Engine Mechanical - 5.7L

Specifications

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Accelerator Control Cable Bracket Bolts	10 N·m	89 lb in
Air Conditioning Compressor Bolts	50 N·m	37 lb ft
Air Conditioning Compressor Bracket Bolts	50 N·m	37 lb ft
Air Conditioning Idler Pulley Bolt	50 N·m	37 lb ft
Air Conditioning Tensioner Bolt	25 N·m	18 lb ft
Air Injection Reaction (AIR) Pipe-to-Exhaust Manifold Bolts	20 N·m	15 lb ft
Camshaft Retainer Bolts	25 N·m	18 lb ft
Camshaft Sensor Bolt	25 N·m	18 lb ft
Camshaft Sprocket Bolts	35 N·m	26 lb ft
Catalytic Converter Nut	25 N·m	18 lb ft
Connecting Rod Bolts - First Design (First Pass)	20 N·m	15 lb ft
Connecting Rod Bolts - First Design (Final Pass)	60 degrees	
Connecting Rod Bolts - Second Design (First Pass)	20 N·m	15 lb ft
Connecting Rod Bolts - Second Design (Final Pass)	75 degrees	
Coolant Temperature Gauge Sensor	20 N·m	15 lb ft
Crankshaft Balancer Bolt (Installation Pass-to Ensure the Balancer is Completely Installed)	330 N·m	240 lb ft
Crankshaft Balancer Bolt (First Pass-Install a NEW Bolt After the Installation Pass and Tighten as Described in the First and Final Passes)	50 N·m	37 lb ft
Crankshaft Balancer Bolt (Final Pass)	140 degrees	
Crankshaft Bearing Cap Bolts (Inner Bolts-First Pass in Sequence)	20 N·m	15 lb ft
Crankshaft Bearing Cap Bolts (Inner Bolts-Final Pass in Sequence)	80 degrees	
Crankshaft Bearing Cap Side Bolts	25 N·m	18 lb ft
Crankshaft Bearing Cap Studs (Outer Studs-First Pass in Sequence)	20 N·m	15 lb ft
Crankshaft Bearing Cap Studs (Outer Studs-Final Pass in Sequence)	53 degrees	
Crankshaft Oil Deflector Nuts	25 N·m	18 lb ft
Crankshaft Position Sensor Bolt	25 N·m	18 lb ft
Cylinder Head Bolts (First Pass all M11 Bolts in Sequence)	30 N·m	22 lb ft
Cylinder Head Bolts (Second Pass all M11 Bolts in Sequence)	90 degrees	
Cylinder Head Bolts (Final Pass all M11 Bolts in Sequence-Excluding the Medium Length Bolts at the Front and Rear of Each Cylinder Head)	90 degrees	
Cylinder Head Bolts (Final Pass M11 Medium Length Bolts at the Front and Rear of Each Cylinder Head in Sequence)	50 degrees	
Cylinder Head Bolts (M8 Inner Bolts in Sequence)	30 N·m	22 lb ft
Cylinder Head Coolant Plug	20 N·m	15 lb ft
Cylinder Head Core Hole Plug	20 N·m	15 lb ft
Drive Belt Idler Pulley Bolt	50 N·m	37 lb ft
Drive Belt Tensioner Bolts	50 N·m	37 lb ft
Engine Block Coolant Drain Plugs	60 N·m	44 lb ft
Engine Block Heater	40 N·m	30 lb ft
Engine Block Oil Gallery Plugs	60 N·m	44 lb ft
Engine Coolant Air Bleed Pipe Bolts and Studs	12 N·m	106 lb in
Engine Crossmember Bolts (Large)	145 N·m	107 lb ft

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Fastener Tightening Specifications (cont'd)

Application	Specification	
	Metric	English
Engine Crossmember Bolts (Small)	125 N·m	92 lb ft
Engine Flywheel Bolts (First Pass)	20 N·m	15 lb ft
Engine Flywheel Bolts (Second Pass)	50 N·m	37 lb ft
Engine Flywheel Bolts (Final Pass)	100 N·m	74 lb ft
Engine Flywheel-to-Torque Converter Bolts	60 N·m	44 lb ft
Engine Front Cover Bolts	25 N·m	18 lb ft
Engine Mount Heat Shield Nuts	10 N·m	89 lb in
Engine Mount Stud-to-Engine Block	50 N·m	37 lb ft
Engine Mount Through Bolts	95 N·m	70 lb ft
Engine Mount Through Bolt Nuts	80 N·m	59 lb ft
Engine Mount-to-Engine Block Bolts	50 N·m	37 lb ft
Engine Rear Cover Bolts	25 N·m	18 lb ft
Engine Service Lift Bracket M10 Bolts	50 N·m	37 lb ft
Engine Service Lift Bracket M8 Bolt	25 N·m	18 lb ft
Engine Valley Cover Bolts	25 N·m	18 lb ft
Engine Wire Harness Clip Bolt	50 N·m	37 lb ft
Engine Wire Harness Ground Strap Bolt	50 N·m	37 lb ft
Exhaust Gas Recirculation (EGR) Valve Bolts (First Pass)	10 N·m	89 lb in
EGR Valve Bolts (Final Pass)	30 N·m	22 lb ft
EGR Valve Pipe-to-Cylinder Head Bolts	50 N·m	37 lb ft
EGR Valve Pipe-to-Exhaust Manifold Bolts	30 N·m	22 lb ft
EGR Valve Pipe-to-Intake Manifold Bolt	10 N·m	89 lb in
Exhaust Manifold Bolts (First Pass)	15 N·m	11 lb ft
Exhaust Manifold Bolts (Final Pass)	25 N·m	18 lb ft
Exhaust Manifold Heat Shield Bolts	9 N·m	80 lb in
Exhaust Manifold Pipe Nuts	35 N·m	26 lb ft
Front Shock-to-Engine Crossmember Bolts	65 N·m	48 lb ft
Fuel Injection Fuel Rail Bolts	10 N·m	89 lb in
Generator Bracket Bolts	50 N·m	37 lb ft
Generator Rear Bracket-to-Engine Block Bolt	25 N·m	18 lb ft
Generator Rear Bracket-to-Generator Bolt	25 N·m	18 lb ft
Ground Strap Bolt (at Rear of Cylinder Head)	50 N·m	37 lb ft
Ignition Coil-to-Bracket Bolts	12 N·m	106 lb in
Ignition Coil Bracket-to-Valve Rocker Arm Cover Bolts	12 N·m	106 lb in
Intake Manifold Bolts (First Pass in Sequence)	5 N·m	44 lb in
Intake Manifold Bolts (Final Pass in Sequence)	10 N·m	89 lb in
Knock Sensors	20 N·m	15 lb ft
Oil Filter	30 N·m	22 lb ft
Oil Filter Fitting	55 N·m	40 lb ft
Oil Level Indicator Tube Bolt	25 N·m	18 lb ft
Oil Level Sensor	13 N·m	115 lb in
Oil Pan Baffle Bolts	12 N·m	106 lb in
Oil Pan Closeout Cover Bolt (Left Side)	12 N·m	106 lb in
Oil Pan Closeout Cover Bolt (Right Side)	12 N·m	106 lb in
Oil Pan Cover Bolts	12 N·m	106 lb in
Oil Pan Drain Plug	25 N·m	18 lb ft
Oil Pan M8 Bolts (Oil Pan-to-Engine Block and Oil Pan-to-Front Cover)	25 N·m	18 lb ft

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Fastener Tightening Specifications (cont'd)

Application	Specification	
	Metric	English
Oil Pan M6 Bolts (Oil Pan-to-Rear Cover)	12 N·m	106 lb in
Oil Pressure Sensor	20 N·m	15 lb ft
Oil Pump-to-Engine Block Bolts	25 N·m	18 lb ft
Oil Pump Cover Bolts	12 N·m	106 lb in
Oil Pump Relief Valve Plug	12 N·m	106 lb in
Oil Pump Screen Nuts	25 N·m	18 lb ft
Oil Pump Screen-to-Oil Pump Bolt	12 N·m	106 lb in
Oxygen Sensor	42 N·m	31 lb ft
Positive Crankcase Ventilation (PCV) System Strap Nut (at Right Front Vapor Vent Pipe Stud)	12 N·m	106 lb in
Power Steering Pump Bolts	25 N·m	18 lb ft
Power Steering Pump Bracket Bolts	25 N·m	18 lb ft
Spark Plugs (Cylinder Heads-New)	20 N·m	15 lb ft
Spark Plugs (all Subsequent Installations)	15 N·m	11 lb ft
Throttle Body Bolts	12 N·m	106 lb in
Transmission Housing Bolt	50 N·m	37 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
Water Pump Bolts (First Pass)	15 N·m	11 lb ft
Water Pump Bolts (Final Pass)	30 N·m	22 lb ft
Water Pump Cover Bolts	15 N·m	11 lb ft

Engine Mechanical Specifications

Application	Specification	
	Metric	English
General Data		
Engine Type	V 8	
Displacement	5.7L-5665 cc	346 CID
Bore	99.0 mm	3.898 in
Stroke	92.0 mm	3.622 in
Compression Ratio	10.1:1	
Firing Order	1-8-7-2-6-5-4-3	
Spark Plug Gap	1.524 mm	0.06 in
Lubrication System		
Oil Capacity (without Oil Filter Change)	4.7 Liters	5.0 Quarts
Oil Capacity (with Oil Filter Change)	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 Type	5W-30	
Camshaft		
Camshaft End Play	0.025–0.305 mm	0.001–0.012 in
Camshaft Journal Diameter	54.99–55.04 mm	2.164–2.166 in

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Engine Mechanical Specifications (cont'd)

Application	Specification	
	Metric	English
Camshaft Journal Diameter Out-of-Round	0.025 mm	0.001 in
Camshaft Lobe Lift (Intake)	7.43 mm	0.292 in
Camshaft Lobe Lift (Exhaust)	7.43 mm	0.292 in
Camshaft Runout (Measured at the Intermediate Journals)	0.05 mm	0.002 in
Connecting Rod		
Connecting Rod Bearing Bore Diameter	56.505–56.525 mm	2.224–2.225 in
Connecting Rod Bearing Bore Out-of-Round (Production)	0.004 mm	0.00015 in
Connecting Rod Bearing Bore Out-of-Round (Service Limit)	0.008 mm	0.0003 in
Connecting Rod Bearing Clearance (Production)	0.015–0.063 mm	0.0006–0.00248 in
Connecting Rod Bearing Clearance (Service Limit)	0.015–0.076 mm	0.0006–0.003 in
Connecting Rod Side Clearance	0.11–0.51 mm	0.00433–0.02 in
Crankshaft		
Crankshaft Bearing Clearance (Production)	0.018–0.054 mm	0.0007–0.00212 in
Crankshaft Connecting Rod Journal Diameter (Production)	53.318–53.338 mm	2.0991–2.0999 in
Crankshaft Connecting Rod Journal Diameter (Service Limit)	53.308 mm	2.0987 in
Crankshaft Connecting Rod Journal Taper (Production)	0.005 mm (Maximum for 1/2 of the Journal Length)	0.0002 in (Maximum for 1/2 of the Journal Length)
Crankshaft Connecting Rod Journal Taper (Service Limit)	0.02 mm (Maximum)	0.00078 in (Maximum)
Crankshaft Connecting Rod Journal Out-of-Round (Production)	0.005 mm	0.002 in
Crankshaft Connecting Rod Journal Out-of-Round (Service Limit)	0.01 mm	0.00039 in
Crankshaft End Play	0.04–0.2 mm	0.0015–0.0078 in
Crankshaft Main Journal Diameter (Production)	64.993–65.007 mm	2.558–2.559 in
Crankshaft Main Journal Diameter (Service Limit)	64.993 mm (Minimum)	2.558 in (Minimum)
Crankshaft Main Journal Out-of-Round (Production)	0.003 mm	0.000118 in
Crankshaft Main Journal Out-of-Round (Service Limit)	0.008 mm	0.00031 in
Crankshaft Main Journal Taper (Production)	0.01 mm	0.00039 in
Crankshaft Main Journal Taper (Service Limit)	0.02 mm	0.00078 in
Crankshaft Reluctor Ring Runout (Measured 1.0 mm (0.04 in) Below the Tooth Diameter)	0.25 mm	0.01 in
Crankshaft Runout (at Rear Flange)	0.05 mm (Maximum)	0.002 in (Maximum)
Crankshaft Thrust Wall Runout	0.025 mm	0.001 in
Crankshaft Thrust Wall Width (Production)	26.14–26.22 mm	1.029–1.032 in
Crankshaft Thrust Wall Width (Service)	26.2 mm (Maximum)	1.0315 in (Maximum)
Cylinder Bore		
Cylinder Bore Diameter	99.0–99.018 mm	3.897–3.898 in
Cylinder Bore Taper Thrust Side	0.018 mm (Maximum)	0.0007 in (Maximum)
Cylinder Head		
Cylinder Head Engine Block Deck Flatness (Measured within a 152.4 mm (6.0 in) area)	0.08 mm	0.003 in
Cylinder Head Engine Block Deck Flatness (Measuring the Overall Length of the Cylinder Head)	0.1 mm	0.004 in
Cylinder Head Exhaust Manifold Deck Flatness	0.22 mm	0.008 in
Cylinder Head Intake Manifold Deck Flatness	0.22 mm	0.008 in
Cylinder Head Height (Measured from the Cylinder Head Deck to the Valve Rocker Arm Cover Seal Surface)	120.2 mm (Minimum)	4.732 in (Minimum)
Engine Block		
Camshaft Bearing Bore Diameter	55.063–55.088 mm	2.168–2.169 in

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Engine Mechanical Specifications (cont'd)

Application	Specification	
	Metric	English
Engine Block Cylinder Head Deck Surface Flatness (Measured within a 152.4 mm (6.0 in) area)	0.08 mm	0.003 in
Engine Block Cylinder Head Deck Surface Flatness (Measuring the Overall Length of the Block Deck)	0.22 mm	0.008 in
Engine Block Cylinder Head Deck Height (Measuring from the Centerline of Crankshaft to the Deck Face)	234.57–234.82 mm	9.235–9.245 in
Main Bearing Bore Diameter (Production)	69.871–69.889 mm	2.75–2.751 in
Main Bearing Bore Out-of-Round	0.5 mm	0.02 in
Valve Lifter Bore Diameter (Production)	21.417–21.443 mm	0.843–0.844 in
Intake Manifold		
Intake Manifold Cylinder Head Deck Flatness (Measured at Gasket Sealing Surfaces)	0.5 mm	0.02 in
Oil Pan and Front/Rear Cover Alignment		
Oil Pan to Rear of Engine Block Alignment (at Transmission Bellhousing Mounting Surface)	0.0–0.25 mm (Maximum)	0.0–0.01 in (Maximum)
Front Cover Alignment (at Oil Pan Surface)	0.0–0.5 mm	0.0–0.02 in
Rear Cover Alignment (at Oil Pan Surface)	0.0–0.5 mm	0.0–0.02 in
Piston		
Piston Outside Diameter (at Size Point)	98.964–98.982 mm	3.8962–3.8969 mm
Piston Out-of-Round (Service Limit)	0.018 mm	0.0007 in
Piston to Bore Clearance (Production)	0.018–0.054 mm	0.0007–0.00212 in
Piston to Bore Clearance (Service Limit)	0.018–0.054 mm (Maximum)	0.0007–0.00212 in (Maximum)
Piston Pin		
Piston Pin Clearance to Piston Bore (Production)	0.01–0.02 mm	0.0004–0.00078 in
Piston Pin Clearance to Piston Bore (Service Limit)	0.01–0.02 mm (Maximum)	0.0004–0.00078 in (Maximum)
Piston Pin Diameter	23.997–24.0 mm	0.9447–0.9448 in
Piston Pin Fit in Connecting Rod	0.02–0.043 mm (Interference)	0.00078–0.00169 in (Interference)
Piston Rings		
Piston Compression Ring End Gap (Production—Top) (Measured in Cylinder Bore)	0.23–0.38 mm	0.009–0.0149 in
Piston Compression Ring End Gap (Production—2nd) (Measured in Cylinder Bore)	0.44–0.64 mm	0.0173–0.0251 in
Piston Oil Ring End Gap (Production) (Measured in Cylinder Bore)	0.18–0.69 mm	0.007–0.0271 in
Piston Compression Ring End Gap (Service—Top) (Measured in Cylinder Bore)	0.23–0.38 mm (Maximum)	0.009–0.0149 in (Maximum)
Piston Compression Ring End Gap (Service—2nd) (Measured in Cylinder Bore)	0.44–0.64 mm (Maximum)	0.0173–0.0251 in (Maximum)
Piston Oil Ring End Gap (Service Limit) (Measured in Cylinder Bore)	0.18–0.69 mm (Maximum)	0.007–0.0271 in (Maximum)
Piston Compression Ring Groove Clearance (Production—Top)	0.04–0.085 mm	0.00157–0.003346 in
Piston Compression Ring Groove Clearance (Production—2nd)	0.04–0.08 mm	0.00157–0.003149 in
Piston Oil Ring Groove Clearance (Production)	0.01–0.22 mm	0.0004–0.00866 in
Piston Compression Ring Groove Clearance (Service—Top)	0.04–0.085 mm (Maximum)	0.00157–0.003346 in (Maximum)
Piston Compression Ring Groove Clearance (Service—2nd)	0.04–0.08 mm (Maximum)	0.00157–0.003149 in (Maximum)
Piston Oil Ring Groove Clearance (Service Limit)	0.01–0.22 mm (Maximum)	0.0004–0.00866 in (Maximum)

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Engine Mechanical Specifications (cont'd)

Application	Specification	
	Metric	English
Valve System		
Valve Face Angle	45 degrees	
Valve Guide Installed Height (Measured from the Cylinder Head Spring Seat Surface to the Top of the Valve Guide)	17.32 mm	0.682 in
Valve Lash	Net Lash—No Adjustment	
Valve Lift (Exhaust)	12.15 mm	0.479 in
Valve Lift (Intake)	11.99 mm	0.472 in
Valve Lifter	Hydraulic Roller	
Valve Margin	1.25 mm (Minimum)	0.05 in (Minimum)
Valve Rocker Arm Ratio	1.70:1	
Valve Seat Angle	46 degrees	
Valve Seat Runout	0.05 mm (Maximum)	0.002 in (Maximum)
Valve Seat Width (Exhaust)	1.78 mm	0.07 in
Valve Seat Width (Intake)	1.02 mm	0.04 in
Valve Spring Free Length	52.9 mm	2.08 in
Valve Spring Installed Height (Exhaust)	45.75 mm	1.8 in
Valve Spring Installed Height (Intake)	45.75 mm	1.8 in
Valve Spring Pressure (Closed)	340 N at 45.75 mm	76 lb at 1.8 in
Valve Spring Pressure (Open)	980 N at 33.55 mm	220 lb at 1.32 in
Valve Stem Clearance (Production—Exhaust)	0.025–0.066 mm	0.001–0.0026 in
Valve Stem Clearance (Production—Intake)	0.025–0.066 mm	0.001–0.0026 in
Valve Stem Clearance (Service—Exhaust)	0.093 mm (Maximum)	0.0037 in (Maximum)
Valve Stem Clearance (Service—Intake)	0.093 mm (Maximum)	0.0037 in (Maximum)
Valve Stem Diameter (Production)	7.955–7.976 mm	0.313–0.314 in
Valve Stem Diameter (Service)	7.95 mm (Minimum)	0.313 in (Minimum)
Valve Stem Oil Seal Installed Height (Measured from the Valve Spring Shim to Top Edge of Seal Body)	18.1–19.1 mm	0.712–0.752 in

GM SPO Group Numbers

Application	GM SPO Group Number
Camshaft	0.519
Camshaft Bearing	0.539
Camshaft Timing Chain	0.724
Connecting Rod	0.603
Connecting Rod Bearing Kit	0.616
Coolant Radiator	1.219
Crankshaft	0.646
Crankshaft Balancer	0.659
Crankshaft Bearing Kit	0.096
Crankshaft Transmission Pilot Bearing	0.649
Crankshaft Oil Deflector	1.430
Crankshaft Front Oil Seal	0.213
Crankshaft Rear Oil Seal	0.137
Cylinder Head	0.269
Cylinder Head Gasket	0.289
Engine Block	N.S.
Engine Coolant Air Bleed Pipe	0.1097
Engine Coolant Air Bleed Pipe Gasket	0.1097

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GM SPO Group Numbers (cont'd)

Application	GM SPO Group Number
Engine Cooling Thermostat	1.246
Engine Front Cover	0.206
Engine Front Cover Gasket	0.207
Engine Flywheel (Automatic Transmission)	0.666
Engine Flywheel (Manual Transmission)	0.666
Engine Rear Cover	0.137
Engine Rear Cover Gasket	0.137
Exhaust Manifold	3.601
Exhaust Manifold Gasket	3.27
Ignition Coil	2.17
Intake Manifold	3.265
Intake Manifold Gasket	3.270
Oil Filter	1.836
Oil Level Indicator	1.516
Oil Level Indicator Tube	1.516
Oil Pan	1.426
Oil Pan Gasket	1.429
Oil Pump	1.652
Oil Pump Screen	1.656
Oil Pan Cover	1.426
Oil Pan Cover Gasket	1.429
Piston with Pin	0.629
Piston with Ring Kit	0.643
Radiator Fan Shroud	1.277
Spark Plug	2.270
Starter Motor	2.041
Throttle Body	3.335
Throttle Body Gasket	3.336
Valley Cover	3.265
Valley Cover Gasket	3.270
Valve Lifter	0.459
Valve Lifter Guide	0.439
Valve Pushrod	0.426
Valve Rocker Arm	0.333
Valve Rocker Arm Cover	0.386
Valve Rocker Arm Cover Gasket	0.423
Valve Rocker Arm Support	0.429
Valve Spring	0.303
Valve Spring Shim	0.303
Valve Stem Oil Seal	0.308
Water Pump Gasket	1.079
Water Pump with Gasket	1.069

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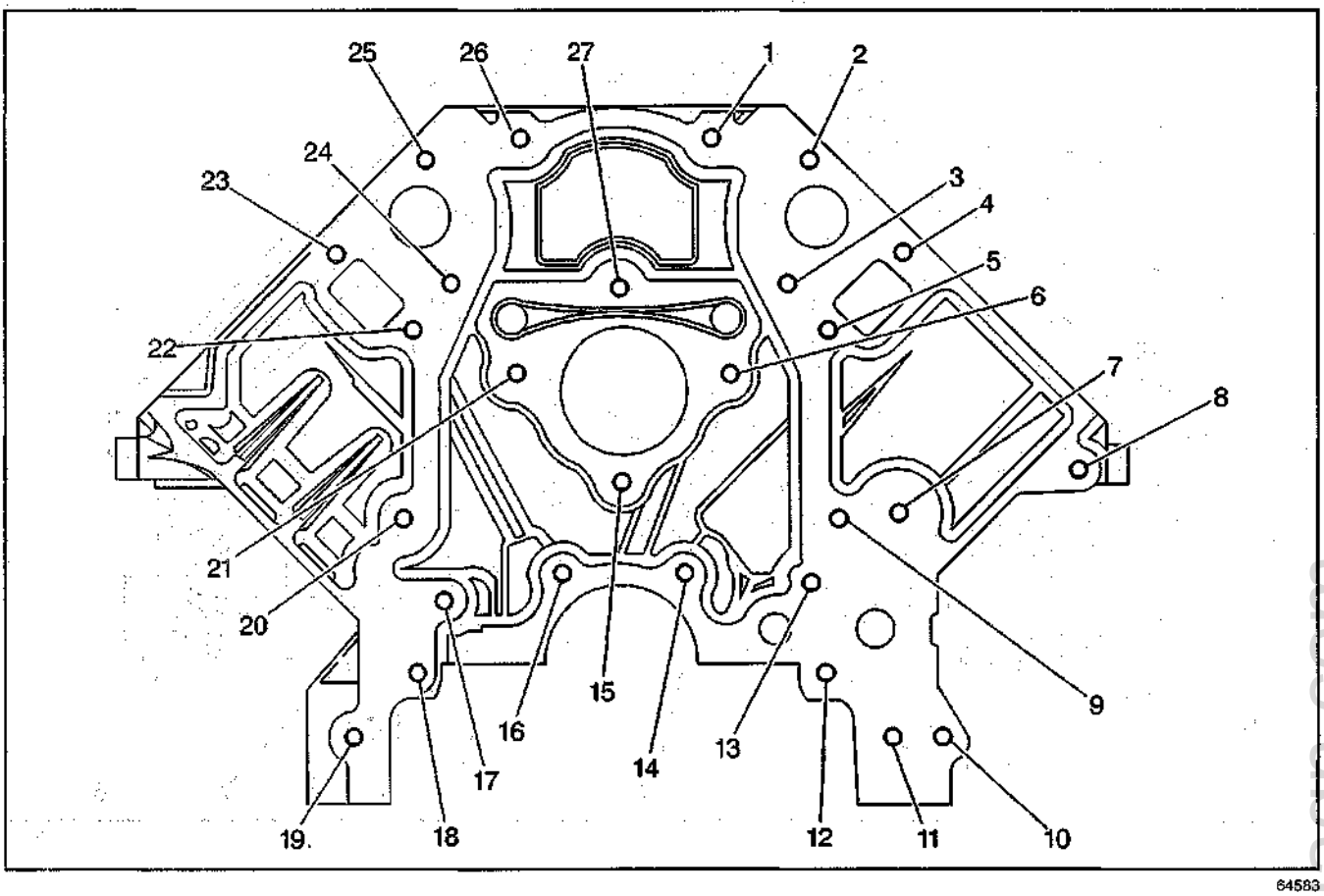
Sealers, Adhesives, and Lubricants

Application	Type of Material	GM Part Number
Coolant Sensor Threads	Sealant	12346004
Cylinder Head Core Hole Plugs	Threadlock	12345382
Cylinder Head Expansion Plugs	Threadlock	12345382
Cylinder Head M8 Bolt Threads	Threadlock	12345382
Engine Block Front Oil Gallery Plug	Threadlock	12345382
Engine Block Plug Sealing Washers	Sealant	12346004
Engine Flywheel Bolt Threads	Threadlock	12345382
Engine Oil (F/V Car)	5W–30 Oil	12345610
Engine Oil (Y Car)	5W–30 Synthetic Oil	12345885
Engine Oil Supplement	Lubricant	12345795
Exhaust Manifold Bolt Threads	Threadlock	12345493
Fuel Rail Bolt Threads	Threadlock	12345382
Ignition Coil and Bracket Assembly Bolts	Threadlock	12345382
Intake Manifold Bolt Threads	Threadlock	12345382
Oil Pan Surface at Front and Rear Covers	Sealant	12378190
Oil Pressure Sensor Threads	Sealant	12346004

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Thread Repair Specifications

Engine Block-Front View



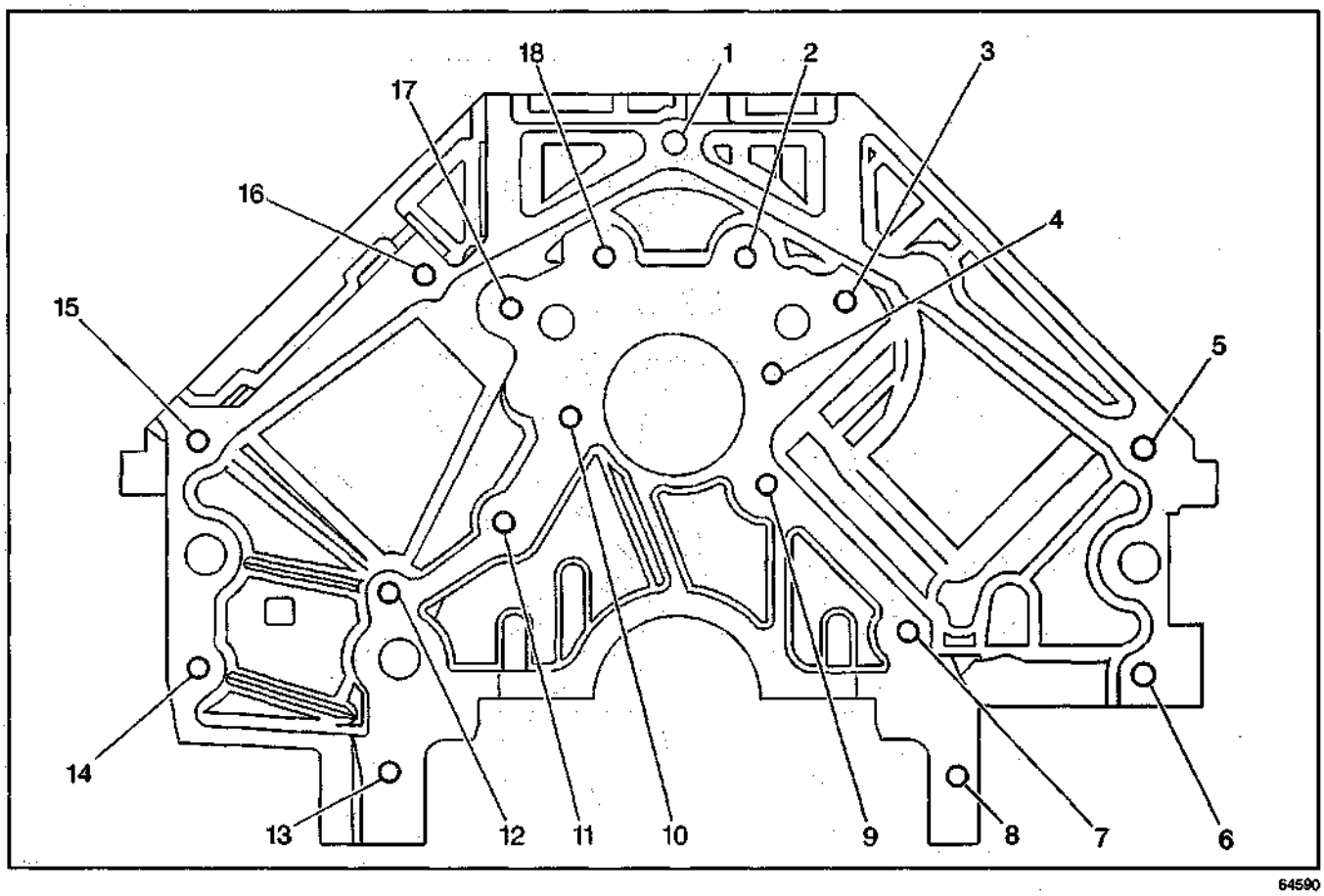
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Engine Block-Front View

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum) mm (in)	Tap Depth (Maximum) mm (in)
1–6	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5 (0.885)	17.5 (0.688)
7	M10 x 1.5	J 42385-215	J 42385-211	J 42385-212	J 42385-213	J 42385-214	25.0 (0.984)	19.5 (0.767)
8	M10 x 1.5	J 42385-215	J 42385-211	J 42385-212	J 42385-213	J 42385-214	32.5 (1.28)	25.0 (0.984)
9	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5 (0.885)	17.5 (0.688)
10	M10 x 1.5	J 42385-215	J 42385-211	J 42385-212	J 42385-213	J 42385-214	Thru	Thru
11–13	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5 (0.885)	17.5 (0.688)
14	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	Thru	18.0 (0.708)
15	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5 (0.885)	17.5 (0.688)
16	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	Thru	18.0 (0.708)
17–27	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5 (0.885)	17.5 (0.688)

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Engine Block-Rear View

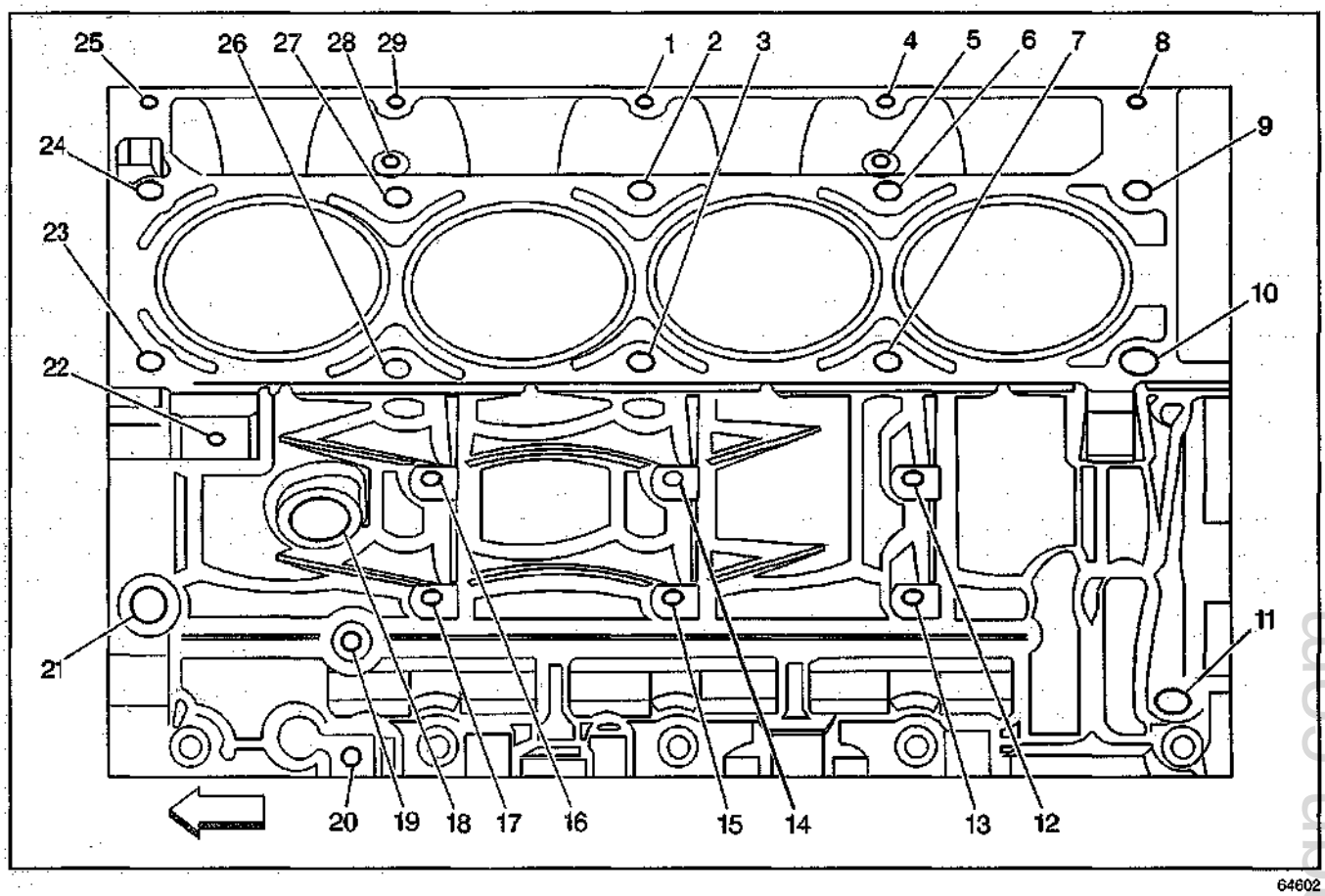


Engine Block-Rear View

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum) mm (in)	Tap Depth (Maximum) mm (in)
1	M10 x 1.5	J 42385-215	J 42385-211	J 42385-212	J 42385-213	J 42385-214	27.0 (1.06)	21.5 (0.846)
2–4	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5 (0.885)	17.5 (0.688)
5–6	M10 x 1.5	J 42385-215	J 42385-211	J 42385-212	J 42385-213	J 42385-214	27.0 (1.06)	21.5 (0.846)
7–13	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5 (0.885)	17.5 (0.688)
14–16	M10 x 1.5	J 42385-215	J 42385-211	J 42385-212	J 42385-213	J 42385-214	27.0 (1.06)	21.5 (0.846)
17–18	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5 (0.885)	17.5 (0.688)

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Engine Block-Left Side View



Engine Block-Left Side View

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum) mm (in)	Tap Depth (Maximum) mm (in)
1	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5 (1.04)	19.0 (0.784)
2-3	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	124.0 (4.88)	115.0 (4.52)
4	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5 (1.04)	19.0 (0.784)
5	M6 x 1.0	J 42385-205	J 42385-201	J 42385-202	J 42385-203	J 42385-204	22.5 (0.885)	16.0 (0.629)
6-7	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	124.0 (4.88)	115.0 (4.52)
8	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5 (1.04)	19.0 (0.784)
9	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	69.0 (2.72)	60.0 (2.36)
10	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	124.0 (4.88)	115.0 (4.52)
11	M16 x 1.5	—	—	—	—	—	—	—
12-17	M10 x 1.5	J 42385-215	J 42385-211	J 42385-212	J 42385-213	J 42385-214	29.0 (1.14)	23.0 (0.905)
18	M28 x 1.25	—	—	—	—	—	—	—

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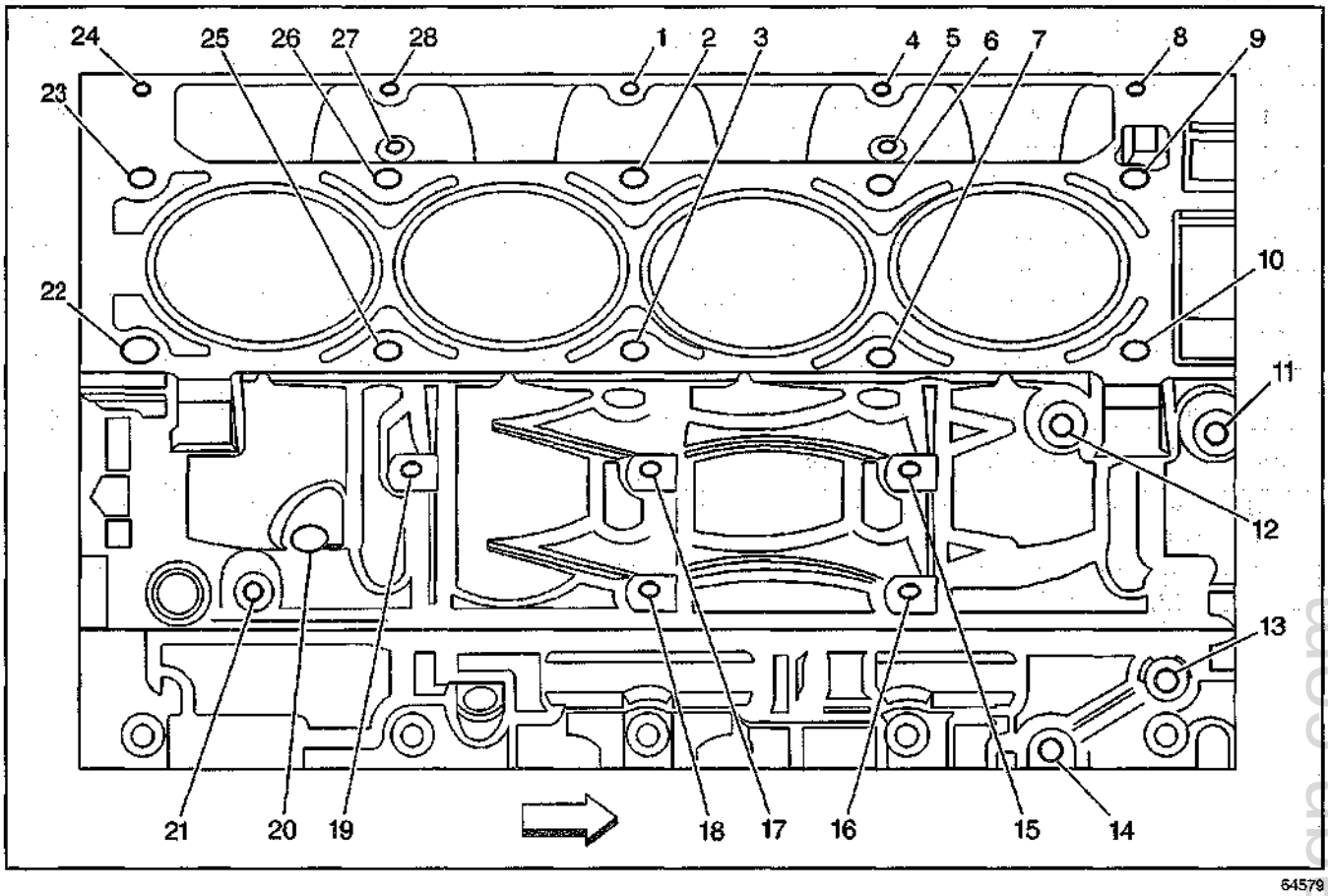
Engine Block-Left Side View (cont'd)

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum) mm (in)	Tap Depth (Maximum) mm (in)
19–20	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	21.0 (0.826)	16.0 (0.629)
21	M16 x 1.5	—	—	—	—	—	—	—
22	M10 x 1.5	J 42385-215	J 42385-211	J 42385-212	J 42385-213	J 42385-214	27.0 (1.06)	21.5 (0.846)
23	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	124.0 (4.88)	115.0 (4.52)
24	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	69.0 (2.72)	60.0 (2.36)
25	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5 (1.04)	19.0 (0.784)
26–27	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	124.0 (4.88)	115.0 (4.52)
28	M6 x 1.0	J 42385-205	J 42385-201	J 42385-202	J 42385-203	J 42385-204	22.5 (0.885)	16.0 (0.629)
29	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5 (1.04)	19.0 (0.784)

- Bolt holes 2, 3, 6, 7, 10, 23, 26, and 27 have a 85 mm (3.34 in) counterbore included in the 124.0 mm (4.88 in) drill depth.
- Bolt holes 9 and 24 have a 30 mm (1.18 in) counterbore included in the 69.0 mm (2.72 in) drill depth. Use sleeve J 42385-315 with the drill and tap.

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Engine Block-Right Side View



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Engine Block-Right Side View

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum) mm (in)	Tap Depth (Maximum) mm (in)
1	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5 (1.04)	19.0 (0.784)
2-3	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	124.0 (4.88)	115.0 (4.52)
4	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5 (1.04)	19.0 (0.784)
5	M6 x 1.0	J 42385-205	J 42385-201	J 42385-202	J 42385-203	J 42385-204	22.5 (0.885)	15.0 (0.590)
6-7	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	124.0 (4.88)	115.0 (4.52)
8	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5 (1.04)	19.0 (0.784)
9	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	69.0 (2.72)	60.0 (2.36)
10	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	124.0 (4.88)	115.0 (4.52)
11-14	M10 x 1.5	J 42385-215	J 42385-211	J 42385-212	J 42385-213	J 42385-214	27.0 (1.06)	21.5 (0.846)
15-19	M10 x 1.5	J 42385-215	J 42385-211	J 42385-212	J 42385-213	J 42385-214	29.0 (1.14)	23.0 (0.905)
20	M16 x 1.5	—	—	—	—	—	—	—

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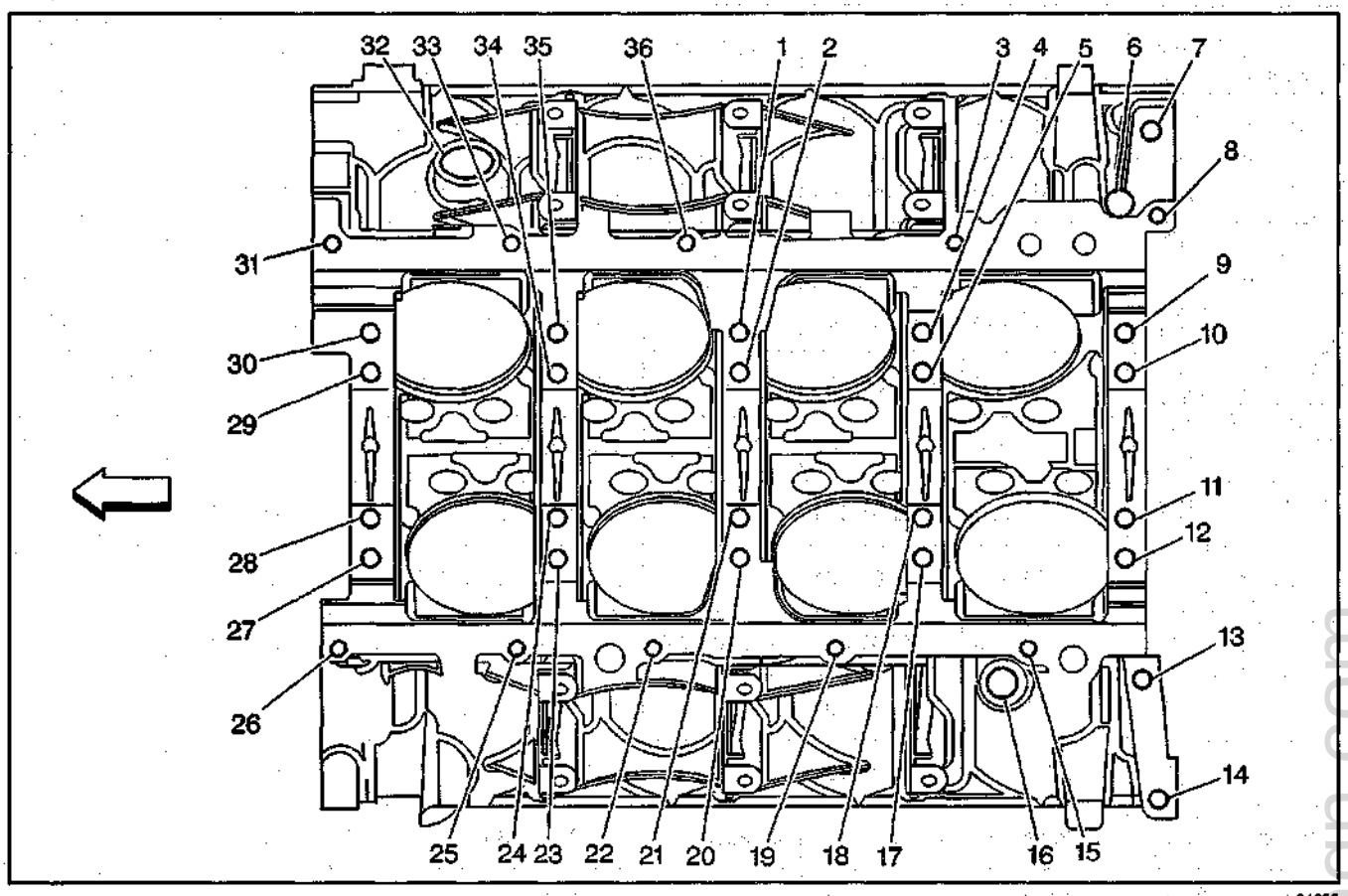
Engine Block-Right Side View (cont'd)

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum) mm (in)	Tap Depth (Maximum) mm (in)
21	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5 (0.885)	17.5 (0.688)
22	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	124.0 (4.88)	115.0 (4.52)
23	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	69.0 (2.72)	60.0 (2.36)
24	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5 (1.04)	19.0 (0.784)
25–26	M11 x 2.0	J 42385-108	J 42385-105	—	J 42385-106	J 42385-107	124.0 (4.88)	115.0 (4.52)
27	M6 x 1.0	J 42385-205	J 42385-201	J 42385-202	J 42385-203	J 42385-204	22.5 (0.885)	15.0 (0.590)
28	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5 (1.04)	19.0 (0.784)

- Bolt holes 2, 3, 6, 7, 10, 22, 25, and 26 have a 85 mm (3.34 in) counterbore included in the 124.0 mm (4.88 in) drill depth.
- Bolt holes 9 and 23 have a 30 mm (1.18 in) counterbore included in the 69.0 mm (2.72 in) drill depth. Use sleeve J 42385-315 with the drill and tap.

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Engine Block-Bottom View



Engine Block-Bottom View

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum) mm (in)	Tap Depth (Maximum) mm (in)
1	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	31.0 (1.22)	25.5 (1.0)
2	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	53.5 (2.10)	44.0 (1.73)
3	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5 (0.885)	17.5 (0.688)
4	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	31.0 (1.22)	25.5 (1.0)
5	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	53.5 (2.10)	44.0 (1.73)
6	M16 x 1.5	—	—	—	—	—	—	—
7	N/A	—	—	—	—	—	—	—
8	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5 (0.885)	17.5 (0.688)
9	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	31.0 (1.22)	25.5 (1.0)
10–11	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	53.5 (2.10)	44.0 (1.73)
12	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	31.0 (1.22)	25.5 (1.0)

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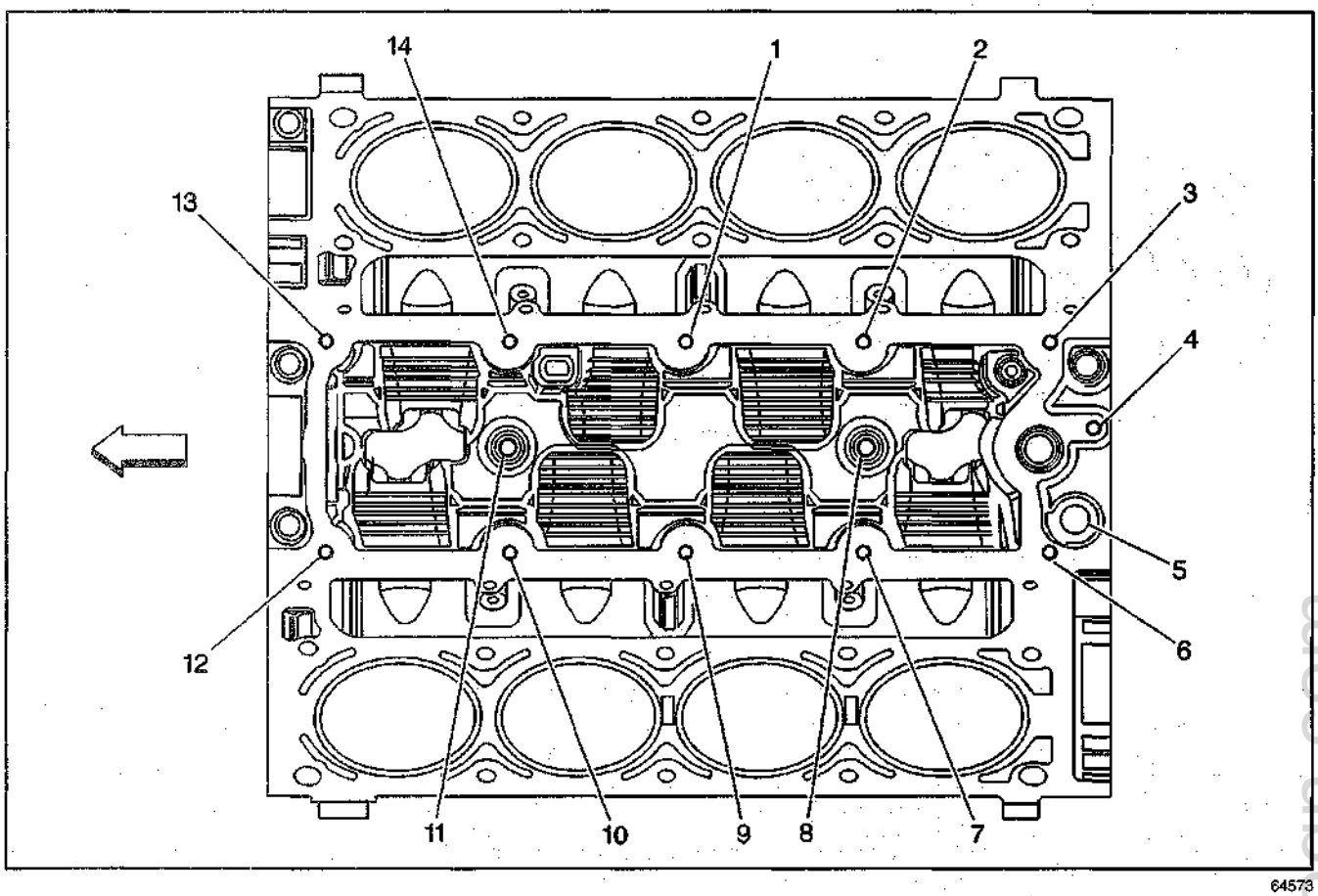
Engine Block-Bottom View (cont'd)

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum) mm (in)	Tap Depth (Maximum) mm (in)
13–14	M10 x 1.5	J 42385-215	J 42385-101	—	J 42385-213	J 42385-214	42.5 (1.67)	37.0 (1.45)
15	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5 (0.885)	17.5 (0.688)
16	M16 x 1.5	—	—	—	—	—	—	—
17	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	53.5 (2.10)	44.0 (1.73)
18	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	31.0 (1.22)	25.5 (1.0)
19	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5 (0.885)	17.5 (0.688)
20	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	53.5 (2.10)	44.0 (1.73)
21	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	31.0 (1.22)	25.5 (1.0)
22	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5 (0.885)	17.5 (0.688)
23	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	31.0 (1.22)	25.5 (1.0)
24	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	53.5 (2.10)	44.0 (1.73)
25–26	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5 (0.885)	17.5 (0.688)
27	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	31.0 (1.22)	25.5 (1.0)
28–29	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	53.5 (2.10)	44.0 (1.73)
30	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	31.0 (1.22)	25.5 (1.0)
31	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5 (0.885)	17.5 (0.688)
32	M28 x 1.25	—	—	—	—	—	—	—
33	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5 (0.885)	17.5 (0.688)
34	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	53.5 (2.10)	44.0 (1.73)
35	M10 x 2.0	J 42385-104	J 42385-101	—	J 42385-102	J 42385-103	31.0 (1.22)	25.5 (1.0)
36	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	22.5 (0.885)	17.5 (0.688)

- Bolt holes 2, 5, 10, 11, 18, 21, 24, 28, 29, and 34 have a 20.5 mm (0.807 in) counterbore included in the 53.5 mm (2.10 in) drill depth.
- Bolt holes 1, 4, 9, 12, 17, 20, 23, 27, 30, and 35 have 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 holes 13 and 14 have a 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.

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Engine Block-Top View

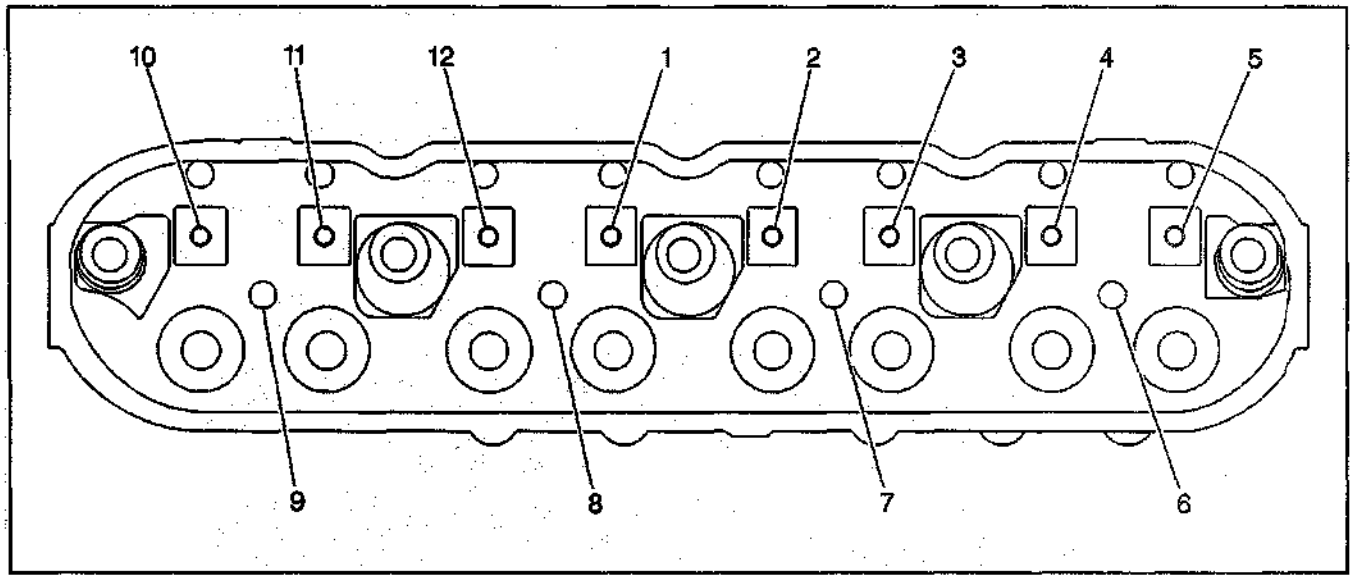


Engine Block-Top View

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum) mm (in)	Tap Depth (Maximum) mm (in)
1–4	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5 (1.04)	19.0 (0.784)
5	M16 x 1.5	—	—	—	—	—	—	—
6–7	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5 (1.04)	19.0 (0.784)
8	M10 x 1.5	J 42385-216	J 42385-211	J 42385-212	J 42385-213	J 42385-214	22.5 (0.885)	17.0 (0.669)
9–10	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5 (1.04)	19.0 (0.784)
11	M10 x 1.5	J 42385-216	J 42385-211	J 42385-212	J 42385-213	J 42385-214	22.5 (0.885)	17.0 (0.669)
12–14	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5 (1.04)	19.0 (0.784)

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Cylinder Head-Top View



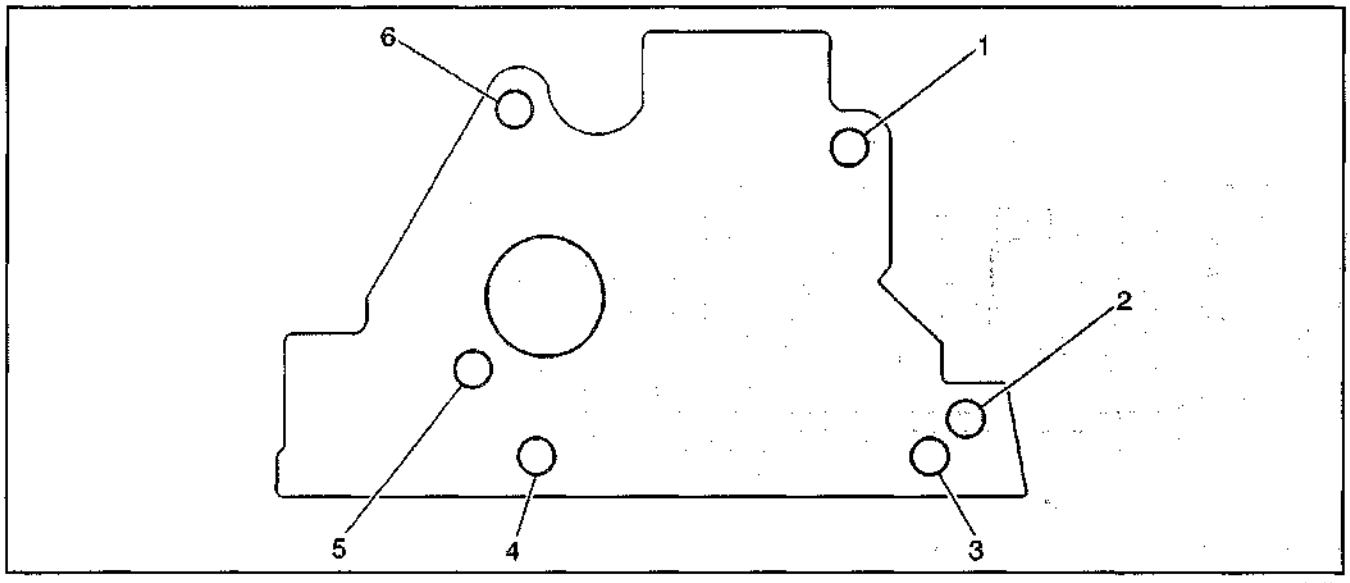
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Cylinder Head-Top View

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum) mm (in)	Tap Depth (Maximum) mm (in)
1–5	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5 (1.04)	19.0 (0.784)
6–9	M6 x 1.0	J 42385-205	J 42385-201	J 42385-202	J 42385-203	J 42385-204	20.05 (0.789)	16.05 (0.632)
10–12	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	26.5 (1.04)	19.0 (0.784)

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Cylinder Head-End View



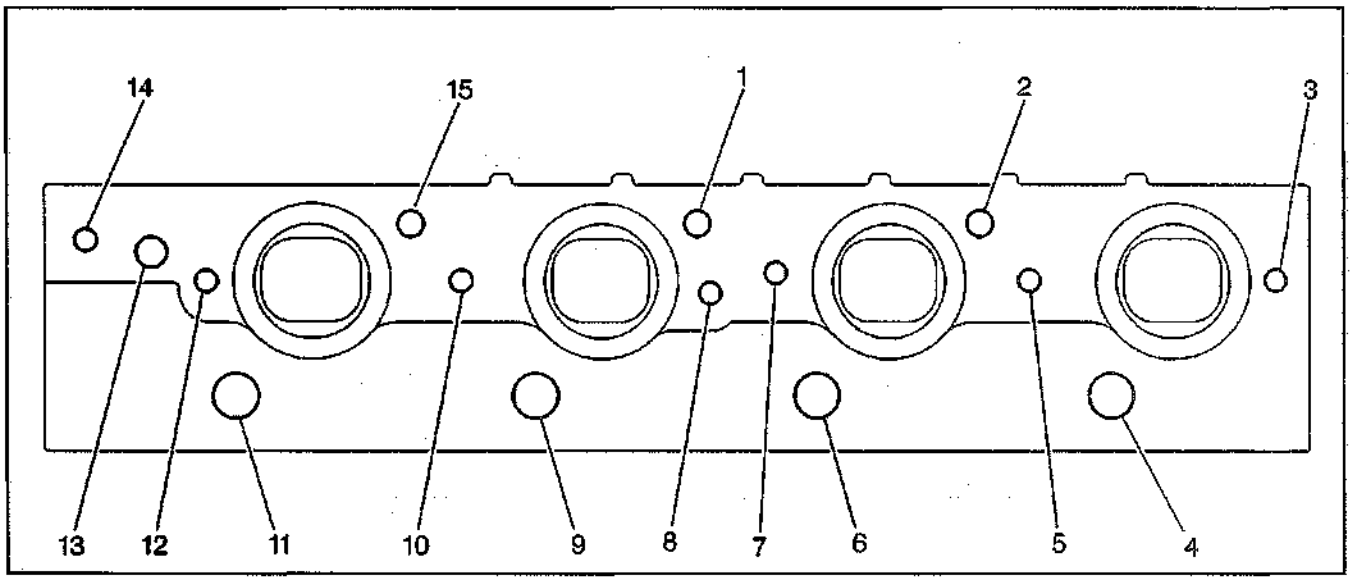
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Cylinder Head-End View

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum) mm (in)	Tap Depth (Maximum) mm (in)
1	M10 x 1.5	J 42385-215	J 42385-211	J 42385-212	J 42385-213	J 42385-214	28.0 (1.10)	20.0 (0.787)
2	—	N/A	—	—	—	—	—	—
3	M10 x 1.5	J 42385-215	J 42385-211	J 42385-212	J 42385-213	J 42385-214	28.0 (1.10)	20.0 (0.787)
4	N/A	—	—	—	—	—	—	—
5–6	M10 x 1.5	J 42385-215	J 42385-211	J 42385-212	J 42385-213	J 42385-214	28.0 (1.10)	20.0 (0.787)

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Cylinder Head-Exhaust Manifold Deck View



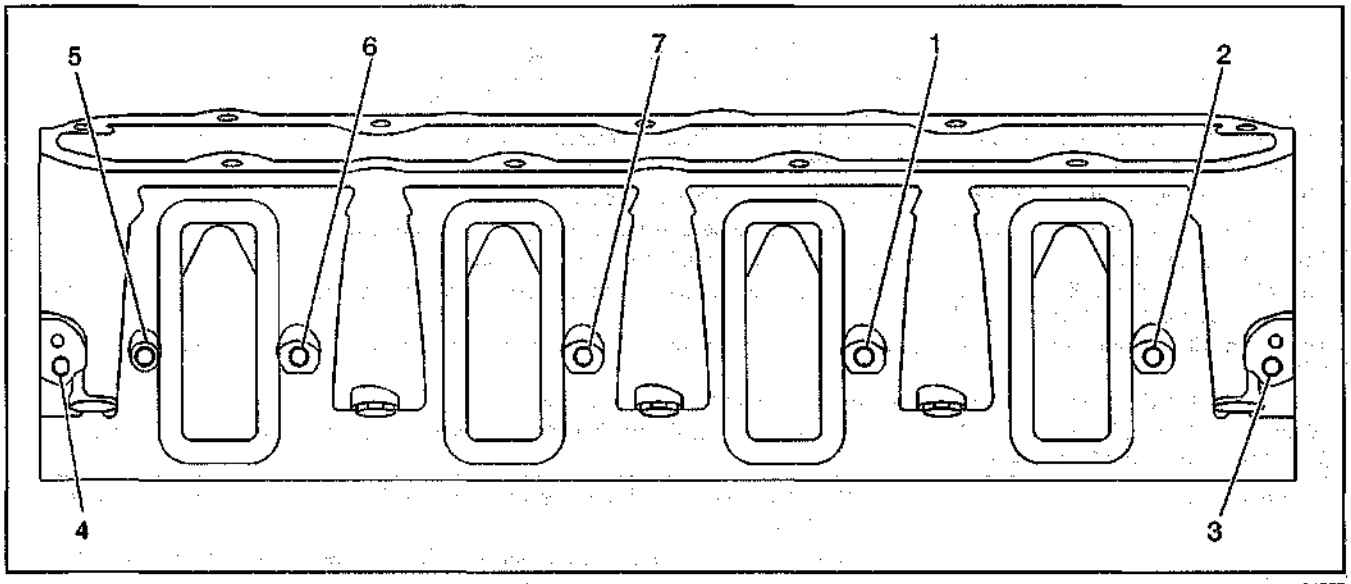
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Cylinder Head-Exhaust Manifold Deck View

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum) mm (in)	Tap Depth (Maximum) mm (in)
1–2	M10 x 1.5	J 42385-215	J 42385-211	J 42385-212	J 42385-213	J 42385-214	28.0 (1.10)	20.0 (0.787)
3	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	21.0 (0.826)	16.0 (0.629)
4	M14 x 1.25	—	—	—	—	—	—	—
5	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	21.0 (0.826)	16.0 (0.629)
6	M14 x 1.25	—	—	—	—	—	—	—
7–8	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	21.0 (0.826)	16.0 (0.629)
9	M14 x 1.25	—	—	—	—	—	—	—
10	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	21.0 (0.826)	16.0 (0.629)
11	M14 x 1.25	—	—	—	—	—	—	—
12	M8 x 1.25	J 42385-210	J 42385-206	J 42385-207	J 42385-208	J 42385-209	21.0 (0.826)	16.0 (0.629)
13	M12 x 1.5	—	—	—	—	—	—	—
14–15	M10 x 1.5	J 42385-215	J 42385-211	J 42385-212	J 42385-213	J 42385-214	28.0 (1.10)	20.0 (0.787)

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Cylinder Head-Intake Manifold Deck View



64557

Cylinder Head-Intake Manifold Deck View

Hole	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum) mm (in)	Tap Depth (Maximum) mm (in)
1–2	M6 x 1.0	J 42385-205	J 42385-201	J 42385-202	J 42385-203	J 42385-204	Thru	Thru
3–4	M6 x 1.0	J 42385-205	J 42385-201	J 42385-202	J 42385-203	J 42385-204	22.5 (0.885)	15.0 (0.688)
5–7	M6 x 1.0	J 42385-205	J 42385-201	J 42385-202	J 42385-203	J 42385-204	Thru	Thru

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Diagnostic Information and Procedures

Base Engine Misfire Diagnosis

Checks	Action
Engine performance diagnosis procedures are covered in Engine Controls and should be consulted for diagnosis of any Driveability, Emissions, or Malfunctioning Indicator Lamp (MIL) concerns. The following diagnosis covers common concerns and possible causes. When the proper diagnosis is made, the concern should be corrected by adjustment, repair or replacement as required. Refer to the appropriate section of the service manual for each specific procedure. This diagnostic table will assist in engine misfire diagnosis due to a mechanical concern such as a faulty camshaft, worn or damaged bearings or bent pushrod. This table will not isolate a crossed injector wire, faulty injector or any other driveability component failure that may cause a misfire. The Powertrain On-Board Diagnostic System checks must be performed first. When using this table to make a Base Engine Misfire diagnosis, begin with the preliminary information below and then proceed to the specific category.	
Preliminary	1. Perform DTC P0300 before proceeding with Base Engine Misfire Diagnosis information. DTC P0300 will assist in determining which cylinder or cylinders are misfiring. 2. Perform a visual inspection for the following: • A loose or improperly installed engine flywheel or crankshaft balancer • Worn, damaged, or misaligned accessory drive system components 3. Listen to the engine for any abnormal internal engine noises. 4. Inspect the engine for acceptable oil pressure. Refer to *Oil Pressure Diagnosis and Testing*. 5. Verify if the engine has excessive oil consumption. 6. Verify if the engine has coolant consumption. 7. Perform a compression test on the engine. Refer to *Engine Compression Test*.
Intake Manifold Leaks	An intake manifold that has a vacuum leak may cause a misfire. Inspect for the following: • Improperly installed or damaged vacuum hoses • Faulty or improperly installed intake manifold and/or gaskets • Loose Exhaust Gas Recirculaton (EGR) valve pipe or damaged or missing O-ring seal • Cracked or damaged intake manifold Inspect the areas between the intake runners. • Improperly installed or damaged Manifold Absolute Pressure (MAP) sensor housing (located at the rear of the intake manifold) • Improperly installed or damaged MAP sensor housing O-ring seal • Improperly installed MAP sensor or vacuum hoses The sealing grommet of the MAP sensor should not be torn or damaged. • Improperly installed throttle body or damaged gasket • A loose EGR valve pipe assembly or damaged or missing O-ring seal • Warped intake manifold • Warped or damaged cylinder head sealing surface
Coolant Consumption	Coolant consumption may or may not cause the engine to overheat. Inspect for the following: • External coolant leaks • Faulty cylinder head gasket • Warped cylinder head • Cracked cylinder head • Damaged engine block

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Base Engine Misfire Diagnosis (cont'd)

Checks	Action
Oil Consumption	1. Oil consumption may or may not cause the engine to misfire. 2. Remove the spark plugs and inspect for an oil fouled spark plug. 3. Perform a cylinder compression test. Refer to *Engine Compression Test.* 4. If the compression test indicates worn valves or valve guides, inspect for the following: • Worn valve guides • Worn valve stems • Worn or burnt valves or valve seats • Worn, brittle, or improperly installed valve stem oil seals 5. If the compression test indicates worn or damaged piston rings, inspect the following: • Broken or improperly seated piston rings • Excessive piston ring end gap • Excessive cylinder bore wear or taper • Cylinder damage • Piston damage
Abnormal Internal Engine Noises	1. With the engine running try and determine if the noise is timed to camshaft speed or crankshaft speed. 2. Using a timing light, two knocks per flash is crankshaft speed and one knock per flash is camshaft speed. 3. If the noise is timed to camshaft speed, inspect the following: • Missing or loose valve train components • Worn or loose valve rocker arms • Worn or bent pushrods • Faulty valve springs • Bent or burnt valves • Worn camshaft lobes • Worn or damaged timing chain and/or sprockets **Important:** A slight COLD knock or piston slapping noise could be considered normal if not present after the engine has reached normal operating temperatures. 4. If the knock is timed to crankshaft speed, inspect the following: • Worn crankshaft main or connecting rod bearings • Piston or cylinder damage • Worn piston or piston pin • Damaged or faulty connecting rod • Excessive carbon build-up on the top of the piston
No Abnormal Internal Engine Noise	1. Inspect for a worn or improperly installed timing chain and/or sprockets. 2. Remove the valve rocker arm cover on the side of the engine with the cylinder that is misfiring. 3. Inspect for the following: • Loose valve rocker arm bolts • Bent push rods • Faulty valve springs • Faulty valve lifters (bleeding down) • Worn or improperly seated valves • Worn camshaft lobes

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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 the spark plugs.
5. Block the throttle plate wide open.
6. Start with the compression gauge at zero, and crank the engine through four compression strokes (four puffs).
7. Make the compression check for each cylinder. Record the reading.
8. If a cylinder has low compression, inject approximately 15 ml (one tablespoon) of engine oil into the combustion chamber through the spark plug hole.

   Recheck the compression and record the reading.
9. The minimum compression in any one 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 one cylinder is 1035 kPa (150 psi), the lowest allowable pressure for any other cylinder would be 725 kPa (105 psi). (1035 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 then 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 two 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.

Engine Noise Diagnosis

Symptom	Cause
There are four steps to diagnosing engine noise. You must determine the following: • The type of noise For example, is the noise a light rattle/tapping or a low rumble/knocking? • The exact operating condition under which the noise exists Note factors such as the ambient temperature, the amount of engine warm-up time, the engine temperature, engine RPMs, and other specifics. • At what rate the noise occurs, and at what location in the engine Remember, engine noises are generally synchronized to either engine speed (crankshaft, flywheel, connecting rods, balancer, or pistons and related components) or one-half engine speed (valve train noise such as rocker arms, valve lifters, and timing chain). Try to determine the rate at which the noise is occurring. • Compare the engine sounds to other engines and make sure you are not trying to correct a normal condition.	
Noise on Start-Up but Only Lasts a Few Seconds	• Improper oil viscosity. Install the recommended oil viscosity for the expected temperatures. • Incorrect oil filter without the anti-drainback feature • Worn or dirty valve lifters • Excessive piston to bore clearance • Excessive piston pin to piston clearance • Excessive crankshaft bearing clearance
Knocks Cold and Continues for 1 to 2 Minutes	• Loose or broken crankshaft balancer or accessory drive components • Excessive piston to bore clearance A cold piston knock which disappears in 1.5 minutes should be considered acceptable. • A cold engine knock usually disappears when the specific cylinders secondary ignition circuit is grounded out.
Intermittent Noise on Idle, Disappearing When Engine Speed is Increased	• Improper oil viscosity. Install the recommended oil viscosity for the expected temperatures. • Lower than specified oil pressure Install an oil pressure gauge and measure the engine oil pressure. • Dirty or worn valve lifter

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Engine Noise Diagnosis (cont'd)

Symptom	Cause
Valve Train Noise (Rattle/Tapping)	The following conditions may cause valve train noise: • Lower than specified oil pressure • Worn or faulty oil pump • Loose oil pump-to-engine block bolts • Loose valve rocker arm attachments • Worn valve rocker arm bearings • Worn valve rocker arm and/or pushrod • Broken valve spring • Sticking valves • Worn, dirty, or faulty valve lifters • Worn camshaft lifter lobes • Worn valve guides or valve stems • Bent, broken, or damaged timing chain sprocket teeth
Knocks at Idle Hot (Rumble/Knocking)	The following conditions may cause a knocking noise: • Malfunctioning accessory drive system components • Loose or broken crankshaft balancer • Loose prop shaft hub or clamp (Corvette only) • Detonation or spark knock Check for proper operation of the cooling, knock, and ignition control components. Refer to diagnostic information in Engine Controls. • Excessive connecting rod bearing clearance • Excessive piston pin to bore clearance • Bent connecting rod • Excessive crankshaft main or thrust bearing clearance • Loose torque converter bolts • Cracked or damaged flywheel • Exhaust leak at the manifold
Exhaust System Noise and/or Leakage	Exhaust system noise and/or leakage may be caused by the following conditions: • Improperly installed or misaligned exhaust system components • A cracked or broken exhaust manifold • Damaged or worn gaskets and/or seals • Burned or rusted out exhaust system components • A broken or loose exhaust clamp and/or bracket

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Valve Train Diagnosis

Symptom	Cause
• A light tapping noise at one-half engine speed, or any varying frequency, may indicate a valve train problem. • These tapping noises will typically increase with engine speed. • Before attempting to diagnose valve train noise, check for the proper oil level and thoroughly warm up the engine. By doing this you will bring all engine components to a normal state of expansion. • While sitting in the drivers seat, run the engine at various speeds and listen for any abnormal engine noise. • Whenever Valve Lifter Diagnosis is necessary, always use a listening device such as and engine stethoscope, or listening ears J 39565. These tools will help to isolate any lifter noise and identify noises that could be mis-diagnosed as lifter noise.	
A light tapping noise similar to valve train noise may be caused by the following components:	• Fuel injectors • Evaporative emission (EVAP) purge solenoid • Detonation • Loose heat shields
The Causes of Valve Train Noise May Include the Following Conditions:	• Poor oil quality caused by water contamination, aeration, or fuel dilution • Low engine oil pressure • Worn or faulty oil pump • A loose or plugged oil pump screen • Loose valve rocker arm attachments (causing excessive valve lash) • Worn or damaged valve rocker arm bearings • Worn valve rocker arm and/or pushrod • Broken valve spring • Sticking valves • Valve lifters worn, dirty, or faulty • Broken valve lifter guide • Camshaft valve lifter lobes worn • Worn valve guides or valve stems • Worn, damaged, or missing valve keys • Bent pushrods • Excessive play in the camshaft timing chain • Bent, broken, or damaged timing chain sprocket teeth

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Diagnostic Table

Step	Action	Value(s)	Yes	No
DEFINITION: A light tapping noise at one half engine speed, or any varying frequency.				
1	Is there valve train noise?	—	*Go to Step 2*	System OK
2	Check for a high engine oil level. A engine with the oil level above the FULL mark allows the crankshaft counterweights to churn the oil into foam. When foamy oil is pumped into the lifters, the lifters become noisy. A solid column of oil ensures proper lifter operation. Is the oil level too high?	—	Drain the oil to the proper level. System OK	*Go to Step 3*
3	Check for a low engine oil level. A engine with the oil level below the ADD mark may allow the oil pump to pump air at high engine RPMs. Is the oil level too low?	—	Add oil as required. System OK	*Go to Step 4*
4	Check for proper engine oil pressure. Refer to *Engine Mechanical Specifications* and *Oil Pressure Diagnosis and Testing.* Is the engine oil pressure within specifications?	—	*Go to Step 7*	*Go to Step 5*
5	1. Check the oil pump screen for damage or a loose fit to the oil pump. 2. Inspect for a missing or damaged oil pump screen O-ring seal. Is the oil pump screen loose or is the screen or O-ring seal damaged?	—	Repair as required. System OK	*Go to Step 6*
6	Check for a damaged oil pump or loose mounting bolts Refer to *Oil Pump Clean and Inspect* Is the oil pump damaged or are the fasteners loose?	—	Repair as required. System OK	*Go to Step 10*
7	Remove and inspect the valve lifters, guides, rocker arms, and pushrods. Refer to *Valve Rocker Arm and Push Rods Clean and Inspect* and *Valve Lifters and Guides Clean and Inspect.* Are components worn or damaged?	—	Replace the components as required. System OK	*Go to Step 8*
8	Perform a camshaft lobe lift test. Refer to *Camshaft and Bearings Clean and Inspect* Is the test within *Engine Mechanical Specifications* ?	—	Camshaft is OK *Go to Step 9*	Replace the camshaft and valve lifters. System OK
9	Remove the engine front cover and inspect the timing chain and sprockets for excessive wear or damage. Refer to *Timing Chain and Sprockets Clean and Inspect* **Important:** Pushrod engines are designed so that a timing chain more than one tooth improperly positioned will cause valve interference with the piston. Are the components worn or damaged, or improperly positioned?	—	Replace the components as required. System OK	*Go to Step 10*
10	Perform a complete disassembly of the engine and inspect all components. Are the components worn or damaged?	—	Replace the components as required. System OK	—

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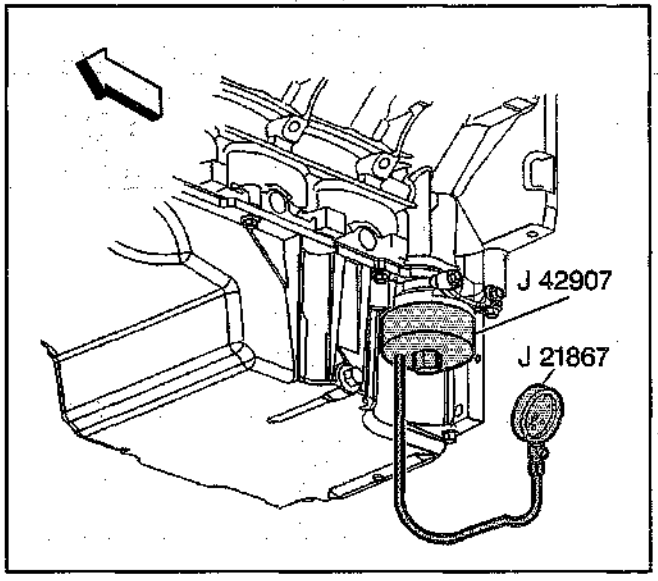
Oil Consumption Diagnosis

Checks	Causes
Excessive oil consumption (not due to leaks) is the use of 0.95 liters (1.0 qt) or more of engine oil within 2 414 kilometers (1,500 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 check 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 • Worn valve guides and/or valve stems Refer to *Cylinder Head Clean and Inspect.* • Worn or improperly installed valve stem oil seals • Piston rings broken, worn, not seated properly Allow adequate time for the rings to seat. Replace worn piston rings as necessary. • Piston and rings improperly installed or miss-fitted to the cylinder bore

Oil Pressure Diagnosis and Testing

Tools Required

- *J 21867* Pressure Gauge and Hose Assembly
- *J 42907* Oil Pressure Testing Tool



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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 for a low 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. Inspct for the following:
   - Oil diluted by water or glycol (anti freeze)
   - Foamy oil
6. Remove the oil filter and install the *J 42907.*
7. Install *J 21867* or equivalent to the *J 42907.*
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 one or more of the following:
    - Oil pump worn or dirty
      Refer to *Oil Pump Clean and Inspect.*
    - Oil pump-to-engine block bolts loose
      Refer to *Oil Pump, Pump Screen and Deflector Installation.*
    - Oil pump screen loose, plugged, or damaged
    - Oil pump screen O-ring seal missing or damaged
    - Malfunctioning oil pump pressure regulator 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* or equivalent is within specifications, inspect for the following:
    - Plugged or incorrect oil filter and/or malfunctioning oil bypass valve
    - Malfunctioning oil pressure gauge or sensor
      Repair as necessary

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Oil Leak Diagnosis

Step	Action	Value(s)	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.				
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. Check 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. Check 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. Check 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*
7	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check 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*

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Oil Leak Diagnosis (cont'd)

Step	Action	Value(s)	Yes	No
8	Use *J 28428-E* 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. Check 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

Symptoms - Drive Belt

Important: Review the drive belt system operation in order to familiarize yourself with the system functions. Refer to *Drive Belt System Description*.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the drive belts.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Inspect the drive belt for excessive wear, shredding, or missing sections.
- Inspect the drive belt for contamination of excessive dirt, oil, coolant or other substances that may affect the drive belt operation.

Intermittent

- Drive belt symptoms may be from intermittent failure of an accessory drive component.
- Drive belt symptoms may occur from changes in load of the accessory drive components.
- Ambient temperatures, moisture, or engine operating temperature can affect the drive belt operation.

Symptom List

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

- *Drive Belt Chirping Diagnosis*
- *Drive Belt Squeal Diagnosis*
- *Drive Belt Whine Diagnosis*
- *Drive Belt Rumbling Diagnosis*
- *Drive Belt Vibration Diagnosis*
- *Drive Belt Falls Off Diagnosis*
- *Drive Belt Excessive Wear Diagnosis*

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Drive Belt Chirping Diagnosis

Diagnostic Aids

The symptom may be intermittent due to moisture on the drive belt(s) or the pulleys. 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(s) duplicates the symptom, cleaning the belt pulleys may be the probable solution.

A loose or improper installation of a body component, a suspension component, or other item(s) on the vehicle may cause the chirping noise.

Test Description

The number(s) below refer to the step number(s) 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. Remove the drive belt(s) and operate the engine for a brief period, this will verify if the chirping noise is related to the drive belt(s). With the drive belt(s) remove the water pump may not be operate and the engine may overheat. Also DTCs may set when the engine is operated with the drive belt(s) removed.
4. Inspect all drive belt pulleys for pilling. Pilling is the small balls or pills or it may 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 may be 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. Inspection 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 dents or other damage to the pulleys that would prevent the drive belt(s) 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. Replacing the drive belt(s) when it is not damaged or there is not excessive pilling will only be a temporary repair.

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Drive Belt Chirping Diagnosis

Step	Action	Yes	No
	Notice: Refer to *Belt Dressing Notice* in Cautions and Notices. DEFINITION: The following items are indications of chirping: • A high pitched noise that is heard once per revolution of the drive belt or a pulley. • Chirping may occur on cold damp startup conditions and will subside once the vehicle reaches normal operating temperature.		
1	Did you review the Symptoms - Drive Belt diagnostic information and perform the necessary inspections?	Go to *Step 2*	Go to *Symptoms - Drive Belt*
2	Verify that there is a chirping noise. Does the engine make the chirping noise?	Go to *Step 3*	Go to Diagnostic Aids
3	1. Remove the drive belt. 2. Operate the engine for no longer than 30 to 40 seconds. Does the chirping noise still exist?	Go to *Engine Noise Diagnosis*	Go to *Step 4*
4	Inspect for severe pilling exceeding 1/3 of the belt groove depth. Does the belt grooves have pilling?	Go to *Step 5*	Go to *Step 6*
5	Clean the drive belt pulleys with a suitable wire brush. Were the drive belt pulleys cleaned?	Go to*Step 15*	Go to*Step 6*
6	Inspect for a misalignment of the pulleys. Are any of the pulleys misaligned?	Go to *Step 7*	Go to *Step 8*
7	Replace and/or repair any misaligned pulleys. Were the misaligned pulleys repaired and/or replaced?	Go to *Step 15*	Go to *Step 8*
8	Inspect for bent and/or cracked brackets. Did you find any bent and/or cracked brackets?	Go to *Step 9*	Go to *Step 10*
9	Replace any bent and/or cracked brackets. Were the bent and/or cracked brackets replaced?	Go to *Step 15*	Go to *Step 10*
10	Inspect for improper, missing and/or loose fasteners. Were there any improper, missing and/or loose fasteners?	Go to *Step 11*	Go to *Step 12*
11	Replace any improper and/or missing fasteners. Tighten any loose fasteners. Refer to *Fastener Tightening Specifications.* Did you complete the repair?	Go to *Step 15*	Go to *Step 12*
12	Inspect for a bent pulley. Did you find the condition?	Go to *Step 13*	Go to *Step 14*
13	Replace the bent pulley. Was the bent pulley replaced?	Go to *Step 15*	Go to *Step 14*
	Replace the drive belt(s). Refer to *Drive Belt Replacement - Accessory* or *Drive Belt Replacement - A/C.* Was the drive belt(s) replaced?	Go to *Step 15*	Go to Diagnostic Aids
15	Run the engine in order to verify the repair. Does the drive belt still chirp?	Go to *Step 3*	System OK

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Drive Belt Squeal Diagnosis

Diagnostic Aids

A loose or improper installation of a body component, a suspension component, or other items on the vehicle may cause the squeal noise.

If the noise is intermittent, verify that the accessory drive components are not the cause, by varying their loads making sure they are operating to their maximum capacity. An overcharged A/C system, a power steering system restriction, or incorrect fluid, or a failing generator are suggested items to inspect.

Test Description

The number(s) below refer to the step number(s) 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. Remove the drive belt(s) and operate the engine for a brief period, this will verify that the squeal noise is the drive belt(s) or an accessory drive component. With the drive belt(s) removed the water pump may not operate and the engine may overheat. Also DTCs may set when the engine is operated with the drive belt(s) removed.
4. This test is to verify that an accessory drive component does not have a seized bearing. With the drive belt(s) removed test the bearings in the accessory drive components for smooth operation. Test the accessory drive components with the engine operating by varying the load on the components to verify that the components operate properly.
5. This test is to verify that the drive belt(s) 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 belt squeal noise.
6. This test is to verify that the drive belt(s) is not to long, which would prevent the drive belt tensioner from operating properly. Also if an incorrect length drive belt(s) were installed, it may not be routed properly and may be turning an accessory drive component in the wrong direction.
7. 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 is 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.
8. This test is to verify that the pulleys are the correct diameter or width. Using a known good vehicle to compare the pulley sizes.

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Drive Belt Squeal Diagnosis

Step	Action	Yes	No
	Notice: Refer to *Belt Dressing Notice* in Cautions and Notices. DEFINITION: The following items are indications of drive belt squeal: • 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.		
1	Did you review the Symptoms - Drive Belt diagnostic information and perform the necessary inspections?	Go to *Step 2*	Go to *Symptoms - Drive Belt*
2	Verify that there is a squeal noise. Does the engine make the squeal noise?	Go to *Step 3*	Go to Diagnostic Aids
3	1. Remove the drive belt(s). 2. Operate the engine for no longer than 30 to 40 seconds. Does the squeal noise still exist?	Go to *Engine Noise Diagnosis*	Go to *Step 4*
4	Inspect for an accessory drive component seized bearing or a faulty accessory drive component. Did you find and correct the condition?	Go to *Step 9*	Go to *Step 5*
5	Inspect the drive belt tensioner for proper operation. Refer to *Drive Belt Tensioner Diagnosis.* Did you find and correct the condition?	Go to *Step 9*	Go to *Step 6*
6	Check for the correct drive belt length. Refer to *Drive Belt Replacement - Accessory* or *Drive Belt Replacement - A/C.* Did you find and correct the condition?	Go to *Step 9*	Go to *Step 7*
7	Inspect for misalignment of a pulley. Did you find and correct the condition?	Go to *Step 9*	Go to *Step 8*
8	Inspect for the correct pulley size. Did you find and correct the condition?	Go to *Step 9*	Go to Diagnostic Aids
9	Run the engine in order to verify the repair. Does the drive belt still squeal?	Go to *Step 3*	System OK

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Drive Belt Whine Diagnosis

Diagnostic Aids

The drive belt(s) will not cause the whine noise.

If the whine noise is intermittent, verify that the accessory drive components are not the cause, by varying their loads making sure they are operating to their maximum capacity. An overcharged A/C system, a power steering system restriction, or incorrect fluid, or a failing generator are suggested items to inspect.

Test Description

The number(s) below refer to the step number(s) on the diagnostic table.

3. This test is to verify that the noise is being caused by the drive belt(s) or the accessory drive components. With the drive belt(s) removed the water pump may not operate and the engine may overheat. Also DTCs may set when the engine is operated with the drive belt(s) removed.
4. The inspection should include checking the drive belt tensioner and the drive belt idler pulley bearings. The drive belt(s) may have to be installed and the accessory drive components operated separately by varying their loads. Refer to the suspected accessory drive component for the proper inspection and replacement procedure.

Drive Belt Whine Diagnosis

Step	Action	Yes	No
	Notice: Refer to *Belt Dressing Notice* in Cautions and Notices. DEFINITION: A high pitched continuous noise that may be caused by an accessory drive component failed bearing.		
1	Did you review the Symptoms - Drive Belt diagnostic information and perform the necessary inspections?	Go to *Step 2*	Go to *Symptoms - Drive Belt*
2	Verify that there is a whine noise. Does the engine make the whine noise?	Go to *Step 3*	Go to Diagnostic Aids
3	1. Remove the drive belt(s). 2. Operate the engine for no longer than 30 to 40 seconds. Does the whine noise still exist?	Go to *Engine Noise Diagnosis*	Go to *Step 4*
4	Inspect for a failed accessory drive component bearing. Did you find and repair the condition?	Go to *Step 5*	Go to Diagnostic Aids
5	Run the engine in order to verify the repair. Does the drive belt still whine?	—	System OK

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Drive Belt Rumbling Diagnosis

Diagnostic Aids

Vibration when the engine is operating may cause a body component or another part of the vehicle to produce a rumbling noise.

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

If after replacing the drive belt(s) and completing the diagnostic table, the noise is only heard with the drive belt(s) installed, there may be an accessory drive component failure. Varying the load on the accessory drive components may aid in identifying which accessory drive component is causing the rumbling noise.

Test Description

The number(s) below refer to the step number(s) 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 the drive belt(s) is causing the rumbling noise. The 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. With the drive belt(s) removed the water pump may not operate and the engine may overheat. Also DTCs may set when the engine is operating with the drive belt(s) removed.
4. Inspect the drive belt(s) to ensure that the drive belt is not the cause of the noise. Small cracks across the ribs of the drive belt will not cause the rumbling noise. Belt separation is identified by the plys of the drive belt separating, this may be seen at the edge of the belt or 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.

Drive Belt Rumbling Diagnosis

Step	Action	Yes	No
	Notice: Refer to *Belt Dressing Notice* in Cautions and Notices. DEFINITION: • 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		
1	Did you review the Symptoms - Drive Belt diagnostic information and perform the necessary inspections?	Go to *Step 2*	Go to *Symptoms - Drive Belt*
2	Verify that there is a rumbling noise. Does the engine make the rumbling noise?	Go to *Step 3*	Go to Diagnostic Aids
3	1. Remove the drive belt(s). 2. Operate the engine for no longer than 30 to 40 seconds. Does the rumbling noise still exist?	Go to *Engine Noise Diagnosis*	Go to *Step 4*
4	Inspect the drive belt(s) for damage, separation, or sections of missing ribs. 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 belt. Refer to *Drive Belt Replacement - Accessory* or *Drive Belt Replacement - A/C.* Did you complete the repair?	Go to *Step 8*	Go to *Step 7*
7	Install a new drive belt. Refer to *Drive Belt Replacement - Accessory* or *Drive Belt Replacement - A/C.* Did you complete the replacement?	Go to *Step 8*	—
8	Run the engine in order to verify the repair. does the drive belt still rumble?	Go to Diagnostic Aids	System OK

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Drive Belt Vibration Diagnosis

Diagnostic Aids

The accessory drive components may have an affect on engine vibration. An overcharged A/C system, a power steering system restriction, or incorrect fluid, or an extra load placed on the generator are some systems that should be inspected. To help identify an intermittent or an improper condition, vary the loads on the accessory drive components.

Test Description

The number(s) below refer to the step number(s) 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 such as the exhaust system, or the drivetrain.
3. This test is to verify that the drive belt(s) or accessory drive components may be causing the vibration. With the drive belt(s) removed the water pump may not operate and the engine may overheat. Also DTCs may set when the engine is operated with the drive belt(s) removed.
4. The drive belt(s) may cause a vibration. With the drive belt(s) removed inspect the condition of the drive belt.
6. Inspection of the fasteners can eliminate the possibility that a wrong bolt, nut, spacer, or washer was installed.
8. This step should only be performed if the cooling fan is driven by the drive belt. Inspect the engine cooling fan for bent, twisted, loose, or cracked blades. Inspect the fan clutch for smooth operation. Inspect for a bent fan shaft or a bent mounting flange.
9. 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.
10. Accessory drive component brackets that are bent, cracked, or loose may put an extra strain on that accessory component causing it to vibrate.

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Drive Belt Vibration Diagnosis

Step	Action	Yes	No
	Notice: Refer to *Belt Dressing Notice* in Cautions and Notices. 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 - Drive Belt diagnostic information and perform the necessary inspections?	Go to *Step 2*	Go to *Symptoms - Drive Belt*
2	Verify that the vibration is engine related. Does the engine make the vibration?	Go to *Step 3*	Go to Diagnostic Aids
3	1. Remove the drive belt (s). 2. Operate the engine for no longer than 30 to 40 seconds. Does the engine still make the vibration?	Go to *Engine Related Vibration* in Vibration and Diagnosis	Go to *Step 4*
4	Inspect the drive belt for wear, damage, debris build-up and missing drive belt ribs. Did you find any of these conditions?	Go to *Step 5*	Go to *Step 6*
5	Install a new drive belt. Refer to *Drive Belt Replacement - Accessory* or *Drive Belt Replacement - A/C.* Did you complete the replacement?	Go to *Step 11*	—
6	Inspect for improper, missing or loose fasteners. Did you find any of these conditions?	Go to *Step 7*	Go to *Step 8*
7	Replace improper or missing fasteners. Tighten any loose fasteners. Refer to *Fastener Tightening Specifications.* Did you complete the repair?	Go to *Step 11*	—
8	Inspect for damaged fan blades or a bent fan clutch shaft, if the fan is belt driven. Did you find and correct the condition?	Go to *Step 11*	Go to *Step 9*
9	Inspect for a bent water pump shaft, if the water pump is belt driven. Refer to *Water Pump Replacement (5.7 L)* in Engine Cooling. Did you find and correct the condition?	Go to *Step 11*	Go to *Step 10*
10	Inspect for bent or cracked brackets. Did you find and correct the condition?	Go to *Step 11*	Go to Diagnostic Aids
11	Run the engine in order to verify the repair. Does the drive belt still vibrate?	—	System OK

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Drive Belt Falls Off Diagnosis

Diagnostic Aids

If the drive belt(s) repeatedly falls off the drive belt pulleys, this may be caused by pulley misalignment.

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

If the drive belt(s) is the incorrect length, the drive belt tensioner may not maintain the proper tension on the drive belt.

Test Description

The number(s) below refer to the step number(s) on the diagnostic table.

2. This inspection is to verify the condition of the drive belt(s). Damage may have occurred to the drive belt when the drive belt(s) fell off the pulley. The drive belt(s) may have been damaged in which case caused the drive belt to fall off the pulley. Inspect the drive belt(s) 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 is 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 of that pulley.
5. Inspect the pulleys for dents, bends or other damage. Damage to the pulleys would prevent the drive belt(s) from seating properly in the pulley grooves. Damage would also prevent proper alignment of the drive belt to pulley, when the smooth surface of the drive belt is required to drive the pulley.
6. Accessory drive component brackets that are bent or cracked will allow the drive belt(s) to fall off the pulley.
7. Inspection of the fasteners can eliminate the possibility that a wrong bolt, nut, spacer, or washer was installed. Missing, loose, or incorrect fasteners may cause pulley misalignment from the bracket moving under load. Over tightening of the fasteners may also cause misalignment of the accessory component bracket.

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Drive Belt Falls Off Diagnosis

Step	Action	Yes	No
	Notice: Refer to *Belt Dressing Notice* in Cautions and Notices. DEFINITION: The drive belt falls off the pulleys or may not ride correctly on the pulleys.		
1	Did you review the Symptoms - Drive Belt diagnostic information and perform the necessary inspections?	Go to *Step 2*	Go to *Symptoms - Drive Belt*
2	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. Refer to *Drive Belt Replacement - Accessory* or *Drive Belt Replacement - A/C.* Does the drive belt continue to fall off?	Go to *Step 4*	System OK
4	Inspect for misalignment of the pulleys. 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 bracket. Did you find and repair the condition?	Go to *Step 12*	Go to *Step 7*
7	Inspect for improper, missing or loose fasteners. Did you find loose or missing fasteners?	Go to *Step 8*	Go to *Step 9*
8	Tighten any loose fasteners. Refer to *Fastener Tightening Specifications.* Replace improper or missing fasteners. Does the drive belt continue to fall off?	Go to *Step 9*	System OK
9	Test the drive belt tensioner for operating correctly. Refer to *Drive Belt Tensioner Diagnosis.* Does the drive belt tensioner operate correctly?	Go to *Step 11*	Go to *Step 10*
10	Replace the drive belt tensioner. Refer to *Drive Belt Replacement - Accessory* or *Drive Belt Replacement - A/C.* Does the drive belt continue to fall off?	Go to *Step 11*	System OK
11	Inspect for failed drive belt idler and drive belt tensioner pulley bearings. Did you find and repair the condition?	Go to *Step 12*	Go to Diagnostic Aids
12	Run the engine in order to verify the repair. Does the drive biet still fall off?	System OK	—

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Drive Belt Excessive Wear Diagnosis

Diagnostic Aids

Excessive wear on a drive belt(s) is usually caused by incorrect installation or the wrong drive belt(s) for the application.

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

Excessive misalignment of the drive belt pulleys will cause excessive wear and may also make the drive belt(s) fall off the pulley(s).

Test Description

The number(s) below refer to the step number(s) on the diagnostic table.

2. The inspection is to verify that the drive belt(s) is correctly installed over all of the drive belt pulleys. Wear on the drive belt(s) may be caused by mis-positioning the drive belt(s) by one groove on a pulley.
3. The installation of a drive belt that is to wide or to narrow will cause wear on the drive belt(s). The drive belt ribs should match all of the grooves on the pulleys.
4. This inspection is to verify the drive belt(s) is not contacting any parts 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(s) should not come in contact with an engine or a body component when snapping the throttle.

Drive Belt Excessive Wear Diagnosis

Step	Action	Yes	No
	Notice: Refer to *Belt Dressing Notice* in Cautions and Notices. DEFINITION: Wear at the outside ribs of the drive belt(s) due to an incorrectly installed drive belt(s).		
1	Did you review the Symptoms - Drive Belt diagnostic information and perform the necessary inspections?	Go to *Step 2*	Go to *Symptoms - Drive Belt*
2	Inspect the drive belt(s) for the proper installation. Refer to *Drive Belt Replacement - Accessory* or *Drive Belt Replacement - A/C.* Did you find this condition?	Go to *Step 5*	Go to *Step 3*
3	Inspect for the proper drive belt. Did you find this condition?	Go to *Step 5*	Go to *Step 4*
4	Inspect for the drive belt rubbing against a bracket, hose, or wiring harness. Did you find and repair the condition?	Go to *Step 6*	Go to Diagnostic Aids
5	Replace the drive belt. Refer to *Drive Belt Replacement - Accessory* or *Drive Belt Replacement - A/C.* Did you complete the replacement?	Go to *Step 6*	—
6	Run the engine in order to verify the repair. Is there still excessive drive belt wear?	—	System OK

Drive Belt Tensioner Diagnosis

Important: 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.

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

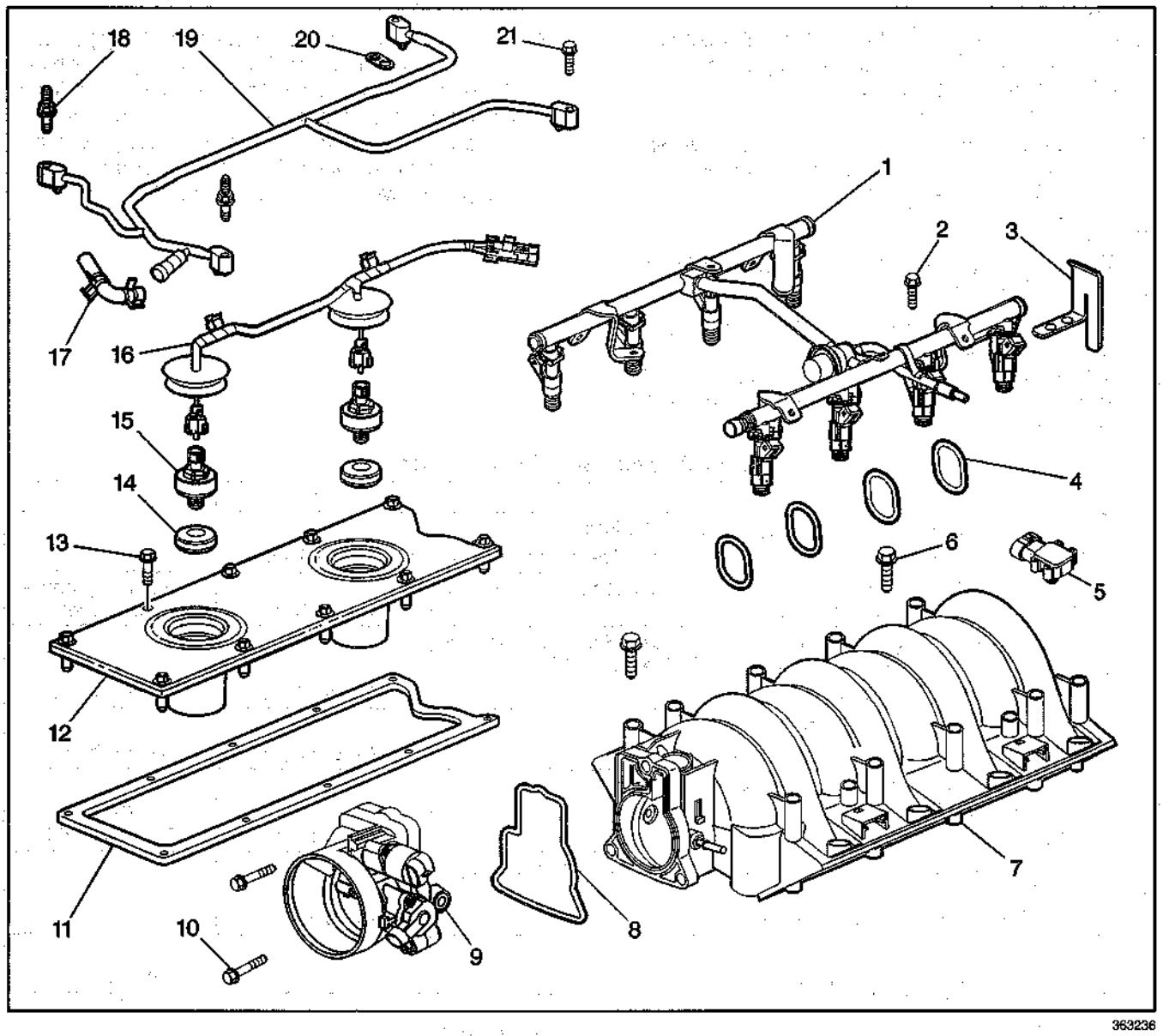
1. Remove the drive belt. Refer to *Drive Belt Replacement - Accessory* or *Drive Belt Replacement - A/C.*
2. Position a hex-head socket on the belt tensioner pulley bolt.
3. Move the belt tensioner through it's full travel.
   - The movement should feel smooth.
   - There should be no binding.
   -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

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Visual Identification

Disassembled Views

Intake Manifold/Upper Engine



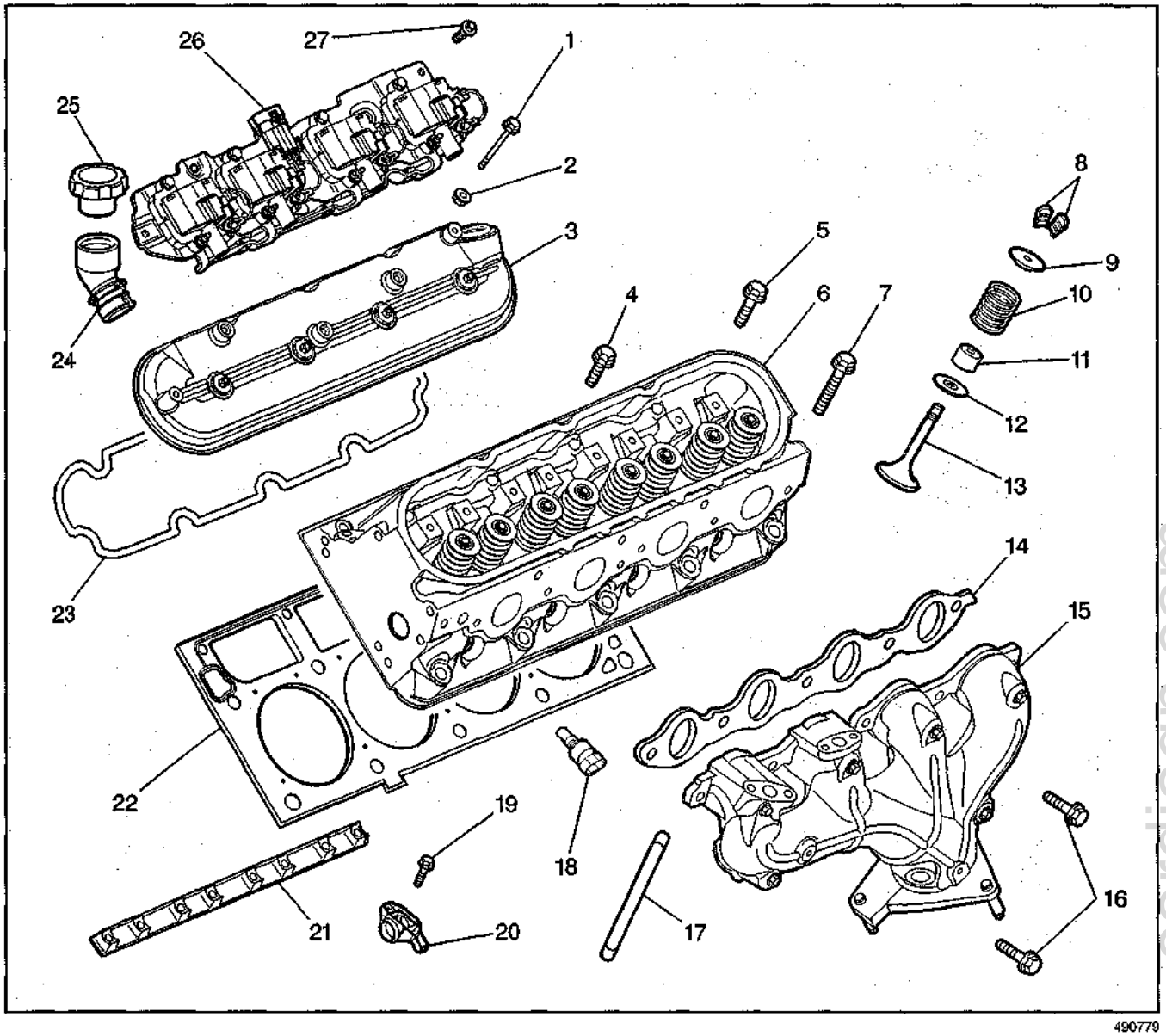
363236

Legend

(1) Fuel Rail (with Injectors)
(2) Fuel Rail Bolt
(3) Fuel Rail Stop Bracket
(4) Intake Manifold Gasket
(5) Manifold Absolute Pressure (MAP) Sensor
(6) Intake Manifold Bolt
(7) Intake Manifold
(8) Throttle Body Gasket
(9) Throttle Body
(10) Throttle Body Bolt
(11) Valley Cover Gasket
(12) Valley Cover
(13) Valley Cover Bolt
(14) Knock Sensor Oil Seal
(15) Knock Sensor
(16) Knock Sensor Wire Harness
(17) Engine Coolant Air Bleed Hose
(18) Engine Coolant Air Bleed Pipe Stud
(19) Engine Coolant Air Bleed Pipe
(20) Engine Coolant Air Bleed Pipe Gasket
(21) Engine Coolant Air Bleed Pipe Bolt

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Cylinder Head/Upper Engine



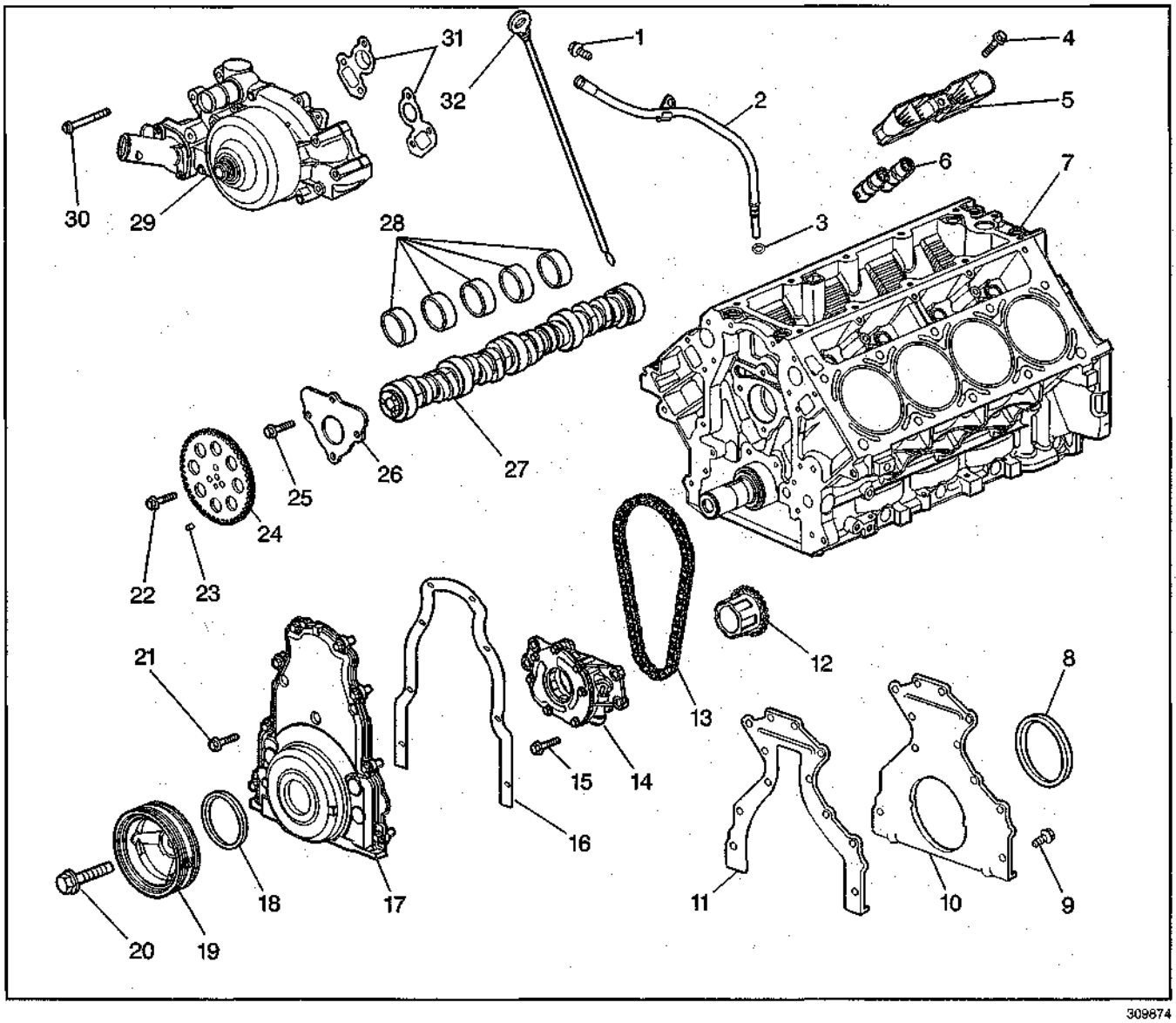
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Legend

(1) Valve Rocker Arm Cover Bolt
(2) Valve Rocker Arm Cover Bolt Grommet
(3) Valve Rocker Arm Cover
(4) Cylinder Head Bolt (Short)
(5) Cylinder Head Bolt (Medium)
(6) Cylinder Head
(7) Cylinder Head Bolt (Long)
(8) Valve Stem Keys
(9) Valve Spring Cap
(10) Valve Spring
(11) Valve Stem Oil Seal
(12) Valve Spring Shim
(13) Valve
(14) Exhaust Manifold Gasket
(15) Exhaust Manifold (with Heat Shield)
(16) Exhaust Manifold Bolts
(17) Pushrod
(18) Coolant Temperature Gauge Sensor
(19) Valve Rocker Arm Bolt
(20) Valve Rocker Arm
(21) Valve Rocker Arm Pivot Support
(22) Cylinder Head Gasket
(23) Valve Rocker Arm Cover Gasket
(24) Oil Fill Tube
(25) Oil Fill Tube Cap
(26) Ignition Coil and Bracket Assembly
(27) Ignition Coil and Bracket Assembly Bolt

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Lower Front of Engine



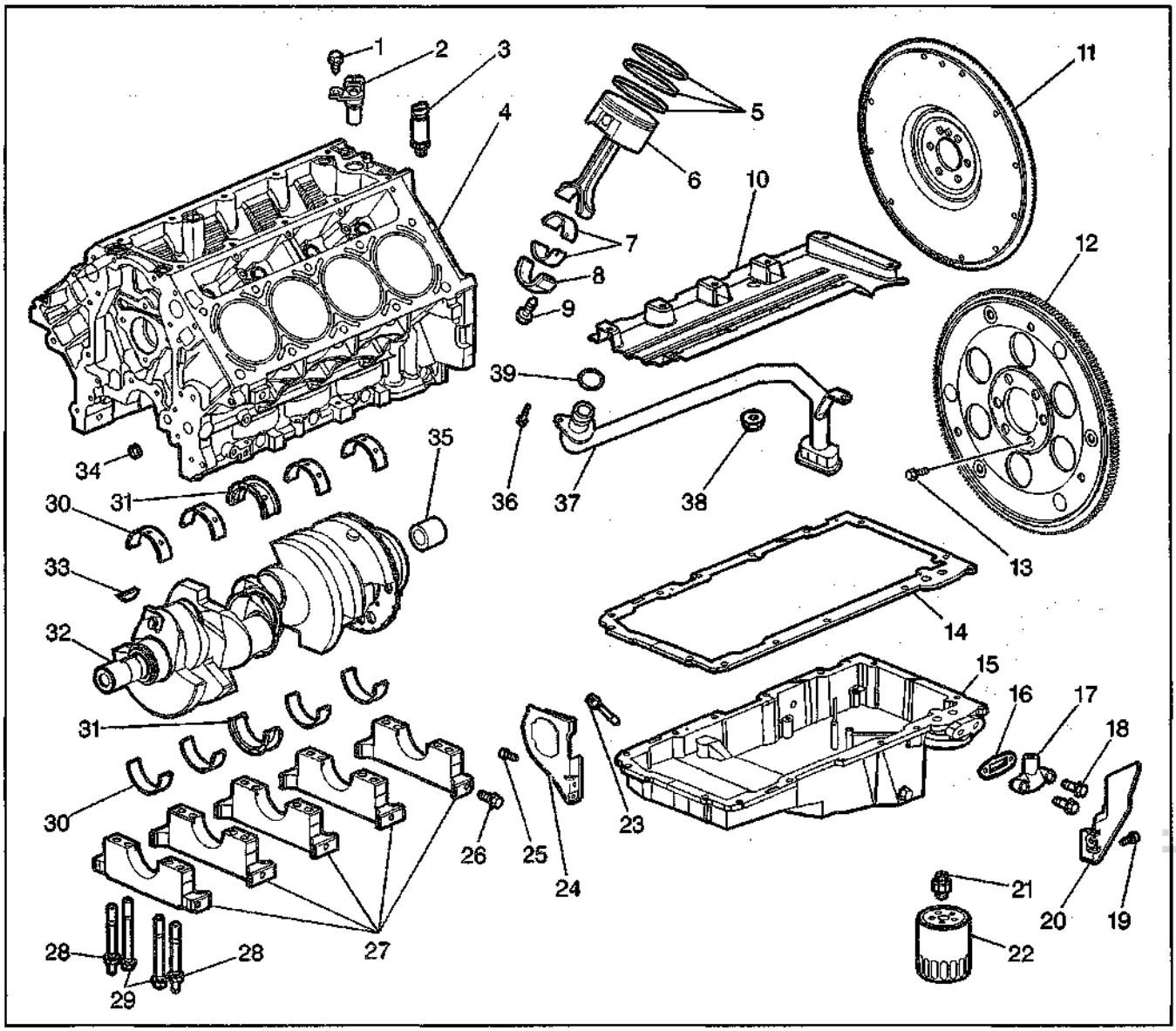
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Legend

(1) Oil Level Indicator Tube Bolt
(2) Oil Level Indicator Tube
(3) Oil Level Indicator Tube O-ring Seal
(4) Valve Lifter Guide Bolt
(5) Valve Lifter Guide
(6) Valve Lifter
(7) Engine Block
(8) Crankshaft Rear Oil Seal
(9) Engine Rear Cover Bolt
(10) Engine Rear Cover
(11) Engine Rear Cover Gasket
(12) Crankshaft Sprocket
(13) Timing Chain
(14) Oil Pump Assembly
(15) Oil Pump Assembly Bolt
(16) Engine Front Cover Gasket
(17) Engine Front Cover
(18) Crankshaft Front Oil Seal
(19) Crankshaft Balancer
(20) Crankshaft Balancer Bolt
(21) Engine Front Cover Bolt
(22) Camshaft Sprocket Bolt
(23) Camshaft Sprocket Locating Pin
(24) Camshaft Sprocket
(25) Camshaft Retainer Bolt
(26) Camshaft Retainer
(27) Camshaft
(28) Camshaft Bearings
(29) Water Pump
(30) Water Pump Bolt
(31) Water Pump Gaskets
(32) Oil Level Indicator

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Lower Engine Assembly



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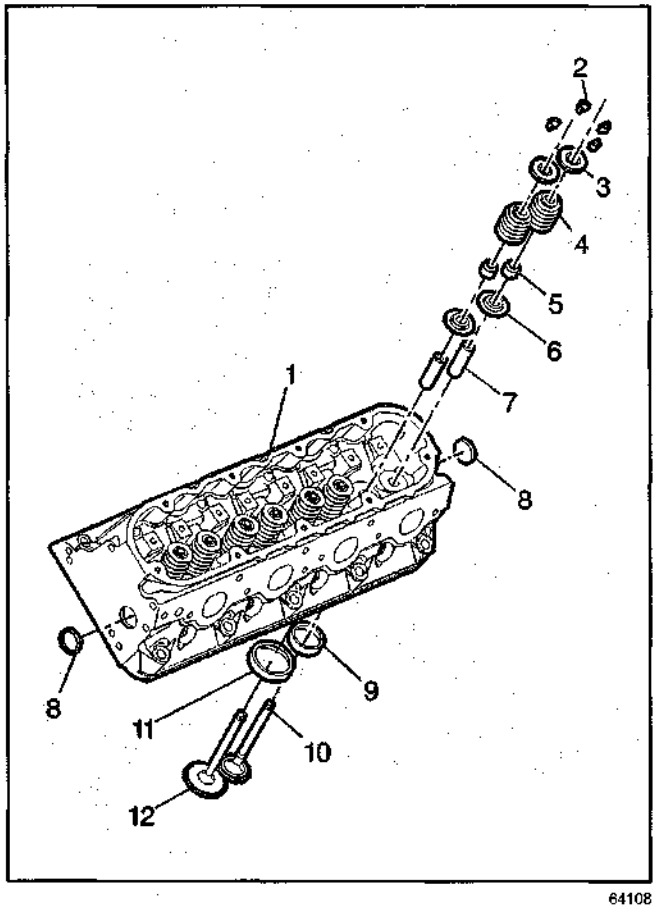
Legend

(1) Camshaft Position Sensor Bolt
(2) Camshaft Position Sensor
(3) Oil Pressure Sensor
(4) Engine Block
(5) Piston Rings
(6) Piston and Connecting Rod Assembly
(7) Connecting Rod Bearings
(8) Connecting Rod Cap
(9) Connecting Rod Bolt
(10) Crankshaft Oil Deflector
(11) Engine Flywheel (Manual Transmission)
(12) Engine Flywheel (Automatic Transmission)
(13) Engine Flywheel Bolt
(14) Oil Pan Gasket
(15) Oil Pan
(16) Oil Pan Cover Gasket
(17) Oil Pan Cover
(18) Oil Pan Cover Bolt
(19) Oil Pan Closeout Cover Bolt (Left Side)
(20) Oil Pan Closeout Cover (Left Side)
(21) Oil Filter Adapter
(22) Oil Filter
(23) Oil Level Sensor
(24) Oil Pan Closeout Cover (Right Side)
(25) Oil Pan Closeout Cover Bolt (Right Side)
(26) Crankshaft Bearing Cap Side Bolt
(27) Crankshaft Bearing Caps
(28) Crankshaft Bearing Cap Studs
(29) Crankshaft Bearing Cap Bolts
(30) Crankshaft Bearing
(31) Crankshaft Thrust Bearing
(32) Crankshaft

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(33) Crankshaft Sprocket Key
(34) Engine Block Front Oil Gallery Plug
(35) Clutch Pilot Bearing
(36) Oil Pump Screen Bolt
(37) Oil Pump Screen
(38) Oil Pump Screen Nut
(39) Oil Pump Screen O-Ring

Cylinder Head Assembly (Aluminum)



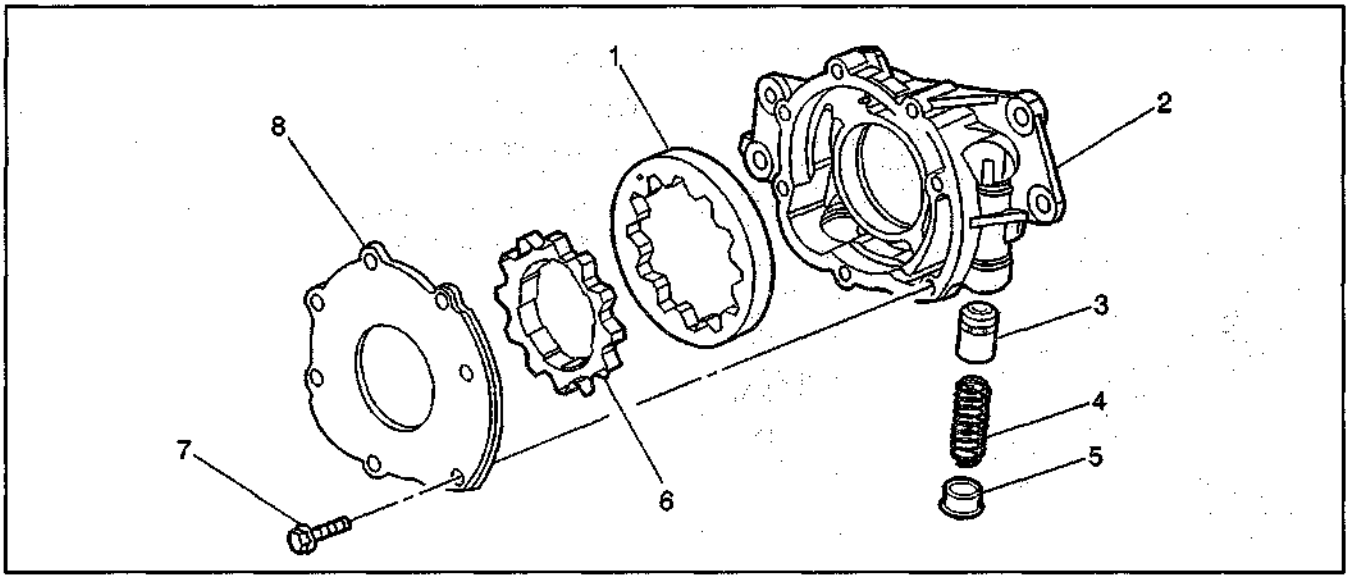
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Legend

(1) Cylinder Head
(2) Valve Stem Keys
(3) Valve Spring Cap
(4) Valve Spring
(5) Valve Stem Oil Seal
(6) Valve Spring Shim
(7) Valve Guide
(8) Cylinder Head Expansion Plugs
(9) Exhaust Valve Seat
(10) Exhaust Valve
(11) Intake Valve Seat
(12) Intake Valve

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Oil Pump Assembly



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Legend

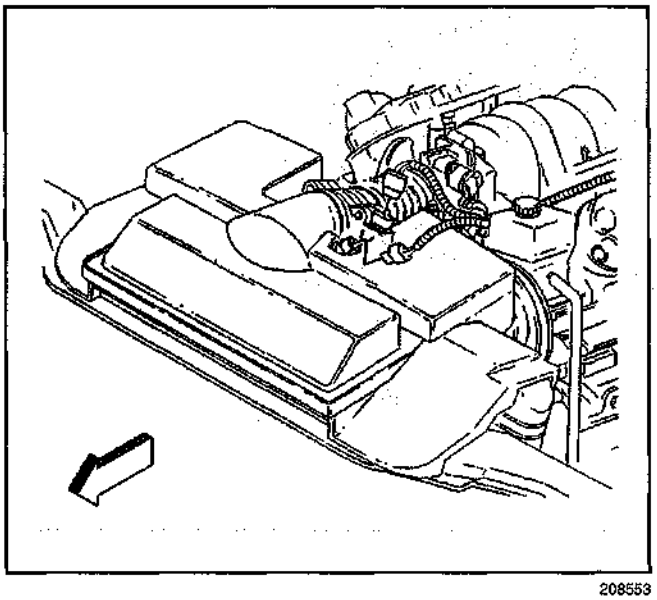
(1) Driven Gear
(2) Oil Pump Housing
(3) Pressure Relief Valve
(4) Pressure Relief Valve Spring
(5) Plug
(6) Drive Gear
(7) Cover Bolt
(8) Cover

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Repair Instructions

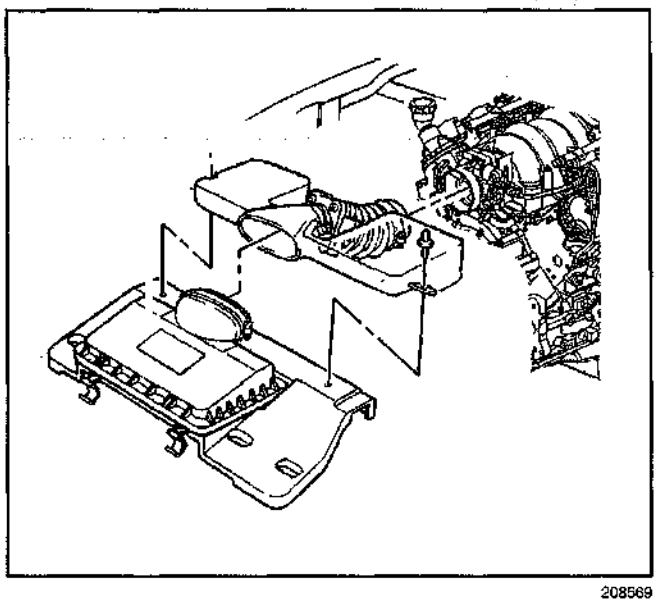
Drive Belt Replacement - Accessory

Removal Procedure



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1. Disconnect the intake air temperature (IAT) sensor electrical connector.
2. Disconnect the mass airflow (MAF) sensor electrical connector.

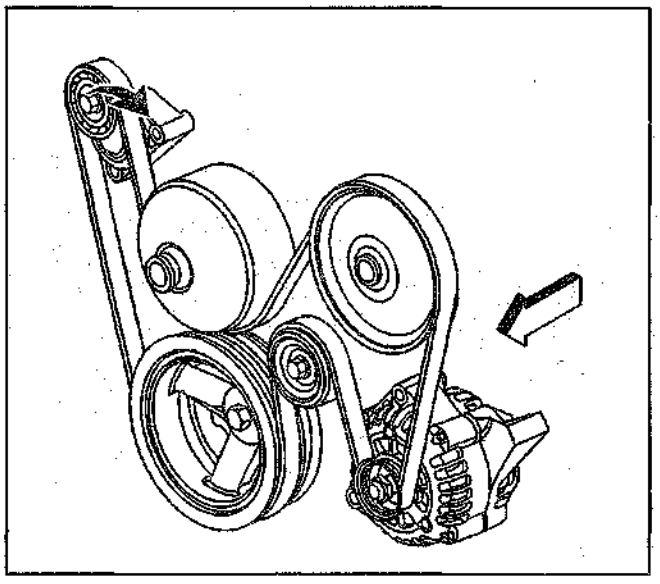


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3. Remove the air intake duct from the throttle body and the air cleaner box.

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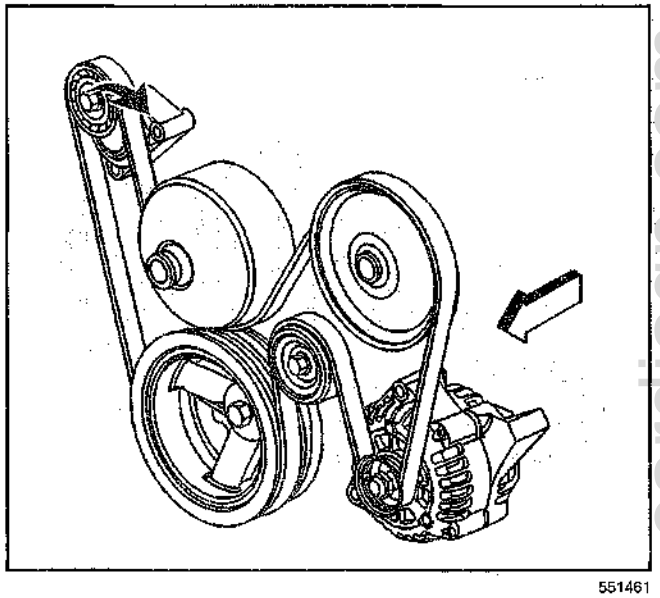
4. Position a hex-head socket on the belt tensioner bolt.
5. Rotate the drive belt tensioner clockwise to relieve the tension on the drive belt.
6. Remove the drive belt from the tensioner and pulleys.
7. Clean and inspect the belt surfaces of all the pulleys.



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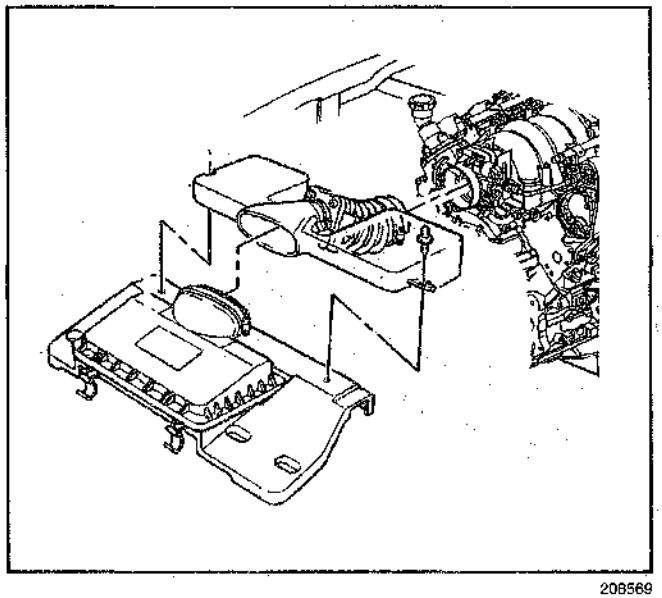
Installation Procedure

1. Route the drive belt around the pulleys.
2. Position a hex-head socket on the belt tensioner bolt.
3. Rotate the drive belt tensioner clockwise to relieve the tension.
4. Install the drive belt onto the drive belt tensioner.
5. Inspect the drive belt to ensure that the belt is properly aligned into the grooves of the pulleys.



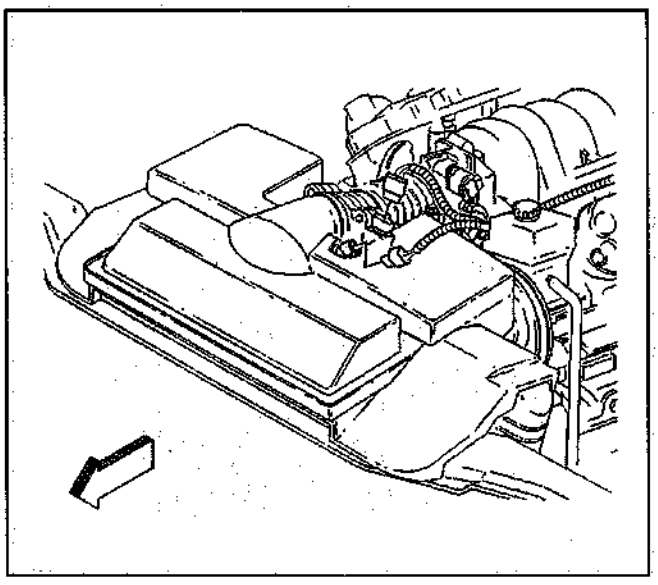
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6. Install the air intake duct to the throttle body and the air cleaner box.



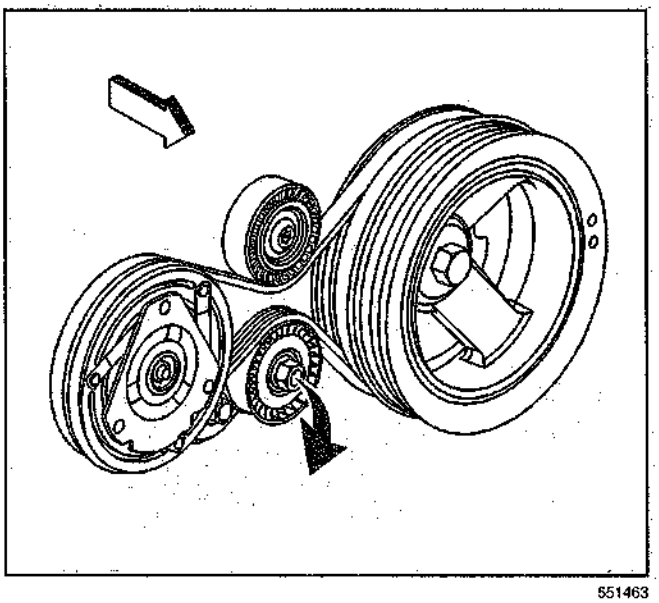
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7. Connect the MAF sensor electrical connector.
8. Connect the IAT sensor electrical connector.

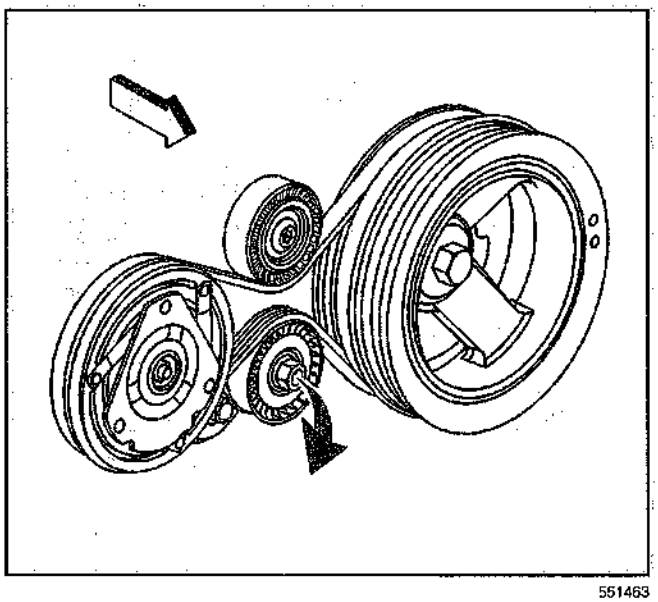


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Drive Belt Replacement - A/C

Removal Procedure

1. Remove the accessory drive belt. Refer to *Drive Belt Replacement - Accessory*.
2. Position a hex-head socket on the belt tensioner bolt.
3. Rotate the air conditioning (A/C) drive belt tensioner clockwise to relieve the tension on the drive belt.
4. Remove the A/C drive belt from the crankshaft balancer and A/C compressor.
5. Clean and inspect the A/C belt surfaces of the balancer and compressor pulley.



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Installation Procedure

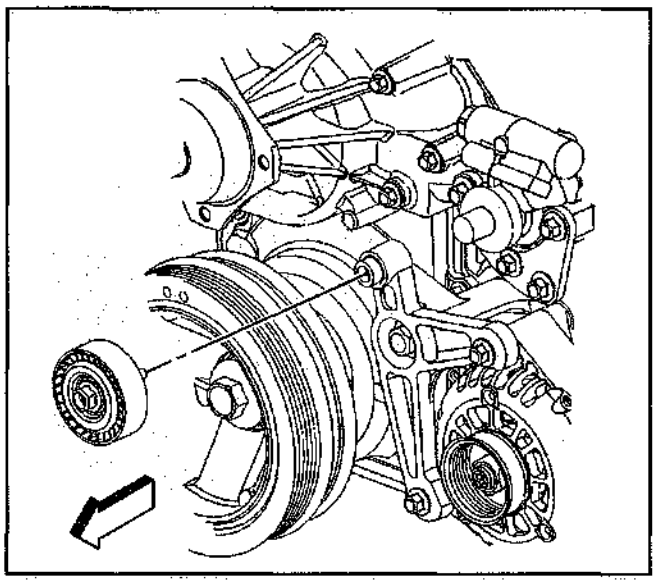
1. Route the A/C belt over the crankshaft balancer.
2. Rotate the A/C belt tensioner clockwise to relieve the tension.
3. Install the drive belt between the idler and the tensioner and over the compressor pulley.
4. Inspect the drive belt to ensure that the belt is properly aligned on all the pulleys.
5. Install the accessory drive belt. Refer to *Drive Belt Replacement - Accessory*.

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Drive Belt Idler Pulley Replacement - Accessory

Removal Procedure

1. Remove the accessory drive belt. Refer to *Drive Belt Replacement - Accessory*.
2. Remove the drive belt idler pulley bolt.
3. Remove the drive belt idler pulley.



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Installation Procedure

1. Install the drive belt idler pulley.

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

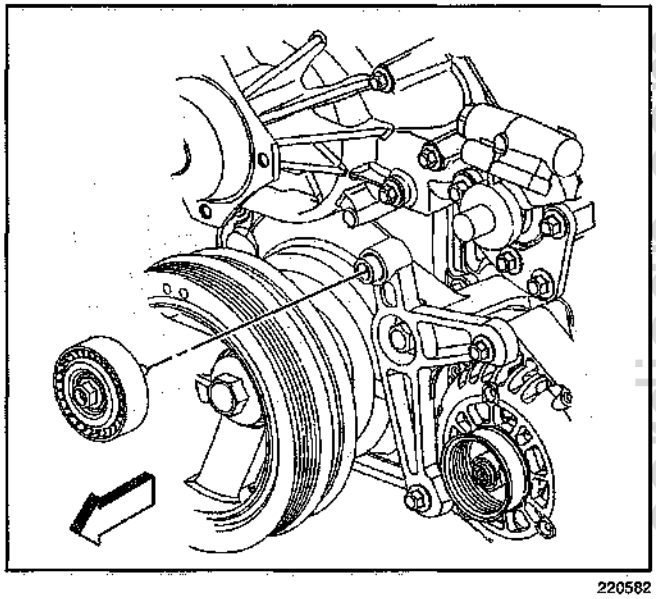
Important: Be sure the idler pulley is fully seated against the shoulder on the generator bracket before tightening the bolt.

2. Install the drive belt idler pulley bolt.

   Tighten

   Tighten the drive belt idler pulley bolt to 50 N·m (37 lb ft).

3. Install the accessory drive belt. Refer to *Drive Belt Replacement - Accessory*.

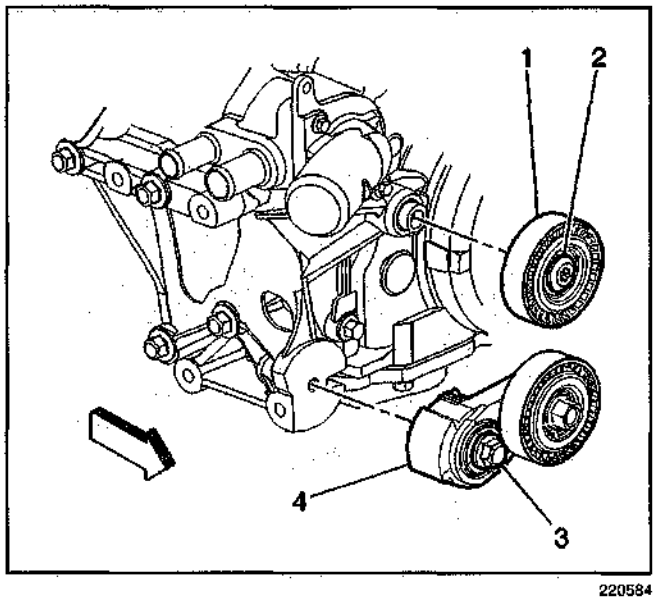


220582

Drive Belt Idler Pulley Replacement - A/C

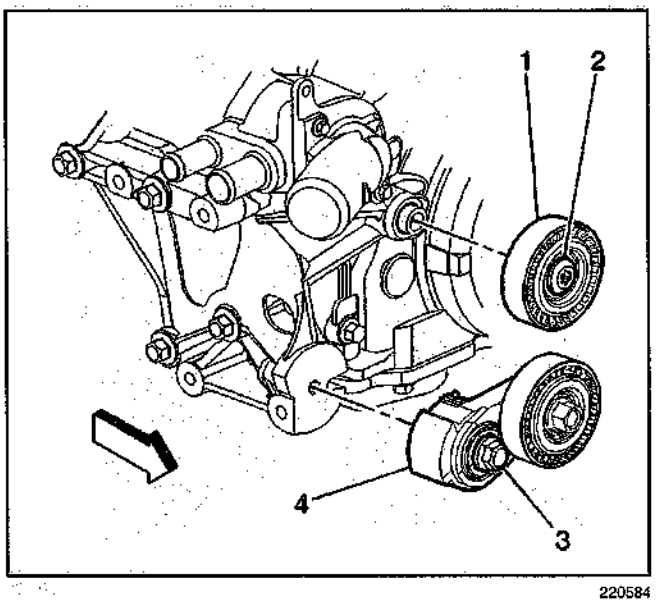
Removal Procedure

1. Remove the air conditioning (A/C) drive belt. Refer to *Drive Belt Replacement - A/C*.
2. Remove the A/C drive belt idler pulley bolt (2).
3. Remove the A/C drive belt idler pulley (1).



220584

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220584

Installation Procedure

1. Install the A/C drive belt idler pulley (1).

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

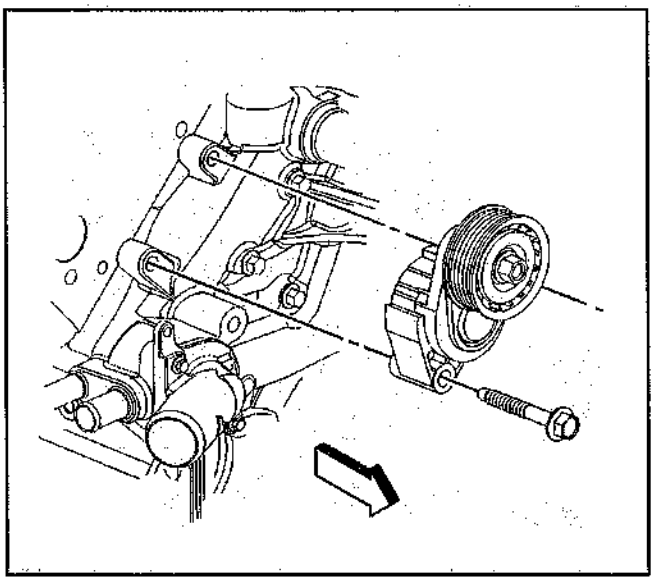
Important: Be sure the idler pulley is fully seated against the shoulder on the A/C compressor bracket before tightening the bolt.

2. Install the A/C drive belt idler pulley bolt (2).

   Tighten

   Tighten the A/C drive belt idler pulley bolt to 50 N·m (37 lb ft).

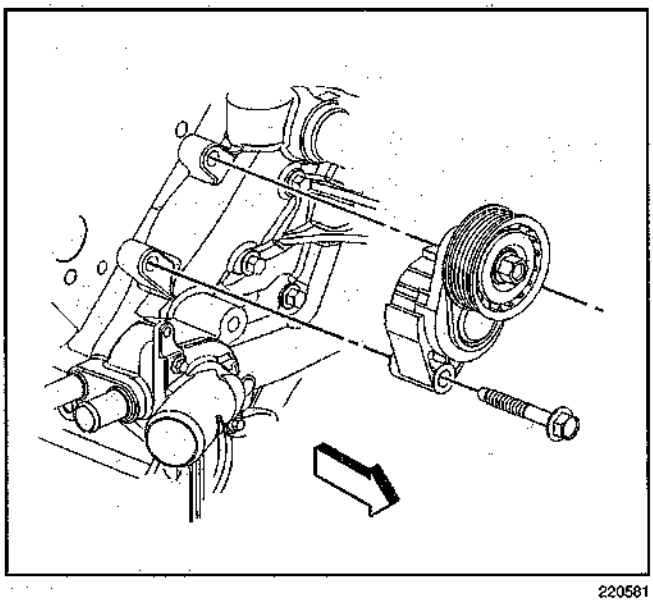
3. Install the A/C drive belt. Refer to *Drive Belt Replacement - A/C.*


220581

Drive Belt Tensioner Replacement - Accessory

Removal Procedure

1. Remove the accessory drive belt. Refer to *Drive Belt Replacement - Accessory.*
2. Remove the drive belt tensioner bolts.
3. Remove the drive belt tensioner.


220581

Installation Procedure

1. Install the drive belt tensioner.

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

2. Install the drive belt tensioner bolts.

   Tighten

   Tighten the drive belt tensioner bolts to 50 N·m (37 lb ft).

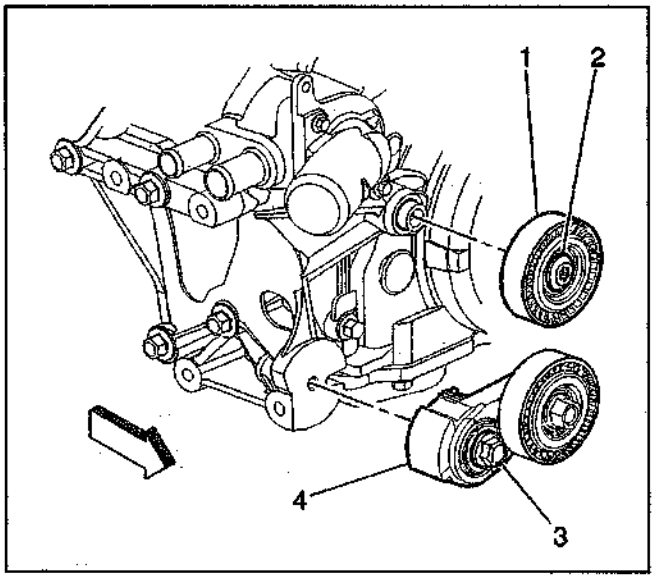
3. Install the accessory drive belt. Refer to *Drive Belt Replacement - Accessory.*

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Drive Belt Tensioner Replacement - A/C

Removal Procedure

1. Remove the air conditioning (A/C) drive belt. Refer to *Drive Belt Replacement - A/C*.
2. Remove the A/C drive belt tensioner bolt (3).
3. Remove the A/C drive belt tensioner (4).



220584

Installation Procedure

1. Install the A/C drive belt tensioner (4).

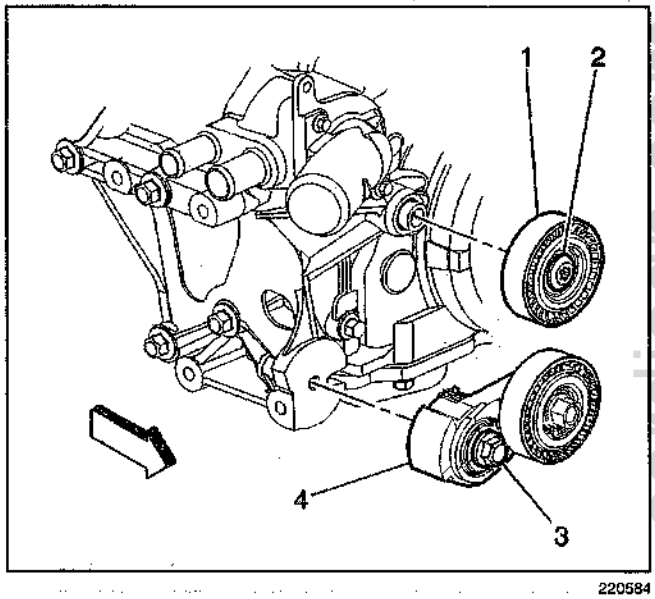
Notice: Refer to *Fastener Notice* in Cautions and Notices.

Important: Be sure the tensioner is fully seated against the compressor bracket before tightening the bolt.

2. Install the A/C drive belt tensioner bolt (3).

   Tighten

   Tighten the A/C drive belt tensioner bolt (3) to 25 N·m (18 lb ft).
3. Install the A/C drive belt. Refer to *Drive Belt Replacement - A/C*.



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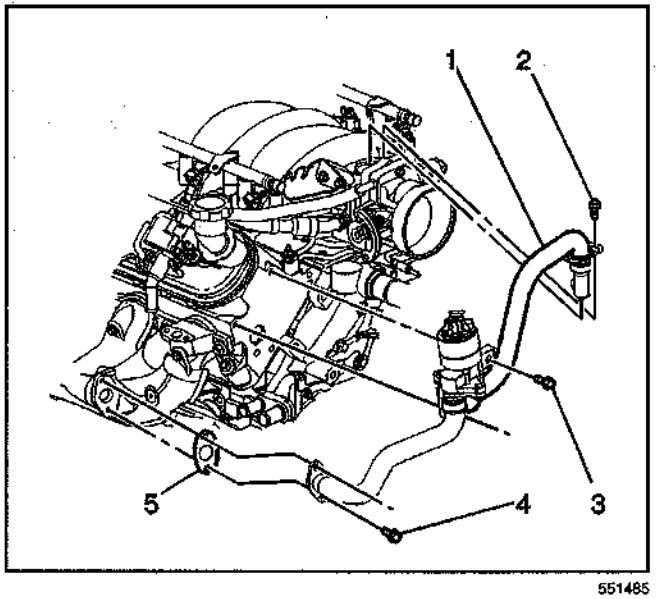
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Engine Mount Inspection

Notice: Broken or deteriorated mounts can cause misalignment and destruction of certain drive train components. When a single mount breaks, the remaining mounts are subjected to abnormally high stresses.

Notice: When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal, or the crankshaft pulley. Lifting the engine in an unapproved manner may cause component damage.

1. Measure the engine movement at the engine mounts in order to check for damage to the rubber portions of the mount.
   1.1. Apply the park brake.
   1.2. Start the engine.
   1.3. Firmly apply the primary brakes.
   1.4. Have an assistant stand to the side of the vehicle to observe for engine movement.
   1.5. Slightly load the engine in reverse and drive. If the engine moves more than 24 mm (0.945 in) from the at rest position, in either direction, check the engine mount attachment.
2. If the engine mount attachment is within specifications, replace the engine mount.
3. Replace the engine mount also if any of the following conditions exist:
   - Heat check cracks cover the hard rubber surface.
   - The rubber cushion is separated from the metal plate of the mount.
   - There is a split through the rubber cushion.
4. If the mount is loose, lower the engine and tighten the bolts or the nuts to the engine frame or the bracket. Refer to *Fastener Tightening Specifications*.



551485

Engine Support Fixture

Installation Procedure

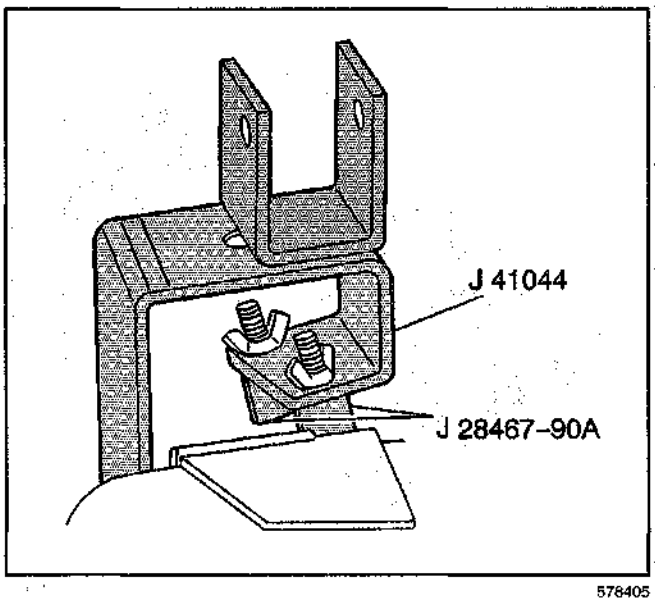
Tools Required

- *J 28467-90A* Engine Support Adapters
- *J 41044* Engine Support Adapters
- *J 42451* Engine Support Adapter Kit
- *J 28467-B* Universal Engine Support Fixture
- *J 36462-A* Engine Support Adapter Leg

1. Remove the exhaust gas recirculation (EGR) valve pipe bolts (2, 3, and 4).
2. Remove the EGR valve pipe (1) and solenoid.

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3. Remove two strut mounting nuts from the left and right strut towers.
4. Screw the engine support fixture adapters *J 28467-90A* onto the strut tower studs.
5. Set the engine support adapters J 41044-1 and J 41044-2 over the fixture adapters *J 28467-90A* on each strut tower.
6. Secure with the wings nuts provided.
7. Place the cross bar J 28467-3 into the engine support adapters J 41044-1 and J 41044-2.
8. Secure with the quick release pins.
9. Install the fixture support leg J 28467-2A through the cross bracket J 28467-1A on the top of the cross bar J 28467-3.
10. Place the rubber padded foot of the front support J 28467-4A on the radiator support.
11. Install the tube of the front support J 28467-4A through the large hole in the support leg J 28467-2A until level.
12. Install the quick release pin.
13. Install the support leg J 36462-A through the cross bracket J 28467-1A on the top of the cross bar J 28467-3.
14. Bolt the lifting brackets to the cylinder heads.
15. Thread lift hooks J 28467-50 and J 28467-8 or (8A) into the support hook brackets J 28467-6A.
16. Place the support hook brackets J 28467-6A over the cross bar J 28467-3 and connect the hooks to the lifting brackets.
17. Tighten the large wing nuts J 28467-34.

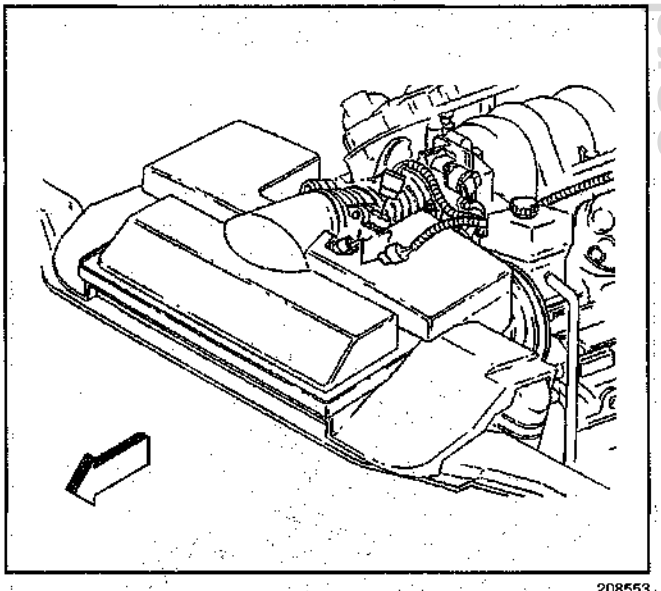


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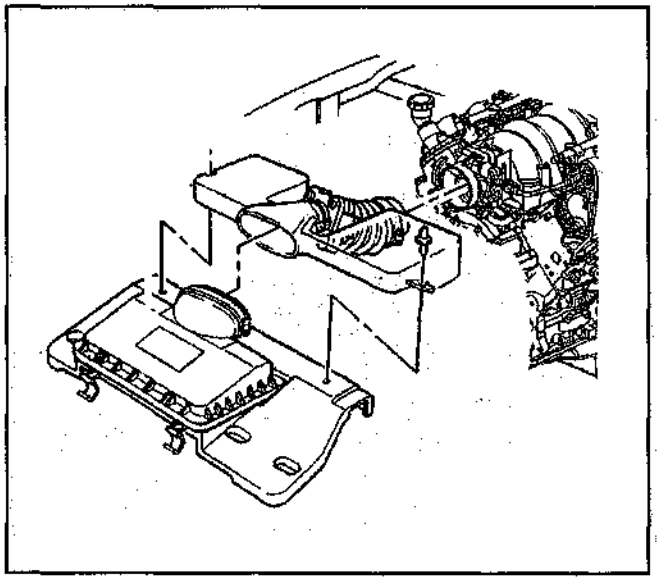
Engine Mount Replacement (Left)

Removal Procedure

1. Disconnect the intake air temperature (IAT) sensor electrical connector.
2. Disconnect the mass airflow (MAF) sensor electrical connector.

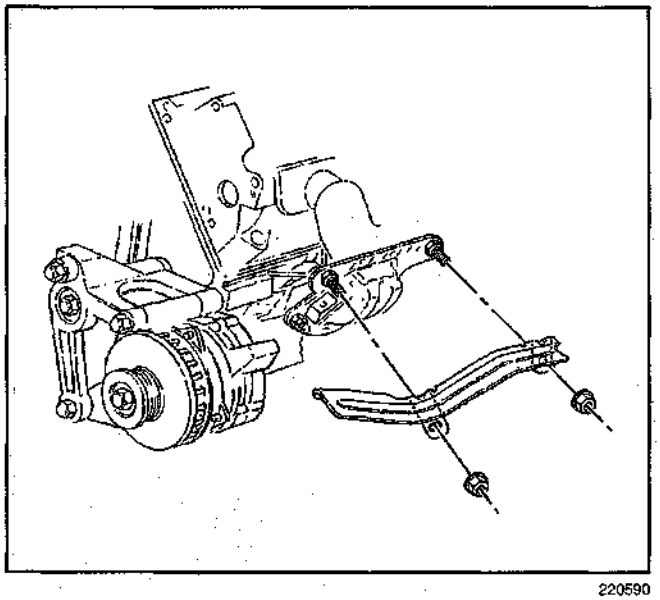

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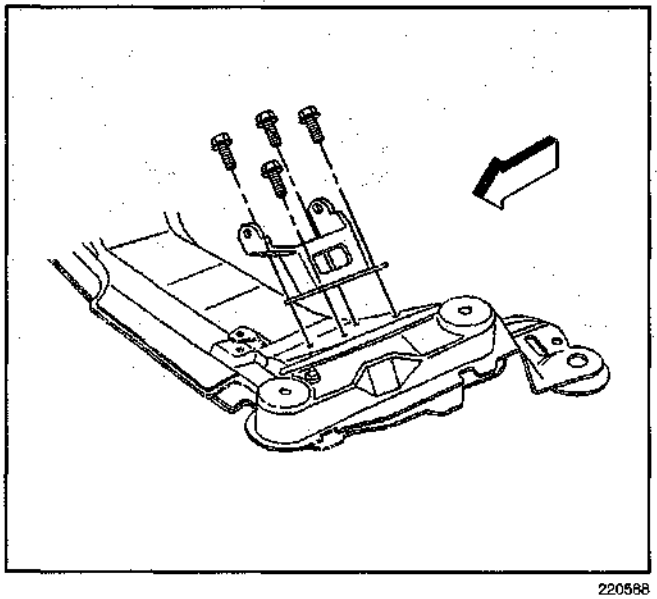
208569

3. Remove the air intake duct from the throttle body and the air cleaner box.
4. Install the engine support fixture. Refer to *Engine Support Fixture.*
5. Raise and suitably support the vehicle. Refer to *Lifting and Jacking the Vehicle* in General Information.
6. Remove the left oxidation catalytic converter. Refer to *Oxidation Catalytic Converter Replacement (5.7 L Left)* in Engine Exhaust.



220590

7. Remove the engine mount heat shield nuts.
8. Remove the engine mount heat shield.

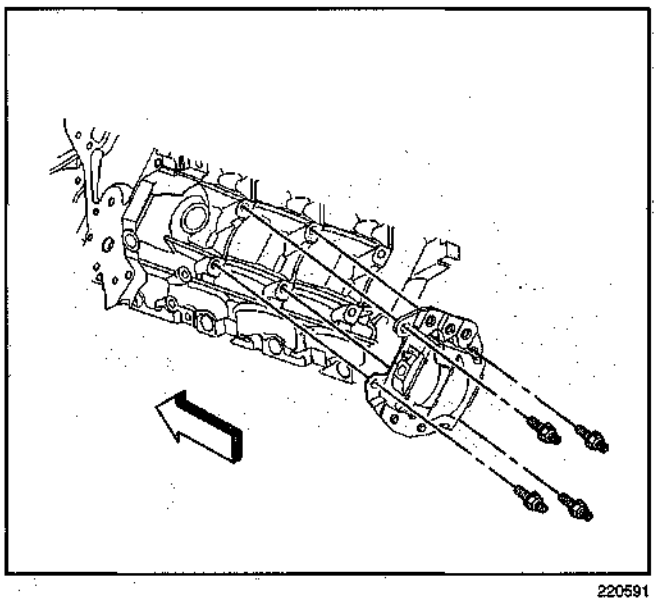


220588

9. Remove the engine mount bracket to crossmember bolts.
10. Lower the vehicle.
11. Raise the left side of the engine using the support fixture in order to remove tension on the engine mount.
12. Raise and suitably support the vehicle. Refer to *Lifting and Jacking the Vehicle* in General Information.

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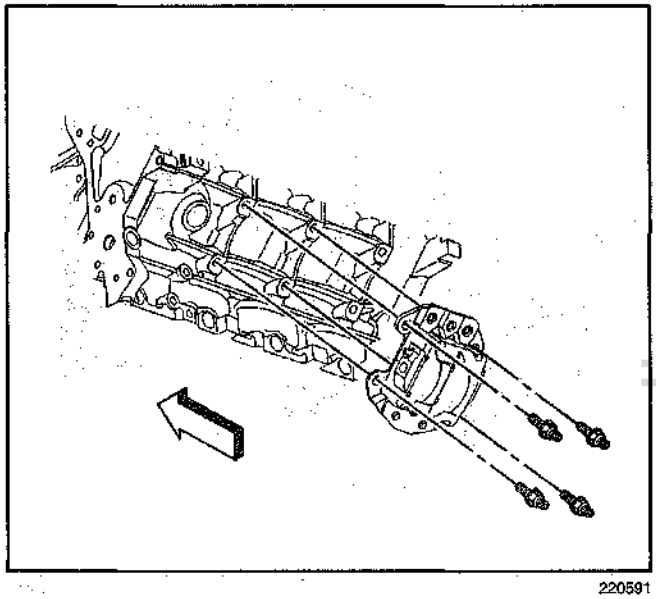
13. Remove the engine mount bracket to block studs.
14. Remove the engine mount assembly.
15. Separate the upper and lower mount on the bench.



220591

Installation Procedure

1. Loosely install the upper and lower mount together on the bench.
2. Install the engine mount assembly.
3. Loosely install the engine mount bracket to block studs.
4. Lower the vehicle.
5. Lower the left side of the engine using the support fixture.
6. Raise and suitably support the vehicle. Refer to *Lifting and Jacking the Vehicle* in General Information.



220591

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

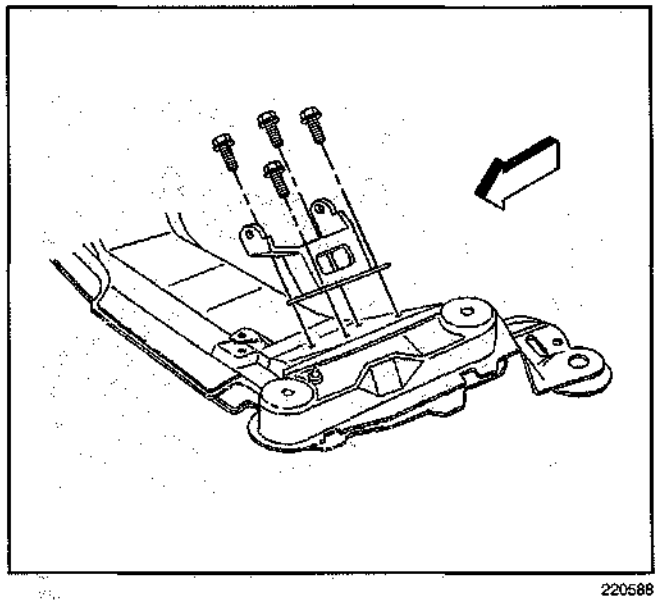
7. Install the engine mount bracket to crossmember bolts.

   Tighten

   - Tighten the engine mount bracket to crossmember bolts to 58 N·m (43 lb ft).
   - Tighten the engine mount bracket to block studs to 50 N·m (37 lb ft).
8. Tighten the engine mount through bolt and mount nut.

