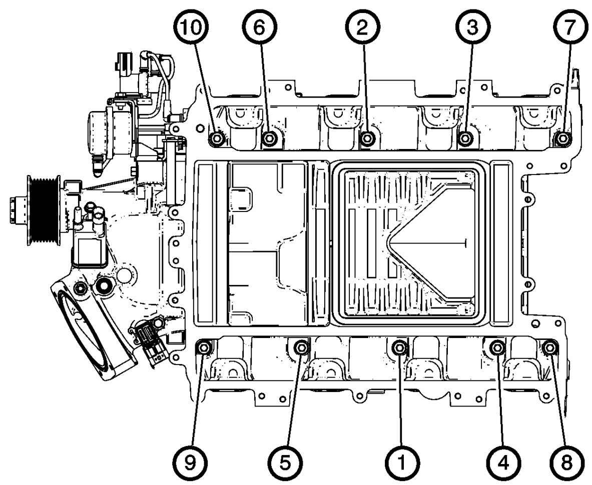
2. Install the EN 48898 fixture to the supercharger.
3. Tighten the EN 48898 fixture bolts and nuts until snug.
4. Using the lifting device, install the supercharger onto the engine. Align the dowel pin at the right front of the supercharger to the cylinder head.



2156748

5. Apply a 5 mm (0.2 in) band of threadlocker GM P/N 12345382 (Canadian P/N 10953489) or equivalent to the threads of the bolts.

6. Install the supercharger bolts (1).

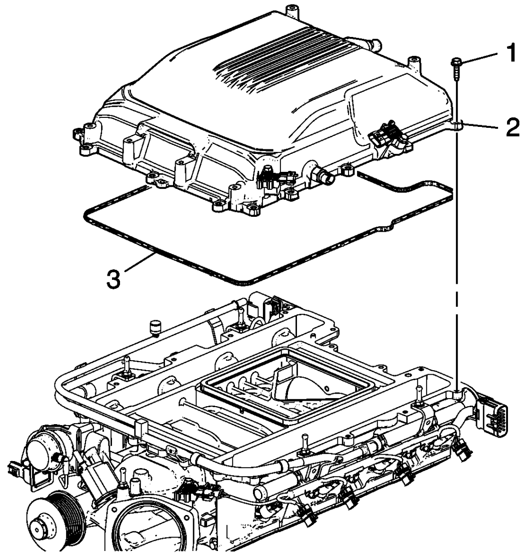


2156871

7. Tighten the bolts.

8. Tighten the bolts a first pass in sequence to 5 N·m (44 lb in) .

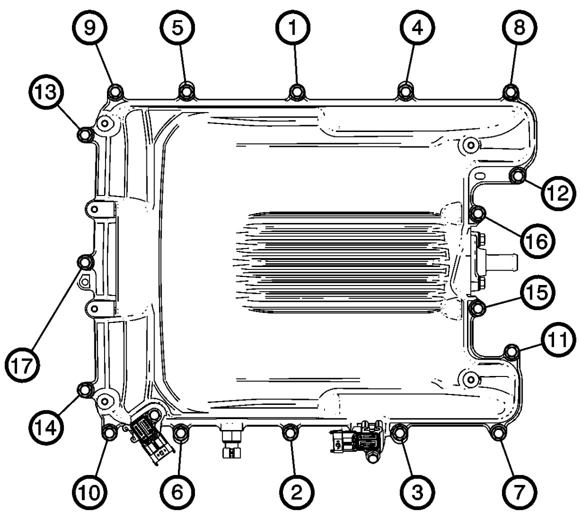
9. Tighten the bolts a final pass in sequence to 10 N·m(89 lb in) .



2156354

10. Install a NEW supercharger cover seal (3).

11. Install the supercharger cover bolts (1) and the supercharger cover (2).



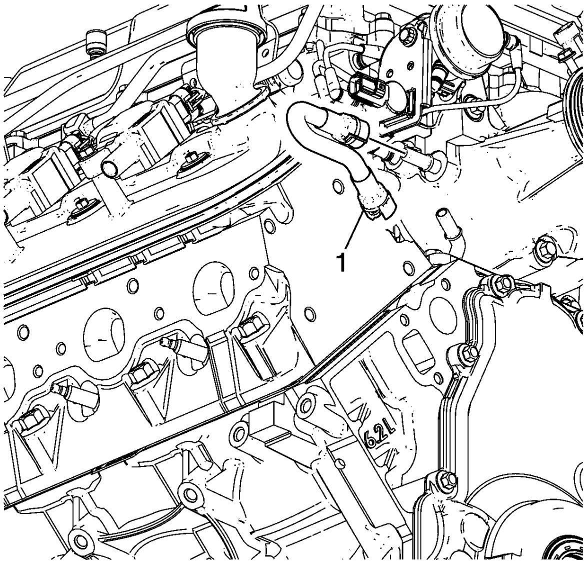
2156876

12. Tighten the bolts.

13. Tighten the bolts a first pass in sequence to 5 N·m (44 lb in) .

14. Tighten the bolts a final pass in sequence to 10 N·m (89 lb in) .

15. Install the fuel rail with injectors as required. Refer to *Fuel Rail and Injectors Installation* .



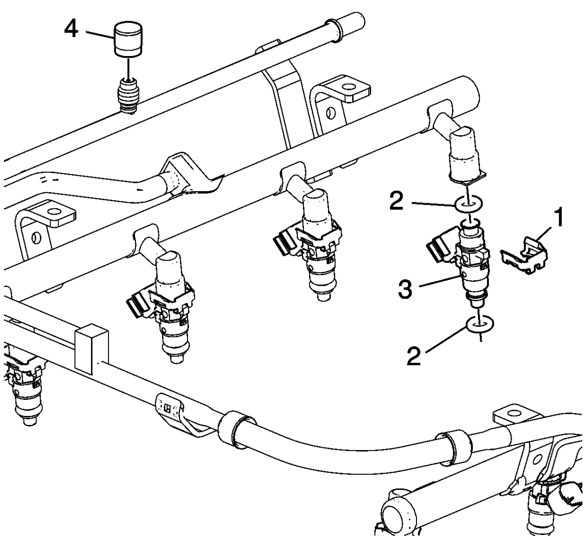
2156737

16. Install the positive crankcase ventilation (PCV) – dirty air hose (1) to the valley cover and supercharger.

Repair Instructions

2159123

Fuel Rail and Injectors Installation

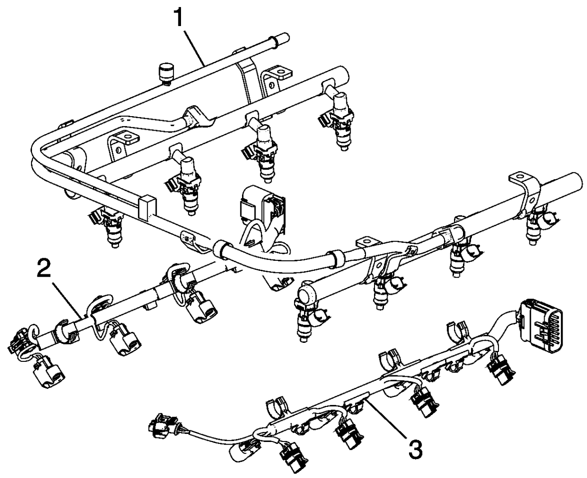


2156729

Note 1. DO NOT use the fuel injector O-ring seals again. Install NEW fuel injector O-ring seals during assembly. **1.** Lubricate the NEW fuel injector O-ring seals (2) with clean engine oil.

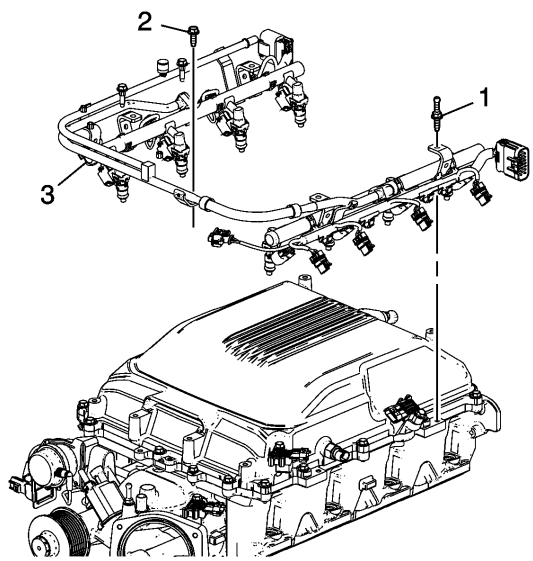
2. Install the O-ring seals to the fuel injectors.

3. Install the fuel injectors (3) and retainers (1).



2156724

4. Install the wiring harnesses (2) and (3) onto the fuel rail (1).



2173554

5. Install the fuel rail assembly (3). Install the right side first, then install the left side with flex hose until all injectors have entered their bores.

6. Apply a 5 mm (0.2 in) band of threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the threads of the fuel rail studs and bolt. Refer to *Adhesives, Fluids, Lubricants, and Sealers* .

Caution: Refer to *Fastener Caution* .

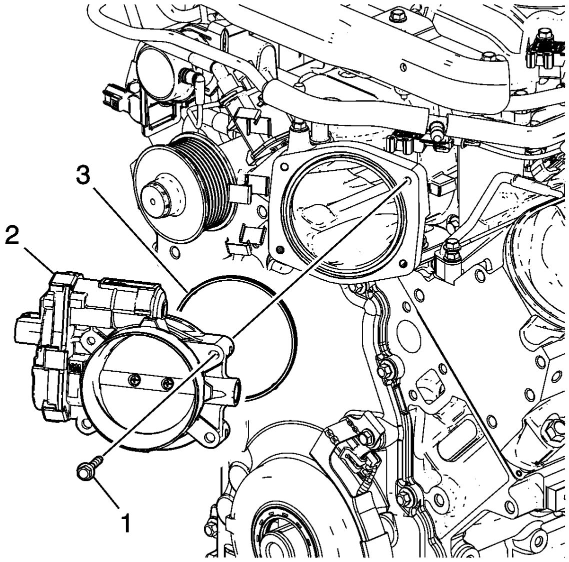
7. Install the fuel rail studs (1) and bolt (2) and tighten to 10 N·m (89 lb in) .

Repair Instructions

2159124

Throttle Body Assembly Installation

Throttle Body:Assembly Installation



2156351

Note 1. DO NOT use the throttle body gasket again. Install a NEW gasket during assembly. **1.** Install the throttle body gasket (3) to the supercharger.

