2008 ENGINE

Engine Mechanical - 6.6L - Cab & Chassis Sierra, Cab & Chassis Silverado, Sierra & Silverado

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Application	Specification	
	Metric	English
A/C Compressor Bolt	50 N.m	37 lb ft
Air Cleaner Outlet Duct Clamp	8 N.m	71 lb in
Air Conditioning Compressor/Power Steering Pump Bracket Bolt	46 N.m	34 lb ft
Air Inlet Tube Nut	25 N.m	18 lb ft
Battery Cable Bracket Bolt	12 N.m	106 lb in
Battery Cable Bracket Nut	8 N.m	71 lb in
Bypass Pipe Bolt	25 N.m	18 lb ft
Camshaft Gear Bolt	234 N.m	173 lb ft
Camshaft Position Sensor Bolt	10 N.m	89 lb in
Camshaft Position Sensor Exciter Ring Bolt	9 N.m	80 lb in
Camshaft Thrust Plate Bolt	22 N.m	16 lb ft
Charged Air Cooler Bolt	21 N.m	15 lb ft
Charged Air Cooler Clamp	8 N.m	71 lb in
Connecting Rod Cap Bolt - Angular Tightening Method	1st Step 64 N.m	1st Step 47 lb ft
	2nd Step 30 degrees	2nd Step 30 degrees
	3rd Step 30 degrees	3rd Step 30 degrees
Coolant Pipe Bolt and Nut	25 N.m	18 lb ft
Coolant Tube to Water Pump Nut	25 N.m	18 lb ft
Cooling Fan Pulley	41 N.m	30 lb ft
Crankshaft Balancer Bolt	1st Step 100 N.m	1st Step 74 lb ft
	2nd Step 105 degrees	2nd Step 105 degrees
	1st Step 98 N.m	1st Step 72 lb ft
	2nd Step 132 N.m	2nd Step 97 lb ft

Crankshaft Bearing Cap Bolt	3rd Step 30 degrees	3rd Step 30 degrees
Crankshaft Bearing Cap Bolt - Angular Tightening Method	1st Step 100 N.m	1st Step 74 lb ft
	2nd Step 90 degrees	2nd Step 90 degrees
Crankshaft Bearing Cap Side Bolt	70 N.m	52 lb ft
Crankshaft Position Sensor Bolt	10 N.m	89 lb in
Crankshaft Position Sensor Spacer Bolt	10 N.m	89 lb in
Crossmember Bolt	100 N.m	74 lb ft
Cylinder Head M12 Bolt - Angular Tightening Method	1st Step 50 N.m	1st Step 37 lb ft
	2nd Step 80 N.m	2nd Step 59 lb ft
	3rd Step 60 degrees	
	4th Step 60 degrees	
Cylinder Head M8 Bolt	25 N.m	18 lb ft
Drive Belt Tensioner Pulley Bolt	50 N.m	37 lb ft
EGR to EGR Cooler Bolt	25 N.m	18 lb ft
EGR Bracket	25 N.m	18 lb ft
EGR Bracket Bolt	25 N.m	18 lb ft
EGR Bracket to Cooler Bolt	25 N.m	18 lb ft
Electrical Harness Bracket Bolt	10 N.m	89 lb in
Engine Block Coolant Plug	18 N.m	13 lb ft
Engine Block Ground Bolt	34 N.m	25 lb ft
Engine Mount Through Bolt to Frame	75 N.m	55 lb ft
Engine Mount to Block Bolts	58 N.m	43 lb ft
Engine Mount to Frame Bolt	65 N.m	48 lb ft
Engine Shield Bolt	20 N.m	15 lb ft
Exhaust Heat Shield Nut	10 N.m	89 lb in
Exhaust Manifold Bolt/Nut	57 N.m	42 lb ft
Exhaust Manifold Heat Shield Bolts	10 N.m	89 lb in
Exhaust Outlet Clamp	15 N.m	11 lb ft
Exhaust Outlet Heat Shield Bolts	10 N.m	89 lb in
Exhaust Pipe Bracket Nut	53 N.m	39 lb ft
Exhaust Pipe Clamp	53 N.m	39 lb ft
Exhaust Pipe Heat Shield Bolts	10 N.m	89 lb in
Exhaust Pipe to EGR Cooler Nuts	26 N.m	19 lb ft

Fan Pulley Bracket Bolt	50 N.m	37 lb ft
Flywheel Bolt - Angular Tightening Method	1st Step 79 N.m	1st Step 58 lb ft
	2nd Step 60 degrees	2nd Step 60 degrees
	3rd Step 60 degrees	3rd Step 60 degrees
Flywheel Housing Bolt	80 N.m	60 lb ft
Flywheel Housing to Upper Oil Pan Bolt	50 N.m	37 lb ft
Front Engine Cover Bolt	25 N.m	18 lb ft
Fuel Filter Bracket Bolt	30 N.m	22 lb ft
Fuel Injection Pipe Nut	41 N.m	30 lb ft
Fuel Injector Bracket Bolt	30 N.m	22 lb ft
Fuel Inlet Pipe Bracket Bolt	21 N.m	15 lb ft
Fuel Injection Pump Assembly to Cylinder Block Bolt	25 N.m	18 lb ft
Fuel Injection Pump to Bracket Bolt	28 N.m	20 lb ft
Fuel Injection Pump Drive Gear Nut	70 N.m	52 lb ft
Fuel Line Bracket Nut	21 N.m	15 lb ft
Fuel Temperature Sensor	22 N.m	16 lb ft
Fuel Pipes Bracket Bolt	25 N.m	18 lb ft
Fuel Pressure Relief Valve	100 N.m	74 lb ft
Fuel Rail Assembly Bolt	25 N.m	18 lb ft
Fuel Rail Balance Pipe Bolt	21 N.m	15 lb ft
Generator Bracket Bolt and Nut	50 N.m	37 lb ft
Generator Positive Cable Nut	9 N.m	80 lb in
Glow Plug	18 N.m	13 lb ft
Glow Plug Controller Bolt	10 N.m	89 lb in
Glow Plug Harness Bracket Bolt	10 N.m	89 lb in
Glow Plug Nut	2 N.m	18 lb in
Glow Plug Power Feed Nut	15 N.m	11 lb ft
Glow Plug Relay Assembly Bolt	10 N.m	89 lb in
Heater Outlet Pipe Bolt	25 N.m	18 lb ft
Heater Pipe Bolt	25 N.m	18 lb ft
Hood Hinge Bolt	25 N.m	18 lb ft
Idle Pulley Bolt	50 N.m	37 lb ft

Injector Bracket Bolt	23 N.m	16 lb ft
Intake Manifold Bolts/Nuts	25 N.m	18 lb ft
Oil Cooler Adapter Bolts	25 N.m	18 lb ft
Oil Cooler Adapter Nuts	25 N.m	18 lb ft
Oil Cooler Assembly Bolts	25 N.m	18 lb ft
Oil Cooler Adapter Stud	10 N.m	89 lb in
Oil Drain Plug	84 N.m	62 lb ft
Oil Fill Tube Bolt	25 N.m	18 lb ft
Oil Filter	24 N.m	18 lb ft
Oil Gallery Plugs	53 N.m	39 lb ft
Oil Level Indicator Tube Bolt	21 N.m	15 lb ft
Oil Level Sensor Bolt	10 N.m	89 lb in
Oil Level Sensor Harness Bolt	40 N.m	29 lb ft
Oil Pan Bolts/Nuts - Lower	10 N.m	89 lb in
Oil Pan Bolt - Upper	20 N.m	15 lb ft
Oil Pan Skid Plate Bolt	20 N.m	15 lb ft
Oil Pressure Sensor Unit	49 N.m	36 lb ft
Oil Pressure Relief Valve	39 N.m	29 lb ft
Oil Pump Bolt	21 N.m	15 lb ft
Oil Pump Driven Gear Nut	100 N.m	74 lb ft
Oil Pump Gear Cover Bolt	21 N.m	15 lb ft
Oil Pump Pipe and Screen Assembly Bolts and Nuts	25 N.m	18 lb ft
Piston Cooling Nozzle Eye Bolt	21 N.m	15 lb ft
Positive Cable Junction Block Bracket to Power Steering Pump Bolt	9 N.m	80 lb in
Positive Crankcase Ventilation Cover Screws	4 N.m	35 lb in
Positive Crankcase Ventilation Oil Separator Bracket Nut	25 N.m	18 lb ft
Power Steering Pump Bracket Bolt	50 N.m	37 lb ft
Power Steering Pump Bolt	50 N.m	37 lb ft
Rocker Arm Shaft Bracket Bolt	41 N.m	30 lb ft
Starter Motor Bolt	78 N.m	58 lb ft
Transmission Fill Tube Nut	18 N.m	13 lb ft
Thermostat Housing Bolts/Nuts	25 N.m	18 lb ft
Thermostat Cover Bolt	25 N.m	18 lb ft

Torque Converter Bolt	60 N.m	44 lb ft
Transmission Oil Cooler Clip Nut	9 N.m	80 lb in
Turbocharger Bolt	108 N.m	80 lb ft
Turbocharger Coolant Outlet Pipe Bracket Nut	10 N.m	89 lb in
Turbocharger Heat Shield Bolts	10 N.m	89 lb in
Turbocharger Oil Return Pipe Stud	10 N.m	89 lb in
Turbocharger Oil Supply Hose Eye Bolt	26 N.m	19 lb ft
Turbocharger Oil Return Pipe Bolts/Nuts	25 N.m	18 lb ft
Upper Oil Pan to Flywheel Housing Bolts	20 N.m	15 lb ft
Valve Adjusting Nut	22 N.m	16 lb ft
Valve Lifter Holdown Bracket Bolt	11 N.m	97 lb in
Valve Rocker Arm Cover Bolt - Lower	10 N.m	89 lb in
Valve Rocker Arm Cover Bolt - Upper	8 N.m (Two Times)	71 lb in (Two Times)
Water Outlet Bolts	25 N.m	18 lb ft
Water Pump Bolt	25 N.m	18 lb ft
Water Pump Inlet Pipe Bolts	25 N.m	18 lb ft

ENGINE MECHANICAL SPECIFICATIONS

Application	Specification	
	Metric	English
General		
• Engine Type	90 degree V-8	
• Displacement	6.6 Liter	402 cu in
• RPO	LMM	
• Bore	103 mm	4.0551 in
• Stroke	99 mm	3.8976 in
• Compression Ratio	16.8:1	
• Engine Compression Test - Minimum	2069 KPa	300 psi
• Idle Speed	680 RPM	
• Firing Order	1-2-7-8-4-5-6-3	
Block		
	103.11 mm	4.0594 in

• Cylinder Bore Diameter - Service Limits		
• Cylinder Bore Diameter - Production Value	103.0-103.014 mm	4.0551-4.0557 in
• Cylinder Bore Out-of-Round - Production Value	0.015 mm	0.0006 in
• Cylinder Bore Taper - Production Value	0.015 mm	0.0006 in
Camshaft		
• Camshaft Bearing Inside Diameter - Service Limit	61.07 mm	2.4043 in
• Camshaft Bearing Inside Diameter - Production Value	61.00-61.03 mm	2.4016-2.4028 in
• Camshaft End Play - Service Limit	0.2 mm	0.0079 in
• Camshaft Journal Diameter - Service Limit	60.92 mm	2.3984 in
• Camshaft Journal Diameter - Production Value	60.932-60.962 mm	2.3990-2.4001 in
• Camshaft Lobe Lift - Exhuast - Production Value	5.907 mm	0.2326 in
• Camshaft Lobe Lift - Intake - Production Value	7.273 mm	0.2863 in
• Camshaft Runout - Service Limit	0.05 mm	0.0020 in
Cooling System		
• Capacity @ Engine RPM	270 L/min @ 3172 RPM	
• Thermostat Full Open Temperature	110 degrees C	230 degrees F
• Turbocharger Coolant Bypass Valve	60 degrees C	140 degrees F
Connecting Rod		
• Connecting Rod Bearing Clearance - Service Limit	0.10 mm	0.0039 in
• Connecting Rod Bearing Clearance - Production Value	0.036-0.077 mm	0.0014-0.0030 in
• Connecting Rod Bore Diameter - Bearing End - Production Value	62.958-62.979 mm	2.4789-2.4795 in
• Connecting Rod Bore Diameter - Pin End - Service Limit	34.53 mm	1.3594 in
• Connecting Rod Bore Diameter - Pin End -		

Production Value	34.512-34.522 mm	1.3587-1.3591 in
• Connecting Rod Length	163.0 mm	6.42 in
• Connecting Rod Side Clearance - Service Limit	0.54 mm	0.0213 in
• Connecting Rod Side Clearance - Production Value	0.31-0.49 mm	0.0122-0.0193 in
Crankshaft		
• Connecting Rod Journal Diameter - Service Limit	62.88 mm	2.4756 in
• Connecting Rod Journal Diameter - Production Value	62.902-62.922 mm	2.4764-2.4772 in
• Crankshaft End Play - Service Limit	0.54 mm	0.0213 in
• Crankshaft End Play - Production Value	0.04-0.205 mm	0.0016-0.0081 in
• Crankshaft Main Bearing Clearance - Service Limit	0.14 mm	0.0055 in
• Crankshaft Main Bearing Clearance - Production Value	0.039-0.070 mm	0.0015-0.0028 in
• Crankshaft Main Journal Diameter - Service Limit	79.89 mm	3.1453 in
• Crankshaft Main Journal Diameter - Production Value	79.905-79.925 mm	3.1459-3.1466 in
• Crankshaft Runout - Service Limit	0.44 mm	0.0173 in
• Crankshaft Runout - Production Value	0.05 mm	0.0020 in
Cylinder Head		
• Surface Flatness - Block Deck - Service Limit	0.2 mm	0.0079 in
• Surface Flatness - Block Deck - Production Value	0.075 mm	0.0030 in
• Surface Flatness - Exhaust Manifold Deck - Production Value	0.1 mm	0.0039 in
• Surface Flatness - Intake Manifold Deck - Production Value	0.1 mm	0.0039 in
Exhaust Manifold		
	0.3 mm	0.0118 in

• Surface Flatness- Production Value		
Intake Manifold		
• Surface Flatness - Production Value	0.3 mm	0.0118 in
Lubrication System		
• Oil Capacity - with Filter	10 qt	9.5 L
• Oil Capacity - without Filter	9.2 qt	8.7 L
• Oil Pressure - Minimum- Hot - at idle	98 KPa	14 psi
• Oil Pressure - Minimum - 1800 RPM	294 KPa	42 psi
• Oil Relief Valve Opening Pressure	441 KPa	64 psi
• Piston Cooling Jet Valve Opening Pressure	196 KPa	29 psi
Oil Pump		
• Gear Shaft Outside Diameter - Drive - Service Limit	19.86 mm	0.7819 in
• Gear Shaft Outside Diameter - Drive - Production Value	19.947-19.960 mm	0.7853-0.7858 in
• Gear Shaft Outside Diameter - Driven - Service Limit	19.86 mm	0.7819 in
• Gear Shaft Outside Diameter - Driven - Production Value	19.947-19.960 mm	0.7853-0.7858 in
• Gear Shaft-to-Bushing - Service Limit Clearance	0.14 mm	0.0055 in
• Gear-to-Cover Clearance - Drive/Driven - Service Limit	0.109 mm	0.0043 in
• Gear-to-Cover Clearance - Drive/Driven - Production Value	0.064-0.109 mm	0.0025-0.0043 in
• Gear-to-Housing Clearance - Drive/Driven - Service Limit	0.22 mm	0.0087 in
• Gear-to-Housing Clearance - Drive/Driven - Production Value	0.125-0.221 mm	0.0049-0.0087 in
Piston Rings		
• Piston Ring End Gap-First Compression Ring - Service Limit	1.37 mm	0.0539 in

• Piston Ring End Gap-First Compression Ring - Production Value	0.3-0.45 mm	0.0118-0.0177 in
• Piston Ring End Gap-Second Compression Ring - Service Limit	1.35 mm	0.0531 in
• Piston Ring End Gap-Second Compression Ring - Production Value	0.50-0.65 mm	0.0197-0.0256 in
• Piston Ring End Gap-Oil Control Ring - Service Limit	1.20 mm	0.0472 in
• Piston Ring End Gap-Oil Control Ring - Production Value	0.15-0.35 mm	0.0059-0.0138 in
• Piston Ring to Groove Clearance-First Compression Ring - Service Limit	0.26 mm	0.0102 in
• Piston Ring to Groove Clearance-First Compression Ring - Production Value	0.08-0.17 mm	0.0030-0.0067 in
• Piston Ring to Groove Clearance-Second Compression Ring - Service Limit	0.10 mm	0.0039 in
• Piston Ring to Groove Clearance-Second Compression Ring - Production Value	0.01-0.03 mm	0.0004-0.0012 in
• Piston Ring to Groove Clearance-Oil Control Ring - Service Limit	0.12 mm	0.0047 in
• Piston Ring to Groove Clearance-Oil Control Ring - Production Value	0.01-0.03 mm	0.0004-0.0012 in
Pistons and Pins		
• Piston-Piston Diameter	102.948-102.960 mm	4.0531-4.0535 in
• Piston-Piston Pin Bore Diameter	34.504-34.512 mm	1.3584-1.3587 in
• Pin-Piston Pin Clearance to Piston Pin Bore - Service Limit	0.017 mm	0.0007 in
• Pin-Piston Pin Clearance to Piston Pin Bore - Production Value	0.004-0.017 mm	0.0002-0.0007 in
• Pin-Piston Pin Diameter - Service Limit	34.45 mm	1.3563 in
• Pin-Piston Pin Diameter - Production Value	34.495-34.5 mm	1.3581-1.3583 in
Starter		

• Rated Output	3.5 KW	
Valve System		
• Valves-Valve Face Angle - Production Value	45 degrees	
• Valves-Valve Face Width - Service Limit	2.5 mm	0.0984 in
• Valves-Valve Face Width - Production Value	2.1 mm	0.0827 in
• Valves-Valve Head Diameter - Exhaust	31.0 mm	1.22 in
• Valves-Valve Head Diameter - Intake	33.0 mm	1.30 in
• Valves-Valve Seat Angle	45 degrees	
• Valves-Valve Stem Diameter	7.0 mm	0.28 in
• Valves-Valve Stem Oil Seal Installed Height	6.05 mm	0.2382 in
• Valves-Valve Stem-to-Guide Clearance - Service Limit	0.20 mm	0.0079 in
• Valves-Valve Stem-to-Guide Clearance - Exhaust - Production Value	0.038-0.071 mm	0.0015-0.0028 in
• Valves-Valve Stem-to-Guide Clearance - Intake - Production Value	0.030-0.063 mm	0.0012-0.0025 in
• Valves-Valve Stem-to-Guide Clearance	0.20 mm	0.0079 in
• Valve Lifters/Push Rods-Push Rod Straightness	0.8 mm	0.0315 in
• Rocker Arms-Valve Rocker Arm Bore Diameter	22.010-22.035 mm	0.8665-0.8675 in
• Rocker Arms-Valve Rocker Arm Bore-to-Shaft Clearance - Service Limit	0.20 mm	0.0079 in
• Rocker Arms-Valve Rocker Arm Bore-to-Shaft Clearance - Production Value	0.010-0.056 mm	0.0004-0.0022 in
• Rocker Arms-Valve Rocker Arm Ratio - Exhaust	1.69:1	
• Rocker Arms-Valve Rocker Arm Ratio - Intake	1.36:1	
• Rocker Arms-Valve Rocker Arm Shaft Diameter - Service Limit	21.85 mm	0.8602 in
• Rocker Arms-Valve Rocker Arm Shaft Diameter - Production Value	21.979-22.000 mm	0.8653-0.8661 in

• Valve Springs-Valve Spring Free Length - Production Value	56.6 mm	2.2283 in
• Valve Springs-Valve Spring Installed Height - Production Value	41 mm	1.6142 in
• Valve Springs-Valve Spring Load - Exhaust - Service Limit	275 N at 41 mm	61.8 lb at 1.61 in
• Valve Springs-Valve Spring load - Exhaust - Production Value	315-363 N at 41 mm	71-81.6 lb at 1.61 in
• Valve Springs-Valve Spring Load - Intake - Service Limit	306 N at 41 mm	68.8 lb at 1.61 in
• Valve Springs-Valve Spring Load - Intake - Production Value	315-363 N at 41 mm	71-81.6 lb at 1.61 in

SEALERS, ADHESIVES, AND LUBRICANTS

Application	Type of Material	GM Part Number	
		United States	Canada
Sealing Cup Plug	Locktite 272T or Equivalent	12345493	10953488
Upper Oil Pan to Cylinder Block	Sealant	12378521	88901148
Flywheel Housing to Cylinder Block	Sealant	12378521	88901148
Engine Front Cover to Cylinder Block	Sealant	12378521	88901148
Lower Oil Pan to Upper Oil Pan	Sealant	12378521	88901148
Crankshaft Bearing Side Cap Bolts	Sealant	12346004	10953480
Intake Manifold to Cylinder Head	Sealant	12378521	88901148
Camshaft Bearing	Engine Oil	12345634	993297
Rocker Arm Shaft	Engine Oil	12345634	993297
Valve Bridge Cap	Engine Oil	12345634	993297
Valve Stem Seal	Engine Oil	12345634	993297
Valve Lifter	Engine Oil	12345634	993297
Piston Ring	Engine Oil	12345634	993297
Crankshaft Bearing	Engine Oil	12345634	993297
Connecting Rod Bearing	Engine Oil	12345634	993297
Thrust Bearing	Engine Oil	12345634	993297

Camshaft Bearing	Engine Oil	12345634	993297
Camshaft	Engine Oil	12345634	993297
Connecting Rod Small End Bushing	Engine Oil	12345634	993297
Push Rod	Engine Oil	12345634	993297
Crankshaft Bearing Cap Bolt	Molybdenum Disulfide	1052948	992926
Lithium Grease	Lubricant	12346293	-
Parts Cleaner	Cleaner	12377981	10953463

CONNECTING ROD BEARINGS SELECTION SPECIFICATIONS

Connecting Rod Bearing Grade

Connecting Rod Grade (Stamped on Connecting Rod)	Use This Bearing Color	Bearing Thickness		Oil Clearance	
		Metric (mm)	English (in)	Metric (mm)	English (in)
A	Green	2.007 - 2.013	0.0790 - 0.0793	0.037 - 0.076	0.0015 - 0.0030
B	Yellow	2.011 - 2.017	0.0792 - 0.0794	0.037 - 0.076	0.0015 - 0.0030

CYLINDER HEAD GASKET SELECTION SPECIFICATIONS

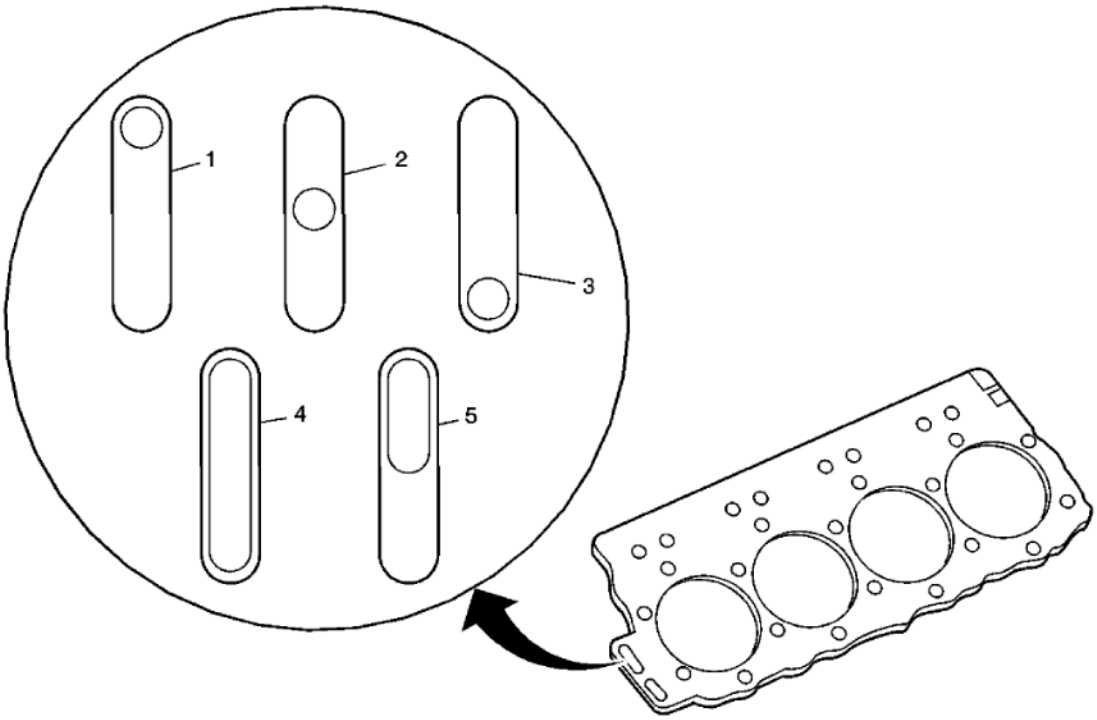


Fig. 1: View Of Cylinder Head Gasket Selection Marks
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Grade A
2	Grade B
3	Grade C
4	Block Over-Bored
5	Block Over-Bored and Deck Milled

Cylinder Head Gasket Grade	Ti Max (Piston Projection)		Compressed Gasket Thickness	
	Metric (mm)	English (in)	Metric (mm)	English (in)
Grade A	0.223 -0.274	0.0088 -0.0108	0.90-1.00	0.0354-0.0394
Grade B	0.274-0.325	0.0108-0.0128	0.95-1.05	0.0374-0.0413
Grade C	0.325-0.376	0.0128-0.0148	1.00-1.10	0.0394-0.0433
Block Over-Bored 0.010-0.030 in (0.254-0.762 mm)	0.223-0.376	0.0088-0.0148	1.00-1.10	0.0394-0.0433

Block Over-Bored 0.010-0.030 in (0.254-0.762 mm) and Deck Milled 0.008 in (0.203 mm)	0.4257-0.5777	0.0168-0.0228	1.25-1.35	0.0492-0.0532

CRANKSHAFT BEARING SELECTION SPECIFICATIONS

Cylinder Block Grade	Crankshaft Journal Grade	Identification Bearing Color	Oil Clearance	
			Metric (mm)	English (in)
1	1	Black	0.041-0.068	0.0016-0.0027
1	2	Brown	0.039-0.065	0.0015-0.0026
2	1	Blue	0.043-0.070	0.0017-0.0028
2	2	Black	0.041-0.067	0.0016-0.0027

VALVE CLEARANCE ADJUSTMENT SPECIFICATIONS

Cylinder		Adjust at No 1 Compression Stroke TDC		Adjust at No 1 Exhaust Stroke TDC	
Left Bank	Right Bank	Intake	Exhaust	Intake	Exhaust
-	1	X	X	-	-
2	-	-	X	X	-
-	3	X	-	-	X
4	-	-	-	X	X
-	5	X	-	-	X
6	-	X	-	-	X
-	7	-	X	X	-
8	-	-	X	X	-

THREAD REPAIR SPECIFICATIONS

Cylinder Head - Exhaust View

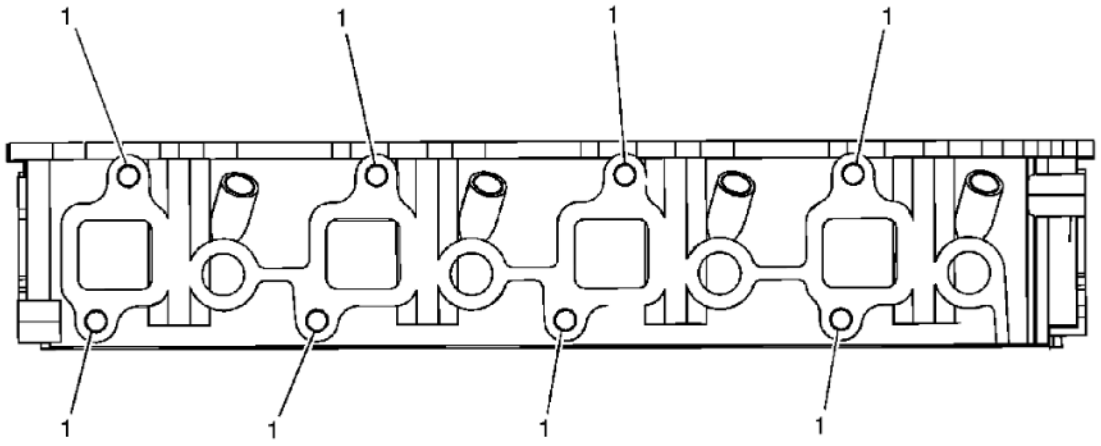


Fig. 2: Cylinder Head (Exhaust View)
Courtesy of GENERAL MOTORS CORP.

Cylinder Head - Exhaust View

Service Hole Location	Thread Size	Drill	Counterbore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Max)		Tap Depth (Min)	
								mm	(in)	mm	(in)
1	M 10 x 1.5	-211	-212	N/A	-213	-214	-215	25	0.985	21	0.827

Cylinder Head - Intake View

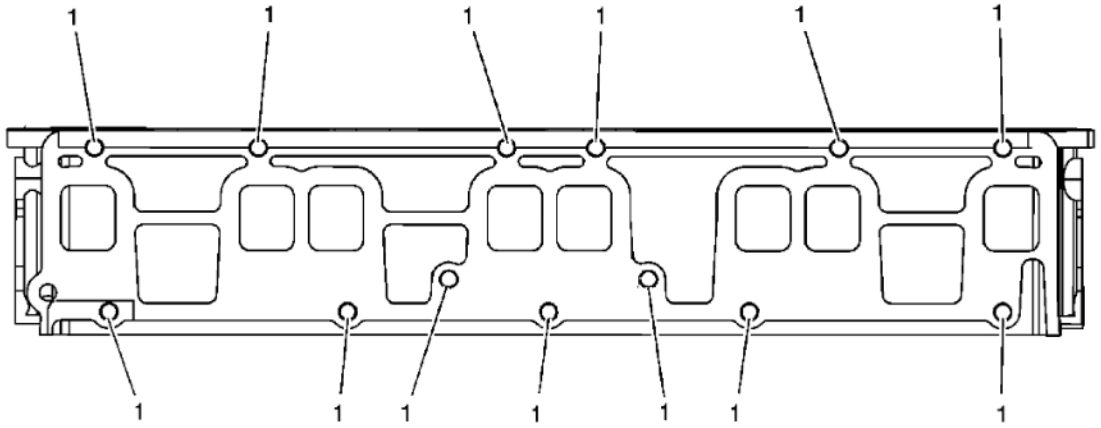


Fig. 3: Cylinder Head (Intake View)
Courtesy of GENERAL MOTORS CORP.

Cylinder Head - Intake View

Service Hole Location	Thread Size	Drill	Counterbore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Max)		Tap Depth (Min)	
								mm	(in)	mm	(in)
1	M 8 x 1.25	-206	-207	N/A	-208	-209	-210	21	0.827	17	0.669

Cylinder Head - Top View

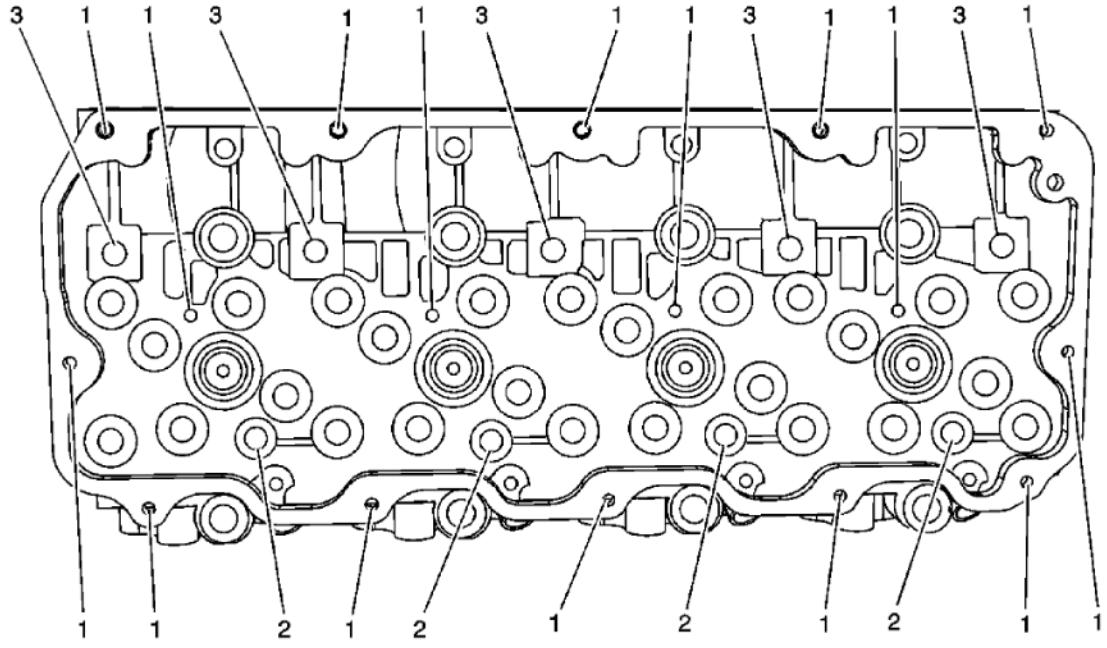


Fig. 4: Cylinder Head (Top View)
Courtesy of GENERAL MOTORS CORP.

Cylinder Head - Top View

Service Hole Location	Thread Size	Drill	Counterbore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Max)		Tap Depth (Min)	
								mm	(in)	mm	(in)
1	M 6 x 1.0	-201	-202	N/A	-203	-204	-205	17	0.669	13	0.512
2	M 8 x 1.25	-206	-207	N/A	-208	-209	-210	26	1.024	20	0.788

3	M 10 x 1.5	-211	-212	N/A	-213	-214	-215	26	1.024	20	0.788

Cylinder Head - Rear View

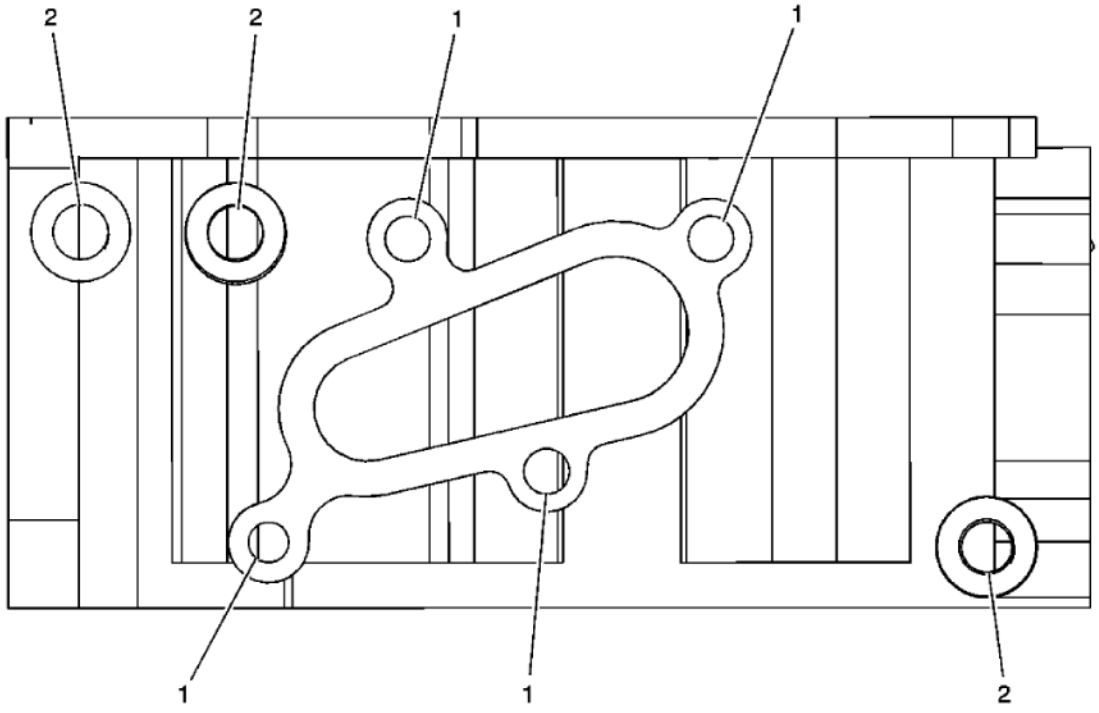


Fig. 5: Cylinder Head (Rear View)
Courtesy of GENERAL MOTORS CORP.

Cylinder Head - Rear View

Service Hole Location	Thread Size	Drill	Counterbore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Max)		Tap Depth (Min)	
								mm	(in)	mm	(in)
1	M 8 x 1.25	-206	-207	N/A	-208	-209	-210	17	0.669	13	0.512
2	M 10 x 1.5	-211	-212	N/A	-213	-214	-216	20	0.788	16	0.630

Cylinder Head - Front View

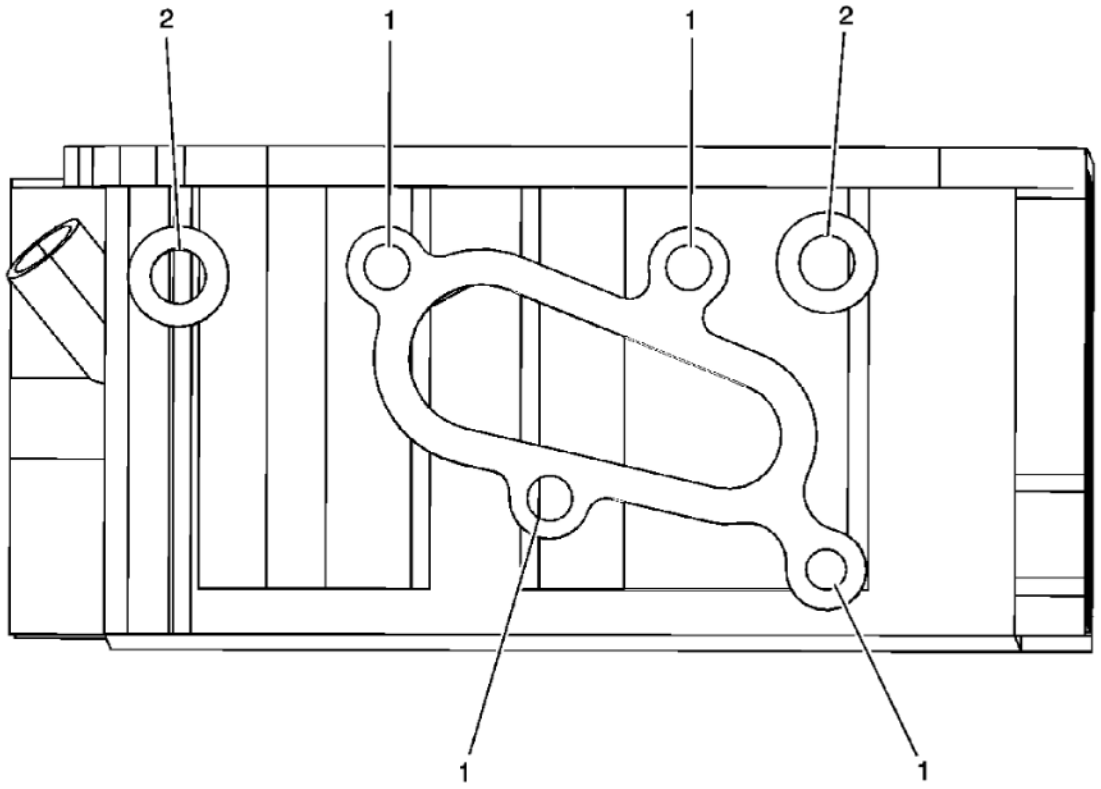


Fig. 6: Cylinder Head (Front View)
Courtesy of GENERAL MOTORS CORP.

Cylinder Head - Front View

Service Hole Location	Thread Size	Drill	Counterbore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Max)		Tap Depth (Min)	
								mm	(in)	mm	(in)
1	M 8 x 1.25	-206	-207	N/A	-208	-209	-210	17	0.669	13	0.512
2	M 10 x 1.5	-211	-212	N/A	-213	-214	-216	20	0.788	16	0.630

Intake Manifold - Right Side View

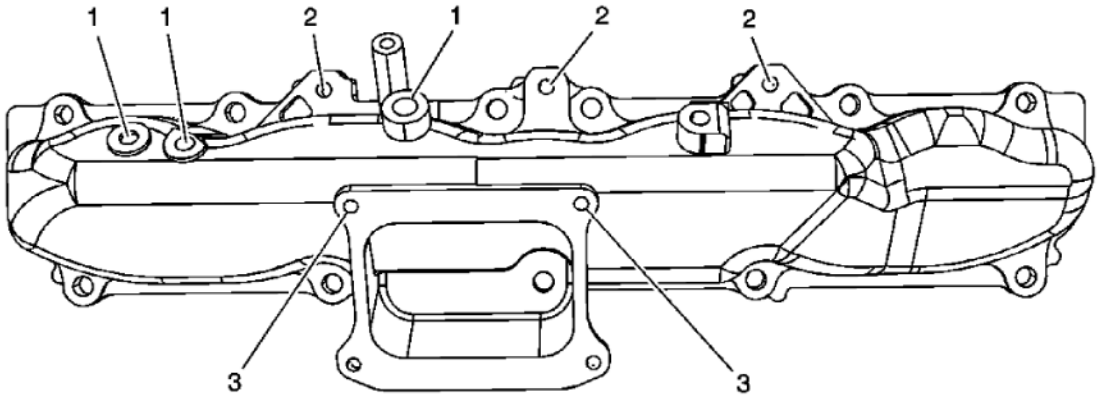


Fig. 7: Intake Manifold (Right Side View)
Courtesy of GENERAL MOTORS CORP.

Intake Manifold - Right Side View

Service Hole Location	Thread Size	Drill	Counterbore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Max)		Tap Depth (Min)	
								mm	(in)	mm	(in)
1	M 8 x 1.25	-206	-207	N/A	-208	-209	-415	16	0.630	13	0.512
2	M 8 x 1.25	-206	-207	N/A	-208	-209	-210	THRU		THRU	
3	M 6 x 1.0	-201	-202	N/A	-203	-204	-205	16	0.0630	12	0.472

Intake Manifold - Left Side View

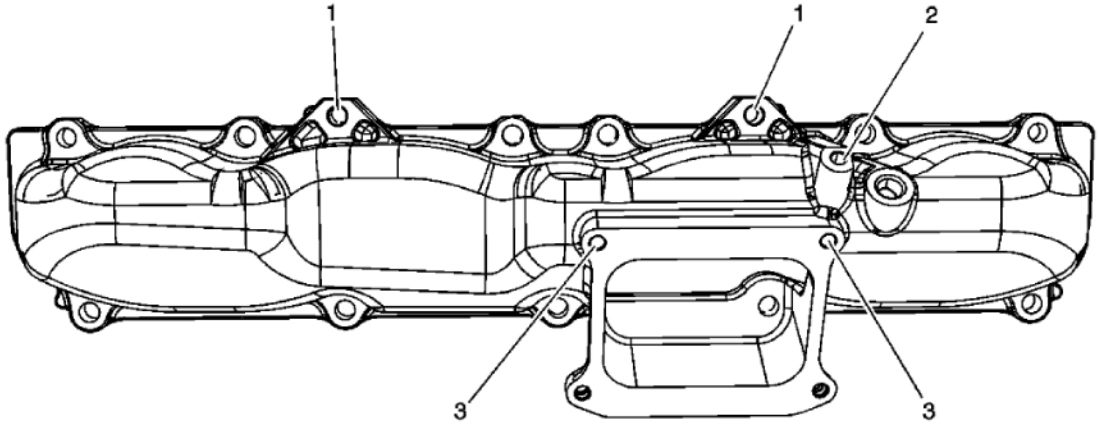


Fig. 8: Intake Manifold (Left Side View)
Courtesy of GENERAL MOTORS CORP.

Intake Manifold - Left Side View

Service Hole Location	Thread Size	Drill	Counterbore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Max)		Tap Depth (Min)	
								mm	(in)	mm	(in)
1	M 8 x 1.25	-206	-207	N/A	-208	-209	-210	THRU		THRU	
2	M 6 x 1.0	-201	-202	N/A	-203	-204	-205	14	0.551	11	0.433
3	M 6 x 1.0	-201	-202	N/A	-203	-204	-205	16	0.630	12	0.472

Oil Cooler

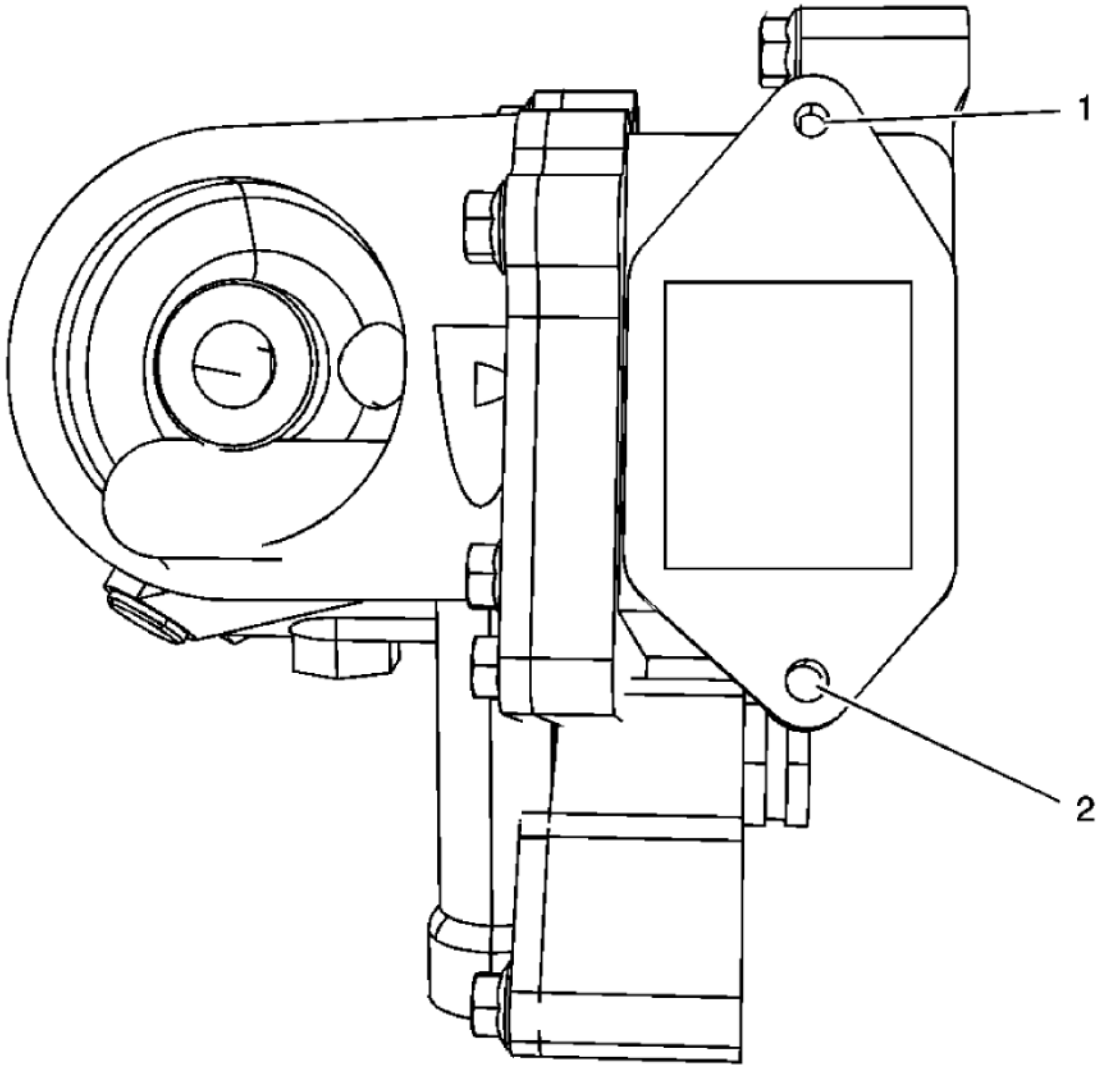


Fig. 9: View Of Oil Cooler
Courtesy of GENERAL MOTORS CORP.

Oil Cooler

Service Hole Location	Thread Size	Drill	Counterbore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Max)		Tap Depth (Min)	
								mm	(in)	mm	(in)
1	M 8 x 1.25	-206	-207	N/A	-208	-209	-210	21	0.827	17	0.669
2	M 8 x 1.25	-206	-207	N/A	-208	-209	-210	THRU		THRU	

EGR Cooler - Rear View

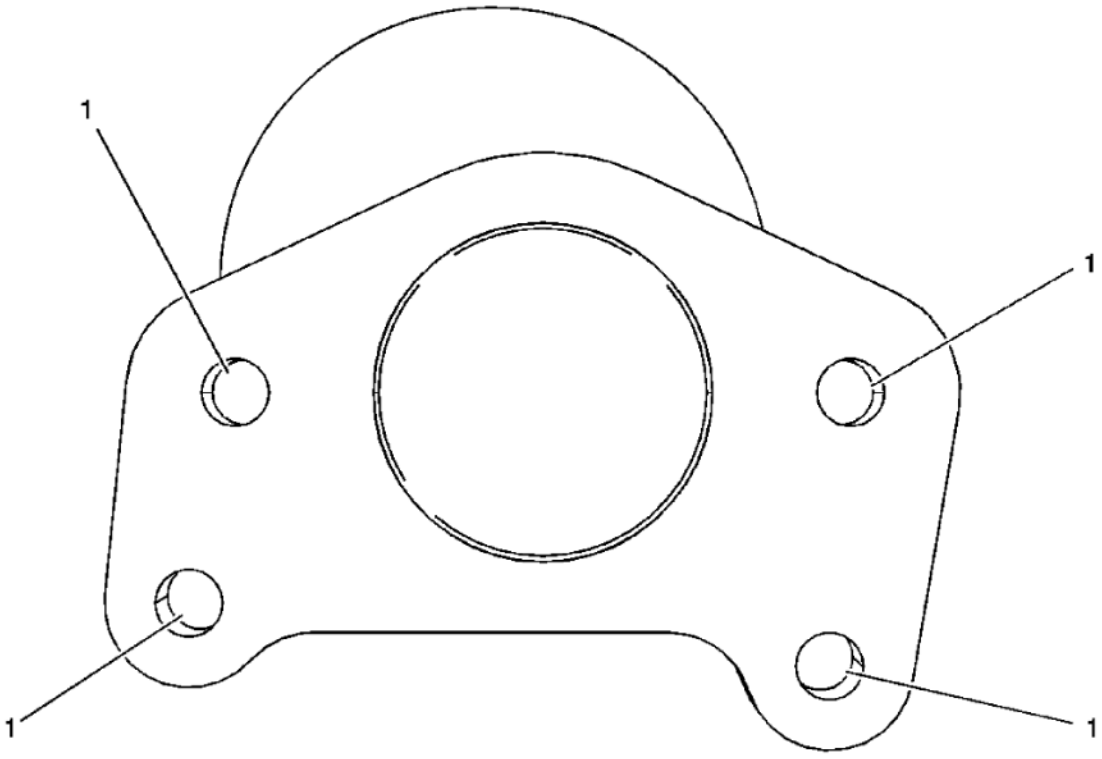


Fig. 10: EGR Cooler (Rear View)
Courtesy of GENERAL MOTORS CORP.

EGR Cooler - Rear View

Service Hole Location	Thread Size	Drill	Counterbore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Max)		Tap Depth (Min)	
								mm	(in)	mm	(in)
1	M 8 x 1.25	-206	-207	N/A	-208	-209	-210	THRU		THRU	

EGR Cooler - Front View

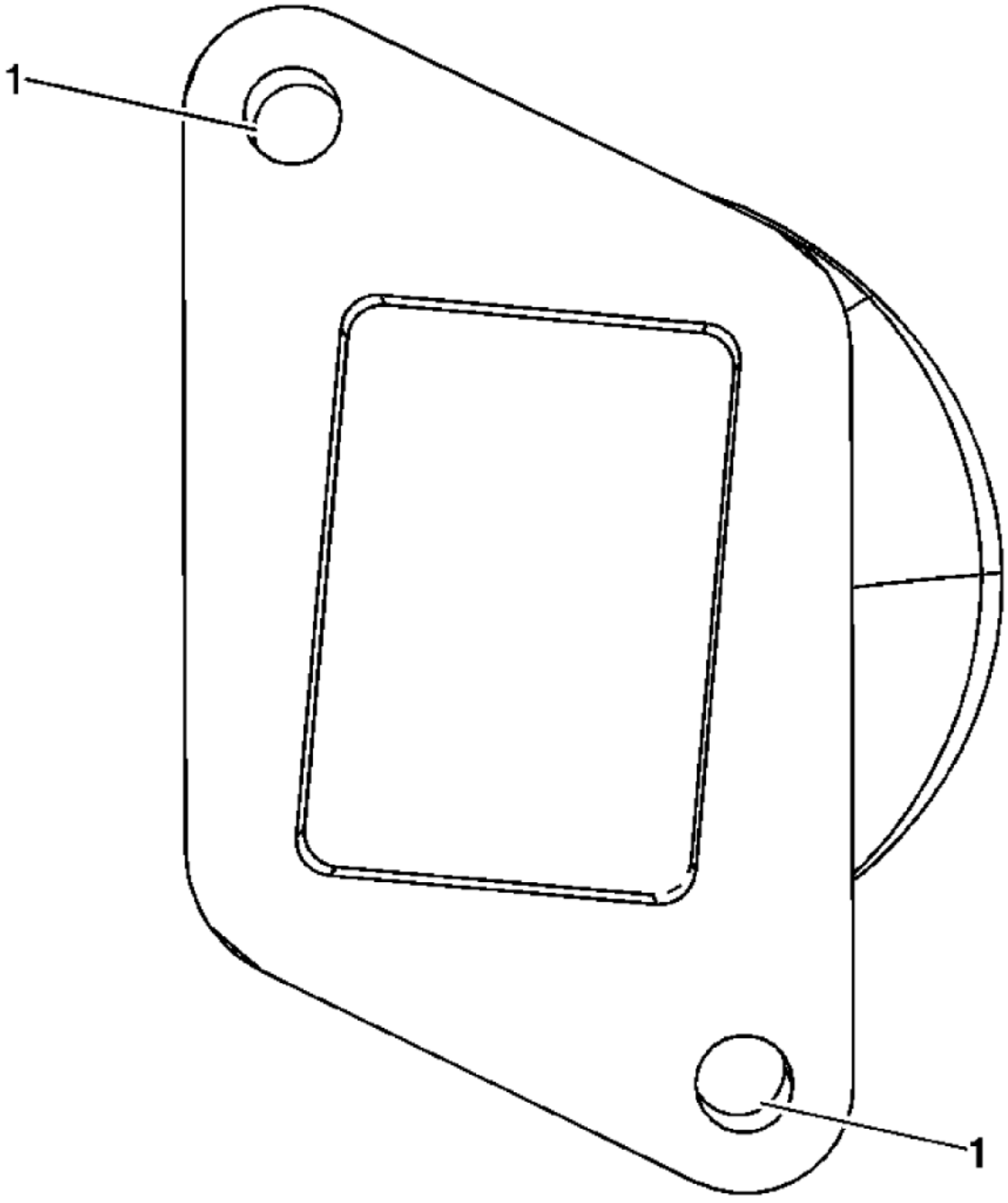


Fig. 11: EGR Cooler (Front View)
Courtesy of GENERAL MOTORS CORP.

EGR Cooler - Front View

Service Hole	Thread		Counterbore	Stop				Drill Depth (Max)		Tap Depth (Min)	

Location	Size	Drill	Tool	Collar	Tap	Driver	Insert	mm	(in)	mm	(in)
1	M 8 x 1.25	-206	-207	N/A	-208	-209	-210	THRU		THRU	

EGR - Top View

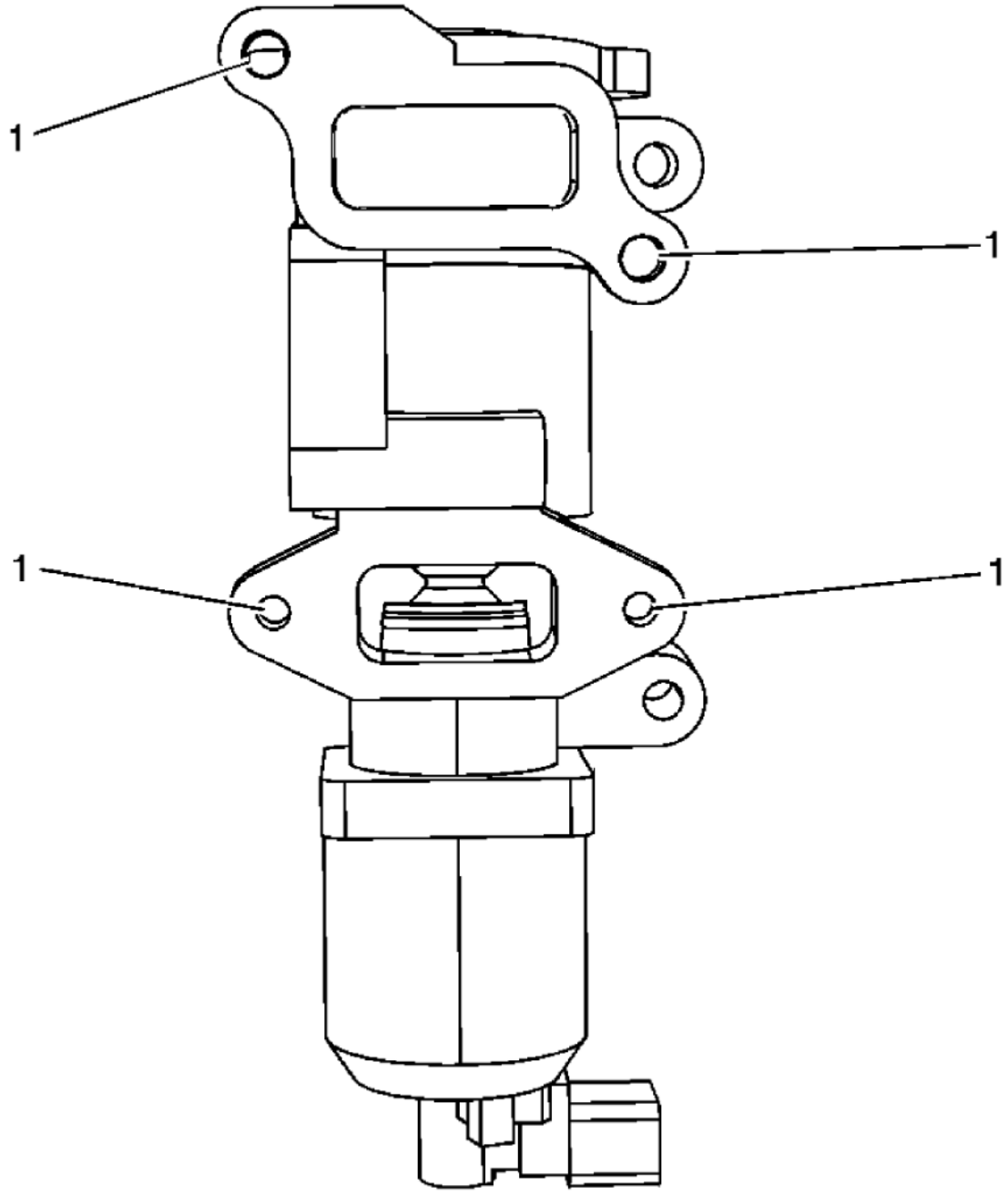


Fig. 12: EGR (Top View)

Courtesy of GENERAL MOTORS CORP.

EGR - Top View

Service Hole Location	Thread Size	Drill	Counterbore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Max)		Tap Depth (Min)	
								mm	(in)	mm	(in)
1	M 8 x 1.25	-206	-207	N/A	-208	-209	-210	THRU		THRU	

Thermostat Housing - Top View

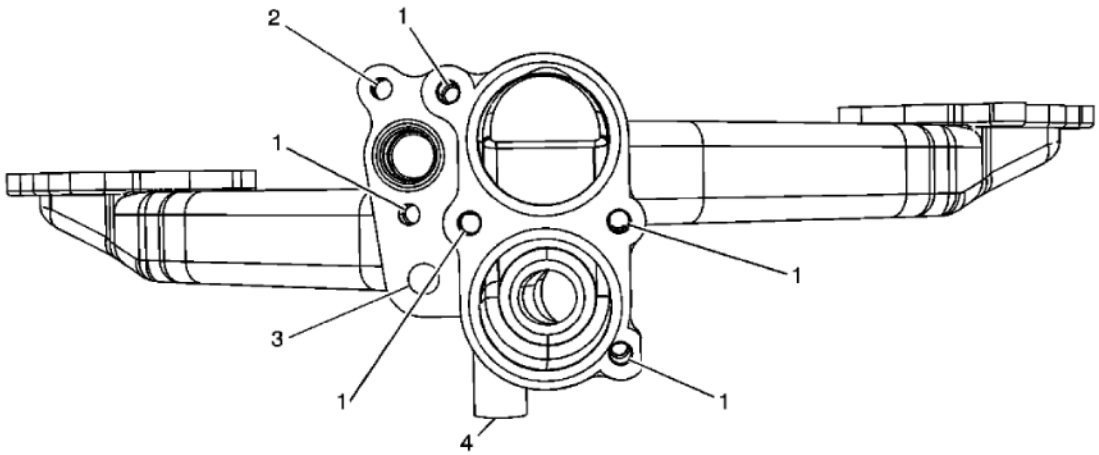


Fig. 13: Thermostat Housing (Top View)
Courtesy of GENERAL MOTORS CORP.

Thermostat Housing - Top View

Service Hole Location	Thread Size	Drill	Counterbore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Max)		Tap Depth (Min)	
								mm	(in)	mm	(in)
1	M 8 x 1.25	-206	-207	N/A	-208	-209	-210	21	0.827	17	0.669
2	M 8 x 1.25	-206	-207	N/A	-208	-209	-210	THRU		THRU	
3	NPT 3/8	-2013	N/A	N/A	-294	-2015	-2016	THRU		THRU	
4	M 8 x 1.25	-206	-207	N/A	-208	-209	-210	19	0.748	15	0.591

AC Bracket

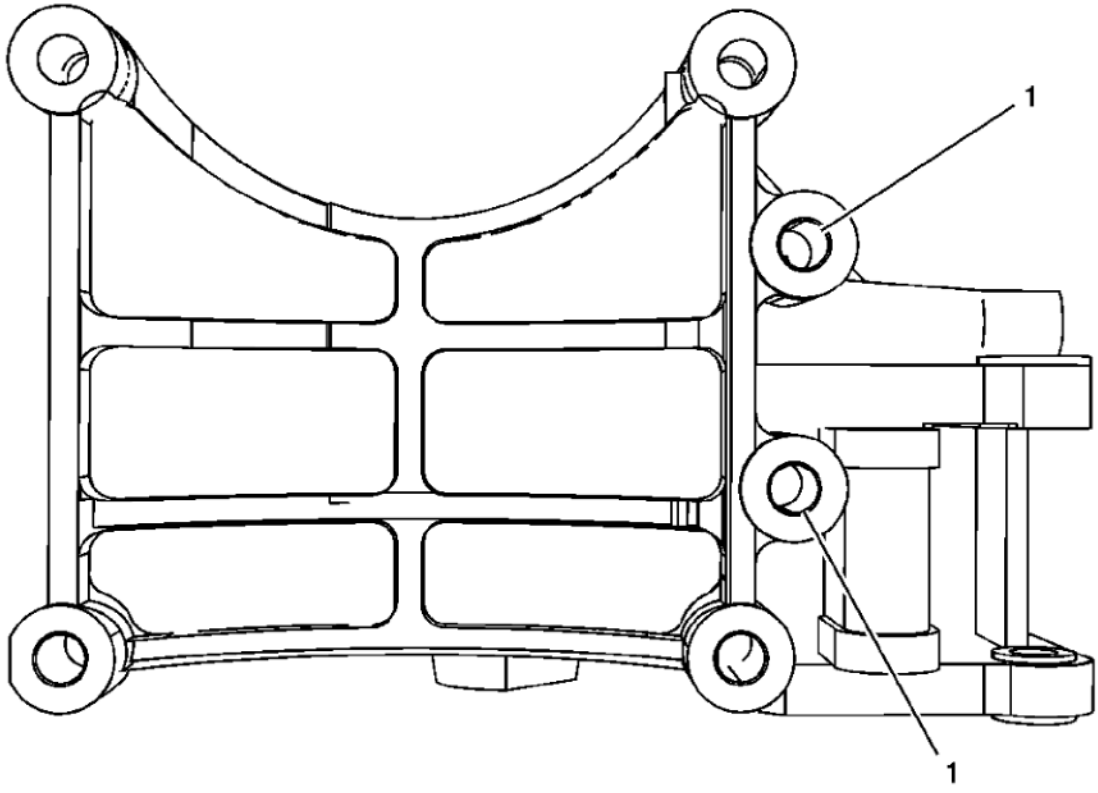


Fig. 14: View Of AC Bracket
Courtesy of GENERAL MOTORS CORP.

AC Bracket

Service Hole Location	Thread Size	Drill	Counterbore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Max)		Tap Depth (Min)	
								mm	(in)	mm	(in)
1	M 10 x 1.5	-211	-212	N/A	-213	-214	-420	30	1.182	25	0.985

Generator Bracket - Front View

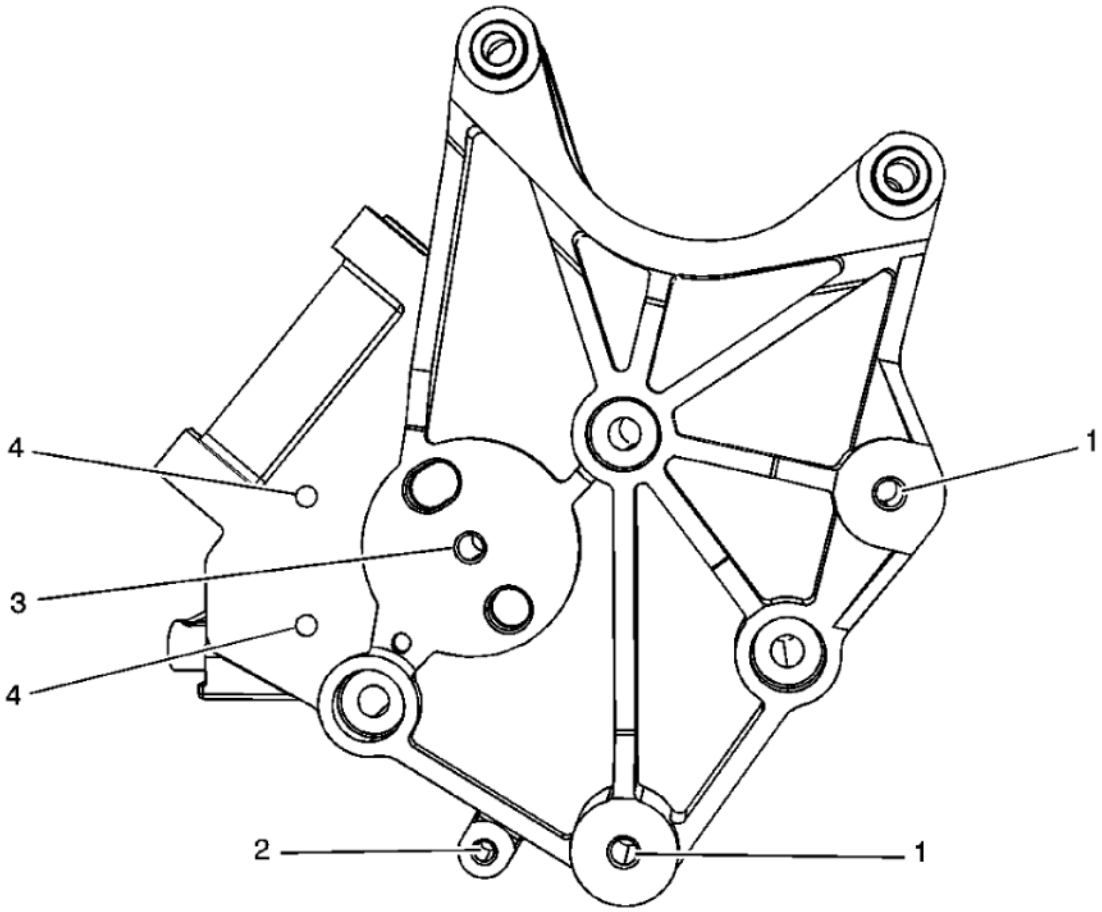


Fig. 15: Generator Bracket (Front View)
Courtesy of GENERAL MOTORS CORP.

Generator Bracket - Front View

Service Hole Location	Thread Size	Drill	Counterbore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Max)		Tap Depth (Min)	
								mm	(in)	mm	(in)
1	M 10 x 1.5	-211	-212	N/A	-213	-214	-215	THRU		THRU	
2	M 8 x 1.25	-206	-207	N/A	-208	-209	-415	17	0.669	12	0.472
3	M 10 x 1.5	-211	-212	N/A	-213	-214	-420	THRU		25	0.985
4	M 8 x 1.25	-206	-207	N/A	-208	-209	-210	22	0.866	17	0.669

Generator Bracket - Rear View

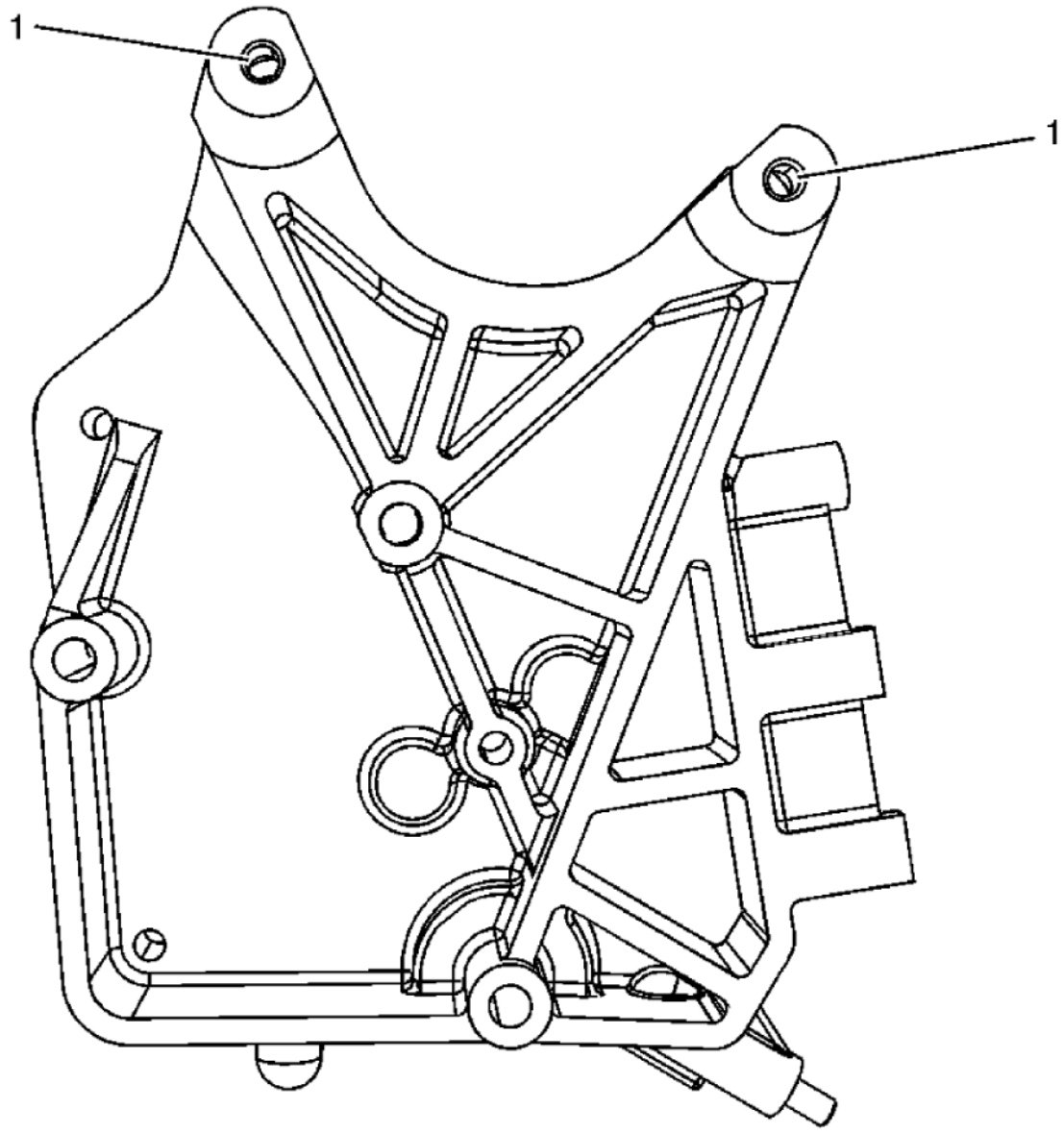


Fig. 16: Generator Bracket (Rear View)
Courtesy of GENERAL MOTORS CORP.

Generator Bracket - Rear View

Service Hole Location	Thread Size	Drill	Counterbore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Max)		Tap Depth (Min)	
								mm	(in)	mm	(in)

1	M 10 x 1.5	-211	-212	N/A	-213	-214	-215	THRU	THRU

Generator Bracket - Side View

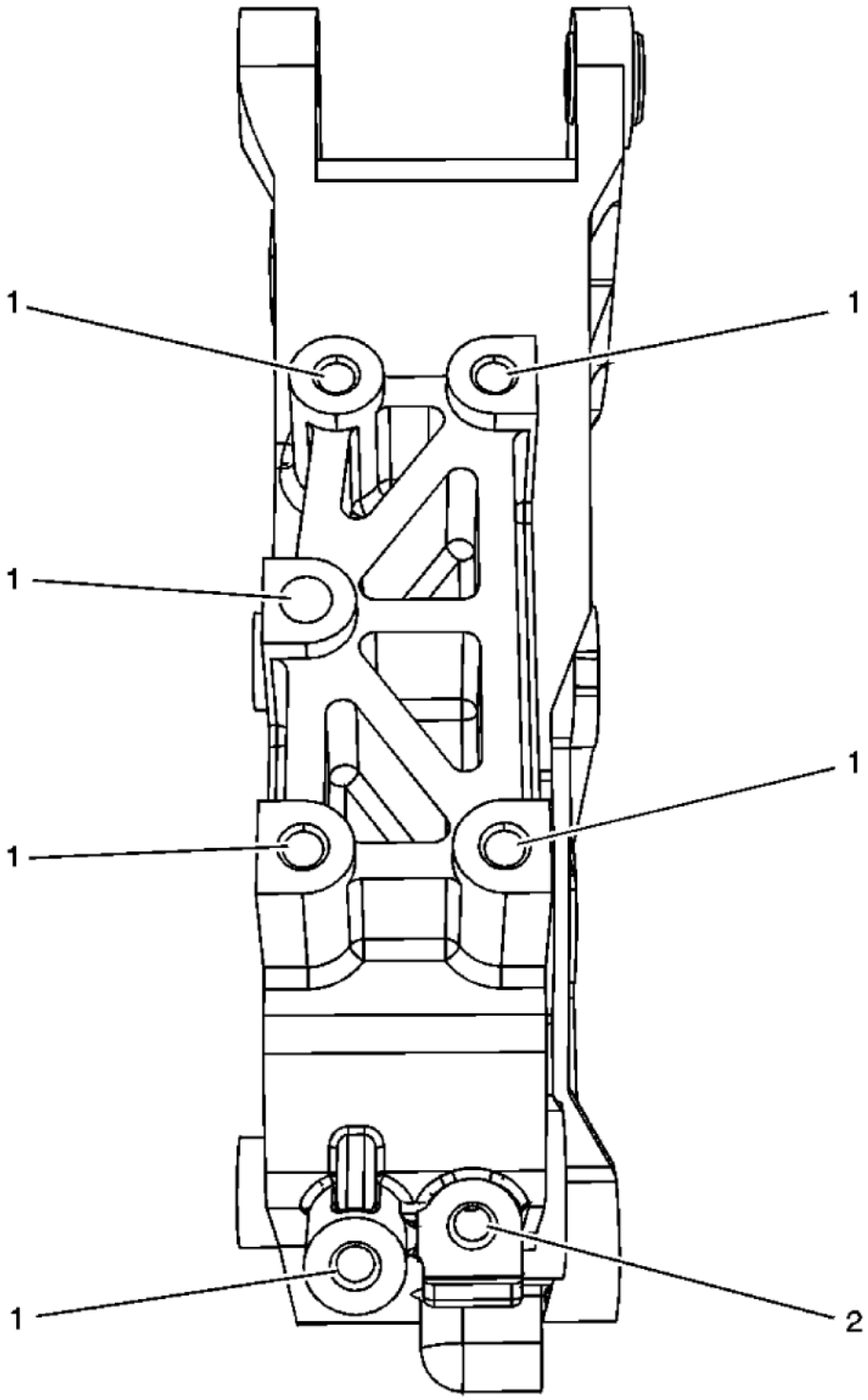


Fig. 17: Generator Bracket (Side View)
Courtesy of GENERAL MOTORS CORP.

Generator Bracket - Side View

Service Hole Location	Thread Size	Drill	Counterbore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Max)		Tap Depth (Min)	
								mm	(in)	mm	(in)
1	M 8 x 1.25	-206	-207	N/A	-208	-209	-210	22	0.866	17	0.669
2	M 8 x 1.25	-206	-207	N/A	-208	-209	-210	17	0.669	12	0.472

Engine Front Cover - Front View

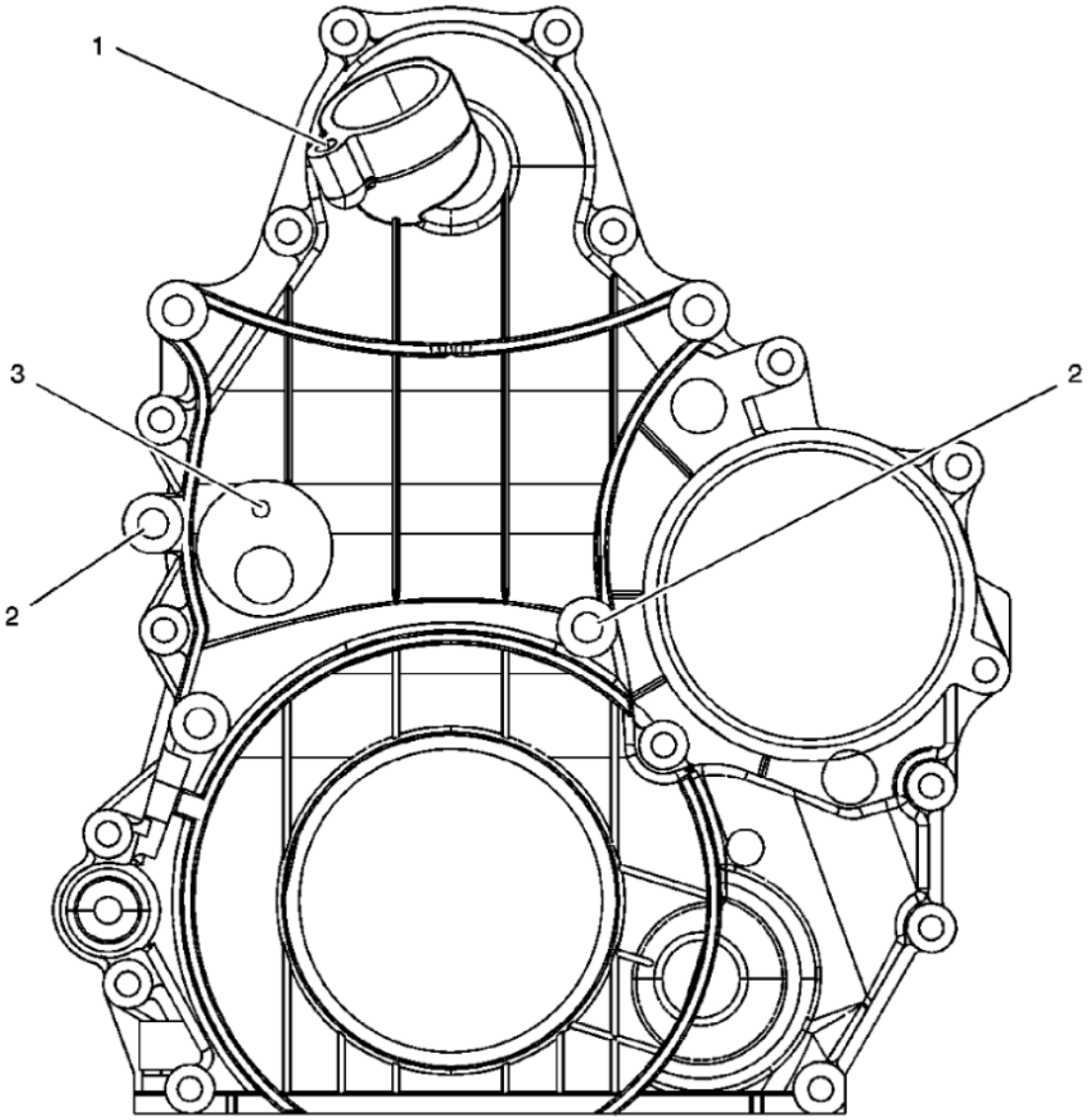


Fig. 18: Engine Front Cover (Front View)
Courtesy of GENERAL MOTORS CORP.

Engine Front Cover - Front View

Service Hole Location	Thread Size	Drill	Counterbore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Max)		Tap Depth (Min)	
								mm	(in)	mm	(in)
1	M 8 x 1.25	-206	-207	N/A	-208	-209	-210	19	0.748	15	0.591
2	M 10 x 1.5	-211	-212	N/A	-213	-214	-216	20	0.788	16	0.630
3	M 6 x 1.0	-201	-202	N/A	-203	-204	-205	14	0.551	10	0.394

Engine Front Cover - Side View

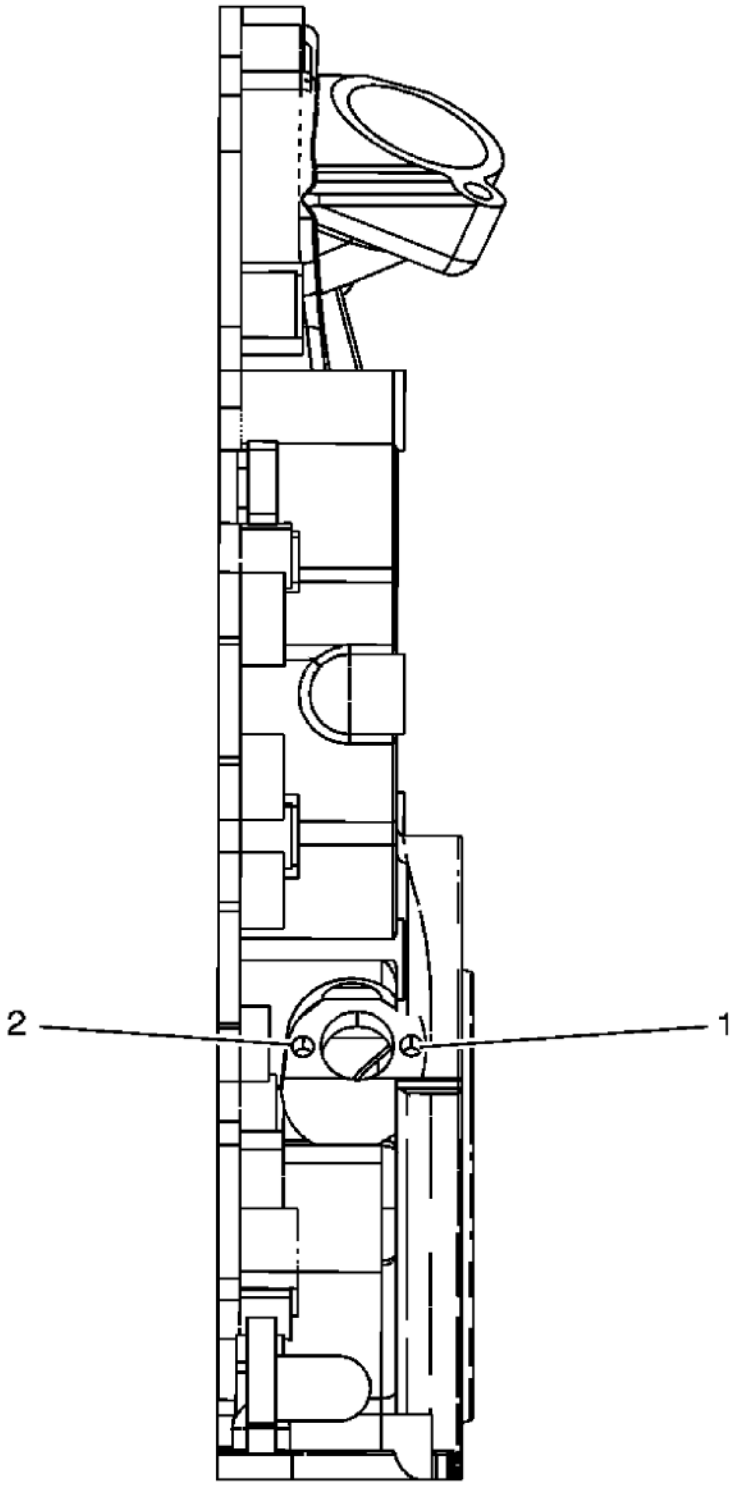


Fig. 19: Engine Front Cover (Side View)
Courtesy of GENERAL MOTORS CORP.

Engine Front Cover - Side View

Service Hole Location	Thread Size	Drill	Counterbore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Max)		Tap Depth (Min)	
								mm	(in)	mm	(in)
1	M 6 x 1.0	-201	-202	N/A	-203	-204	-205	14	0.551	10	0.394
2	M 6 x 1.0	-201	-202	N/A	-203	-204	-205	THRU		10	0.394

Engine Front Cover - Bottom View

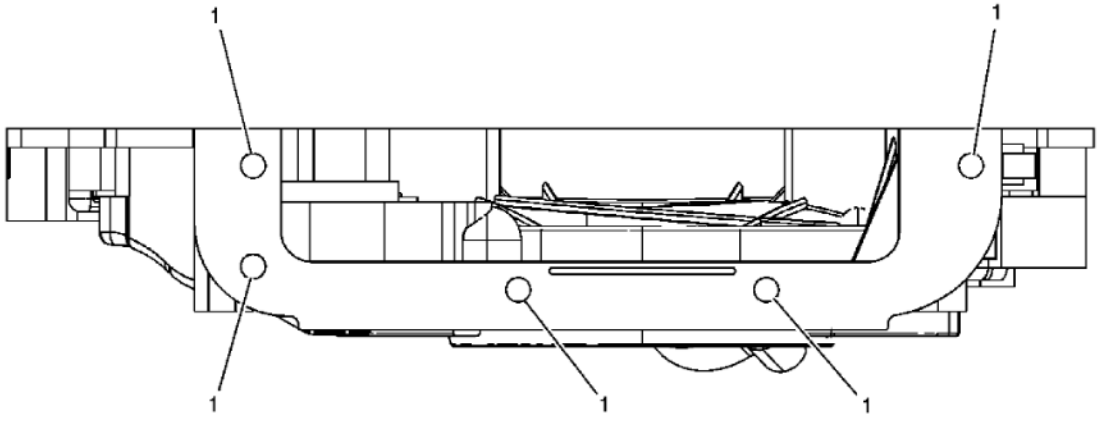


Fig. 20: Engine Front Cover (Bottom View)
Courtesy of GENERAL MOTORS CORP.

Engine Front Cover - Bottom View

Service Hole Location	Thread Size	Drill	Counterbore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Max)		Tap Depth (Min)	
								mm	(in)	mm	(in)
1	M 8 x 1.25	-206	-207	N/A	-208	-209	-210	17	0.669	13	0.512

Lower Rocker Arm Cover - Top View

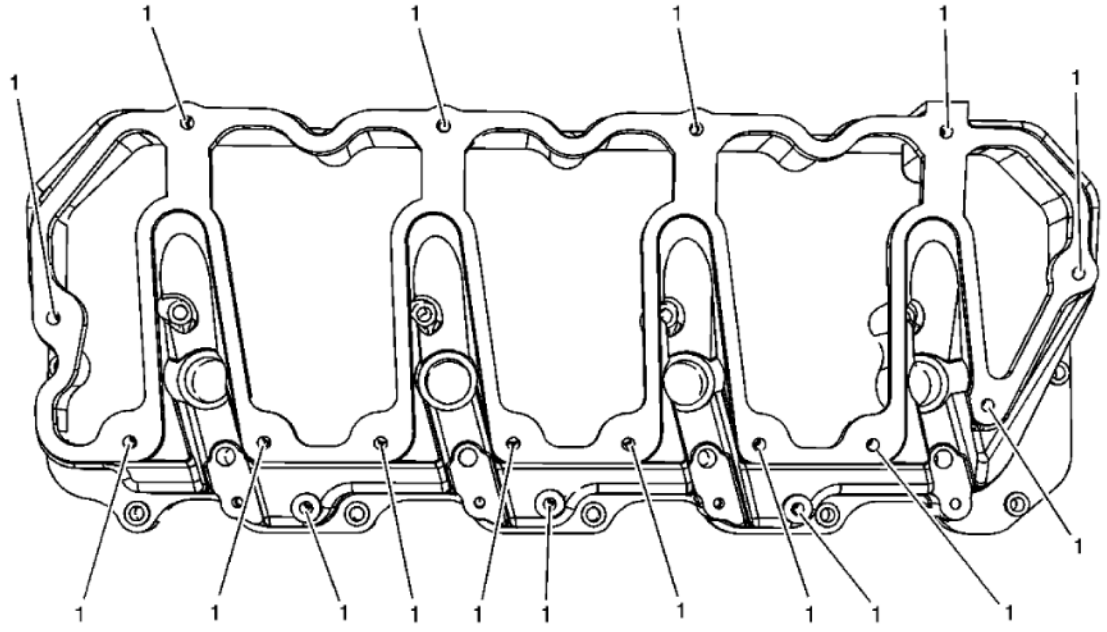


Fig. 21: Lower Rocker Arm Cover (Top View)
Courtesy of GENERAL MOTORS CORP.

Lower Rocker Arm Cover - Top View

Service Hole Location	Thread Size	Drill	Counterbore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Max)		Tap Depth (Min)	
								mm	(in)	mm	(in)
1	M 6 x 1.0	-201	-202	N/A	-203	-204	-205	18	0.709	15	0.591

Lower Rocker Arm Cover - Side View

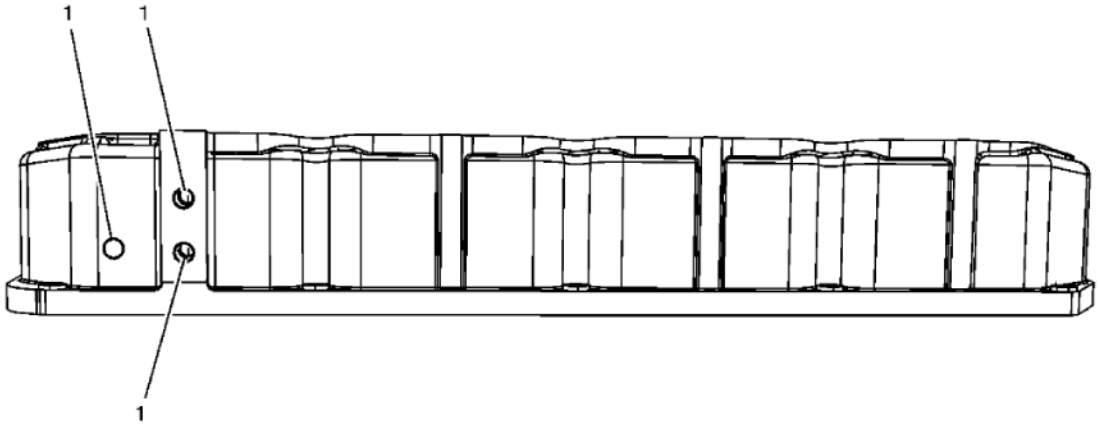


Fig. 22: Lower Rocker Arm Cover (Side View)
Courtesy of GENERAL MOTORS CORP.

Lower Rocker Arm Cover - Side View

Service Hole Location	Thread Size	Drill	Counterbore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Max)		Tap Depth (Min)	
								mm	(in)	mm	(in)
1	M 8 x 1.25	-206	-207	N/A	-208	-209	-210	21	0.827	17	0.669

Upper Rocker Arm Cover - Top View

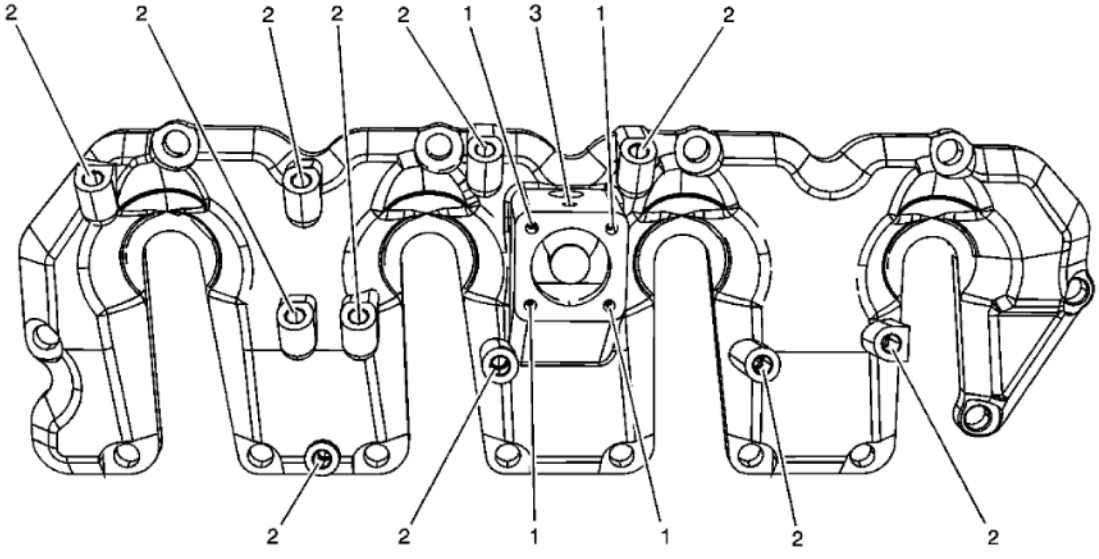


Fig. 23: Upper Rocker Arm Cover (Top View)
Courtesy of GENERAL MOTORS CORP.

Upper Rocker Arm Cover - Top View

Service Hole Location	Thread Size	Drill	Counterbore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Max)		Tap Depth (Min)	
								mm	(in)	mm	(in)
1	M 5 x 0.8	N/A	N/A	N/A	N/A	N/A	N.A	13	0.512	10	0.394
2	M 8 x 1.25	-206	-207	N/A	-208	-209	-210	21	0.827	17	0.669
3	M 6 x 1.0	-201	-202	N/A	-203	-204	-205	16	0.630	12	0.472

Upper Rocker Arm Cover - Bottom View

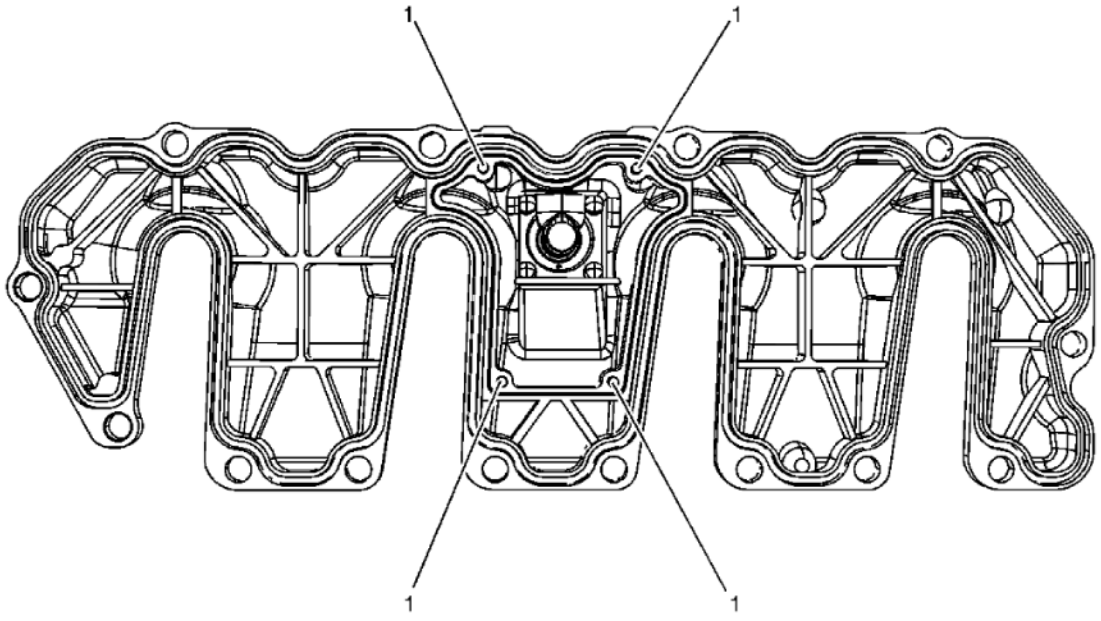


Fig. 24: Upper Rocker Arm Cover (Bottom View)
Courtesy of GENERAL MOTORS CORP.

Upper Rocker Arm Cover - Bottom View

Service								Drill Depth	Tap Depth

Hole Location	Thread Size	Drill	Counterbore Tool	Stop Collar	Tap	Driver	Insert	(Max)		(Min)	
								mm	(in)	mm	(in)
1	M 5 x 0.8	N/A	N/A	N/A	N/A	N/A	N/A	13	0.512	10	0.394

Flywheel Housing - Rear View

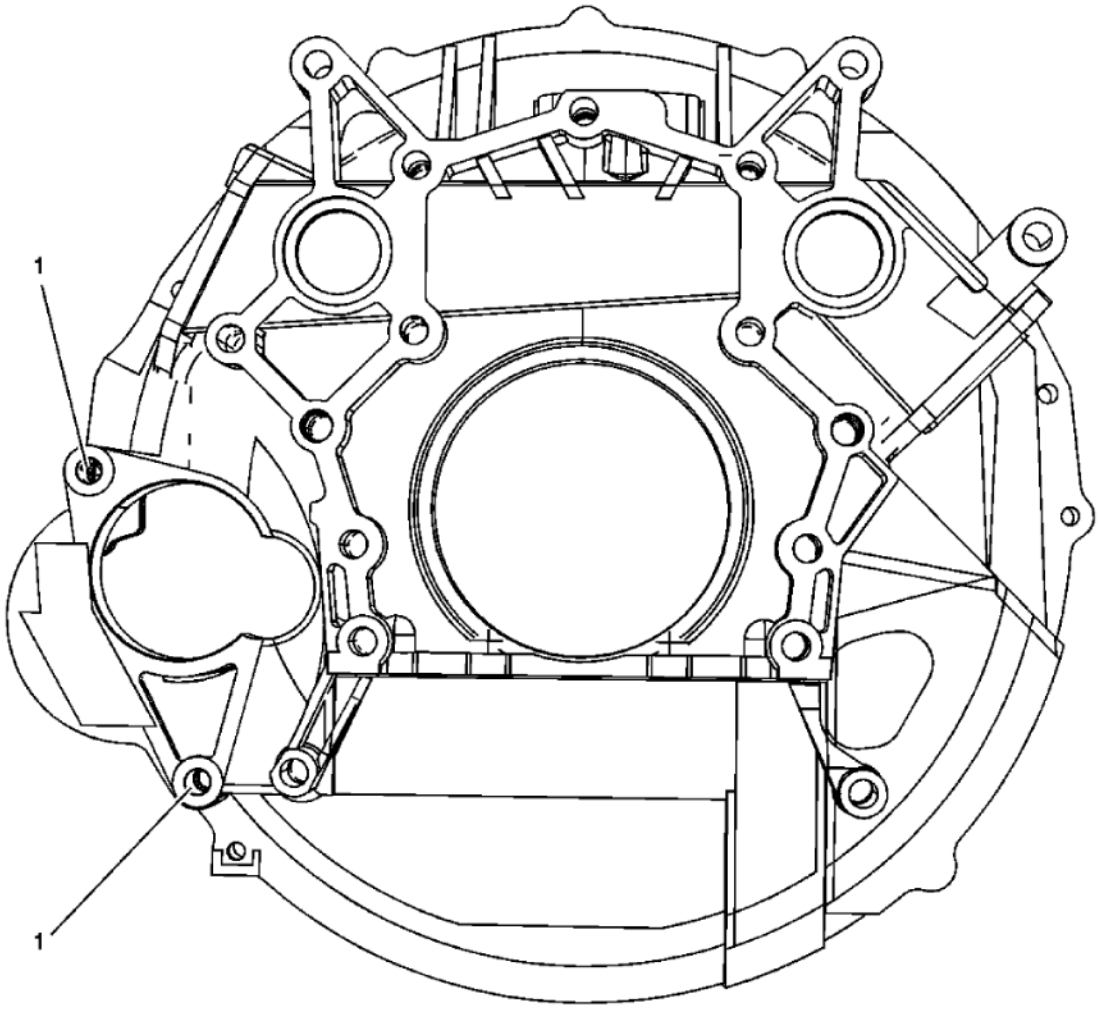


Fig. 25: Flywheel Housing (Rear View)
Courtesy of GENERAL MOTORS CORP.

Flywheel Housing - Rear View

Service Hole	Thread		Counterbore	Stop				Drill Depth (Max)		Tap Depth (Min)	
								mm	(in)	mm	(in)

Location	Size	Drill	Tool	Collar	Tap	Driver	Insert	mm	(in)	mm	(in)
1	M 12 x 1.75	-856	-857	N/A	-858	-859	-855	28	1.103	23	0.906

Flywheel Housing - Top View

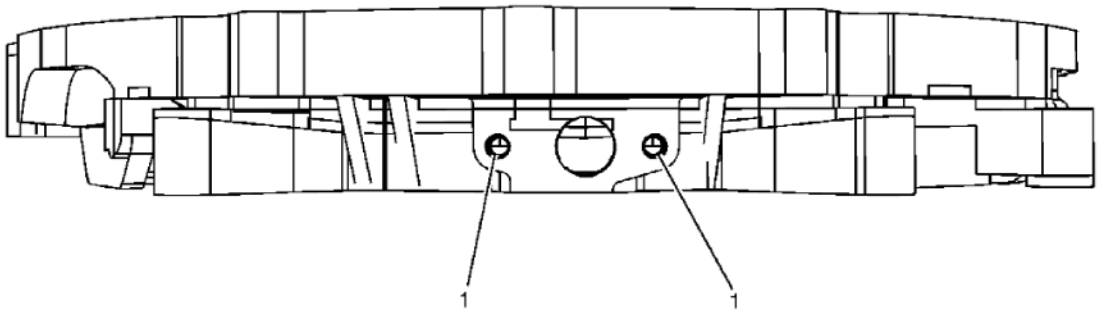


Fig. 26: Flywheel Housing (Top View)
Courtesy of GENERAL MOTORS CORP.

Flywheel Housing - Top View

Service Hole Location	Thread Size	Drill	Counterbore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Max)		Tap Depth (Min)	
								mm	(in)	mm	(in)
1	M 8 x 1.25	-206	-207	N/A	-208	-209	-210	17	0.669	13	0.512

Flywheel Housing - Bottom View

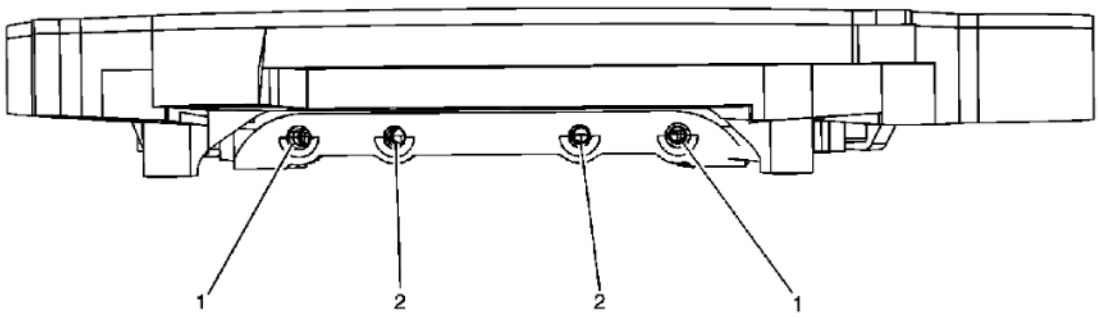


Fig. 27: Flywheel Housing (Bottom View)
Courtesy of GENERAL MOTORS CORP.

Flywheel Housing - Bottom View

Service Hole Location	Thread Size	Drill	Counterbore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Max)		Tap Depth (Min)	
								mm	(in)	mm	(in)
1	M 8 x 1.25	-206	-207	N/A	-208	-209	-210	21	0.827	18	0.709
2	M 8 x 1.25	-206	-207	N/A	-208	-209	-210	17	0.669	14	0.551

Flywheel Housing - Right View

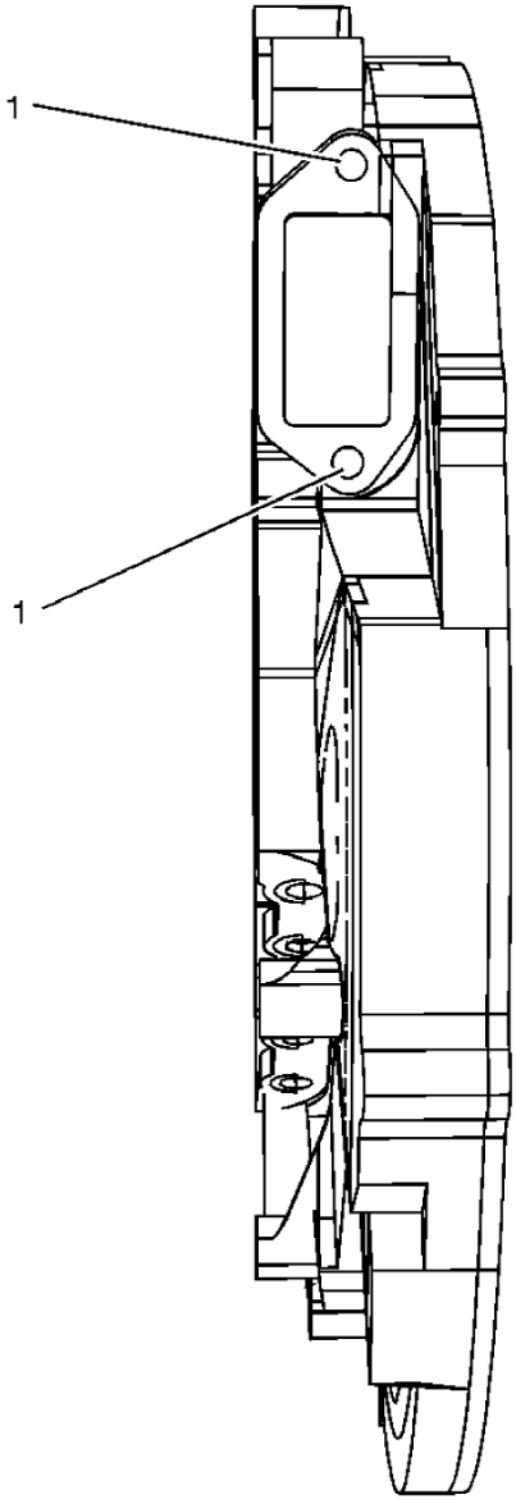


Fig. 28: Flywheel Housing (Right View)
Courtesy of GENERAL MOTORS CORP.

Flywheel Housing - Right View

Service Hole Location	Thread Size	Drill	Counterbore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Max)		Tap Depth (Min)	
								mm	(in)	mm	(in)
1	M 8 x 1.25	-206	-207	N/A	-208	-209	-210	17	0.669	13	0.512

Flywheel Housing - Left View

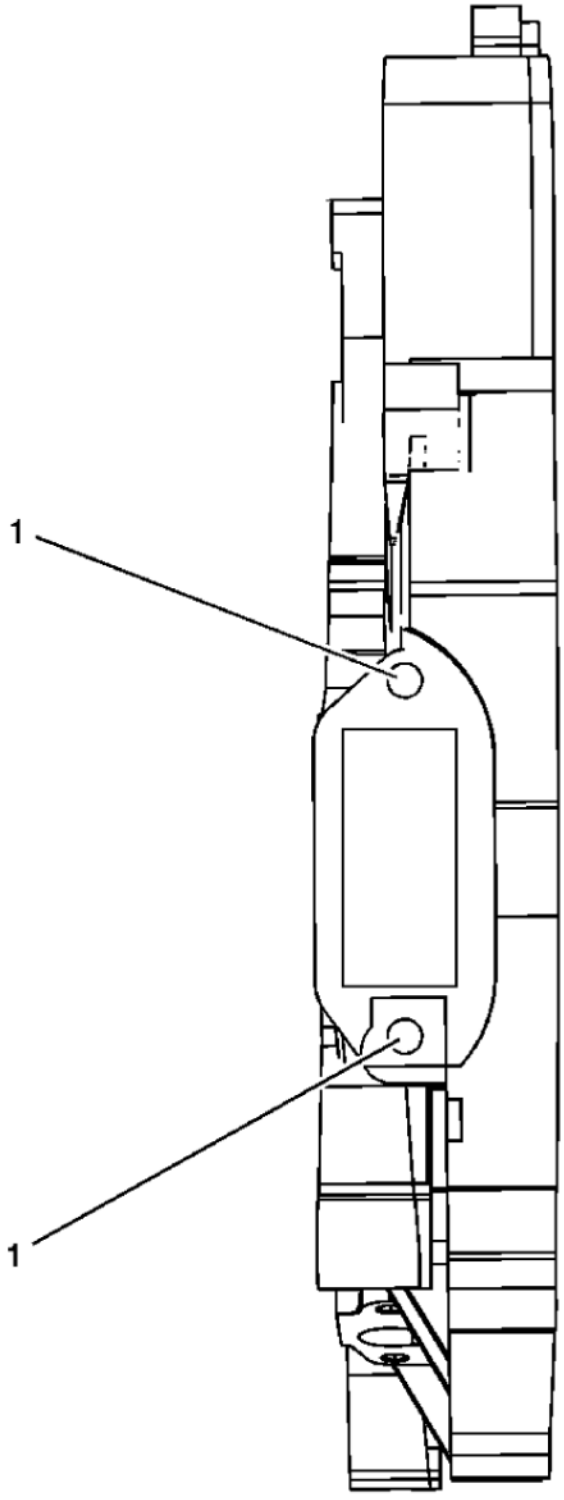


Fig. 29: Flywheel Housing (Left View)
Courtesy of GENERAL MOTORS CORP.

Flywheel Housing - Left View

Service Hole Location	Thread Size	Drill	Counterbore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Max)		Tap Depth (Min)	
								mm	(in)	mm	(in)
1	M 8 x 1.25	-206	-207	N/A	-208	-209	-210	17	0.669	13	0.512

Upper Oil Pan - Bottom View

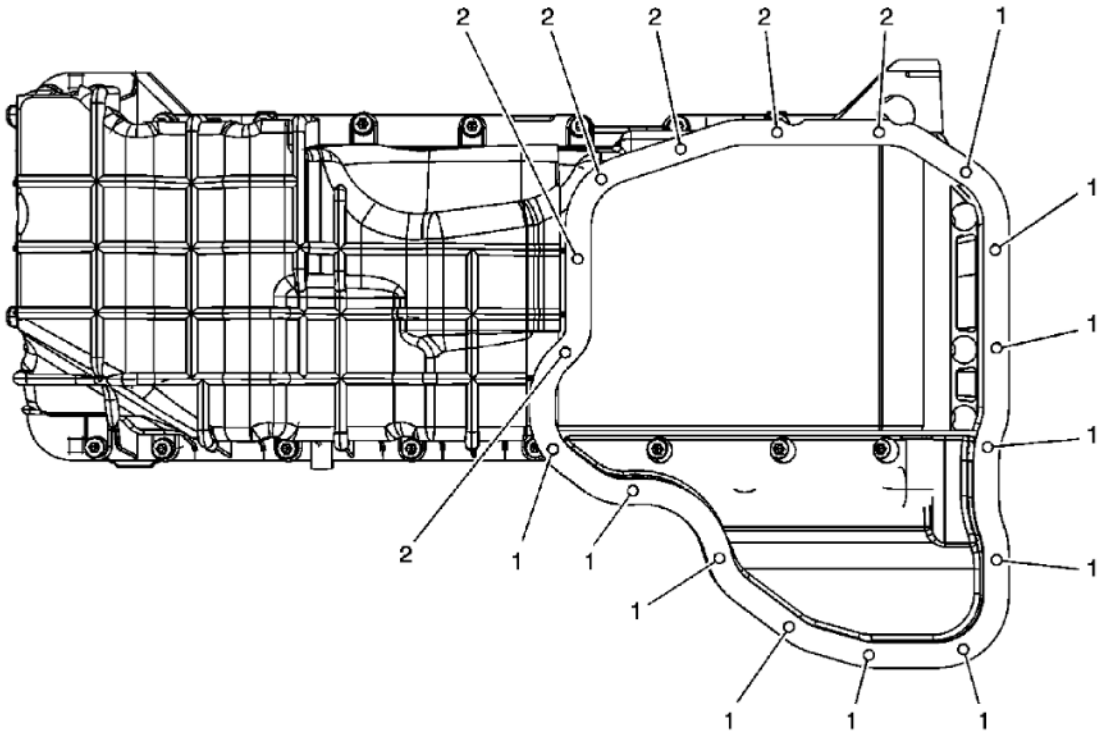


Fig. 30: Upper Oil Pan (Bottom View)
Courtesy of GENERAL MOTORS CORP.

Upper Oil Pan - Bottom View

Service Hole Location	Thread Size	Drill	Counterbore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Max)		Tap Depth (Min)	
								mm	(in)	mm	(in)
1	M 6 x 1.0	-201	-202	N/A	-203	-204	-205	THRU		THRU	
	M 6 x	-201	-202	N/A	-203	-204	-205	17	0.669	13	0.512

2	1.0										

Upper Oil Pan - Top View

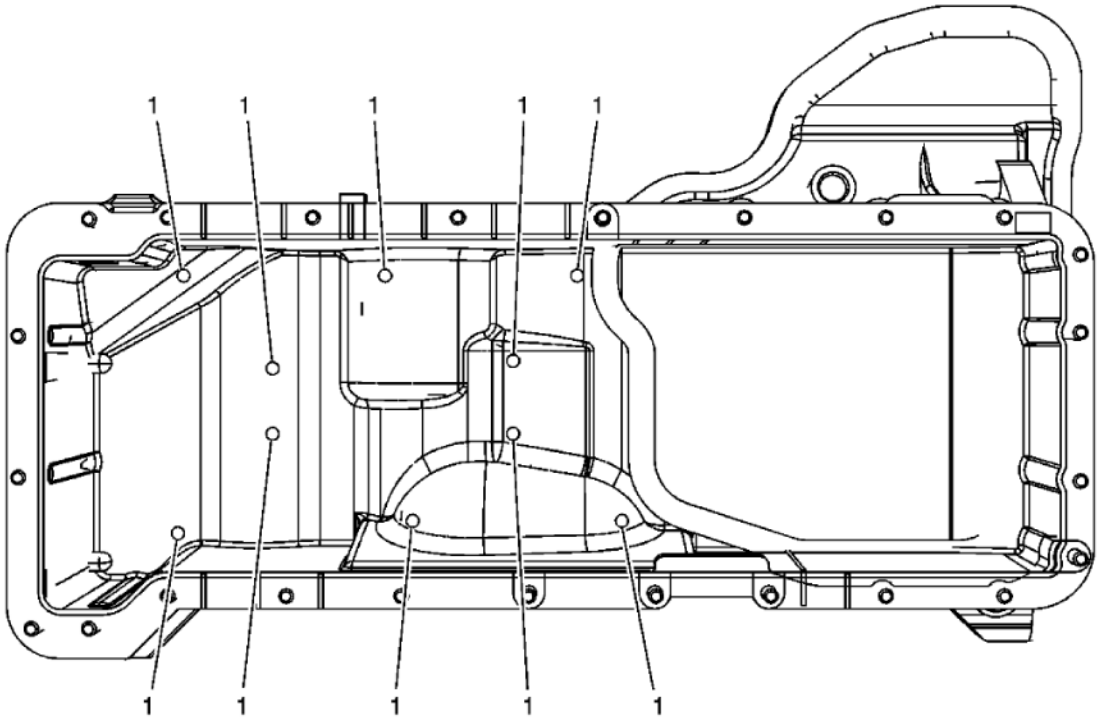


Fig. 31: Upper Oil Pan (Top View)
Courtesy of GENERAL MOTORS CORP.

Upper Oil Pan - Top View

Service Hole Location	Thread Size	Drill	Counterbore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Max)		Tap Depth (Min)	
								mm	(in)	mm	(in)
1	M 8 x 1.25	-206	-207	N/A	-208	-209	-210	17	0.669	13	0.512

Upper Oil Pan - Front View

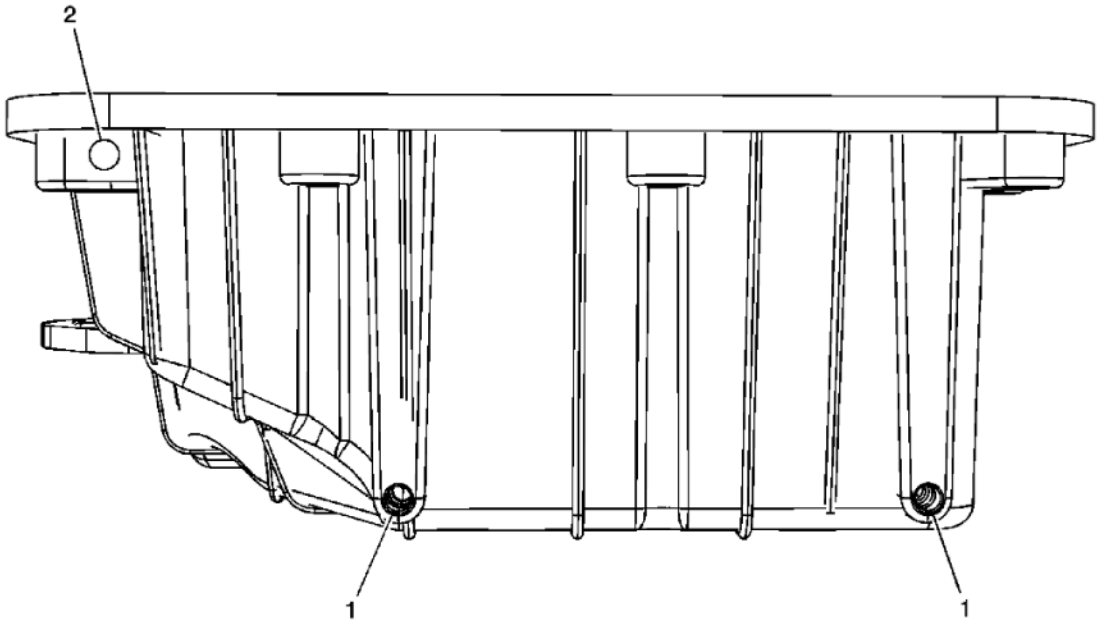


Fig. 32: Upper Oil Pan (Front View)
Courtesy of GENERAL MOTORS CORP.

Upper Oil Pan - Front View

Service Hole Location	Thread Size	Drill	Counterbore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Max)		Tap Depth (Min)	
								mm	(in)	mm	(in)
1	M 6 x 1.0	-201	-202	N/A	-203	-204	-205	17	0.669	13	0.512
2	M 8 x 1.25	-206	-207	N/A	-208	-209	-210	21	0.827	17	0.669

Upper Oil Pan - Rear View

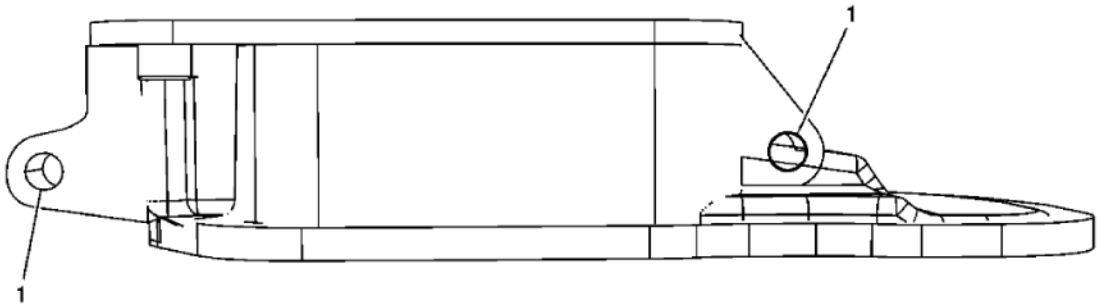


Fig. 33: Upper Oil Pan (Rear View)
Courtesy of GENERAL MOTORS CORP.

Upper Oil Pan - Rear View

Service Hole Location	Thread Size	Drill	Counterbore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Max)		Tap Depth (Min)	
								mm	(in)	mm	(in)
1	M 12 x 1.75	-856	-857	N/A	-858	-859	-855	22	0.866	16	0.630

Upper Oil Pan - Side View

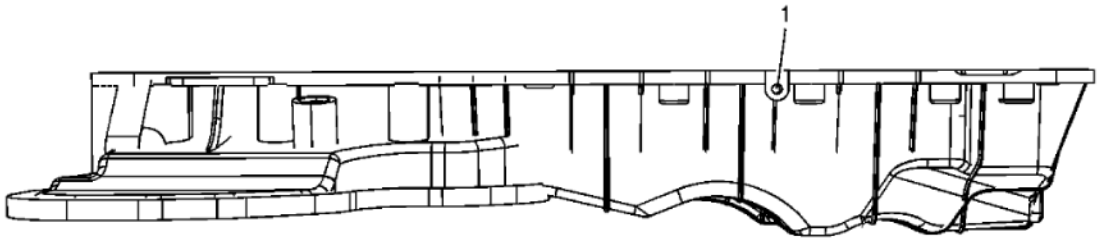


Fig. 34: Upper Oil Pan (Side View)
Courtesy of GENERAL MOTORS CORP.

Upper Oil Pan - Side View

Service Hole Location	Thread Size	Drill	Counterbore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Max)		Tap Depth (Min)	
								mm	(in)	mm	(in)
1	M 6 x 1.0	-201	-202	N/A	-203	-204	-205	17	0.669	13	0.512

SCHEMATIC AND ROUTING DIAGRAMS

ENGINE MECHANICAL SCHEMATICS

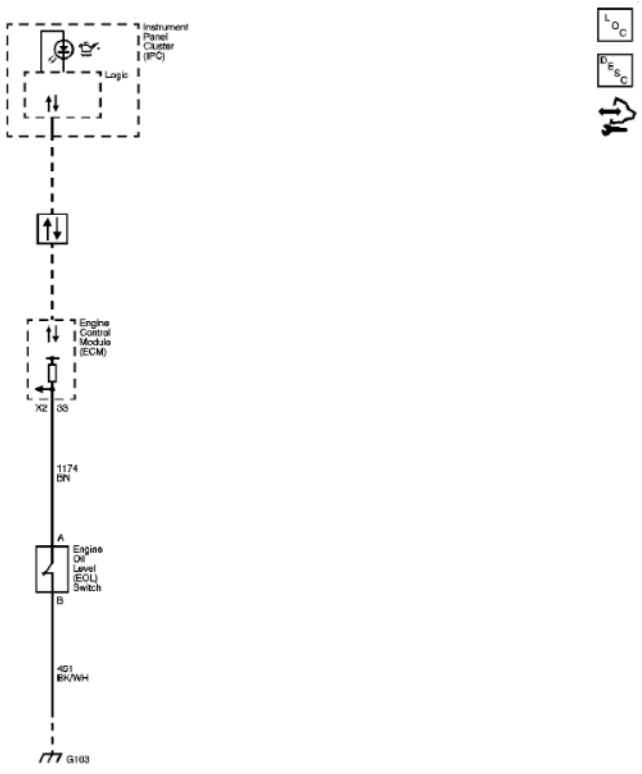


Fig. 35: ngine Mechanical Schematic
Courtesy of GENERAL MOTORS CORP.

COMPONENT LOCATOR

DISASSEMBLED VIEWS

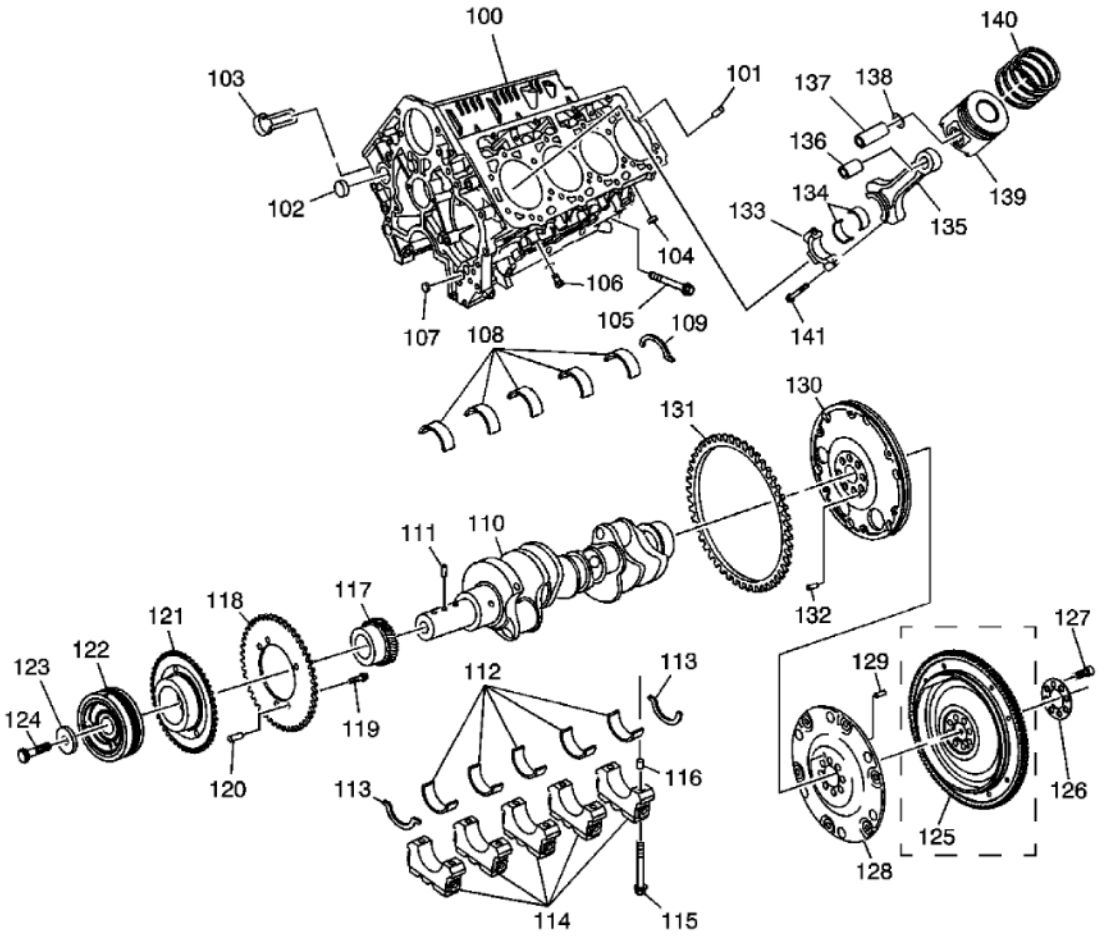


Fig. 36: Engine Block, Crankshaft, Piston Components View
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
100	Engine Block
101	Dowel Pin
102	Engine Block Plug
103	Engine Block Heater
104	Engine Block Plug
105	Crankshaft Bearing Cap Bolt
106	Engine Block Plug
107	Engine Block Plug
108	Upper Crankshaft Bearings
109	Upper Thrust Bearing

110	Crankshaft
111	Crankshaft Pin
112	Lower Crankshaft Bearings
113	Lower Thrust Bearings
113	Lower Thrust Bearings
114	Crankshaft Bearing Cap
115	Crankshaft Bearing Cap Bolt
116	Dowel Pin
117	Crankshaft Gear
118	Crankshaft Position Sensor Exciter Ring
119	Crankshaft Position Sensor Exciter Ring Bolt
120	Crankshaft Position Sensor Exciter Ring Pin
121	Oil Pump Drive Gear
122	Crankshaft Balancer
123	Crankshaft Balancer Washer
124	Crankshaft Balancer Bolt
125	Flywheel - Manual Transmission
126	Flywheel Washer
127	Flywheel Bolt
128	Flywheel Plate
129	Dowel Pin
130	Flywheel - Automatic Transmission
131	Ring Gear
132	Dowel Pin
133	Connecting Rod Cap
134	Connecting Rod Bearings
135	Connecting Rod
136	Connecting Rod Bushing
137	Piston Pin
138	Piston Pin Retainer
139	Piston
140	Piston Rings
141	Connecting Rod Bolt

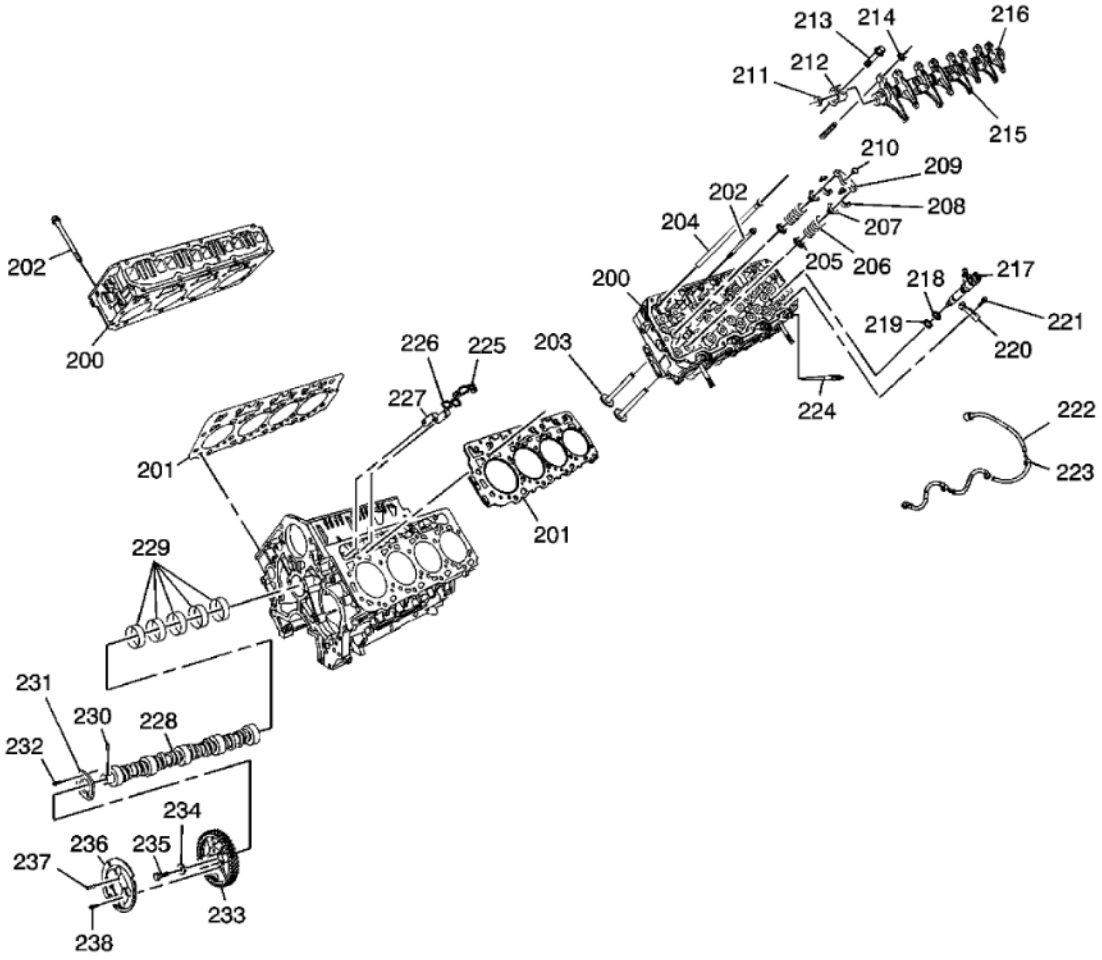


Fig. 37: Cylinder Head, Valves, Lifters, Timing Components, Camshaft Components View
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
200	Cylinder Head
200	Cylinder Head
201	Cylinder Head Gasket
201	Cylinder Head Gasket
202	Cylinder Head Bolt
202	Cylinder Head Bolt
203	Exhaust Valve
204	Pushrod
205	Valve Spring Seat

206	Valve Spring
207	Valve Spring Retainer
208	Valve Key
209	Valve Bridge
210	Valve Bridge Pin
211	Rocker Arm Shaft Plug
212	Rocker Arm Shaft Mount
213	Rocker Arm Shaft Mount Bolt
214	Rocker Arm Shaft Assembly Lock Nut
215	Rocker Arm
216	Rocker Arm Shaft Assembly
217	Fuel Injector
218	Fuel Injector O-ring Seal
219	Fuel Injector Gasket
220	Fuel Injector Bracket
221	Fuel Injector Bracket Bolt
222	Fuel Return Pipe
223	Fuel Return Pipe Bolt
224	Glow Plug
225	Valve Lifter Guide Bracket
226	Valve Lifter Guide
227	Valve Lifter
228	Camshaft
229	Camshaft Bearings
230	Camshaft Pin
231	Camshaft Thrust Plate
232	Camshaft Thrust Plate Bolt
233	Camshaft Gear
234	Camshaft Gear Washer
235	Camshaft Gear Bolt
236	Camshaft Position Sensor Exciter Ring
237	Camshaft Position Sensor Exciter Ring Pin
238	Camshaft Position Sensor Exciter Ring Bolt

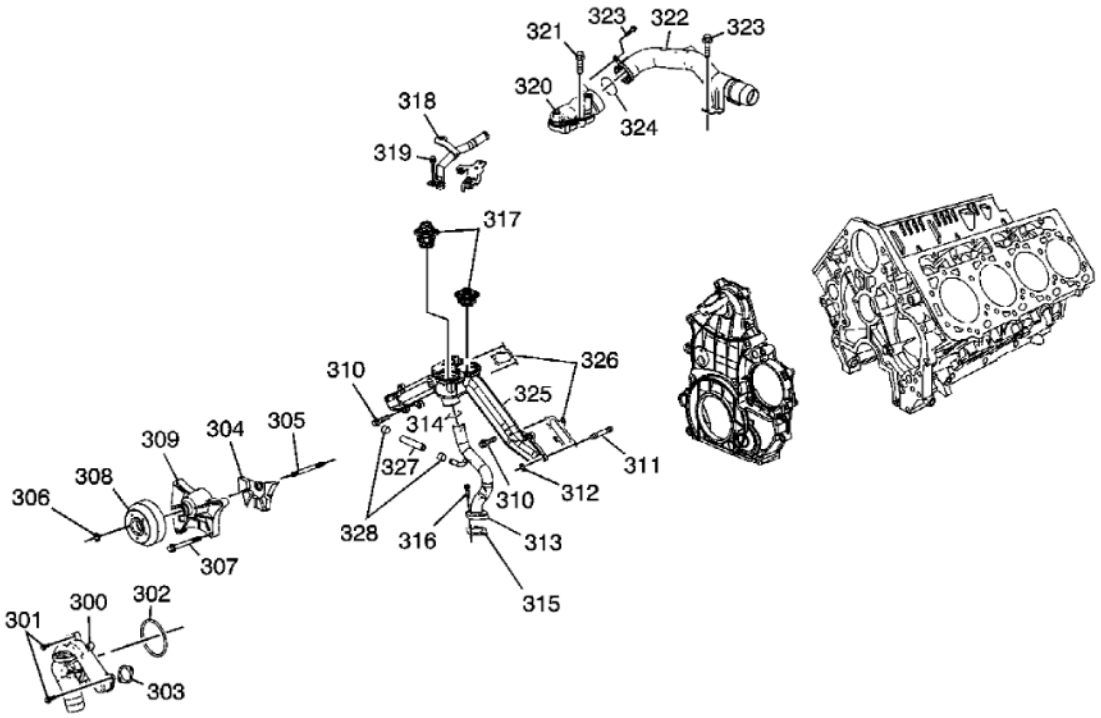


Fig. 38: Cooling, Water Pump Components View
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
300	Water Pump
301	Water Pump Bolt
302	Water Pump O-ring Seal
303	Water Pump Gasket
304	Cooling Fan Pulley Insulator
305	Cooling Fan Pulley Stud
306	Cooling Fan Pulley Nut
307	Cooling Fan Pulley Bolt
308	Cooling Fan Pulley
309	Cooling Fan Pulley Bracket
310	Thermostat Housing Bolt
310	Thermostat Housing Bolt
311	Thermostat Housing Stud
312	Thermostat Housing Nut
313	Thermostat Bypass Pipe

314	Thermostat Bypass Pipe O-ring
315	Thermostat Bypass Pipe Gasket
316	Thermostat Bypass Pipe Bolt
317	Thermostat
318	Heater Pipe
319	Heater Pipe Bolt
320	Thermostat Cover
321	Thermostat Cover Bolt
322	Water Outlet
323	Water Outlet Bolt
323	Water Outlet Bolt
324	Water Outlet O-ring Seal
325	Thermostat Housing
326	Thermostat Housing Gasket
327	Thermostat Bypass Pipe Crossover Tube
328	Thermostat Bypass Pipe Crossover Tube Clamps

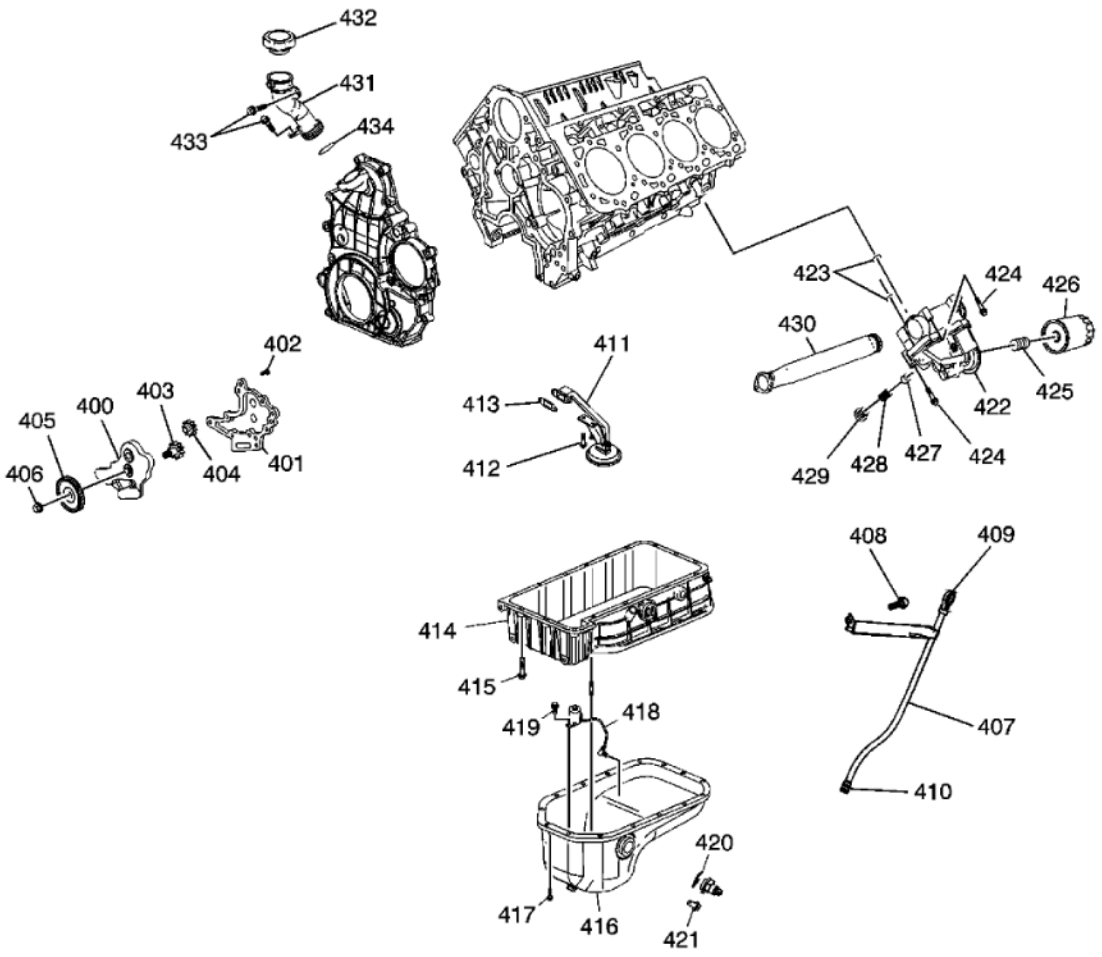


Fig. 39: Oil Pan, Pump, Filter, Tube Components View
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
400	Oil Pump Housing
401	Oil Pump Cover
402	Oil Pump Cover Bolt
403	Oil Pump Drive Gear
404	Oil Pump Driven Gear
405	Oil Pump Gear
406	Oil Pump Gear Nut
407	Oil Level Indicator Tube
408	Oil Level Indicator Tube Bolt
409	Oil Level Indicator

410	Oil Level Indicator Tube O-ring
411	Oil Pump Pipe and Screen Assembly
412	Oil Pump Pipe and Screen Assembly Bolt
413	Oil Pump Pipe and Screen assembly Gasket
414	Upper Oil Pan
415	Upper Oil Pan Bolt
416	Lower Oil Pan
417	Lower Oil Pan Bolt
418	Oil Level Sensor
419	Oil Level Sensor Bolt
420	Oil Level Sensor Retainer
421	Oil Drain Plug
422	Engine Oil Cooler
423	Engine Oil Cooler O-ring
424	Engine Oil Cooler Bolt
424	Engine Oil Cooler Bolt
425	Oil Filter Adapter
426	Oil Filter
427	Oil Pressure Relief Valve Spring Cup
428	Oil Pressure Relief Valve Spring
429	Oil Pressure Relief Valve Spring Plug
430	Oil Cooler Tube
431	Oil Fill Tube
432	Oil Fill Tube Cap
433	Oil Fill Tube Bolt
434	Oil Fill Tube O-ring

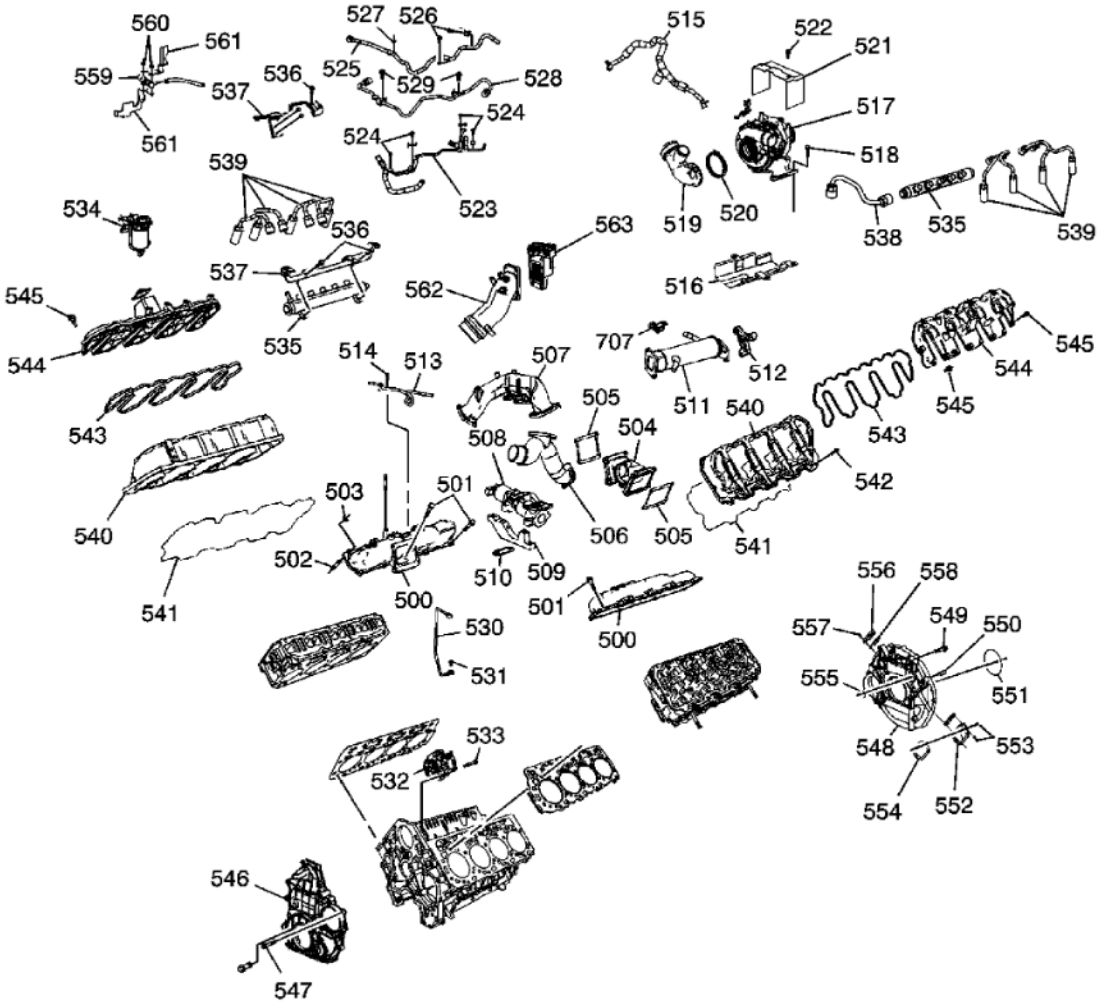


Fig. 40: Intake Manifold, Rails, Covers
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
500	Intake Manifold
500	Intake Manifold
501	Intake Manifold Bolt
501	Intake Manifold Bolt
502	Intake Manifold Stud
503	Intake Manifold Nut
504	Intake Manifold Crossover
505	Intake Manifold Crossover Gasket
505	Intake Manifold Crossover Gasket

506	Intake Manifold Tube
507	Air Inlet Tube
508	EGR
509	EGR Bracket
510	EGR Gasket
511	EGR Cooler
512	EGR Cooler Bracket
513	Fuel Pipe
514	Fuel Pipe Bolt
515	PCV Hose
516	Lower Turbocharger Heat Shield
517	Turbocharger
518	Turbocharger Bolt
519	Turbocharger Air Inlet
520	Turbocharger Air Inlet Clamp
521	Upper Turbocharger Heat Shield
522	Upper Turbocharger Heat Shield Bolt
523	Fuel Inlet Pipe Assembly
524	Fuel Inlet Pipe Assembly Bolt
524	Fuel Inlet Pipe Assembly Bolt
525	Fuel Feed Pipe
526	Fuel Feed Pipe Bolt
527	Fuel Feed Pipe Nut
528	Fuel Rail Balance Pipe
529	Fuel Rail Balance Pipe Bolt
530	Turbocharger Oil Supply Line
531	Turbocharger Oil Supply Line Bolt
532	Fuel Injection Pump
533	Fuel Injection Pump Bolt
534	Fuel Filter Assembly
535	Fuel Rail
535	Fuel Rail
536	Fuel Rail Bolts
536	Fuel Rail Bolts
537	Fuel Rail Bracket

	Fuel Rail Bracket
538	Fuel Injection Pump Pipe
539	Injection Pipes
539	Injection Pipes
540	Lower Valve Rocker Arm Cover
540	Lower Valve Rocker Arm Cover
541	Lower Valve Rocker Arm Cover Gasket
541	Lower Valve Rocker Arm Cover Gasket
542	Lower Valve Rocker Arm Cover Bolt
543	Upper Valve Rocker Arm Cover Gasket
543	Upper Valve Rocker Arm Cover Gasket
544	Upper Valve Rocker Arm Cover
544	Upper Valve Rocker Arm Cover
545	Upper Valve Rocker Arm Cover Bolt
545	Upper Valve Rocker Arm Cover Bolt
545	Upper Valve Rocker Arm Cover Bolt
546	Engine Front Cover
547	Engine Front Cover Bolt
548	Flywheel Housing
549	Flywheel Housing Bolt
550	Dowel Pin
551	Crankshaft Rear Oil Seal
552	Flywheel Housing Oil Cooler Adapter
553	Flywheel Housing Oil Cooler Adapter Bolt
554	Flywheel Housing Oil Cooler Adapter Gasket
555	Flywheel Housing O-ring
556	Flywheel Housing Cover
557	Flywheel Housing Cover Bolt
558	Flywheel Housing Cover Gasket
559	Fuel Schrader Valve
560	Fuel Schrader Valve Nuts
561	Fuel Schrader Valve Bracket
561	Fuel Schrader Valve Bracket
562	Intake Pipe
563	Intake Heater

	Turbocharger Boost Sensor

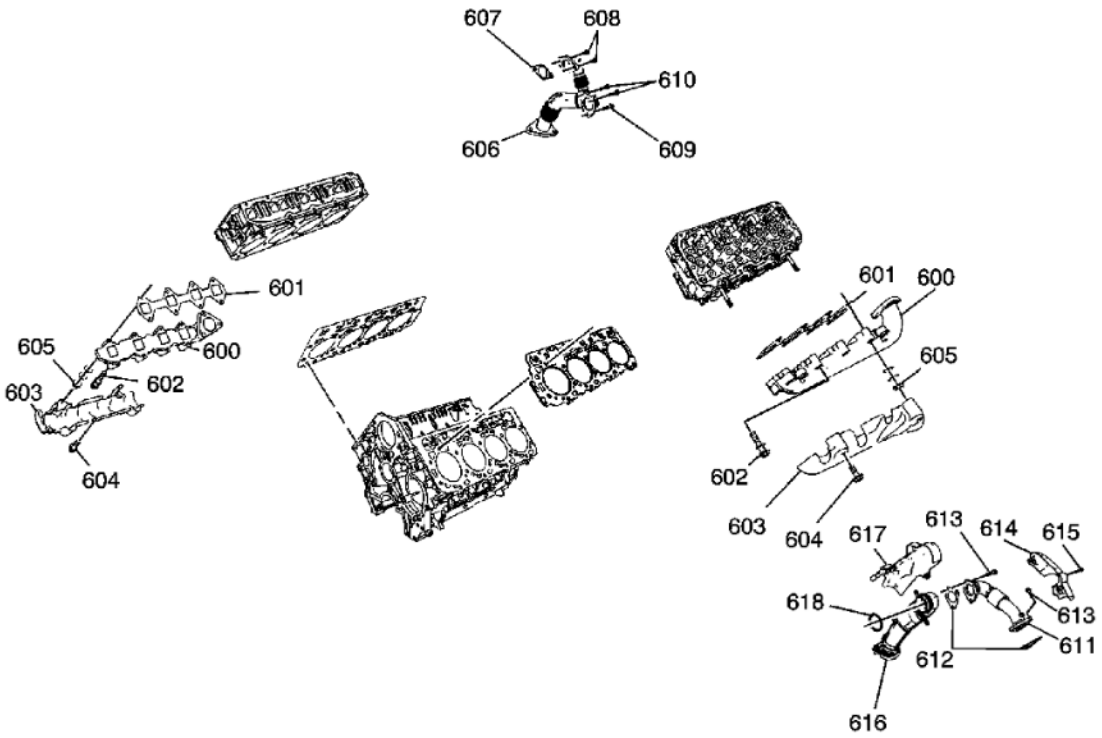


Fig. 41: Exhaust Manifolds, EGR, Air Components View
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
600	Exhaust Manifold
600	Exhaust Manifold
601	Exhaust Manifold Gasket
601	Exhaust Manifold Gasket
602	Exhaust Manifold Bolt
602	Exhaust Manifold Bolt
603	Exhaust Manifold Heat Shield
603	Exhaust Manifold Heat Shield
604	Exhaust Manifold Heat Shield Bolt
604	Exhaust Manifold Heat Shield Bolt
605	Exhaust Manifold Nut
605	Exhaust Manifold Nut
606	Exhaust Pipe

607	Exhaust Pipe Gasket
608	Exhaust Pipe Bolt
609	Exhaust Pipe Stud
610	Exhaust Pipe Nut
611	Exhaust Crossover Pipe
612	Exhaust Crossover Pipe Gasket
613	Exhaust Crossover Pipe Bolt
613	Exhaust Crossover Pipe Bolt
614	Exhaust Crossover Pipe Heat Shield
615	Exhaust Crossover Pipe Heat Shield Bolt
616	Exhaust Outlet Adapter
617	Exhaust Outlet Heat Shield
618	Exhaust Outlet Adapter Clamp

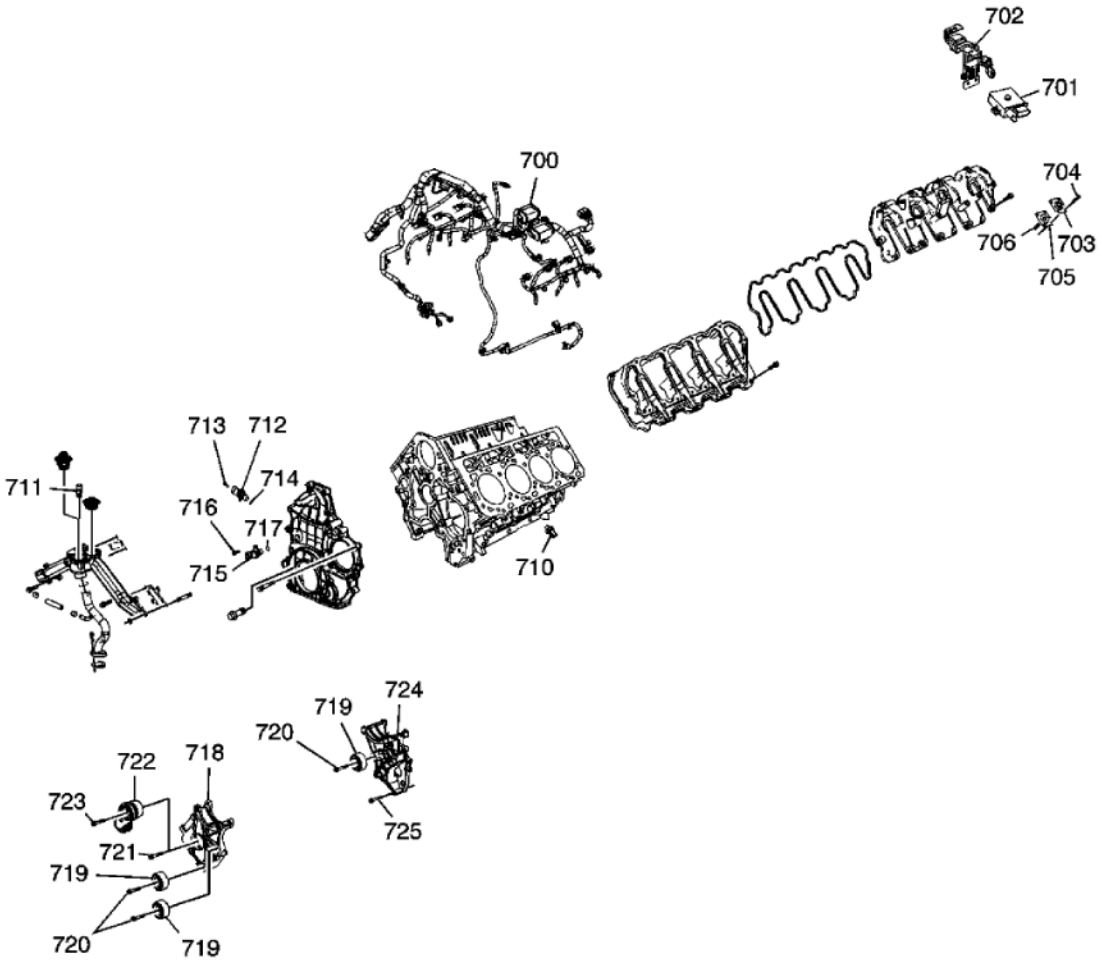


Fig. 42: Miscellaneous, Sensors, Ignition, Vacuum Hoses, Electrical
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
700	Engine Wiring Harness
701	Glow Plug Controller
702	Glow Plug Controller Bracket
703	PCV Cover
704	PCV Cover Bolt
705	PCV Diaphragm
706	PCV Spring
710	Oil Pressure Sensor
711	Coolant Temperature Sensor
712	Crankshaft Position Sensor
713	Crankshaft Position Sensor Bolt
714	Crankshaft Position Sensor O-ring
715	Camshaft Position Sensor
716	Camshaft Position Sensor Bolt
717	Camshaft Position Sensor O-ring
718	Generator Mounting Bracket
719	Idler Pulley
719	Idler Pulley
719	Idler Pulley
720	Idler Pulley Bolt
720	Idler Pulley Bolt
721	Generator Mounting Bracket Bolt
722	Drive Belt Tensioner
723	Drive Belt Tensioner Bolt
724	Power Steering Pump Bracket
725	Power Steering Pump Bracket Bolt

ENGINE IDENTIFICATION

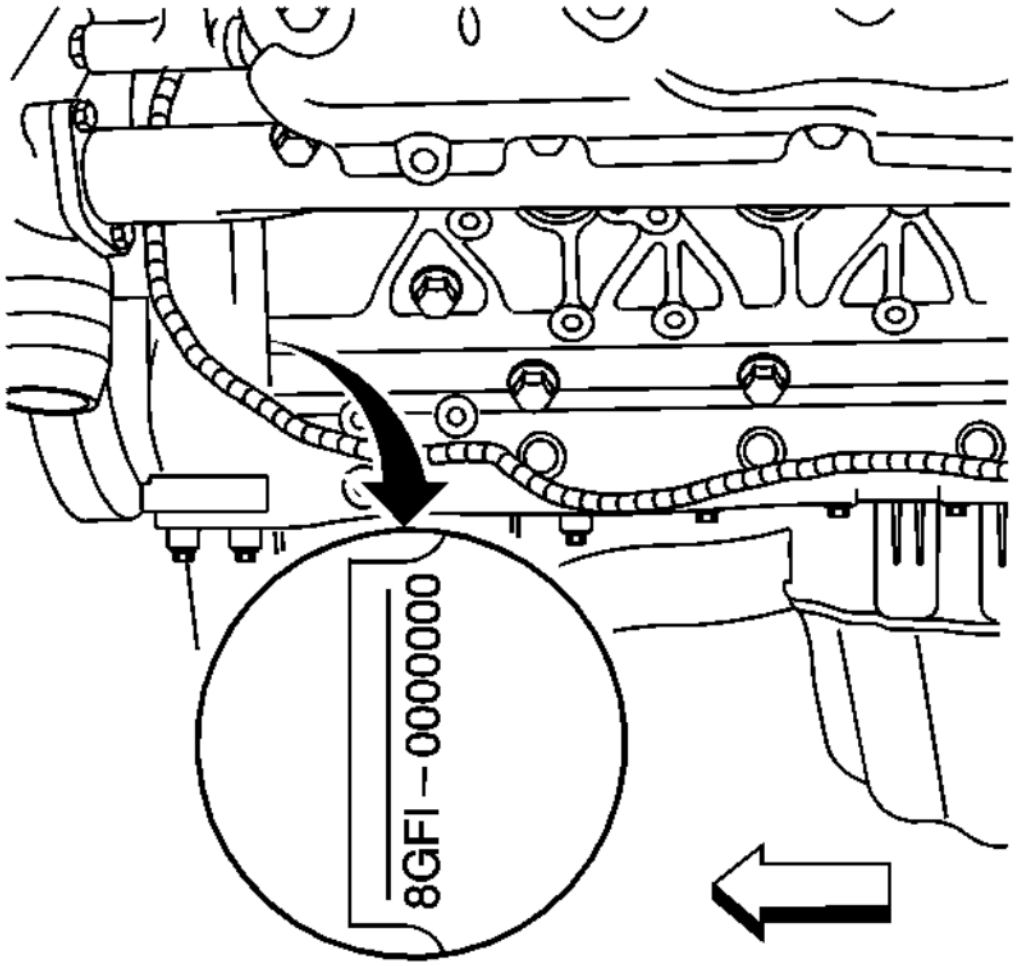


Fig. 43: View Of Engine Identification Tag
Courtesy of GENERAL MOTORS CORP.

The engine identification tag is located on the left side of the block. It is on the front edge of the block.

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC STARTING POINT - ENGINE MECHANICAL

Begin the system diagnosis by reviewing the **Disassembled Views**, **Engine Component Description** and **Lubrication Description** and the **Drive Belt System Description**. Reviewing

the description and operation information will help you determine the correct symptom diagnostic procedure when a malfunction exists. Reviewing the description and operation information will also help you determine if the condition described to you by the customer is normal operation. Refer to **Symptoms - Engine Mechanical** in order to identify the correct procedure for diagnosing the system and where the procedure is located.

SYMPTOMS - ENGINE MECHANICAL

Strategy Based Diagnostics

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

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

Visual/Physical Inspection

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

Intermittent

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

Symptom List

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

symptom:

- **Base Engine Misfire without Internal Engine Noises**
- **Base Engine Misfire with Abnormal Internal Lower Engine Noises**
- **Base Engine Misfire with Abnormal Valve Train Noise**
- **Base Engine Misfire with Coolant Consumption**
- **Base Engine Misfire with Excessive Oil Consumption**
- **Engine Compression Test**
- **Engine Noise on Start-Up, but Only Lasting a Few Seconds**
- **Upper Engine Noise, Regardless of Engine Speed**
- **Lower Engine Noise, Regardless of Engine Speed**
- **Engine Noise Under Load**
- **Engine Will Not Crank - Crankshaft Will Not Rotate**
- **Oil Pressure Diagnosis and Testing**
- **Oil Leak Diagnosis**
- **Drive Belt Rumbling and Vibration Diagnosis**
- **Drive Belt Rumbling and Vibration Diagnosis**
- **Drive Belt Falls Off and Excessive Wear Diagnosis**
- **Drive Belt Tensioner Diagnosis**

BASE ENGINE MISFIRE WITHOUT INTERNAL ENGINE NOISES

Condition	Action
Abnormalities (severe cracking, bumps or missing areas) in the accessory drive belt. Also worn, damaged, or misaligned accessory drive components or excessive pulley runout.	Abnormalities in the accessory drive belt and/or components may cause engine RPM variations, noises similar to a faulty lower engine and also lead to a misfire condition. A misfire code may be present without an actual misfire condition. 1. Inspect the accessory drive components. 2. Repair or replace all damaged components.
Loose and/or damaged crankshaft balancer	A misfire code may be present without an actual misfire condition.

	1. Inspect crankshaft balancer and balancer bolt. 2. Repair or replace all damaged components.
Loose torque converter bolts	A misfire code may be present without an actual misfire condition. 1. Inspect torque converter bolts and flywheel. 2. Repair or replace all damaged components.
Loose and/or damaged flywheel	A misfire code may be present without an actual misfire condition. 1. Inspect flywheel and flywheel attaching bolts. 2. Repair or replace all damaged components.
Restricted exhaust system	A severe restriction in the exhaust flow can cause significant loss of engine performance and may set a misfire code. Possible causes of restrictions include collapsed or dented pipes, plugged mufflers and/or catalytic converters. Repair or replace all damaged components.
Air in fuel system	1. Inspect fuel filter, fuel system for leaks and/or restrictions. 2. Repair or replace all damaged components.
Bent and/or worn valve pushrod	1. Inspect valve pushrod and valve rocker arm. 2. Repair or replace all damaged components.
Sticking valve	Carbon on the valve stem or valve seat may cause the valve to stick. 1. Inspect valves and valve guides. 2. Repair or replace all damaged

	components.
Damaged or misaligned timing gears	1. Inspect timing gears. 2. Replace all damaged components.
Worn or faulty camshaft lobes	1. Inspect camshaft lobes. 2. If damaged replace camshaft and all lifters.
Excessive piston-to-cylinder bore clearance	1. Perform cylinder leak down and compression tests. 2. Inspect the piston, piston rings and cylinder bore. 3. Repair or replace all damaged components.
Faulty cylinder head gaskets and/or cracking or other damage to the cylinder heads and engine block cooling system passages. (Coolant consumption may or may not cause the engine to overheat.)	1. Perform cylinder leak down and compression tests. 2. Inspect the piston, piston rings and cylinder bore. 3. Repair or replace all damaged components.
Overfilled Crankcase	1. Check engine oil level with vehicle on a level surface. 2. Correct any overfilled condition. 3. Inspect for fuel leaks into the crankcase. Refer to **Fuel in Engine Oil**. 4. Repair any fuel leaks.

BASE ENGINE MISFIRE WITH ABNORMAL INTERNAL LOWER ENGINE NOISES

Condition	Action
Abnormalities (severe cracking, bumps or missing areas) in the accessory drive belt.	Abnormalities in the accessory drive belt and/or components may cause engine RPM variations, noises similar to a faulty lower engine and also lead to a misfire condition. A misfire code may be present without an actual misfire condition. 1. Inspect the accessory drive components.

	2. Repair or replace all damaged components.
Worn, damaged, or misaligned accessory drive components or excessive pulley runout	A misfire code may be present without an actual misfire condition. 1. Inspect the accessory drive components. 2. Repair or replace all damaged components.
Loose and/or damaged crankshaft balancer	A misfire code may be present without an actual misfire condition. 1. Inspect crankshaft balancer and balancer bolt. 2. Repair or replace all damaged components.
Loose torque converter bolts	A misfire code may be present without an actual misfire condition. 1. Inspect torque converter bolts and flywheel. 2. Repair or replace all damaged components.
Loose and/or damaged flywheel	A misfire code may be present without an actual misfire condition. 1. Inspect flywheel and flywheel attaching bolts. 2. Repair or replace all damaged components.
Excessive piston-to-cylinder bore clearance	1. Perform cylinder leak down and compression tests 2. Inspect the piston, piston rings and cylinder bore. 3. Repair or replace all damaged components.
Excessive crankshaft thrust bearing clearance	Severely worn thrust surfaces on the crankshaft and/or thrust bearing may permit

	for and aft movement of the crankshaft and create a misfire code without an actual misfire condition. 1. Inspect the crankshaft end play and crankshaft thrust bearings. 2. Repair or replace all damaged components.
Overfilled crankcase	1. Check engine oil level with vehicle on a level surface. 2. Correct any overfilled condition. 3. Inspect for fuel leaks into the crankcase. 4. Repair any fuel leaks.

BASE ENGINE MISFIRE WITH ABNORMAL VALVE TRAIN NOISE

Condition	Action
Loose, worn or damaged rocker arm	1. Inspect valve rocker arm and rocker arm shaft. 2. Repair or replace all damaged components.
Loose valve rocker arm attachments	1. Inspect valve rocker arm and rocker arm shaft. 2. Repair or replace all damaged components.
Worn or damaged pushrods	1. Inspect the pushrods for excessive wear. 2. Inspect the pushrods for bent condition. 3. Inspect the pushrods for broken tip. 4. Replace pushrod if any damage is found.
Broken valve springs	1. Inspect valve springs. 2. Repair or replace all damaged components.
Worn and/or damaged valve rotator	1. Inspect valve rotators. 2. Repair or replace all damaged components.

Sticking valve	Carbon on the valve stem or valve seat may cause the valve to stick. 1. Inspect valves and valve guides. 2. Repair or replace all damaged components.
Worn or faulty camshaft lobes	1. Inspect camshaft lobes. 2. If damaged replace camshaft and all lifters.
Excessive valve lash	1. Check the valve lash adjustment, and correct if above specifications. 2. Repair or replace all damaged components.

BASE ENGINE MISFIRE WITH COOLANT CONSUMPTION

Inspection	Action
DEFINITION: Base engine misfire with coolant consumption	
Preliminary Inspection	Verify that there are no external coolant leaks. Refer to **Loss of Coolant** .
Isolate Affected Cylinders	• Cylinder balance test with scan tool • Cooling system pressurization • Inspection of glow plugs • Compression test • Cylinder leakdown test
EGR System Inspection	1. Inspect EGR valve and intake system for evidence of coolant leakage. 2. Replace the EGR cooler if any problem is found.
Cylinder Head Gasket Leakage	• Remove cylinder heads of the affected cylinder bank and inspect for damage. • Replace components as necessary.
	1. Inspect the cylinder heads for cracks and warpage. 2. Inspect the cylinder block for damage.

Cylinder Head or Engine Block Damage	3. Inspect the cylinder block to head mating surface for straightness. 4. Replace components as necessary.

BASE ENGINE MISFIRE WITH EXCESSIVE OIL CONSUMPTION

Condition	Action
Worn valve guides	1. Inspect the valves and valve guides. 2. Repair or replace all damaged components.
Worn valve stem oil seals	1. Inspect the valve stem oil seals. 2. Repair or replace all damaged components.
Excessive piston-to-cylinder bore clearance	1. Perform cylinder leak down and compression tests to determine the cause. 2. Inspect the piston rings for low ring tension, broken or worn rings. 3. Inspect cylinder bore. 4. Repair or replace all damaged components.

ENGINE NOISE ON START-UP, BUT ONLY LASTING A FEW SECONDS

Condition	Action
Incorrect oil viscosity	1. Drain the oil. 2. Install the correct viscosity oil.
Excessive piston-to-cylinder bore clearance	1. Inspect the piston and piston skirt, connecting rod, and cylinder bore. 2. Repair or replace all damaged components.
Damaged or faulty oil filter by-pass valve	1. Inspect the oil filter by-pass valve for proper operation. 2. Repair or replace as necessary.

UPPER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

Condition	Action
Low oil pressure	Insufficient or poor oil supply to valve train. 1. Perform oil pressure test. 2. Repair or replace all damaged components.
Improper lubrication to the valve rocker arms	1. Inspect valve rocker arm and shaft, valve pushrod, oil filter bypass valve, oil pump and pump screen, and engine block oil galleries. 2. Repair or replace all damaged components.
Excessive valve lash	1. Check the valve lash adjustment, and correct if above specifications. 2. Repair or replace all damaged components.
Worn pushrod upper end ball	1. Inspect pushrod end ball. 2. Repair or replace all damaged components.
Bent valve pushrod	1. Inspect valve pushrod and valve rocker arm. 2. Repair or replace all damaged components.
Loose, worn or damaged valve rocker arm	1. Inspect valve rocker arm and rocker arm shaft. 2. Repair or replace all damaged components.
Loose valve rocker arm attachments	1. Inspect valve rocker arm and rocker arm shaft. 2. Repair or replace all damaged components.
Broken valve springs	1. Inspect valve springs. 2. Repair or replace all damaged

	components.
Worn and/or damaged valve spring shims, seats, or keys	1. Inspect valve spring shims, seats, and keys. 2. Repair or replace all damaged components.
Sticking valve	Carbon on the valve stem or valve seat may cause the valve to stick. 1. Inspect valves and valve guides. 2. Repair or replace all damaged components.
Missing or improperly positioned lifter guides	1. Inspect lifter guides. 2. Repair or replace all damaged components.
Worn or faulty camshaft lobes	1. Inspect camshaft lobes. 2. If damaged replace camshaft and all lifters.
Worn valve guide	1. Inspect the valves and valve guides. 2. Repair or replace all damaged components.
Damaged or misaligned timing gears	1. Inspect timing gears. 2. Replace all damaged components.

LOWER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

Condition	Action
Worn accessory drive components (abnormalities such as severe cracking, bumps or missing areas in the accessory drive belt and/or misalignment of the system components.)	1. Inspect the accessory drive components. 2. Repair or replace all damaged components.
Low oil pressure	Insufficient or poor oil supply to crankshaft and connecting rod bearings. 1. Perform oil pressure test. 2. Repair or replace all damaged

	components.
Leaking and/or sticking fuel injection nozzle (A stuck fuel injection nozzle can cause a noise similar to a damaged piston, rod or rod bearing.)	1. Use the cylinder balance diagnostic procedure to help locate the cylinder that is the source of the noise. 2. If you cannot locate the cylinder that is the source of the noise, diagnose the engine for mechanical damage. 3. If it has been determined that the fuel injection nozzle is causing the noise, replace the fuel injection nozzle.
Loose and/or damaged crankshaft balancer	1. Inspect crankshaft balancer and balancer bolt. 2. Repair or replace all damaged components.
Loose torque converter bolts	1. Inspect torque converter bolts and flywheel. 2. Repair or replace all damaged components.
Loose and/or damaged flywheel	1. Inspect flywheel and flyweel attaching bolts. 2. Repair or replace all damaged components.
Excessive piston-to-cylinder bore clearance	1. Inspect the piston, piston rings and cylinder bore. 2. Repair or replace all damaged components.
Excessive piston pin-to-bore clearance	1. Inspect the piston, piston pin, and the connecting rod. 2. Repair or replace all damaged components.
Misaligned or bent connecting rod	1. Inspect connecting rod and connecting rod bearings. 2. Repair or replace all damaged components.
Excessive connecting rod bearing clearance	1. Inspect the connecting rod bearings,

	connecting rods, crankshaft and crankshaft journals. 2. Repair or replace all damaged components.
Excessive crankshaft bearing clearance	1. Inspect the crankshaft bearings and crankshaft journals. 2. Repair or replace all damaged components.
Oil pump pickup tube or screen bent or loose	1. Inspect the oil pump pickup tube and/or screen. 2. Repair or repalce all damaged components.

ENGINE NOISE UNDER LOAD

Cause	Correction
Low oil pressure	Insufficient or poor oil supply to components. 1. Perform oil pressure test. 2. Repair or replace all damaged components.
Loose torque converter bolts	1. Inspect the torque converter bolts and flywheel. 2. Repair or replace all damaged components.
Loose and/or damaged flywheel	1. Inspect the flywheel and flywheel attaching bolts. 2. Repair or replace all damaged components.
Excessive piston-to-cylinder bore clearance	1. Inspect the piston rings for low ring tension, broken or worn rings, inspect cylinder bore. 2. Repair or replace all damaged components.
Excessive crankshaft thrust bearing clearance	1. Inspect the crankshaft end play and crankshaft thrust bearings.

	2. Repair or replace all damaged components.
Excessive crankshaft bearing clearance	1. Inspect the crankshaft bearings and crankshaft journals. 2. Repair or replace all damaged components.

ENGINE WILL NOT CRANK - CRANKSHAFT WILL NOT ROTATE

Cause	Correction
Seized accessory drive system component	1. Remove accessory drive belt(s). 2. Remove the glow plugs. 3. Rotate crankshaft by hand at the balancer.
Hydraulically locked cylinder • Coolant/antifreeze in cylinder • Oil in cylinder • Fuel in cylinder	1. Inspect for fluid at glow plug hole. 2. Inspect for broken head gasket(s). 3. Inspect for cracked engine block or cylinder head. 4. Inspect for a sticking fuel injector.
Seized automatic transmission torque converter	1. Remove the engine assembly. The torque converter bolts are not accessible with the engine installed to the transmission. 2. Rotate crankshaft by hand at the balancer or flywheel location.
Seized manual transmission	1. Disengage the clutch. 2. Rotate crankshaft by hand at the balancer.
Material in cylinder: • Broken valve • Piston material • Foreign material	1. Inspect cylinder for damaged components and/or foreign materials. 2. Repair or replace as required.
Seized crankshaft or connecting rod bearings	1. Inspect crankshaft and connecting rod bearings.

	2. Repair as required.
Bent or broken connecting rod	1. Inspect connecting rods. 2. Repair as required.
Broken crankshaft	1. Inspect crankshaft. 2. Repair as required.

COOLANT IN COMBUSTION CHAMBER

Inspection	Action
DEFINITION: Excessive white smoke and/or coolant type odor coming from the exhaust pipe may indicate coolant in the combustion chamber. Low coolant levels, an inoperative cooling fan, or a faulty thermostat may lead to an "overtemperature" condition which may cause engine component damage.	
Preliminary Inspection	Verify that there are no external coolant leaks. Refer to **Loss of Coolant** .
Isolate Affected Cylinders	• Cylinder balance test with scan tool • Cooling system pressurization • Inspection of glow plugs • Compression test • Cylinder leakdown test
EGR System Inspection	1. Inspect EGR valve and intake system for evidence of coolant leakage. 2. Replace the EGR cooler if any problem is found.
Cylinder Head Gasket Leakage	• Remove cylinder heads of the affected cylinder bank and inspect for damage. • Replace components as necessary.
Cylinder Head or Engine Block Damage	1. Inspect the cylinder heads for cracks and warpage. 2. Inspect the cylinder block for damage. 3. Inspect the cylinder block to head mating surface for straightness. 4. Replace components as necessary.

COOLANT IN ENGINE OIL

Cause	Correction
DEFINITION: Foamy or discolored oil or an engine oil "overfill" condition may indicate coolant entering the engine crankcase. Low coolant levels, an inoperative cooling fan, or a faulty thermostat may lead to an "overtemperature" condition which may cause engine component damage. Contaminated engine oil and oil filter should be changed. 1. Inspect the oil for excessive foaming or an overfill condition. Oil diluted by coolant may not properly lubricate the crankshaft bearings and may lead to component damage. Refer to **Lower Engine Noise, Regardless of Engine Speed**. 2. Inspect by performing a Cylinder Leak-Down Test. During this test, excessive air bubbles within the cooling system may indicate a faulty gasket or damaged component. 3. Inspect by performing a cylinder compression test. Two cylinders "side-by-side" on the engine block with low compression may indicate a failed cylinder head gasket. Refer to **Engine Compression Test**.	
Faulty cylinder head gasket	Replace the head gasket and components as required. Refer to **Cylinder Head Cleaning and Inspection** and **Cylinder Head Replacement - Left Side** or **Cylinder Head Replacement - Right Side** .
Warped cylinder head	Replace the cylinder head gasket. Refer to **Cylinder Head Replacement - Left Side** or **Cylinder Head Replacement - Right Side** .
Cracked cylinder head	Replace the cylinder head and gasket.
Cracked engine block	Replace the components as required.
Cylinder head, block, or manifold porosity	Replace the components as required.
Leaking engine oil cooler	Replace components as required.
Faulty water pump	Replace components as required.
Leaking cylinder head cup plug (under rocker cover)	Replace components as required.

FUEL IN ENGINE OIL

Definition: If fuel is suspected of leaking into the crankcase, the following procedure should be performed to verify the condition.

1. Remove the oil level indicator and allow oil to drop onto a clean white paper towel.
2. If the oil is diluted with fuel, it will become apparent as the towel wicks the fuel away from

the drop of oil on the towel. The fuel will expand out in a ring around the oil droplet.

3. If fuel dilution is apparent, refer to **Fuel Leak Diagnosis** for diagnosis and repair. Inspect the vehicle for aftermarket performance accessories that may cause damage to the injection pump. After repairs are completed, perform the test again to verify the condition is corrected.
4. If no fuel dilution is present, verify the oil level and correct as needed.

TURBOCHARGER WHINE NOISE

Condition	Action
Some whine noise is normal. Compare to a known good vehicle.	
Leaking charge air cooler/pipes/hoses	Inspect for leaks in charge air cooler/pipes/hoses using **J 46091** .
Worn turbocharger bearings	Visually inspect for evidence of compressor wheel to housing contact. If the turbocharger bearings are worn or damaged, inspect for a **Turbocharger Lack of Oil Supply**.
Intake system leaks or obstructions	1. With the engine off, pressurize the intake system using **J 46091** and inspect for intake manifold leaks. 2. Inspect for obstructions in the intake manifolds.

TURBOCHARGER HISSING NOISE

Condition	Action
Air inlet leaks or obstructions	Inspect for leaks or obstructions in the turbocharger inlet pipes/hoses.
Leaking charge air cooler/pipes/hoses	Inspect for leaks or obstructions in the charge air cooler/pipes/hoses using **J 46091** .
Leaking or restricted exhaust system	1. Inspect for a leak in the exhaust system. 2. Inspect for a restricted exhaust system.
Intake system leaks or obstructions	1. With the engine off, pressurize the intake system using **J 46091** and inspect for intake manifold leaks. 2. Inspect for obstructions in the intake

	manifolds.

TURBOCHARGER OIL LEAK FROM COMPRESSOR SEAL

Condition	Action
IMPORTANT: **Oil in the turbocharger air inlet duct,oil on the compressor wheel, and oil throughout the charge air cooler system is normal with a closed PCV system. Do not attempt repairs for this condition.**	
Restricted air system	Inspect for clogged air filter element or restricted air inlet system.
Restricted exhaust system	Inspect for a restricted exhaust.
Leaking exhaust system.	Inspect for exhaust manifold leaks.
Poor oil drainage from turbocharger	Inspect for restricted turbocharger oil drain pipe.
Restricted crankcase ventilation system	Inspect for restricted crankcase ventilation system.
Worn internal engine components	Inspect for excessive blowby or engine oil consumption.

TURBOCHARGER OIL LEAK FROM TURBINE SEAL

Condition	Action
Poor oil drainage from turbocharger	Inspect for a restricted turbocharger oil drain pipe.
Restricted crankcase ventilation system	Inspect for a restricted crankcase ventilation system.
Worn internal engine components	Inspect for excessive blowby or engine oil consumption.

TURBOCHARGER LACK OF OIL SUPPLY

Condition	Action
Restricted oil supply hose	Inspect for restricted turbocharger oil supply hose.
Spun camshaft bearing	1. Remove the oil supply hose. Refer to **Turbocharger Oil Feed Pipe Replacement** . 2. Visually inspect for correct alignment of

	the camshaft bearing oil hole. 3. Rotate the engine 1/2 turn and inspect the camshaft bearing oil hole for movement, indicating a spun camshaft bearing.

ENGINE COMPRESSION TEST

Tools Required

- **J 26999** Compression Gage. See **Special Tools**.
- **EN-47603** Compression Gage Adapter. See **Special Tools**.

Test

1. Ensure that the vehicle's batteries are in good condition, and fully charged.
2. Operate the vehicle until the engine is at normal operating temperature.
3. Shut off engine.
4. Disconnect the crankshaft position sensor.
5. Disconnect glow plug nut; remove all 8 glow plugs. All 8 glow plugs must be removed from the engine during each cylinder test to obtain valid test results.
6. Prior to taking a compression reading, verify the cranking speed is greater than 140 RPM. If the cranking speed is below 140 RPM, repair the slow cranking speed condition before continuing with the compression test. Refer to **Engine Cranks Slowly** .
7. Install the **EN-47603** in the glow plug hole for the cylinder that is being checked. See **Special Tools**.

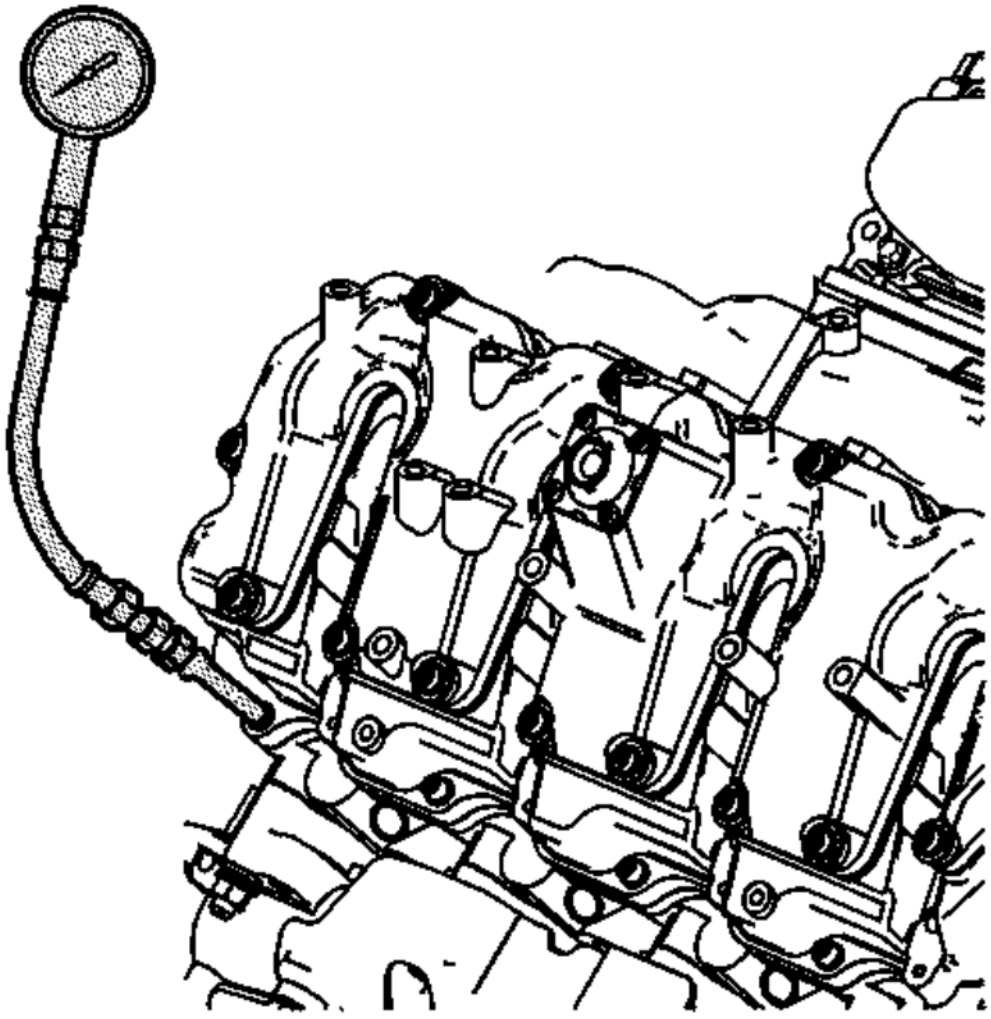


Fig. 44: View Of J 26999 For A Compression Test
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not add oil to any cylinder during a compression test as extensive engine damage may result.

8. Connect the **J 26999** to the **EN-47603** . See **Special Tools**.
9. Using the vehicle's starter motor, rotate or crank the engine for 6 compression strokes, puffs,

for the cylinder being tested.

10. Observe the **J 26999** and note the reading as the compression test is being performed. See **Special Tools**. A normal cylinder reading will be indicated if compression builds up quickly and evenly to the specified level. An abnormal reading will be indicated if compression is low on the first compression stroke, starts increasing on the following compression strokes but does not reach the specified level.
11. Record the compression reading for the cylinder just tested.
12. Disconnect the **J 26999** from the **EN-47603** and remove adapter from the glow plug hole. See **Special Tools**.
13. Repeat steps 8 through 13 for all remaining cylinders. All 8 cylinders must be tested to obtain valid test results. Record the readings.
14. The minimum compression in any one cylinder is 2069 kPa (300 psi). There should not be more than 345 kPa (50 psi) difference between a suspect cylinder and the average compression of all 8 cylinders.
    - Normal-Compression builds up quickly and evenly to the specified compression for each cylinder.
    - Piston Rings Leaking-Compression is low on the first stroke. Compression builds up with the following strokes but does not reach normal.
    - Valves Leaking-Compression is low on the first stroke. Compression usually does not build up on the following strokes.

CYLINDER LEAKAGE TEST

Tools Required

- **J 35667-A** Cylinder Head Leakdown Tester
- **J-35667-8** Cylinder Head Leakdown Adapter. See **Special Tools**.

Test

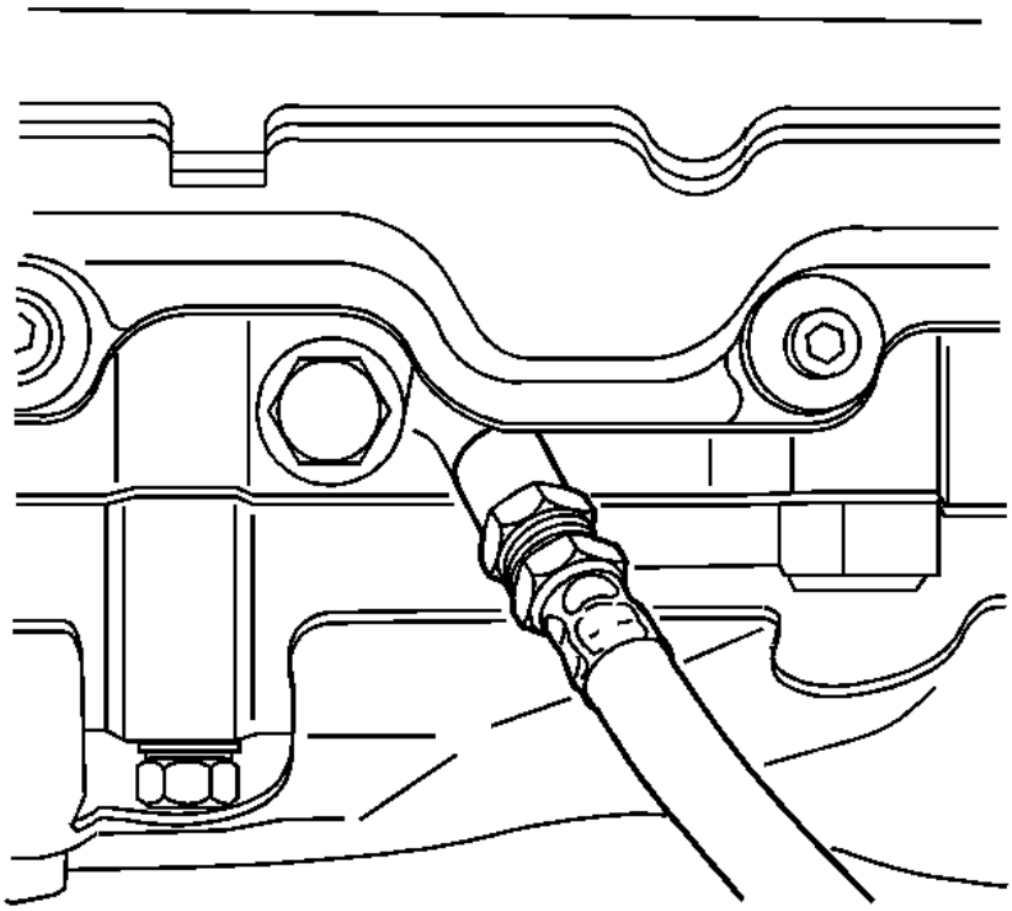


Fig. 45: Testing Cylinder Leakage
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to BATTERY DISCONNECT CAUTION

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

- **Worn, burnt, or stuck valves**
- **Broken valve springs**

- **Incorrect valve lash**
- **Damaged valve train components**
- **Damaged piston**
- **Worn piston rings**
- **Worn or scored cylinder bore**
- **Damaged cylinder head gasket**
- **Cracked or damaged cylinder head**
- **Cracked or damaged engine block**

1. Disconnect the battery ground negative cable.
2. Remove the glow plugs.
3. Rotate the crankshaft to place the piston in the cylinder being tested at Top Dead Center (TDC) of the compression stroke.
4. Install **J-35667-8** and **J 35667-A** . See **Special Tools**.

IMPORTANT: It may be necessary to hold the crankshaft balancer bolt to prevent the engine from rotating.

5. Apply shop air pressure to **J 35667-A** and adjust according to the manufacturers instructions.
6. Record the cylinder leakage value. Cylinder leakage that exceeds 25 percent is considered excessive and may require component service. In excessive leakage situations, inspect for the following conditions:
   - Air leakage sounds at the intake manifold tube, may indicate a worn, stuck or burnt intake valve, broken valve spring, incorrect valve lash or damaged valve train components.
   - Air leakage sounds at the exhaust system tailpipe may indicate a worn, burnt, or stuck exhaust valve, broken valve spring, incorrect valve lash or damaged valve train components.
   - Air leakage sounds from the crankcase, oil level indicator tube, or oil fill tube may indicate worn piston rings, a damaged piston, a worn or scored cylinder bore, a damaged engine block or a damaged cylinder head.
   - Air bubbles in the cooling system may indicate a damaged cylinder head or gasket.
7. Perform the leakage test on the remaining cylinders and record the values.

OIL CONSUMPTION DIAGNOSIS

The accepted rate of oil consumption, not due to leaks, is the use of 0.946 liter (1 qt) or less within 379 liters (100 gallons) of fuel used. This rate only applies to vehicles under warranty, maintained in accordance with the appropriate maintenance schedule, driven at legal speeds and within design intent of the vehicle.

Oil economy should not be tested until the vehicle has accumulated at least 8000 km (5000 mi) and the oil has been changed for the first time. During initial engine break-in periods before the first oil change, oil consumption may exceed 1.9 liters (2 qts) or more per 379 liters (100 gallons) of fuel used.

Checks	Causes
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 • Oil residue in the charge air cooler system is normal with a closed PCV system • Worn valve guides and/or valve stems • 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 improperly fit to the cylinder bore

OIL PRESSURE DIAGNOSIS AND TESTING

Step	Action	Yes	No
DEFINITION: Low or no engine oil pressure indicates a potentially serious condition with all of the engine mechanical components. Once the cause of the low or no oil pressure condition has been identified, repair all collateral damage to the engine mechanical components as well as the initial cause of the condition.			
1	Check engine oil level. Use only the GM service parts brand and recommended grade of engine oil specified for the vehicle. Is the engine oil level between ADD and FULL on the oil level indicator?	Go to **Step 2**	-
2	1. Operate vehicle until engine reaches normal operating temperature. Refer to **Engine Mechanical Specifications**. 2. Park vehicle on a level surface. 3. Wait 15 minutes. 4. Check engine oil level. Use only the GM service parts brand and recommended grade of engine oil specified for the vehicle. Is the engine oil level between ADD and FULL on the oil level indicator?	Go to **Step 3**	-
3	Operate the engine and measure the engine oil pressure with the vehicle gage or light. Refer to **Engine Mechanical Specifications**. Is engine oil pressure within specification?	System OK	Go to **Step 4**
	1. Remove the oil pressure sender or engine block oil gallery plug. 2. Install a mechanical oil pressure gage.		

4	3. Operate the engine and measure the engine oil pressure with the mechanical oil pressure gage. Refer to **Engine Mechanical Specifications**. Is engine oil pressure within specification?	System OK	Go to **Step 5**
5	Change the engine oil and filter. • Use only the GM service parts brand and recommended grade of engine oil specified for the vehicle. Refer to Owners' Manual. • Use only the GM service parts brand and recommended type of engine oil filter specified for the vehicle. Refer to Owners' Manual. Operate the engine and measure the engine oil pressure with the mechanical oil pressure gage. Refer to **Engine Mechanical Specifications**. Is engine oil pressure within specification?	System OK	Go to **Step 6**
6	1. Inspect the engine for mechanical damage. Special interest should be shown to the following areas: • Malfunctioning oil bypass valve • Oil pump worn or dirty • Oil pump-to-engine block bolts loose • Oil pump O-ring damaged or missing • Oil pump to oil pump pipe and screen assembly gasket missing or damaged • Oil pump pipe and screen assembly restrictions or damaged • Oil pump driven gear damaged or loose • Oil pump drive gear damaged • Oil cooler restrictions • Oil cooler O-rings damaged or		

	missing • Excessive bearing clearances • Cracked, porous or restricted oil galleries • Oil gallery plugs missing or incorrectly installed • Damaged or missing oil spray cooling nozzles 2. Inspect the engine for customer modifications. Is there mechanical damage, or customer modifications to the engine?	Go to **Step 7**	Go to **Step 1**
7	Repair or replace all damaged or modified components. Is the repair complete?	Go to **Step 1**	-

OIL LEAK DIAGNOSIS

Step	Action	Yes	No
IMPORTANT: **You can repair most fluid leaks by first visually locating the leak, repairing or replacing the component, or by resealing the gasket surface. Once the leak is identified, determine the cause of the leak. Repair the cause of the leak as well as the leak itself.**			
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 7**	Go to **Step 3**
	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas.		

3	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 7**	Go to **Step 4**
4	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 7**	Go to **Step 5**
5	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 7**	Go to **Step 6**
6	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 7**	System OK

7	1. Inspect the engine for mechanical damage and repair or replace as necessary. Special attention should be shown to the following areas: • Plugged or malfunctioning crankcase ventilation system. Refer to **Crankcase Ventilation System Inspection/Diagnosis**. • Higher than recommended fluid levels • Higher than recommended fluid pressures • Plugged or malfunctioning fluid filters or pressure bypass valves • 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 8**	System OK
8	Repair or replace all damaged or modified components. Does the engine still leak oil?	Go to **Step 1**	System OK

CRANKCASE VENTILATION SYSTEM INSPECTION/DIAGNOSIS

Concern	Action
IMPORTANT: **Oil in the charged air cooler, hoses, turbocharger, or intake manifolds is normal with a closed crankcase ventilation system.**	

The maximum crankcase pressure is 4 kPa or 16 in of water at 3,100 RPM measured at the oil level indicator tube.	
PVC check valve stuck closed	• Excessive crankcase pressure • Possible oil leaks. Replace the valve.
Odors	Normal situation
Noise	Cracked hoses
Smoke	Damaged PCV diaphragm
Excessive Oil Consumption	Damaged PCV diaphragm, missing or broken spring

DRIVE BELT CHIRPING, SQUEAL, AND WHINE DIAGNOSIS

Diagnostic Aids

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

Test Description

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

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

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

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

6: Misalignment of the pulleys may be caused from improper mounting of the accessory

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

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

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

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

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

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

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

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

Step	Action	Yes	No
NOTE: **Refer to Belt Dressing Notice .** 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 start-ups and will subside once the vehicle reaches normal operating temp.			

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.

DEFINITION: The following items are indications of drive belt whine:

- A high pitched continuous noise.
- The noise may be caused by an accessory drive component failed bearing.

1	Did you review the drive belt symptom operation and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Engine Mechanical**
2	Verify that there is a chirping, squeal or whine noise. Does the engine make the chirping squeal or whine noise?	Go to **Step 3**	Go to Diagnostic Aids
3	1. Remove the drive belt. If the engine has multiple drive belts, remove the belts one at a time and perform the test below each time a belt is removed. 2. Operate the engine for no longer than 30-40 seconds. 3. Repeat this test if necessary by removing the remaining belt(s). Does the chirping, squeal or whine noise still exist?	Go to **Symptoms - Engine Mechanical**	Go to **Step 4**
4	If diagnosing a chirping noise, inspect for severe pilling exceeding 1/3 of the belt groove depth. If diagnosing a squeal or whine noise, proceed to step 13.		

	Do the belt grooves have pilling?	Go to **Step 5**	Go to **Step 6**
5	Clean the drive belt pulleys with a suitable wire brush. Did you complete the repair?	Go to **Step 20**	Go to **Step 6**
6	Inspect for misalignment of the pulleys. Are any of the pulleys misaligned?	Go to **Step 7**	Go to **Step 8**
7	Replace or repair any misaligned pulleys. Did you complete the repair?	Go to **Step 20**	Go to **Step 8**
8	Inspect for bent or cracked brackets. Did you find any bent or cracked brackets?	Go to **Step 9**	Go to **Step 10**
9	Replace any bent or cracked brackets. Did you complete the repair?	Go to **Step 20**	Go to **Step 10**
10	Inspect for improper, loose or missing fasteners. Did you find the condition?	Go to **Step 11**	Go to **Step 12**
11	**NOTE:** **Refer to Fastener Notice .** 1. Tighten any loose fasteners. Refer to **Fastener Tightening Specifications**. 2. Replace any improper or missing fasteners. Did you complete the repair?	Go to **Step 20**	Go to **Step 12**
12	Inspect for a bent pulley. Did you find the condition?	Go to **Step 18**	Go to **Step 19**
13	Inspect for an accessory drive component seized bearing or a faulty accessory drive component. If diagnosing a whine noise and the condition still exist, proceed to Diagnostic Aids. Did you find and correct the condition?	Go to **Step 20**	Go to **Step 14**
14	Test the drive belt tensioner for proper operation. Refer to **Drive Belt Tensioner Diagnosis**. Did you find and correct the condition?	Go to **Step 20**	Go to **Step 15**
15	Inspect for the correct drive belt length. Did you find and correct the condition?	Go to **Step 20**	Go to **Step 16**
	Inspect for misalignment of a pulley.		

16	Did you find and correct the condition?	Go to **Step 20**	Go to **Step 17**
17	Inspect for the correct pulley size. Did you find and correct the condition?	Go to **Step 20**	Go to Diagnostic Aids
18	Replace the bent pulley. Did you complete the repair?	Go to **Step 20**	Go to **Step 19**
19	Replace the drive belt. Refer to **Drive Belt Replacement** . Did you complete the repair?	Go to **Step 20**	Go to Diagnostic Aids
20	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 3**

DRIVE BELT RUMBLING AND VIBRATION DIAGNOSIS

Diagnostic Aids

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

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

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

Test Description

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

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

3: This test is to verify that one of the drive belts is causing the rumbling noise or vibration. Rumbling noise may be confused with an internal engine noise due to the similarity in the description. Remove only one drive belt at a time if the vehicle has multiple drive belts. When removing the drive belts the water pump may not be operating and the engine may

overheat. Also DTCs may set when the engine is operating with the drive belts removed.

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

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

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

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

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

Step	Action	Yes	No
NOTE: **Refer to Belt Dressing Notice .** DEFINITION: The following items are indications of drive belt rumbling: • A low pitch tapping, knocking, or thumping noise heard at or just above idle. • Heard once per revolution of the drive belt or a pulley. • Rumbling may be caused from: ○ Pilling, the accumulation of rubber dust that forms small balls (pills) or strings in the drive belt pulley groove ○ The separation of the drive belt ○ A damaged drive belt DEFINITION: The following items are indications of drive belt vibration: • The vibration is engine-speed related. • The vibration may be sensitive to accessory load.			
1	Did you review the drive belt symptom operation and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Engine Mechanical**
	Verify that there is a rumbling noise or that the		

	vibration is engine related.		
2	Does the engine make the rumbling noise or vibration?	Go to **Step 3**	Go to Diagnostic Aids
3	**IMPORTANT:** **If the engine has multiple drive belts, remove the belts one at a time and perform the test below each time a belt is removed.** 1. Remove the drive belt. 2. Operate the engine for no longer than 30-40 seconds. 3. Repeat this test if necessary by removing the remaining belt(s). Does the rumbling or vibration still exist?	Go to **Symptoms - Engine Mechanical** or Go to **Vibration Analysis - Engine**	Go to **Step 4**
4	Inspect the drive belts for wear, damage, separation, sections of missing ribs, and debris build-up. Did you find any of these conditions?	Go to **Step 7**	Go to **Step 5**
5	Inspect for severe pilling of more than 1/3 of the drive belt pulley grooves. Did you find severe pilling?	Go to **Step 6**	Go to **Step 7**
6	1. Clean the drive belt pulleys using a suitable wire brush. 2. Reinstall the drive belts. Refer to **Drive Belt Replacement** . Did you correct the condition?	Go to **Step 8**	Go to **Step 7**
7	Install a new drive belt. Refer to **Drive Belt Replacement** . Did you complete the replacement?	Go to **Step 8**	Go to **Step 9**
8	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 9**
9	Inspect for improper, loose or missing fasteners. Did you find any of these conditions?	Go to **Step 10**	Go to **Step 11**
	NOTE: **Refer to Fastener Notice .**		

10	1. Tighten any loose fasteners. Refer to **Fastener Tightening Specifications**. 2. Replace improper or missing fasteners. Did you complete the repair?	Go to **Step 13**	Go to **Step 11**
11	Inspect for a bent water pump shaft. Refer to **Water Pump Replacement (LU3)** or **Water Pump Replacement (LY6, L76 and L92)** or **Water Pump Replacement (LH6, LY2, LY5, and LMG)** or **Water Pump Replacement (LMM)** . Did you find and correct the condition?	Go to **Step 13**	Go to **Step 12**
12	Inspect for bent or cracked brackets. Did you find and correct the condition?	Go to **Step 13**	Go to Diagnostic Aids
13	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 3**

DRIVE BELT FALLS OFF AND EXCESSIVE WEAR DIAGNOSIS

Diagnostic Aids

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

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

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

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

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

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

Test Description

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

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

4: Misalignment of the pulleys may be caused from improper mounting of the accessory drive component, incorrect installation of the accessory drive component pulley, or the pulley 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: Inspecting the pulleys for being bent should include inspecting for a dent or other damage to the pulleys that would prevent the drive belt from not seating properly in all of the pulley grooves or on the smooth surface of a pulley when the back side of the belt is used to drive the pulley.

6: Accessory drive component brackets that are bent or cracked will let the drive belt fall off.

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

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

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

15: This inspection is to verify the drive belt is not contacting any 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 should not come in contact with an engine or a body component when snapping the throttle.

Step	Action	Yes	No
NOTE: **Refer to Belt Dressing Notice .** DEFINITION: The drive belt falls off the pulleys or may not ride correctly on the pulleys.DEFINITION: Wear at the outside ribs of the drive belt due to an incorrectly installed drive belt.			

1	Did you review the drive belt symptom operation and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Engine Mechanical**
2	• If diagnosing excessive wear, proceed to step 13. • If diagnosing a drive belt that falls off, inspect for a damaged drive belt. Did you find the condition?	Go to **Step 3**	Go to **Step 4**
3	Install a new drive belt. Refer to **Drive Belt Replacement** . 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, loose or missing fasteners. Did you find loose or missing fasteners?	Go to **Step 8**	Go to **Step 9**
8	**NOTE:** **Refer to Fastener Notice .** 1. Tighten any loose fasteners. Refer to **Fastener Tightening Specifications**. 2. 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 Tensioner Replacement** . 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	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 2**
13	Inspect the drive belt for the proper installation. Refer to **Drive Belt Replacement** . Did you find this condition?	Go to **Step 16**	Go to **Step 14**
14	Inspect for the proper drive belt. Did you find this condition?	Go to **Step 16**	Go to **Step 15**
15	Inspect for the drive belt rubbing against a bracket, hose, or wiring harness. Did you find and repair the condition?	Go to **Step 17**	Go to Diagnostic Aids
16	Replace the drive belt. Refer to **Drive Belt Replacement** . Did you complete the replacement?	Go to **Step 17**	-
17	Operate the system in order to verify the repair. Did you correct the condition?	System OK	-

DRIVE BELT TENSIONER DIAGNOSIS

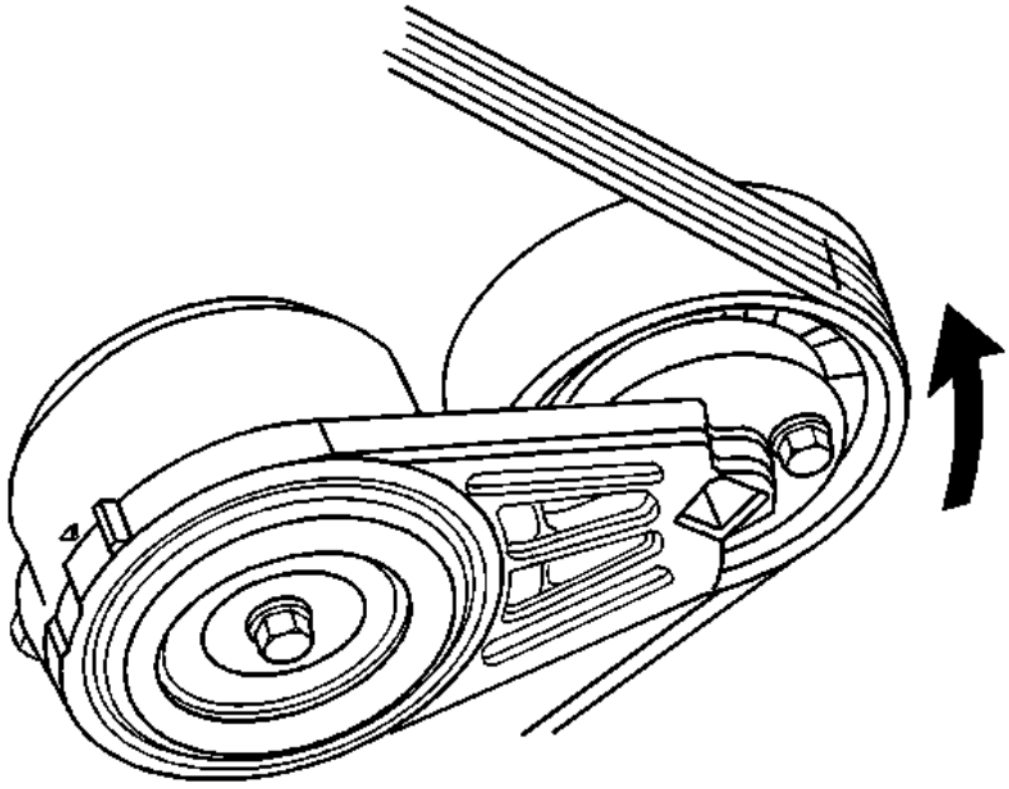


Fig. 46: View Of Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

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

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

1. Remove the drive belt. Refer to **Drive Belt Replacement** .
2. Position a 3/8-inch drive breaker bar into the drive belt tensioner opening and rotate the tensioner counterclockwise.
3. Move the drive belt tensioner through its full travel.

- The movement should feel smooth
- There should be no binding
- The tensioner should return freely

4. If any binding is observed, replace the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement** .
5. Install the drive belt. Refer to **Drive Belt Replacement** .

DESCRIPTION AND OPERATION

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 1 belt or 2 belts. The drive belt is thin so that it can bend backwards and has several ribs to match the grooves in the pulleys. 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.

ENGINE COMPONENT DESCRIPTION

Engine Block

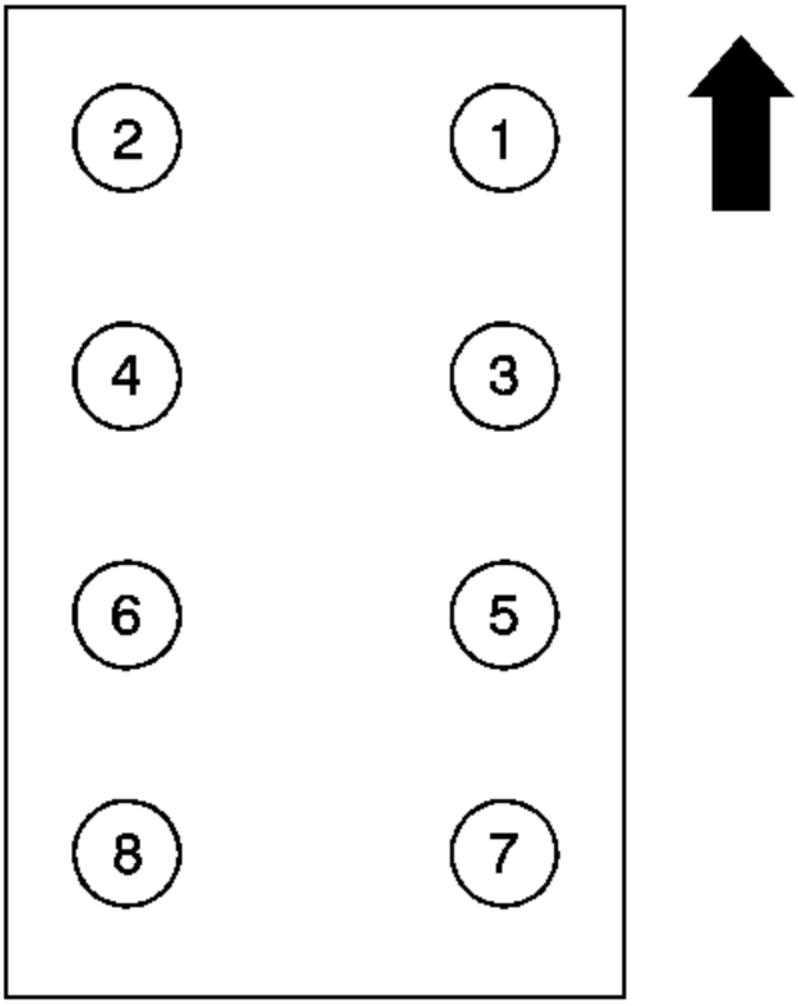


Fig. 47: Identifying 6.6L Cylinder Locations
Courtesy of GENERAL MOTORS CORP.

The engine block utilizes a deep skirt design for increased rigidity. The cylinders are positioned in a 90 degree "V" orientation with the number one cylinder being the right front. The block is induction hardened for increased durability. The crankshaft bearing caps are cross-bolted to enhance structural rigidity.

Upper Oil Pan

A single piece cast aluminum upper oil pan contributes to crankshaft and block rigidity while reducing overall weight.

Crankshaft

The crankshaft is a nitride hardened steel design with five main bearings. Crankshaft thrust is controlled by the number 5 bearing.

Connecting Rods

The connecting rods are one-piece hot forged steel. The connecting rods and caps are of a fractured split design to improve durability and reduce internal friction. The connecting rod small end is tapered cut for reduced weight and improved durability.

Pistons

The pistons are a full-floating design. The piston pins are a slip fit in the bronze bushed connecting rod and are retained in the piston by round wire retainers. The pistons have a piston cooling oil channel cast inside of the piston. These cooling oil channels utilize an oil jet located at the bottom of the cylinder bore to direct oil into the piston channel. There are two compression rings and one oil control ring. There is a groove machined into the pistons between the first and second compression rings. This groove reduces compression ring leakage by providing an empty space for expanding gases, reducing the combustion gas pressure on the second compression ring.

Cylinder Heads

The cylinder heads are made of aluminum for lighter weight and rapid heat dissipation. There are 4 valves per cylinder and the ports are of a high swirl design for improved combustion. The cylinder head gaskets consist of an all steel laminated construction.

Valve Train

The engine utilizes a mechanical roller lifter for valve operation. The shaft mounted rocker arms have roller tips for reduced friction and wear. One rocker arm operates two valves simultaneously through a valve bridge.

Fuel System

The fuel system is of a direct injection fuel rail design. A high pressure pump mounted within the valley is gear driven directly from the camshaft. This pump provides a continuous and constant high pressure fuel supply to the fuel rails. The electronically controlled fuel injectors receive their fuel supply from these fuel rails. The fuel injection control utilizes a pilot injection method to reduce the combustion noise that is common in traditional diesel engines. The pilot injection

method reduces noise by supplying a small amount of fuel to the cylinder just before the normal combustion timing.

Turbocharger

The turbocharger is water cooled for improved durability.

Oil Cooler

The oil cooler lowers engine temperature by cooling the oil with engine coolant. Engine coolant is directed from the water pump to the oil cooler by a coolant tube. The oil filter attaches directly to the oil cooler.

Oil Pump

The oil pump is gear driven directly from the crankshaft. The oil pump drive gear is a slip fit to the crankshaft.

Water Pump

The water pump is gear driven for improved reliability.

Engine Covers

There is a front engine cover and a flywheel housing, both are made of aluminum. The full bell flywheel housing is cross bolted to the upper oil pan. The flywheel housing also supplies a crossover passage for engine coolant. The front engine cover houses the gear train and provides a mounting surface for the cooling fan pulley assembly.

LUBRICATION DESCRIPTION

Lubrication Flow Schematic

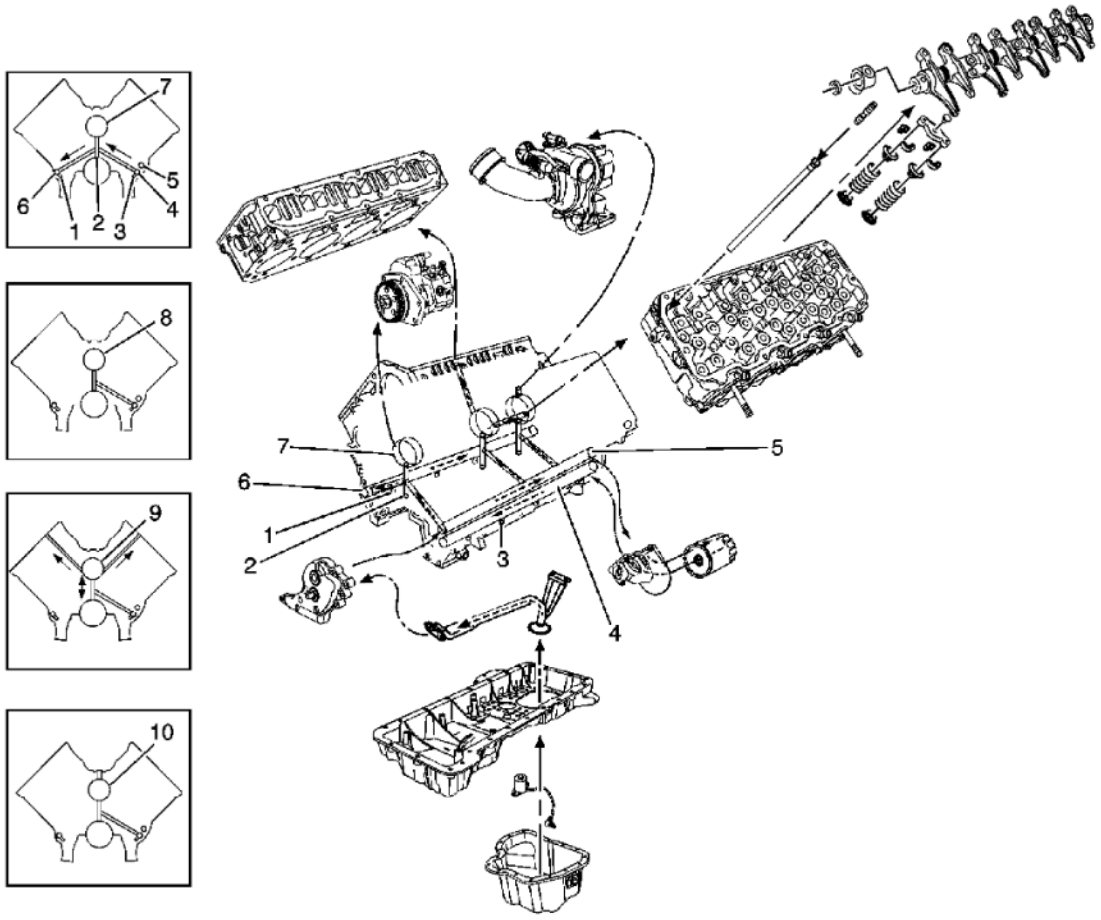


Fig. 48: Lubrication Flow Schematic
Courtesy of GENERAL MOTORS CORP.

Engine lubrication is supplied by a gear type oil pump assembly. The pump is mounted on the front of the engine block and driven by the oil pump drive gear on the crankshaft. 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 safety relief valve that eliminates overpressurization. Pressurized oil is directed through the sub oil gallery (5) to the full flow oil filter where harmful contaminants are removed. Two bypass valves are incorporated into the oil cooler assembly which will permit oil flow in the event the filter or the oil cooler become restricted.

The oil is directed to the main oil gallery (4), and from the main oil gallery it flows to the piston cooling channel left bank (3), and the sub oil gallery (6) on the right bank. The sub oil gallery on the right bank supplies oil to the right bank piston cooling channel (1). Located in the front cover at the sub oil gallery (6) is an oil pressure relief valve which regulates oil pressure within operating range.

Oil flows from the main gallery (4) to the vertical crankshaft/camshaft bearing galleries (2). From the crankshaft/camshaft bearing galleries (2), the oil flows to both the camshaft bearings and the crankshaft main bearings. Oil flows from the crankshaft main bearings to the connecting rod big end.

Oil flows from the crankshaft/camshaft bearing galleries (2) to the number 1 camshaft bearing (7), where it splash lubricates the fuel injection pump gear.

Oil flows from the crankshaft/camshaft bearing galleries (2) to the number 2 and 5 camshaft bearings (8).

Oil flows from the crankshaft/camshaft bearing galleries (2) to the number 3 camshaft bearing (9), where it exits to both cylinder heads and enters the hollow rocker arm shafts. Oil flows through the rocker arm shafts and rocker arms where it lubricates the upper valve train components.

On production LB7 engines through 2004, oil flowed through the rocker arms, through the passage in the valve adjusting screw, and into the hollow pushrods where it was directed to the valve lifters. Beginning with the 2004.5 engine (LLY), lifters with hardened rollers were used and did not require hollow pushrods for additional oil flow. However, hollow pushrods were used in production until approximately the start of the 2006 model year, after which the hole in the push rod ends was removed. The hollow pushrods can be used for any model year, whereas the pushrods without the holes in the ends can only be used for 2004.5 model year and newer production engines.

Oil flows from the crankshaft/camshaft bearing galleries (2) to the number 4 camshaft (10), where it exits into the turbocharger oil supply line to lubricate the turbocharger. Oil exiting the turbocharger is routed through the turbocharger oil return pipe and into the flywheel housing.

CLEANLINESS AND CARE

An automobile engine is a combination of many of the following surfaces:

- Machined
- Honed
- Polished
- Lapped

The tolerances of these surfaces are measured in the ten-thousandths of an inch. When you service any internal engine part, cleanliness and care are important. Apply a liberal coating of engine oil

to the friction areas during assembly in order to protect and lubricate the surfaces on initial operation. Throughout this section, practice proper cleaning and protection procedures to the machined surfaces and to the friction areas.

NOTE: Engine damage may result if an abrasive paper, pad, or motorized wire brush is used to clean any engine gasket surfaces.

Whenever you remove the valve train components, keep the components in order. Follow this procedure in order to install the components in the same locations and with the same mating surfaces as when removed.

CAUTION: Refer to BATTERY DISCONNECT CAUTION .

Disconnect the negative battery cables before you perform any major work on the engine. For more information on the disconnection of the battery, refer to **Battery Negative Cable Disconnection and Connection (w/Single Battery)** or **Battery Negative Cable Disconnection and Connection (w/Auxiliary Battery)** or **Battery Negative Cable Disconnection and Connection (w/Dual Batteries)** .

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

REPLACING ENGINE GASKETS

Gasket Reuse and Applying Sealant

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

Separating Components

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

USE OF ROOM TEMPERATURE VULCANIZING (RTV) AND ANAEROBIC SEALANT

Sealant Types

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

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

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

- Pipe
- Threadlock

Aerobic Type Room Temperature Vulcanizing (RTV) Sealant

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

Use the following information when using RTV sealant:

- Do not use RTV sealant in areas where extreme temperatures are expected. These areas include:
  - The exhaust manifold
  - The head gasket
  - Any other surfaces where a different type of sealant is specified in the service procedure
- Always follow all the safety recommendations and the directions that are on the RTV sealant container.
- Use a plastic or wood scraper in order to remove all the RTV sealant from the components.

IMPORTANT: Do not allow the RTV sealant to enter any blind threaded holes, as it may prevent the fasteners from clamping properly or cause damage when the fastener is tightened.

- The surfaces to be sealed must be clean and dry.
- Use a RTV sealant bead size as specified in the service procedure.
- Apply the RTV sealant bead to the inside of any bolt holes areas.
- Assemble the components while the RTV sealant is still wet to the touch (within 3 minutes). Do not wait for the RTV sealant to skin over.
- Tighten the fasteners in sequence (if specified) and to the proper torque specifications. DO NOT overtighten the fasteners.

Anaerobic Type Gasket Eliminator Sealant

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

anaerobic type gasket eliminator sealant.

Use the following information when using gasket eliminator sealant:

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

  The surfaces to be sealed must be clean and dry.

  IMPORTANT: Do not allow the gasket eliminator sealant to enter any blind threaded holes, as the gasket eliminator sealant may prevent the fasteners from clamping properly, seating properly, or cause damage when the fastener tightened.

- Apply the gasket eliminator sealant evenly to get a uniform thickness of the gasket eliminator sealant on the sealing surface.

  IMPORTANT: Gasket eliminator sealed joint fasteners that are partially torqued and the gasket eliminator sealant allowed to cure more than five minutes, may result in incorrect shimming and sealing of the joint.

- Tighten the fasteners in sequence (if specified) and to the proper torque specifications. DO NOT overtighten the fasteners.
- After properly tightening the fasteners, remove the excess gasket eliminator sealant from the outside of the joint.

Anaerobic Type Threadlock Sealant

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

Use the following information when using threadlock sealant:

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

IMPORTANT: Fasteners that are partially torqued and then the threadlock sealant allowed to cure more than five minutes, may result in incorrect clamp load of assembled components.

- Tighten the fasteners in sequence (if specified) and to the proper torque specifications. DO NOT overtighten the fasteners.

Anaerobic Type Pipe Sealant

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

Use the following information when using pipe sealant:

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

IMPORTANT: Do not allow the pipe sealant to enter any of the blind threaded holes, as the pipe sealant may prevent the fastener from clamping properly, or cause component damage when the fastener is tightened.

- Apply the pipe sealant bead to the inside of any bolt hole areas.
- Apply a continuous bead of pipe sealant to 1 sealing surface.
- Tighten the fasteners in sequence (if specified) and to the proper torque specifications. DO NOT overtighten the fasteners.

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

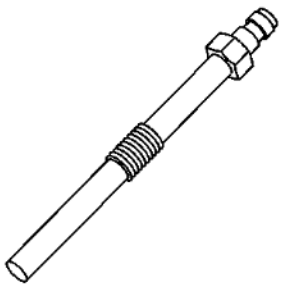
will also minimize possible damage to engine components. Some precision measuring tools are required for inspection of certain critical components. Torque wrenches and a torque angle meter are necessary for the proper tightening of various fasteners.

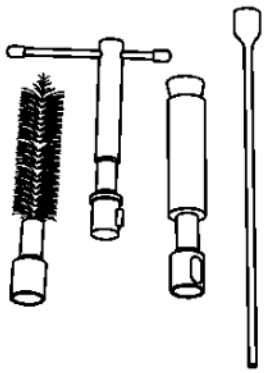
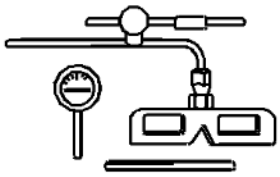
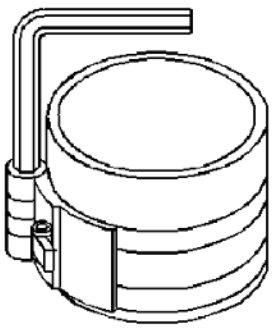
- To properly service the engine assembly, the following items should be readily available:
  - Approved eye protection and safety gloves
  - A clean, well-lit, work area
  - A suitable parts cleaning tank
  - A compressed air supply
  - Trays or storage containers to keep parts and fasteners organized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

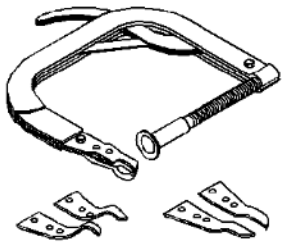
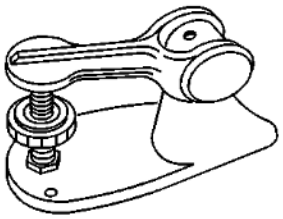
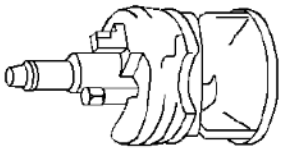
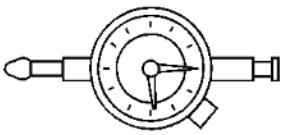
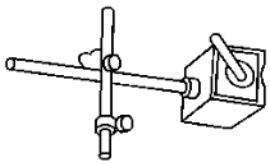
SPECIAL TOOLS AND EQUIPMENT

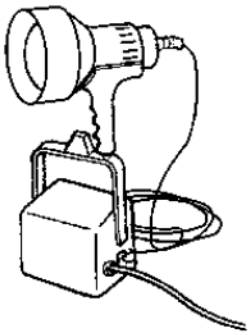
SPECIAL TOOLS

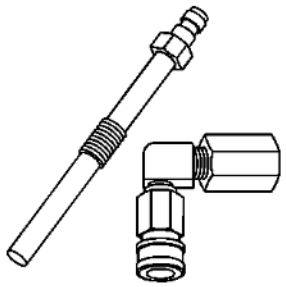
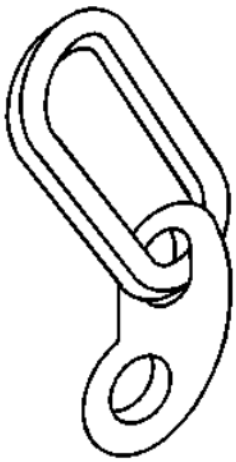
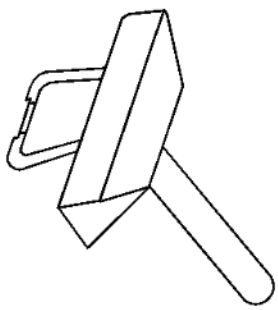
Special Tools

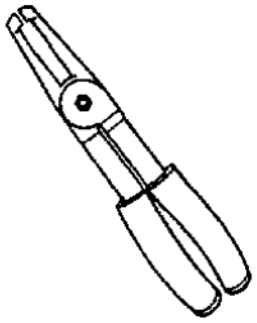
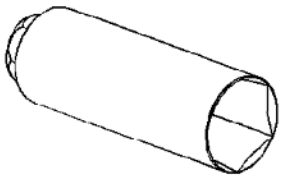
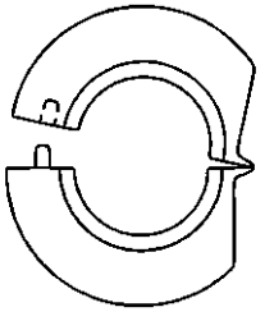
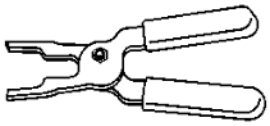
Illustration	Tool Number/Description
	EN 47603 Compression Gage Adapter
	EN 47909 Injector Bore and Sleeve Cleaning Kit

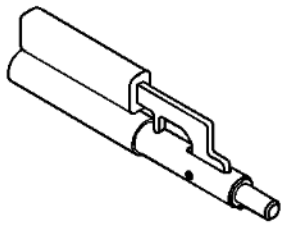
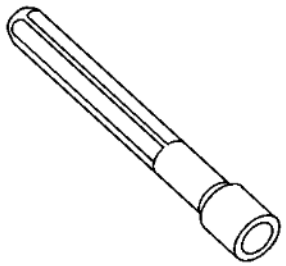
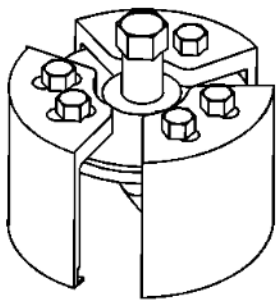
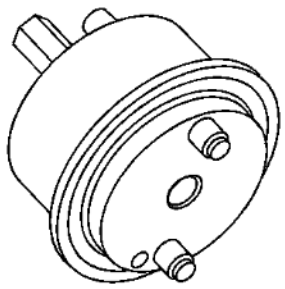
	
	J 7872 Dial Indicator Set
	J 8037 Piston Ring Compressor
	J 8062 Valve Spring Compressor

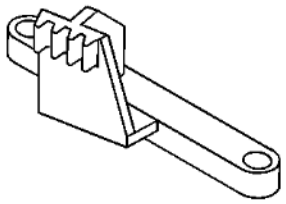
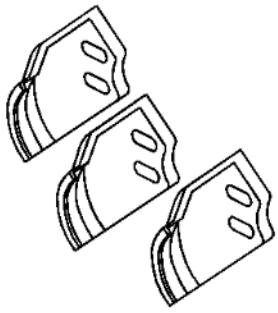
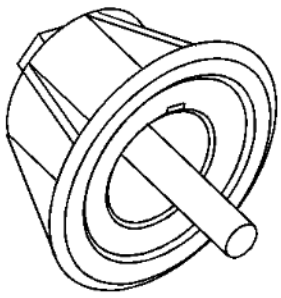
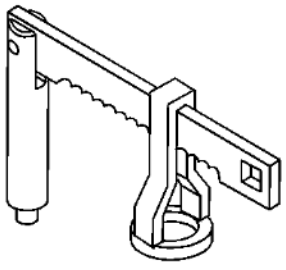
	
	J 9666 Valve Spring Tester
	J 24270 Cylinder Bore Ridge Reamer
	J 26900-12 Dial Indicator
	J 26900-13 Magnetic Indicator Base

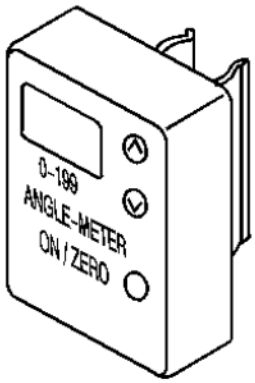
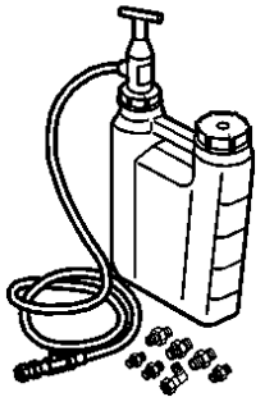
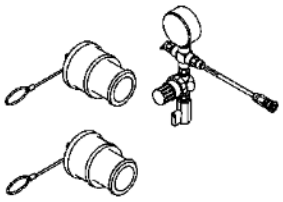
	J 26999 Compression Gage
	J 28428-E High Intensity Black Light
	J 35667-A Cylinder Leakdown Tester
	J 35667-8 Cylinder Head Leakdown Adapter

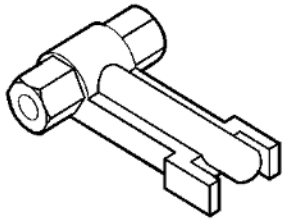
	
	J 36857 Engine Lift Bracket
	J 37228 Seal Cutter

	J 38820 Valve Stem Oil Seal Remover
	J 41712 Oil Pressure Switch Socket
	J 43181 Quick Connect Connector Remover
	J 43244 Relay Puller Pliers

	J 43654 Piston Pin Retainer Clip Remover/ Installer
	J 44640 Valve Stem Seal Installer
	J 44641 Crankshaft Rear Oil Seal Remover
	J 44642 Crankshaft Rear Oil Seal Installer

	J 44643 Flywheel Holding Tool
	J 44644 Crankshaft Front Oil Seal Remover
	J 44645 Crankshaft Front Oil Seal Installer
	J 44646 Valve Spring Compressor

	J 45059 Angle Meter
	J 45299 Engine Preluber
	J 46091 Charge Air Cooler Tester
	J 46594

	Fuel Injector Puller

2008 ENGINE

Engine Mechanical - 6.6L - Cab & Chassis Sierra, Cab & Chassis Silverado, Sierra & Silverado

ON-VEHICLE REPAIR INSTRUCTIONS

DRIVE BELT REPLACEMENT

Removal Procedure

1. Remove the upper fan shroud. Refer to **Engine Coolant Fan Upper Shroud Replacement (Mechanical)** or **Engine Coolant Fan Upper Shroud Replacement (Automatic Transmission - Diesel)** .

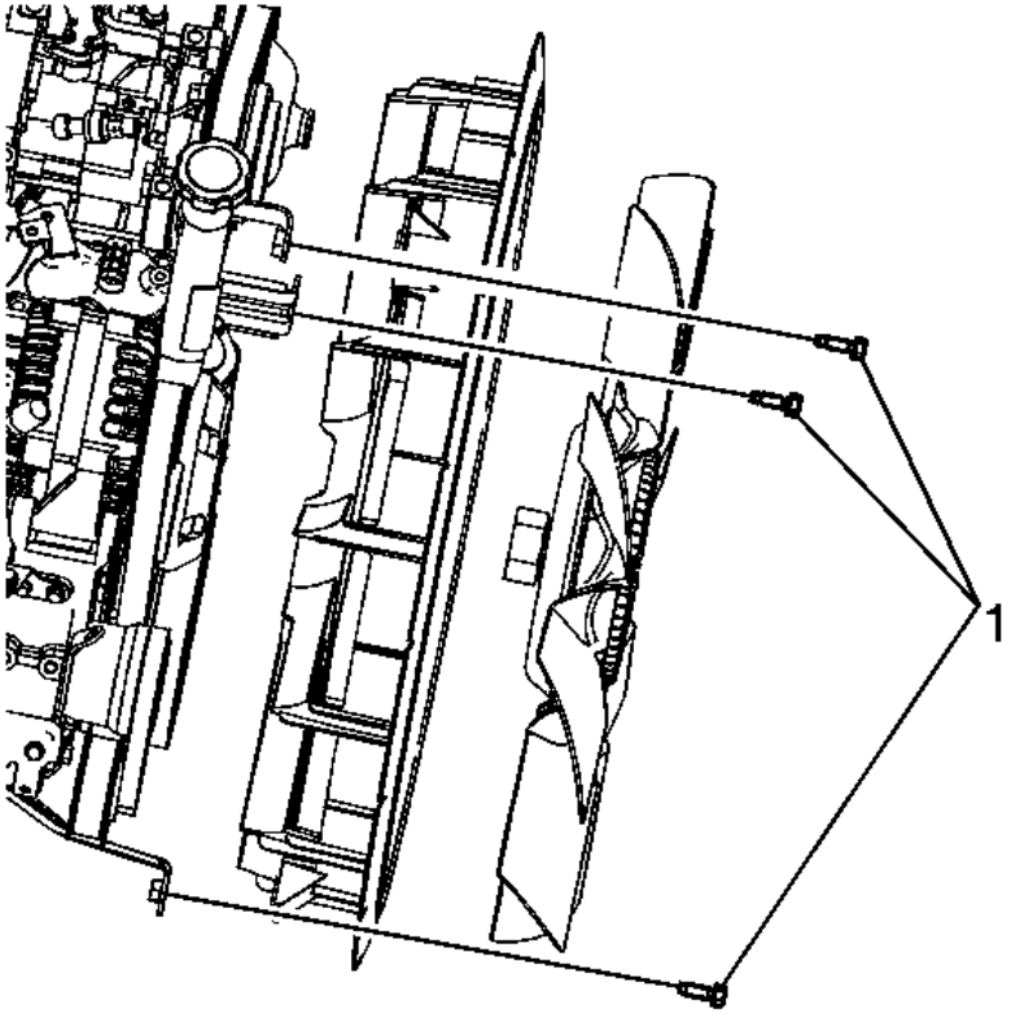


Fig. 1: Identifying Fan Shroud Mounting Brackets & Bolts
Courtesy of GENERAL MOTORS CORP.

2. Remove the 3 engine cooling fan shroud bolts (1).

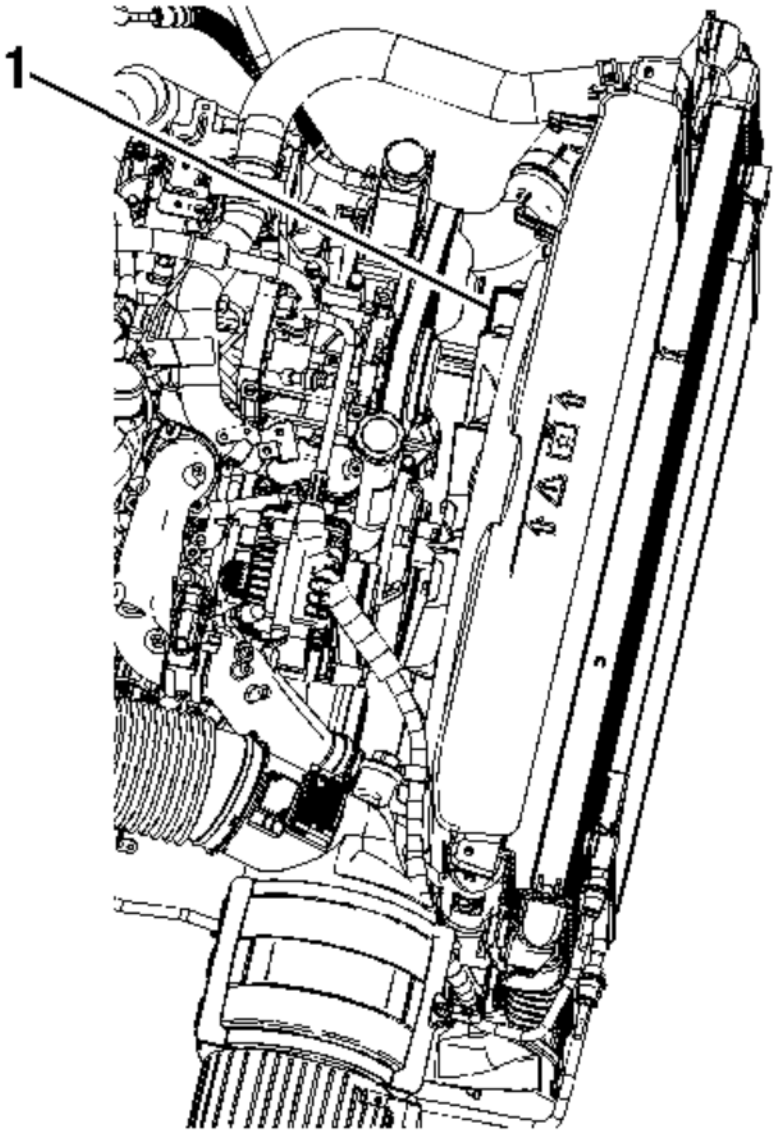


Fig. 2: View Of Cooling Fan Shroud
Courtesy of GENERAL MOTORS CORP.

3. Position the engine cooling fan shroud (1) forward to the radiator.
4. Install a 3/8-inch breaker bar into the tensioner opening and rotate the tensioner counterclockwise.

5. Remove the belt from the tensioner.
6. Slowly release the tension on the tensioner arm.

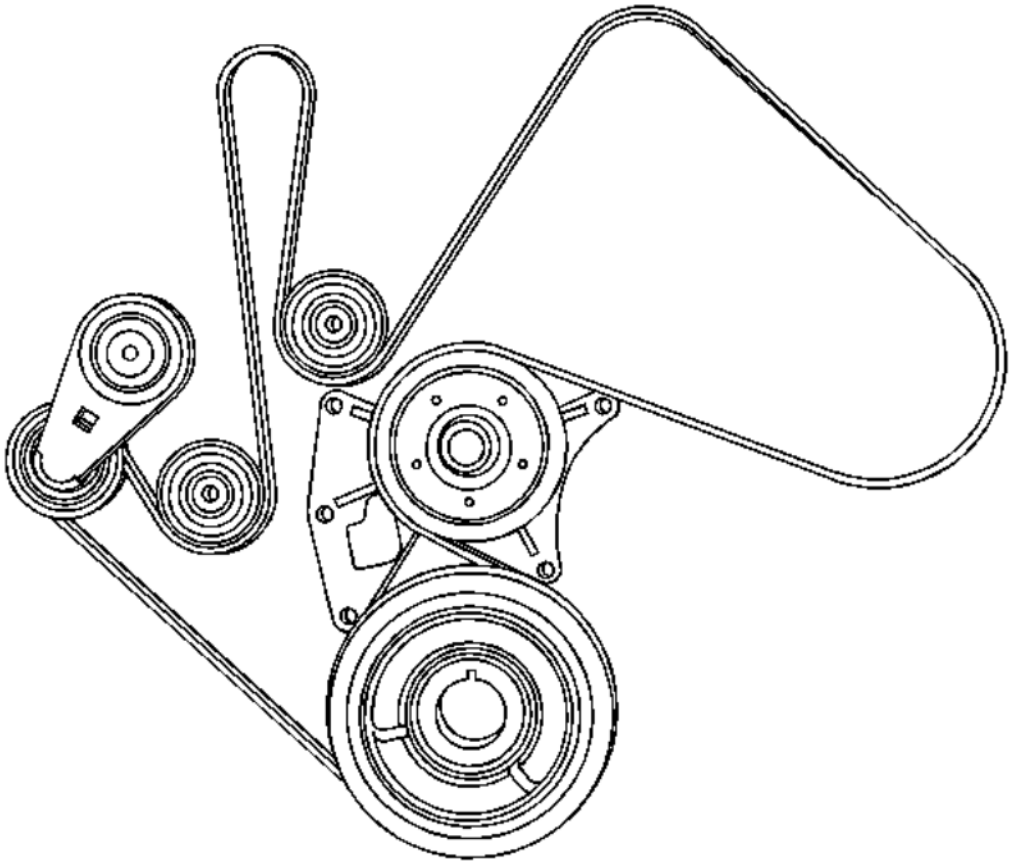


Fig. 3: View Of Drive Belt (Single Generator)
Courtesy of GENERAL MOTORS CORP.

7. Remove the drive belt from the drive pulleys, if equipped with a single generator.

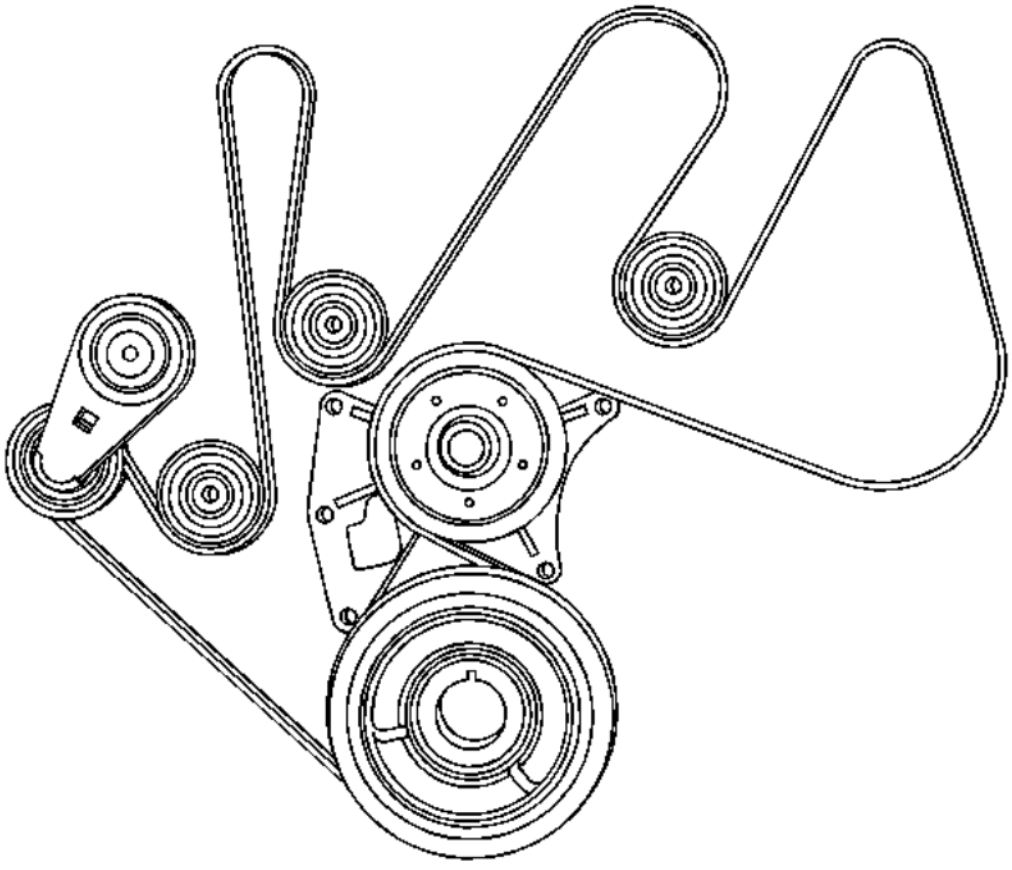


Fig. 4: View Of Drive Belt (Dual Generator)
Courtesy of GENERAL MOTORS CORP.

8. Remove the drive belt from the drive pulleys, if equipped with dual generators.
9. Inspect the drive belt for excessive cracking or any visible damage and replace if necessary.

Installation Procedure

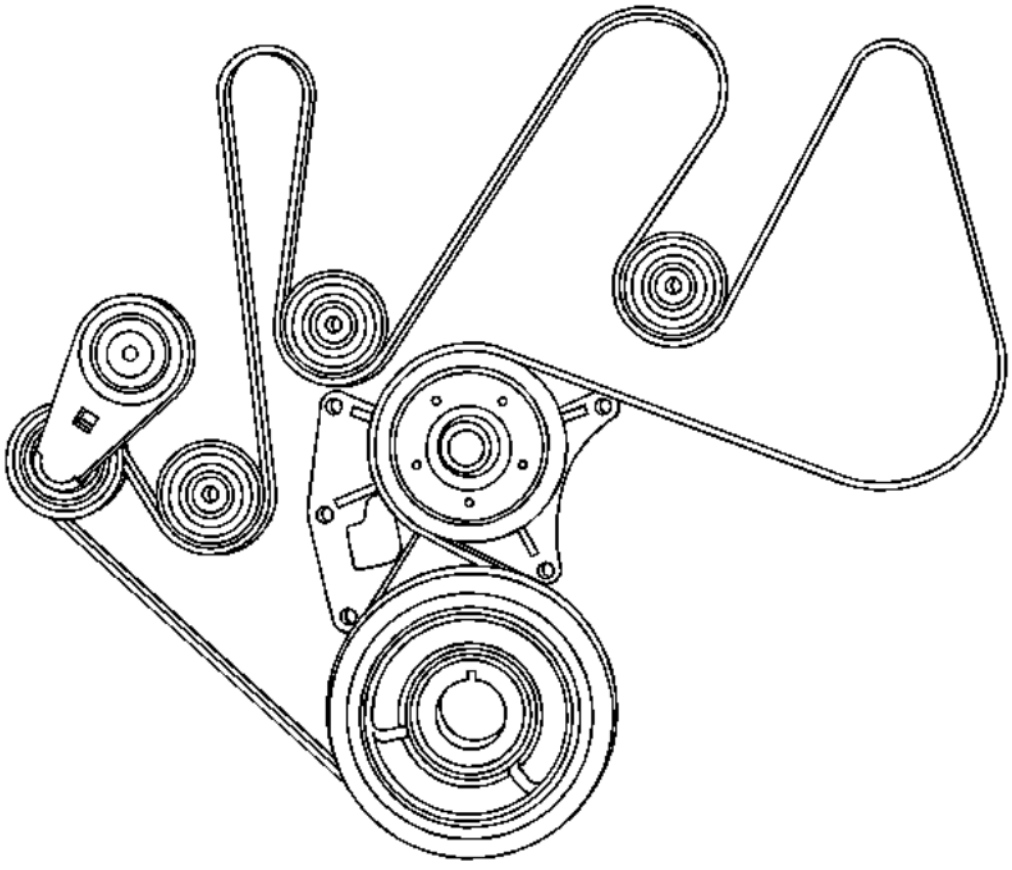


Fig. 5: View Of Drive Belt (Dual Generator)
Courtesy of GENERAL MOTORS CORP.