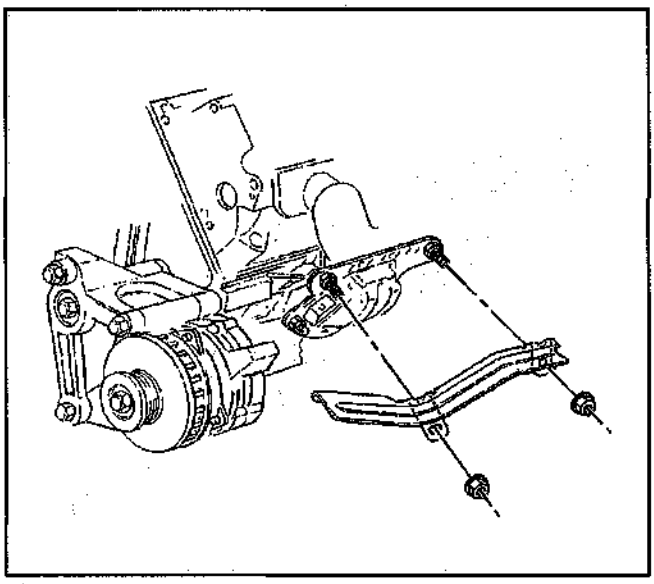
   Tighten

   - Tighten the engine mount through bolt to 95 N·m (70 lb ft).
   - Tighten the engine mount through bolt nut to 80 N·m (59 lb ft).



220588

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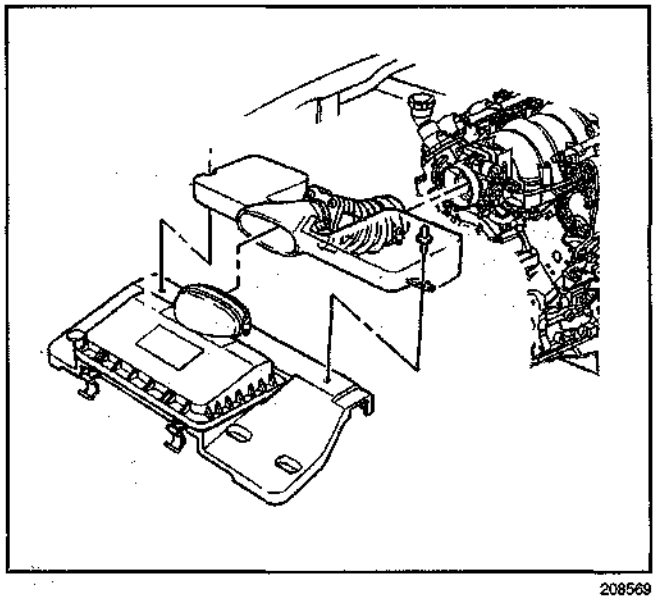


220590

9. Install the engine mount heat shield.
10. Install the engine mount heat shield nuts.

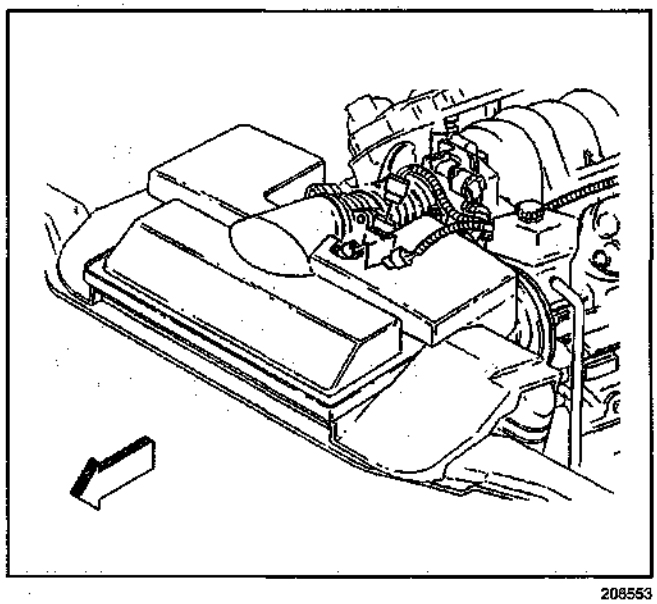
    Tighten

    Tighten the engine mount heat shield nuts to 10 N·m (89 lb in).
11. Install the left oxidation catalytic converter. Refer to *Oxidation Catalytic Converter Replacement (5.7 L Left)* in Engine Exhaust.
12. Lower the vehicle.
13. Remove the engine support fixture.



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14. Install the air intake duct to the throttle body and the air cleaner box.



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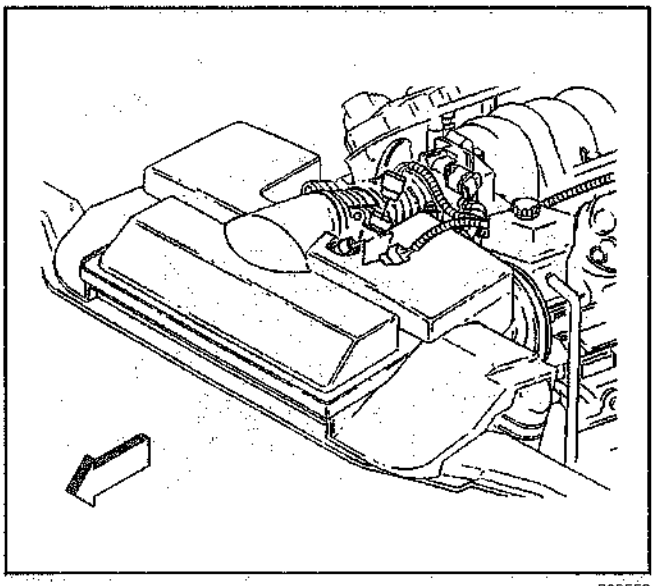
15. Connect the IAT sensor electrical connector.
16. Connect the MAF sensor electrical connector.

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Engine Mount Replacement (Right)

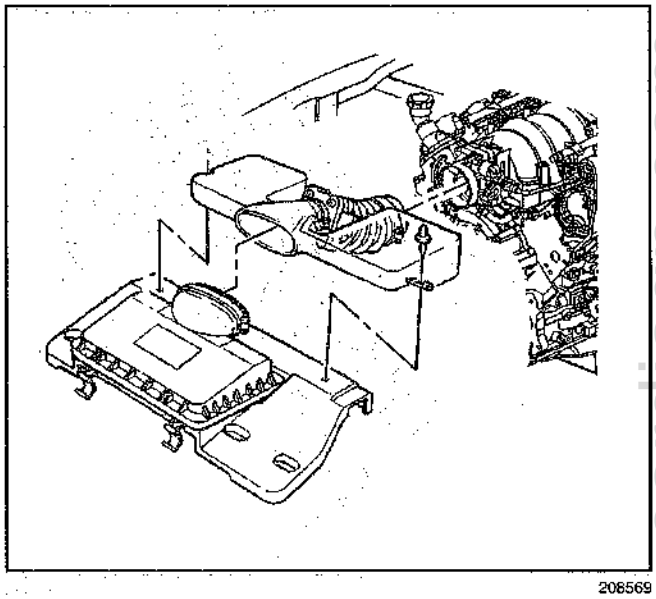
Removal Procedure

1. Disconnect the intake air temperature (IAT) sensor electrical connector.
2. Disconnect the mass airflow (MAF) sensor electrical connector.



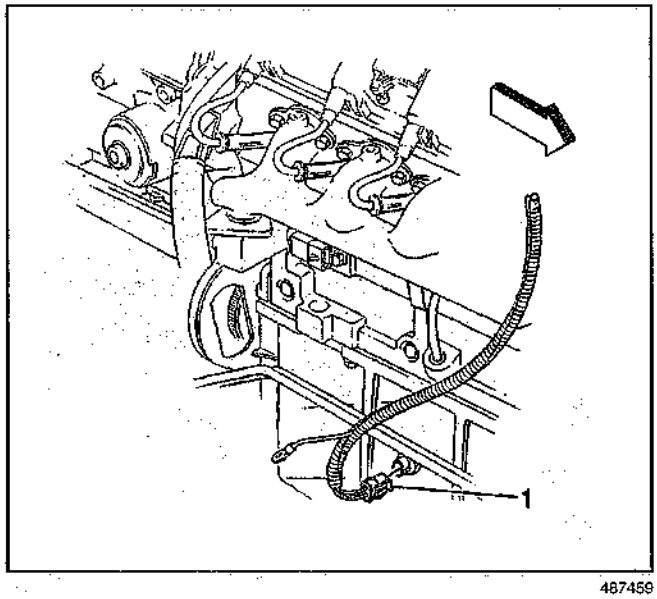
208553

3. Remove the air intake duct from the throttle body and the air cleaner box.
4. Install the engine support fixture. Refer to *Engine Support Fixture*.
5. Raise and suitably support the vehicle. Refer to *Lifting and Jacking the Vehicle* in General Information.



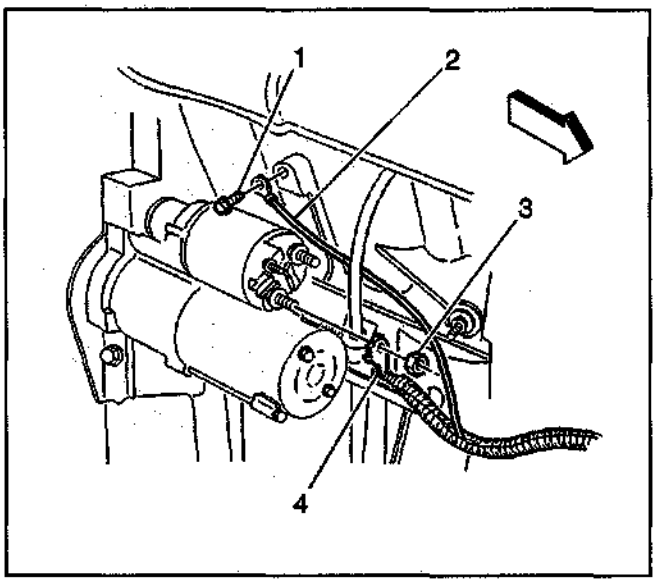
208569

6. Disconnect the oil level sensor electrical connector (1).



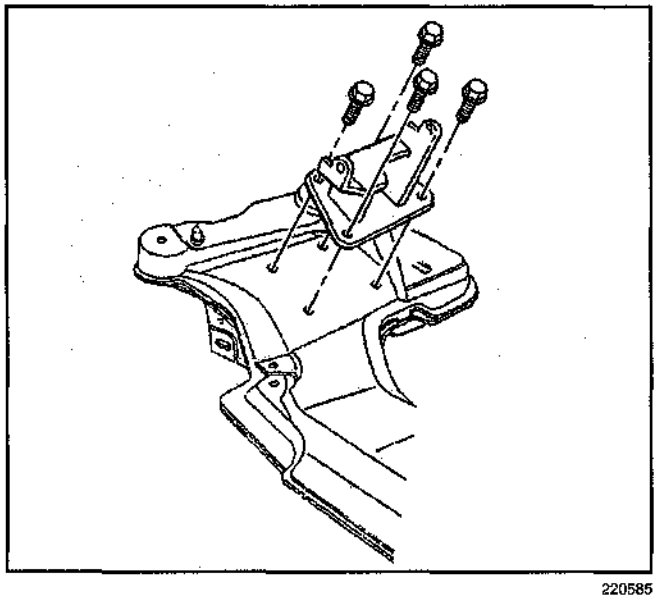
487459

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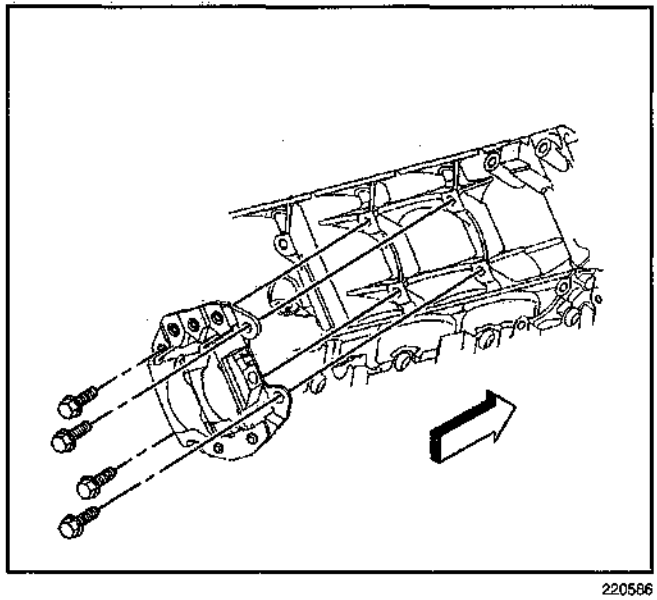
211595

7. Remove the negative battery cable lead to engine block bolt (1).
8. Remove the starter motor. Refer to *Starter Motor Replacement (5.7 L)* in Engine Electrical.



220585

9. Remove the engine mount bracket to crossmember bolts.
10. Lower the vehicle.
11. Raise the right side of the engine using the support fixture in order to remove tension on the engine mount.
12. Raise and suitably support the vehicle. Refer to *Lifting and Jacking the Vehicle* in General Information.



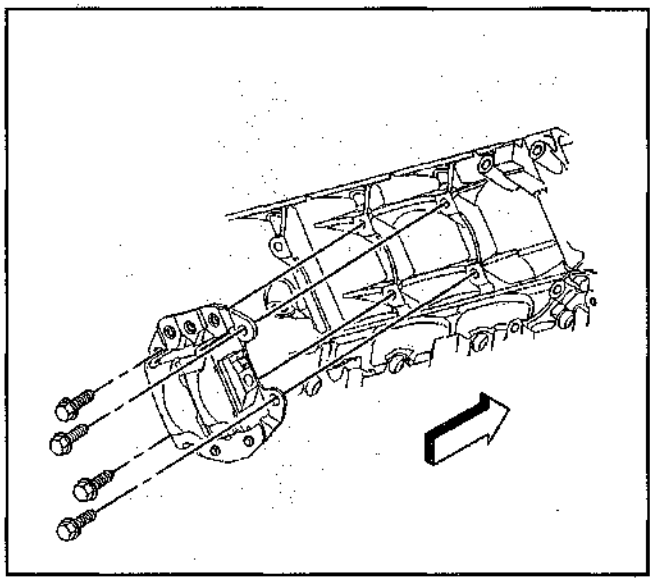
220586

13. Remove the engine mount bracket to block bolts.
14. Remove the engine mount assembly.
15. Separate the upper and lower mount on the bench.

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Installation Procedure

1. Loosely install the upper and lower mount together on the bench.
2. Loosely install the engine mount bracket to block bolts.
3. Lower the vehicle.
4. Lower the right side of the engine using the support fixture.
5. Raise and suitably support the vehicle. Refer to *Lifting and Jacking the Vehicle* in General Information.



220586

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

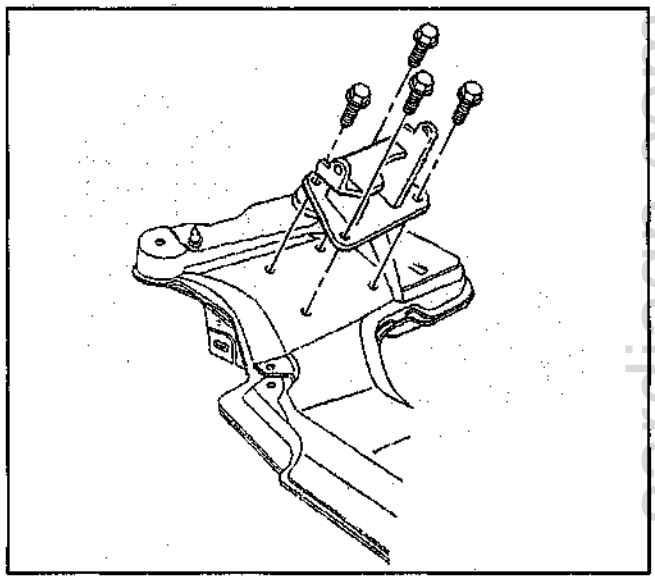
6. Install the engine mount bracket to crossmember bolts.

   Tighten

   - Tighten the engine mount bracket to crossmember bolts to 58 N·m (43 lb ft).
   - Tighten the engine mount bracket to block bolts to 50 N·m (37 lb ft).
7. Tighten the engine mount through bolt and mount nut.

   Tighten

   - Tighten the engine mount through bolt to 95 N·m (70 lb ft).
   - Tighten the engine mount through bolt nut to 80 N·m (59 lb ft).

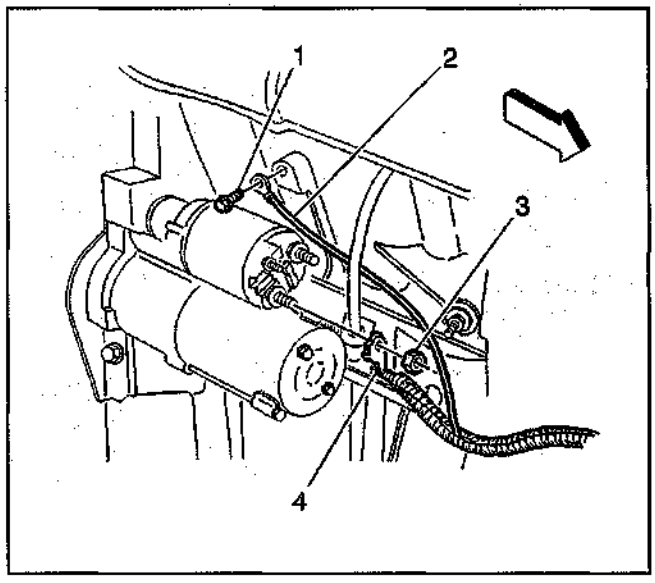


220585

8. Install the starter motor. Refer to *Starter Motor Replacement (5.7 L)* in Engine Electrical.
9. Install the negative battery cable lead to engine block bolt (1).

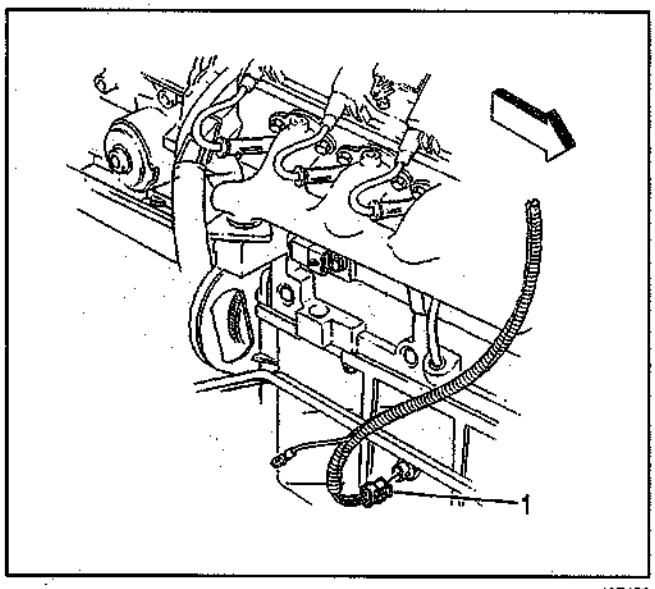
   Tighten

   Tighten the negative battery cable lead to engine block bolt (1) to 32 N·m (24 lb ft)



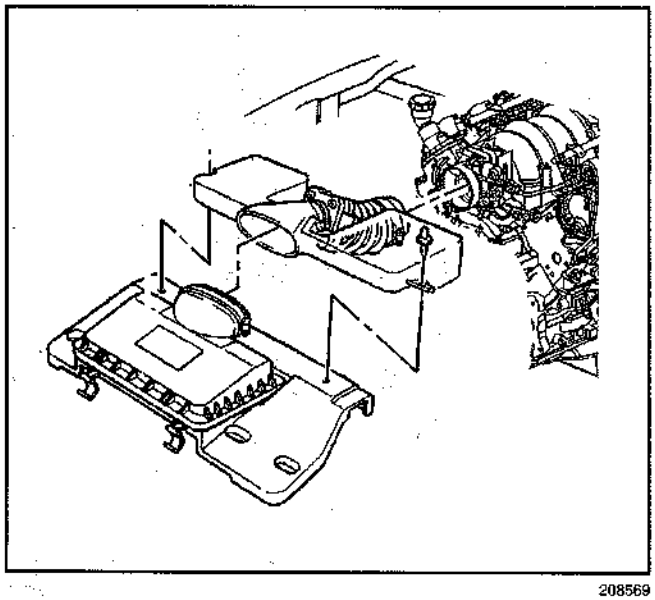
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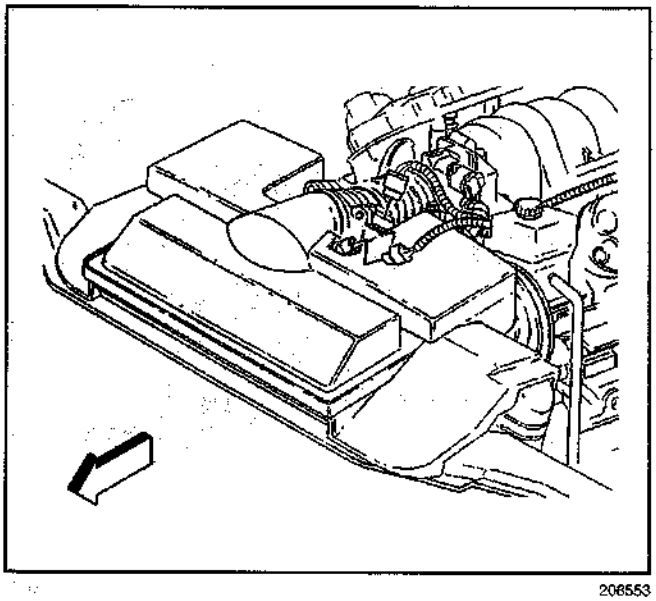
487459

10. Connect the oil level sensor electrical connector (1).
11. Lower the vehicle.
12. Remove the engine support fixture.



208569

13. Install the air intake duct to the throttle body and the air cleaner box.



208553

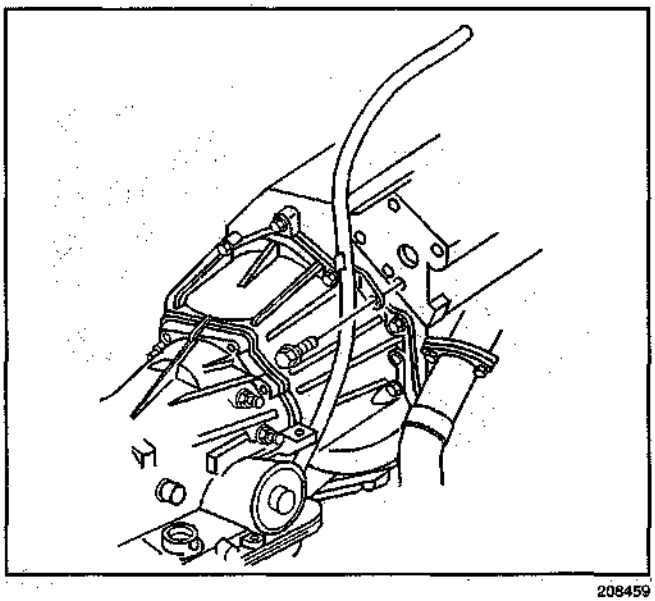
14. Connect the IAT sensor electrical connector.
15. Connect the MAF sensor electrical connector.

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Intake Manifold Replacement

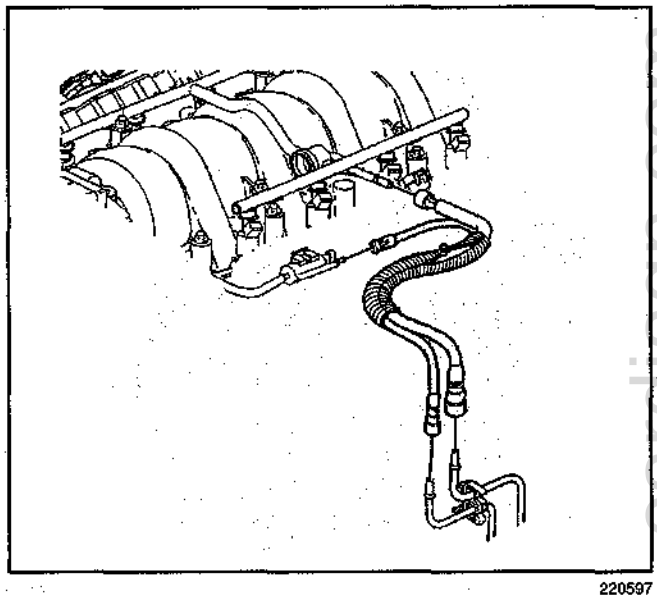
Removal Procedure

1. Drain the cooling system. Refer to *Draining and Filling Cooling System (5.7 L)* in Engine Cooling.
2. Raise and suitably support the vehicle. Refer to *Lifting and Jacking the Vehicle* in General Information
3. Remove the transmission fluid level indicator tube bolt.
4. Lower the vehicle.
5. Relieve the fuel system pressure. Refer to *Fuel Pressure Relief Procedure* in Engine Controls - 5.7 L.

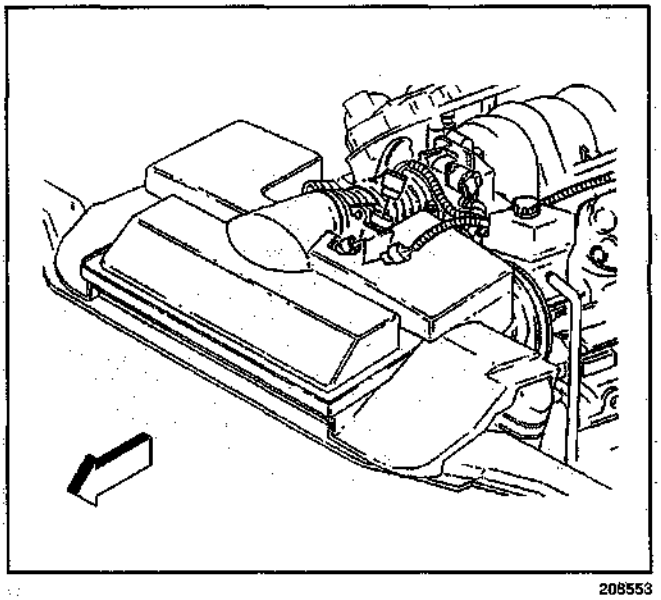

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Important: Cap the fittings and plug the holes when separating fuel system components in order to prevent dripping of fuel and/or dirt and other contaminants from entering the fuel system.

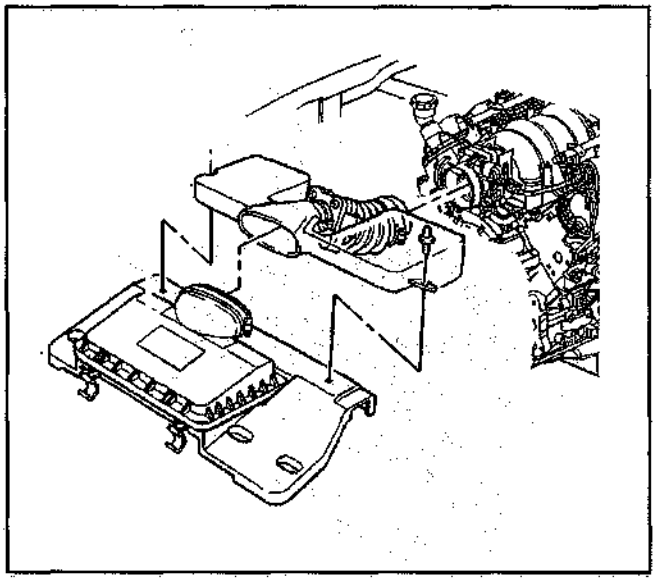
6. Disconnect the fuel line from the fuel rail.
7. Disconnect the vapor line from the fuel vapor purge valve.


220597

8. Disconnect the intake air temperature (IAT) sensor electrical connector.
9. Disconnect the mass airflow (MAF) sensor electrical connector.

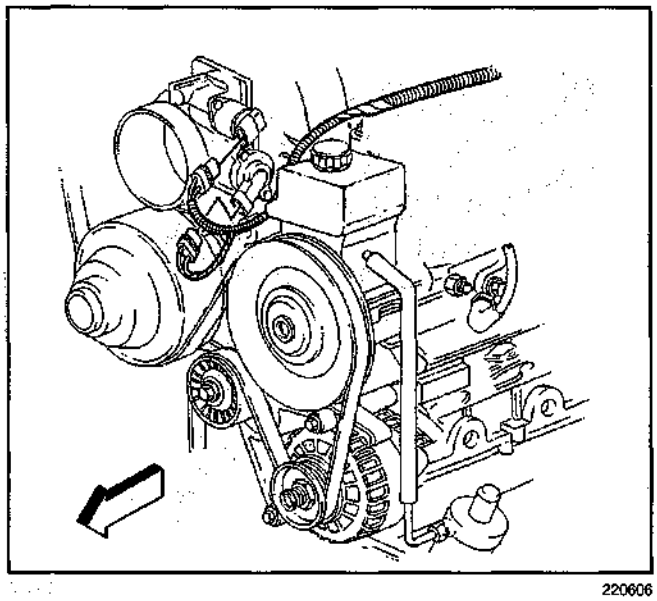

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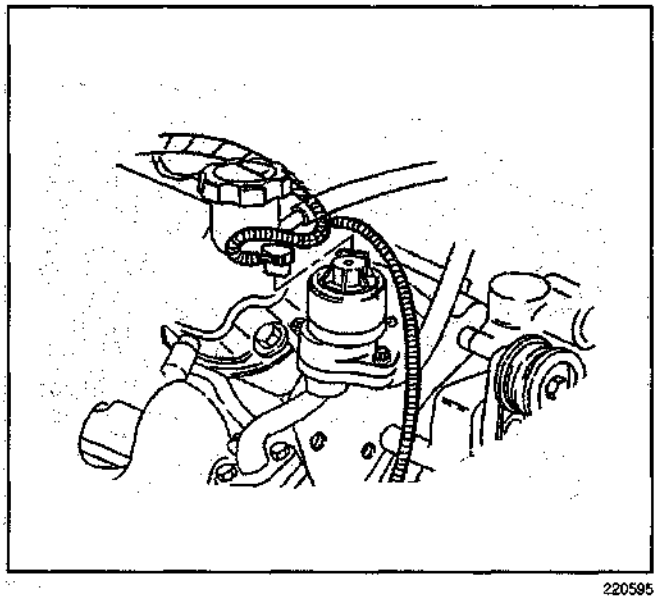
208569

10. Remove the air intake duct from the throttle body and the air cleaner box.



220606

11. Disconnect the idle air control (IAC) valve electrical connector from the throttle body.
12. Disconnect the throttle position sensor (TPS) electrical connector from the throttle body.
13. Remove the accessory drive belt. Refer to *Drive Belt Replacement - Accessory*.

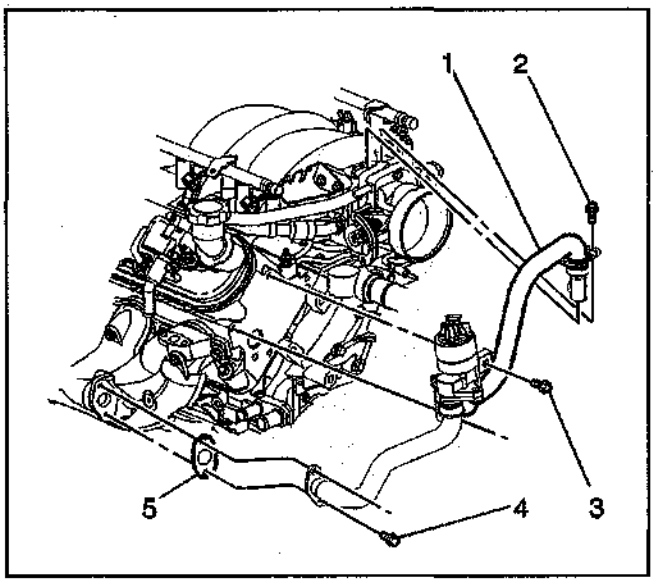


220595

14. Disconnect the exhaust gas recirculation (EGR) solenoid electrical connector.

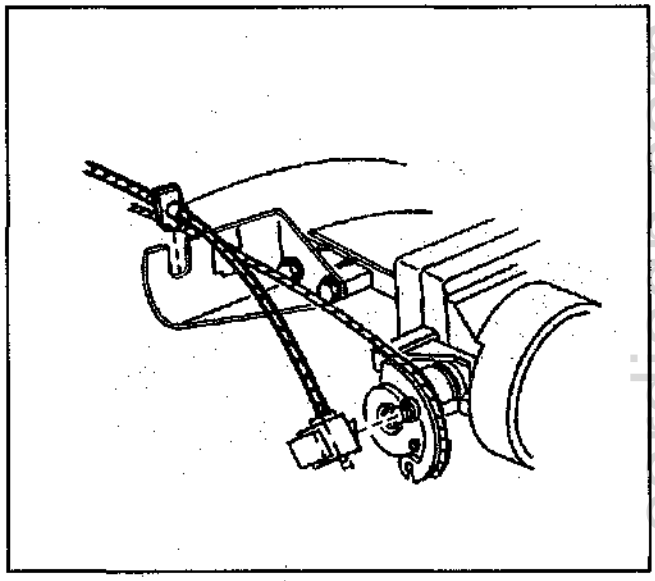
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15. Remove the EGR valve pipe bolts (2, 3, and 4).
16. Using mild force, pull the EGR valve pipe (1) up out of the intake manifold.
17. Remove the O-ring seal from the EGR valve pipe (1).
18. Discard the exhaust manifold gasket (5) and O-ring seal.

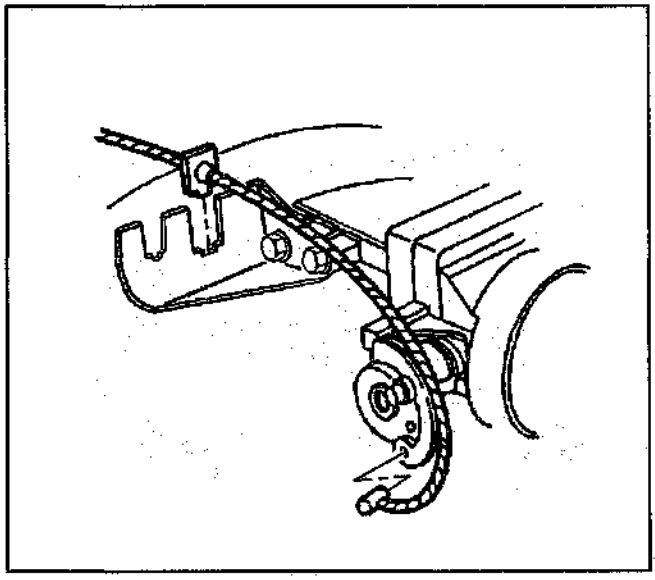


551485

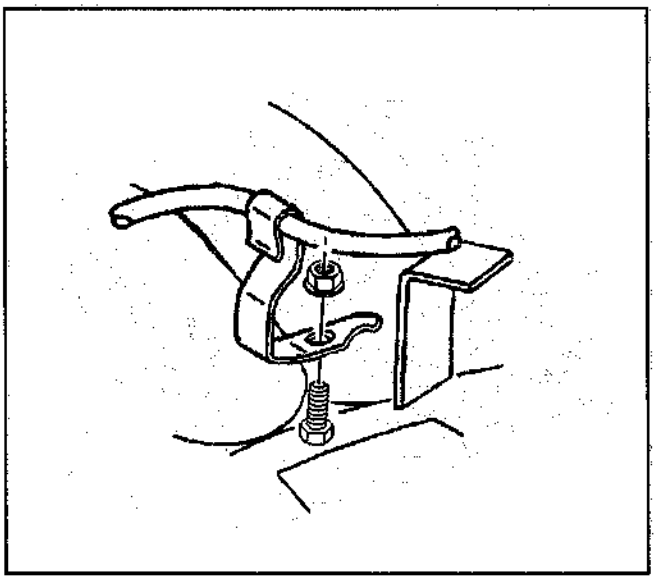
19. Unsnap the cruise control cable from the throttle lever, if equipped.
    - Push the cruise cable connector forward to unsnap.
    - Unsnap the cable from the engine bracket.


220601

20. Remove the accelerator cable from the throttle lever.

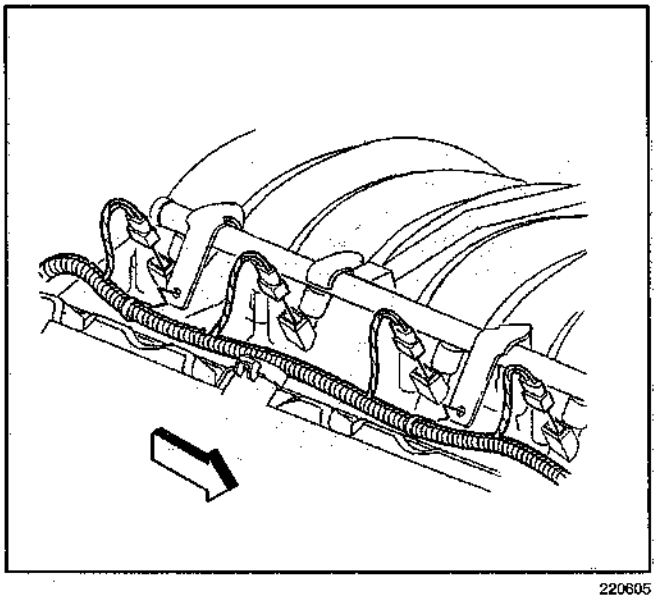

220602

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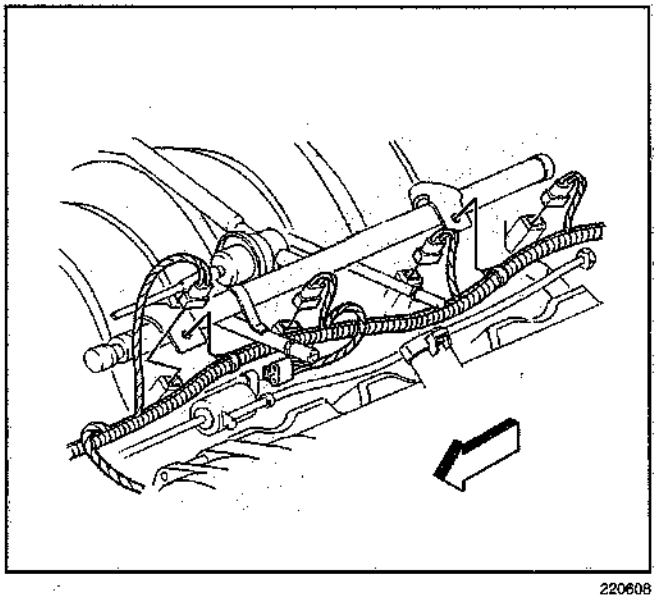
220603

21. Remove the accelerator control cable and cruise control servo bracket.



220605

22. Disconnect the right side fuel injector electrical connectors.

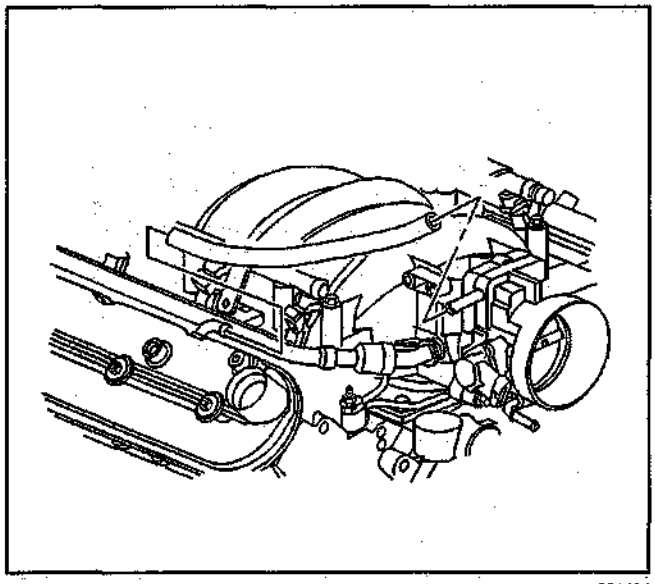


220608

23. Disconnect the left side fuel injector electrical connectors.
24. Disconnect the secondary air injection (AIR) solenoid electrical connector.
25. Remove the fuel rail. Refer to *Fuel Rail and Injectors Removal.*

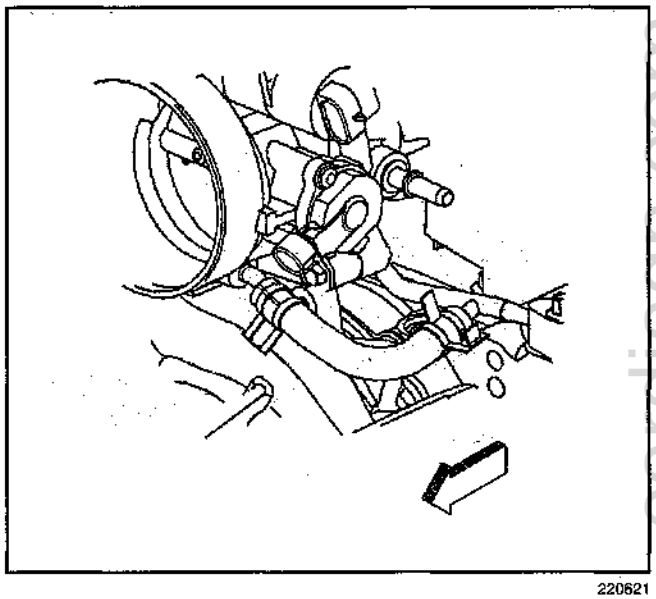
cardiagn.com

26. Remove the fresh air tube from the throttle body and rocker cover.



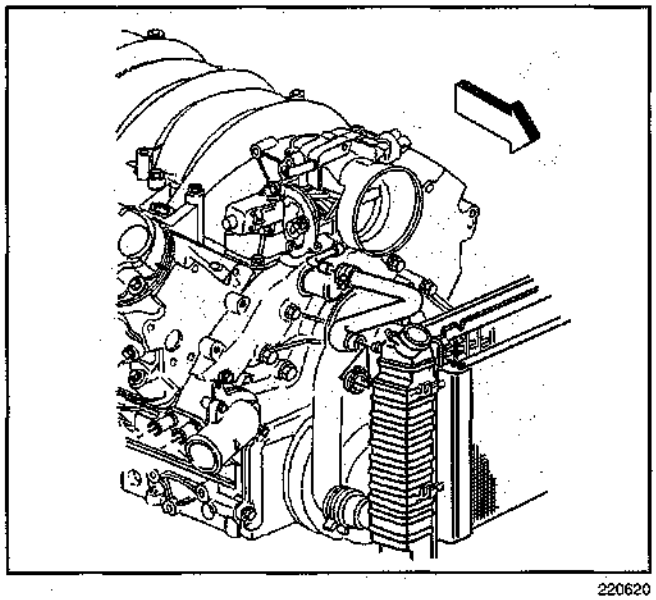
551464

27. Remove the vapor vent tube from the throttle body.



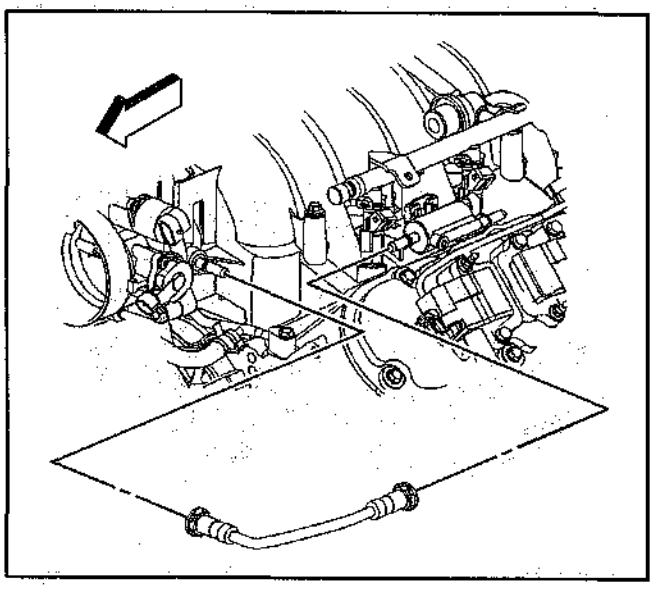
220621

28. Remove the throttle body heater outlet hose from the throttle body.



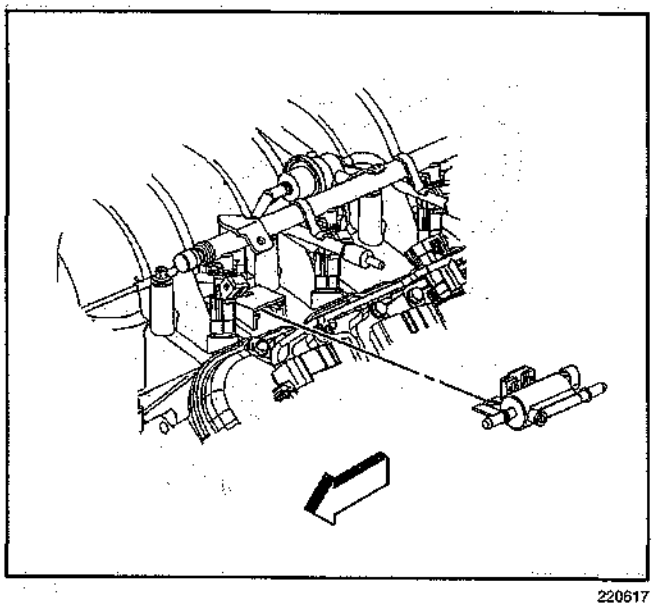
220620

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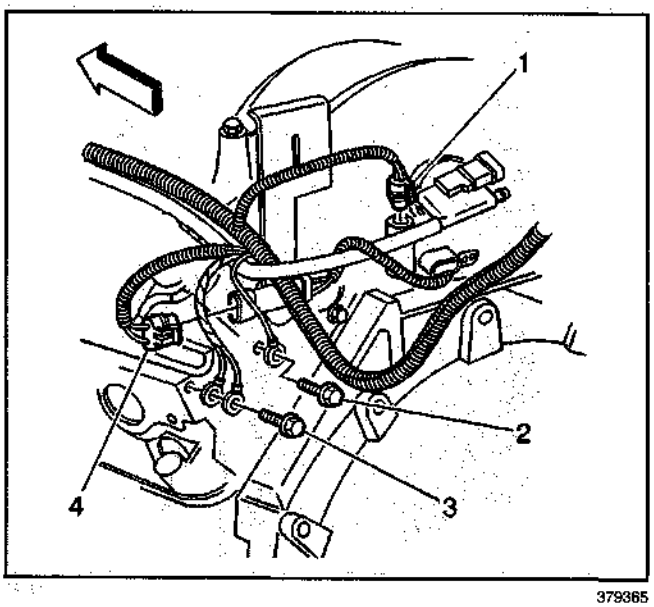
220615

29. Remove the evaporative emission (EVAP) canister purge tube.



220617

30. Remove the canister purge valve and bracket from the intake manifold.

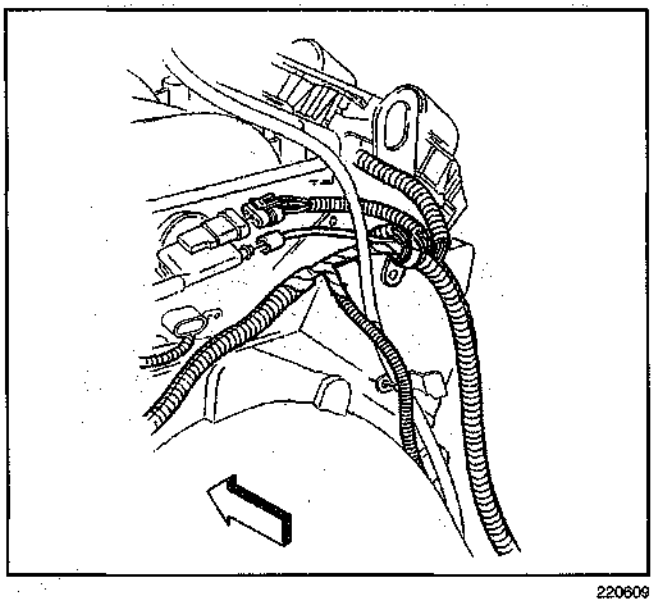


379365

31. Disconnect the knock sensor harness electrical connector (4).

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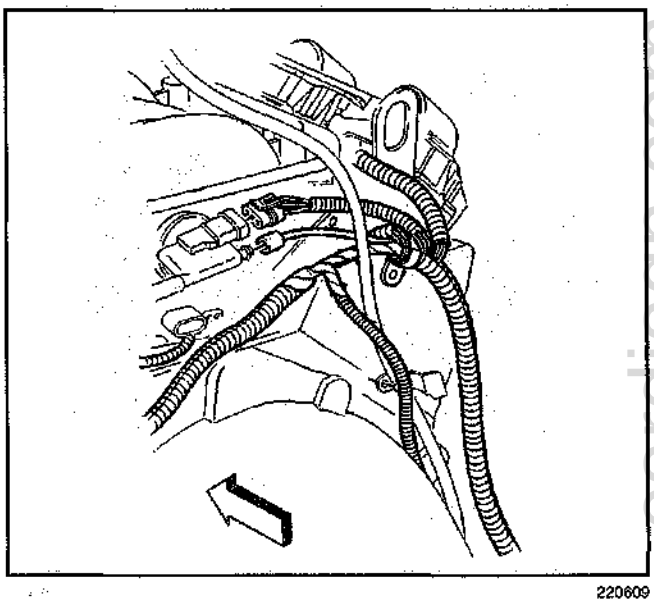
32. Disconnect the manifold absolute pressure (MAP) sensor electrical connector.
33. Disconnect the vacuum hose from the vacuum port on the MAP sensor housing.
34. Disconnect all the remaining electrical connections from the intake manifold.
35. Remove the intake manifold. Refer to *Intake Manifold Removal.*



220609

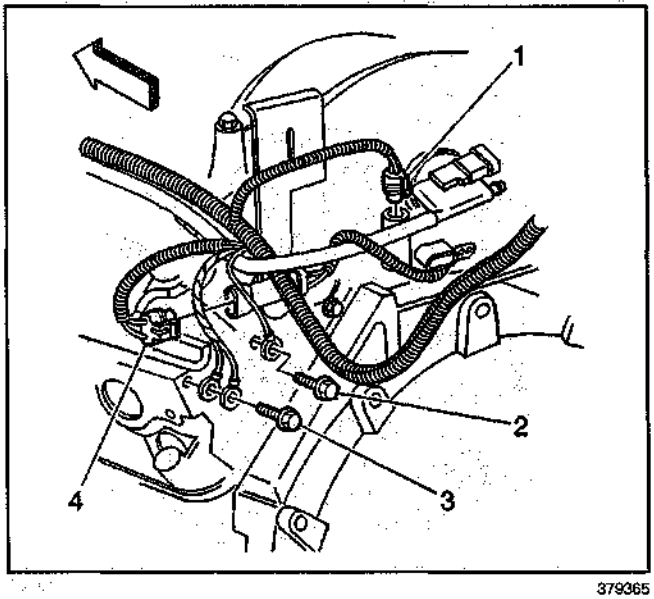
Installation Procedure

1. Install the intake manifold. Refer to *Intake Manifold Installation.*
2. Connect the MAP sensor electrical connector.
3. Connect the vacuum hose to the vacuum port on the MAP sensor housing.



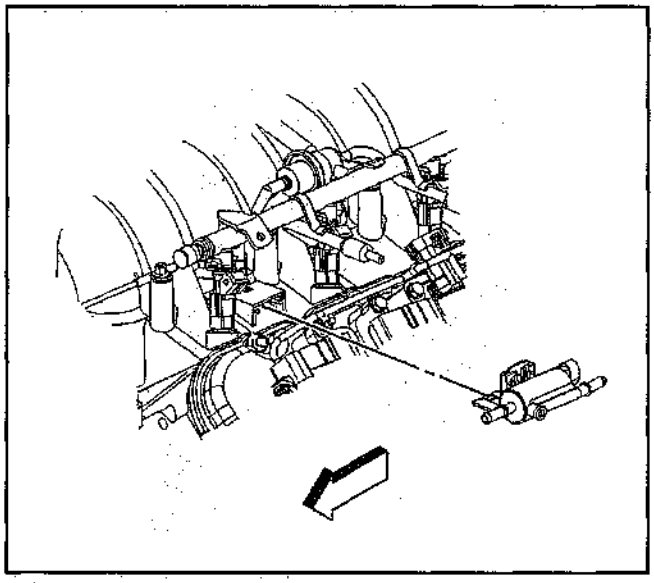
220609

4. Connect the knock sensor harness electrical connector (4).



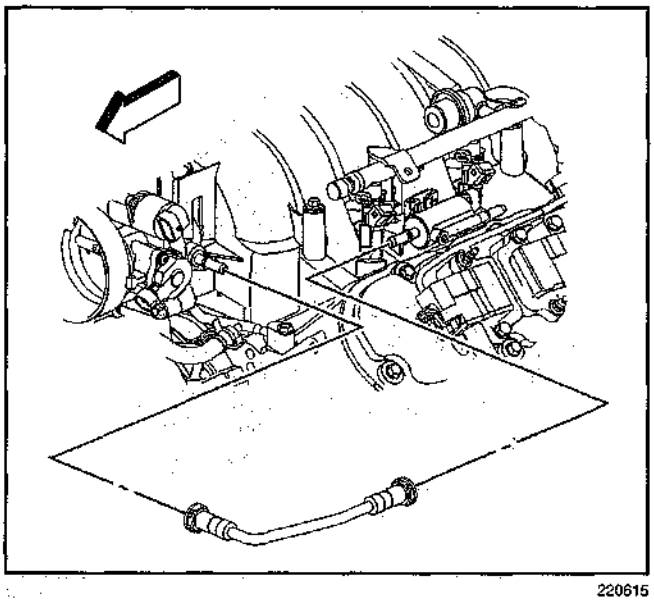
379365

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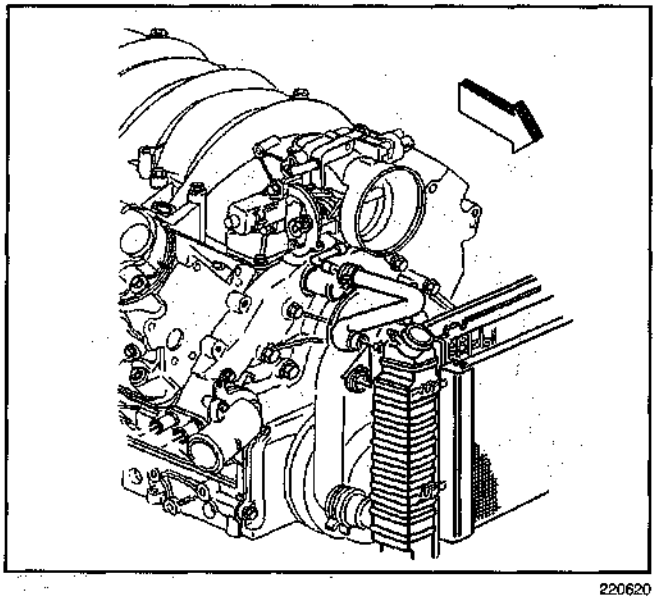
220617

5. Install the canister purge valve and bracket to the intake manifold.



220615

6. Install the EVAP canister purge tube.

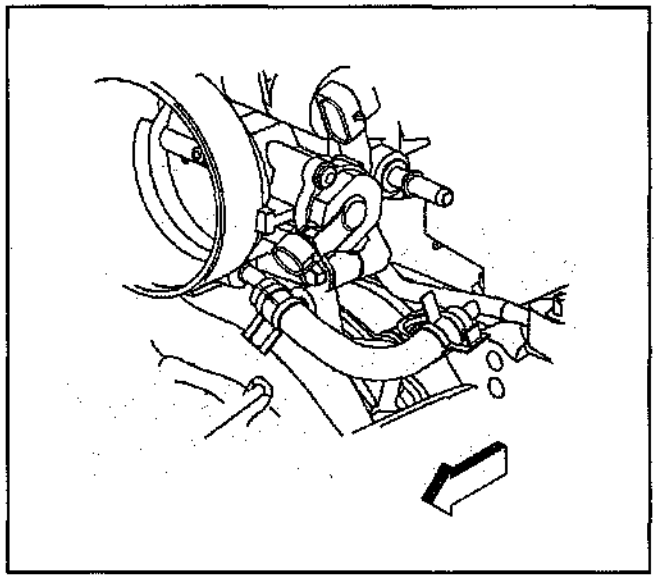


220620

7. Install the throttle body heater outlet hose to the throttle body.

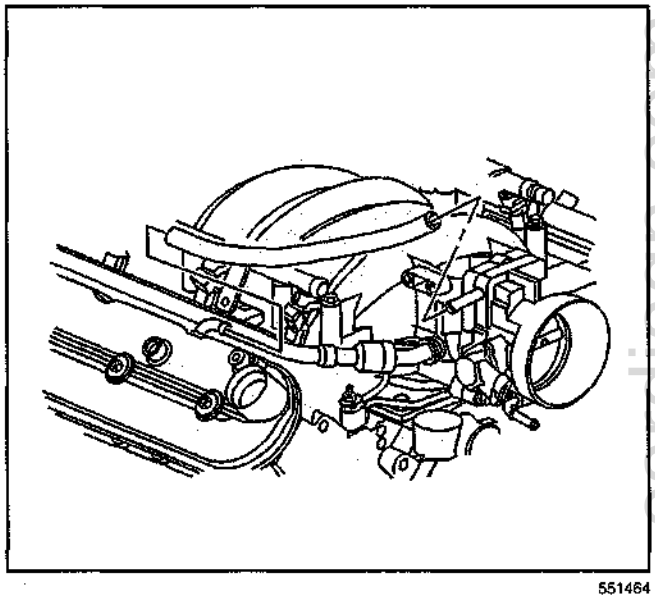
cardiagn.com

8. Install the vapor vent tube hose to the throttle body.



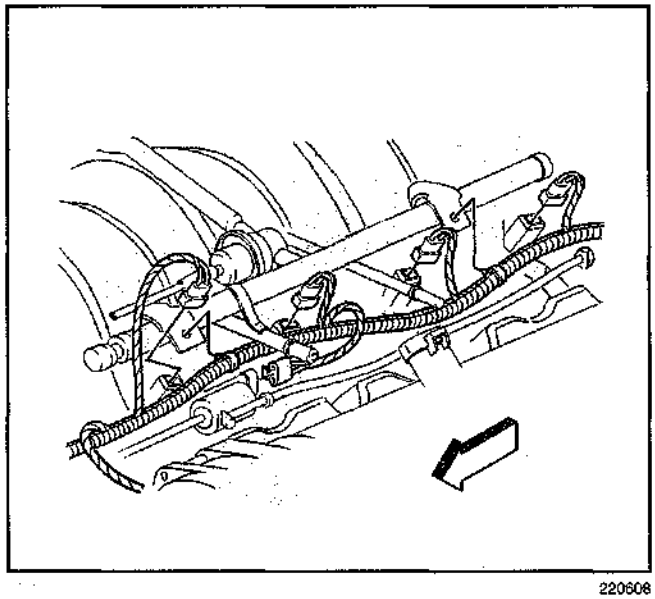
220621

9. Install the fresh air tube to the throttle body and rocker cover.
10. Install the fuel rail. Refer to *Fuel Rail and Injectors Installation.*



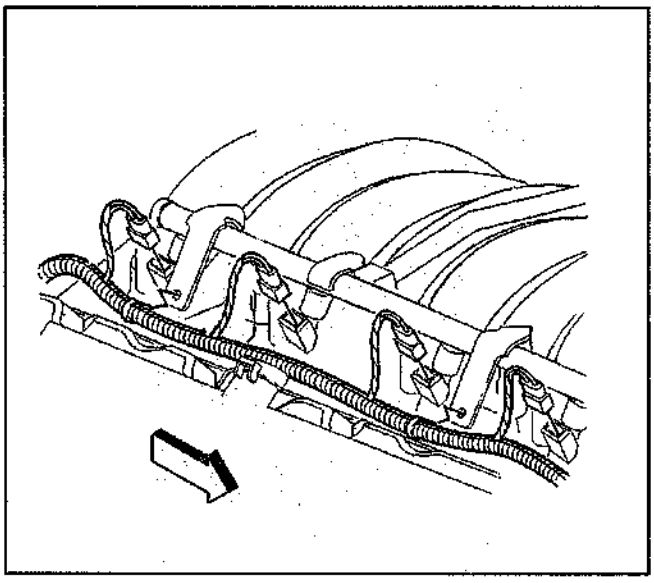
551464

11. Connect the left side fuel injector electrical connectors.
12. Connect the AIR solenoid electrical connector.



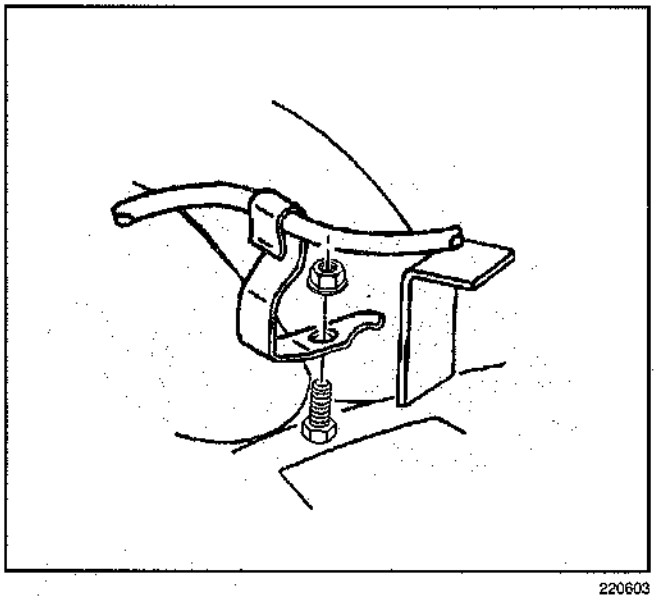
220608

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220605

13. Connect the right side fuel injector electrical connectors.
14. Connect all remaining electrical connectors to the intake manifold.



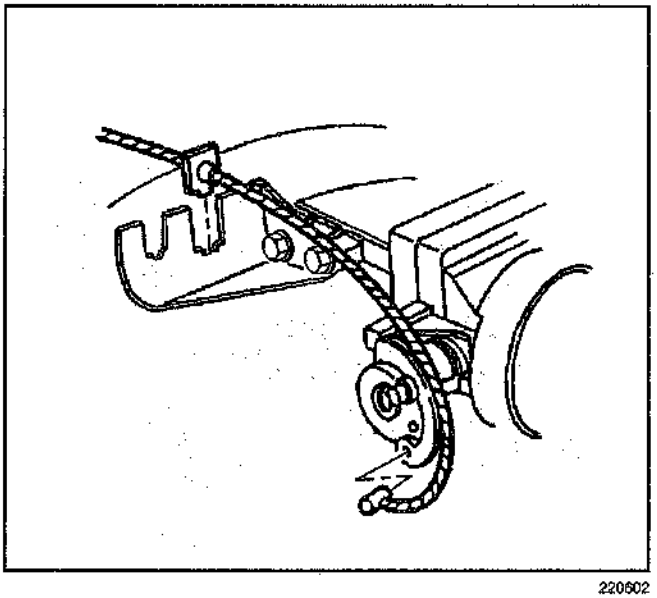
220603

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

15. Install the accelerator control cable and cruise control servo bracket.

    Tighten

    Tighten the accelerator control cable and cruise control servo bracket nut to 10 N·m (89 lb in).

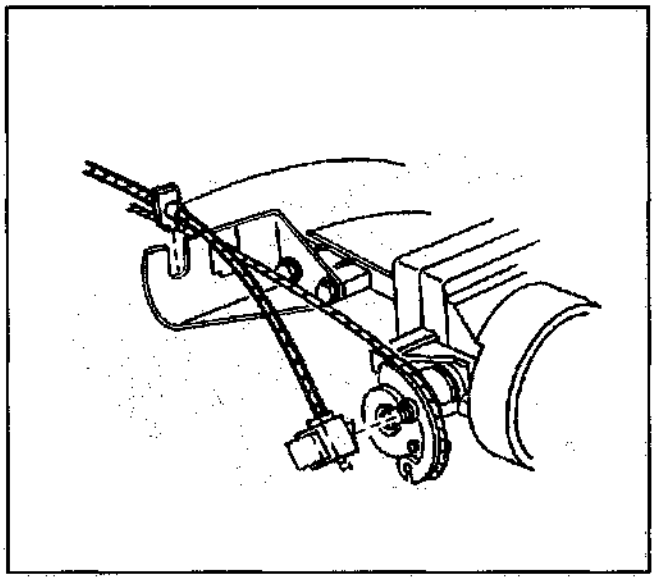


220602

16. Install the accelerator cable to the throttle lever.

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17. Install the cruise control cable to the throttle lever, if equipped.



220601

Important: Do not reuse EGR pipe gaskets or seals during assembly, install NEW gaskets and seals.

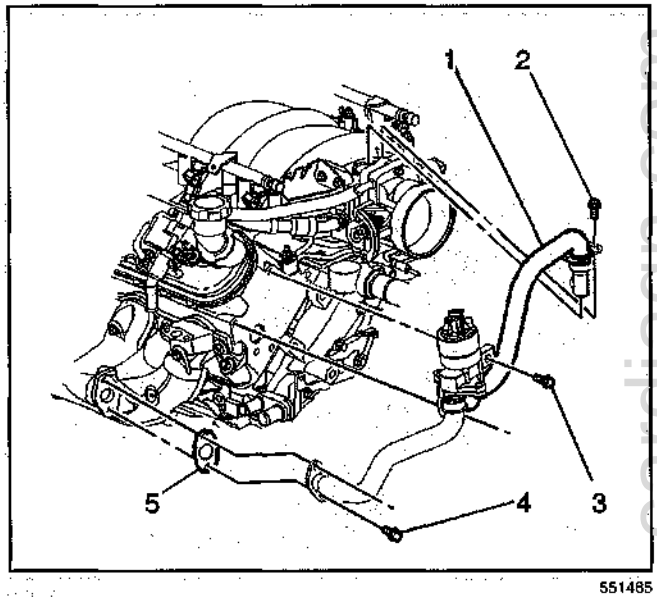
18. Apply a light coating of clean engine oil to a NEW O-ring seal and install the seal onto the EGR valve pipe (1).
19. Install the EGR valve pipe (1) into the intake manifold.
20. Finger start the EGR valve pipe (1) to intake manifold bolt (2).
21. Finger start the EGR valve pipe (1) to cylinder head bolts (3).
22. Finger start a NEW EGR valve pipe exhaust manifold gasket (5) and bolts (4).

    Tighten

    22.1. Tighten the EGR valve pipe to intake manifold bolt (2) to 10 N·m (89 lb in).

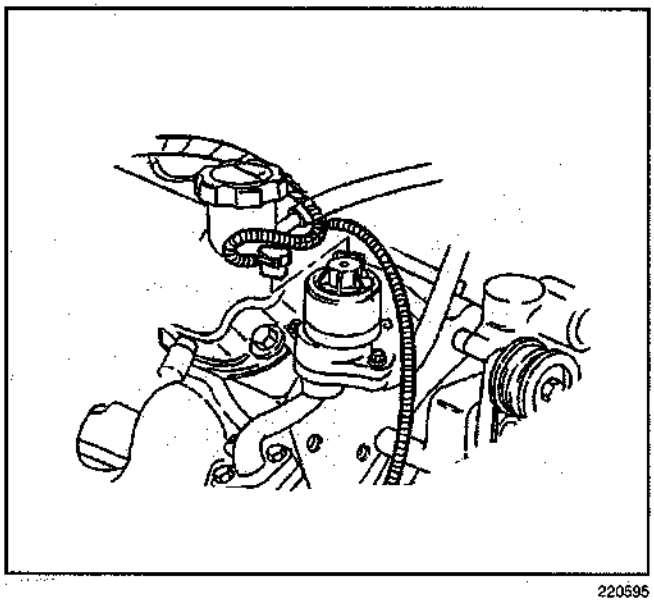
    22.2. Tighten the EGR valve pipe to cylinder head bolts (3) to 50 N·m (37 lb ft).

    22.3. Tighten the EGR valve pipe to the exhaust manifold bolts (4) to 30 N·m (22 lb ft).



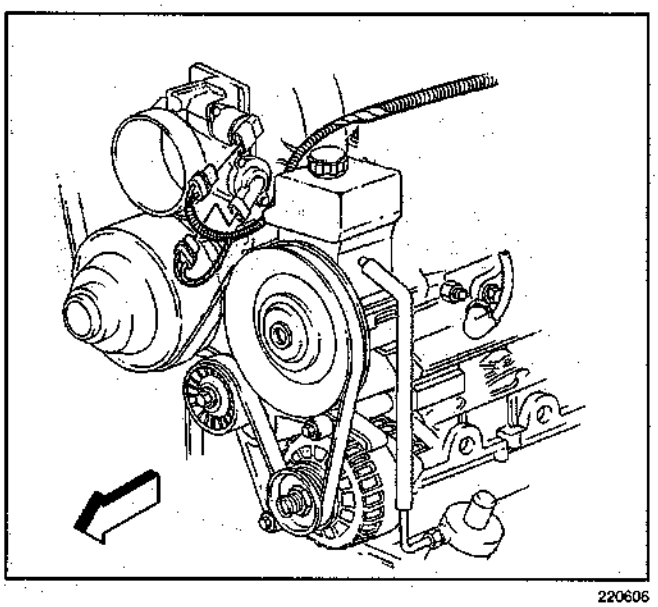
551485

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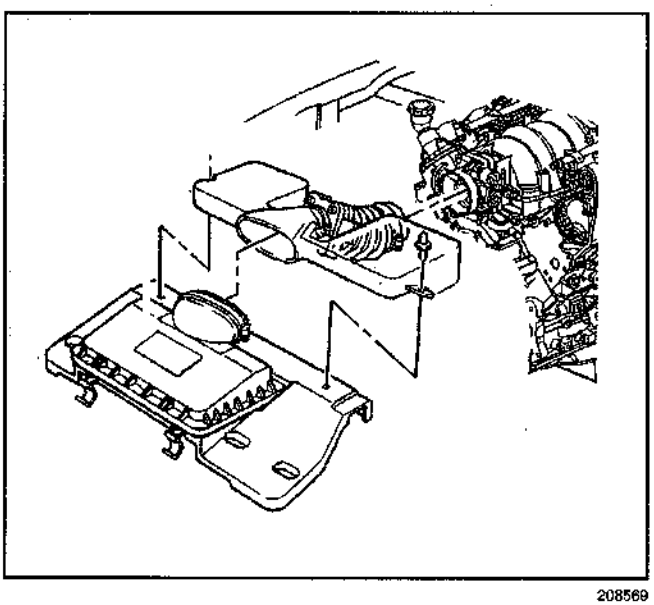
220595

23. Connect the EGR valve electrical connector.
24. Install the accessory drive belt. Refer to *Drive Belt Replacement - Accessory*.



220606

25. Connect the TPS sensor electrical connector to the throttle body.
26. Connect the IAC sensor electrical connector to the throttle body.

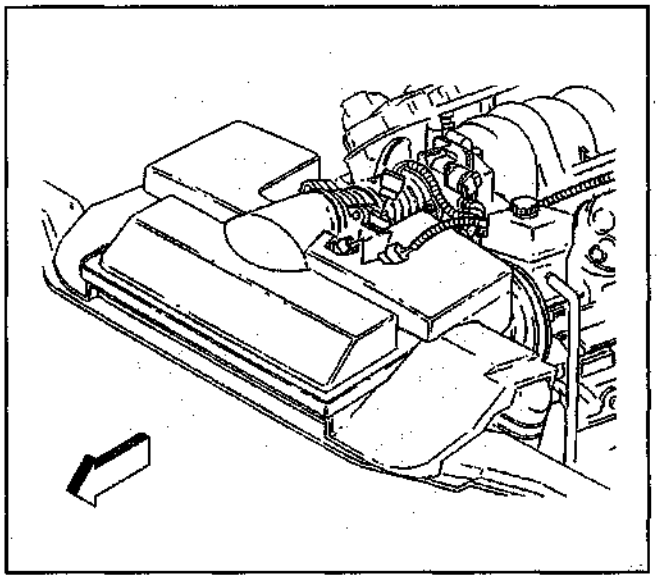


208569

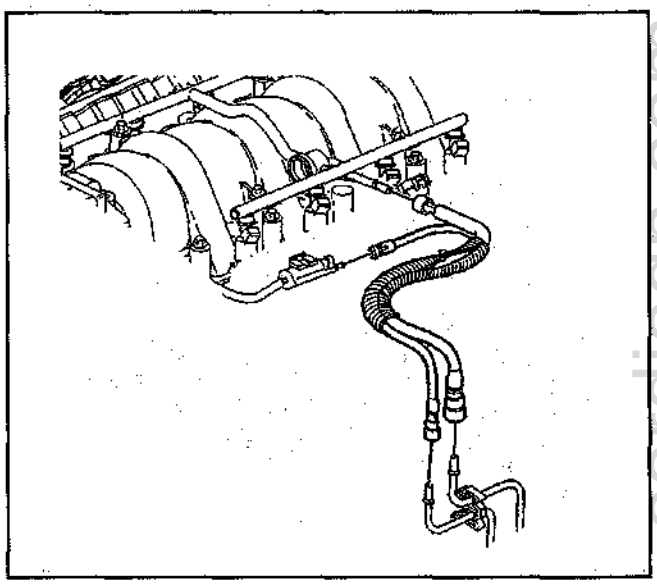
27. Install the air intake duct to the throttle body and the air cleaner box.

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28. Connect the MAF sensor electrical connector to the intake duct.
29. Connect the IAT sensor electrical connector to the intake duct.


208553

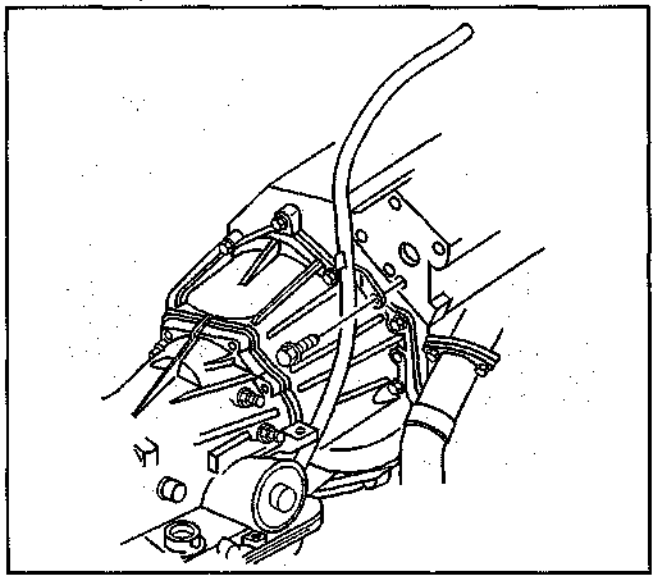
30. Connect the fuel line to the fuel rail.
31. Connect the vapor line to the fuel vapor purge valve.
32. Raise and suitably support the vehicle. Refer to *Lifting and Jacking the Vehicle* in General Information


220597

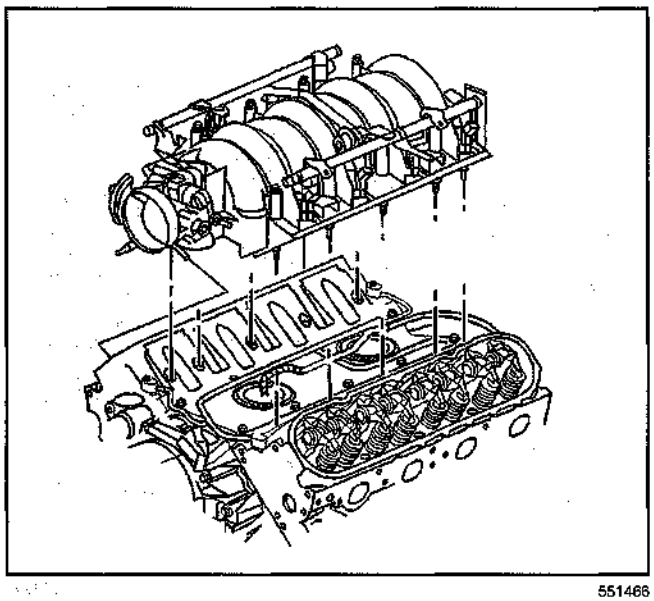
33. Install the transmission fluid indicator tube bolt.

    Tighten

    Tighten the transmission fluid indicator tube bolt to 50 N·m (37 lb ft).
34. Lower the vehicle.
35. Fill the cooling system. Refer to *Draining and Filling Cooling System (5.7 L)* in Engine Cooling.


208459

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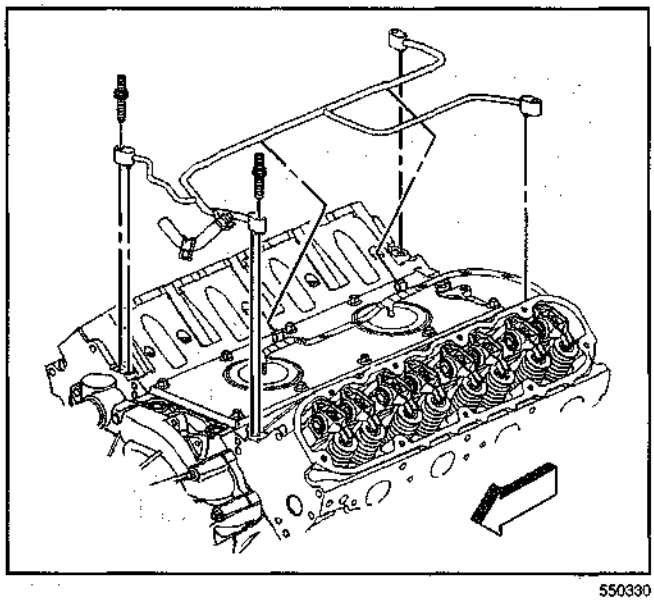


551466

Vapor Vent Pipe Replacement

Removal Procedure

1. Remove the intake manifold. Refer to *Intake Manifold Replacement*.

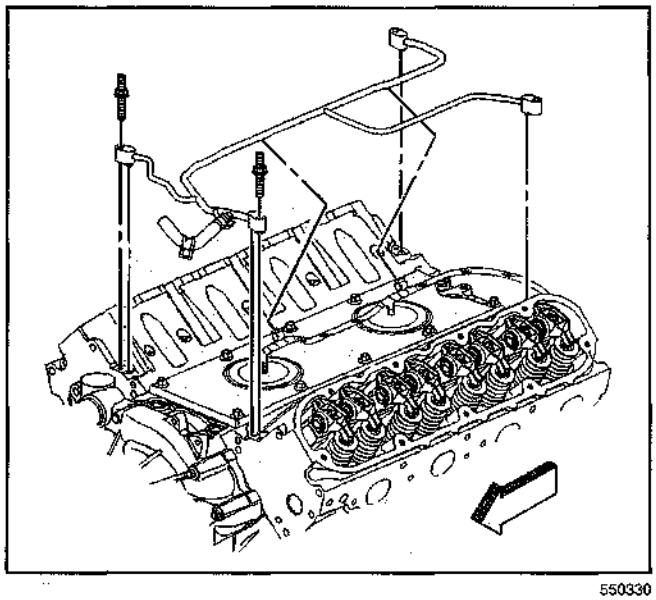


550330

2. Remove the engine coolant air bleed pipe. Refer to *Vapor Vent Pipe Removal*.

Installation Procedure

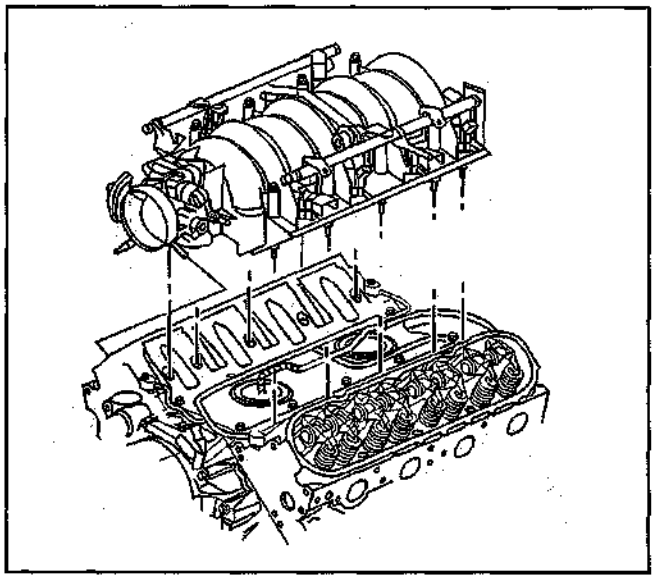
1. Install the engine coolant air bleed pipe. Refer to *Vapor Vent Pipe Installation*.



550330

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2. Install the intake manifold. Refer to *Intake Manifold Replacement*.

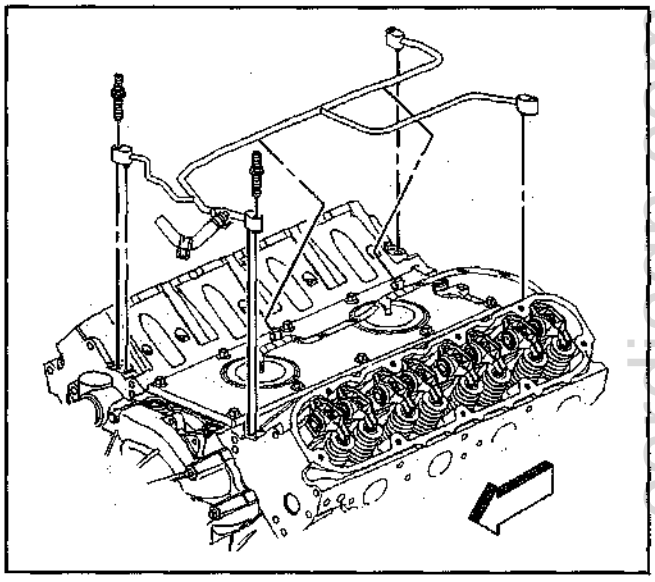


551466

Engine Valley Cover Replacement

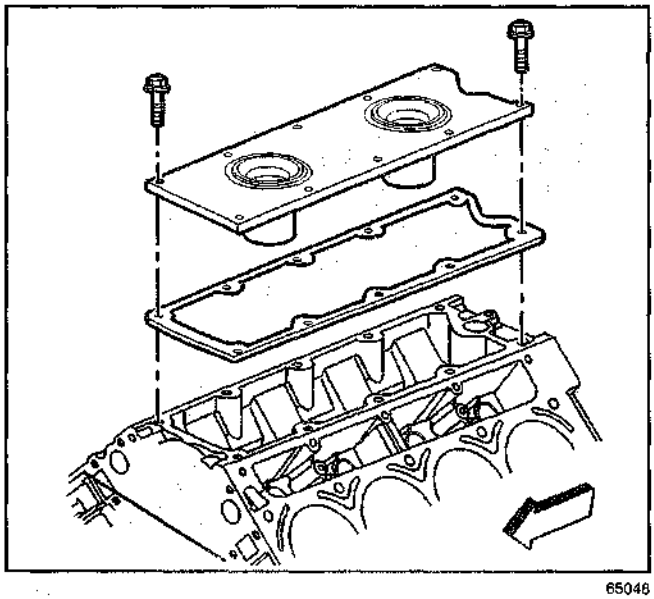
Removal Procedure

1. Remove the engine coolant air bleed pipe. Refer to *Vapor Vent Pipe Removal*.



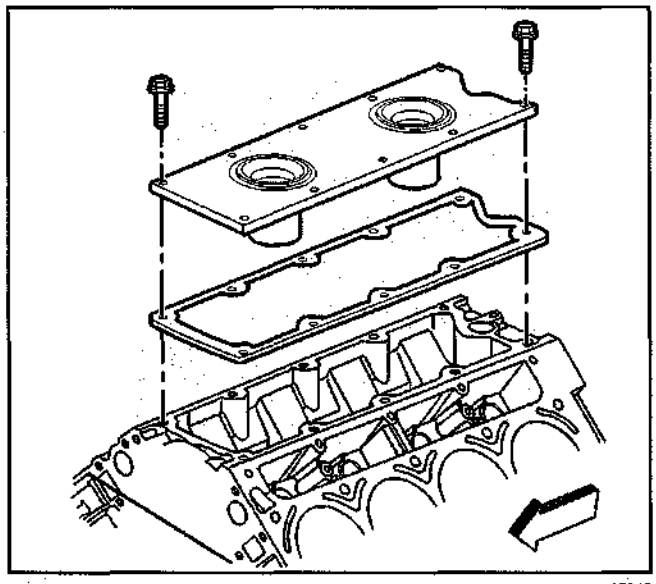
550330

2. Remove the engine valley cover. Refer to *Engine Valley Cover Removal*.



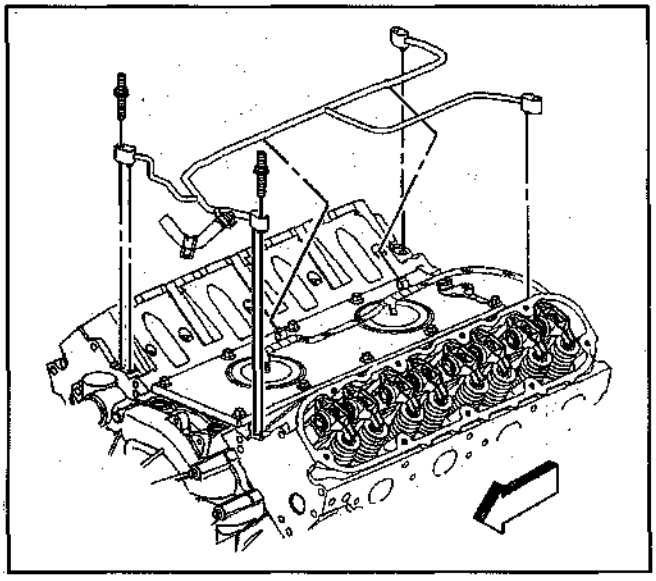
65048

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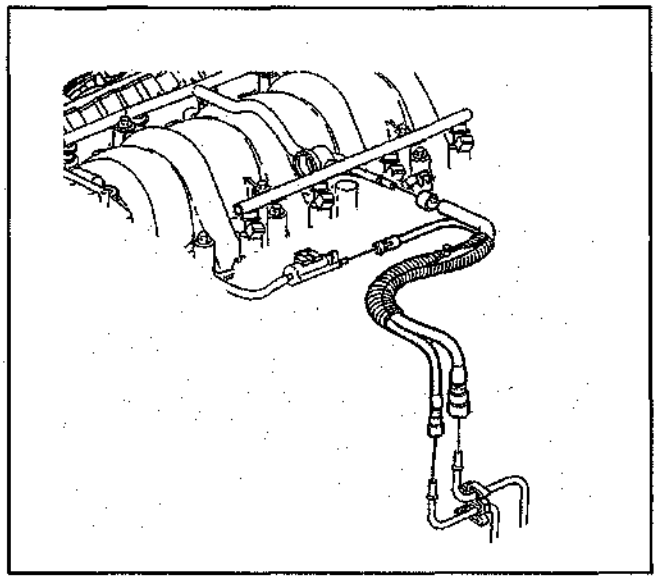

65048

Installation Procedure

1. Install the engine valley cover. Refer to *Engine Valley Cover Installation.*


550330

2. Install the engine coolant air bleed pipe. Refer to *Vapor Vent Pipe Installation.*


220597

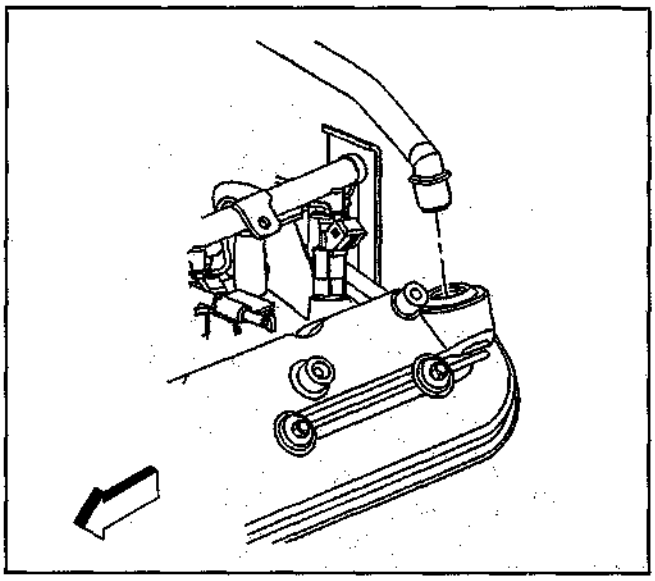
Valve Rocker Arm Cover Replacement (Left)

Removal Procedure

1. Relieve the fuel system pressure. Refer to *Fuel Pressure Relief Procedure* in Engine Controls - 5.7 L.
2. Disconnect the fuel line from the fuel rail.
3. Disconnect the vapor line from the fuel vapor purge valve.

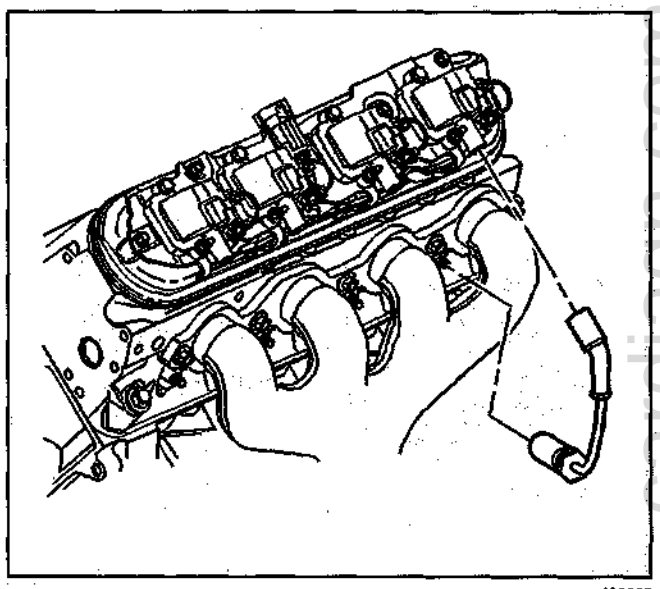
cardiagn.com

4. Remove the positive crankcase ventilation (PCV) valve pipe from the rocker cover.



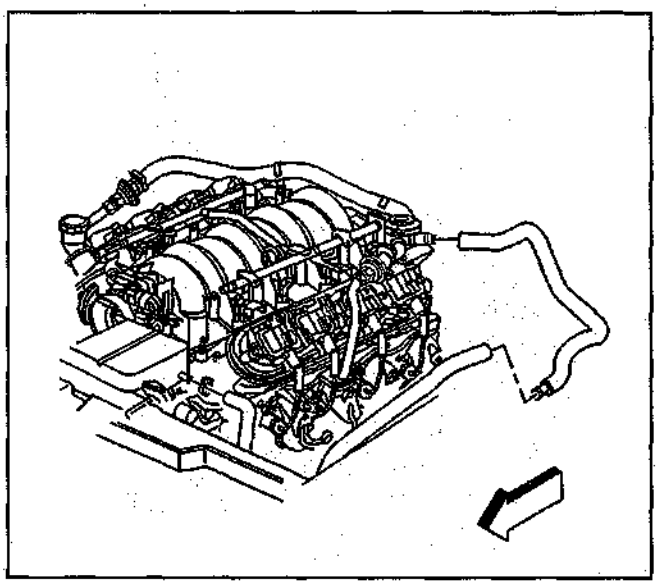
379366

5. Disconnect the ignition coil harness main electrical connector.
6. Remove the spark plug wires from the ignition coils.
7. Remove the spark plug wires from the spark plugs.



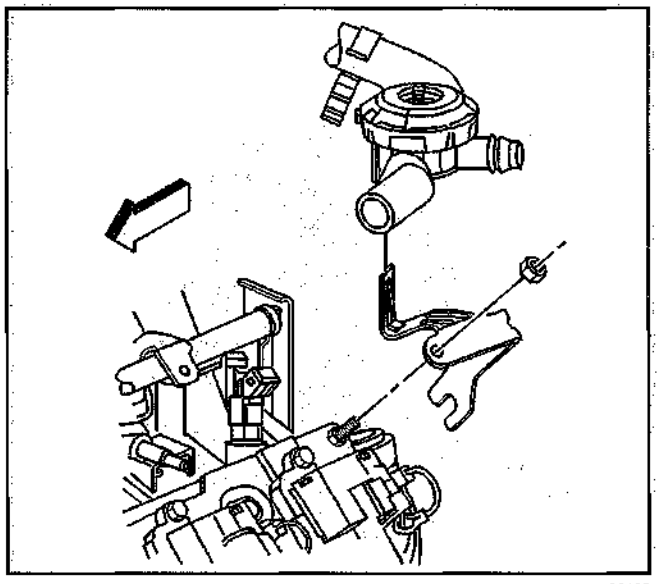
490925

8. Disconnect the secondary air injection (AIR) pump hose from the AIR shutoff valve.
9. Separate the AIR pump hose, if necessary.

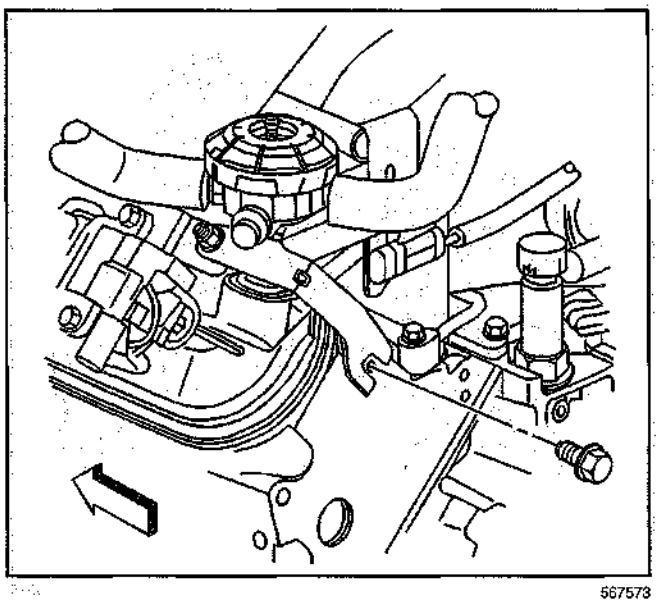


551472

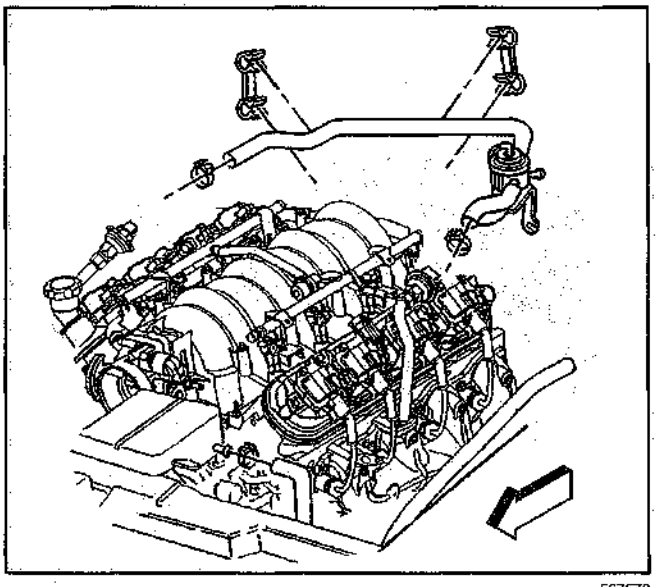
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628105

10. Remove the AIR shutoff valve bracket nut.
11. Disconnect the AIR solenoid tube from the shutoff valve.


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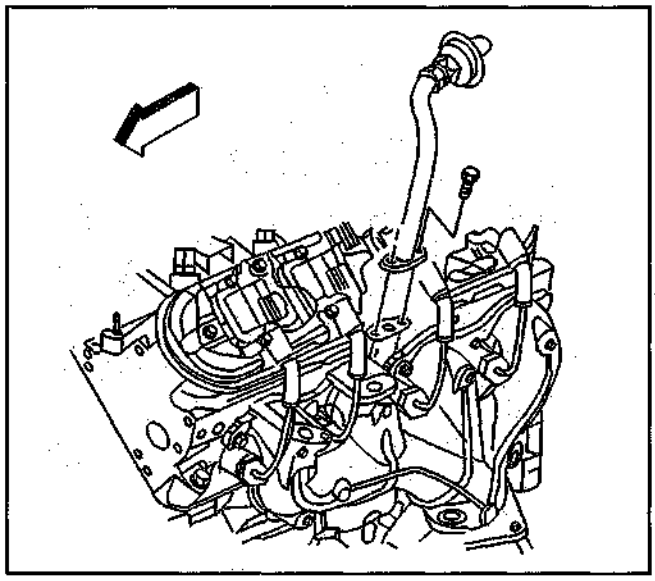
12. Loosen the AIR shutoff valve bolt on the rear of the cylinder head.
13. Slide the AIR shutoff valve off from the bolt.


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14. Remove the AIR shutoff valve hose clamps and hose.

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15. Remove the AIR pipe (with check valve), bolts and gasket from the left exhaust manifold.
16. Remove the valve rocker arm cover. Refer to *Valve Rocker Arm Cover Removal (Left Side)*.



551470

Installation Procedure

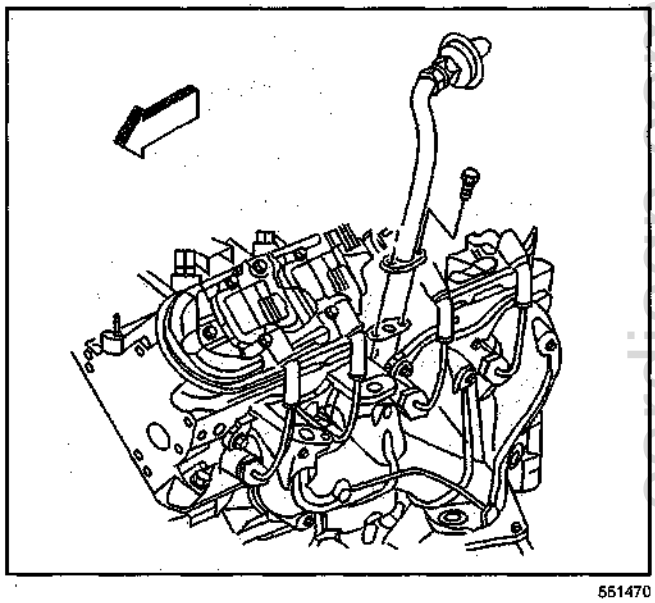
1. Install the valve rocker arm cover. Refer to *Valve Rocker Arm Cover Installation (Left Side)*.

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

2. Install the AIR pipe (with check valve), NEW gasket and bolts to the left exhaust manifold.

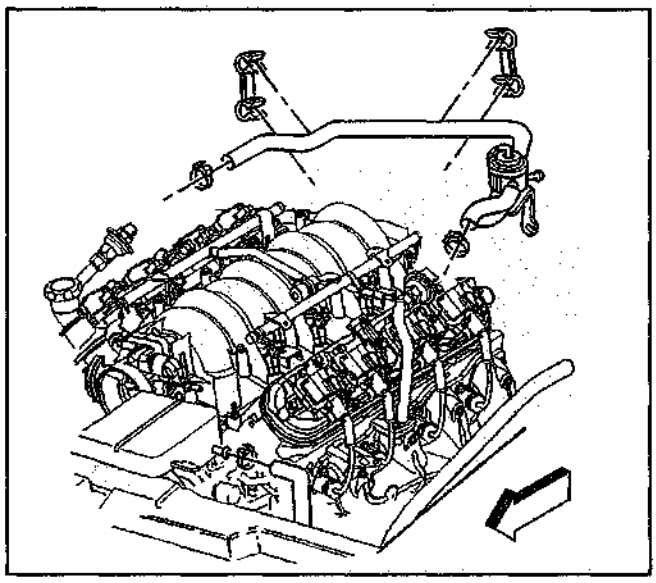
   Tighten

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



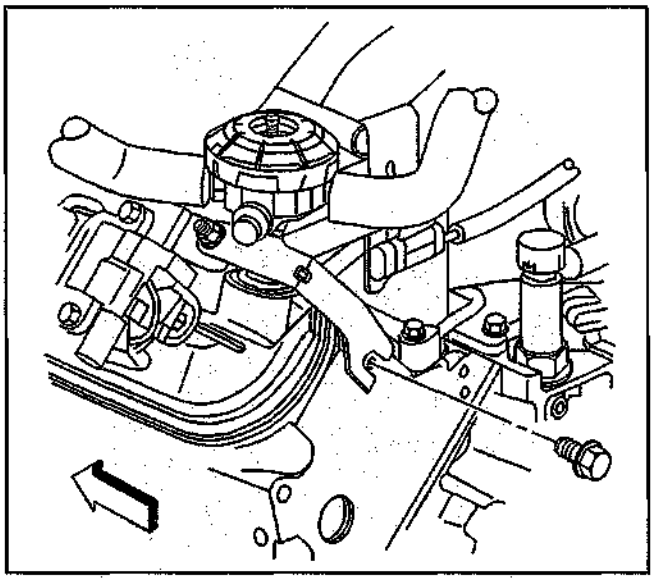
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3. Install the AIR shutoff valve hose and clamps.



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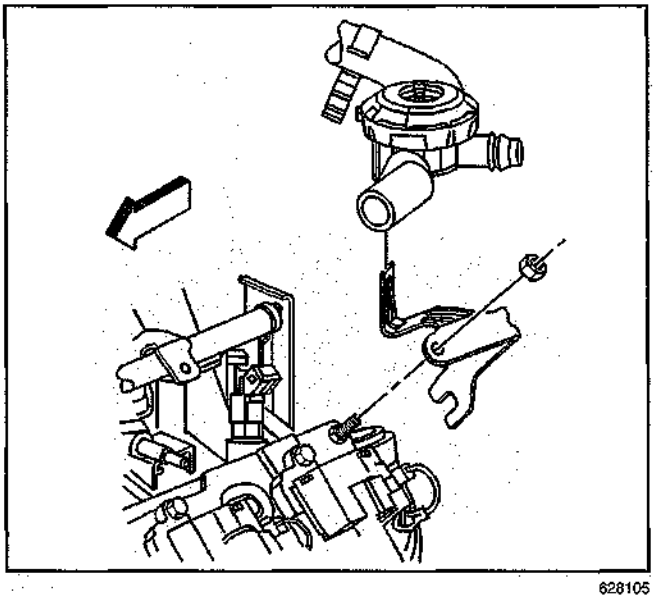
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4. Slide the AIR shutoff valve onto the bolt.
5. Tighten the AIR shutoff valve bolt on the rear of the cylinder head.

   Tighten

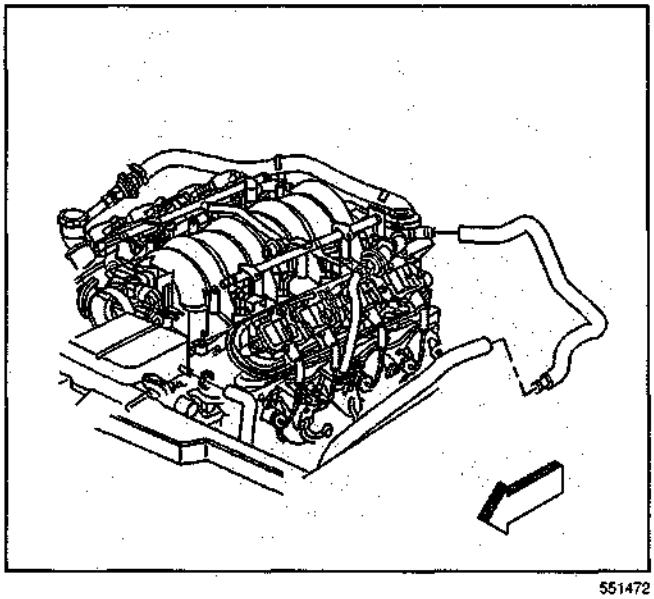
   Tighten the AIR shutoff valve bolt to 20 N·m (15 lb ft).


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6. Install the AIR shutoff valve bracket nut.

   Tighten

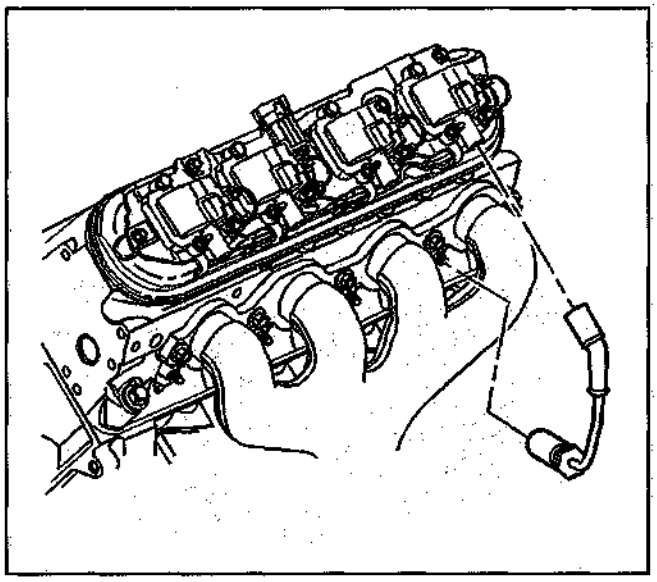
   Tighten the AIR shutoff valve bracket nut to 12 N·m (106 lb in).
7. Connect the AIR solenoid tube to the shutoff valve.
8. Connect the AIR pump hose together, if necessary.


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9. Connect the AIR pump hose to the AIR shutoff valve.

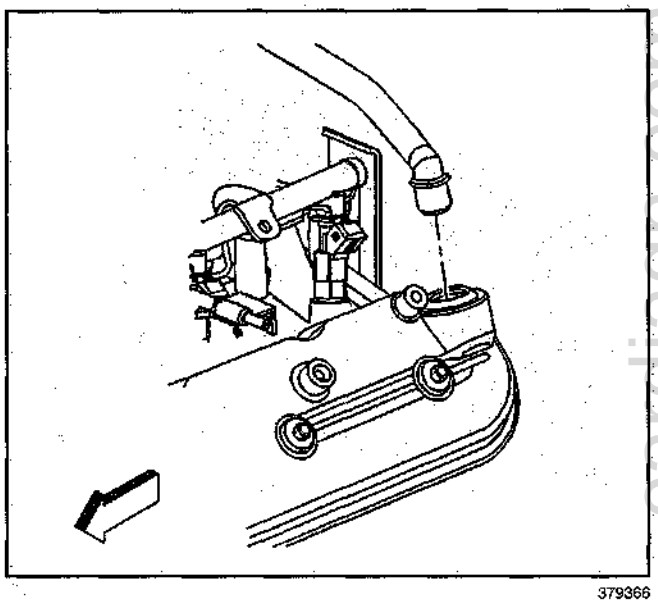
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10. Install the spark plug wires to the spark plugs.
11. Install the spark plug wires to the ignitions coils.
12. Connect the ignition coil harness main electrical connector.



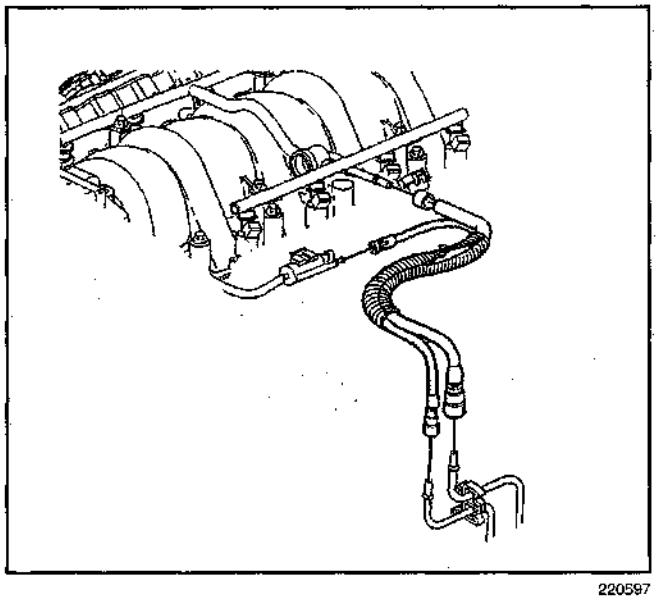
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13. Install the PCV valve pipe to the rocker cover.



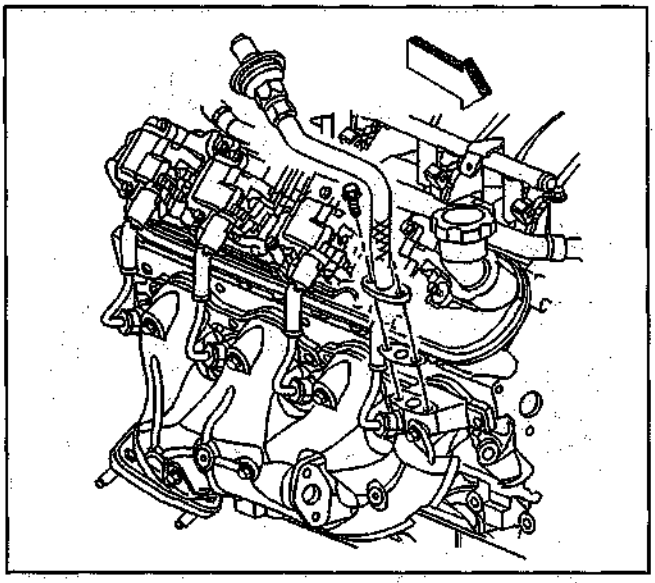
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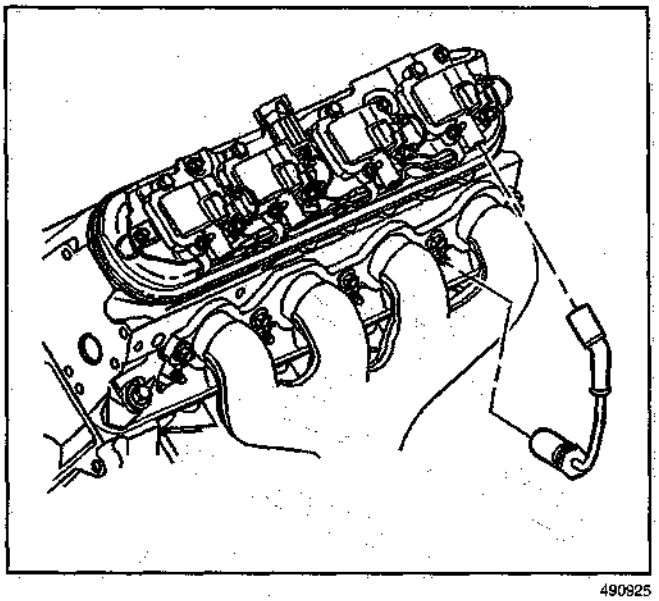
14. Install the fuel line to the fuel rail.
15. Install the vapor line to the fuel vapor purge valve.



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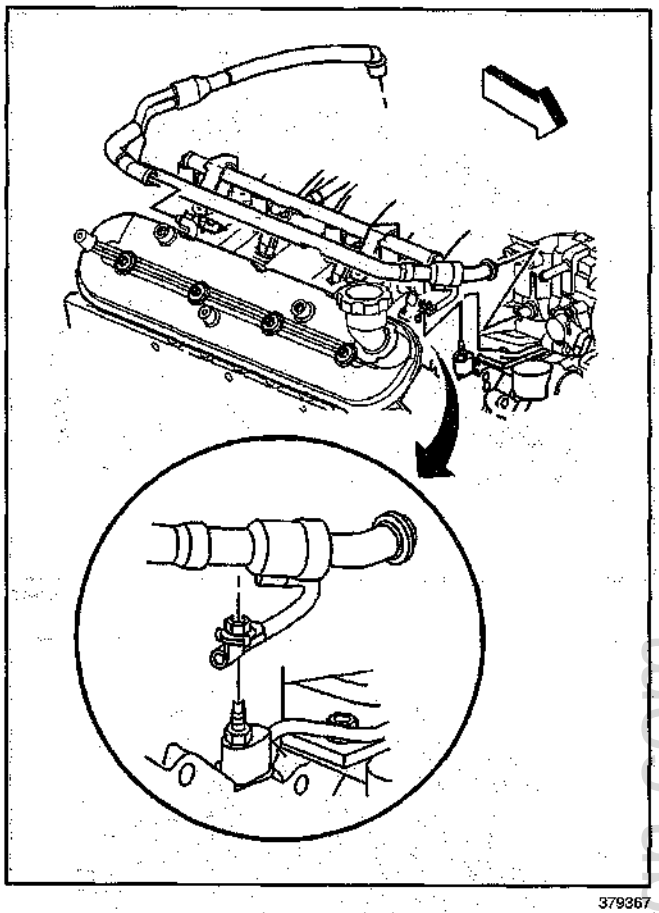
Valve Rocker Arm Cover Replacement (Right)

Removal Procedure

1. Remove the evaporator tube. Refer to *Evaporator Tube Replacement* in Heating, Ventilation and Air Conditioning.
2. Remove the heater hoses/pipes. Refer to *Heater Hose Assembly Replacement (5.7 L)* in Heating, Ventilation and Air Conditioning.
3. Remove the secondary air injection (AIR) pump hose from the hose clamps.
4. Disconnect the AIR pump hose from the shutoff valve.
5. Remove the AIR pipe (with check valve), bolts and gasket from the right exhaust manifold.
6. Disconnect the ignition coil harness main electrical connector.
7. Remove the spark plug wires from the ignition coils.
8. Remove the spark plug wires from the spark plugs.

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9. Remove the positive crankcase ventilation (PCV) valve pipe from the rocker cover.
10. Remove the PCV valve pipe strap nut, if needed.
11. Remove the PCV valve pipe from the intake manifold, if needed.
12. Remove the valve rocker arm cover. Refer to *Valve Rocker Arm Cover Removal (Right Side)*.



379367

Installation Procedure

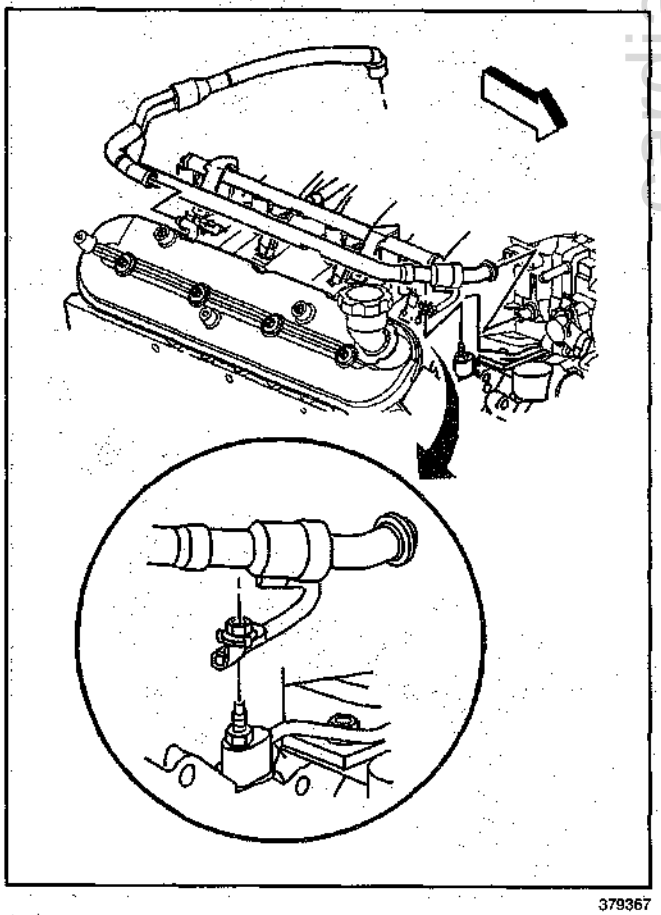
1. Install the valve rocker arm cover. Refer to *Valve Rocker Arm Cover Installation (Right Side)*.
2. Install the PCV valve pipe to the intake manifold, if removed.

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

3. Install the PCV valve pipe strap nut, if removed.

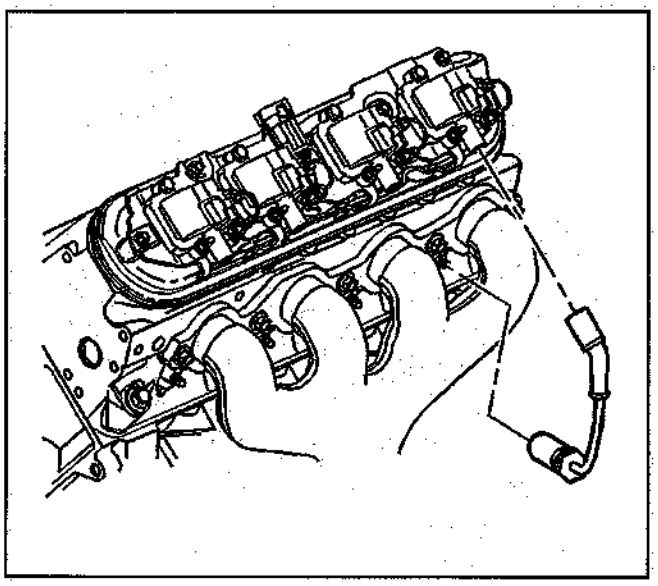
   Tighten

   Tighten the PCV valve pipe strap nut to 12 N·m (106 lb in).
4. Install the PCV valve pipe to the rocker cover.



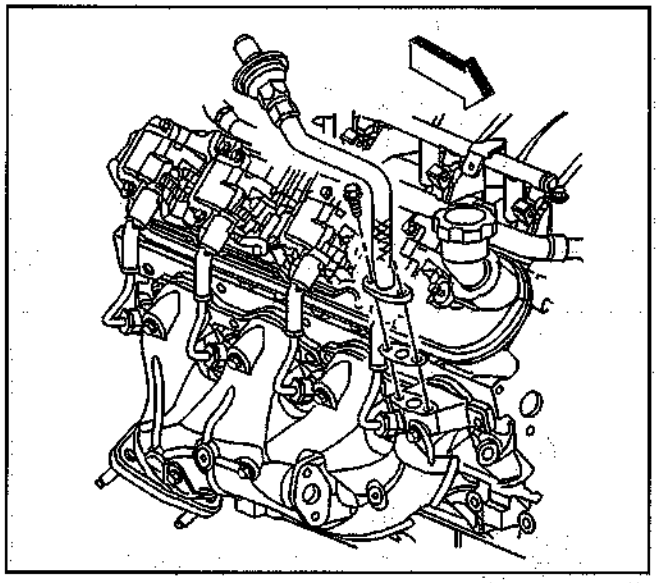
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5. Install the spark plug wires to the spark plugs.
6. Install the spark plug wires to the ignition coils.
7. Connect the ignition coil harness main electrical connector.

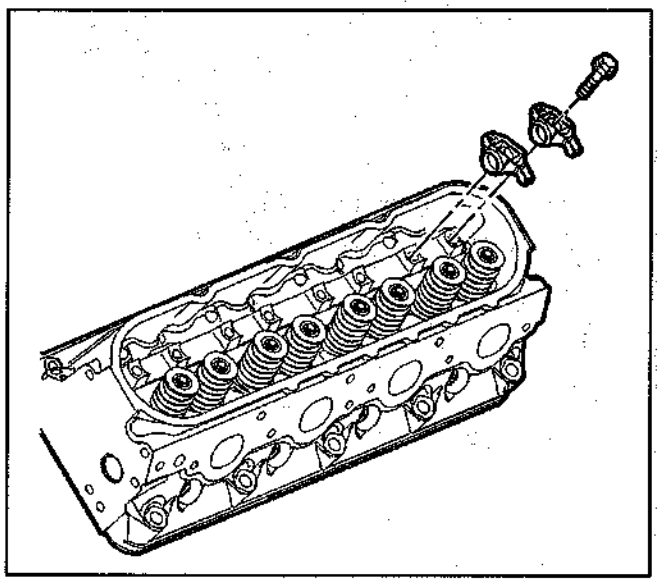


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8. Install the AIR pipe (with check valve), NEW gasket and bolts to the right exhaust manifold.

   Tighten

   Tighten the AIR pipe bolts to 20 N·m (15 lb ft).
9. Connect the AIR pump hose to the shutoff valve.
10. Connect the AIR pump hose to the hose clamps.
11. Install the heater hoses/pipes. Refer to *Heater Hose Assembly Replacement (5.7 L)* in Heating, Ventilation and Air Conditioning.
12. Install the evaporator tube. Refer to *Evaporator Tube Replacement* in Heating, Ventilation and Air Conditioning.



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Valve Rocker Arm and Push Rod Replacement

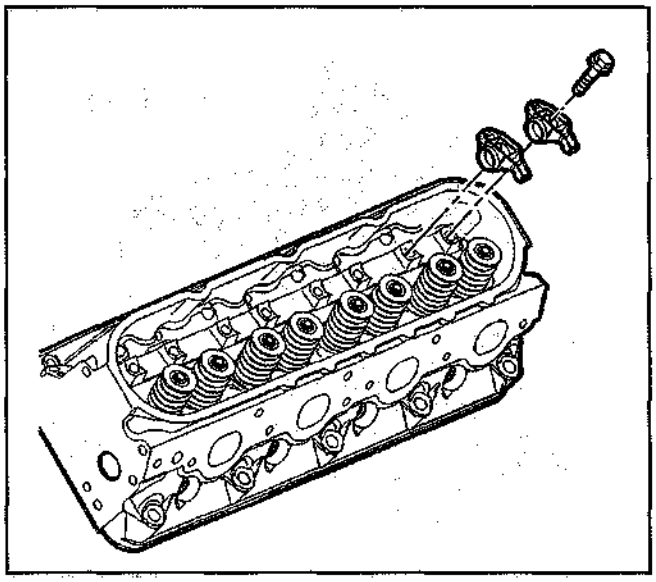
Removal Procedure

1. Remove the valve rocker arm covers. Refer to *Valve Rocker Arm Cover Replacement (Right)* or *Valve Rocker Arm Cover Replacement (Left)*.
2. Remove the valve rocker arms, push rods, and pedestals. Refer to *Valve Rocker Arm and Push Rod Removal*.

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Installation Procedure

1. Install the valve rocker arms, push rods, and pedestals. Refer to *Valve Rocker Arm and Push Rod Installation*.
2. Install the valve rocker arm covers. Refer to *Valve Rocker Arm Cover Replacement (Left)* or *Valve Rocker Arm Cover Replacement (Right)*.



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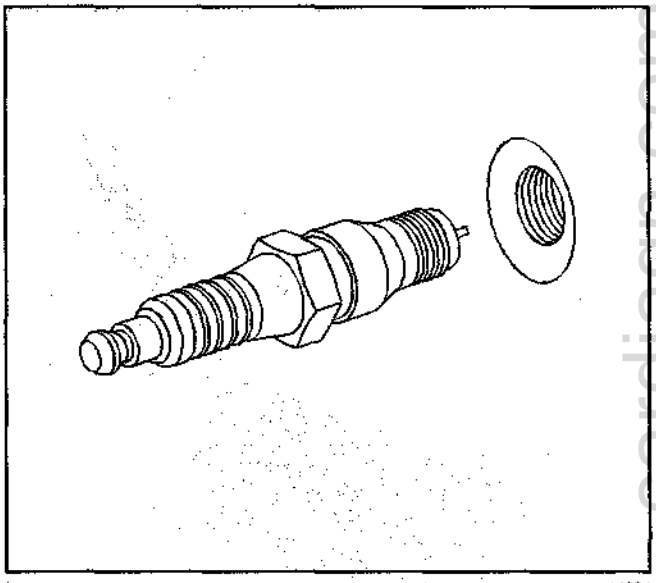
Valve Stem Oil Seal and Valve Spring Replacement

Removal Procedure

Tools Required

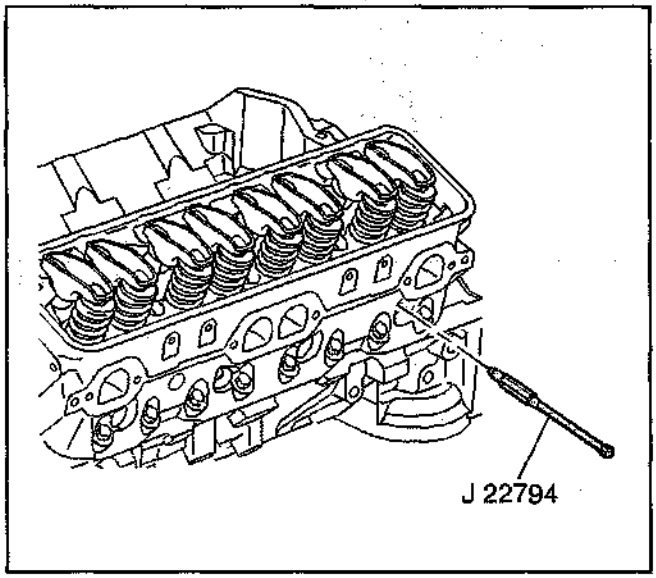
- *J 22794* Spark Plug Port Adapter
- *J 38606* Valve Spring Compressor (Head-on)
- *J 42078* Valve Stem Oil Seal Installer

1. Remove the valve rocker arms and pushrods. Refer to *Valve Rocker Arm and Push Rod Replacement*.
2. Remove the spark plug from the cylinder to be serviced.



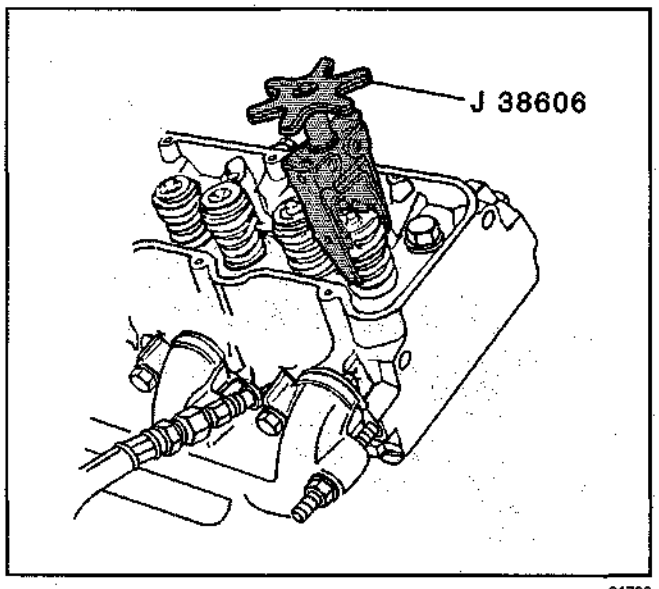
14824

3. Install the *J 22794* to the spark plug hole.
4. Attach and apply compressed air to the *J 22794* in order to retain the valves in their closed position.



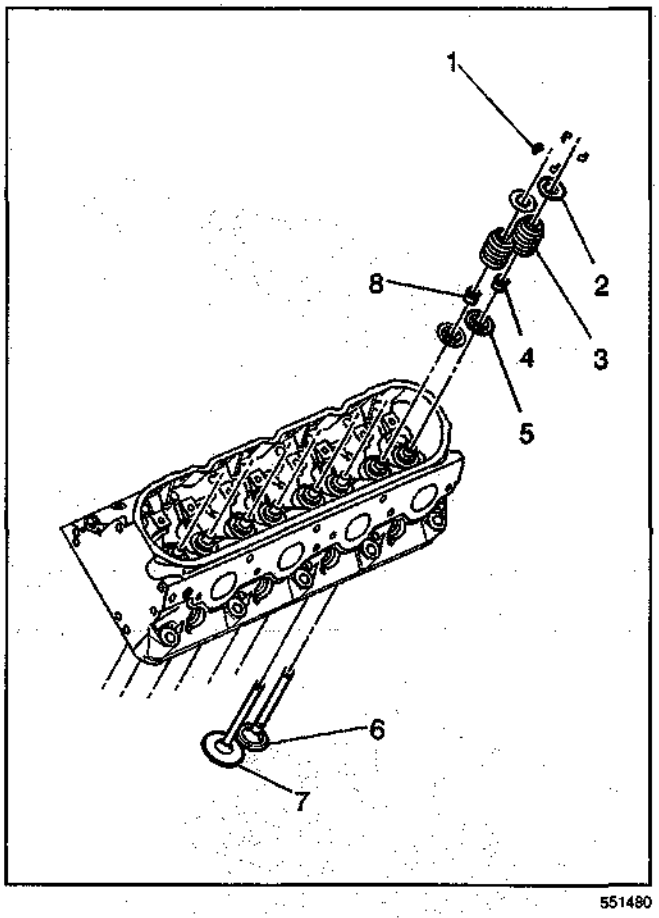
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5. Compress the valve spring (4) using *J 38606*.



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6. Remove the valve stem keys (1).
7. Release the valve spring compressor.
8. Remove the valve spring cap (2).
9. Remove the valve spring (3).
10. Remove the valve stem oil seal (4 or 8).

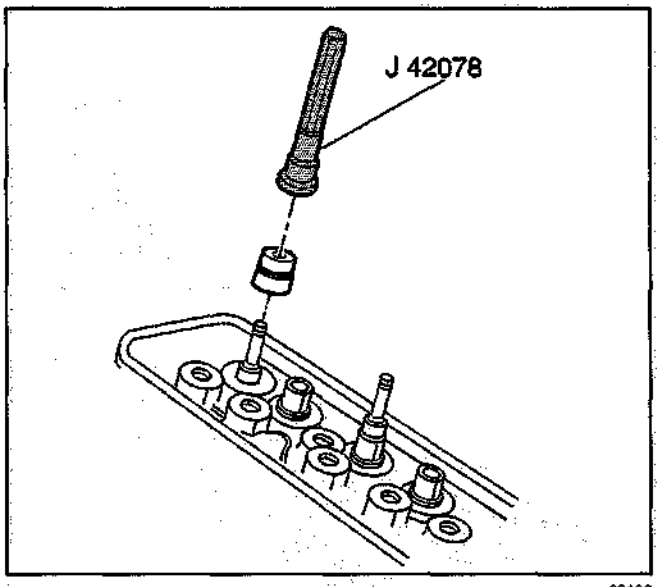
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Installation Procedure

Important: The valve stem oil seal alignment and position on the valve guide is critical.

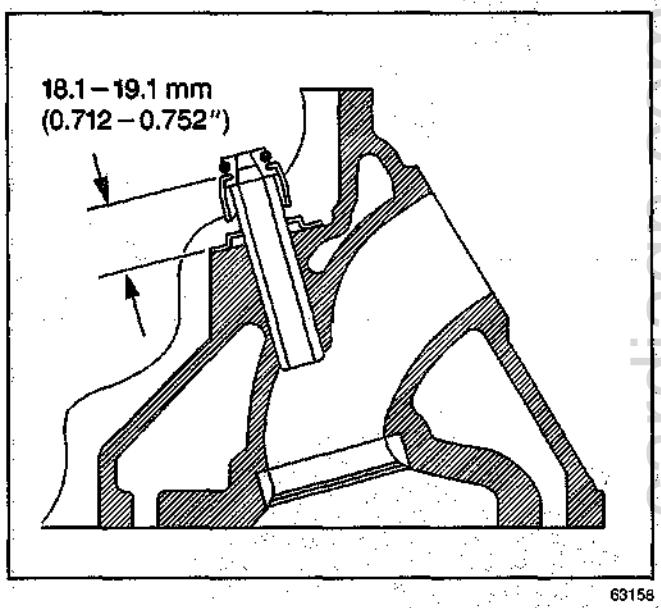
An improperly installed valve stem oil seal may lead to excessive oil consumption, increased vehicle emissions, or component damage.

1. Install the valve stem oil seal onto the guide.
   1.1. Lubricate the valve guide and valve stem oil seal with clean engine oil.
   1.2. Install the valve stem oil seal onto the valve stem.
   1.3. Using the *J 42078* Push the seal down until the seal contacts the valve guide.



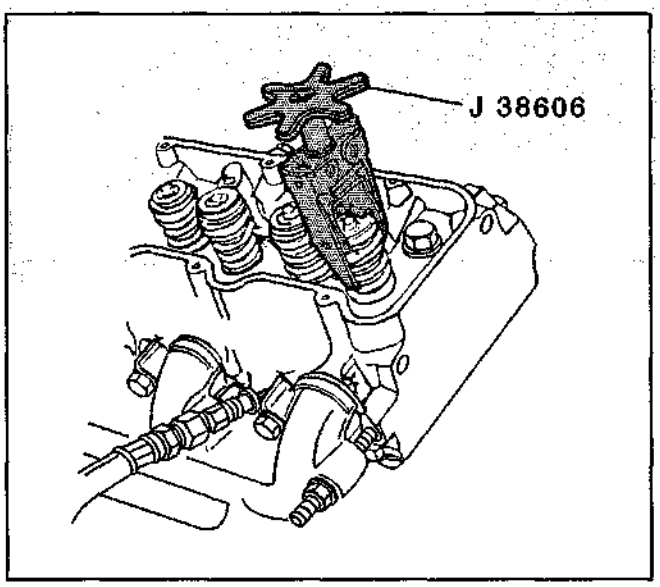
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2. Measure the valve stem oil seal for the properly installed height.
   There should be a 18.1-19.1 mm (0.712-0.752 in) gap between the top edge of the oil seal body and the shim spring seat surface.



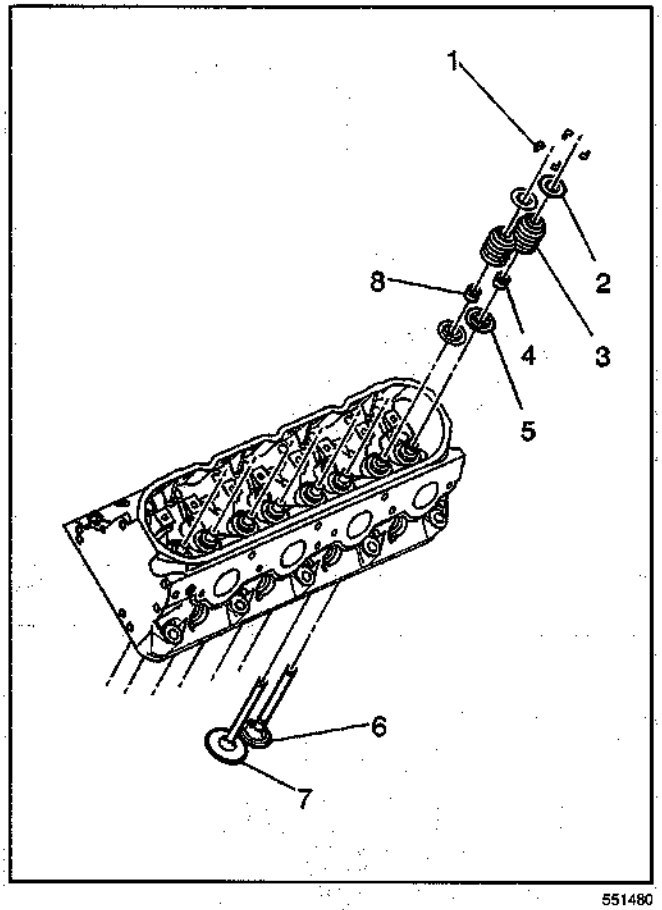
63158

3. Install the valve spring to *J 38606*.
4. Compress the valve spring using *J 38606*.



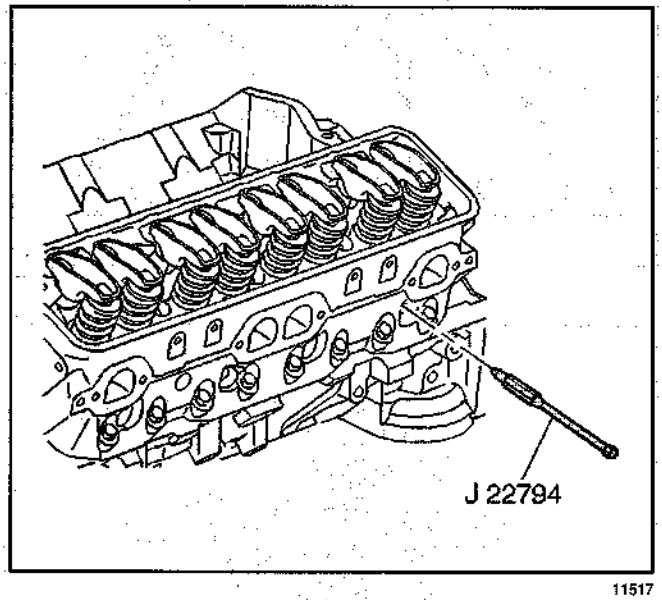
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5. Install the valve spring cap (2).
6. Install the valve stem keys (1).
   6.1. Use grease to hold the keys (1) in place and remove the *J 38606*.
   6.2. Make sure the keys (1) seat properly in the groove of the valve (10 and 12) stem.
   6.3. Tap the end to the valve (6 and 7) stem with a plastic faced hammer to seat the keys (if necessary).



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7. Disconnect and remove the air supply from *J 22794*.
8. Remove *J 22794* from the spark plug hole.

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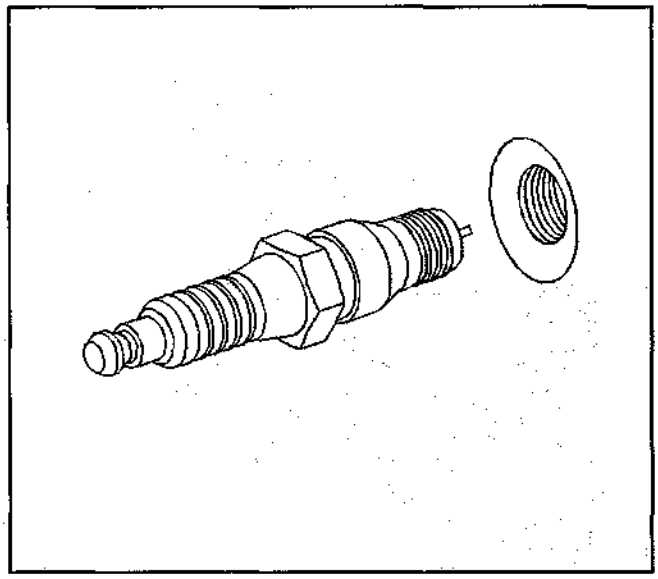
Notice: Refer to *Fastener Notice* in Cautions and Notices.

9. Install the spark plug.

   Tighten

   Tighten the spark plug to 15 N·m (11 lb ft).

10. Install the valve rocker arms, pedestal, and valve pushrods. Refer to Refer to *Valve Rocker Arm and Push Rod Replacement.*

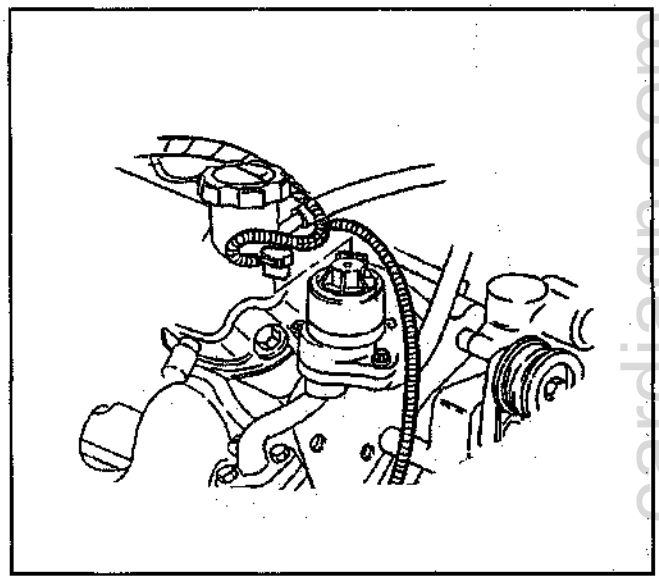


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Oil Level Indicator and Tube Replacement

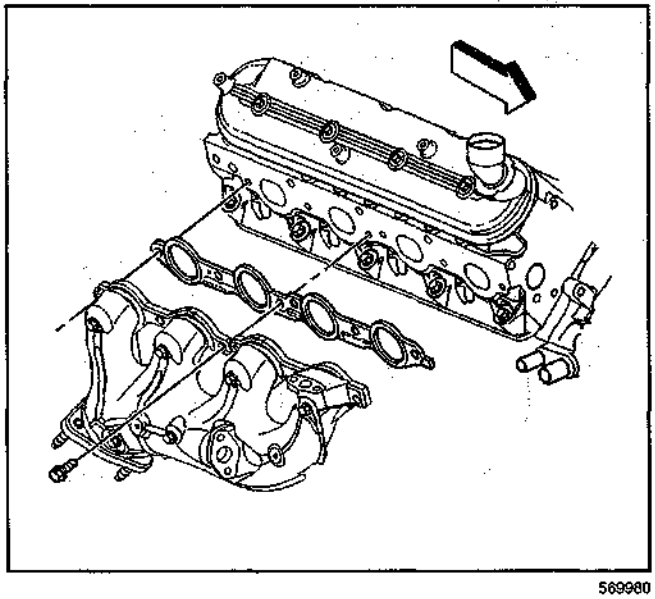
Removal Procedure

1. Disconnect the exhaust gas recirculation (EGR) solenoid electrical connector.



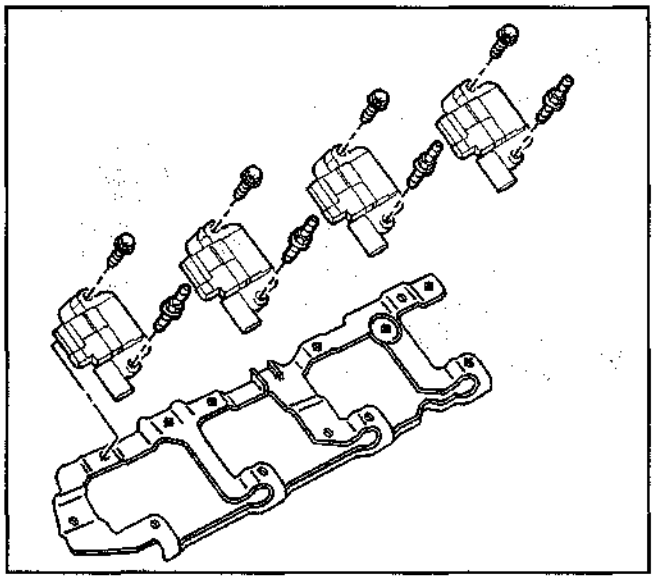
220595

2. Remove the EGR valve pipe bolts (2, 3, and 4).
3. Using mild force, pull the EGR valve pipe (1) up out of the intake manifold.
4. Remove the O-ring seal from the EGR valve pipe (1).
5. Discard the exhaust manifold gasket (5) and O-ring seal.
6. Remove the number 4 and 6 spark plug wires.



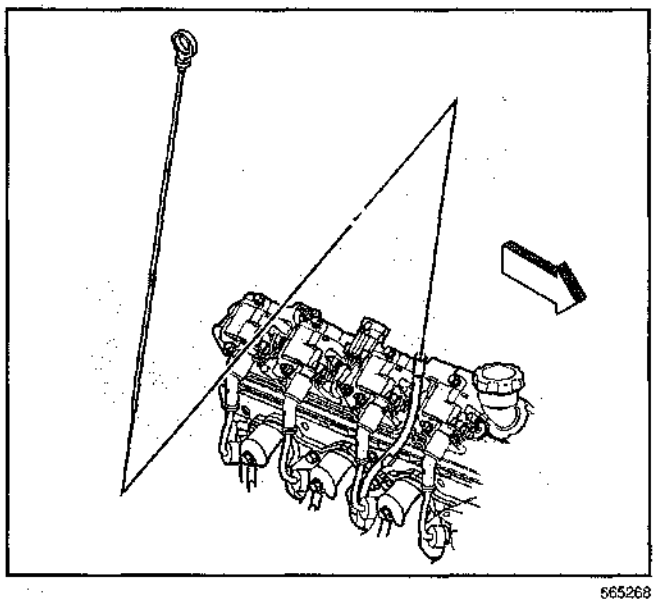
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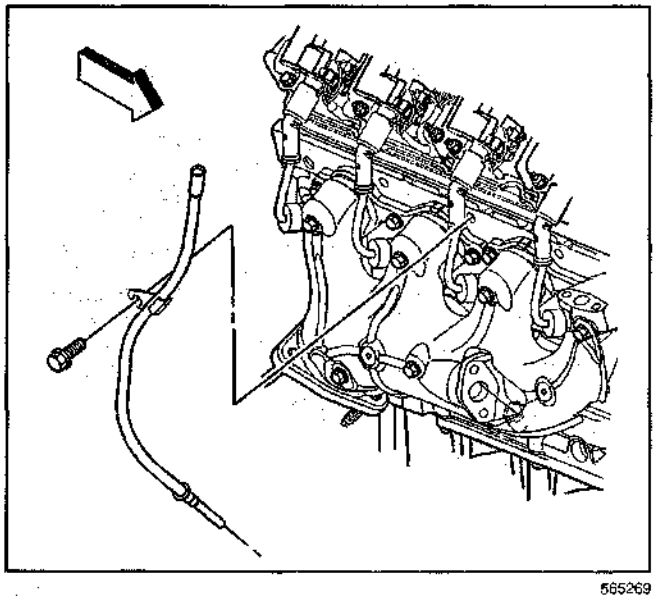
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7. Remove the number 4 and 6 ignition coils from the coil bracket.



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8. Remove the oil level indicator from the indicator tube.



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9. Remove the oil level indicator tube bolt.
10. Remove the indicator tube from the engine block.
11. Remove the O-ring from the tube.

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Installation Procedure

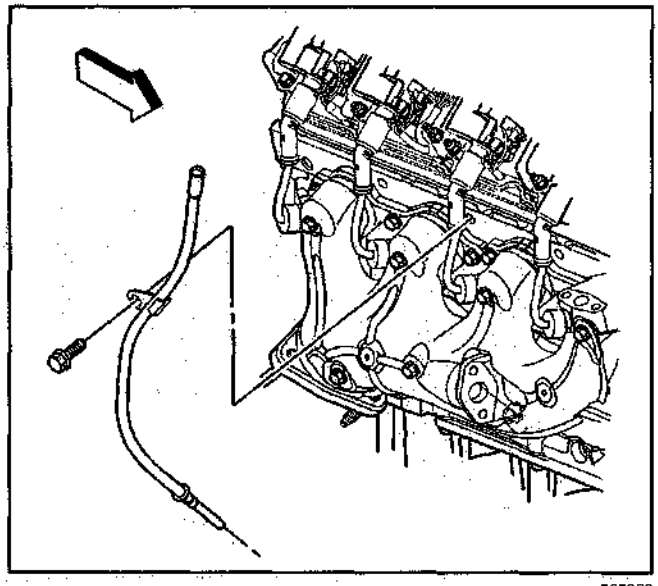
1. Clean the indicator tube.
2. Install a new O-ring to the tube.
3. Install the oil level indicator tube.
4. Rotate the tube into the proper position.

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

5. Install the oil level indicator tube bolt.

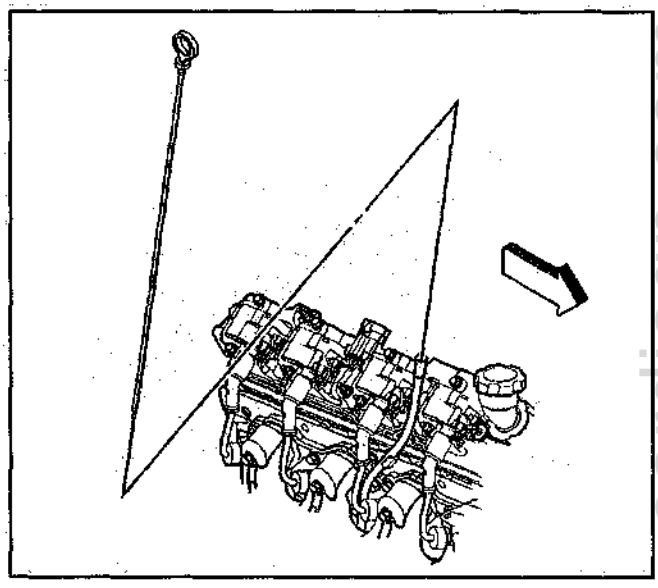
   Tighten

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



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6. Install the indicator to the indicator tube.



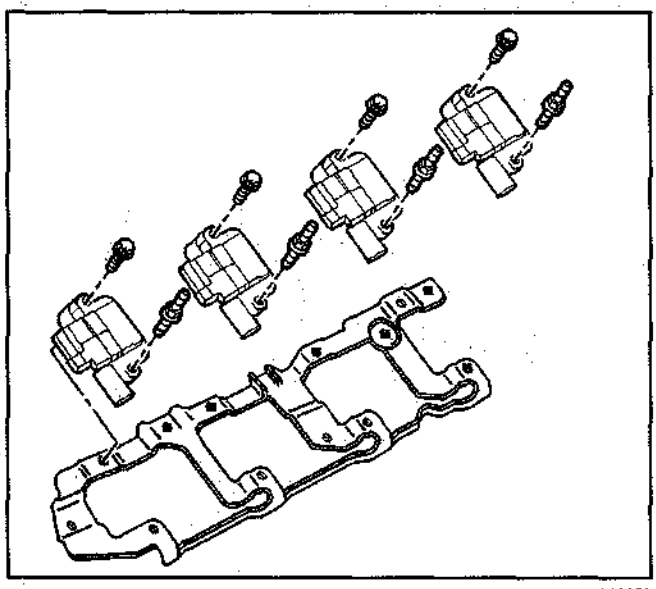
565268

7. Install the number 4 and 6 ignition coils to the coil bracket.

   Tighten

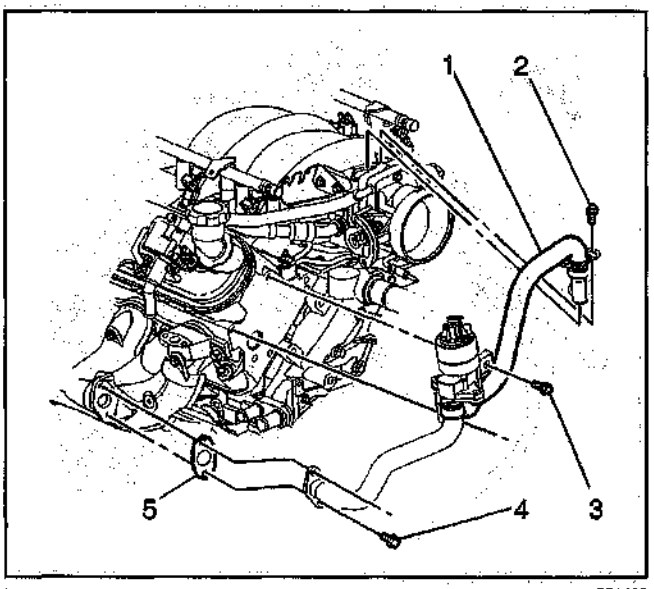
   Tighten the ignition coil bolts to 12 N·m (106 lb in).

8. Install the number 4 and 6 spark plug wires.

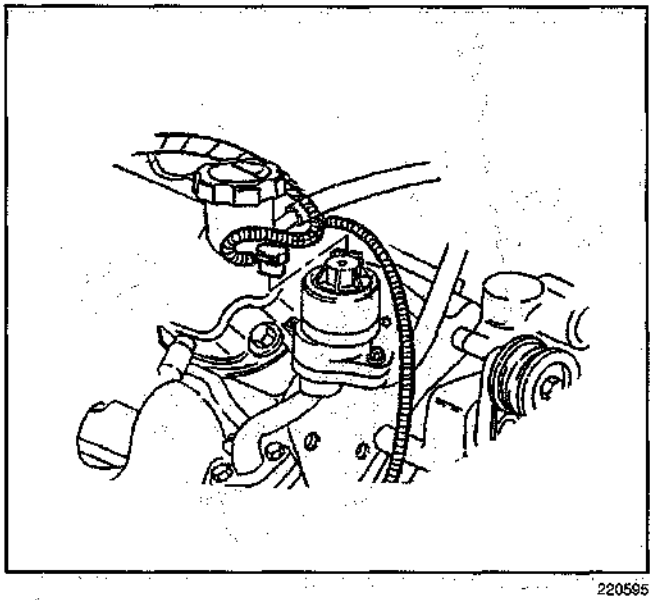


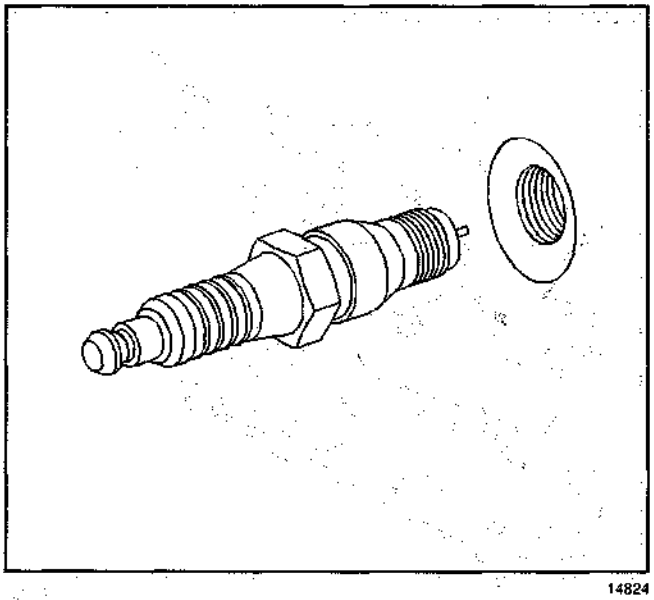
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Important: Do not reuse EGR pipe gaskets or seals during assembly, install NEW gaskets and seals.

9. Apply a light coating of clean engine oil to a NEW O-ring seal and install the seal onto the EGR valve pipe (1).
10. Install the EGR valve pipe (1) into the intake manifold.
11. Finger start the EGR valve pipe (1) to intake manifold bolt (2).
12. Finger start the EGR valve pipe (1) to cylinder head bolts (3).
13. Finger start a NEW EGR valve pipe exhaust manifold gasket (5) and bolts (4).
    Tighten
    13.1. Tighten the EGR valve pipe to intake manifold bolt (2) to 10 N·m (89 lb in).
    13.2. Tighten the EGR valve pipe to cylinder head bolts (3) to 50 N·m (37 lb ft).
    13.3. Tighten the EGR valve pipe to the exhaust manifold bolts (4) to 30 N·m (22 lb ft).
14. Connect the EGR solenoid electrical connector.

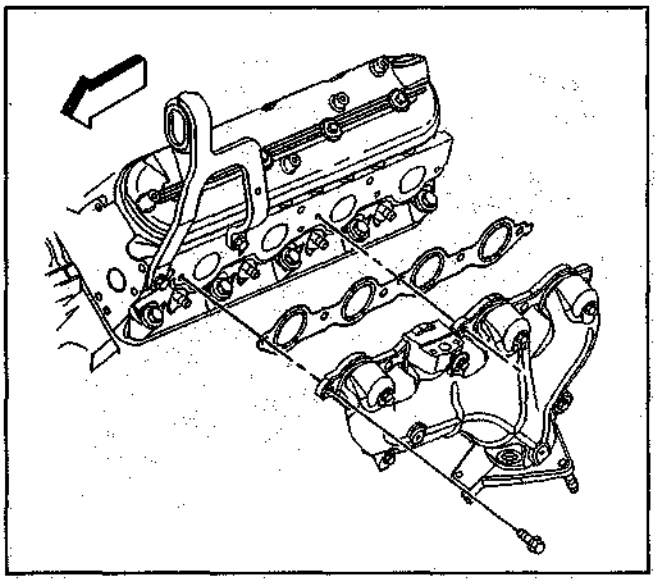
Exhaust Manifold Replacement (Left)

Removal Procedure

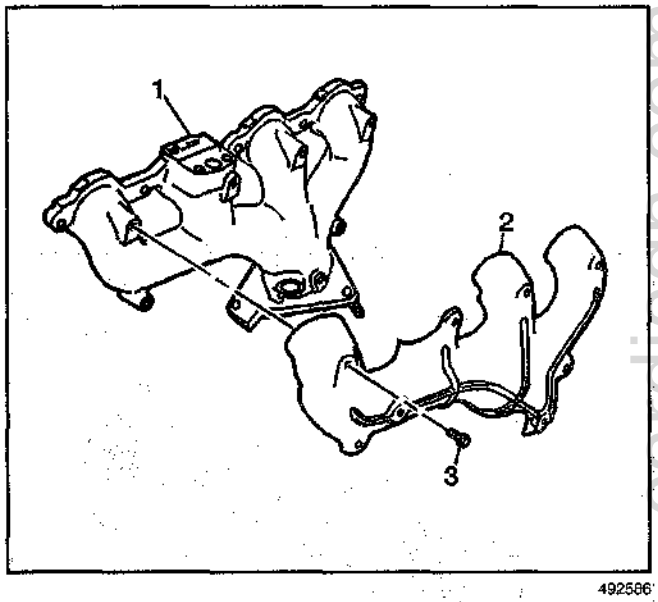
1. Remove the left valve rocker arm cover. Refer to *Valve Rocker Arm Cover Replacement (Left)*.
2. Remove the spark plugs.
3. Raise and suitably support the vehicle. Refer to *Lifting and Jacking the Vehicle* in General Information.
4. Remove the left side catalytic converter. Refer to *Oxidation Catalytic Converter Replacement (5.7 L Left)* in Engine Exhaust.

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5. Remove the left exhaust manifold bolts.
6. Remove the left exhaust manifold and gasket.
7. Discard the gasket.


569981

8. Remove the heat shield bolts (3) and heat shield (2) from the manifold (1), if required.



492586

Installation Procedure

Important: Tighten the exhaust manifold bolts as specified in the service procedure. Improperly installed and/or leaking exhaust manifold gaskets may effect vehicle emissions and/or on-board diagnostic (OBD) II system performance.

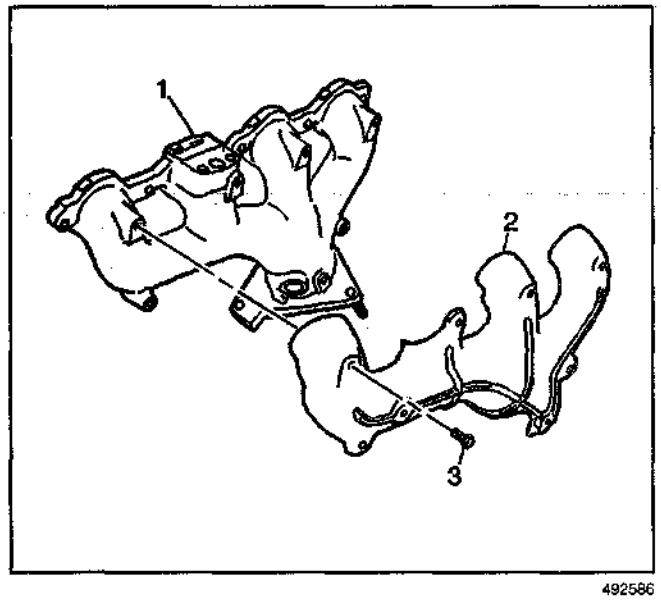
The cylinder head exhaust manifold bolt hole threads must be clean and free of debris and/or threadlocking material.

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

1. Install the heat shield (2) and heat shield bolts (3) to the manifold (1), if required.

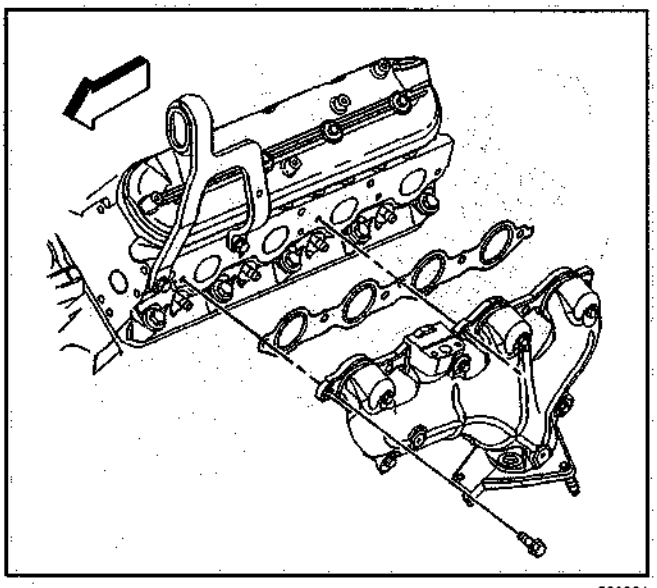
   Tighten

   Tighten the heat shield bolts (3) to 9 N·m (80 lb in).

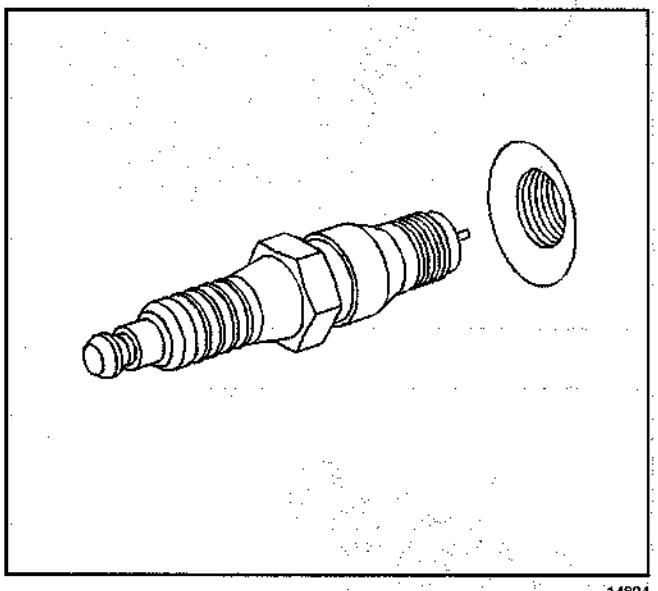


492586

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569981



14824

Important: Do not apply threadlock to the first three threads of the exhaust manifold bolts.

2. Apply a 5 mm (0.2 in) wide band of threadlock GM P/N 12345493 or equivalent to the threads of the exhaust manifold bolts.
3. Install a NEW exhaust manifold gasket and the exhaust manifold.
4. Install the exhaust manifold bolts.

   Tighten

   4.1. Tighten the exhaust manifold bolts a first pass to 15 N·m (11 lb ft). Tightening 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 25 N·m (18 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 cylinder head.
6. Install the left side catalytic converter. Refer to *Oxidation Catalytic Converter Replacement (5.7 L Left)* in Engine Exhaust.
7. Lower the vehicle.
8. Install the spark plugs.

   Tighten

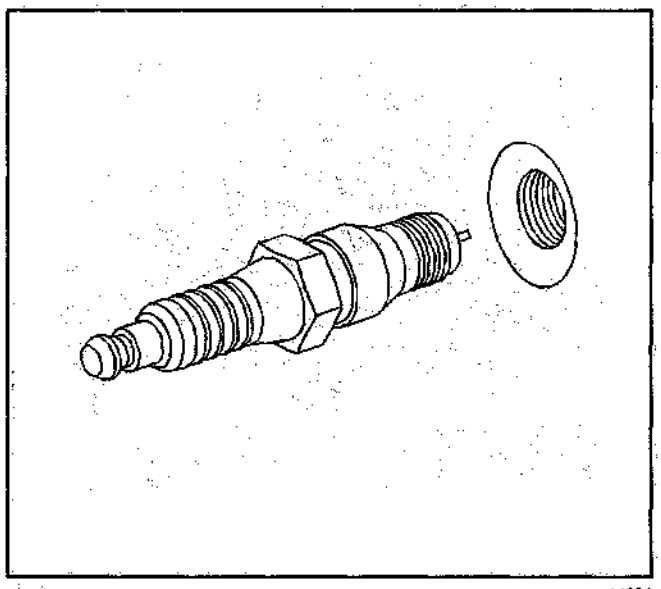
   Tighten the spark plugs to 15 N·m (11 lb ft).
9. Install the left valve rocker arm cover. Refer to *Valve Rocker Arm Cover Replacement (Left)*.

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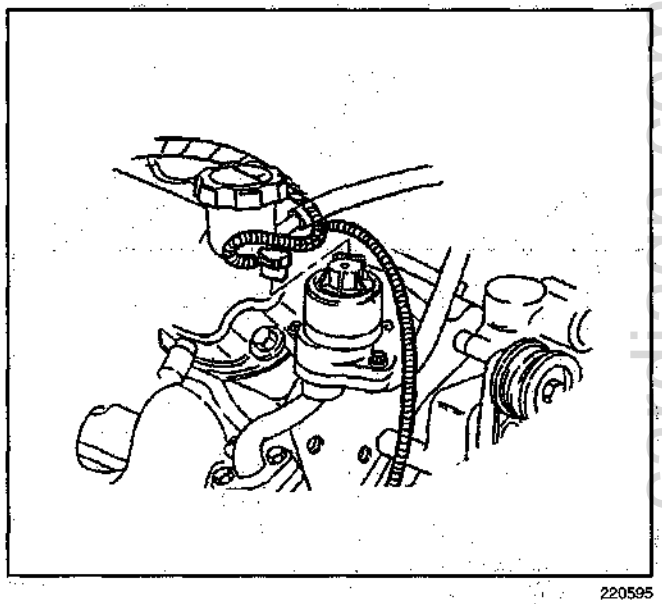
Exhaust Manifold Replacement (Right)

Removal Procedure

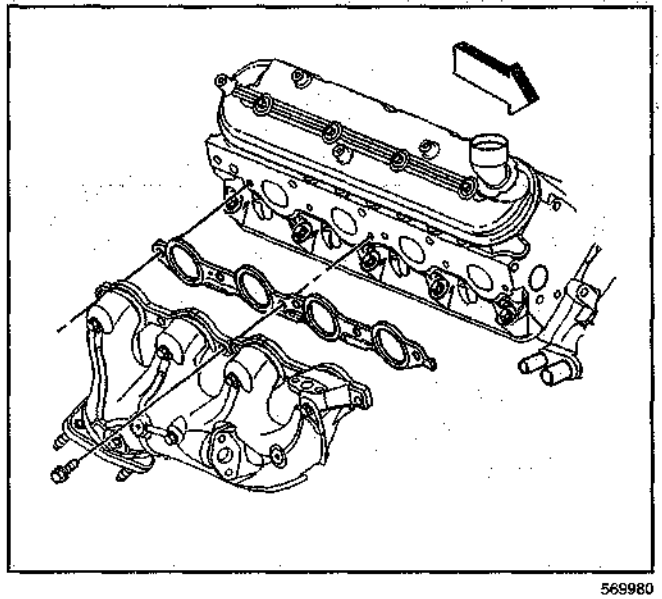
1. Remove the valve rocker arm cover. Refer to *Valve Rocker Arm Cover Replacement (Right).*
2. Remove the right side catalytic converter. Refer to *Oxidation Catalytic Converter Replacement (5.7 L Right).*
3. Remove the spark plugs.


14824

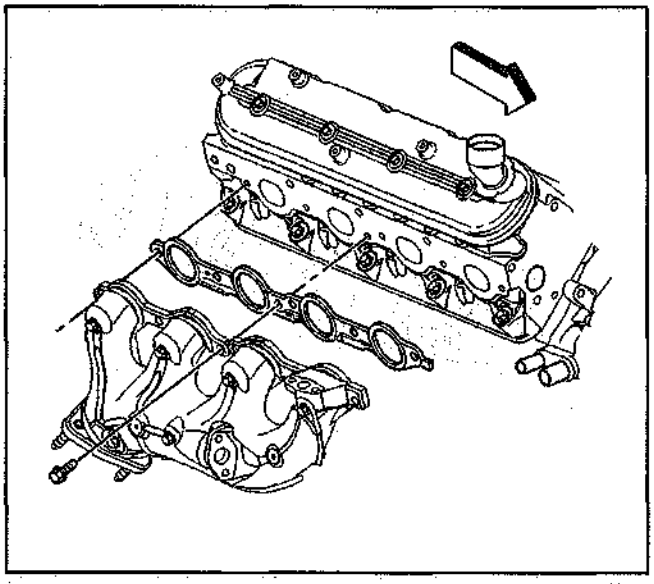
4. Disconnect the exhaust gas recirculation (EGR) valve electrical connector.