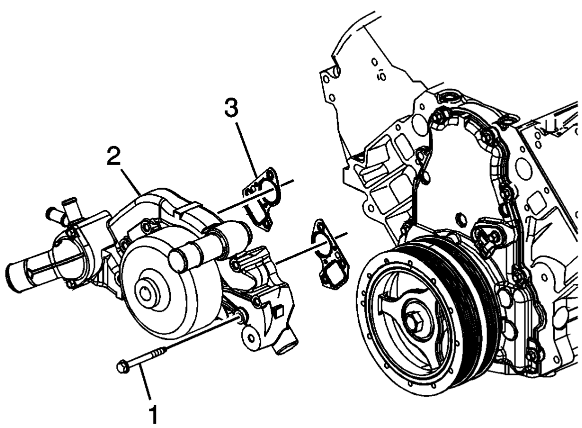
Caution: Refer to *Fastener Caution* .

2. Install the throttle body (2) and bolts (1) and tighten to 10 N·m (89 lb in) .

Repair Instructions

2159125

Water Pump Installation



2054126

Note 1. All gasket surfaces are to be free of oil or other foreign material during assembly. **1.** Install the water pump (2) and NEW gaskets (3).

Caution: Refer to *Fastener Caution* .

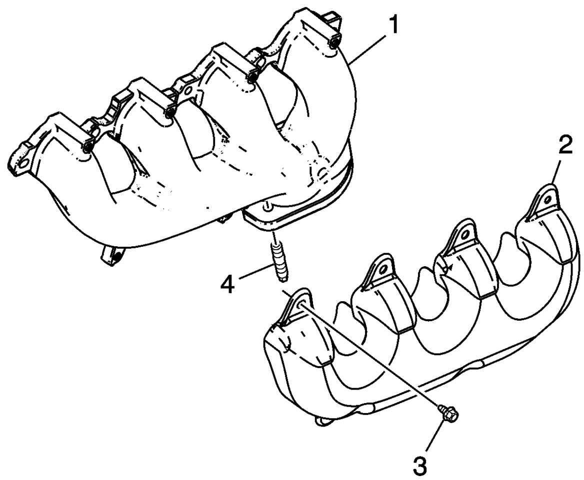
2. Install the water pump bolts (1).

- **2.1.** Tighten the water pump bolts a first pass to 15 N·m (11 lb ft) .
- **2.2.** Tighten the water pump bolts a final pass to 30 N·m (22 lb ft) .

Repair Instructions

2159127

Exhaust Manifold Installation - Left Side



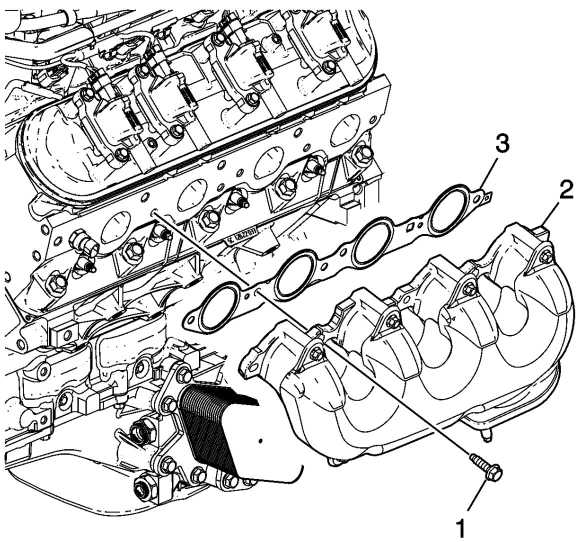
2156337

Caution: Refer to *Fastener Caution* .

Note

- Tighten the exhaust manifold bolts as specified in the service procedure. Improperly installed and/or leaking exhaust manifold gaskets may affect vehicle emissions and/or on-board diagnostic (OBD) II system performance.
- The cylinder head exhaust manifold bolt hole threads must be clean and free of debris or threadlocking material.
- Do not apply sealant to the first 3 threads of the bolt.

1. Install the heat shield (2) and bolts (3) onto the manifold (1) and tighten to 12 N·m (106 lb in) .
2. Install the exhaust pipe studs (4) and tighten to 20 N·m (15 lb ft) .



2156331

3. Apply a 5 mm (0.2 in) wide band of threadlock GM P/N 12345493 (Canadian P/N 10953488), or equivalent, to the threads of the exhaust manifold bolts. Refer to *Adhesives, Fluids, Lubricants, and Sealers* .
4. Install the exhaust manifold (2), NEW gasket (3), and bolts (1).

4.1. Tighten the exhaust manifold bolts a first pass to 15 N·m(11 lb ft) . Tighten the exhaust manifold bolts beginning with the center 2 bolts. Alternate from side-to-side, and work toward the outside bolts.

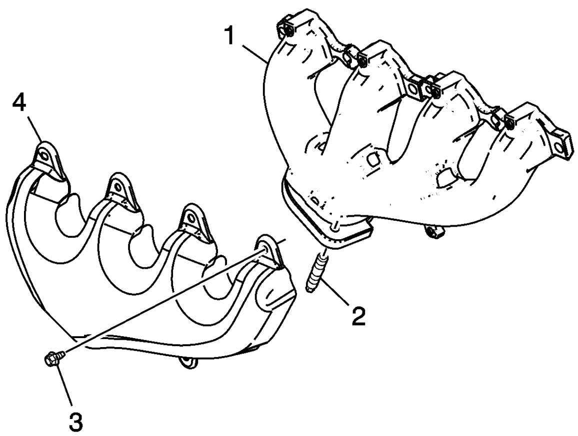
4.2. Tighten the exhaust manifold bolts a final pass to 20 N·m(15 lb ft) . Tighten the exhaust manifold bolts beginning with the center 2 bolts. Alternate from side-to-side, and work toward the outside bolts.

5. Using a flat punch, bend over the exposed edge of the exhaust manifold gasket at the rear of the left cylinder head.

Repair Instructions

2159129

Exhaust Manifold Installation - Right Side



2156341

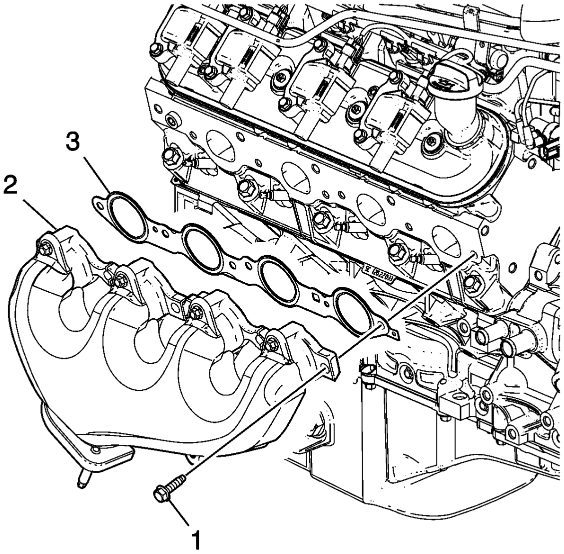
Caution: Refer to *Fastener Caution* .

Note

- Tighten the exhaust manifold bolts as specified in the service procedure. Improperly installed and/or leaking exhaust manifold gaskets may affect vehicle emissions and/or on-board diagnostic (OBD) II system performance.
- The cylinder head exhaust manifold bolt hole threads must be clean and free of debris or threadlocking material.
- Do not apply sealant to the first 3 threads of the bolt.

1. Install the heat shield (4) and bolts (3) onto the manifold (1) and tighten to 12 N·m (106 lb in) .

2. Install the exhaust pipe studs (2) and tighten to 20 N·m (15 lb ft) .



2156977

3. Apply a 5 mm (0.2 in) wide band of threadlock GM P/N 12345493 (Canadian P/N 10953488), or equivalent, to the threads of the exhaust manifold bolts. Refer to *Adhesives, Fluids, Lubricants, and Sealers* .

4. Install the exhaust manifold (2), NEW gasket (3), and bolts (1).

4.1. Tighten the exhaust manifold bolts a first pass to 15 N·m (11 lb ft) . Tighten the exhaust manifold bolts beginning with the center 2 bolts. Alternate from side-to-side, and work toward the outside bolts.

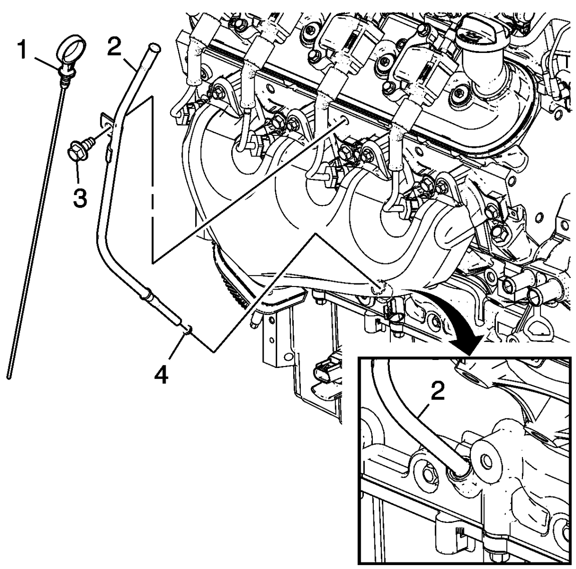
4.2. Tighten the exhaust manifold bolts a final pass to 20 N·m (15 lb ft) . Tighten the exhaust manifold bolts beginning with the center 2 bolts. Alternate from side-to-side, and work toward the outside bolts.

5. Using a flat punch, bend over the exposed edge of the exhaust manifold gasket at the rear of the left cylinder head.

Repair Instructions

2159131

Oil Level Indicator and Tube Installation



2156315

1. Inspect the O-ring seal (4) for cuts or damage. If the oil level indicator tube O-ring seal is not cut or damaged, it may be used again.

2. Lubricate the O-ring seal with clean engine oil.

3. Install the O-ring seal onto the oil level indicator tube (2).

4. Install the oil level indicator tube into the engine block and rotate into proper position.

Caution: Refer to *Fastener Caution* .

5. Install the tube bolt (3) and tighten the oil level indicator tube bolt to 25 N·m (18 lb ft) .
6. Install the oil level indicator (1) into the tube.

Repair Instructions

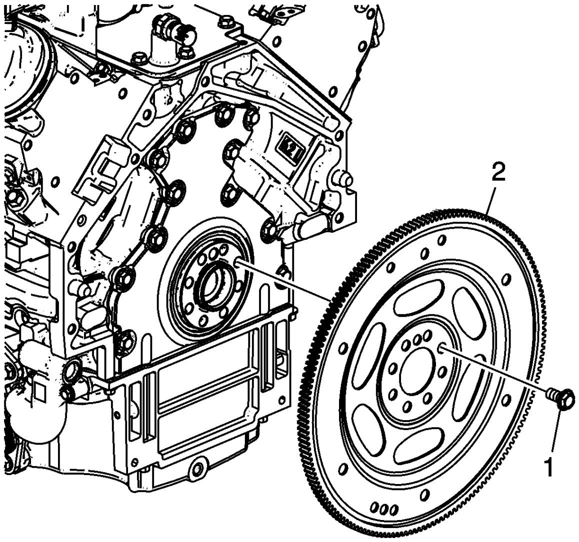
2136283

Engine Flywheel Installation (6.2L)

Special Tools

J 42386-A Flywheel Holding Tool

For equivalent regional tools, refer to *Special Tools* .