1. Install the drive belt, if equipped with dual generators.
2. Route the drive belt over and/or around all the drive pulleys except for the tensioner.

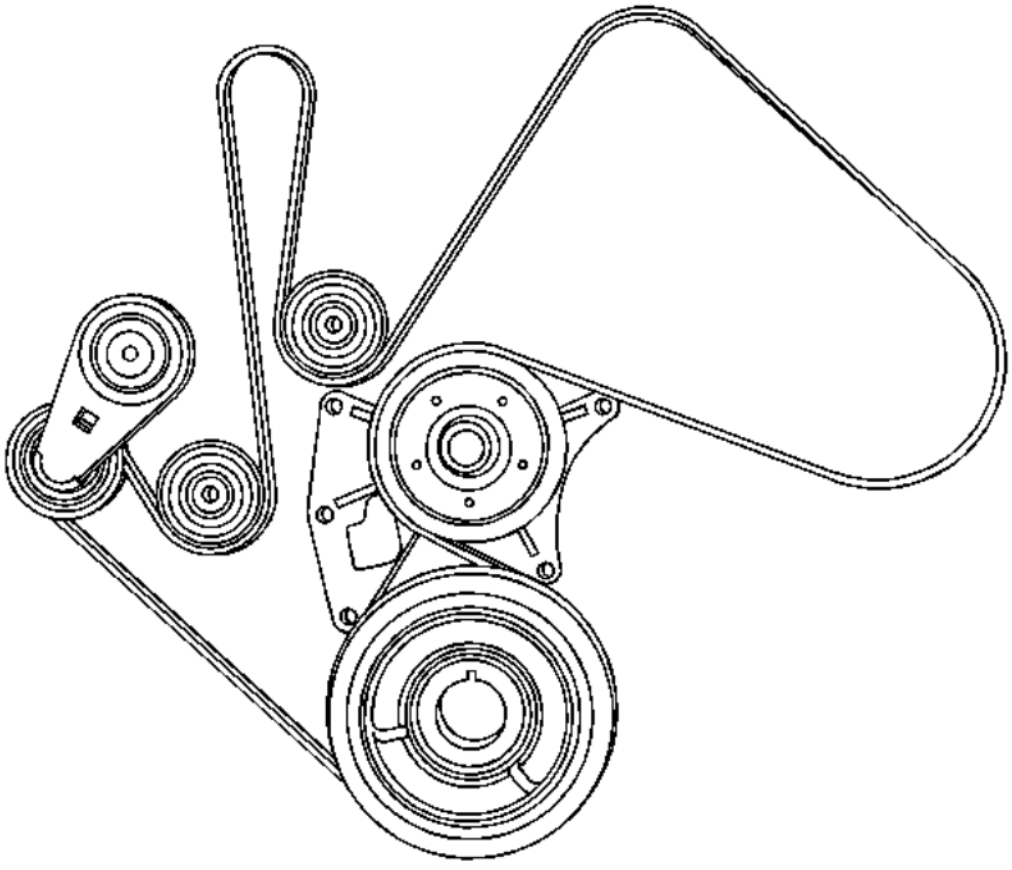


Fig. 6: View Of Drive Belt (Single Generator)
Courtesy of GENERAL MOTORS CORP.

3. Install the drive belt, if equipped with a single generator.
4. Route the drive belt over and/or around all the drive pulleys except for the tensioner.
5. Install a 3/8 inch breaker bar into the tensioner opening and rotate the tensioner counterclockwise.
6. Install the belt over and/or around the tensioner.
7. Slowly release the tension on the tensioner arm.
8. Inspect the drive belt for proper installation on and/or around all pulleys.

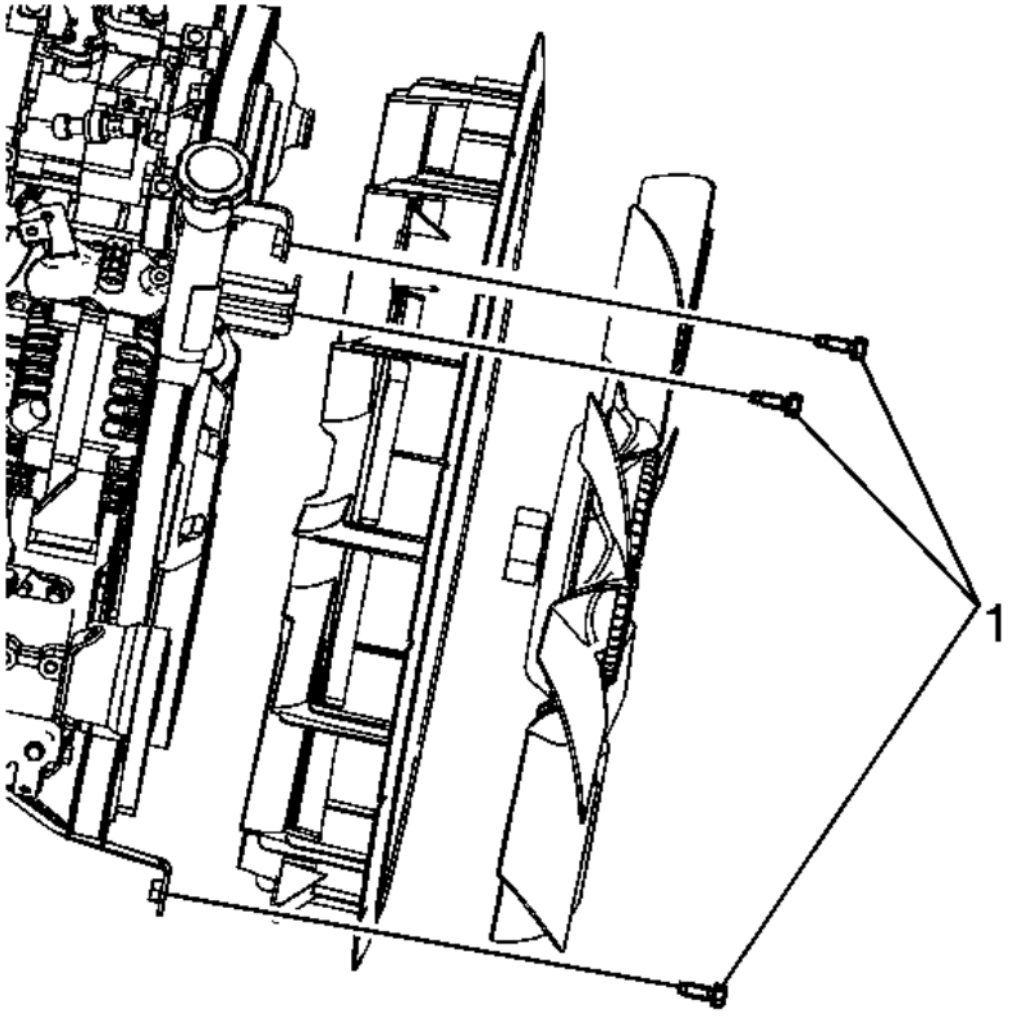


Fig. 7: Identifying Fan Shroud Mounting Brackets & Bolts
Courtesy of GENERAL MOTORS CORP.

9. Position the engine cooling fan shroud on the 3 mounting brackets (1).

NOTE: Refer to Fastener Notice .

10. Install the bolts. Loosely tighten the top mounting bolt at the oil filler neck.

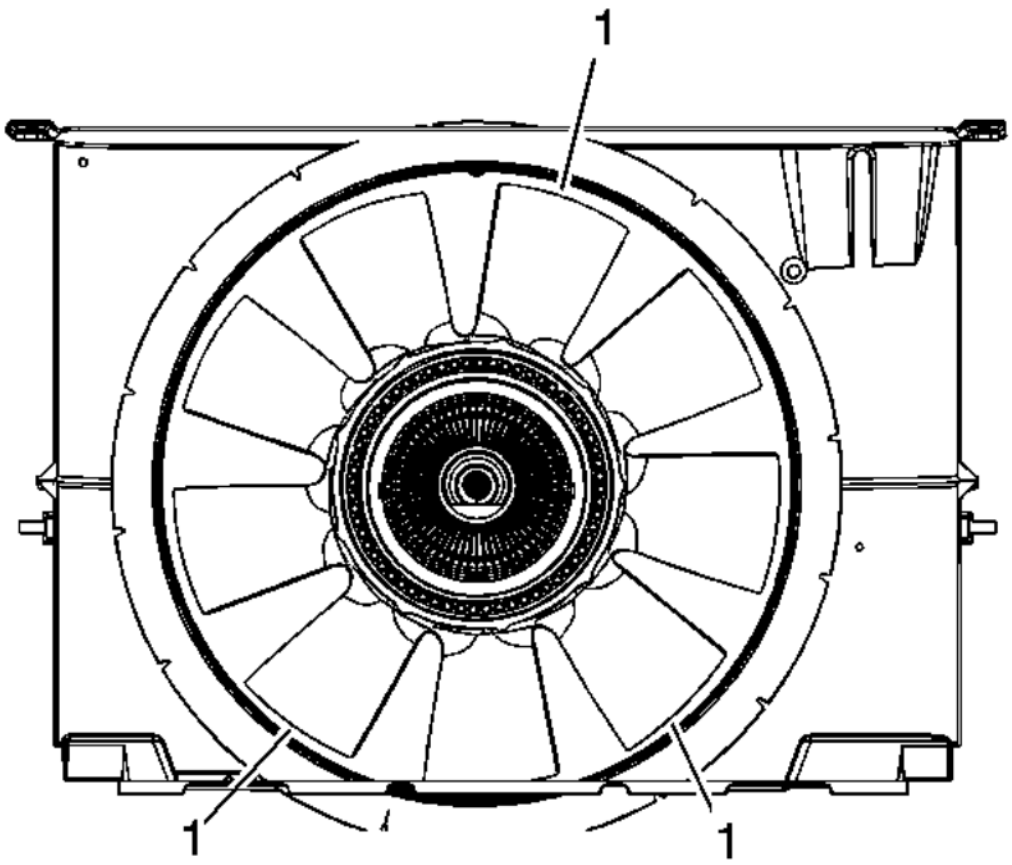


Fig. 8: View Of Cooling Fan Shroud
Courtesy of GENERAL MOTORS CORP.

11. Center the engine cooling fan shroud to the fan blade in 3 places (1).

IMPORTANT: Maintain a 6 mm (0.25 in) minimum clearance at all 3 places.

12. Fully tighten the 3 engine cooling fan shroud bolts (1).

Tighten: Tighten the bolts to 8 N.m (71 lb in).

13. Install the upper fan shroud. Refer to **Engine Coolant Fan Upper Shroud Replacement (Mechanical)** or **Engine Coolant Fan Upper Shroud Replacement (Automatic Transmission - Diesel)** .

DRIVE BELT TENSIONER REPLACEMENT

Removal Procedure

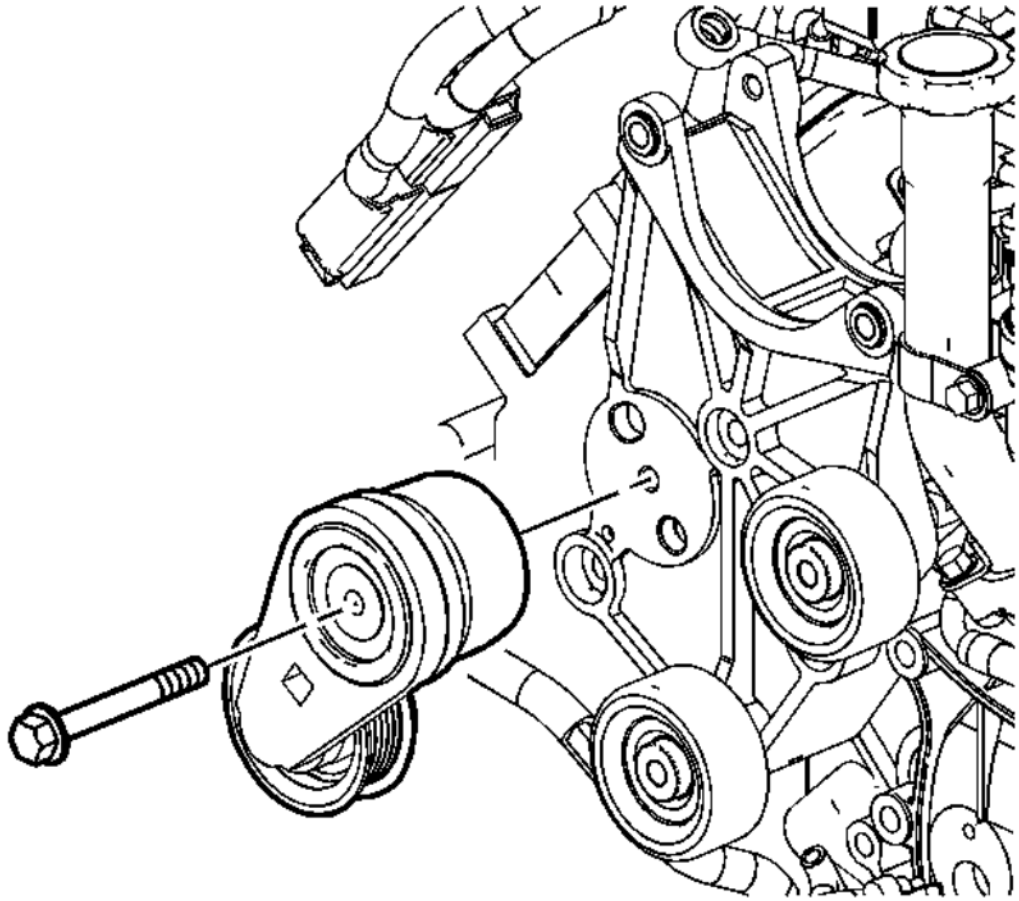


Fig. 9: View Of Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

1. Remove the drive belt. Refer to **Drive Belt Replacement**.
2. Remove the drive belt tensioner bolt.
3. Remove the drive belt tensioner.

Installation Procedure

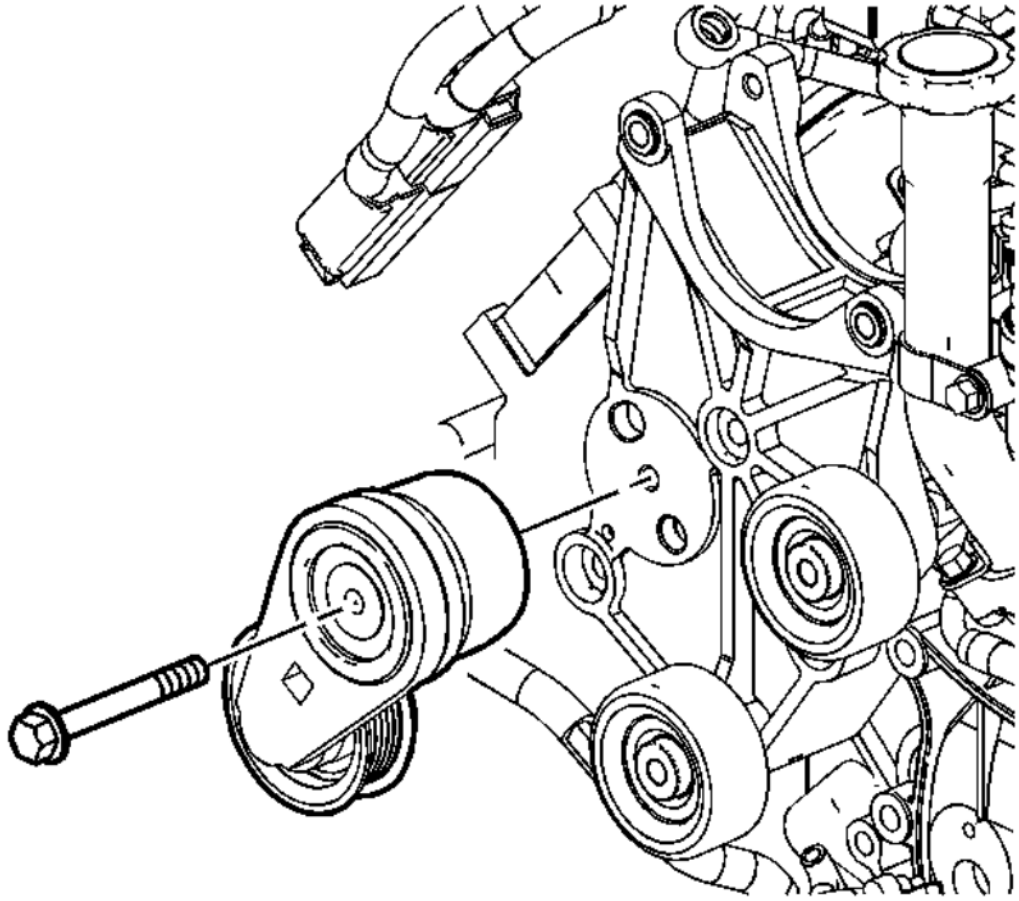


Fig. 10: View Of Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

1. Install the drive belt tensioner. Align the pin with the hole in the generator bracket.
2. Install the drive belt tensioner bolt.

   Tighten: Tighten bolt to 50 N.m (37 lb ft).

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

DRIVE BELT IDLER PULLEY REPLACEMENT

Removal Procedure

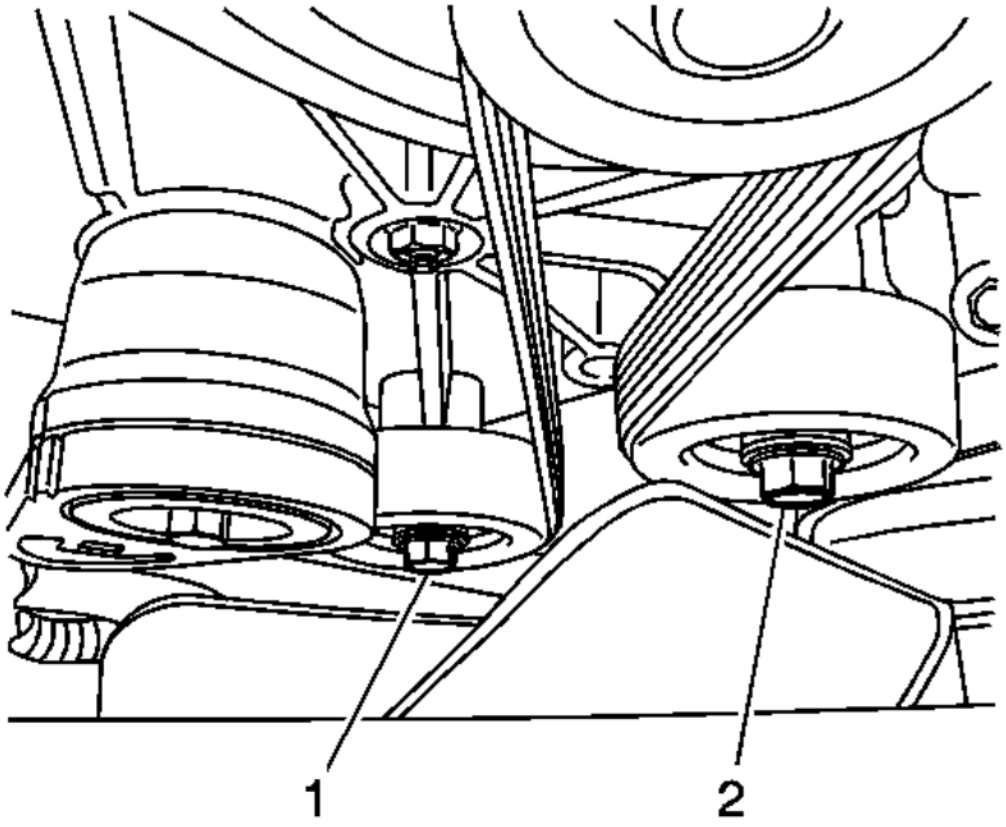


Fig. 11: View Of Right Side Idler & Center Idler Pulley Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the drive belt. Refer to **Drive Belt Replacement**.
2. Remove the bolt (1) from the right side idler pulley.
3. Remove the idler pulley.
4. Remove the bolt (2) for the center idler pulley.
5. Remove the idler pulley.
6. If equipped with dual generators, remove the bolt from the left side idler pulley.
7. If equipped with dual generators, remove the idler pulley.

Installation Procedure

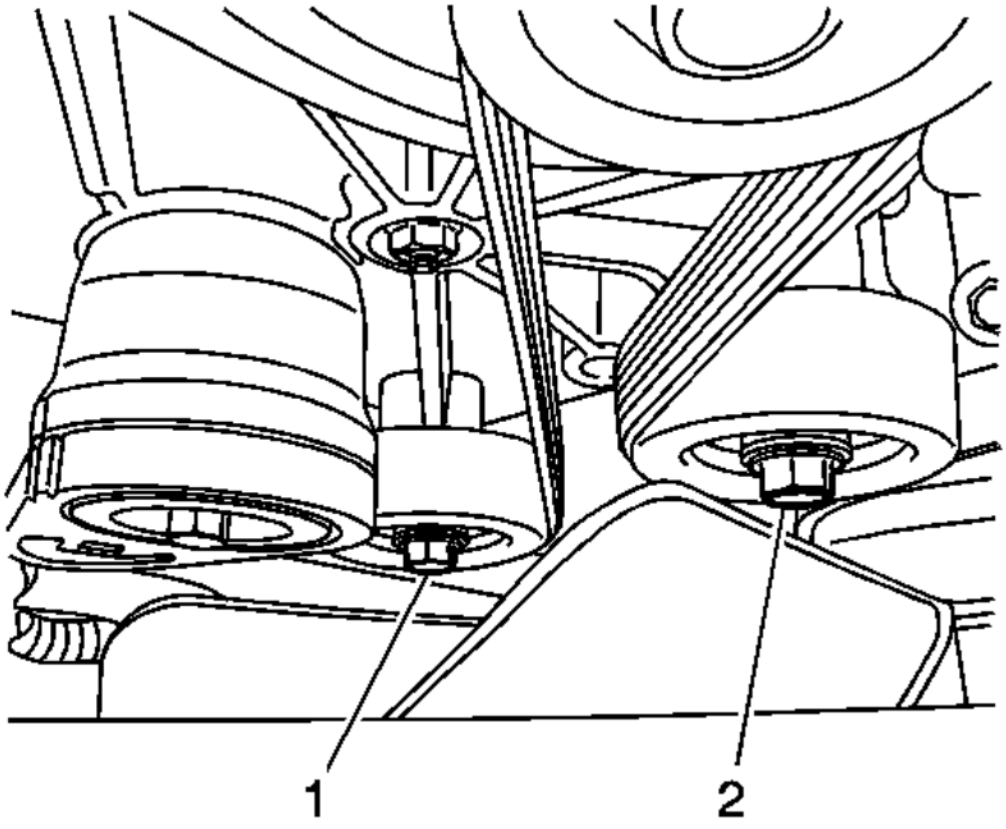


Fig. 12: View Of Right Side Idler & Center Idler Pulley Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

1. Install the right side idler pulley and bolt (1).

   Tighten: Tighten the bolt to 50 N.m (37 lb ft).

2. Install the center idler pulley and bolt (2).

   Tighten: Tighten the bolt to 50 N.m (37 lb ft).

3. If equipped with dual generators, install the left side idler pulley and bolt.

Tighten: Tighten the bolt to 50 N.m (37 lb ft).

4. Install the drive belt. Refer to **Drive Belt Replacement**.

INTAKE MANIFOLD COVER REPLACEMENT

Removal Procedure

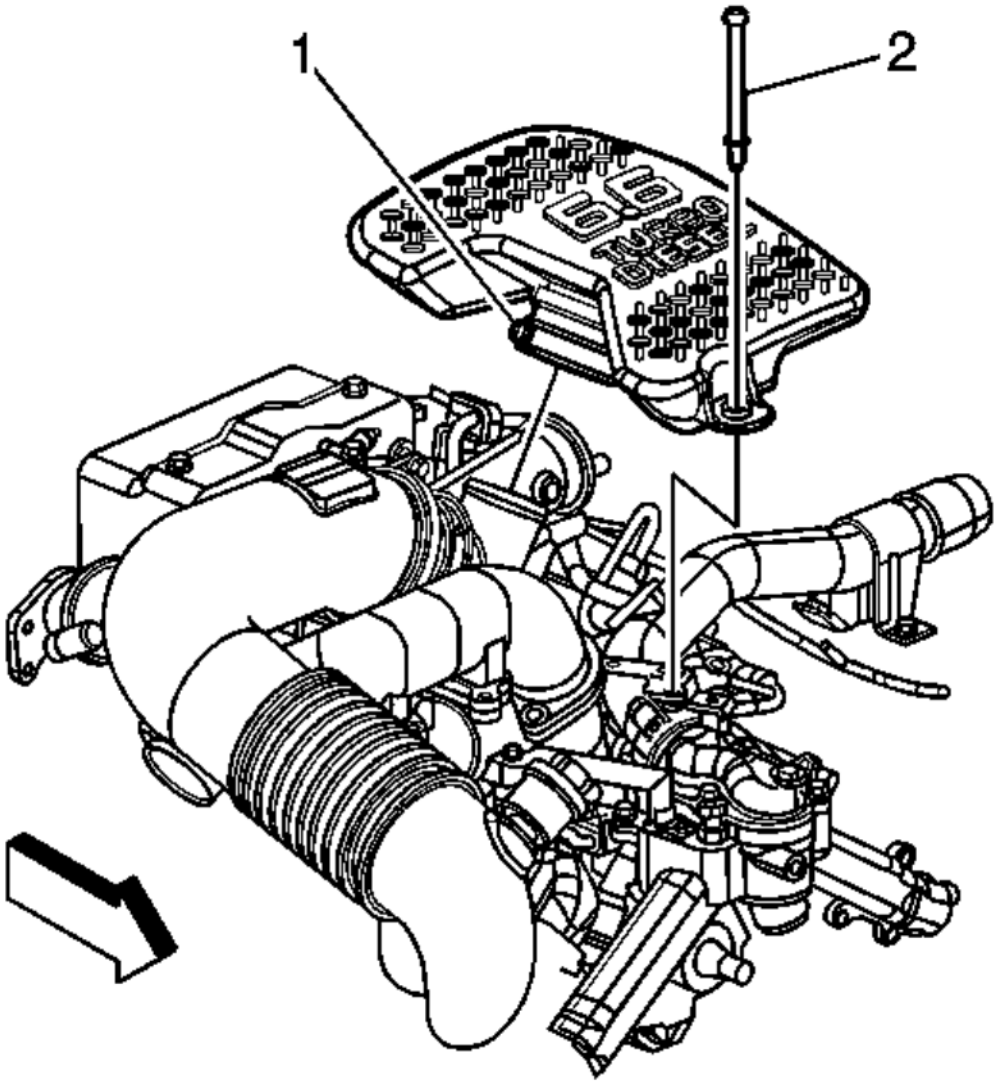


Fig. 13: View Of Intake Manifold Cover
Courtesy of GENERAL MOTORS CORP.

1. Loosen the intake manifold cover clamp (1) at the resonator.
2. Loosen the intake manifold cover bolt (2).
3. Remove the intake manifold cover.

Installation Procedure

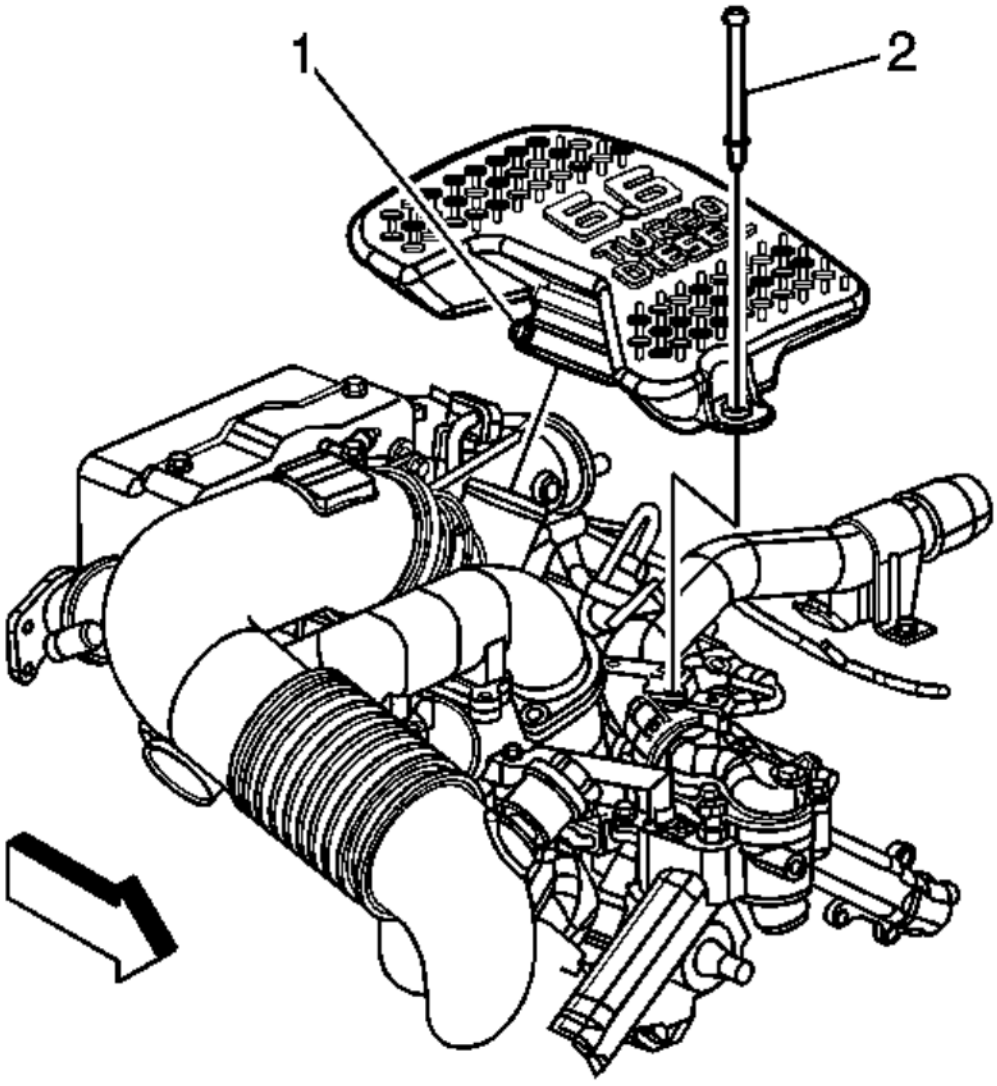


Fig. 14: View Of Intake Manifold Cover
Courtesy of GENERAL MOTORS CORP.

1. Install the intake manifold cover.
2. Tighten the intake manifold cover bolt (2) until snug.

NOTE: **Refer to Fastener Notice .**

3. Tighten the intake manifold cover clamp (1) at the resonator.

   Tighten: Tighten the clamp to 6 N.m (53 lb in).

ENGINE MOUNT INSPECTION

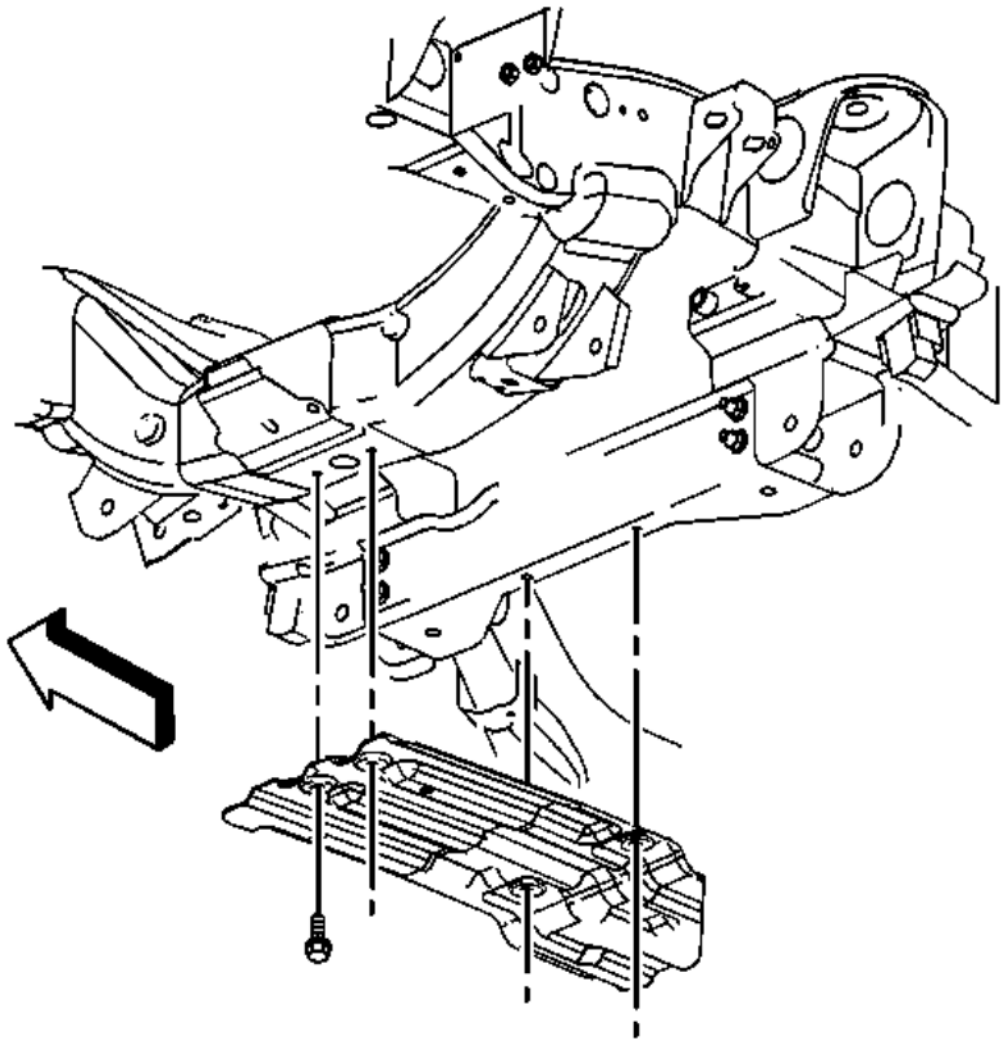


Fig. 15: Identifying Oil Pan Skid Plate
Courtesy of GENERAL MOTORS CORP.

1. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the oil pan skid plate.

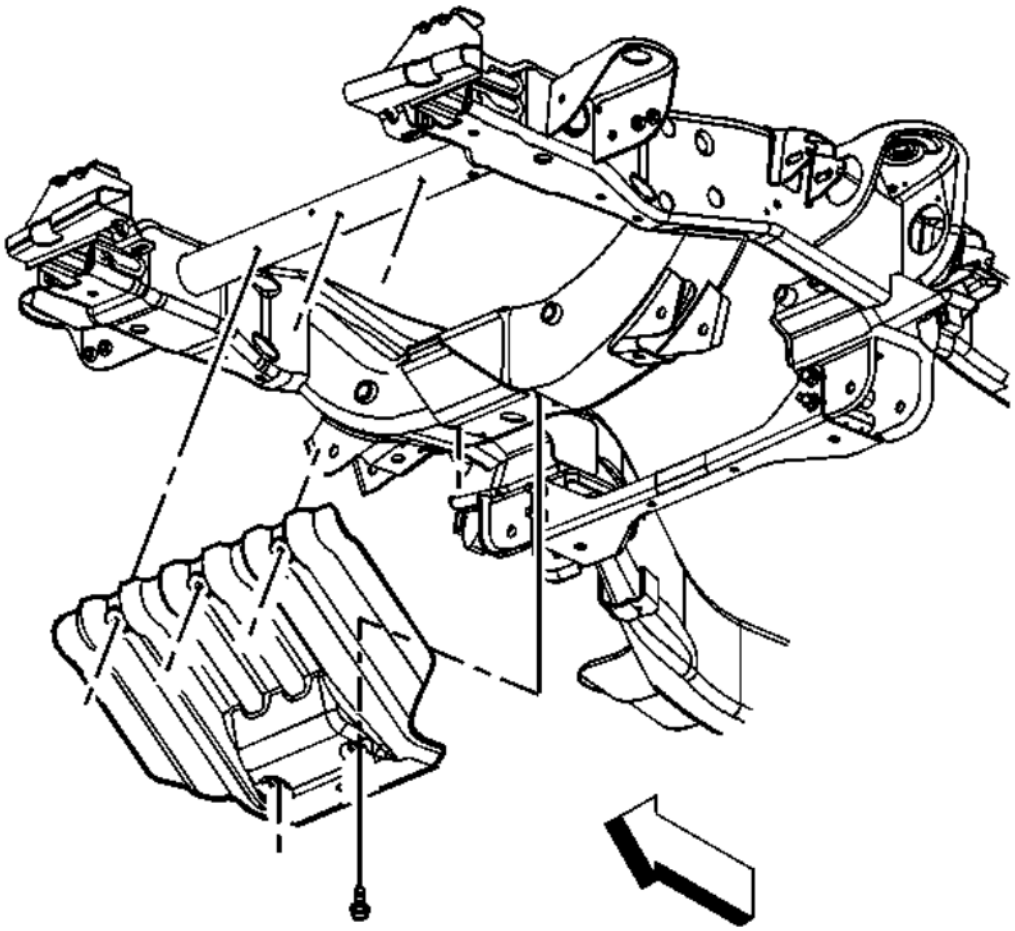


Fig. 16: Identifying Engine Shield And Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

3. Remove the engine protection shield.

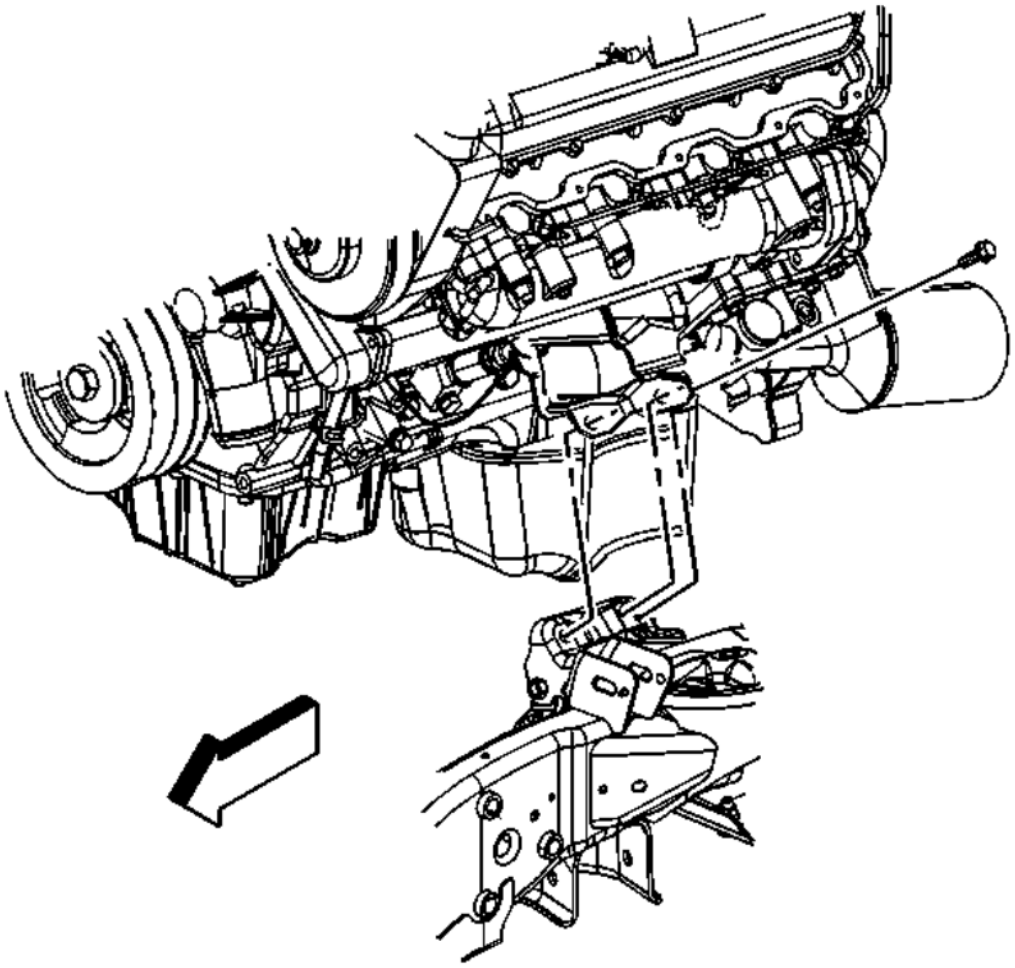


Fig. 17: View Of Engine Mount To Engine Mount Frame Bracket
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Engine Mounting Notice .

4. Inspect for loose or missing bolts at the following locations:
   - Engine mount bracket to engine
   - Engine mount frame bracket to frame
   - Engine mount to engine mount bracket
   - Engine mount to engine mount frame bracket

5. Replace missing or loose bolts. Refer to **Engine Mechanical Specifications** .

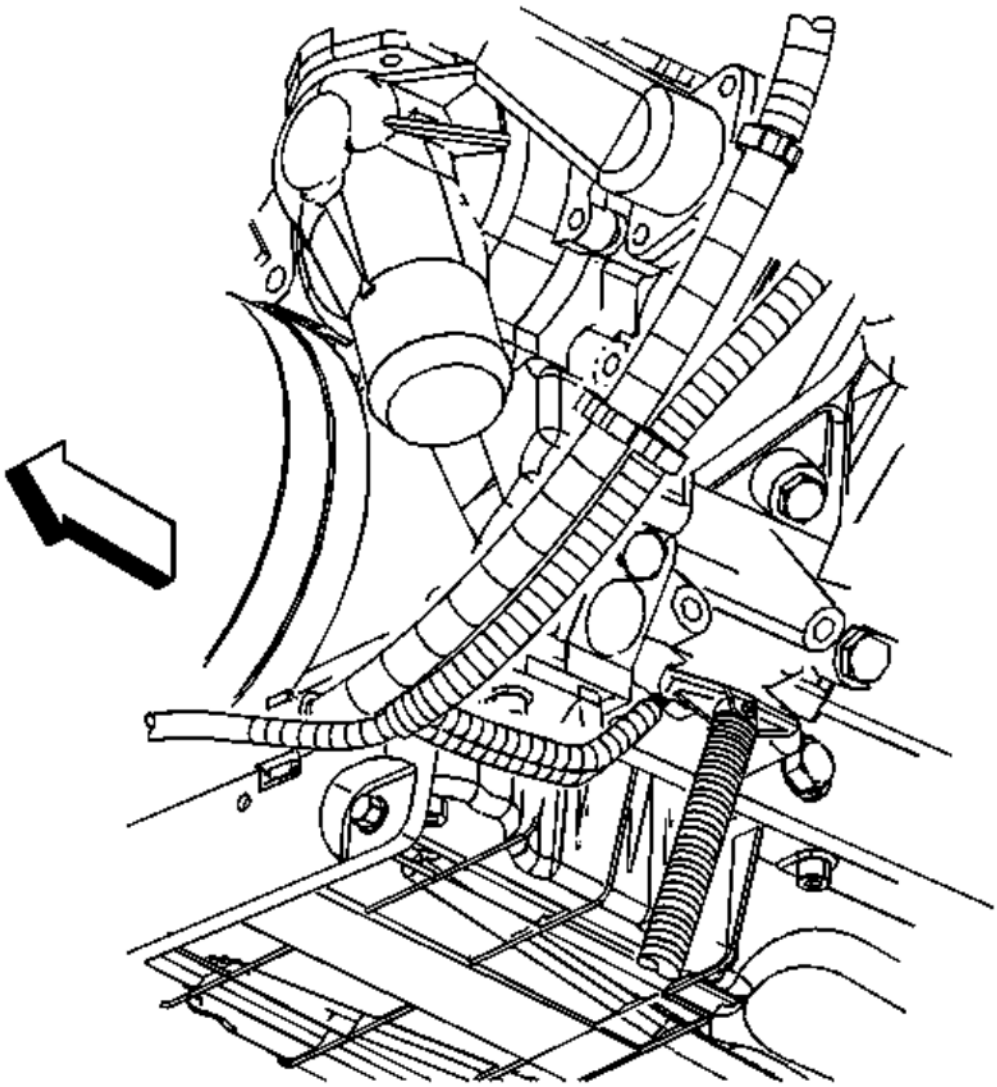


Fig. 18: View Of Ground Wire Bolt Bosses (Left Side)
Courtesy of GENERAL MOTORS CORP.

NOTE: **Refer to Engine Lifting Notice .**

6. If the vehicle is 4-wheel drive (4WD), you will not be able to access the lifting points on the engine. In order to raise the engine, attach a chain to the front of the engine. Then follow the inspection steps.
7. If the vehicle is rear-wheel drive (RWD), in order to raise the engine to inspect the left engine mount, use a suitable jack on the ground wire bolt bosses on the left side of the engine

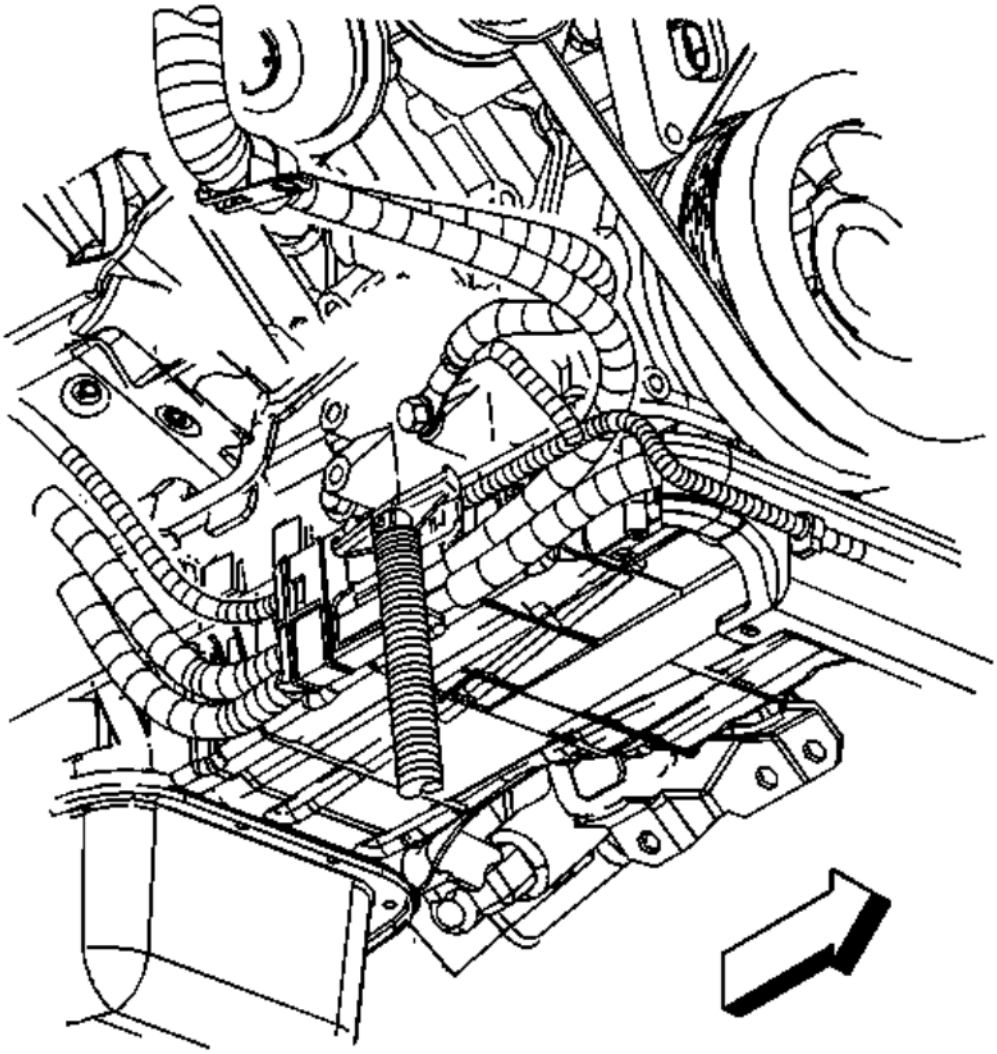


Fig. 19: View Of Ground Wire Bolt Bosses (Right Side)

Courtesy of GENERAL MOTORS CORP.

8. If equipped with an automatic transmission, remove the bolt retaining the transmission oil cooler line bracket.
9. Move the transmission oil cooler lines aside.
10. In order to raise the engine to inspect the right engine mount, use a suitable jack on the ground wire bolt bosses on the right side of the engine
11. Perform the following in order to inspect the engine mounts:
    1. Raise the engine to remove weight from the engine mount.
    2. Place a slight tension on the rubber cushion.
    3. Observe the engine mount for the following while raising the engine:
        - Heat check cracks covering the hard rubber surface
        - The rubber cushion is separated from the metal plate of the engine mount.
        - There is a split through the rubber cushion.
12. Replace the engine mount if any of the above conditions exist.

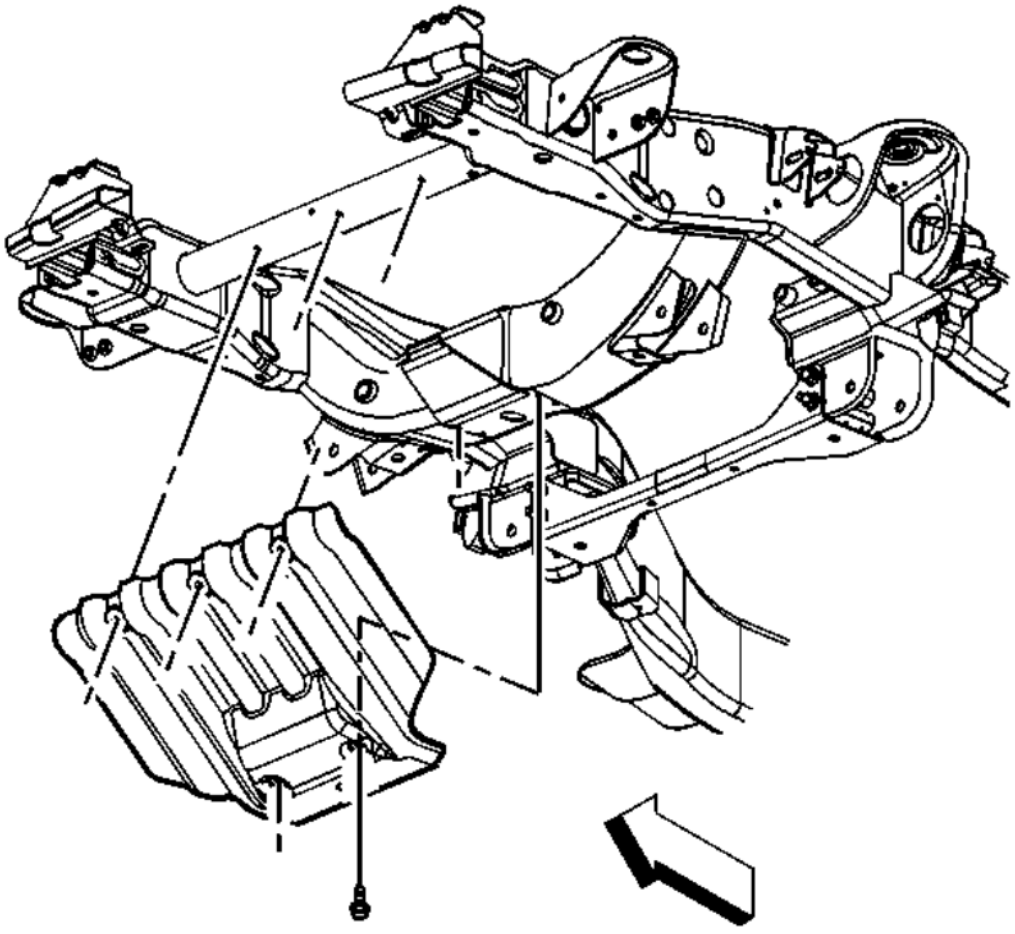


Fig. 20: Identifying Engine Shield And Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

13. Install the engine protection shield and bolts.

    Tighten: Tighten the engine protection shield bolts to 20 N.m (15 lb ft).

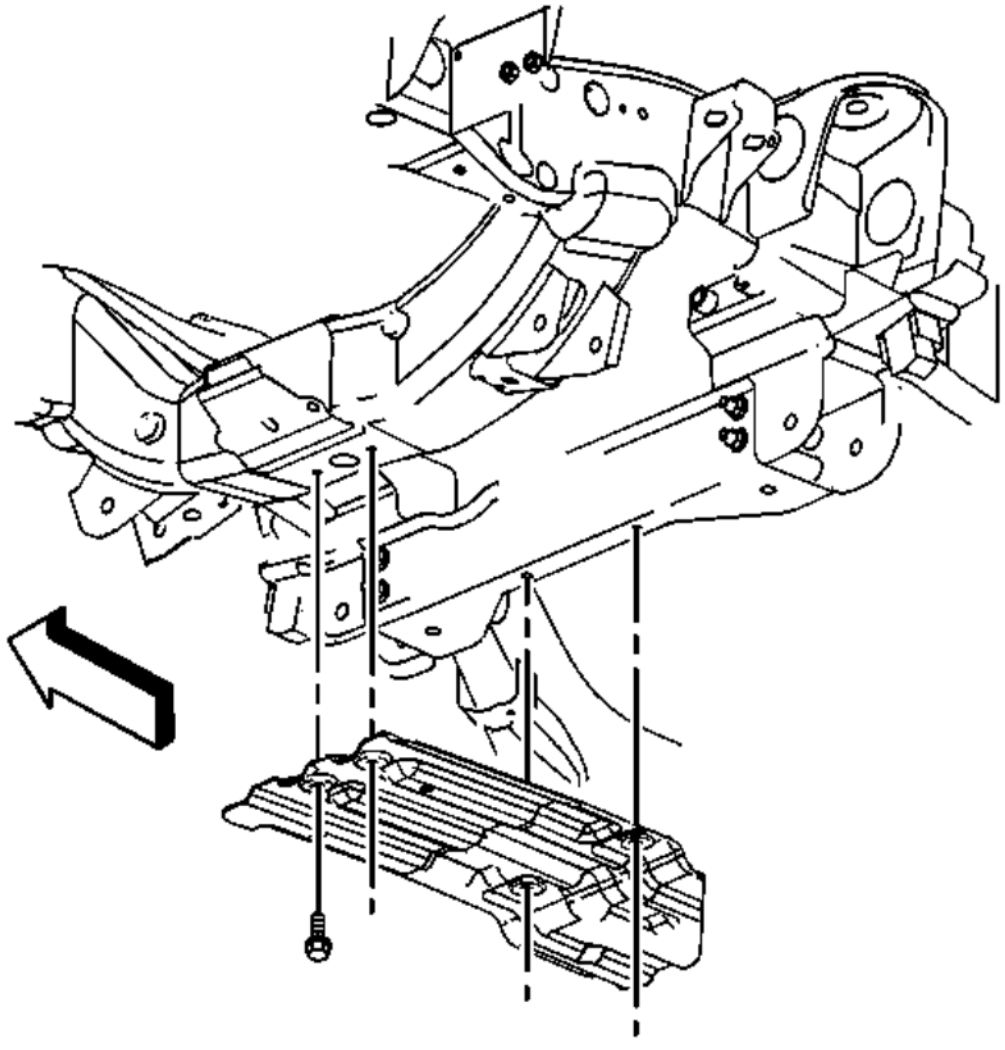


Fig. 21: Identifying Oil Pan Skid Plate
Courtesy of GENERAL MOTORS CORP.

14. Install the oil pan skid plate and bolts.

    Tighten: Tighten the oil pan skid plate bolts to 20 N.m (15 lb ft).

15. Lower the vehicle.

ENGINE MOUNT REPLACEMENT - LEFT SIDE

Removal Procedure

1. If RWD vehicle, raise the vehicle to a height to work through the front wheelhouse opening. Refer to **Lifting and Jacking the Vehicle** .
2. If 4-wheel drive (4WD) vehicle, raise the vehicle in order to remove the front tires and wheels and support with jackstands.
3. Remove the wheelhouse inner panel. Refer to **Front Wheelhouse Liner Replacement - Left Side (Chevrolet)** or **Front Wheelhouse Liner Replacement - Left Side (GMC)** .

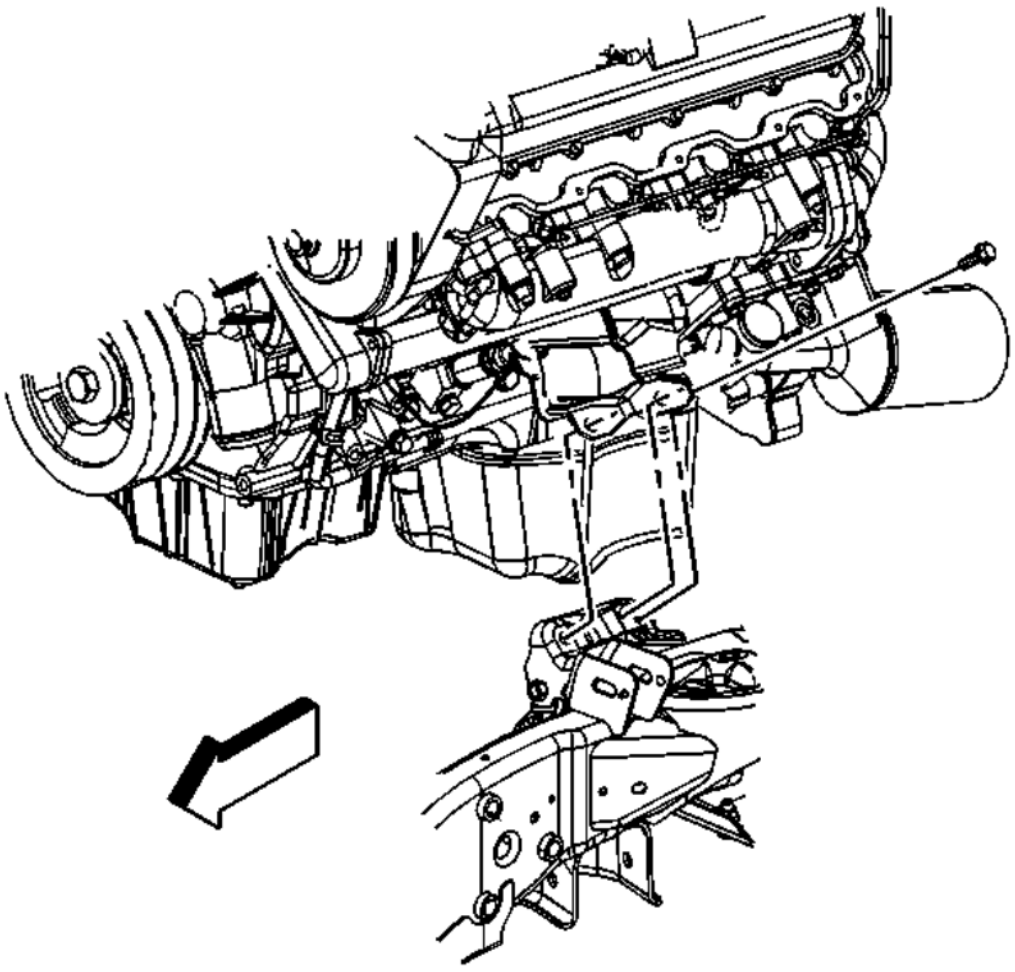


Fig. 22: View Of Engine Mount To Engine Mount Frame Bracket
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to ENGINE MOUNTING NOTICE .

4. Working through the wheelhouse opening remove the 3 bolts retaining the engine mount to the engine mount frame bracket.

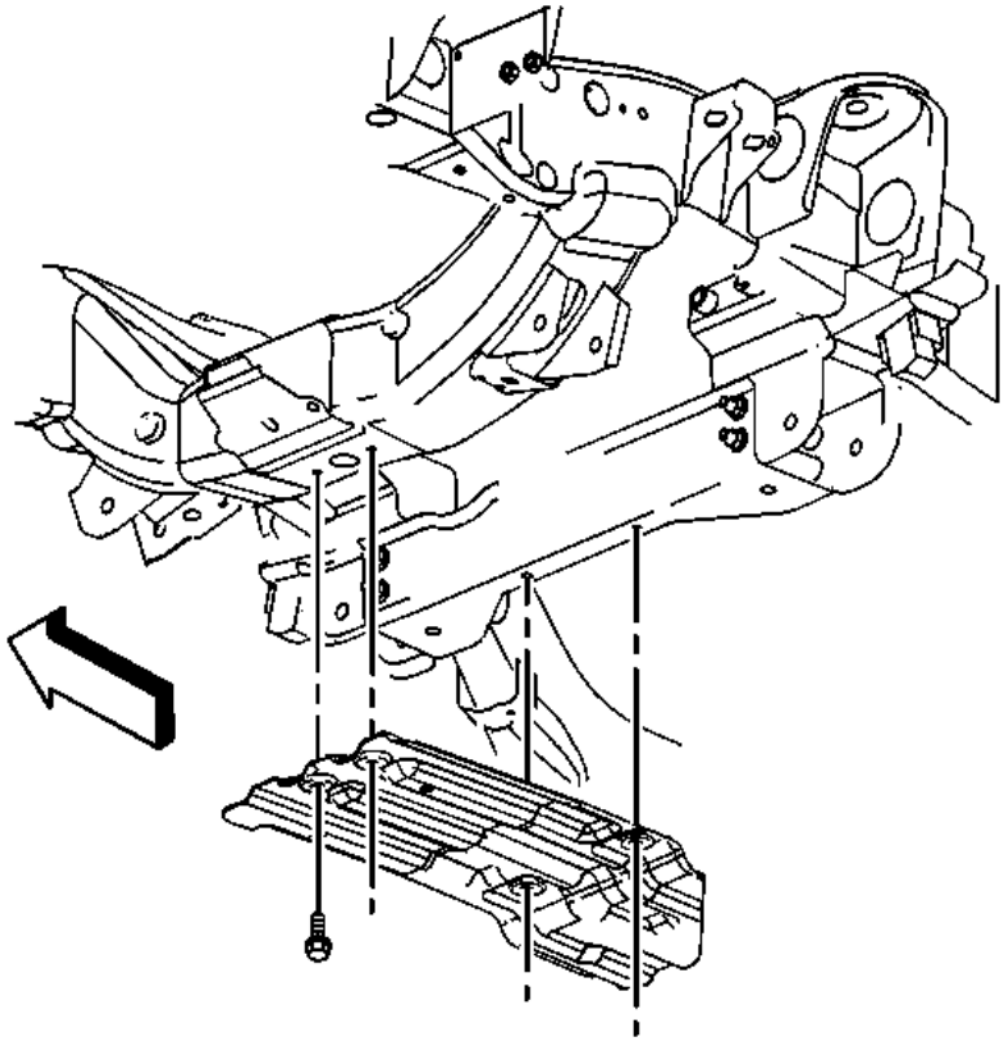


Fig. 23: Identifying Oil Pan Skid Plate

Courtesy of GENERAL MOTORS CORP.

5. Remove the oil pan skid plate, if equipped.

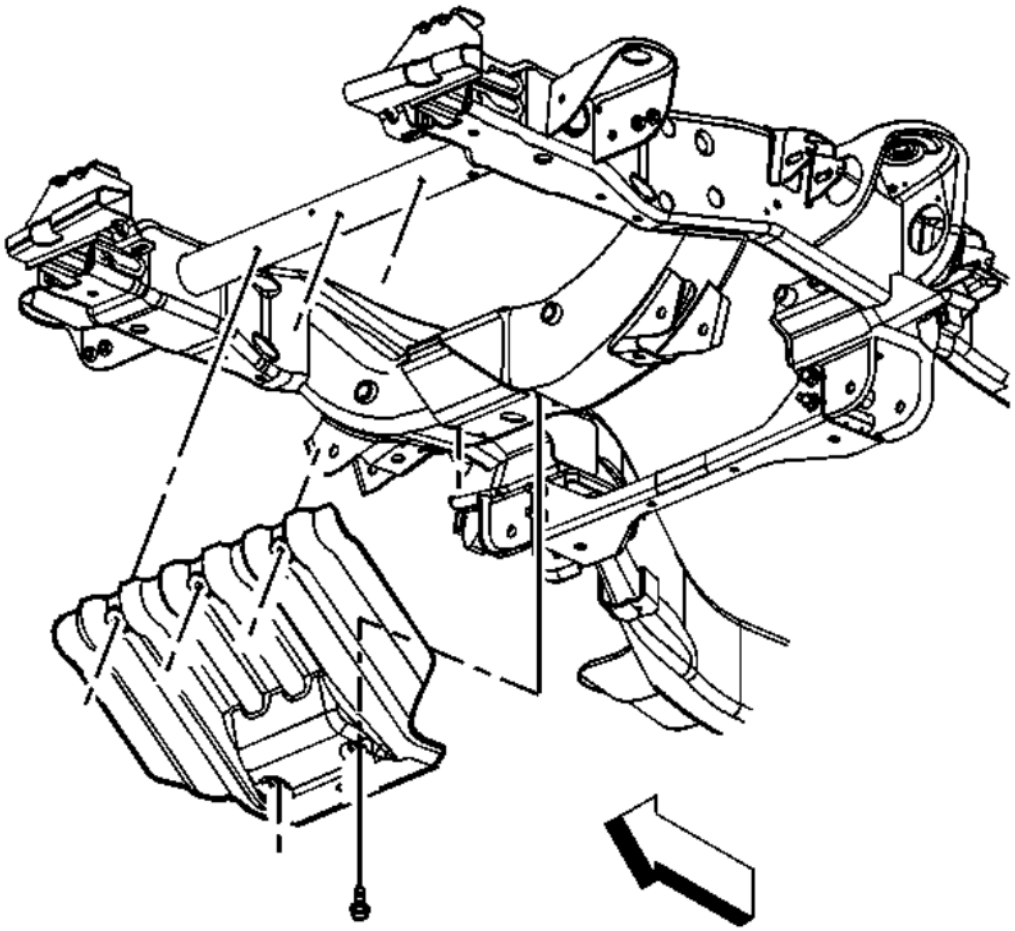


Fig. 24: Identifying Engine Shield And Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

6. Remove the engine protection shield from the vehicle, if equipped.

NOTE: Refer to ENGINE LIFTING NOTICE .

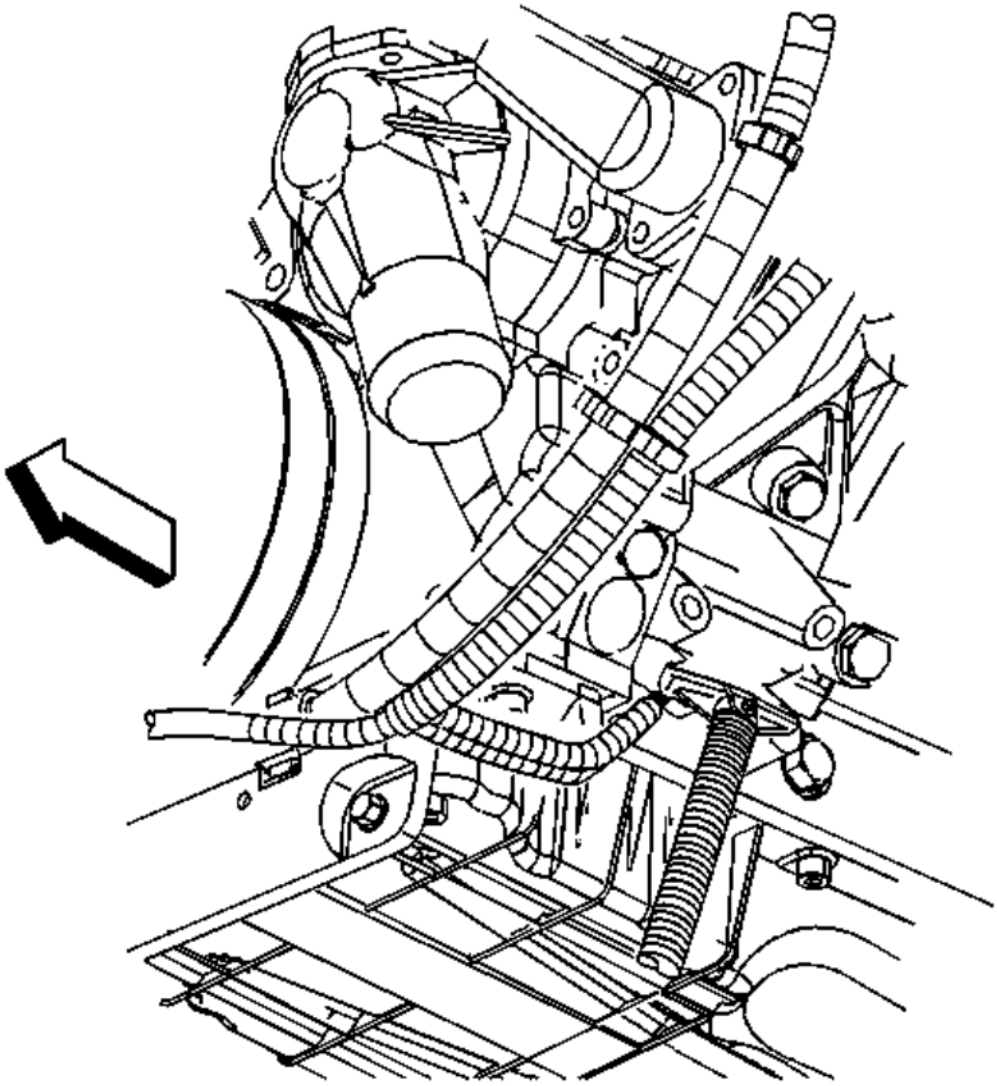


Fig. 25: View Of Ground Wire Bolt Bosses (Left Side)
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: When raising the engine only raise enough to separate the engine mount from the engine mount bracket. Raising any further will require removal of the fan shroud or the exhaust pipe.

7. If RWD vehicle, using a suitable jack on the ground wire bolt bosses, raise the engine.

   Only raise the engine enough to separate the engine mount to engine mount bracket.

8. If 4WD vehicle, attach a chain to the front of the engine. Use accessible mounting bolts for the generator mounting bracket and the power steering pump mounting bracket.
9. Raise the engine with a suitable lifting device to remove the engine mount.

   Only raise the engine enough to separate the engine mount to engine mount bracket.

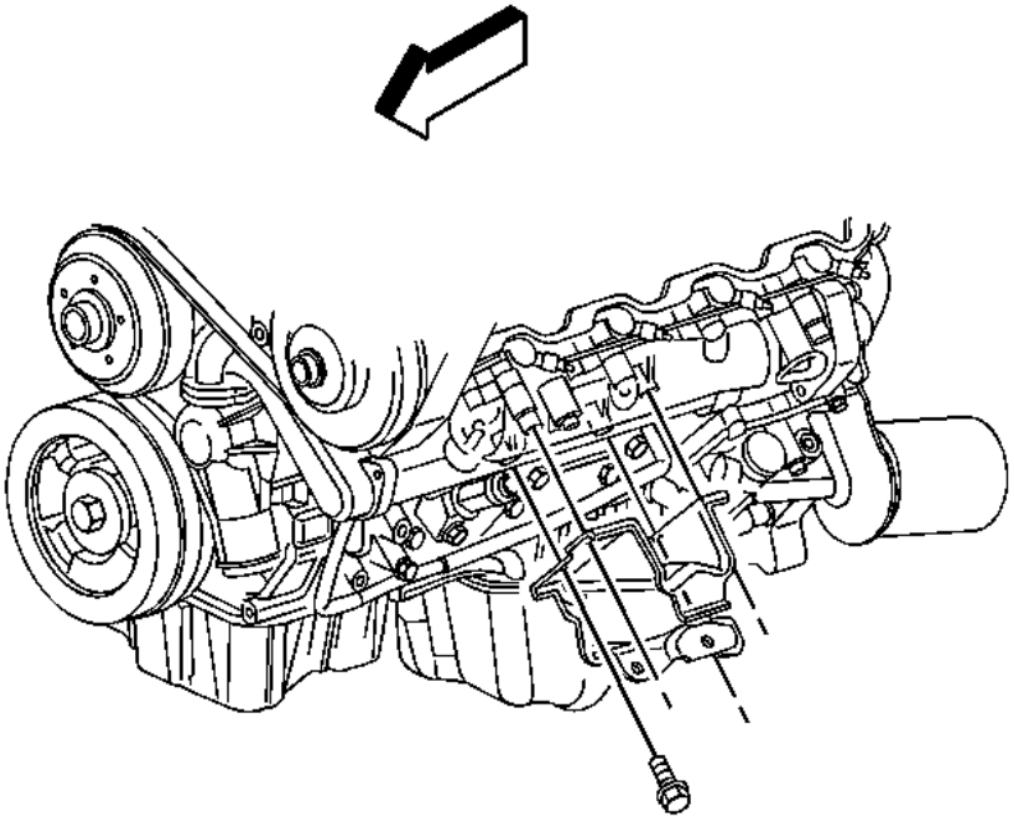


Fig. 26: Identifying Engine Mount Bolts
Courtesy of GENERAL MOTORS CORP.

10. Remove the bolts holding the engine mount to the engine.

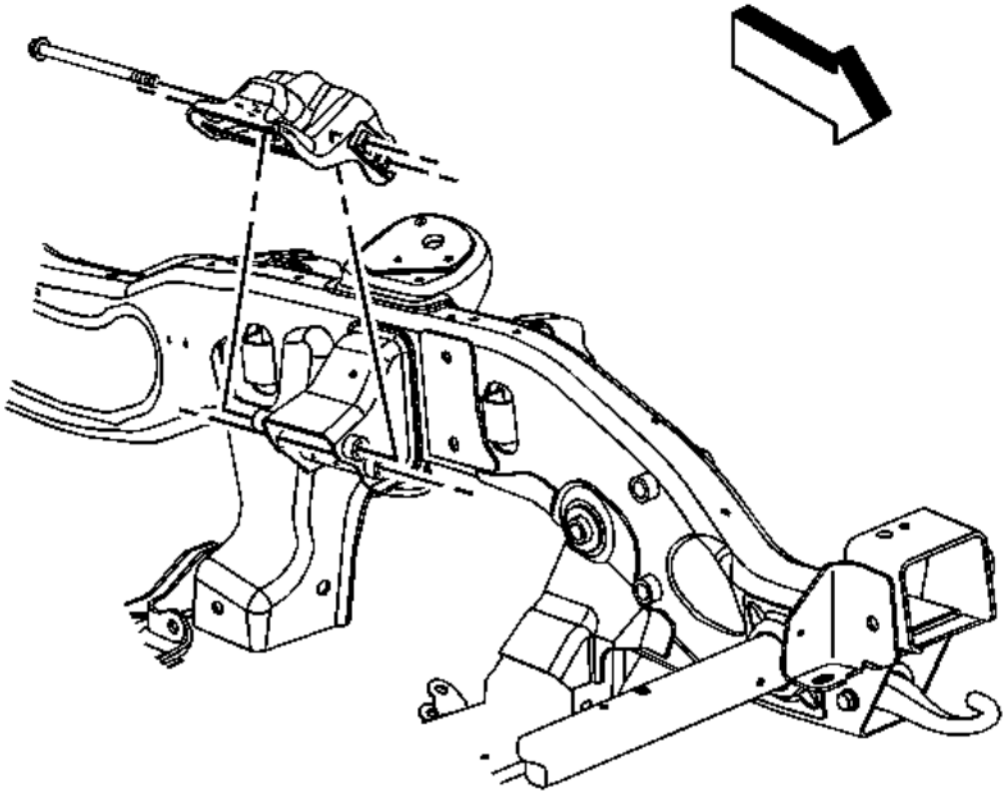


Fig. 27: Identifying Engine Mount Frame Bracket Through Bolt
Courtesy of GENERAL MOTORS CORP.

11. Remove the 2 through-bolts for the engine mount frame bracket.
12. Remove the engine mount frame bracket.
13. Remove the engine mount.

Installation Procedure

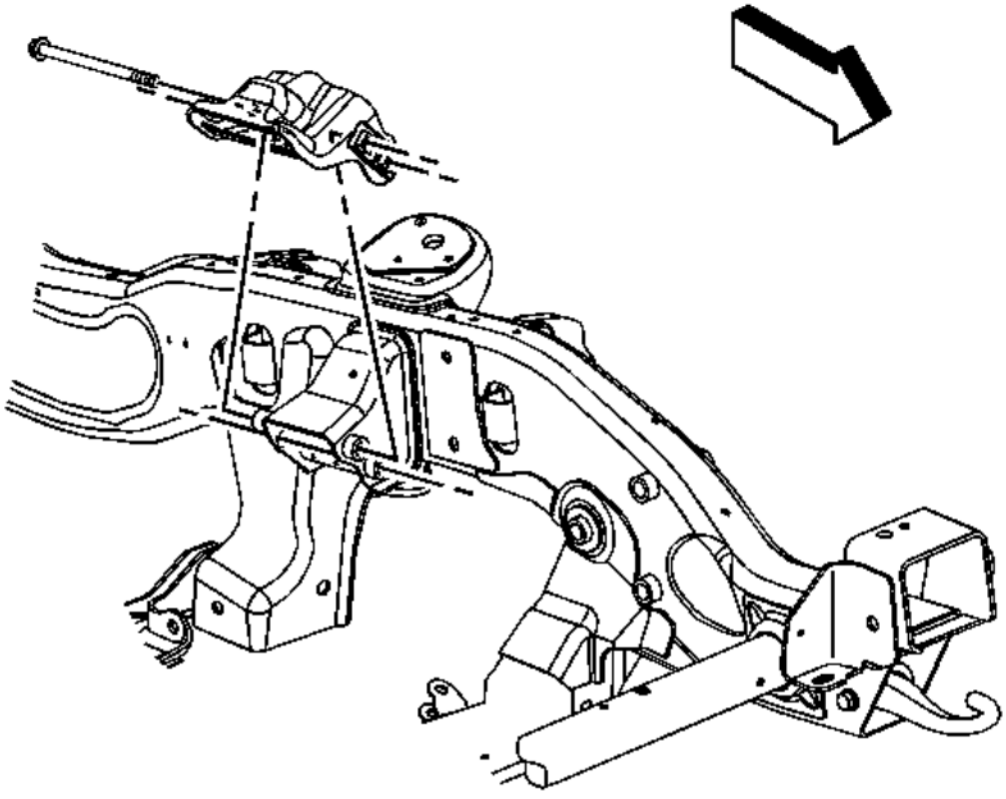


Fig. 28: Identifying Engine Mount Frame Bracket Through Bolt
Courtesy of GENERAL MOTORS CORP.

1. Position the engine mount frame bracket on the frame. Do not install the bolts.

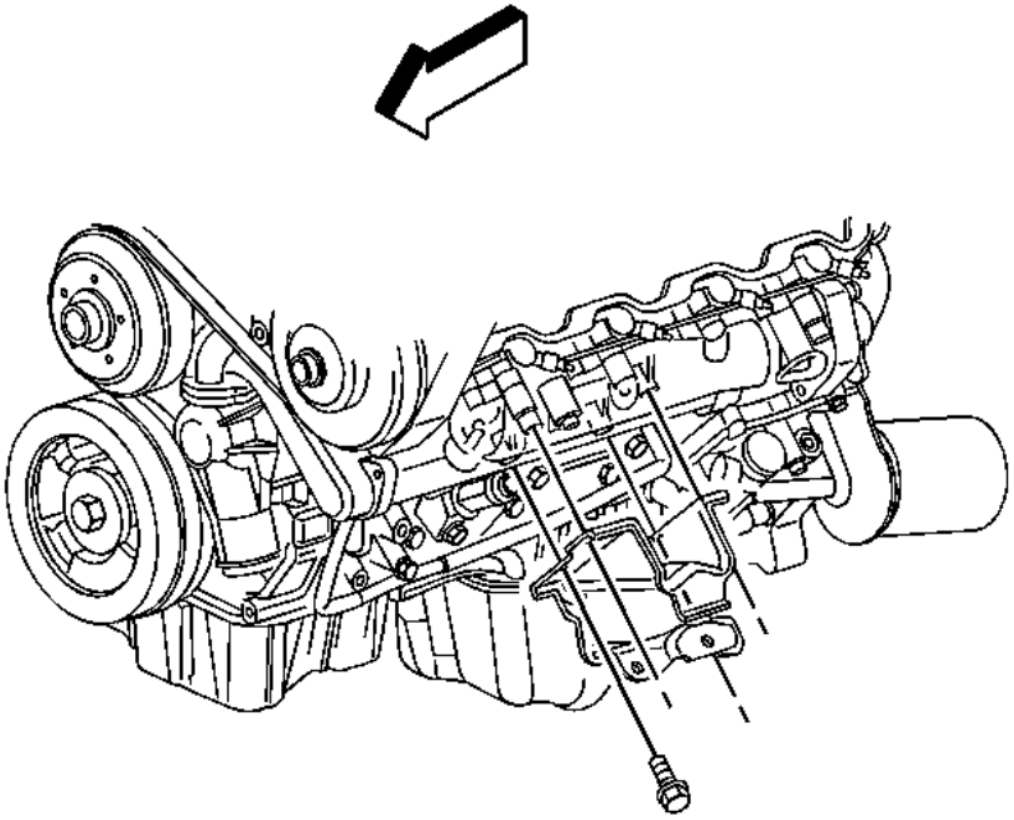


Fig. 29: Identifying Engine Mount Bolts
Courtesy of GENERAL MOTORS CORP.

2. Install the engine mount.
3. Perform the following procedure prior to installing the engine mount bracket bolts.
    1. Remove all traces of the original adhesive patch.
    2. Clean the threads of the bolt with denatured alcohol or equivalent and allow to dry.
    3. Apply threadlocker GM P/N 12345382 (Canadian P/N 10953489) or equivalent to the bolts.

NOTE: Refer to Fastener Notice .

4. Install the 2 through-bolts.

Tighten: Tighten the through-bolts to 75 N.m (55 lb ft).

5. Install the bolts holding the engine mount to the engine.

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

6. Lower the engine.
7. If 4WD vehicle remove the chain from the front of the engine.
8. If 4WD vehicle, install the generator mounting bracket and the power steering mount bracket bolt.

   Tighten: Tighten the mounting bracket bolts to 50 N.m (37 lb ft).

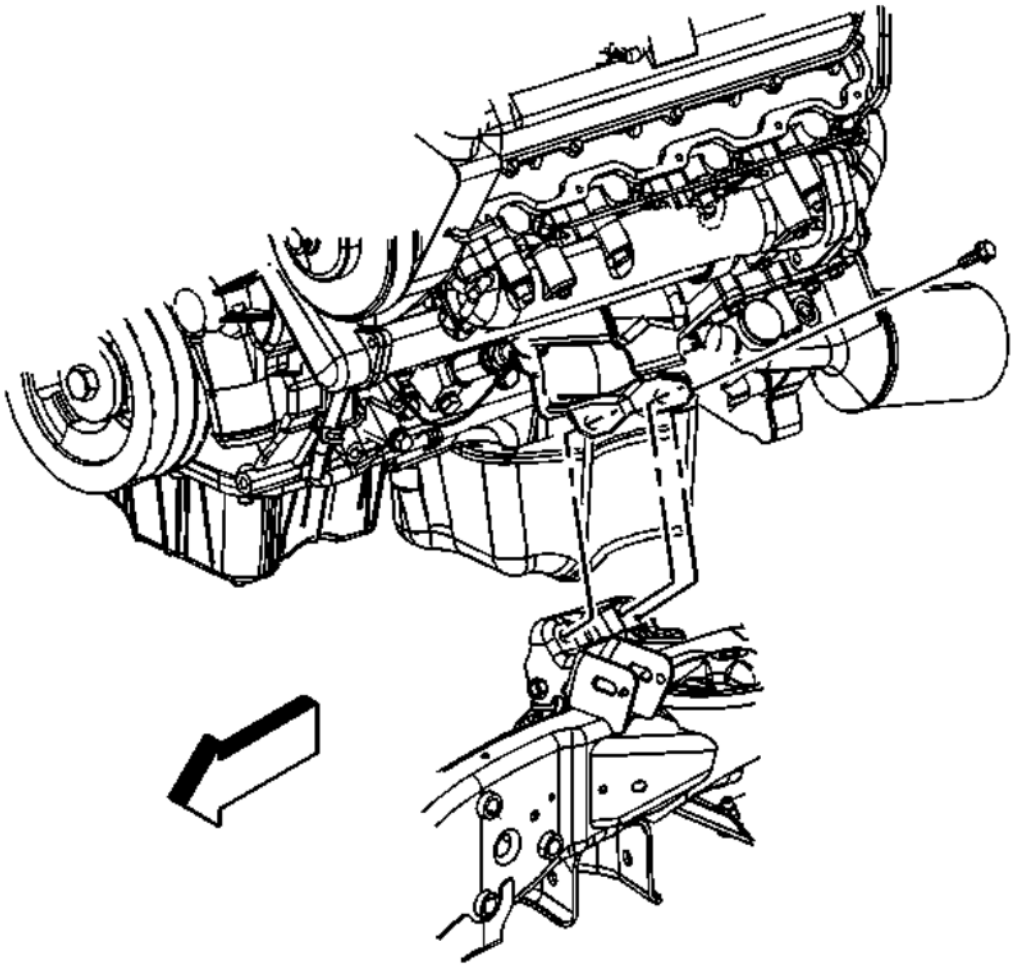


Fig. 30: View Of Engine Mount To Engine Mount Frame Bracket
Courtesy of GENERAL MOTORS CORP.

9. Install the 3 bolts holding the engine mount to the engine mount frame bracket.

   Tighten: Tighten the engine mount to engine mount frame bracket bolts to 65 N.m (48 lb ft).

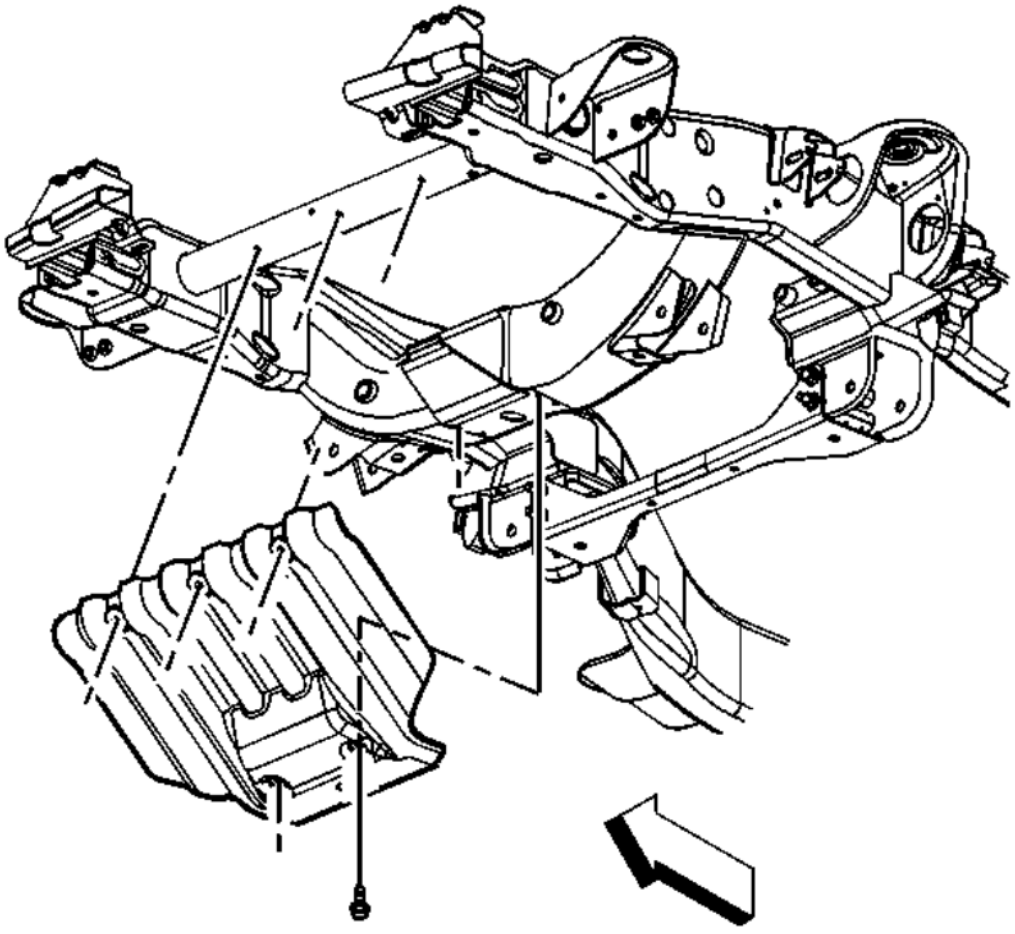


Fig. 31: Identifying Engine Shield And Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

10. Install the engine protection shield and bolts.

    Tighten: Tighten the engine protection shield bolts to 20 N.m (15 lb ft).

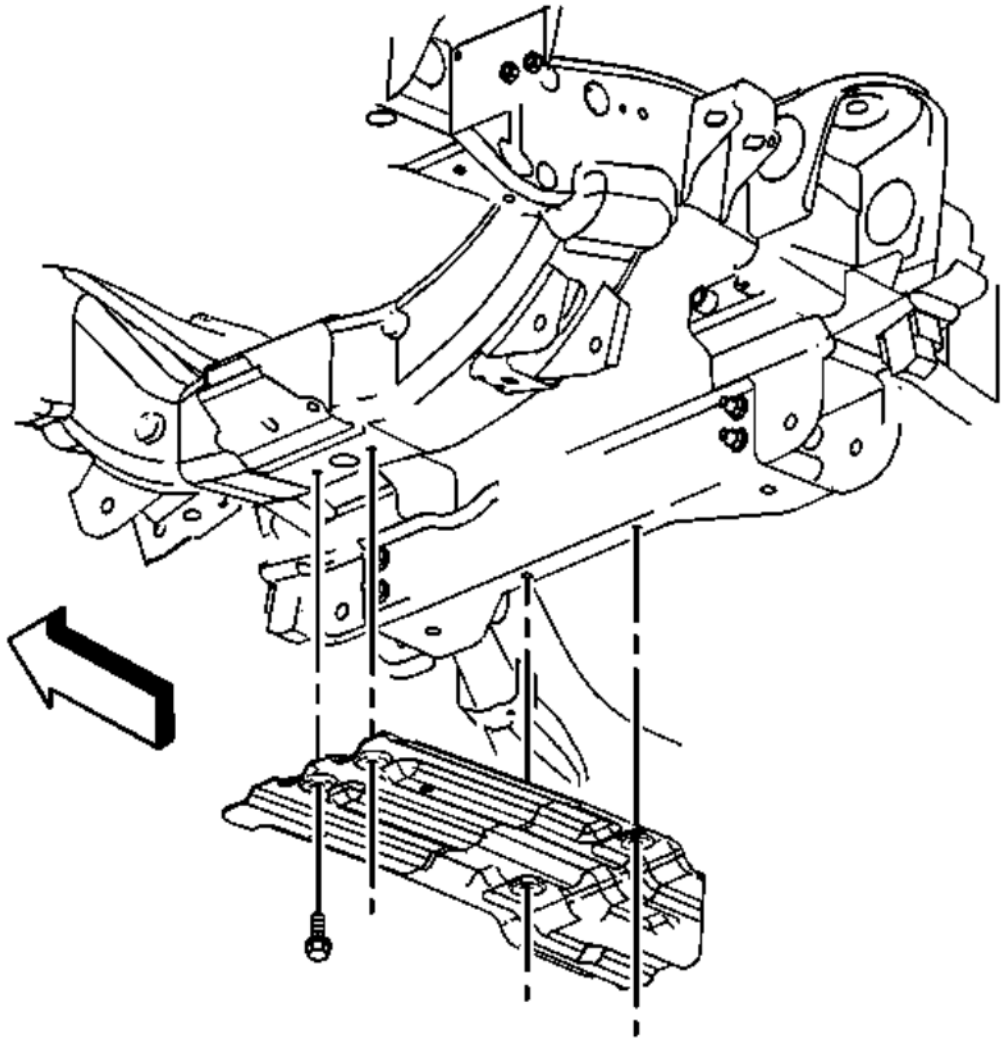


Fig. 32: Identifying Oil Pan Skid Plate
Courtesy of GENERAL MOTORS CORP.

11. Install the oil pan skid plate.

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

12. Remove the wheelhouse inner panel. Refer to **Front Wheelhouse Liner Replacement - Left Side (Chevrolet)** or **Front Wheelhouse Liner Replacement - Left Side (GMC)** .

13. Lower the vehicle.

ENGINE MOUNT REPLACEMENT - RIGHT SIDE

Removal Procedure

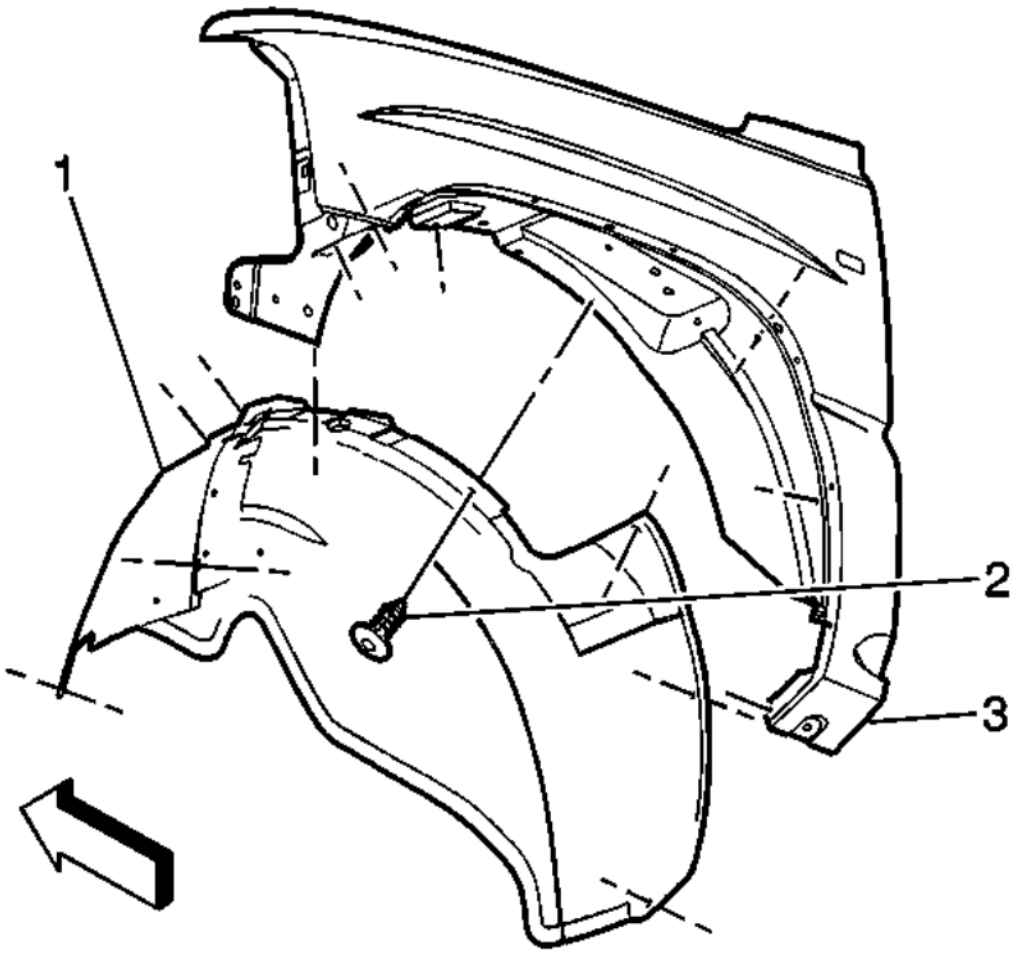


Fig. 33: View Of Wheelhouse Panel & Push-In Retainers
Courtesy of GENERAL MOTORS CORP.

1. Remove the starter motor. Refer to **Starter Motor Replacement (6.6L)** .
2. If RWD vehicle, raise the vehicle to a height to work through the front wheelhouse opening. Refer to **Lifting and Jacking the Vehicle** .

3. If 4-wheel drive (4WD) vehicle, raise the vehicle in order to remove the front tires and wheels and support with jackstands.
4. Remove the right front tire and wheel, if necessary. Refer to **Tire and Wheel Removal and Installation** .
5. Remove the pushpins holding the right front fender wheelhouse inner panel (1).
6. Remove the wheelhouse inner panel.

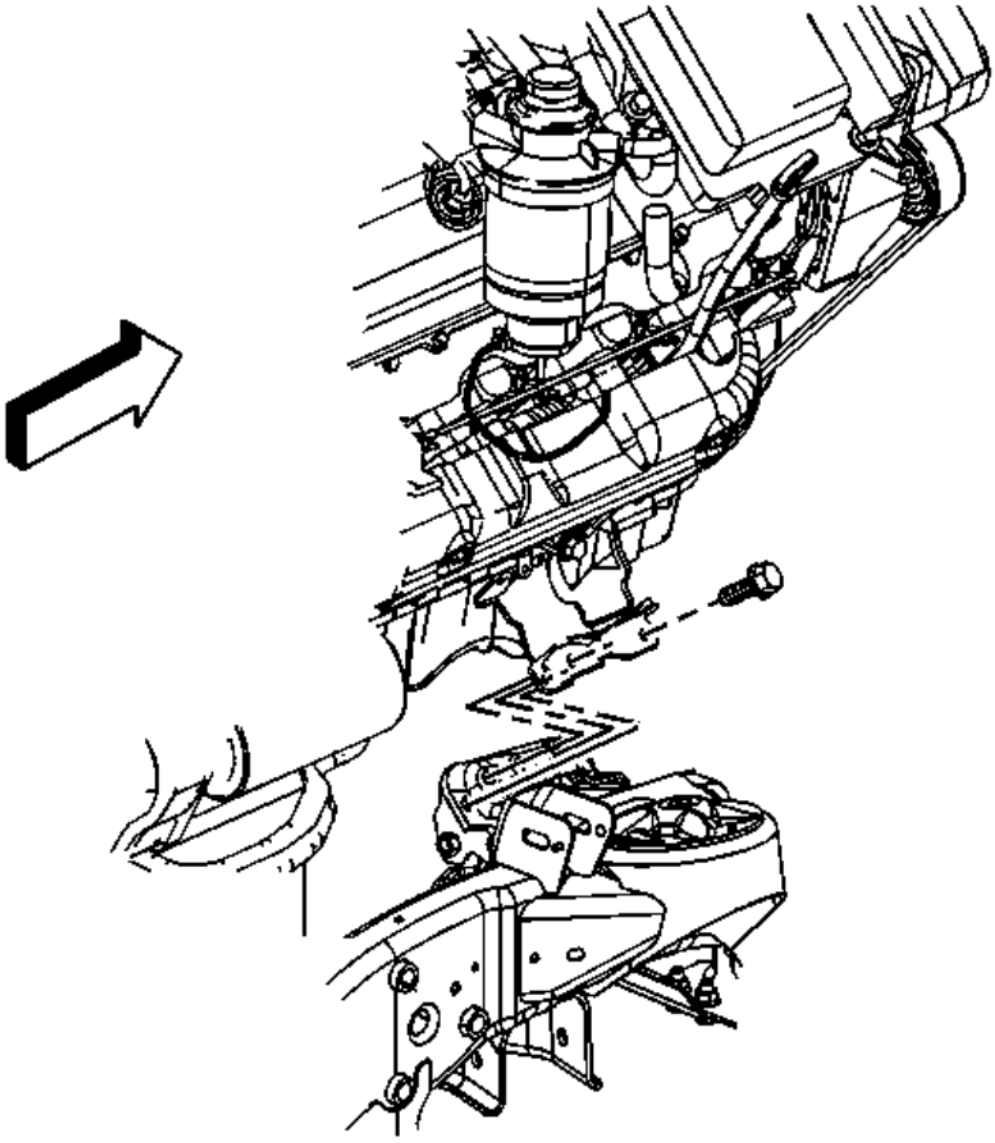


Fig. 34: View Of Engine Mount To Engine Mount Frame Bracket Bolt (Right)
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to ENGINE MOUNTING NOTICE

7. Working through the wheelhouse opening remove the 3 bolts retaining the engine mount to

the engine mount frame bracket.

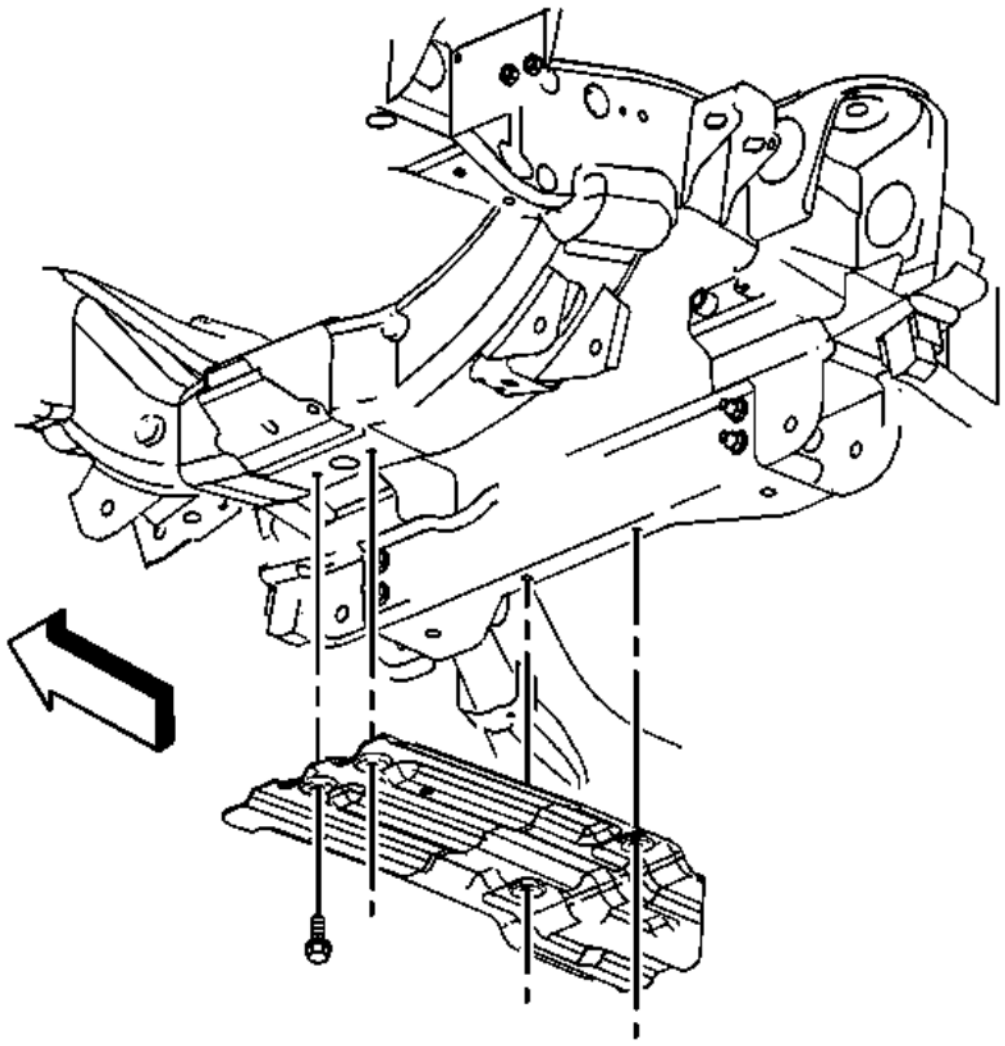


Fig. 35: Identifying Oil Pan Skid Plate
Courtesy of GENERAL MOTORS CORP.

8. Remove the oil pan skid plate, if equipped.

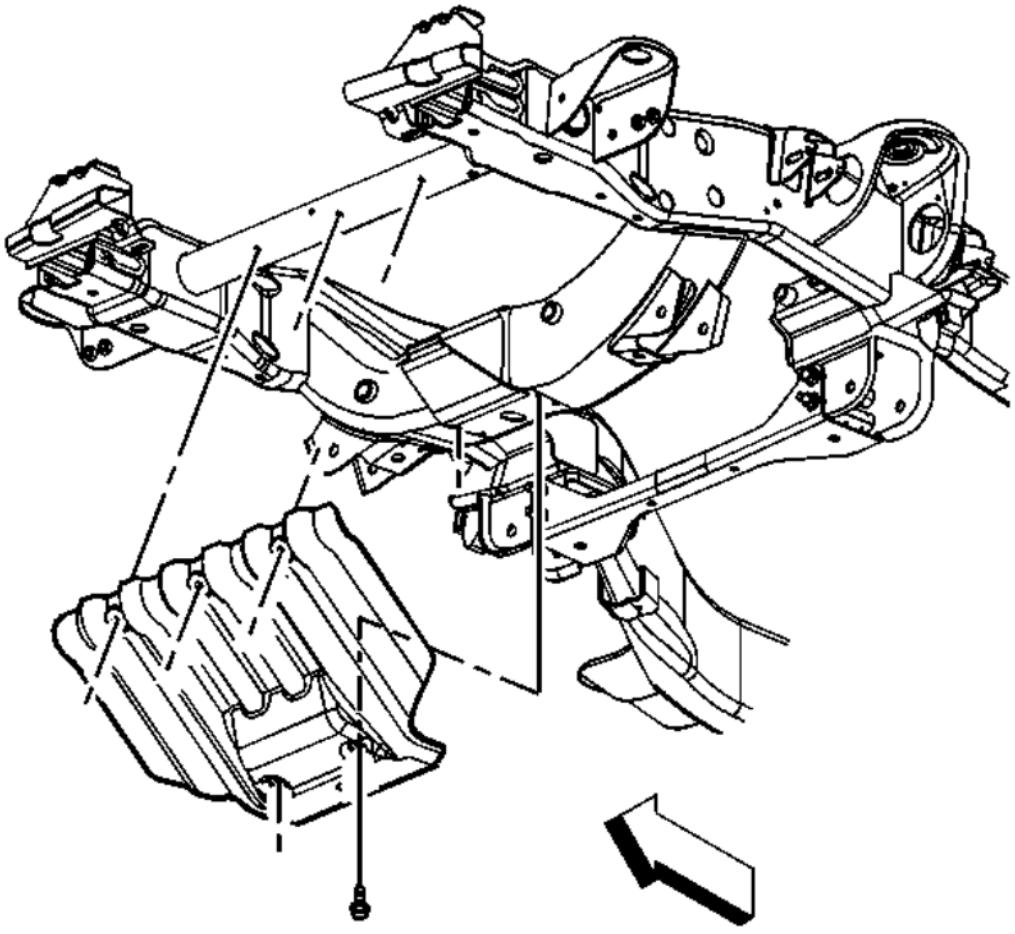


Fig. 36: Identifying Engine Shield And Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

9. Remove the engine protection shield from the vehicle, if equipped.

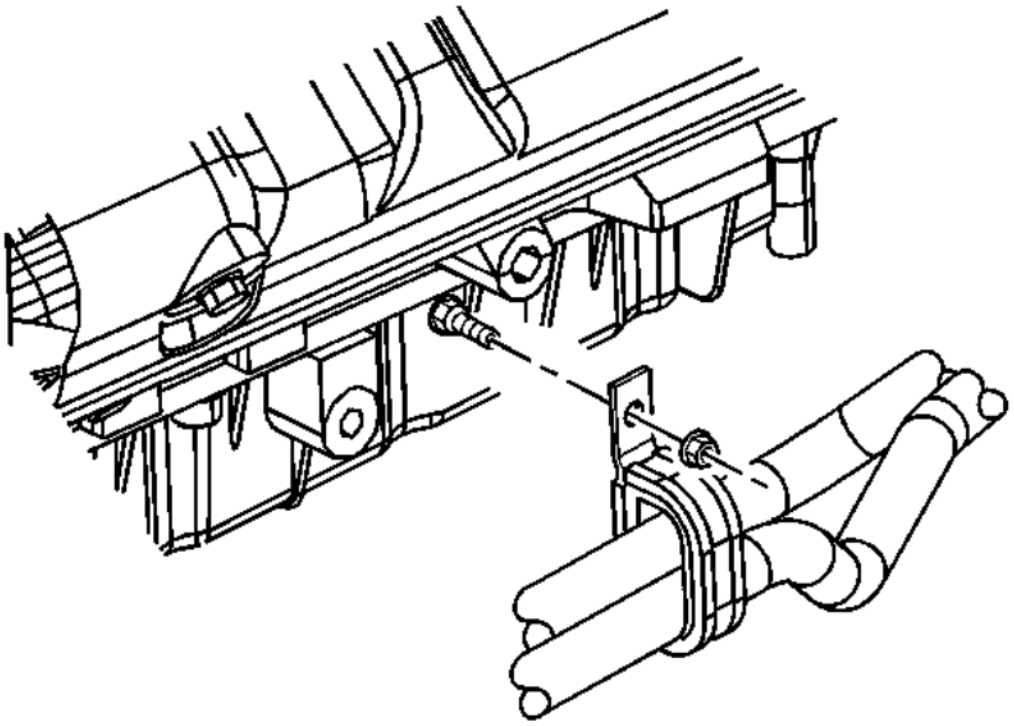


Fig. 37: View Of Transmission Oil Cooler Lines, Bracket & Bolt
Courtesy of GENERAL MOTORS CORP.

10. If RWD vehicle and equipped with an automatic transmission, remove the bracket bolt for the transmission oil cooler lines to the engine.
11. Move the transmission oil cooler lines aside.

NOTE: Refer to ENGINE LIFTING NOTICE

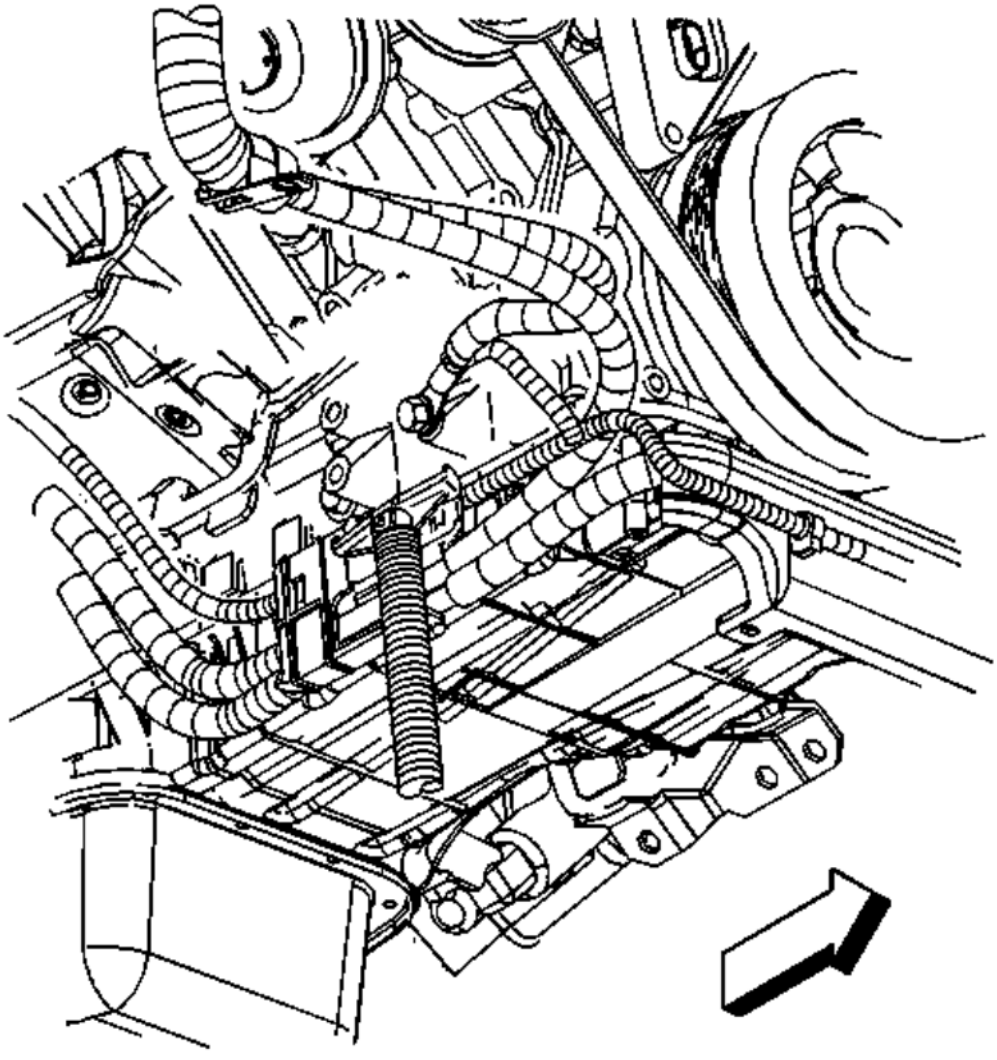


Fig. 38: View Of Ground Wire Bolt Bosses (Right Side)
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: When raising the engine only raise enough to separate the engine mount from the engine mount bracket. Raising any further the fan shroud or the exhaust pipe will require removal.

12. If RWD vehicle, using a suitable jack on the ground wire bolt bosses, raise the engine.

    Only raise the engine enough to separate the engine mount to engine mount bracket.

13. If 4WD vehicle, attach a chain to the front of the engine. Use accessible mounting bolts for the generator mounting bracket and the power steering pump mounting bracket.
14. Raise the engine with a suitable lifting device to remove the engine mount.

    Only raise the engine enough to separate the engine mount to engine mount bracket.

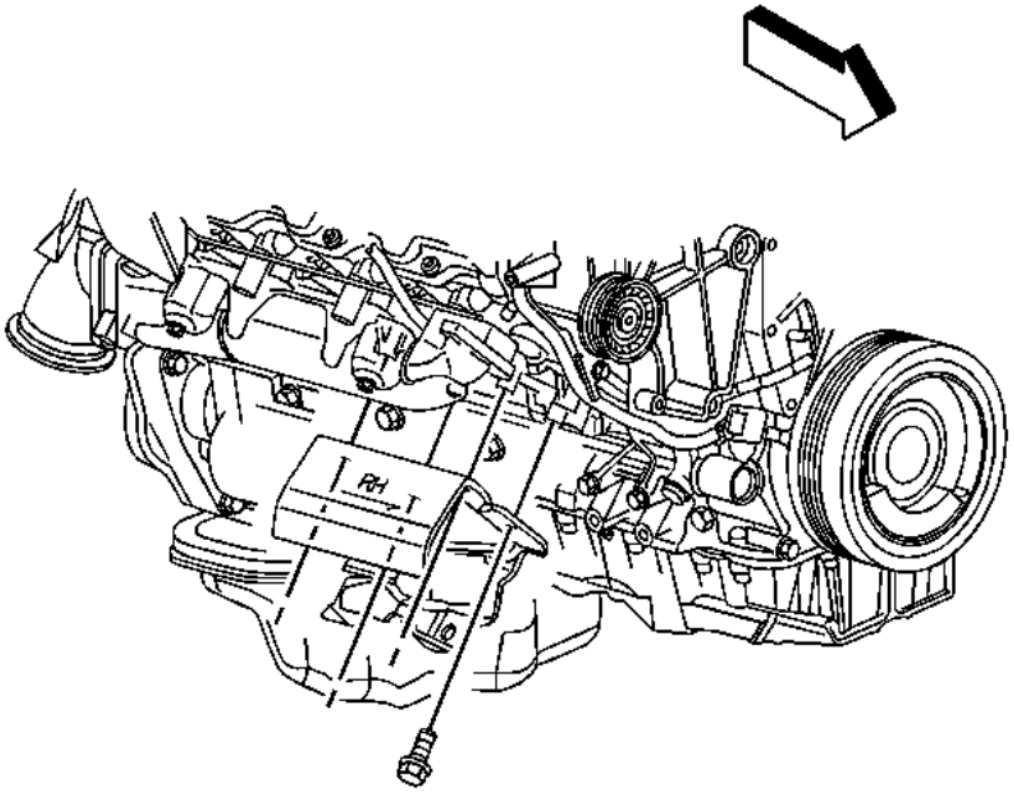


Fig. 39: Identifying Engine Mount Bolts
Courtesy of GENERAL MOTORS CORP.

15. Remove the bolts holding the engine mount to the engine.

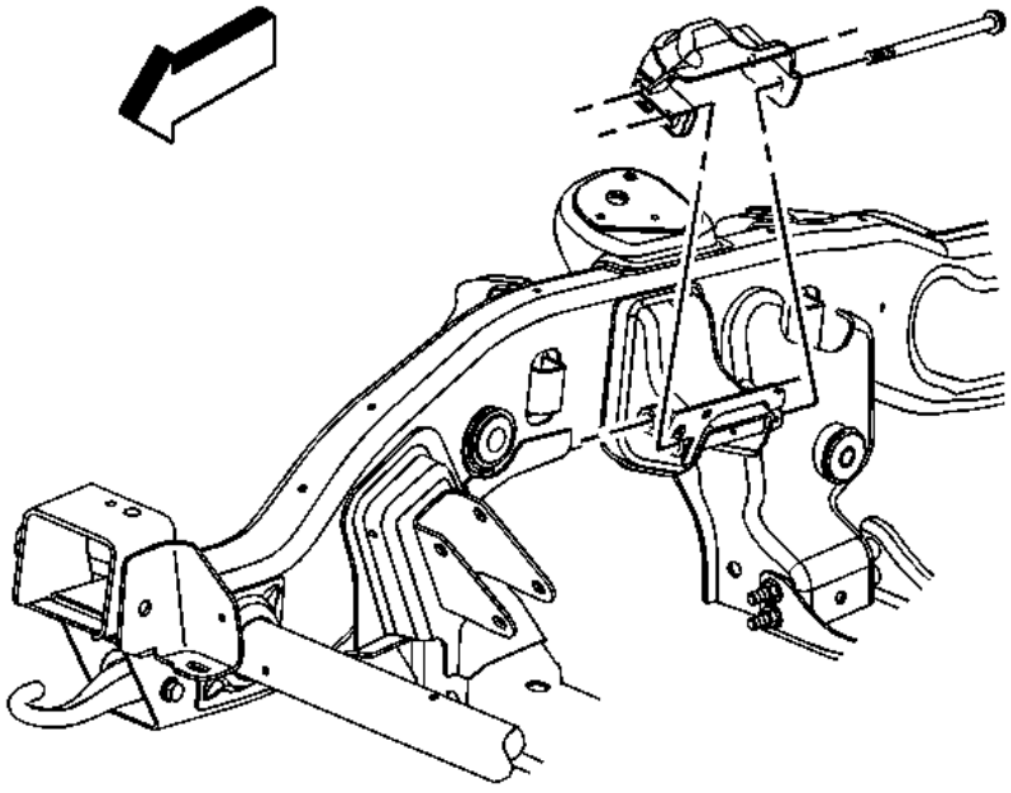


Fig. 40: Identifying Frame Bracket
Courtesy of GENERAL MOTORS CORP.

16. Remove the 2 through-bolts for the engine mount frame bracket.
17. Remove the engine mount frame bracket.
18. Remove the engine mount.

Installation Procedure

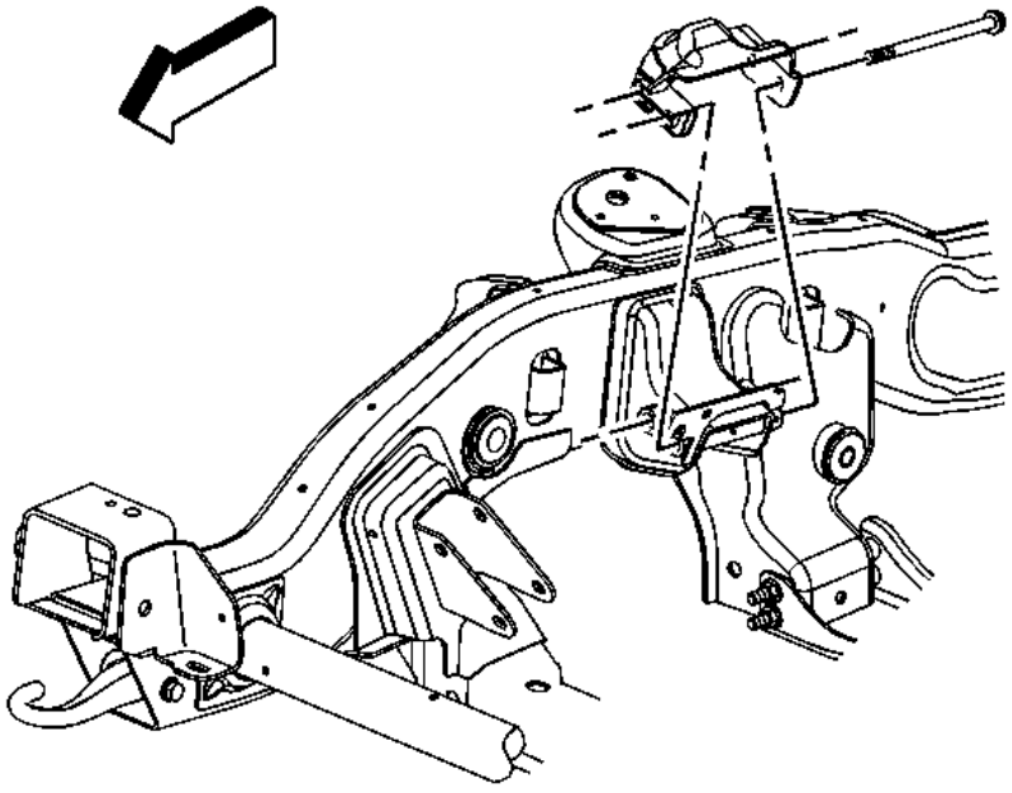


Fig. 41: Identifying Frame Bracket
Courtesy of GENERAL MOTORS CORP.

1. Position the engine mount frame bracket on the frame. Do not install the bolts.
2. Install the engine mount.
3. Perform the following procedure prior to installing the engine mount bracket bolts.
    1. Remove all traces of the original adhesive patch.
    2. Clean the threads of the bolt with denatured alcohol or equivalent and allow to dry.
    3. Apply threadlocker GM P/N 12345382 (Canadian P/N 10953489) or equivalent to the bolts.

NOTE: Refer to Fastener Notice .

4. Install the 2 through-bolts.

Tighten: Tighten the through-bolts to 75 N.m (55 lb ft).

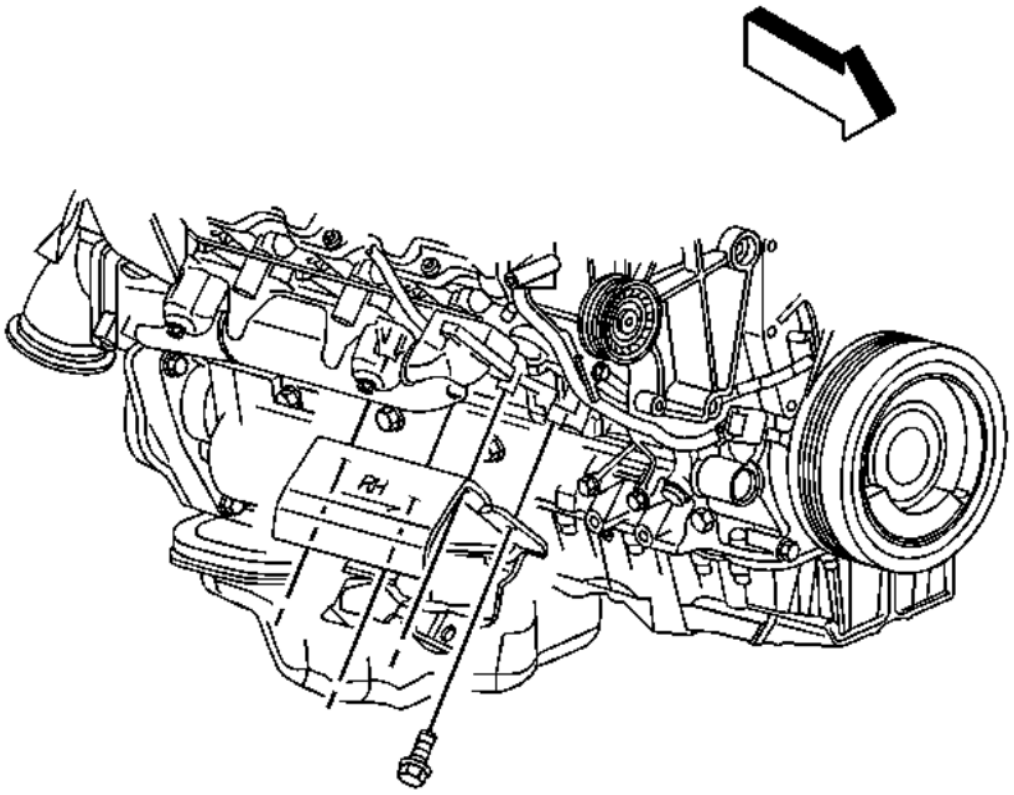


Fig. 42: Identifying Engine Mount Bolts
Courtesy of GENERAL MOTORS CORP.

5. Install the bolts holding the engine mount to the engine.

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

6. Lower the engine.
7. If 4WD vehicle, remove the chain from the front of the engine.
8. If 4WD vehicle, install the generator mounting bracket and the power steering mount bracket bolt.

   Tighten: Tighten the mounting bracket bolts to 50 N.m (37 lb ft).

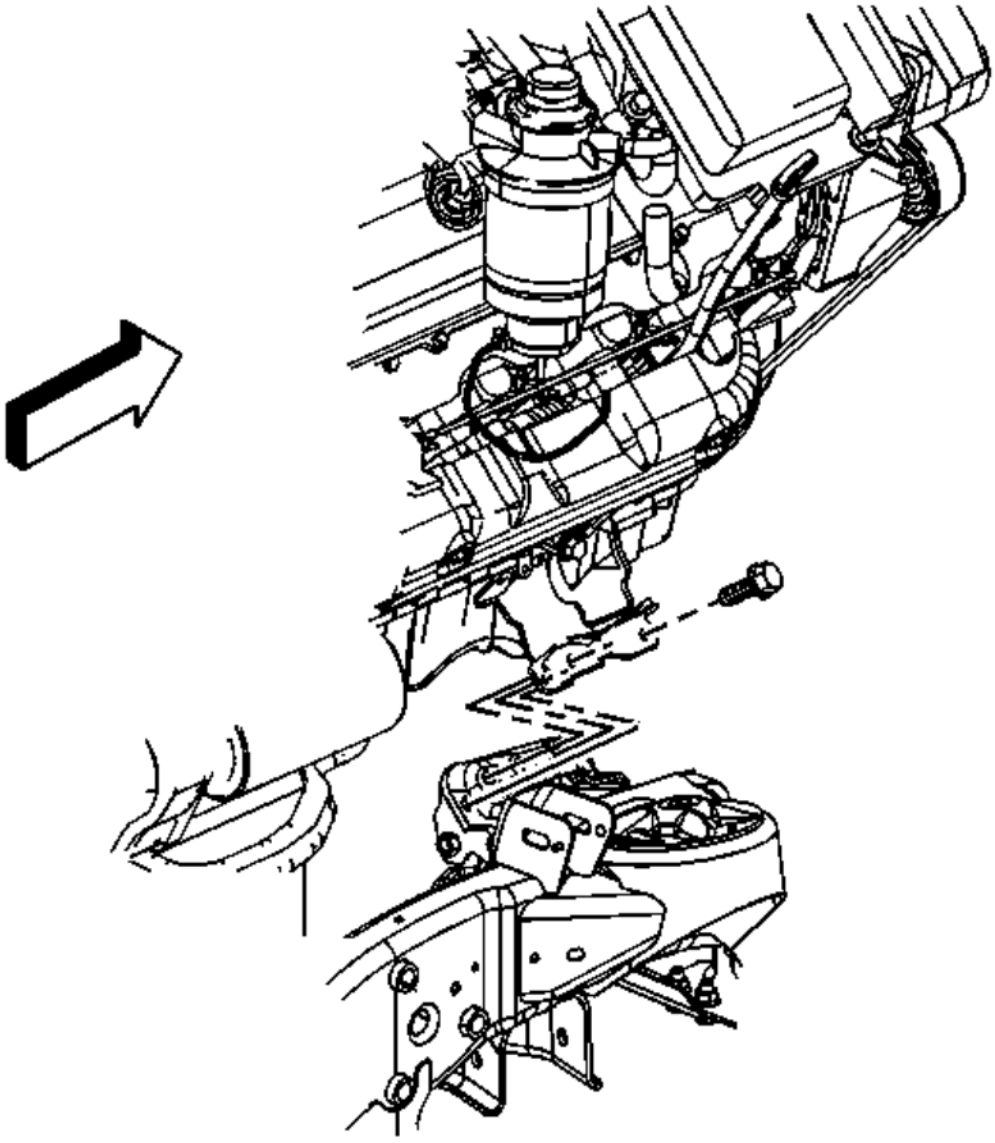


Fig. 43: View Of Engine Mount To Engine Mount Frame Bracket Bolt (Right)
Courtesy of GENERAL MOTORS CORP.

9. Install the 3 bolts holding the engine mount to the engine mount frame bracket.

   Tighten: Tighten the engine mount to engine mount frame bracket bolts to 65 N.m (48 lb

ft).

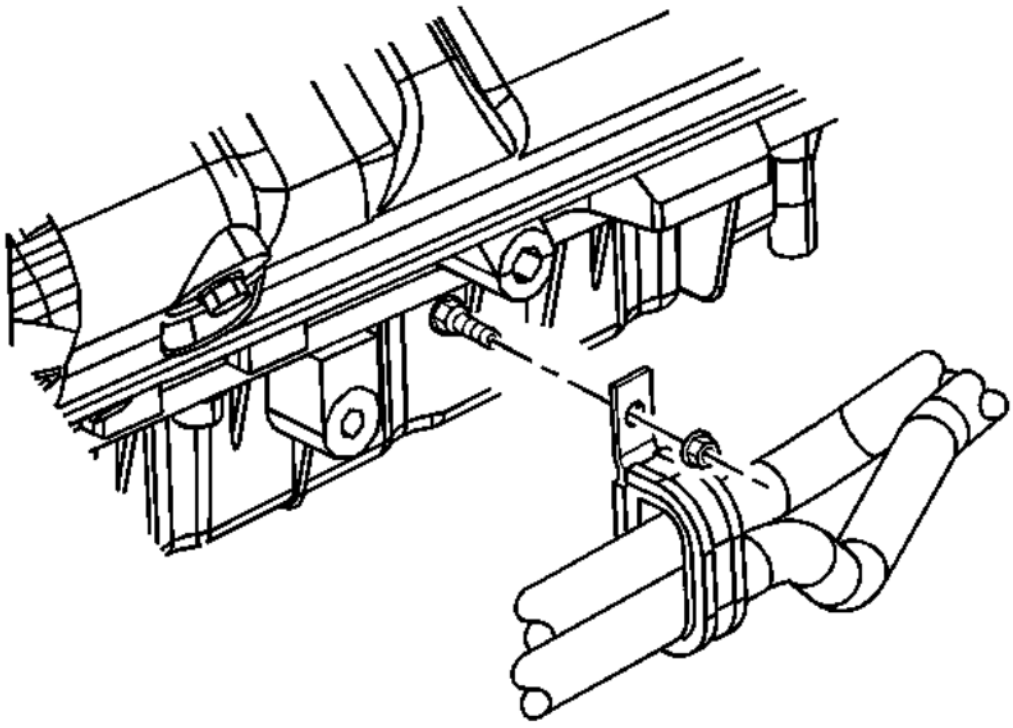


Fig. 44: View Of Transmission Oil Cooler Lines, Bracket & Bolt
Courtesy of GENERAL MOTORS CORP.

10. If RWD vehicle with an automatic transmission, install the bolt for the transmission oil cooler line bracket.

    Tighten: Tighten the transmission oil cooler line bracket bolt to 9 N.m (80 lb in).

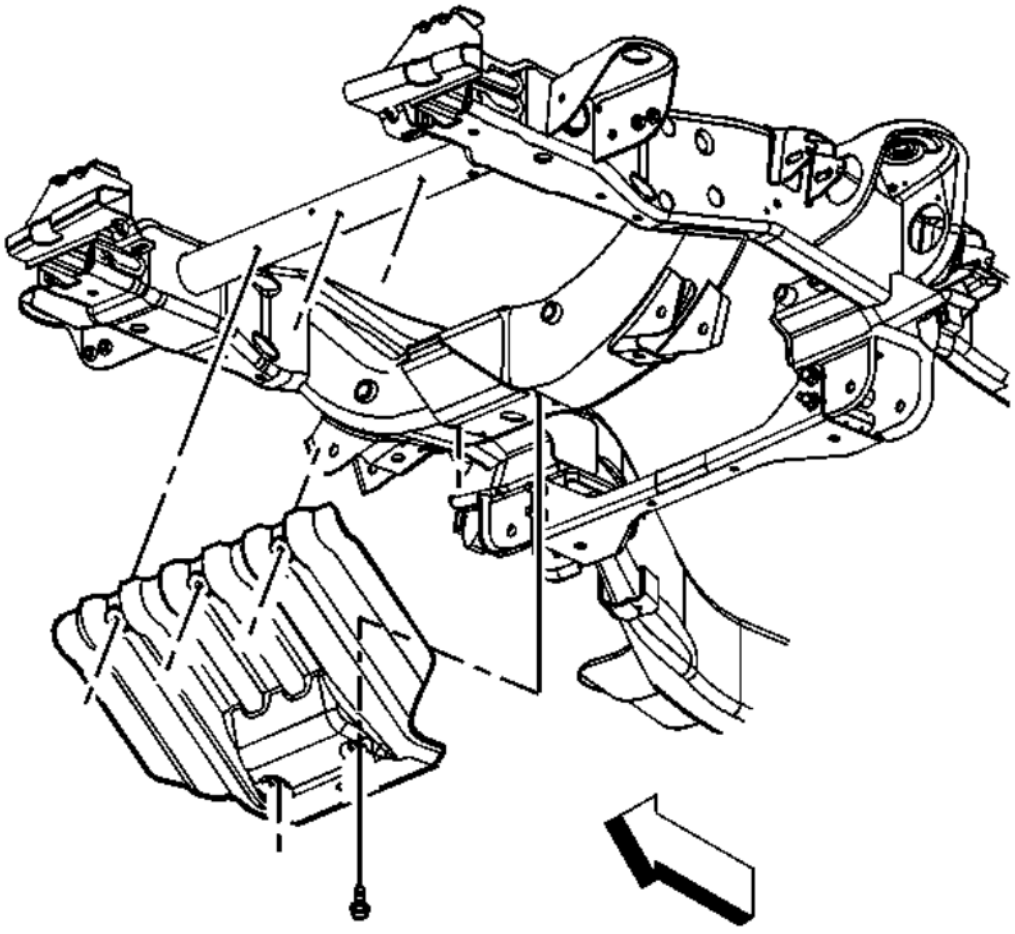


Fig. 45: Identifying Engine Shield And Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

11. Install the engine protection shield and bolts.

    Tighten: Tighten the engine protection shield bolts to 20 N.m (15 lb ft).

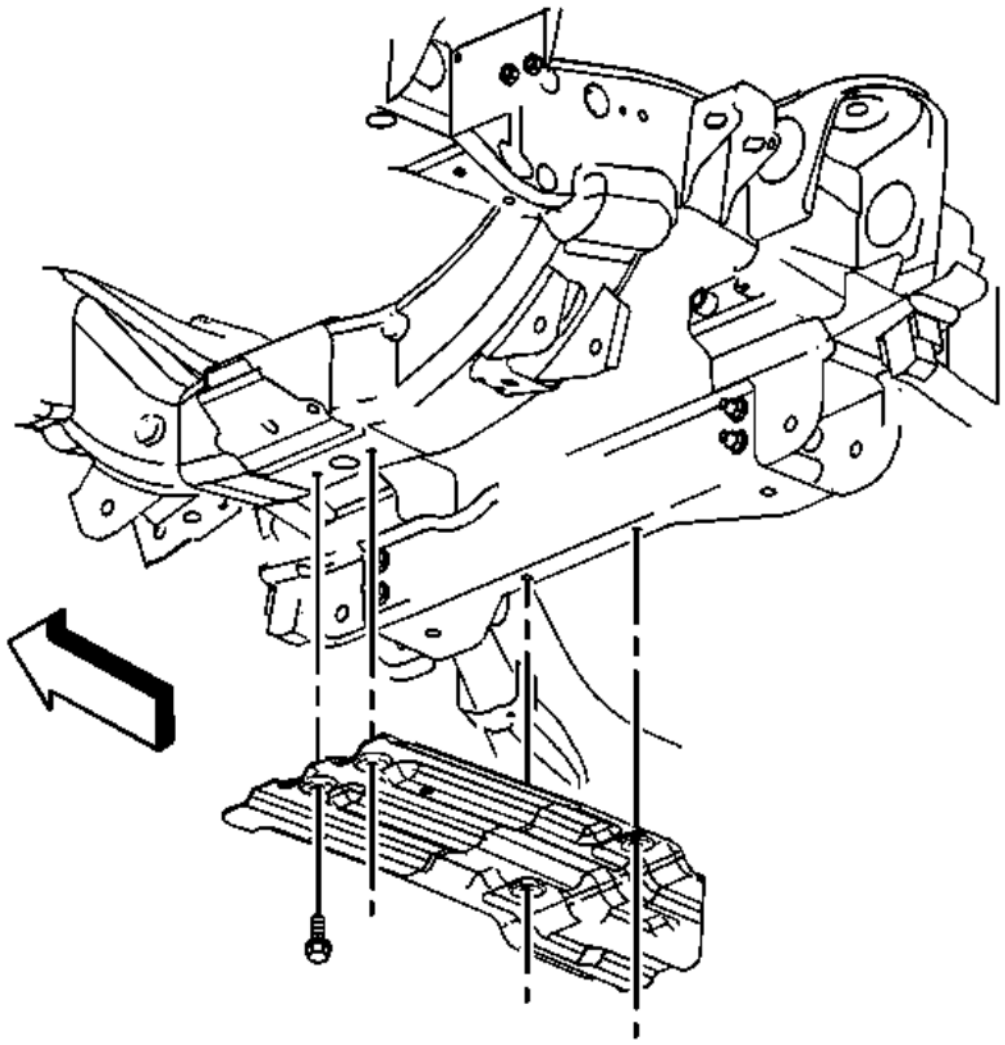


Fig. 46: Identifying Oil Pan Skid Plate
Courtesy of GENERAL MOTORS CORP.

12. Install the oil pan skid plate.

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

13. Install the right front tire and wheel. Refer to **Tire and Wheel Removal and Installation** .
14. Install the front fender wheelhouse inner panel.

15. Install the starter motor. Refer to **Starter Motor Replacement (6.6L)** .
16. Lower the vehicle.

POSITIVE CRANKCASE VENTILATION VALVE REPLACEMENT (DRIVER SIDE)

Removal Procedure

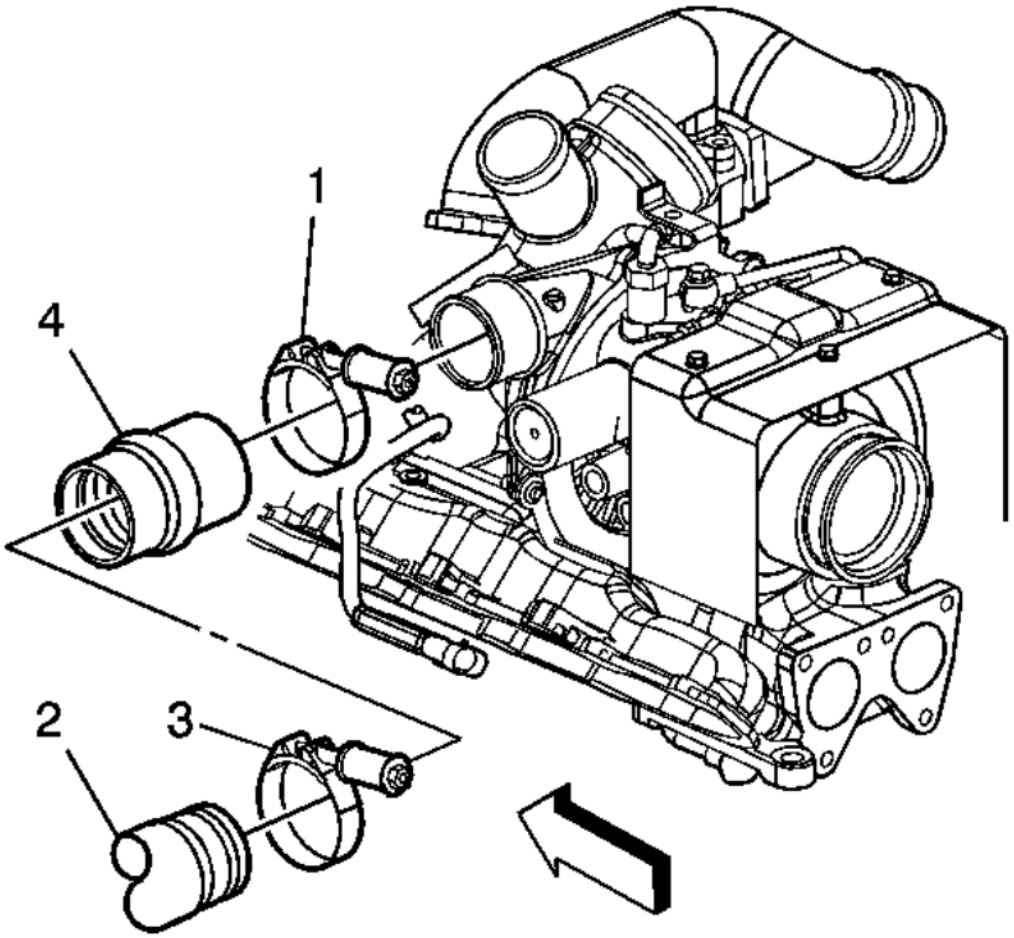


Fig. 47: View Of Turbocharger Clamp & Charged Air Cooler Inlet Duct Connector
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: After removing the charged air cooler duct, cover the turbocharger opening with tape in order to prevent entry of

objects.

1. Loosen the charged air cooler inlet duct connector to turbocharger clamp (1).

IMPORTANT: Do not use a screwdriver or other tool to pry the hose loose. The hose can be torn or damaged. Loosen the hose by twisting.

2. Remove the charged air cooler inlet duct connector (4) from the turbocharger.

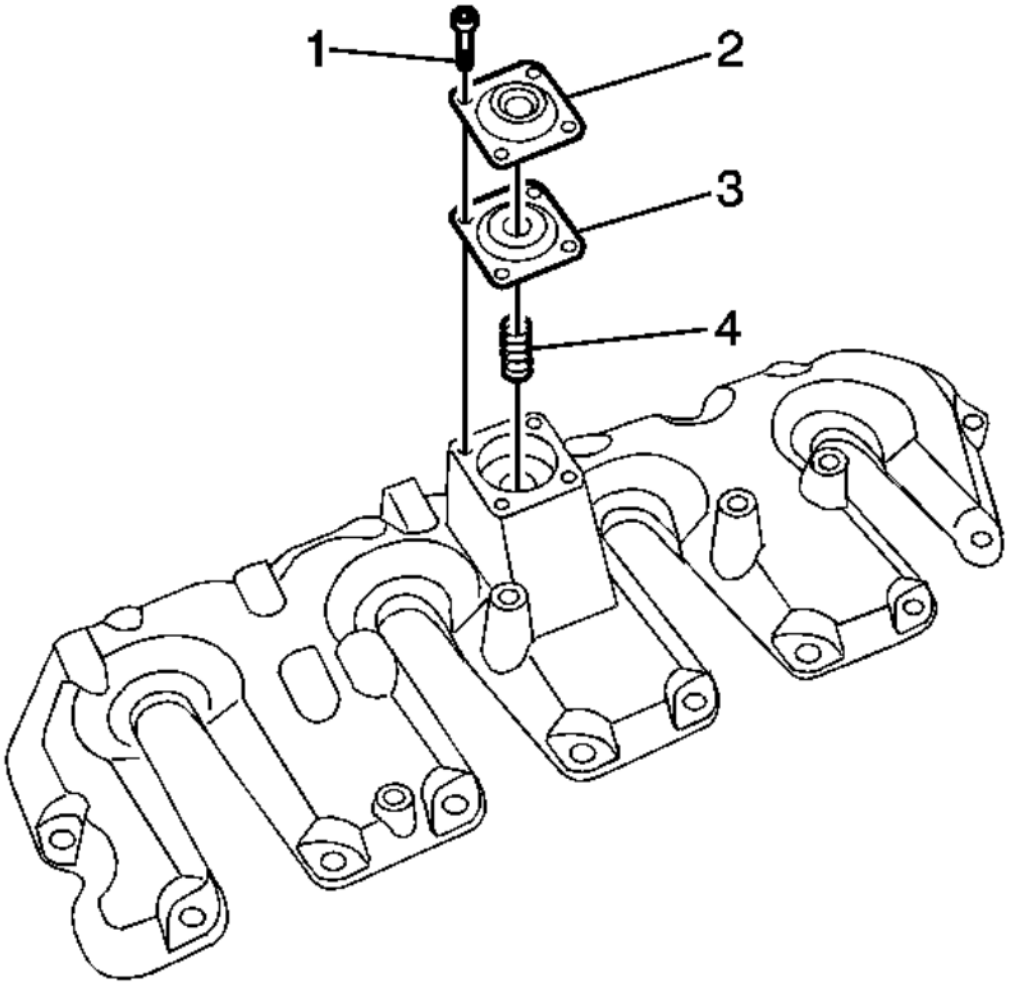


Fig. 48: View Of PCV Cover, Diaphragm & Spring
Courtesy of GENERAL MOTORS CORP.

3. Remove the positive crankcase ventilation (PCV) cover screws.
4. Remove the PCV cover, diaphragm, and spring.
5. Clean and inspect the cover, diaphragm, and spring.
6. Discard the diaphragm if damage is found.

Installation Procedure

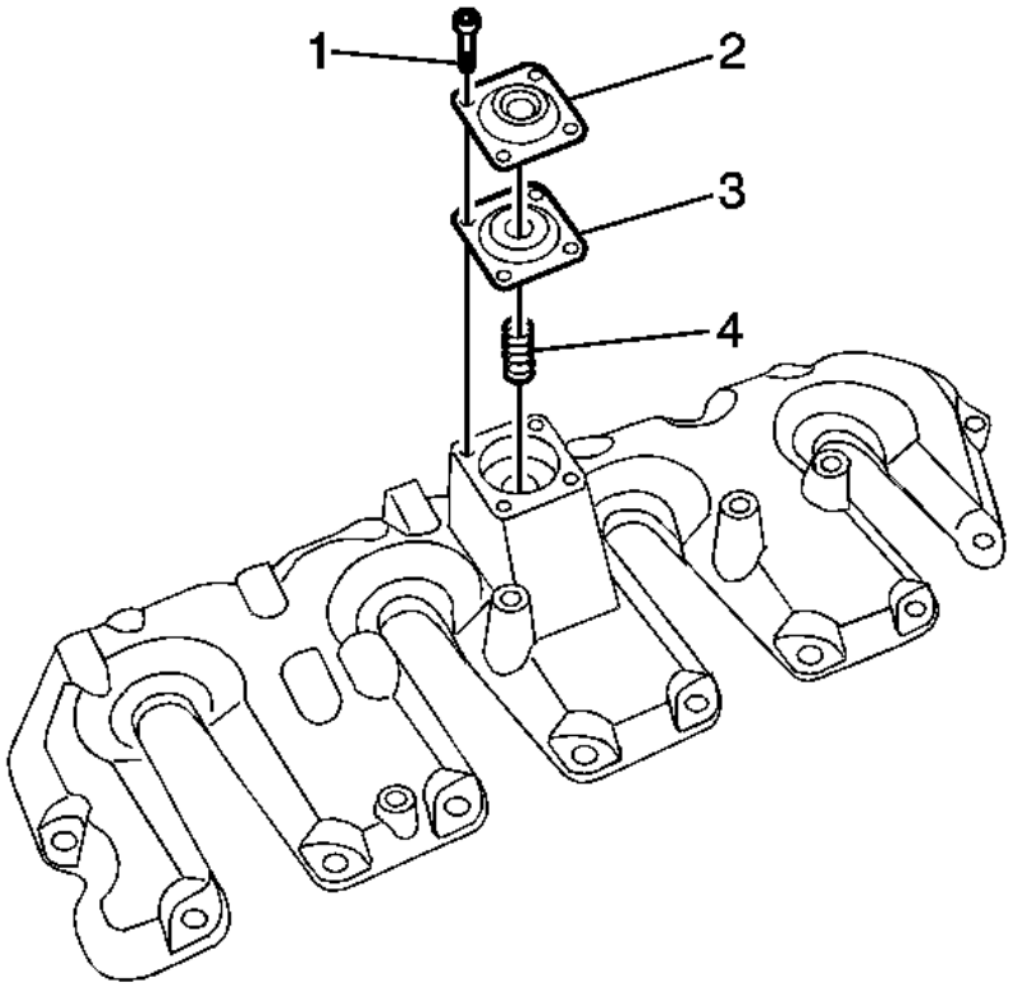


Fig. 49: View Of PCV Cover, Diaphragm & Spring
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

1. Install the spring, diaphragm, and cover.
2. Install the PCV cover screws.

Tighten: Tighten the screws to 4 N.m (35 lb in).

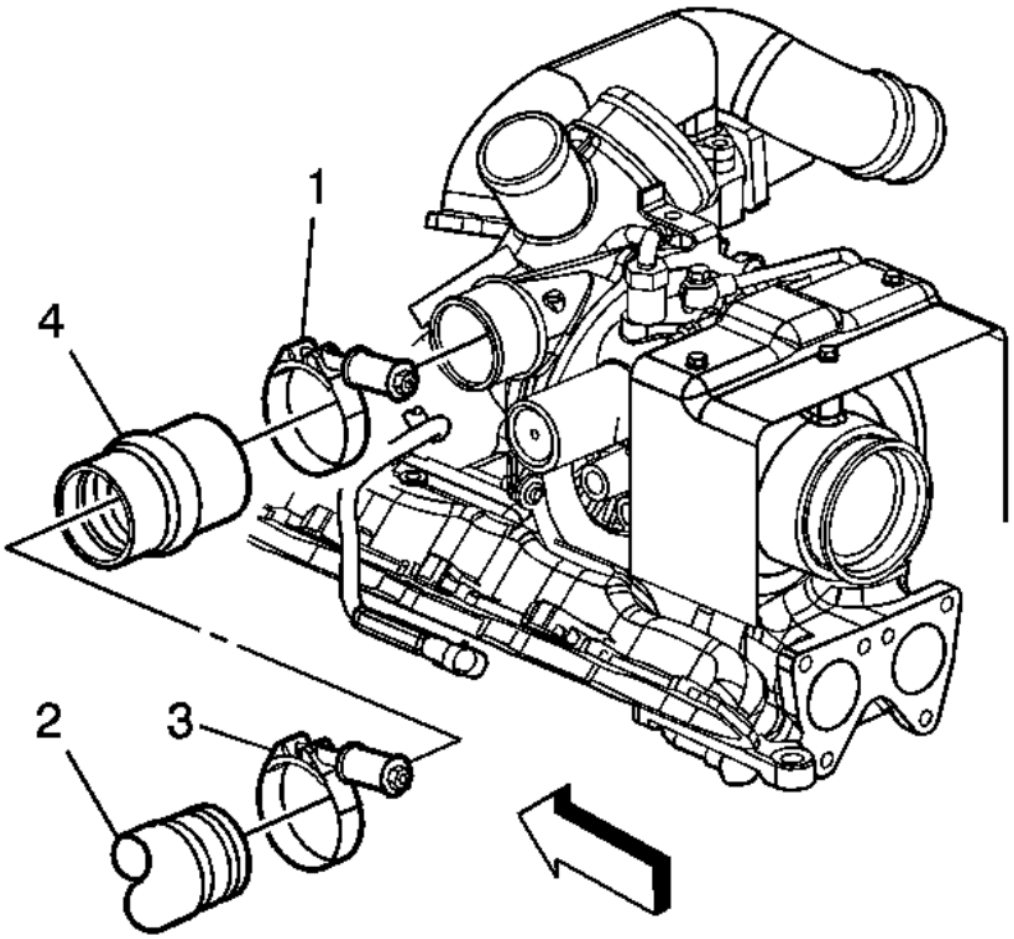


Fig. 50: View Of Turbocharger Clamp & Charged Air Cooler Inlet Duct Connector
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Lubricate the end of the duct prior to installation.

3. Remove the tape from the turbocharger openings.
4. Install the charged air cooler inlet duct connector (4) to the turbocharger.
5. Tighten the charged air cooler inlet duct connector to turbocharger clamp (1).

Tighten: Tighten the clamp to 6 N.m (53 lb in).

POSITIVE CRANKCASE VENTILATION VALVE REPLACEMENT (PASSENGER SIDE)

Removal Procedure

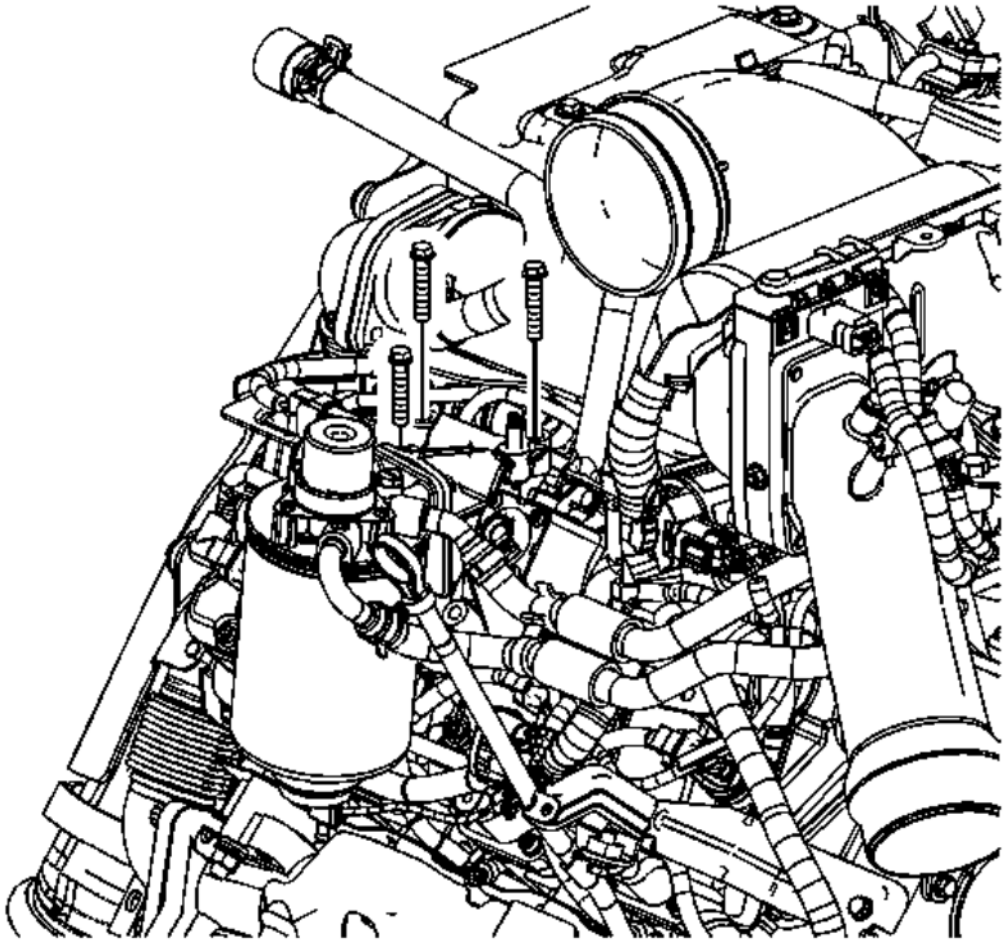


Fig. 51: Identifying Fuel Filter Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the air cleaner outlet duct. Refer to **Air Cleaner Assembly Replacement** .
2. Remove the fuel filter bracket bolts.
3. Position the fuel filter assembly out of the way.

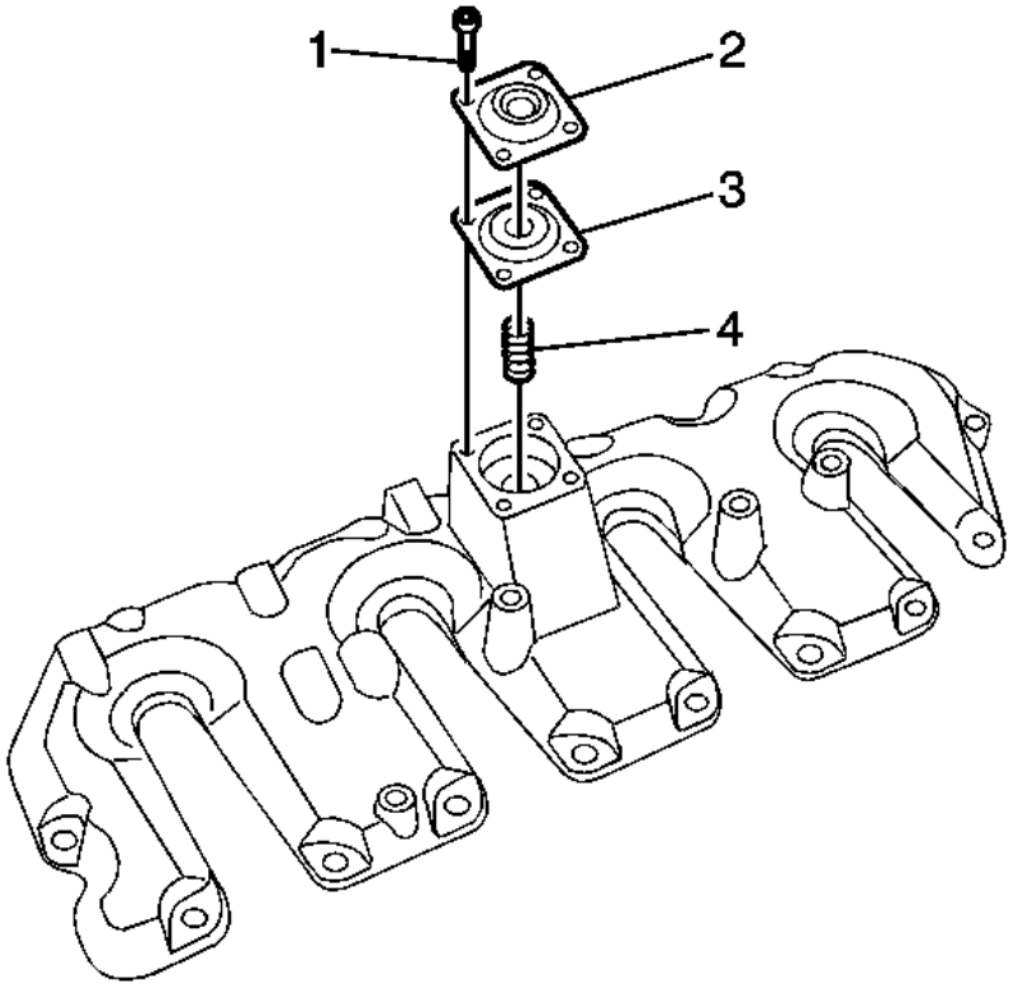


Fig. 52: View Of PCV Cover, Diaphragm & Spring
Courtesy of GENERAL MOTORS CORP.

4. Remove the positive crankcase ventilation (PCV) cover screws.
5. Remove the PCV cover, diaphragm, and spring.
6. Clean and inspect the cover, diaphragm and spring.
7. Discard the diaphragm if damage is found.

Installation Procedure

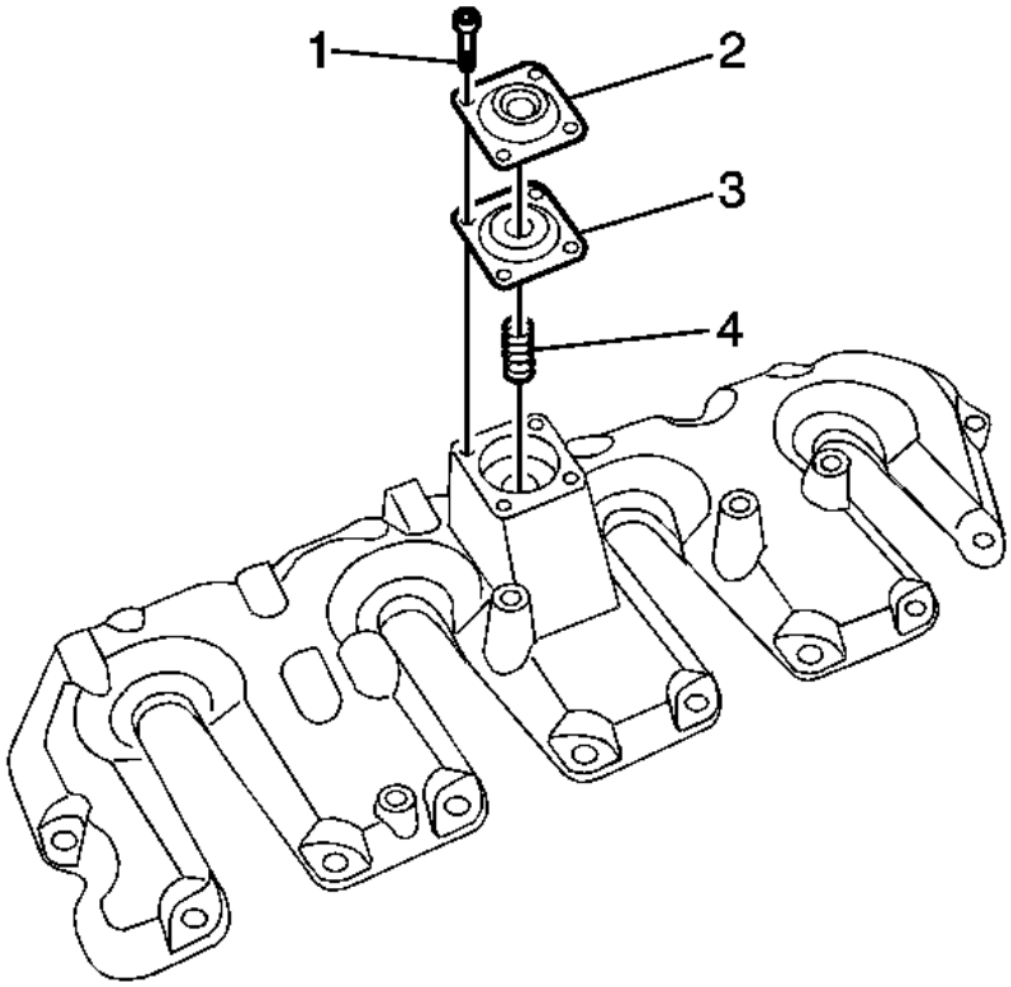


Fig. 53: View Of PCV Cover, Diaphragm & Spring
Courtesy of GENERAL MOTORS CORP.

NOTE: **Refer to Fastener Notice .**

1. Install the spring, diaphragm and cover.
2. Install the PCV cover screws.

   Tighten: Tighten the screws to 4 N.m (35 lb in).

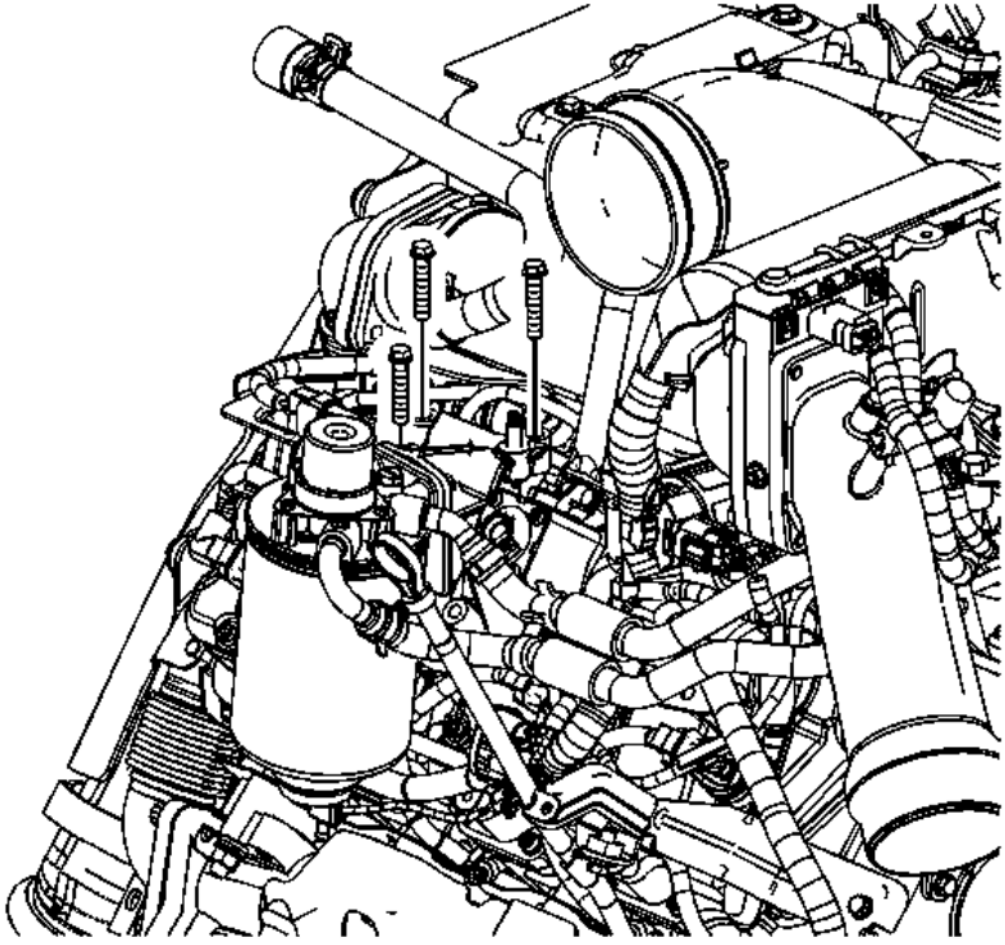


Fig. 54: Identifying Fuel Filter Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

3. Position the fuel filter assembly to the engine.

4. Install the fuel filter bracket bolts.

   Tighten: Tighten the bolts to 21 N.m (15 lb ft).

5. Install the air cleaner outlet duct. Refer to **Air Cleaner Assembly Replacement** .

POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT

Removal Procedure

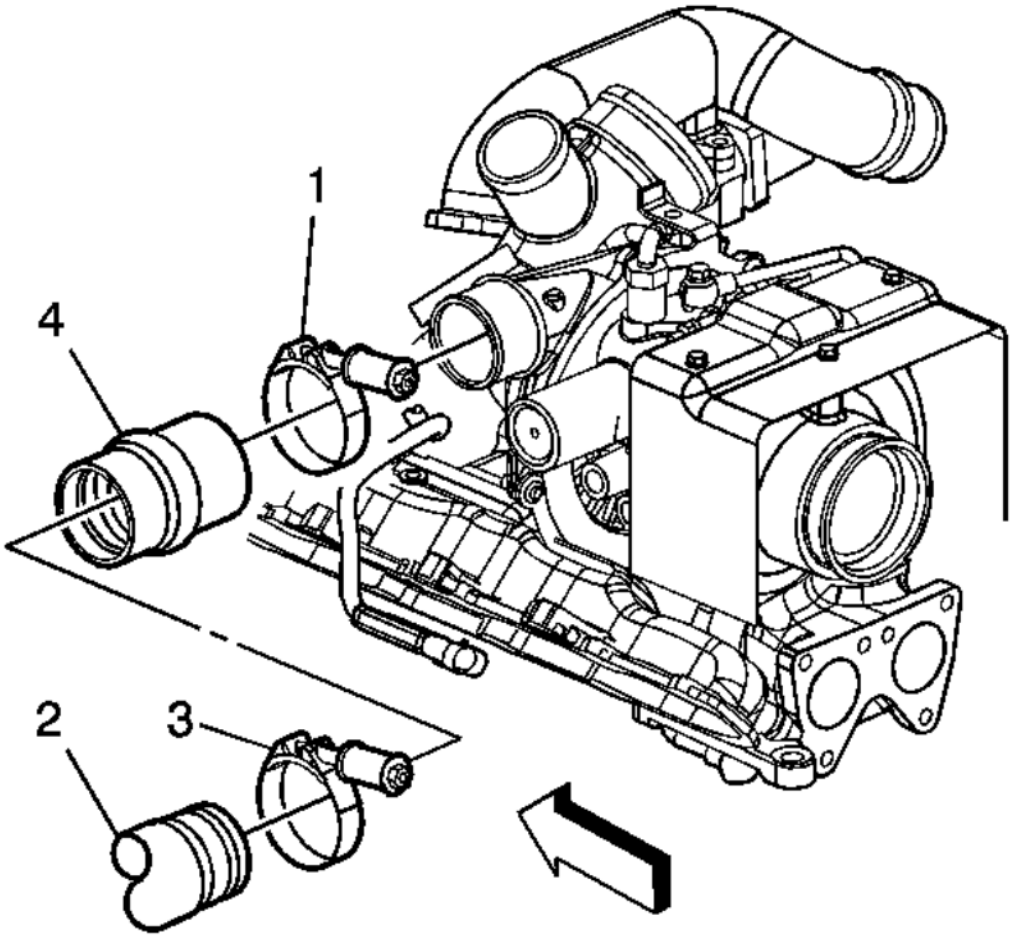


Fig. 55: View Of Turbocharger Clamp & Charged Air Cooler Inlet Duct Connector
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: After removing the charged air cooler duct, cover the turbocharger opening with tape in order to prevent entry of objects.

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.
2. Loosen the charged air cooler inlet duct connector to turbocharger clamp (1).

IMPORTANT: Do not use a screwdriver or other tool to pry the hose loose. The hose can be torn or damaged. Loosen the hose by twisting.

3. Remove the charged air cooler inlet duct connector (4) from the turbocharger.
4. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .

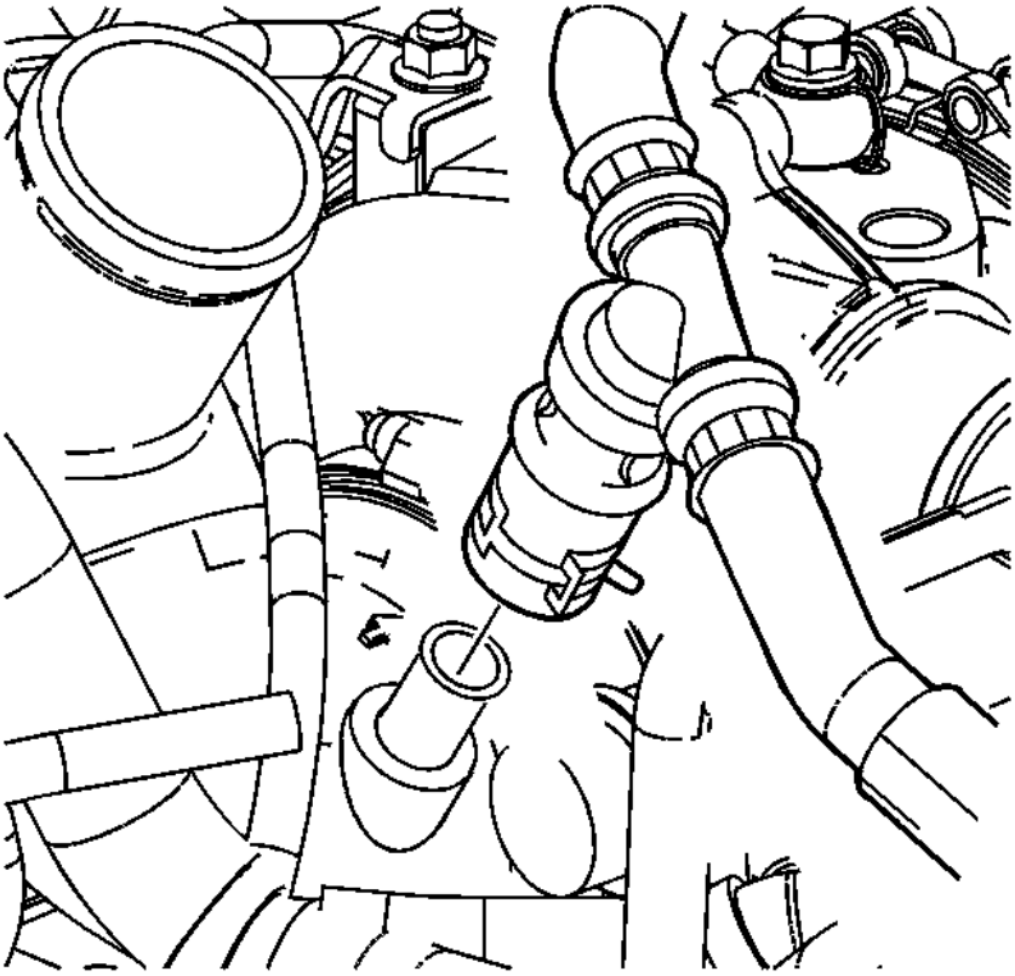


Fig. 56: View Of PCV Hose Clamp
Courtesy of GENERAL MOTORS CORP.

5. Reposition the positive crankcase ventilation (PCV) hose clamp.
6. Remove the PCV hose from the air inlet pipe.
7. Remove the PCV hose from the clip on the top of the turbocharger.

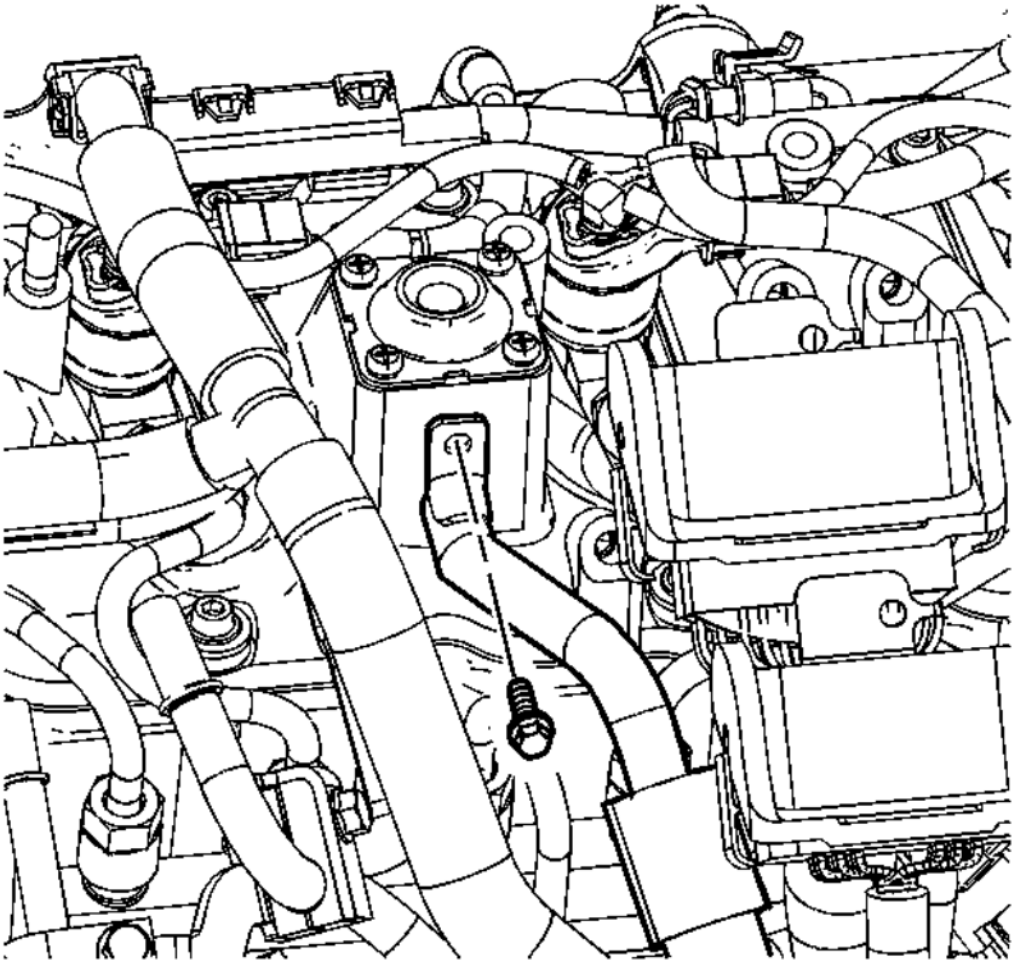


Fig. 57: View Of Left PCV Hose/Pipe Bolt
Courtesy of GENERAL MOTORS CORP.

8. Remove the left PCV hose/pipe bolt.

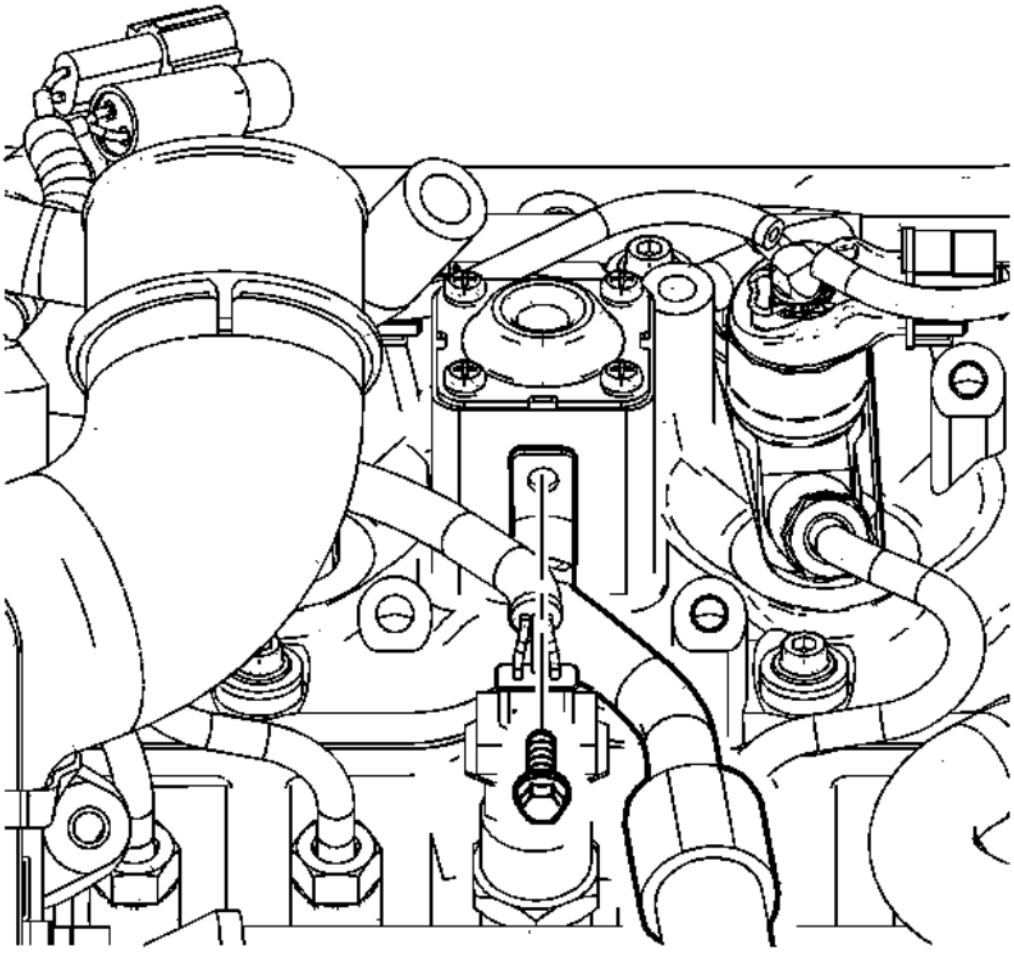


Fig. 58: View Of Right PCV Hose/Pipe Bolt
Courtesy of GENERAL MOTORS CORP.

9. Remove the right PCV hose/pipe bolt.
10. Remove the PCV hose/pipe.

Installation Procedure

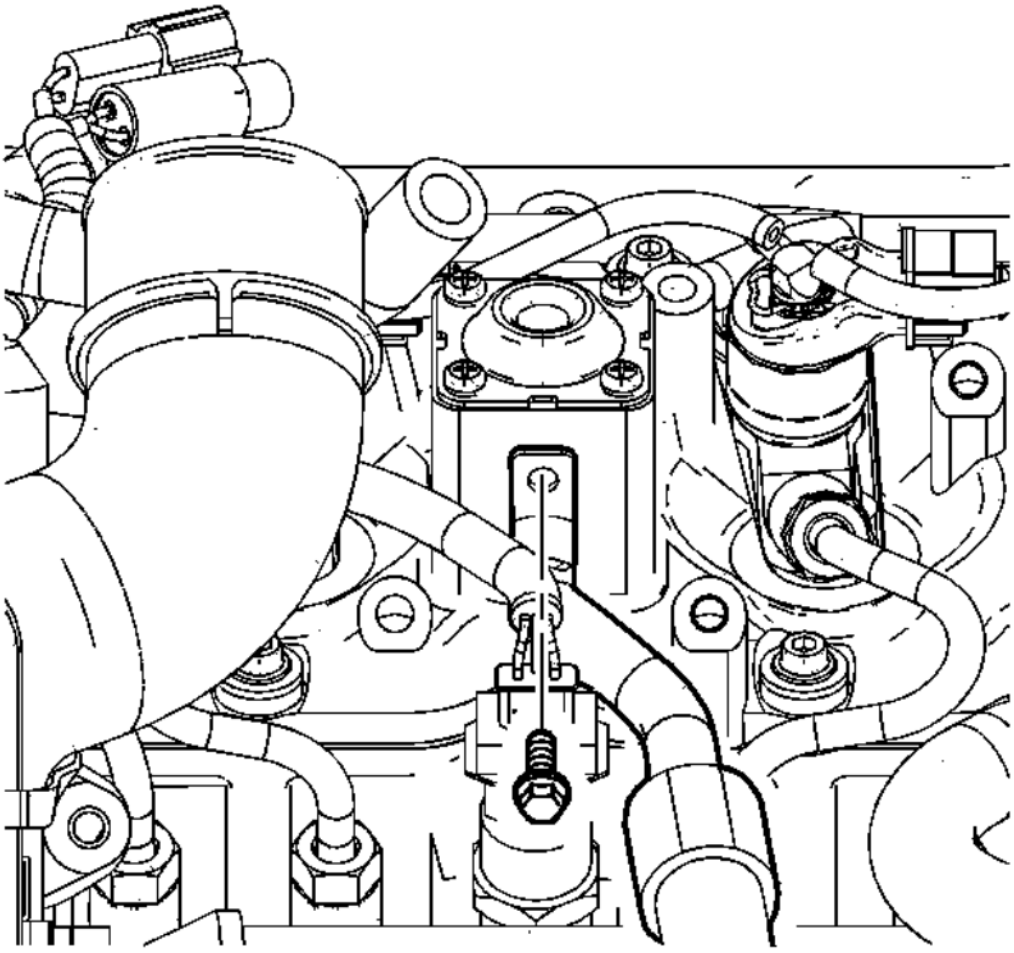


Fig. 59: View Of Right PCV Hose/Pipe Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

1. Install the PCV hose/pipe.
2. Install the right PCV hose/pipe bolt.

Tighten: Tighten the bolt to 18 N.m (13 lb ft).

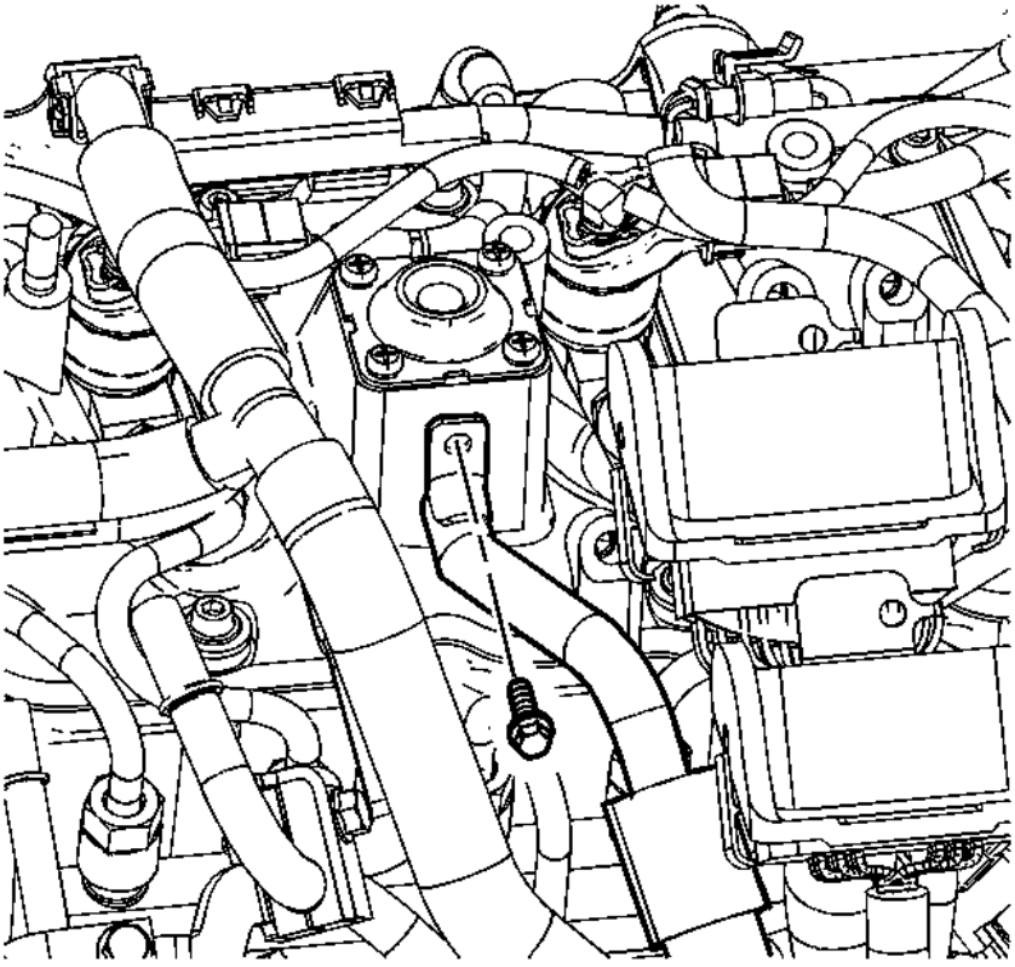


Fig. 60: View Of Left PCV Hose/Pipe Bolt
Courtesy of GENERAL MOTORS CORP.

3. Install the left PCV hose/pipe bolt.

   Tighten: Tighten the bolt to 18 N.m (13 lb ft).

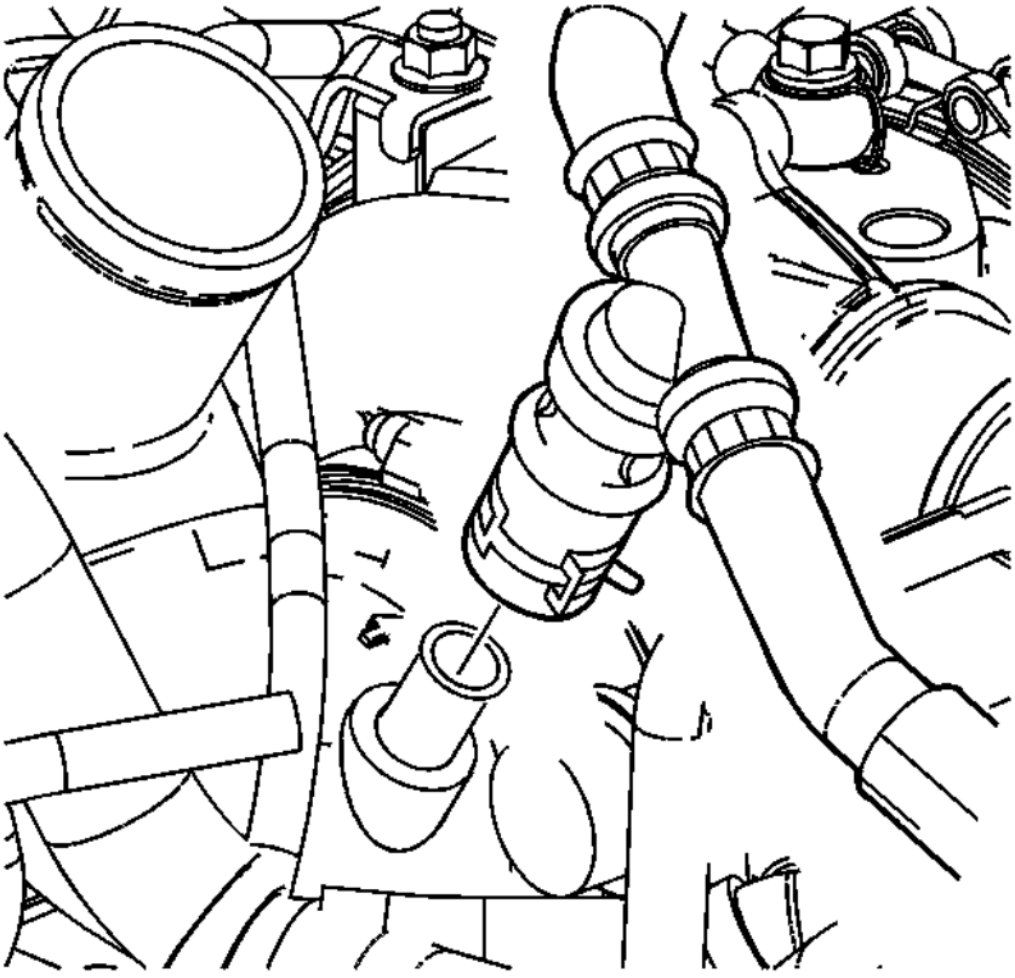


Fig. 61: View Of PCV Hose Clamp
Courtesy of GENERAL MOTORS CORP.

4. Install the PCV hose to the air inlet pipe.
5. Position the PCV hose clamp.
6. Install the PCV hose to the clip on the top of the turbocharger.
7. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .

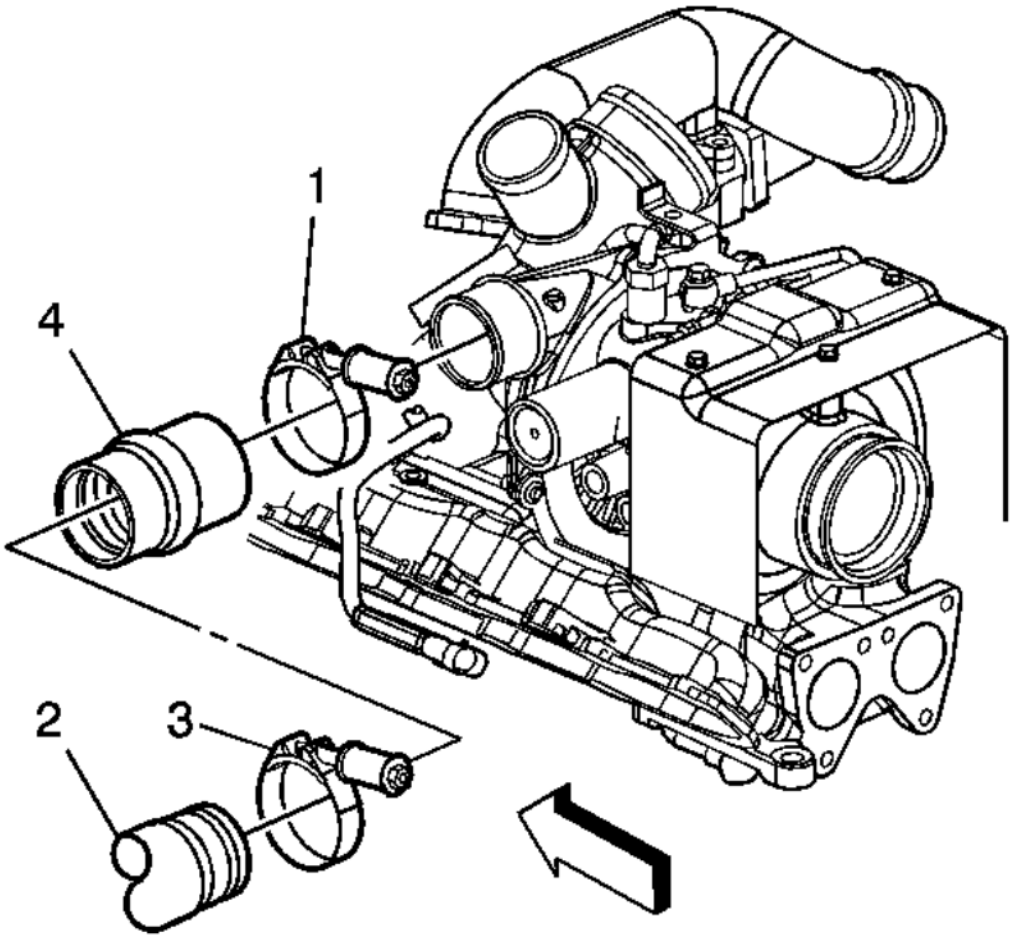


Fig. 62: View Of Turbocharger Clamp & Charged Air Cooler Inlet Duct Connector
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Lubricate the end of the duct prior to installation.

8. Remove the tape from the turbocharger openings.
9. Install the charged air cooler inlet duct connector (4) to the turbocharger.
10. Tighten the charged air cooler inlet duct connector to turbocharger clamp (1).

Tighten: Tighten the clamp to 6 N.m (53 lb in).

11. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.

INTAKE MANIFOLD TUBE REPLACEMENT

Removal Procedure

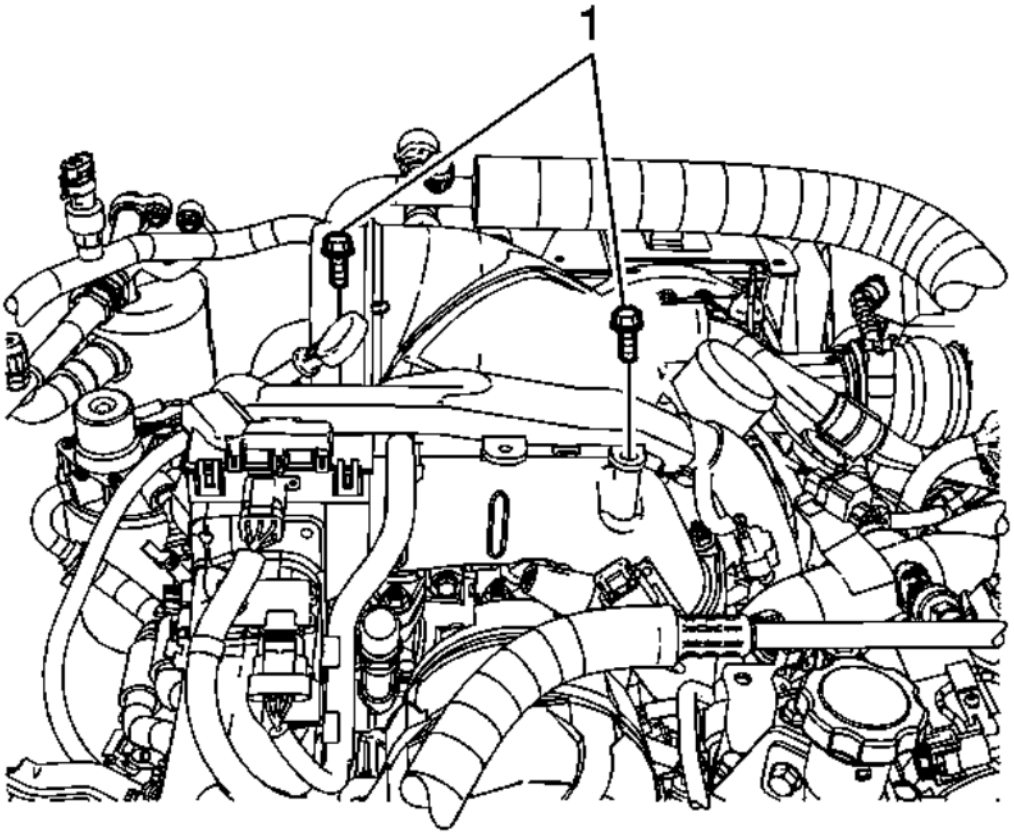


Fig. 63: View Of Electrical Harness Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the intake air valve. Refer to **Intake Air Valve Replacement** .
2. Remove the electrical harness bolts (1).
3. Reposition the harness clip from the intake manifold tube, as needed.

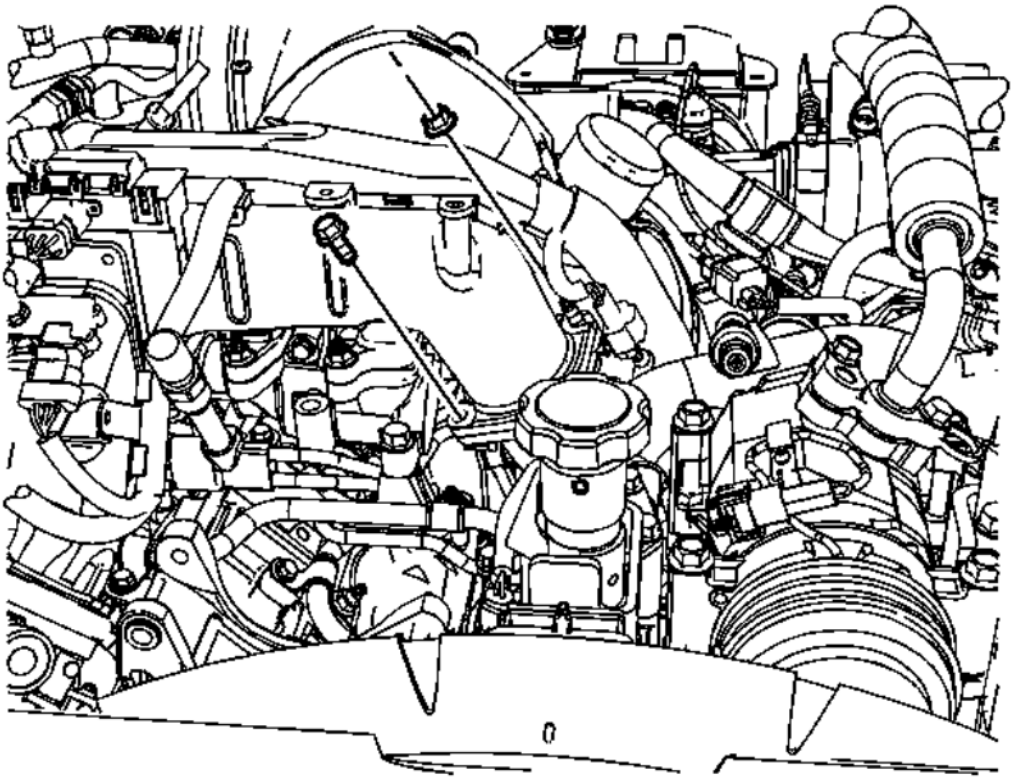


Fig. 64: View Of Air Inlet Tube To Intake Manifold Tube Bolt & Nut
Courtesy of GENERAL MOTORS CORP.

4. Remove the air inlet tube to intake manifold tube bolt and nut.

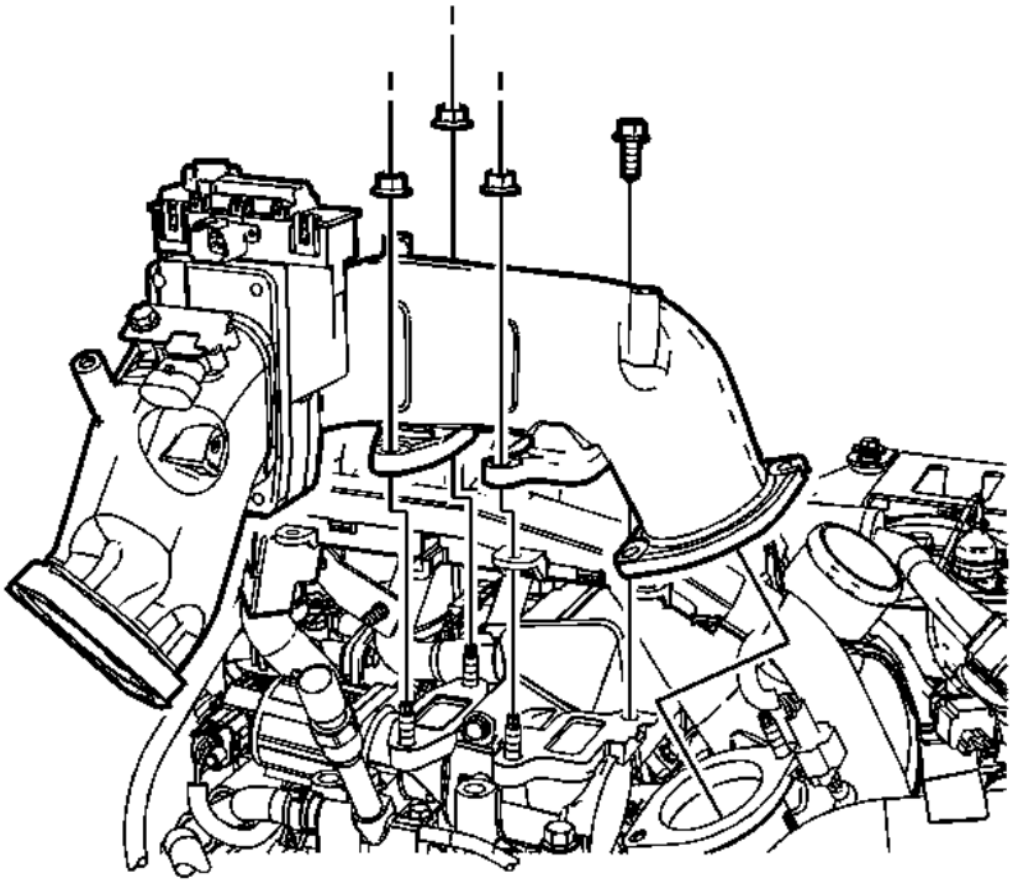


Fig. 65: View Of Air Inlet Tube & Components
Courtesy of GENERAL MOTORS CORP.

5. Disconnect the intake air heater electrical connector.
6. Disconnect the manifold absolute pressure (MAP) sensor electrical connector.
7. Remove the engine harness clip from the air inlet tube.
8. Remove the air inlet tube nuts and bolt.
9. Remove the air inlet tube.

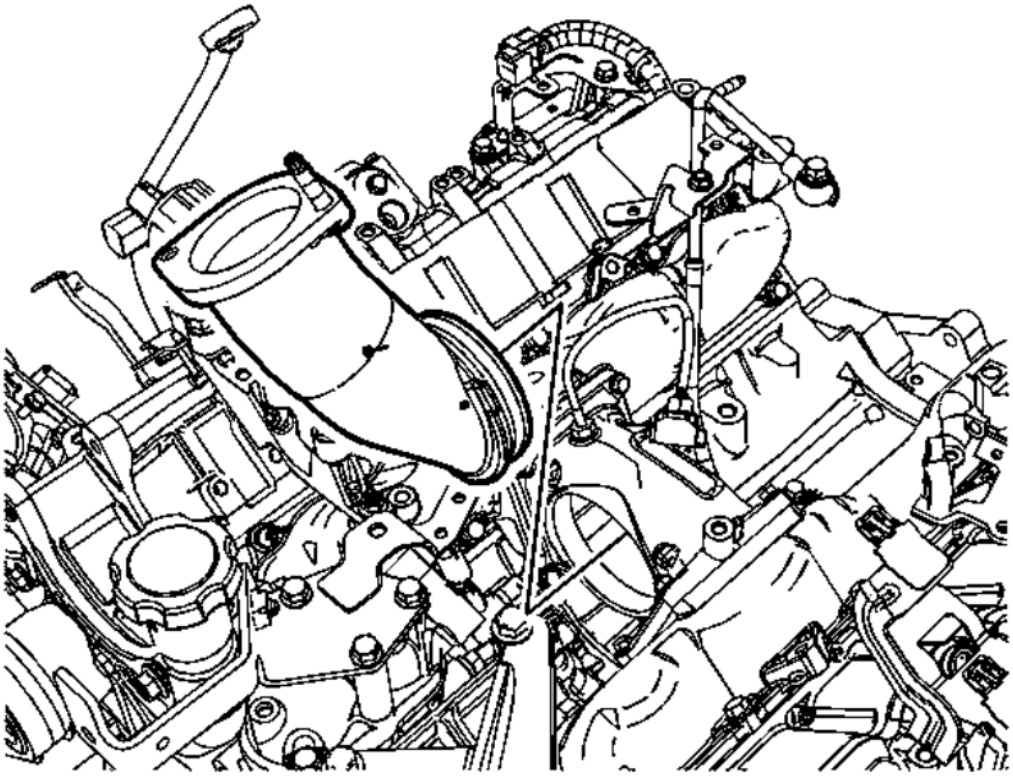


Fig. 66: View Of Intake Manifold Tube
Courtesy of GENERAL MOTORS CORP.

10. If necessary, remove the intake manifold tube.
11. If necessary, remove and discard the 2 O-ring seals from the tube.
12. Clean the gasket surfaces of the exhaust gas recirculation (EGR) cooler tube, intake manifold tube and inlet tube.

Installation Procedure

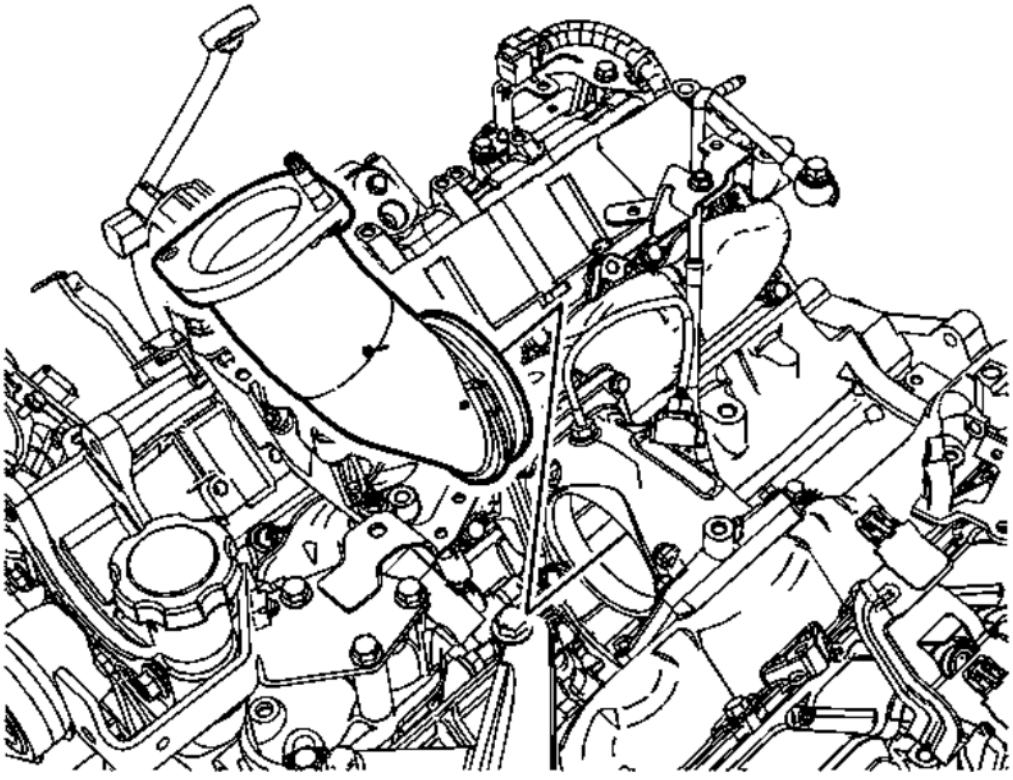


Fig. 67: View Of Intake Manifold Tube
Courtesy of GENERAL MOTORS CORP.

1. If necessary, install NEW O-ring seals onto the tube.
2. If necessary, install the intake manifold tube.

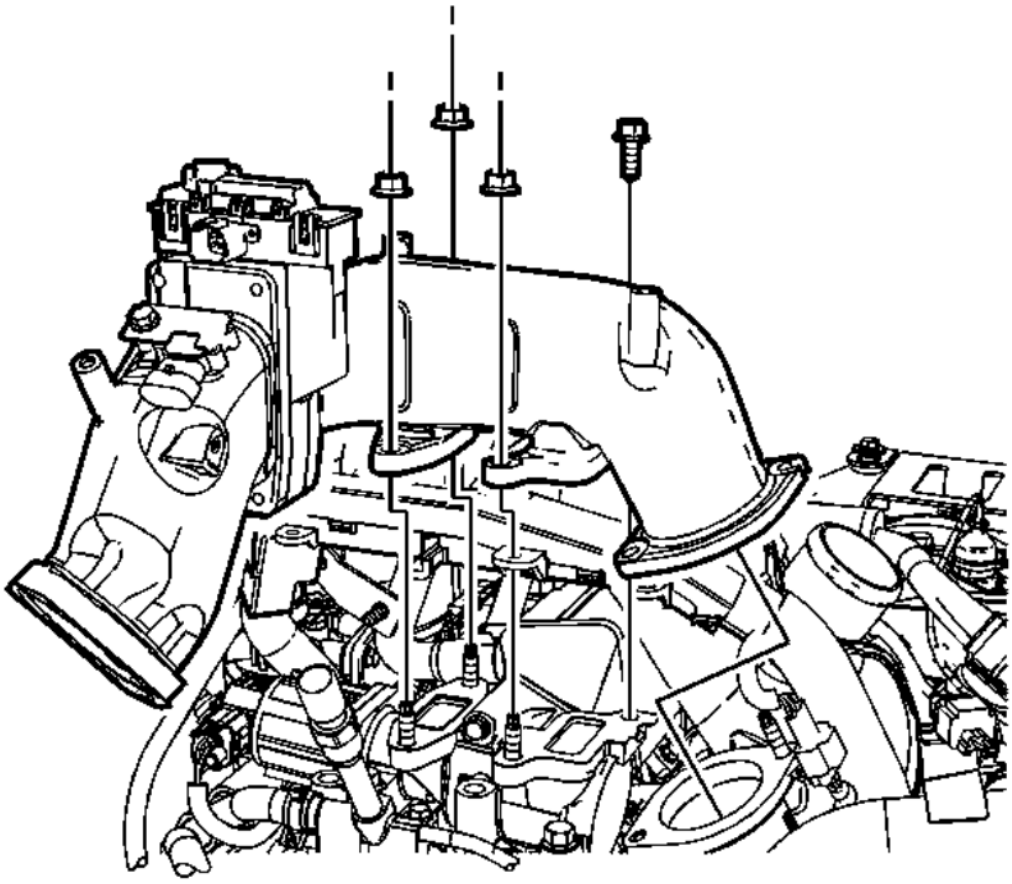


Fig. 68: View Of Air Inlet Tube & Components
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

3. Install the air inlet tube and NEW gaskets.
4. Install the air inlet tube nuts and bolt.

Tighten: Tighten the nuts to 25 N.m (18 lb ft).

5. Connect the intake air heater electrical connector.
6. Connect the MAP sensor electrical connector.
7. Install the engine harness clip to the air inlet tube.

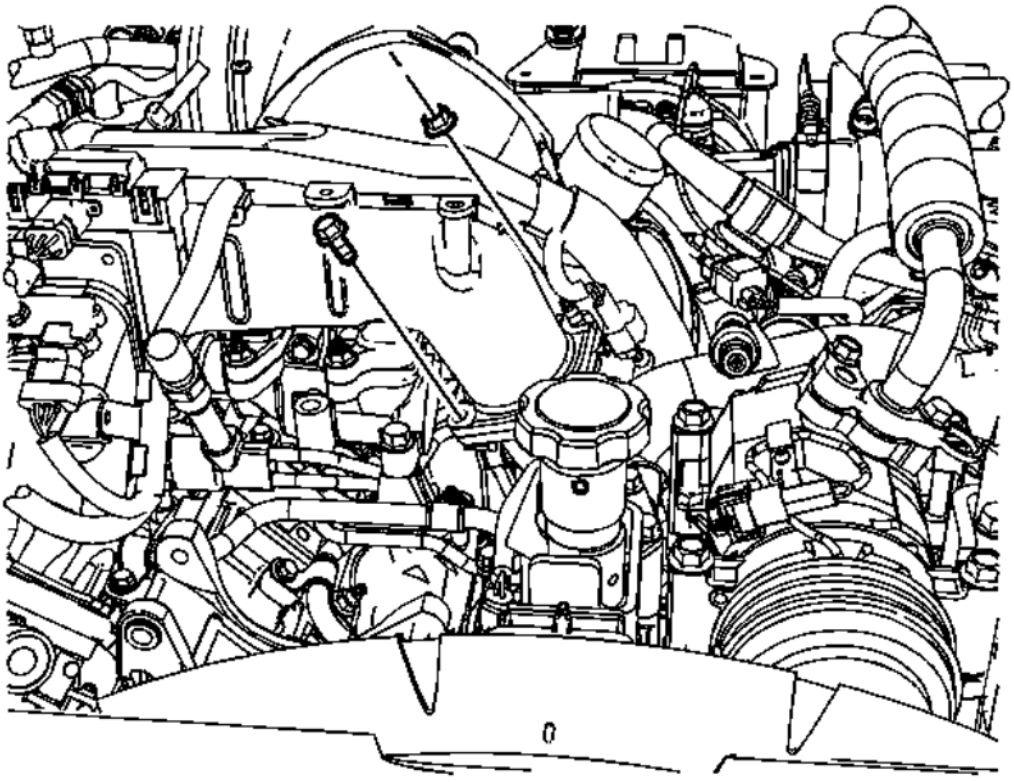


Fig. 69: View Of Air Inlet Tube To Intake Manifold Tube Bolt & Nut
Courtesy of GENERAL MOTORS CORP.

8. Install the air inlet tube to intake manifold tube bolt and nut.

   Tighten: Tighten the bolt/nut to 10 N.m (89 lb in).

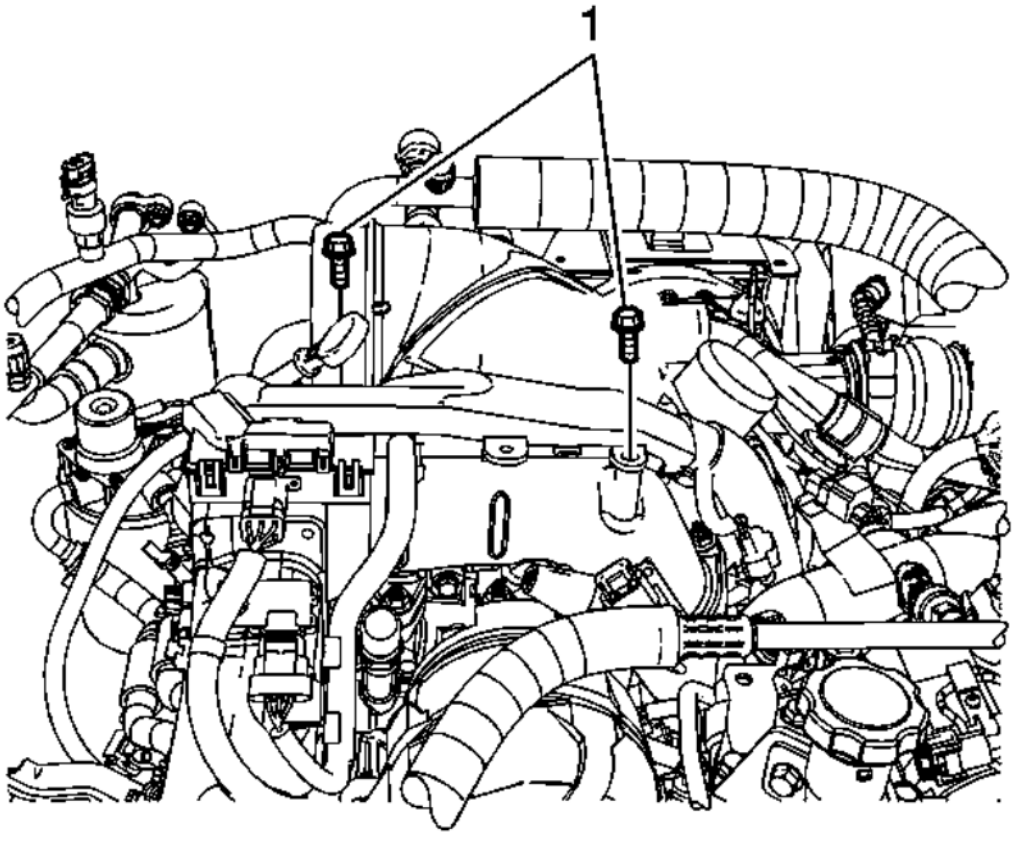


Fig. 70: View Of Electrical Harness Bolts
Courtesy of GENERAL MOTORS CORP.

9. Install the electrical harness bolts (1).

   Tighten: Tighten the bolts to 4 N.m (35 lb in).

10. Install the intake air valve. Refer to **Intake Air Valve Replacement** .

CENTER INTAKE MANIFOLD REPLACEMENT

Removal Procedure

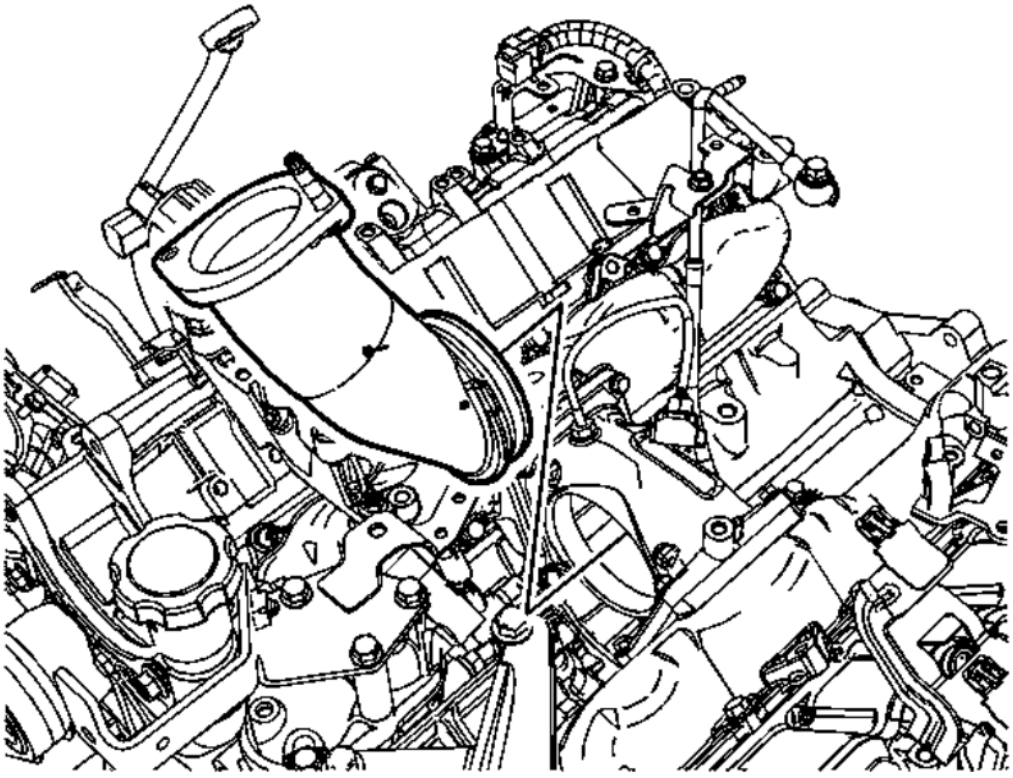


Fig. 71: View Of Intake Manifold Tube
Courtesy of GENERAL MOTORS CORP.

1. Remove the exhaust gas recirculation (EGR) valve cooler tube. Refer to **Exhaust Gas Recirculation Valve Cooler Replacement** .
2. Remove the water outlet tube. Refer to **Water Outlet Tube Replacement (LMM)** .
3. Remove the intake manifold tube.
4. Remove and discard the 2 intake manifold tube gaskets.
5. Remove the turbocharger. Refer to **Turbocharger Replacement**.

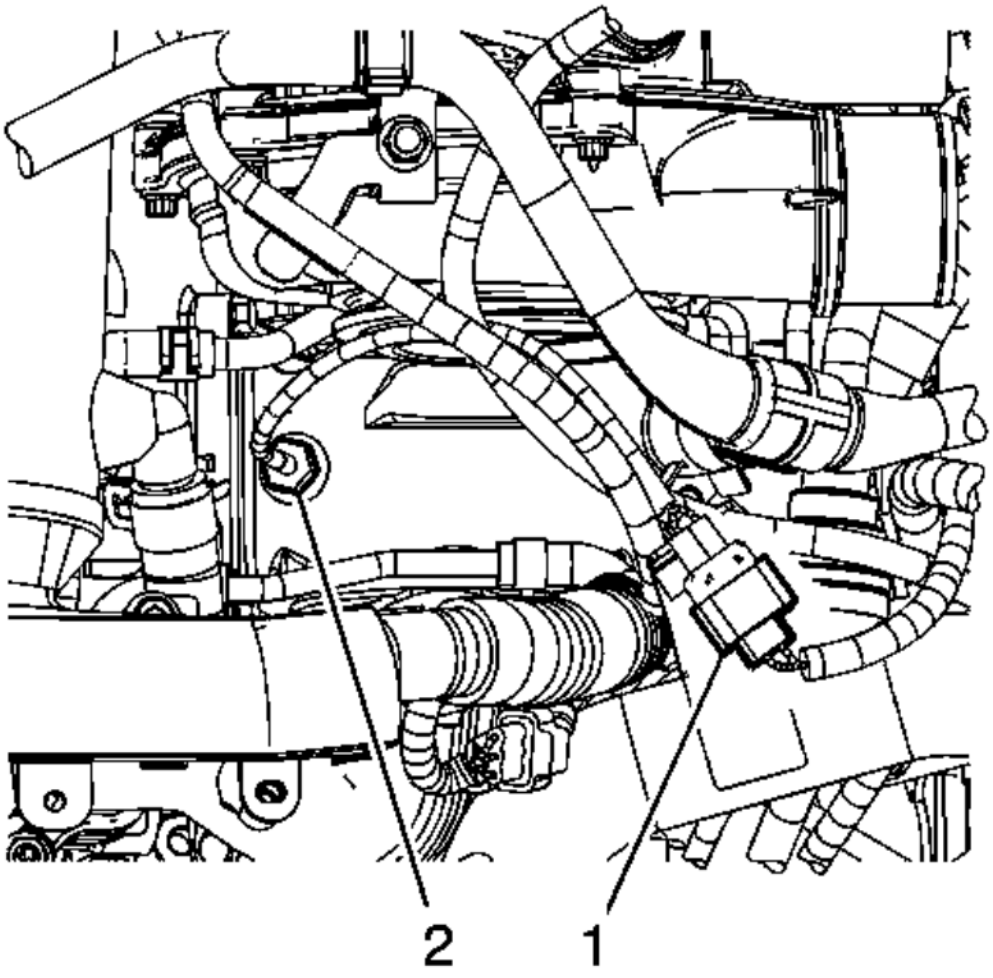


Fig. 72: View Of IAT Sensor & Electrical Connector
Courtesy of GENERAL MOTORS CORP.

6. Disconnect the intake air temperature (IAT) sensor electrical connector (1).
7. Remove the IAT sensor (2).

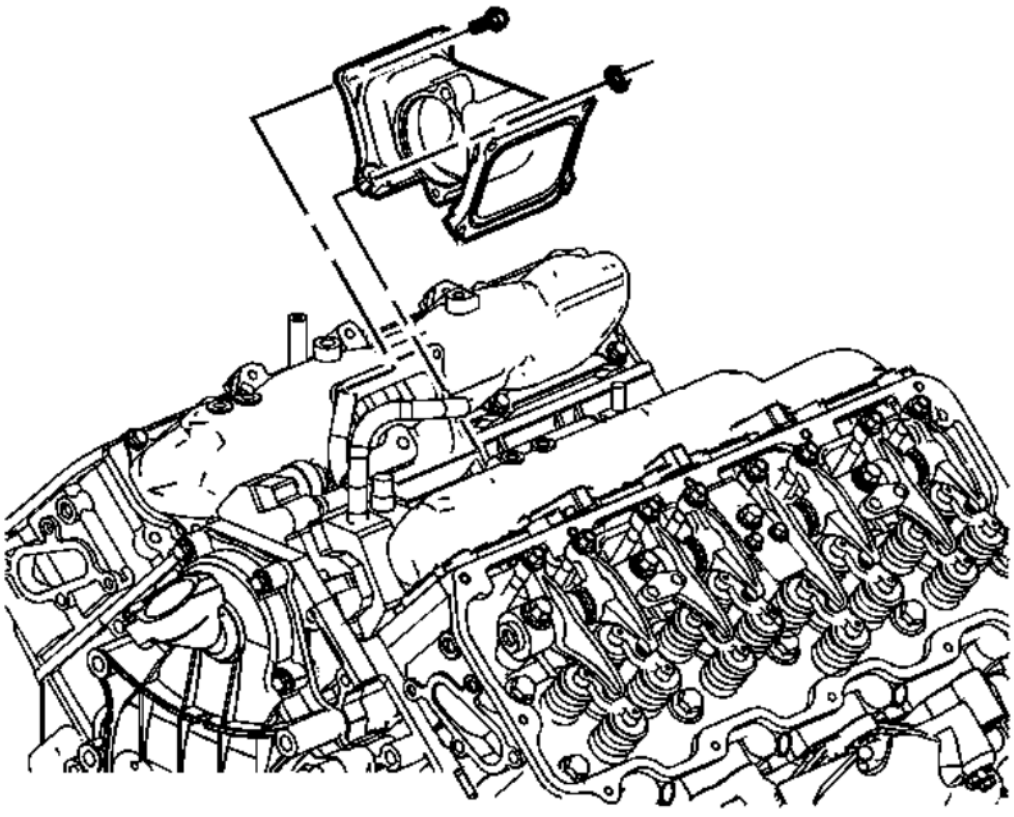


Fig. 73: View Of Center Intake Manifold
Courtesy of GENERAL MOTORS CORP.

8. Remove the center intake manifold bolts/nuts.
9. Pull-up the center intake manifold in order to remove.
10. Remove and discard the gaskets.
11. Clean the center intake manifold in cleaning solvent and air dry.

Installation Procedure

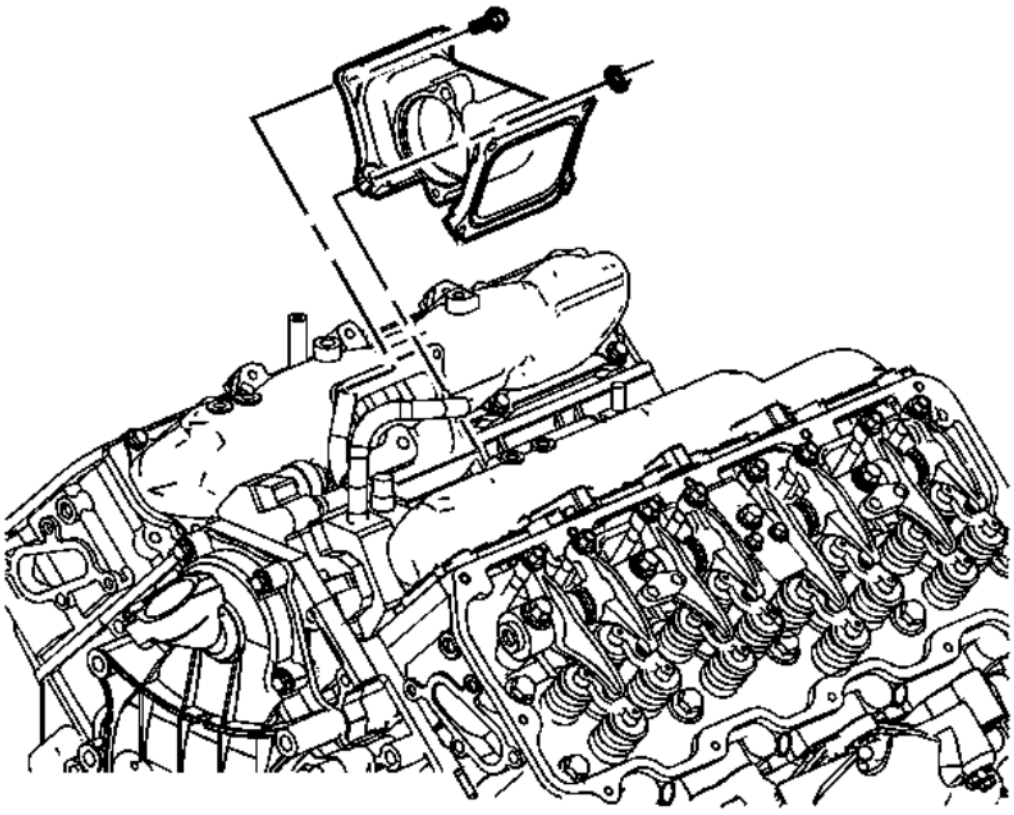


Fig. 74: View Of Center Intake Manifold
Courtesy of GENERAL MOTORS CORP.

1. Install NEW center intake manifold gaskets.
2. Install the center intake manifold.

NOTE: Refer to Fastener Notice .

3. Install the center intake manifold bolts/nuts.

Tighten: Tighten the bolts/nuts to 10 N.m (89 lb in).

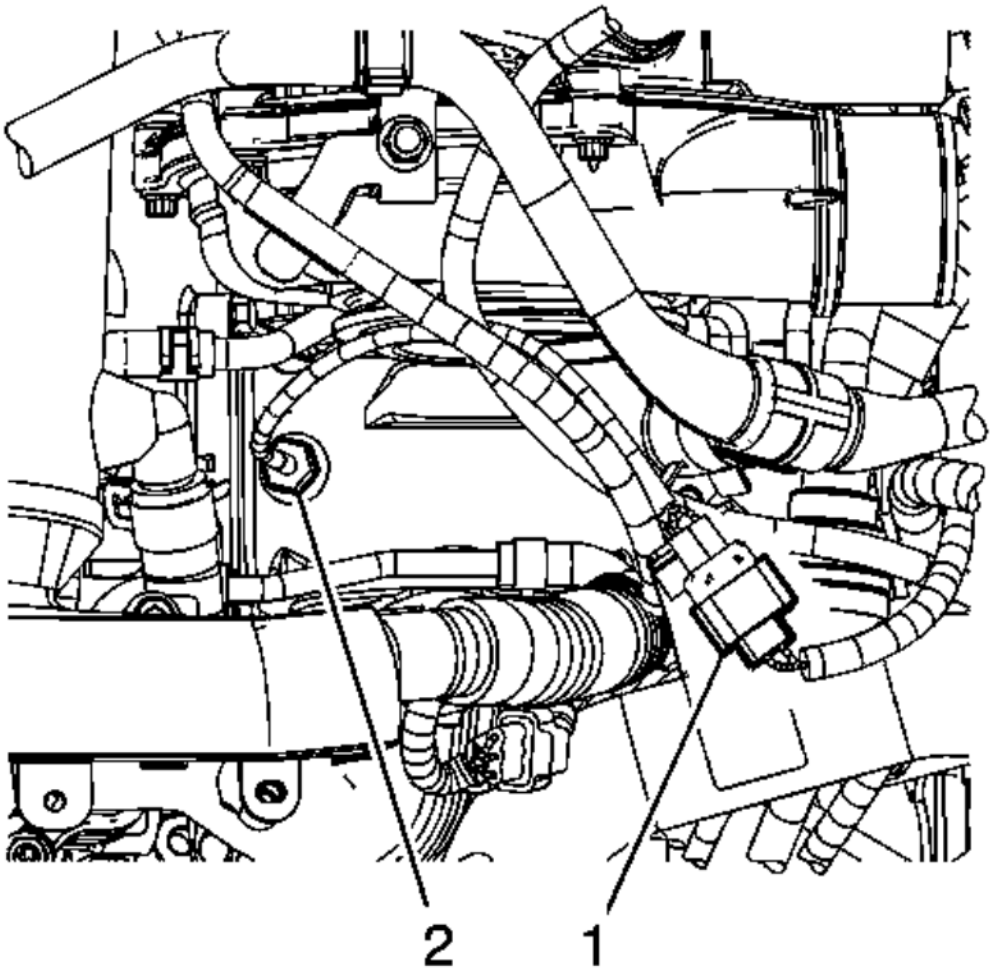


Fig. 75: View Of IAT Sensor & Electrical Connector
Courtesy of GENERAL MOTORS CORP.

4. Install the IAT sensor (2).

   Tighten: Tighten the sensor to 10 N.m (89 lb in).

5. Connect the IAT sensor electrical connector (1).
6. Install the turbocharger. Refer to **Turbocharger Replacement**.

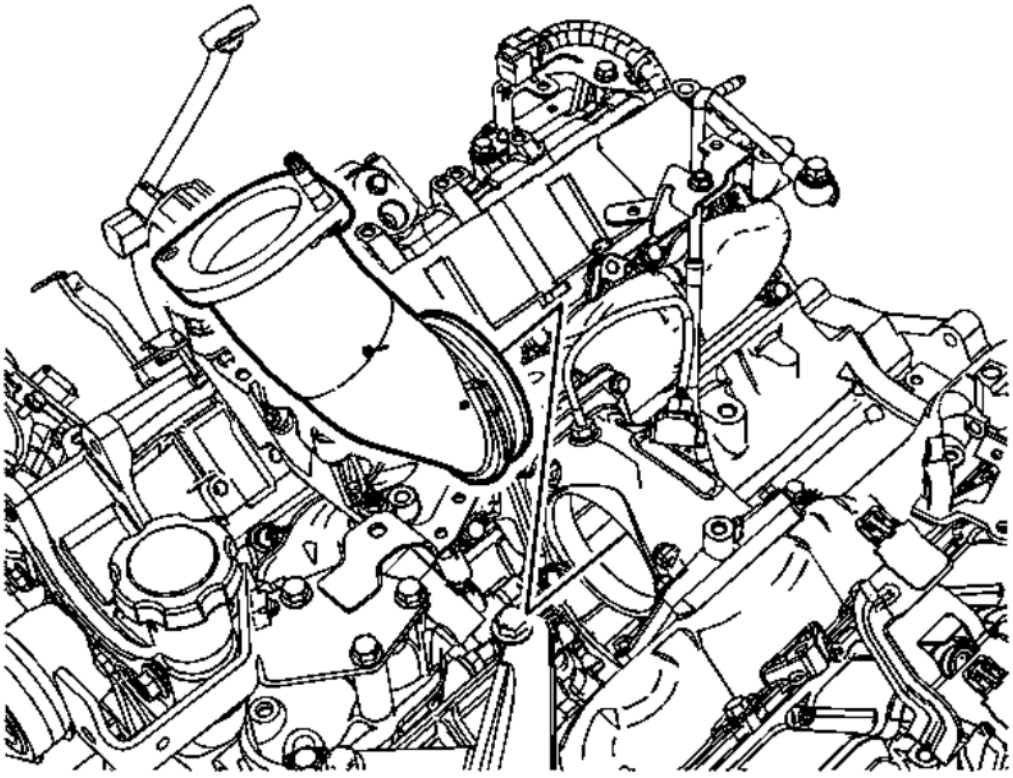


Fig. 76: View Of Intake Manifold Tube
Courtesy of GENERAL MOTORS CORP.

7. Install 2 NEW O-rings onto the intake manifold tube.
8. Lubricate the O-rings with clean engine oil to aid in the installation.
9. Install the intake manifold tube.
10. Install the water outlet tube. Refer to **Water Outlet Tube Replacement (LMM)** .
11. Install the EGR valve cooler tube. Refer to **Exhaust Gas Recirculation Valve Cooler Replacement** .

INTAKE MANIFOLD REPLACEMENT - LEFT SIDE

Removal Procedure

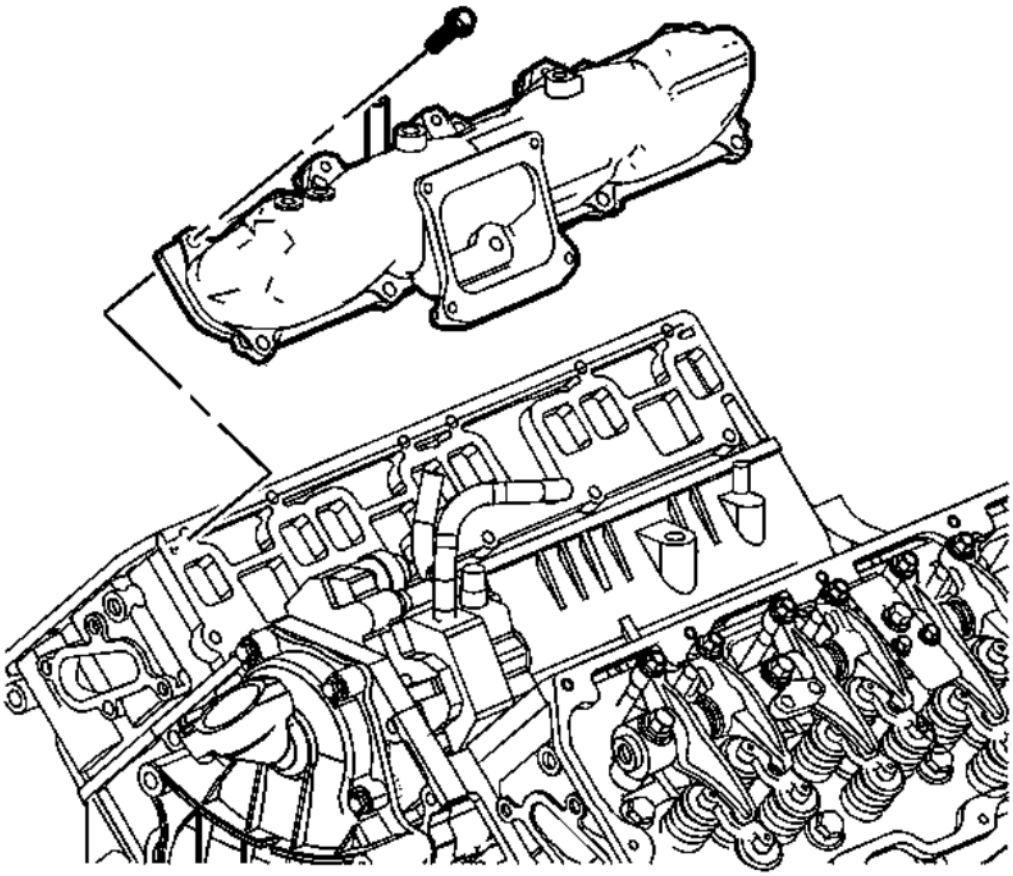


Fig. 77: View Of Intake Manifold (Right)
Courtesy of GENERAL MOTORS CORP.

1. Remove the center intake manifold. Refer to **Center Intake Manifold Replacement**.
2. Remove the right fuel rail. Refer to **Fuel Rail Fuel Feed Pipe Replacement - Right Side** .
3. Remove the intake manifold bolts/nuts.

IMPORTANT: The intake manifold uses sealer. Pry at the area by the fuel rail bolt holes in order to avoid damage to the sealing surfaces.

4. Remove the intake manifold.

5. To prevent entry of debris in the cylinder head tape the openings.
6. If required, clean and inspect the intake manifold. Refer to **Intake Manifold Cleaning and Inspection** .

Installation Procedure

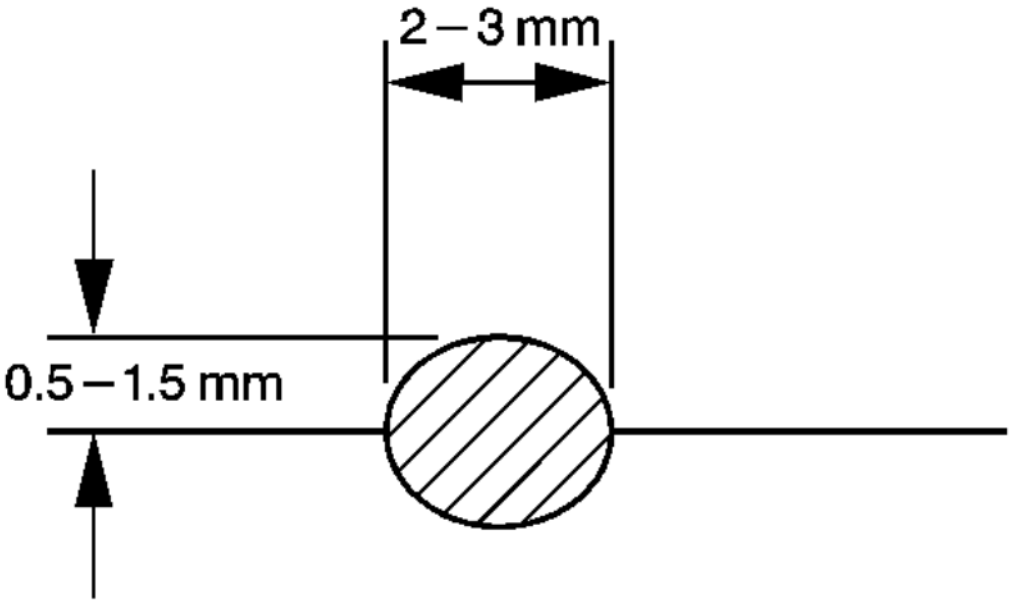


Fig. 78: Determining Sealant Bead Dimensions
Courtesy of GENERAL MOTORS CORP.

1. Apply a 2-3 mm (1/8 in) wide, by 0.5-1.5 mm (1/16 in) high bead of sealant to the intake manifold. Refer to **Sealers, Adhesives, and Lubricants** for the correct part number.

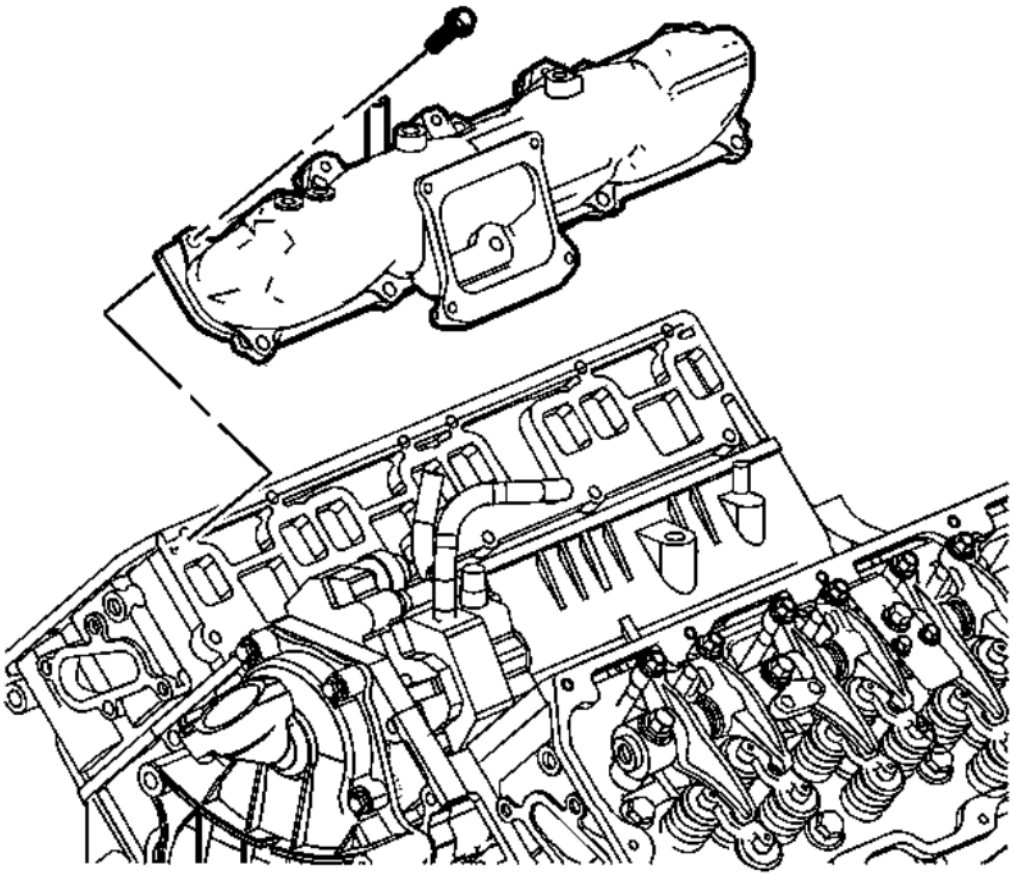


Fig. 79: View Of Intake Manifold (Right)
Courtesy of GENERAL MOTORS CORP.

2. Install the intake manifold.
3. Install the intake manifold bolts/nuts.

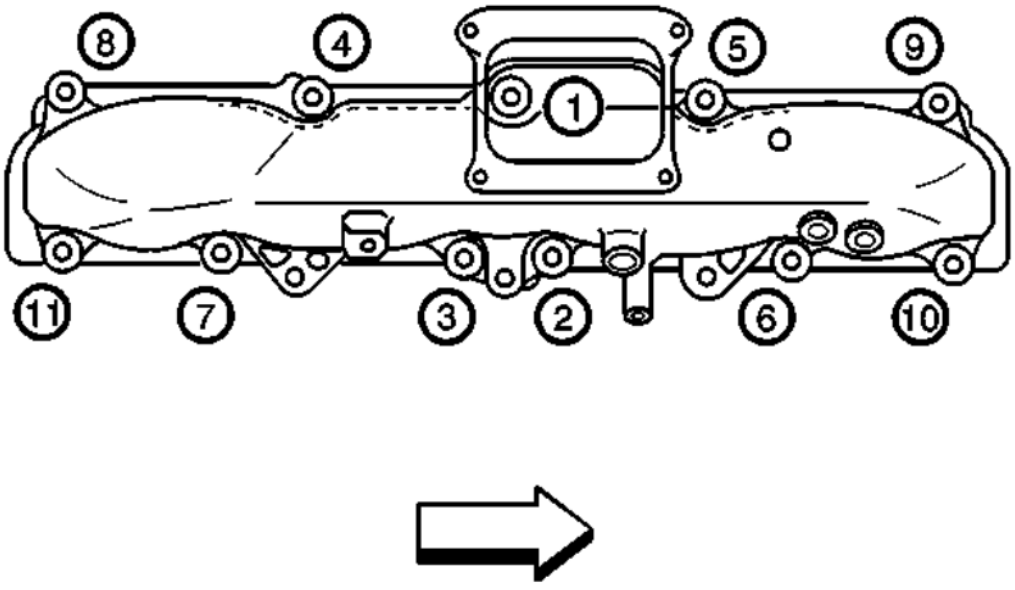


Fig. 80: Intake Manifold Bolt Tightening Sequence (Right)
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

4. Tighten the intake manifold bolts/nuts in the sequence shown.

   Tighten: Tighten the bolts/nuts to 21 N.m (15 lb ft).

5. Install the right fuel rail. Refer to **Fuel Rail Fuel Feed Pipe Replacement - Right Side** .
6. Install the center intake manifold. Refer to **Center Intake Manifold Replacement**.