220595

5. Remove the EGR valve pipe bolts (2, 3, and 4).
6. Using mild force, pull the EGR valve pipe (1) up out of the intake manifold.
7. Remove the O-ring seal from the EGR valve pipe (1).
8. Discard the exhaust manifold gasket (5) and O-ring seal.

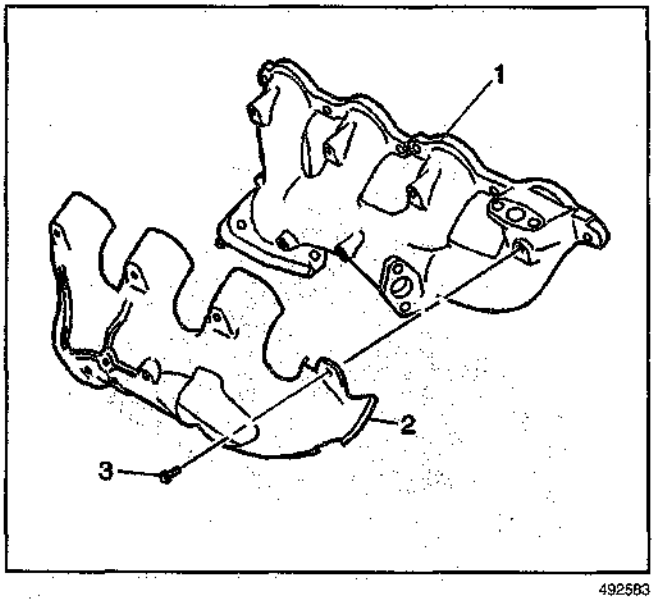

569980

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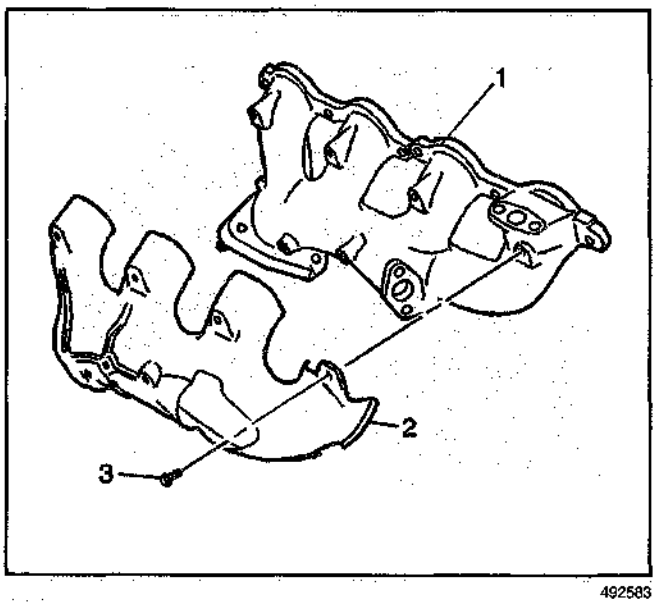
569980

9. Remove the left exhaust manifold bolts.
10. Remove the left exhaust manifold and gasket.
11. Discard the gasket.



492583

12. Remove the heat shield bolts (3) and heat shield (2) from the manifold (1), if required.



492583

Installation Procedure

Important: Tighten the exhaust manifold bolts as specified in the service procedure. Improperly installed and/or leaking exhaust manifold gaskets may effect vehicle emissions and/or on-board diagnostics (OBD) II system performance.

The cylinder head exhaust manifold bolt hole threads must be clean and free of debris and/or threadlocking material.

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

1. Install the heat shield (2) and heat shield bolts (3) to the manifold (1), if required.

   Tighten

   Tighten the heat shield bolts (3) to 9 N·m (80 lb in).

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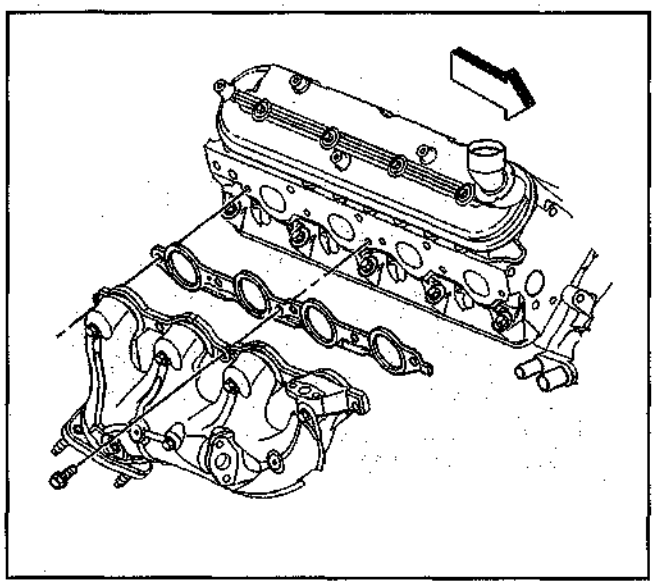
Important: Do not apply threadlock to the first three threads of the exhaust manifold bolts.

2. Apply a 5 mm (0.2 in) wide band of threadlock GM P/N 12345493 or equivalent to the threads of the exhaust manifold bolts.
3. Install a NEW exhaust manifold gasket and the exhaust manifold.
4. Install the exhaust manifold bolts.

   Tighten

   4.1. Tighten the exhaust manifold bolts a first pass to 15 N·m (11 lb ft). Tightening 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 25 N·m (18 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 cylinder head.



569980

Important: Do not reuse EGR pipe gaskets or seals during assembly. Install NEW gaskets and seals.

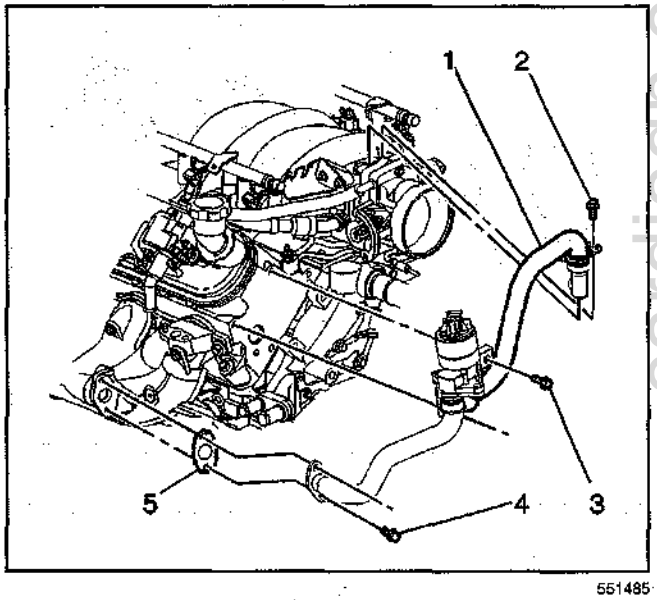
6. Apply a light coating of clean engine oil to a NEW O-ring seal and install the seal onto the EGR valve pipe (1).
7. Install the EGR valve pipe (1) into the intake manifold.
8. Finger start the EGR valve pipe (1) to intake manifold bolt (2).
9. Finger start the EGR valve pipe (1) to cylinder head bolts (3).
10. Finger start a NEW EGR valve pipe exhaust manifold gasket (5) and bolts (4).

    Tighten

    10.1. Tighten the EGR valve pipe to intake manifold bolt (2) to 10 N·m (89 lb in).

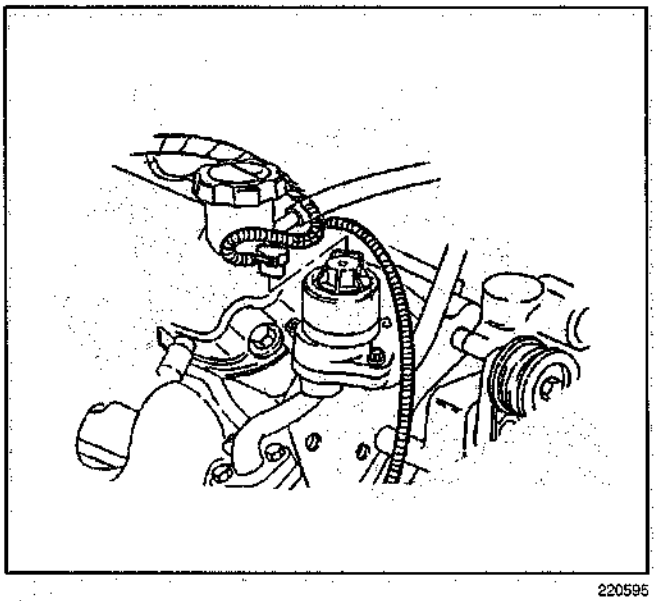
    10.2. Tighten the EGR valve pipe to cylinder head bolts (3) to 50 N·m (37 lb ft).

    10.3. Tighten the EGR valve pipe to the exhaust manifold bolts (4) to 30 N·m (22 lb ft).



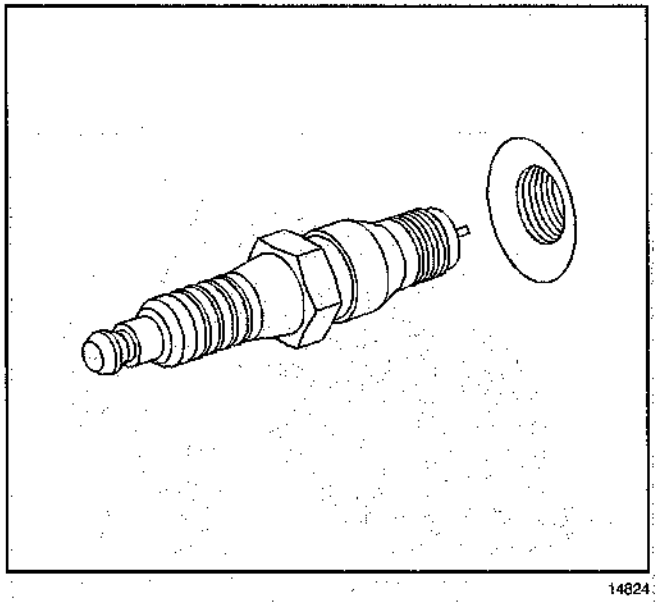
551485

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220595

11. Connect the EGR valve electrical connector.

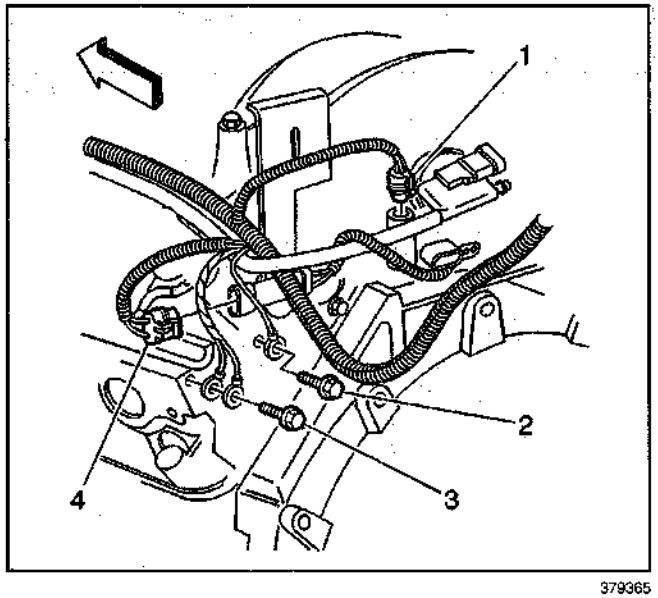


14824

12. Install the spark plugs.

    Tighten

    Tighten the spark plugs to 15 N·m (11 lb ft).
13. Install the right side catalytic converter. Refer to *Oxidation Catalytic Converter Replacement (5.7 L Right)*.
14. Install the valve rocker arm cover. Refer to *Valve Rocker Arm Cover Replacement (Right)*.



379365

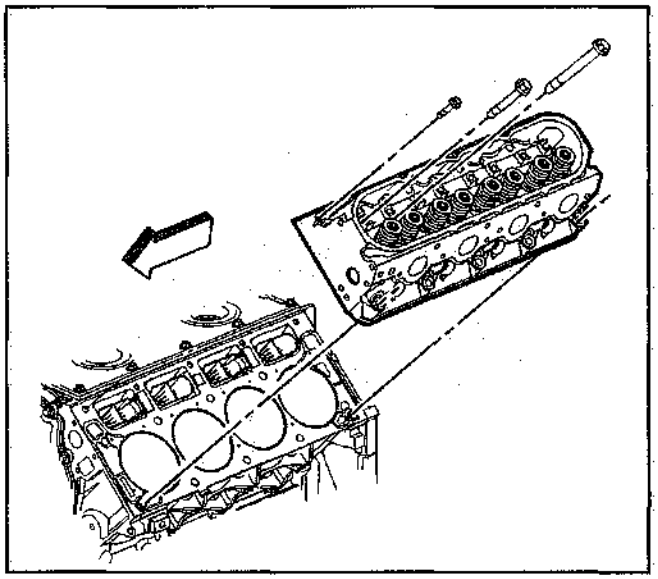
Cylinder Head Replacement (Left)

Removal Procedure

1. Remove the engine coolant air bleed pipe. Refer to *Vapor Vent Pipe Replacement*.
2. Remove the power steering pump rear bracket. Refer to *Power Steering Pump Rear Bracket Replacement* in Power Steering System.
3. Remove the left side exhaust manifold. Refer to *Exhaust Manifold Replacement (Left)*.
4. Remove the valve rocker arms and pushrods. Refer to *Valve Rocker Arm and Push Rod Replacement*.
5. Remove the harness ground bolts (2 and 3) from the rear of the cylinder head.

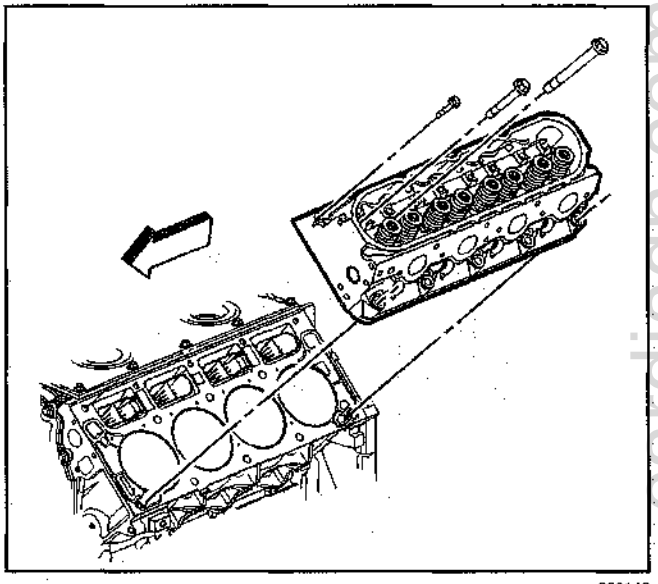
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6. Remove the left side cylinder head. Refer to *Cylinder Head Removal (Left Side)*.


260146

Installation Procedure

1. Install the left side cylinder head. Refer to *Cylinder Head Installation (Left Side)*.


260146

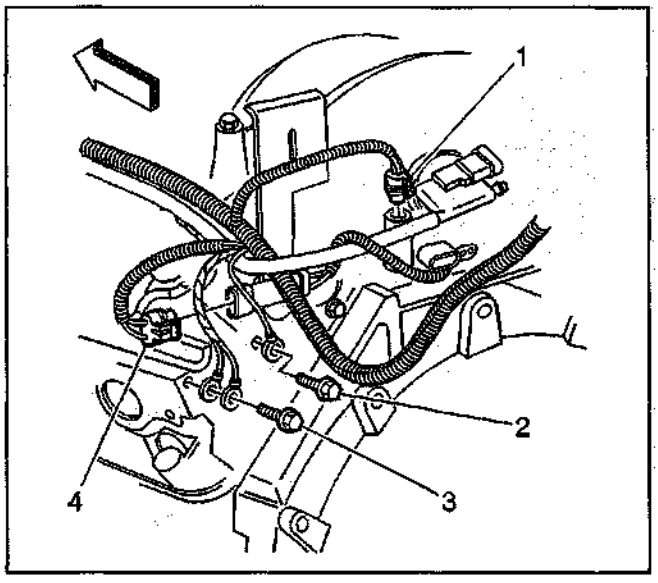
Notice: Refer to *Fastener Notice* in Cautions and Notices.

2. Install the harness ground bolts to the cylinder head.

   Tighten

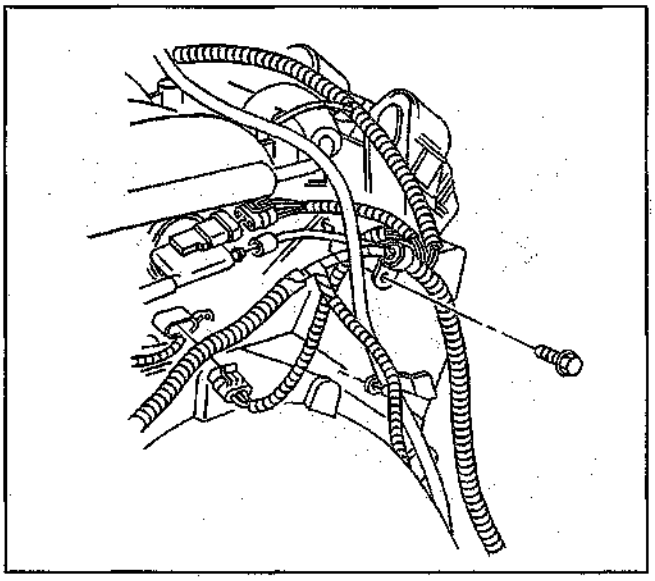
   Tighten the harness ground bolts (2 and 3) to 50 N·m (37 lb ft).

3. Install the valve rocker arms and pushrods. Refer to *Valve Rocker Arm and Push Rod Replacement*.
4. Install the left side exhaust manifold. Refer to *Exhaust Manifold Replacement (Left)*.
5. Install the power steering pump rear bracket. Refer to *Power Steering Pump Rear Bracket Replacement* in Power Steering.
6. Install the engine coolant air bleed pipe. Refer to *Vapor Vent Pipe Replacement*.



379365

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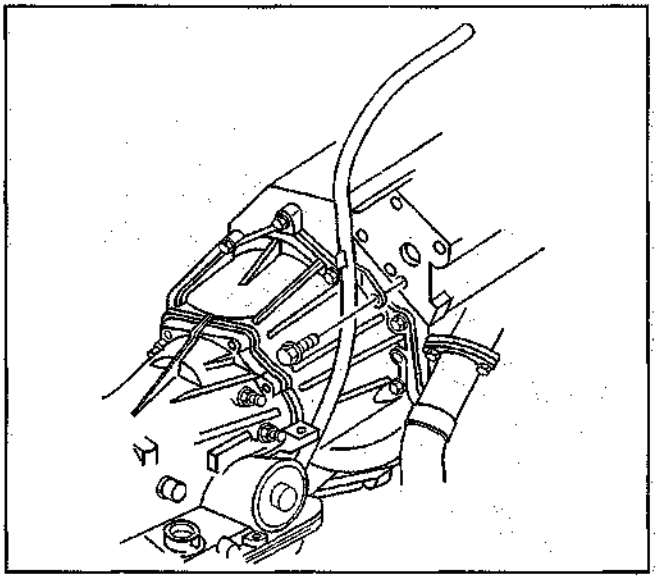


346049

Cylinder Head Replacement (Right)

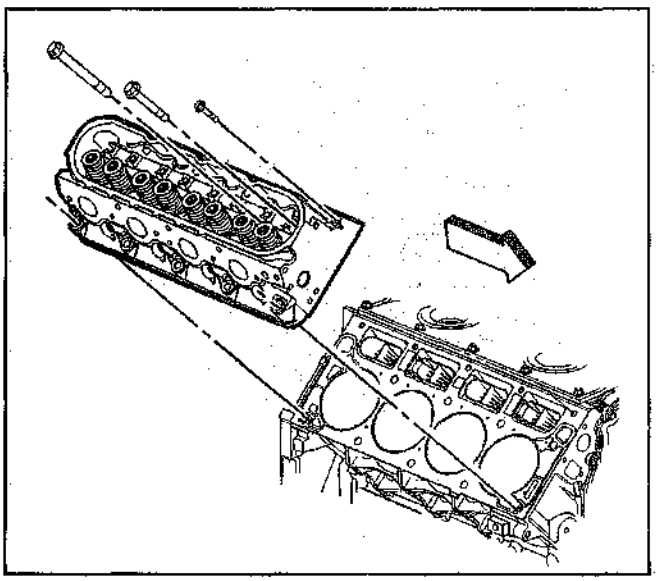
Removal Procedure

1. Remove the engine coolant air bleed pipe. Refer to *Vapor Vent Pipe Replacement.*
2. Remove the right side exhaust manifold. Refer to *Exhaust Manifold Replacement (Right).*
3. Remove the valve rocker arms and pushrods. Refer to *Valve Rocker Arm and Push Rod Replacement.*
4. Remove the engine wiring harness clip bolt from the cylinder head.



208459

5. Remove the transmission fill tube bolt from the cylinder head.



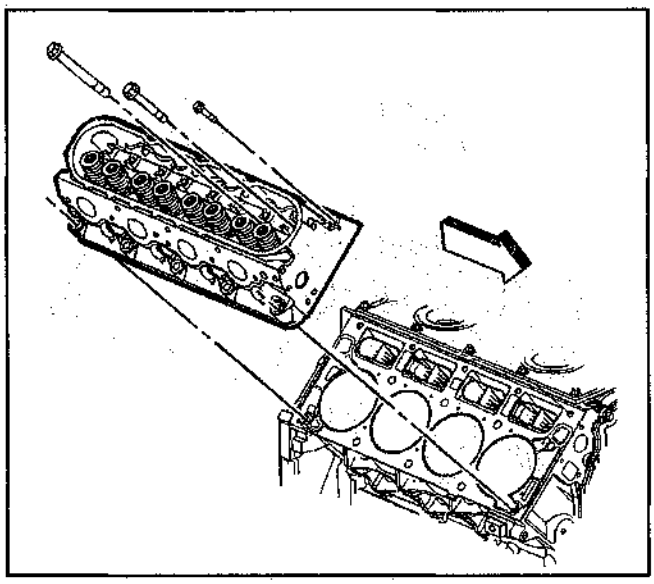
260149

6. Remove the right side cylinder head. Refer to *Cylinder Head Removal (Right Side).*

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Installation Procedure

1. Install the right side cylinder head. Refer to *Cylinder Head Installation (Right Side)*.



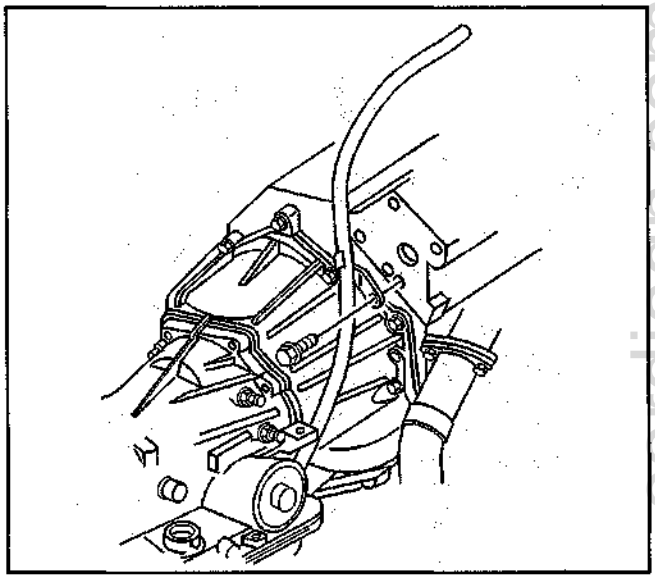
260149

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

2. Install the transmission fill tube bolt to the cylinder head.

   Tighten

   Tighten the transmission fill tube bolt to 47 N·m (35 lb ft).



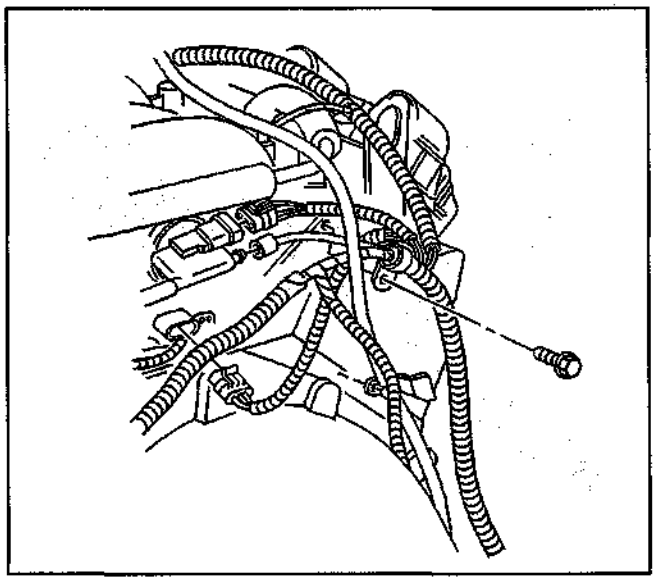
208459

3. Install the engine wiring harness clip bolt to the rear of the cylinder head.

   Tighten

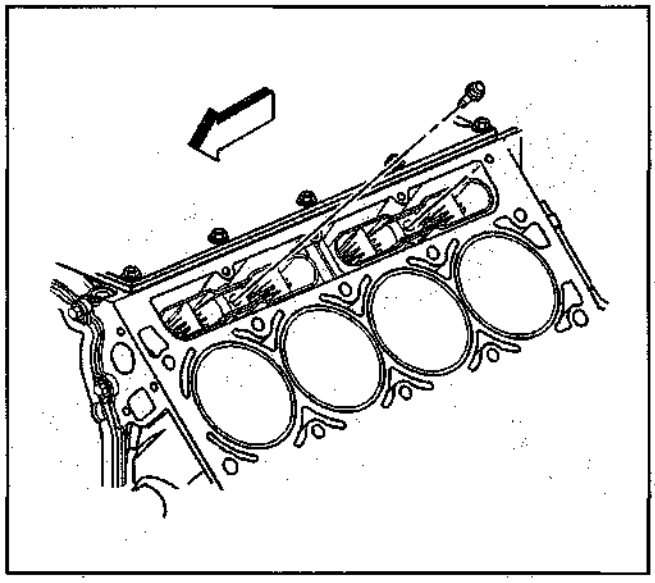
   Tighten the engine wiring harness clip bolt to 50 N·m (37 lb ft).

4. Install the valve rocker arms and pushrods. Refer to *Valve Rocker Arm and Push Rod Replacement*.
5. Install the right side exhaust manifold. Refer to *Exhaust Manifold Replacement (Right)*.
6. Install the engine coolant air bleed pipe. Refer to *Vapor Vent Pipe Replacement*.



346049

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551476

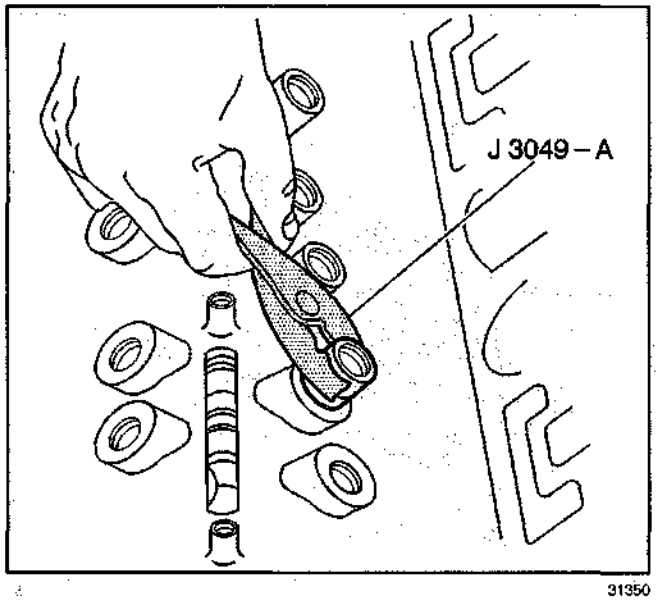
Valve Lifter Replacement

Removal Procedure

Tools Required

J 3049-A Valve Lifter Remover

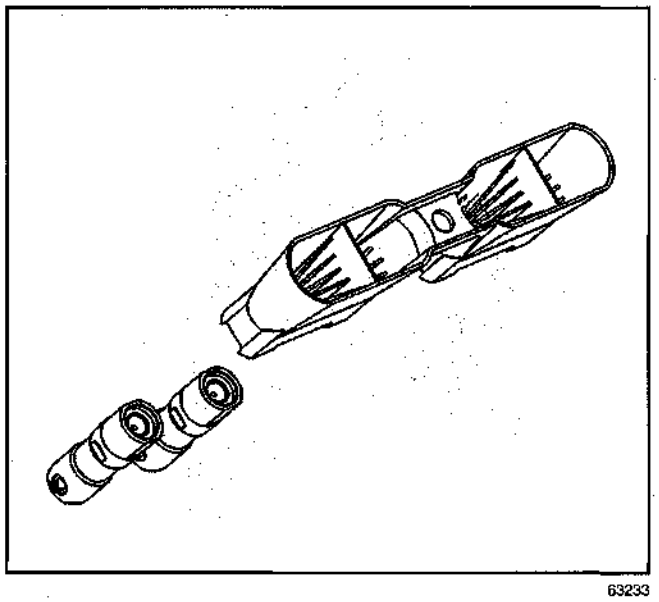
1. Remove the cylinder head. Refer to *Cylinder Head Replacement (Right)* or *Cylinder Head Replacement (Left)*.
2. Remove the valve lifter guide bolt.
3. Remove the valve lifter guide.



31350

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

4. Use the *J 3049-A* or equivalent to remove the valve lifters, if required.



63233

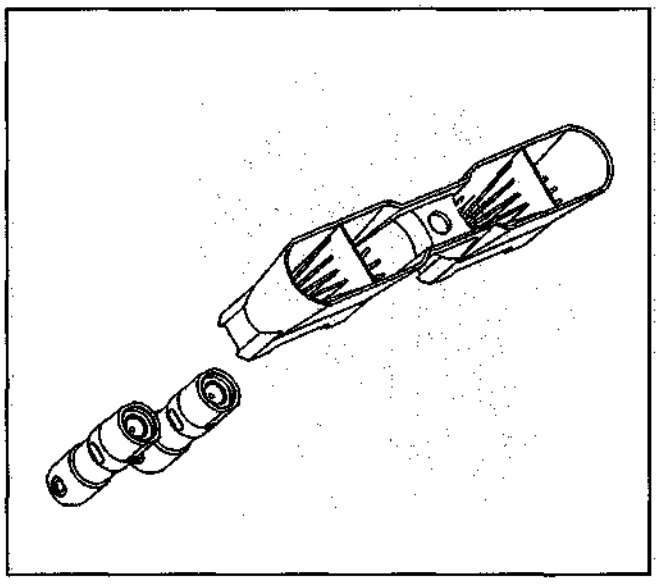
5. Remove the valve lifters from the lifter guide, if necessary.
6. Organize or mark the lifters so that they can be installed in the same location from which they were removed.

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Installation Procedure

Important: When reusing lifters, install the lifters in their original locations.

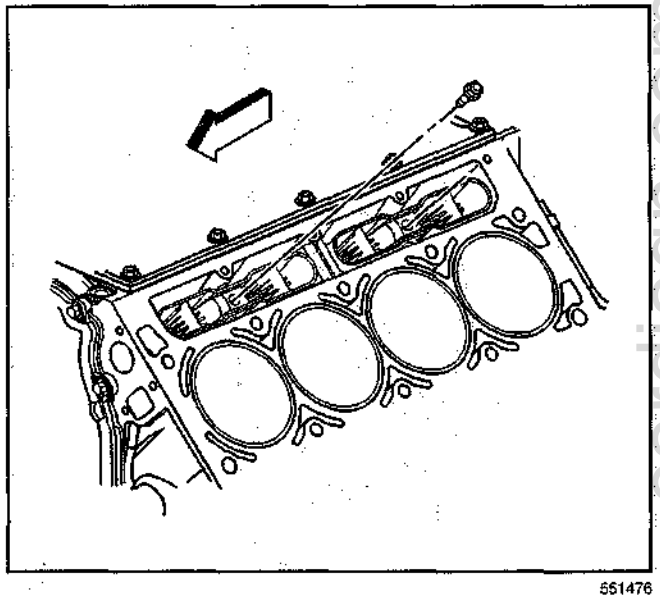
1. Lubricate the valve lifters and engine block lifter bores with clean engine oil.
2. Insert the lifter into the lifter guides.
   Align the flat area on top of the lifter with the flat area in the lifter guide bore. Push the lifter completely into the guide bore.


63233

3. Install the lifters and guide to the engine block.

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

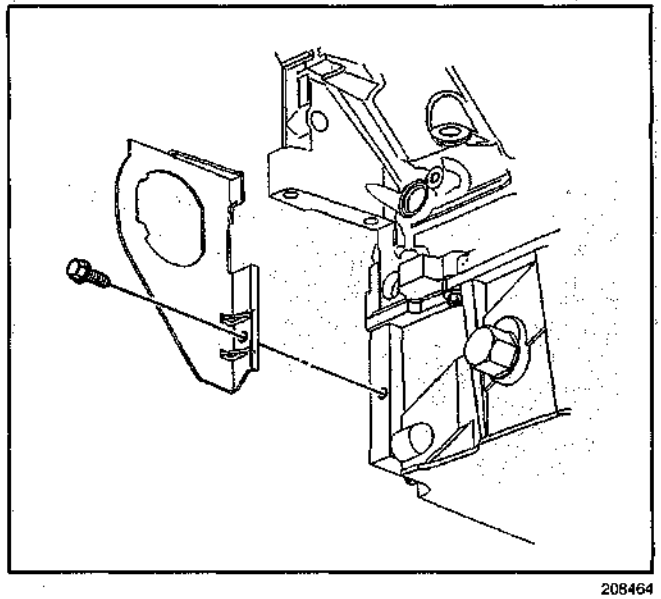
4. Install the lifter guide bolt.
   Tighten
   Tighten the lifter guide bolt to 12 N·m (106 lb in).
5. Install the cylinder head. Refer to *Cylinder Head Replacement (Right)* or *Cylinder Head Replacement (Left)*.


551476

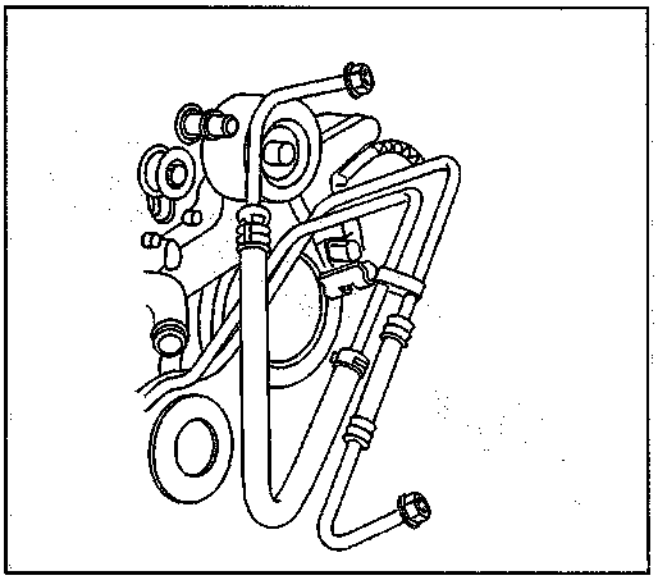
Crankshaft Balancer Replacement

Removal Procedure

1. Remove the air conditioning (A/C) drive belt. Refer to *Drive Belt Replacement - A/C*.
2. Raise and suitably support the vehicle. Refer to *Lifting and Jacking the Vehicle* in General Information.
3. Remove the starter motor. Refer to *Starter Motor Replacement (5.7 L)* in Engine Electrical.
4. Remove the right closeout cover and bolt.

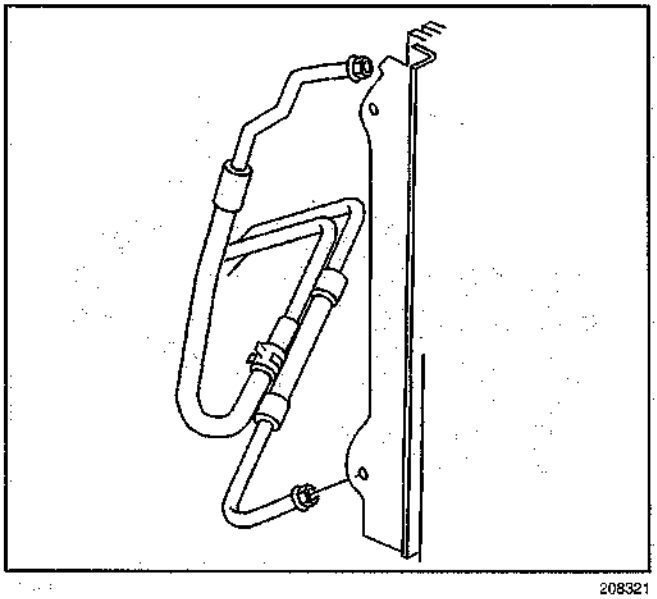

208464

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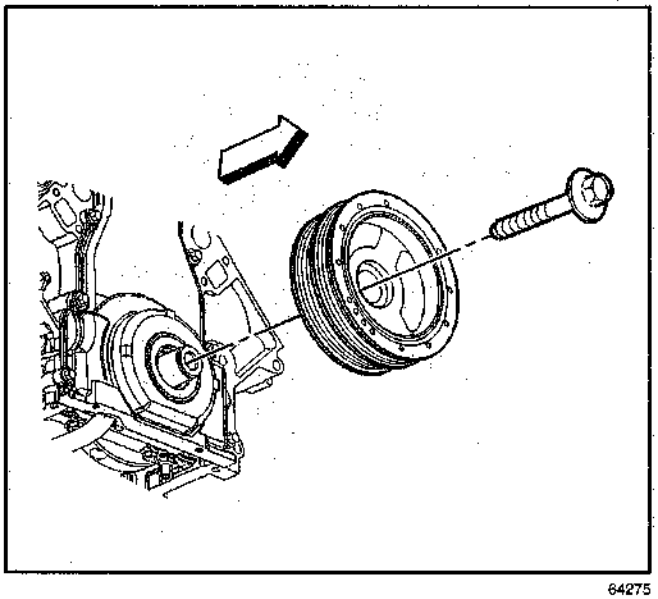
341084

5. Unsnap the oil cooler lines from the clip at the generator.



208321

6. Remove the transmission oil cooler lines from the radiator.
7. Remove the power steering cooler, if equipped. Refer to *Power Steering Cooler Pipe/Hose Replacement* in Steering.



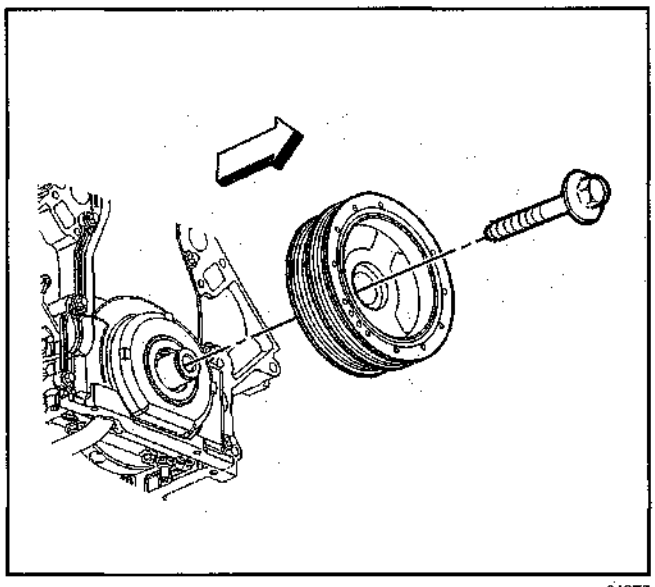
64275

8. Remove the crankshaft balancer. Refer to *Crankshaft Balancer Removal.*

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Installation Procedure

1. Install the crankshaft balancer. Refer to *Crankshaft Balancer Installation*.
2. Install the power steering cooler, if removed. Refer to *Power Steering Cooler Pipe/Hose Replacement* in Steering.



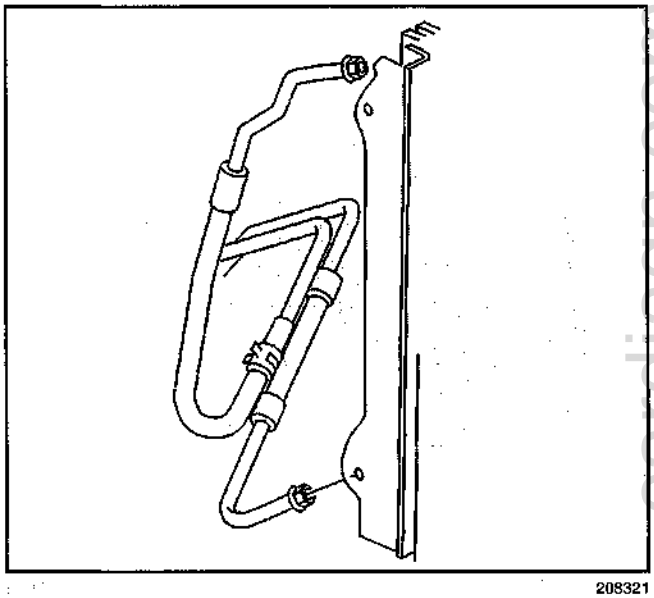
64275

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

3. Install the transmission oil cooler lines to the radiator.

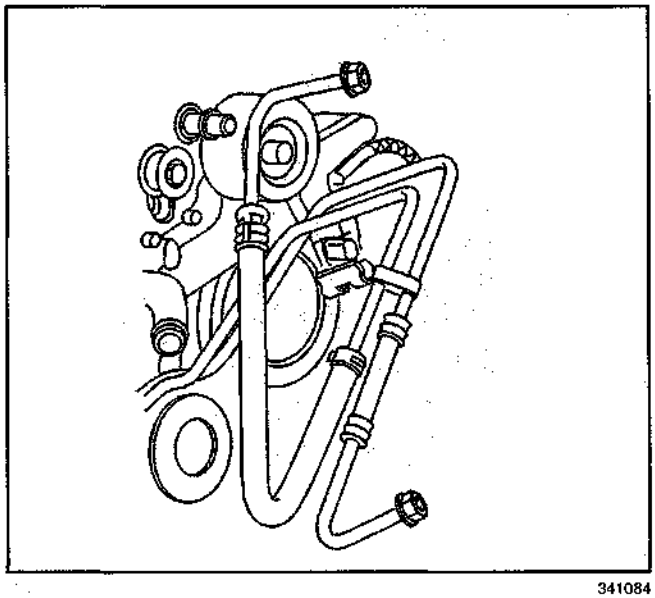
   Tighten

   Tighten the oil cooler line connections to 27 N·m (20 lb ft).



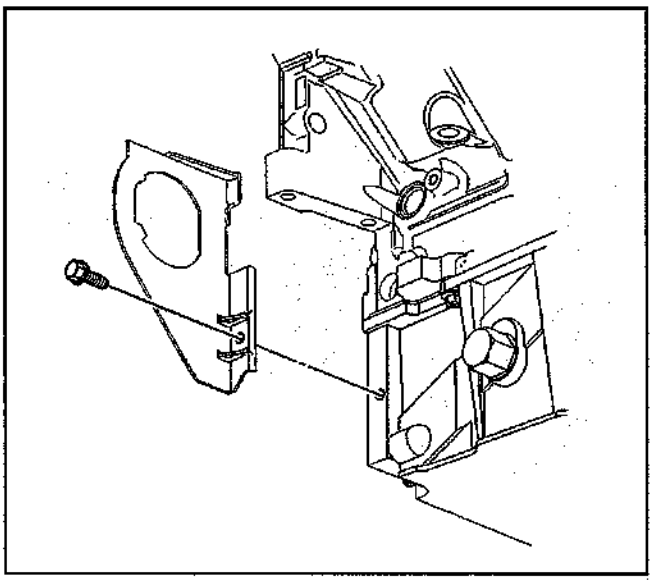
208321

4. Snap the oil cooler lines into the clip at the generator.



341084

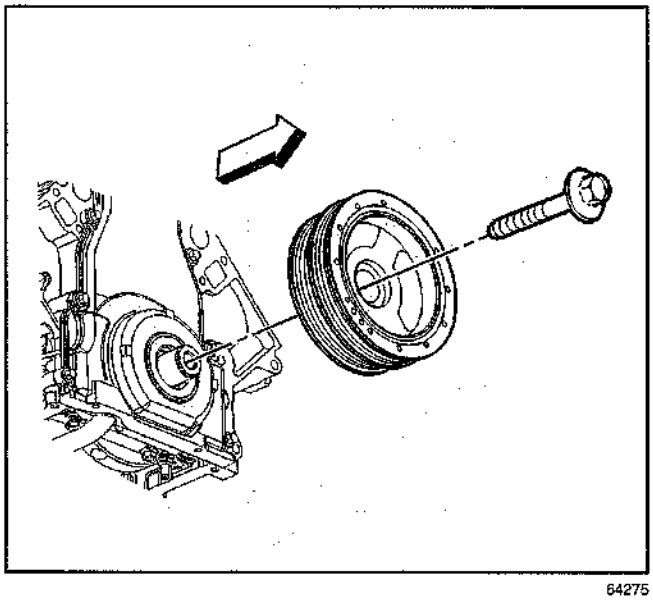
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208464

5. Install the right closeout cover and bolt.

   Tighten

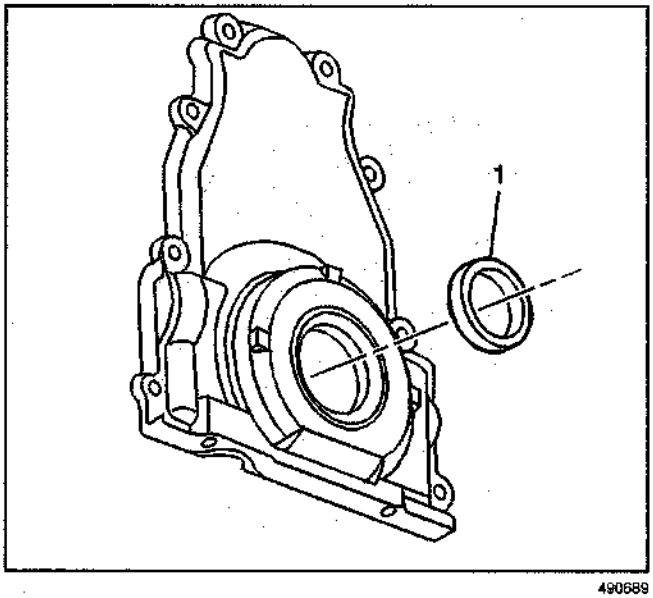
   Tighten the closeout cover bolt to 12 N·m (106 lb in).
6. Install the starter motor. Refer to *Starter Motor Replacement (5.7 L)* in Engine Electrical.
7. Lower the vehicle.
8. Install the A/C drive belt. Refer to *Drive Belt Replacement - A/C.*
9. Perform the crankshaft postion (CKP) system variation learn procedure. Refer to *CKP System Variation Learn Procedure* in Engine Controls - 5.7 L.


64275

Crankshaft Front Oil Seal Replacement

Removal Procedure

1. Remove the crankshaft balancer. Refer to *Crankshaft Balancer Replacement.*
2. Pry the crankshaft oil seal out from the front cover.



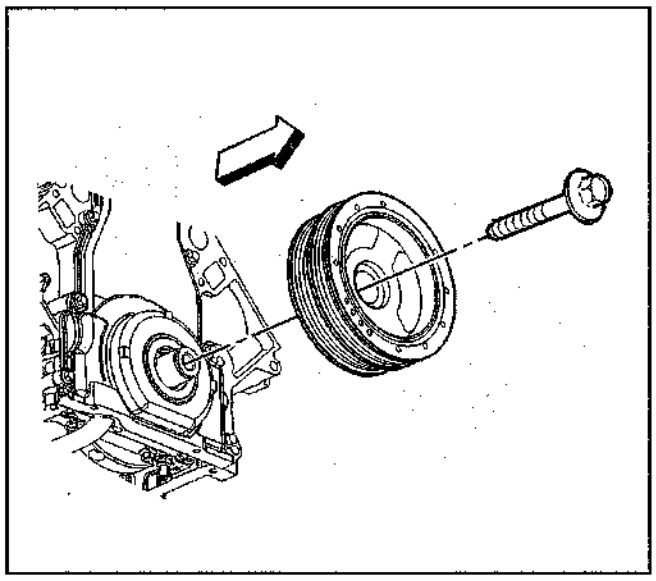
490689

Installation Procedure

1. Install a NEW crankshaft front oil seal (1). Refer to *Crankshaft Front Oil Seal Installation.*

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2. Install the crankshaft balancer. Refer to *Crankshaft Balancer Replacement*.

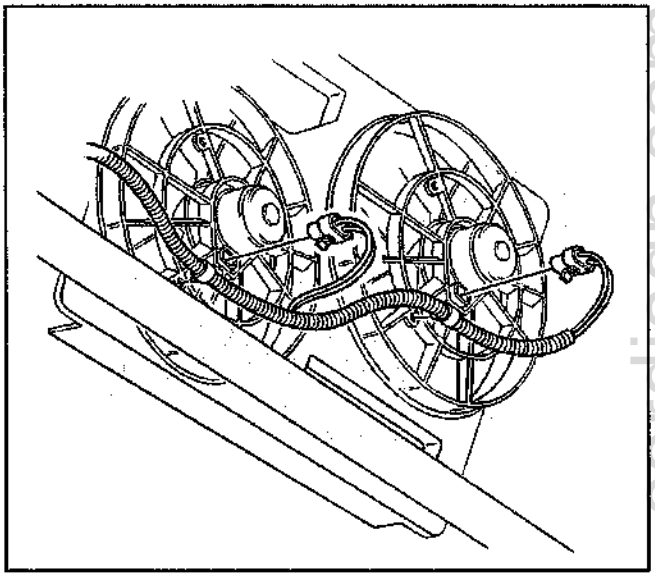


64275

Engine Front Cover Replacement

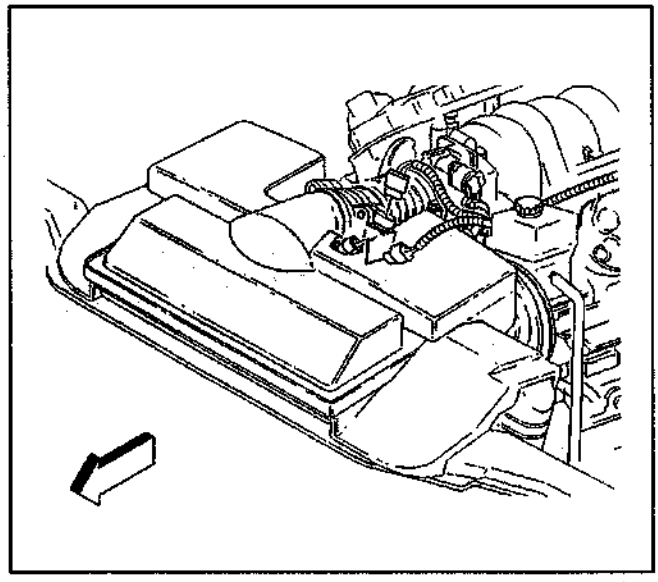
Removal Procedure

1. Raise and suitably support the vehicle. Refer to *Lifting and Jacking the Vehicle* in General Information.
2. Remove the cooling fan electrical connectors.
3. Remove the harness rosebud clips from the fan shroud.
4. Drain the cooling system. Refer to *Draining and Filling Cooling System (5.7 L)* in Engine Cooling.
5. Lower the vehicle.



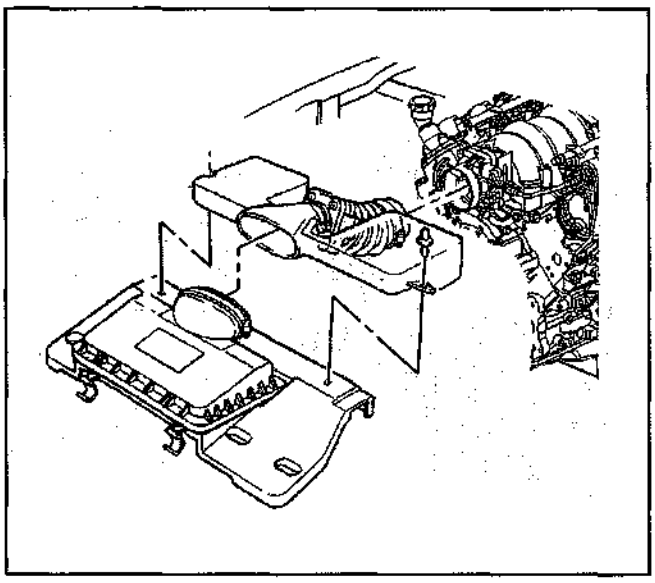
221692

6. Disconnect the intake air temperature (IAT) sensor electrical connector.
7. Disconnect the mass airflow (MAF) sensor electrical connector.



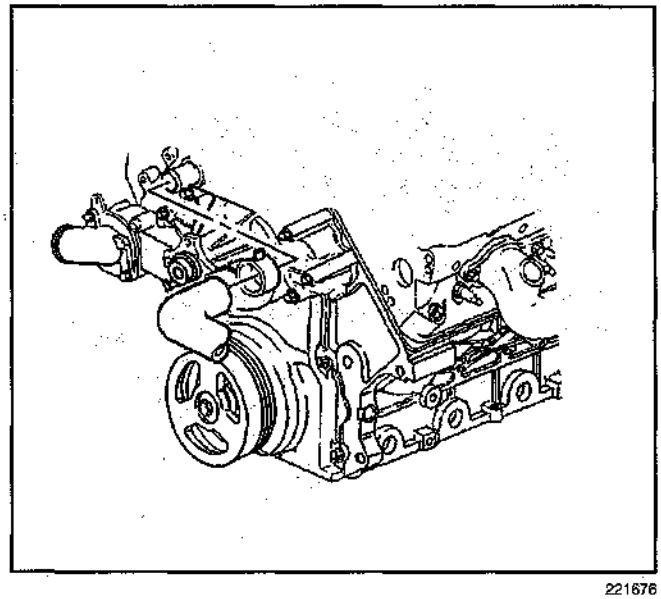
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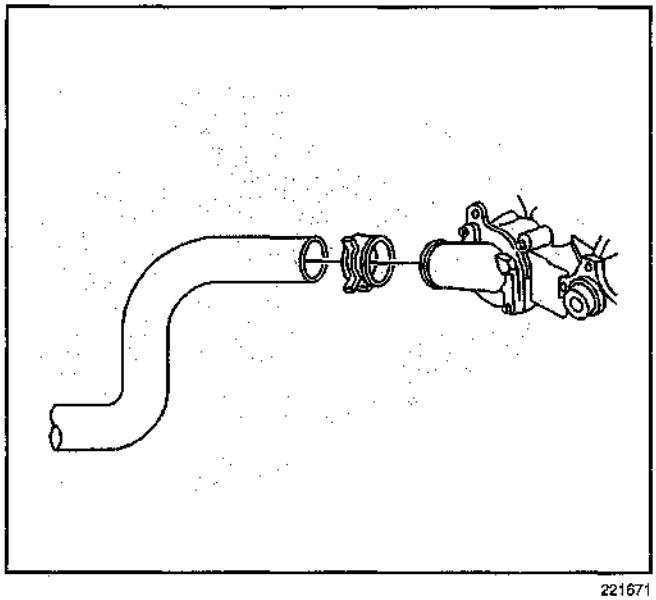
208569

8. Remove the air intake duct.
9. Remove the air conditioning (A/C) drive belt. Refer to *Drive Belt Replacement - A/C.*



221676

10. Remove the upper radiator hose from the water pump.

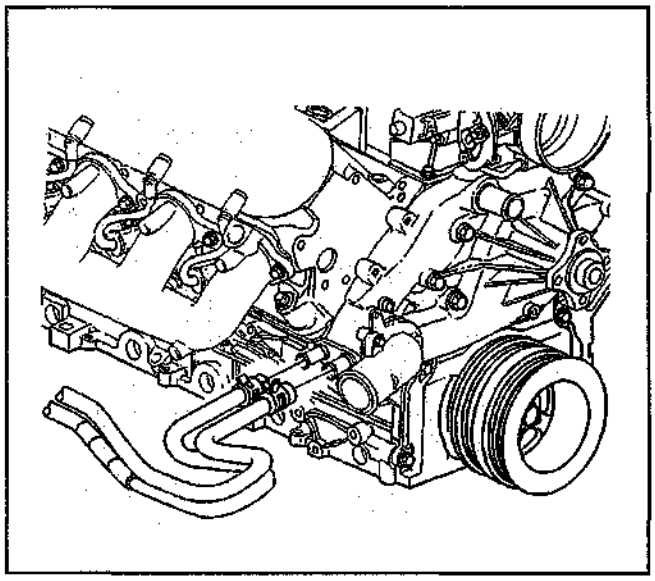


221671

11. Remove the radiator hose from the water inlet housing.

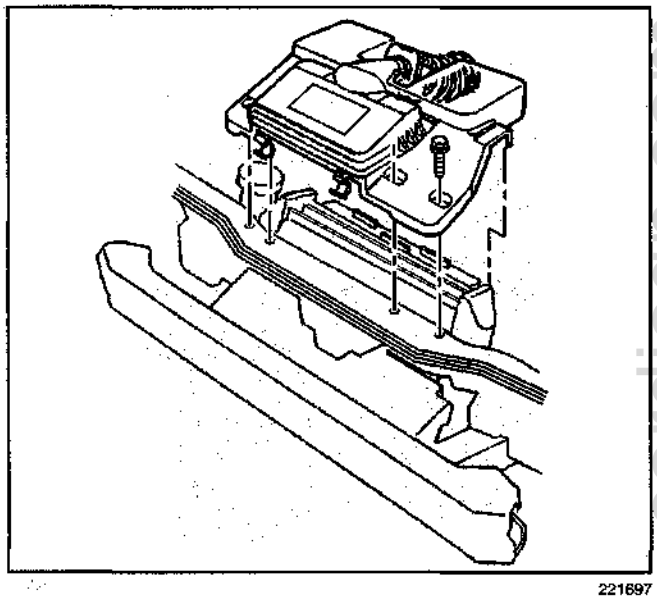
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12. Remove the two heater hoses from the water pump.



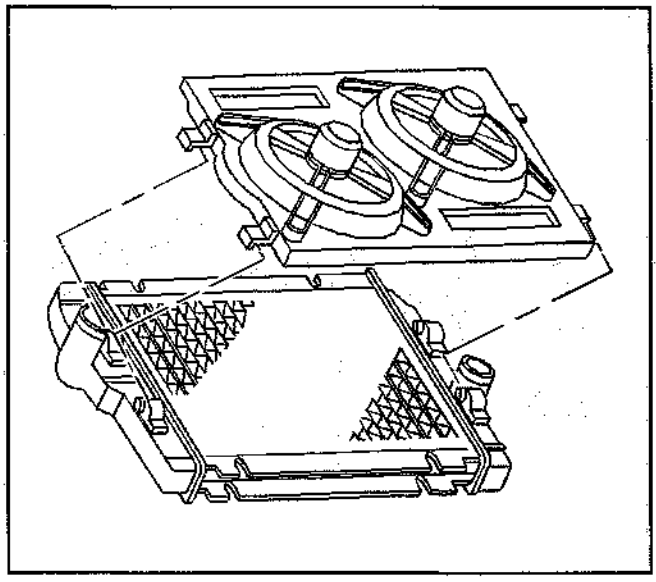
282934

13. Remove the upper radiator support.



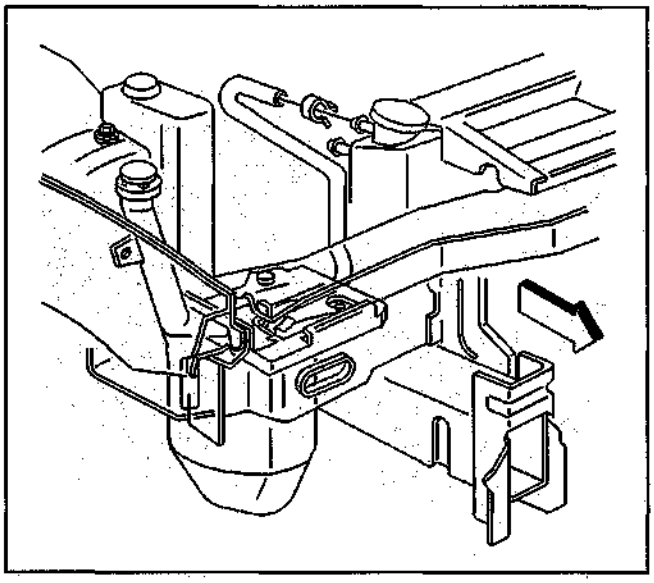
221697

14. Remove the fan shroud.
15. Remove the drive belt tensioner. Refer to *Drive Belt Tensioner Replacement - Accessory.*



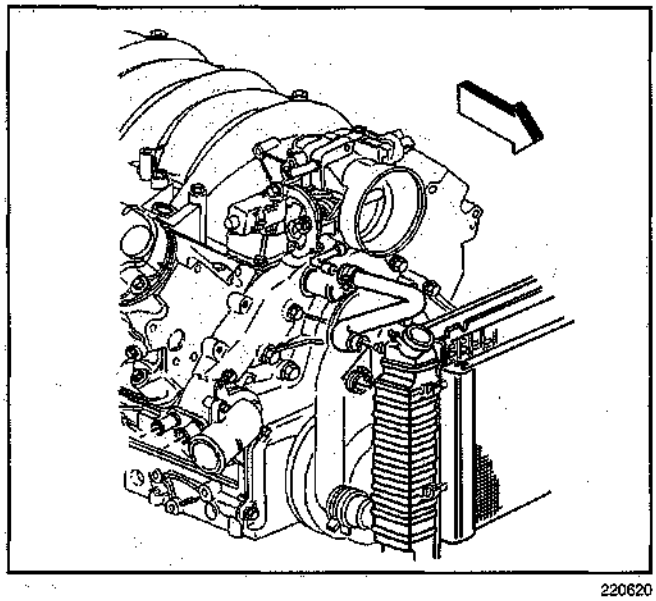
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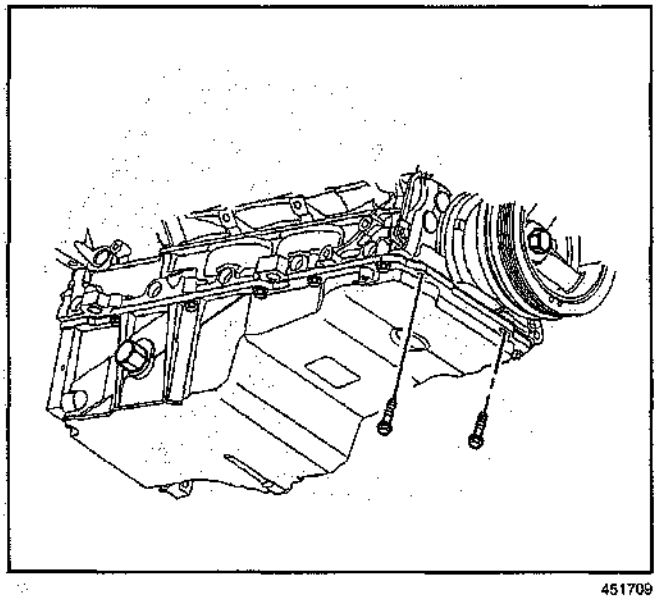
221645

16. Remove the overflow hose from the radiator.



220620

17. Remove the throttle body heater hose from the radiator.
18. Remove the drive belt idler pulley. Refer to *Drive Belt Idler Pulley Replacement - Accessory*.
19. Remove the water pump. Refer to *Water Pump Replacement (5.7 L)* in Engine Cooling.
20. Raise and suitably support the vehicle. Refer to *Lifting and Jacking the Vehicle* in General Information.
21. Remove the crankshaft balancer. Refer to *Crankshaft Balancer Replacement*.



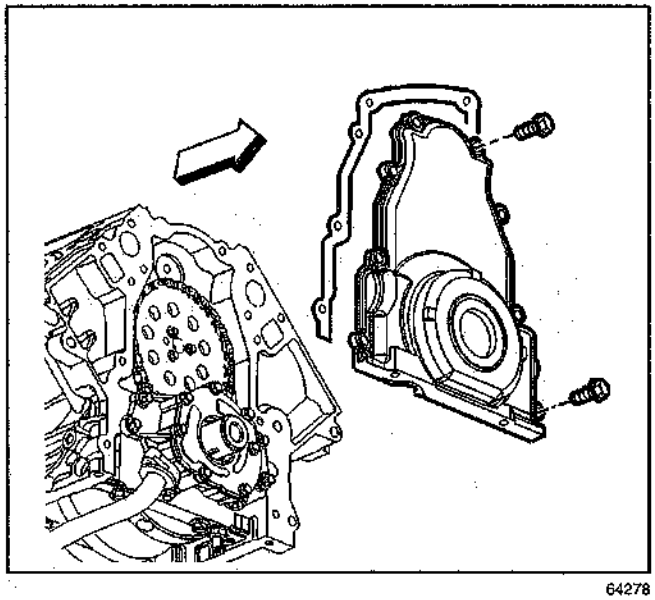
451709

22. Remove the oil pan-to-front cover bolts.

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Important: Do not slide the front cover/gasket across the oil pan gasket or damage could result.

23. Remove the front cover-to-engine block bolts.
24. Remove the front cover and gasket.
25. Discard the front cover gasket.
26. Remove the crankshaft oil seal from the cover.
27. Discard the oil seal.



64278

Installation Procedure

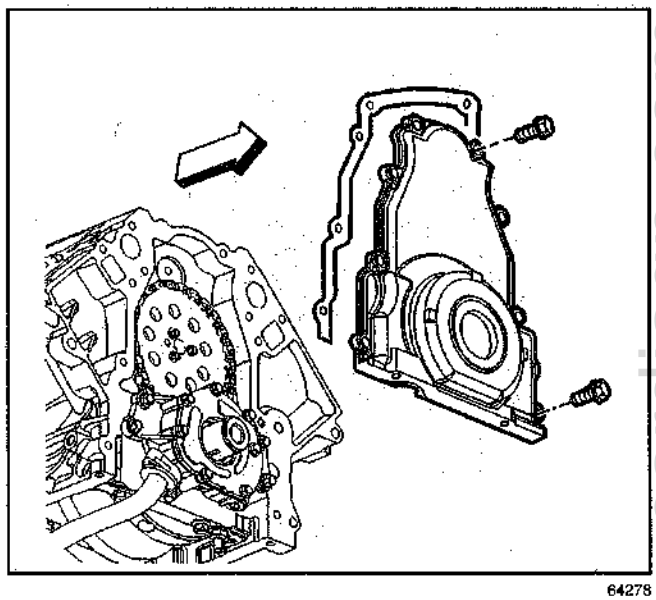
Tools Required

J 41476 Front/Rear Cover Alignment-Crankshaft Oil Seal Area

Important:

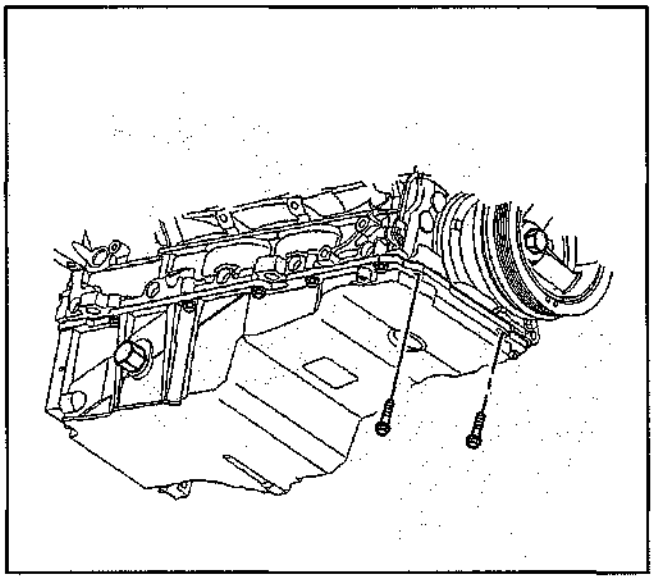
- Do not reuse the crankshaft oil seal or front cover gasket.
- Do not slide the front cover/gasket across the oil pan gasket
- The special tool in this procedure is used to properly align the crankshaft front oil seal.
- The crankshaft front oil seal MUST be centered in relation to the crankshaft.
- An improperly aligned front cover may cause premature front oil seal wear and/or engine oil leaks.

1. Install a NEW crankshaft oil seal to the front cover.
2. Apply a 5 mm (0.20 in) bead of sealant GM P/N 12378190 to the corner where the oil pan meets the engine block.
3. Install the front cover, gasket and bolts on to the engine.
4. Install the front cover bolts finger tight. Do not overtighten.

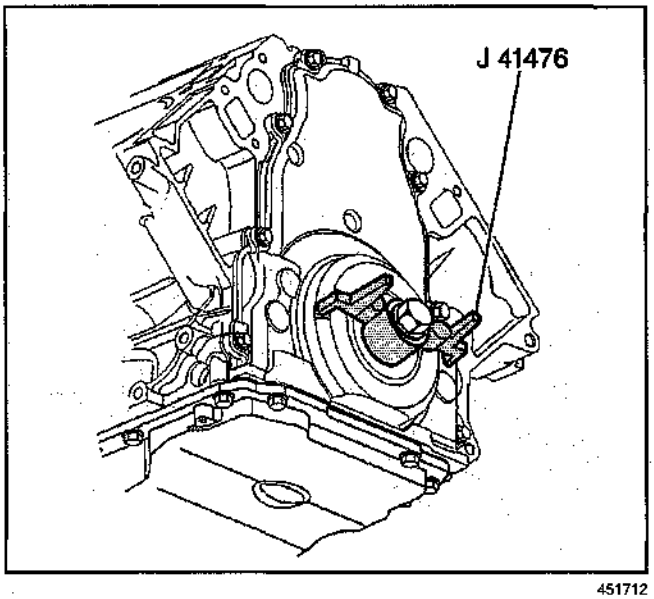


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451709

5. Install the oil pan-to-front cover bolts until snug in order to position the cover at the pan rail.



451712

6. Install the *J 41476* to the front cover.
7. Align the tapered legs of the *J 41476* with the machined alignment surfaces on the front cover.
8. Install the crankshaft balancer bolt until snug. Do not overtighten.

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

9. Tighten the oil pan bolts in the following order:

   Tighten

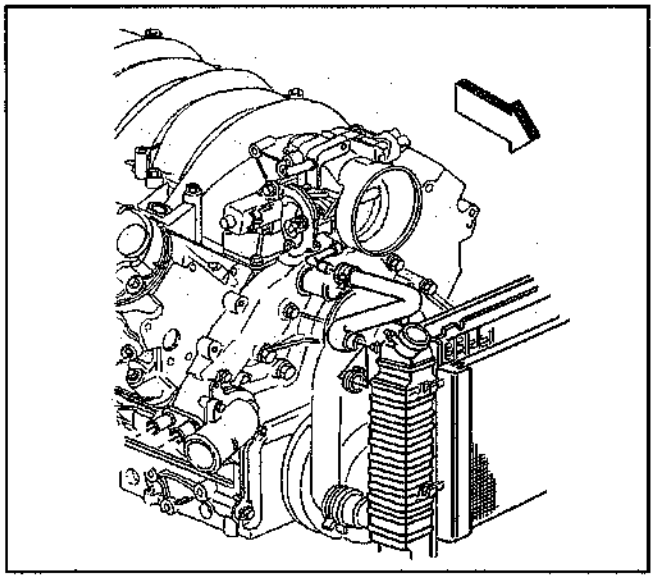
   9.1. Tighten the oil pan-to-front cover bolts to 25 N·m (18 lb ft).

   9.2. Tighten the engine front cover bolts to 25 N·m (18 lb ft).

10. Remove the *J 41476*.
11. Install the crankshaft balancer. Refer to *Crankshaft Balancer Replacement*.
12. Lower the vehicle.
13. Install the water pump. Refer to *Water Pump Replacement (5.7 L)* in Engine Cooling.
14. Install the drive belt idler pulley. Refer to *Drive Belt Idler Pulley Replacement - Accessory*.

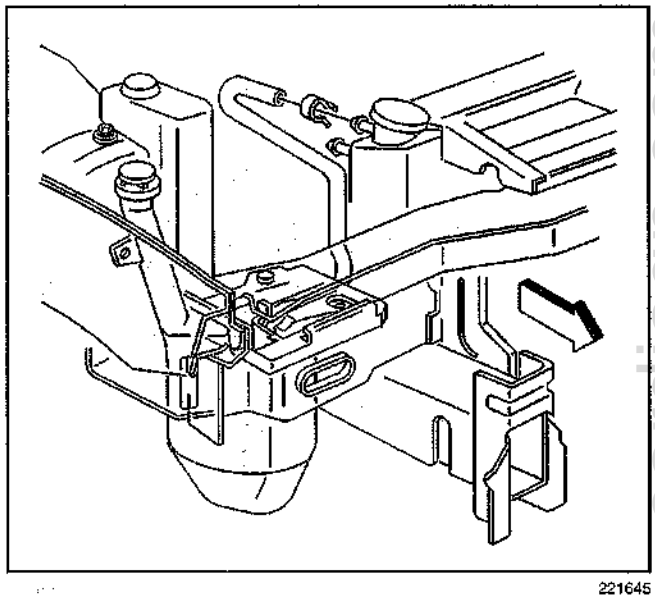
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15. Install the throttle body heater hose to the radiator.



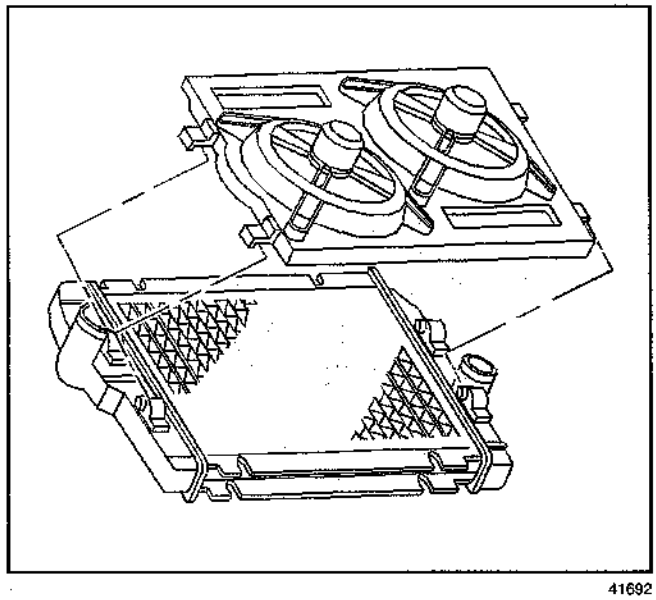
220620

16. Install the overflow hose to the radiator.
17. Install the drive belt tensioner. Refer to *Drive Belt Tensioner Replacement - Accessory*.



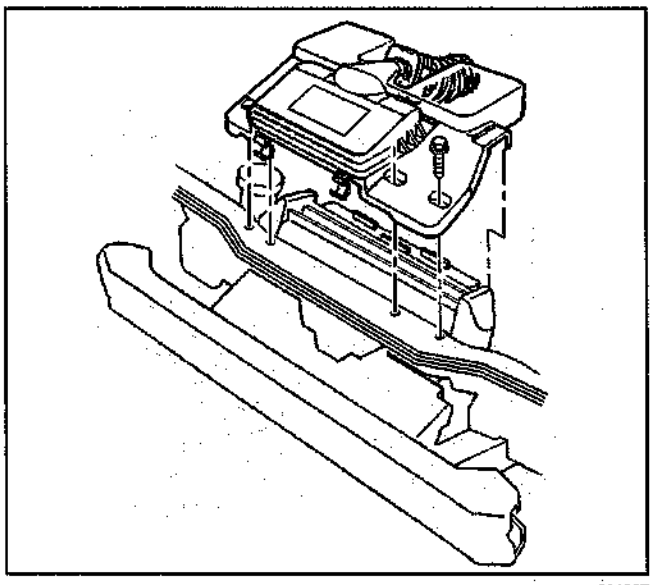
221645

18. Install the fan shroud.



41692

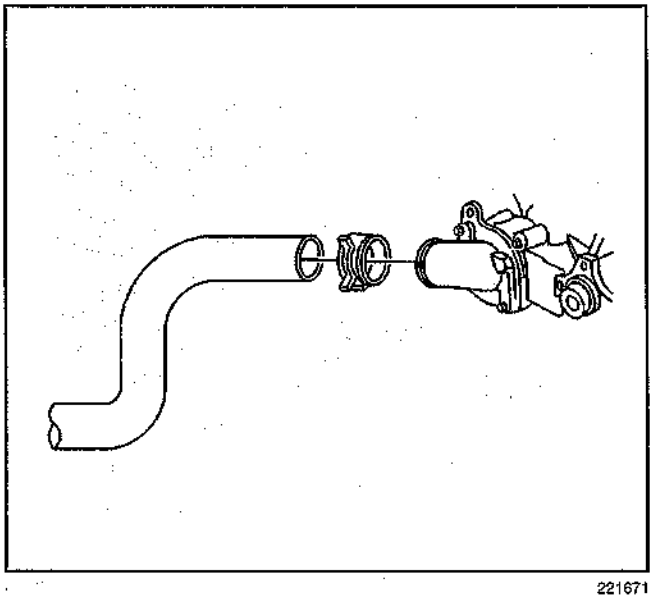
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221697

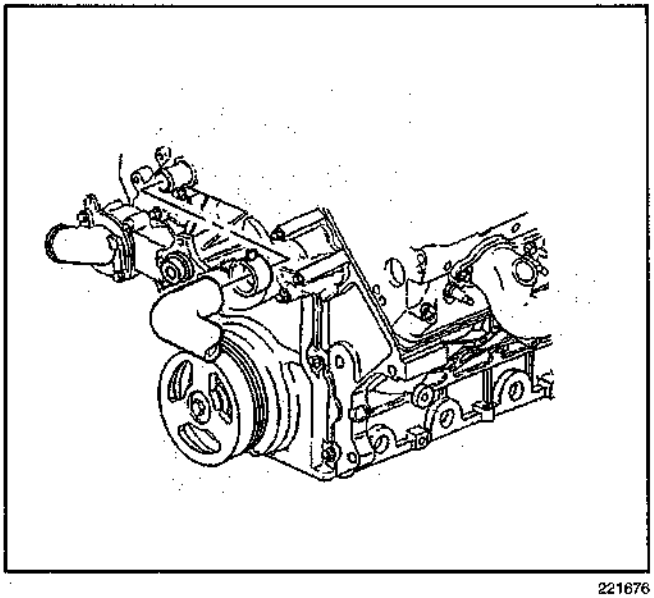
19. Install the upper radiator support.

Tighten

Tighten the radiator support/air cleaner bolts to 12 N·m (106 lb in).


221671

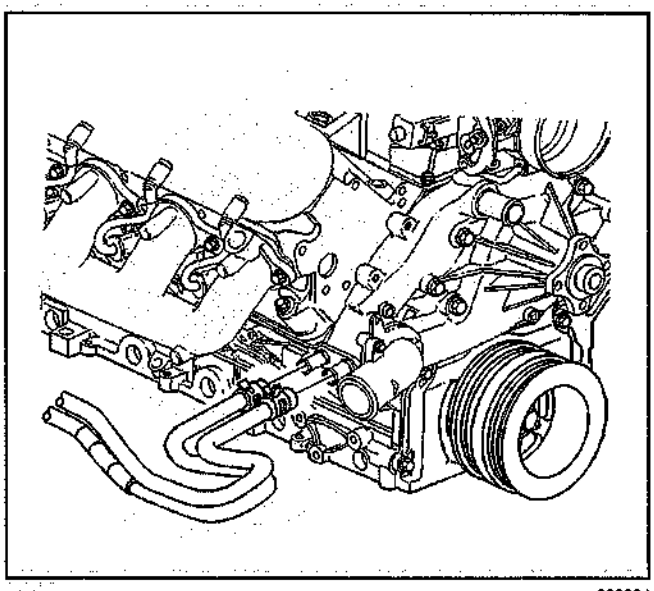
20. Install the lower radiator hose to the water inlet housing.


221676

21. Install the upper radiator hose to the water pump.

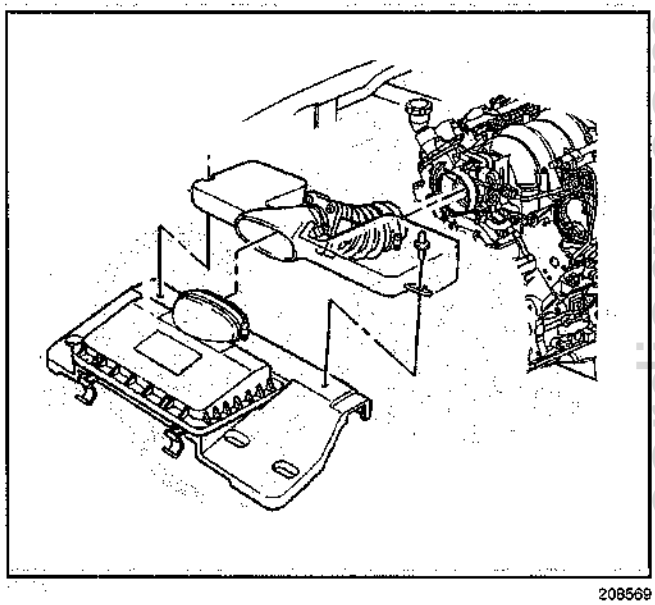
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22. Install the two heater hoses from the water pump.
23. Install the A/C drive belt. Refer to *Drive Belt Replacement - A/C.*



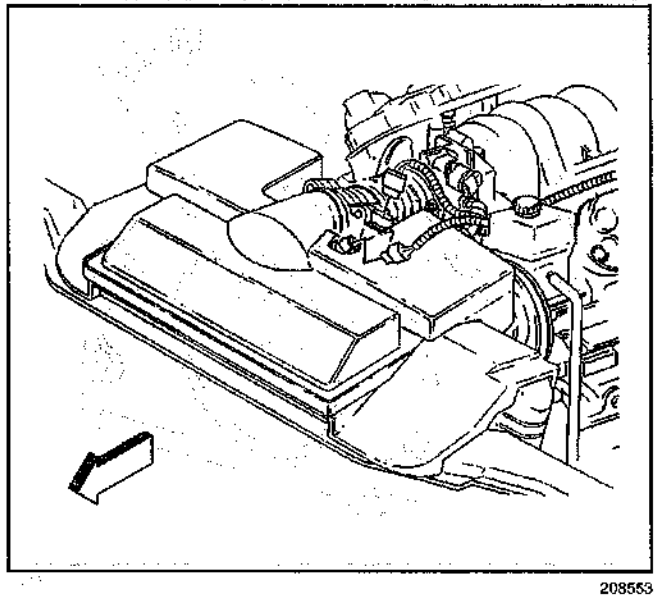
282934

24. Install the air intake duct.



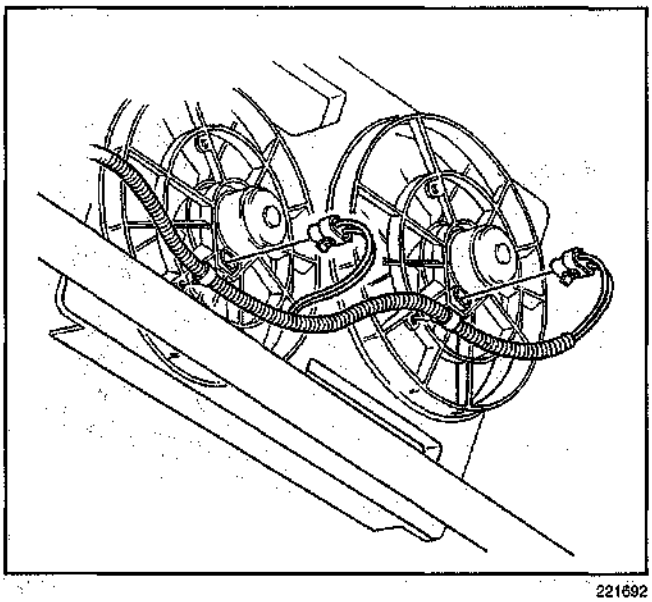
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25. Connect the MAF sensor electrical connector.
26. Connect the IAT sensor electrical connector.
27. Refill the cooling system. Refer to *Draining and Filling Cooling System (5.7 L)* in Engine Cooling.

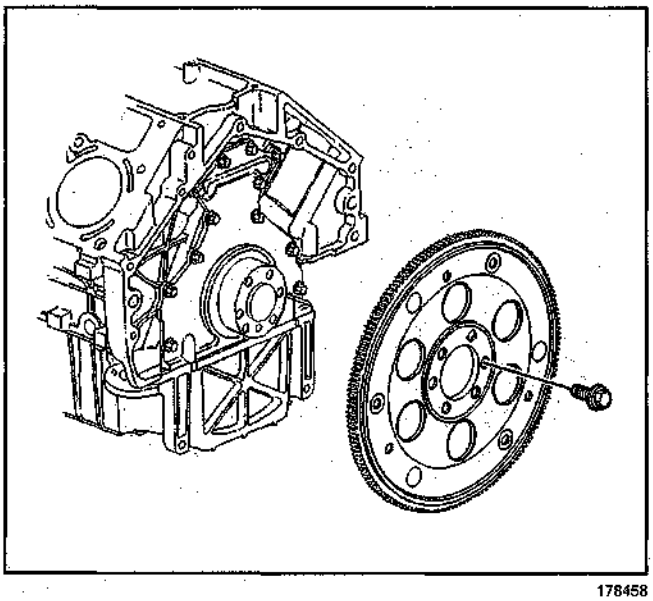


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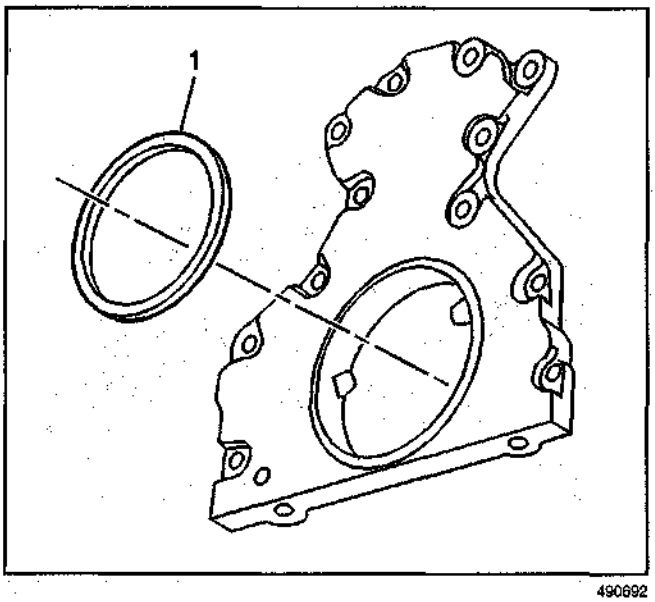
28. Install the electrical connectors to the fan shroud.
29. Install the rosebud clips to the fan shroud.


178458

Crankshaft Rear Oil Seal Replacement

Removal Procedure

1. Remove the flywheel. Refer to *Engine Flywheel Replacement.*



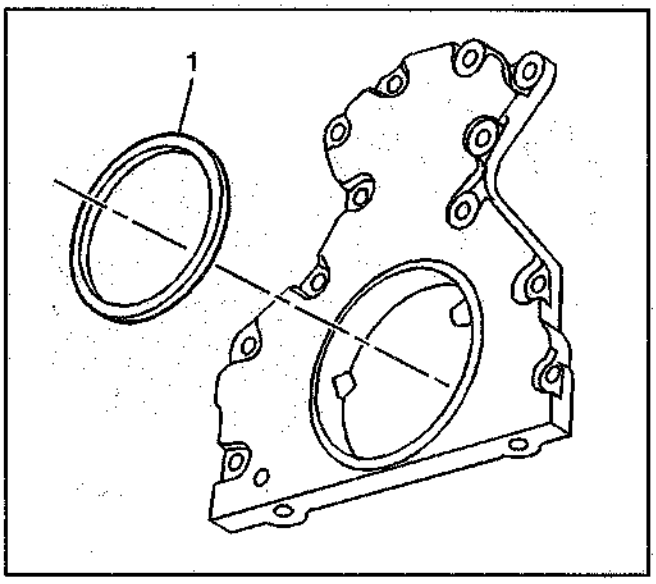
490692

2. Pry the crankshaft rear oil seal (1) out of the rear cover.

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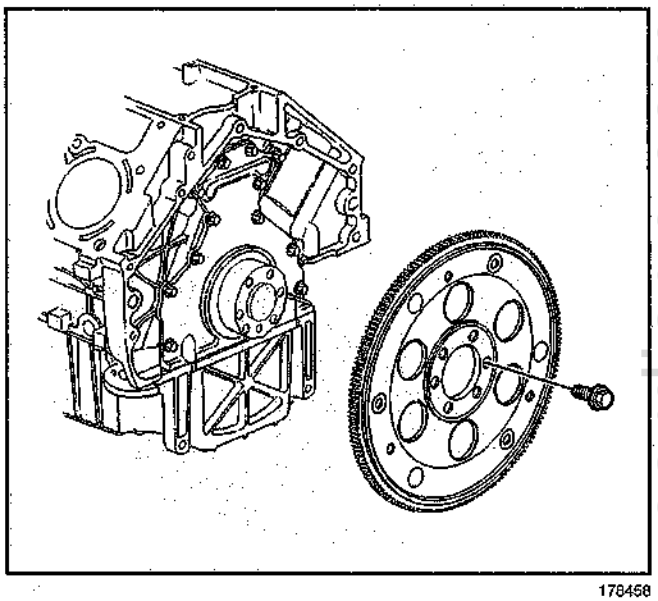
Installation Procedure

1. Install the crankshaft rear oil seal (1). Refer to *Crankshaft Rear Oil Seal Installation*.



490692

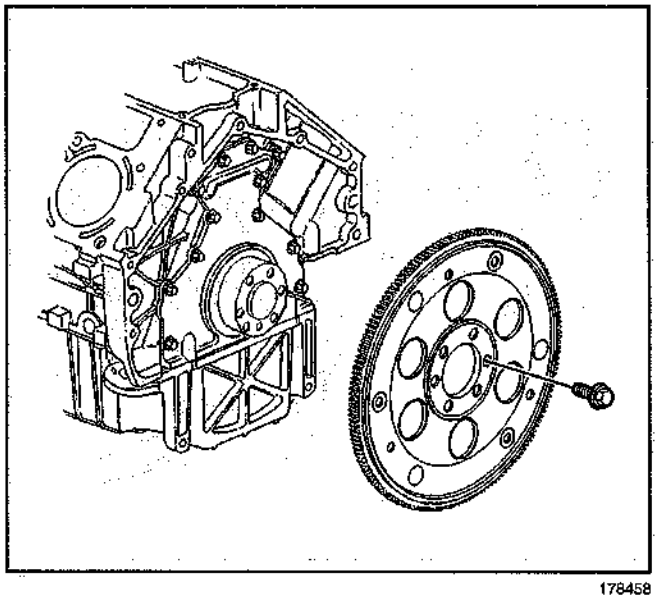
2. Install the flywheel. Refer to *Engine Flywheel Replacement*.


178458

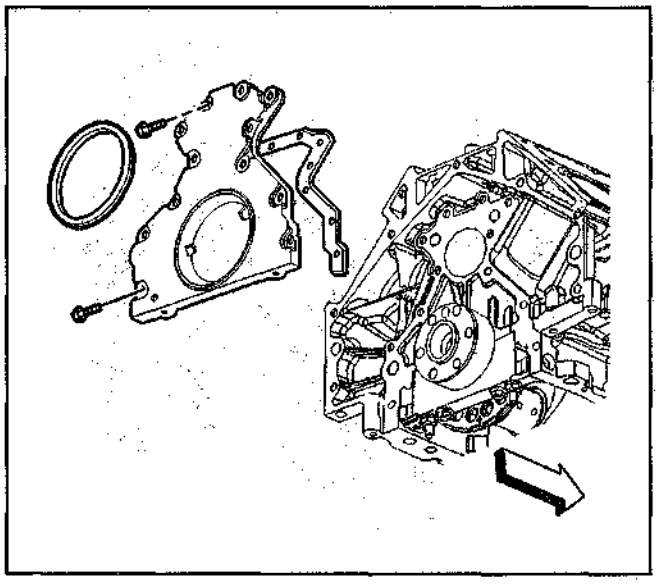
Engine Rear Cover Replacement

Removal Procedure

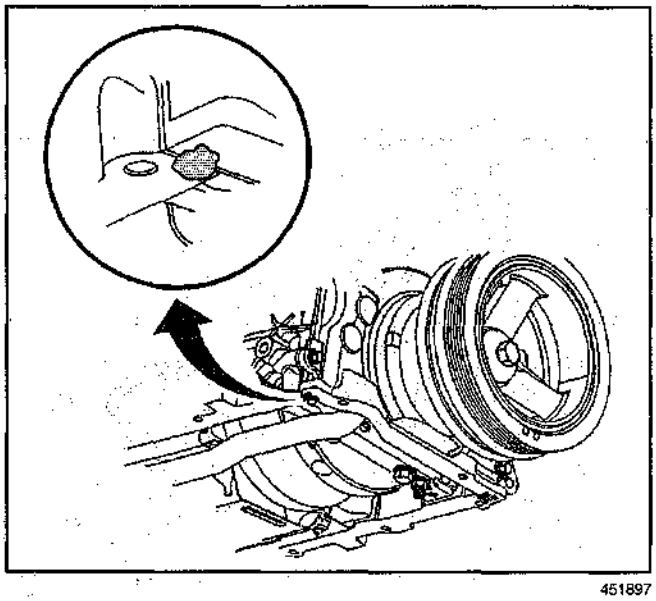
1. Remove the flywheel. Refer to *Engine Flywheel Replacement*.
2. Remove the oil pan-to-rear cover bolts.


178458

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64282

3. Remove the rear cover bolts.
4. Remove the rear cover and gasket.
5. Remove the crankshaft oil seal from the cover.
6. Inspect for the following:
   - Gasket sealing surfaces for excessive scratches or gouging.
   - Cover -to-oil pan threaded bolt holes for damaged threads or debris.
   - Crankshaft oil seal mounting bore for damage.
   - Oil pan gasket for damage.


451897

Installation Procedure

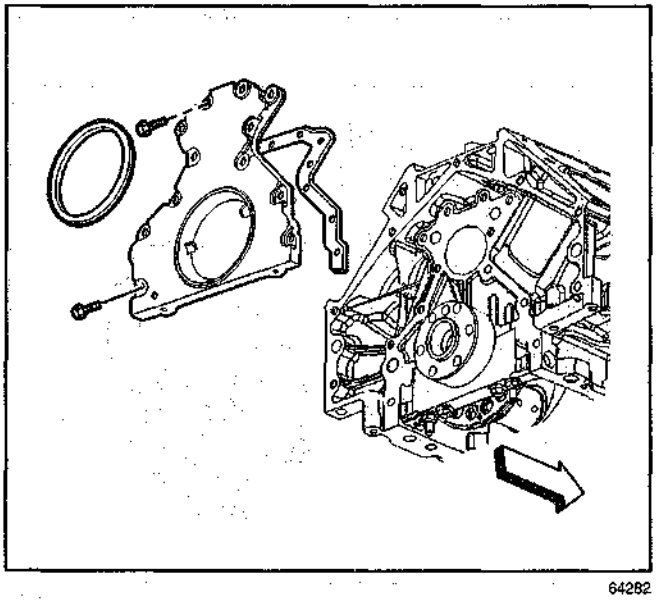
Tools Required

J 41476 Front/Rear Cover Alignment-Crankshaft Oil Seal Area

Important:

- Do not reuse the crankshaft oil seal or rear cover gasket.
- Do not slide the rear cover gasket across the oil pan gasket.
- The special tool in this procedure is used to properly align the crankshaft rear oil seal.
- The crankshaft rear oil seal MUST be centered in relation to the crankshaft.
- An improperly aligned rear cover may cause premature rear oil seal wear and/or engine oil leaks.

1. Apply a 5 mm (0.20 in) bead of sealant GM P/N 12378190 to the corner where the oil pan meets the engine block.


64282

2. Install the rear cover, gasket and bolts to the engine.
3. Tighten the rear cover bolts finger tight. Do not overtighten.
4. Install the oil pan-to-rear cover bolts finger tight. Do not overtighten.

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5. To properly align the rear cover, rotate the crankshaft until two opposing flywheel bolt holes are parallel to the oil pan surface.
6. Align the tapered legs of *J 41476* so the legs enter the rear cover oil seal bore.
7. Install the *J 41476* and bolts onto the rear of the crankshaft.
8. Tighten the tool mounting bolts by hand until snug. Do not overtighten.
9. Install the oil pan-to-cover bolts until snug in order to position the cover to the pan rail.

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

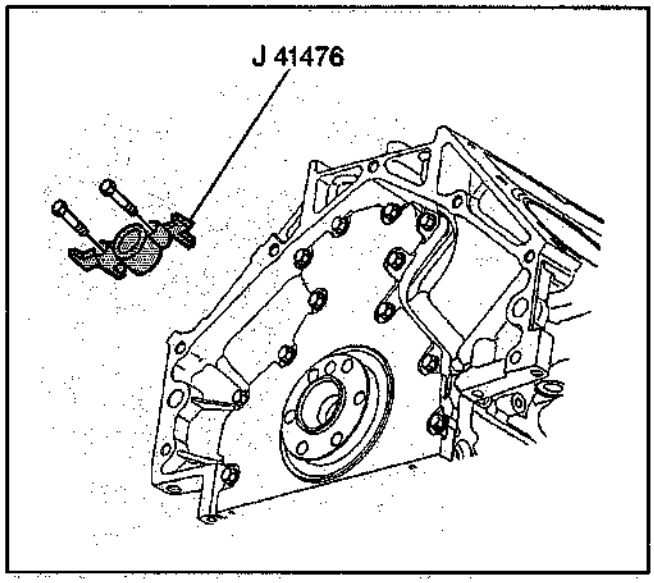
10. Tighten the oil pan-to-rear cover bolts in the following order:

    Tighten

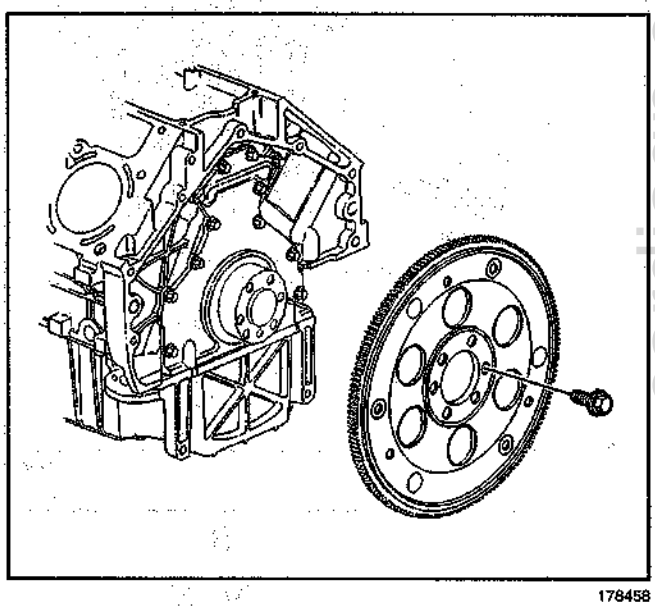
    10.1. Tighten the oil pan-to-rear cover bolts to 12 N·m (106 lb in).

    10.2. Tighten the rear cover bolts to 25 N·m (18 lb ft).

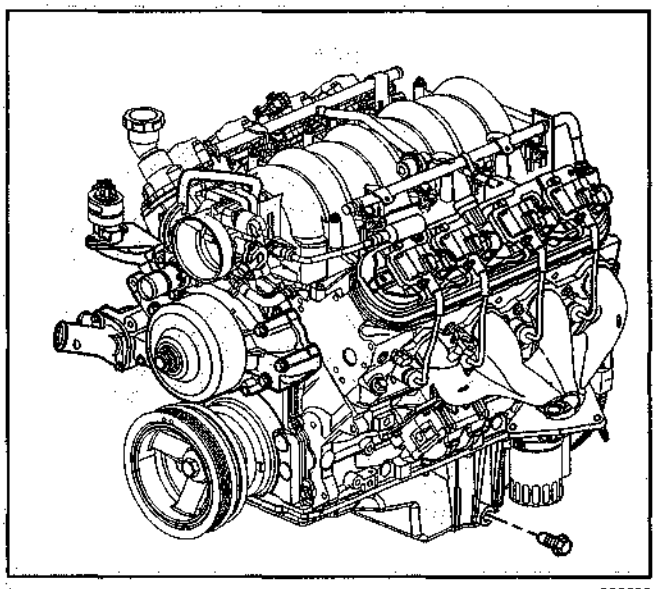
11. Remove the *J 41476*.
12. Install the rear oil seal. Refer to *Crankshaft Rear Oil Seal Installation*.
13. Install the flywheel. Refer to *Camshaft Replacement*.



451716


178458

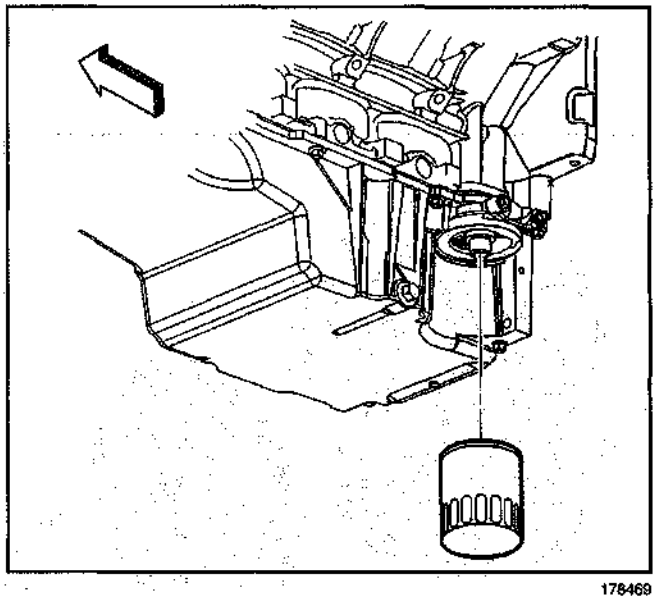
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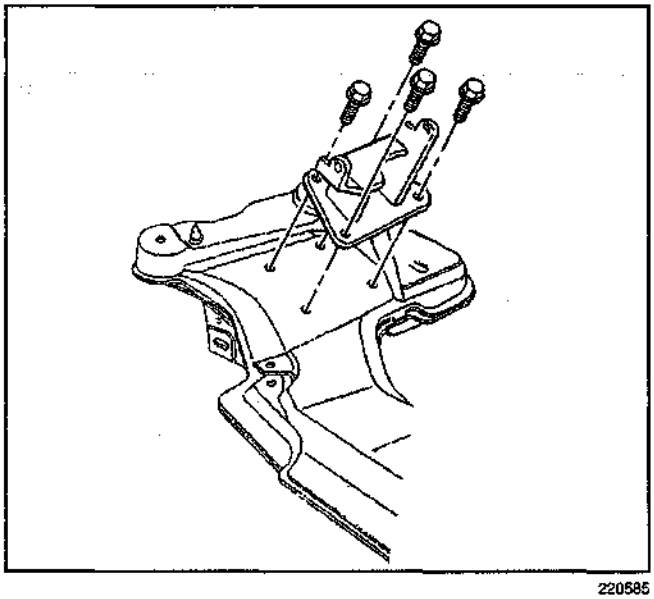
Oil Pan Replacement

Removal Procedure

1. Install the engine support fixture to the engine. Refer to *Engine Support Fixture.*
2. Raise and suitably support the vehicle. Refer to *Lifting and Jacking the Vehicle* in General Information.
3. Remove the oil drain plug.
4. Drain the engine oil.


178469

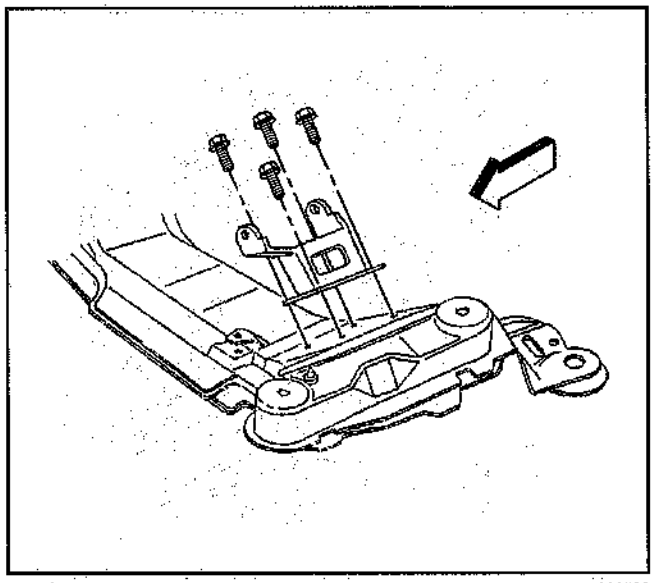
5. Remove the oil filter.


220585

6. Remove the right side engine mount to cradle bolts.

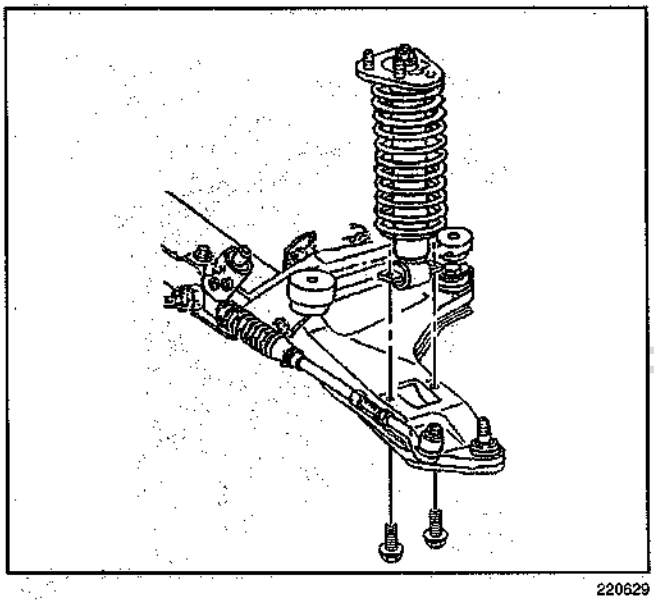
cardiagn.com

7. Remove the left side engine mount to cradle bolts.



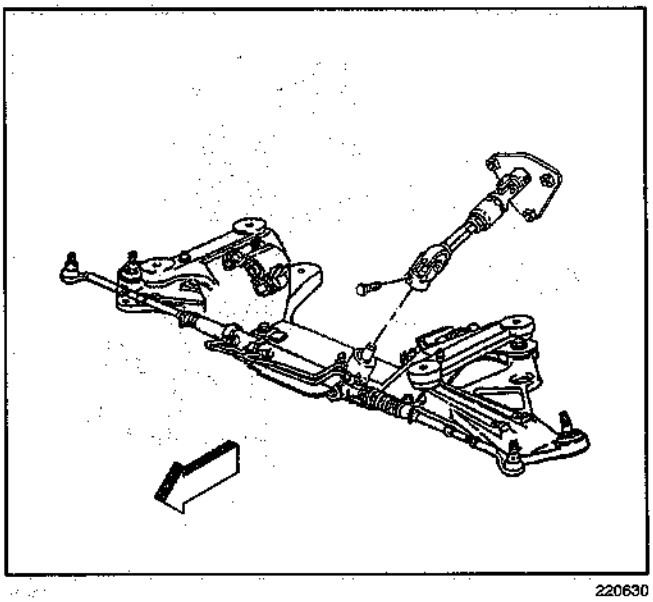
220588

8. Remove the right and left side shock absorber lower mounting bolts.



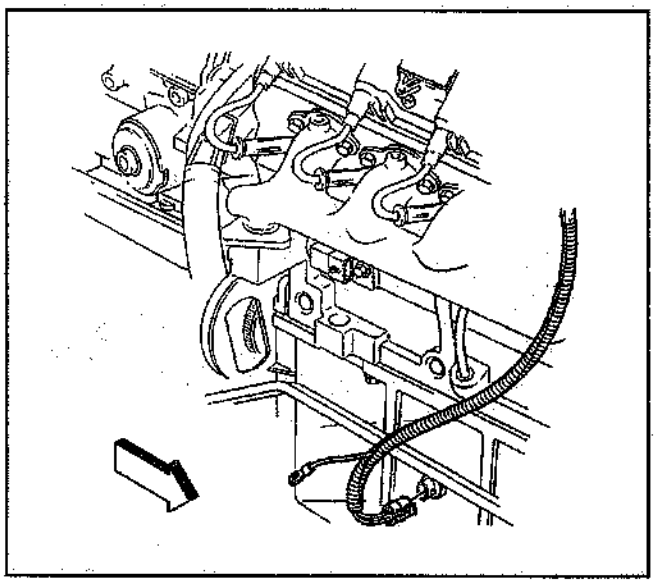
220629

9. Remove the intermediate steering shaft bolt.
10. Support the engine cradle using adjustable jack stands.

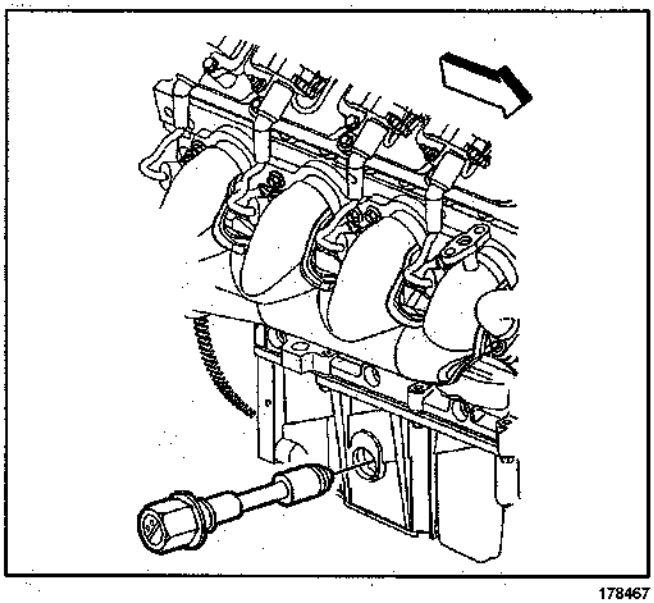


220630

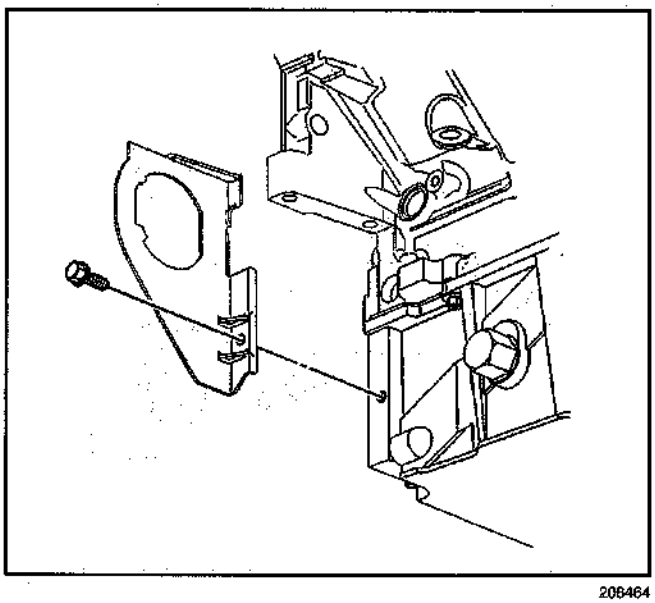
cardiagn.com


220633

11. Disconnect the oil level sensor connector, if required.


178467

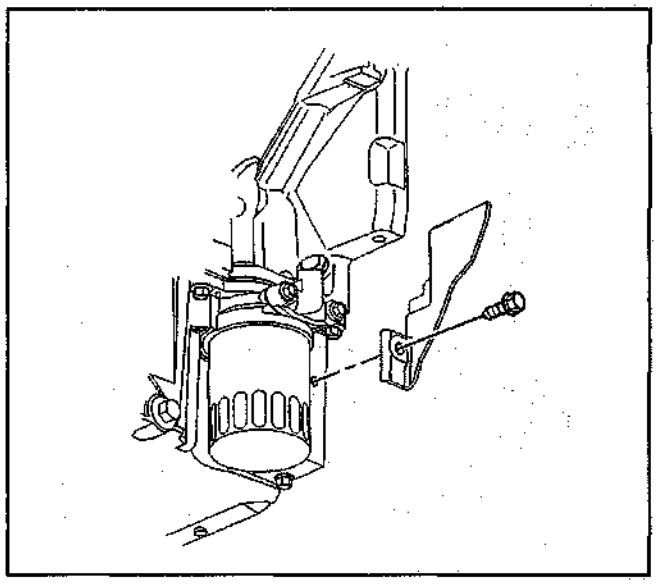
12. Remove the oil level sensor from the oil pan, if required.
13. Remove the starter motor. Refer to *Starter Motor Replacement (5.7 L)* in Engine Electrical.


208464

14. Remove the right side closeout and bolt.

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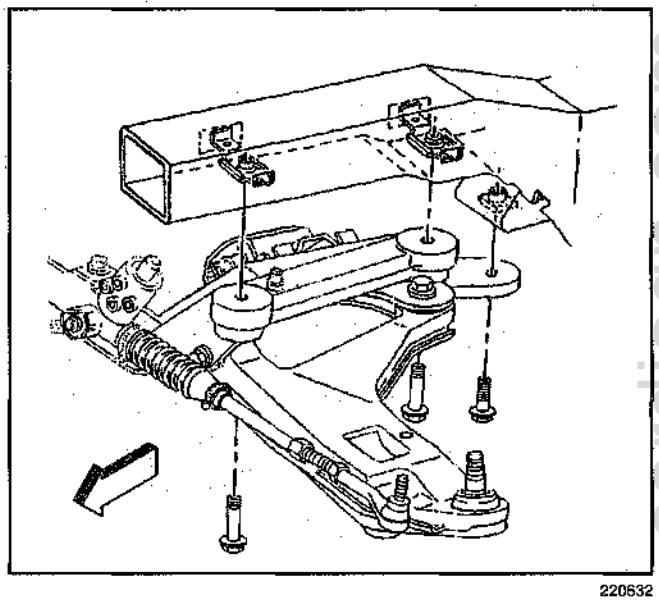
15. Remove the left side closeout and bolt.



208478

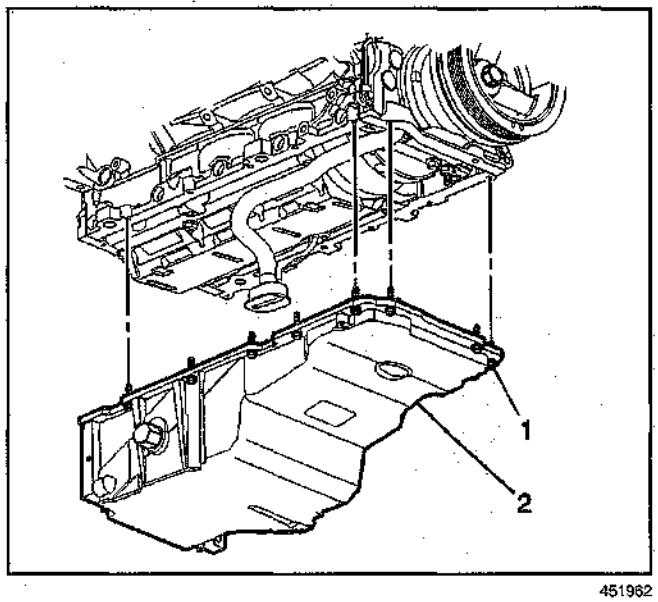
16. Loosen the six cradle bolts three or four turns.
17. Lower the cradle slightly using the cradle support, using the adjustable jack stands.

    It may be necessary to also raise the engine using the support fixture.
18. Remove the bottom two transmission bellhousing bolts.



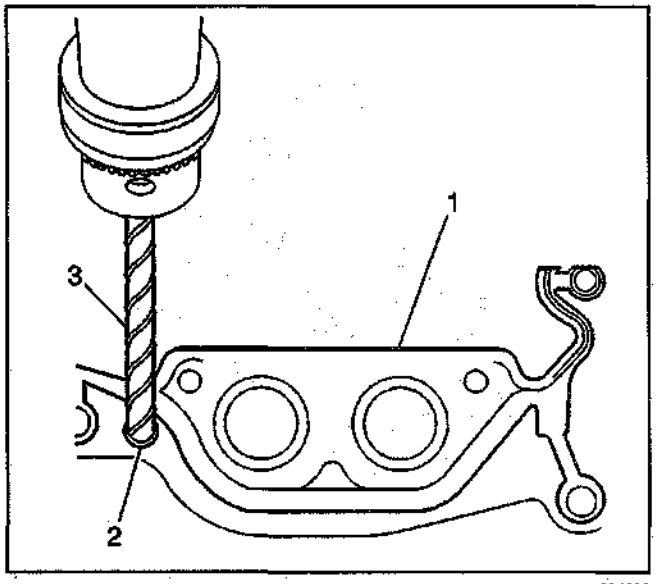
220632

19. Remove the oil pan bolts (1).
20. Lower the oil pan, position the pan until it can be removed from around the oil pump screen.
21. Use care not to gouge, score, or damage the oil pan sealing surface.



451962

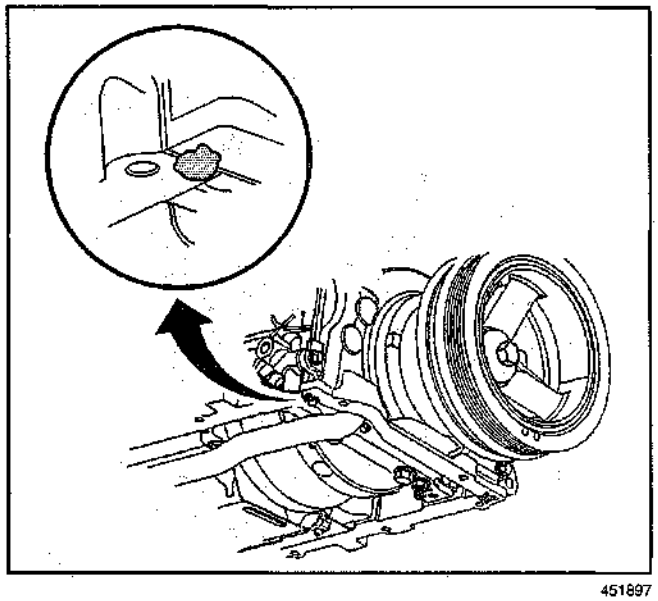
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384699

Important: DO NOT allow foreign material to enter the oil passages of the oil pan, cap or cover the openings as required.

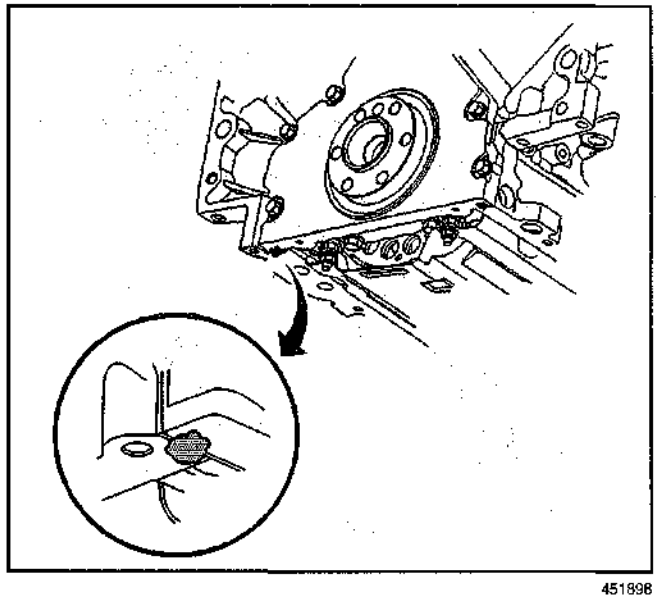
22. Drill out the oil pan gasket rivets (2) and remove the gasket (1) from the oil pan.
23. Discard the old gasket and rivets.


451897

Installation Procedure

Important: The alignment of the structural oil pan is critical. The rear bolt hole locations of the oil pan provide mounting points for the transmission bellhousing. 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 must NEVER protrude beyond the engine block and transmission bellhousing plane.

1. Apply a 5 mm (0.2 in) bead of sealant GM P/N 12378190 or equivalent 20 mm (0.8 in) long to the engine block.
2. Apply the sealant directly onto the tabs of the front cover gasket that protrudes into the oil pan surface.


451898

3. Apply a 5 mm (0.2 in) bead of sealant GM P/N 12378190 or equivalent 20 mm (0.8 in) long to the engine block.
4. Apply the sealant directly onto the tabs of the rear cover gasket that protrudes into the oil pan surface.

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5. Pre-assemble the oil pan gasket to the pan (2).
   5.1. Install the gasket onto the pan (2).
   5.2. Install the oil pan bolts (1) to the pan through the gasket.
6. Install the oil pan (2), gasket and bolts (1) to the engine block.
7. Snug the oil pan bolts (1) finger tight. Do not overtighten.
8. Install the two lower bellhousing bolts to position the oil pan correctly.

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

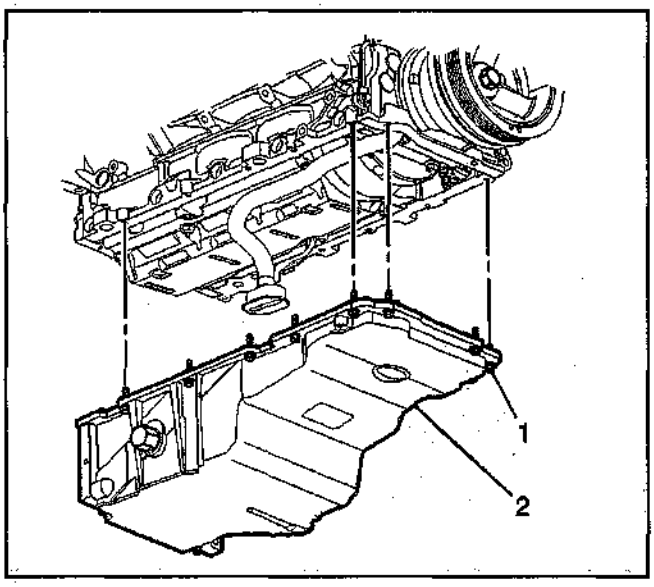
9. Snug the lower bellhousing bolt finger tight. Do not overtighten.

   Tighten

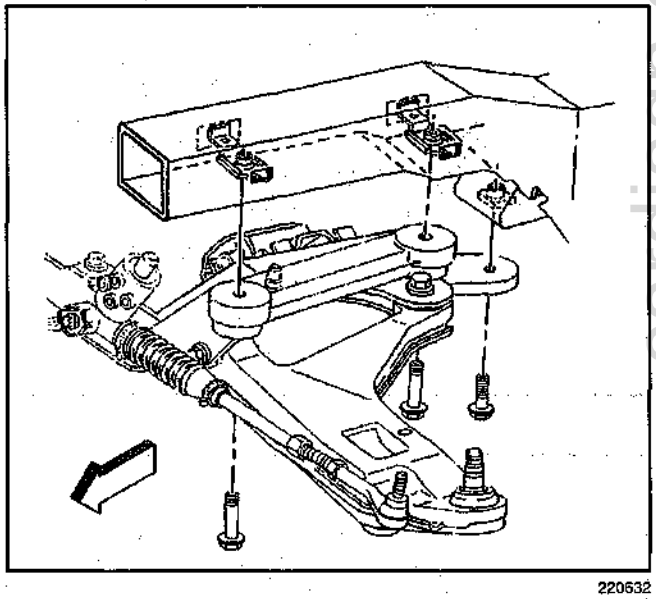
   9.1. Tighten the oil pan-to-block and oil pan-to-oil pan front cover bolts to 25 N·m (18 lb ft).
   9.2. Tighten the oil pan-to-rear cover bolts to 12 N·m (106 lb in).
   9.3. Tighten the bellhousing bolts to 50 N·m (37 lb ft).
10. Raise the engine cradle and/or if necessary, lower the engine.
11. Tighten the cradle bolts.

    Tighten

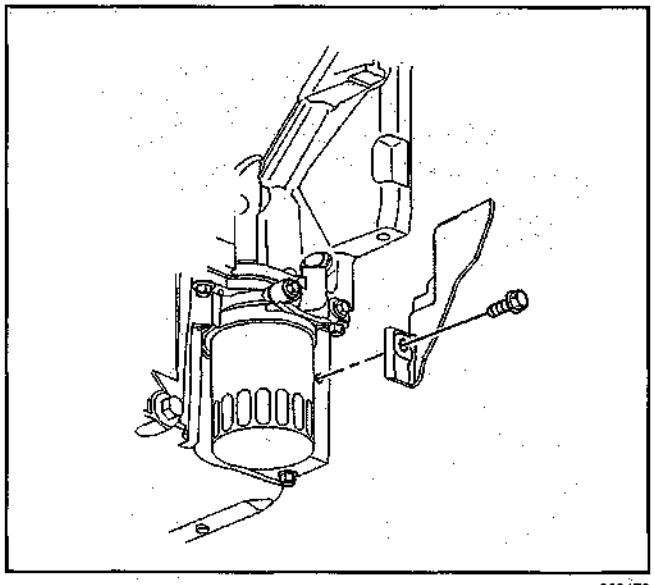
    - Tighten the upper four cradle bolts to 125 N·m (92 lb ft).
    - Tighten the lower two cradle bolts to 145 N·m (107 lb ft).



451962


220632

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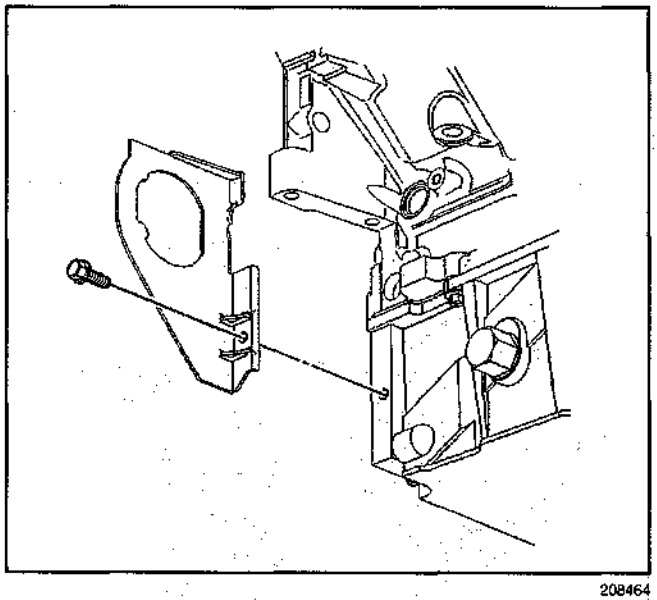


206478

12. Install the left side closeout and bolt.

Tighten

Tighten the left side closeout bolt to 12 N·m (106 lb in).



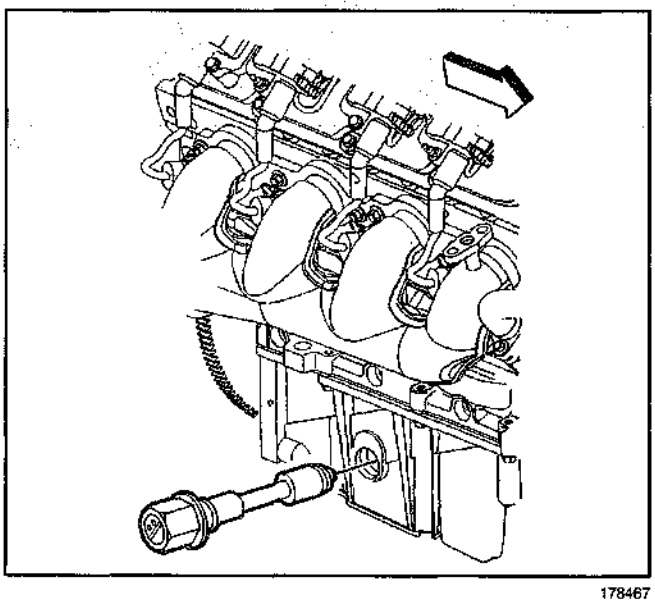
208464

13. Install the right side closeout and bolt.

Tighten

Tighten the right closeout bolt to 12 N·m (106 lb in).

14. Install the starter motor. Refer to *Starter Motor Replacement (5.7 L)* in Engine Electrical.



178467

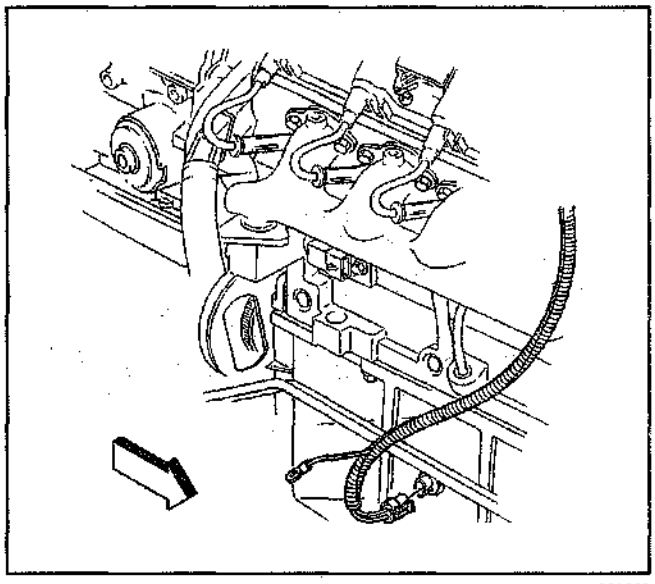
15. Install the oil level sensor to the oil pan, if removed.

Tighten

Tighten the oil level sensor to 35 N·m (26 lb ft).

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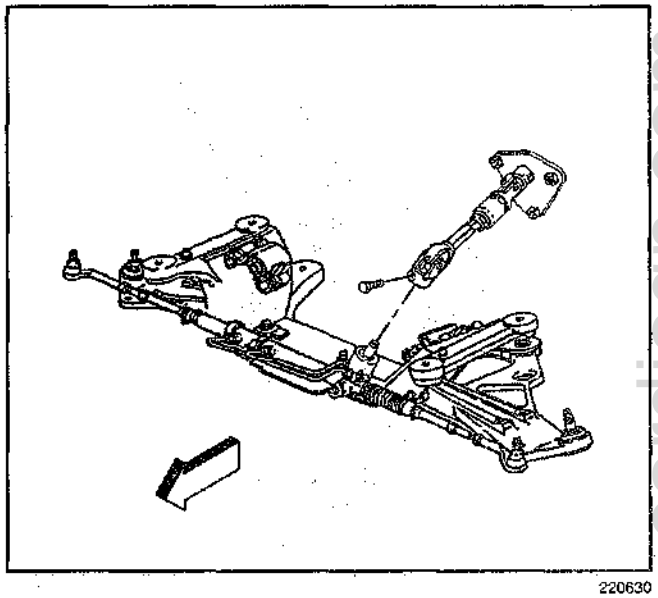
16. Connect the oil level sensor electrical connector.
17. Remove the cradle support.


220633

18. Connect the intermediate steering shaft bolt.

Tighten

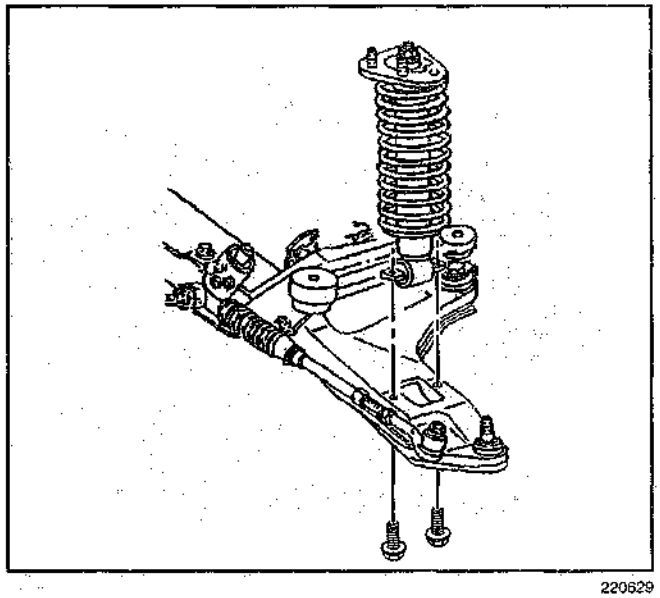
Tighten the intermediate shaft bolt to 47 N·m (35 lb ft).


220630

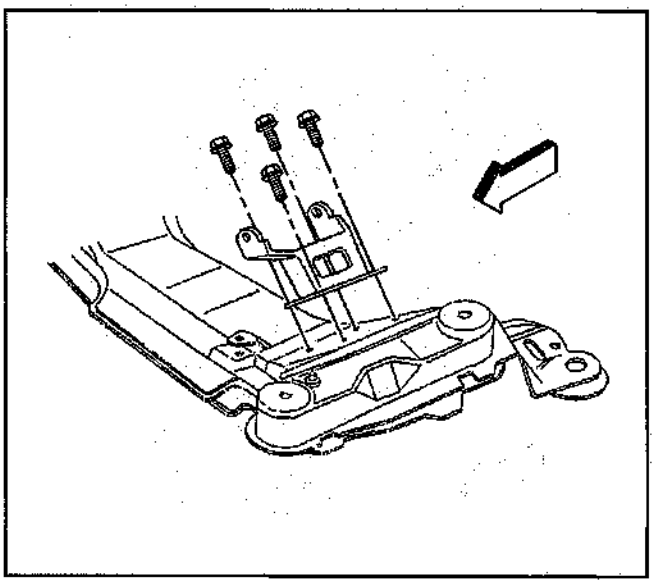
19. Install the right and left side shock absorber lower mounting bolts.

Tighten

Tighten the shock absorbers bolts to 65 N·m (48 lb ft).


220629

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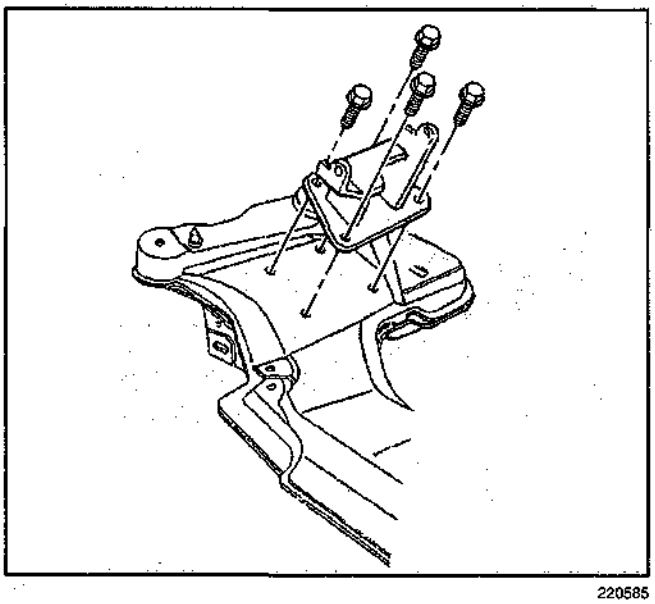


220588

20. Install the left side engine mount cradle bolts.

Tighten

Tighten the engine mount to cradle bolts to 58 N·m (43 lb ft).

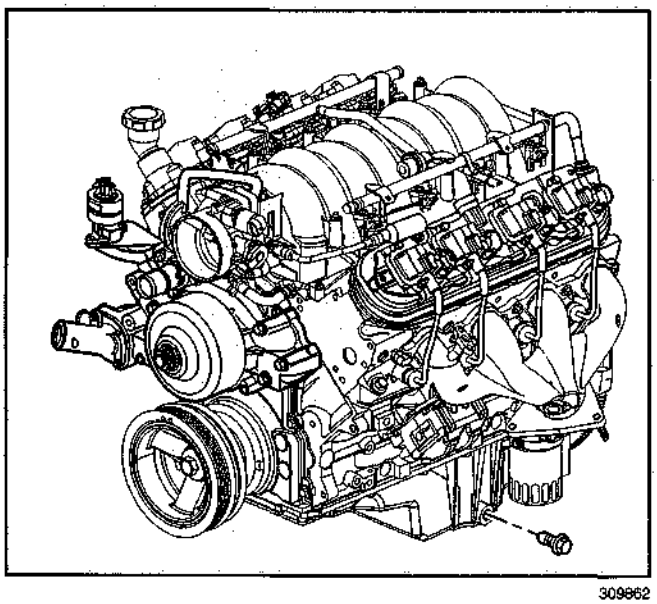


220585

21. Install the right side engine mount cradle bolts.

Tighten

Tighten the right side engine mount cradle bolts to 58 N·m (43 lb ft).



309862

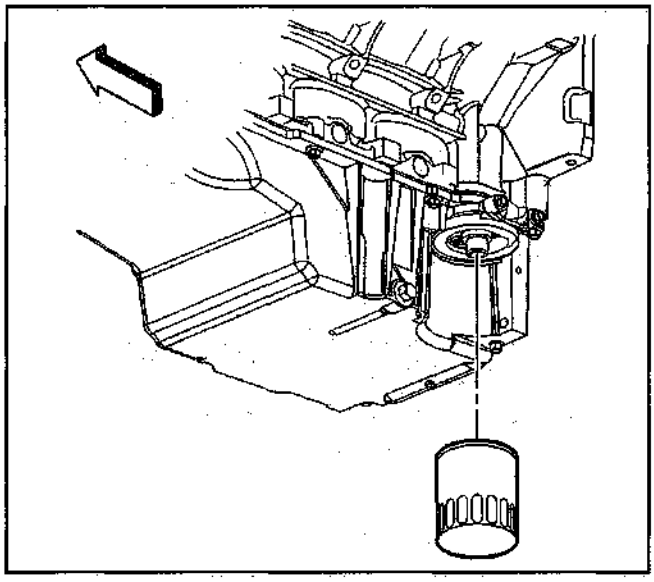
22. Install the oil drain plug.

Tighten

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

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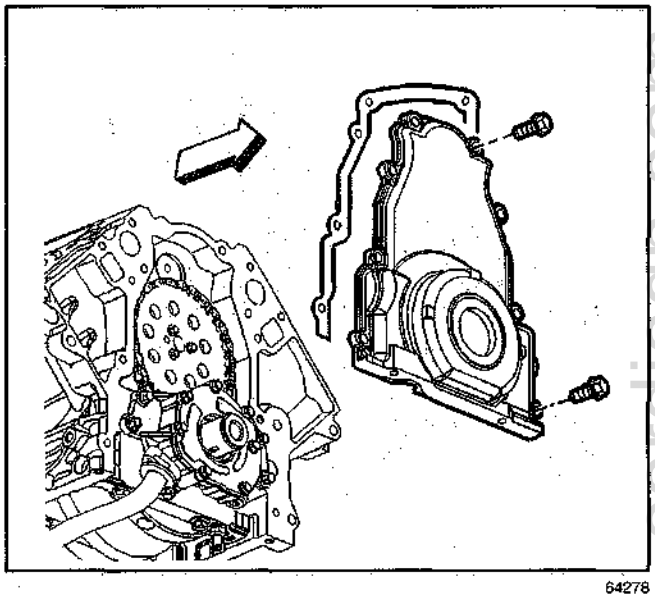
23. Install the oil filter.
    Tighten
    Tighten the oil filter to 30 N·m (22 lb ft).
24. Lower the vehicle.
25. Remove the engine support fixture.
26. Change the engine oil. Refer to *Engine Oil and Oil Filter Change*.


178469

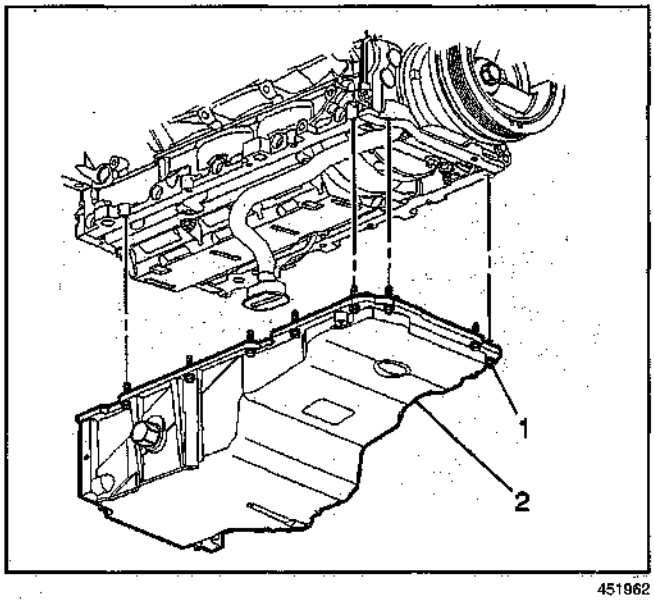
Oil Pump, Pump Screen and Deflector Replacement

Removal Procedure

1. Remove the engine front cover. Refer to *Engine Front Cover Replacement*.

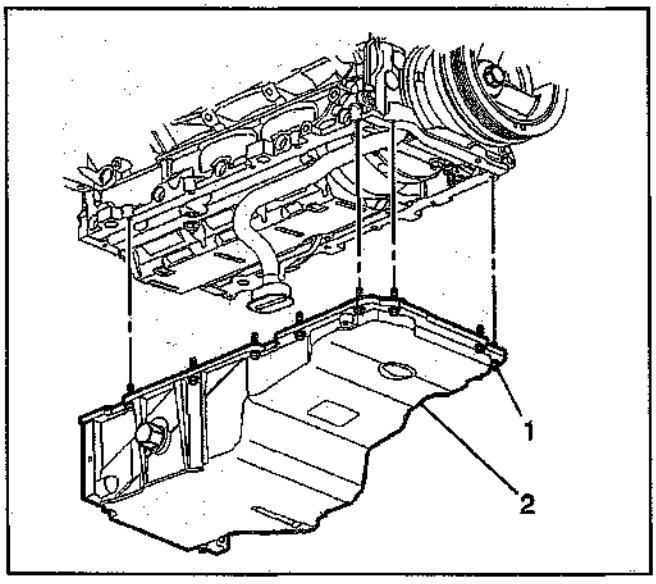

64278

2. Remove the engine oil pan (2). Refer to *Oil Pan Replacement*.
3. Remove the oil pump, pump screen and deflector. Refer to *Oil Pump, Pump Screen and Deflector Removal*.



451962

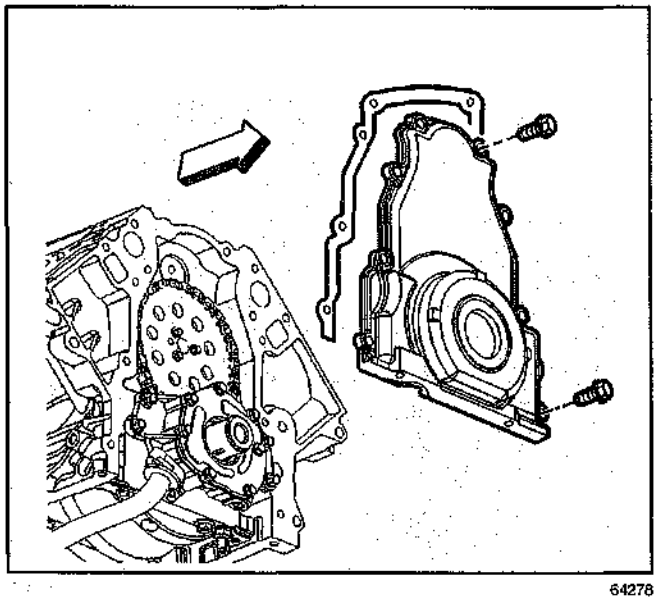
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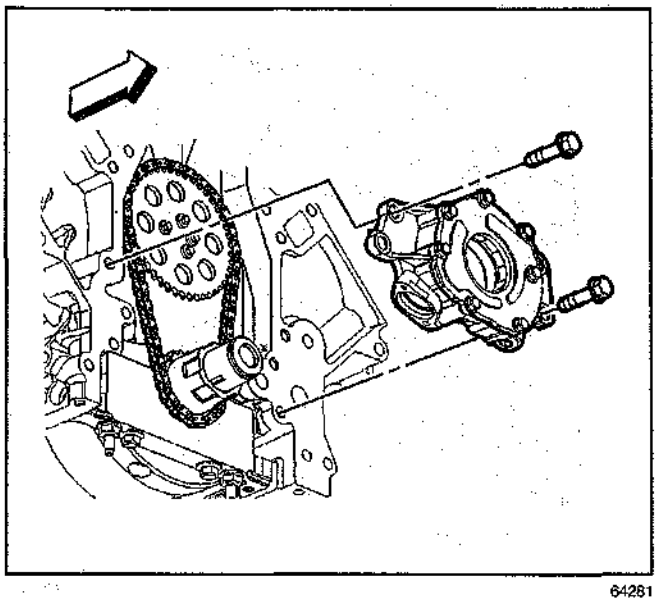
451962

Installation Procedure

1. Install the deflector, pump screen and oil pump. Refer to *Oil Pump, Pump Screen and Deflector Installation.*
2. Install the engine oil pan (2). Refer to *Oil Pan Replacement.*


64278

3. Install the engine front cover. Refer to *Engine Front Cover Replacement.*


64281

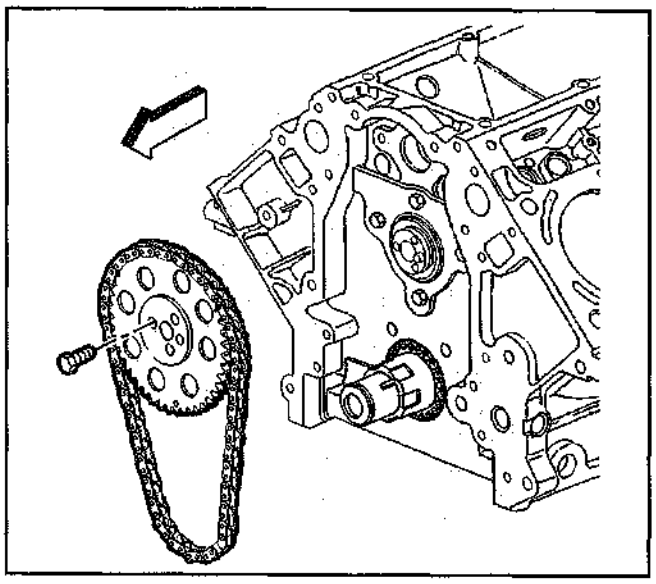
Timing Chain and Sprockets Replacement

Removal Procedure

1. Remove the oil pump. Refer to *Oil Pump, Pump Screen and Deflector Replacement.*

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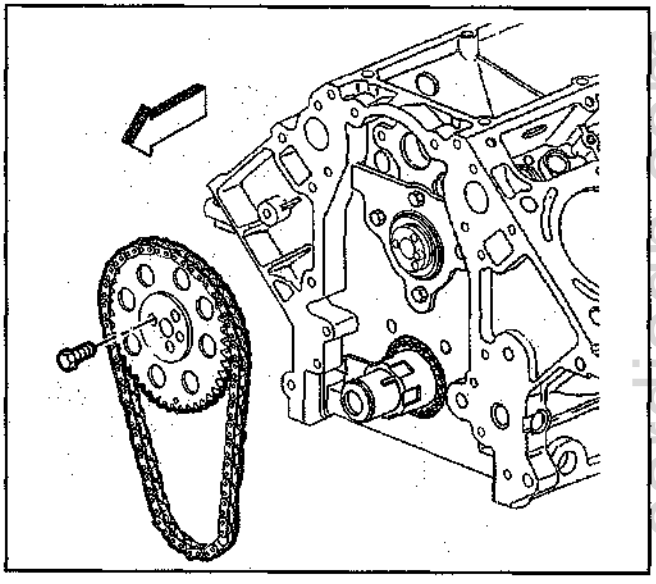
2. Remove the timing chain and sprocket. Refer to *Timing Chain and Sprockets Removal.*



63263

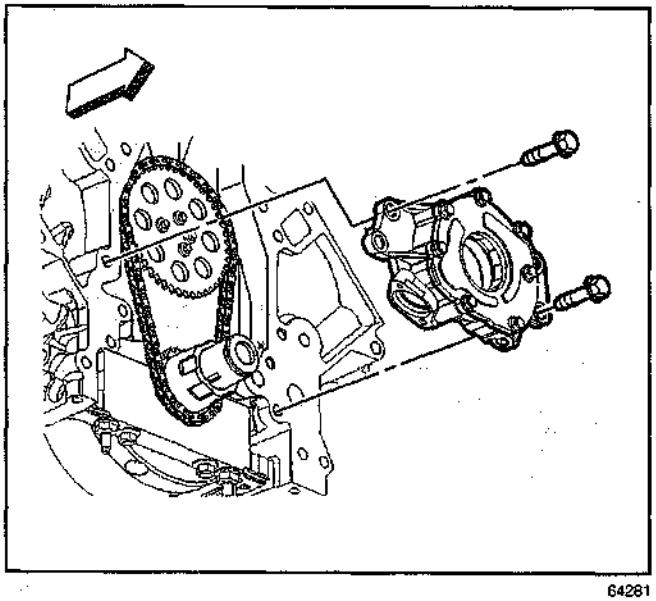
Installation Procedure

1. Install the timing chain and sprocket. Refer to *Timing Chain and Sprockets Installation.*



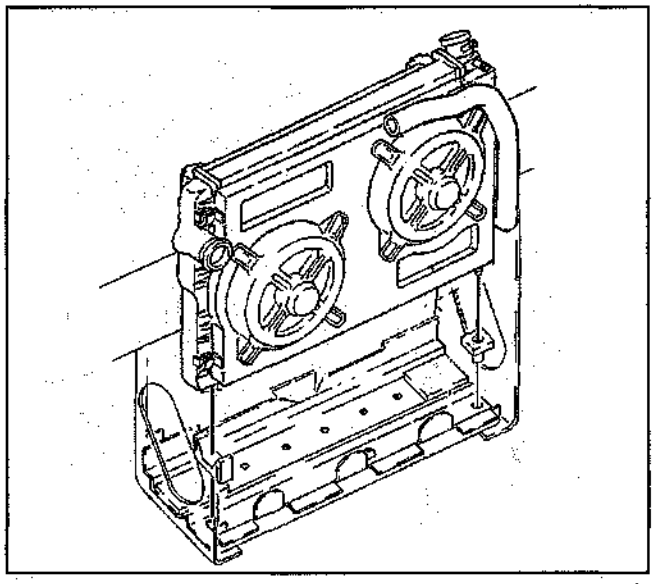
63263

2. Install the oil pump. Refer to *Oil Pump, Pump Screen and Deflector Replacement.*



64281

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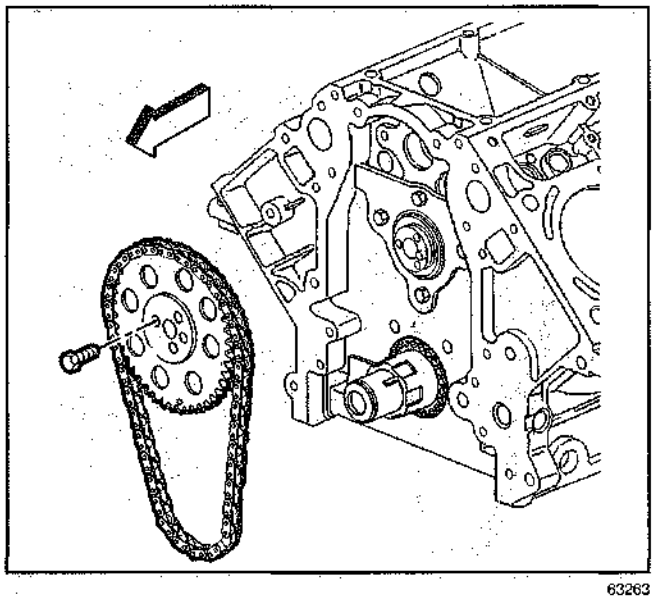


221724

Camshaft Replacement

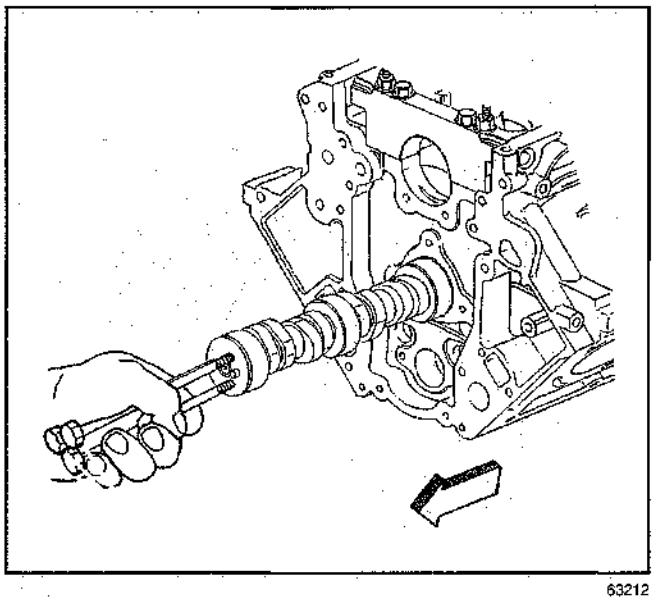
Removal Procedure

1. Remove the valve lifters. Refer to *Valve Lifter Replacement.*
2. Remove the radiator. Refer to *Radiator Replacement* in Engine Cooling.



63263

3. Remove the timing chain and sprocket. Refer to *Timing Chain and Sprockets Replacement.*



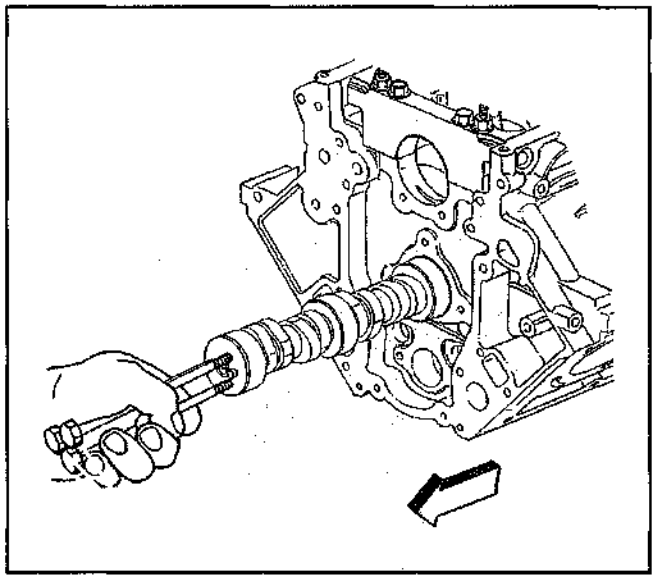
63212

4. Remove the camshaft. Refer to *Camshaft Removal.*

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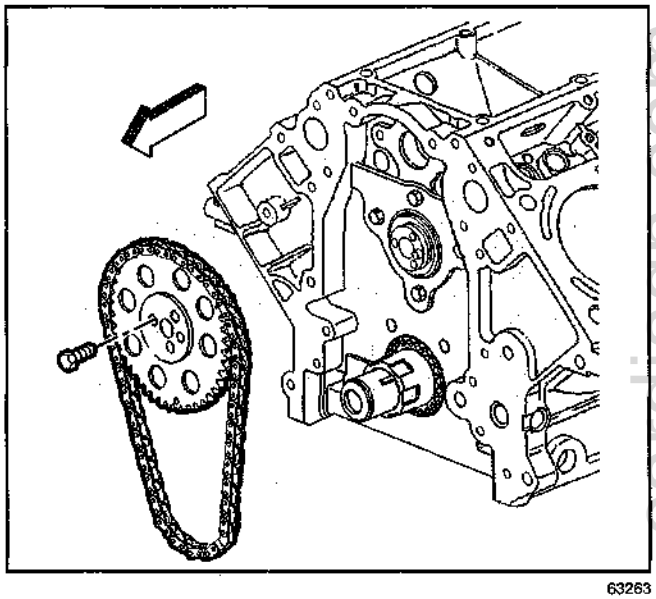
Installation Procedure

1. Install the camshaft. Refer to *Camshaft Installation.*



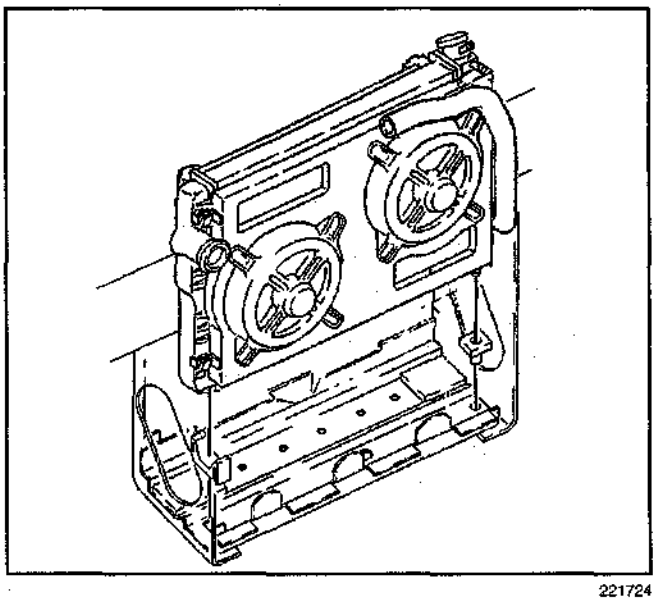
63212

2. Install the timing chain and sprocket. Refer to *Timing Chain and Sprockets Replacement.*



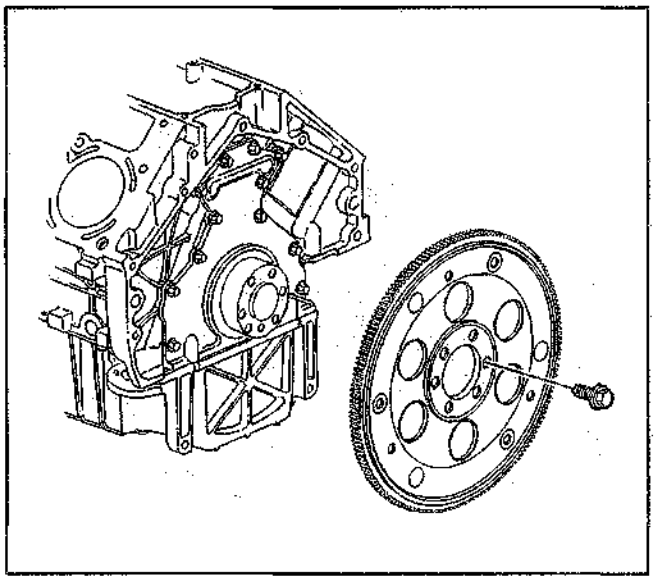
63263

3. Install the radiator. Refer to *Radiator Replacement* in Engine Cooling.
4. Install the valve lifters. Refer to *Valve Lifter Replacement.*



221724

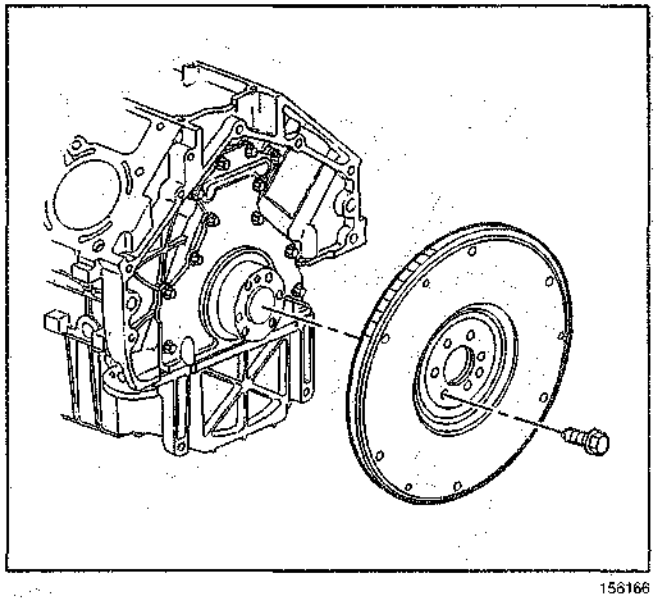
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178458

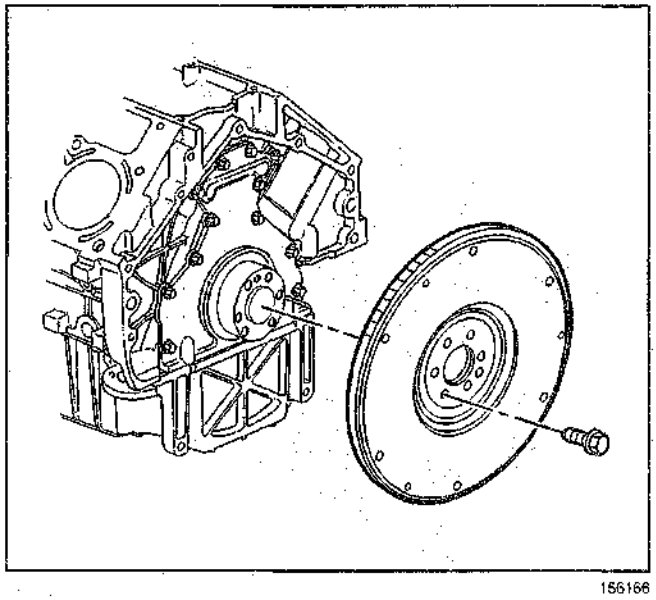
Engine Flywheel Replacement

Removal Procedure

1. Remove the automatic transmission, if applicable. Refer to *Transmission Replacement (5.7 L)* in Automatic Transmission - 4L60-E.
2. Remove the automatic transmission flywheel, if applicable. Refer to *Engine Flywheel Removal*.


156166

3. Remove the manual transmission, if applicable. Refer to *Transmission Replacement* in Manual Transmission - MM6.
4. Remove the manual transmission flywheel, if applicable. Refer to *Engine Flywheel Removal*.

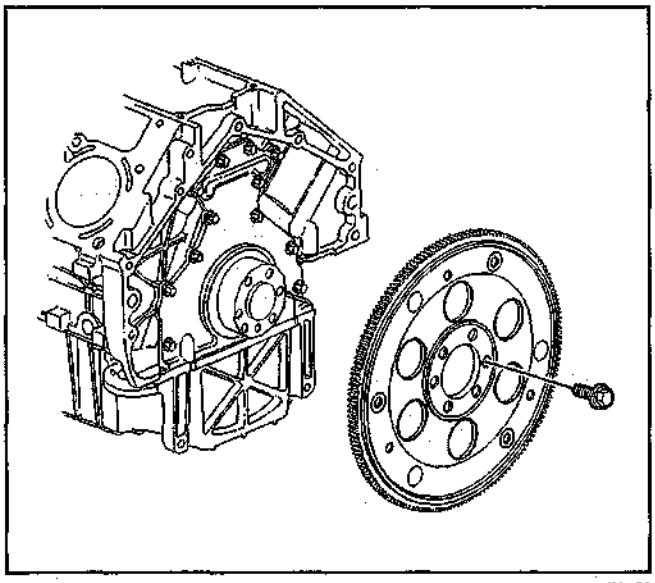

156166

Installation Procedure

1. Install the manual transmission flywheel, if applicable. Refer to *Engine Flywheel Installation*.
2. Install the manual transmission, if applicable. Refer to *Transmission Replacement* in Manual Transmission - MM6.

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3. Install the automatic transmission flywheel, if applicable. Refer to *Engine Flywheel Installation*.
4. Install the automatic transmission, if applicable. Refer to *Transmission Replacement (5.7 L)* in Automatic Transmission - 4L60-E.


178458

Engine Replacement

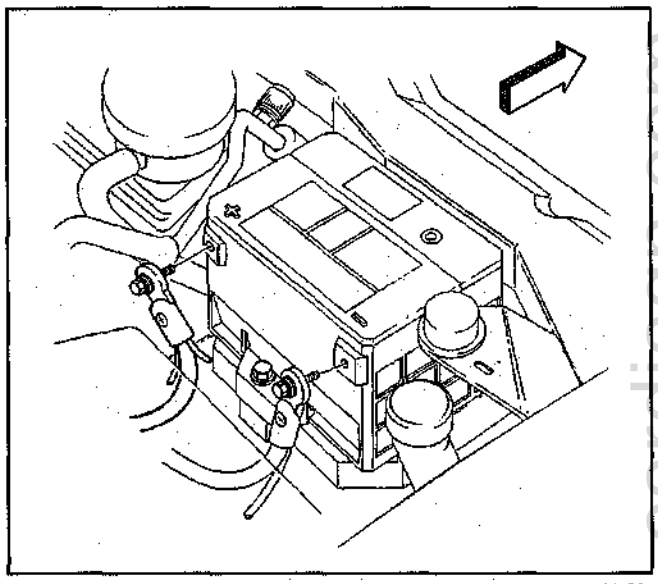
Removal Procedure

Tools Required

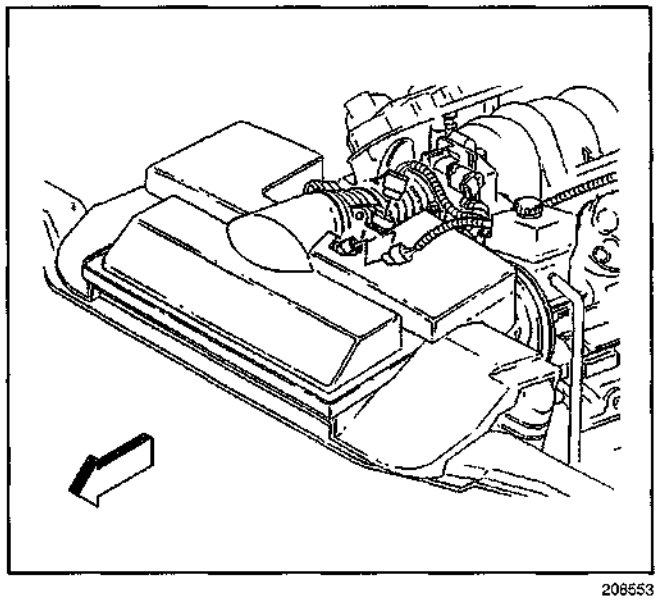
- *J 39580* Engine Support Table
- *J 36221* Hydraulic Clutch Line Separator
- *J 39549* Ball Joint/Tie Rod Separator
- *J 21366* Converter Holding Strap
- *J 39411* Flywheel Holding Tool

Caution: Refer to Battery Disconnect Caution in Cautions and Notices.