2173548

Note

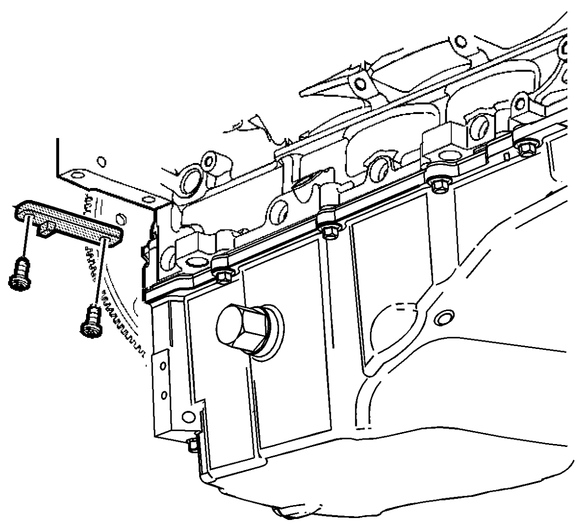
- For manual transmission applications, note the position and direction of the engine flywheel before removal. Mark or scribe the end of the crankshaft and flywheel before component removal. The existing manual transmission engine flywheel must be installed to the original position and direction.
- The flywheel does not use a locating pin for alignment and will not initially seat against the crankshaft flange, but will be pulled onto the crankshaft by the engine flywheel bolts. This procedure requires a 3 stage tightening process.

1. Install the automatic transmission flex plate to the crankshaft, if applicable.

2. Install the manual transmission flywheel (2) to the crankshaft, if applicable. Refer to *Engine Balancing* .

3. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the threads of the flywheel bolts (1).

4. Install the bolts loosely.



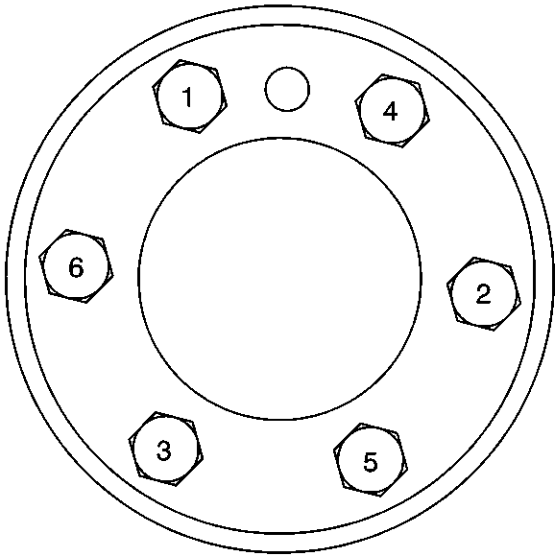
1199283

Caution: Refer to *Fastener Caution* .

5. Install the J 42386-A flywheel holding tool and bolts.

Use 1 M10 – 1.5 x 120 mm and 1 M10 – 1.5 x 45 mm bolt for proper tool operation.

Tighten the J 42386-A flywheel holding tool and bolts to 50 N·m (37 lb ft) .



63174

6. Torque the bolts.
   6.1. Tighten the bolts (1–6) a first pass in sequence to 20 N·m (15 lb ft) .
   6.2. Tighten the bolts (1–6) a second pass in sequence to 50 N·m (37 lb ft) .
   6.3. Tighten the bolts (1–6) a final pass in sequence to 100 N·m (74 lb ft) .
7. Remove the J 42386-A flywheel holding tool

Repair Instructions

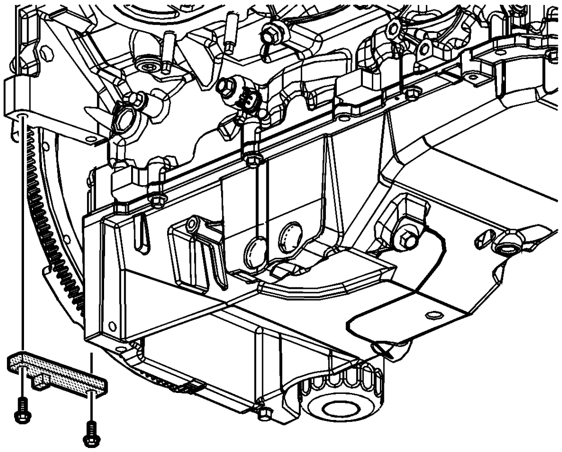
2159133

Crankshaft Balancer Installation

Special Tools

- EN-47812 Installer Bolt
- J 41665-A Crankshaft Balancer and Sprocket Installer
- J 42386-A Flywheel Holding Tool
- J 45059 Angle Meter

For equivalent regional tools, refer to *Special Tools*



1552525

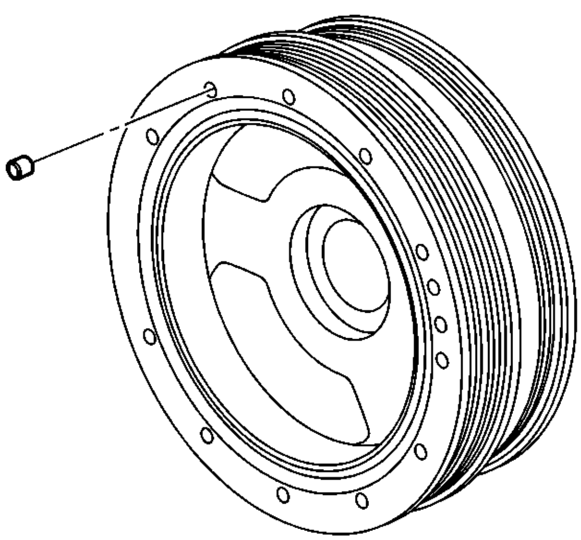
Caution: Refer to *Fastener Caution* .

Note

- If replacing the crankshaft balancer, note the location of any existing balance weights, if applicable. Install new balance weights into the new crankshaft balancer, if applicable. Crankshaft balance weights must be installed into the new balancer in the same location as the old balancer. A properly installed balance weight will be either flush or below flush with the face of the balancer. Refer to *Engine Balancing* and *Crankshaft Balancer Cleaning and Inspection* .
- Ensure the teeth of the tool engage the engine flywheel teeth.
- The used crankshaft balancer bolt is used only during the installation procedure. Install a NEW crankshaft balancer bolt during final assembly.

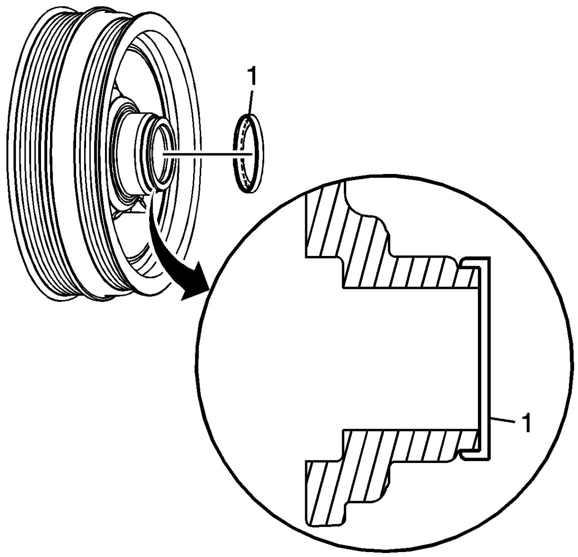
1. Install the J 42386-A holding tool and bolts.

Use 1 M10 – 1.5 x 120 mm and 1 M10 – 1.5 x 45 mm bolt for proper tool operation and tighten the J 42386-A holding tool bolts to 50 N·m (37 lb ft) .



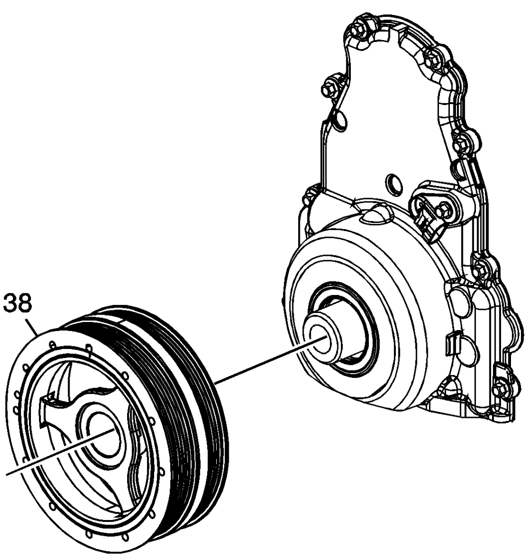
63153

2. Install balance weights into the new balancer, if applicable.



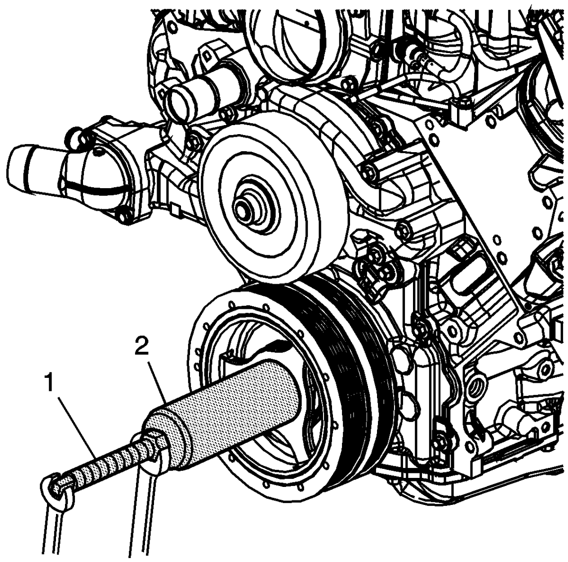
1759519

3. Install the crankshaft balancer washer (1) onto the crankshaft balancer.



1777113

Note 4. The balancer should be positioned onto the end of the crankshaft as straight as possible prior to tool installation. **4.** Position the balancer (138) onto the end of the crankshaft.



1552514

5. Use the J 41665-A installer (2) and the EN-47812 installer bolt (1) in order to install the balancer.

5.1. Assemble the EN-47812 installer bolt (1), nut, washer and the J 41665-A installer (2).

Insert the smaller end of the J 41665-A installer (2) into the front of the balancer.

5.2. Use a wrench and hold the hex end of the EN-47812 installer bolt (1).

5.3. Use a second wrench and rotate the installation tool nut clockwise until the balancer is started onto the crankshaft.