INTAKE MANIFOLD REPLACEMENT - RIGHT SIDE

Removal Procedure

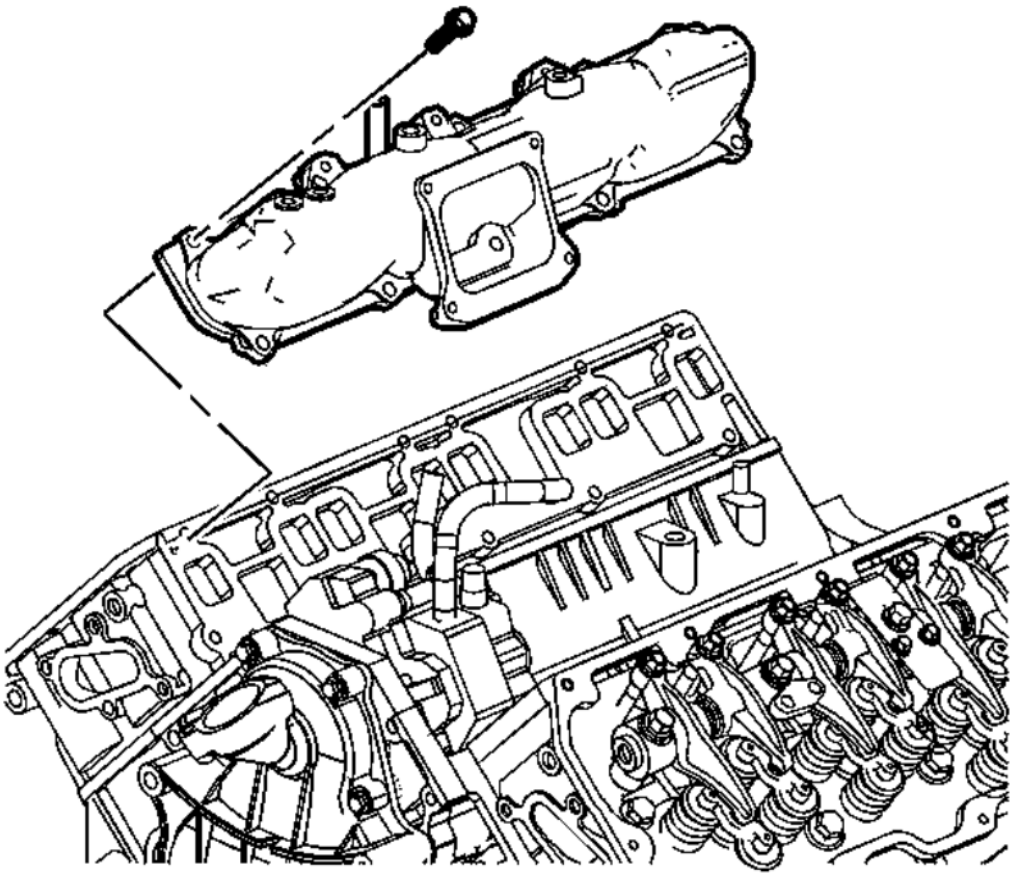


Fig. 81: View Of Intake Manifold (Right)
Courtesy of GENERAL MOTORS CORP.

1. Remove the center intake manifold. Refer to **Center Intake Manifold Replacement**.
2. Remove the right fuel rail. Refer to **Fuel Rail Fuel Feed Pipe Replacement - Right Side** .
3. Remove the intake manifold bolts/nuts.

IMPORTANT: The intake manifold uses sealer. Pry at the area by the fuel rail bolt holes in order to avoid damage to the sealing surfaces.

4. Remove the intake manifold.

5. To prevent entry of debris in the cylinder head tape the openings.
6. If required, clean and inspect the intake manifold. Refer to **Intake Manifold Cleaning and Inspection** .

Installation Procedure

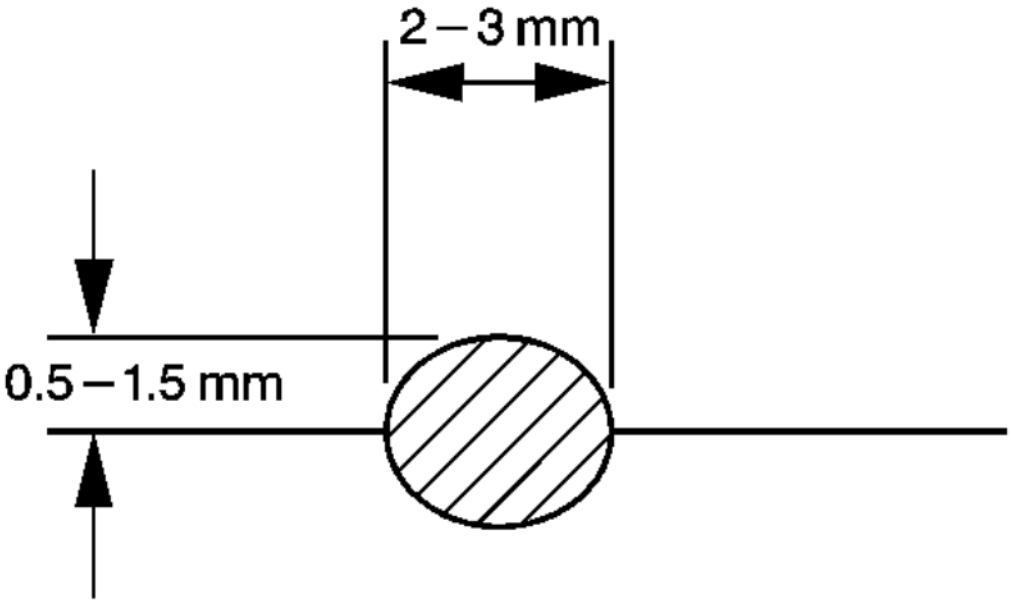


Fig. 82: Determining Sealant Bead Dimensions
Courtesy of GENERAL MOTORS CORP.

1. Apply a 2-3 mm (1/8 in) wide, by 0.5-1.5 mm (1/16 in) high bead of sealant to the intake manifold. Refer to **Sealers, Adhesives, and Lubricants** for the correct part number.

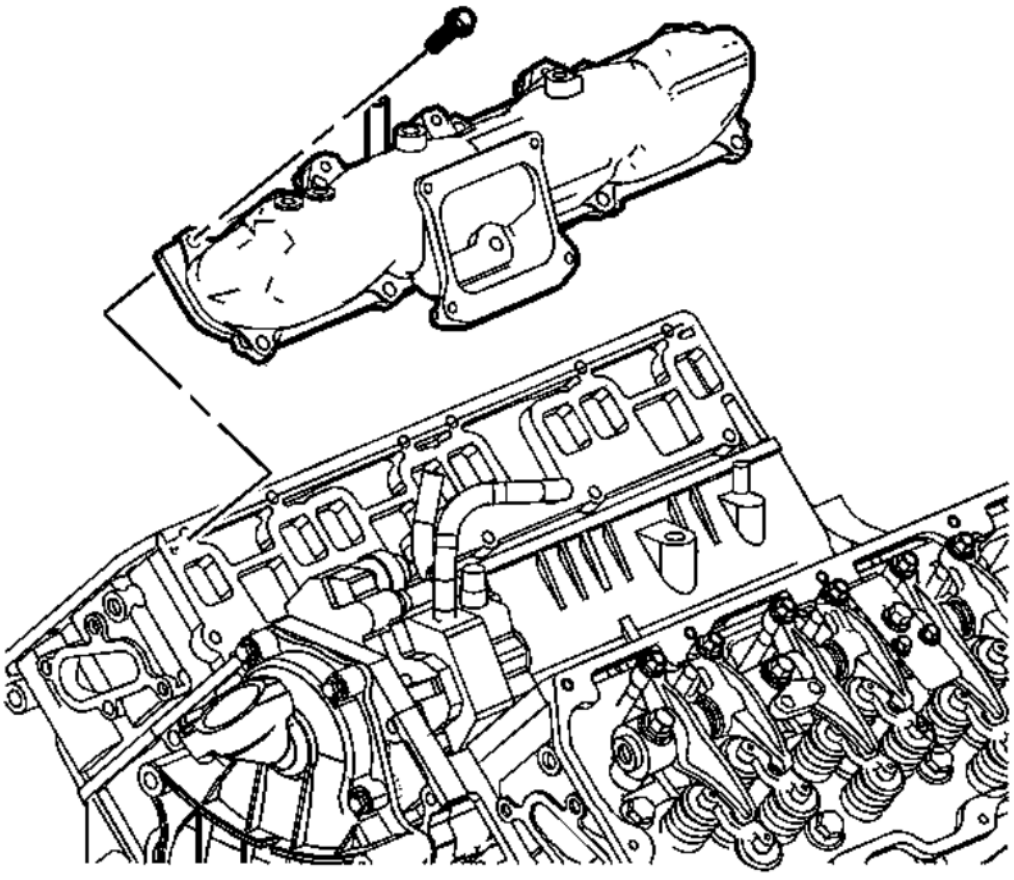


Fig. 83: View Of Intake Manifold (Right)
Courtesy of GENERAL MOTORS CORP.

2. Install the intake manifold.
3. Install the intake manifold bolts/nuts.

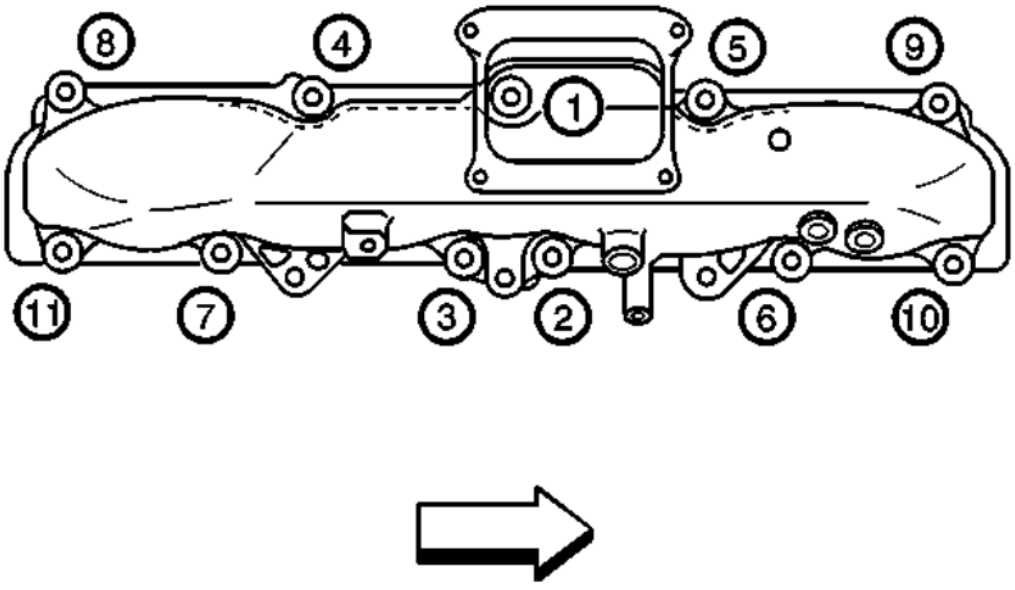


Fig. 84: Intake Manifold Bolt Tightening Sequence (Right)
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

4. Tighten the intake manifold bolts/nuts in the sequence shown.

   Tighten: Tighten the bolts/nuts to 21 N.m (15 lb ft).

5. Install the right fuel rail. Refer to **Fuel Rail Fuel Feed Pipe Replacement - Right Side** .
6. Install the center intake manifold. Refer to **Center Intake Manifold Replacement**.

OIL FILLER TUBE REPLACEMENT

Removal Procedure

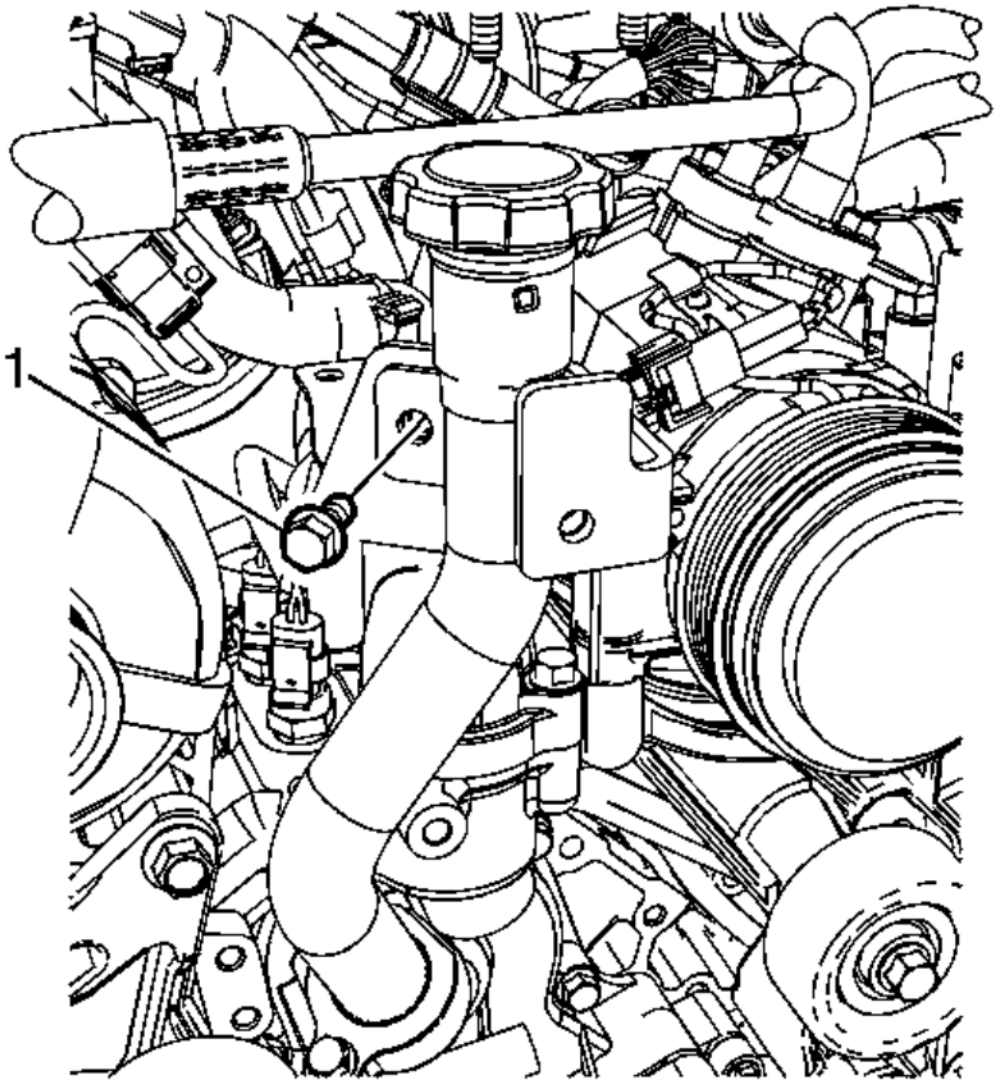


Fig. 85: View Of Upper Oil Fill Tube Bolt
Courtesy of GENERAL MOTORS CORP.

1. Remove the fan and clutch assembly. Refer to **Cooling Fan and Shroud Replacement (Non-HP2)** .
2. Remove the drive belt. Refer to **Drive Belt Replacement**.
3. Remove the upper oil fill tube bolt (1).

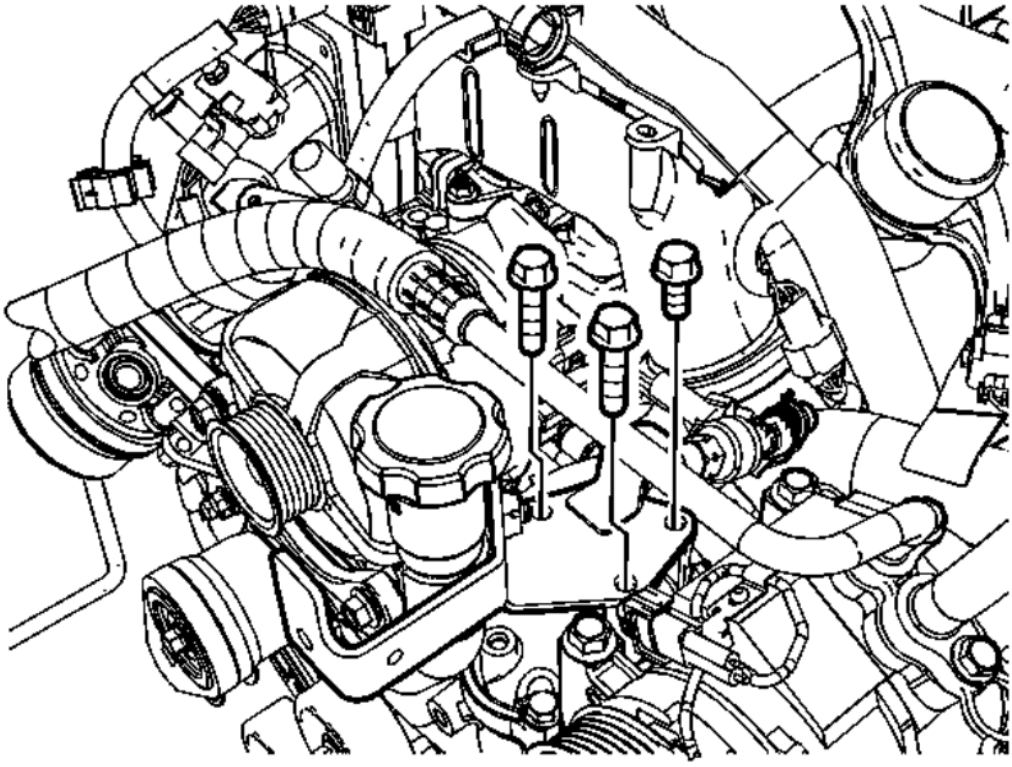


Fig. 86: View Of Oil Fill Tube Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the oil filler tube bracket bolts.
5. Remove the oil fill tube bracket.

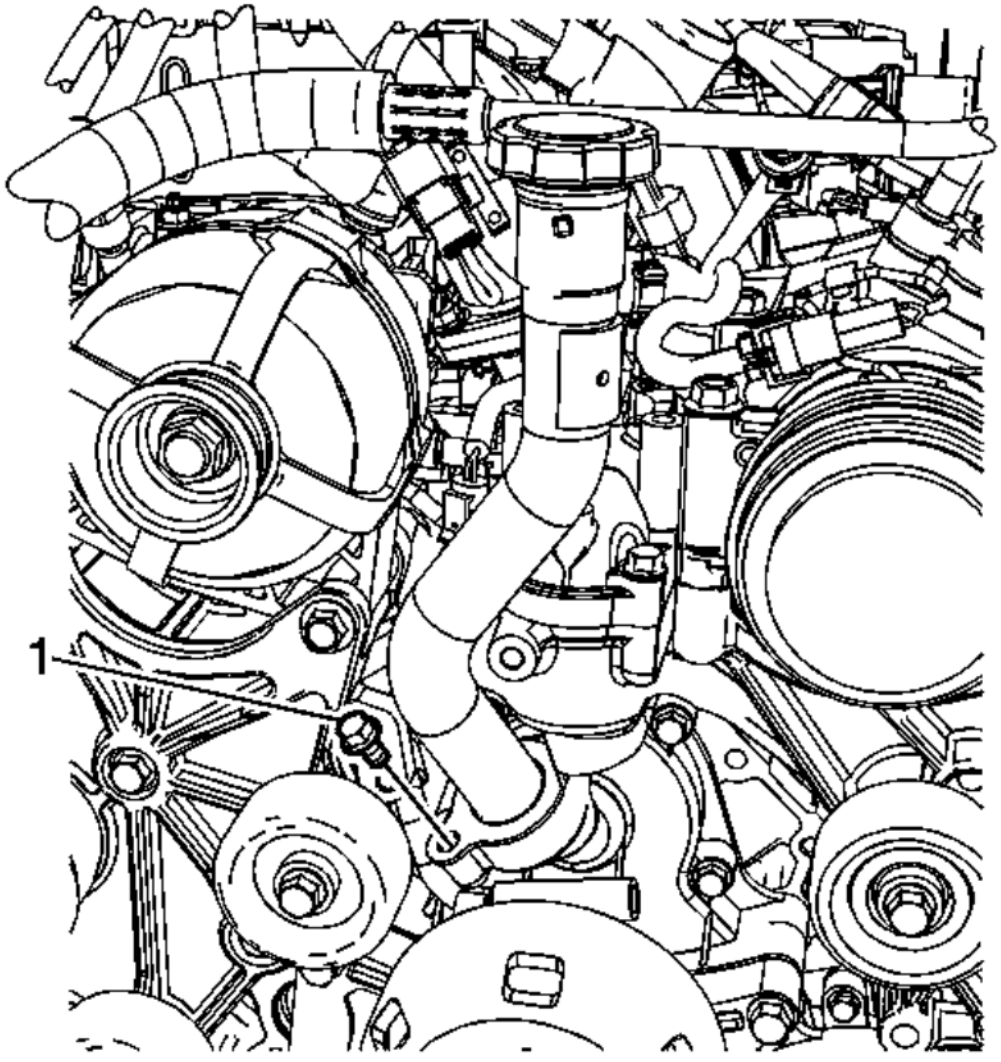


Fig. 87: View Of Lower Oil Fill Tube Bolt
Courtesy of GENERAL MOTORS CORP.

6. Remove the lower oil fill tube bolt (1).

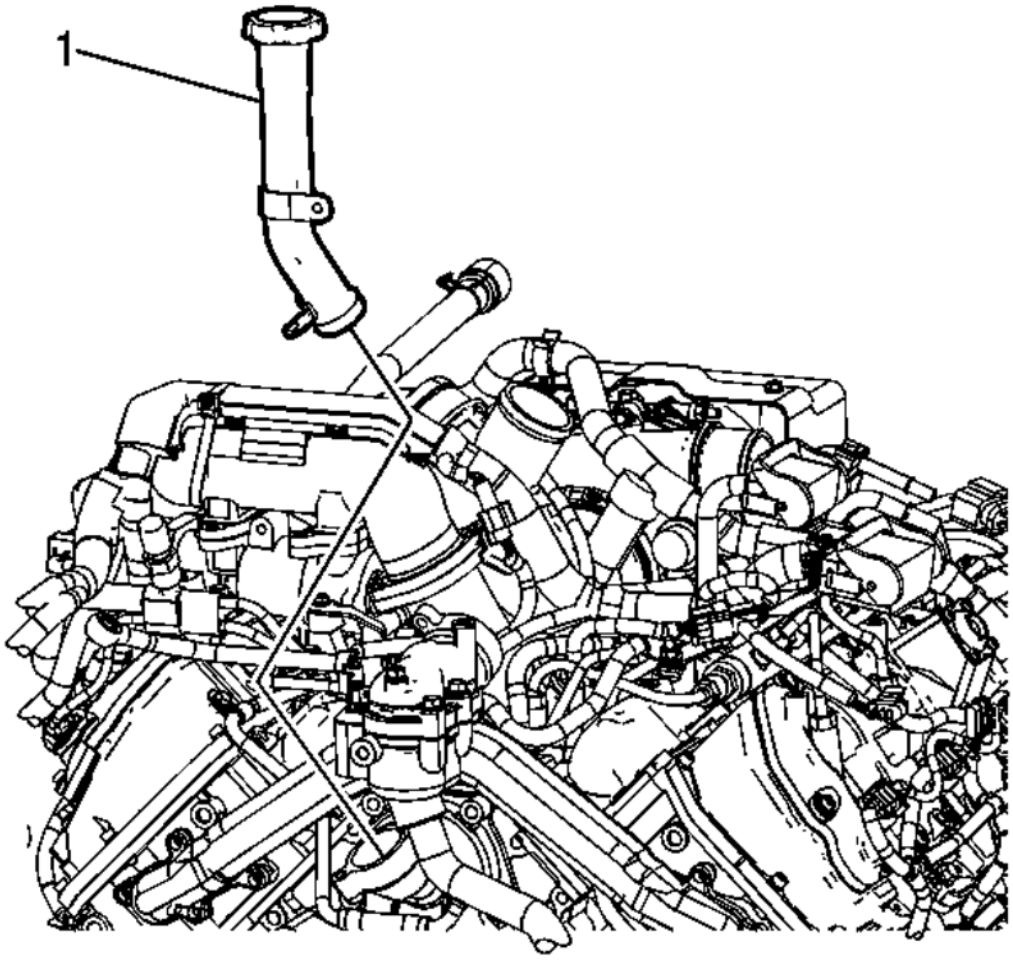


Fig. 88: View Of Oil Filler Tube
Courtesy of GENERAL MOTORS CORP.

7. Remove the oil fill tube.
8. Remove and discard the oil fill tube O-ring seal.

Installation Procedure

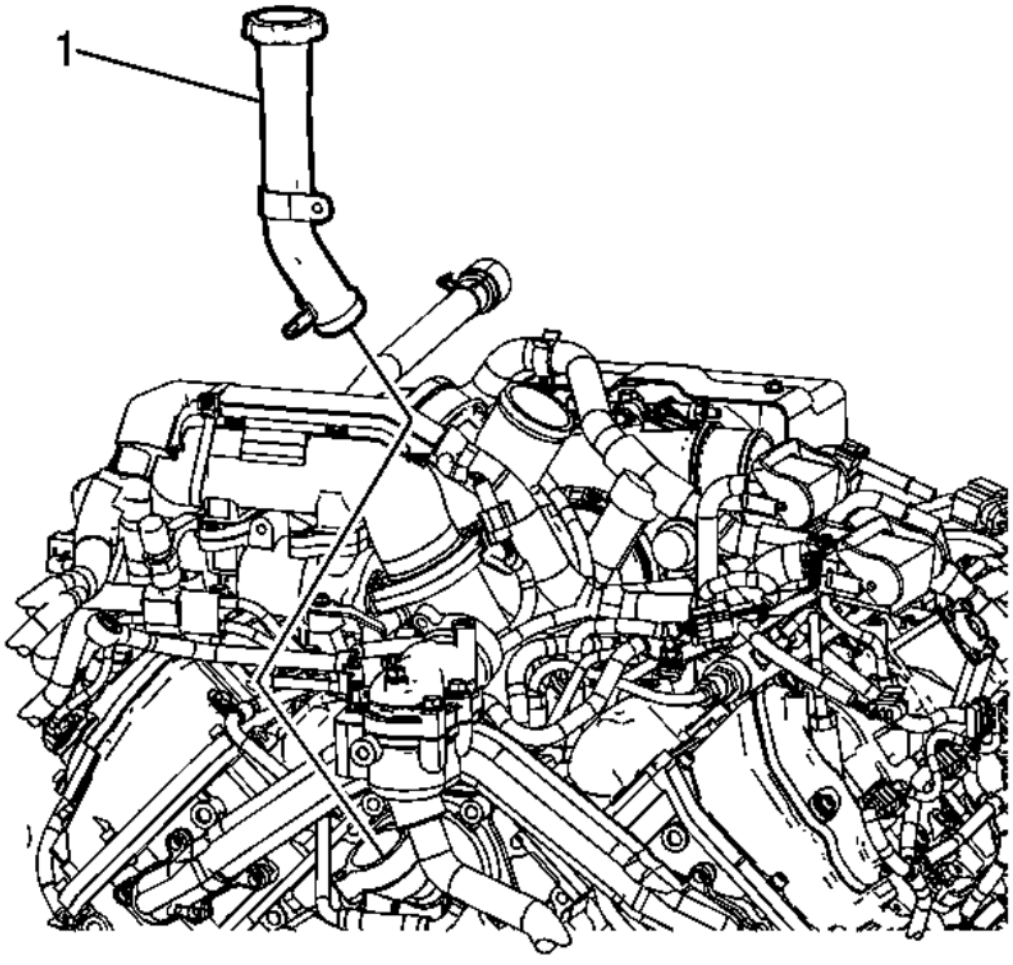


Fig. 89: View Of Oil Filler Tube
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW O-ring seal onto the oil fill tube.
2. Install the oil fill tube.

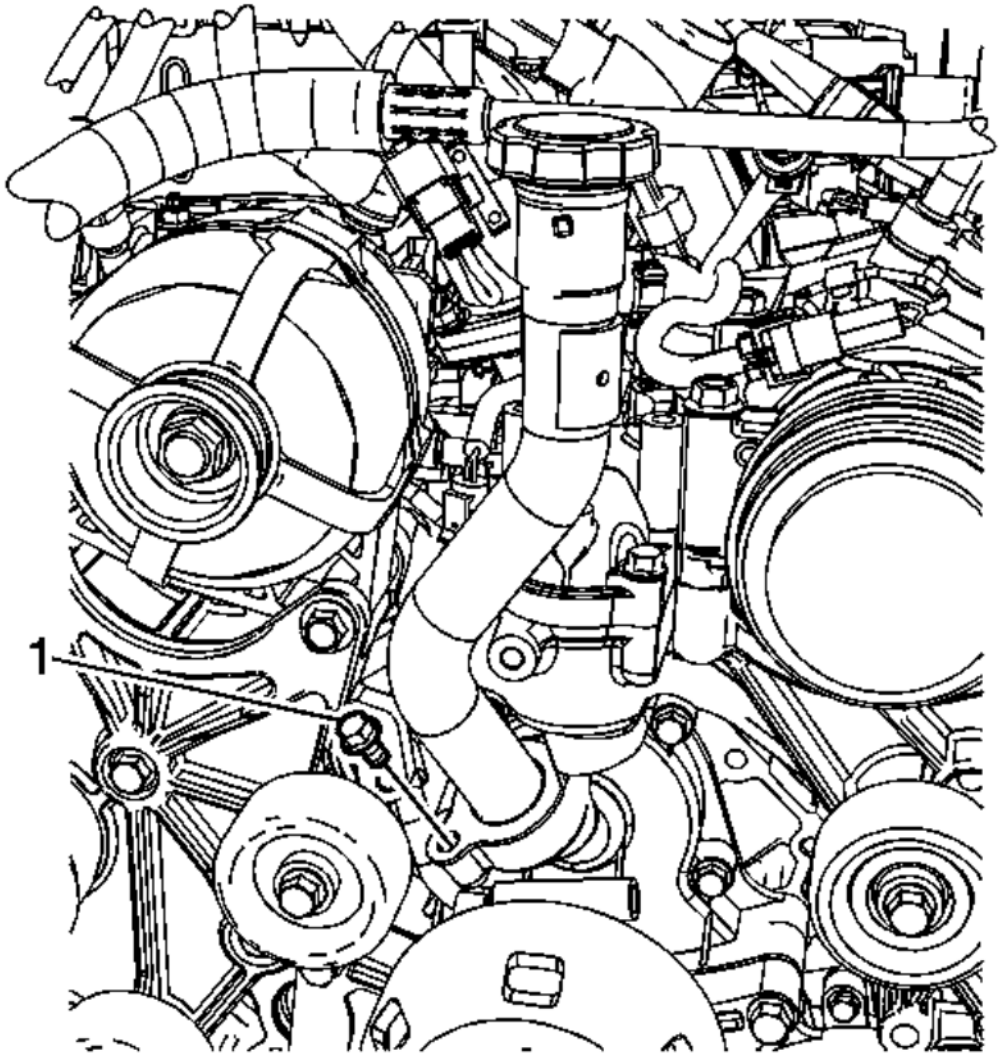


Fig. 90: View Of Lower Oil Fill Tube Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

3. Install the lower oil fill tube bolt (1).

Tighten: Tighten the bolts to 21 N.m (15 lb ft).

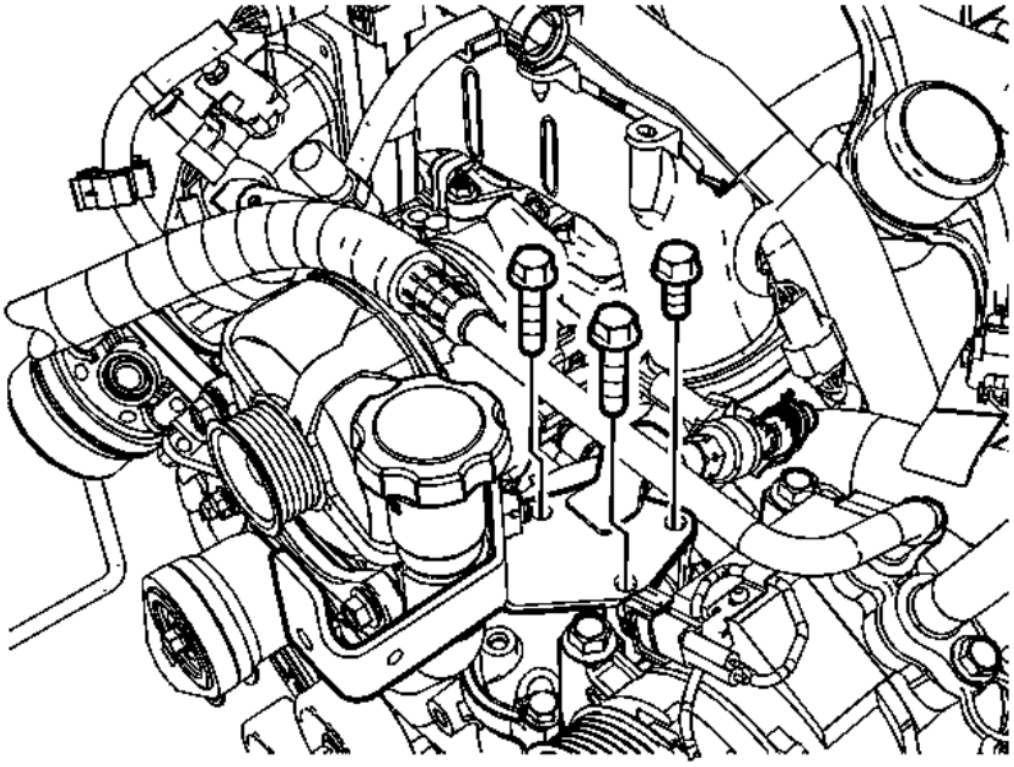


Fig. 91: View Of Oil Fill Tube Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Install the oil fill tube bracket.
5. Install the oil filler tube bracket bolts.

Tighten: Tighten the bolts to 21 N.m (15 lb ft).

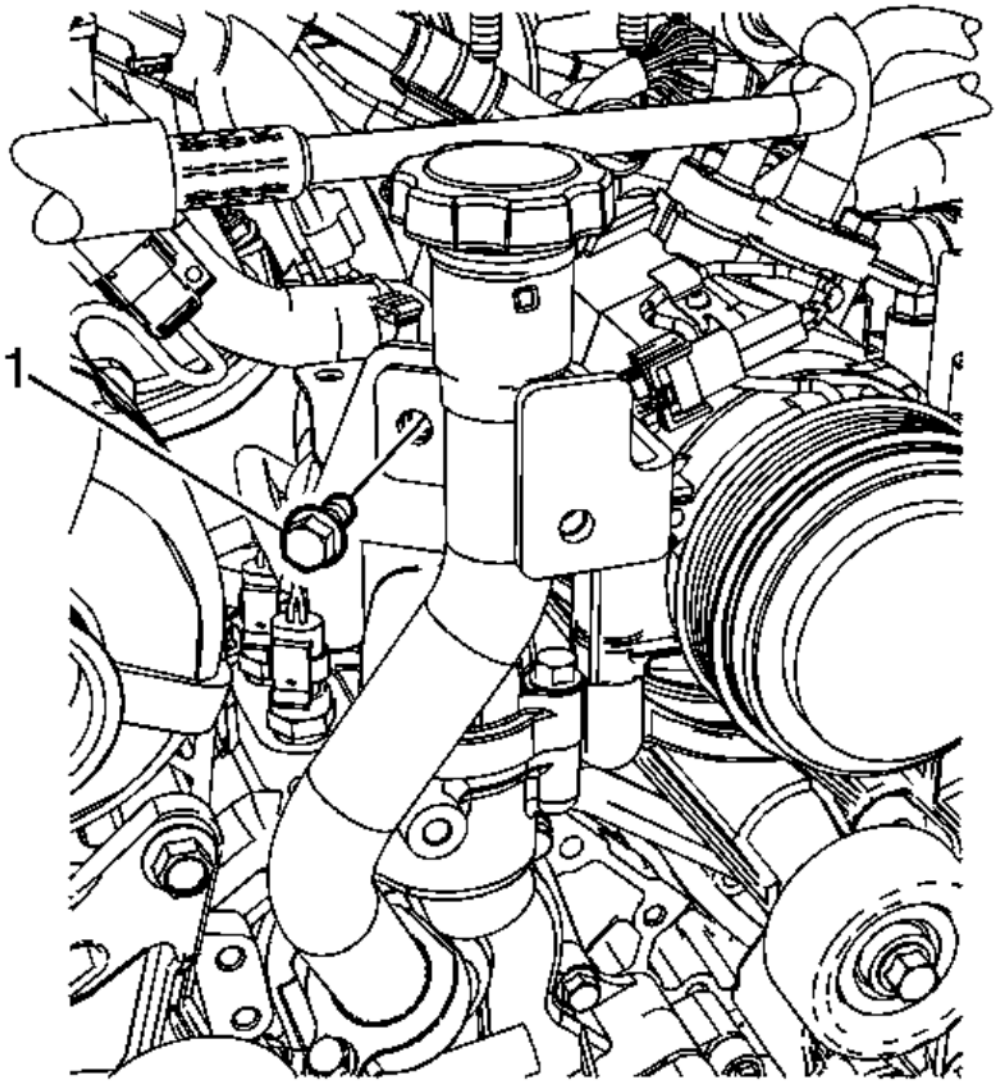


Fig. 92: View Of Upper Oil Fill Tube Bolt
Courtesy of GENERAL MOTORS CORP.

6. Install the upper oil fill tube bolt (1).

   Tighten: Tighten the bolts to 21 N.m (15 lb ft).

7. Install the drive belt. Refer to **Drive Belt Replacement**.

8. Install the fan and clutch assembly. Refer to **Cooling Fan and Shroud Replacement (Non-HP2)** .

OIL LEVEL INDICATOR AND TUBE REPLACEMENT

Removal Procedure

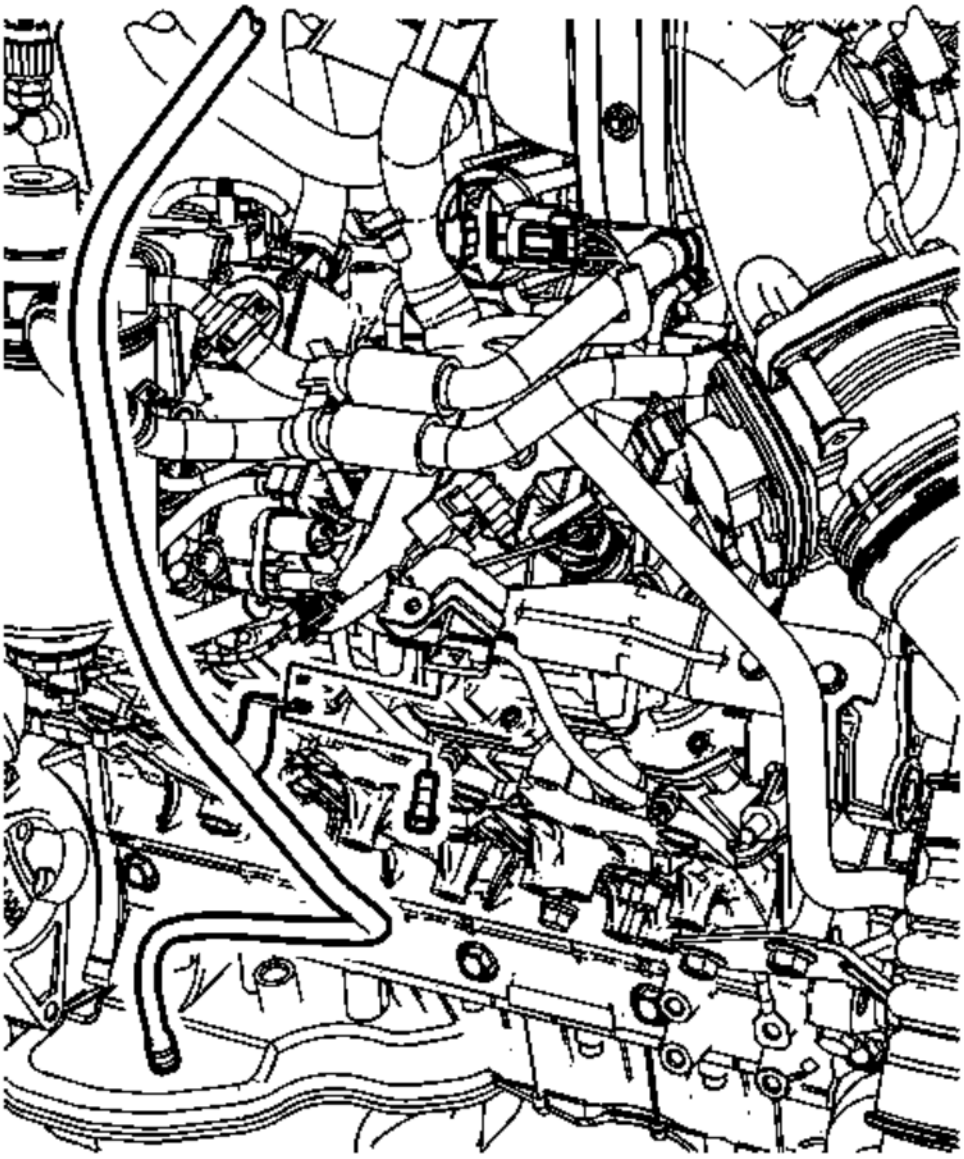


Fig. 93: View Of Oil Level Indicator Tube & Bolt
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil level indicator.
2. Remove the exhaust manifold. Refer to **Exhaust Manifold Replacement - Right Side**

(6.6L) .

3. Remove the starter motor. Refer to **Starter Motor Replacement (6.6L)** .
4. Remove the oil level indicator tube bolt at the indicator tube bracket.
5. Remove the oil level indicator tube and O-ring seals.
6. Remove and discard the O-ring seals.

Installation Procedure

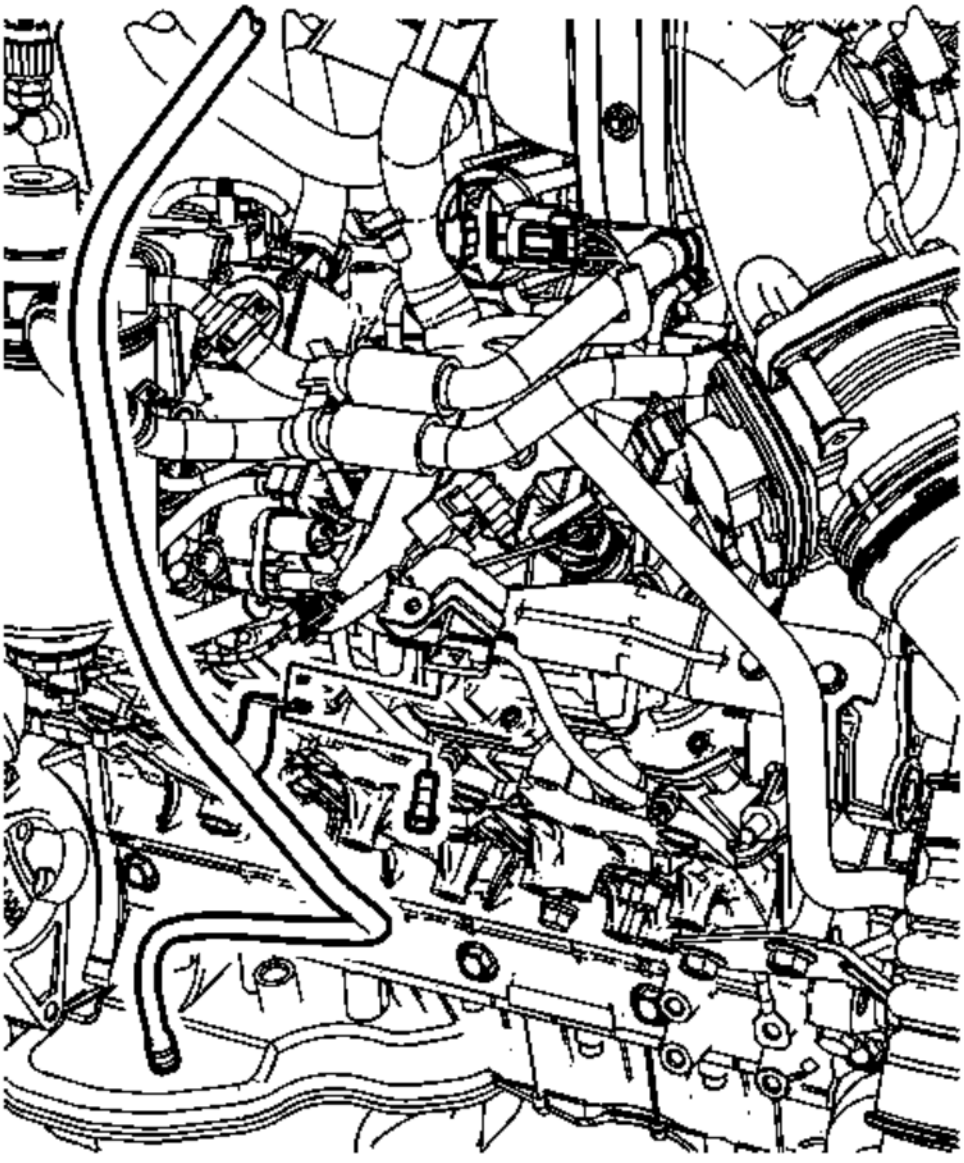


Fig. 94: View Of Oil Level Indicator Tube & Bolt
Courtesy of GENERAL MOTORS CORP.

1. Install NEW O-ring seals onto the oil level indicator tube.
2. Lightly lubricate the O-ring seals with engine oil.

3. Install the oil level indicator tube.

NOTE: Refer to Fastener Notice .

4. Install the oil level indicator tube bolt at the indicator tube bracket.

Tighten: Tighten the bolt to 21 N.m (15 lb ft).

5. Install the starter motor. Refer to **Starter Motor Replacement (6.6L)** .
6. Install the exhaust manifold. Refer to **Exhaust Manifold Replacement - Right Side (6.6L)** .
7. Install the oil level indicator.

VALVE ROCKER ARM COVER REPLACEMENT - UPPER LEFT SIDE

Removal Procedure

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.
2. Drain the cooling system. Refer to **Cooling System Draining and Filling (Vac-N-Fill)** or **Cooling System Draining and Filling (Static Fill)** .
3. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (w/Single Battery)** or **Battery Negative Cable Disconnection and Connection (w/Auxiliary Battery)** or **Battery Negative Cable Disconnection and Connection (w/Dual Batteries)** .

IMPORTANT: After removing the charged air cooler duct, cover the turbocharger opening with tape in order to prevent entry of objects.

4. Remove the charged air cooler inlet duct. Refer to **Charge Air Cooler Inlet Pipe Replacement** .

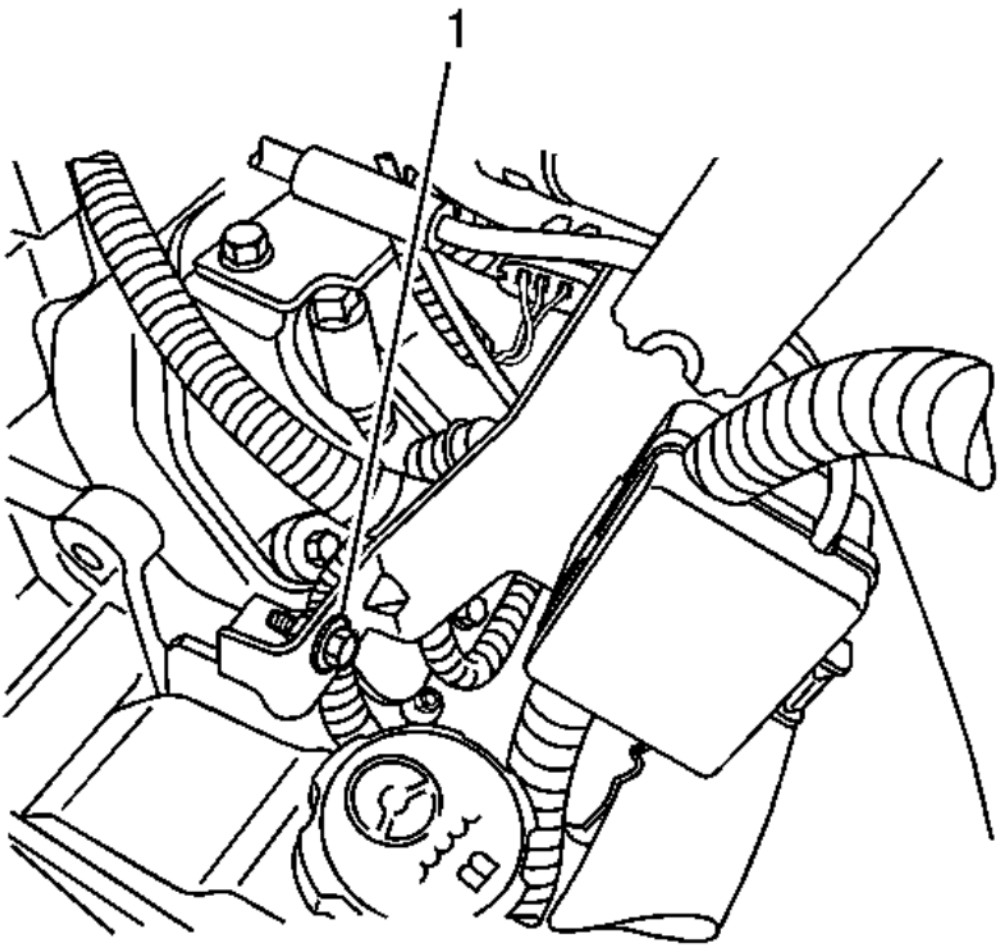


Fig. 95: View Of Battery Cable Junction Block Bolt At Power Steering Pump Bracket
Courtesy of GENERAL MOTORS CORP.

5. Remove the battery cable to generator nut.
6. If equipped, remove the battery cable to the auxiliary generator.
7. Remove the battery cable harness clip from the bracket.
8. Remove the battery cable junction block bolt (1) from the power steering pump.
9. Move and secure the battery cables out of the way.

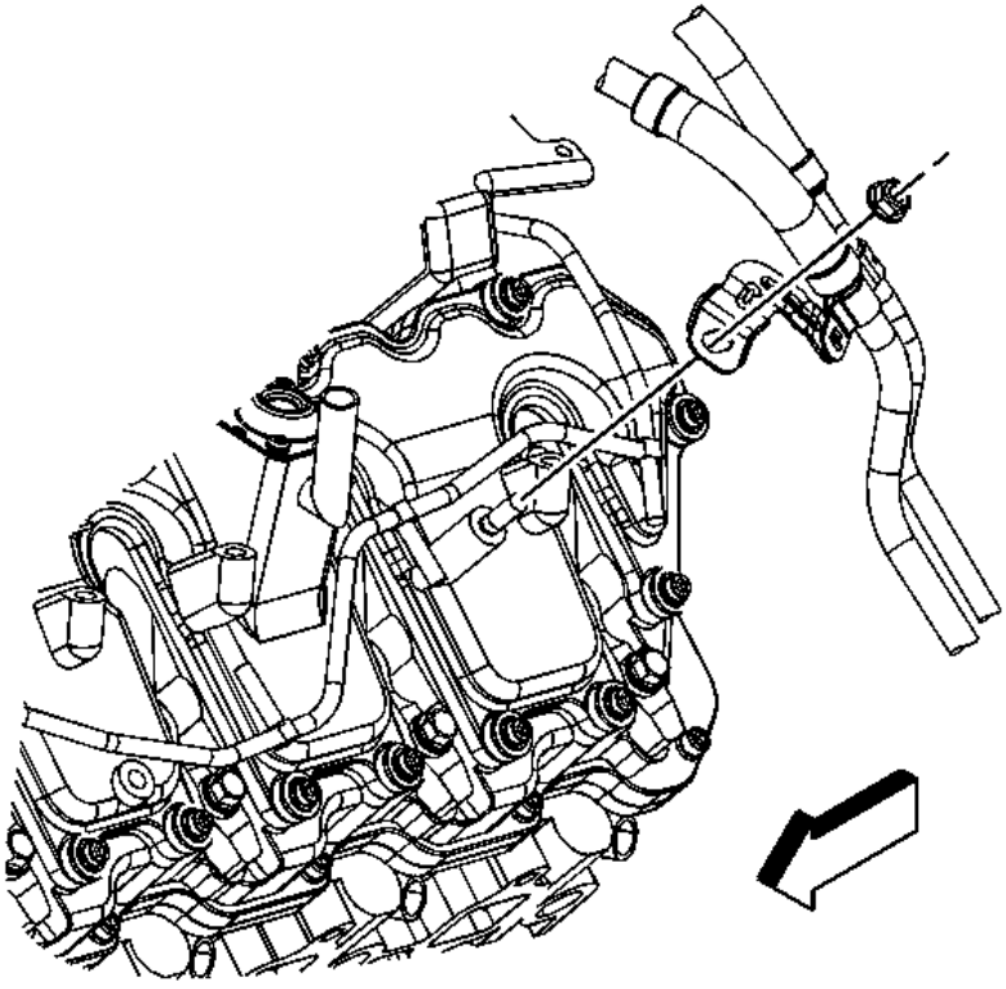


Fig. 96: View Of Fuel Line Bracket & Nut
Courtesy of GENERAL MOTORS CORP.

10. Disconnect the fuel lines. Refer to **Metal Collar Quick Connect Fitting Service** .
11. Remove the fuel hose bracket nut.

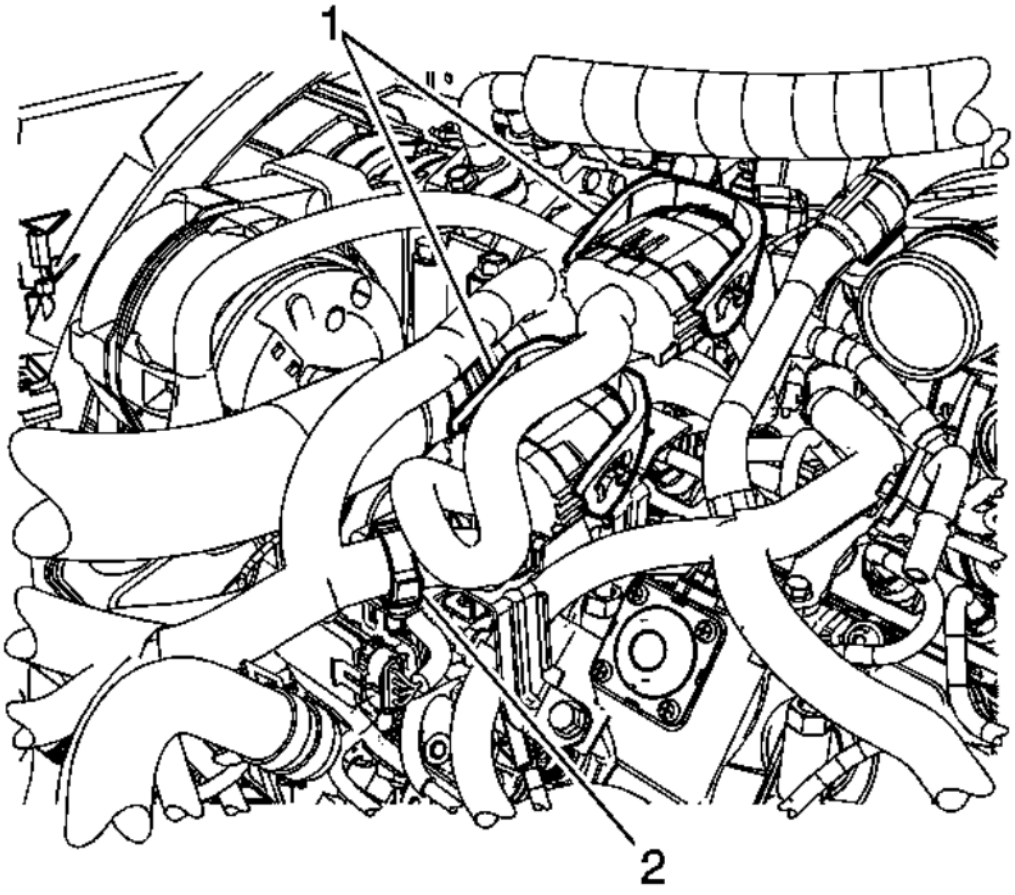


Fig. 97: View Of Main Engine Electrical Harness Connector Latches & Clips
Courtesy of GENERAL MOTORS CORP.

12. Disconnect the main engine electrical harness connectors. Lift up on the latches (1) in order to disconnect the connectors.
13. Open the harness clip (2).
14. Remove the main engine electrical harness connectors.

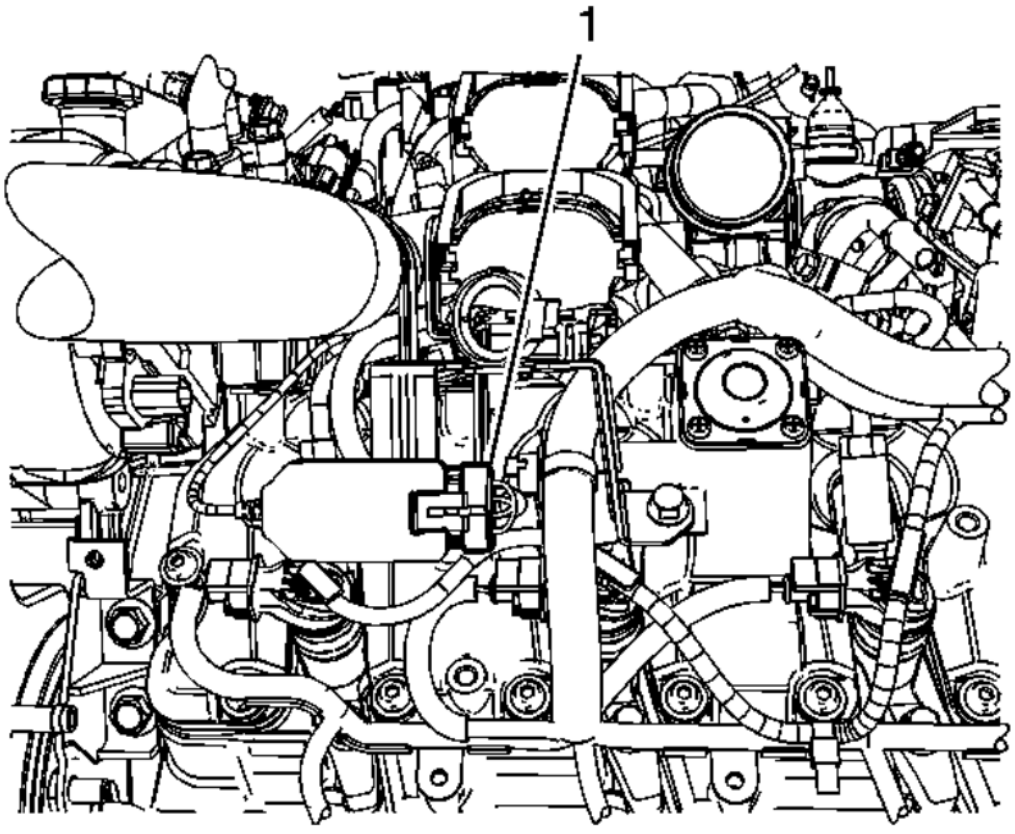


Fig. 98: View Of Turbocharger Vane Position Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

15. Disconnect the turbocharger vane position sensor electrical connector (1).

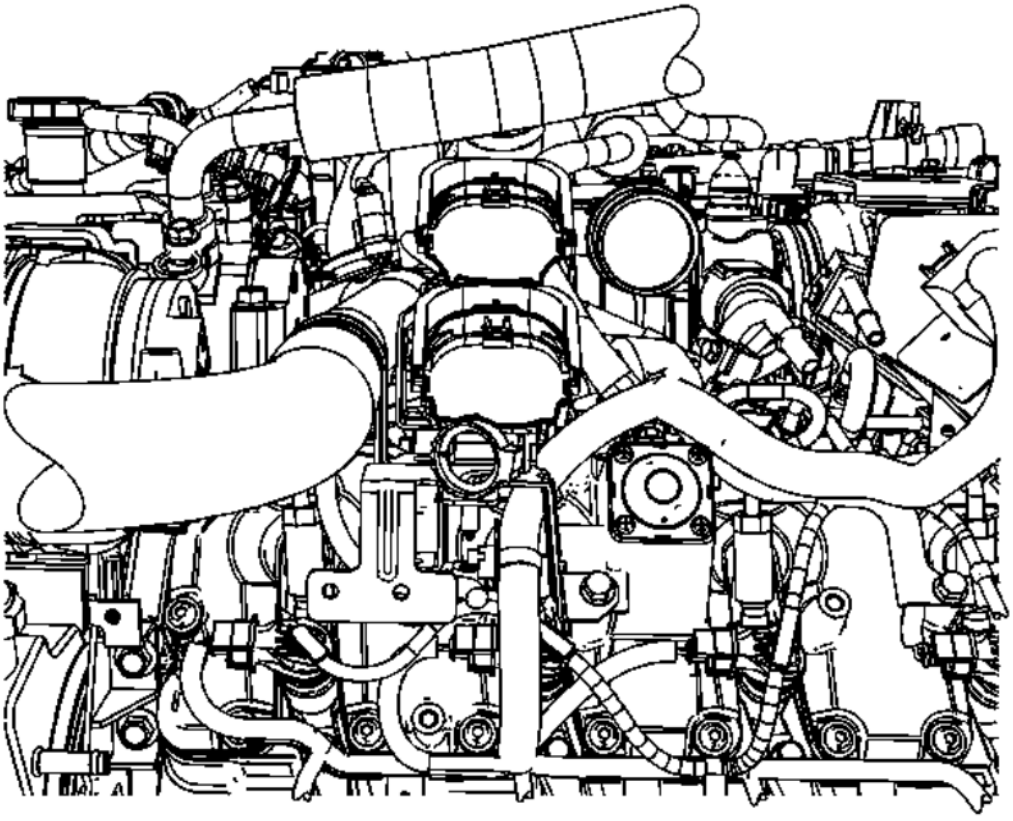


Fig. 99: View Of Main Engine Electrical Harness Connectors & Latches
Courtesy of GENERAL MOTORS CORP.

16. Unclip the main engine electrical harness connectors from the main electrical connector harness bracket.

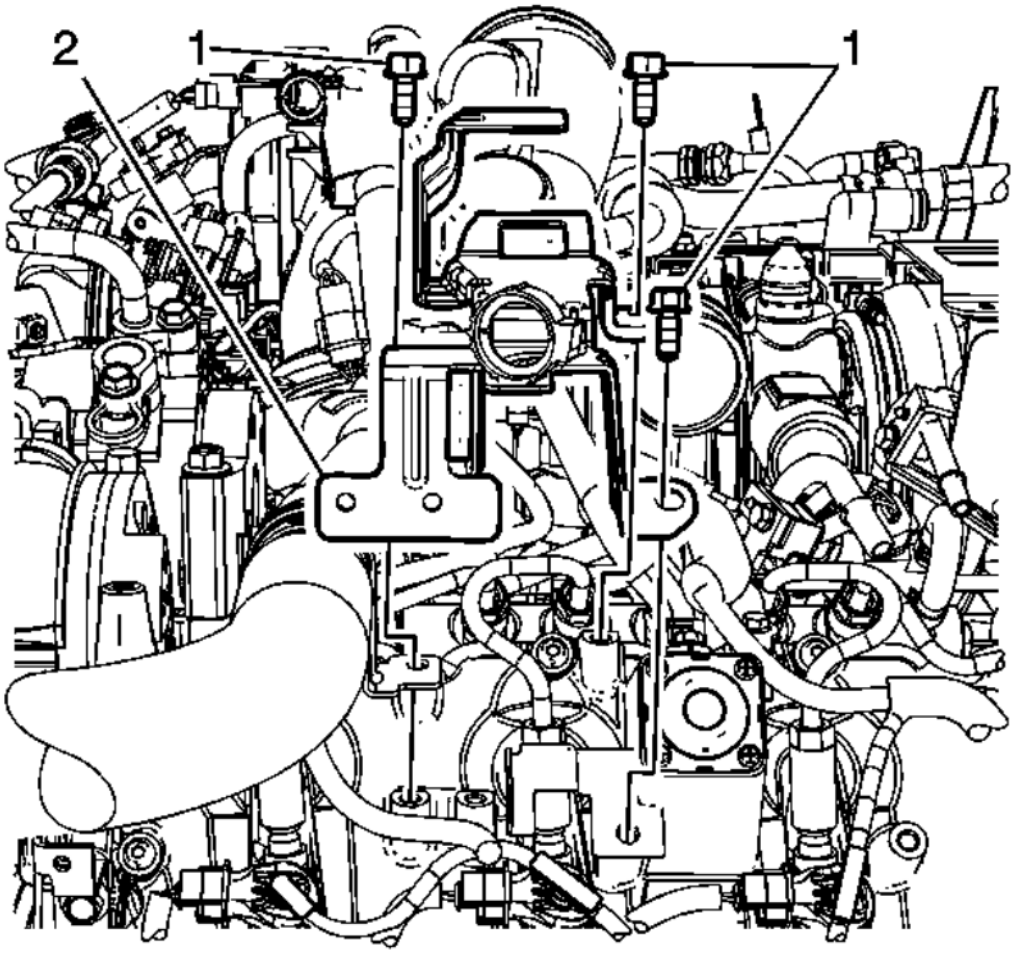


Fig. 100: View Of Main Electrical Harness Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

17. Remove the main electrical connector harness bracket bolts (1).
18. Remove the main electrical connector harness bracket (2).
19. Remove the water outlet tube. Refer to **Water Outlet Tube Replacement (LMM)** .
20. Remove the auxiliary generator, if equipped. Refer to **Auxiliary Generator Replacement (6.6L)** .
21. Remove the positive crankcase ventilation (PCV) hose/pipe. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement**.

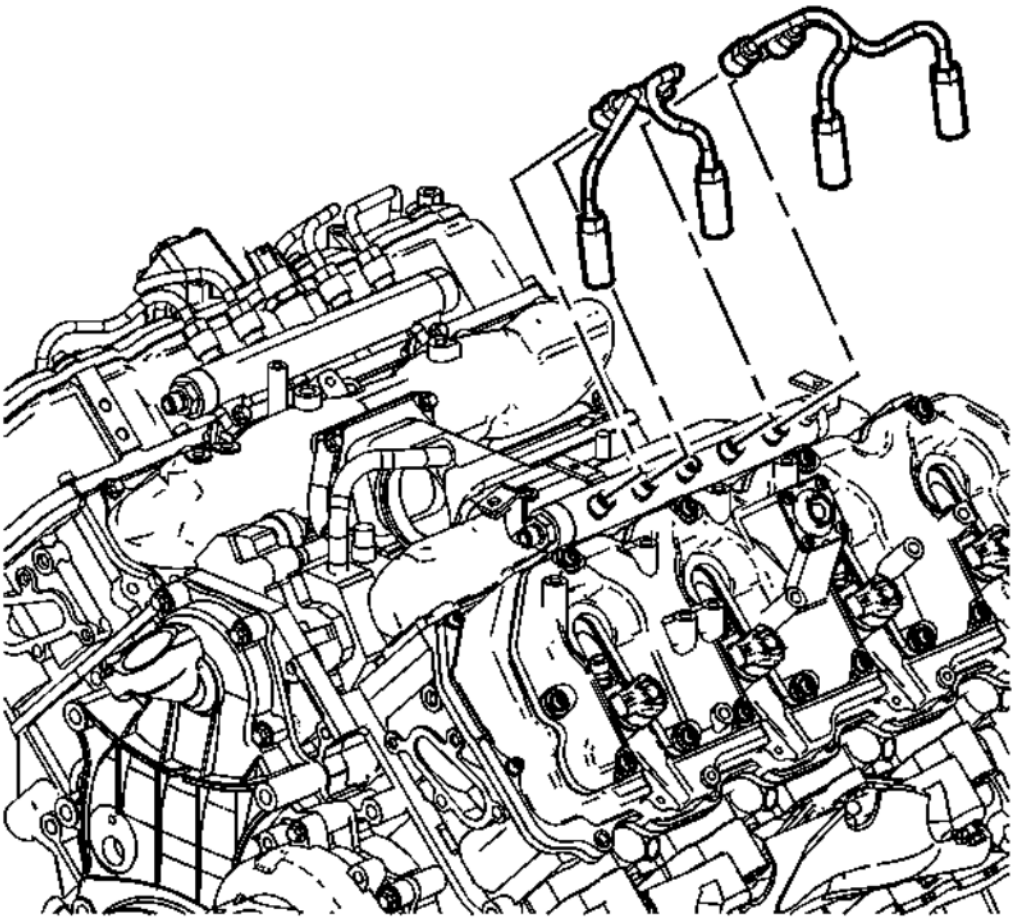


Fig. 101: View Of Left Fuel Injector Pipes
Courtesy of GENERAL MOTORS CORP.

22. Prior to removing the fuel injector pipes, use compressed air to blow any debris from between the injector line and fittings. Wipe the fittings clean of debris.
23. Spray lithium grease between the fuel injector line and fittings to assist in containing any debris during removal. Refer to **Sealers, Adhesives, and Lubricants** for the correct part number.

NOTE: DO NOT use compressed air to clean debris from the fuel injector inlet after the fuel line is removed. Using compressed air can allow debris to enter the fuel injector inlet and damage

the fuel injector.

24. Remove the left fuel injector pipes.

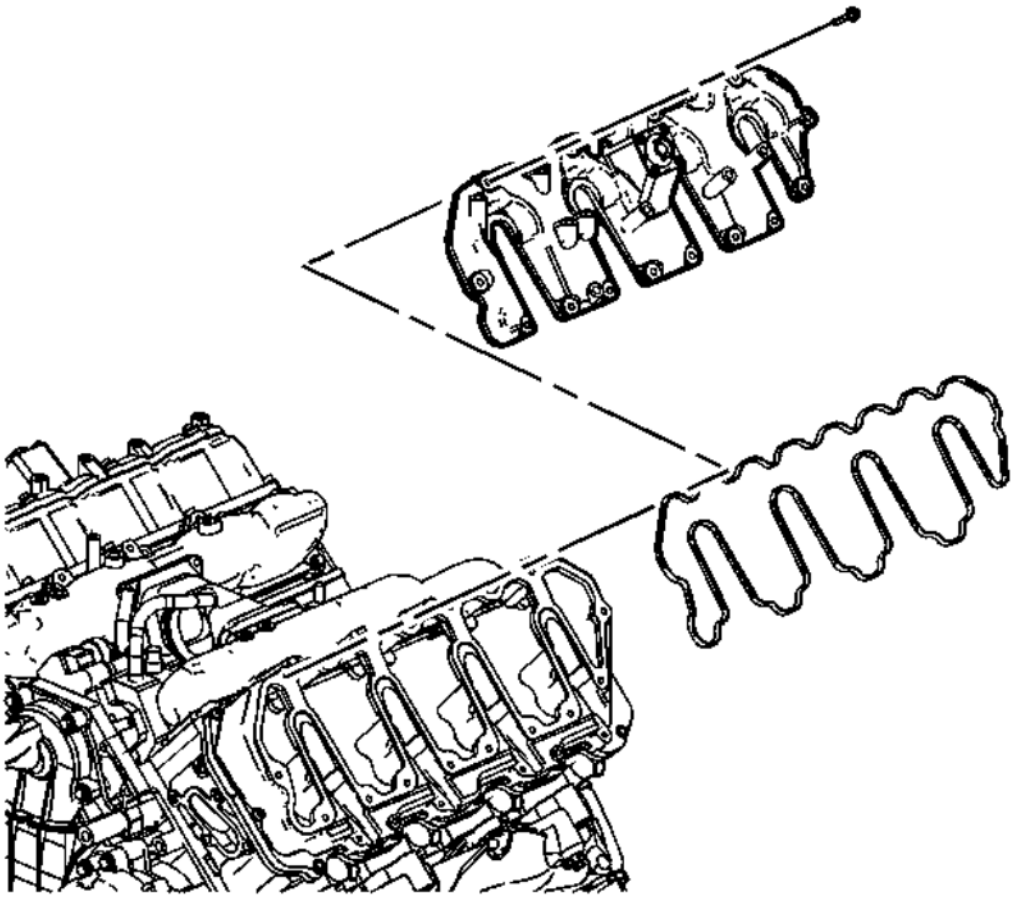


Fig. 102: View Of Upper Valve Rocker Arm Cover & Gasket
Courtesy of GENERAL MOTORS CORP.

25. Remove the upper valve rocker arm cover bolts.
26. Remove the upper valve rocker arm cover.
27. Remove the upper valve rocker arm cover gasket.
28. Inspect the upper valve rocker arm cover gasket for damage, replace if necessary. Otherwise reuse the old gasket.

29. If required, clean and inspect the upper valve rocker arm cover. Refer to **Valve Rocker Arm Cover Cleaning and Inspection - Upper** .

Installation Procedure

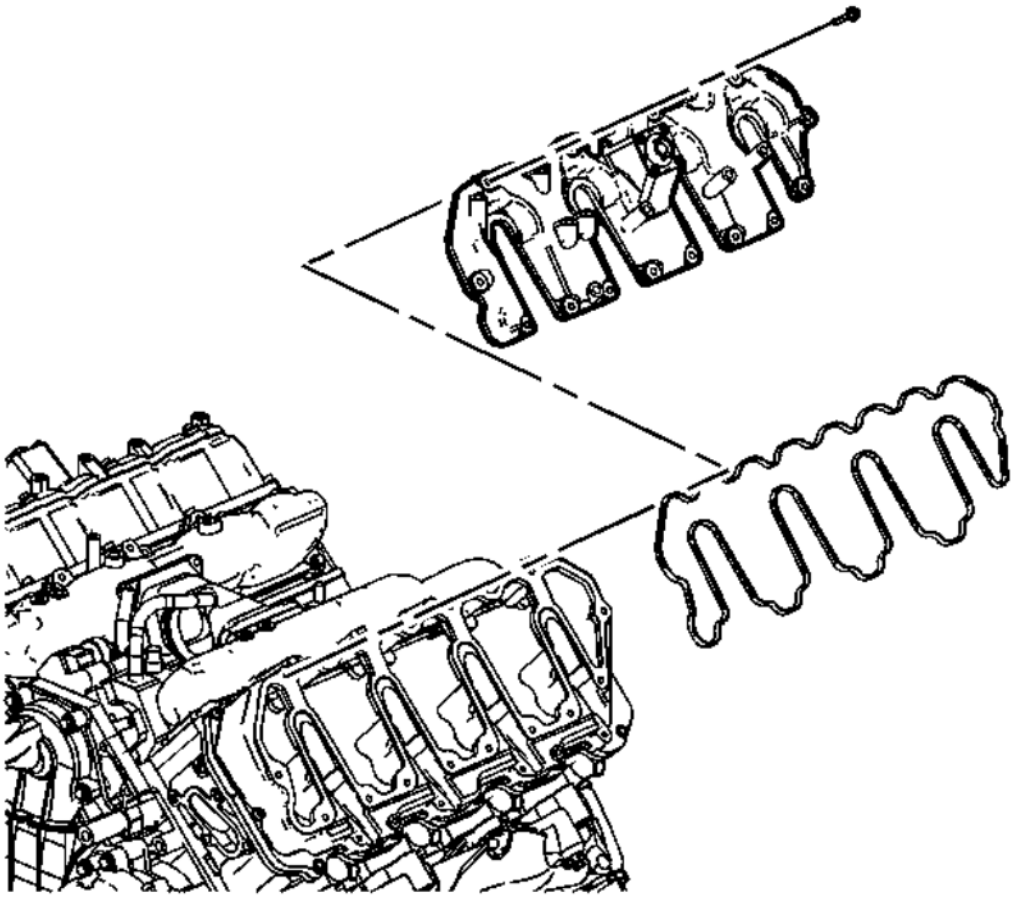


Fig. 103: View Of Upper Valve Rocker Arm Cover & Gasket
Courtesy of GENERAL MOTORS CORP.

1. Install the valve rocker arm cover gasket.
2. Install the upper valve rocker arm cover.
3. Install the upper valve rocker arm cover bolts.

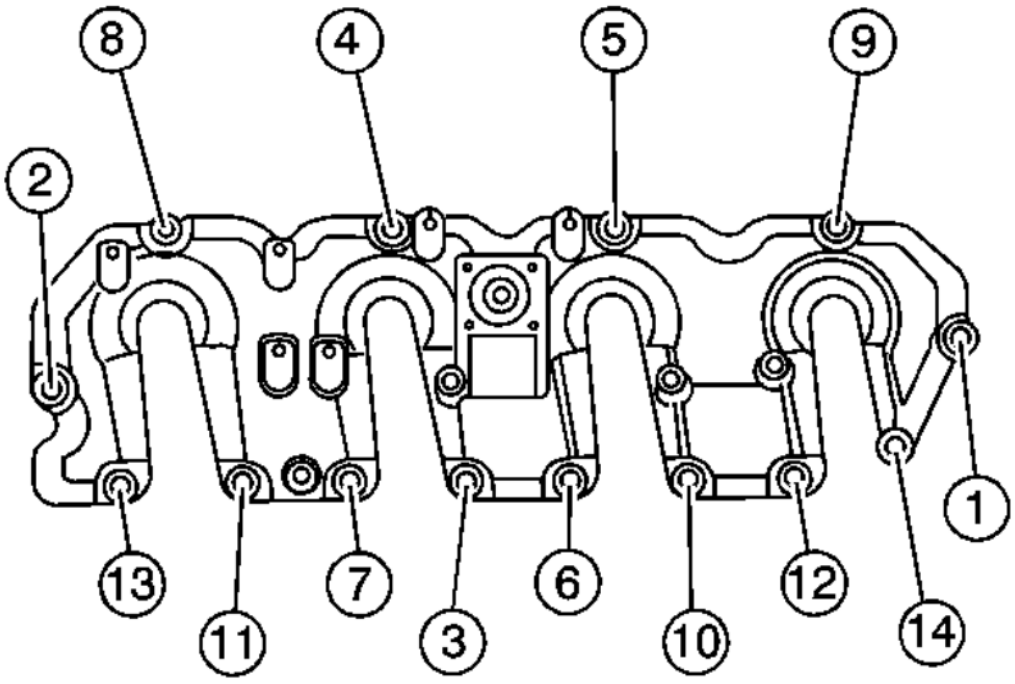


Fig. 104: Upper Valve Rocker Arm Cover Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

4. Tighten the upper valve rocker arm cover bolts in the sequence shown.

   Tighten: Tighten the bolts to 8 N.m (71 lb in).

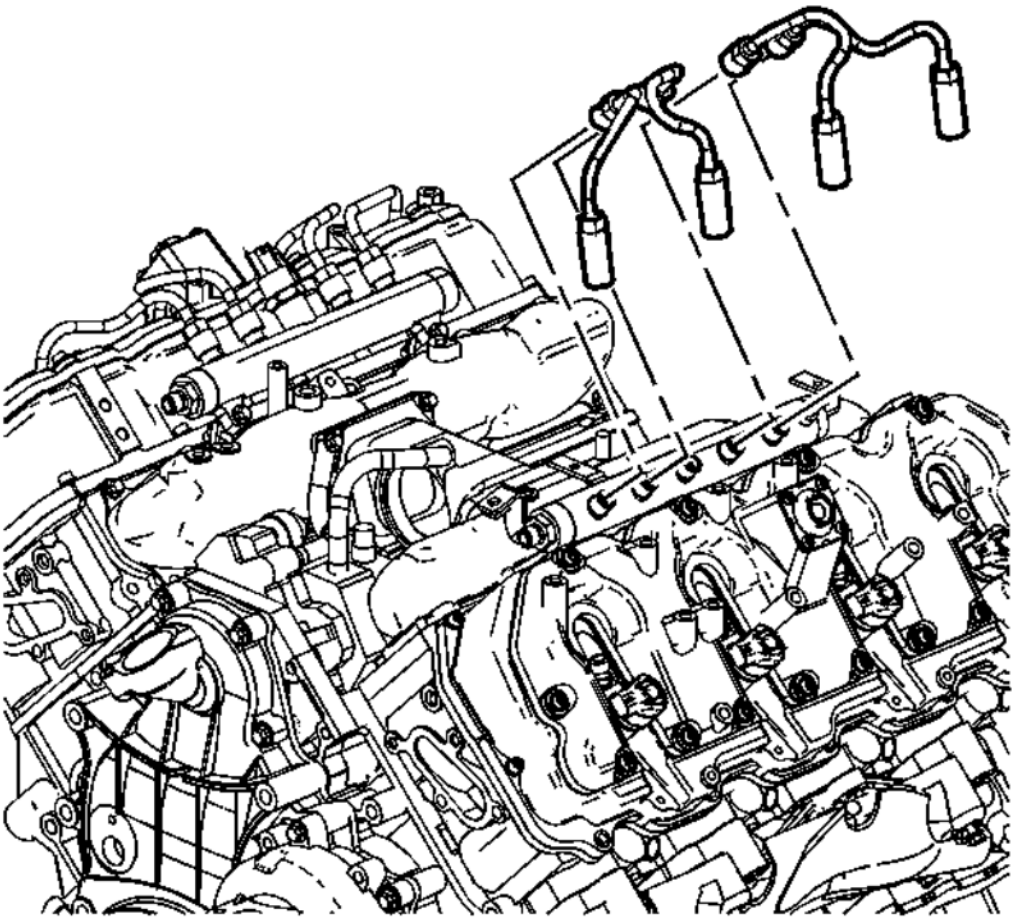


Fig. 105: View Of Left Fuel Injector Pipes
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure proper torquing of the fuel injector line. An under-torqued fuel injector line will not seal properly and an over-torqued fuel injector line may damage the fuel injector fitting. An improperly sealed or damaged fuel injector line or fuel injector fitting will cause a fuel leak.

5. Install the left fuel injector pipes.

Tighten: Tighten the pipes to 41 N.m (30 lb ft).

6. Install the water outlet tube. Refer to **Water Outlet Tube Replacement (LMM)** .
7. Install the auxiliary generator, if equipped. Refer to **Auxiliary Generator Replacement (6.6L)** .
8. Install the PCV hose/pipe. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement**.

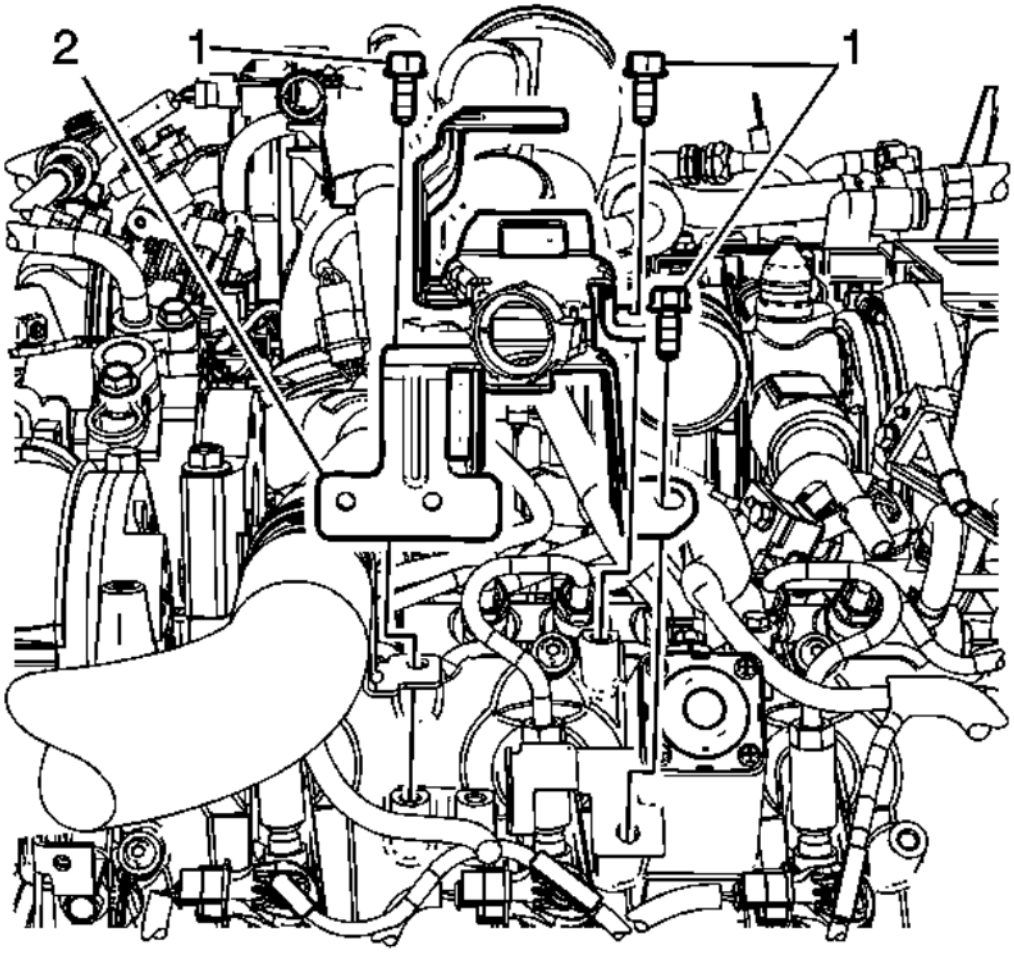


Fig. 106: View Of Main Electrical Harness Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

9. Install the main electrical connector harness bracket (2).
10. Install the main electrical connector harness bracket bolts (1).

Tighten: Tighten the bolts to 21 N.m (15 lb ft).

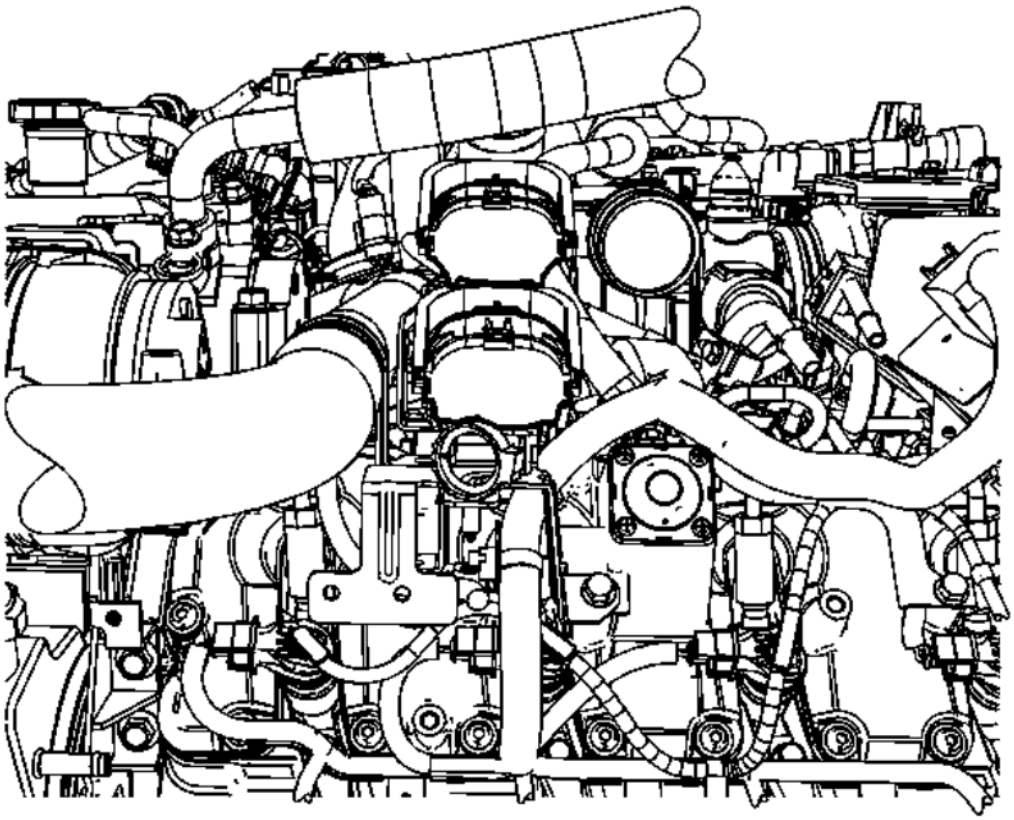


Fig. 107: View Of Main Engine Electrical Harness Connectors & Latches
Courtesy of GENERAL MOTORS CORP.

11. Clip the main engine electrical harness connectors to the main electrical connector harness bracket.

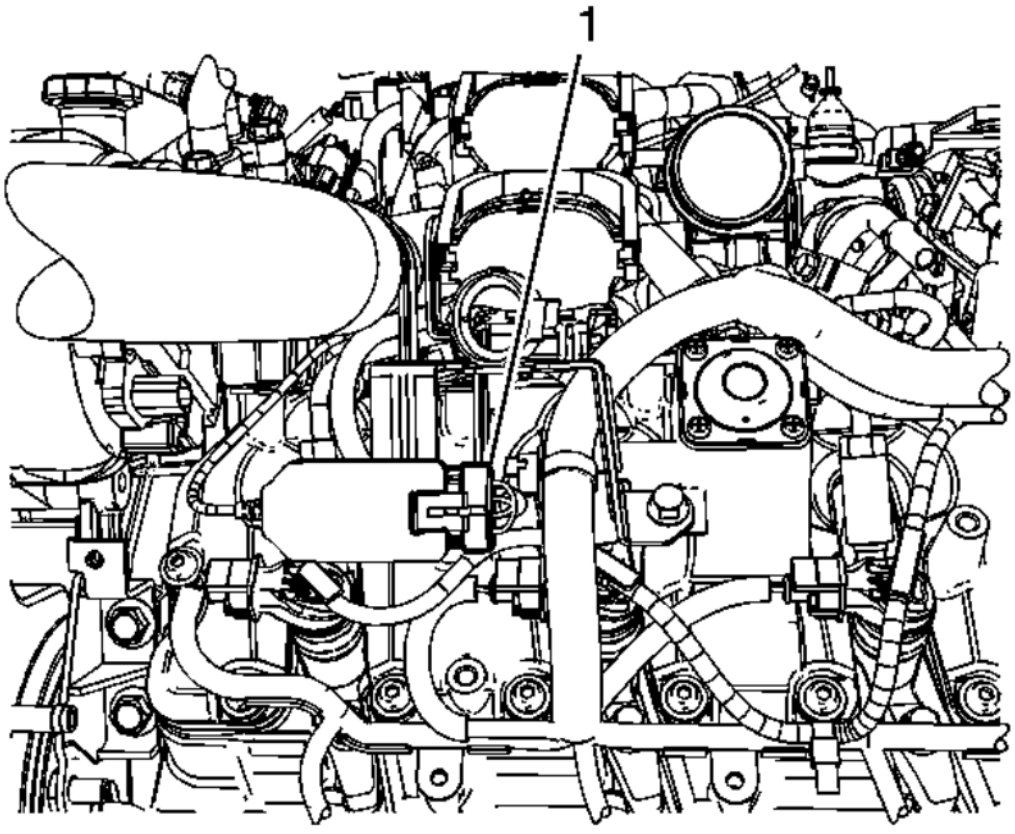


Fig. 108: View Of Turbocharger Vane Position Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

12. Connect the turbocharger vane position sensor electrical connector (1).

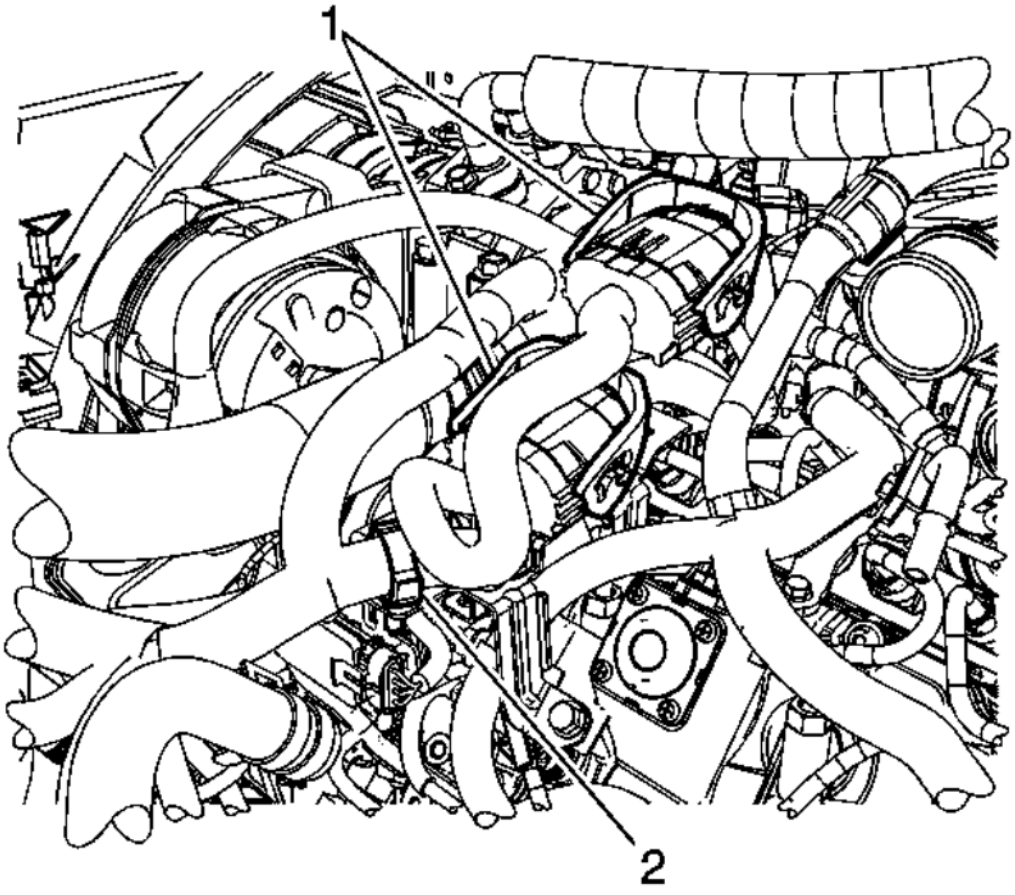


Fig. 109: View Of Main Engine Electrical Harness Connector Latches & Clips
Courtesy of GENERAL MOTORS CORP.

13. Connect the main engine electrical harness connectors.
14. Push down on the latches (1) in order to connect the connectors.
15. Close the harness clip (2).

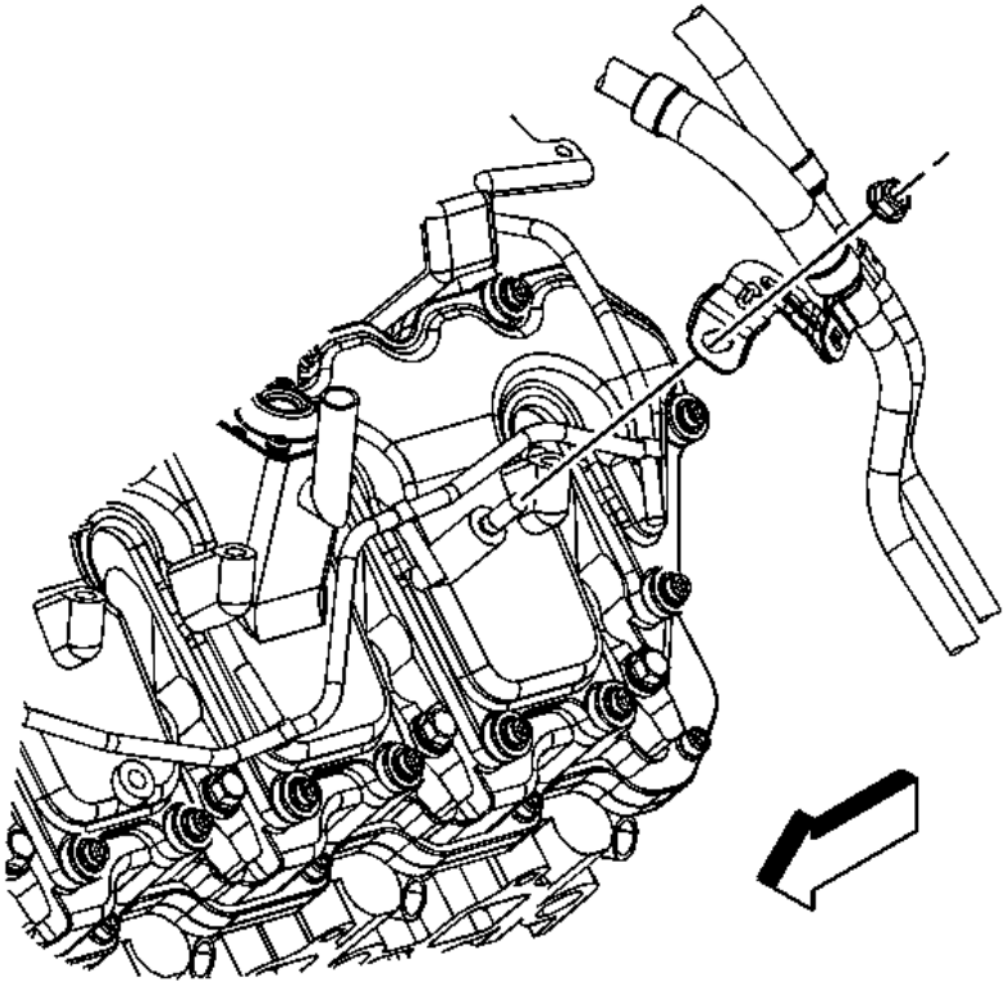


Fig. 110: View Of Fuel Line Bracket & Nut
Courtesy of GENERAL MOTORS CORP.

16. Connect the fuel lines. Refer to **Metal Collar Quick Connect Fitting Service** .
17. Install the fuel hose bracket nut.

Tighten: Tighten the nut to 21 N.m (15 lb ft).

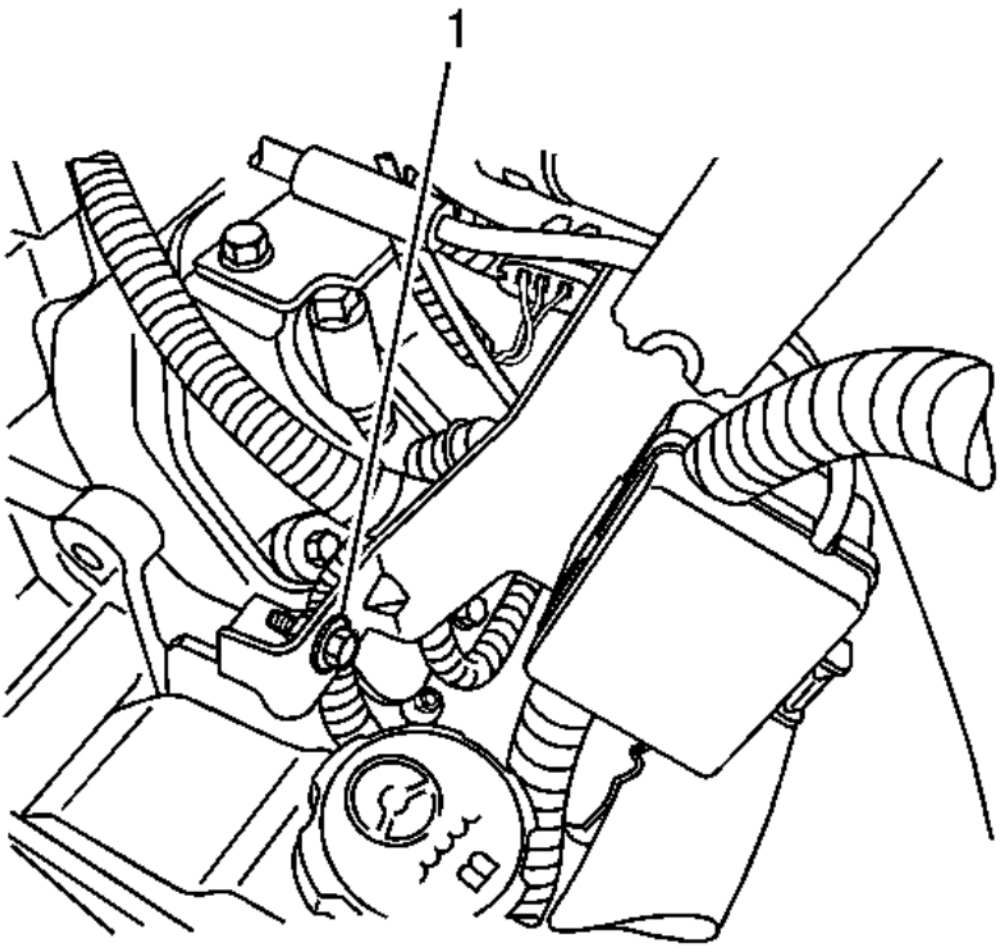


Fig. 111: View Of Battery Cable Junction Block Bolt At Power Steering Pump Bracket
Courtesy of GENERAL MOTORS CORP.

18. Position the generator positive cable.
19. Install the generator positive cable in the clip on the engine front cover.
20. Install the generator positive cable and nut.

    Tighten: Tighten the nut to 9 N.m (80 lb in).

21. Install the positive battery cable junction block bracket and bolt (1) to the power steering

pump.

Tighten: Tighten the bolt to 9 N.m (80 lb in).

22. Remove the tape from the turbocharger openings.
23. Install the charged air cooler inlet duct. Refer to **Charge Air Cooler Inlet Pipe Replacement** .
24. Fill the cooling system. Refer to **Cooling System Draining and Filling (Vac-N-Fill)** or **Cooling System Draining and Filling (Static Fill)** .
25. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (w/Single Battery)** or **Battery Negative Cable Disconnection and Connection (w/Auxiliary Battery)** or **Battery Negative Cable Disconnection and Connection (w/Dual Batteries)** .
26. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.

VALVE ROCKER ARM COVER REPLACEMENT - UPPER RIGHT SIDE

Removal Procedure

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.
2. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
3. Remove the charged air cooler outlet duct. Refer to **Charge Air Cooler Outlet Pipe Replacement** .
4. Remove the exhaust gas recirculation (EGR) cooler tube. Refer to **Exhaust Gas Recirculation Valve Cooler Replacement** .
5. Remove the heater outlet hose bolt from the bracket.
6. Position the heater outlet hose out of the way.

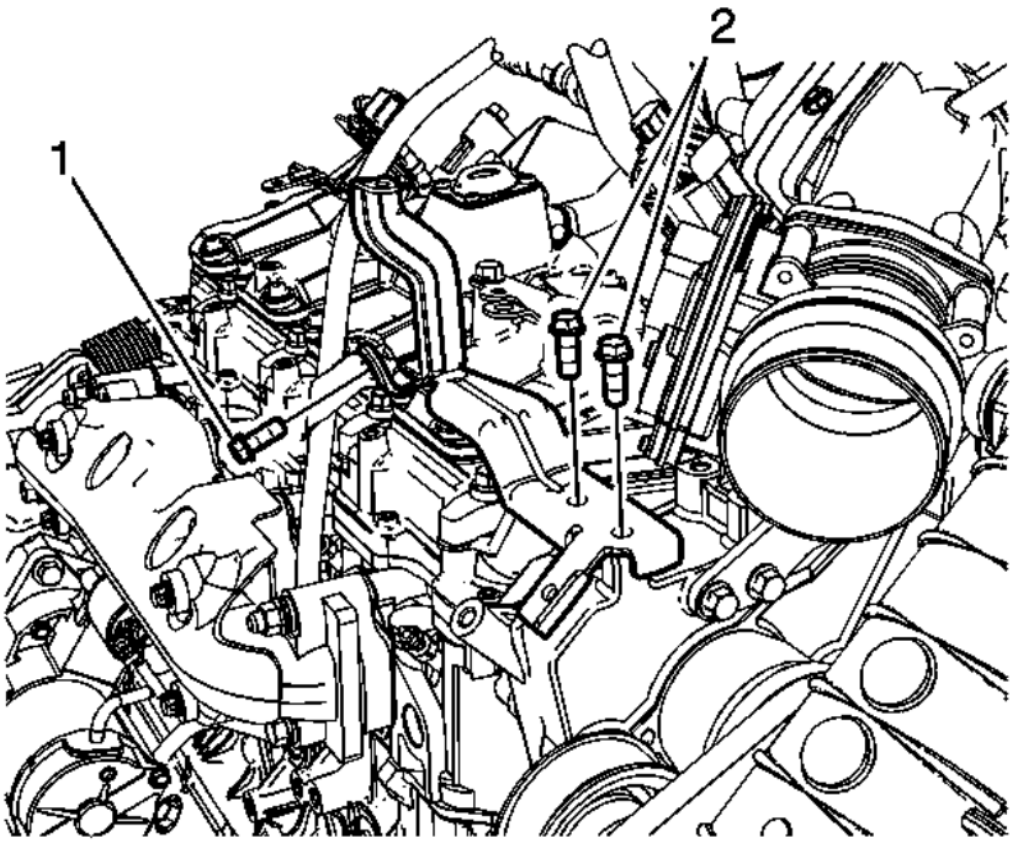


Fig. 112: View Of Oil Level Indicator Tube Bolts & Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

7. Remove the wiring harness retainer from the bracket.
8. Remove the oil level indicator tube bolt (1).
9. Remove the oil level indicator tube bracket bolts (2).
10. Remove the bracket.

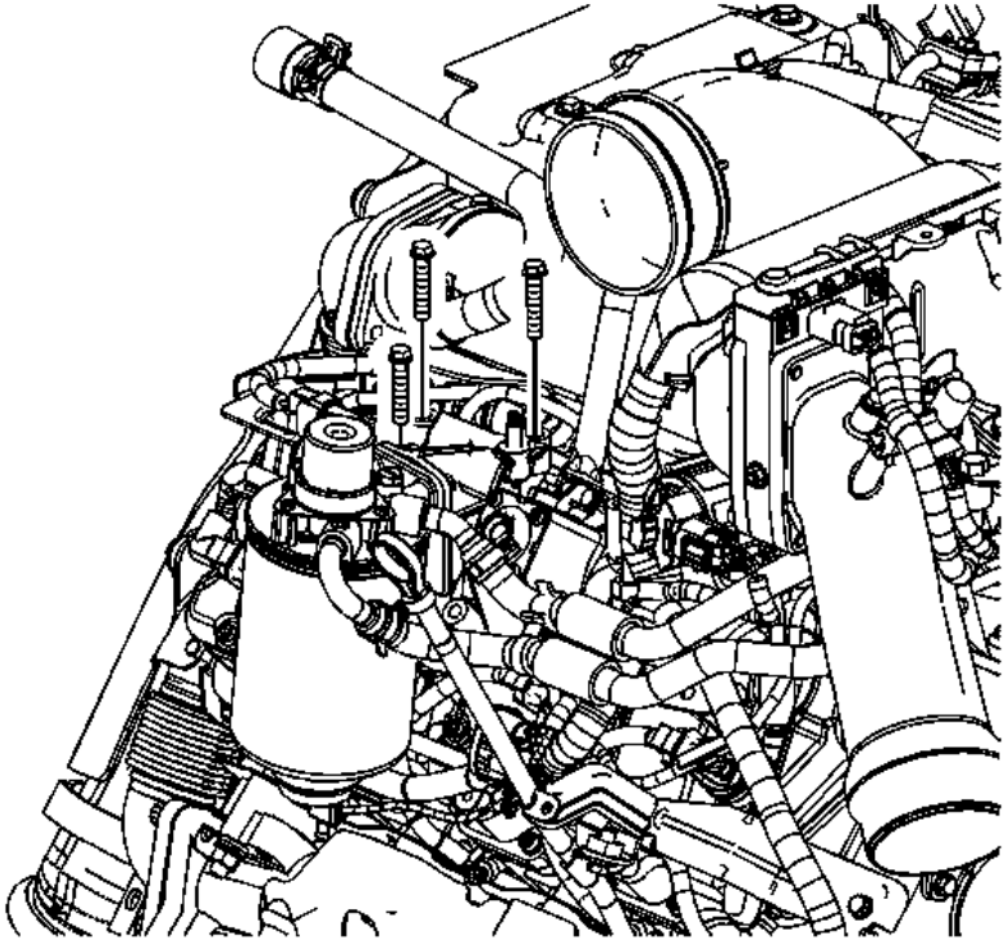


Fig. 113: Identifying Fuel Filter Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

11. Remove the fuel filter bracket bolts.
12. Reposition the fuel filter with bracket.
13. Remove the positive crankcase ventilation (PCV) hose/pipe. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement**.

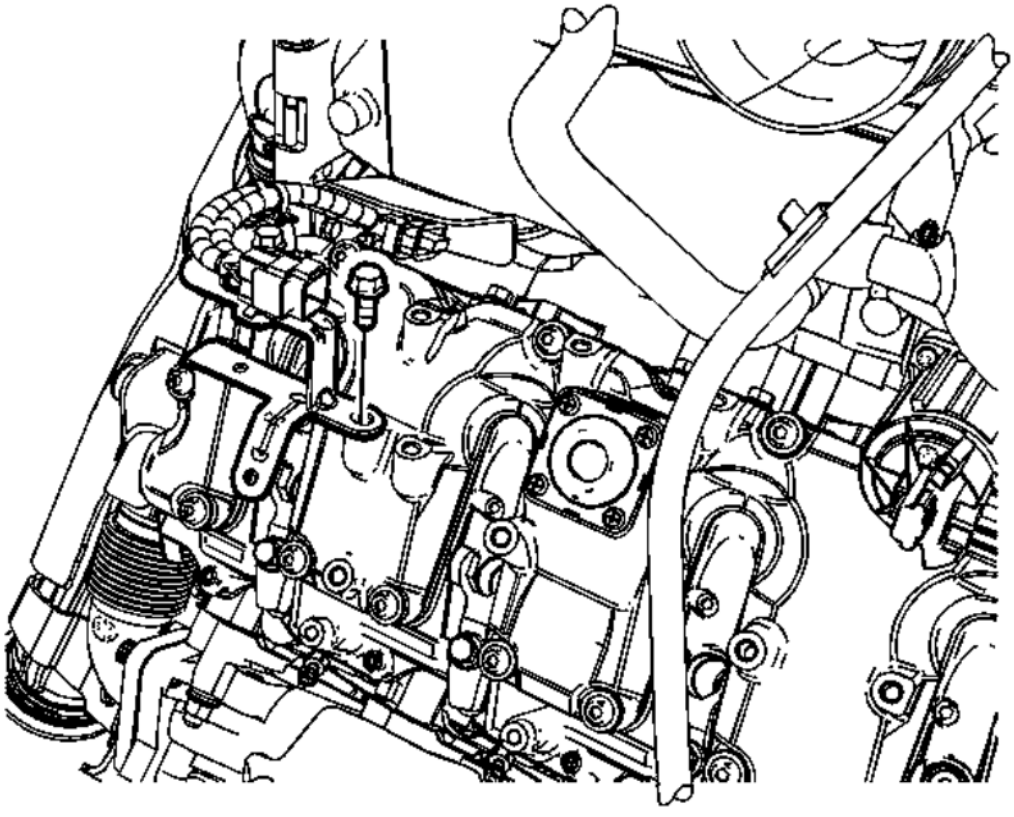


Fig. 114: View Of Engine Harness Bracket Bolt
Courtesy of GENERAL MOTORS CORP.

14. Remove the engine harness bracket bolt.
15. Position engine harness brackets aside.

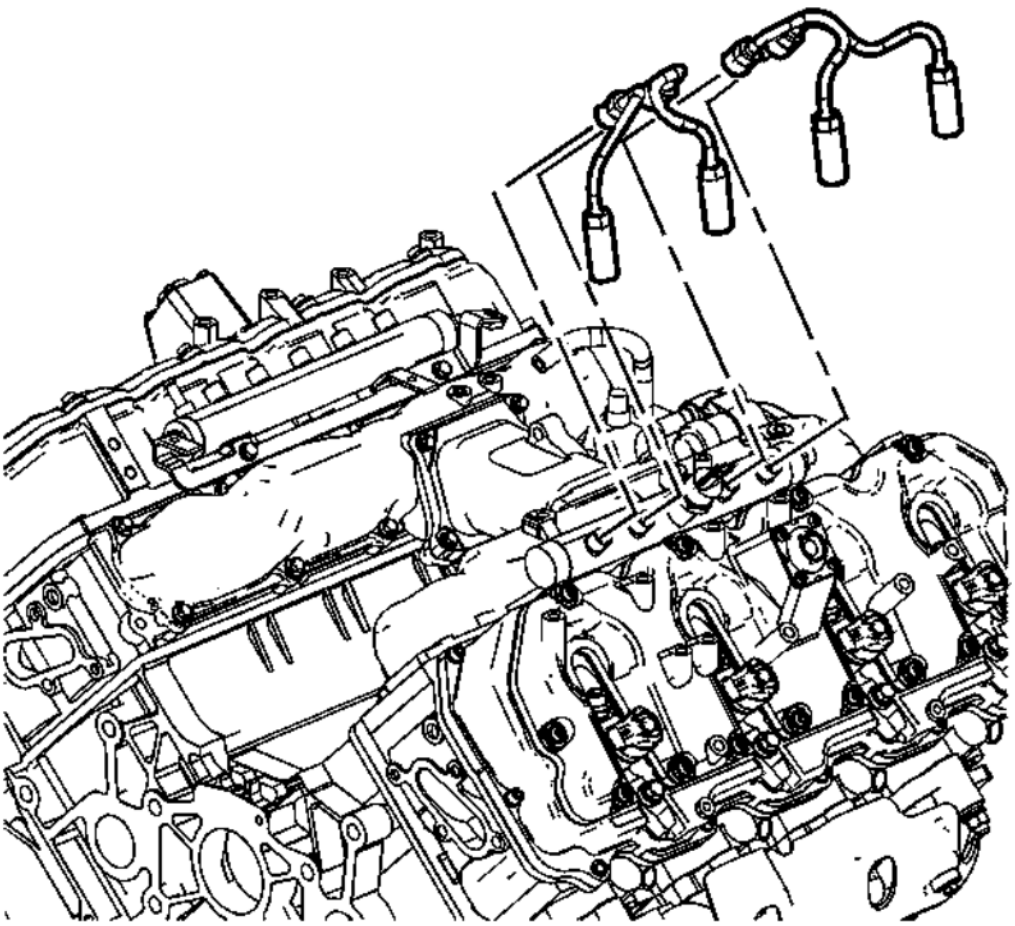


Fig. 115: View Of Fuel Injector Pipes
Courtesy of GENERAL MOTORS CORP.

16. Prior to removing the fuel injector pipes, use compressed air to blow any debris from between the injector line and fittings. Wipe the fittings clean of debris.
17. Spray lithium grease between the fuel injector line and fittings to assist in containing any debris during removal. Refer to **Sealers, Adhesives, and Lubricants** for the correct part number.

NOTE: DO NOT use compressed air to clean debris from the fuel injector inlet after the fuel line is removed. Using compressed air can allow debris to enter the fuel injector inlet and damage

the fuel injector.

18. Remove the right fuel injector pipes.

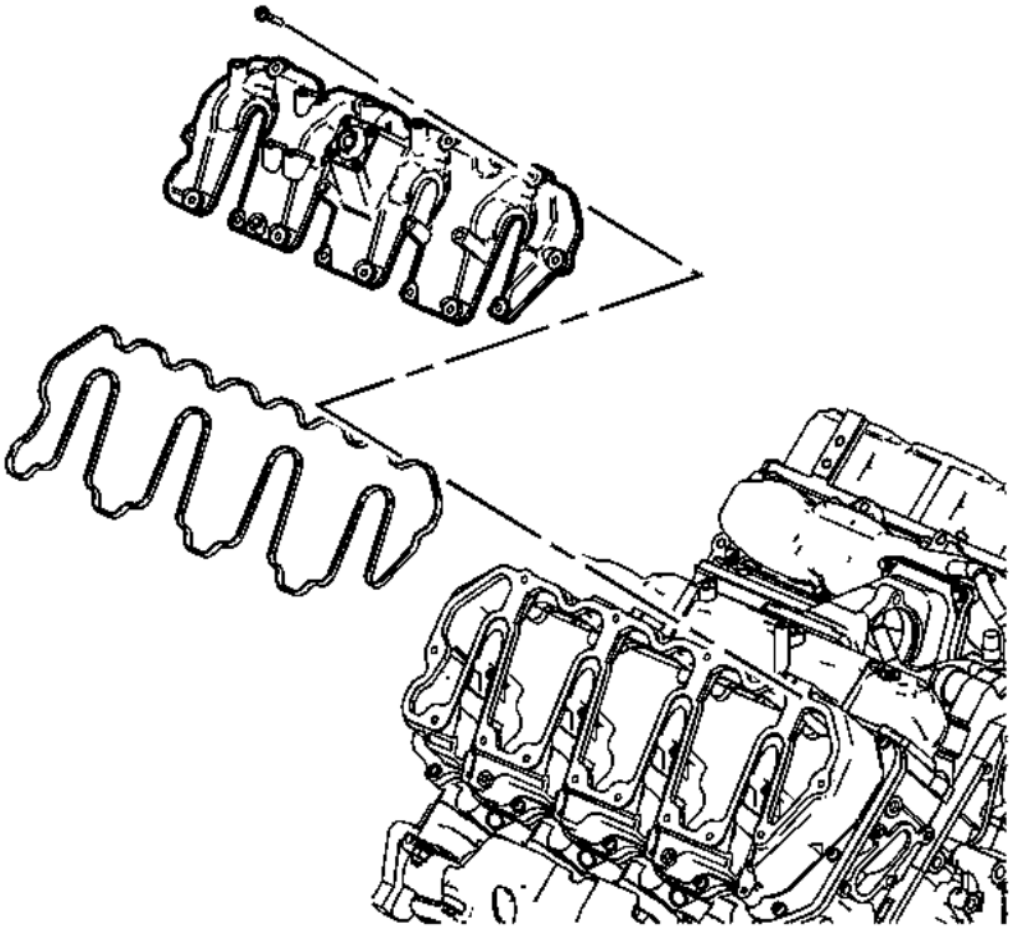


Fig. 116: View Of Upper Valve Rocker Arm Cover & Gasket
Courtesy of GENERAL MOTORS CORP.

19. Remove the upper valve rocker arm cover bolts.
20. Remove the upper valve rocker arm cover.
21. Remove the upper valve rocker arm cover gasket.
22. Inspect the upper valve rocker arm cover gasket for damage, replace if necessary. Otherwise

reuse the old gasket.

23. If required, clean and inspect the upper valve rocker arm cover. Refer to **Valve Rocker Arm Cover Cleaning and Inspection - Upper** .

Installation Procedure

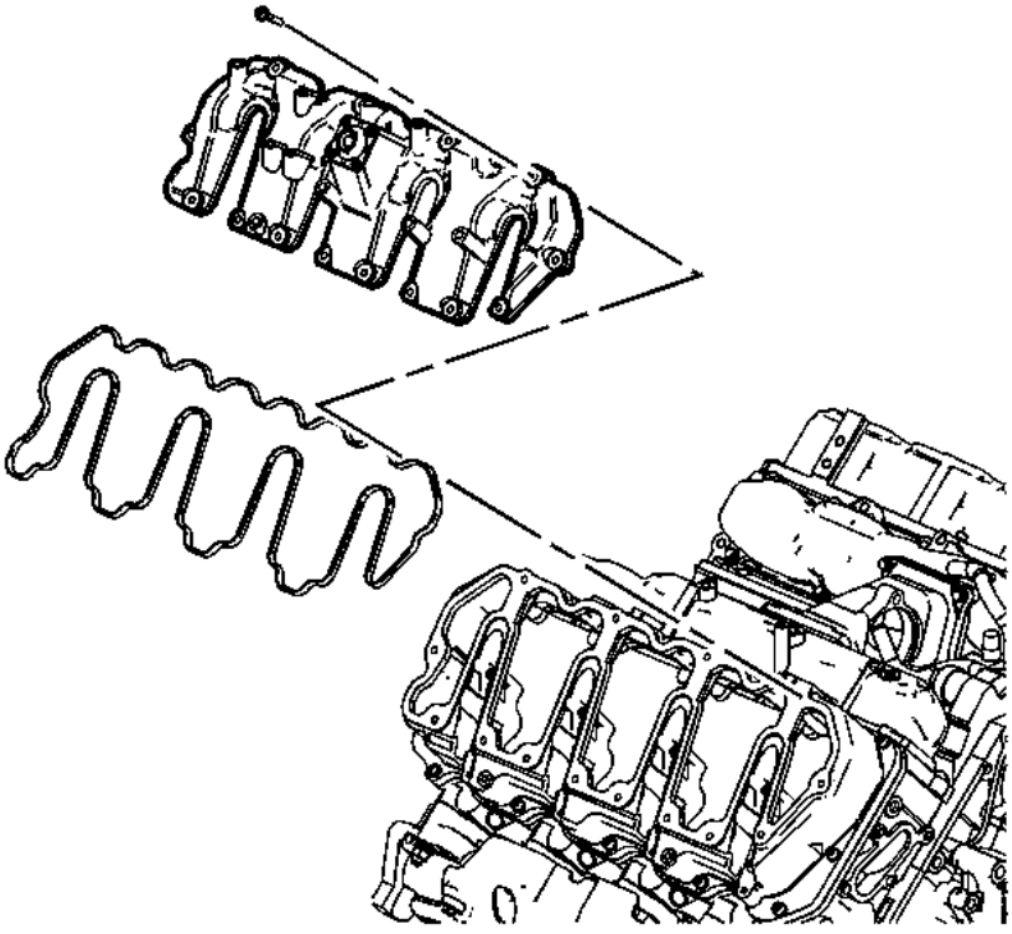


Fig. 117: View Of Upper Valve Rocker Arm Cover & Gasket
Courtesy of GENERAL MOTORS CORP.

1. Install the upper valve rocker arm cover gasket.
2. Install the upper valve rocker arm cover.
3. Install the upper valve rocker arm cover bolts.

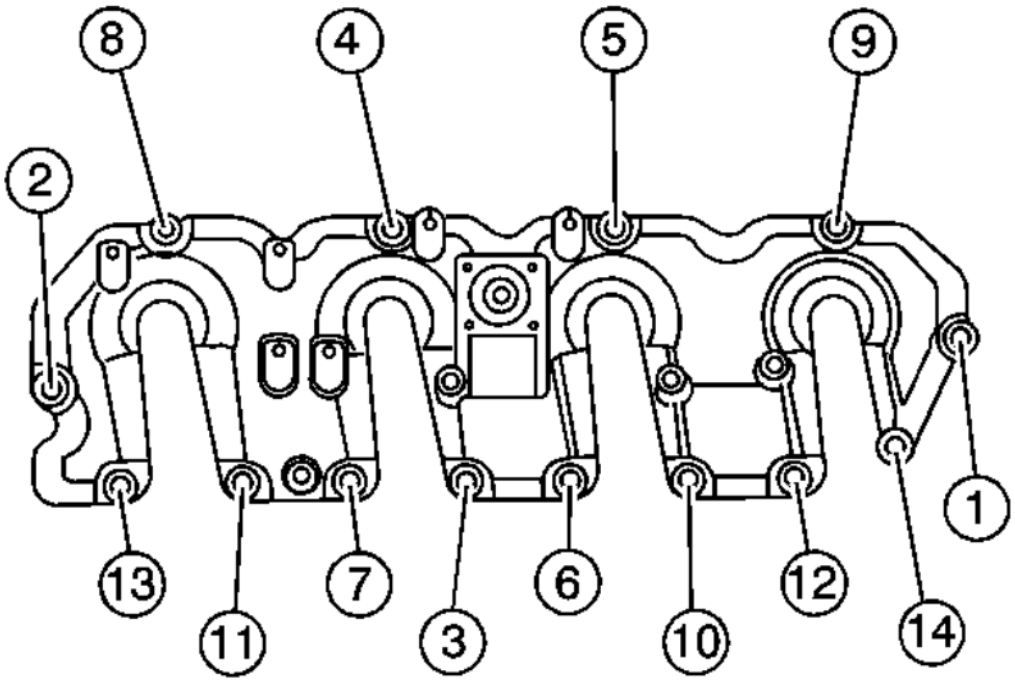


Fig. 118: Upper Valve Rocker Arm Cover Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

4. Tighten the upper valve rocker arm cover bolts in the sequence shown.

   Tighten: Tighten the bolts to 8 N.m (71 lb in).

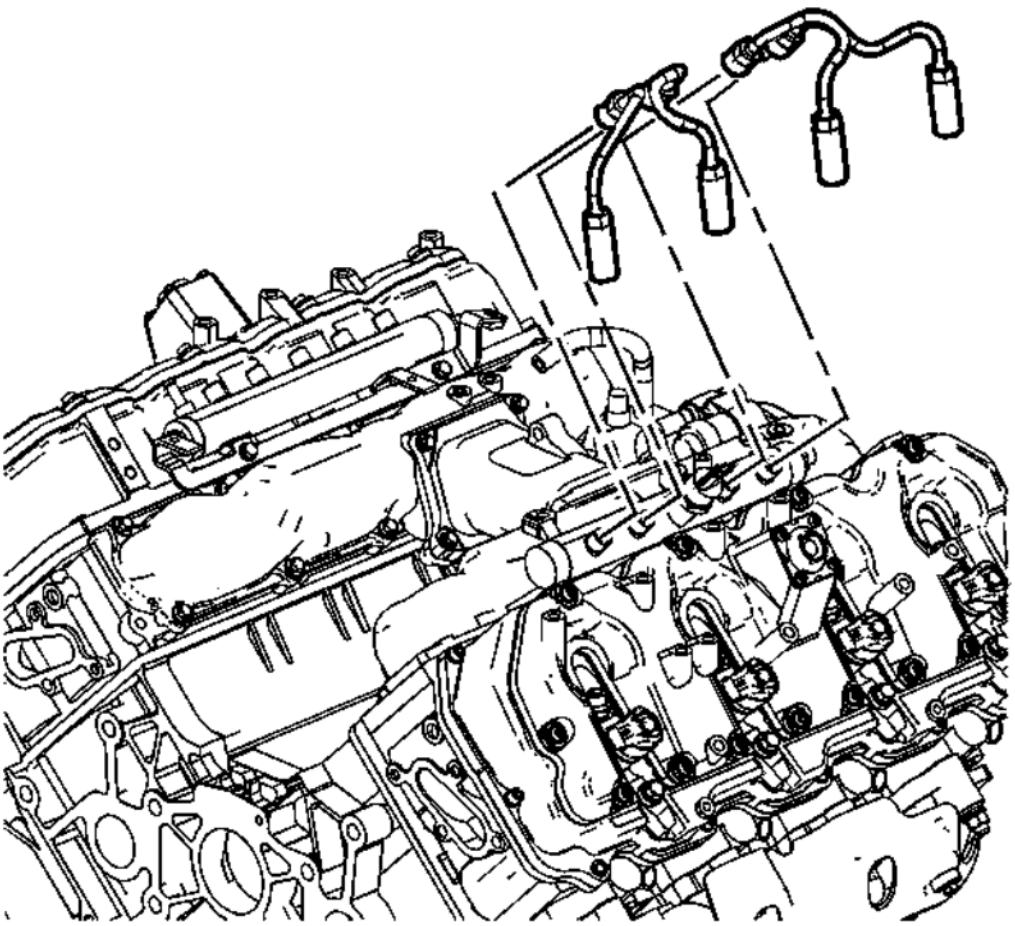


Fig. 119: View Of Fuel Injector Pipes
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure proper torquing of the fuel injector line. An under-torqued fuel injector line will not seal properly and an over-torqued fuel injector line may damage the fuel injector fitting. An improperly sealed or damaged fuel injector line or fuel injector fitting will cause a fuel leak.

5. Install the fuel injector pipes.

Tighten: Tighten the pipes to 41 N.m (30 lb ft).

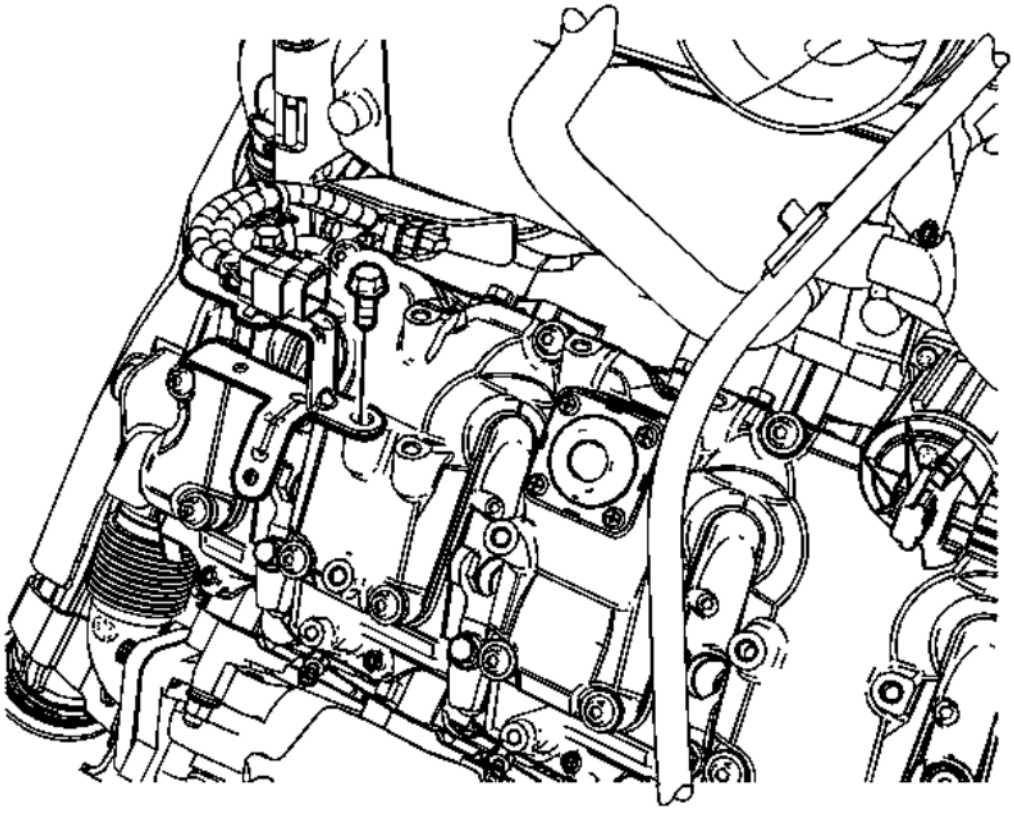


Fig. 120: View Of Engine Harness Bracket Bolt
Courtesy of GENERAL MOTORS CORP.

6. Position engine harness brackets.
7. Install the engine harness bracket bolt.

   Tighten: Tighten the bolt to 21 N.m (15 lb ft).

8. Install the PCV hose/pipe. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement**.

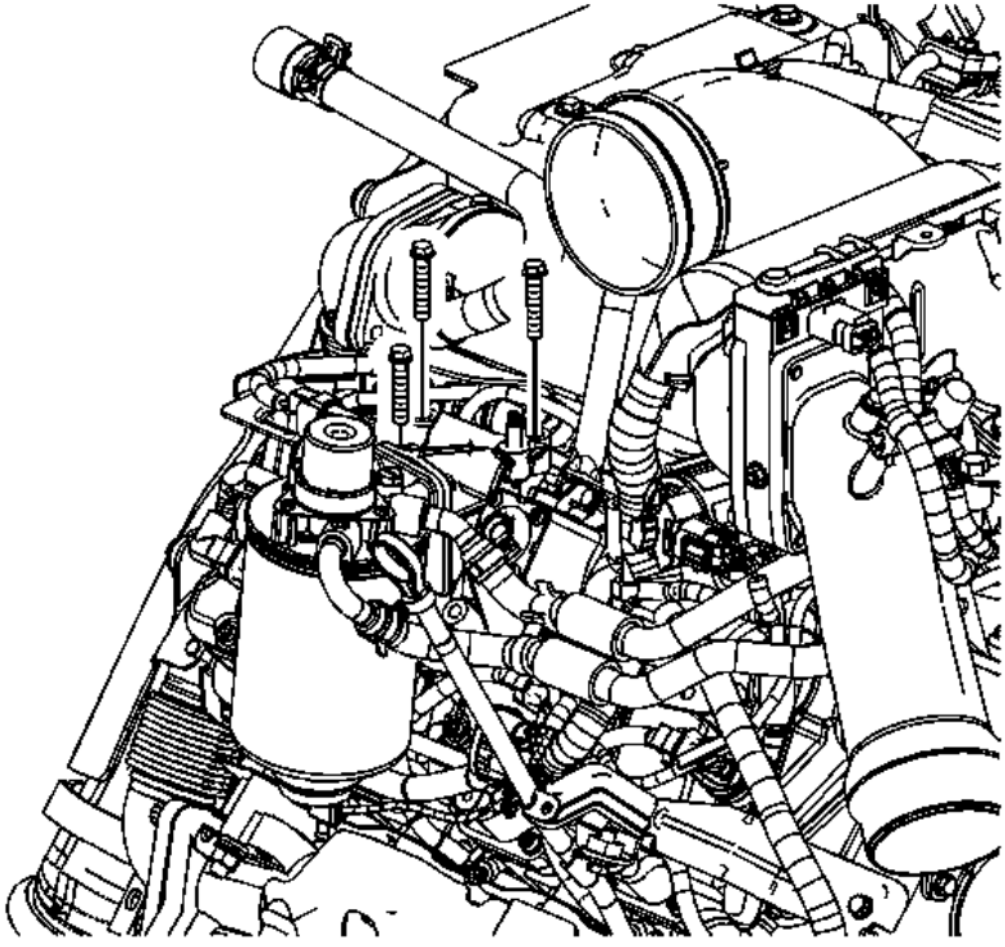


Fig. 121: Identifying Fuel Filter Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

9. Position the fuel filter with bracket to the rocker cover.
10. Install the fuel filter bracket bolts.

    Tighten: Tighten the bolts to 21 N.m (15 lb ft).

11. Position the heater outlet hose.
12. Install the heater hose bracket bolt to the bracket.

Tighten: Tighten the bolt to 21 N.m (15 lb ft).

13. Install the EGR cooler tube. Refer to **Exhaust Gas Recirculation Valve Cooler Replacement** .

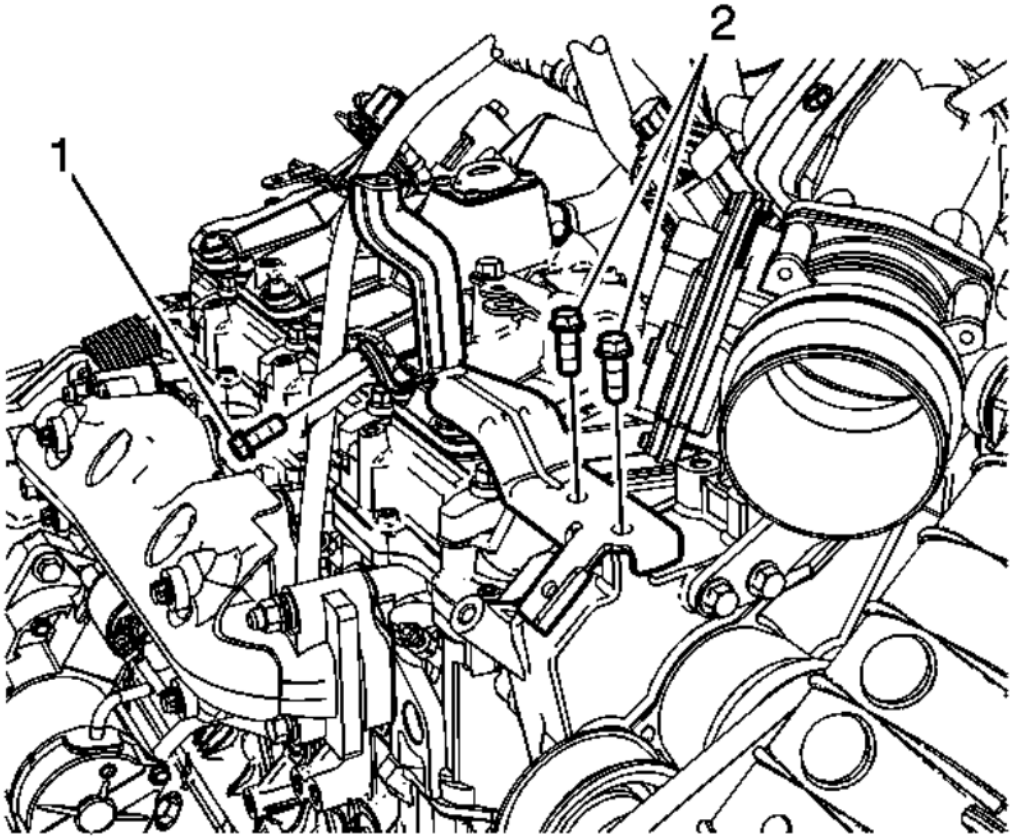


Fig. 122: View Of Oil Level Indicator Tube Bolts & Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

14. Install the bracket.
15. Install the oil level indicator tube bracket bolts (2).

Tighten: Tighten the bolts to 21 N.m (15 lb ft).

16. Install the oil level indicator tube bolt (1).

Tighten: Tighten the bolt to 21 N.m (15 lb ft).

17. Install the wiring harness retainer to the bracket.
18. Install the charged air cooler outlet duct. Refer to **Charge Air Cooler Outlet Pipe Replacement** .
19. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
20. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.

VALVE ROCKER ARM COVER REPLACEMENT - LOWER LEFT SIDE

Removal Procedure

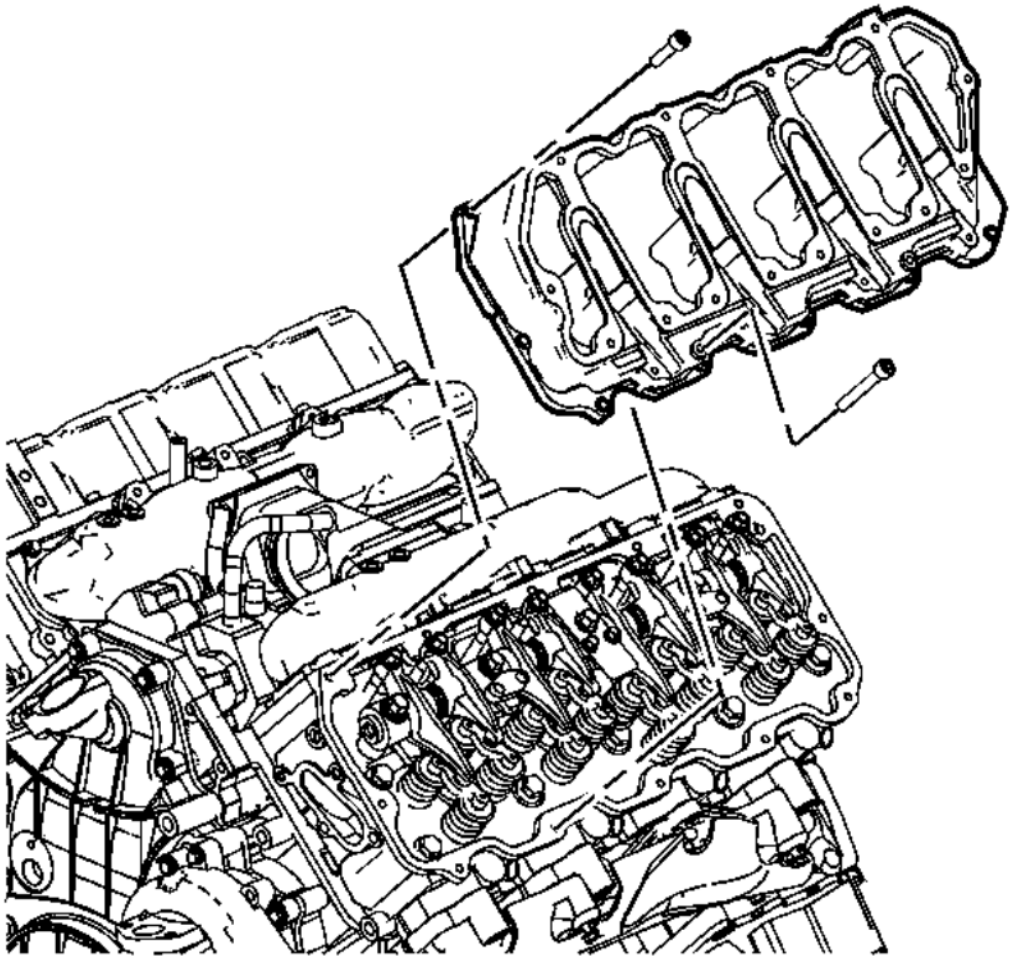


Fig. 123: View Of Lower Valve Rocker Arm Cover (Left)
Courtesy of GENERAL MOTORS CORP.

1. Remove the upper left valve rocker arm cover. Refer to **Valve Rocker Arm Cover Replacement - Upper Left Side**.
2. Remove the fuel injectors. Refer to **Fuel Injector Replacement (Left)** or **Fuel Injector Replacement (Right)** .
3. Remove the lower valve rocker arm cover bolts.
4. Remove the lower valve rocker arm cover.
5. Remove the gasket from the lower valve rocker arm cover.

6. Inspect the lower valve rocker arm cover gasket for damage, replace if necessary. Otherwise reuse the old gasket.
7. If required, clean and inspect the lower valve rocker arm cover. Refer to **Valve Rocker Arm Cover Cleaning and Inspection - Lower** .

Installation Procedure

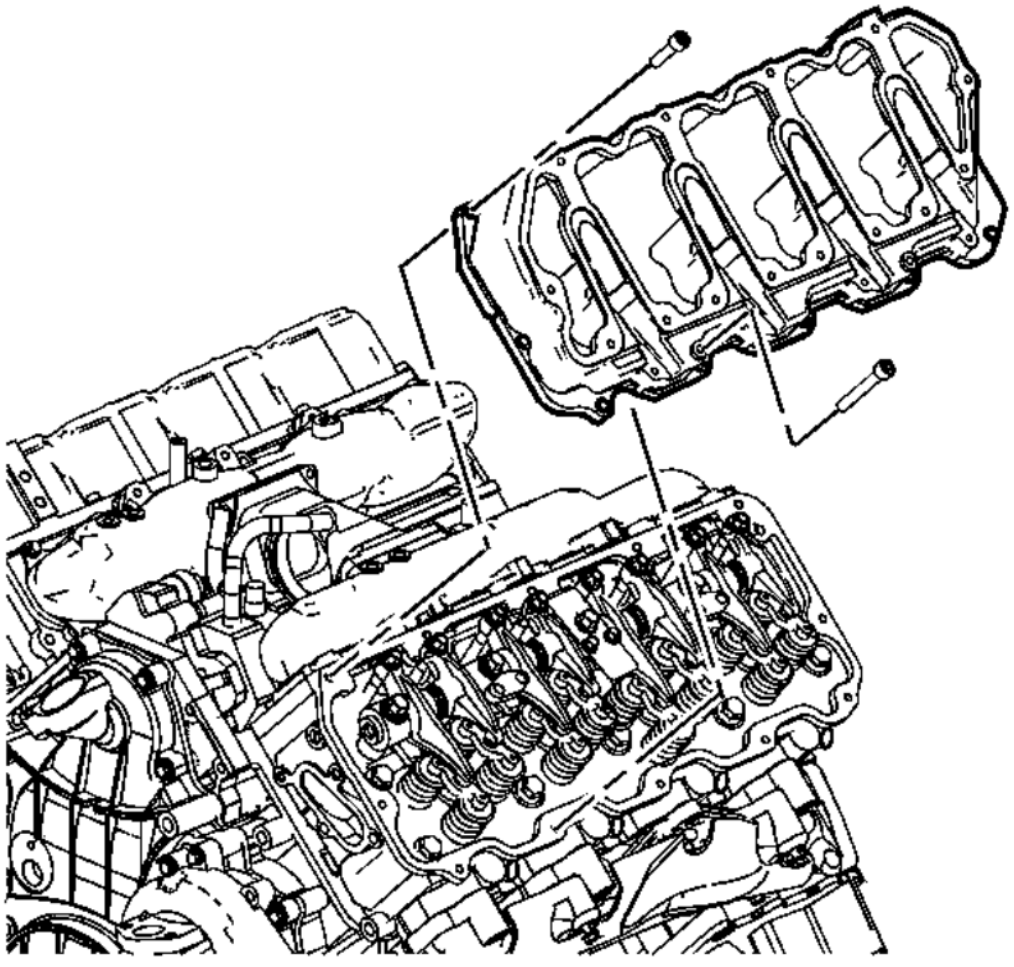


Fig. 124: View Of Lower Valve Rocker Arm Cover (Left)
Courtesy of GENERAL MOTORS CORP.

1. Install the lower valve rocker arm cover gasket.

2. Install the lower valve rocker arm cover.
3. Install the lower valve rocker arm cover bolts.

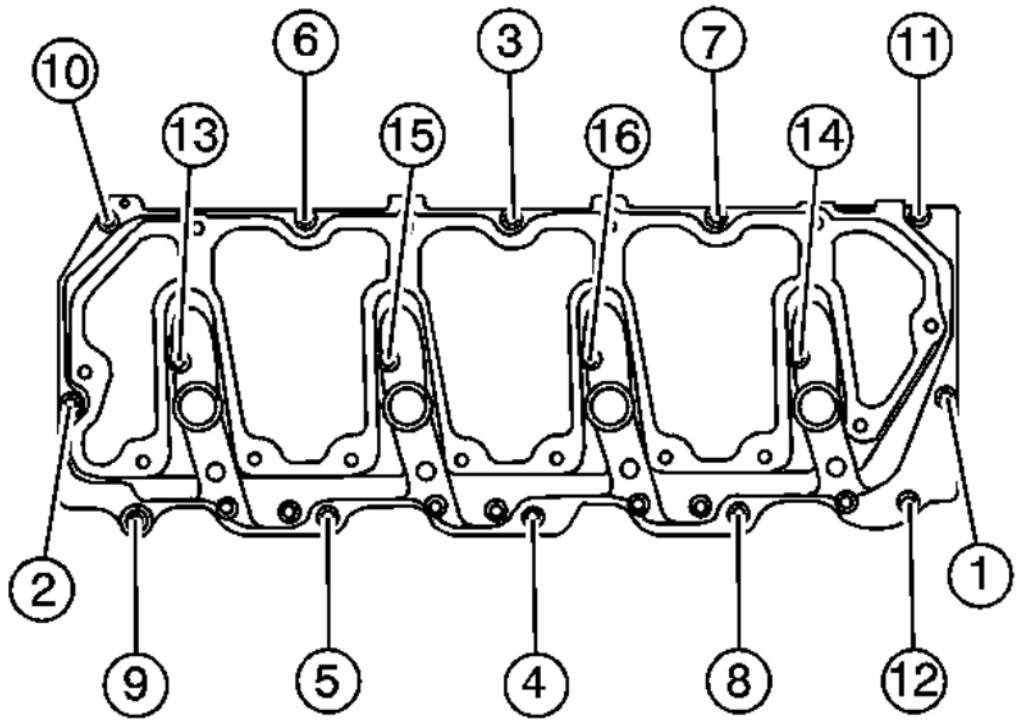


Fig. 125: Lower Valve Rocker Arm Cover Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

4. Tighten the lower valve rocker arm cover bolts in the sequence shown.

   Tighten: Tighten the bolts to 10 N.m (89 lb in).

5. Install the fuel injectors. Refer to **Fuel Injector Replacement (Left)** or **Fuel Injector Replacement (Right)** .
6. Install the upper left valve rocker arm cover. Refer to **Valve Rocker Arm Cover Replacement - Upper Left Side**.

VALVE ROCKER ARM COVER REPLACEMENT - LOWER RIGHT SIDE

Removal Procedure

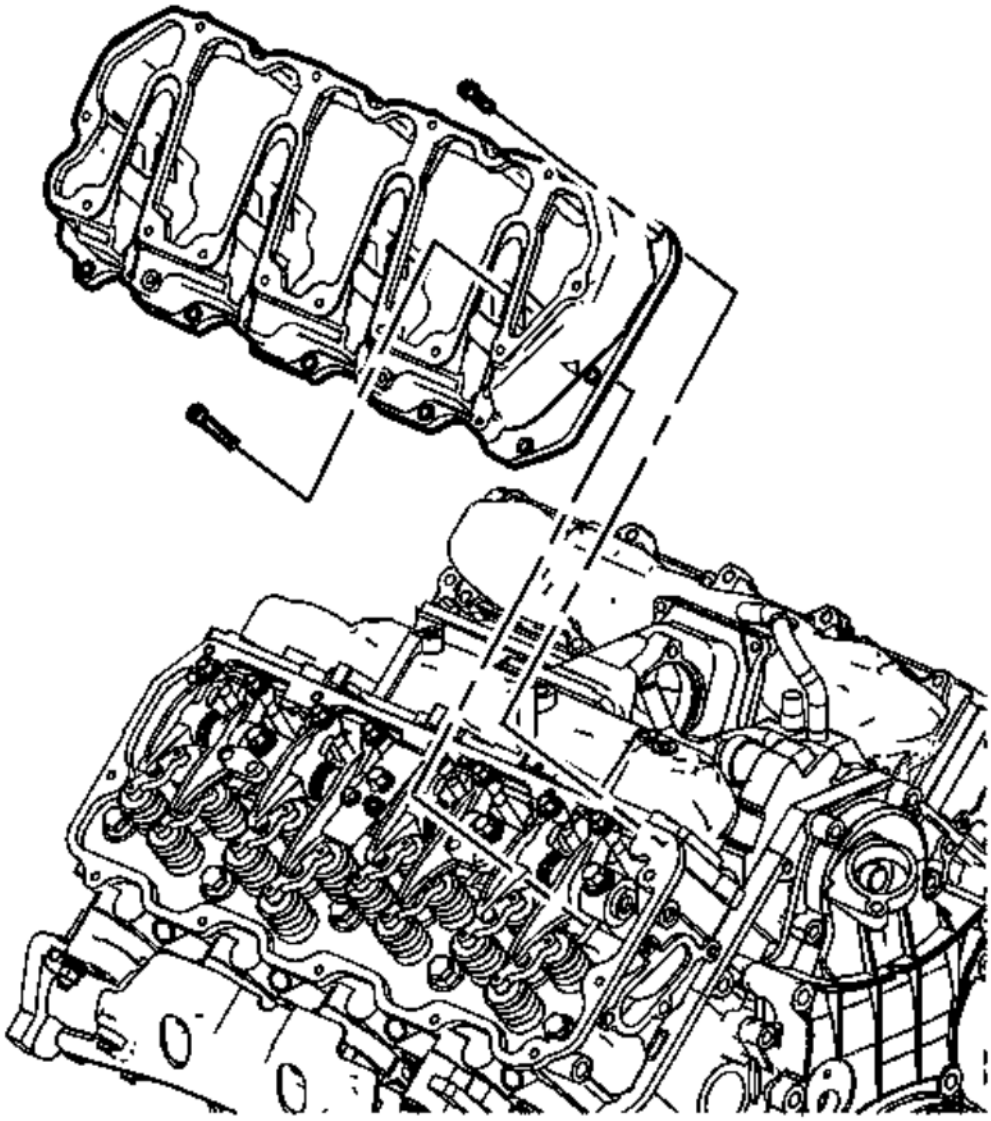


Fig. 126: View Of Lower Valve Rocker Arm Cover (Right)
Courtesy of GENERAL MOTORS CORP.

1. Remove the upper right valve rocker arm cover. Refer to **Valve Rocker Arm Cover Replacement - Upper Right Side**.
2. Remove the fuel injectors. Refer to **Fuel Injector Replacement (Left)** or **Fuel Injector Replacement (Right)** .
3. Remove the lower valve rocker arm cover bolts.
4. Remove the lower valve rocker arm cover.
5. Remove the gasket from the lower valve rocker arm cover.
6. Inspect the lower valve rocker arm cover gasket for damage, replace if necessary. Otherwise reuse the old gasket.
7. If required, clean and inspect the lower valve rocker arm cover. Refer to **Valve Rocker Arm Cover Cleaning and Inspection - Lower** .

Installation Procedure

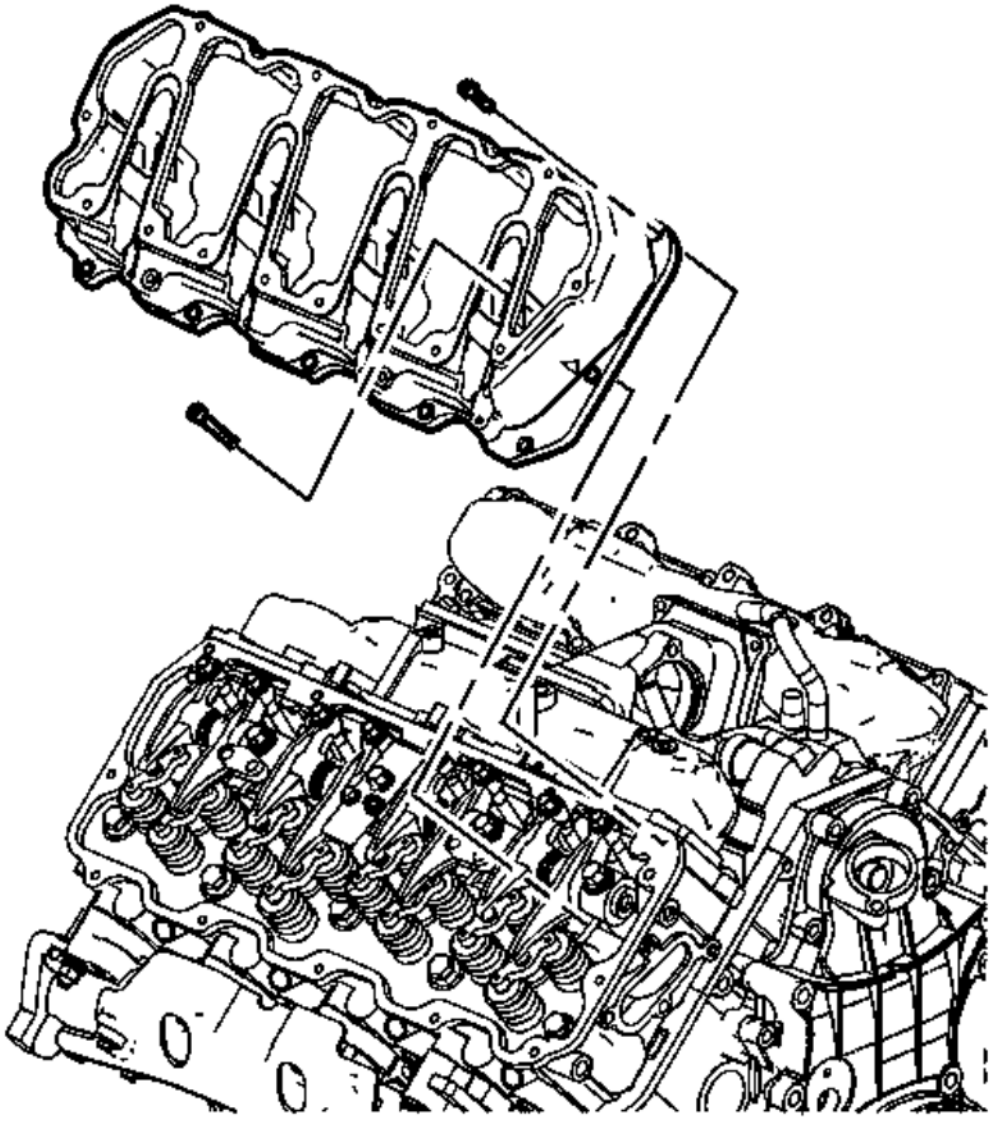


Fig. 127: View Of Lower Valve Rocker Arm Cover (Right)
Courtesy of GENERAL MOTORS CORP.

1. Install the lower valve rocker arm cover gasket.
2. Install the lower valve rocker arm cover.
3. Install the lower valve rocker arm cover bolts.

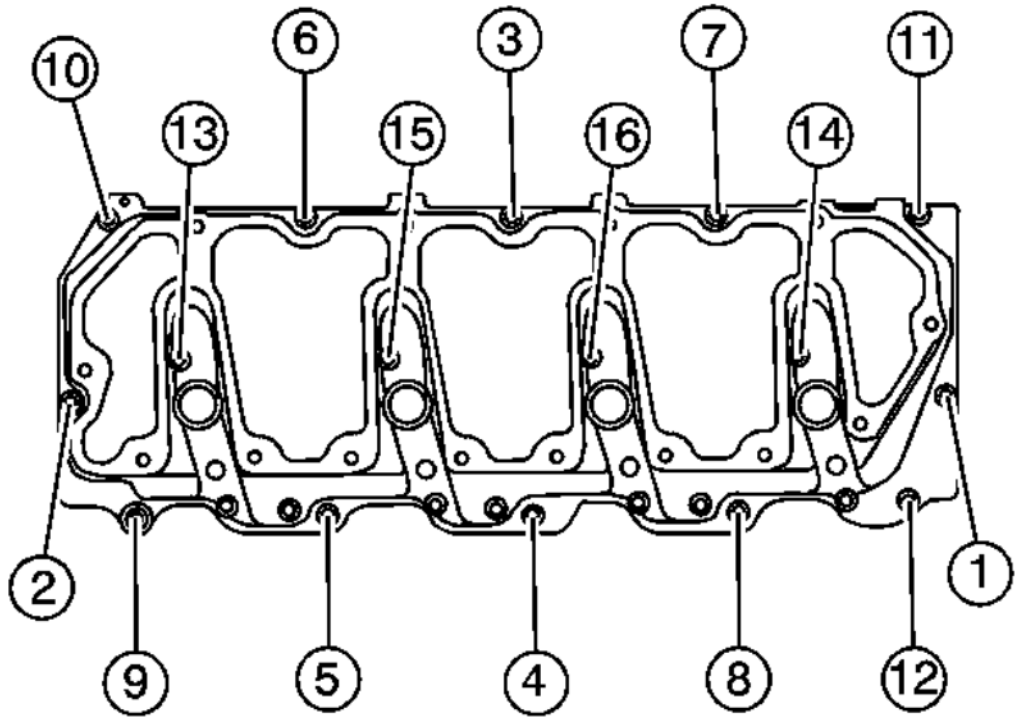


Fig. 128: Lower Valve Rocker Arm Cover Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

4. Tighten the bolts in the sequence shown.

   Tighten: Tighten the bolts to 10 N.m (89 lb in).

5. Install the fuel injectors. Refer to **Fuel Injector Replacement (Left)** or **Fuel Injector Replacement (Right)** .
6. Install the right upper valve rocker arm cover. Refer to **Valve Rocker Arm Cover Replacement - Upper Right Side**.

VALVE ROCKER ARM, SHAFT, AND PUSH ROD REPLACEMENT

Removal Procedure

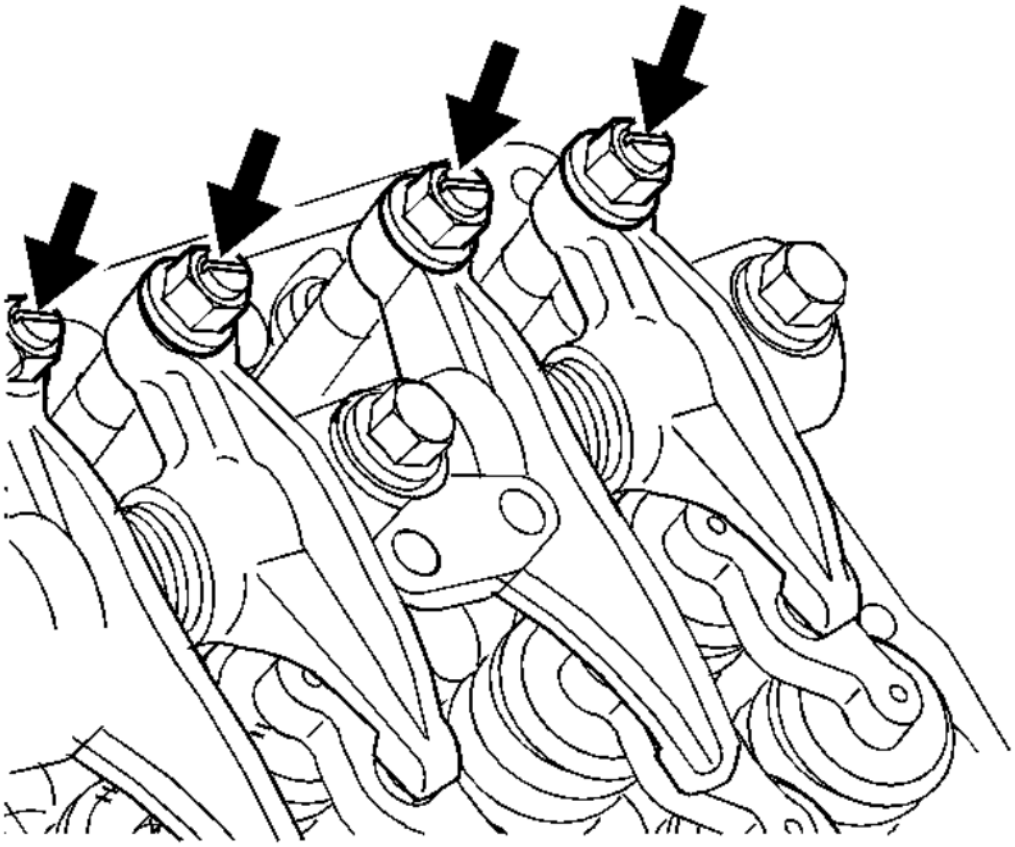


Fig. 129: View Of Valve Clearance Adjusting Screw
Courtesy of GENERAL MOTORS CORP.

1. Remove the lower valve rocker arm covers. Refer to **Valve Rocker Arm Cover Replacement - Lower Left Side** or **Valve Rocker Arm Cover Replacement - Lower Right Side**.
2. Loosen the valve clearance lock nuts on each rocker arm.
3. Loosen the valve clearance adjusting screw on each rocker arm in order to relieve tension on the valvetrain.

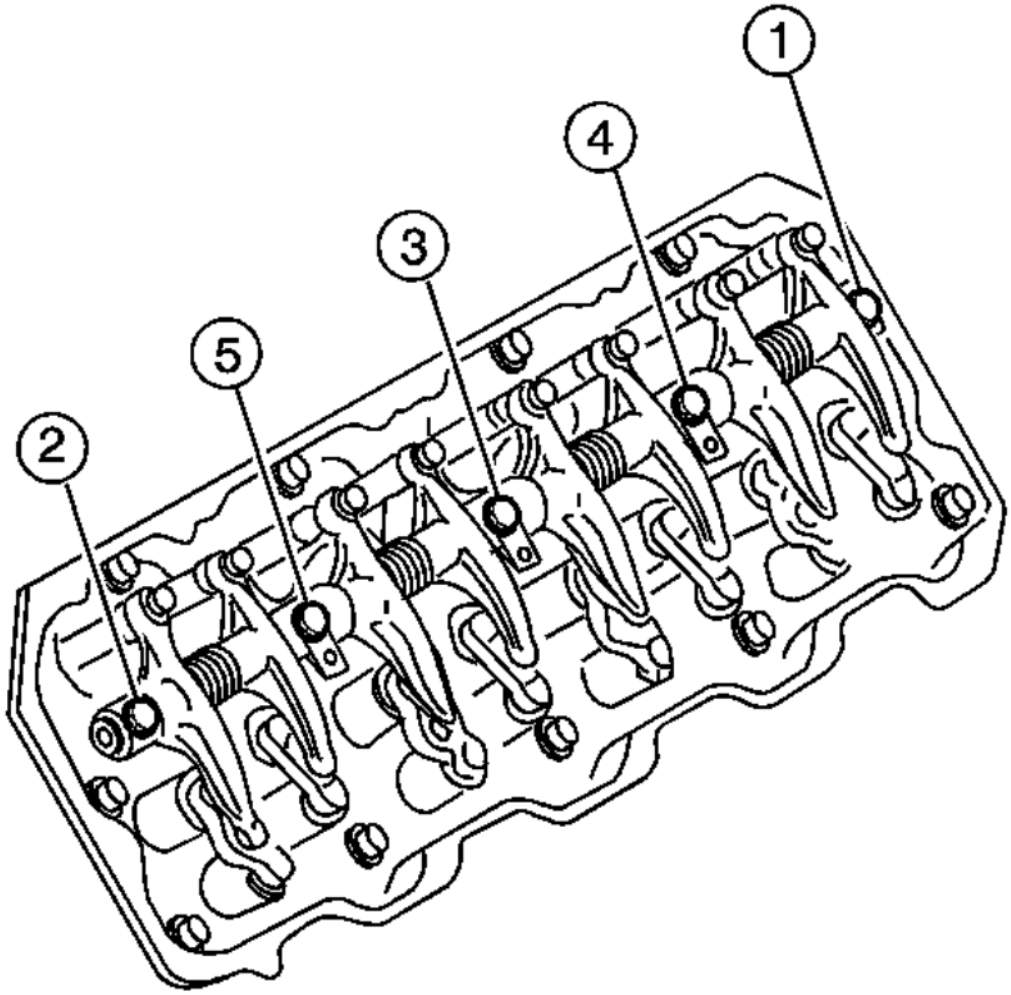


Fig. 130: Rocker Arm Shaft Bolts Loosening Sequence
Courtesy of GENERAL MOTORS CORP.

4. Remove the rocker arm shaft assembly bolts in the sequence shown. Leave the bolts in the rocker arm shaft brackets.

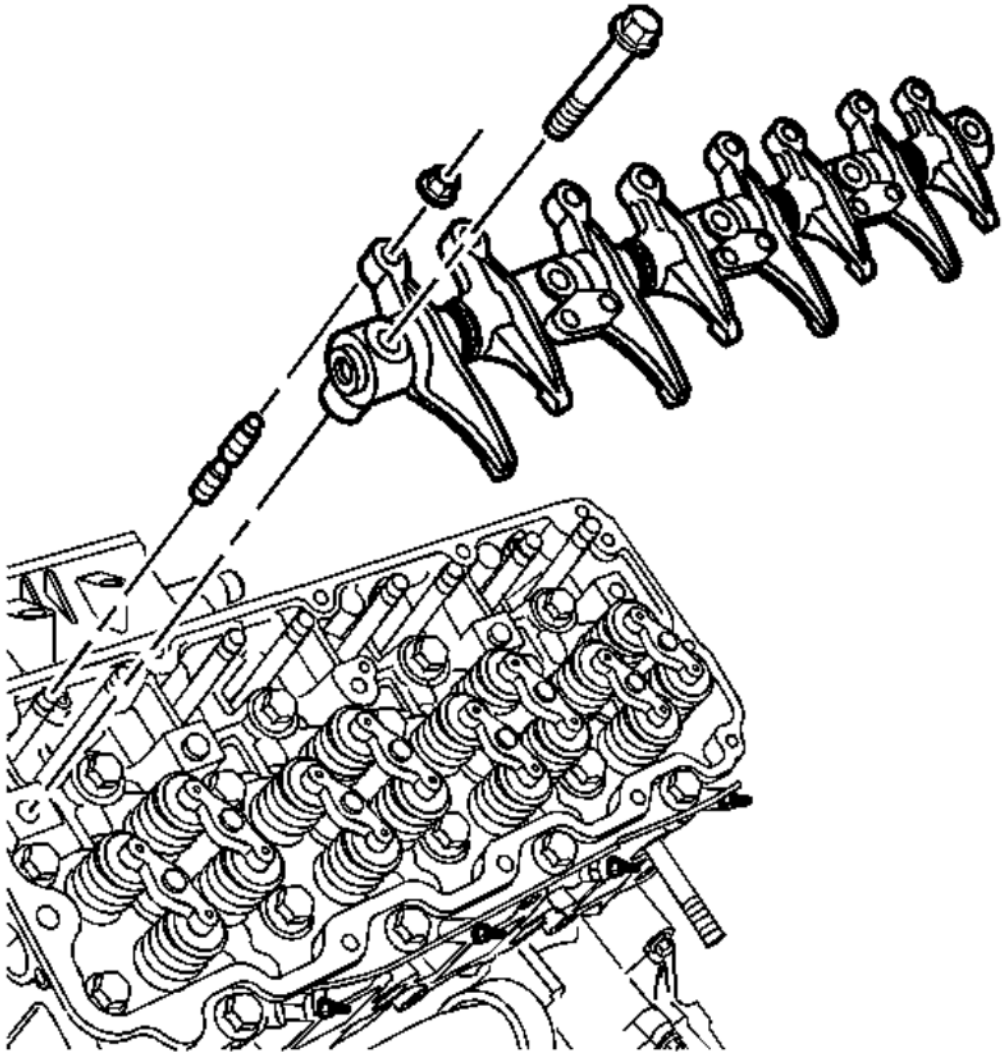


Fig. 131: View Of Rocker Arm Shaft
Courtesy of GENERAL MOTORS CORP.

5. Remove the rocker arm shaft assembly from the cylinder head.

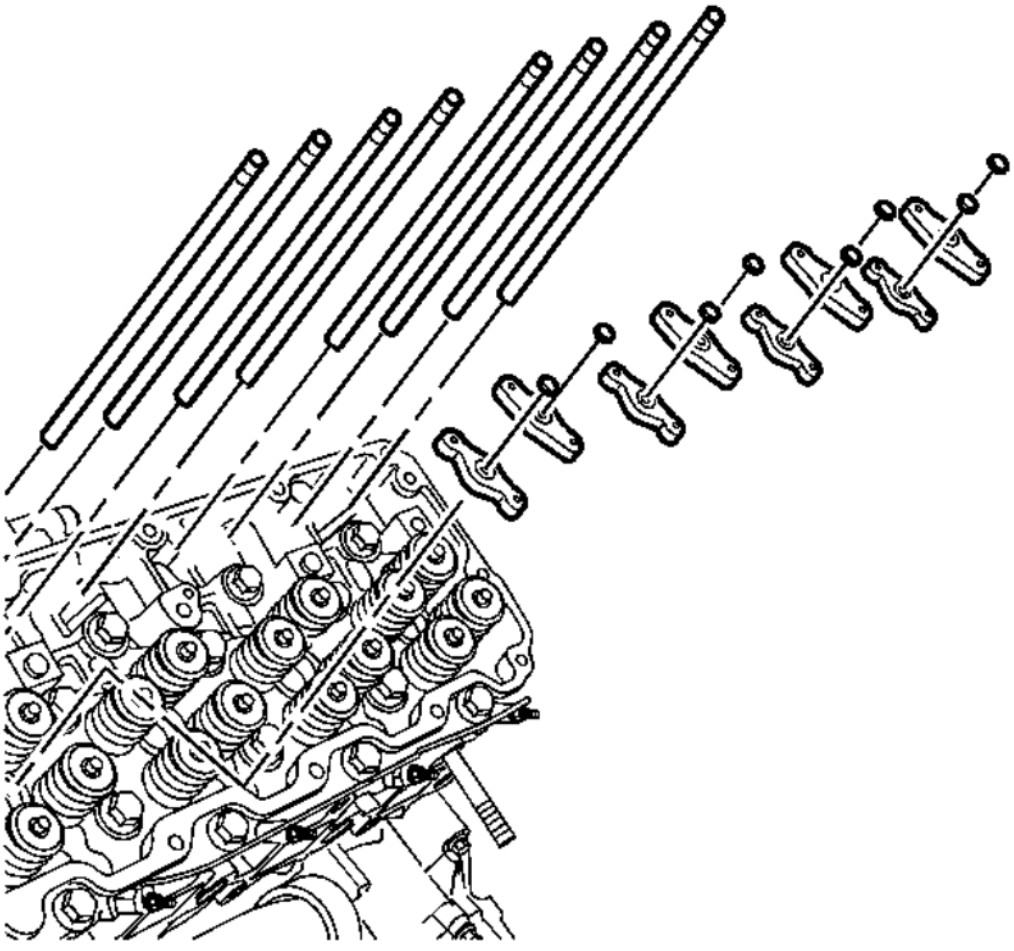


Fig. 132: View Of Pushrods, Valve Spring Caps & Valve Lifter Bridges
Courtesy of GENERAL MOTORS CORP.

6. Remove the valve bridge pins.
7. Remove the valve bridges.
8. Remove the pushrods.

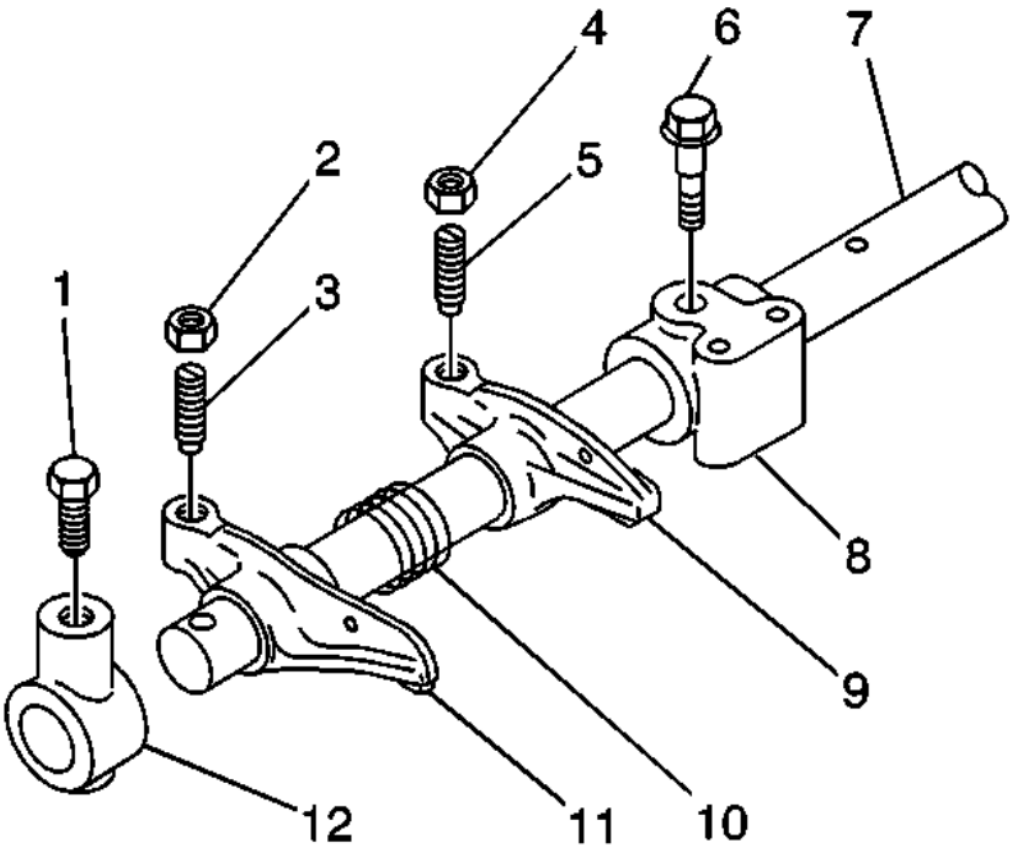


Fig. 133: View Of Rocker Arm Components
Courtesy of GENERAL MOTORS CORP.

9. Remove the rocker arm shaft bracket bolts (1), if necessary.
10. Remove the bracket (12), rocker arm (11), and spring (10), if necessary.
11. Remove the remaining rocker arms, springs, and brackets, if necessary.
12. If required, clean and inspect the valve rocker arm and shaft. Refer to **Valve Rocker Arm and Shaft Cleaning and Inspection** .

Installation Procedure

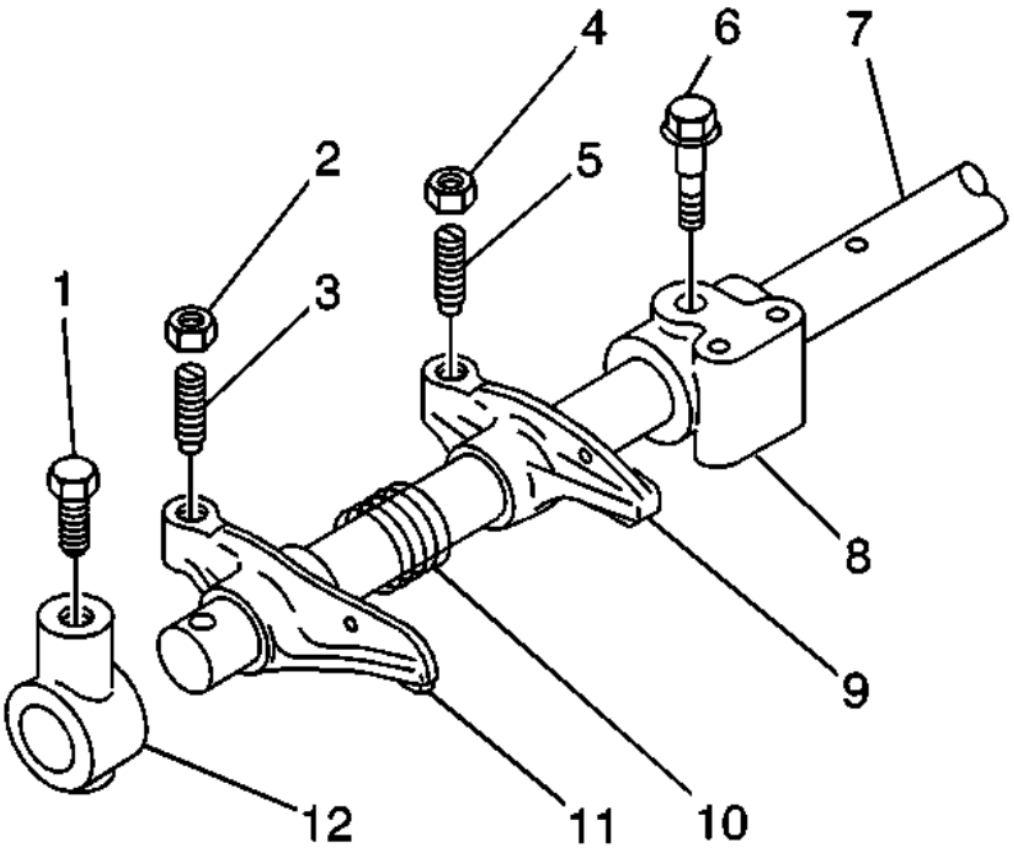


Fig. 134: View Of Rocker Arm Components
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the rocker arm shaft (7) and the inside of the rocker arms with clean engine oil, if necessary.
2. Install the rocker arm bracket (12) and bolt (1) on one end of the rocker arm shaft, if necessary.
3. Install the intake rocker arm (9), spring (10), exhaust rocker arm (11), and bracket (12) with bolt (1). Continue in the same sequence to the last bracket, if necessary.
4. Push the bracket (12) to compress the springs and then install the bolt (1), if necessary.

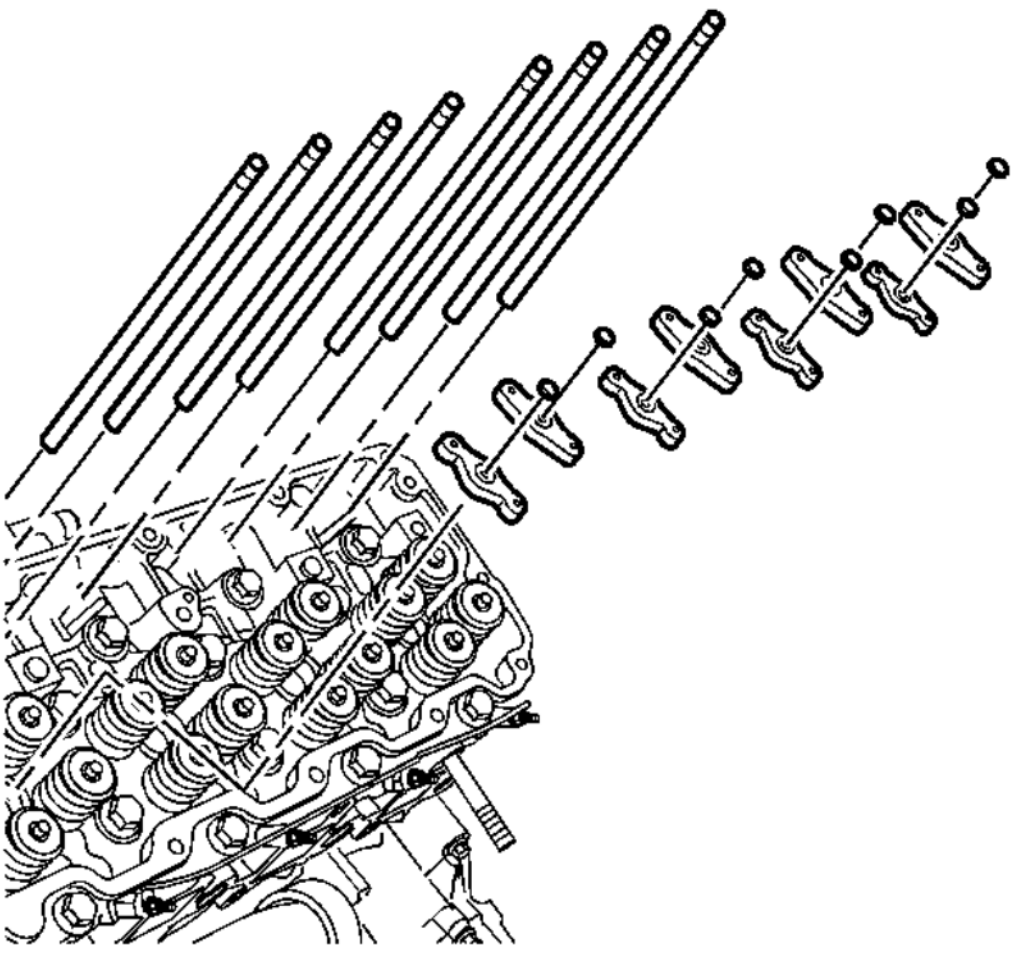


Fig. 135: View Of Pushrods, Valve Spring Caps & Valve Lifter Bridges
Courtesy of GENERAL MOTORS CORP.

5. Lubricate the top of the valves, the valve bridge stem, the valve lifter bridge, and the valve spring caps with clean engine oil.
6. Install the valve bridge.
7. Install the valve bridge pins.
8. Lubricate the valve lifter end of the pushrod with clean engine oil.
9. Install the pushrods.

To ensure the pushrod is properly installed, gently pull up on the pushrod. Resistance should

be felt from the pushrod trying to lift the valve lifter.

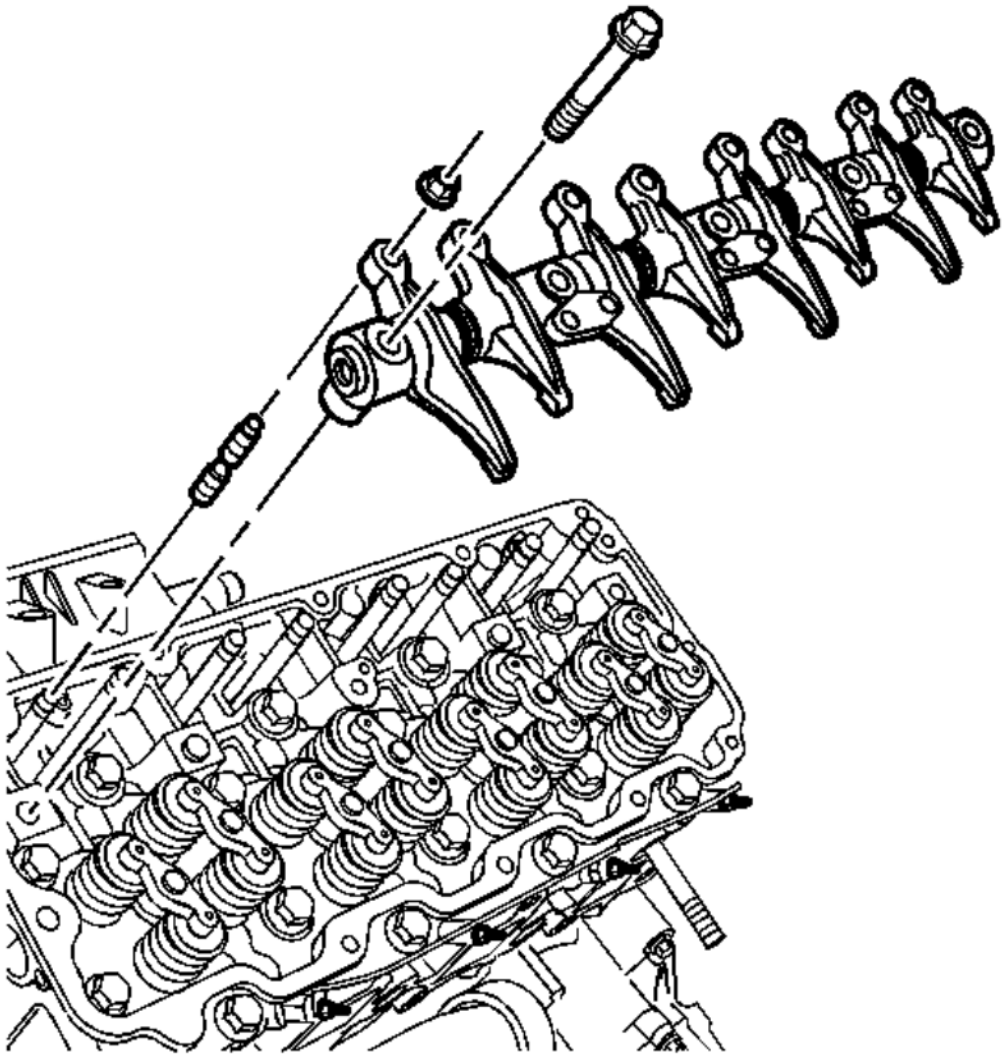


Fig. 136: View Of Rocker Arm Shaft
Courtesy of GENERAL MOTORS CORP.

NOTE: The pushrods must be correctly seated in the valve lifter and valve rocker arms before the rocker arm shaft assembly is torqued into place. Improper seating of the pushrods can cause

damage to the pushrods or the valve rocker arm shaft assembly components.

10. Install the rocker arm shaft assembly.

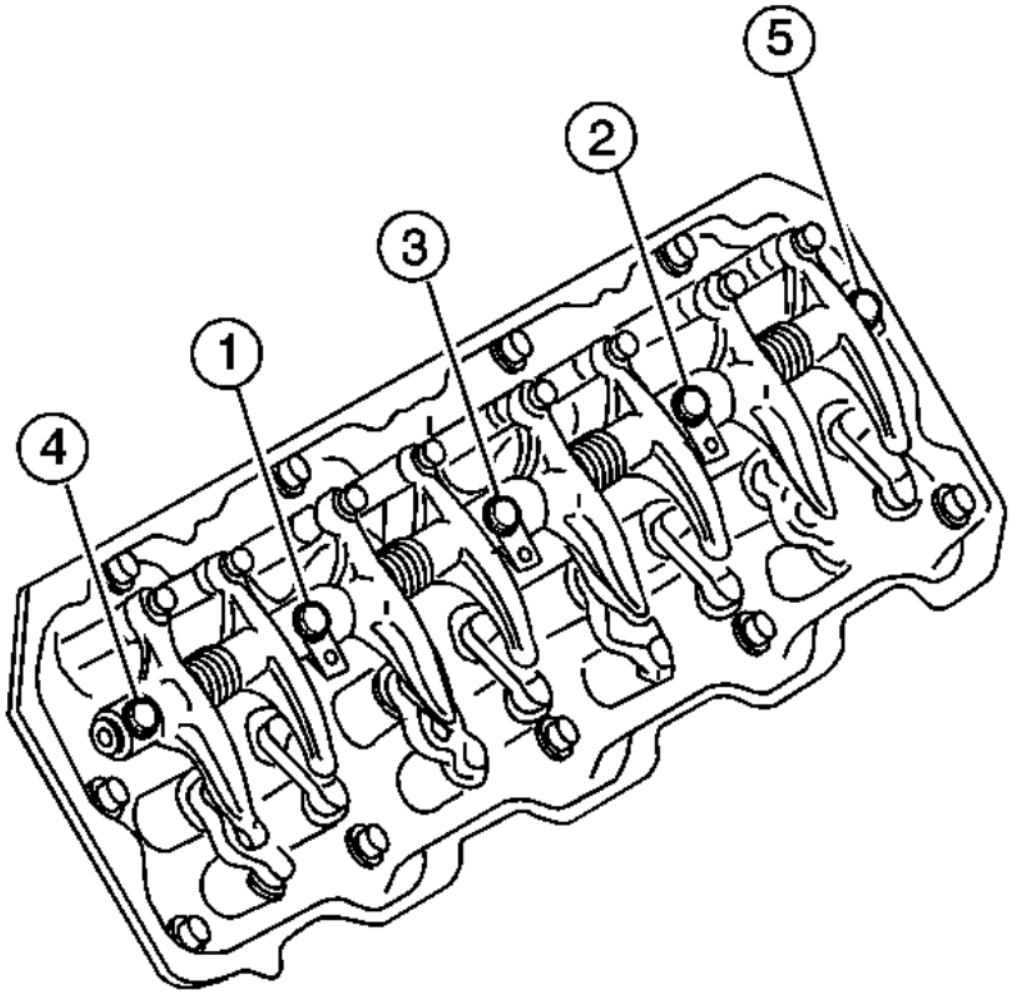


Fig. 137: Rocker Arm Shaft Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: **Refer to Fastener Notice .**

11. Tighten the rocker arm shaft bolts in the sequence shown.

    Tighten: Tighten the bolts to 41 N.m (30 lb ft).

12. Adjust the valve clearance. Refer to **Valve Lash Adjustment** .
13. Install the lower valve rocker arm covers. Refer to **Valve Rocker Arm Cover Replacement - Lower Left Side** or **Valve Rocker Arm Cover Replacement - Lower Right Side**.

VALVE CLEARANCE ADJUSTMENT

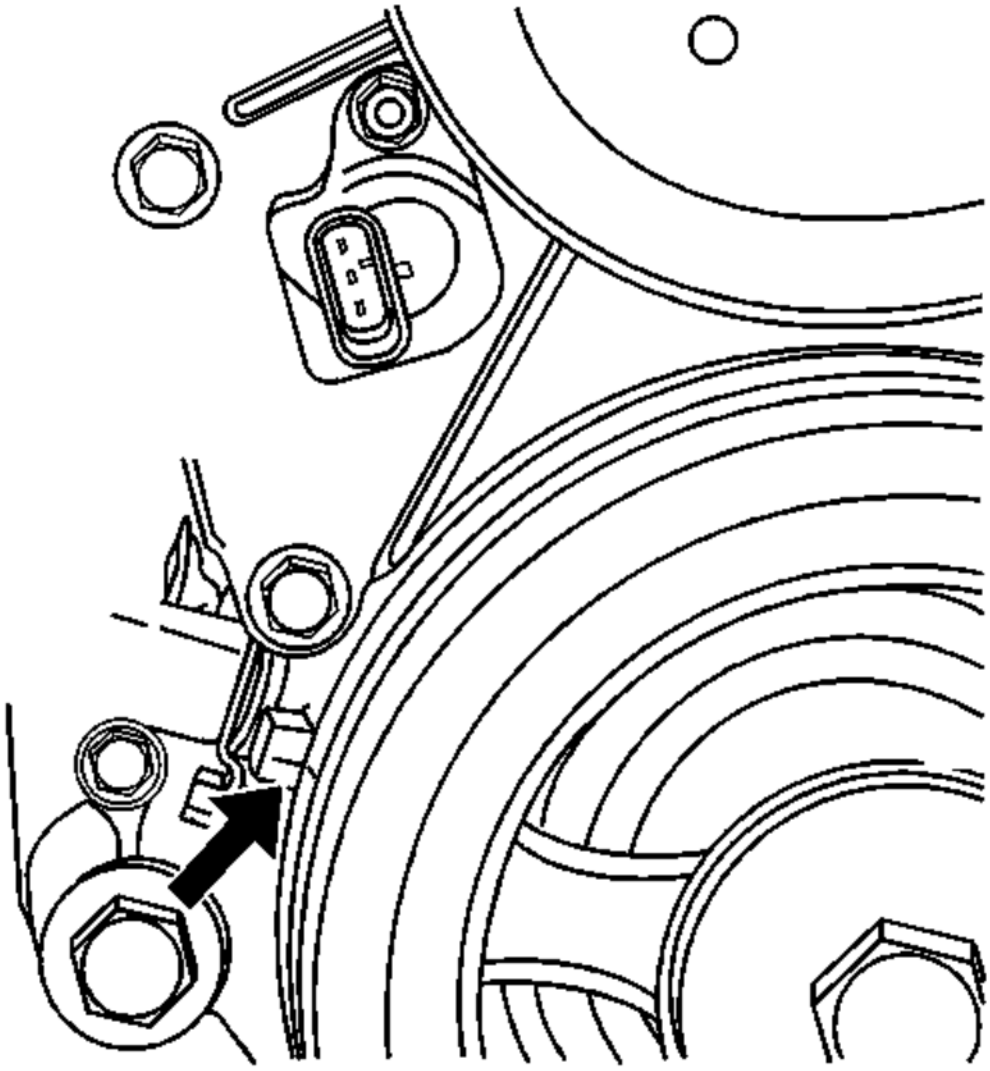


Fig. 138: View Of Crankshaft Balancer Mark Aligned With Engine Mark
Courtesy of GENERAL MOTORS CORP.

1. Remove the fan clutch. Refer to **Fan Clutch Replacement (Diesel)** .
2. Remove the upper valve rocker arm covers. Refer to **Valve Rocker Arm Cover Replacement - Upper Left Side** and **Valve Rocker Arm Cover Replacement - Upper Right Side**.

3. Rotate the crankshaft in order to bring the number 1 cylinder to top dead center (TDC) of the compression stroke. The number 1 cylinder is the front cylinder on the right bank. The mark on the crankshaft balancer should be aligned with the mark on the engine.

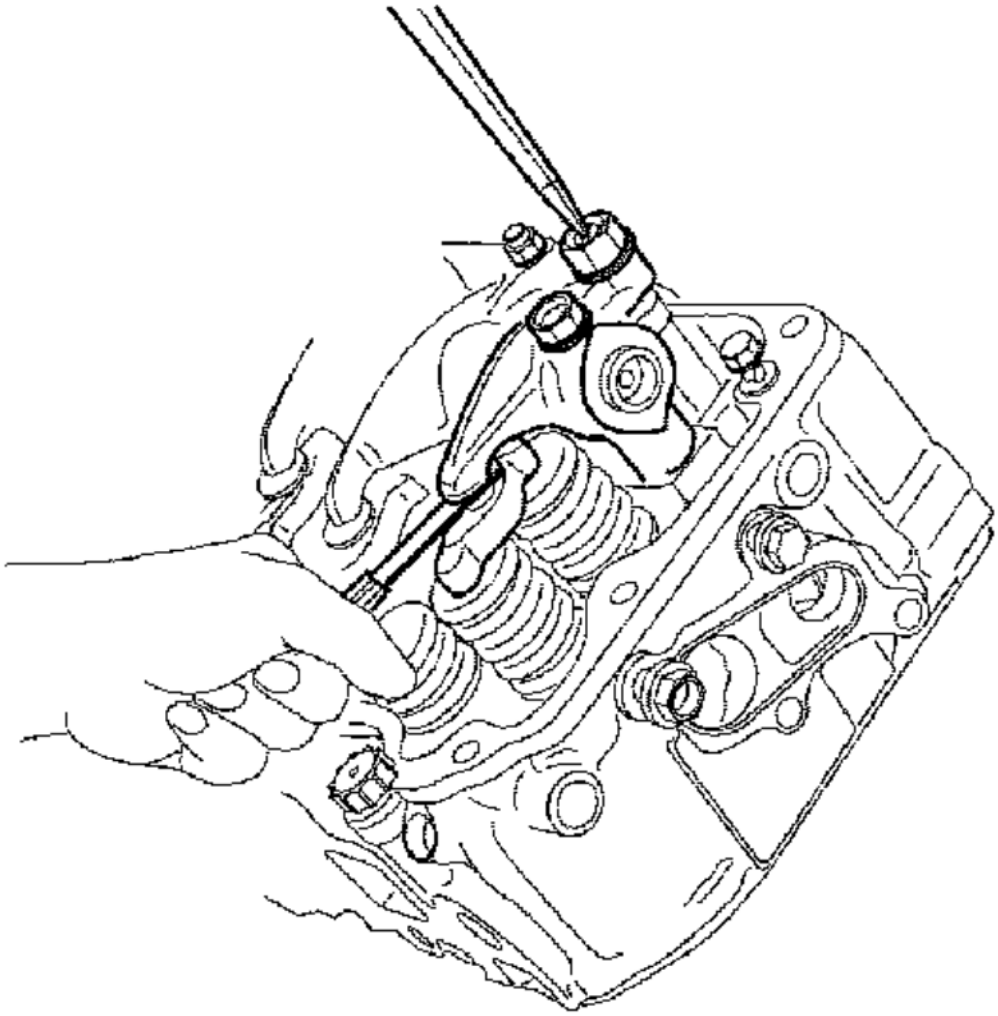


Fig. 139: View Of Feeler Gage Between Tip Of Rocker Arm & Valve Lifter Bridge
Courtesy of GENERAL MOTORS CORP.

4. Loosen the valve adjusting screws.
5. Insert a feeler gage between the tip of the rocker arm and the valve bridge.

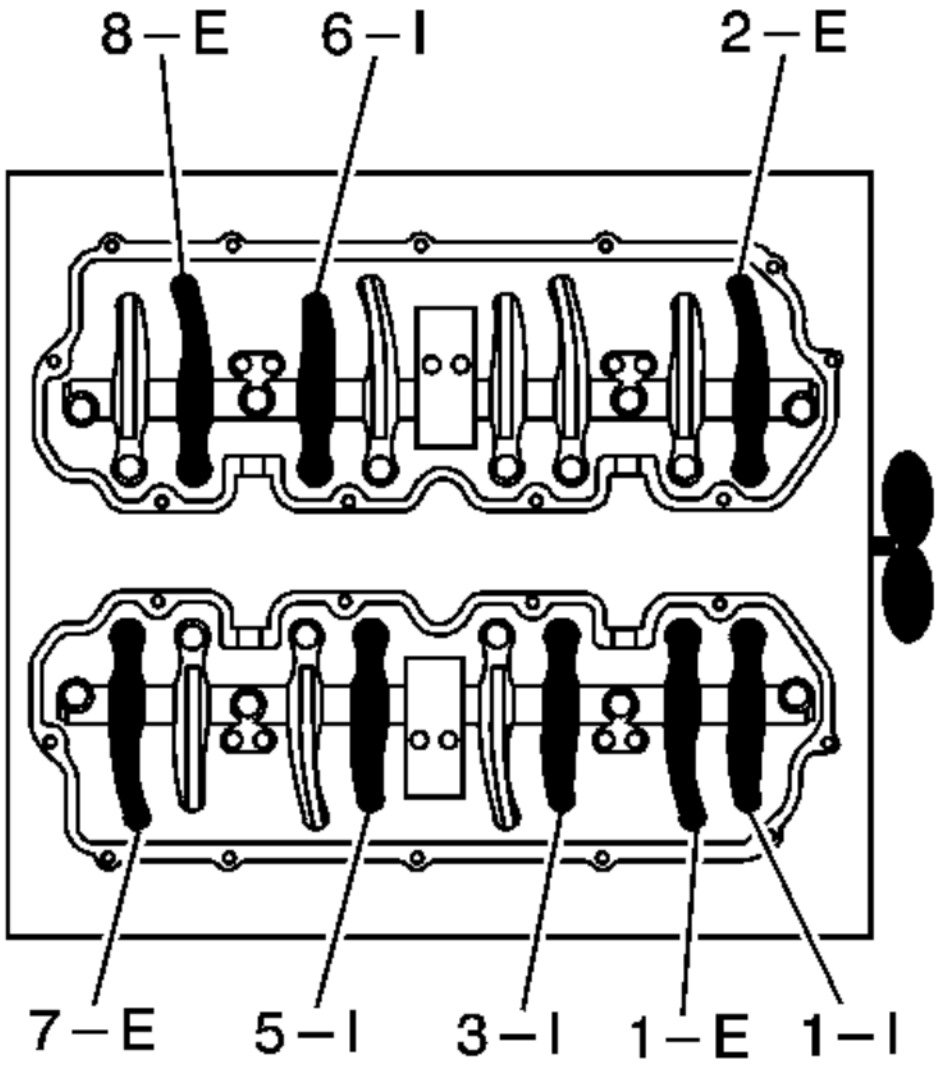


Fig. 140: View Of Rocker Arm Intake & Exhaust Valves 1, 2, 3, 5, 6, 7 & 8
Courtesy of GENERAL MOTORS CORP.

NOTE: **Refer to Fastener Notice .**

6. Adjust the valve lash to 0.3 mm (0.012 in). Refer to **Valve Clearance Adjustment Specifications** to determine which valves can be adjusted when the engine is at TDC.

7. Tighten the lock nut.

   Tighten: Tighten nut to 22 N.m (16 lb ft).

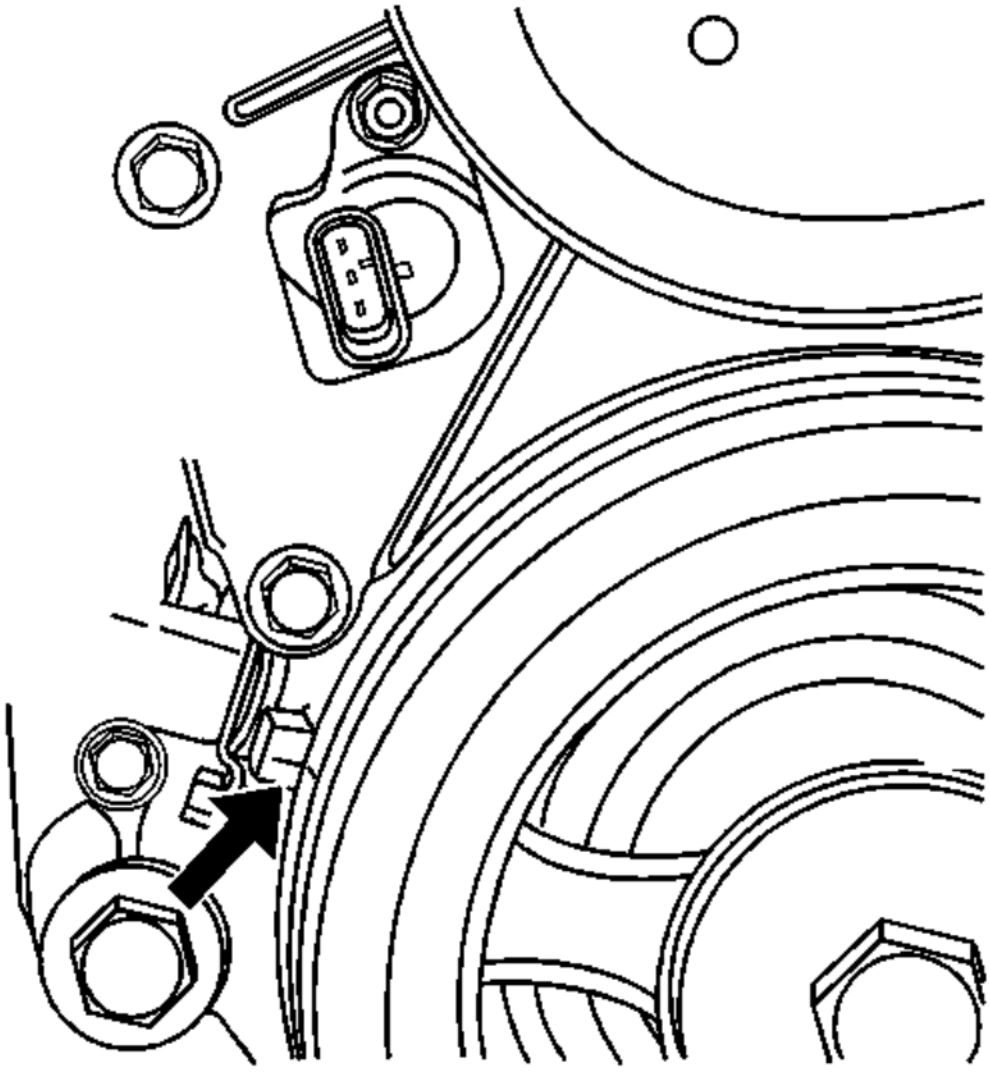


Fig. 141: View Of Crankshaft Balancer Mark Aligned With Engine Mark
Courtesy of GENERAL MOTORS CORP.

8. Rotate the crankshaft one revolution in order to bring the number 1 cylinder to TDC of the

exhaust stroke.

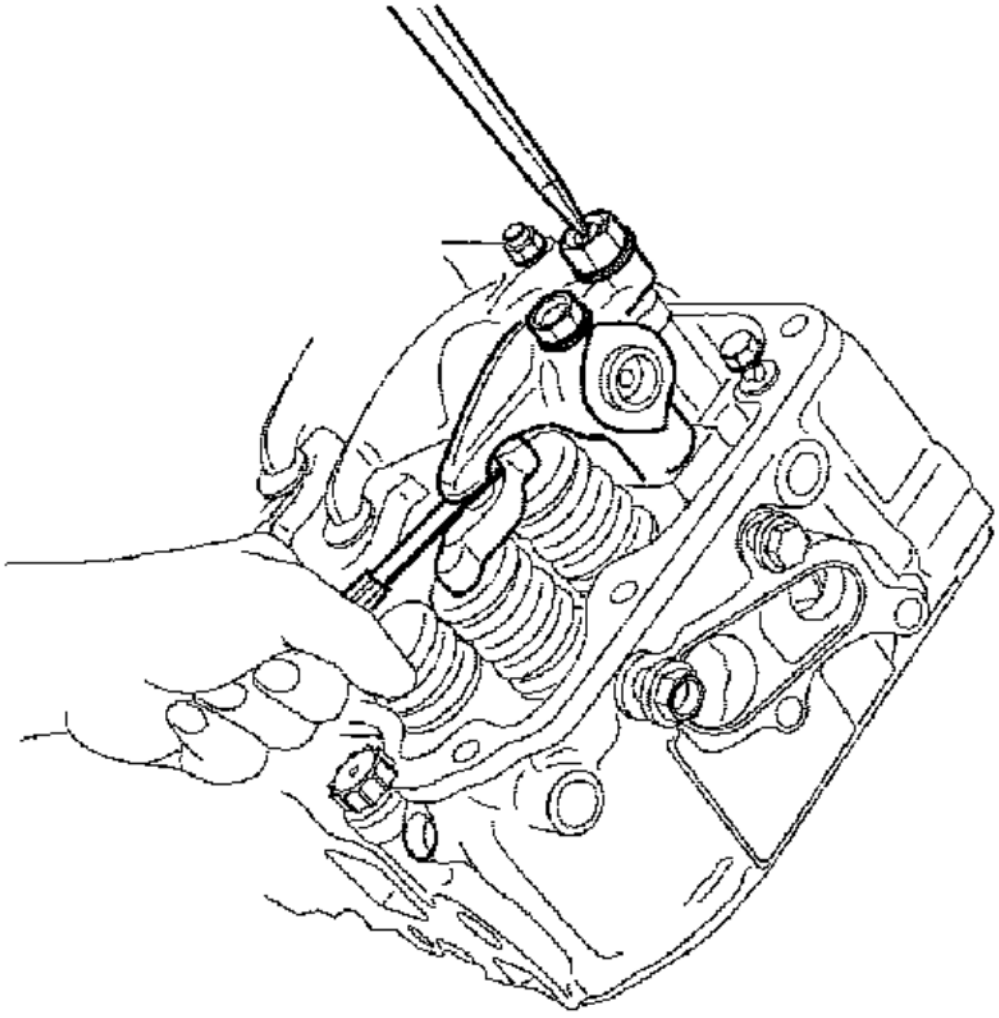


Fig. 142: View Of Feeler Gage Between Tip Of Rocker Arm & Valve Lifter Bridge
Courtesy of GENERAL MOTORS CORP.

9. Loosen the valve adjusting screws.
10. Insert a feeler gage between the tip of the rocker arm and the valve bridge.

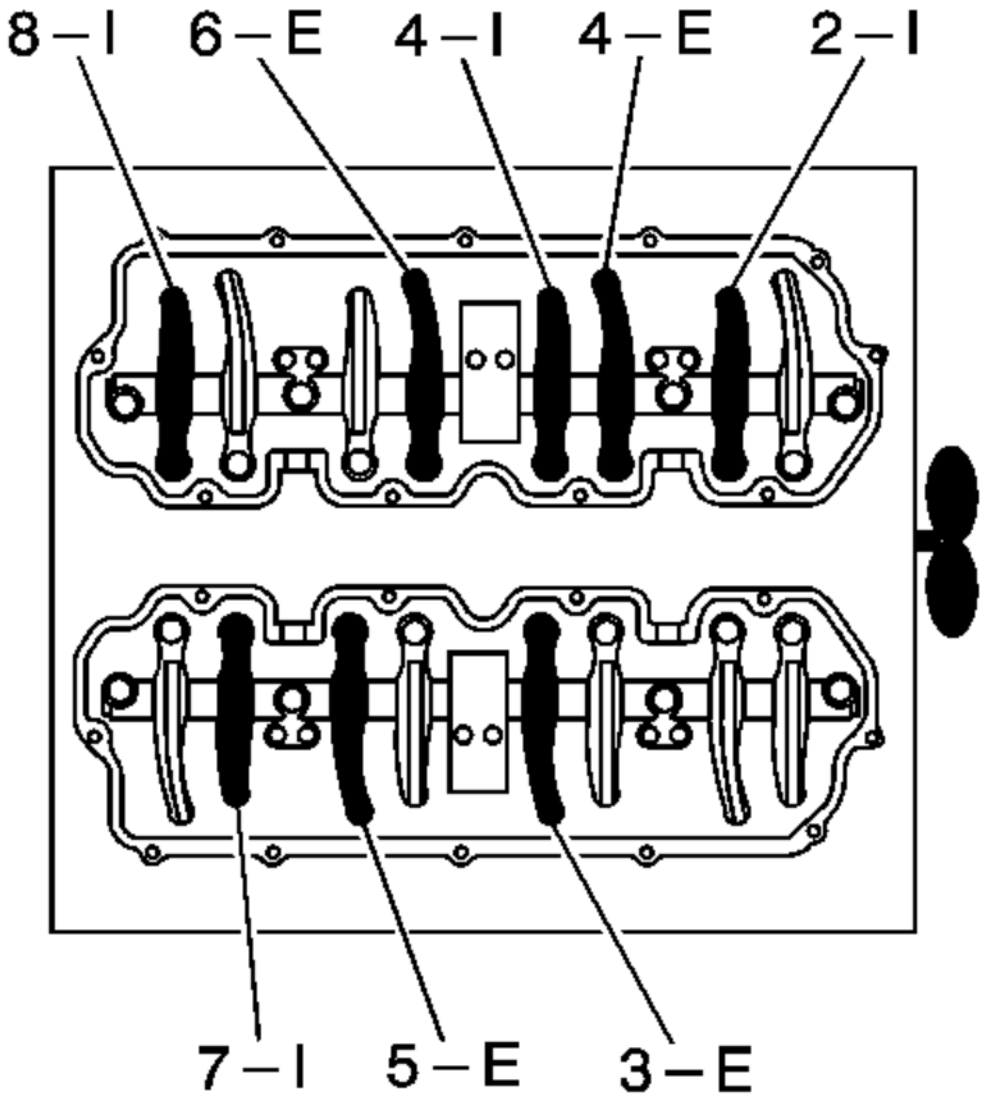


Fig. 143: View Of Rocker Arm Intake & Exhaust Valves 2, 3, 4, 5, 6, 7 & 8
Courtesy of GENERAL MOTORS CORP.

11. Adjust the valve clearance to 0.3 mm (0.012 in). Refer to **Valve Clearance Adjustment Specifications** to determine which valves can be adjusted when the engine is at TDC.
12. Tighten the lock nut.

Tighten: Tighten nut to 22 N.m (16 lb ft).

13. Install the upper valve rocker arm covers. Refer to **Valve Rocker Arm Cover Replacement - Upper Left Side** and **Valve Rocker Arm Cover Replacement - Upper Right Side**.
14. Install the fan clutch. Refer to **Fan Clutch Replacement (Diesel)** .

TURBOCHARGER REPLACEMENT

Removal Procedure

NOTE: If a turbocharger has failed, clean any turbocharger debris or excessive oil from the charge air cooler system before installing the new turbocharger. Failure to clean debris from the charge air cooler system will cause severe turbocharger and engine damage upon startup. Failure to clean excessive oil from the charge air cooler system may cause an engine runaway condition on startup, resulting in severe engine damage.

IMPORTANT: If a turbocharger failure is thought to be caused due to lack of oil, the camshaft bearing should be checked. The number 4 camshaft bearing bore feeds the turbocharger oil supply (feed) pipe. If this camshaft bearing spins in the bore, the turbocharger will be starved for oil. This will cause a failure of the turbocharger. Failure to diagnosis this condition will result in repeat turbocharger failures.

1. Remove the transmission. Refer to **Transmission Replacement** .
2. Remove the left and right wheelhouse liners. Refer to **Front Wheelhouse Liner Replacement - Right Side (GMC)** or **Front Wheelhouse Liner Replacement - Right Side (Chevrolet)** and **Front Wheelhouse Liner Replacement - Left Side (Chevrolet)** or **Front Wheelhouse Liner Replacement - Left Side (GMC)** .

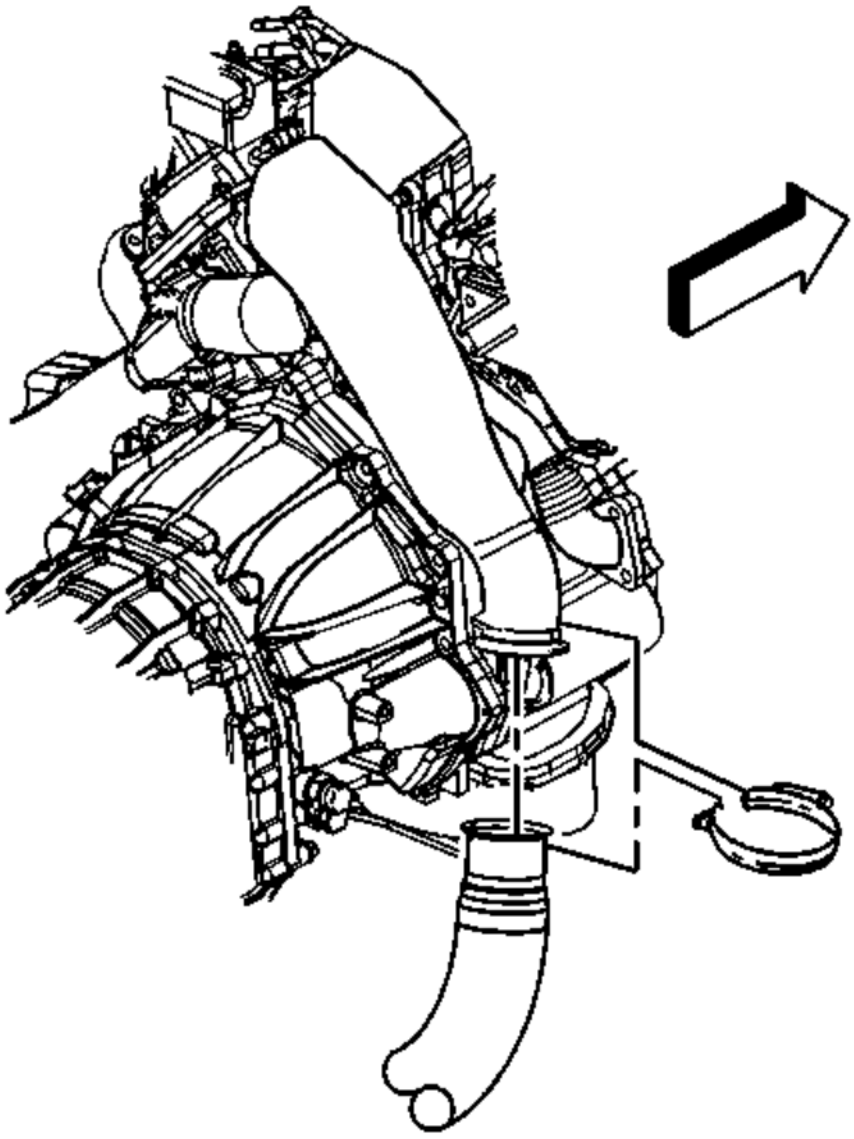


Fig. 144: View Of Turbocharger Exhaust Pipe & Clamp
Courtesy of GENERAL MOTORS CORP.

3. Loosen the exhaust pipe clamp. Slide the clamp onto the exhaust pipe.

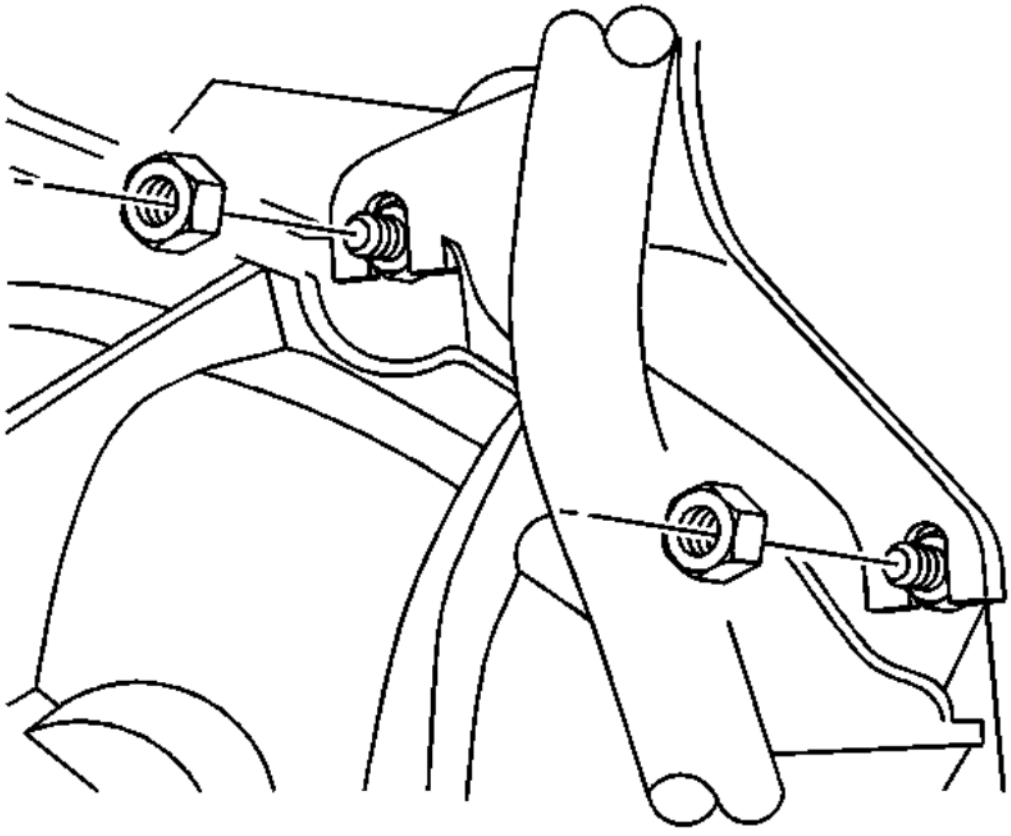


Fig. 145: View Of Fill Tube To Bellhousing Nuts
Courtesy of GENERAL MOTORS CORP.

4. If equipped with an automatic transmission, remove the transmission fill tube to bellhousing nuts.
5. Lift the fill tube up from the studs and reposition the tube to the right side of the vehicle. The tube does not require removal from the transmission.

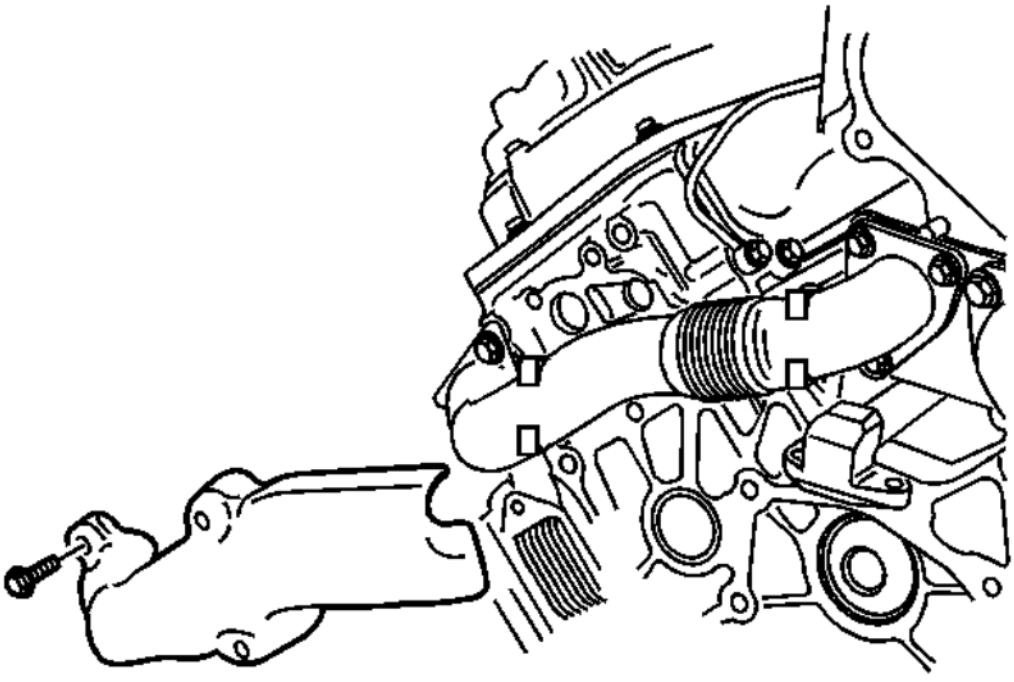


Fig. 146: View Of Left Exhaust Pipe Heat Shield & Bolts
Courtesy of GENERAL MOTORS CORP.

6. Remove the left exhaust pipe heat shield bolts.
7. Remove the heat shield.

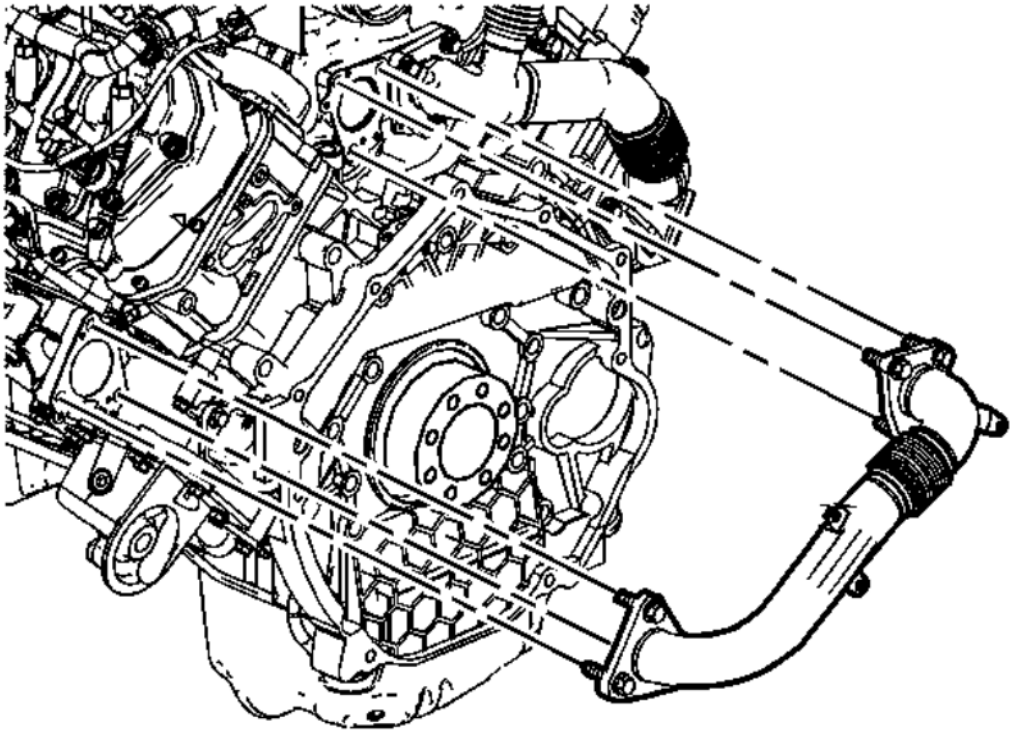


Fig. 147: View Of Left Exhaust Pipe
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not bend the exhaust pipe at the expansion area.

8. Remove the left exhaust pipe to exhaust manifold bolts.
9. Remove and discard the exhaust manifold gasket.

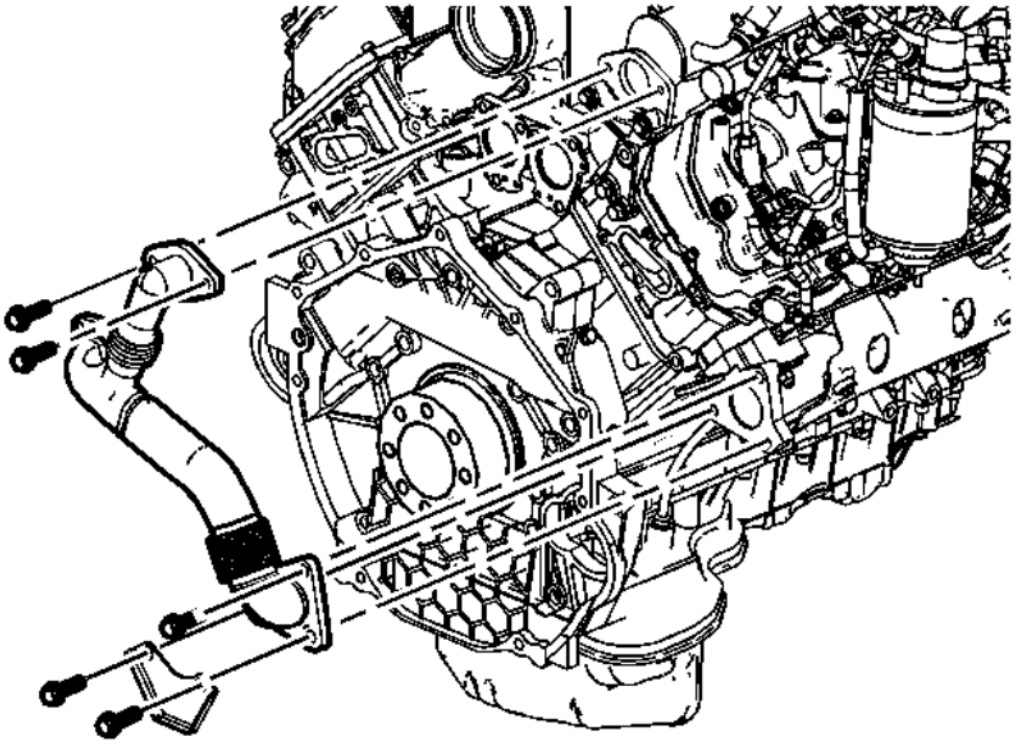


Fig. 148: View Of Right Exhaust Pipe
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not bend the exhaust pipe at the expansion area.

10. Remove the right exhaust pipe to exhaust manifold bolts.
11. Remove and discard the exhaust manifold gasket.

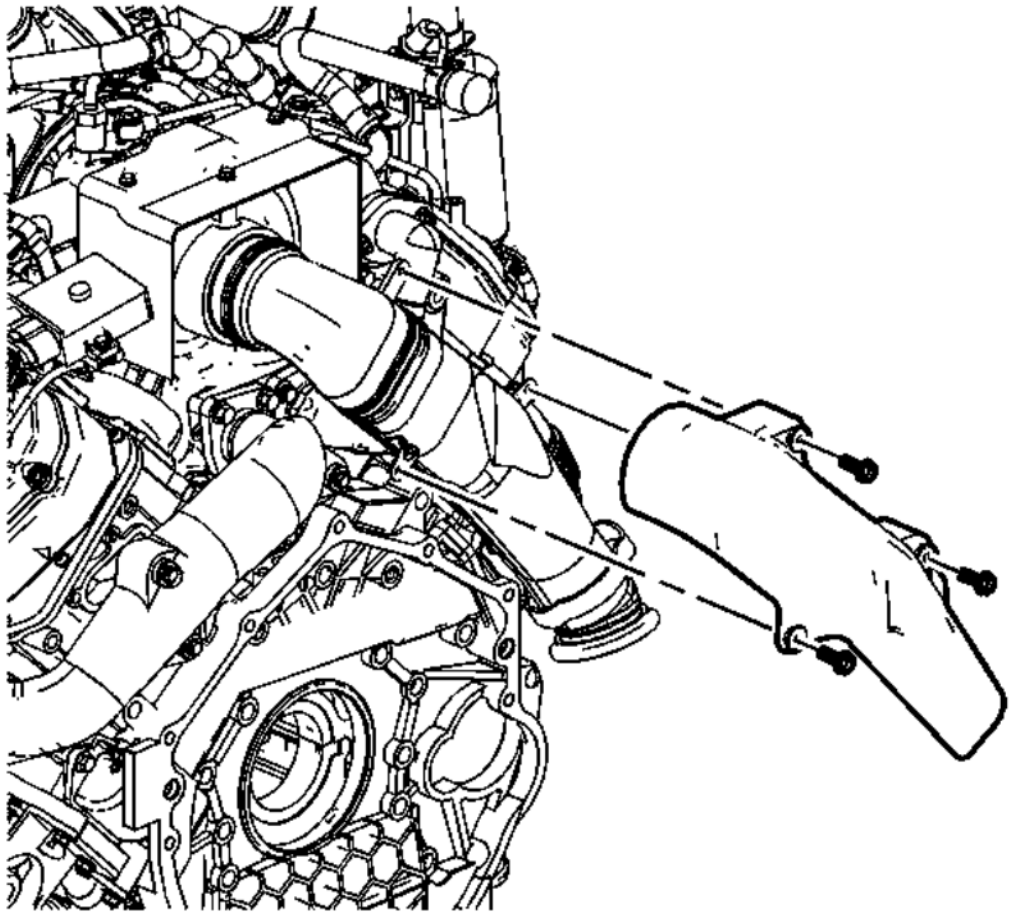


Fig. 149: View Of Exhaust Outlet Shield
Courtesy of GENERAL MOTORS CORP.

12. Remove the lower bolt for the exhaust outlet shield.
13. Drain the cooling system. Refer to **Cooling System Draining and Filling (Vac-N-Fill)** or **Cooling System Draining and Filling (Static Fill)** .
14. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
15. Remove the charged air cooler outlet duct. Refer to **Charge Air Cooler Outlet Pipe Replacement** .

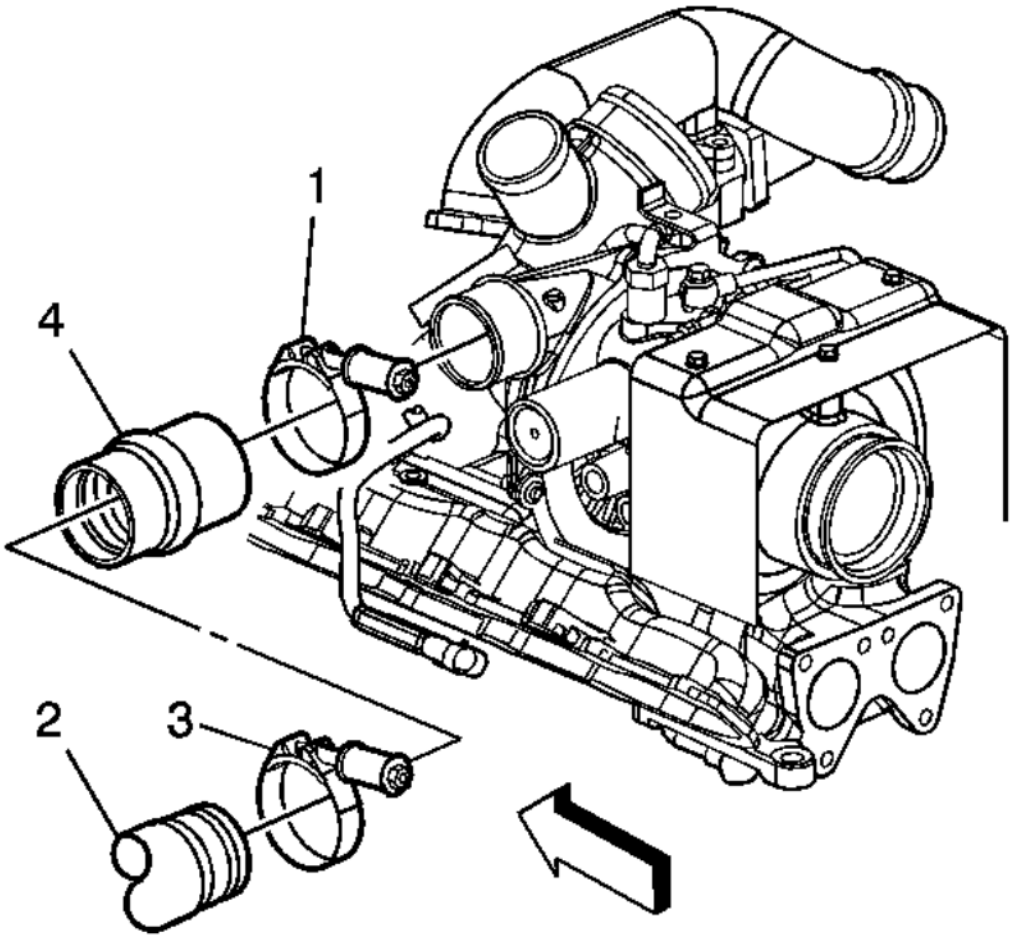


Fig. 150: View Of Turbocharger Clamp & Charged Air Cooler Inlet Duct Connector
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: After removing the charged air cooler duct, cover the turbocharger opening with tape in order to prevent entry of objects.

16. Loosen the charged air cooler inlet duct connector to turbocharger clamp (1).

IMPORTANT: Do not use a screwdriver or other tool to pry the hose loose. The hose can be torn or damage. Loosen the hose by

twisting.

17. Remove the charged air cooler inlet duct connector (4) from the turbocharger.

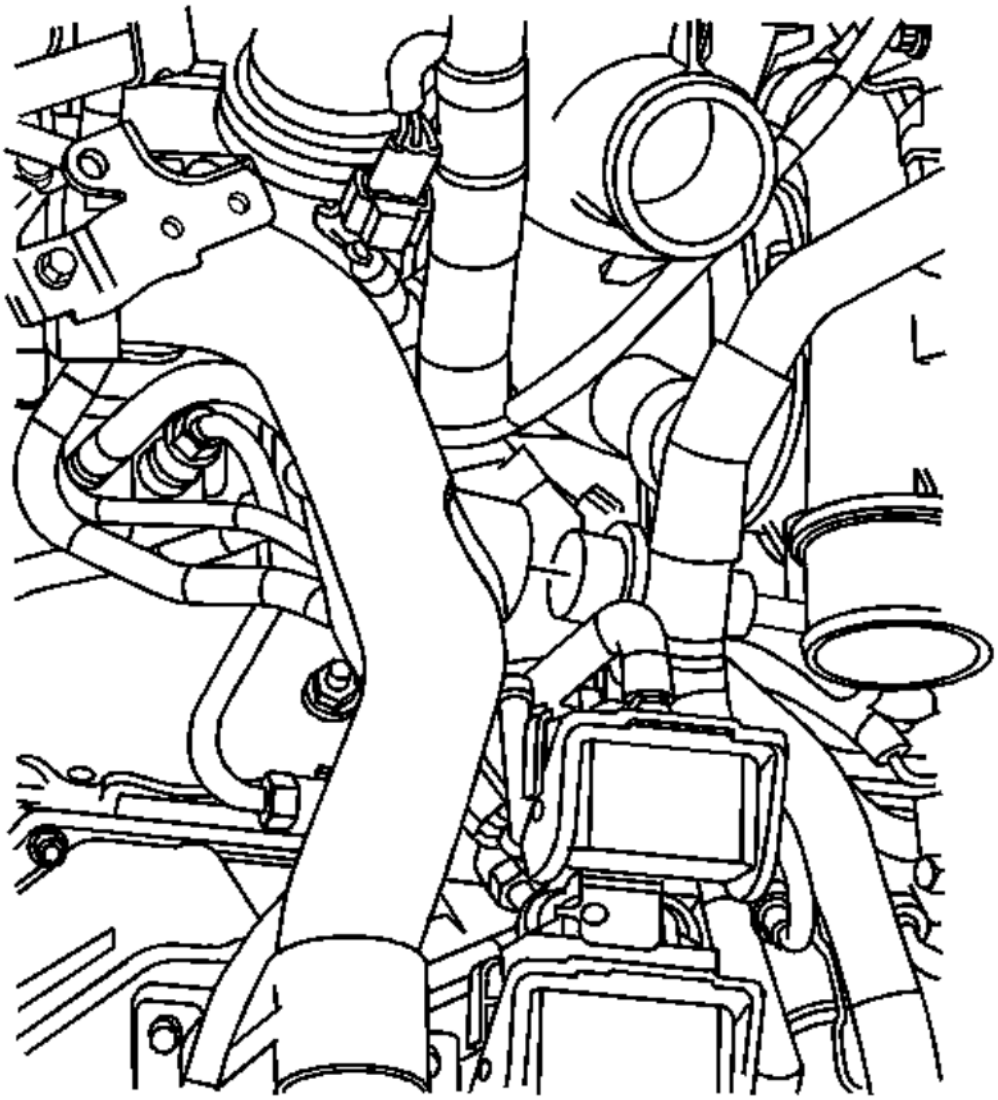


Fig. 151: View Of Turbocharger Inlet Coolant Hose At Turbocharger Coolant Bypass
Courtesy of GENERAL MOTORS CORP.

18. Remove the turbocharger inlet coolant hose from the turbocharger coolant bypass valve.

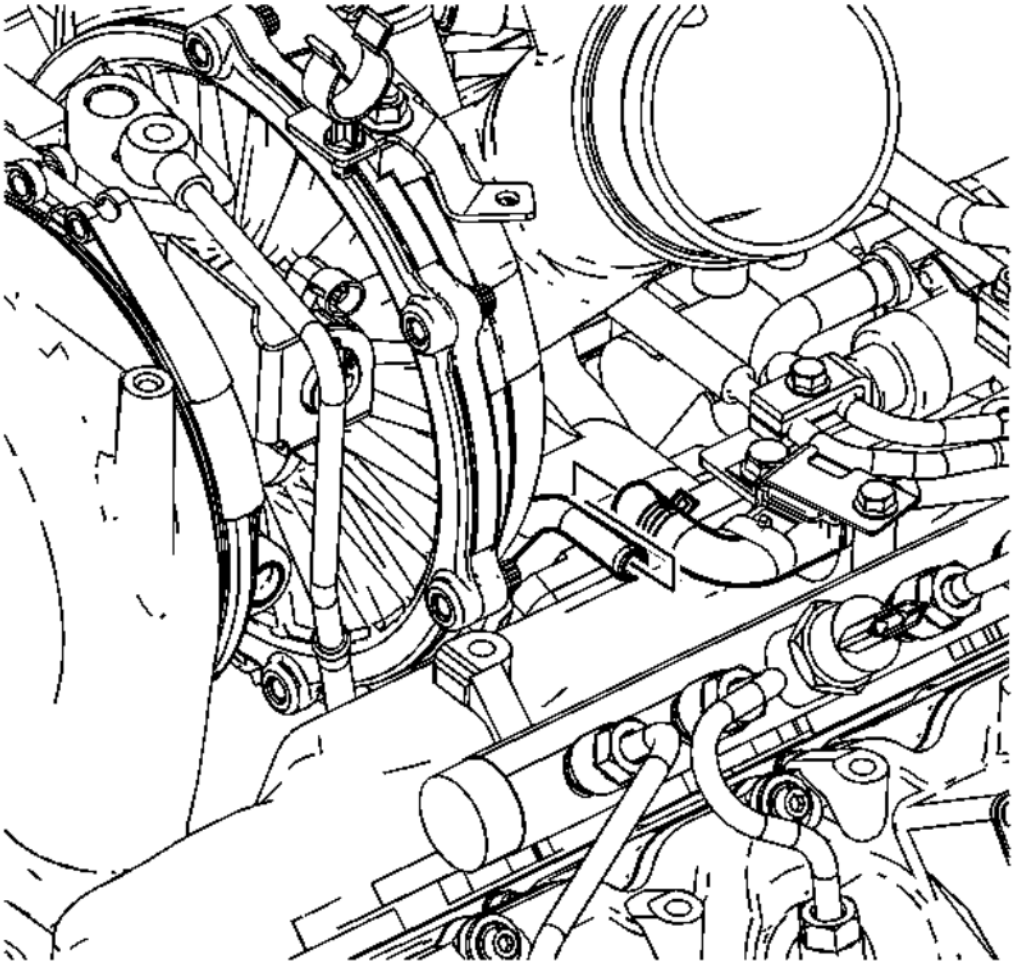


Fig. 152: View Of Turbocharger Outlet Coolant Pipe
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Use care not to damage this hose during the procedure.

19. Reposition the hose clamp and remove the turbocharger outlet coolant hose from the turbocharger.
20. Remove the turbocharger outlet coolant pipe banjo bolt and washers.
21. Remove the positive crankcase ventilation (PCV) hose/pipe. Refer to **Positive Crankcase**

Ventilation Hose/Pipe/Tube Replacement.

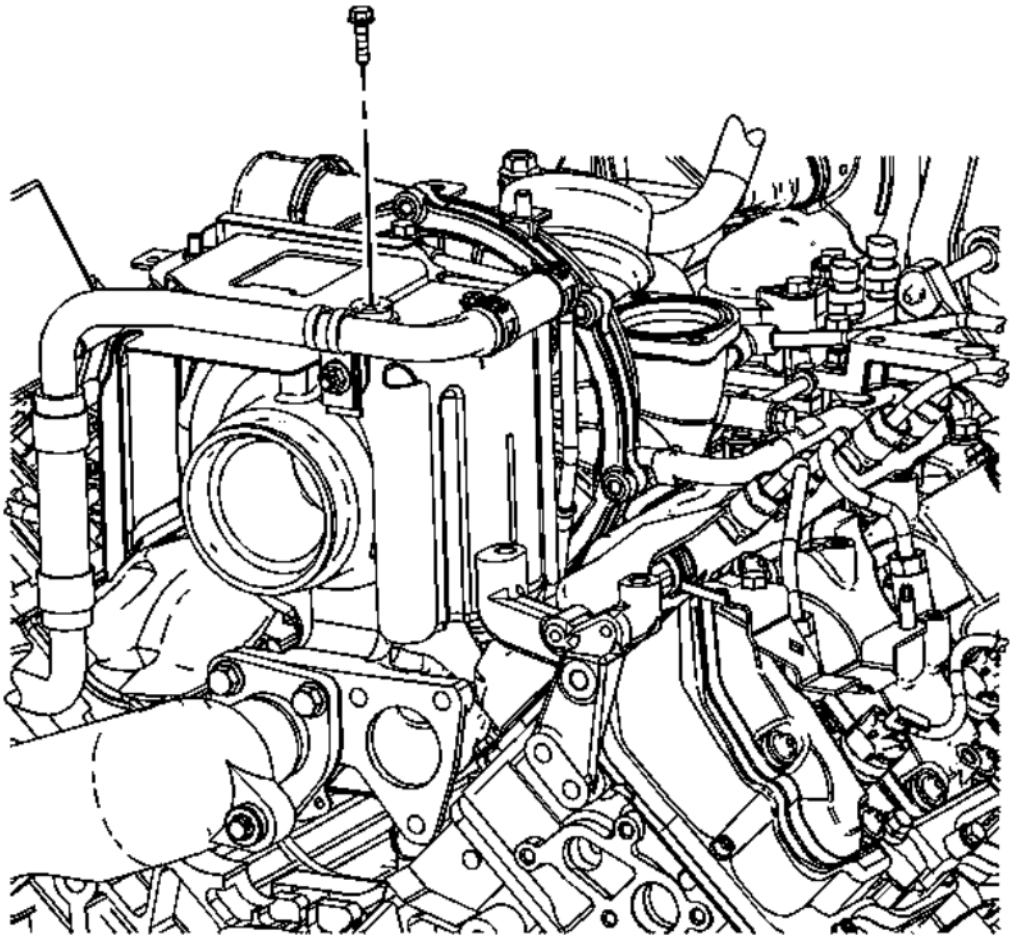


Fig. 153: Identifying Upper EGR Cooler Pipe Bolt
Courtesy of GENERAL MOTORS CORP.

22. Remove the EGR cooler pipe bolt.

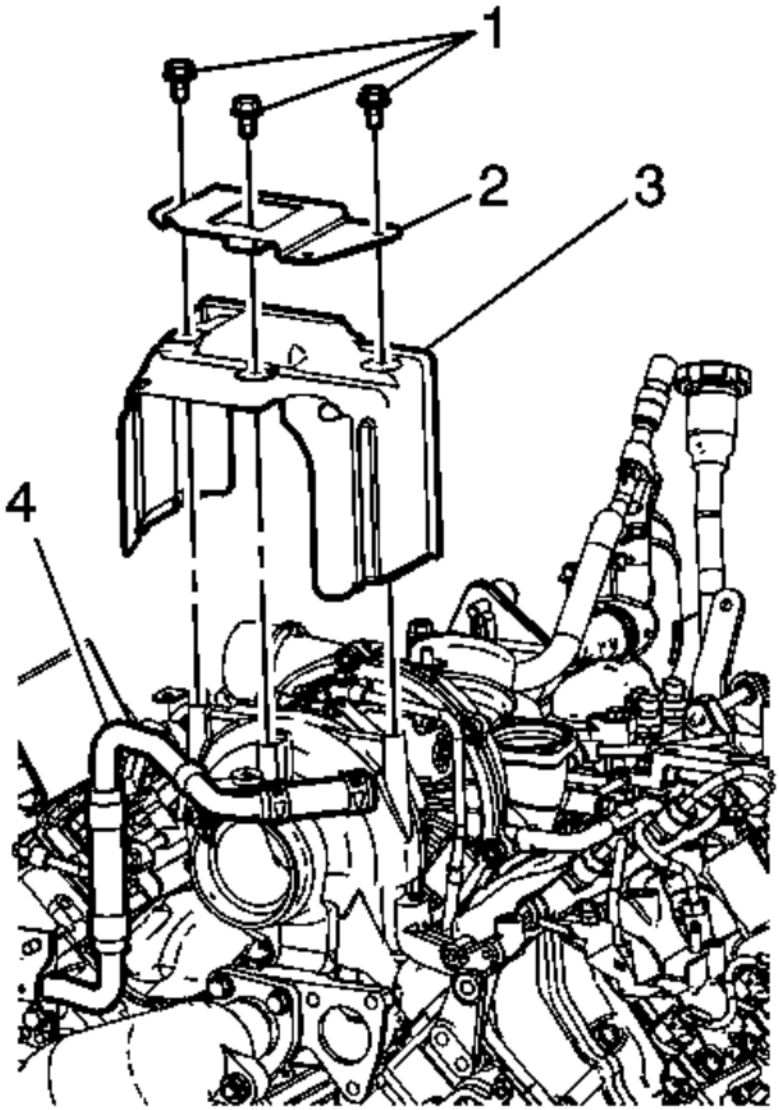


Fig. 154: View Of Turbocharger Heat Shield & EGR Cooler Pipe
Courtesy of GENERAL MOTORS CORP.

23. Reposition the EGR cooler pipe (4) out of the way.
24. Remove the EGR valve adapter pipe bracket bolts (1).
25. Remove the EGR valve adapter pipe bracket (2) and turbocharger heat shield (3).

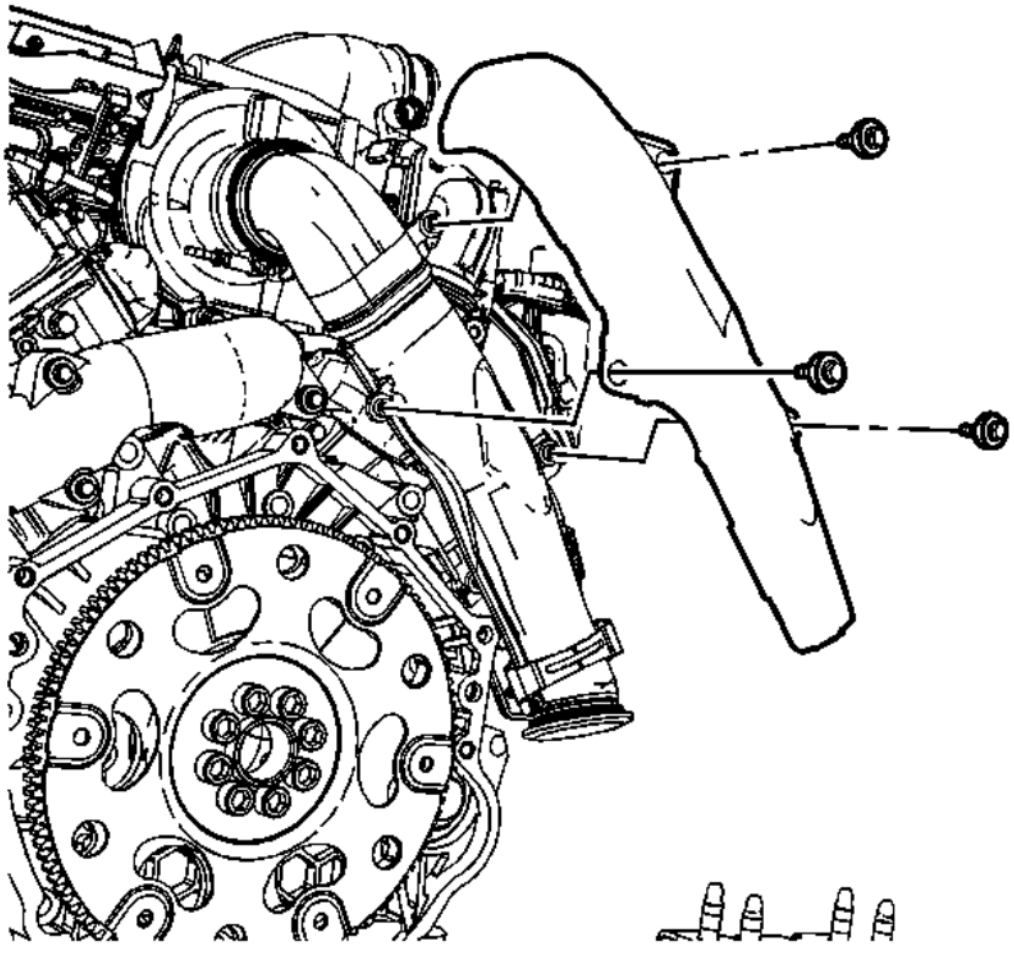


Fig. 155: View Of Exhaust Outlet Heat Shield & Bolts
Courtesy of GENERAL MOTORS CORP.