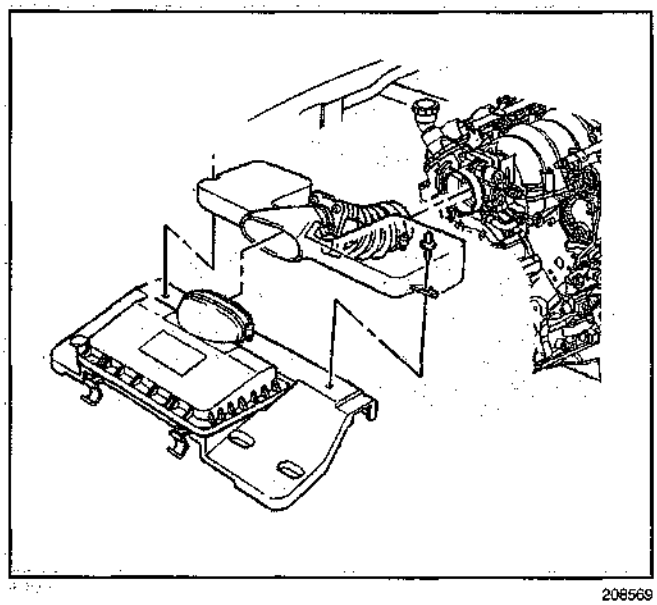
1. Disconnect the positive battery cable. Refer to *Battery Negative Cable Disconnect/Connect Procedure* in Engine Electrical.


211587

2. Disconnect the intake air temperature (IAT) sensor electrical connector.
3. Disconnect the mass airflow (MAF) sensor electrical connector.

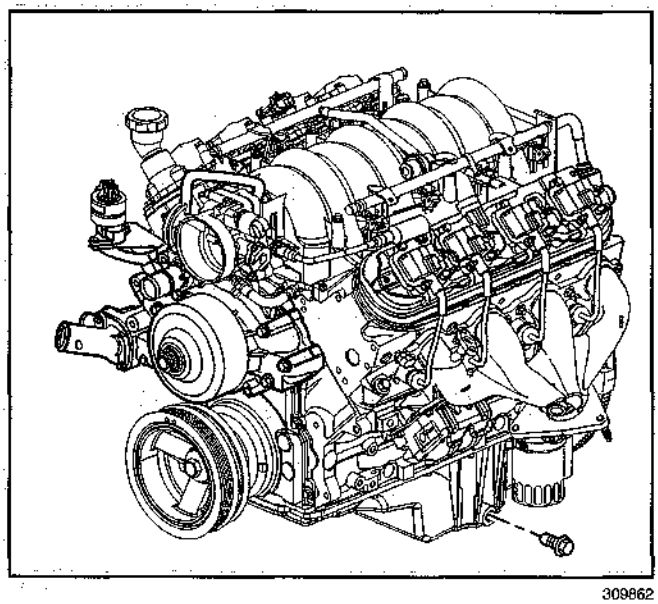

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208569

4. Remove the air intake duct resonator.
5. Recover the refrigerant. Refer to *Refrigerant Recovery and Recharging* in Heating, Ventilation and Air Conditioning.
6. Relieve the fuel system pressure. Refer to *Fuel Pressure Relief Procedure* in Engine Controls.
7. Raise and suitably support the vehicle. Refer to *Lifting and Jacking the Vehicle* in General Information

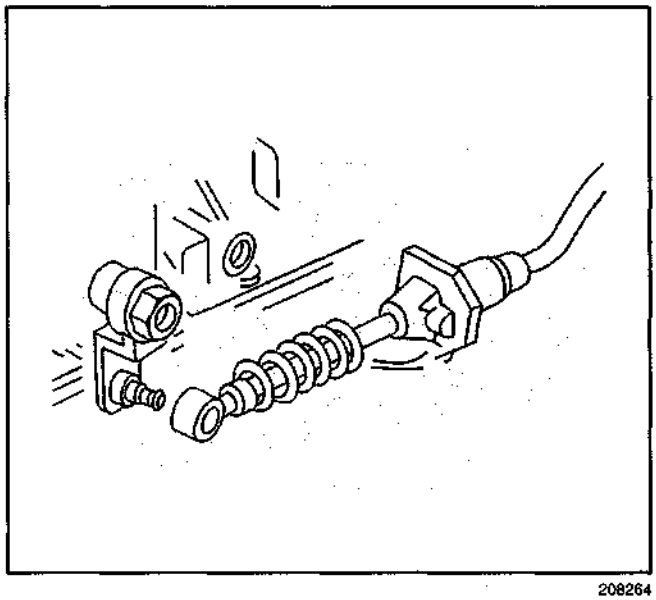


309862

8. Remove the oil pan drain plug.
9. Drain the engine oil.
10. Remove the front wheels. Refer to *Tire and Wheel Removal and Installation* in Tires and Wheels.
11. Drain the engine coolant. Refer to *Draining and Filling Cooling System (5.7 L)* in Engine Cooling.
12. Remove the left catalytic converter. Refer to *Oxidation Catalytic Converter Replacement (5.7 L Left)* in Engine Exhaust.
13. Remove the right catalytic converter. Refer to *Oxidation Catalytic Converter Replacement (5.7 L Right)* in Engine Exhaust
14. Drain the transmission fluid, if equipped with a manual transmission.
15. Remove the propeller shaft. Refer to *Propeller Shaft Replacement - One Piece* in Propeller Shaft.
16. Remove the torque arm. Refer to *Torque Arm Replacement* in Rear Suspension.
17. Remove the starter motor. Refer to *Starter Motor Replacement (5.7 L)* in Engine Electrical.

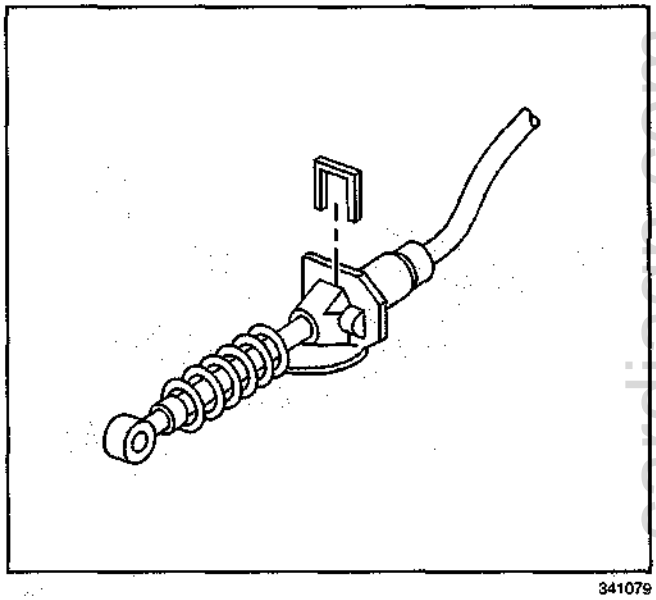
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18. On vehicles equipped with a automatic transmission, unsnap the transmission range selector lever cable from the range selector lever at the transmission.



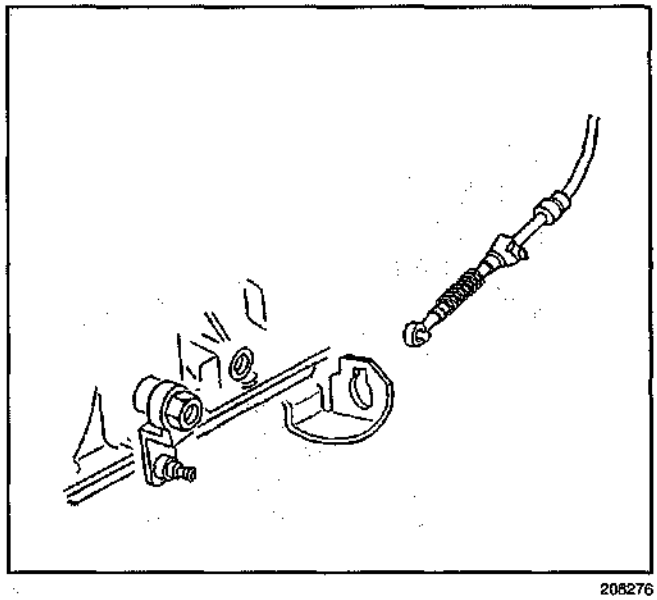
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19. Remove the retainer from the range selector lever cable.



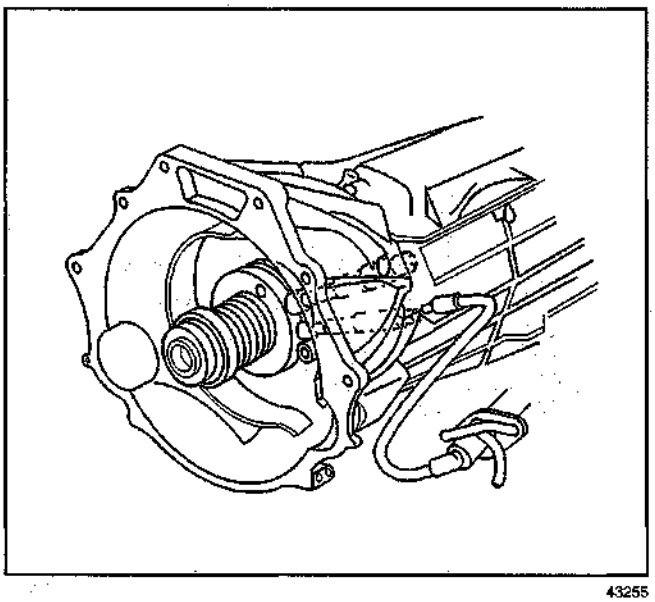
341079

20. Remove the range selector lever cable from the cable bracket.



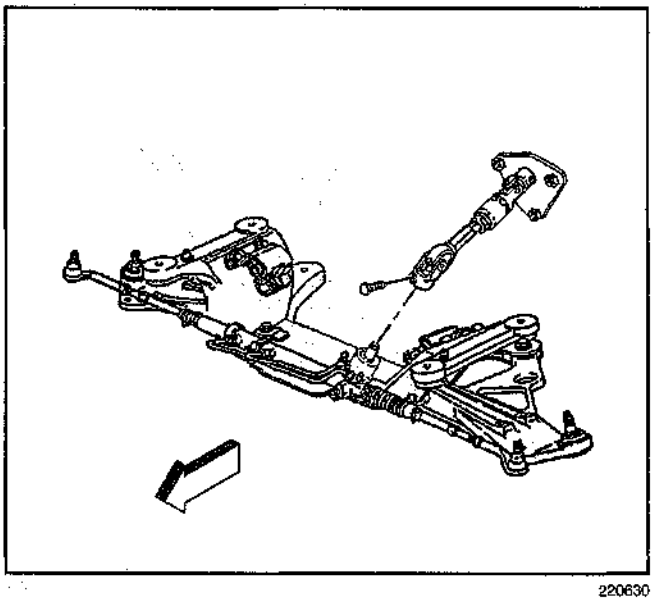
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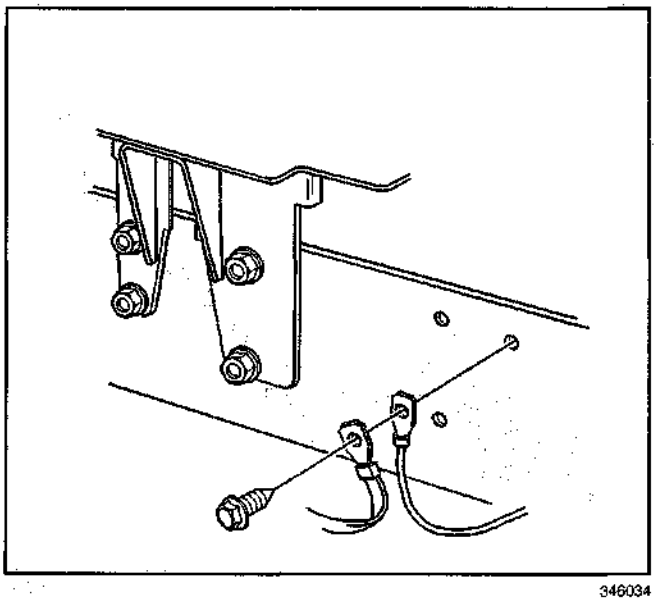
43255

21. On vehicles equipped with a manual transmission, disconnect the clutch actuator cylinder line from the actuator cylinder using *J 36221*.
22. Remove the left side front air deflector. Refer to *Air Deflector Replacement - Front Bumper Fascia* in Bumpers.
23. Remove the stabilizer bar bracket bolts.
24. Remove the stabilizer bar brackets.



220630

25. Remove the intermediate steering shaft bolt and shaft from the rack.

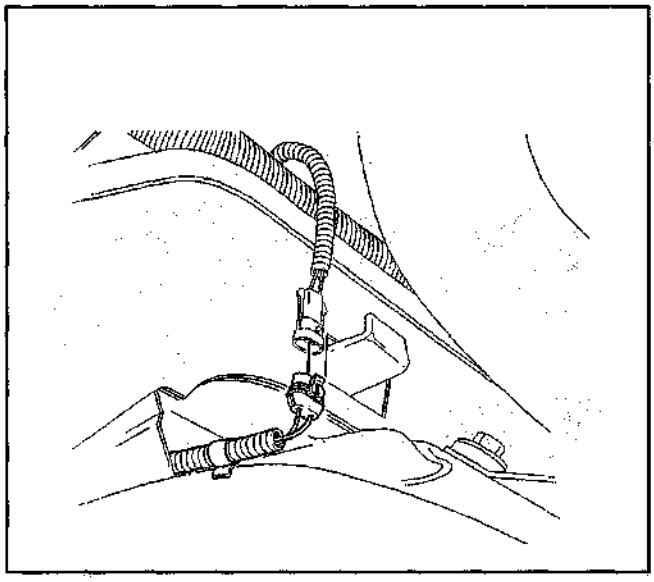


346034

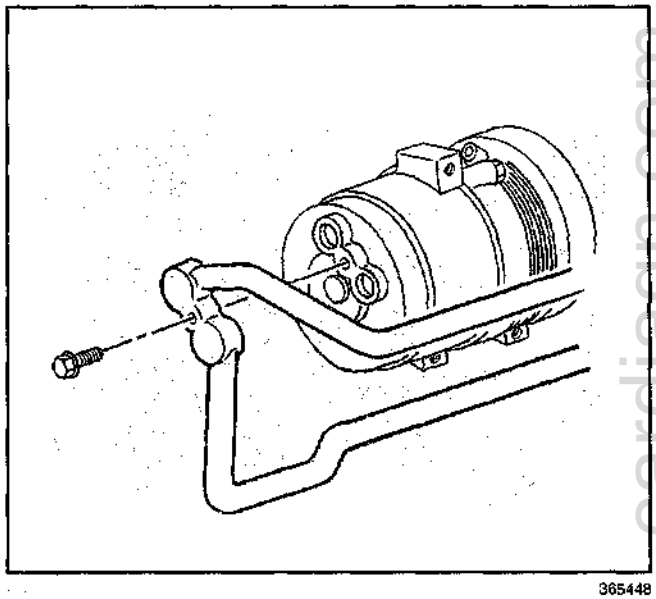
26. Remove the wiring harness ground bolt and RF (Radio Frequency) ground strap and cruise control ground lead from the front rail.

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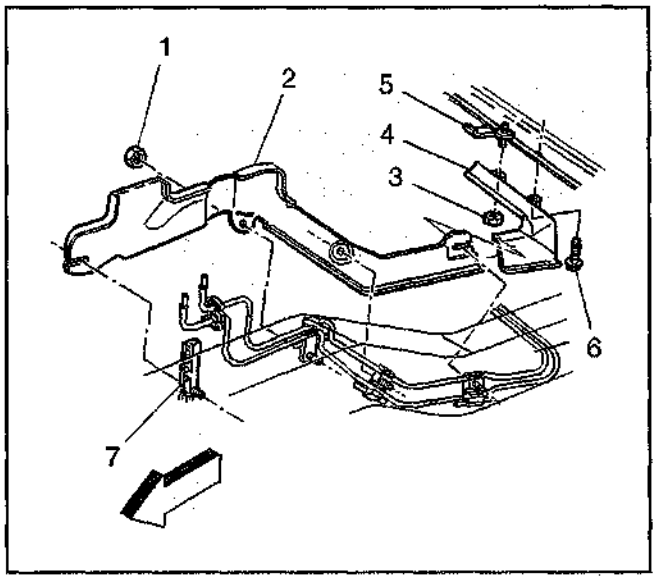
27. Disconnect the wheel speed sensor electrical connectors.


346036

28. Remove the air conditioning (A/C) compressor and condenser hose bolt.
29. Discard the O-ring.

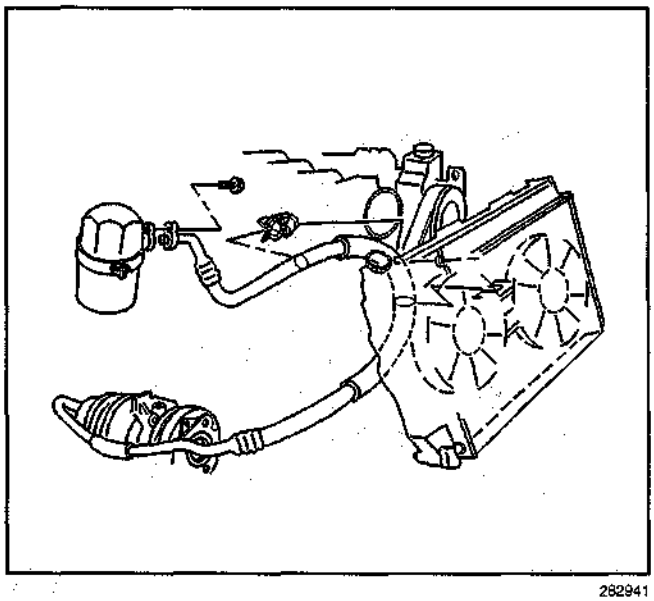

365448

30. Remove the front fuel pipe heat shield nuts (1).
31. Remove the front fuel pipe heat shield (2).
32. Disconnect the brake lines from the brake pipe clip.
33. Lower the vehicle.



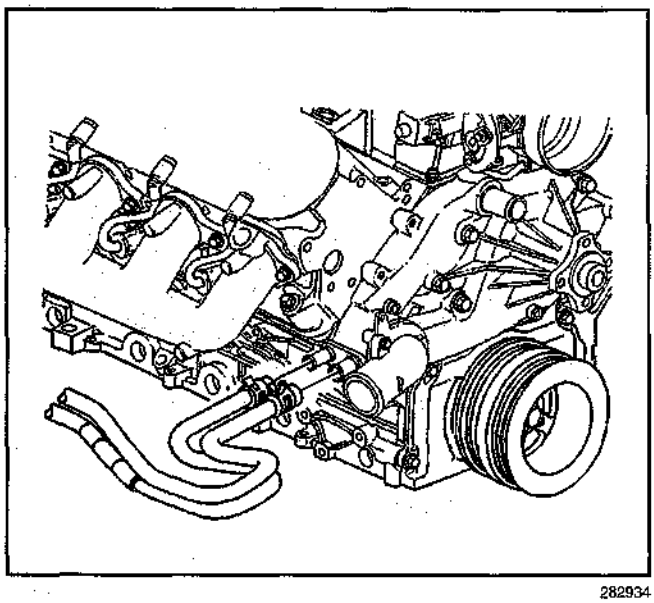
173551

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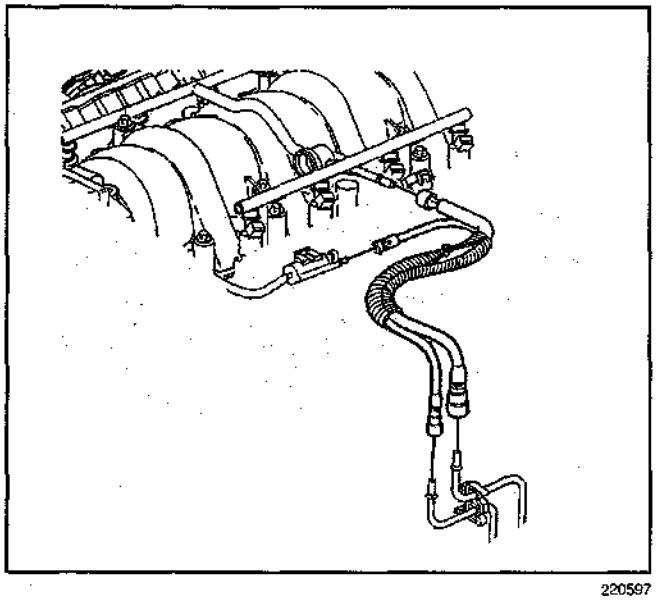
282941

34. Remove the A/C compressor and condenser hose bolt at the accumulator.
35. Discard the O-ring.



282934

36. Remove the inlet and outlet heater hoses from the water pump.
    36.1. Squeeze the hose clamp together with pliers.
    36.2. Slide the hose clamp away from the water pump fitting.
    36.3. Gently twist and pull the heater hose from the water pump fitting.

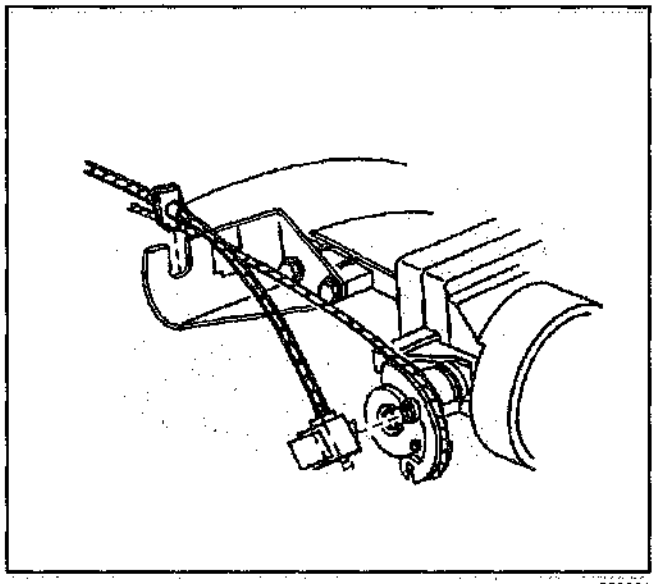


220597

37. Disconnect the fuel line from the fuel rail.
38. Disconnect the vapor line from the fuel vapor purge valve.

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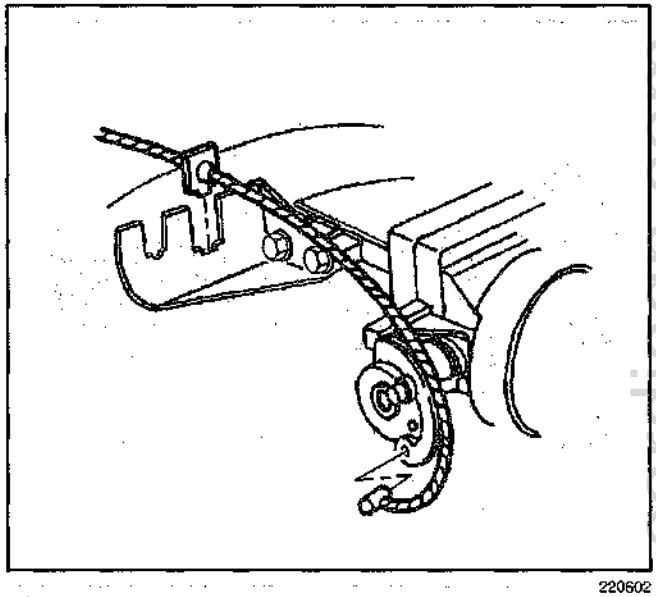
39. Remove the cruise control cable from the throttle lever.


220601

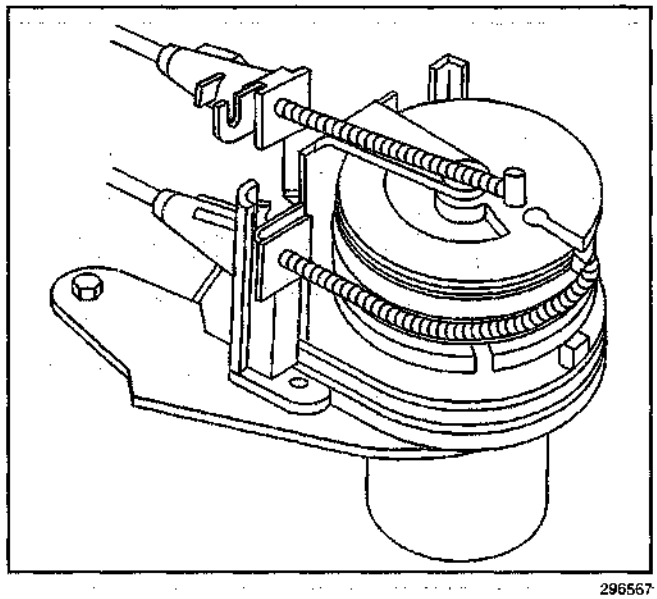
Caution: In order to avoid possible injury or vehicle damage, always replace the accelerator control cable with a NEW cable whenever you remove the engine from the vehicle.

In order to avoid cruise control cable damage, position the cable out of the way while you remove or install the engine. Do not pry or lean against the cruise control cable and do not kink the cable. You must replace a damaged cable.

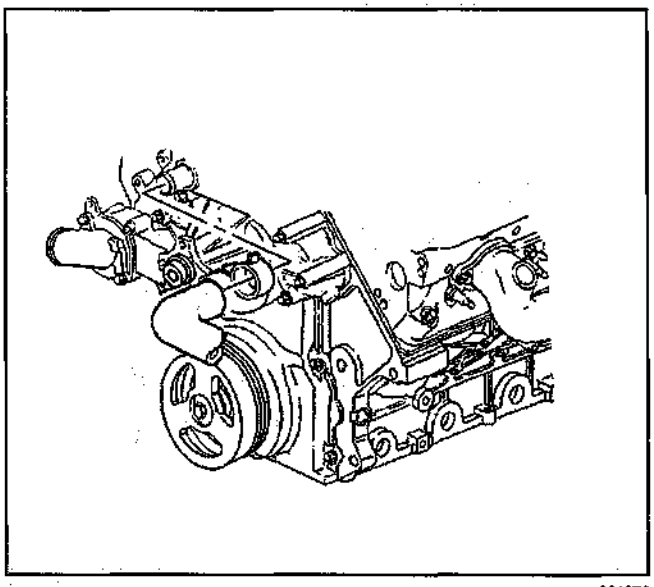
40. Remove the accelerator control cable from the throttle lever.
41. Unsnap and remove the accelerator and cruise control cable from the throttle body bracket.


220602

42. Remove the cruise control and accelerator control cables from the servo adjuster, if equipped.

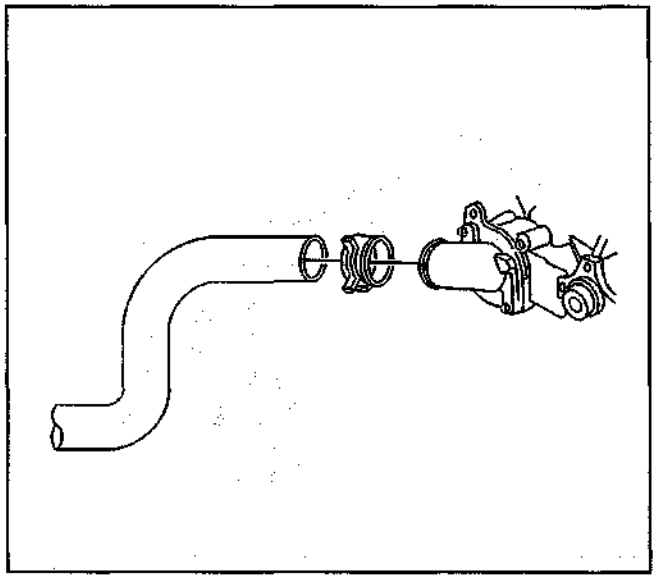

296567

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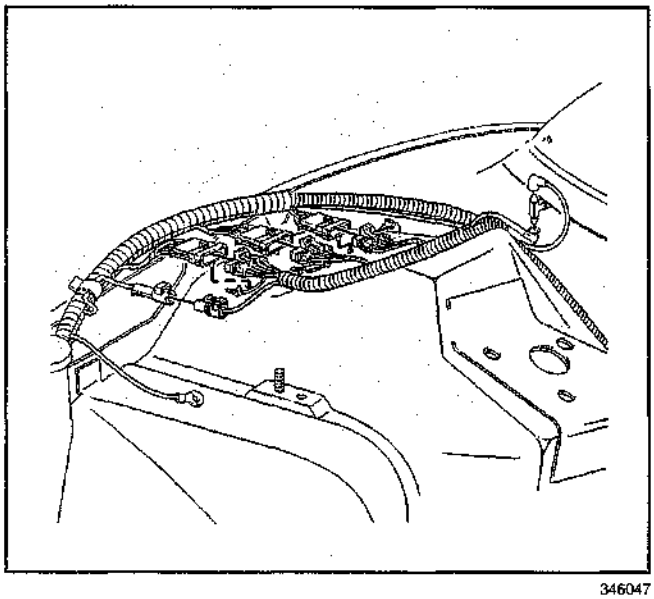
221676

43. Remove the outlet hose from the water pump.



221671

44. Remove the inlet hose from the water inlet.
45. Remove the brake booster vacuum hose.
46. Remove the front two brake lines from the brake pressure modulator valve.

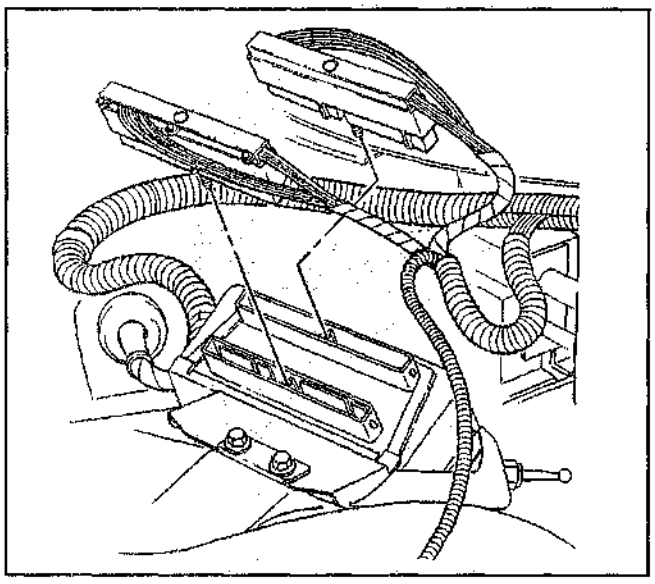


346047

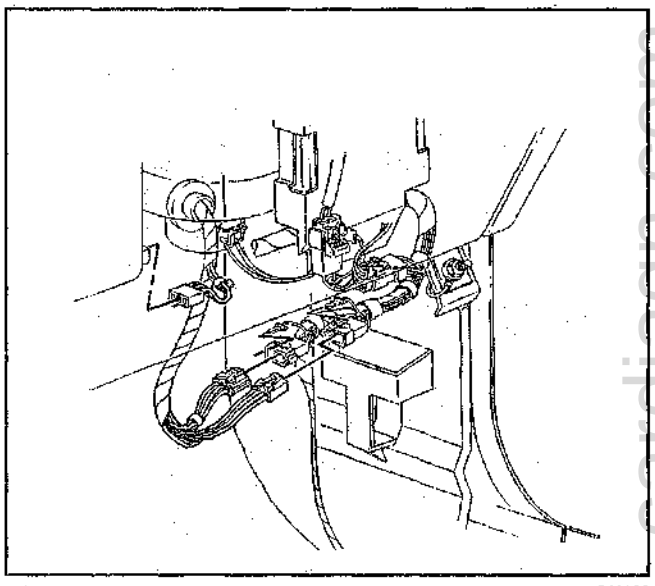
47. Disconnect the secondary captured locks.
48. Disconnect the forward lamp harness from the engine harness.
49. Disconnect the engine harness vacuum tube from the bottom of the vacuum check valve.

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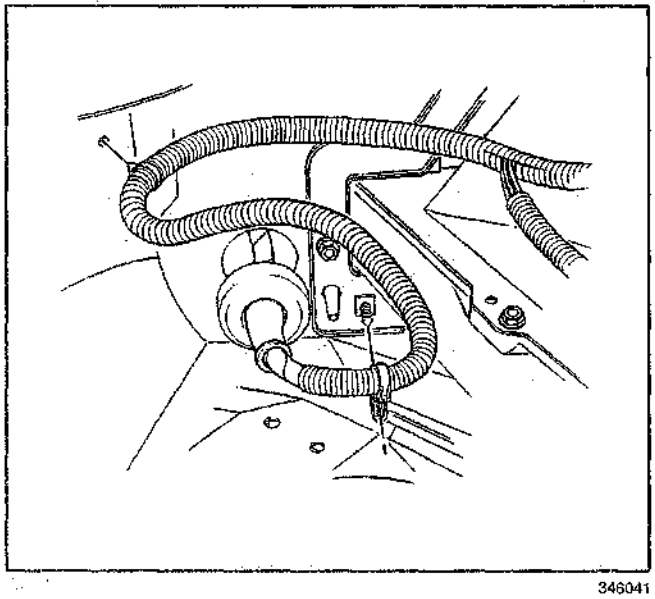
50. Disconnect the powertrain control module (PCM) connectors.
51. Remove the PCM from the vehicle.
52. Remove the right side insulator panel. Refer to *Closeout/Insulator Panel Replacement - Right* in Instrument Panel, Gauges and Console.
53. Remove the hinge pillar trim panel. Refer to *Trim Replacement - Hinge Pillar* in Interior Trim.


346043

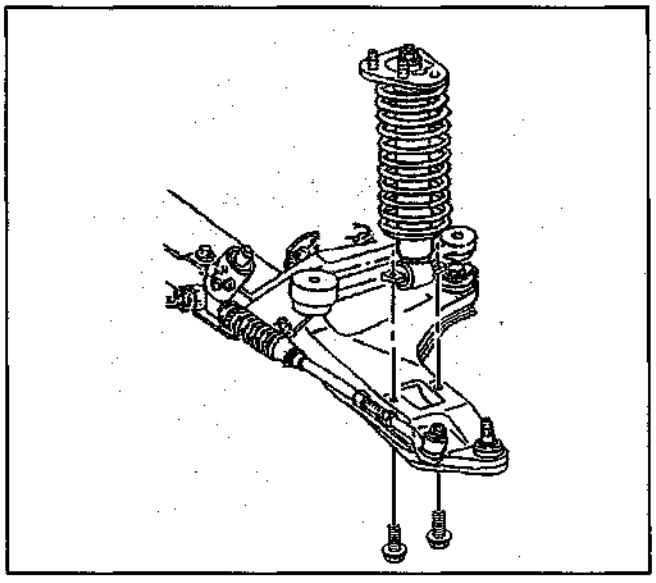
54. Disconnect the engine wiring harness from the instrument panel wiring harness.


346039

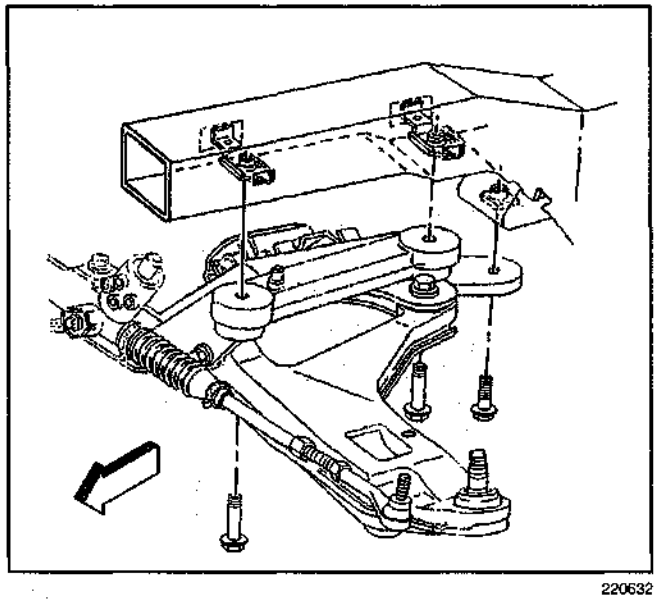
55. Remove the engine wire harness through the front of dash. Place the harness on top of the engine.
56. Remove the floor shift control, if equipped. Refer to *Floor Shift Control Replacement* in Automatic Transmission - 4L60-E.
57. Remove the transmission control, if equipped. Refer to *Shift Control Assembly Replacement* in Manual Transmission - MM6.
58. Raise and suitably support the vehicle. Refer to *Lifting and Jacking the Vehicle* in General Information.


346041

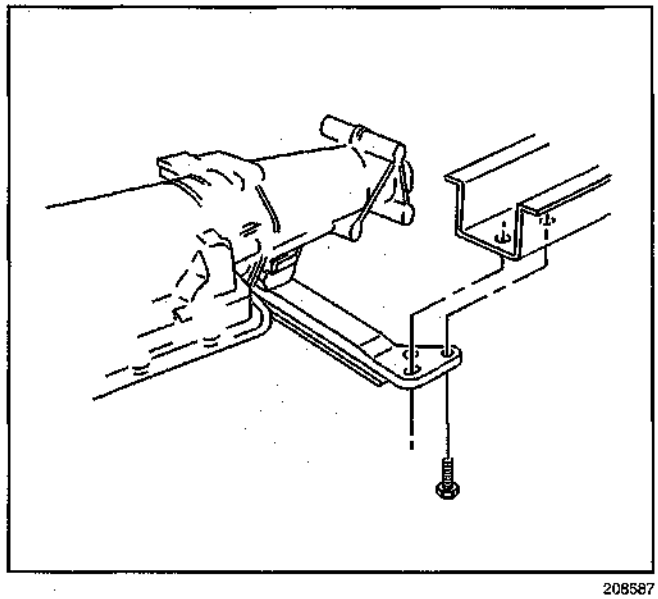
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220629

59. Remove the right and left side shock absorber lower mounting bolts.
60. Remove the cotter pins and nuts from the left and right upper ball joints.
61. Using *J 39549* separate the upper control arms from the steering knuckles.
62. Support both steering knuckles.
63. Position the *J 39580* below the vehicle.
64. Lower the vehicle until the crossmember is resting on the *J 39580*.
65. Lay the engine wire harness on top of the engine.


220632

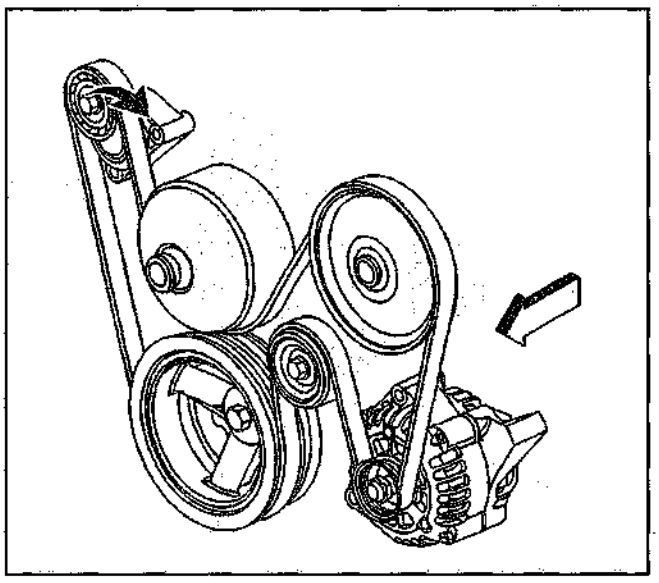
66. Remove the front crossmember bolts.


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67. Remove the transmission support bolts.
68. Raise the vehicle and remove the engine and transmission from the vehicle.
69. Secure the crossmember to the *J 39580*.

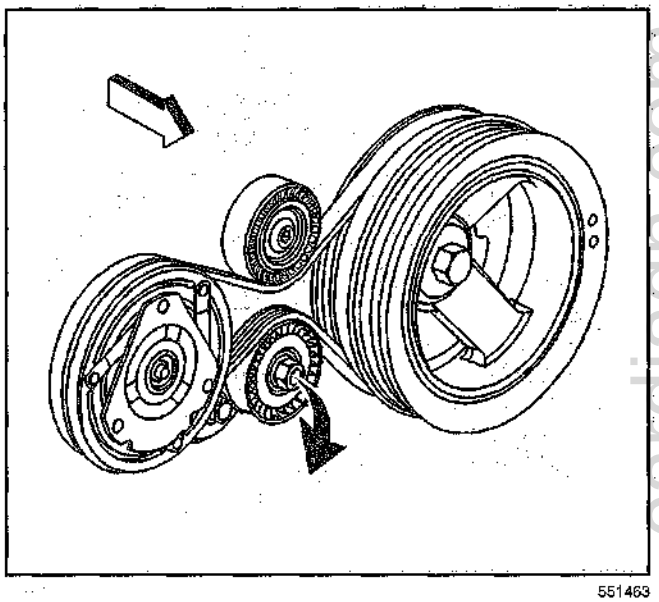
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70. Position a hex-head socket on the belt tensioner pulley bolt.
71. Rotate the drive belt tensioner clockwise to relieve the tension on the drive belt.
72. Remove the drive belt from the tensioner and pulleys.



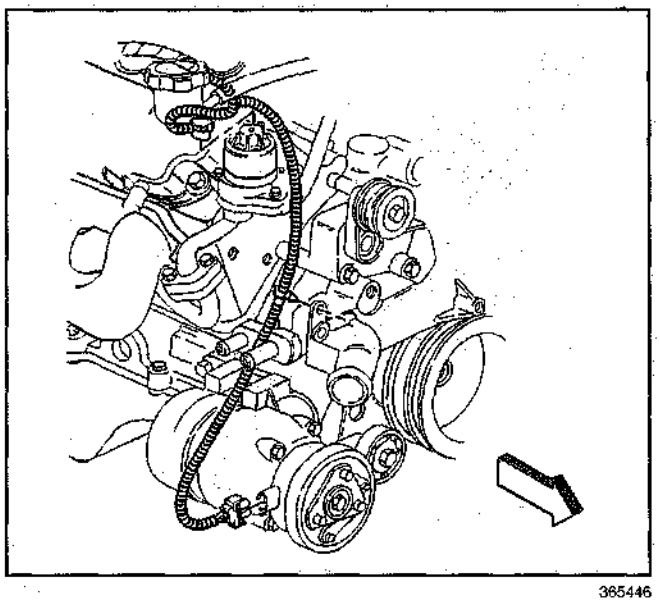
551461

73. Position a hex-head socket on the belt tensioner pulley bolt.
74. Rotate the air conditioning (A/C) drive belt tensioner clockwise to relieve the tension on the drive belt.
75. Remove the A/C drive belt from the crankshaft balancer and A/C compressor.



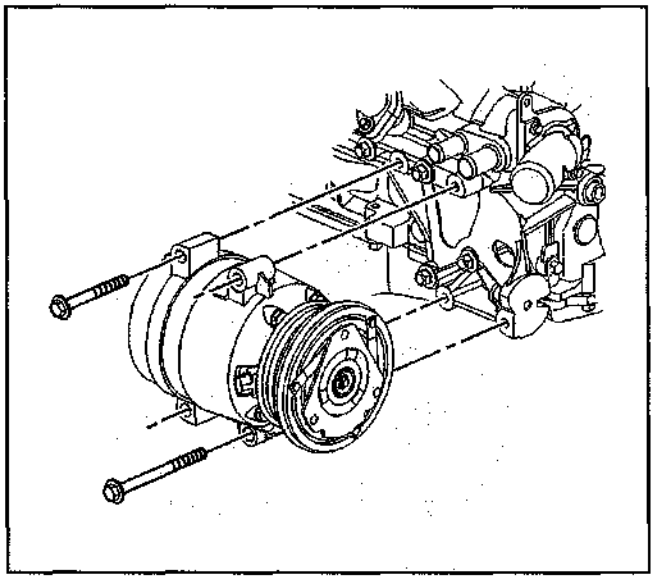
551463

76. Disconnect the A/C compressor electrical connector.



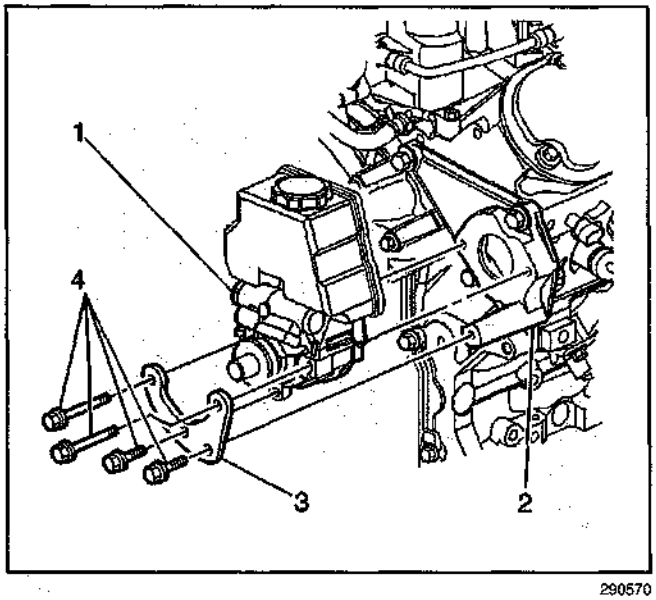
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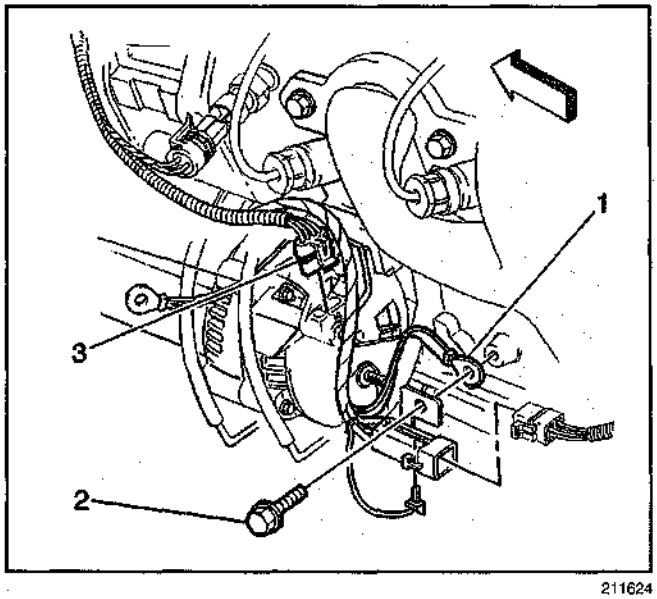
282955

77. Remove the A/C compressor bolts.
78. Remove the A/C compressor.



290570

79. Remove the power steering pump bolts (4) and pump brace (3).
80. Remove the power steering pump (1) from the bracket (2).
81. Reposition the power steering pump to the crossmember.

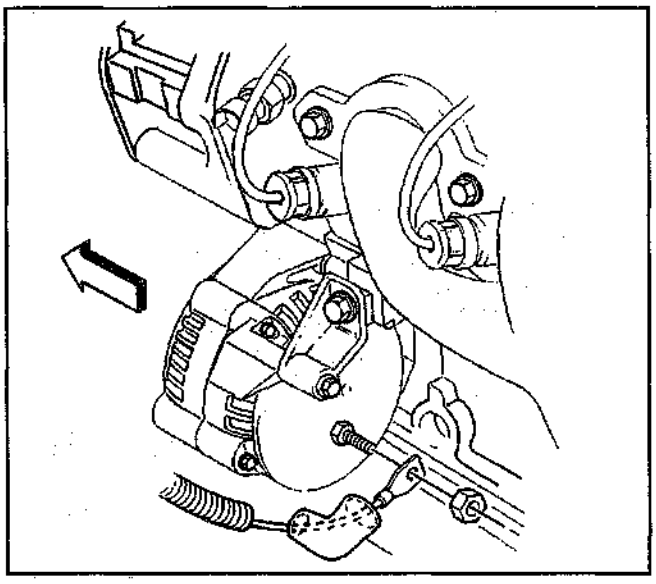


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82. Disconnect the generator electrical connector (3).

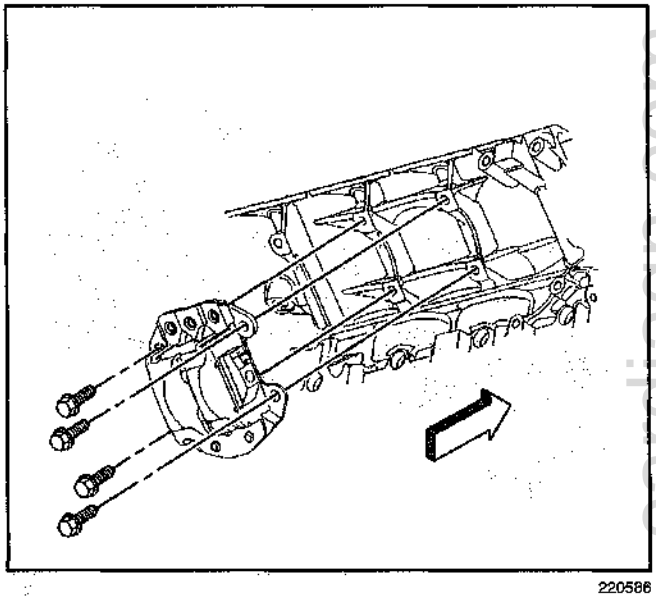
cardiagn.com

83. Remove the positive cable nut from the generator.
84. Remove the positive cable from the generator.
85. Install a engine hoist the block.



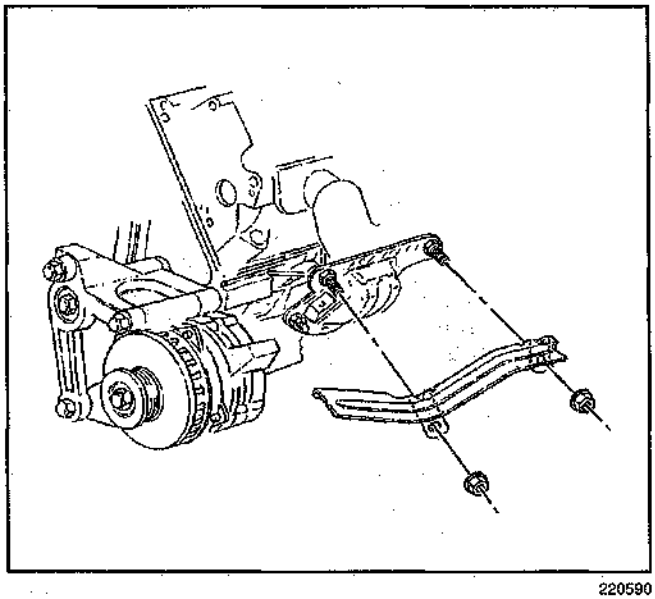
211599

86. Remove the right side engine mount bracket to block bolts and bracket.



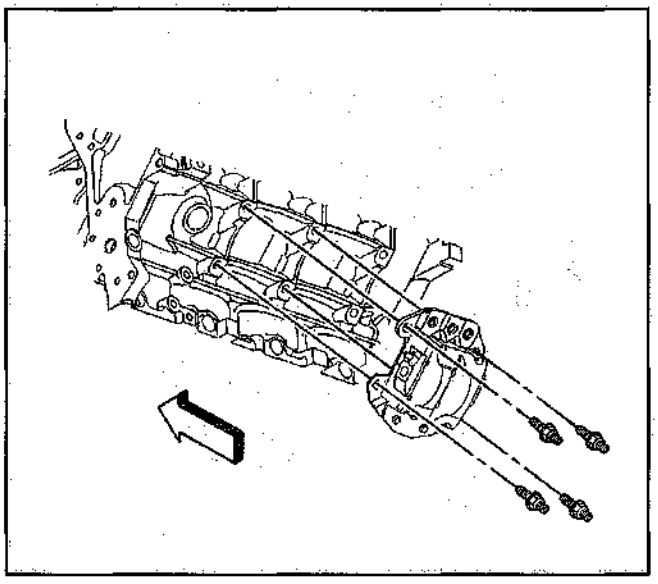
220586

87. Remove the engine mount heat shield nuts.
88. Remove the engine mount heat shield.



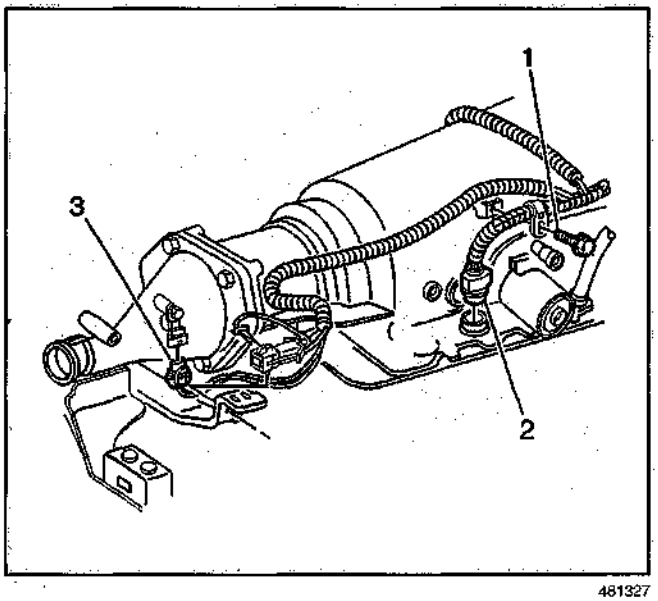
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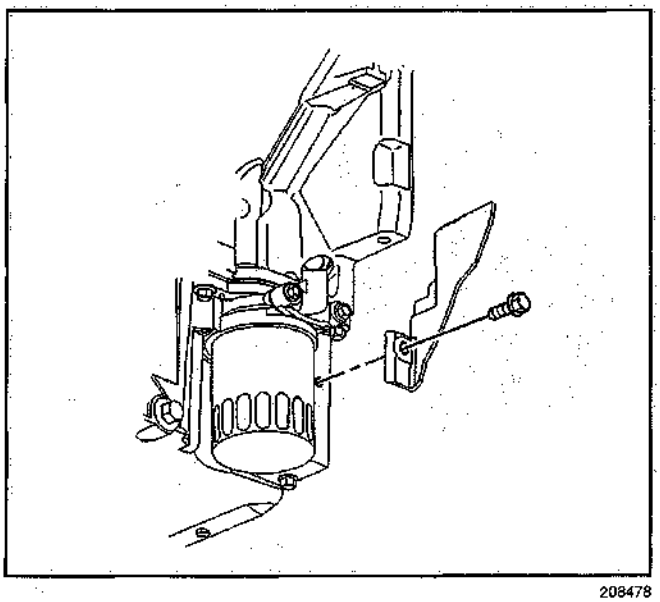
220591

89. Remove the left side engine mount bracket to block studs and bracket.
90. With the aide of an assistant, raise the engine and transmission from the crossmember.



481327

91. Remove the harness clamp bolt (1).
92. Disconnect the following electrical connectors from the transmission:
    - 20-way connector (2)
    - Vehicle speed sensor (3)
93. If equipped with an automatic transmission perform the following:

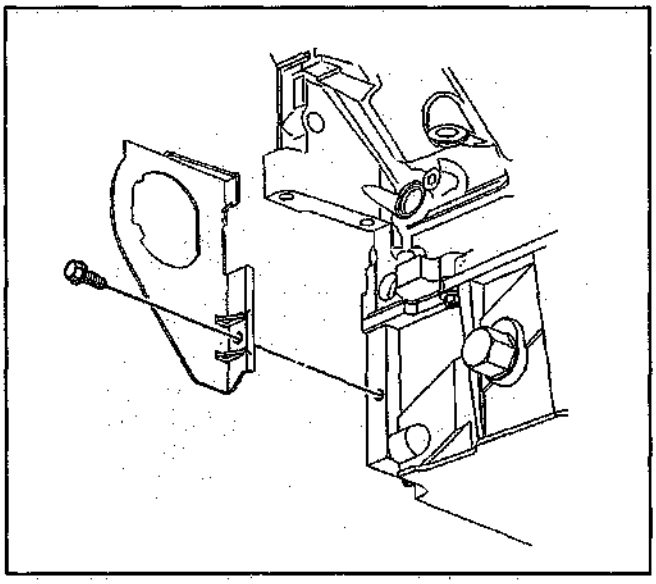


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94. Remove the left side transmission closeout and bolt.

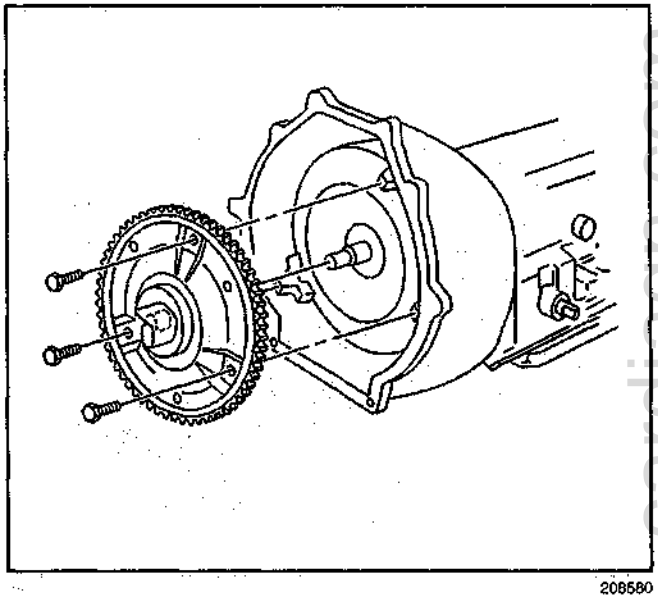
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95. Remove the right side transmission closeout and bolt.



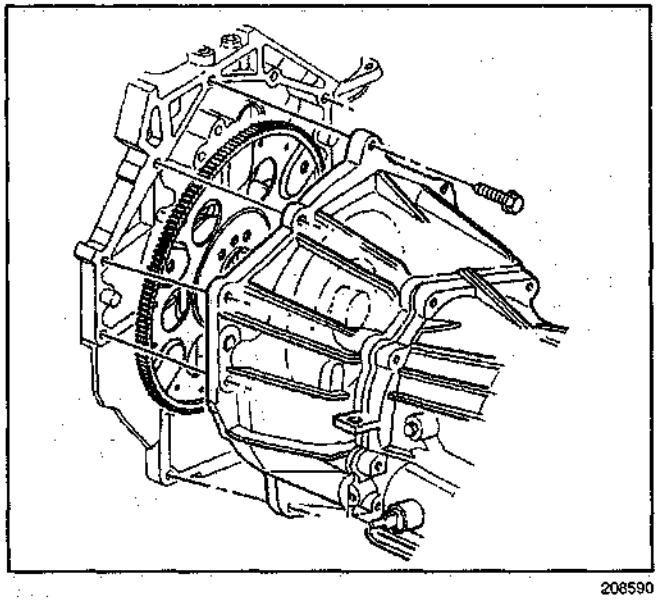
206464

96. Remove the flywheel to torque converter bolts.



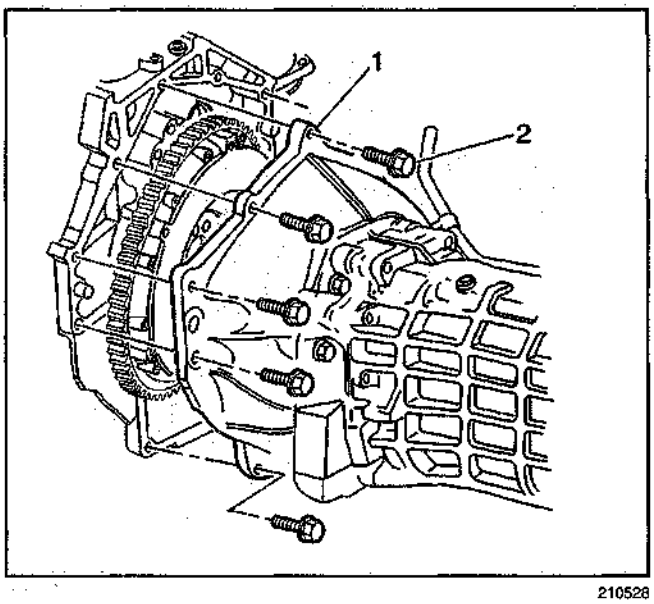
208580

97. Remove the transmission to engine bolts.
98. Separate the transmission from the engine.
99. Attach the *J 21366* to the transmission.
100. If equipped with a manual transmission, perform the following:



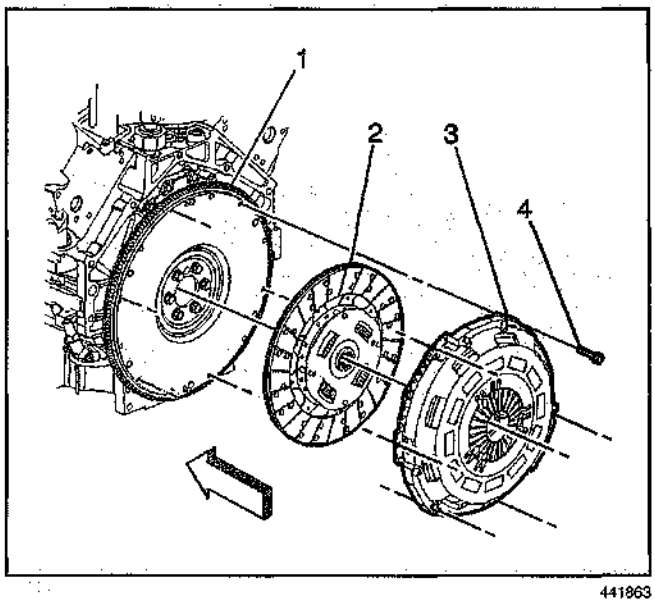
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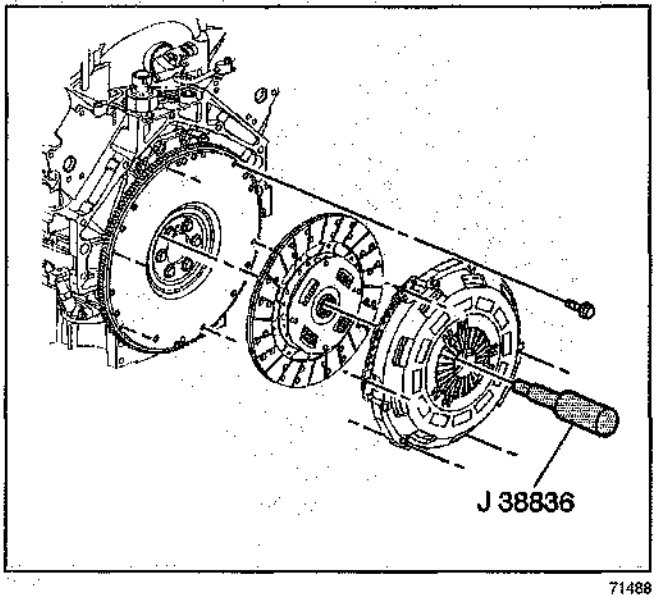
210528

101. Remove the flywheel housing to engine bolts (2).
102. Separate the flywheel housing from the engine.



441863

103. Remove the pressure plate bolts (4).
104. Remove the pressure plate (3) and clutch disc (2) from the flywheel (1).
105. Install the engine to a engine stand.
106. Remove the engine hoist.



71488

Installation Procedure

Tools Required

J 38836 Pilot Bushing Installer/Clutch Alignment Arbor

1. Install a engine hoist to the block.
2. Remove the engine from the engine stand.
3. If equipped with a manual transmission, perform the following:
4. Install the clutch disc and pressure plate to the flywheel.
5. Install the pressure plate bolts finger tight.
6. Use the *J 38836* to align the clutch disc splines with the pilot bearing.

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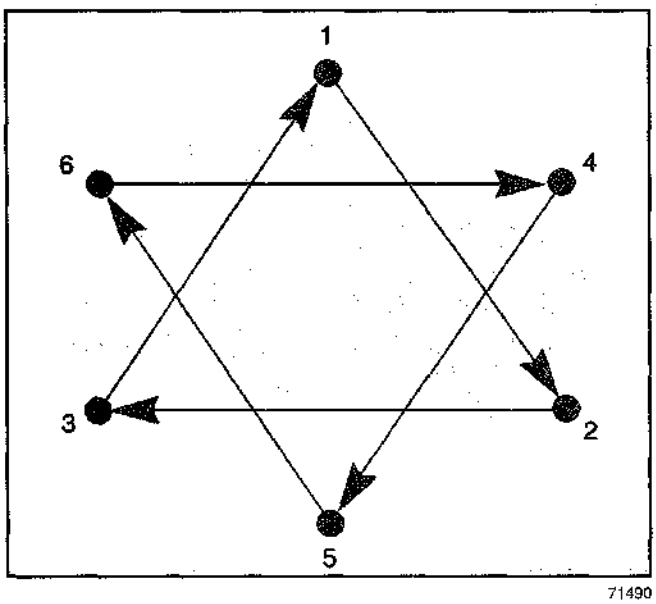
Notice: Refer to *Fastener Notice* in Cautions and Notices.

7. Tighten the clutch pressure plate bolts.

   Tighten

   Tighten the clutch pressure plate bolts in sequence (as shown) and evenly over 3 increments with the fourth increment to 70 N·m (52 lb ft).

8. Remove the *J 38836*.



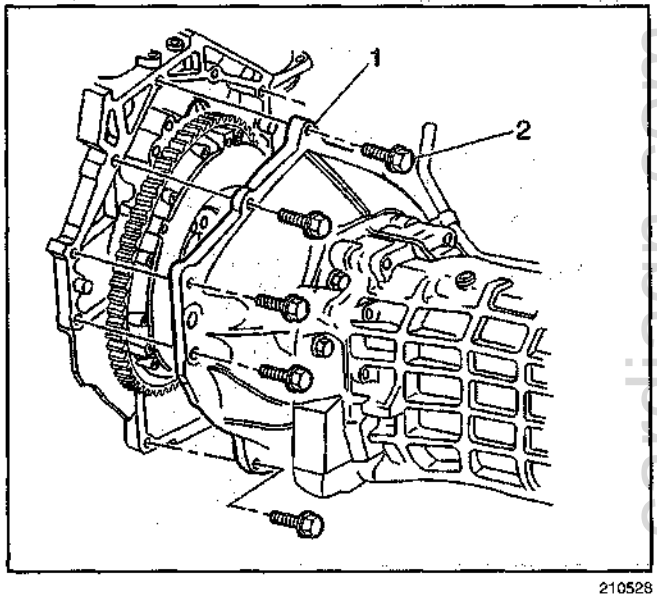
71490

9. Install the flywheel housing to engine bolts (2).

   Tighten

   Tighten the flywheel housing to engine bolts (2) to 50 N·m (37 lb ft).

10. If equipped with an automatic transmission perform the following:

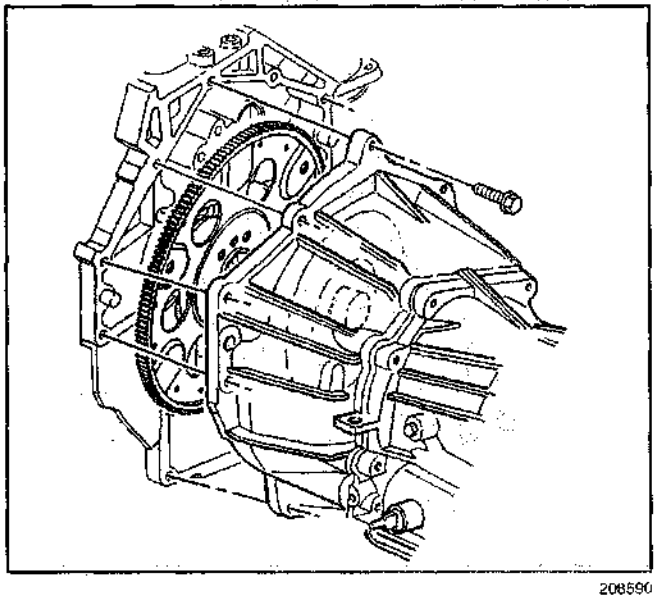


210528

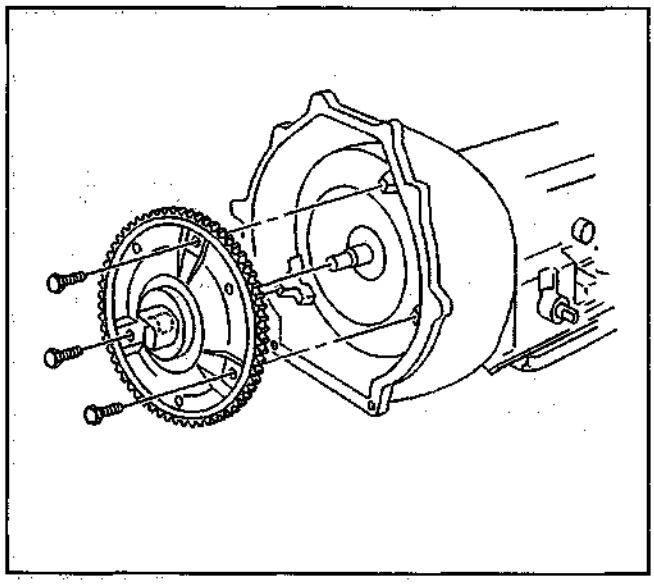
11. Remove the *J 21366* from the transmission.
12. Install the transmission to engine bolts.

    Tighten

    Tighten the transmission to engine bolts to 50 N·m (37 lb ft).


208590

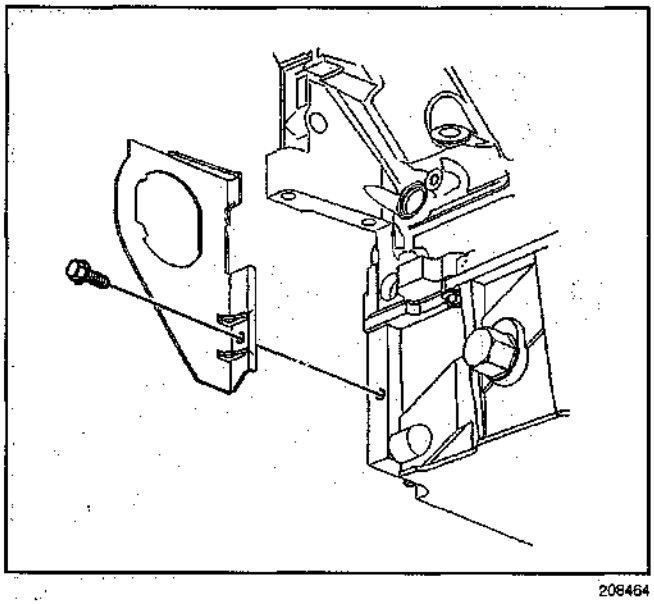
cardiagn.com


208580

13. Install the flywheel to torque converter bolts.

Tighten

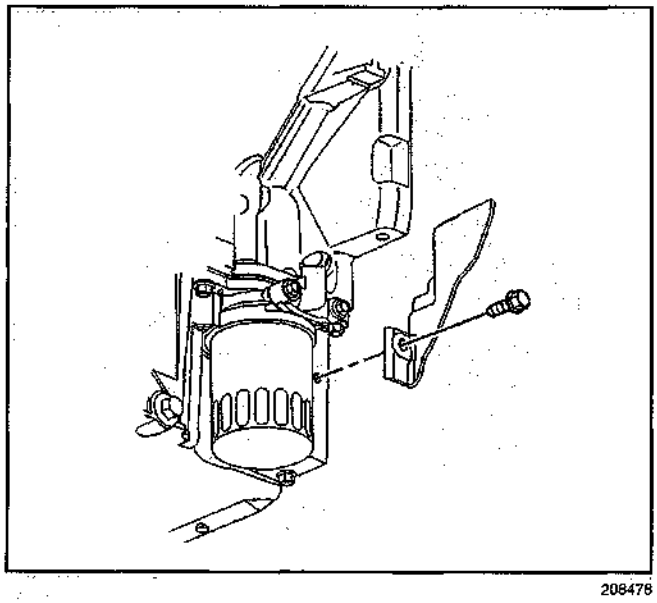
Tighten the flywheel to torque converter cover bolts to 60 N·m (44 lb ft).


208464

14. Install the right side transmission closeout and bolt.

Tighten

Tighten the right side closeout bolt to 12 N·m (106 lb in).


208478

15. Install the left side transmission closeout and bolt.

Tighten

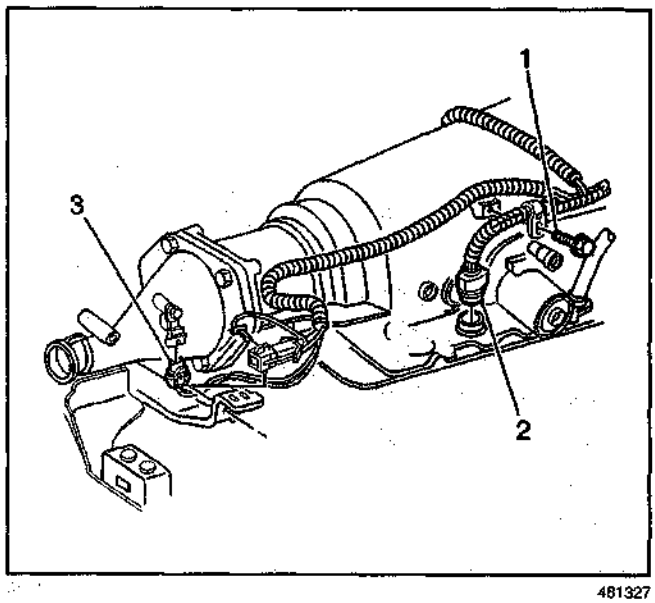
Tighten the left side closeout bolt to 12 N·m (106 lb in).

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16. Connect the following electrical connectors to the transmission:
    - 20-way connector (2)
    - Vehicle speed sensor (3)
17. Install the harness clamp bolt (1).

    Tighten

    Tighten the harness clamp bolt (1) to 2.5 N·m (22 lb in).
18. With the aide of an assistant, lower the engine and transmission to the crossmember.

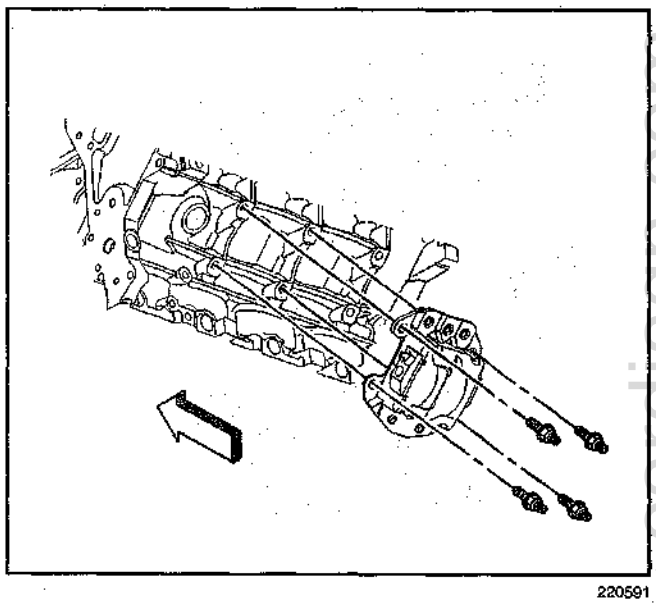


481327

19. Install the left side engine mount bracket and studs.

    Tighten

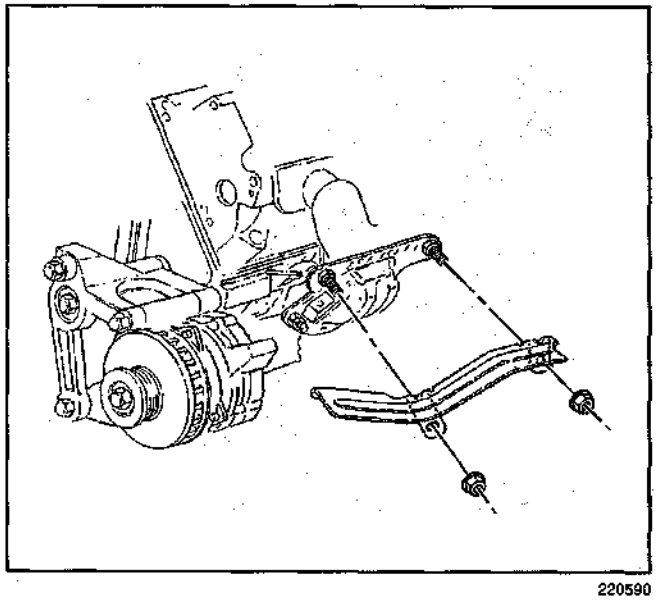
    Tighten the engine mount bracket studs to 50 N·m (37 lb ft).


220591

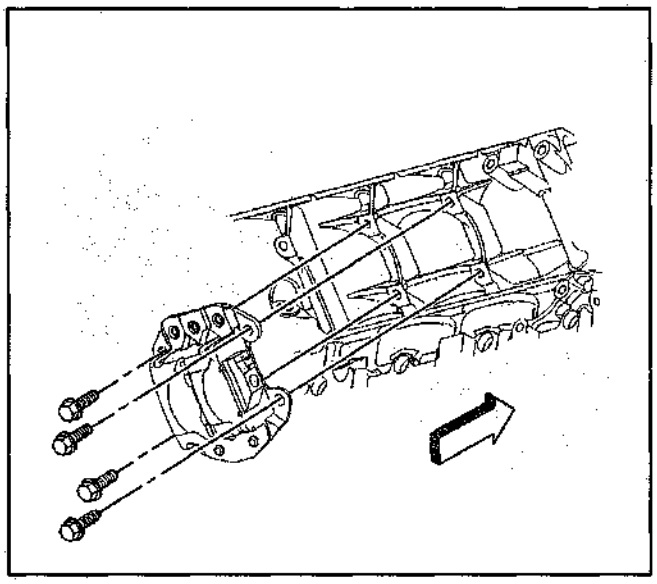
20. Install the engine mount heat shield.
21. Install the engine mount heat shield nuts.

    Tighten

    Tighten the engine mount heat shield nuts to 10 N·m (89 lb ft).


220590

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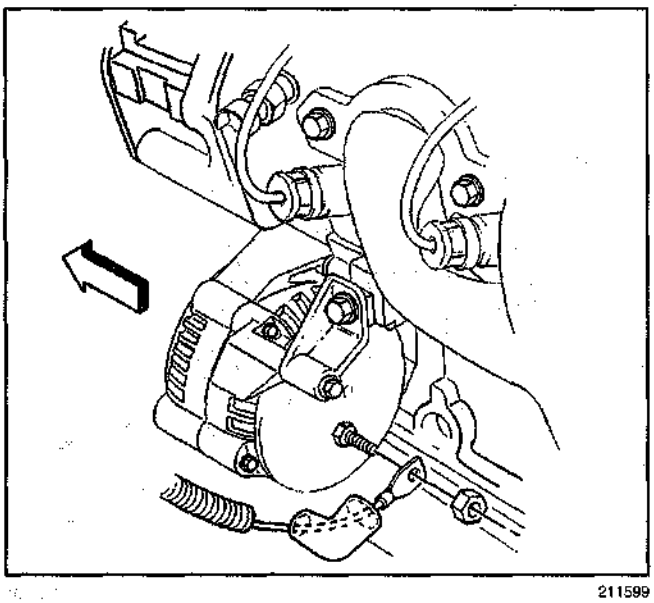

220586

22. Install the right side engine mount bracket and bolts.

    Tighten

    Tighten the engine mount bracket bolts to 50 N·m (37 lb ft).

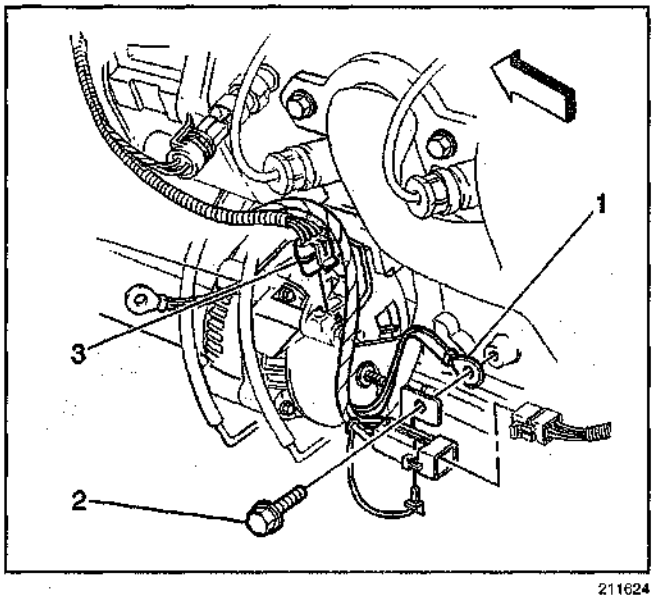
23. Remove the hoist from the engine.


211599

24. Install the positive cable to the generator.
25. Install the positive cable nut to the generator.

    Tighten

    Tighten the positive cable nut to the generator to 22 N·m (16 lb ft).



211624

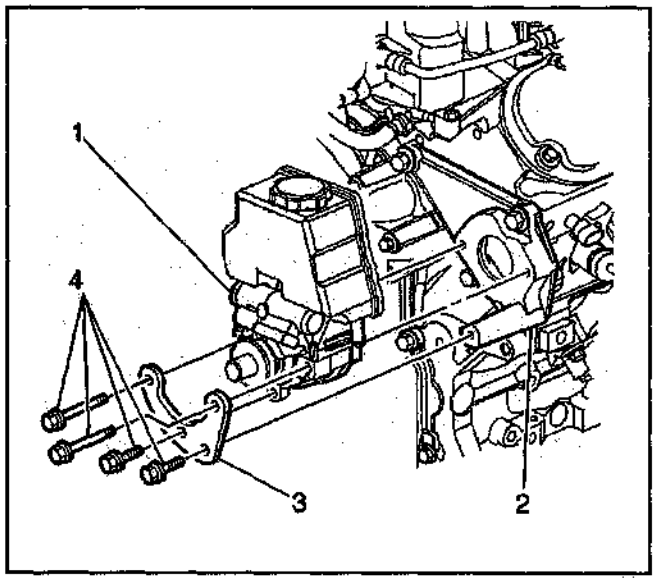
26. Connect the generator electrical connector (3).

cardiagn.com

27. Install the power steering pump (1) to the bracket (2).
28. Install the power steering brace (3) and bolts (4).

Tighten

Tighten the power steering pump bolts (4) to 25 N·m (18 lb ft).

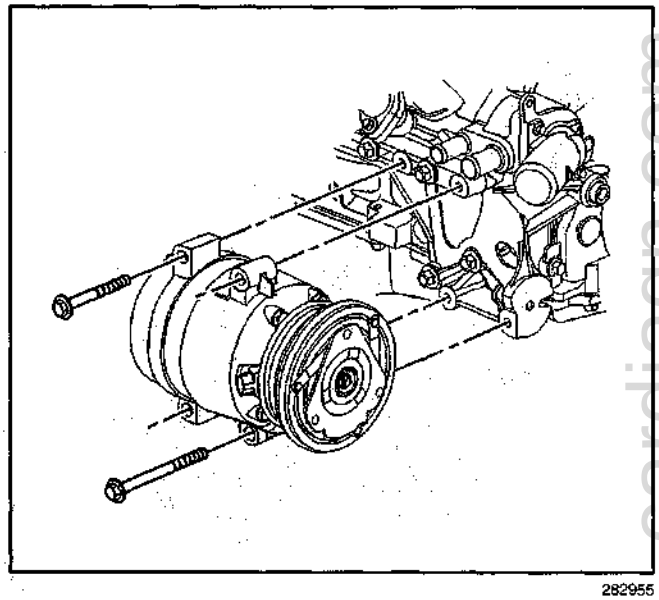


290570

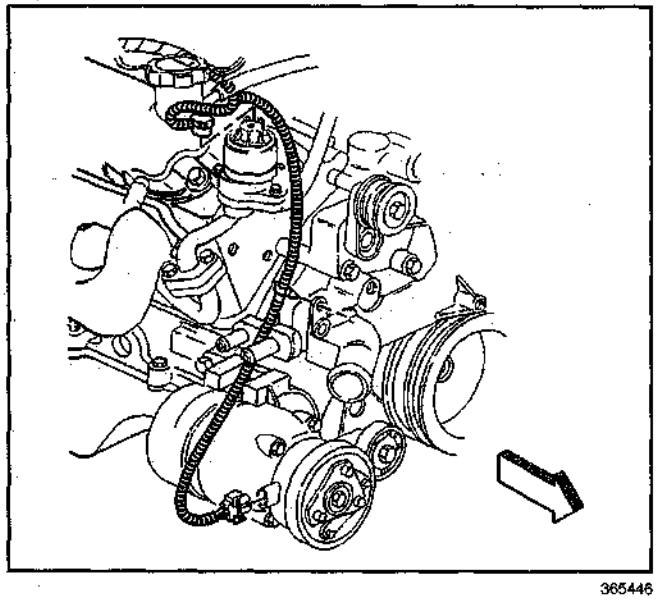
29. Install the A/C compressor.
30. Install the A/C compressor bolts.

Tighten

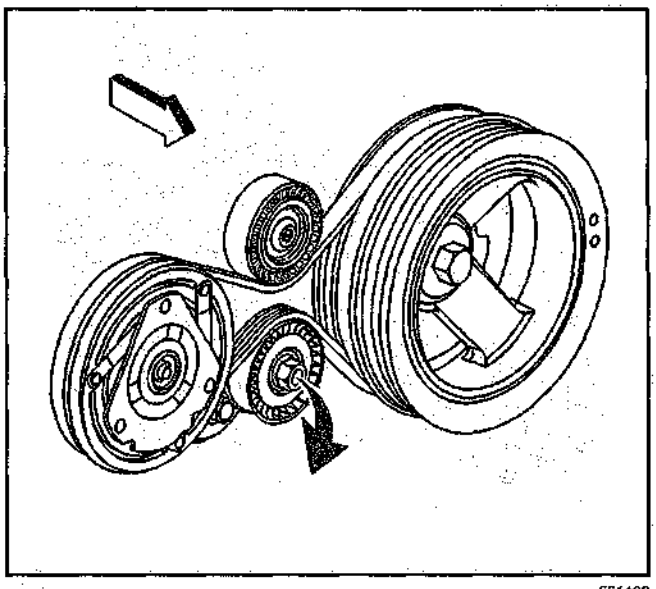
Tighten the A/C compressor bolts to 50 N·m (37 lb ft).


282955

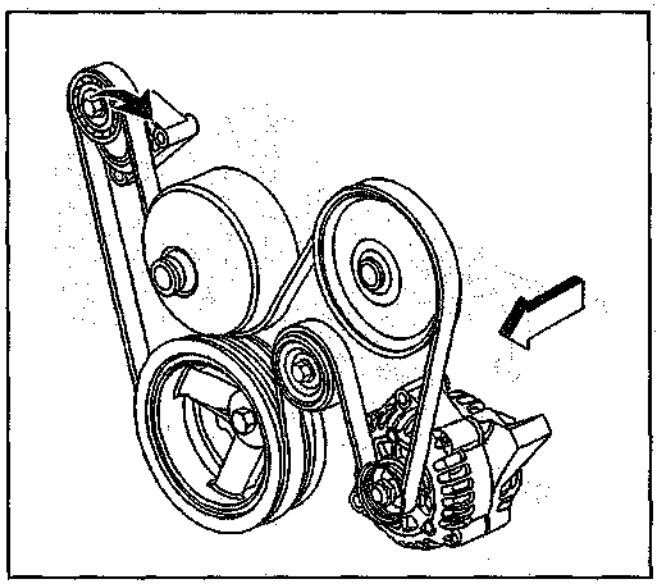
31. Connect the A/C compressor electrical connector.


365446

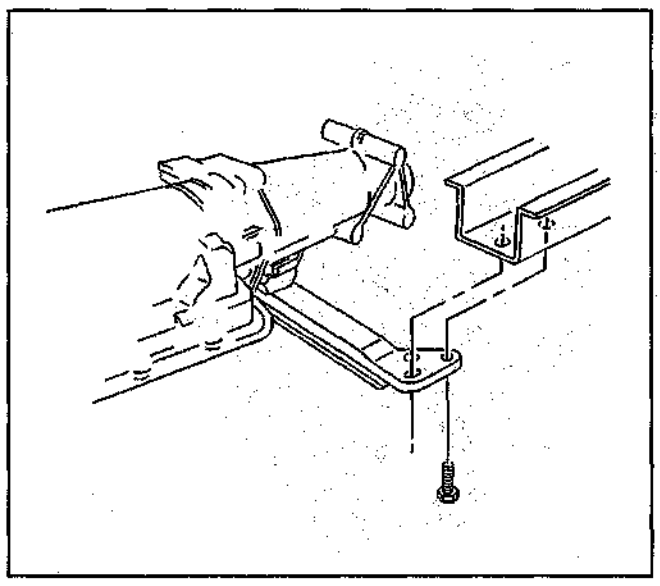
cardiagn.com


551463

32. Route the A/C belt over the crankshaft balancer.
33. Rotate the A/C drive belt tensioner clockwise to relieve the tension.
34. Install the drive belt between the idler and over the tensioner (1) and onto the compressor pulley.


551461

35. Route the drive belt around the pulleys.
36. Position the hex-head socket on the belt tensioner pulley bolt.
37. Rotate the drive belt tensioner clockwise to relieve tension.
38. Install the drive belt around the tensioners.
39. Remove the strap from the crossmember to the *J 39580*.
40. Lower the vehicle and install the engine and transmission to the vehicle.


208587

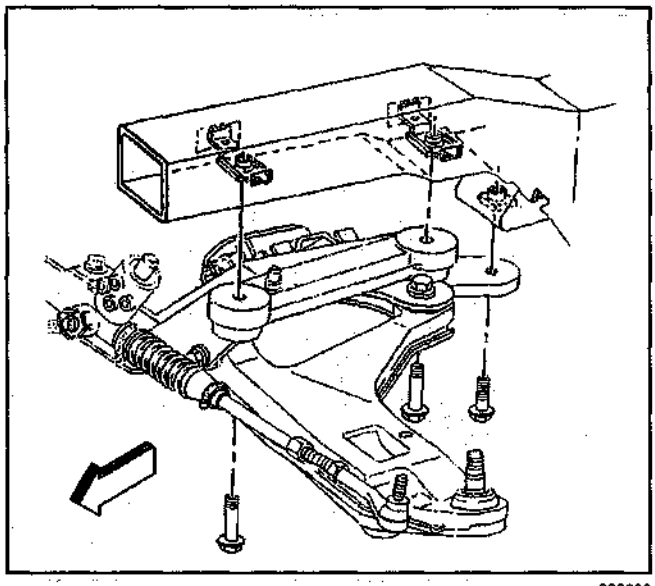
41. Install the transmission support bolts.

Tighten

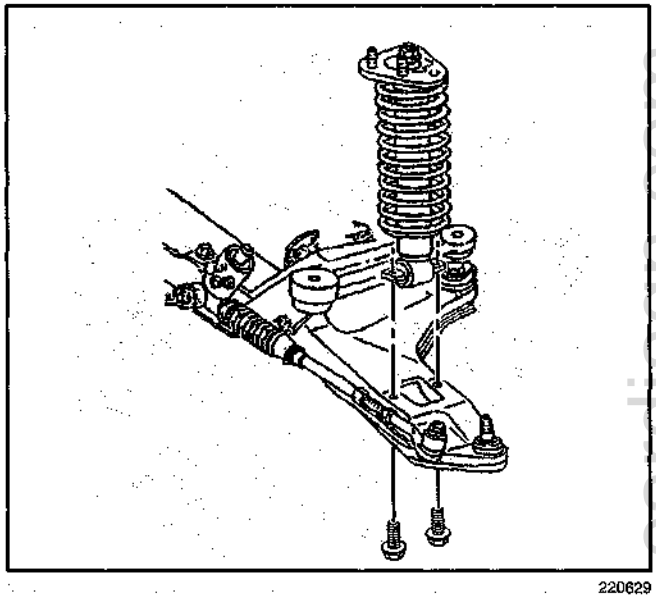
Tighten the transmission support bolts to 90 N·m (66 lb ft).

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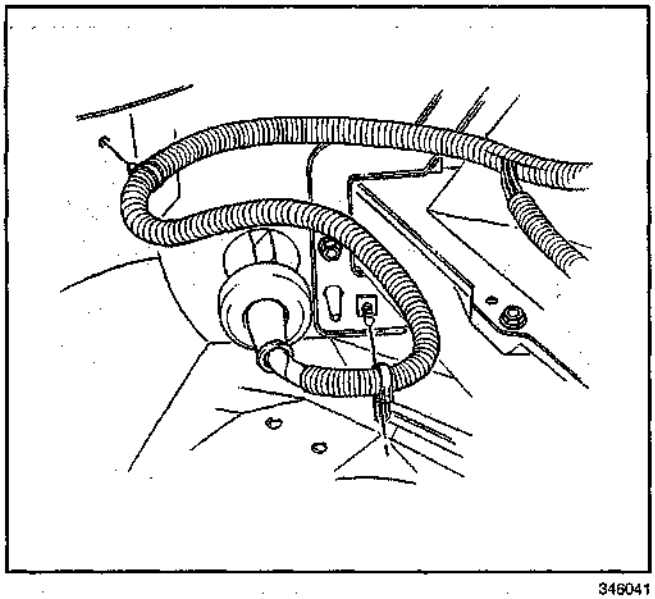
42. Install the front crossmember bolts.
    Tighten
    - Tighten the four upper crossmember bolts to 125 N·m (92 lb ft).
    - Tighten the two lower crossmember bolts to 145 N·m (107 lb ft).
43. Raise and suitably support the vehicle. Refer to *Lifting and Jacking the Vehicle* in General Information.
44. Remove the *J 39580* from below the vehicle.
45. Remove the support from both steering knuckles.
46. Install the upper control arm ball studs to the steering knuckles.
47. Install the nuts to the left and right upper ball joints.
    Tighten
    Tighten the upper control arm nuts to 53 N·m (39 lb ft).
48. Install cotter pins to the upper control arm nuts.


220632

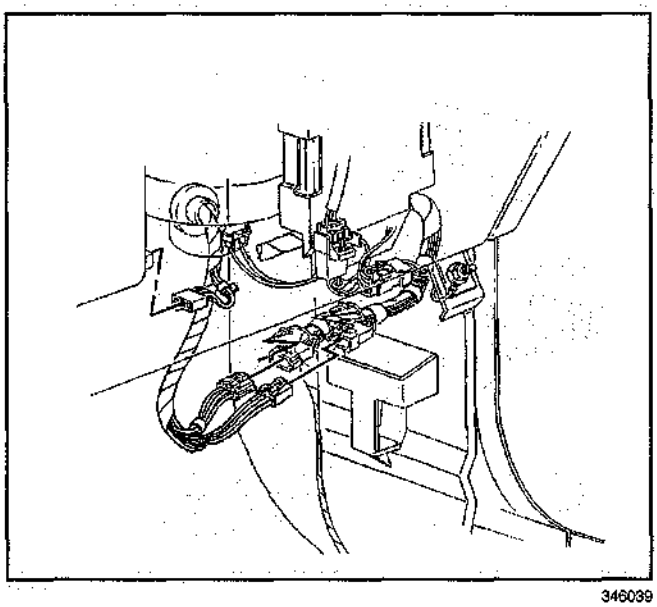
49. Install the right and left side shock absorber lower mounting bolts.
    Tighten
    Tighten the shock absorber bolts to 65 N·m (48 lb ft).
50. Lower the vehicle.
51. Install the transmission control, if equipped. Refer to *Shift Control Assembly Replacement* in Manual Transmission - MM6.
52. Install the floor shift control, if equipped. Refer to *Floor Shift Control Replacement* in Automatic Transmission - 4L60-E.


220629

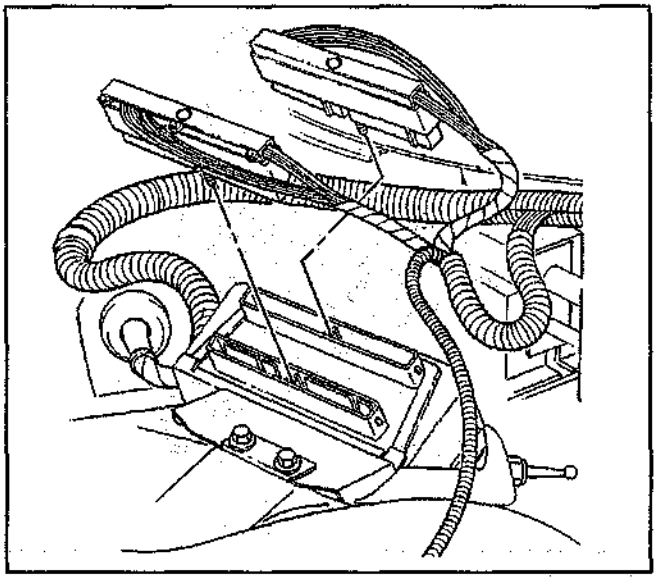
53. Install the engine wire harness through the front of dash.


346041

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346039

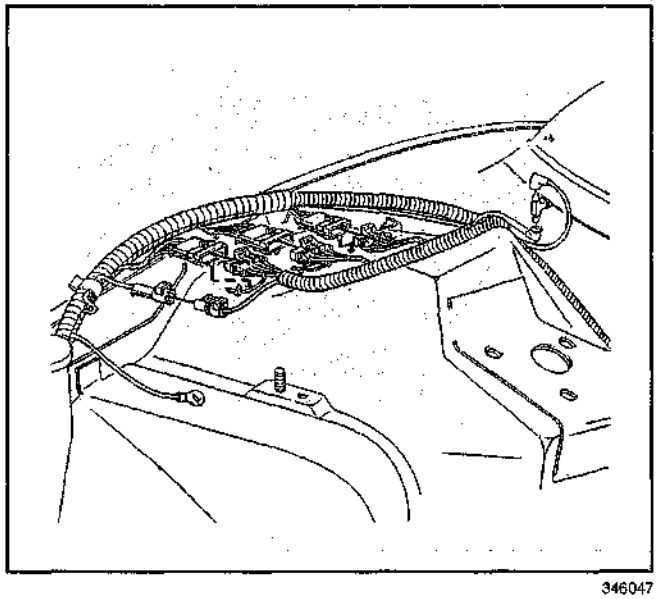
54. Connect the engine wiring harness to the I/P wiring harness.
55. Install the hinge pillar trim panel. Refer to *Trim Replacement - Hinge Pillar* in Interior Trim.
56. Install the right side insulator panel. Refer to *Closeout/Insulator Panel Replacement - Right* in Instrument Panel, Gauges and Console.
57. Install the PCM to the vehicle.


346043

58. Connect the PCM connectors to the PCM.

    Tighten

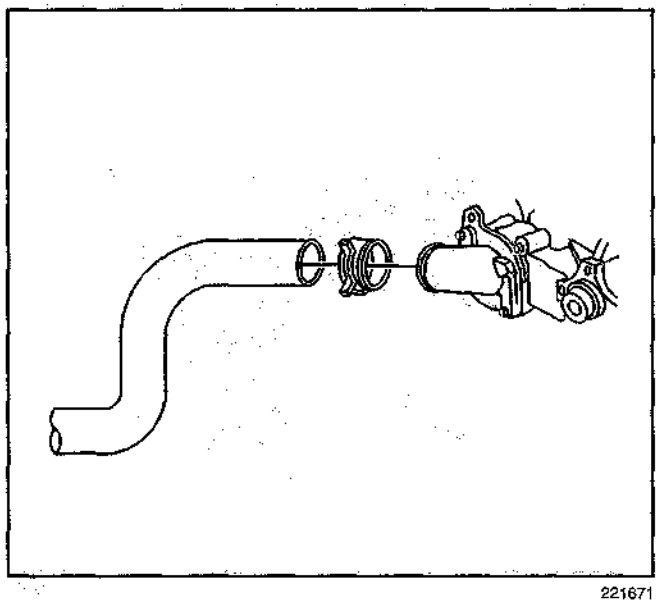
    Tighten the PCM connector bolts to 8 N·m (71 lb in).


346047

59. Connect the engine harness vacuum tube to the bottom of the vacuum check valve.
60. Connect the forward lamp harness to the engine harness.
61. Connect the secondary captured locks.
62. Install the front two brake pipes to the brake pressure modulator valve.
63. Install the brake booster vacuum hose.

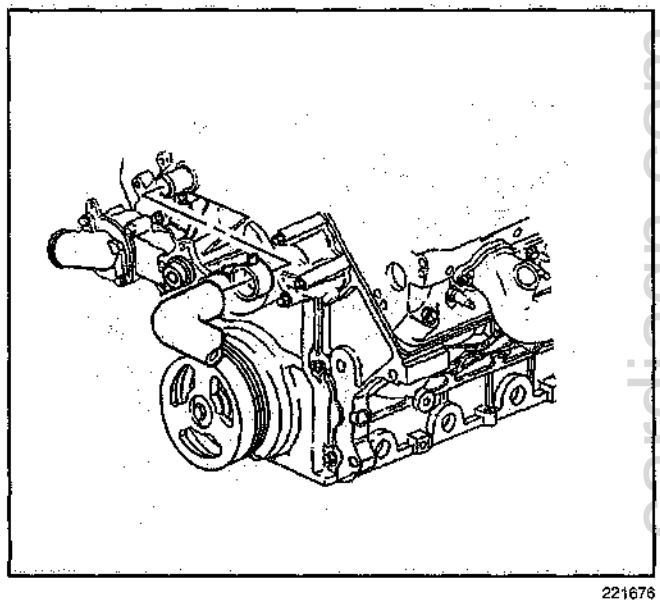
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64. Install the inlet hose to the water inlet.



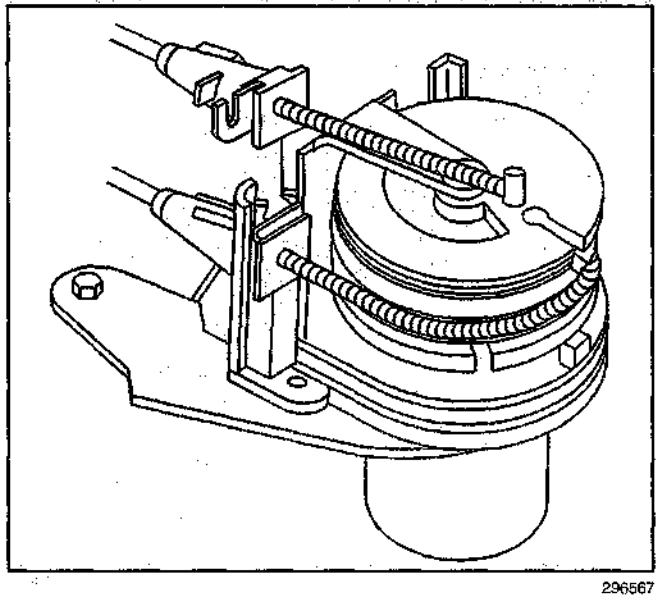
221671

65. Install the outlet hose to the water pump.



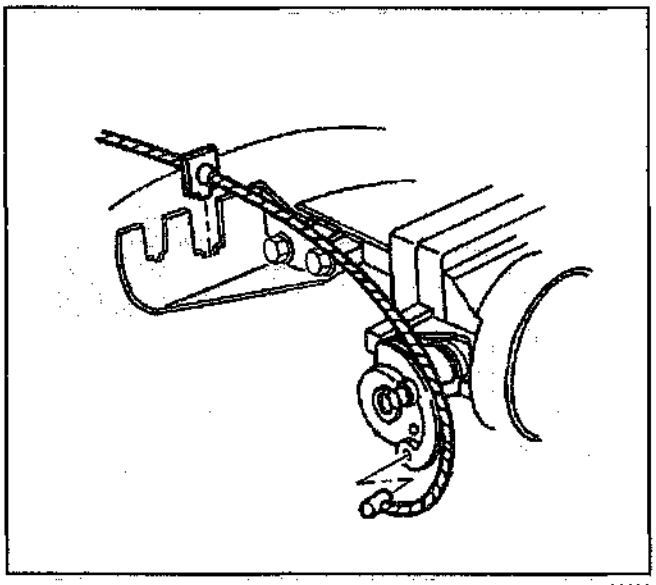
221676

66. Install the cruise control and accelerator control cables to the servo adjuster, if equipped.



296567

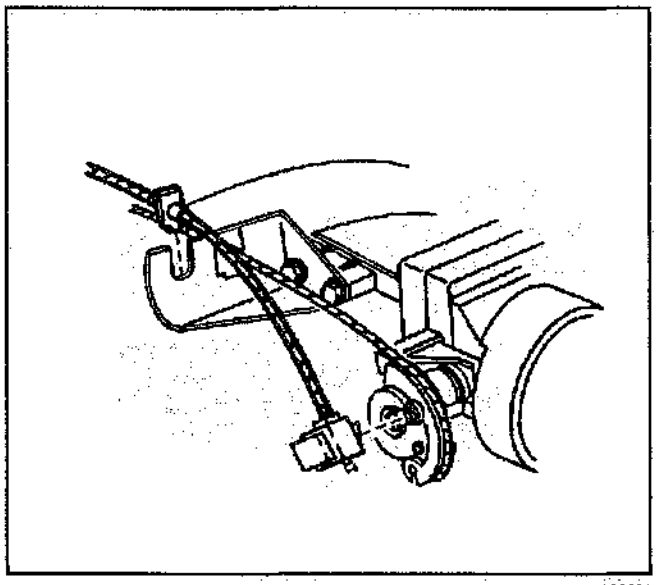
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220602

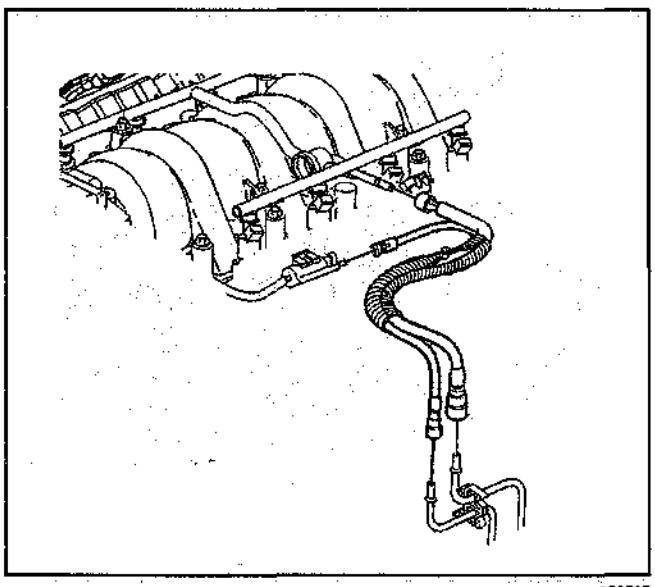
Caution: In order to avoid possible injury or vehicle damage, always replace the accelerator control cable with a NEW cable whenever you remove the engine from the vehicle.

In order to avoid cruise control cable damage, position the cable out of the way while you remove or install the engine. Do not pry or lean against the cruise control cable and do not kink the cable. You must replace a damaged cable.

67. Install the accelerator control cable to the throttle body bracket.
68. Install a NEW accelerator control cable to the throttle lever.


220601

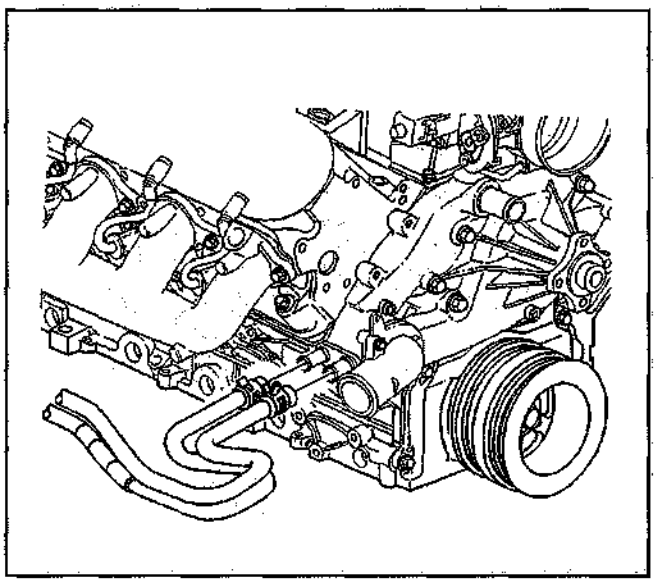
69. Install the cruise control cable to the throttle lever.


220597

70. Connect the fuel line to the fuel rail.
71. Connect the vapor line to the fuel vapor purge valve.

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72. Install the inlet and outlet heater hoses to the water pump.

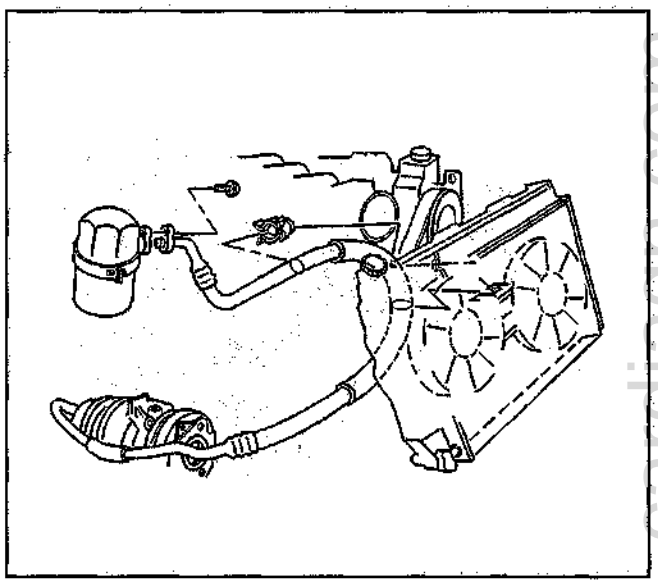


282934

73. Install a new O-ring.
74. Install the A/C compressor and condenser hose bolt at the accumulator.

    Tighten

    Tighten the A/C compressor and condenser hose bolt to 16 N·m (12 lb ft).
75. Raise and suitably support the vehicle. Refer to *Lifting and Jacking the Vehicle* in General Information.

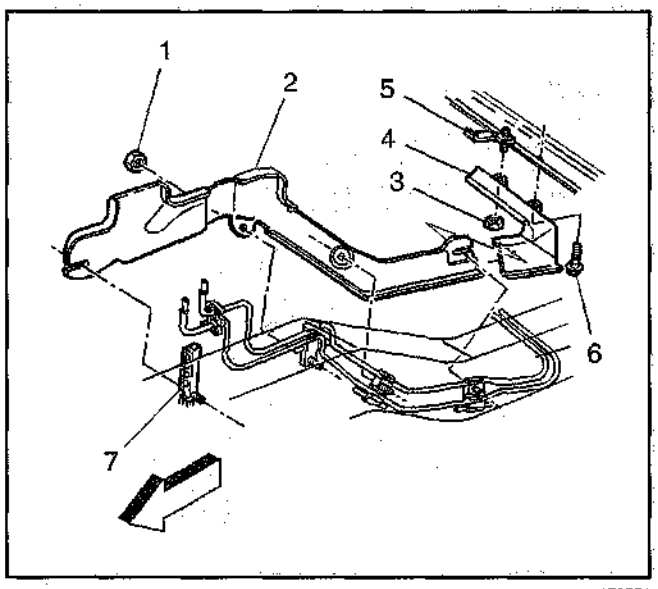


282941

76. Connect the brake lines to the brake pipe clip.
77. Install the front fuel pipe heat shield (2).
78. Install the front fuel pipe heat shield nuts (1).

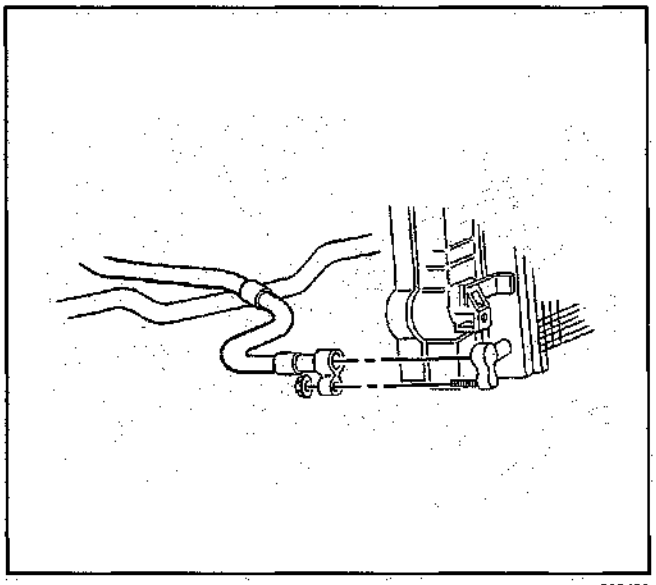
    Tighten

    Tighten the front fuel pipe heat shield nuts (1) to 5 N·m (44 lb in).



173551

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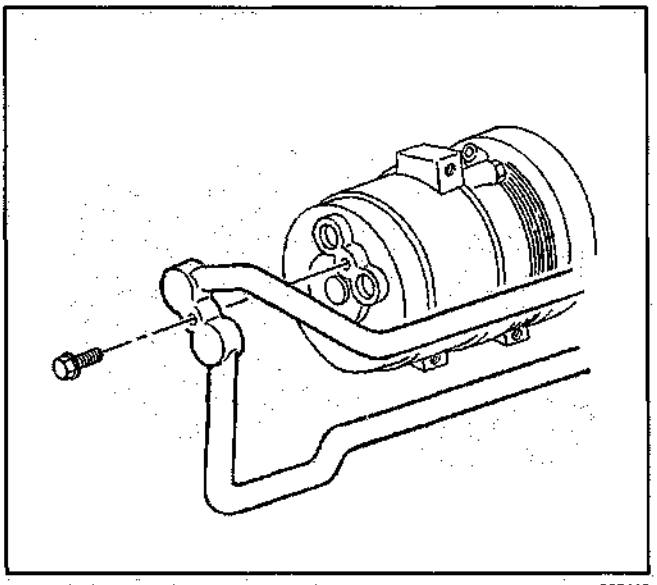


365450

79. Install a new O-ring.
80. Install the A/C compressor and condenser hose nut at the condenser.

    Tighten

    Tighten the A/C compressor and condenser hose nut at the condenser to 16 N·m (12 lb ft).

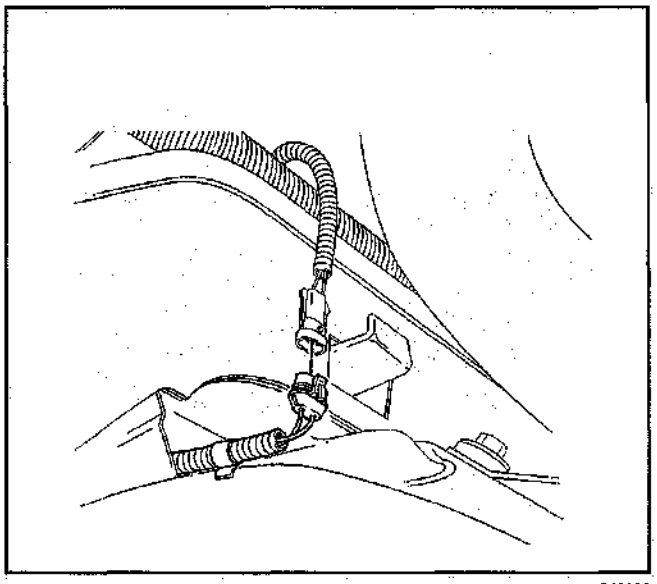


365448

81. Install a new O-ring.
82. Install the A/C compressor and condenser hose bolt.

    Tighten

    Tighten the A/C compressor and condenser hose bolt to 33 N·m (24 lb ft).



346036

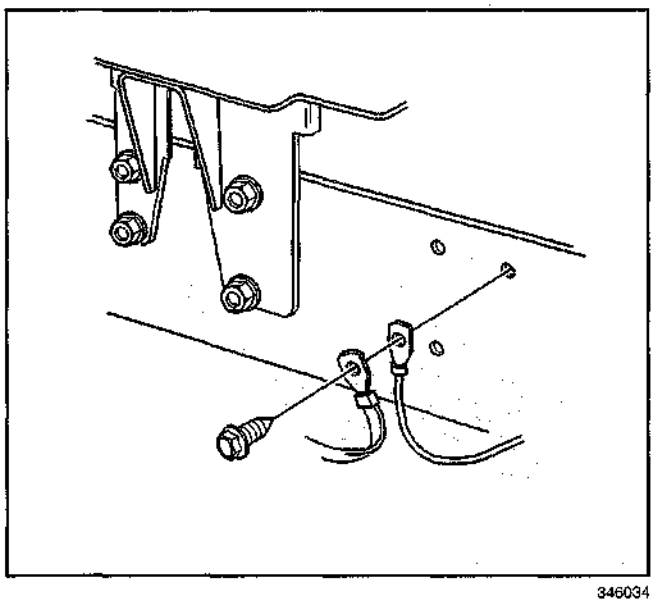
83. Connect the wheel speed sensor electrical connectors.

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84. Install the RF ground strap and cruise control ground lead from the front rail.
85. Install the wiring harness ground bolt.

    Tighten

    Tighten the wiring harness ground bolt to 12 N·m (106 lb in).



346034

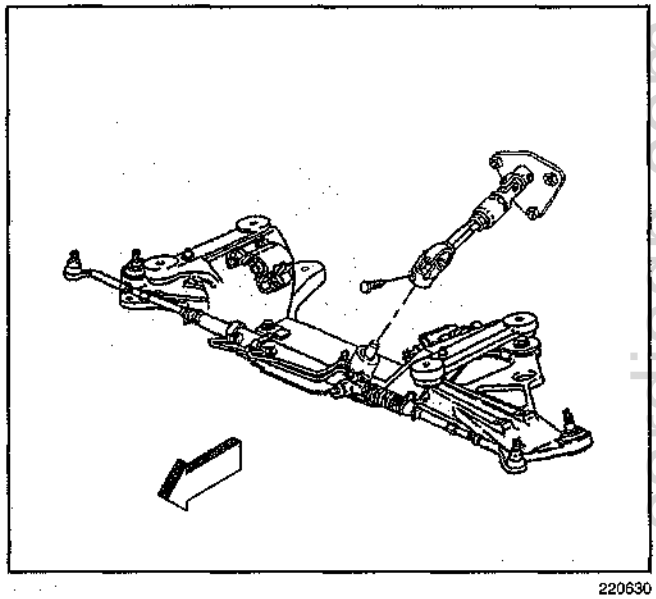
86. Install the intermediate steering shaft and shaft bolt to the rack.

    Tighten

    Tighten the intermediate steering shaft bolt to 47 N·m (35 lb ft).
87. Install the stabilizer bar brackets.
88. Install the stabilizer bar bracket bolts.

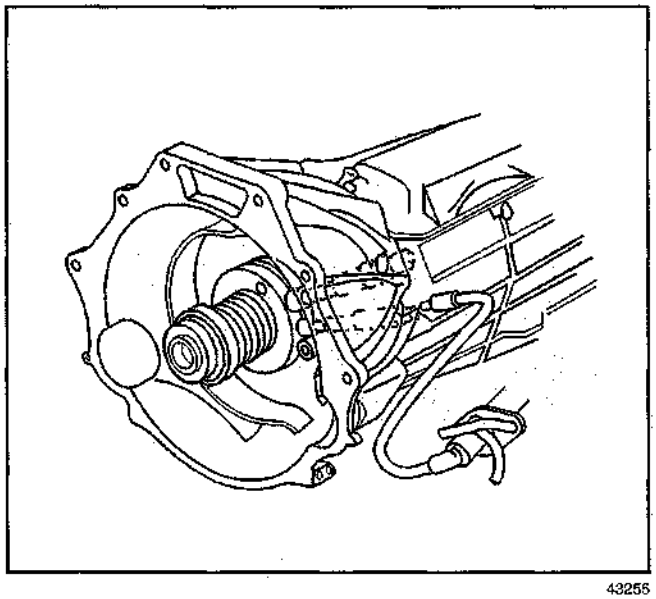
    Tighten

    Tighten the stabilizer bar bracket bolts to 55 N·m (41 lb ft).
89. Install the left side front air deflector. Refer to *Air Deflector Replacement - Front Bumper Fascia* in Bumpers.



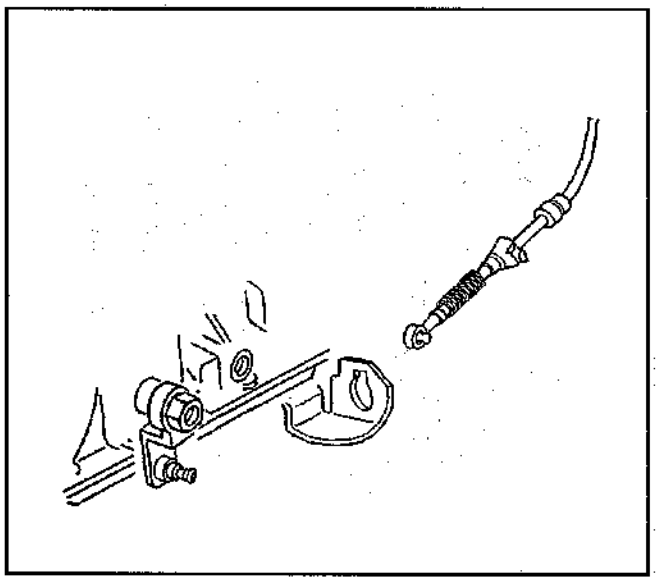
220630

90. On vehicles equipped with a manual transmission, connect the clutch actuator cylinder line to the actuator cylinder.

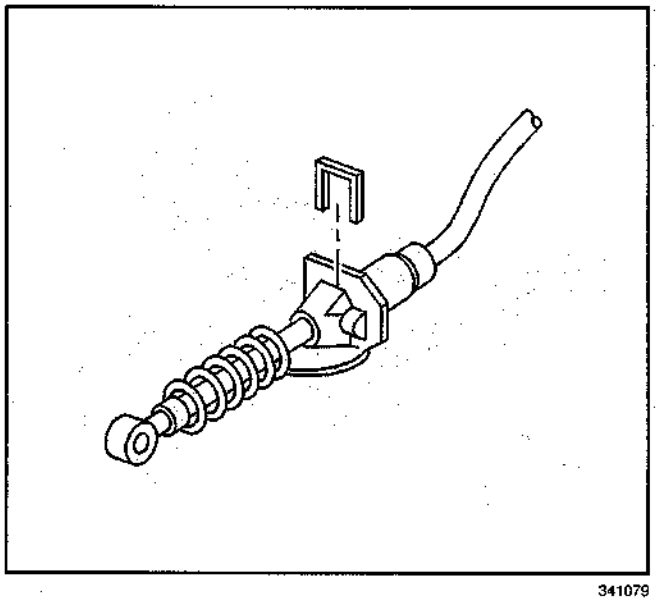


43255

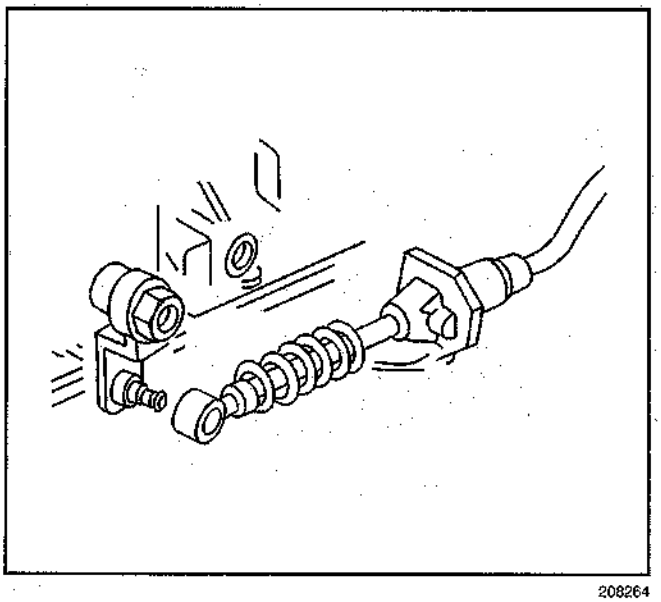
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206276

91. On vehicles equipped with a automatic transmission, install the range selector lever cable to the cable bracket.


341079

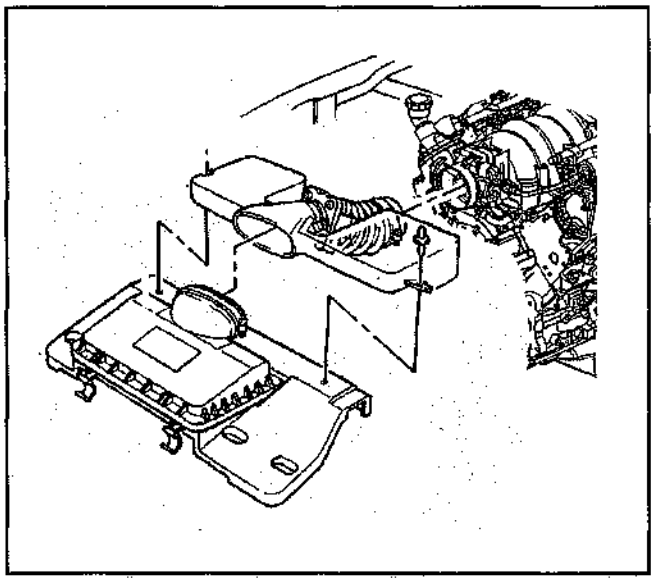
92. Install the retainer to the range selector lever cable.


208264

93. Snap the transmission range selector lever cable to the range selector lever at the transmission.
94. Install the starter motor. Refer to *Starter Motor Replacement (5.7 L)* in Engine Electrical.
95. Install the torque arm. Refer to *Torque Arm Replacement* in Rear Suspension.
96. Install the propeller shaft. Refer to *Propeller Shaft Replacement - One Piece* in Propeller Shaft.
97. Install the right side catalytic converter. Refer to *Oxidation Catalytic Converter Replacement (5.7 L Right)* in Engine Exhaust.
98. Install the left side catalytic converter. Refer to *Oxidation Catalytic Converter Replacement (5.7 L Left)* in Engine Exhaust.
99. Install the front wheels. Refer to *Tire and Wheel Removal and Installation* in Tires and Wheels.
100. Lower the vehicle.

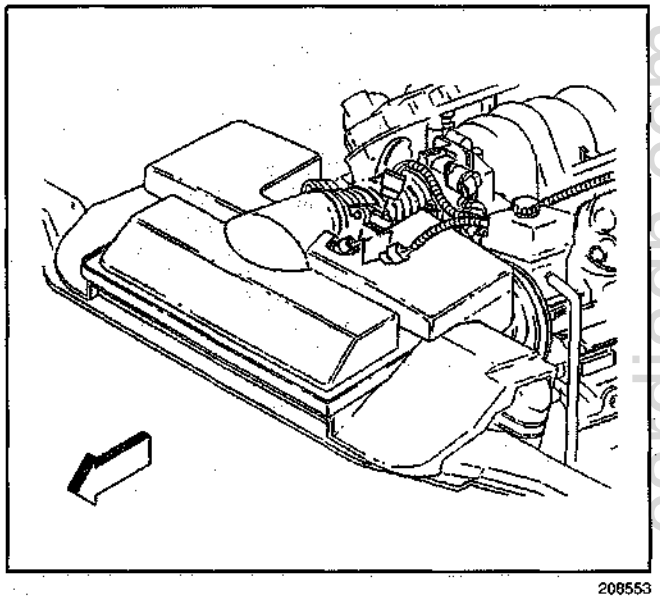
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101. Install the air intake duct resonator.



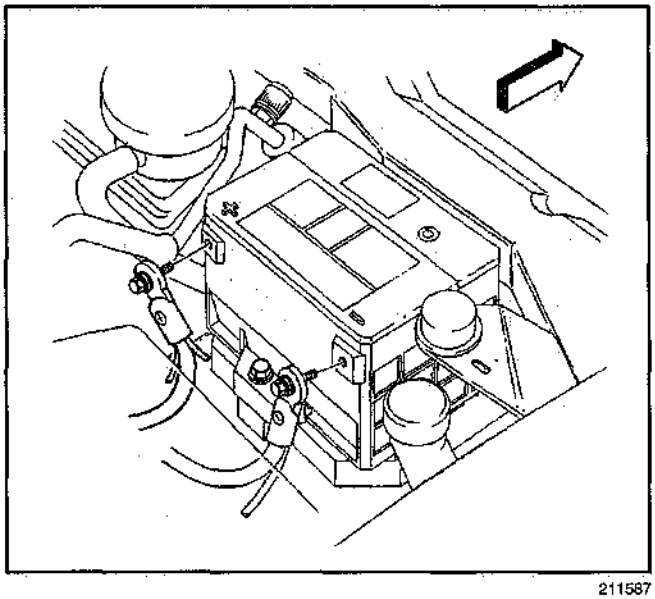
208569

102. Connect the IAT sensor electrical connector.
103. Connect the MAF sensor electrical connector.



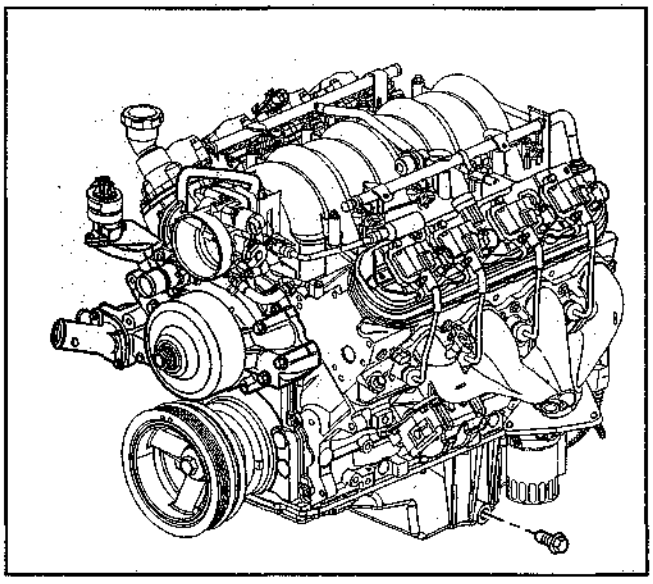
208553

104. Connect the positive battery cable.
105. Refill the engine oil.
106. Refill the transmission fluid.
107. Recharge the refrigerant. Refer to *Refrigerant Recovery and Recharging* in Heating, Ventilation and Air Conditioning.
108. Bleed the brakes. Refer to *Hydraulic Brake System Bleeding (Manual Bleeding)* or *Hydraulic Brake System Bleeding (Pressure Bleeding)* in Hydraulic Brakes.
109. Bleed the clutch hydraulic system. Refer to *Clutch Pedal Replacement* in Clutch.
110. Perform the crankshaft position (CKP) system variation learn procedure. Refer to *CKP System Variation Learn Procedure* in Engine Controls - 5.7 L.



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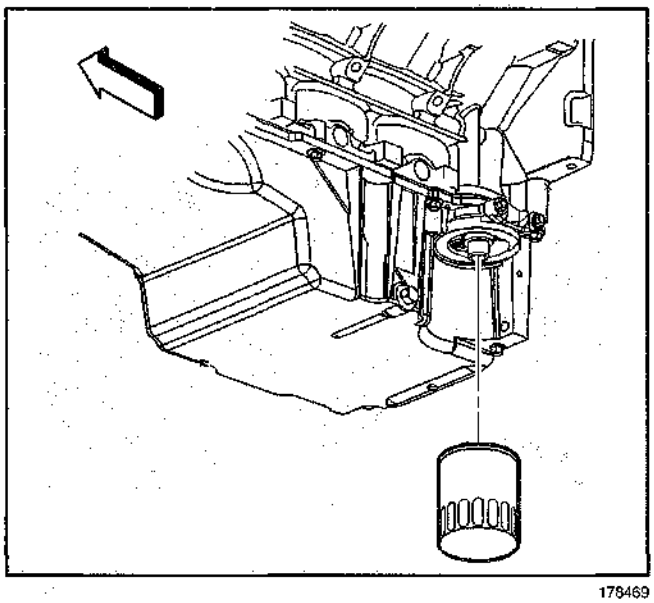
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309862

Engine Oil and Oil Filter Change

Removal Procedure

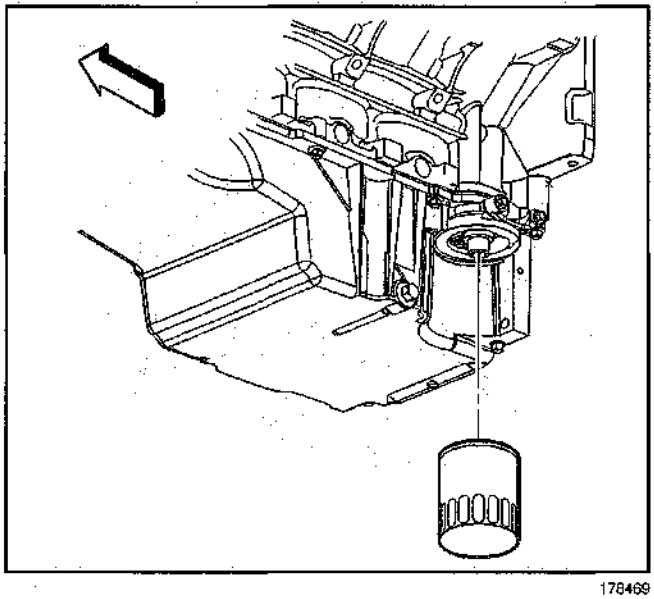
1. Open the hood.
2. Remove the oil fill cap.
3. Raise and suitably support the vehicle. Refer to *Lifting and Jacking the Vehicle* in General information.
4. Remove the oil pan drain plug.
5. Drain the engine oil.
6. Wipe the excess oil from the drain plug hole and plug.


178469

7. Remove the oil filter from the engine block.

Important: Check the old oil filter to ensure that the filter seal is not left on the engine block.

8. Wipe the excess oil from the oil filter mounting.


178469

Installation Procedure

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

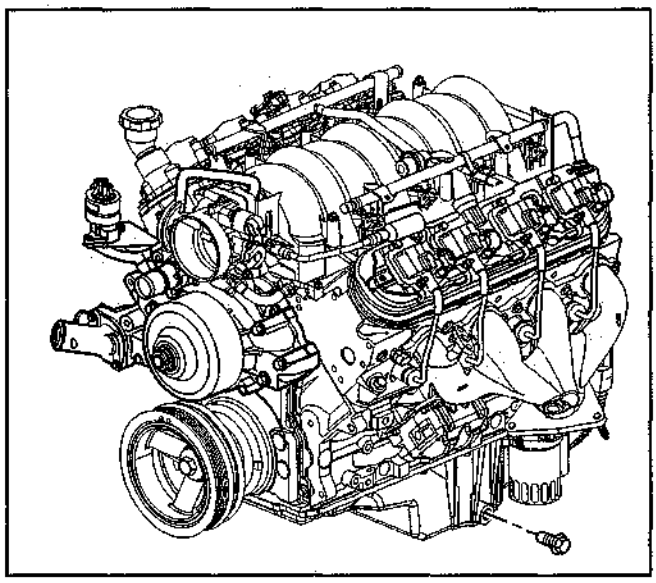
1. Install the oil filter to the engine block.

   Tighten

   Tighten the oil filter to 30 N·m (22 lb ft).

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2. Install the drain plug to the oil pan.
   Tighten
   Tighten the drain plug to 25 N·m (18 lb ft).
3. Lower the vehicle.
4. Fill the engine with oil.
5. Remove the oil level indicator in order to check the oil level.
6. Reinstall the oil level indicator.
7. Close the hood.



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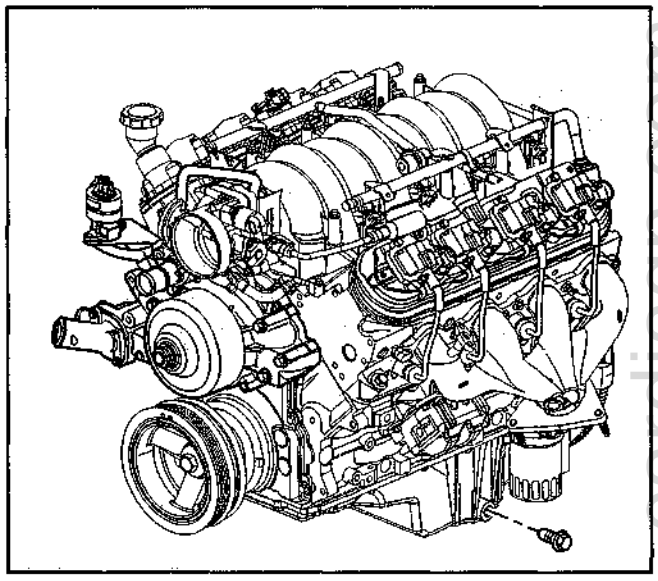
Draining Fluids and Oil Filter Removal

Tools Required

J 41712 Oil Pressure Sensor Socket

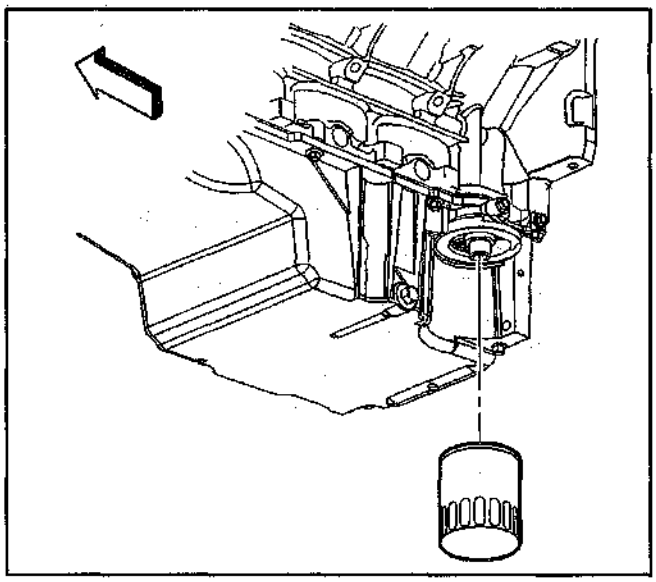
Important: In order to completely drain the oil from the oil pan internal baffling, the bottom of the oil pan must be level during the oil drain procedure.

1. Remove the oil pan drain plug and allow the oil to drain.



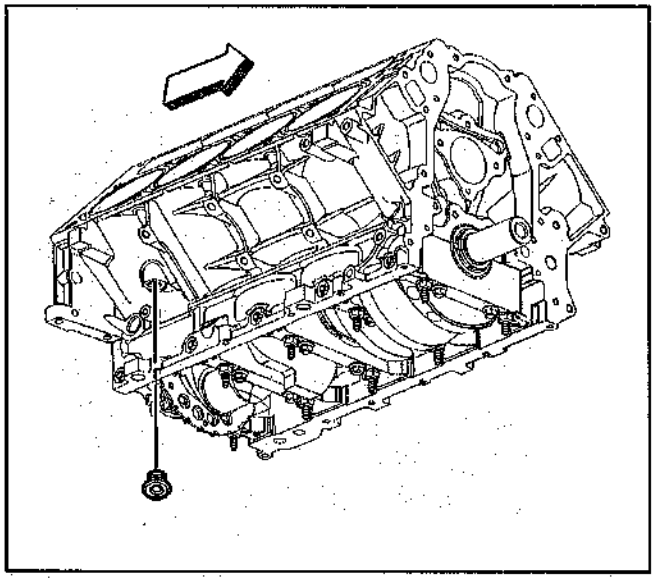
309862

2. Remove the engine oil filter.



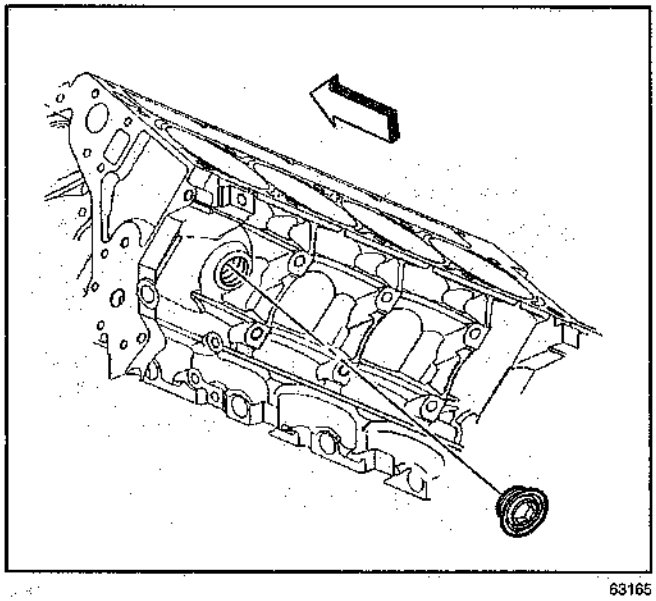
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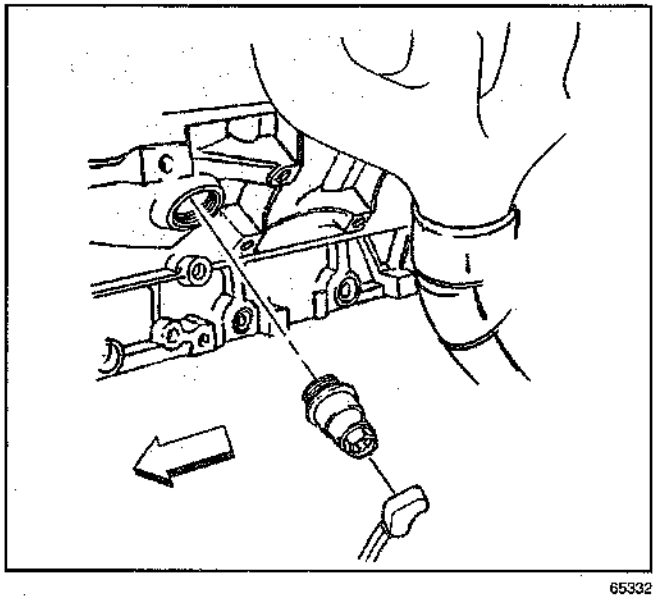
63164

3. Remove the right rear engine block coolant drain plug and allow the coolant to drain.



63165

4. Remove the left front engine block coolant drain plug (if applicable) and allow the coolant to drain.

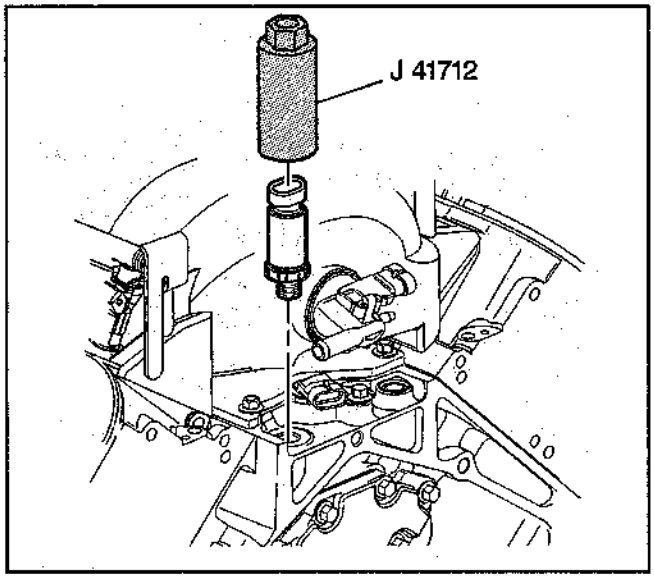


65332

5. Remove the engine block coolant heater (if applicable) and allow the coolant to drain.

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6. Use the *J 41712* or equivalent in order to remove the oil pressure sensor (if required).



178483

Crankshaft Balancer Removal

Tools Required

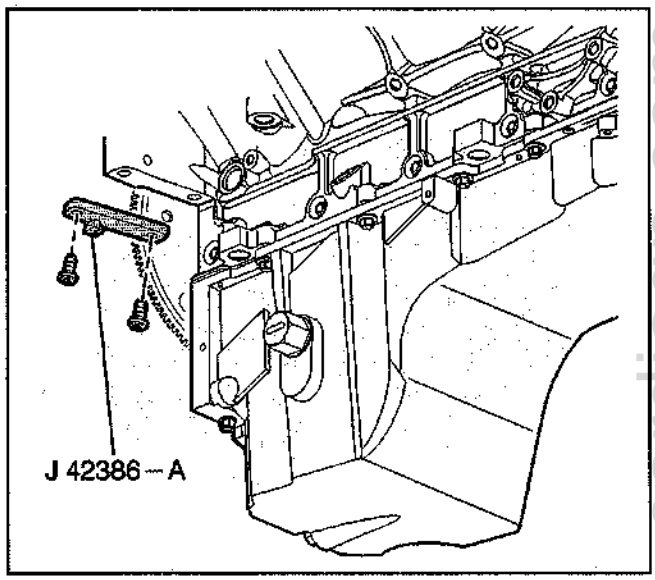
- *J 41816* Crankshaft Balancer Remover
- *J 41816-2* Crankshaft End Protector
- *J 42386-A* Flywheel Holding Tool

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

Important:

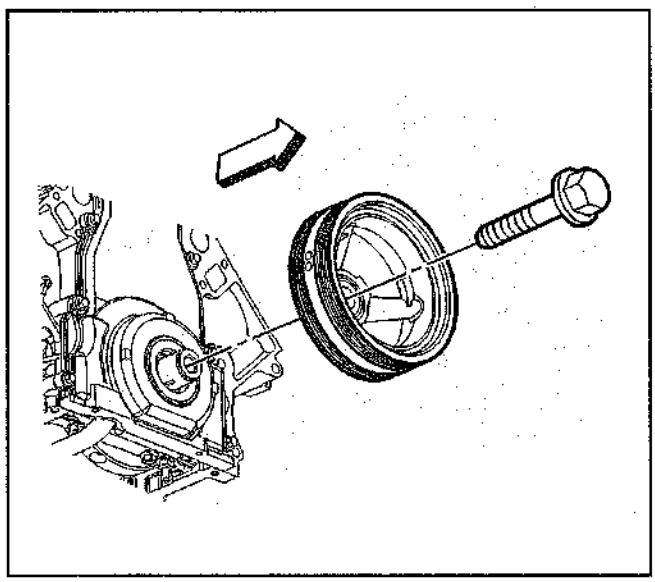
- Do not reuse the crankshaft balancer bolt. Install a NEW crankshaft balancer bolt during final assembly.
- Make sure that the teeth of the flywheel holding tool mesh with the teeth of the engine flywheel.

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



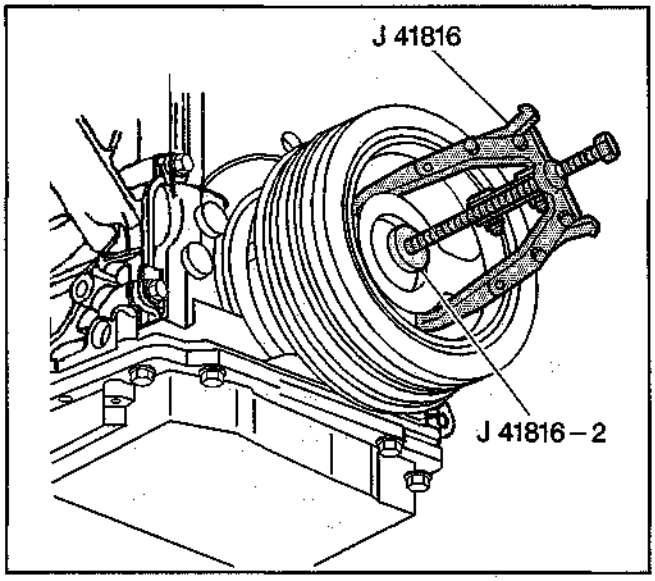
260126

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



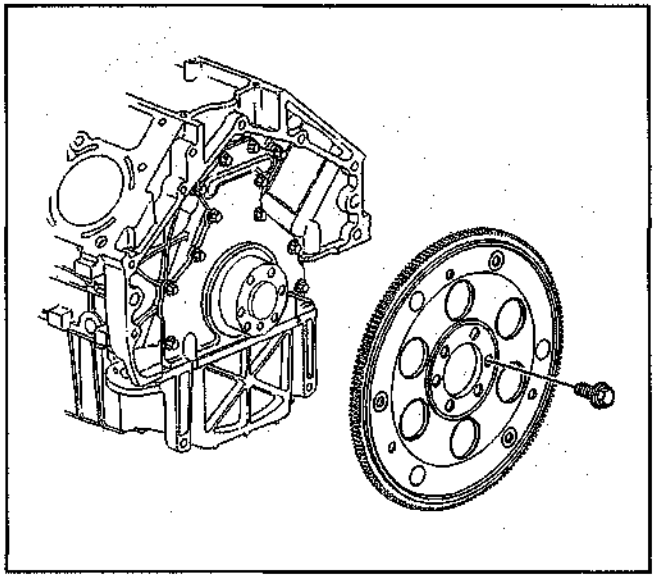
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156164

3. Use the *J 41816* and the *J 41816-2* in order to remove the crankshaft balancer.
4. Remove the *J 42386-A* and bolts.

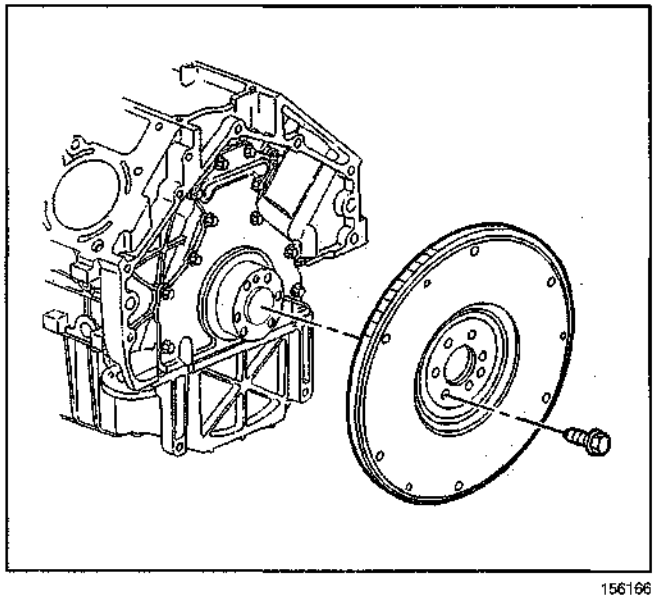


178458

Engine Flywheel Removal

Important: Note the position and direction of the engine flywheel before removal. 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 three stage tightening process.

1. Remove the engine flywheel bolts.
2. Remove the automatic transmission engine flywheel (if applicable).



156166

3. Remove the manual transmission engine flywheel (if applicable).

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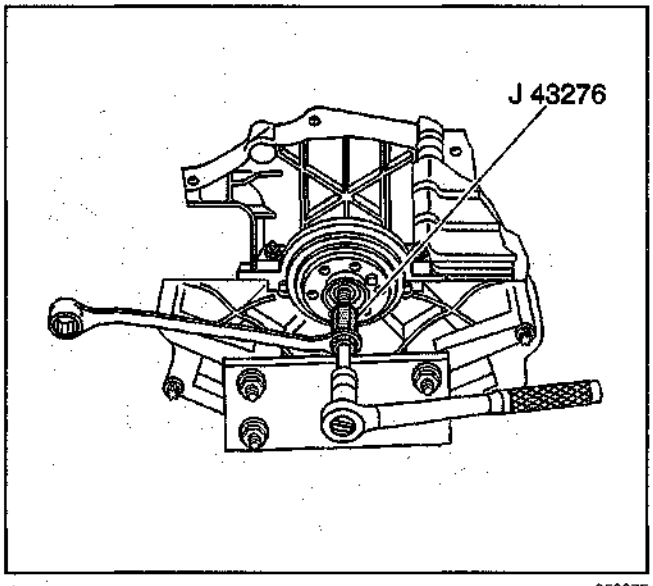
Clutch Pilot Bearing Removal

Tools Required

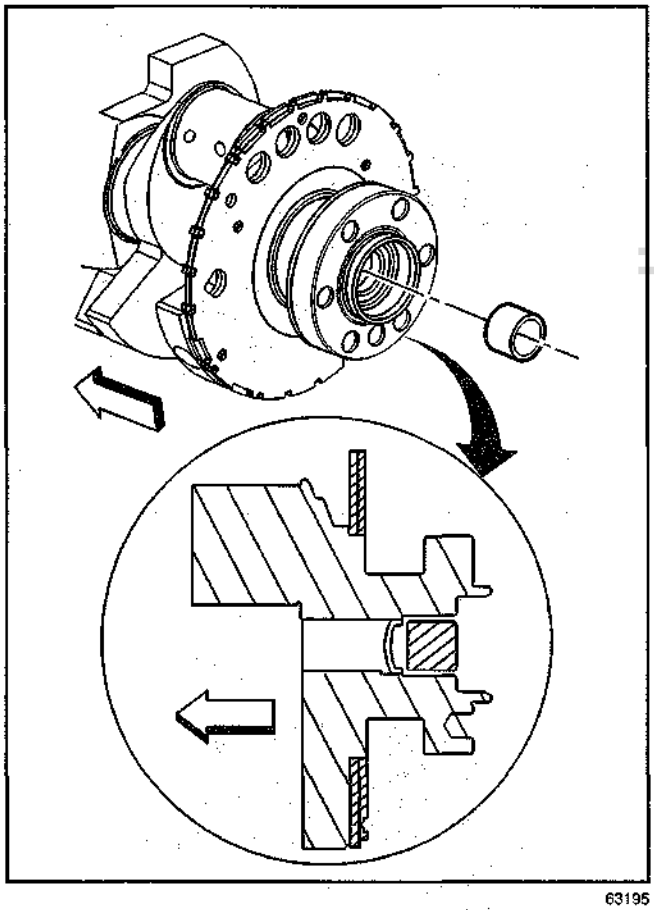
J 43276 Clutch Pilot Bearing Remover

Notice: When using the J 43276 Clutch Pilot Bearing Remover always secure the J 43276-1 Clutch Pilot Bearing Remover tool body using a wrench. Do not allow the J 43276-1 Clutch Pilot Bearing Remover tool body to rotate. Failing to do so will cause damage to the J 43276-1 Clutch Pilot Bearing Remover tool body.

1. Remove the clutch pilot bearing using the *J 43276*.
   1.1. Install the J43276-1 into the clutch pilot bearing.
   1.2. Using a wrench, secure the J43276-1.
   1.3. Insert the J43276-2 into the J43276-1.
   1.4. Rotate the J43276-2 clockwise into the J43276-1until the clutch pilot bearing is completely removed from the crankshaft.
   1.5. Rotate the J43276-2 counterclockwise to remove the J43276-2 from the J43276-1.
   1.6. Remove the J43276-1 from the tool body.
2. Discard the pilot bearing.

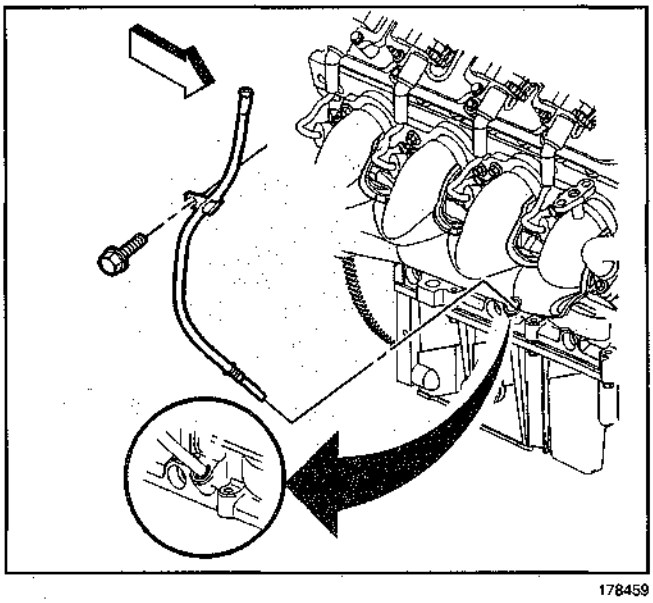


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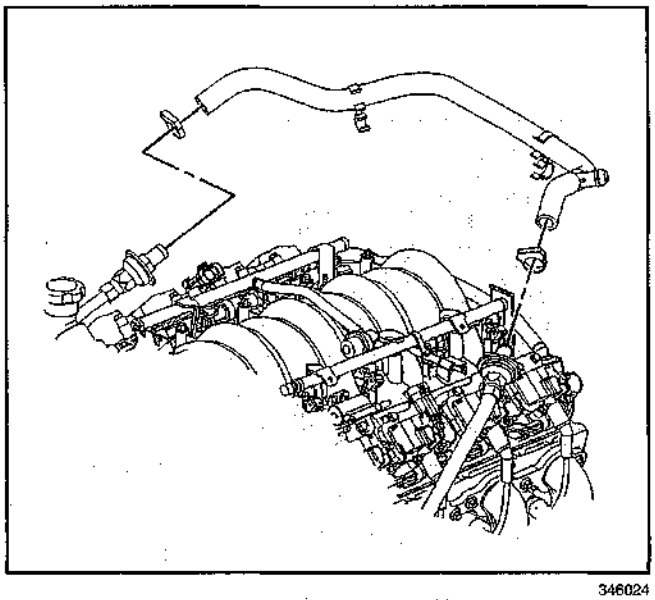

178459

Oil Level Indicator and Tube Removal

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

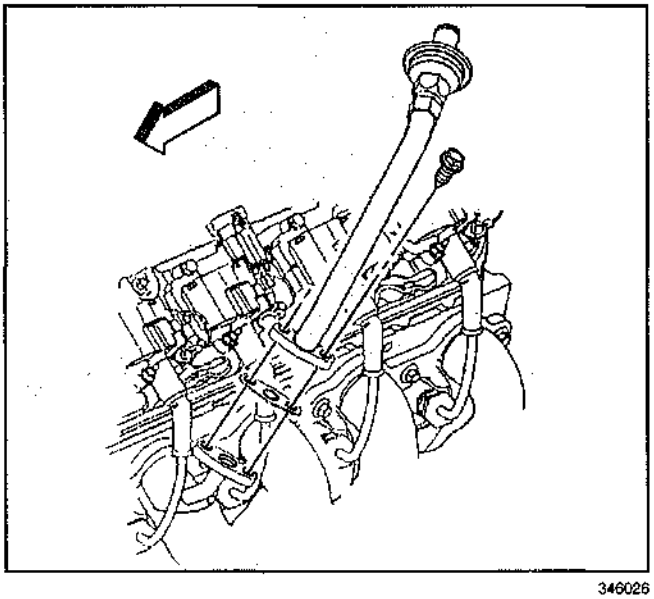
Important: Inspect the O-ring seal for cuts or damage. The O-ring seal may be reused if not cut or damaged.

4. Remove the O-ring seal from the tube (if required).


346024

Exhaust Manifold Removal (Left Side)

1. Loosen the Air Injection Reaction (AIR) hose clamps and remove the hose assembly.


346026

Important: Do not remove the check valve from the AIR pipe unless service is required.

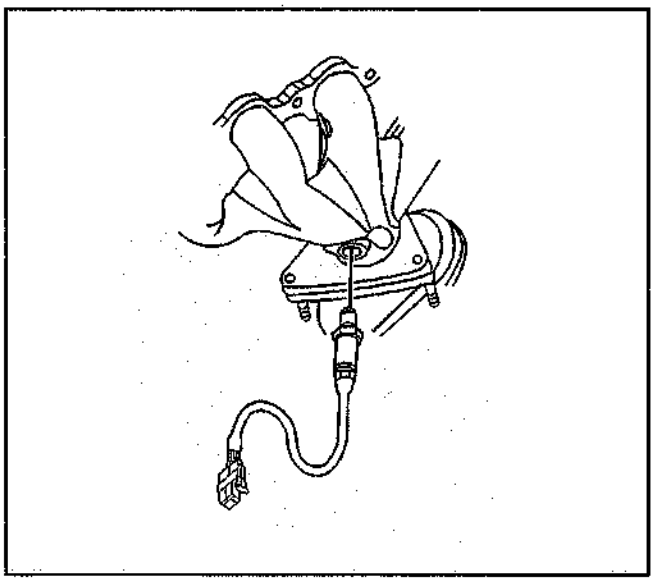
2. Remove the AIR pipe (with check valve), bolts and gasket from the left exhaust manifold.
3. Remove the spark plug wires from the spark plugs.

   Do not remove the spark plug wires from the ignition coils unless required.

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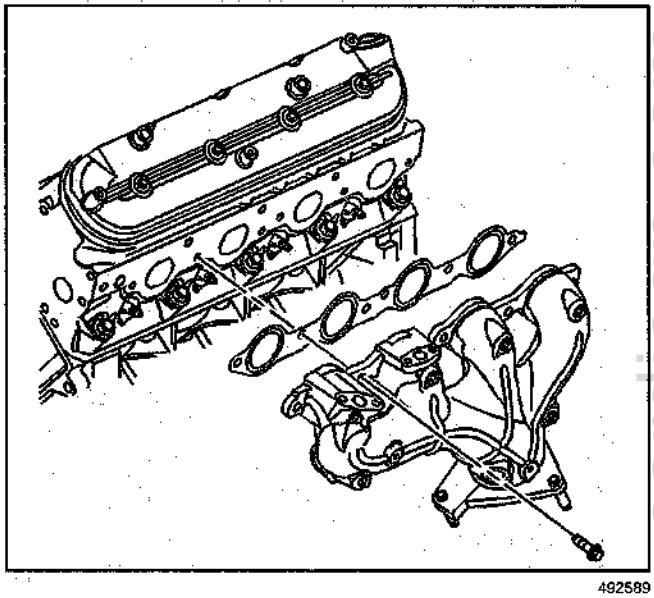
Important: Do not remove the oxygen sensor from the manifold unless service is required.

4. Remove the oxygen sensor from the manifold (if required).



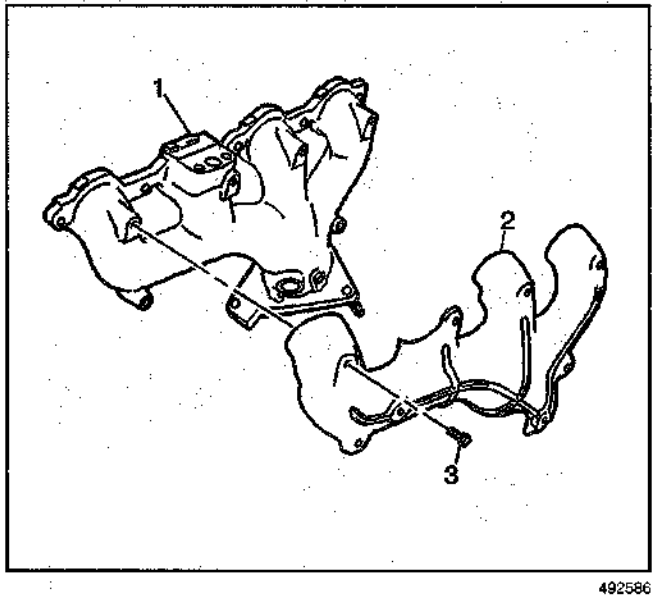
346021

5. Remove the exhaust manifold, bolts and gasket.
6. Discard the gasket.



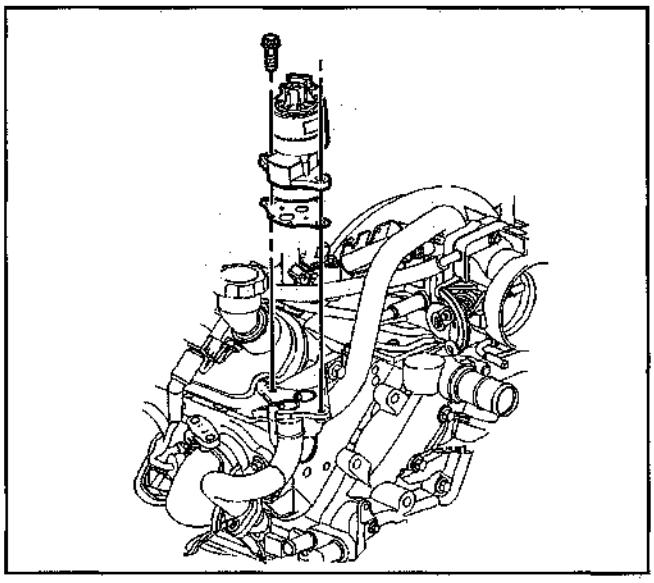
492589

7. Remove the heat shield (2) and bolts (3) from the manifold (1) (if required).



492586

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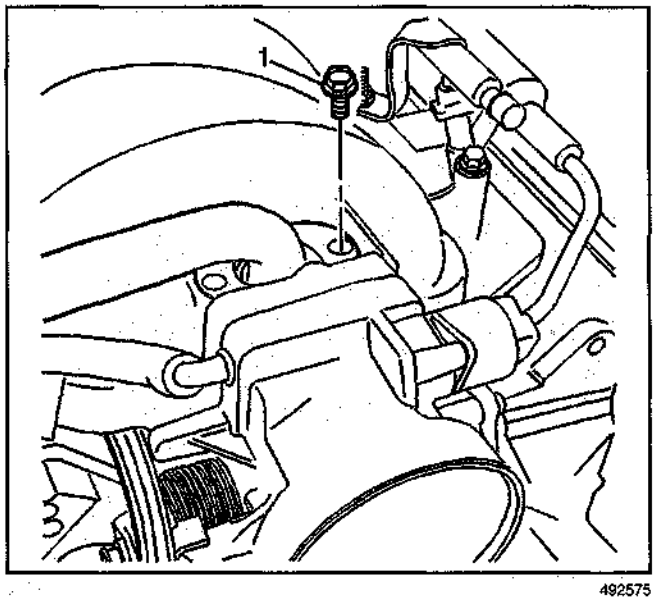


178487

Exhaust Manifold Removal (Right Side)

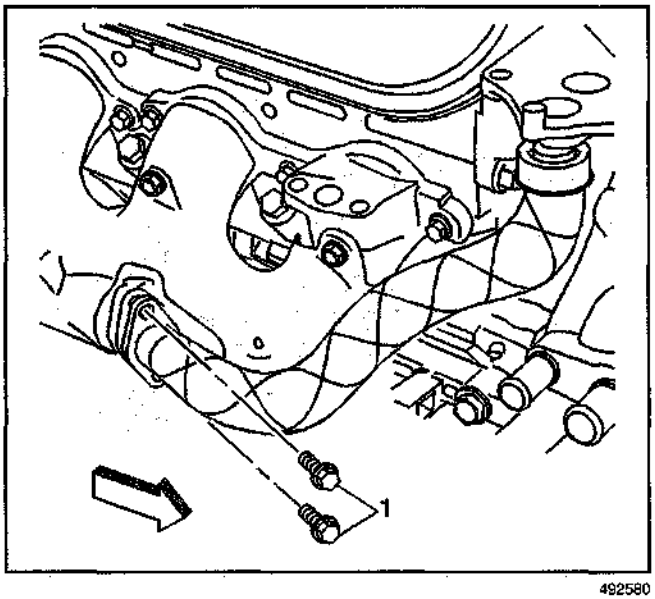
Important: Do not remove the Exhaust Gas Recirculation (EGR) valve from the pipe assembly unless service is required.