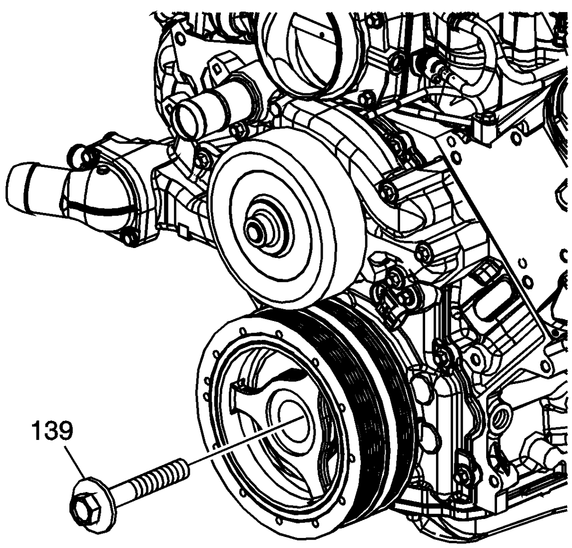
5.4. Remove the J 41665-A installer (2) and reverse the installation tool.

Position the larger end of the J 41665-A installer (2) against the front of the balancer.

5.5. Use a wrench and hold the end of the EN-47812 installer bolt (1).

5.6. Use a second wrench and rotate the installation tool nut clockwise until the balancer is installed onto the crankshaft.

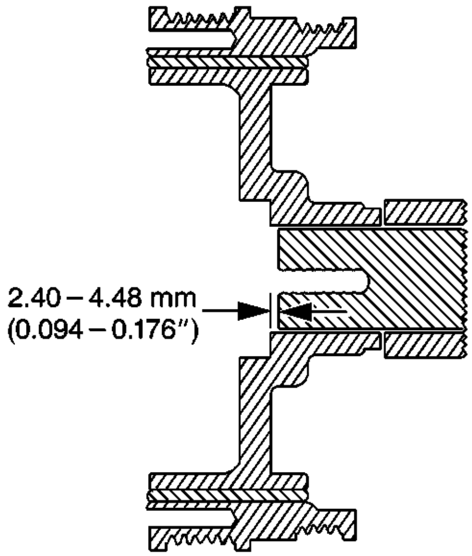
5.7. Remove the balancer installation tools.



1552516

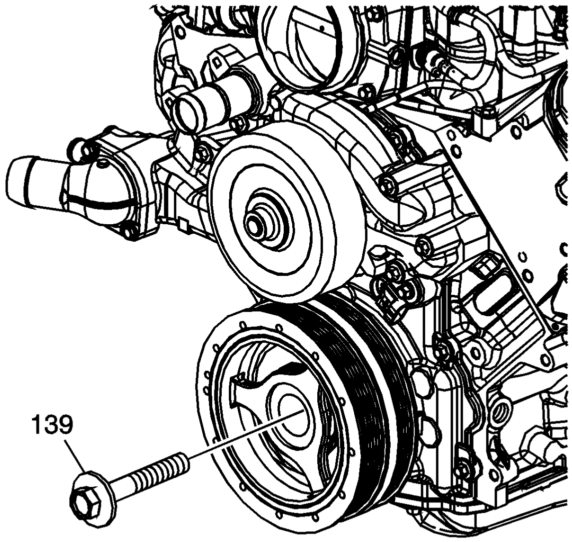
6. Install the used crankshaft balancer bolt (139) and tighten to 330 N·m (240 lb ft) to fully seat the balancer.

7. Remove the used crankshaft balancer bolt.



63245

Note 8. The nose of the crankshaft should be recessed 2.40–4.48 mm (0.094–0.176 in) into the balancer bore. **8.** Measure for a correctly installed balancer. If the balancer is not installed to the proper dimensions, install the J 41665 installer and repeat the installation procedure.



1552516

9. Install the NEW crankshaft balancer bolt (139):

- **9.1.** Tighten the crankshaft balancer bolt to 150 N·m (110 lb ft) .
- **9.2.** Loosen the crankshaft balancer bolt 360 degrees .
- **9.3.** Tighten the crankshaft balancer bolt to 80 N·m (59 lb ft) .
- **9.4.** Tighten the crankshaft balancer bolt a final pass to 200 degrees using the J 45059 meter .

10. Remove the J 42386-A tool .

Repair Instructions

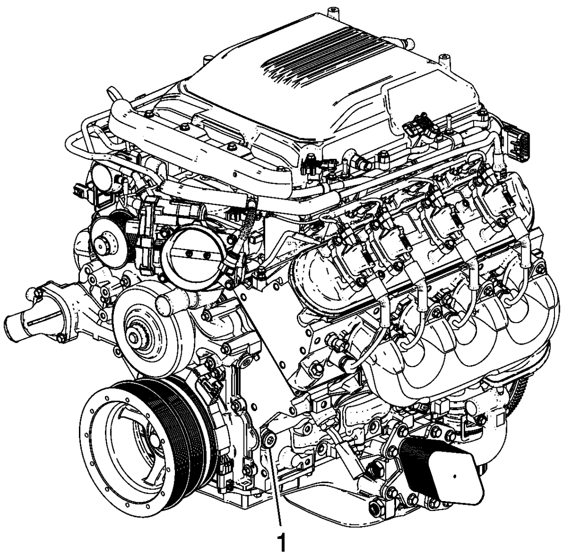
2159136

Engine Prelubing

Special Tools

J 45299 Engine Preluber

For equivalent regional tools, refer to *Special Tools*



2156882

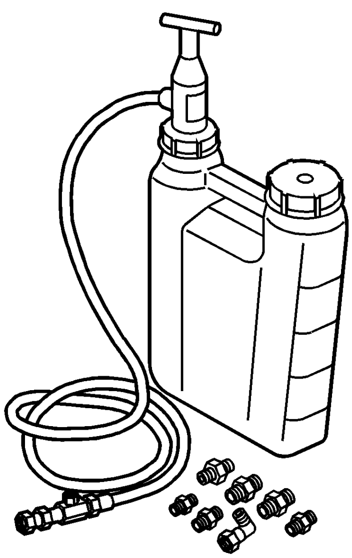
Note 1. A constant and continuous flow of clean engine oil is required in order to properly prime the engine. Be sure to use an approv
Remove the engine oil filter, and fill with clean engine oil.

Caution: Refer to *Fastener Caution* .

2. Install the oil filter and tighten to 30 N·m (22 lb ft) .

3. Locate the engine block left front oil gallery plug (1).

4. Install the M16 x 1.5 adapter P/N 509375.



863255

5. Install the flexible hose to the adapter and open the valve.

6. Pump the handle on the J 45299 preluber in order to flow a minimum of 1–1.9 liters (1–2 quarts) engine oil. Observe the flow of engine oil through the flexible hose and into the engine assembly.

7. Close the valve and remove the flexible hose and adapter from the engine.

8. Install the gallery plug to the engine and tighten to 60 N·m (44 lb ft) .

9. Top-off the engine oil to the proper level.

Engine

Engine Mechanical -6.0L,6.2L

Description and Operation

2155454

Crankcase Ventilation System Description (LSA)

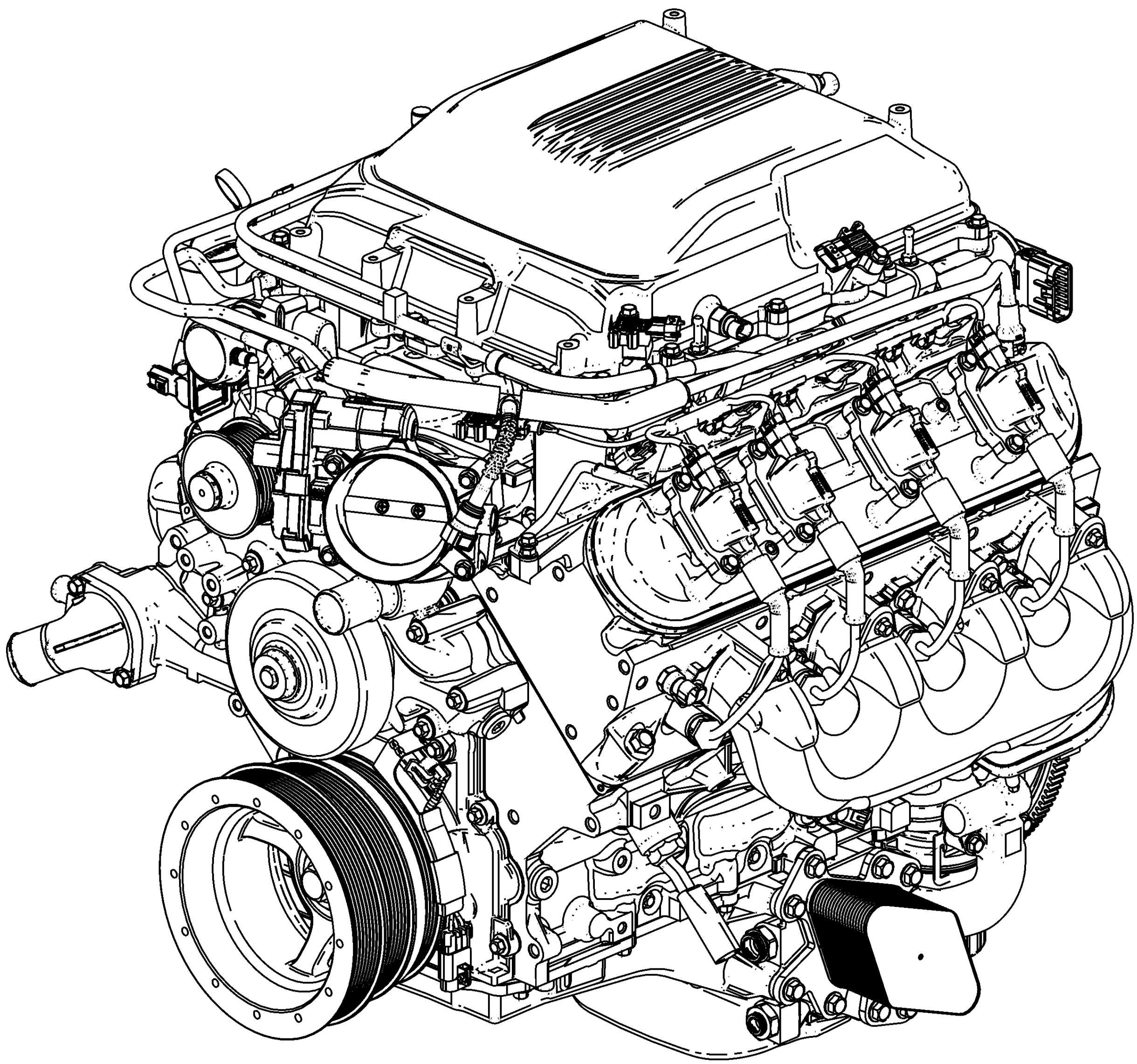
A closed crankcase ventilation system is used in order to provide a more complete scavenging of crankcase vapors. Filtered air from the air induction system duct is supplied to the crankcase, mixed with blow-by vapors, and passes through a crankcase ventilation metering device before entering the supercharger. The primary component in the positive crankcase ventilation (PCV) system is the PCV flow metering device (valve or orifice) . Vacuum changes within the supercharger result in flow variations of the blow-by vapors. If abnormal operating conditions occur, the design of the PCV system permits excessive mounts of blow-by vapors to back flow through the crankcase vent tube.