26. Remove the remaining exhaust outlet heat shield bolts.
27. Remove the exhaust outlet heat shield.

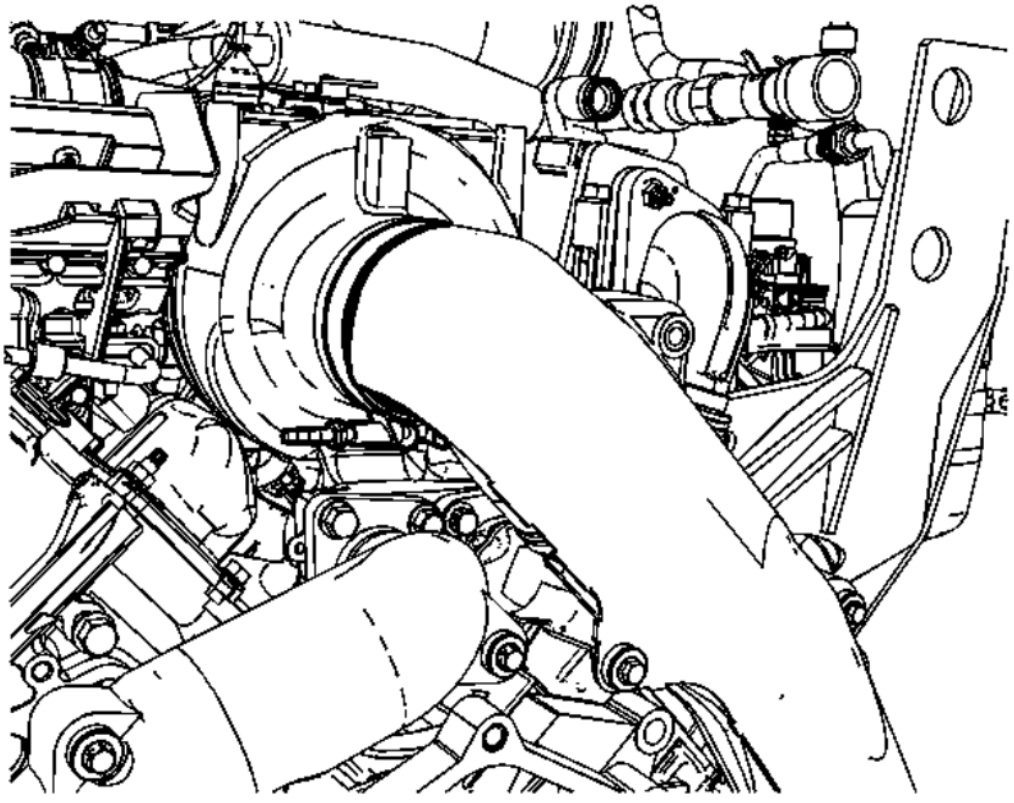


Fig. 156: View Of Exhaust Outlet Clamp
Courtesy of GENERAL MOTORS CORP.

28. Loosen the exhaust outlet clamp.

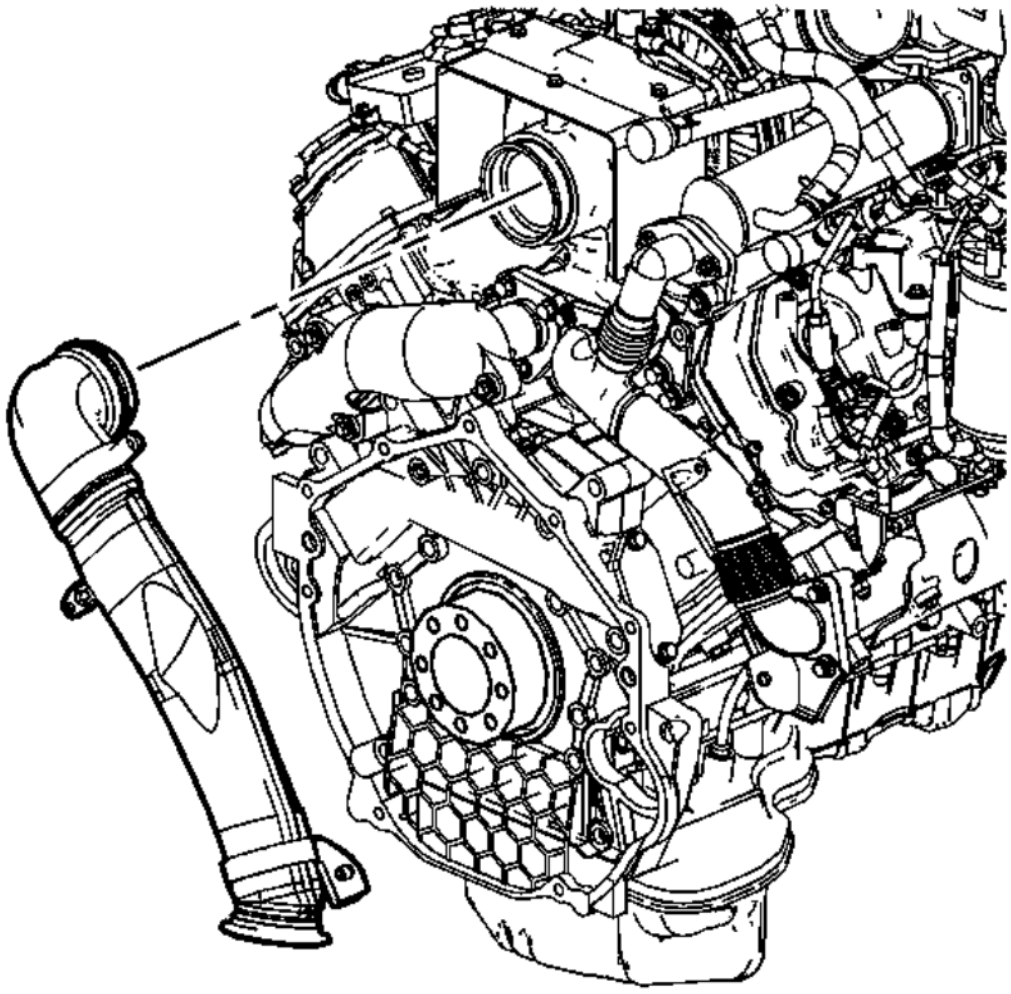


Fig. 157: View Of Exhaust Outlet
Courtesy of GENERAL MOTORS CORP.

29. Remove the exhaust outlet.

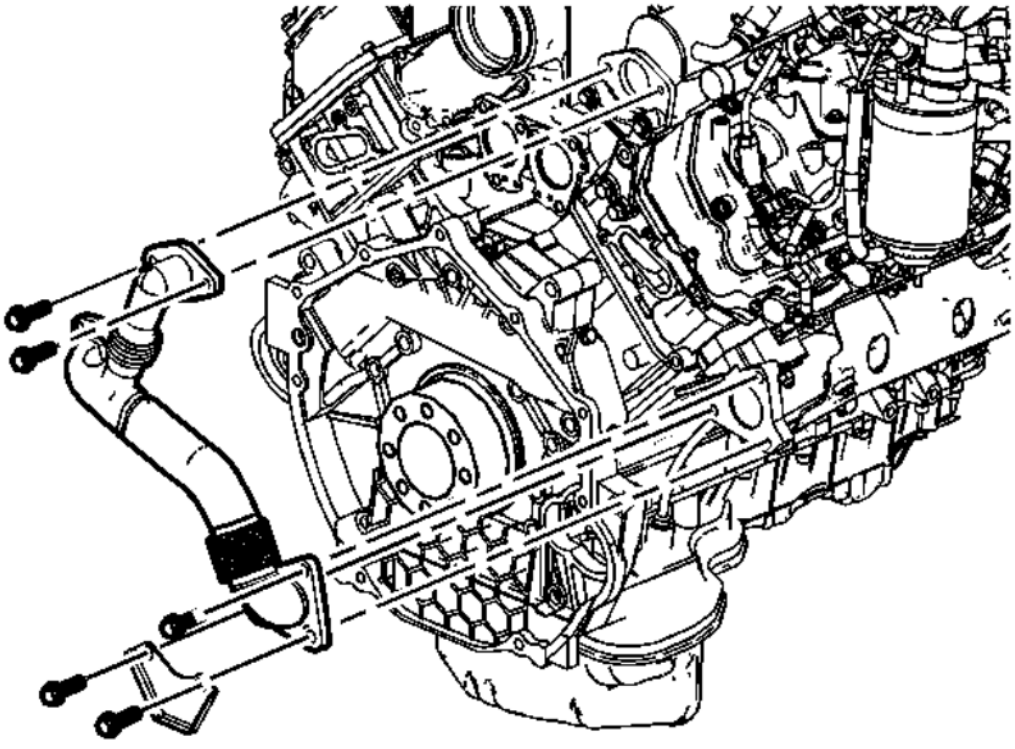


Fig. 158: View Of Right Exhaust Pipe
Courtesy of GENERAL MOTORS CORP.

30. Remove the right exhaust pipe to turbocharger bolts.
31. Remove the right exhaust pipe.
32. Remove and discard the gasket.

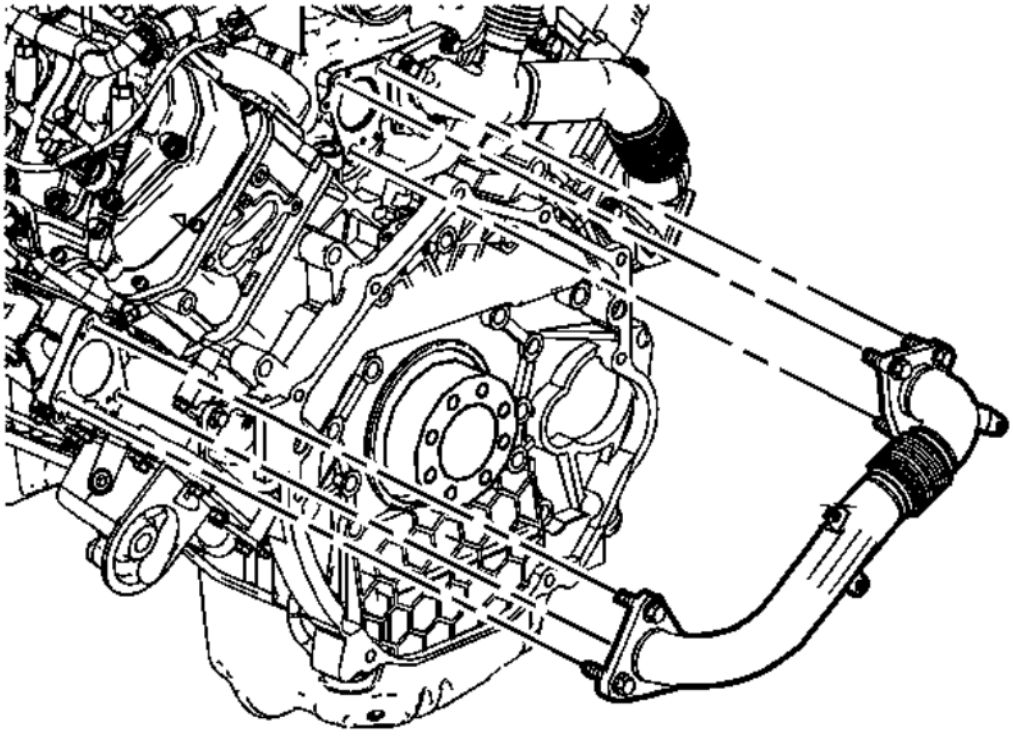


Fig. 159: View Of Left Exhaust Pipe
Courtesy of GENERAL MOTORS CORP.

33. Remove the left exhaust pipe to turbocharger bolts.
34. Remove the left exhaust pipe.
35. Remove and discard the gasket.

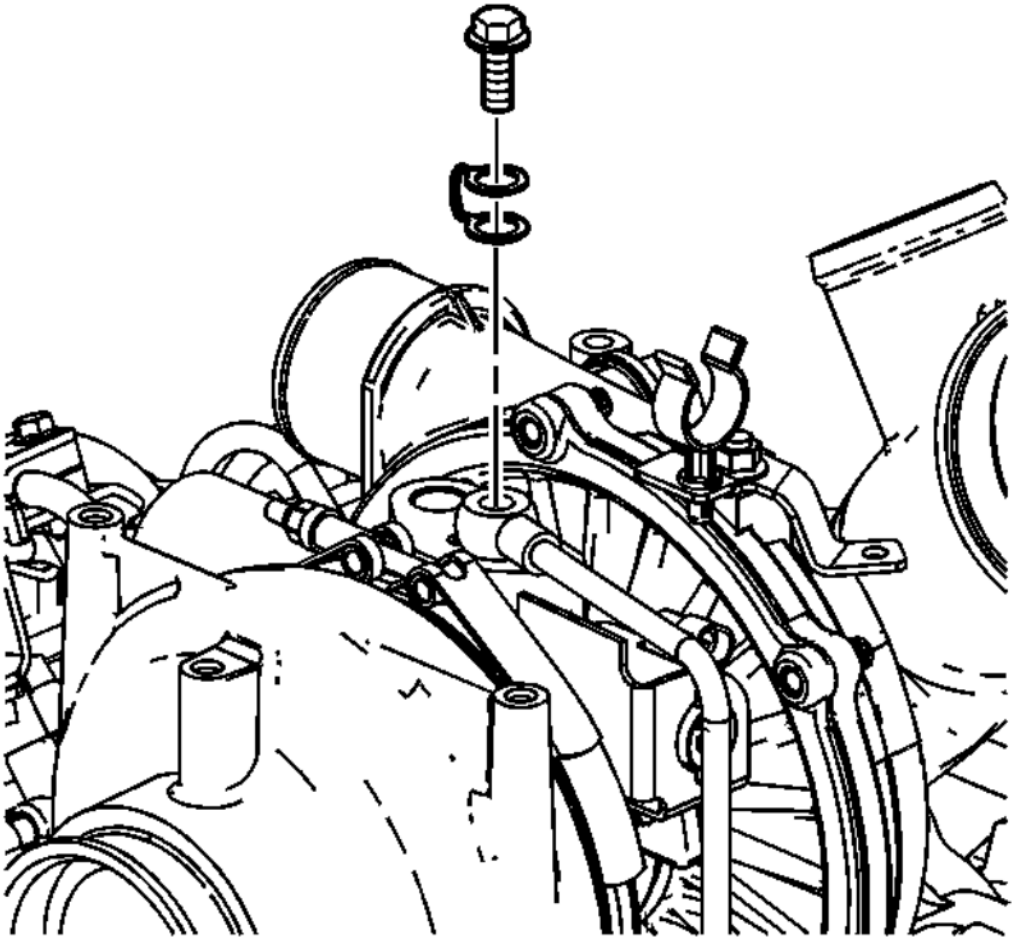


Fig. 160: View Of Turbocharger Oil Feed Pipe Banjo Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not twist the turbocharger oil feed pipe. Twisting of the feed pipe will result in the collapse and deformation of the plastic pipe, restricting oil flow and causing turbocharger damage. During turbocharger replacement, gently push the oil feed pipe towards the front of the engine to clear the turbocharger. Assistance may be required to keep the pipes clear of the turbocharger during removal or installation.

36. Remove the turbocharger oil feed pipe banjo bolt and washer.

37. Reposition the oil feed pipe out of the way.
38. Remove the turbocharger oil return pipe nuts at the top of the flywheel housing.

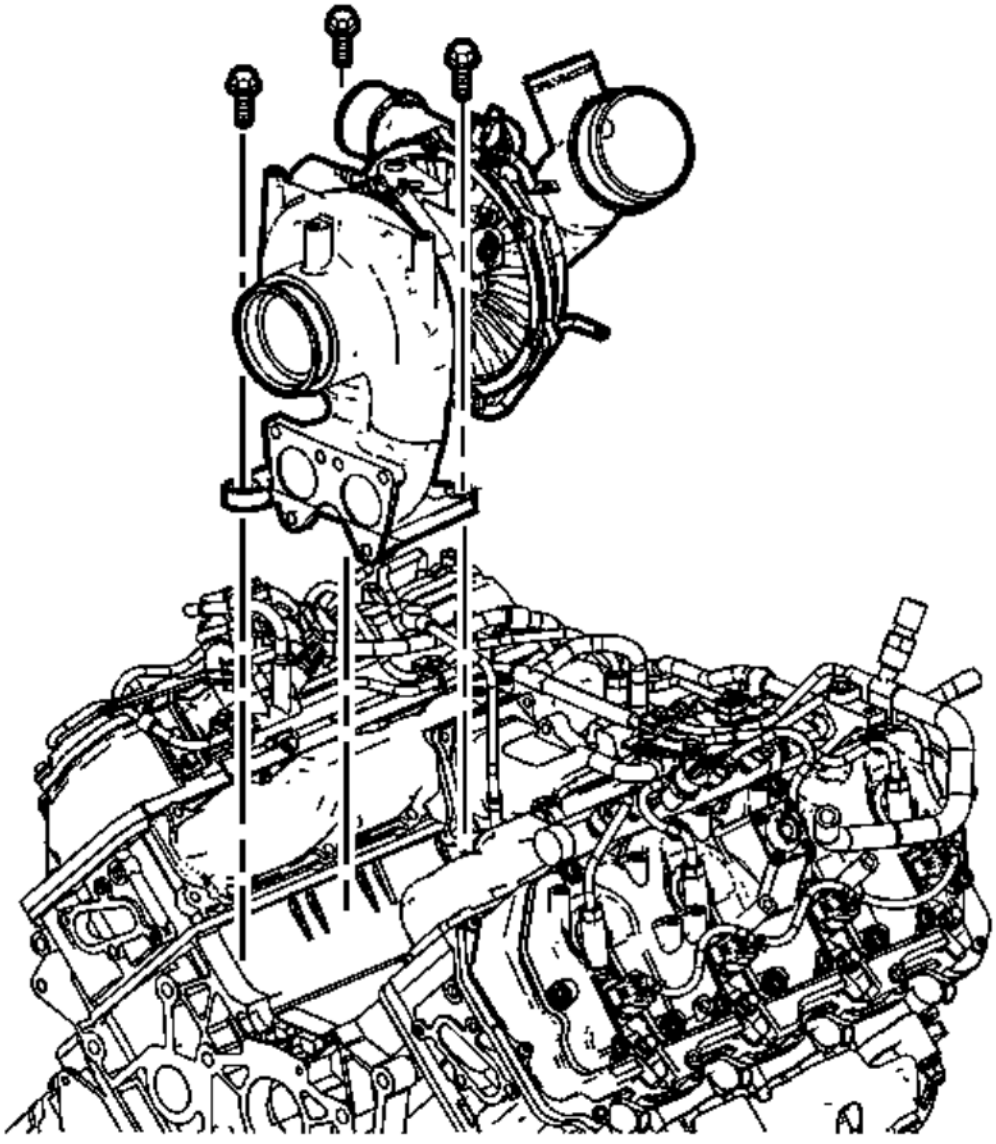


Fig. 161: View Of Turbocharger W/Oil Return Pipe
Courtesy of GENERAL MOTORS CORP.

39. Remove the turbocharger bolts.
40. Remove the turbocharger (with the oil return pipe).
41. Remove and discard the turbocharger oil return pipe gasket at the flywheel housing.

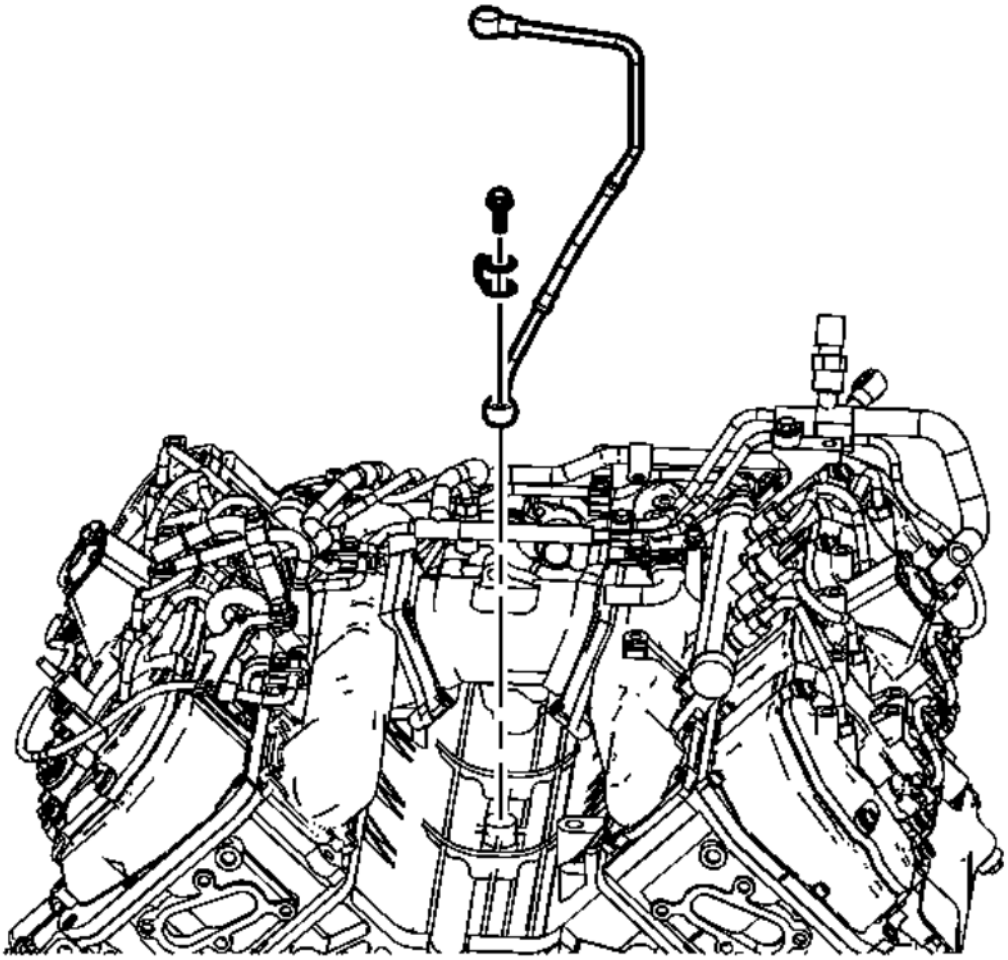


Fig. 162: View Of Oil Feed Pipe Bolt, Washer & Pipe
Courtesy of GENERAL MOTORS CORP.

42. Remove the turbocharger lower heat shield, if necessary.
43. Remove the oil feed pipe bolt, washer, and pipe, if necessary.
44. If the turbocharger has failed, perform the following steps the verify the condition of the

number 4 camshaft bearing before installing a new turbocharger:

1. Visually inspect for correct alignment of the number 4 camshaft bearing oil hole through the turbocharger oil supply hole in the block.
2. Turn the engine over by hand 1/2 turn and inspect for camshaft bearing movement, indicating a spun camshaft bearing.
3. If the bearing is spun the engine MUST be replaced.

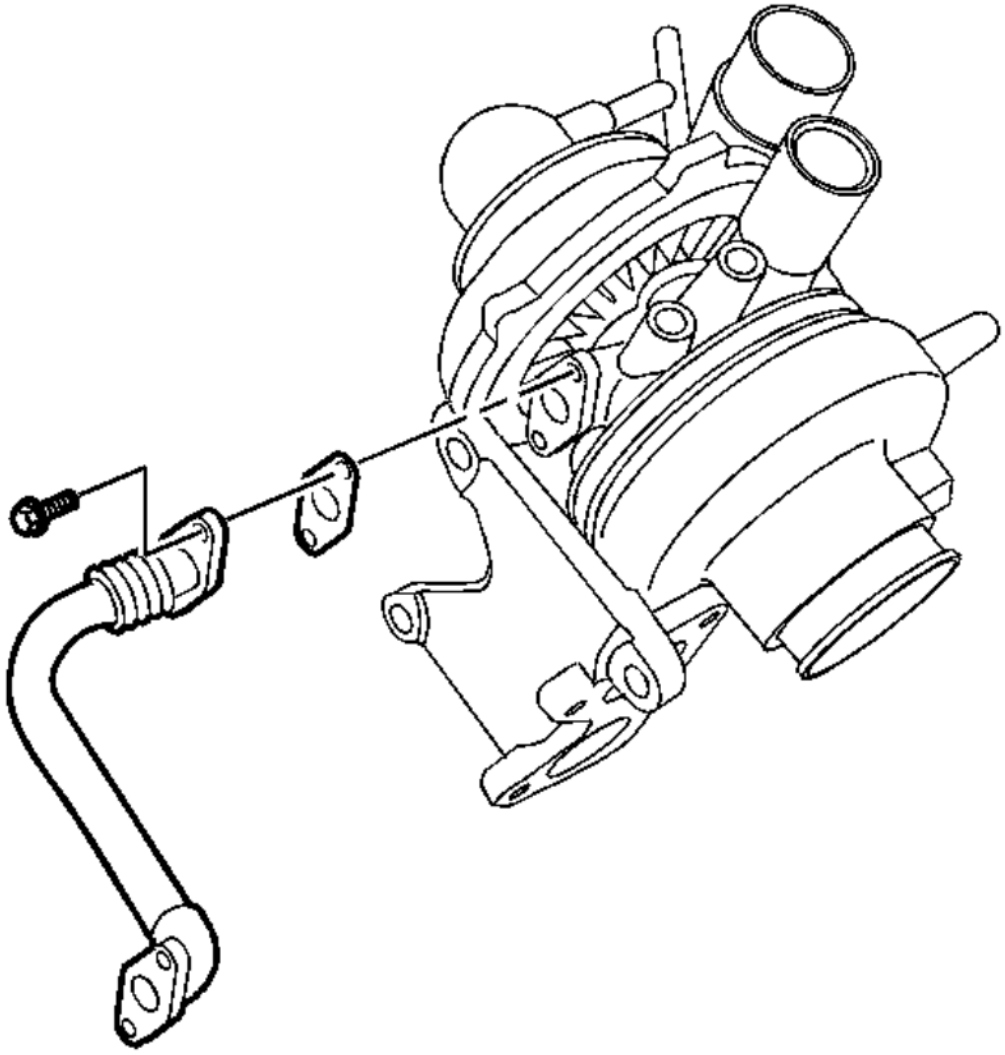


Fig. 163: View Of Oil Return Pipe Bolts

Courtesy of GENERAL MOTORS CORP.

45. If replacing the turbocharger, remove the oil return pipe bolts, pipe and gasket. Discard the gasket.
46. Clean all turbocharger to engine gasket mating surfaces.
47. If required, clean and inspect the turbocharger. Refer to **Turbocharger Cleaning and Inspection**

Installation Procedure

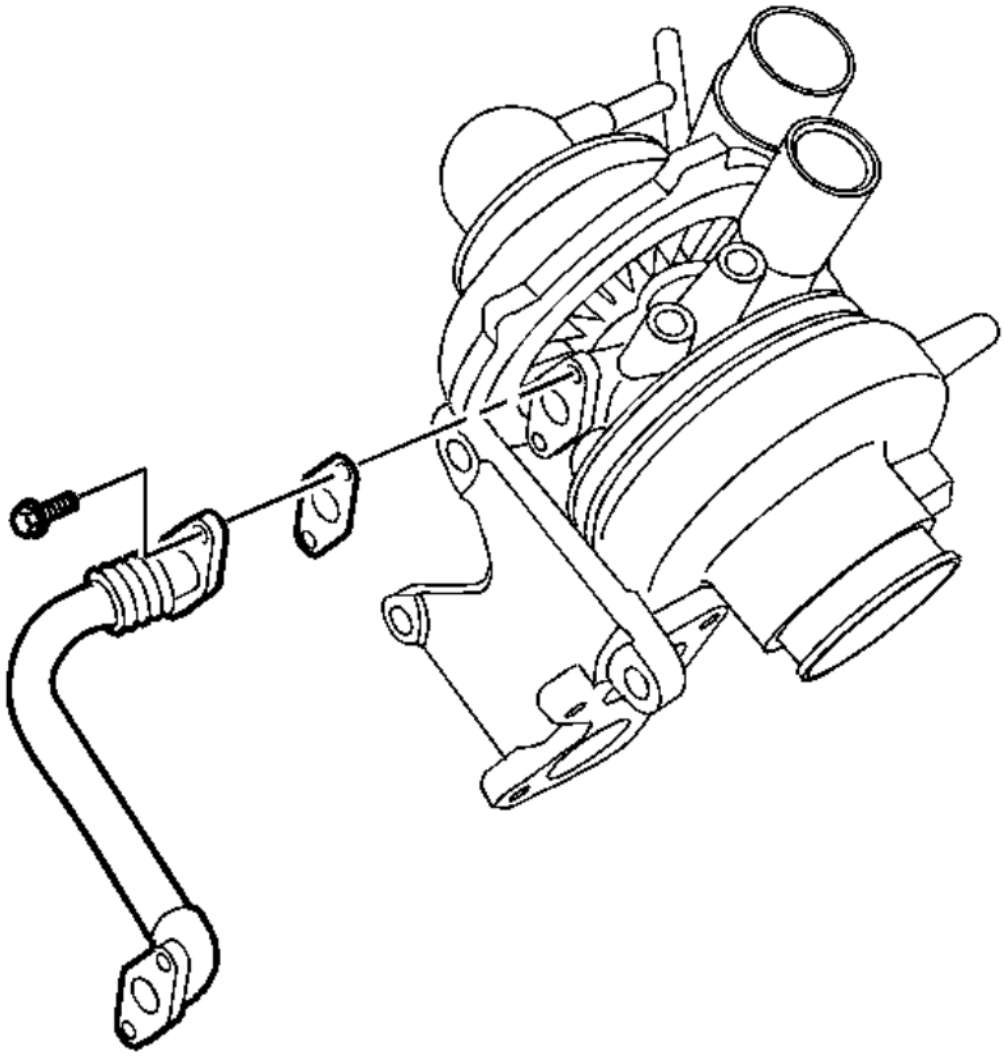


Fig. 164: View Of Oil Return Pipe Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

1. If the turbocharger was replaced, install the oil return pipe, bolts, and a NEW gasket.

   Tighten: Tighten the bolts to 21 N.m (15 lb ft).

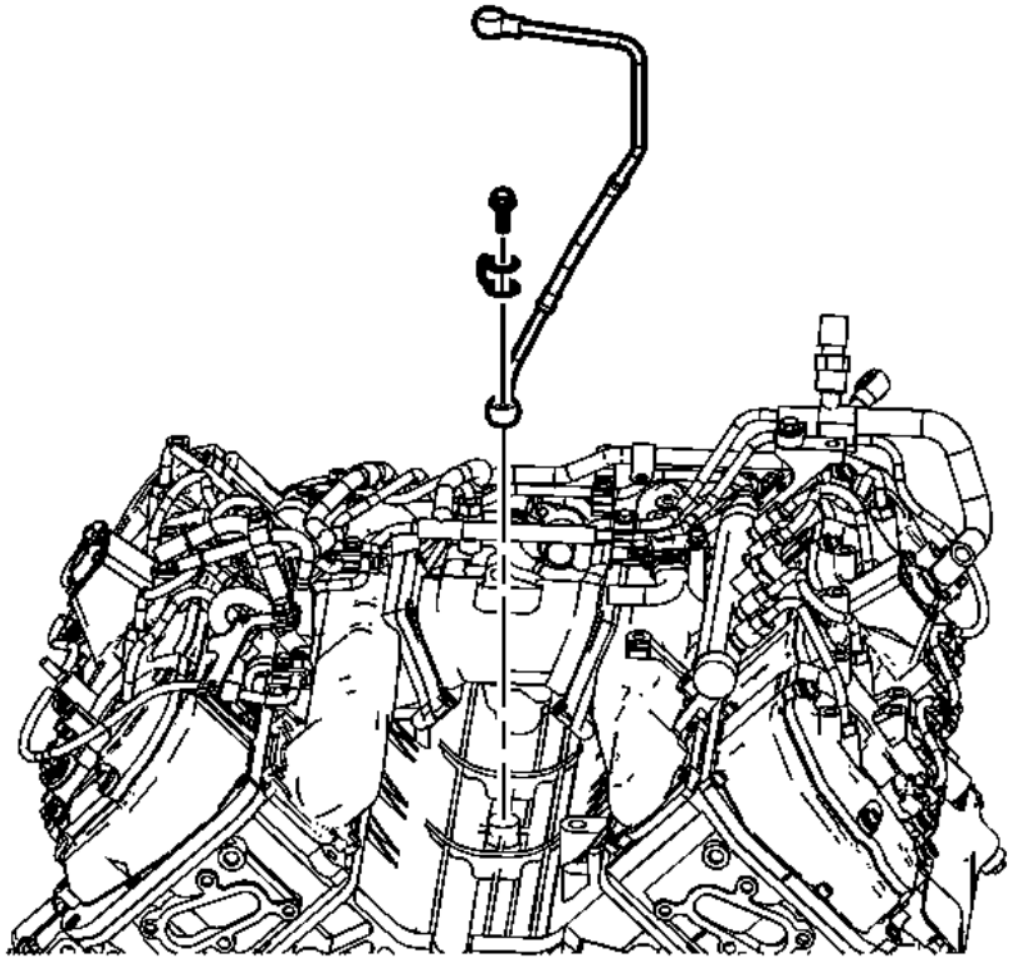


Fig. 165: View Of Oil Feed Pipe Bolt, Washer & Pipe
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not twist the turbocharger oil feed pipe. Twisting of the feed pipe will result in the collapse and deformation of the plastic pipe, restricting oil flow and causing turbocharger damage. During turbocharger replacement, gently push the oil feed pipe towards the front of the engine to clear the turbocharger. Assistance may be required to keep the pipes clear of the turbocharger during removal or installation.

IMPORTANT: Lubricate the washer with diesel fuel prior to installing.

2. Install the oil feed pipe, washer, and bolt, if necessary.

   Tighten: Tighten the bolt to 34 N.m (25 lb ft).

3. Install the turbocharger lower heat shield, if necessary.

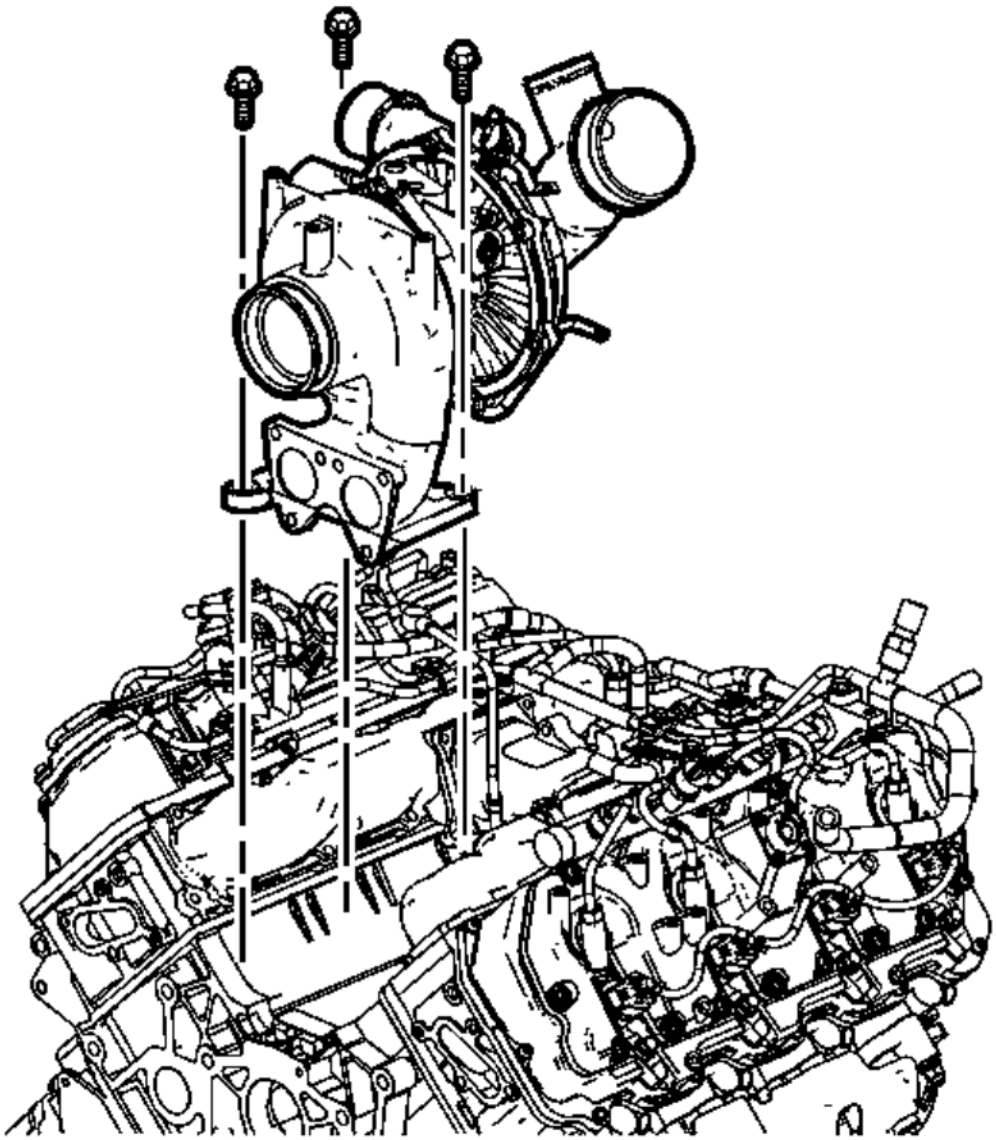


Fig. 166: View Of Turbocharger W/Oil Return Pipe
Courtesy of GENERAL MOTORS CORP.

4. Install a NEW turbocharger oil return pipe gasket at the flywheel housing.
5. Install the turbocharger (with the oil return pipe).
6. Install the turbocharger bolts.

Tighten: Tighten the bolts to 108 N.m (80 lb ft).

7. Install the turbocharger oil return pipe nuts at the top of the flywheel housing.

   Tighten: Tighten the nuts to 25 N.m (18 lb ft).

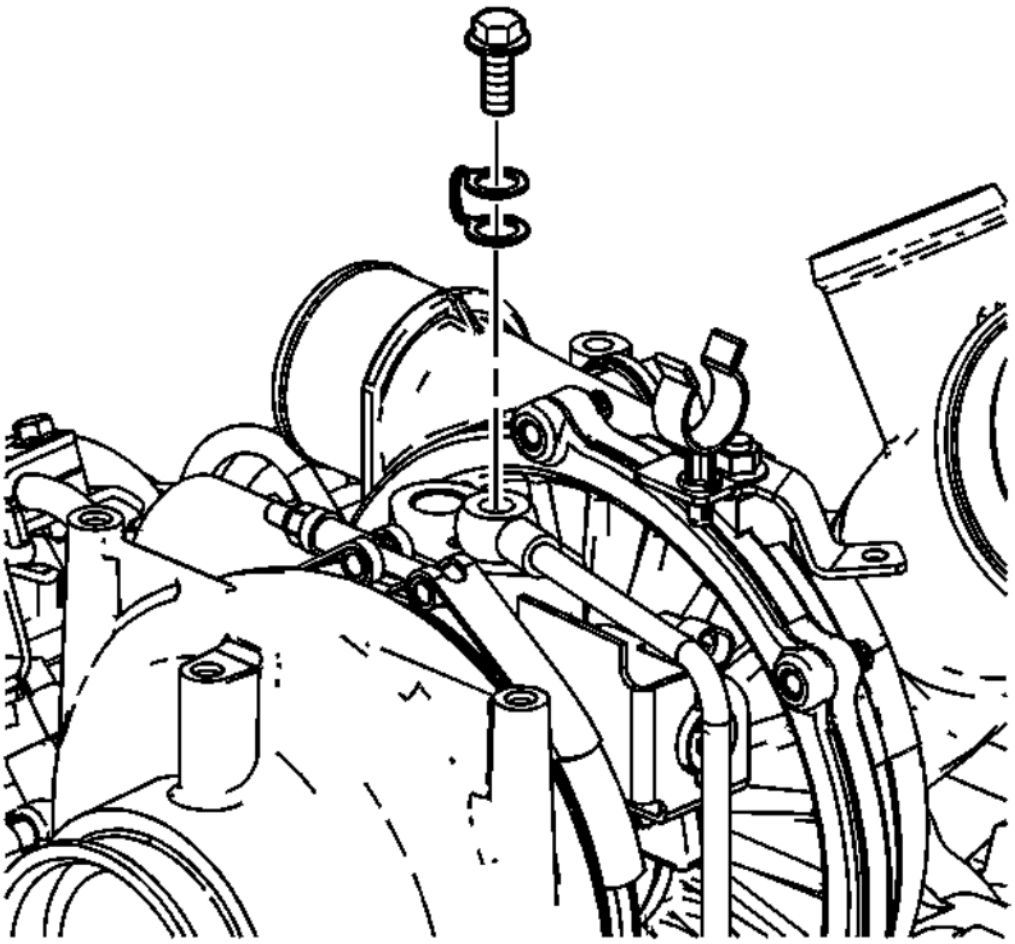


Fig. 167: View Of Turbocharger Oil Feed Pipe Banjo Bolt
Courtesy of GENERAL MOTORS CORP.

8. If installing a NEW turbocharger, add about 120-150 cc (4-5 oz) of clean engine oil in the turbocharger oil feed pipe opening while rotating the impeller.
9. Position the oil feed pipe to the turbocharger.

10. Install a NEW turbocharger oil feed pipe washer and the banjo bolt.

    Tighten: Tighten the bolt to 34 N.m (25 lb ft).

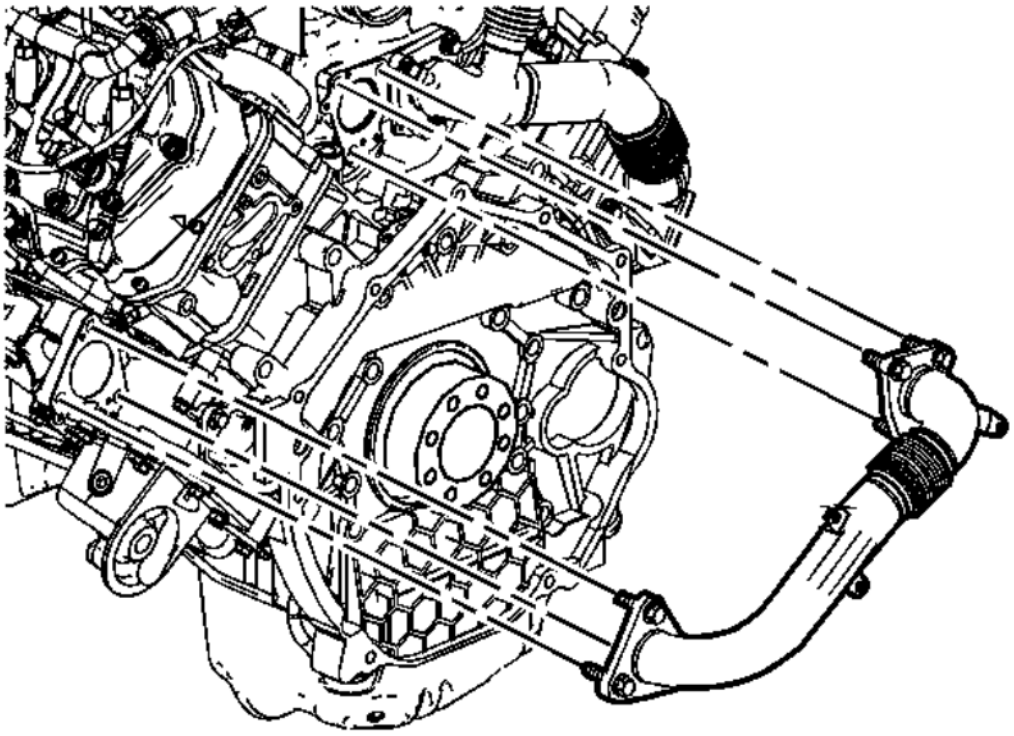


Fig. 168: View Of Left Exhaust Pipe
Courtesy of GENERAL MOTORS CORP.

11. Install the left exhaust pipe and a NEW gasket.
12. Install the left exhaust pipe to turbocharger bolts.

    Tighten: Tighten the bolt to 53 N.m (39 lb ft).

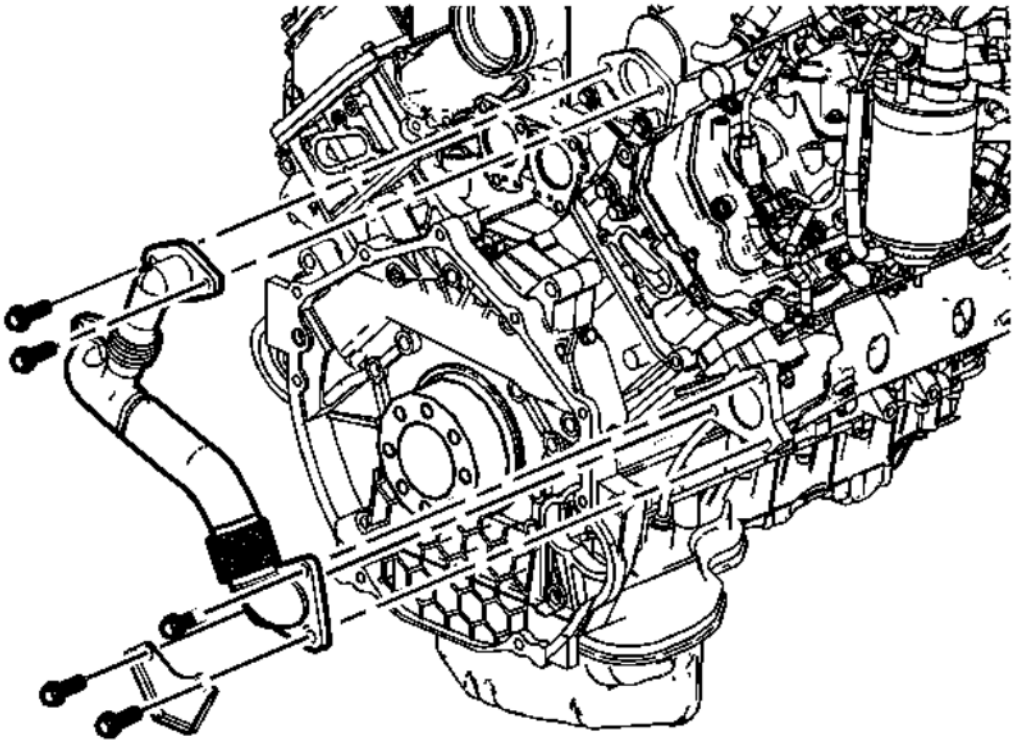


Fig. 169: View Of Right Exhaust Pipe
Courtesy of GENERAL MOTORS CORP.

13. Install the right exhaust pipe and a NEW gasket.
14. Install the right exhaust pipe to turbocharger bolts.

Tighten: Tighten the bolt to 53 N.m (39 lb ft).

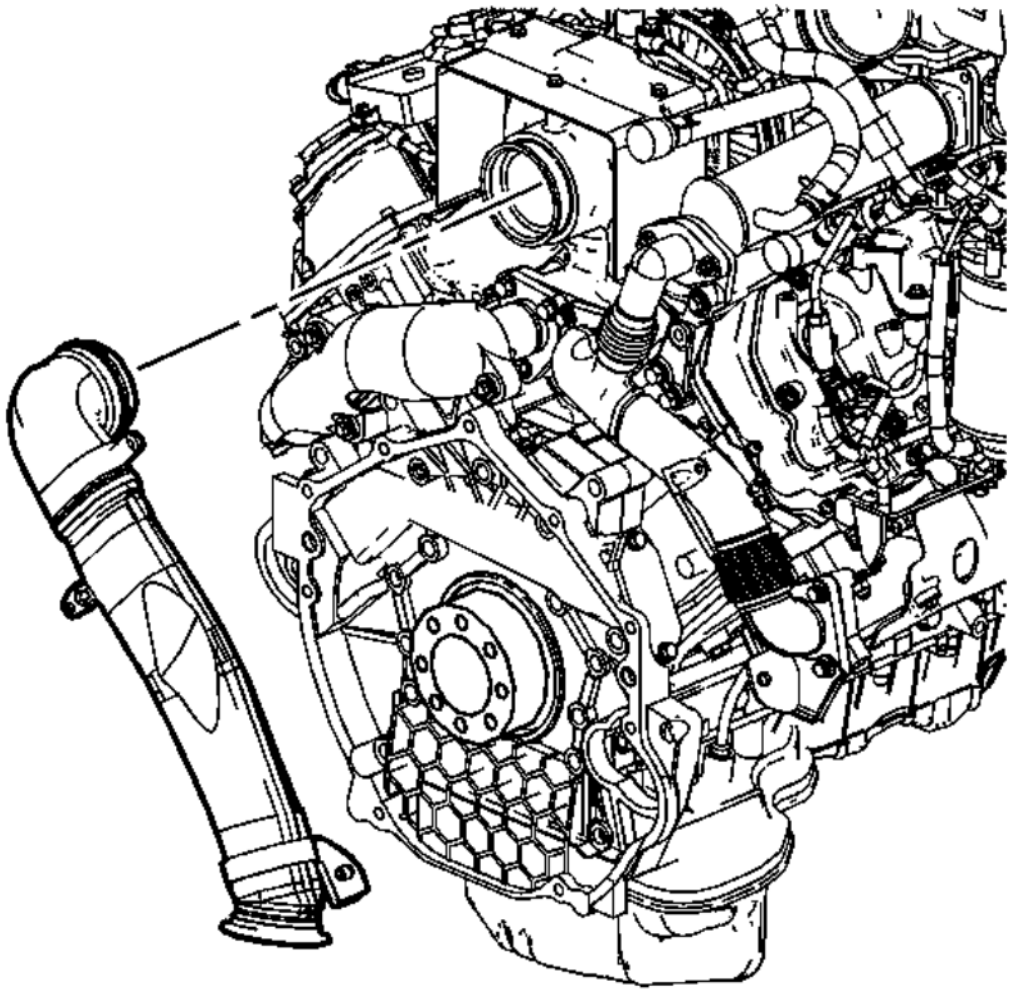


Fig. 170: View Of Exhaust Outlet
Courtesy of GENERAL MOTORS CORP.

15. Install the exhaust outlet.

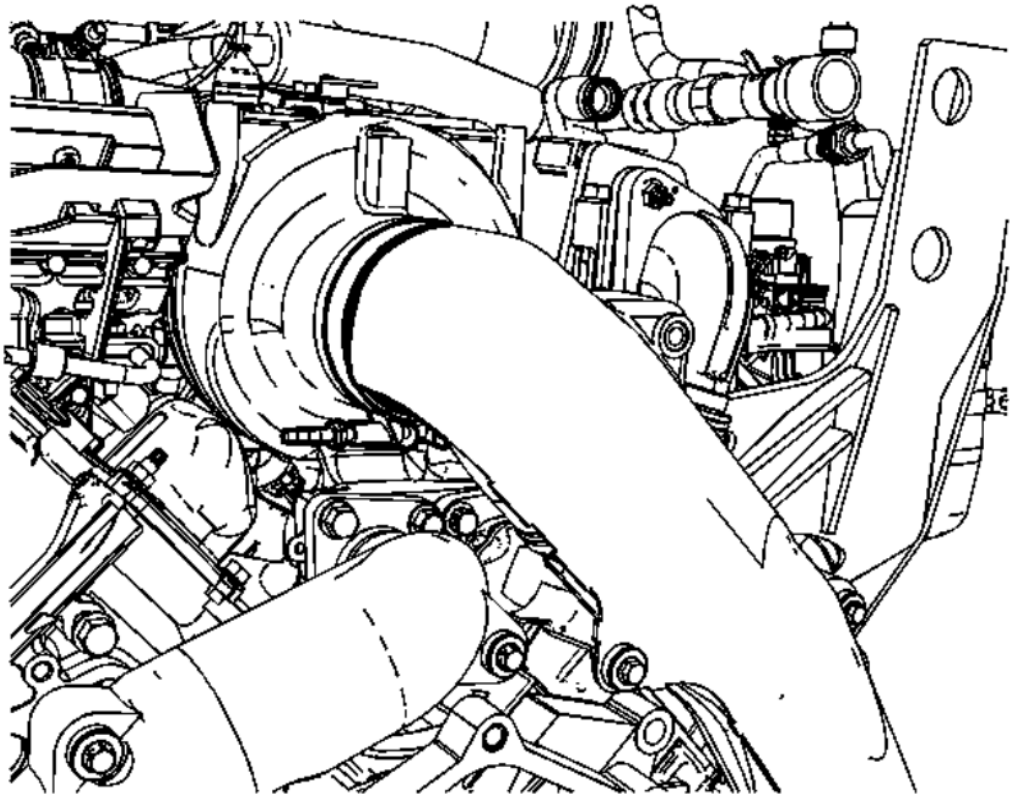


Fig. 171: View Of Exhaust Outlet Clamp
Courtesy of GENERAL MOTORS CORP.

16. Tighten the exhaust outlet clamp.

    Tighten: Tighten the clamp to 15 N.m (11 lb ft).

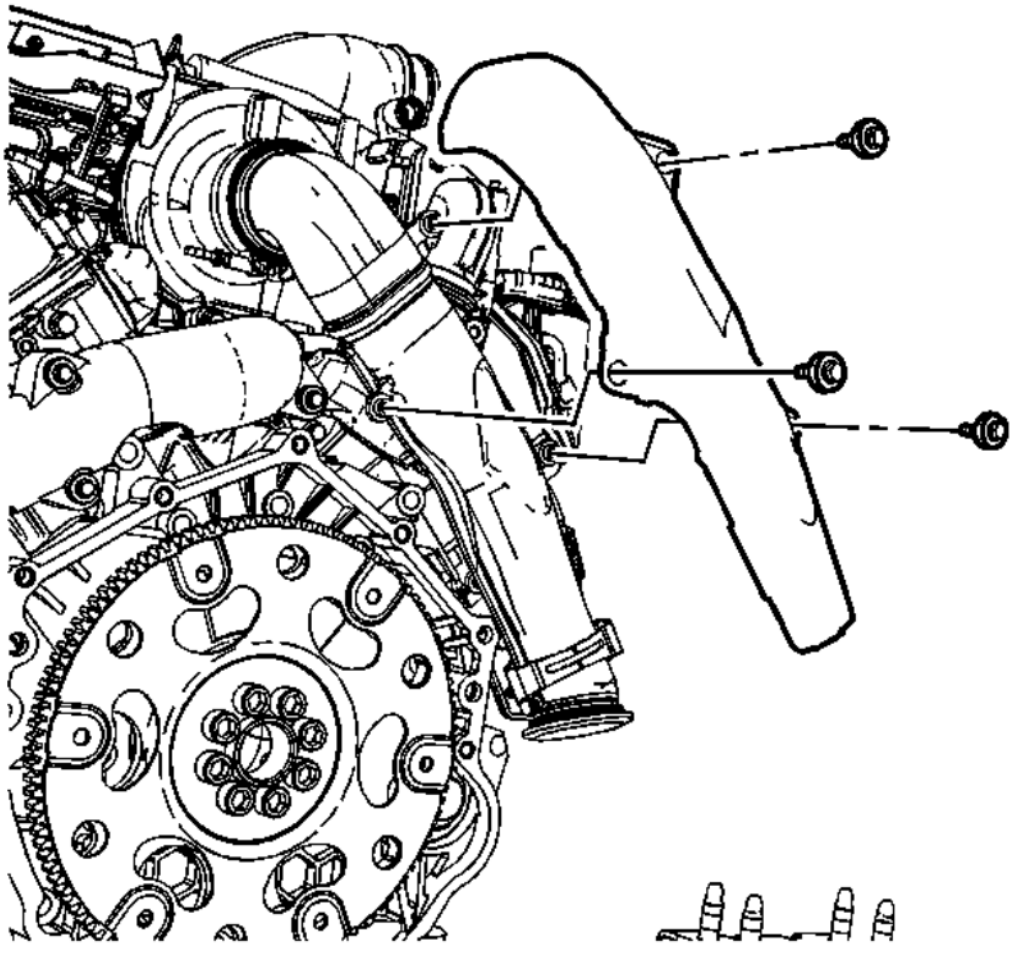


Fig. 172: View Of Exhaust Outlet Heat Shield & Bolts
Courtesy of GENERAL MOTORS CORP.

17. Install the exhaust outlet heat shield.
18. Install the remaining exhaust outlet heat shield bolts.

    Tighten: Tighten the bolt to 8 N.m (71 lb in).

19. Install the PCV hose/pipe. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement**.

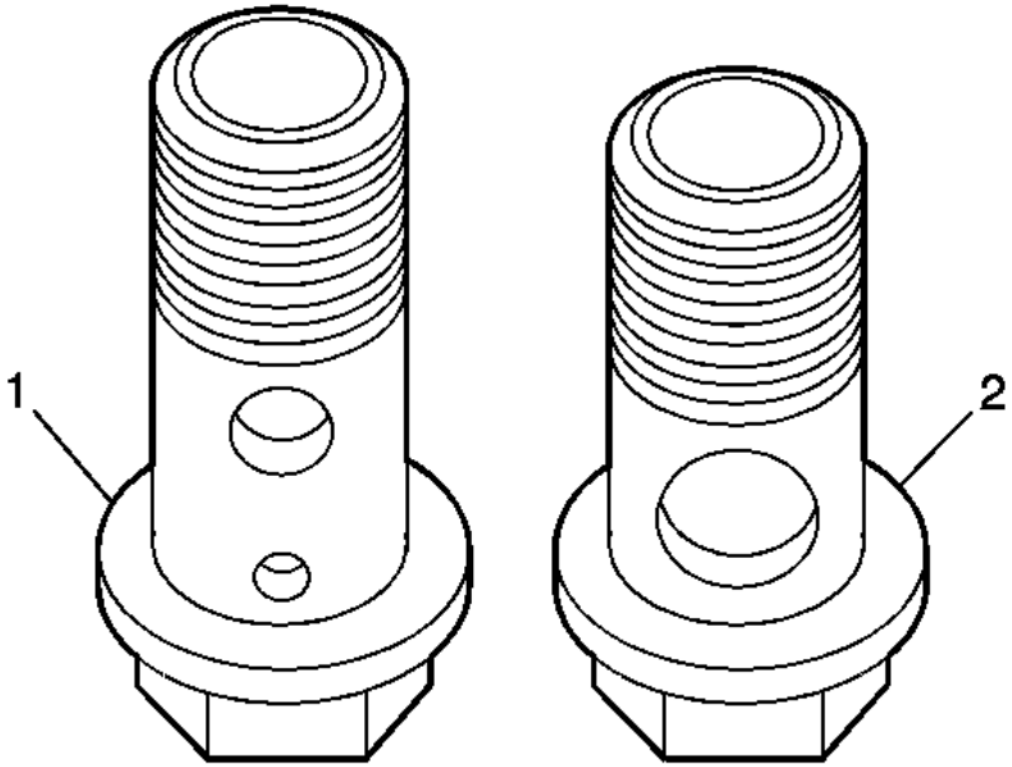


Fig. 173: View Of Cooling Outlet Hose Eye Bolts
Courtesy of GENERAL MOTORS CORP.

20. If the cooling outlet hose eye bolts were removed, install the longer bolt (1) with 2 holes, in the top location. Install the shorter bolt (2) in the lower location.

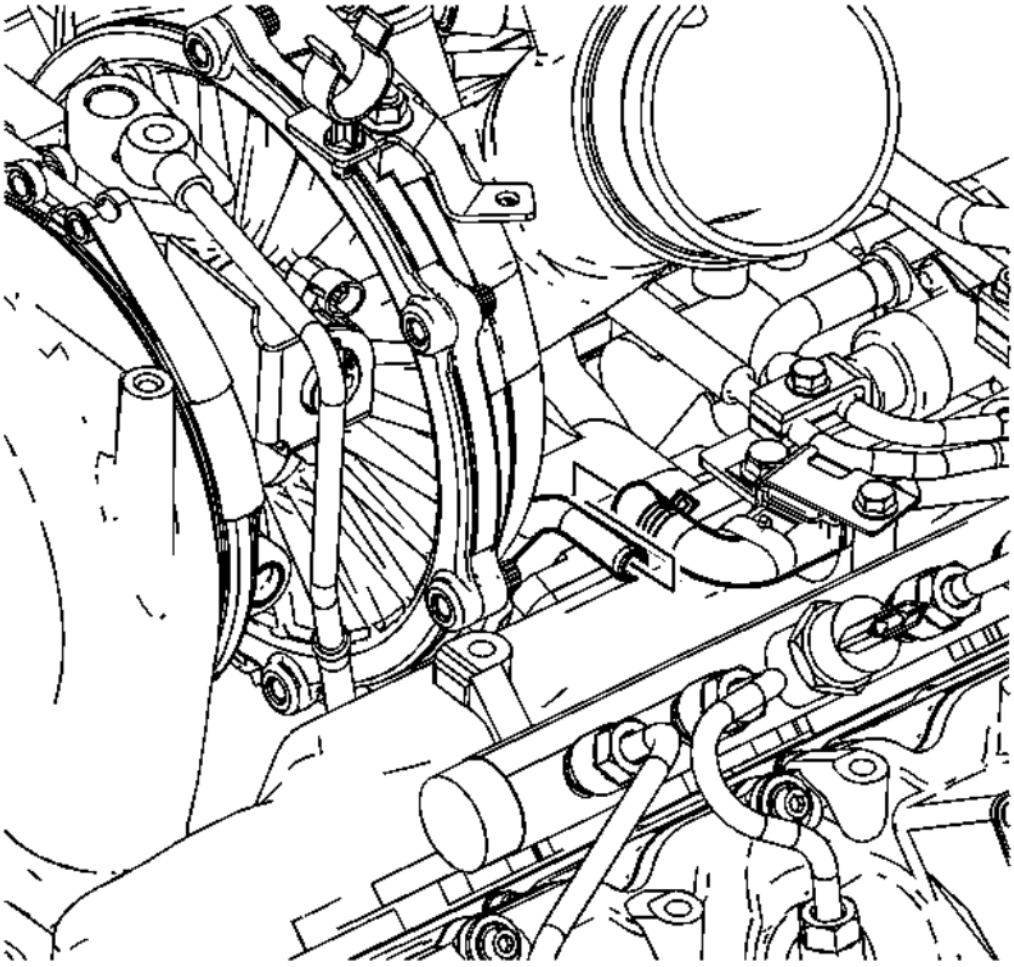


Fig. 174: View Of Turbocharger Outlet Coolant Pipe
Courtesy of GENERAL MOTORS CORP.

21. Install the turbocharger outlet coolant pipe banjo bolt and washers.

    Tighten: Tighten the bolt to 26 N.m (19 lb ft).

22. Install the turbocharger outlet coolant hose to the turbocharger and position the hose clamp.

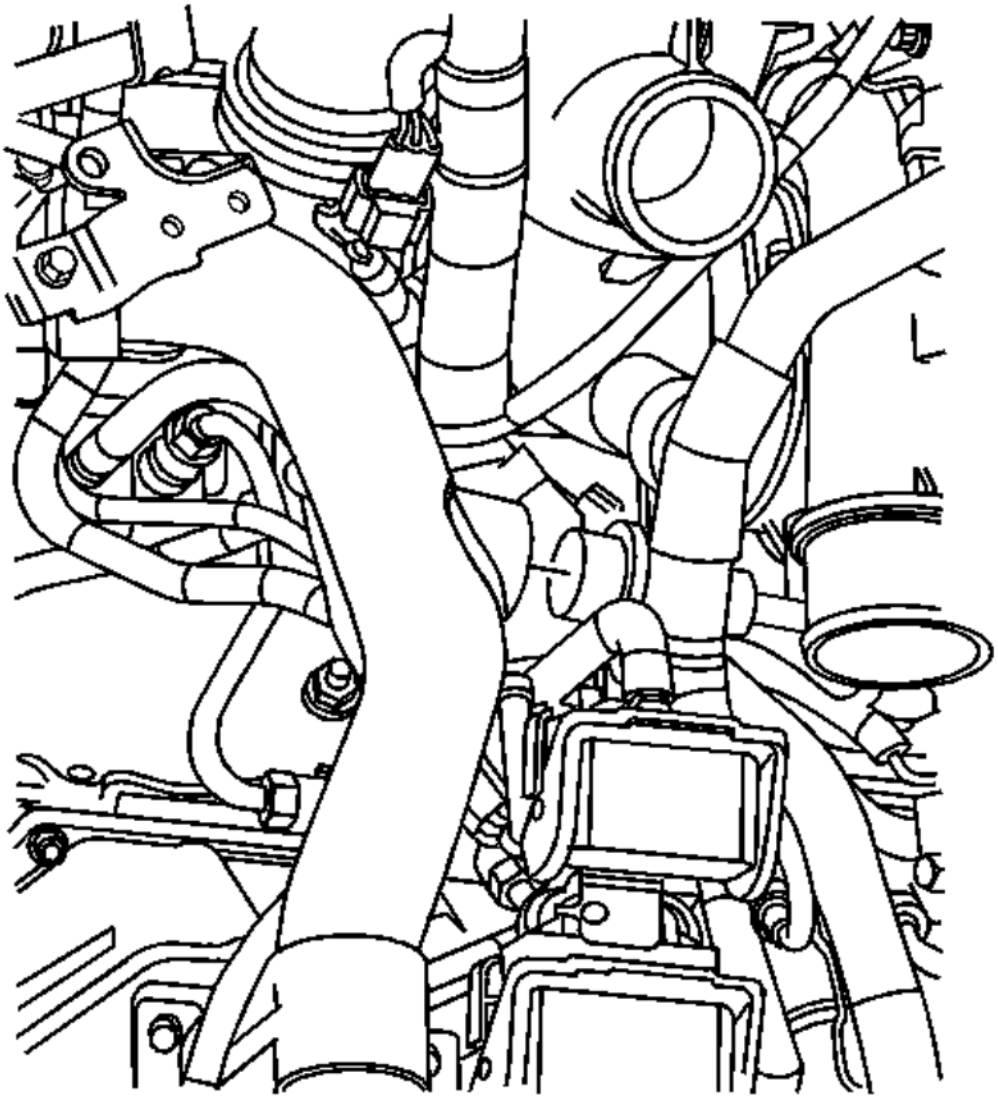


Fig. 175: View Of Turbocharger Inlet Coolant Hose At Turbocharger Coolant Bypass
Courtesy of GENERAL MOTORS CORP.

23. Install the turbocharger inlet coolant hose to the turbocharger coolant bypass valve.

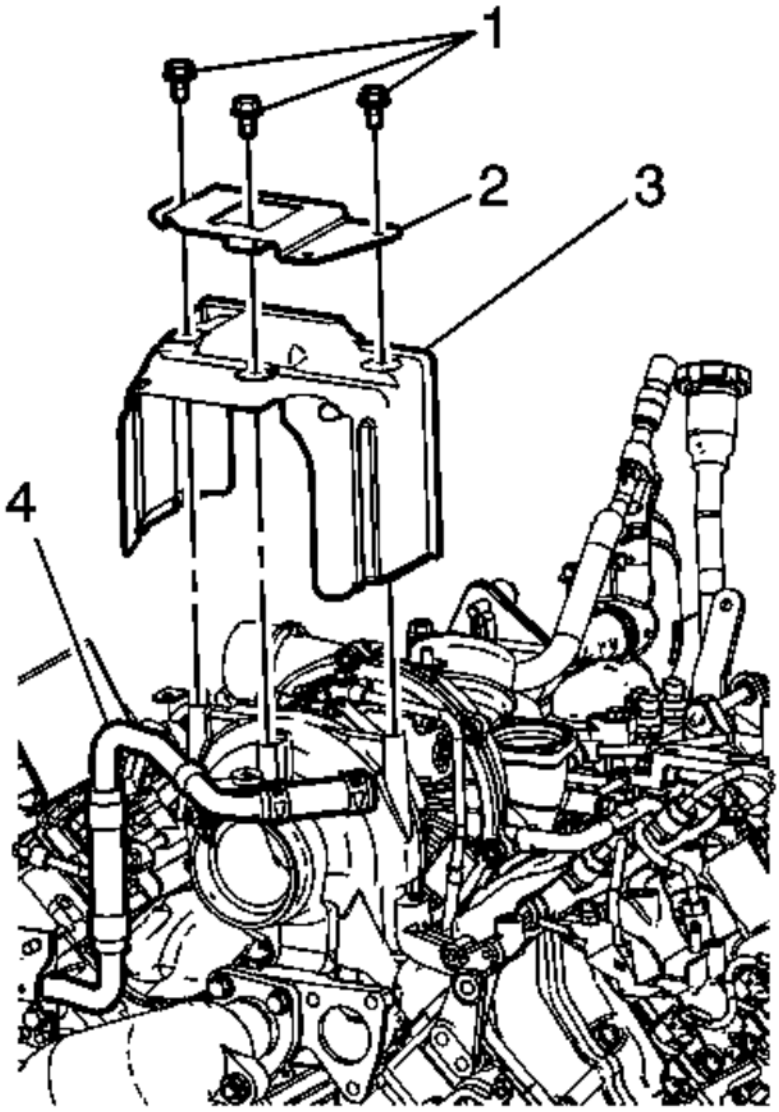


Fig. 176: View Of Turbocharger Heat Shield & EGR Cooler Pipe
Courtesy of GENERAL MOTORS CORP.

24. Install the turbocharger heat shield (3) and EGR valve adapter pipe bracket (2).
25. Install the EGR valve adapter pipe bracket bolts (1).

Tighten: Tighten the bolts to 9 N.m (80 lb in).

26. Position the EGR cooler pipe (4).

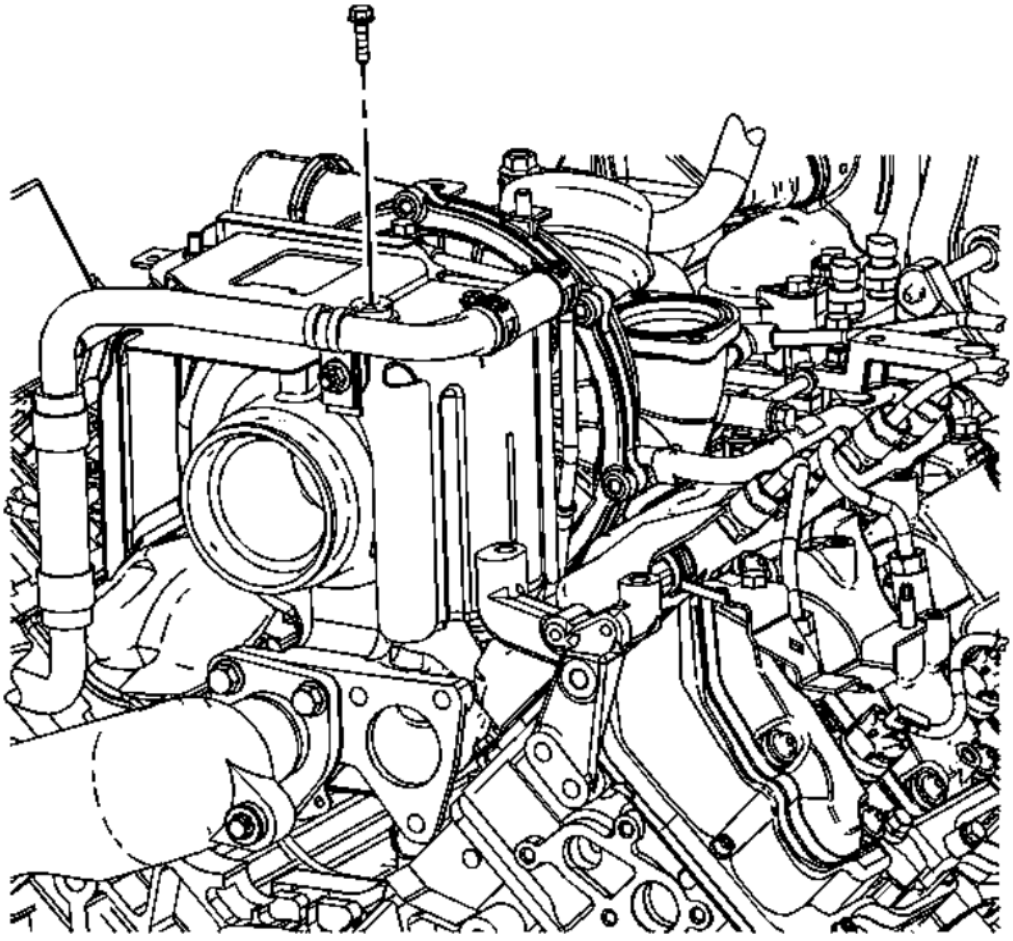


Fig. 177: Identifying Upper EGR Cooler Pipe Bolt
Courtesy of GENERAL MOTORS CORP.

27. Install the EGR cooler pipe bolt.

    Tighten: Tighten the bolt to 9 N.m (80 lb in).

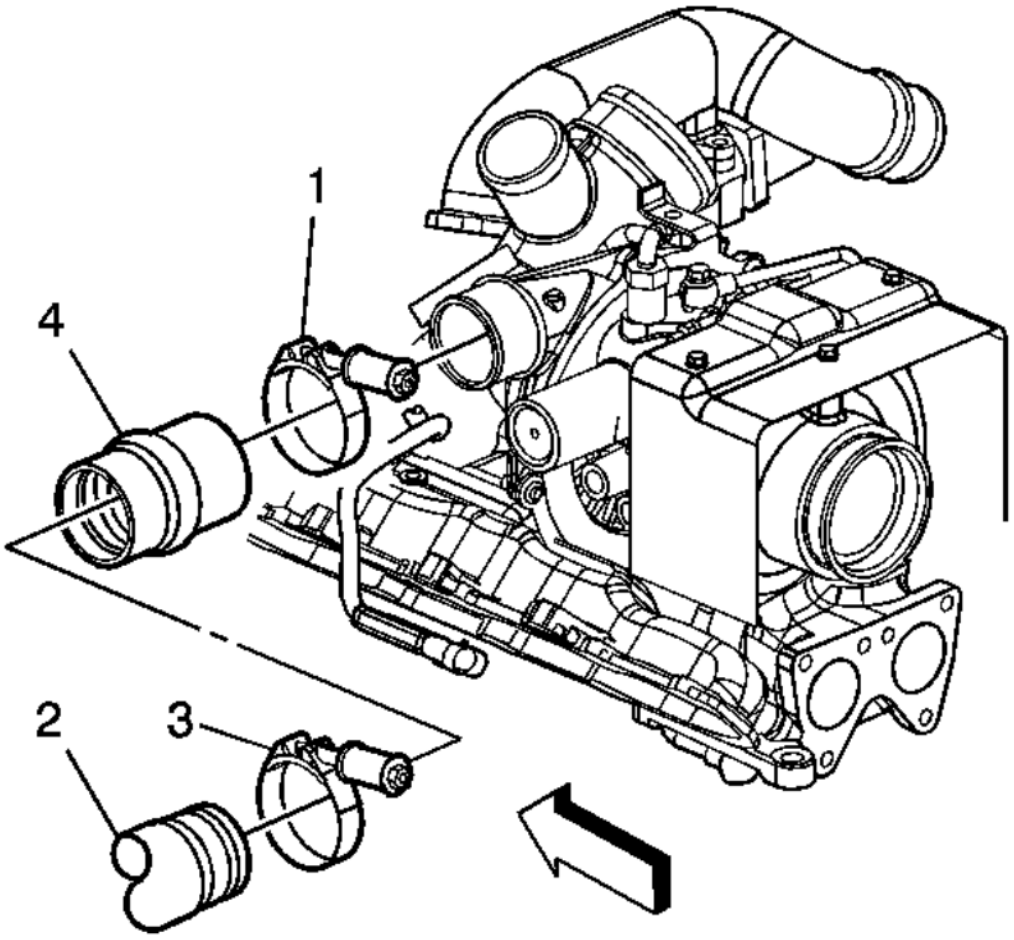


Fig. 178: View Of Turbocharger Clamp & Charged Air Cooler Inlet Duct Connector
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Lubricate the end of the duct prior to installation.

28. Remove the tape from the turbocharger openings.
29. Install the charged air cooler inlet duct connector (4) to the turbocharger.
30. Tighten the charged air cooler inlet duct connector to turbocharger clamp (1).

Tighten: Tighten the clamp to 6 N.m (53 lb in).

31. Install the charged air cooler outlet duct. Refer to **Charge Air Cooler Outlet Pipe Replacement** .
32. Fill the cooling system. Refer to **Cooling System Draining and Filling (Vac-N-Fill)** or **Cooling System Draining and Filling (Static Fill)** .

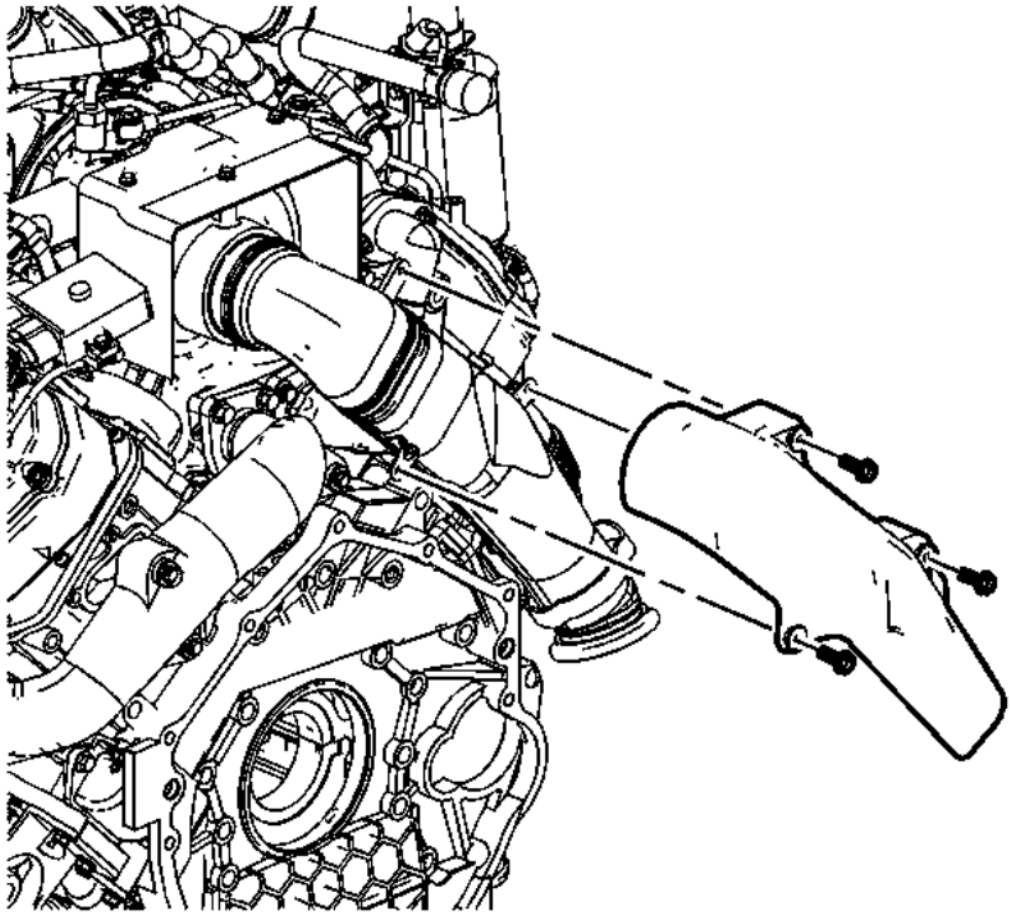


Fig. 179: View Of Exhaust Outlet Shield
Courtesy of GENERAL MOTORS CORP.

33. Install the lower bolt for the exhaust outlet shield.

Tighten: Tighten the bolt to 8 N.m (71 lb in).

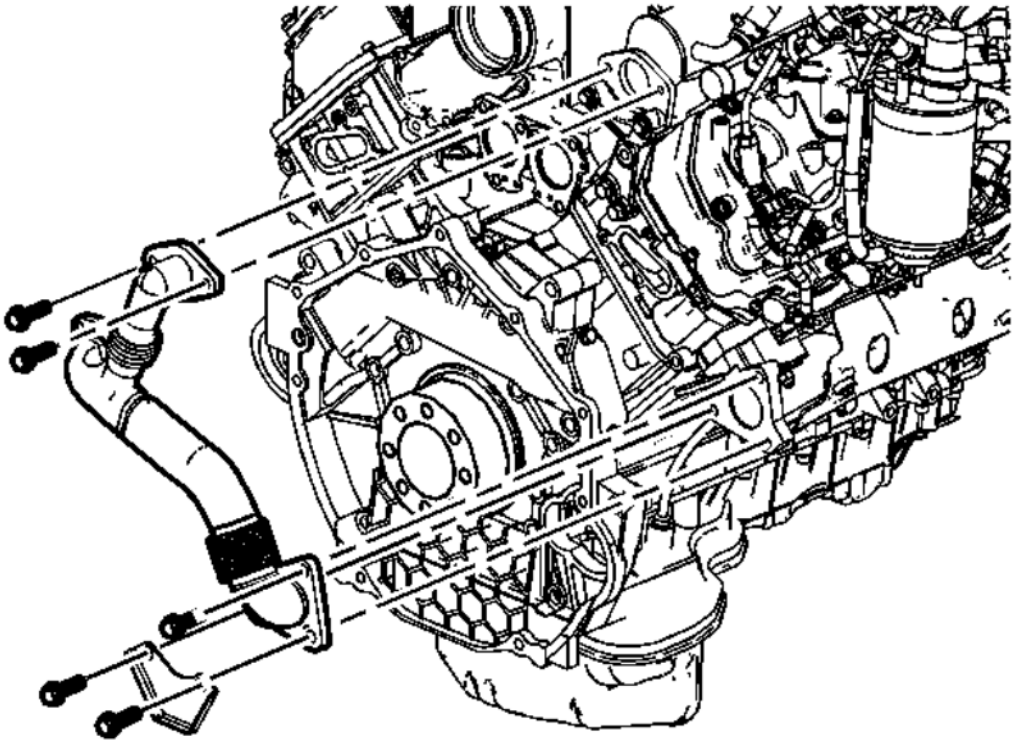


Fig. 180: View Of Right Exhaust Pipe
Courtesy of GENERAL MOTORS CORP.

34. Install a NEW exhaust manifold gasket.
35. Install the right exhaust pipe to exhaust manifold bolts.

Tighten: Tighten the bolts to 53 N.m (39 lb ft).

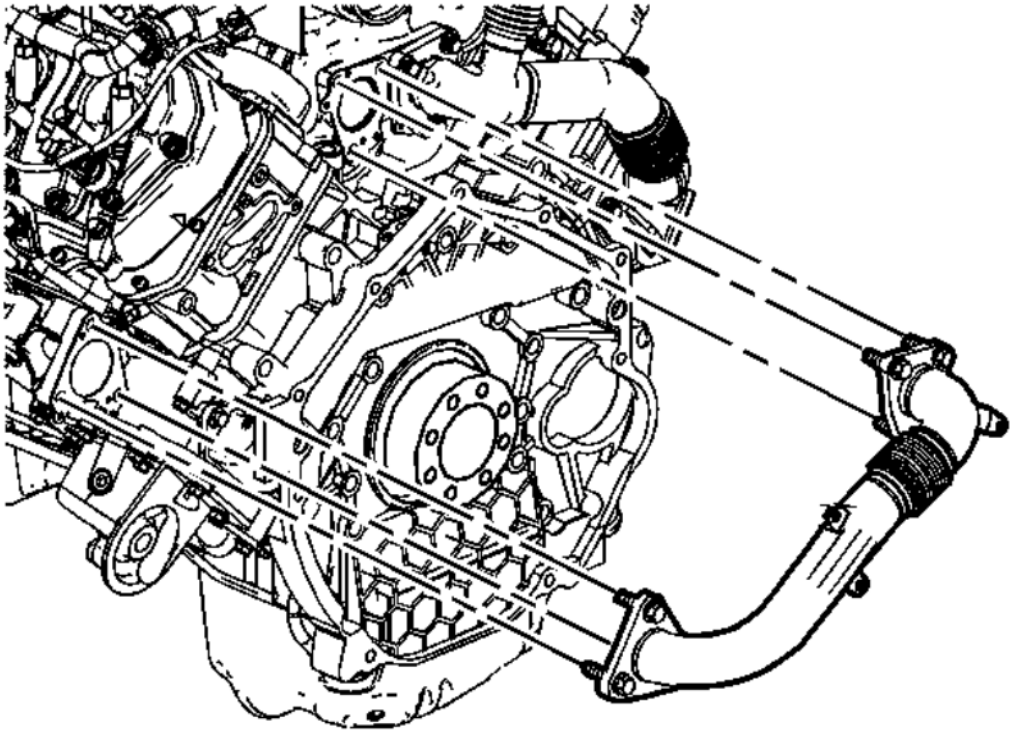


Fig. 181: View Of Left Exhaust Pipe
Courtesy of GENERAL MOTORS CORP.

36. Install a NEW exhaust manifold gasket.
37. Install the left exhaust pipe to exhaust manifold bolts.

Tighten: Tighten the bolts to 53 N.m (39 lb ft).

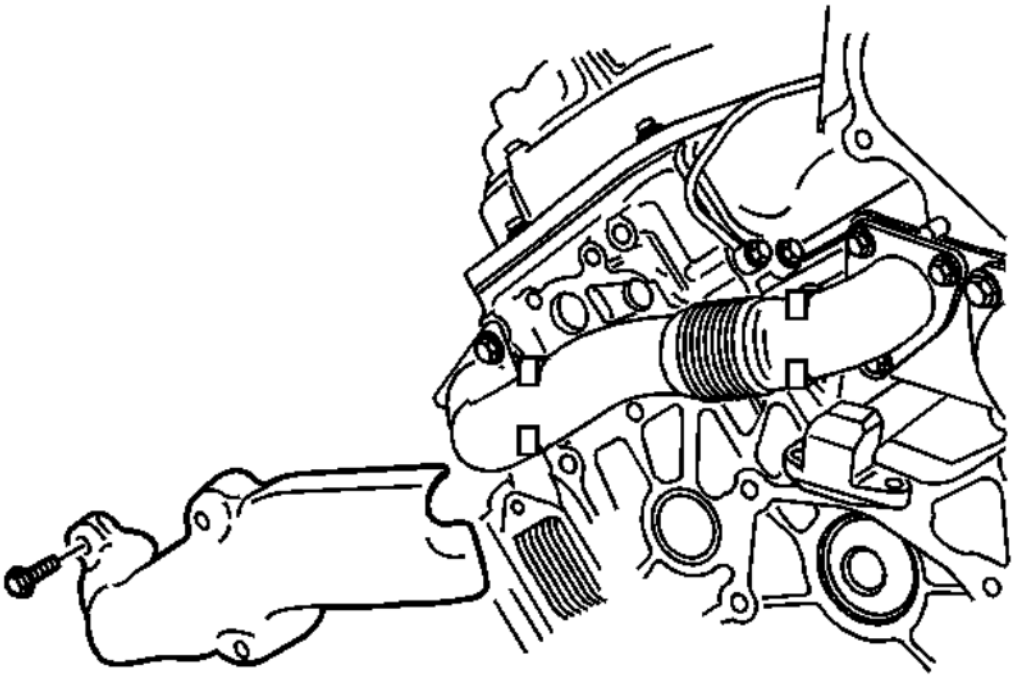


Fig. 182: View Of Left Exhaust Pipe Heat Shield & Bolts
Courtesy of GENERAL MOTORS CORP.

38. Install the heat shield.
39. Install the left exhaust pipe heat shield bolts.

Tighten: Tighten the bolts to 8 N.m (71 lb in).

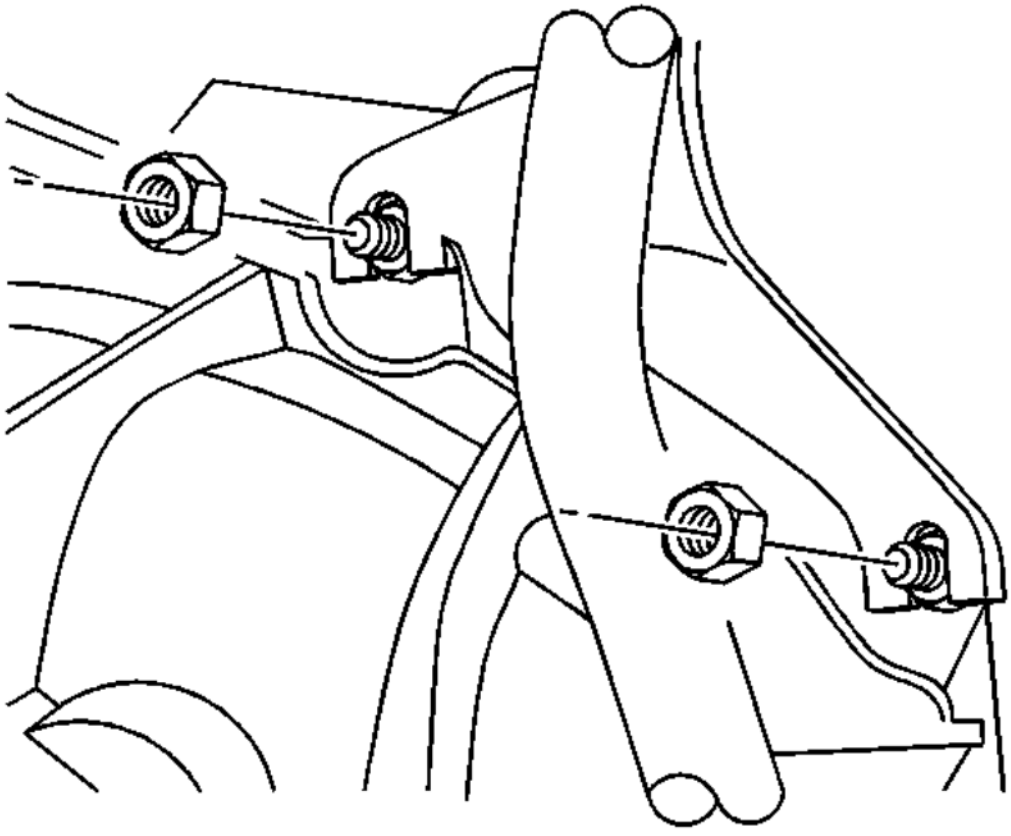


Fig. 183: View Of Fill Tube To Bellhousing Nuts
Courtesy of GENERAL MOTORS CORP.

40. If equipped with an automatic transmission, position the fill tube to the studs.
41. Install the transmission fill tube to bellhousing nuts.

Tighten: Tighten the nuts to 18 N.m (13 lb ft).

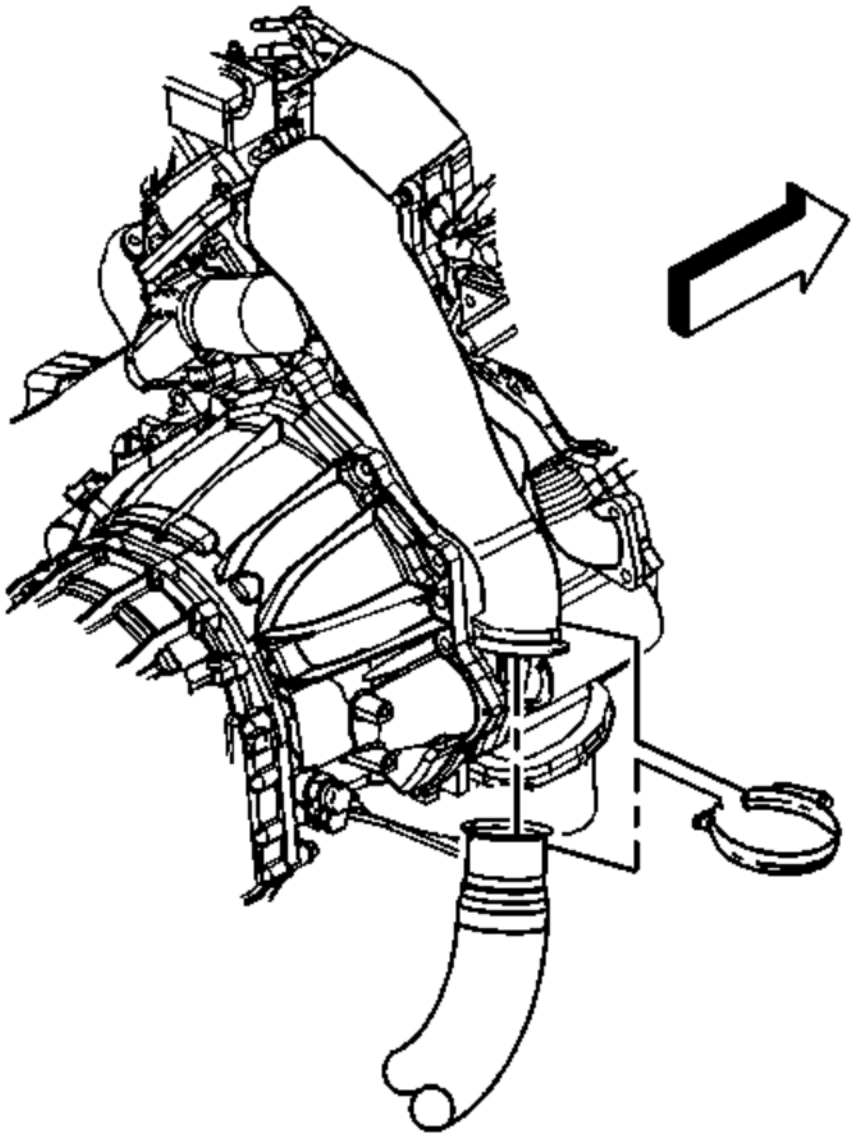


Fig. 184: View Of Turbocharger Exhaust Pipe & Clamp
Courtesy of GENERAL MOTORS CORP.

42. Slide the clamp onto the exhaust pipe. Tighten the exhaust pipe clamp.

Tighten: Tighten the clamp to 40 N.m (30 lb ft).

43. Install the left and right wheelhouse liners. Refer to **Front Wheelhouse Liner Replacement - Right Side (GMC)** or **Front Wheelhouse Liner Replacement - Right Side (Chevrolet)** and **Front Wheelhouse Liner Replacement - Left Side (Chevrolet)** or **Front Wheelhouse Liner Replacement - Left Side (GMC)** .
44. Install the transmission. Refer to **Transmission Replacement** .
45. If a NEW turbocharger was installed, perform the turbocharger learn procedure. Refer to **Turbocharger Learn** .
46. Road test the vehicle for normal operation.
47. Inspect for coolant, oil, or exhaust leaks. Correct as necessary.

TURBOCHARGER OIL FEED PIPE REPLACEMENT

Removal Procedure

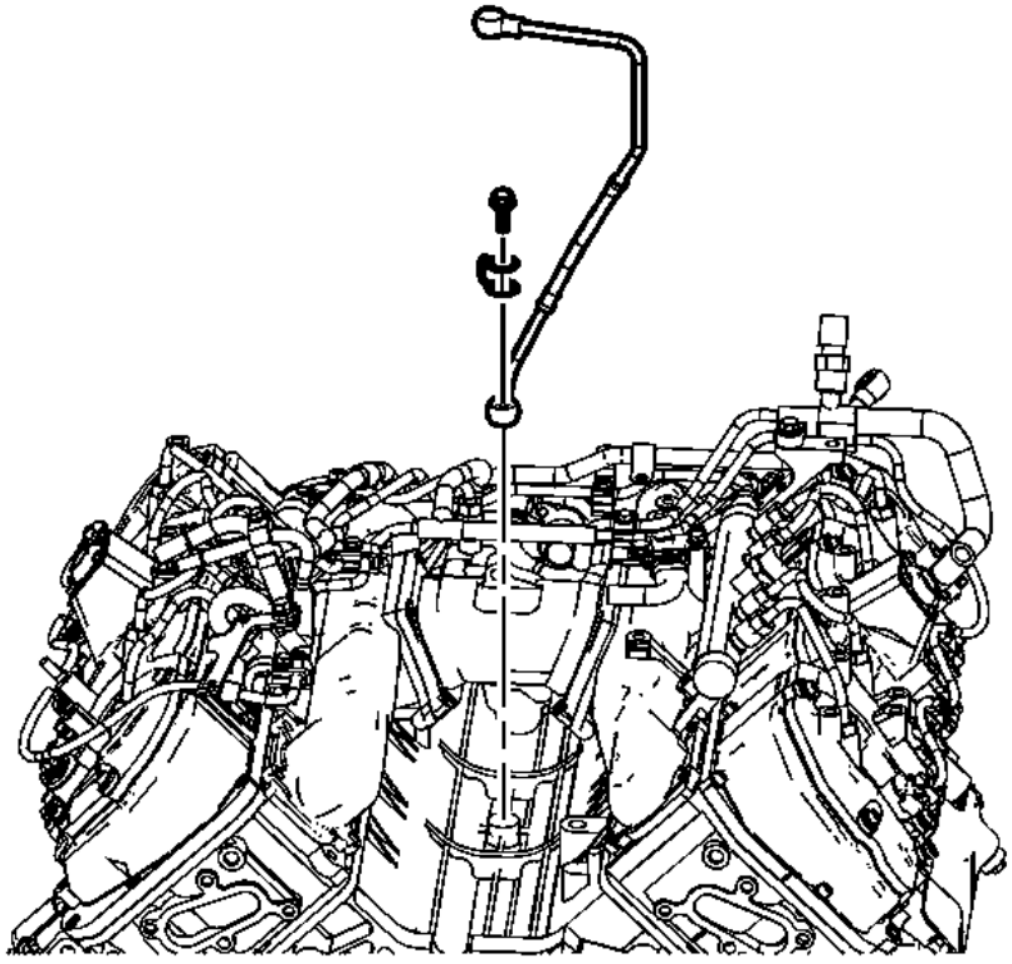


Fig. 185: View Of Oil Feed Pipe Bolt, Washer & Pipe
Courtesy of GENERAL MOTORS CORP.

1. Remove the turbocharger. Refer to **Turbocharger Replacement**.
2. Remove the turbocharger oil feed pipe bolt.
3. Remove the oil feed pipe and washer.

Installation Procedure

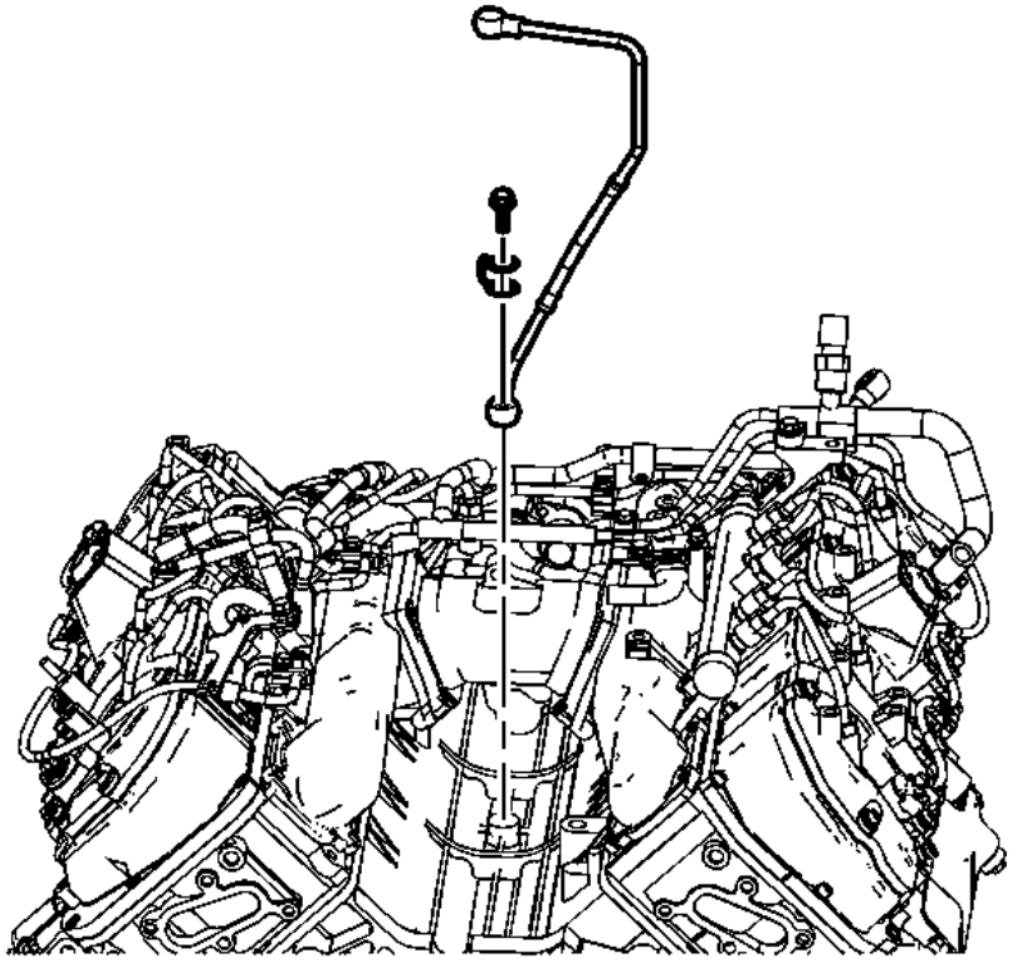


Fig. 186: View Of Oil Feed Pipe Bolt, Washer & Pipe
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not twist the turbocharger oil feed pipe. Twisting of the feed pipe will result in the collapse and deformation of the plastic pipe, restricting oil flow and causing turbocharger damage. During turbocharger replacement, gently push the oil feed pipe towards the front of the engine to clear the turbocharger. Assistance may be required to keep the pipes clear of the turbocharger during removal or installation.

IMPORTANT: Lubricate the NEW washer with diesel fuel before installing.

NOTE: Refer to Fastener Notice .

1. Position the oil feed pipe and a NEW washer into place.
2. Install the oil feed pipe bolt.

   Tighten: Tighten the bolt to 34 N.m (25 lb ft).

3. Install the turbocharger. Refer to **Turbocharger Replacement**.

AIR CONDITIONING (A/C) COMPRESSOR AND POWER STEERING PUMP BRACKET REPLACEMENT

Removal Procedure

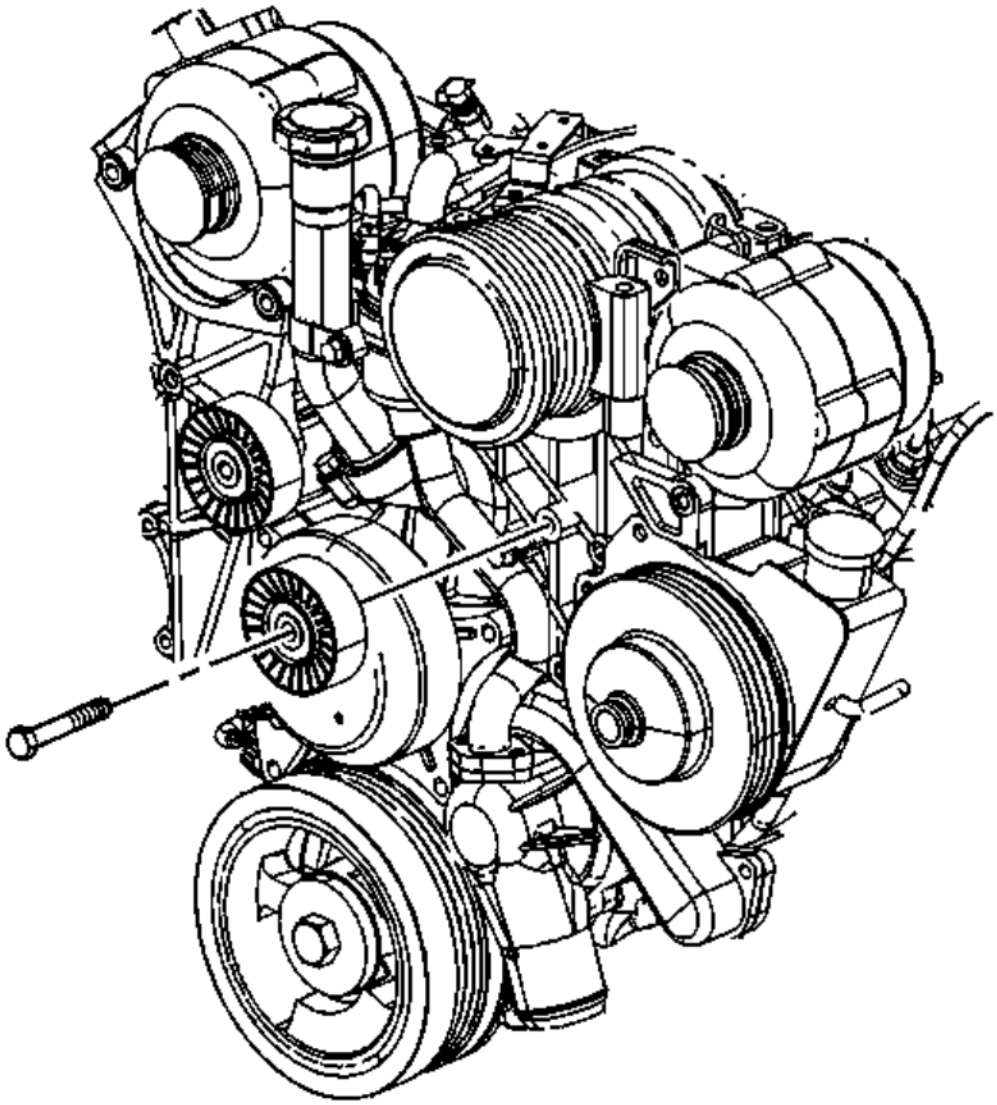


Fig. 187: View Of Left Side Idler Pulley & Bolt (Dual Generators)
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (w/Single Battery)** or **Battery Negative Cable Disconnection and Connection (w/Auxiliary Battery)** or **Battery Negative Cable Disconnection and Connection (w/Dual Batteries)** .

2. Remove the cooling fan and shroud. Refer to **Cooling Fan and Shroud Replacement (Non-HP2)** .
3. Remove the drive belt. Refer to **Drive Belt Replacement**.
4. If equipped, remove the auxiliary generator. Refer to **Auxiliary Generator Replacement (6.6L)** .
5. If equipped with dual generators, remove the bolt from the left side idler pulley (smooth pulley).
6. Remove the idler pulley.

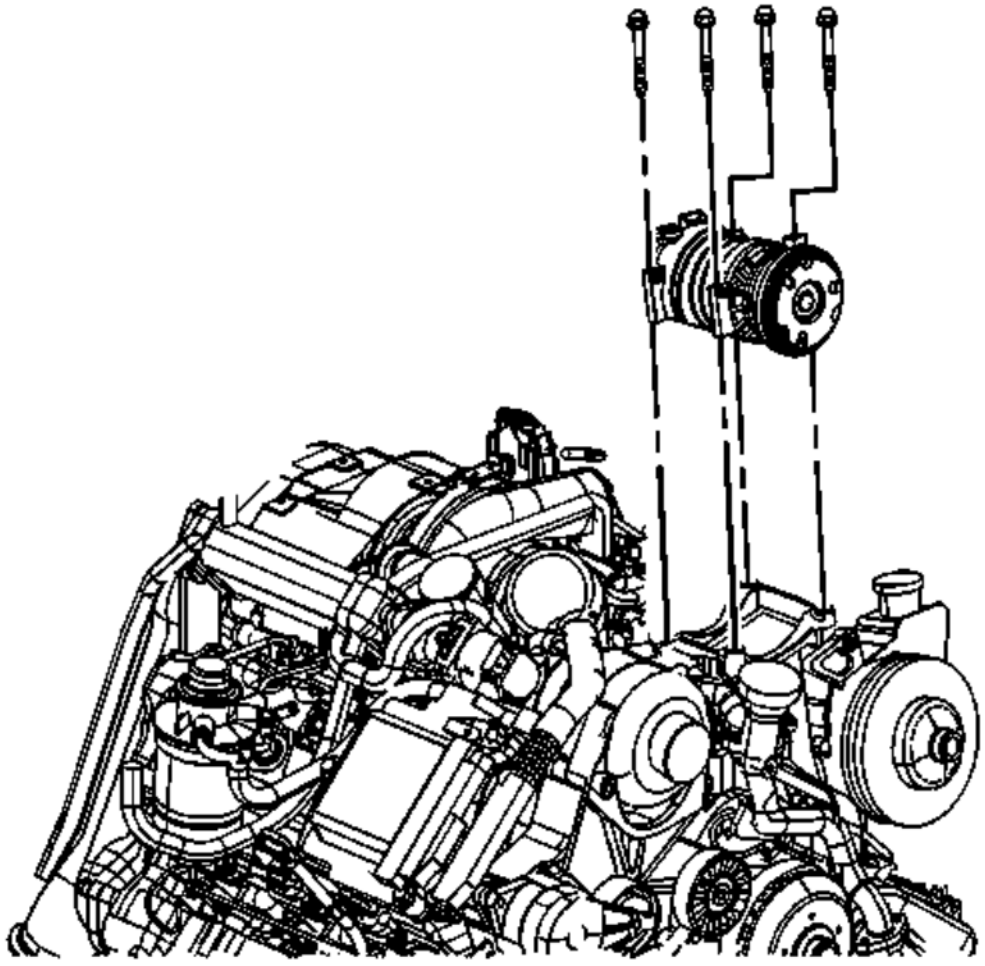


Fig. 188: View Of A/C Compressor & Bolts
Courtesy of GENERAL MOTORS CORP.

7. Disconnect the air conditioning (A/C) compressor clutch electrical connector.
8. Disconnect the A/C cut out switch electrical connector.
9. Remove the A/C compressor bolts.
10. Move the A/C compressor with the hoses attached to the right side of the engine compartment.

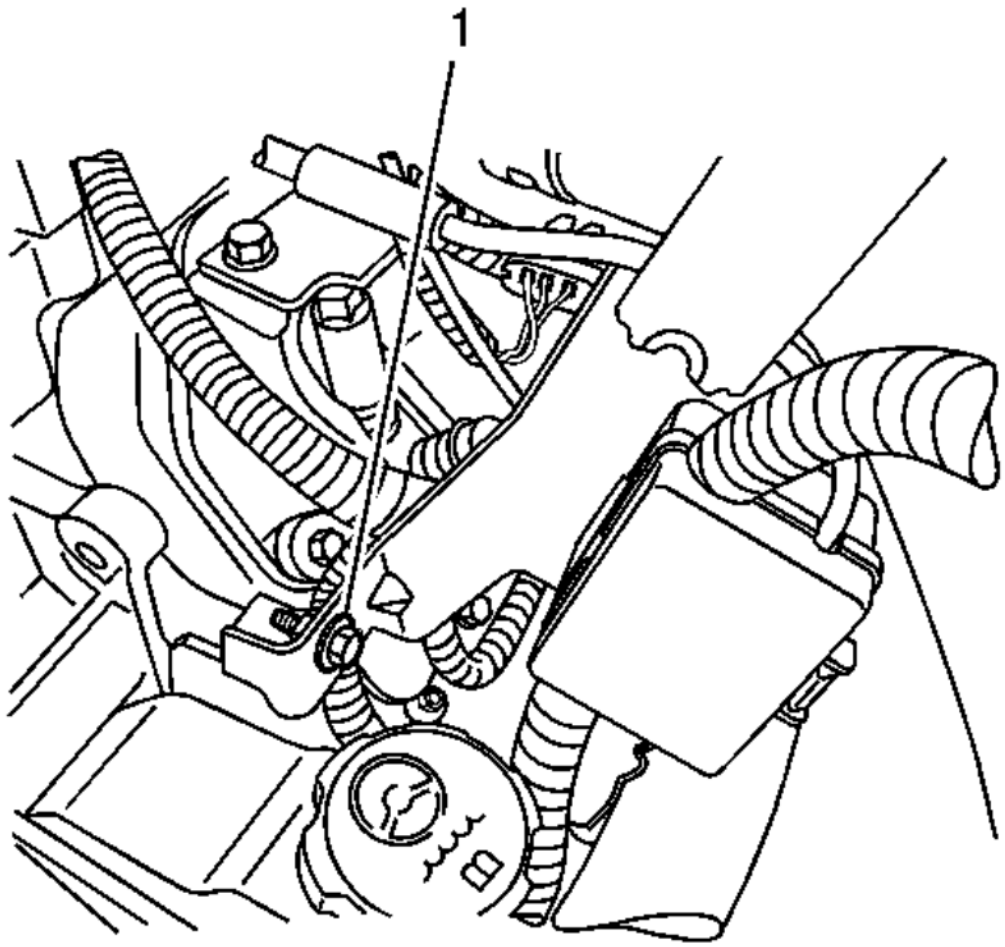


Fig. 189: View Of Battery Cable Junction Block Bolt At Power Steering Pump Bracket

Courtesy of GENERAL MOTORS CORP.

11. Remove the positive cable junction block to power steering pump bolt (1).
12. Secure the junction block out of the way.

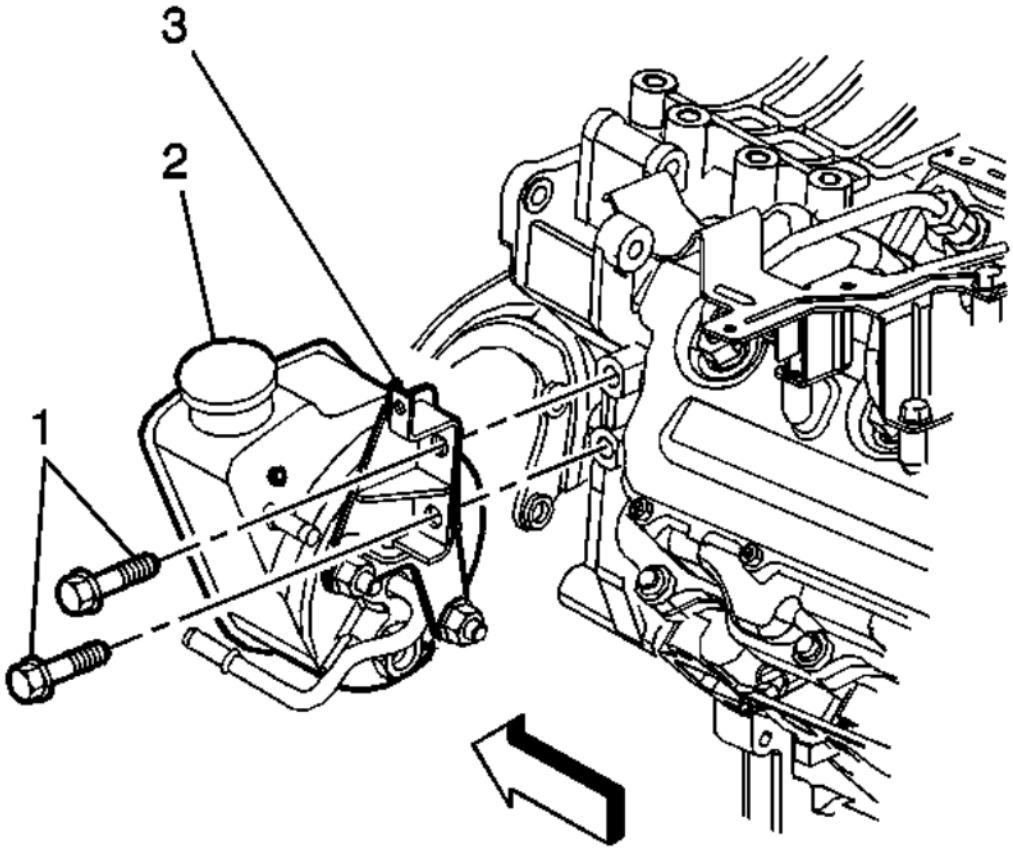


Fig. 190: View Of Rear Power Steering Pump, Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

13. Remove the rear power steering pump bracket bolts (1).

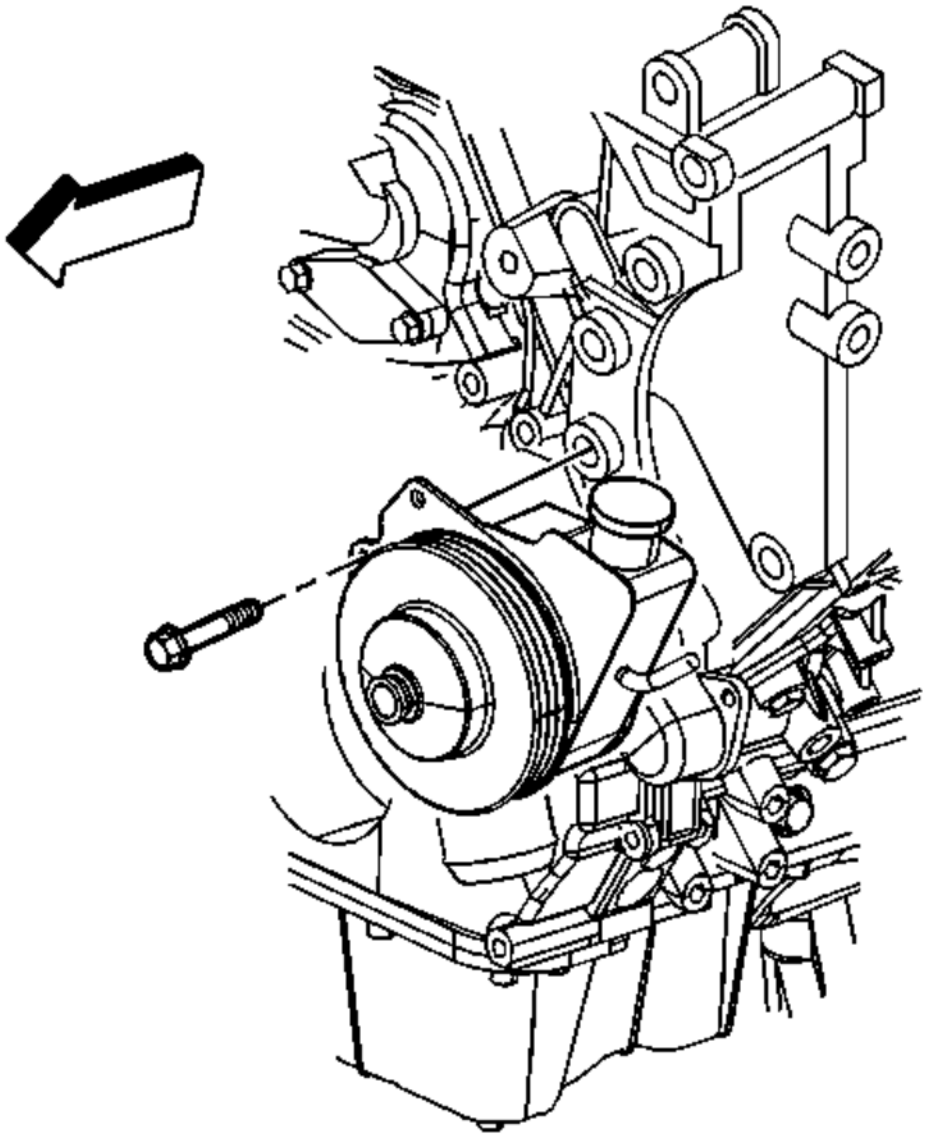


Fig. 191: View Of Power Steering Pump Front Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

14. Remove the power steering pump front bracket bolt.
15. Move and secure the power steering pump out of the way. The hoses and battery cables can remain attach to pump.

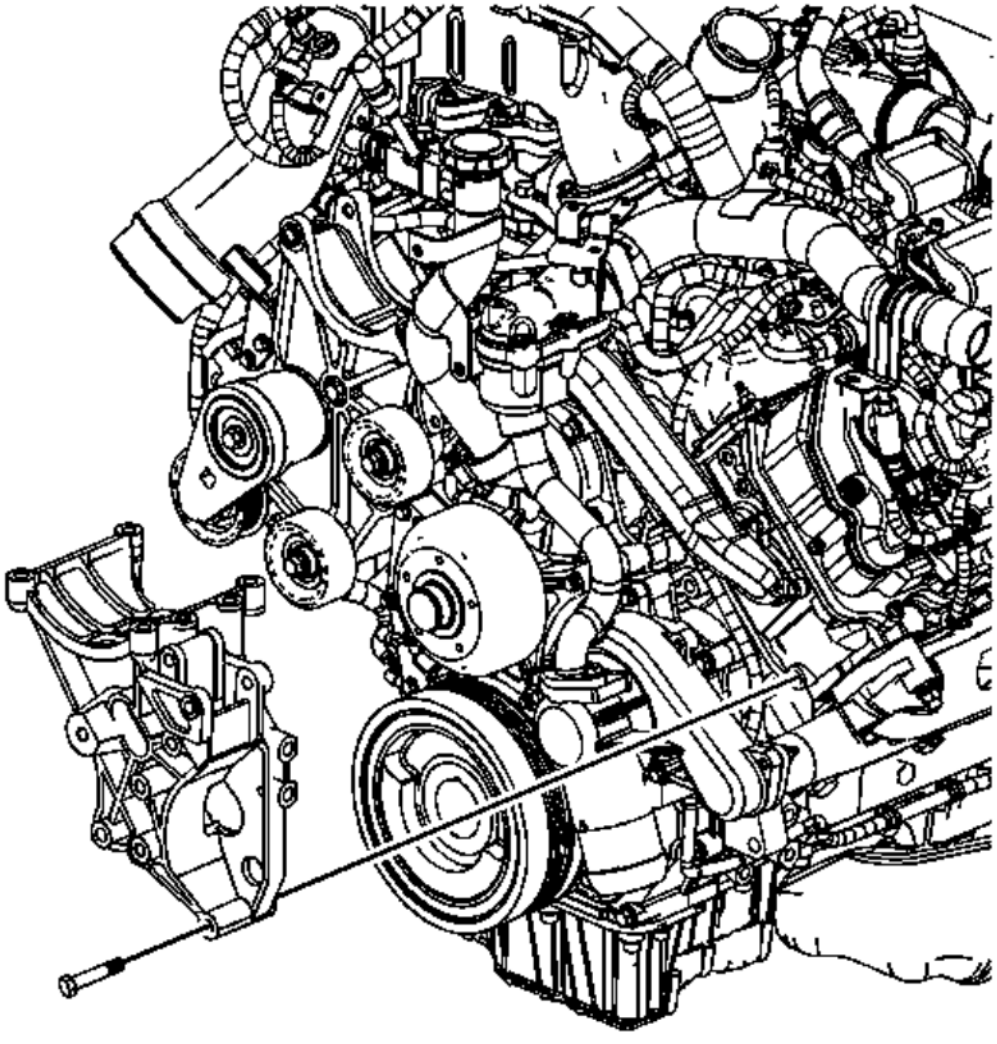


Fig. 192: A/C Compressor And Power Steering Pump Bracket
Courtesy of GENERAL MOTORS CORP.

16. Remove the A/C compressor and power steering pump bracket bolts.
17. Remove the A/C compressor and power steering pump bracket.

Installation Procedure

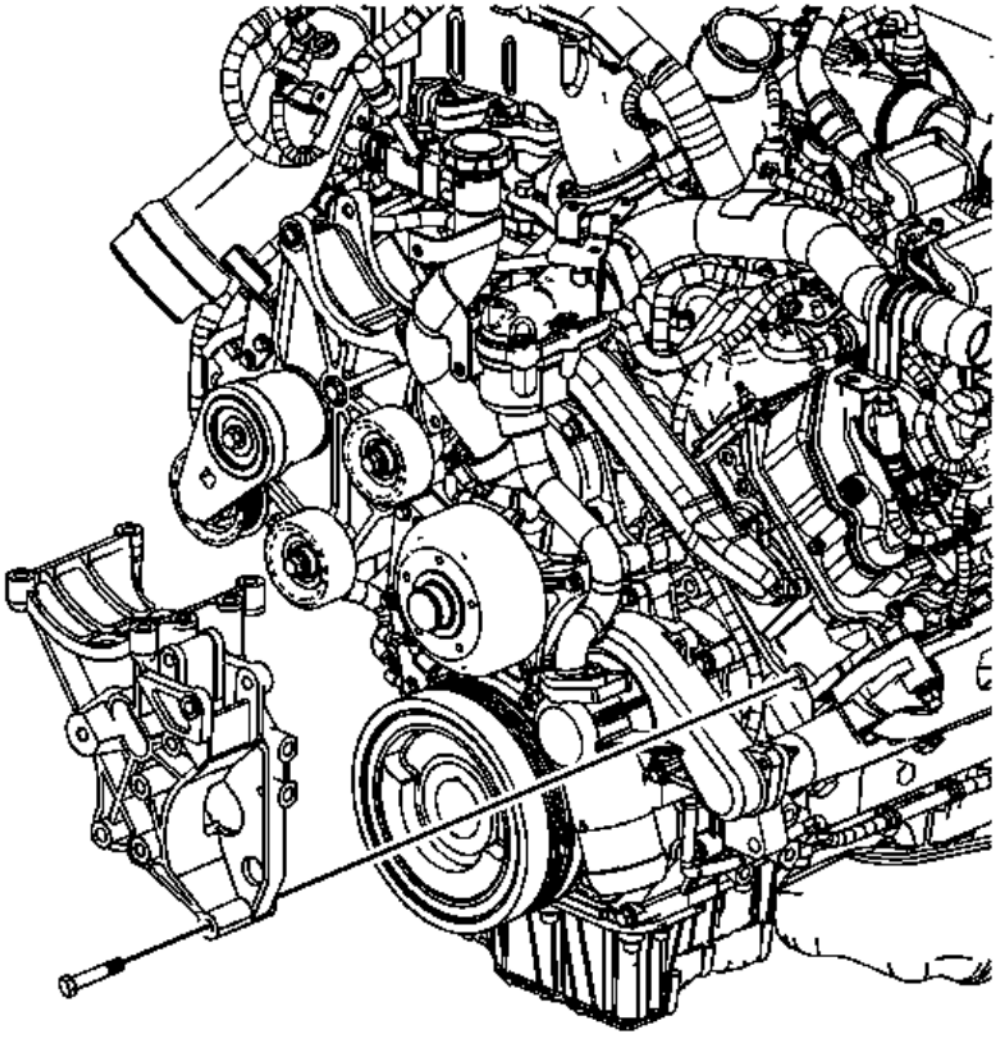


Fig. 193: A/C Compressor And Power Steering Pump Bracket
Courtesy of GENERAL MOTORS CORP.

1. Position the A/C compressor and power steering pump bracket.

NOTE: **Refer to Fastener Notice .**

2. Install the A/C compressor and power steering pump bracket bolts.

Tighten: Tighten the bolts to 46 N.m (34 lb ft).

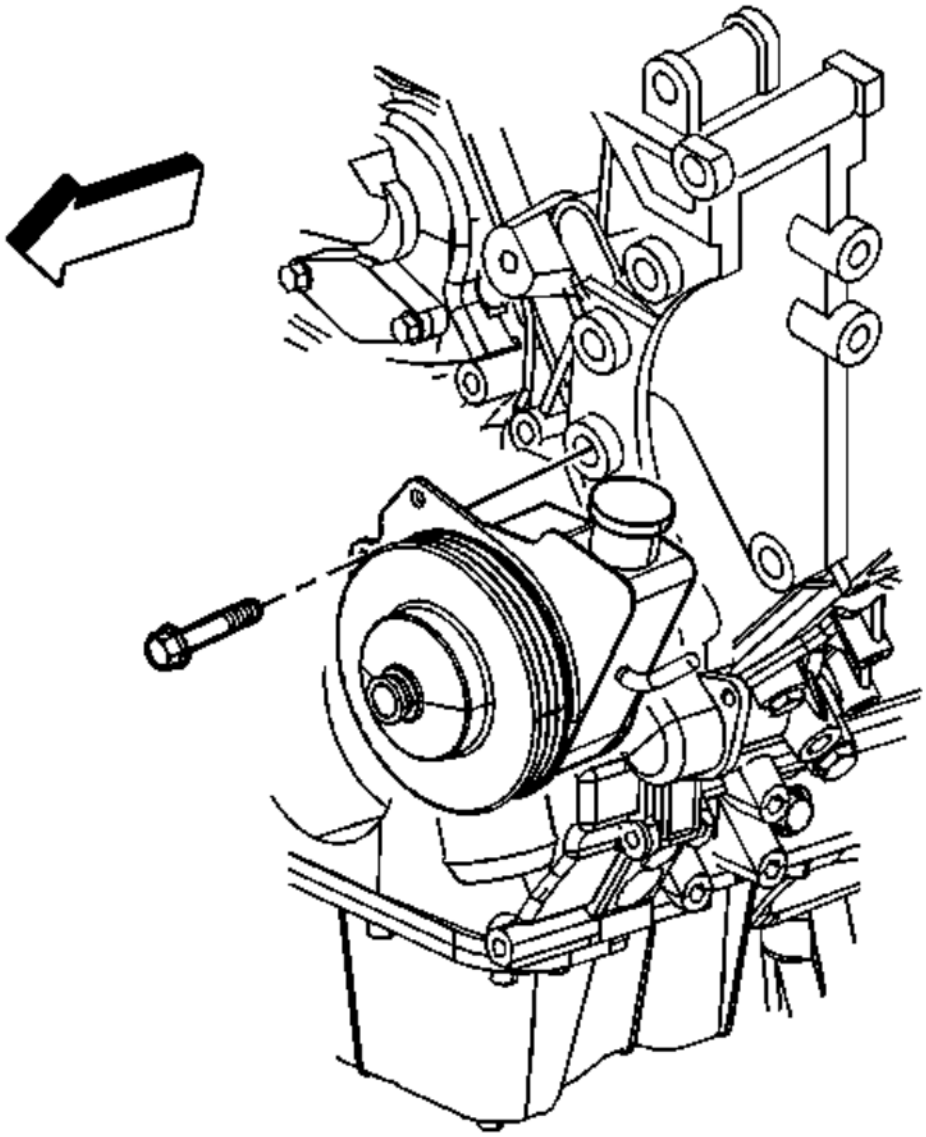


Fig. 194: View Of Power Steering Pump Front Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

3. Install the power steering pump and loosely install the front bracket bolts.

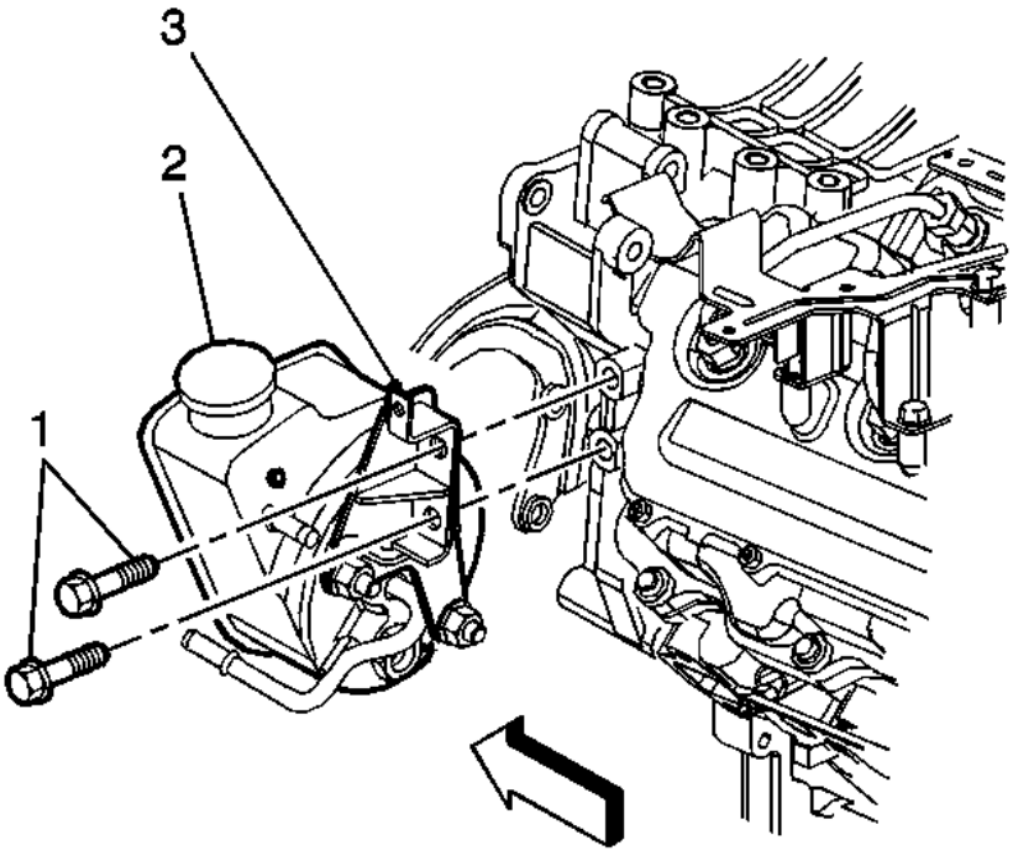


Fig. 195: View Of Rear Power Steering Pump, Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Tighten the front bracket bolts before the rear bracket bolts to ensure pulley alignment.

4. Loosely install the rear power steering pump bracket bolts (1).

Tighten:

1. Tighten the front bracket bolts to 50 N.m (37 lb ft).
2. Tighten the rear bracket bolts to 50 N.m (37 lb ft).

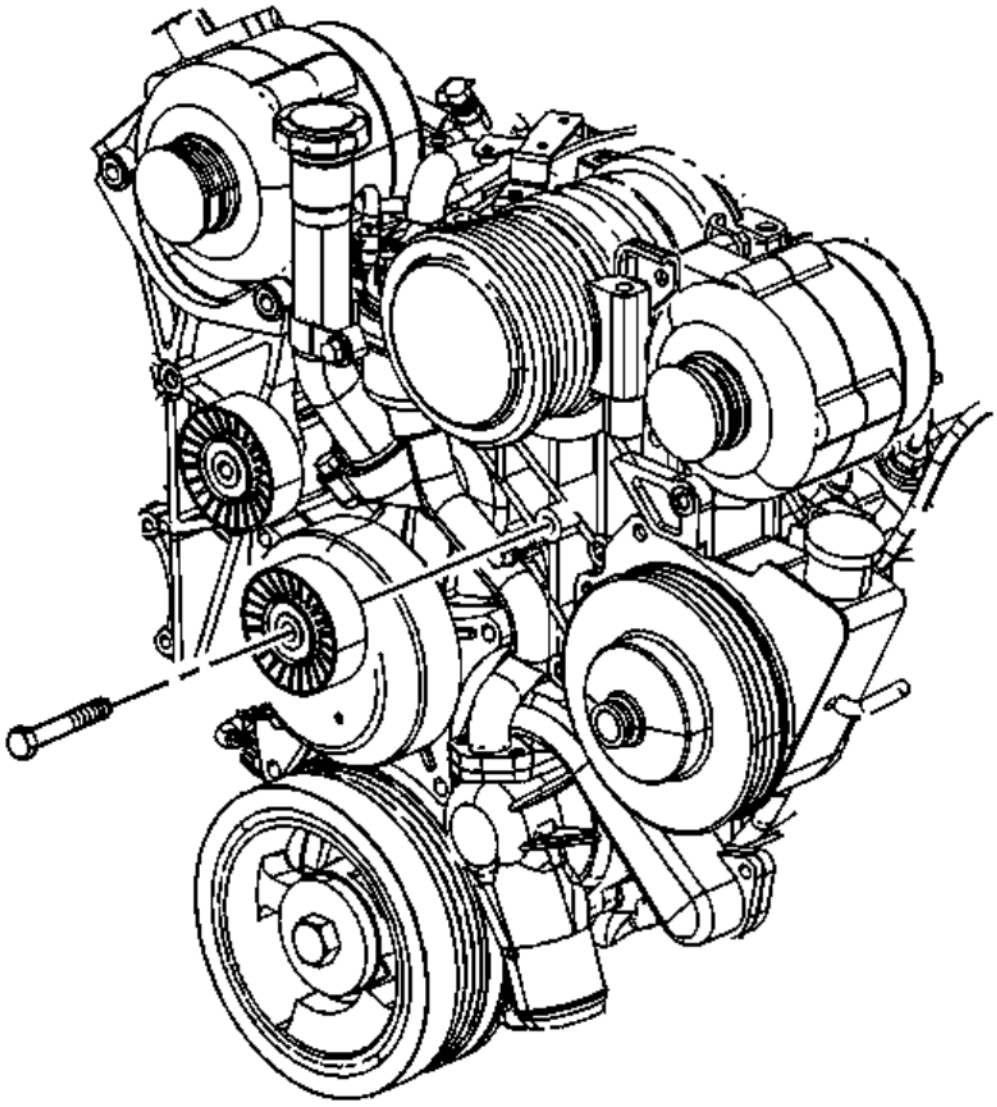


Fig. 196: View Of Left Side Idler Pulley & Bolt (Dual Generators)
Courtesy of GENERAL MOTORS CORP.

5. If equipped with dual generators, install the left side idler pulley and bolt.

   Tighten: Tighten the bolt to 43 N.m (32 lb ft)

6. Install the auxiliary generator. Refer to **Auxiliary Generator Replacement (6.6L)** .

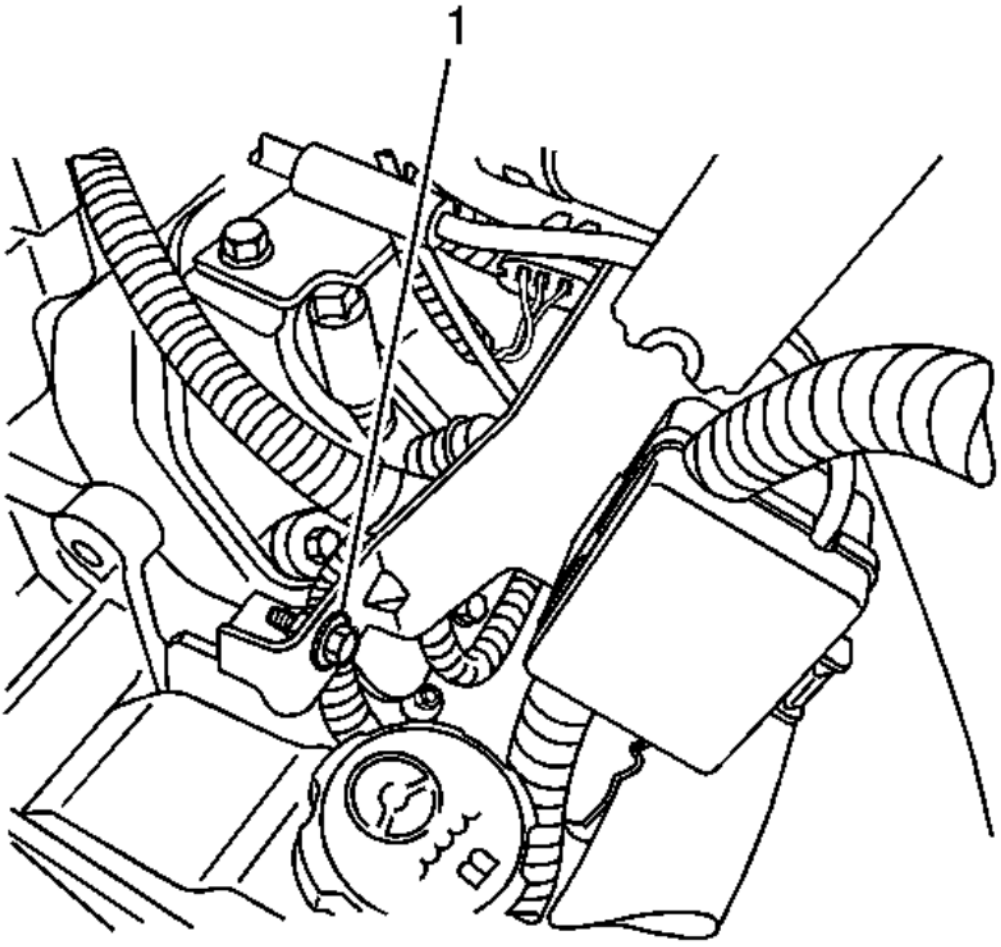


Fig. 197: View Of Battery Cable Junction Block Bolt At Power Steering Pump Bracket
Courtesy of GENERAL MOTORS CORP.

7. Install the battery cable junction block and bolt (1).

Tighten: Tighten the bolt to 9 N.m (80 lb in).

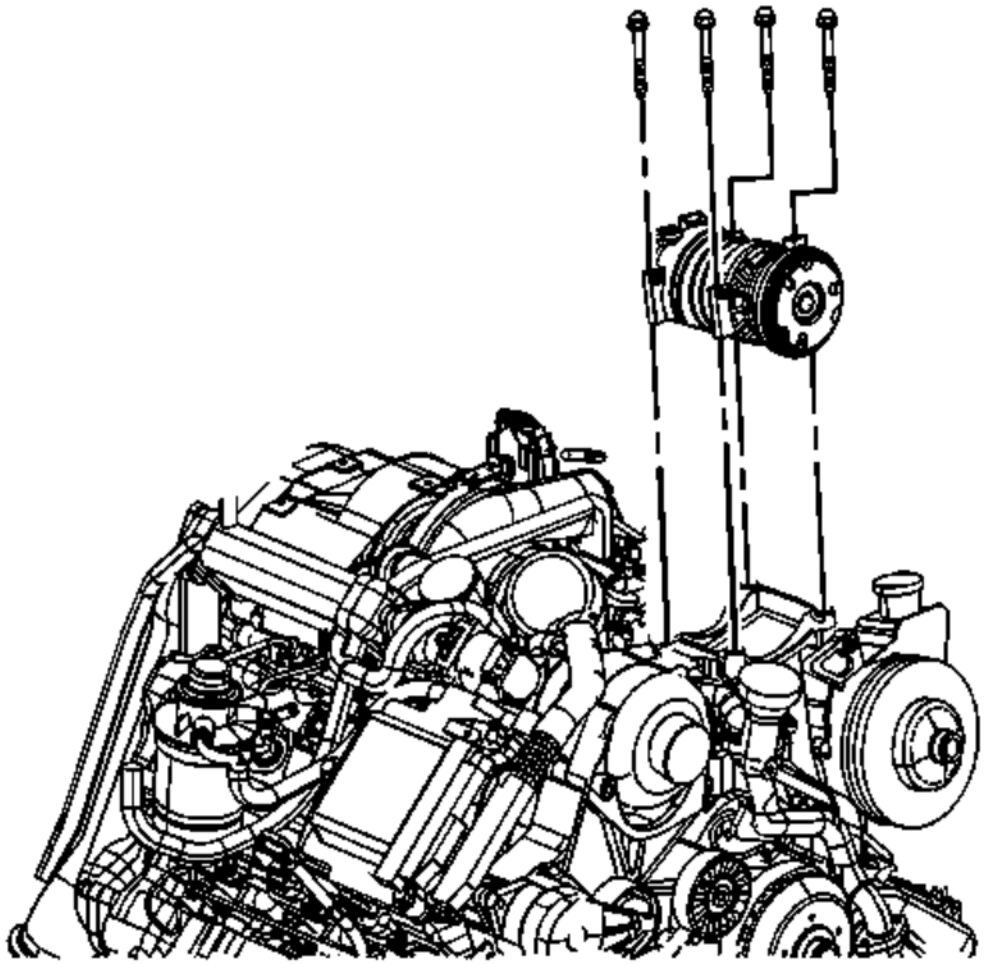


Fig. 198: View Of A/C Compressor & Bolts
Courtesy of GENERAL MOTORS CORP.

8. Position the A/C compressor.
9. Install the A/C compressor bolts.

   Tighten: Tighten the bolts to 50 N.m (37 lb ft).

10. Connect the A/C cut out switch electrical connector.
11. Connect the A/C clutch electrical connector.

12. Install the drive belt. Refer to **Drive Belt Replacement**.
13. Install the cooling fan and shroud. Refer to **Cooling Fan and Shroud Replacement (Non-HP2)** .
14. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (w/Single Battery)** or **Battery Negative Cable Disconnection and Connection (w/Auxiliary Battery)** or **Battery Negative Cable Disconnection and Connection (w/Dual Batteries)** .

CYLINDER HEAD REPLACEMENT - LEFT SIDE

Tools Required

J 45059 Angle Meter

Removal Procedure

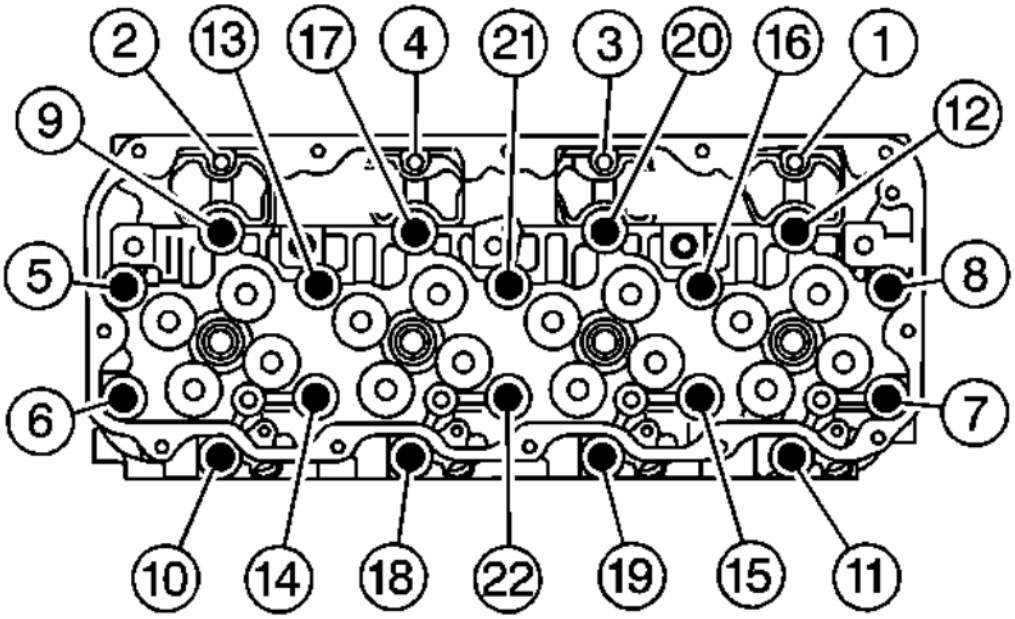


Fig. 199: Cylinder Head Bolt Removal Sequence
Courtesy of GENERAL MOTORS CORP.

1. Remove the thermostat housing crossover. Refer to **Thermostat Housing Crossover**

Replacement (LMM) .

2. Remove the intake manifold. Refer to **Intake Manifold Replacement - Left Side**.
3. Remove the exhaust manifold. Refer to **Exhaust Manifold Replacement - Left Side (6.6L)** .
4. Remove the bolt and ground straps from the rear of the cylinder head.
5. Remove the valve rocker arm shaft, pushrods, and valve bridges. Refer to **Valve Rocker Arm, Shaft, and Push Rod Replacement**.
6. Remove the glow plugs. Refer to **Glow Plug Replacement - Bank 2** .
7. Remove the cylinder head bolts in the sequence shown.
8. Discard the large M12 bolts.

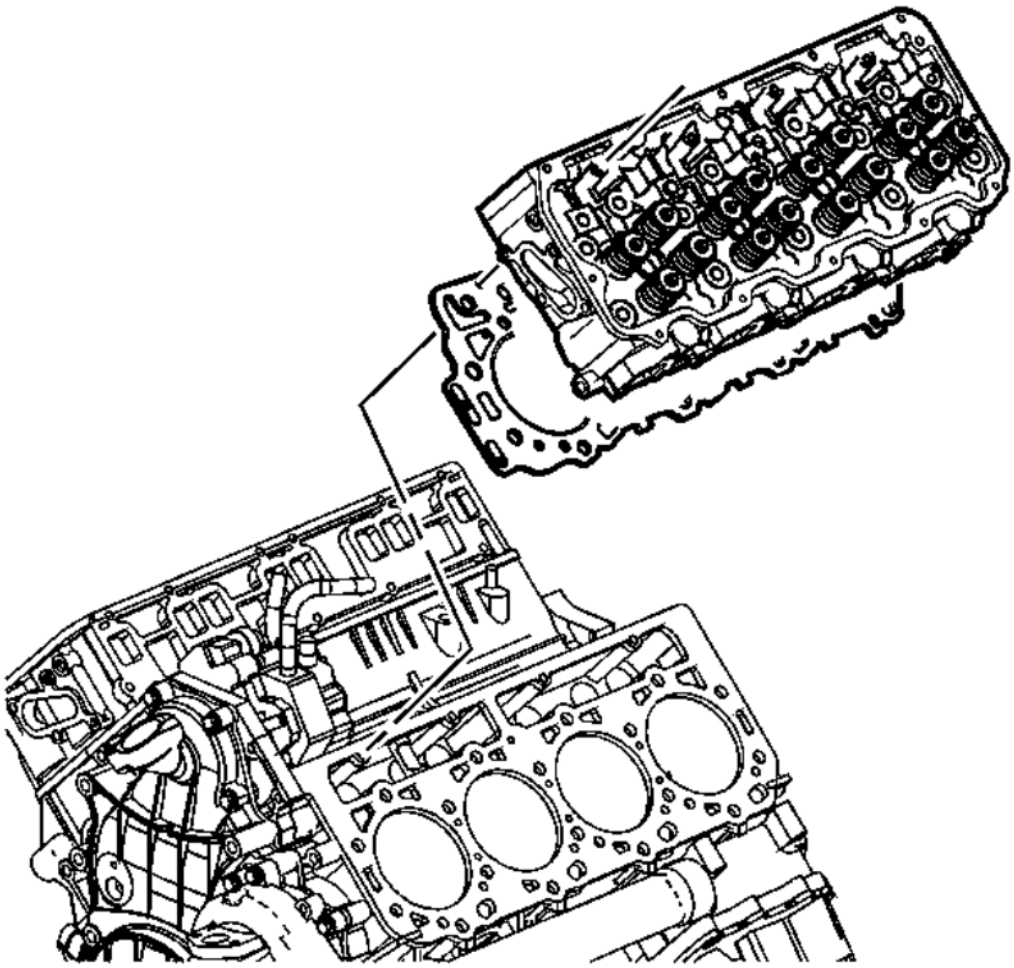


Fig. 200: View Of Left Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

9. Remove the cylinder head.
10. Remove and discard the cylinder head gasket.
11. Clean the sealing surface of the engine block and the cylinder head.

NOTE: 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.

12. Clean the cylinder head bolt holes in the engine block.
13. For service to the cylinder head refer to the following:
    - **Cylinder Head Disassemble**
    - **Cylinder Head Cleaning and Inspection**
    - **Cylinder Head Assemble**

Installation Procedure

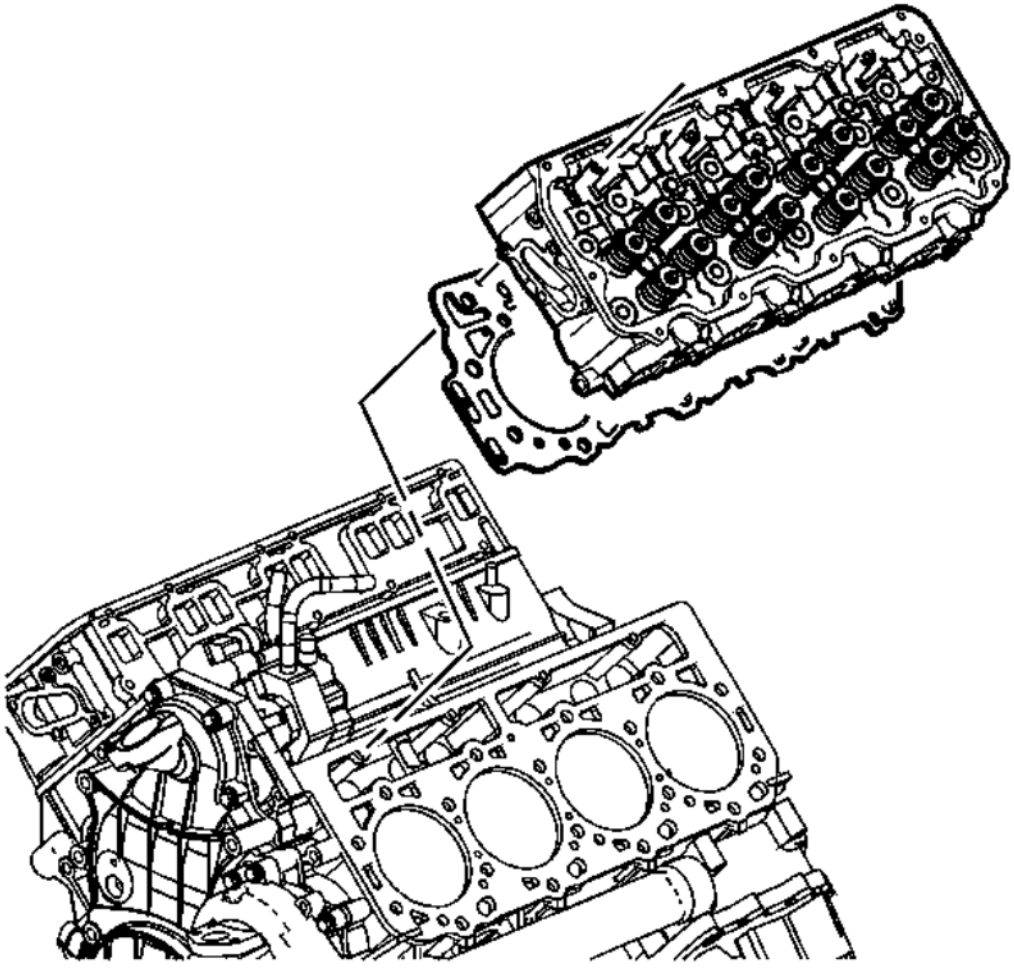


Fig. 201: View Of Left Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

NOTE: **The left and right cylinder head gaskets are not interchangeable. Improper placement of the cylinder head gasket will block coolant and oil passages. Blocked coolant and oil passages will cause severe engine damage.**

1. Install the cylinder head gasket of the correct grade. Refer to **Cylinder Head Gasket Selection Specifications** .
2. Install the cylinder head.

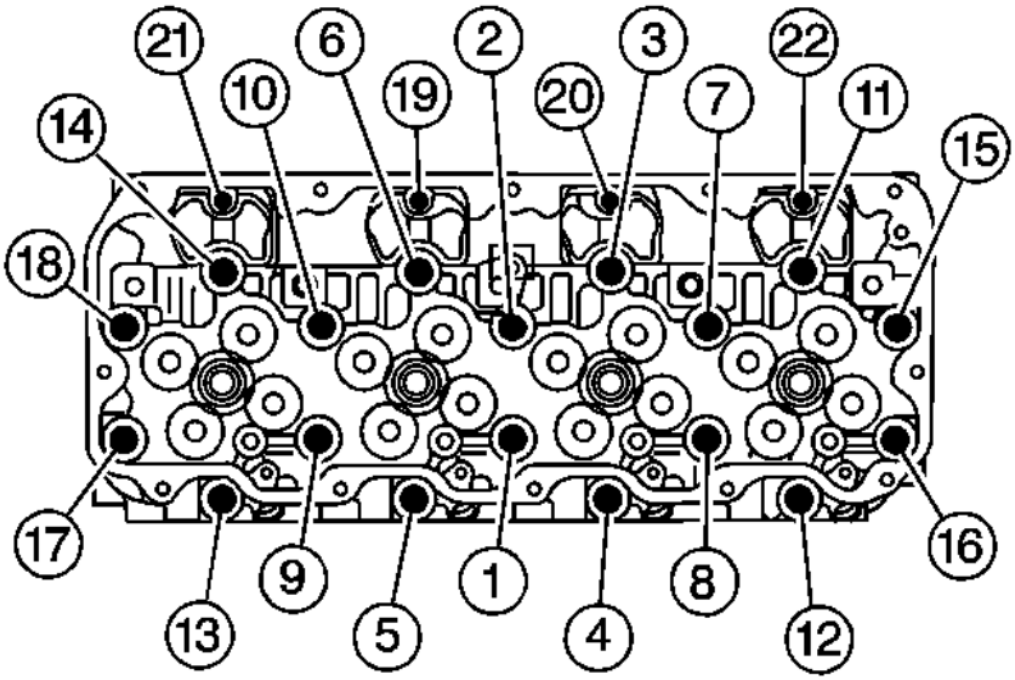


Fig. 202: Cylinder Head Bolt Installation Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: **This component uses bolts with a preapplied molybdenum disulfide coating for thread lubrication. Do not remove the coating or use any additional lubricant. Improperly lubricated threads will adversely affect the bolt torque and clamp load. Improper bolt torque and clamp load can lead to engine**

damage.

3. Install NEW M12 cylinder head bolts.
4. Reuse the M8 cylinder head bolts.

NOTE: Refer to Fastener Notice .

5. Tighten the cylinder head bolts in the following steps using the sequence shown:

   Tighten:
   1. Tighten the M12 bolts a first pass to 50 N.m (37 lb ft).
   2. Tighten the M12 bolts a second pass to 80 N.m (59 lb ft)
   3. Tighten the M12 bolts a third pass to 60 degrees, using **J 45059** .
   4. Tighten the M12 bolts a final pass to 60 degrees, using **J 45059** .
   5. Tighten the M8 bolts to 25 N.m (18 lb ft).

6. Position the ground straps to the rear of the cylinder head, and install the bolt.

   Tighten: Tighten the bolt to 34 N.m (25 lb ft).

7. Install the glow plugs. Refer to **Glow Plug Replacement - Bank 2** .
8. Install the valve rocker arm shaft, pushrods, and valve bridges. Refer to **Valve Rocker Arm, Shaft, and Push Rod Replacement**.
9. Install the exhaust manifold. Refer to **Exhaust Manifold Replacement - Left Side (6.6L)** .
10. Install the intake manifold. Refer to **Intake Manifold Replacement - Left Side**.
11. Install the thermostat housing crossover. Refer to **Thermostat Housing Crossover Replacement (LMM)** .
12. Road test the vehicle for normal operation.
13. Inspect for coolant, oil, or exhaust leaks.

CYLINDER HEAD REPLACEMENT - RIGHT SIDE

Tools Required

J 45059 Angle Meter

Removal Procedure

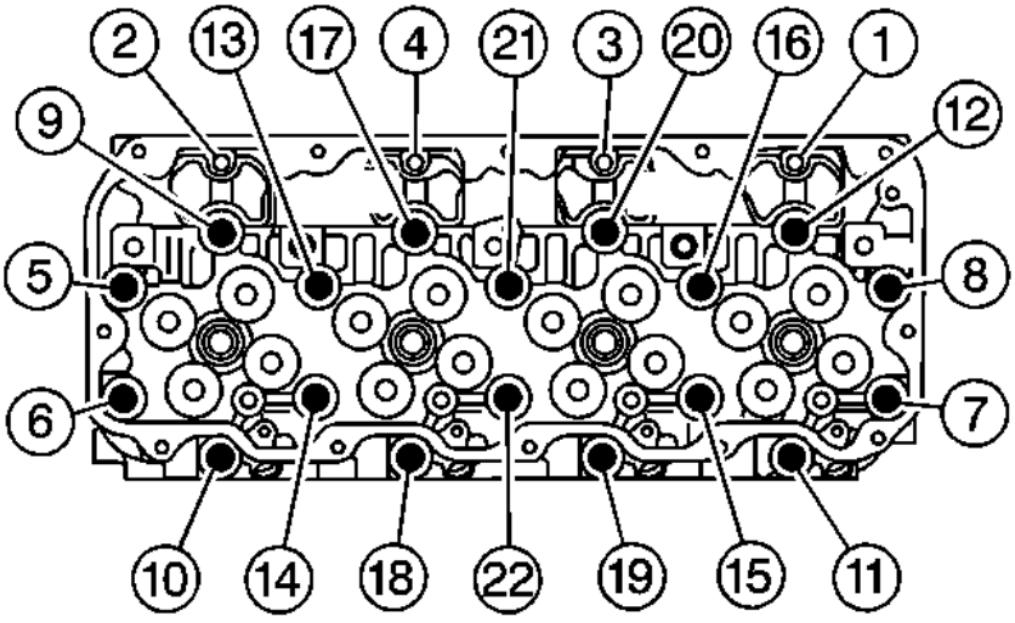


Fig. 203: Cylinder Head Bolt Removal Sequence
Courtesy of GENERAL MOTORS CORP.

1. Remove the thermostat housing crossover. Refer to **Thermostat Housing Crossover Replacement (LMM)** .
2. Remove the intake manifold. Refer to **Intake Manifold Replacement - Right Side**.
3. Remove the exhaust manifold. Refer to **Exhaust Manifold Replacement - Right Side (6.6L)** .
4. Remove the valve rocker arm shaft, pushrods, and valve bridges. Refer to **Valve Rocker Arm, Shaft, and Push Rod Replacement**.
5. Remove the glow plugs. Refer to **Glow Plug Replacement - Bank 1** .
6. Remove the cylinder head bolts in the sequence shown.
7. Discard the large M12 bolts.

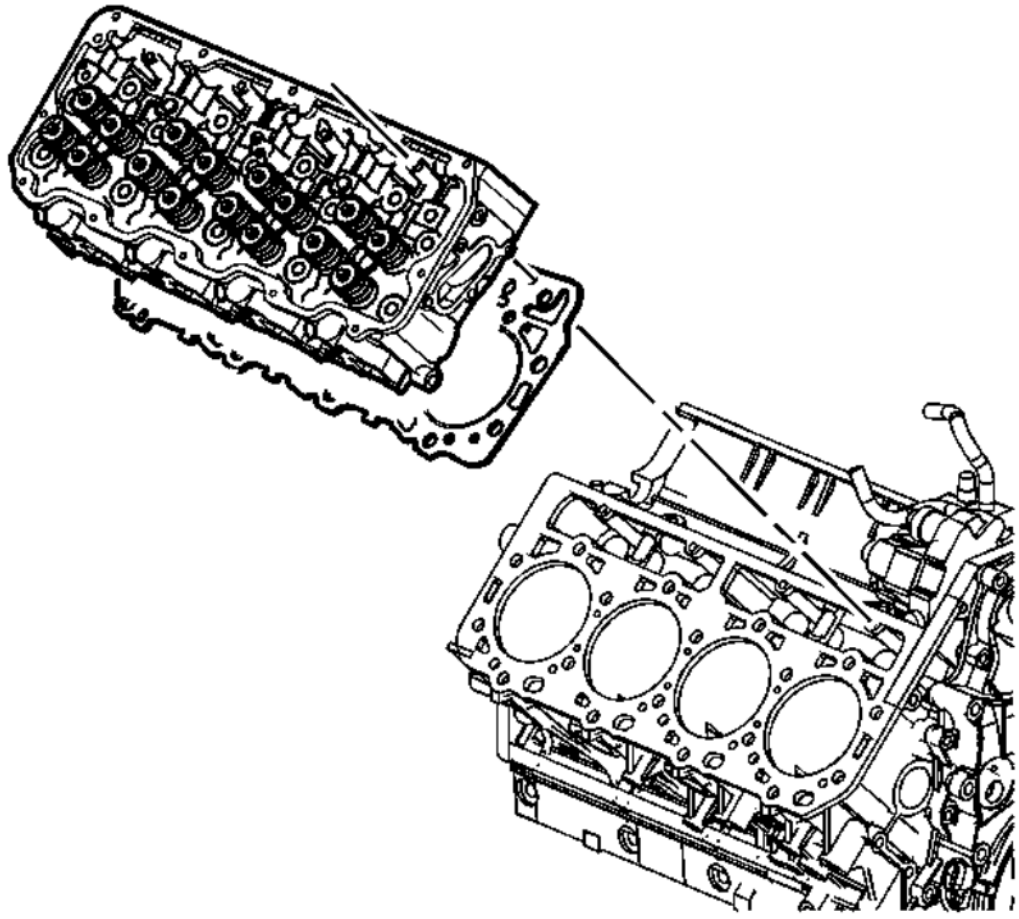


Fig. 204: View Of Cylinder Head & Gasket (Right)
Courtesy of GENERAL MOTORS CORP.

8. Remove the cylinder head.
9. Remove and discard the cylinder head gasket.
10. Clean the sealing surface of the engine block and the cylinder head.

NOTE: 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.

11. Clean the cylinder head bolt holes in the engine block.
12. For service to the cylinder head refer to the following:
    - **Cylinder Head Disassemble**
    - **Cylinder Head Cleaning and Inspection**
    - **Cylinder Head Assemble**

Installation Procedure

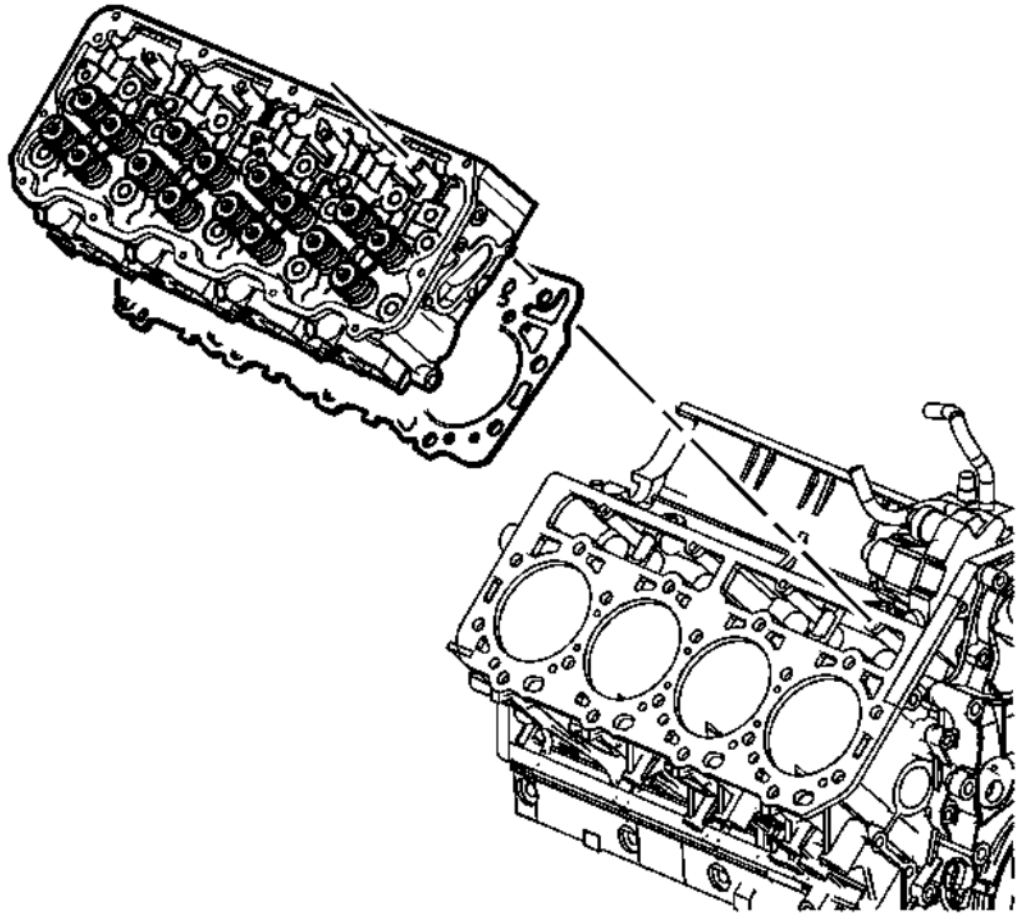


Fig. 205: View Of Cylinder Head & Gasket (Right)
Courtesy of GENERAL MOTORS CORP.

NOTE: **The left and right cylinder head gaskets are not interchangeable. Improper placement of the cylinder head gasket will block coolant and oil passages. Blocked coolant and oil passages will cause severe engine damage.**

1. Install the cylinder head gasket of the correct grade. Refer to **Cylinder Head Gasket Selection Specifications** .
2. Install the cylinder head.

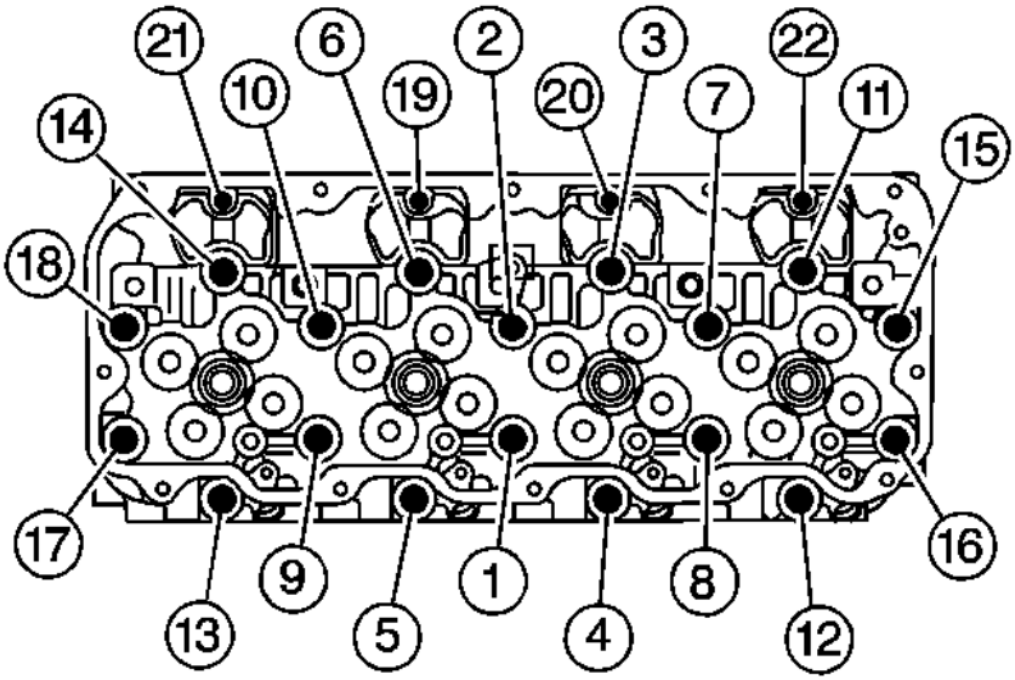


Fig. 206: Cylinder Head Bolt Installation Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: **This component uses bolts with a preapplied molybdenum disulfide coating for thread lubrication. Do not remove the coating or use any additional lubricant. Improperly lubricated threads will adversely affect the bolt torque and clamp load. Improper bolt torque and clamp load can lead to engine**

damage.

3. Install the NEW M12 cylinder head bolts.
4. Reuse the M8 cylinder head bolts.

NOTE: Refer to Fastener Notice .

5. Tighten the cylinder head bolts in the following steps using the sequence shown:

Tighten:

1. Tighten the M12 bolts a first pass to 50 N.m (37 lb ft).
2. Tighten the M12 bolts a second pass to 80 N.m (59 lb ft)
3. Tighten the M12 bolts a third pass to 60 degrees, using **J 45059** .
4. Tighten the M12 bolts a final pass to 60 degrees, using **J 45059** .
5. Tighten the M8 bolts to 25 N.m (18 lb ft).

6. Install the valve rocker arm shaft, pushrods, and valve bridges. Refer to **Valve Rocker Arm, Shaft, and Push Rod Replacement**.
7. Install the glow plugs. Refer to **Glow Plug Replacement - Bank 1** .
8. Install the right exhaust manifold. Refer to **Exhaust Manifold Replacement - Right Side (6.6L)** .
9. Install the right intake manifold. Refer to **Intake Manifold Replacement - Right Side**.
10. Install the thermostat housing crossover. Refer to **Thermostat Housing Crossover Replacement (LMM)** .
11. Road test the vehicle for normal operation.
12. Inspect for coolant, oil, or exhaust leaks.

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT

Tools Required

- **J 26999** Compression Gage. See **Special Tools** .
- **J 26999-20** Compression Gage Adapter
- **J 44646** Valve Spring Compressor. See **Special Tools** .
- **J 44640** Valve Stem Seal Installer. See **Special Tools** .

Removal Procedure

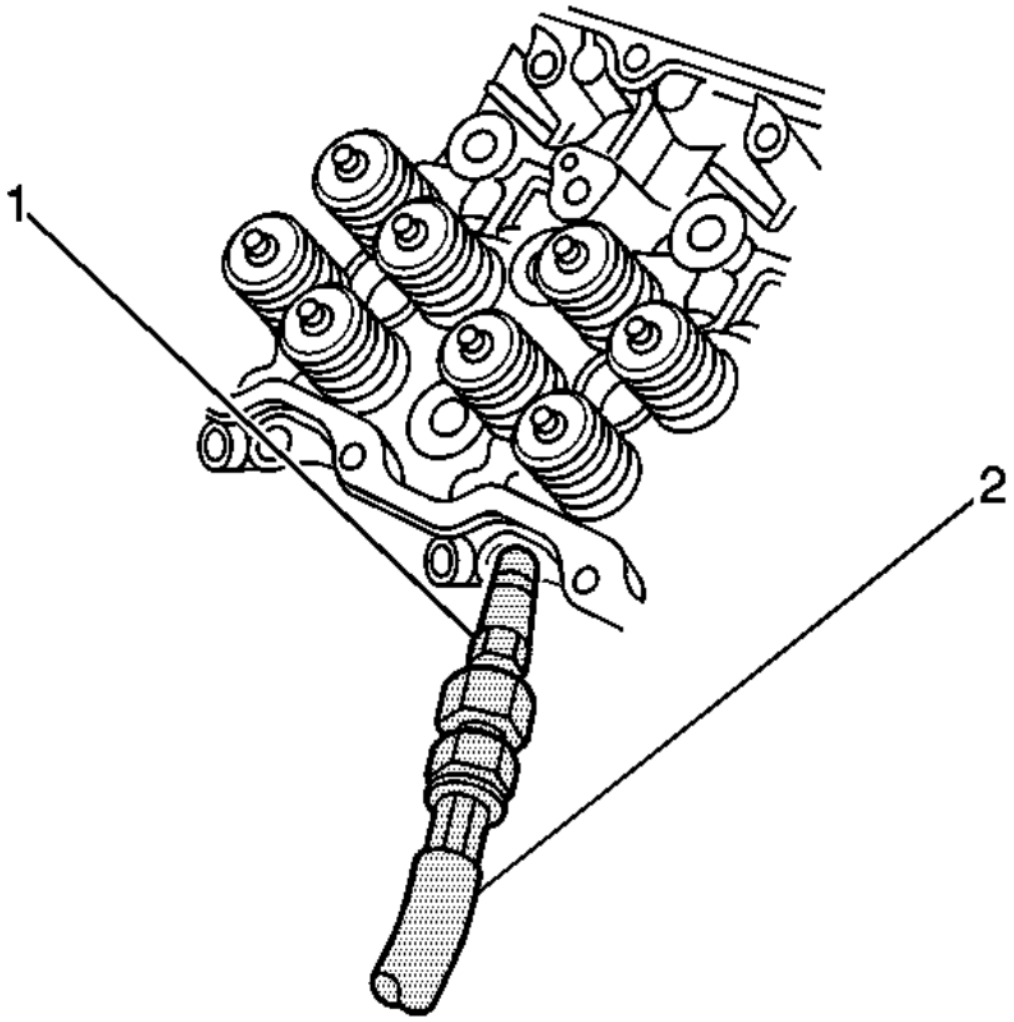


Fig. 207: View Of J 26999-20 & J 26999
Courtesy of GENERAL MOTORS CORP.

1. Remove the upper and lower fan shroud. Refer to **Engine Coolant Fan Lower Shroud Replacement (Mechanical)** and **Engine Coolant Fan Upper Shroud Replacement (Mechanical)** or **Engine Coolant Fan Upper Shroud Replacement (Automatic Transmission - Diesel)** .
2. Remove the valve rocker arm shaft, valve bridges, and pushrods for the cylinder head being serviced. Refer to **Valve Rocker Arm, Shaft, and Push Rod Replacement**.

3. Remove the glow plug for the cylinder requiring service. Refer to **Glow Plug Replacement - Bank 1** or **Glow Plug Replacement - Bank 2** .
4. In order to apply shop air to the cylinders use the following procedures to modify **J 26999-20** (1) and **J 26999** (2):. See **Special Tools** .
    1. Remove the valve core from **J 26999-20** to allow air to flow.
    2. Remove the quick connect fitting from **J 26999** . See **Special Tools** .
    3. Adapt the quick connect fitting in order to use for shop air.
    4. Connect the quick connect fitting to **J 26999-20** .

IMPORTANT: Rotate the cylinder to be serviced to the bottom of the stroke. This is to ensure that the engine does not rotate when the compressed air is applied to the cylinder being serviced.

5. Install **J 26999-20** into the glow plug hole for the cylinder being serviced.
6. Apply compressed air to hold the valves in place. If the compressed air is released, the valves can drop into the cylinder.

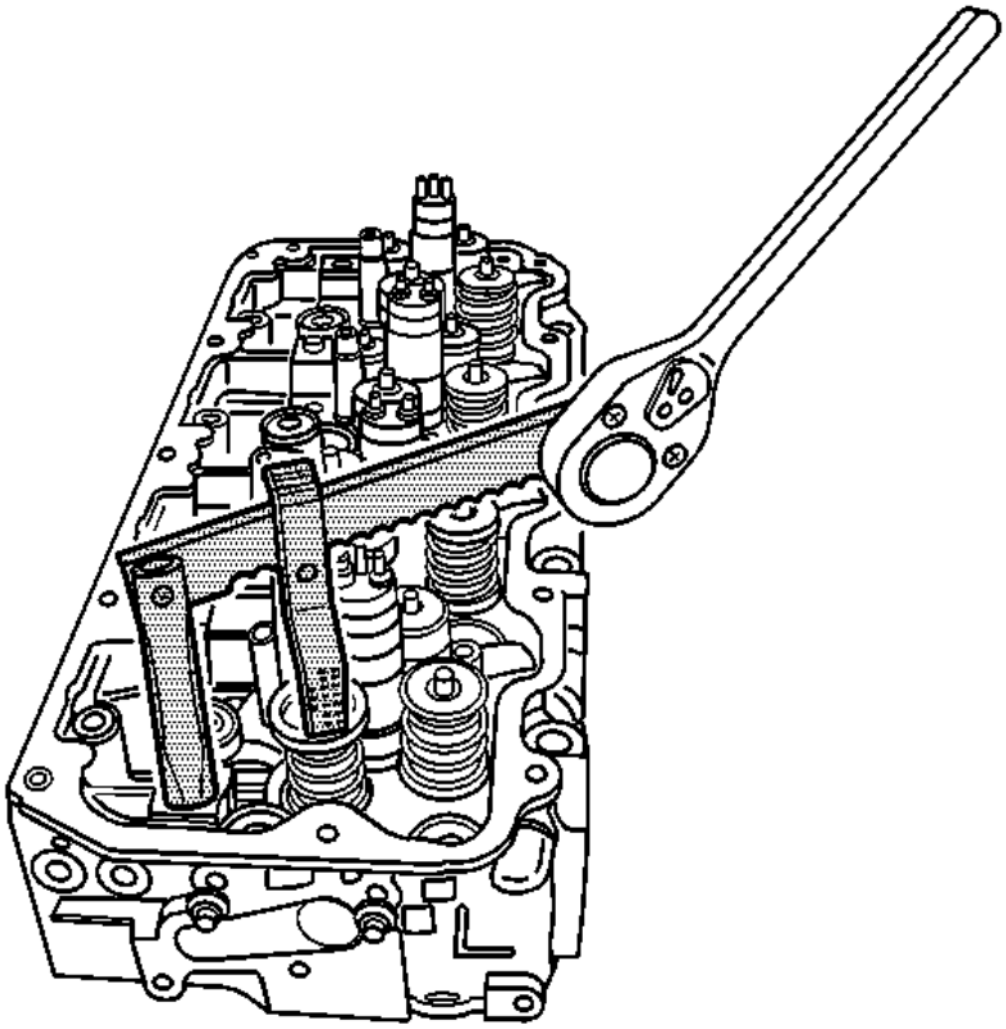


Fig. 208: Compressing Valve Spring Using J 44646
Courtesy of GENERAL MOTORS CORP.

CAUTION: Compressed valve springs have high tension against the valve spring compressor. Valve springs that are not properly compressed by or released from the valve spring compressor can be ejected from the valve spring compressor with intense force. Use care when compressing or releasing the valve spring with the valve

spring compressor and when removing or installing the valve stem keys. Failing to use care may cause personal injury.

7. Install **J 44646** to the rocker arm bosses on the cylinder head. See **Special Tools** .

   J 44646 should be installed in the rocker arm boss next to the cylinder being serviced. See **Special Tools** . The pivot pin can be removed from the stand to allow the stand to be installed. The lever has different locating holes for the pivot pin depending on available clearance. The lever is also notched for different locations of the compressor.

8. Using **J 44646** compress the valve spring. See **Special Tools** .

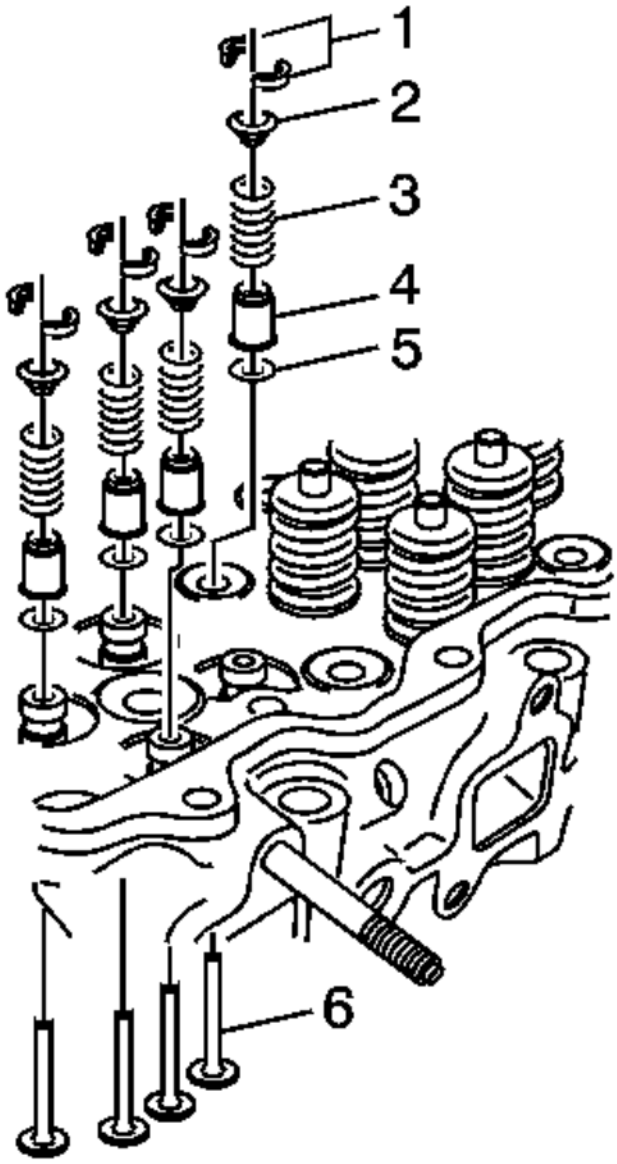


Fig. 209: View Of Valve Stem Oil Seal & Valve Spring
Courtesy of GENERAL MOTORS CORP.

9. Remove the valve keys (1) from the valve stem.
10. Carefully release the valve spring tension.

11. Remove the valve spring upper seat (2) and the valve spring (3).
12. Remove the valve stem oil seal (4).
13. Remove the valve spring lower seat (5).
14. Continue removing the remaining valve stem seals for the cylinder using the above procedure.

Installation Procedure

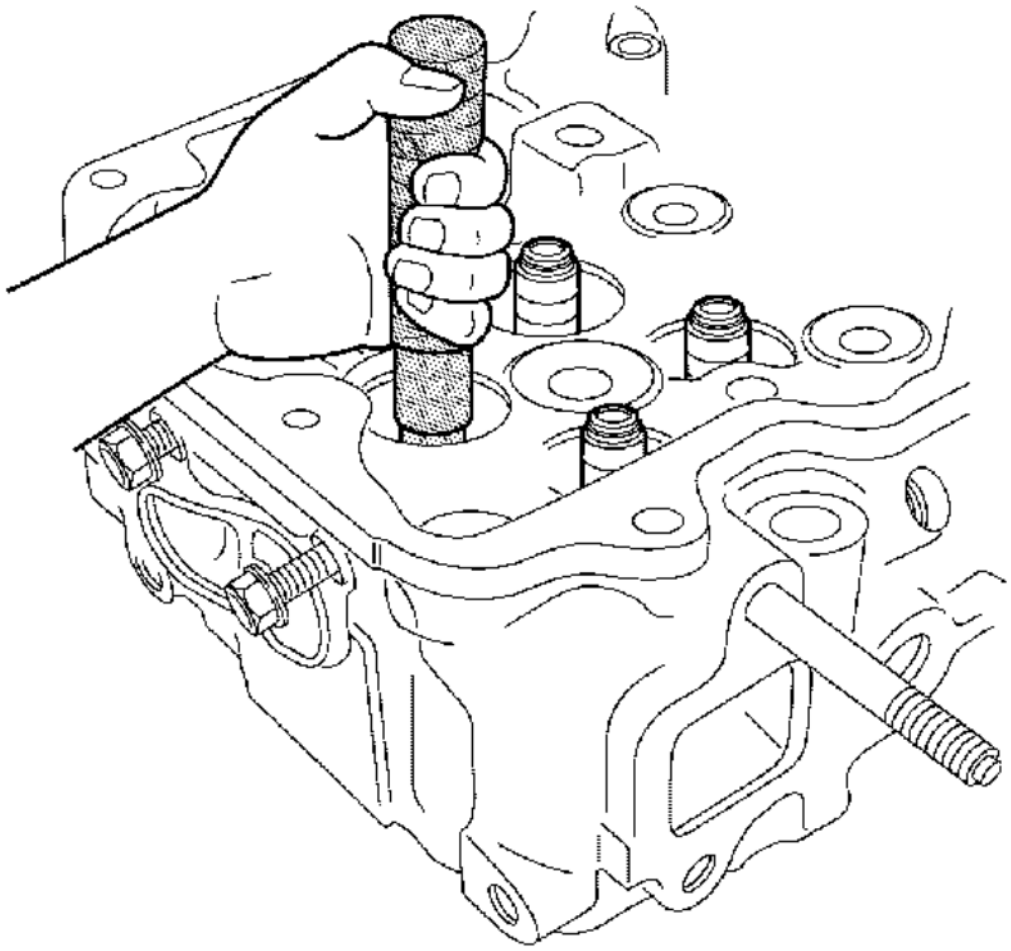


Fig. 210: Installing Valve Stem Using J 44640
Courtesy of GENERAL MOTORS CORP.

NOTE: Air pressure should remain applied to the cylinder for installation.

1. Install the valve spring lower seat.
2. Install the valve stem seal using **J 44640** . See **Special Tools** .

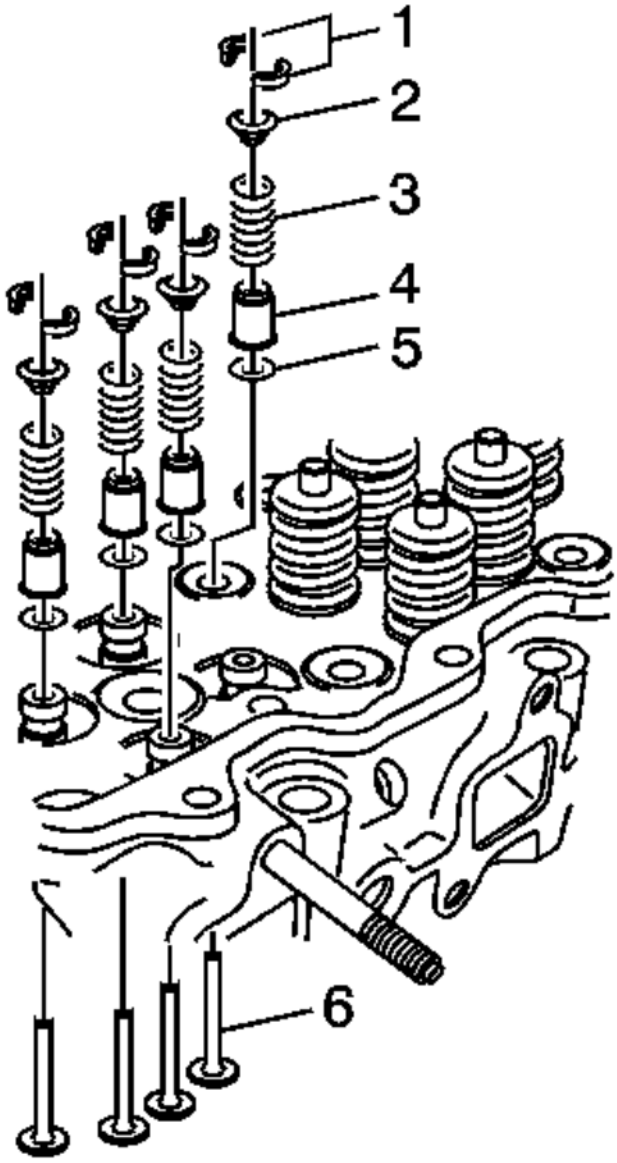


Fig. 211: View Of Valve Stem Oil Seal & Valve Spring
Courtesy of GENERAL MOTORS CORP.

3. Install the valve spring (3), the painted end of the valve spring goes toward the cylinder head.

4. Install the valve spring upper seat (2).

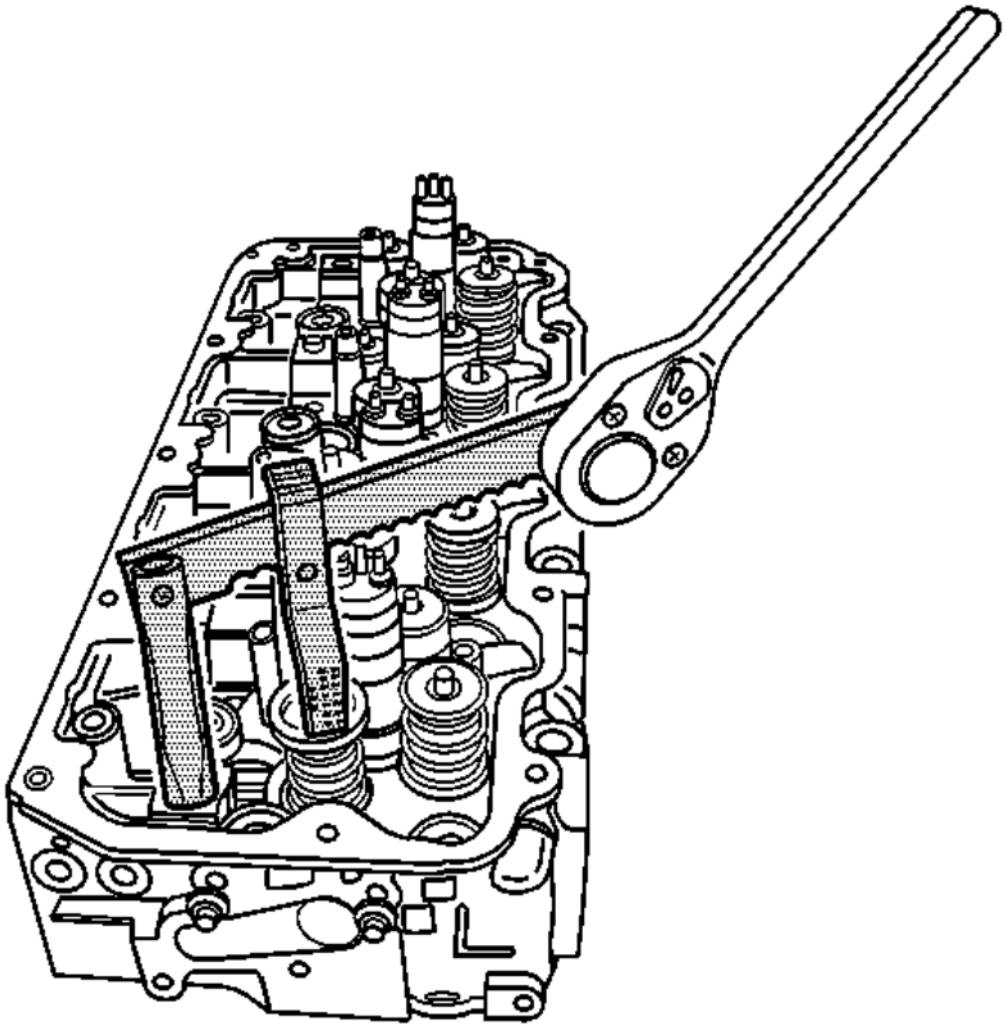


Fig. 212: Compressing Valve Spring Using J 44646
Courtesy of GENERAL MOTORS CORP.

CAUTION: Compressed valve springs have high tension against the valve spring compressor. Valve springs that are not properly compressed by or released from the valve spring compressor can be ejected from the valve spring

compressor with intense force. Use care when compressing or releasing the valve spring with the valve spring compressor and when removing or installing the valve stem keys. Failing to use care may cause personal injury.

5. Using **J 44646** compress the valve spring. See **Special Tools** .
6. Install the valve keys to the valve stem.

NOTE: The valve stem keys must correctly seat in the valve spring cap. Engine damage may occur by not installing properly.

7. Carefully release the valve spring pressure. Make sure the valve keys stay in place.
8. Continue to install the 3 remaining valve stem seals for the cylinder.

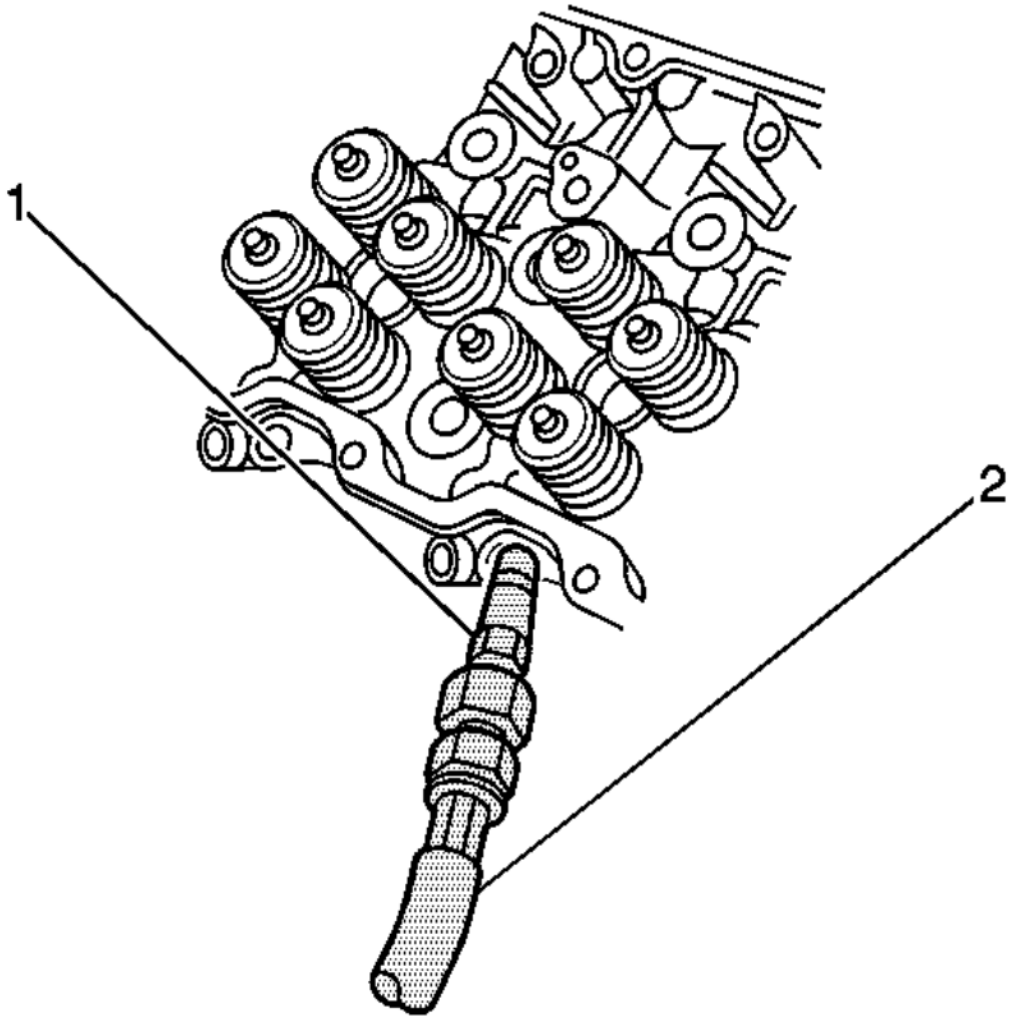


Fig. 213: View Of J 26999-20 & J 26999
Courtesy of GENERAL MOTORS CORP.

9. Release the compressed air holding the valves in place.
10. Remove **J 26999-20** (1) from the glow plug hole.
11. Continue to replace the valve stem seals on the remaining cylinders using the above procedures.
12. Install the glow plug. Refer to **Glow Plug Replacement - Bank 1** or **Glow Plug Replacement - Bank 2** .

13. Install the valve rocker arm shaft, the valve bridges, and the push rods. Refer to **Valve Rocker Arm, Shaft, and Push Rod Replacement**.
14. Install the upper and lower fan shroud. Refer to **Engine Coolant Fan Lower Shroud Replacement (Mechanical)** and **Engine Coolant Fan Upper Shroud Replacement (Mechanical)** or **Engine Coolant Fan Upper Shroud Replacement (Automatic Transmission - Diesel)** .

VALVE LIFTER REPLACEMENT

Removal Procedure

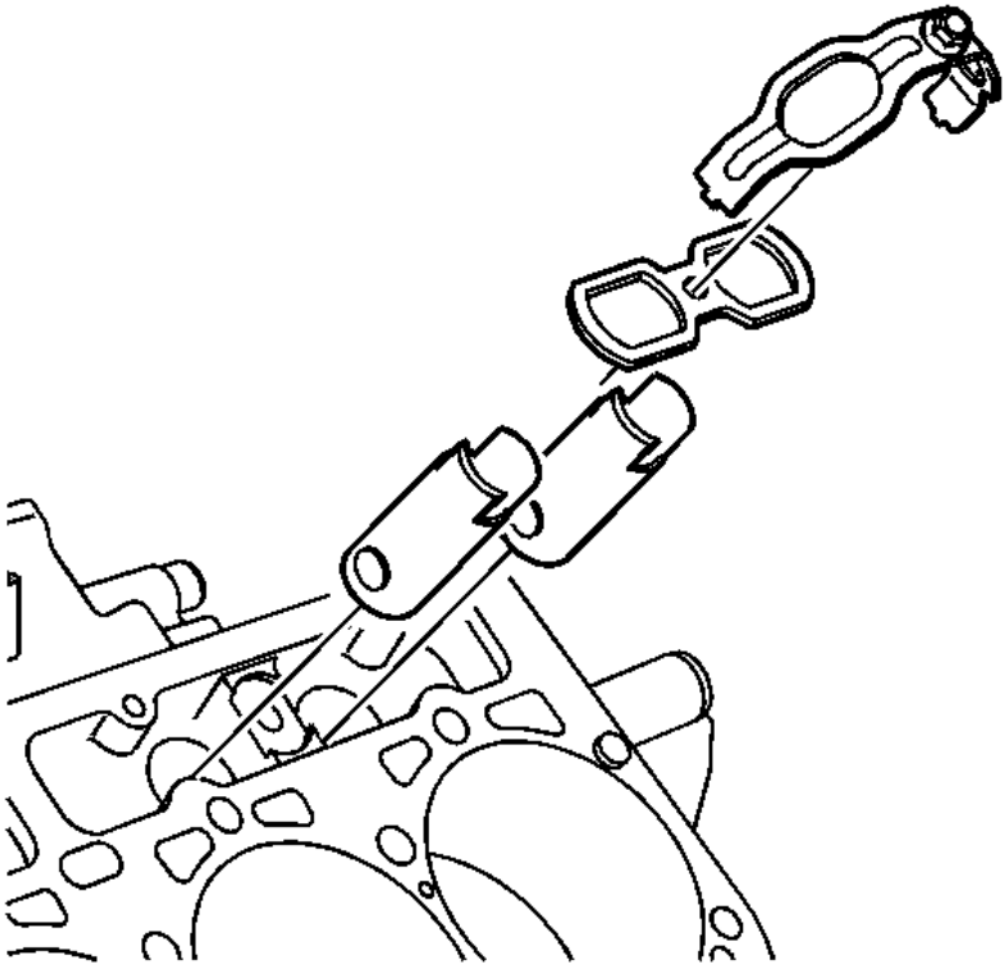


Fig. 214: View Of Valve Lifter, Guides, Retainers & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the cylinder head. Refer to **Cylinder Head Replacement - Left Side** or **Cylinder Head Replacement - Right Side**.
2. Loosen the valve lifter guide retainer bolts.
3. Remove the valve lifter guide retainers.
4. Remove the valve lifter guides.
5. Remove the valve lifters.
6. If required, clean and inspect the lifters. Refer to **Valve Lifters Cleaning and Inspection** .

Installation Procedure

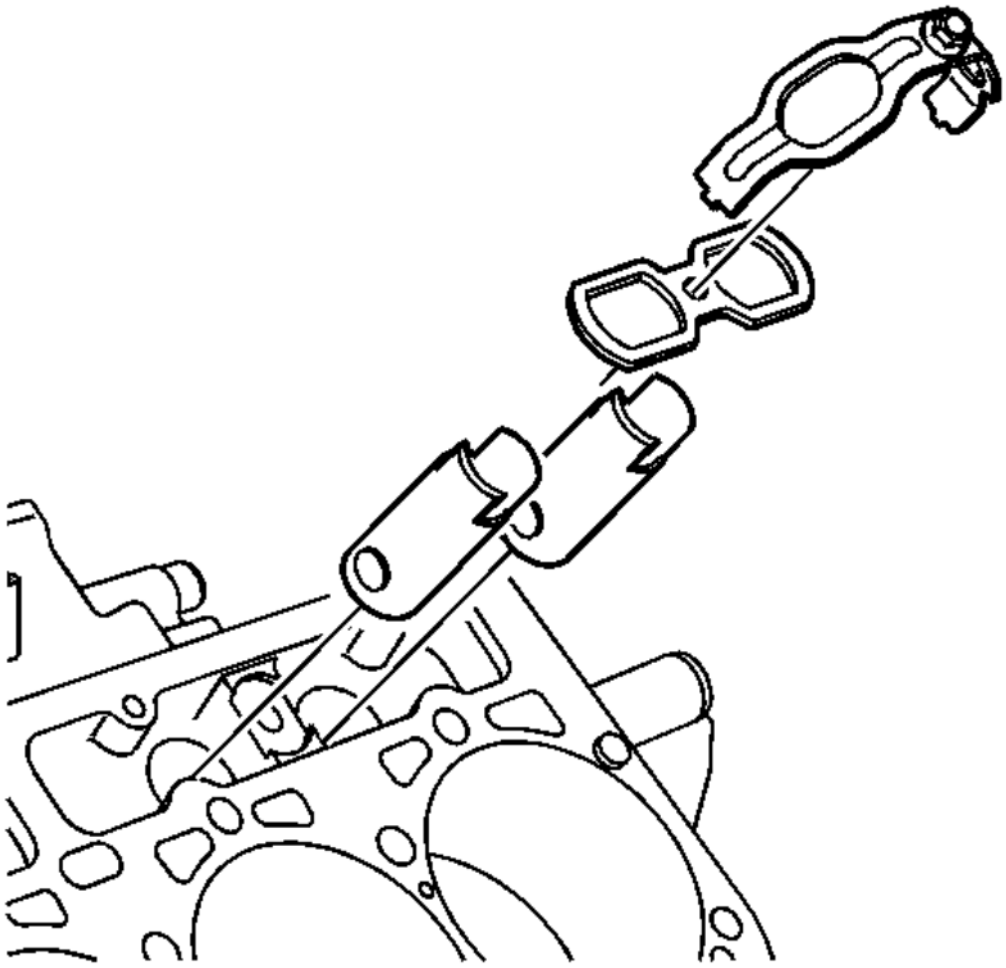


Fig. 215: View Of Valve Lifter, Guides, Retainers & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Apply clean engine oil to the roller and outside of the valve lifter.
2. Install the valve lifter.
3. Install the valve lifter guides.
4. Install the valve lifter guide retainer.

NOTE: Refer to Fastener Notice .

5. Install the valve lifter guide retainer bolt.

   Tighten: Tighten the bolt to 11 N.m (97 lb in).

6. Install the cylinder head. Refer to **Cylinder Head Replacement - Left Side** or **Cylinder Head Replacement - Right Side**.

CRANKSHAFT BALANCER REPLACEMENT

Tools Required

J 44643 Flywheel Holding Tool. See **Special Tools** .

Removal Procedure

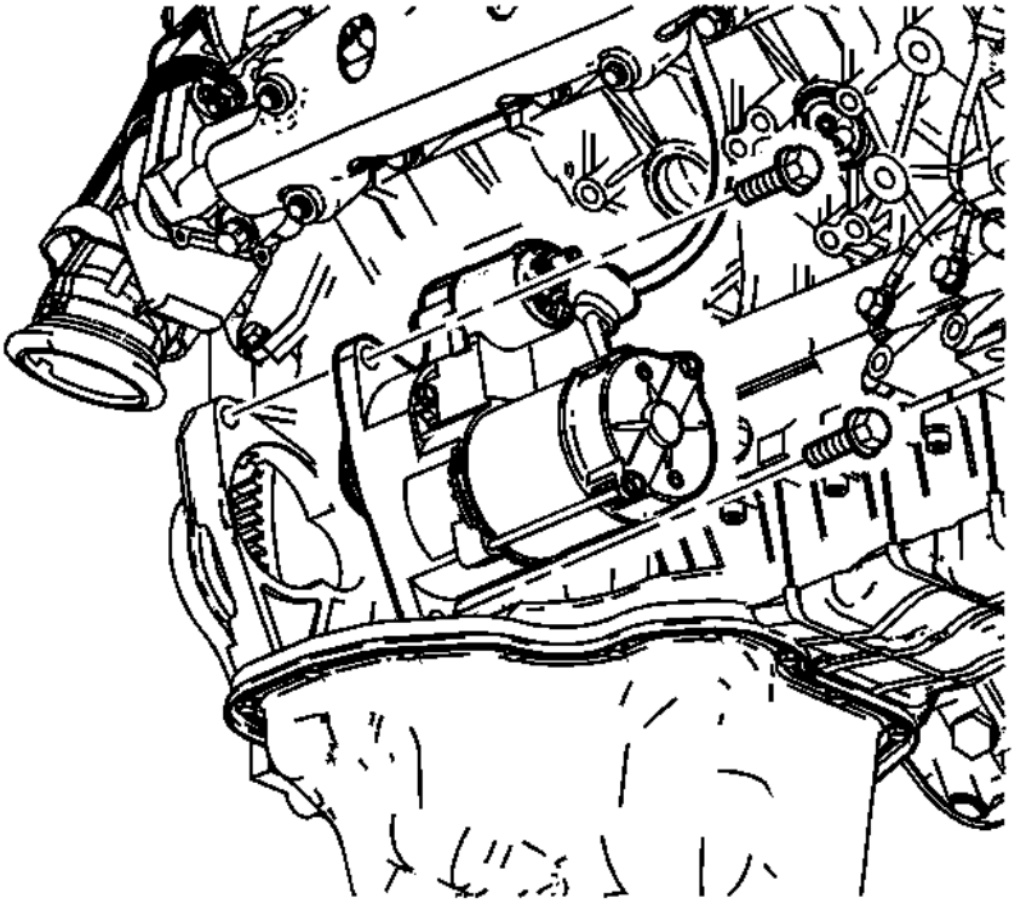


Fig. 216: View Of Starter
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (w/Single Battery)** or **Battery Negative Cable Disconnection and Connection (w/Auxiliary Battery)** or **Battery Negative Cable Disconnection and Connection (w/Dual Batteries)** .
2. Remove the right wheelhouse panel. Refer to **Front Wheelhouse Liner Replacement - Right Side (GMC)** or **Front Wheelhouse Liner Replacement - Right Side (Chevrolet)** .
3. Remove the starter motor bolts. Reposition the starter aside. The wiring to the starter does not require removal.

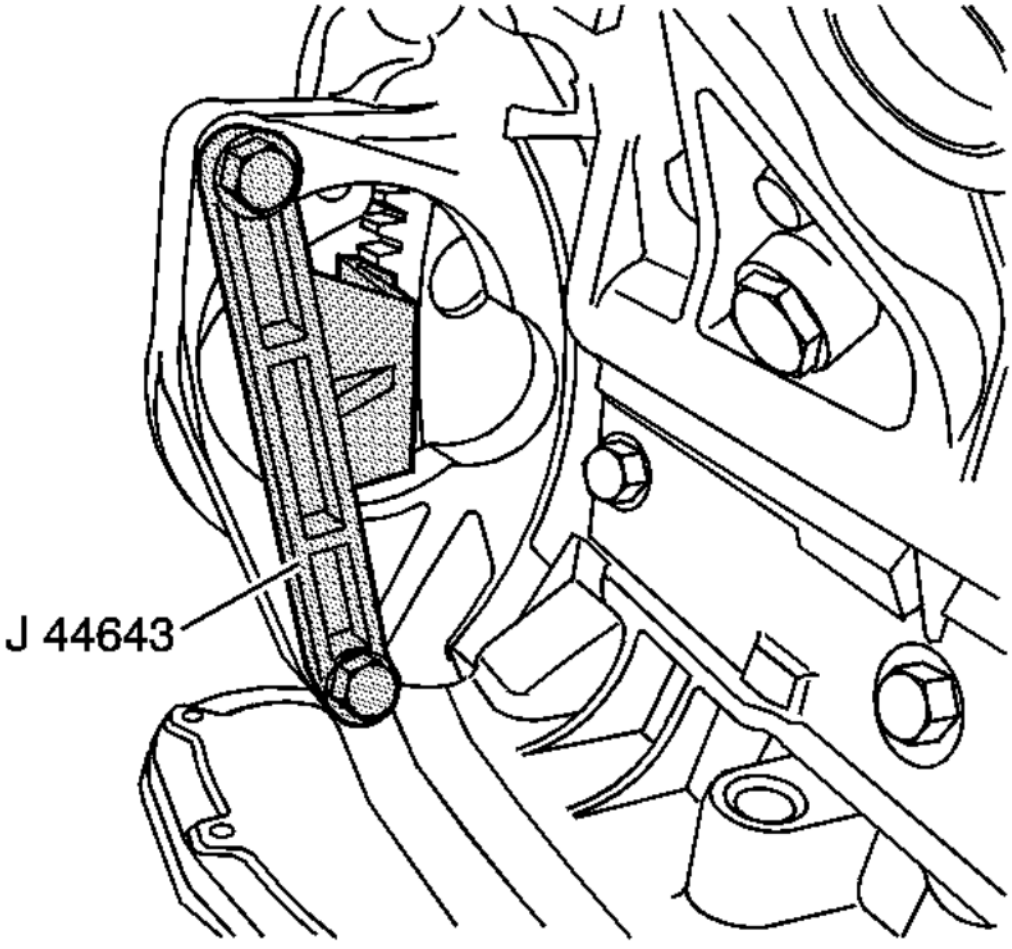


Fig. 217: Locking Flywheel Using J 44643
Courtesy of GENERAL MOTORS CORP.

4. Install **J 44643** in order to hold the flywheel. See **Special Tools** .
5. Remove the lower fan shroud. Refer to **Engine Coolant Fan Lower Shroud Replacement (Mechanical)** .

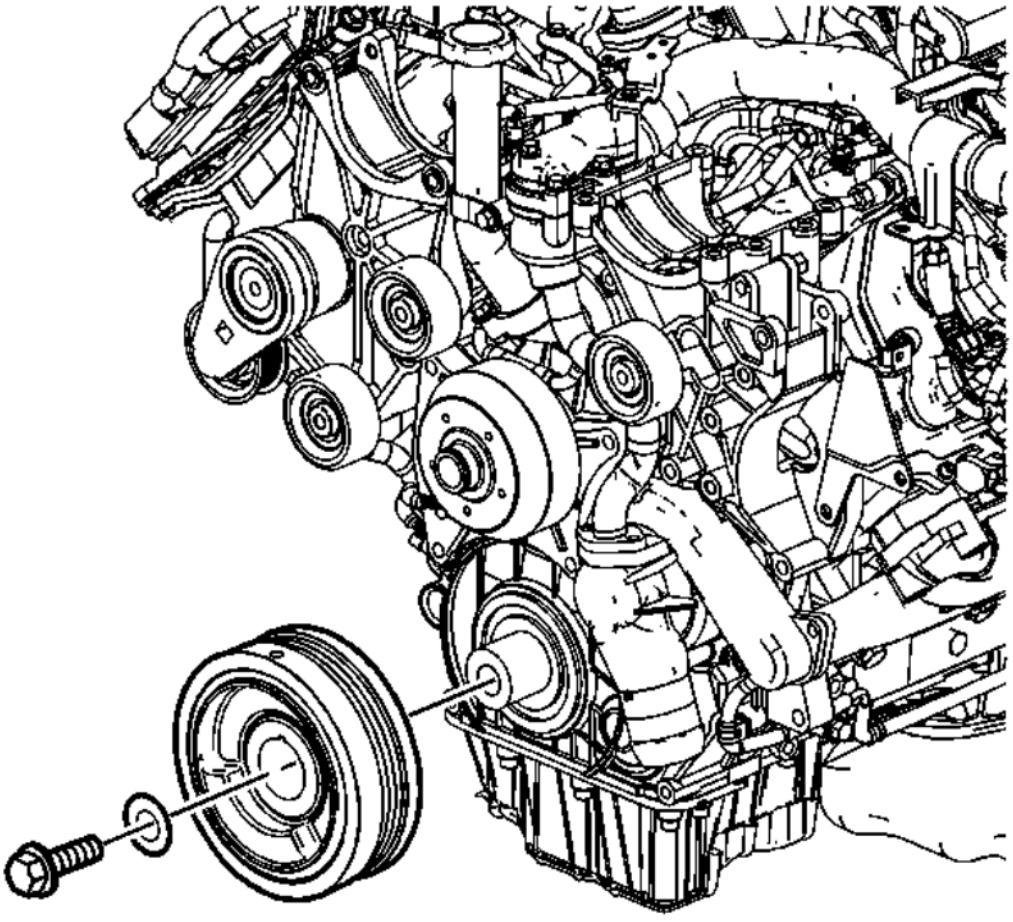


Fig. 218: View Of Crankshaft Balancer & Bolt
Courtesy of GENERAL MOTORS CORP.

6. Remove the crankshaft balancer bolt.
7. Remove the crankshaft balancer.
8. If required, clean and inspect the crankshaft balancer. Refer to **Crankshaft Balancer Cleaning and Inspection** .

Installation Procedure

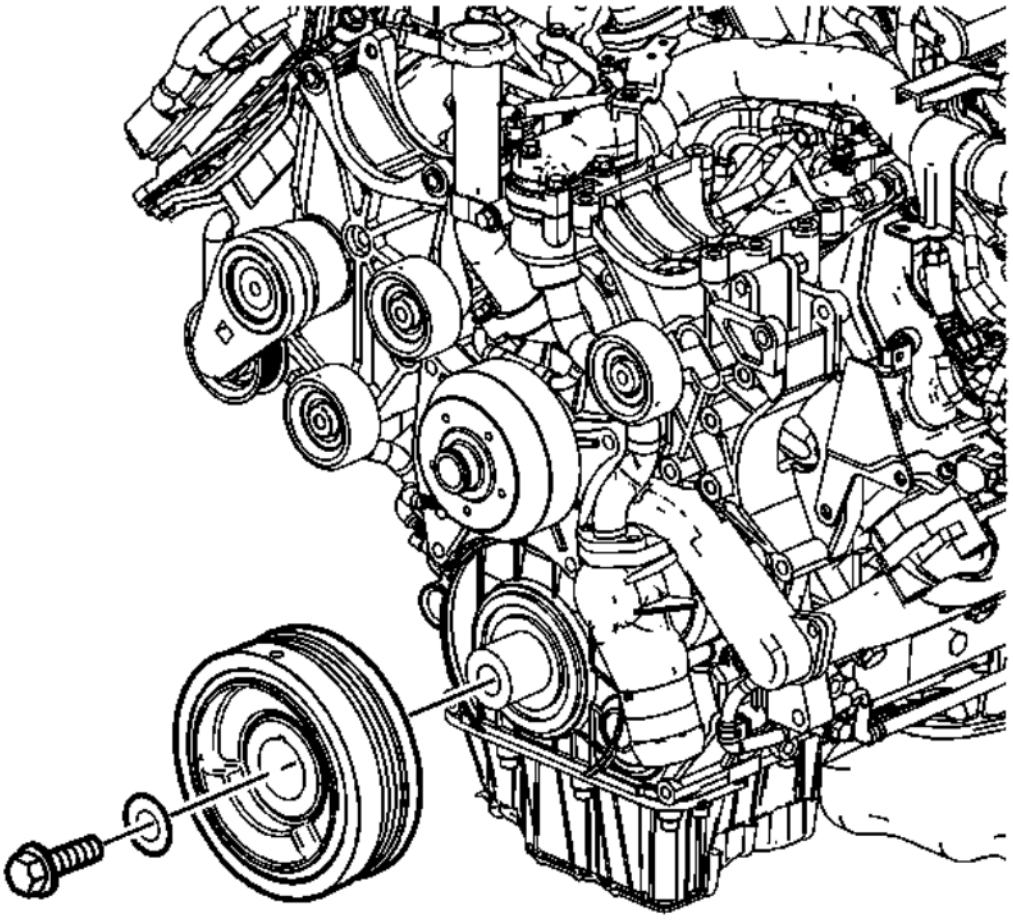


Fig. 219: View Of Crankshaft Balancer & Bolt
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the crankshaft balancer internal hub with clean engine oil.
2. Install the crankshaft balancer on the crankshaft.
3. Lubricate the crankshaft balancer bolt with clean engine oil.

NOTE: Refer to Fastener Notice .

4. Install the crankshaft balancer bolt and washer.

Tighten: Tighten the bolt to 353 N.m (260 lb ft).

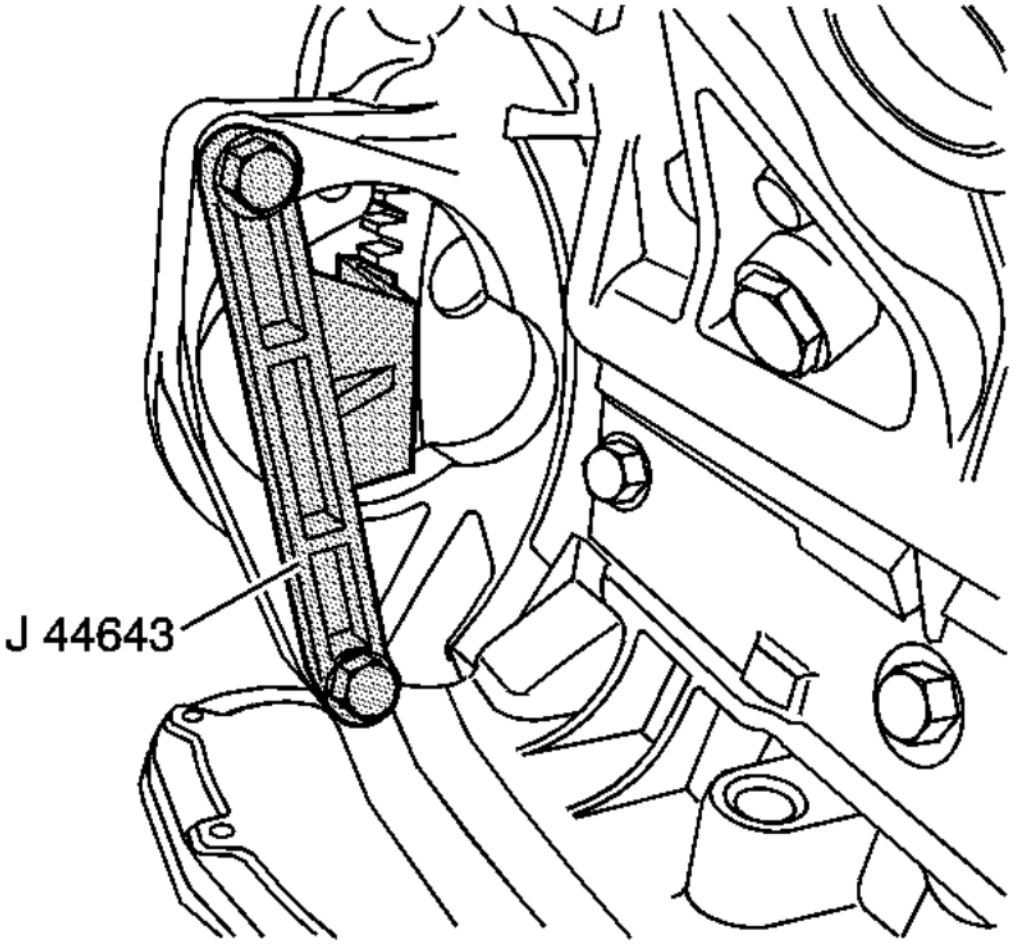


Fig. 220: Locking Flywheel Using J 44643
Courtesy of GENERAL MOTORS CORP.

5. Remove **J 44643** . See **Special Tools** .

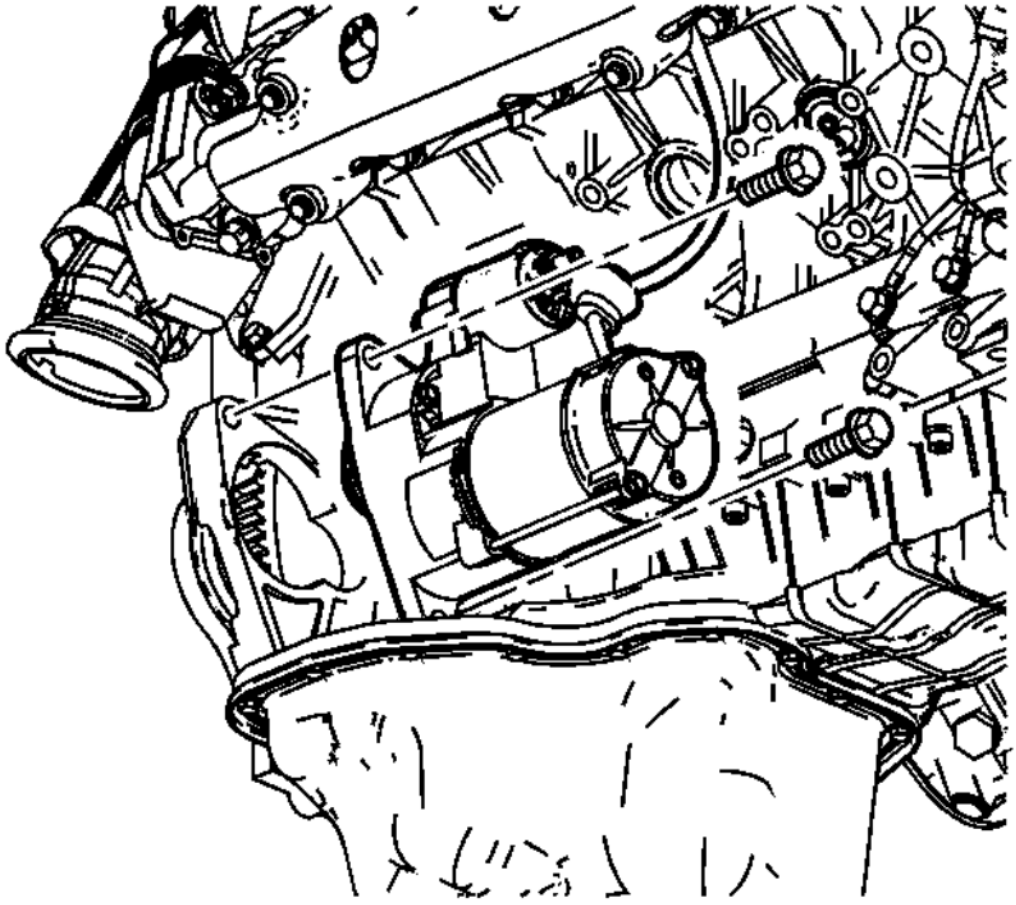


Fig. 221: View Of Starter
Courtesy of GENERAL MOTORS CORP.

6. Position the starter motor.
7. Install the starter motor bolts.

   Tighten: Tighten the bolts to 78 N.m (58 lb ft).

8. Install the right wheelhouse panel. Refer to **Front Wheelhouse Liner Replacement - Right Side (GMC)** or **Front Wheelhouse Liner Replacement - Right Side (Chevrolet)** .
9. Install the lower fan shroud. Refer to **Engine Coolant Fan Lower Shroud Replacement**

(Mechanical) .

10. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (w/Single Battery)** or **Battery Negative Cable Disconnection and Connection (w/Auxiliary Battery)** or **Battery Negative Cable Disconnection and Connection (w/Dual Batteries)** .

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

Tools Required

- **J 44644** Crankshaft Front Oil Seal Remover. See **Special Tools** .
- **J 44645** Crankshaft Front Oil Seal Installer. See **Special Tools** .

Removal Procedure

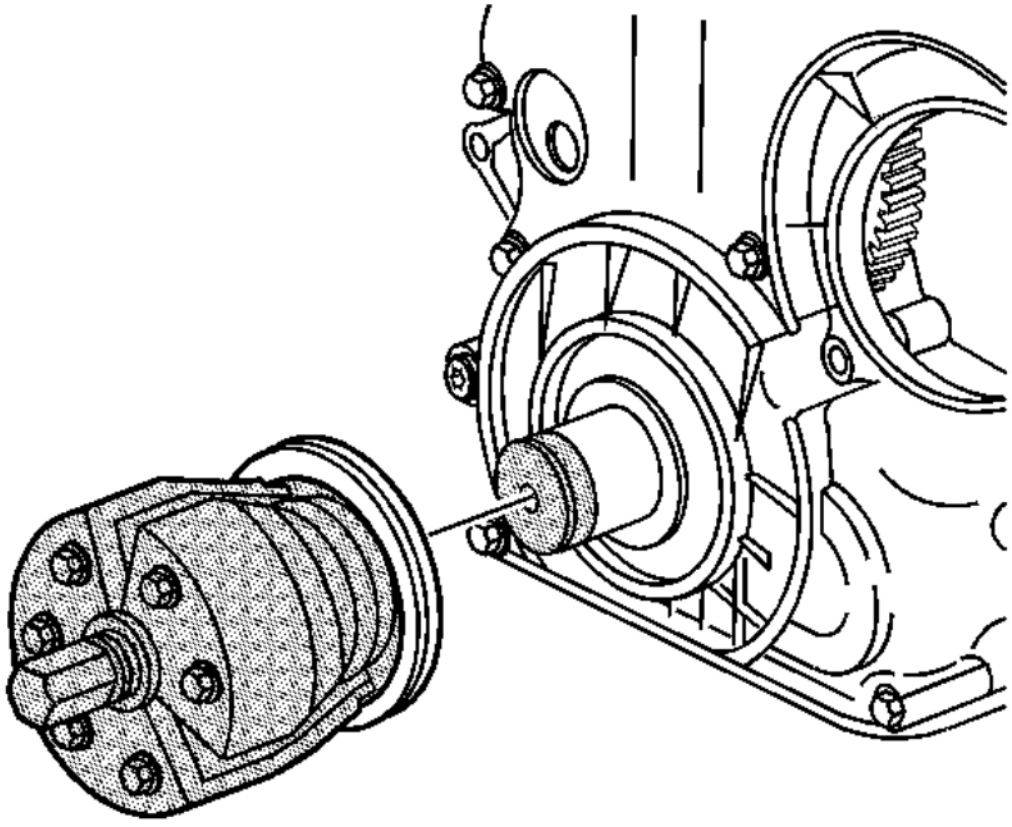


Fig. 222: Removing Crankshaft Front Oil Seal Using J 44644
Courtesy of GENERAL MOTORS CORP.

1. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
2. Install **J 44644** to the crankshaft front oil seal. See **Special Tools** . The jaws of the **J 44644** fit into the inner sleeve. See **Special Tools** .
3. Using **J 44644** , remove the crankshaft front oil seal. See **Special Tools** .

Installation Procedure

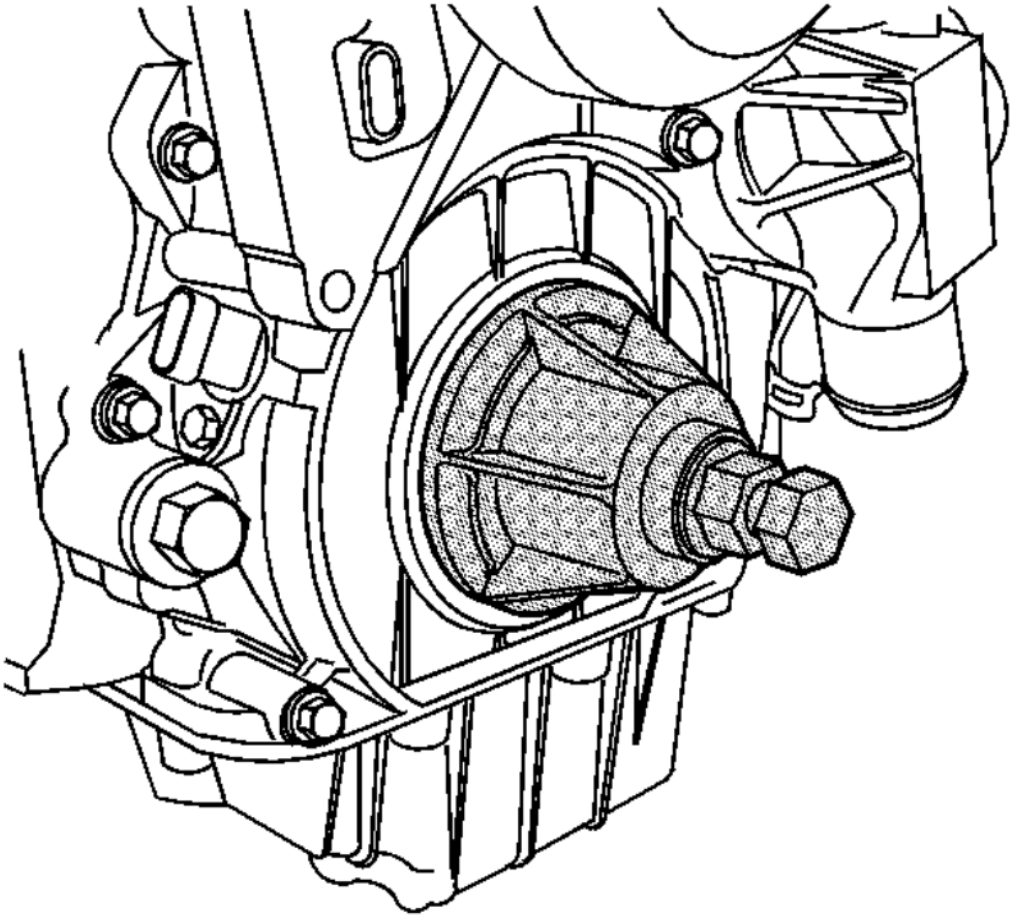


Fig. 223: Pressing Crankshaft Front Oil Seal On Using J 44645
Courtesy of GENERAL MOTORS CORP.

1. Clean the front crankshaft seal bore and the crankshaft.
2. Lubricate the crankshaft sealing surface with clean engine oil.
3. Place the crankshaft front oil seal onto the crankshaft.
4. Install **J 44645** to the crankshaft. See **Special Tools** .
5. Press the crankshaft front oil seal onto the crankshaft using **J 44645** until the tool bottoms out. See **Special Tools** .
6. Remove **J 44645** . See **Special Tools** .

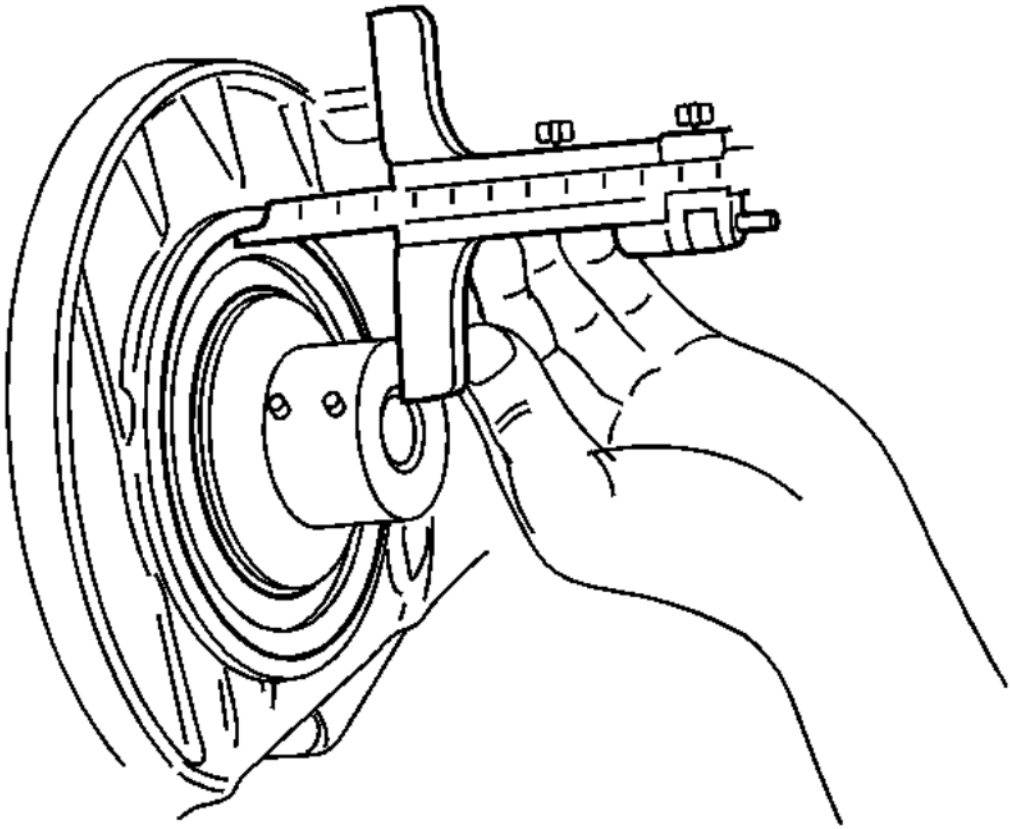


Fig. 224: Measuring Distance Between Crankshaft End & Oil Seal
Courtesy of GENERAL MOTORS CORP.

7. Measure the distance between the end of the crankshaft and the oil seal.
8. The service measurement is 43.45-44.05 mm (1.7106-1.7342 in).

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

ENGINE FRONT COVER REPLACEMENT

Tools Required

J 37228 Seal Cutter. See **Special Tools** .

Removal Procedure

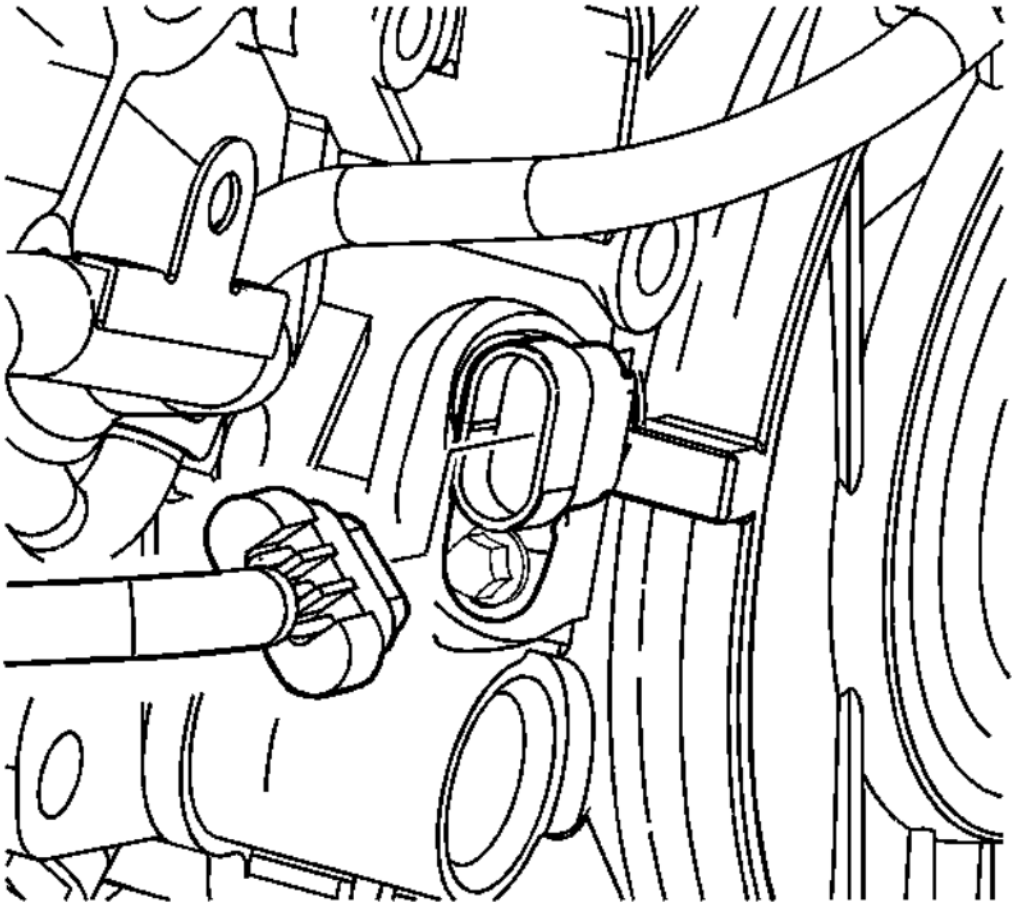


Fig. 225: View Of Crankshaft Position Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection**

and Connection (w/Single Battery) or **Battery Negative Cable Disconnection and Connection (w/Auxiliary Battery)** or **Battery Negative Cable Disconnection and Connection (w/Dual Batteries)** .

2. Remove the water pump. Refer to **Water Pump Replacement (LMM)** .
3. Remove the crankshaft front oil seal. Refer to **Crankshaft Front Oil Seal Replacement**.
4. Remove the right wheelhouse panel. Refer to **Front Wheelhouse Liner Replacement - Right Side (GMC)** or **Front Wheelhouse Liner Replacement - Right Side (Chevrolet)** .
5. Disconnect the crankshaft position (CKP) sensor electrical connector.

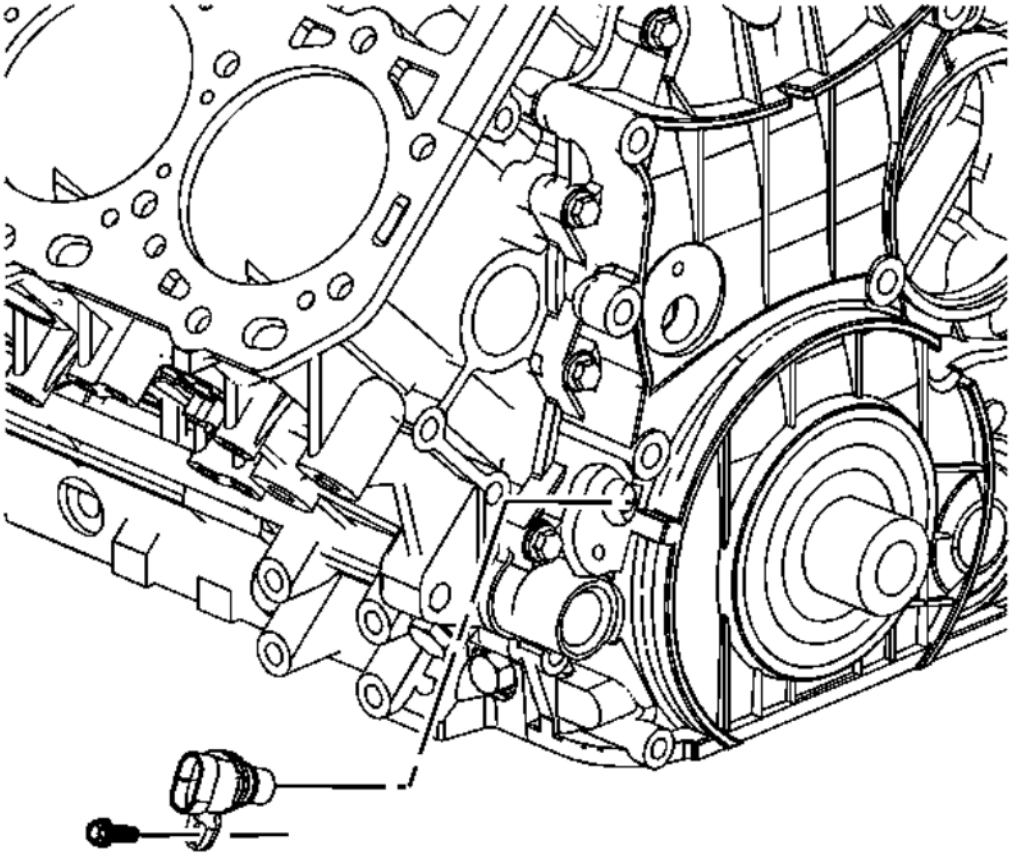


Fig. 226: View Of CKP Sensor & Bolt
Courtesy of GENERAL MOTORS CORP.

6. Remove the CKP sensor bolt and sensor.
7. Remove the CKP sensor spacer bolts and spacer.
8. Remove and discard the O-rings from the sensor and the spacer.

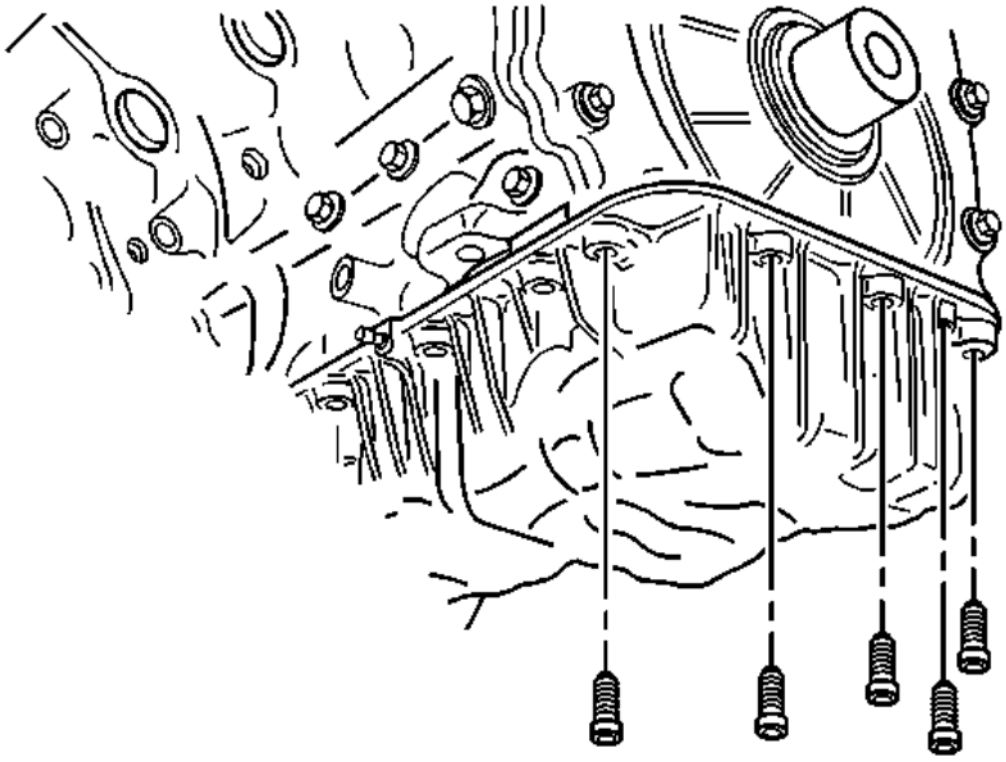


Fig. 227: View Of Upper Oil Pan To Engine Front Cover Bolts
Courtesy of GENERAL MOTORS CORP.

9. Remove the upper oil pan to engine front cover bolts.

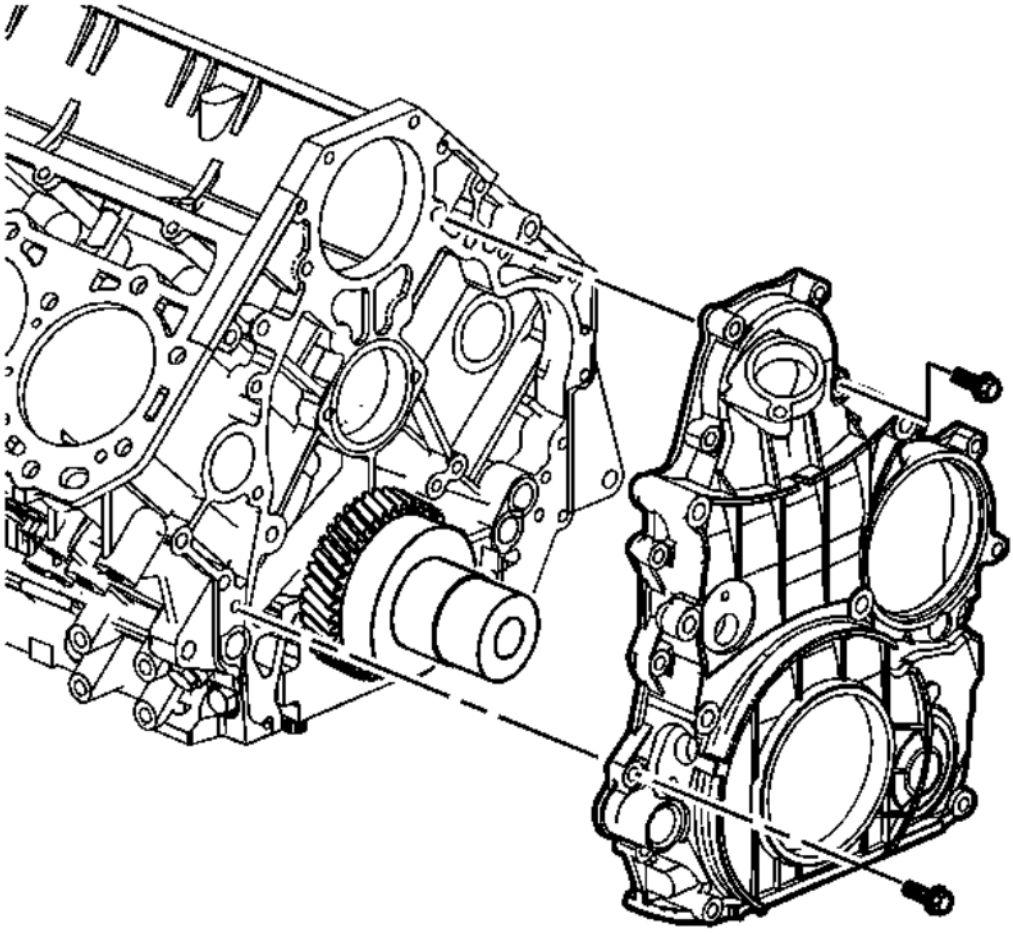


Fig. 228: View Of Engine Front Cover
Courtesy of GENERAL MOTORS CORP.

10. Remove the engine front cover bolts.
11. Separate the engine front cover from the cylinder block and upper oil pan using **J 37228** . See **Special Tools** .

IMPORTANT: Do not bend the turbocharger coolant pipe.