1. Remove the EGR valve, gasket, and bolts.



492575

2. Remove the EGR valve pipe bolt (1) from the intake manifold.

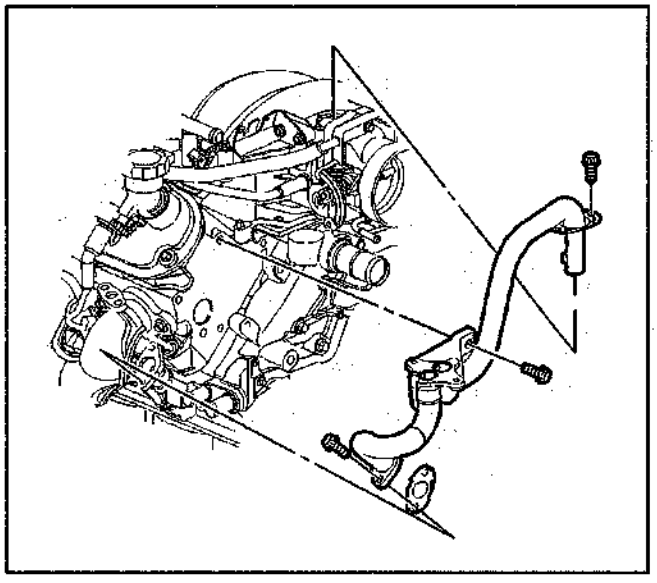


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3. Remove the EGR valve pipe bolts (1) and gasket from the exhaust manifold.

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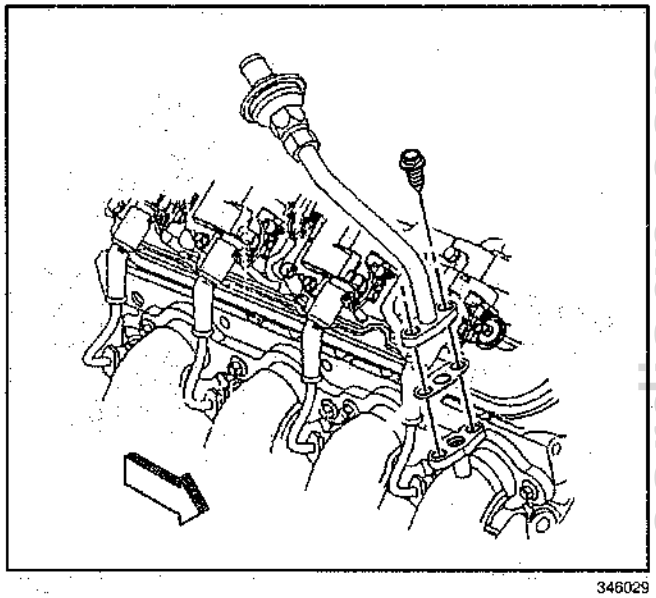
4. Remove the EGR valve pipe bolts from the cylinder head.
5. Remove the EGR valve pipe assembly.
   With mild force, pull the EGR valve pipe from the intake manifold.
6. Remove the O-ring seal from the EGR valve pipe assembly.
7. Discard the exhaust manifold gasket and O-ring seal.



178489

Important: Do not remove the check valve from the Air Injection Reaction (AIR) pipe unless service is required.

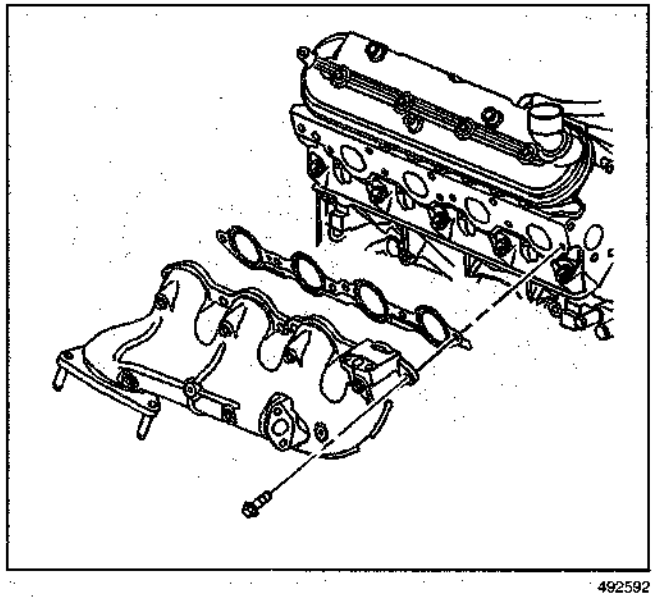
8. Remove the AIR pipe (with check valve), bolts, and gasket from the right exhaust manifold.
9. Remove the spark plug wires from the spark plugs.
   Do not remove the spark plug wires from the ignition coils unless required.



346029

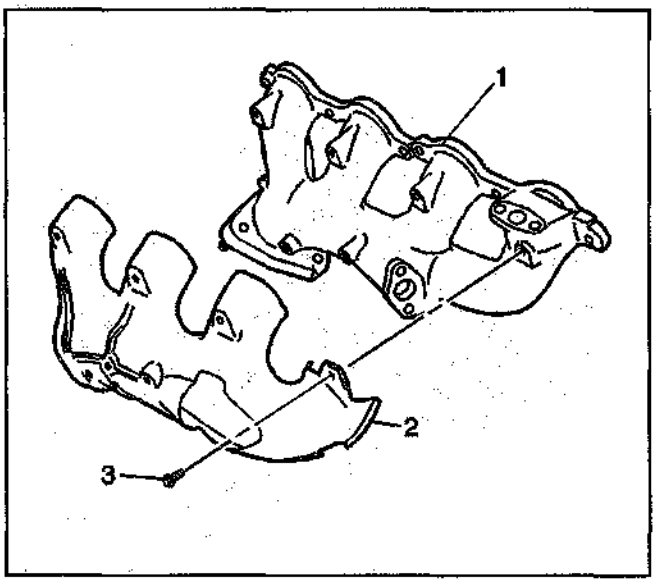
Important: Do not remove the oxygen sensor from the manifold unless service is required.

10. Remove the oxygen sensor from the manifold.
11. Remove the exhaust manifold, bolts, and gasket.
12. Discard the gasket.



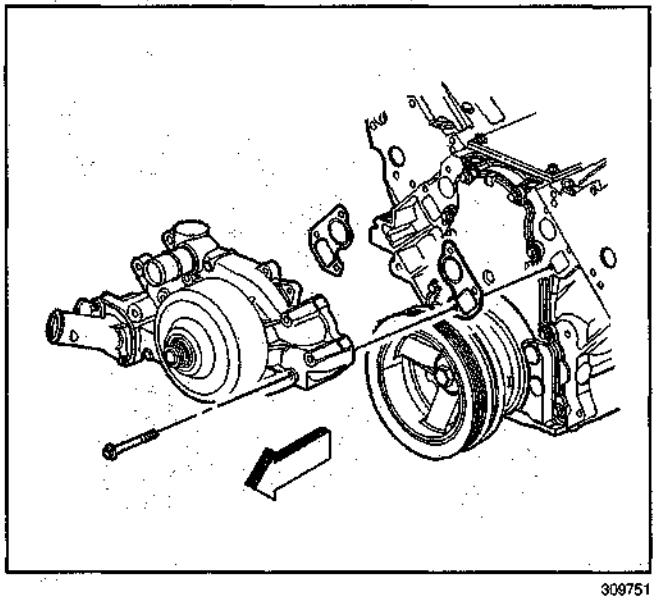
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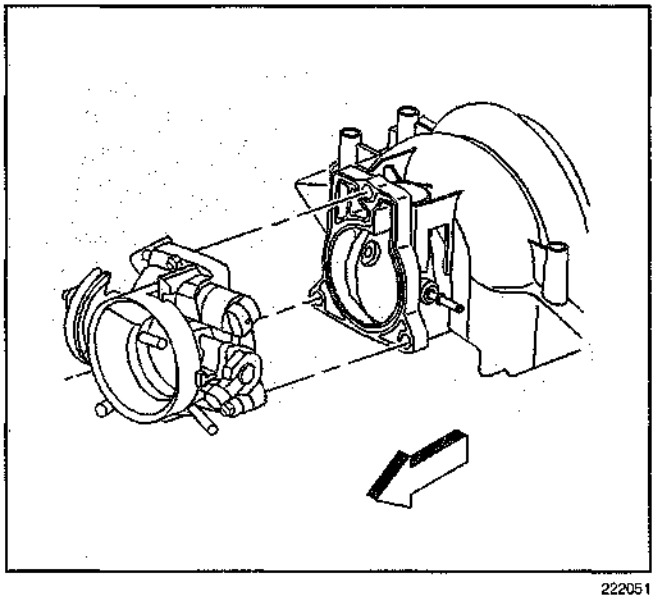
13. Remove the heat shield (2) and bolts (3) from the manifold (1) (if required).



309751

Water Pump Removal

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



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Throttle Body Removal

Important: The intake manifold, throttle body, fuel injection rail, and fuel injectors may be removed as an assembly. If not servicing the individual components, remove the manifold as a complete assembly.

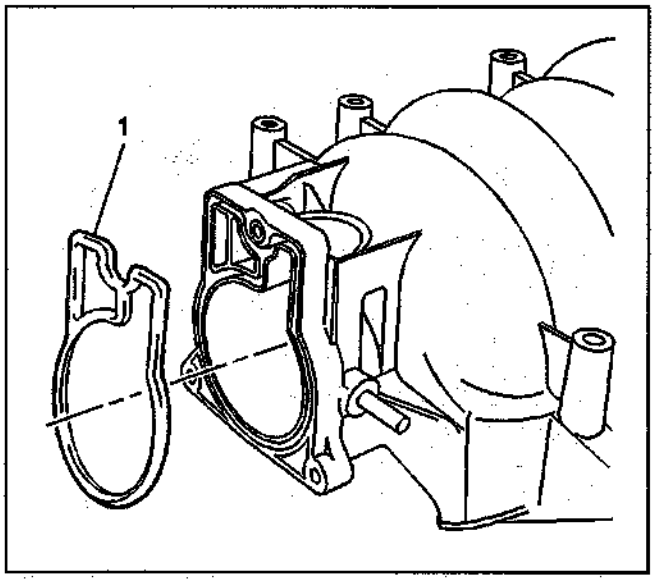
1. Remove the electrical wire harness connectors from the throttle body.
2. Remove the engine coolant air bleed hose and clamp.
3. Remove the throttle body bolts.
4. Remove the throttle body.

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5. Remove the throttle body gasket (1).

Important: DO NOT reuse the throttle body gasket. Install a NEW gasket during assembly.

6. Discard the gasket.



490580

Fuel Rail and Injectors Removal

Important: The intake manifold, throttle body, fuel injection rail and fuel injectors may be removed as an assembly. If not servicing the individual components, remove the intake manifold as a complete assembly.

Caution: The fuel rail stop bracket must be installed onto the engine assembly. The stop bracket serves as a protective shield for the fuel rail in the event of a vehicle frontal crash. If the fuel rail stop bracket is not installed and the vehicle is involved in a frontal crash, fuel could be sprayed possibly causing a fire and personal injury from burns.

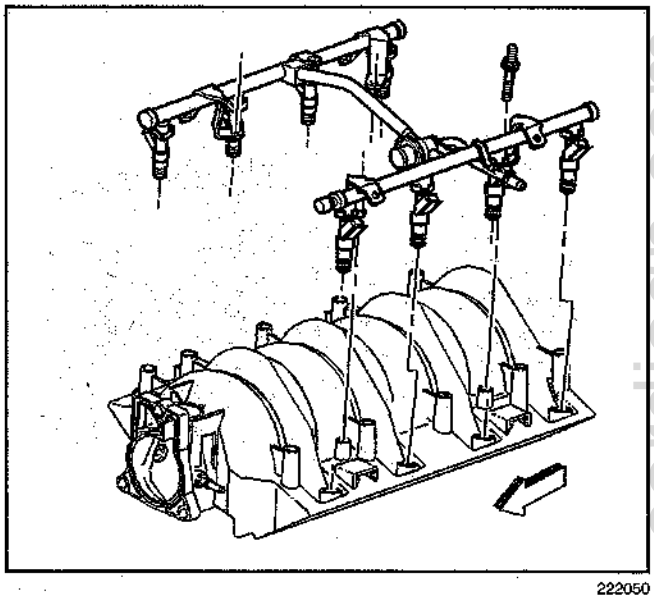
1. Remove the fuel rail bolts.

Important: 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.

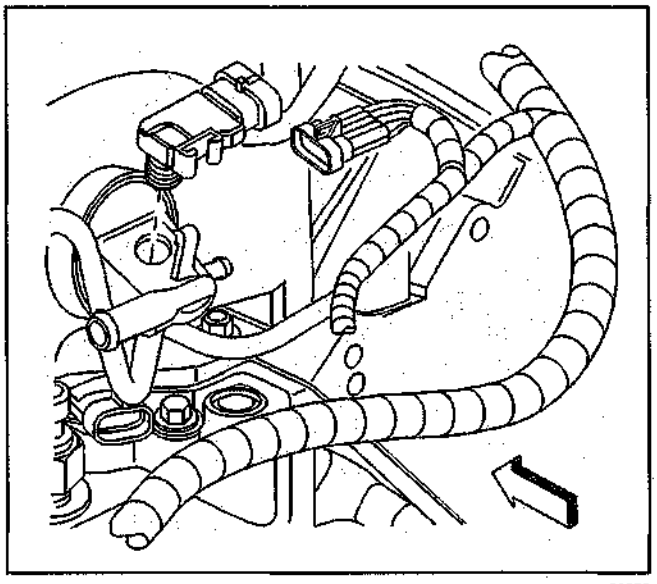
Do not allow dirt or debris to enter the fuel injectors or fuel rail components, cap ends as necessary.

2. Remove the fuel rail (with injectors), lifting evenly from both sides of the fuel rail until all the injectors have left their bores.



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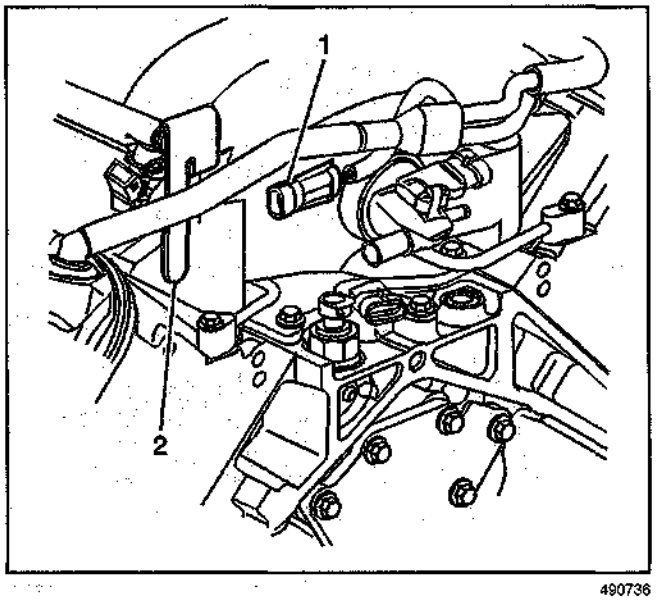


58838

Intake Manifold Removal

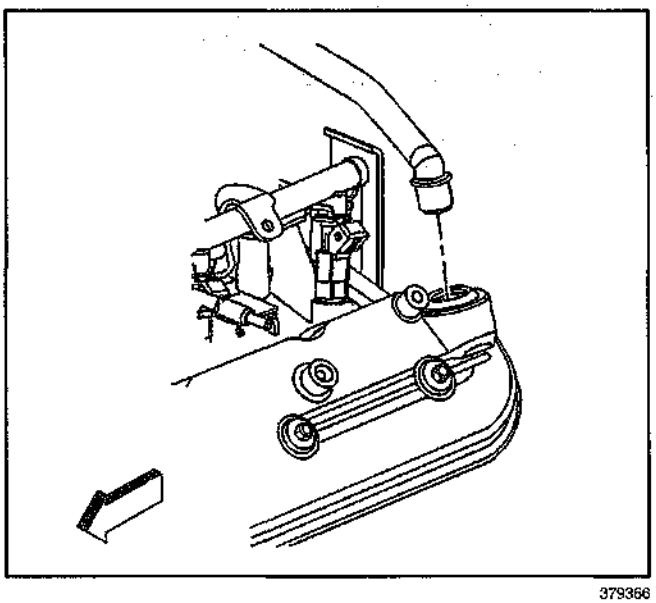
Important: The intake manifold, throttle body, fuel injection rail, and fuel injectors may be removed as an assembly. If not servicing the individual components, remove the manifold as a complete assembly.

1. Remove the Manifold Absolute Pressure (MAP) sensor (if required).



490736

2. Disconnect the knock sensor wire harness connector (1) from the fuel rail stop bracket (2).

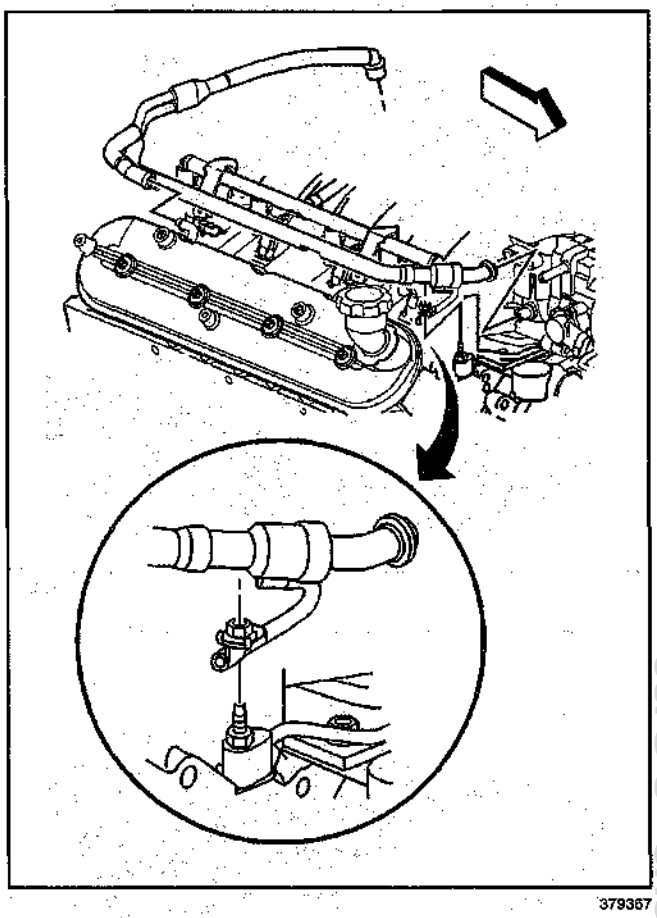


379366

3. Remove the Positive Crankcase Ventilation (PCV) valve pipe from the left rocker cover (if required).

cardiagn.com

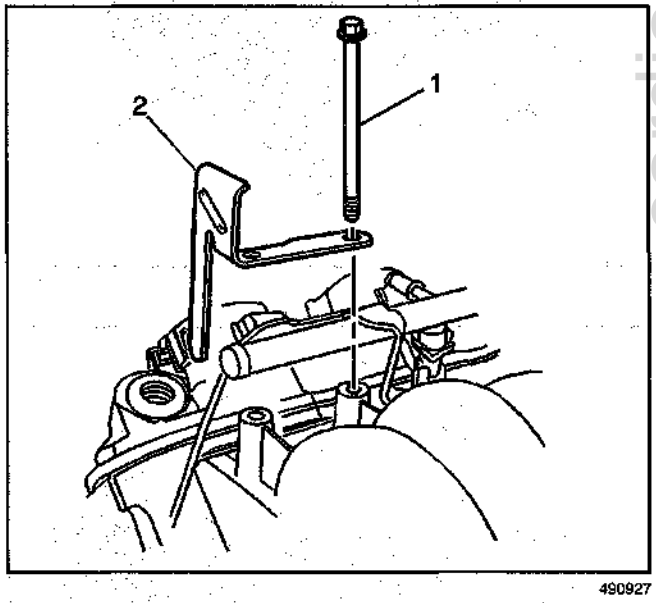
4. Remove the PCV valve pipe strap nut.
5. Remove the PCV valve pipe from the right rocker cover and intake manifold.



379367

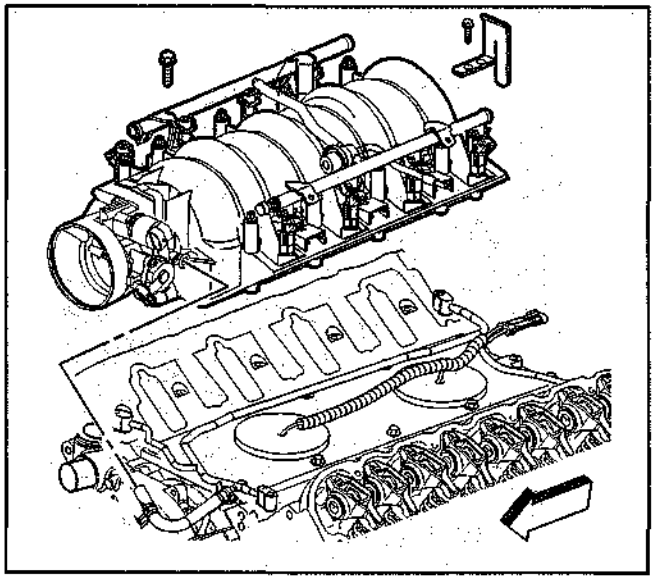
Caution: The fuel rail stop bracket must be installed onto the engine assembly. The stop bracket serves as a protective shield for the fuel rail in the event of a vehicle frontal crash. If the fuel rail stop bracket is not installed and the vehicle is involved in a frontal crash, fuel could be sprayed possibly causing a fire and personal injury from burns.

6. Remove the intake manifold bolts (1) and fuel rail stop bracket (2).



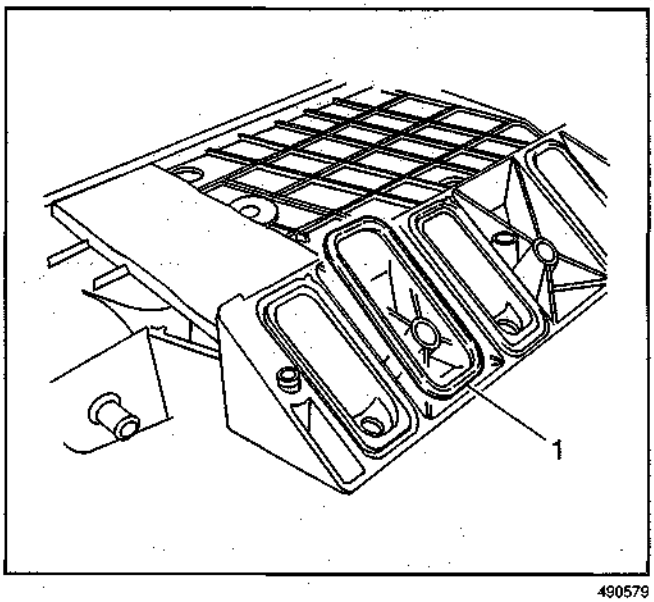
490927

cardiagn.com



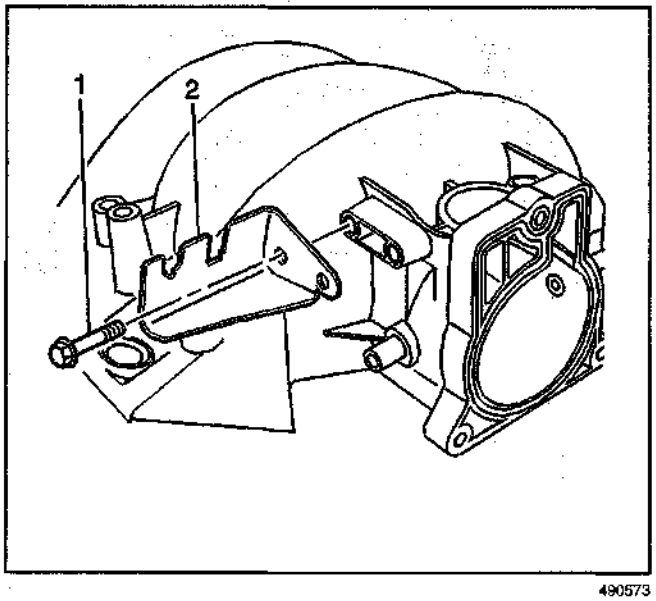
178557

7. Remove the engine coolant air bleed clamp and hose from the throttle body.
8. Remove the intake manifold.



490579

9. Remove the intake manifold-to-cylinder head gaskets (1).
10. Discard the gaskets.



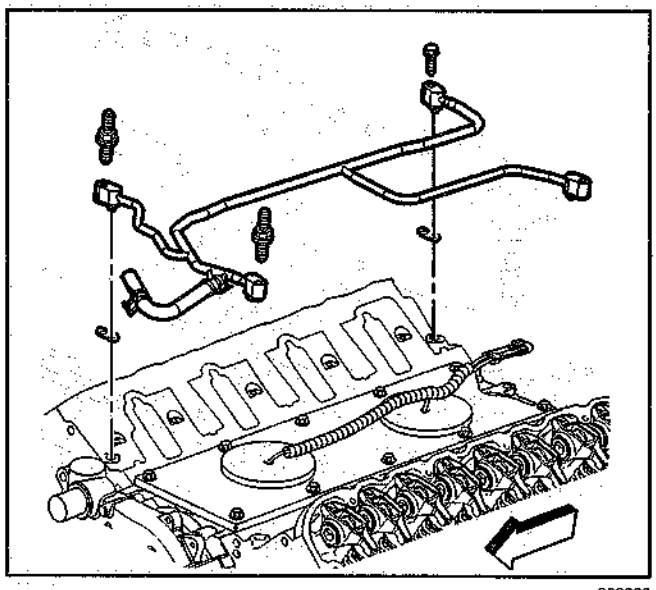
490573

11. Remove the throttle cable bracket (2) and bolt (1) from the manifold (if required).

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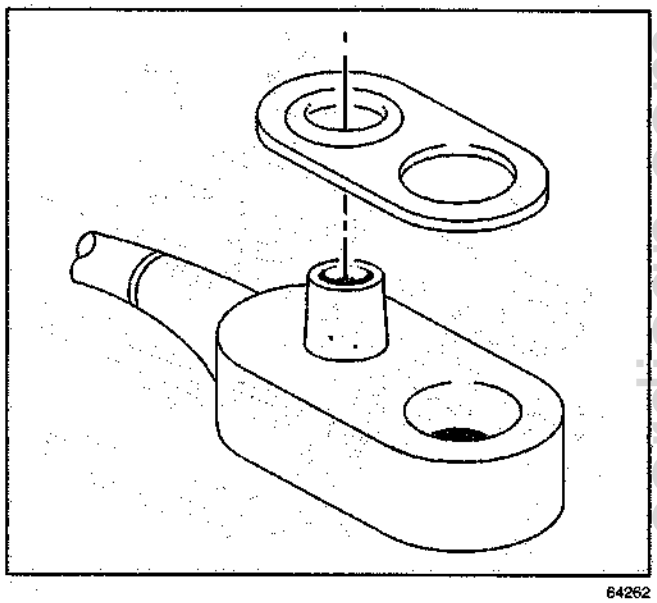
Vapor Vent Pipe Removal

1. Disconnect the knock sensor wire harness retaining clips from the pipe.
2. Remove the engine coolant air bleed pipe bolts and studs.
3. Remove the pipe and gaskets.



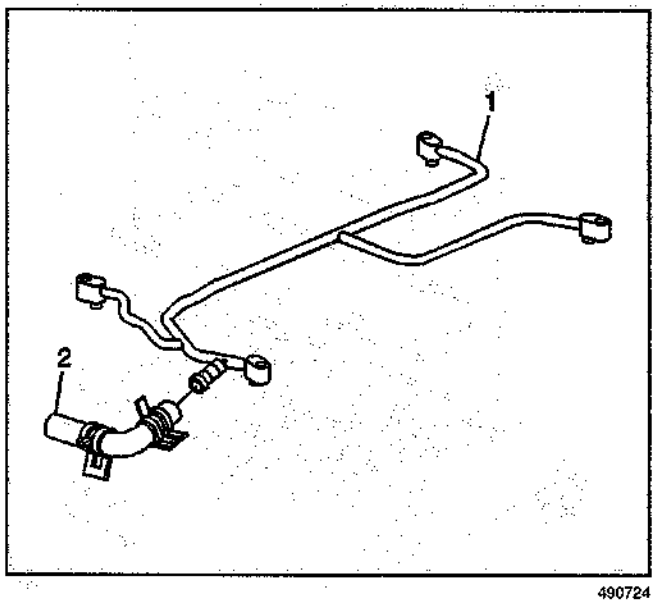
363239

4. Remove the gaskets from the pipe.
5. Discard the gaskets.



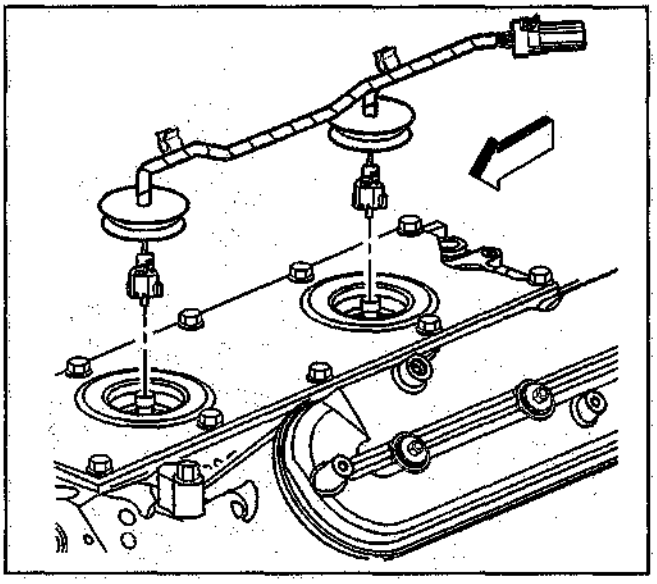
64262

6. Remove the hose (2) from the pipe (1).



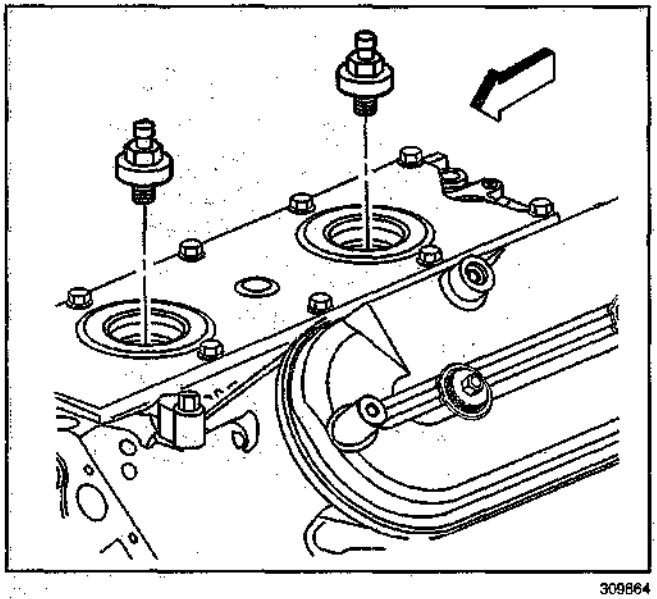
490724

cardiagn.com

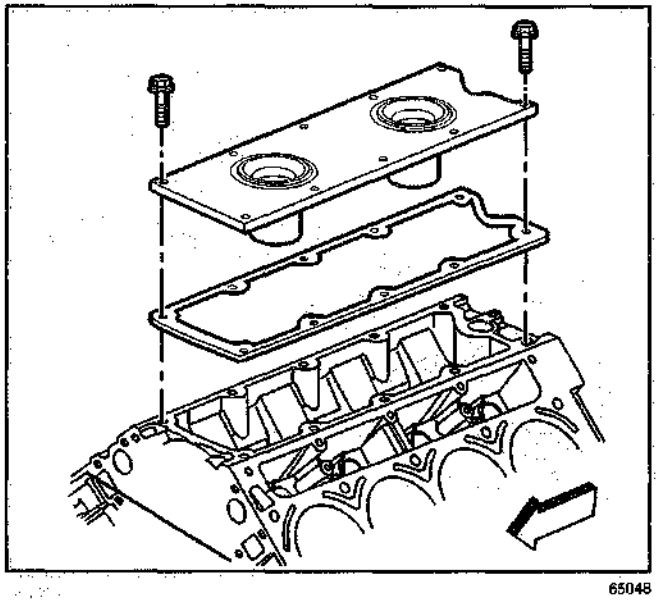

309859

Engine Valley Cover Removal

1. Remove the knock sensor wire harness.


309864

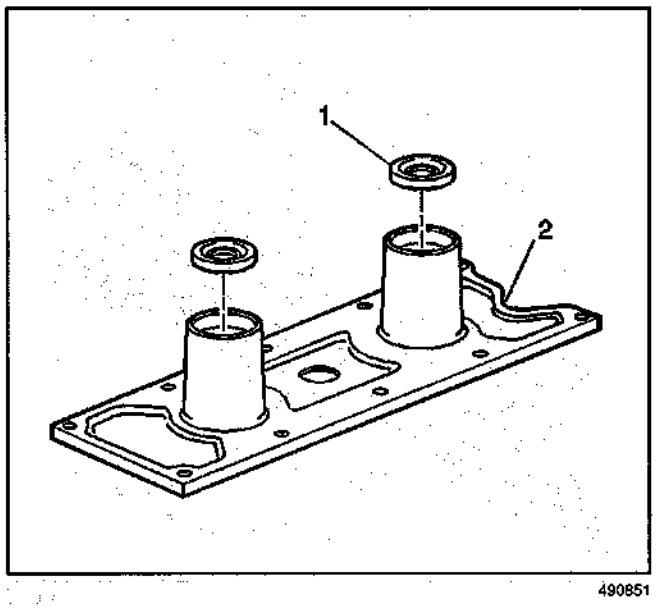
2. Remove the knock sensors.


65048

3. Remove the valley cover bolts.
4. Remove the valley cover and gasket.
5. Discard the valley cover gasket.

cardiagn.com

6. Remove the knock sensor oil seals (1) from the cover (2).



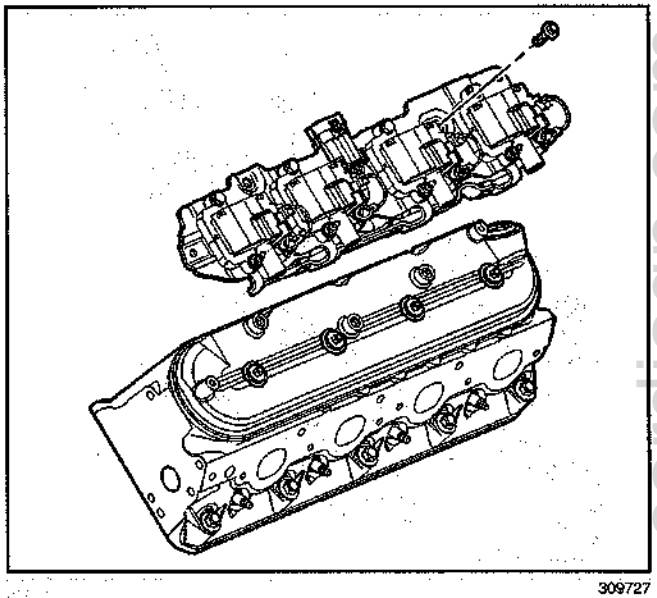
490851

Valve Rocker Arm Cover Removal (Left Side)

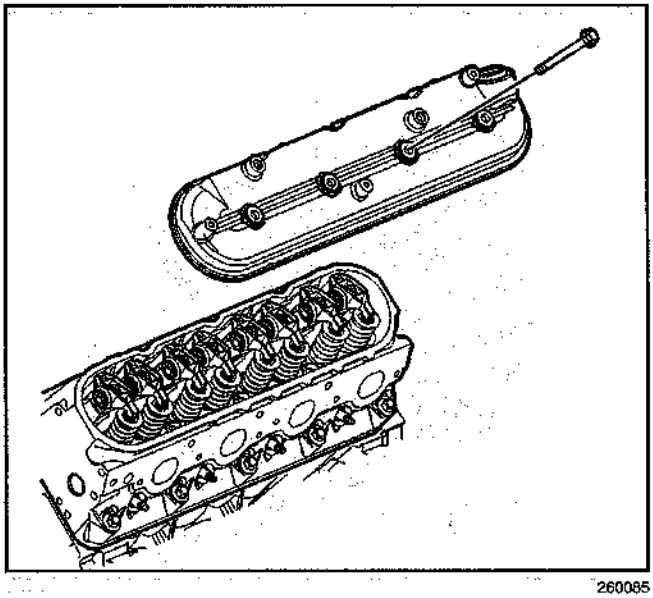
Important: Do not remove the Positive Crankcase Ventilation (PCV) valve grommet from the cover unless service is required.

If the grommet has been removed from the cover, a NEW grommet must be installed.

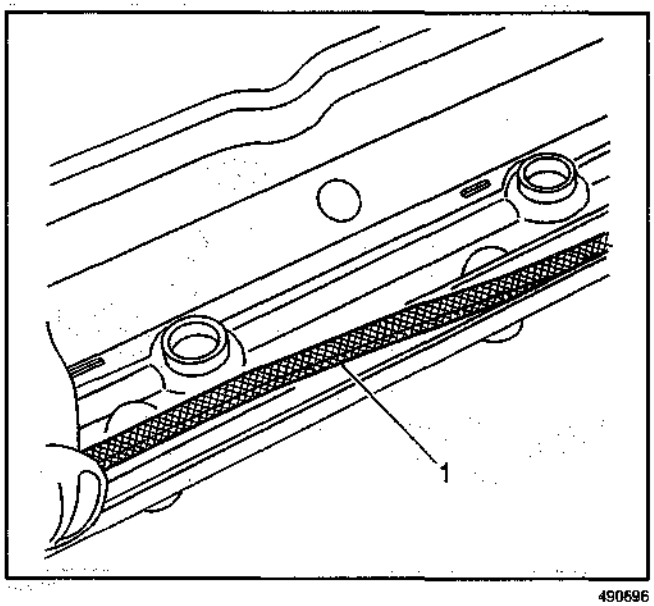
1. Remove the ignition coil and bracket assembly and bolts.


309727

2. Remove the valve rocker arm cover bolts.
3. Remove the valve rocker arm cover.

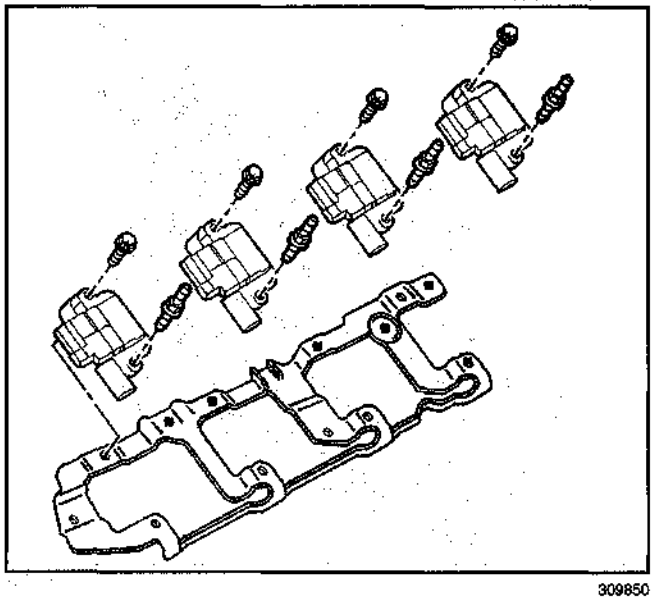

260085

cardiagn.com

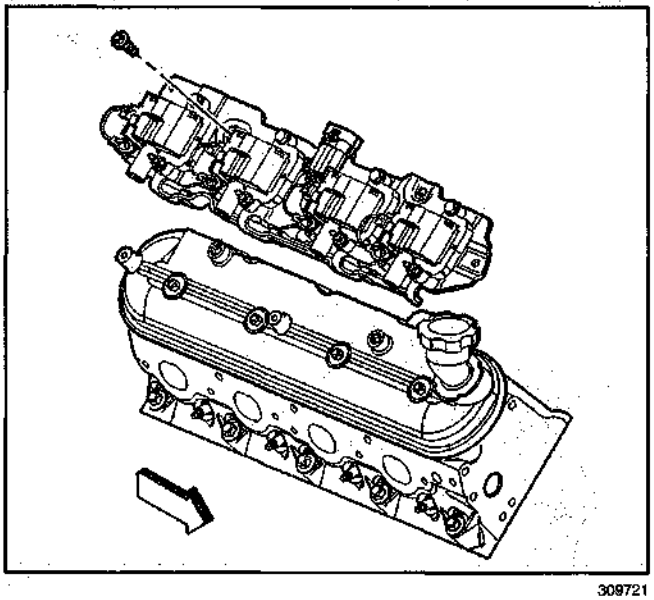


490696

4. Remove the gasket (1) from the cover.
5. Discard the gasket.
   The bolt grommets may be reused if not damaged.


309850

6. Remove the ignition coils, wire harness, and bolts from the bracket (if required).


309721

Valve Rocker Arm Cover Removal (Right Side)

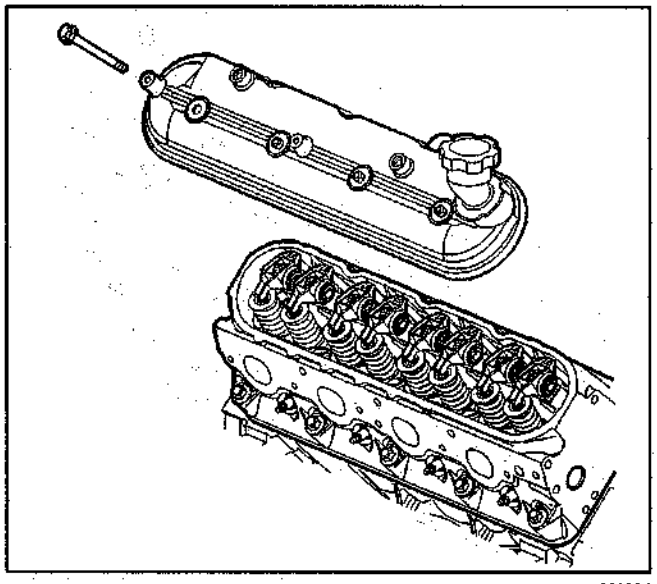
Important: Do not remove the oil fill tube from the cover unless service is required.

If the oil fill tube has been removed from the cover, install a NEW tube during assembly.

1. Remove the ignition coil and bracket assembly and bolts.

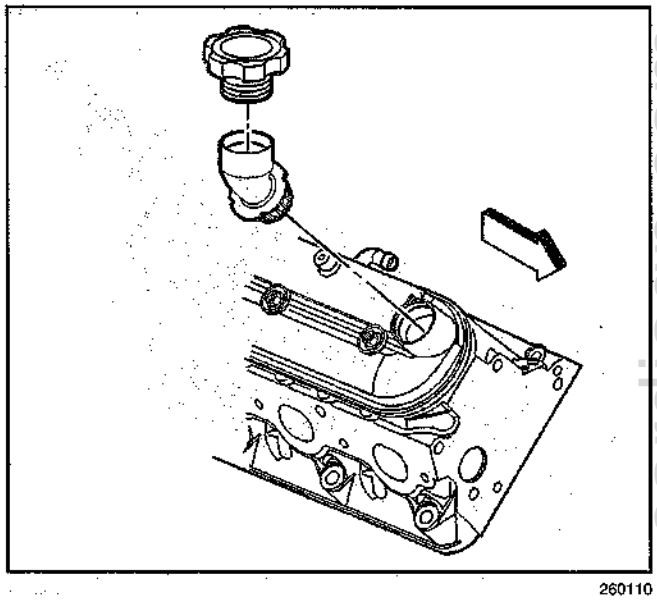
cardiagn.com

2. Remove the valve rocker arm cover bolts.
3. Remove the valve rocker arm cover.



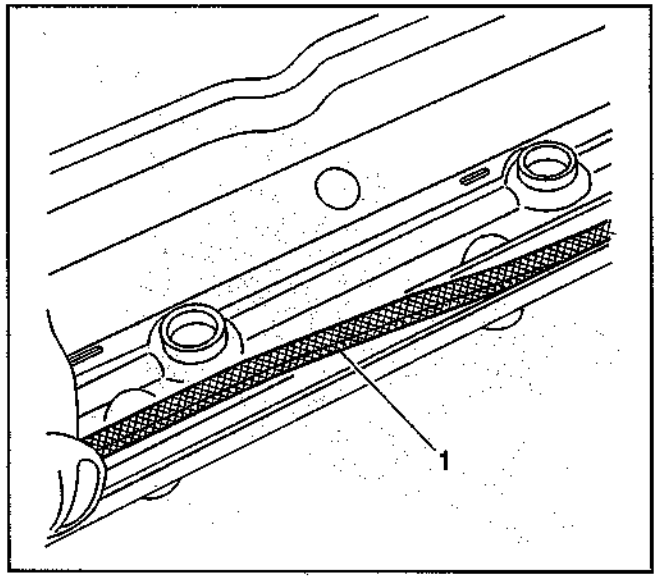
260084

4. Remove the oil fill cap from the oil fill tube.
5. Remove the oil fill tube (if required).
6. Discard the oil fill tube.



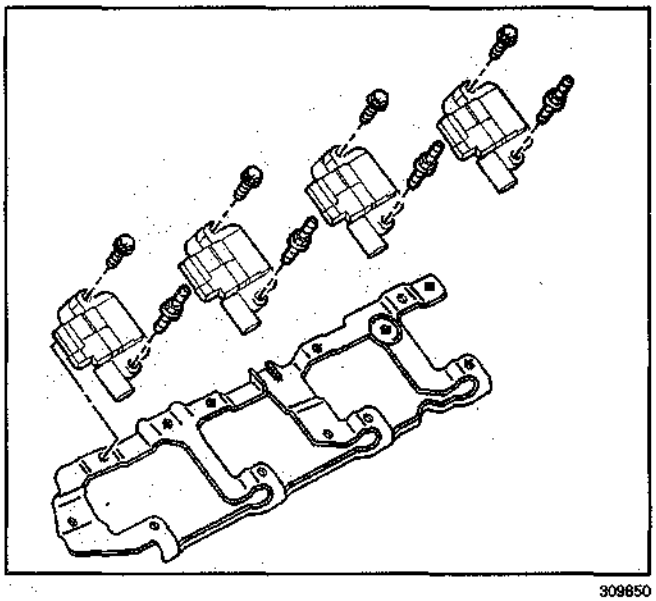
260110

7. Remove the gasket (1) from the cover.
8. Discard the gasket.
   The bolt grommets may be reused if not damaged.



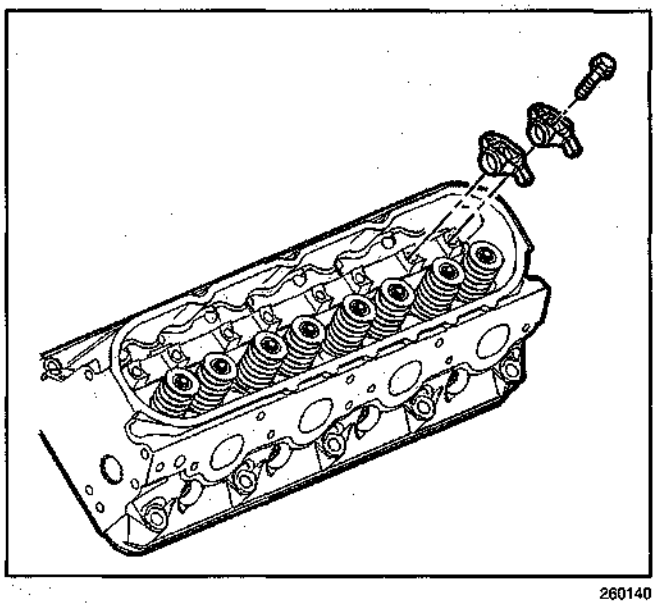
490696

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309850

9. Remove the ignition coils, wire harness, and bolts from the bracket (if required).

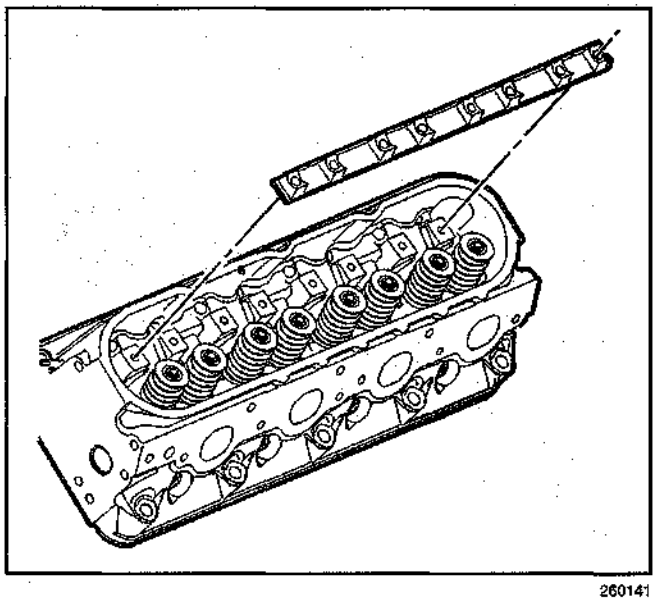


260140

Valve Rocker Arm and Push Rod Removal

Important: Place valve rocker arms, valve pushrods, and pivot support, in a rack so that they can be installed in the same location from which they were removed.

1. Remove the valve rocker arm bolts.
2. Remove the valve rocker arms.

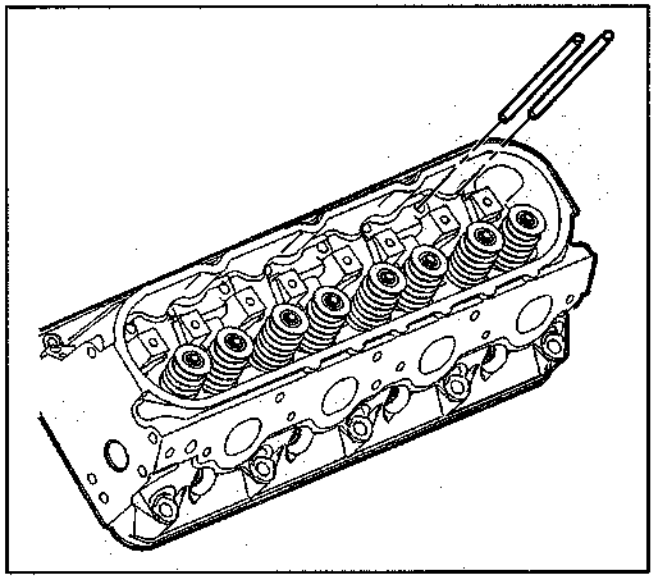


260141

3. Remove the valve rocker arm pivot support.

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4. Remove the pushrods.



260142

Cylinder Head Removal (Left Side)

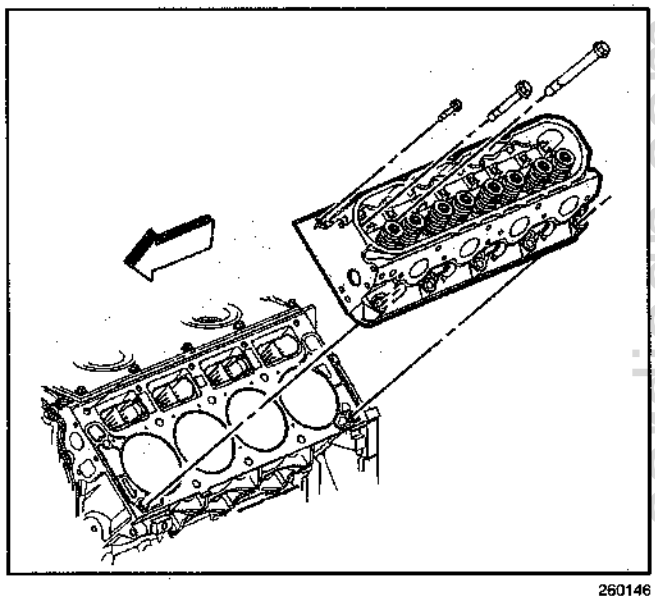
1. Remove the spark plugs from the cylinder head.

Important: The M11 cylinder head bolts are NOT reuseable. Install NEW M11 cylinder head bolts during assembly.

2. Remove the cylinder head bolts.

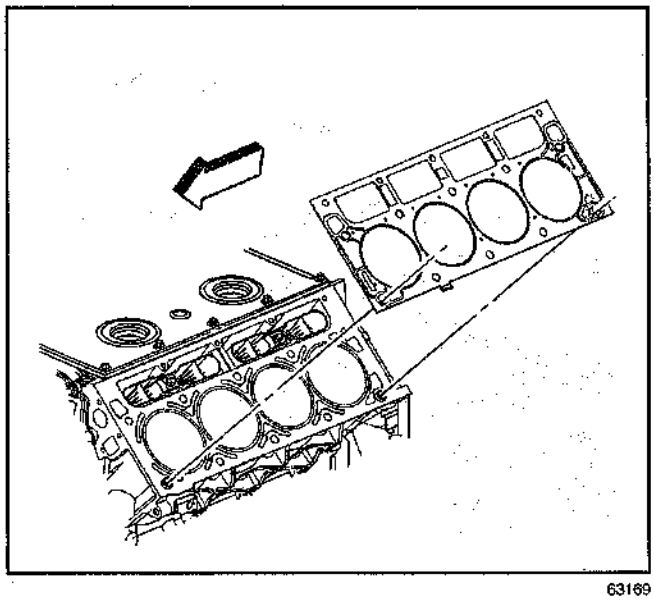
Notice: After removal, place the cylinder head on two wood blocks to prevent damage.

3. Remove the cylinder head.



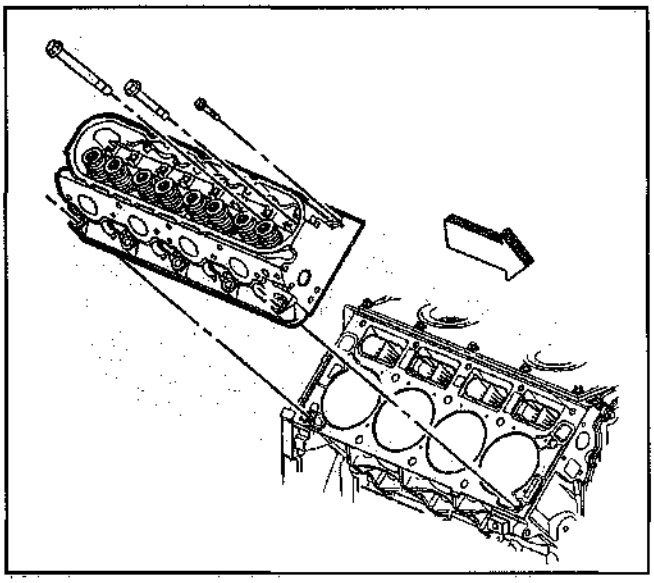
260146

4. Remove the gasket.
5. Discard the gasket.
6. Discard the M11 cylinder head bolts.



63169

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260149

Cylinder Head Removal (Right Side)

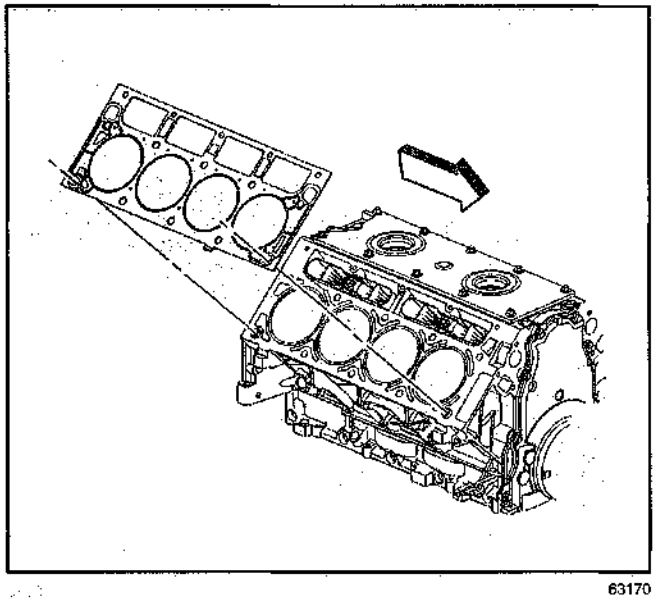
1. Remove the spark plugs from the cylinder head.

Important: The M11 cylinder head bolts are NOT reuseable. Install NEW M11 cylinder head bolts during assembly.

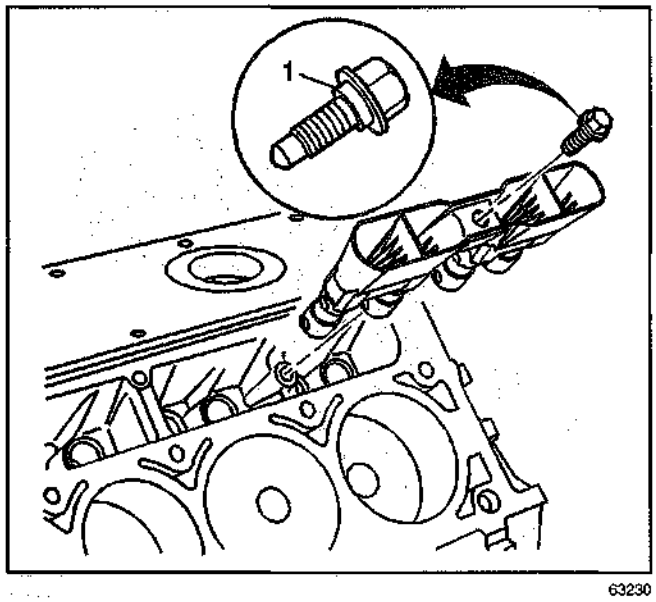
2. Remove the cylinder head bolts.

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

3. Remove the cylinder head.


63170

4. Remove the gasket.
5. Discard the gasket.
6. Discard the M11 cylinder head bolts.



63230

Valve Lifter Removal

Tools Required

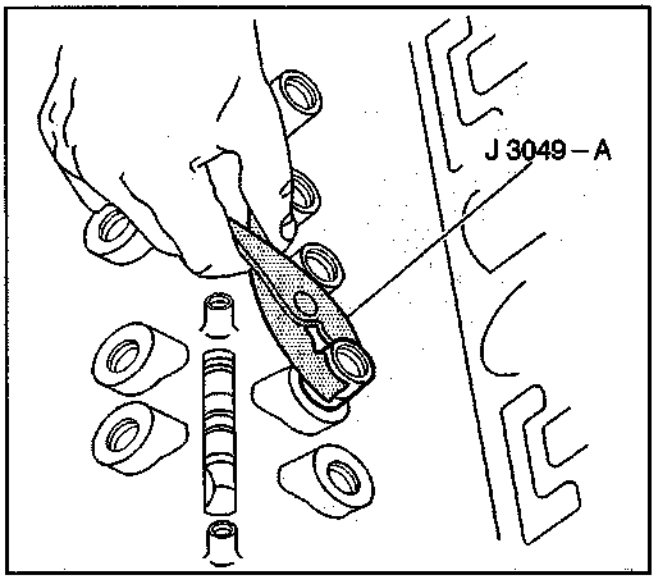
J 3049-A Valve Lifter Remover

1. Remove the valve lifter guide bolts (**1**).
2. Remove the valve lifters and guide.

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

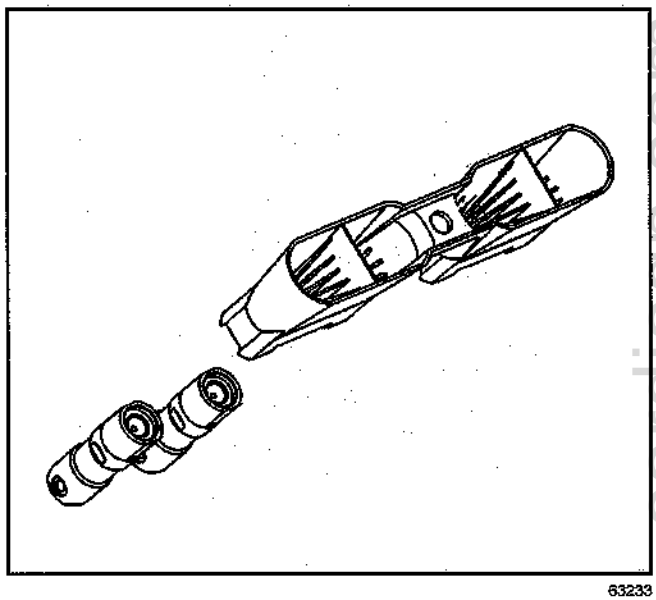
3. Use the *J 3049-A* or equivalent in order to remove the valve lifters (if required).



31350

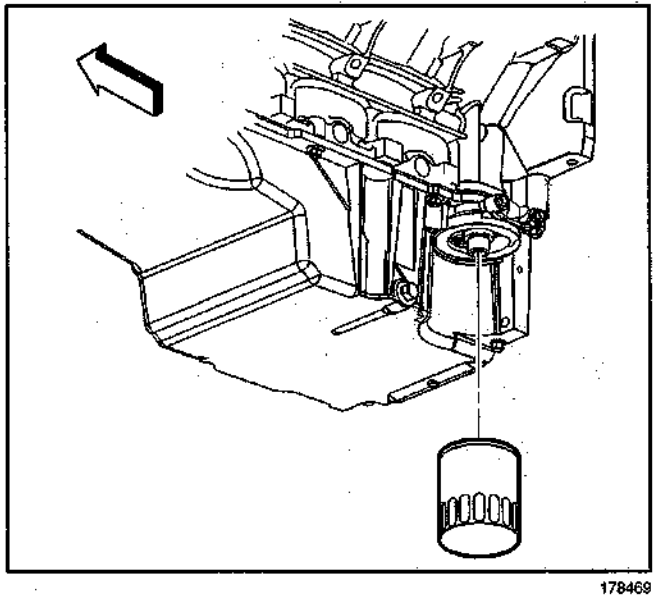
4. Remove the valve lifters from the guide.
5. Organize or mark the components so that they can be installed in the same location from which they were removed.

   Refer to *Separating Parts*.

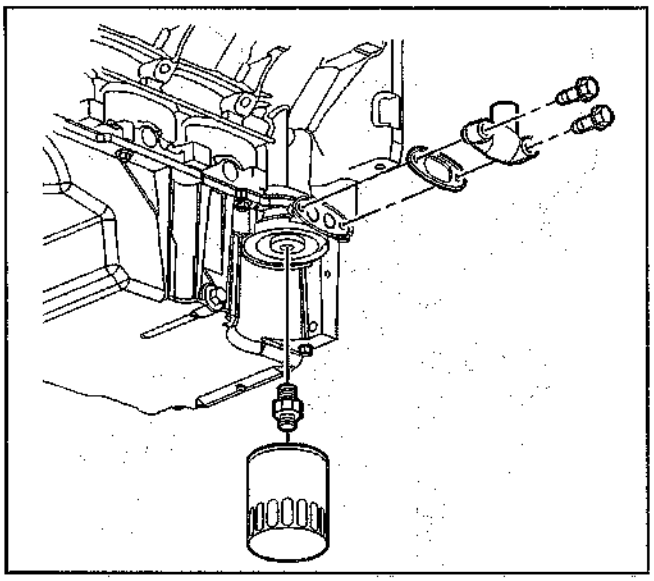

63233

Oil Filter, Adapter and Pan Cover Removal

1. Remove the oil filter.

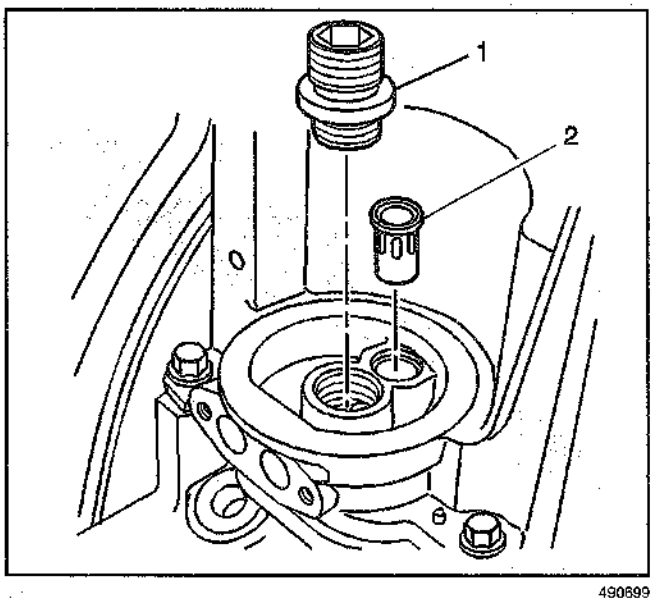

178469

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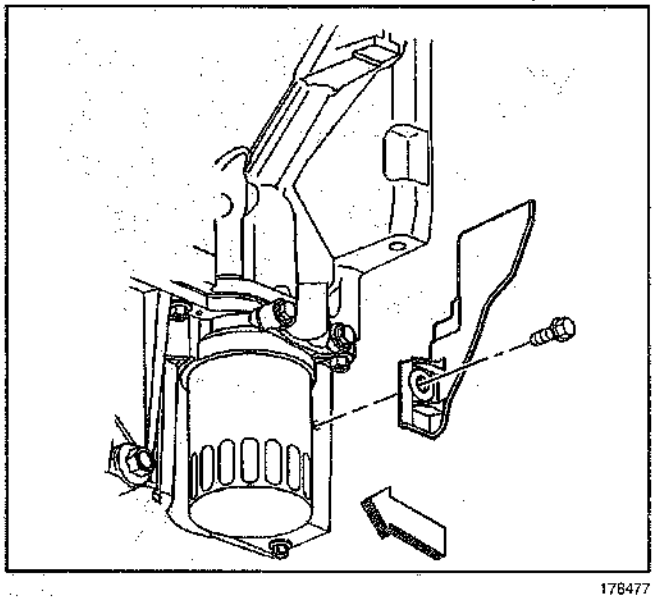
178471

2. Remove the oil pan cover, bolts, and gasket.
3. Discard the gasket.



490699

4. Remove the oil filter fitting (1) and bypass valve (2) (if required).



178477

Oil Pan Removal

Important: 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.

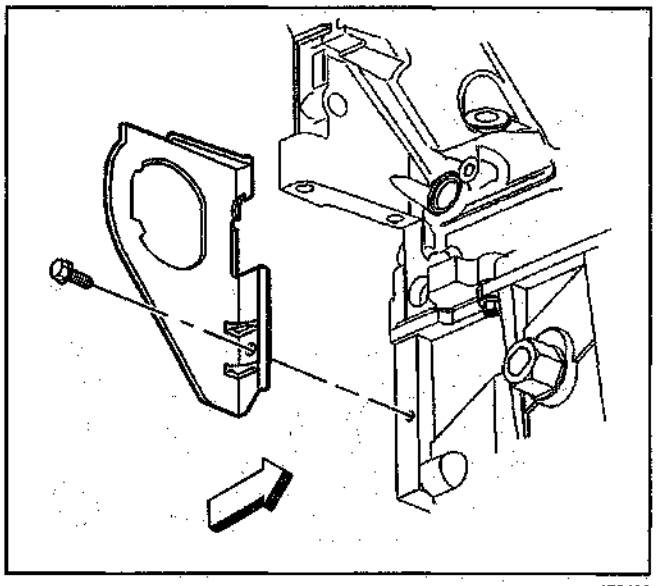
DO NOT reuse the oil pan gasket. When installing the oil pan, install a NEW oil pan gasket.

It is not necessary to remove the oil level sensor prior to oil pan removal. Remove the oil level sensor if service is required.

1. Remove the left closeout cover and bolt.

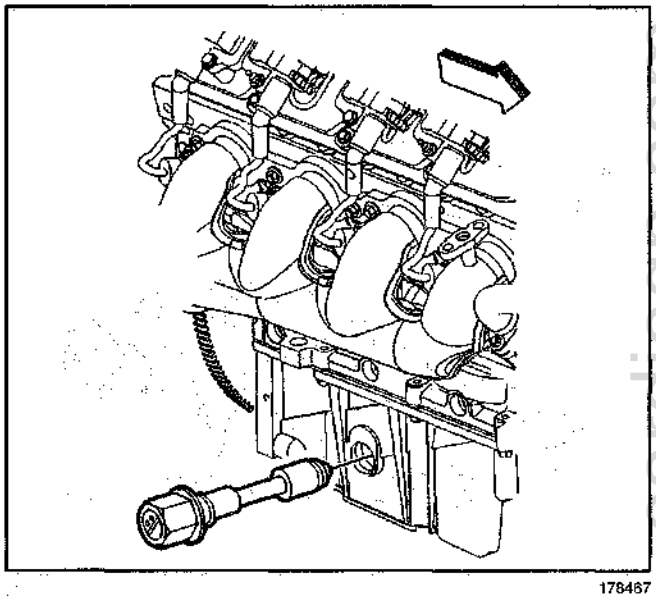
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2. Remove the right closeout cover and bolt.



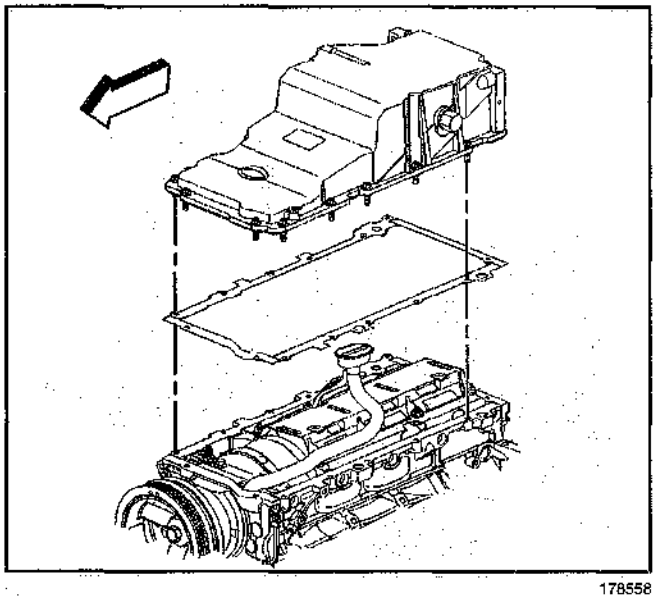
178480

3. Remove the oil level sensor from the oil pan (if required).



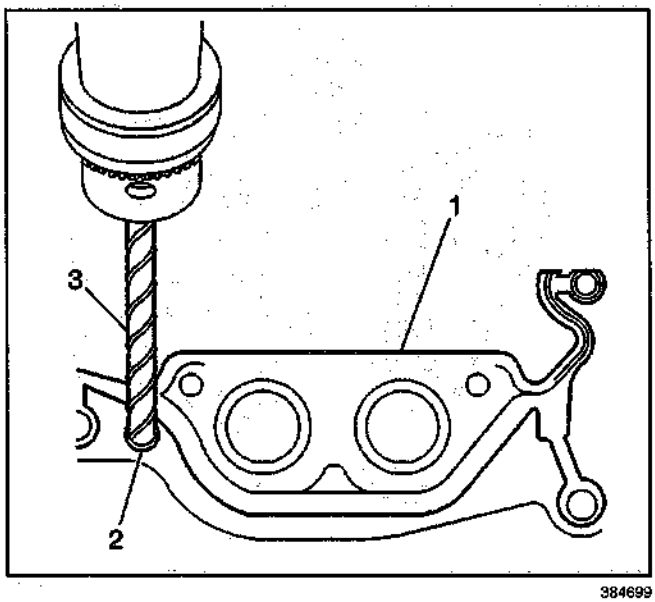
178487

4. Remove the oil pan bolts.
5. Remove the oil pan.



178558

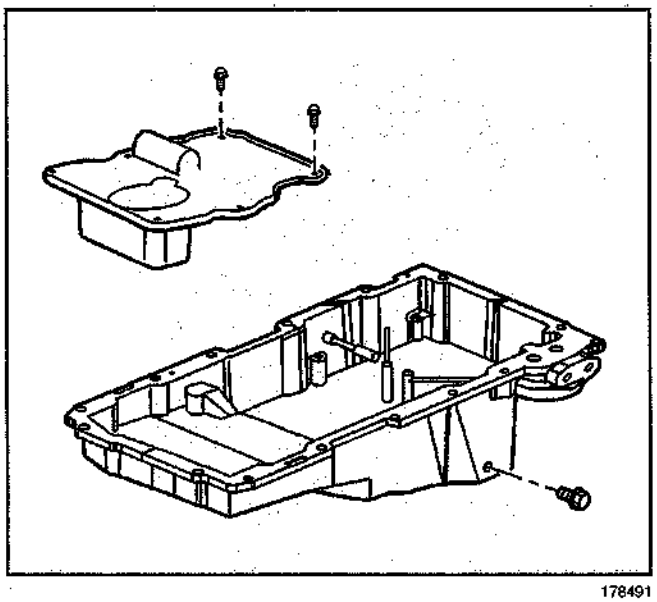
cardiagn.com



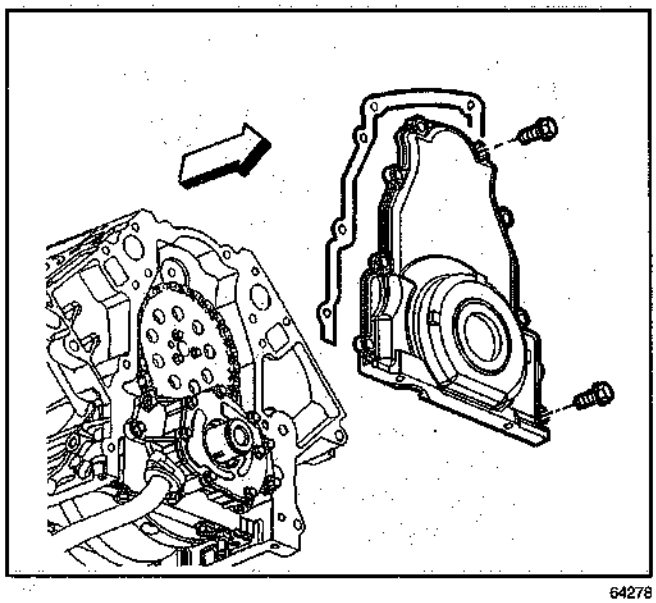
384699

Important: DO NOT allow foreign material to enter the oil passages of the oil pan, cap or cover the openings as required.

6. Drill (3) out the oil pan retaining rivets (2) (if required).
7. Discard the gasket and rivets.


178491

8. Remove the oil pan baffle bolts and baffle (if required).

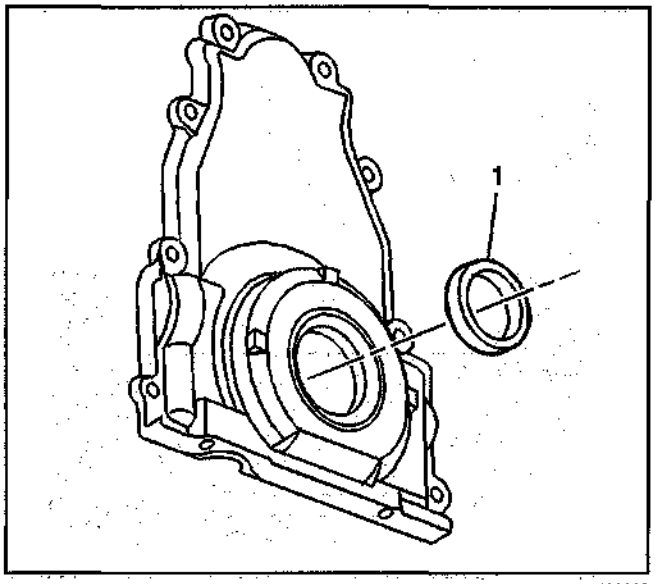

64278

Engine Front Cover Removal

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

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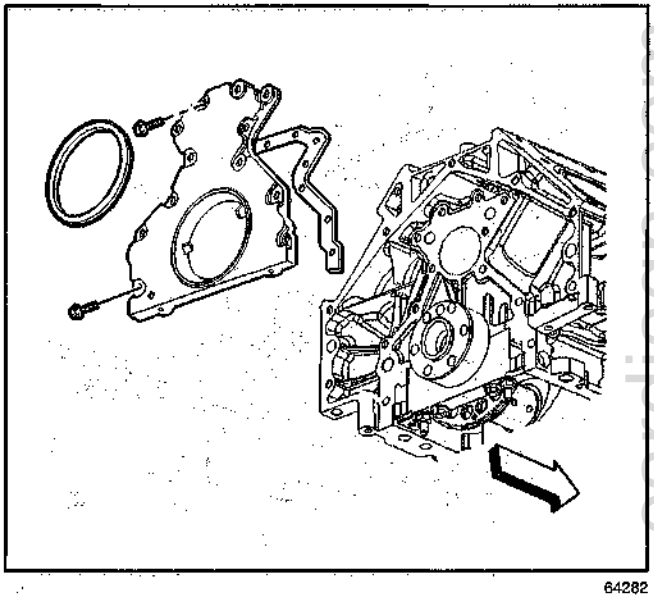
4. Remove the crankshaft front oil seal (1) from the cover.



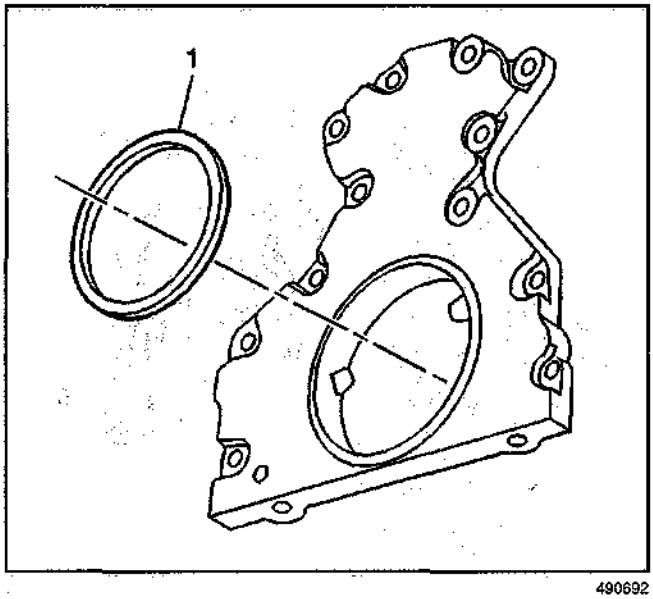
490689

Engine Rear Cover Removal

1. Remove the rear cover bolts.
2. Remove the rear cover and gasket.
3. Discard the rear cover gasket.

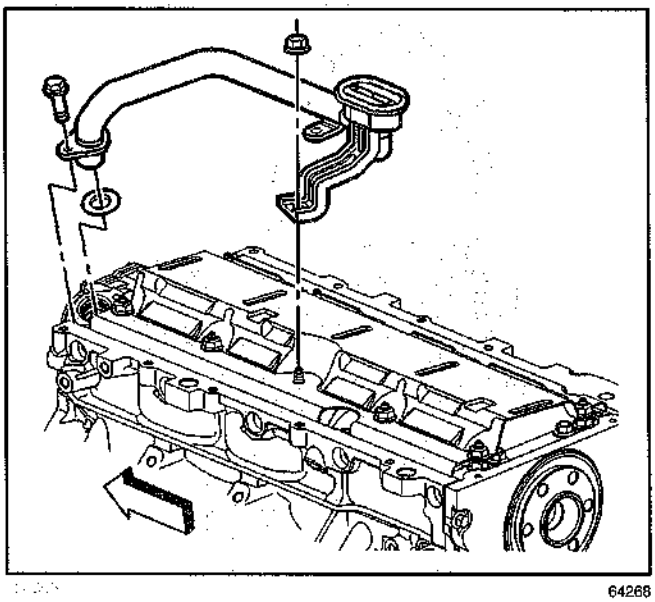

64282

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



490692

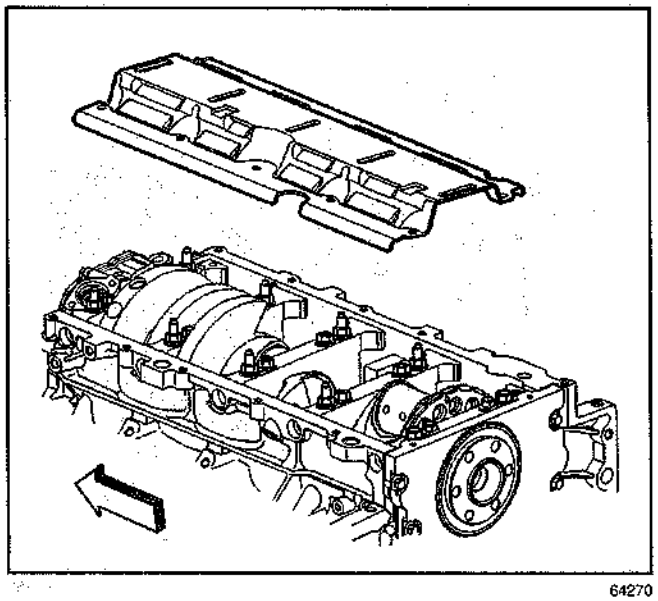
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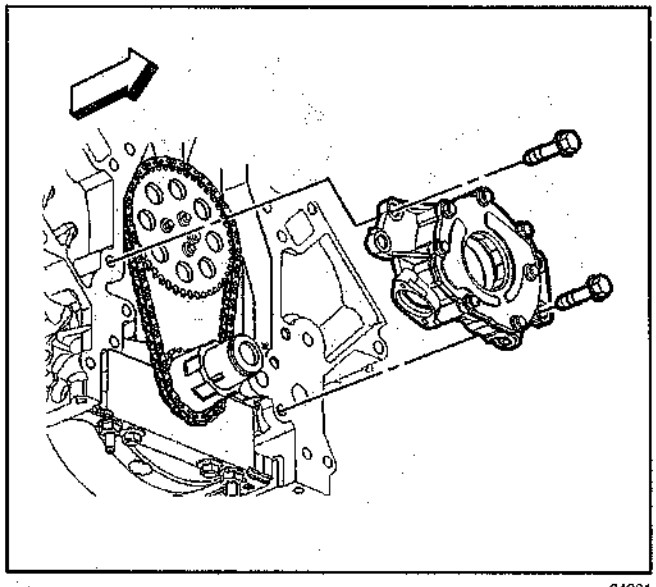
Oil Pump, Pump Screen and Deflector Removal

1. Remove the oil pump screen bolt and nuts.
2. Remove the oil pump screen with O-ring seal.
3. Remove the O-ring seal from the pump screen.
4. Discard the O-ring seal.



64270

5. Remove the remaining crankshaft oil deflector nuts.
6. Remove the crankshaft oil deflector.



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7. Remove the oil pump bolts.

Important: Do not allow dirt or debris to enter the oil pump assembly, cap ends as necessary.

8. Remove the oil pump.

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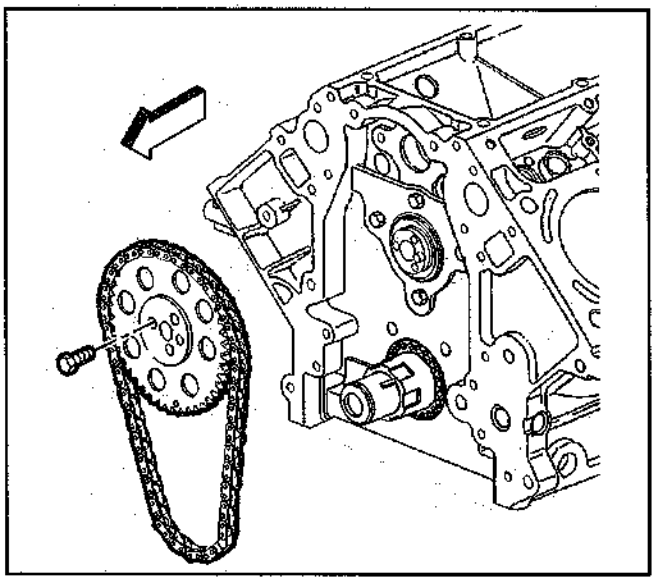
Timing Chain and Sprockets Removal

Tools Required

- *J 8433* Two Jaw Puller
- *J 41816-2* Crankshaft Pilot
- *J 41558* Crankshaft Sprocket Remover

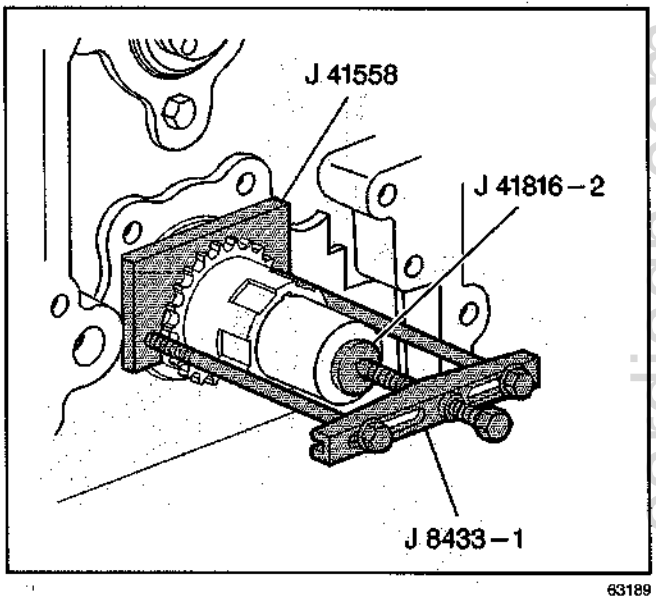
Notice: Do not turn the crankshaft assembly after the timing chain has been removed in order to prevent damage to the piston assemblies or the valves.

1. Remove the camshaft sprocket bolts.
2. Remove the camshaft sprocket and timing chain.



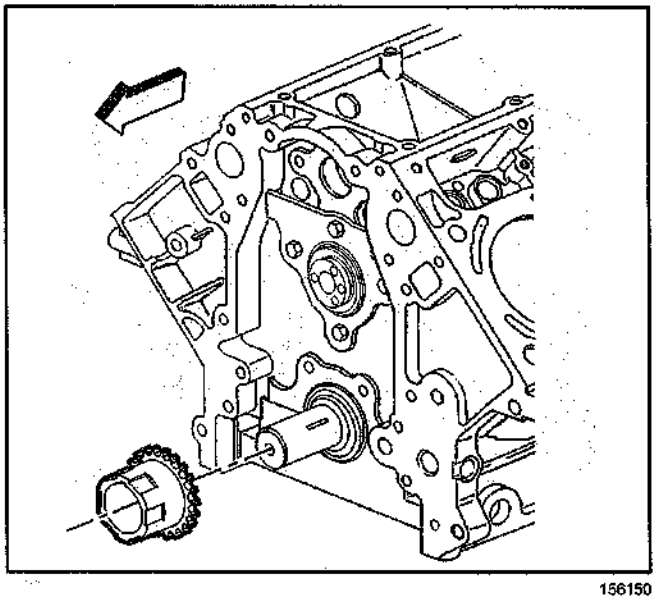
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3. Use the *J 8433*, the *J 41816-2*, and the *J 41558* in order to remove the crankshaft sprocket.



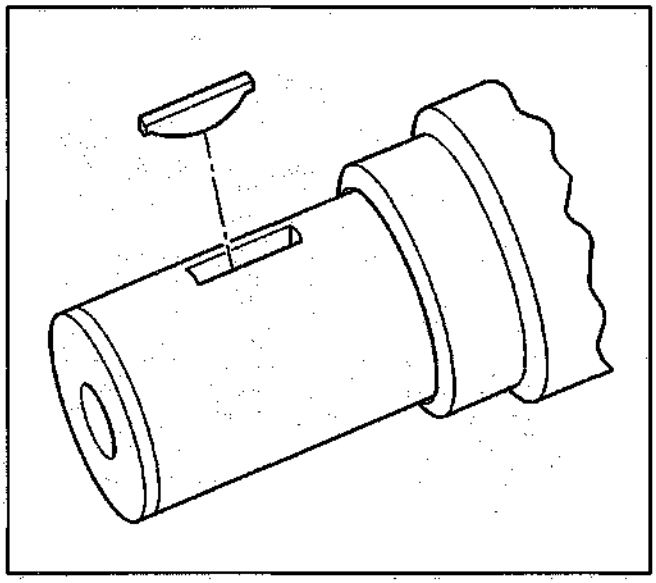
63189

4. Remove the crankshaft sprocket.



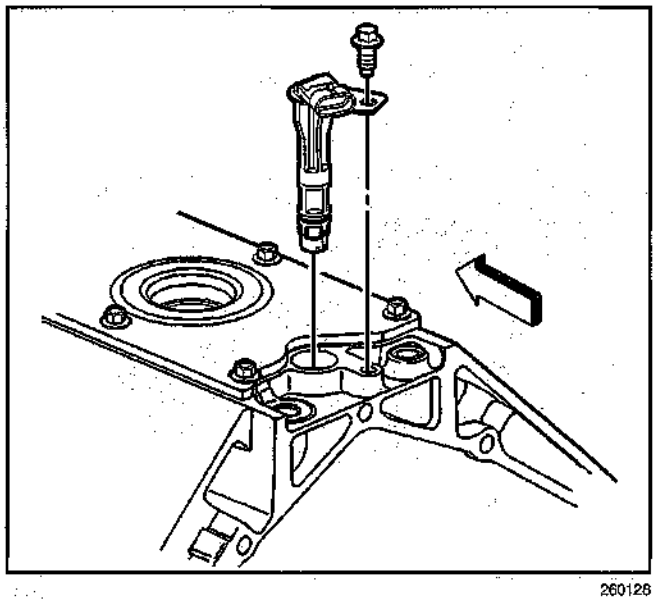
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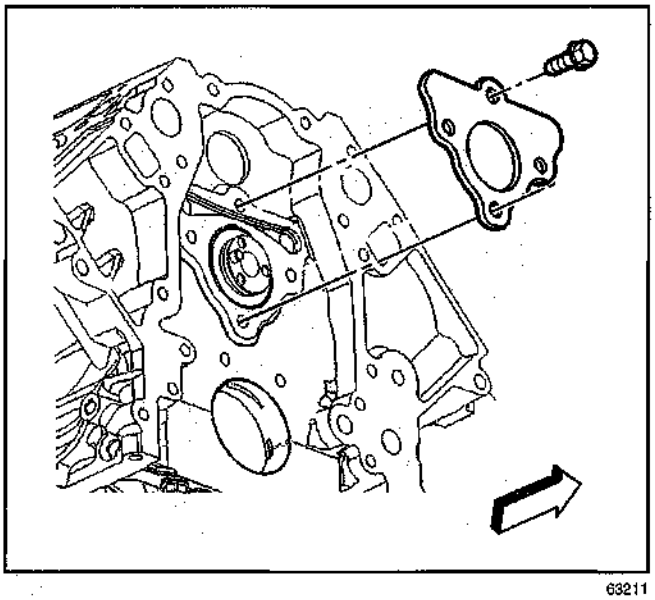
5. Remove the crankshaft sprocket key (if required).



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Camshaft Removal

1. Remove the camshaft sensor bolt and the sensor.



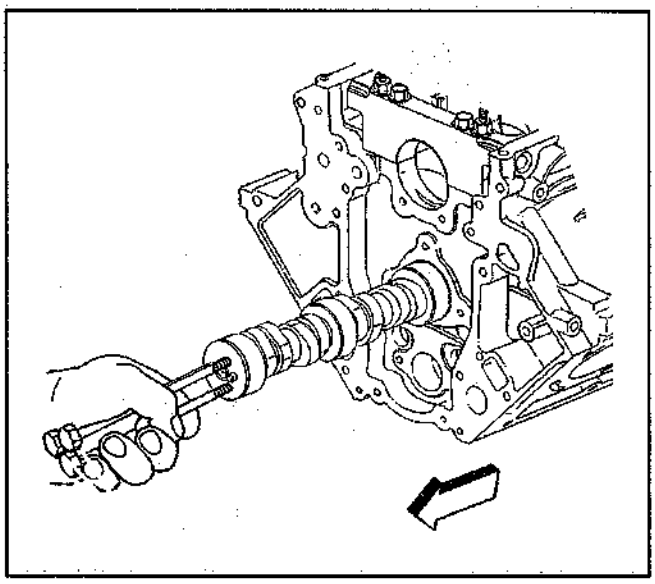
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2. Remove the camshaft retainer bolts and the retainer.

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Notice: 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. Remove the camshaft.
   3.1. Install the three M8-1.25 x 100 mm bolts in the camshaft front bolt holes.
   3.2. Using the bolts as a handle, carefully rotate and pull the camshaft out of the engine block.
   3.3. Remove the bolts from the front of the camshaft.



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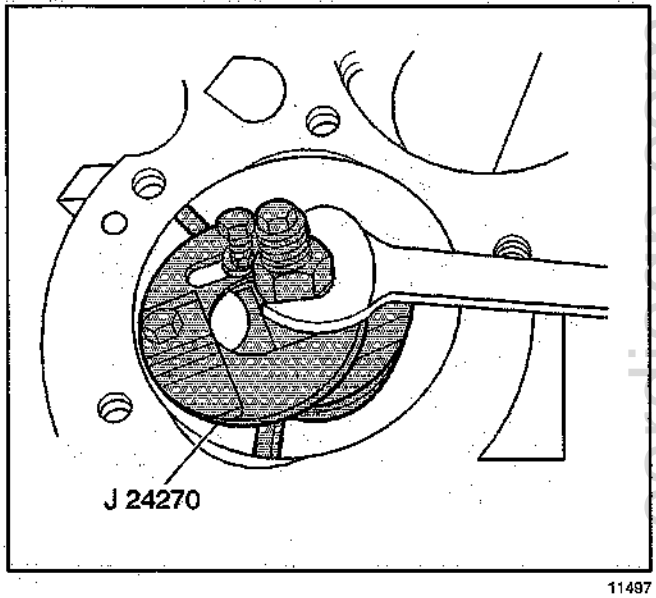
Piston, Connecting Rod, and Bearing Removal

Tools Required

- *J 41556* Connecting Rod Guide
- *J 24270* Cylinder Ring Ridge Remover

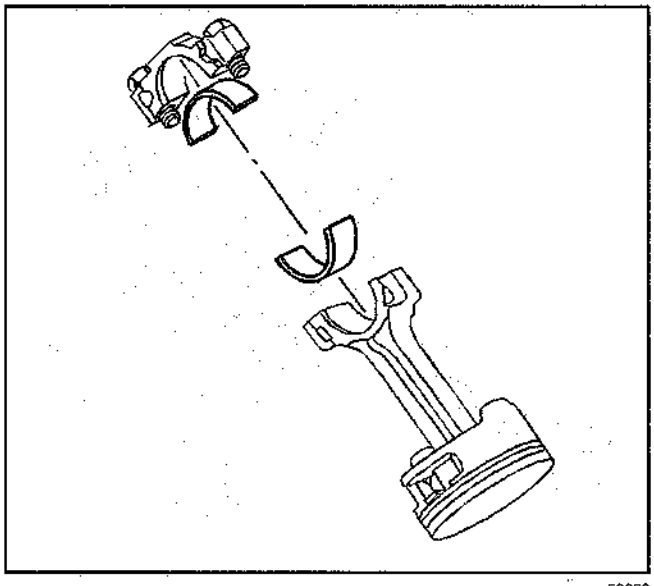
Important: The connecting rods and the bearing caps are NOT interchangeable.

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 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.



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Important: 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.

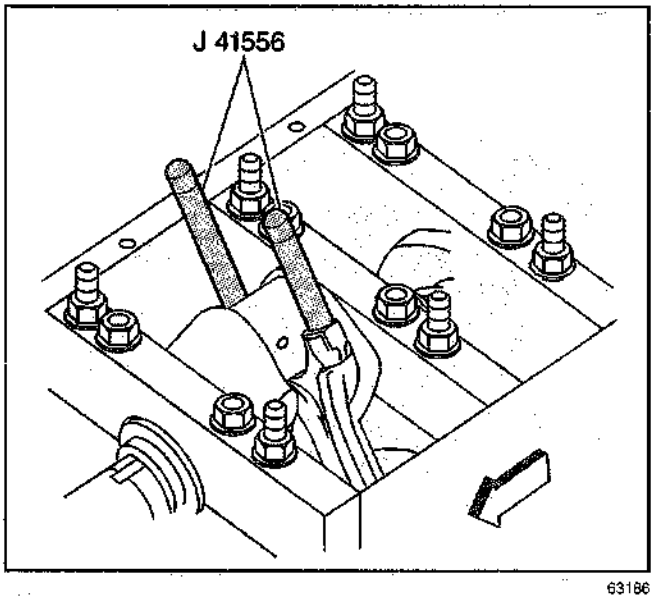
A stamping mark on the side of the connecting rod at the crank journal may effect component geometry.

Mark the top of the piston to the specific cylinder bore.

2. Remove the connecting rod bolts.

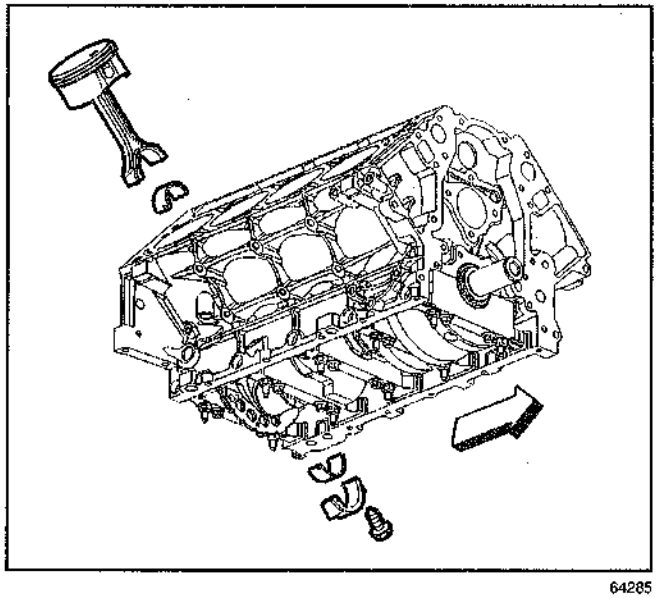
Important: Mark, sort, or organize the connecting rod bearings so they may be installed to their original position and location.

3. Remove the connecting rod cap.
   Refer to *Separating Parts*.



63186

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

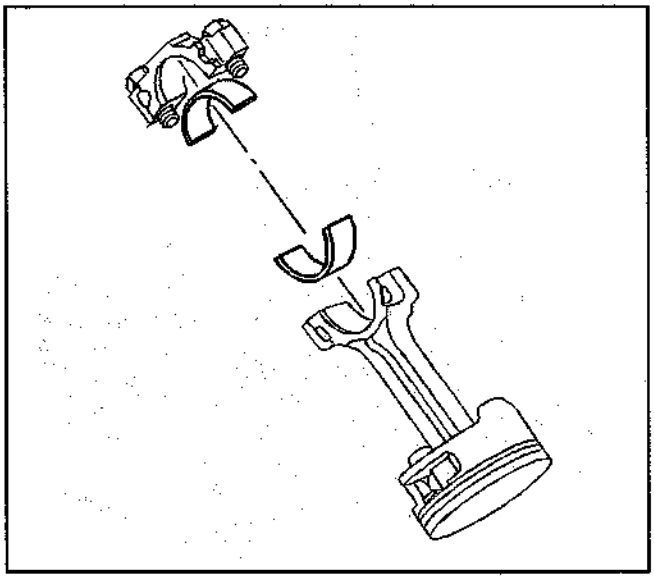


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5. Use a hammer and tap lightly on the end of the *J 41556* in order to remove the piston and connecting rod assembly from the cylinder bore.

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



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Crankshaft and Bearings Removal

Tools Required

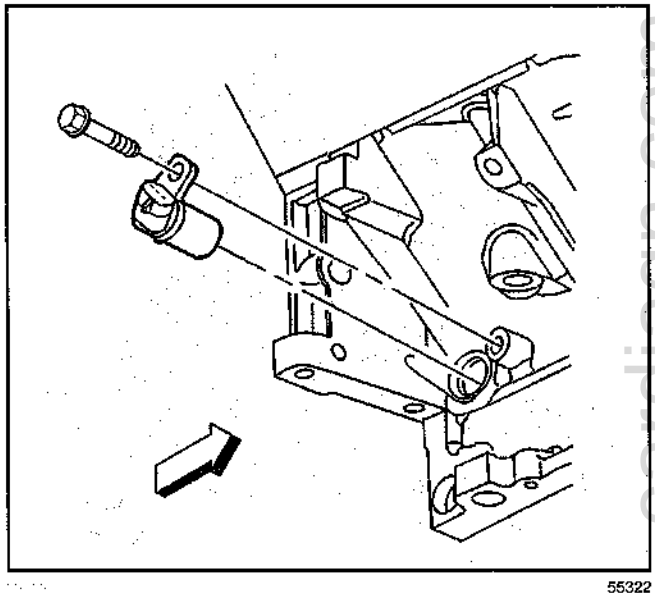
- *J 41818* Crankshaft Bearing Cap Remover
- *J 6125-1B* Slide Hammer

Important: 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.

Do not reuse the bearing cap M8 side bolts.

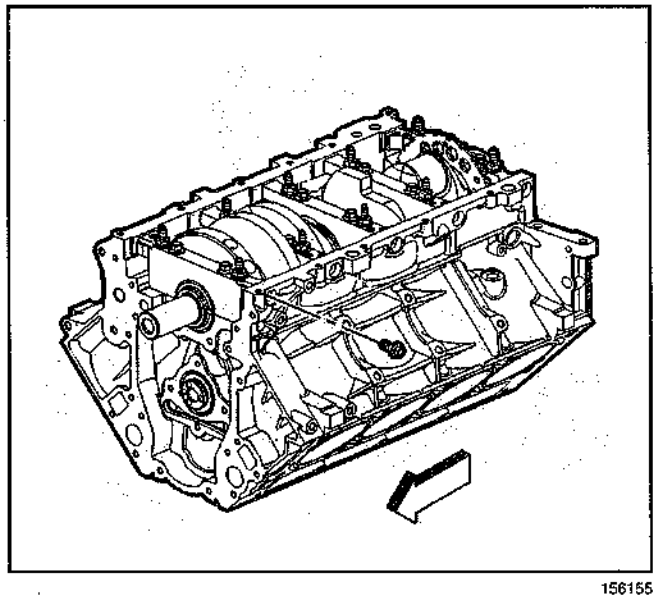
Remove the bearing cap M8 side bolts prior to cap removal.

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



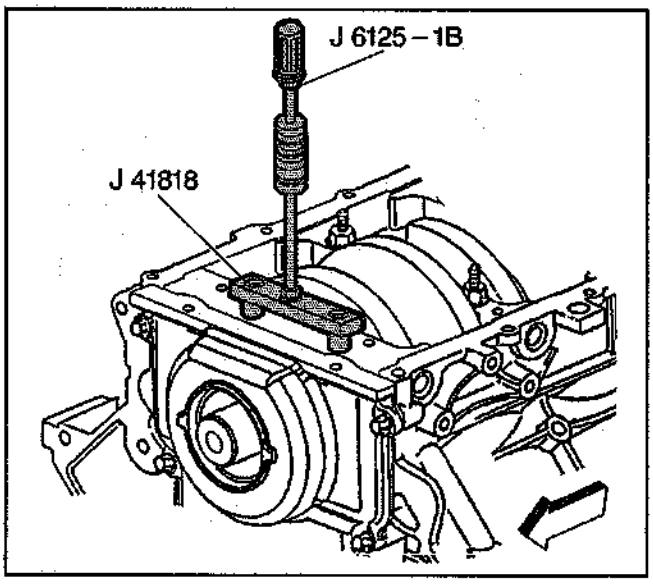
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3. Remove the crankshaft bearing cap M8 side bolts.
4. Remove the bearing cap M10 bolts and studs. Note the M10 stud locations.



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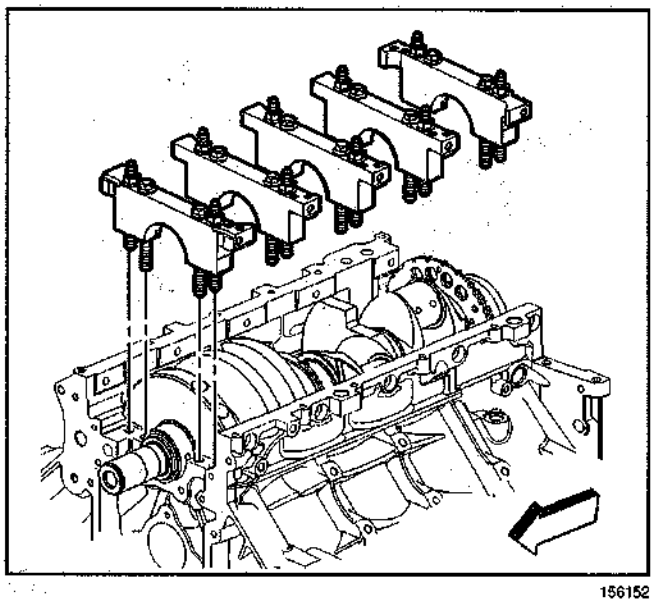
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Notice: Refer to *Fastener Notice* in Cautions and Notices.

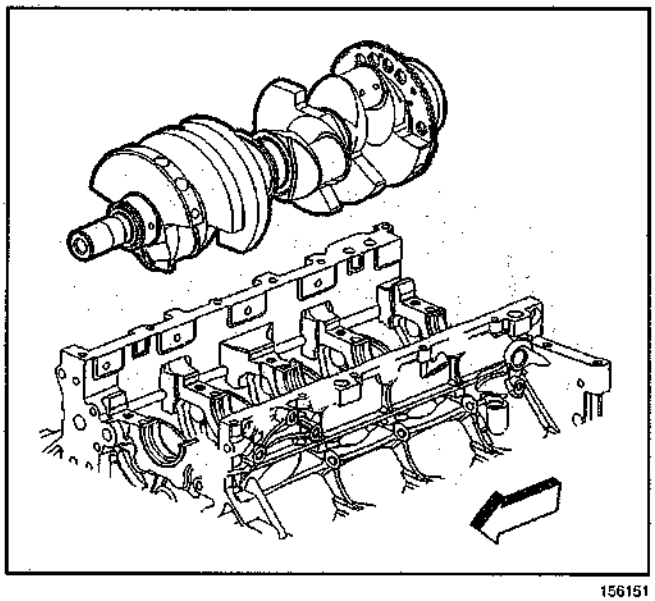
5. Install the *J 41818*.

   Tighten

   Tighten the *J 41818* bolts to 11 N·m (100 lb in).
6. Install the *J 6125-1B* to the *J 41818* in order to remove the crankshaft bearing caps.


156152

7. Remove the bearing caps.

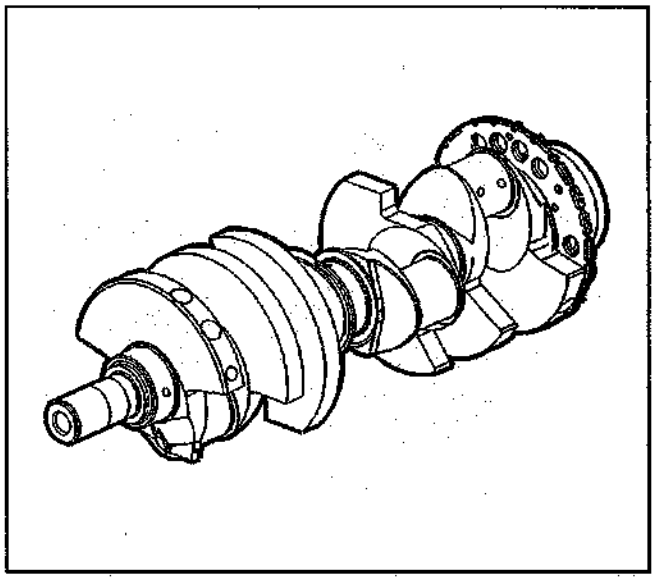

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8. Remove the crankshaft.

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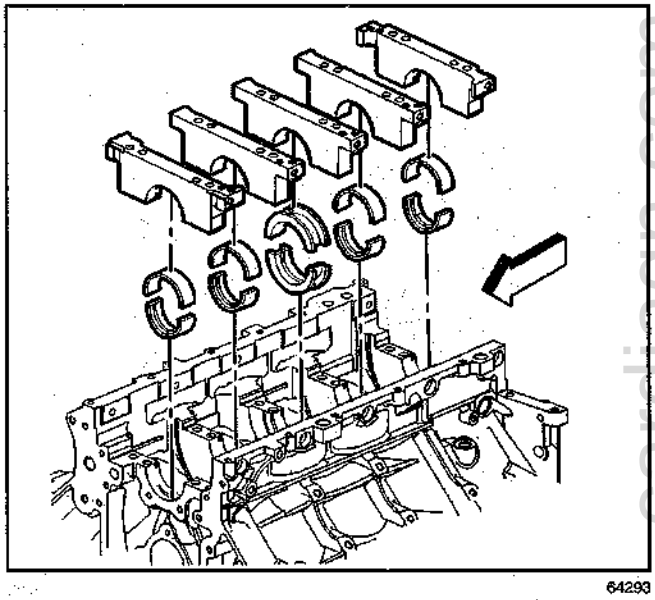
Important: Use care when handling the crankshaft. Avoid damage to the crankshaft position sensor reluctor ring teeth. Nicks, burrs or other damage to the teeth may effect On-Board Diagnostics (OBD) II system performance.

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



156153

10. Remove the crankshaft bearings from the bearing caps and the engine block.
11. Mark, sort, or organize the crankshaft bearings so they may be installed to their original position and location. Refer to *Separating Parts*.



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Engine Block Plug Removal

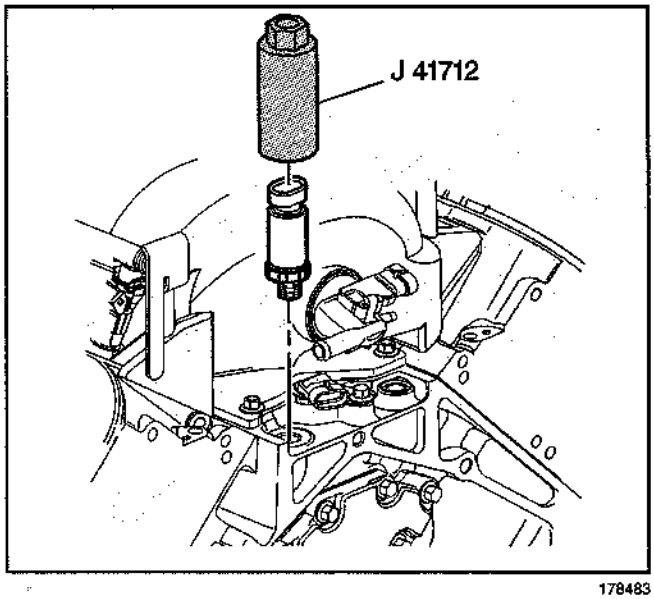
Tools Required

J 41712 Oil Pressure Sensor Socket

Important: Do not remove the engine block front oil gallery plug unless service is required.

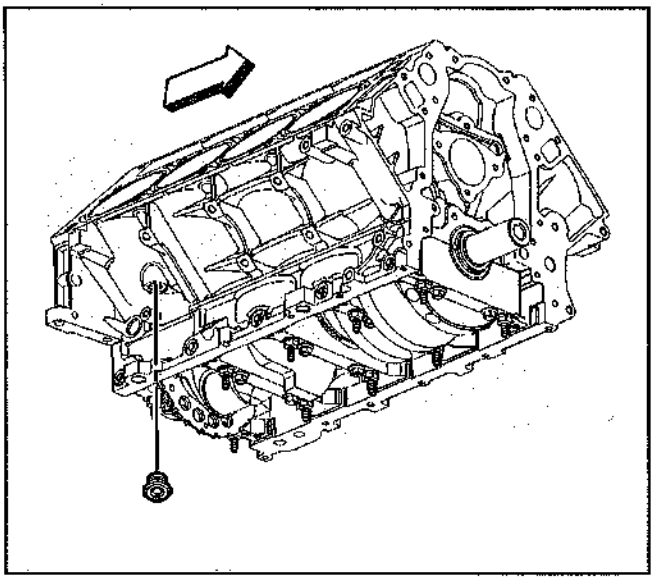
If the front oil gallery plug is removed for service, a NEW oil gallery plug must be installed.

1. Remove the oil pressure sensor (if not previously removed) using the *J 41712* or equivalent.



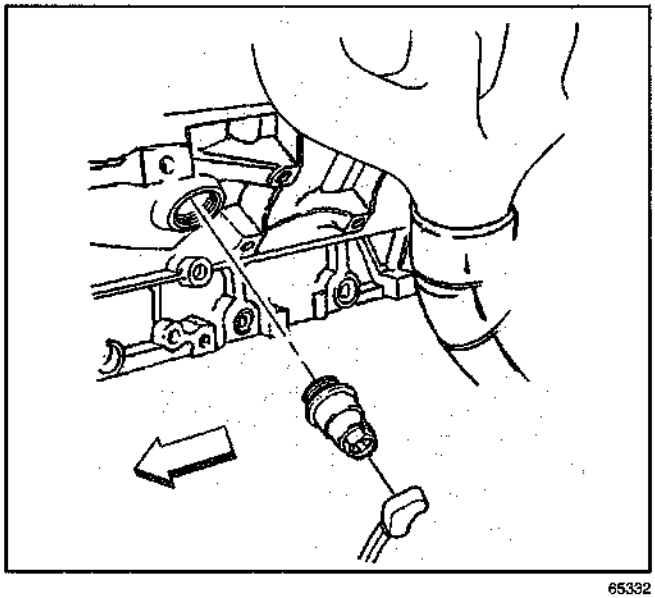
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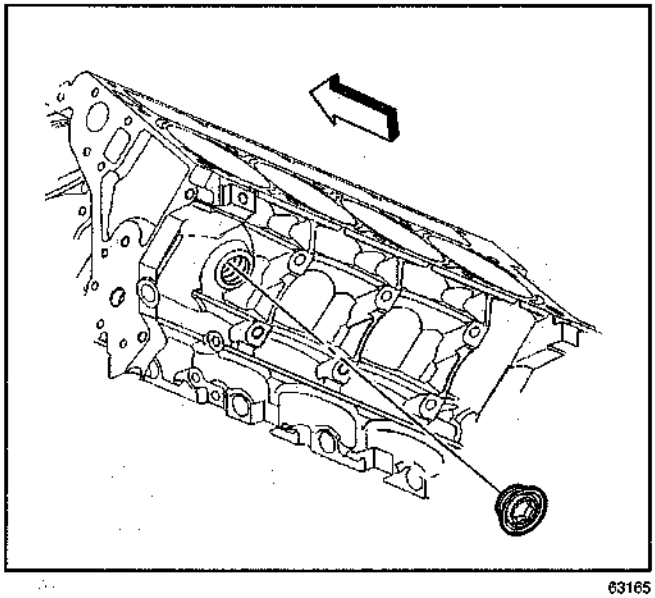
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2. Remove the engine block right rear coolant plug.



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3. Remove the engine block coolant heater (if applicable).

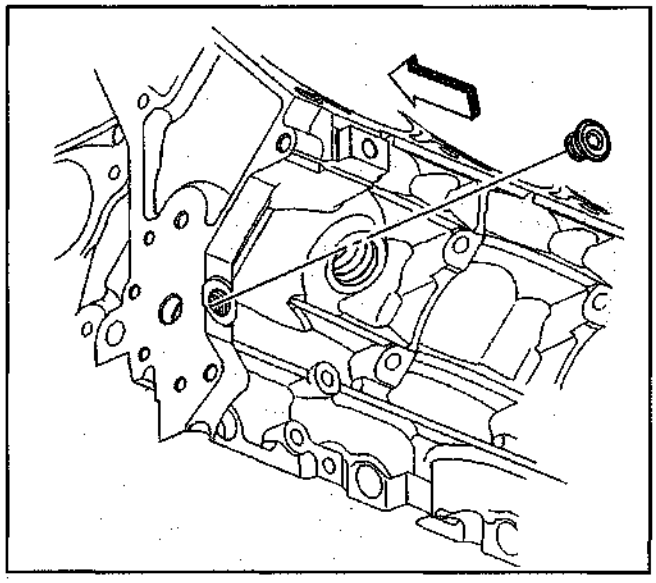


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4. Remove the engine block left front coolant plug (if applicable).

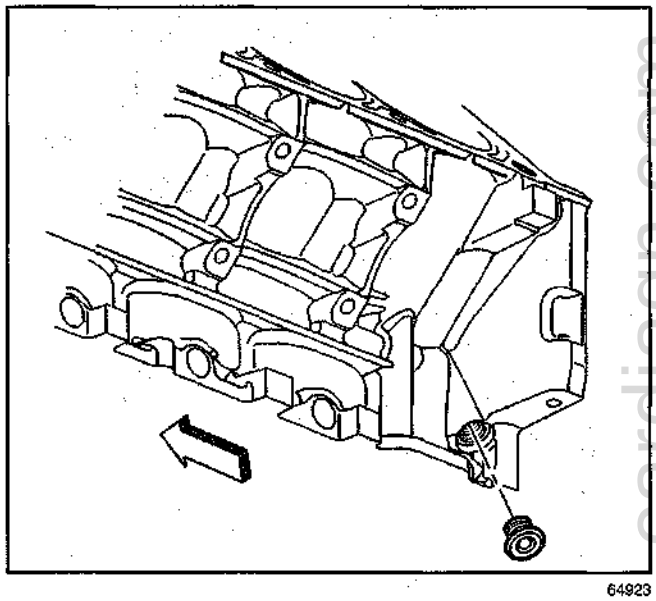
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5. Remove the engine block left front oil gallery plug.



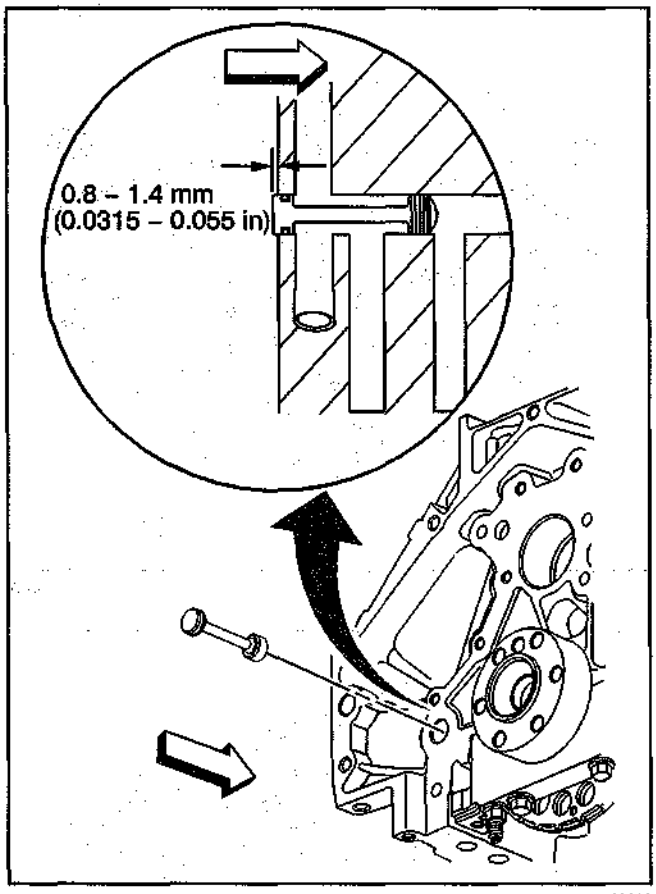
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6. Remove the engine block left rear oil gallery plug.
7. Inspect the block plug sealing washers.
   If the block plug and heater sealing washers are not damaged, they may be used during assembly.



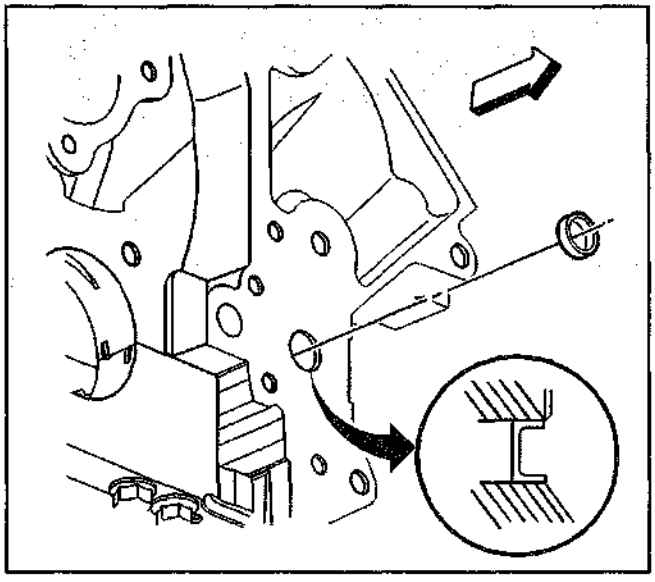
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8. Remove the engine block rear oil gallery plug.
9. Inspect the O-ring seal of the rear oil gallery plug.
   If the O-ring seal is not cut or damaged, the plug and O-ring seal may be use during assembly.



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Important: Remove the front oil gallery plug only if service is required.

If the front oil gallery plug is removed, a NEW oil gallery plug must be installed.

10. Remove the engine block front oil gallery plug.

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Engine Block Clean and Inspect

Tools Required

J 8087 Cylinder Bore Checking Gauge

1. Clean the following areas:

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

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

- The engine block in the solvent, remove all sludge, dirt, or debris.

  Refer to *Cleanliness and Care.*

Caution: Wear safety glasses in order to avoid eye damage.

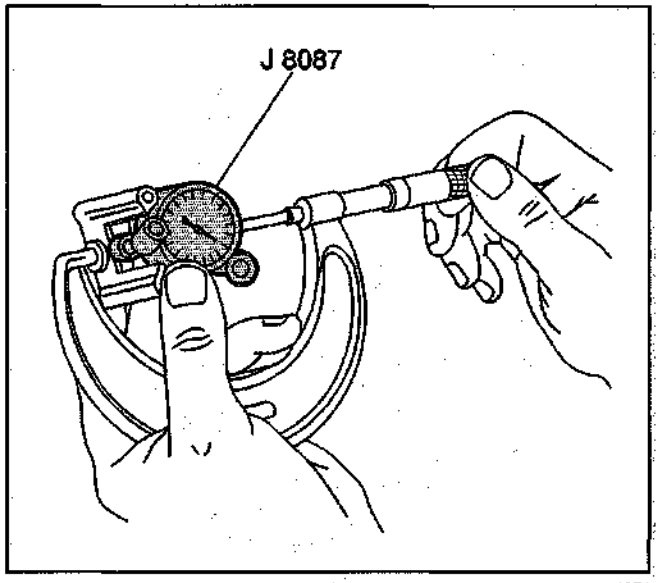
- Dry the block with compressed air.
- The gasket surfaces

  Refer to *Replacing Engine Gaskets.*
- The coolant passages
- The oil galleries
- The main bearing caps
- The engine block cylinder head bolt holes for threadlocking material

  Thread repair driver tool J 42385–107 may be used to clean the threads of old threadlocking material.

2. Inspect the following areas:
   - The cylinder walls for excessive scratches, gouging, or ring ridge
   - The coolant jacket for cracks
   - The valve lifter bores for excessive scoring or wear
   - The crankshaft bearing webs for cracks
   - The gasket sealing surfaces for excessive scratches or gouging

     Refer to *Replacing Engine Gaskets.*
   - The oil galleries for restrictions
   - All threaded bolt holes for damage
3. Measure the following areas:
   - The cylinder bores for taper
   - The cylinder bores for excessive ring ridge at the top of the cylinder

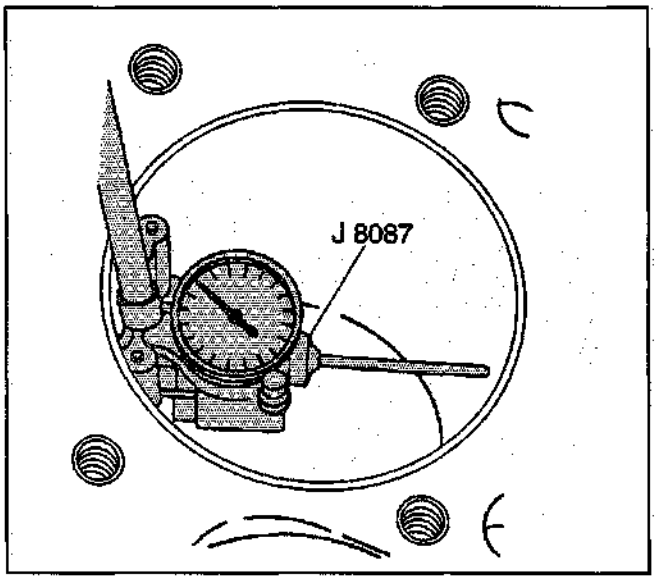


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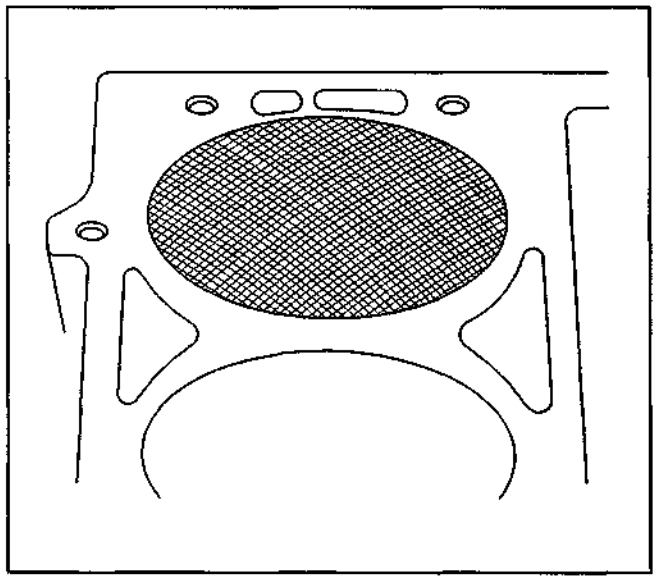
Measuring Cylinder Taper

1. Adjust the micrometer to 96.0 mm (3.78 in).

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2. Insert the bore gauge into the micrometer and zero the bore gauge dial.
3. Use a bore gauge and measure the cylinder bore for taper.

   Slide the bore gauge up and down throughout the length of the cylinder bore. Check the bore both parallel and perpendicular to the centerline of the crankshaft.

   Recondition cylinders with less than 0.018 mm (0.0007 in) wear or taper with a hone.

   Cylinders with more than 0.018 mm (0.0007 in) wear or taper must be fitted with an oversize piston.

Cylinder Boring and Honing

Boring Procedure

1. A 0.25 mm (0.01 in) oversize service piston and piston ring set are available for the LS1 engine.

Important: Do not bore the cylinder liners on the LS1 engine.

2. It is recommended to hone the cylinder to achieve proper fit for the oversize piston.

   Refer to the Cylinder Honing information for the proper honing procedure.

Honing Procedure

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.

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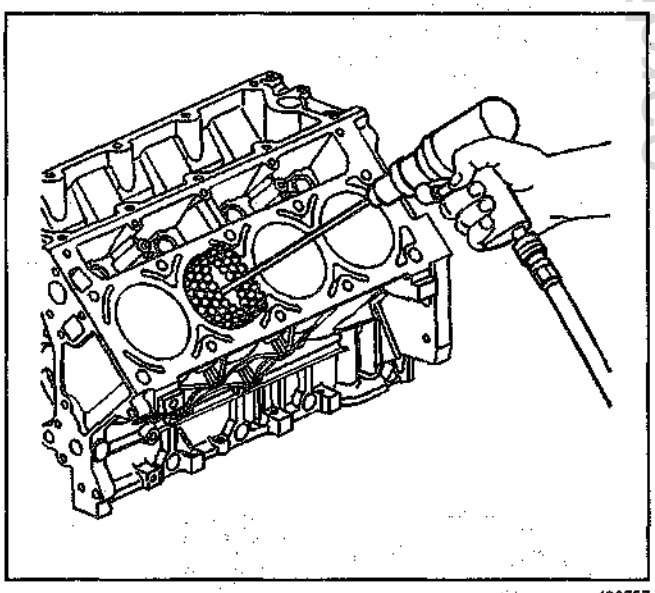
5. When honing to eliminate taper in the cylinder, make full strokes the complete length of the bore.

   Repeatedly check the measurement at the top, the middle, and the bottom of the bore.
6. The finish marks should be clean but not sharp. The finish marks should also be free from imbedded particles and torn or folded metal.
7. 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.
8. When finished, the reconditioned cylinder bores should have less than or meet the specified out-of-round and taper requirements.
9. 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.
10. Perform final measurements of the piston and the cylinder bore.
11. Permanently mark the top of the piston for the specific cylinder to which it has been fitted.
12. Apply clean engine oil to each cylinder bore in order to prevent rusting.

Deglazing Procedure

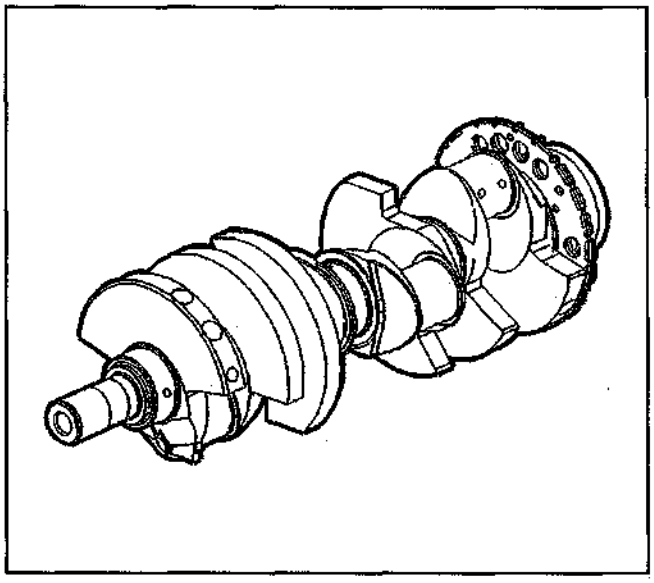
Using a ball type or self centering honing tool, deglaze the cylinder bore lightly. Deglazing should be done only to remove any deposits that may have formed. Use a 240 grit stone of silicone carbide or equivalent material when preforming the deglazing procedure.

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.



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Crankshaft and Bearings Clean and Inspect

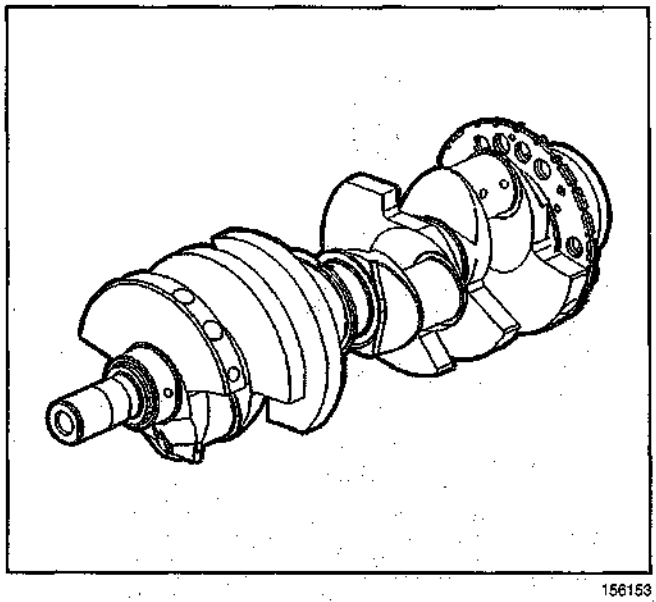
Cleaning Procedure

Important: Use care when handling the crankshaft. Avoid damage to the bearing surfaces or the lobes of the crankshaft position reluctor ring. Damage to the teeth of the crankshaft position reluctor ring may effect On-Board Diagnostics (OBD) II system performance.

1. Clean the crankshaft with solvent.
2. Thoroughly clean all oil passages and inspect for restrictions or burrs.

Caution: Wear safety glasses in order to avoid eye damage.

3. Dry the crankshaft with compressed air.


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Inspection Procedure

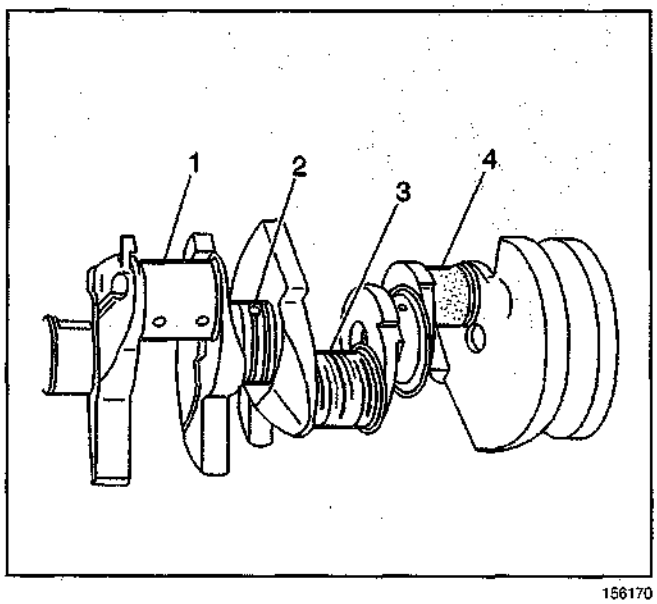
Tools Required

- *J 7872* Magnetic Base Dial Indicator Set
- *J 36660-A* Torque Angle Meter

Important: The reluctor ring teeth should not have imperfections on the rising or falling edges.

Imperfections of the reluctor ring teeth may effect OBD II system performance.

1. Perform a visual inspection of the crankshaft for damage.
2. Inspect the crankshaft position reluctor ring lobes for damage.

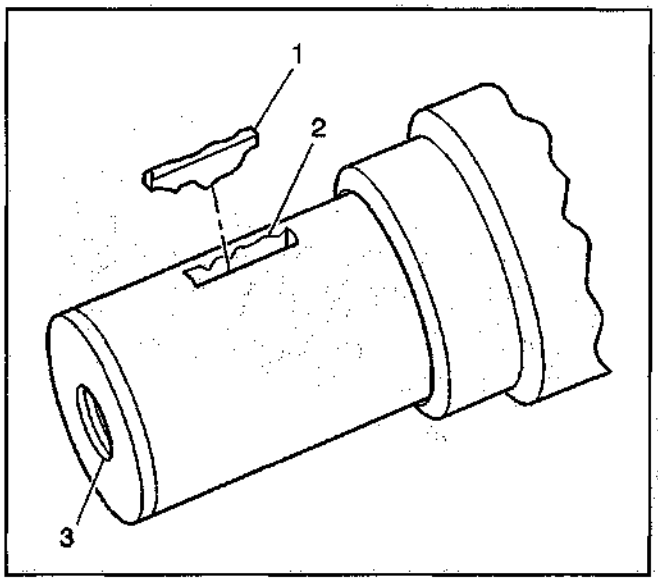


156170

3. Inspect the crankshaft journals for wear (1). Journals should be smooth with no signs of scoring, wear, or damage.
4. Inspect the crankshaft journals for grooves or scoring (2).
5. Inspect the crankshaft journals for scratches or wear (3).
6. Inspect the crankshaft journals for pitting or imbedded bearing material (4).

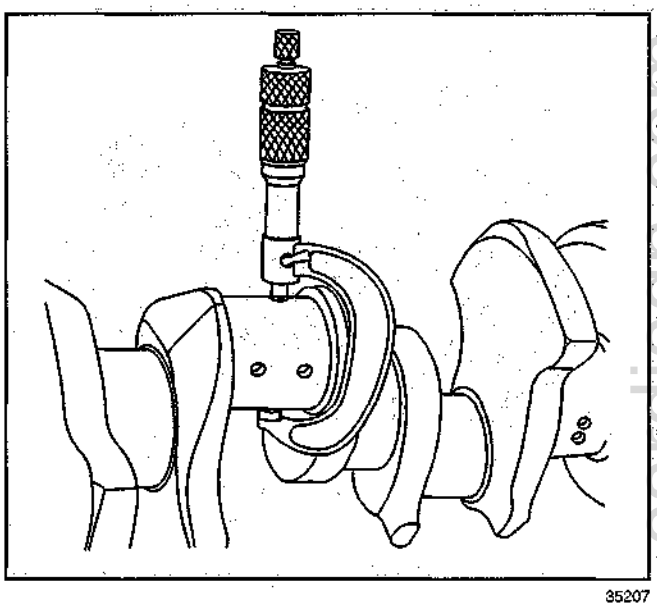
cardiagn.com

7. Inspect the crankshaft key (1), keyway (2), and threaded hole (3) for damage.

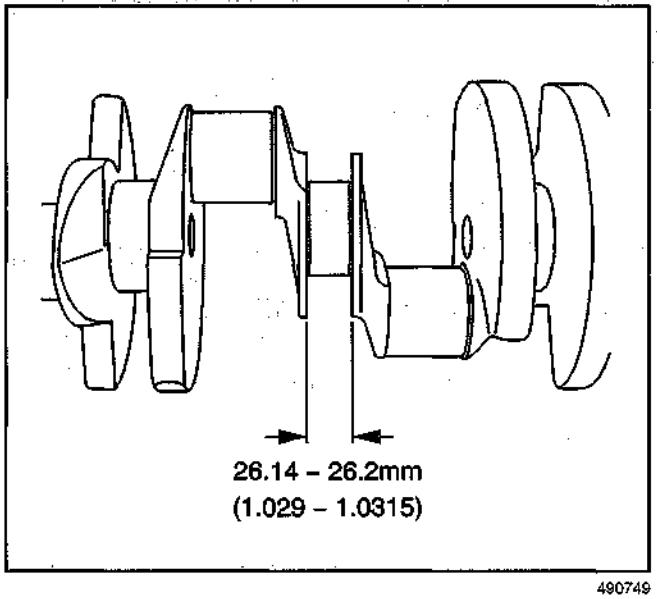


188090

8. Measure the crankpins for the out-of-round.
9. Measure the crankpins for taper.

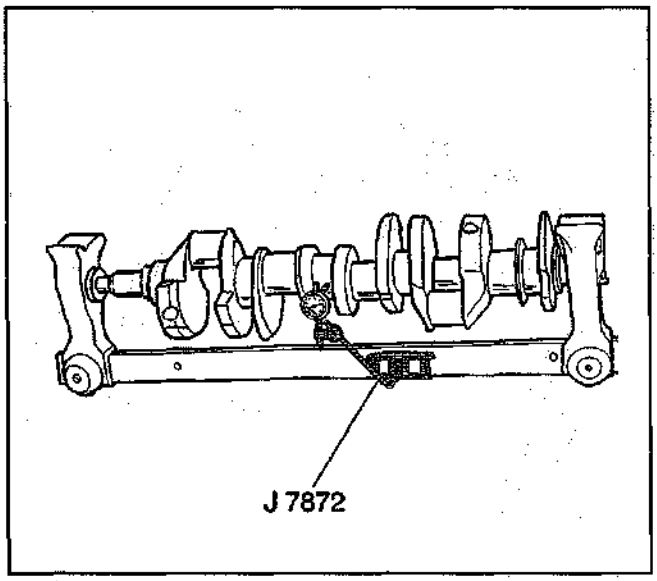

35207

10. Measure the crankshaft thrust wall width.
    A crankshaft with a thrust wall width in excess of 26.2 mm (1.0315 in) must be replaced.



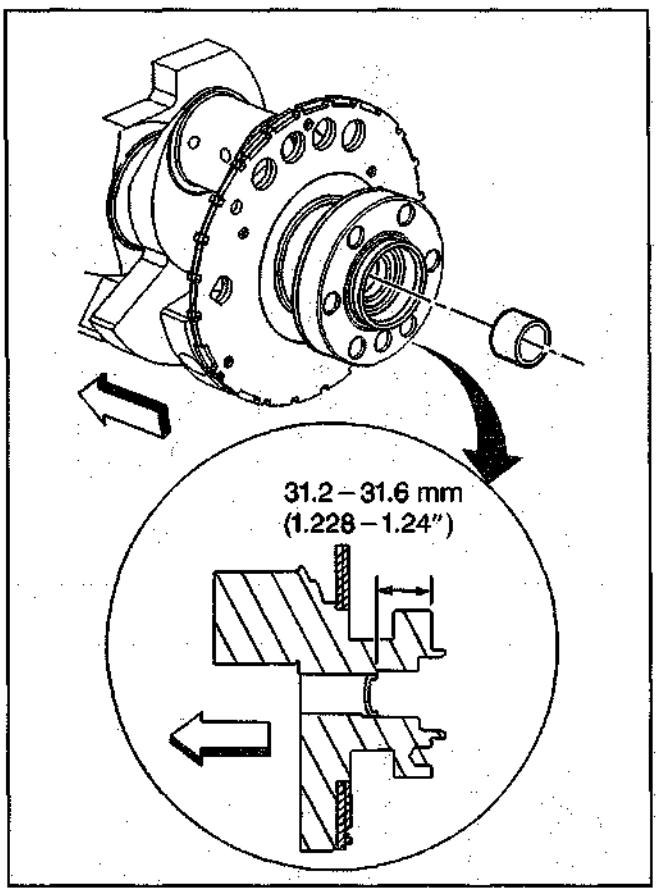
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35210

11. Measure the crankshaft runout.
    Use wooden V blocks or a fixture to support the crankshaft on the front and rear journals.
12. Use the *J 7872* in order to measure the crankshaft runout at the front and rear intermediate journals.
13. Use the *J 7872* in order to measure the runout of the crankshaft rear flange.
14. Use the *J 7872* 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 0.25 mm (0.01 in), replace the crankshaft.



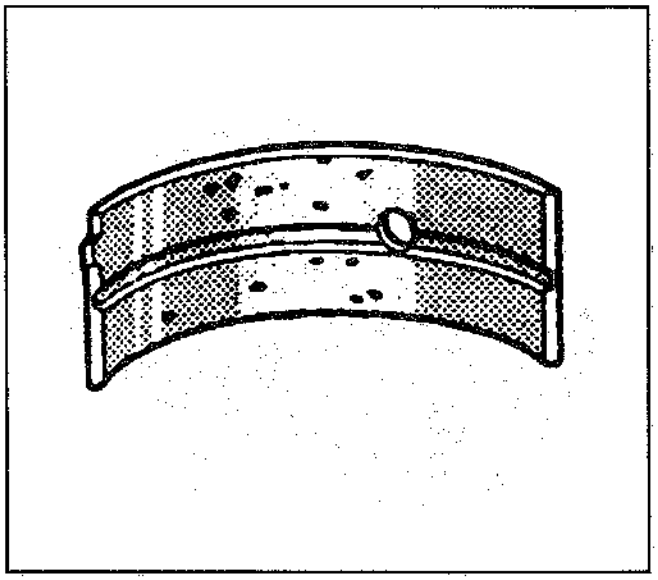
63238

Important: A loose or damaged crankshaft oil gallery plug must be replaced.

15. Inspect the rear crankshaft oil gallery plug for a loose fit or leaking.

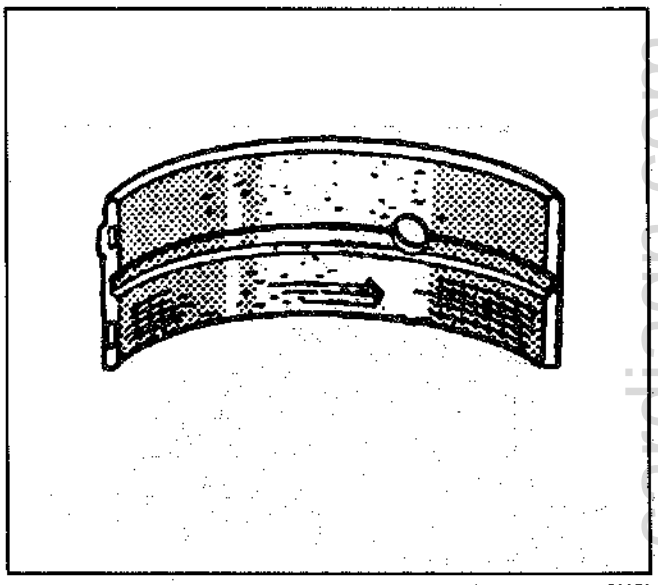
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16. Inspect crankshaft bearings for craters or pockets. Flattened sections on the bearing halves also indicate fatigue.



52051

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

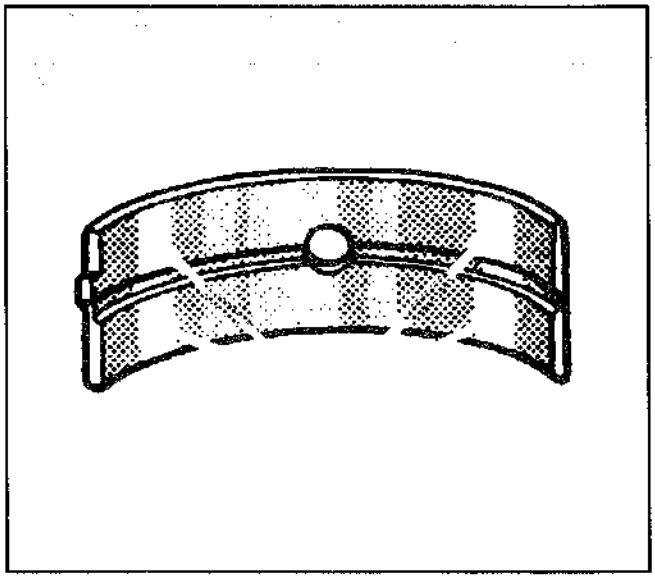


52053

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

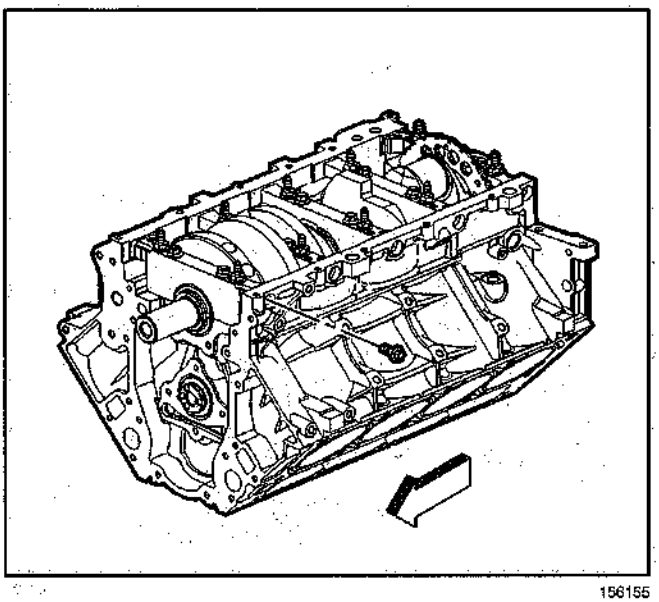
    If the lower half of the bearing is worn or damaged, both upper and lower halves should be replaced.

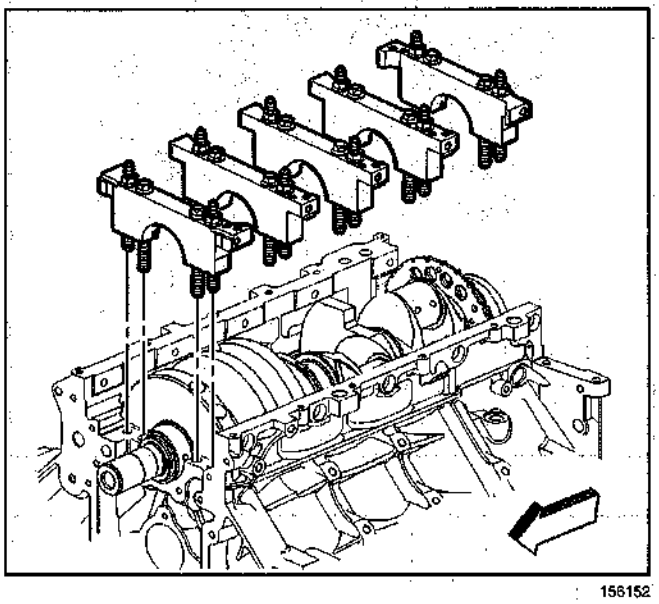
    Generally, if the lower half is suitable for use, the upper half should also be suitable for use.



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156155


156152

Measuring Main Bearing Clearance

Tools Required

- *J 41818* Crankshaft Bearing Cap Remover
- *J 6125-1B* Slide Hammer
- *J 36660-A* Torque Angle Meter

Important: 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 gauging plastic is between the crankshaft journal and the bearing surface.

The crankshaft bearing clearances are critical. Excessive bearing clearance may effect crankshaft position sensor signals and may effect On-Board Diagnostics (OBD) II system operation.

Important: Remove the bearing cap side bolts prior to cap removal.

1. Remove the bearing cap M8 side bolts.
2. Remove the bearing cap M10 bolts and studs.

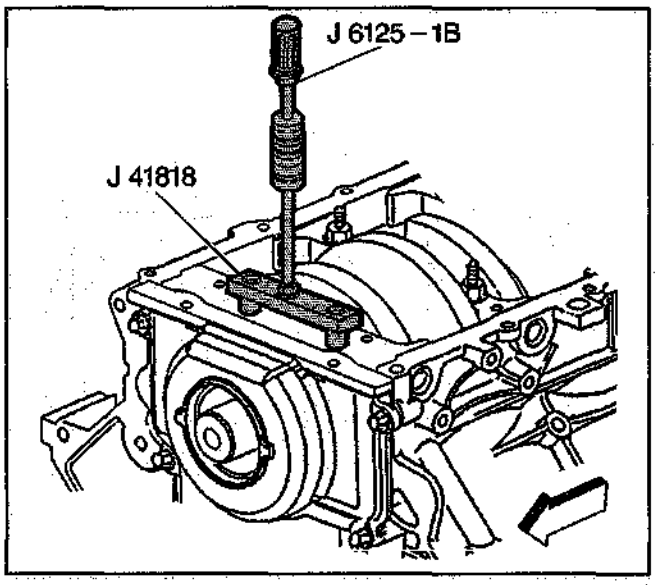
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Notice: Refer to *Fastener Notice* in Cautions and Notices.

3. Install the *J 41818* to the bearing cap.

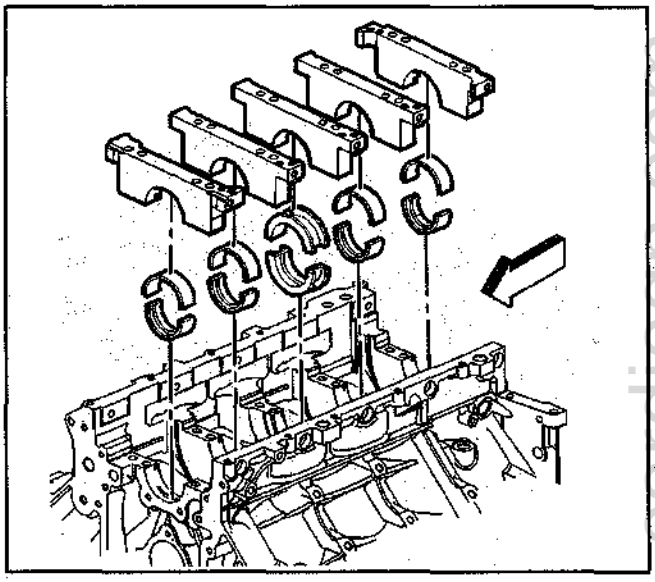
   Tighten

   Tighten the *J 41818* bolts to 11 N·m (100 lb in).
4. Install the *J 6125-1B* to the *J 41818* in order to remove the bearing cap.



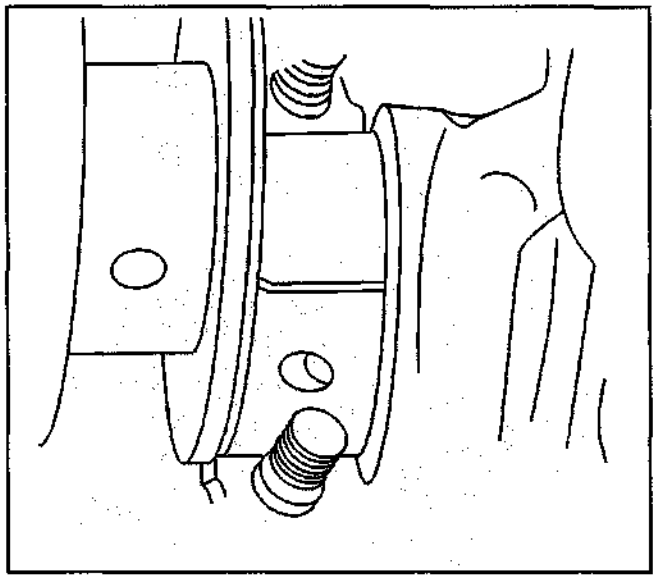
63188

5. Remove the bearing cap and lower bearing.



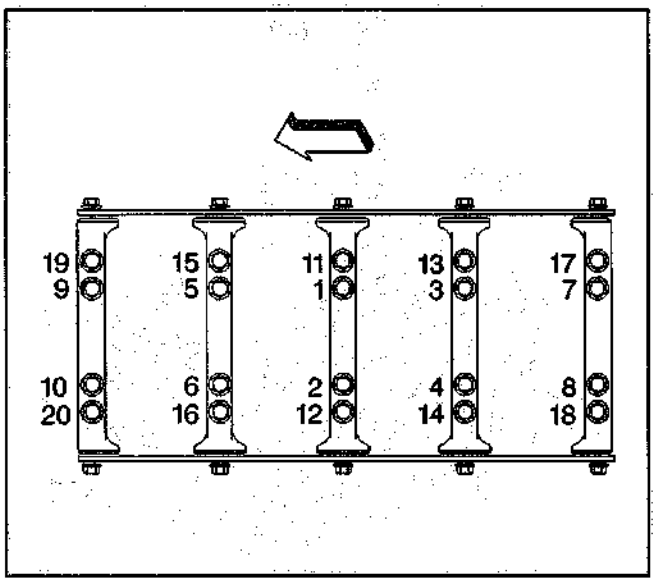
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6. Install gauging plastic onto the crankshaft journal. Install the gauging plastic the full width of crankshaft bearing journal.



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7. Install the bearing, bearing cap, bolts and studs.

Tighten

7.1. Tighten the inner bolts (1–10) a first pass in sequence to 20 N·m (15 lb ft).

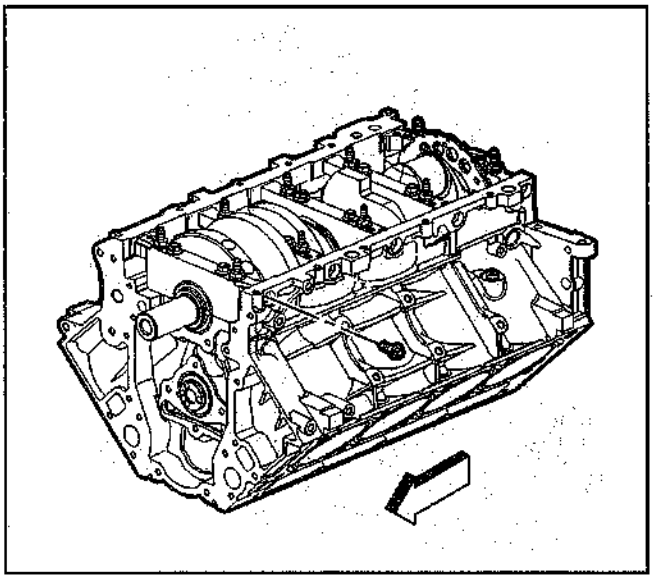
7.2. Tighten the inner bolts (1–10) a final pass in sequence to 80 degrees using the *J 36660-A*.

7.3. Tighten the outer studs (11–20) a first pass in sequence to 20 N·m (15 lb ft).

7.4. Tighten the outer studs (11–20) a final pass in sequence to 53 degrees using the *J 36660-A*.

7.5. Tighten the side cap bolts to 25 N·m (18 lb ft).

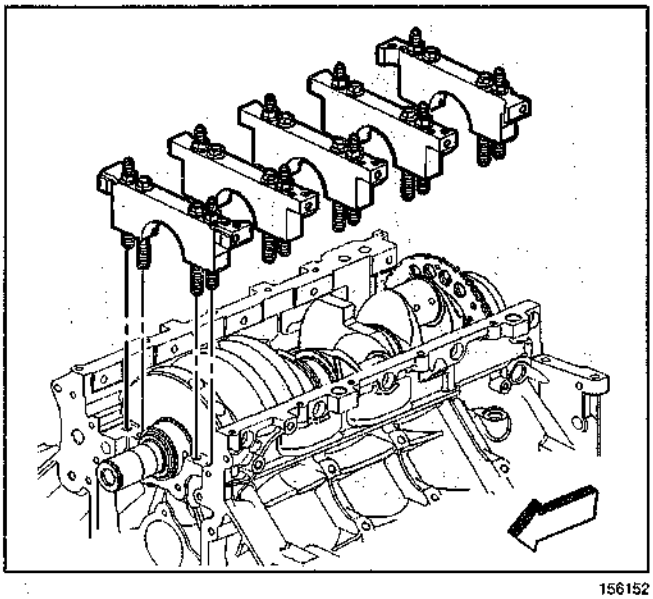
Tighten the bolt on one side of the bearing cap and then tighten the bolt on the opposite side of the same bearing cap.



156155

Important: Remove the bearing cap side bolts prior to cap removal.

8. Remove the bearing cap M8 side bolts.

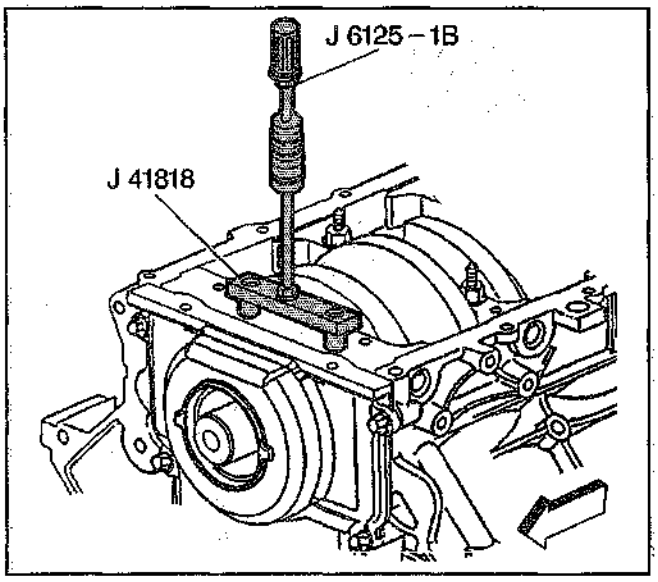


156152

9. Remove the bearing cap bolts and studs.

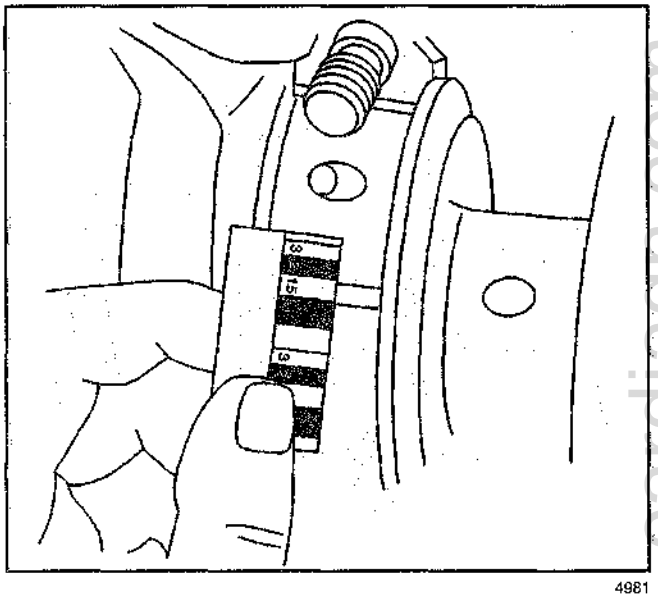
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10. Use the *J 41818* and the *J 6125-1B* in order to remove the bearing cap.

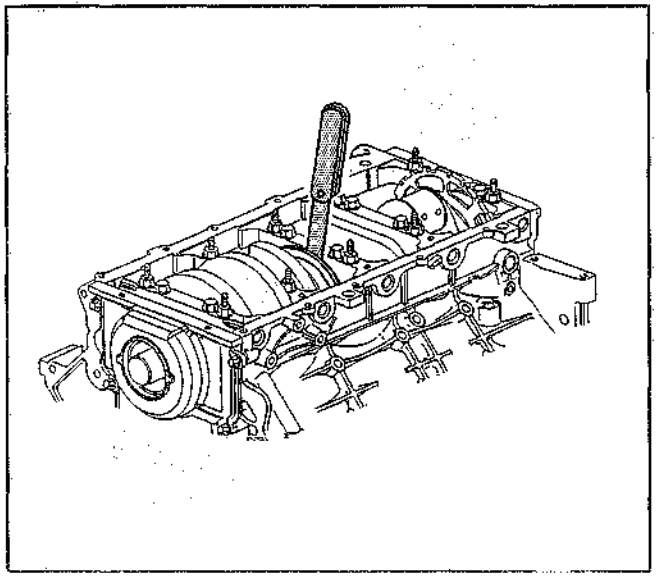


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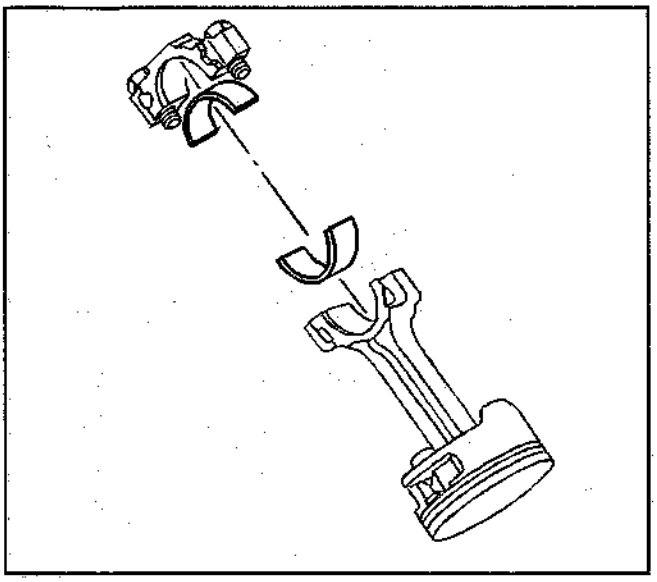
11. Measure the gauging plastic at its widest area using the scale supplied with the plastic gauging kit.
    - If the gauging plastic shows irregularity in the journal exceeding 0.025 mm (0.001 in), remove the crankshaft and measure the journal with a micrometer.
    - If the bearing clearance is greater than 0.054 mm (0.00212 in), select and install an undersized bearing set, and measure the clearance with gauging plastic.
    - If clearance cannot be brought to specifications, replace the crankshaft or grind the crankshaft for use with the next undersized bearing.


4981

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.
    - Replace the thrust bearings and measure the end play.
    - If the correct measurements cannot be obtained, repair the crankshaft thrust surfaces or replace the crankshaft.


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53223

Measuring Connecting Rod Bearing Clearance

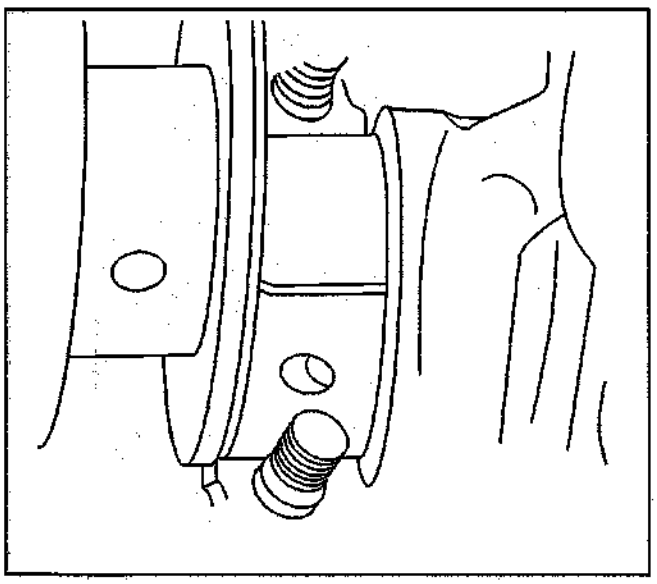
Tools Required

J 36660-A Torque Angle Meter

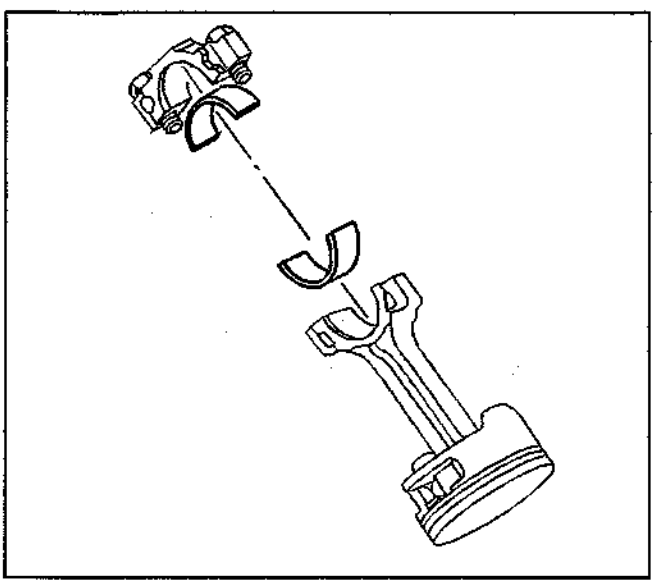
Important: Connecting rod bearings are a precision insert type. Connecting rods are of a powdered metal design and cannot be shimmed or filed for bearing fit. If clearances are found to be excessive, a new bearing and/or connecting rod are required.

Do not rotate the crankshaft while gauging plastic is between the crankshaft journal and the bearing surface.

1. Remove the bearing cap, bearing half and bolts.


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2. Install the gauging plastic onto the connecting rod bearing journal. Install the gauging plastic the full width of the journal.

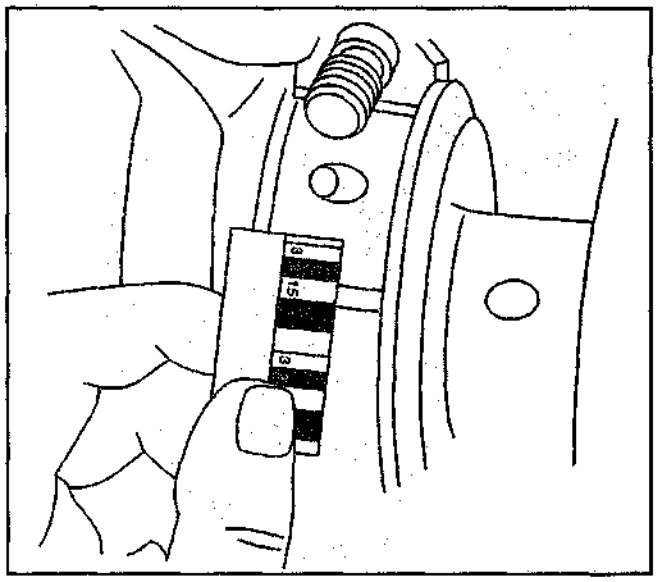

53223

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

3. Install the bearing cap, bearing, and bolts.
   Tighten
   3.1. Tighten the connecting rod bolts first pass to 20 N·m (15 lb ft).
   3.2. Tighten the connecting rod bolts final pass to 60 degrees using the *J 36660-A*.
4. Remove the bearing cap, bearing, and bolts.