Description and Operation

2158699

Engine Component Description

Figure 2158128**The 6.2L LSA Liter V8 Engine**



2157026

The 6.2L Liter V8 engine is identified as RPO LSA.

Camshaft and Drive System

A billet steel 1 piece camshaft is supported by 5 bearings pressed into the engine block. The camshaft timing chain sprocket is mounted to the front of the camshaft and is driven by the crankshaft sprocket through the camshaft timing chain. The camshaft position (CMP) sensor lobes are incorporated into the front face of the camshaft sprocket with the CMP sensor mounted to the engine front cover. A timing chain tensioner is mounted to the front of the engine block above the crankshaft sprocket. The externally splined crankshaft sprocket is positioned to the crankshaft by a key and keyway. The crankshaft sprocket external splines drive the gerotor type oil pump drive gear. A retaining plate mounted to the front of the engine block maintains camshaft location.

Crankshaft

The precision-balanced crankshaft is forged steel and is supported by 5 crankshaft bearings. The bearings are retained by forged steel crankshaft bearing caps, which are machined with the engine block for proper alignment and clearance. The crankshaft journals are undercut and rolled. The center main journal is the thrust journal. A crankshaft position (CKP) reluctor ring is press-fit mounted at the rear of the crankshaft. The reluctor ring is not serviceable separately.

Cylinder Heads

The cylinder heads are cast aluminum and include pressed-in-place powdered metal valve guides, 55 mm (2.19 in) diameter solid intake valves, 40.4 mm (1.59 in) diameter solid exhaust valves, and 66.85 cubic centimeter combustion chambers. Passages for the engine coolant air bleed system are at the front of each cylinder head. The valve rocker arm covers are retained to the cylinder heads by 4 center mounted rocker arm cover bolts.

Engine Block

The engine block is a cam-in-block deep skirt 90 degree V configuration with 5 forged steel crankshaft bearing caps. The engine block is cast aluminum with press-in-place cast iron cylinder liners. The 5 crankshaft bearing caps each have 4 vertical M10 and 2 horizontal M8 mounting bolts. The camshaft is supported by 5 press-in-place camshaft bearings. Eight piston cooling oil nozzle assemblies are mounted between each of the opposing cylinders. The oil nozzles spray oil up the cylinder bore directing oil to the bottom of the pistons.

Exhaust Manifolds

The exhaust manifolds are a 1 piece cast iron design. The exhaust manifolds direct exhaust gasses from the combustion chambers to the exhaust system. Each manifold also has an externally mounted heat shield that is retained by bolts.

Intake Manifold/Supercharger

Refer to *Supercharger Description and Operation* .

Oil Pan

The structural rear-sump oil pan is cast aluminum. Incorporated into the design is the oil filter mounting boss, oil level sensor, and drain plug opening. An external oil cooler assembly is mounted directly to the left side of the oil pan. The alignment of the structural oil pan to the rear of the engine block and transmission housing is critical.

Piston and Connecting Rod Assembly

The pistons are cast aluminum. The pistons use 2 compression rings and 1 oil control ring assembly. The piston is a low friction, lightweight design with a flat or recessed top and barrel shaped skirt. The piston pins are chromium steel and are a full-floating design. The connecting rods are powdered metal. The connecting rods are fractured at the connecting rod journal and then machined for the proper clearance. All applications use a piston with a graphite coated skirt. The piston/pin and connecting rod may be serviced as individual components.

Valve Rocker Arm Cover Assemblies

The valve rocker arm covers are cast aluminum and use a pre-molded silicon gasket for sealing. The ignition coils mount directly to the covers with no mounting bracket. Incorporated into the covers are the positive crankcase ventilation (PCV) system fresh air passages. The right rocker arm cover also includes the oil fill tube and cap.

Valve Train

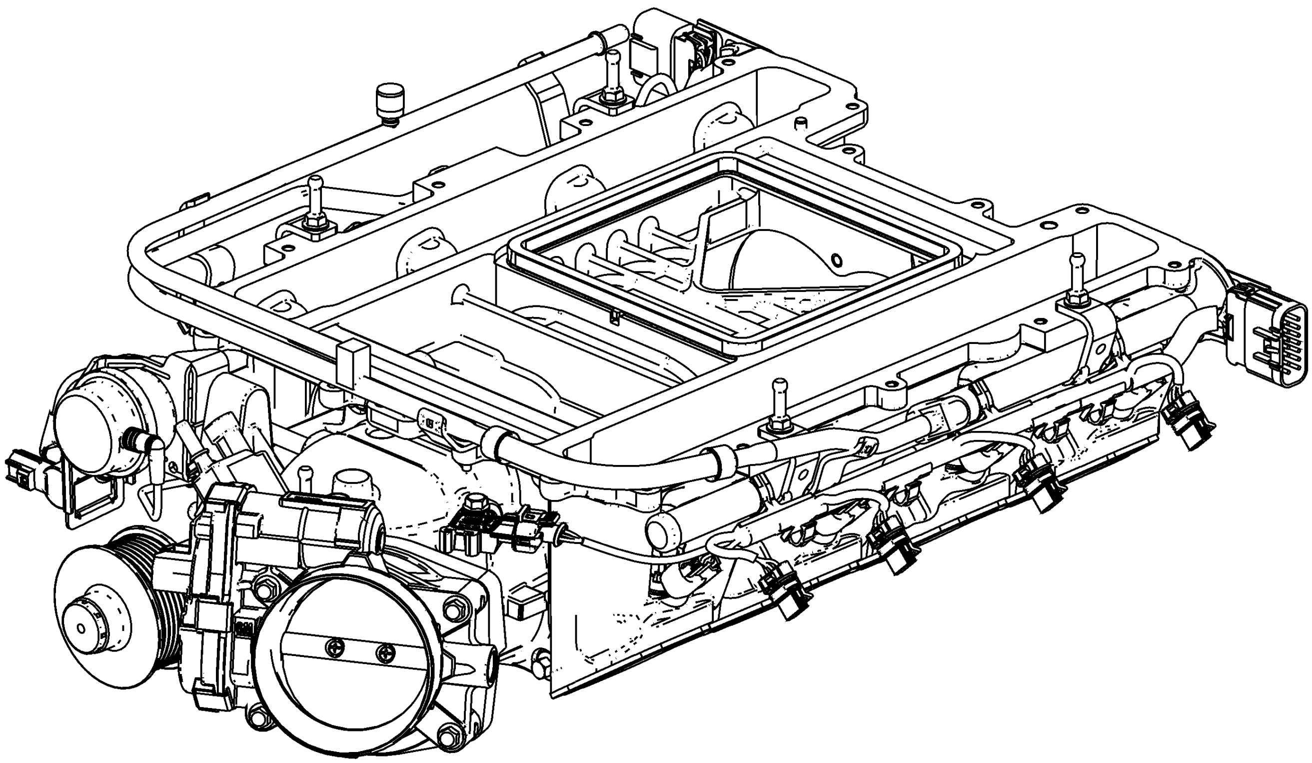
Motion is transmitted from the camshaft, through the hydraulic roller valve lifters and tubular pushrods, to the roller type rocker arms. The nylon valve lifter guides position and retain the valve lifters. The valve rocker arms for each bank of cylinders are mounted on pedestals or pivot supports. Each rocker arm is retained on the pivot support and cylinder head by a bolt. Valve lash is net build. The intake rocker arms are of an off-set design.

Description and Operation

2158706

Supercharger Description and Operation

Figure 2158160**Intake Manifold/Supercharger Assembly**



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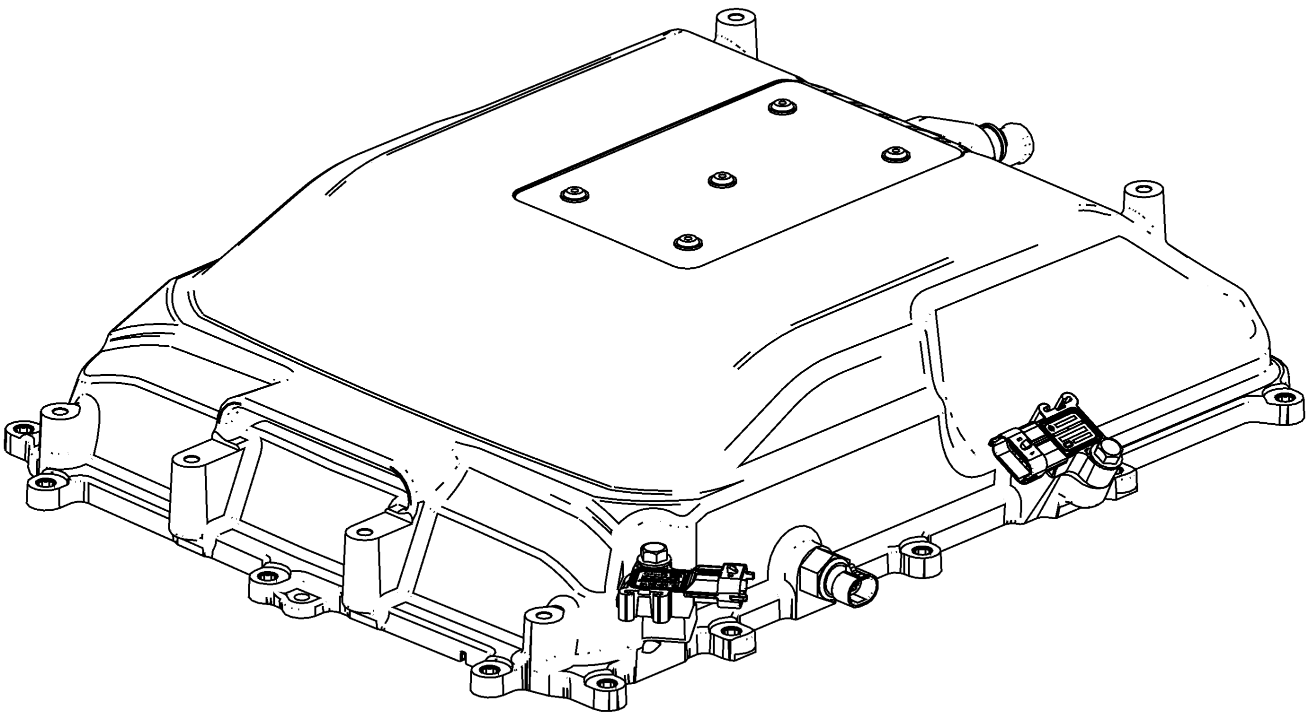
Intake Manifold/Supercharger Assembly

The LSA Roots-type supercharger is a positive displacement pump that consists of 2 counter-rotating rotors installed into the lower intake manifold housing. The rotors are designed with 4 lobes and a helical twist. The rotors of the supercharger are designed to run at a minimal clearance, not in contact with each other or the housing and are timed to each other by a pair of precision spur gears which are pressed onto the rotor shafts. The rotors are supported at each end by self-lubricating non-serviceable bearings. The drive belt pulley is pressed onto the input shaft. The input shaft is coupled to the rotor shaft. Both the belt pulley and torsional isolator are also non-serviceable.