12. Remove the engine front cover.

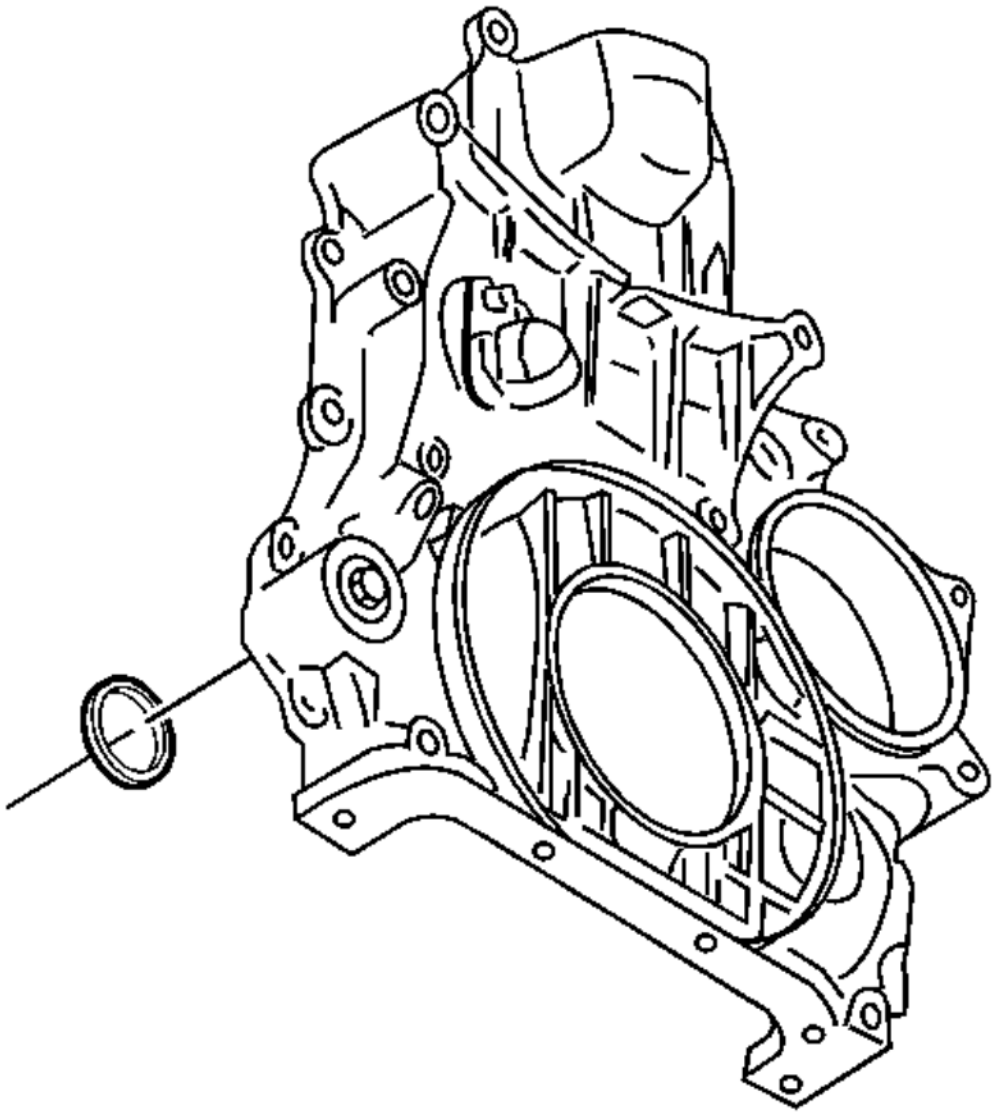


Fig. 229: View Of Pressure Relief Valve O-Ring
Courtesy of GENERAL MOTORS CORP.

13. If necessary, remove the pressure relief valve O-ring.
14. Clean and inspect the front cover. Refer to **Engine Front Cover Cleaning and Inspection** .

Installation Procedure

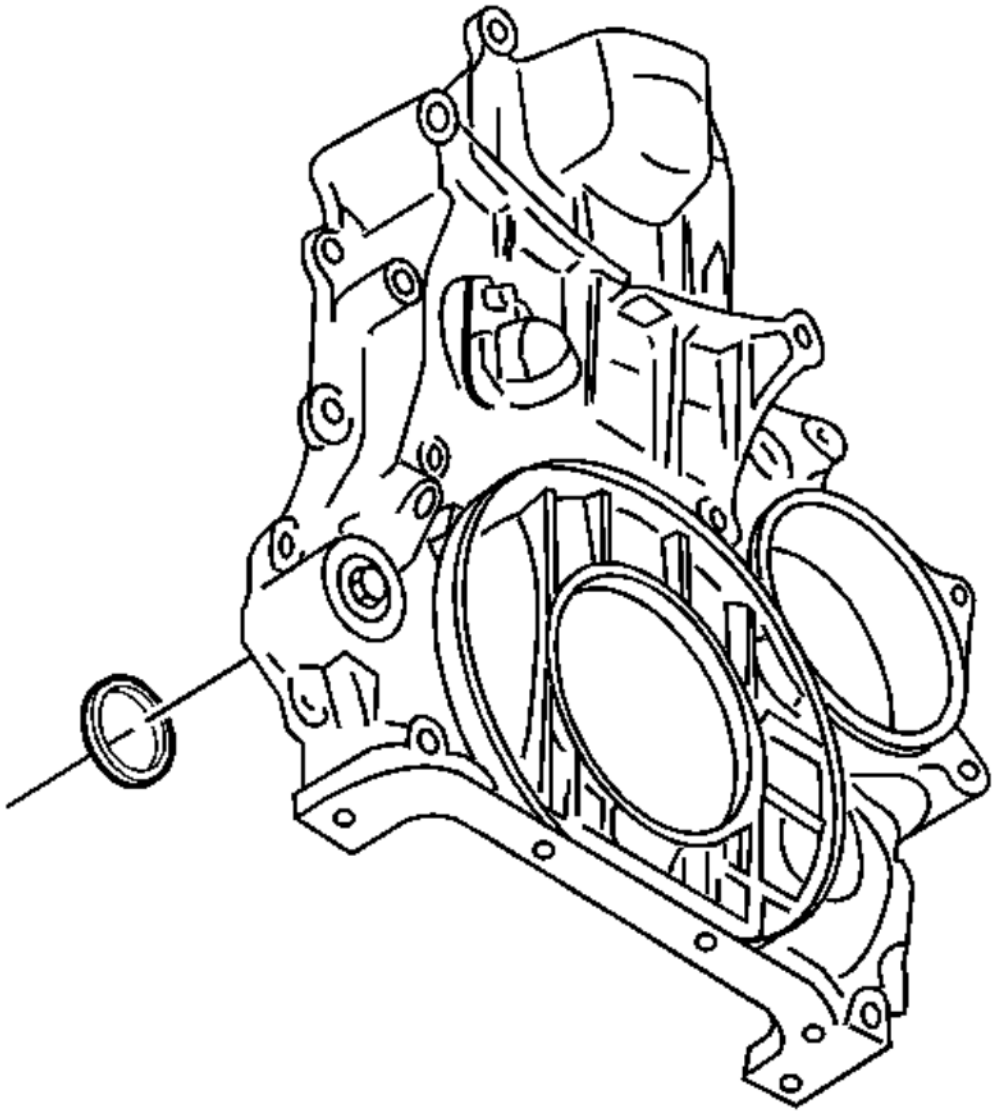


Fig. 230: View Of Pressure Relief Valve O-Ring
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to **Fastener Notice** .

1. If necessary, install a NEW pressure relief valve O-ring.
2. Lubricate the O-ring with engine oil.

Tighten: Tighten the valve to 39 N.m (29 lb ft).

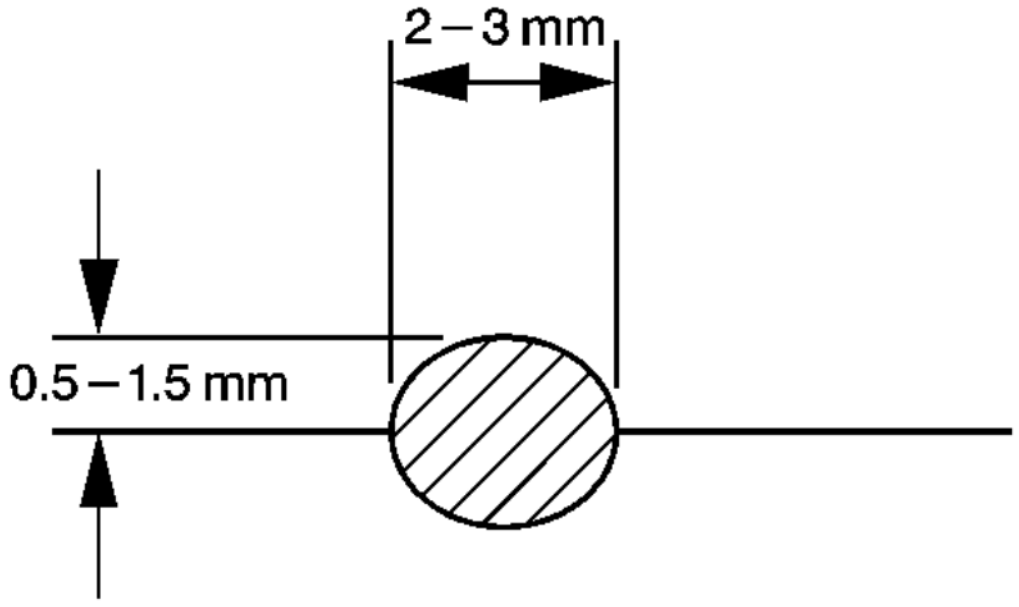


Fig. 231: Determining Sealant Bead Dimensions
Courtesy of GENERAL MOTORS CORP.

3. Apply a 2-3 mm (1/8 in) wide by 0.5-1.5 mm (1/16 in) high, bead of sealant to the engine front cover sealing surface to the engine block. Refer to **Sealers, Adhesives, and Lubricants** for the correct part number.
4. Apply a 2-3 mm (1/8 in) wide by 0.5-1.5 mm (1/16 in) high, bead of sealant to the engine front cover sealing surface to the upper oil pan. Refer to **Sealers, Adhesives, and Lubricants** for the correct part number.

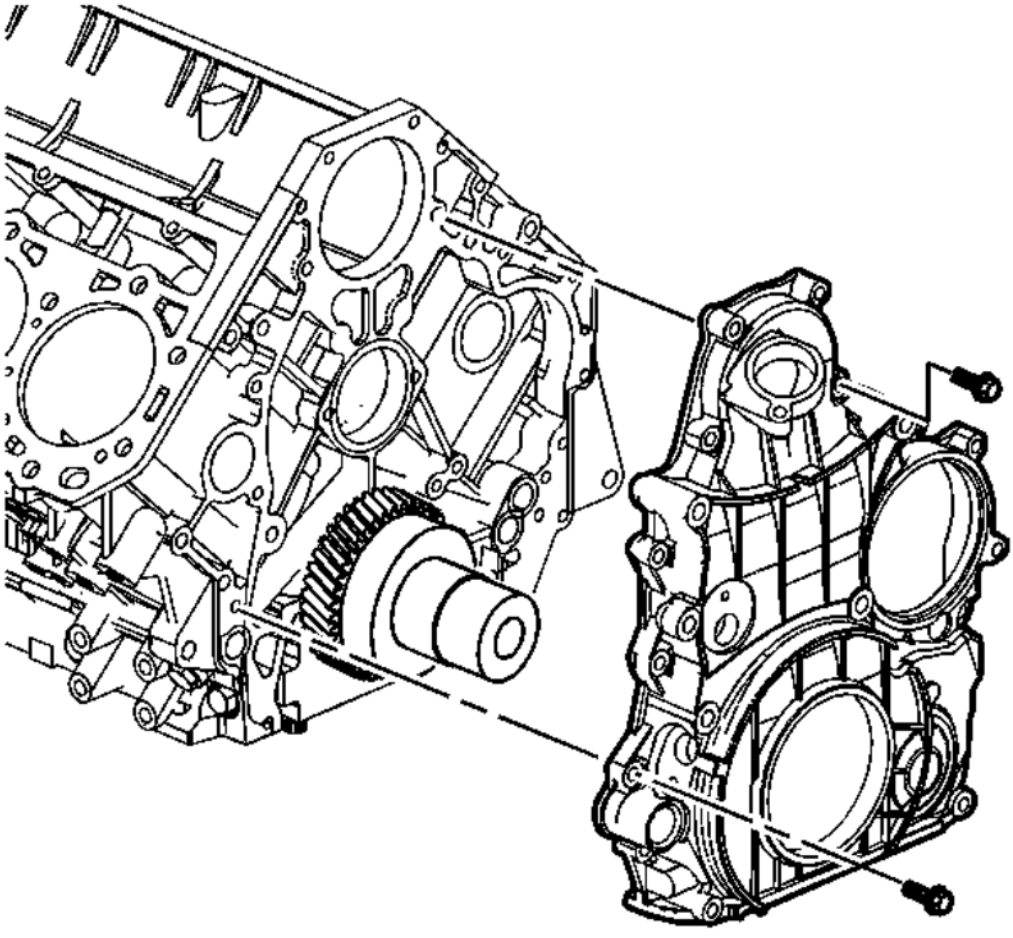


Fig. 232: View Of Engine Front Cover
Courtesy of GENERAL MOTORS CORP.

5. Install the engine front cover.
6. Install the engine front cover bolts.

Tighten: Tighten the bolts to 25 N.m (18 lb ft).

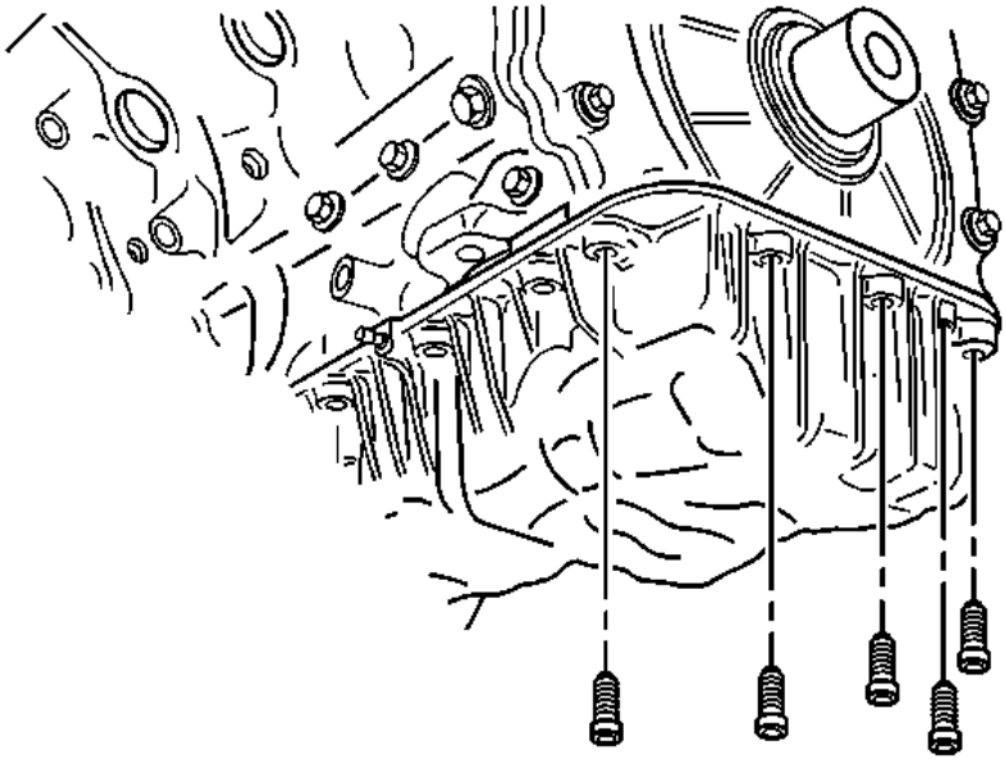


Fig. 233: View Of Upper Oil Pan To Engine Front Cover Bolts
Courtesy of GENERAL MOTORS CORP.

7. Install the upper oil pan to engine front cover bolts.

   Tighten: Tighten the bolts to 21 N.m (15 lb ft).

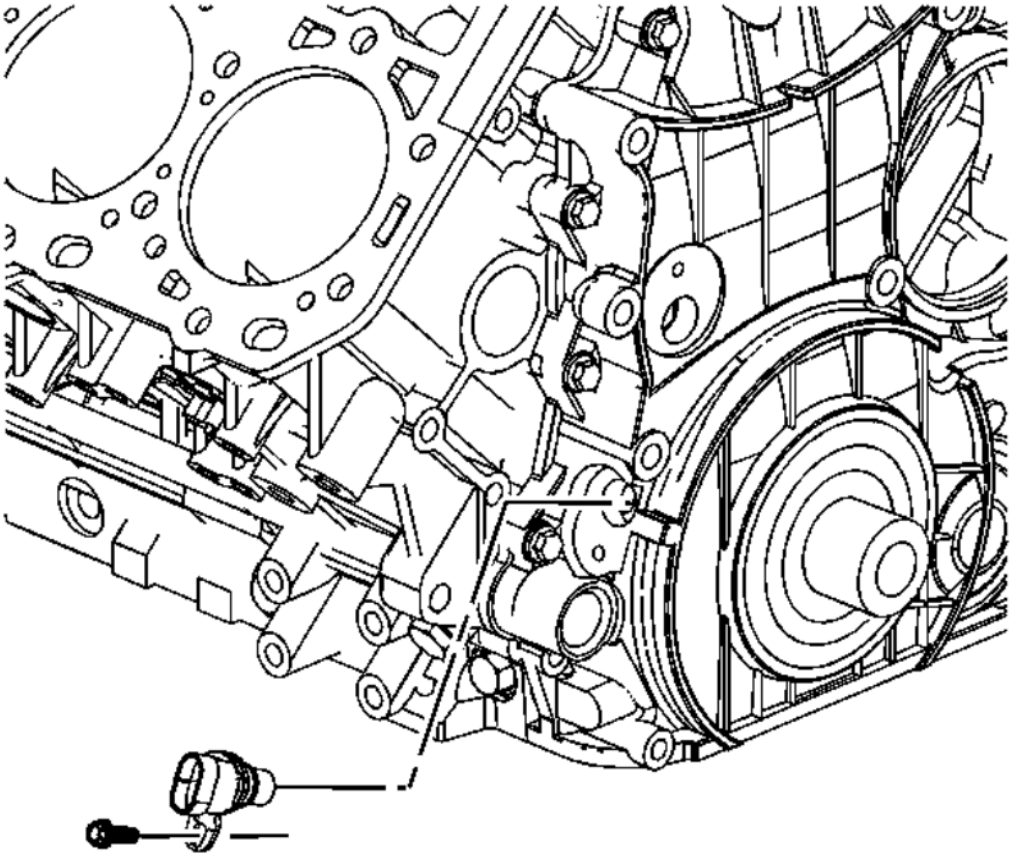


Fig. 234: View Of CKP Sensor & Bolt
Courtesy of GENERAL MOTORS CORP.

8. Install a NEW O-ring to the CKP sensor spacer.
9. Lubricate the O-ring with clean engine oil.

IMPORTANT: The crankshaft position sensor spacers are machined with different timing positions. However, if the crankshaft position sensor spacer requires replacement, replace with a grade "C" spacer.

10. Install the CKP sensor spacer and bolts.

Tighten: Tighten the bolts to 10 N.m (89 lb in).

11. Install a NEW O-ring to the CKP sensor.
12. Lubricate the O-ring with clean engine oil.
13. Install the CKP sensor and bolt.

    Tighten: Tighten the bolt to 10 N.m (89 lb in).

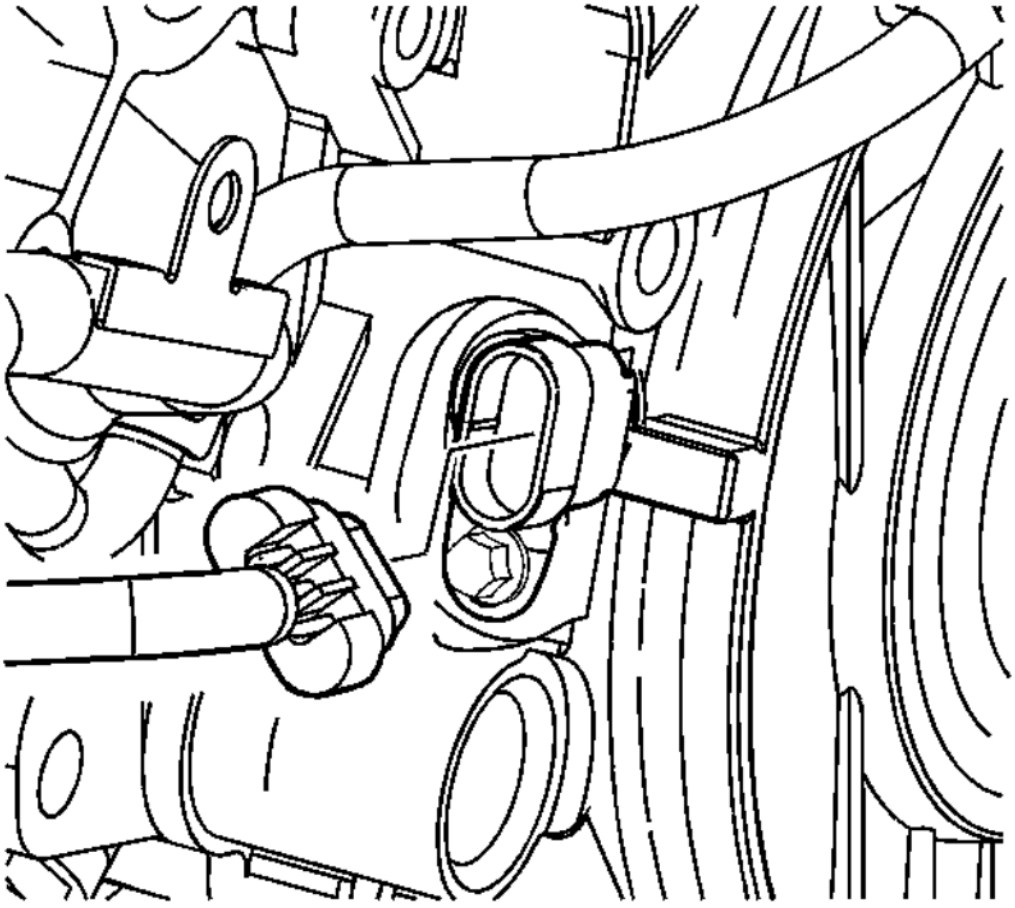


Fig. 235: View Of Crankshaft Position Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

14. Connect the CKP sensor electrical connector.
15. Install the right wheelhouse panel. Refer to **Front Wheelhouse Liner Replacement - Right Side (GMC)** or **Front Wheelhouse Liner Replacement - Right Side**

(Chevrolet) .

16. Install the crankshaft front oil seal. Refer to **Crankshaft Front Oil Seal Replacement**.
17. Install the water pump. Refer to **Water Pump Replacement (LMM)** .
18. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (w/Single Battery)** or **Battery Negative Cable Disconnection and Connection (w/Auxiliary Battery)** or **Battery Negative Cable Disconnection and Connection (w/Dual Batteries)** .

CAMSHAFT RELUCTOR REPLACEMENT

Removal Procedure

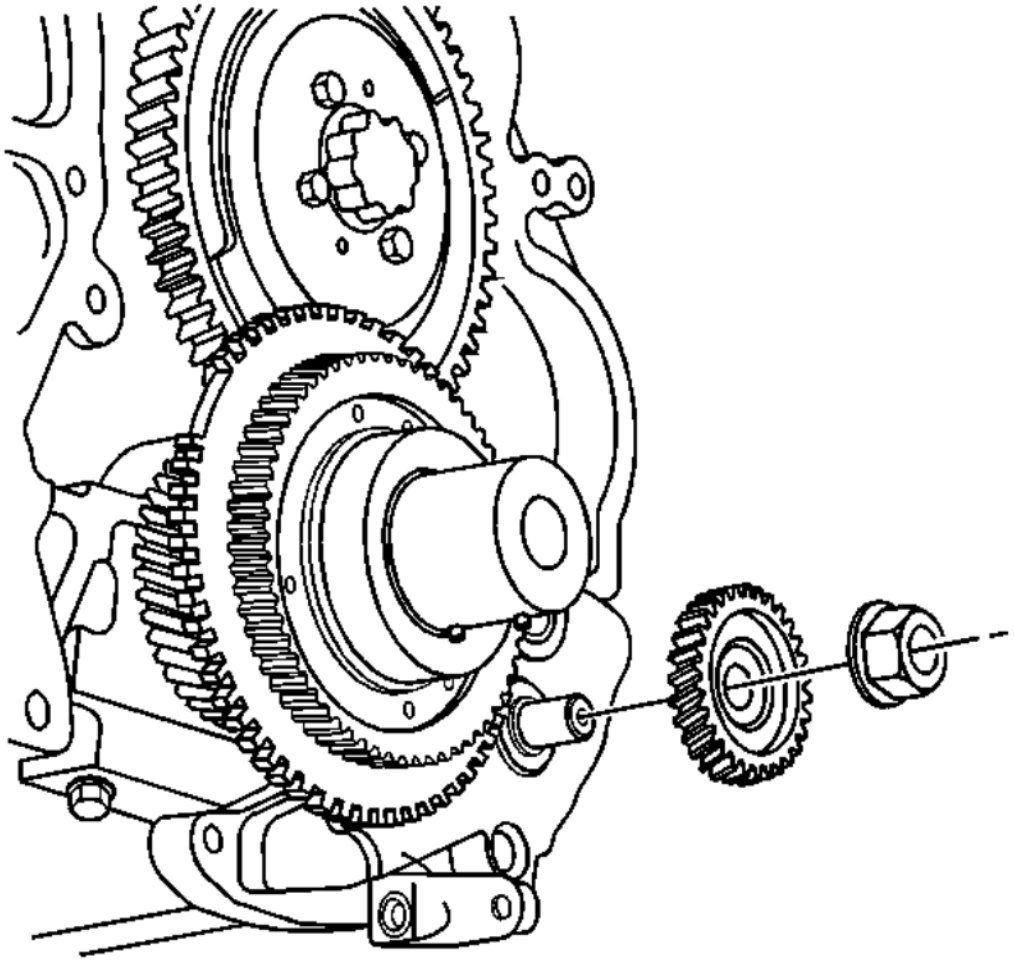


Fig. 236: View Of Oil Pump Driven Gear & Nut
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the upper oil pan. Refer to **Upper Oil Pan Replacement**.

NOTE: Do not use an impact driver to remove or install the oil pump driven gear nut. Use of an impact driver may shear the oil pump drive gear pin in the crankshaft.

3. While holding the secondary oil pump shaft with a hex driver, remove the oil pump driven

gear nut.

4. Remove the oil pump driven gear.

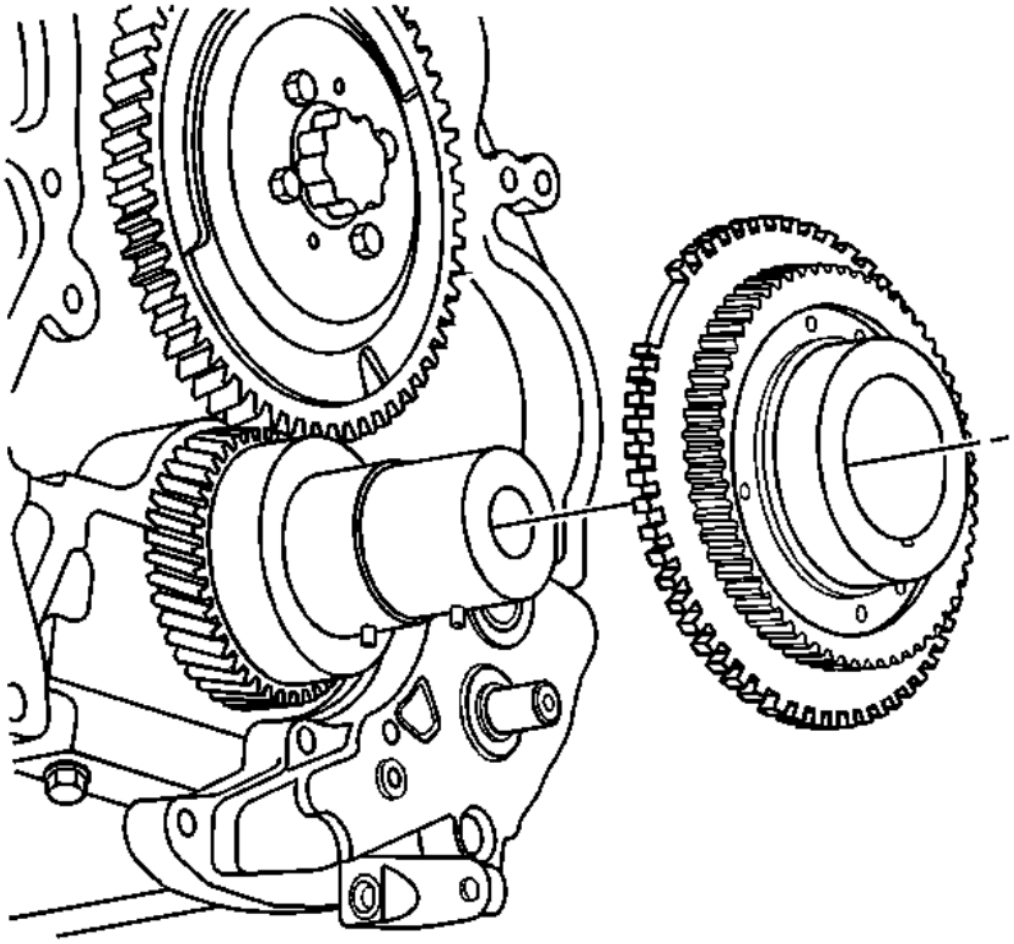


Fig. 237: View Of Oil Pump Drive Gear
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: DO NOT remove the reluctor from the oil pump drive gear. The reluctor is timed to the gear and once removed the correct timing will be lost.

5. Remove the oil pump drive gear and crankshaft sensor reluctor.

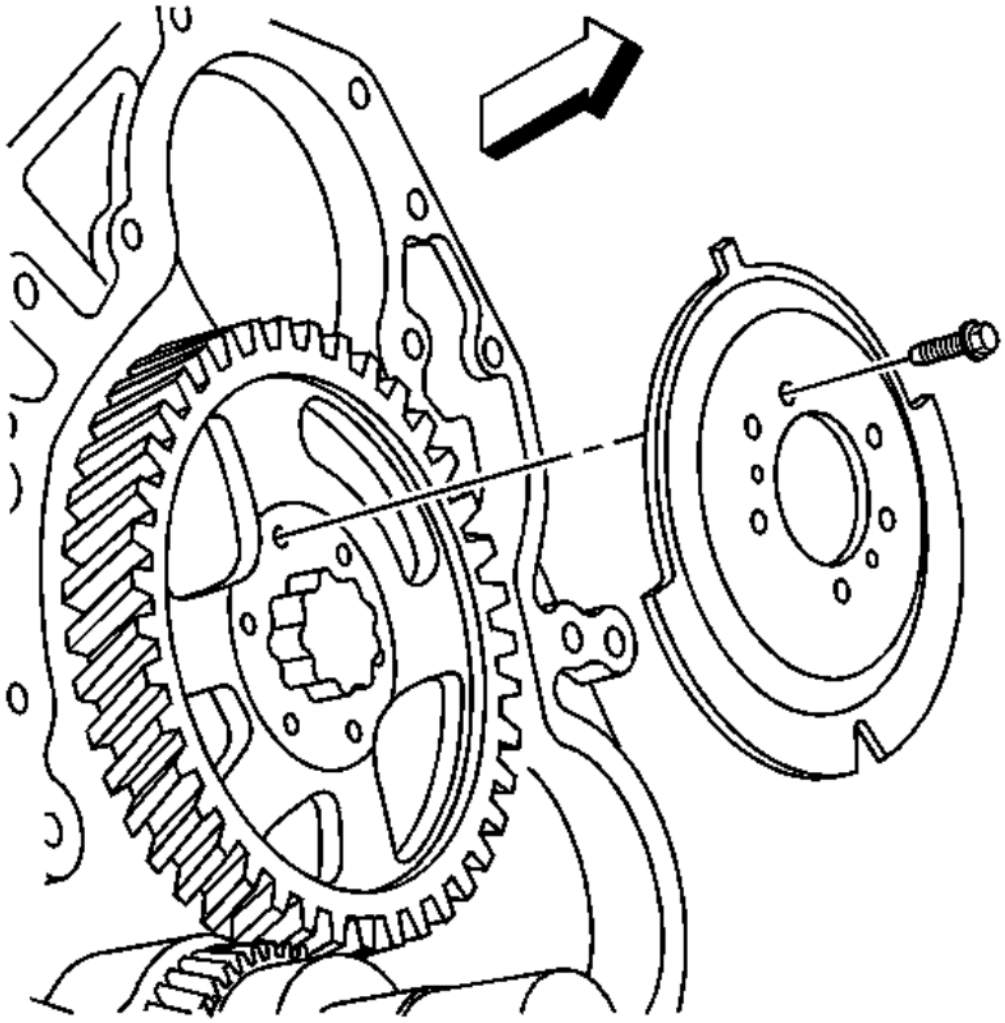


Fig. 238: View Of Camshaft Reluctor & Bolts
Courtesy of GENERAL MOTORS CORP.

6. Remove the camshaft reluctor screws.
7. Remove the camshaft reluctor.
8. Clean and inspect the camshaft reluctor for damage. Replace the reluctor if damage is found.

Installation Procedure

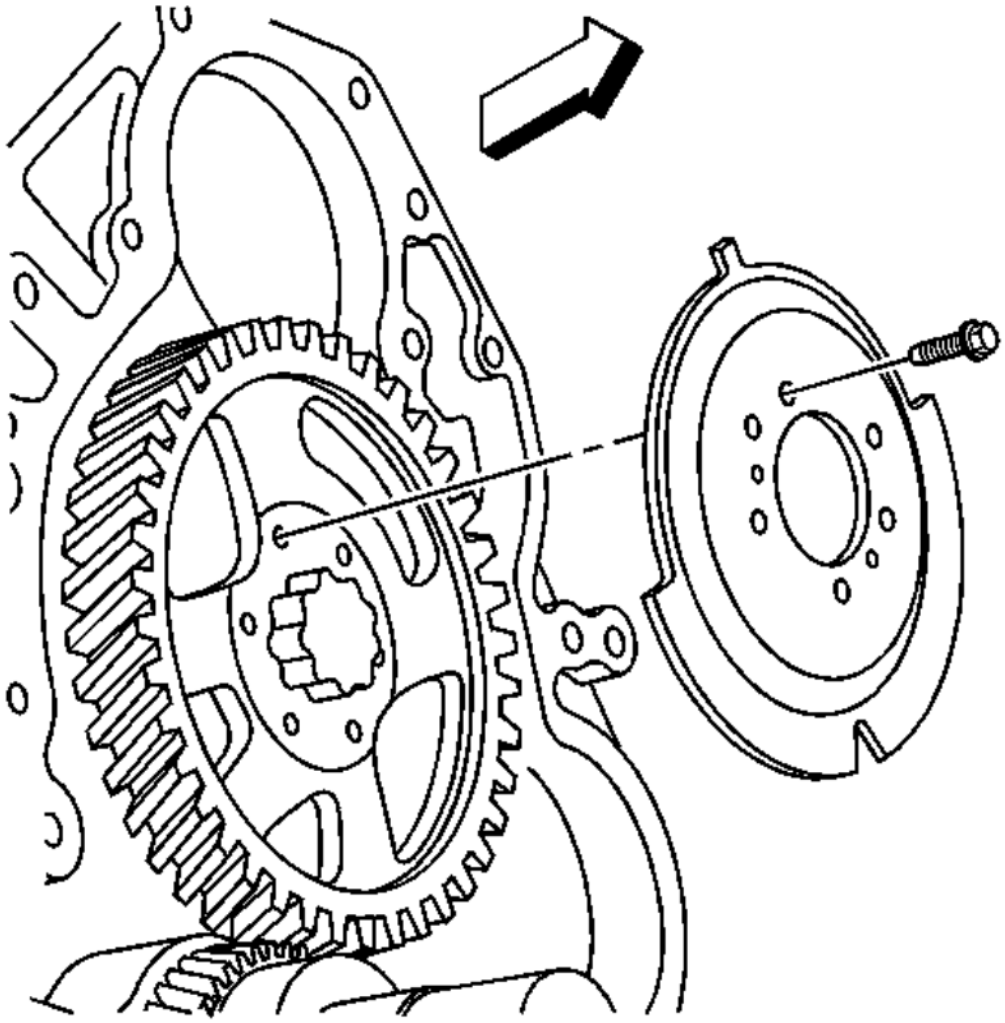


Fig. 239: View Of Camshaft Reluctor & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

1. Position the camshaft reluctor to the camshaft gear.
2. Install the camshaft reluctor bolts.

Tighten: Tighten the bolts to 9 N.m (80 lb in).

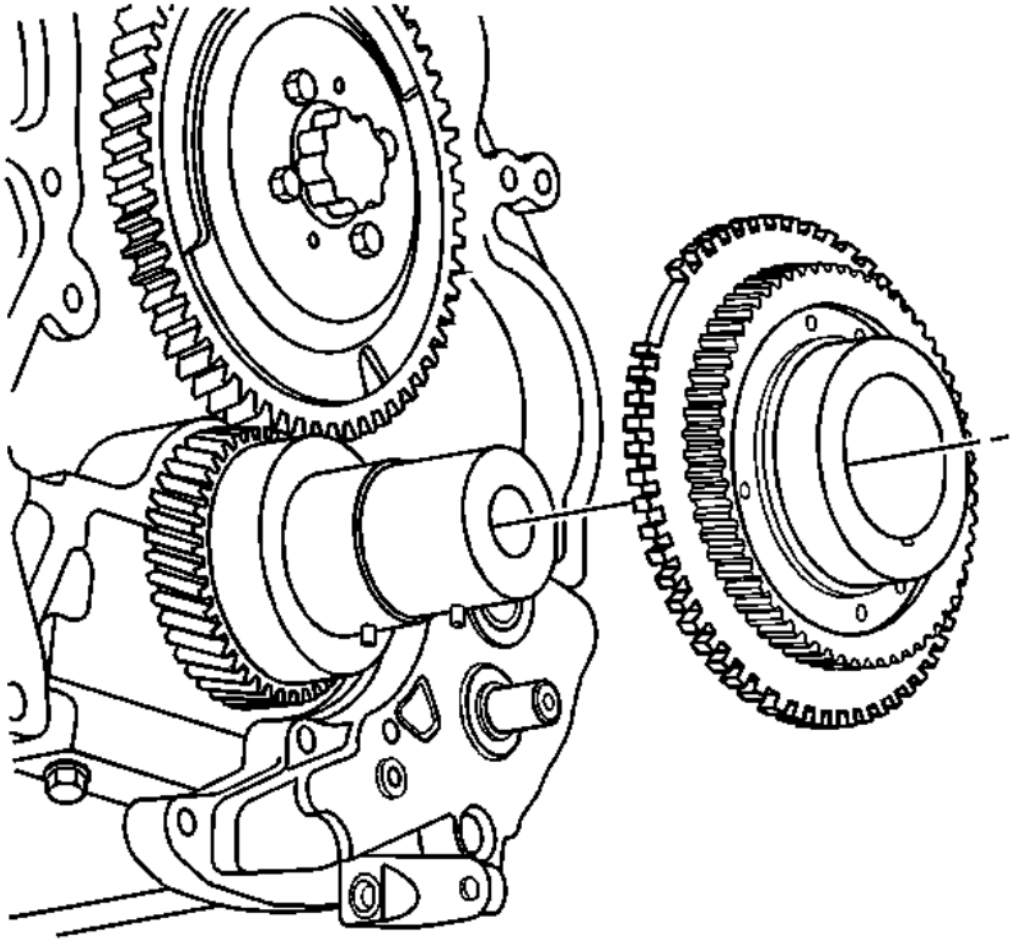


Fig. 240: View Of Oil Pump Drive Gear
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not damage the teeth on the reluctor.

3. Install the oil pump drive gear and reluctor to the crankshaft.

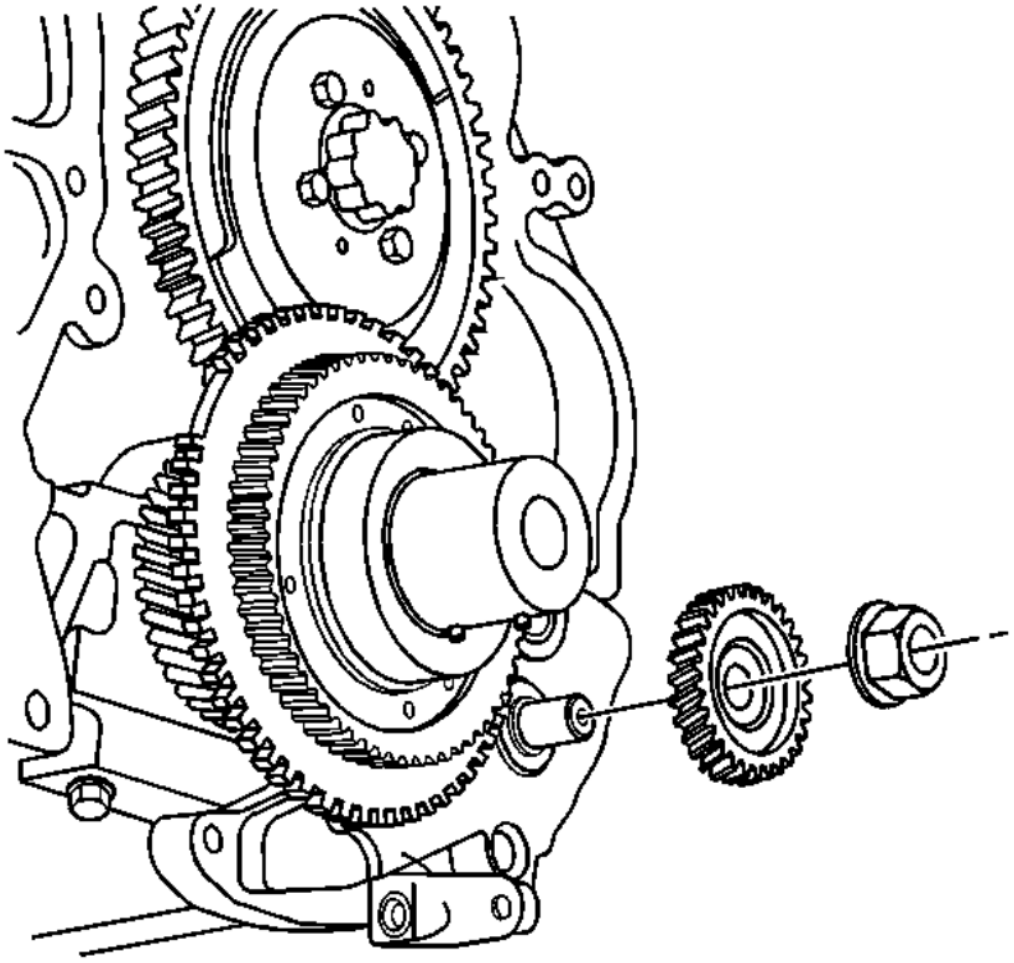


Fig. 241: View Of Oil Pump Driven Gear & Nut
Courtesy of GENERAL MOTORS CORP.

4. Install the oil pump driven gear.

NOTE: Do not use an impact driver to remove or install the oil pump driven gear nut. Use of an impact driver may shear the oil pump drive gear pin in the crankshaft.

5. While holding the secondary oil pump shaft with a hex driver, install the oil pump driven gear nut.

Tighten: Tighten the nut to 100 N.m (74 lb ft).

6. Install the upper oil pan. Refer to **Upper Oil Pan Replacement**.
7. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

CRANKSHAFT RELUCTOR AND OIL PUMP DRIVE GEAR REPLACEMENT

Removal Procedure

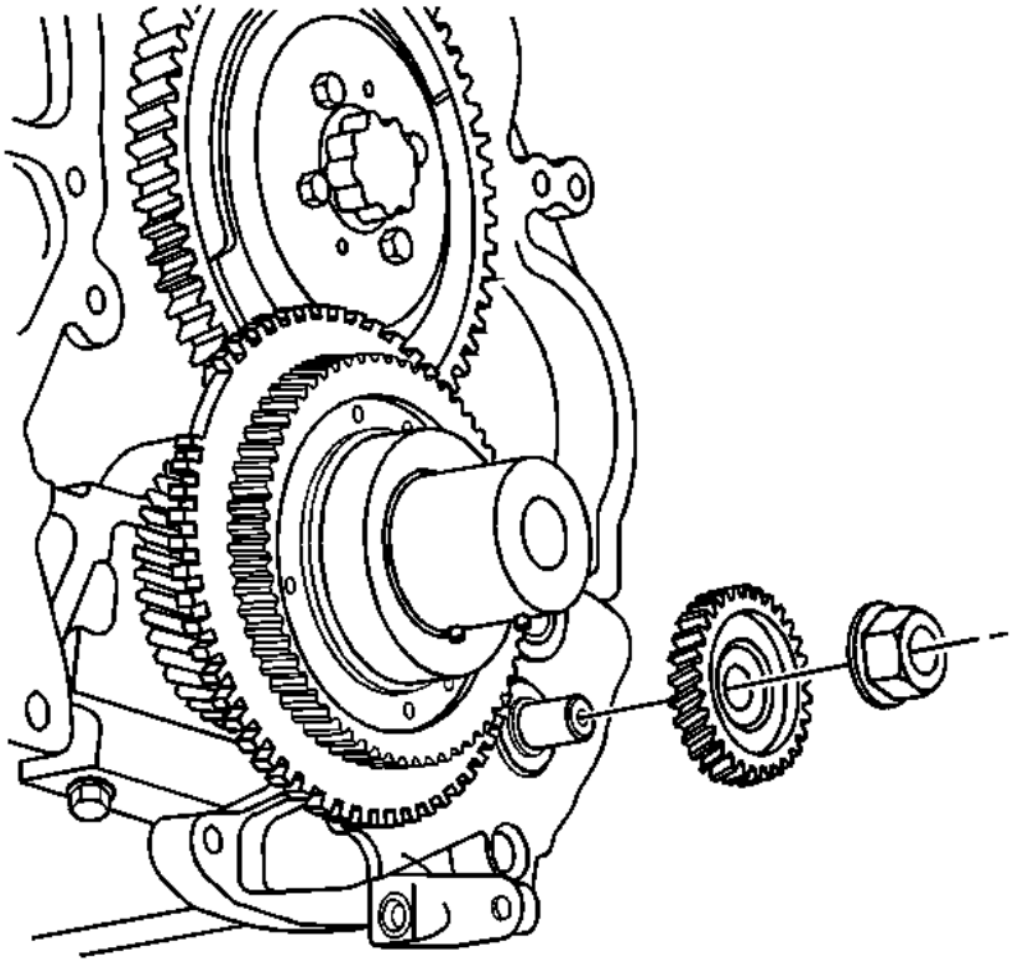


Fig. 242: View Of Oil Pump Driven Gear & Nut
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not use an impact driver to remove or install the oil pump driven gear nut. Use of an impact driver may shear the oil pump drive gear pin in the crankshaft.

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. While holding the secondary oil pump shaft with a hex driver, remove the oil pump driven gear nut.
3. Remove the oil pump driven gear.

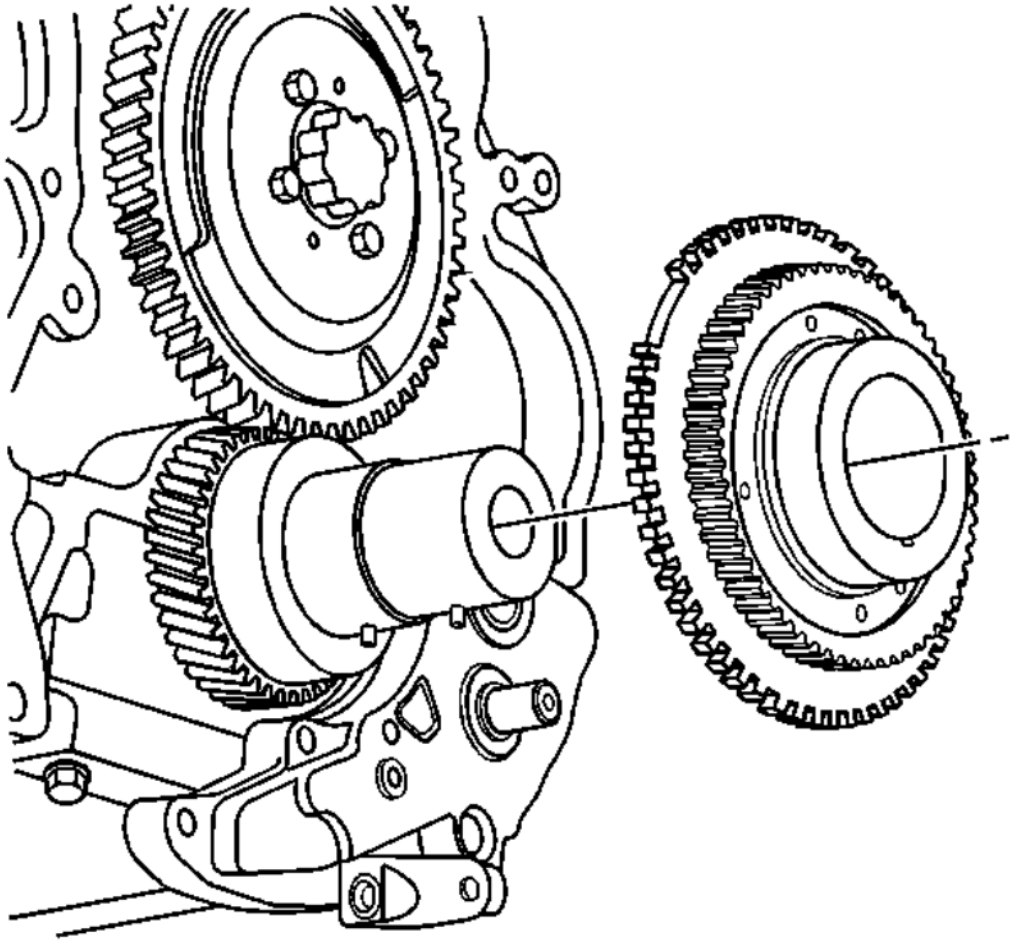


Fig. 243: View Of Oil Pump Drive Gear
Courtesy of GENERAL MOTORS CORP.

4. Remove the oil pump drive gear and crankshaft sensor reluctor. Do not damage the crankshaft reluctor teeth.

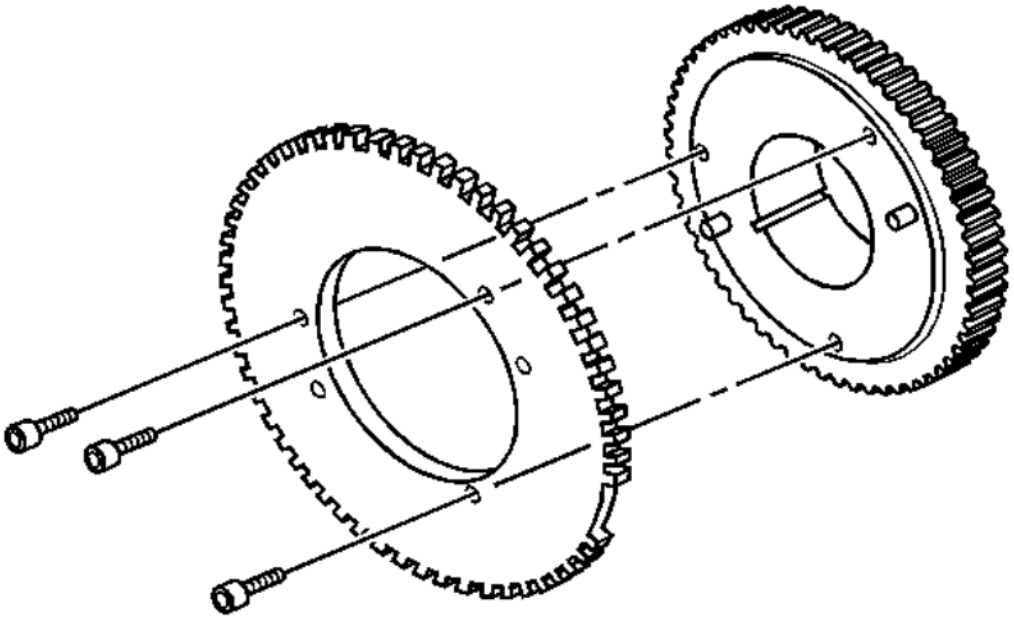


Fig. 244: View Of Crankshaft Reluctor & Oil Pump Drive Gear Bolts
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not remove the reluctor from the oil pump drive gear unless replacing the reluctor or the oil pump drive gear. The reluctor is timed to the gear and once removed the correct timing will be lost.

5. Remove the crankshaft reluctor to oil pump drive gear bolts.
6. Inspect the crankshaft reluctor for the damage, bent teeth, being bent or warped.
7. Inspect the oil pump drive gear for damaged or worn teeth.
8. Inspect the oil pump drive gear crankshaft pin for wear.
9. Inspect the groove of the crankshaft pin in the oil pump drive gear for wear.
10. Replace any parts that are damaged or worn.

Installation Procedure

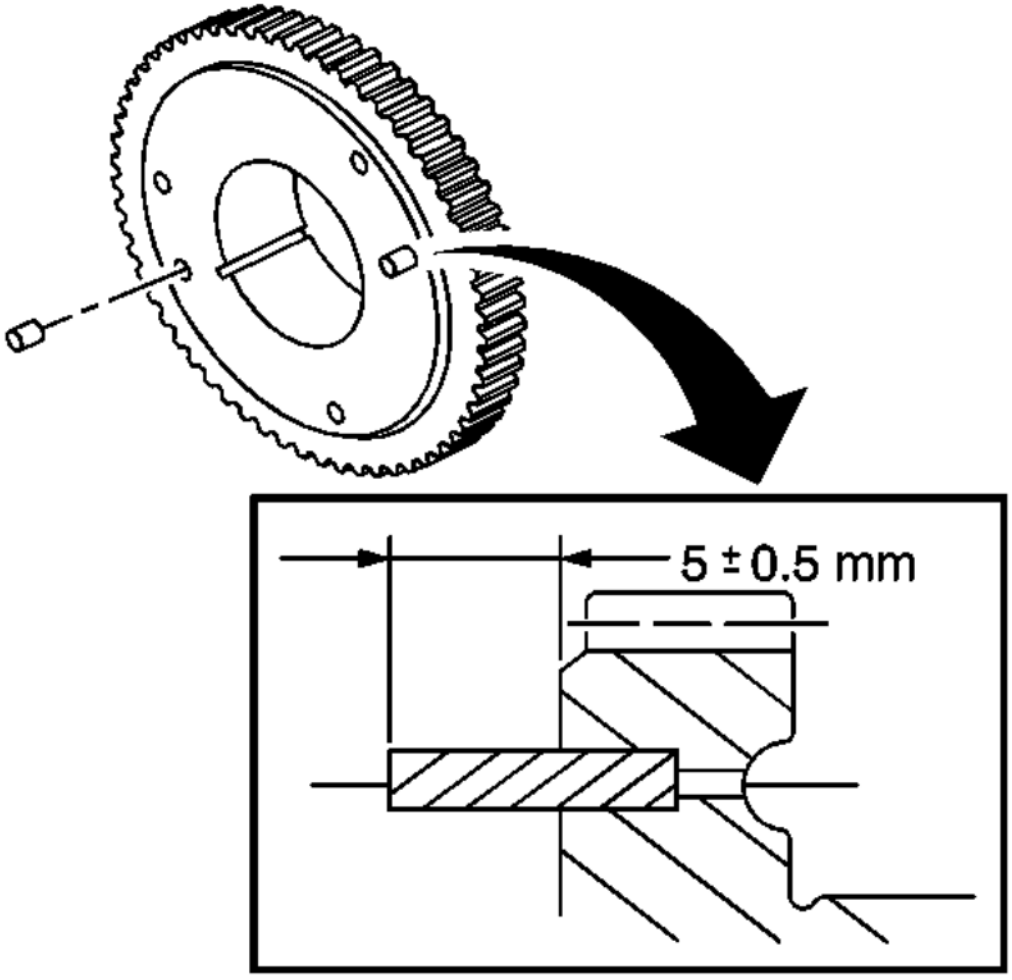


Fig. 245: View Of Knock Pins Proper Installation Position In Oil Pump Drive Gear
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The crankshaft reluctor and the oil pump drive gear are timed at the factory. In order to re-establish proper timing, install knock pins in the oil pump drive gear if the crankshaft reluctor was removed from the oil pump drive gear. The knock pins are available through the parts department.

1. Install the knock pins in the oil pump drive gear to a height of 4.5-5.5 mm (0.177-0.217 in)

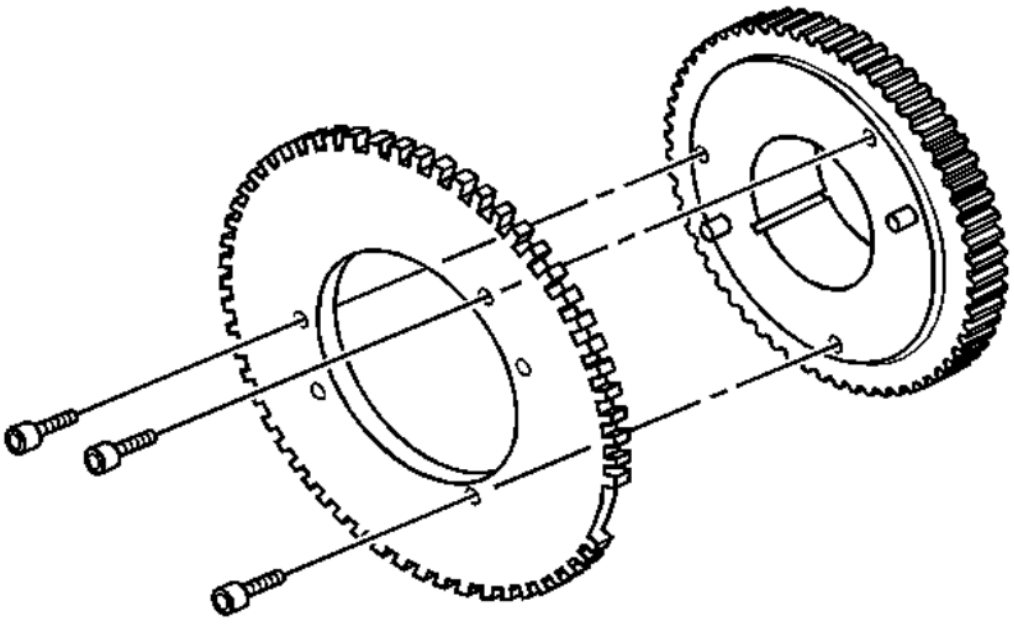


Fig. 246: View Of Crankshaft Reluctor & Oil Pump Drive Gear Bolts
Courtesy of GENERAL MOTORS CORP.

2. Install the crankshaft reluctor on the oil pump drive gear. Ensure the reluctor is aligned on the knock pins.

NOTE: **Refer to Fastener Notice .**

3. Install the crankshaft reluctor bolts.

Tighten: Tighten the bolts to 8 N.m (71 lb in).

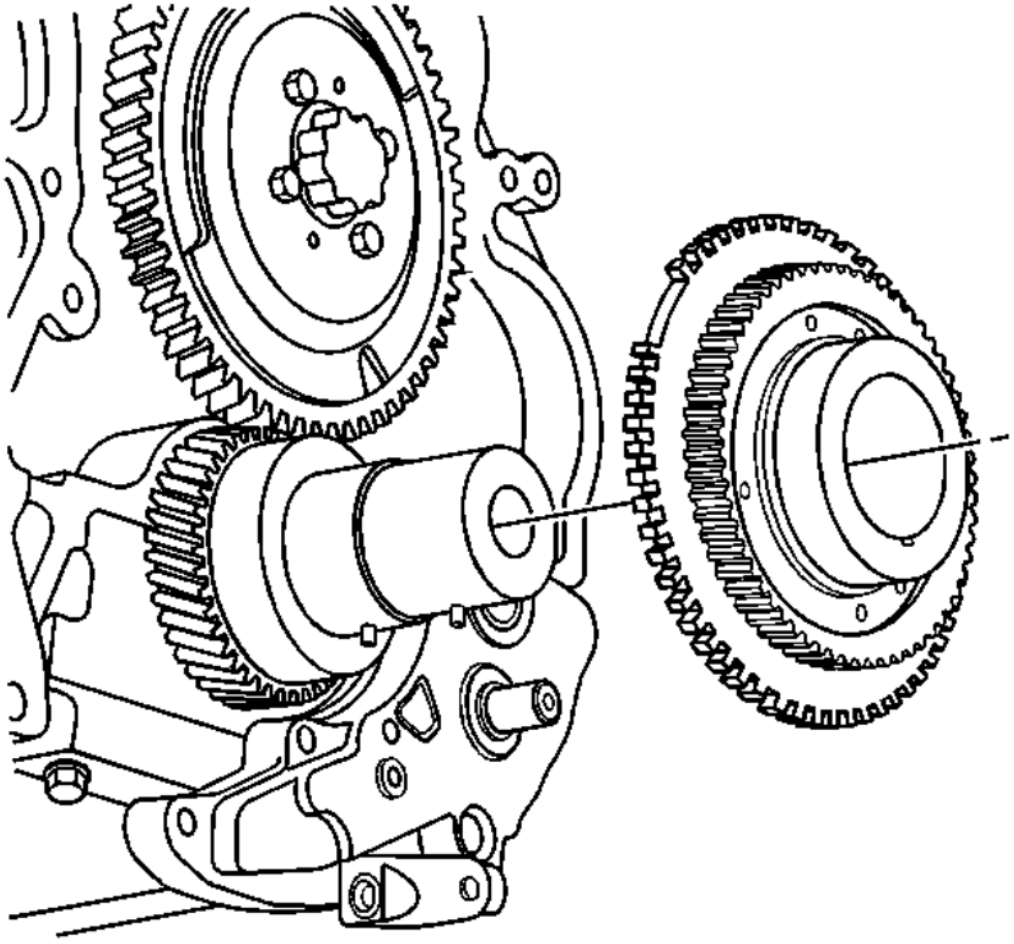


Fig. 247: View Of Oil Pump Drive Gear
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not damage the teeth on the crankshaft reluctor.

4. Install the oil pump drive gear and reluctor to the crankshaft.

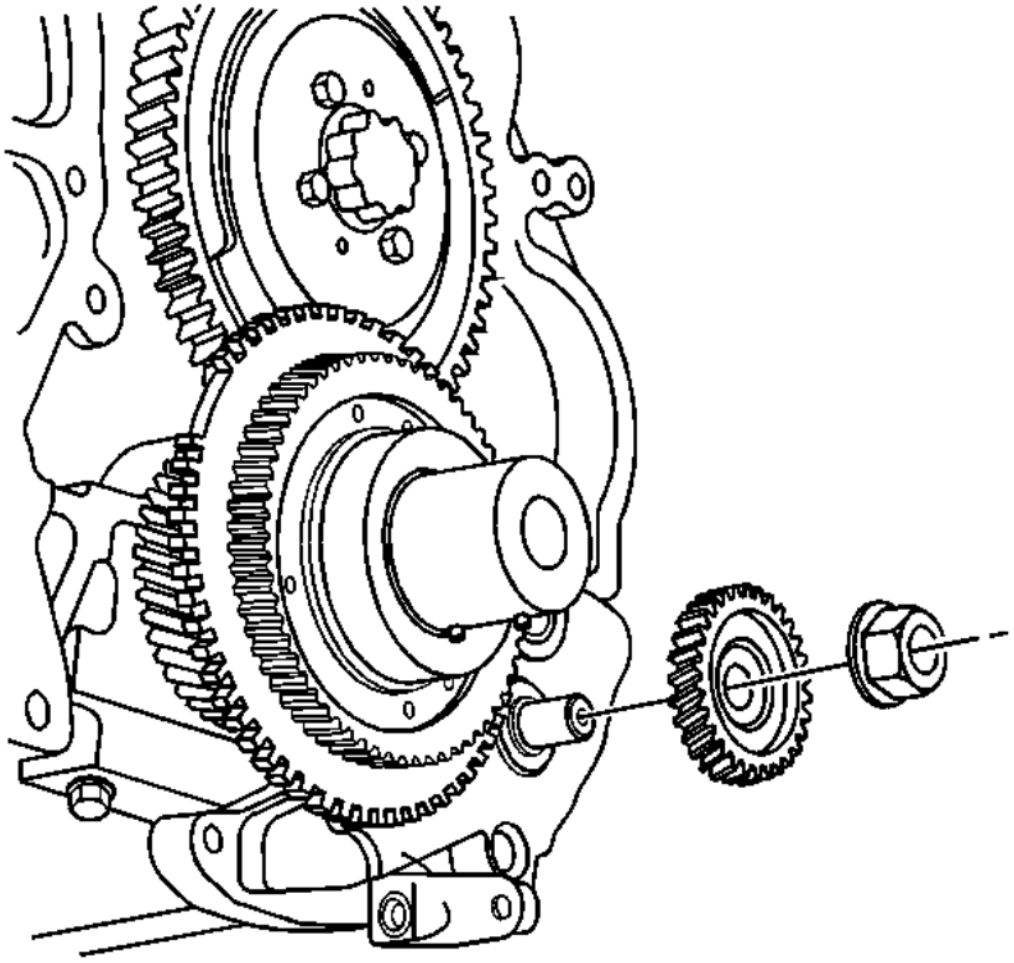


Fig. 248: View Of Oil Pump Driven Gear & Nut
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not use an impact driver to remove or install the oil pump driven gear nut. Use of an impact driver may shear the oil pump drive gear pin in the crankshaft.

5. Install the oil pump driven gear.
6. While holding the secondary oil pump shaft with a hex driver, install the oil pump driven gear nut.

Tighten: Tighten the nut to 100 N.m (74 lb ft).

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

CAMSHAFT REPLACEMENT

Tools Required

- **J 44643** Flywheel Holding Tool. See **Special Tools** .
- **J 26900-13** Magnetic Base. See **Special Tools** .
- **J 26900-12** Dial Indicator. See **Special Tools** .

Removal Procedure

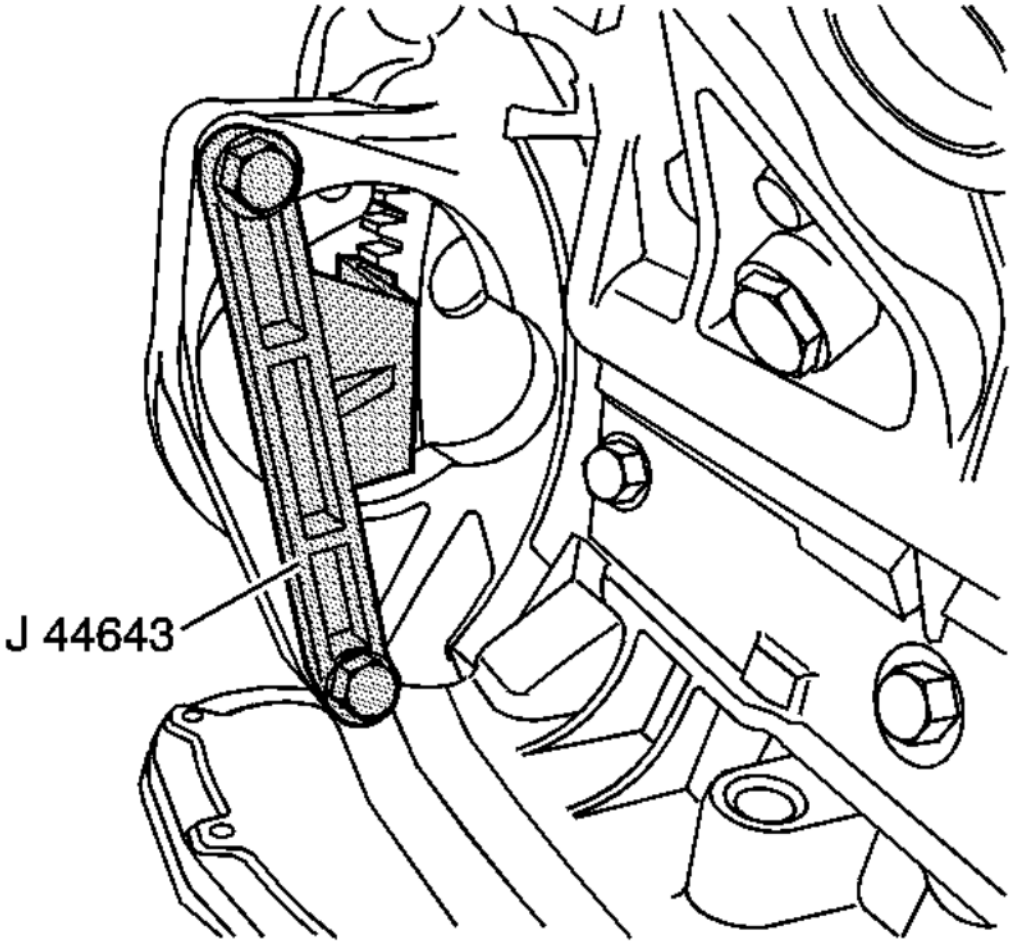


Fig. 249: Locking Flywheel Using J 44643
Courtesy of GENERAL MOTORS CORP.

1. Remove the valve lifters. Refer to **Valve Lifter Replacement**.
2. Remove the charged air cooler. Refer to **Charge Air Cooler Replacement** .
3. Remove the air conditioning (A/C) condenser. Refer to **Condenser Replacement** .
4. Remove the starter. Refer to **Starter Motor Replacement (6.6L)** .
5. Install **J 44643** flush to the flywheel opening. See **Special Tools** .
6. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.

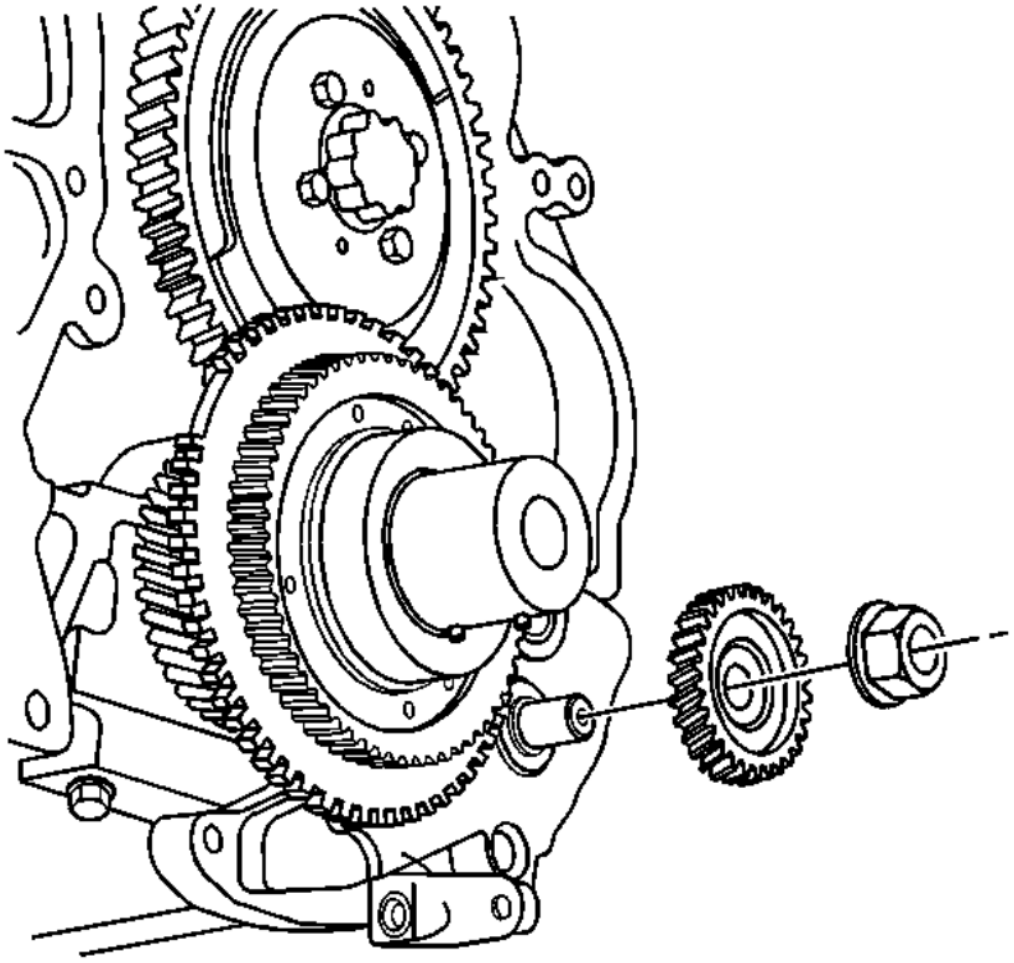


Fig. 250: View Of Oil Pump Driven Gear & Nut
Courtesy of GENERAL MOTORS CORP.

7. Remove the oil pump driven gear nut.
8. Remove the oil pump driven gear.

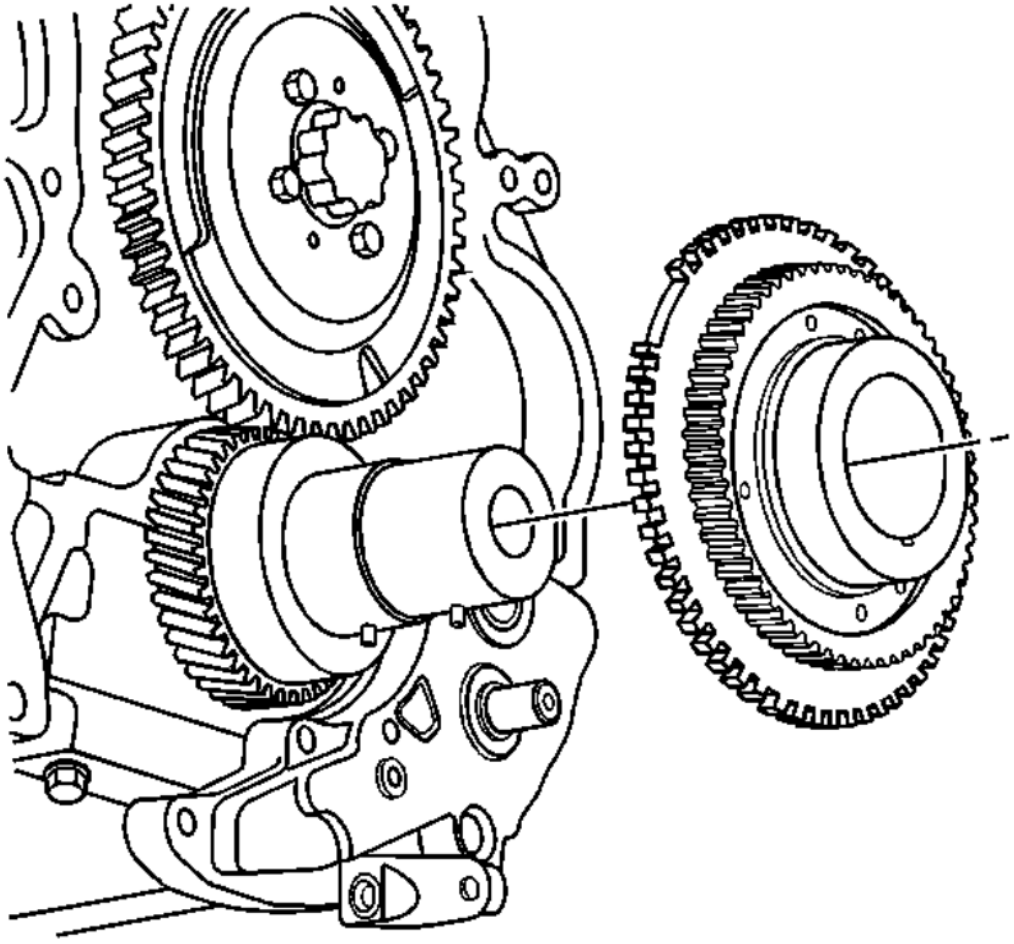


Fig. 251: View Of Oil Pump Drive Gear
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The crankshaft reluctor and the oil pump drive gear are timed together at the factory. Do not remove the crankshaft reluctor from the oil pump drive gear.

9. Remove the oil pump drive gear and crankshaft reluctor.
   - Do not remove the crankshaft reluctor bolts.
   - Do not damage the reluctor teeth.

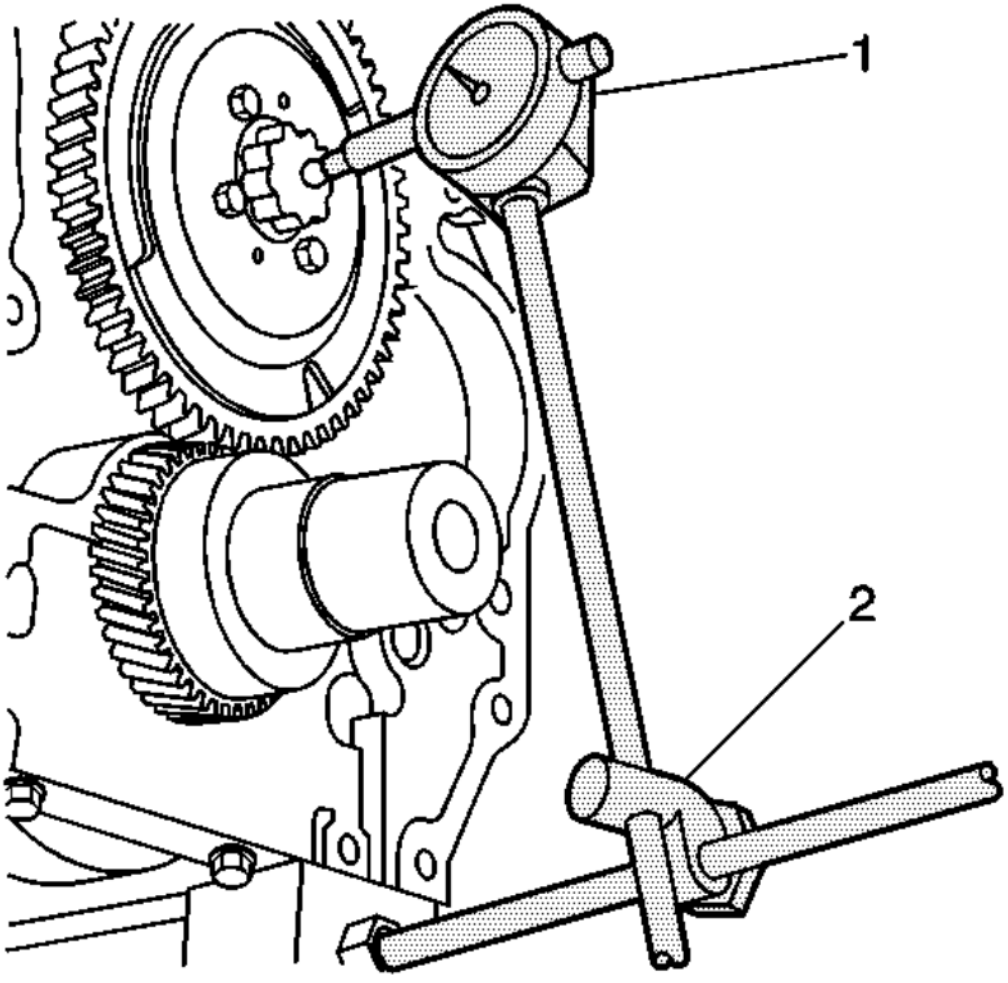


Fig. 252: Measuring Camshaft End Play Using J 26900-12 & J 26900-13
Courtesy of GENERAL MOTORS CORP.

10. Using **J 26900-12** (1) and **J 26900-13** (2), measure the camshaft end play. See **Special Tools** .
    - The production value is 0.050-0.114 mm (0.002-0.0045 in) and service limit is 0.20 mm (0.008 in).
    - Replace the camshaft gear or the camshaft thrust plate if measured value exceeds service limit.

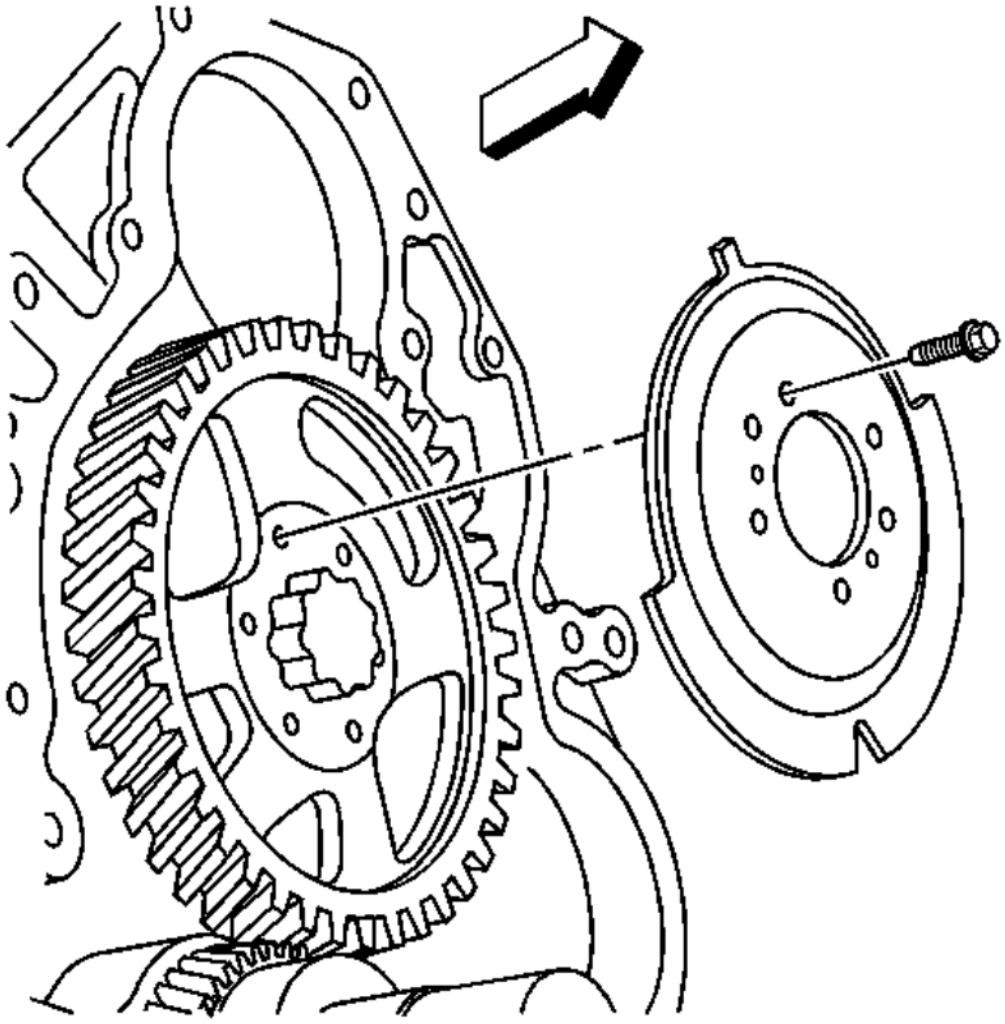


Fig. 253: View Of Camshaft Reluctor & Bolts
Courtesy of GENERAL MOTORS CORP.

11. Remove the camshaft reluctor screws.
12. Remove the camshaft reluctor.

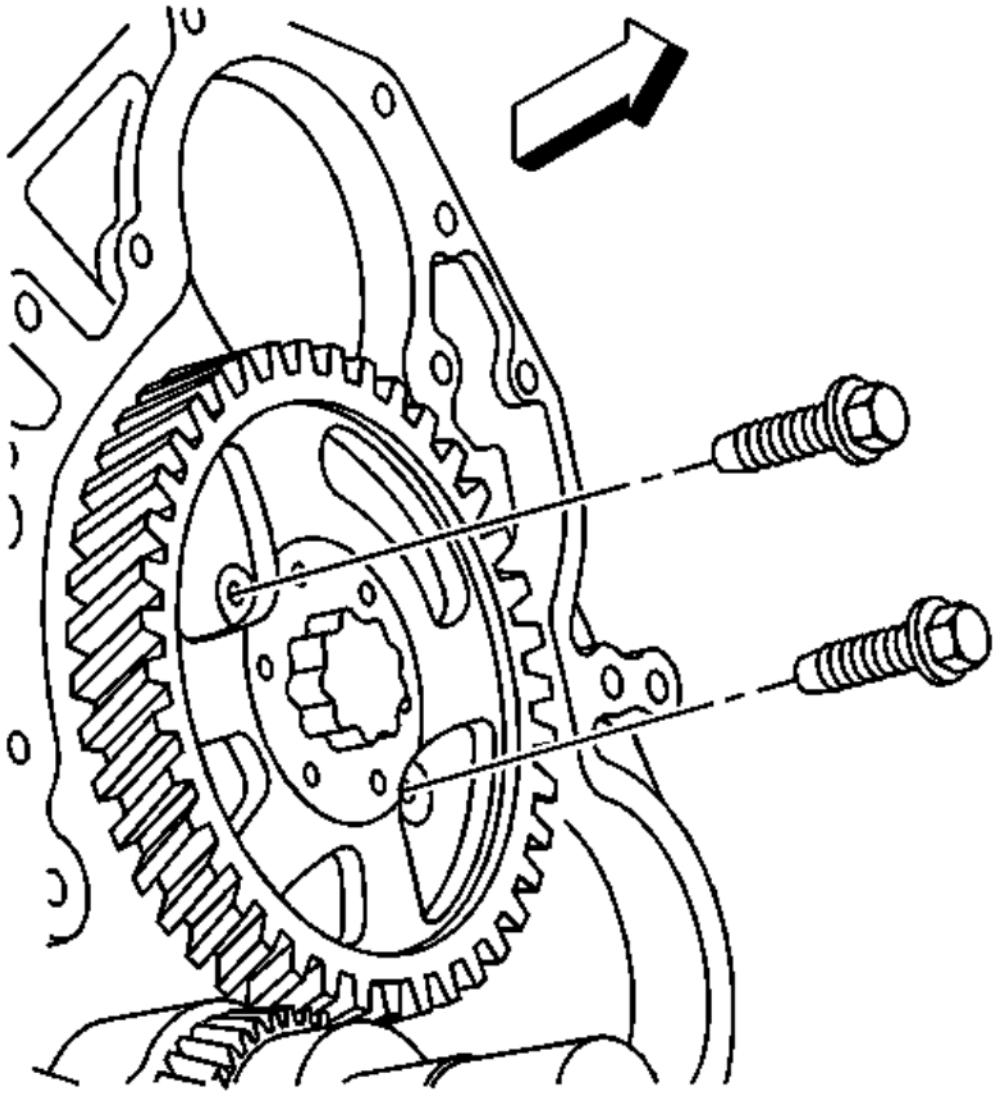


Fig. 254: View Of Camshaft Thrust Plate Bolts
Courtesy of GENERAL MOTORS CORP.

13. In order to loosen the camshaft gear bolt use **J 44643** in order to hold the engine from turning. See **Special Tools** .
14. Loosen the camshaft gear bolt and leave the bolt finger tight.
15. Remove the camshaft thrust plate bolts through the holes in the camshaft gear.

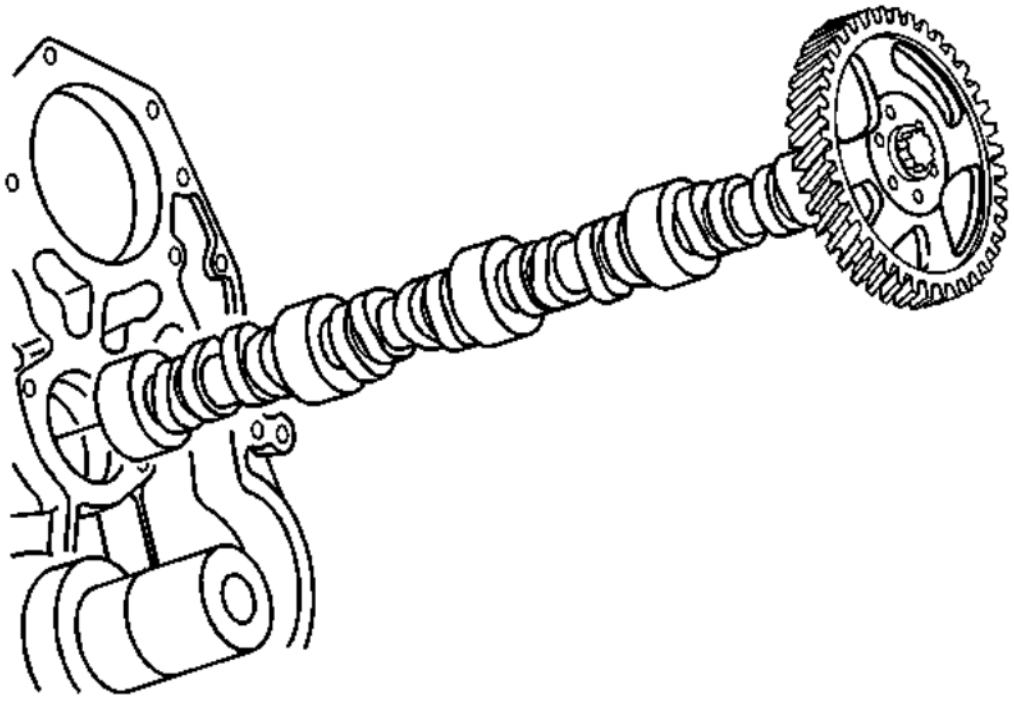


Fig. 255: View Of Camshaft & Camshaft Gear
Courtesy of GENERAL MOTORS CORP.

16. Remove the camshaft with the camshaft gear attached.

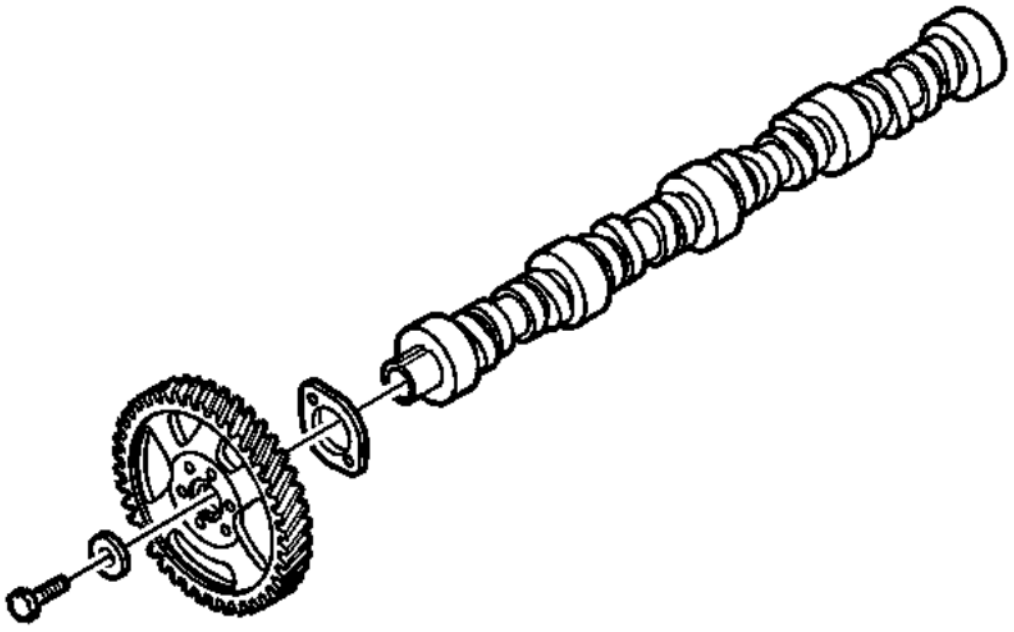


Fig. 256: View Of Camshaft, Camshaft Gear & Camshaft Thrust Plate
Courtesy of GENERAL MOTORS CORP.

17. Remove the camshaft gear bolt and discard.
18. Remove the camshaft gear.
19. Remove the camshaft thrust plate.
20. Clean and inspect the camshaft and bearings. Refer to **Camshaft and Bearings Cleaning and Inspection** .

    If the camshaft bearings are worn or damaged the engine will require removal in order to replace the camshaft bearings. Refer to **Engine Replacement**.

Installation Procedure

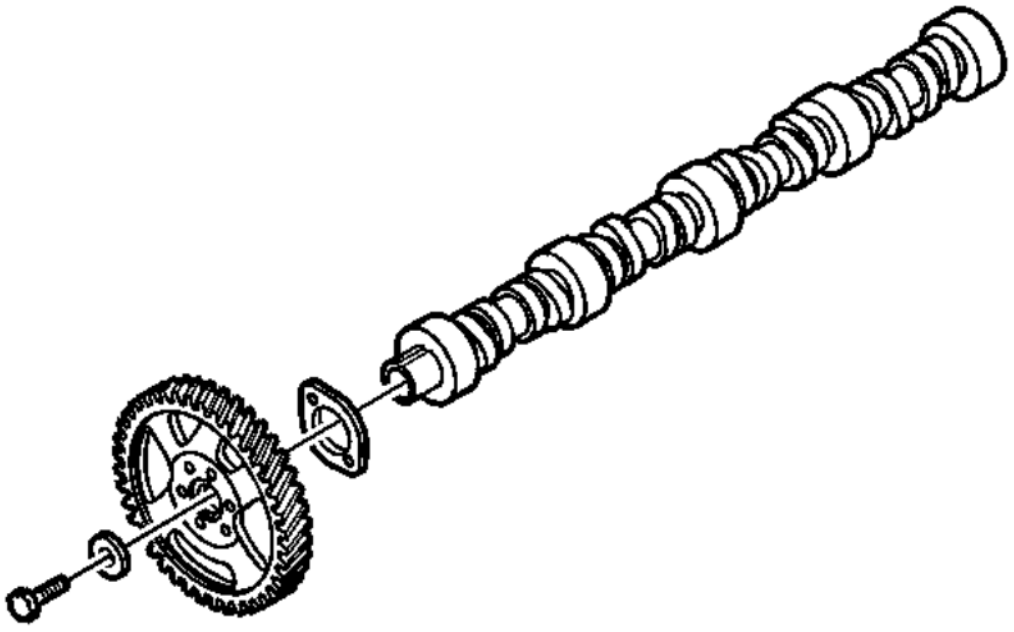


Fig. 257: View Of Camshaft, Camshaft Gear & Camshaft Thrust Plate
Courtesy of GENERAL MOTORS CORP.

1. Install the camshaft thrust plate to the camshaft.
2. Install the camshaft driven gear.
3. Install a NEW camshaft driven gear bolt.

   Leave the bolt finger tight.

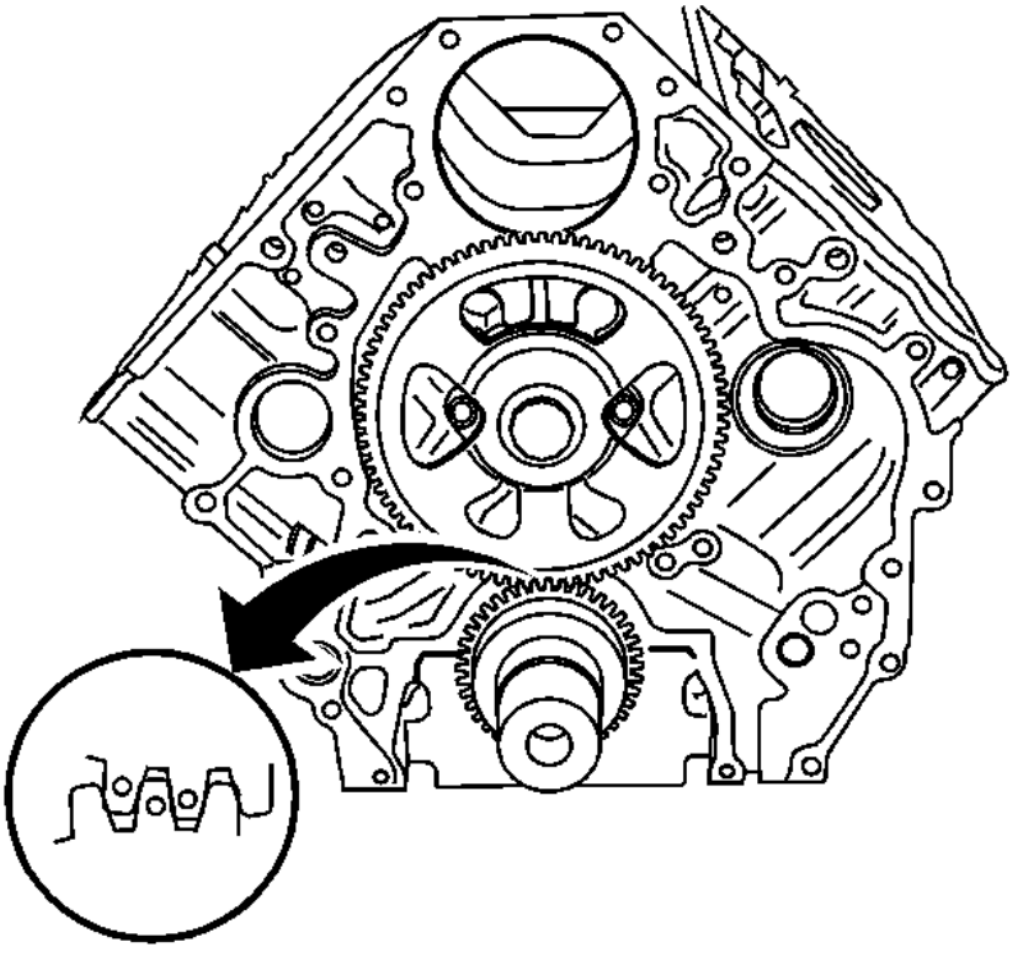


Fig. 258: View Of Camshaft Gear Aligned With Crankshaft Gear
Courtesy of GENERAL MOTORS CORP.

4. Install the camshaft into the cylinder block, align the camshaft gear to the crankshaft gear as shown.

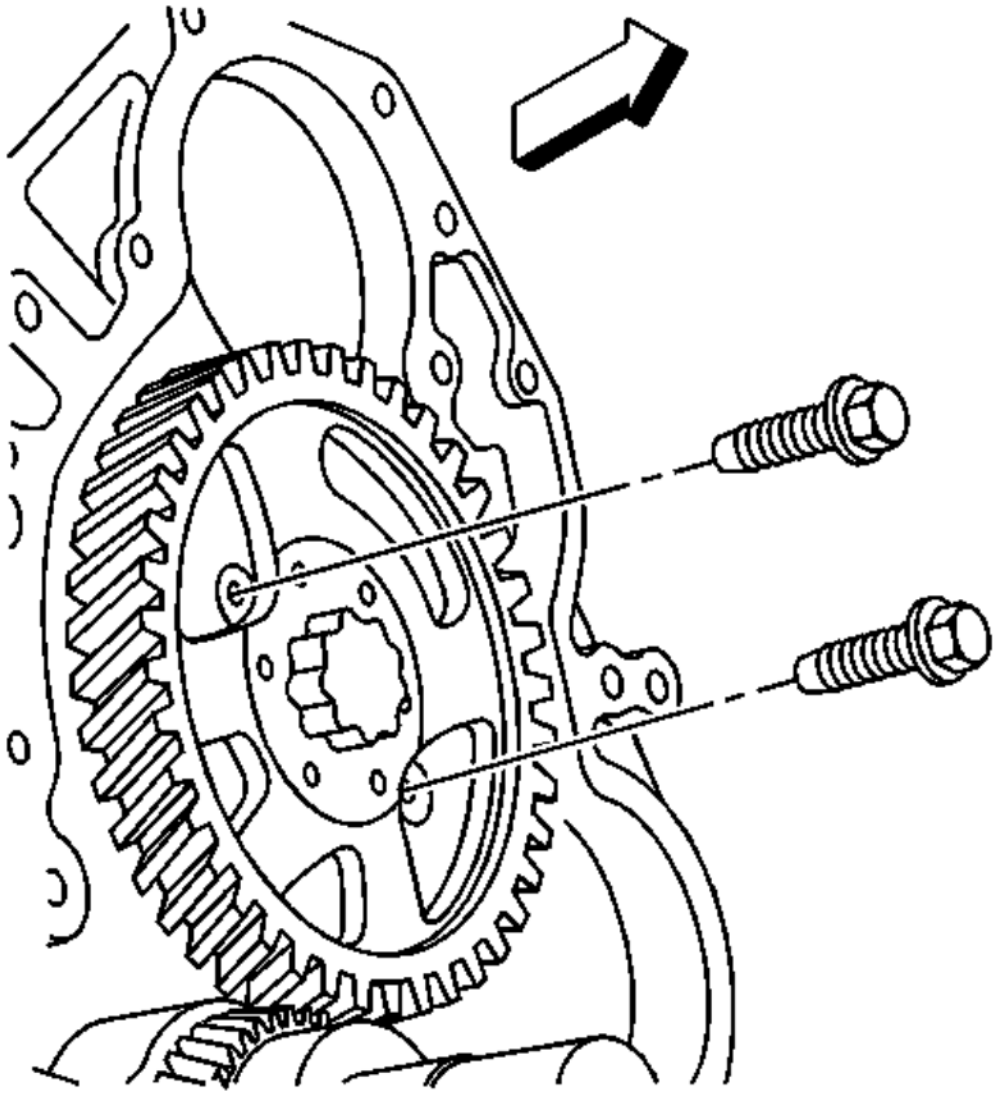


Fig. 259: View Of Camshaft Thrust Plate Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

5. Apply threadlock to the threads of the camshaft thrust plate bolts. Refer to **Sealers, Adhesives, and Lubricants** for the correct part number.

6. Install the camshaft thrust plate bolts.

   Tighten: Tighten the bolts to 22 N.m (16 lb ft).

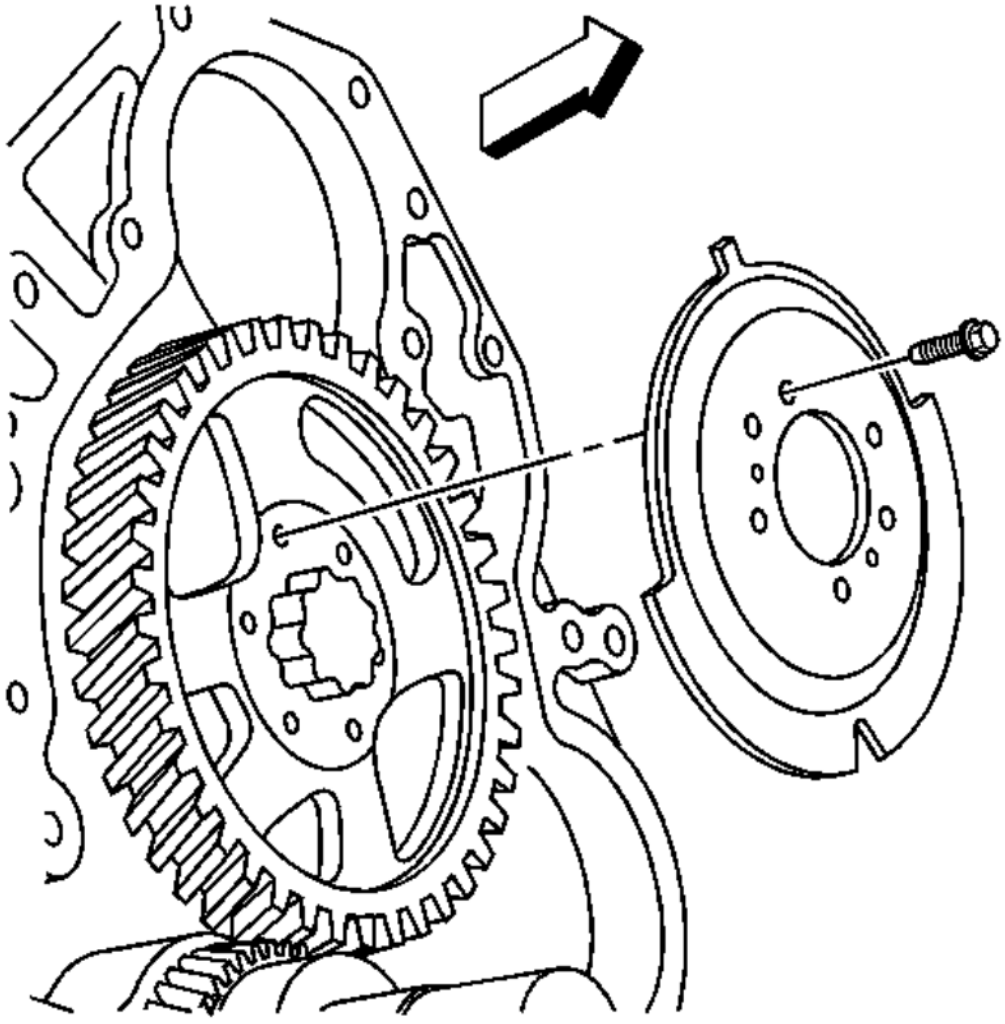


Fig. 260: View Of Camshaft Reluctor & Bolts
Courtesy of GENERAL MOTORS CORP.

7. Install the camshaft reluctor to the camshaft gear.
8. Install the camshaft reluctor bolts.

Tighten: Tighten the bolts in a cross-bolt pattern to 9 N.m (80 lb in).

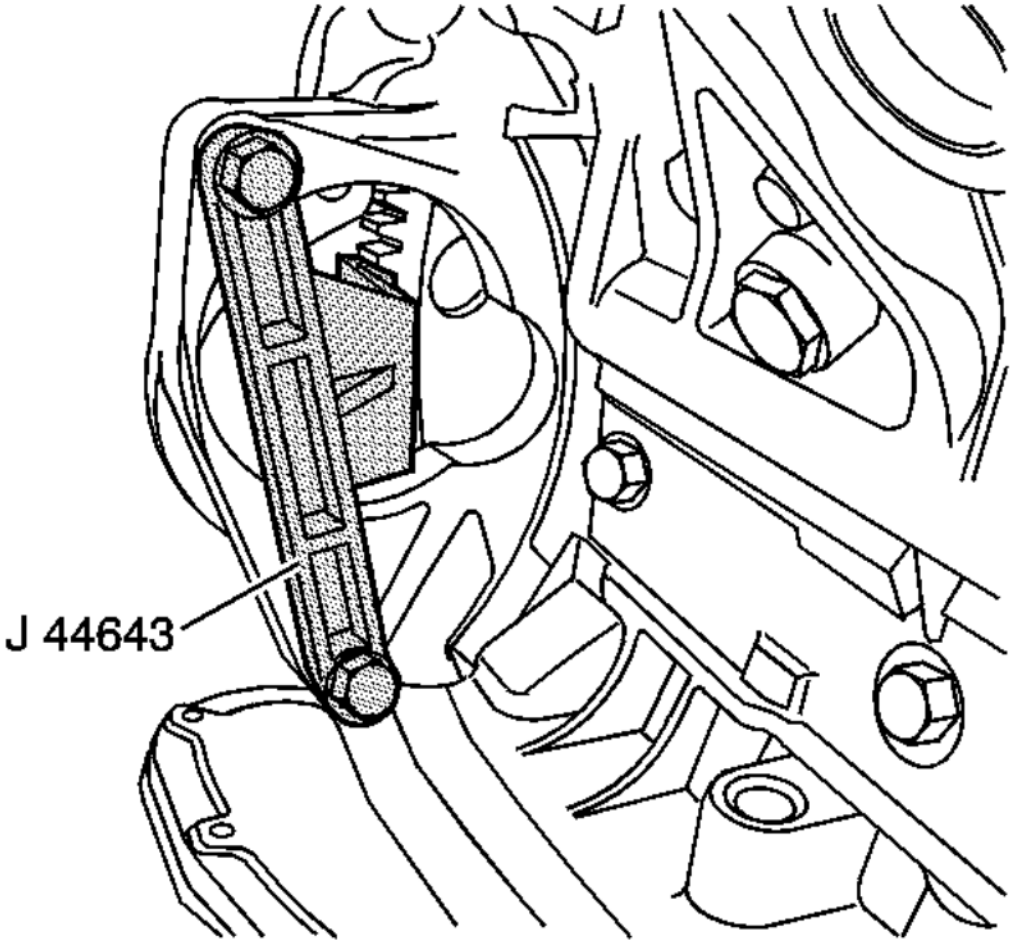


Fig. 261: Locking Flywheel Using J 44643
Courtesy of GENERAL MOTORS CORP.

9. Reinstall **J 44643** in the starter opening, if removed. See **Special Tools** .
10. Install a NEW camshaft gear bolt.

Tighten: Tighten the bolt to 234 N.m (173 lb ft).

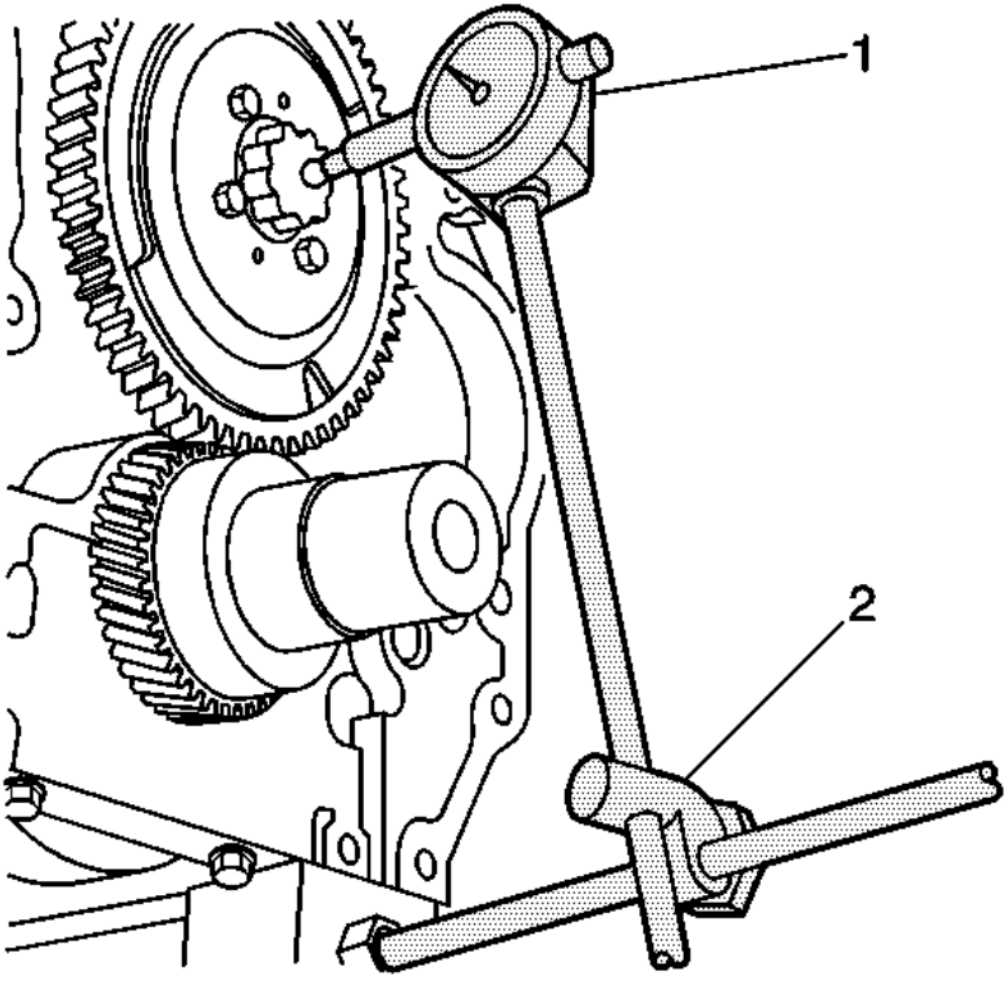


Fig. 262: Measuring Camshaft End Play Using J 26900-12 & J 26900-13
Courtesy of GENERAL MOTORS CORP.

11. Using **J 26900-12** (1) and **J 26900-13** (2) measure the camshaft end play. See **Special Tools** .
    - The production value is 0.050-0.114 mm (0.002-0.0045 in) and service limit is 0.20 mm (0.008 in).
    - Replace the camshaft gear or the camshaft thrust plate if measured value exceeds the service limit.

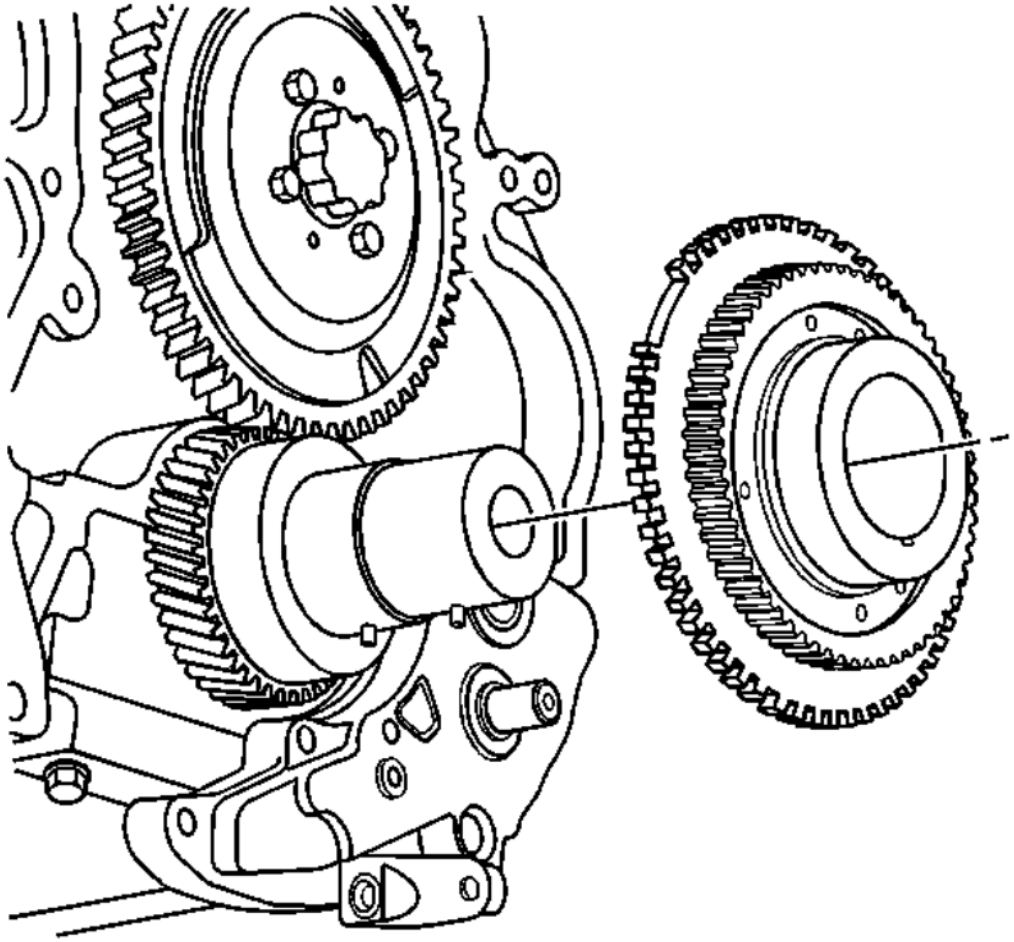


Fig. 263: View Of Oil Pump Drive Gear
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not damage the teeth on the crankshaft reluctor.

12. Install the oil pump drive gear and reluctor to the crankshaft.

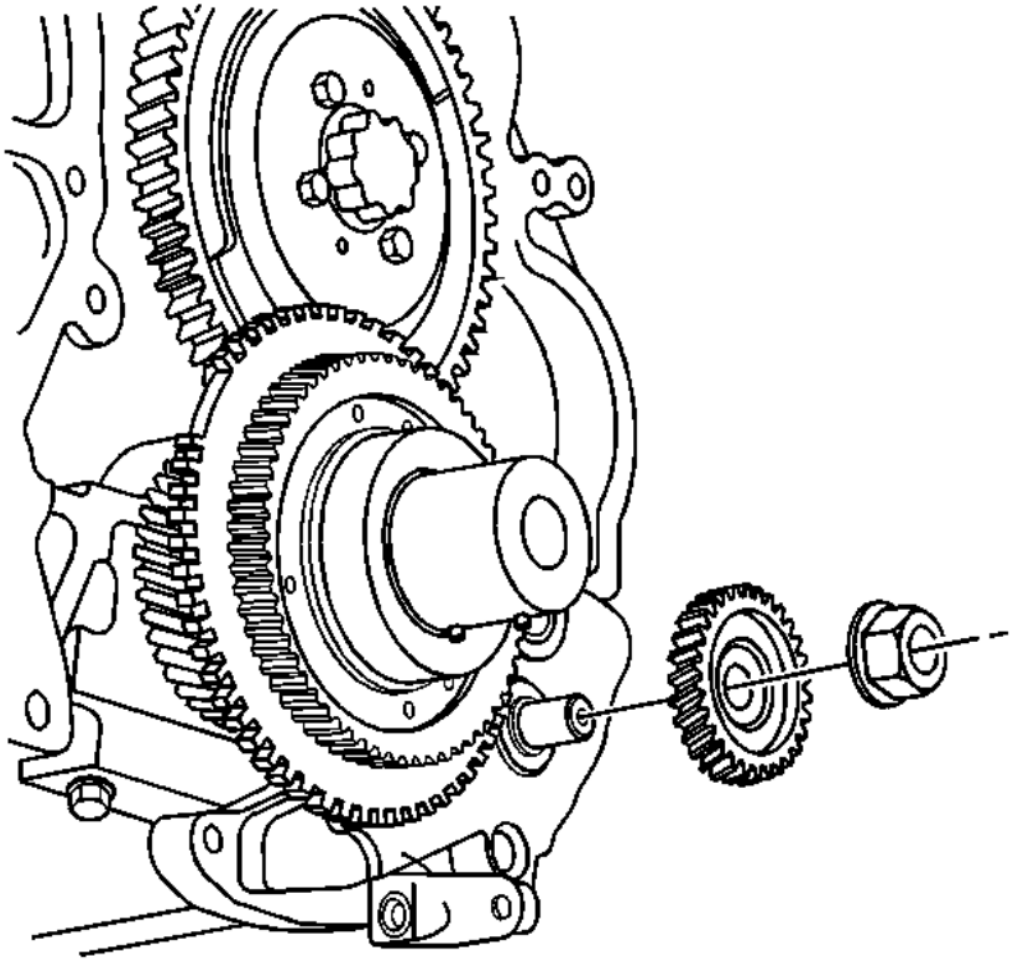


Fig. 264: View Of Oil Pump Driven Gear & Nut
Courtesy of GENERAL MOTORS CORP.

13. Install the oil pump driven gear.
14. Install the oil pump driven gear nut.

    Tighten: Tighten the nut to 100 N.m (74 lb ft).

15. Install the engine front cover. Refer to **Engine Front Cover Replacement**.
16. Install the starter. Refer to **Starter Motor Replacement (6.6L)** .
17. Install the A/C condenser. Refer to **Condenser Replacement** .

18. Install the charged air cooler. Refer to **Charge Air Cooler Replacement** .
19. Install the valve lifters. Refer to **Valve Lifter Replacement**.

CRANKSHAFT REAR OIL SEAL REPLACEMENT

Tools Required

- **J 44641** Crankshaft Rear Oil Seal Remover. See **Special Tools** .
- **J 44642** Crankshaft Rear Oil Seal Installer. See **Special Tools** .

Removal Procedure

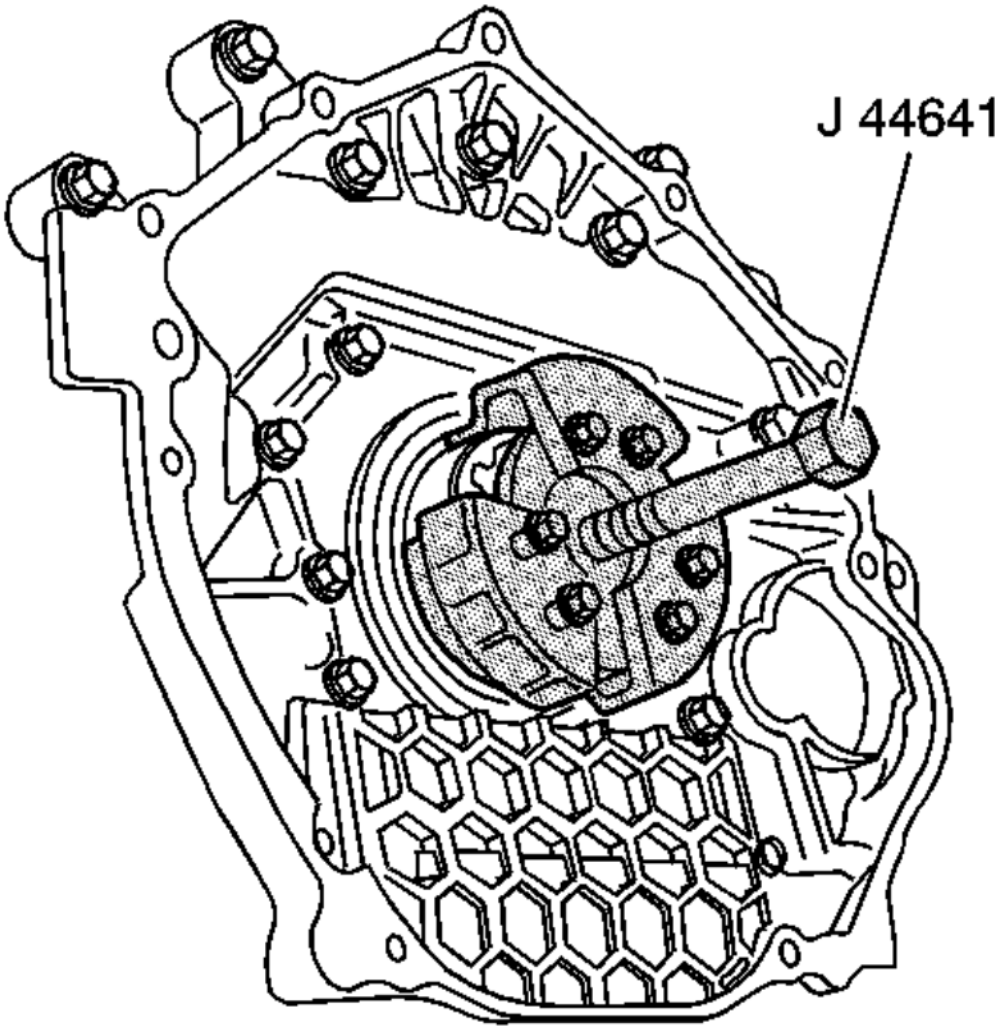


Fig. 265: Removing Crankshaft Rear Oil Seal Using J 44641
Courtesy of GENERAL MOTORS CORP.

1. Remove the flywheel. Refer to **Engine Flywheel Replacement**.
2. Clean the area around the crankshaft rear oil seal.
3. Install **J 44641** to the crankshaft rear oil seal. See **Special Tools** .
4. Remove the crankshaft rear oil seal using **J 44641** . See **Special Tools** .

Installation Procedure

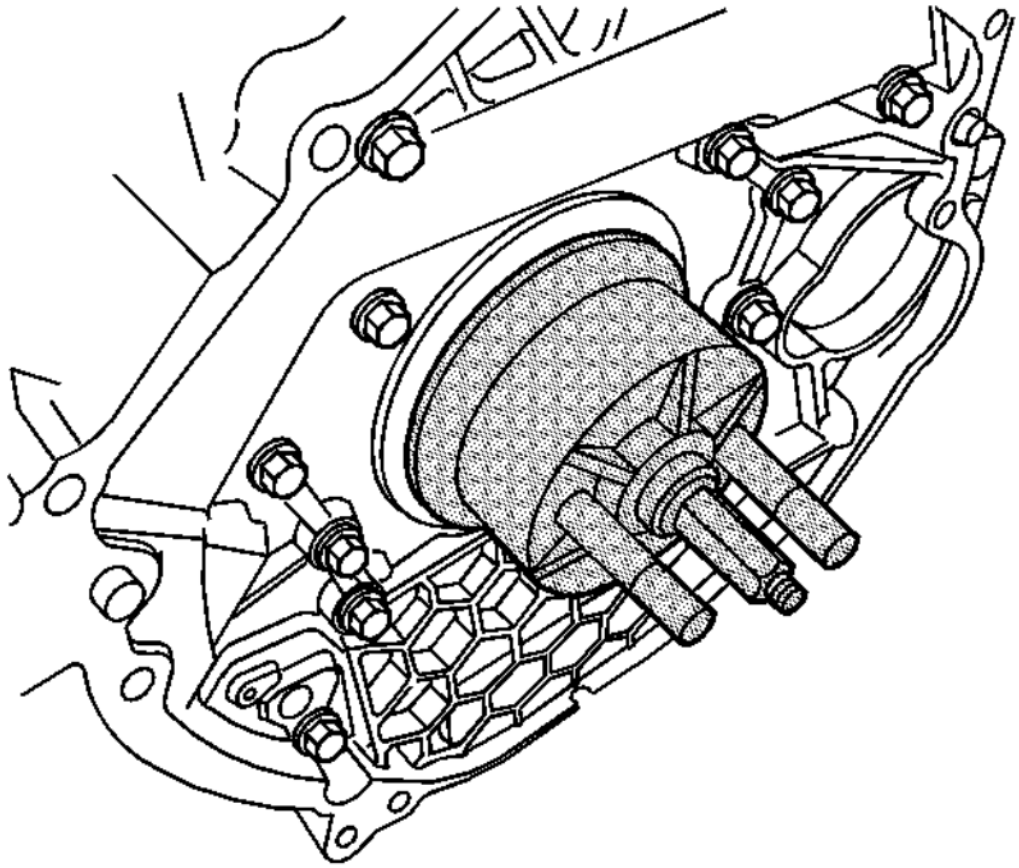


Fig. 266: Pressing Crankshaft Rear Oil Seal In Using J 44642
Courtesy of GENERAL MOTORS CORP.

1. Ensure that the crankshaft is free of oil and dirt.
2. Clean the seal bore in the flywheel housing.
3. Position the crankshaft rear oil seal onto the crankshaft.

IMPORTANT: J 44642 must be fully secured to the crankshaft to ensure proper seal depth. See Special Tools .

4. Install **J 44642** to the crankshaft. See **Special Tools** .
5. Press the crankshaft rear oil seal into position using **J 44642** , the tool will bottom out when the seal reaches the proper depth. See **Special Tools** .

6. Remove **J 44642** . See **Special Tools** .
7. Install the flywheel. Refer to **Engine Flywheel Replacement**.

ENGINE FLYWHEEL HOUSING REPLACEMENT

Tools Required

J 37228 Seal Cutter. See **Special Tools** .

Removal Procedure

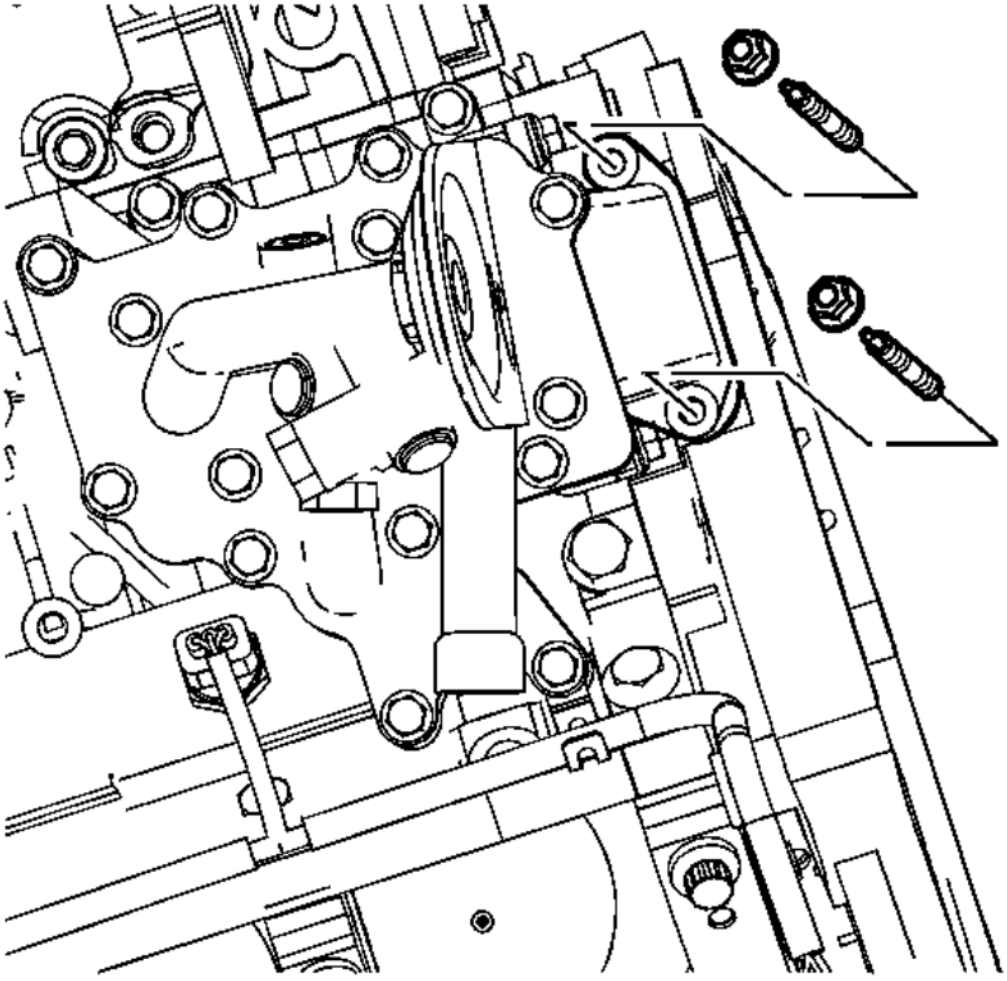


Fig. 267: View Of Turbocharger Oil Return Pipe Nuts
Courtesy of GENERAL MOTORS CORP.

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Vac-N-Fill)** or **Cooling System Draining and Filling (Static Fill)** .
2. Remove the crankshaft rear oil seal. Refer to **Crankshaft Rear Oil Seal Replacement**.
3. Remove the turbocharger oil return pipe nuts from the top of the flywheel housing.

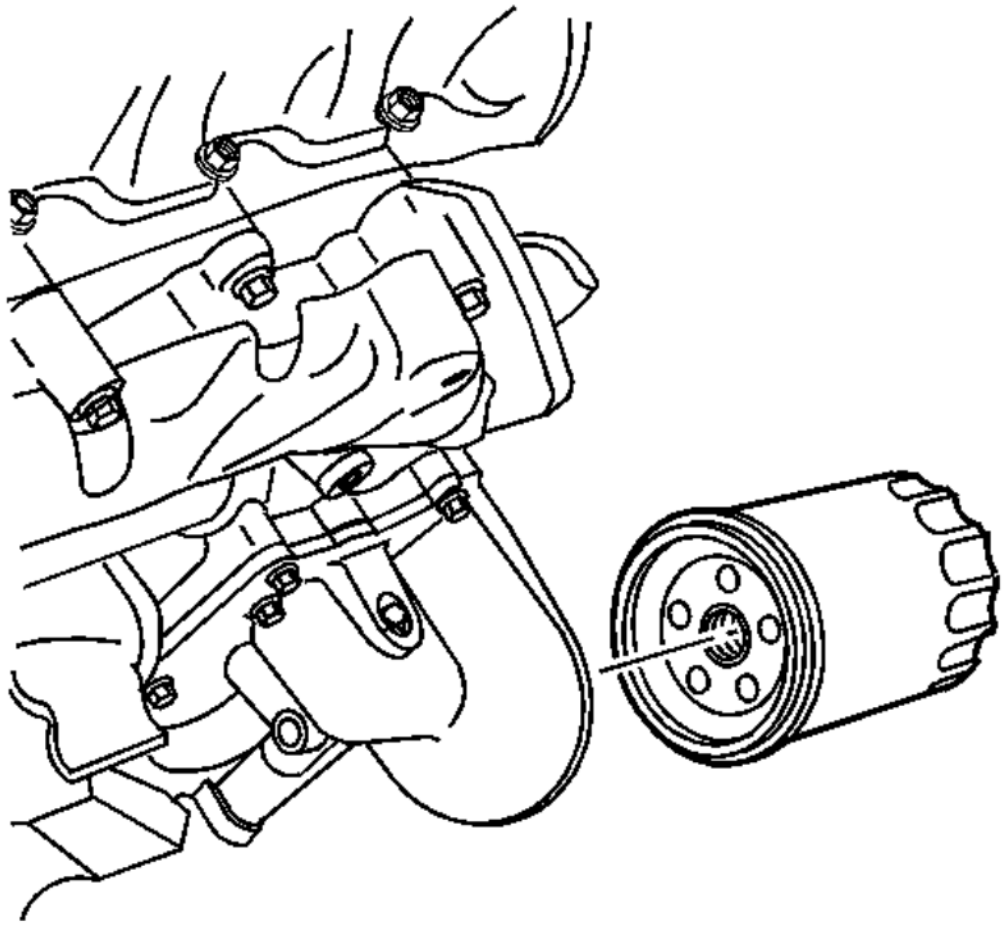


Fig. 268: View Of Oil Filter
Courtesy of GENERAL MOTORS CORP.

4. Remove the upper oil pan. Refer to **Upper Oil Pan Replacement**.
5. Remove the oil filter.

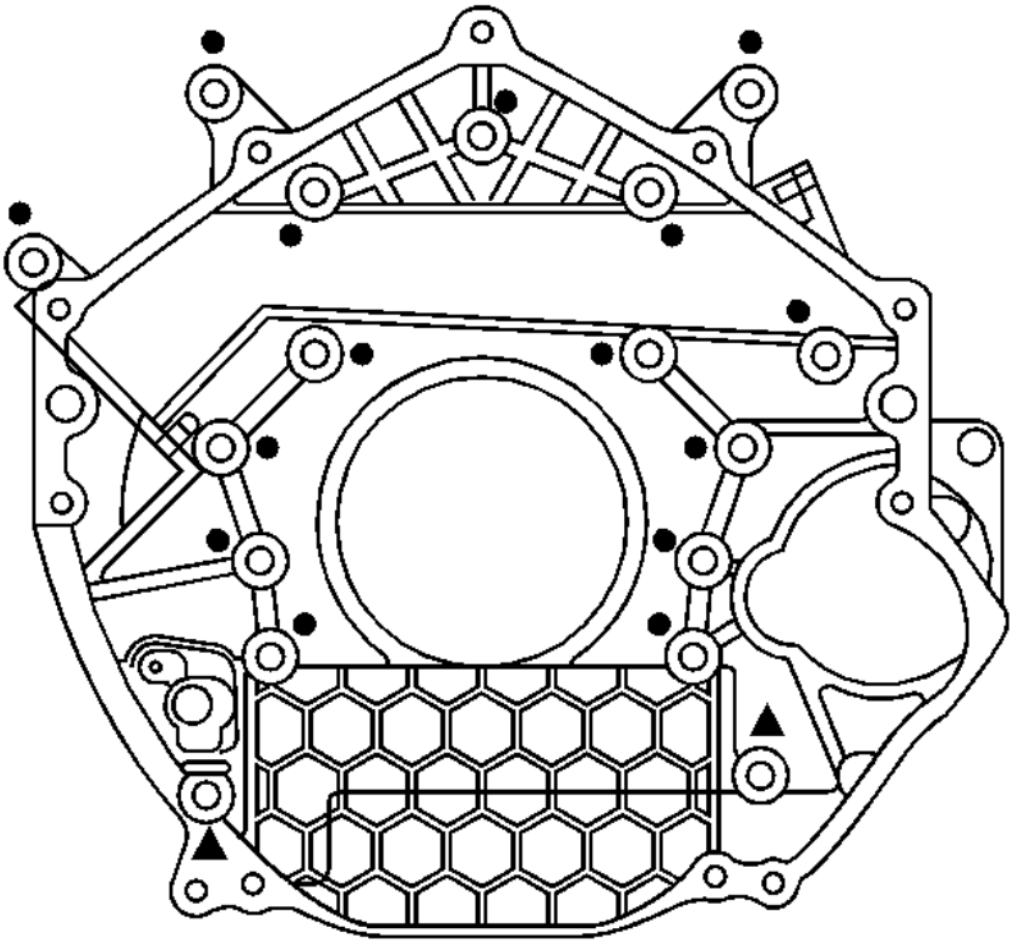


Fig. 269: View Of Engine Rear Cover Bolts & Flywheel Housing To Upper Oil Pan Bolts
Courtesy of GENERAL MOTORS CORP.

6. Remove the flywheel housing bolts, denoted by the black circles.
7. Separate the flywheel from the cylinder block using **J 37228** . See **Special Tools** .
8. Remove the flywheel housing.

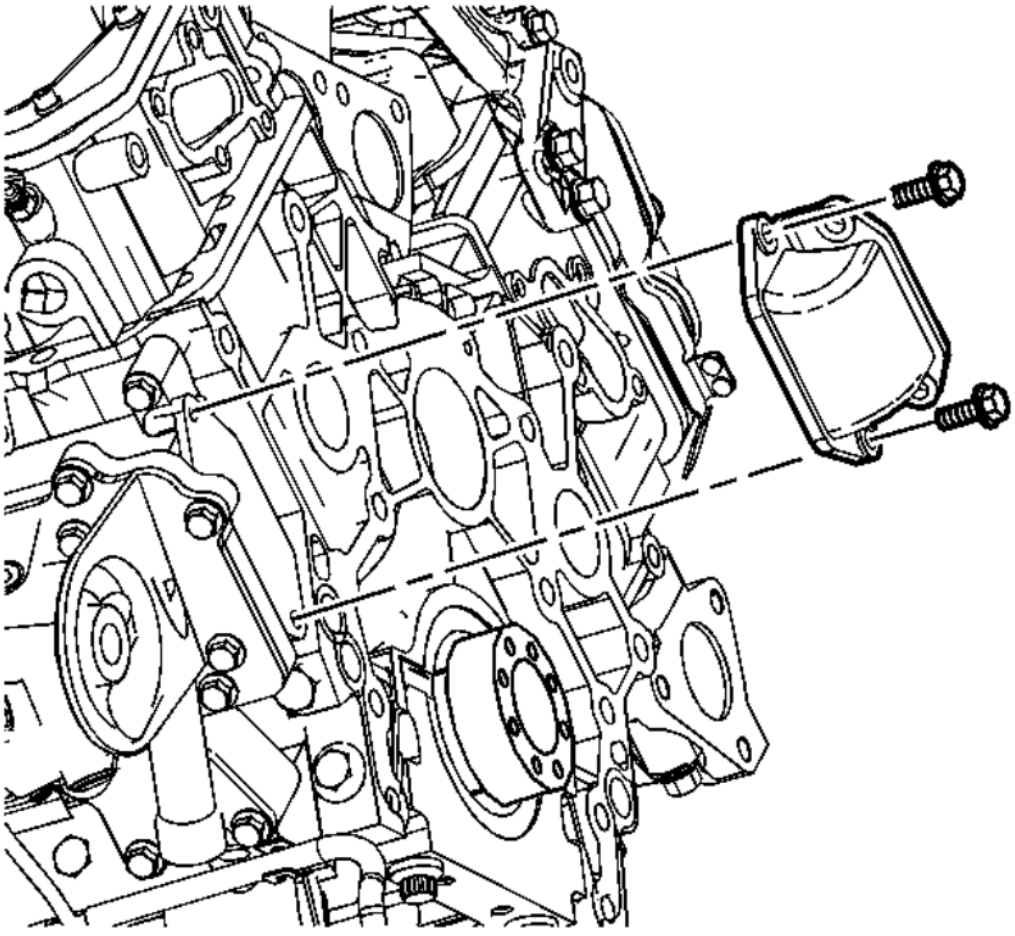


Fig. 270: View Of Oil Cooler Adapter
Courtesy of GENERAL MOTORS CORP.

9. Remove the turbocharger oil return pipe gasket from the flywheel housing.
10. Remove the oil cooler adapter bolts.
11. Remove the oil cooler adapter and gaskets.
12. If required, clean and inspect the flywheel housing. Refer to **Engine Flywheel Housing Cleaning and Inspection** .

Installation Procedure

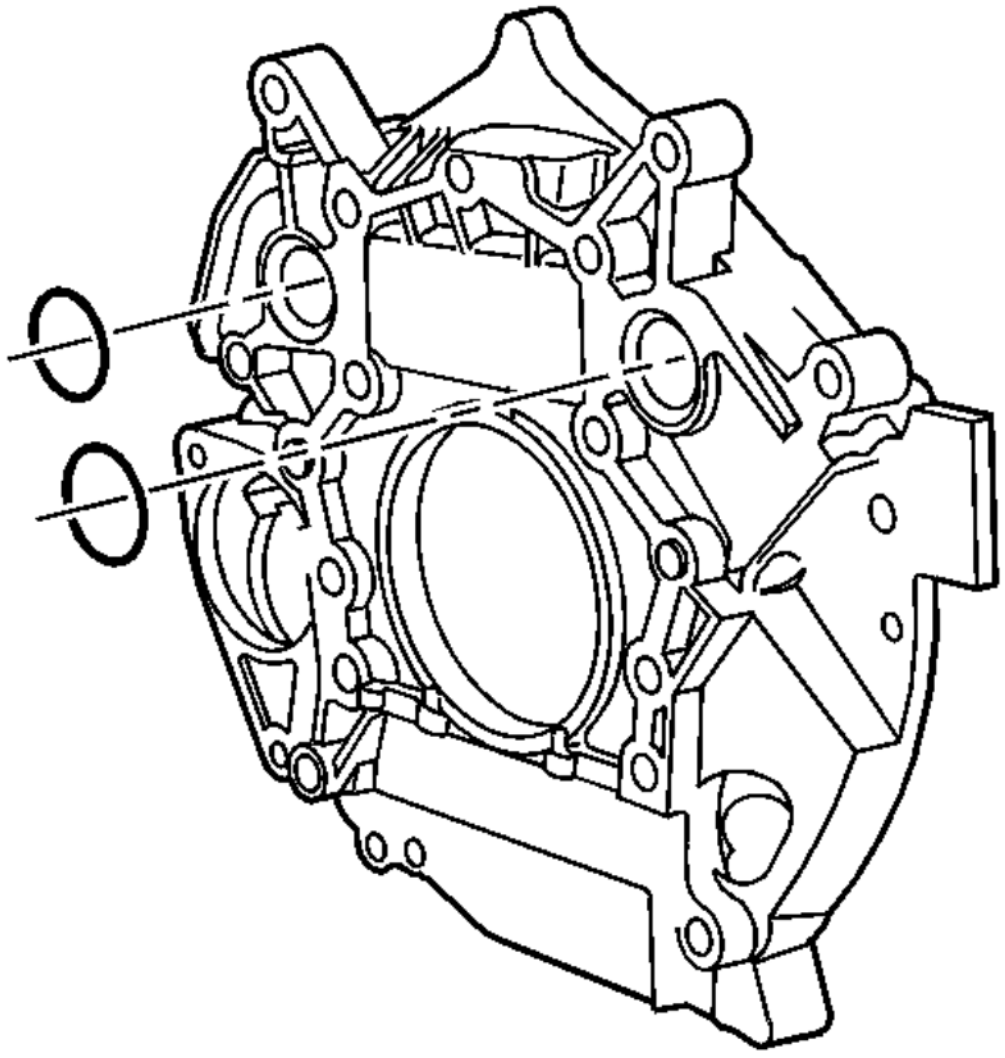


Fig. 271: View Of Flywheel Housing O-Ring Seals
Courtesy of GENERAL MOTORS CORP.

1. Install NEW O-ring seals to the flywheel housing, if necessary.

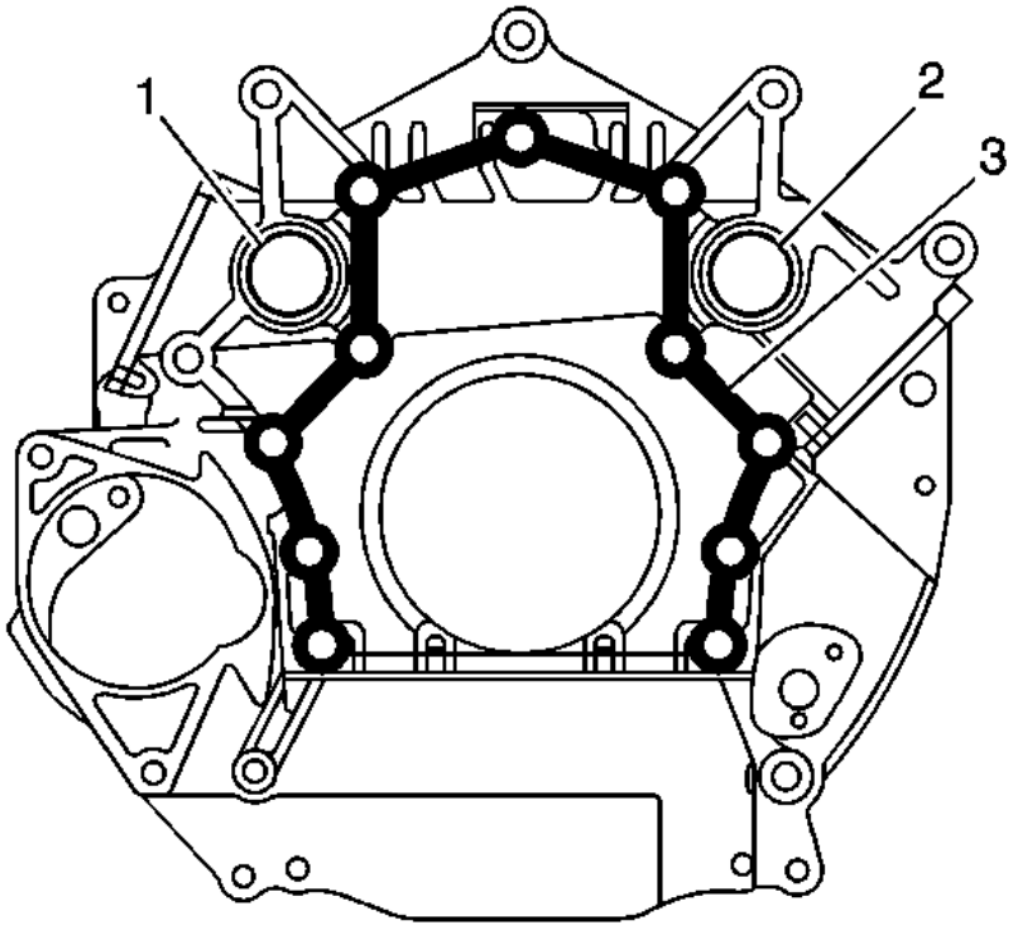


Fig. 272: View Of Engine Rear Cover Sealing Surfaces Sealant Application Area
Courtesy of GENERAL MOTORS CORP.

2. Apply a 2 mm (1/8 in) wide bead of sealant (3) to the flywheel housing sealing surfaces. Refer to **Sealers, Adhesives, and Lubricants** for the correct part number.

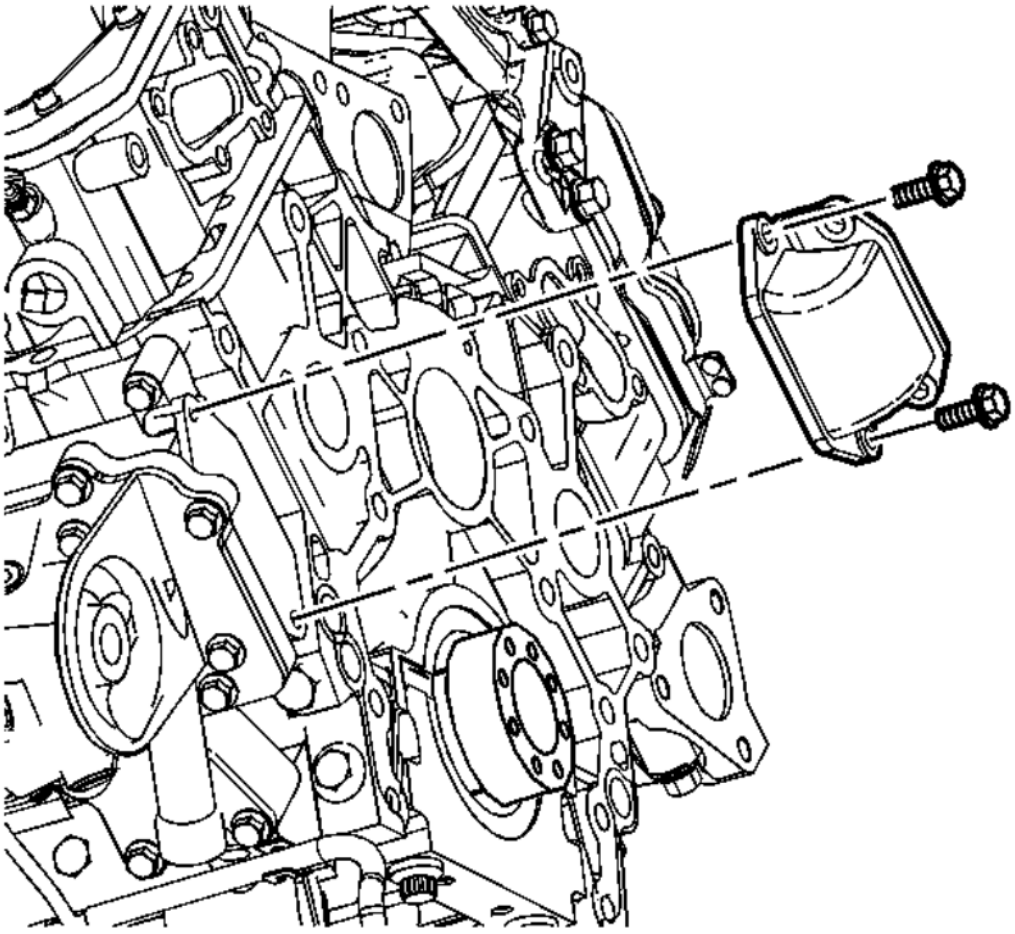


Fig. 273: View Of Oil Cooler Adapter
Courtesy of GENERAL MOTORS CORP.

3. Install a NEW oil cooler adapter gasket.
4. Install a NEW oil cooler adapter to flywheel housing gasket.
5. Install the oil cooler adapter to the flywheel housing.

NOTE: Refer to Fastener Notice .

6. Install the oil cooler adapter bolts.

Tighten: Tighten the bolts/nuts to 21 N.m (15 lb ft).

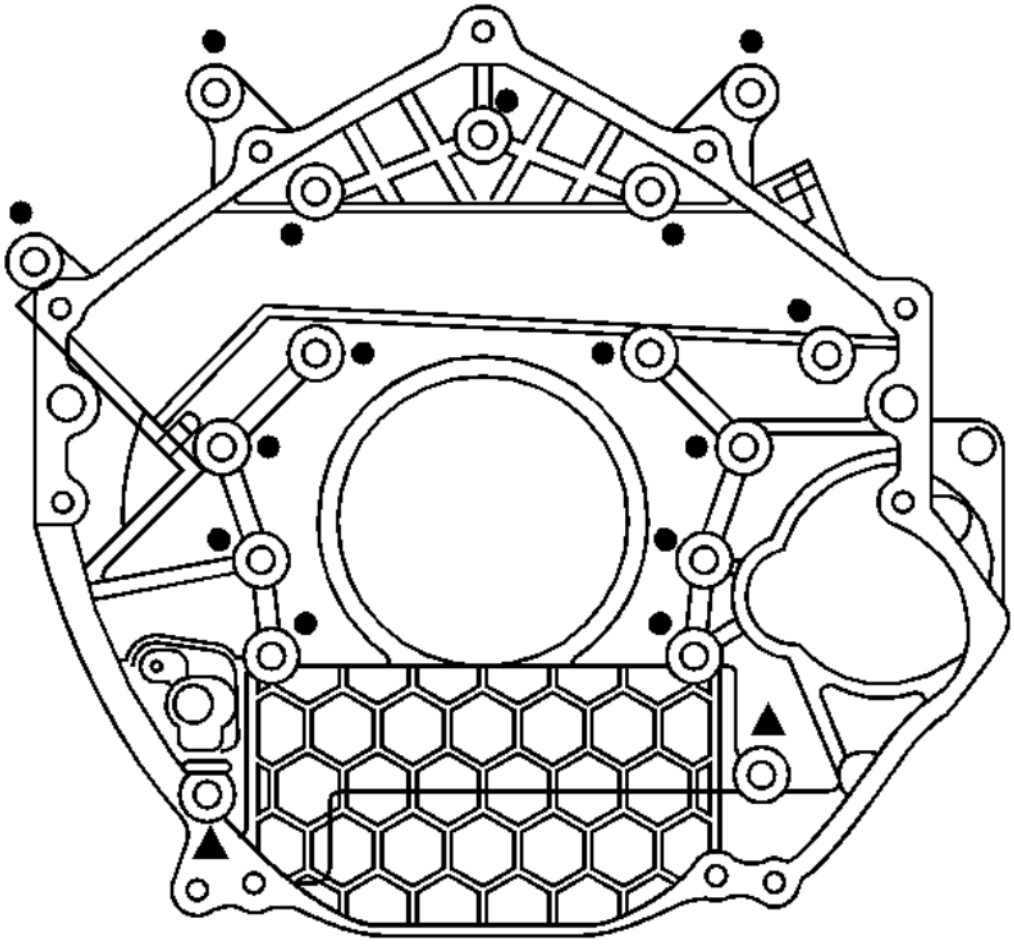


Fig. 274: View Of Engine Rear Cover Bolts & Flywheel Housing To Upper Oil Pan Bolts
Courtesy of GENERAL MOTORS CORP.

7. Install the flywheel housing bolts, denoted by the black circles.

   Tighten: Tighten the bolts to 90 N.m (67 lb ft).

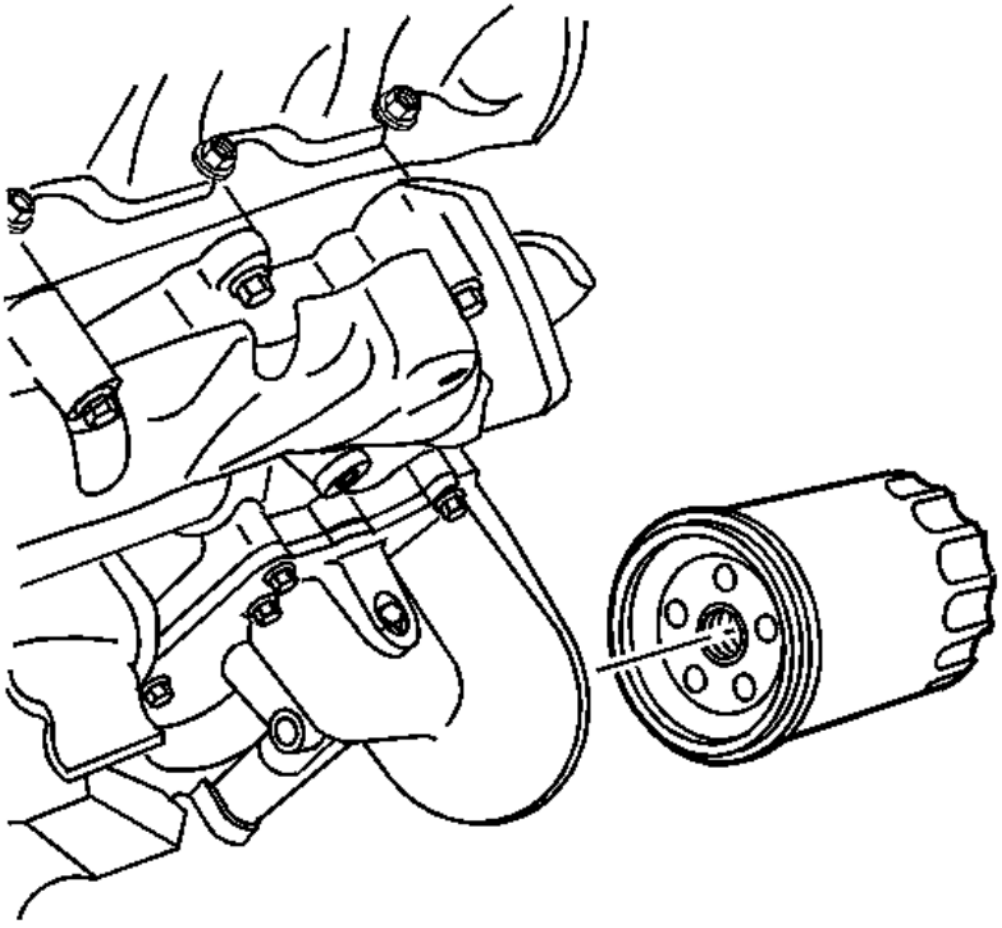


Fig. 275: View Of Oil Filter
Courtesy of GENERAL MOTORS CORP.

8. Install the oil filter.
9. Install the upper oil pan. Refer to **Upper Oil Pan Replacement**.

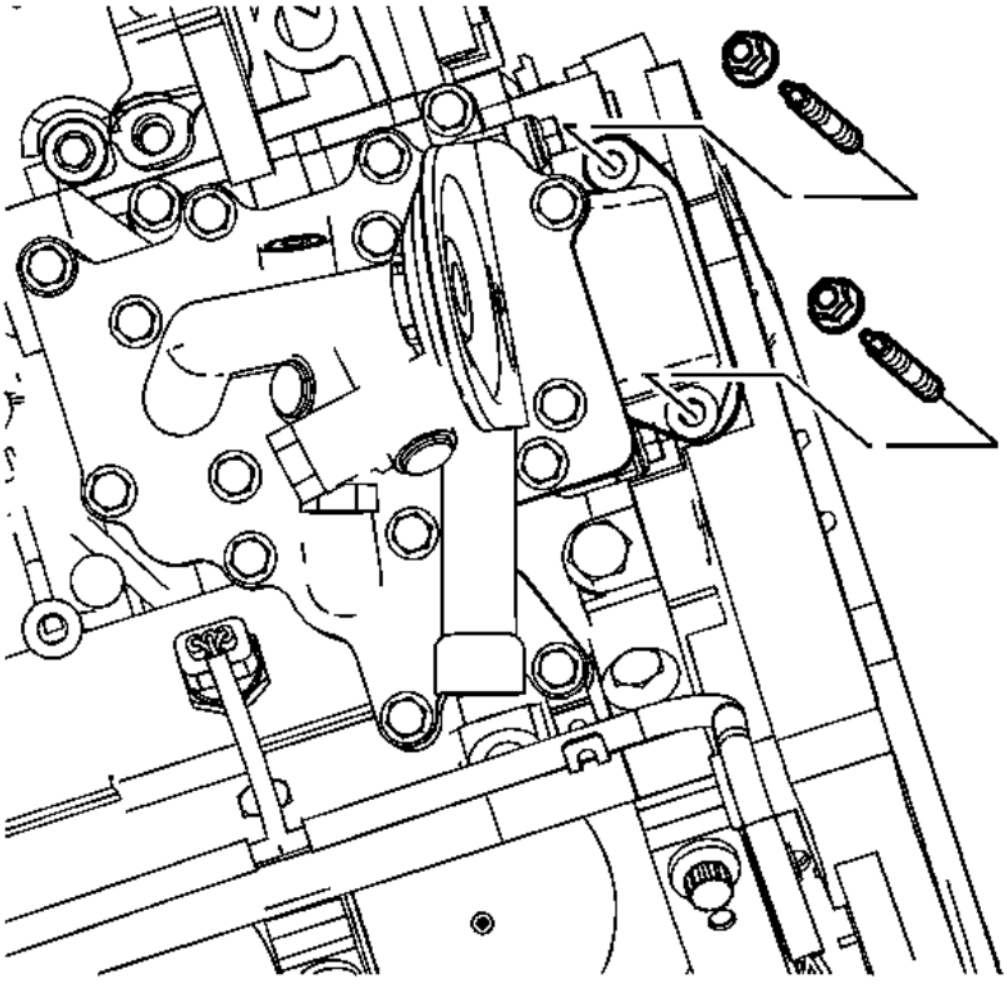


Fig. 276: View Of Turbocharger Oil Return Pipe Nuts
Courtesy of GENERAL MOTORS CORP.

10. Install a NEW gasket to the turbocharger oil return pipe.
11. Install the turbocharger oil return pipe to flywheel housing nuts.

    Tighten: Tighten the nuts to 21 N.m (15 lb ft).

12. Install the crankshaft rear oil seal. Refer to **Crankshaft Rear Oil Seal Replacement**.
13. Fill the cooling system. Refer to **Cooling System Draining and Filling (Vac-N-Fill)** or

Cooling System Draining and Filling (Static Fill) .

ENGINE FLYWHEEL REPLACEMENT

Tools Required

- **J 44643** Flywheel Holding Tool. See **Special Tools** .
- **J 45059** Angle Meter

Removal Procedure

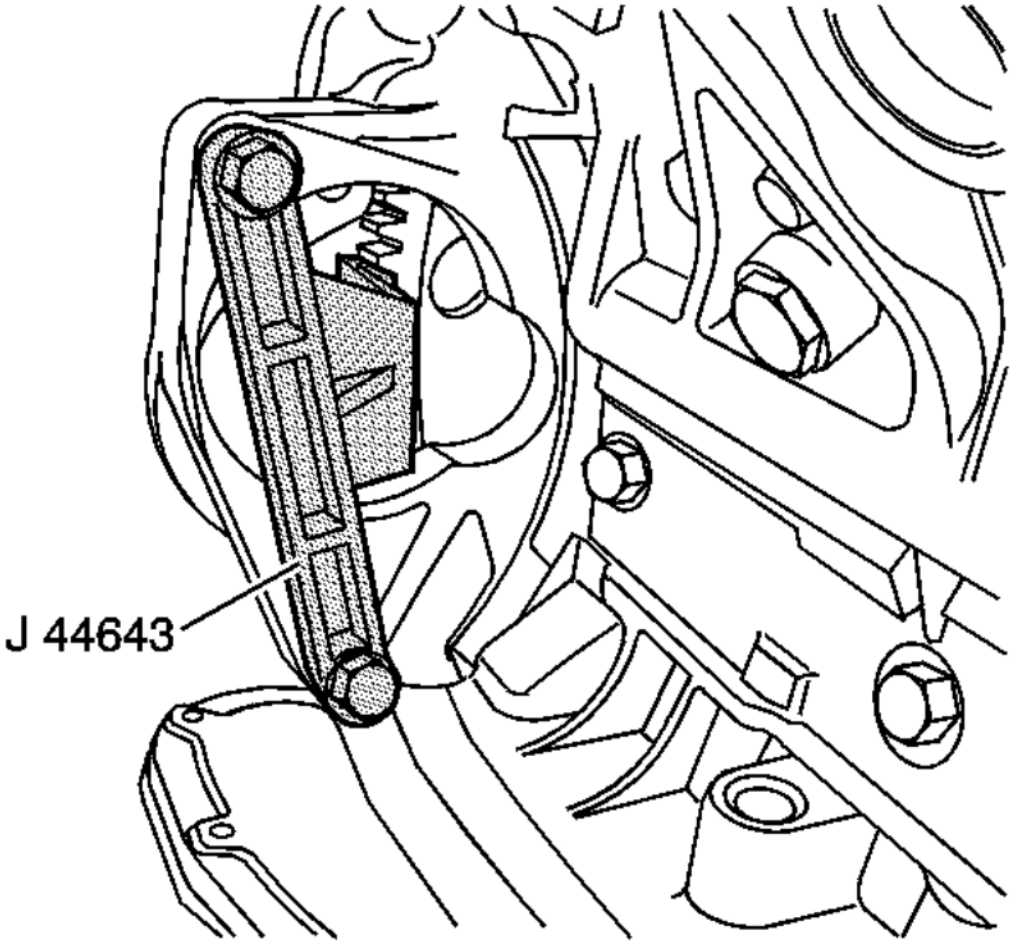


Fig. 277: Locking Flywheel Using J 44643

Courtesy of GENERAL MOTORS CORP.

1. Remove the transmission. Refer to **Transmission Replacement** for the 4L60-E /4L65-E/4L70-E transmission, **Transmission Replacement** for the 4L50/4L80/4L90 transmission, or **Transmission Replacement** for the Allison transmission.
2. Install **J 44643** in order to hold the flywheel. See **Special Tools** .

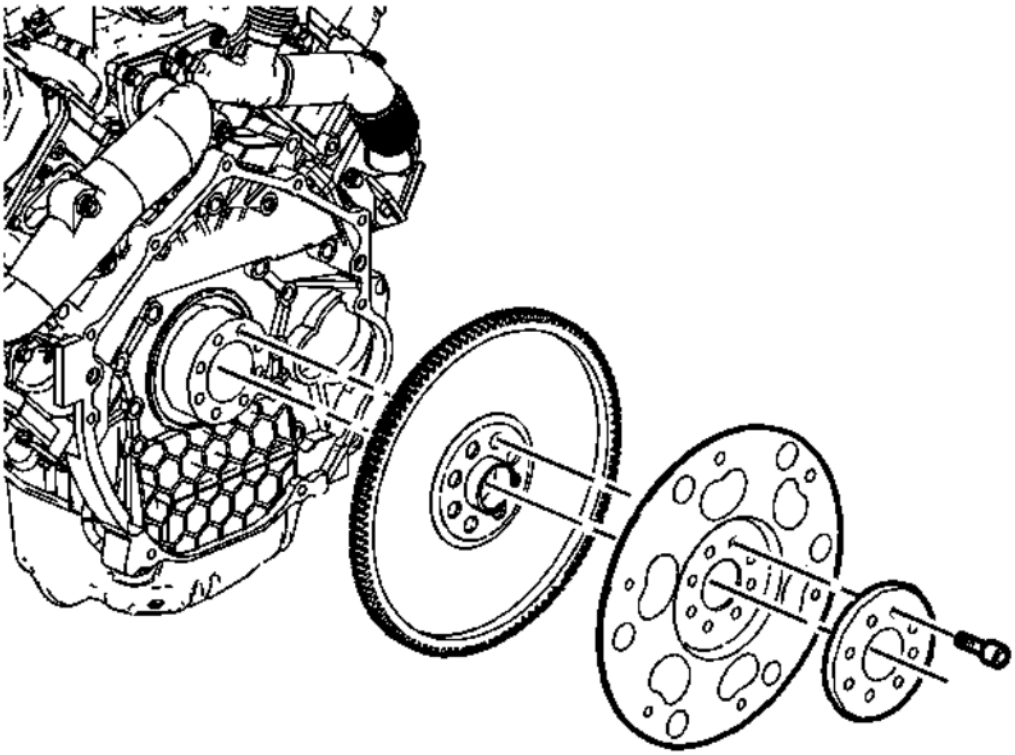


Fig. 278: View Of Flywheel & Washer (Automatic)
Courtesy of GENERAL MOTORS CORP.

CAUTION: When removing, handling or installing this component wear protective gloves. The sharp edges on the component may be very sharp and may cause injury.

3. Remove and discard the flywheel bolts.
4. Remove the flywheel washer and flywheel.

Installation Procedure

CAUTION: When removing, handling or installing this component wear protective gloves. The sharp edges on the component may be very sharp and may cause injury.

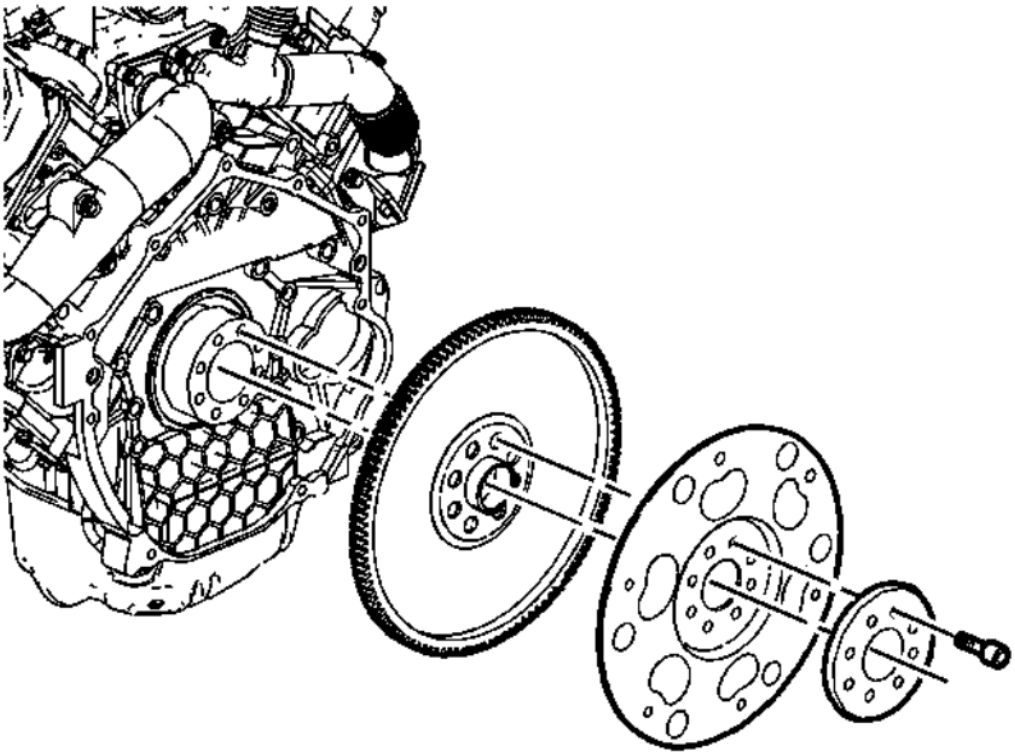


Fig. 279: View Of Flywheel & Washer (Automatic)
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: When installing the flywheel, ensure that the tapered side of the teeth are facing the starter.

1. Install the flywheel.
2. Install the flywheel washer with the beveled side facing the engine.

NOTE: Refer to Fastener Notice .

NOTE: **This component uses bolts with a preapplied molybdenum disulfide coating for thread lubrication. Do not remove the coating or use any additional lubricant. Improperly lubricated threads will adversely affect the bolt torque and clamp load. Improper bolt torque and clamp load can lead to engine damage.**

3. Install NEW flywheel bolts.

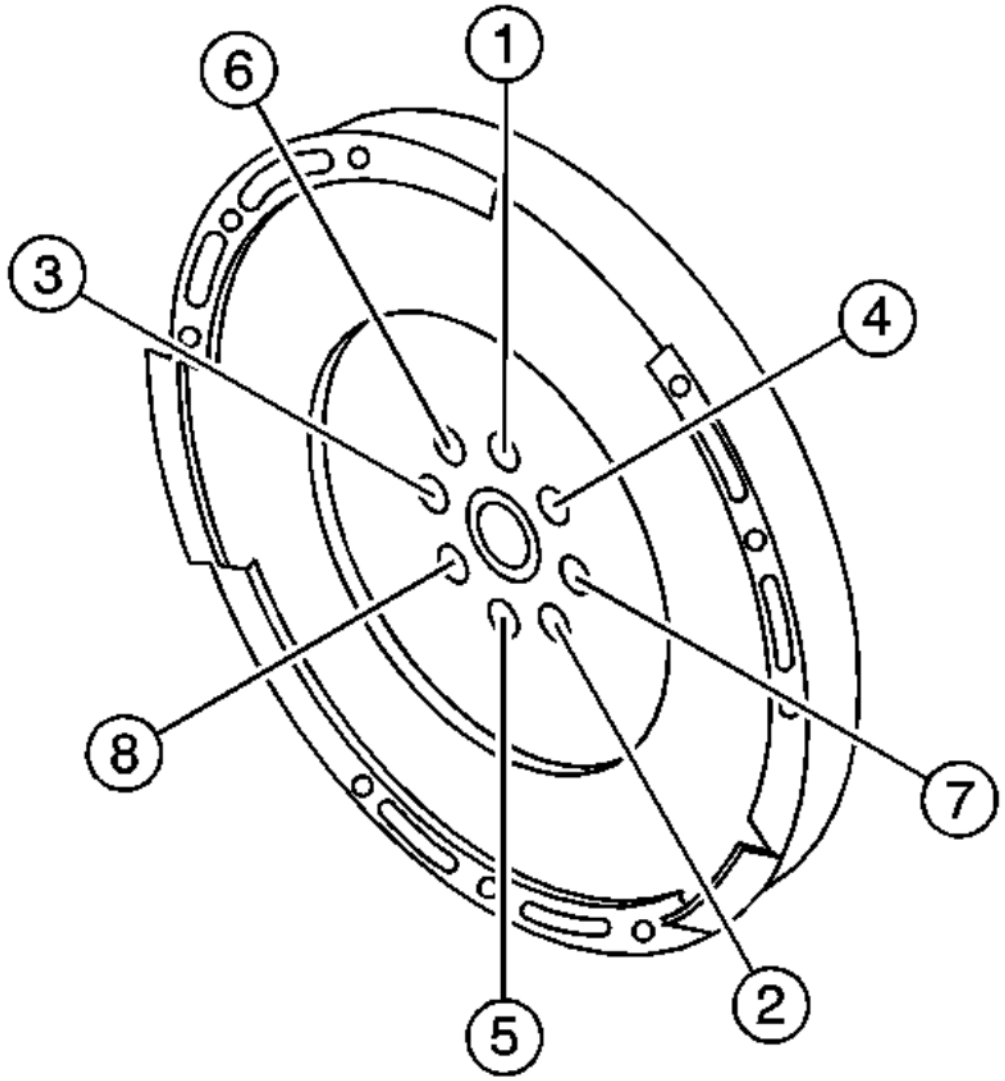


Fig. 280: Flywheel Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

4. Tighten the flywheel bolts in the proper sequence.

Tighten:

1. Tighten the bolts a first pass to 79 N.m (58 lb ft).

2. Tighten the bolts a second pass to 60 degrees using **J 45059** .
3. Tighten the bolts a final pass an additional 60 degrees using **J 45059** .

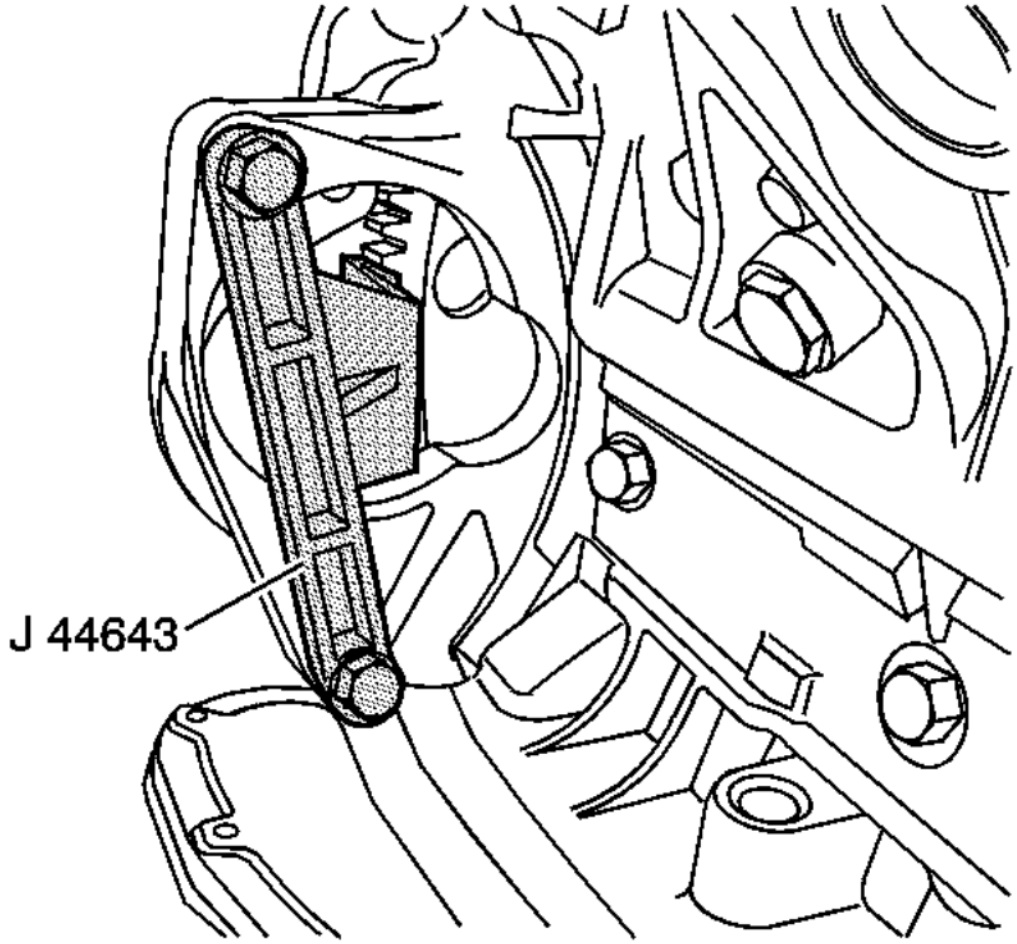


Fig. 281: Locking Flywheel Using J 44643
Courtesy of GENERAL MOTORS CORP.

5. Remove **J 44643** from the flywheel. See **Special Tools** .
6. Install the transmission. Refer to **Transmission Replacement** for the 4L60-E/4L65-E/4L70-E transmission, **Transmission Replacement** for the 4L50/4L80/4L90 transmission, or **Transmission Replacement** for the Allison transmission.

LOWER OIL PAN REPLACEMENT

Tools Required

J 37228 Seal Cutter. See **Special Tools** .

Removal Procedure

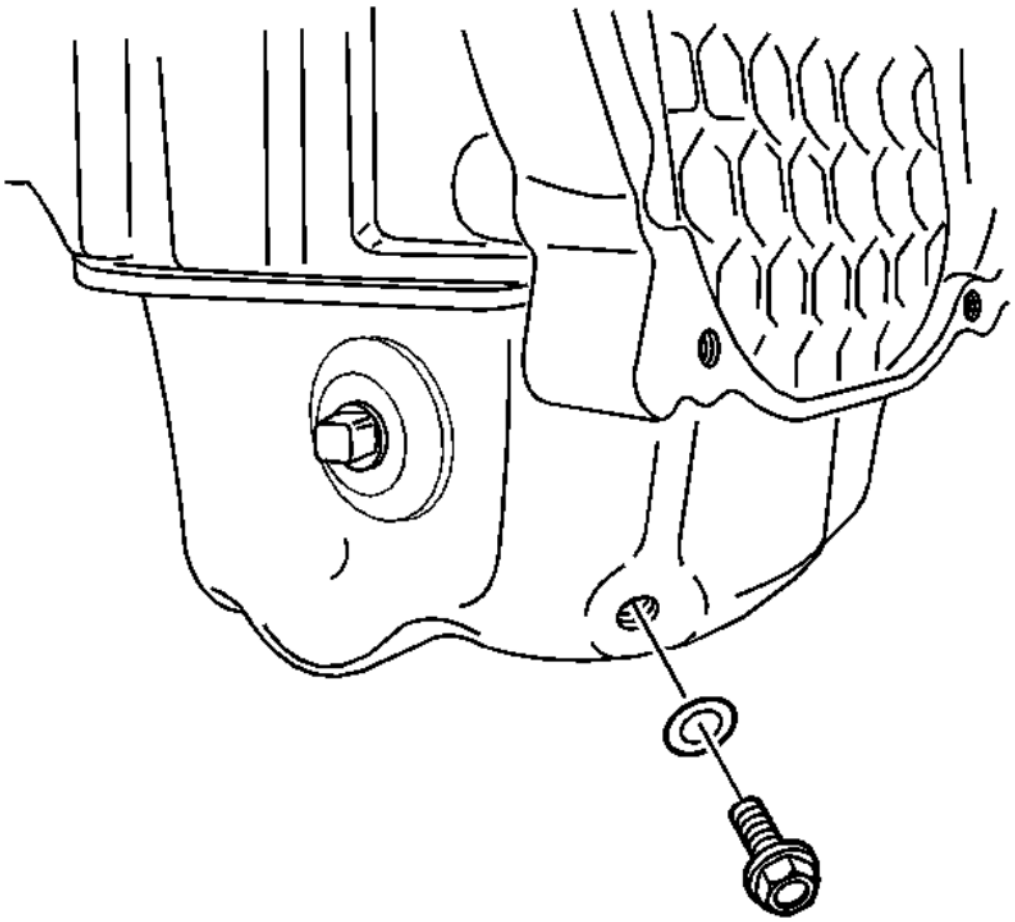


Fig. 282: View Of Engine Oil Drain Plug
Courtesy of GENERAL MOTORS CORP.

1. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Place a suitable container under the engine in order to drain the oil.

3. Remove the oil drain plug.
4. Drain the engine oil.

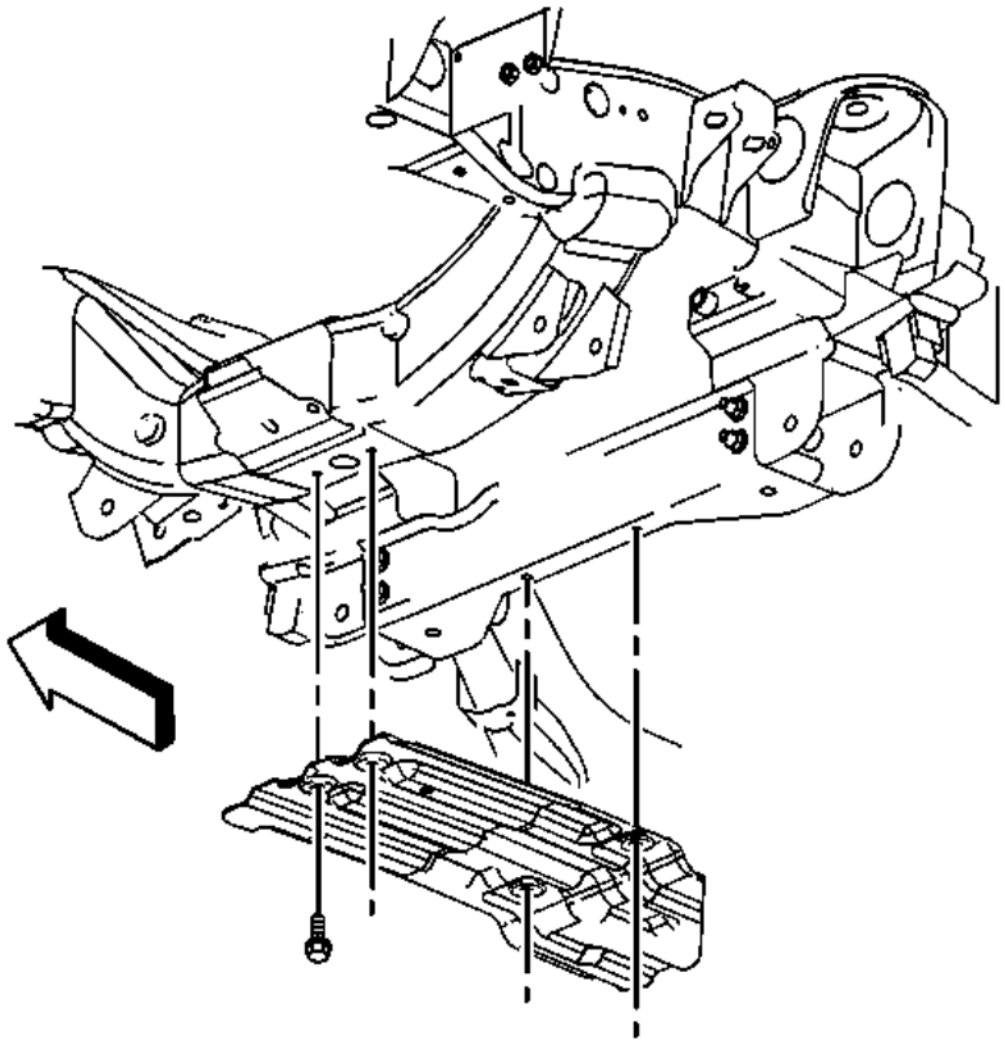


Fig. 283: Identifying Oil Pan Skid Plate
Courtesy of GENERAL MOTORS CORP.

5. Remove the oil pan skid plate bolts and plate, if equipped.

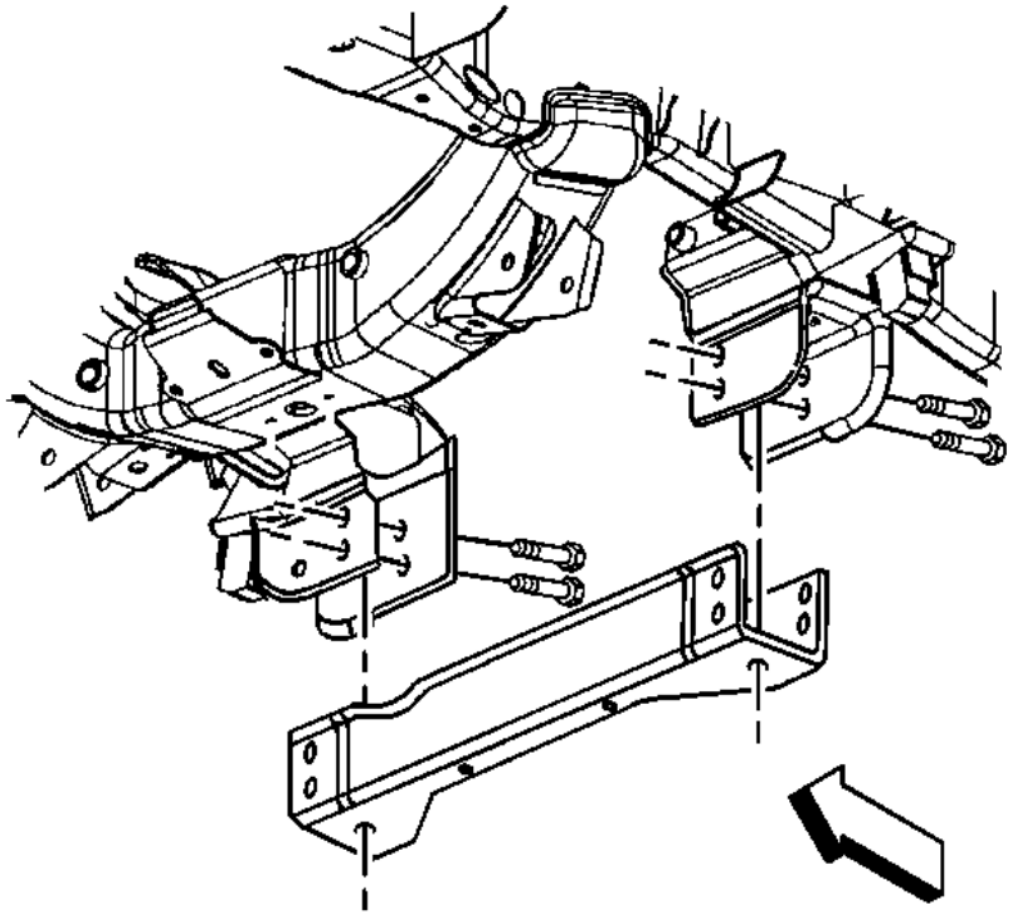


Fig. 284: View Of Crossbar Bolts & Bar (2WD)
Courtesy of GENERAL MOTORS CORP.

6. If equipped with a 2-wheel drive (2WD) vehicle, remove the crossmember bolts and crossmember.

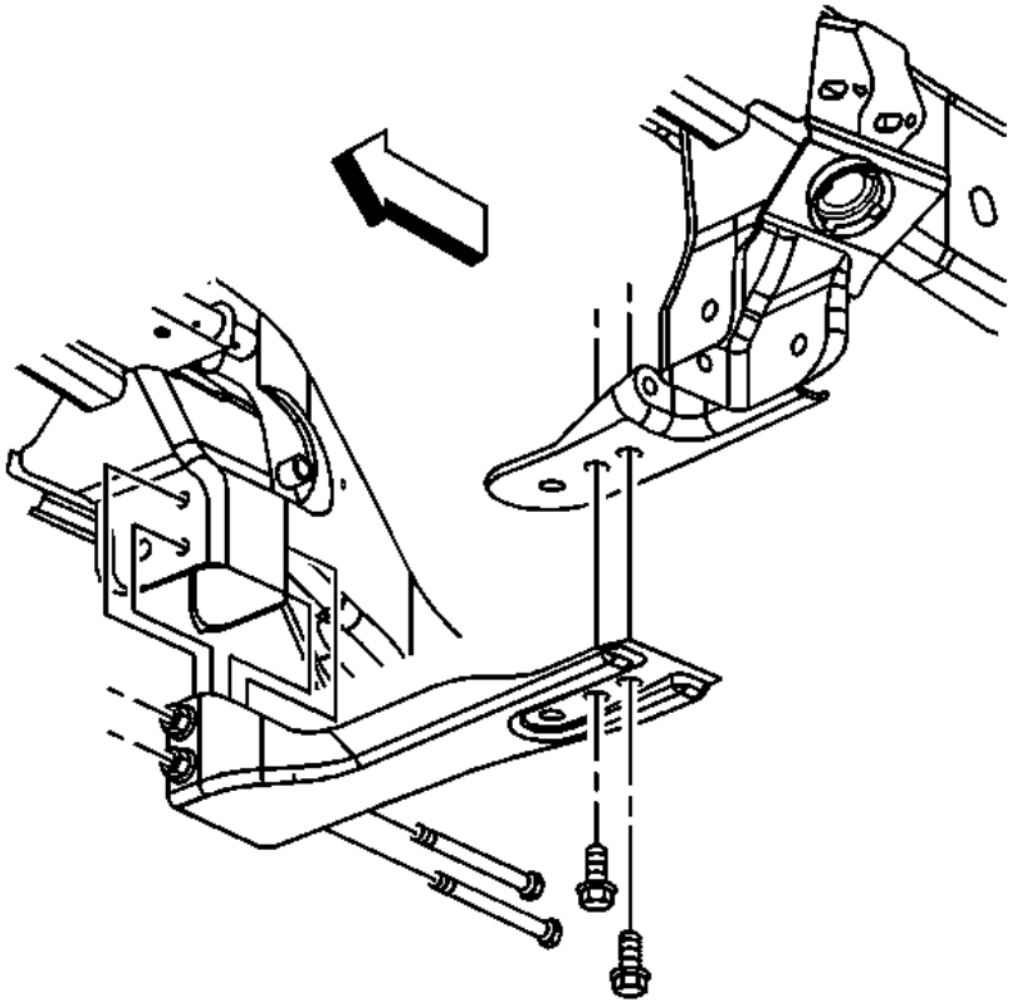


Fig. 285: View Of Crossmember Bolts & Bar (4WD Only)
Courtesy of GENERAL MOTORS CORP.

7. If equipped with a 4-wheel drive (4WD) vehicle, remove the crossmember bolts and crossmember.

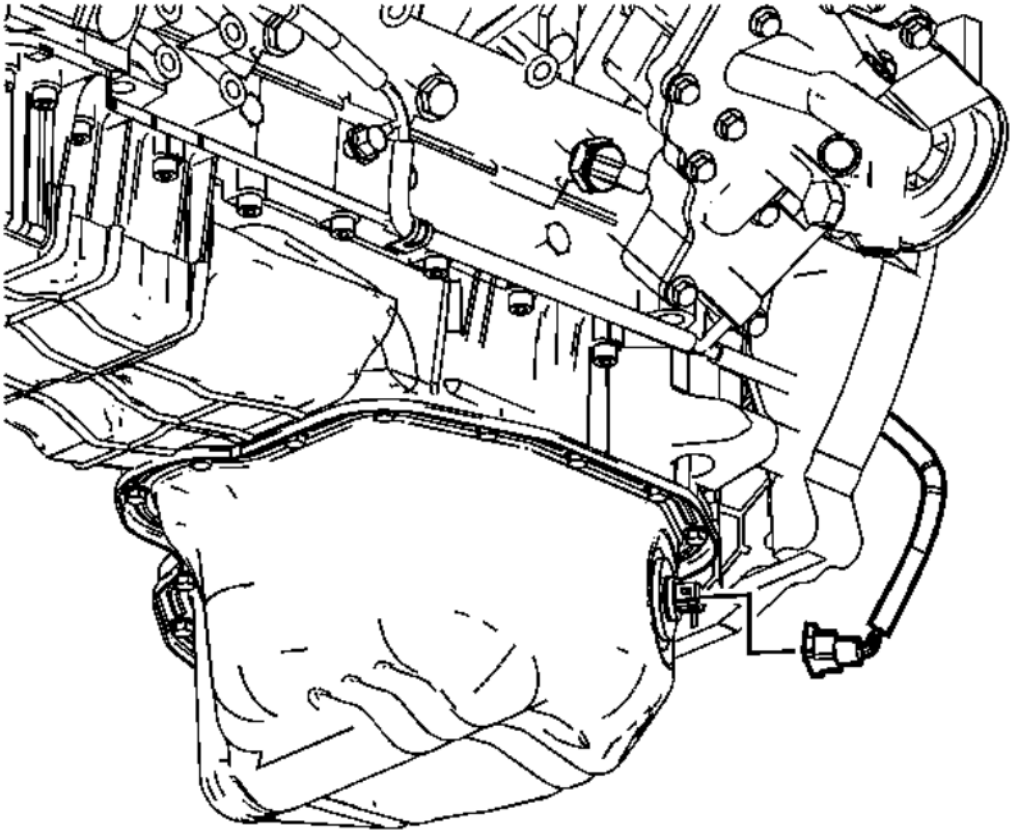


Fig. 286: View Of Oil Level Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

8. Disconnect the oil level sensor electrical connector.

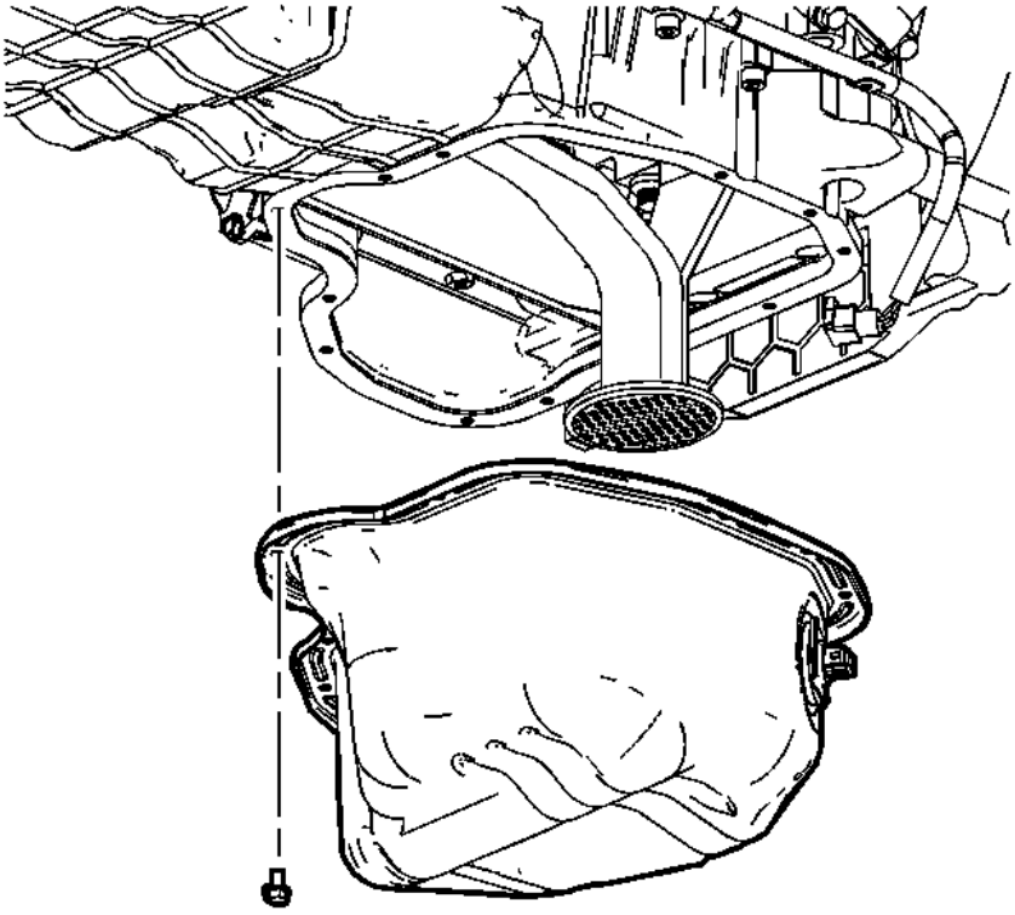


Fig. 287: View Of Lower Oil Pan & Bolts/Nuts
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: DO NOT damage the sealing surfaces when separating the lower oil pan from the upper oil pan.

9. Remove the lower oil pan bolts/nuts.
10. Separate the lower oil pan from the upper oil pan using **J 37228** . See **Special Tools** .
11. Remove the lower oil pan.
12. If necessary, clean and inspect the lower oil pan. Refer to **Lower Oil Pan Cleaning and Inspection** .

Installation Procedure

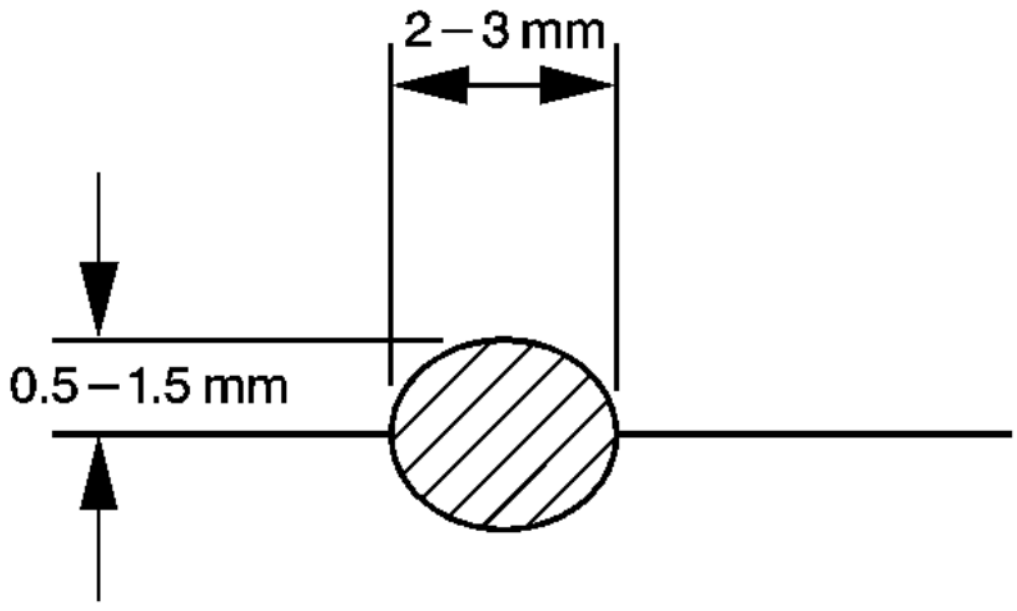


Fig. 288: Determining Sealant Bead Dimensions
Courtesy of GENERAL MOTORS CORP.

1. Apply a 2-3 mm (0.79-0.118 in) by 0.5-1.5 mm (0.02-0.06 in) wide bead of sealant to the lower oil pan mating surface. Refer to **Sealers, Adhesives, and Lubricants** for the correct part number.

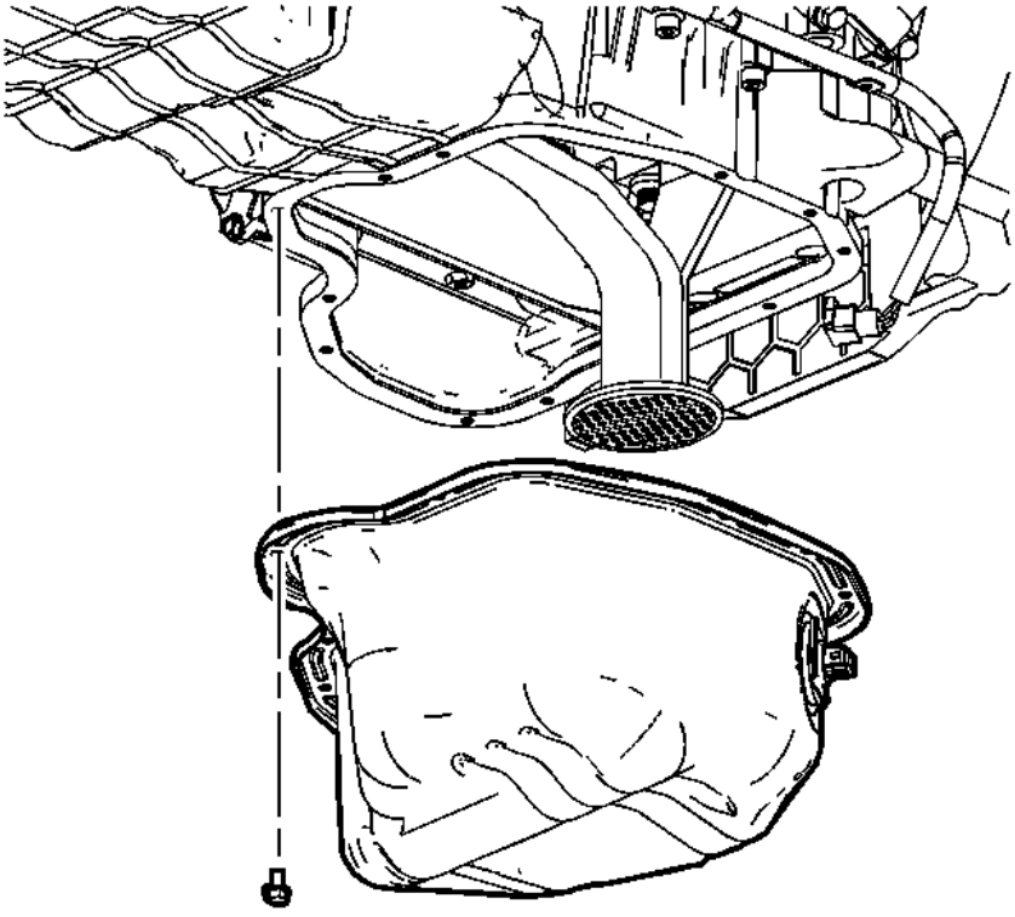


Fig. 289: View Of Lower Oil Pan & Bolts/Nuts
Courtesy of GENERAL MOTORS CORP.

2. Install the lower oil pan.
3. Install the lower oil pan bolts/nuts.

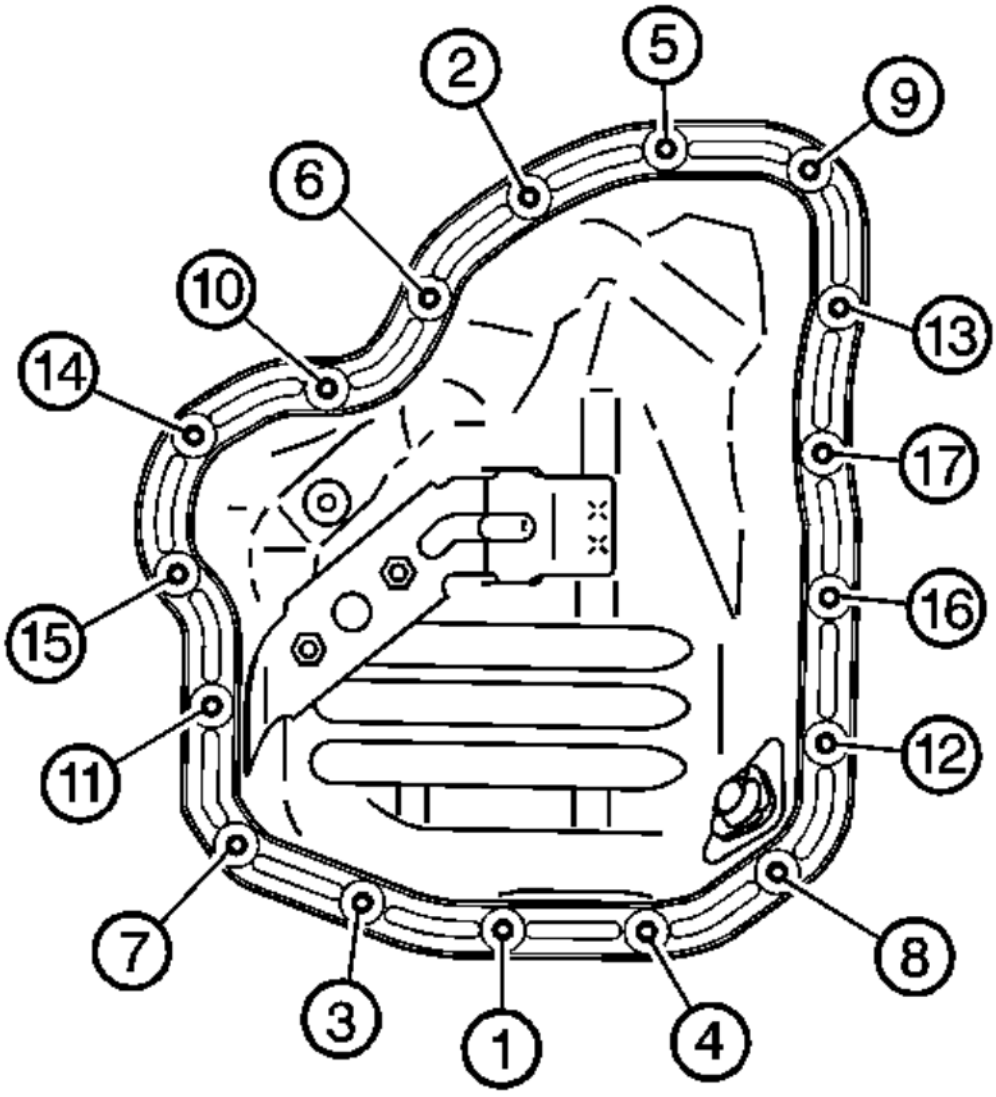


Fig. 290: Lower Oil Pan Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

4. Tighten the oil pan bolts/nuts in the sequence shown.

Tighten: Tighten the bolts/nuts to 10 N.m (89 lb in).

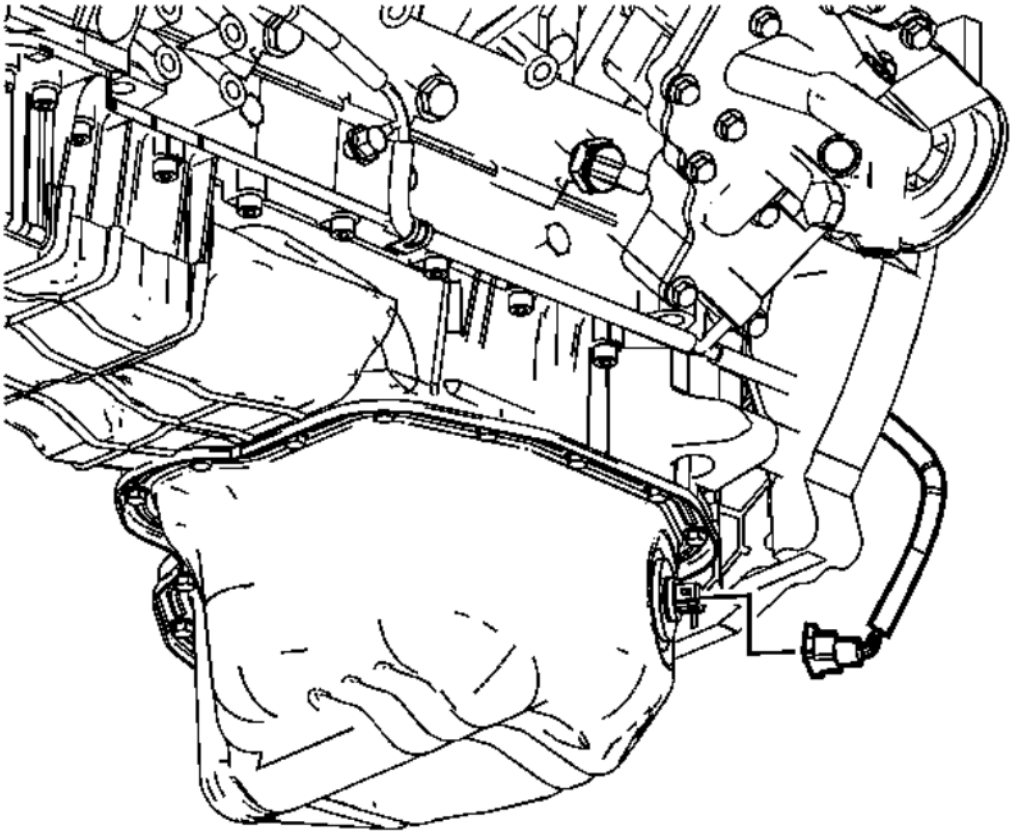


Fig. 291: View Of Oil Level Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

5. Connect the oil level sensor electrical connector.

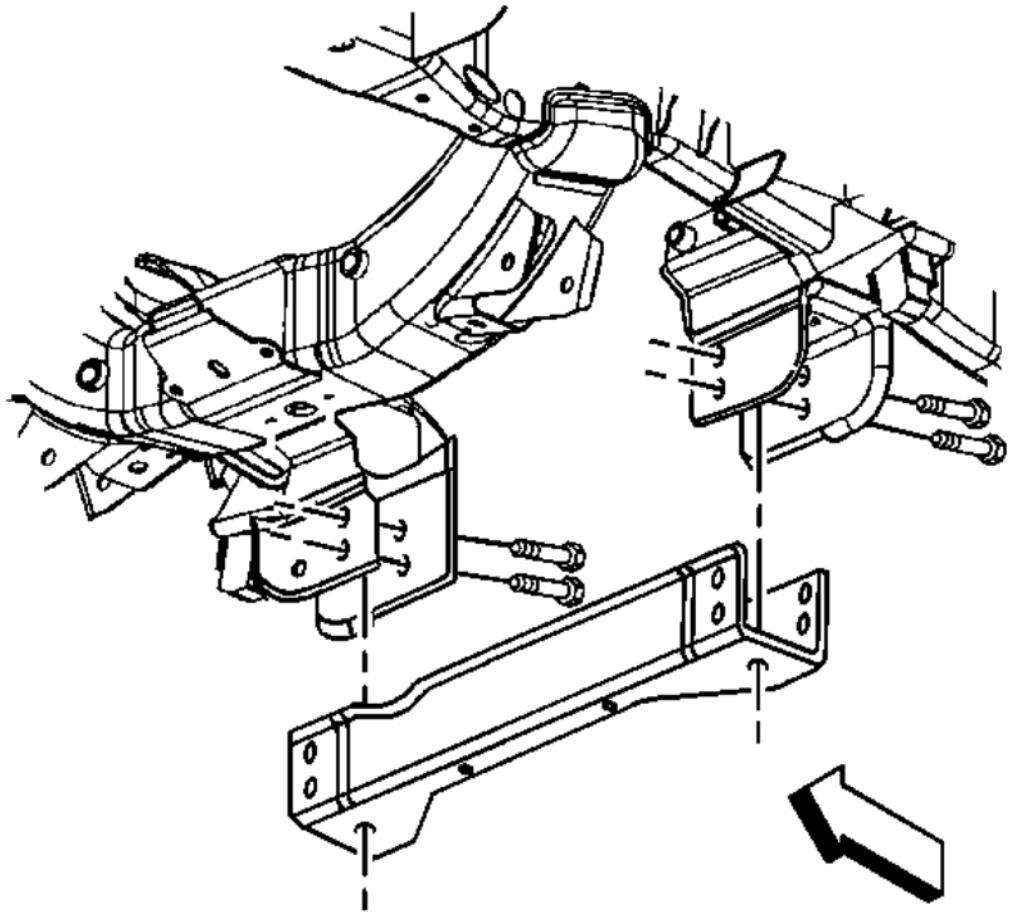


Fig. 292: View Of Crossbar Bolts & Bar (2WD)
Courtesy of GENERAL MOTORS CORP.

6. If equipped with a 2WD, install the crossmember and bolts.

   Tighten: Tighten the bolts to 100 N.m (74 lb ft).

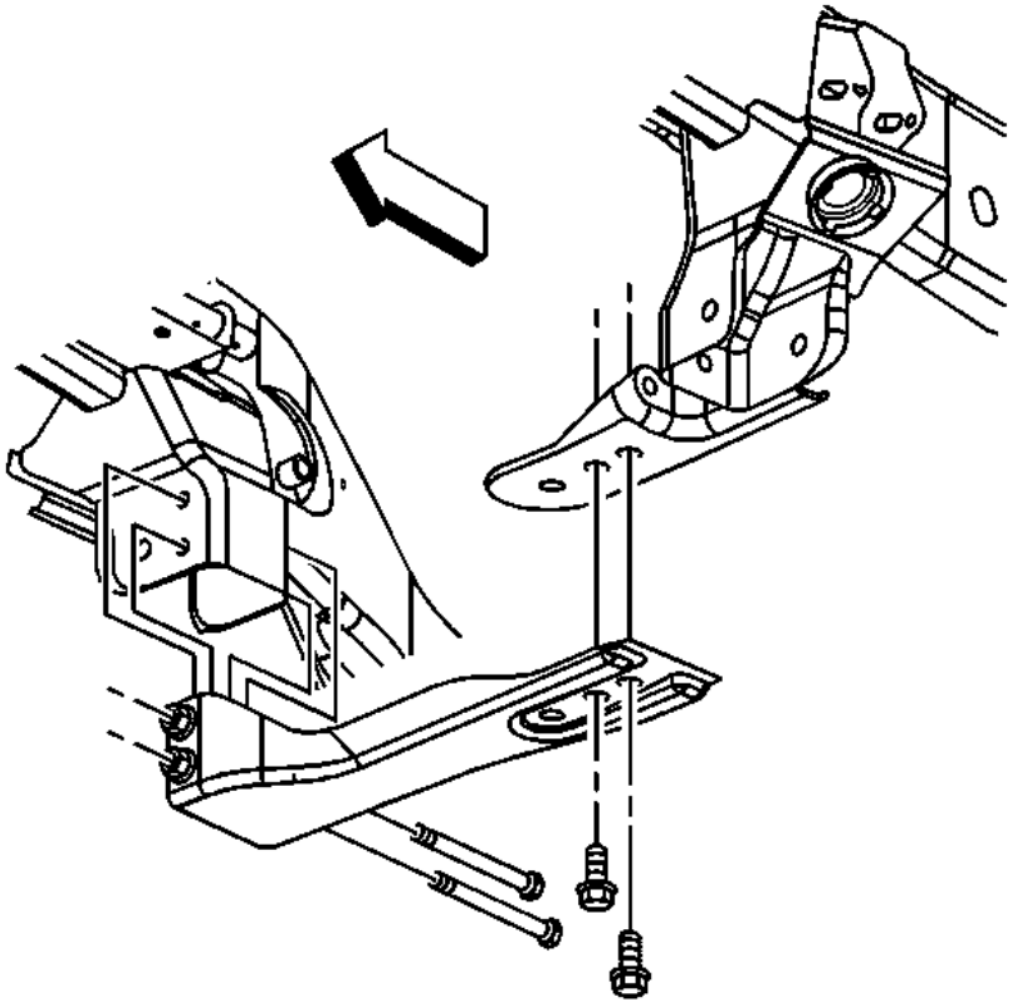


Fig. 293: View Of Crossmember Bolts & Bar (4WD Only)
Courtesy of GENERAL MOTORS CORP.

7. If equipped with a 4WD, install the crossmember and bolts.

   Tighten: Tighten the bolts to 100 N.m (74 lb ft).

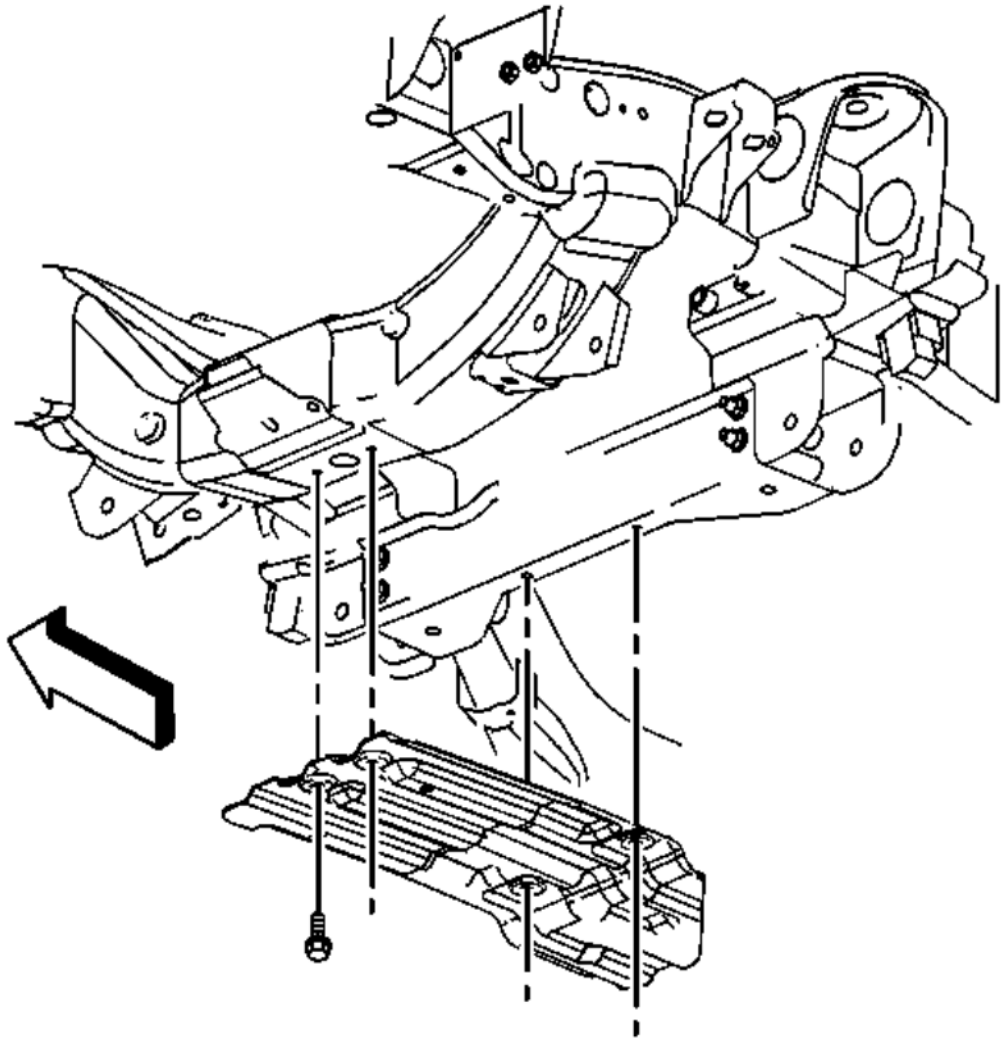


Fig. 294: Identifying Oil Pan Skid Plate
Courtesy of GENERAL MOTORS CORP.

8. Install the oil pan skid plate and bolts, if equipped.

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

9. Install NEW engine oil and a oil filter. Refer to **Engine Oil and Oil Filter Replacement**.
10. Lower the vehicle.

UPPER OIL PAN REPLACEMENT

Tools Required

J 37228 Seal Cutter. See **Special Tools** .

Removal Procedure

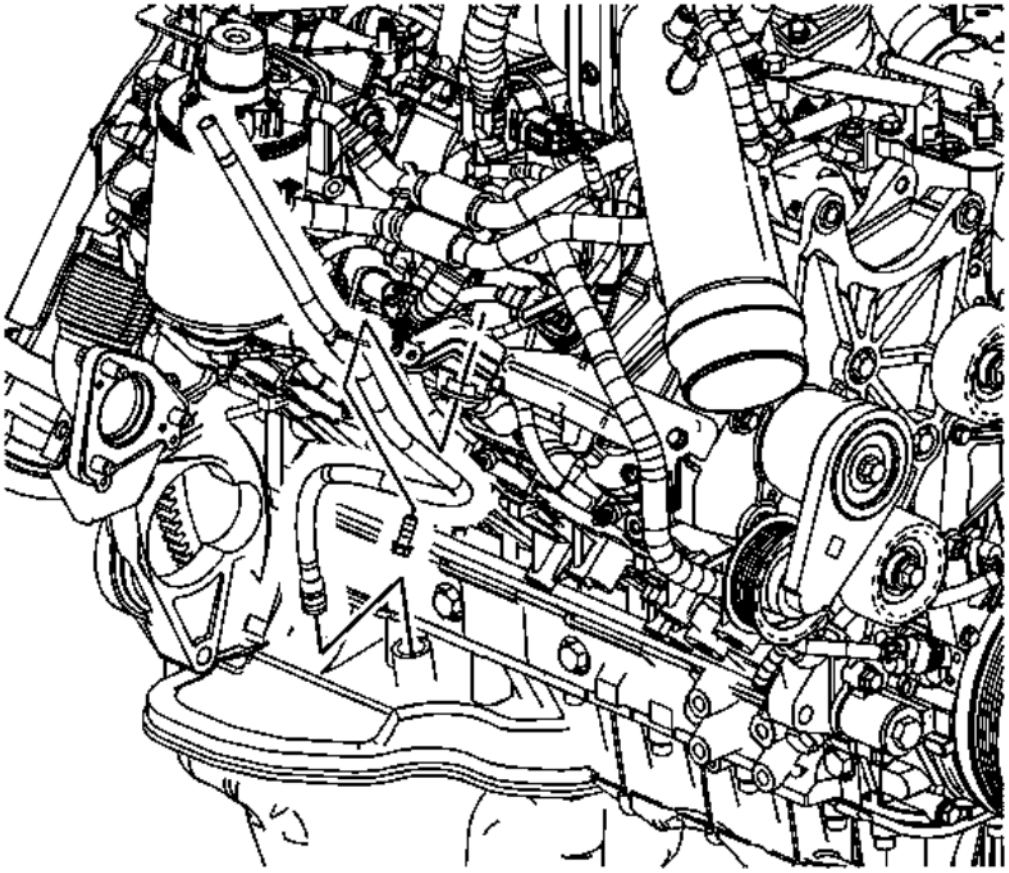


Fig. 295: Oil Level Indicator Tube
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil level indicator.
2. Remove the oil level indicator tube bolt from the indicator tube bracket.
3. If vehicle is a 4-wheel drive (4WD), remove the front differential carrier. Refer to

Differential Carrier Assembly Replacement (1500 FWD) or **Differential Carrier Assembly Replacement (2500 4WD)** .

4. If vehicle is a 2-wheel drive (2WD), disconnect the relay rod from the pitman arm and idler arm. Refer to **Relay Rod Replacement** .
5. Remove the lower oil pan. Refer to **Lower Oil Pan Replacement**.
6. Remove the engine flywheel. Refer to **Engine Flywheel Replacement**.

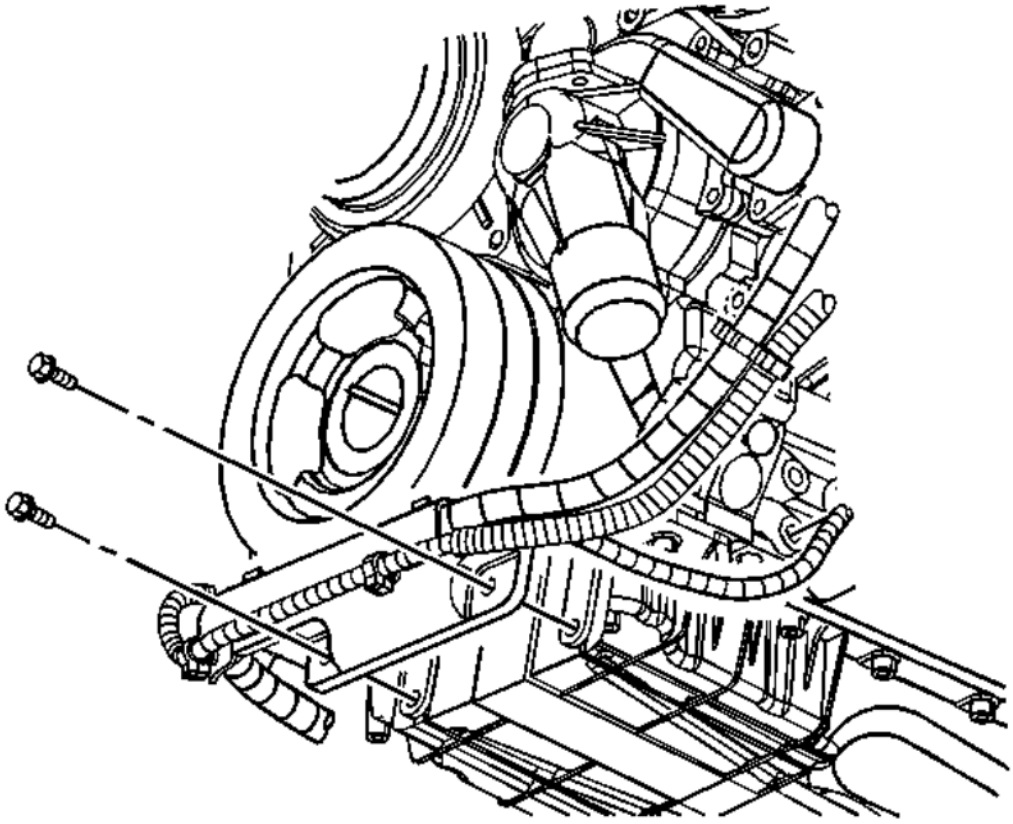


Fig. 296: View Of Battery Cable Bracket Bolts At Lower Crankcase
Courtesy of GENERAL MOTORS CORP.

7. Remove the battery cable bracket bolts.

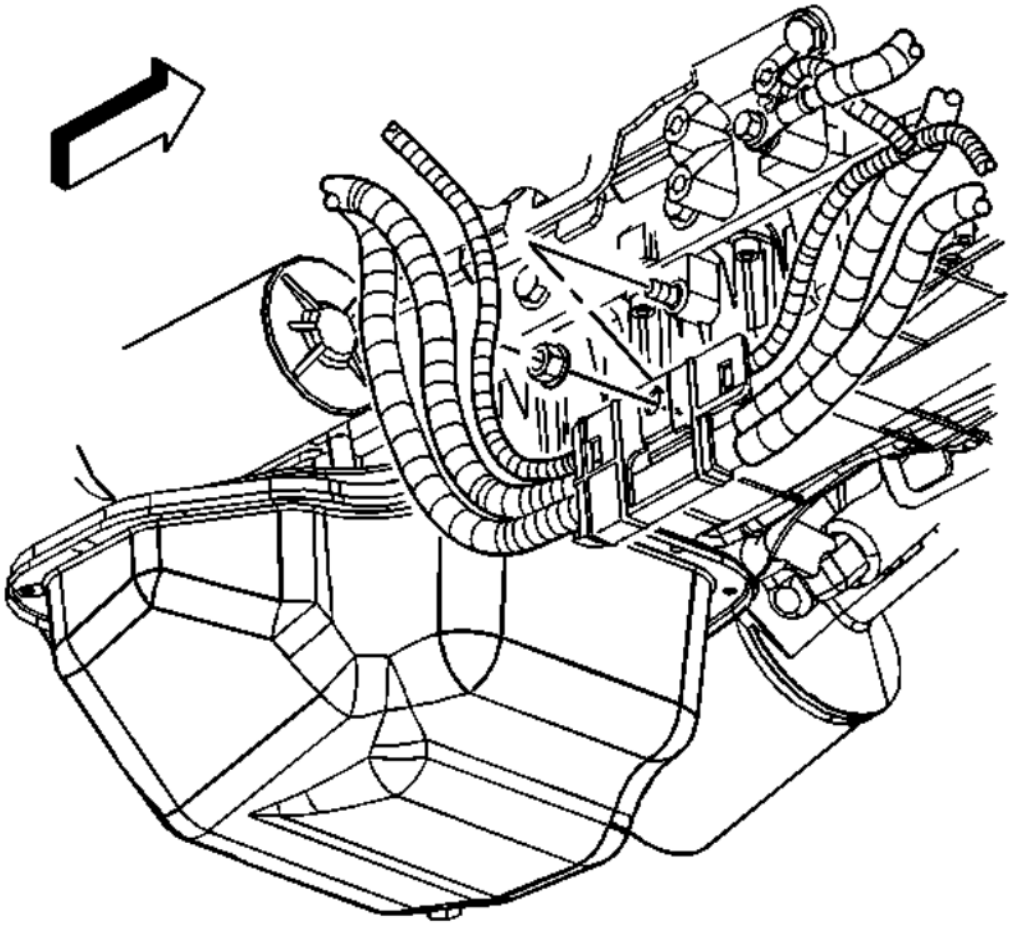


Fig. 297: View Of Battery Cable Bracket Nut
Courtesy of GENERAL MOTORS CORP.

8. Remove the battery cable bracket nut.

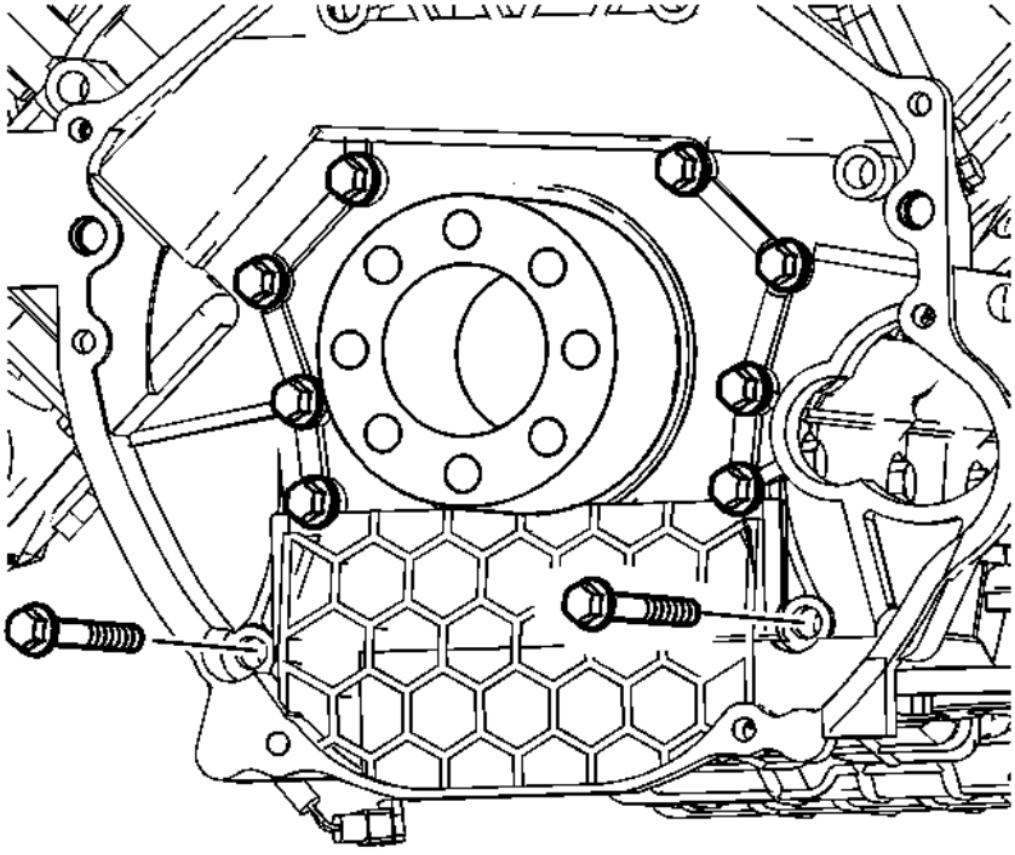


Fig. 298: View Of Flywheel Housing To Upper Oil Pan Bolts
Courtesy of GENERAL MOTORS CORP.

9. Remove the two flywheel housing to upper oil pan bolts.

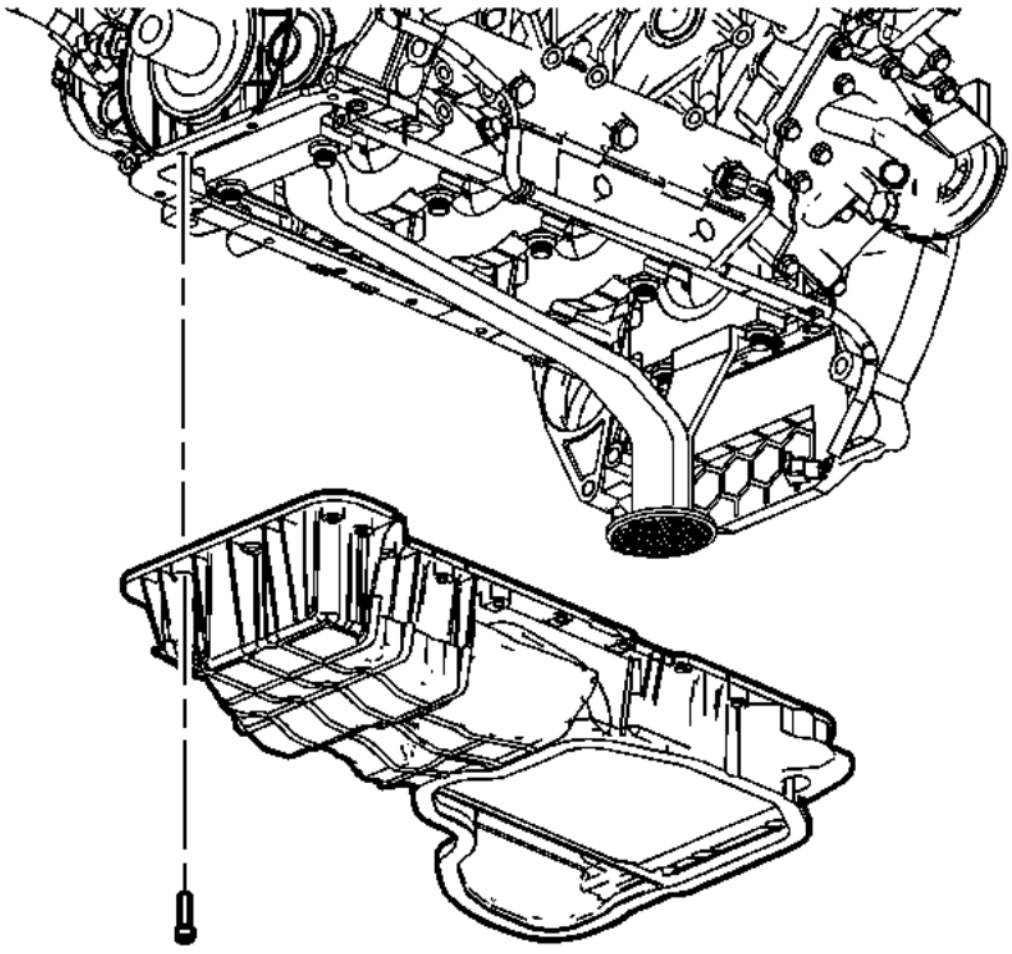


Fig. 299: View Of Upper Oil Pan
Courtesy of GENERAL MOTORS CORP.

10. Remove the upper oil pan bolts and any brackets. Mark the bolt location of the bracket.
11. Separate the upper oil pan from the engine block using **J 37228** . See **Special Tools** .
12. Remove the upper oil pan. The oil level indicator tube needs to be removed while lowering the upper oil pan.
13. If required, clean and inspect the upper oil pan. Refer to **Upper Oil Pan Cleaning and Inspection** .

Installation Procedure

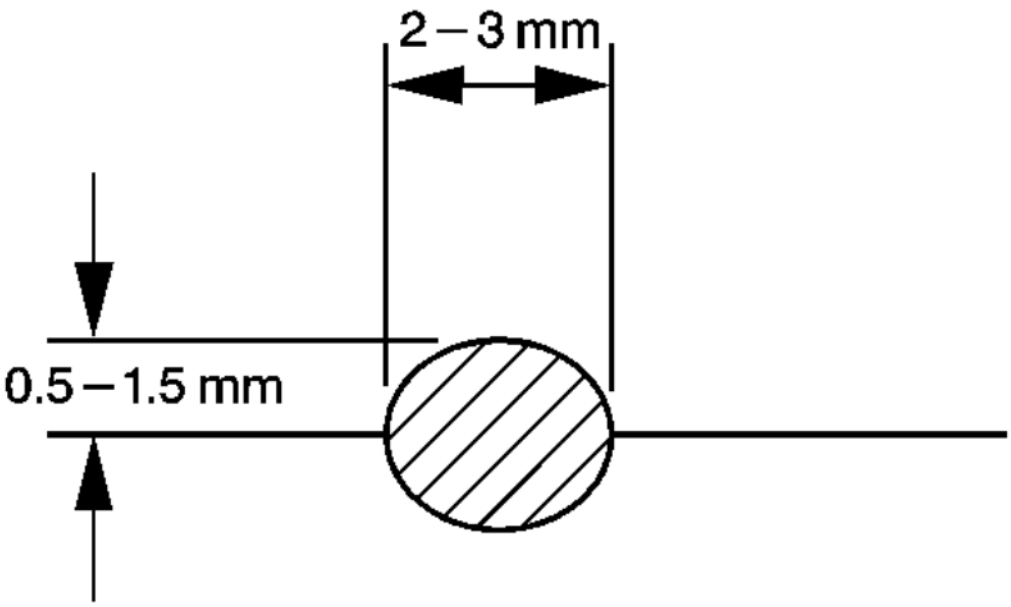


Fig. 300: Determining Sealant Bead Dimensions
Courtesy of GENERAL MOTORS CORP.

1. Apply a 2-3 mm (0.79-0.118 in) wide by 0.5-1.5 mm (0.02-0.06 in) bead of sealant to the upper oil pan mating surfaces. Refer to **Sealers, Adhesives, and Lubricants** for the correct part number.
2. Apply a 2-3 mm (0.79-0.118 in) wide by 0.5-1.5 mm (0.02-0.06 in) bead of sealant to the flywheel housing sealing surface. Refer to **Sealers, Adhesives, and Lubricants** for the correct part number.

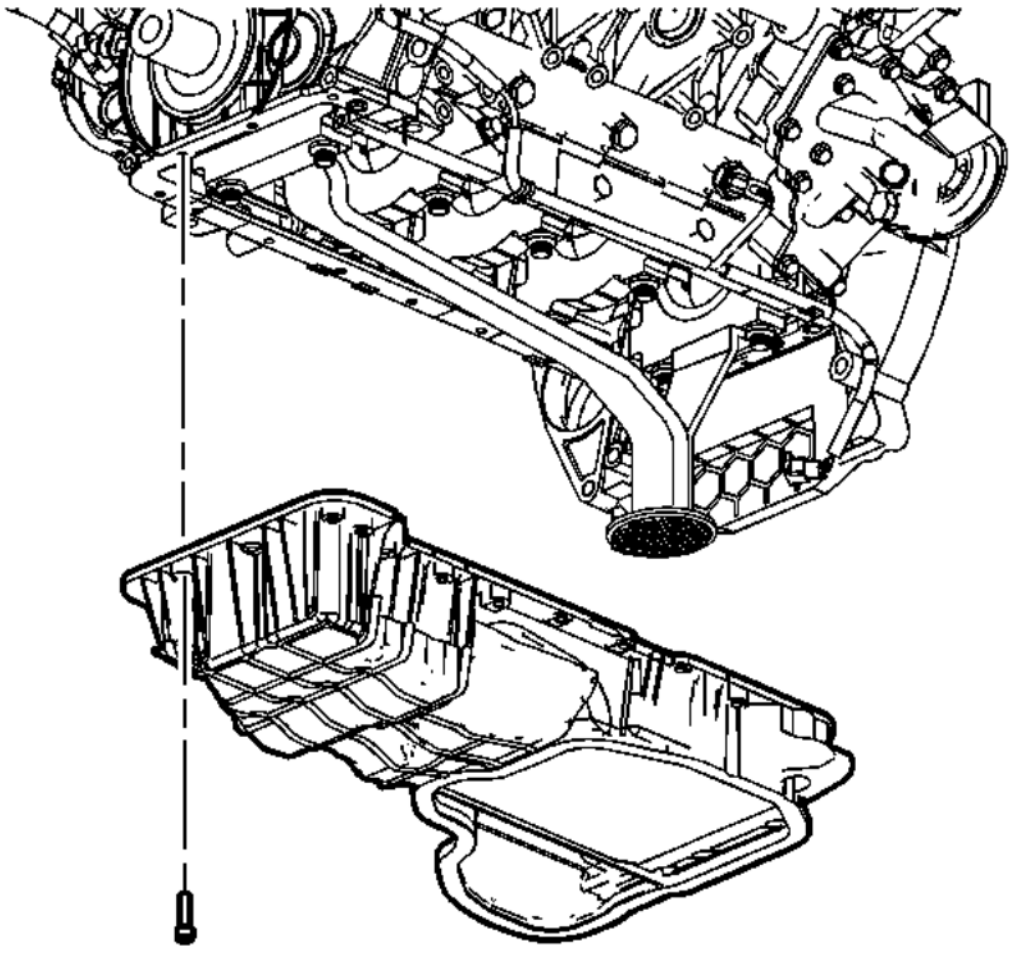


Fig. 301: View Of Upper Oil Pan
Courtesy of GENERAL MOTORS CORP.

3. Install the upper oil pan to the engine block. Ensure the oil level indicator tube is installed into the upper oil pan.

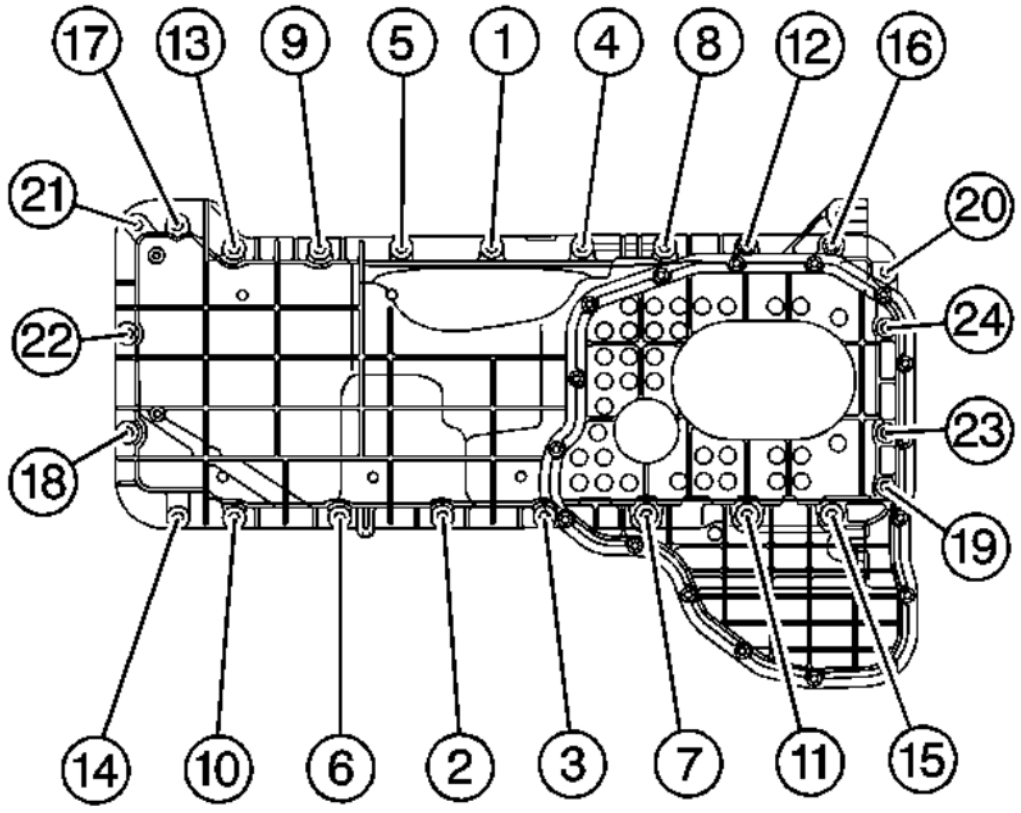


Fig. 302: Upper Oil Pan Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

4. Install any brackets and the upper oil pan bolts in the sequence shown.

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

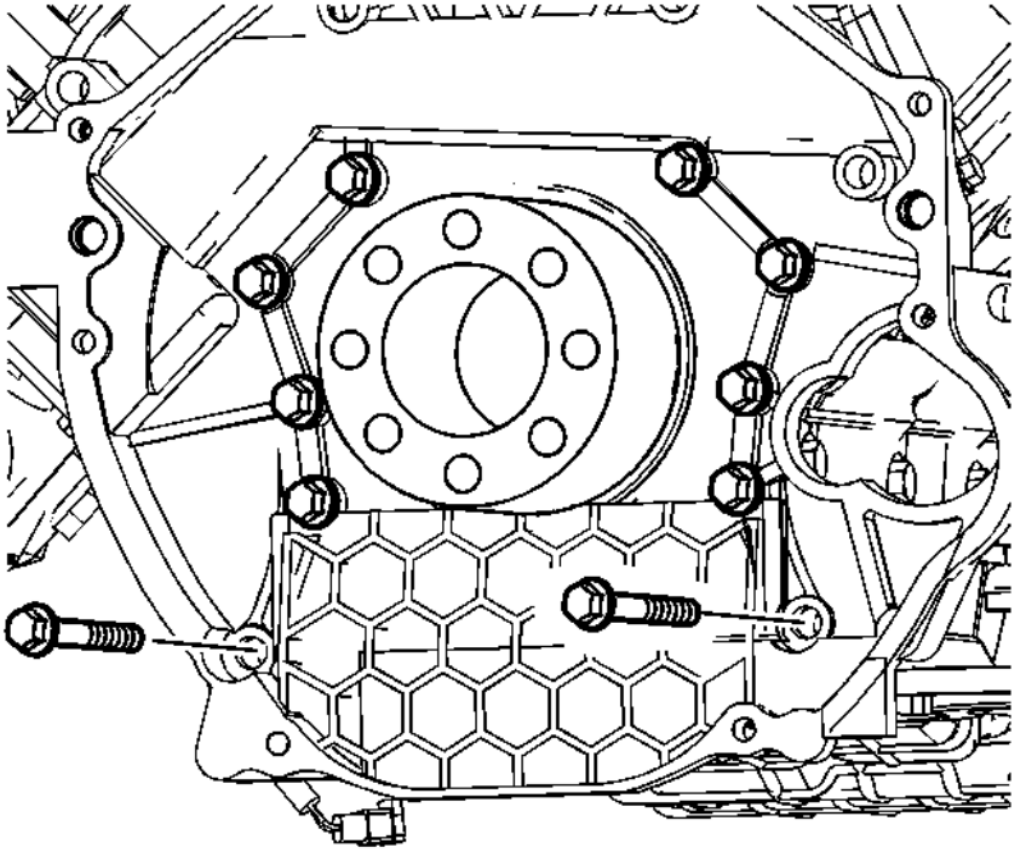


Fig. 303: View Of Flywheel Housing To Upper Oil Pan Bolts
Courtesy of GENERAL MOTORS CORP.

5. Install the two flywheel housing to upper oil pan bolts.

   Tighten: Tighten the bolts to 50 N.m (37 lb ft).

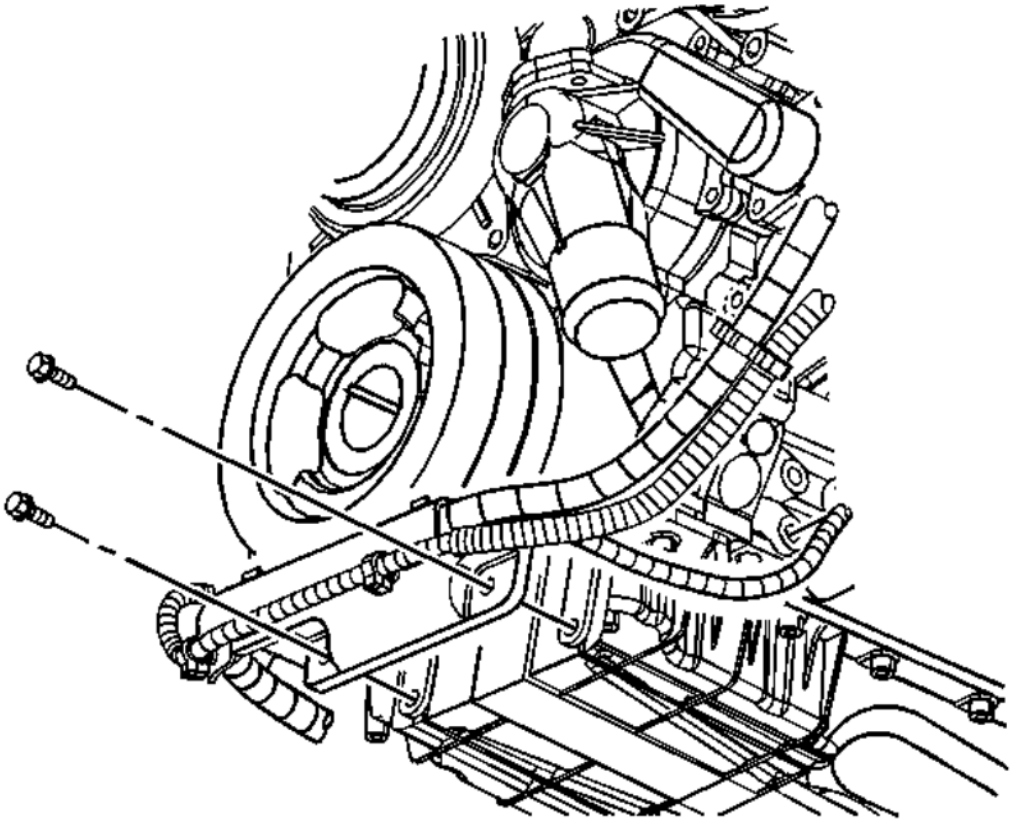


Fig. 304: View Of Battery Cable Bracket Bolts At Lower Crankcase
Courtesy of GENERAL MOTORS CORP.