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5. Measure the gauging plastic at its widest area using the scale supplied with the plastic gauging kit.
   The connecting rod bearing clearance should be 0.015–0.076 mm (0.0006–0.003 in).



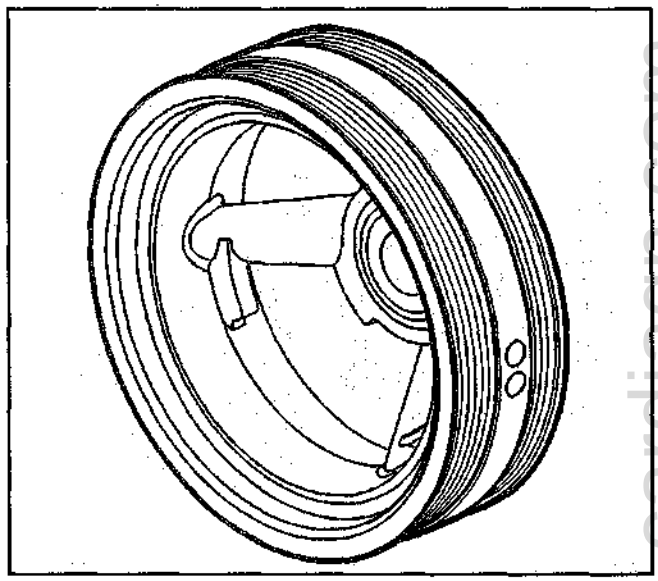
4981

Crankshaft Balancer Clean and Inspect

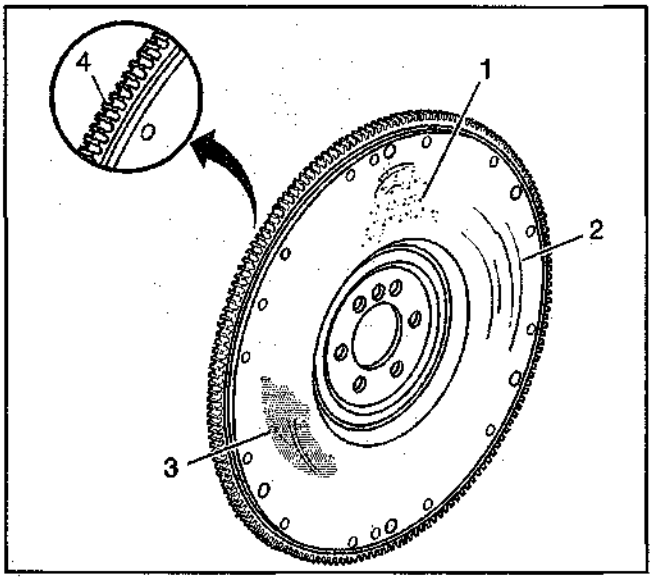
1. Clean the crankshaft balancer in solvent.
2. Clean the belt grooves of all dirt or debris with a wire brush.
3. Dry the crankshaft balancer with compressed air.
4. Inspect the crankshaft balancer for the following:
   - Worn, grooved, or damaged hub seal surface
     A crankshaft balancer hub seal 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.

Important: In order for the belt to track properly, the belt grooves should be free of all dirt or 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


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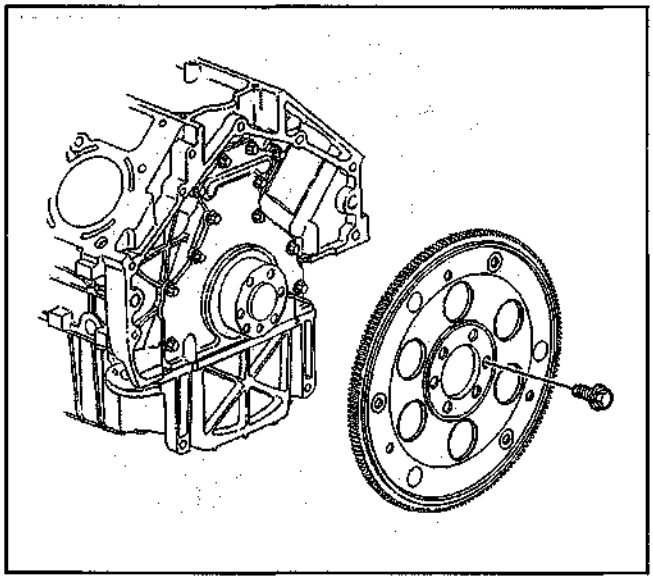
188086

Engine Flywheel Clean and Inspect

1. Clean the flywheel in solvent.
2. Dry the flywheel with compressed air.
3. Inspect the manual transmission flywheel for the following:
   - Pitted surfaces (1)
   - Grooves or scoring (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

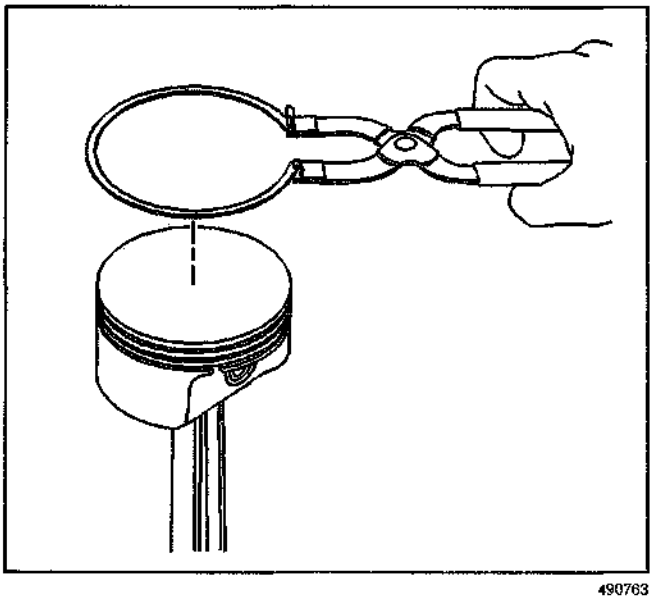
     The two locating pins are installed into the flywheel and spaced 170 degrees apart.


178458

4. Inspect the automatic transmission flywheel for the following:
   - Damaged ring gear teeth
   - Stress cracks around the flywheel-to-crankshaft bolt hole locations

Important: Do not attempt to repair the welded areas that retain the ring gear to the flywheel plate. Install a new flywheel.

- Welded areas that retain the ring gear onto the flywheel for cracking


490763

Piston and Connecting Rod Disassemble

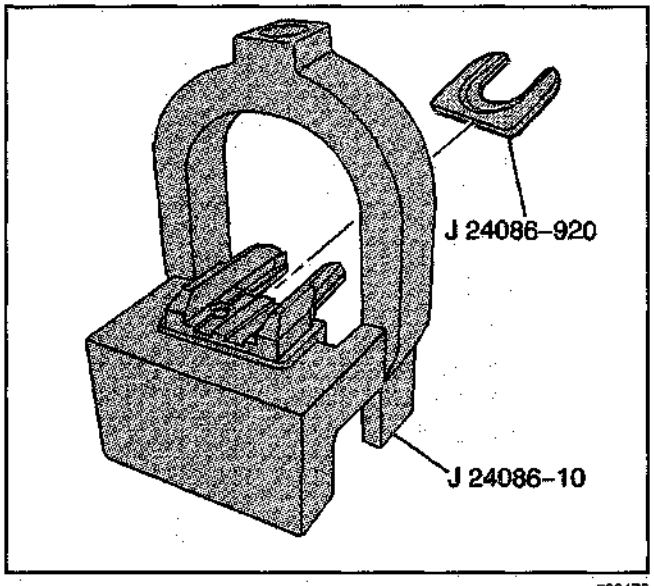
Tools Required

J 24086-C Piston Pin Remover/Installer

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

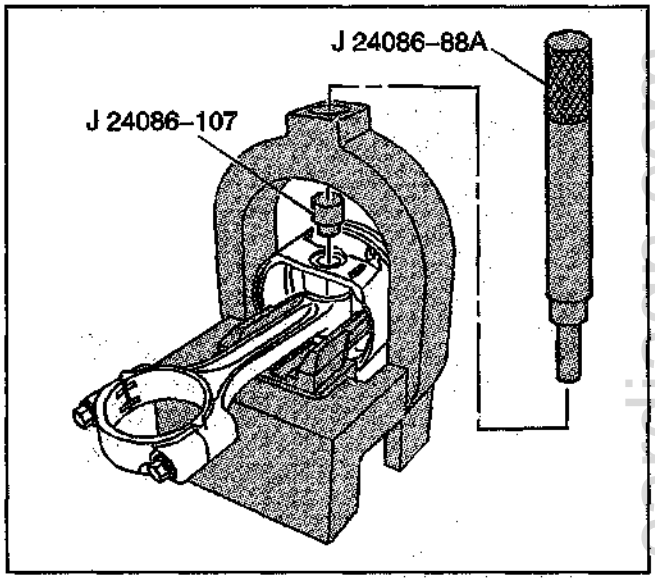
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2. Install fork insert J 24086-920 into fixture *J 24086-10* Piston Pin Remover/Installer Base.



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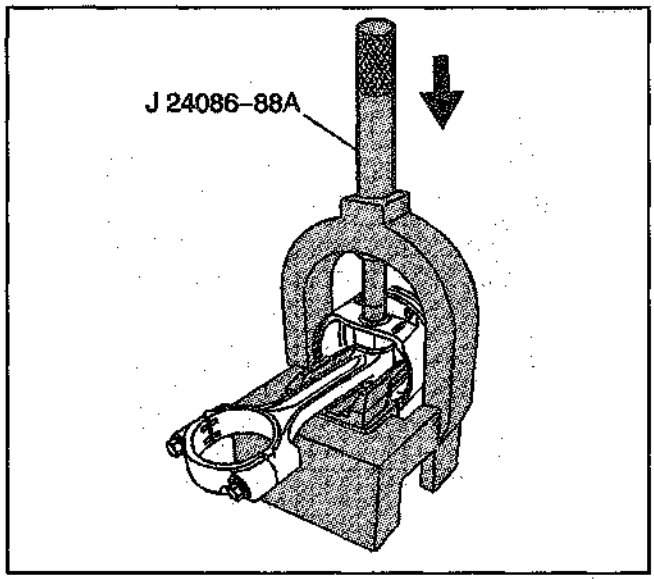
3. Install the piston and connecting rod assembly onto *J 24086-10*.
4. Install the J 24086-107 into the piston pin and J 24086-88A through the fixture and into J 24086-107.



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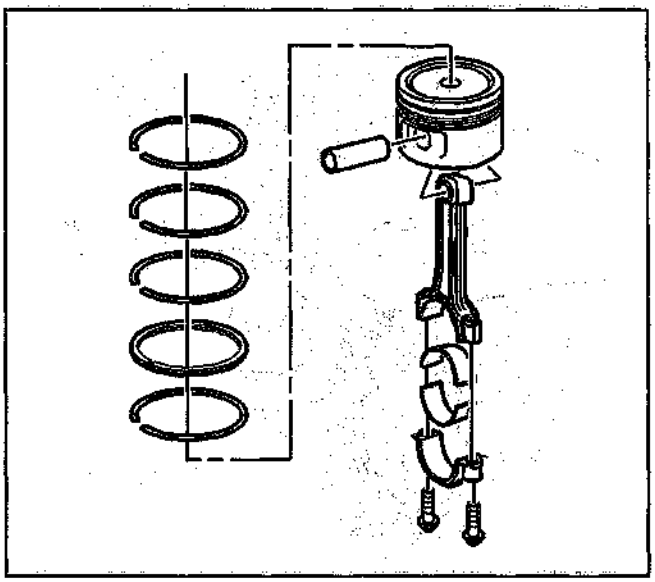
Notice: After the installer hub bottoms on the support assembly, do not exceed 35 000 kPa (5,000 psi) pressure, this could cause damage to the tool.

5. Press the piston pin from the piston and connecting rod assembly.
6. The piston and pin are a matched set and are not to be serviced seperately. Mark, sort or organize the piston and the matching piston pin.
   Refer to *Separating Parts*.



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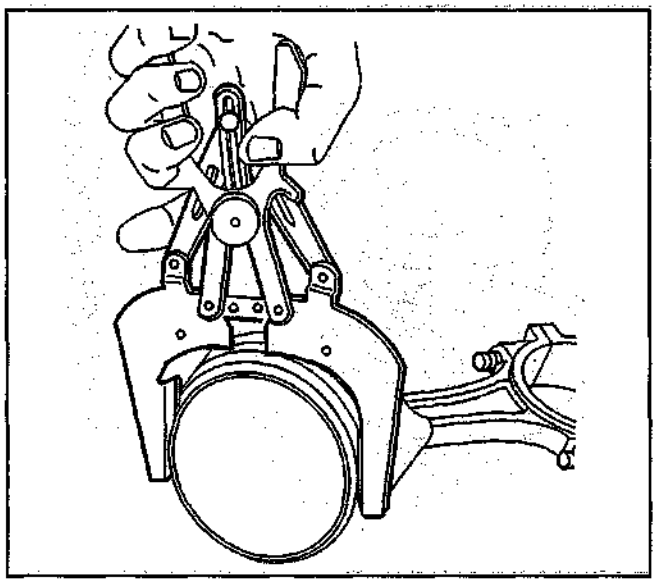
Piston, Connecting Rod, and Bearings Clean and Inspect (Piston and Pin)

Important: Replace the pistons and the pins that are damaged or show signs of excessive wear.

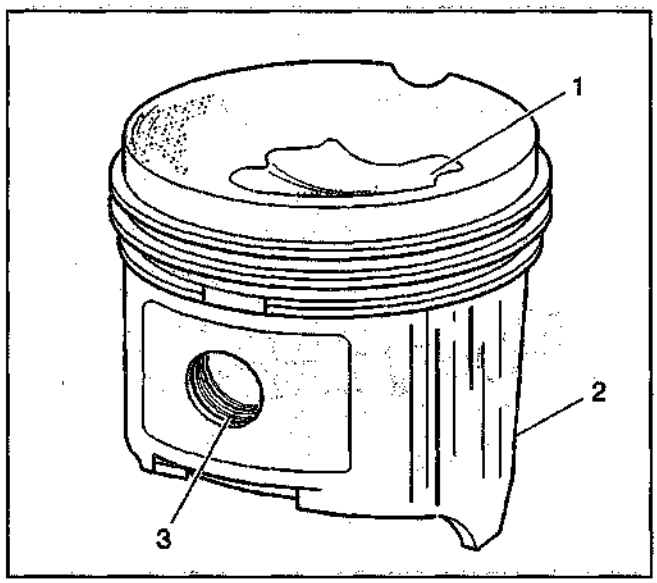
The piston and the pin are a matched set. If service is required, replace the piston and the pin as an assembly.

Do not wire brush any part of the piston.

1. Clean the varnish from the piston and the pin with cleaning solvent.
2. Dry the piston and the pin with compressed air.


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3. Clean the piston ring grooves with a suitable ring groove cleaning tool.
4. Clean the oil lubrication holes and slots.



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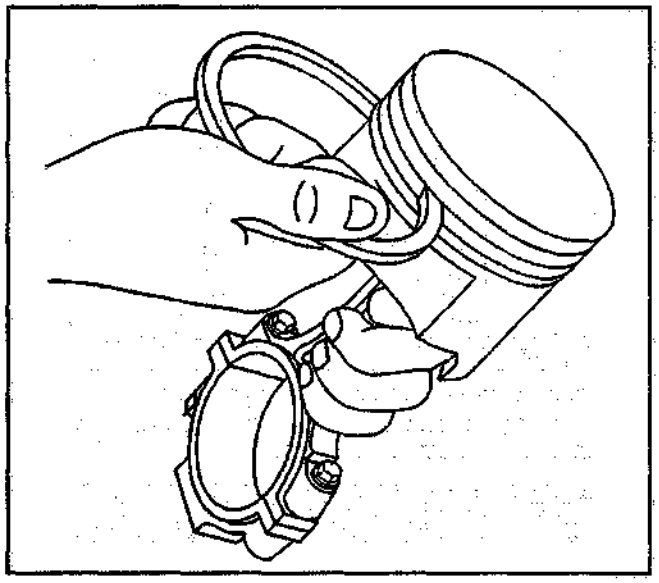
5. Inspect the piston and the pin for the following:
   - Cracks in the piston ring lands, the piston skirt, or the pin bosses
   - Piston ring grooves for nicks, burrs, or warpage which may cause the piston ring to bind

     MINOR imperfections may be removed from the piston with a fine file.
   - Scuffed or damaged skirts (2)
   - Eroded areas at the top of the piston (1)
   - Scoring to the piston pin bore (3) or the piston pin

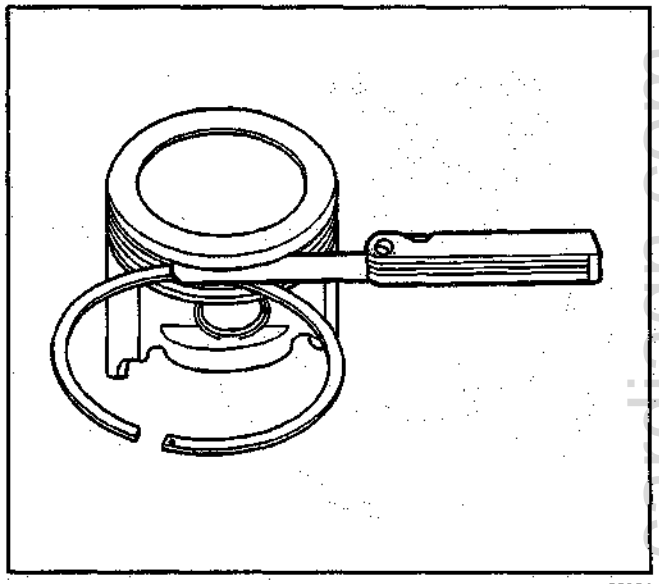
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Important: Measurements of components should be taken with the components at normal room temperature.

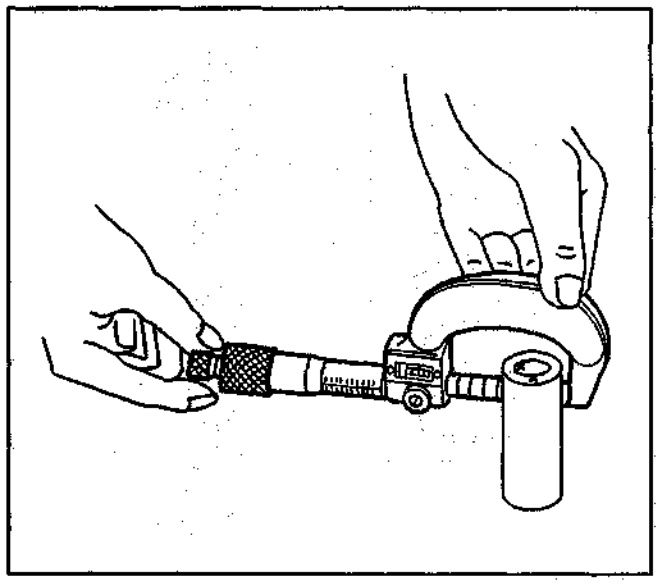
6. Measure the piston ring-to-piston ring groove side clearance.
   6.1. Insert the edge of the piston ring into the piston ring groove.
   6.2. Roll the piston ring completely around the piston.
   - If binding is caused by a distorted piston ring groove, MINOR ring groove imperfections may be removed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


4969

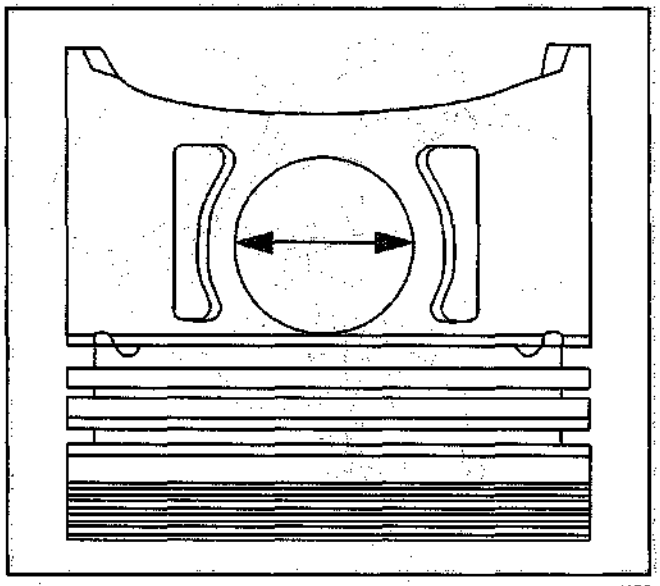
7. Measure the piston ring side clearance with a feeler gauge.
8. If side clearance is not within specifications, try another piston ring set.
9. The proper piston ring-to-piston ring groove side clearance is:
   - The top compression ring side clearance is 0.04–0.085 mm (0.00157–0.003346 in).
   - The second compression ring side clearance is 0.04–0.08 mm (0.00157–0.003149).
   - The oil control ring side clearance is 0.01–0.22 mm (0.0004–0.00866).
10. If proper piston ring-to-piston ring groove side clearance cannot be achieved, replace the piston and pin assembly.


22934

11. To determine piston pin-to-bore clearance, use a micrometer and measure the piston pin.


4976

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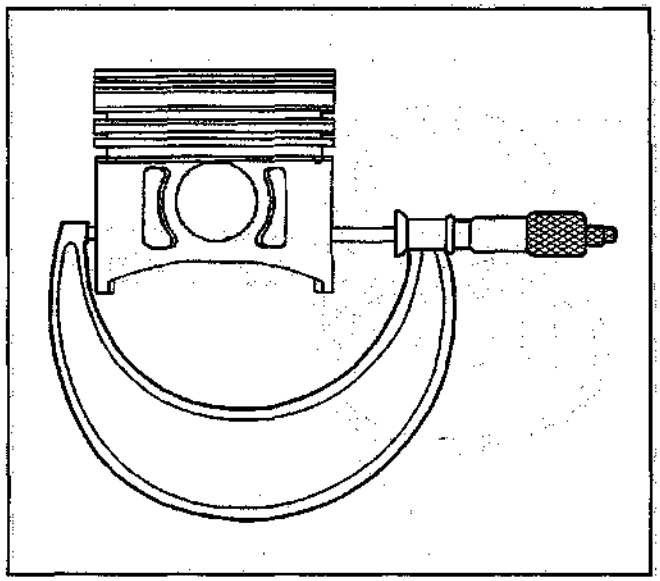

4975

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

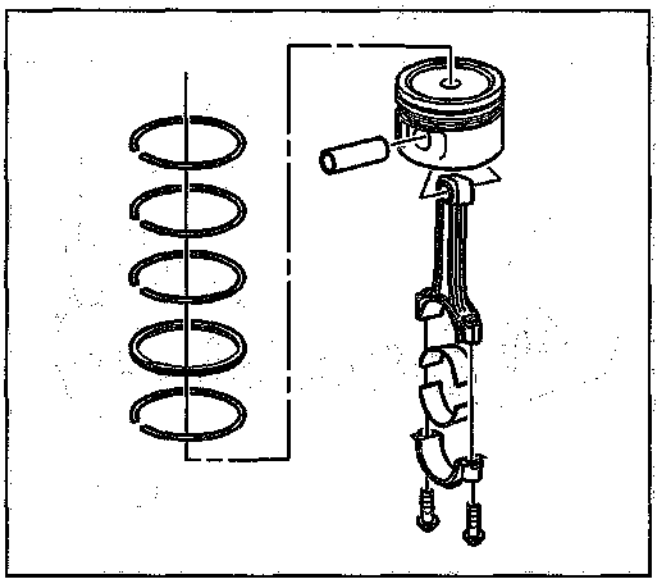
Important: The piston and pin are a matched set. If the clearance is not within specifications, replace the piston and pin as an assembly.

13. To determine the proper piston pin-to-bore clearance, subtract the piston pin diameter from the piston pin bore diameter.

    The proper piston pin-to-bore clearance is 0.01–0.02 mm (0.0004–0.00078).


188016

14. Measure the piston for out-of-round.
    - 14.1. With the micrometer at a right angle to the piston, measure the piston at 11 mm (0.433 in) from the bottom of the skirt.
    - 14.2. Measure the piston at two different points and compare the readings.
    - 14.3. If the piston is more than 0.018 mm (0.0007 in) out-of-round, replace the piston and pin as an assembly.


64180

Piston, Connecting Rod, and Bearings Clean and Inspect (Connecting Rod and Bearings)

Important: The powdered metal connecting rod and cap are machined for the proper clearances. The connecting rod and the cap must be used as an assembly with no repair or modifications to either mating surface.

Do not attempt to repair the connecting rod or the cap mating surfaces. If service is required, the connecting rod and the cap must be replaced as an assembly.

1. Clean the connecting rod and the cap in solvent.

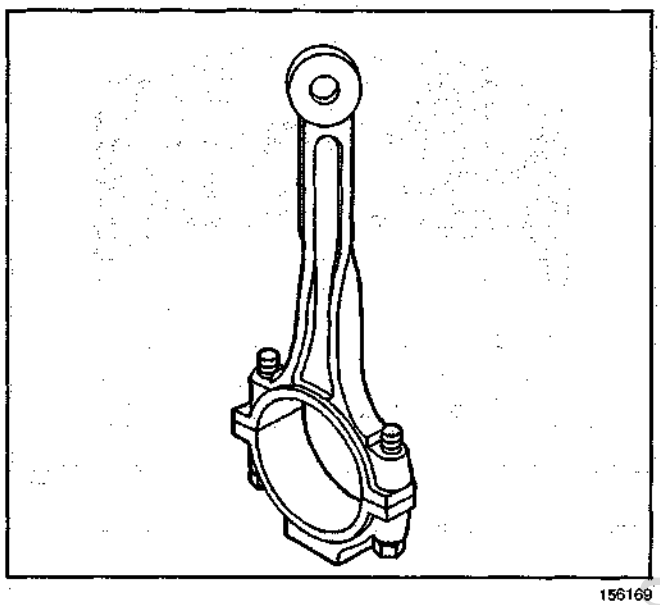
Important: Replace the connecting rod if the bolt hole threads are damaged. Do not attempt to repair the bolt hole threads of the connecting rod.

2. Clean the connecting rod threaded bolts holes.

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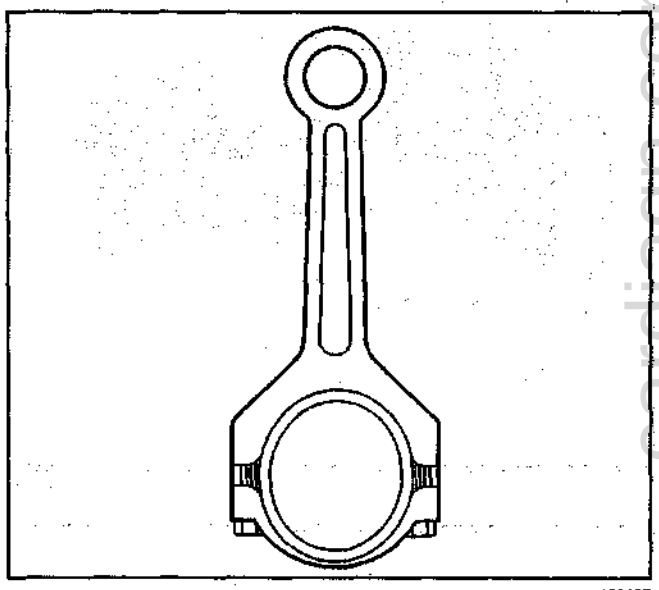
Caution: Wear safety glasses in order to avoid eye damage.

3. Dry the connecting rod with compressed air.
4. Inspect the connecting rod for the following:
   - Twisting
   - Nicks or gouging in the bearing bore
   - Damage to the bearing locating slots in the bearing bore
   - Proper fit of the connecting rod and the cap mating surfaces

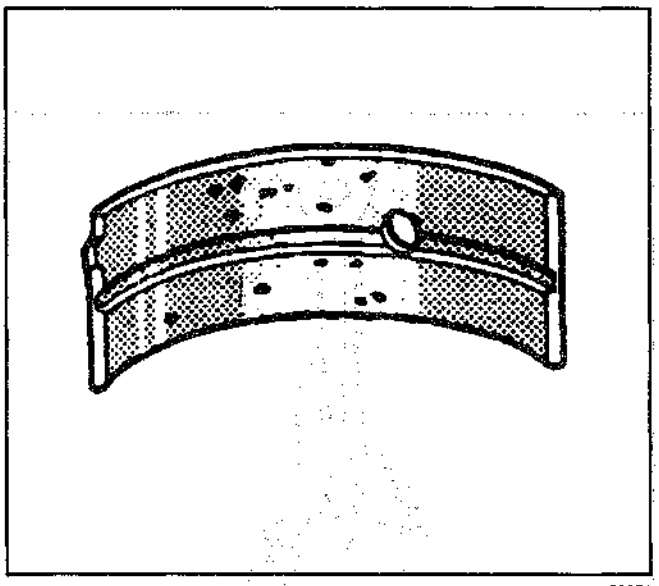

156169

5. Measure the connecting rod bearing bore for out-of-round.

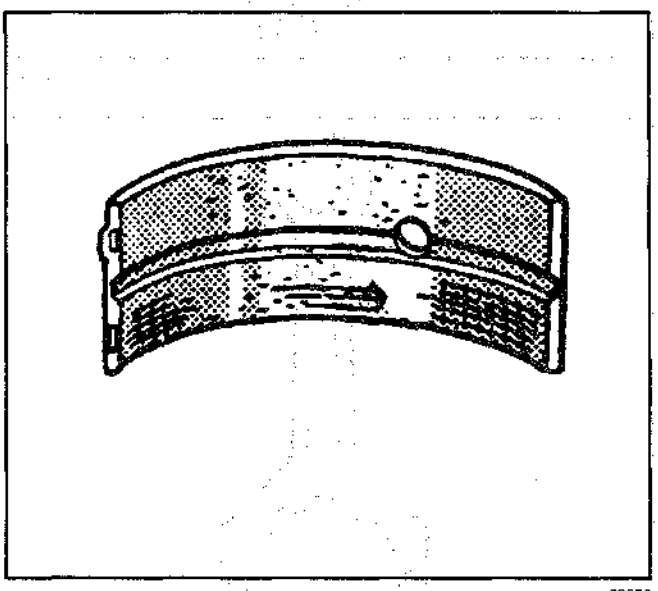
   If the measurement exceeds 0.008 mm (0.0003 in), replace the connecting rod assembly.


156167

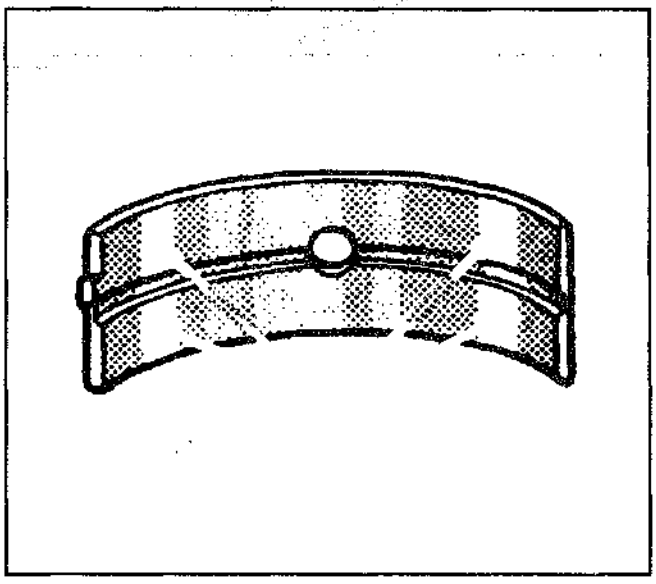
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52051

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


52053

7. Inspect the connecting rod bearings for excessive scoring or discoloration.
8. Inspect the connecting rod bearings for dirt or debris imbedded into the bearing material.


52056

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

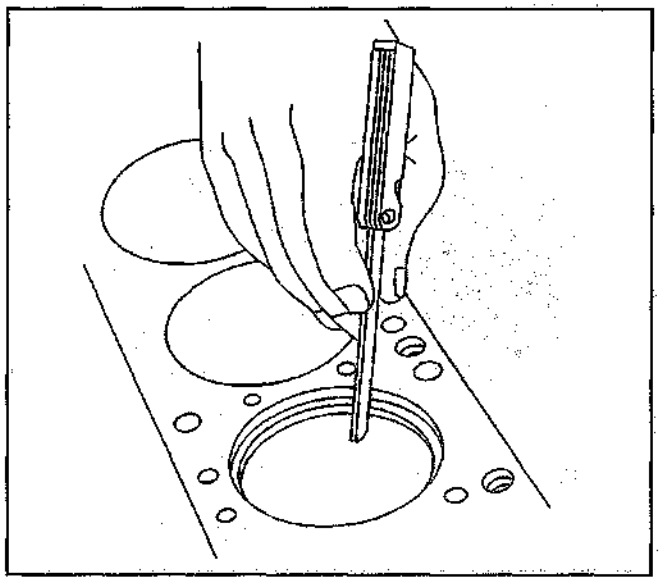
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Piston, Connecting Rod, and Bearings Clean and Inspect (Measuring Piston Ring End Gap)

Important: Do not attempt to file the end of the piston ring for fit in the cylinder bore.

Important: Measure the piston ring in the cylinder in which the piston ring will be used.

1. Place the piston ring into the cylinder bore.
2. Push the piston ring into the bore 6.5 mm (0.25 in) below the piston ring travel area.
3. Insert a feeler gauge and measure the piston ring end gap.
   - The proper top compression ring end gap is 0.23–0.38 mm (0.009–0.0149 in).
   - The proper second compression ring end gap is 0.44–0.64 mm (0.0173–0.0251 in).
   - The proper oil control ring end gap is 0.18–0.69 mm (0.007–0.0271 in).



4968

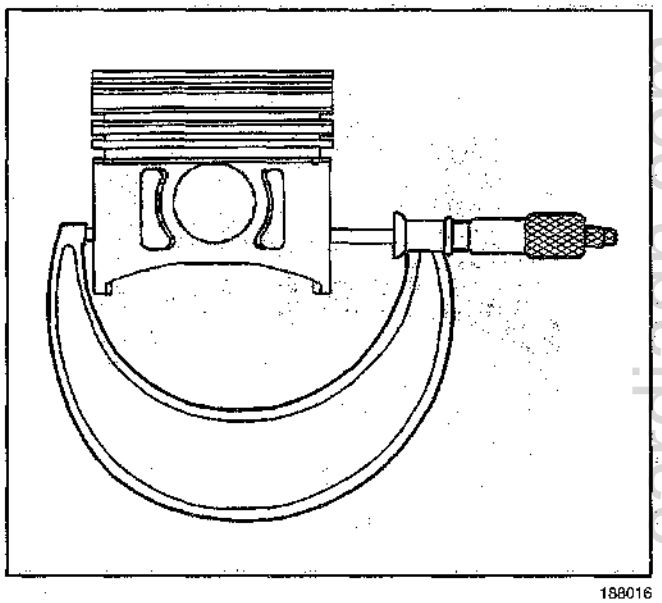
Piston Selection

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

For proper piston fit, the engine block cylinder bores must not have excessive wear or taper.

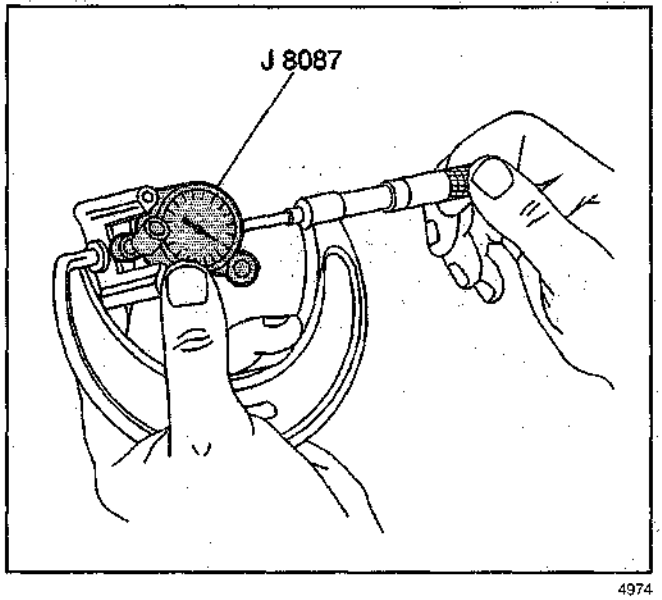
A used piston and pin set may be reinstalled if, after cleaning and inspection, they are within specifications.

1. Inspect the engine block cylinder bore for scoring or other damage.
2. Inspect the piston and the piston pin.
   Refer to *Piston, Connecting Rod, and Bearings Clean and Inspect (Piston and Pin).*
3. With a micrometer or caliper at a right angle to the piston, measure the piston 11 mm (0.433 in) from the bottom of the skirt.
4. Record the piston diameter.



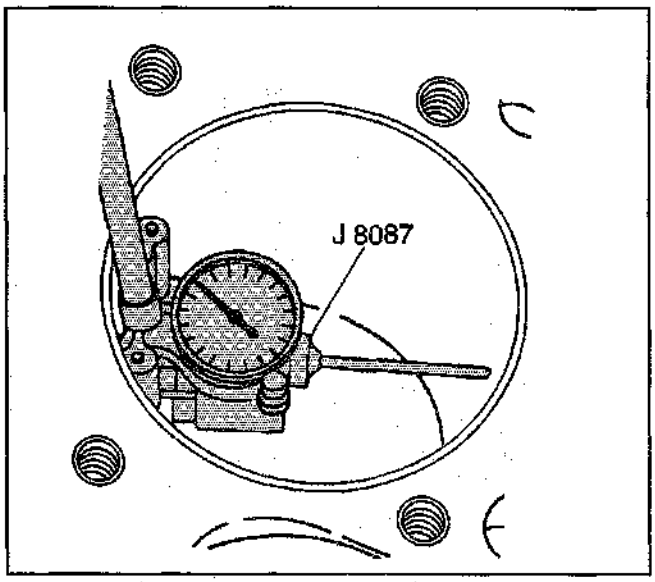
188016

5. Adjust the micrometer to the recorded piston diameter.
6. Insert the bore gauge into the micrometer and zero the bore gauge dial.



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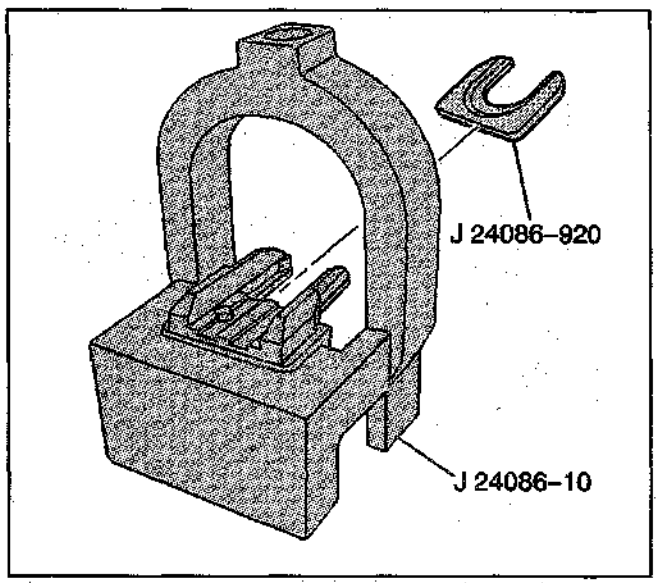
4972

7. Use a bore gauge and measure the cylinder bore diameter. Measure at a point 64 mm (2.5 in) from the top of the cylinder bore.
8. Record the cylinder bore diameter.
9. Subtract the piston diameter from the cylinder bore diameter in order to determine piston-to-bore clearance.

   The proper piston-to-bore clearance should be between 0.018–0.054 mm (0.0007–0.00212 in).
10. If the proper clearance cannot be obtained, select another piston and measure for the clearances.

    If the proper fit cannot be obtained, the cylinder bore may require honing for an oversize piston or block replacement.
11. When the piston-to-cylinder bore clearance is within specifications, permanently mark the top of the piston for installation to the proper cylinder.

    Refer to *Separating Parts*.



533475

Piston and Connecting Rod Assemble

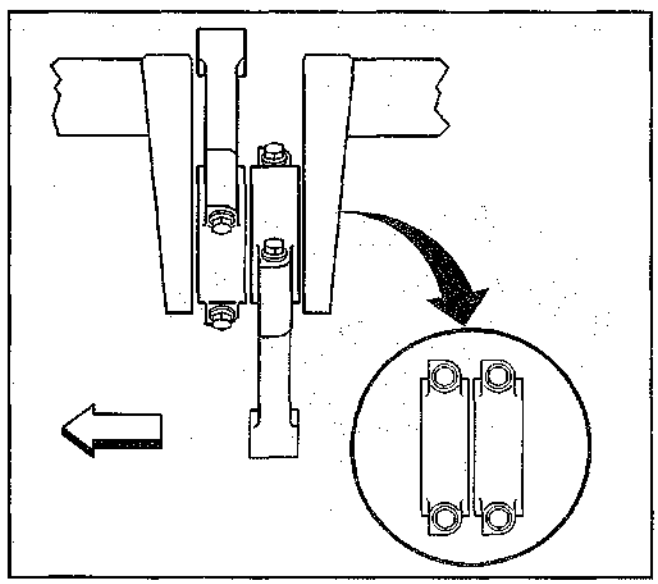
Tools Required

J 24086-C Piston Pin Remover/Installer Set

Important: Assemble the piston for the specific cylinder with the connecting rod for the corresponding crankshaft journal.

The piston and connecting rod MUST be assembled properly.

1. Install fork insert J 24086-920 into fixture *J 24086-10*.


63227

Caution: Avoid contact with HOT components. Wear safety glasses and protective gloves to avoid personal injury.

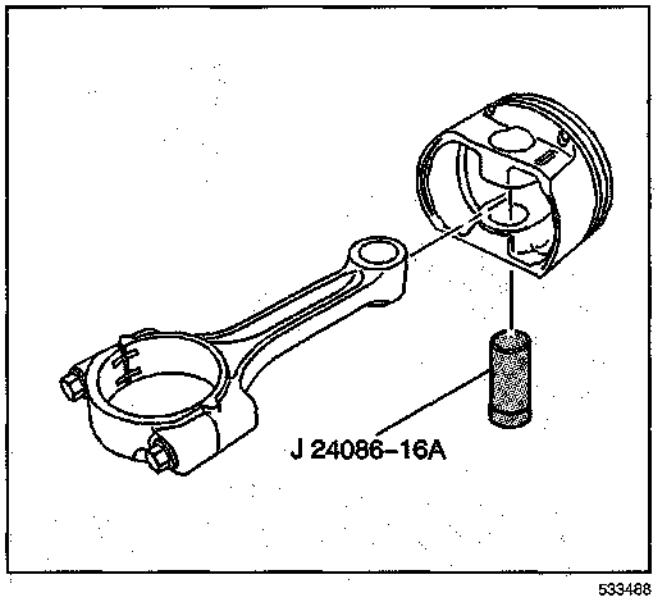
Notice: Applying excessive heat to the connecting rod may damage or distort the rod. Rod temperature SHOULD NOT exceed 315°C (600°F). At this temperature the end of the connecting rod will turn a straw color upon visual inspection.

2. Use a torch and apply MILD heat to the pin end of the connecting rod.

   Mild heating of the connecting rod will ease in piston and pin assembly.
3. With the piston and connecting rod properly assembled, both the flat flange area of the connecting rod and the alignment mark on the top of the piston will be facing the front of the engine.

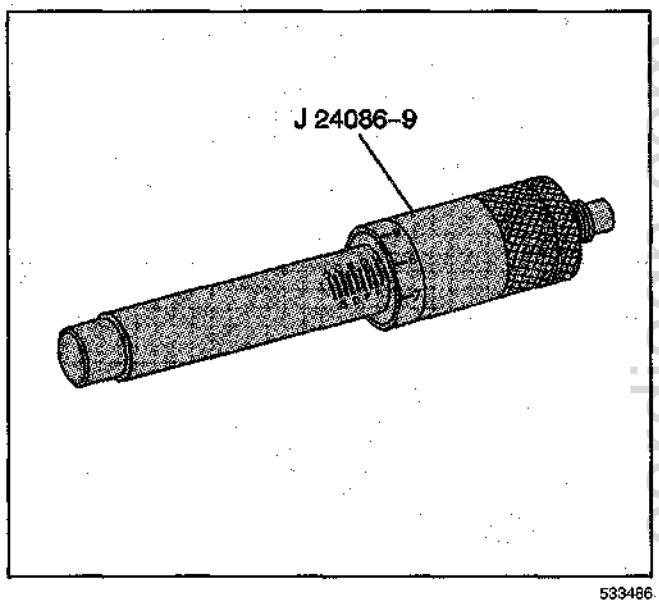
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4. Assemble the piston, connecting rod and adapter J 24086-16A and install onto fixture *J 24086-10*.



533488

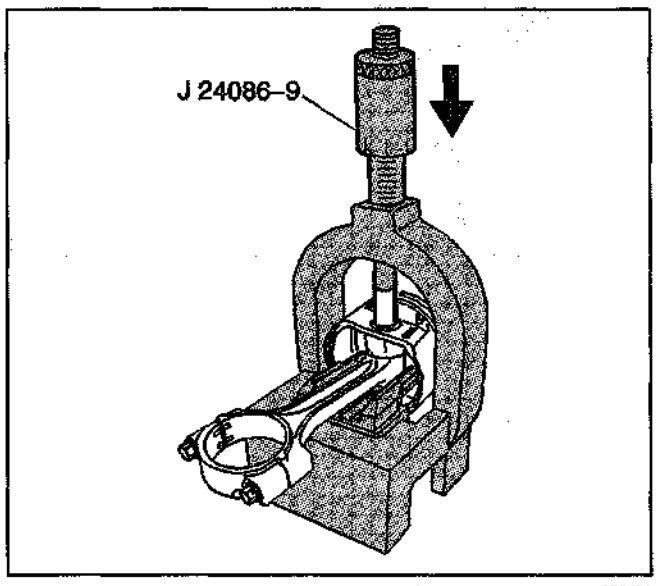
5. Adjust installation pin *J 24086-9* to I-8.



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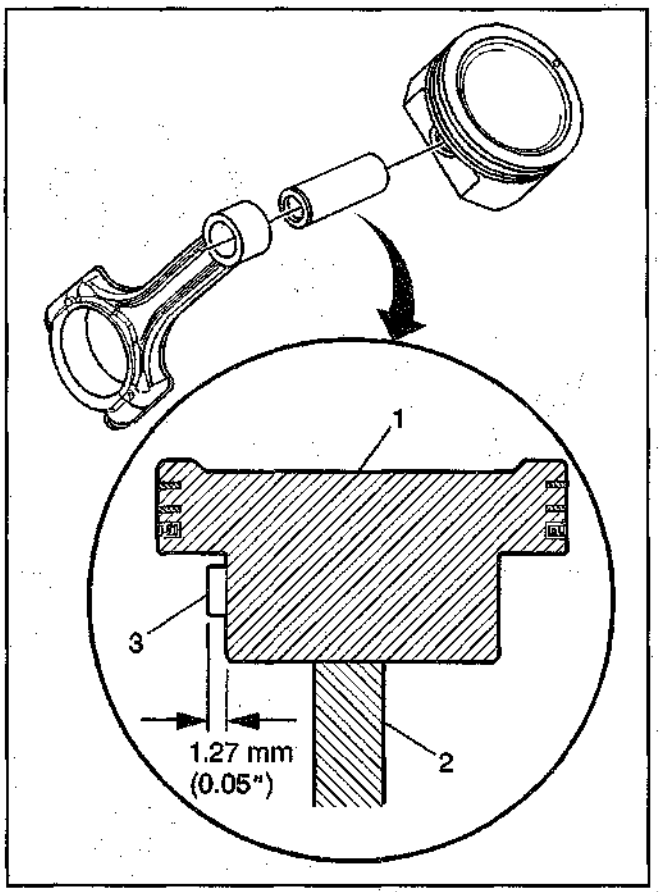
Notice: After the installer hub bottoms on the support assembly, do not exceed 35 000 kPa (5,000 psi) pressure, this could cause damage to the tool.

6. Insert pin J 24086-9 through fixture *J 24086-10* and to the piston pin.
7. Press pin J 24086-9 until the installer bottoms on fixture *J 24086-10*.



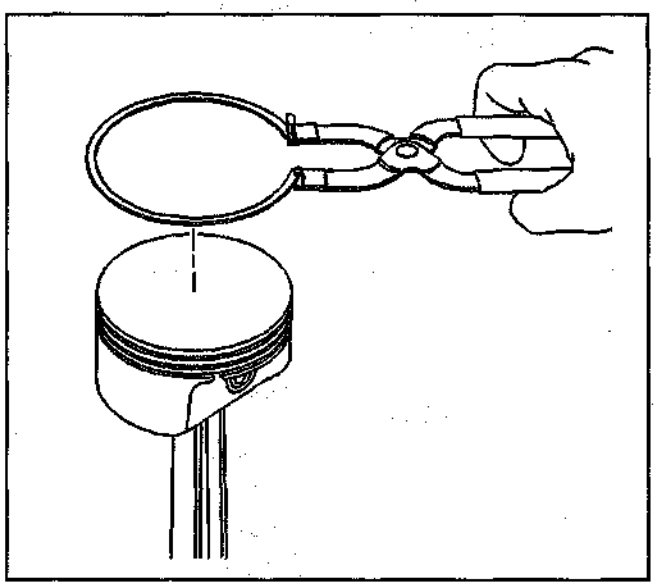
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63156

8. Measure the piston (1), pin (3), and connecting rod (2) for proper assembly.
   8.1. Place the piston and connecting rod assembly onto a table or other flat surface.
   Lay the flat top of the piston (1) onto the table surface.
   8.2. Slide the connecting rod (2) and pin (3) to one side and hold firmly against the inside of the piston (1).
   8.3. Measure the pin (3) for proper installation.
   A properly installed piston pin should protrude 1.27 mm (0.05 in) from the side of the piston.



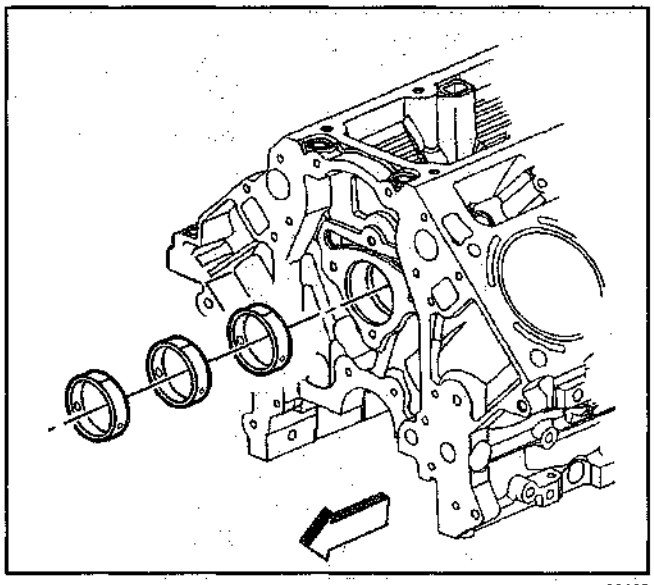
490763

Important: When installing the piston rings onto the piston, use a ring expanding plier type tool. Do not roll the piston rings into the grooves of the piston.
Use caution and care to expand the piston rings only slightly larger than the Outside Diameter (OD) of the piston.

9. Using piston ring pliers, install the piston rings onto the piston.
   9.1. Install the oil control ring spacer in the groove.
   9.2. Install the lower oil control ring.
   The oil control rings do not have a dimple or orientation mark and may be installed in either direction.
   9.3. Install the upper oil control ring.
   9.4. Stagger the three oil control ring end gaps a minimum of 90 degrees.
   9.5. Using piston ring pliers, install the lower compression ring.
   The lower compression ring has a dimple or orientation mark and must face the top of the piston.
   9.6. Using piston ring pliers, install the upper compression ring.
   The upper compression ring does not have a dimple or orientation mark and may be installed in either direction.
   9.7. Stagger the compression ring end gaps a minimum of 25 mm (1.0 in).

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Camshaft Bearing Removal

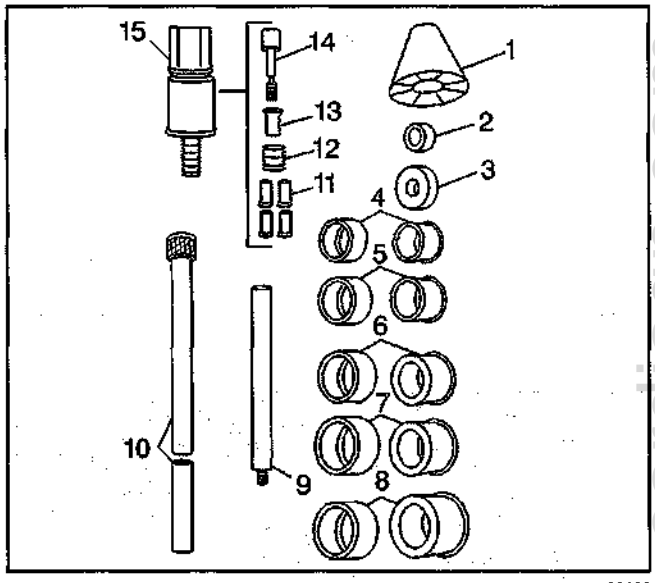

63163

Tools Required

J 33049 Camshaft Bearing Remover/Installer

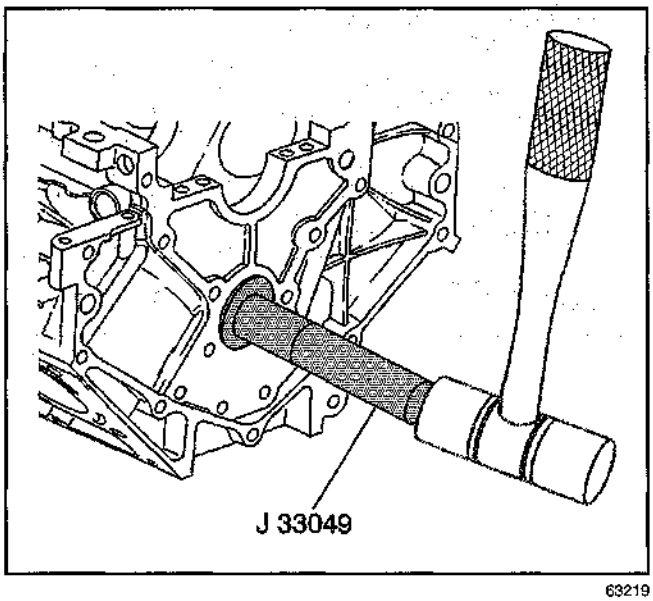
Important: A loose camshaft bearing may be caused by an enlarged, out of round or damaged engine block bearing bore.

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



66100

3. Select the expanding driver (4–8) and washer (2 or 3) from the tool usage information.
4. Assemble the tool.



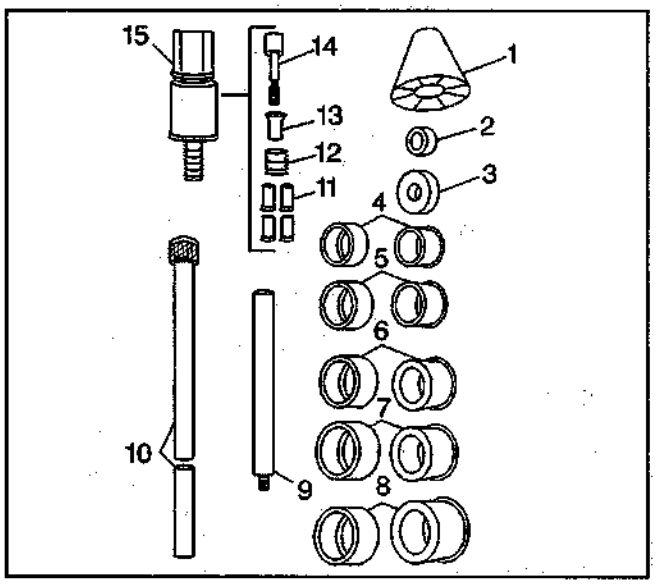
63219

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 to align the tool.
8. Drive the bearing from the block bore.

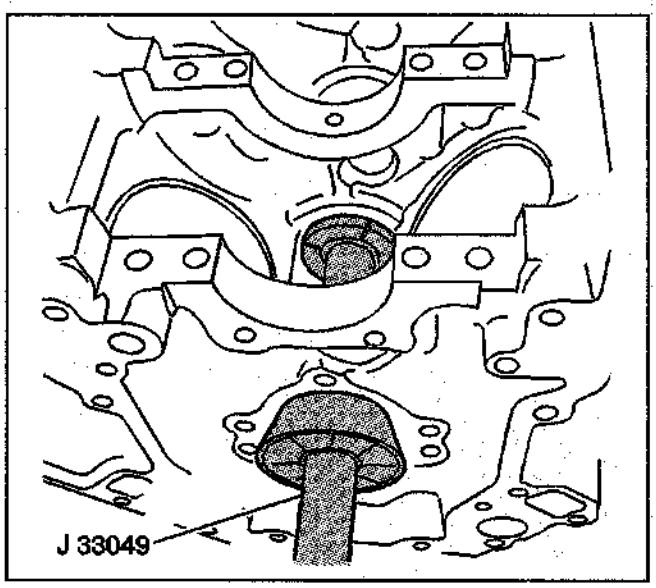
Important: To remove the front camshaft bearing, operate the tool from the rear of the block using the guide cone (1) in the rear camshaft bearing bore.

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

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66100



64183

Tool Usage Information

Bearing, Expander, and Expander Driver Information

- 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).
- Expander bearing driver number one inside diameter is 28.575–37.465 mm (1.125–1.475 in) and is used with the expander assembly and the small washer.
- Expander bearing driver number two inside diameter is 37.465–43.18 mm (1.475–1.7 in) and is used with number one expanding driver and the small washer.
- Expander bearing driver number three inside diameter is 43.18–48.895 mm (1.7–1.925 in) and is used with number two expanding driver and the large washer.
- Expander bearing driver number four inside diameter is 48.895–54.61 mm (1.925–2.15 in) and is used with number three expanding driver and the large washer.
- Expander bearing driver number five inside diameter is 54.61–60.325 mm (2.15–2.375 in) and is used with number four expanding driver and the large washer.
- Expander bearing driver number six inside diameter is 60.325–68.326 mm (2.375–2.69 in) and is used with number five expanding driver 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. Check to insure that the separation lines between the segments of the expanding driver align with the separation lines of the expander assembly.
4. Place the guide cone over the driving bar (with the small end of the cone facing the driver assembly).
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.

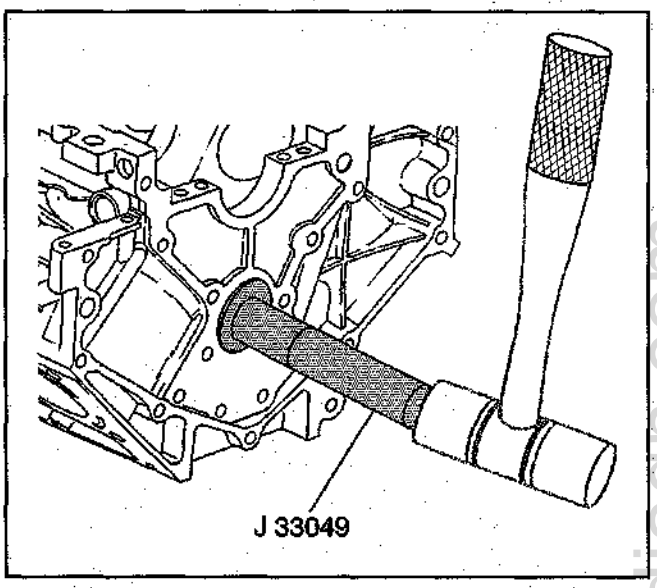
   It may be necessary to install the driver bar extension for removal of the inner bearings.

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7. Insert the tool into a 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 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.
11. For the two end bearings (front and rear), remove the nylon cone and driver bar extension.
12. Drive the bearings out of or into the engine block.



63219

Camshaft and Bearings Clean and Inspect

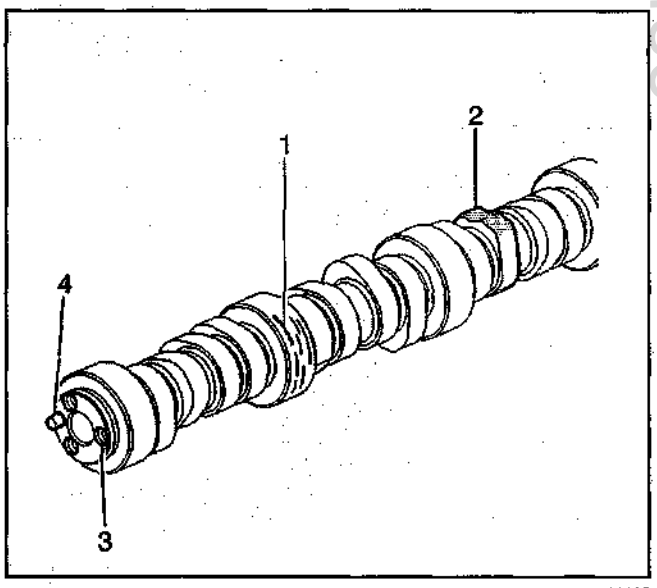
Tools Required

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

1. Clean the components in solvent.

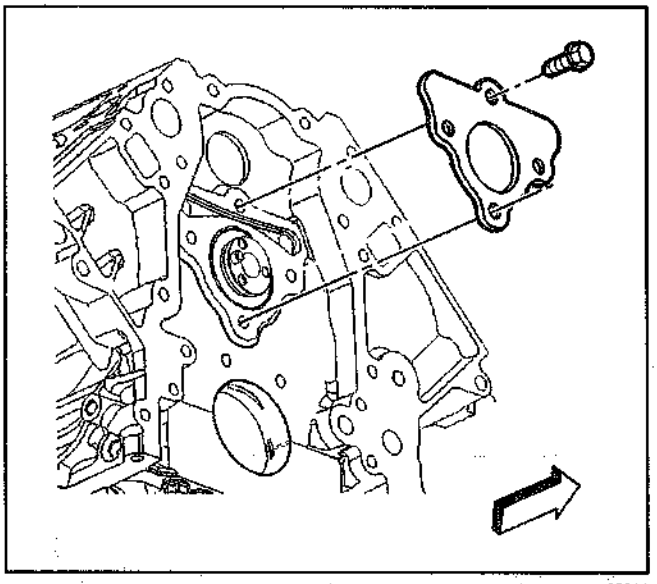
Caution: Wear safety glasses in order to avoid eye damage.

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 holes (3) in the front of the camshaft for damaged threads or debris.
6. Inspect the camshaft sprocket pin (4) for damage.
7. Inspect the camshaft position reluctor ring for nicks or damage.



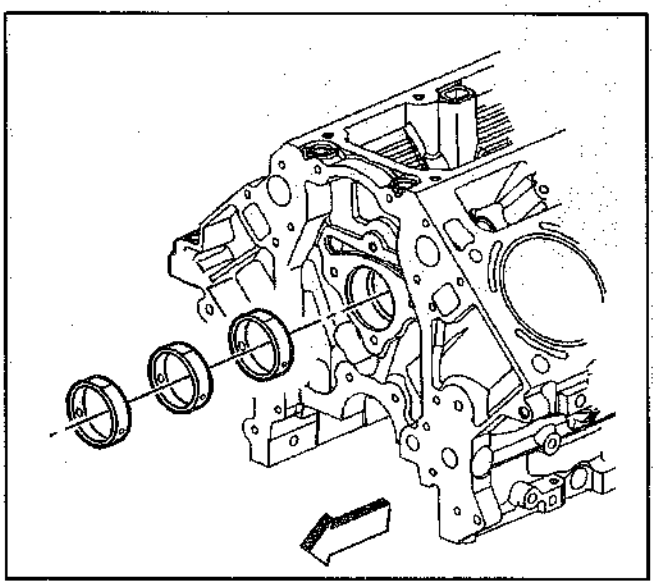
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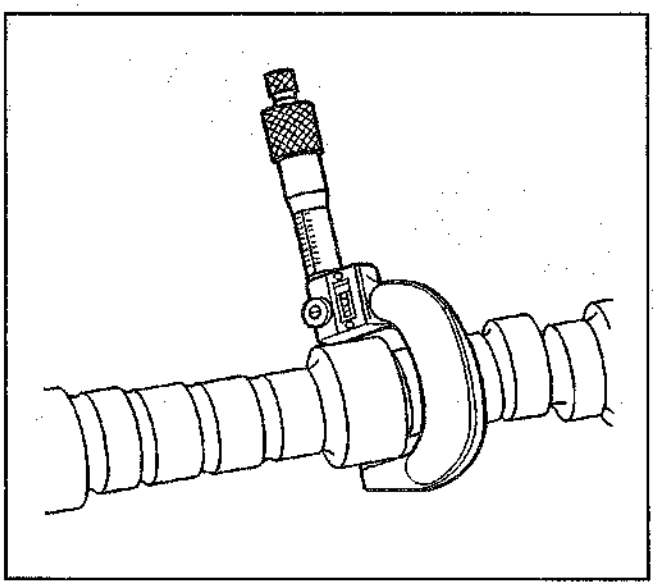
8. Inspect the camshaft retainer plate for wear or a damaged sealing gasket.

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


63163

9. Inspect the camshaft bearings for proper fit in the engine block. The camshaft bearings have an interference fit to the engine block and should not be loose in their engine block bearing bores.
10. Inspect the camshaft bearings for excessive wear or scoring.

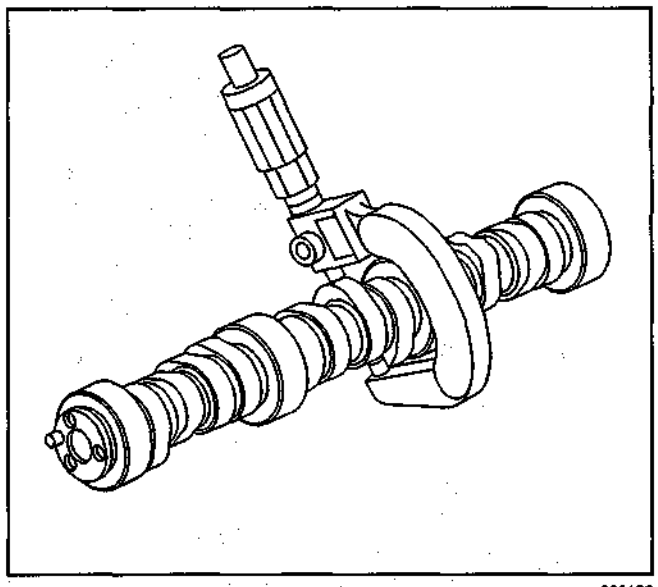
    Bearings with excessive scoring or wear must be replaced.


35212

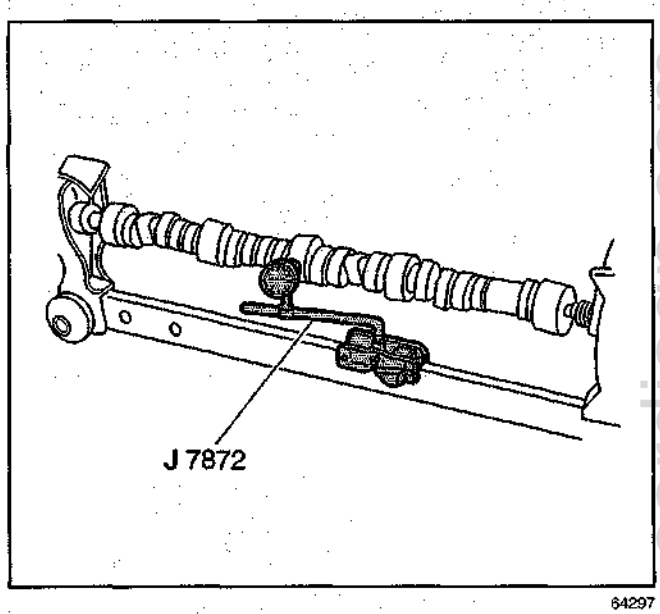
11. Measure the camshaft journals for wear and out-of-round with a micrometer.
    - A camshaft with bearing journals that measure more than 0.025 mm (0.001 in) out-of-round, must be replaced.
    - A camshaft with bearing journal diameters that measure less that 54.99 mm (2.164 in), must be replaced.

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12. Measure the camshaft lobes for wear with a micrometer.
    - A camshaft with an intake lobe that measures 46.67 mm (1.8376 in) or less, must be replaced.
    - A camshaft with an exhaust lobe that measures 46.67 mm (1.8376 in) or less, must be replaced.

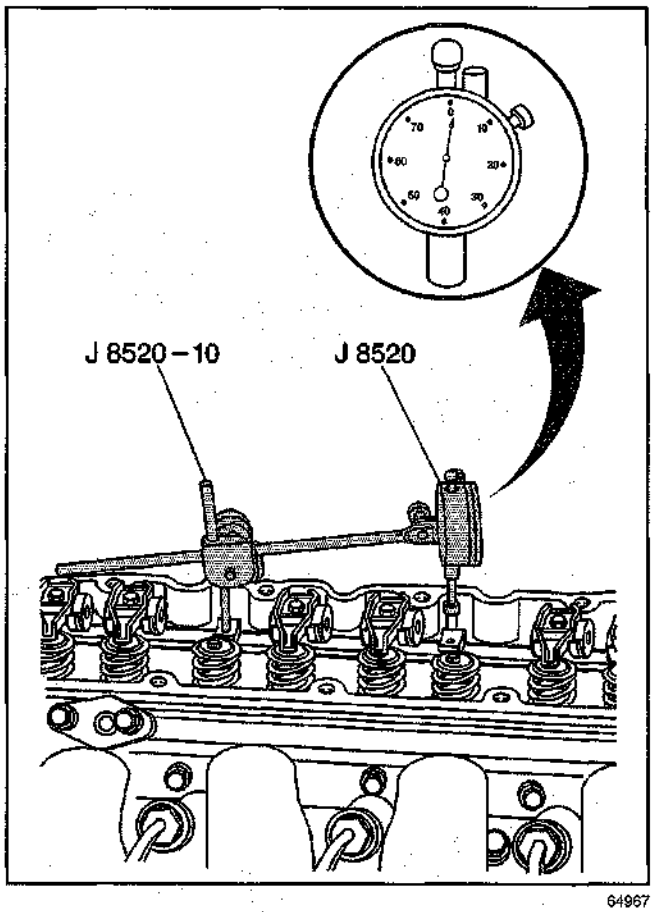

260130

13. Measure the camshaft runout.
    13.1. Mount the camshaft in wooden V-blocks or between centers on a fixture.
    13.2. Check the runout of the intermediate camshaft bearing journals using the *J 7872*.
    13.3. If camshaft runout exceeds 0.05 mm (0.002 in), the camshaft is bent and should be replaced.

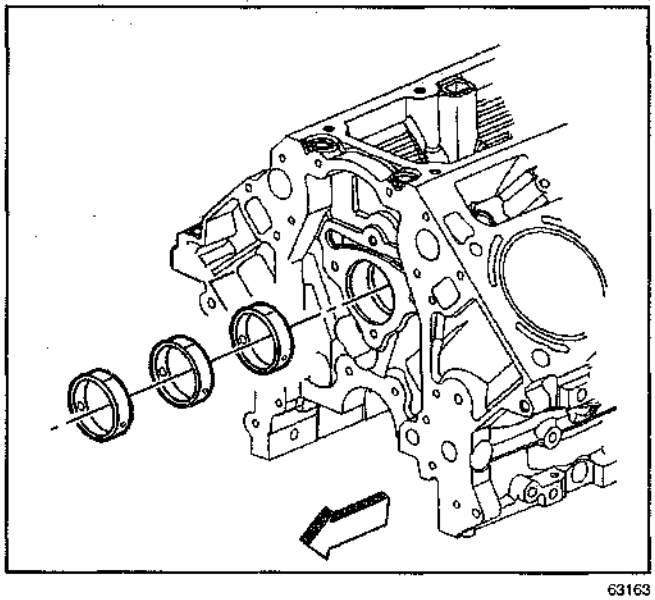


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Measuring Camshaft Lobe Lift

Important: Measuring camshaft lobe lift is a procedure used to determine if the camshaft lobes have worn. This test is to be performed prior to engine disassembly and with the camshaft and valve train components installed in the engine.

1. Measure camshaft lobe lift using *J 8520*.
   1.1. Remove the valve rocker arms and bolts
   1.2. Install the dial indicator mounting stud into the valve rocker arm bolt hole.
   1.3. Assemble the components of the *J 8520* and position onto the stud.
   1.4. Position the shaft of the dial indicator onto the end of the pushrod.
   1.5. Rotate the face of the dial indicator to zero.
   1.6. Slowly rotate the crankshaft clockwise until the dial indicator obtains its highest and lowest readings.
   1.7. Compare the total lift shown to specifications.
   - The proper lobe lift for the intake lobes is 7.43 mm (0.292 in).
   - The proper lobe lift for the exhaust lobes is 7.43 mm (0.292 in).
   1.8. Remove the tool.
2. Compare measurements to specifications.
   If the readings are not within specifications, remove the camshaft. Inspect and/or replace components as required.

Camshaft Bearing Installation

Tools Required

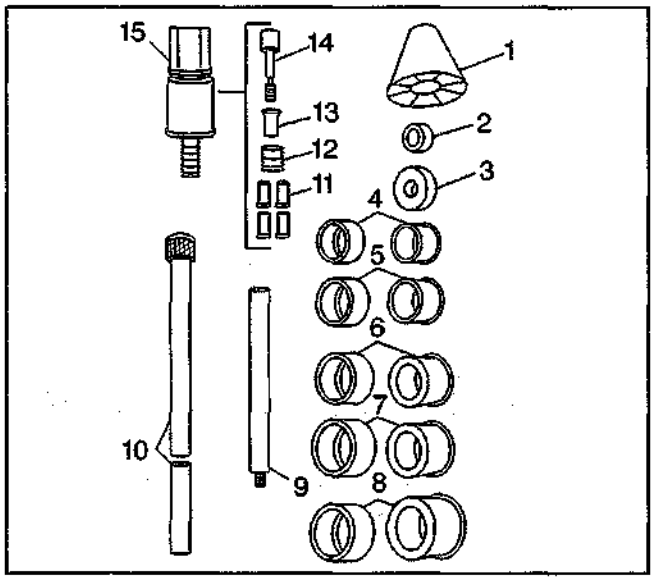
J 33049 Camshaft Bearing Remover/Installer

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.
2. Repair or replace the components as required.

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3. Select the expanding driver (4–8) and washer (2 or 3) from the tool usage information.
4. Assemble the tool.

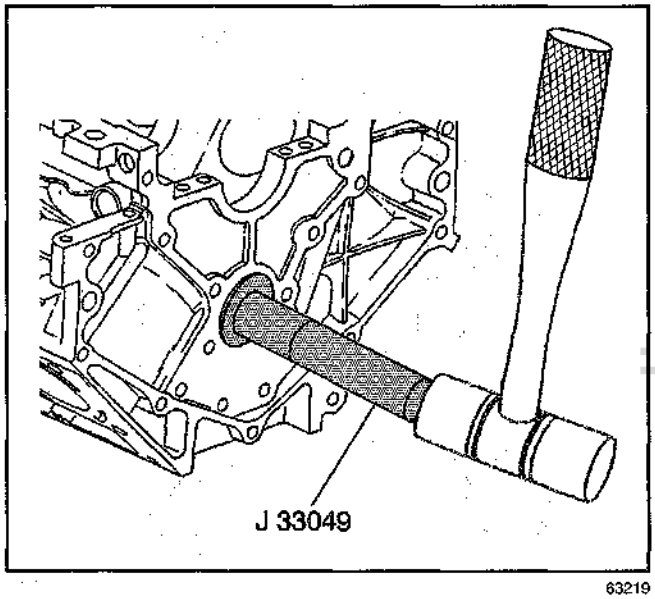


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5. Insert the tool through the front of the engine block and to the bearing bore.
6. Install the new bearing onto the tool.
7. Tighten the expander assembly nut until snug.
8. Push the guide cone into the front camshaft bearing to align the tool.
9. Properly align the oil hole in the bearing with the oil gallery in the engine block.
10. Drive the bearing into the block bore.

Important: To install the front camshaft bearing, operate the tool from the rear of the block using the guide cone in the rear camshaft bearing bore.

11. Repeat the above procedures to install the remaining bearings.
12. Check the installed bearing for proper alignment of the oil gallery holes.



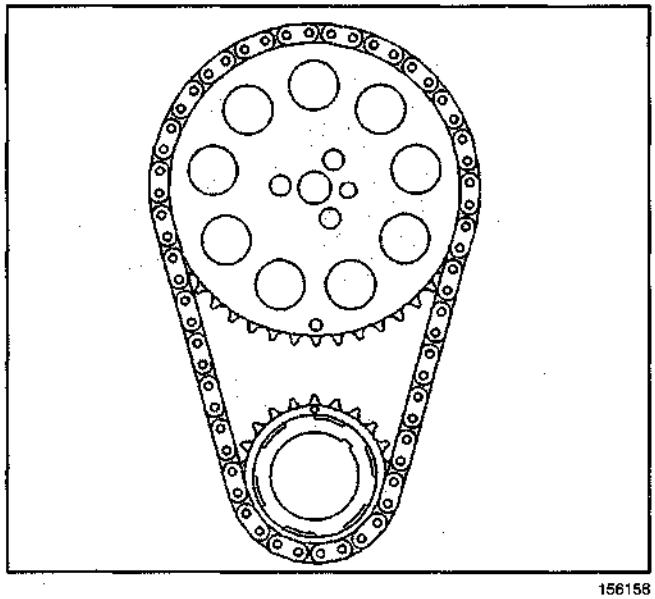
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Timing Chain and Sprockets Clean and Inspect

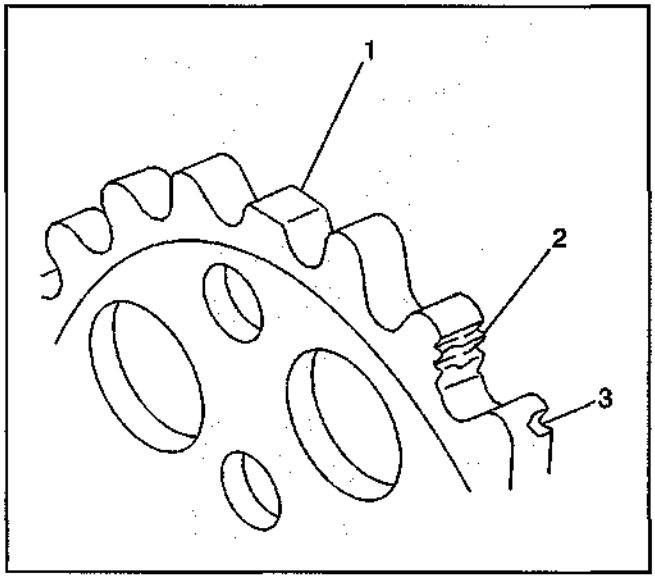
1. Clean the components with cleaning solvent.

Caution: Wear safety glasses in order to avoid eye damage.

2. Dry the components with compressed air.
3. Inspect the timing chain for binding or wear.

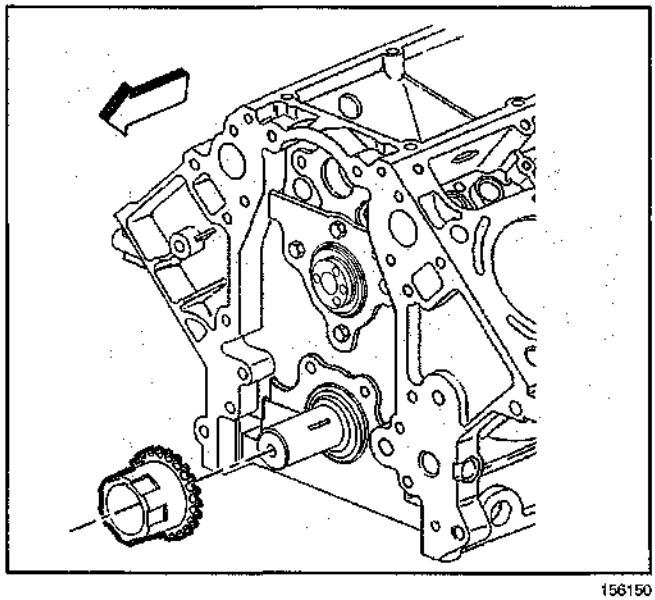

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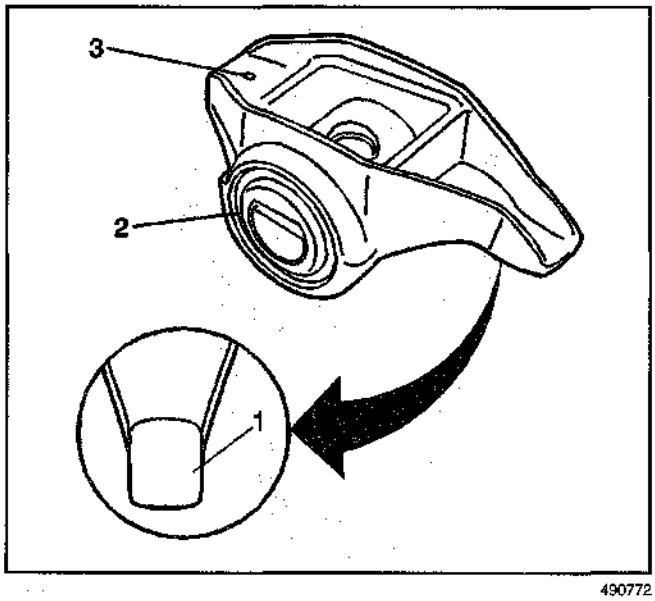


188097

4. Inspect the camshaft and crankshaft sprockets for:
   - Worn teeth (1)
   - Damaged teeth (2)
   - Chipped teeth (3)
   - Worn valleys between the sprocket teeth


156150

5. Inspect the crankshaft sprocket keyway for wear.
6. Inspect the crankshaft sprocket oil pump drive splines for wear.



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Valve Rocker Arm and Push Rods Clean and Inspect

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

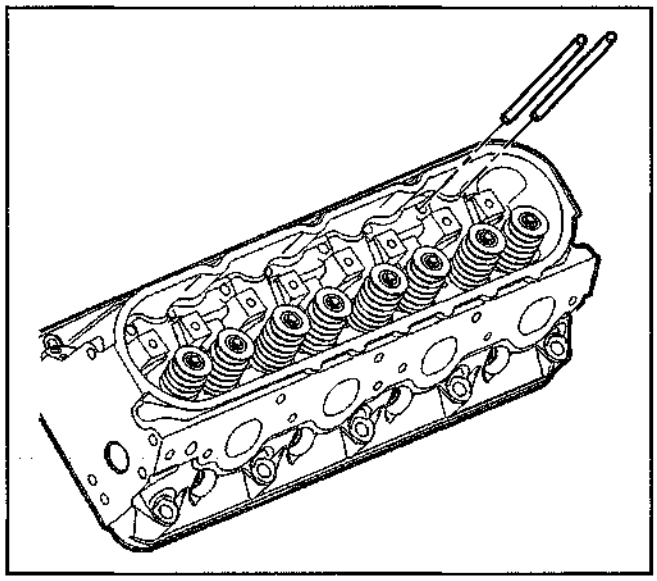
1. Mark, sort, or organize the components for assembly.
   Refer to *Separating Parts.*
2. Clean the components with cleaning solvent.

Caution: Wear safety glasses in order to avoid eye damage.

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.

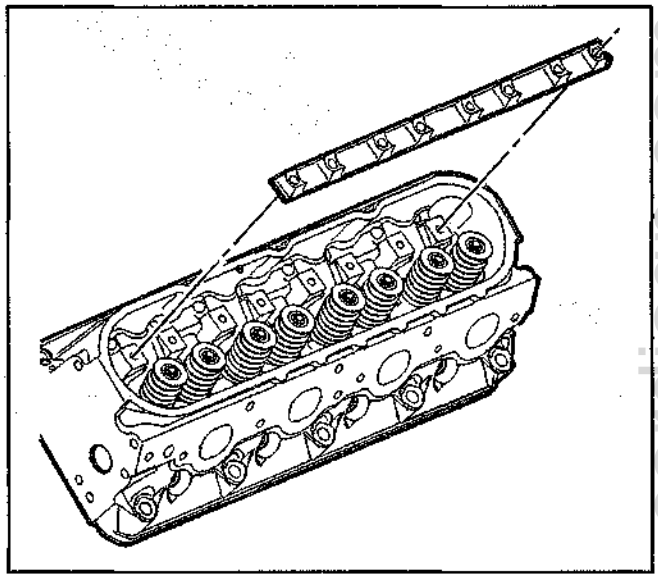
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6. Inspect the pushrods for worn or scored ends. These surfaces should be smooth with no scoring or exceptional wear.
7. Inspect the pushrods for bends. Roll the pushrod on a flat surface to determine if the pushrod is bent.
8. Inspect the pushrod oil passages for restrictions.



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9. Inspect the pivot supports for cracks, wear, or other damage.



260141

Valve Lifters and Guides Clean and Inspect

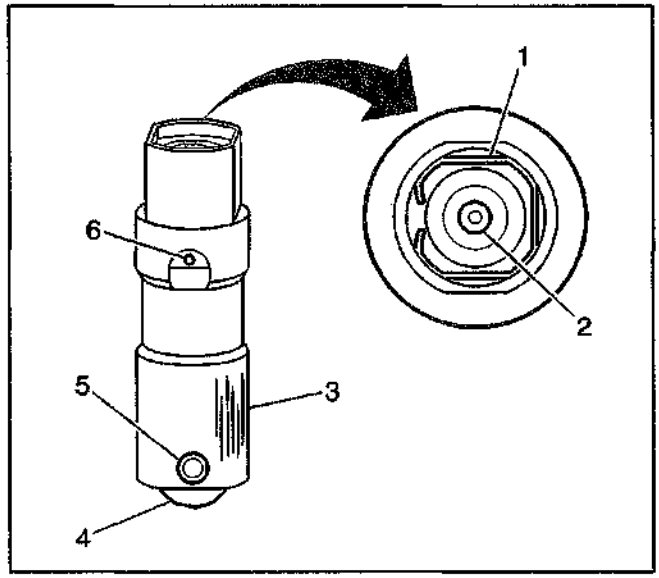
Important: Components that are to be reused must be marked, sorted or organized for assembly.

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

   Refer to *Separating Parts*.
2. Clean the components in cleaning solvent.

Caution: Wear safety glasses in order to avoid eye damage.

3. Dry the components with compressed air.



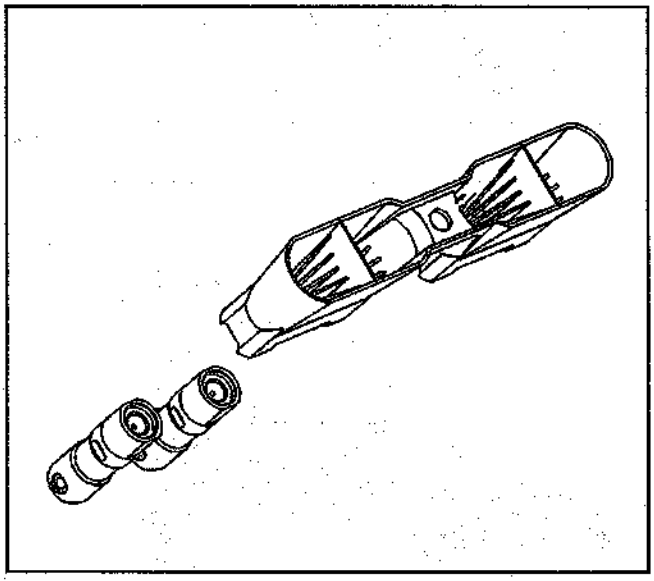
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4. Inspect the valve lifters for the following:
   - Bent or broken clip (1)
   - Worn pushrod socket (2)
   - Scuffed or worn sides (3)

     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.



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5. Inspect the valve lifter guides for the following:
   - For cracks or damage
   - Excessive wear in the lifter mounting bores

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Cylinder Head Disassemble

Tools Required

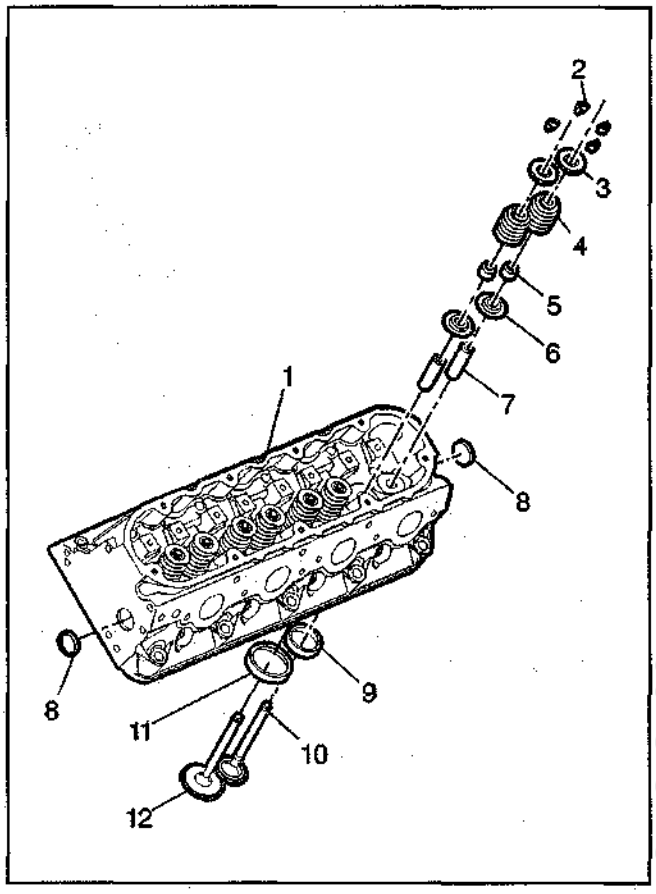
J 8062 Valve Spring Compressor

Important: Remove the spark plugs from the cylinder head with the components at room temperature.

Mark, organize, or sort the cylinder head components for assembly. Return the components to their original location during assembly.

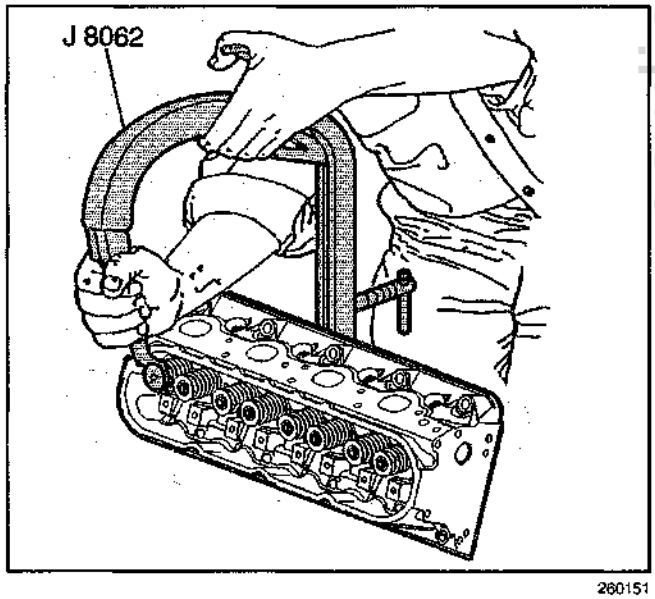
Do not remove the cylinder head expansion plugs (8) or valve seats (9 and 11) unless service is required.

1. Remove the spark plugs from the cylinder heads.



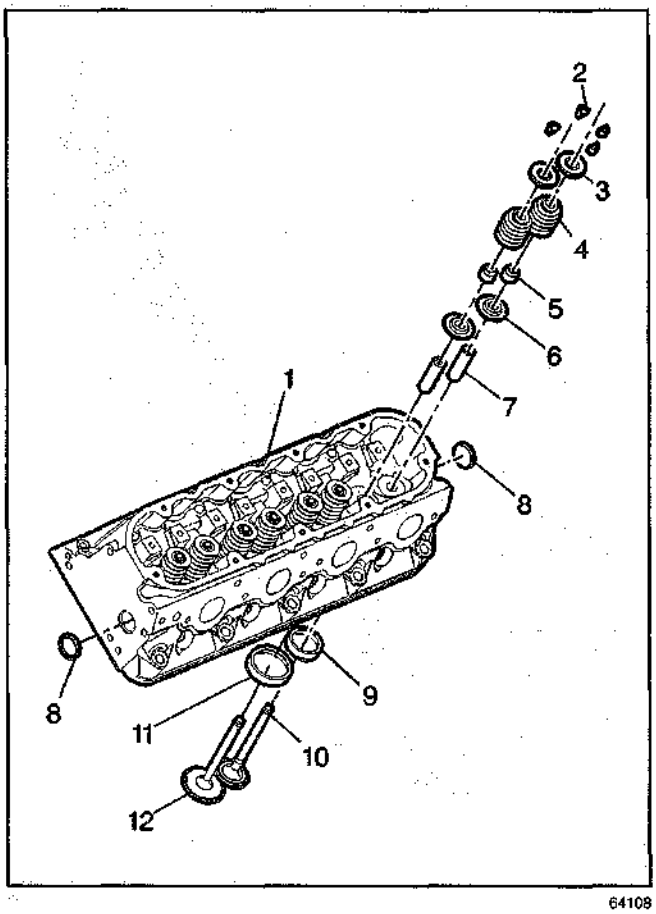
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2. Use the *J 8062* in order to compress the valve spring.



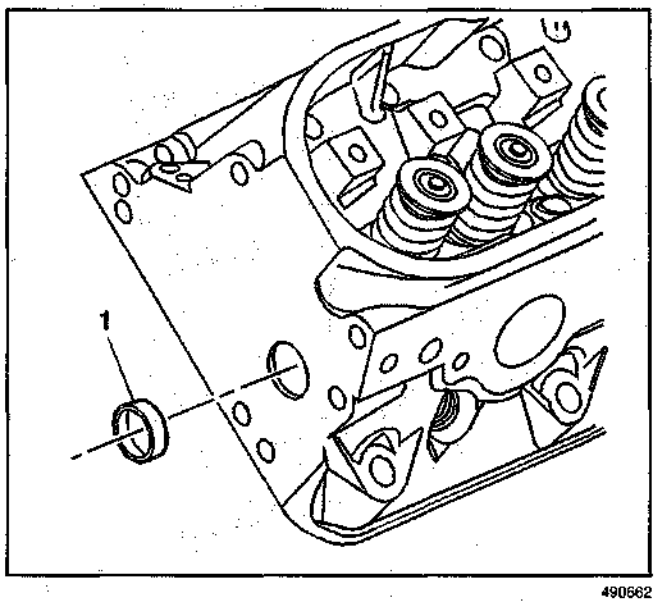
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3. Remove the valve stem keys (2).
4. Remove the valve spring cap (3).
5. Remove the valve spring (4).
6. Remove the valves (10 and 12).
7. Remove the valve stem oil seal (5).
8. Remove the valve spring shim (6).
   Refer to *Separating Parts*.

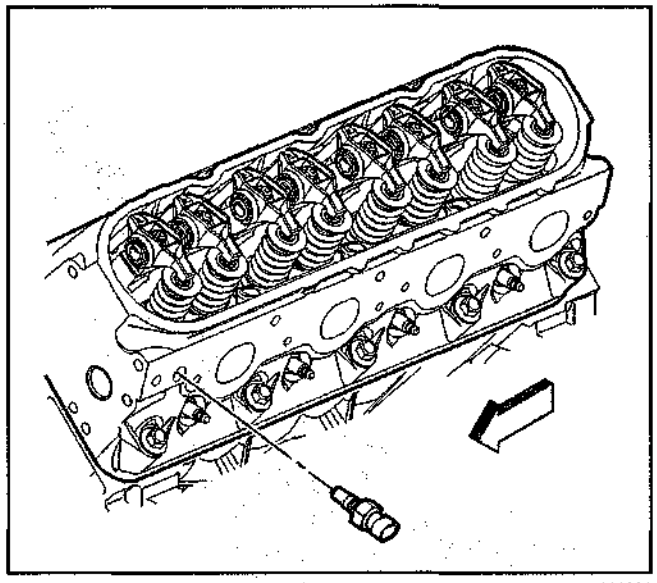


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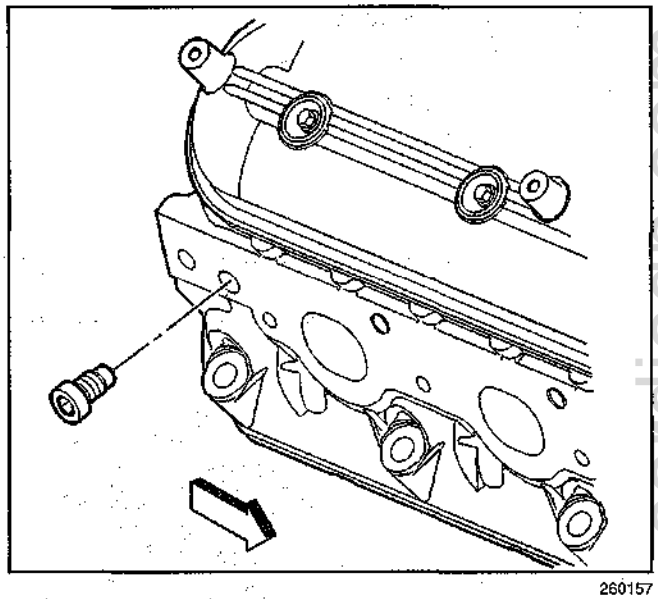
9. Remove the cylinder head expansion plugs (1) (if required).

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10. Remove the coolant sensor from the left cylinder head.


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11. Remove the coolant plug from the right cylinder head.


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Cylinder Head Clean and Inspect

Tools Required

- *J 8089* Carbon Removing Brush
- *J 9666* Valve Spring Tester

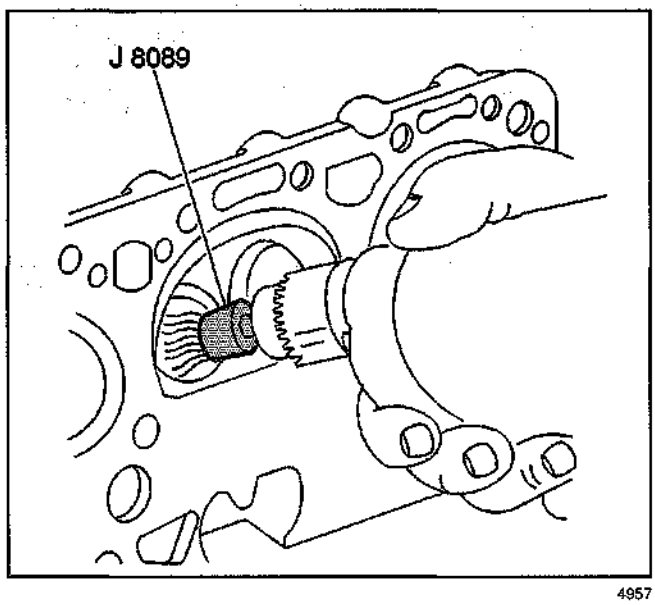
Caution: Wear safety glasses in order to avoid eye damage.

Important: When cleaning an cylinder head in a thermal type oven, do not exceed 204°C (400°F).

1. Clean the following components:

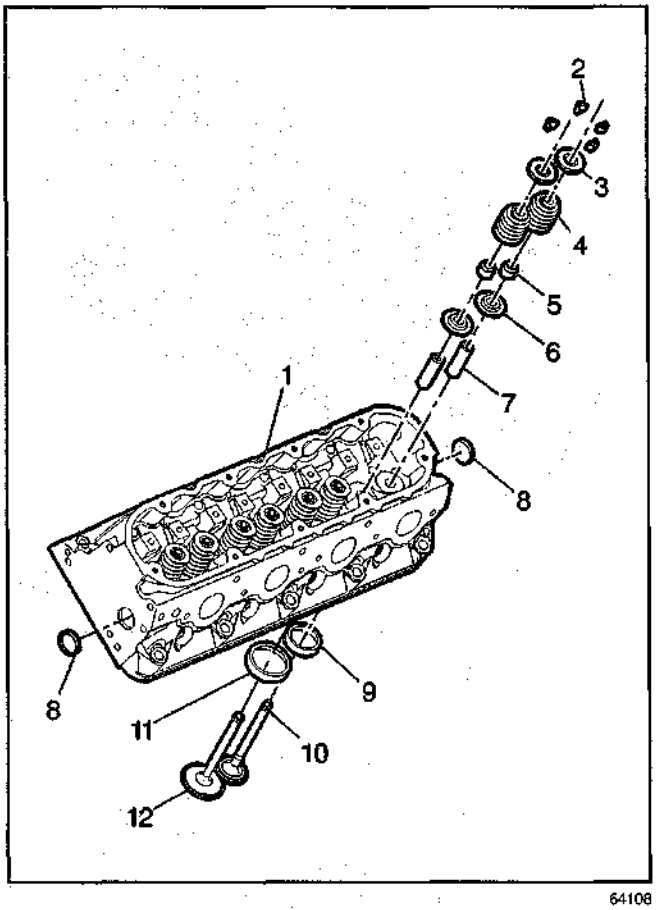
Important: Be careful not to scuff the chamber.

- Use the *J 8089* 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.



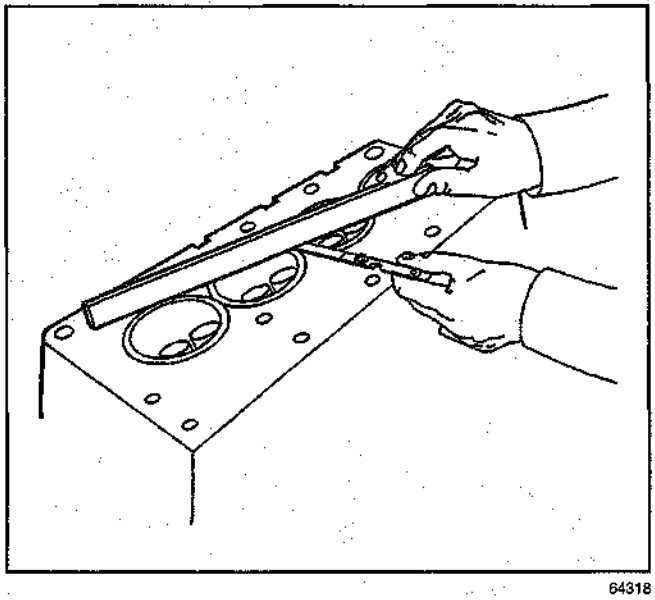
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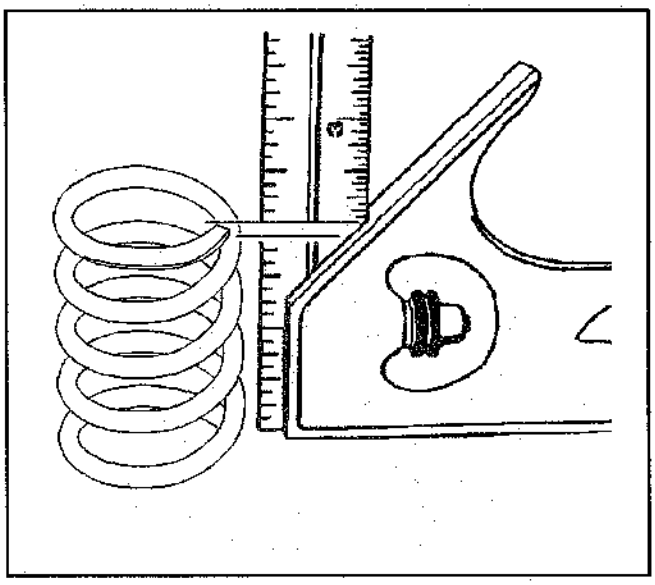
2. Inspect the following:
   2.1. The cylinder head (1) for cracks in the exhaust ports and combustion chambers
   2.2. The cylinder head for external cracks in the water chambers
   2.3. The gasket surfaces for excessive scratches or gouging.
   Refer to *Replacing Engine Gaskets*.
   2.4. The bolt hole threads for debris or damaged threads.
   Refer to *Thread Repair* or *Thread Repair Specifications*.


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3. Inspect the cylinder head for warpage.

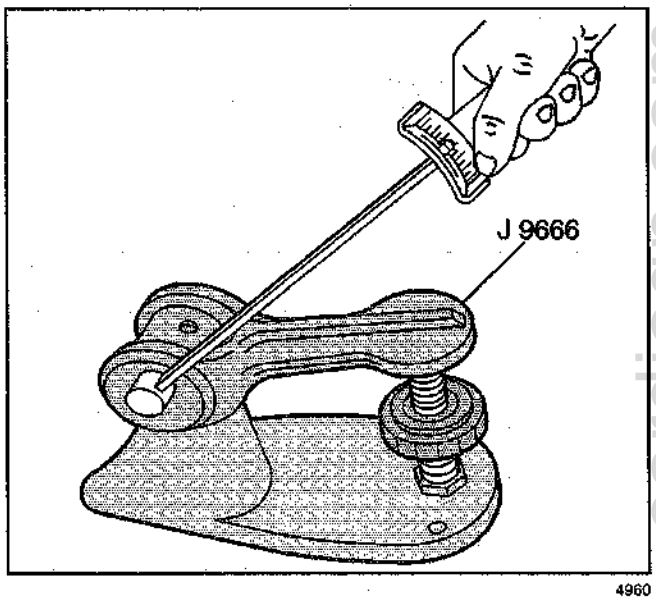
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4. Inspect the valve springs for squareness.



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5. Use the *J 9666* in order to measure the valve spring tension.
   Replace the spring if the spring tension is less than 310 N (70 lb) at 45.75 mm (1.80 in).



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Valve Guide Reaming/Valve and Seat Grinding

Valve Guide Reming

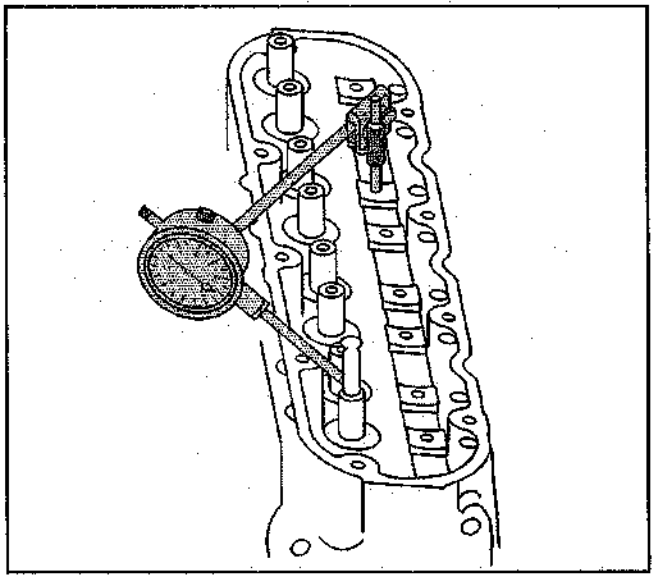
Tools Required

J 37378-1 Valve Guide Reamer

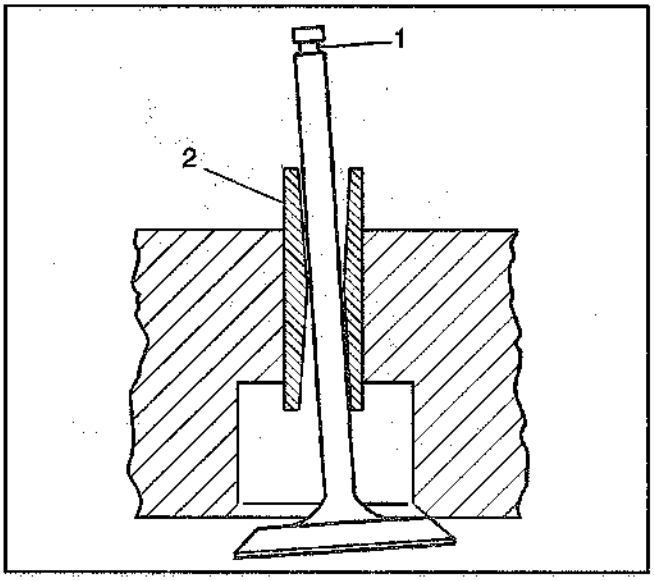
Important: Excessive valve stem-to-guide clearance may cause a noisy valve train, premature valve stem oil seal wear, component damage, and/or excessive engine oil consumption.

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. Measure the valve stem-to-guide clearance using a dial indicator.
   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.

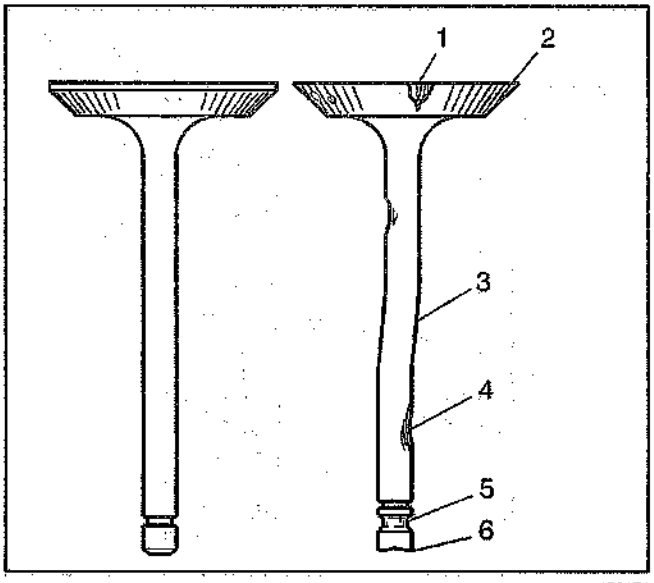

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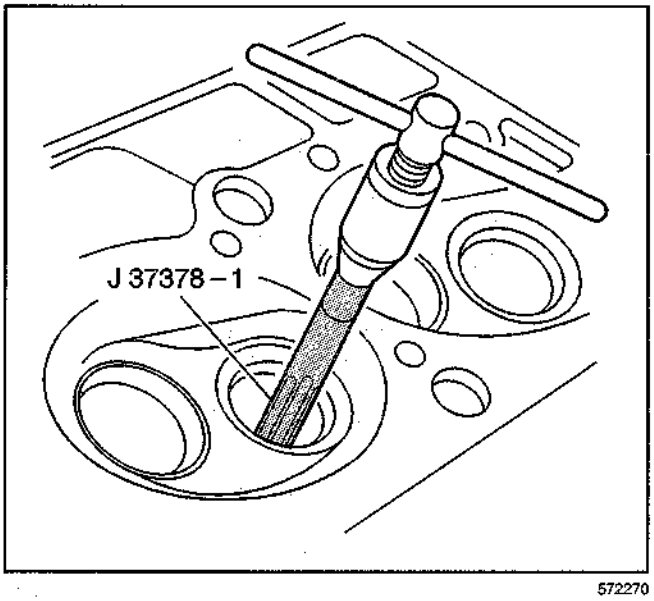
2. A valve stem (1) and guide (2) with clearance in excess of 0.093 mm (0.0037 in) must be repaired or the components replaced.



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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.
   - A valve guide that is worn and has excessive stem-to-guide clearance should be reamed and valves with oversize stems installed.
4. Measure the valve stem diameter. A valve stem with a diameter less than 7.95 mm (0.313 in) must be replaced. Position the tip of the dial indicator at the top of the valve guide.

   If the valve stem diameter is within specifications, and the stem-to-guide clearance is excessive, the valve guide must be reamed oversize and a valve with oversize stem installed.

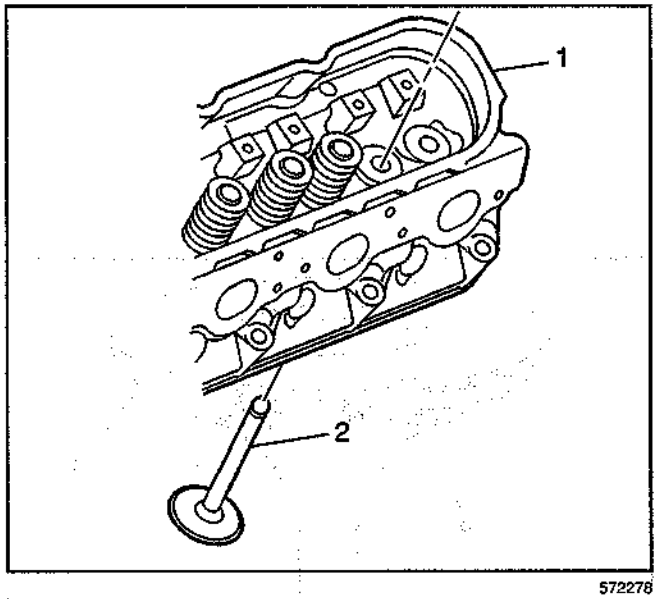


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5. Ream the valve guide using the *J 37378-1*.
6. Clean the guide bore of all metal shavings and debris.

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7. Install the valve (2) (with oversize stem) into the cylinder head (1).
8. Inspect the valve for proper fit.
   Move the valve back and forth in the guide. The valve should move freely with no resistance or drag.

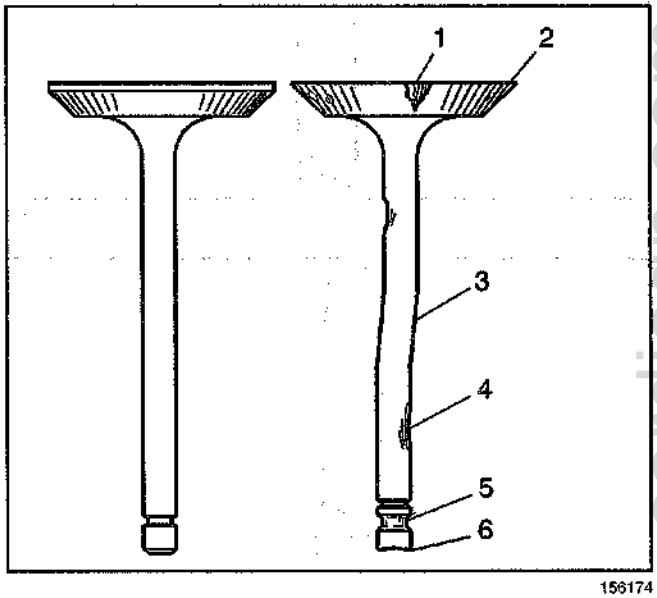


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Valve and Seat Grinding

Important:

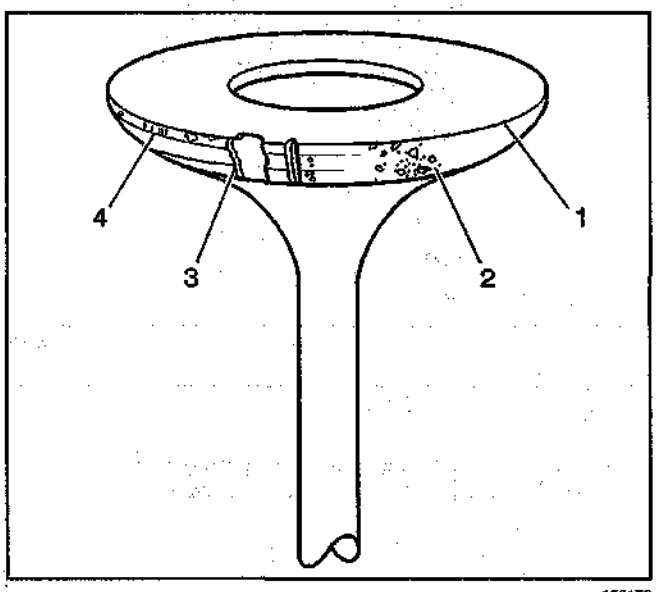
- Reconditioning the valve seats is very important. The seating of the valves must be perfect for the engine to deliver optimum power and performance. Several different types of equipment are available for grinding valve seats.
- Another important factor is the cooling of the valve head. Good contact between the valve and the seat will ensure that heat will be properly dissipated.
- The recommendations of the manufacturer of the equipment should be followed carefully to obtain the proper results. Regardless of what type of equipment is used, it is essential that valve guide bores be free from carbon or dirt to ensure proper centering of 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 is less than 1.25 mm (0.05 in) after grinding, replace the valve.
- Several different types of equipment are available for refacing valves. The recommendation of the manufacturer of the equipment should be carefully followed to obtain the proper results.
- DO NOT reface intake valves. Intake valves with excessive wear or damage MUST be replaced.



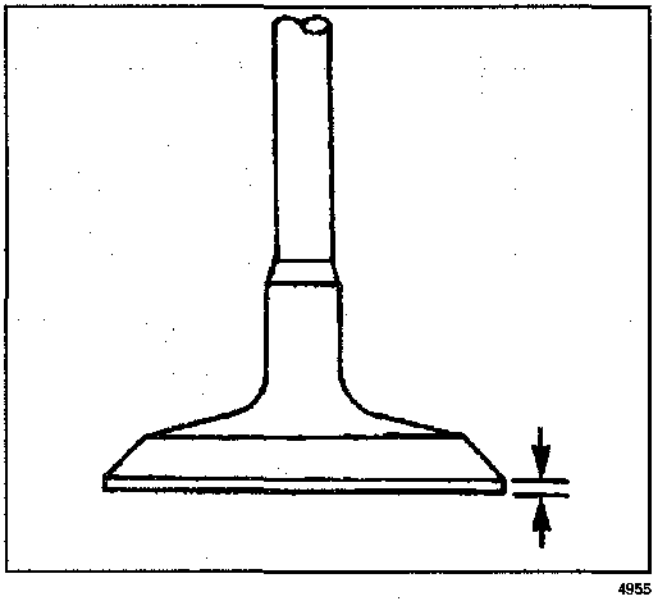
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1. Inspect the valve for the following:
   - Burnt or eroded areas (1)
   - A worn margin (2)
   - A bent stem (3)
   - A worn or scored stem (4)
   - A worn key groove (5)
   - A worn stem tip (6)
2. Inspect the valve face for the following:
   - Worn or no margin (1 or 4)
   - Pitted surfaces (2)
   - Burnt or eroded areas (3)



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3. Inspect the valve margin.

   The exhaust valve may be refaced if the margin is greater than 1.25 mm (0.05 in) thick before grinding.
4. Reface pitted exhaust valves on a suitable valve refacing machine.
5. Replace the valve if the margin is less than 1.25 mm (0.05 in) thick after grinding.
6. If the valve face has been ground, it may be necessary to shim the valve spring to obtain the proper spring installed height. Refer to *Cylinder Head Assemble*.

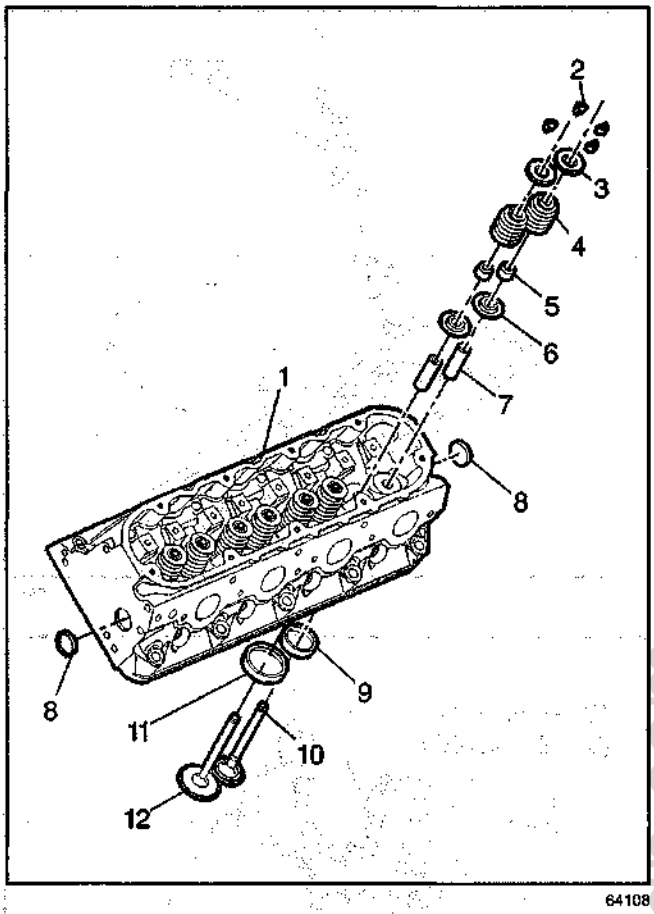
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7. Inspect for a loose valve seat (9 or 11) in the cylinder head (1). The valve seat has an interference fit to the cylinder head.
8. Clean the valve guide (7) bores with a suitable tool. Remove all carbon or dirt from the bores.

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

   The recommendations of the manufacturer of the equipment should be followed carefully to obtain the proper results. Regardless of what type of equipment is used, it is essential that valve guide bores be free from carbon or dirt to ensure proper centering of the tool pilot in the guide.
10. Inspect the valve seats.
    - The valve seats should be concentric to within 0.05 mm (0.0021 in) total indicator reading.
    - If the valve seat has been ground, it may be necessary to shim the valve spring to attain the proper spring installed height.

      Refer to *Cylinder Head Assemble.*



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Cylinder Head Assemble

Tools Required

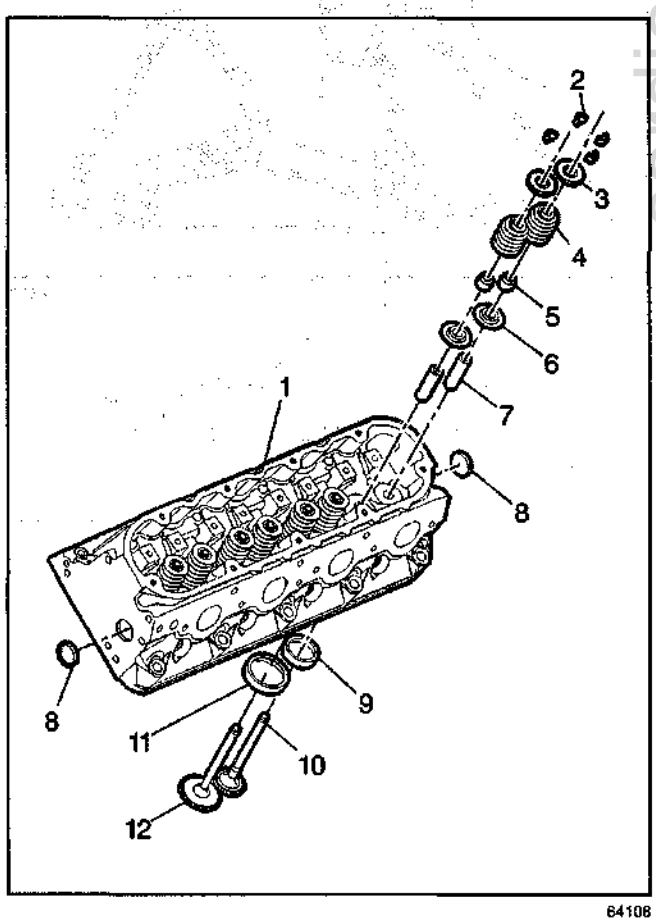
- *J 8062* Valve Spring Compressor
- *J 42078* Valve Stem Oil Seal Installer

1. Clean the cylinder head valve spring shim area.

Important: When reusing the valves and related components, install the parts to their original location.

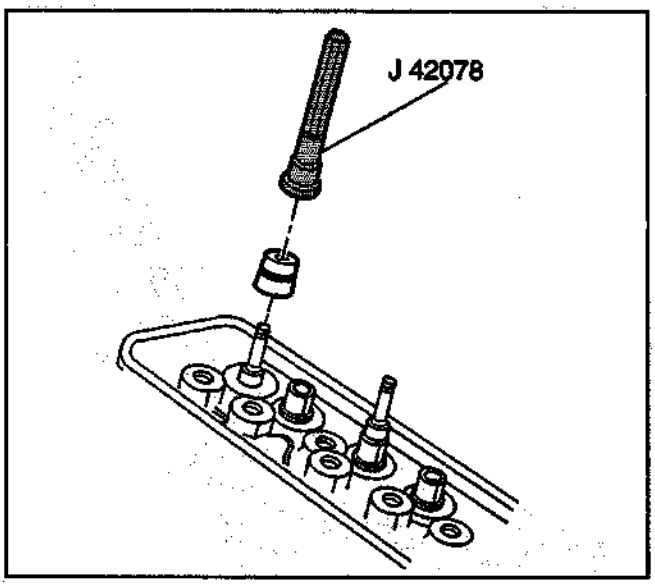
2. Install the valves (10 and 12) into the proper port.

   Refer to *Separating Parts.*
3. Install the valve spring shim (6).

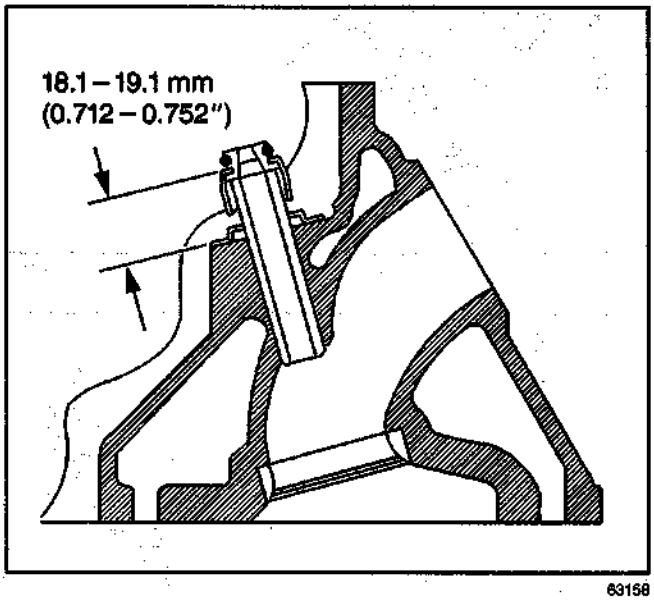


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Important: The valve stem oil seal alignment and position on the valve guide is critical.

An improperly installed valve stem oil seal may lead to excessive oil consumption, increased vehicle emissions, or component damage.

4. Install the valve stem oil seal (5) onto the guide (7).
   - 4.1. Lubricate the valve guide (7) and valve stem (5) oil seal with clean engine oil.
   - 4.2. Install the valve stem oil seal onto the valve stem. Push the seal down until the seal contacts the valve guide.
   - 4.3. Use the *J 42078* in order to install the valve stem oil seal.

     Push or lightly tap the tool until the tool bottoms against the valve spring shim (6).

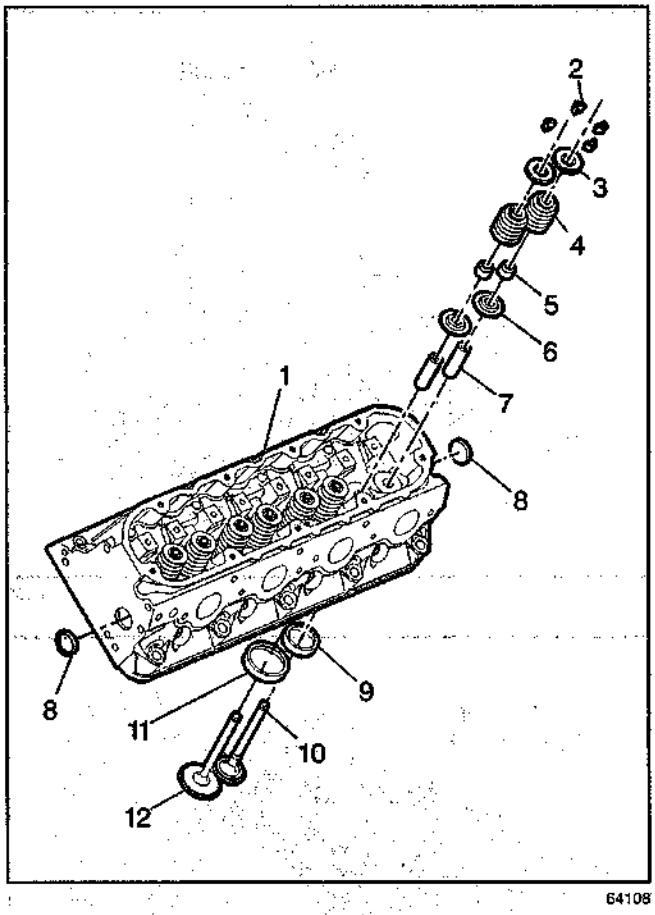
5. Measure the valve stem oil seal for the properly installed height.

   Specification

   There should be a 18.1–19.1 mm (0.712–0.752 in) gap between the top edge of the oil seal body and the valve spring shim surface.

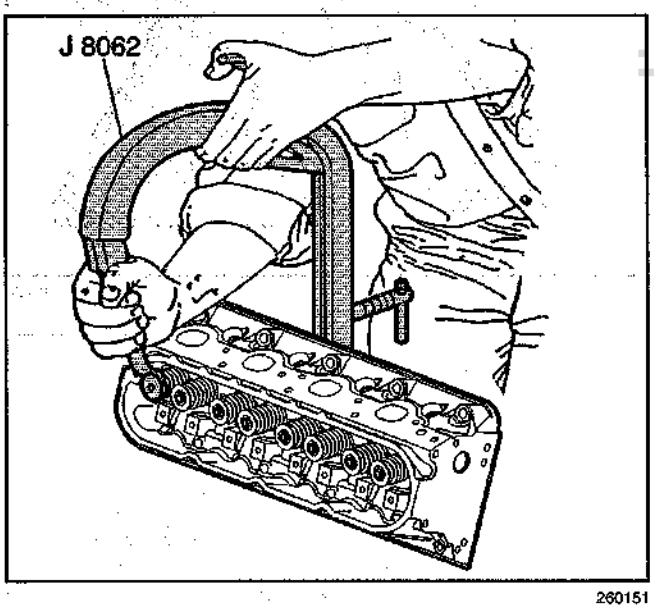
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6. Install the valve spring (4).
7. Install the valve spring cap (3).



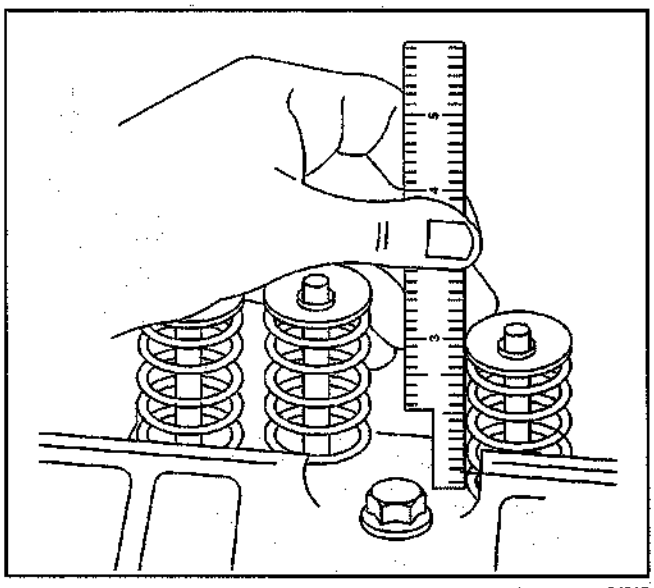
64108

8. Compress the valve spring (4) using the *J 8062*.
9. Install the valve stem keys (2).
   9.1. Use grease to hold the keys (2) in place and remove the *J 8062*.
   9.2. Make sure the keys (2) seat properly in the groove of the valve stem (10 and 12).
   9.3. Tap the end to the valve stem (10 and 12) with a plastic faced hammer to seat the keys (if necessary).



260151

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64315

10. Measure the valve spring installed height using a ruler.

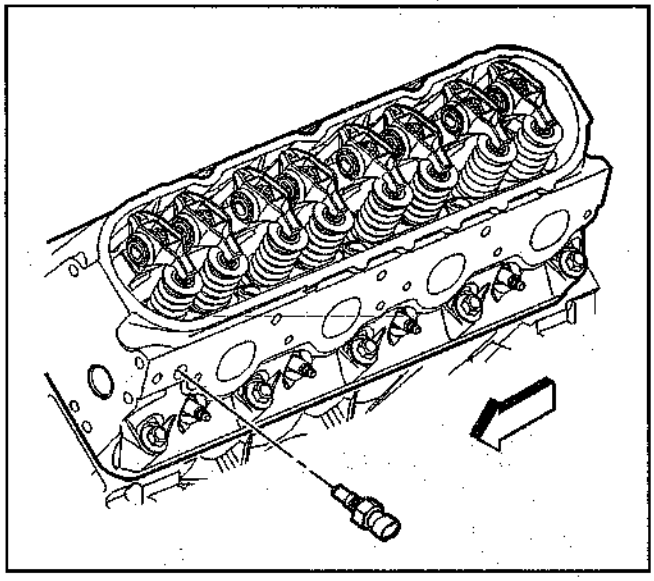
    Measure from the base of the valve spring to the top of the valve spring.

    Specification

    - If the installed height exceeds 46.25 mm (1.82 in), install a valve spring shim of approximately 0.5 mm (0.02 in) thick.
    - Do not shim the valve spring to obtain less than the specified height.

      Do not assemble the components without a spring shim on the cylinder head.

11. Install the remaining valves (10 and 12), springs (4) and other components.


260086

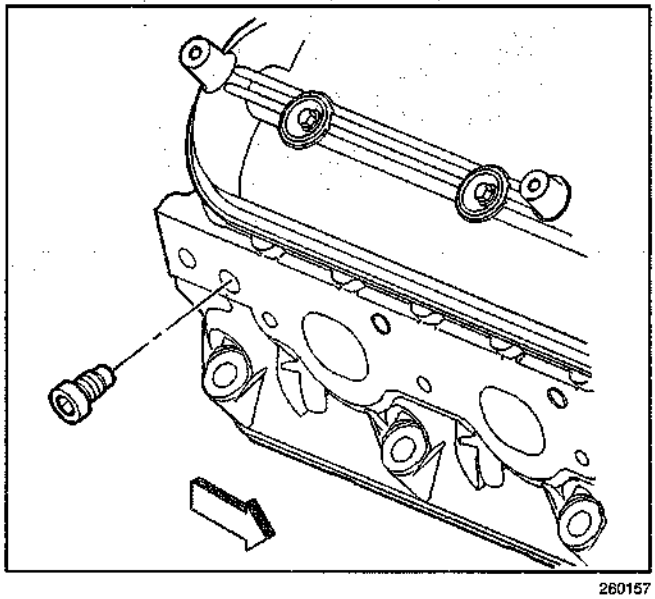
12. Install sealant GM P/N 12346004 or equivalent to the threads of the coolant sensor.

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

13. Install the coolant sensor into the left cylinder head.

    Tighten

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


260157

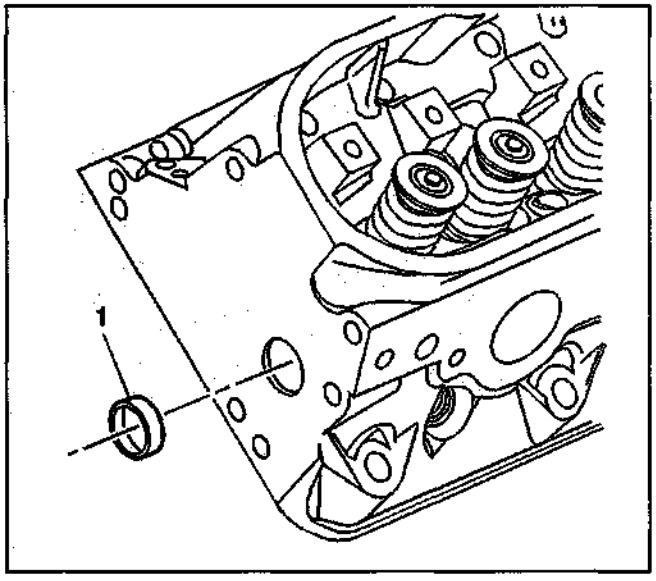
14. Install the coolant plug to the right cylinder head.

    Tighten

    Tighten the coolant plug to 20 N·m (15 lb ft).

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15. Apply threadlock GM P/N 12345382 or equivalent to the sides of the cylinder head expansion plugs (1).
16. Install the expansion plugs into the cylinder head.
    A properly installed plug should be slightly below flush with the face of the head.

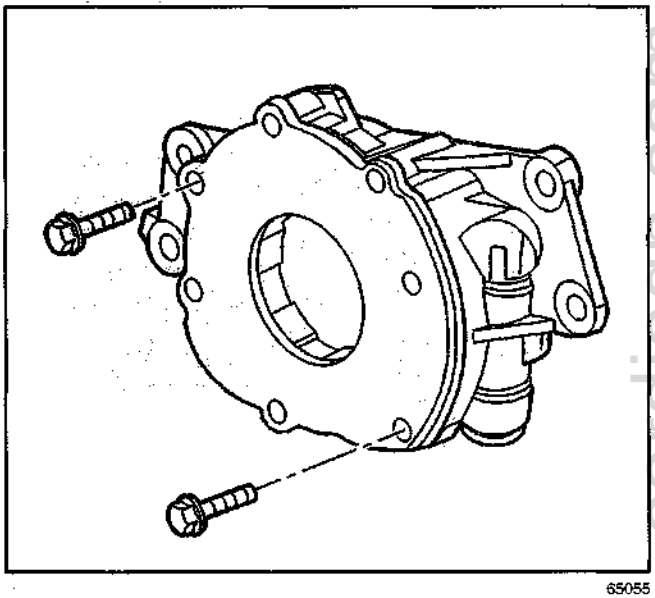


490662

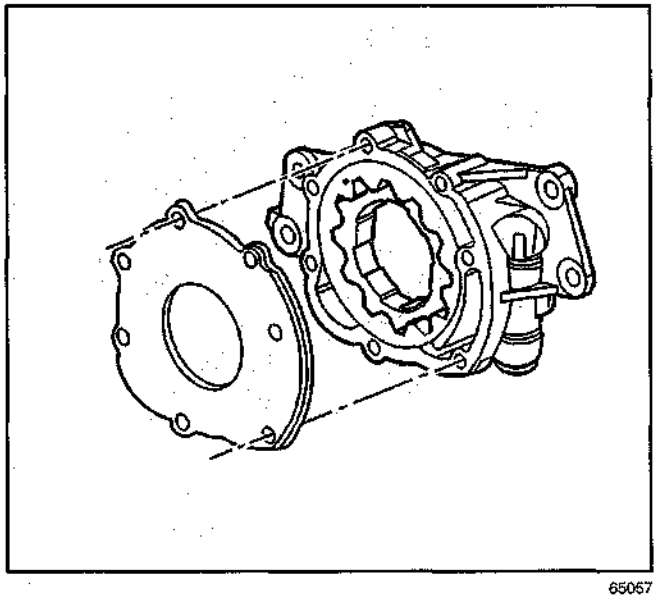
Oil Pump Disassemble

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.

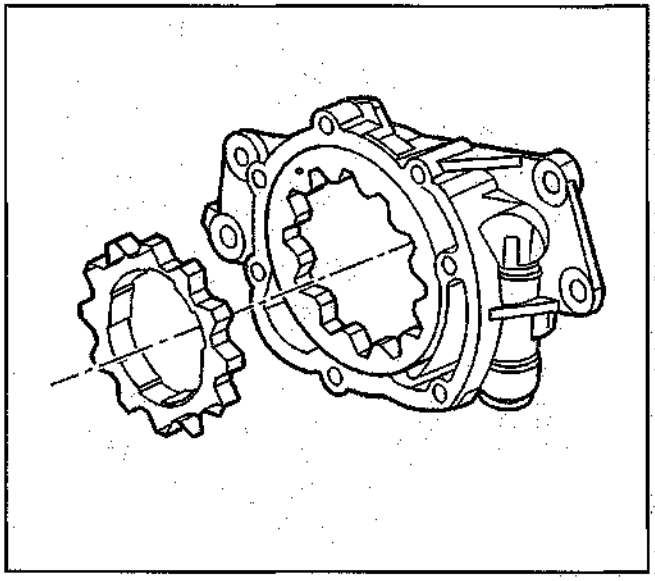
1. Remove the oil pump cover bolts.


65055

2. Remove the oil pump cover.


65057

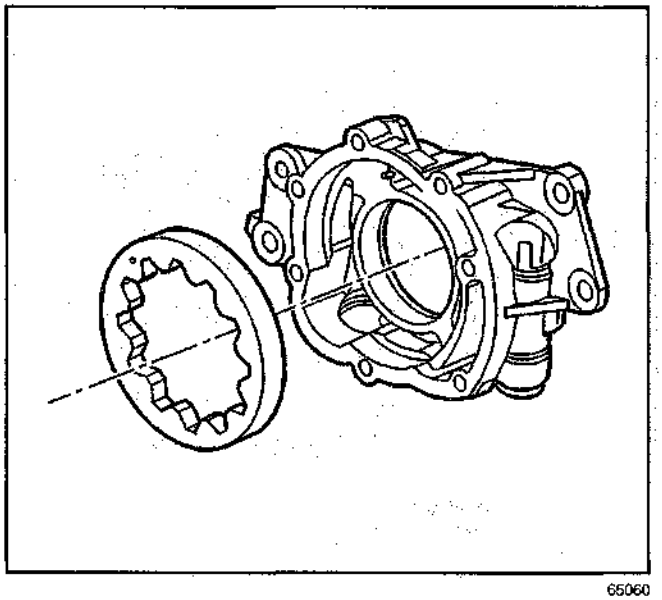
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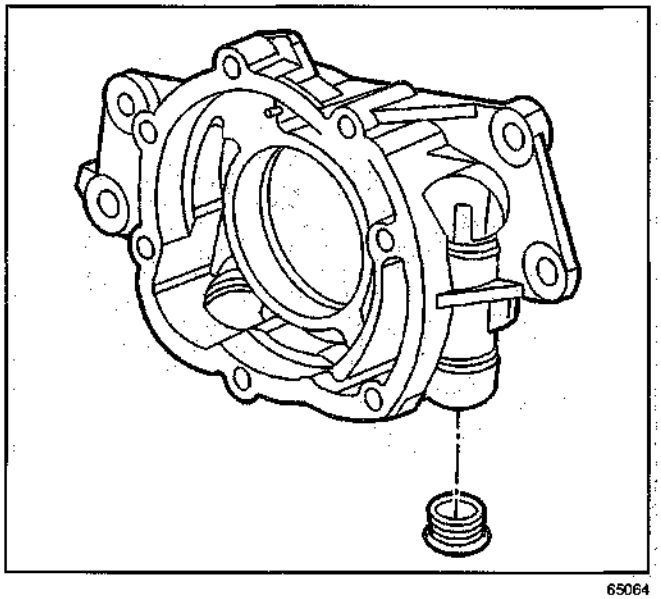
Important: Mark or identify the gears for assembly. Refer to *Separating Parts*.

3. Remove the drive gear.



65060

4. Remove the driven gear.

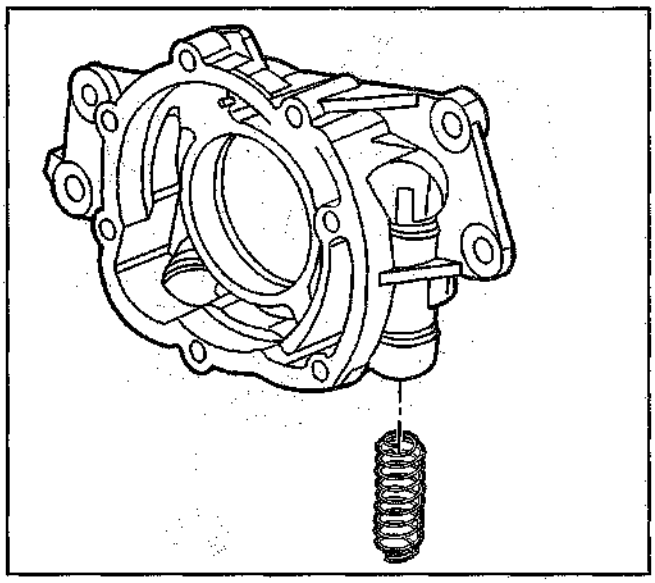


65064

5. Remove the pressure relief valve plug.

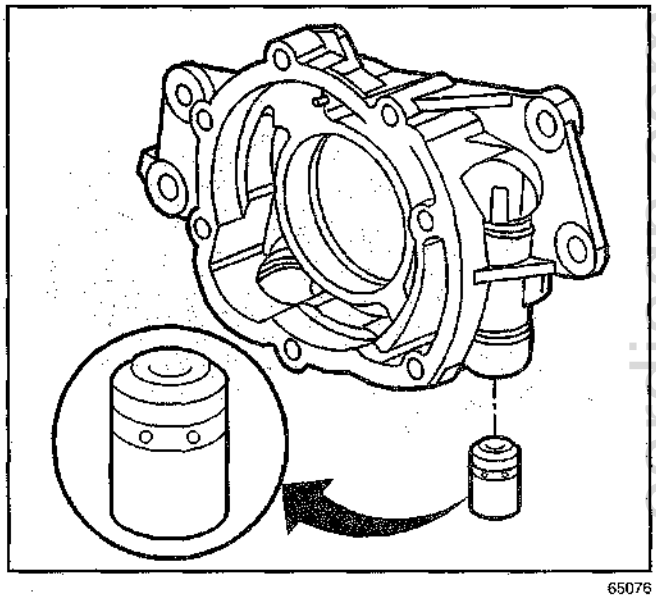
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6. Remove the pressure relief valve spring.



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7. Remove the pressure relief valve.
8. Inspect the oil pump components.
   Refer to *Oil Pump Clean and Inspect*.



65076

Oil Pump Clean and Inspect

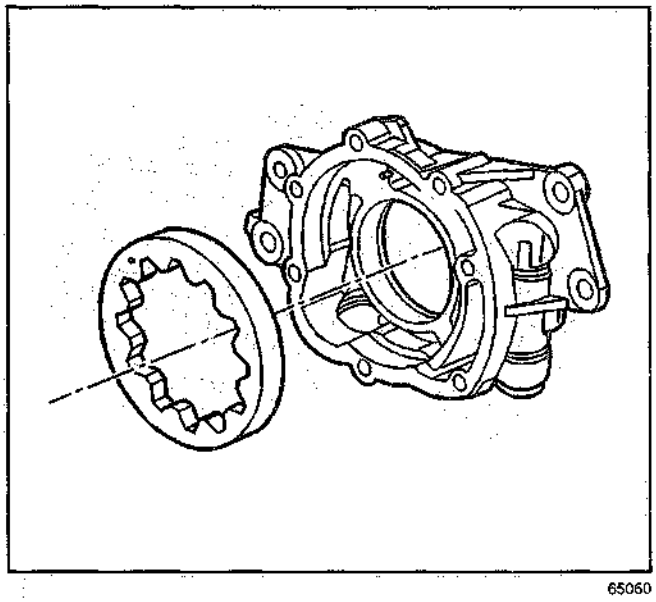
Important: The internal parts of the oil pump assembly are not serviced separately (excluding the spring). If the oil pump components are worn or damaged, replace the oil pump as an assembly.

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.

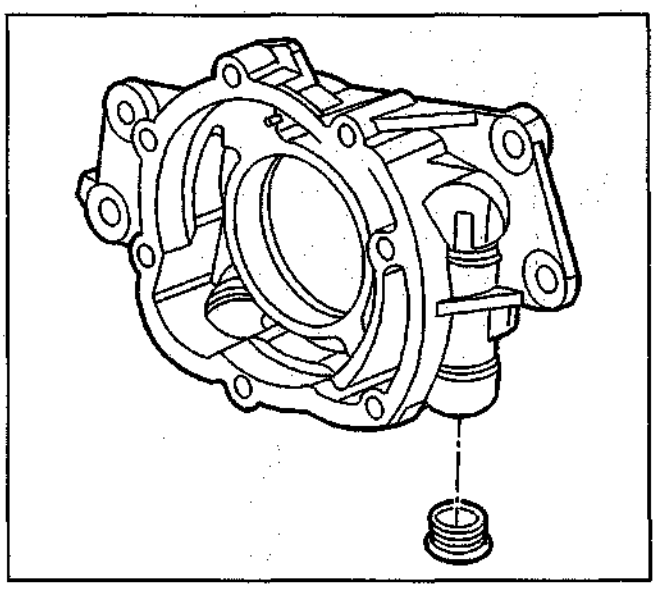
Caution: Wear safety glasses in order to avoid eye damage.

2. Dry the parts with compressed air.
3. Inspect the oil pump housing and the cover 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.



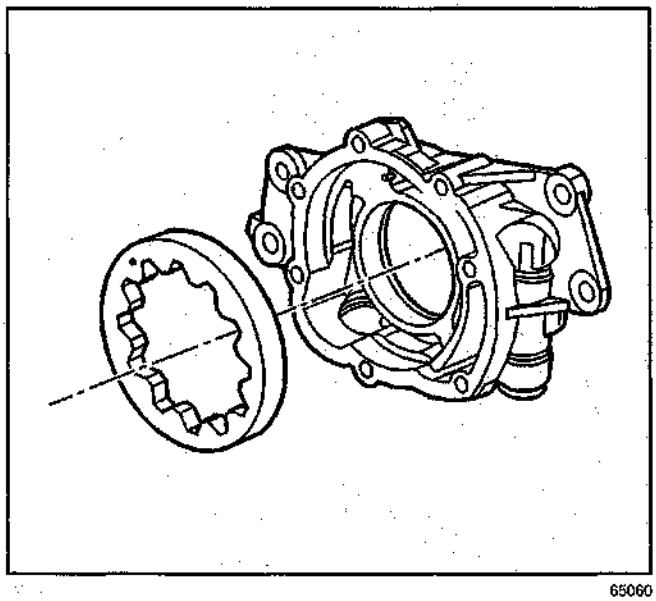
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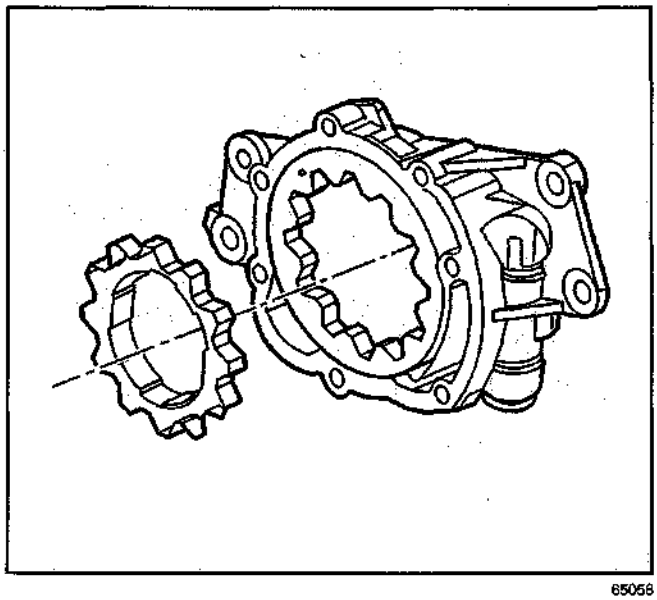
65064

6. Inspect the relief valve plug and plug bore for damaged threads.
7. Inspect the oil pump internal oil passages for restrictions.



65060

8. Inspect the drive gear and driven gear for chipping, galling or wear.
   Minor burrs or imperfections on the gears may be removed with a fine oil stone.

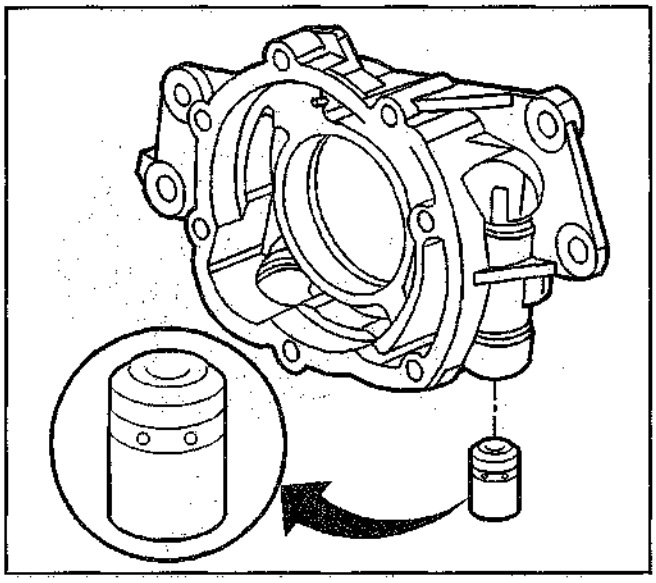


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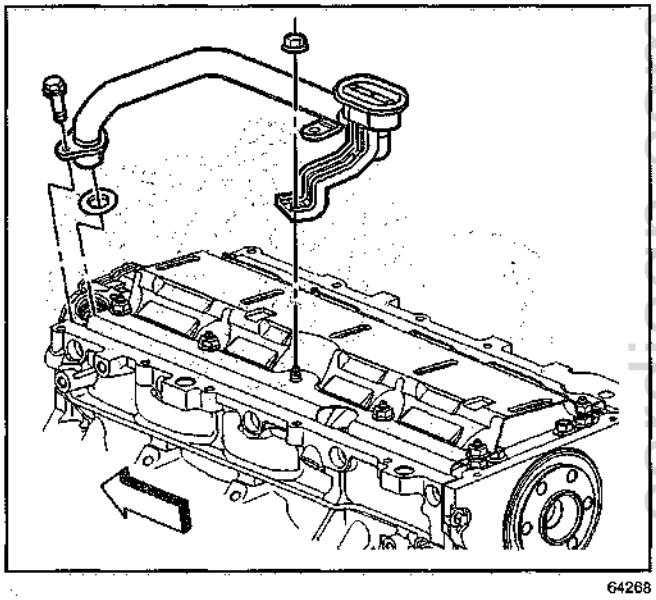
9. Inspect the drive gear splines for excessive wear.

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10. Inspect the pressure relief valve and bore for scoring or wear.
    The valve must move freely in the bore with no restrictions.


65076

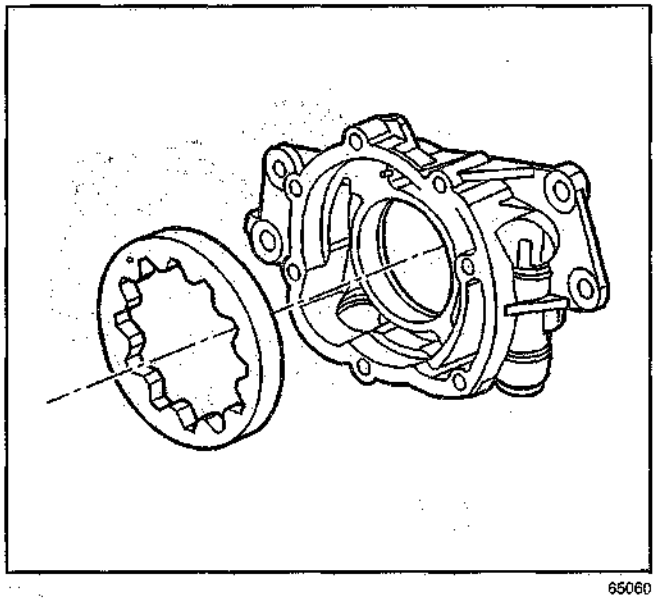
11. Inspect the oil pump screen for debris or restrictions.
12. Inspect the oil pump screen for broken or loose wire mesh.


64268

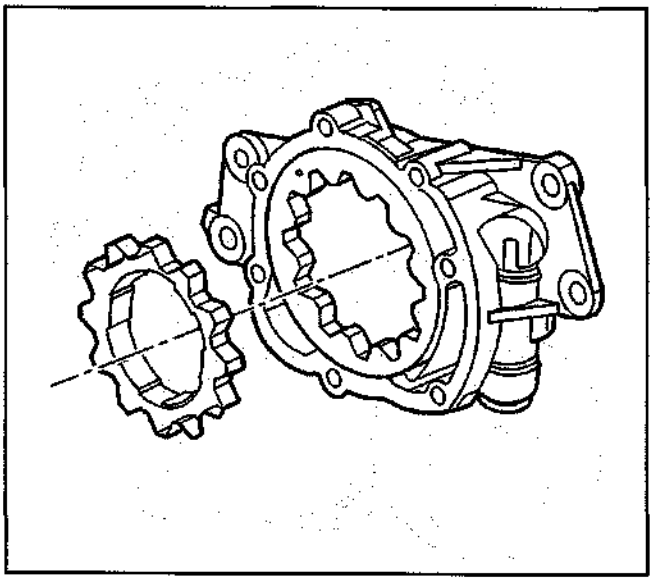
Oil Pump Assemble

Important: Prior to assembling the oil pump, coat all wear or internal surfaces with clean engine oil.

1. Install the driven gear into the pump housing.
   Install the driven gear with the orientation mark facing the pump cover.

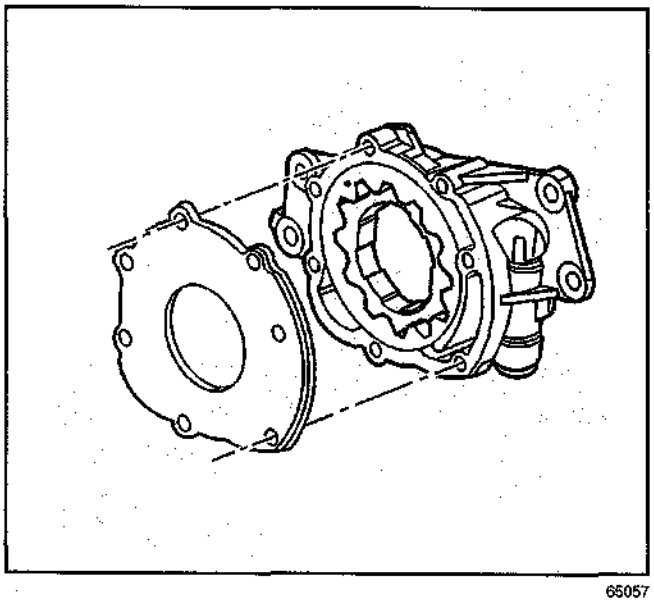

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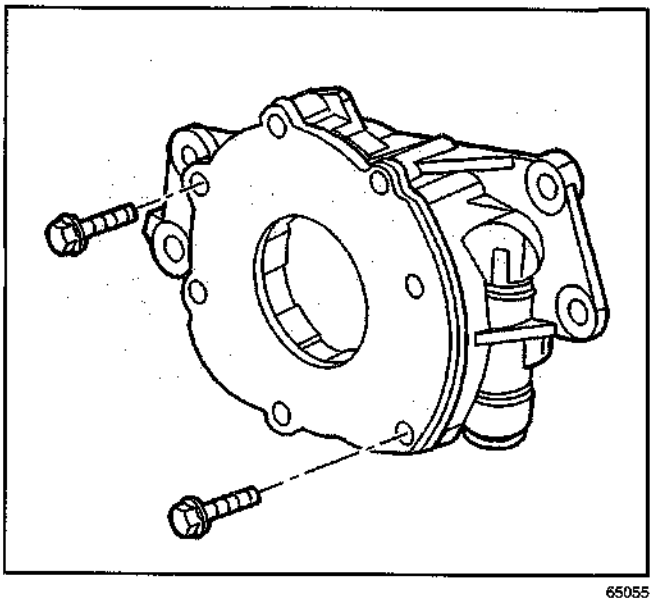
65058

2. Install the drive gear into the pump housing.



65057

3. Install the oil pump cover.



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

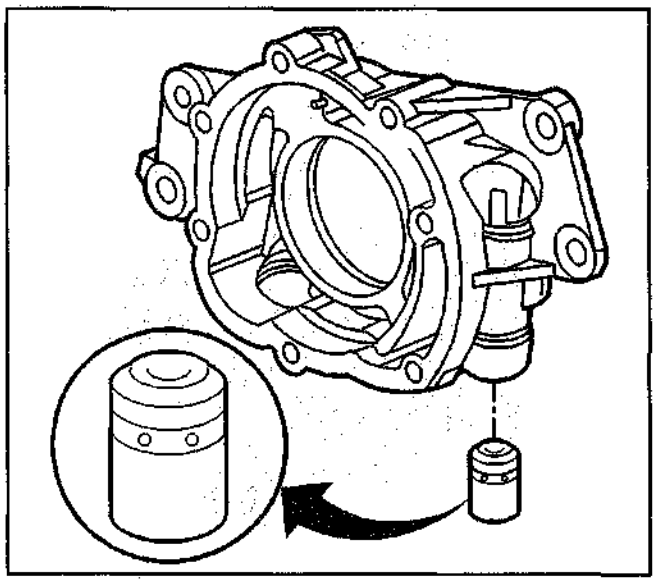
4. Install the pump cover bolts.

   Tighten

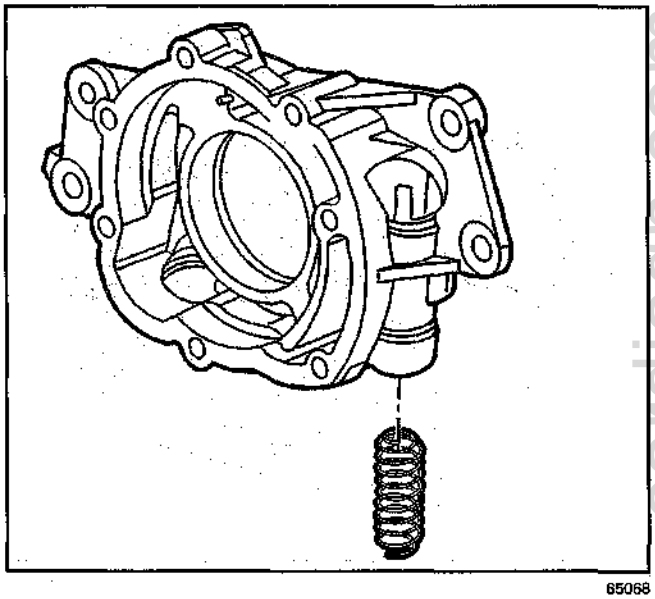
   Tighten the oil pump cover bolts to 12 N·m (106 lb in).

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5. Install the regulator valve.


65076

6. Install a NEW regulator valve spring.

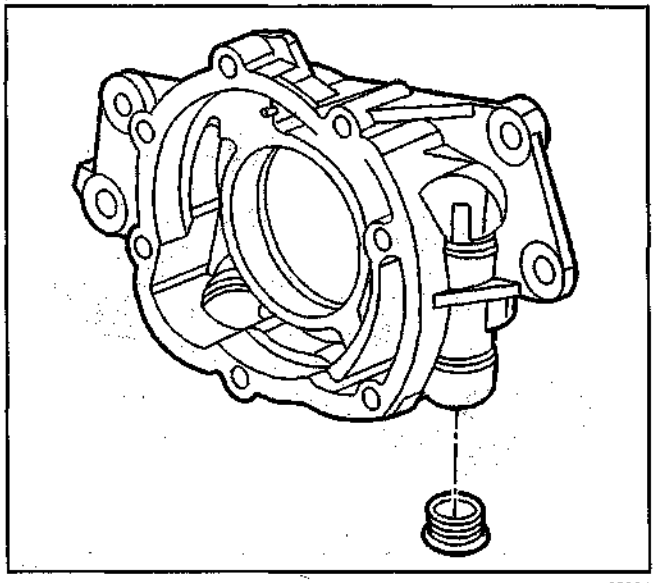

65068

7. Install the pressure relief valve plug.

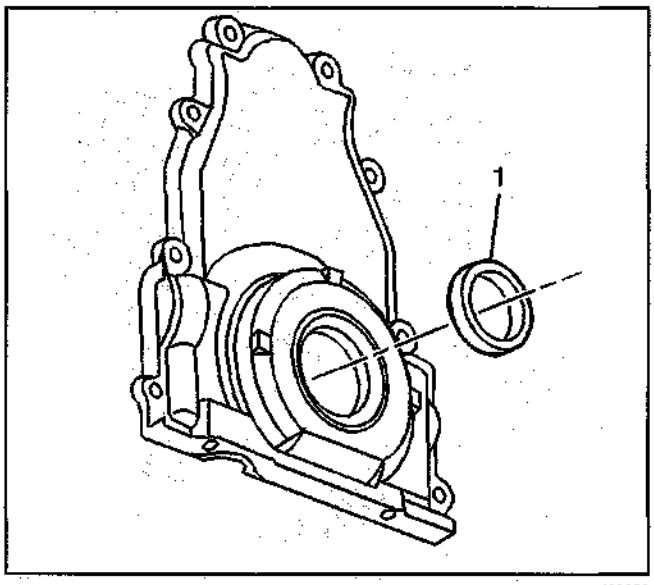
   Tighten

   Tighten the pressure relief valve plug to 12 N·m (106 lb in).

8. Inspect the oil pump for smoothness of operation by rotating the drive gear.


65064

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490689

Engine Front Cover Clean and Inspect

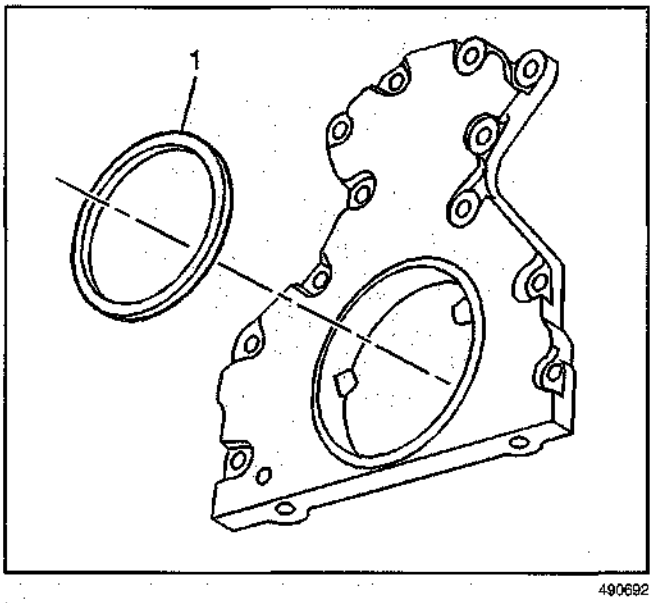
Important: Do not reuse the crankshaft oil seal. Install a NEW crankshaft oil seal during assembly.

Do not reuse the front cover-to-engine block gasket. Install a NEW gasket during assembly.

1. Remove the crankshaft oil seal (1) from the front cover.
2. Clean the cover in solvent. Remove the sealant from the cover oil pan surface.
   Refer to *Replacing Engine Gaskets.*

Caution: Wear safety glasses in order to avoid eye damage.

3. Dry the cover with compressed air.
4. Inspect the gasket sealing surfaces for excessive scratches or gouging.
5. Inspect the cover-to-oil pan threaded bolt holes for damaged threads or debris.
6. Inspect the crankshaft oil seal mounting bore for damage.