The lower supercharger assembly consists of the following components:

- Lower Intake Manifold Housing, to include rotors, gears, bearings, torsional isolator, and drive belt pulley
- Bypass Valve
- Bypass Actuator
- Charged Air Bypass Valve
- Fuel Rail with Injectors
- Throttle Body Assembly
- Evaporative Emission Canister Purge Valve
- Inlet Air Pressure Sensor

Figure 2158174**Cover/Intercooler**



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Cover/Intercooler

The cover assembly has an integrated intercooler. Cooling the air enhances the effectiveness of the supercharger. The intercooler uses conventional coolant in a system that is separate from the engine cooling system. The intercooler assembly includes the cover, a charge air cooler/heat exchanger and a variety of sensors to monitor air temperature and pressure. The charge air cooler pipe assembly, located at the rear of cover transfers coolant to the intercooler cooling system via vehicle coolant hoses. The charge air cooler pipe assembly is sealed to the charge air cooler with O-rings and a press-in-place seal. Coolant enters the inlet port of the assembly, is directed into and through the charge air cooler/heat exchanger, and exits returning to the separate cooling system.

The cover/intercooler consists of the following components:

- Charge Air Cooler Pipe Assembly
- Charge Air Cooler Cover
- Charge Air Cooler/Heat Exchanger
- Intake Air Temperature (IAT) Sensor
- Barometric Pressure Sensor
- Air Outlet Pressure Sensor
- Isolator Pad

Operation

The supercharger is designed to increase the air pressure and density in the intake manifold. When this air is mixed with the correct amount of fuel the result is more power from the engine. This excess air creates a boost pressure in the intake manifold with a maximum engine boost of 69.6 kPa (10.1 psi). Because the supercharger is a positive displacement pump and is directly driven from the engine drive belt system, boost pressure is available at all driving conditions.

When boost is not required in situations such as idle or light throttle cruising, the excess air is routed through an internal bypass passage located between the intake manifold and the supercharger inlet. The bypass circuit is regulated by a bypass valve which is similar to a throttle plate. Spring force holds the bypass valve in a normally closed position to create boost.

The bypass actuator is a vacuum operated valve that is connected to the vacuum signal between the throttle and the supercharger inlet. Vacuum to the actuator pulls the bypass valve open during idle and light load conditions to decrease boost.

The charge air bypass valve is a vacuum/electrically operated solenoid valve that is attached to the supercharger housing. The three-way valve is controlled by the engine control module (ECM). The ECM determines when pressure from the manifold is routed to the bypass actuator. The charge air bypass valve allows pressure from the manifold to open the bypass valve and lower boost pressure during specific driving conditions. The open bypass valve reduces the pumping effort of the supercharger, thereby increasing the fuel efficiency in light load operations.

Description and Operation

2208459

New Product Information

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

Changes may include 1 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

- All fasteners and threaded holes on the engine utilize metric threads.
- Certain fasteners should not be used again. Bolts, studs, or other fasteners that must be replaced, willl be called out in the specific service procedure.
- The crankshaft balancer bolt fastener tightening specification has been revised. Refer to *Fastener Tightening Specifications* .
- The crankshaft bearing cap M8 bolts are now tightened using a 2 step process. Refer to *Fastener Tightening Specifications* .

New Sealants and/or Adhesives

No new sealants and or adhesives for 2010.

Changed Engine Specifications

The camshaft bearing to journal clearance and camshaft journal diameter specifications have changed. Refer to *Engine Mechanical Specifications* .

Disassembly and Assembly Procedure Revisions

No disassembly or assembly procedure revisions for 2010.

Engine Mechanical Diagnostic Procedure Revisions

All diagnosis on a vehicle should follow a logical process. Strategy based diagnostics is a uniform approach for repairing all systems. The diagnostic flow may always be used in order to resolve a system condition. The diagnostic flow is the place to start when repairs are necessary. For a detailed explanation, refer to *Strategy Based Diagnosis* or *Diagnostic System Check - Vehicle* .

New Special Tools Required

No new special tools required for 2010.

A Component Comparison from the Previous Year

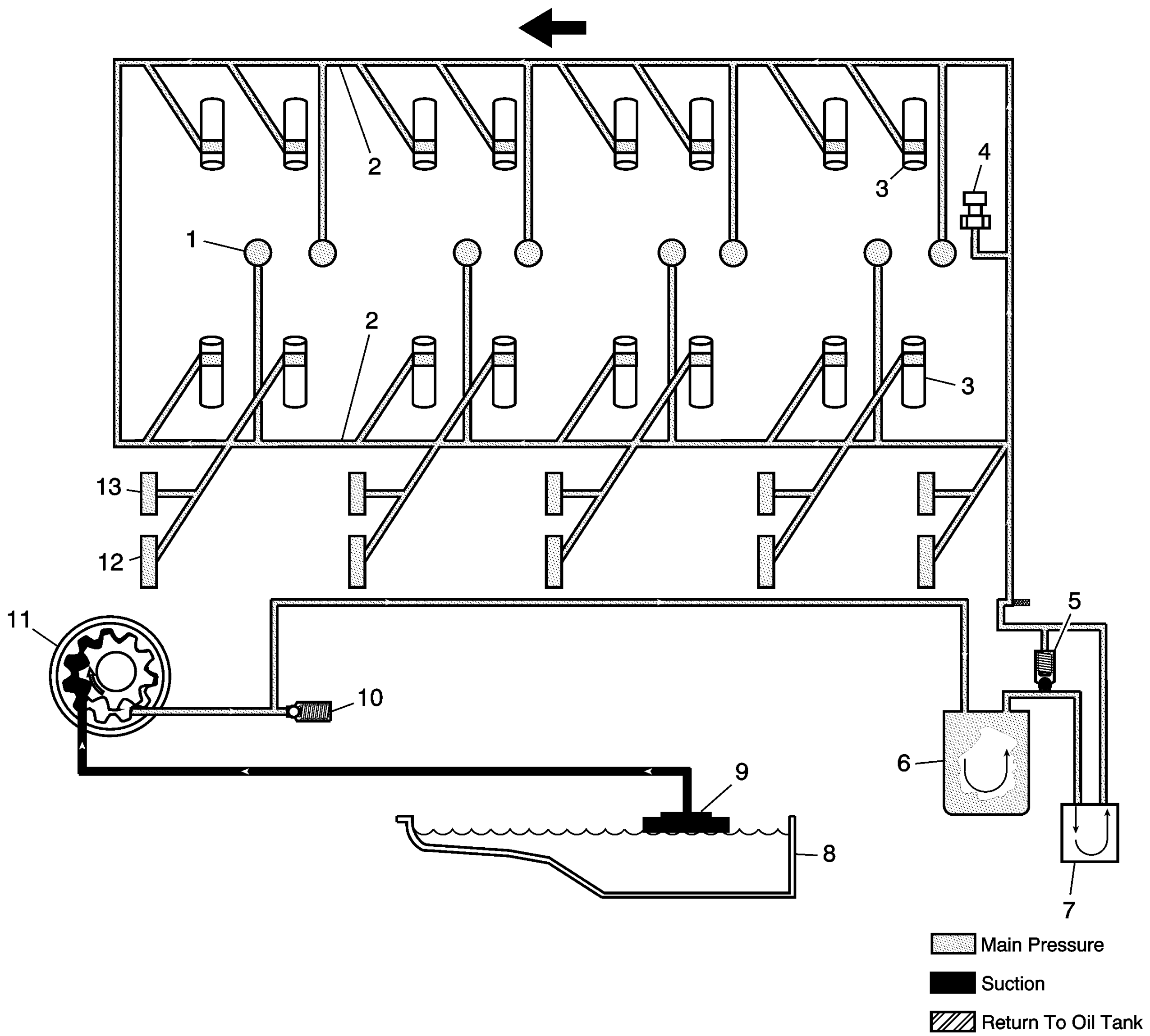
The 2010 6.2L RPO-LSA engine uses a new higher journal polished camshaft. The LSA engine is built with two different camshaft bearing designs: the difference is the composition of the bearing lining material. The first design camshaft bearing is composed of a lining material that uses a lead babbit with copper matrix backing. The second design camshaft bearing is lead-free, the lining is composed of a aluminum-tin material.

Description and Operation

2158718

Lubrication Description

Figure 2158335**Engine Lubrication Flow**



2157032

1. *Piston Oil Nozzle*
2. *Upper Main Oil Galleries*
3. *Valve Lifters*
3. *Valve Lifters*
4. *Oil Pressure Sensor*
5. *Bypass Valve – Oil Cooler*
6. *Oil Filter*
7. *Engine Oil Cooler*
8. *Oil Pan Sump*

9. *Oil Pump Screen*
10. *Pressure Relief Valve – Oil Pump*
11. *Oil Pump*
12. *Crankshaft Bearings*
13. *Camshaft Bearings*

Engine lubrication is supplied by a gerotor type oil pump assembly (11). The oil pump assembly consists of a pump housing, gear set, and pressure relief valve (10). Refer to Oil Pump Assembly in *Disassembled Views* . The pump assembly is mounted at the front of the engine and driven directly by the crankshaft sprocket. The pump gears rotate and draw oil from the oil pan sump (8) through the oil tank screen (9). The oil is pressurized as it passes through the primary pump and is sent through the engine block lower oil gallery. Contained within the primary pump is a pressure relief valve 10) that maintains oil pressure within a specified range. Pressurized oil is directed through the engine block lower oil gallery to the full flow oil filter (6) where harmful contaminants are removed. A bypass valve is incorporated into the oil filter, which permits oil flow in the event the filter becomes restricted. Oil exits the oil filter and is then directed to the external oil cooler (7). A bypass valve (5) is incorporated into the oil cooler assembly in the event oil flow within the cooler is restricted. Oil returns from the oil cooler and is directed to the upper main oil galleries (2). Oil from the left upper oil gallery is directed to the crankshaft bearings (12), valve lifters 1, 3, 5, and 7, camshaft bearings (13), and piston oil nozzles 1, 3, 5, and 7. Oil from the right upper oil gallery is directed to the valve lifters 2, 4, 6, and 8 and piston oil nozzles 2, 4, 6, and 8. The piston oil nozzle assemblies are designed to provide oil to the bottom side of the piston for cooling purposes. The piston oil nozzles have an internal check ball that is held in the normally closed position by the spring until system oil pressure exceeds 20.7 kPa (43.5 psi). Refer to *Piston Oil Nozzle Cleaning and Inspection* . Oil exits the valve lifters (3) and is then pumped through the pushrods to lubricate the valve rocker arms and valve stems. Oil then returns to the oil pan (8).The engine oil pressure sensor (4) is located at the top rear of the engine assembly.