6. Install the battery cable bracket bolts.

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

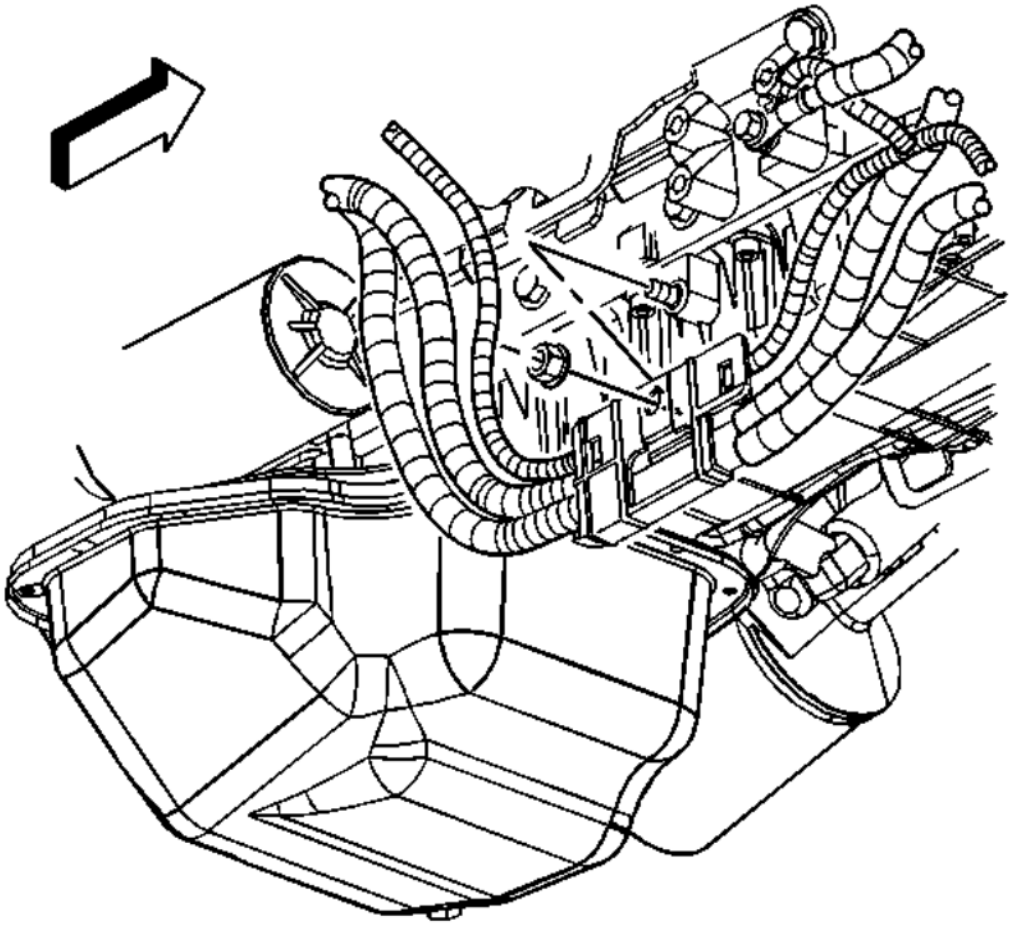


Fig. 305: View Of Battery Cable Bracket Nut
Courtesy of GENERAL MOTORS CORP.

7. Install the battery cable bracket nut.

   Tighten: Tighten the nut to 8 N.m (71 lb in).

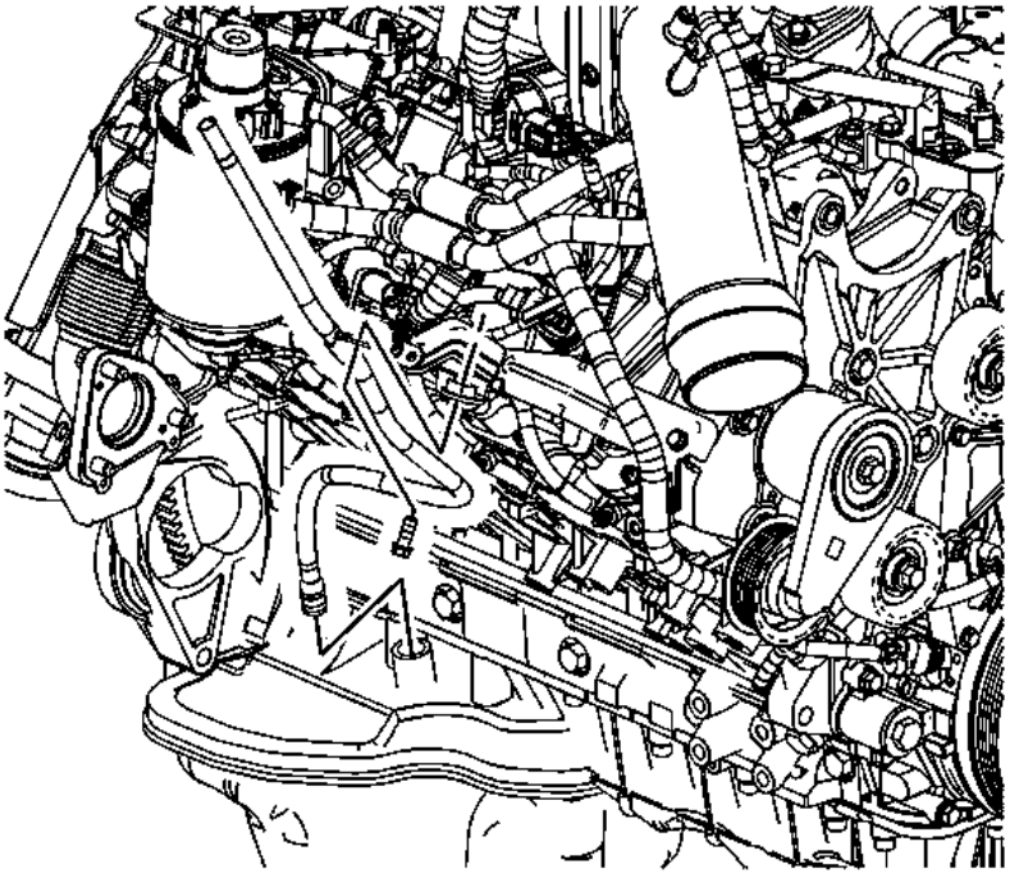


Fig. 306: Oil Level Indicator Tube
Courtesy of GENERAL MOTORS CORP.

8. Install the engine flywheel. Refer to **Engine Flywheel Replacement**.
9. Install the lower oil pan. Refer to **Lower Oil Pan Replacement**.
10. If vehicle is a 4WD, install the front differential carrier. Refer to **Differential Carrier Assembly Replacement (1500 FWD)** or **Differential Carrier Assembly Replacement (2500 4WD)** .
11. If vehicle is a 2WD, Connect the relay rod to the pitman arm and idler arm. Refer to **Relay Rod Replacement** .
12. Lower the vehicle.
13. Install the oil level indicator tube bolt to the indicator tube bracket.

Tighten: Tighten the bolt to 21 N.m (15 lb ft).

14. Install the oil level indicator.
15. Fill the engine with oil. Refer to **Engine Oil and Oil Filter Replacement**.

OIL PUMP REPLACEMENT

Removal Procedure

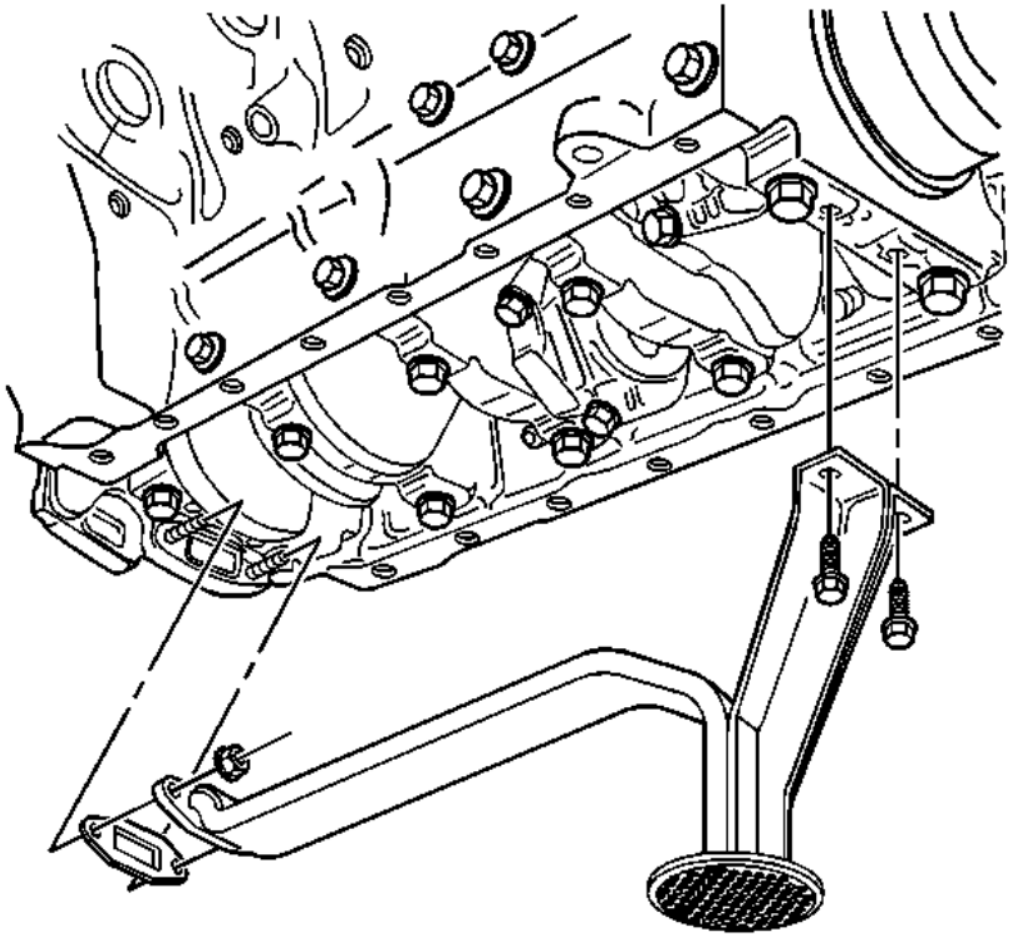


Fig. 307: View Of Oil Pump Screen, Bolts, Nuts & Gasket
Courtesy of GENERAL MOTORS CORP.

1. If the vehicle is a 2-wheel drive (2WD), remove the flywheel housing. Refer to **Engine Flywheel Replacement**.
2. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
3. Remove the upper oil pan. Refer to **Upper Oil Pan Replacement**.
4. Remove the oil pump screen bolts and nuts.
5. Remove the oil pump screen.
6. Remove and discard the oil pump screen gasket.

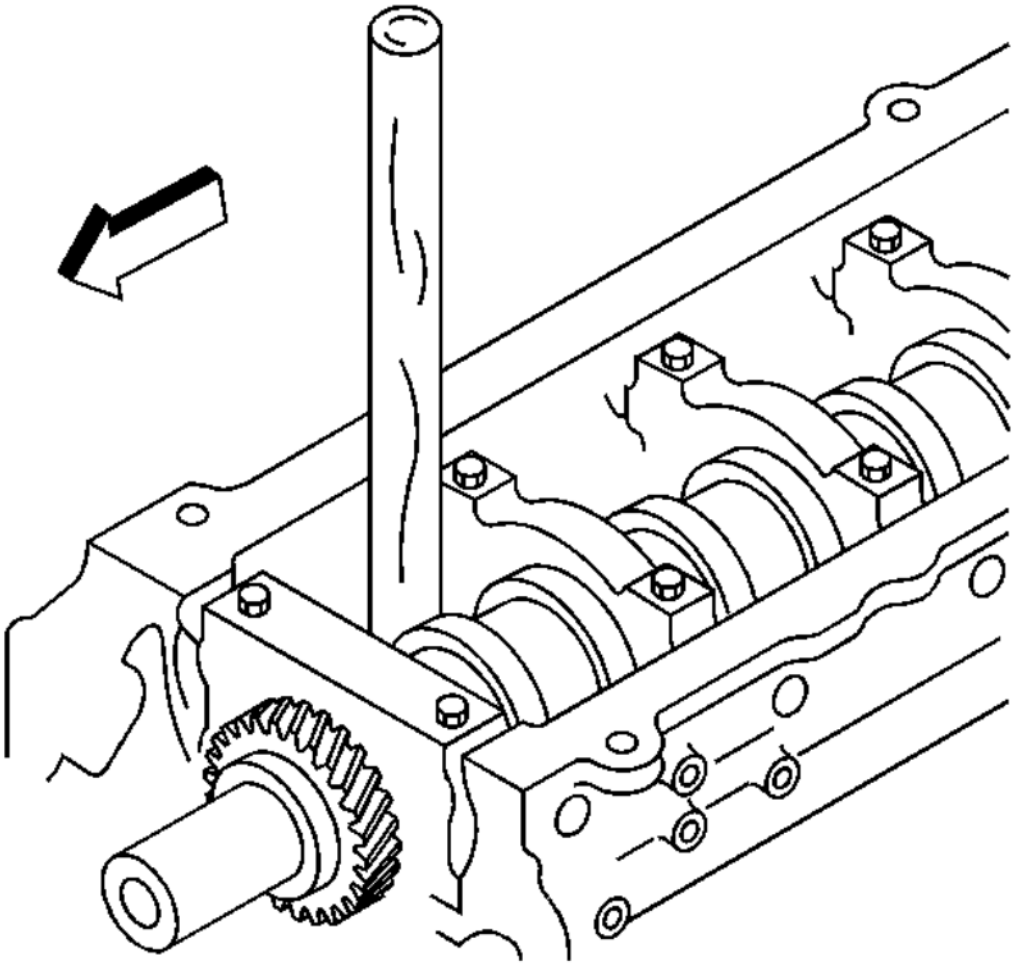


Fig. 308: Blocking Crankshaft From Turning Using Wooden Handle
Courtesy of GENERAL MOTORS CORP.

7. Block the crankshaft from turning with a wooden handle.

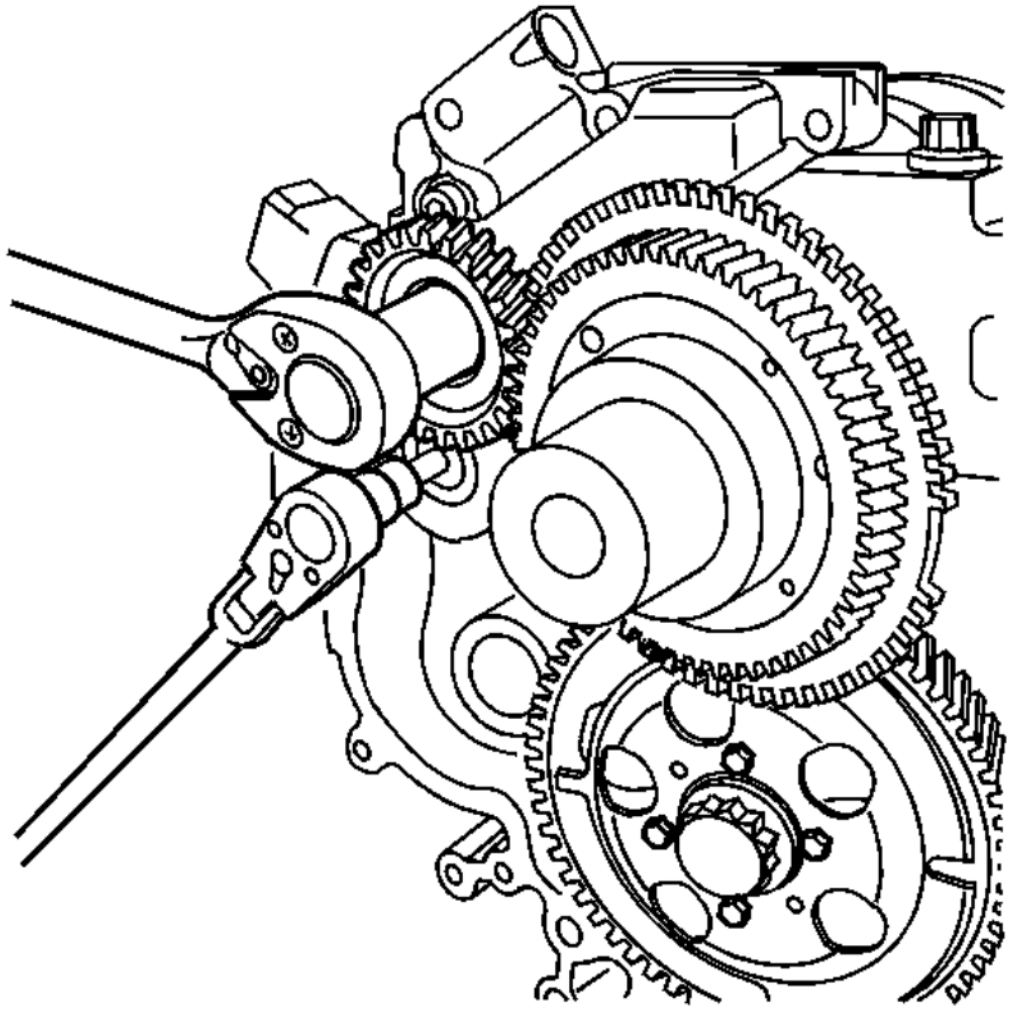


Fig. 309: Removing/Installing Secondary Oil Pump Driven Gear Nut While Holding Oil Pump Shaft
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Look for an "L" on the end of the oil pump shaft. If there is an "L" present, the nut and shaft have left hand threads. Service the nut accordingly.

8. While holding the secondary oil pump shaft with a hex driver, remove the oil pump driven gear nut.

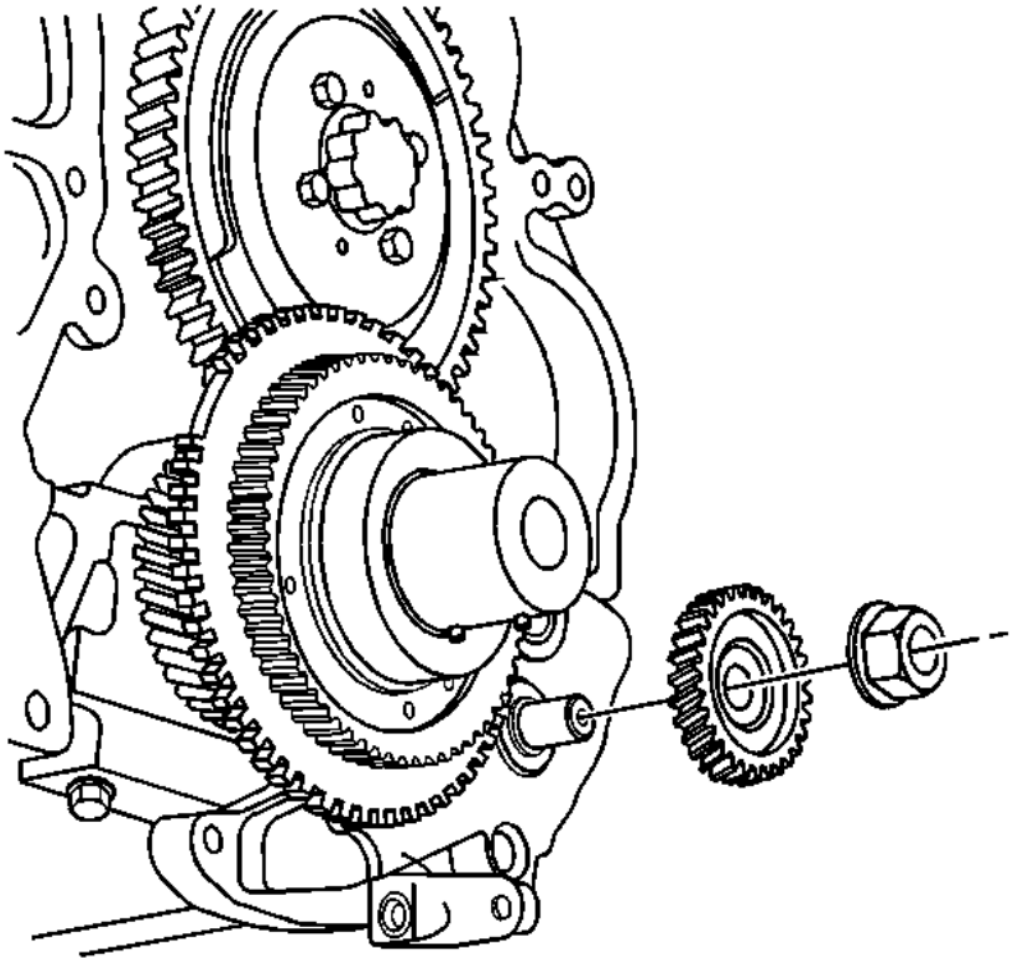


Fig. 310: View Of Oil Pump Driven Gear & Nut
Courtesy of GENERAL MOTORS CORP.

9. Remove the oil pump driven gear.

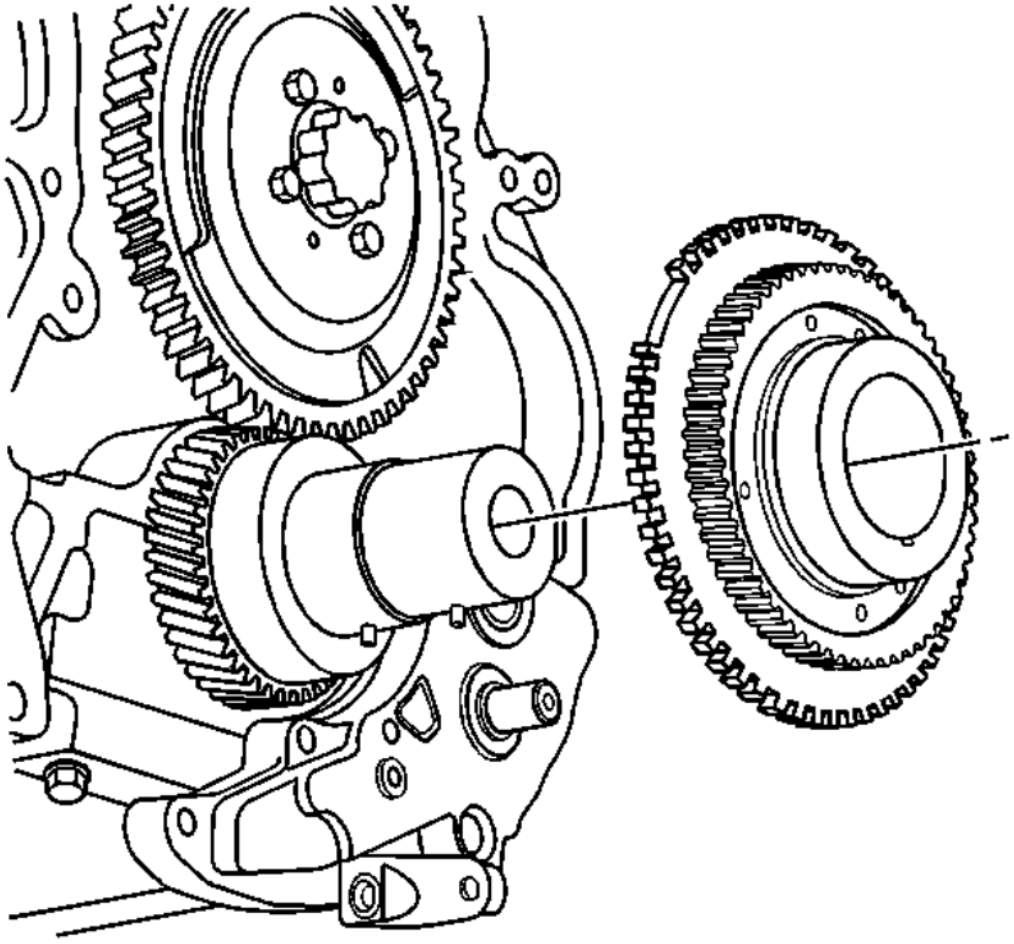


Fig. 311: View Of Oil Pump Drive Gear
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not damage the crankshaft reluctor. Do not remove the crankshaft reluctor to oil pump drive bolts.

10. Remove the oil pump drive gear and crankshaft reluctor.
    - Use a brass drift.
    - Tap on the back as close to the center of the reluctor.

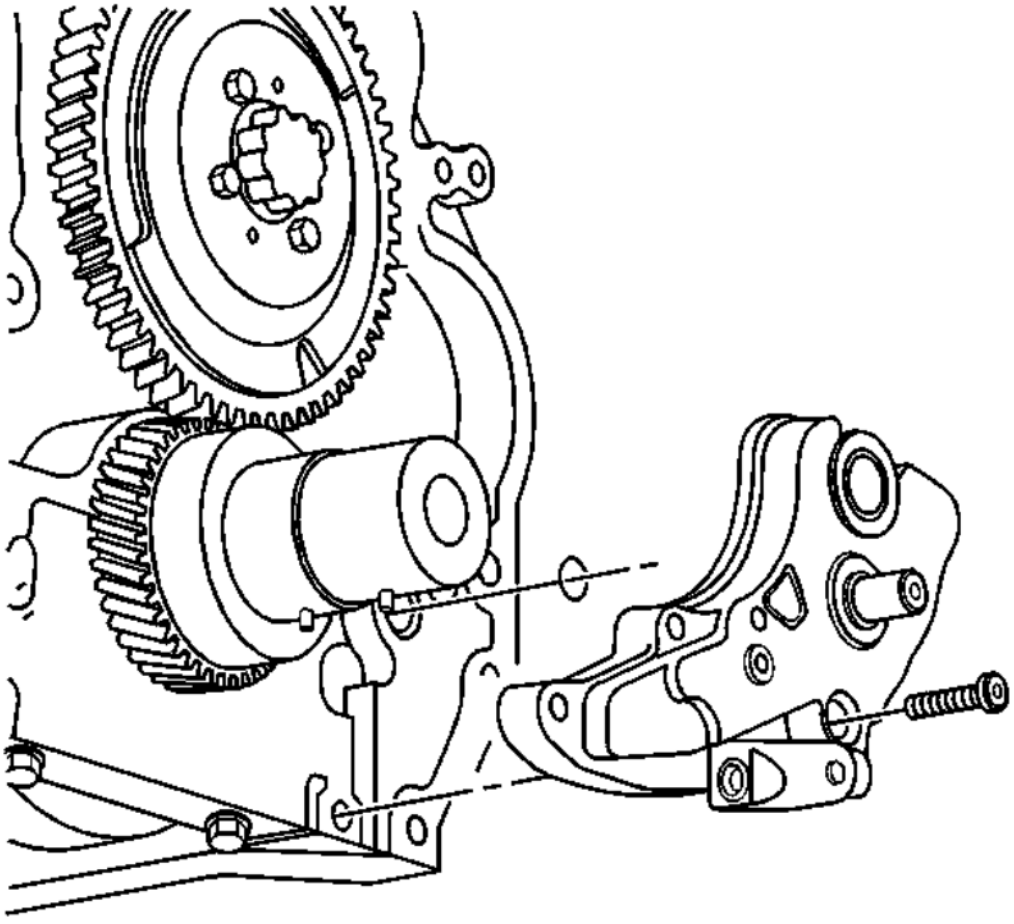


Fig. 312: View Of Oil Pump, O-Ring Seal & Bolt
Courtesy of GENERAL MOTORS CORP.

11. Remove the hex head and the allen head bolt in order to remove the oil pump.
12. Remove the oil pump.
13. Remove the O-ring seal for the oil pump.
14. If required, clean and inspect the oil pump. Refer to **Oil Pump Cleaning and Inspection** .

Installation Procedure

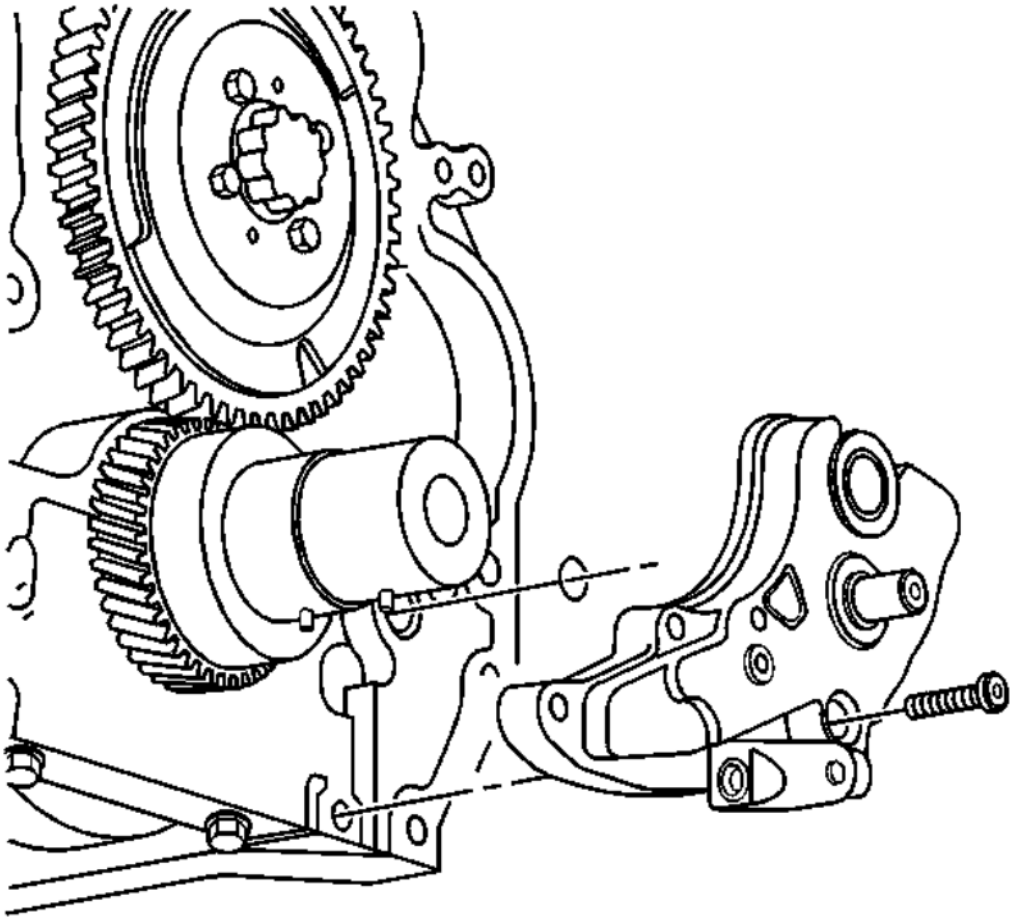


Fig. 313: View Of Oil Pump, O-Ring Seal & Bolt
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW oil pump O-ring seal.
2. Install the oil pump.

NOTE: Refer to Fastener Notice .

3. Install the oil pump bolts.

Tighten: Tighten the bolts to 21 N.m (15 lb ft).

4. Inspect the oil pump drive gear for wear.
5. Replace the oil pump drive gear pin if worn.

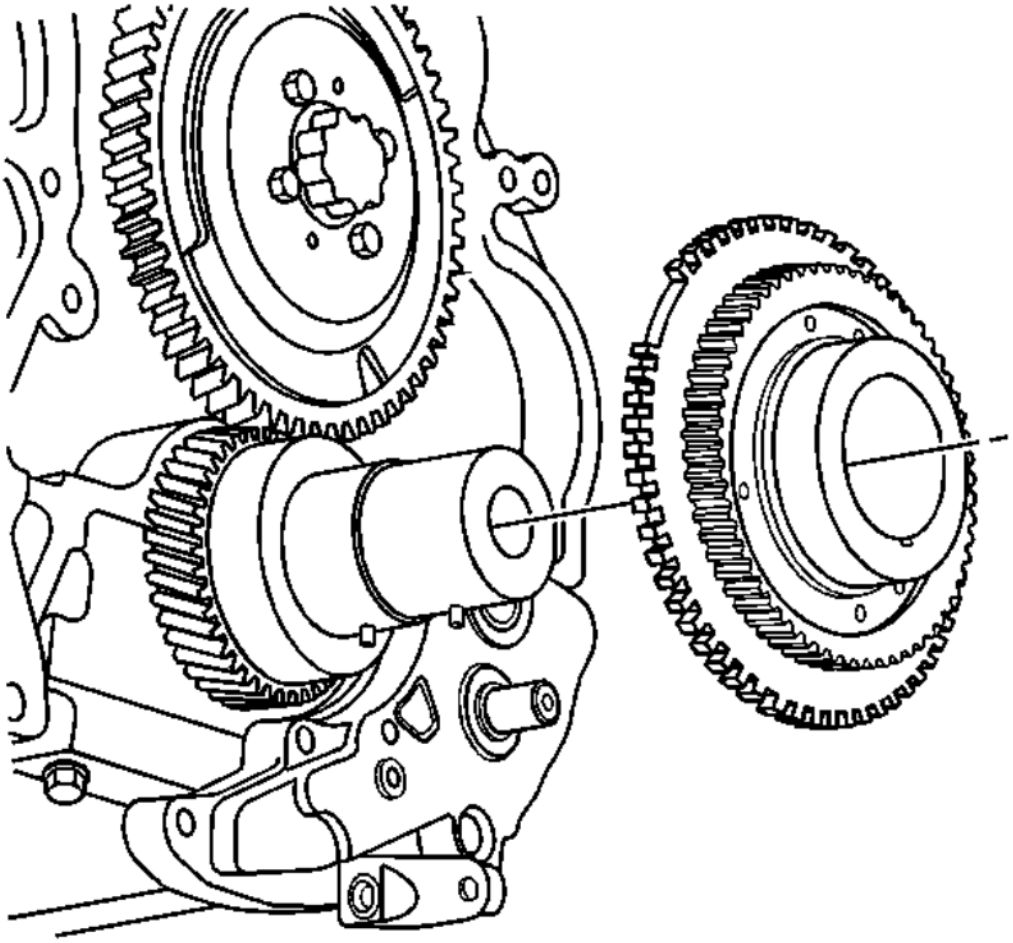


Fig. 314: View Of Oil Pump Drive Gear
Courtesy of GENERAL MOTORS CORP.

6. Install the oil pump drive gear and reluctor to the crankshaft.

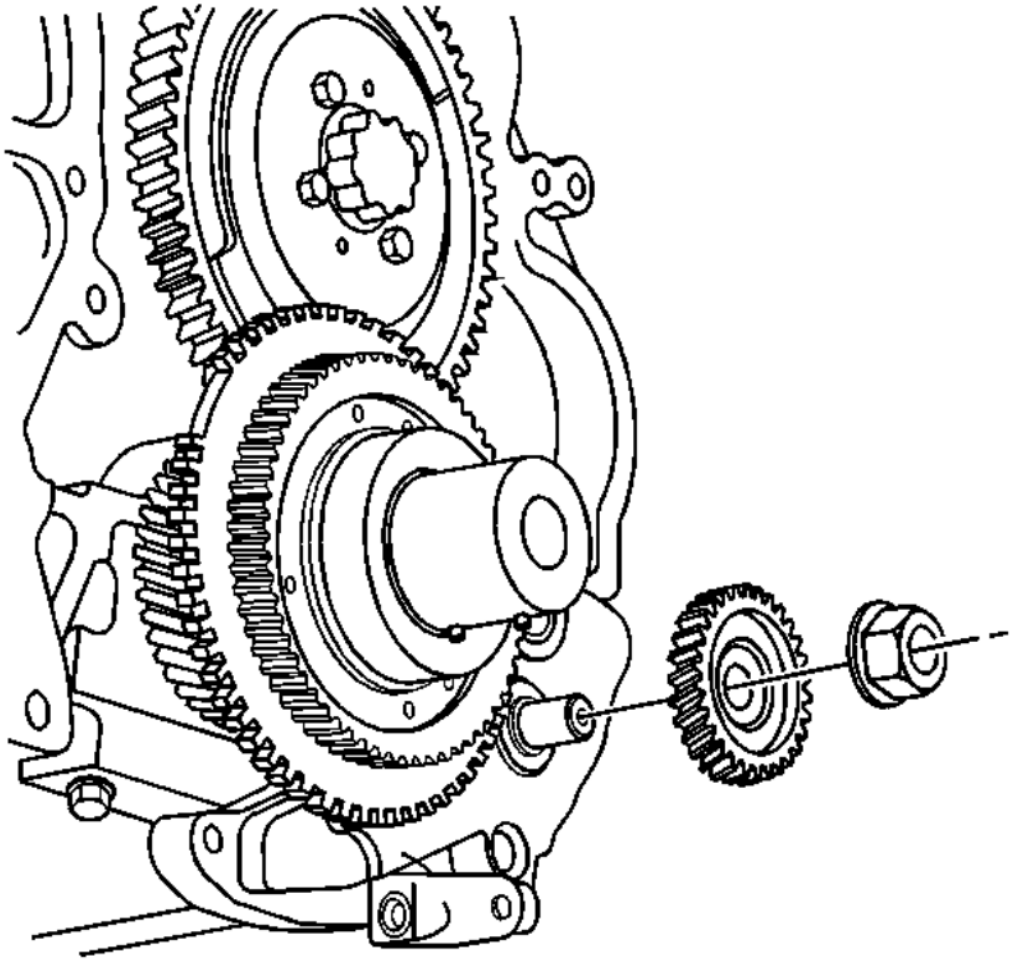


Fig. 315: View Of Oil Pump Driven Gear & Nut
Courtesy of GENERAL MOTORS CORP.

7. Install the oil pump driven gear.

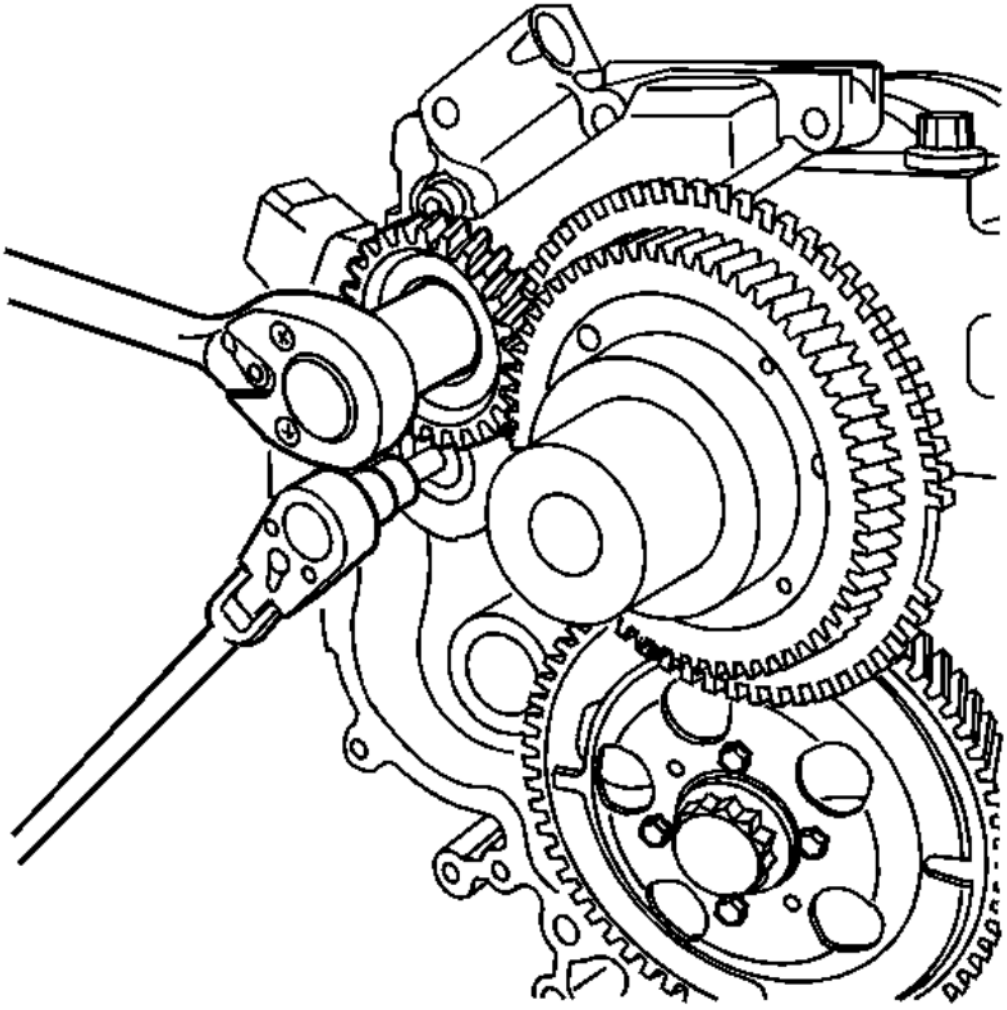


Fig. 316: Removing/Installing Secondary Oil Pump Driven Gear Nut While Holding Oil Pump Shaft
Courtesy of GENERAL MOTORS CORP.

8. While holding the secondary oil pump shaft with a hex driver, install the oil pump driven gear nut.

   Tighten: Tighten the nut to 100 N.m (74 lb ft).

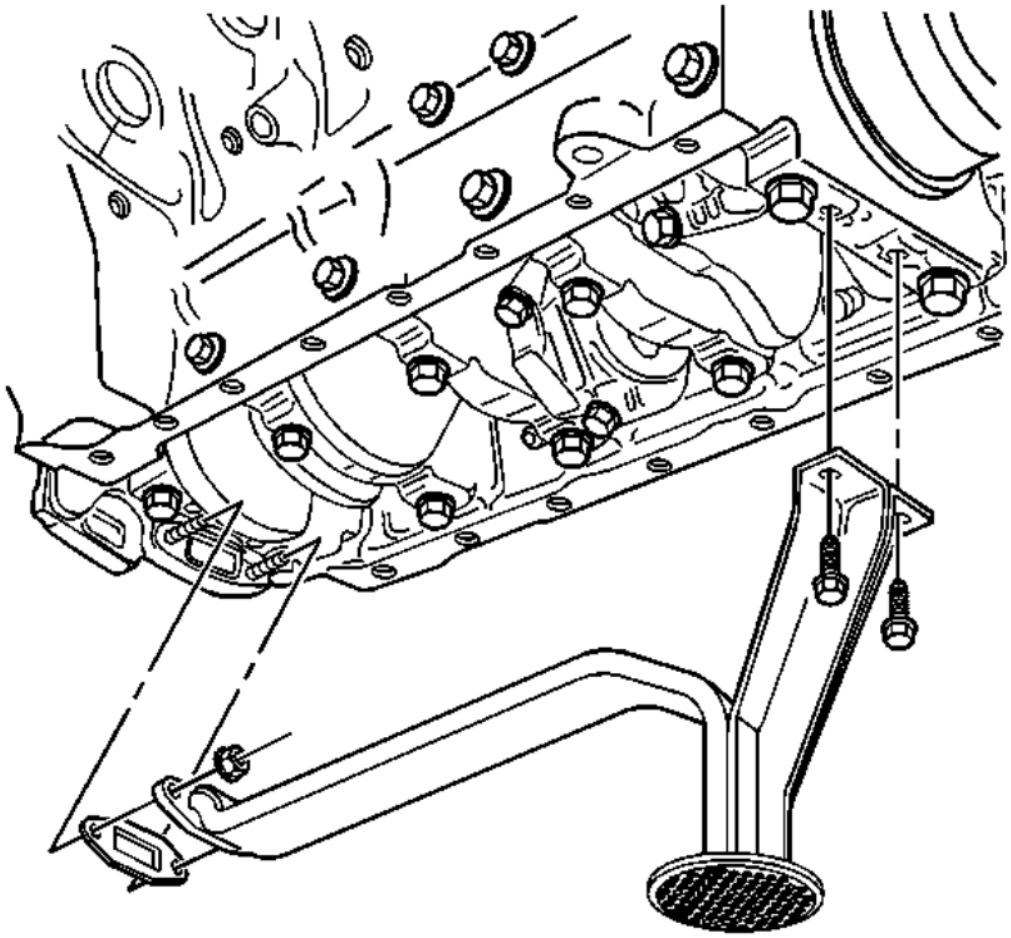


Fig. 317: View Of Oil Pump Screen, Bolts, Nuts & Gasket
Courtesy of GENERAL MOTORS CORP.

9. Install a NEW oil pump screen gasket to the oil pump.
10. Install the oil pump screen.
11. Install the oil pump screen bolts and nuts.

    Tighten: Tighten the bolts/nuts to 25 N.m (18 lb ft).

12. Install the engine front cover. Refer to **Engine Front Cover Replacement**.
13. If the vehicle is a 2WD, install the flywheel housing. Refer to **Engine Flywheel**

Replacement.

14. Install the upper oil pan. Refer to **Upper Oil Pan Replacement**.

OIL FILTER ADAPTER AND OIL COOLER ASSEMBLY REPLACEMENT

Removal Procedure

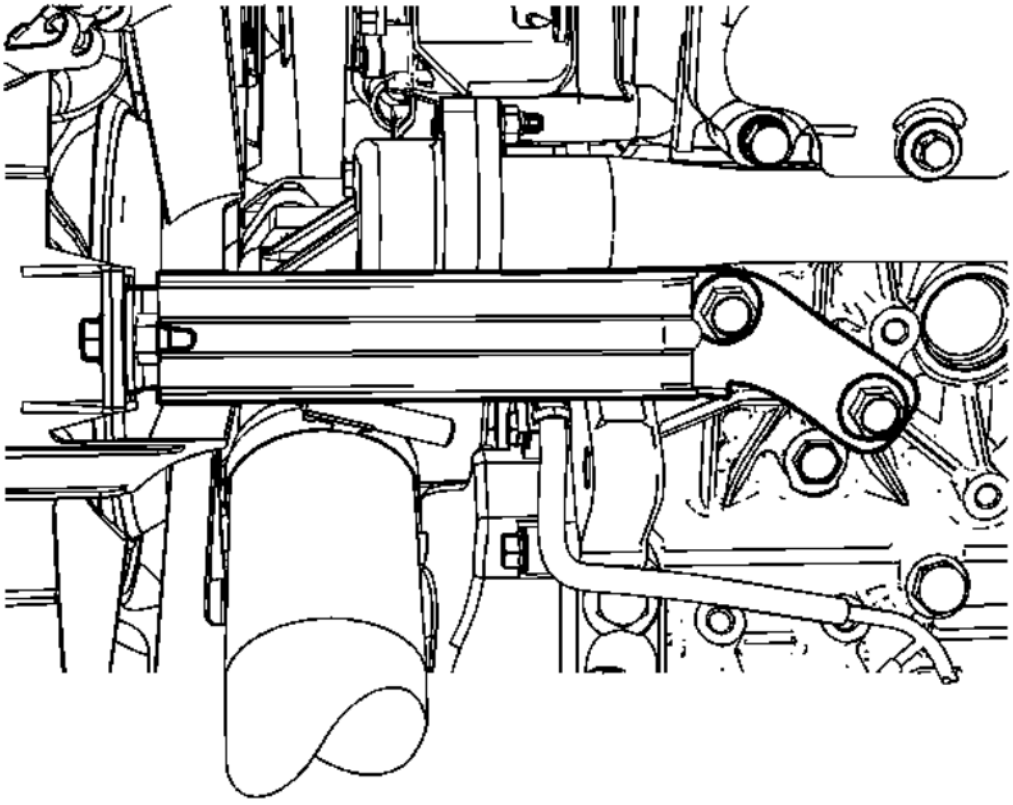


Fig. 318: View Of Charge Air Inlet Pipe
Courtesy of GENERAL MOTORS CORP.

1. Drain the engine coolant and the engine block. Refer to **Cooling System Draining and Filling (Vac-N-Fill)** or **Cooling System Draining and Filling (Static Fill)** .
2. Remove the charge air inlet pipe. Refer to **Charge Air Cooler Inlet Pipe Replacement** .
3. Remove the cooling fan shroud bracket bolts (1).
4. Remove the cooling fan shroud bracket (2).

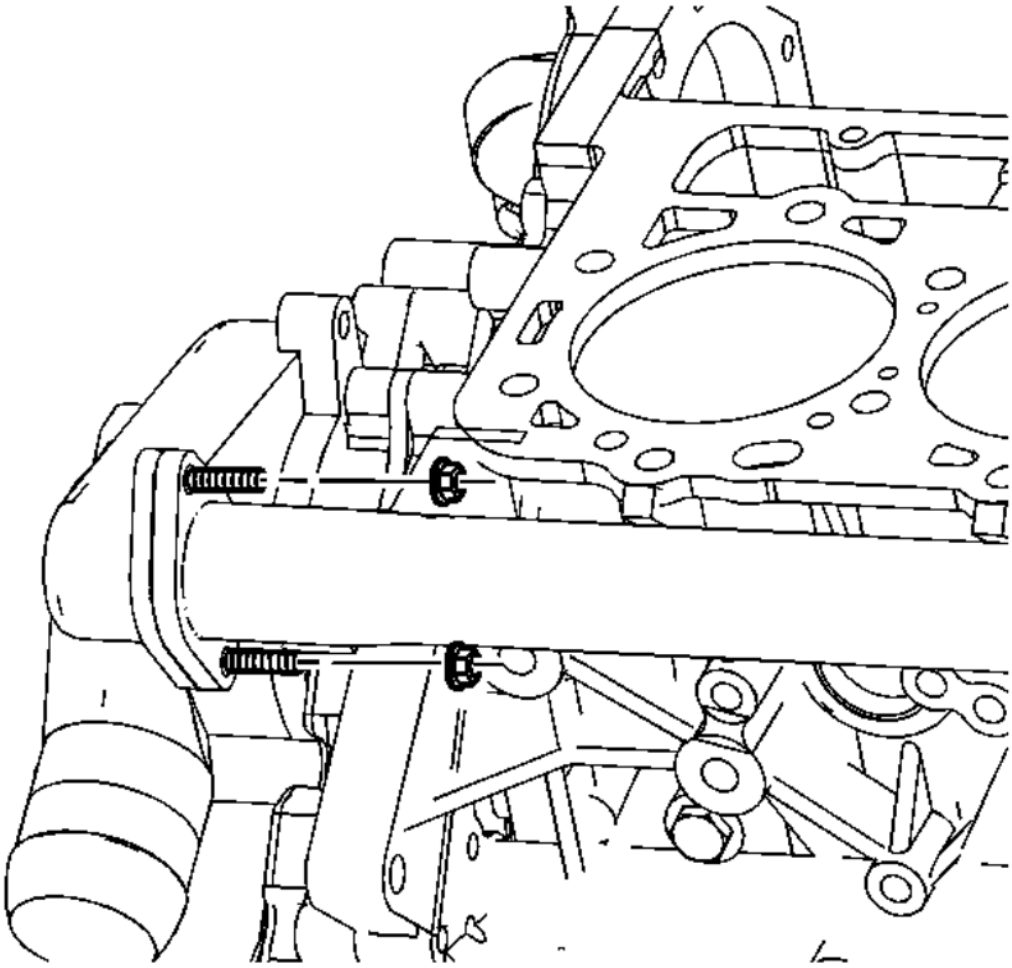


Fig. 319: View Of Water Pump Outlet Pipe Nuts
Courtesy of GENERAL MOTORS CORP.

5. Loosen the water pump outlet pipe nuts at the coolant pipe.

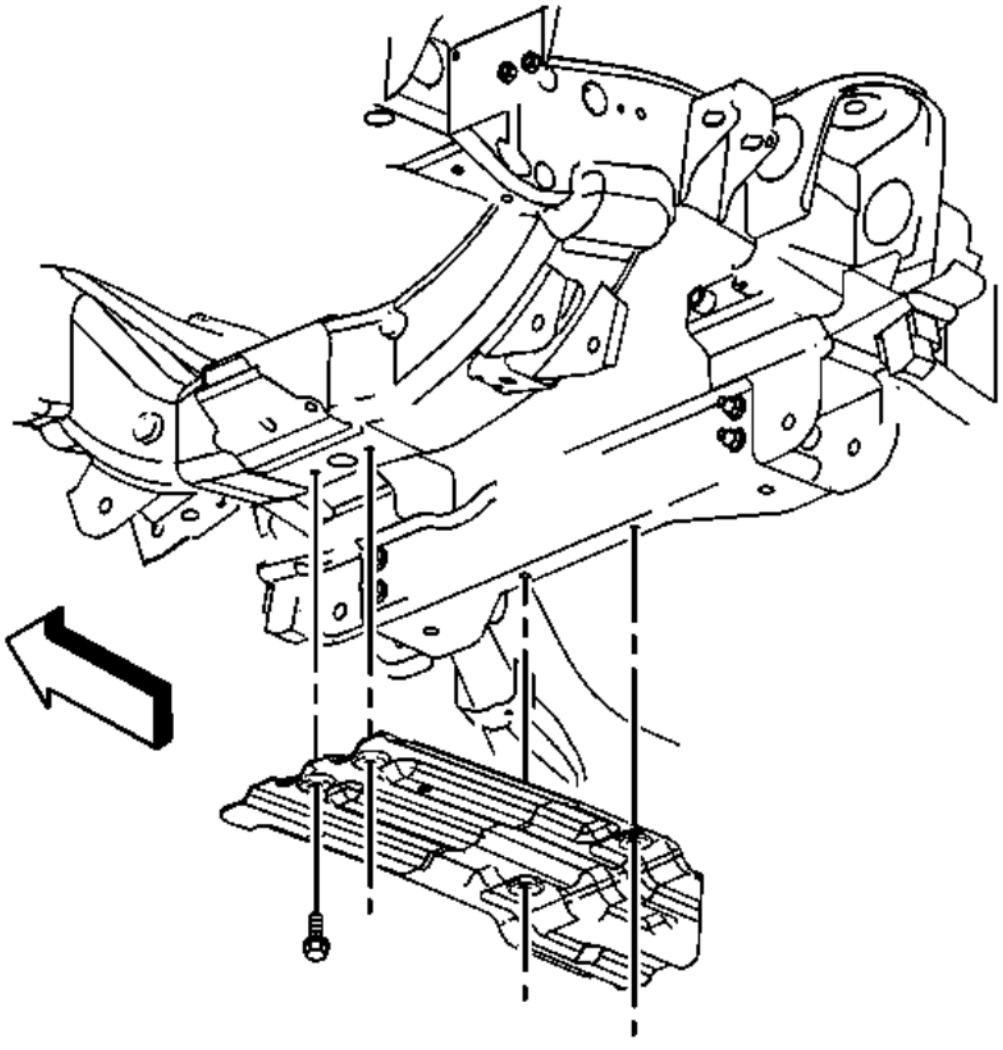


Fig. 320: Identifying Oil Pan Skid Plate
Courtesy of GENERAL MOTORS CORP.

6. If equipped, remove the oil pan skid plate bolts and plate.

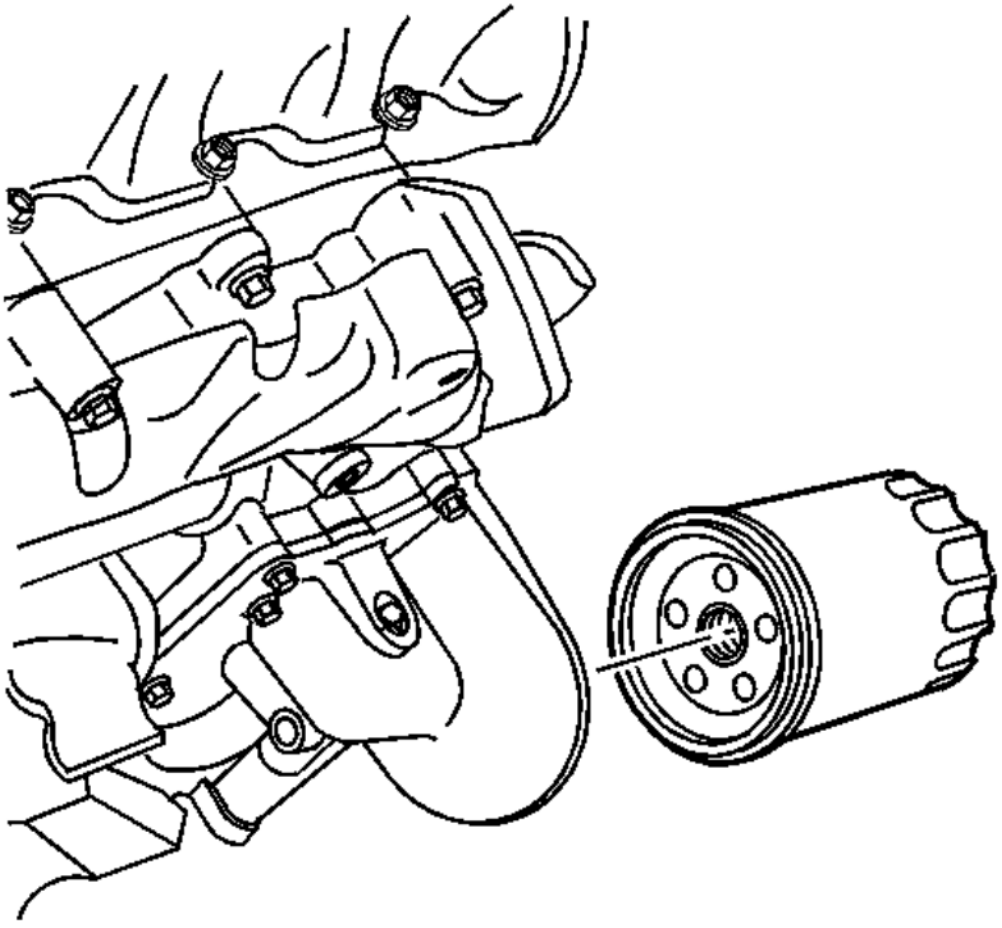


Fig. 321: View Of Oil Filter
Courtesy of GENERAL MOTORS CORP.

7. Remove the oil filter.

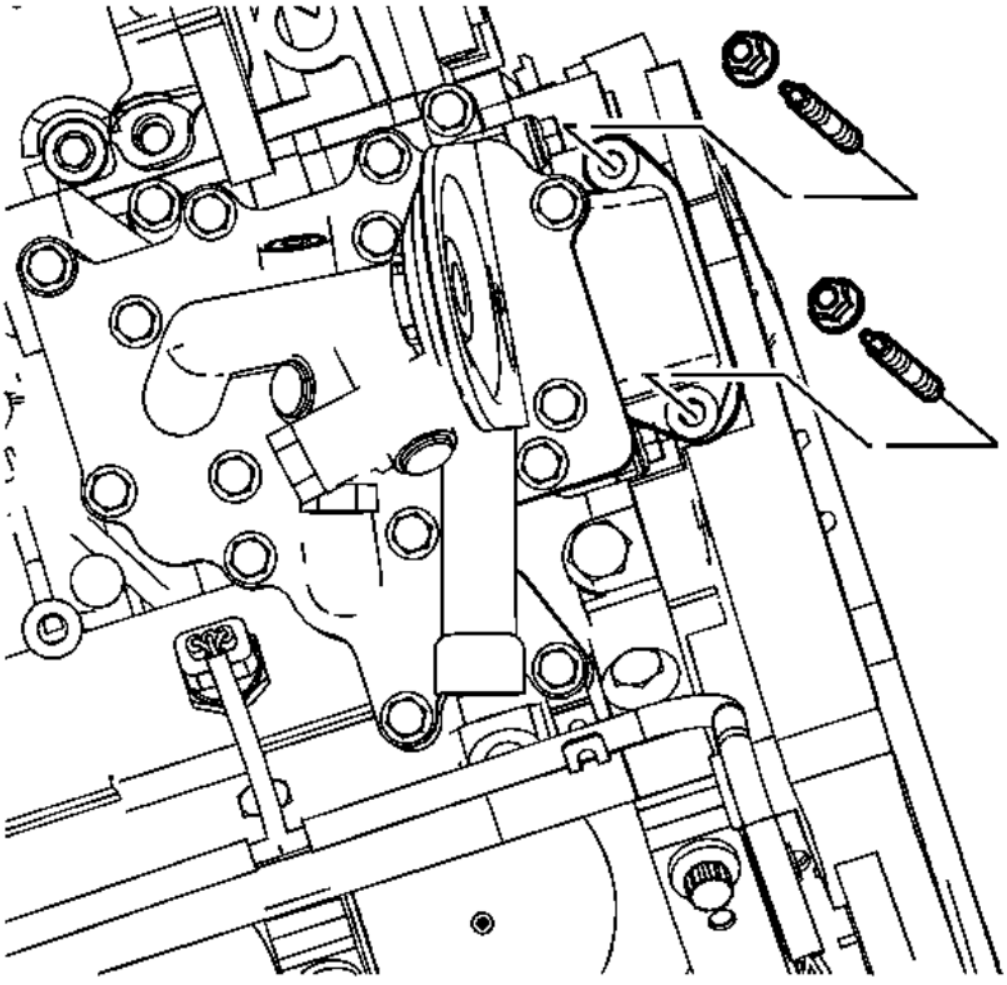


Fig. 322: View Of Turbocharger Oil Return Pipe Nuts
Courtesy of GENERAL MOTORS CORP.

8. Remove the oil cooler adapter nuts and studs from the flywheel housing.

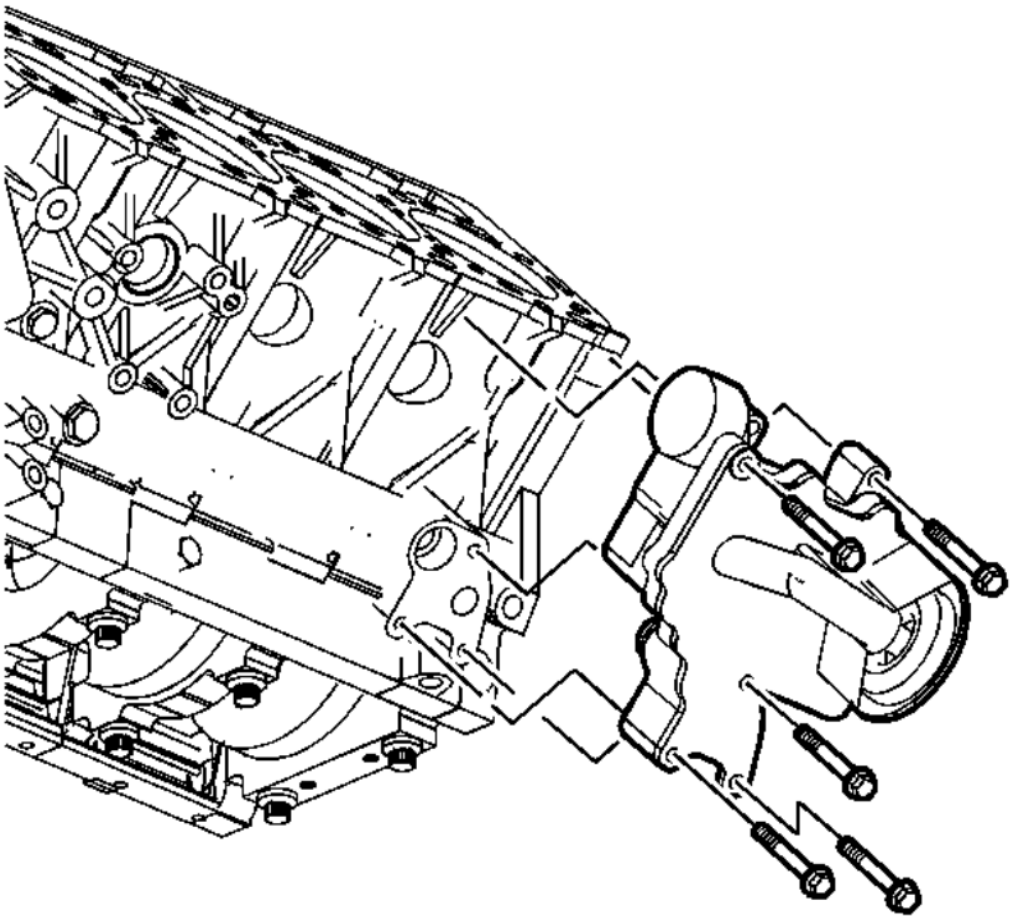


Fig. 323: View Of Oil Filter Adapter/Oil Cooler
Courtesy of GENERAL MOTORS CORP.

9. Remove the oil cooler assembly bolts.

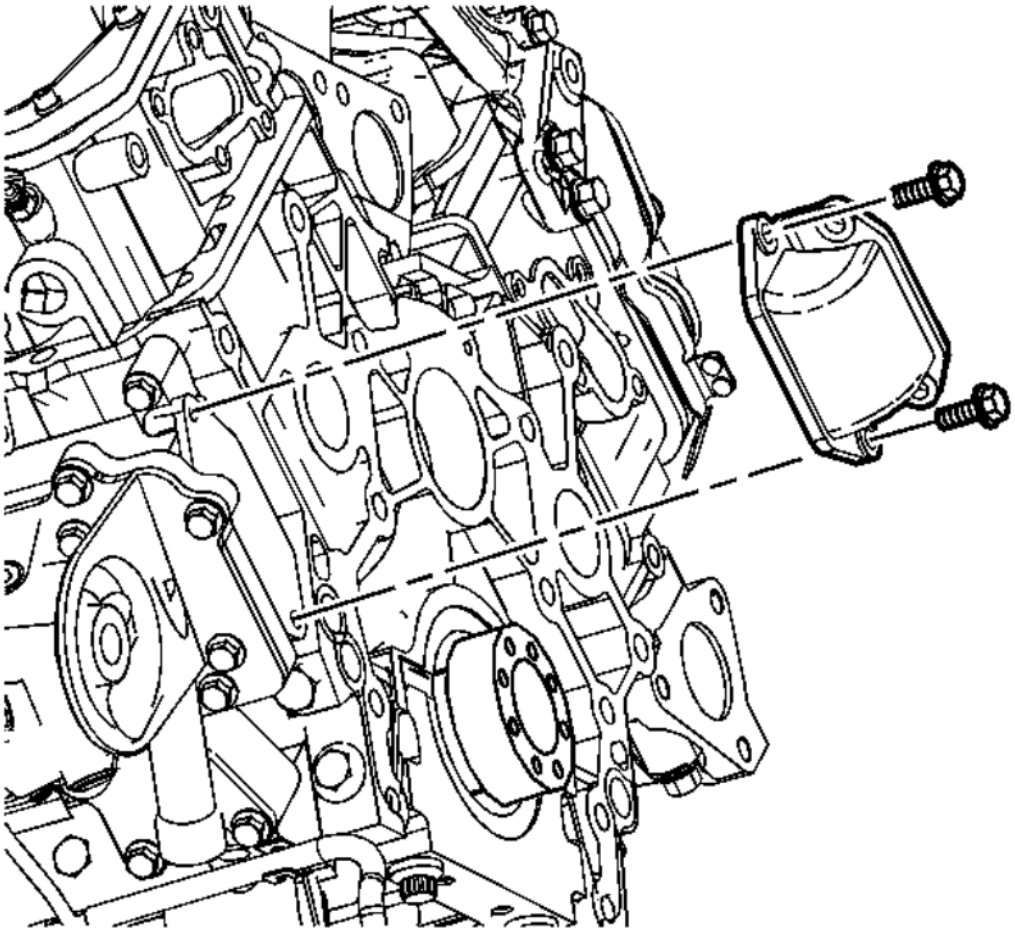


Fig. 324: View Of Oil Cooler Adapter
Courtesy of GENERAL MOTORS CORP.

10. Remove the oil cooler adapter bolts from the oil filter adapter/oil cooler.
11. Remove the oil cooler and adapter.

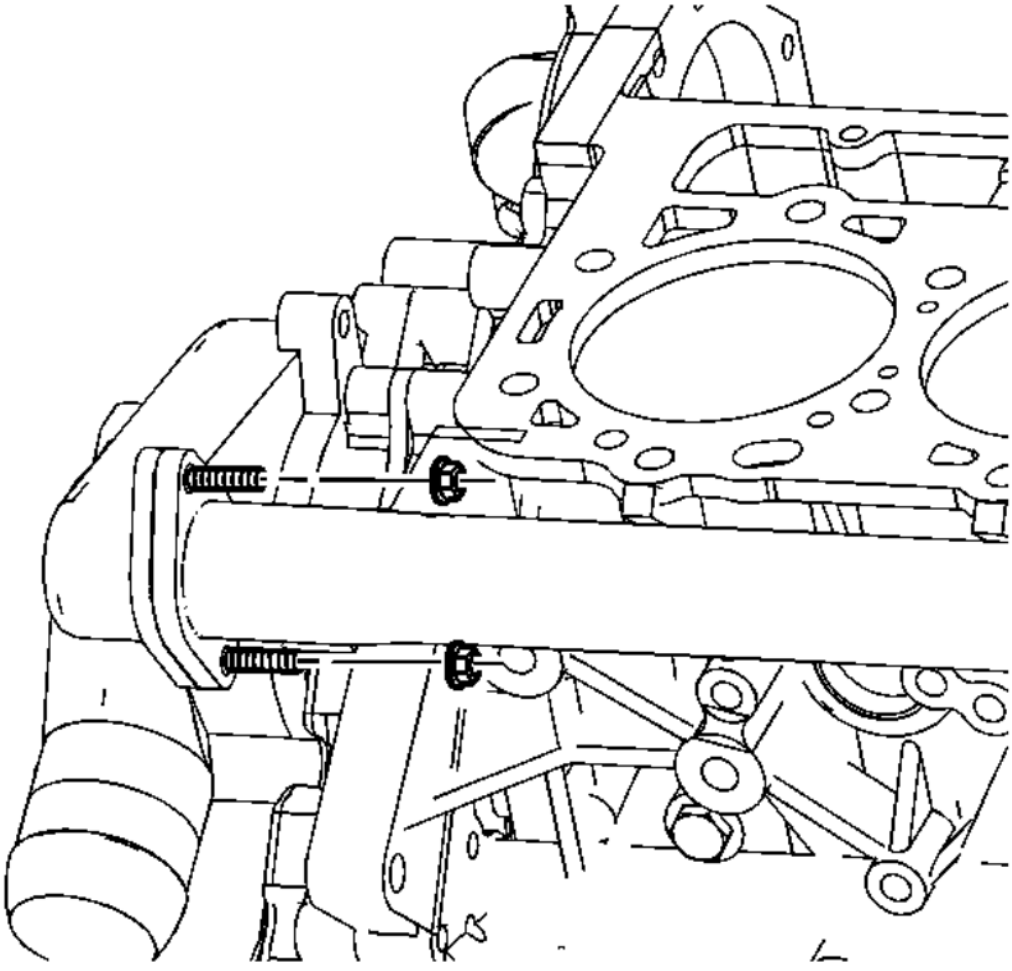


Fig. 325: View Of Water Pump Outlet Pipe Nuts
Courtesy of GENERAL MOTORS CORP.

12. Remove the coolant pipe nuts.

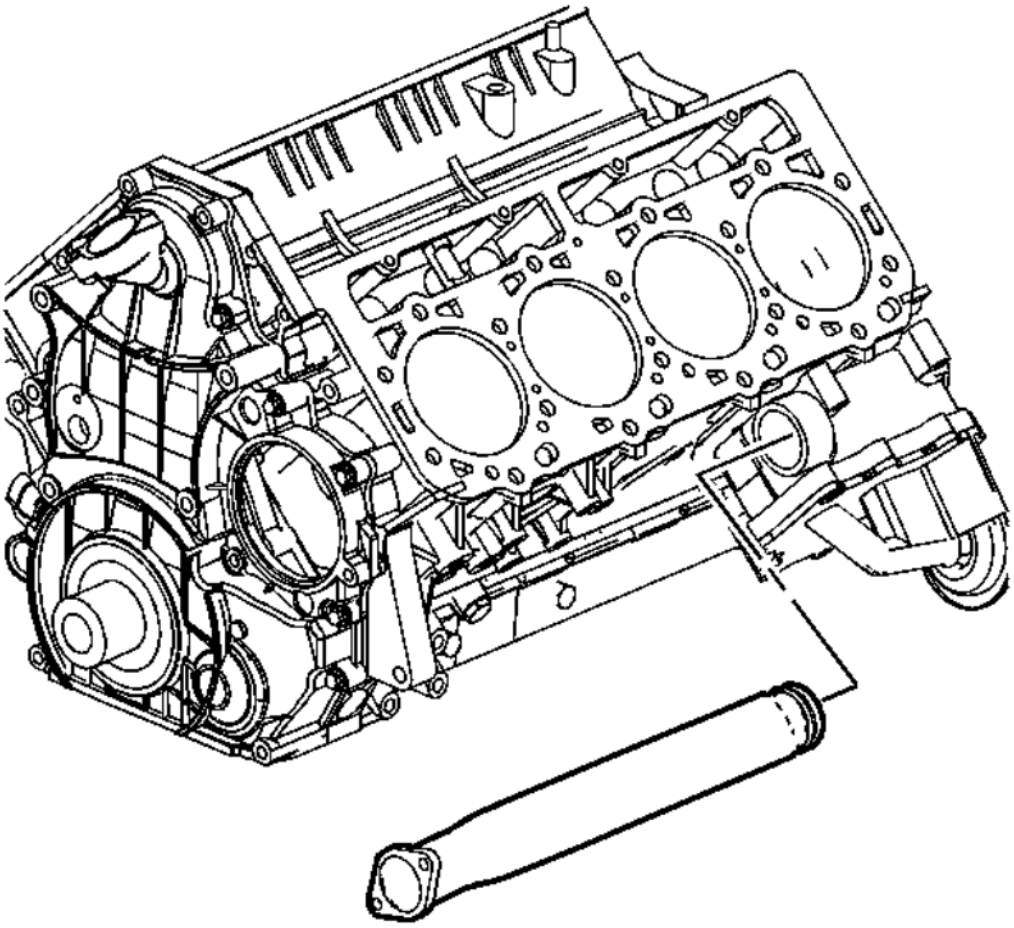


Fig. 326: View Of Engine Coolant Pipe
Courtesy of GENERAL MOTORS CORP.

13. Remove the coolant pipe.
14. Remove and discard the oil filter adapter/oil cooler O-ring seals.
15. Remove and discard the coolant pipe O-ring and gasket.
16. If required, clean and inspect the oil filter adapter/oil cooler. Refer to **Oil Filter Adapter and Oil Cooler Assembly Cleaning and Inspection** .

Installation Procedure

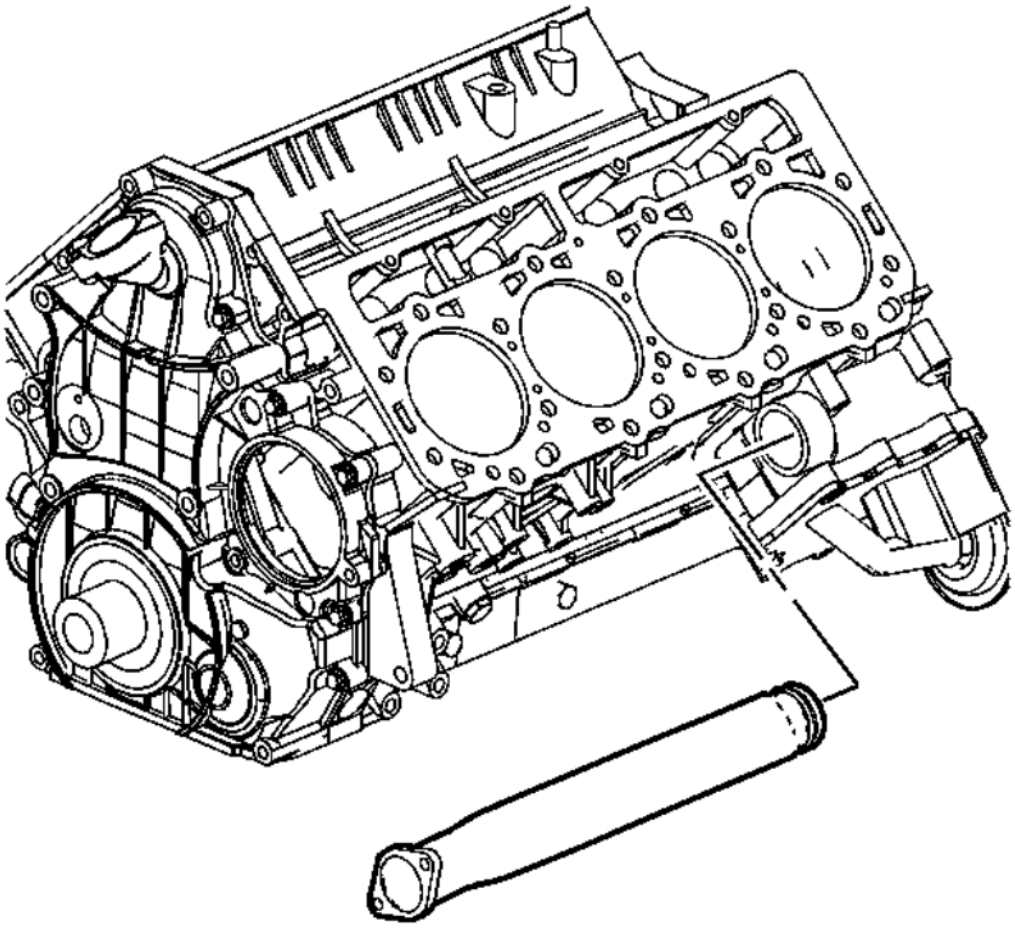


Fig. 327: View Of Engine Coolant Pipe
Courtesy of GENERAL MOTORS CORP.

1. Install new coolant pipe O-ring and gasket.
2. Install new oil filter adapter/oil cooler O-ring seals.
3. Install the coolant pipe.

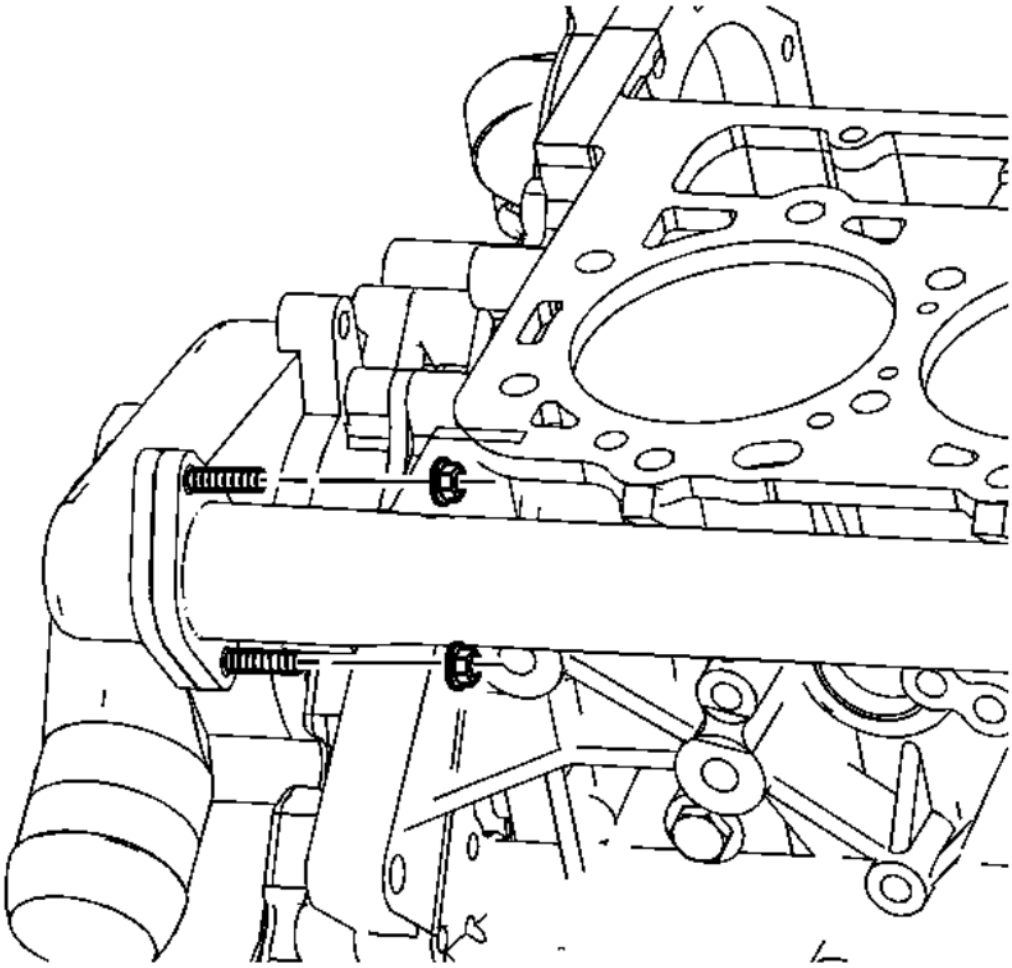


Fig. 328: View Of Water Pump Outlet Pipe Nuts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

4. Install the coolant pipe nuts.

   Tighten: Tighten the coolant pipe nuts to 25 N.m (18 lb ft).

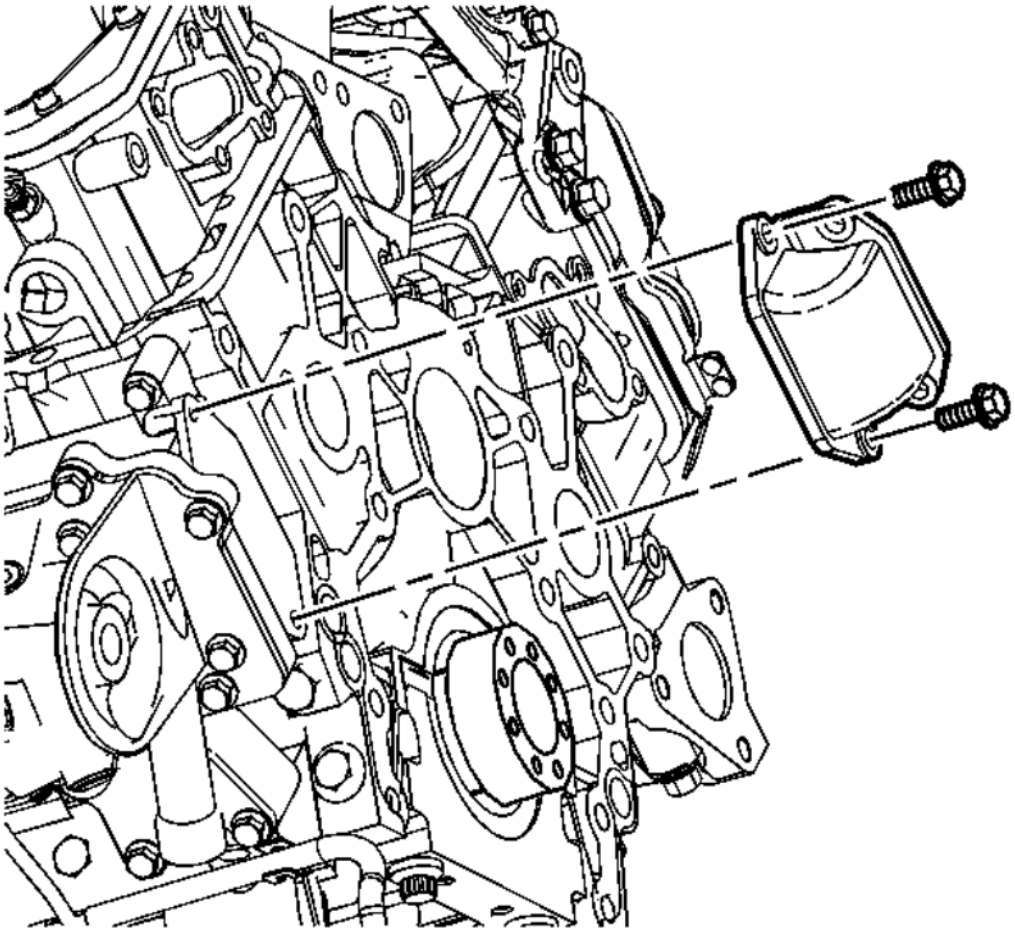


Fig. 329: View Of Oil Cooler Adapter
Courtesy of GENERAL MOTORS CORP.

5. Install the oil cooler and adapter.
6. Install the oil cooler adapter bolts to the oil filter adapter/oil cooler.

Tighten: Tighten the oil cooler adapter bolts to 25 N.m (18 lb ft).

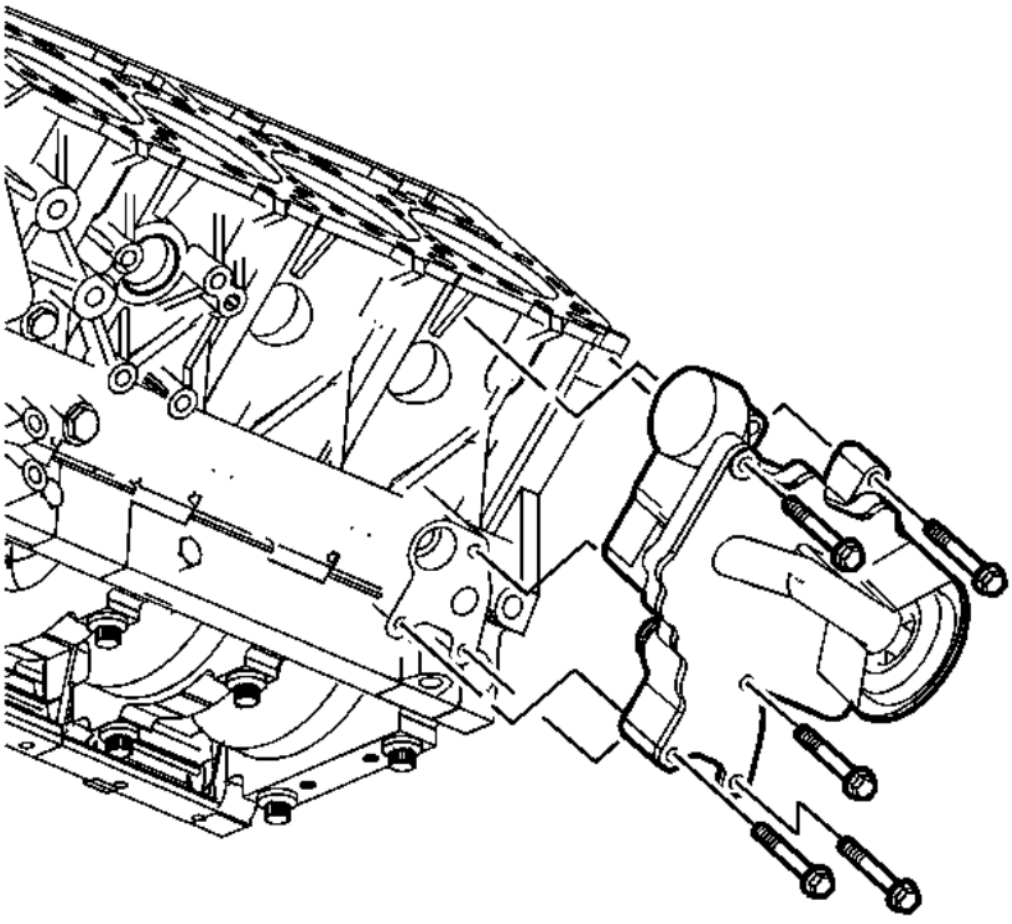


Fig. 330: View Of Oil Filter Adapter/Oil Cooler
Courtesy of GENERAL MOTORS CORP.

7. Install the oil cooler assembly bolts.

   Tighten: Tighten the oil cooler assembly bolts to 25 N.m (18 lb ft).

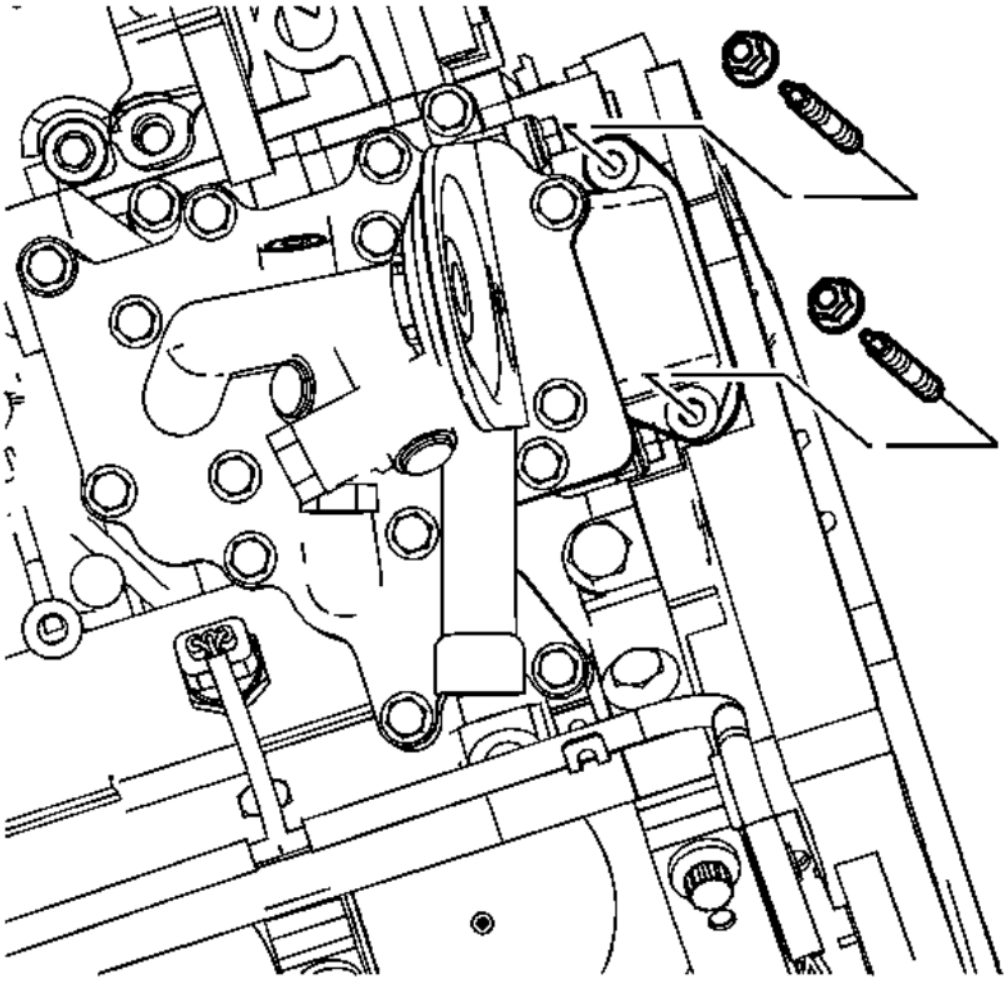


Fig. 331: View Of Turbocharger Oil Return Pipe Nuts
Courtesy of GENERAL MOTORS CORP.

8. Install the oil cooler adapter nuts and studs to the flywheel housing.

Tighten:

- Tighten the oil cooler adapter nuts to 25 N.m (18 lb ft).
- Tighten the oil cooler adapter studs to 10 N.m (89 lb in).

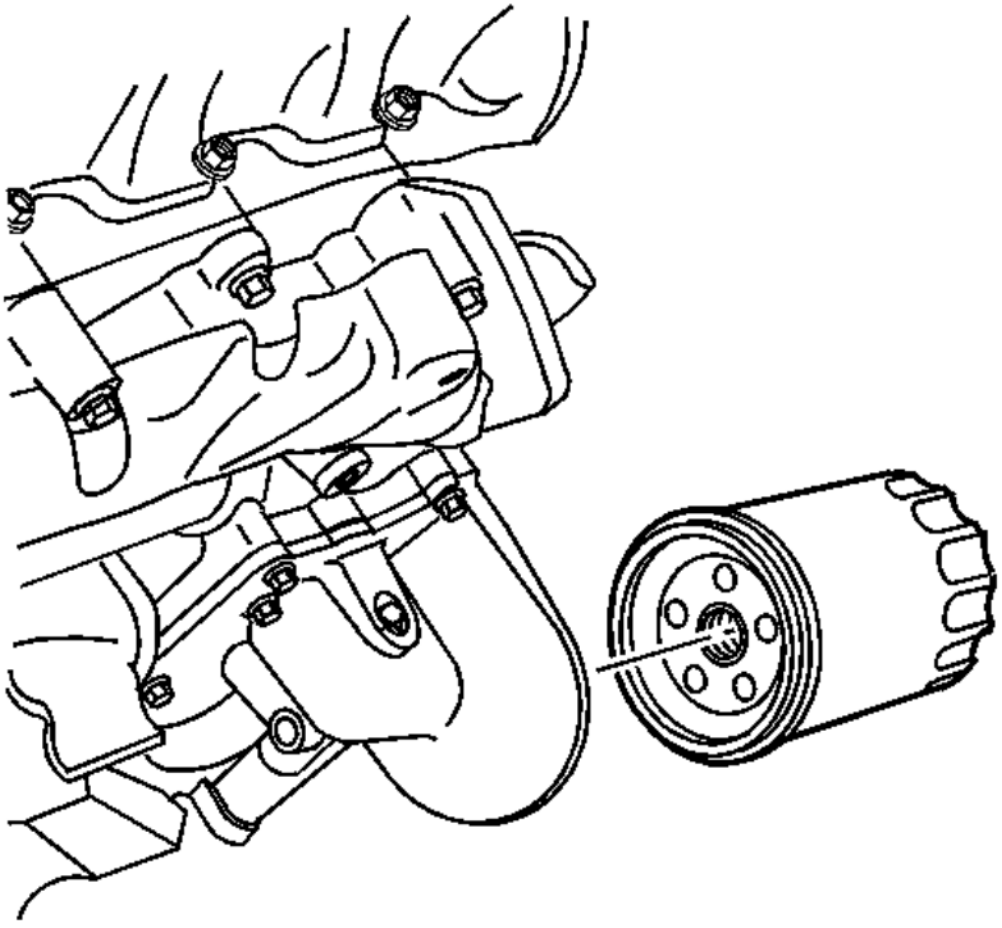


Fig. 332: View Of Oil Filter
Courtesy of GENERAL MOTORS CORP.

9. Install the oil filter.

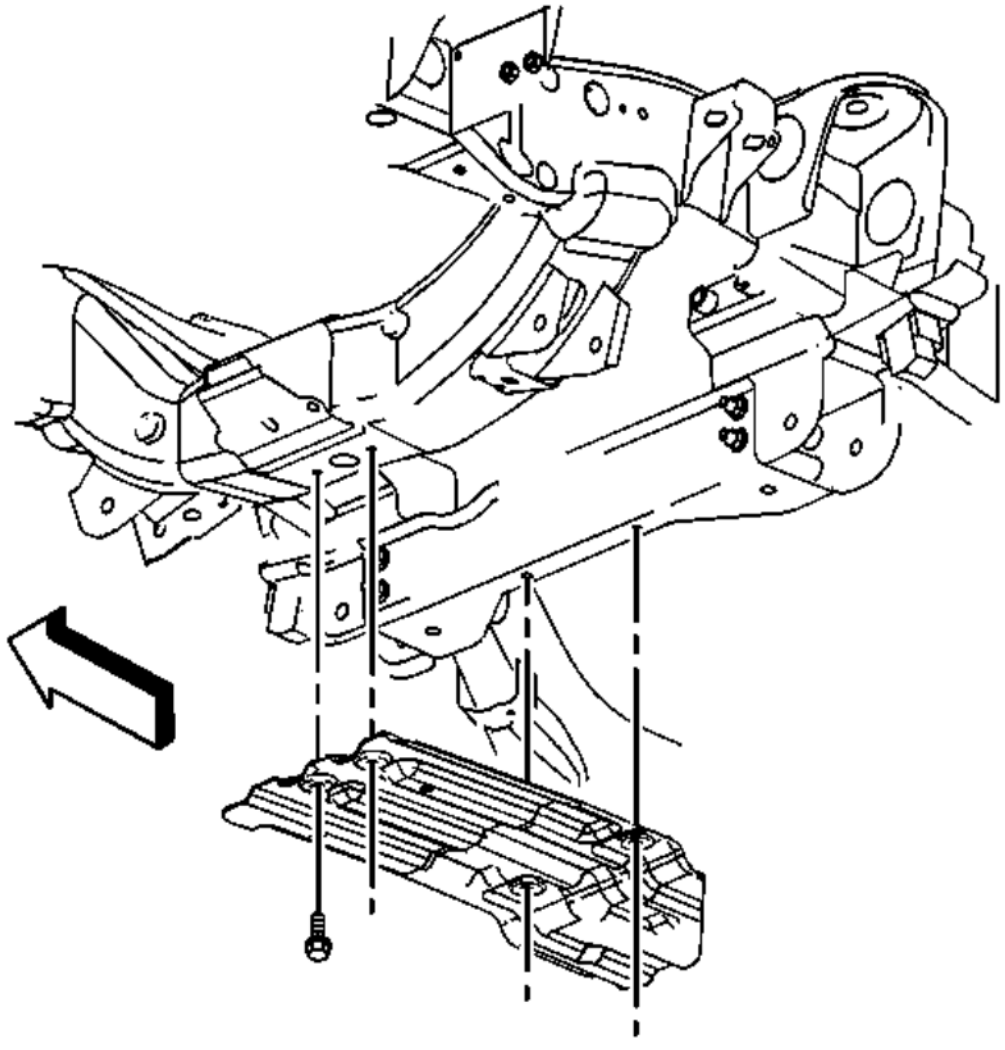


Fig. 333: Identifying Oil Pan Skid Plate
Courtesy of GENERAL MOTORS CORP.

10. If removed, install the oil pan skid plate bolts and plate.

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

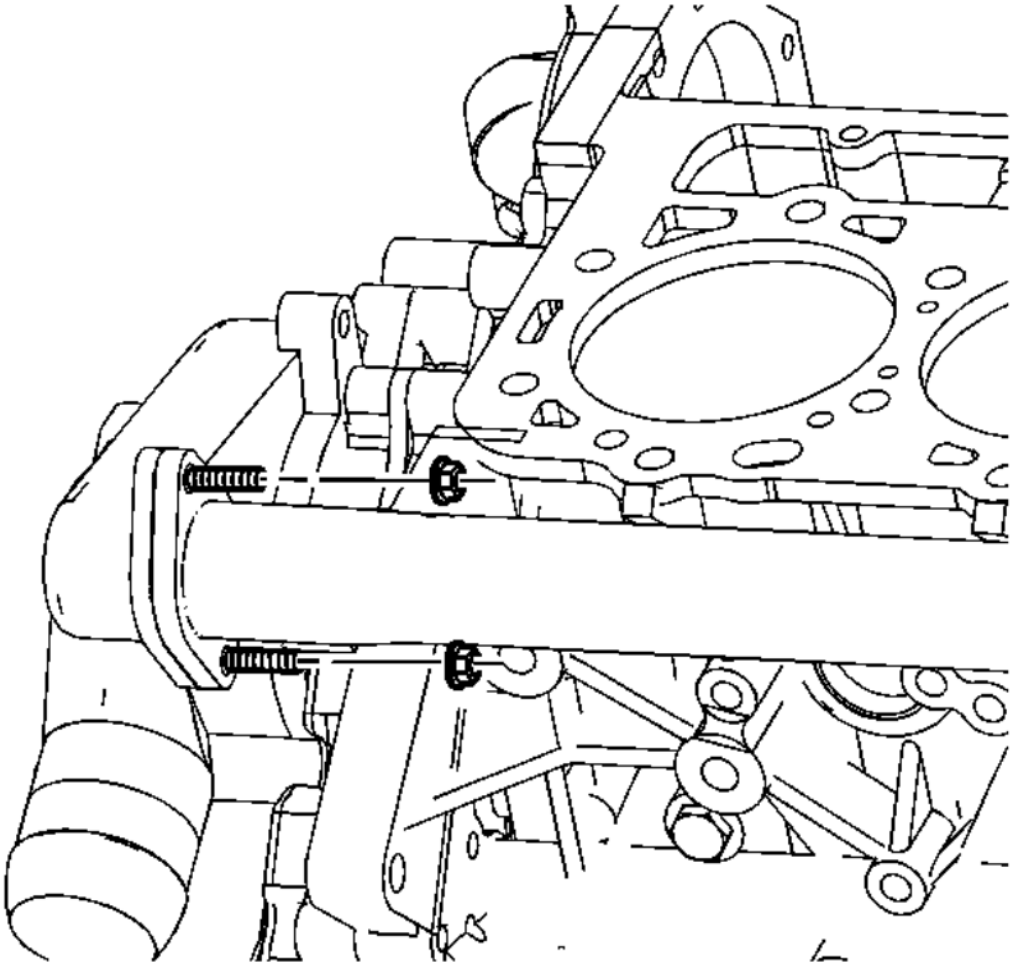


Fig. 334: View Of Water Pump Outlet Pipe Nuts
Courtesy of GENERAL MOTORS CORP.

11. Install the water pump outlet pipe nuts at the coolant pipe.

    Tighten: Tighten the nuts to 25 N.m (18 lb ft).

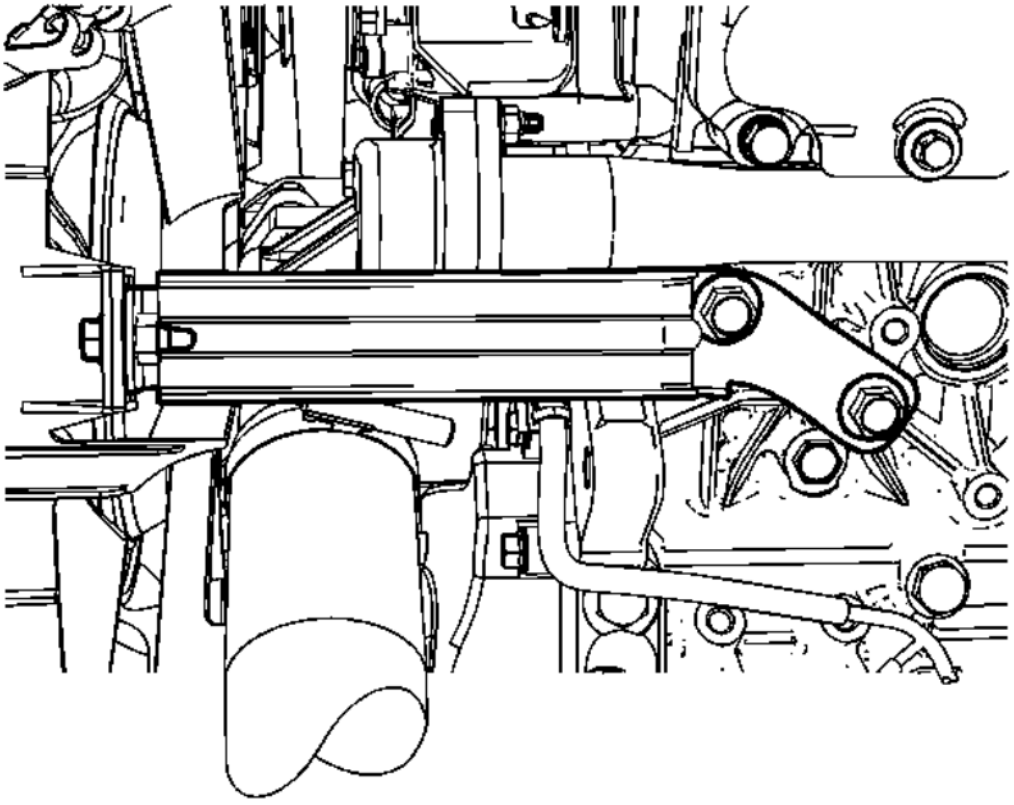


Fig. 335: View Of Charge Air Inlet Pipe
Courtesy of GENERAL MOTORS CORP.

12. Position the cooling fan shroud bracket (2).
13. Install the cooling fan shroud bracket bolts (1).

    Tighten: Tighten the fan shroud bolt to 8 N.m (71 lb in).

    Tighten: Tighten the fan shroud bracket to engine block bolts to 58N.m (63 lb ft).

14. Install the charge air inlet pipe. Refer to **Charge Air Cooler Inlet Pipe Replacement** .
15. Fill the cooling system. Refer to **Cooling System Draining and Filling (Vac-N-Fill)** or **Cooling System Draining and Filling (Static Fill)** .

ENGINE OIL PRESSURE SENSOR AND/OR SWITCH REPLACEMENT

Tools Required

J 41712 Oil Pressure Switch Socket

Removal Procedure

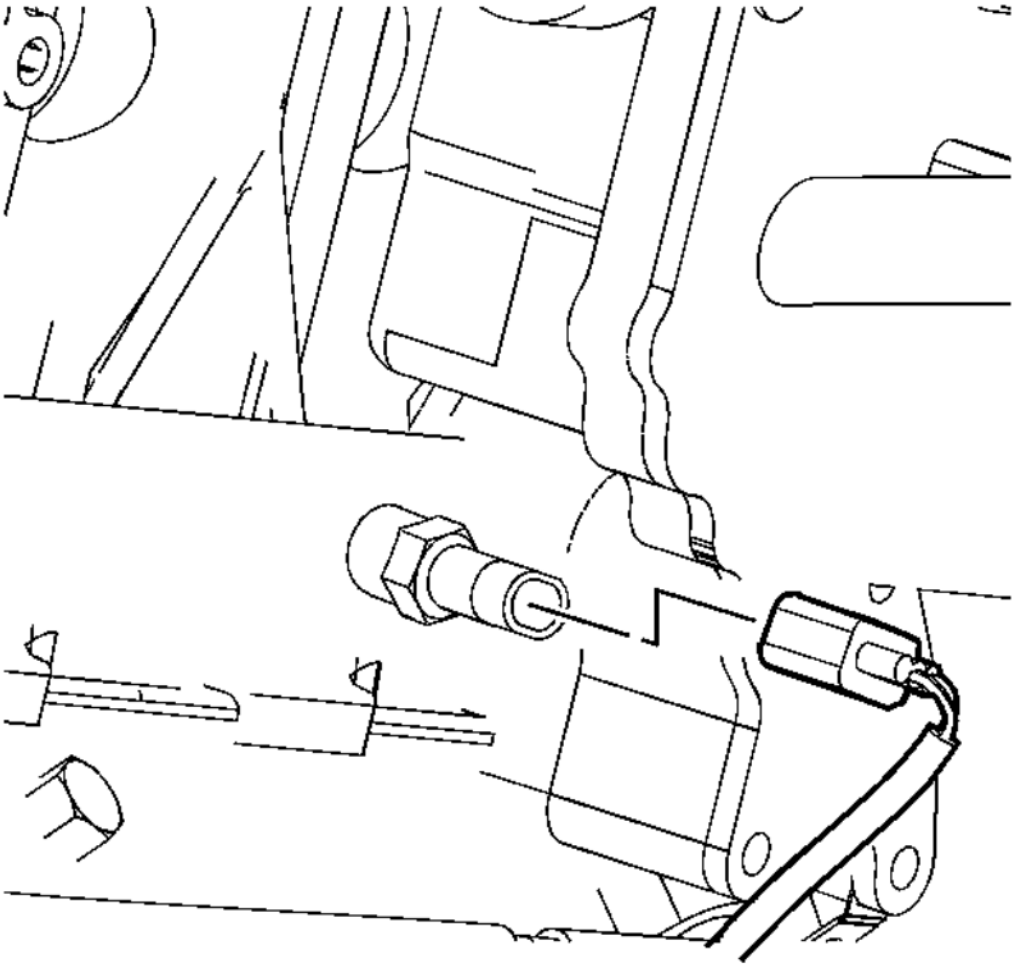


Fig. 336: View Of Oil Pressure Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Clean the area around the sensor. Do not allow debris to enter the engine.

1. Remove the left wheelhouse inner panel. Refer to **Front Wheelhouse Liner Replacement - Left Side (Chevrolet)** or **Front Wheelhouse Liner Replacement - Left Side (GMC)** .
2. Disconnect the oil pressure sensor electrical connector.

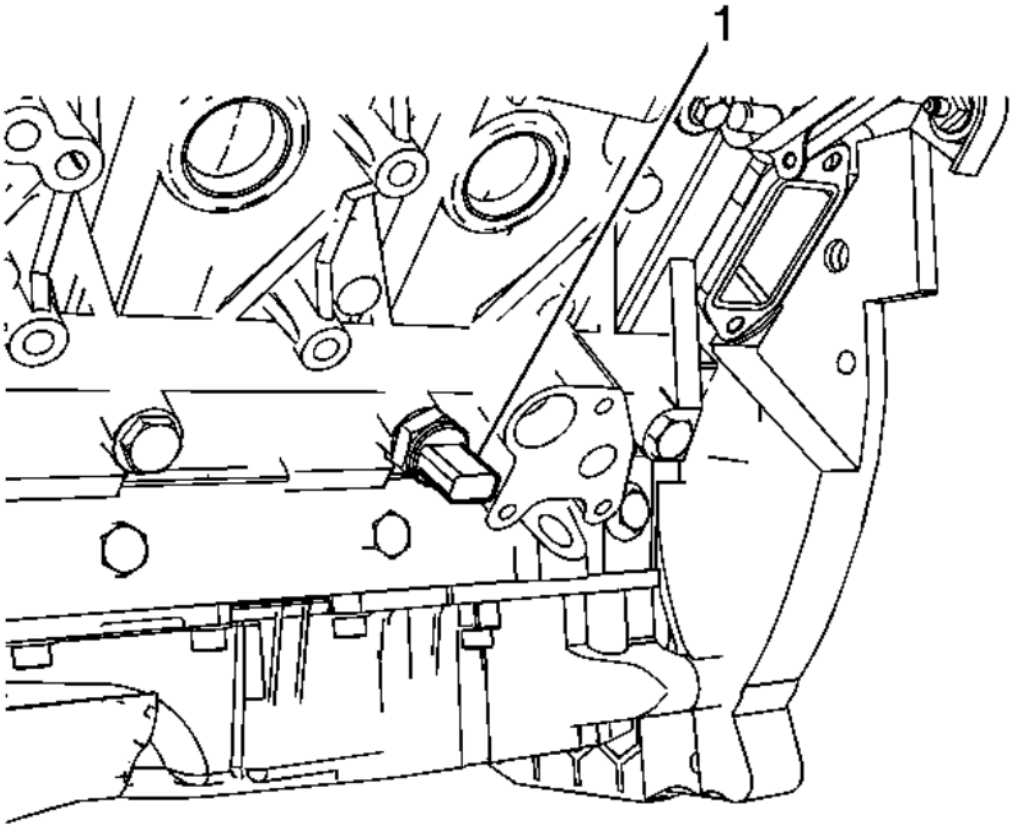


Fig. 337: View Of Oil Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

3. Using **J 41712** , remove the oil pressure sensor (1).

Installation Procedure

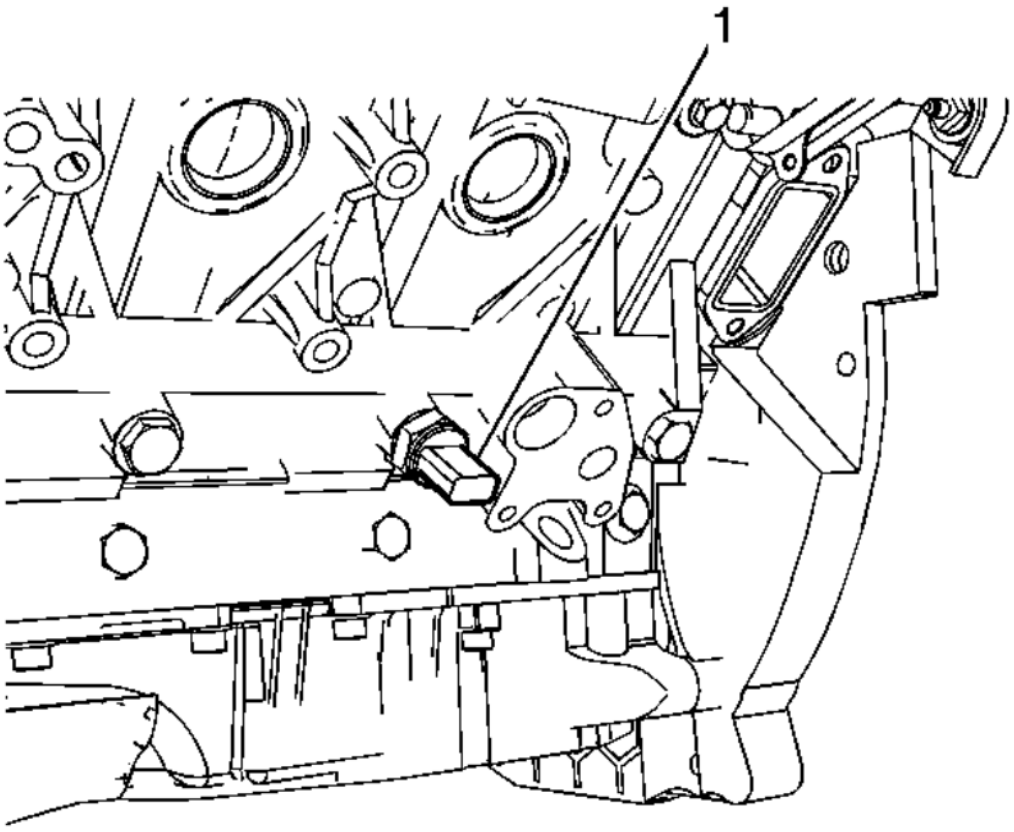


Fig. 338: View Of Oil Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

1. Apply sealant to the threads of the oil pressure sensor. Refer to **Sealers, Adhesives, and Lubricants** for the correct part number.
2. Using **J 41712** , install the oil pressure sensor (1).

Tighten: Tighten the sensor to 49 N.m (36 lb ft).

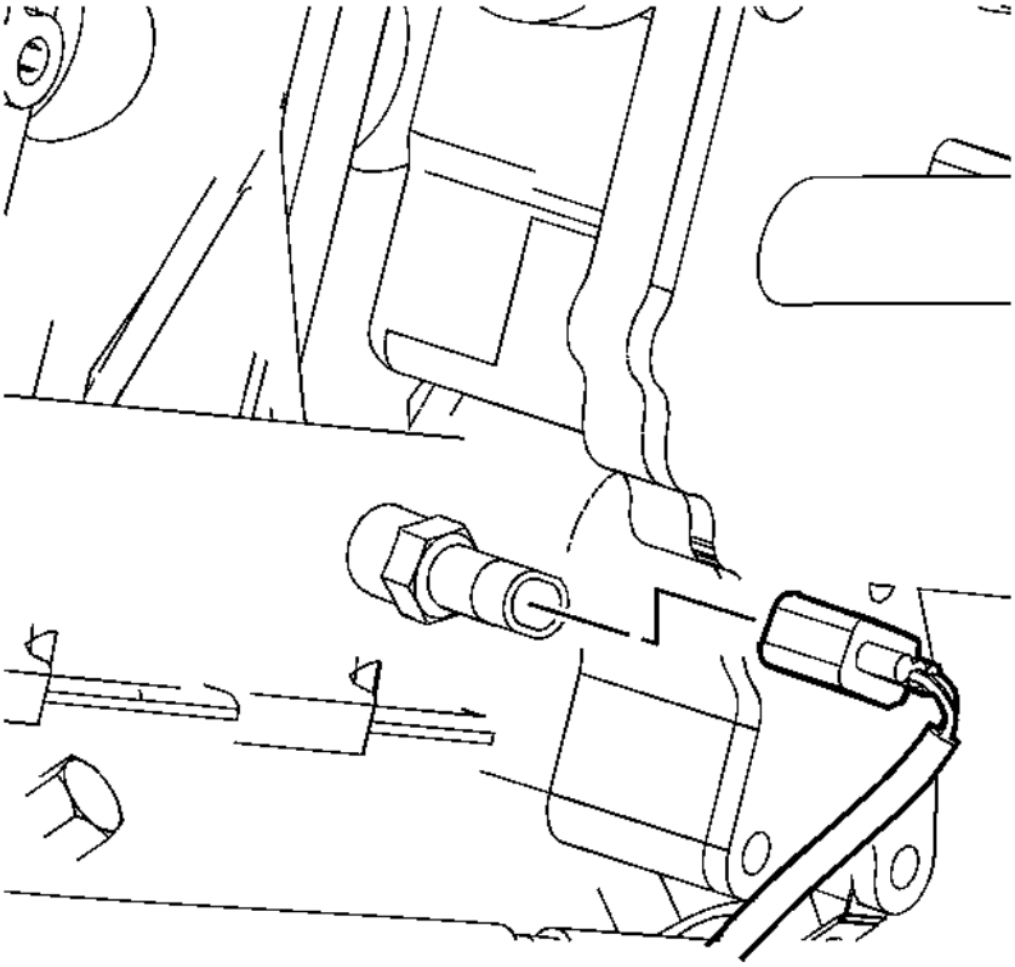


Fig. 339: View Of Oil Pressure Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. Connect the oil pressure sensor electrical connector.
4. Install the left wheelhouse inner panel. Refer to **Front Wheelhouse Liner Replacement - Left Side (Chevrolet)** or **Front Wheelhouse Liner Replacement - Left Side (GMC)** .
5. Check and add engine oil if necessary.

ENGINE OIL LEVEL SENSOR AND/OR SWITCH REPLACEMENT

Removal Procedure

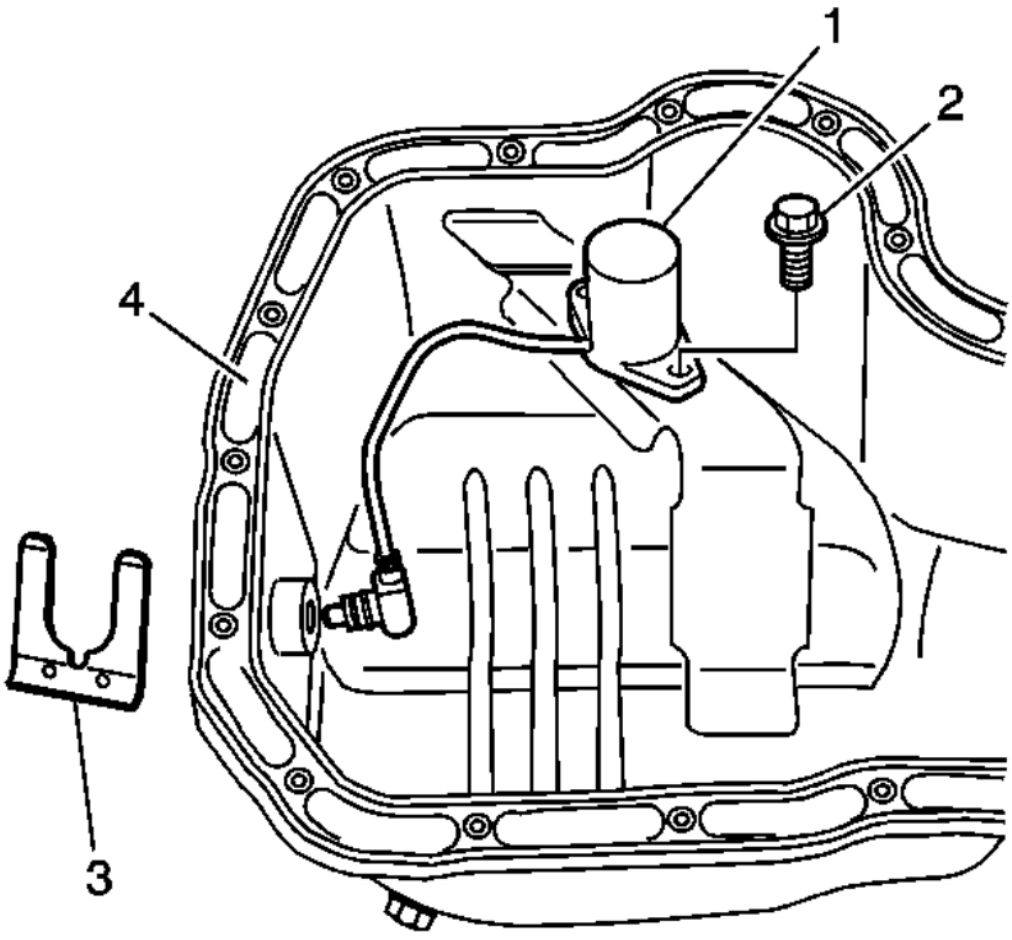


Fig. 340: View Of Oil Level Sensor, Clip, Bolt & Oil Pan Mating Surface
Courtesy of GENERAL MOTORS CORP.

1. Remove the lower oil pan. Refer to **Lower Oil Pan Replacement**.
2. Remove the oil level sensor clip (3).
3. Remove the oil level sensor bolt (2) and sensor (1).

Installation Procedure

IMPORTANT: When routing the oil level sensor wire, ensure that the wire is routed along the side of the oil pan.

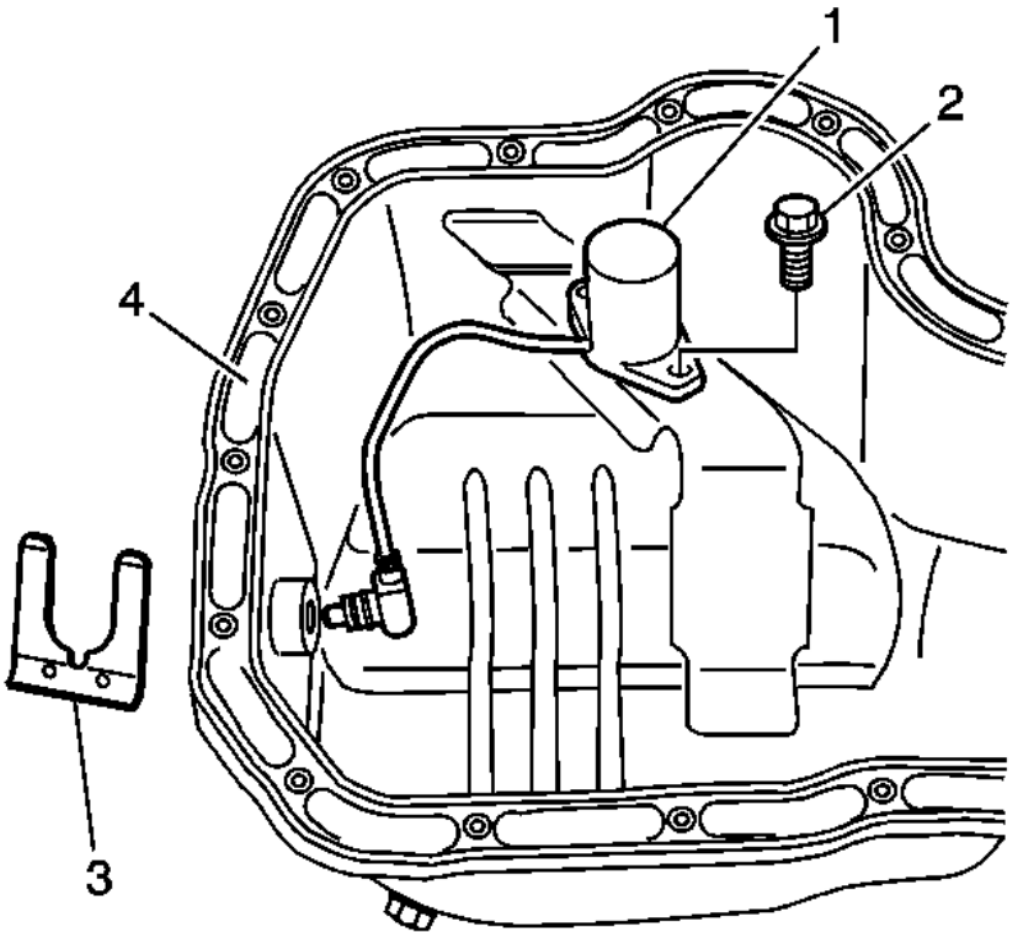


Fig. 341: View Of Oil Level Sensor, Clip, Bolt & Oil Pan Mating Surface
Courtesy of GENERAL MOTORS CORP.

1. Install the oil level sensor (1) and bolt (2).

   Tighten: Tighten the bolt to 9 N.m (80 lb in).

2. Install the oil level sensor clip (3).
3. Install the lower oil pan. Refer to **Lower Oil Pan Replacement**.

ENGINE REPLACEMENT

Tools Required

- **J 36857** Engine Lift Brackets. See **Special Tools** .
- **J 43181** Quick Connect Connector Removal. See **Special Tools** .

Removal Procedure

IMPORTANT: In order to remove the engine the vehicle needs to be on a hoist. The front wheels and tires will also require removal. The vehicle will have to be supported by the frame when the tires are removed.

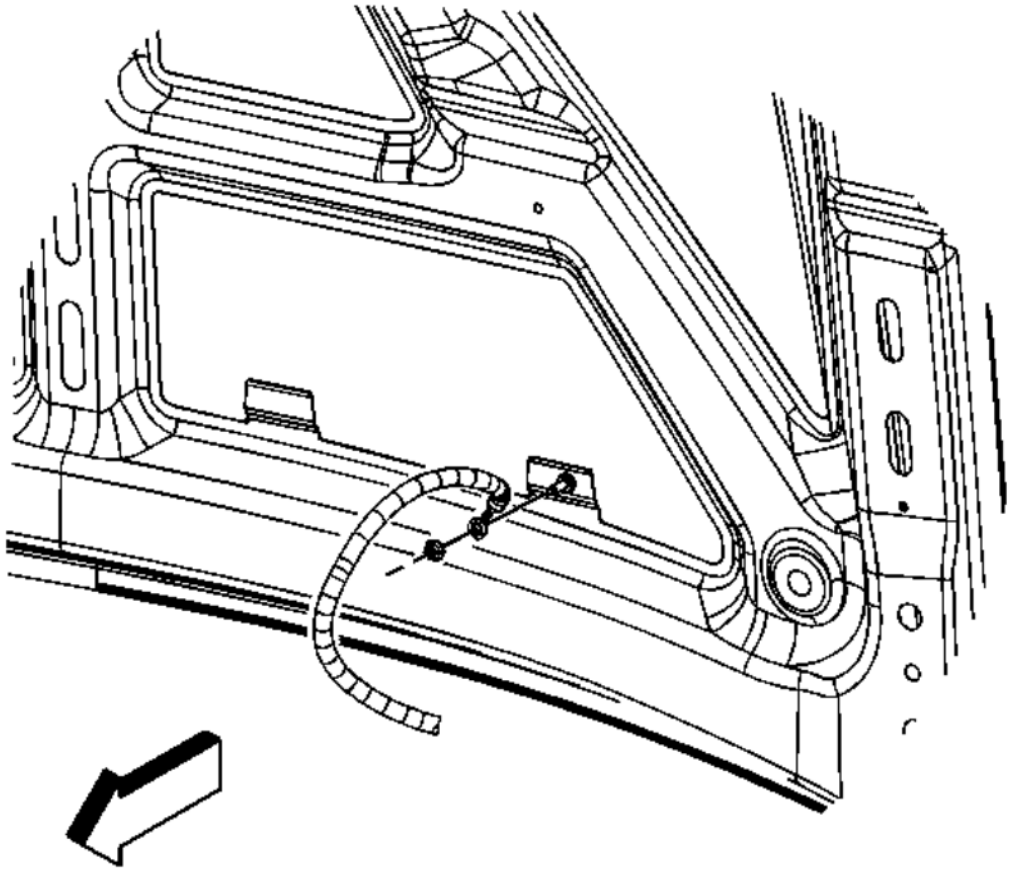


Fig. 342: View Of Ground Strap & Nut

Courtesy of GENERAL MOTORS CORP.

1. Open the hood.
2. Remove the ground strap from the stud.

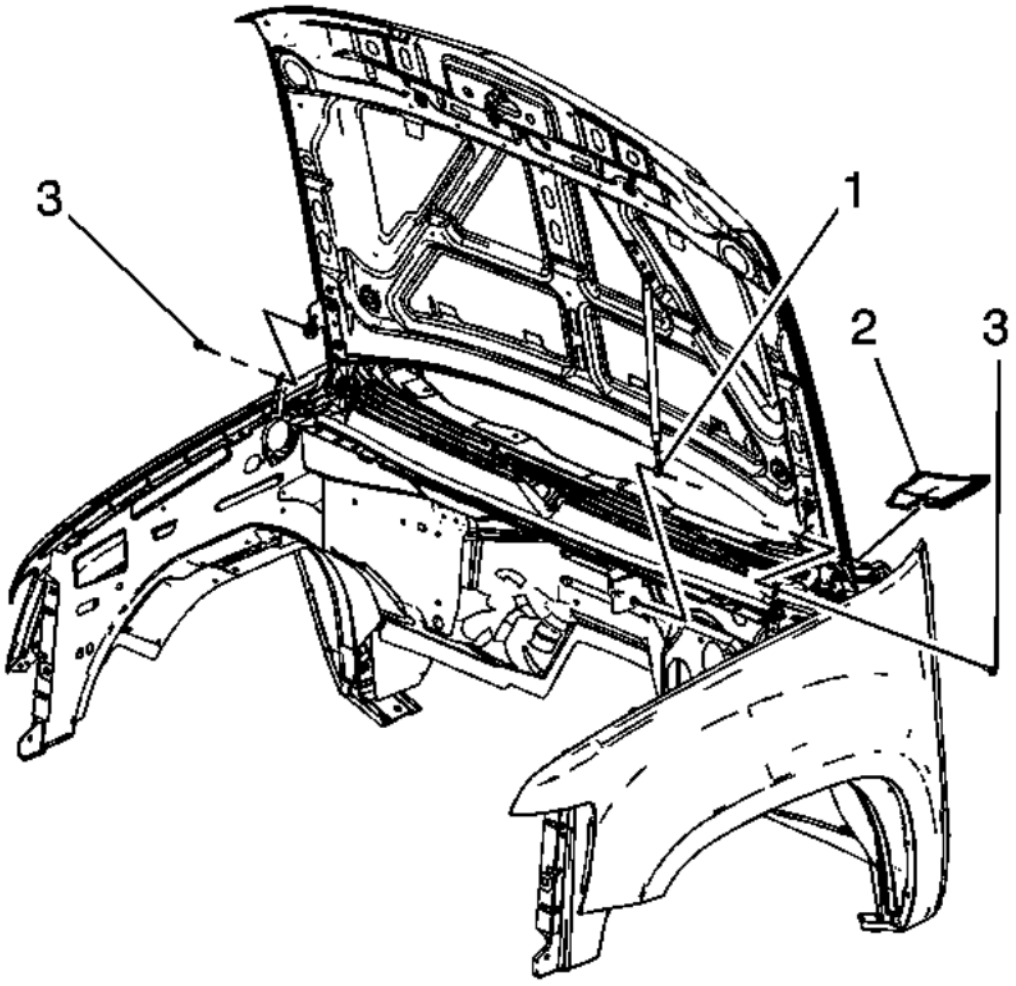


Fig. 343: View Of Hood Strut Rod, Grille End Caps & Hood Hinge Bolts
Courtesy of GENERAL MOTORS CORP.

3. Assemble 2 sets of the following: an M6 bolt, 2 each 19.05 mm (0.75 in) flat washers and an M6 nut.
4. Release the retainer securing the hood strut rod to the hood strut bracket stud.

5. Remove the air inlet grille end caps (1), lift the end cap up in order to disengage the retainers. (left side shown, right side similar).
6. Have an assistant support the hood.
7. Remove the hood hinge bolts (2) and set aside.

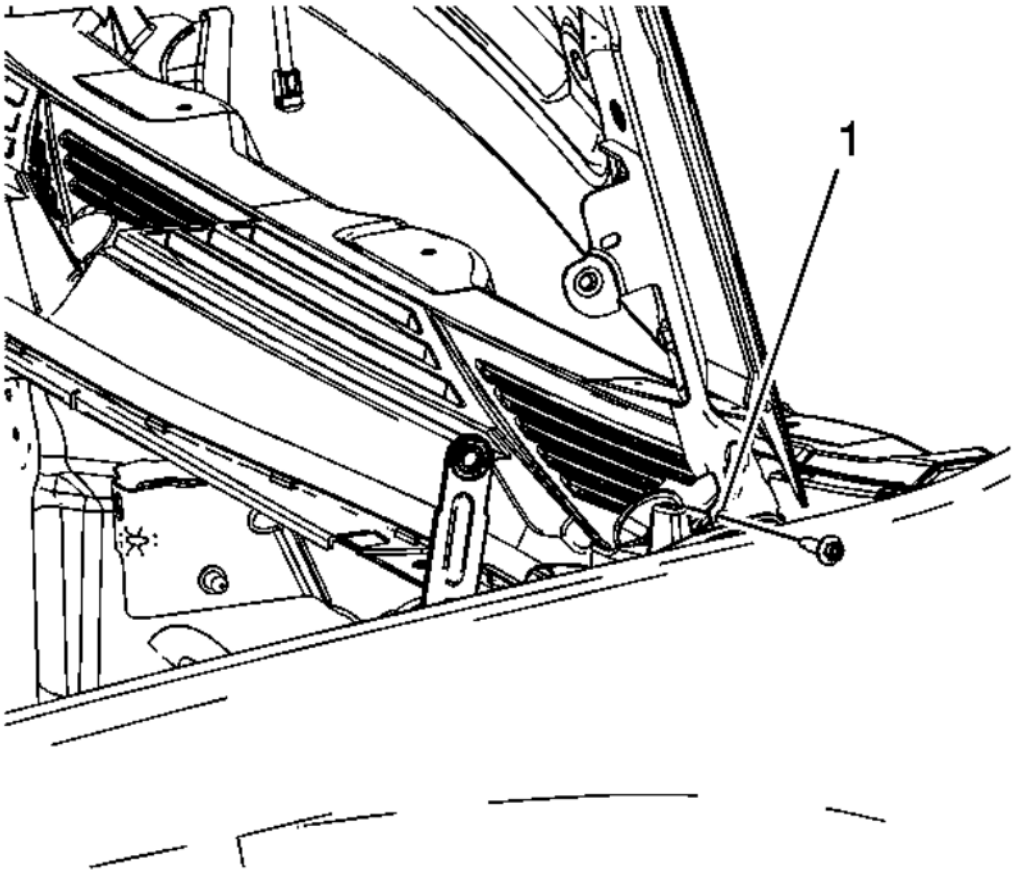


Fig. 344: View Of Service Piston Notch
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: There is a positive stop which limits the hood from being opened too far.

8. Raise the hood until the service position notch (1) in the upper hinge is reached.
9. Install the 2 sets of the M6 bolts to both the left and right side service notches and tighten

finger tight.

NOTE: Refer to Fastener Notice .

10. Lower the hood until the bolts rest against the lower hinge, tighten the bolts to secure the hood.

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

11. The hood is now set in the service position.
12. Recover the air conditioning (A/C) system. Refer to **Refrigerant Recovery and Recharging** .
13. Disconnect the negative battery cables. Refer to **Battery Negative Cable Disconnection and Connection (w/Single Battery)** or **Battery Negative Cable Disconnection and Connection (w/Auxiliary Battery)** or **Battery Negative Cable Disconnection and Connection (w/Dual Batteries)** .
14. Drain the cooling system. Refer to **Cooling System Draining and Filling (Vac-N-Fill)** or **Cooling System Draining and Filling (Static Fill)** .

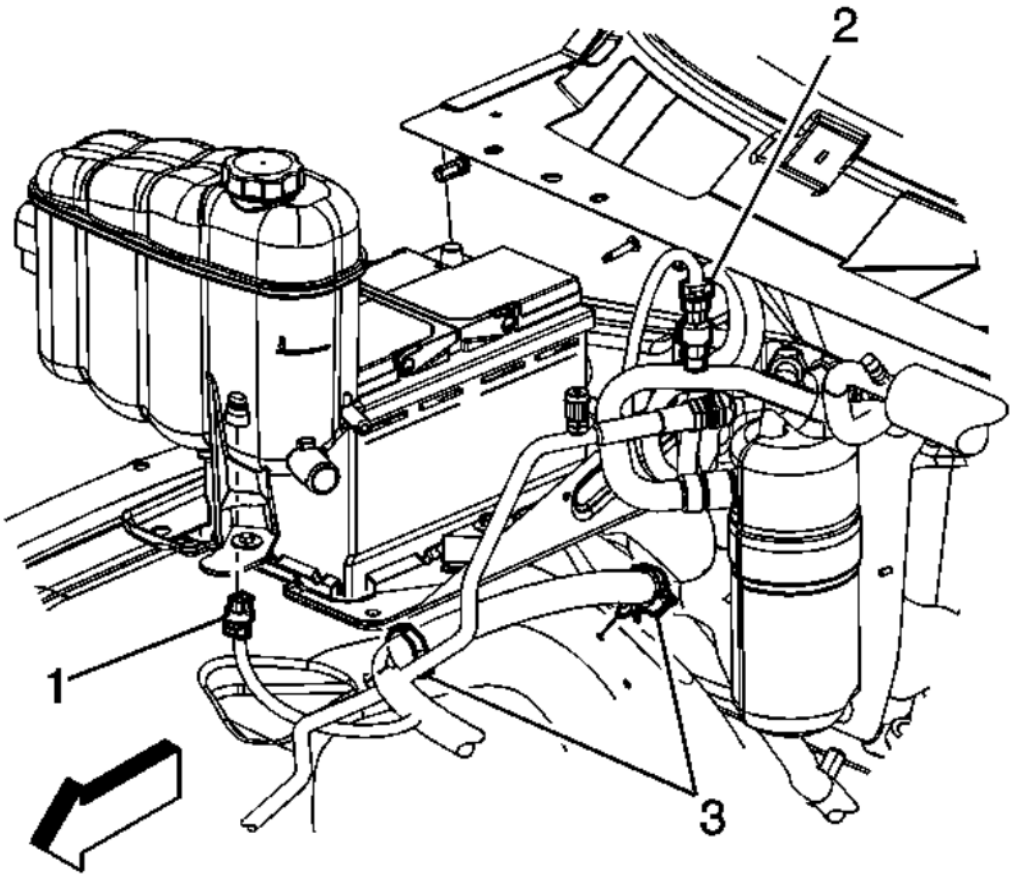


Fig. 345: View Of Engine Wire Harness Clips, A/C Pressure Cycling Switch & Surge Tank Switch
Courtesy of GENERAL MOTORS CORP.

15. Disconnect the following engine wire harness connectors:
    - Surge tank switch (1)
    - A/C pressure cycling switch (2)
    - Remove the engine wire harness clips from the wheelhouse inner panel (3).
16. Remove the air cleaner. Refer to **Air Cleaner Assembly Replacement** .
17. Remove the surge tank. Refer to **Radiator Surge Tank Replacement (Non-HP2)** .
18. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
19. Remove both front tires and wheels. Refer to **Tire and Wheel Removal and Installation** .

20. Remove both fender wheelhouse inner panels. Refer to **Front Wheelhouse Liner Replacement - Right Side (GMC)** or **Front Wheelhouse Liner Replacement - Right Side (Chevrolet)** and **Front Wheelhouse Liner Replacement - Left Side (Chevrolet)** or **Front Wheelhouse Liner Replacement - Left Side (GMC)** .
21. Lower the vehicle.
22. Remove the charged air cooler pipes. Refer to **Charge Air Cooler Inlet Pipe Replacement** and **Charge Air Cooler Outlet Pipe Replacement** .
23. Remove the radiator inlet hose **Radiator Inlet Hose Replacement (Non-HP2)** .
24. Remove the upper fan shroud. Refer to **Engine Coolant Fan Upper Shroud Replacement (Mechanical)** or **Engine Coolant Fan Upper Shroud Replacement (Automatic Transmission - Diesel)** .
25. Remove the lower fan shroud. Refer to **Engine Coolant Fan Lower Shroud Replacement (Mechanical)** .

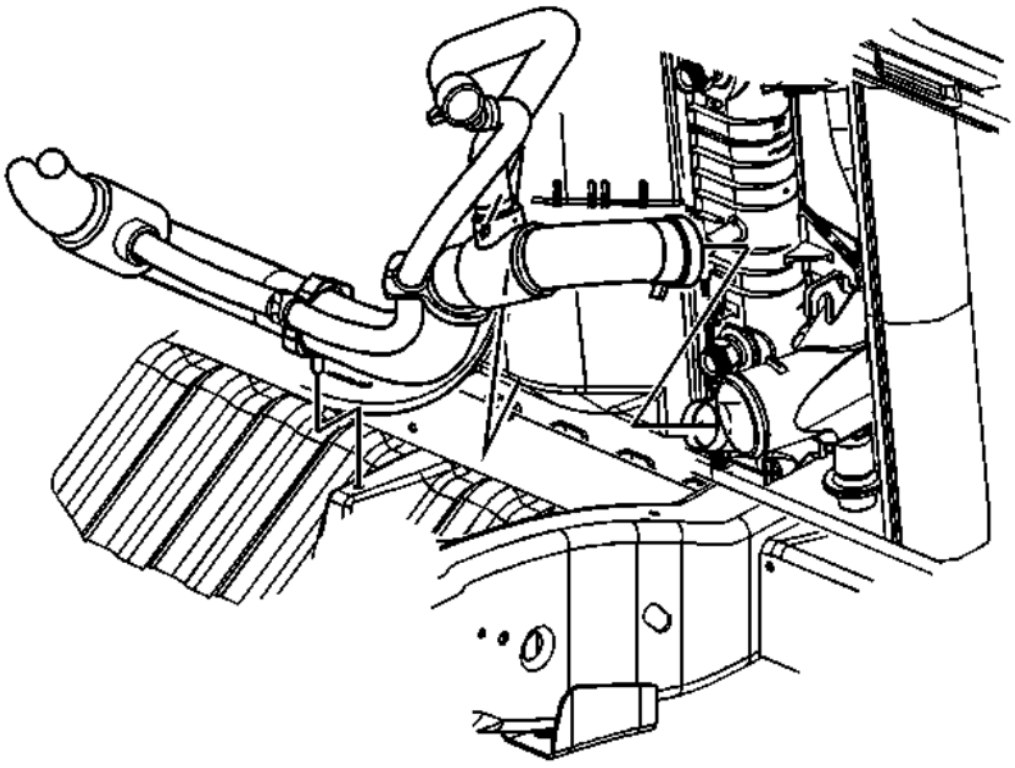


Fig. 346: View Of Radiator Outlet Hose & Outlet Heater Hose
Courtesy of GENERAL MOTORS CORP.

26. Loosen the hose clamp and remove the radiator outlet hose from the radiator.
27. Disconnect the outlet heater hose from the outlet radiator hose.
28. Remove the hose clips from the frame.

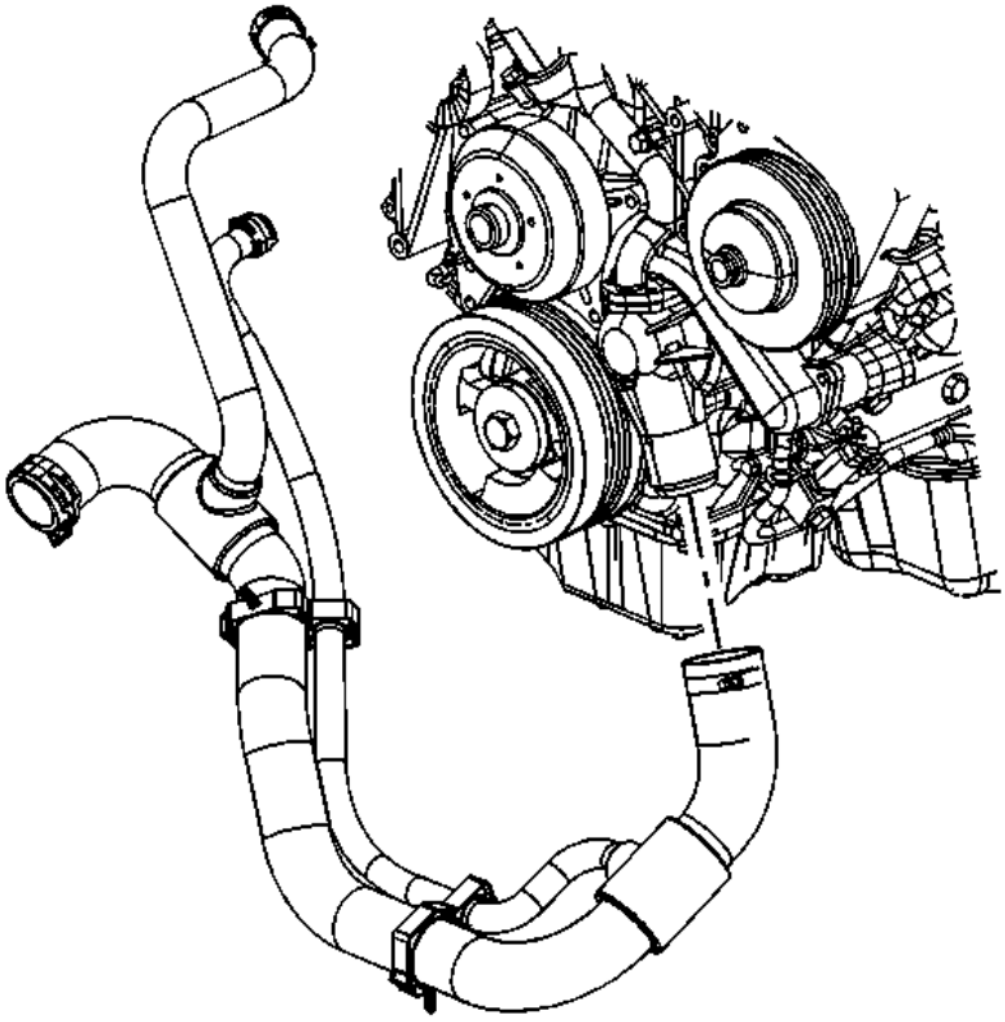


Fig. 347: View Of Radiator Outlet Hose At Engine
Courtesy of GENERAL MOTORS CORP.

29. Loosen the hose clamp and remove the radiator outlet hose from the engine.
30. Remove the outlet heater hose pipe bolt from the bracket.
31. Remove the outlet heater hose pipe nut.
32. Move the heater hose and secure aside.
33. Remove the upper radiator support. Refer to **Radiator Support Replacement** .
34. Remove the radiator. Refer to **Radiator Replacement (LLM)** .
35. Remove the charged air cooler. Refer to **Charge Air Cooler Replacement** .
36. Remove the A/C condenser. Refer to **Condenser Replacement** .

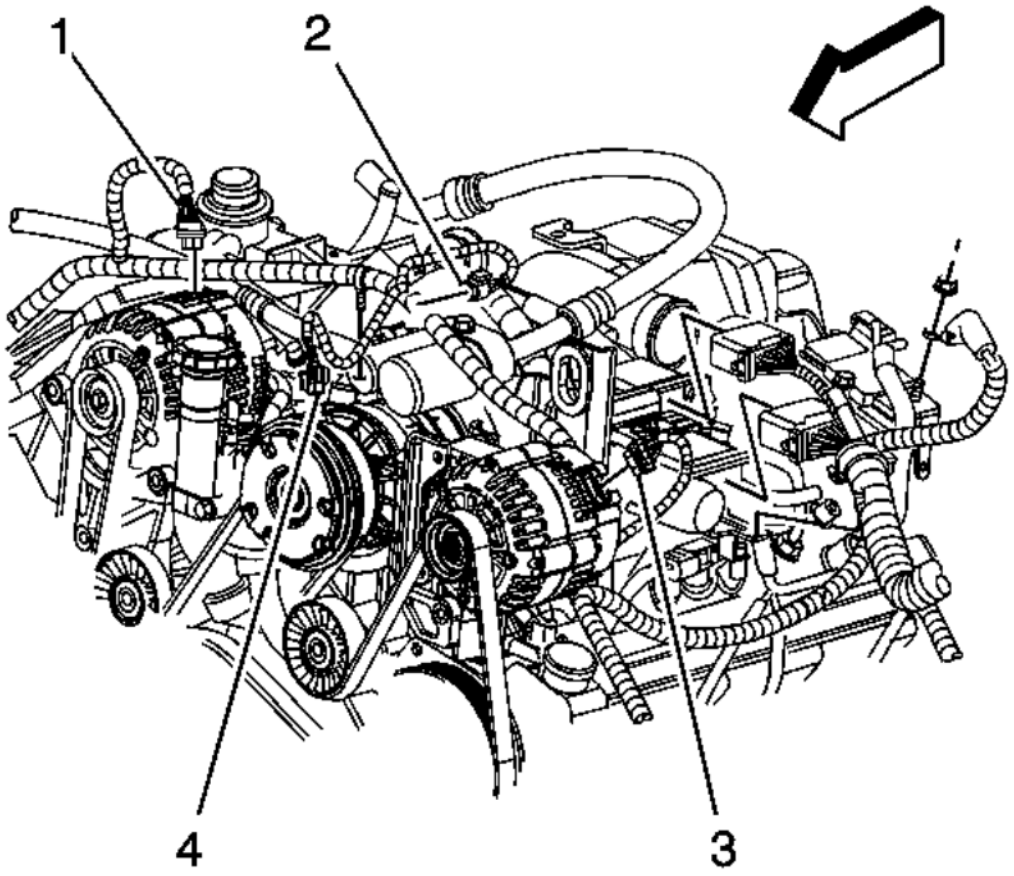


Fig. 348: View Of A/C & Generator Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

37. Disconnect the following electrical connectors:
    - Generator connector (1)
    - A/C refrigerant switch (2)
    - Dual generator harness connector (3), if equipped
    - A/C compressor clutch (4)
38. Remove the harness clip from the A/C compressor bracket.

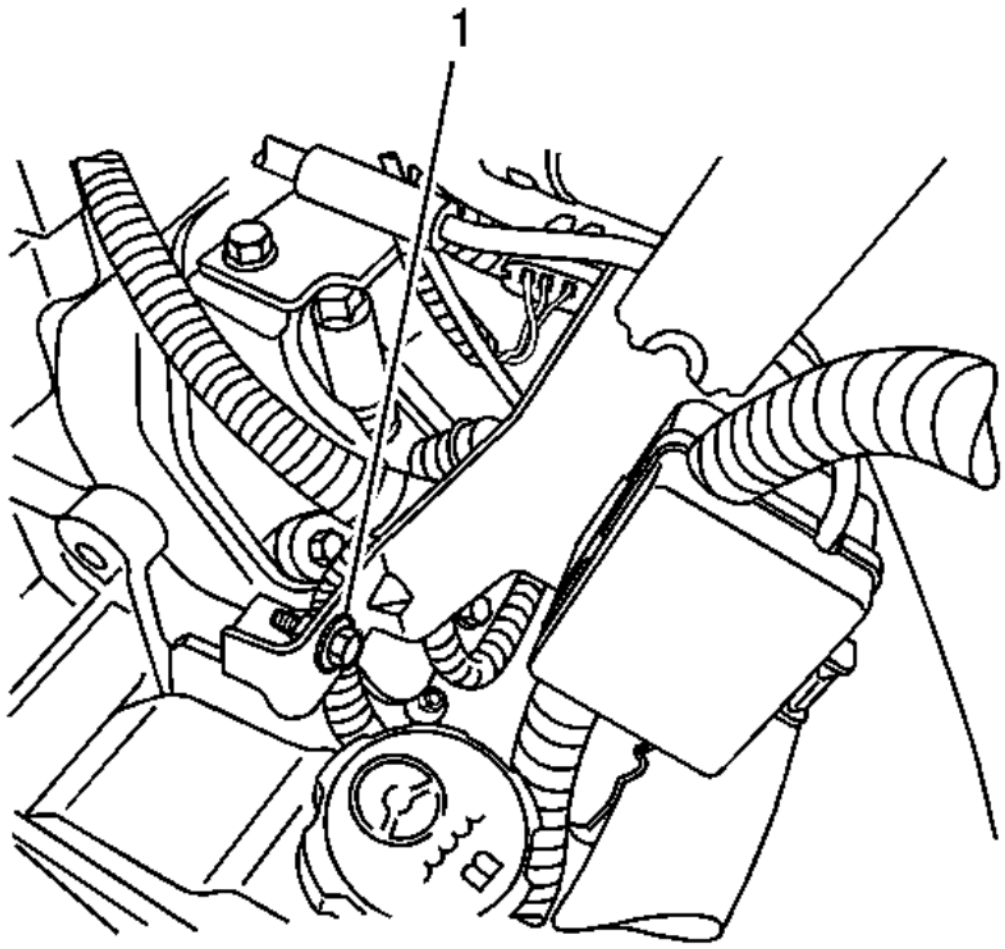


Fig. 349: View Of Battery Cable Junction Block Bolt At Power Steering Pump Bracket
Courtesy of GENERAL MOTORS CORP.

39. Remove the battery cable to the generator.
40. If equipped, remove the battery cable to the auxiliary generator.
41. Remove the battery cable harness clip from the bracket.
42. Remove the battery cable junction block bolt (1) from the power steering pump.
43. Move and secure the battery cables out of the way.

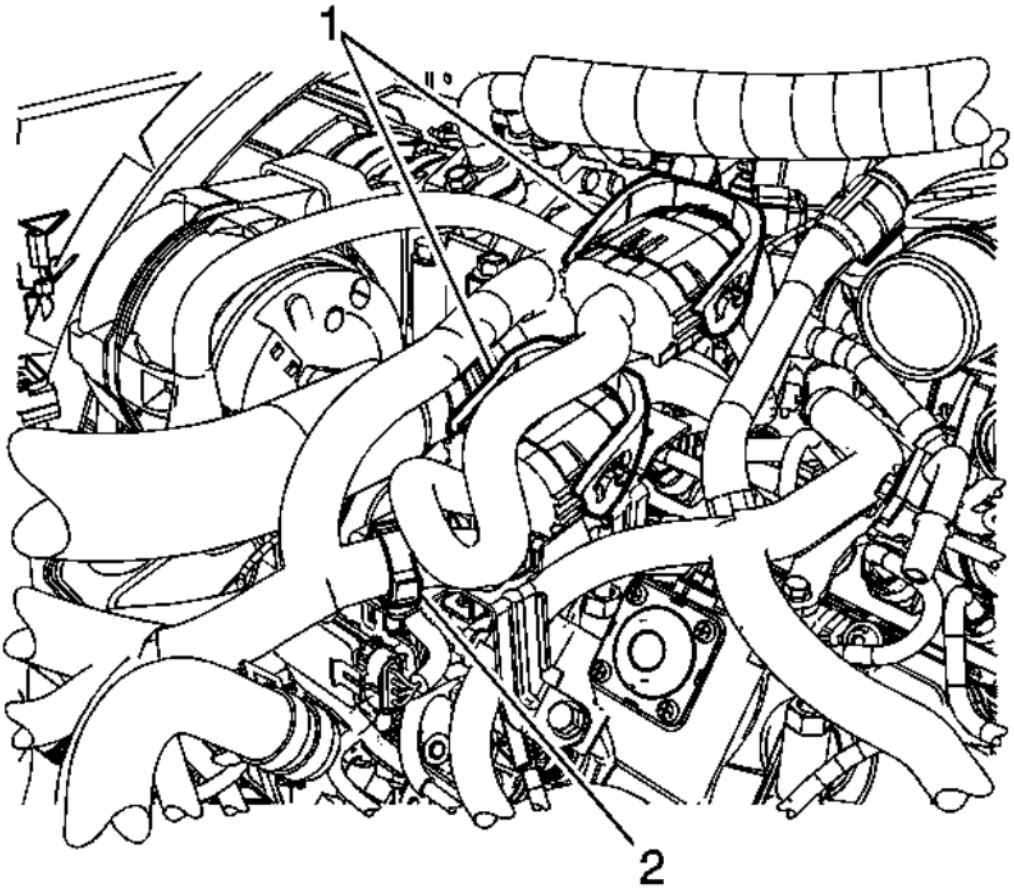


Fig. 350: View Of Main Engine Electrical Harness Connector Latches & Clips
Courtesy of GENERAL MOTORS CORP.

44. Disconnect the main engine electrical harness connectors. Lift up on the latches (1) in order to disconnect the connectors.
45. Open the harness clip (2).

46. Remove the main engine electrical harness connectors.

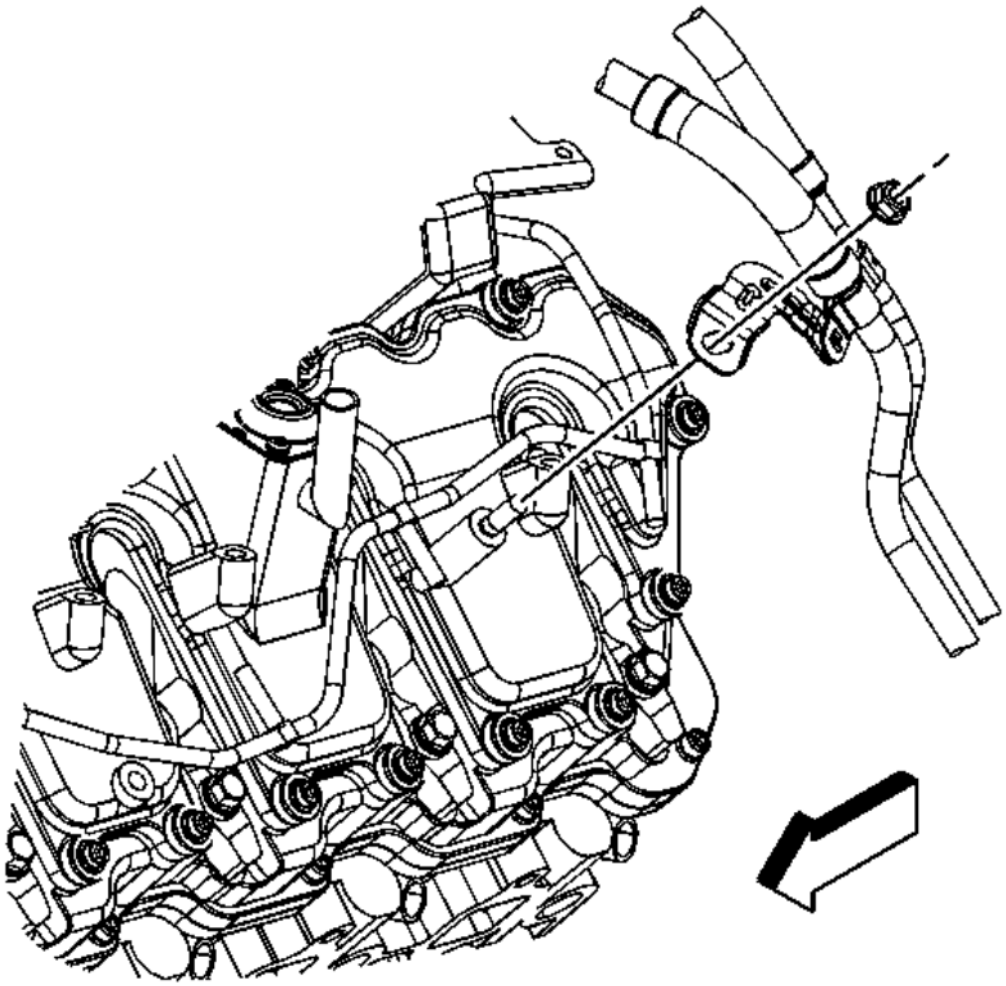


Fig. 351: View Of Fuel Line Bracket & Nut
Courtesy of GENERAL MOTORS CORP.

47. Disconnect the fuel lines at the engine. Refer to **Metal Collar Quick Connect Fitting Service** .
48. Remove the nut and the fuel line bracket from the upper valve rocker arm cover stud.
49. Secure the fuel lines out of the way.

50. Remove the drive belt. Refer to **Drive Belt Replacement**.
51. Disconnect the suction hose from the accumulator. The compressor end can remain on the compressor.
52. Remove the A/C compressor bolts.
53. Move the A/C compressor with the hoses attached to the right side of the engine compartment.
54. Move the wiring harness to the left side of the vehicle and secure out to the way.

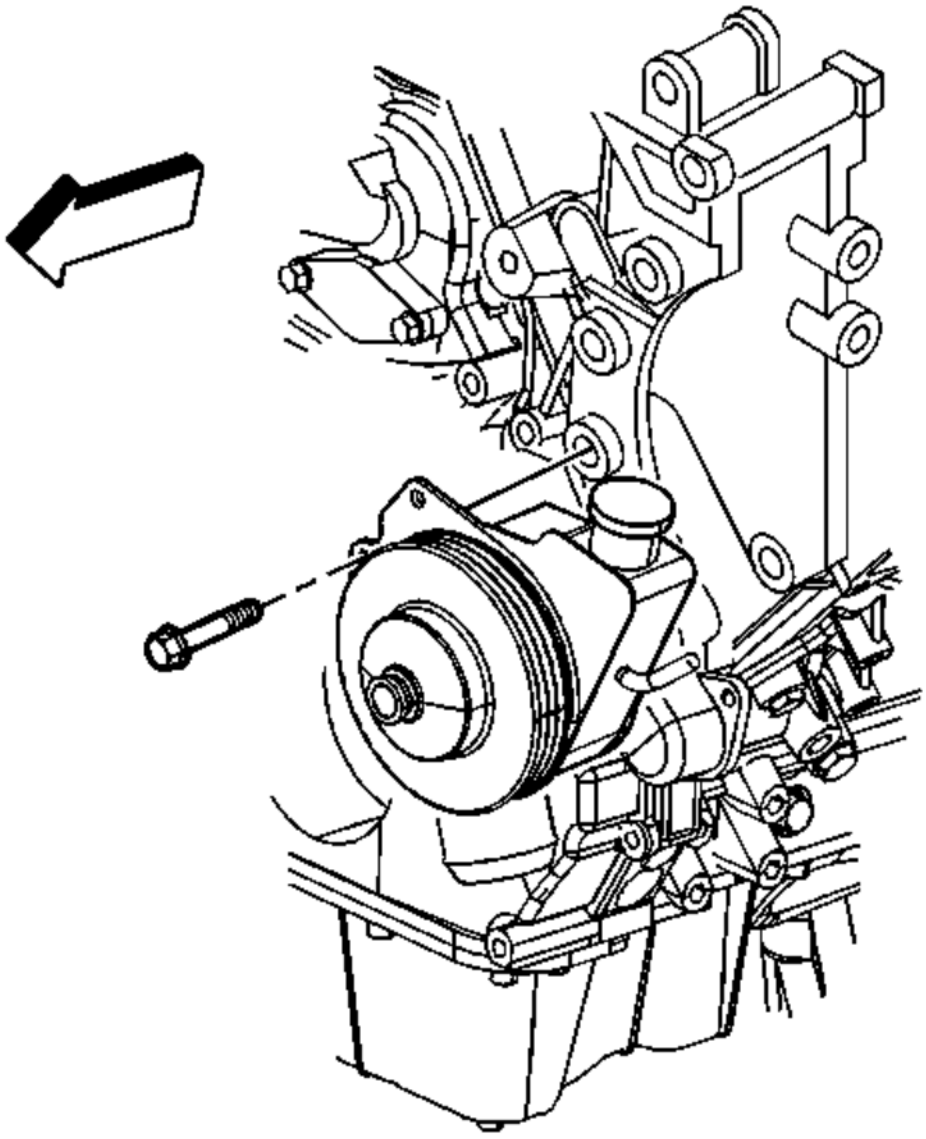


Fig. 352: View Of Power Steering Pump Front Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

55. Remove the bolts retaining the power steering pump front bracket to the power steering pump and the air conditioner compressor mounting bracket.
56. Remove the air conditioning and power steering pump mounting bracket. Refer to **Air**

Conditioning (A/C) Compressor and Power Steering Pump Bracket Replacement.

When the battery cables are removed from the engine the power steering pump can be removed further out of the way.

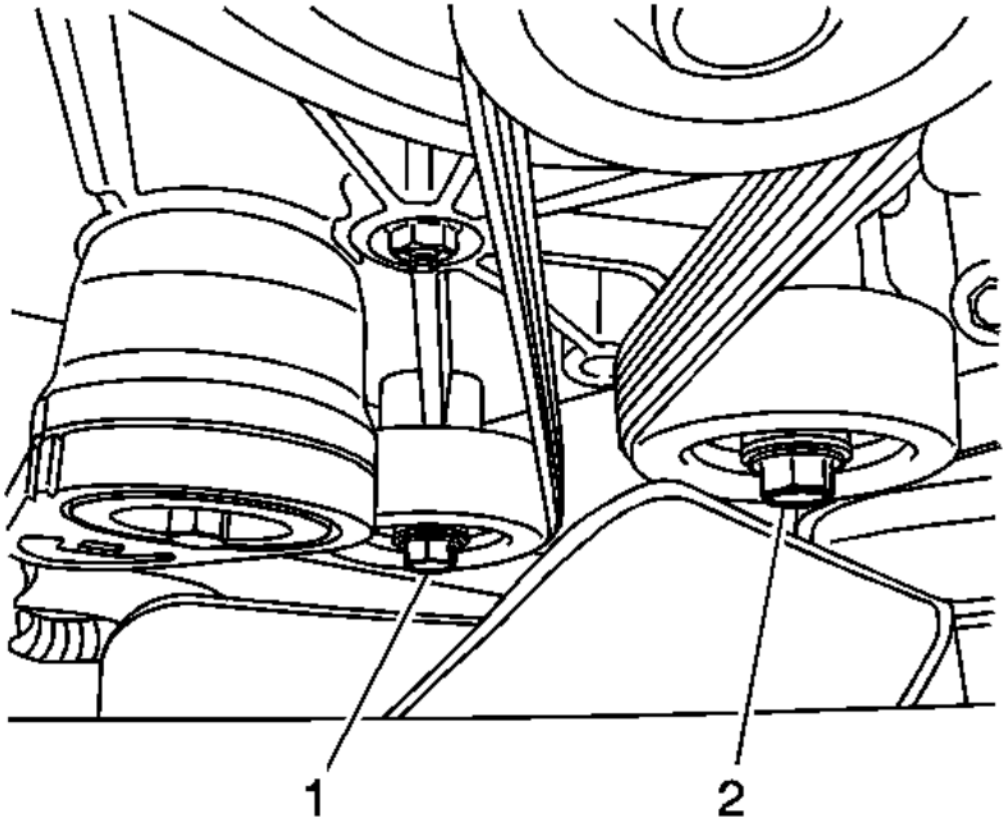


Fig. 353: View Of Right Side Idler & Center Idler Pulley Bolts
Courtesy of GENERAL MOTORS CORP.

57. Remove the right idler pulley bolt (1) and pulley.

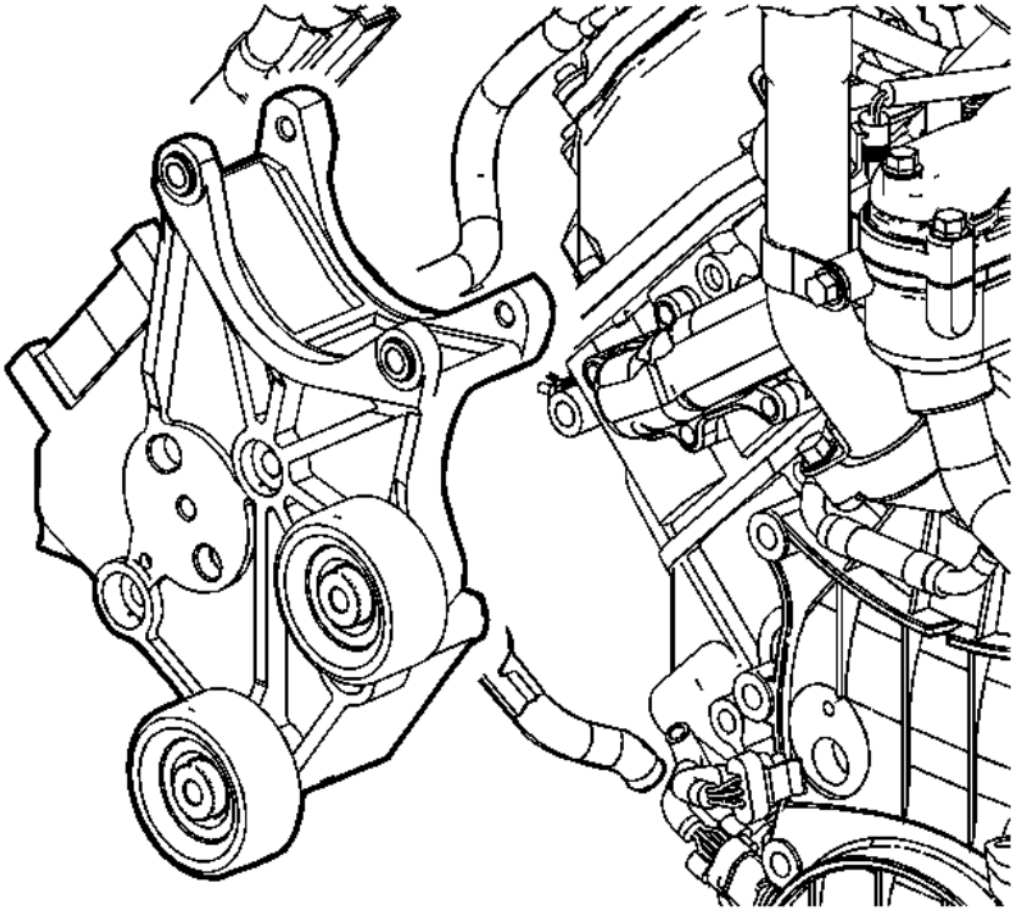


Fig. 354: View Of Generator Mounting Bracket
Courtesy of GENERAL MOTORS CORP.

58. Remove the generator mounting bracket and secure to the side.
    - The generator does not require removal.
    - The drive belt tensioner does not require removal.

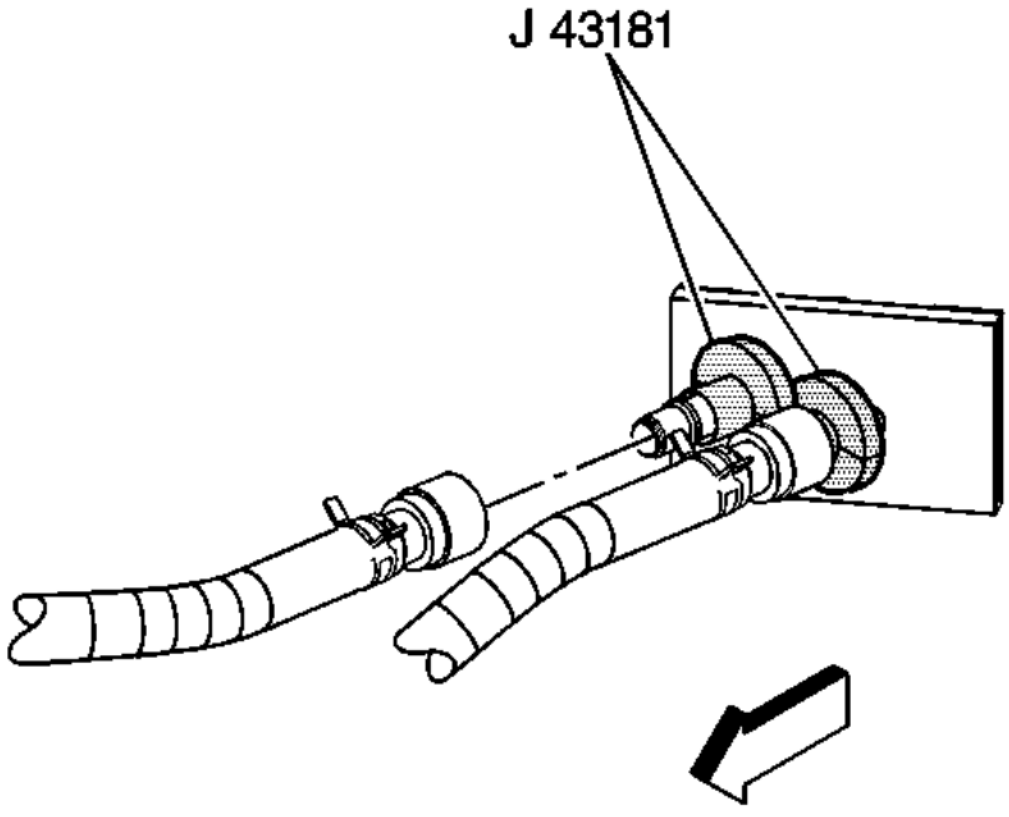


Fig. 355: Identifying Heater Hose To Heater Core Fittings
Courtesy of GENERAL MOTORS CORP.

59. Use the **J 43181** in order to disconnect the inlet heater hose from the heater core inlet. See **Special Tools** .
60. Remove the bolt and the ground wires at the rear of the left cylinder head.
61. Raise the vehicle.
62. Remove the oil pan skid plate. Refer to **Oil Pan Skid Plate Replacement (2500/3500 with RPO NZZ)** .
63. Remove the engine shield from the vehicle, if equipped. Refer to **Engine Shield Replacement** .

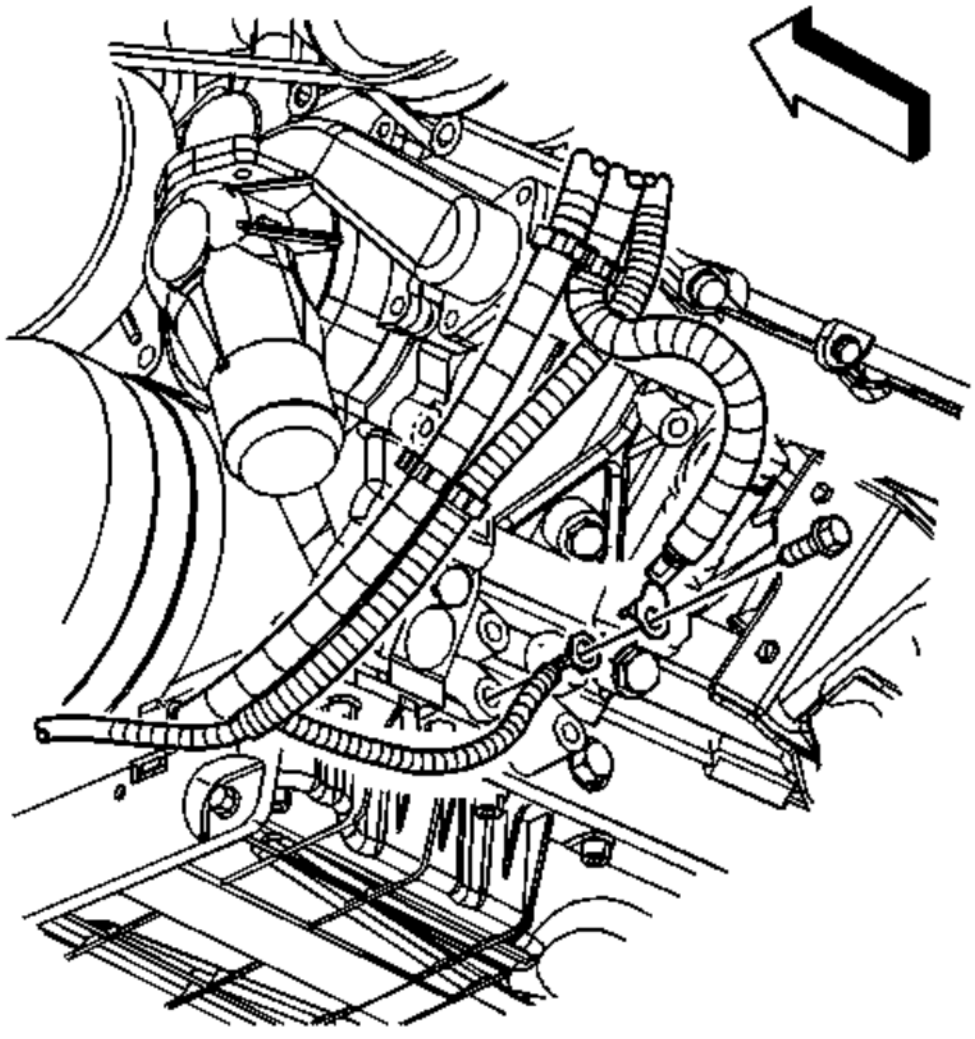


Fig. 356: View Of Engine Wiring Harness Ground Wire & Battery Negative Cable (Left Side Of Engine)
Courtesy of GENERAL MOTORS CORP.

64. Remove the bolt for the battery negative cable and the engine wiring harness ground wire from the left side of the engine.

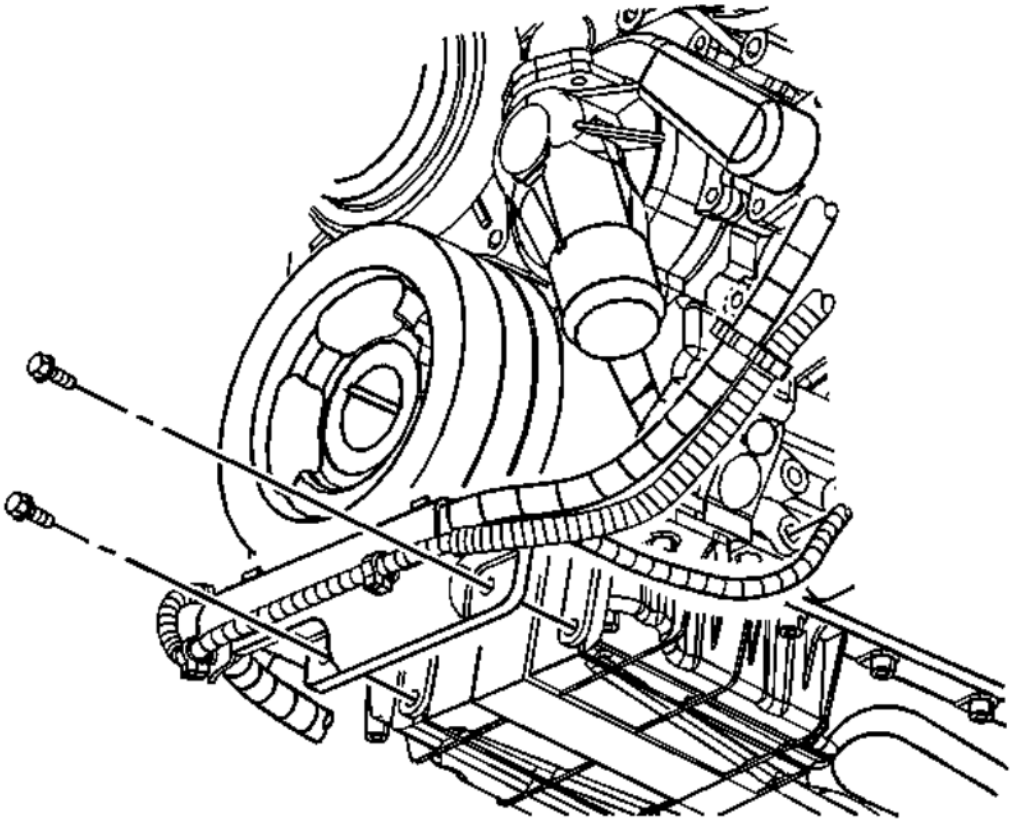


Fig. 357: View Of Battery Cable Bracket Bolts At Lower Crankcase
Courtesy of GENERAL MOTORS CORP.

65. Remove the bolts holding the battery cable channel retainer to the lower crankcase.

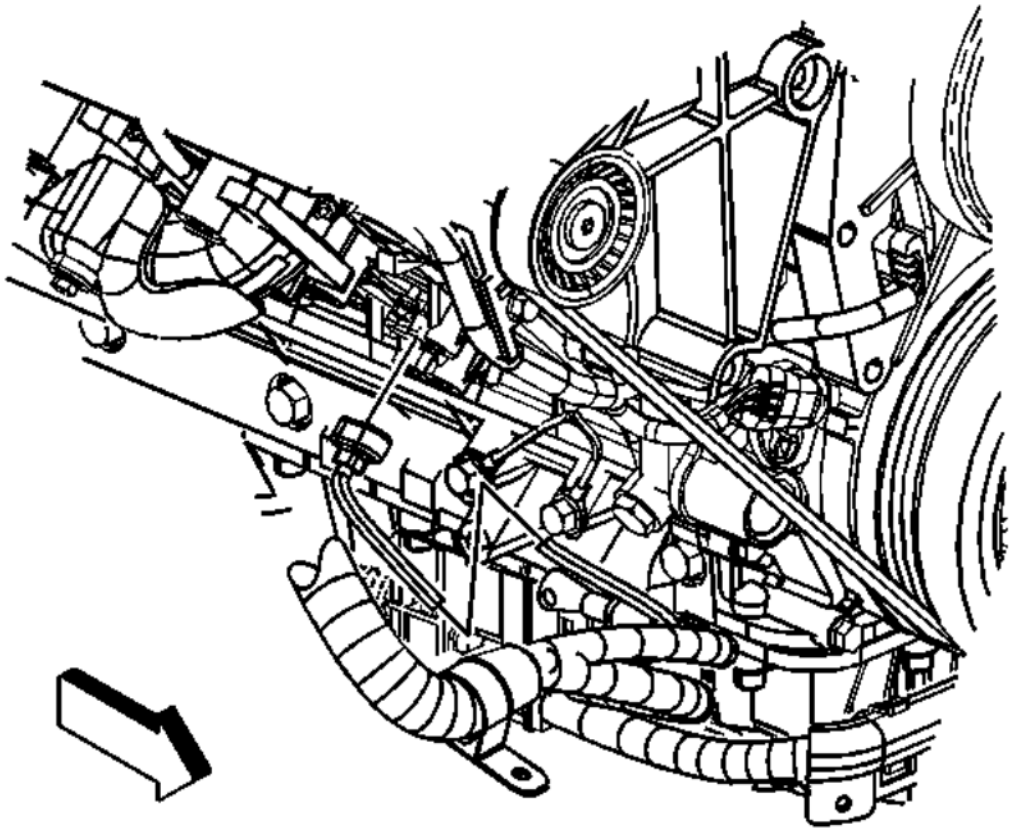


Fig. 358: View Of Engine Coolant Heater Cord
Courtesy of GENERAL MOTORS CORP.

66. Disconnect the cord for the engine coolant heater.
67. Remove the starter. Refer to **Starter Motor Replacement (6.6L)** .

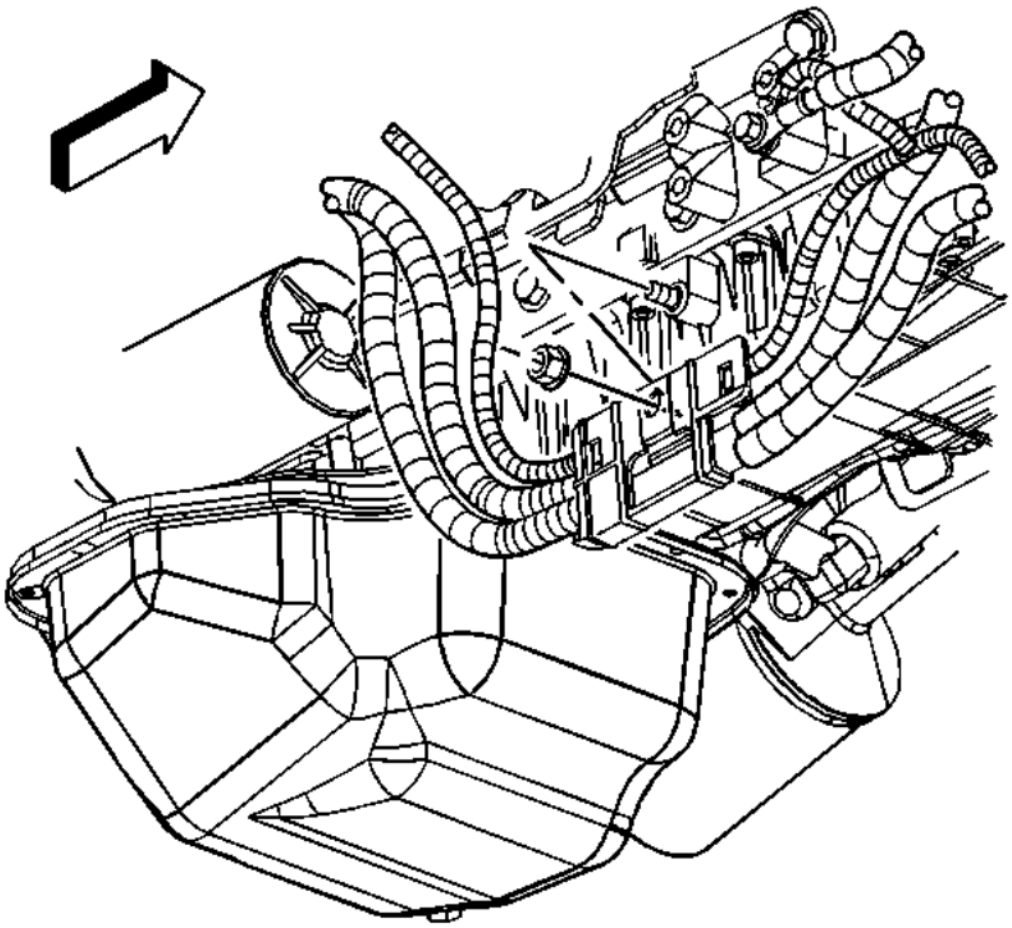


Fig. 359: View Of Battery Cable Bracket Nut
Courtesy of GENERAL MOTORS CORP.

68. Remove the nut holding the battery cable bracket to the right side of the lower crankcase.

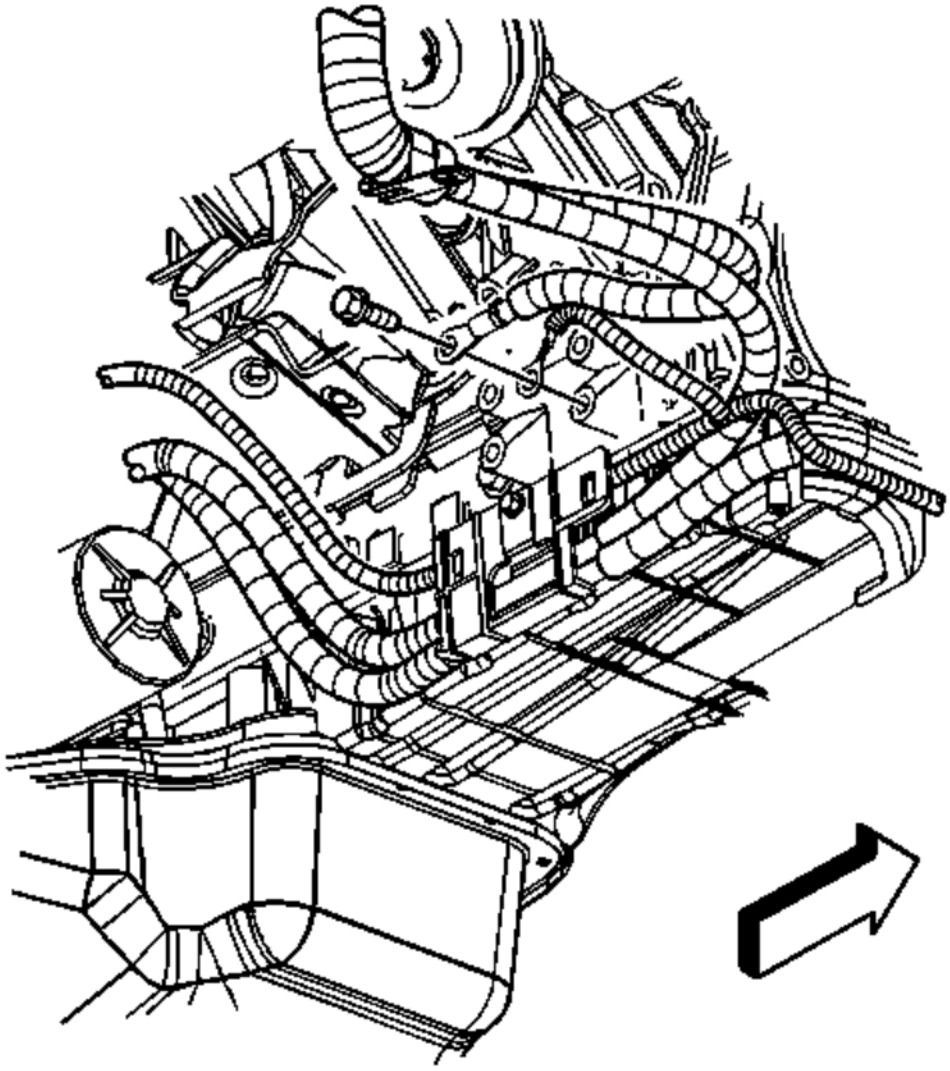


Fig. 360: View Of Auxiliary Battery Negative Cable & Engine Wiring Harness Ground Wires Bolt (Right Side Of Engine)
Courtesy of GENERAL MOTORS CORP.

69. Remove the bolt holding the auxiliary battery negative cable and the engine wiring harness ground wires to the right side of the engine.
70. Move and secure the battery cables out of the way.

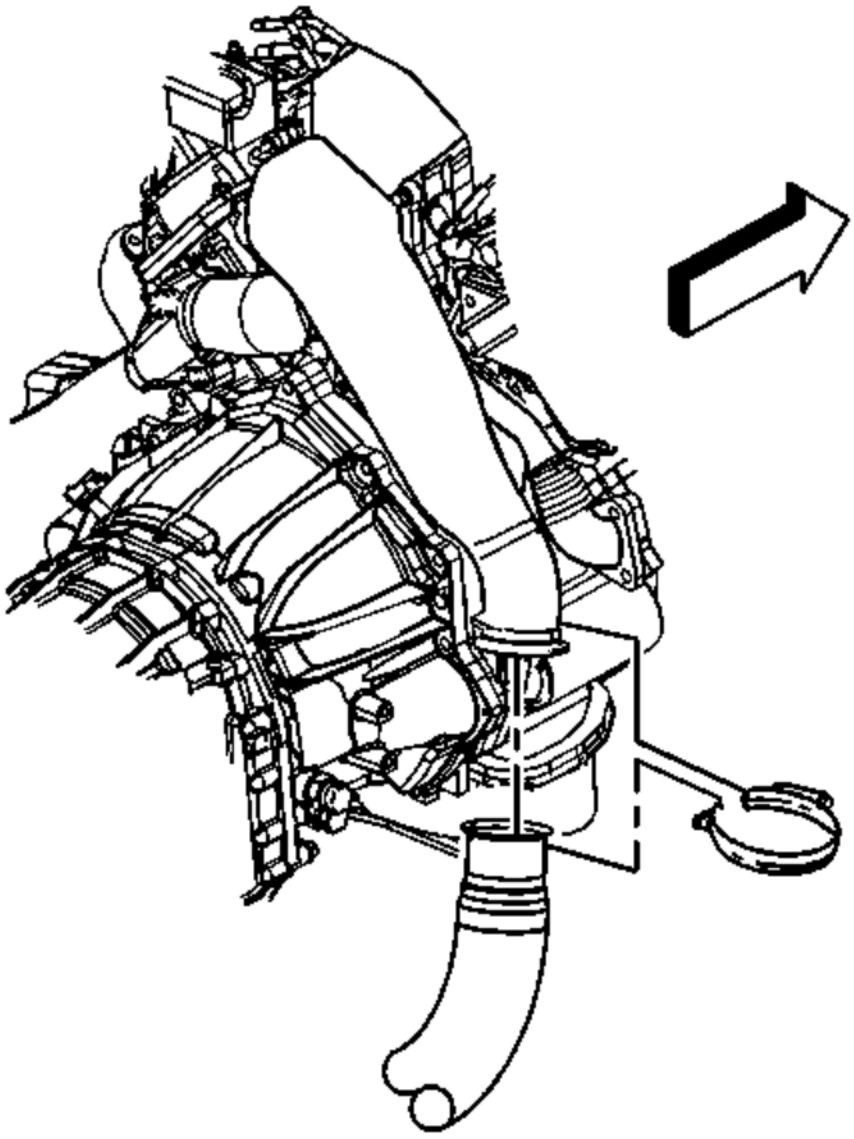


Fig. 361: View Of Turbocharger Exhaust Pipe & Clamp
Courtesy of GENERAL MOTORS CORP.

71. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** .
72. Drain the engine oil.
73. Remove the exhaust pipe to the exhaust outlet clamp. Move the clamp onto the exhaust pipe.

74. If vehicle is 4-wheel drive (4WD) remove the lower oil pan. Refer to **Lower Oil Pan Replacement**.

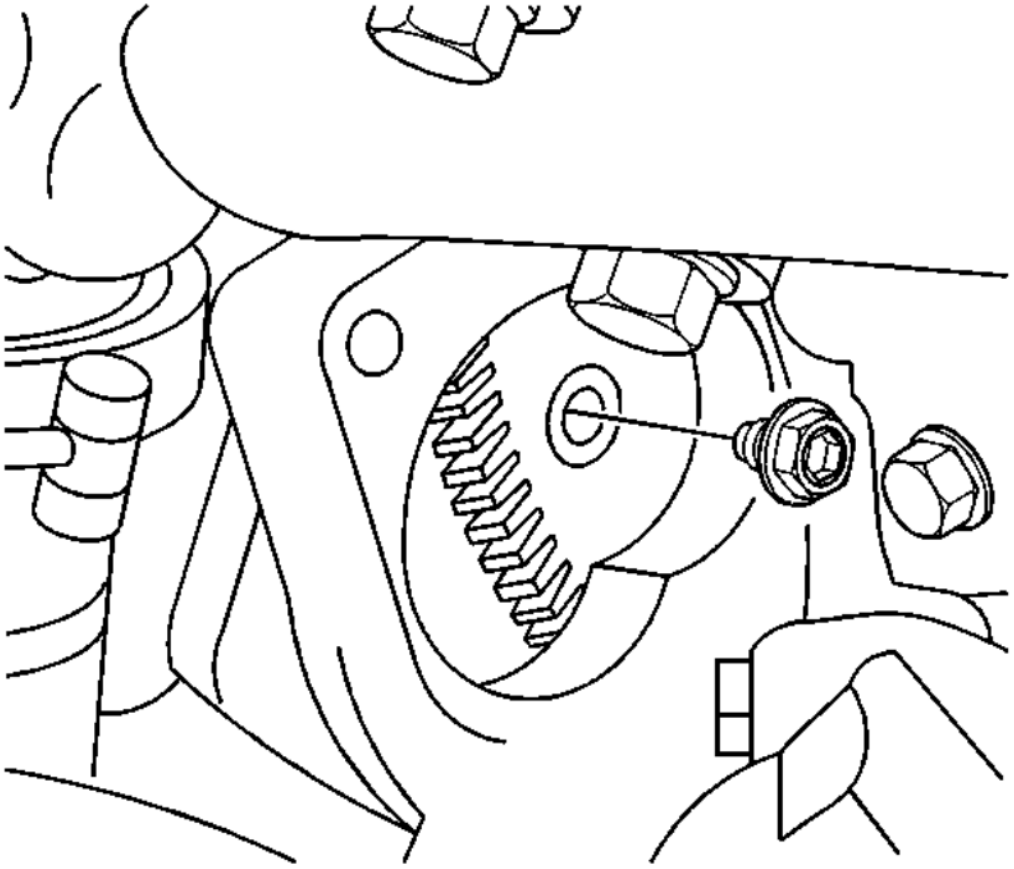


Fig. 362: View Of Torque Convertor Bolt
Courtesy of GENERAL MOTORS CORP.

75. If equipped with an automatic transmission, mark the flywheel and torque converter relationship for assembly purposes.
76. Remove the torque convertor bolts through the starter opening.

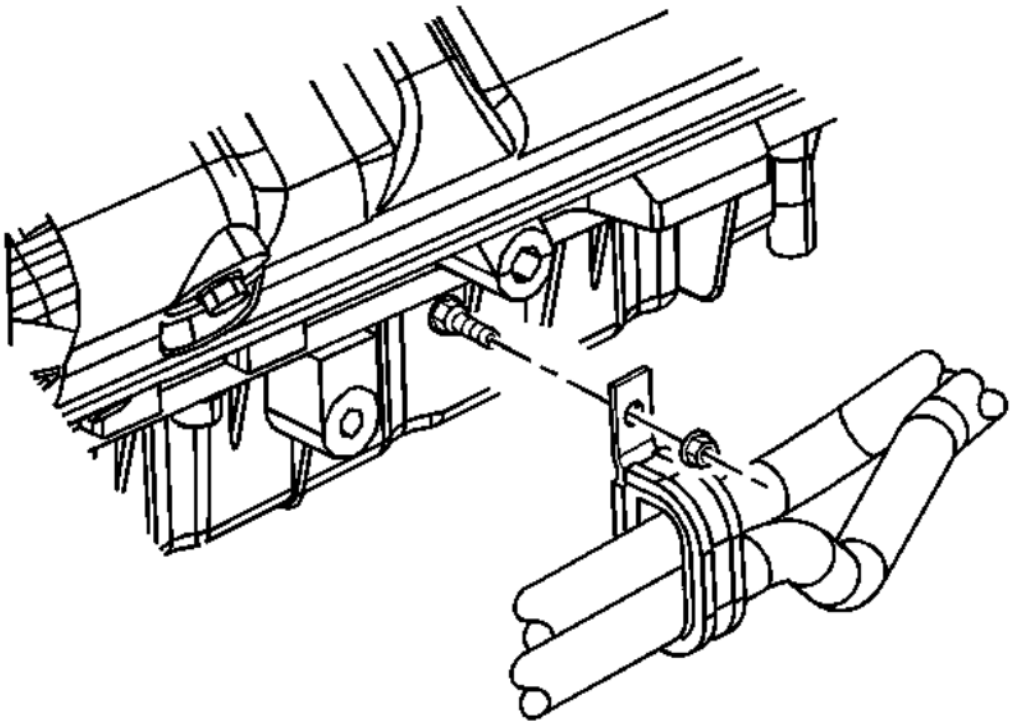


Fig. 363: View Of Transmission Oil Cooler Lines, Bracket & Bolt
Courtesy of GENERAL MOTORS CORP.

77. If equipped with an automatic transmission, remove the transmission oil line clip nut.

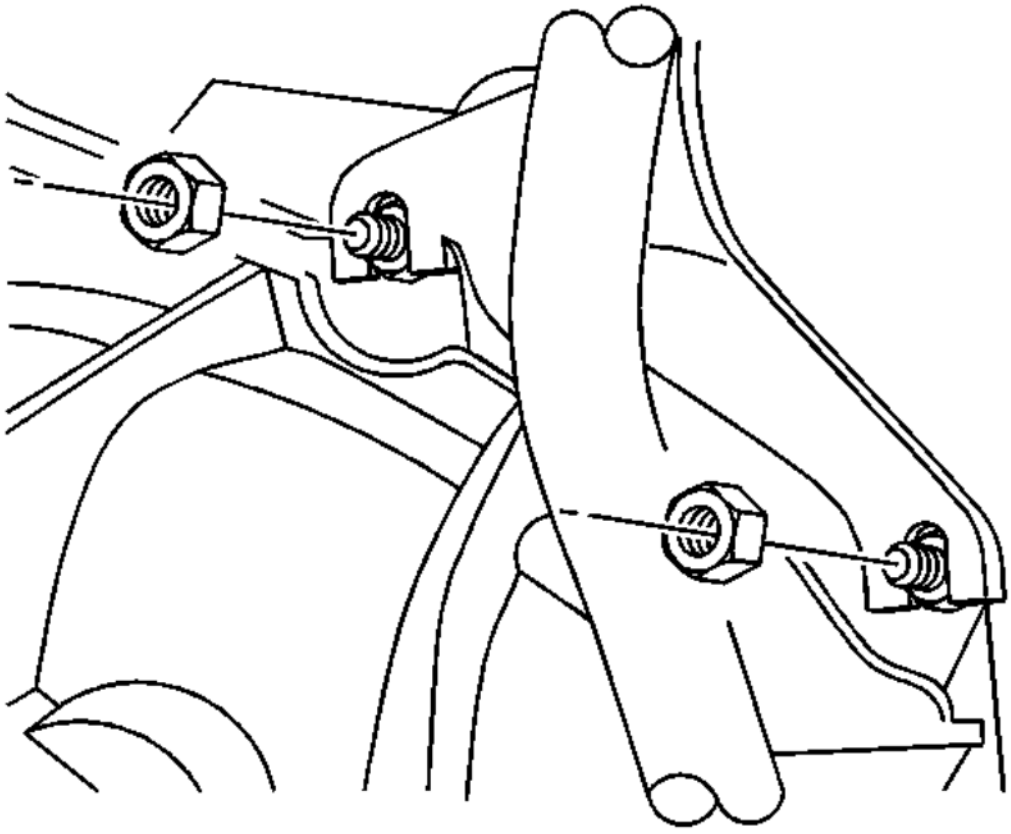


Fig. 364: View Of Fill Tube To Bellhousing Nuts
Courtesy of GENERAL MOTORS CORP.

78. If equipped with an automatic transmission, remove the nuts retaining transmission fluid fill tube bracket.

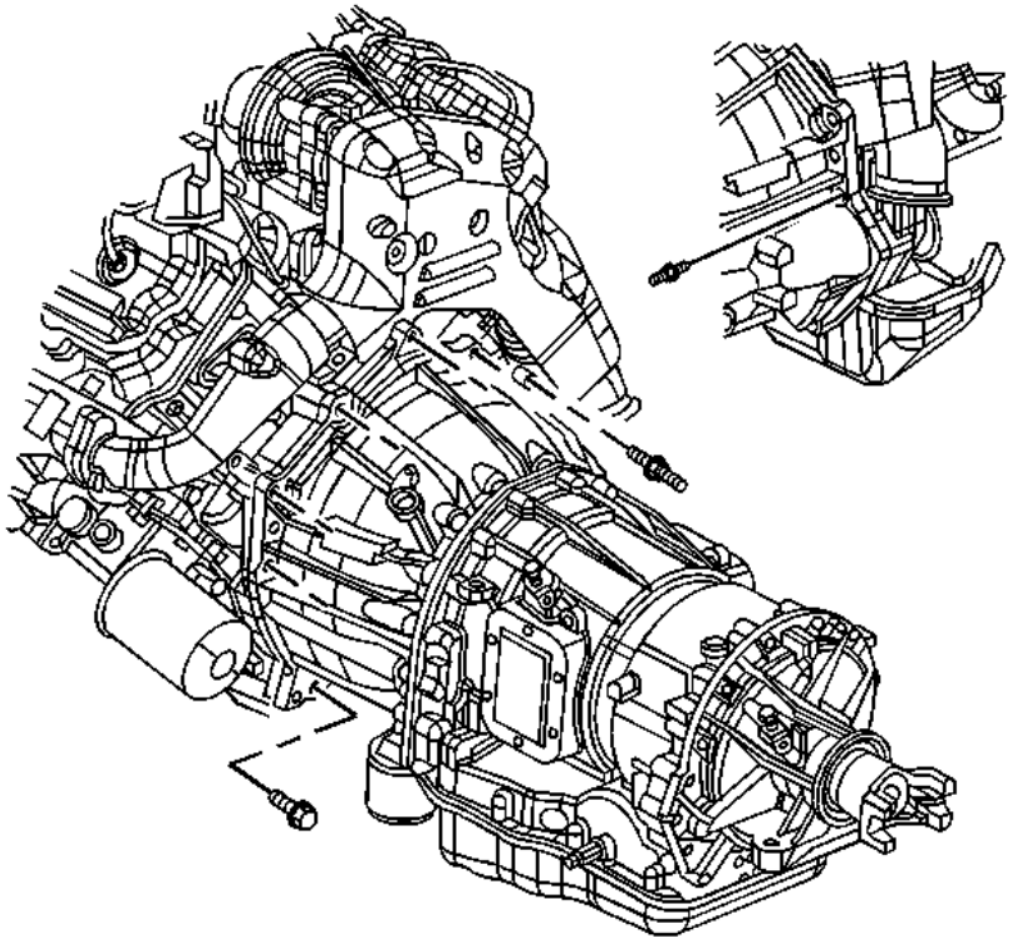


Fig. 365: View of Transmission To Engine Stud & Bolts
Courtesy of GENERAL MOTORS CORP.

79. Remove the transmission to engine stud and bolts (automatic transmission shown). Note the location of the studs and any brackets attached to the studs.

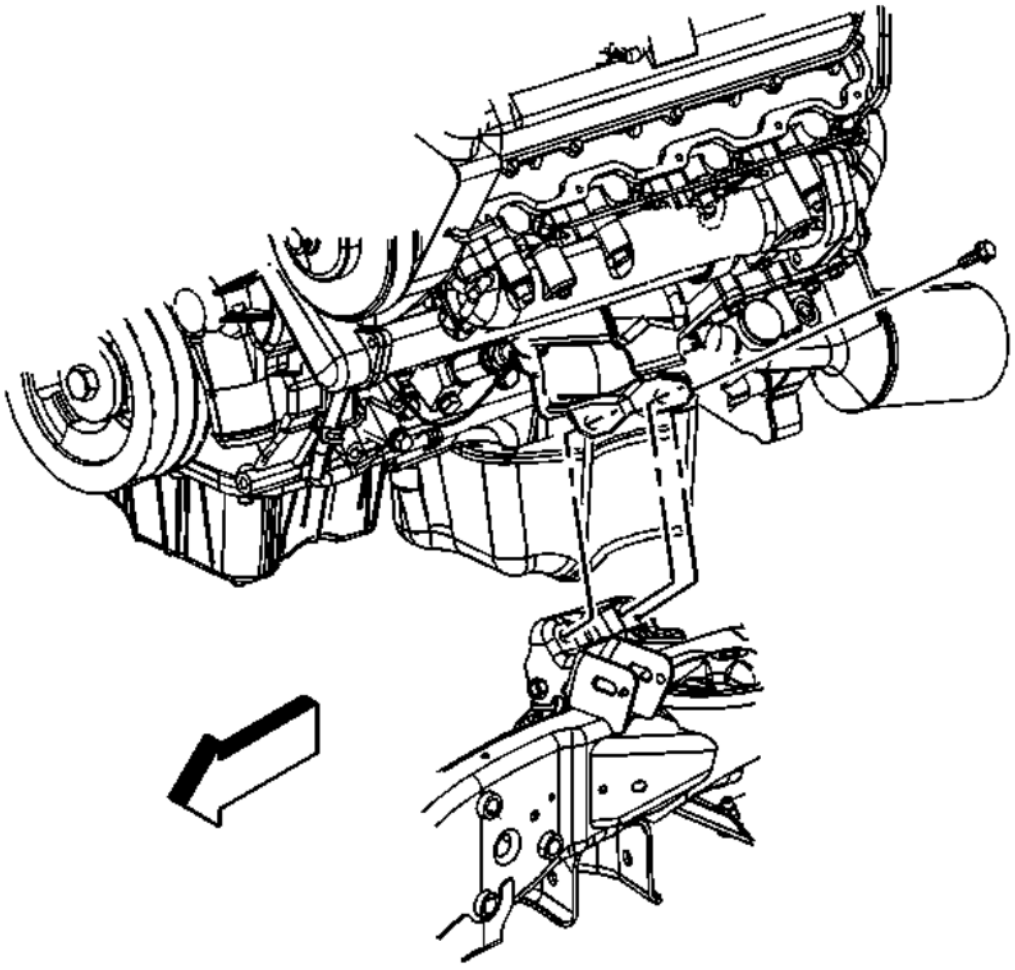


Fig. 366: View Of Engine Mount To Engine Mount Frame Bracket
Courtesy of GENERAL MOTORS CORP.

80. Lower the vehicle to work through the wheelhouse opening.
81. Remove the engine mount to frame bracket bolts (left side shown).
82. Lower the vehicle.

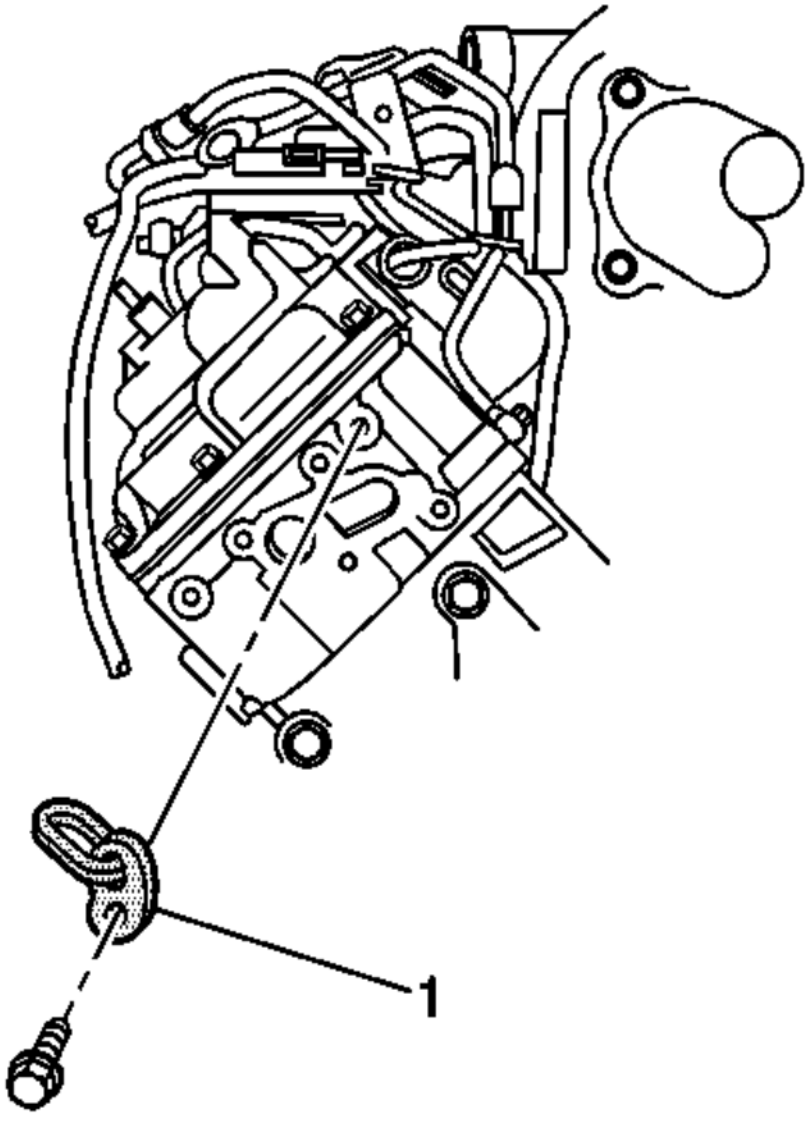


Fig. 367: View Of J 36857 & Bolt At Rear Of Left Cylinder Head
Courtesy of GENERAL MOTORS CORP.

83. Install the **J 36857** (1) to the rear of the left cylinder head with a suitable bolt. See **Special Tools** .

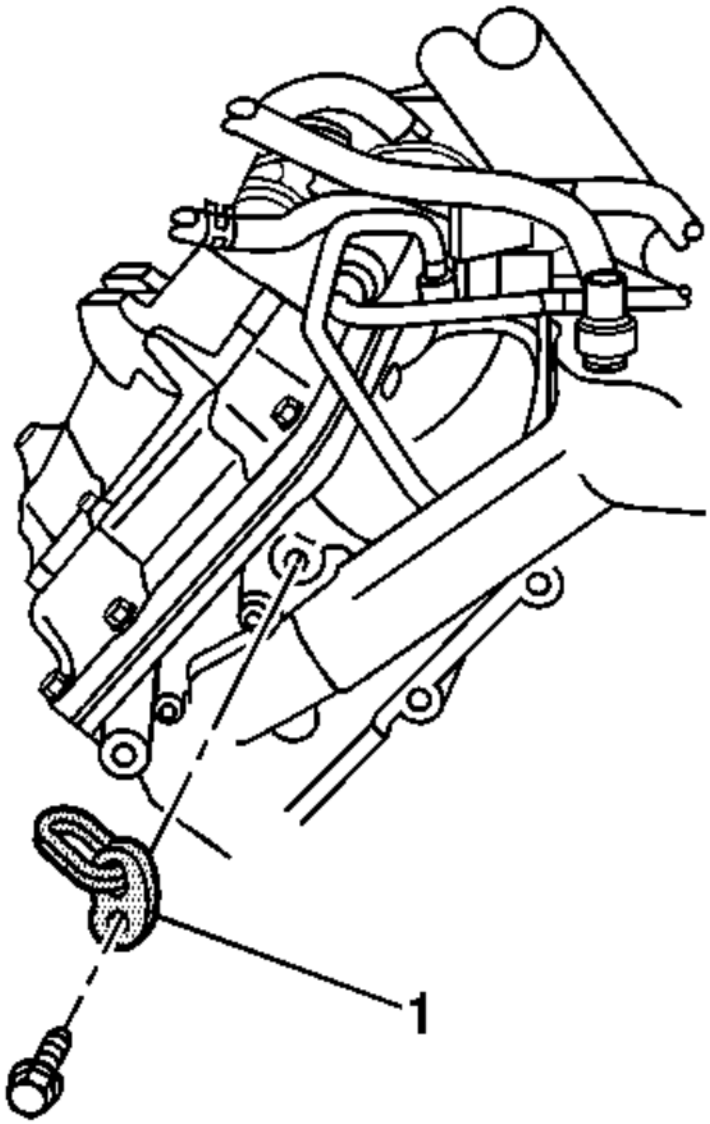


Fig. 368: View Of J 36857 & Bolt At Front Of Right Cylinder Head
Courtesy of GENERAL MOTORS CORP.

84. Install the **J 36857** (1) to the front of the right cylinder head with a suitable bolt. See **Special Tools** .
85. Install a suitable lifting device. The engine will have to be angled in order to remove. Use a

load positioning sling to assist in angling the engine.

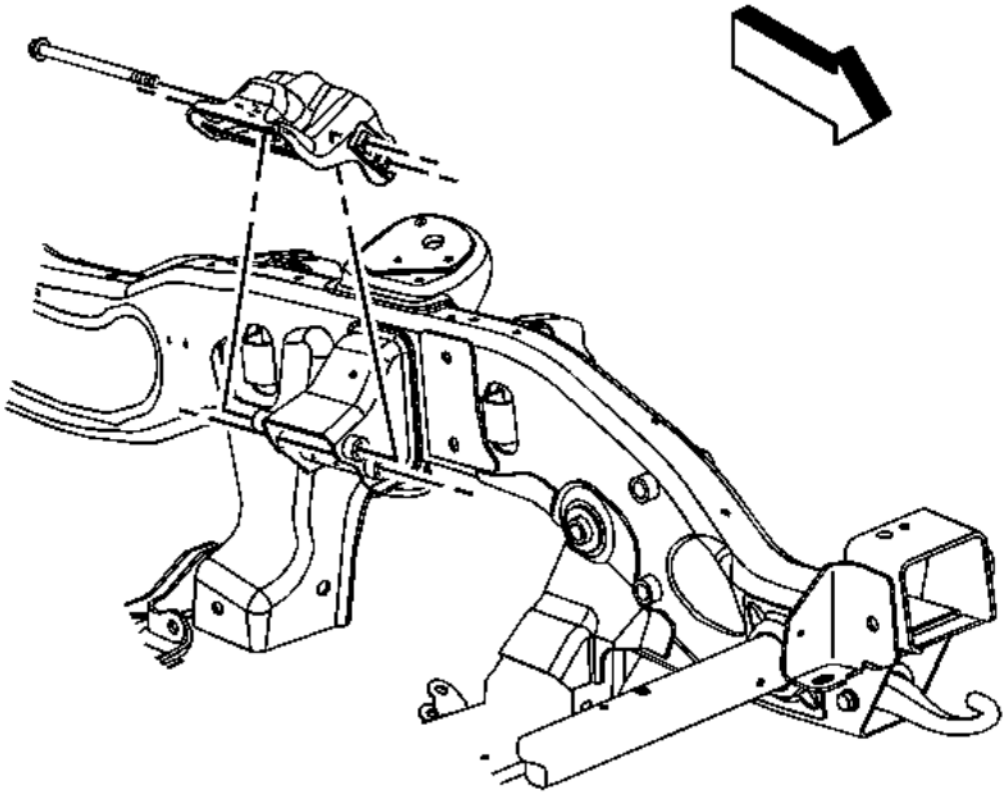


Fig. 369: Identifying Engine Mount Frame Bracket Through Bolt
Courtesy of GENERAL MOTORS CORP.

86. Raise the vehicle off of the engine mounts.
87. Remove the left and right engine mount frame brackets.
88. Remove the engine from the vehicle.
89. In order to secure the engine to an engine stand remove the following and follow the special procedures:
    - Refer to **Engine Flywheel Removal (Automatic Transmission)** or **Engine Flywheel Removal (Manual Transmission)** .
    - Refer to **Exhaust Outlet Removal** .
    - Refer to **Upper Oil Pan Removal** .

- Refer to **Engine Flywheel Housing Removal** .
- Refer to **Engine Mounting to Stand** .

Installation Procedure

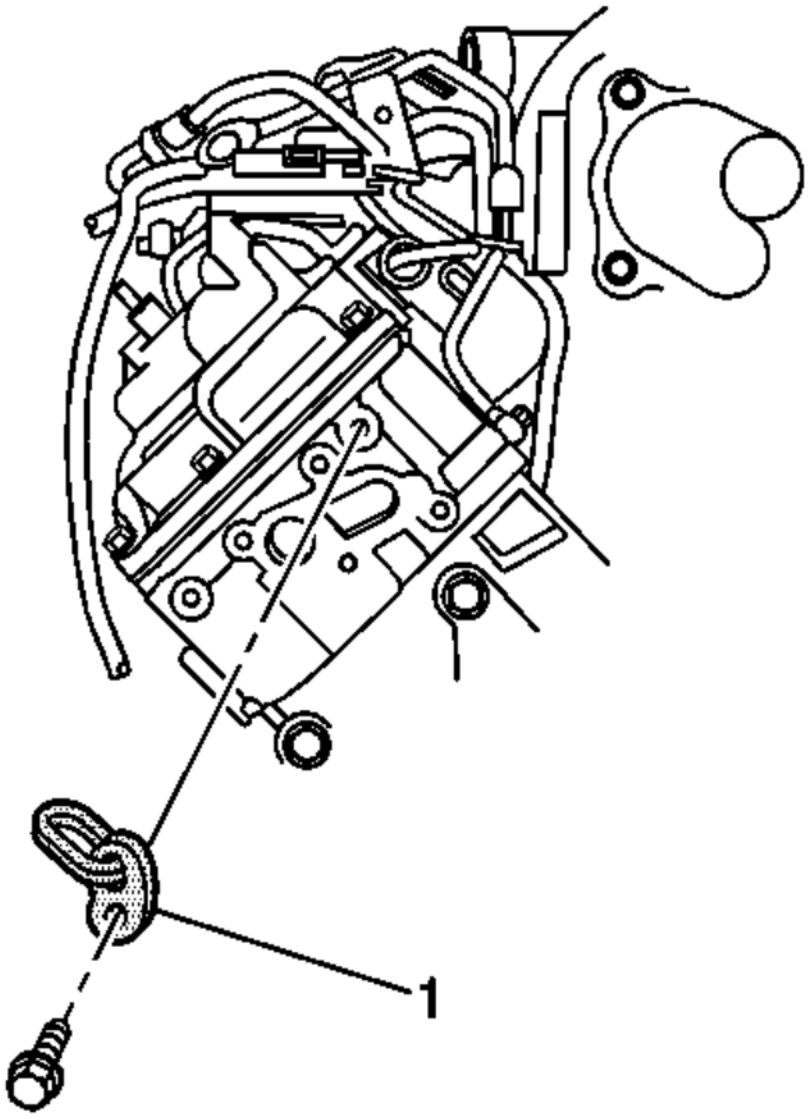


Fig. 370: View Of J 36857 & Bolt At Rear Of Left Cylinder Head

Courtesy of GENERAL MOTORS CORP.

1. Install the **J 36857** (1) to the rear of the left cylinder head with a suitable bolt. See **Special Tools** .

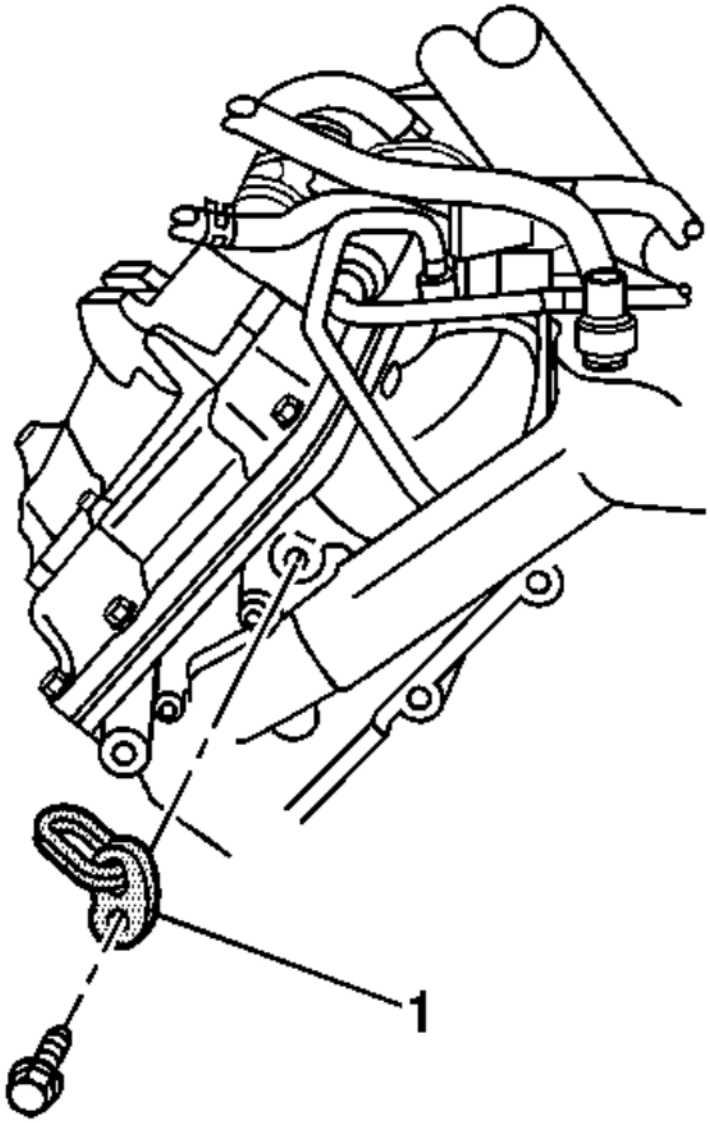


Fig. 371: View Of J 36857 & Bolt At Front Of Right Cylinder Head

Courtesy of GENERAL MOTORS CORP.

2. Install the **J 36857** (1) to the front of the right cylinder head with a suitable bolt. See **Special Tools** .
3. Install a suitable lifting device. The engine will have to be angled in order to install. Use a load positioning sling to assist in angling the engine.
4. Remove the engine from the stand. Refer to **Engine Removal from Stand** .
5. Install the following:
   - Refer to **Engine Flywheel Installation (Automatic Transmission)** or **Engine Flywheel Installation (Manual Transmission)** .
   - Refer to **Exhaust Outlet Installation** .
   - Refer to **Upper Oil Pan Installation** .
   - Refer to **Engine Flywheel Housing Installation** .
6. Install the engine in the vehicle.

IMPORTANT: Do not draw the engine to the transmission using the transmission bolts. If everything is aligned properly the engine and transmission will come together.

7. Loosely install 2 transmission to engine bolts.

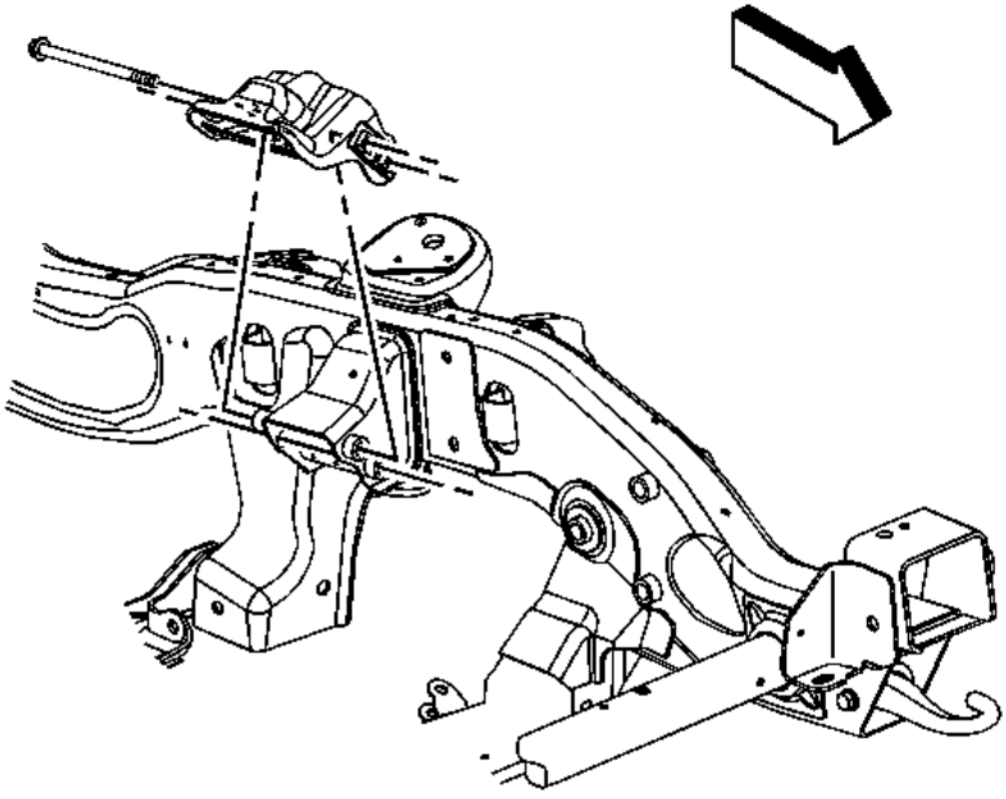


Fig. 372: Identifying Engine Mount Frame Bracket Through Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

8. Install the left and right side engine mount frame brackets.

   Tighten: Tighten the through-bolts to 75 N.m (55 lb ft).

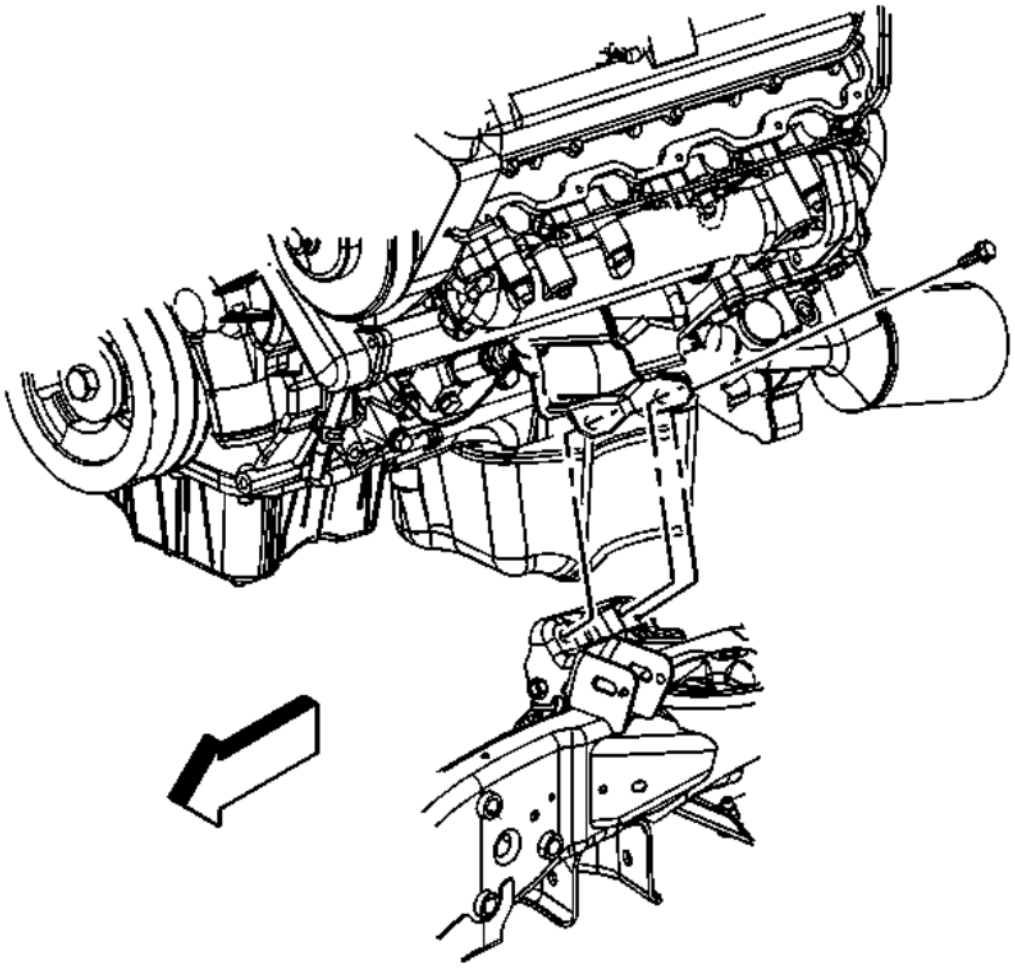


Fig. 373: View Of Engine Mount To Engine Mount Frame Bracket
Courtesy of GENERAL MOTORS CORP.

9. Install the engine mount to frame bracket bolts (left side shown).

   Tighten: Tighten the bolts to 65 N.m (50 lb ft).

10. Remove the **J 36857** from the cylinder heads. See **Special Tools** .
11. Raise the vehicle.

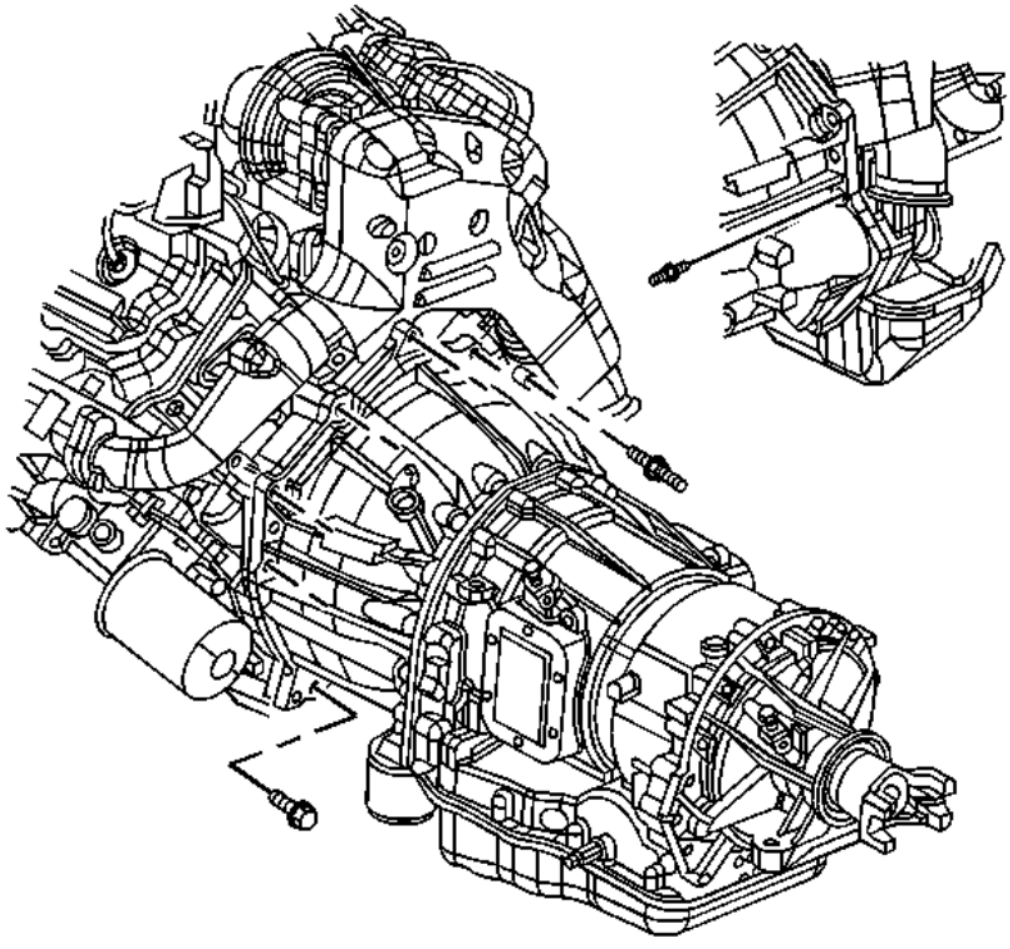


Fig. 374: View of Transmission To Engine Stud & Bolts
Courtesy of GENERAL MOTORS CORP.

12. Install the transmission to engine bolts (automatic transmission shown).

    Tighten: Tighten the studs and bolts to 50 N.m (37 lb ft).

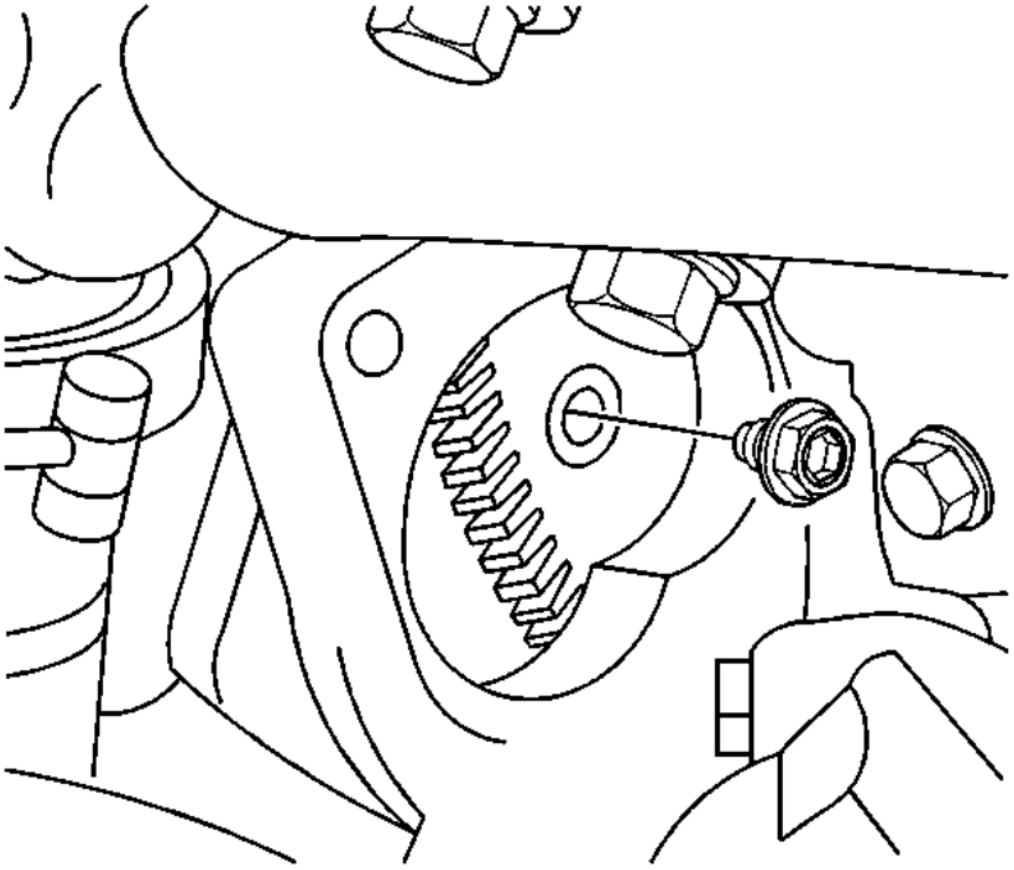


Fig. 375: View Of Torque Convertor Bolt
Courtesy of GENERAL MOTORS CORP.

13. If equipped with an automatic transmission install the torque convertor bolts.

    Tighten: Tighten the bolts to 60 N.m (44 lb ft).

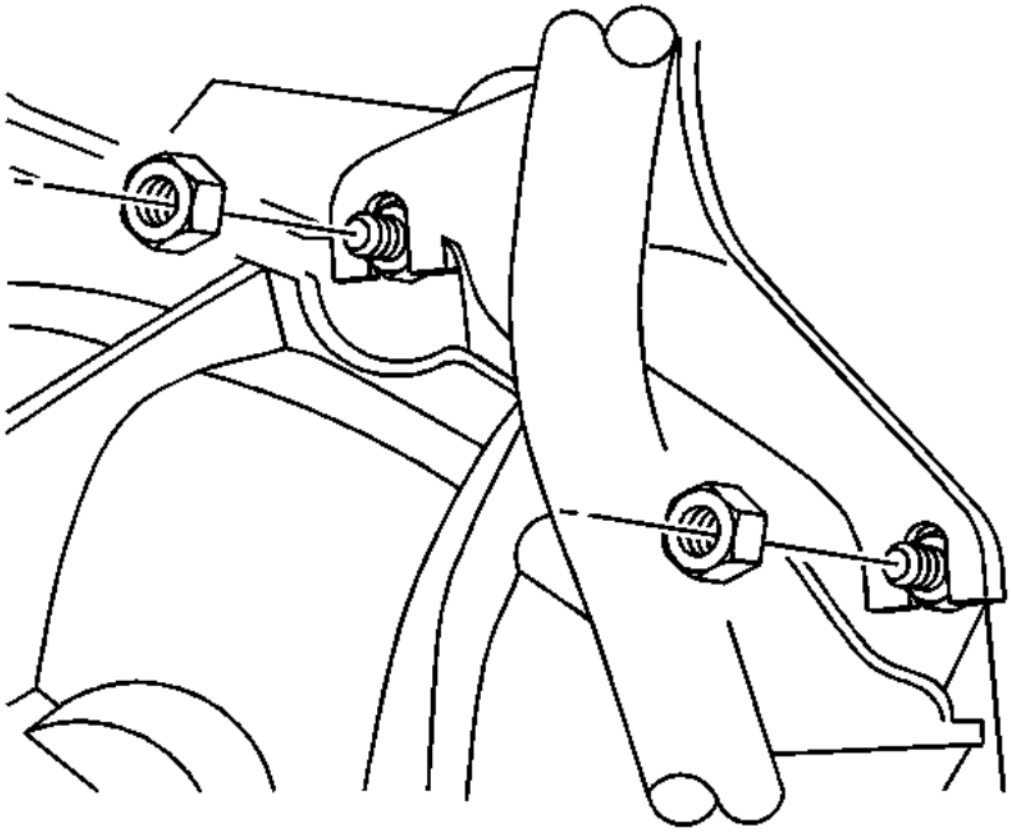


Fig. 376: View Of Fill Tube To Bellhousing Nuts
Courtesy of GENERAL MOTORS CORP.

14. If equipped with an automatic transmission, install the nuts retaining the transmission fluid fill tube bracket.

    Tighten: Tighten the nuts to 18 N.m (13 lb ft).

15. If the vehicle is 4WD, install the lower oil pan. Refer to **Lower Oil Pan Replacement**.

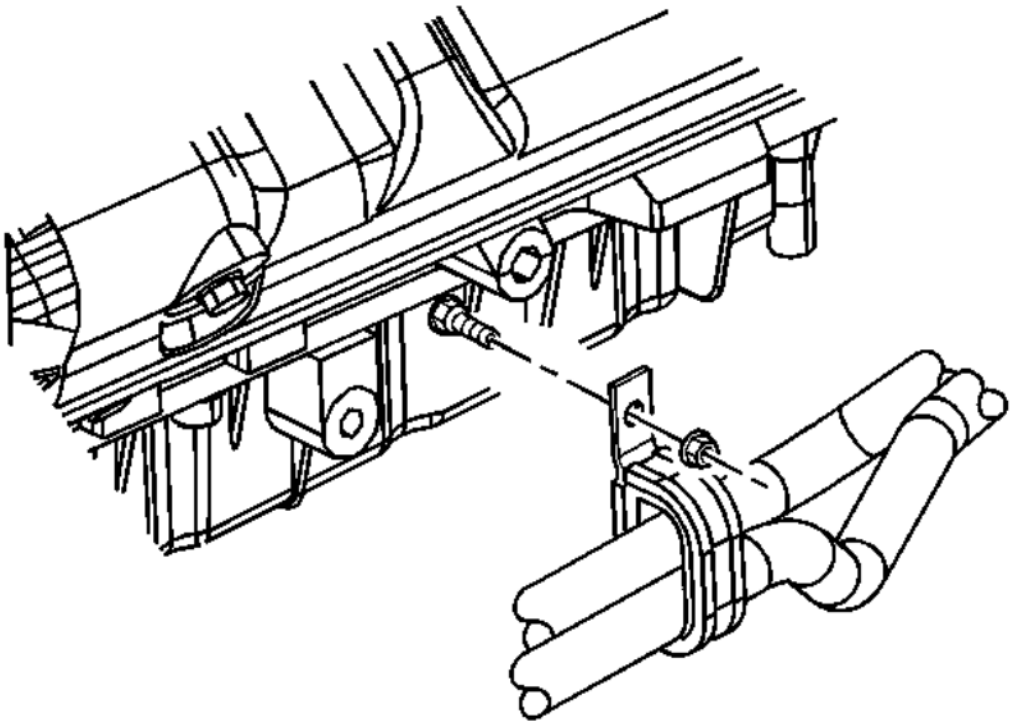


Fig. 377: View Of Transmission Oil Cooler Lines, Bracket & Bolt
Courtesy of GENERAL MOTORS CORP.

16. If equipped with an automatic transmission, install the nut retaining the transmission oil cooler line clip.

    Tighten: Tighten the nut to 9 N.m (80 lb in).

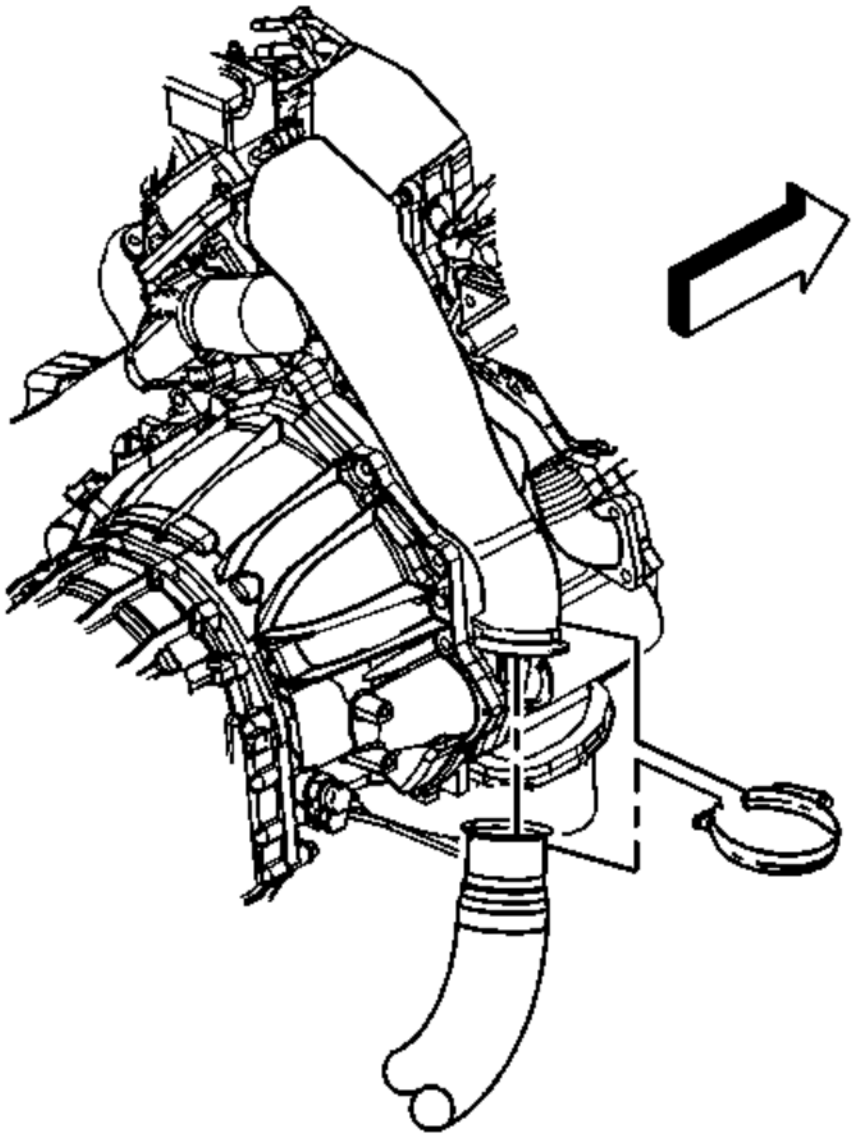


Fig. 378: View Of Turbocharger Exhaust Pipe & Clamp
Courtesy of GENERAL MOTORS CORP.

17. Install the exhaust pipe to the exhaust outlet.
18. Install the exhaust manifold pipe to the exhaust outlet clamp.

Tighten: Tighten the clamp to 40 N.m (30 lb ft).

19. Lower the vehicle to work through the front fender wheelhouse openings.

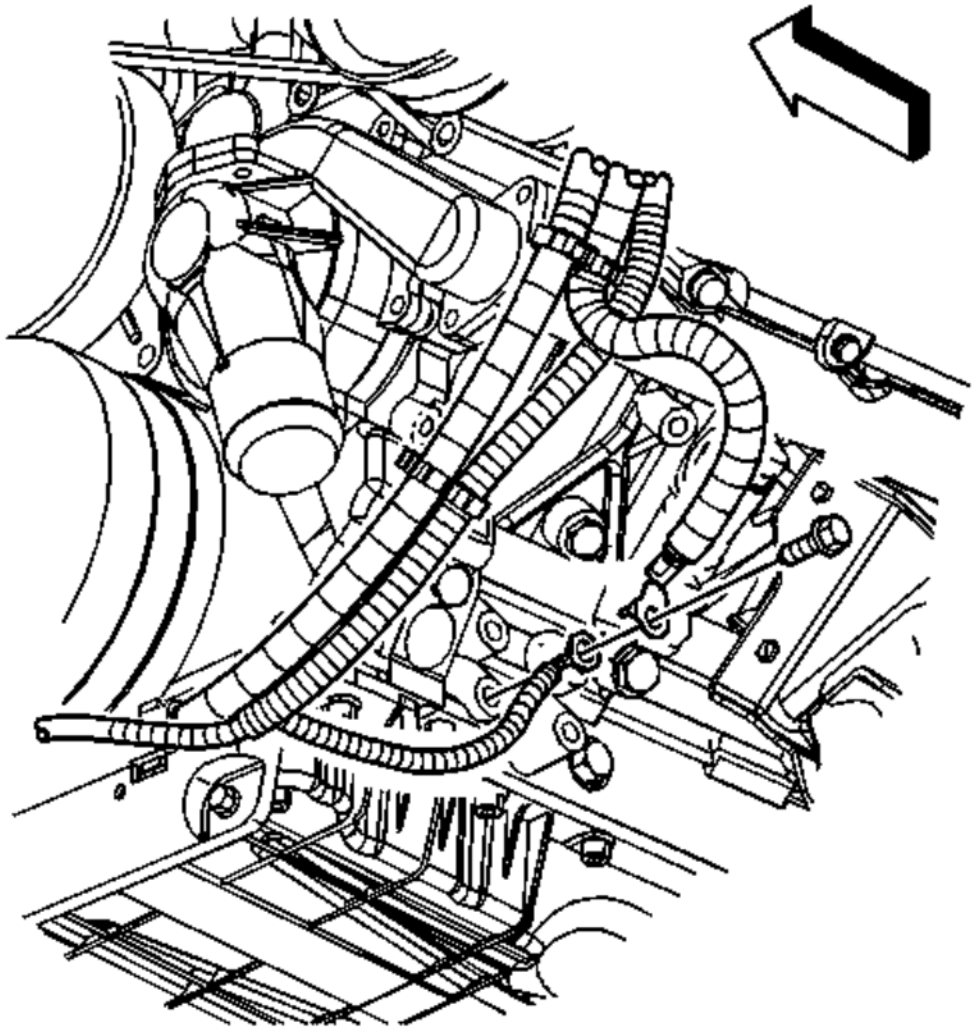


Fig. 379: View Of Engine Wiring Harness Ground Wire & Battery Negative Cable (Left Side Of Engine)
Courtesy of GENERAL MOTORS CORP.

20. Install the bolt retaining the battery negative cable and the engine wiring harness ground

wire to the left side of the engine.

Tighten: Tighten the bolt to 34 N.m (25 lb ft).

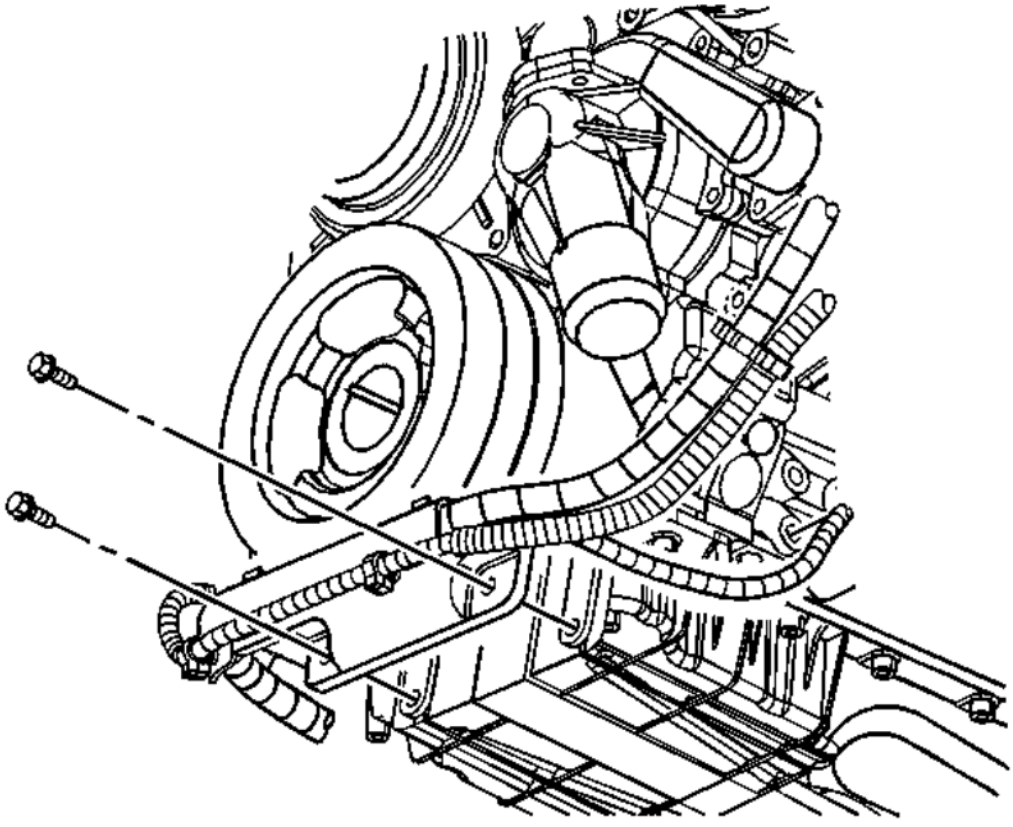


Fig. 380: View Of Battery Cable Bracket Bolts At Lower Crankcase
Courtesy of GENERAL MOTORS CORP.