490692

Engine Rear Cover Clean and Inspect

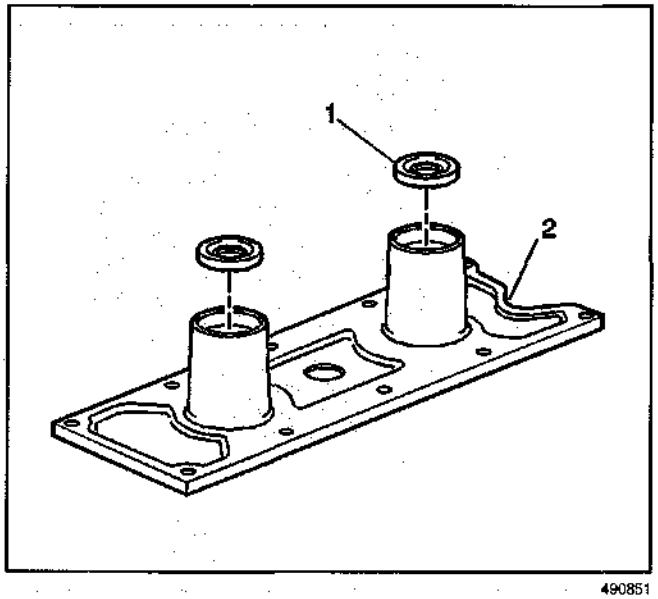
Important: Do not reuse the crankshaft oil seal. Install a NEW crankshaft oil seal during assembly.

Do not reuse the rear cover-to-engine block gasket. Install a NEW gasket during assembly.

1. Remove the crankshaft oil seal (1) from the rear cover.
2. Clean the cover in solvent. Remove the sealant from the cover oil pan surface.
   Refer to *Replacing Engine Gaskets.*

Caution: Wear safety glasses in order to avoid eye damage.

3. Dry the cover with compressed air.
4. Inspect the gasket sealing surfaces for excessive scratches or gouging.
5. Inspect the cover-to-oil pan threaded bolt holes for damaged threads or debris.
6. Inspect the crankshaft oil seal mounting bore for damage.



490851

Engine Valley Cover Clean and Inspect

Important: Do not reuse the valley cover knock sensor oil seals. Install NEW oil seals during assembly.

Do not reuse the valley cover gasket. Install a NEW gasket during assembly.

1. Remove the knock sensor oil seals (1) from the valley cover (2).
2. Clean the valley cover in solvent.

Caution: Wear safety glasses in order to avoid eye damage.

3. Dry the valley cover with compressed air.
4. Inspect the gasket sealing surfaces for excessive scratches or gouging.
   Refer to *Replacing Engine Gaskets.*
5. Inspect the valley cover oil seal bores for excessive scratches or gouging.

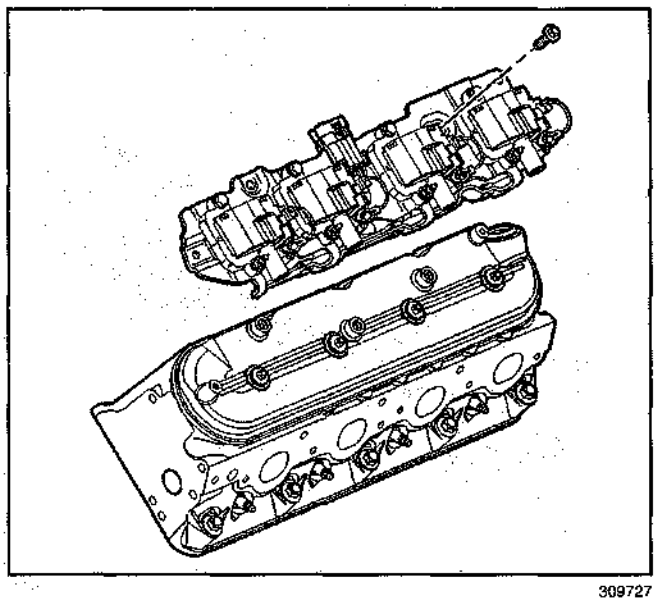
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Valve Rocker Arm Cover Clean and Inspect

Important:

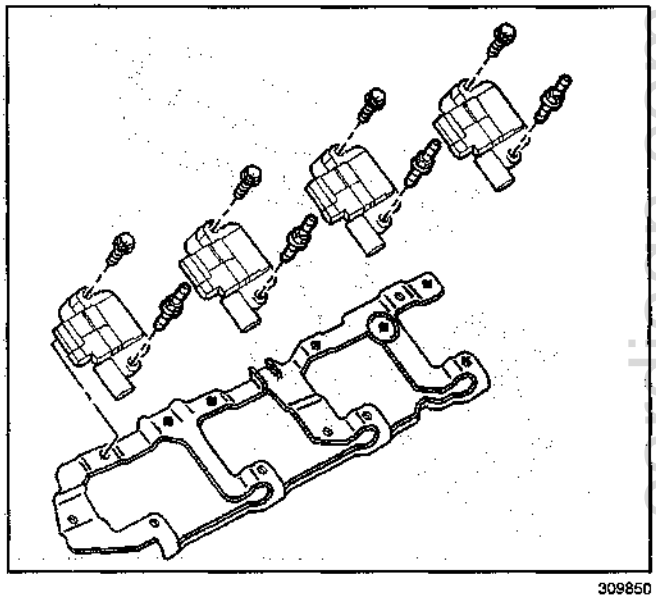
- Do not reuse the valve rocker arm cover gasket. Install a NEW gasket during assembly.
- Remove the ignition coils from the bracket before cleaning the bracket in solvent. Do not submerge the ignition coils in solvent.
- Do not remove the oil fill tube from the cover unless service is required.
- If the oil fill tube has been removed from the rocker arm cover, install a NEW tube during assembly.

1. Remove the ignition coil and bracket assembly and bolts from the rocker cover (if required).



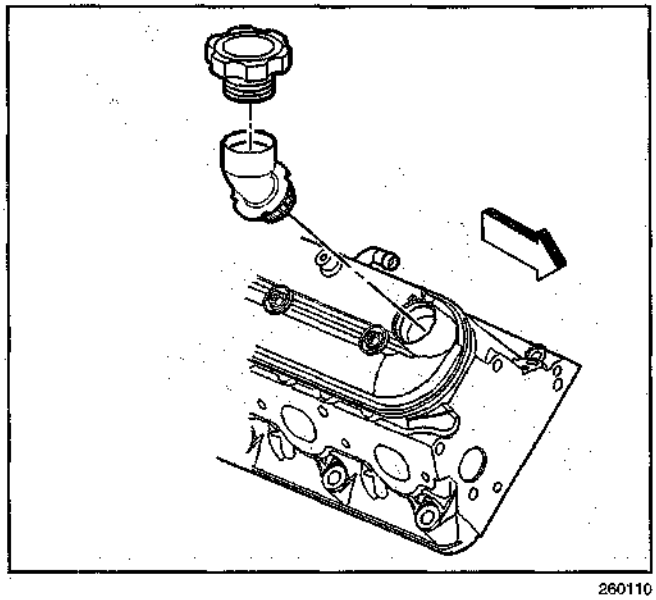
309727

2. Remove the ignition coils and bolts from the bracket (if required).



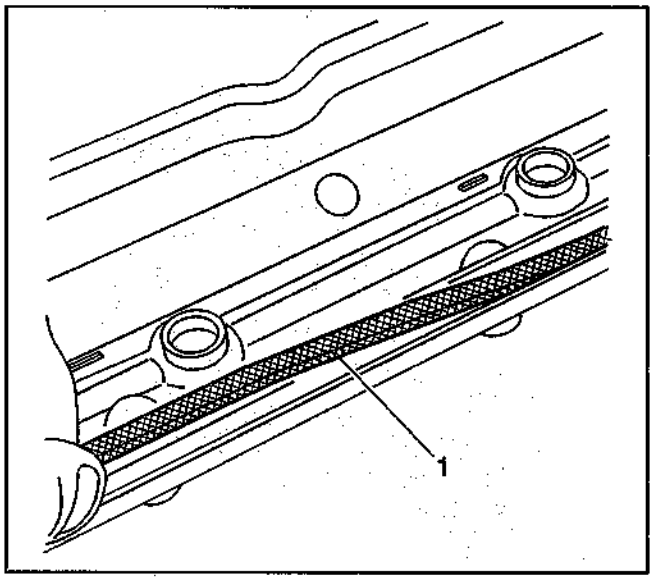
309850

3. Inspect the tube for a loose fit or damage.
4. Remove the oil fill cap and tube from the right cover (if required).



260110

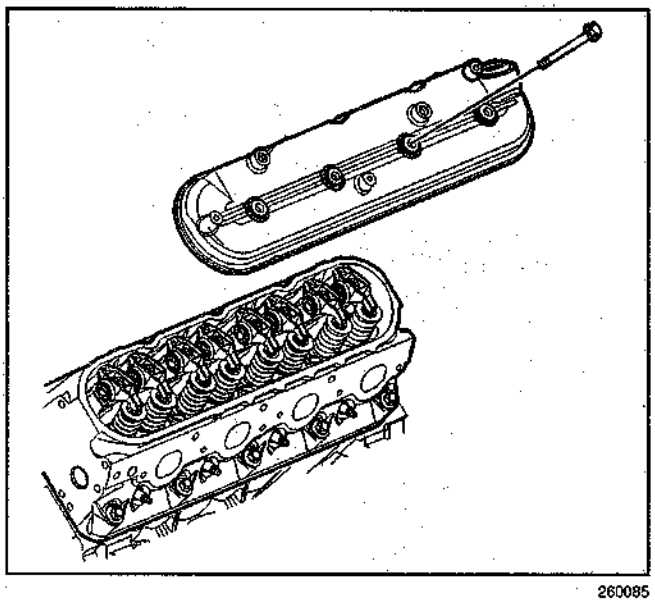
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5. Remove the gaskets (1) from the covers.
6. Remove the cover mounting bolts (with grommets).

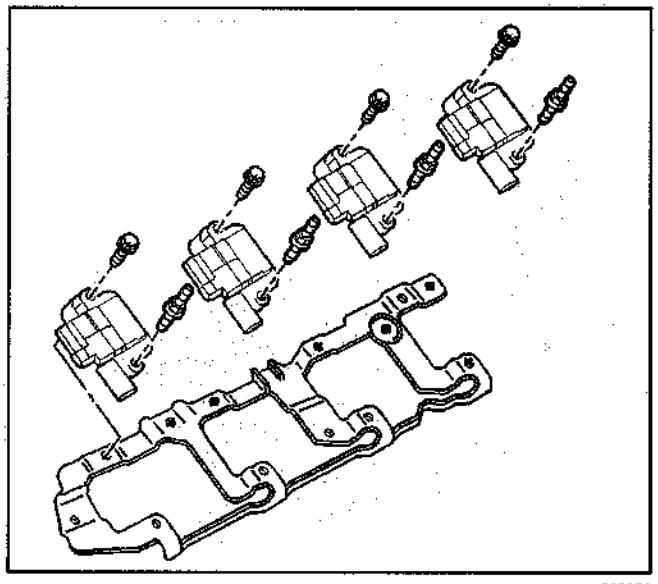
   Cover mounting bolts and grommets that are not damaged may be reused during assembly.
7. Clean the covers and coil brackets in solvent.



260095

Caution: Wear safety glasses in order to avoid eye damage.

8. Dry the components with compressed air.
9. Inspect the ventilation system passages for restrictions.
10. Inspect the gasket grooves for damage.
11. Inspect the coil bracket threaded bolt holes for damaged threads or debris.



309850

12. Inspect the coil mounting brackets for cracking, stripped bolt hole threads, or other damage.
13. Inspect the ignition coils for exterior damage and bent or broken connector pins.

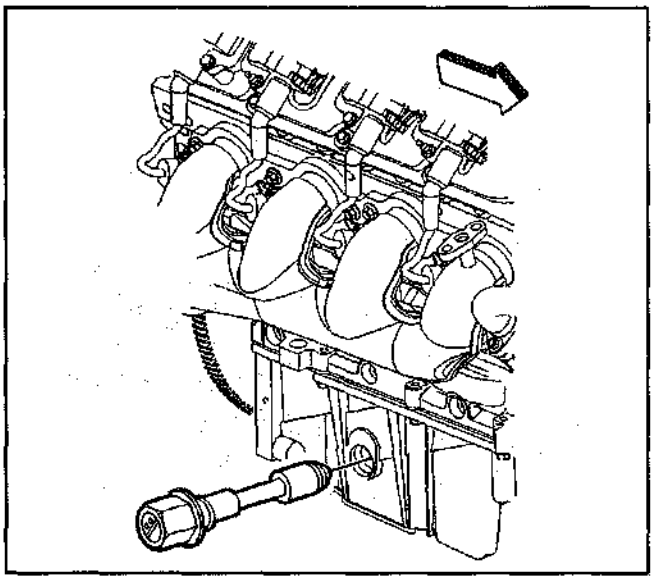
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Oil Pan Clean and Inspect

Important:

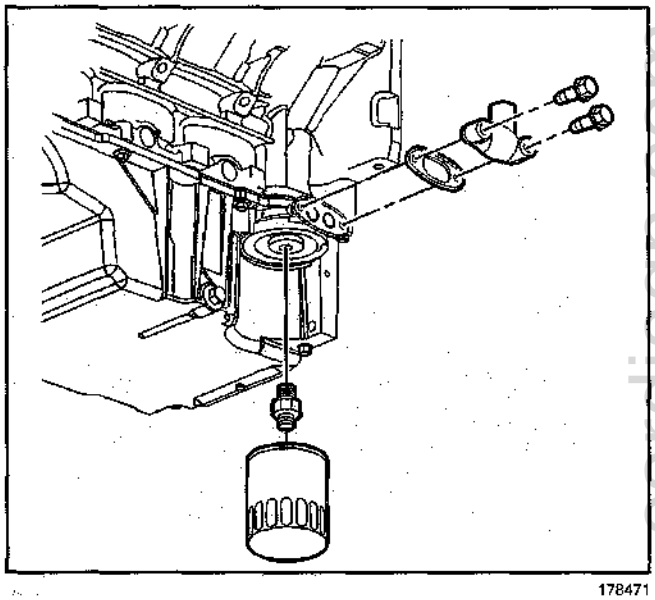
- Do not reuse the oil pan cover gasket. Install a NEW cover gasket during assembly.
- Do not reuse the oil pan to engine block gasket. Install a NEW gasket during assembly.
- When installing a NEW oil pan gasket, it is not necessary to install the rivets that retain the NEW gasket to the pan.

1. Remove the oil level sensor from the pan.



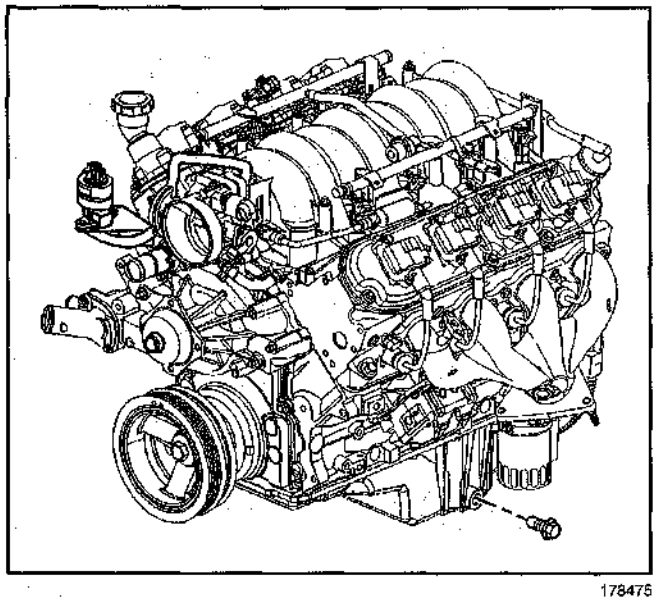
178467

2. Remove the oil pan cover, gasket, and bolts.



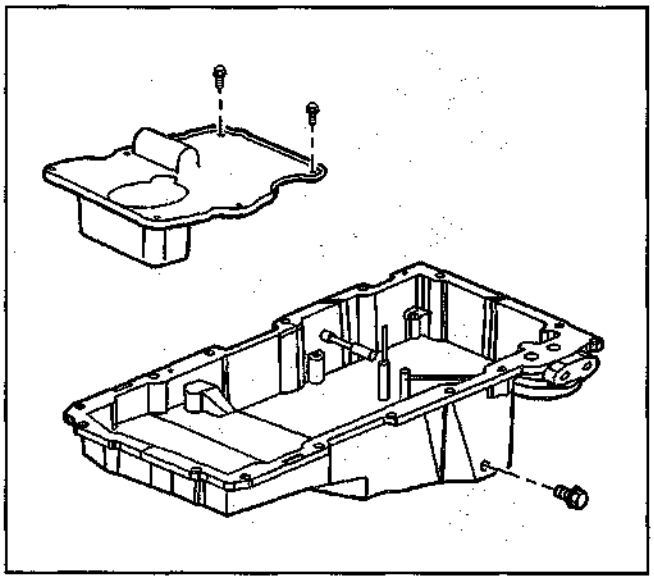
178471

3. Remove the oil pan drain plug and O-ring seal.



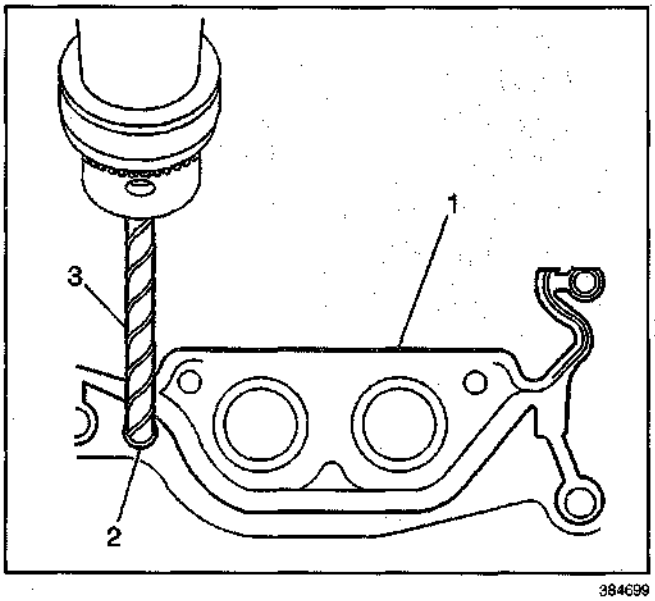
178475

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178491

4. Remove the oil pan baffle bolts and baffle.

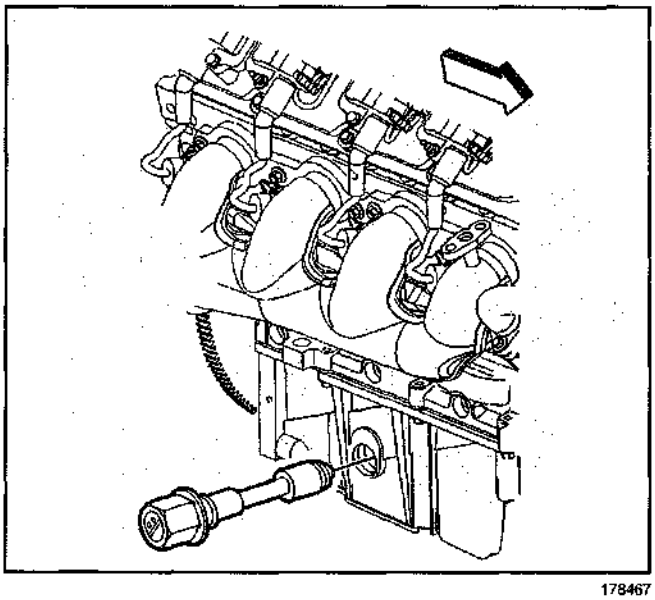


384699

5. Drill out (3) the oil pan gasket retaining rivets (2) (if required).
6. Remove the gasket (1) from the oil pan.
7. Clean the oil pan in solvent. Be sure to thoroughly clean all of the oil passages and recesses of the pan.
8. Clean the oil pan gasket surfaces. Refer to *Replacing Engine Gaskets*.

Caution: Wear safety glasses in order to avoid eye damage.

9. Dry the oil pan with compressed air.
10. Inspect the gasket sealing surfaces for excessive scratches or gouging. Refer to *Replacing Engine Gaskets*.



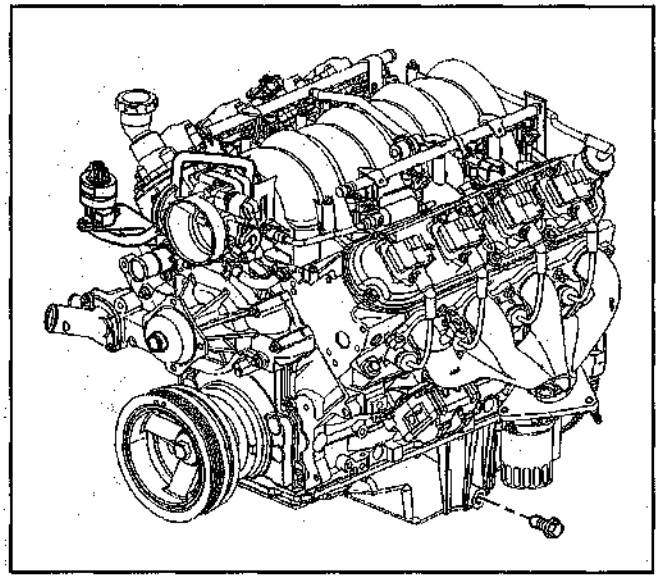
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11. Inspect the oil pan oil level sensor seal surface for damage.

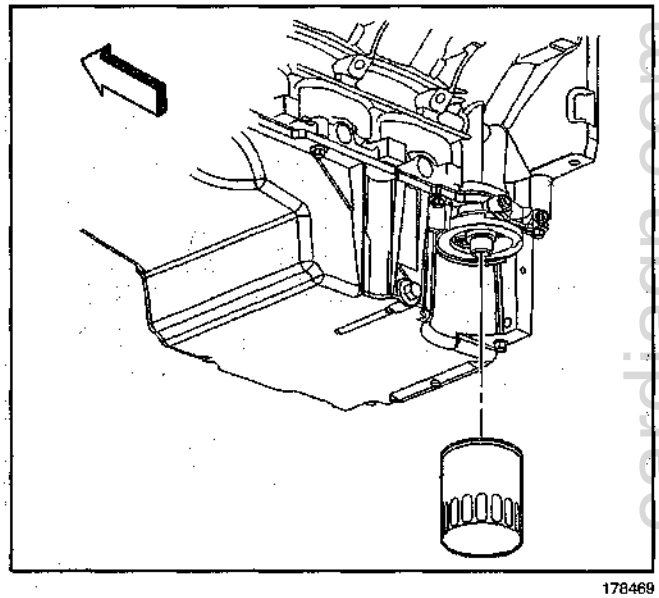
    If the O-ring seal of the sensor is not cut or damaged, it may be reused.

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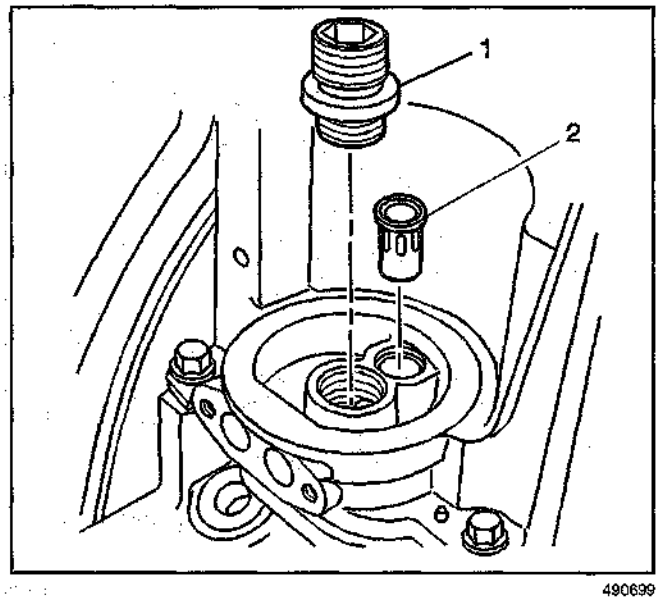
12. Inspect the oil pan drain plug and threaded drain hole for damaged threads.
    The drain plug O-ring seal may be reused if not cut or damaged.


178475

13. Inspect the oil filter sealing surface for scratches or gouging.
14. Inspect the oil passages for restrictions.

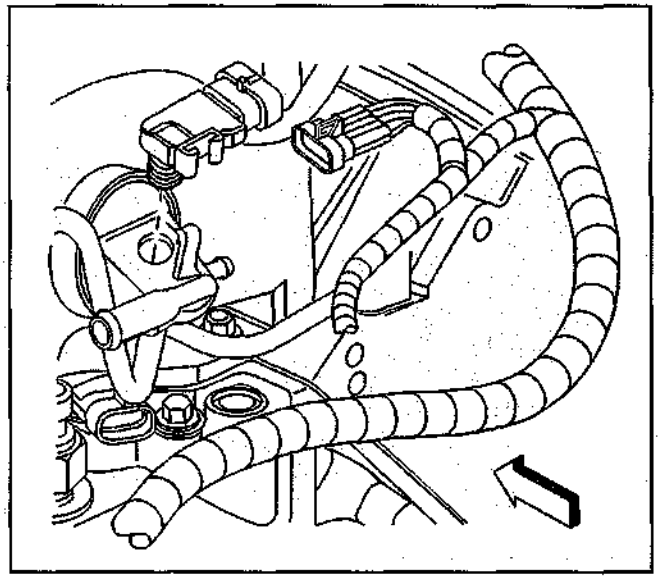

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15. Inspect the oil filter fitting (1) for a loose fit or damaged threads.
16. Inspect the oil filter bypass valve (2) for proper operation.
    Lightly push the bypass valve into the bore. The valve spring should reseat the valve to the proper position.



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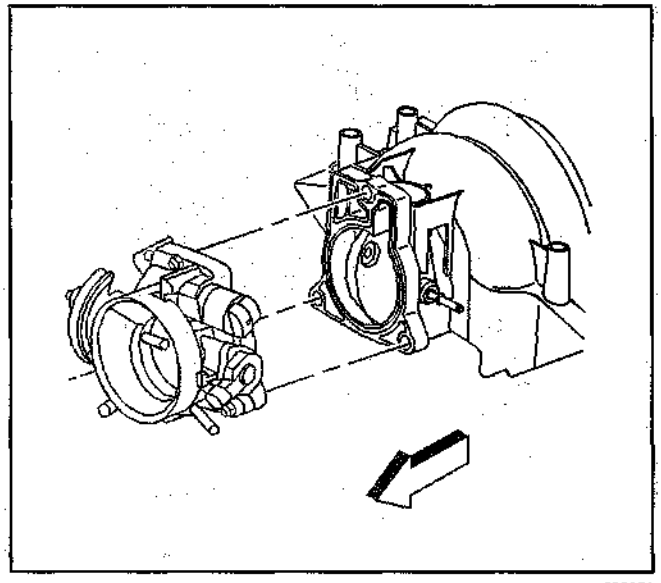
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Intake Manifold Clean and Inspect

Cleaning Procedure

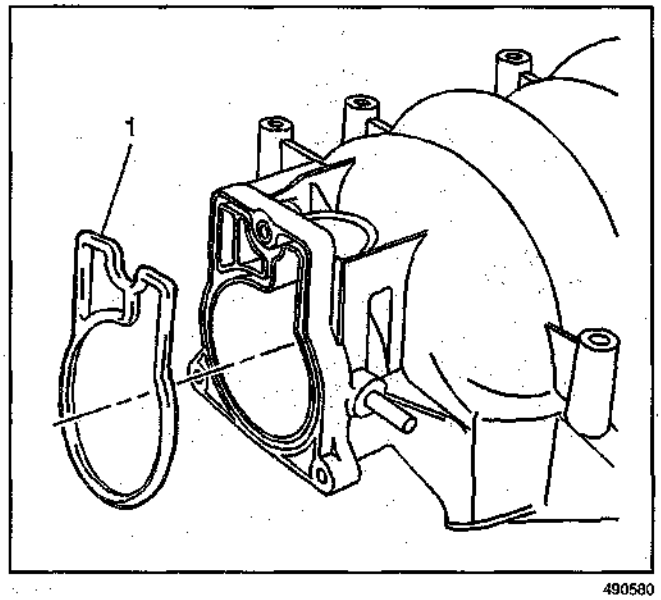
Important: Do not reuse the intake manifold-to-cylinder head sealing gaskets.

1. Remove the Manifold Absolute Pressure (MAP) sensor from the rear of the intake (the MAP sensor is to be reinstalled upon completion of the cleaning and inspection procedures).
2. Inspect the sealing grommet on the MAP sensor. The grommet should not be torn or damaged.



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3. Remove the throttle body and bolts.

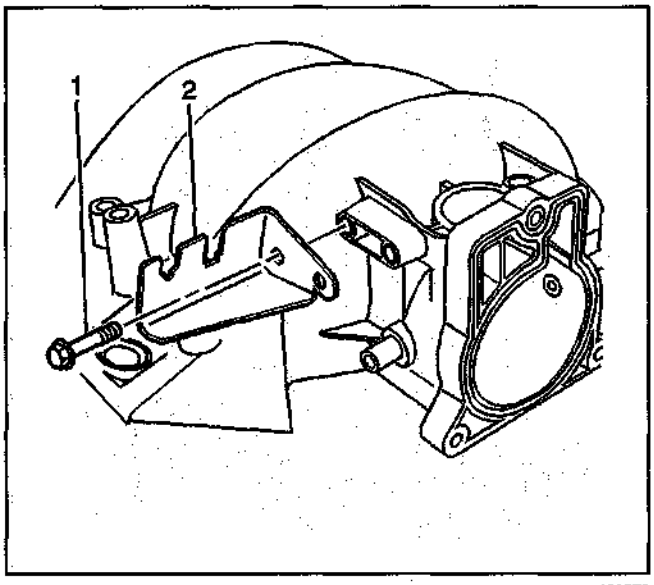


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4. Remove the throttle body gasket (1).
5. Discard the gasket.

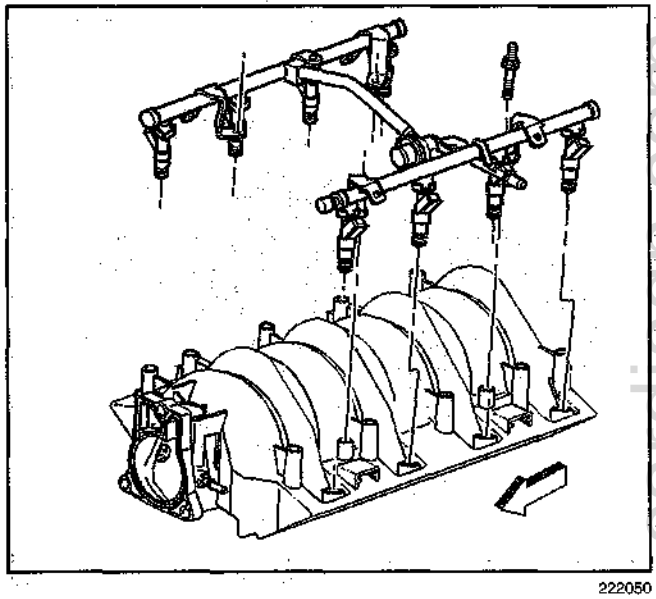
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6. Remove the accelerator control cable bracket (2) and bolts (1) (if required).

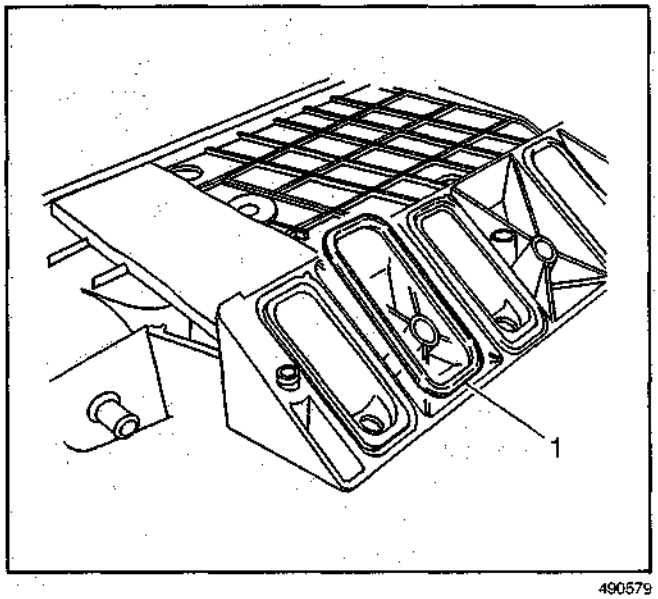


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7. Remove the fuel rail with injectors.
   Refer to *Fuel Rail and Injectors Removal*.

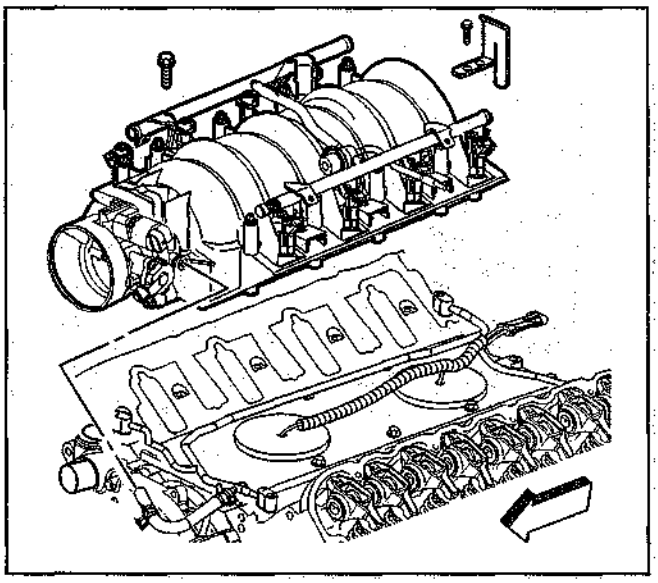

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8. Remove and discard the intake manifold-to-cylinder head gaskets (1).



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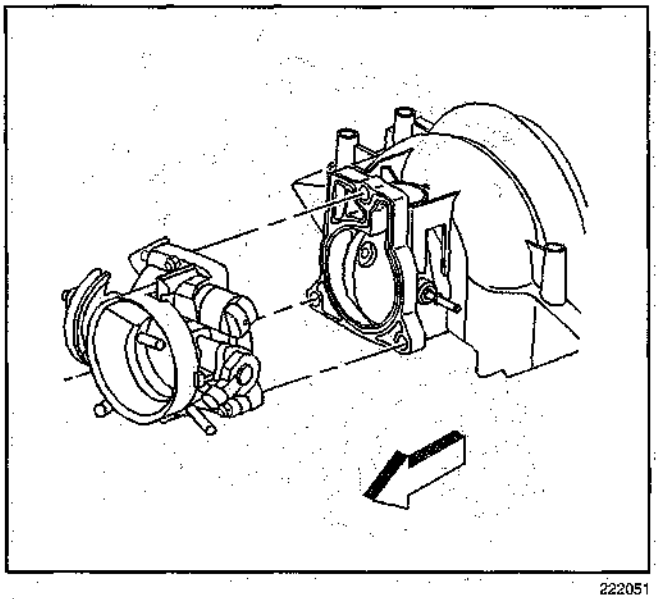
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9. Clean the intake manifold in solvent.
   - Clean the intake manifold gasket grooves.
   - Clean the intake manifold vacuum passages at the rear of the intake.

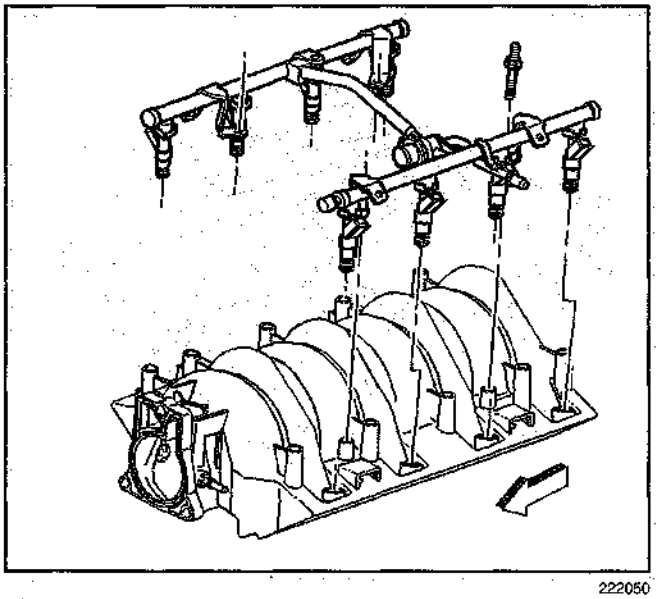
Caution: Wear safety glasses in order to avoid eye damage.

10. Dry the intake manifold with compressed air.
11. Upon installation of the intake manifold, install NEW manifold-to-cylinder head gaskets.


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Inspection Procedure

1. Inspect the throttle body bolt inserts for looseness or damaged threads.


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2. Inspect the fuel rail bolt inserts for looseness or damaged threads.
3. Inspect the intake manifold vacuum passages for debris or restrictions.

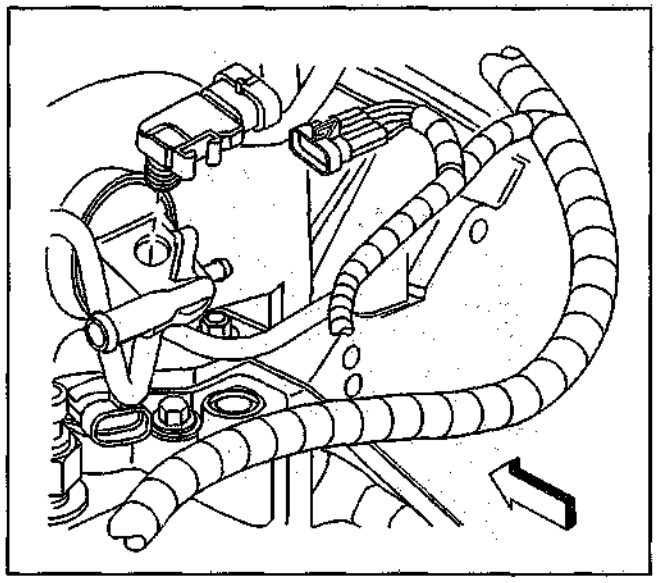
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Important: The rear Manifold Absolute Pressure (MAP) sensor housing is retained to the intake manifold by push-in-place snap lock design.

The rear MAP sensor housing is sealed at the intake manifold by an O-ring seal.

4. Inspect the rear MAP sensor housing.
   - Inspect for damaged or broken vacuum fittings, damaged MAP sensor mounting bore, or broken MAP sensor retaining tab.
   - Inspect the rear MAP sensor housing for looseness or poor sealing to the intake manifold. Repair or replace the components as necessary.
5. Inspect the composite intake manifold assembly for cracks or damage.

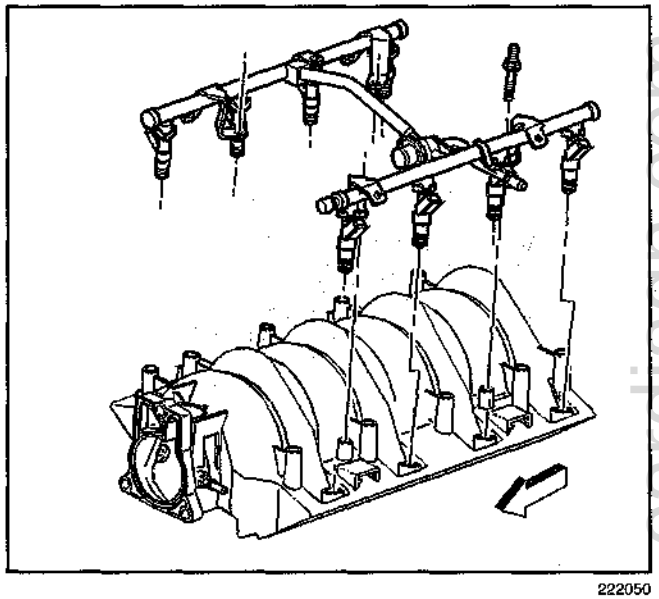
   Inspect the areas between the intake runners.
6. Inspect all the gasket sealing surfaces and grooves for cracking or damage.



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7. Inspect the fuel injector bores for excessive scoring or damage.
8. Inspect the intake manifold cylinder head deck for warpage.
   8.1. Locate a straight edge across the intake manifold cylinder head deck surface.
   8.2. Insert a feeler gauge between the intake manifold and the straight edge.

   A intake manifold with warpage in excess of 0.5 mm (0.02 in), must be replaced.
9. Upon completion of inspection, install the MAP sensor to the manifold.



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Exhaust Manifold Clean and Inspect

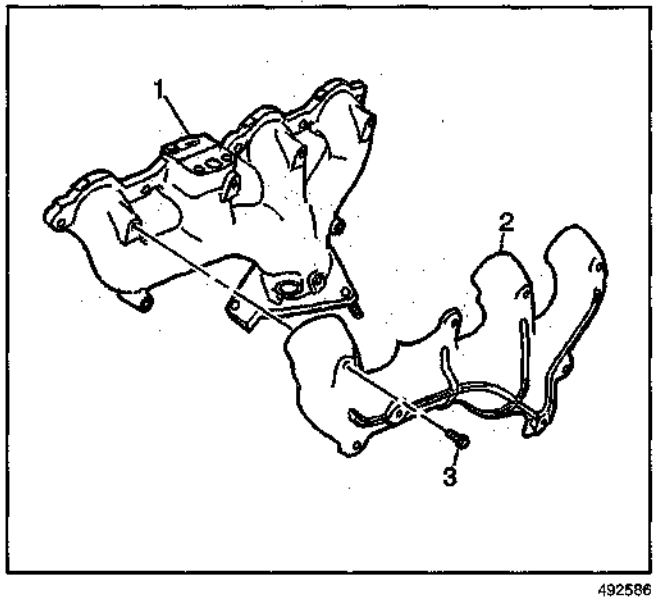
Important:

- Do not reuse the exhaust manifold-to-cylinder head gaskets. Upon installation of the exhaust manifold, install a NEW gasket. A improperly installed gasket or leaking exhaust system may effect On-Board Diagnostics (OBD) II system performance.
- Remove the oxygen sensor prior to cleaning the manifold, do not submerge the oxygen sensor in cleaning solvent.

1. Remove the oxygen sensor from the manifold.
2. Clean the exhaust manifold (1) and heat shield (2) in solvent.

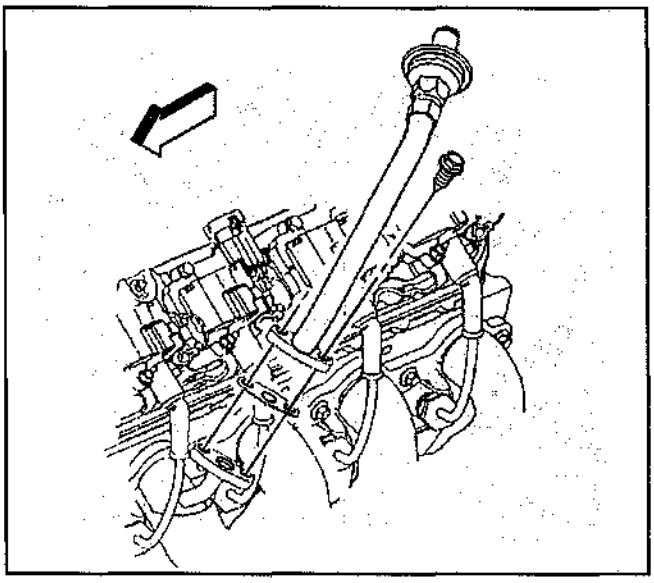
Caution: Wear safety glasses in order to avoid eye damage.

3. Dry the exhaust manifold with compressed air.

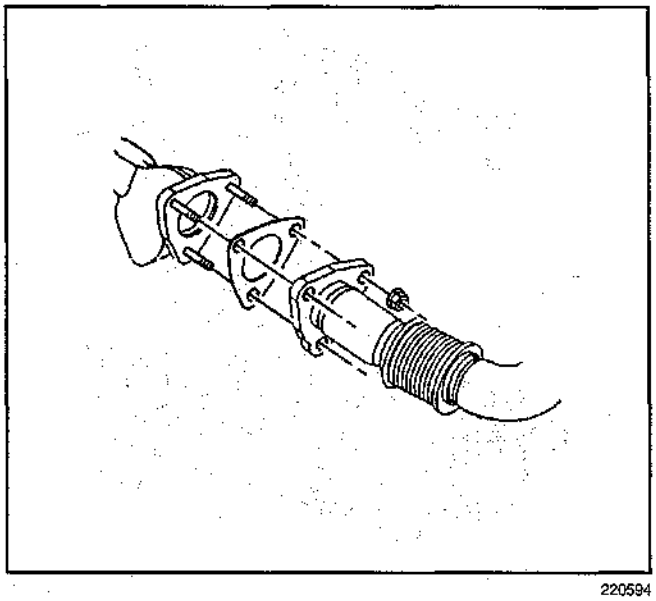


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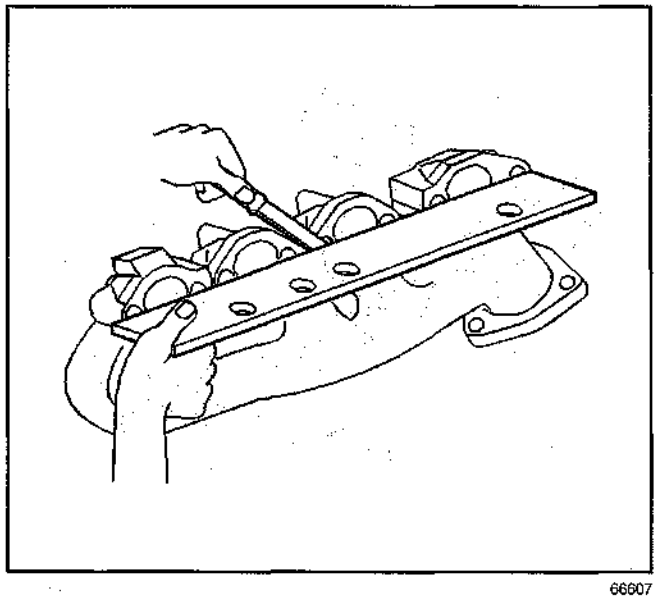
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4. Inspect the exhaust manifold air injection reaction (AIR) passages for restrictions.
5. Inspect the AIR flange threaded bolt holes threads for damage.
6. Inspect the AIR flange gasket surface for excessive scratches or gouging.
7. Inspect the exhaust manifold-to-cylinder head gasket surface for excessive scratches or gouging.
8. Inspect the right side manifold exhaust gas recirculation (EGR) flange sealing surface for excessive scratches or gouging.
9. Inspect the right side manifold EGR flange bolt hole threads for damage.
10. Inspect for a loose or damaged heat shield (2) or missing bolts (3).


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11. Inspect the take down studs for damaged threads.


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

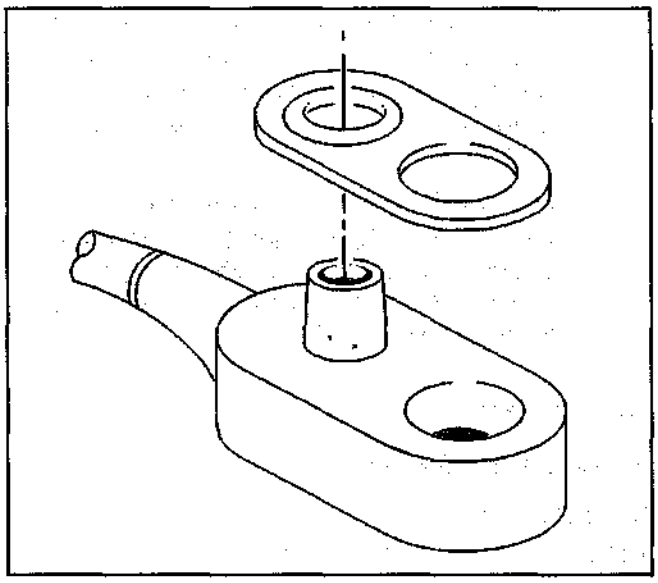
    A exhaust manifold deck with warpage in excess of 0.25 mm (0.01 in), may cause an exhaust leak and may effect OBD II system performance. Exhaust manifolds not within specifications must be replaced.

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Vapor Vent Pipe Clean and Inspect

Important: Do not reuse the engine coolant air bleed pipe gaskets. Upon installation of the pipe, install NEW gaskets.

1. Remove the engine coolant air bleed hose, clamps, and sealing gaskets from the pipe.

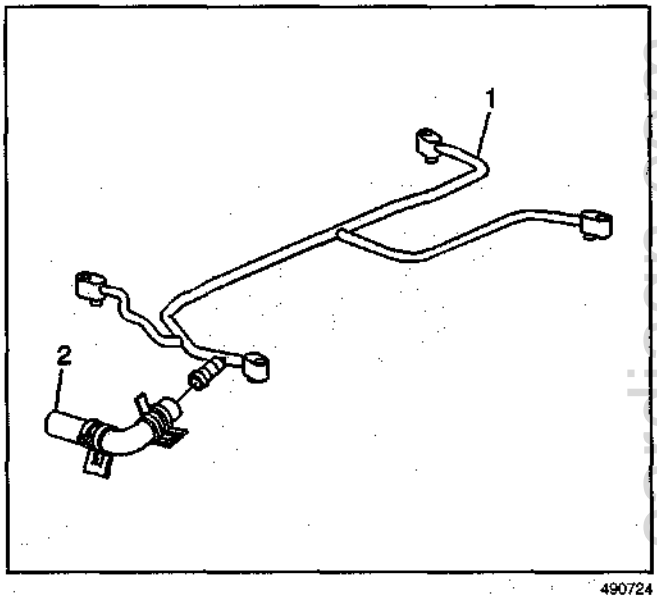

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2. Clean the pipe (1) and hose (2) in solvent.

Caution: Wear safety glasses in order to avoid eye damage.

3. Dry the pipe with compressed air.
4. Inspect the pipe for damage or restrictions.
5. Inspect the gasket and hose sealing surfaces for damage.
6. Inspect the hose (2) for restrictions, cracking or wear.

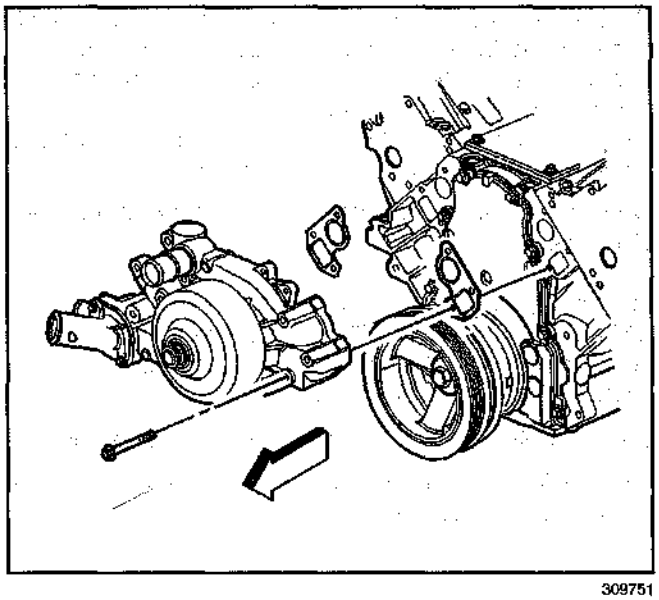
   The hose may be reused if not damaged.



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Water Pump Clean and Inspect

1. Remove the old gasket from the water pump sealing surfaces. Refer to *Replacing Engine Gaskets*.
2. Clean all dirt and debris from the water pump housing.
3. Inspect the water pump for the following:
   - Gasket sealing surfaces for excessive scratches or gouging
   - Hose sealing surfaces for scratches or gouging
   - Restrictions within the internal coolant passages


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- Excessive side-to-side play in the pulley shaft
- A loose belt pulley or a pulley with excessive wear or scoring on the belt tracking area
- Leakage at the water outlet housing or rear cover gasket
- Leakage at the water pump vent hole

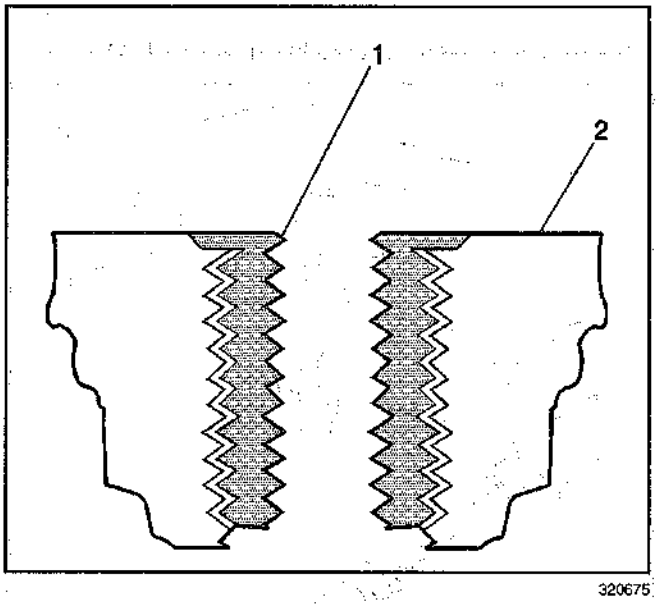
  A stain around the vent hole is acceptable. If leakage occurs (dripping) with the engine running and the cooling system pressurized, replace the water pump.

Thread Repair

General Thread Repair

Tools Required

J 42385-200 General Threads Kit



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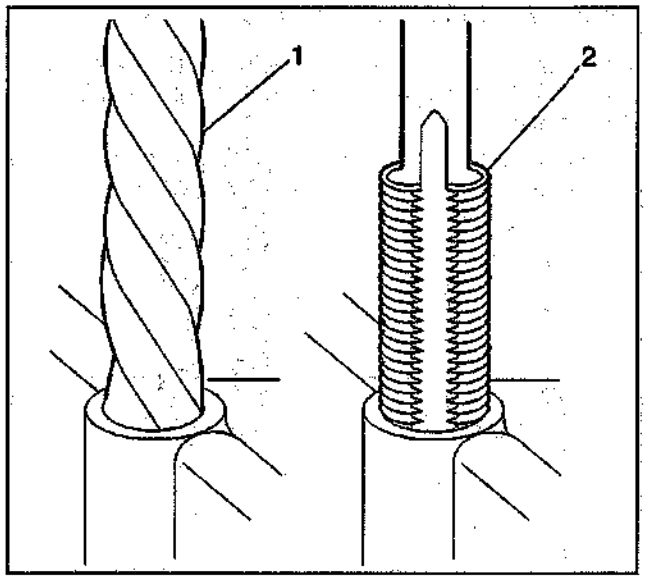
The thread repair process involves a solid, thin walled, self-locking, carbon steel, bushing type insert (1). During the bushing installation process, the driver tool expands the bottom external threads of the insert into the base material (2). This action mechanically locks the insert in place. Also,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

Caution: Wear safety glasses in order to avoid eye damage.

Important: The use of a cutting type fluid GM P/N 1052864, WD 40®, or equivalent is recommended when performing the drilling, counterboring, and tapping procedures.

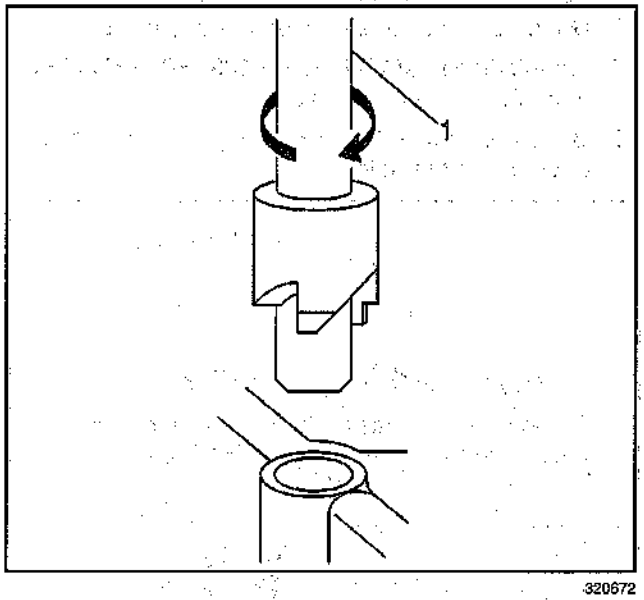
Driver oil MUST be used on the installer driver tool.

The tool kits are designed for use with either a suitable tap wrench or drill motor.



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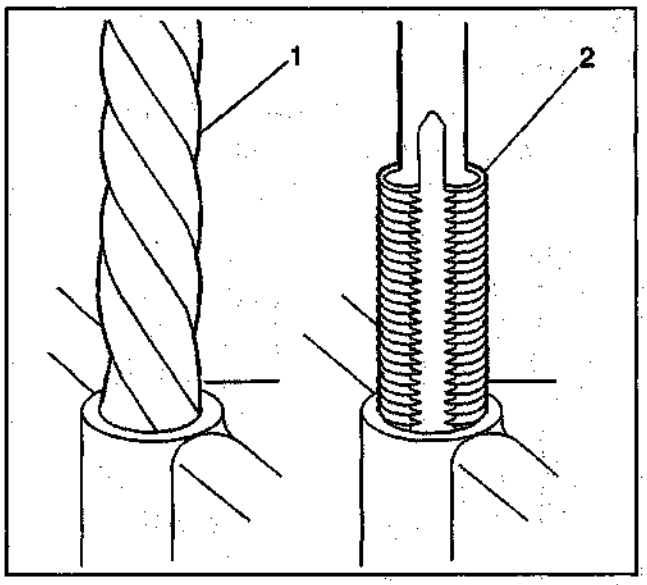
1. Drill out the threads of the damaged hole (1).
   - M6 inserts require a minimum drill depth of 15 mm (0.59 in).
   - M8 inserts require a minimum drill depth of 20 mm (0.79 in).
   - M10 inserts require a minimum drill depth of 23.5 mm (0.93 in).
2. Using compressed air, clean out any chips.



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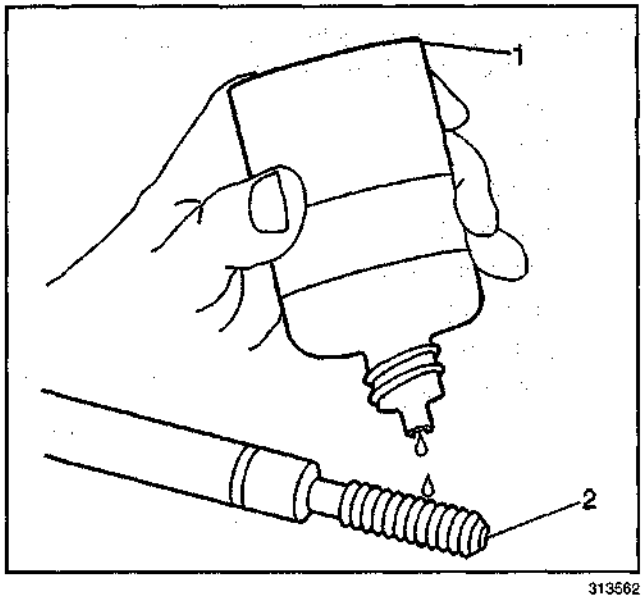
3. Counterbore the hole to the full depth permitted by the tool (1).
4. Using compressed air, clean out any chips.

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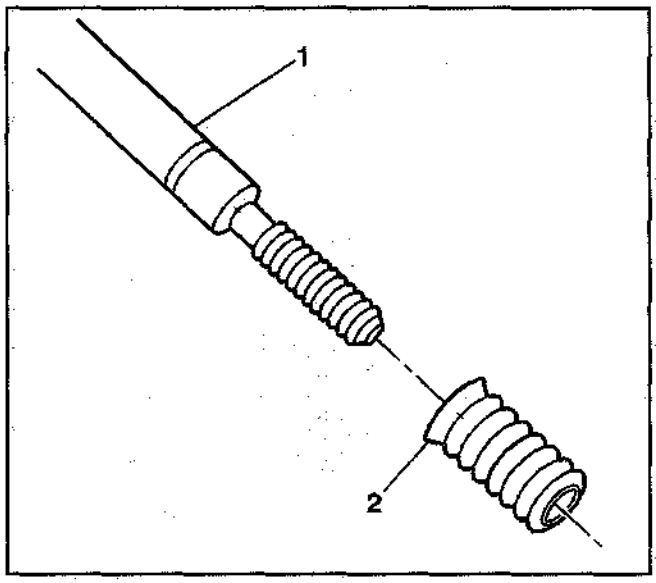
5. Using a tap wrench (2), tap the threads of the drilled hole.
   - M6 inserts require a minimum tap depth of 15 mm (0.59 in).
   - M8 inserts require a minimum tap depth of 20 mm (0.79 in).
   - M10 inserts require a minimum tap depth of 23.5 mm (0.93 in).
6. Using compressed air, clean out any chips.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



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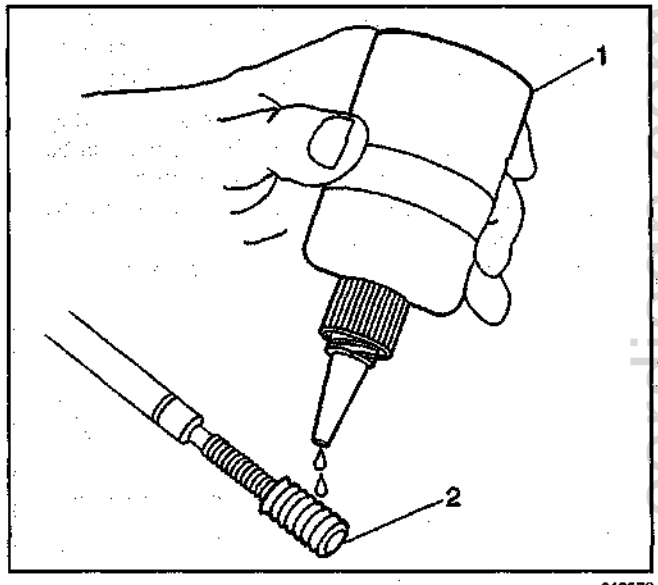
Important: Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.

9. Lubricate the threads of the installer tool (2) with the driver oil (1).



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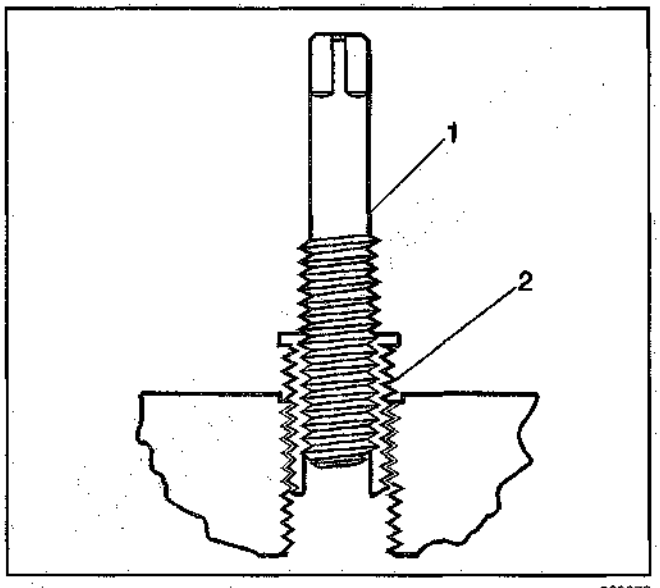
10. Install the insert (2) onto the driver tool (1).



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

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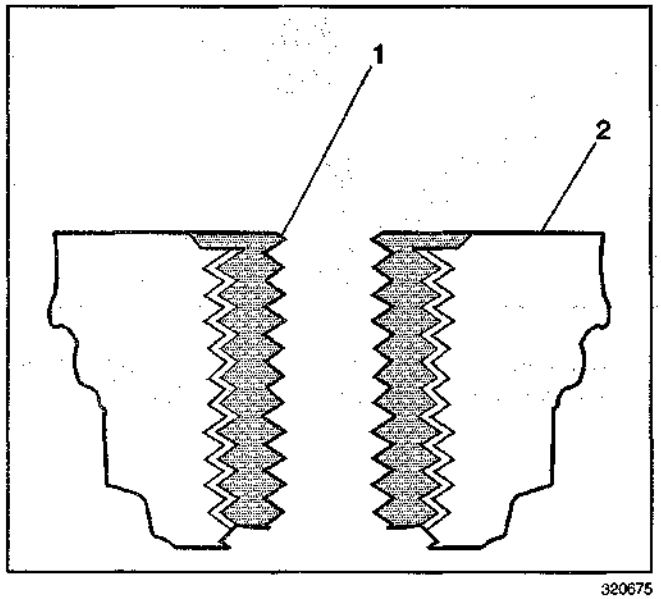


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12. Install the insert (2) into the hole.

    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.



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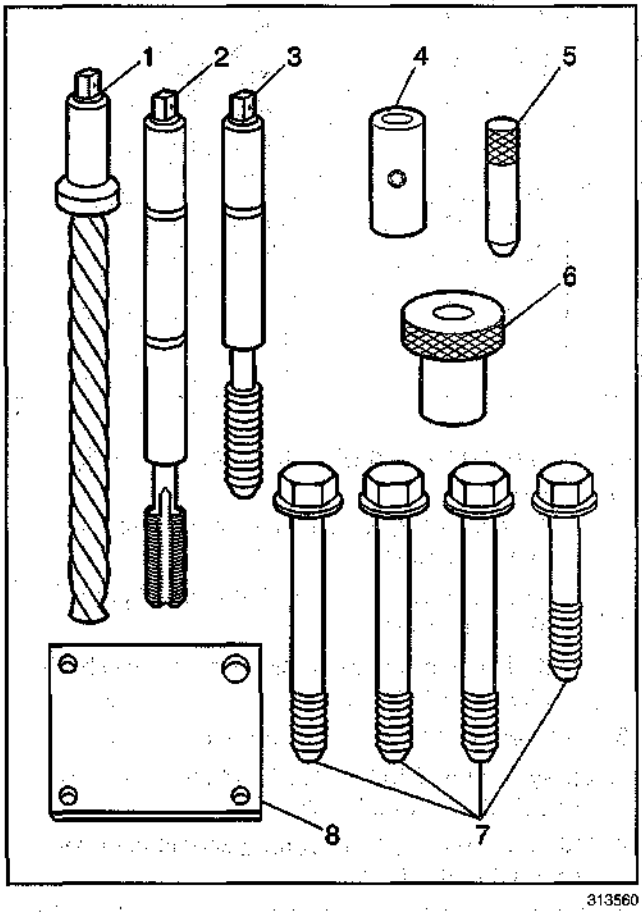
13. Inspect the insert for proper installation into the hole.

    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

Tools Required

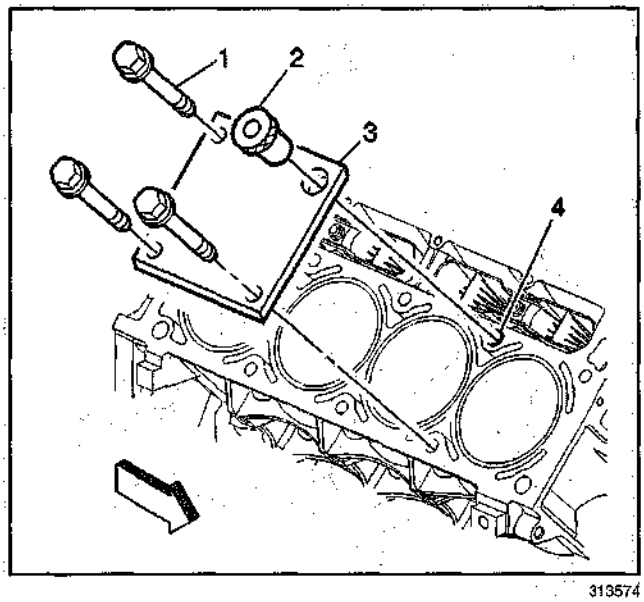
- *J 42385-100* Cylinder Head/Main Bearing Bolt Kit
- *J 42385-300* Fixtures and Hardware Kit



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1. The cylinder head bolt hole thread repair kit consists of the following items:
   - Drill (1)
   - Tap (2)
   - Installer (3)
   - Sleeve (4)
   - Alignment Pin (5)
   - Bushing (6)
   - Bolts (7)
   - Fixture Plate (8)

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Caution: Wear safety glasses in order to avoid eye damage.

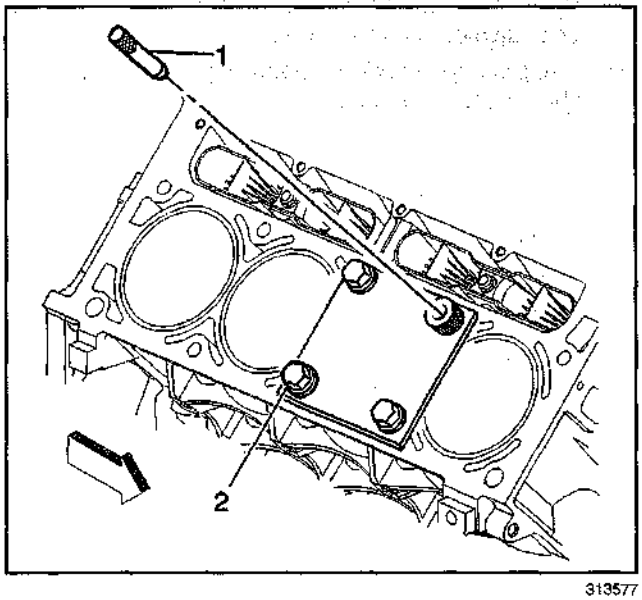
Important: The use of a cutting type fluid GM P/N 1052864, WD 40®, or equivalent is recommended when performing the drilling and tapping procedures.

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.

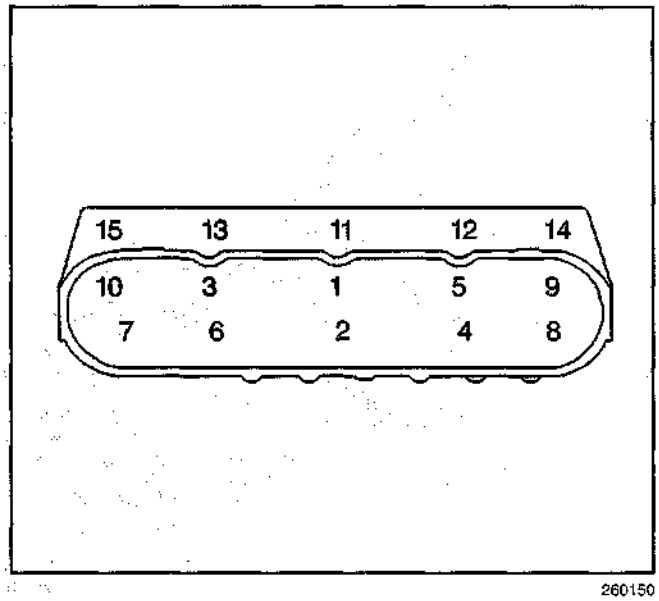
2. Install the fixture plate (3), bolts (1), and bushing (2) onto the engine block deck.

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



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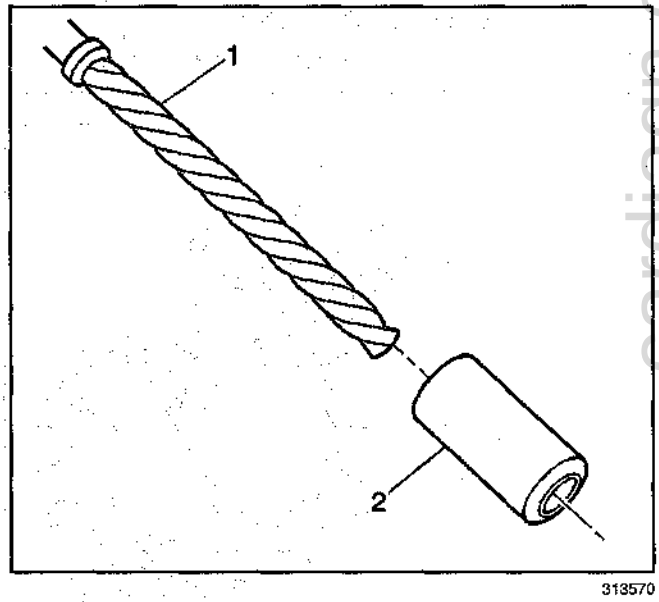
3. Position the alignment pin (1) through the bushing and into the hole.
4. With the alignment pin in the desired hole, tighten the fixture retaining bolts (2).
5. Remove the alignment pin from the hole.



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6. Cylinder head bolt holes 1–8 are the deep holes and will be drilled without the drill sleeve.

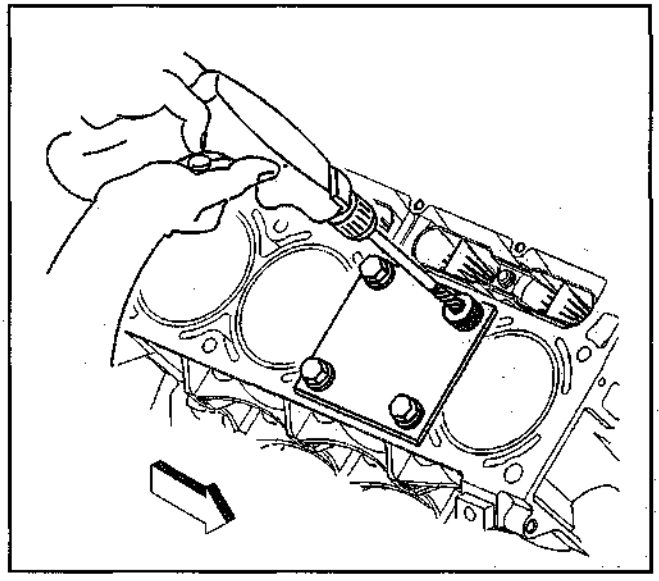
   Cylinder head bolt holes 9 and 10 are the shallower holes, drilling MUST be done with the drill sleeve in place.



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7. Install the sleeve (2) onto the drill (1) (if required).

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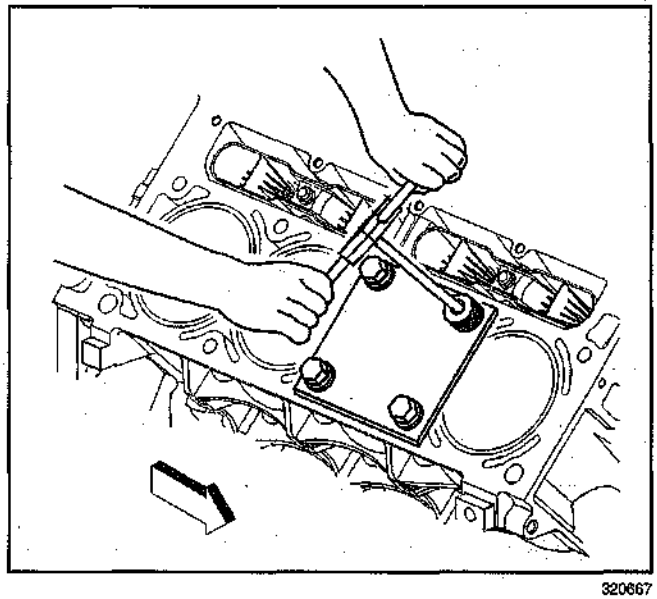

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Important: During the reaming process, it is necessary to repeatedly remove the drill and clean the chips from the hole.

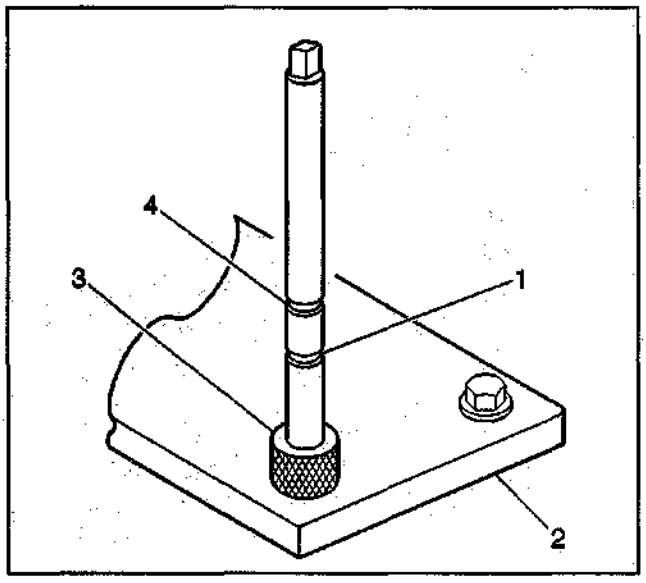
8. Drill out the threads of the damaged hole.

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

9. Using compressed air, clean out any chips.


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



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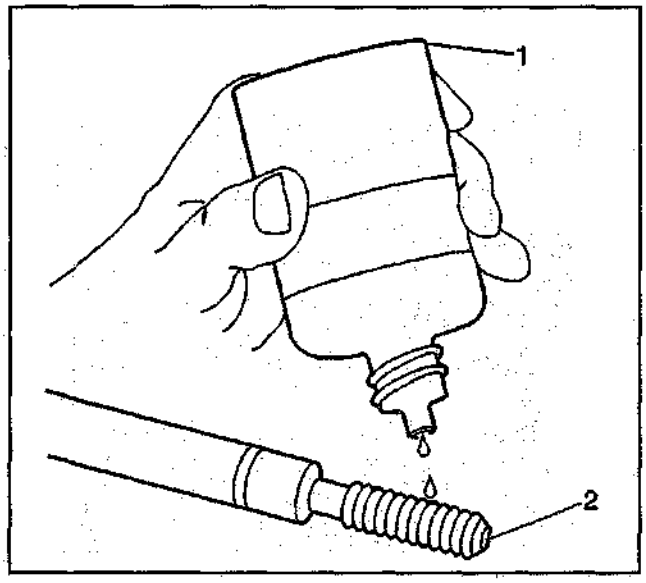
11. In order to tap the new threads to the proper depth, rotate the tap into the hole until the marks (1 or 4) on the tap align with the top of the drill bushing (3).

    For the deeper cylinder head bolt holes (1–8), rotate the tap until the upper mark on the tap (4) aligns with the top of the drill bushing.

    For the shallower cylinder head bolt holes (9 and 10), rotate the tap until the lower mark on the tap (1) aligns with the top of the drill bushing.

12. Remove the fixture plate (2), bushing (3), and bolts.
13. Using compressed air, clean out any chips.
14. Spray cleaner GM P/N 12346139, P/N 12377981, or equivalent into the hole.
15. Using compressed air, clean any cutting oil and chips out of the hole.

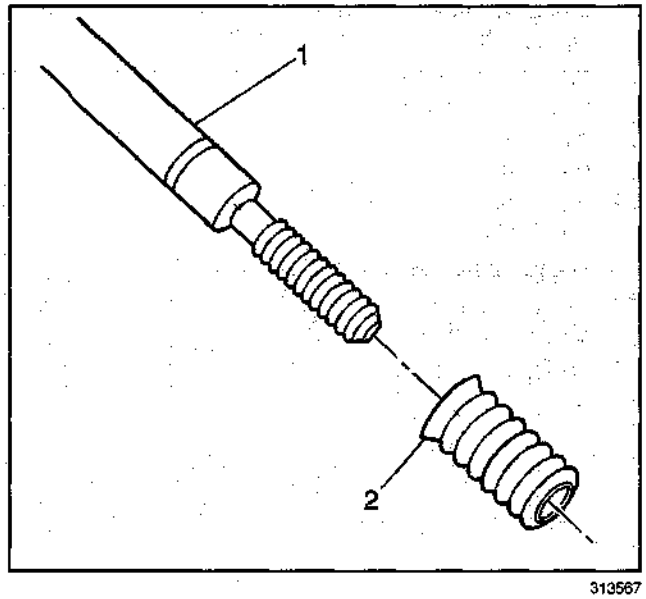
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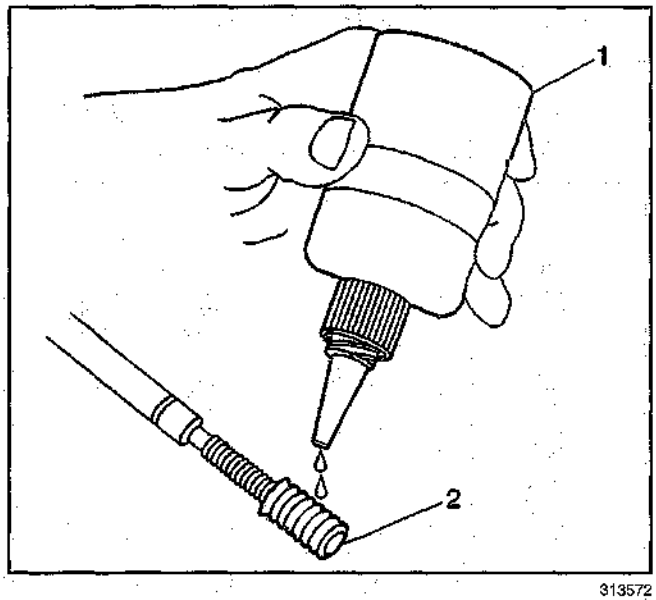
Important: Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.

16. Lubricate the threads of the installer tool (2) with the driver oil (1).



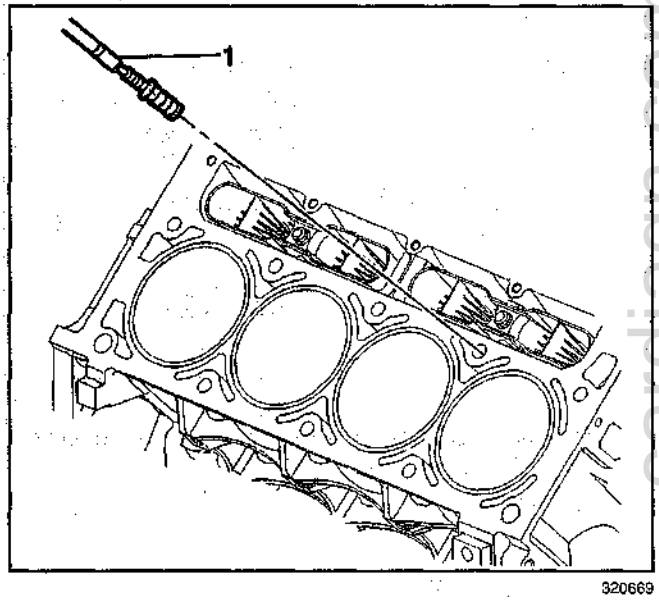
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17. Install the insert (2) onto the driver tool (1).



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18. Apply threadlock Loctite® 277, J 42385-109 (1), or equivalent to the insert OD threads (2).



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19. 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.

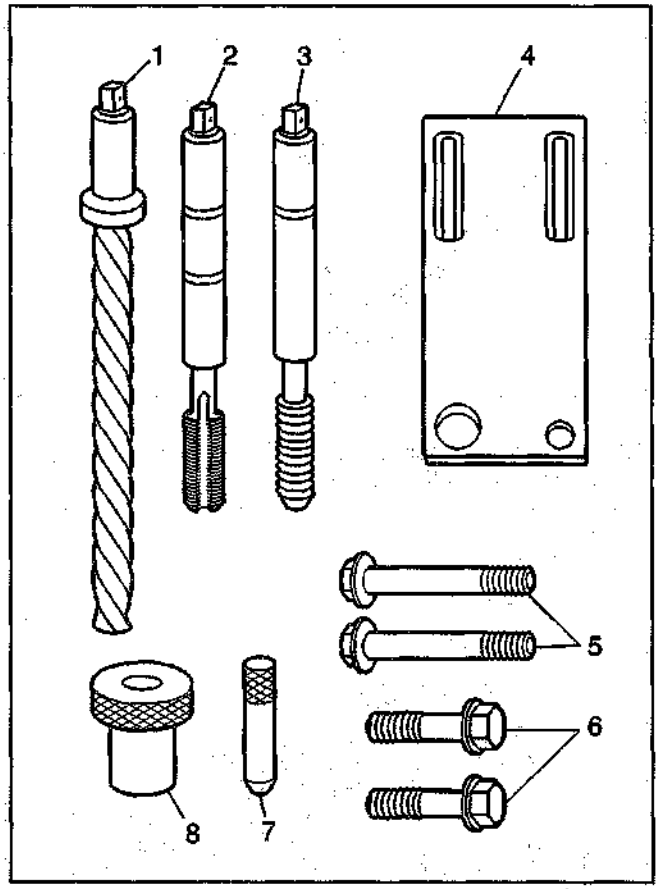
    The installer tool will tighten up before screwing completely through the insert. This is acceptable. You are forming the bottom threads of the insert and mechanically locking the insert to the base material threads.

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Main Cap Bolt Hole Thread Repair

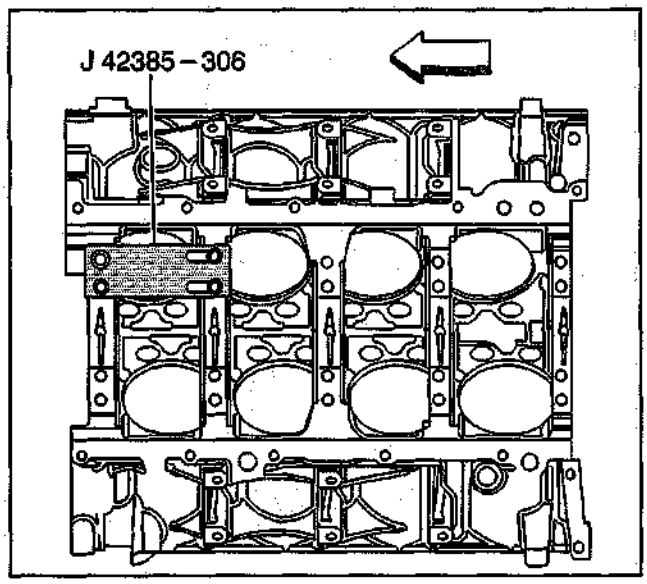
Tools Required

- *J 42385-100* Cylinder Head/Main Bearing Bolt Kit
- *J 42385-300* Fixtures and Hardware Kit



313556

1. The main cap bolt hole thread repair kit consists of the following items:
   - Drill (1)
   - Tap (2)
   - Installer (3)
   - Fixture Plate (4)
   - Long Bolts (5)
   - Short Bolts (6)
   - Alignment Pin (7)
   - Bushing (8)

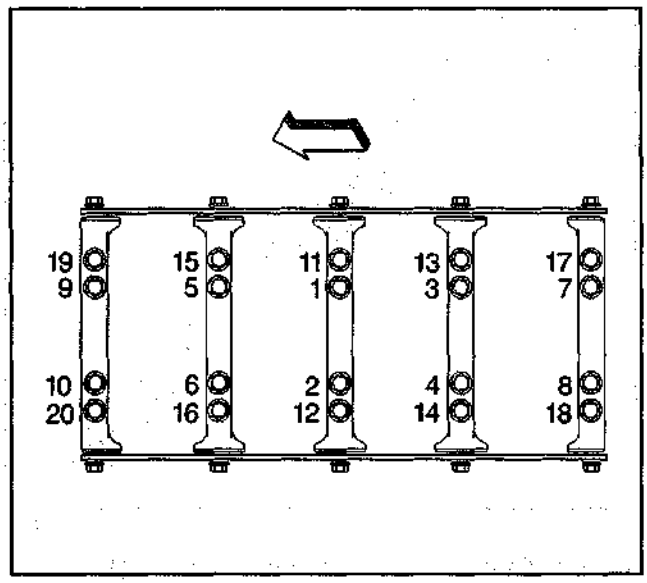


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2. Install the fixture plate, bolt, and bushing, onto the engine block.

   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.



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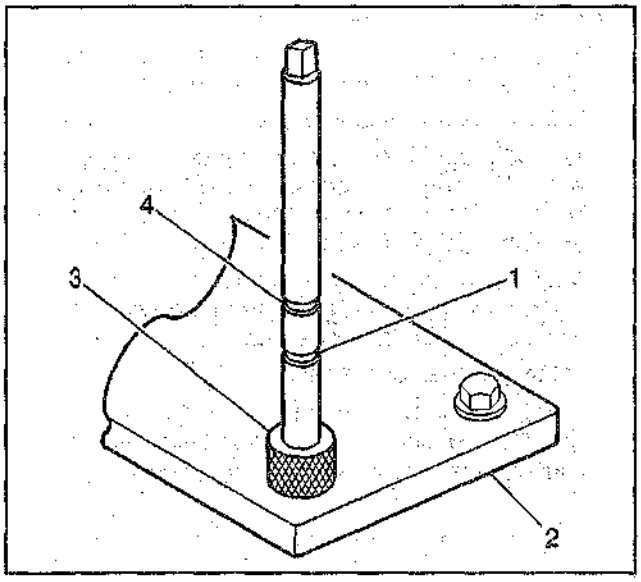
4. Drill out the damaged hole.

   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.

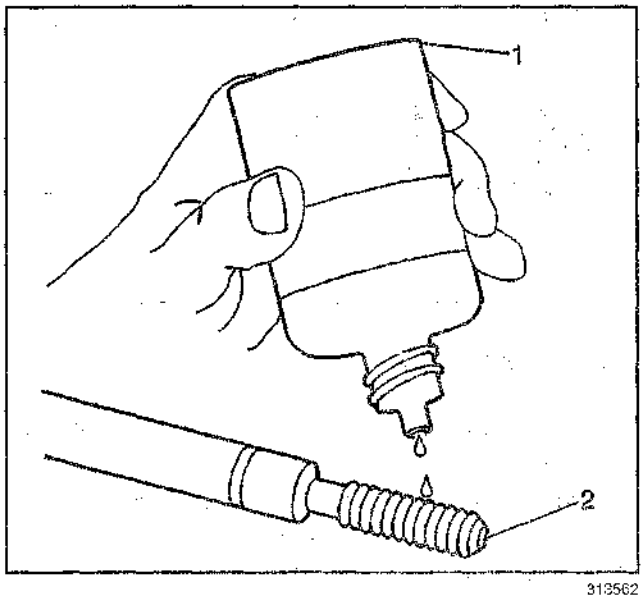
5. Using compressed air, clean out any chips.

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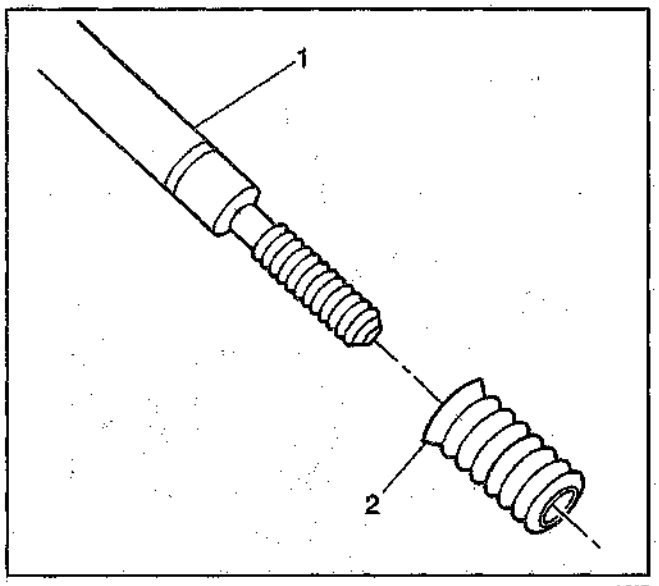
6. Using a tap wrench, tap the threads of the drilled hole.
   In order to tap the new threads to the proper depth, rotate the tap into the hole until the mark on the tap aligns with the top of the bushing.
   For the deeper main cap holes (1–10), rotate the tap until the upper mark (4) on the tap aligns 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, or equivalent into the hole.
9. Using compressed air, clean any cutting oil and chips out of the hole.



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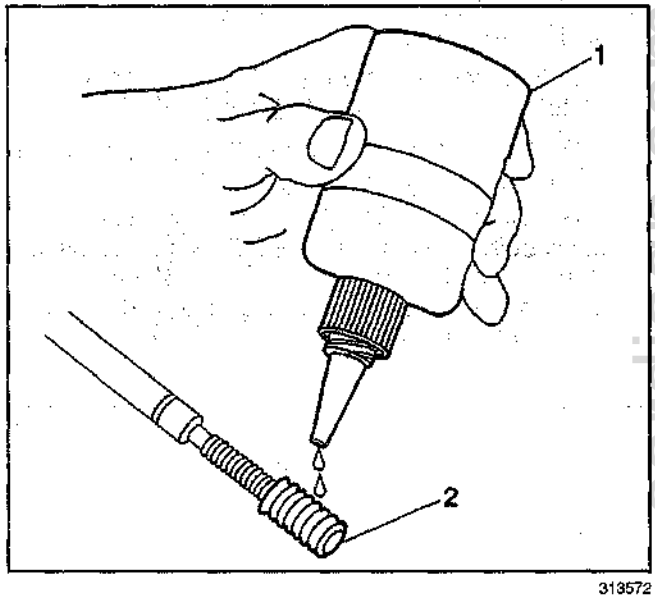
Important: Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.

10. Lubricate the threads of the installer tool (2) with the driver oil (1).



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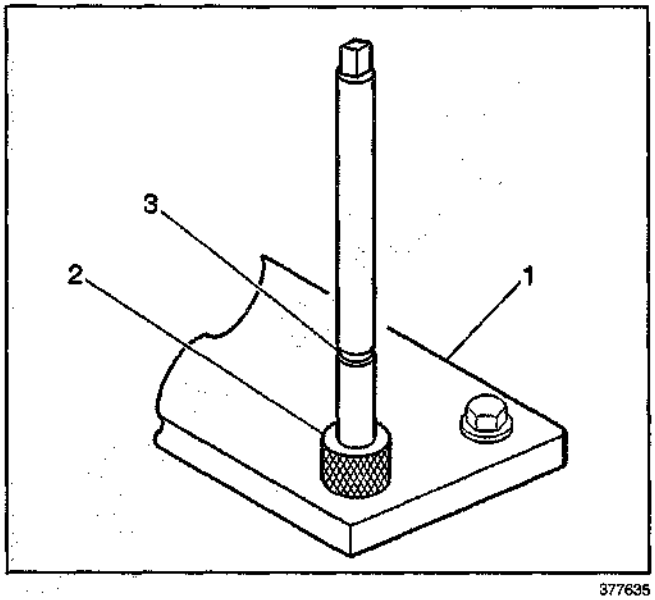
11. Install the insert (2) onto the driver tool (1).



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

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Important: 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.

Service Prior to Assembly

- Dirt or debris will cause premature wear of the rebuilt engine. Clean all the components.

  Refer to *Cleanliness and Care*.
- Use the proper tools to measure components when checking for excessive wear. Components that are not within the manufacturers specifications must be repaired or replaced.
- When the components are reinstalled into an engine, return the components to their original location, position and direction.

  Refer to *Separating Parts*.
- During assembly, lubricate all the moving parts with clean engine oil. This will provide initial lubrication when the engine is first started.

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Engine Block Plug Installation

Tools Required

J 41712 Oil Pressure Sensor Socket

Important:

- Engine block plug (oil gallery and coolant) sealing washers may be reused if not bent, scored or otherwise damaged.
- Apply the proper amount and type of sealant to the sealing washer as recommended in the service procedure.

1. Apply a 3.175 mm (0.125 in) bead of sealant GM P/N 12346004 or equivalent to the engine block coolant heater sealing washer (if applicable). Refer to *Sealers, Adhesives, and Lubricants*.

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

2. Install the engine block coolant heater to the engine block (if applicable).

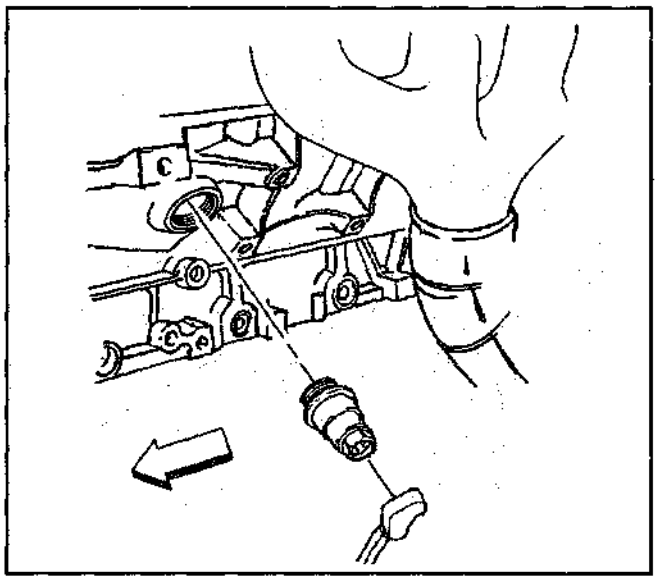
   Tighten

   Tighten the block coolant heater to 40 N·m (30 lb ft).

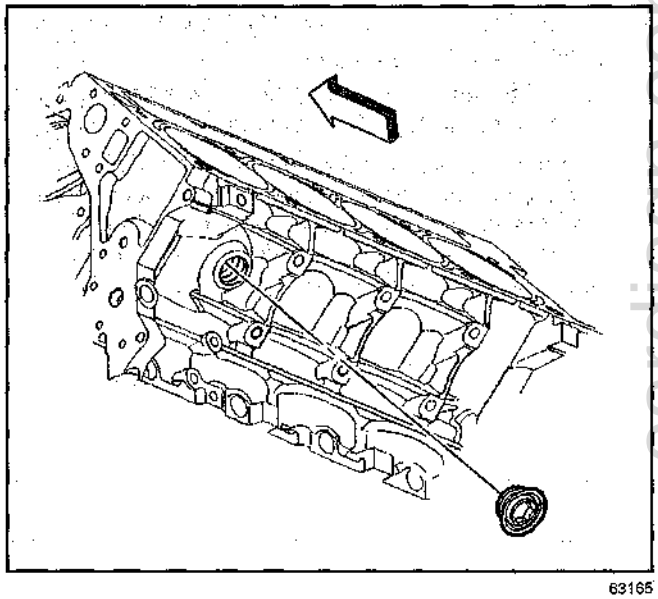
3. Apply a 3.175 mm (0.125 in) bead of sealant GM P/N 12346004 or equivalent to the engine block left front coolant drain plug sealing washer (if applicable).
4. Install the engine block left front coolant drain plug (if applicable).

   Tighten

   Tighten the block left front coolant drain plug to 60 N·m (44 lb ft).

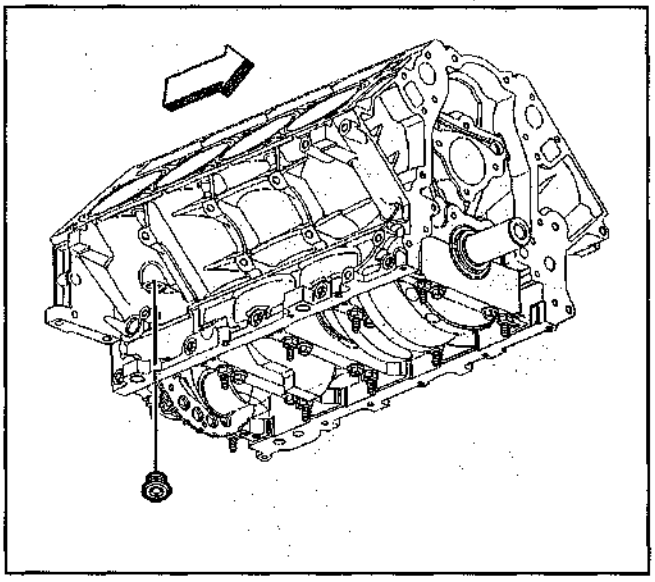


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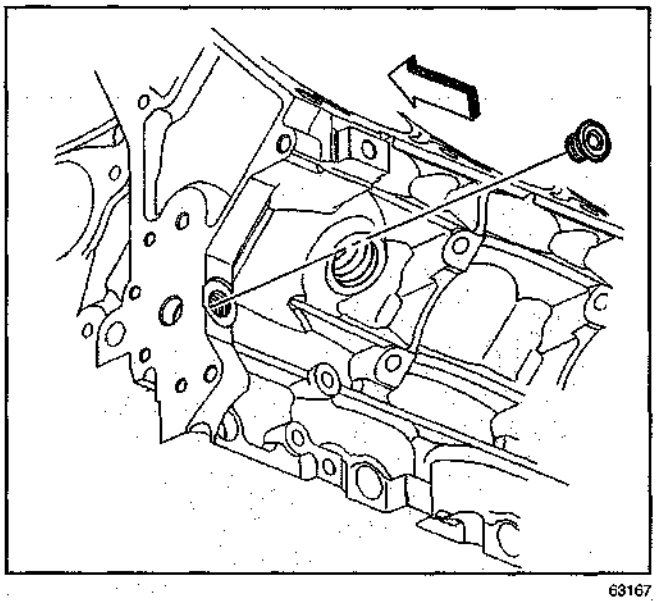


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5. Apply a 3.175 mm (0.125 in) bead of sealant GM P/N 12346004 or equivalent to the engine block right rear coolant drain plug sealing washer.
6. Install the engine block right rear coolant drain plug.

   Tighten

   Tighten the block right rear coolant drain plug to 60 N·m (44 lb ft).

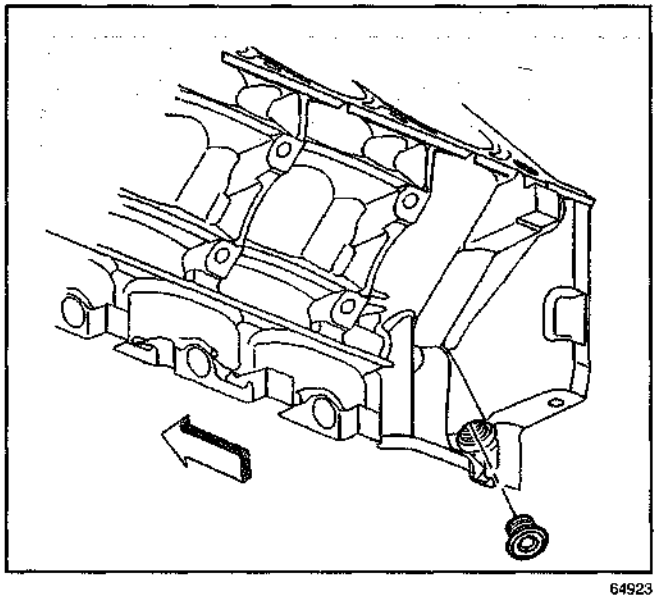


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7. Apply a 3.175 mm (0.125 in) bead of sealant GM P/N 12346004 or equivalent to the engine block left front oil gallery plug sealing washer.
8. Install the engine block left front oil gallery plug.

   Tighten

   Tighten the block left front oil gallery plug to 60 N·m (44 lb ft).



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9. Apply a 3.175 mm (0.125 in) bead of sealant GM P/N 12346004 or equivalent to the engine block left rear oil gallery plug sealing washer.
10. Install the engine block left rear oil gallery plug.

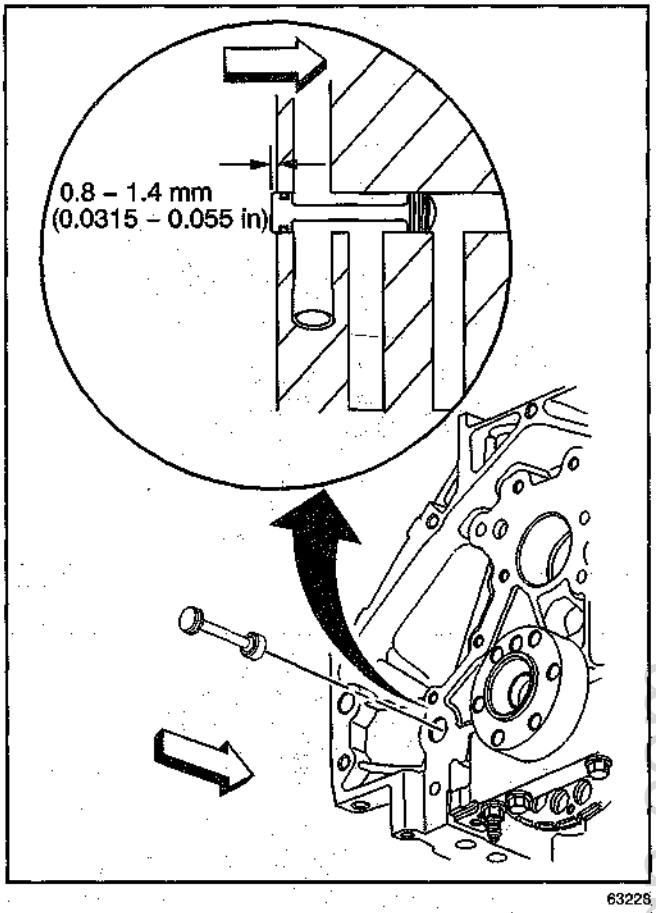
    Tighten

    Tighten the block left rear oil gallery plug to 60 N·m (44 lb ft).

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11. 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 reused.
12. Lubricate the O-ring seal with clean engine oil.
13. Install the block rear oil gallery plug into the oil gallery bore.

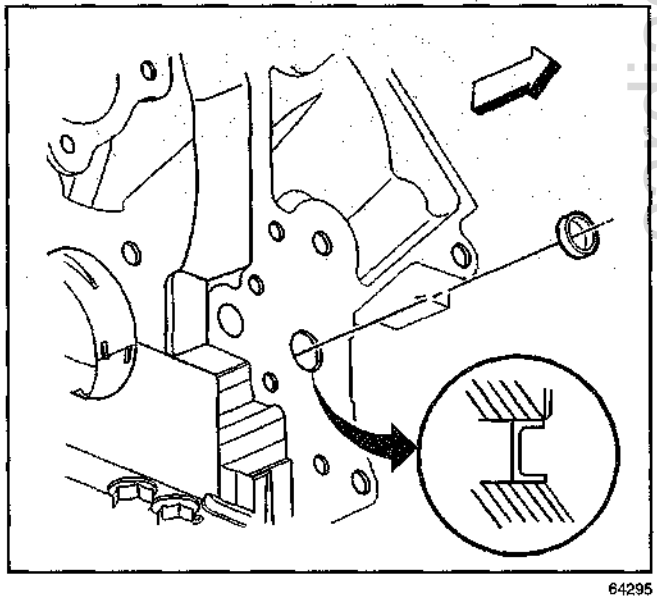
    A properly installed oil gallery plug will protrude 0.8–1.4 mm (0.0315–0.055 in) beyone the rear face of the block.



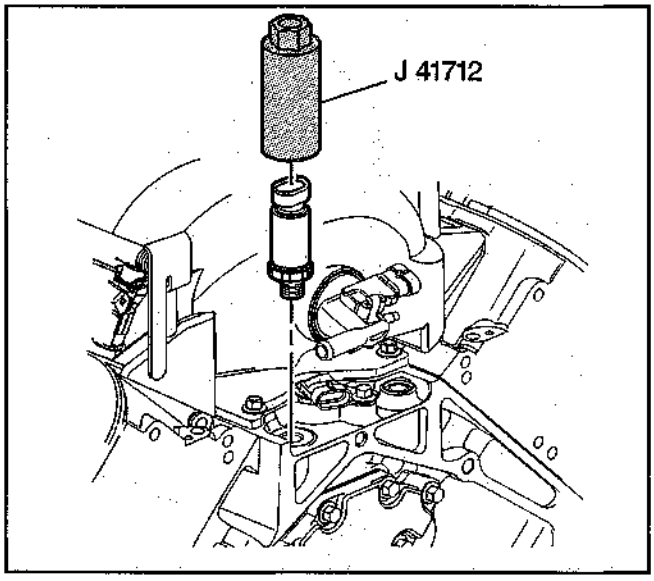
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Important: The engine block front oil gallery plug should not be removed unless service is required.

14. Apply sealant GM P/N 12345382 or equivalent to the sides of the NEW front oil gallery plug.
15. Install a NEW engine block front oil gallery plug (if required). Install the front oil gallery plug into the oil gallery bore 2.2–2.8 mm (0.0086–0.011 in) below flush.


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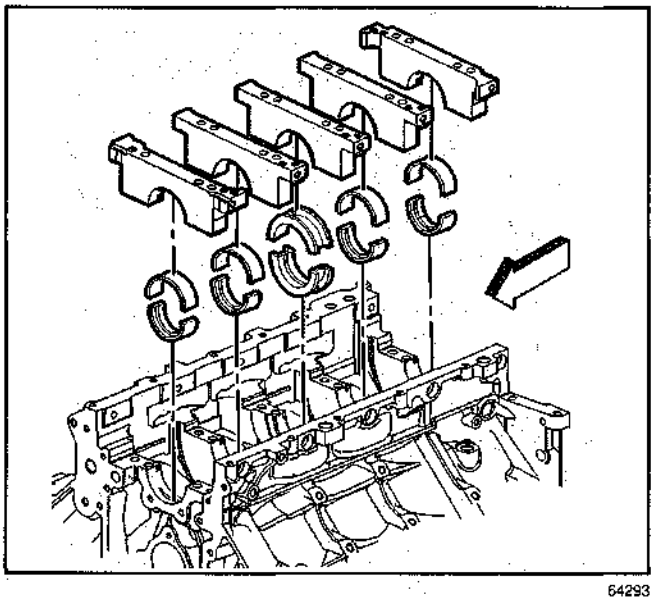


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16. Apply sealant GM P/N 12346004 or equivalent to the threads of the oil pressure sensor.
17. Use the *J 41712* or equivalent in order to install the oil pressure sensor.

    Tighten

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



64293

Crankshaft and Bearings Installation

Tools Required

J 36660-A Torque Angle Meter

Important:

- Crankshaft bearing clearances are critical. Excessive crankshaft bearing clearance may effect crankshaft position sensor signals and/or On-Board Diagnostics (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.
- To prevent engine block oil leakage, install NEW M8 crankshaft bearing cap side bolts.

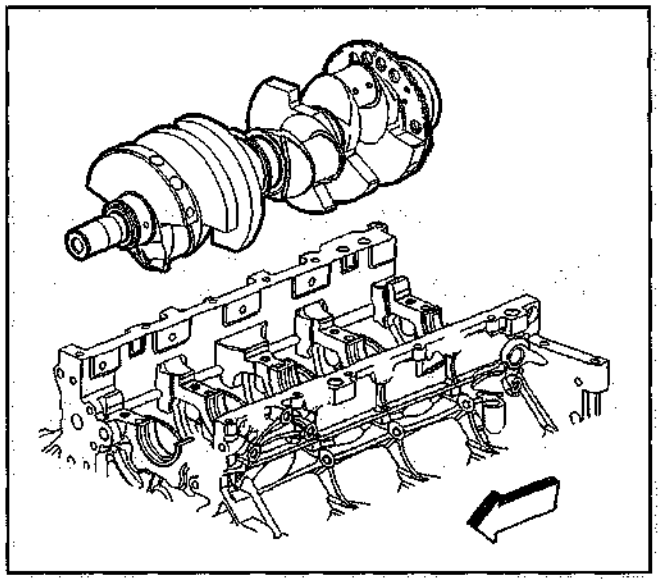
  The crankshaft bearing cap M8 side bolts have a sealant patch applied to the bolt flange.

1. Install the crankshaft thrust bearings to the engine block and center bearing cap.
2. Install the remaining crankshaft bearings to the engine block and bearing caps.
3. Lubricate the bearing surfaces and crankshaft journals with clean engine oil.

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

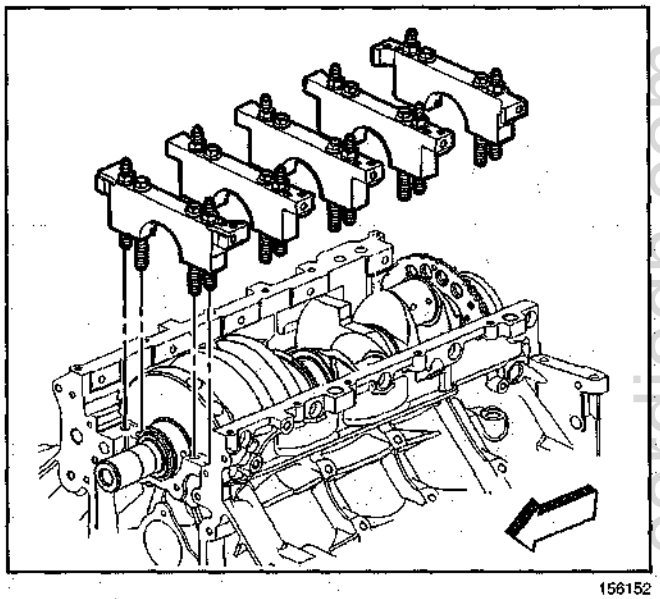
4. Install the crankshaft.



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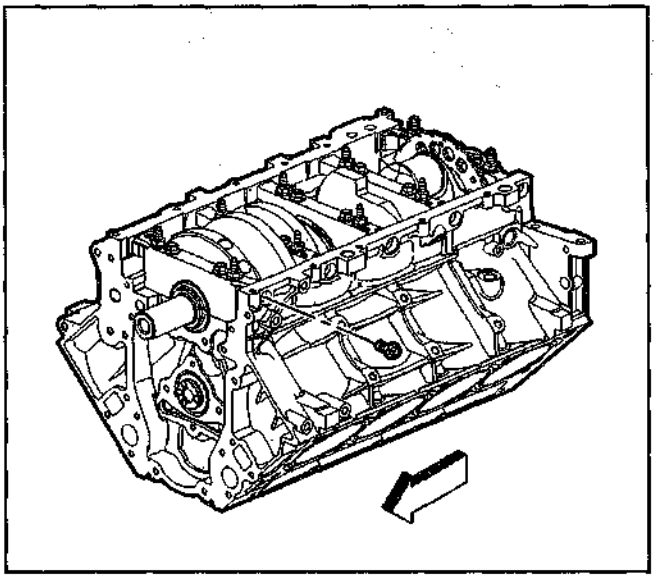
Important: The bearing caps must be installed in the proper location and direction.

5. Install the crankshaft bearing caps (with bearings) into the engine block.
6. Start the M10 bolts and studs.
7. Tap the bearing caps into place with a plastic-faced hammer.



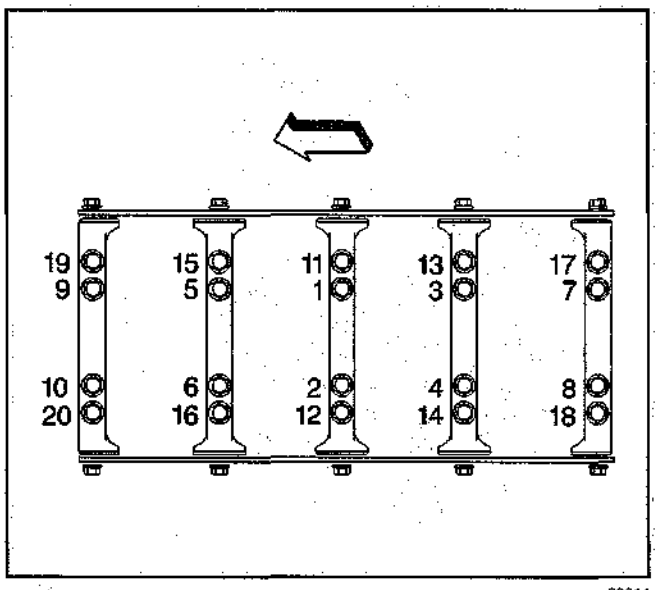
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8. Install the NEW M8 bearing cap side bolts.

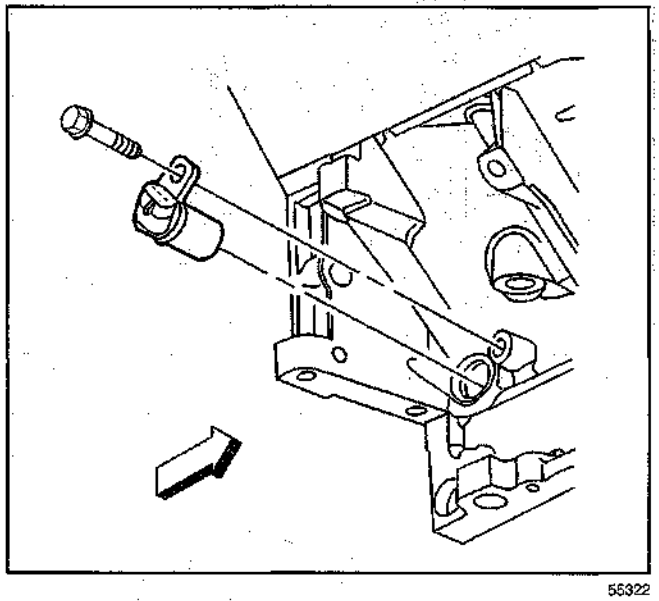


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Notice: Refer to *Fastener Notice* in Cautions and Notices.

9. Tighten the bearing cap bolts and studs.

   Tighten

   Tighten the inner M10 bearing cap bolts first pass in sequence to 20 N·m (15 lb ft).

Important: To properly align the crankshaft thrust bearings, the final thrust of the crankshaft MUST be in the forward direction.

10. Using a plastic faced hammer, tap the crankshaft rearward then forward to align the thrust bearings.

    Tighten

    10.1. Tighten the inner M10 bolts final pass in sequence 80 degrees using the *J 36660-A*.

    10.2. Tighten the outer M10 bolts first pass in sequence to 20 N·m (15 lb ft).

    10.3. Tighten the outer M10 bolts final pass in sequence 53 degrees using the *J 36660-A*.

    10.4. Tighten the bearing cap side M8 bolts to 25 N·m (18 lb ft).

    Tighten the bolt on one side of the bearing cap and then tighten the bolt on the opposite side of the same bearing cap.

11. Install the crankshaft position sensor.

    11.1. Inspect the crankshaft position sensor O-ring seal. If the O-ring seal is not cut or damaged, it may be used.

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

    11.3. Install the sensor. Align the notch in the sensor retaining bracket with the bolt hole in the block.

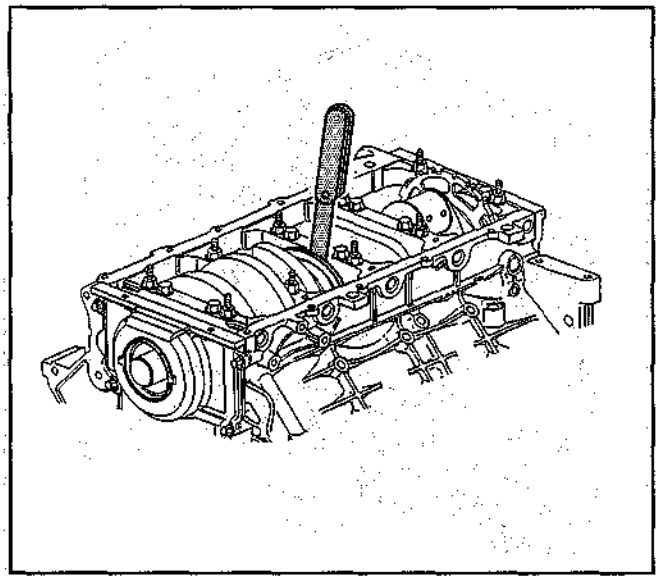
    11.4. Install the sensor bolt.

    Tighten

    Tighten the crankshaft position sensor bolt to 25 N·m (18 lb ft).

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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.


64316

Piston, Connecting Rod, and Bearing Installation

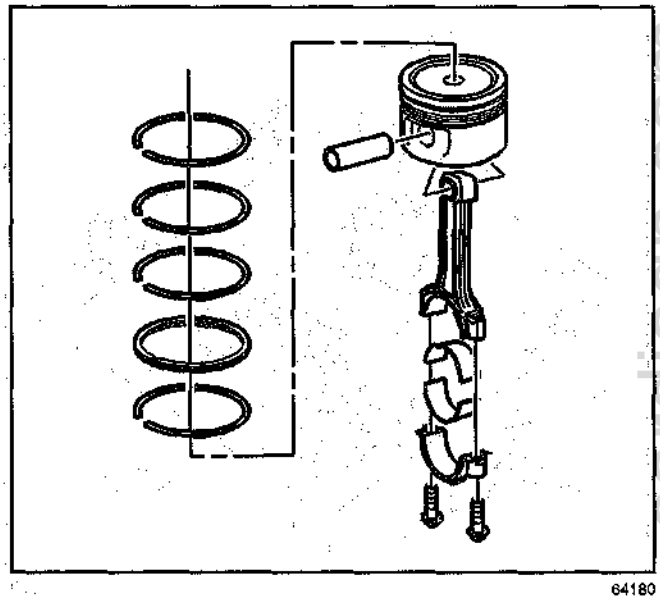
Tools Required

- *J 41556* Connecting Rod Guide
- *J 8037* Piston Ring Compressor
- *J 36660-A* Torque Angle Meter

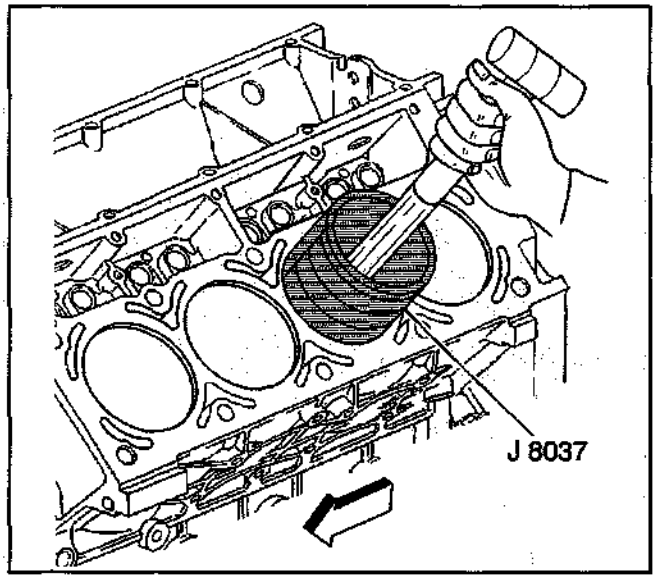
Important: The piston and cylinder bore have been measured and the bore has been sized for the proper clearance. Install the piston and connecting rod assembly into the proper cylinder bore.

The piston alignment mark MUST face the front of the engine block.

1. Lightly lubricate the following components with clean engine oil:
   - The piston
   - The piston rings
   - The cylinder bore
   - The bearing surfaces
2. Stagger the oil control ring end gaps a minimum of 90 degrees.
3. Stagger the compression ring end gaps a minimum of 25 mm (1.0 in).
4. Install the *J 41556* to the connecting rod.
5. Install the *J 8037* onto the piston and compress the piston rings.


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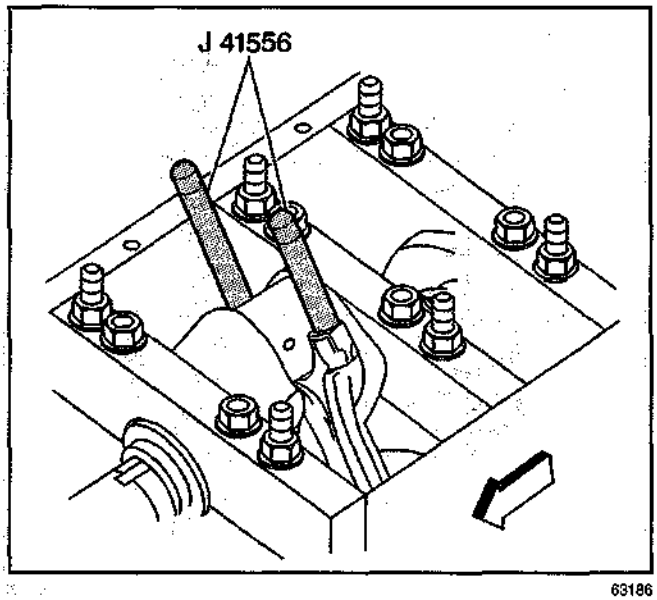
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Important: The piston alignment mark MUST facing the front of the engine block.

6. Install the piston and connecting rod assembly into the proper cylinder bore.
   6.1. Hold the piston ring compressor firmly against the engine block. Using a wooden hammer handle, lightly tap the top of the piston until all of the piston rings enter the cylinder bore.
   6.2. Use the *J 41556* to guide the connecting rod end onto the crankshaft journal.

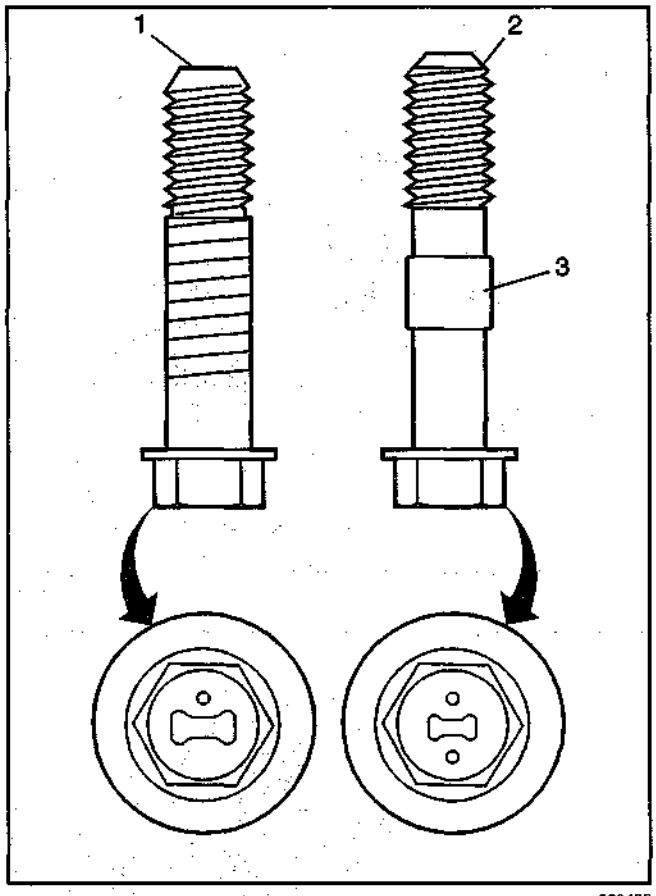


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7. Remove the *J 41556*.

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8. Identify the type of connecting rod bolt.
   - The first design connecting rod bolt (1) can be identified by a single dimple/mark on the head of the bolt and no retaining sleeve on the bolt shank.
   - The second design connecting rod bolt (2) can be identified by two dimples/marks on the head of the bolt and a retaining sleeve (3) on the bolt shank.



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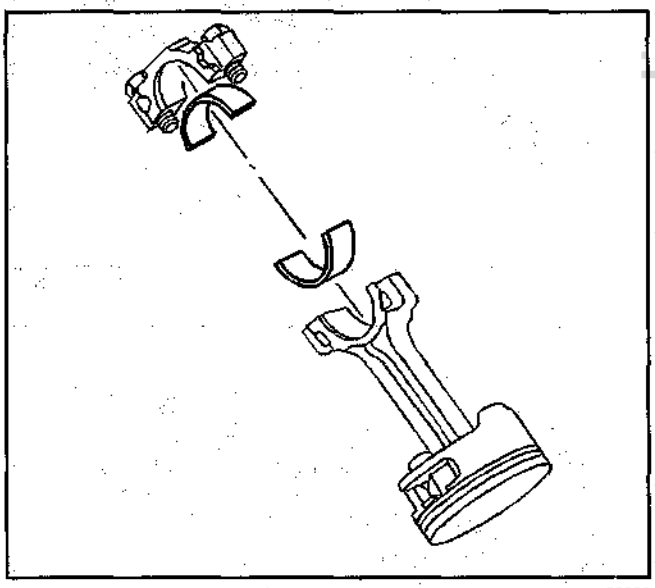
Notice: Refer to *Fastener Notice* in Cautions and Notices.

Important:

- When replacing connecting rod bolts, both bolts MUST be of the same design for each connecting rod assembly.

  The use of different design connecting rod bolts on the same connecting rod assembly may lead to uneven clamploads and/or connecting rod bearing bore distortion.
- Position the connecting rod cap onto the connecting rod properly.

  Align the flat side of the connecting rod cap with the flat side of the connecting rod.


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9. Install the bearing, cap, and bolts.

   Tighten

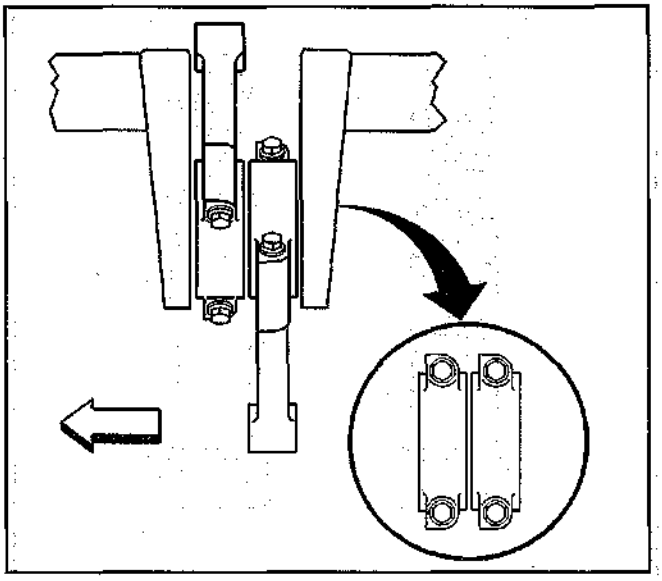
   9.1. Tighten the first design bolts a first pass evenly to 20 N·m (15 lb ft).

   9.2. Tighten the first design bolts a final pass to 60 degrees using the *J 36660-A*.

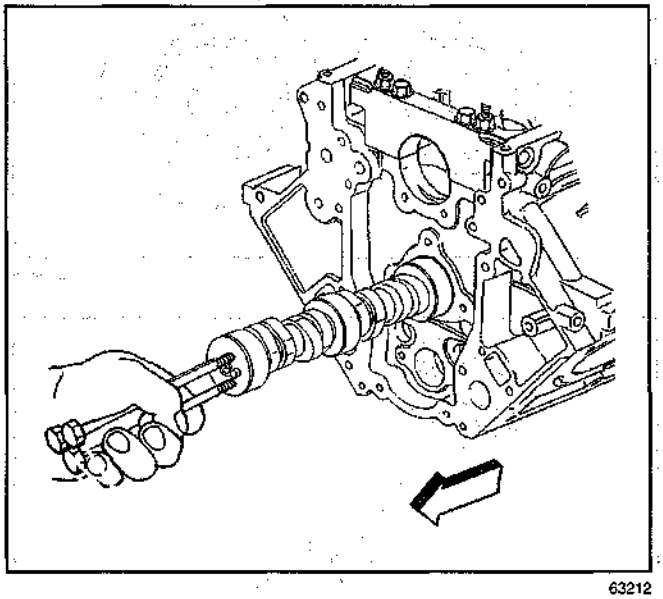
   9.3. Tighten the second design bolts a first pass evenly to 20 N·m (15 lb ft).

   9.4. Tighten the second design bolts a final pass to 75 degrees using the *J 36660-A*.

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10. Inspect the connecting rods for proper orientation onto the crankshaft journal.
11. With the pistons and connecting rods installed, use a soft faced mallet and lightly tap each connecting rod assembly parallel to the crankpin to make sure that the rods have side clearance.
12. Measure the connecting rod side clearance using a feeler gauge or a dial indicator. Connecting rod side clearance should be within 0.11–0.51 mm (0.0043–0.02 in).


63212

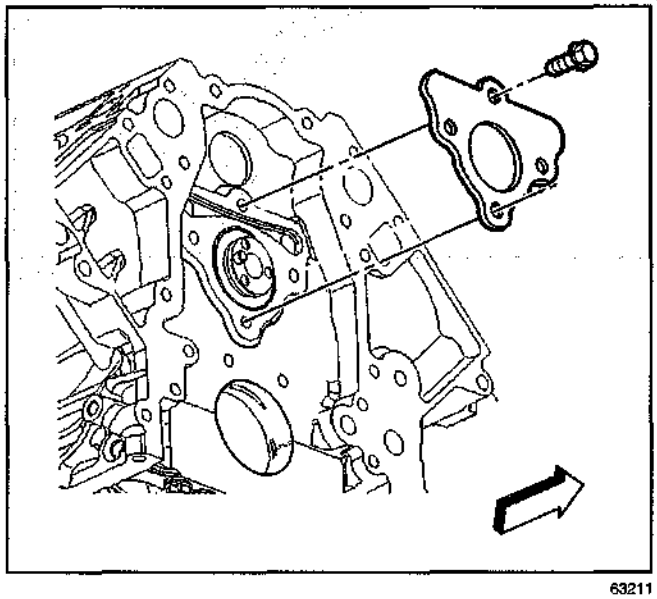
Camshaft Installation

Important: 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 three M8-1.25 x 100 mm (M8-1.25 x 4.0 in) bolts into the camshaft front bolt holes.

Notice: 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 three bolts from the front of the camshaft.


63211

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

Important: Install the retainer plate with the sealing gasket facing the engine block.

The gasket surface on the engine block should be clean and free of dirt or debris.

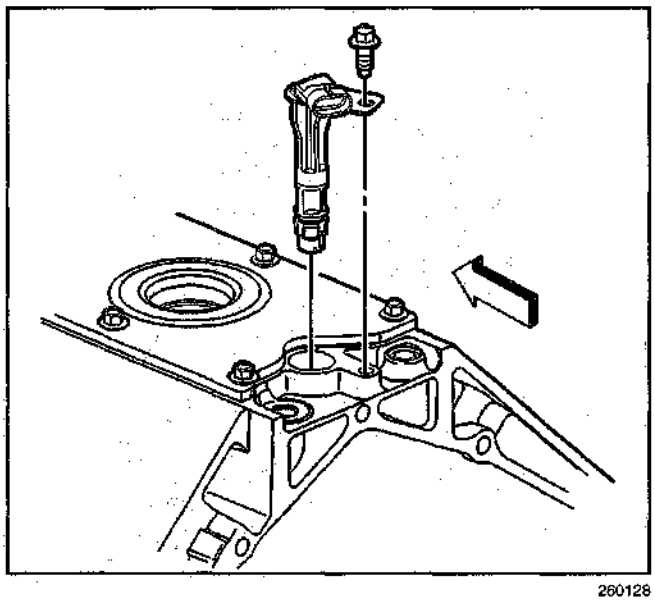
5. Install the camshaft retainer and the bolts.

   Tighten

   Tighten the camshaft retainer bolts to 25 N·m (18 lb ft).
6. Inspect the camshaft sensor O-ring seal. If the O-ring seal is not cut or damaged, it may be reused.
7. Lubricate the O-ring seal with clean engine oil.

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8. Install the camshaft sensor and bolt.
   Tighten
   Tighten the camshaft sensor bolt to 25 N·m (18 lb ft).

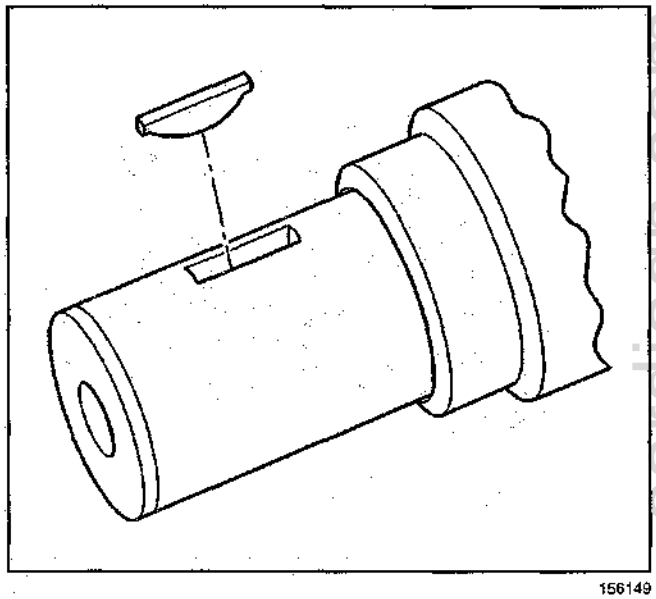

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Timing Chain and Sprockets Installation

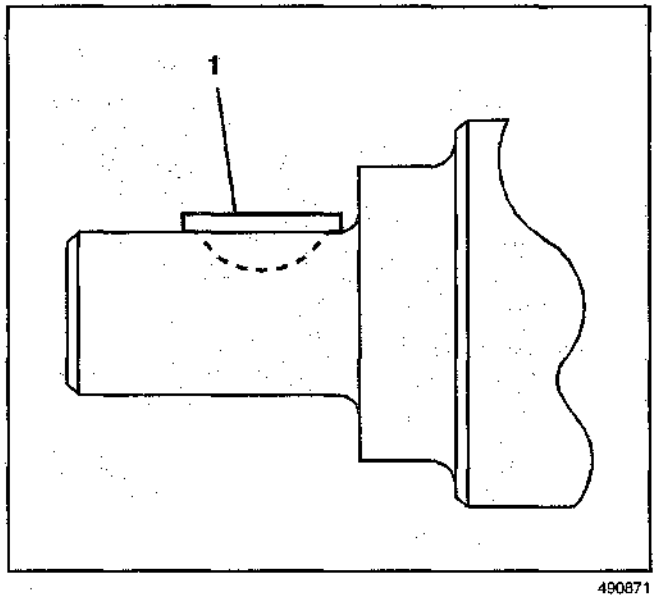
Tools Required

J 41665 Crankshaft Balancer and Sprocket Installer

1. Install the key into the crankshaft keyway (if previously removed).

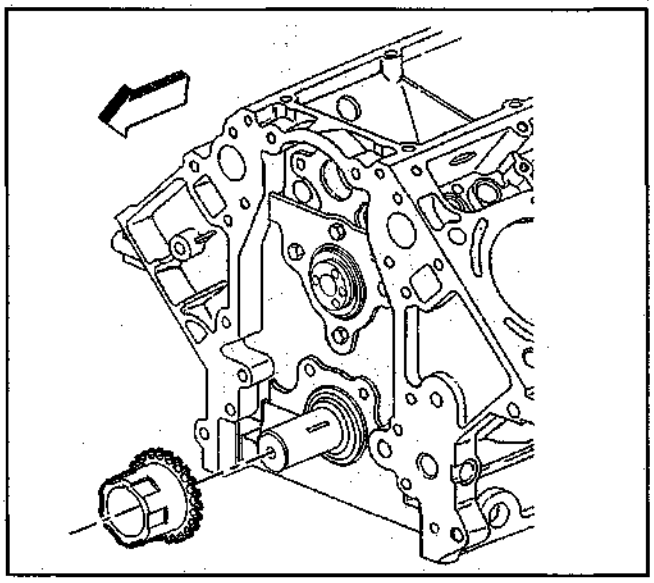

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2. Tap the key (1) into the keyway until both ends of the key bottom onto the crankshaft.

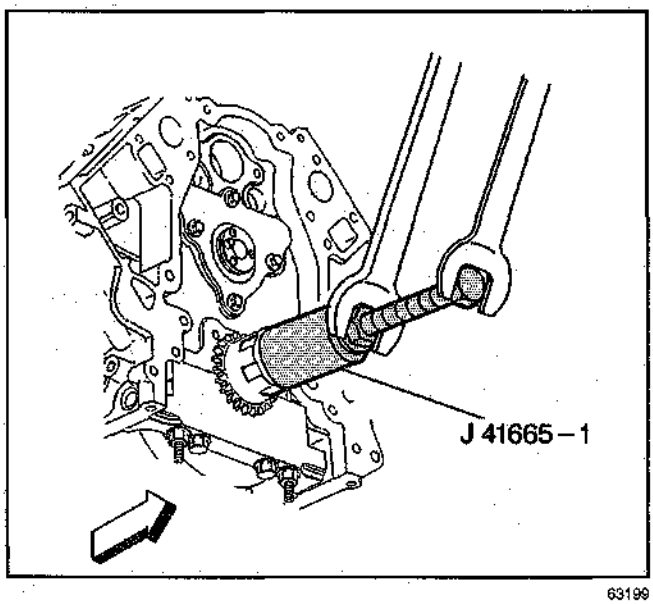


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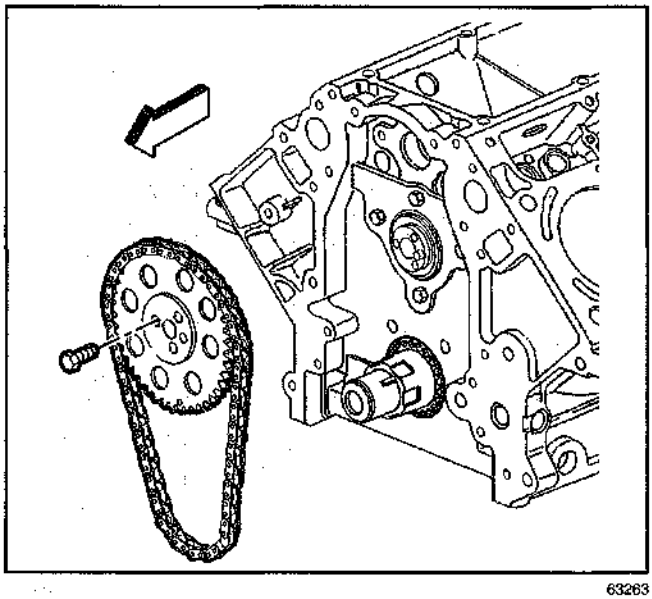
3. Install the crankshaft sprocket onto the front of the crankshaft. Align the crankshaft key with the crankshaft sprocket keyway.



63199

4. Use the *J 41665* 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.


63263

Important:

- Properly locate the camshaft sprocket locating pin with the camshaft sprocket alignment hole.
- The sprocket teeth and timing chain must mesh.
- The camshaft and the crankshaft sprocket alignment marks MUST be aligned properly.

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

6. Install the camshaft sprocket and timing chain.

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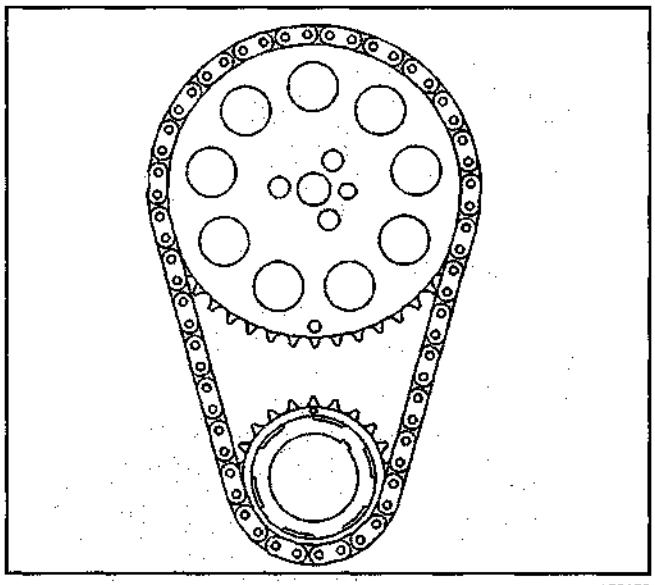
7. If necessary, rotate the camshaft or crankshaft sprockets in order to align the timing marks.

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

8. Install the camshaft sprocket bolts.

   Tighten

   Tighten the camshaft sprocket bolts to 35 N·m (26 lb ft).



156158

Oil Pump, Pump Screen and Deflector Installation

Important: Inspect the oil pump and engine block oil gallery passages. These surfaces must be clear and free of debris or restrictions.

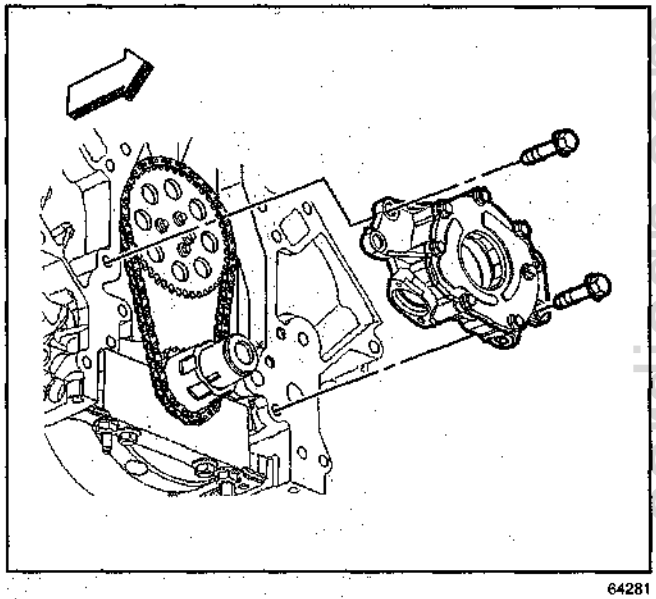
1. Align the splined surfaces of the crankshaft sprocket and the oil pump drive gear and install the oil pump.
2. Install the oil pump onto the crankshaft sprocket until the pump housing contacts the face of the engine block.

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

3. Install the oil pump bolts.

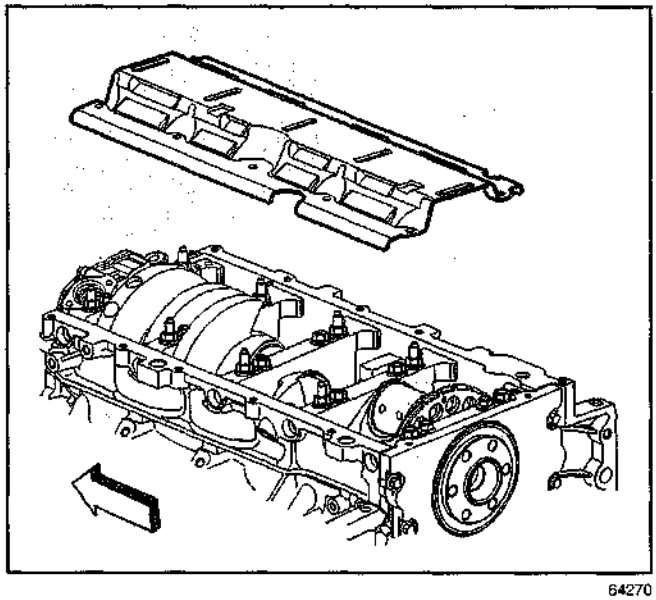
   Tighten

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



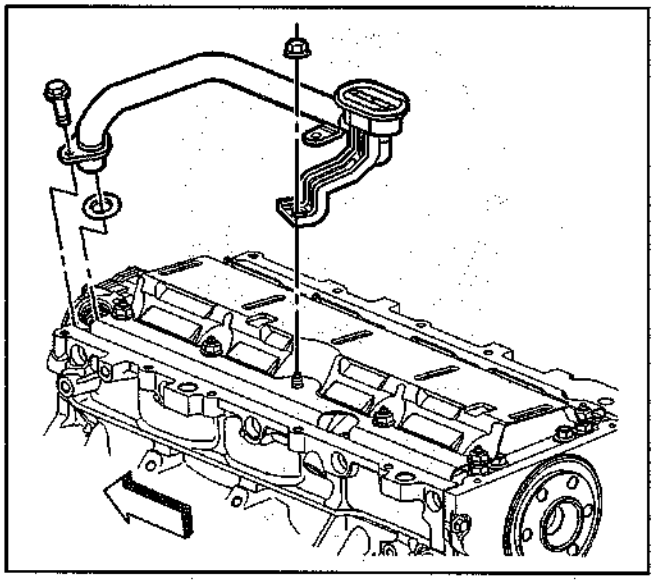
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4. Install the crankshaft oil deflector.
5. Lubricate a NEW oil pump screen O-ring seal with clean engine oil.
6. Install the NEW O-ring seal onto the oil pump screen.



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Important: 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.

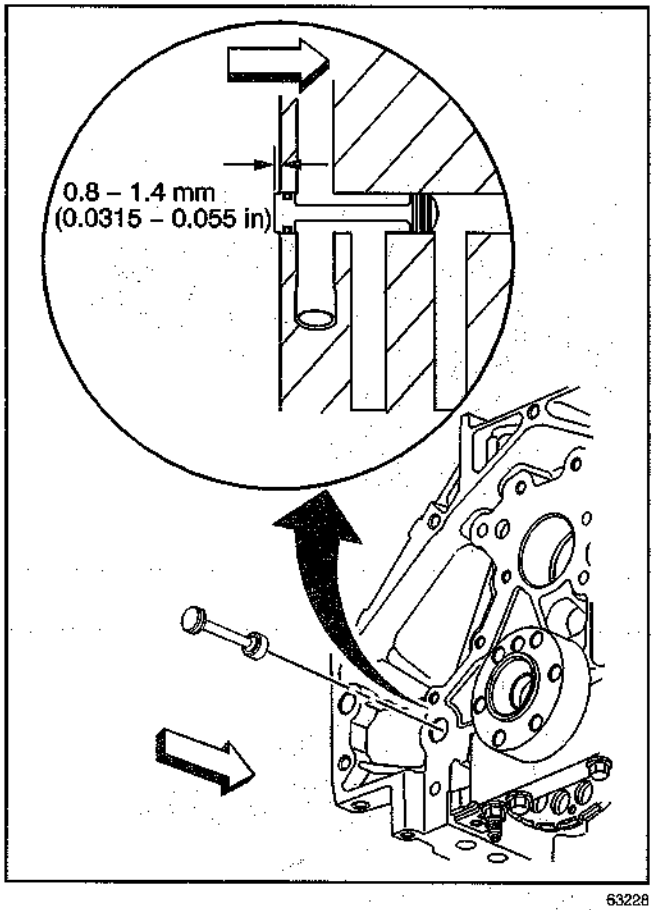
Align the oil pump screen mounting brackets with the correct crankshaft bearing cap studs.

7. Install the oil pump screen.
8. Install the oil pump screen bolt and the deflector nuts.

   Tighten

   8.1. Tighten the oil pump screen bolt to 12 N·m (106 lb in).

   8.2. Tighten the crankshaft oil deflector nuts to 25 N·m (18 lb ft).



63228

Engine Rear Cover Installation

Tools Required

- *J 41480* Front/Rear Cover Alignment (Oil Pan Surface)
- *J 41476* Front/Rear Cover Alignment (Crankshaft Oil Seal Area)

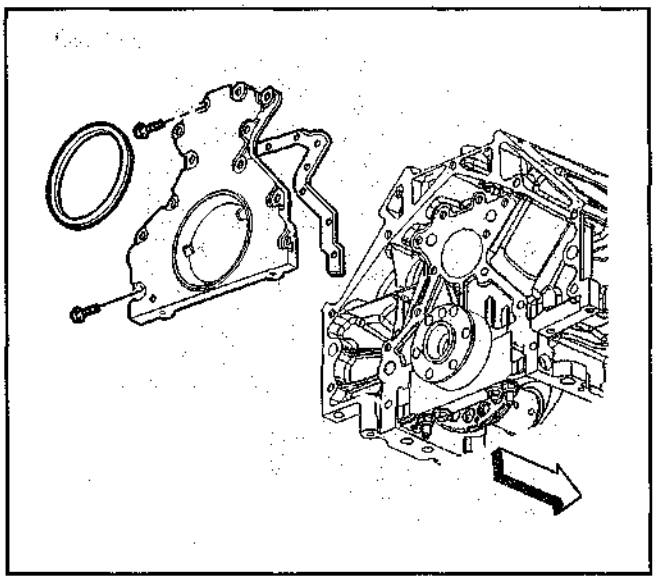
Important:

- Do not reuse the crankshaft rear oil seal or the engine rear cover gasket.
- Do not apply any type sealant to the rear cover gasket (unless specified).
- The special tools in this procedure are used to properly align the engine rear cover at the oil pan surface and to center the crankshaft rear oil seal.
- The crankshaft rear oil seal will be installed after the rear cover has been installed and aligned. Install the rear cover 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 cover and engine block MUST be aligned within specifications.
  - An improperly aligned rear cover may cause premature rear oil seal wear and/or engine assembly oil leaks.

1. Inspect the rear oil gallery plug for proper installation.

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2. Install the rear cover gasket, rear cover and bolts.
3. Tighten the bolts finger tight. Do not overtighten.


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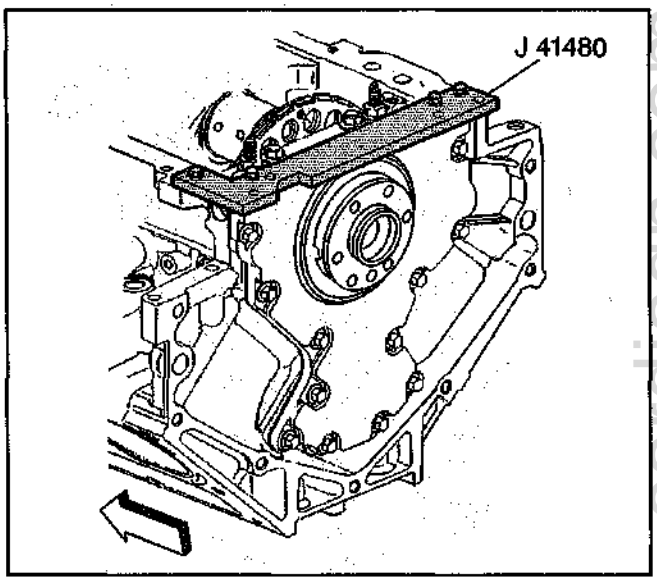
Notice: Refer to *Fastener Notice* in Cautions and Notices.

Important: Start the *J 41480* tool-to-rear cover bolts. Do not tighten the bolts at this time.

4. Install the *J 41480* and bolts.

   Tighten

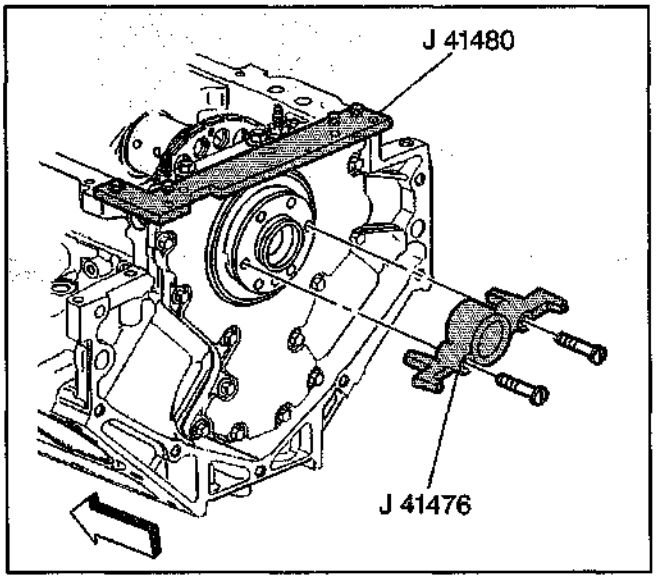
   Tighten the tool-to-engine block bolts to 25 N·m (18 lb ft).



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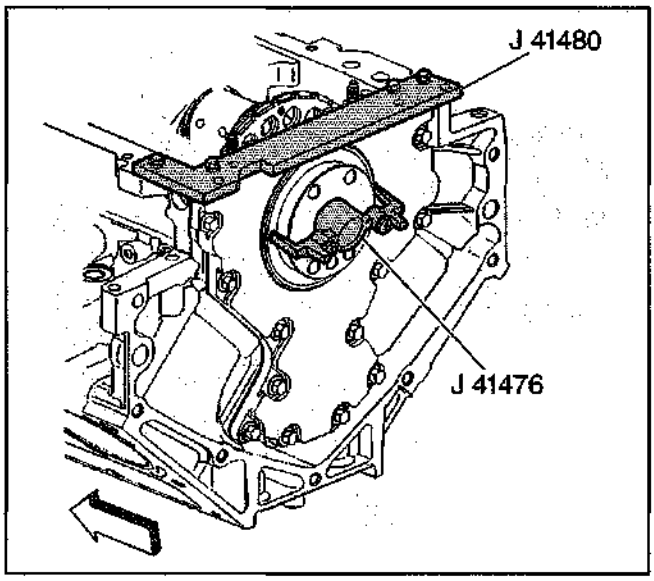
Important: To properly align the rear cover, the *J 41476* must be installed onto the rear of the crankshaft with the tool mounting bolts parallel to the oil pan surface.

5. Rotate the crankshaft until two opposing flywheel bolt holes are parallel to the oil pan surface.



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Important: The tapered legs of the alignment tool must enter the rear cover oil seal bore.

6. Install the *J 41476* and bolts onto the rear of the crankshaft.

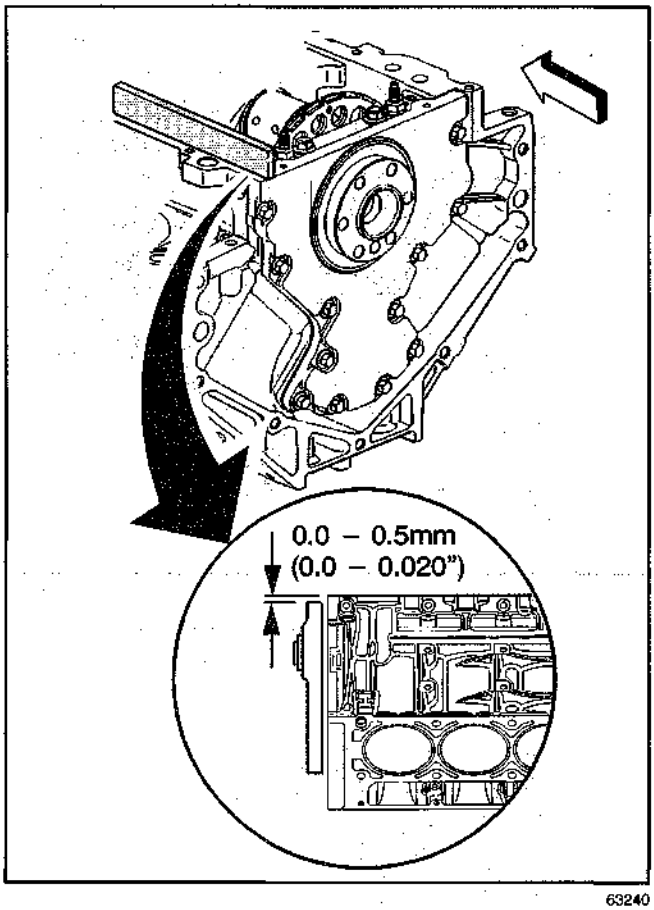
   Tighten

   6.1. Tighten the tool mounting bolts until snug. Do not overtighten.

   6.2. Tighten the *J 41480* tool-to-rear cover bolts evenly to 12 N·m (106 lb in).

   6.3. Tighten the rear cover bolts to 25 N·m (18 lb ft).

7. Remove the tools.



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8. Measure the oil pan surface for flatness (rear cover-to-engine block).

   8.1. Place a straight edge onto the engine block and rear cover 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 cover and the straight edge. The cover must be flush with the oil pan or no more than 0.5 mm (0.02 in) below flush.

9. If the rear cover-to-engine block oil pan surface alignment is not within specifications, repeat the cover alignment procedure.

10. If the correct rear cover-to-engine block alignment at the oil pan surface cannot be obtained, replace the rear cover.

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Crankshaft Rear Oil Seal Installation

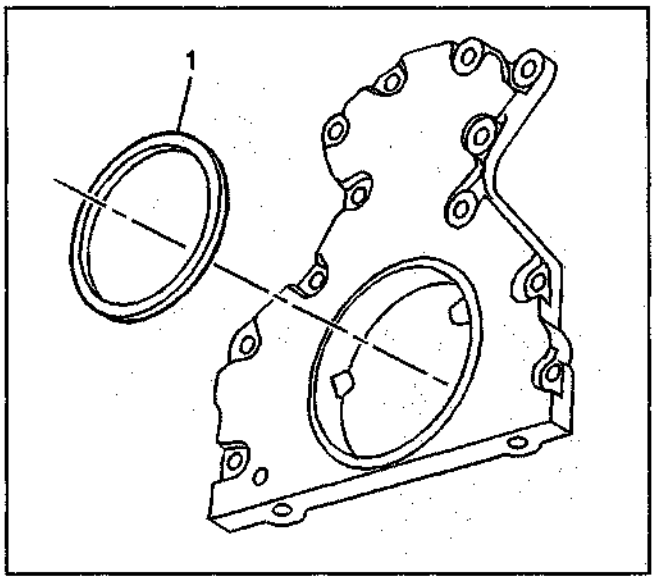
Tools Required

J 41479 Crankshaft Rear Oil Seal Installer

Important:

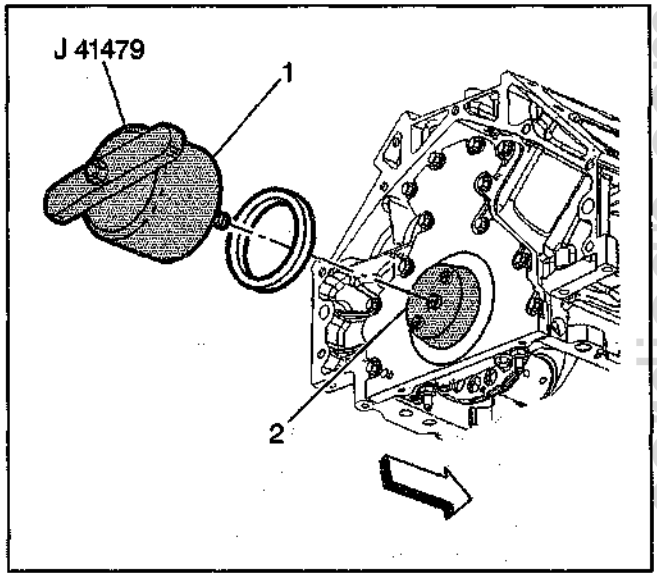
- Do not lubricate the oil seal inside diameter (ID) or the crankshaft surface.
- Do not reuse the crankshaft rear oil seal.

1. Lubricate the outside diameter (OD) of the oil seal (1) with clean engine oil.
   DO NOT allow oil or other lubricants to contact the seal surface.
2. Lubricate the rear cover oil seal bore with clean engine oil.
   DO NOT allow oil or other lubricants to contact the crankshaft surface.



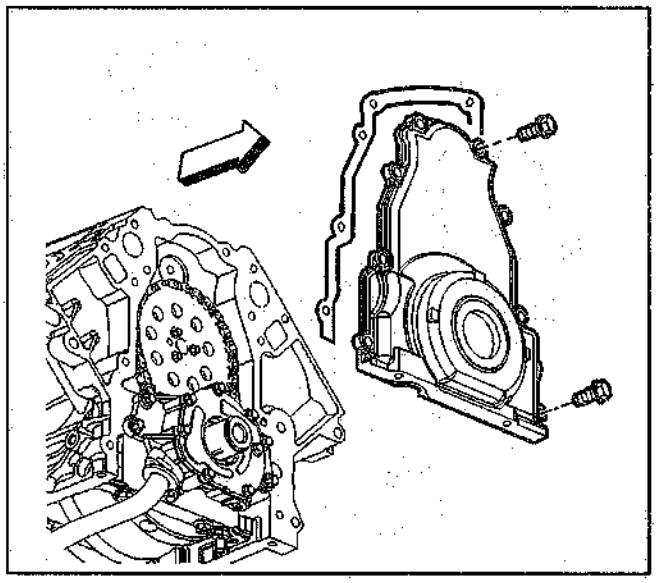
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3. Install the *J 41479* cone (2) and bolts onto the rear of the crankshaft.
4. Tighten the bolts until snug. Do not overtighten.
5. Install the rear oil seal onto the tapered cone (2) and push the seal to the rear cover bore.
6. Thread the *J 41479* threaded rod into the tapered cone until the tool (1) contacts the oil seal.
7. Align the oil seal onto the tool (1).
8. Rotate the handle of the tool (1) clockwise until the seal enters the rear cover and bottoms into the cover bore.
9. Remove the tool.

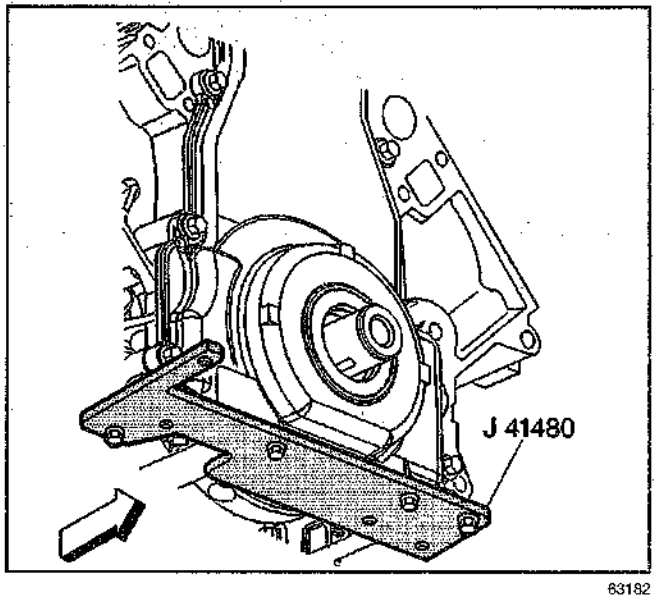


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Engine Front Cover Installation

Tools Required

- *J 41480* Front/Rear Cover Alignment (Oil Pan Surface)
- *J 41476* Front/Rear Cover Alignment (Crankshaft Oil Seal Area)

Important:

- Do not reuse the crankshaft oil seal or the engine front cover gasket.
- Do not apply any type 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.

1. Install the front cover gasket, cover, and bolts onto the engine.
2. Tighten the cover bolts finger tight. Do not overtighten.

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

Important: Start the tool-to-front cover bolts. Do not tighten the bolts at this time.

3. Install the *J 41480*.

   Tighten

   Tighten the tool-to-engine block bolts to 25 N·m (18 lb ft).

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Important: Align the tapered legs of the tool with the machined alignment surfaces on the front cover.

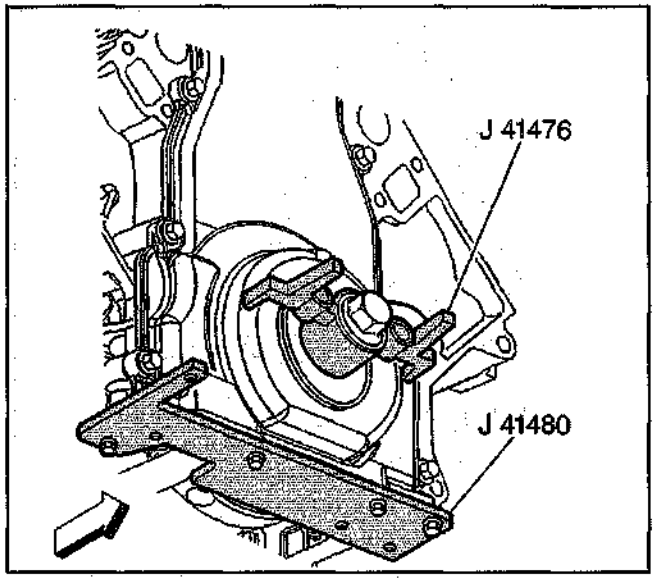
4. Install the *J 41476*.
5. Install the crankshaft balancer bolt.