Introduction

1877832

Cleanliness and Care

- 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, they should be marked, organized or retained in a specific order for assembly. Refer to *Separating Parts* .
- At the time of installation, 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. These surfaces should be covered or protected to avoid component damage.
- A liberal coating of clean engine oil should be applied to friction areas during assembly.
- Proper lubrication will protect and lubricate friction surfaces during initial operation.

Introduction

1407256

Separating Parts

Important:

- Many internal engine components will develop specific wear patterns on their friction surfaces.
- When disassembling the engine, internal components MUST be separated, marked, or organized in a way to ensure installation to their original location and position.

Separate, mark, or organize the following components:

- Piston and the piston pin
- Piston to the specific cylinder bore
- Piston rings to the piston
- Connecting rod location and orientation to the crankshaft journal
- Connecting rod to the bearing cap

A paint stick or etching/engraving type tool are recommended. Stamping the connecting rod or cap near the bearing bore may affect component geometry.

- Crankshaft main and connecting rod bearings
- Camshaft and valve lifters
- Valve lifters, lifter guides, pushrods and rocker arm assemblies
- Valve to the valve guide
- Valve spring to the cylinder head location
- Engine block main bearing cap location and direction
- Oil pump drive and driven gears

Introduction

2155822

Replacing Engine Gaskets

Special Tools

J 28410 Gasket Remover

For equivalent regional tools, refer to *Special Tools*

Gasket Use and Applying Sealants

- Do not use any gasket again unless specified.
- Gaskets that can be used again will be identified in the service procedure.
- Do not apply sealant to any gasket or sealing surface unless called out in the service information.

Separating Components

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

Cleaning Gasket Surfaces

- Remove all gasket and sealing material from the part using the J 28410 remover or equivalent.
- Care must be used to avoid gouging or scraping the sealing surfaces.
- Do not use any other method or technique to remove sealant or 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 oil.
  - This grit is abrasive and has been known to cause internal engine damage.

Assembling Components

Caution: Refer to *Sealant Caution* .

- When assembling components, use only the sealant specified or equivalent in the service procedure.
- Sealing surfaces should 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.
- When applying sealant to a component, apply the amount specified in the service procedure.
- Tighten bolts to specifications. Do not overtighten.

Introduction

2155824

Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant

RTV and Anaerobic Sealer, Use of

Pipe Joint Compound

Note

Three types of sealer are commonly used in engines. These are room temperature vulcanizing (RTV) sealer, anaerobic gasket eliminator sealer, and pipe joint compound. The correct sealer and amount must be used in the proper location to prevent oil leaks. DO NOT interchange the 3 types of sealers. Use only the specific sealer or the equivalent as recommended in the service procedure.

- Pipe joint compound is a pliable sealer that does not completely harden. This type of sealer is used where 2 non-rigid parts, such as the oil pan and the engine block, are assembled together.
- Do not use pipe joint compound in areas where extreme temperatures are expected. These areas include: exhaust manifold, head gasket, or other surfaces where gasket eliminator is specified.
- Follow all safety recommendations and directions that are on the container.

To remove the sealant or the gasket material, refer to *Replacing Engine Gaskets* .

Caution: Refer to *Sealant Caution* .

- Apply the pipe joint compound to a clean surface. Use a bead size or quantity as specified in the procedure. Run the bead to the inside of any bolt holes.
- Apply a continuous bead of pipe joint compound to one sealing surface. Sealing surfaces to be resealed must be clean and dry.
- Tighten the bolts to specifications. Do not overtighten.

RTV Sealer

- RTV sealant hardens when exposed to air. This type of sealer is used where 2 non-rigid parts, such as the intake manifold and the engine block, are assembled together.
- Do not use RTV sealant in areas where extreme temperatures are expected. These areas include: exhaust manifold, head gasket, or other surfaces where a gasket eliminator is specified.
- Follow all safety recommendations and directions that are on the container.

To remove the sealant or the gasket material, refer to *Replacing Engine Gaskets* .

Caution: Refer to *Sealant Caution* .

- Apply RTV sealant to a clean surface. Use a bead size as specified in the procedure. Run the bead to the inside of any bolt holes.
- Assemble components while the RTV sealant is still wet, within 3 minutes. Do not wait for the RTV sealant to skin over.
- Tighten bolts to specifications. Do not overtighten.

Anaerobic Sealer

- Anaerobic gasket eliminator hardens in the absence of air. This type of sealer is used where 2 rigid parts, such as castings, are assembled together. When 2 rigid parts are disassembled and no sealer or gasket is readily noticeable, the parts were probably assembled using a gasket eliminator.
- Follow all safety recommendations and directions that are on the container.

To remove the sealant or the gasket material, refer to *Replacing Engine Gaskets* .

- Apply a continuous bead of gasket eliminator to one flange. Surfaces to be sealed must be clean and dry.

Caution: Refer to *Sealant Caution* .

- Spread the sealer evenly with your finger to get a uniform coating on the sealing surface.

Note • Anaerobic sealed joints that are partially torqued and allowed to cure more than 5 minutes may result in incorrect shimming and sealing of the joint. • Tighten bolts to specifications. Do not overtighten.

- After properly tightening the fasteners, remove the excess sealer from the outside of the joint.

Introduction

1407260

Tools and Equipment

Tools and Equipment

Special tools are listed and illustrated throughout this section, with a complete listing at the end of the section. These tools, or their equivalents, are specially designed to quickly and safely accomplish the operations for which they are intended. The use of these special tools 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

2158727

Special Tools

Special Tools:Engine Mechanical

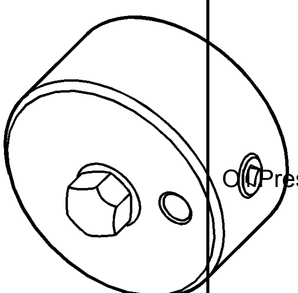
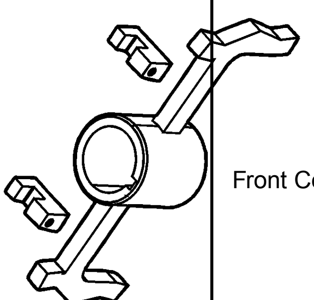
Illustration	Tool Number/Description
 1651441	EN 47971 Oil Pressure Gauge Adapter
 2029090	EN-48853 Front Cover Alignment Tool

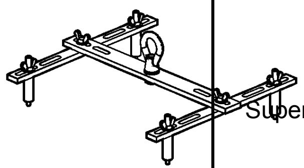
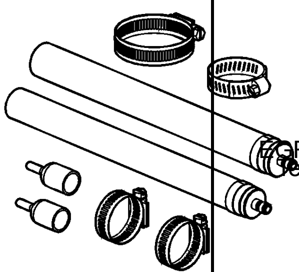
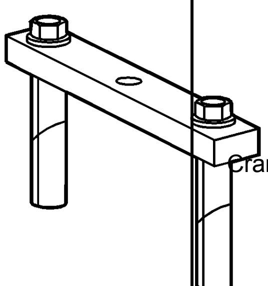
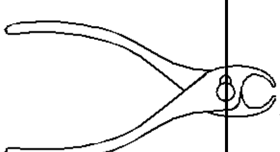
Illustration	Tool Number/Description
 2057056	EN-48898 Supercharger Lift Fixture
 2032464	EN-48974 EGR Cooler Pressure Tester Adapter Set
 2057055	EN-49102 Crankshaft Bearing Cap Remover
 14487	J 3049-A Valve Lifter Remover

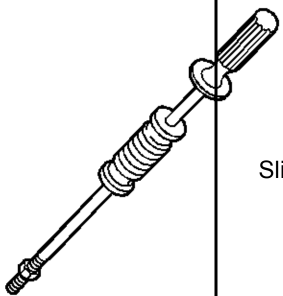
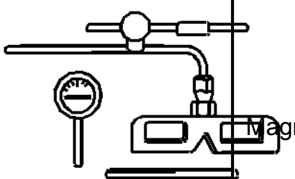
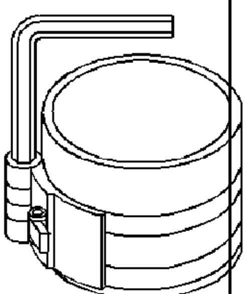
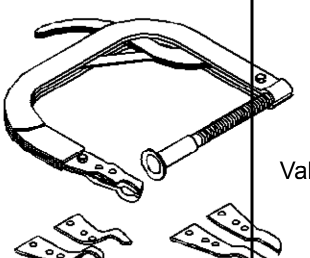
Illustration	Tool Number/Description
 177628	J 6125-1B Slide Hammer Adapter
 35463	J 7872 Magnetic Base Dial Indicator
 3403	J 8037 Ring Compressor
 3414	J 8062 Valve Spring Compressor – Head Off

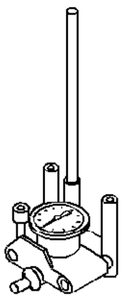
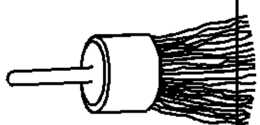
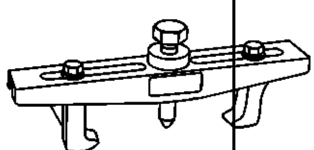
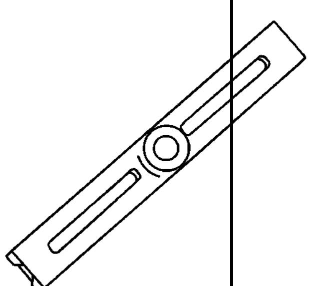
Illustration	Tool Number/Description
 5110	J 8087 Cylinder Bore Gauge
 4994	J 8089 Carbon Removal Brush
 216164	J 8433 Two Jaw Puller
 210221	J 8433-1 Puller Bar