21. Install the bolts holding the battery cable channel retainer to the lower crankcase.

    Tighten: Tighten the bolts to 12 N.m (106 lb ft).

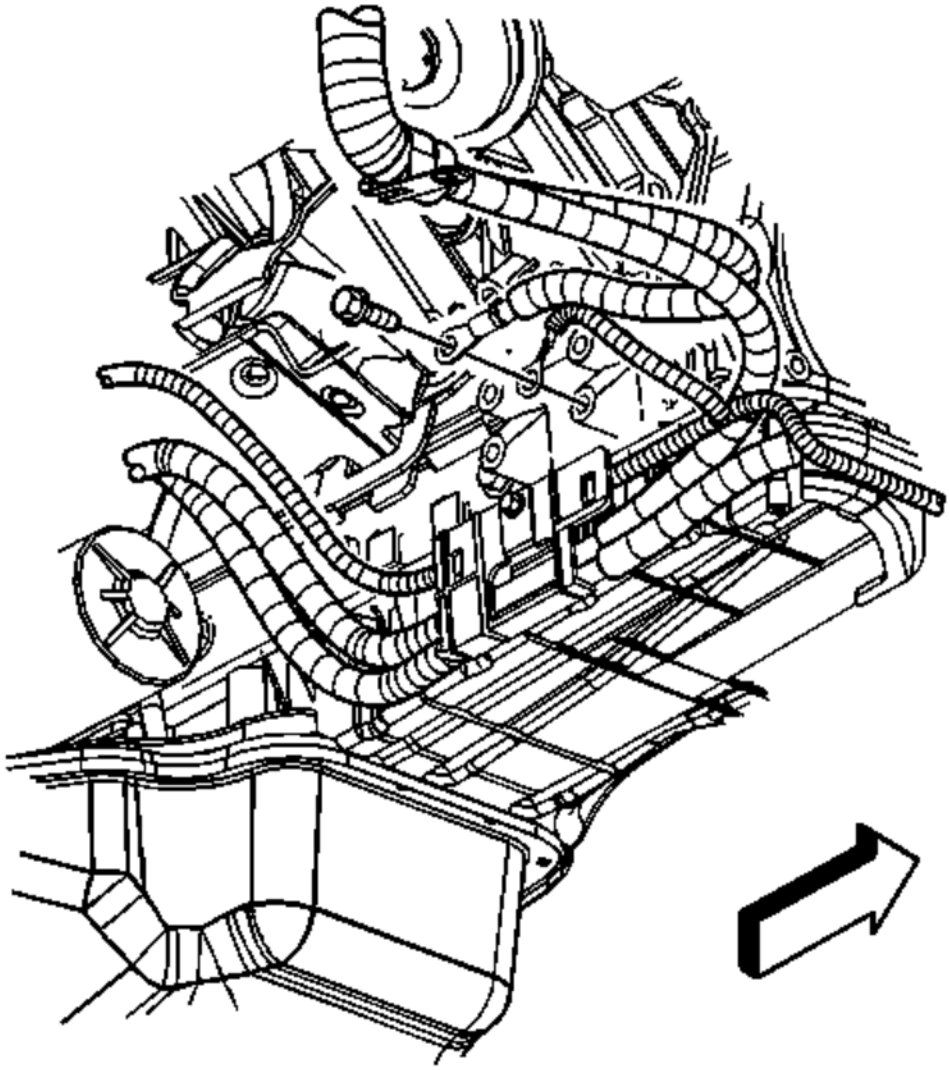


Fig. 381: View Of Auxiliary Battery Negative Cable & Engine Wiring Harness Ground Wires Bolt (Right Side Of Engine)
Courtesy of GENERAL MOTORS CORP.

22. Install the bolts holding the auxiliary battery negative cable and the engine wiring harness ground wires to the right side of the engine.

    Tighten: Tighten the bolts to 34 N.m (25 lb ft).

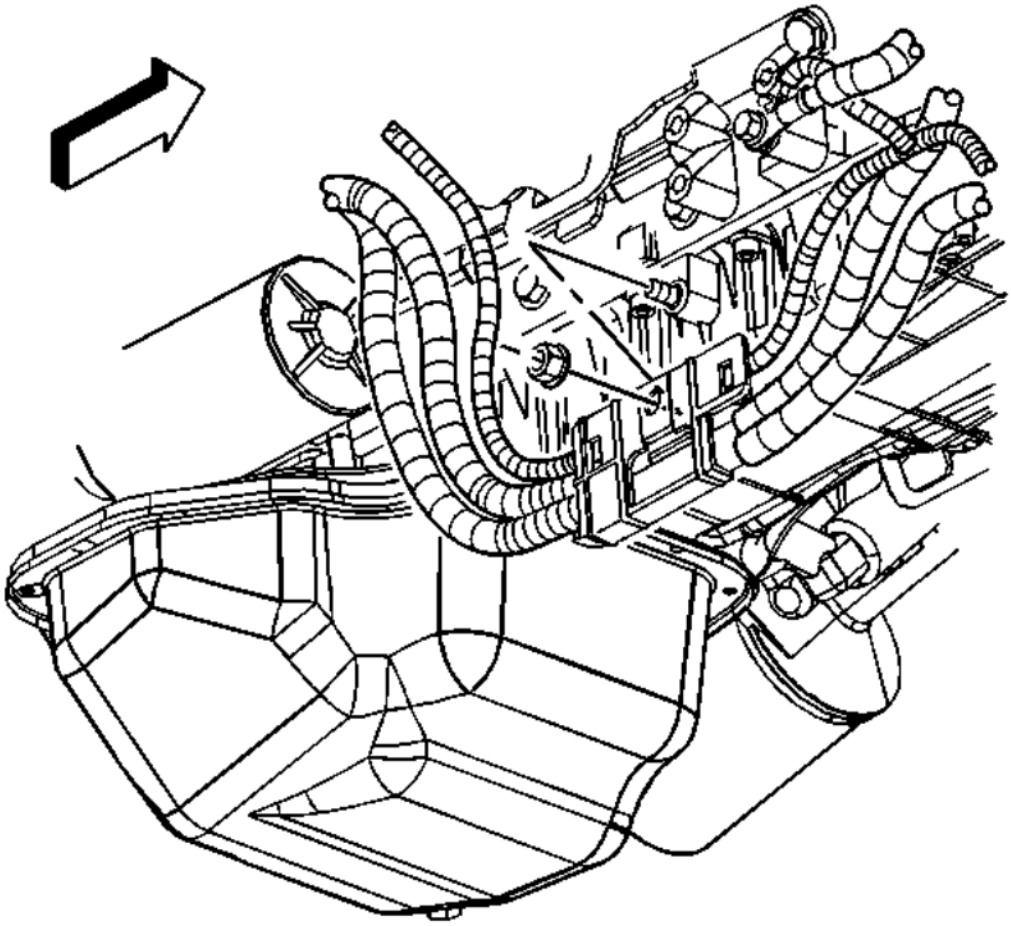


Fig. 382: View Of Battery Cable Bracket Nut
Courtesy of GENERAL MOTORS CORP.

23. Install the nut holding the battery cable bracket to the right side of the lower crankcase.

    Tighten: Tighten the nut to 8 N.m (71 lb in).

24. Install the starter. Refer to **Starter Motor Replacement (6.6L)** .

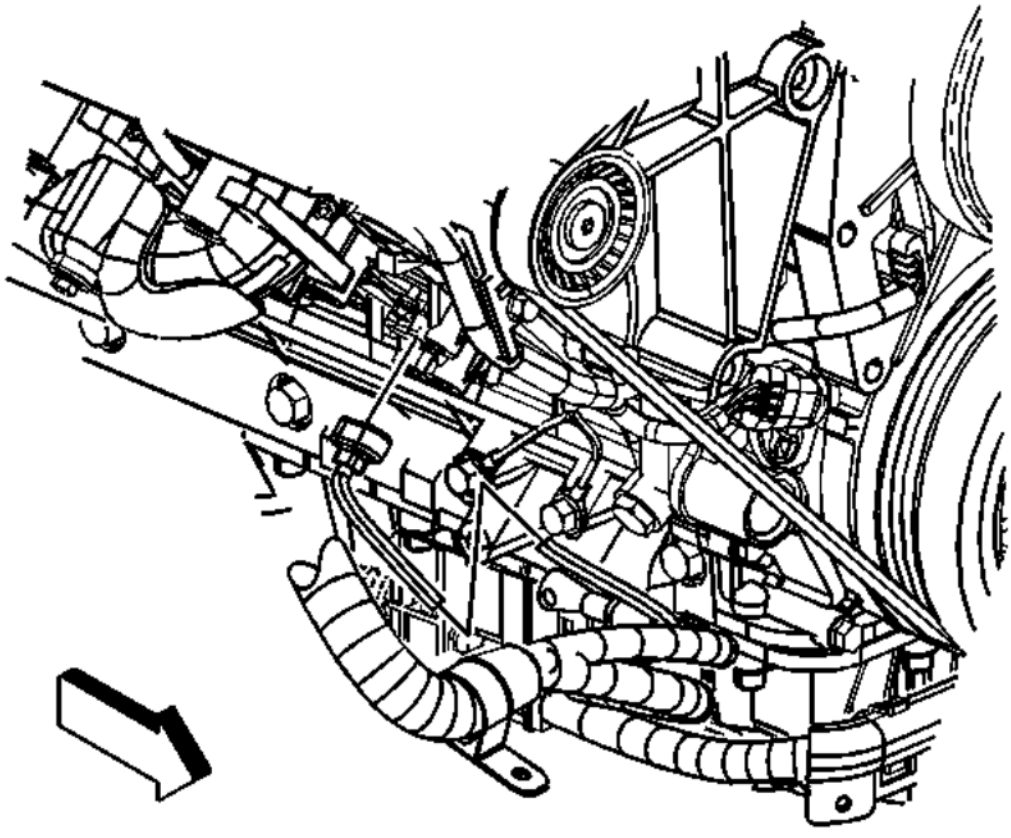


Fig. 383: View Of Engine Coolant Heater Cord
Courtesy of GENERAL MOTORS CORP.

25. Connect the cord for the engine coolant heater.
26. Install the engine oil pan skid plate. Refer to **Oil Pan Skid Plate Replacement (2500/3500 with RPO NZZ)** .
27. Install the engine shield. Refer to **Engine Shield Replacement** .
28. Lower the vehicle.
29. Install the bolt and the ground wires at the rear of the left cylinder head.

Tighten: Tighten the bolt to 34 N.m (25 lb ft).

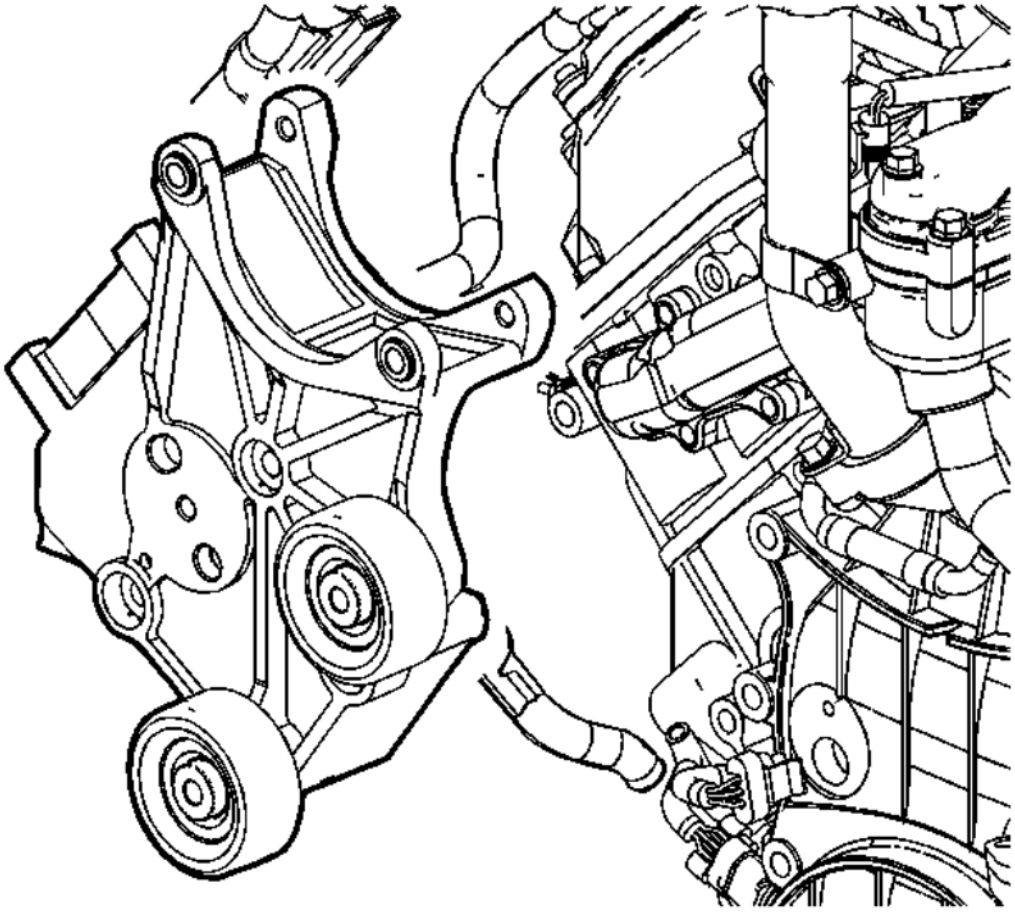


Fig. 384: View Of Generator Mounting Bracket
Courtesy of GENERAL MOTORS CORP.

30. Install the generator mounting bracket and bolts.

    Tighten: Tighten the bolts to 50 N.m (37 lb ft).

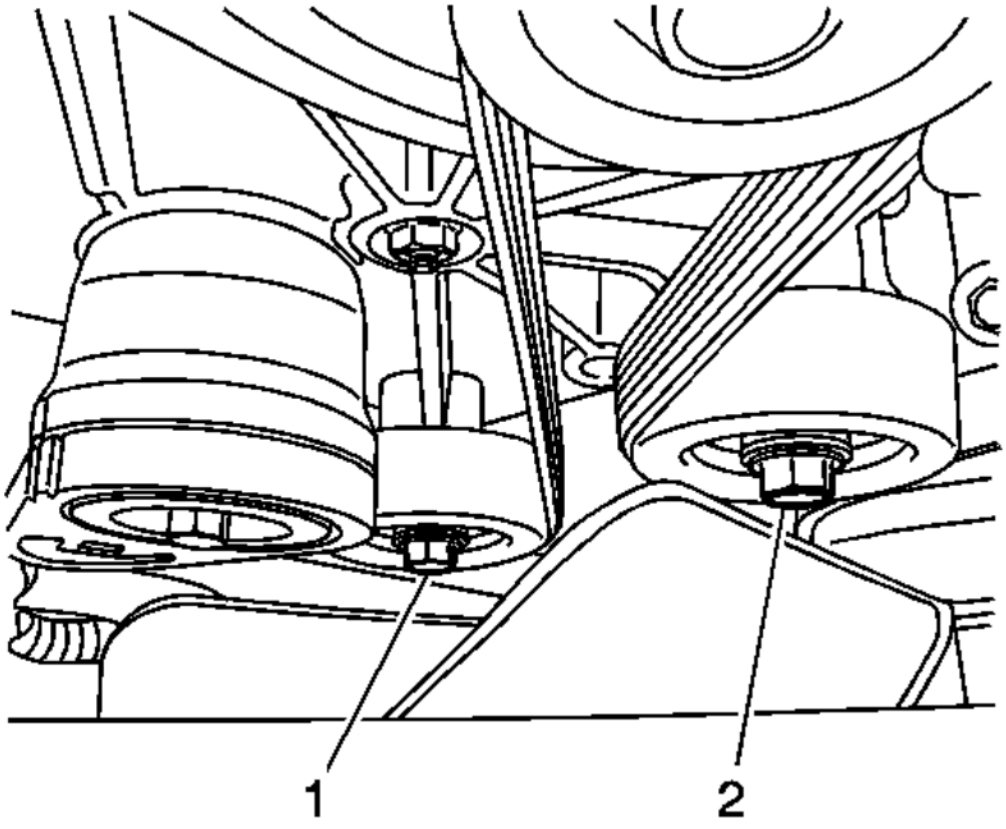


Fig. 385: View Of Right Side Idler & Center Idler Pulley Bolts
Courtesy of GENERAL MOTORS CORP.

31. Install the right idler pulley and bolt (1).

    Tighten: Tighten the bolt to 43 N.m (32 lb ft).

32. Install the air conditioning compressor and the power steering pump mounting bracket. Refer to **Air Conditioning (A/C) Compressor and Power Steering Pump Bracket Replacement**.
33. Position the engine wiring harness on the engine.
34. Position the A/C compressor.
35. Install the A/C compressor mounting bolts.

Tighten: Tighten the bolts to 50 N.m (37 lb ft).

36. Install the A/C suction hose to the accumulator.
37. Install the drive belt. Refer to **Drive Belt Replacement**.

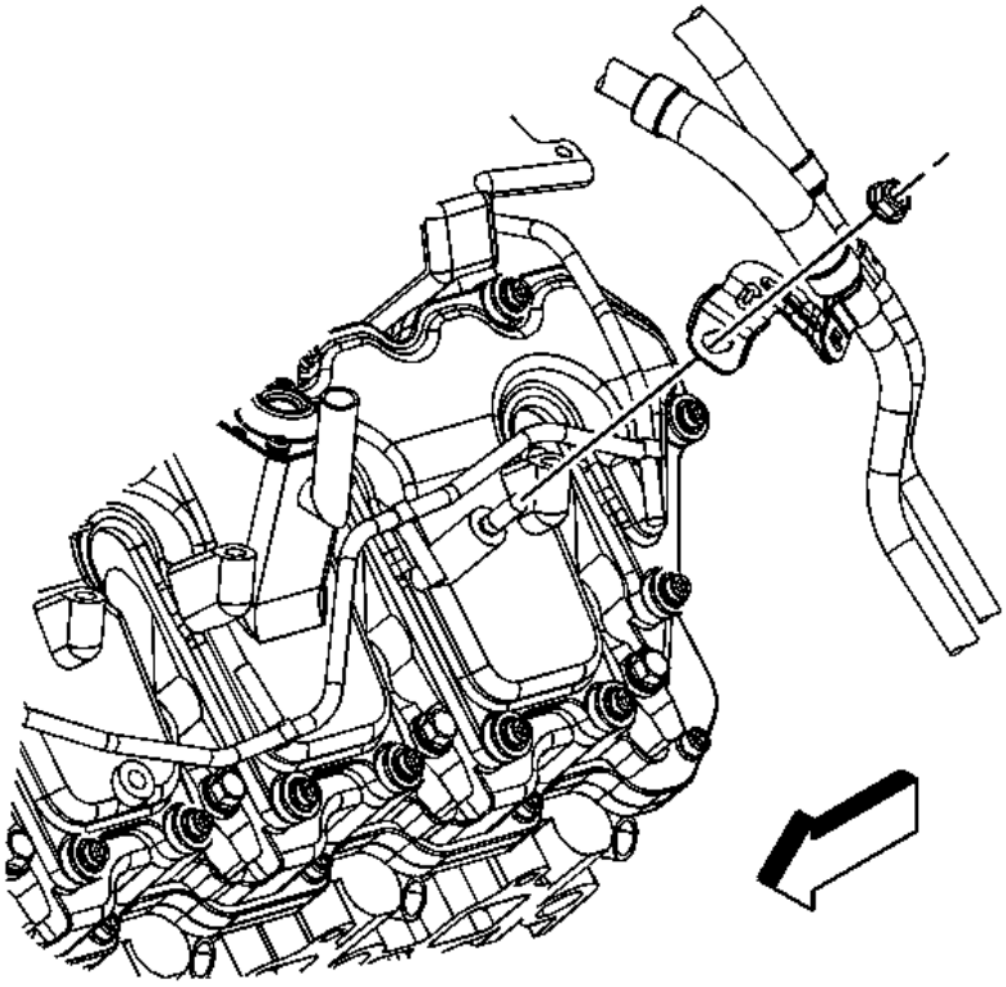


Fig. 386: View Of Fuel Line Bracket & Nut
Courtesy of GENERAL MOTORS CORP.

38. Connect the fuel hoses at the engine.
39. Install the nut and the fuel hose bracket to the valve rocker arm cover stud.

Tighten: Tighten the nut to 21 N.m (15 lb ft).

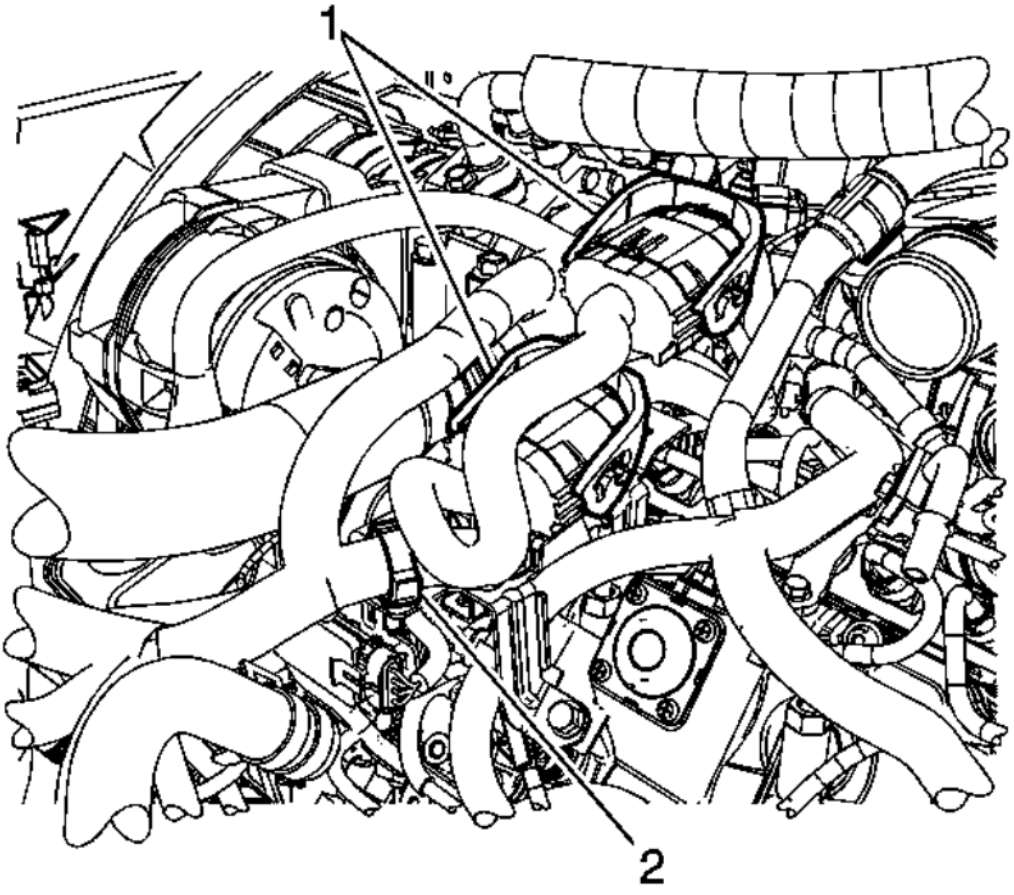


Fig. 387: View Of Main Engine Electrical Harness Connector Latches & Clips
Courtesy of GENERAL MOTORS CORP.

40. Connect the main engine electrical harness connectors.
41. Push down on the latches (1) in order to connect the connectors.
42. Close the harness clip (2).

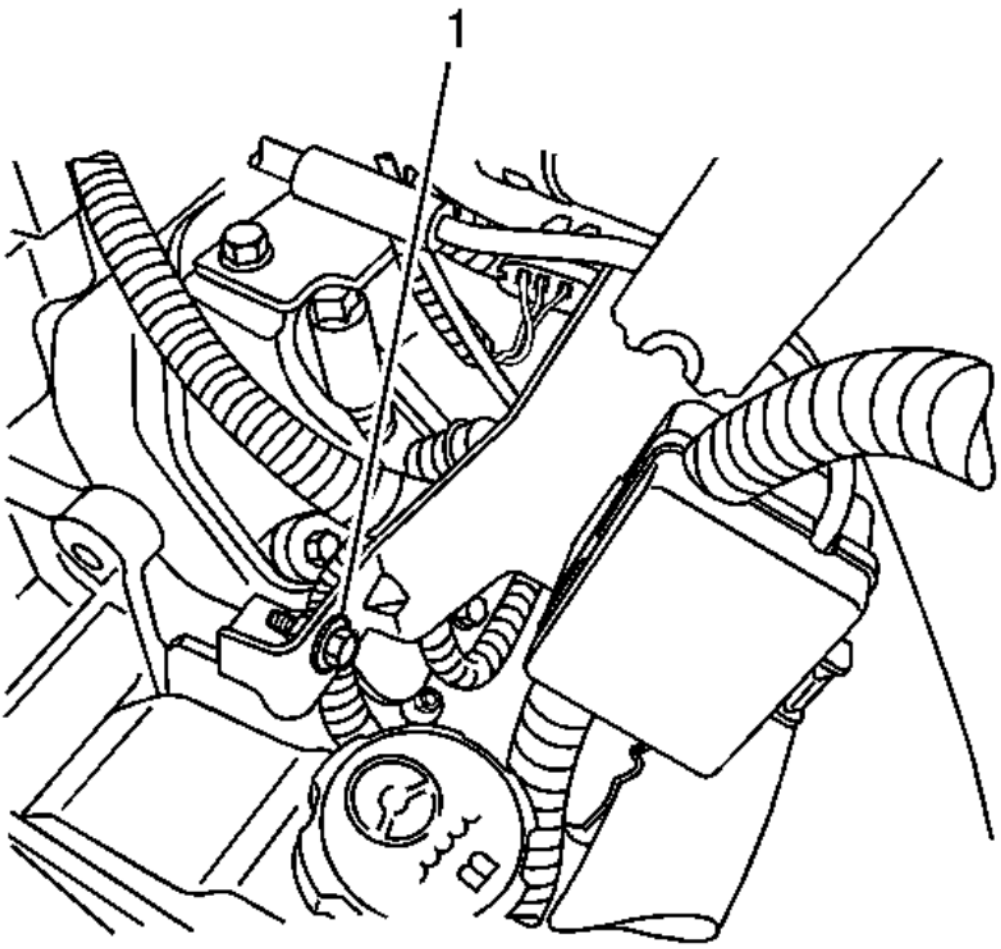


Fig. 388: View Of Battery Cable Junction Block Bolt At Power Steering Pump Bracket
Courtesy of GENERAL MOTORS CORP.

43. Install the cable junction block and bolt (1) to the power steering pump.

    Tighten: Tighten the bolt to 9 N.m (80 lb in).

44. If equipped, install the battery cable to the auxiliary generator.
45. Install the battery cable to the generator.

Tighten: Tighten the nut to 9 N.m (80 lb in).

46. Install the battery cable harness clip to the bracket.

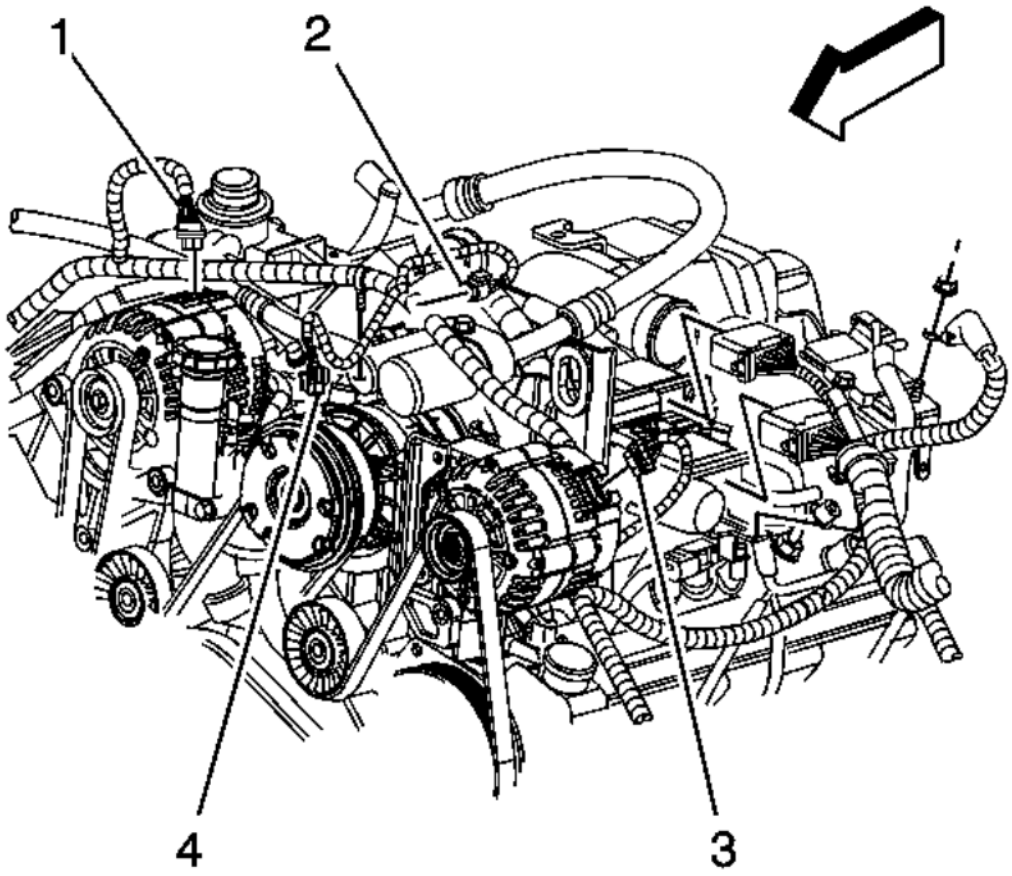


Fig. 389: View Of A/C & Generator Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

47. Connect the following electrical connectors:
    - Generator connector (1)
    - A/C refrigerant switch (2)
    - Dual generator harness connector (3), if equipped
    - A/C compressor clutch (4)

48. Install the harness clip to the A/C compressor bracket.
49. Install the upper radiator support. Refer to **Radiator Support Replacement** .
50. Install the A/C condenser. Refer to **Condenser Replacement** .
51. Install the charged air cooler. Refer to **Charge Air Cooler Replacement** .
52. Install the radiator. Refer to **Radiator Replacement (LLM)** .

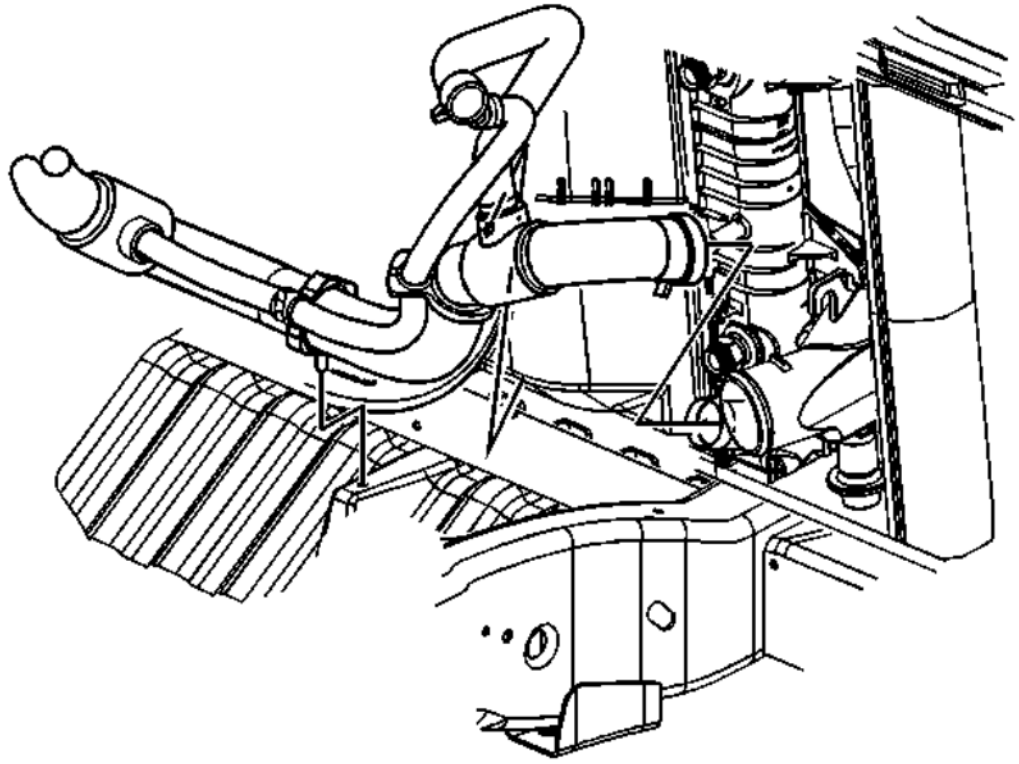


Fig. 390: View Of Radiator Outlet Hose & Outlet Heater Hose
Courtesy of GENERAL MOTORS CORP.

53. Install the outlet radiator hose to the radiator and tighten the hose clamp.
54. Install the hose clips to the frame.

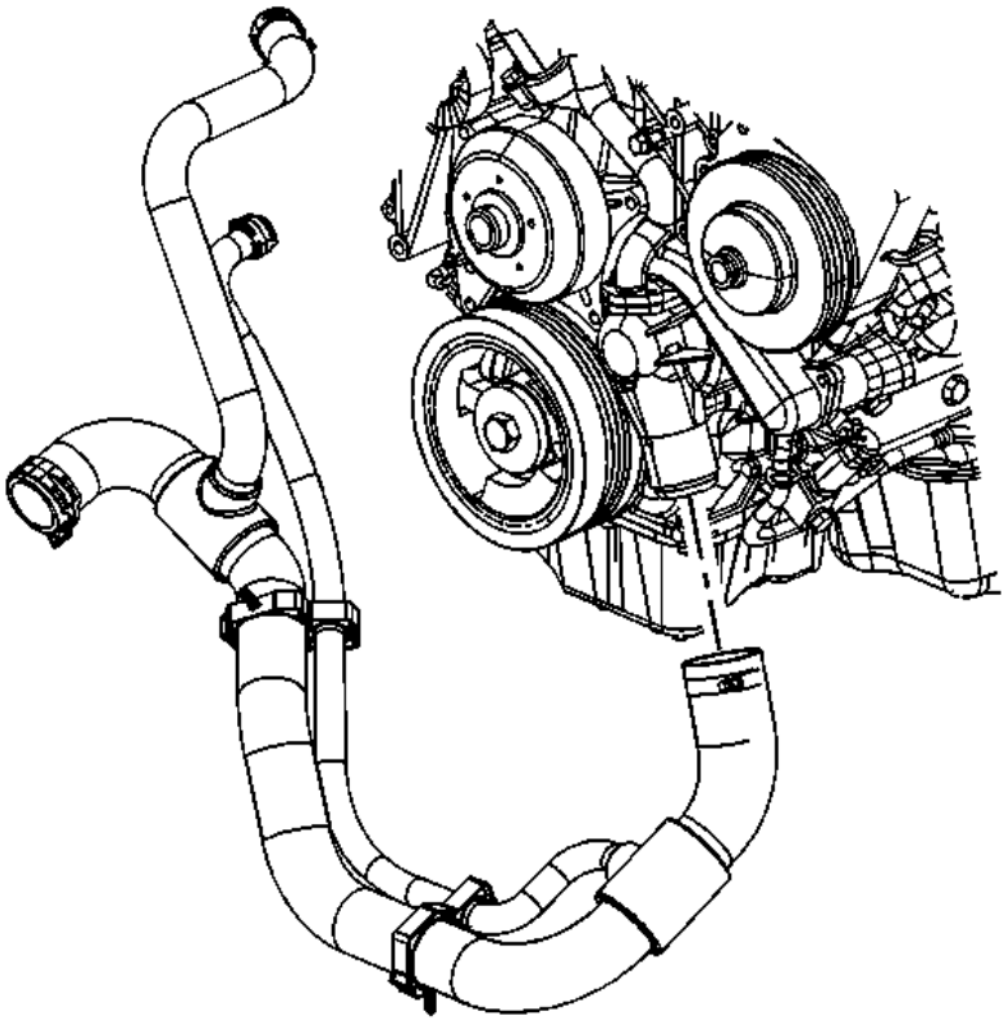


Fig. 391: View Of Radiator Outlet Hose At Engine
Courtesy of GENERAL MOTORS CORP.

55. Install the outlet radiator hose to the engine and tighten the hose clamp.
56. Install the lower fan shroud. Refer to **Engine Coolant Fan Lower Shroud Replacement (Mechanical)** .
57. Install the upper fan shroud. Refer to **Engine Coolant Fan Upper Shroud Replacement (Mechanical)** or **Engine Coolant Fan Upper Shroud Replacement (Automatic Transmission - Diesel)** .

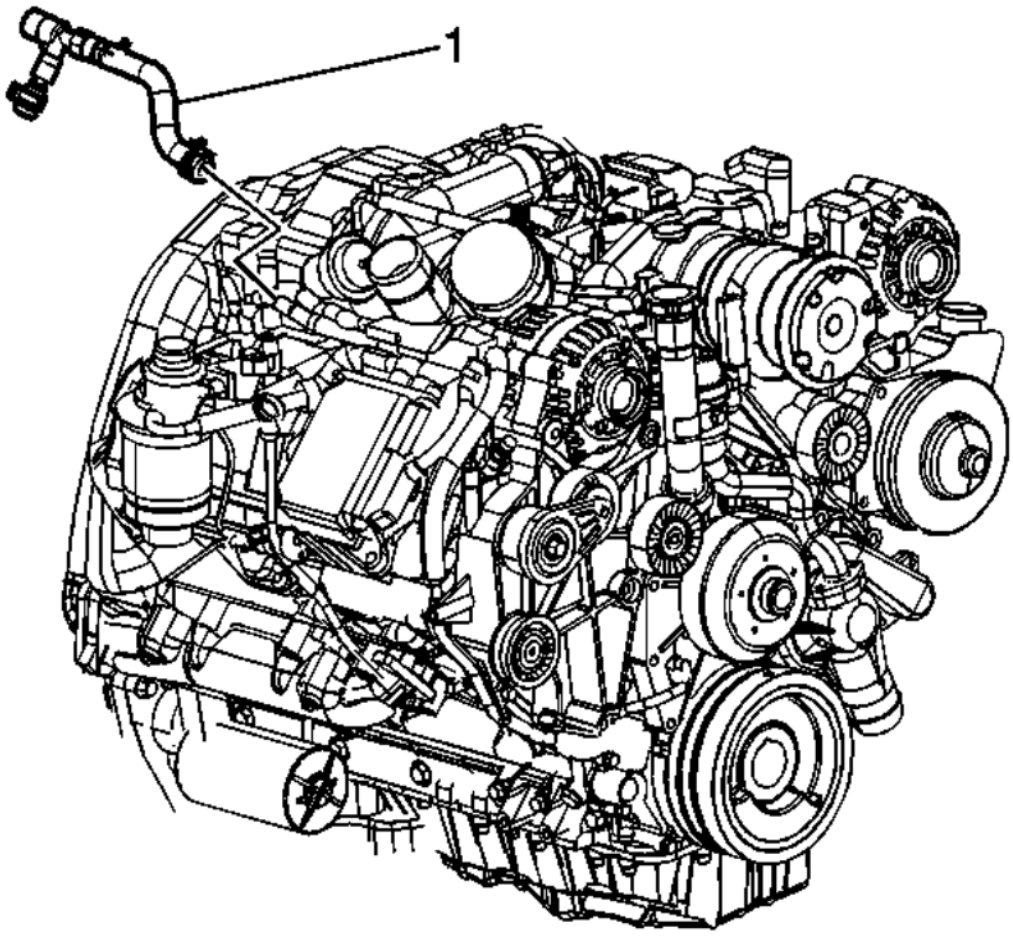


Fig. 392: View Of Inlet Heater Hose
Courtesy of GENERAL MOTORS CORP.

58. Connect the inlet heater hose (1) to the heater core inlet.

    Firmly push to quick connector onto the heater core pipe until you hear an audible click.

59. Install the outlet heater hose to the outlet radiator hose.
60. Install the bolt retaining the heater hose pipe to the bracket.

    Tighten: Tighten the bolt to 25 N.m (18 lb ft).

61. Install the radiator inlet hose **Radiator Inlet Hose Replacement (Non-HP2)** .
62. Install the charged air cooler pipes and hoses to the turbocharger and the charged air cooler. Refer to **Charge Air Cooler Inlet Pipe Replacement** and **Charge Air Cooler Outlet Pipe Replacement** .
63. Install both fender wheelhouse inner panels (1). Refer to **Front Wheelhouse Liner Replacement - Right Side (GMC)** or **Front Wheelhouse Liner Replacement - Right Side (Chevrolet)** and **Front Wheelhouse Liner Replacement - Left Side (Chevrolet)** or **Front Wheelhouse Liner Replacement - Left Side (GMC)** .
64. Install both front tires and wheels. Refer to **Tire and Wheel Removal and Installation** .
65. Install the surge tank. Refer to **Radiator Surge Tank Replacement (Non-HP2)** .
66. Install the air cleaner. Refer to **Air Cleaner Assembly Replacement** .

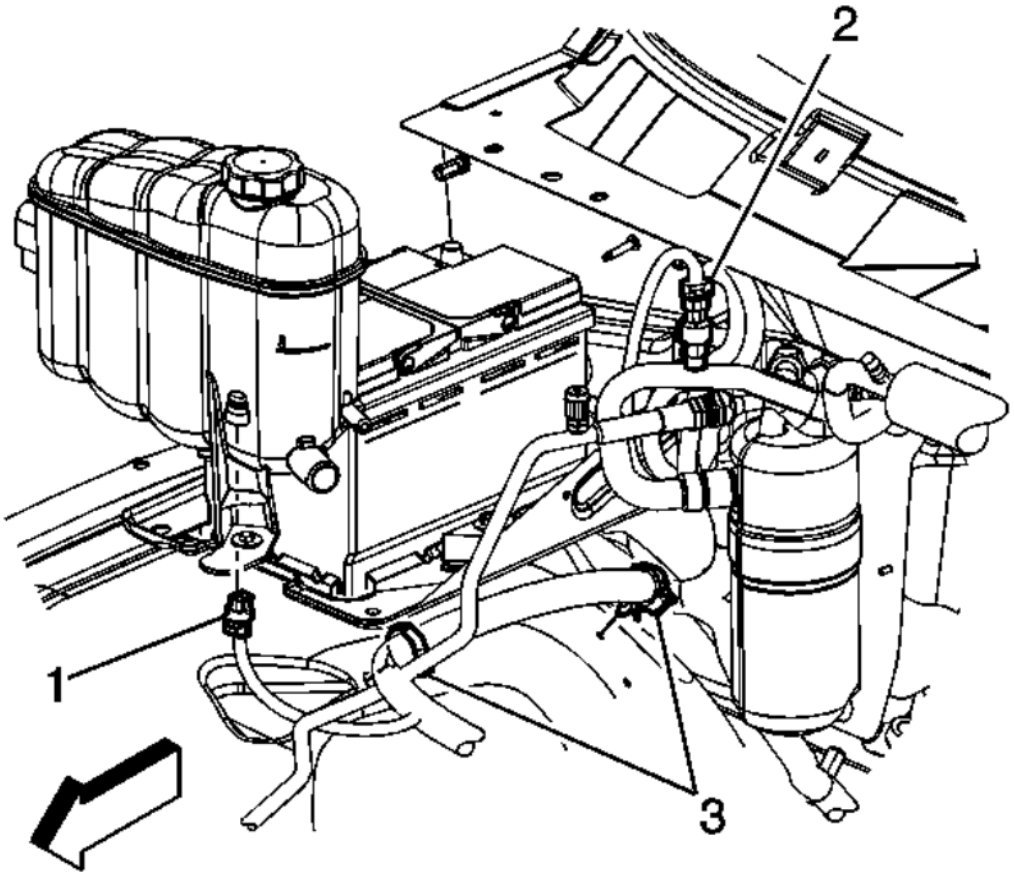


Fig. 393: View Of Engine Wire Harness Clips, A/C Pressure Cycling Switch & Surge Tank Switch
Courtesy of GENERAL MOTORS CORP.

67. Connect the following engine wire harness connectors:
    - Install the engine wire harness clips to the wheelhouse inner panel (3).
    - A/c pressure cycling switch (2)
    - Surge tank switch (1)
68. Connect the batteries negative cables. Refer to **Battery Negative Cable Disconnection and Connection (w/Single Battery)** or **Battery Negative Cable Disconnection and Connection (w/Auxiliary Battery)** or **Battery Negative Cable Disconnection and Connection (w/Dual Batteries)** .
69. Fill the engine coolant. Refer to **Cooling System Draining and Filling (Vac-N-Fill)** or **Cooling System Draining and Filling (Static Fill)** .
70. Prelube the engine. Refer to **Engine Prelubing** .
71. Operate the engine, inspect for coolant, oil, fuel, and exhaust leaks.
72. Inspect for proper oil pressure.
73. Inspect for proper engine operation.

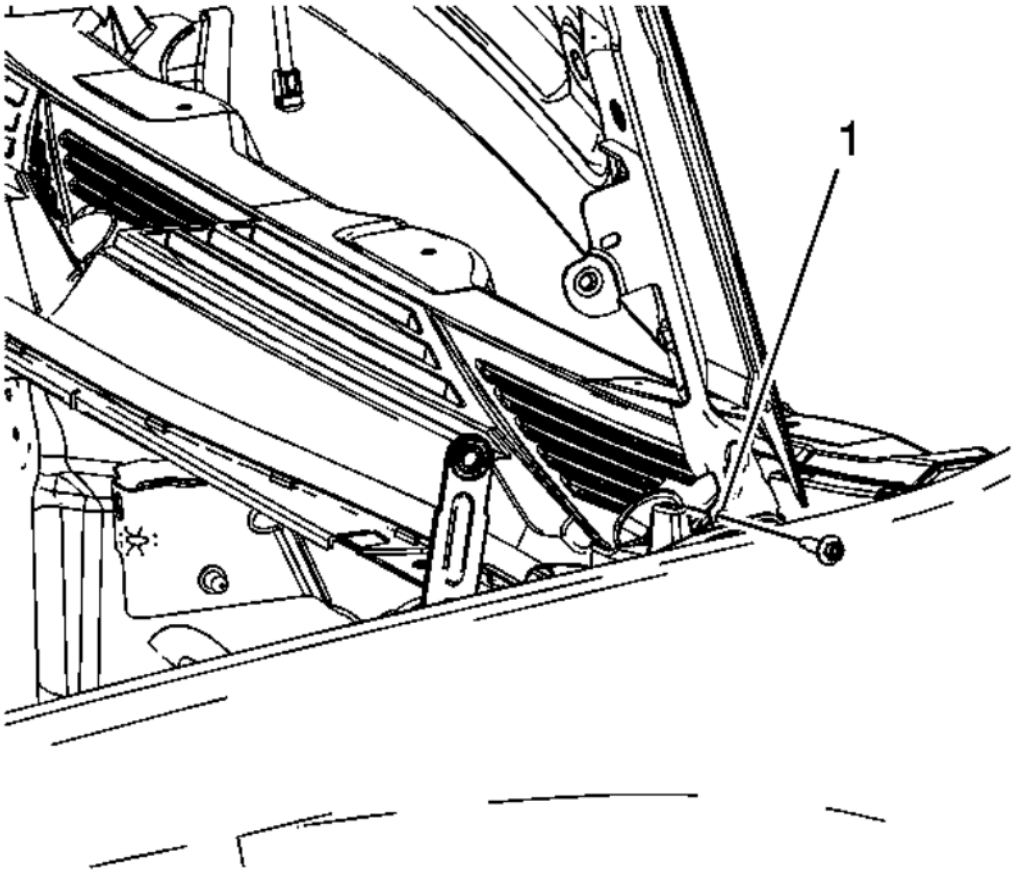


Fig. 394: View Of Service Piston Notch
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: There is a positive stop which limits the hood from being opened too far.

74. With the aid of the assistant raise the hood slightly until the hood hinge bolts can be removed from the service position notch (1).

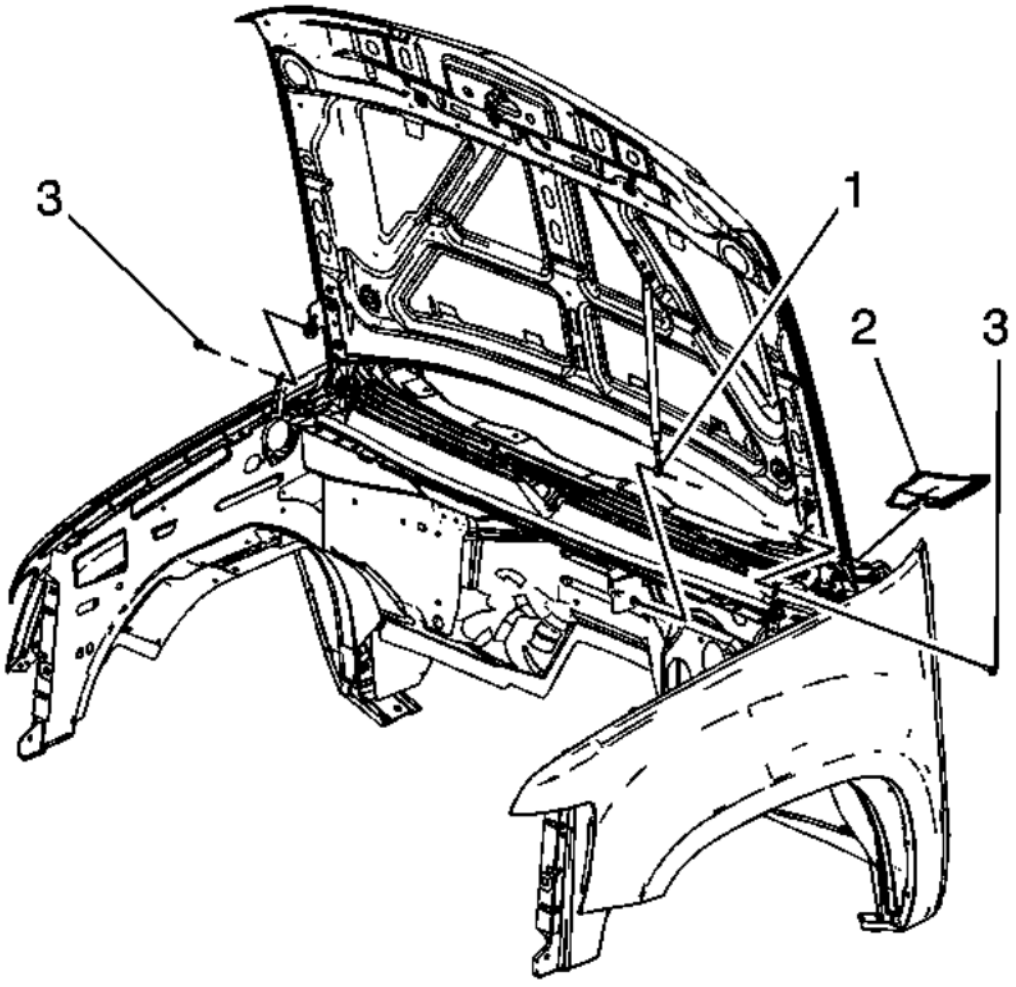


Fig. 395: View Of Hood Strut Rod, Grille End Caps & Hood Hinge Bolts
Courtesy of GENERAL MOTORS CORP.

75. With the aid of an assistant lower the hood and install the hood hinge bolts (2) to the hood hinges.

    Tighten: Tighten the bolts to 25 N.m (18 lb ft).

76. Install the air inlet grille end caps (1), push down the end cap in order to engage the retainers. (left side shown, right side similar).

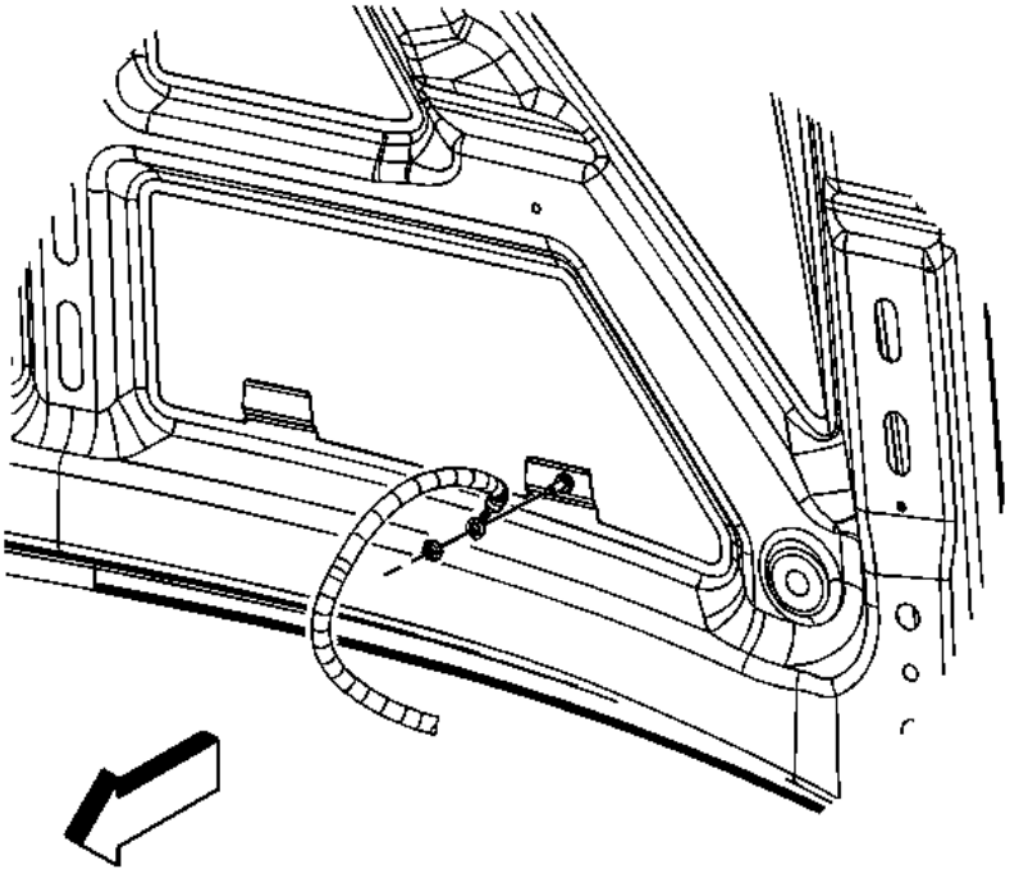


Fig. 396: View Of Ground Strap & Nut
Courtesy of GENERAL MOTORS CORP.

77. Install the ground strap to the hood stud.
78. Install the ground strap nut at the hood stud.

    Tighten: Tighten the nut to 9 N.m (80 lb in).

79. Close the hood.
80. Road test the vehicle for normal operation.
81. Inspect for coolant, oil, or exhaust leaks.

ENGINE OIL AND OIL FILTER REPLACEMENT

Removal Procedure

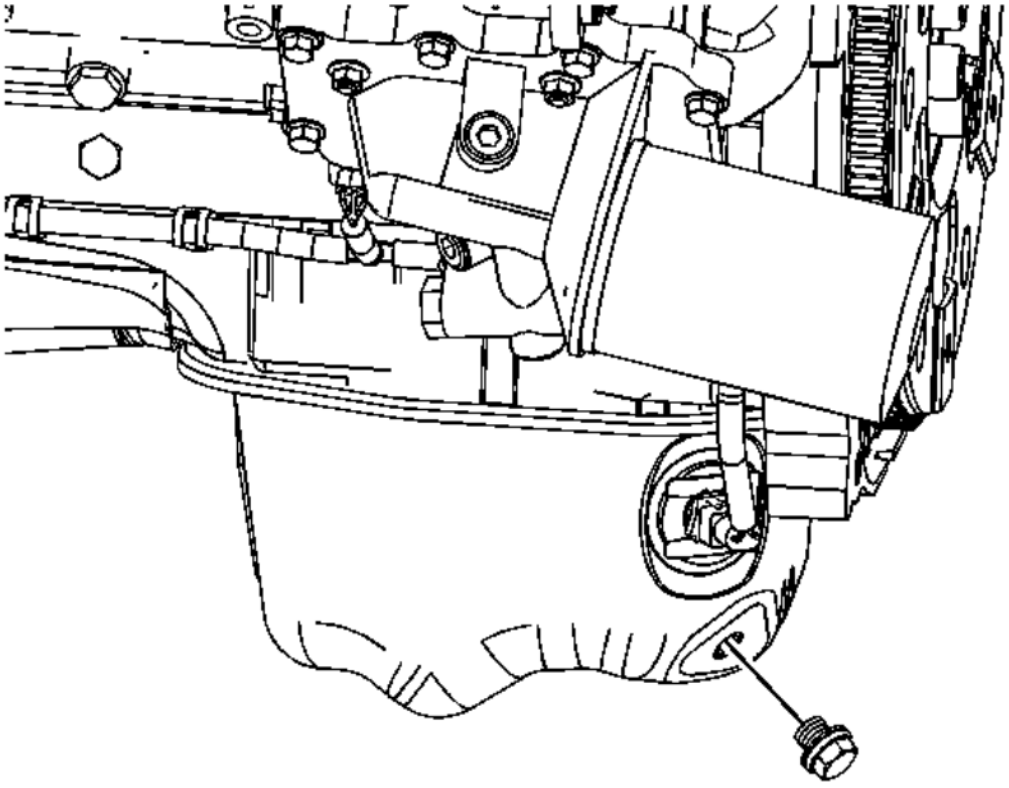


Fig. 397: View Of Oil Drain Plug
Courtesy of GENERAL MOTORS CORP.

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Position a suitable drain pan under the oil pan drain plug.
3. Remove the oil drain plug.
4. Allow the oil to drain completely.
5. Clean and inspect the oil pan drain plug, replace if necessary.
6. Clean and inspect the oil pan drain plug sealing surface, replace the oil pan if necessary.
7. Wipe any remaining oil from the drain plug hole and reinstall the oil pan drain plug until snug.

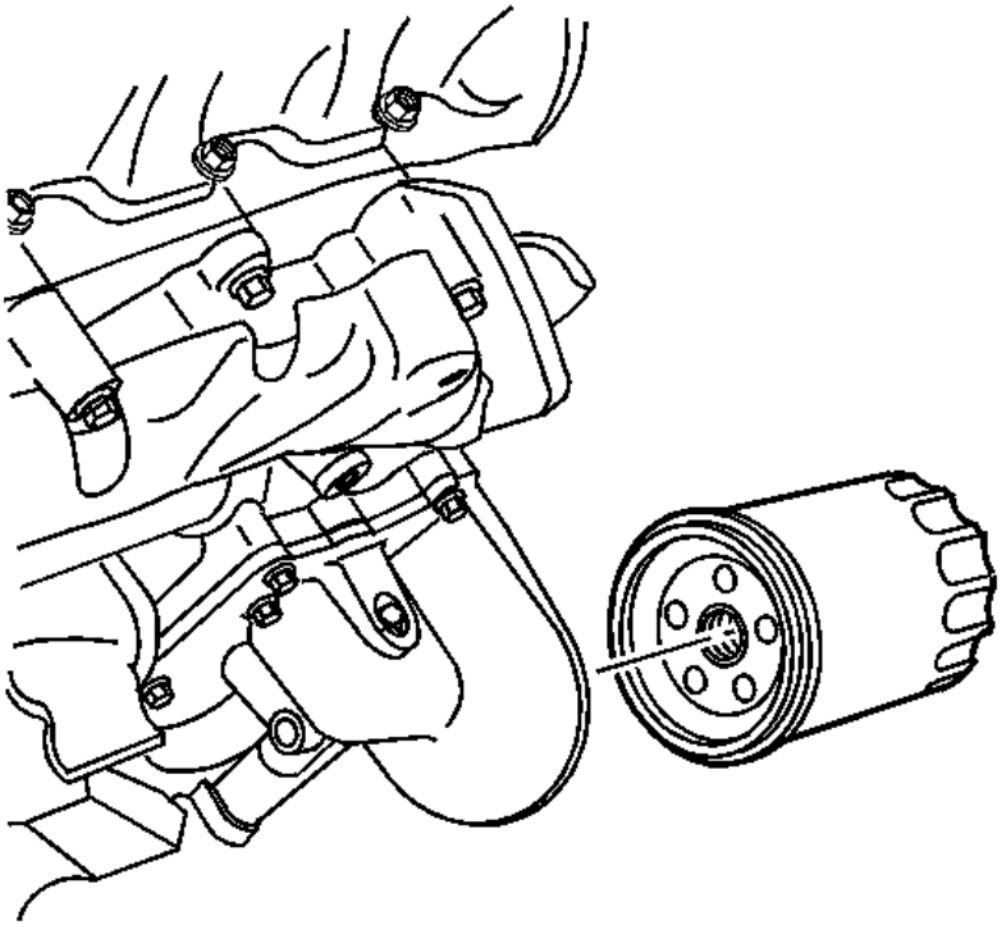


Fig. 398: View Of Oil Filter
Courtesy of GENERAL MOTORS CORP.

8. Position a suitable drain pan under the oil filter
9. Remove the oil filter.
10. Ensure that the oil filter gasket is still on the old oil filter, if not remove the oil filter gasket from the adapter.

Installation Procedure

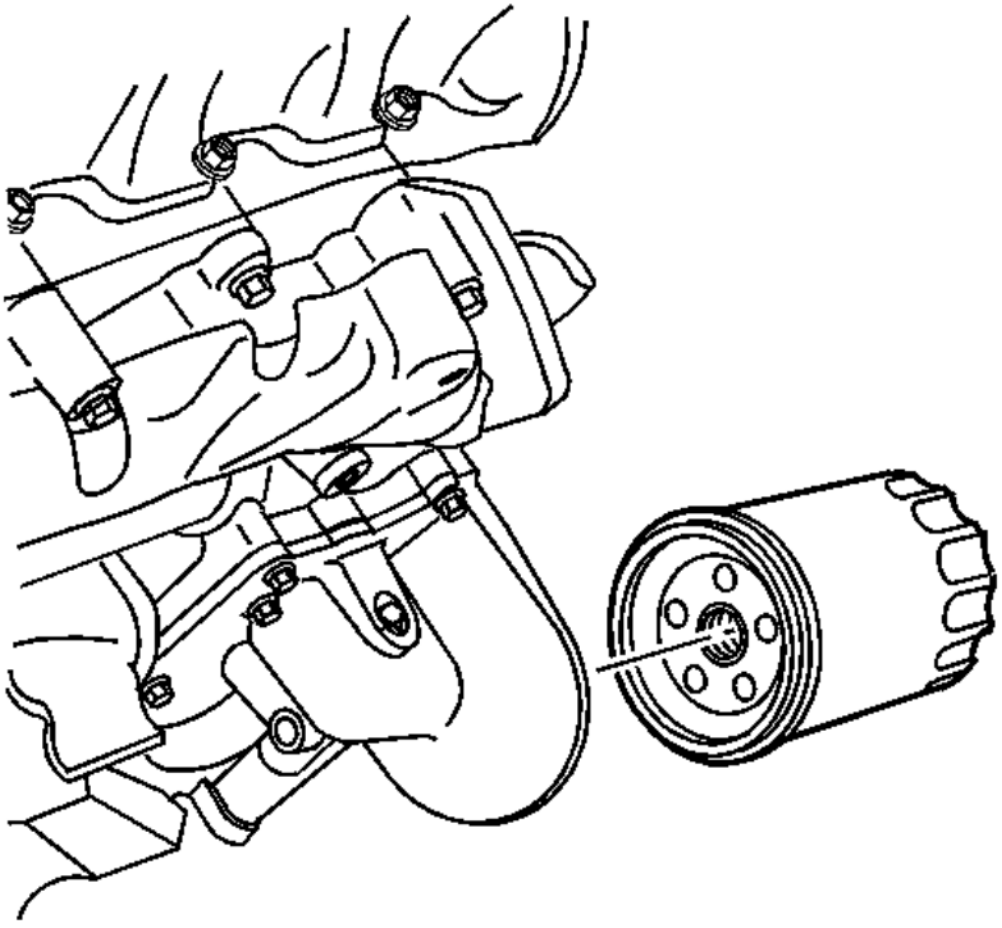


Fig. 399: View Of Oil Filter
Courtesy of GENERAL MOTORS CORP.

1. Apply clean engine oil to the NEW oil filter gasket.
2. Install the NEW oil filter.

Tighten: Tighten the filter after contact plus 1 to 11/4 turn.

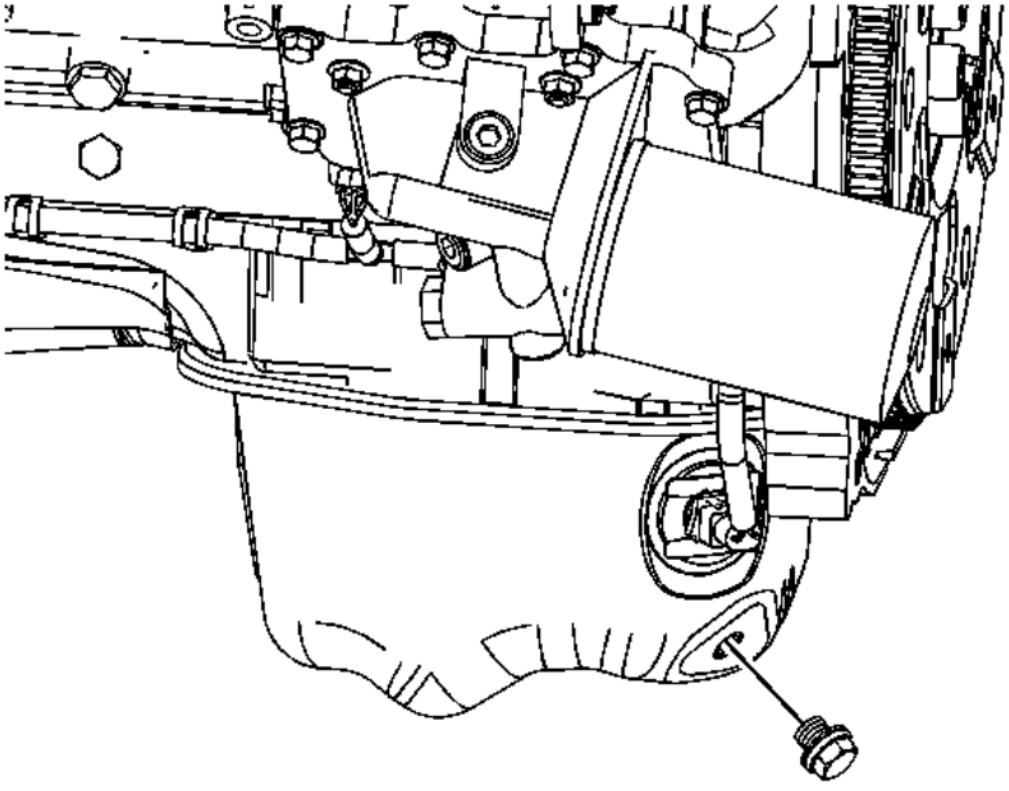


Fig. 400: View Of Oil Drain Plug
Courtesy of GENERAL MOTORS CORP.

3. Tighten the oil pan drain plug.

   Tighten: Tighten the plug to 84 N.m (62 lb ft).

4. Remove the oil drain pan from under the vehicle.
5. Lower the vehicle.
6. Fill the engine with new engine oil. Refer to **Approximate Fluid Capacities** and **Fluid and Lubricant Recommendations** .
7. Start the engine.
8. Inspect for oil leaks after engine start up.
9. Turn off the engine and allow the oil a few minutes to drain back into the oil pan.

10. Remove the oil level indicator from the oil level indicator tube.
11. Clean off the indicator end of the oil level indicator with a clean paper towel or cloth.
12. Install the oil level indicator into the oil level indicator tube until the oil level indicator handle contacts the top of the oil level indicator tube.
13. Again, remove the oil level indicator from the oil level indicator tube keeping the tip of the oil level indicator down.
14. Check the level of the engine oil on the oil level indicator.
15. If necessary, adjust the oil level be adding or draining oil.
16. Check for oil leaks.

OIL PUMP REMOVAL

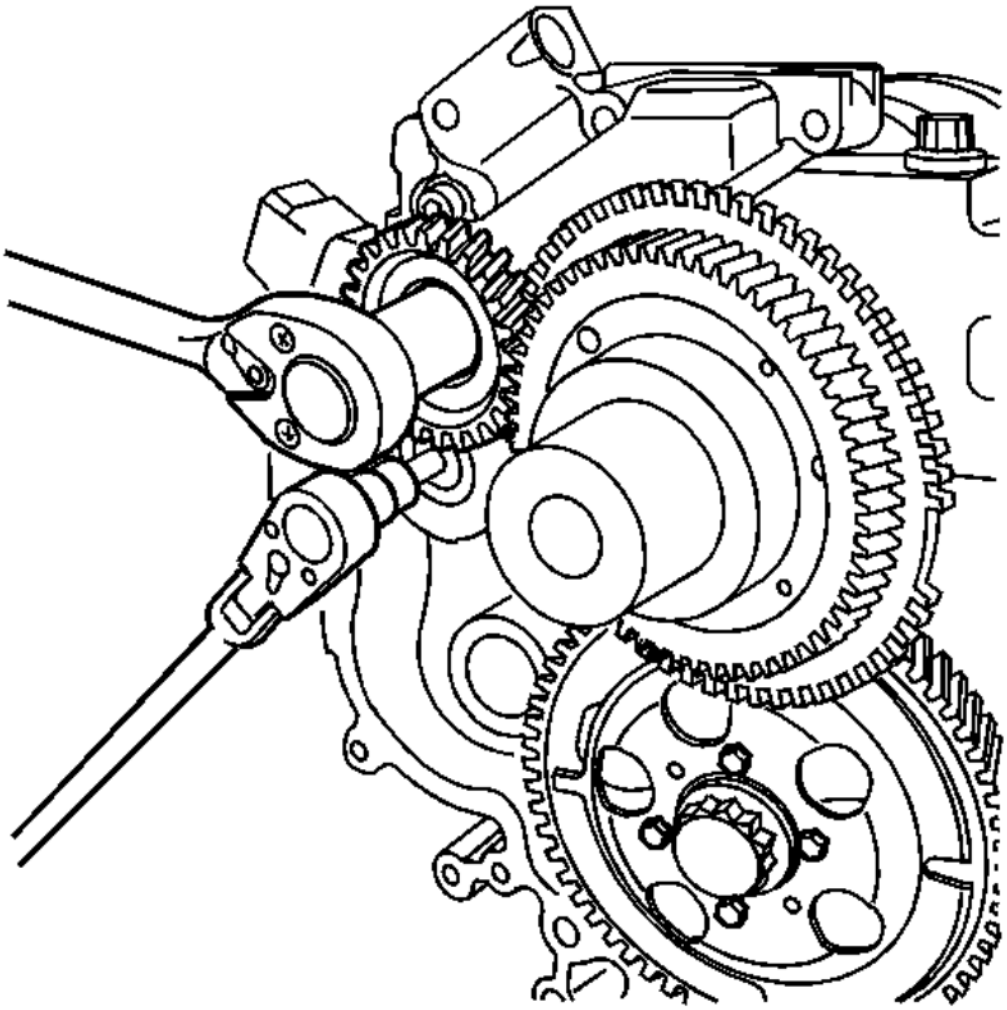


Fig. 401: Removing/Installing Secondary Oil Pump Driven Gear Nut While Holding Oil Pump Shaft
Courtesy of GENERAL MOTORS CORP.

NOTE: **Do not use an impact driver to remove or install the oil pump driven gear nut. Use of an impact driver may shear the oil pump drive gear pin in the crankshaft.**

IMPORTANT: Look for an "L" on the end of the oil pump shaft. If there is an

"L" present, the nut and shaft have left hand threads. Service the nut accordingly.

1. While holding the secondary oil pump shaft with a hex driver, remove the oil pump driven gear nut.

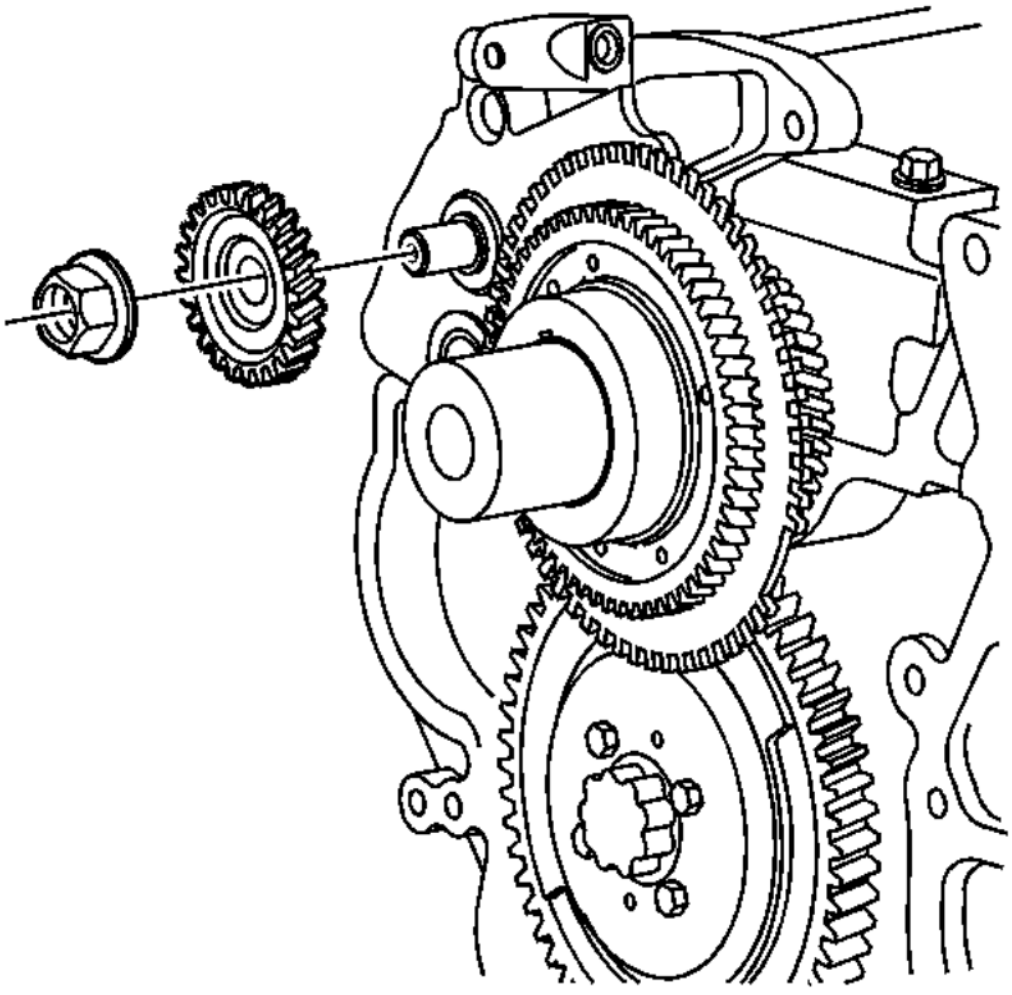


Fig. 402: View Of Oil Pump Driven Gear
Courtesy of GENERAL MOTORS CORP.

2. Remove the oil pump driven gear.

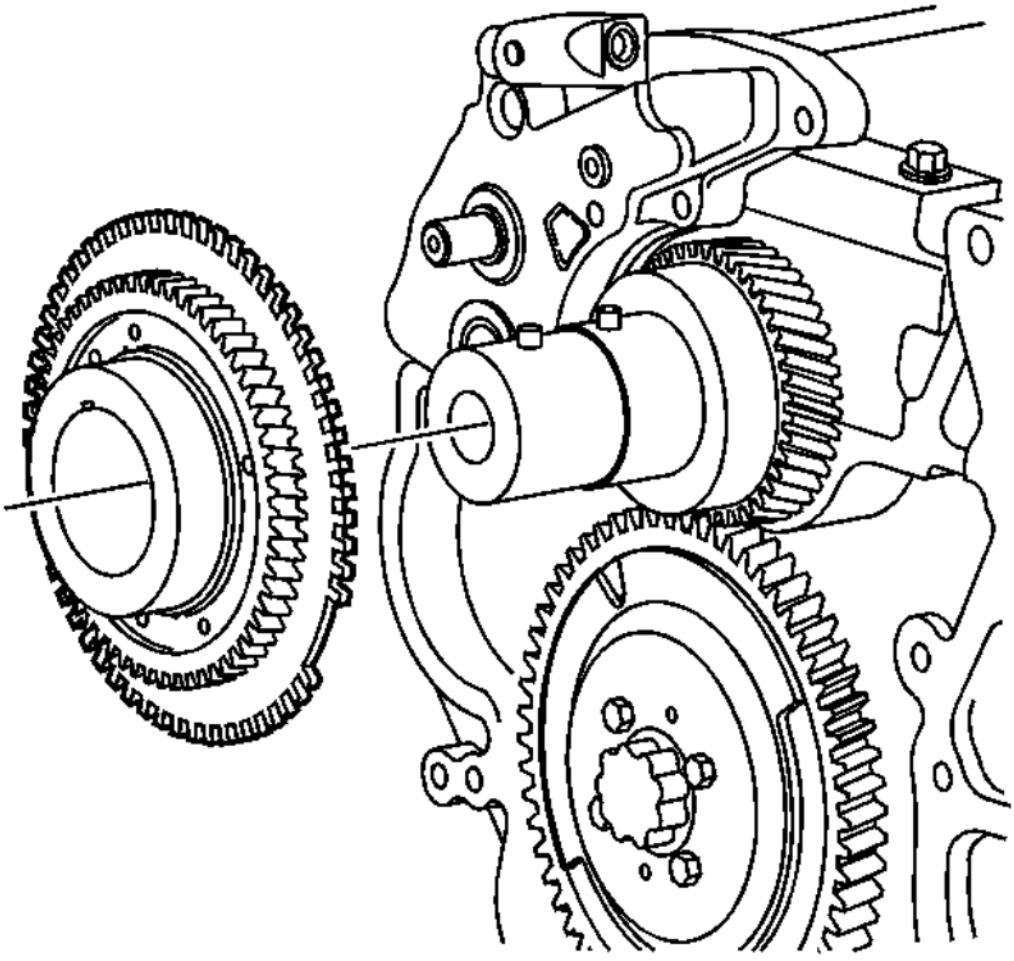


Fig. 403: View Of Oil Pump Drive Gear
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not damage the crankshaft sensor reluctor teeth.

3. Remove the oil pump drive gear and crank sensor reluctor assembly.

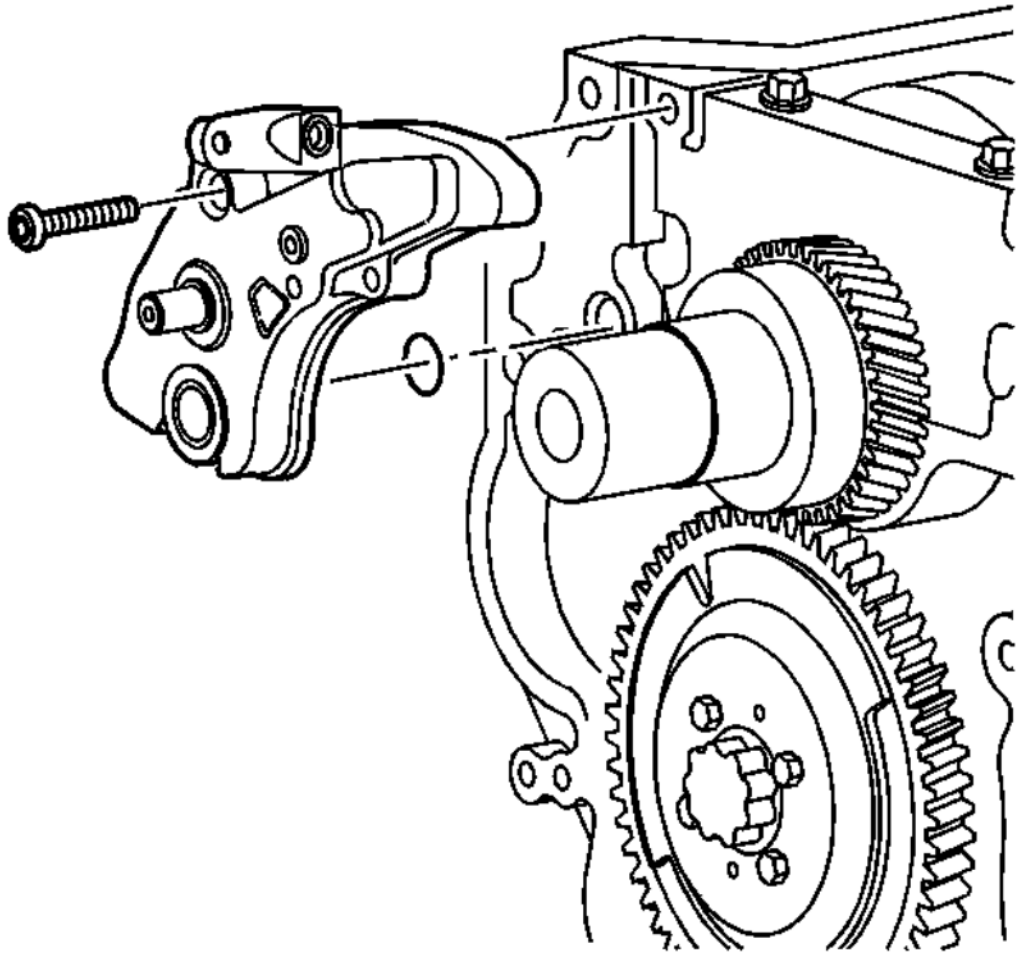


Fig. 404: View Of Oil Pump, Bolts & O-Ring
Courtesy of GENERAL MOTORS CORP.

4. Remove the oil pump bolts.
5. Remove the oil pump.
6. Remove the O-ring and discard.

OFF-VEHICLE REPAIR INSTRUCTIONS

DRAINING FLUIDS AND OIL FILTER REMOVAL

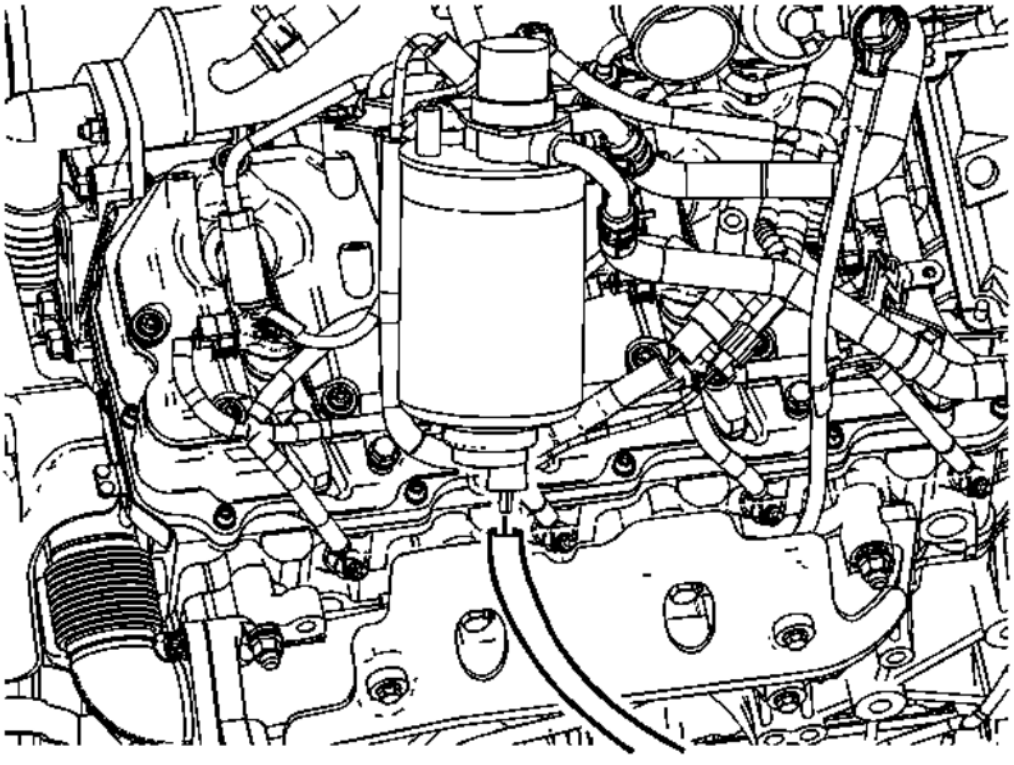


Fig. 405: View Of Fuel Filter
Courtesy of GENERAL MOTORS CORP.

1. Drain the fuel from the fuel filter.
    1. Attach drain tube to fuel filter drain tap.
    2. Place open end of drain tube into a suitable container.
    3. Open fuel filter drain, and allow fuel to drain.
    4. Close fuel filter drain.
    5. Remove drain tube.
    6. Properly dispose of used fuel.

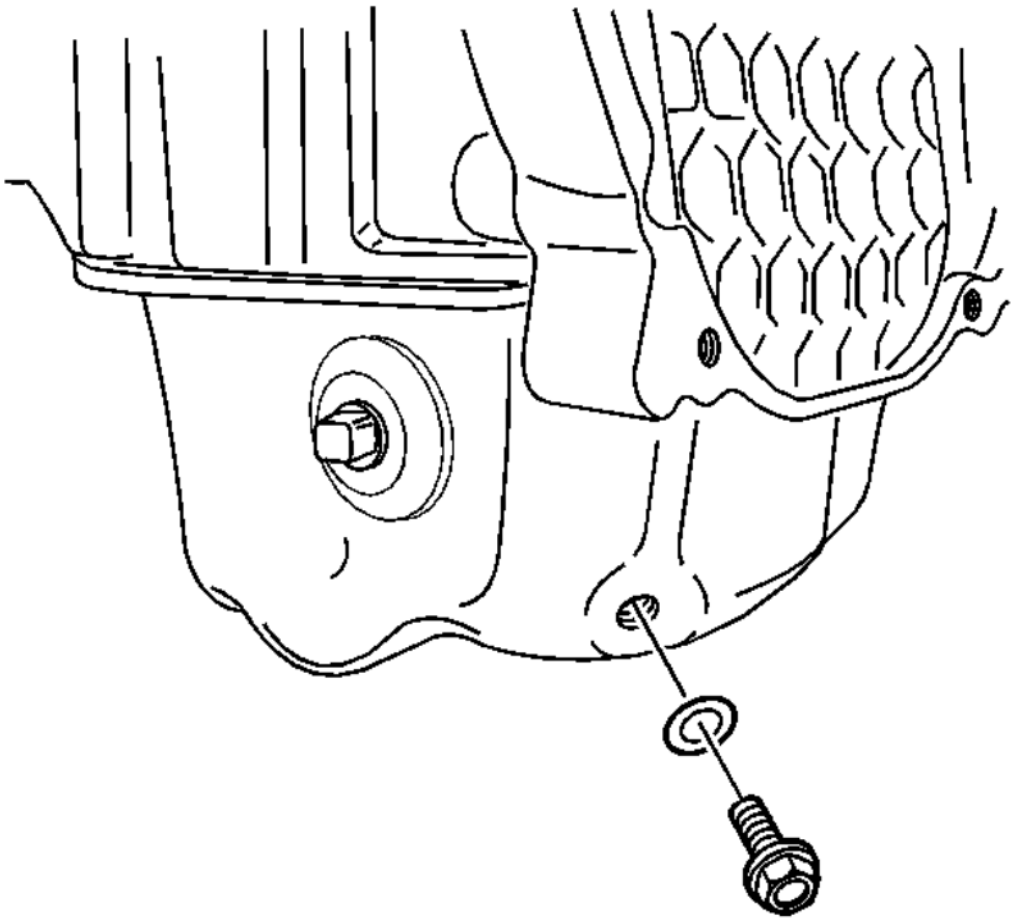


Fig. 406: View Of Engine Oil Drain Plug
Courtesy of GENERAL MOTORS CORP.

2. Remove the oil drain plug and gasket, and allow engine oil to drain.
3. Discard the oil drain plug gasket.

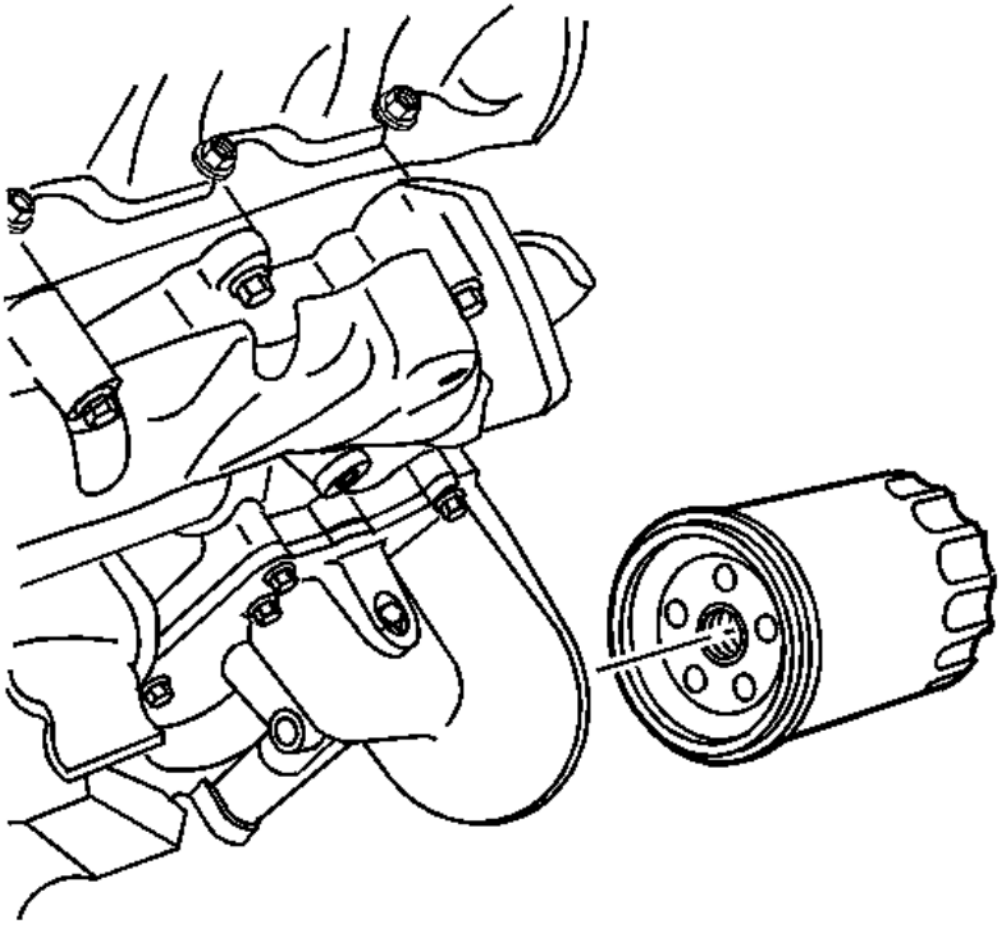


Fig. 407: View Of Oil Filter
Courtesy of GENERAL MOTORS CORP.

4. Remove the oil filter.

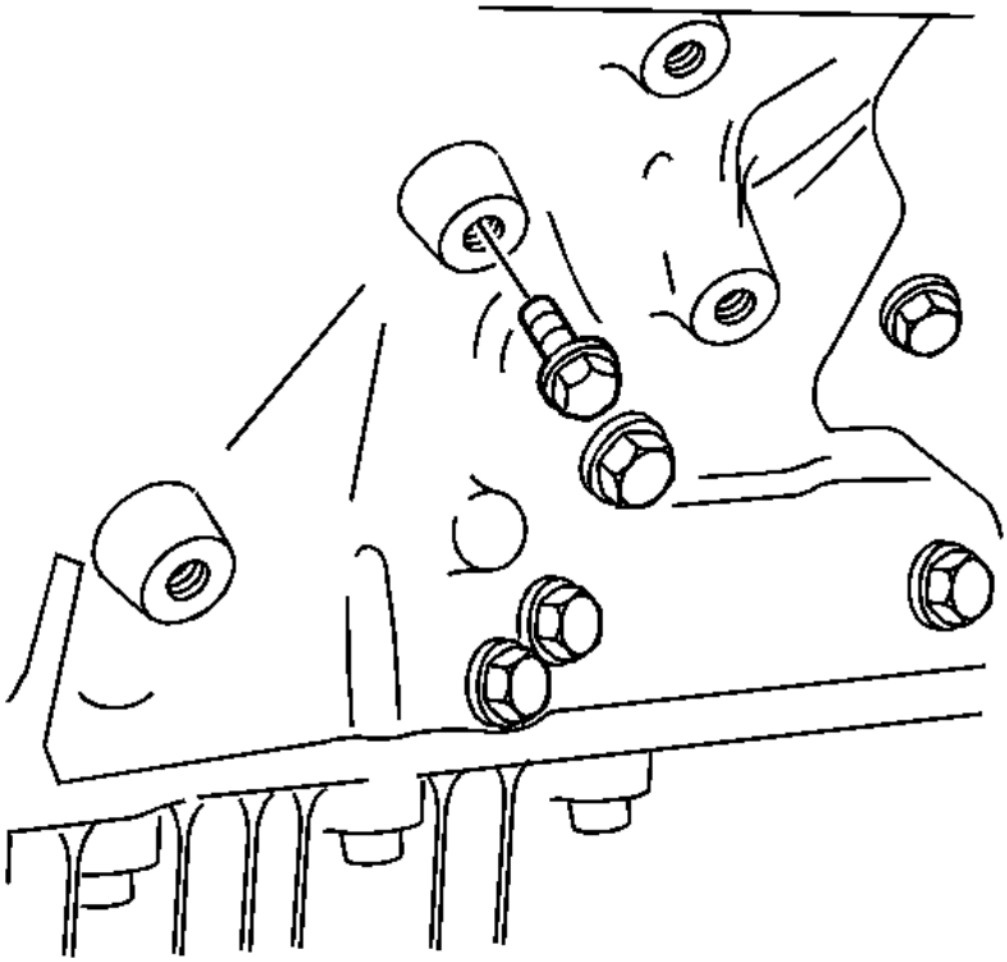


Fig. 408: View Of Engine Block Coolant Plugs
Courtesy of GENERAL MOTORS CORP.

5. Remove the engine block coolant plugs, and allow coolant to drain.

STARTER REMOVAL

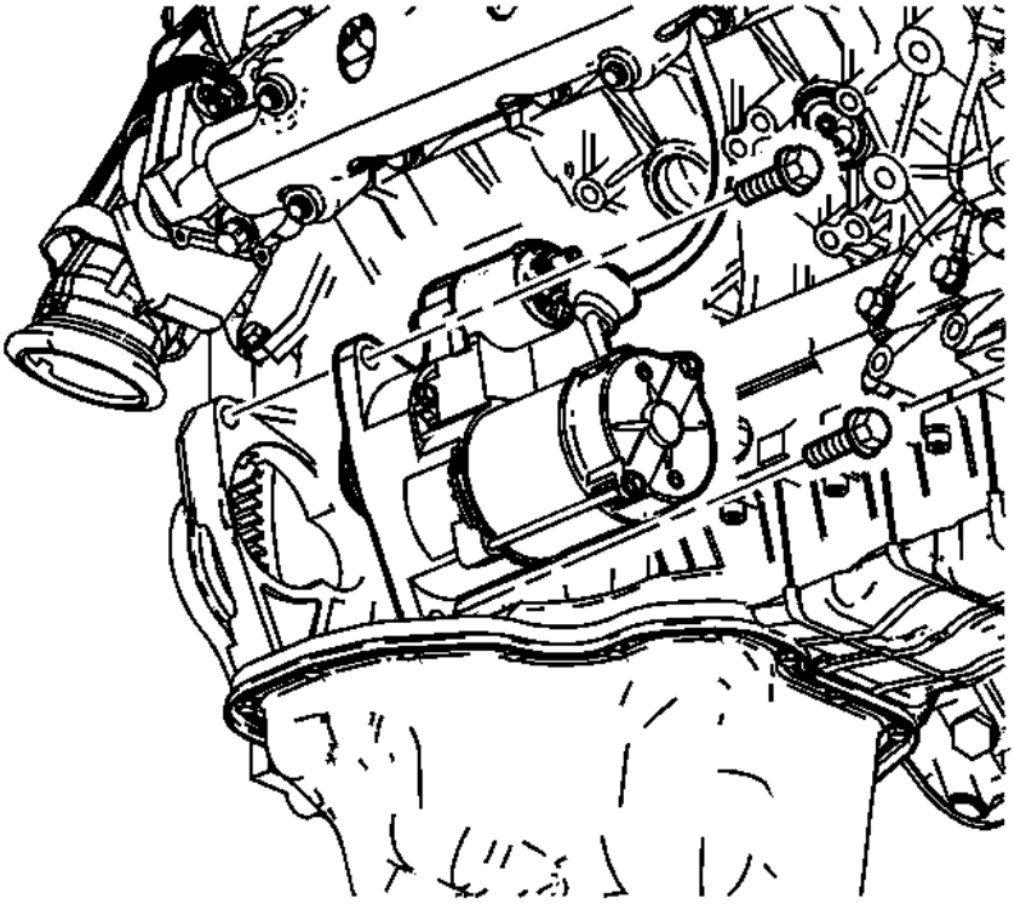


Fig. 409: View Of Starter
Courtesy of GENERAL MOTORS CORP.

1. Remove the starter motor bolts.
2. Remove the starter motor assembly.

CRANKSHAFT BALANCER REMOVAL

Tools Required

J 44643 Flywheel Hold Tool. See **Special Tools** .

Removal

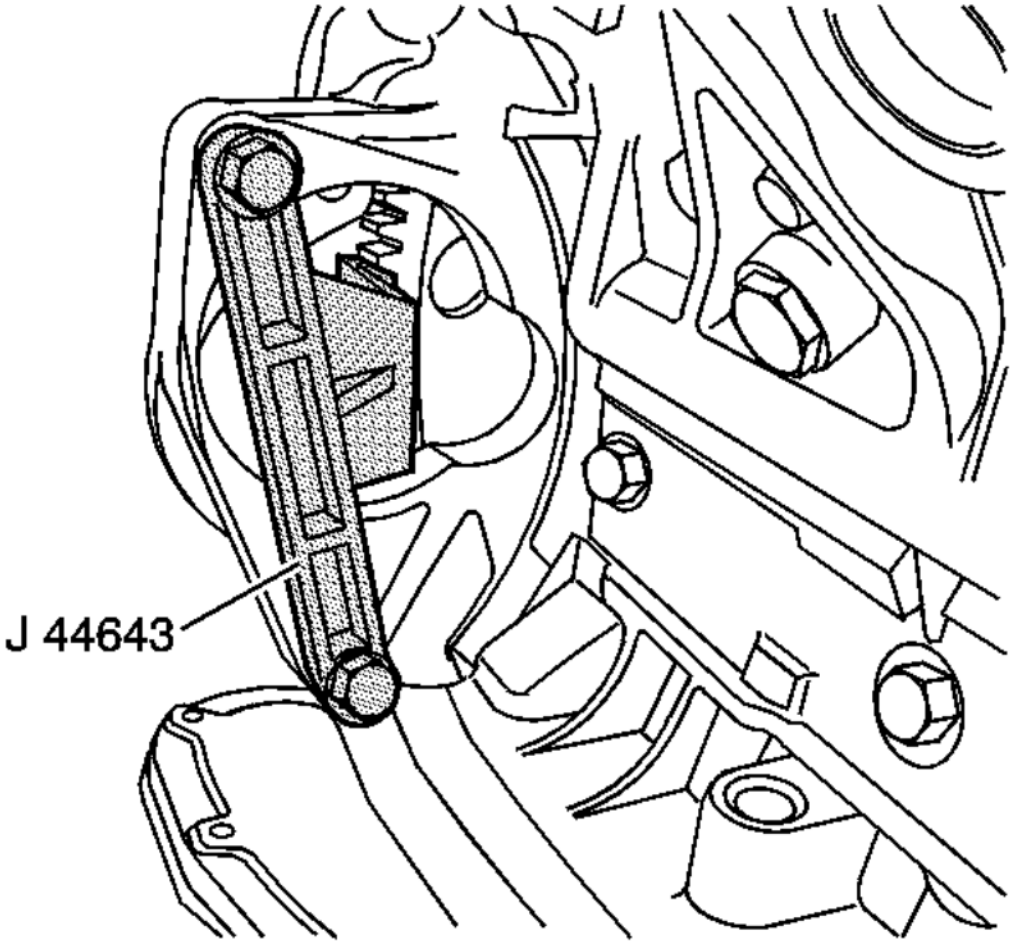


Fig. 410: Locking Flywheel Using J 44643
Courtesy of GENERAL MOTORS CORP.

1. Install **J 44643** to lock the flywheel. See **Special Tools** .

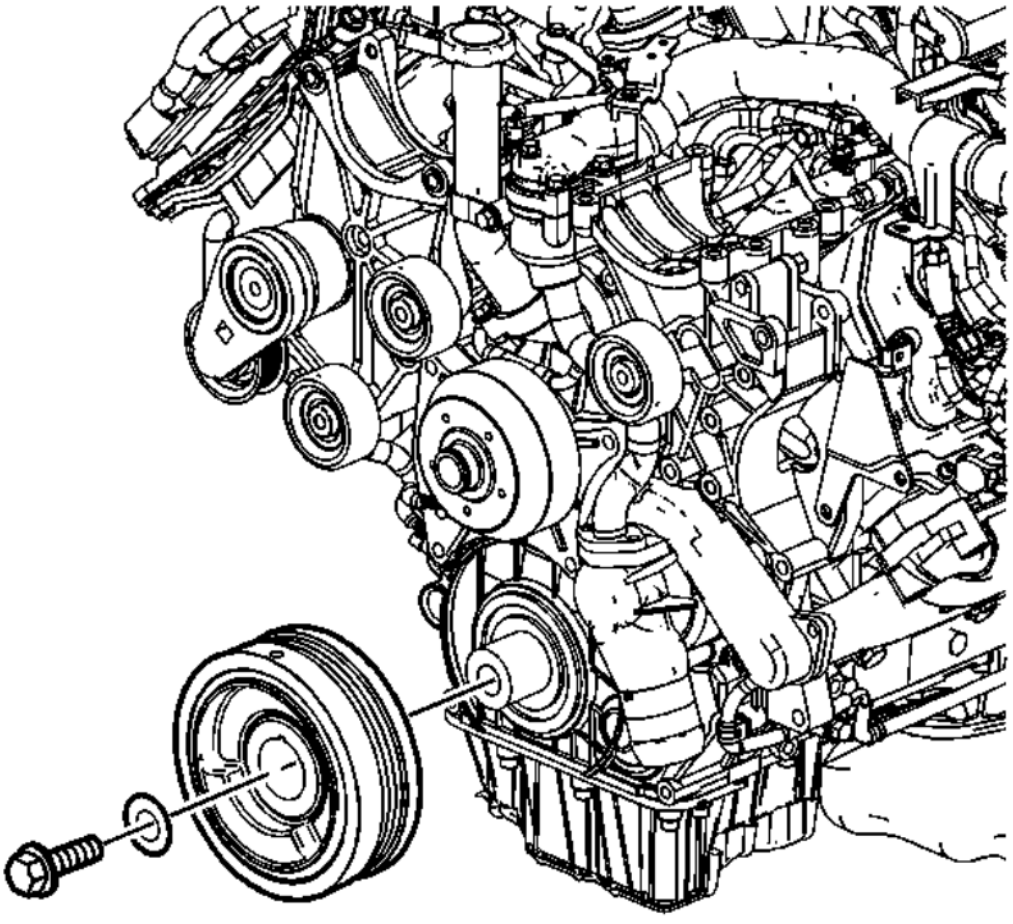


Fig. 411: View Of Crankshaft Balancer & Bolt
Courtesy of GENERAL MOTORS CORP.

2. Remove the crankshaft balancer bolt.
3. Remove the crankshaft balancer.

2008 ENGINE

Engine Mechanical - 6.6L - Cab & Chassis Sierra, Cab & Chassis Silverado, Sierra & Silverado

OFF-VEHICLE REPAIR INSTRUCTIONS (CONT.)

ENGINE FLYWHEEL REMOVAL (AUTOMATIC TRANSMISSION)

Tools Required

J 44643 Flywheel Hold Tool. See **Special Tools** .

Removal

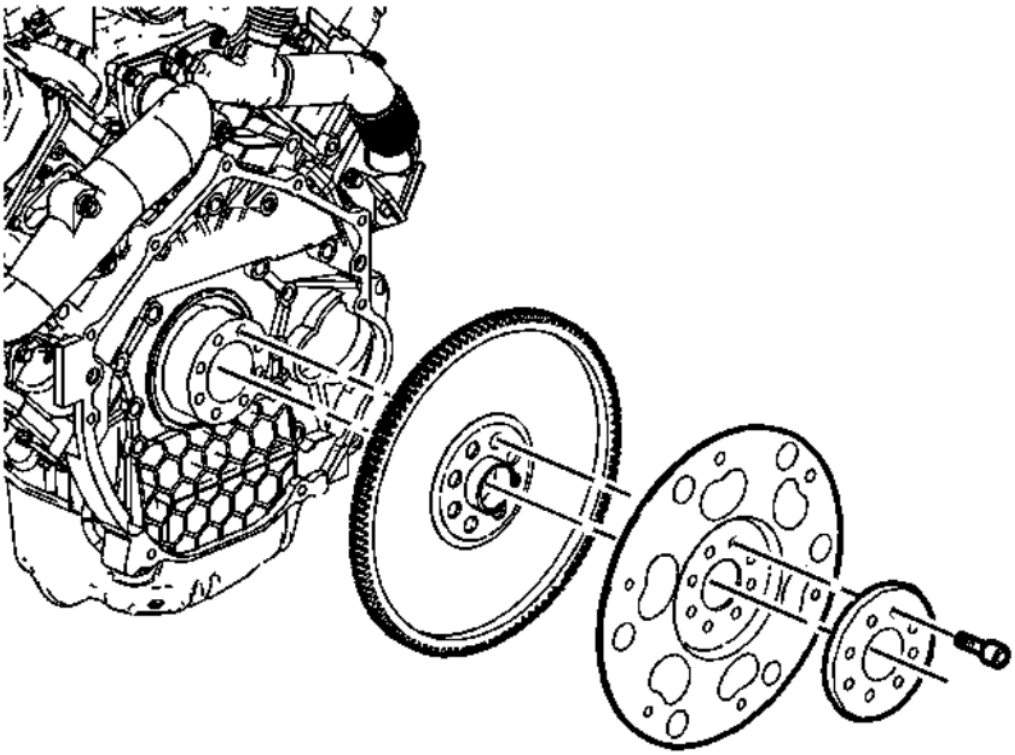


Fig. 1: View Of Flywheel & Washer (Automatic)
Courtesy of GENERAL MOTORS CORP.

1. Remove the flywheel mounting bolts and discard.

2. Remove the flywheel washer.
3. Remove the **J 44643** . See **Special Tools** .
4. Remove the flywheel assembly.

ENGINE FLYWHEEL REMOVAL (MANUAL TRANSMISSION)

Tools Required

J 44643 Flywheel Hold Tool. See **Special Tools** .

Removal

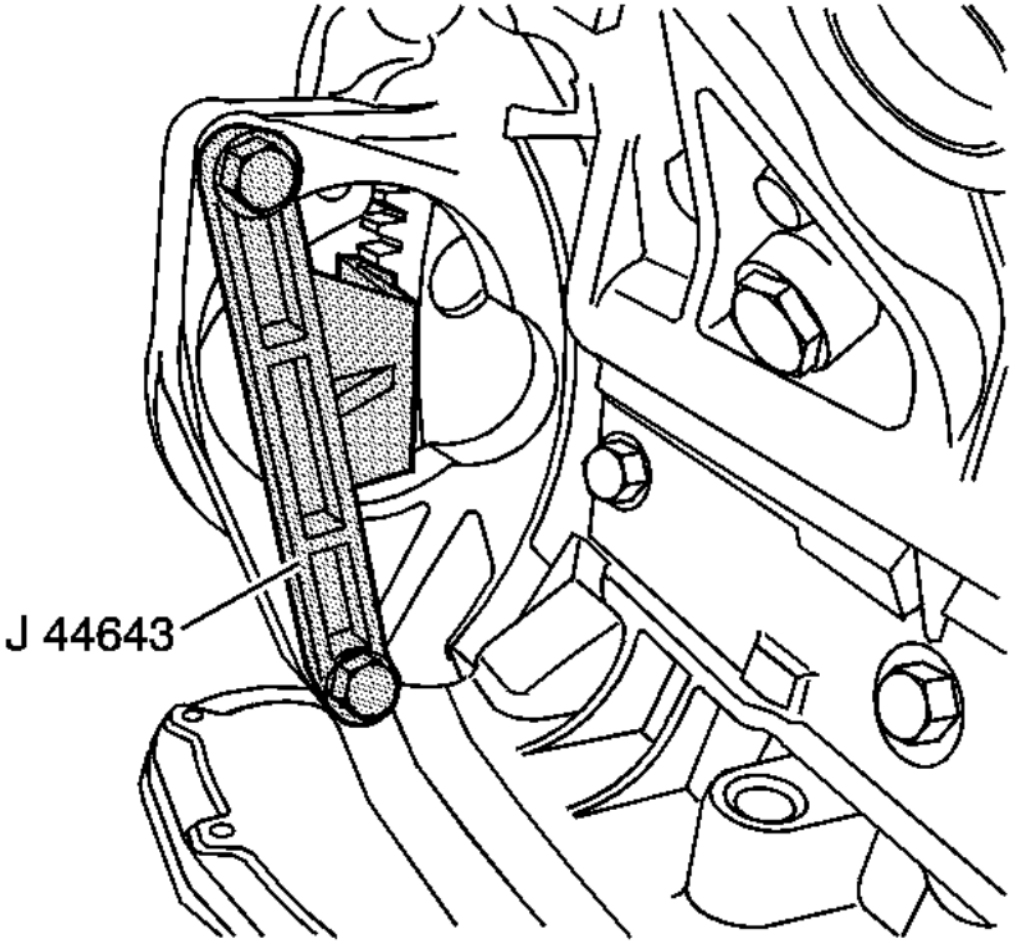


Fig. 2: Locking Flywheel Using J 44643
Courtesy of GENERAL MOTORS CORP.

1. Install the **J 44643** to the starter opening in order to hold the flywheel. See **Special Tools** .

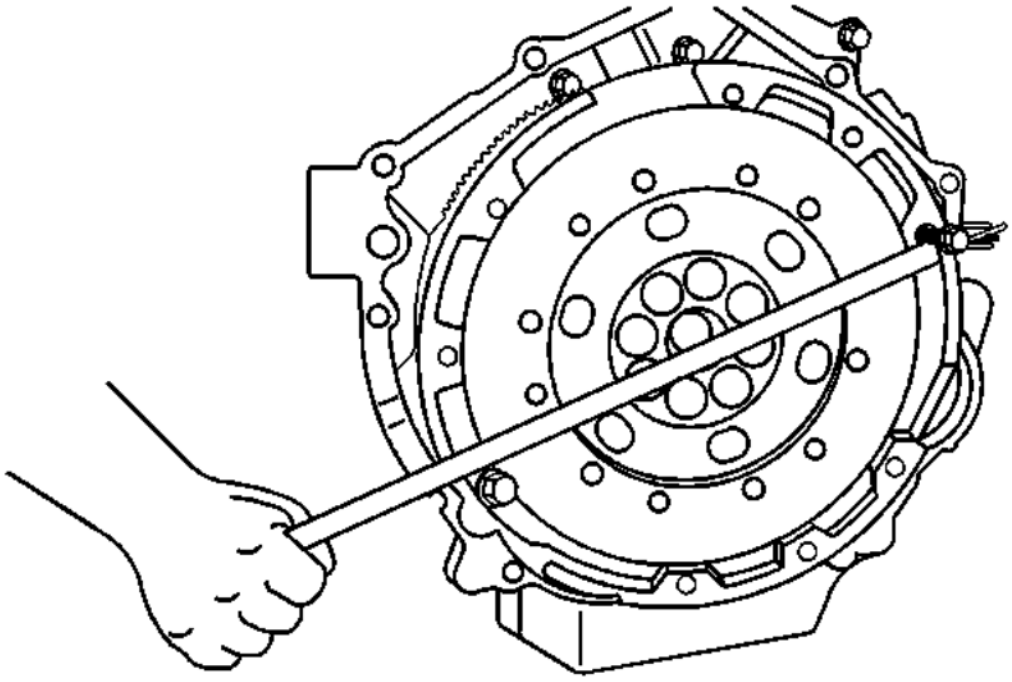


Fig. 3: Accessing Flywheel To Crankshaft Bolts
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not use the clutch pressure plate bolts. Use a bolt of the correct thread and a length that protrudes enough to use a pry bar.

2. Install two bolts into the clutch pressure plate mounting holes 180 degrees apart.
3. Using a long pry bar, turn the secondary ring of the dual mass flywheel clockwise until the flywheel mounting bolts can be accessed. It may require to turn the secondary ring past the bolt holes in order to compensate the spring tension.

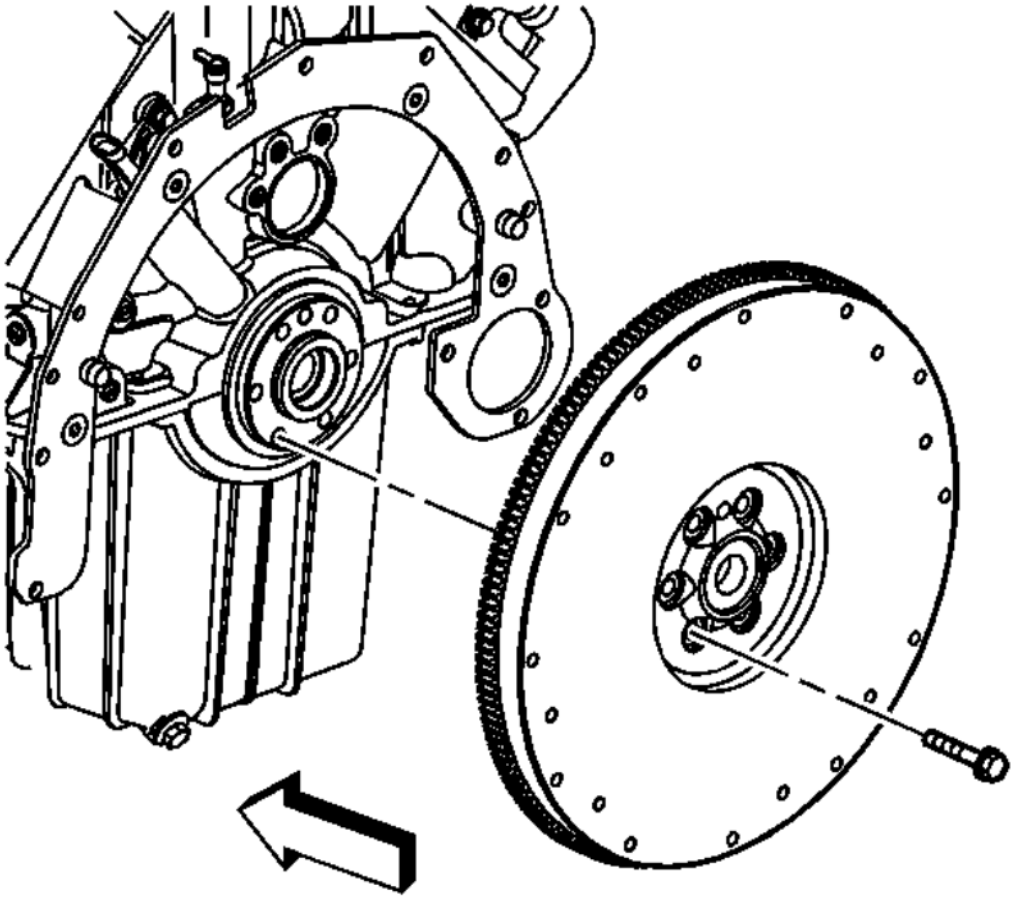


Fig. 4: View Of Flywheel & Mounting Bolts (Manual)
Courtesy of GENERAL MOTORS CORP.

4. Remove the flywheel mounting bolts and discard.
5. Remove the **J 44643** . See **Special Tools** .

CAUTION: When removing, handling or installing this component wear protective gloves. The sharp edges on the component may be very sharp and may cause injury.

6. Remove the flywheel.

CRANKSHAFT REAR OIL SEAL REMOVAL

Tools Required

J 44641 Crankshaft Rear Oil Seal Remover. See **Special Tools** .

Removal

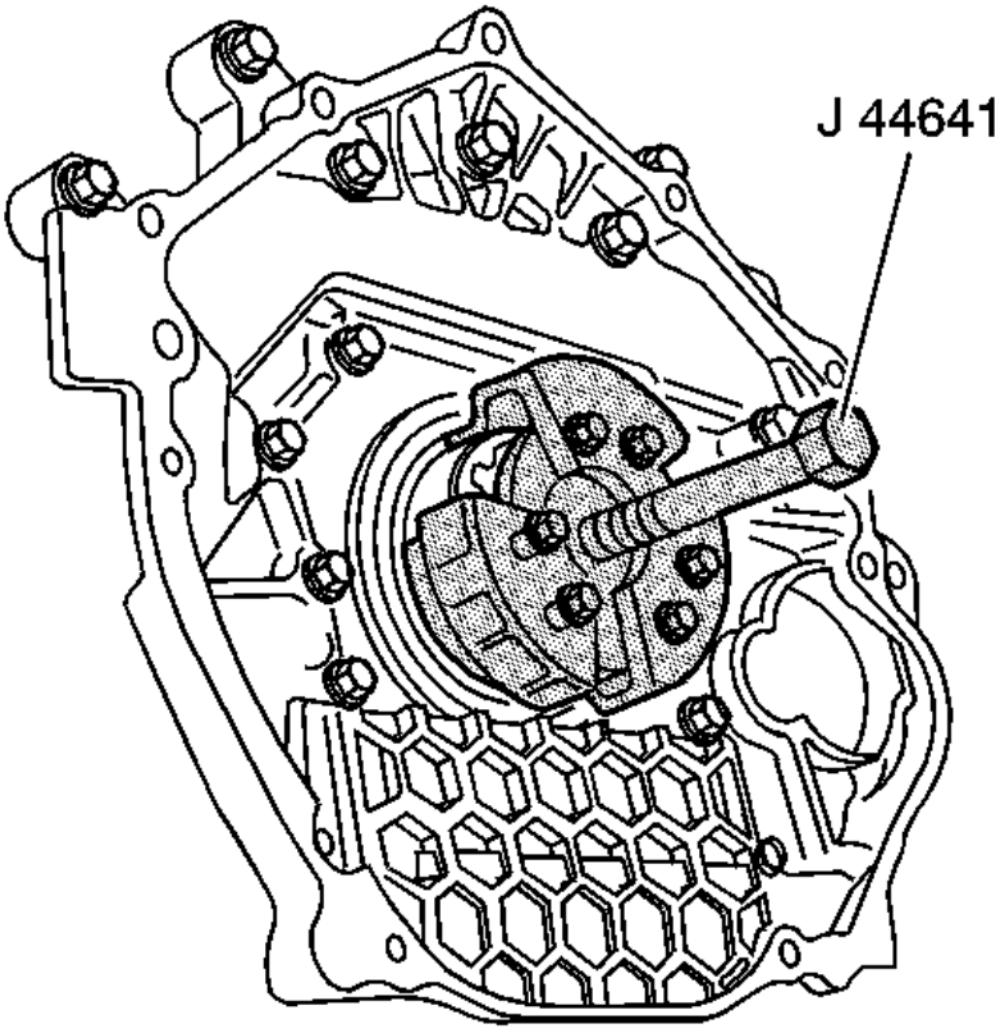


Fig. 5: Removing Crankshaft Rear Oil Seal Using J 44641
Courtesy of GENERAL MOTORS CORP.

1. Install the **J 44641** to the crankshaft rear oil seal. See **Special Tools** .

2. Remove the crankshaft rear oil seal using **J 44641** . See **Special Tools** .

EXHAUST OUTLET REMOVAL

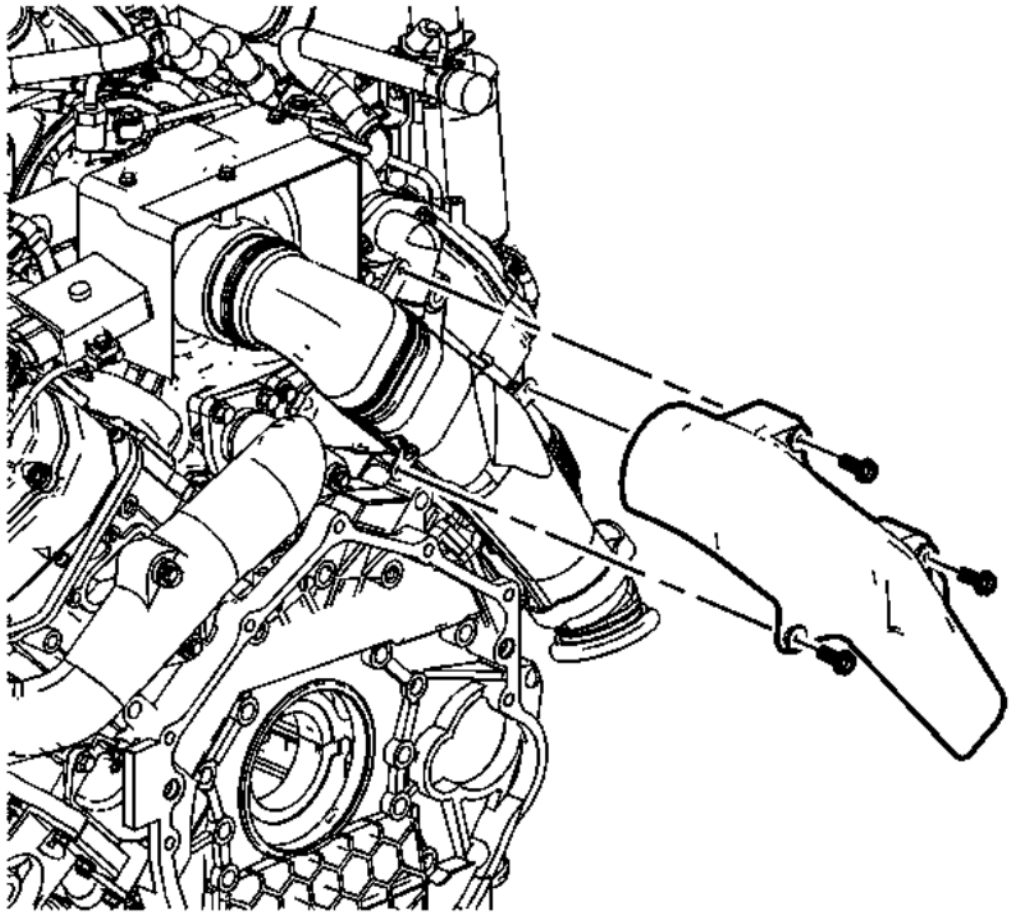


Fig. 6: View Of Exhaust Outlet Shield
Courtesy of GENERAL MOTORS CORP.

1. Remove the exhaust outlet heat shield bolts.
2. Remove the exhaust outlet heat shield.
3. Remove the exhaust outlet to right exhaust pipe bracket bolt.

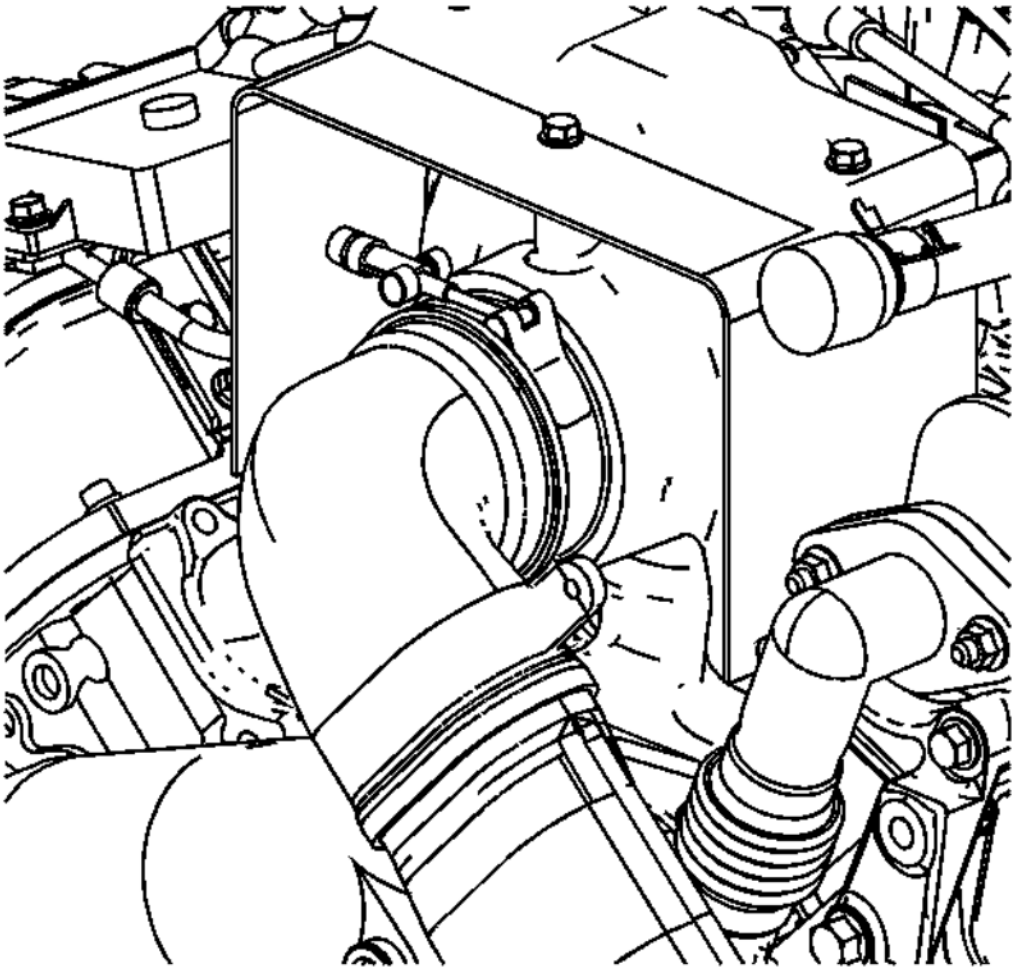


Fig. 7: View Of Exhaust Outlet Clamp
Courtesy of GENERAL MOTORS CORP.

4. Loosen the exhaust outlet holding clamp.

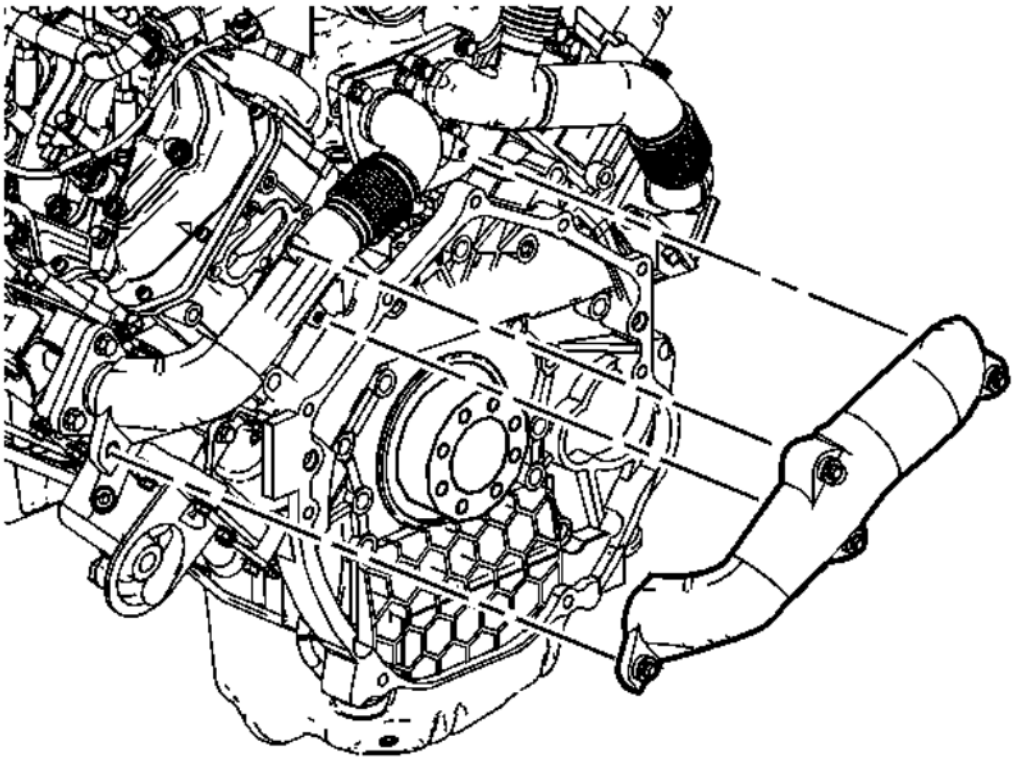


Fig. 8: View Of Exhaust Outlet
Courtesy of GENERAL MOTORS CORP.

5. Remove the exhaust outlet.

EXHAUST PIPE REMOVAL - LEFT SIDE

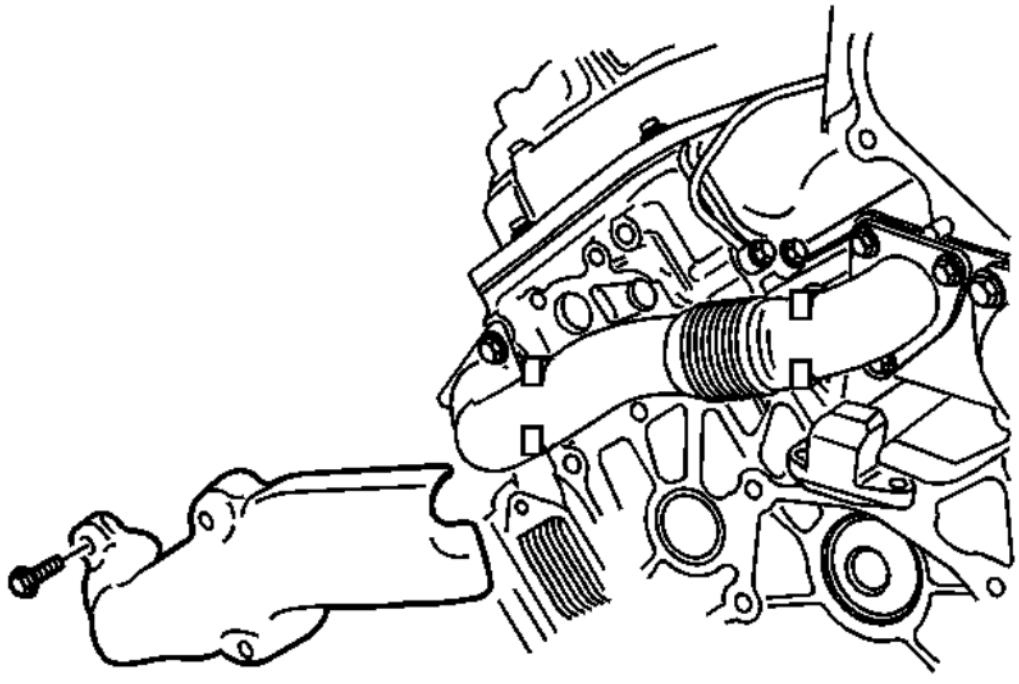


Fig. 9: View Of Left Exhaust Pipe Heat Shield & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the left exhaust pipe heat shield bolts.
2. Remove the left exhaust pipe heat shield.

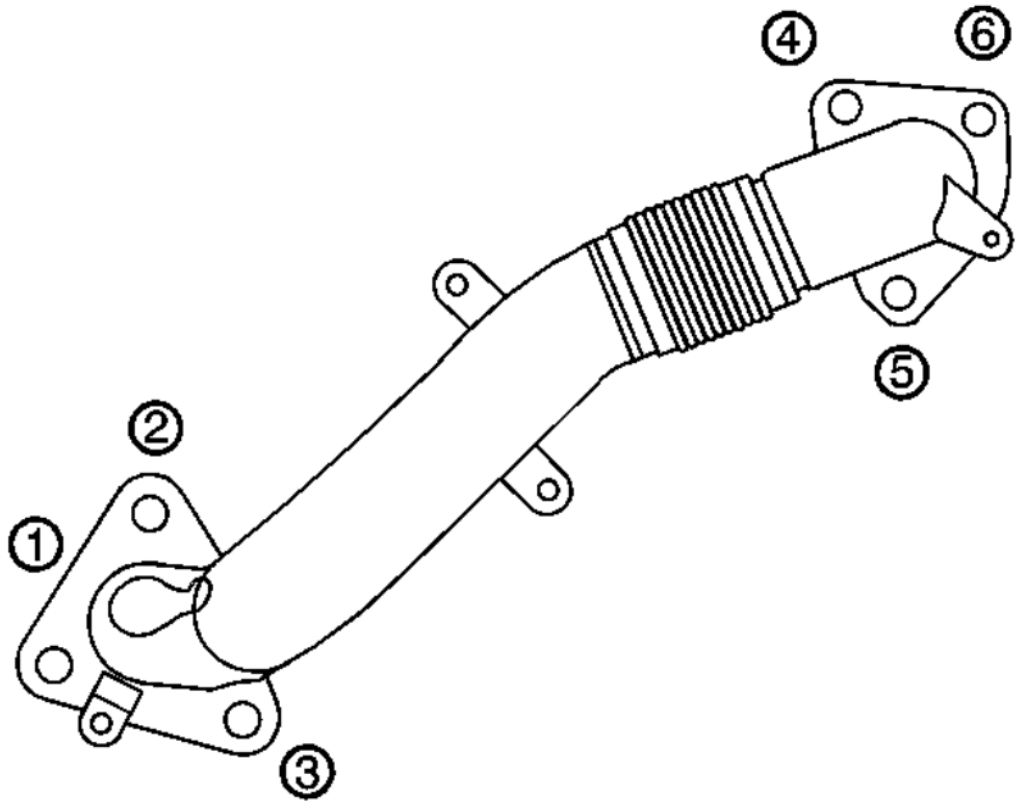


Fig. 10: Left Exhaust Pipe Bolts Removal Sequence
Courtesy of GENERAL MOTORS CORP.

3. Remove the exhaust pipe bolts in the proper sequence.

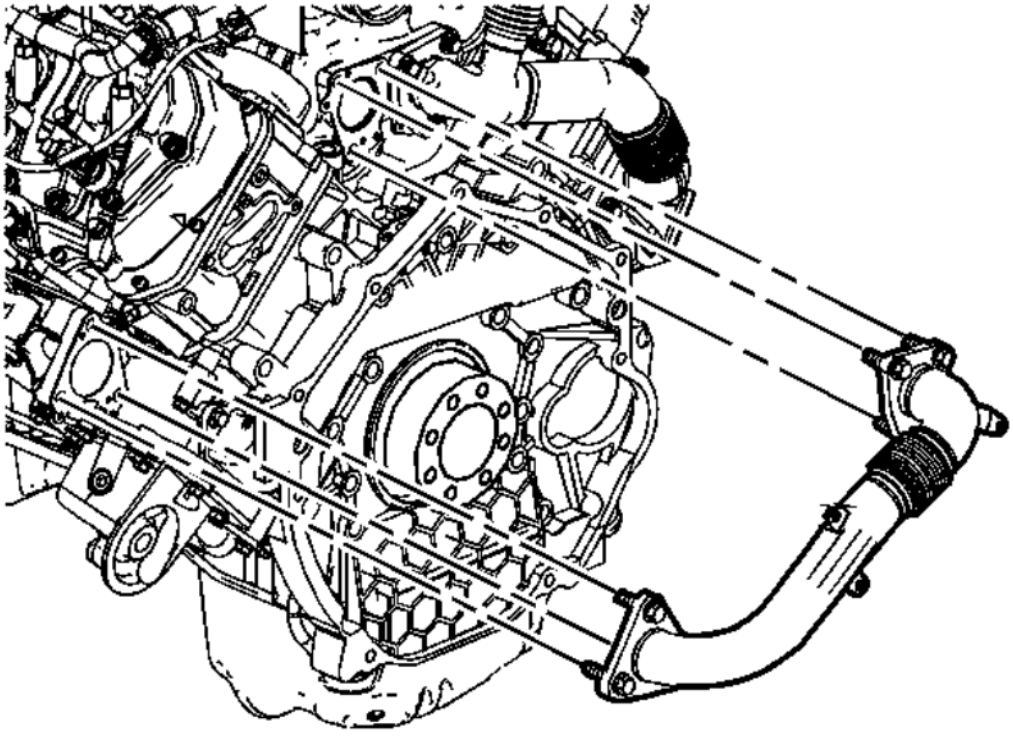


Fig. 11: View Of Left Exhaust Pipe
Courtesy of GENERAL MOTORS CORP.

4. Remove the exhaust pipe and gaskets.

EXHAUST PIPE REMOVAL - RIGHT SIDE

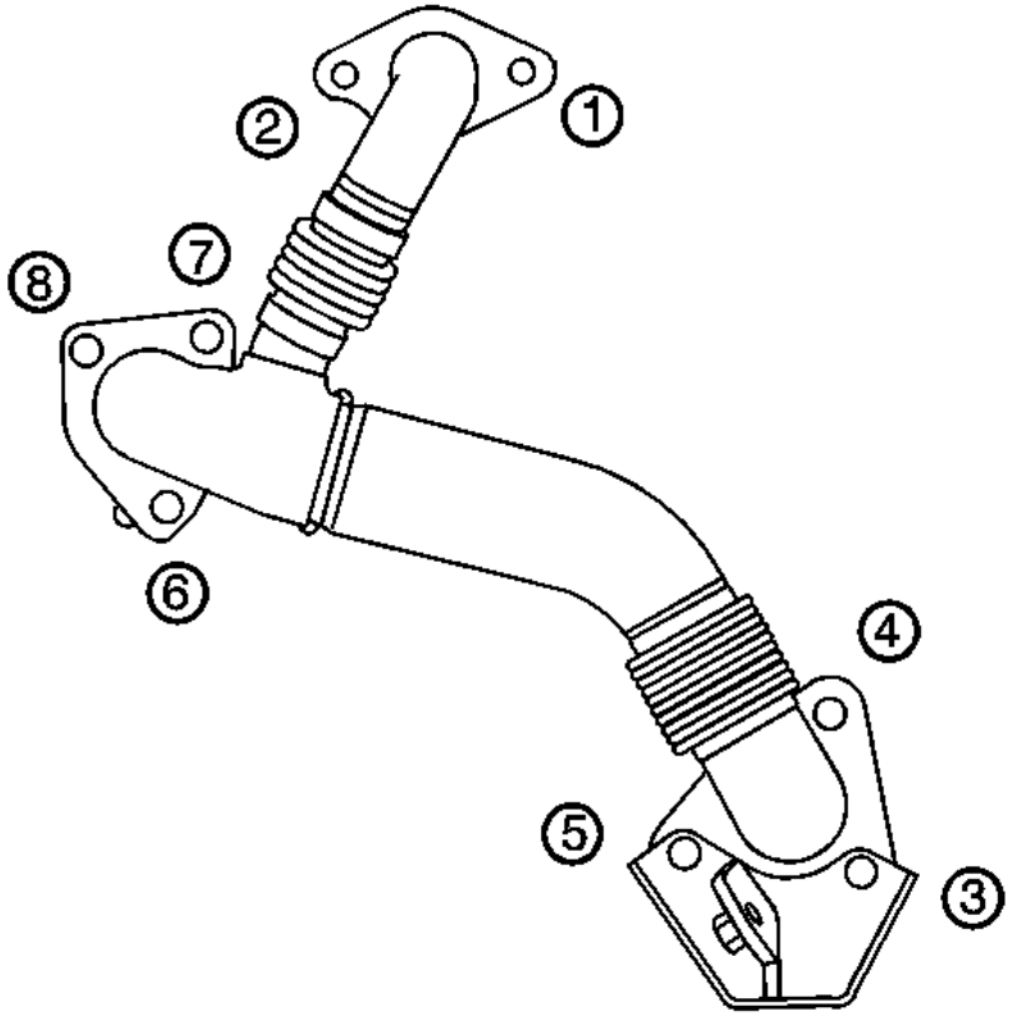


Fig. 12: Exhaust Pipe Bolts Removal Sequence
Courtesy of GENERAL MOTORS CORP.

1. Remove the exhaust pipe bolts in the proper sequence.

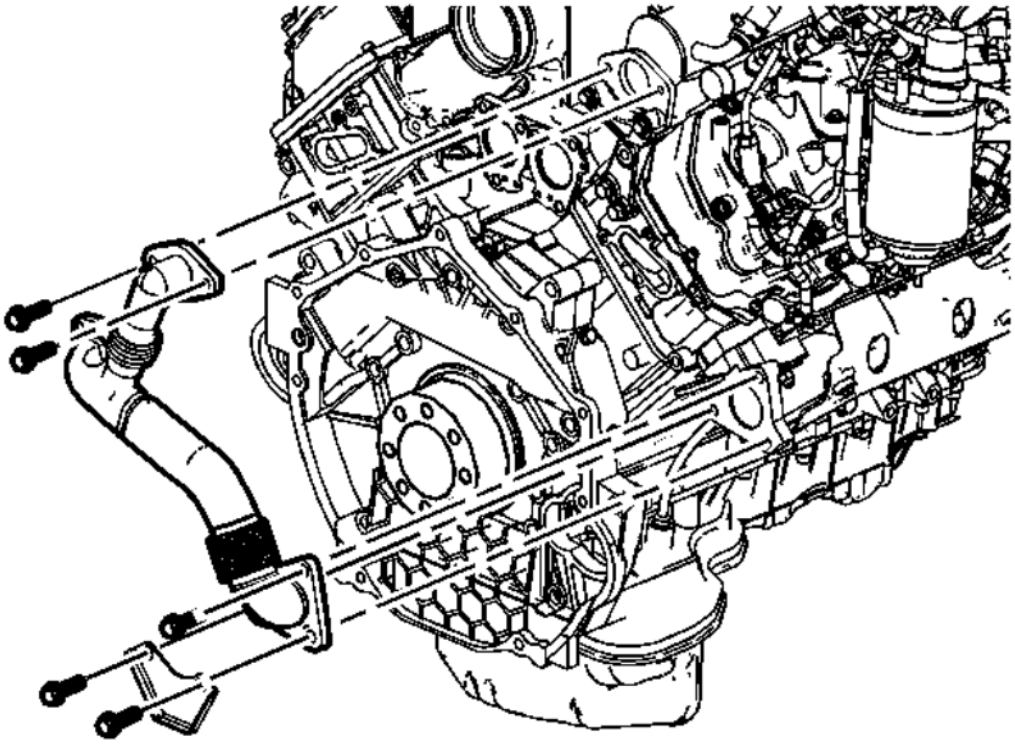


Fig. 13: View Of Right Exhaust Pipe
Courtesy of GENERAL MOTORS CORP.

2. Remove the exhaust pipe, exhaust outlet bracket and gaskets.

LOWER OIL PAN REMOVAL

Tools Required

J 37228 Seal Cutter. See **Special Tools** .

Removal

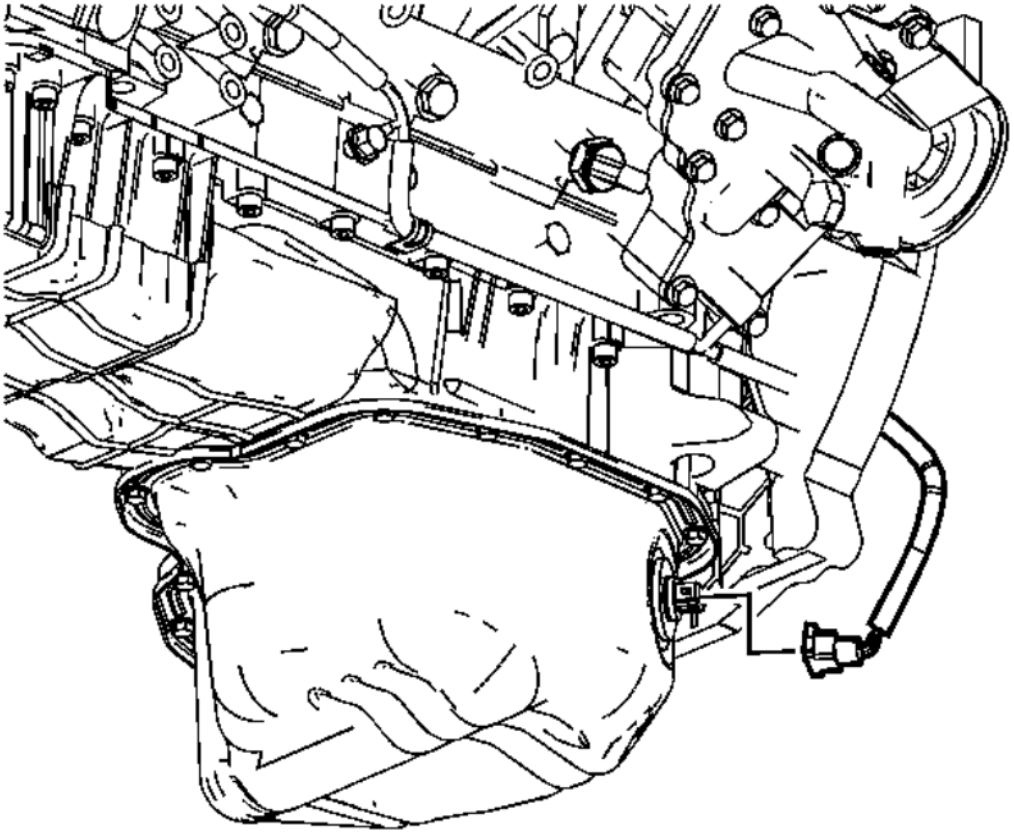


Fig. 14: View Of Oil Level Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the oil level sensor.

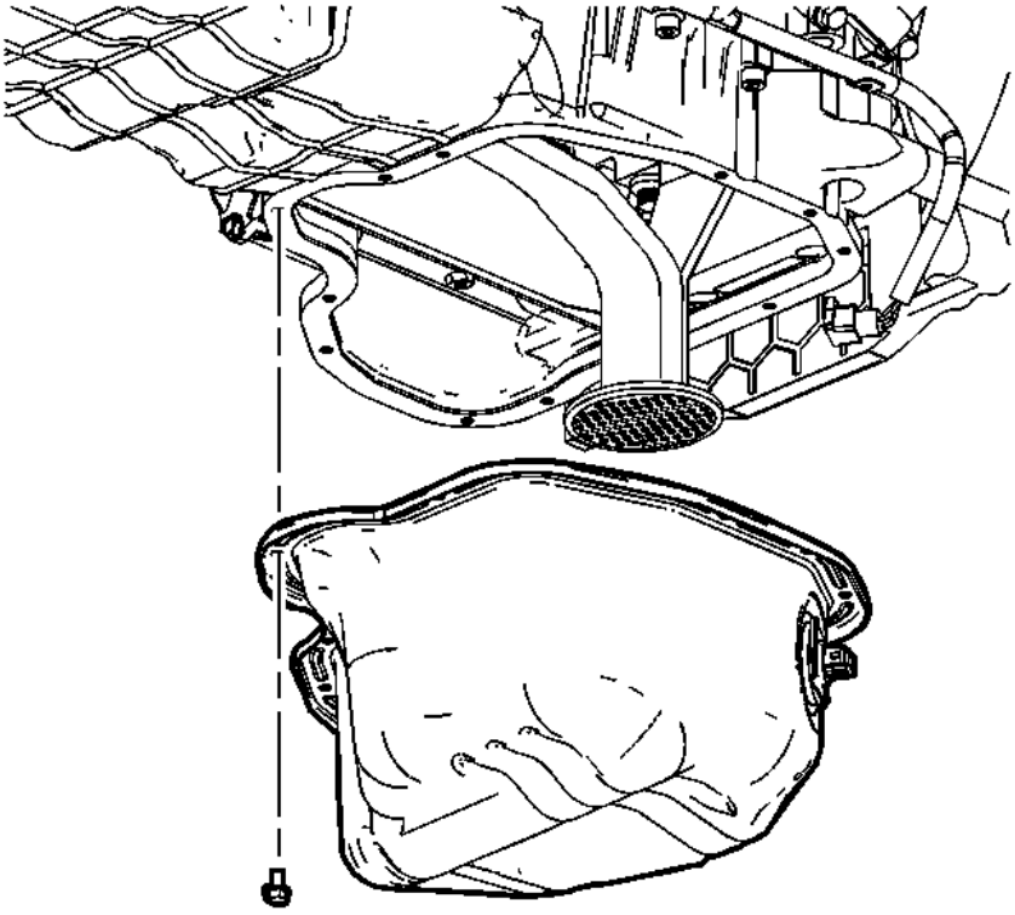


Fig. 15: View Of Lower Oil Pan & Bolts/Nuts
Courtesy of GENERAL MOTORS CORP.

2. Remove the lower oil pan bolts.

IMPORTANT: Do not damage the sealing surfaces when separating the lower oil pan from the upper oil pan.

3. Separate the lower oil pan from the upper oil pan using **J 37228** . See **Special Tools** .
4. Remove the lower oil pan.

UPPER OIL PAN REMOVAL

Tools Required

J 37228 Seal Cutter. See **Special Tools** .

Removal

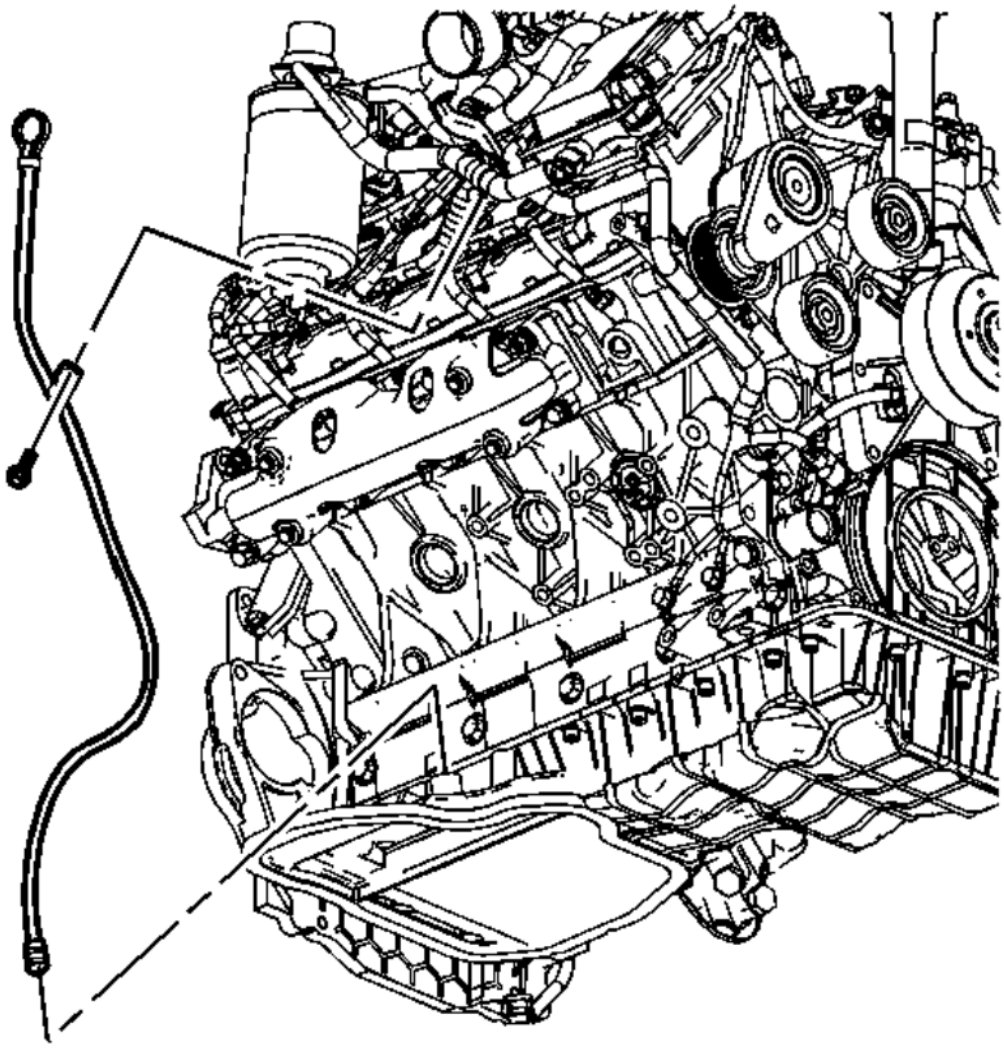


Fig. 16: View Of Oil Level Indicator
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil level indicator tube bracket bolt.

2. Remove the oil level indicator tube.

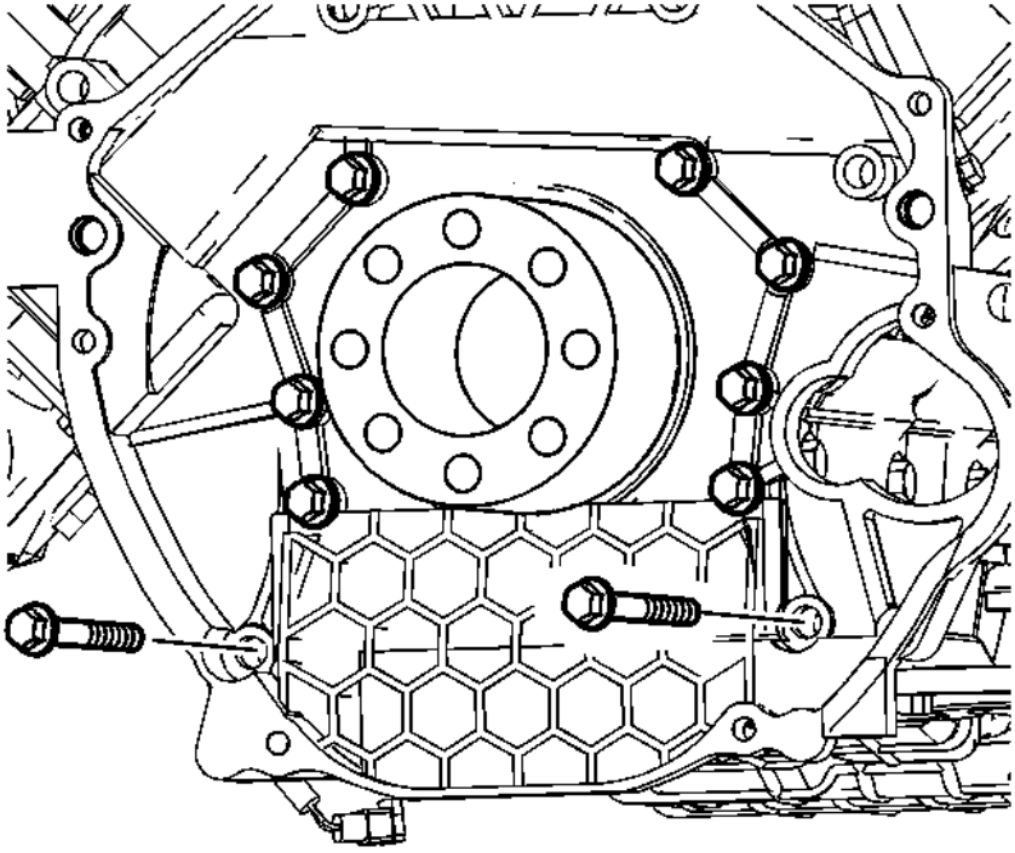


Fig. 17: View Of Flywheel Housing To Upper Oil Pan Bolts
Courtesy of GENERAL MOTORS CORP.

3. Remove the two oil pan to flywheel housing bolts.

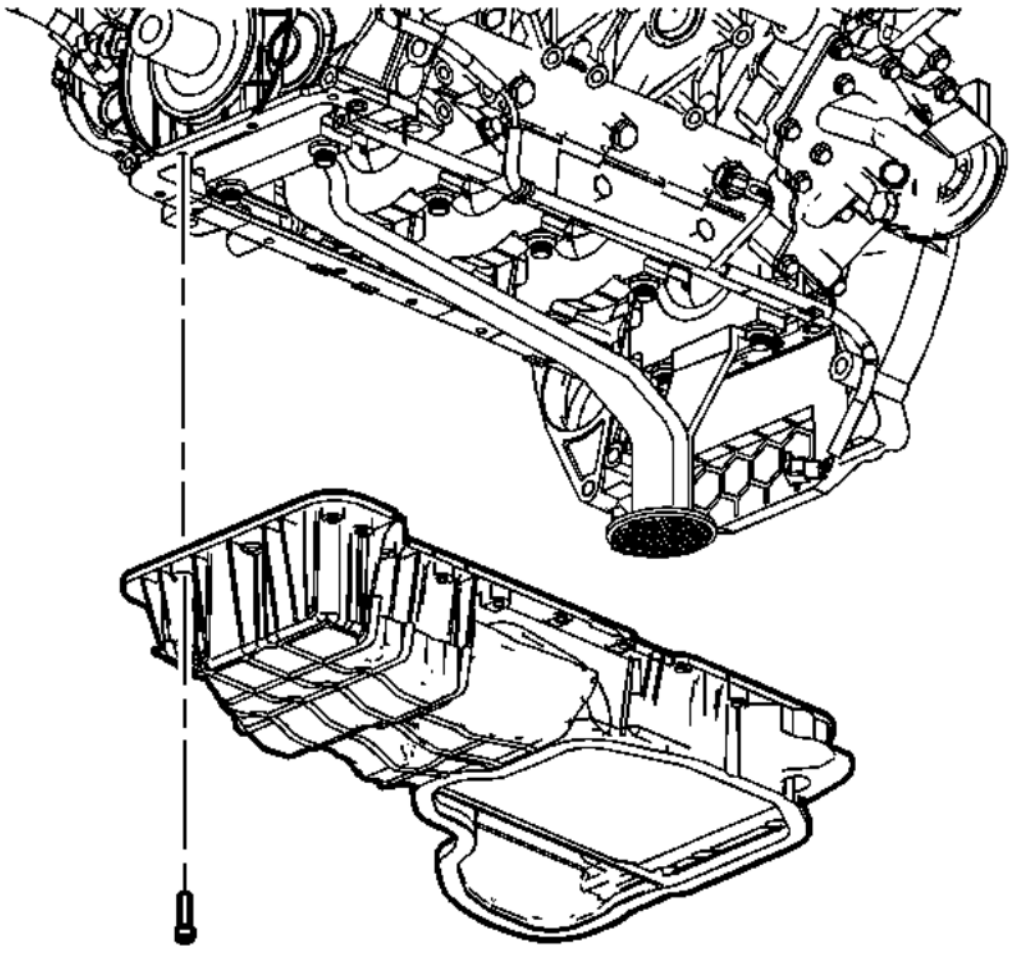


Fig. 18: View Of Upper Oil Pan
Courtesy of GENERAL MOTORS CORP.

4. Remove the 24 upper oil pan bolts using a long bit 6 mm hex driver.
5. Seperate the upper oil pan from the engine block using **J 37228** . See **Special Tools** .
6. Remove the upper oil pan.

ENGINE FLYWHEEL HOUSING REMOVAL

Tools Required

J 37228 Seal Cutter. See **Special Tools** .

Removal

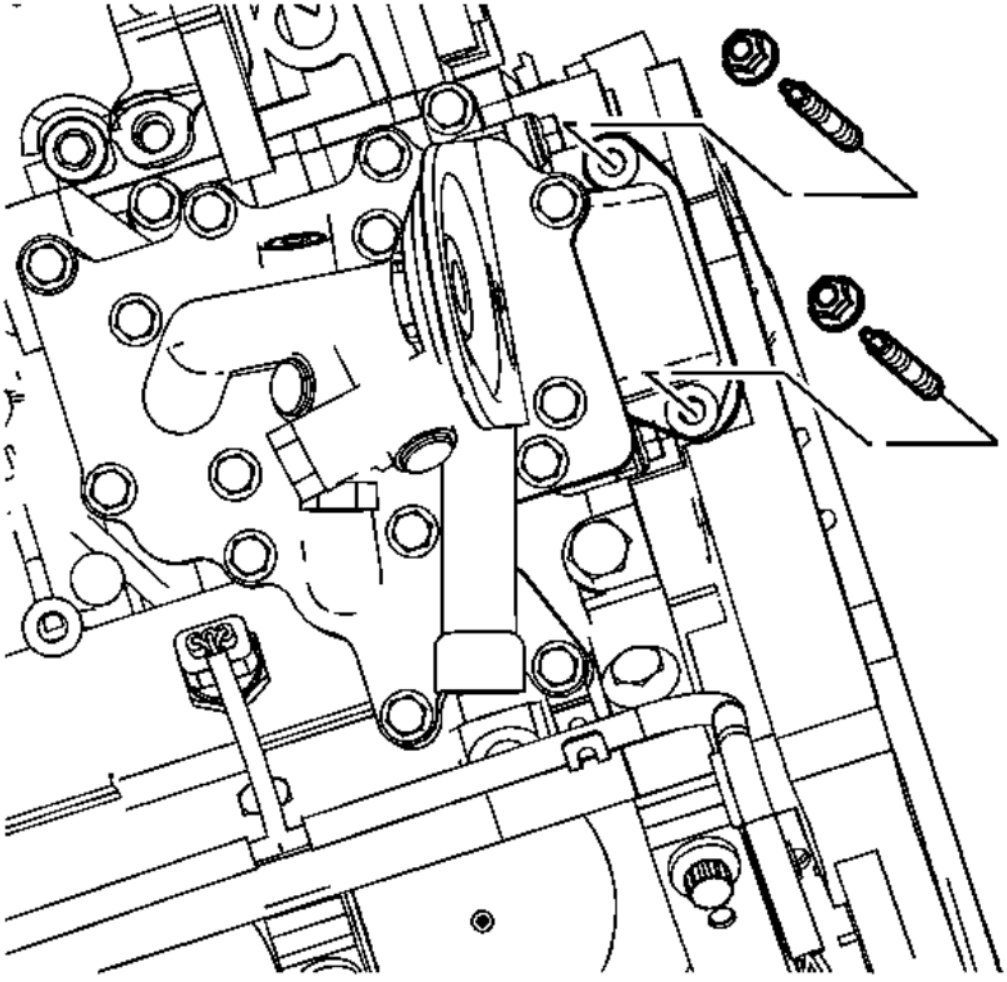


Fig. 19: View Of Turbocharger Oil Return Pipe Nuts
Courtesy of GENERAL MOTORS CORP.

1. Remove the turbocharger oil return pipe nuts from the top of the flywheel housing.
2. Remove the turbocharger oil return pipe studs.

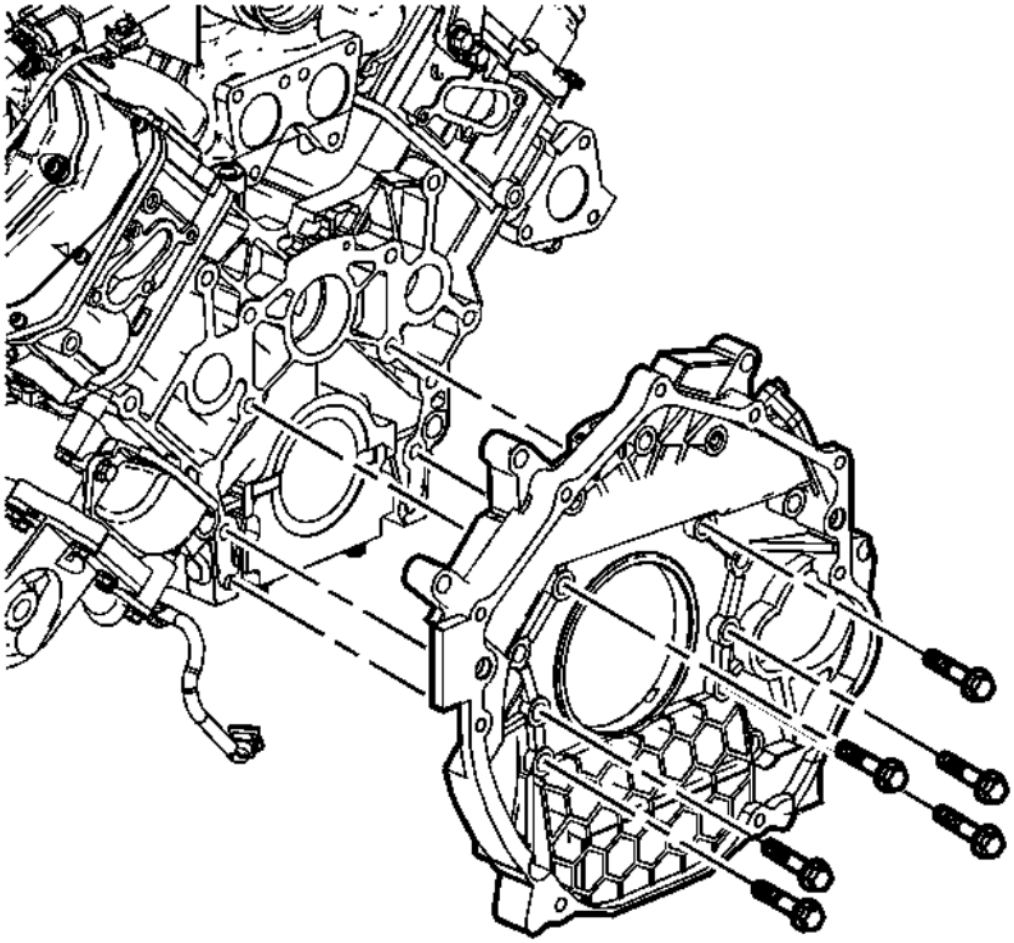


Fig. 20: View Of Flywheel Housing
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The upper oil pan must be removed before removing the flywheel housing.

3. Remove the flywheel housing bolts.
4. Separate the flywheel housing from the cylinder block using **J 37228** . See **Special Tools** .
5. Remove the flywheel housing.

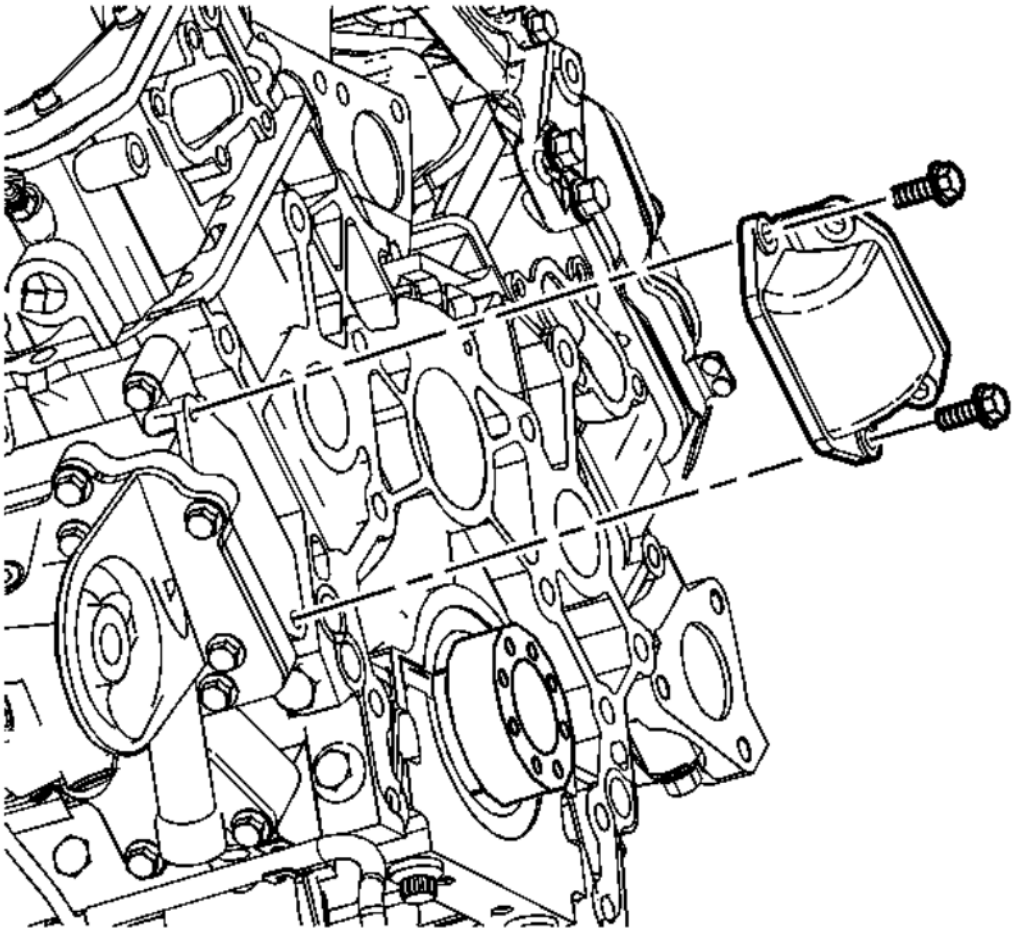


Fig. 21: View Of Oil Cooler Adapter
Courtesy of GENERAL MOTORS CORP.

6. Remove the turbocharger oil return pipe gasket from the flywheel housing.
7. Remove the oil cooler adapter bolts.
8. Remove the oil cooler adapter with gaskets.

ENGINE MOUNTING TO STAND

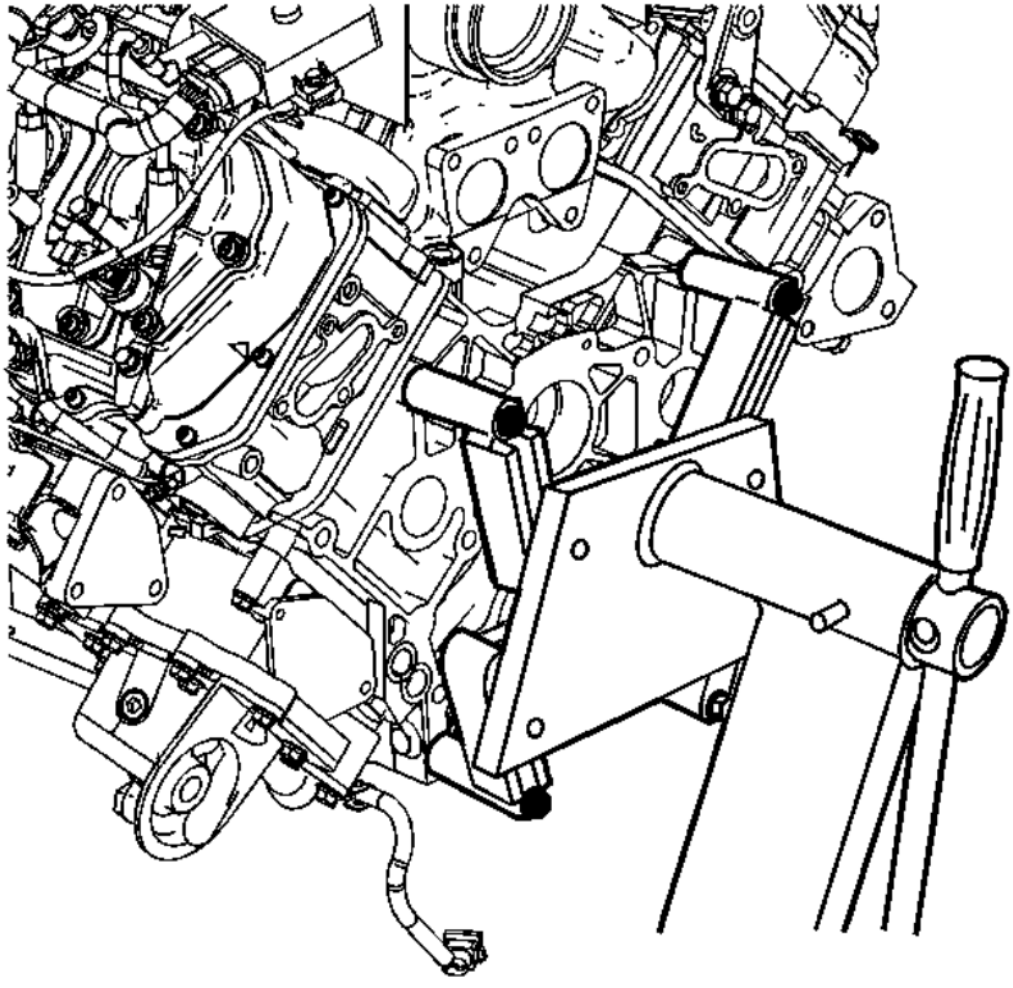


Fig. 22: Mounting Engine Block To Suitable Engine Stand
Courtesy of GENERAL MOTORS CORP.

CAUTION: Do not mount the engine to a engine stand by the flywheel housing. The aluminum flywheel housing is not designed to support the weight of the engine when mounted to a typical rear-mount engine stand. Mounting the engine stand to the aluminum flywheel housing may result in engine damage and serious personal injury.

After the flywheel housing has been removed, mount the engine block to a suitable engine stand.

COOLING FAN PULLEY REMOVAL

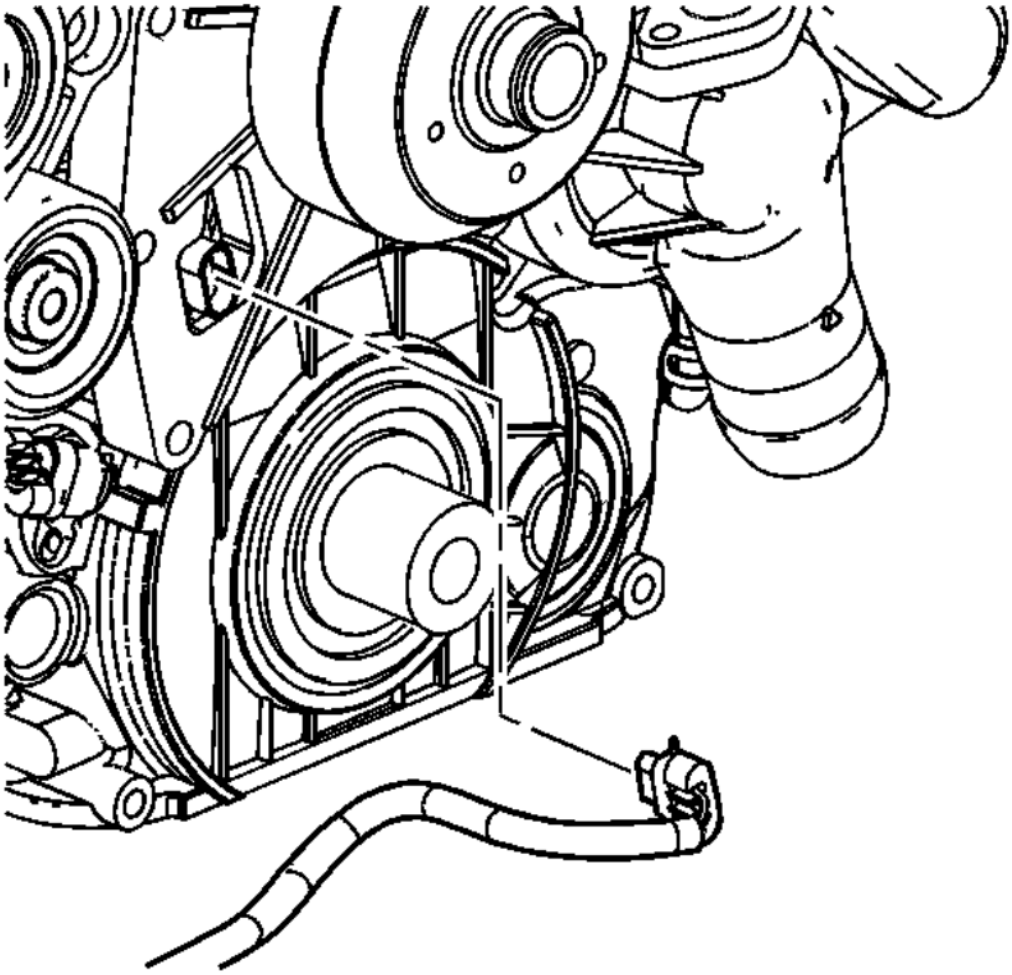


Fig. 23: View Of Camshaft Position Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the camshaft position sensor connector.

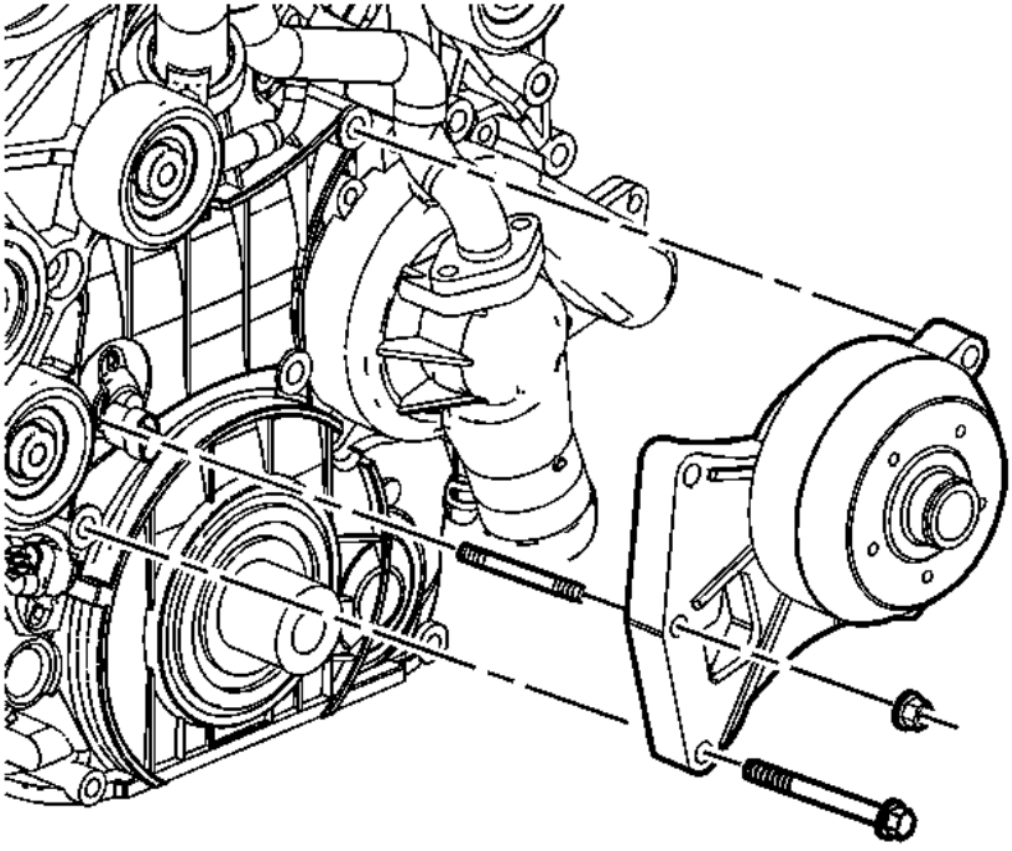


Fig. 24: View Of Cooling Fan Pulley
Courtesy of GENERAL MOTORS CORP.

2. Remove the cooling fan pulley bolts and nuts.
3. Remove the cooling fan pulley.

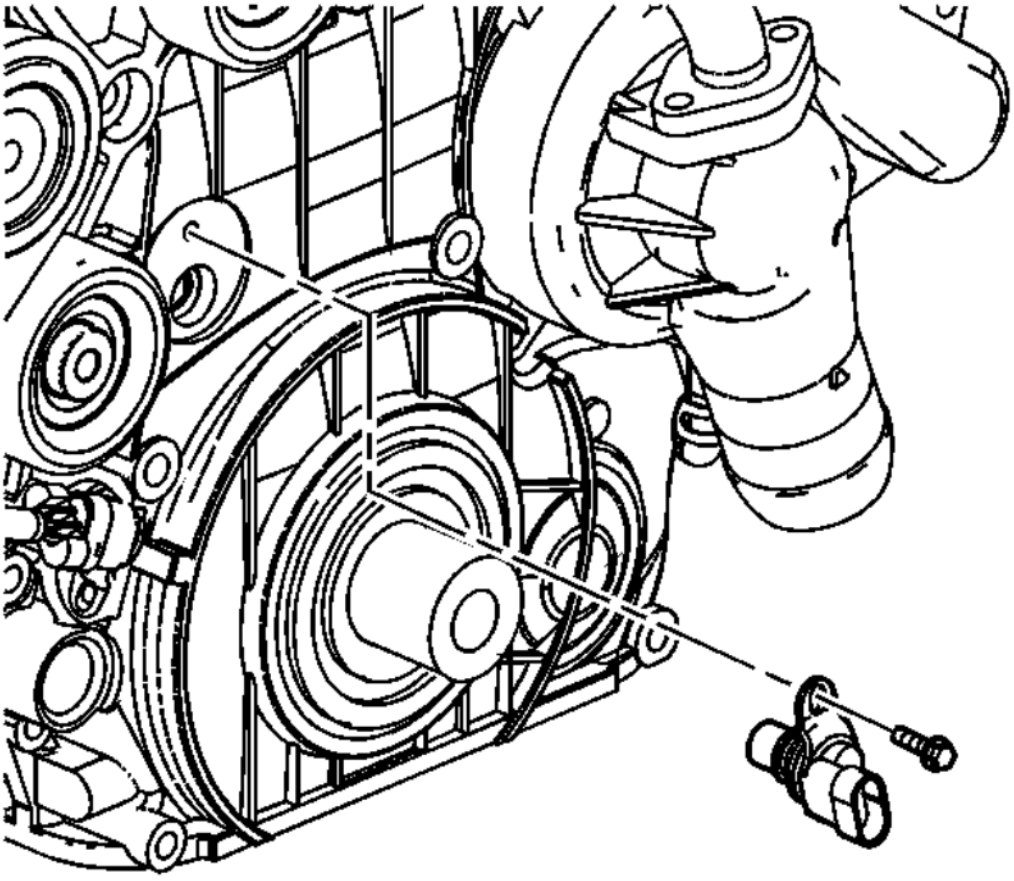


Fig. 25: View Of Camshaft Position Sensor
Courtesy of GENERAL MOTORS CORP.

4. Remove the camshaft position sensor retaining bolt.
5. Remove the camshaft position sensor.

POWER STEERING PUMP MOUNTING BRACKET REMOVAL

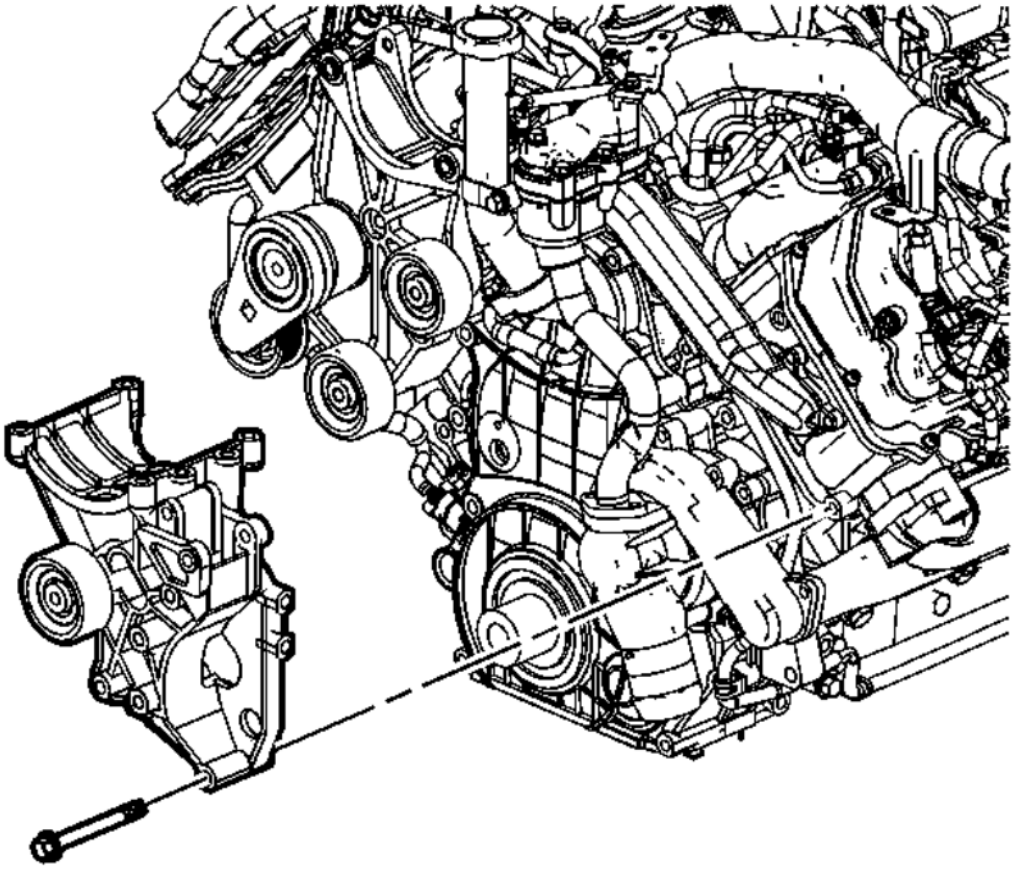


Fig. 26: View Of A/C Compressor & Power Steering Pump Bracket
Courtesy of GENERAL MOTORS CORP.

1. Remove the power steering pump mounting bracket bolts.
2. Remove the power steering pump mounting bracket.

FUEL FILTER ASSEMBLY REMOVAL

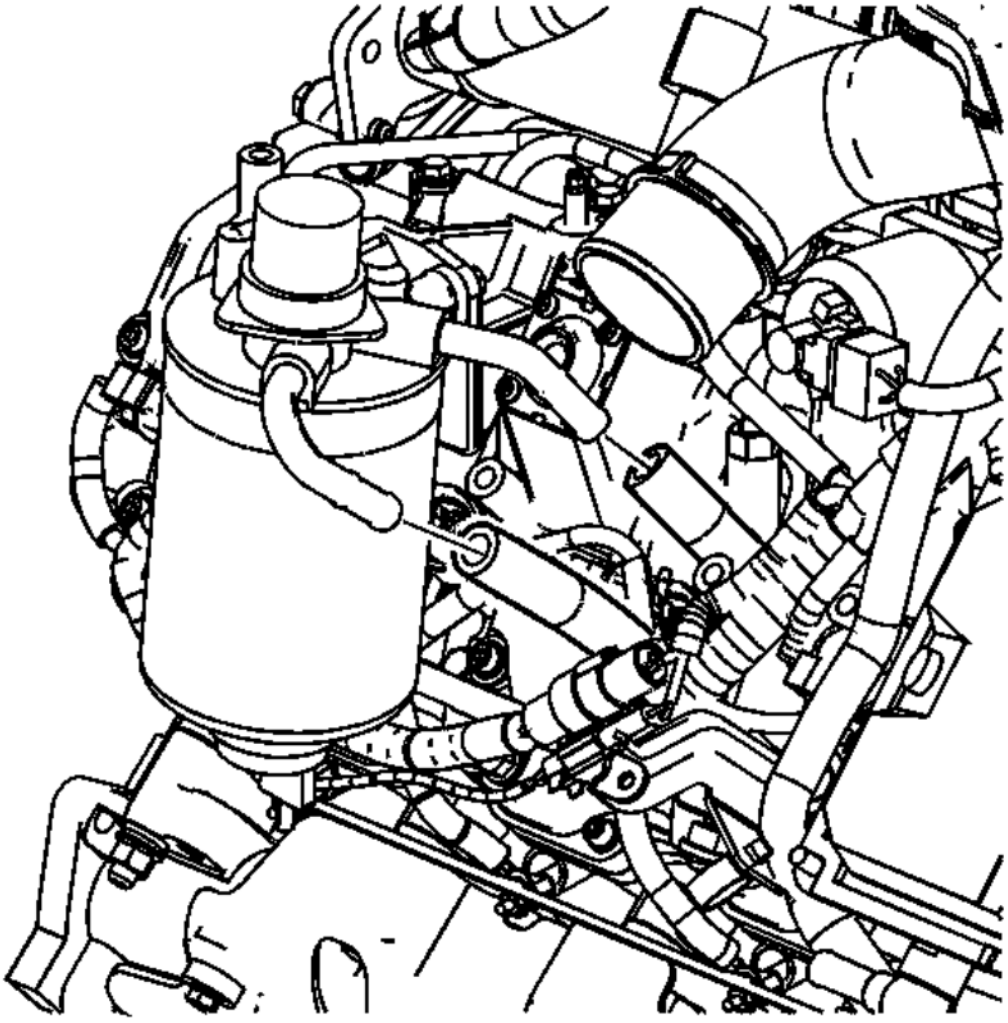


Fig. 27: View Of Fuel Hoses At Fuel Filter
Courtesy of GENERAL MOTORS CORP.

1. Remove the fuel hoses.

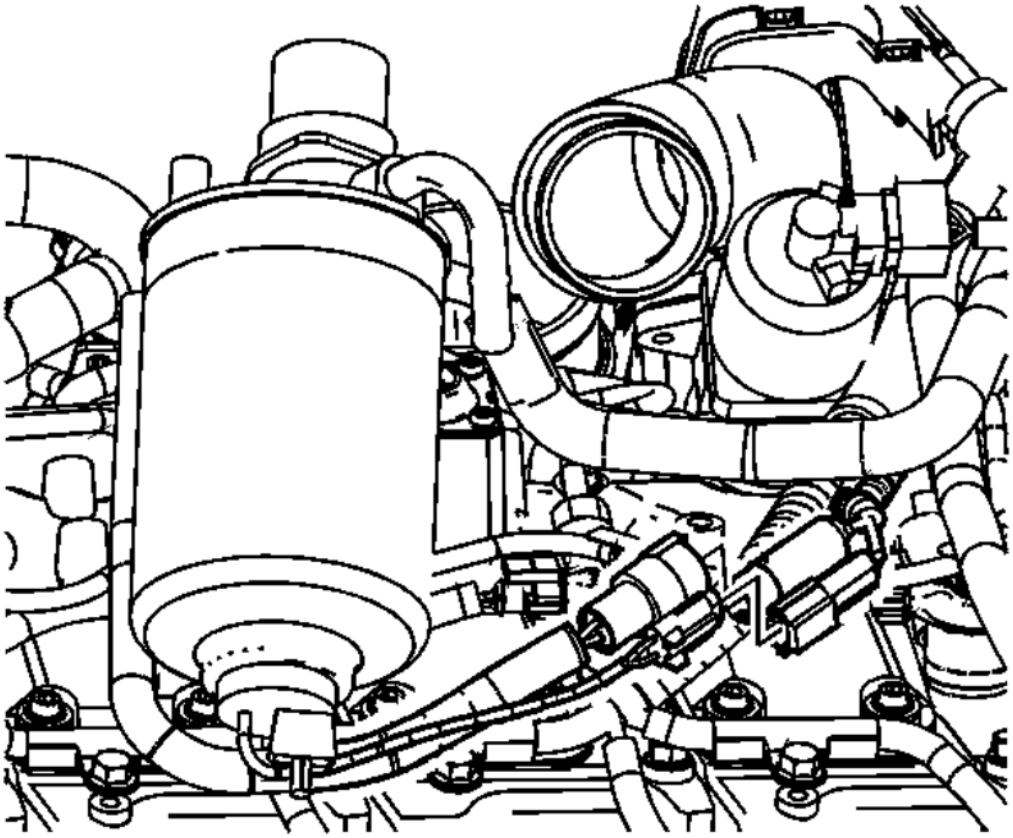


Fig. 28: View Of Fuel Filter Assembly Connectors
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the fuel filter assembly connectors.

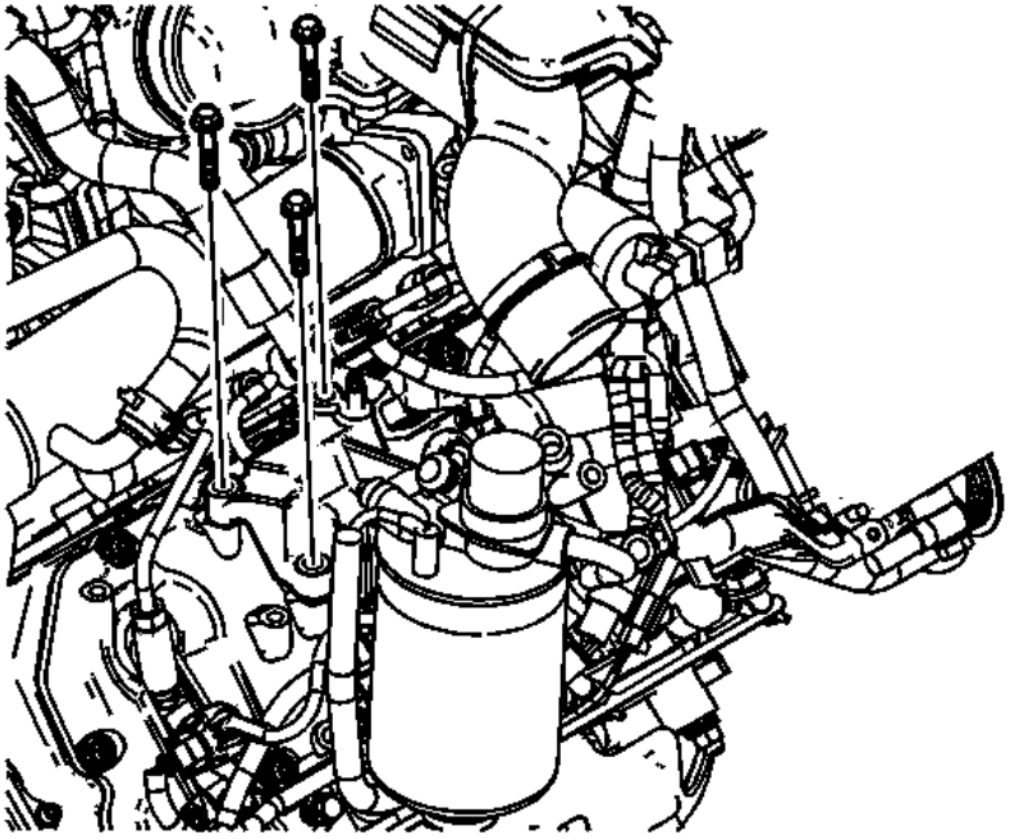


Fig. 29: Identifying Fuel Filter Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

3. Remove the fuel filter bracket bolts.

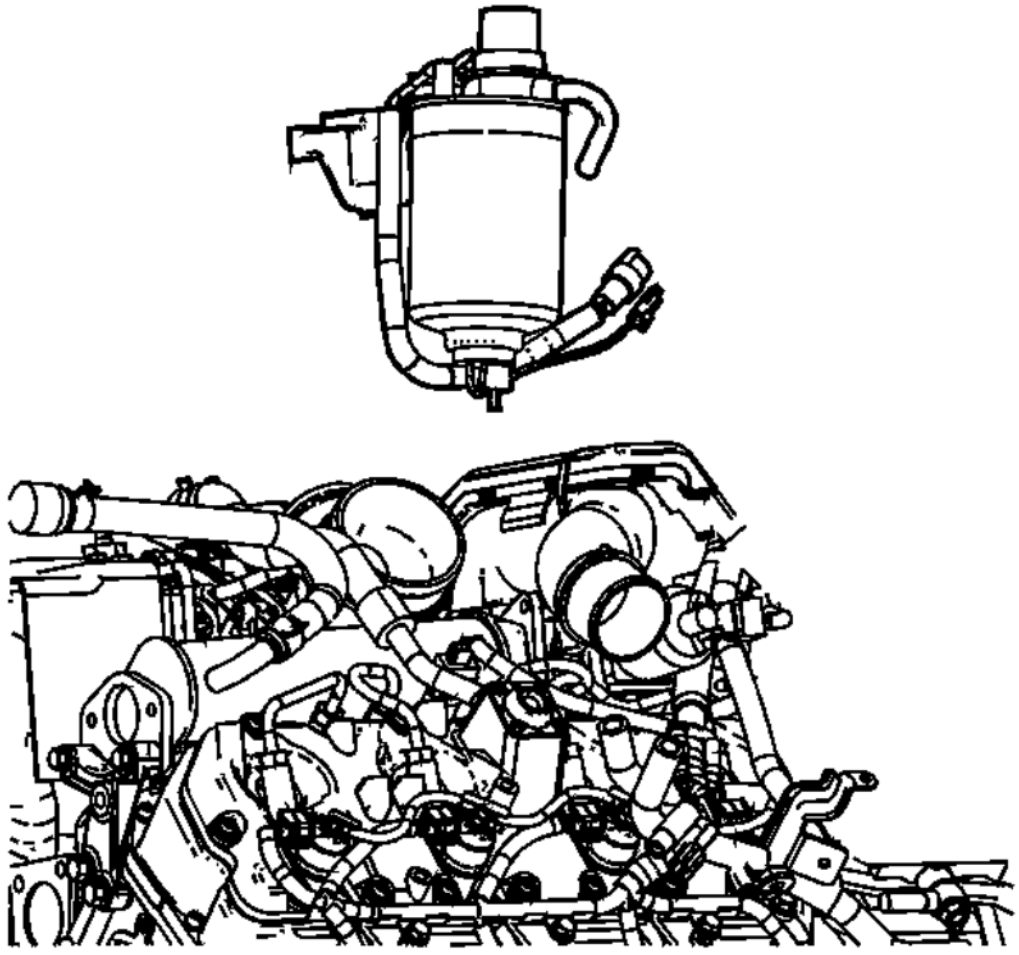


Fig. 30: Identifying Fuel Filter Assembly
Courtesy of GENERAL MOTORS CORP.

4. Remove the fuel filter assembly.

DRIVE BELT TENSIONER AND GENERATOR MOUNTING BRACKET REMOVAL

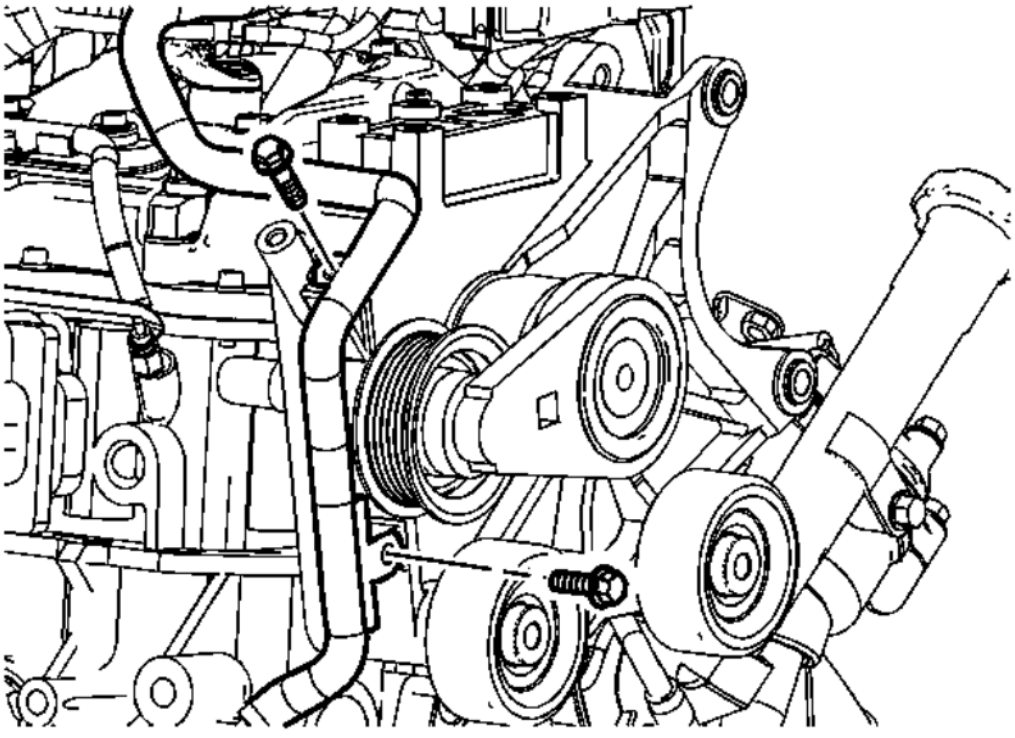


Fig. 31: View Of Electrical Harness Clip Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the electrical harness clip bolts.

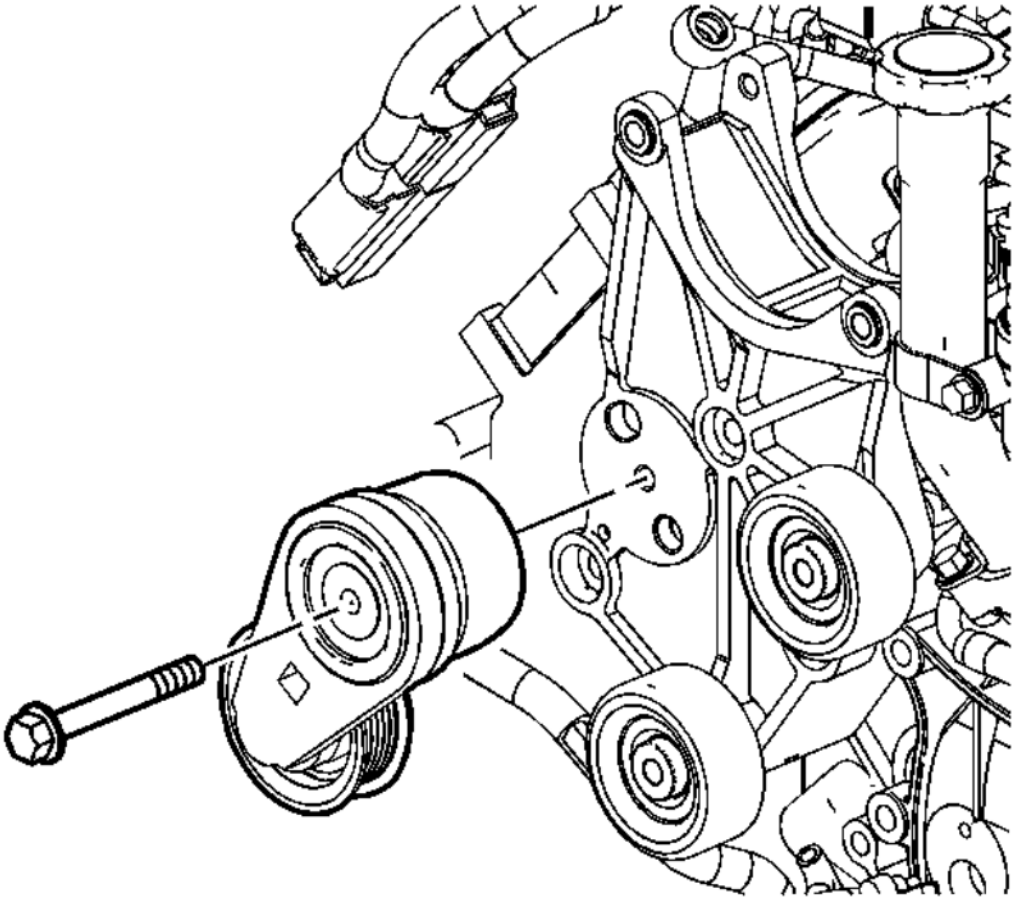


Fig. 32: View Of Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

2. Remove the drive belt tensioner bolt.
3. Remove the drive belt tensioner.

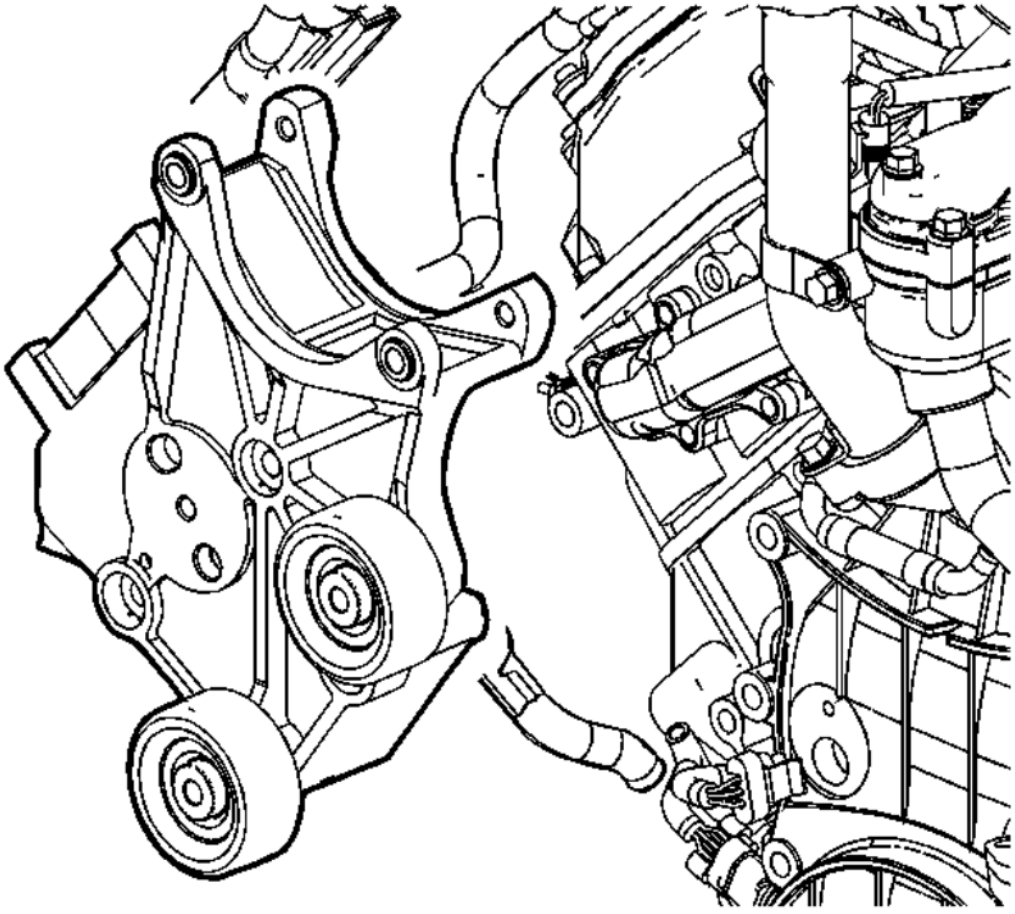


Fig. 33: View Of Generator Mounting Bracket
Courtesy of GENERAL MOTORS CORP.

4. Remove the drive belt tensioner and generator mounting bracket bolts.
5. Remove the drive belt tensioner and generator mounting bracket.

ENGINE COOLANT THERMOSTAT HOUSING REMOVAL

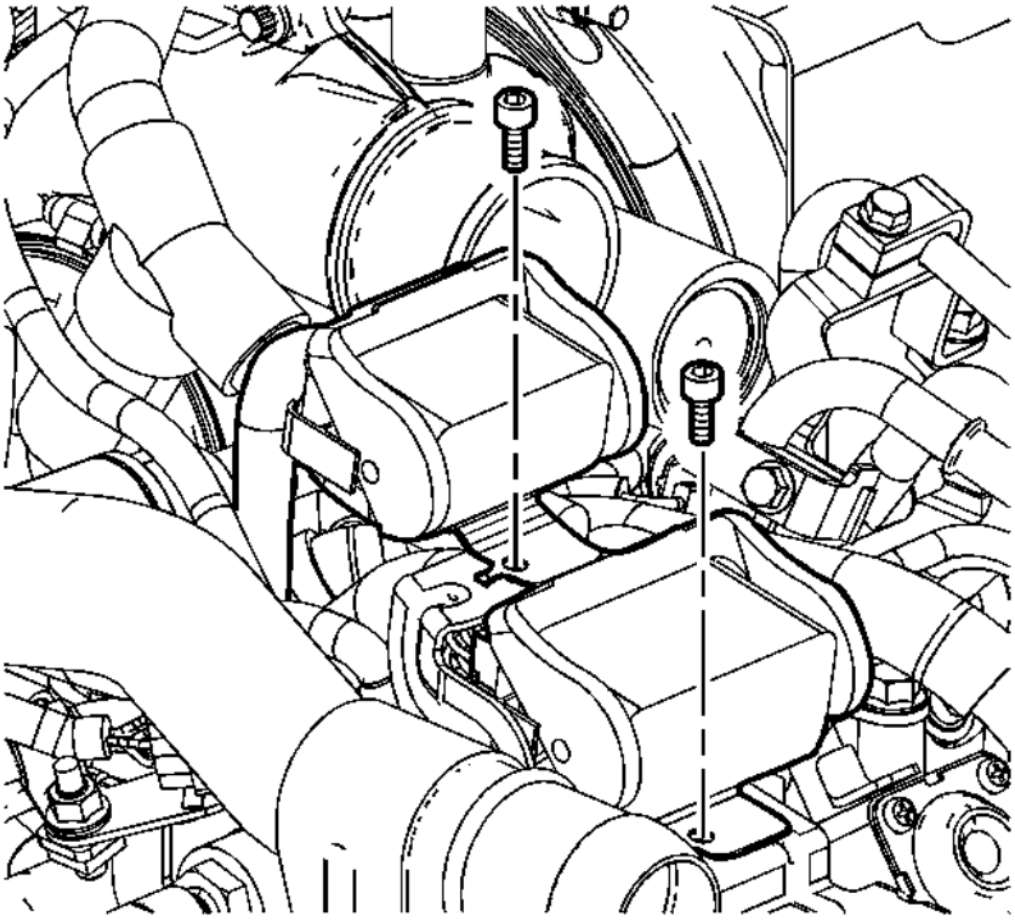


Fig. 34: View Of Main Engine Electrical Harness Connector Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the main engine electrical harness connector hold down bolts.

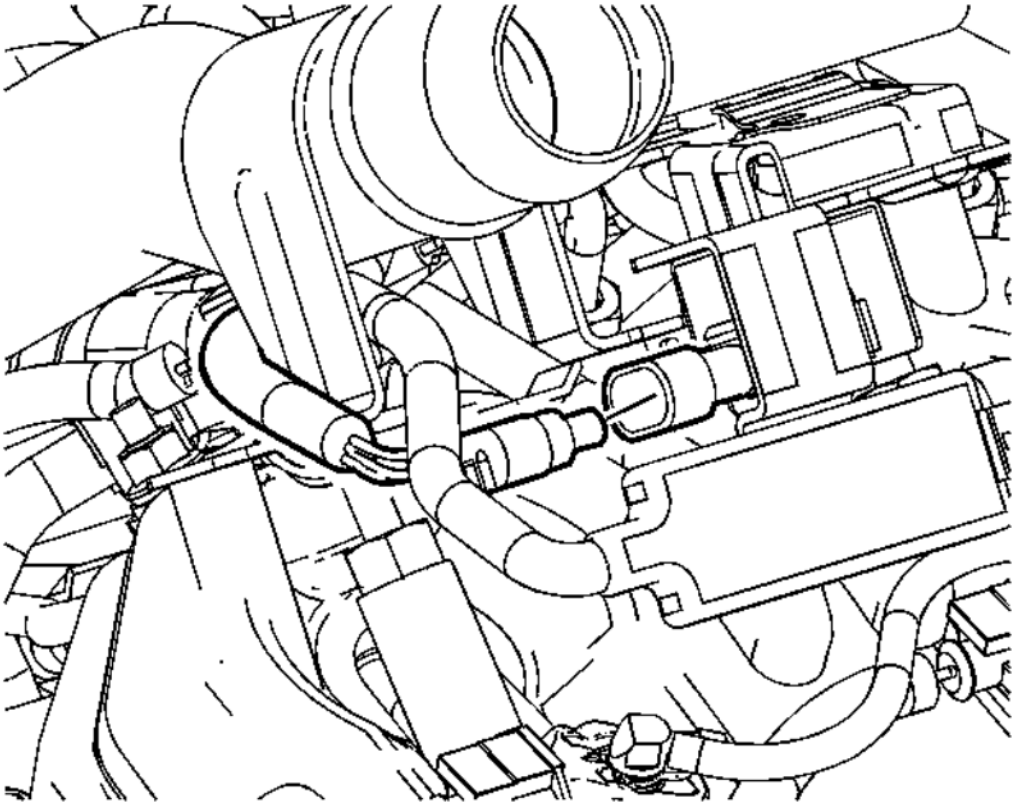


Fig. 35: View Of Barometric Pressure Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

2. Remove the main engine electrical harness connectors.
3. Disconnect and remove the barometric sensor.

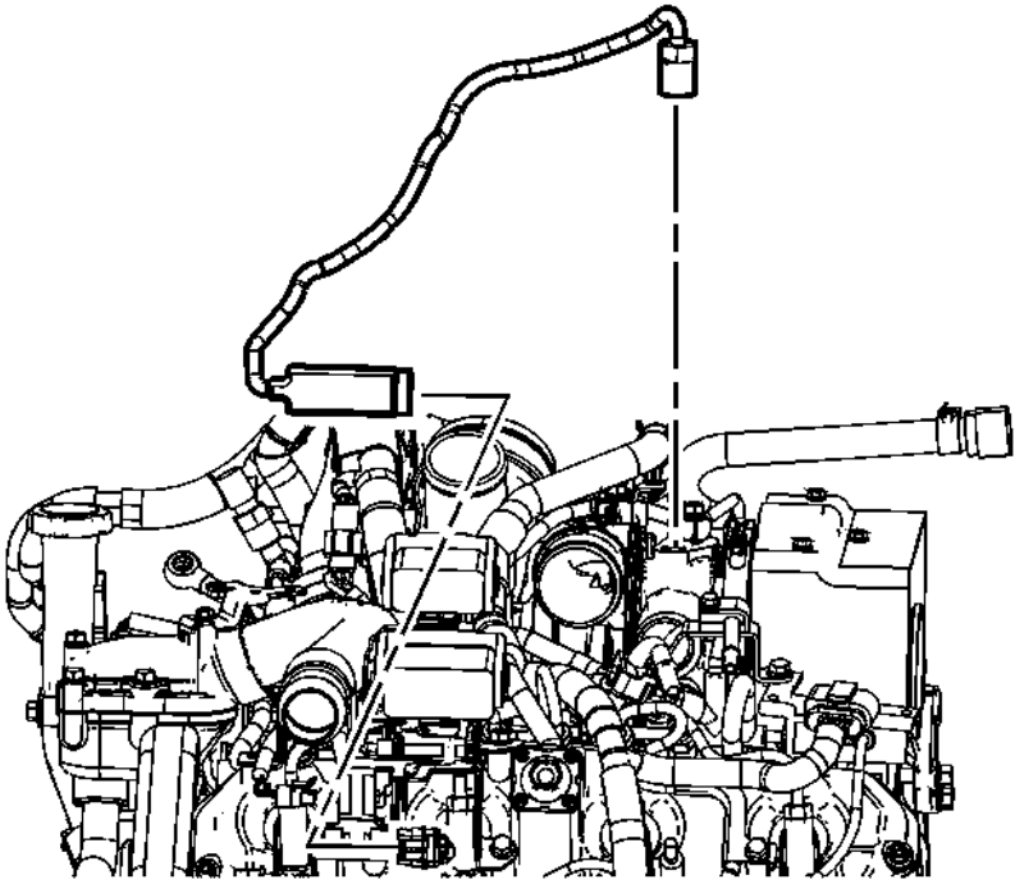


Fig. 36: View Of Turbocharger Vane Position Sensor And Electrical Connector
Courtesy of GENERAL MOTORS CORP.

4. Disconnect and remove the turbocharger vane position sensor.

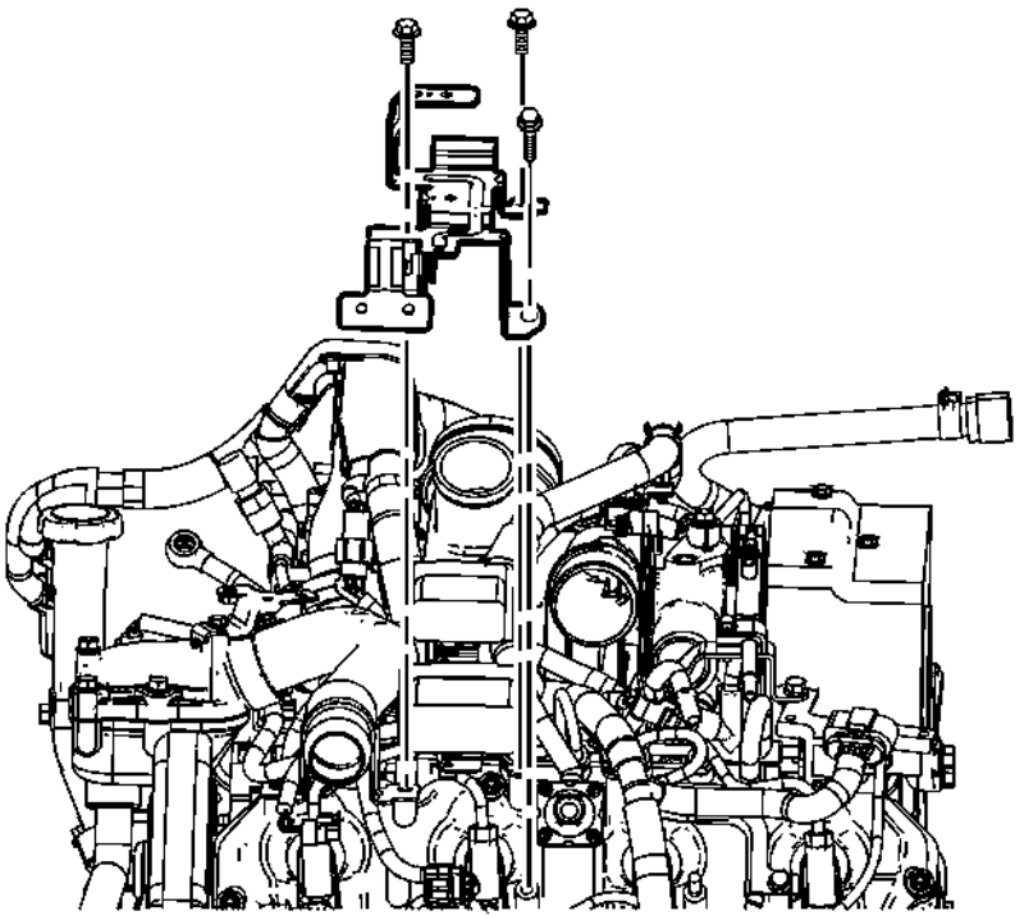


Fig. 37: View Of Main Electrical Connector Harness Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

5. Remove the main electrical harness bracket bolts.
6. Remove the main electrical harness bracket.

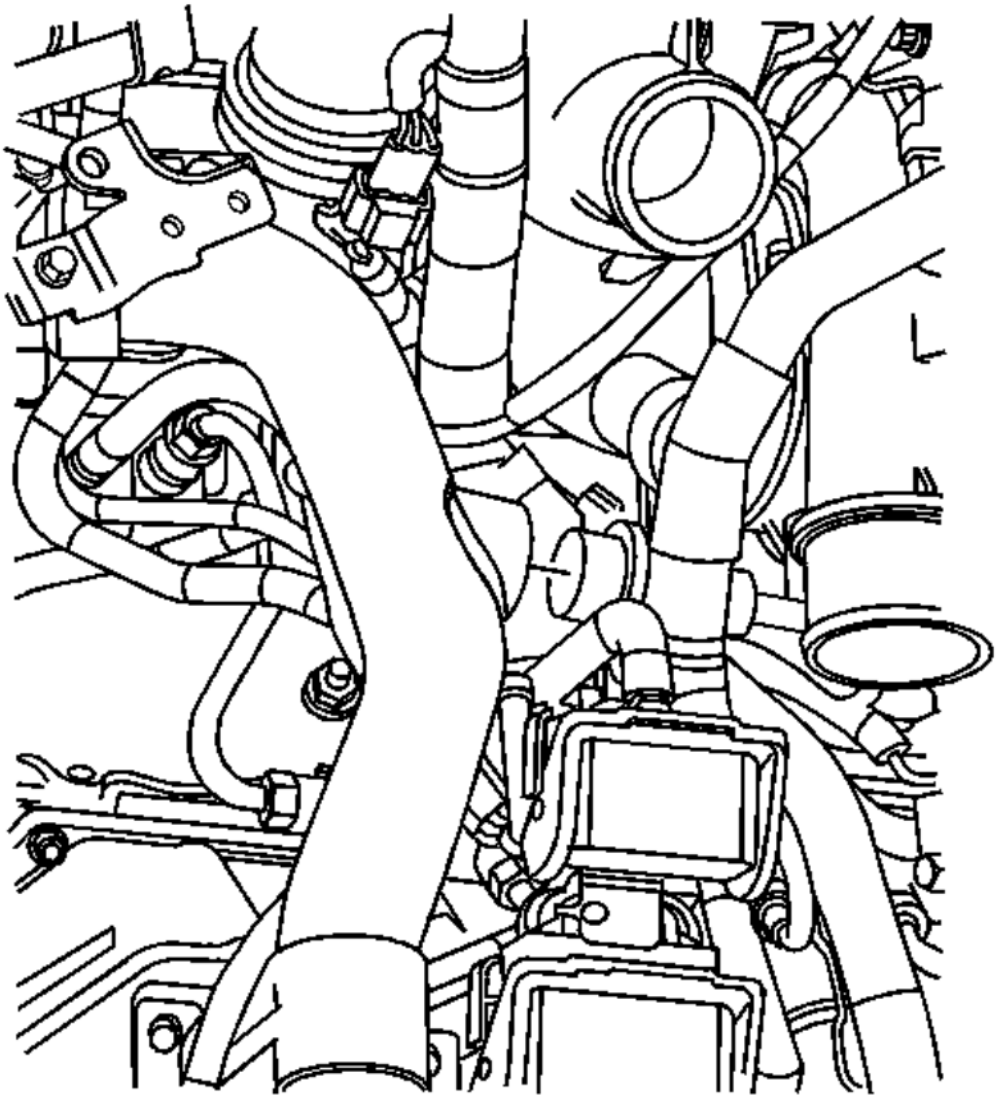


Fig. 38: View Of Turbocharger Inlet Coolant Hose At Turbocharger Coolant Bypass
Courtesy of GENERAL MOTORS CORP.

7. Disconnect the turbocharger coolant inlet hose.

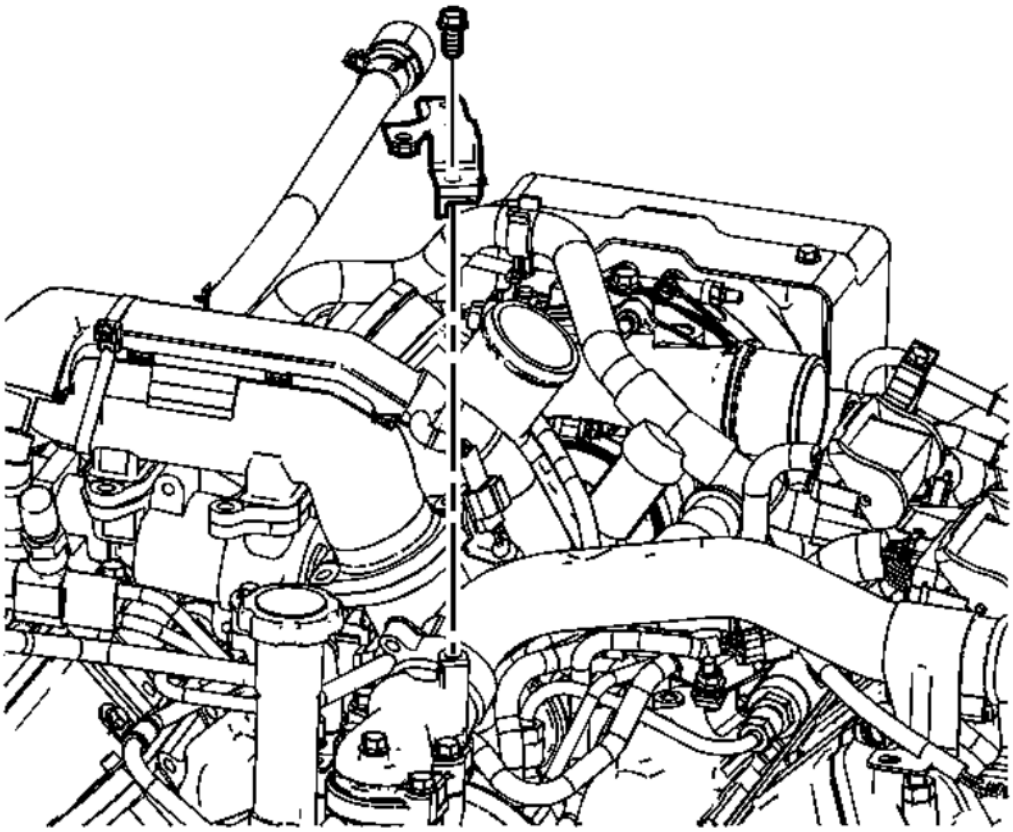


Fig. 39: View Of Electrical Harness Bracket Bolt
Courtesy of GENERAL MOTORS CORP.

8. Remove the electrical harness bracket bolt.
9. Remove the electrical harness bracket.

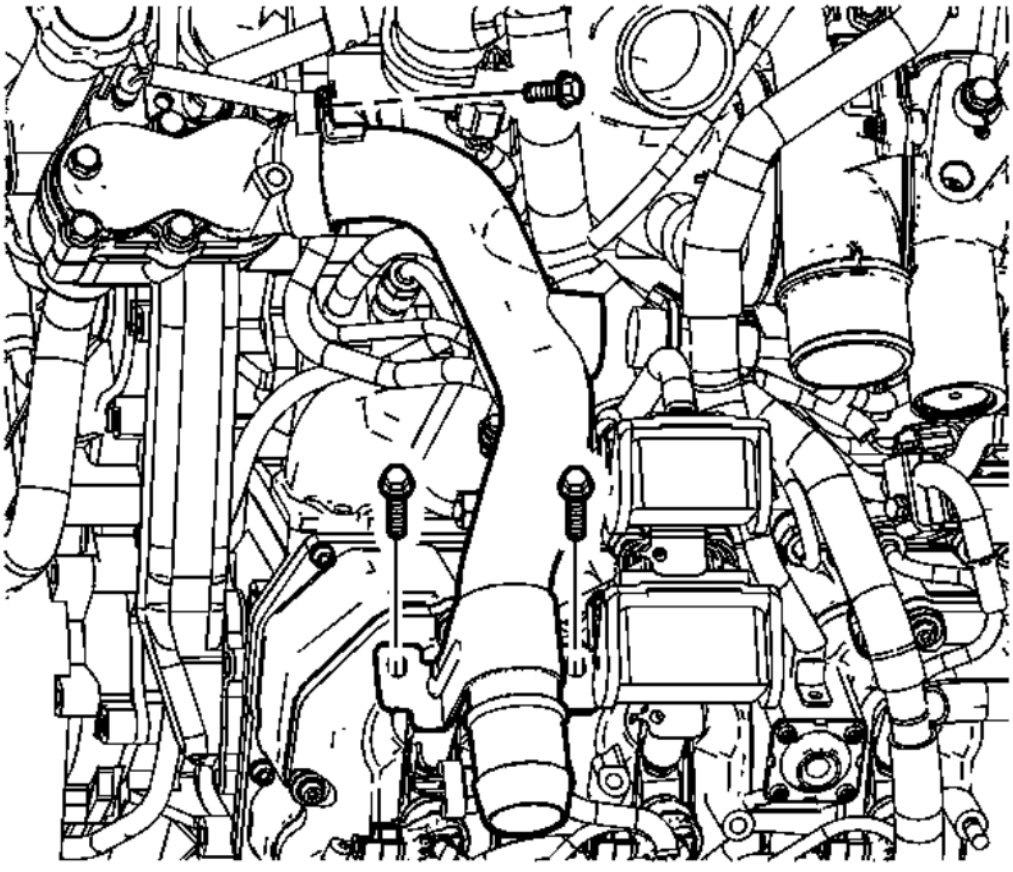


Fig. 40: View Of Water Outlet Bolts
Courtesy of GENERAL MOTORS CORP.

10. Remove the water outlet bolts.

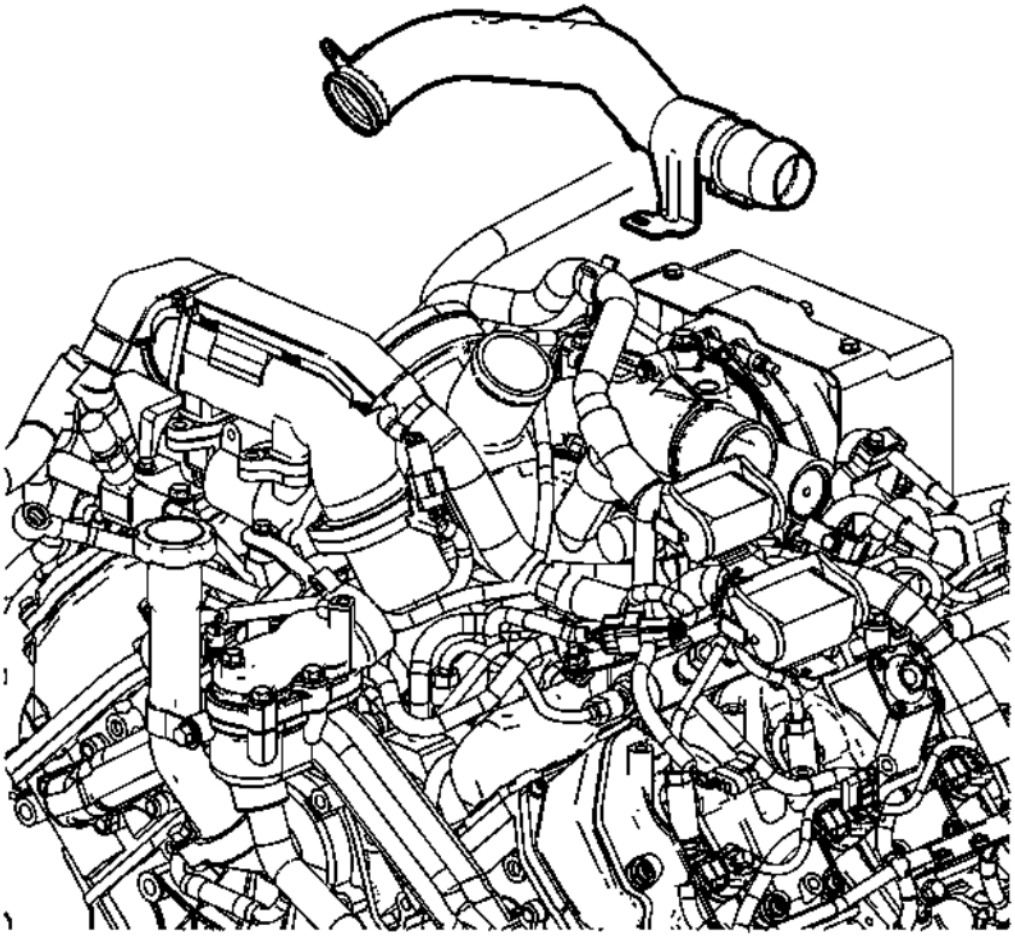


Fig. 41: View Of Water Outlet
Courtesy of GENERAL MOTORS CORP.

11. Remove the water outlet.

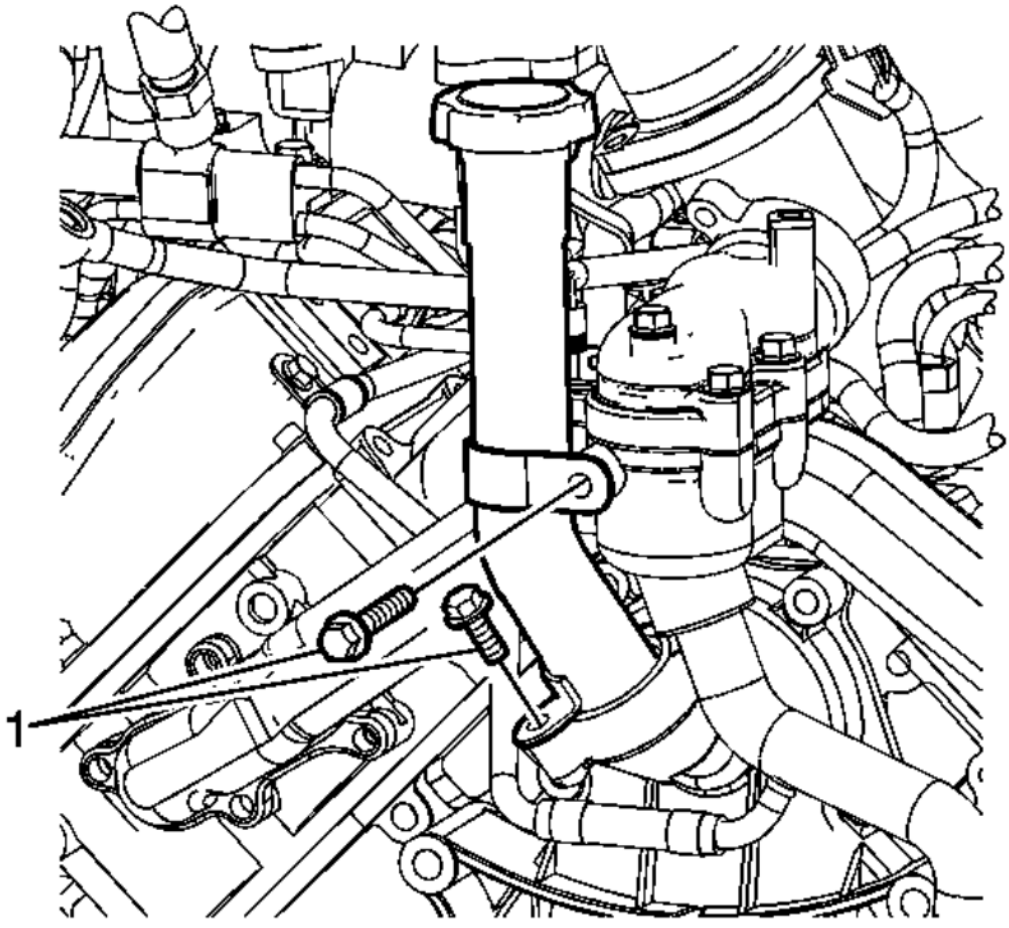


Fig. 42: View Of Oil Filler Tube Bolts
Courtesy of GENERAL MOTORS CORP.

12. Remove the oil fill tube bolts.

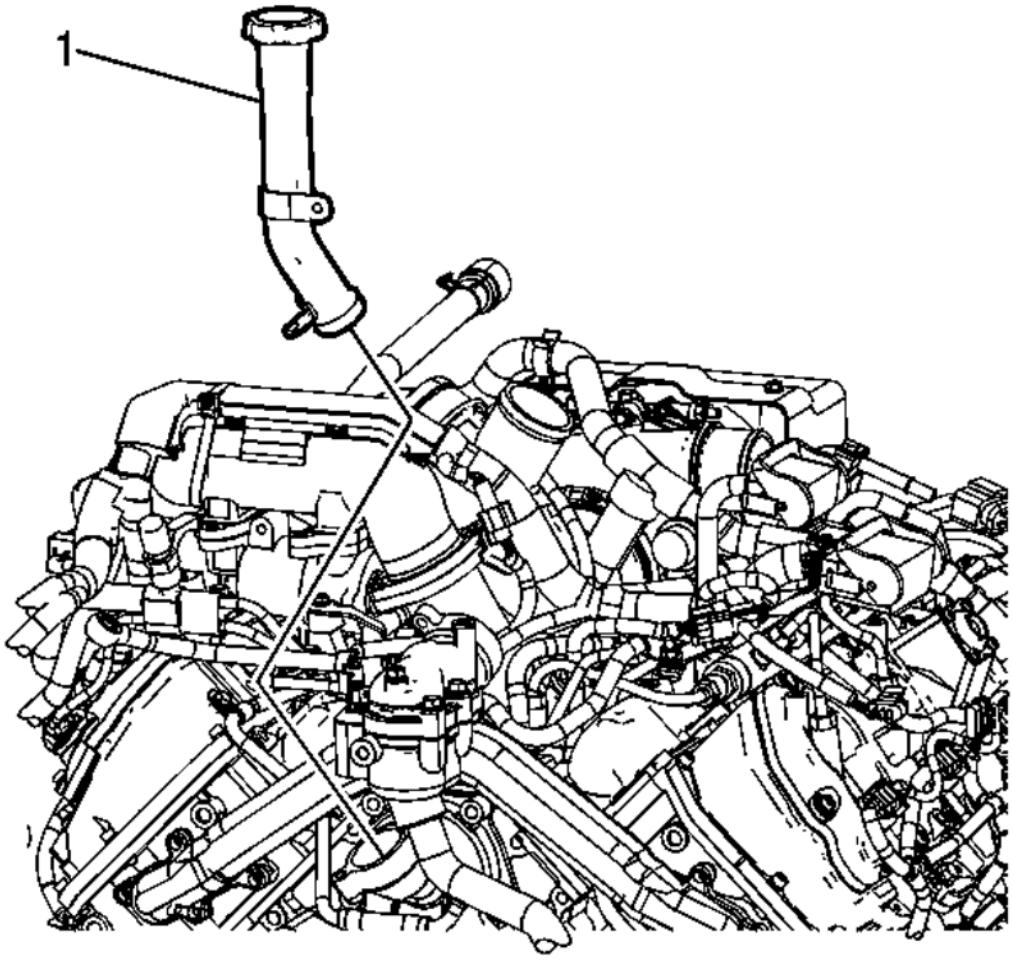


Fig. 43: View Of Oil Filler Tube
Courtesy of GENERAL MOTORS CORP.

13. Remove the oil fill tube.

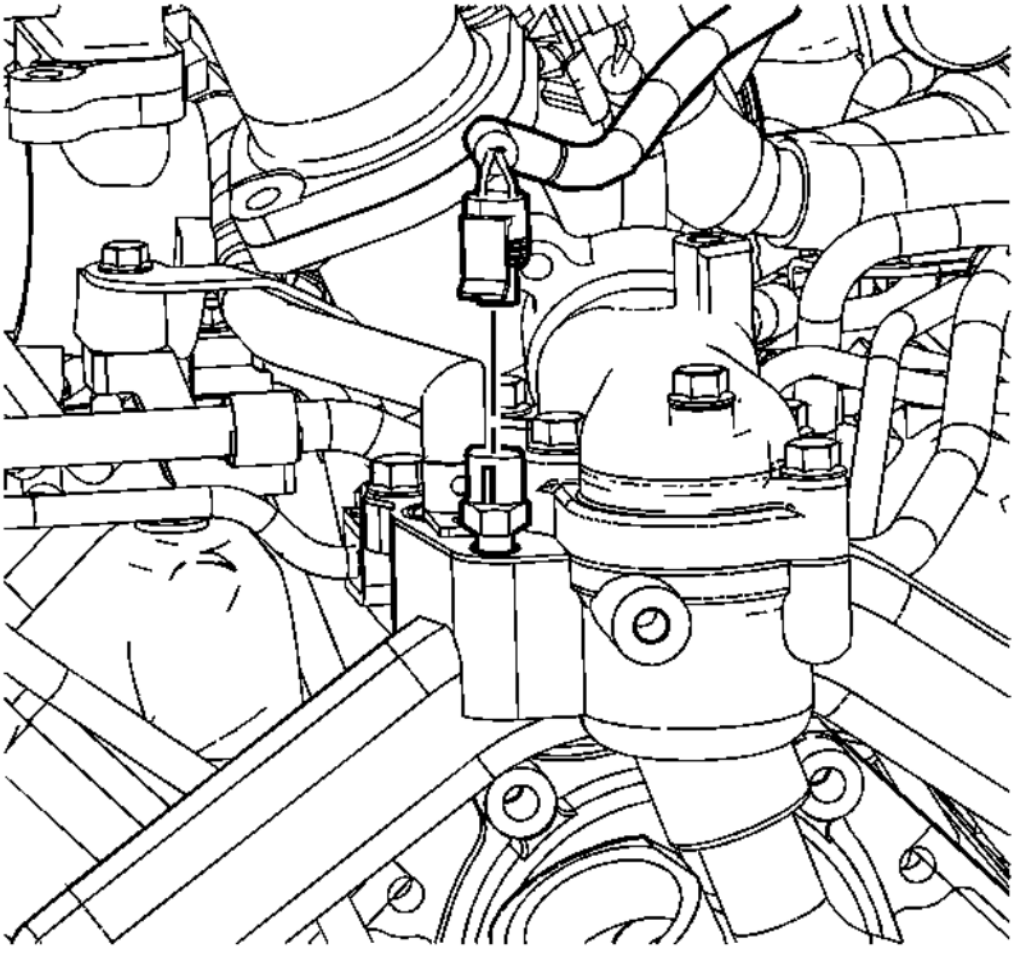


Fig. 44: View Of Engine Coolant Temperature Sensor And Electrical Connector
Courtesy of GENERAL MOTORS CORP.

14. Disconnect the coolant temperature sensor.

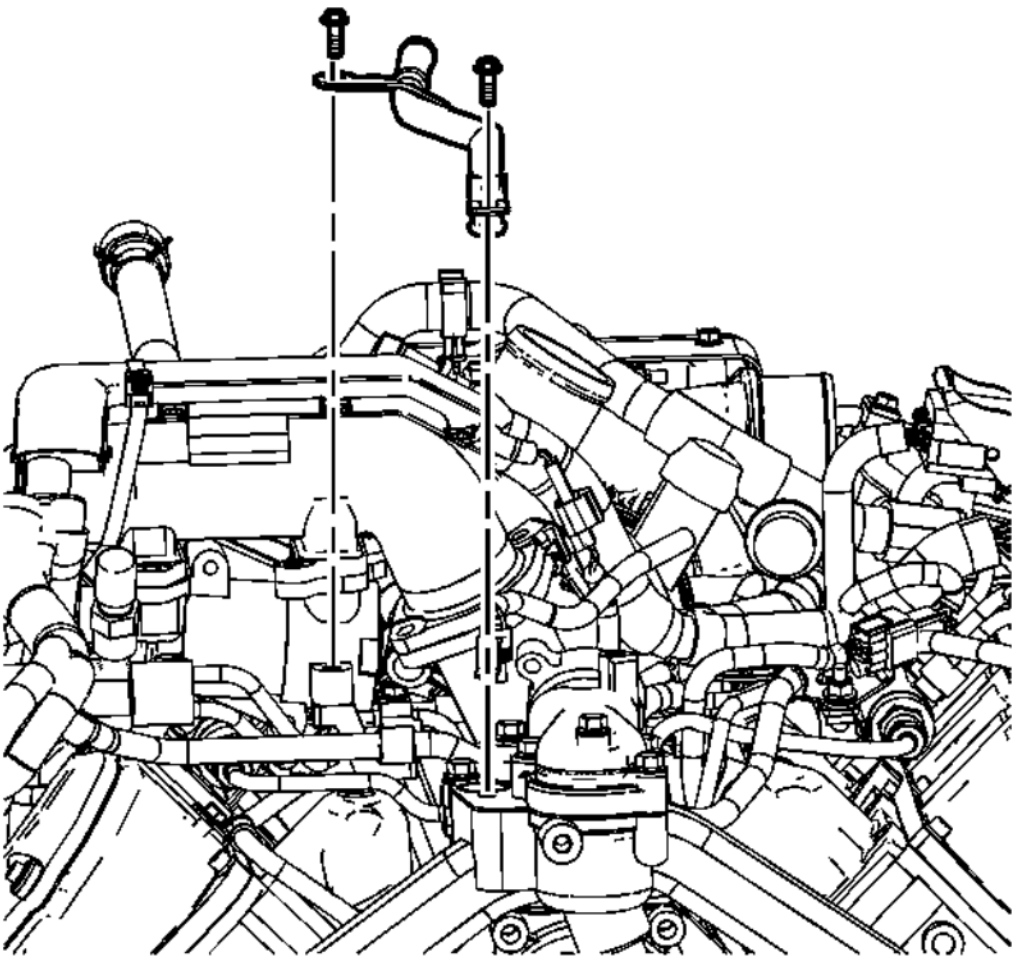


Fig. 45: View Of Exhaust Gas Recirculation (EGR) Coolant Pipe, Hose & Bolts
Courtesy of GENERAL MOTORS CORP.

15. Remove the EGR coolant pipe bolts.
16. Remove the EGR coolant pipe.

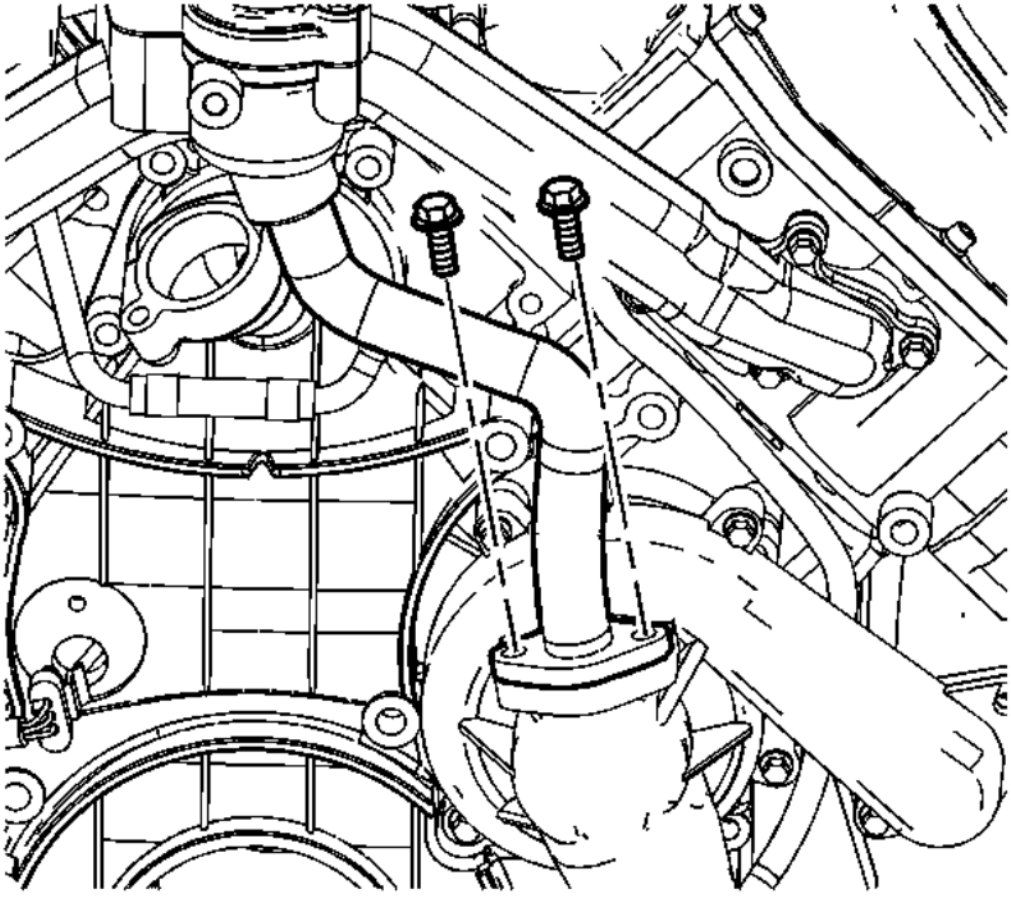


Fig. 46: View Of Water Pump Inlet Pipe Bolts
Courtesy of GENERAL MOTORS CORP.

17. Remove the water pump inlet pipe bolts.

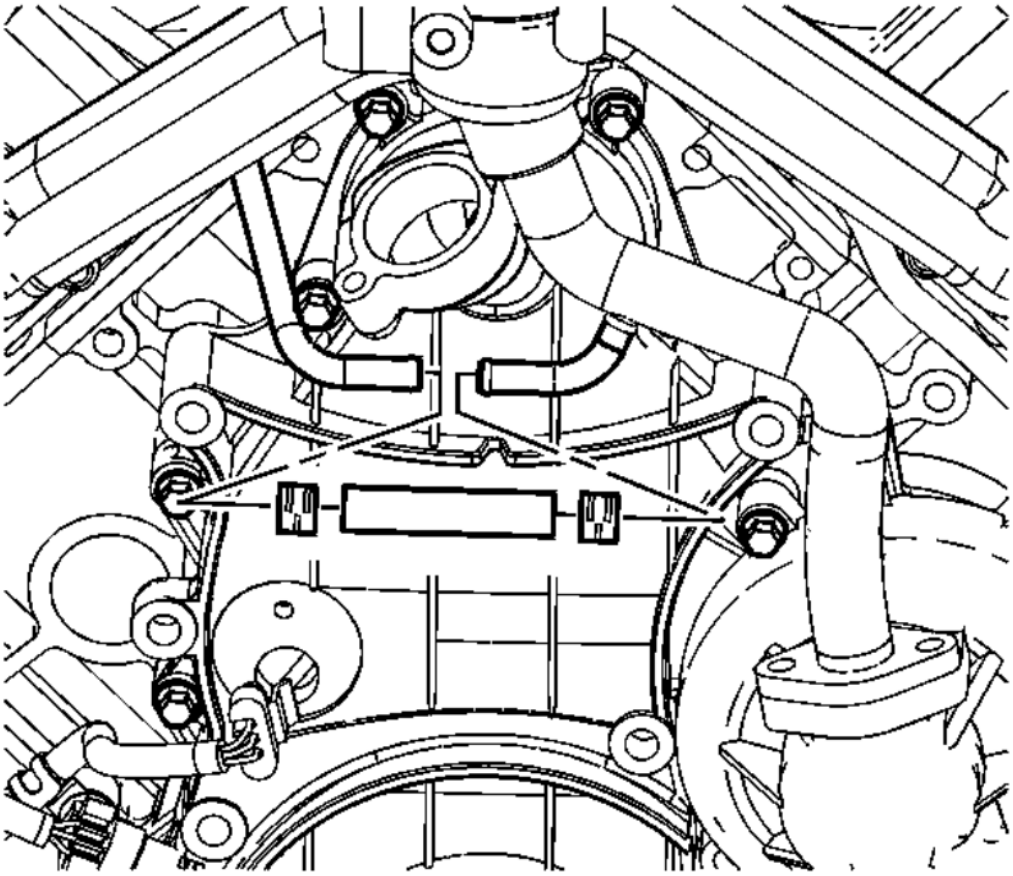


Fig. 47: View Of Turbocharger Coolant Outlet Hose & Clamps
Courtesy of GENERAL MOTORS CORP.