   Tighten

   5.1. Tighten the crankshaft balancer bolt by hand until snug. Do not overtighten.

   5.2. Tighten the *J 41480*.

   5.3. Tighten the engine front cover bolts to 25 N·m (18 lb ft).
6. Remove the tools.



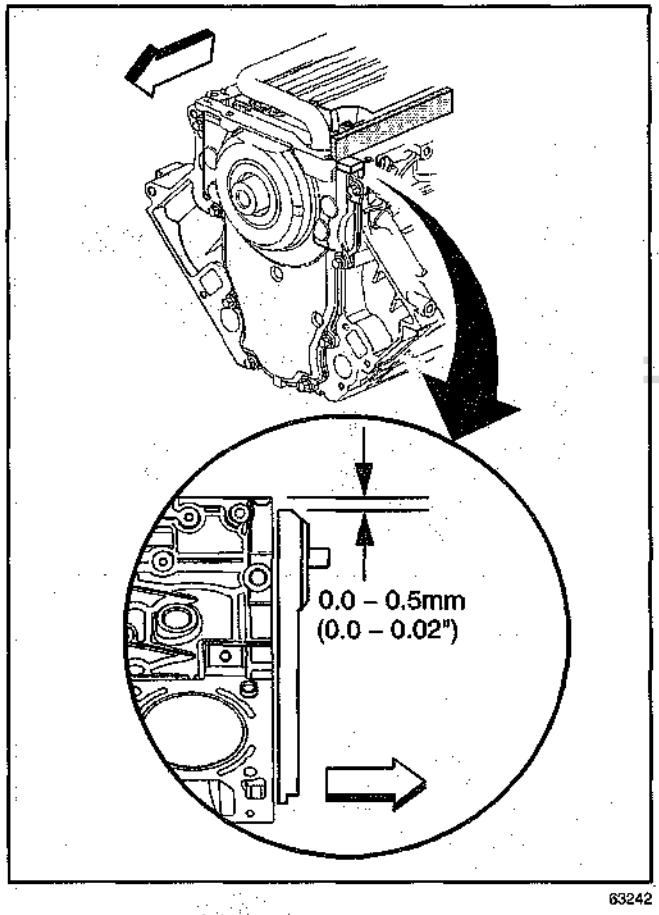
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7. Measure the oil pan surface flatness (front cover-to-engine block).

   7.1. Place a straight edge across the engine block and front cover oil pan sealing surfaces.

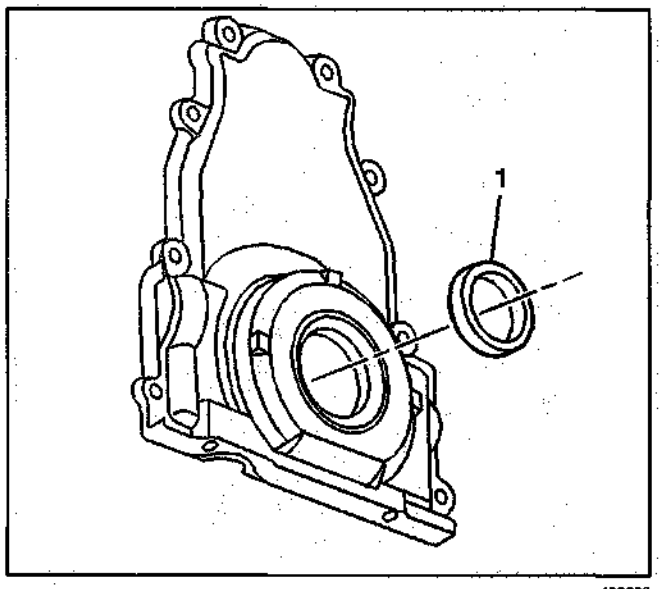
   Avoid contact with the portion of the gasket that protrudes into the oil pan surface.

   7.2. 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 more than 0.5 mm (0.02 in) below flush.
8. If the front cover-to-engine block oil pan surface alignment is not within specifications, repeat the cover alignment procedure.
9. If the correct front cover-to-engine block alignment cannot be obtained, replace the front cover.



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Crankshaft Front Oil Seal Installation

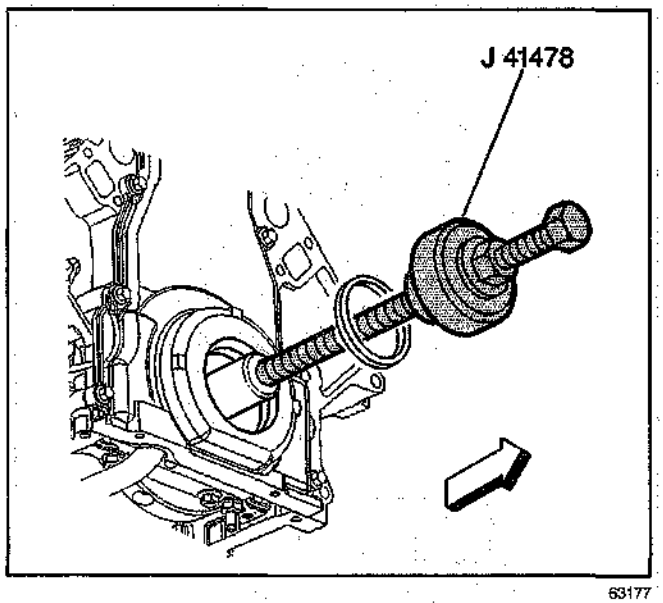
Tools Required

J 41478 Crankshaft Front Oil Seal Installer

Important: Do not lubricate the oil seal sealing surface.

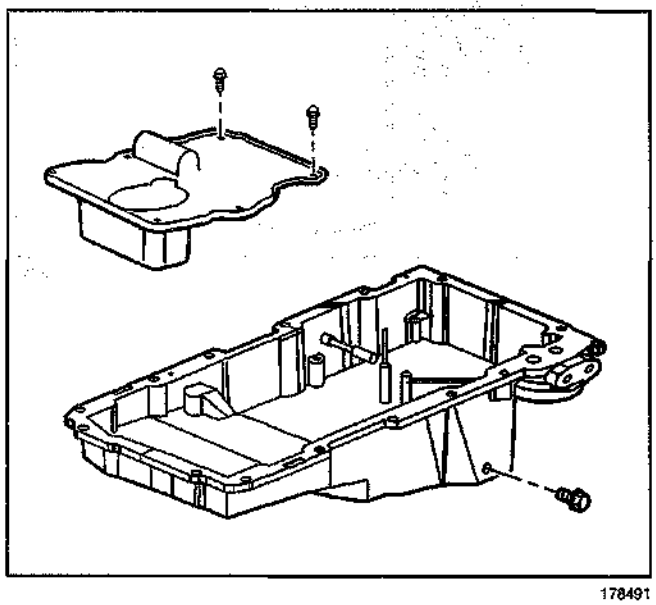
Do not reuse the crankshaft front oil seal.

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.



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3. Install the crankshaft front oil seal onto the *J 41478* guide.
4. Install the *J 41478* threaded rod (with nut, washer, guide, and oil seal) into the end of the crankshaft.
5. Use the *J 41478* 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.


178491

Oil Pan Installation

Important: 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 reuse the oil pan gasket.

It is not necessary to rivet the NEW gasket to the oil pan.

It is not necessary to remove the oil level sensor prior to oil pan installation.

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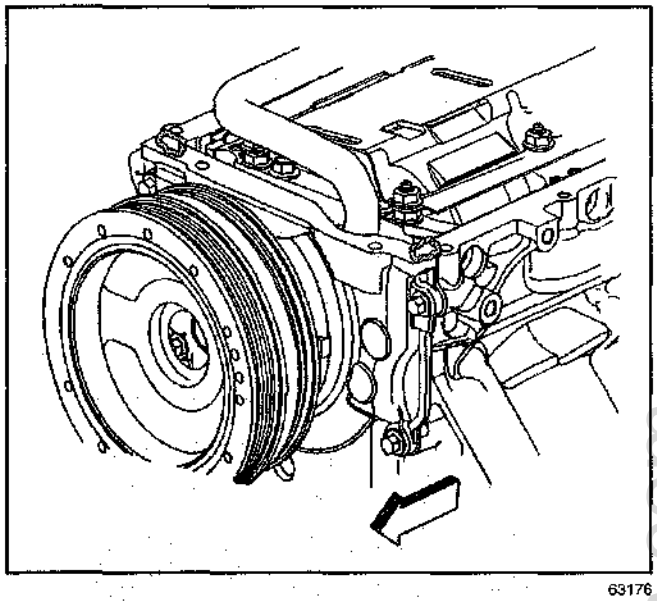
Notice: Refer to *Fastener Notice* in Cautions and Notices.

1. Install the oil pan baffle and bolts (if previously removed).

   Tighten

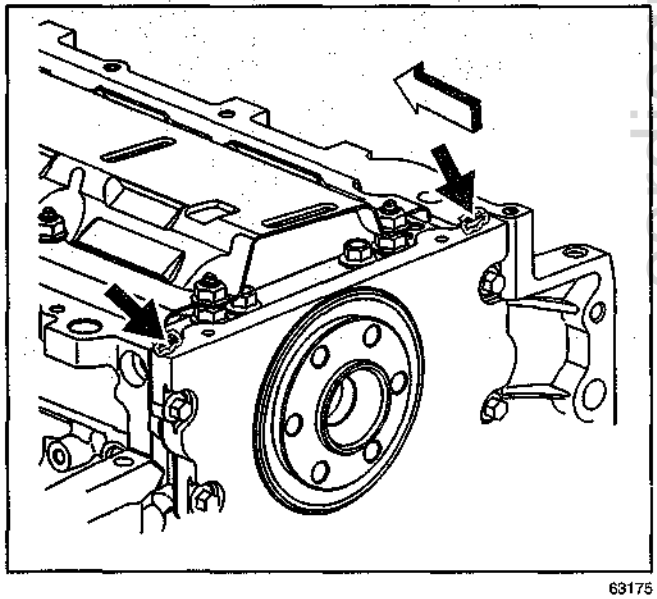
   Tighten the oil pan baffle bolts to 12 N·m (106 lb in).

2. Apply a 5 mm (0.2 in) bead of sealant GM P/N 12378190 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 *Sealers, Adhesives, and Lubricants*.



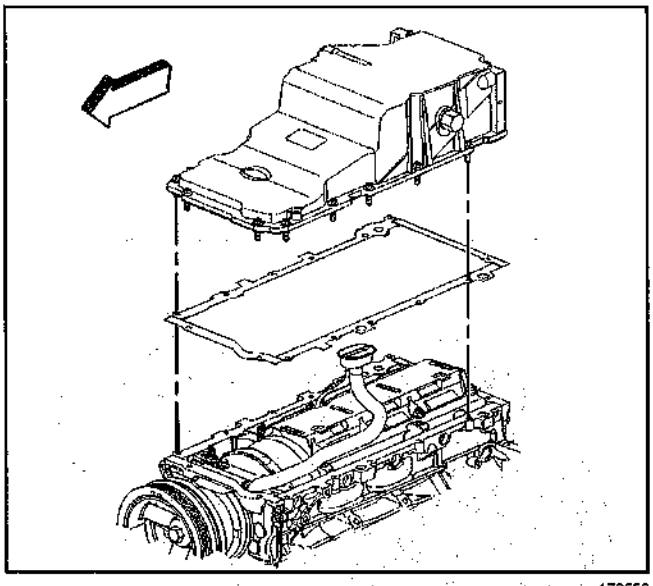
63176

3. Apply a 5 mm (0.2 in) bead of sealant GM P/N 12378190 or equivalent 20 mm (0.8 in) long to the engine block. Apply the sealant directly onto the tabs of the rear cover gasket that protrude into the oil pan surface. Refer to *Sealers, Adhesives, and Lubricants*.

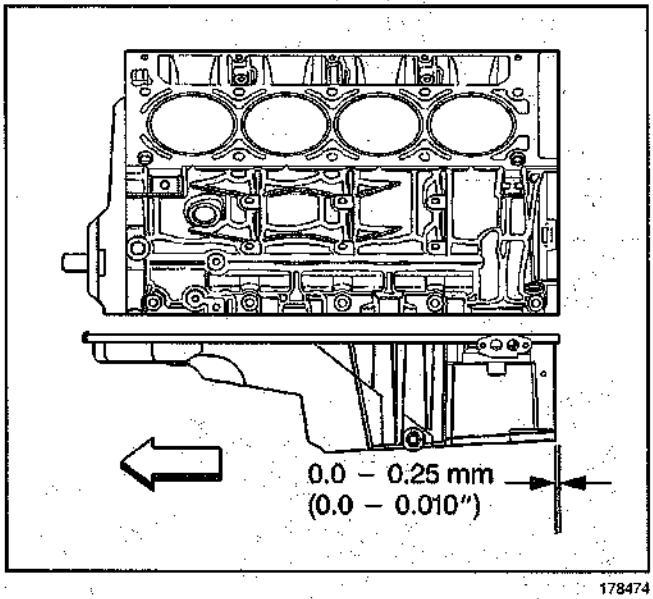


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Important: Be sure to align the oil gallery passages in the oil pan and engine block properly with the oil pan gasket.

4. Preassemble the oil pan gasket to the pan.
   4.1. Install the gasket onto the oil pan.
   4.2. Install the oil pan bolts to the pan and through the gasket.
5. Install the oil pan, gasket and bolts to the engine block.
6. Tighten bolts finger tight. Do not overtighten.
7. Place a straight edge across the rear of the engine block and the rear of the oil pan at the transmission housing mounting surfaces.
8. Align the oil pan until the rear of engine block and rear of oil pan are flush or even.

   Tighten

   8.1. Tighten the oil pan-to-block and oil pan-to-front cover bolts to 25 N·m (18 lb ft).
   8.2. Tighten the oil pan-to-rear cover bolts to 12 N·m (106 lb in).
9. Measure the oil pan-to-engine block alignment.
   9.1. Place a straight edge across the rear of the engine block and rear of oil pan at the transmission housing mounting surfaces.

Important: The rear of the oil pan must NEVER protrude beyond the engine block and transmission housing mounting surfaces.

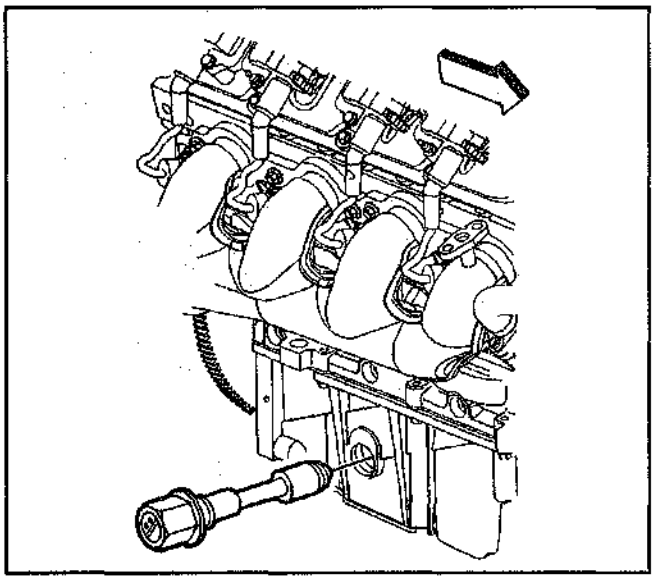
   9.2. Insert a feeler gauge between the straight edge and the oil pan transmission housing mounting surface and check to make sure that there is no more than a 0.25 mm (0.01 in) gap between the pan and straight edge.
   9.3. If the oil pan alignment is not within specifications, remove the oil pan and repeat the above procedure.

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10. Install the oil level sensor.

    Tighten

    Tighten the oil level sensor to 13 N·m (115 lb in).



178467

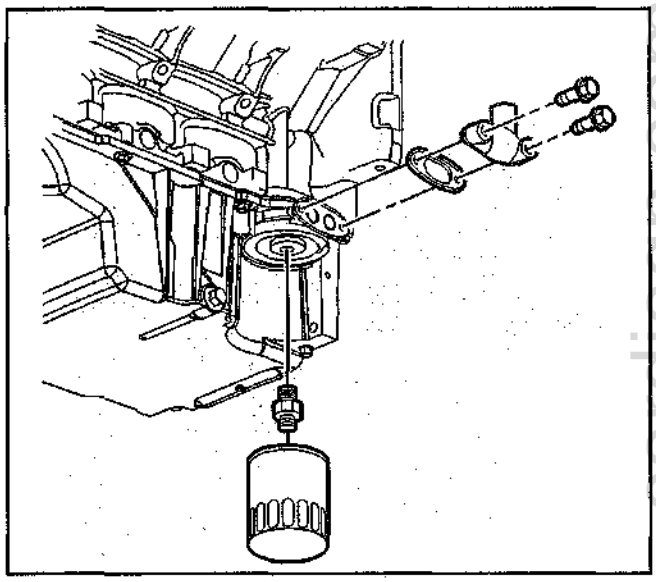
Oil Filter, Adapter, Pan Cover Installation

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

1. Install a NEW oil pan cover gasket, the cover and the bolts.

   Tighten

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

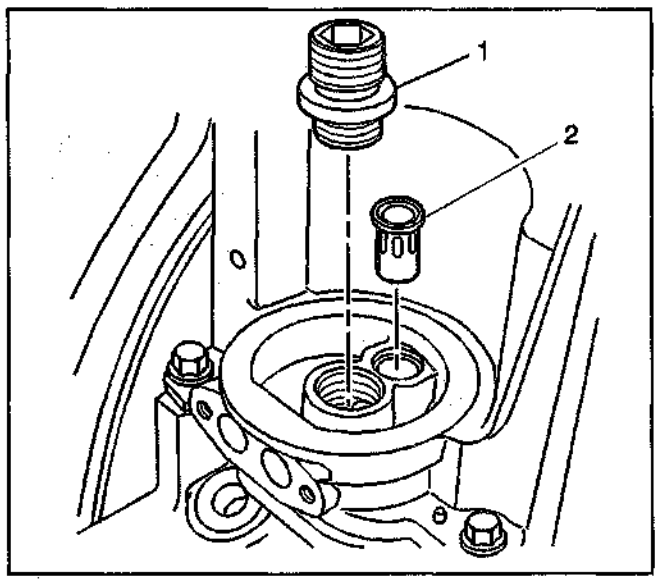


178471

2. Install a new oil filter bypass valve (2) into the oil pan (if required).
3. Install the oil filter fitting (1).

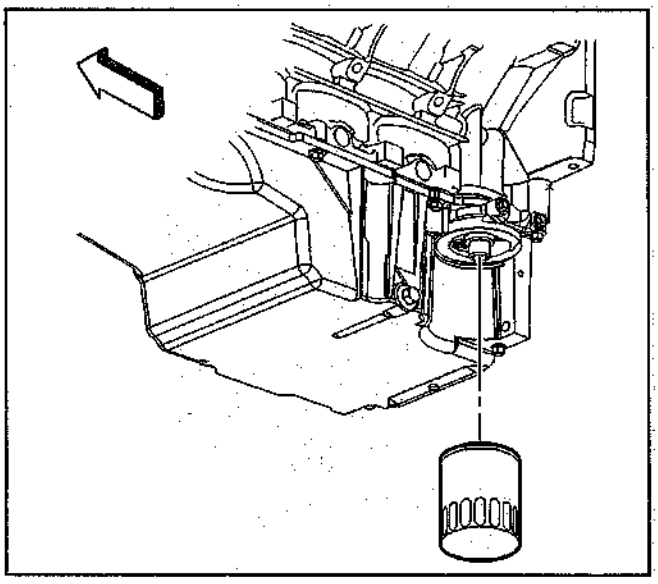
   Tighten

   Tighten the oil filter fitting to 55 N·m (40 lb ft).

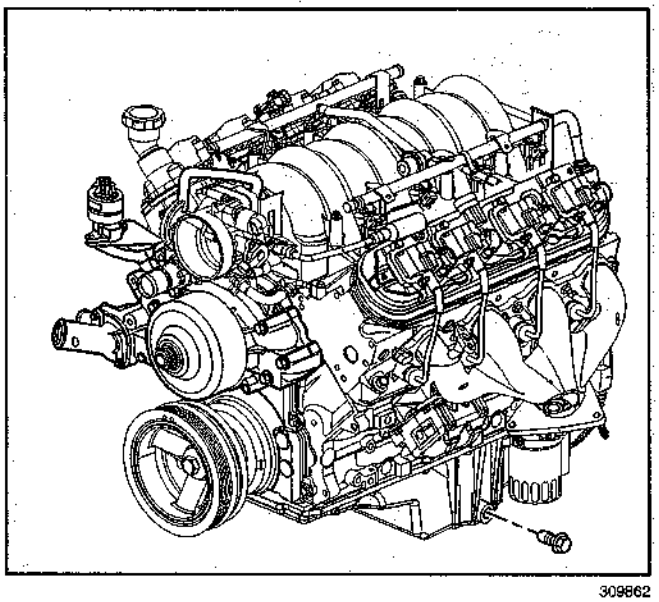


490699

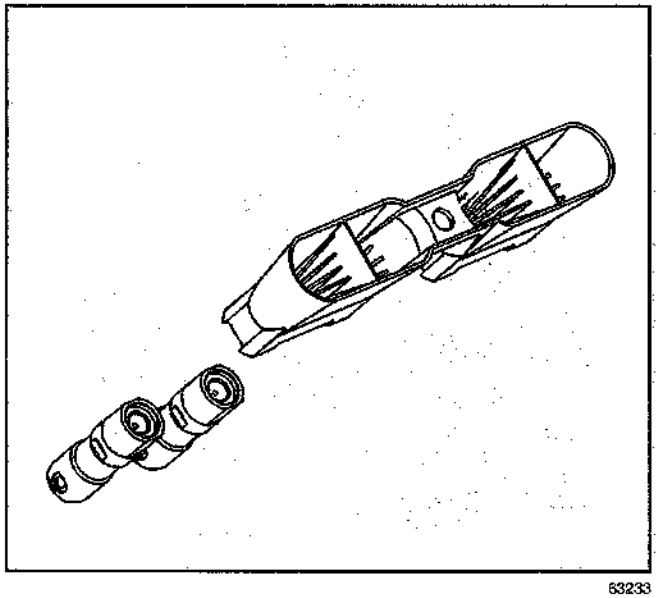
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178469

4. Install the oil filter.
   Tighten
   Tighten the oil filter to 30 N·m (22 lb ft).


309862

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


53233

Valve Lifter Installation

Important: When reusing valve lifters, install the lifters to their original locations.

If camshaft replacement is required, the valve lifters must also be replaced.

1. Lubricate the valve lifters and engine block valve lifter bores with clean engine oil.
2. Insert the valve lifters into the lifter guides.
   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.

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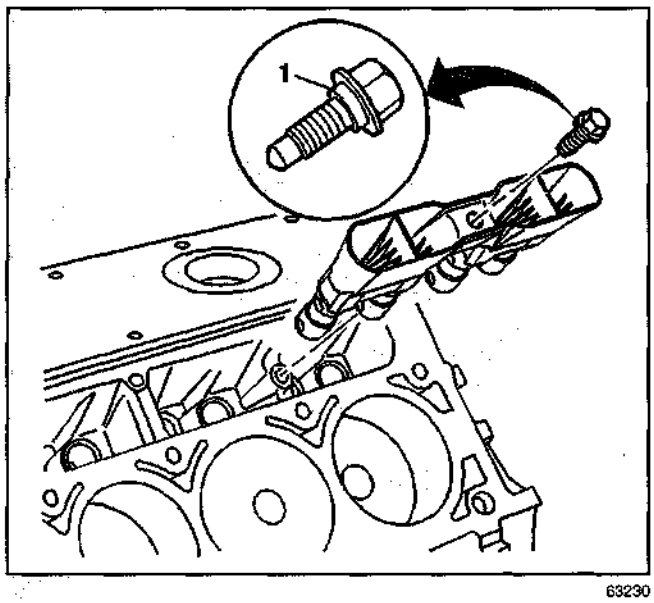
3. Install the valve lifters and guide assembly to the engine block.

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

4. Install the valve lifter guide bolt (1).

Tighten

Tighten the valve lifter guide bolt to 12 N·m (106 lb in).



63230

Cylinder Head Installation (Left Side)

Tools Required

J 36660-A Torque Angle Meter

Important: Do not reuse the M11 cylinder head bolts. Install NEW M11 cylinder head bolts during assembly.

Do not use any type sealant on the cylinder head gasket (unless specified).

The cylinder head gaskets must be installed in the proper direction and position.

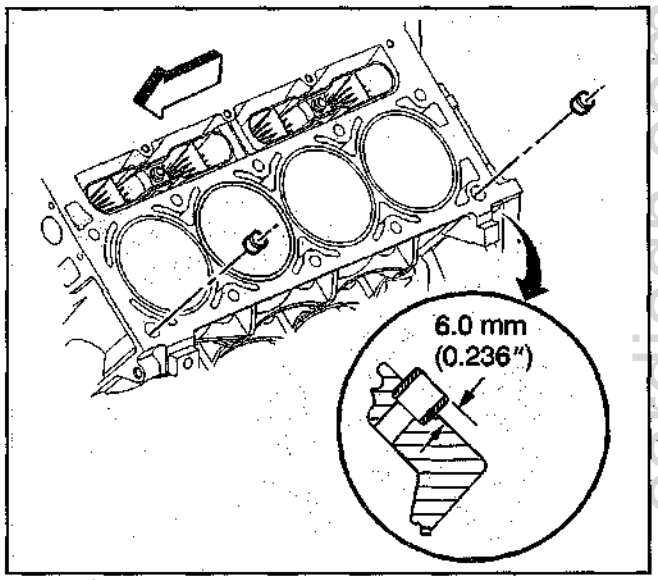
Caution: Wear safety glasses in order to avoid eye damage.

Notice: 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.

1. Clean the engine block cylinder head bolt holes (if required).

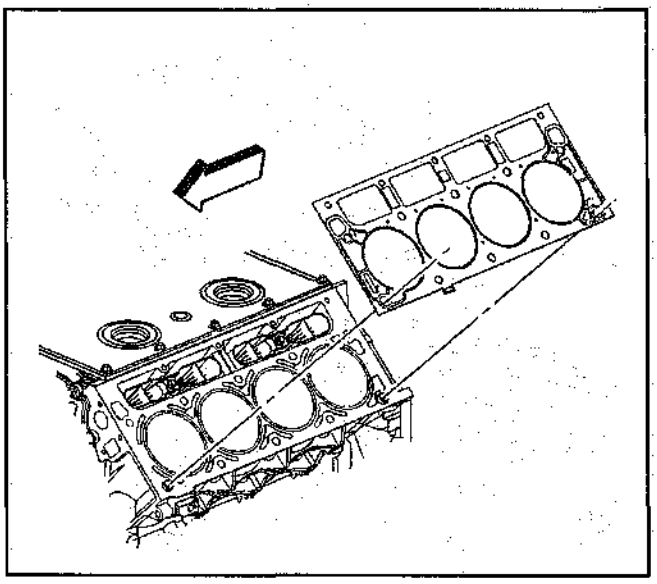
   Thread repair tool J 42385-107 may be used to clean the threads of old threadlocking material.

2. Spray cleaner GM P/N 12346139, P/N 12377981, or equivalent into the hole.
3. Clean the cylinder head bolt holes with compressed air.
4. Check the cylinder head locating pins for proper installation.



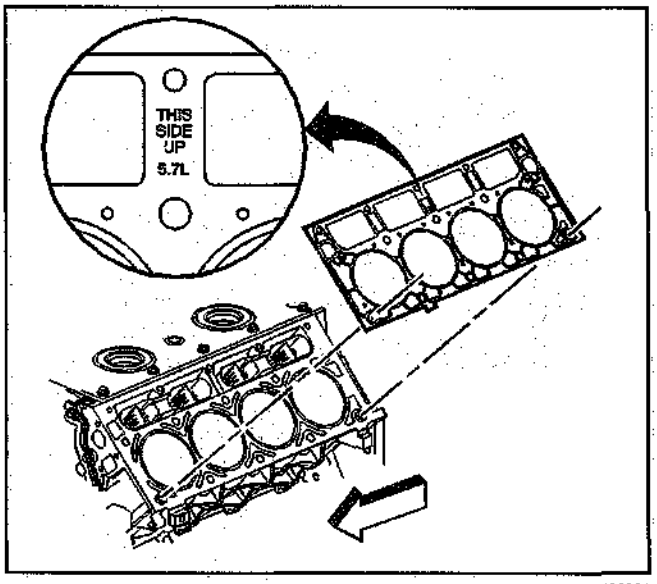
63235

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63169

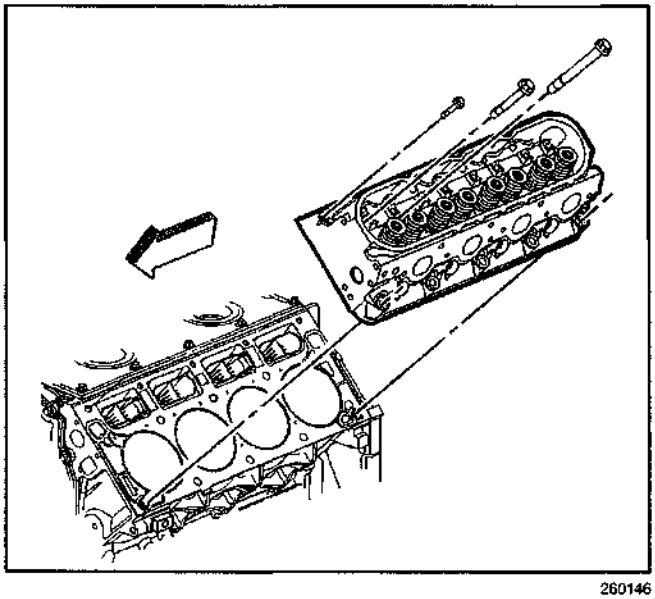
5. Install the NEW left cylinder head gasket onto the locating pins.



490861

Important: When properly installed, the tab on the left cylinder head gasket will be located left of center, or closer to the front of the engine, and the words "This Side Up", and the engine displacement, will be visible.

6. Inspect the gasket for proper installation.



260146

7. Install the cylinder head onto the locating pins and the gasket.
8. Install the NEW M11 cylinder head bolts.
9. Apply a 5 mm (0.2 in) band of threadlock GM P/N 12345382 or equivalent to the threads of the M8 cylinder head bolts.
   Refer to *Sealers, Adhesives, and Lubricants.*
10. Install the M8 cylinder head bolts.

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

11. Tighten the cylinder head bolts.

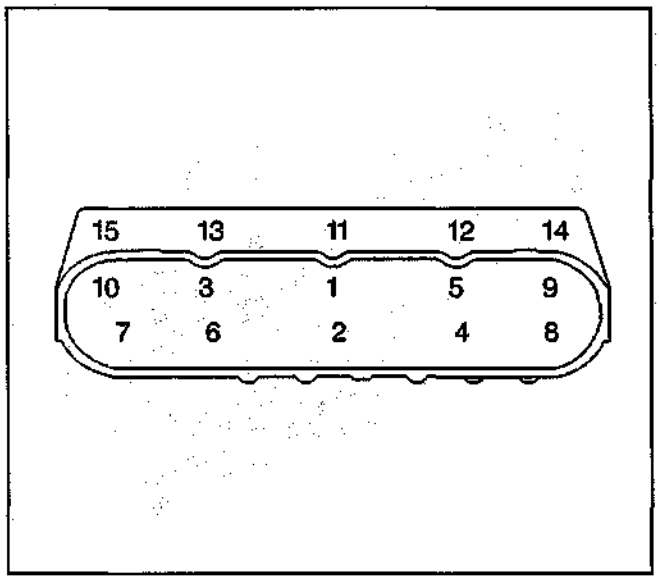
    Tighten

    11.1. Tighten the M11 cylinder head bolts (1–10) a first pass in sequence to 30 N·m (22 lb ft).

    11.2. Tighten the M11 cylinder head bolts (1–10) a second pass in sequence to 90 degrees using the *J 36660-A*.

    11.3. Tighten the M11 cylinder head bolts (1,2,3,4,5,6,7,8) to 90 degrees and the M11 cylinder head bolts (9 and 10) to 50 degrees a final pass in sequence to using the *J 36660-A*.

    11.4. Tighten the M8 cylinder head bolts (11,12,13,14,15) 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.



260150

Cylinder Head Installation (Right Side)

Tools Required

J 36660-A Torque Angle Meter

Important: Do not reuse the M11 cylinder head bolts. Install NEW M11 cylinder head bolts during assembly.

Do not use any type sealant on the cylinder head gasket (unless specified).

The cylinder head gaskets must be installed in the proper direction and position.

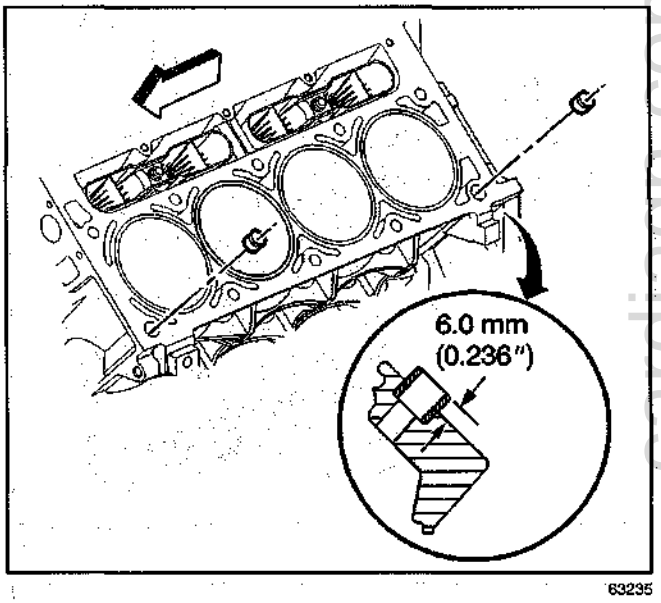
Caution: Wear safety glasses in order to avoid eye damage.

Notice: 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.

1. Clean the engine block cylinder head bolt holes (if required).

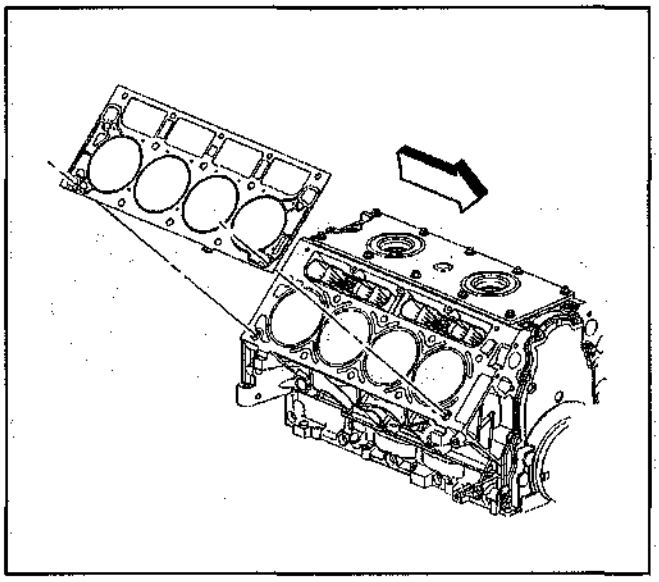
   Thread repair tool J 42385-107 may be used to clean the threads of old threadlocking material.

2. Spray cleaner GM P/N 12346139, P/N 12377981, or equivalent into the hole.
3. Clean the cylinder head bolt holes with compressed air.
4. Check the cylinder head locating pins for proper installation.



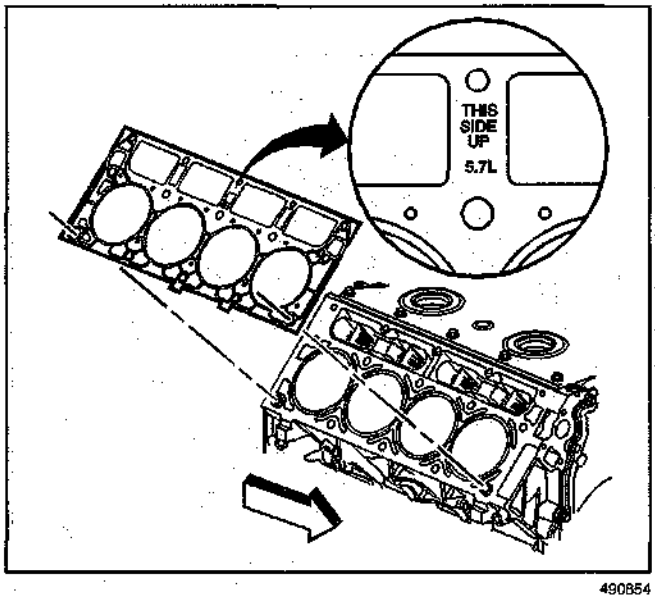
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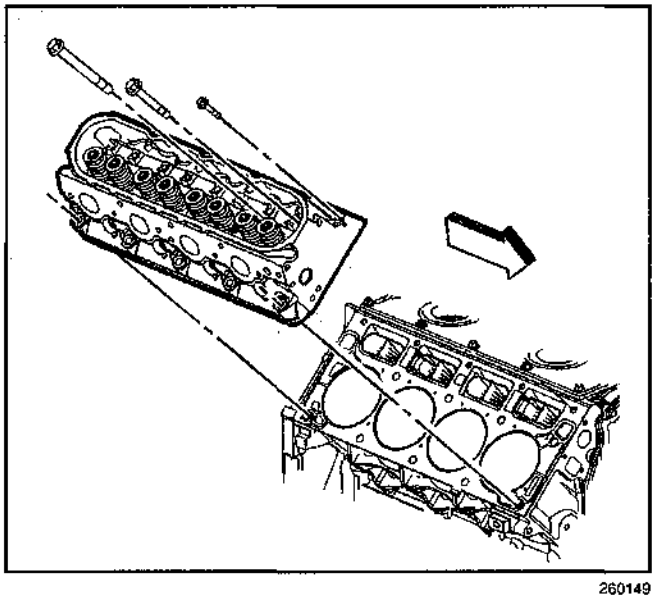
5. Install the NEW right cylinder head gasket onto the locating pins.



490854

Important: When properly installed, the tab on the right cylinder head gasket will be located right of center, or closer to the front of the engine, and the words "This Side Up", and the engine displacement will be visible.

6. Inspect the gasket for proper installation.



260149

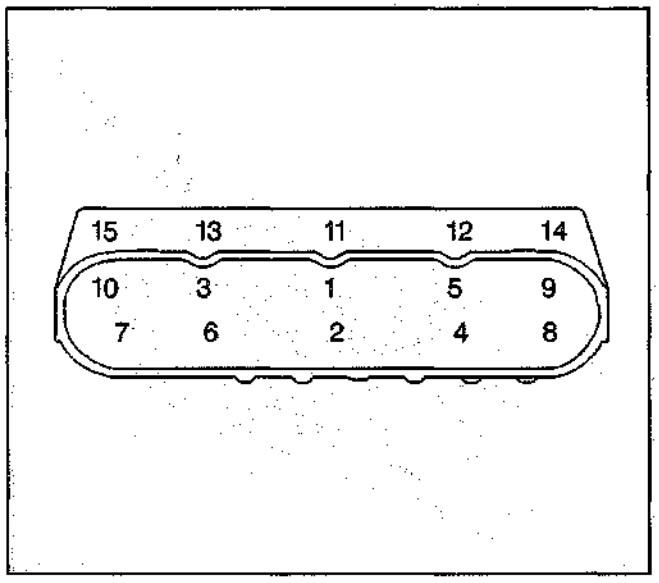
7. Install the cylinder head onto the locating pins and the gasket.
8. Install the NEW M11 cylinder head bolts.
9. Apply a 5 mm (0.2 in) band of threadlock GM P/N 12345382 or equivalent to the threads of the M8 cylinder head bolts.

   Refer to *Sealers, Adhesives, and Lubricants.*
10. Install the M8 cylinder head bolts.

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

11. Tighten the cylinder head bolts.
    Tighten
    11.1. Tighten the M11 cylinder head bolts (1–10) a first pass in sequence to 30 N·m (22 lb ft).
    11.2. Tighten the M11 cylinder head bolts (1–10) a second pass in sequence to 90 degrees using the *J 36660-A*.
    11.3. Tighten the M11 cylinder head bolts (1,2,3,4,5,6,7,8) to 90 degrees and the M11 cylinder head bolts (9 and 10) to 50 degrees a final pass in sequence to using the *J 36660-A*.
    11.4. Tighten the M8 cylinder head bolts (11,12,13,14,15) 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.



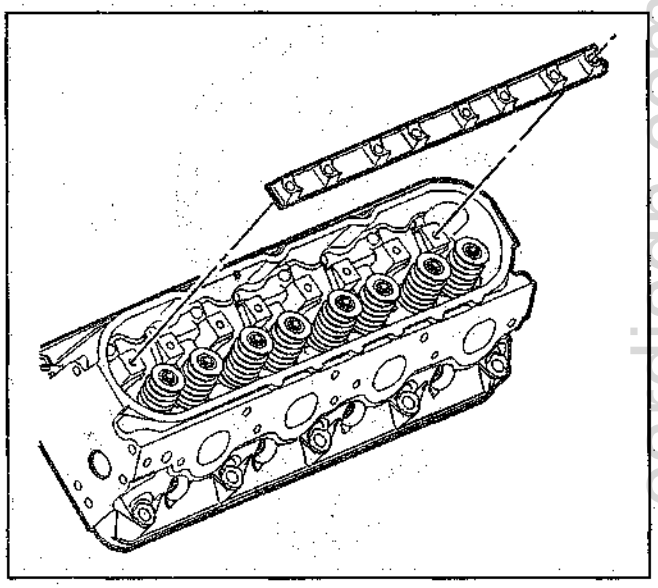
260150

Valve Rocker Arm and Push Rod Installation

Important: When reusing the valve train components, always install the components to the original location and position.

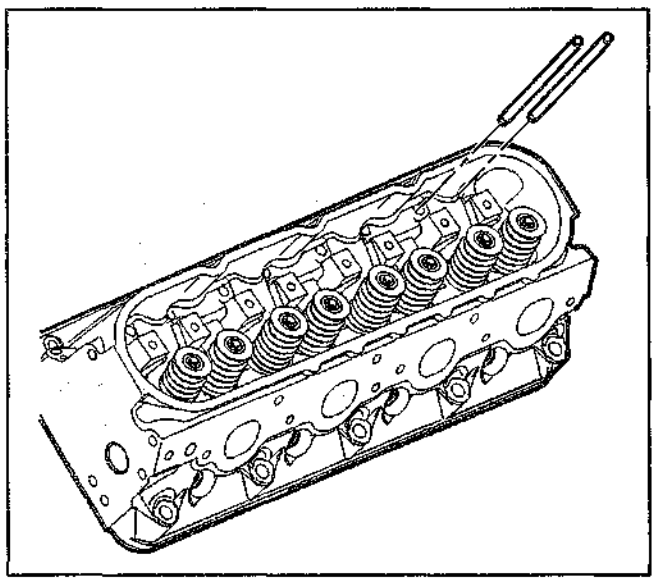
Valve lash is net build, no valve adjustment is required.

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.
   Lubricate the flange or washer surface of the bolt that will contact the valve rocker arm.
3. Install the valve rocker arm pivot support.

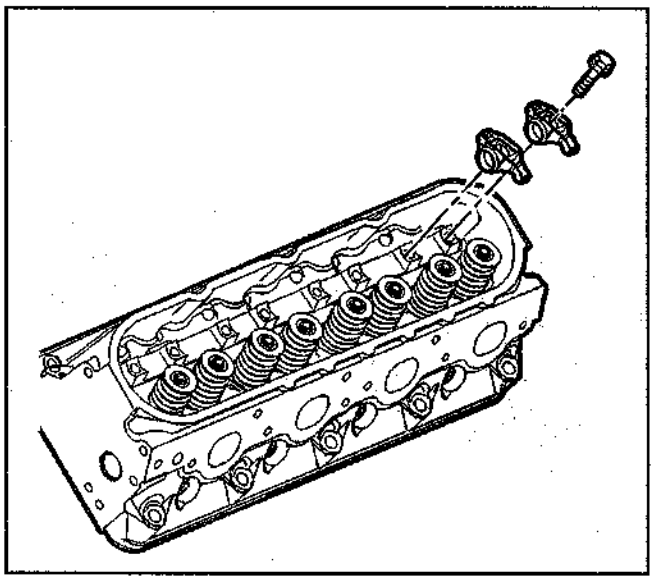

260141

Important: Make sure that the pushrods seat properly to the valve lifter sockets.

4. Install the pushrods.


260142

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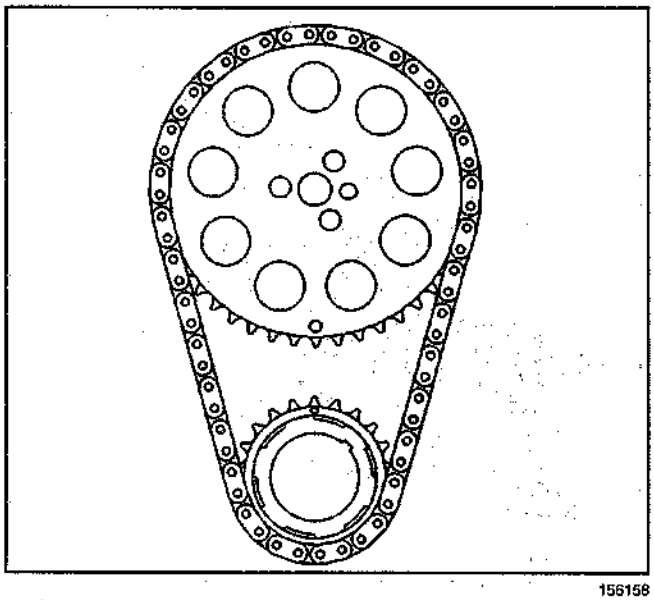


260140

Important: Make sure that the pushrods seat properly to the ends of the rocker arms.

DO NOT tighten the rocker arm bolts at this time.

5. Install the rocker arms and bolts.



156158

6. Rotate the crankshaft until number one piston is at top dead center of compression stroke.

   In this position, the crankshaft and camshaft sprocket marks will be aligned, cylinder number one rocker arms will be off lobe lift, and the crankshaft sprocket key will be at the 1:30 position. While 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.

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

7. With the engine in the number one firing position, tighten the following valve rocker arm bolts:

   Tighten

   - 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).

8. Rotate the crankshaft 360 degrees.
9. Tighten the following valve rocker arm bolts:

   Tighten

   - 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).

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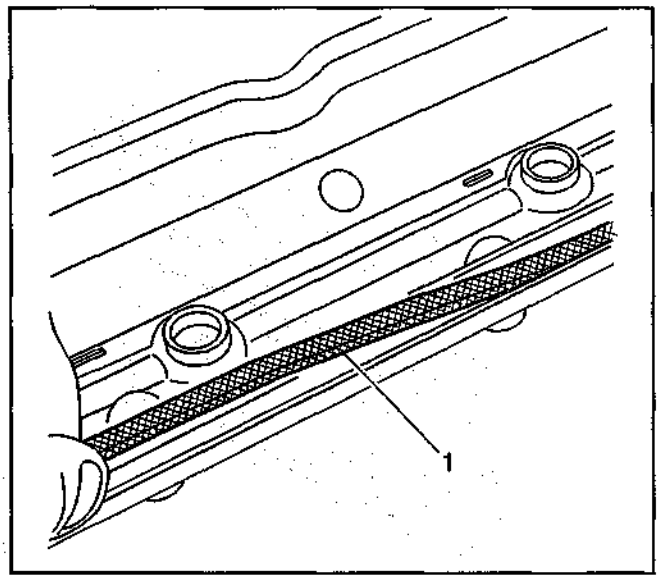
Valve Rocker Arm Cover Installation (Left Side)

Important: All gasket surfaces should be free of oil or other foreign material during assembly.

DO NOT reuse the valve rocker arm cover gasket.

The valve rocker arm cover bolt grommets may be reused.

1. Install a NEW cover gasket (1) into the valve rocker arm cover.



490696

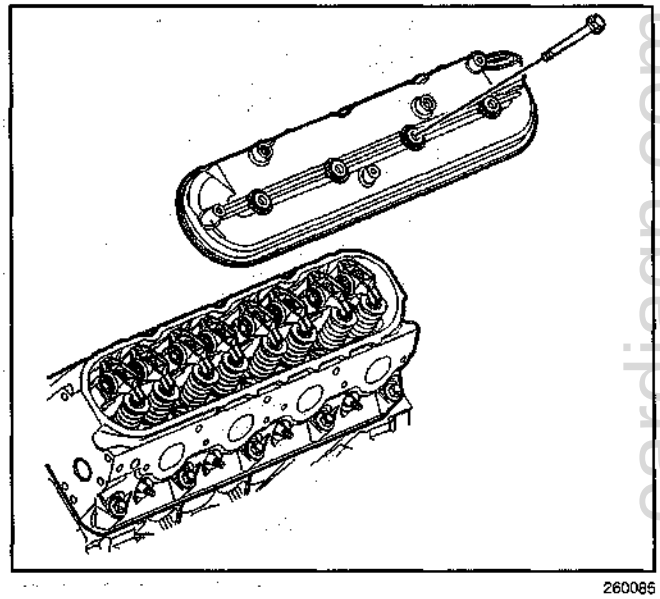
2. Install the valve rocker arm cover onto the cylinder head.

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

3. Install the cover bolts with grommets.

   Tighten

   Tighten the valve rocker arm cover bolts to 12 N·m (106 lb in).

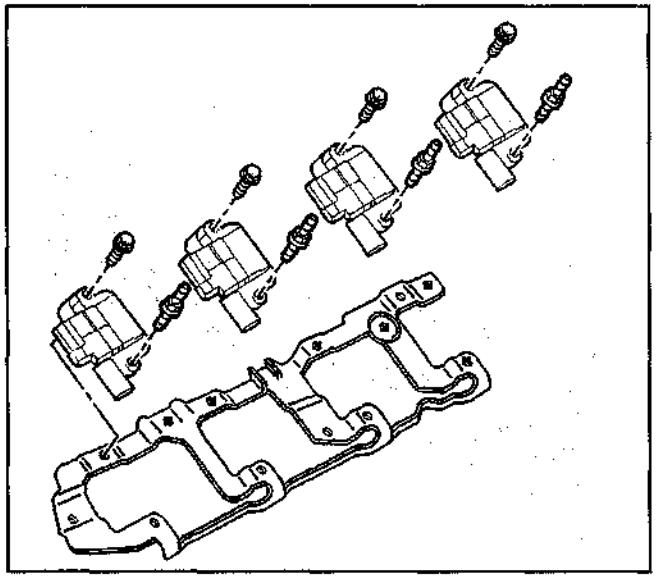


260086

4. Install the ignition coils, wire harness, and bolts onto the mounting bracket.

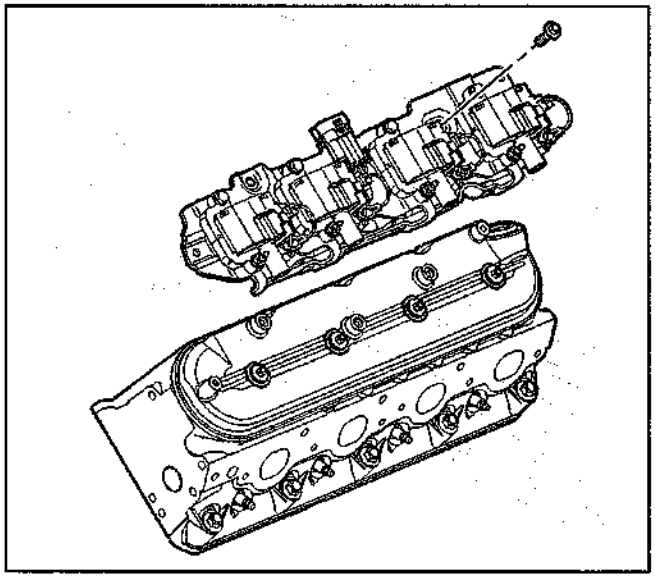
   Tighten

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



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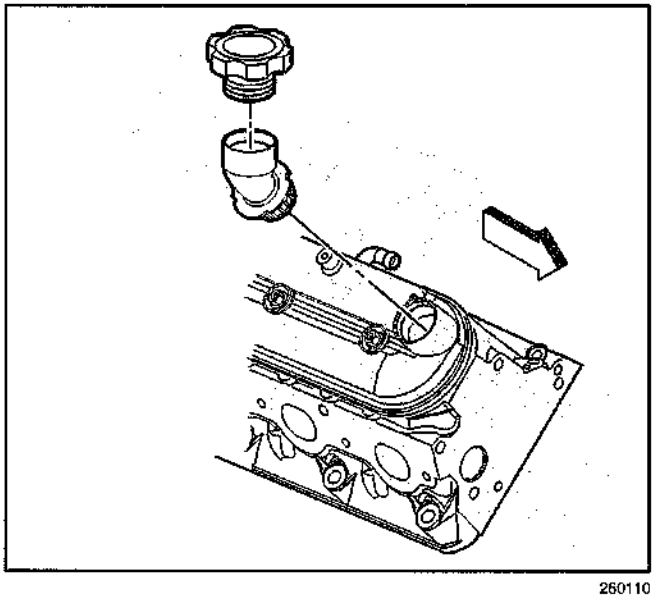


309727

5. Apply threadlock GM P/N 12345382 or equivalent to the threads of the bracket bolts.
6. Install the ignition coils and bracket assembly and bolts onto the rocker cover.

   Tighten

   Tighten the ignition coil bracket bolts to 12 N·m (106 lb in).
7. Install the crankcase ventilation hose.



260110

Valve Rocker Arm Cover Installation (Right Side)

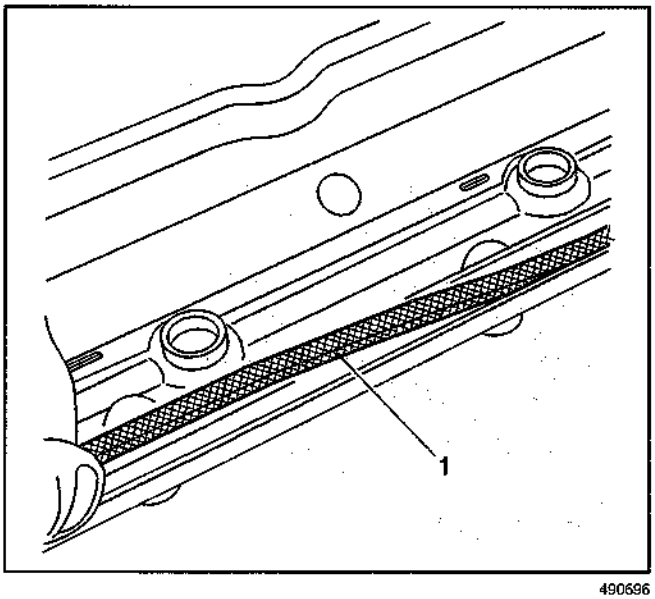
Important: All gasket surfaces should be free of oil or other foreign material during assembly.

DO NOT reuse the valve rocker arm cover gasket.

The valve rocker arm cover bolt grommets may be reused.

If the oil fill tube has been removed from the valve rocker arm cover, install a NEW oil fill tube during assembly.

1. Lubricate the O-ring seal of the NEW oil fill tube with clean engine oil.
2. Insert the NEW oil fill tube into the rocker arm cover and rotate the tube clockwise until locked in the proper position.
3. Install the oil fill cap into the tube and rotate clockwise until locked in the proper position.



490696

4. Install a NEW gasket (1) into the valve rocker arm cover.

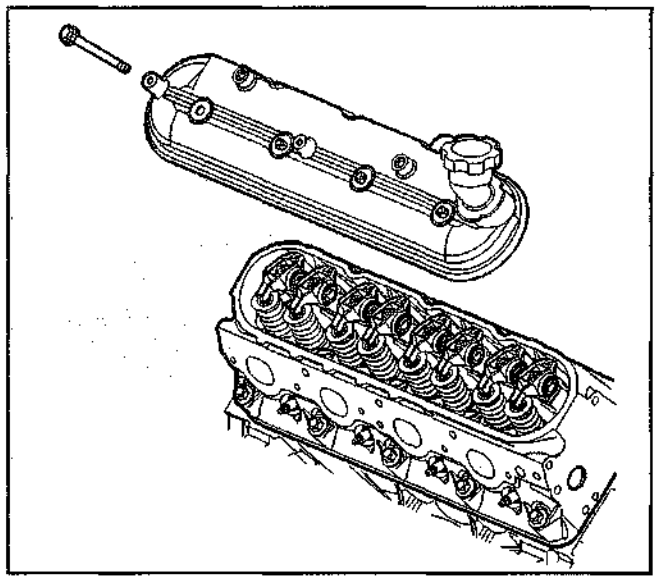
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Notice: Refer to *Fastener Notice* in Cautions and Notices.

5. Install the valve rocker arm cover onto the cylinder head.
6. Install the cover bolts with grommets.

   Tighten

   Tighten the valve rocker arm cover bolts to 12 N·m (106 lb in).

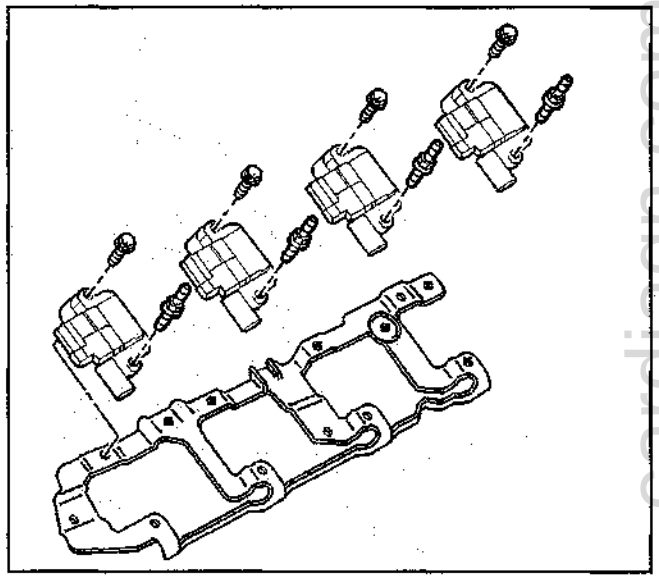


260084

7. Install the ignition coils, wire harness, and bolts onto the mounting bracket.

   Tighten

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

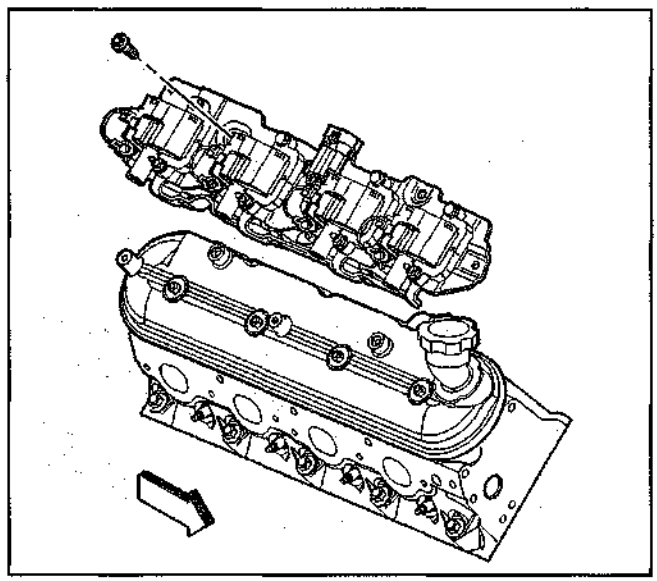


309850

8. Apply threadlock GM P/N 12345382 or equivalent to the threads of the bracket bolts.
9. Install the ignition coils and bracket assembly and bolts to the rocker cover.

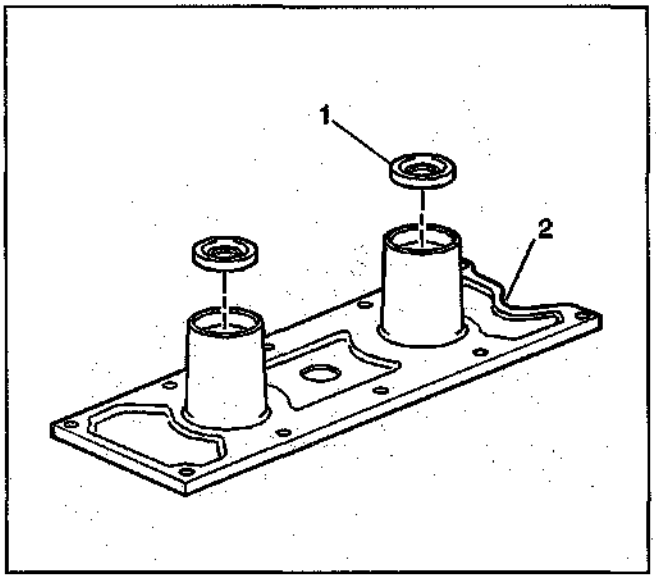
   Tighten

   Tighten the ignition coil bracket bolts to 12 N·m (106 lb in).
10. Install the crankcase ventilation hoses to the cover.



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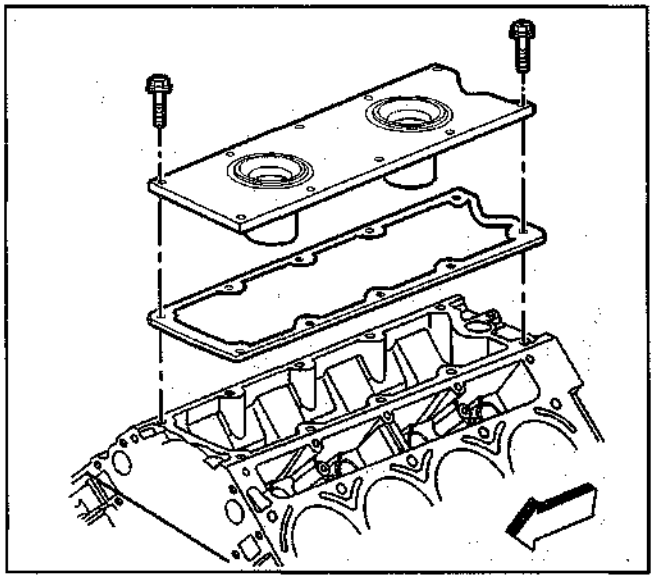


490851

Engine Valley Cover Installation

Important: All gasket surfaces should be free of oil or other foreign material during assembly.

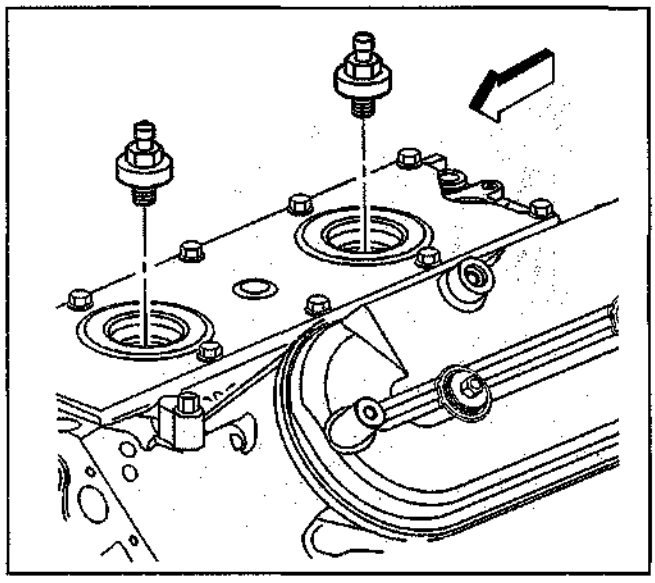
1. Install NEW knock sensor oil seals (1) into the valley cover (2).
   Lubricate the seal surfaces with clean engine oil.


85048

2. Install the valley cover and NEW gasket.

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

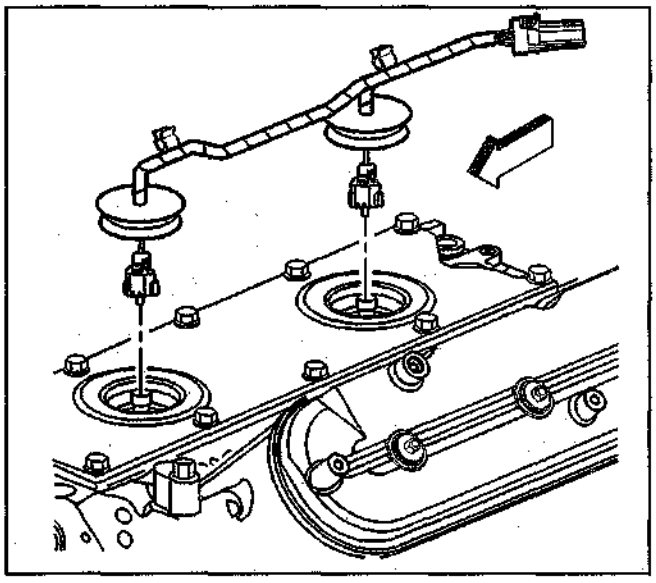
3. Install the valley cover bolts.
   Tighten
   Tighten the valley cover bolts to 25 N·m (18 lb ft).


309864

4. Install the knock sensors.
   Tighten
   Tighten the knock sensors to 20 N·m (15 lb ft).

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5. Install the knock sensor wire harness.



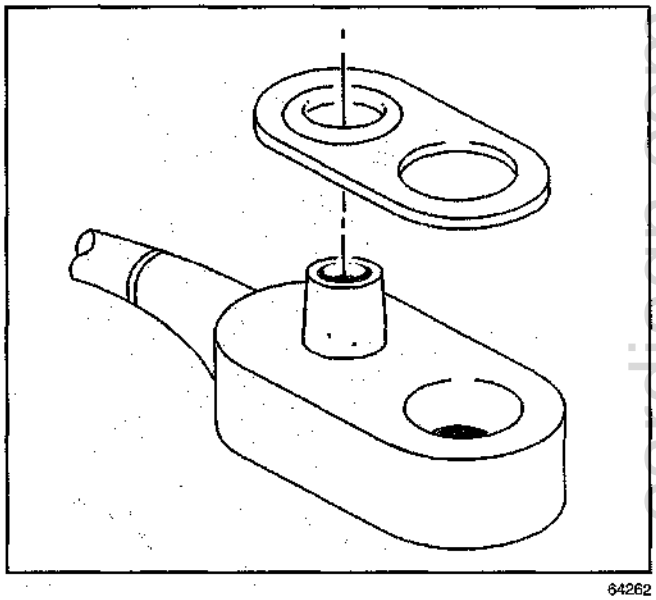
309859

Vapor Vent Pipe Installation

Important: Install the pipe gaskets properly onto the pipe.

Position the gasket O-ring seal onto the nipple portion of the pipe.

1. Install the gaskets onto the engine coolant air bleed pipe.



64262

Important: Route the knock sensor wire harness over the top of the engine coolant air bleed pipe. The pipe and knock sensor wire harness should be installed in a manner as to allow the removal of the wire harness without requiring the removal of the pipe.

2. Install the pipe and gaskets onto the cylinder heads.

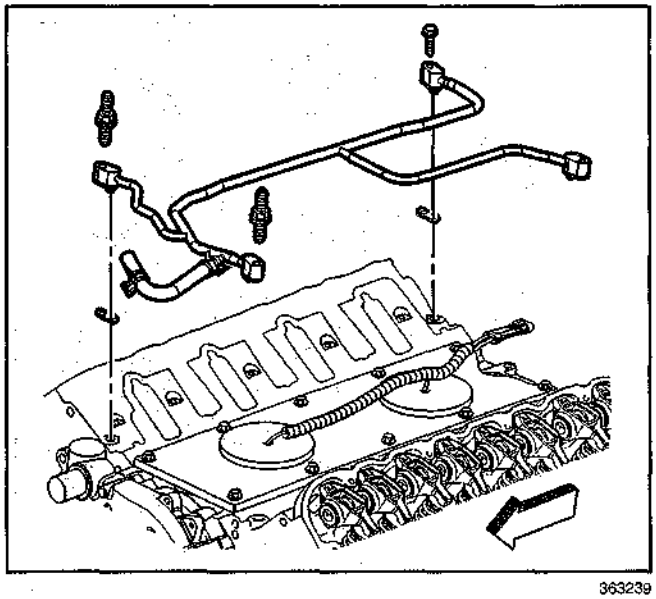
Notice: Refer to *Fastener Notice* in Cautions and Notices.

3. Install the pipe bolts and studs.

   Install the two pipe studs to the front of the engine.

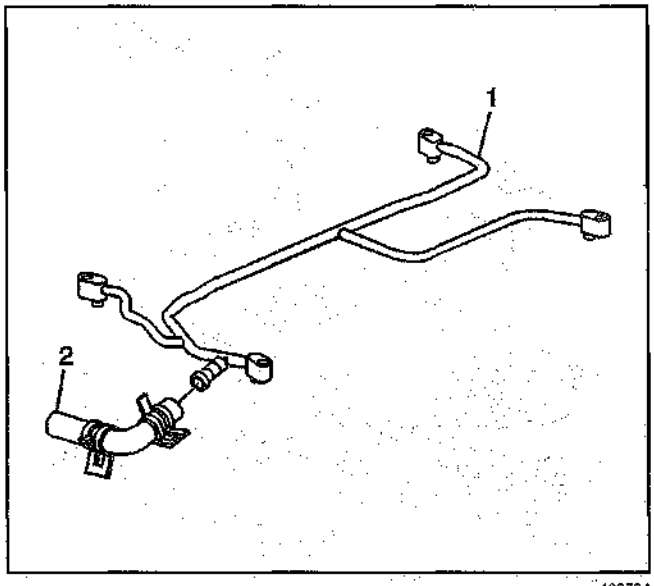
   Tighten

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



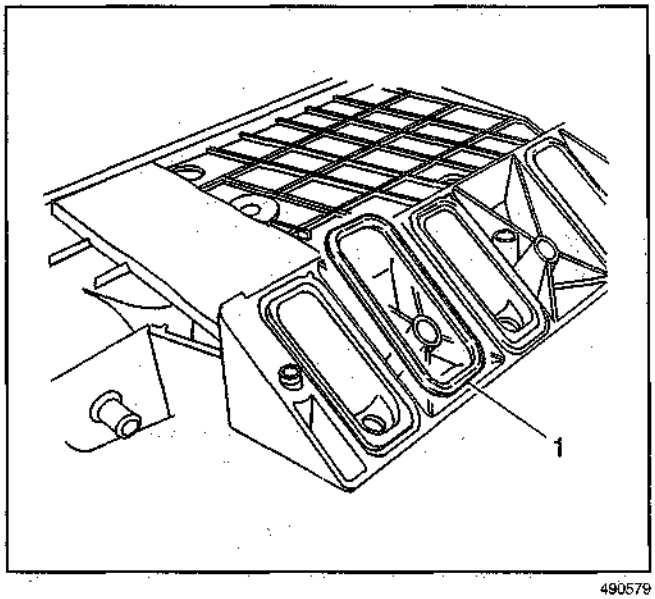
363239

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490724

4. Install the hose and clamp (2) onto the pipe.

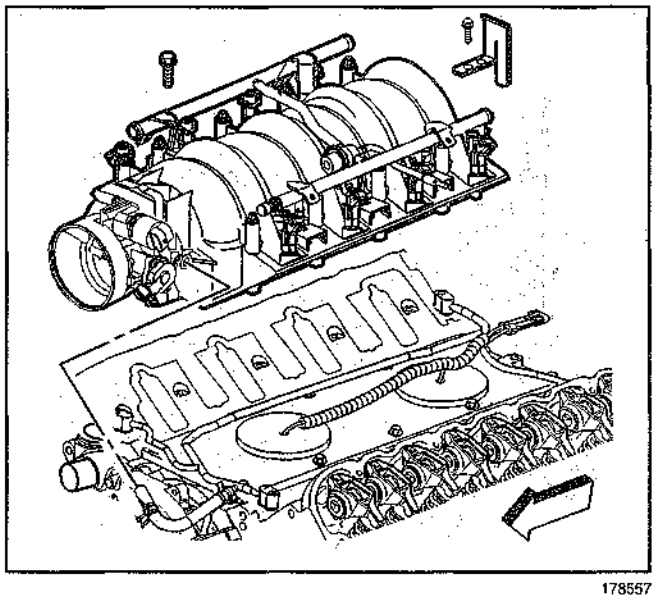


490579

Intake Manifold Installation

Important: The intake manifold, throttle body, fuel injection rail and fuel injectors may be removed as an assembly. If not servicing the individual components, install the intake manifold as a complete assembly.

1. Install NEW intake manifold-to-cylinder head gaskets (1).


178557

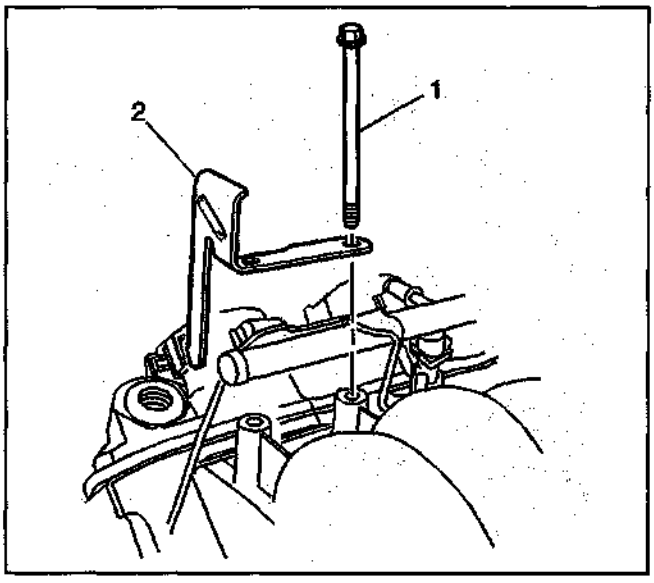
2. Install the manifold to the engine.

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3. Apply threadlock GM P/N 12345382 or equivalent to the threads of the intake manifold bolts (1).
   Refer to *Sealers, Adhesives, and Lubricants*.

Caution: The fuel rail stop bracket must be installed onto the engine assembly. The stop bracket serves as a protective shield for the fuel rail in the event of a vehicle frontal crash. If the fuel rail stop bracket is not installed and the vehicle is involved in a frontal crash, fuel could be sprayed possibly causing a fire and personal injury from burns.

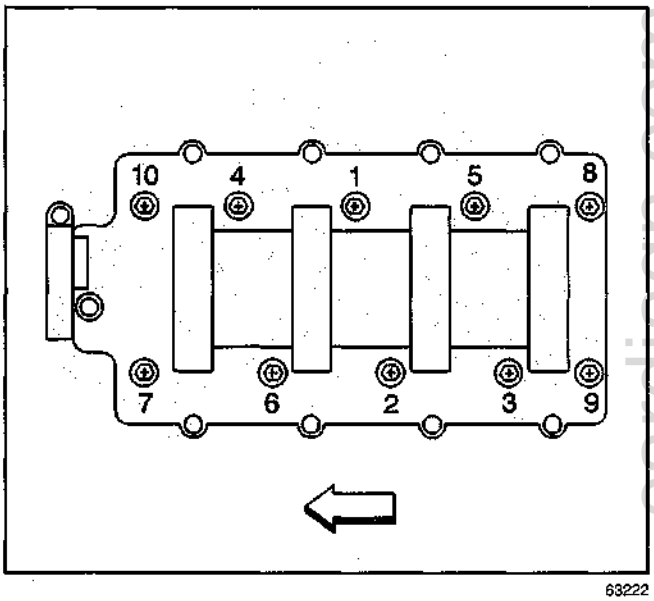
4. Install the fuel rail stop bracket (2).



490927

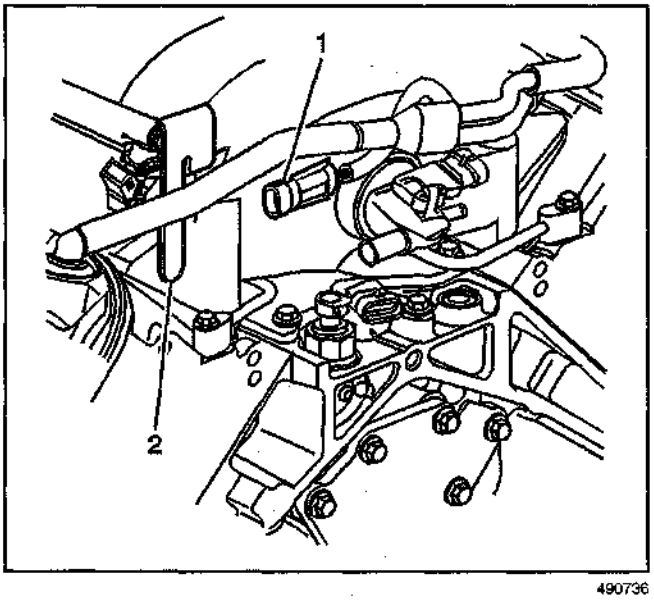
Notice: Refer to *Fastener Notice* in Cautions and Notices.

5. Install the intake manifold bolts.
   Tighten
   5.1. Tighten the intake manifold bolts a first pass in sequence to 5 N·m (44 lb in).
   5.2. Tighten the intake manifold bolts a final pass in sequence to 10 N·m (89 lb in).



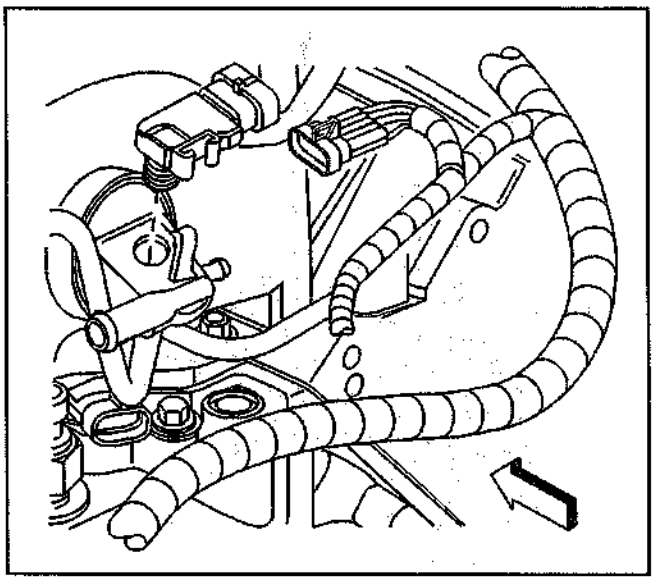
63222

6. Install the knock sensor wire harness connector (1) onto the fuel rail stop bracket (2).



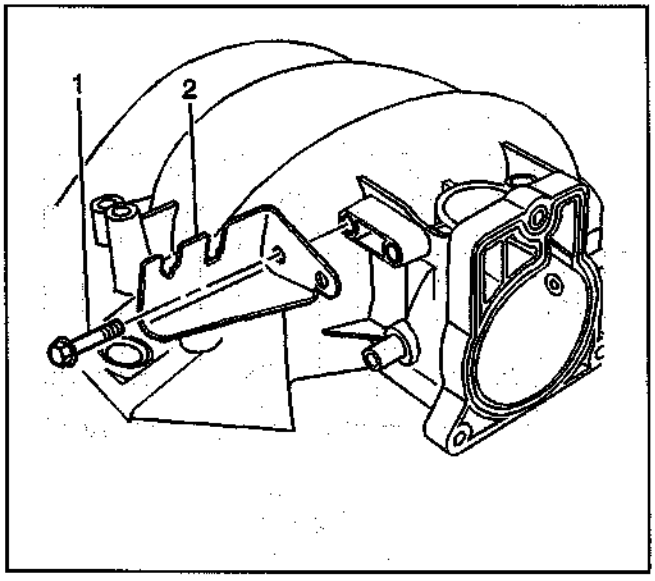
490736

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58838

7. Install the Manifold Absolute Pressure (MAP) sensor (if previously removed).



490573

8. Install the accelerator control cable bracket (2) and bolts (1).

Tighten

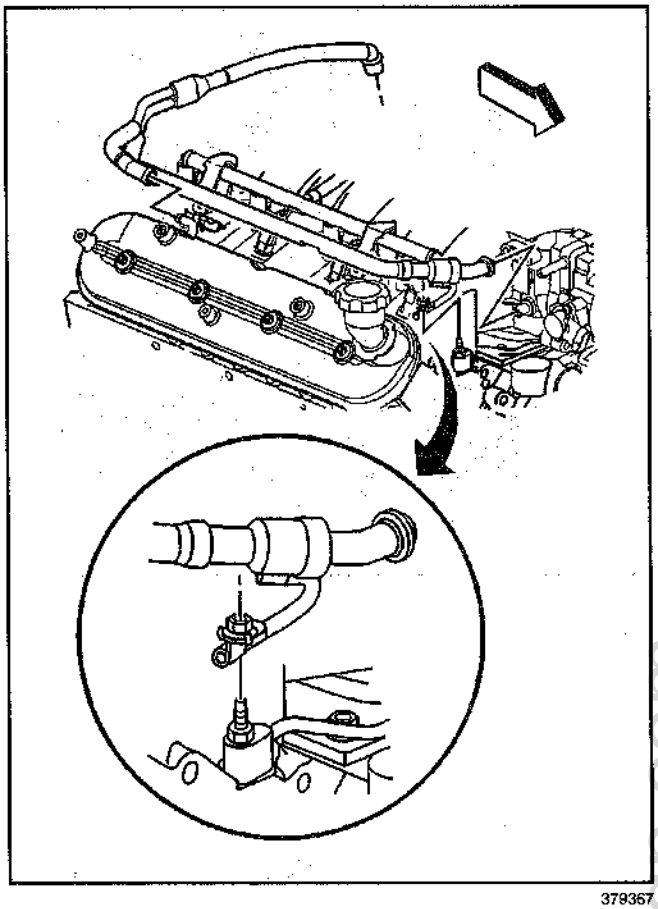
Tighten the bracket bolts to 10 N·m (89 lb in).

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9. Install the Positive Crankcase Ventilation (PCV) valve pipe to the right rocker cover and intake manifold.
10. Install the PCV strap and nut onto the right front vapor vent pipe stud.

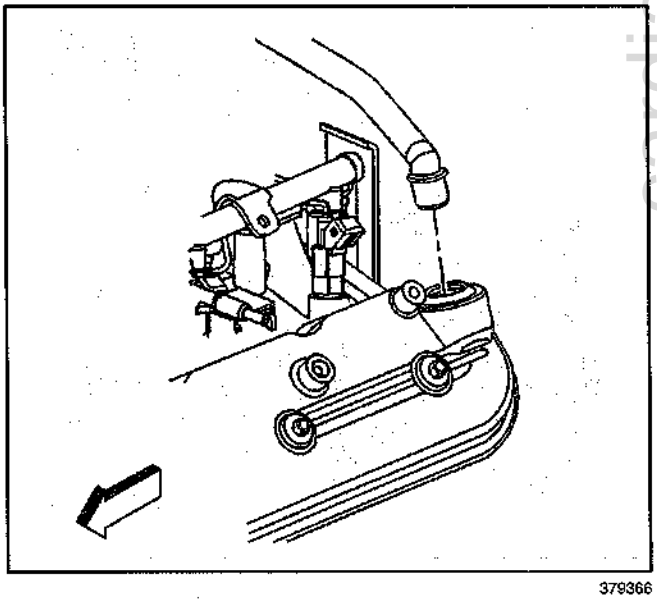
    Tighten

    Tighten the PCV strap nut to 12 N·m (106 lb in).



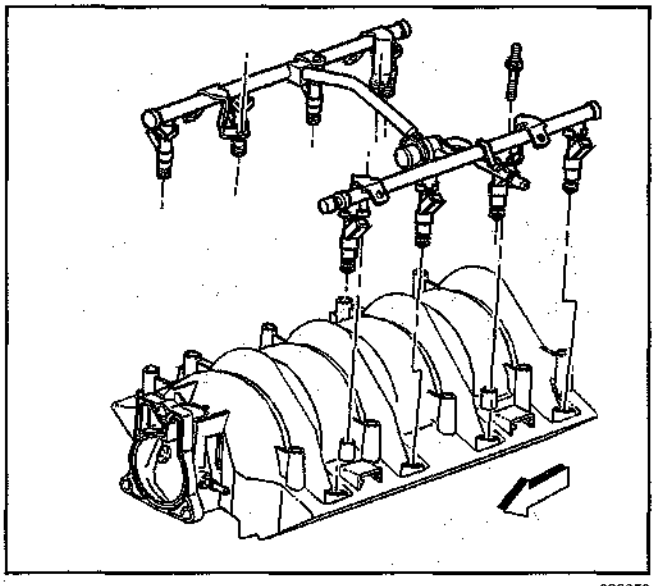
379367

11. Install the PCV valve pipe to the left rocker cover.



379366

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222050

Fuel Rail and Injectors Installation

Important: DO NOT reuse fuel injector O-ring seals. Install NEW fuel injector O-ring seals during assembly.

1. Lubricate the NEW fuel injector O-ring seals with clean engine oil.
2. Install the O-ring seals onto the fuel injectors.
3. Install the fuel rail (with fuel injectors) into the intake manifold.

   Press evenly on both sides of the fuel rail until all of the injectors are seated in their bores.
4. Apply a 5 mm (0.2 in) band of threadlock GM P/N 12345382 or equivalent to the threads of the fuel rail bolts.

   Refer to *Sealers, Adhesives, and Lubricants.*

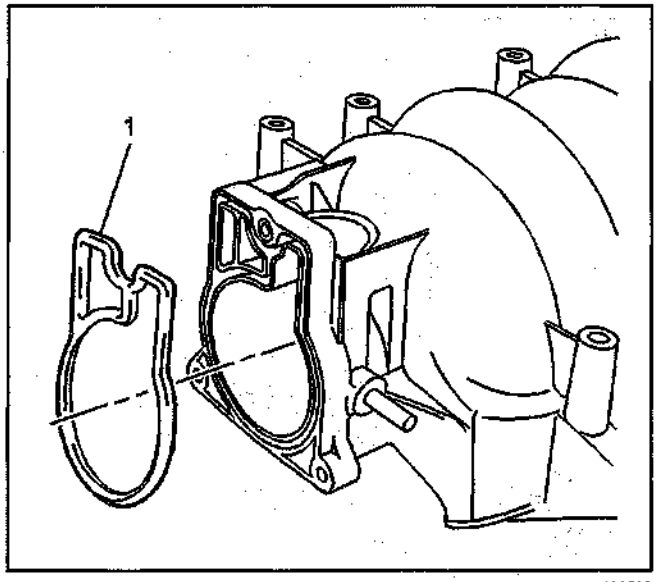
Caution: The fuel rail stop bracket must be installed onto the engine assembly. The stop bracket serves as a protective shield for the fuel rail in the event of a vehicle frontal crash. If the fuel rail stop bracket is not installed and the vehicle is involved in a frontal crash, fuel could be sprayed possibly causing a fire and personal injury from burns.

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

5. Install the fuel rail bolts.

   Tighten

   Tighten the fuel rail bolts to 10 N·m (89 lb in).



490580

Throttle Body Installation

Important: DO NOT reuse the throttle body gasket. Install a NEW gasket during assembly.

1. Install the throttle body gasket (1) to the intake manifold.

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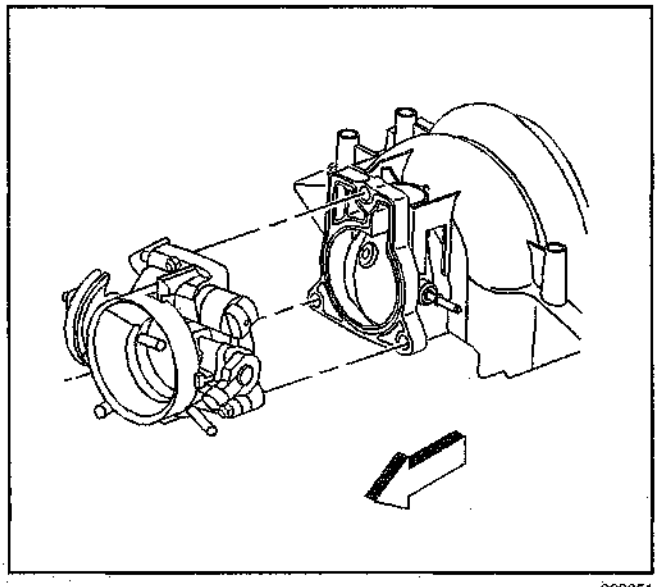
Notice: Refer to *Fastener Notice* in Cautions and Notices.

2. Install the throttle body and bolts.

   Tighten

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

3. Install the engine coolant air bleed hose and clamp.



222051

Water Pump Installation

Notice: DO NOT use cooling system seal tabs (or similar compounds) unless otherwise instructed. The use of cooling system seal tabs (or similar compounds) may restrict coolant flow through the passages of the cooling system or the engine components. Restricted coolant flow may cause engine overheating and/or damage to the cooling system or the engine components/assembly.

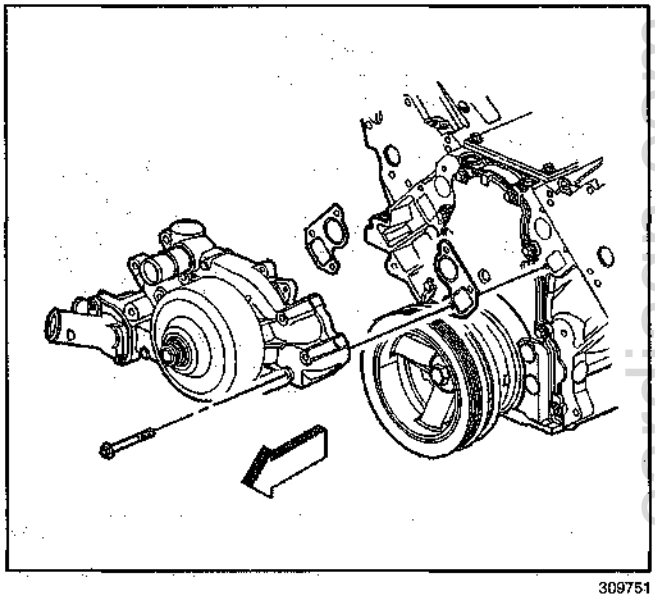
Important: All gasket surfaces should be free of oil or other foreign material during assembly.

1. Install the water pump and NEW gaskets.
2. Install the water pump bolts.

   Tighten

   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).



309751

Exhaust Manifold Installation (Left Side)

Important: Tighten the exhaust manifold bolts as specified in the service procedure. Improperly installed and/or leaking exhaust manifold gaskets may effect vehicle emissions and/or On-Board Diagnostic (OBD) II system performance.

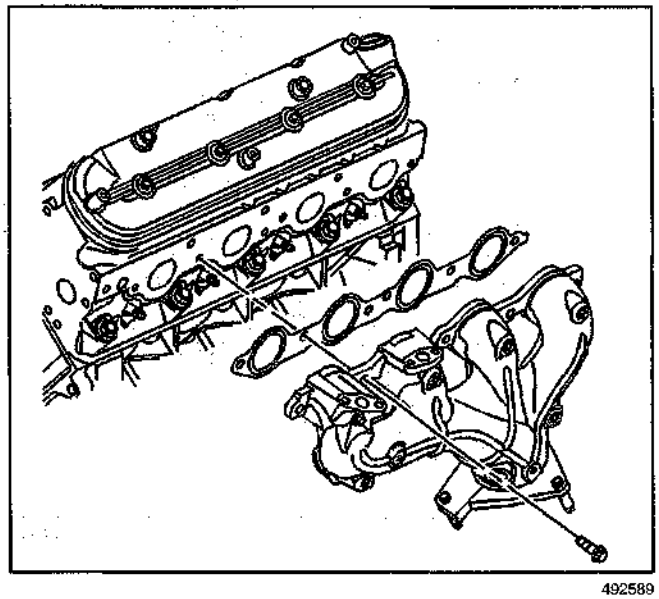
The cylinder head exhaust manifold bolt hole threads must be clean and free of debris or threadlocking material.

Important: Do not apply sealant to the first three threads of the bolt.

1. Apply a 5 mm (0.2 in) wide band of threadlock GM P/N 12345493 or equivalent to the threads of the exhaust manifold bolts.

   Refer to *Sealers, Adhesives, and Lubricants.*

2. Install the exhaust manifold and NEW exhaust manifold gasket.



492589

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

3. Install the exhaust manifold bolts.

   Tighten

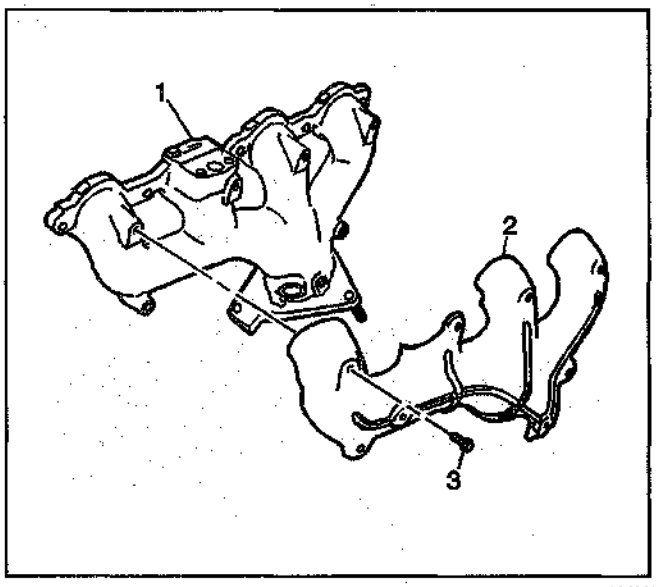
   3.1. Tighten the exhaust manifold bolts a first pass to 15 N·m (11 lb ft). Tighten the exhaust manifold bolts beginning with the center two bolts. Alternate from side-to-side, and work toward the outside bolts.

   3.2. Tighten the exhaust manifold bolts a final pass to 25 N·m (18 lb ft). Tighten the exhaust manifold bolts beginning with the center two bolts. Alternate from side-to-side, and work toward the outside bolts.

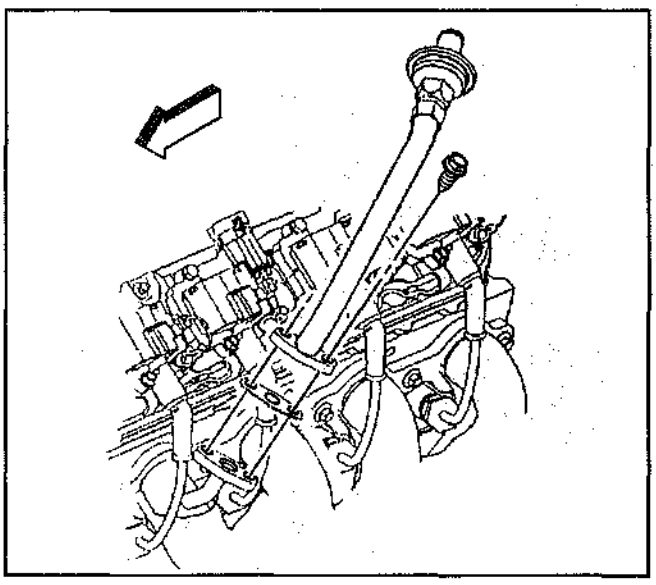
4. Using a flat punch, bend over the exposed edge of the exhaust manifold gasket at the rear of the left cylinder head.
5. Install the heat shield (2) and bolts (3).

   Tighten

   Tighten the heat shield bolts to 9 N·m (80 lb in).



492586


346026

6. Install the Air Injection Reaction (AIR) pipe (with check valve), NEW gasket and bolts.

   Tighten

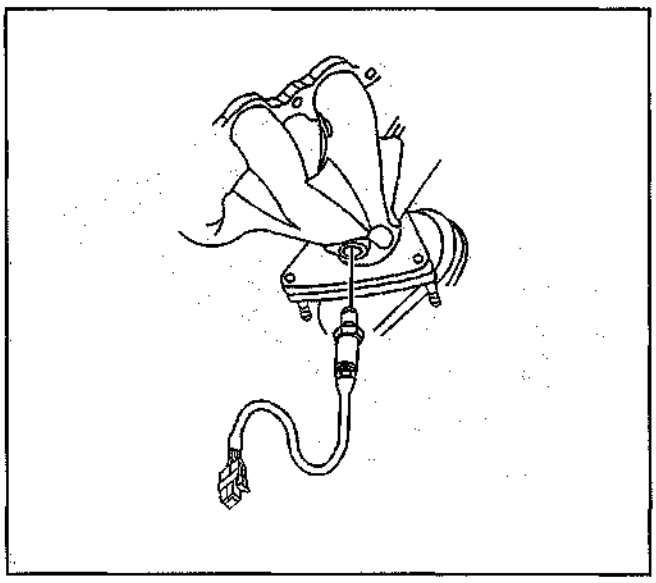
   Tighten the AIR pipe to exhaust manifold bolts to 20 N·m (15 lb ft).

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7. Install the oxygen sensor into the intake manifold.

   Tighten

   Tighten the oxygen sensor to 42 N·m (31 lb ft).



346021

Exhaust Manifold Installation (Right Side)

Important: Tighten the exhaust manifold bolts as specified in the service procedure. Improperly installed and/or leaking exhaust manifold gaskets may effect 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 reuse exhaust gas recirculation (EGR) valve and pipe gaskets or seals during assembly. Install NEW gaskets and O-ring seal.

Important: Do not apply sealant to the first three threads of the bolt.

1. Apply a 5 mm (0.2 in) wide band of threadlock GM P/N 12345493 or equivalent to the threads of the exhaust manifold bolts.

   Refer to *Sealers, Adhesives, and Lubricants.*

2. Install the exhaust manifold gasket and exhaust manifold.

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

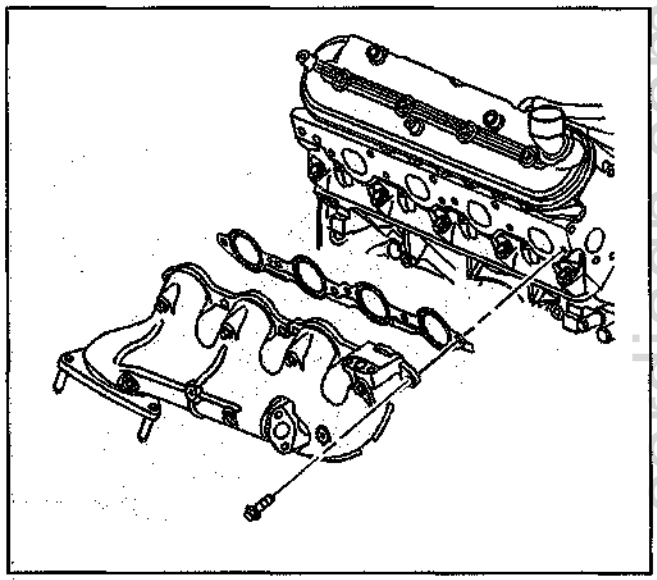
3. Install the exhaust manifold bolts.

   Tighten

   3.1. Tighten the exhaust manifold bolts first pass to 15 N·m (11 lb ft). Tighten the exhaust manifold bolts beginning with the center two bolts. Alternate from side-to-side, and work toward the outside bolts.

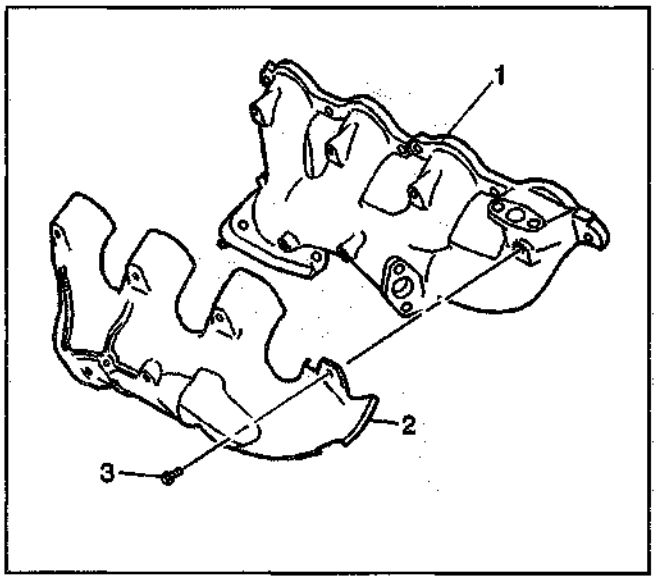
   3.2. Tighten the exhaust manifold bolts final pass to 25 N·m (18 lb ft). Tighten the exhaust manifold bolts beginning with the center two bolts. Alternate from side-to-side, and work toward the outside bolts.

4. Using a flat punch, bend over the exposed edge of the exhaust manifold gasket at the front of the right cylinder head.



492592

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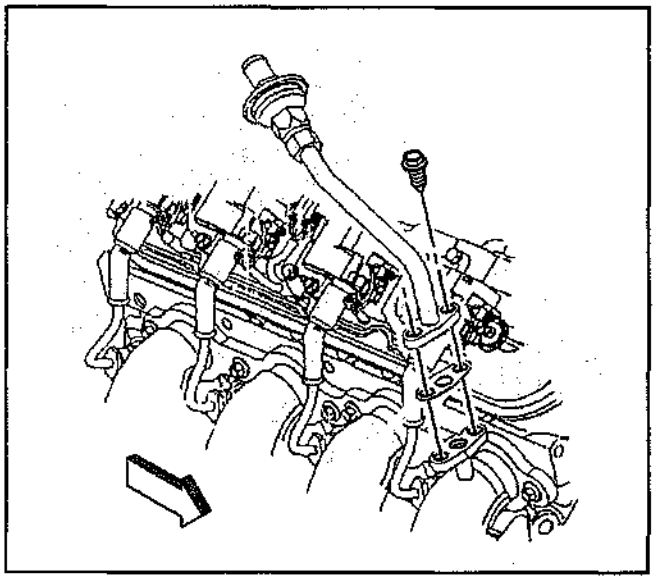


492583

5. Install the heat shield (2) and bolts (3).

Tighten

Tighten the heat shield bolts to 9 N·m (80 lb in).

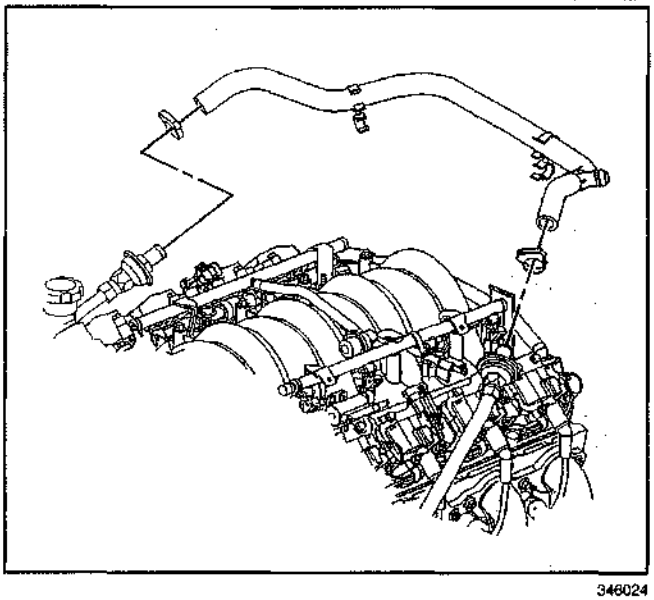


346029

6. Install the air injection reaction (AIR) pipe (with check valve), NEW gasket and bolts.

Tighten

Tighten the AIR pipe to exhaust manifold bolts to 20 N·m (15 lb ft).

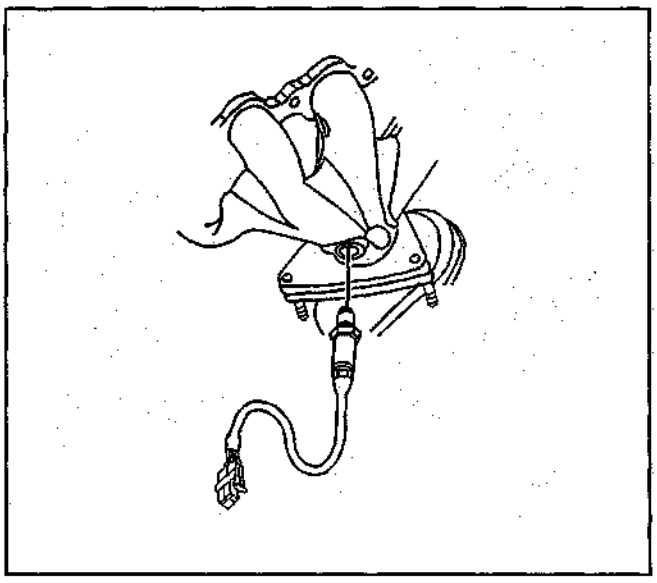


346024

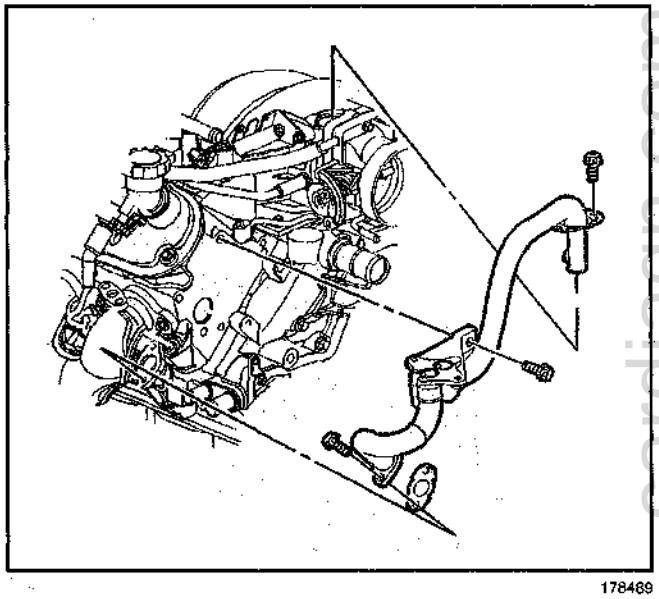
7. Install the AIR tubing and clamps.

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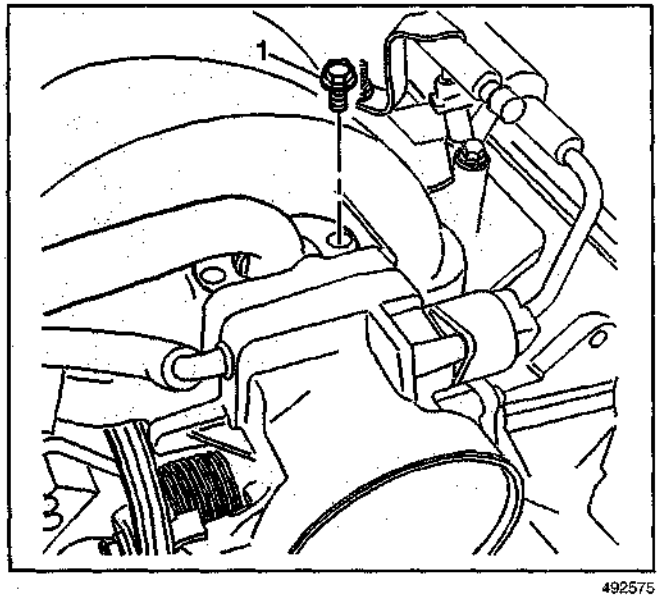
8. Install the oxygen sensor into the intake manifold.
   Tighten
   Tighten the oxygen sensor to 42 N·m (31 lb ft).


346021

9. Apply a light coating of clean engine oil to a NEW O-ring seal and install the seal onto the EGR valve pipe.
10. Insert the EGR pipe into the intake manifold.

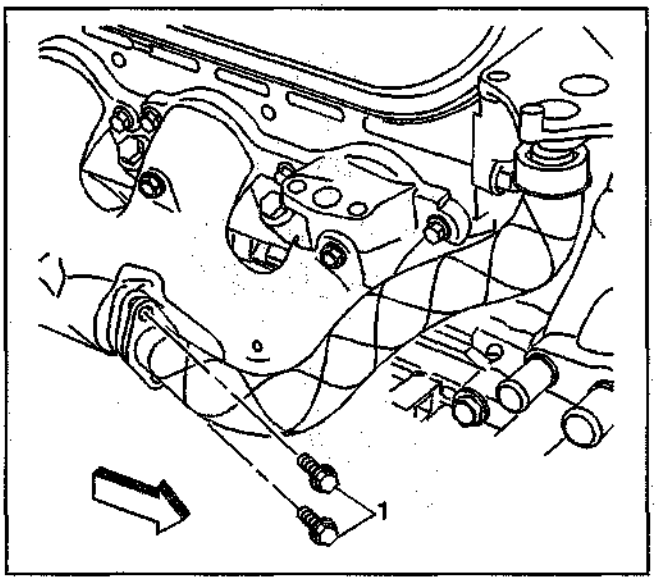

178489

11. Start the EGR valve pipe to intake manifold bolt (1).
    Do not tighten the bolt at this time.
12. Install the EGR valve pipe to cylinder head bolts.
    Do not tighten the bolts at this time.



492575

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492580

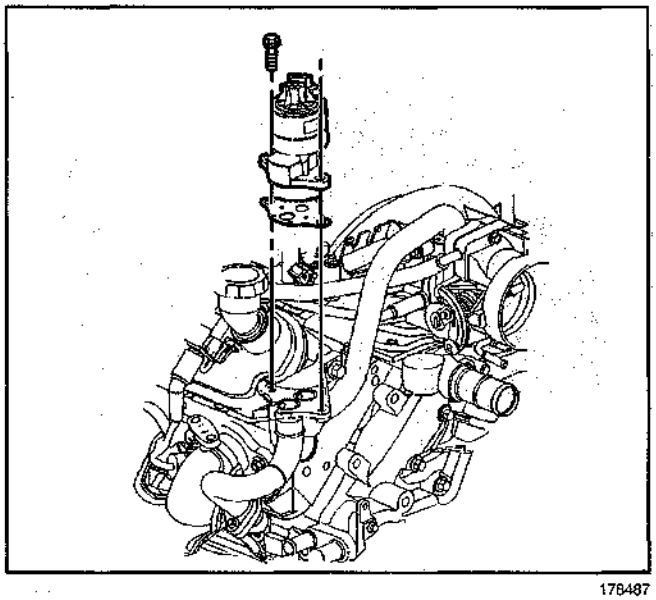
13. Install a NEW EGR valve pipe exhaust manifold gasket and bolts (1).

Tighten

13.1. Tighten the EGR valve pipe to intake manifold bolt to 10 N·m (89 lb in).

13.2. Tighten the EGR valve pipe to cylinder head bolts to 50 N·m (37 lb ft).

13.3. Tighten the EGR valve pipe to exhaust manifold bolts to 30 N·m (22 lb ft).



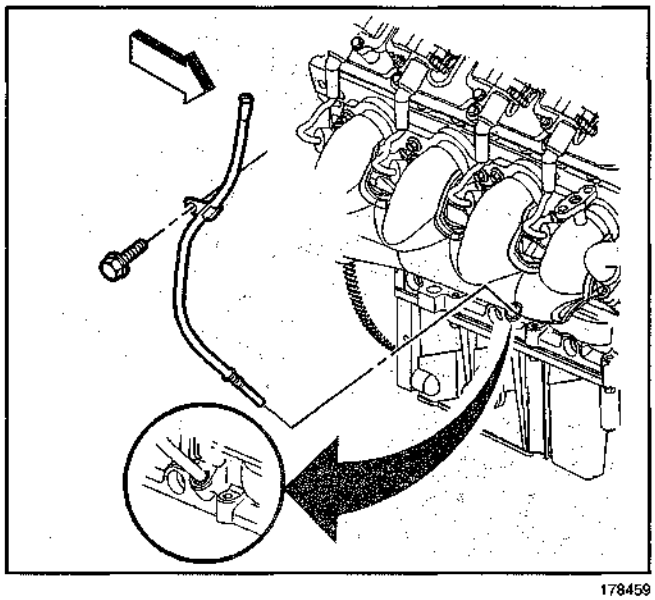
178487

14. Install the EGR valve, a NEW gasket and bolts.

Tighten

14.1. Tighten the EGR valve bolts a first pass to 10 N·m (89 lb in).

14.2. Tighten the EGR valve bolts a final pass to 25 N·m (18 lb ft).



178459

Oil Level Indicator and Tube Installation

1. Inspect the O-ring seal for cuts or damage. If the oil level indicator tube O-ring seal is not cut or damaged, it may be reused.
2. Lubricate the O-ring seal with clean engine oil.
3. Install the O-ring seal onto the oil level indicator tube.
4. Install the oil level indicator tube into the engine block and rotate into proper position.

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

5. Install the tube bolt to the right cylinder head.

Tighten

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

6. Install the oil level indicator into the tube.

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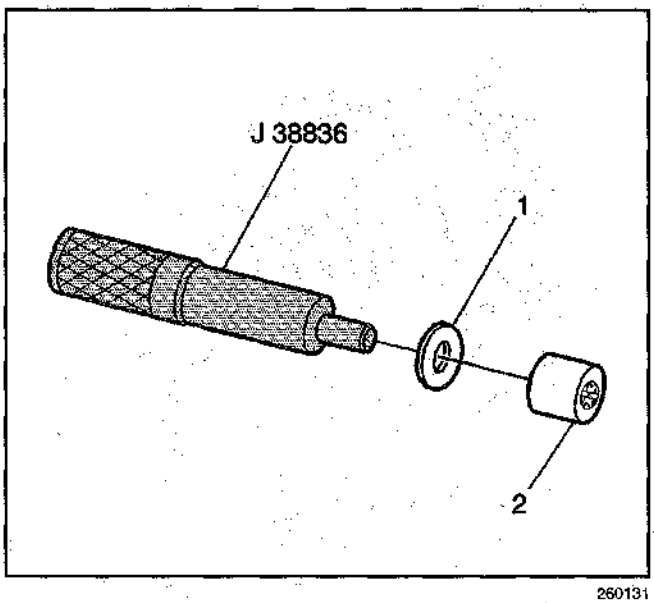
Clutch Pilot Bearing Installation

Tools Required

J 38836 Pilot Bushing Installer/Clutch

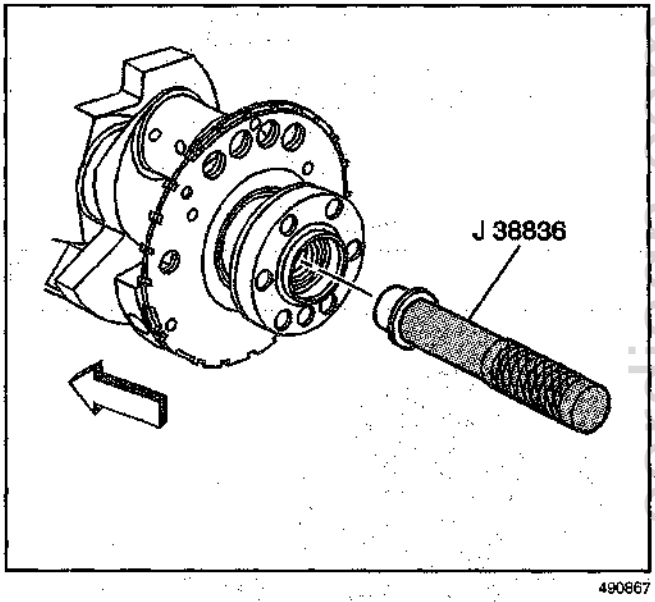
1. Install a 5/8 inch washer (1) onto the *J 38836* or equivalent.

   The washer serves as a stop against the crankshaft face and will assist in installing the bearing to the proper depth.
2. Install the new pilot bearing (2) onto the tool.



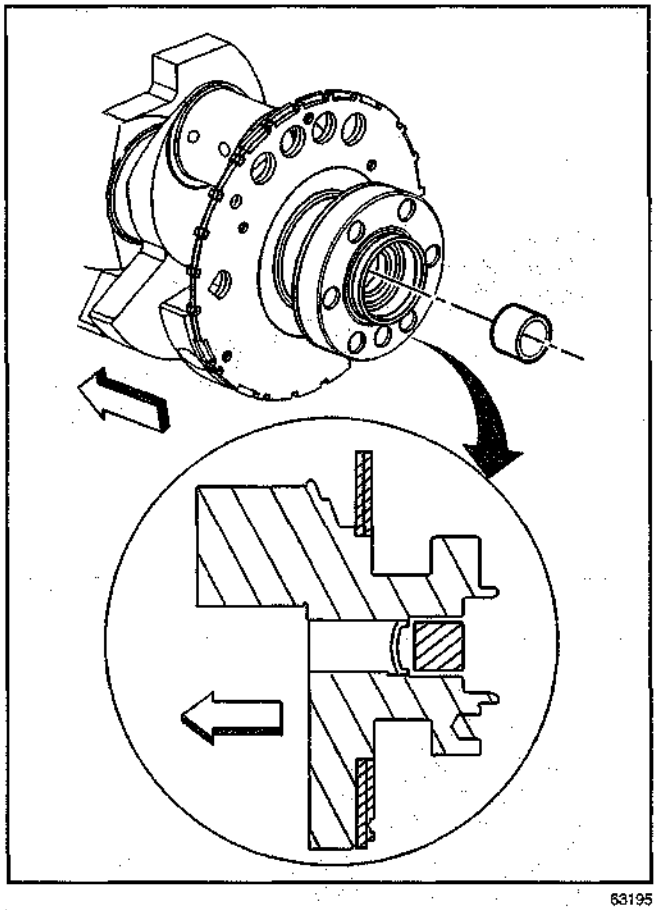
260131

3. Install the new pilot bearing into the crankshaft using the *J 38836*.



490867

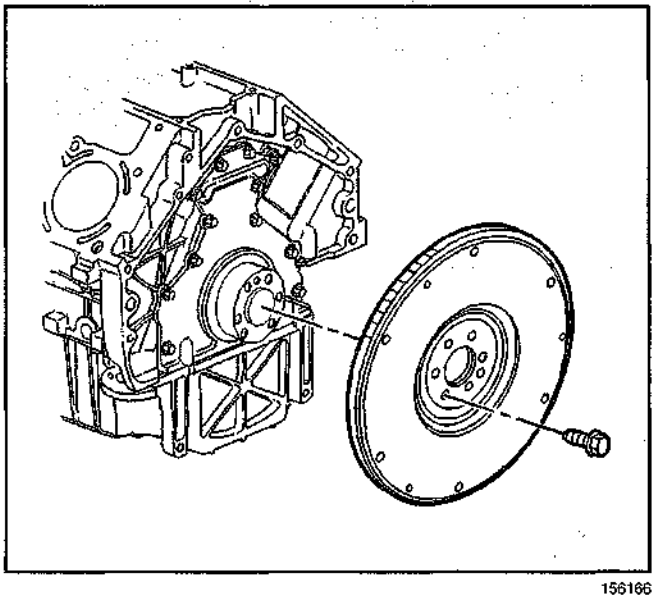
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63195

4. Inspect the clutch pilot bearing for proper installation.

   A properly installed clutch pilot bearing will be installed until flush to the rear face of the crankshaft.



156166

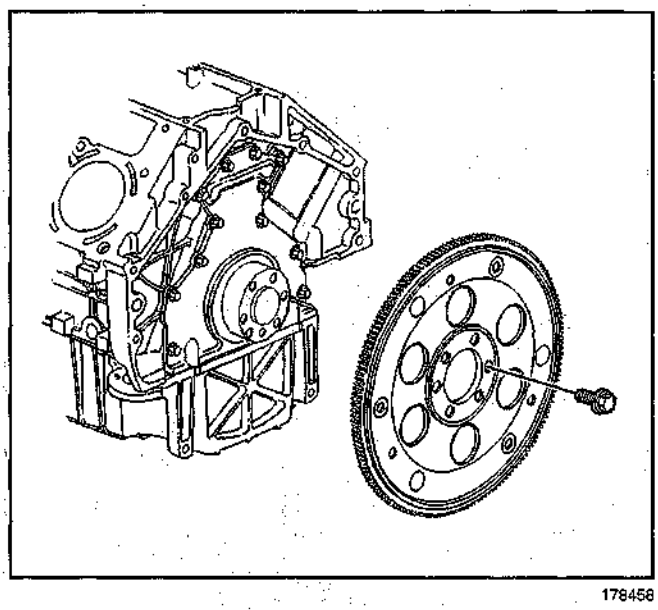
Engine Flywheel Installation

Important: Note the position and direction of the engine flywheel before removal. 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 three stage tightening process.

1. Install the manual transmission engine flywheel to the crankshaft (if applicable).

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2. Install the automatic transmission engine flywheel to the crankshaft (if applicable).


178458

3. Apply threadlock GM P/N 12345382 or equivalent to the threads of the flywheel bolts.

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

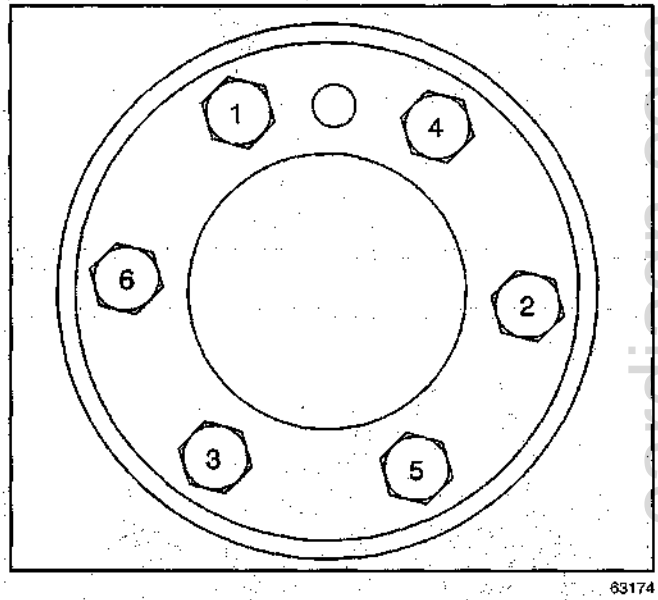
4. Install the engine flywheel bolts.

Tighten

4.1. Tighten the engine flywheel bolts first pass in sequence to 20 N·m (15 lb ft).

4.2. Tighten the engine flywheel bolts second pass in sequence to 50 N·m (37 lb ft).

4.3. Tighten the engine flywheel bolts final pass in sequence to 100 N·m (74 lb ft).



63174

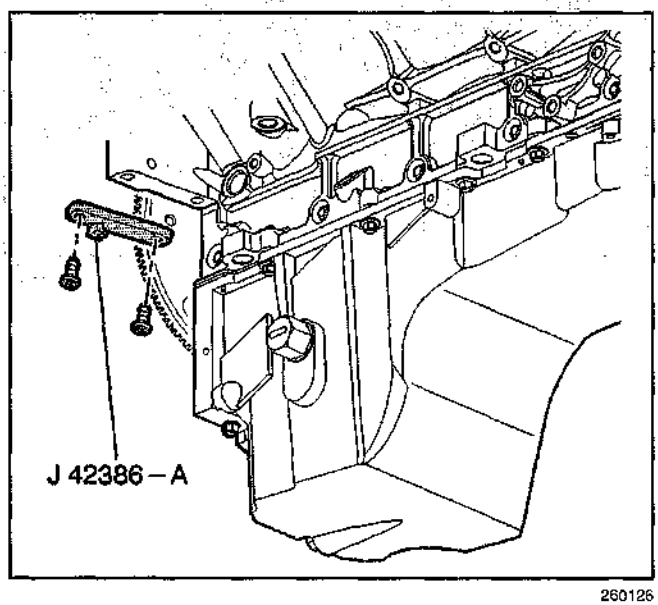
Crankshaft Balancer Installation

Tools Required

- *J 41665* Crankshaft Balancer and Sprocket Installer
- *J 36660-A* Torque Angle Meter
- *J 42386-A* Flywheel Holding Tool

Important: The crankshaft balancer installation and bolt tightening involves a four stage tightening process. The first pass ensures that the balancer is installed completely onto the crankshaft. The second, third and fourth passes tighten the new bolt to the proper torque.

The used crankshaft balancer bolt will be used only during the first pass of the balancer installation procedure. Install a NEW crankshaft balancer bolt and tighten as described in the second, third and fourth passes of the balancer bolt tightening procedure.



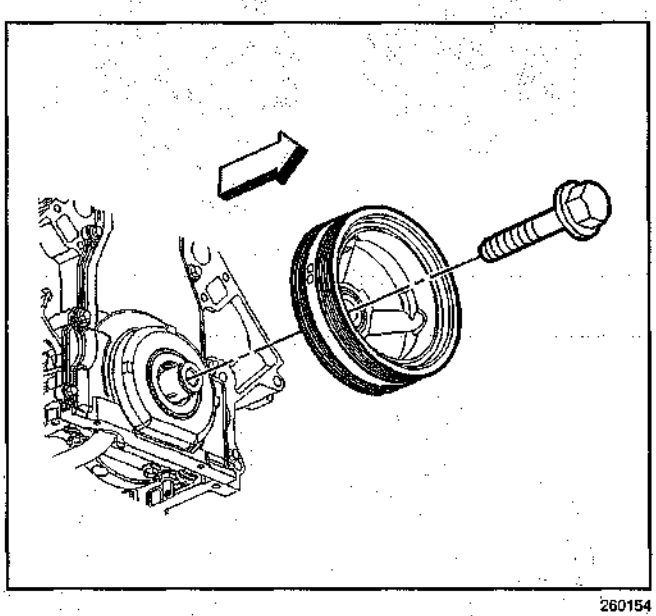
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Important: Make sure the teeth of the tool engage the engine flywheel teeth.

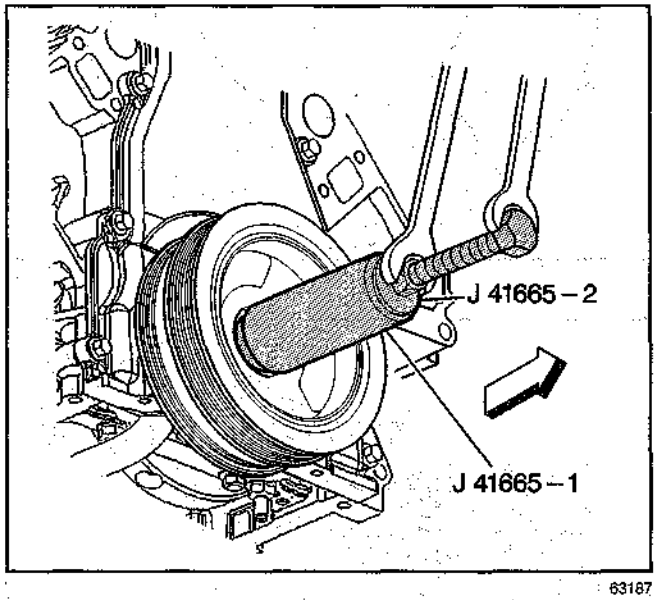
Notice: Refer to *Fastener Notice* in Cautions and Notices.

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


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Important: The balancer should be positioned onto the end of the crankshaft as straight as possible prior to tool installation.

2. Install the balancer onto the end of the crankshaft.



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3. Use the *J 41665* in order to install the balancer.
   3.1. Assemble the threaded rod, nut, washer and installer.
   Insert the smaller end of the installer into the front of the balancer.
   3.2. Use a wrench and hold the hex end of the threaded rod.
   3.3. Use a second wrench and rotate the installation tool nut clockwise until the balancer is started onto crankshaft.
   3.4. Remove and reverse the installation tool.
   Position the larger end of the installer against the front of the balancer.
   3.5. Use a wrench and hold the hex end of the threaded rod.
   3.6. Use a second wrench and rotate the installation tool nut clockwise until the balancer is installed onto the crankshaft.
   3.7. Remove the balancer installation tool.

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4. Install the used crankshaft balancer bolt.

   Tighten

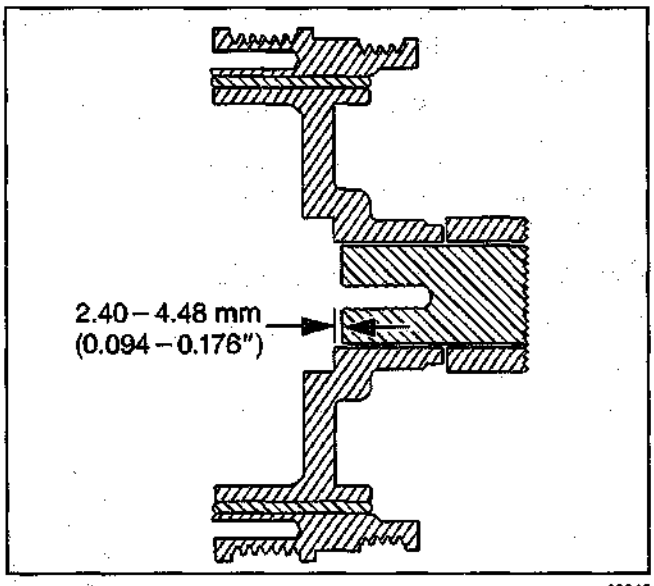
   Tighten the crankshaft balancer bolt to 330 N·m (240 lb ft).

5. Remove the used crankshaft balancer bolt.

Important: The nose of the crankshaft should be recessed 2.40–4.48 mm (0.094–0.176 in) into the balancer bore.

6. Measure for a correctly installed balancer.

   If the balancer is not installed to the proper dimensions, install the *J 41665* and repeat the installation procedure.



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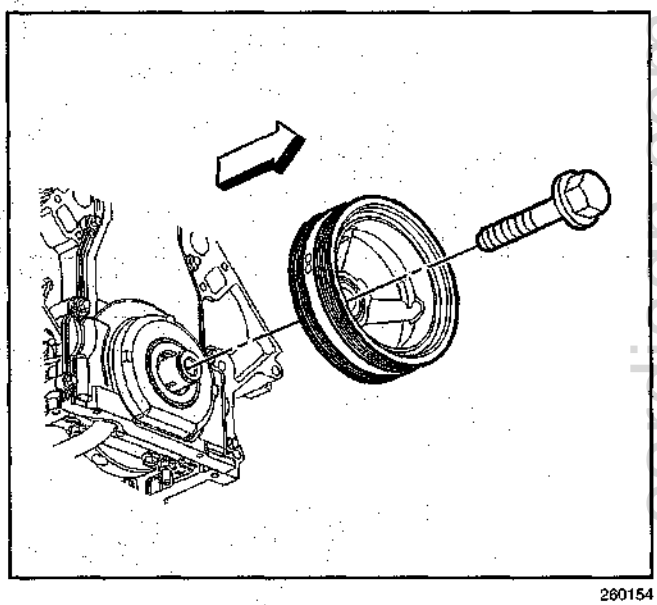
7. Install the NEW crankshaft balancer bolt.

   Tighten

   7.1. Tighten the crankshaft balancer bolt a first pass to 50 N·m (37 lb ft).

   7.2. Tighten the crankshaft balancer bolt a second pass to 140 degrees using the *J 36660-A*.

8. Remove the *J 42386-A*.



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Engine Set-Up and Testing

Important: After overhaul, the engine should be tested before installation into the vehicle. If a suitable test stand is not available, the following procedure can be used after the engine is installed into the vehicle.

1. Fill the crankcase with the proper quantity and grade of engine oil.
2. Add engine oil supplement GM P/N 12345795 or equivalent.

   Refer to *Sealers, Adhesives, and Lubricants*.

3. Fill the cooling system with the proper quantity and grade of coolant.
4. Disable the ignition system.
5. Crank the engine several times. Listen for any unusual noises or evidence that parts are binding.
6. Start the engine and listen for unusual noises.

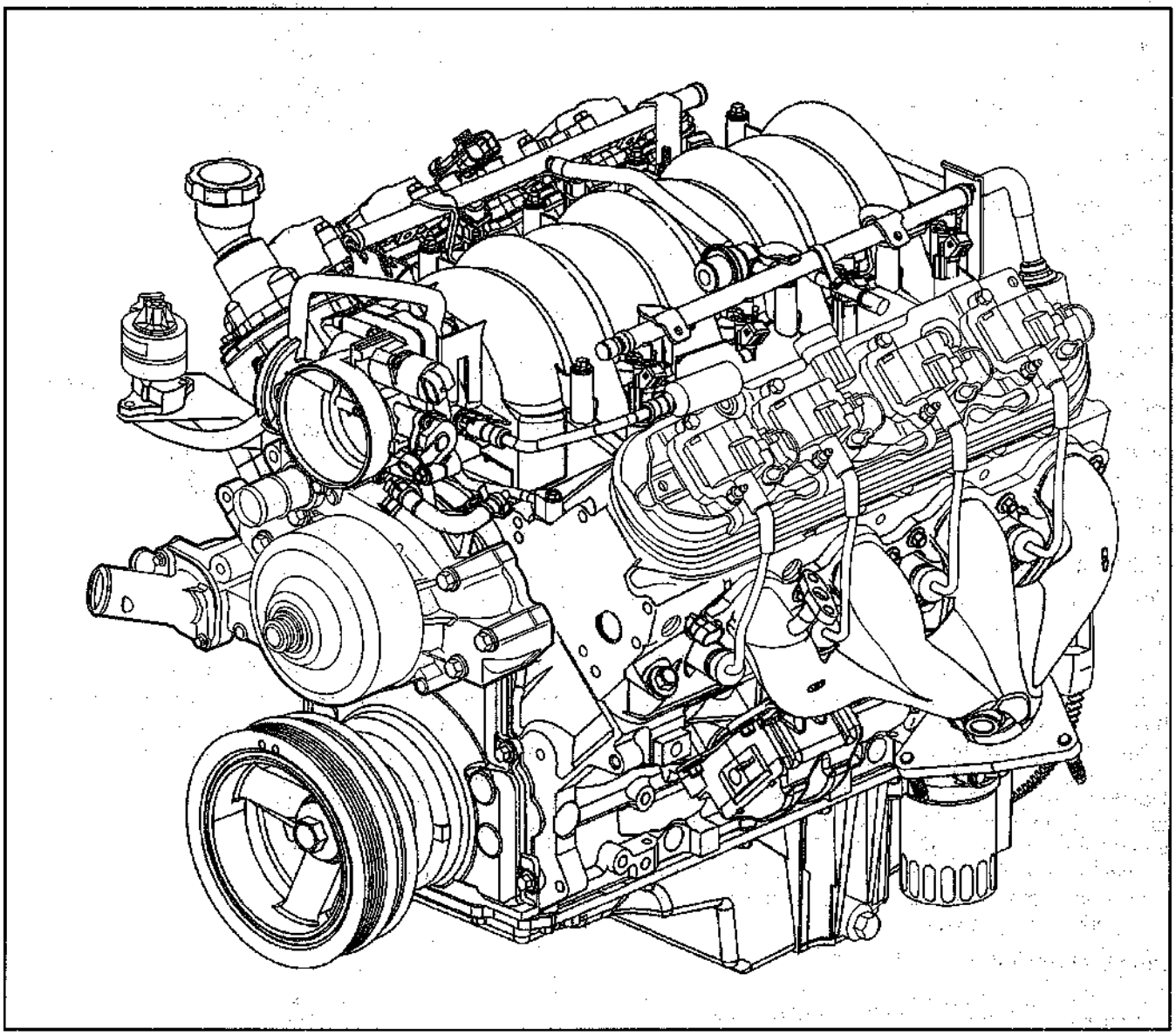
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7. Check the vehicle oil pressure gauge or light and confirm that the engine has acceptable oil pressure.
   If necessary, istall an oil pressure gauge and measure the engine oil pressure.
8. Run the engine speed at about 1000 RPM until the engine has reached normal operating temperature.
9. Listen for sticking lifters and other unusual noises.
10. Inspect for fuel, oil and/or coolant leaks while the engine is running.
11. Perform a final inspection for the proper engine oil and coolant levels.

Description and Operation

Engine Component Description

5.7 Liter LS1 V-8



309875

The 5.7 Liter V-8 engine is identified as RPO-LS1 and VIN-G.

Camshaft and Drive System

A billet steel one piece camshaft is supported by five bearings pressed into the engine block. The camshaft has a machined camshaft sensor reluctor ring incorporated between the fourth and fifth bearing journals. The camshaft timing sprocket is mounted to the front of the camshaft and is driven by the crankshaft sprocket through the camshaft timing chain.

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The crankshaft sprocket is splined and drives the oil pump driven gear. A retaining plate mounted to the front of the engine block maintains camshaft location.

Crankshaft

The crankshaft is cast nodular iron. The crankshaft is supported by five crankshaft bearings. The bearings are retained by crankshaft bearing caps which are machined with the engine block for the proper alignment and clearance. The crankshaft journals are undercut and rolled. The center main journal is the thrust journal. A crankshaft position reluctor ring is mounted at the rear of the crankshaft. The reluctor ring is not serviceable separately.

Cylinder Heads

The cylinder head assemblies are cast aluminum and have pressed in place powdered metal valve guides and valve seats. Passages for the Engine Coolant Air Bleed system are at the front and rear of each cylinder head. There are no exhaust gas passages within the cylinder head. The cylinder head design has changed. Valve rocker arm covers are now retained to the cylinder head by four center mounted rocker arm cover bolts.

Engine Block

The engine block is a cam-in-block deep skirt 90 degree V configuration with five crankshaft bearing caps. The engine block is aluminum with cast in place iron cylinder bore liners. The five crankshaft bearing caps each have four vertical M10 and two horizontal M8 mounting bolts. The camshaft is supported by five camshaft bearings pressed into the block.

Exhaust Manifolds

The exhaust manifolds are one piece cast iron design. The exhaust manifolds direct exhaust gasses from the combustion chambers to the exhaust system. Each manifold has a single inlet for the Air Injection Reaction (AIR) system and the left exhaust manifold has a threaded opening for installation of an oxygen sensor. Exhaust system gasses are directed from the right exhaust manifold through the Exhaust Gas Recirculation (EGR) pipe assembly and valve to the intake manifold. The EGR pipe assembly is retained to the exhaust manifold by two bolts and sealed at the exhaust manifold flange with a gasket. Each manifold also has an externally mounted heat shield that is retained by bolts.

Intake Manifold

The IAFM or integraged air fuel module is a one piece composite design that incorporates brass threaded inserts for mounting the fuel rail, throttle cable bracket, throttle body, and EGR inlet pipe. The intake manifold is sealed to the cylinder heads by eight separate non-reuseable silicone sealing gaskets which press into the grooves of the intake housing. The cable actuated throttle body assembly bolts to the front of the intake manifold. The throttle body is sealed to the intake manifold by a one piece push in place silicone gasket. The fuel rail assembly with eight separate fuel injectors is retained to the intake by four bolts. The injectors are seated in their individual manifold bores with O-ring seals to provide sealing. A fuel rail stop bracket is retained at the rear of the left fuel rail by the intake manifold mounting bolts. A snap fit Manifold Absolute Pressure (MAP) sensor housing is mounted at the rear of the manifold and sealed by an O-ring seal. The MAP sensor is installed and retained to the MAP sensor housing. An externally mounted Exhaust Gas Recirculation (EGR) pipe assembly installs into the top front of the intake manifold. The EGR pipe assembly is sealed to the intake manifold by an O-ring seal and is retained to the manifold by one bolt. There are no coolant passages within the intake manifold.

Oil Pan

The structural oil pan is cast aluminum. Incorporated into the design are the oil filter mounting boss, drain plug opening, oil level sensor mounting bore, and oil pan baffle. The oil pan cover and oil level sensor mount to the side of the oil pan. The alignment of the structural oil pan to the rear of the engine block and transmission bell housing is critical.

Piston and Connecting Rod Assemblies

The pistons are cast aluminum. The pistons use two compression rings and one oil control ring assembly. The piston is a low friction, lightweight design with a flat top and barrel shaped skirt. The piston pins are chromium steel. They have a floating fit in the piston and are retained by a press fit in the connecting rod. The connecting rods are powdered metal. The connecting rods are fractured at the connecting rod journal and then machined for the proper clearance.

Valve Rocker Arm Cover Assemblies

The valve rocker arm covers are cast aluminum and use a pre-molded silicone gasket for sealing. Mounted to each rocker cover is an ignition coil and bracket assembly. Incorporated into the covers are the oil fill tube, the Positive Crankcase Ventilation (PCV) system passages, and the engine fresh air passages. Rocker arm cover design has changed. The covers are now retained to the cylinder head by four center mounted rocker cover bolts.

Valve Train

Motion is transmitted from the camshaft through the hydraulic roller valve lifters and tubular pushrods to the roller type rocker arms. The valve lifter guides position and retain the valve lifters. The valve rocker arms for each bank of cylinders are mounted on pedestals (pivot supports). Each rocker arm is retained on the pivot support and cylinder head by a bolt. Valve lash is net build.

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Drive Belt System Description

The drive belt system consists of the following components:

- The drive belt
- The drive belt tensioner
- The drive belt idler pulley
- The crankshaft balancer pulley
- The accessory drive component mounting brackets
- The accessory drive components
  - The power steering pump, if belt driven
  - The generator
  - The A/C compressor, if equipped
  - The engine cooling fan, if belt driven
  - The water pump, if belt driven
  - The vacuum pump, if equipped
  - The air compressor, if equipped

The drive belt system may use one belt or two belts. The drive belt is thin so that it can bend backwards and has several ribs to match the grooves in the pulleys. There also may be a V-belt style belt used to drive certain accessory drive components. The drive belts are made of different types of rubbers (chloroprene or EPDM) and have different layers or plys containing either fiber cloth or cords for reinforcement.

Both sides of the drive belt may be used to drive the different accessory drive components. When the back side of the drive belt is used to drive a pulley, the pulley is smooth.

The drive belt is pulled by the crankshaft balancer pulley across the accessory drive component pulleys. The spring loaded drive belt tensioner keeps constant tension on the drive belt to prevent the drive belt from slipping. The drive belt tensioner arm will move when loads are applied to the drive belt by the accessory drive components and the crankshaft.

The drive belt system may have an idler pulley, which is used to add wrap to the adjacent pulleys. Some systems use an idler pulley in place of an accessory drive component when the vehicle is not equipped with the accessory.

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 one or more of the following items:

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

Torque Values and/or Fastener Tightening Strategies

- The new service thread repair tools and service procedures are identified.

  Refer to *Thread Repair, Thread Repair Specifications,* and *Fastener Tightening Specifications* for additional information.
- A second design connecting rod bolt may be used. The proper fastener tightening value MUST be used with the correct bolt.

  Refer to *Piston, Connecting Rod, and Bearing Installation.*

New Sealants and/or Adhesives

No sealant or adhesive changes from the previous year. Refer to *Sealers, Adhesives, and Lubricants.*

Engine Mechanical Diagnostic Procedure Revisions

Base Engine Misfire, Valve Train, and other diagnostic information is now provided in table form. Potential or probable causes are supplied for each specific concern.

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New Special Tools Required

The proper thread repair procedures for aluminum cylinder blocks and cylinder heads have been added.

Refer to *Thread Repair.*

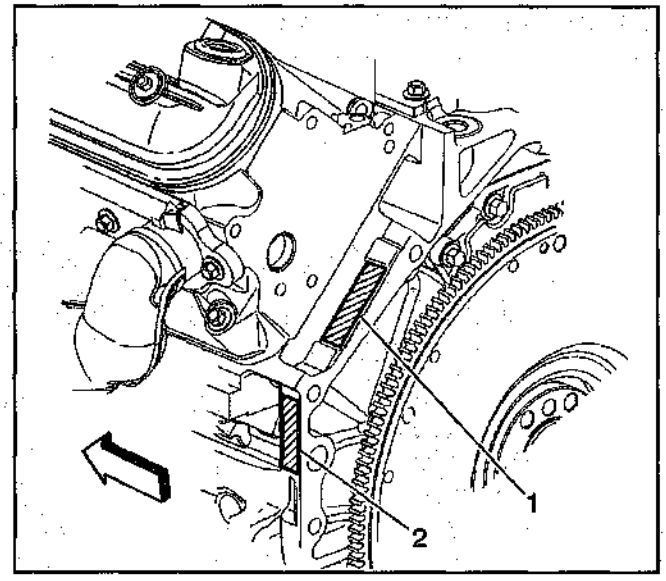
A Component Comparison from the Previous Year

- Exhaust manifolds are a cast iron design with bolt on heat shields.

  Refer to *Engine Component Description.*
- The vapor vent pipe, located above the engine valley cover will now be referred to as the engine coolant air bleed pipe.

  Refer to *Disassembled Views.*

Engine Identification



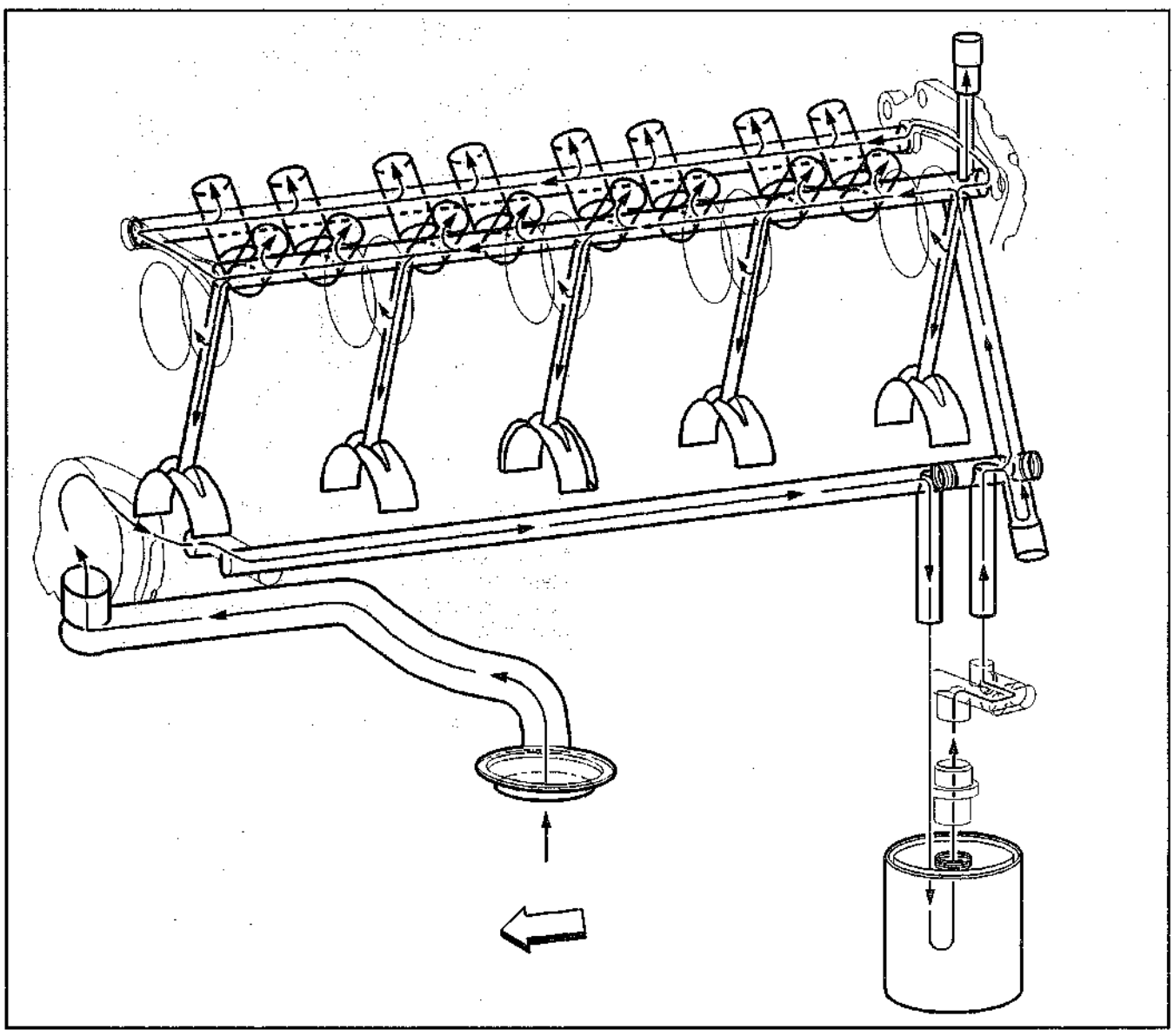
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The 5.7 Liter LS1 engine has two locations where information is stamped on the block to identify the component. Location one (1) is the primary stamping location. Location two (2) is the secondary stamping location. Both stamping locations contain the engine identification numbers.

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Lubrication

Lubrication Flow Schematic

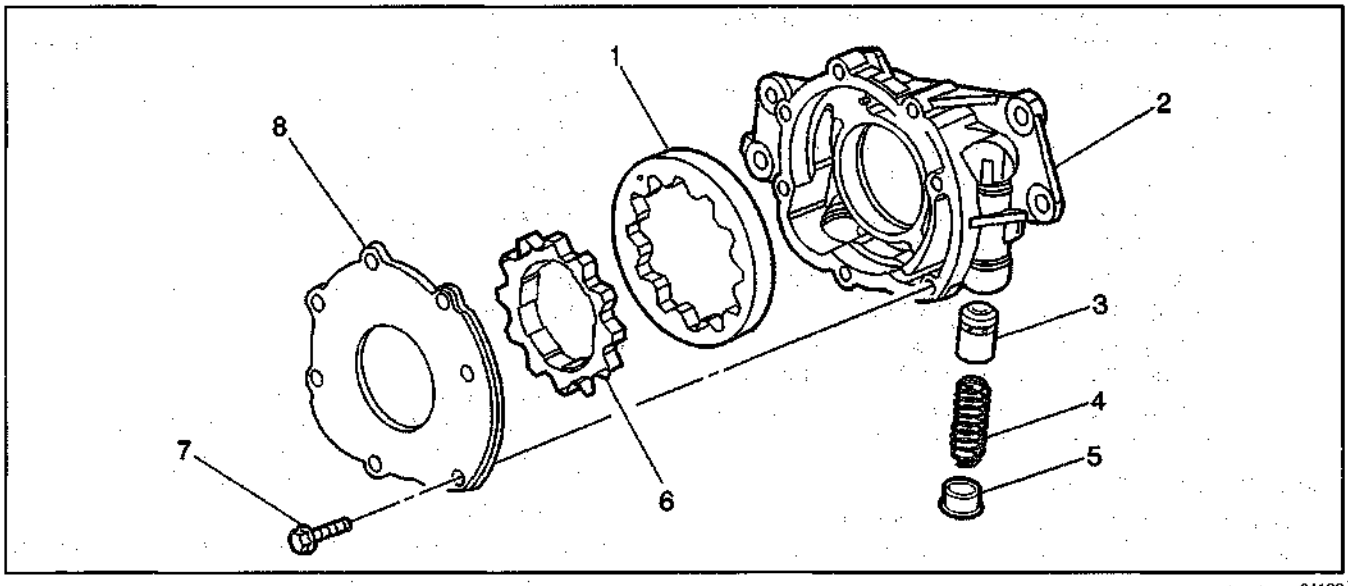


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Engine lubrication is supplied by a gerotor type oil pump assembly. The pump is mounted on the front of the engine block and driven directly by the crankshaft sprocket. The pump gears rotate and draw oil from the oil pan sump through a pick-up screen and pipe. The oil is pressurized as it passes through the pump and is sent through the engine block oil galleries. Contained within the oil pump assembly is a pressure relief valve that maintains oil pressure within a specified range. Pressurized oil is directed through the lower gallery to the full flow oil filter where harmful contaminants are removed. A bypass valve is incorporated into the oil pan which will permit oil flow in the event the filter becomes restricted. At the rear of the block, oil is then directed to the upper main oil galleries which are drilled just above the camshaft assembly. From there oil is then directed to the crankshaft and camshaft bearings. Oil that has entered the upper main oil galleries also pressurizes the valve lifter assemblies and is then pumped through the pushrods to lubricate the valve rocker arms and valve stems. Oil returning to the pan is directed by the crankshaft oil deflector. Oil temperature, pressure and crankcase level are each monitored by individual sensors.

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Oil Pump Assembly



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Legend

(1) Driven Gear
(2) Oil Pump Housing
(3) Pressure Relief Valve
(4) Pressure Relief Valve Spring
(5) Plug
(6) Drive Gear
(7) Cover Bolt
(8) Cover

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 reassembly.

  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.

Replacing Engine Gaskets

Gasket Reuse and Applying Sealants

Tools Required

J 28410 Gasket Remover

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

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Cleaning Gasket Surfaces

- Remove all gasket and sealing material from the part using the *J 28410* 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

- 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.
- Do not allow the sealant to enter into any blind threaded holes, as it may prevent the bolt from clamping properly or cause component damage when tightened.
- Tighten bolts to specifications. Do not overtighten.

Use of RTV and Anaerobic Sealer

Pipe Joint Compound

Important: Three types of sealer are commonly used in engines. These are 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 three 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 sealer is used where two 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*
- 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. Do not allow the sealer to enter any blind threaded holes, as it may prevent the bolt from clamping properly or cause component damage when the bolt is tightened.
- 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

- Room Temperature Vulcanizing (RTV) sealant hardens when exposed to air. This type sealer is used where two non-rigid parts (such as the intake manifold and the engine block) are assembled together.
- Do not use Room Temperature Vulcanizing (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*
- Apply RTV to a clean surface. Use a bead size as specified in the procedure. Run the bead to the inside of any bolt holes. Do not allow the sealer to enter any blind threaded holes, as it may prevent the bolt from clamping properly or cause damage when the bolt is tightened.
- Assemble components while RTV is still wet (within 3 minutes). Do not wait for RTV to skin over.
- Tighten bolts to specifications. Do not overtighten.

Anaerobic Sealer

- Anaerobic gasket eliminator hardens in the absence of air. This type sealer is used where two rigid parts (such as castings) are assembled together. When two 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 resealed must be clean and dry.
- Spread the sealer evenly with your finger to get a uniform coating on the sealing surface.
- Do not allow the sealer to enter any blind threaded holes, as it may prevent the bolt from clamping properly or cause damage when tightened.

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Important: Anaerobic sealed joints that are partially torqued and allowed to cure more than five minutes may result in incorrect shimming and sealing of the joint.

Do not allow the sealer to enter any blind threaded holes, as it may prevent the bolt from seating properly or cause damage when the bolt is tightened.

- Tighten bolts to specifications. Do not overtighten.
- After properly tightening the fasteners, remove the excess sealer from the outside of the joint.

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 reinstallation 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 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, guides, pushrods, pivot supports and rocker arms
- Valve to the valve guide
- Valve spring and shim to the cylinder head location
- Engine block main bearing cap location and direction
- Oil pump drive and driven gears

Installation Precautions

Important: Follow the engine service information below. This information is important in order to prevent damage and in contributing to reliable engine performance.

In order to avoid damage to the engine oil pan, use a block of wood between the jack and the oil pan. Ensure that the block of wood extends past the complete width of the oil pan. Due to the small clearance between the oil pan and the oil pump screen, jacking against the oil pan may cause the oil pan to bend against the pump screen. This condition results in a damaged oil pick-up unit.

Caution: Refer to Fastener Notice in Cautions and Notices.

When working on the engine, remember that the 12–volt electrical system is capable of causing short circuits. When performing any work where electrical terminals may possibly be grounded, disconnect the ground cable of the battery at the battery.

Any time you remove the air cleaner, cover the intake opening. This procedure protects against the accidental entrance of foreign material. Foreign material may follow the intake passage into the cylinder. This condition causes extensive damage when you start the engine.

In the mechanical procedures described in this section, generally no references will be made to the removal of optional equipment such as the power steering pump, the air conditioning compressor, etc.

If you need to remove any optional equipment in order to perform other service, refer to the appropriate section of this service manual for the specific information.

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 will also minimize possible damage to engine components. Some precision measuring tools are required for inspection of certain critical components. Torque wrenches and a torque angle meter are necessary for the proper tightening of various fasteners.

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

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

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Special Tools and Equipment

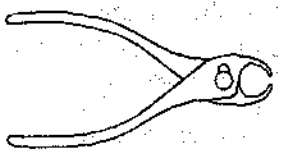
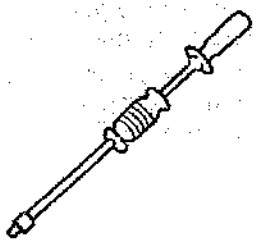
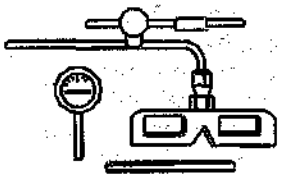
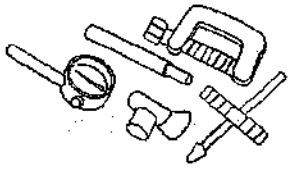
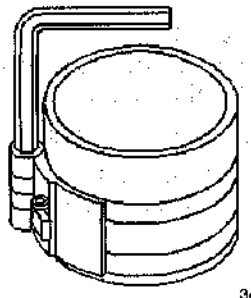
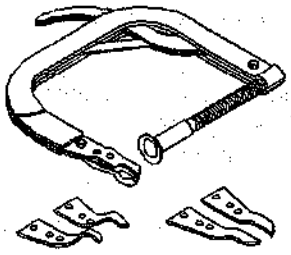
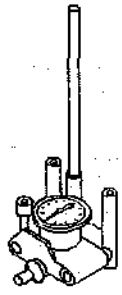
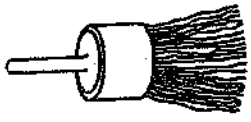
Illustration	Tool Number/ Description
 14487	J 3049-A Valve Lifter Remover
 4865	J 6125-1B Slide Hammer
 35463	J 7872 Magnetic Base Dial Indicator Set
 3415	J 8001 Dial Indicator Set

Illustration	Tool Number/ Description
 3403	J 8037 Piston Ring Compressor
 3414	J 8062 Valve Spring Compressor (head off-vehicle)
 5110	J 8087 Cylinder Bore Checking Gauge
 35464	J 8089 Carbon Removal Brush

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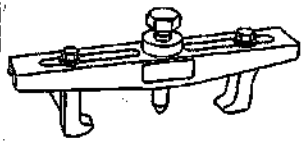
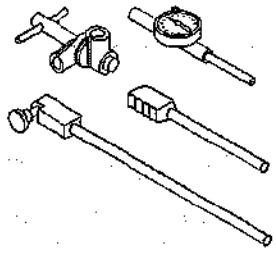
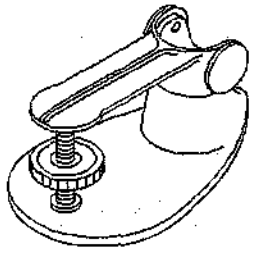
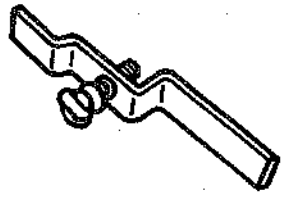
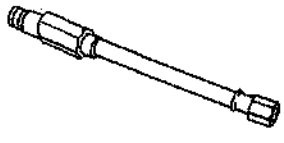
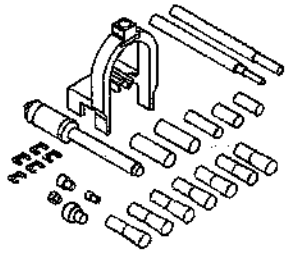
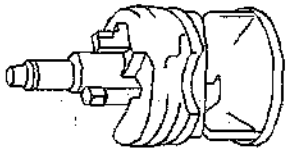
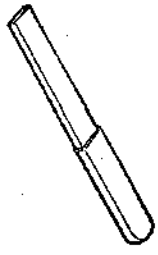
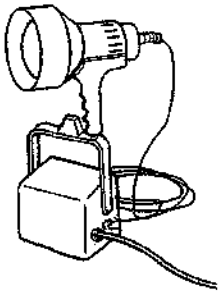
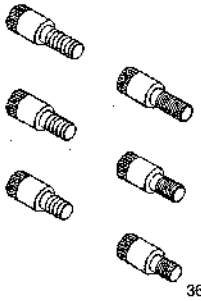
Illustration	Tool Number/ Description
 216164	J 8433 Two Jaw Puller
 3408	J 8520 Camshaft Lobe Lift Dial Indicator Set
 5112	J 9666 Valve Spring Tester
 47935	J 21366 Converter Holding Strap
 26998	J 22794 Spark Plug Port Adapter

Illustration	Tool Number/ Description
 14495	J 24086-C Piston Pin Remover/Installer
 3412	J 24270 Cylinder Ridge Remover
 54479	J 28410 Gasket Remover
 62292	J 28428-E Leak Detector Kit
 367798	J 28467-90A Engine Support Adapters

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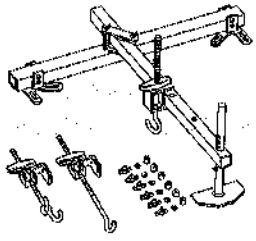
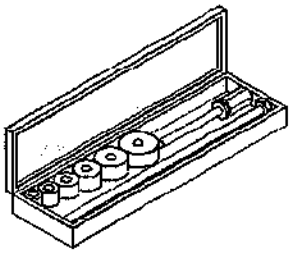
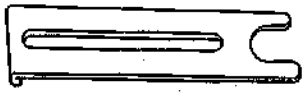
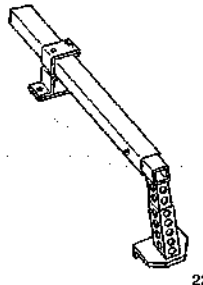
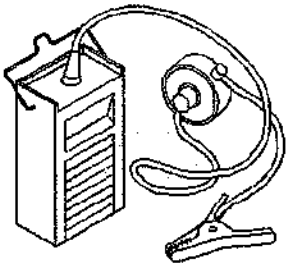
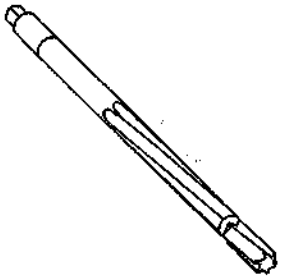
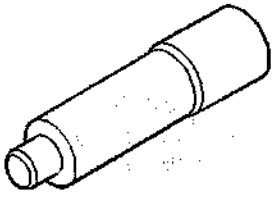
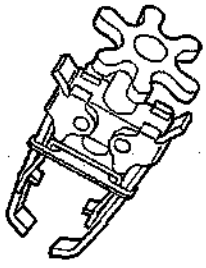
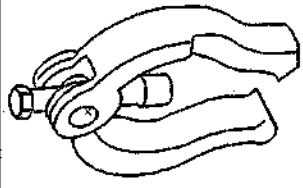
Illustration	Tool Number/ Description
 220640	J 28467-B Universal Support Fixture
 5118	J 33049 Camshaft Bearing Remover/Installer
 105916	J 36221 Hydraulic Clutch Line Separator
 220642	J 36462-A Engine Support Adapter Leg
 3413	J 36660-A Torque Angle Meter

Illustration	Tool Number/ Description
 596942	J 37378-1 Valve Guide Reamer
 18093	J 38836 Pilot Bushing Installer/Clutch
 40271	J 38606 Valve Spring Compressor
 54471	J 39411 Flywheel Holding Tool
 181116	J 39549 Ball Joint/Tie Rod Separator

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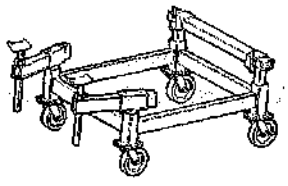
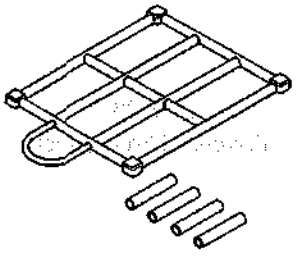
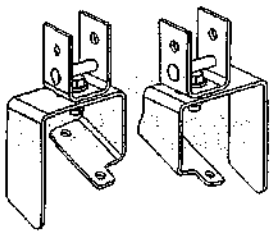
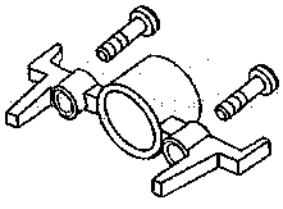
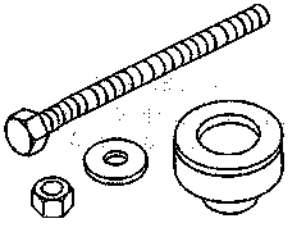
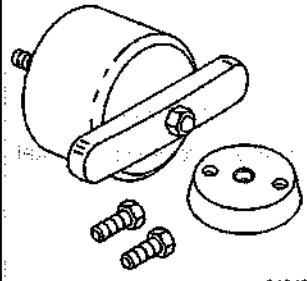
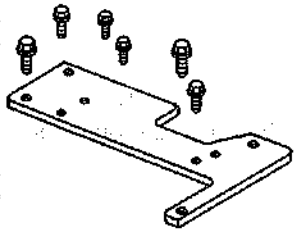
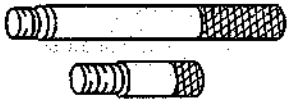
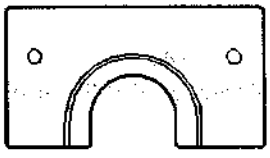
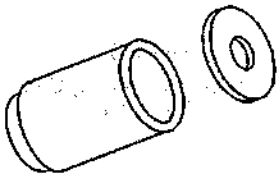
Illustration	Tool Number/ Description
 82341	J 39580 Engine Support Table
 74284	J 39580-500 Engine Support Table Top
 220634	J 41044 Engine Support Adapters
 64207	J 41476 Front and Rear Cover Alignment (at crankshaft seal area)
 64248	J 41478 Crankshaft Front Oil Seal Installer

Illustration	Tool Number/ Description
 64249	J 41479 Crankshaft Rear Oil Seal Installer
 64211	J 41480 Front and Rear Cover Alignment (at oil pan surface)
 64260	J 41556 Connecting Rod Guide
 98060	J 41558 Crankshaft Sprocket Remover
 64240	J 41665 Crankshaft Balancer and Sprocket Installer

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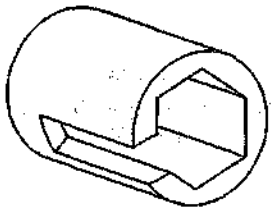
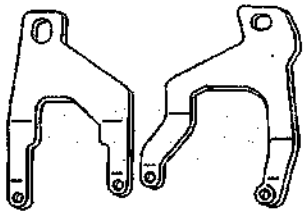
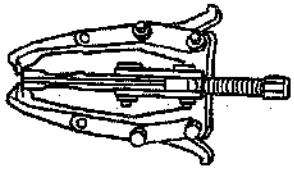
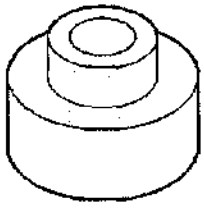
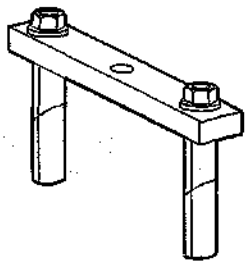
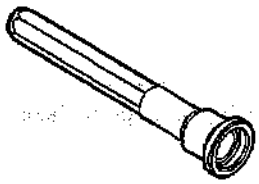
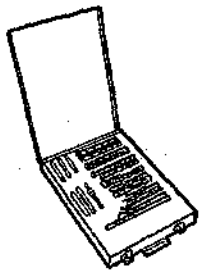
Illustration	Tool Number/ Description
 9192	J 41712 Oil Pressure Sensor Socket
 74283	J 41798 Engine Lifting Brackets
 54474	J 41816 Crankshaft Balancer Remover
 98058	J 41816-2 Crankshaft End Protector
 38515	J 41818 Crankshaft Bearing Cap Remover

Illustration	Tool Number/ Description
 98042	J 42078 Valve Stem Oil Seal Installer
 54471	J 42386 Flywheel Holding Tool
 54577	J 42385-100 Thread Repair Kit (Cylinder Head/Main Bearing Bolt)
 54577	J 42385-200 Thread Repair Kit (General Threads)
 54577	J 42385-300 Thread Repair Kit (Fixtures and Hardware)

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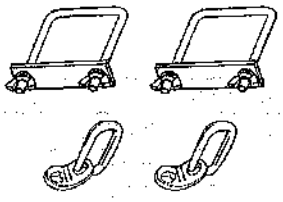
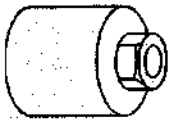
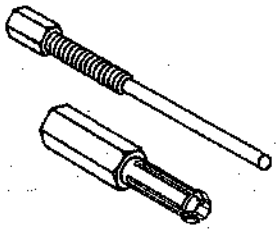
Illustration	Tool Number/ Description
 220638	J 42451 Engine Support Adapter Kit
 13545	J 42907 Oil Pressure Testing Tool

Illustration	Tool Number/ Description
 355040	J 43276 Clutch Pilot Bearing Remover

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