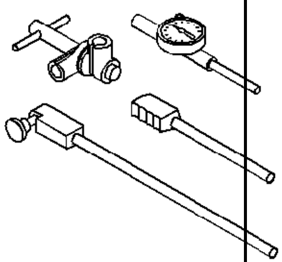
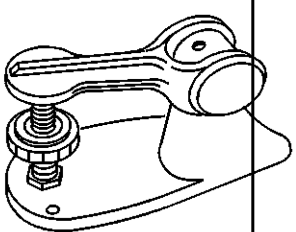
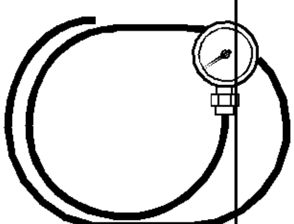
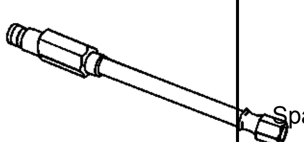
Illustration	Tool Number/Description
 3408	J 8520 Cam Lobe Lift Indicator
 4997	J 9666 Valve Spring Tester
 29339	J 21867 Pressure Gauge
 26998	J 22794 Spark Plug Port Adapter

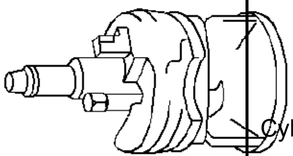
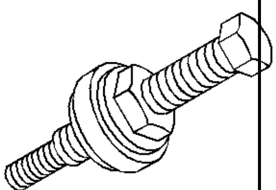
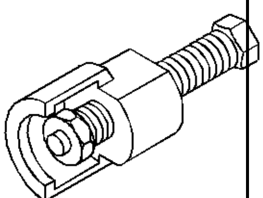
Illustration	Tool Number/Description
 3412	J 24270 Cylinder Bore Ridge Reamer
 676	J 25033-C Pulley Installer
 675	J 25034-C Pulley Remover
 52126	J 28410 Gasket Remover

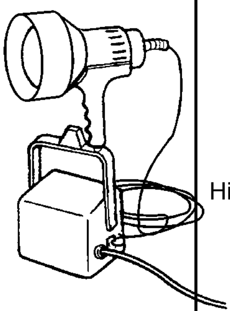
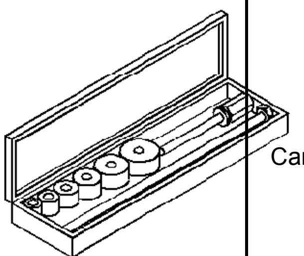
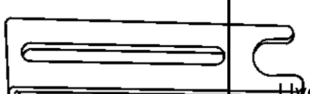
Illustration	Tool Number/Description
 62292	J 28428-E High-Intensity Black Light Kit
 5118	J 33049 Camshaft Bearing Service Set
 62295	J 35667-A Cylinder Head Leakdown Tester
 105916	J 36221 Hydraulic Clutch Line Separator

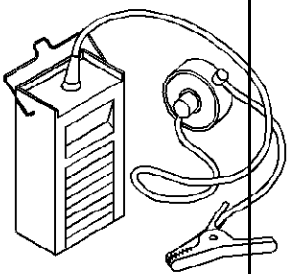
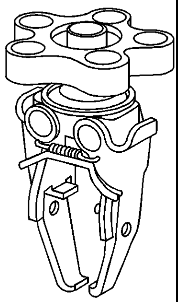
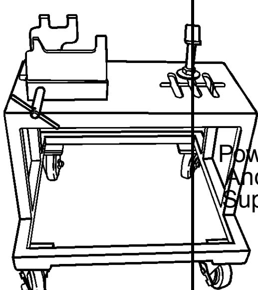
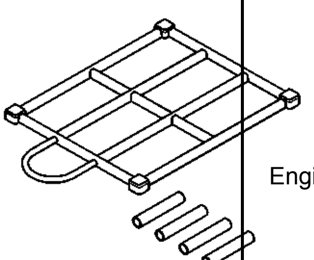
Illustration	Tool Number/Description
 3413	J 36660-A Torque Angle Meter
 33658	J 38606 Valve Spring Compressor
 1241315	J 39580 Power Pack Stand Engine And Transaxle Assembly Support Remove/Installer
 74284	J 39580-500 Engine Support Table Top

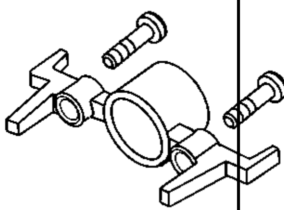
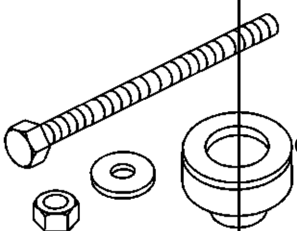
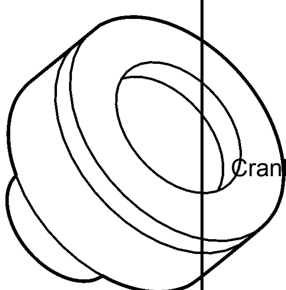
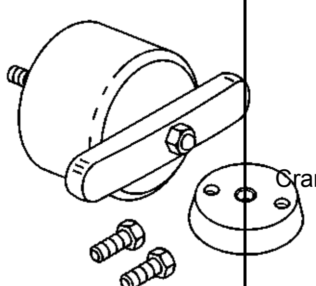
Illustration	Tool Number/Description
 64207	J 41476 Front and Rear Cover Alignment Tool
 64248	J 41478 Crankshaft Front Oil Seal Installer
 2139439	J 41478-1A Crankshaft Front Oil Seal Installer Cone
 64249	J 41479 Crankshaft Rear Oil Seal Installer

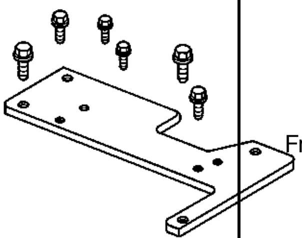
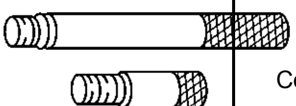
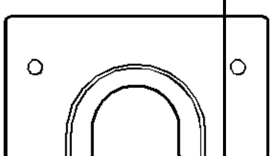
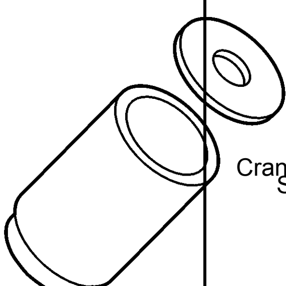
Illustration	Tool Number/Description
 64211	J 41480 Front and Rear Cover Alignment
 64260	J 41556 Connecting Rod Guide
 98060	J 41558 Crankshaft Sprocket Remover
 2139442	J 41665-A Crankshaft Balancer and Sprocket Installer

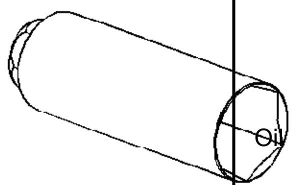
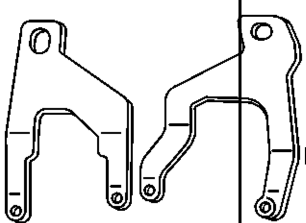
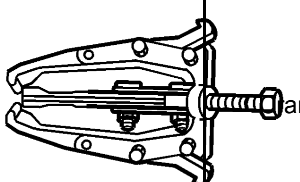
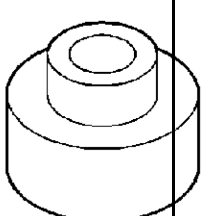
Illustration	Tool Number/Description
 67136	J 41712 Oil Pressure Switch Socket
 74283	J 41798 Engine Lift Bracket
 1313753	J 41816-A Crankshaft Balancer Remover
 142148	J 41816-2 Crankshaft End Protector

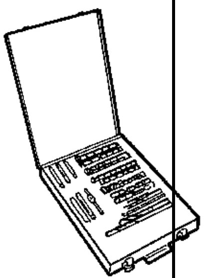
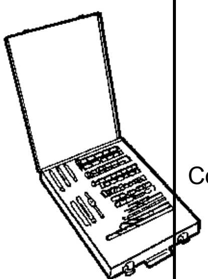
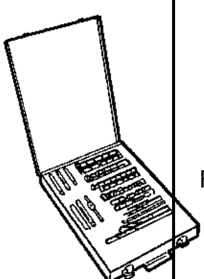
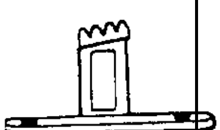
Illustration	Tool Number/Description
 340279	J 42385-100 Head/Main Bolt Thread Repair Kit
 453049	J 42385-200 Common Threads Repair Kit
 453073	J 42385-300 Fixtures and Hardware Kit
 99089	J 42386-A Flywheel Holding Tool

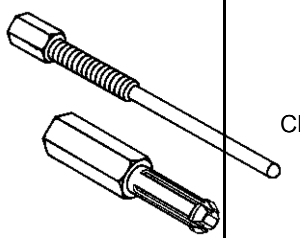
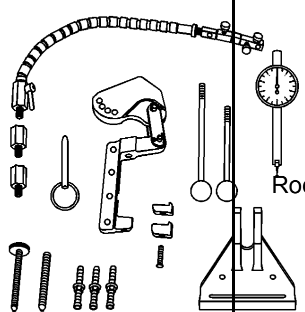
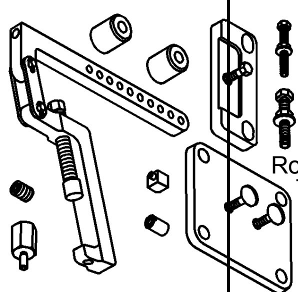
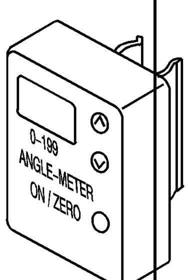
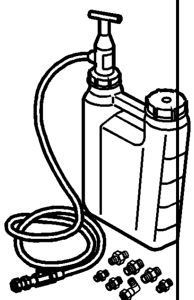
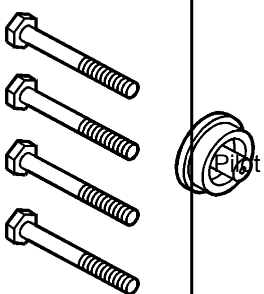
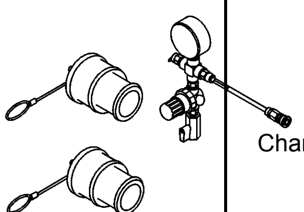
Illustration	Tool Number/Description
 355040	J 43276 Clutch Pilot Bearing Remover
 650651	J 43690 Rod Bearing Clearance Checking Tool
 863073	J 43690-100 Rod Bearing Checking Tool – Adapter Kit
 1197696	J 45059 Angle Meter

Illustration	Tool Number/Description
 852797	J 45299 Engine Preluber
 1244632	J 45949 Pilot Bearing and Flywheel Locator Installer
 870414	J 46091 Charge Air Cooler Tester