18. Remove the turbocharger coolant outlet hose and clamps.

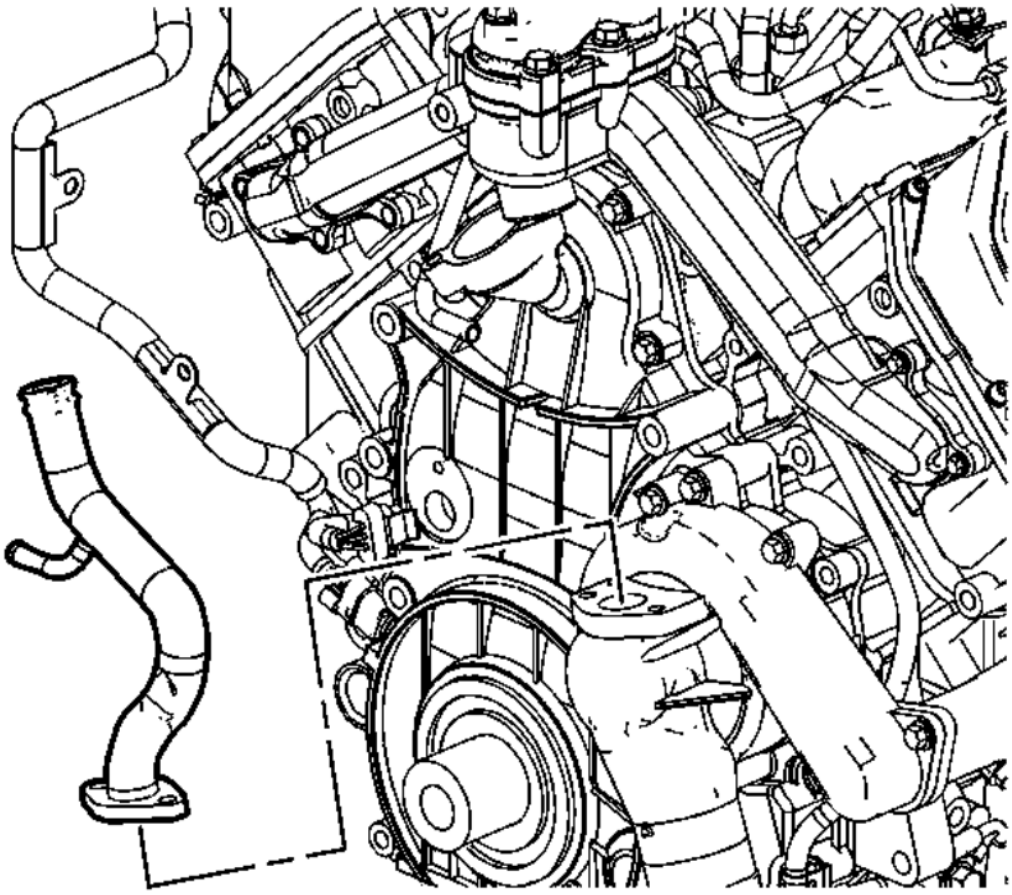


Fig. 48: View Of Water Pump Inlet Pipe
Courtesy of GENERAL MOTORS CORP.

19. Remove the water pump inlet pipe.

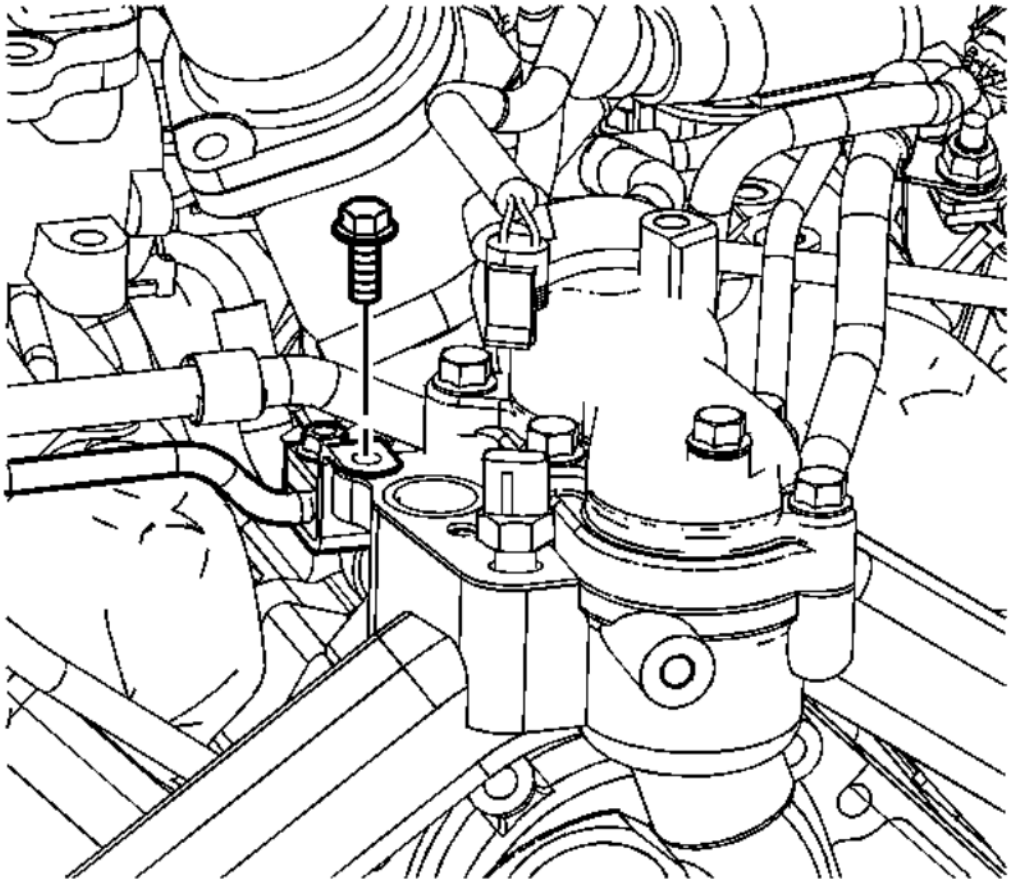


Fig. 49: View Of Fuel Pipe Bracket Bolt
Courtesy of GENERAL MOTORS CORP.

20. Remove the fuel pipe bracket bolt.

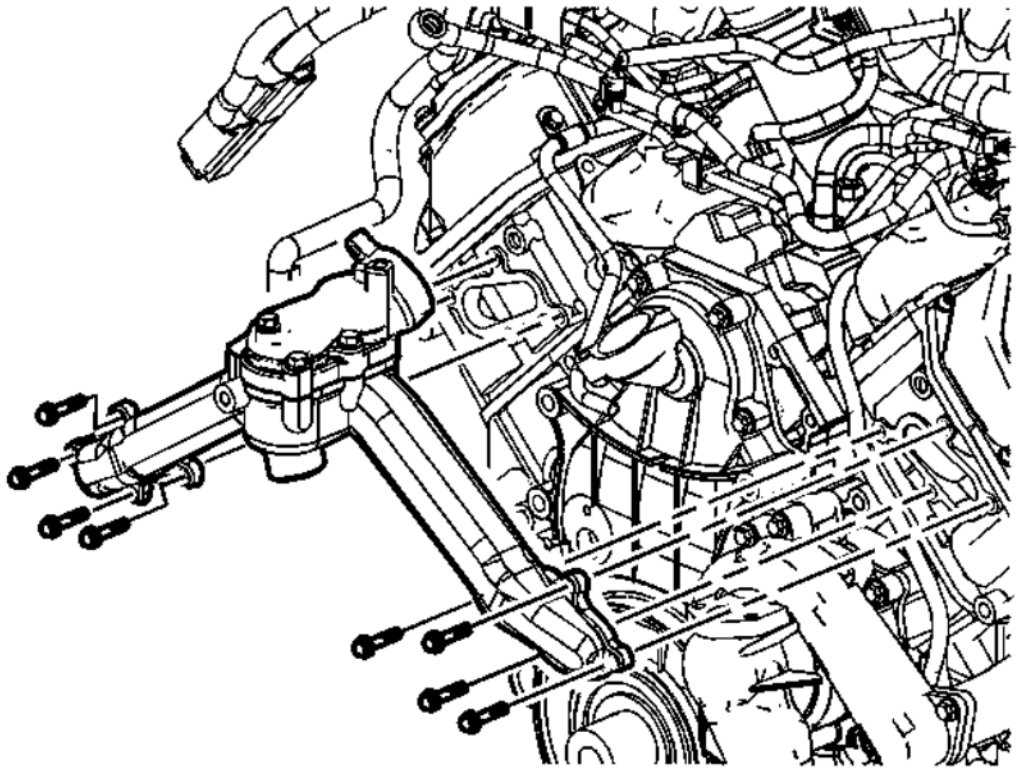


Fig. 50: View Of Thermostat Housing
Courtesy of GENERAL MOTORS CORP.

21. Remove the thermostat housing bolts.
22. Remove the thermostat housing.

ENGINE WIRING HARNESS ASSEMBLY REMOVAL

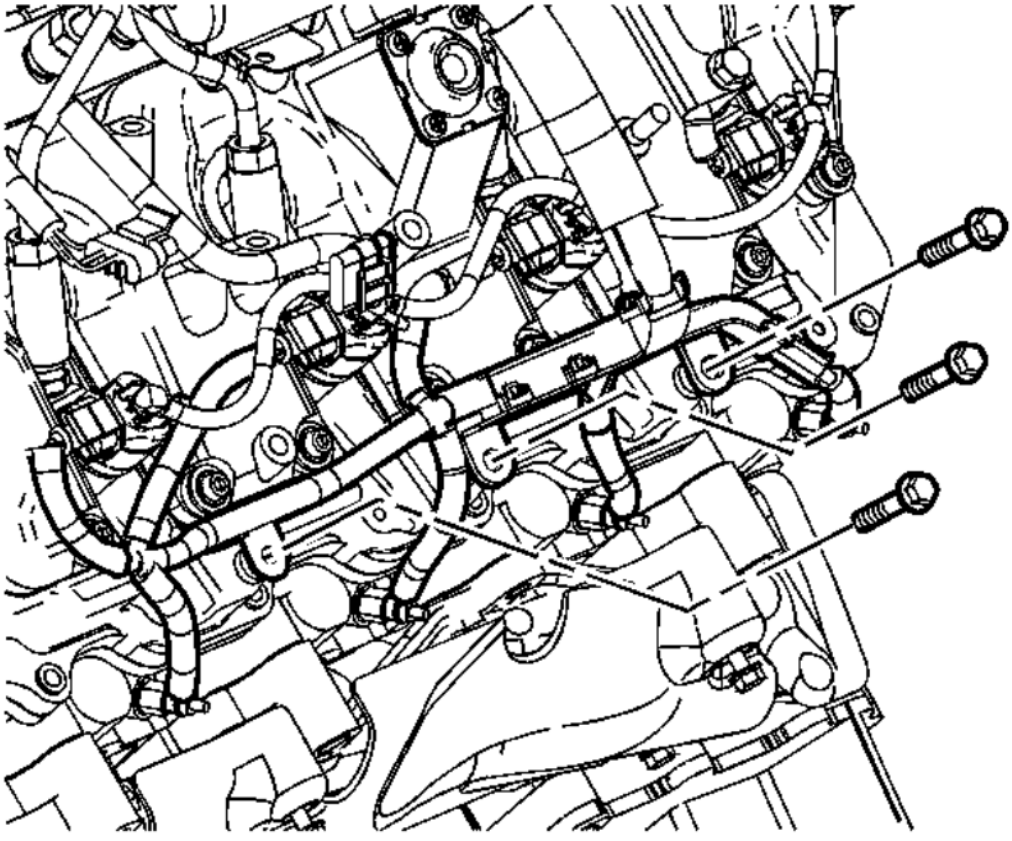


Fig. 51: View Of Left Glow Plug Harness Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the left glow plug harness bracket bolts.

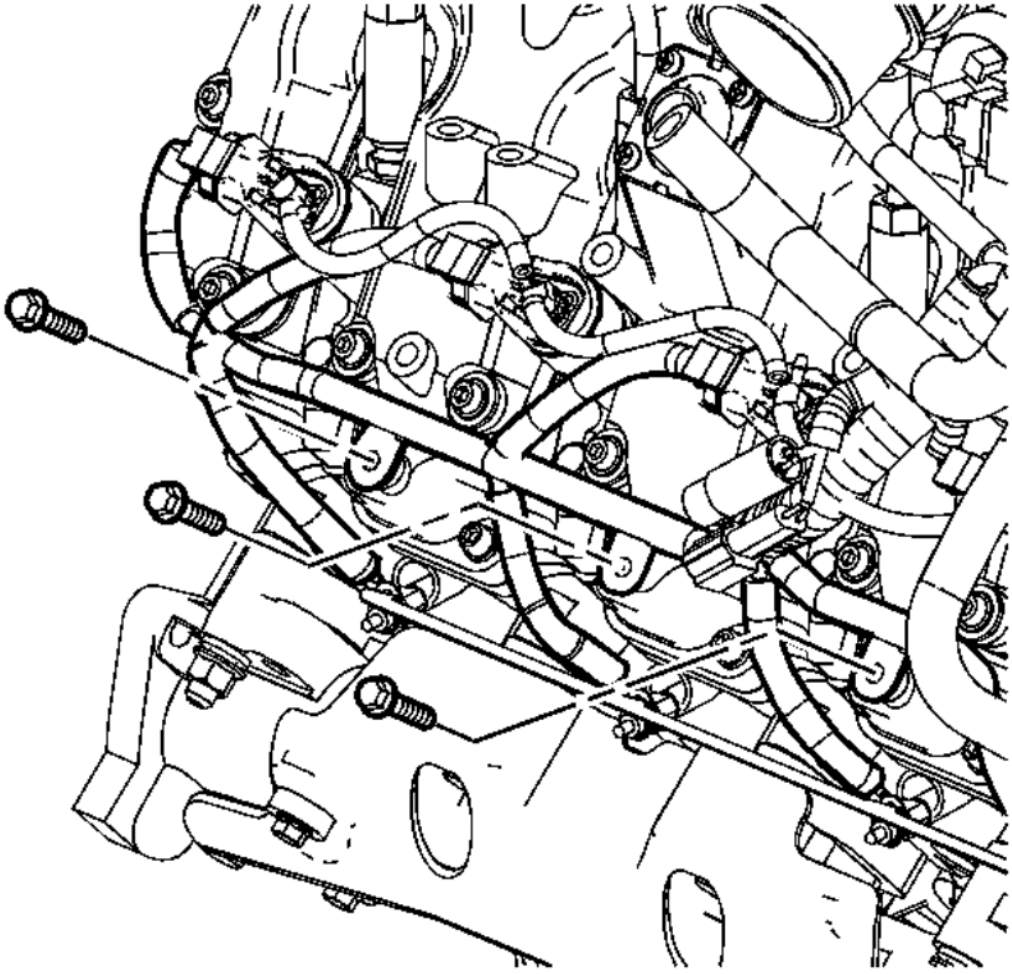


Fig. 52: View Of Right Glow Plug Harness Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

2. Remove the right glow plug harness bracket bolts.

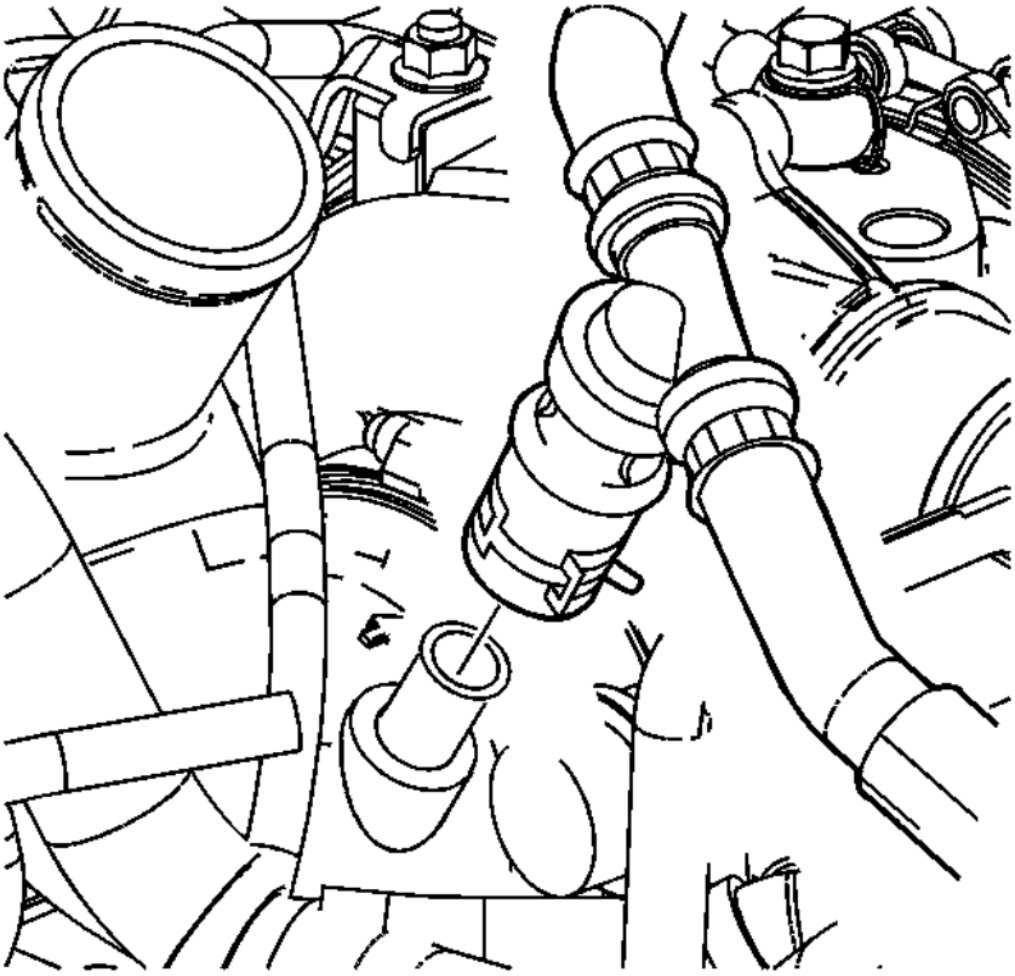


Fig. 53: View Of PCV Hose Clamp
Courtesy of GENERAL MOTORS CORP.

3. Disconnect the positive crankcase ventilation (PCV) hose clamp.

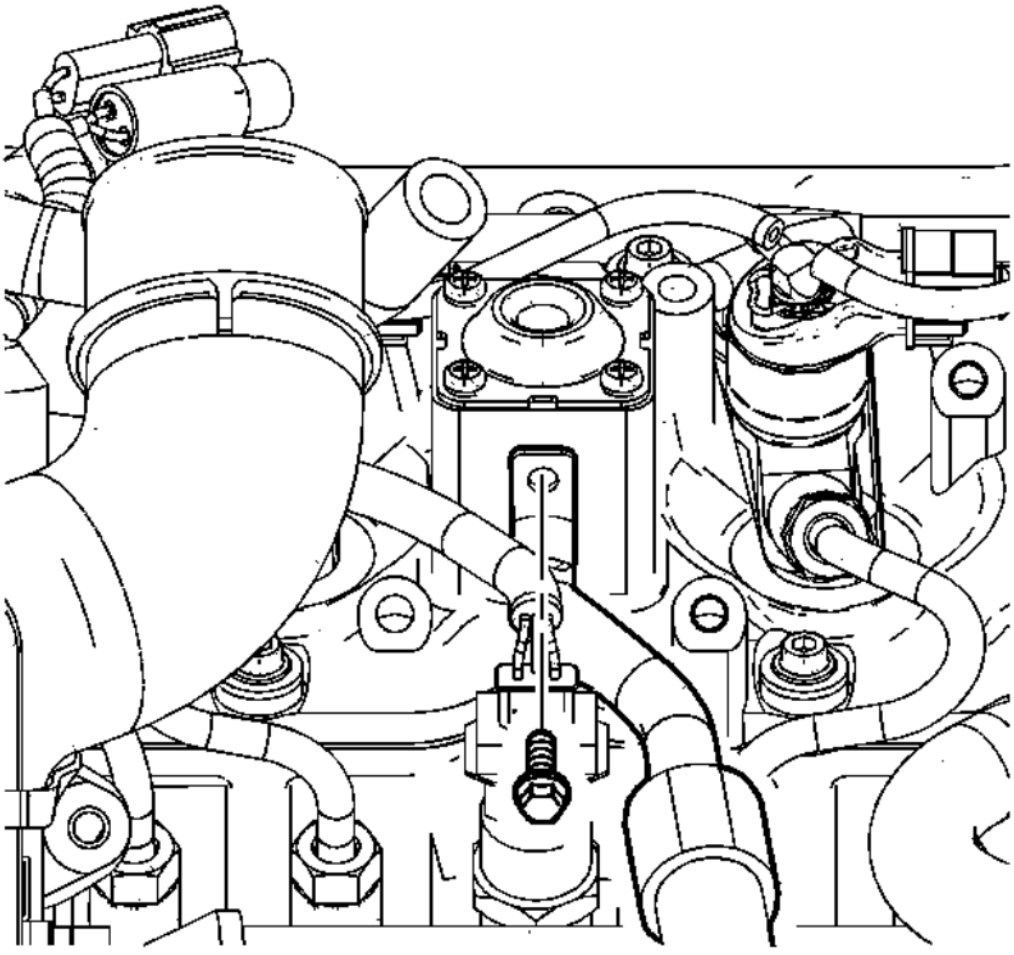


Fig. 54: View Of Right PCV Hose/Pipe Bolt
Courtesy of GENERAL MOTORS CORP.

4. Remove the right PCV pipe bolt.

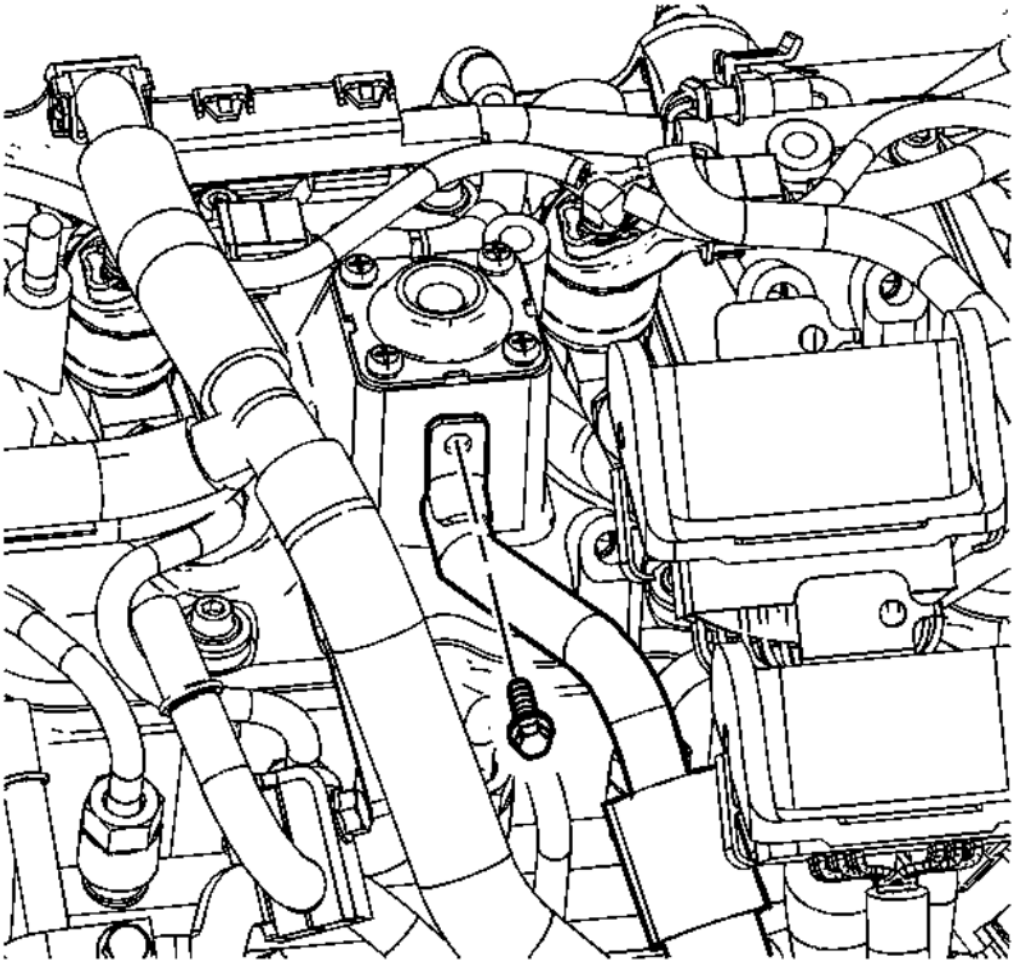


Fig. 55: View Of Left PCV Hose/Pipe Bolt
Courtesy of GENERAL MOTORS CORP.

5. Remove the left PCV pipe bolt.

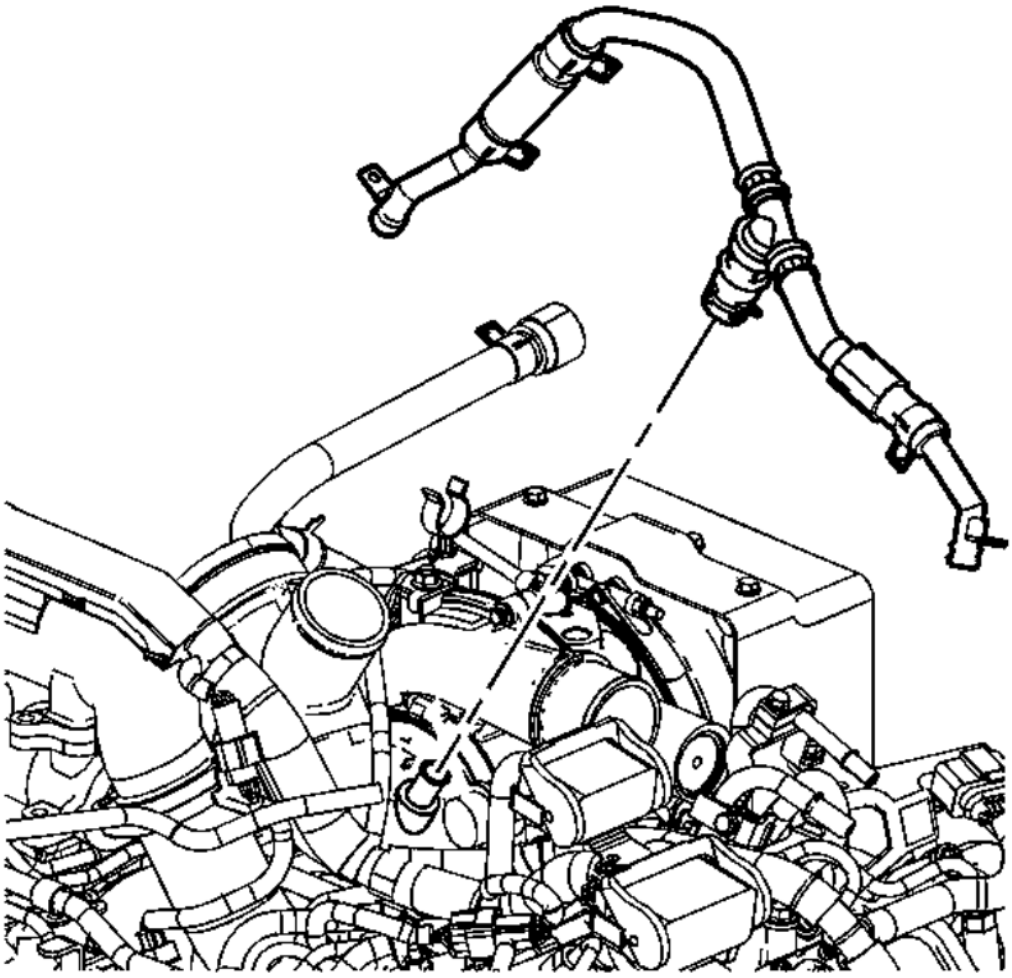


Fig. 56: View Of PCV Pipe
Courtesy of GENERAL MOTORS CORP.

6. Remove the PCV pipe.

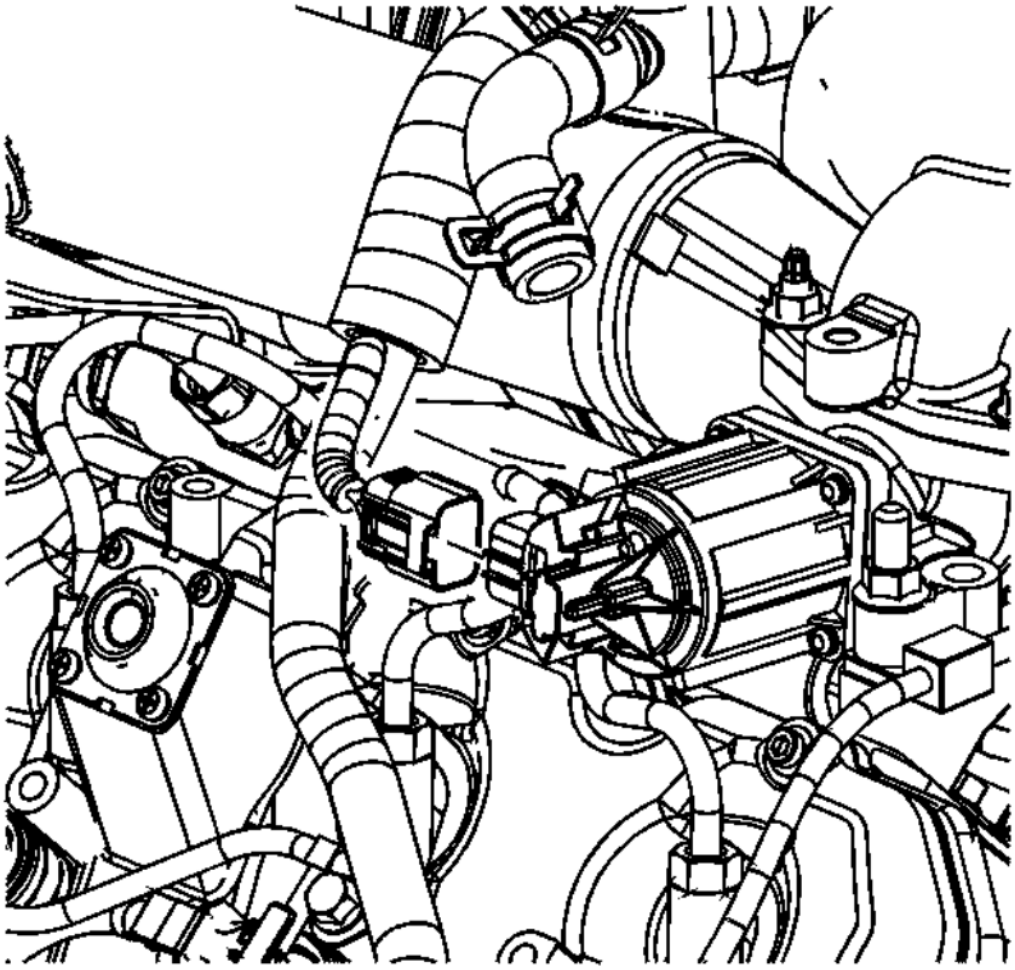


Fig. 57: Identifying EGR Valve Electrical Connector
Courtesy of GENERAL MOTORS CORP.

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

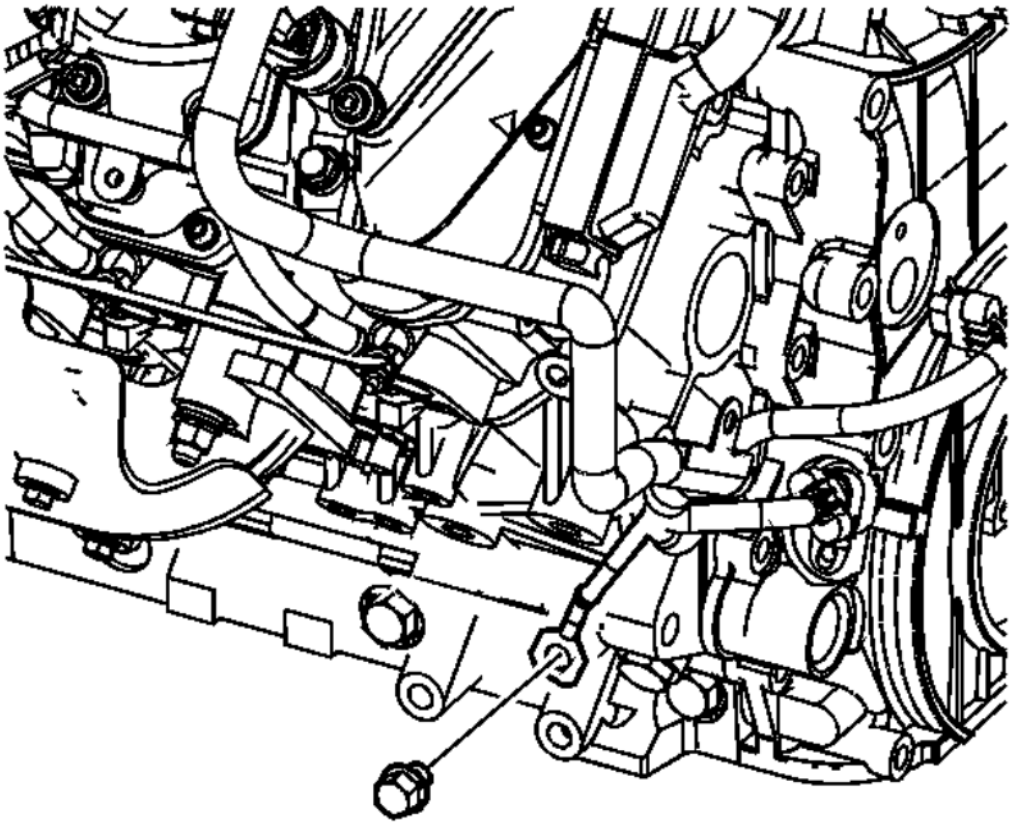


Fig. 58: Identifying Ground Bolt On Engine Block
Courtesy of GENERAL MOTORS CORP.

8. Remove the ground bolt.

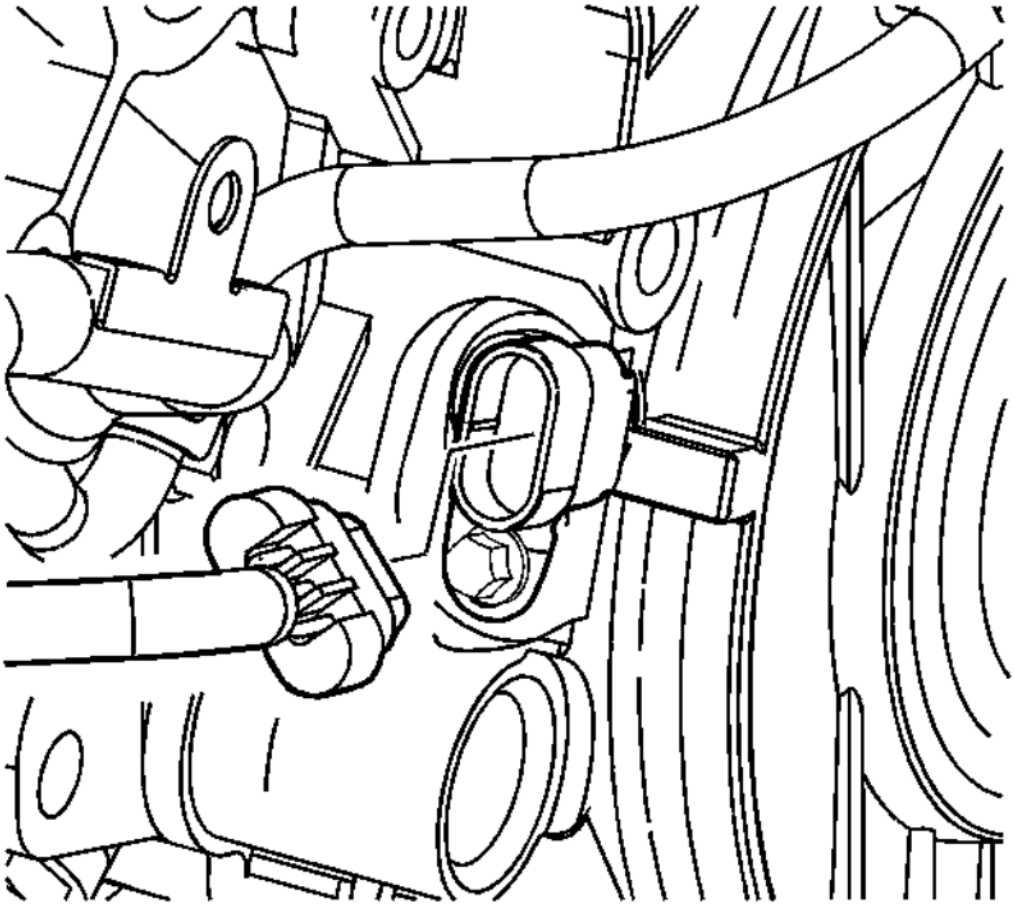


Fig. 59: View Of Crankshaft Position Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

9. Disconnect the crankshaft postion sensor electrical connector.

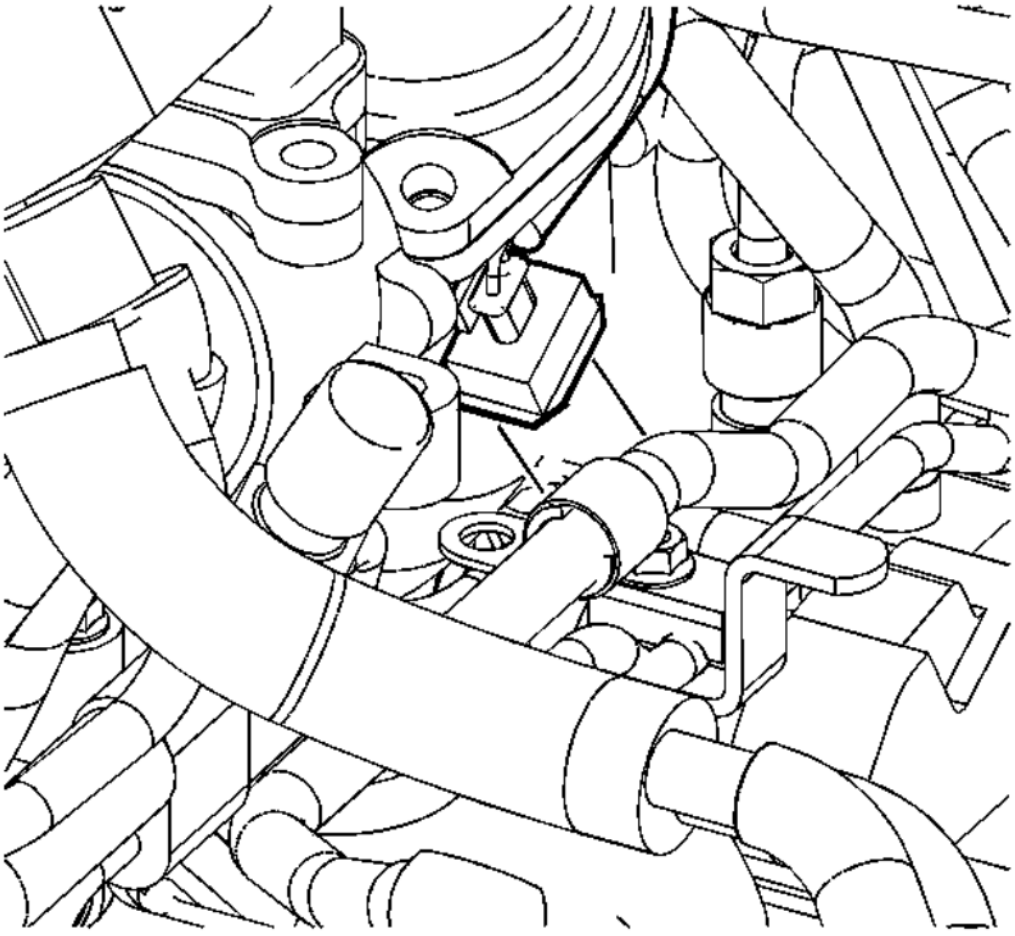


Fig. 60: View Of Fuel Pressure Control Valve Electrical Connector
Courtesy of GENERAL MOTORS CORP.

10. Disconnect the fuel pressure control valve electrical connector.

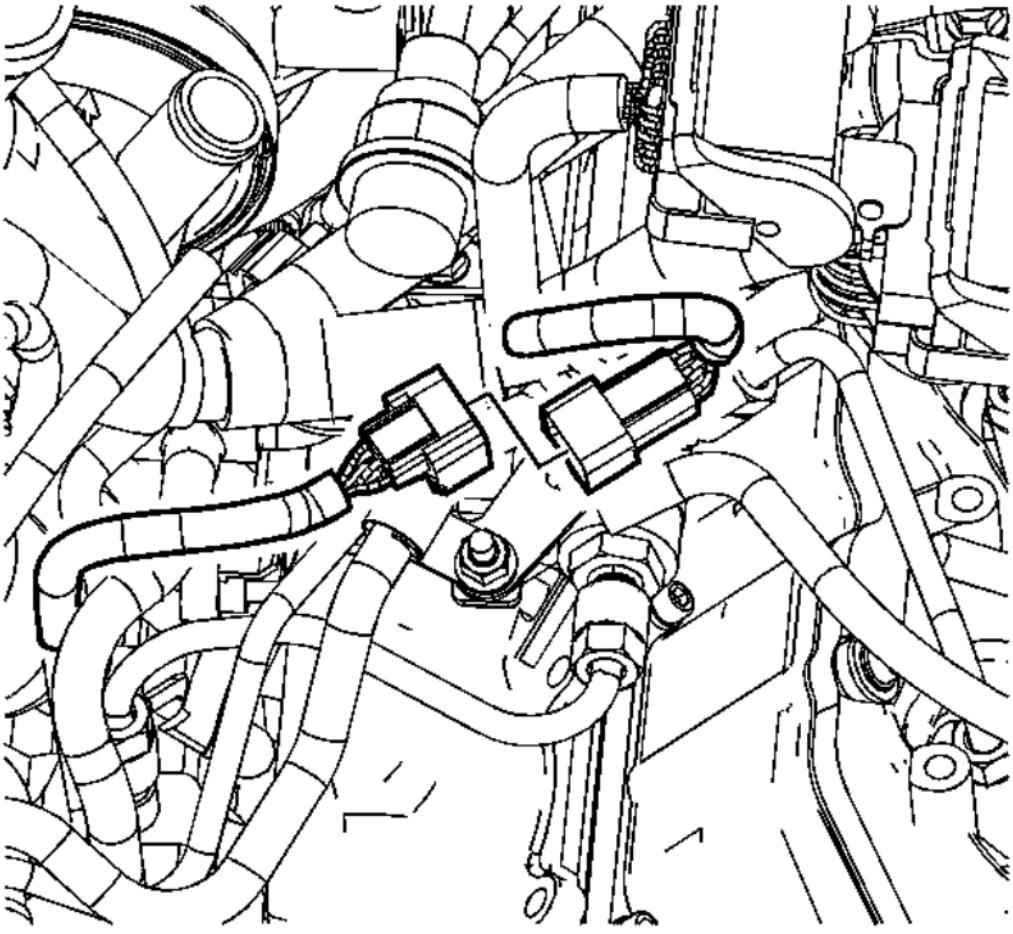


Fig. 61: View Of Oil Level Sensor Electrical Harness Connector
Courtesy of GENERAL MOTORS CORP.

11. Disconnect the oil level sensor electrical harness connector.

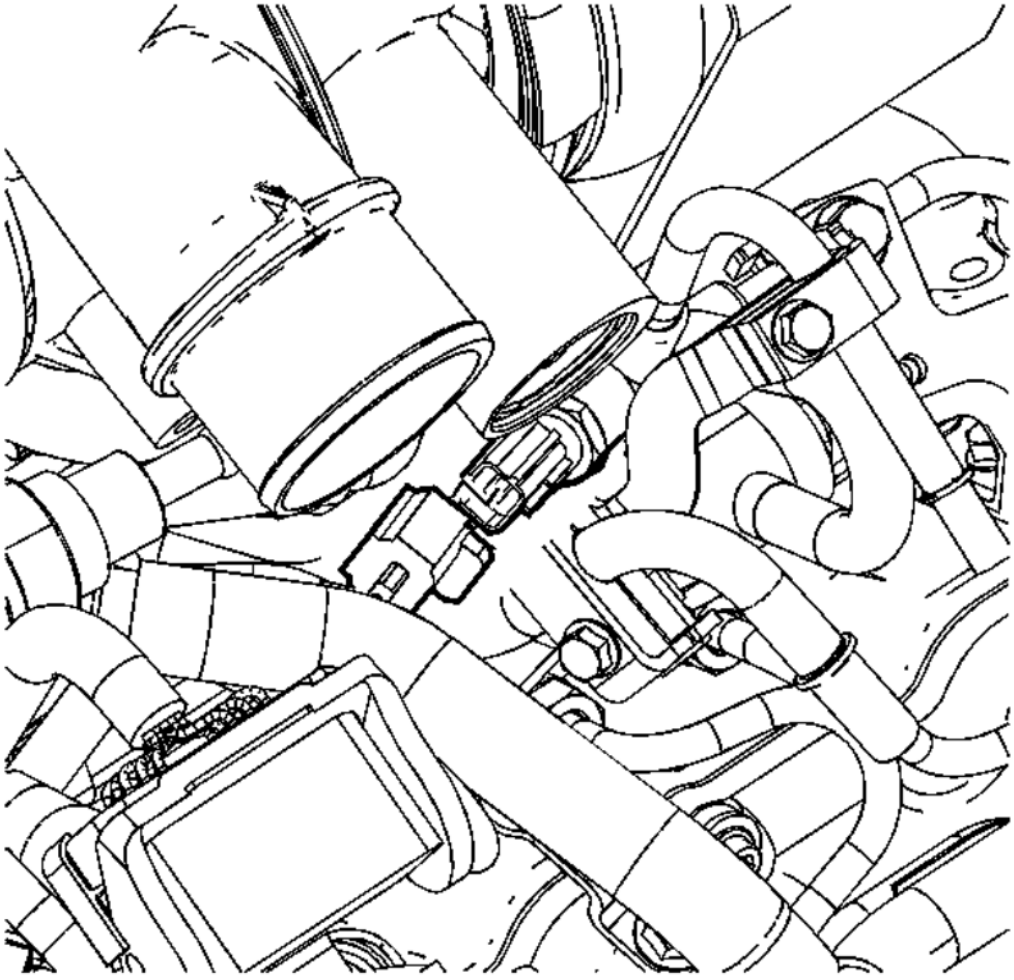


Fig. 62: View Of Fuel Temperature Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

12. Disconnect the fuel temperature sensor connector.

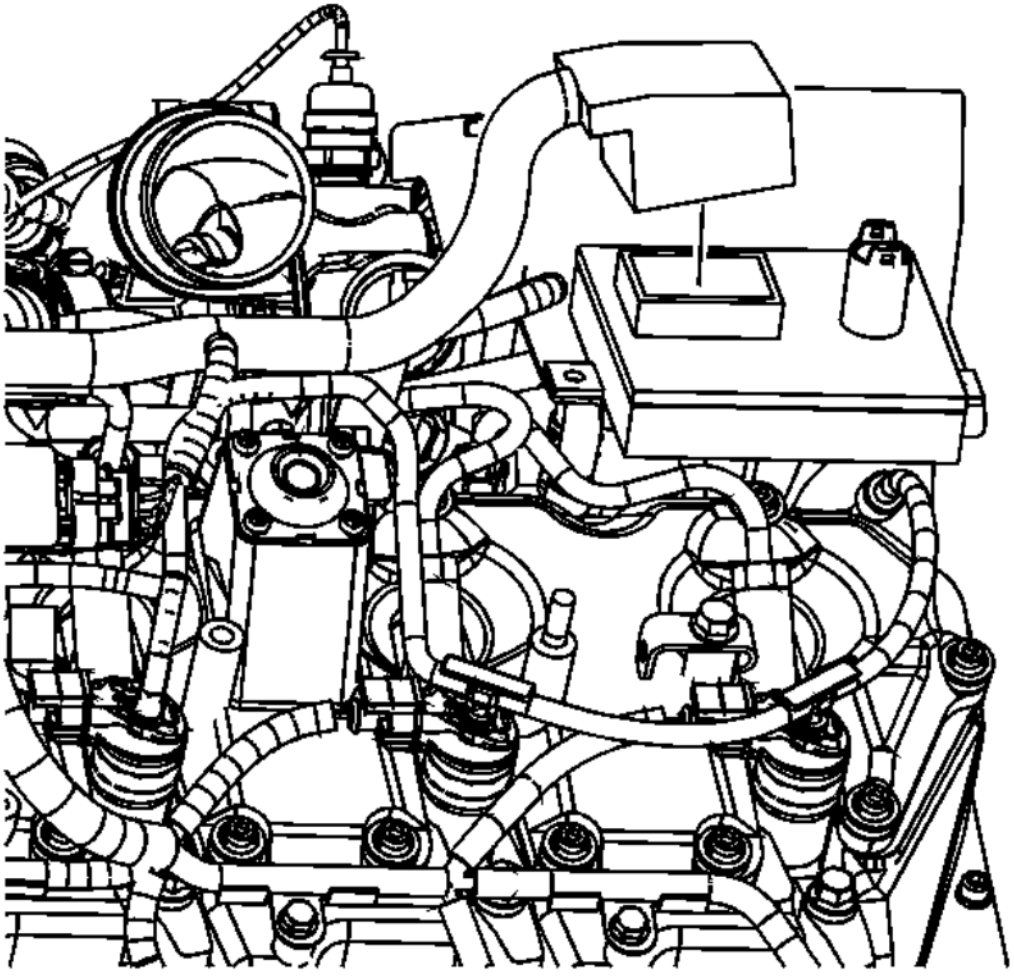


Fig. 63: Identifying Glow Plug Controller
Courtesy of GENERAL MOTORS CORP.

13. Disconnect the glow plug controller electrical connector.

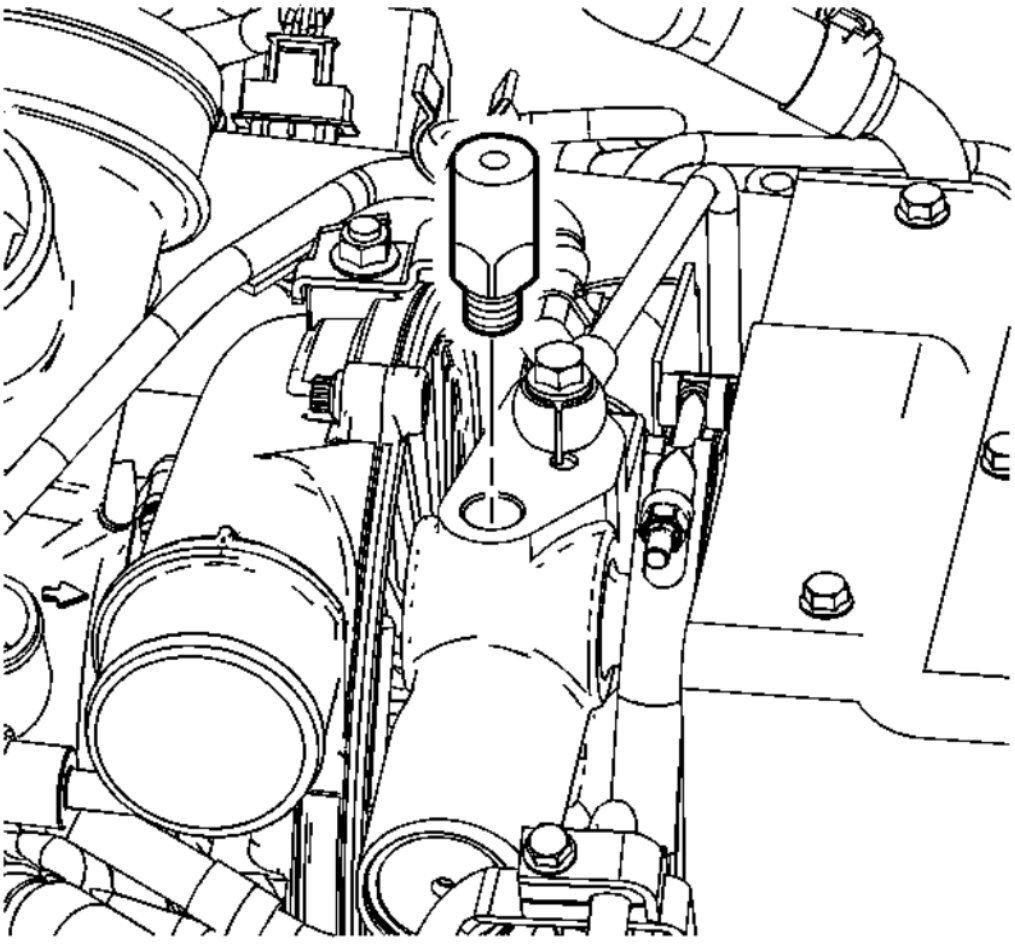


Fig. 64: View Of Turbocharger Vane Position Sensor
Courtesy of GENERAL MOTORS CORP.

14. Disconnect and remove the turbocharger vane positon sensor.

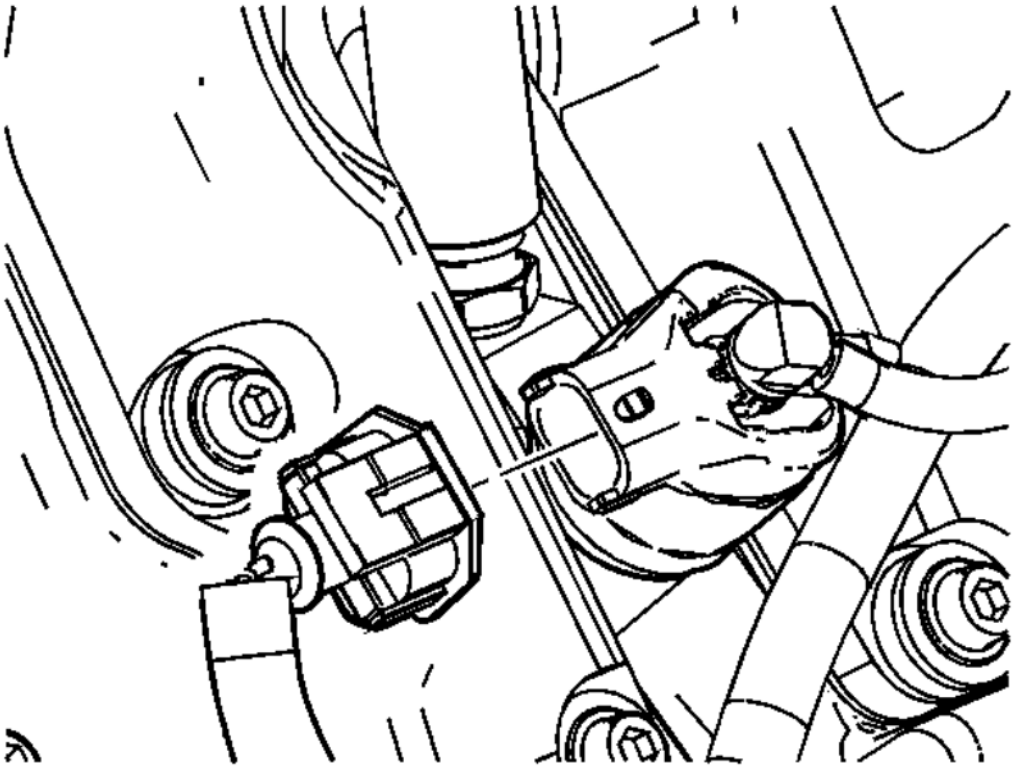


Fig. 65: View Of Fuel Injector Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

NOTE: Label all the injector electrical connectors before the connectors are removed in order to prevent reconnecting to the wrong injector. Failure to properly connect the injectors in the correct sequence will cause severe engine damage.

15. Disconnect the fuel injector electrical connections.

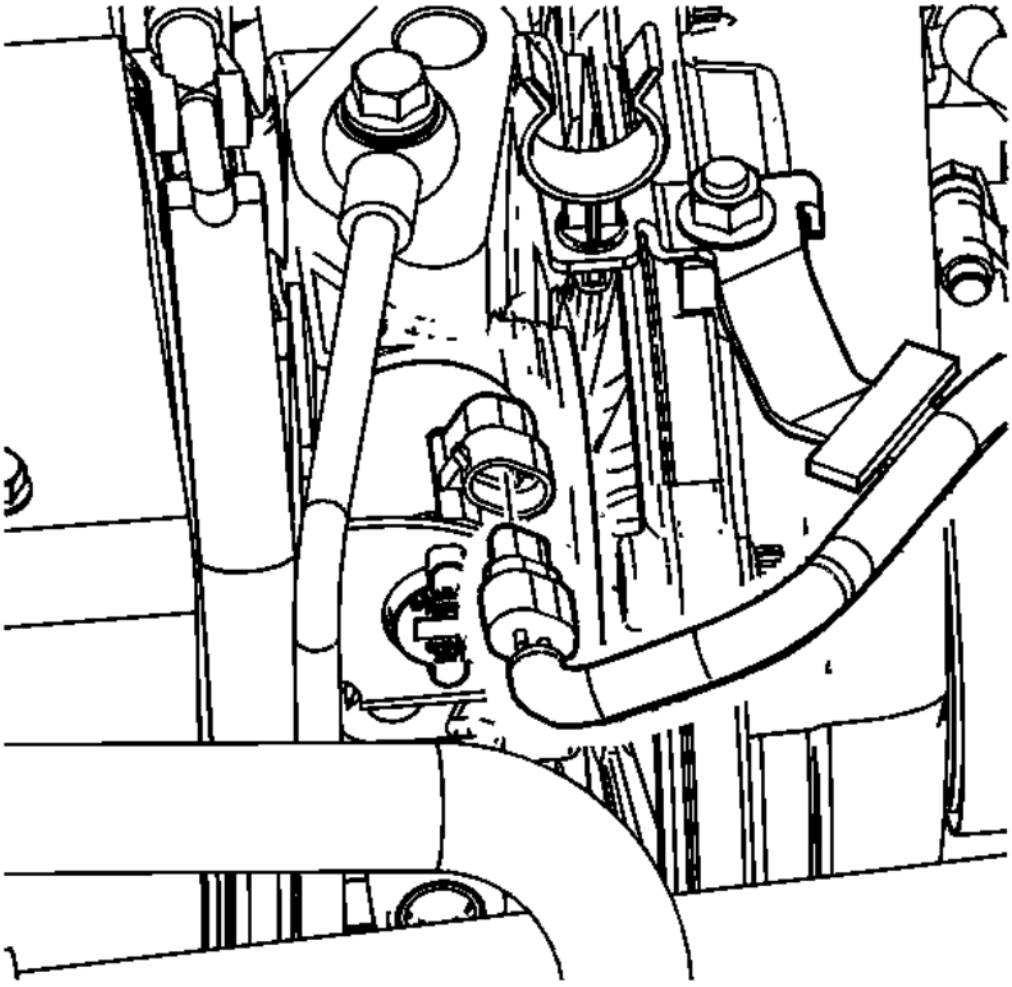


Fig. 66: View Of Turbocharger Vane Control Solenoid Valve & Electrical Connector
Courtesy of GENERAL MOTORS CORP.

16. Disconnect the turbocharger vane control solenoid valve.

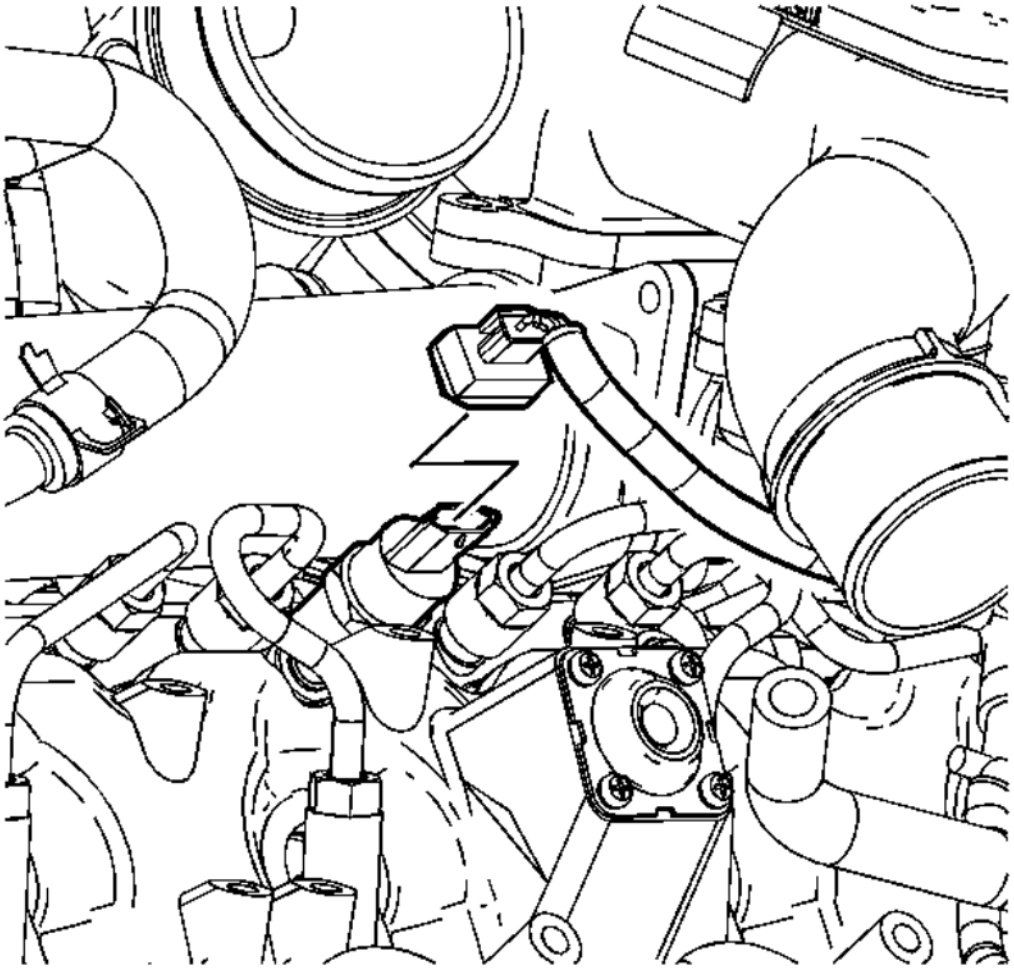


Fig. 67: View Of Fuel Rail Pressure Sensor And Electrical Connector
Courtesy of GENERAL MOTORS CORP.

17. Disconnect the fuel rail pressure sensor.

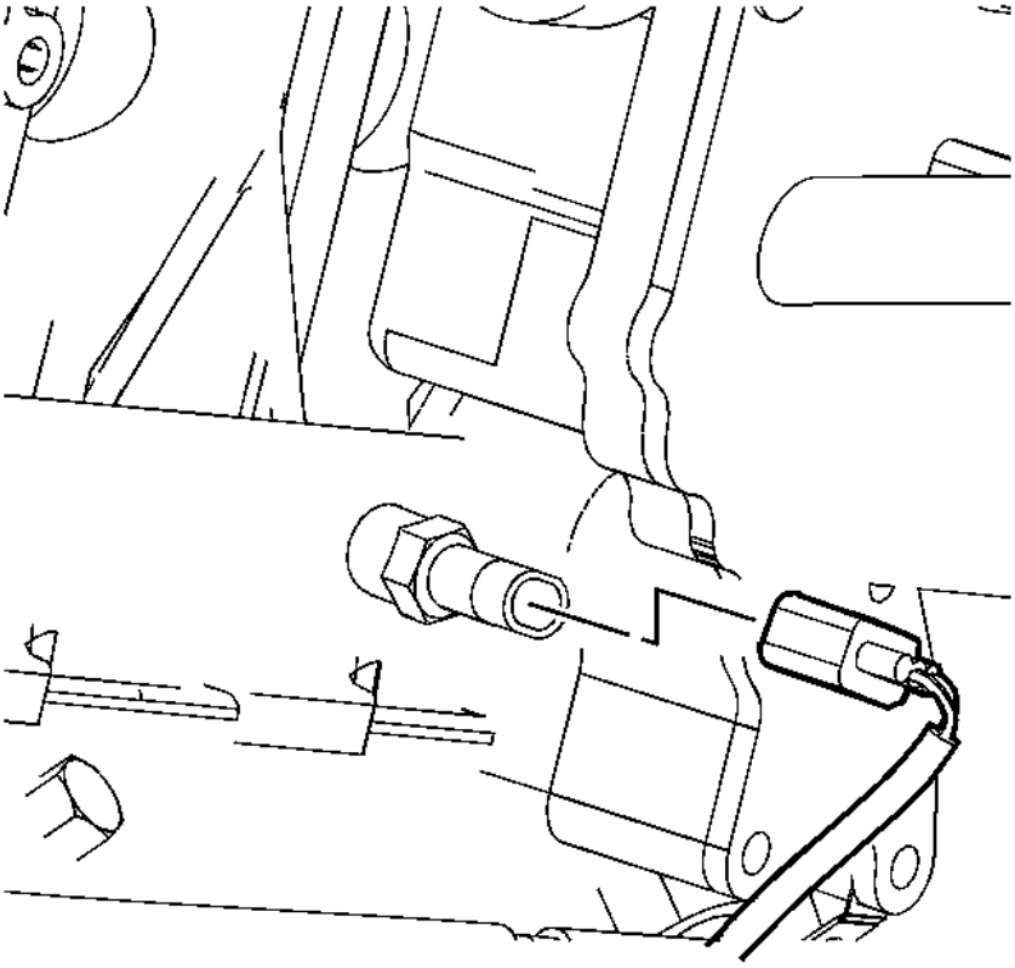


Fig. 68: View Of Oil Pressure Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

18. Disconnect the oil pressure sensor electrical connector.

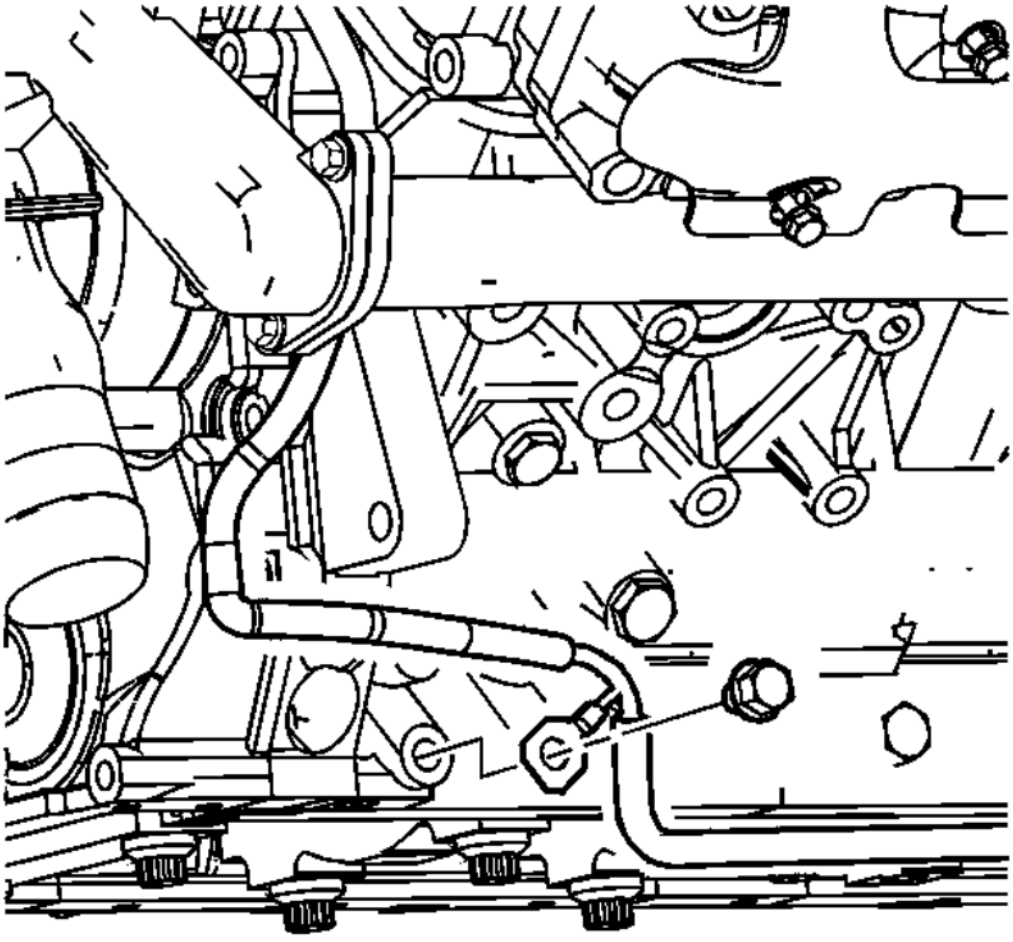


Fig. 69: View Of Oil Level Sensor Harness Bolt
Courtesy of GENERAL MOTORS CORP.

19. Remove the oil level sensor harness bolt.

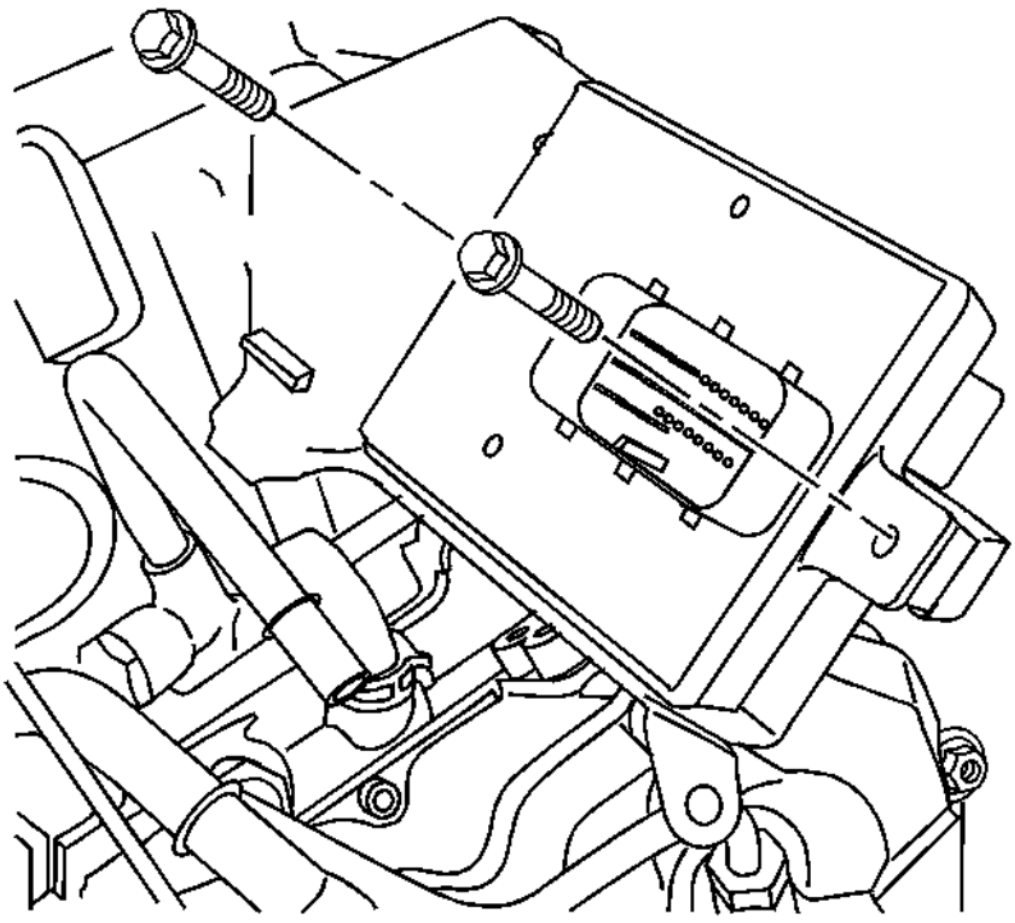


Fig. 70: Identifying glow Plug Controller Bolts
Courtesy of GENERAL MOTORS CORP.

20. Remove the glow plug controller bolts.
21. Remove the glow plug controller.
22. Remove the glow plug controller shield bolts.
23. Remove the glow plug controller shield.

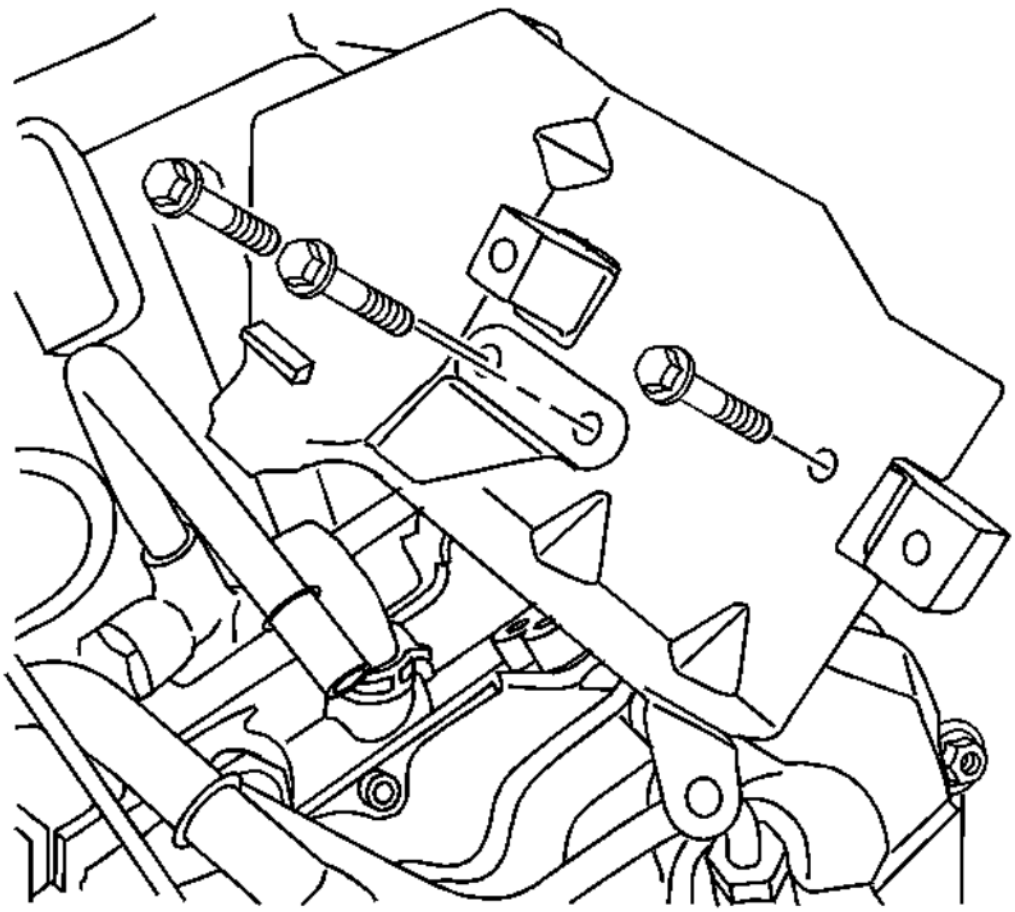


Fig. 71: Glow Plug Controller Bracket Bolt
Courtesy of GENERAL MOTORS CORP.

24. Remove the glow plug controller bracket bolts.

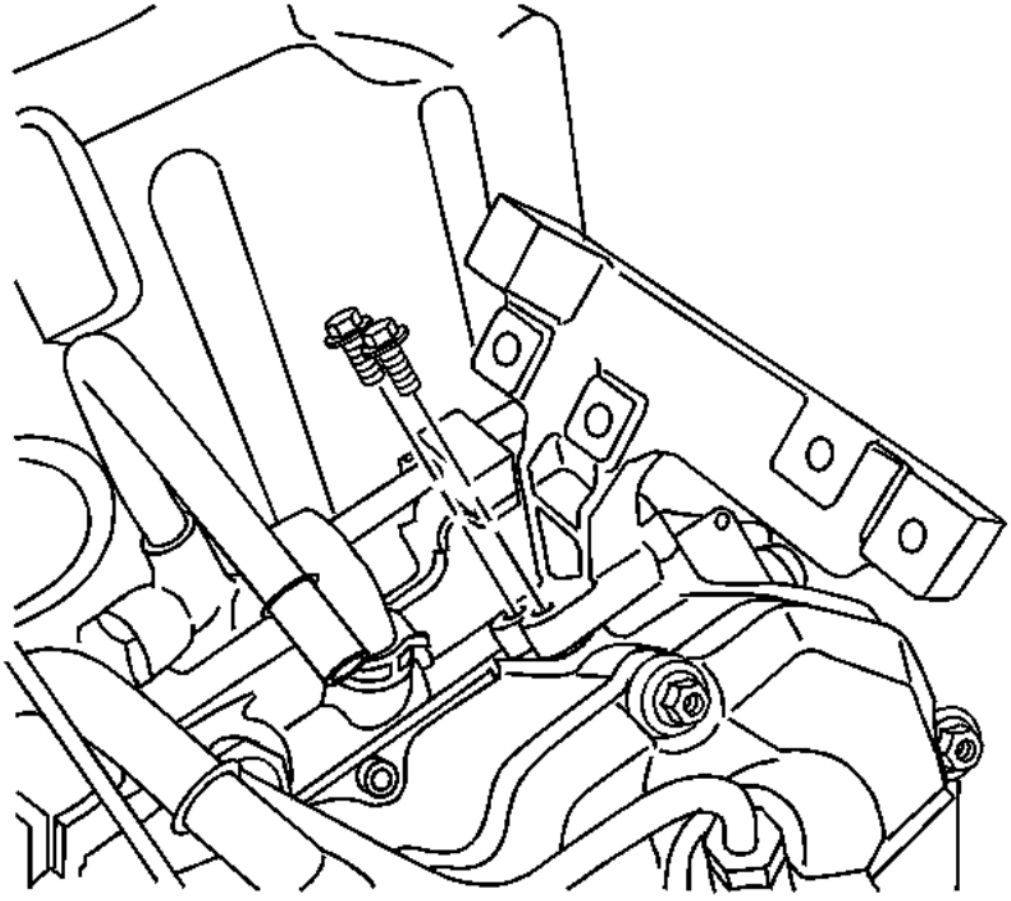


Fig. 72: Identifying Glow Plug Controller Bracket
Courtesy of GENERAL MOTORS CORP.

25. Remove the glow plug controller bracket.

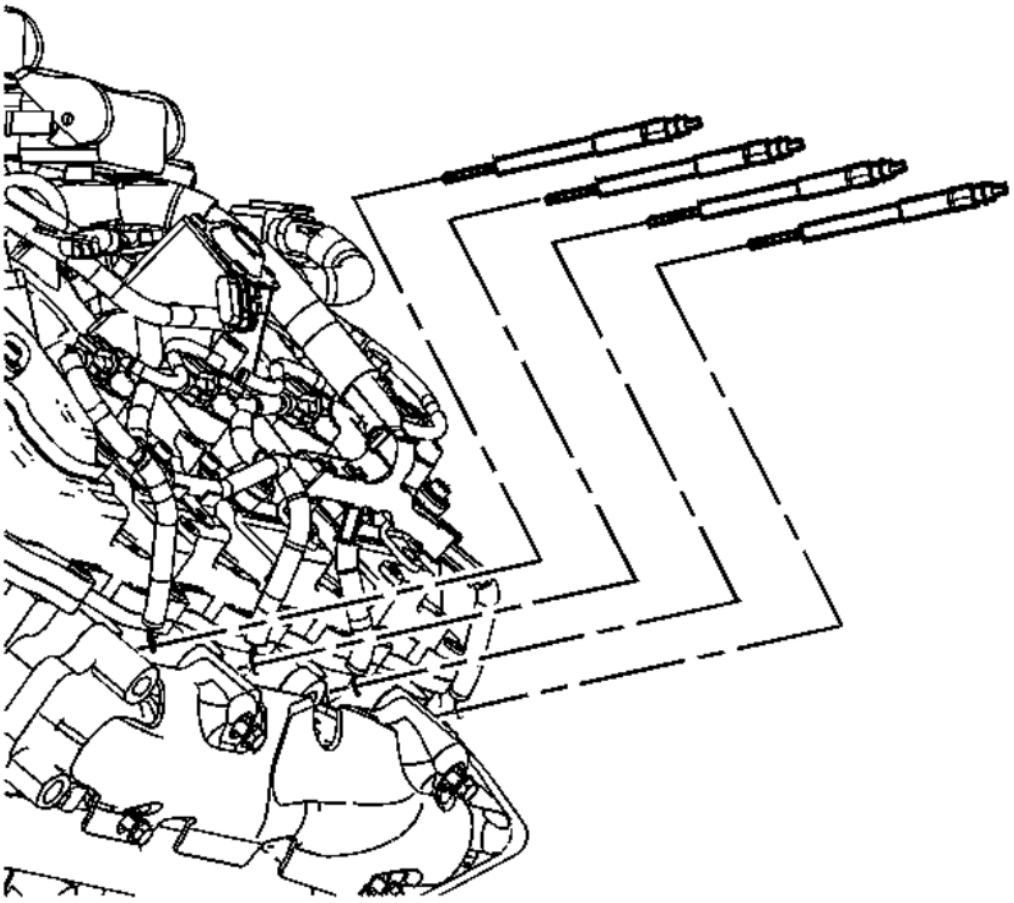


Fig. 73: View Of Left Glow Plugs
Courtesy of GENERAL MOTORS CORP.

26. Remove the left glow plugs.

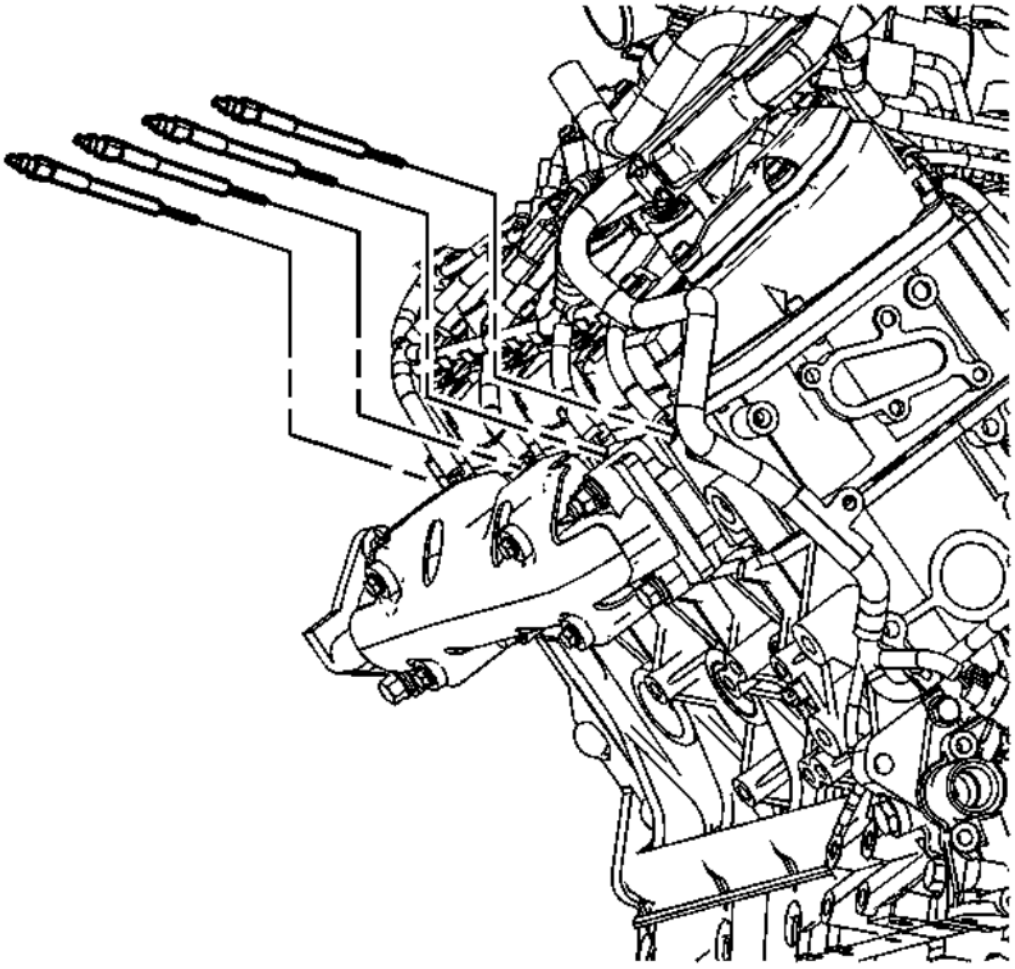


Fig. 74: View Of Right Glow Plugs
Courtesy of GENERAL MOTORS CORP.

27. Remove the right glow plugs.

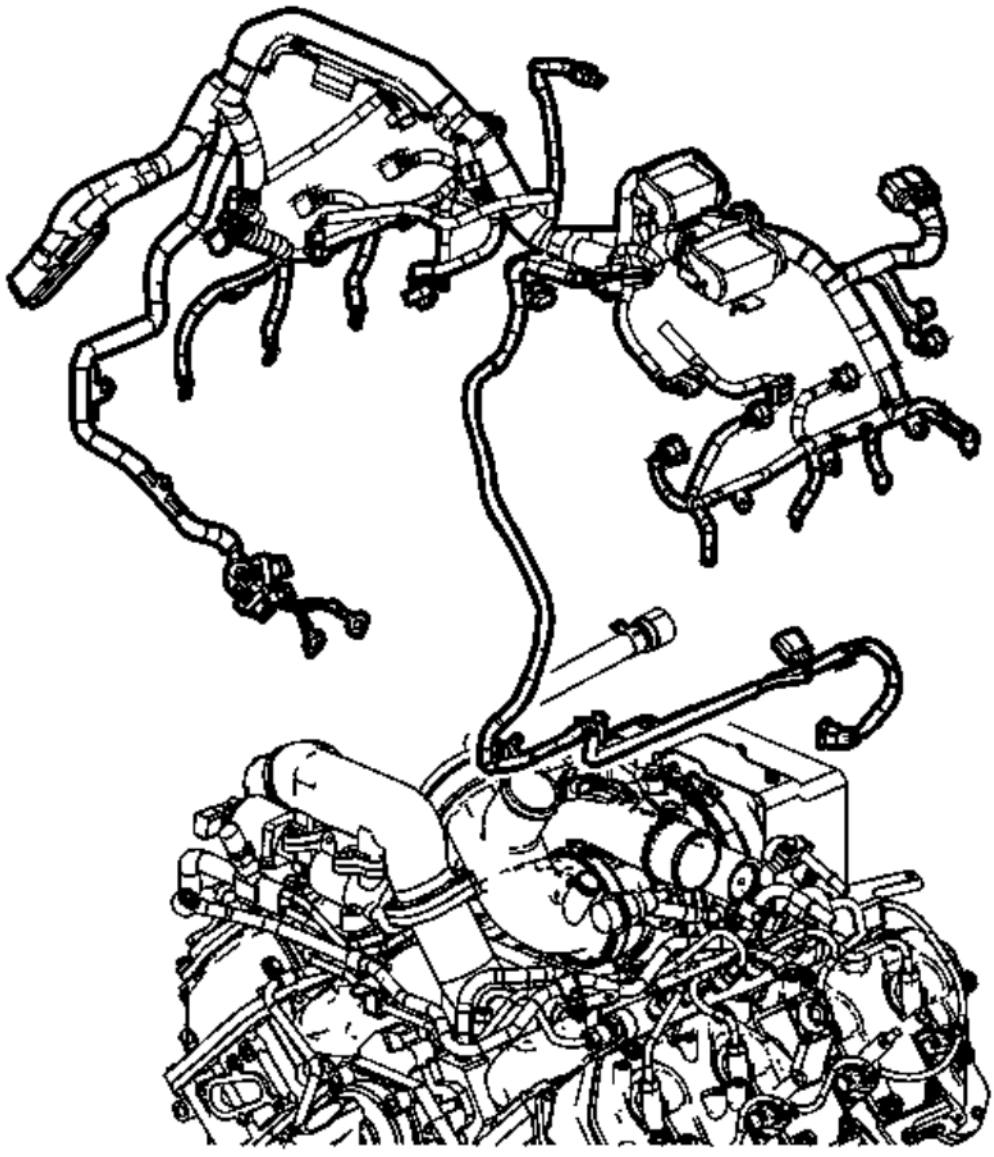


Fig. 75: View Of Fuel Injector Control Module Harness
Courtesy of GENERAL MOTORS CORP.

28. Remove the engine wiring harness.

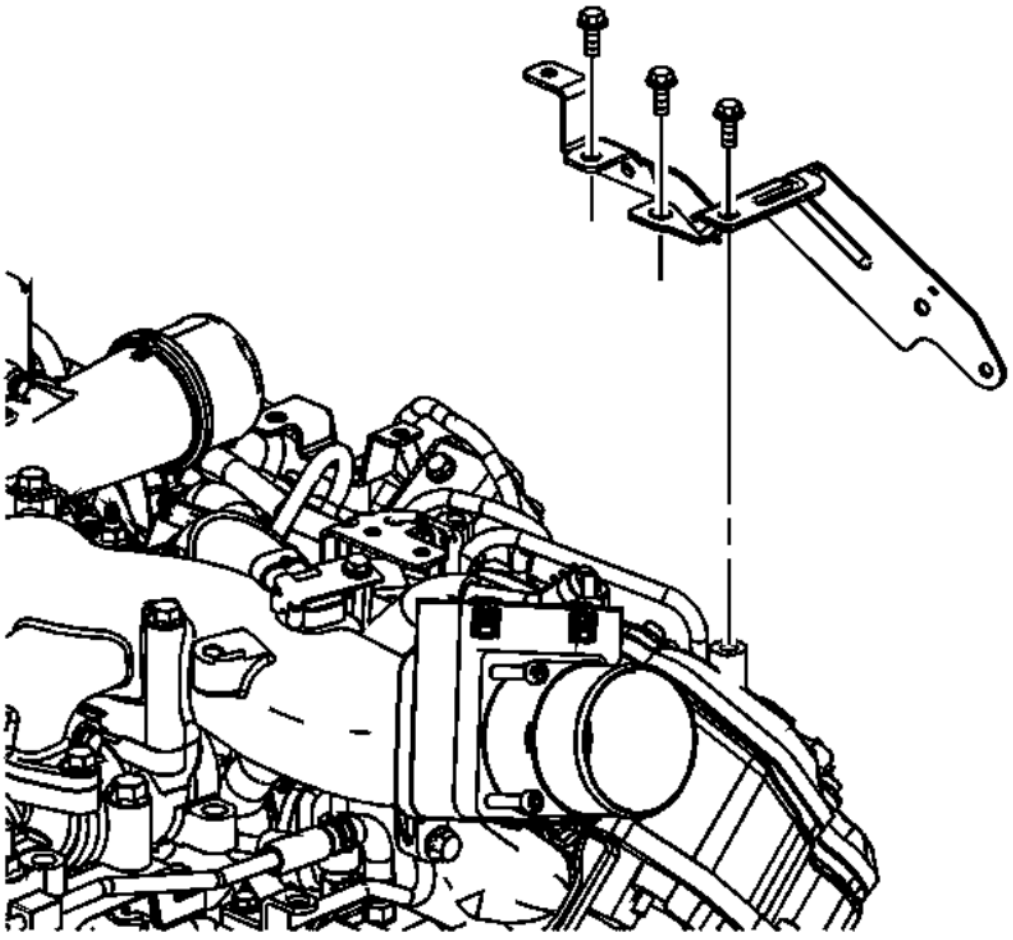


Fig. 76: Identifying Engine Harness Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

29. Remove the engine harness bracket bolts.
30. Remove the engine harness bracket.

EXHAUST GAS RECIRCULATION AND COOLER REMOVAL

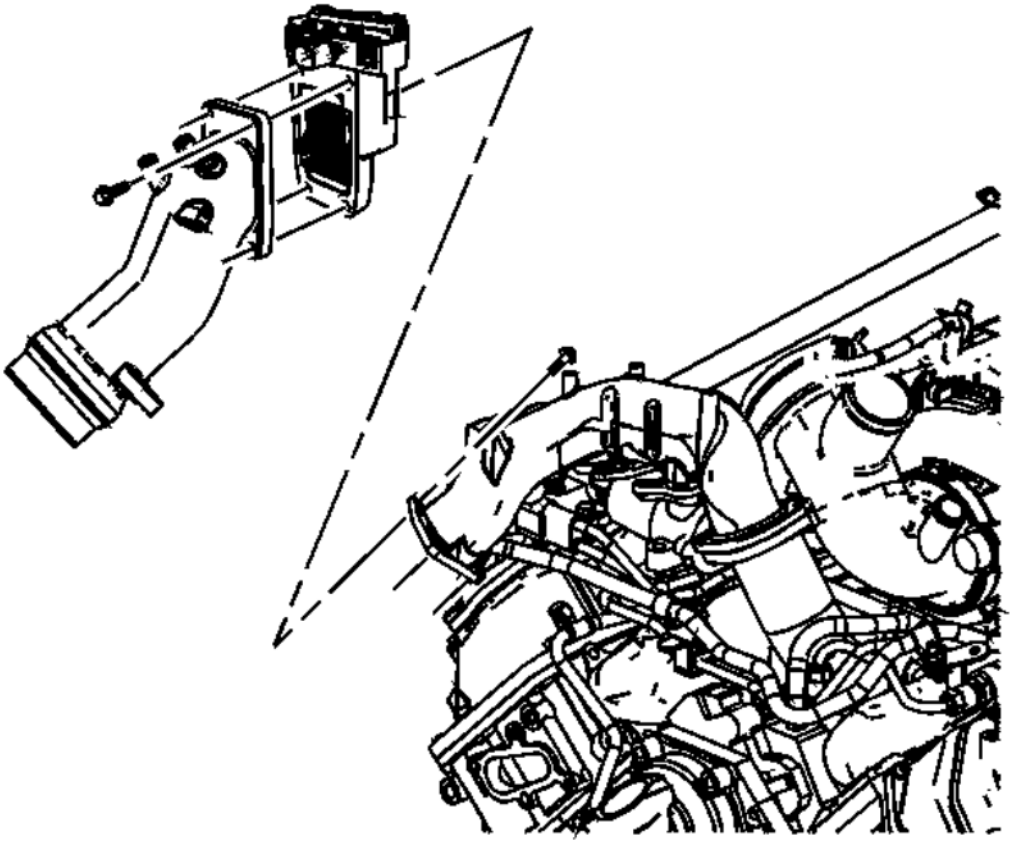


Fig. 77: Identifying Intake Pipe
Courtesy of GENERAL MOTORS CORP.

1. Remove the intake pipe to air inlet tube bolts.
2. Remove the intake pipe.
3. Remove the intake heater.

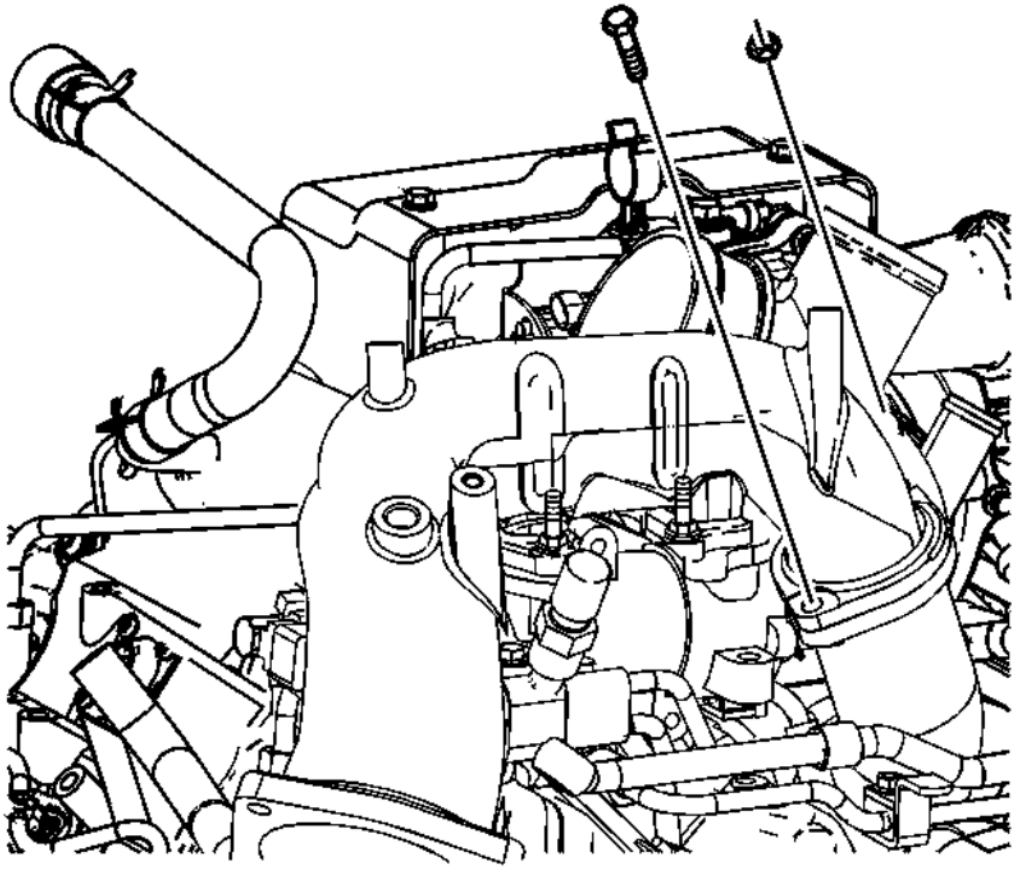


Fig. 78: View Of Air Inlet Tube Bolt And Nut
Courtesy of GENERAL MOTORS CORP.

4. Remove the air inlet tube to intake manifold tube bolt and nut.

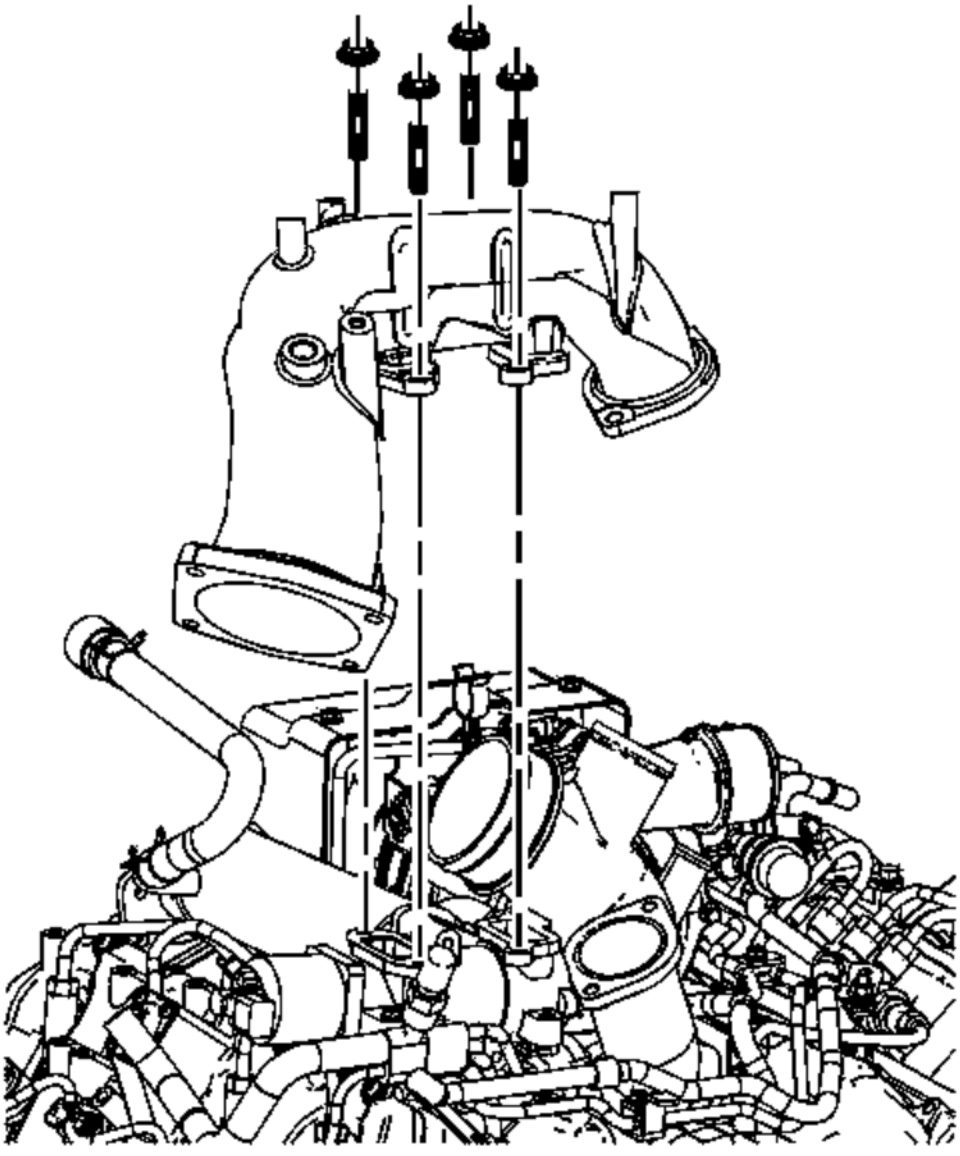


Fig. 79: View Of Air Inlet Tube
Courtesy of GENERAL MOTORS CORP.

5. Remove the air inlet tube nuts.
6. Remove the air inlet tube.

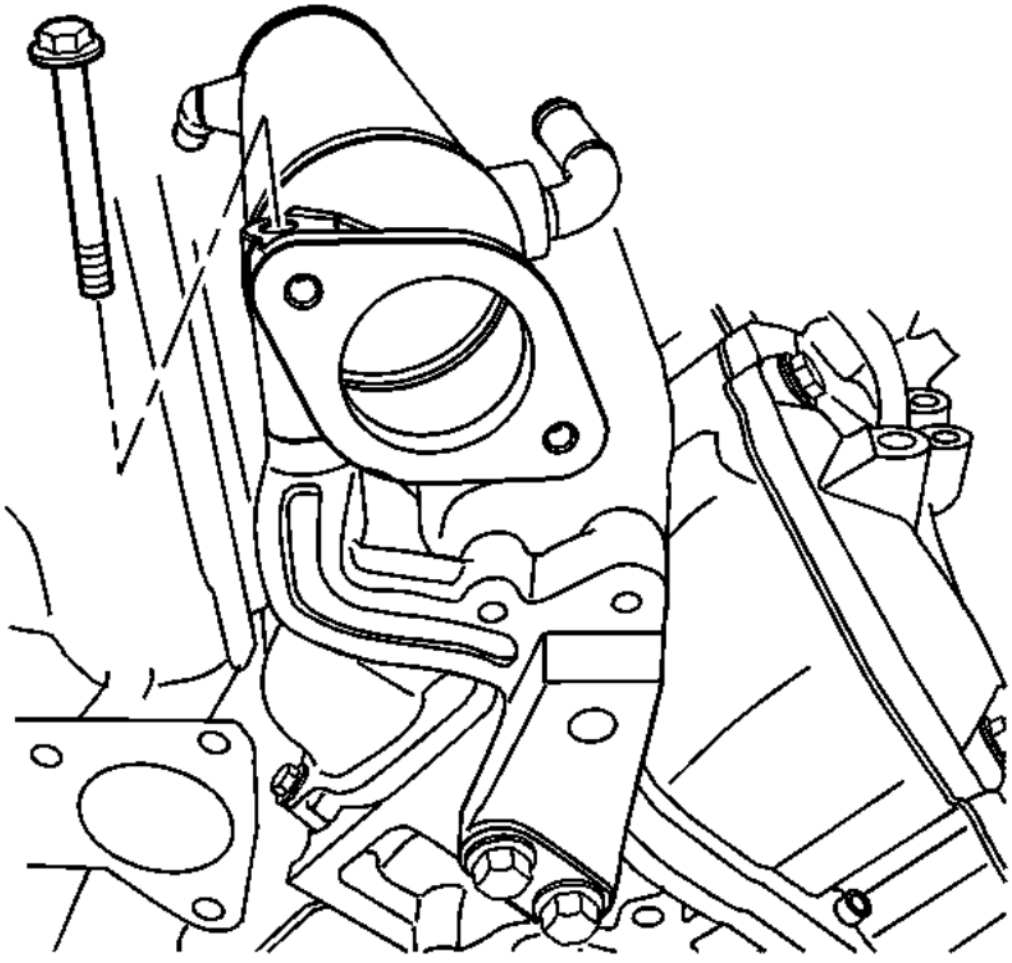


Fig. 80: View Of EGR Cooler
Courtesy of GENERAL MOTORS CORP.

7. Remove the rear EGR cooler bolts.

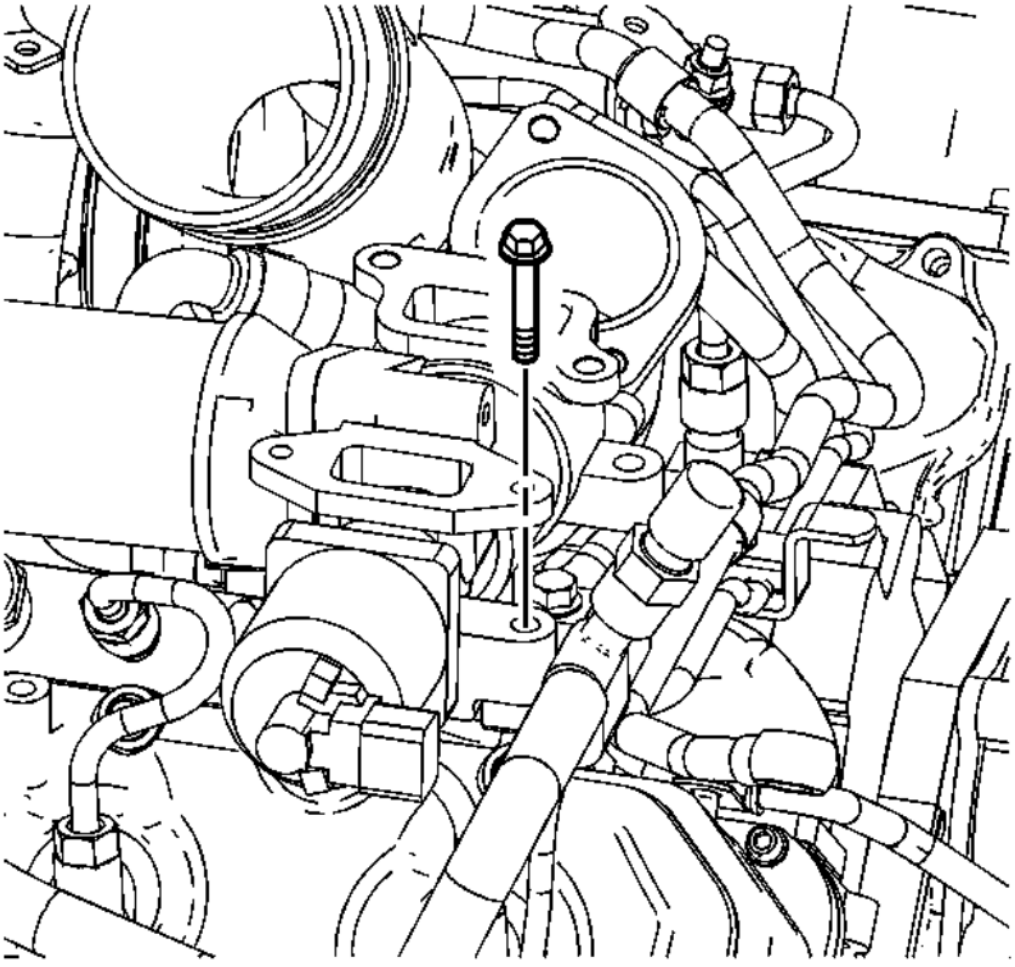


Fig. 81: View Of EGR Mount Bolt
Courtesy of GENERAL MOTORS CORP.

8. Remove the EGR mount bolt.

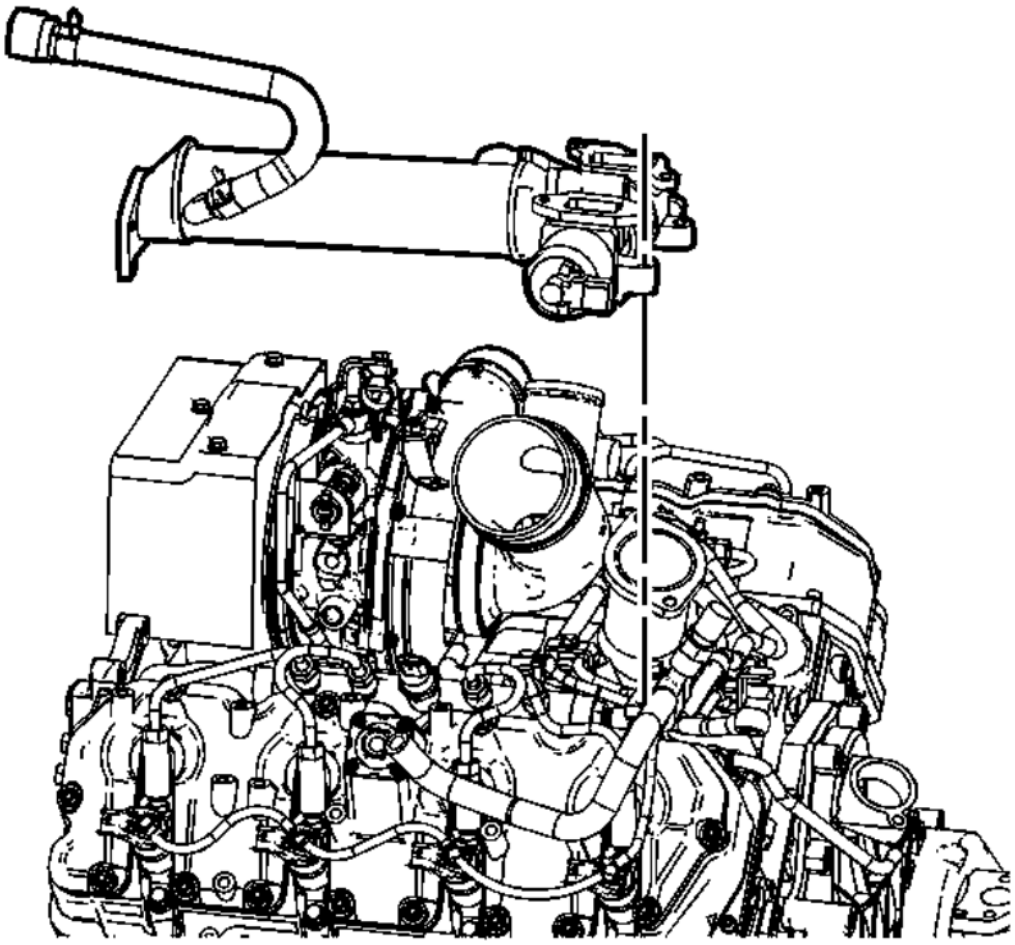


Fig. 82: View Of EGR & Cooler
Courtesy of GENERAL MOTORS CORP.

9. Remove the EGR and cooler.

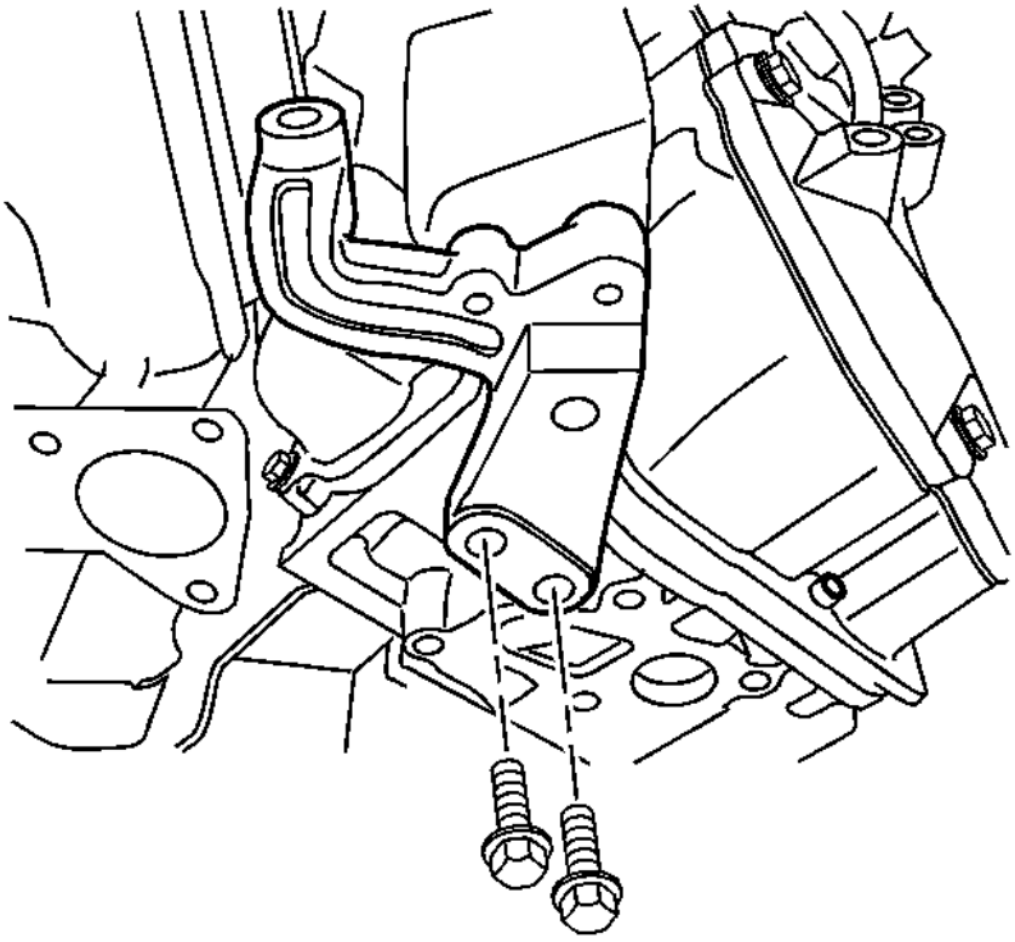


Fig. 83: Identifying EGR Cooler Bracket
Courtesy of GENERAL MOTORS CORP.

10. Remove the EGR cooler bracket bolts.
11. Remove the EGR cooler bracket.

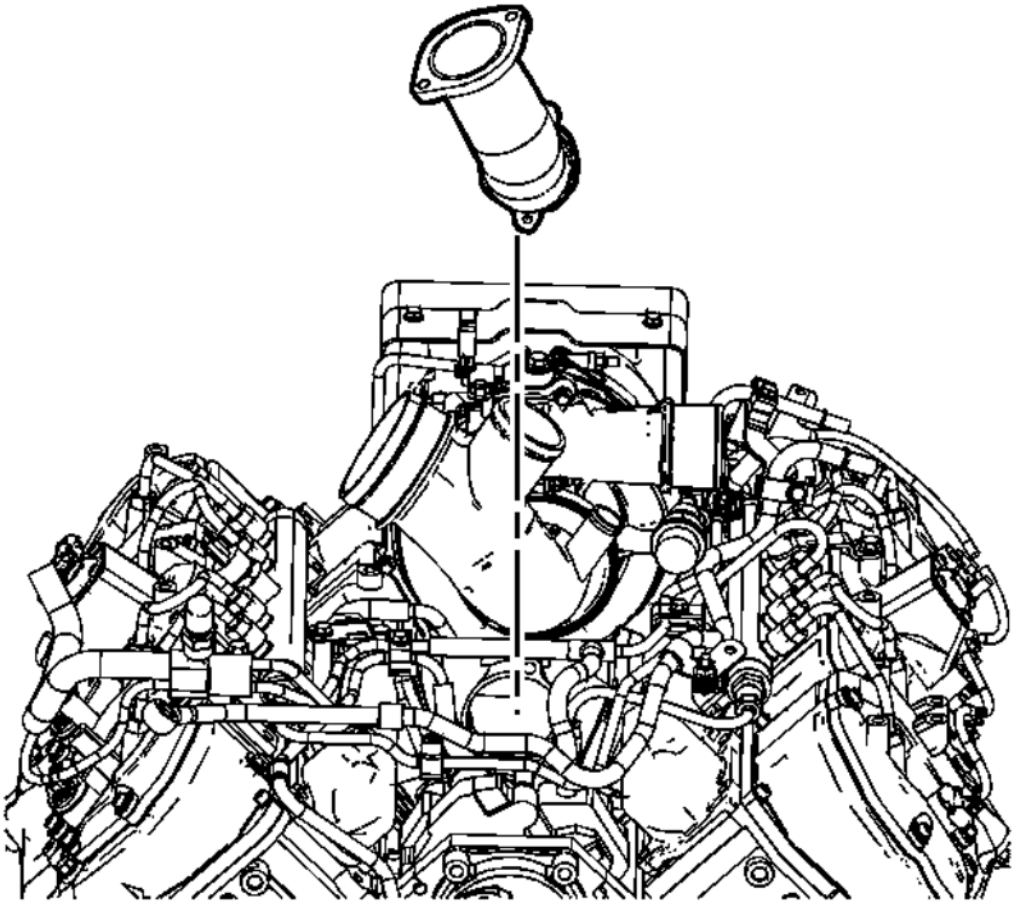


Fig. 84: View Of Intake Manifold Tube
Courtesy of GENERAL MOTORS CORP.

12. Remove the intake manifold tube.

TURBOCHARGER REMOVAL

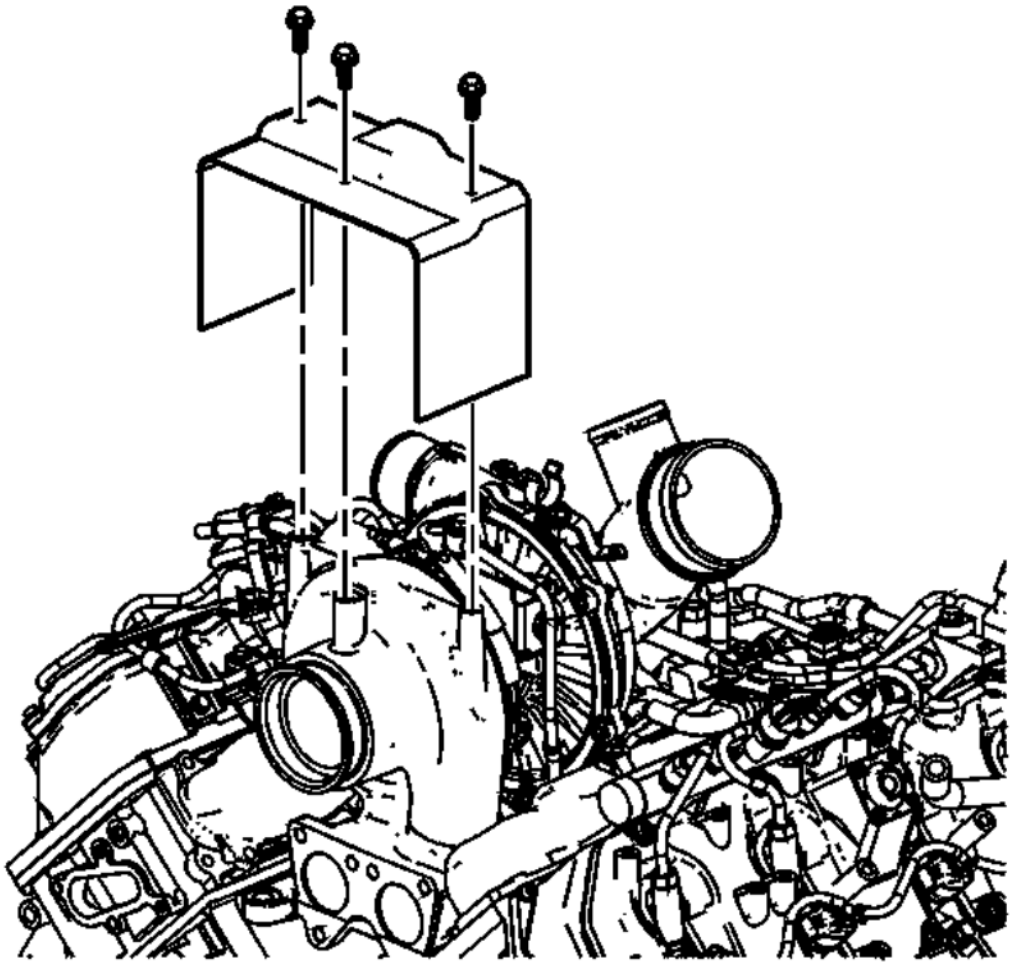


Fig. 85: View Of Turbocharger Upper Heat Shield
Courtesy of GENERAL MOTORS CORP.

1. Remove the turbocharger upper heat shield bolts.
2. Remove the turbocharger upper heat shield.

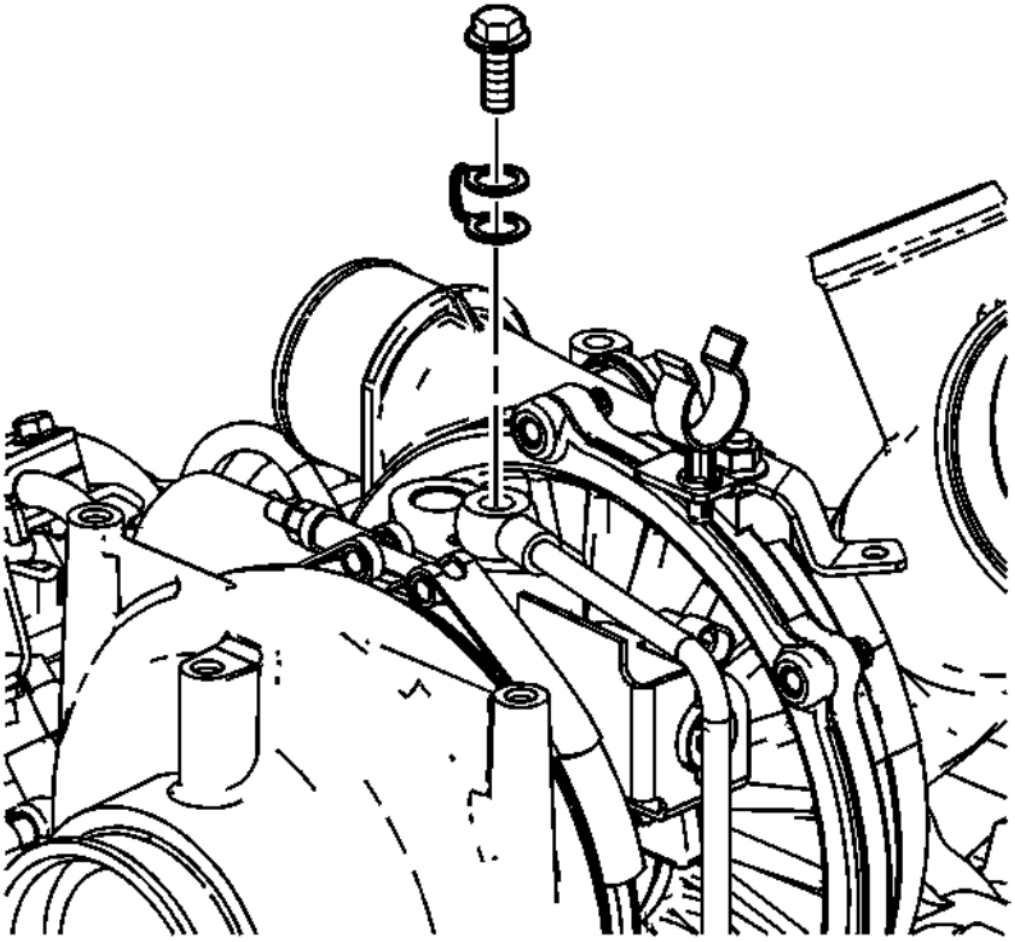


Fig. 86: View Of Turbocharger Oil Feed Pipe Banjo Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not twist the turbocharger oil feed pipe. Twisting of the feed pipe will result in the collapse and deformation of the plastic pipe, restricting oil flow and causing turbocharger damage. During turbocharger replacement, gently push the oil feed pipe towards the front of the engine to clear the turbocharger. Assistance may be required to keep the pipes clear of the turbocharger during removal or installation.

3. Remove the eye bolt and washers from the oil supply hose at the top of the turbocharger.

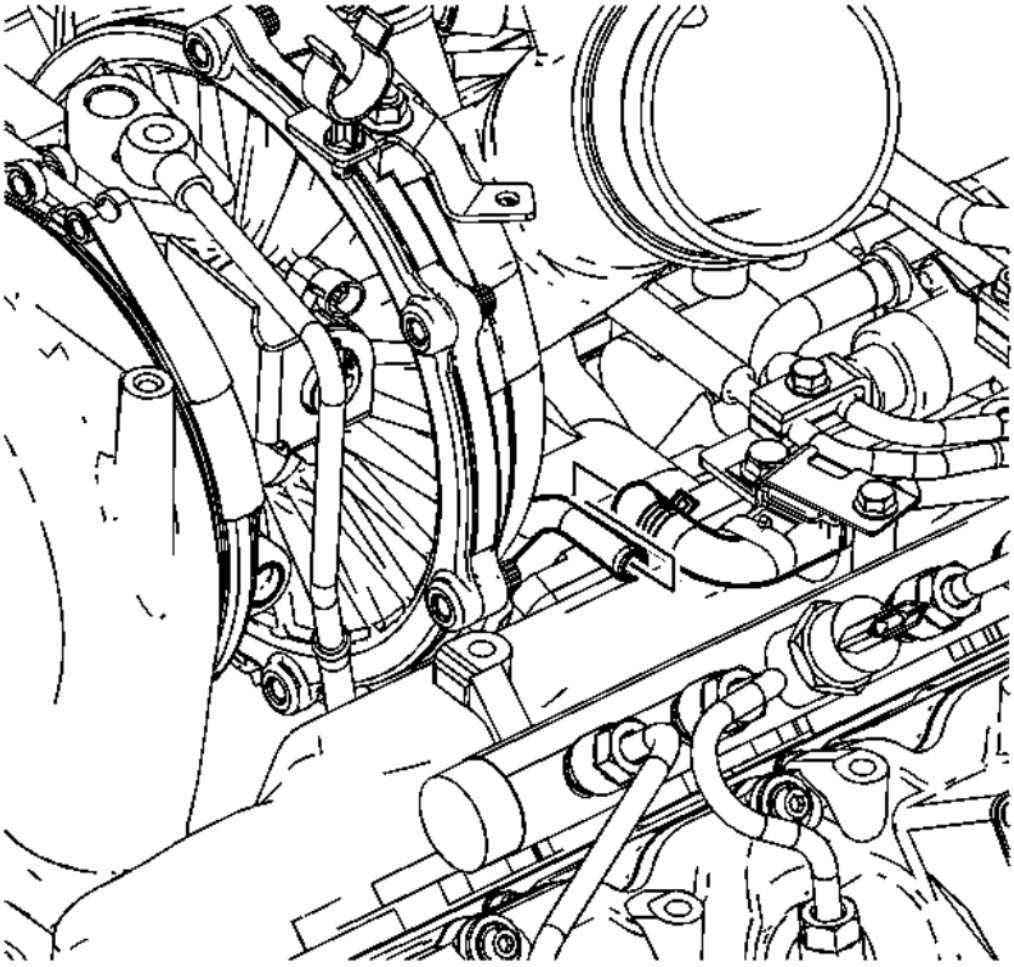


Fig. 87: View Of Turbocharger Outlet Coolant Pipe
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Use care not to damage this hose during the procedure.

4. Loosen the hose clamp and remove the turbocharger cooling outlet hose.

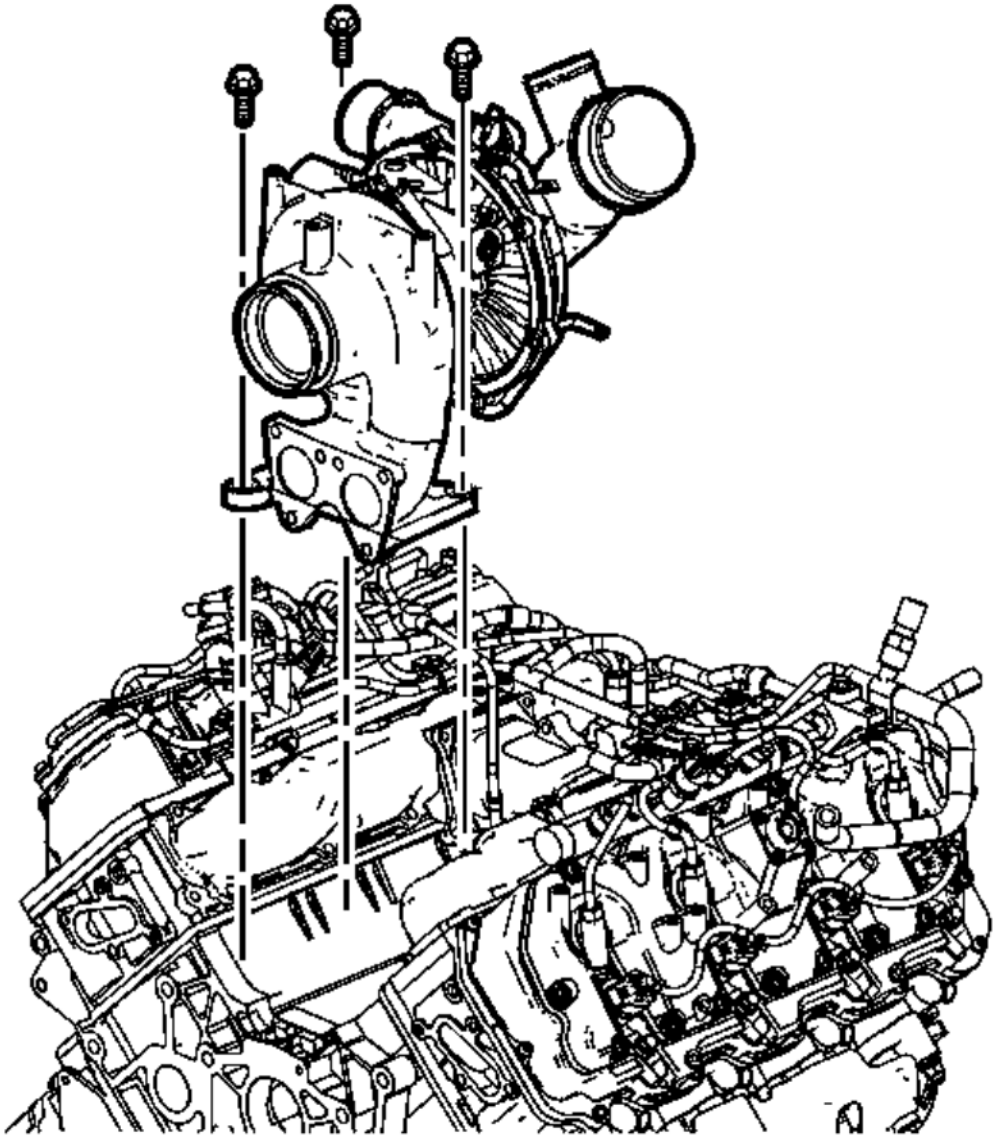


Fig. 88: View Of Turbocharger W/Oil Return Pipe
Courtesy of GENERAL MOTORS CORP.

5. Remove the turbocharger mounting bolts.
6. Remove the turbocharger assembly with the oil return pipe.

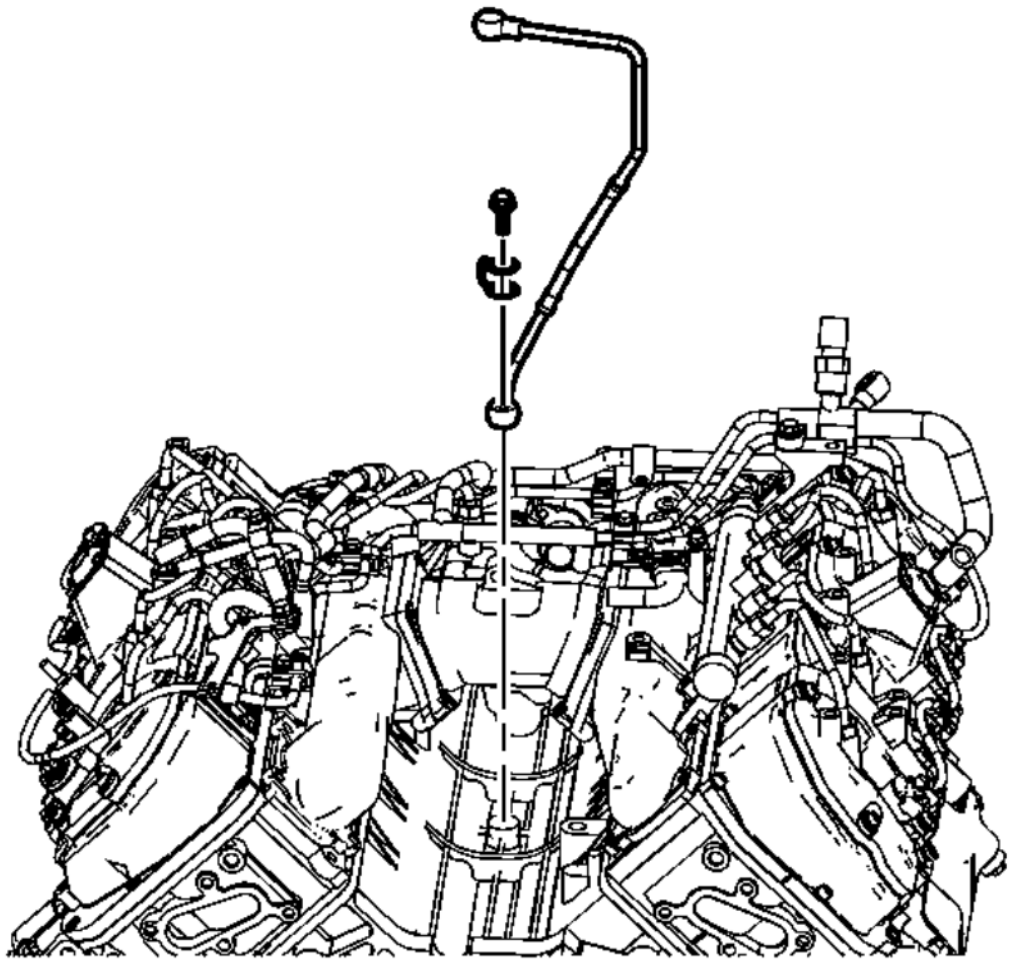


Fig. 89: View Of Oil Feed Pipe Bolt, Washer & Pipe
Courtesy of GENERAL MOTORS CORP.

7. Remove the turbocharger lower heat shield from engine block.

NOTE: Do not twist the turbocharger oil feed pipe. Twisting of the feed pipe will result in the collapse and deformation of the plastic pipe, restricting oil flow and causing turbocharger damage. During turbocharger replacement, gently push the oil feed pipe towards the front of the engine to clear the turbocharger. Assistance may be required to keep the pipes clear of the

turbocharger during removal or installation.

8. Remove the turbocharger oil supply hose eye bolt and washers.
9. Remove the turbocharger oil supply hose.

FUEL PIPES AND FUEL RAIL REMOVAL

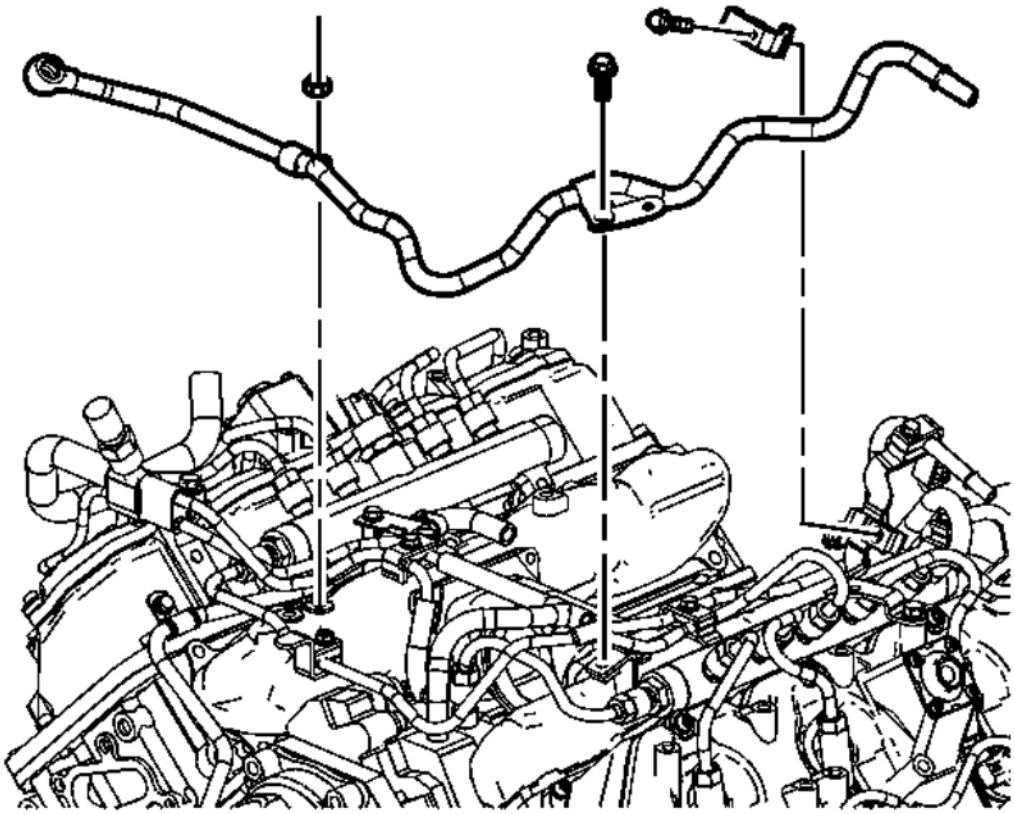


Fig. 90: View Of Fuel Feed Pipe & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the fuel feed pipe attaching nuts and bolts.
2. Remove the fuel feed pipe.

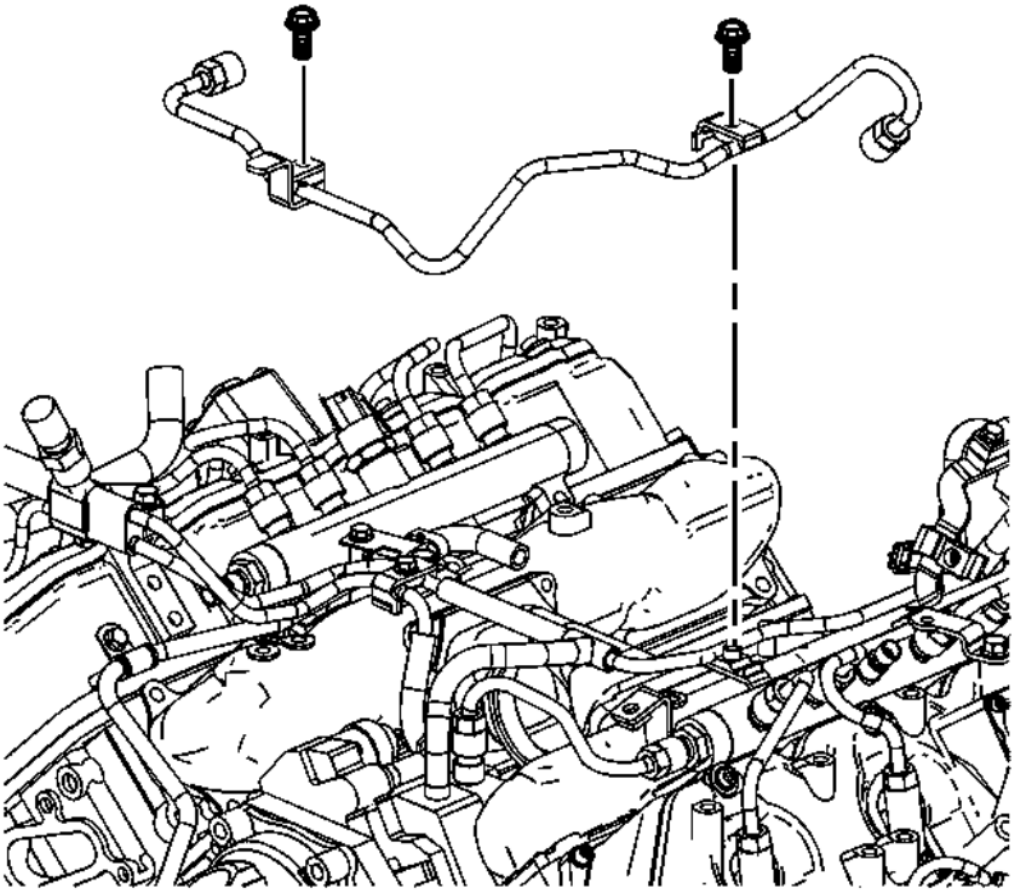


Fig. 91: View Of Fuel Rail Balance Pipe & Bolts
Courtesy of GENERAL MOTORS CORP.

3. Disconnect the fuel rail balance pipe from fuel rails.
4. Remove the fuel rail balance pipe bolts.
5. Remove the fuel rail balance pipe.

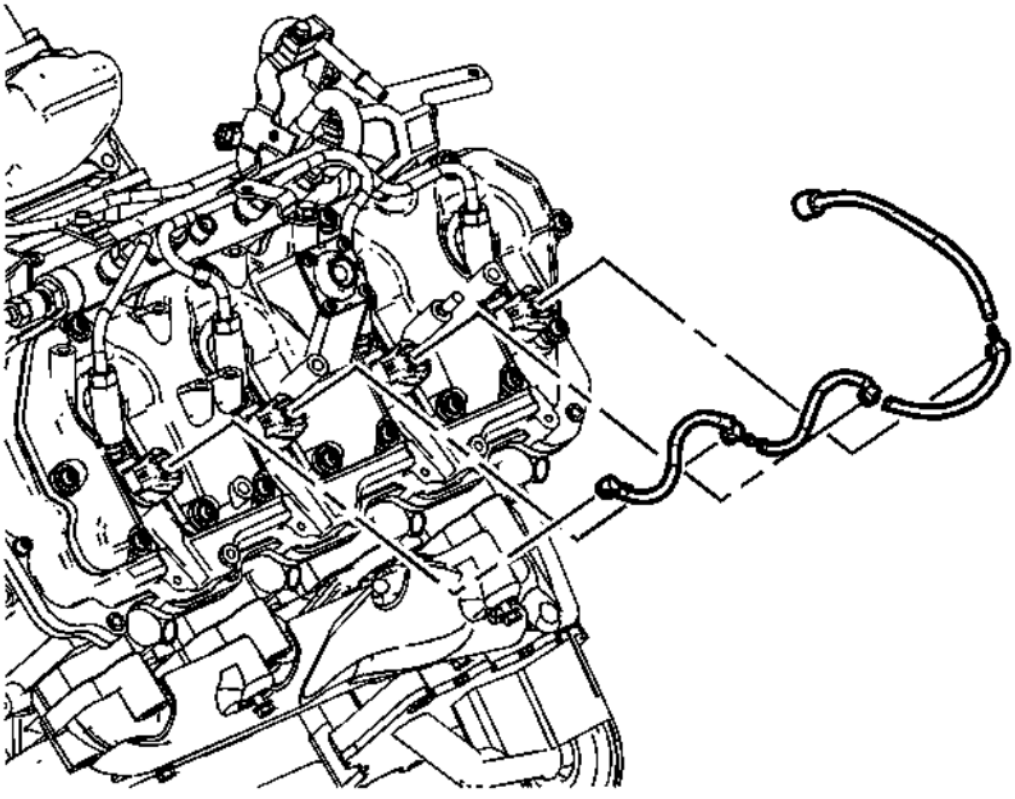


Fig. 92: View Of Fuel Return Hose & Injectors
Courtesy of GENERAL MOTORS CORP.

6. Remove the left fuel return hose.

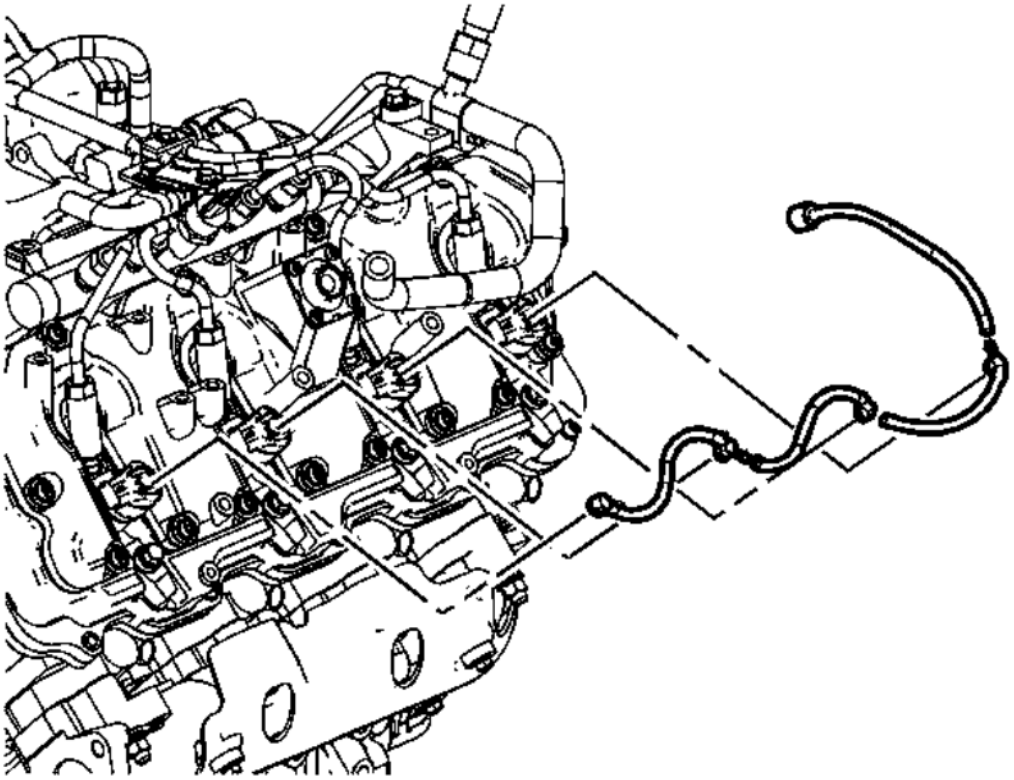


Fig. 93: View Of Right Fuel Return Hose & Injectors
Courtesy of GENERAL MOTORS CORP.

7. Remove the right fuel return hose.

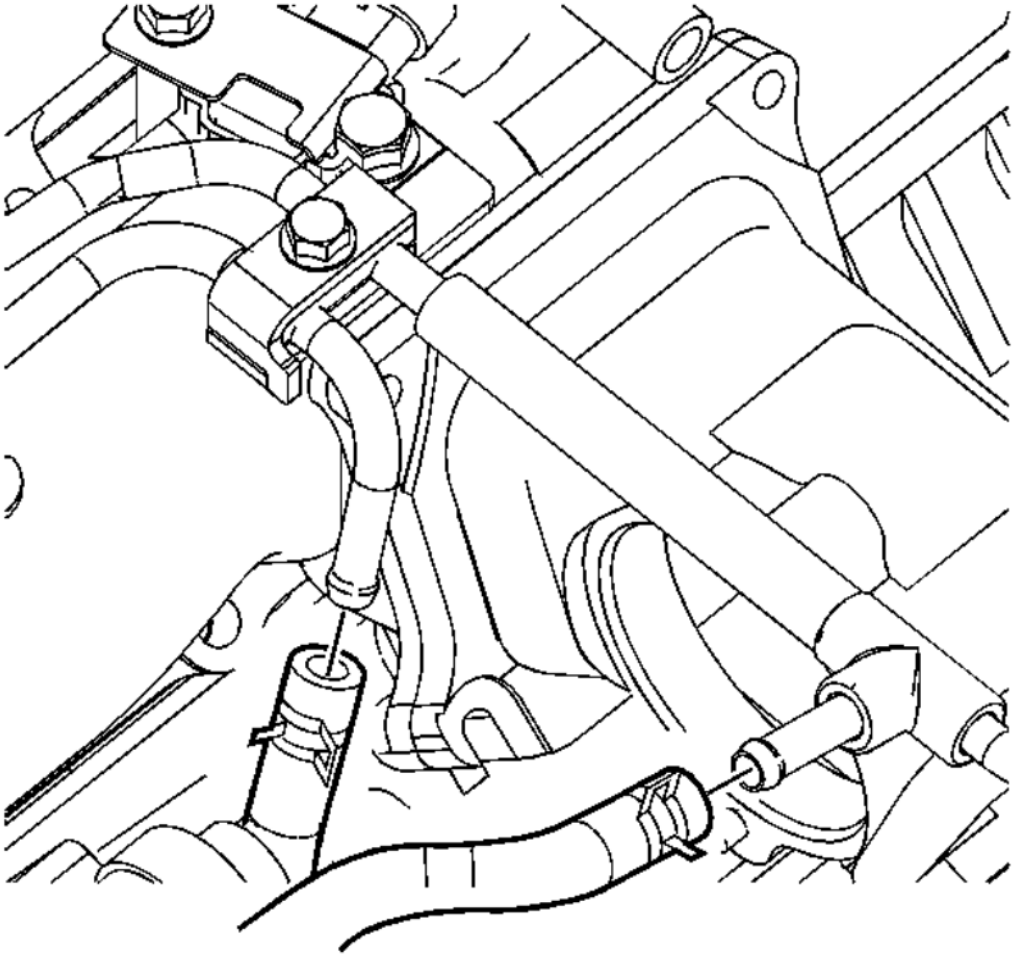


Fig. 94: View Of Fuel Hose Connections
Courtesy of GENERAL MOTORS CORP.

8. Disconnect the fuel hoses from the fuel injector pump.

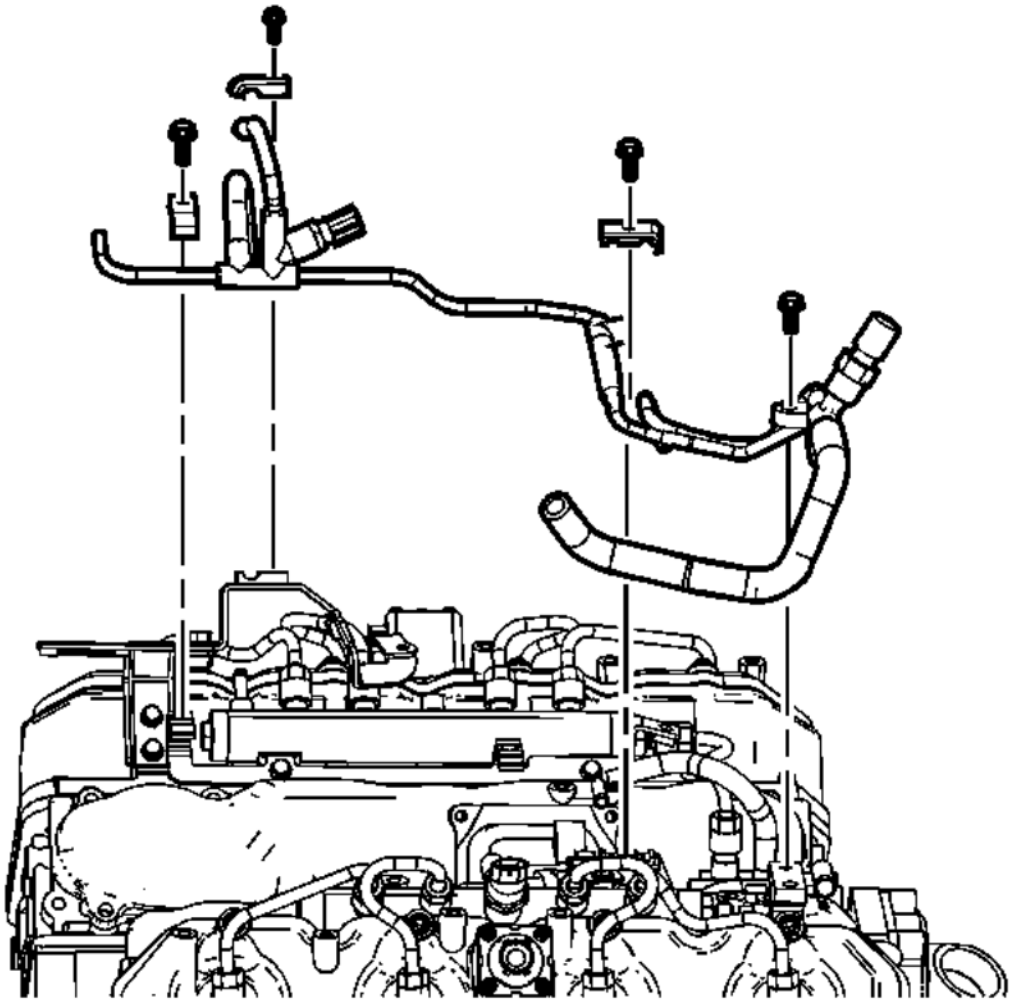


Fig. 95: View Of Distribution Block, Fuel Line Assembly & Bolts
Courtesy of GENERAL MOTORS CORP.

9. Remove the distribution block and fuel line assembly bolts.
10. Remove the distribution block and fuel line assembly.

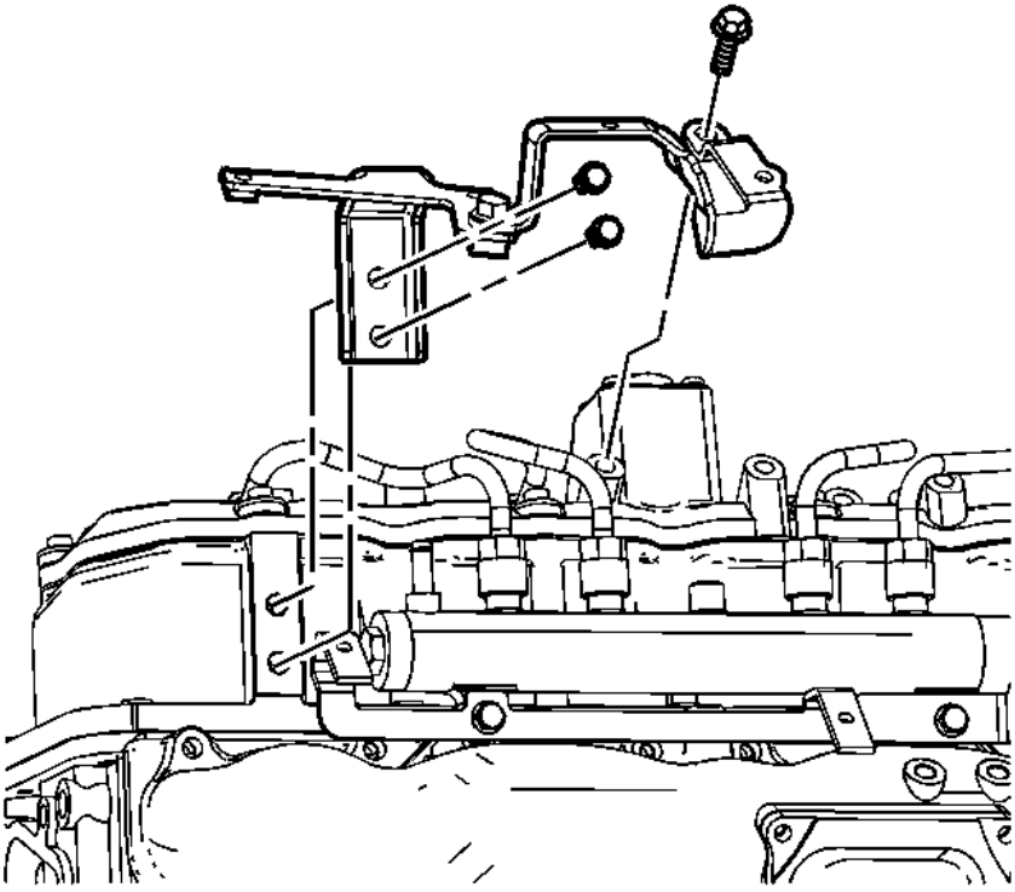


Fig. 96: View Of Fuel Pipe Assembly Bracket
Courtesy of GENERAL MOTORS CORP.

11. Remove the fuel pipe assembly bracket bolts.
12. Remove the fuel pipe assembly bracket.

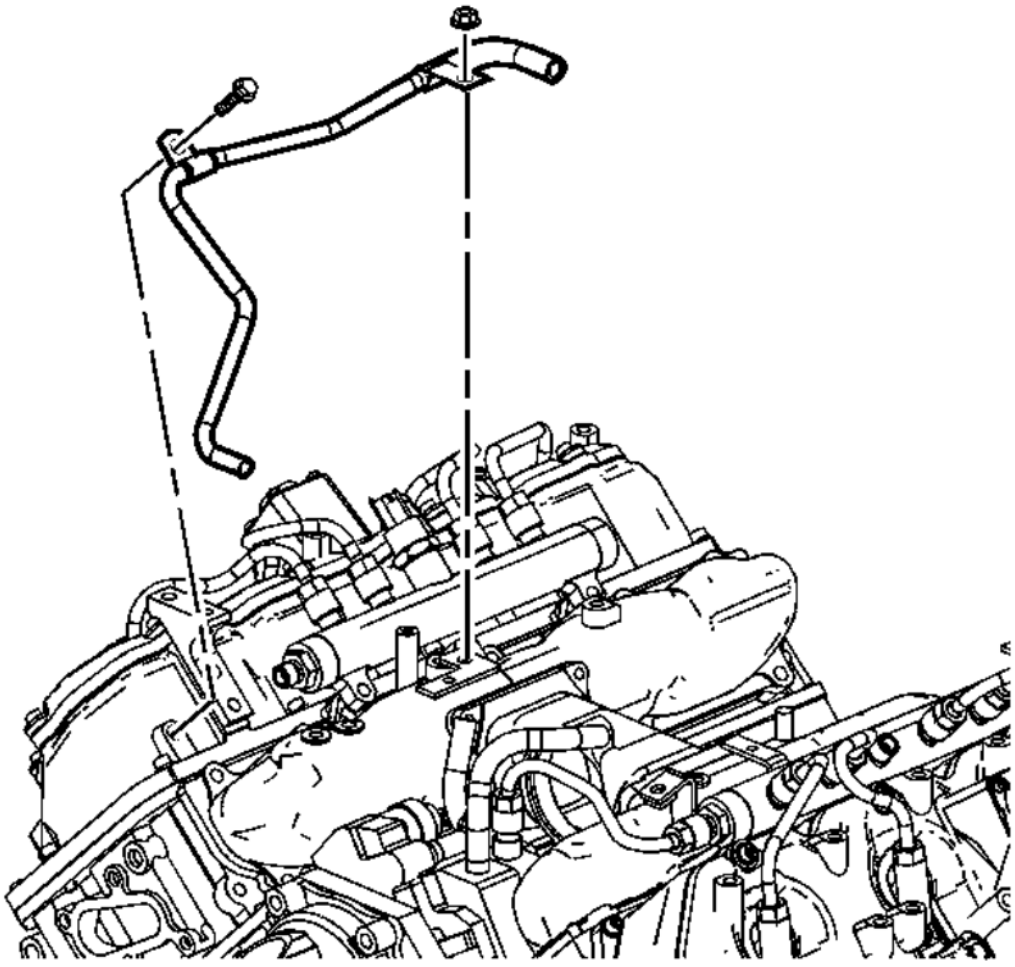


Fig. 97: View Of Coolant Pipe
Courtesy of GENERAL MOTORS CORP.

13. Remove the coolant pipe bolt and nut.
14. Remove the coolant pipe.

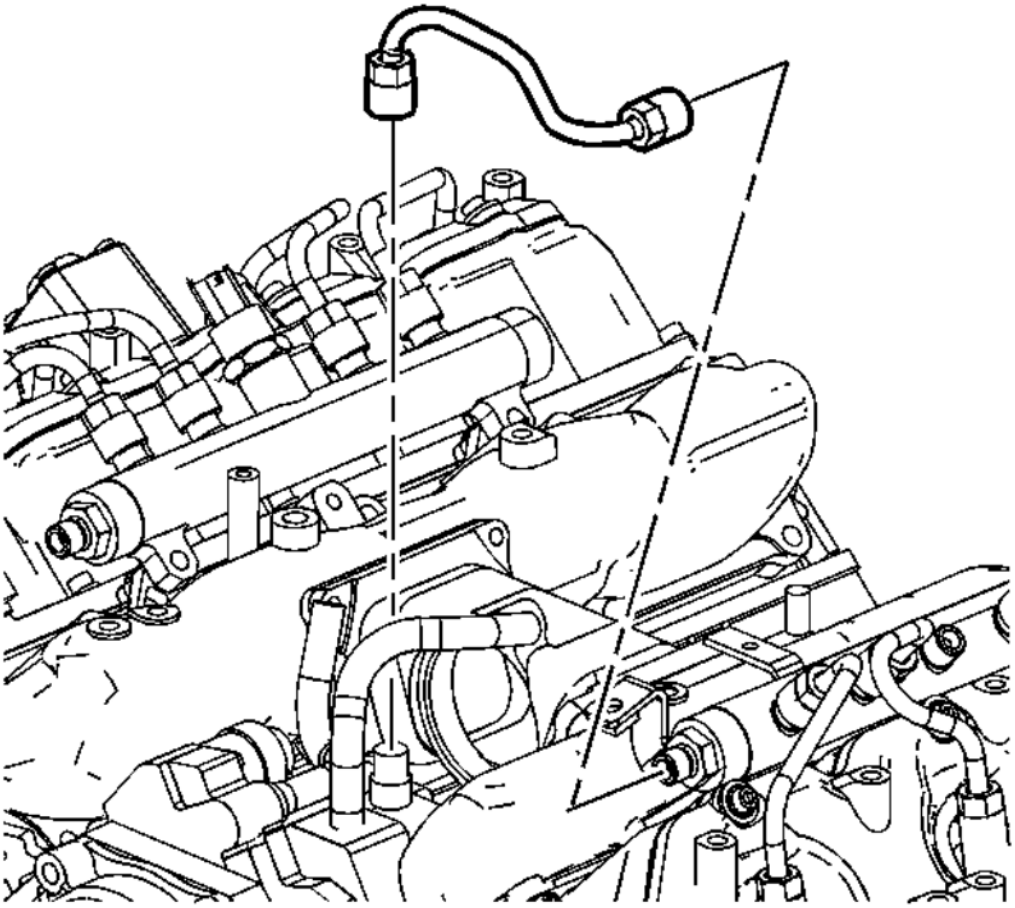


Fig. 98: View Of Left Fuel Rail At Pump Pipe
Courtesy of GENERAL MOTORS CORP.

15. Remove the left fuel rail to pump pipe.

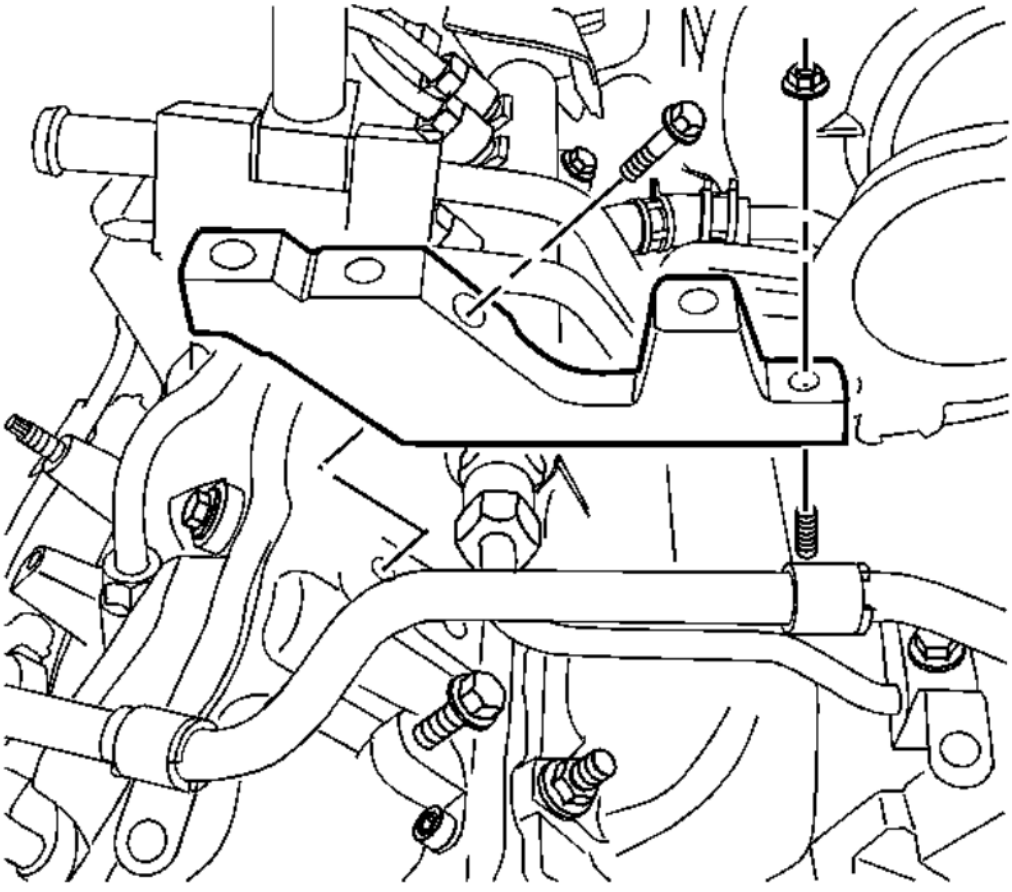


Fig. 99: Identifying EGR Mounting Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

16. Remove the EGR mounting bracket bolt and nut.
17. Remove the EGR mounting bracket.

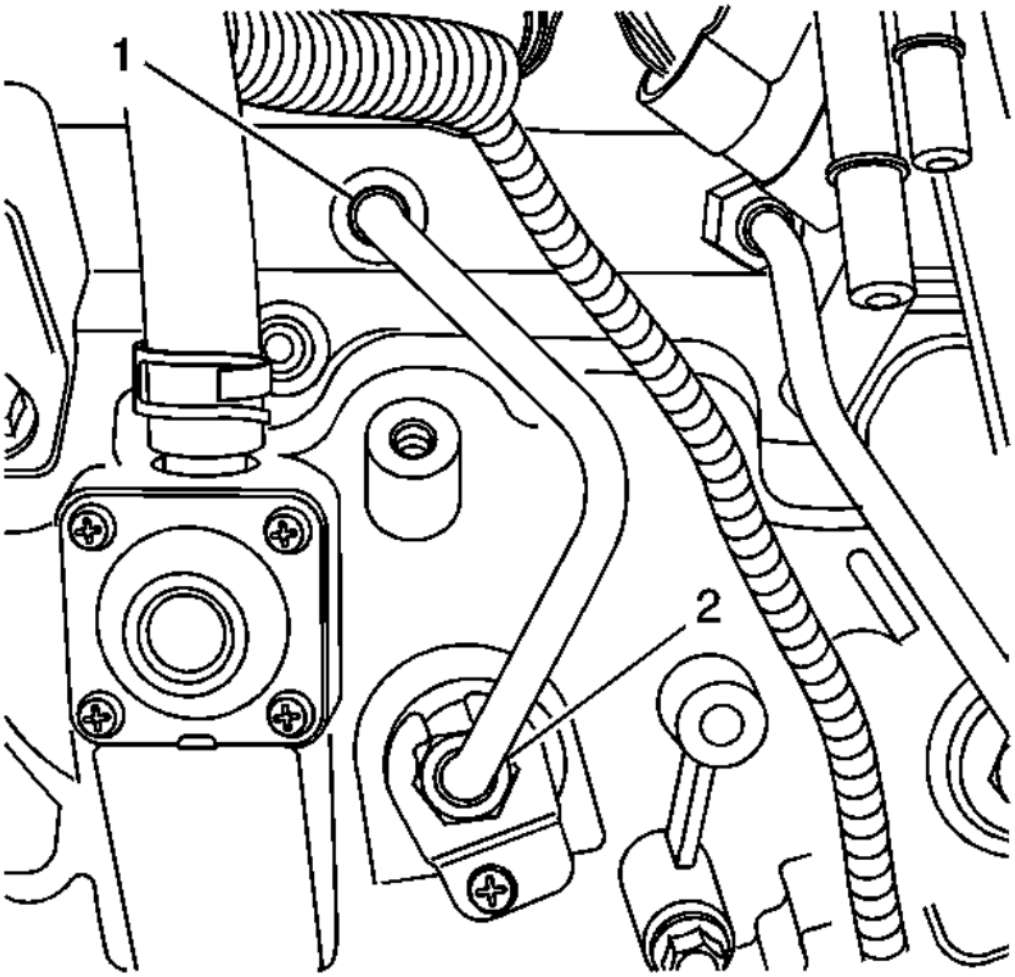


Fig. 100: View Of Fuel Injector Line Fittings
Courtesy of GENERAL MOTORS CORP.

18. Using compressed air to blow away any debris between the fuel injector line and the fittings (1, 2). Wipe clean the fittings (1) of debris.

NOTE: DO NOT use compressed air to clean debris from the fuel injector inlet after the fuel line is removed. Using compressed air can allow debris to enter the fuel injector inlet and damage the fuel injector.

19. Spray lithium grease, GM P/N 12346293 or equivalent, between the fuel injector line and fitting (1, 2) to contain any debris during removal.

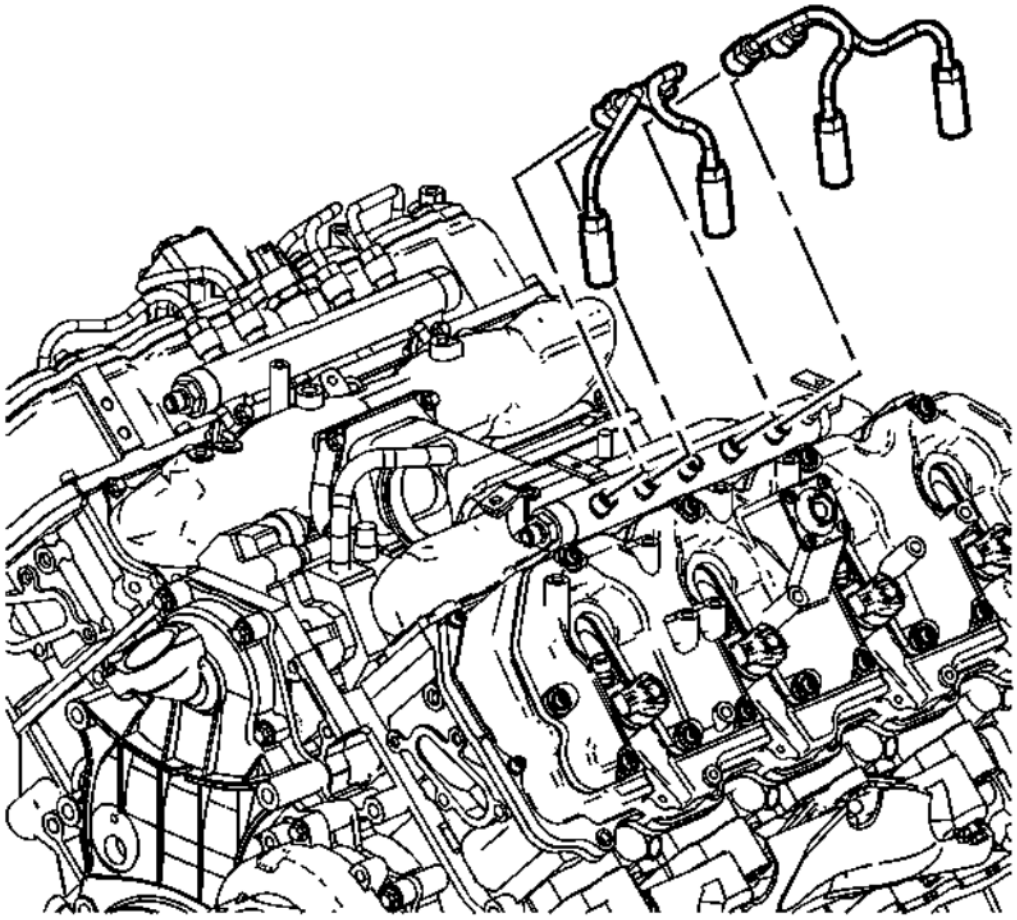


Fig. 101: View Of Left Fuel Injector Pipes
Courtesy of GENERAL MOTORS CORP.

20. Remove the left fuel injector pipes.

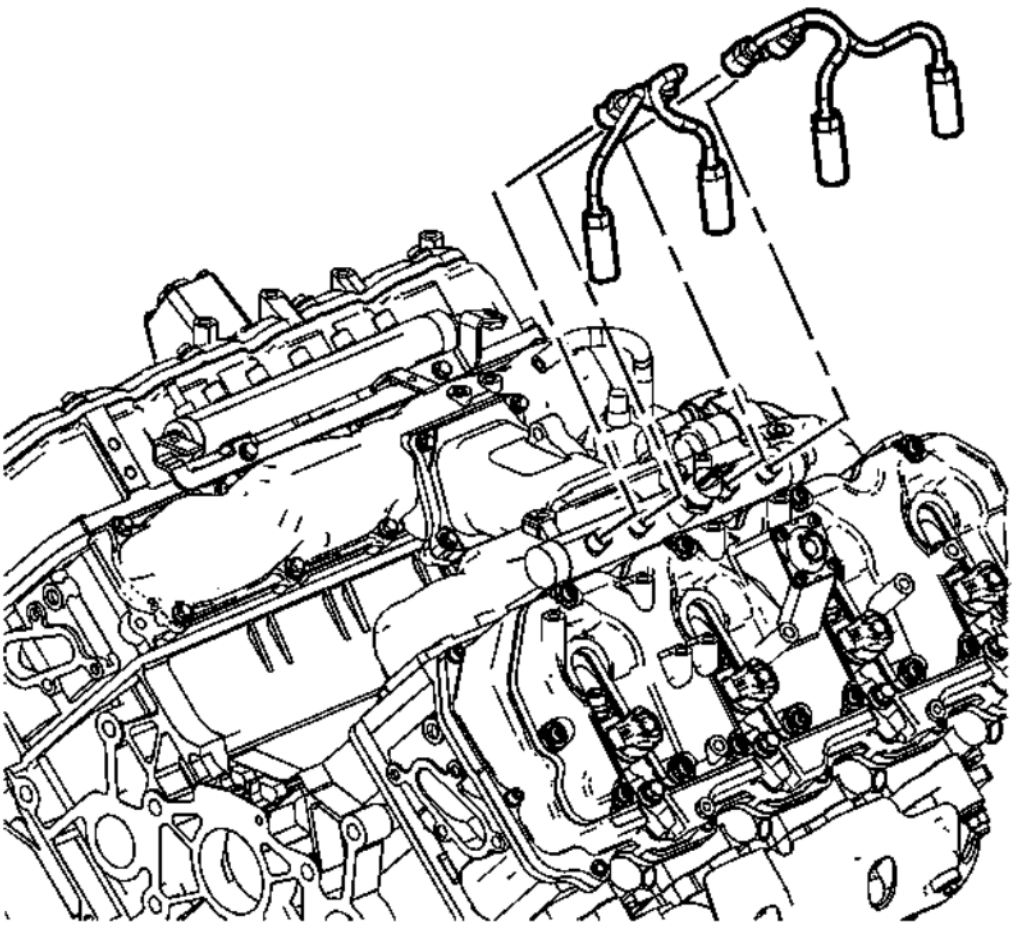


Fig. 102: View Of Fuel Injector Pipes
Courtesy of GENERAL MOTORS CORP.

21. Remove the right fuel injector pipes.

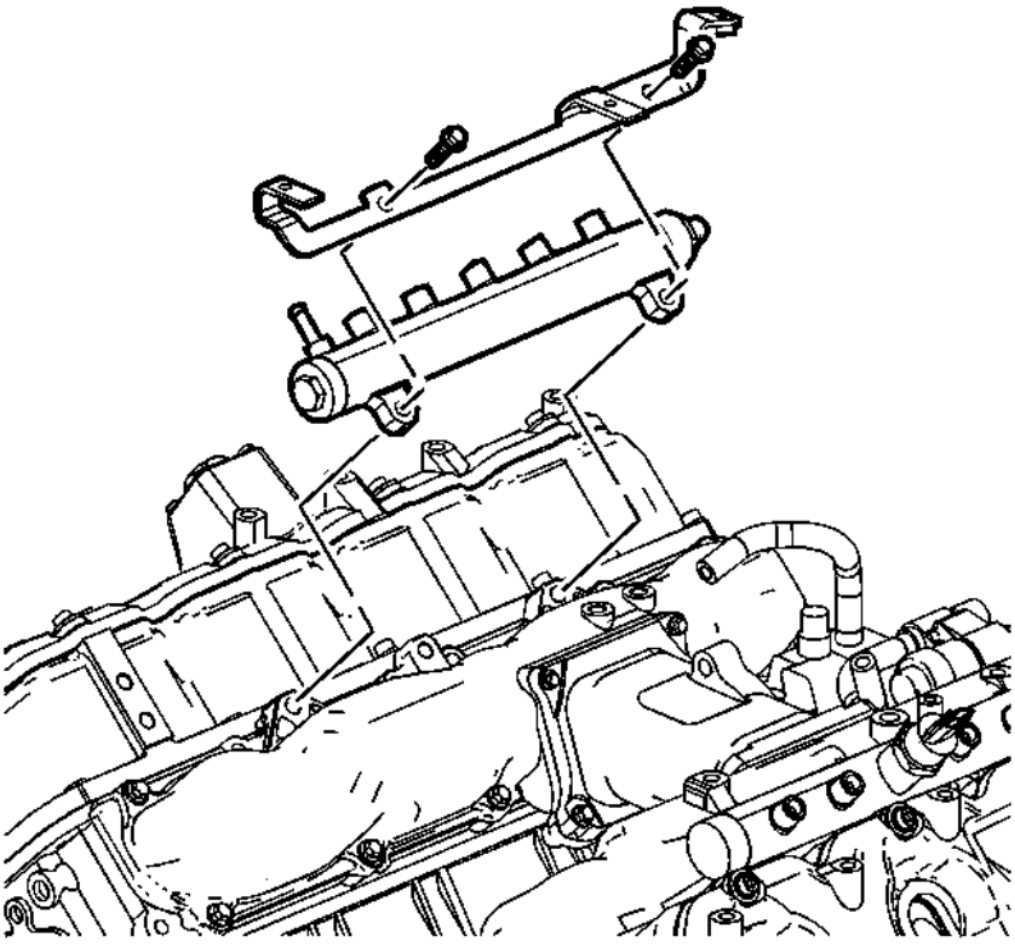


Fig. 103: View Of Left Fuel Rail And Bracket
Courtesy of GENERAL MOTORS CORP.

22. Remove the left fuel rail and bracket bolts.
23. Remove the left fuel rail and bracket.

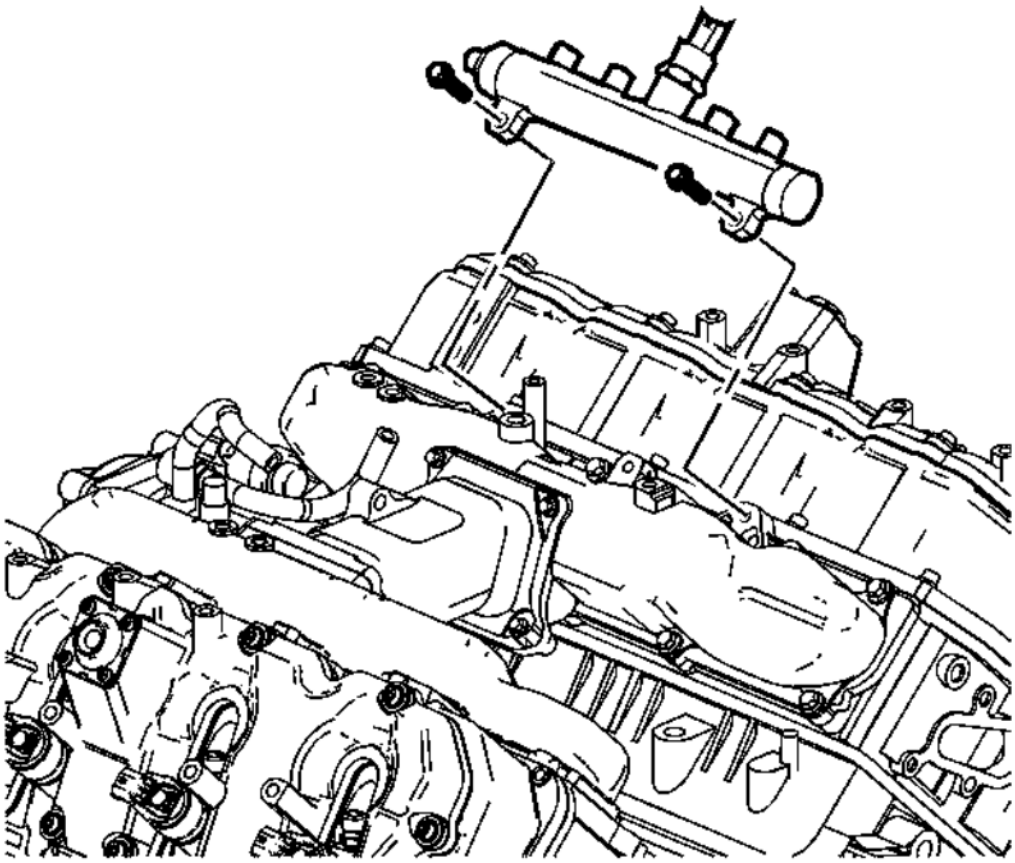


Fig. 104: View Of Right Fuel Rail
Courtesy of GENERAL MOTORS CORP.

24. Remove the right fuel rail bolts.
25. Remove the right fuel rail.

FUEL INJECTORS REMOVAL

Tools Required

J-46594 Fuel Injector Remover

Removal

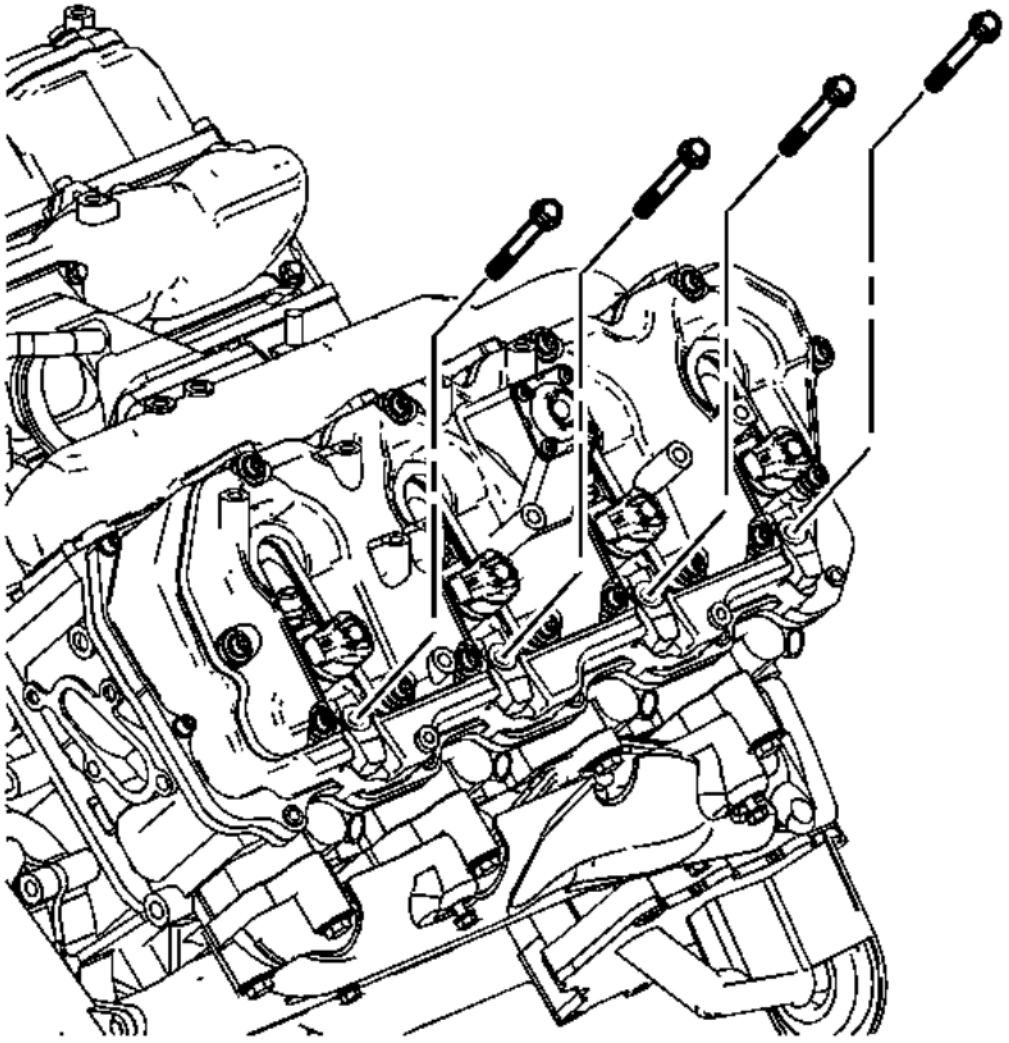


Fig. 105: View Of Left Fuel Injector Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the left fuel injector bracket bolts.

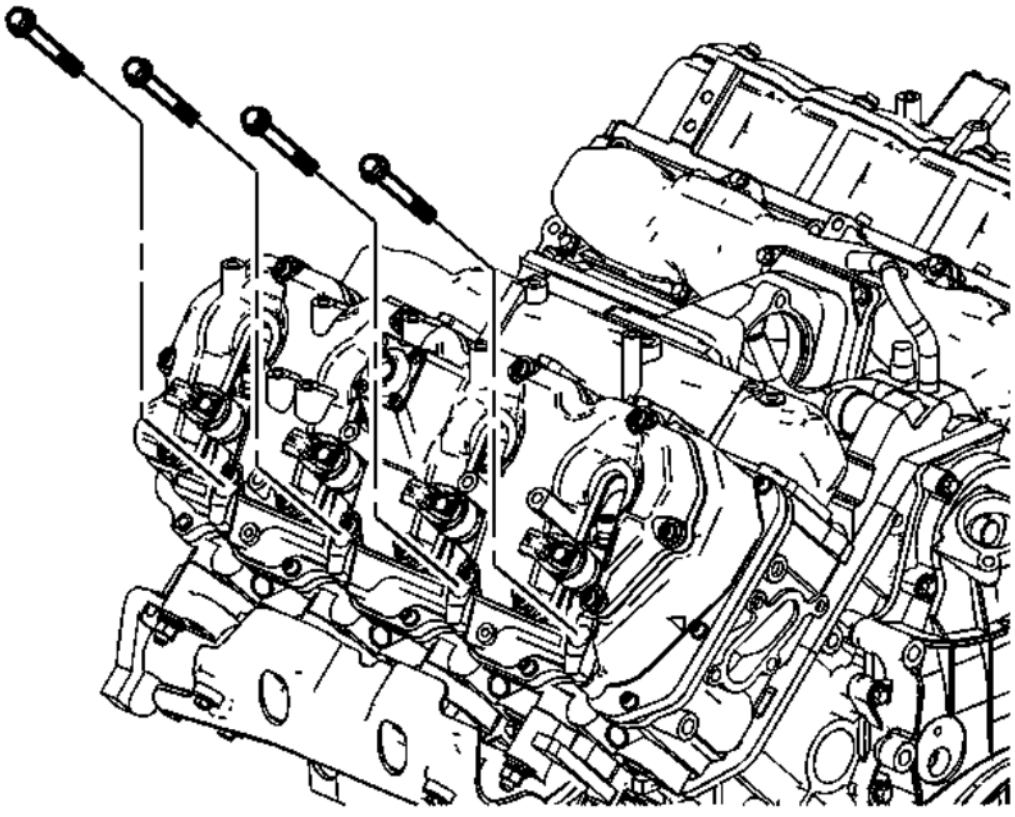


Fig. 106: View Of Right Fuel Injector Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

2. Remove the right fuel injector bracket bolts.

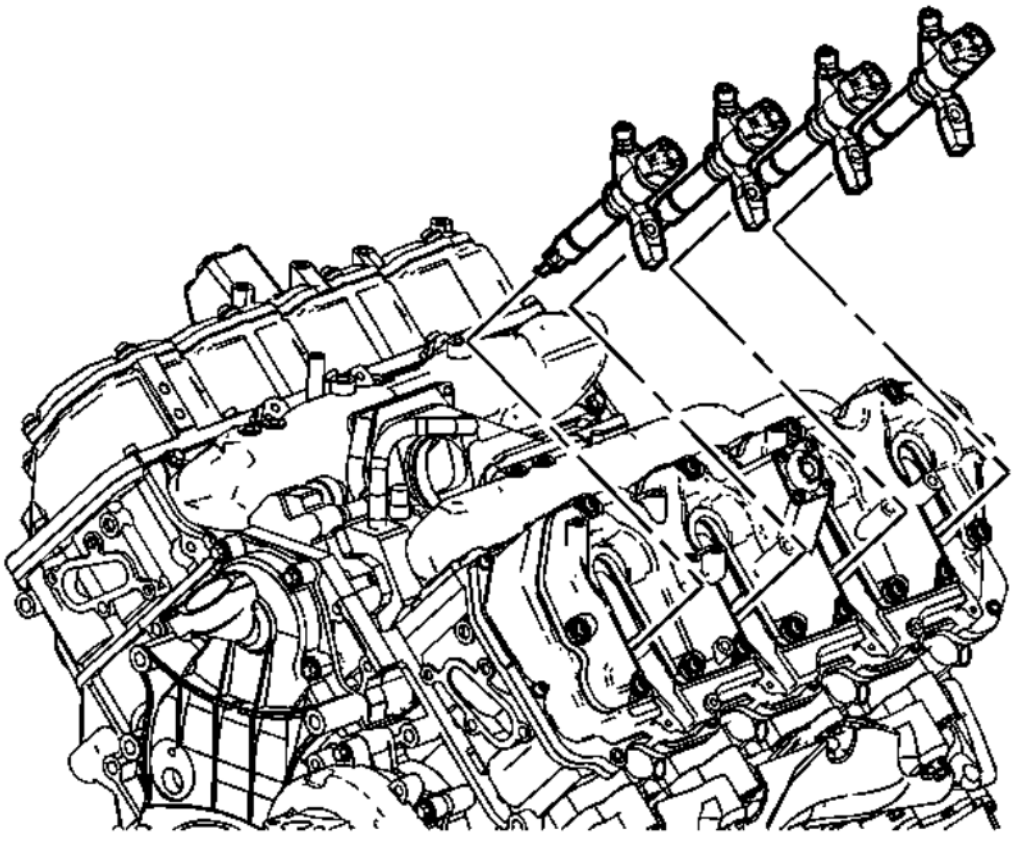


Fig. 107: View Of Left Fuel Injectors W/Brackets
Courtesy of GENERAL MOTORS CORP.

3. Install the **J-46594** into the fuel injector brackets.
4. Pull back on **J-46594** in one steady motion, until the fuel injector breaks free from its seat.
5. Remove the **J-46594** .
6. Remove the left fuel injectors with brackets.

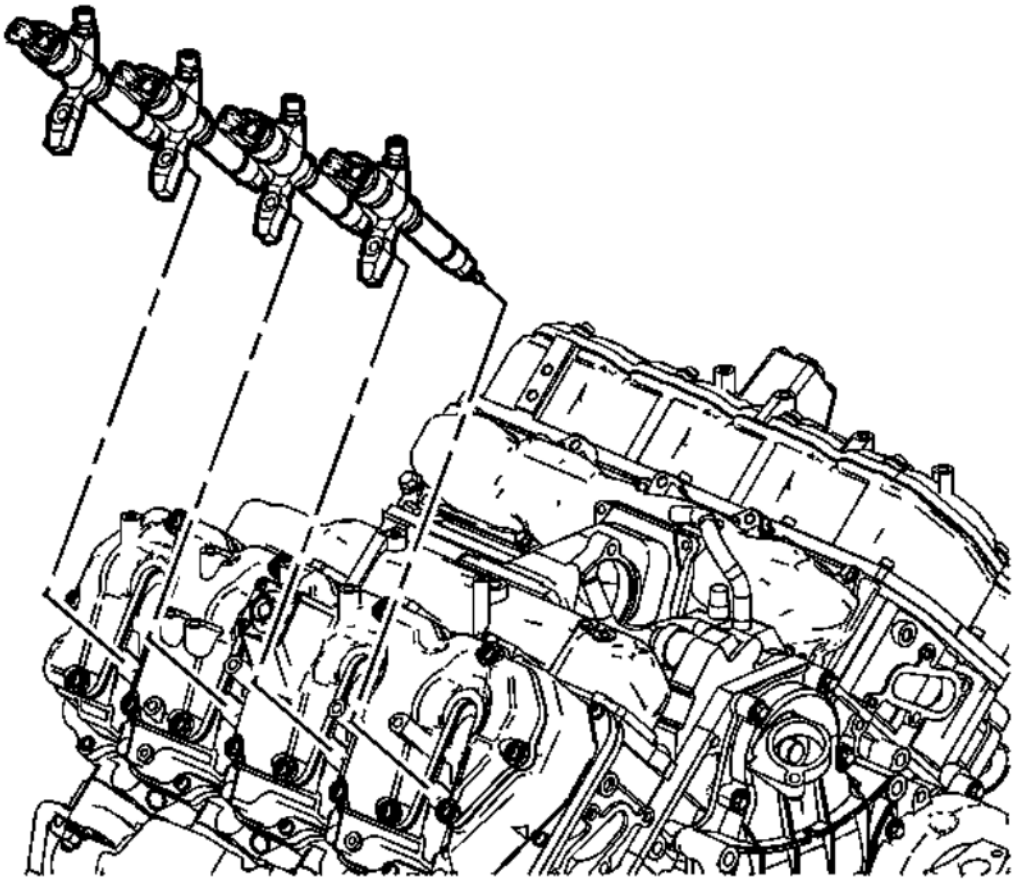


Fig. 108: View Of Right Fuel Injectors W/Brackets
Courtesy of GENERAL MOTORS CORP.

7. Remove the right fuel injectors with brackets.

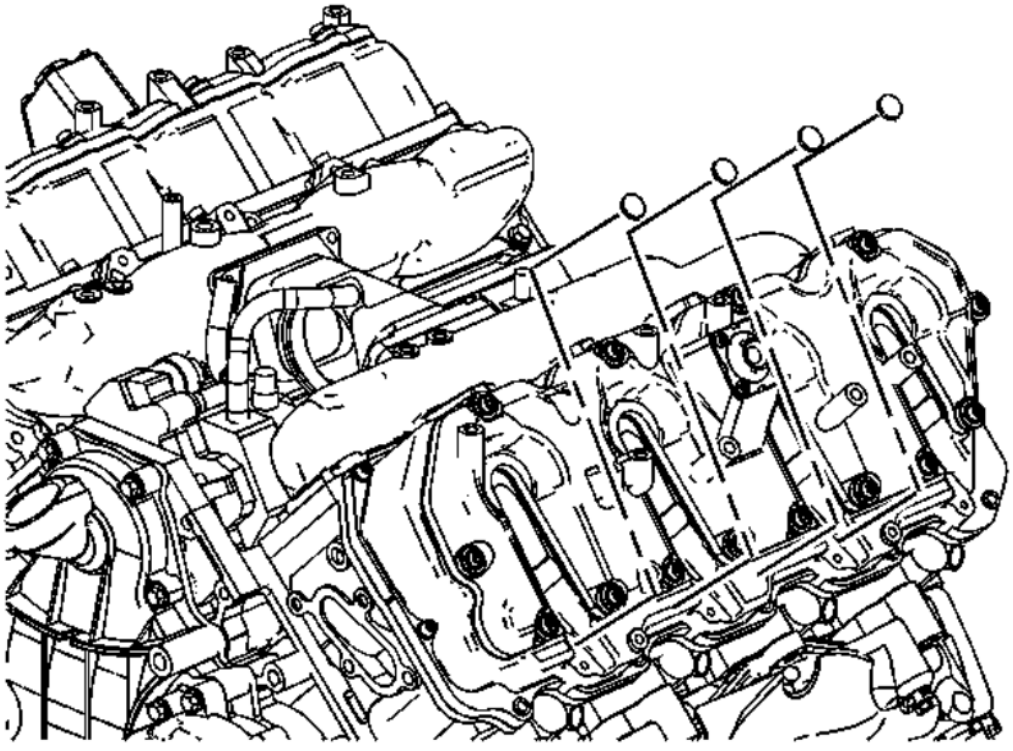


Fig. 109: View Of Left Injector Bracket Pins
Courtesy of GENERAL MOTORS CORP.

8. Remove the left injector bracket pins.

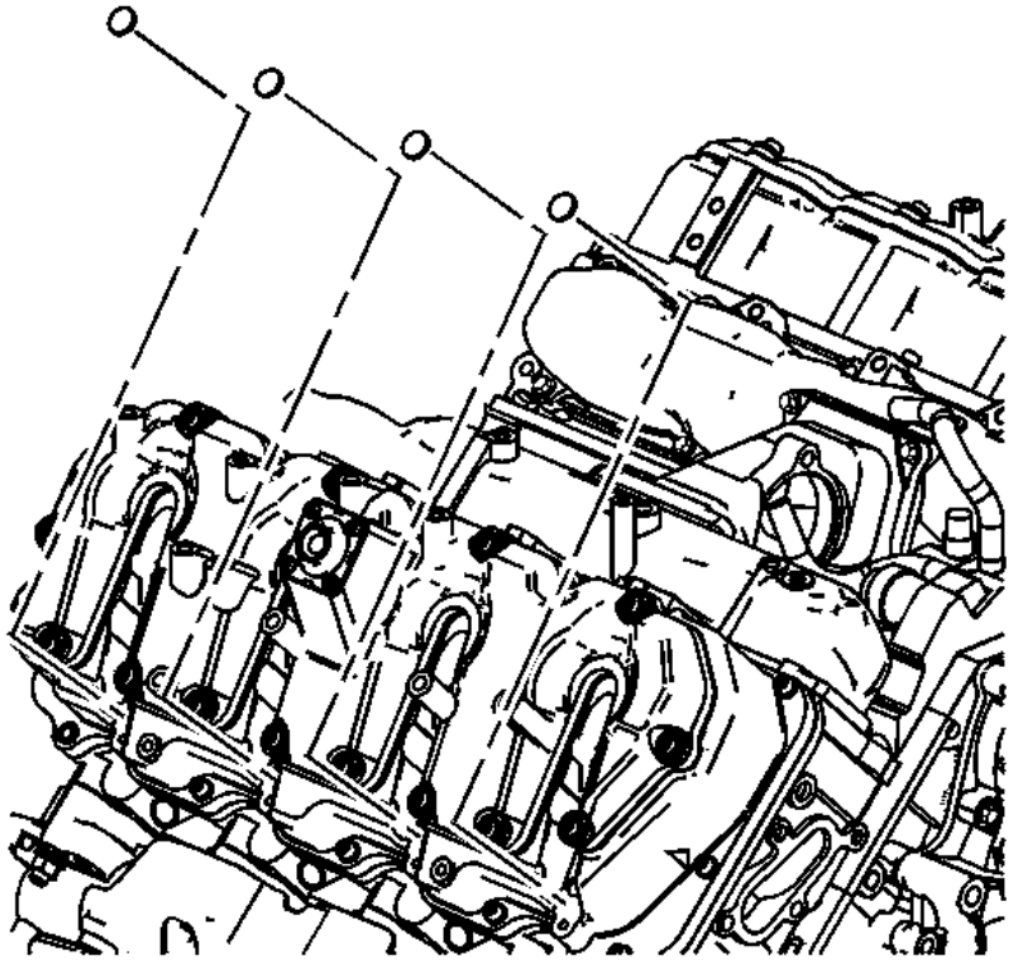


Fig. 110: Identifying Fuel Injector Copper Washers
Courtesy of GENERAL MOTORS CORP.

9. Remove the right injector bracket pins.
10. Remove the copper washer from the injector bore and discard.
11. Remove the O-ring from the injector and discard.

VALVE ROCKER ARM COVER REMOVAL - UPPER LEFT SIDE

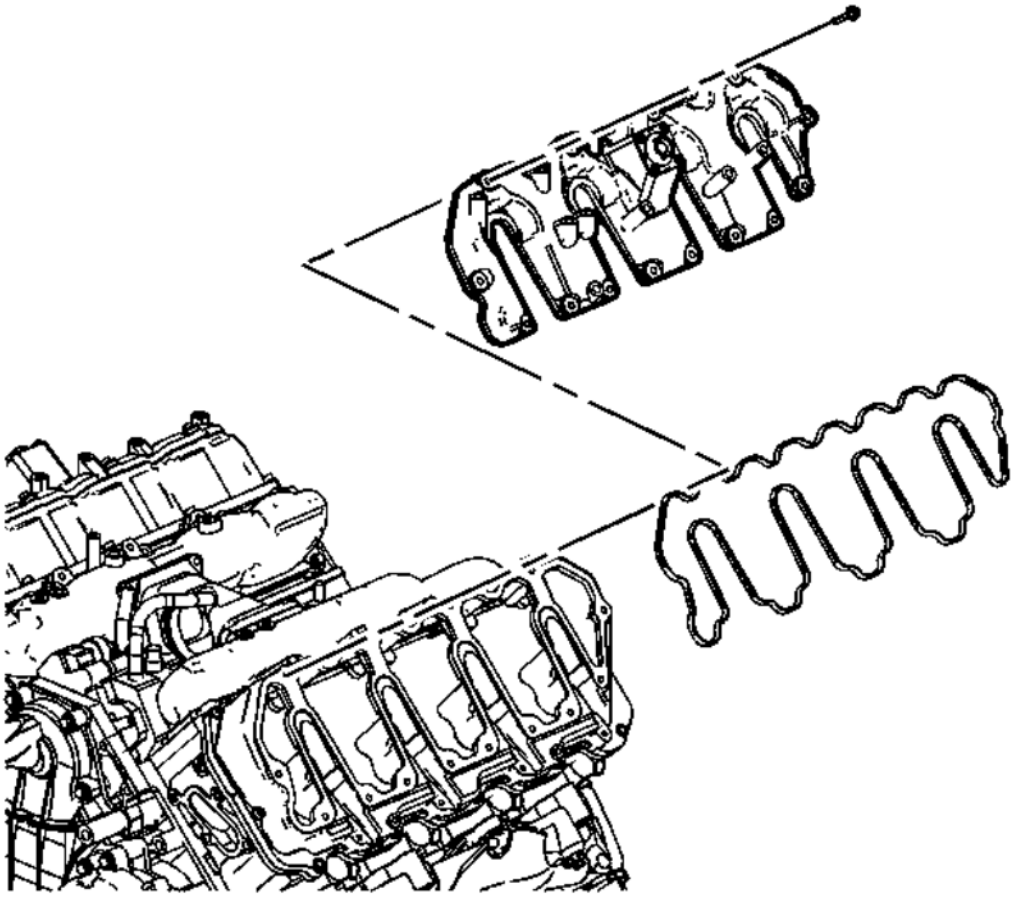


Fig. 111: View Of Upper Valve Rocker Arm Cover & Gasket
Courtesy of GENERAL MOTORS CORP.

1. Remove the left upper valve rocker arm cover bolts.
2. Remove the left upper valve rocker arm cover.

VALVE ROCKER ARM COVER REMOVAL - UPPER RIGHT SIDE

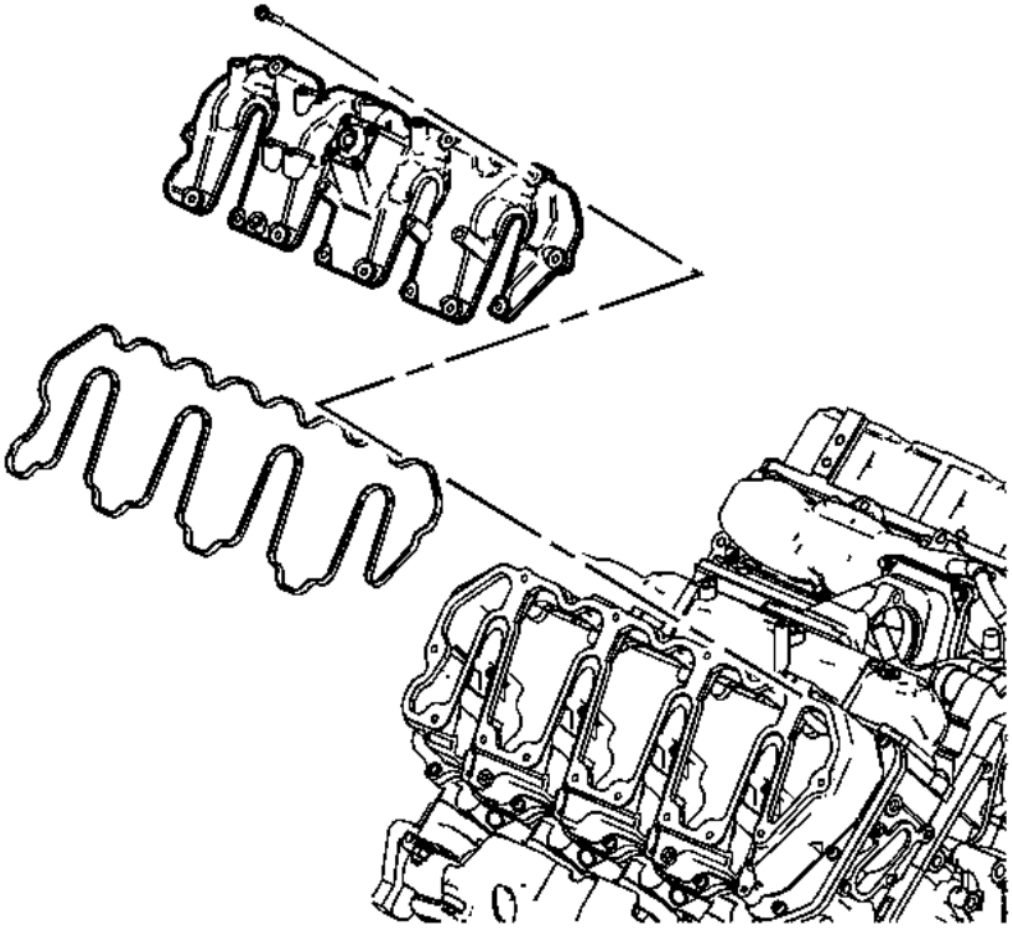


Fig. 112: View Of Upper Valve Rocker Arm Cover & Gasket
Courtesy of GENERAL MOTORS CORP.

1. Remove the right upper valve rocker arm cover bolts.
2. Remove the right upper valve rocker arm cover.

VALVE ROCKER ARM COVER REMOVAL - LOWER LEFT SIDE

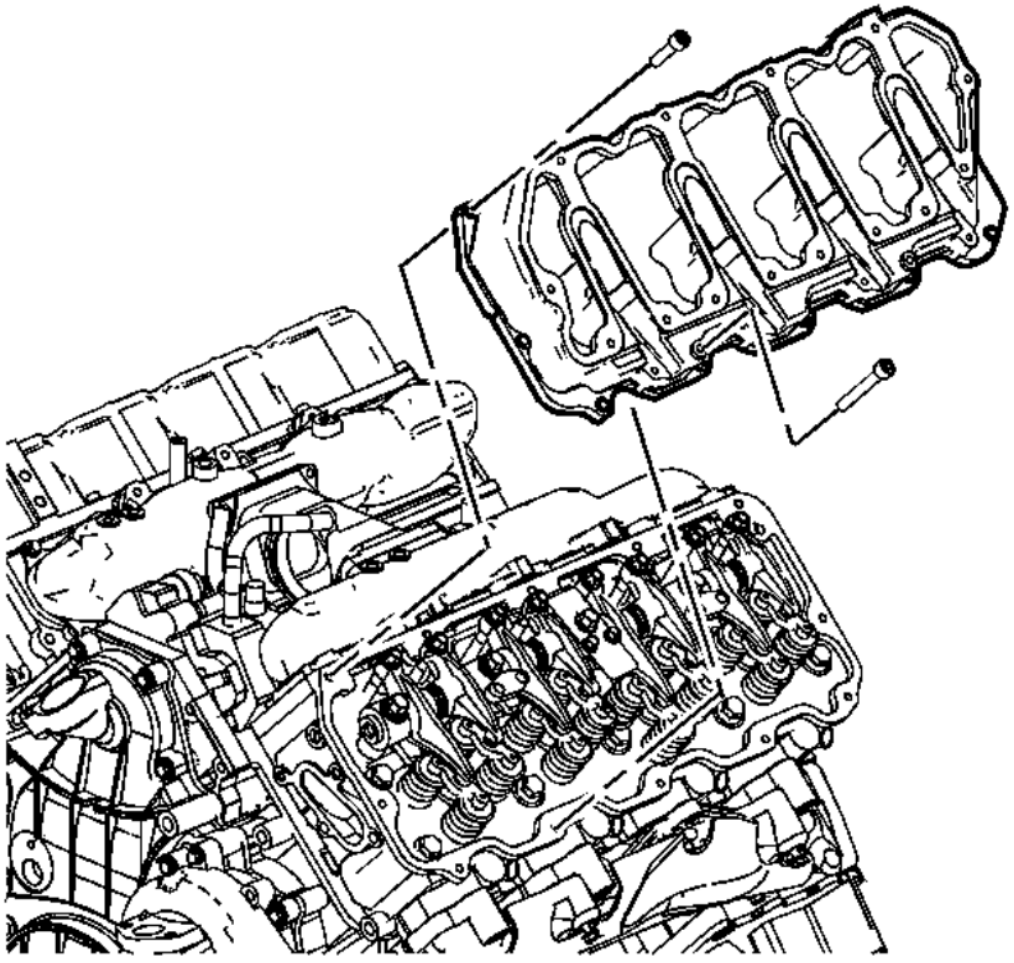


Fig. 113: View Of Lower Valve Rocker Arm Cover (Left)
Courtesy of GENERAL MOTORS CORP.

1. Remove the left lower valve rocker arm cover bolts.
2. Remove the left lower valve rocker arm cover.

VALVE ROCKER ARM COVER REMOVAL - LOWER RIGHT SIDE

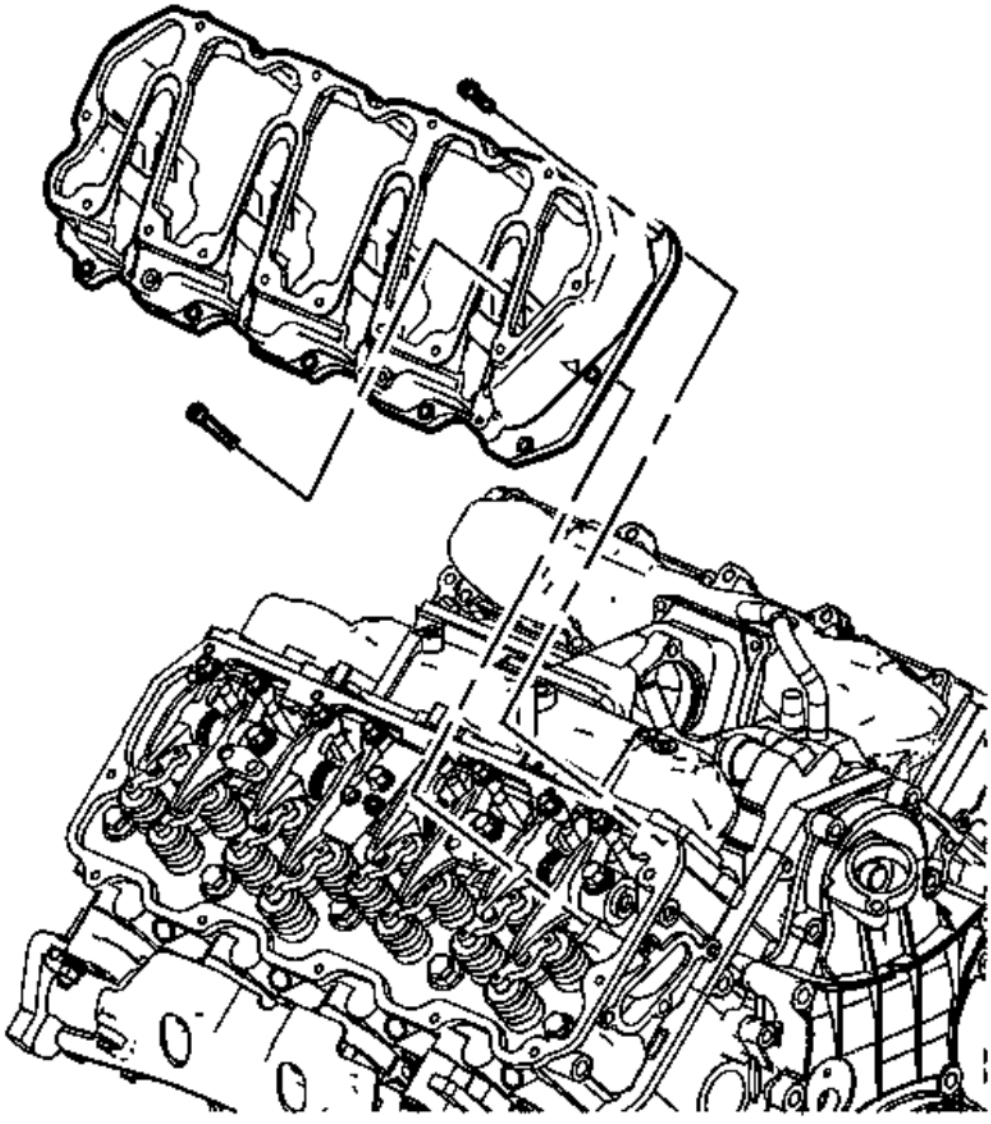


Fig. 114: View Of Lower Valve Rocker Arm Cover (Right)
Courtesy of GENERAL MOTORS CORP.

1. Remove the right lower valve rocker arm cover bolts.
2. Remove the lower valve rocker arm cover.

INTAKE MANIFOLD CROSSOVER REMOVAL

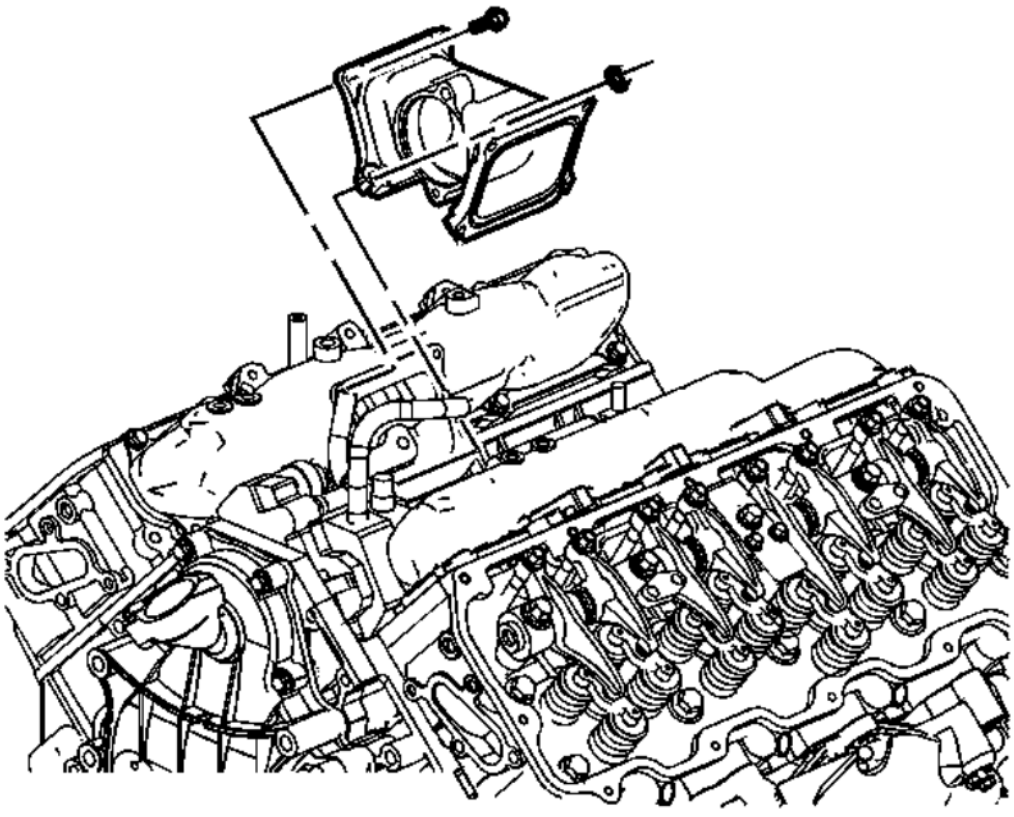


Fig. 115: View Of Center Intake Manifold
Courtesy of GENERAL MOTORS CORP.

1. Remove the intake manifold crossover bolts and nuts.
2. Remove the intake manifold crossover.

INTAKE MANIFOLD REMOVAL - RIGHT SIDE

Tools Required

J 37228 Seal Cutter. See **Special Tools** .

Removal

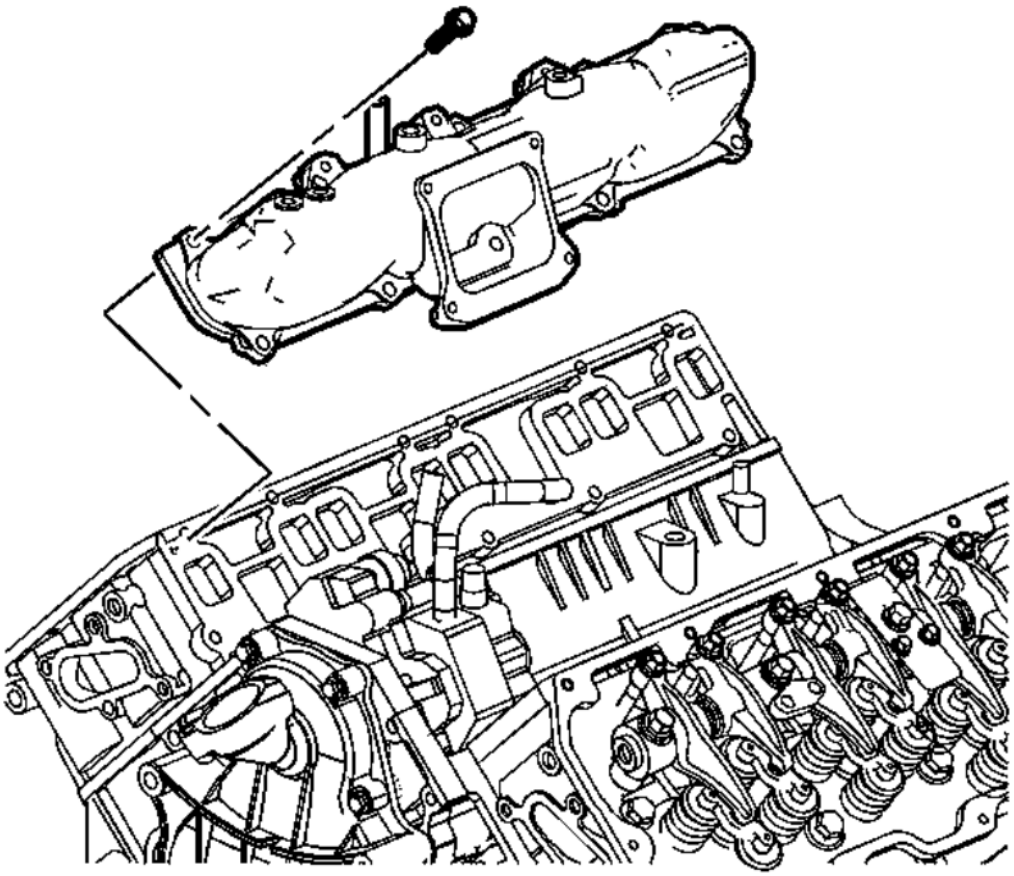


Fig. 116: View Of Intake Manifold (Right)
Courtesy of GENERAL MOTORS CORP.

1. Remove the right intake manifold bolts. Do not forget to remove the bolt inside the intake manifold tube.
2. Separate the intake manifold from the cylinder head using **J 37228** . See **Special Tools** .
3. Remove the right intake manifold.

INTAKE MANIFOLD REMOVAL - LEFT SIDE

Tools Required

J 37228 Seal Cutter. See **Special Tools** .

Removal

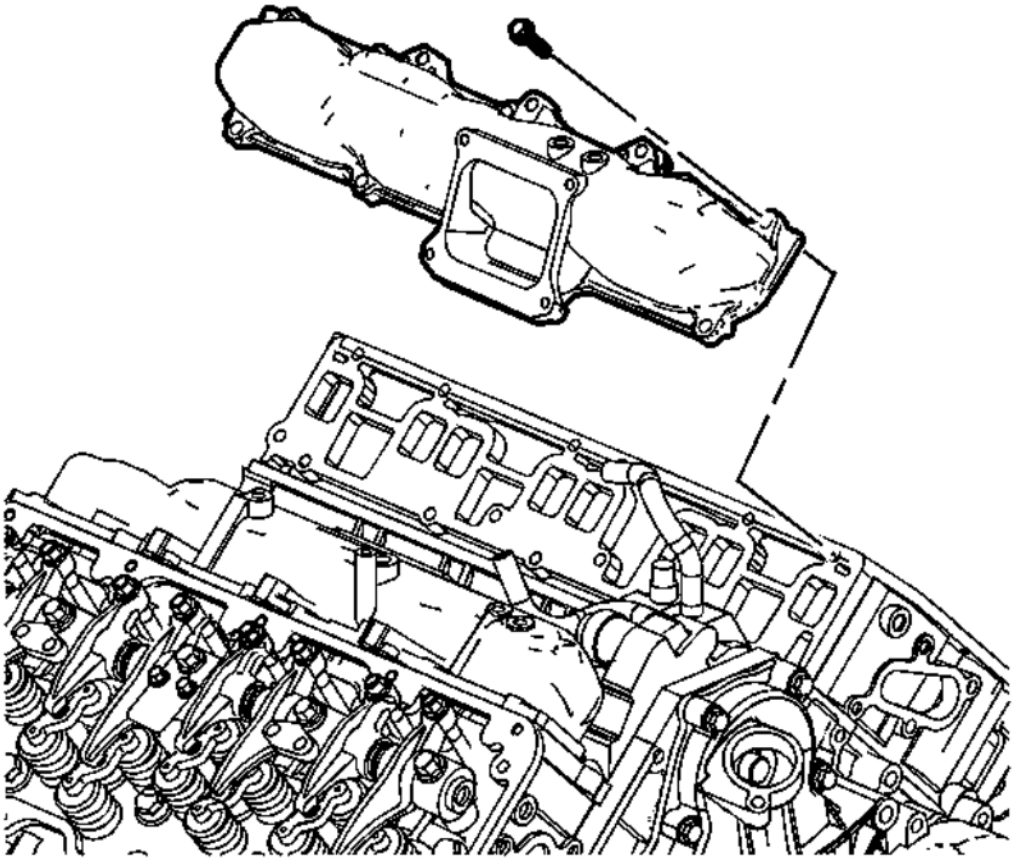


Fig. 117: View Of Intake Manifold (Left)
Courtesy of GENERAL MOTORS CORP.

1. Remove the left intake manifold bolts. Do not forget to remove the bolt inside the intake manifold tube.
2. Separate the intake manifold from the cylinder head using **J 37228** . See **Special Tools** .
3. Remove the left intake manifold.

VALVE ROCKER ARM, SHAFT, AND PUSH ROD REMOVAL

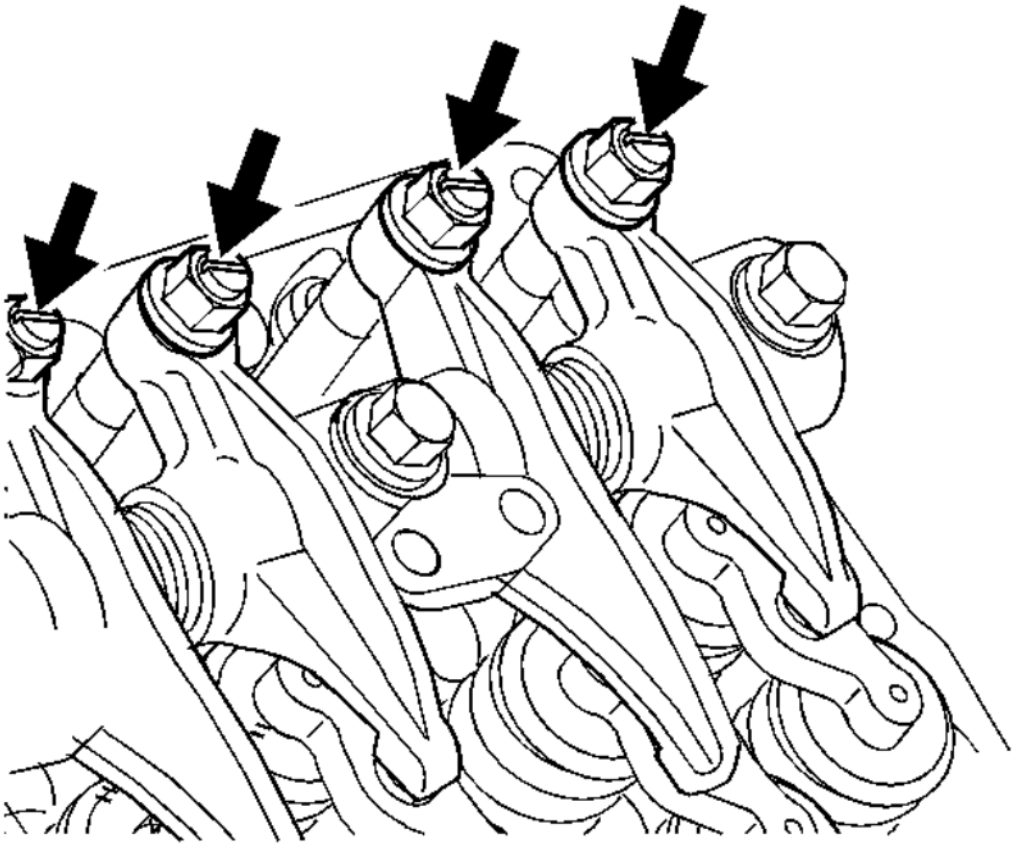


Fig. 118: View Of Valve Clearance Adjusting Screw
Courtesy of GENERAL MOTORS CORP.

1. Loosen the valve clearance lock nuts on each rocker arm.
2. Loosen the valve clearance adjusting screw on each rocker arm to relieve tension on the valve train.

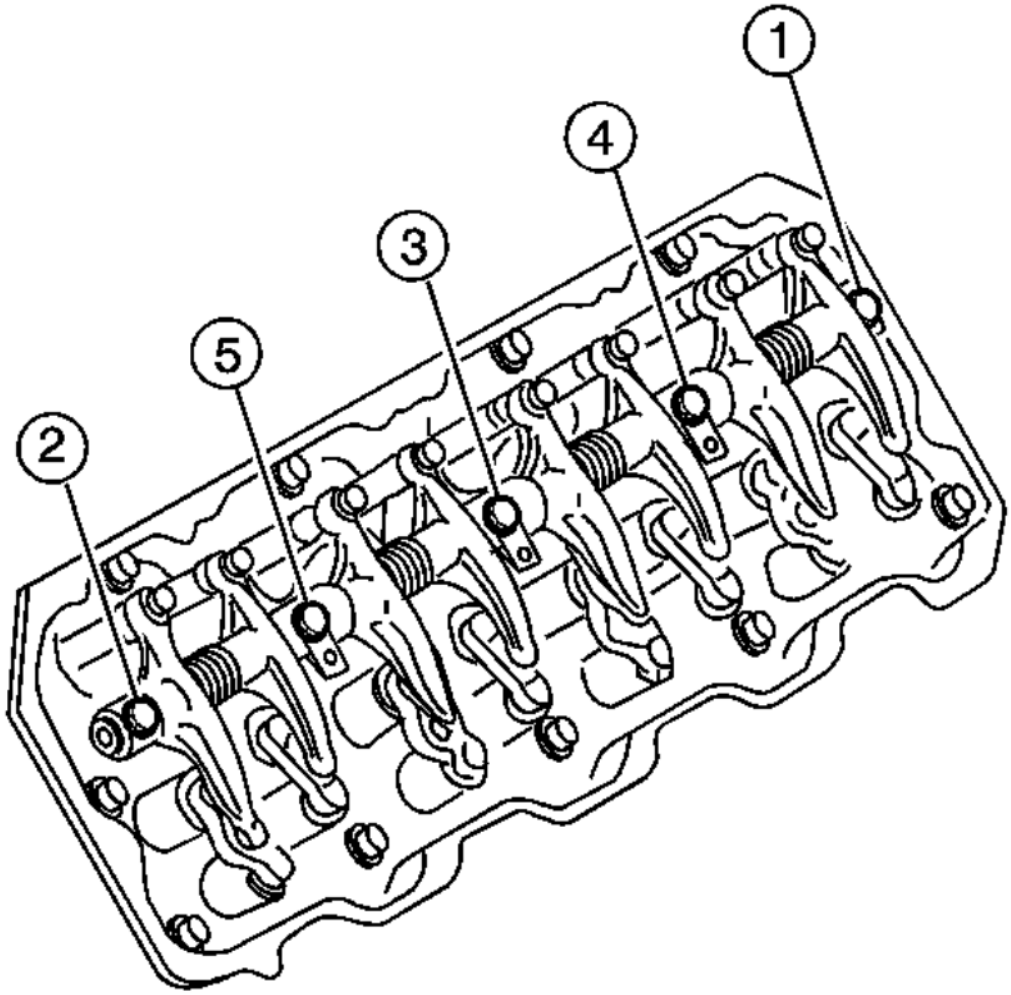


Fig. 119: Rocker Arm Shaft Bolts Loosening Sequence
Courtesy of GENERAL MOTORS CORP.

3. Remove the rocker arm shaft assembly bolts in the proper sequence.
4. Remove the rocker arm shaft assembly from the cylinder head.

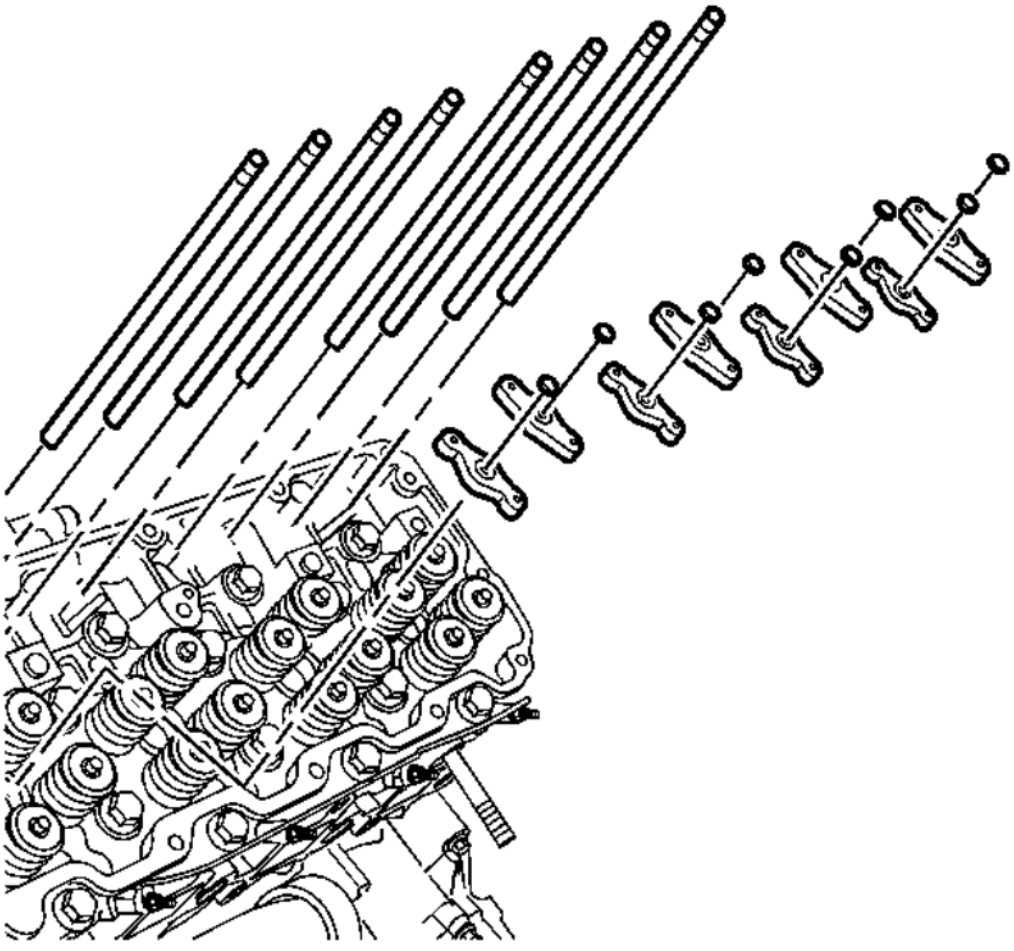


Fig. 120: View Of Pushrods, Valve Spring Caps & Valve Lifter Bridges
Courtesy of GENERAL MOTORS CORP.

5. Remove the valve bridge pins.
6. Remove the valve bridges.
7. Remove the pushrods.

EXHAUST MANIFOLD REMOVAL - LEFT SIDE

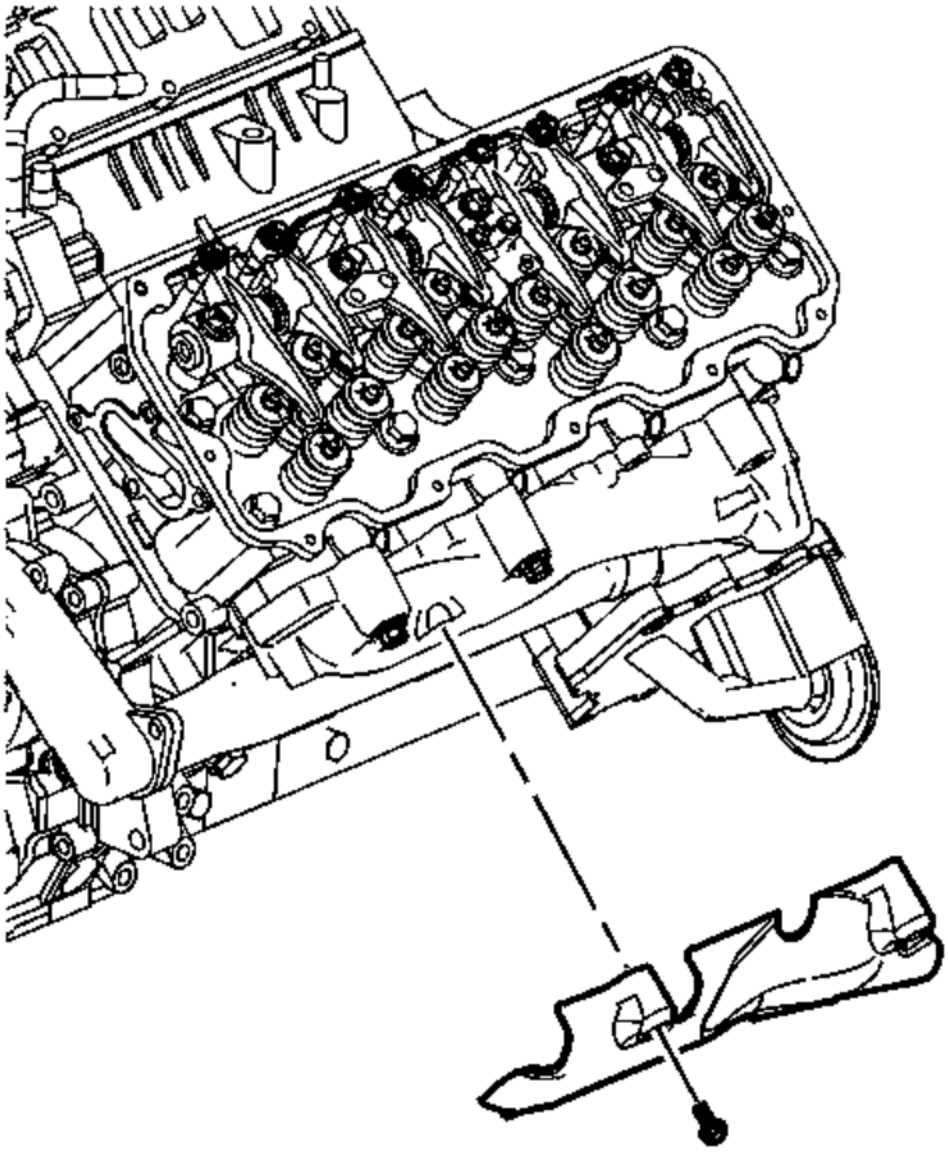


Fig. 121: View Of Exhaust Manifold Heat Shield (Left)
Courtesy of GENERAL MOTORS CORP.

1. Remove the exhaust manifold heat shield bolts.
2. Remove the exhaust manifold heat shield.

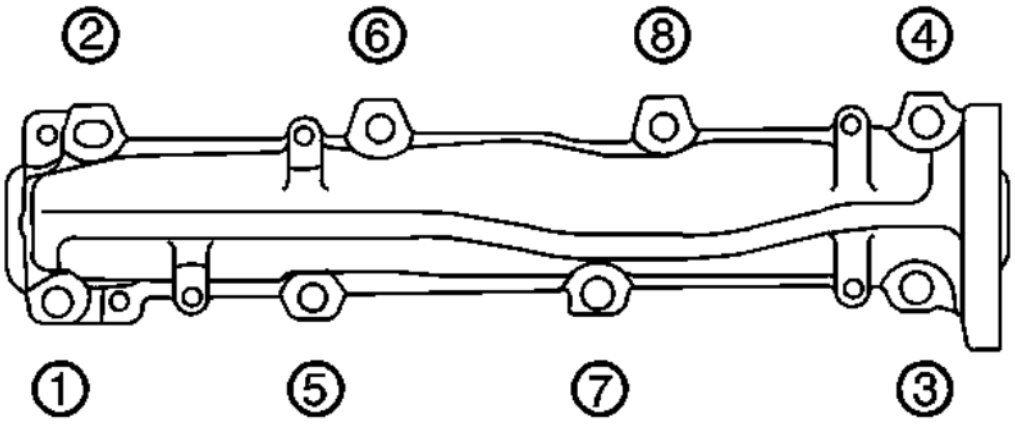


Fig. 122: Left Exhaust Manifold Bolts & Nuts Removal & Installation Sequence
Courtesy of GENERAL MOTORS CORP.

3. Remove the left exhaust manifold bolts and nuts in the proper sequence.

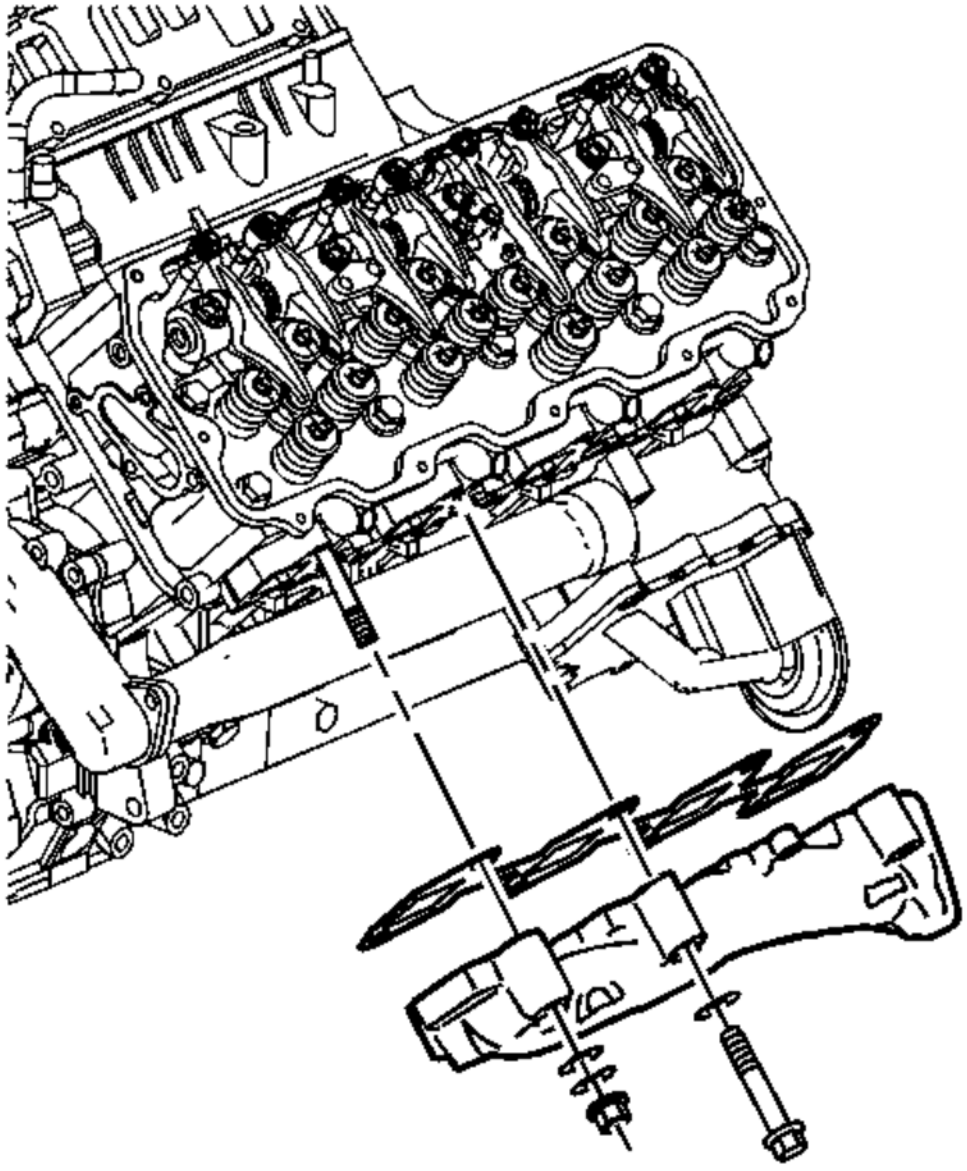


Fig. 123: View Of Left Exhaust Manifold & Gasket
Courtesy of GENERAL MOTORS CORP.

4. Remove the left exhaust manifold and gasket.

EXHAUST MANIFOLD REMOVAL - RIGHT SIDE

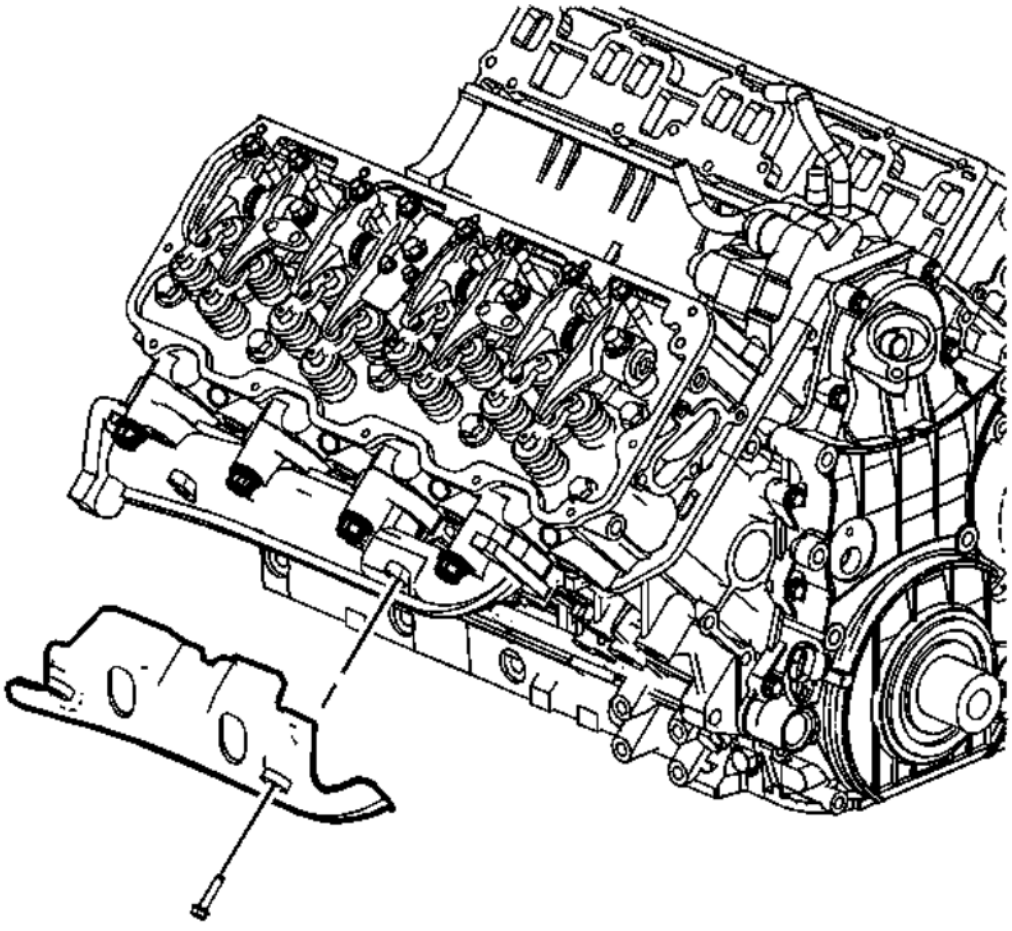


Fig. 124: View Of Exhaust Manifold Heat Shield (Right)
Courtesy of GENERAL MOTORS CORP.

1. Remove the exhaust manifold heat shield bolts.
2. Remove the exhaust manifold heat shield.

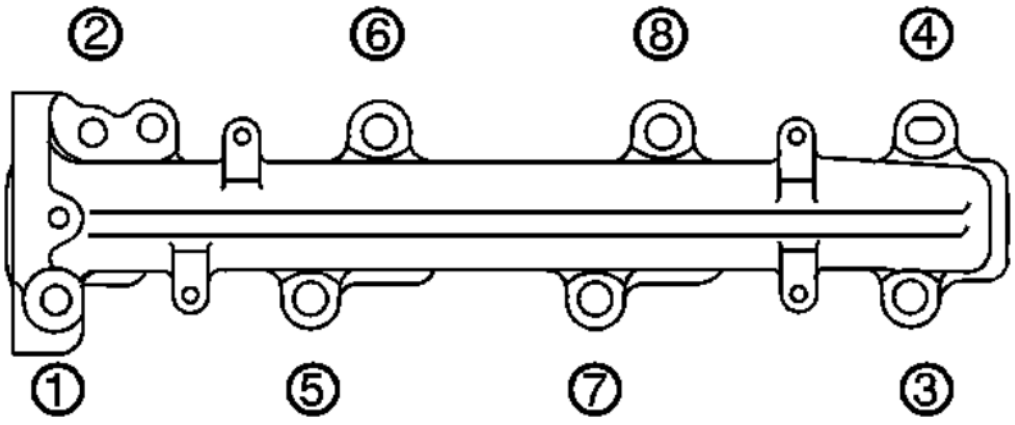


Fig. 125: Right Exhaust Manifold Bolts And Nuts Removal & Installation Sequence
Courtesy of GENERAL MOTORS CORP.

3. Remove the right exhaust manifold bolts and nuts in the proper sequence.

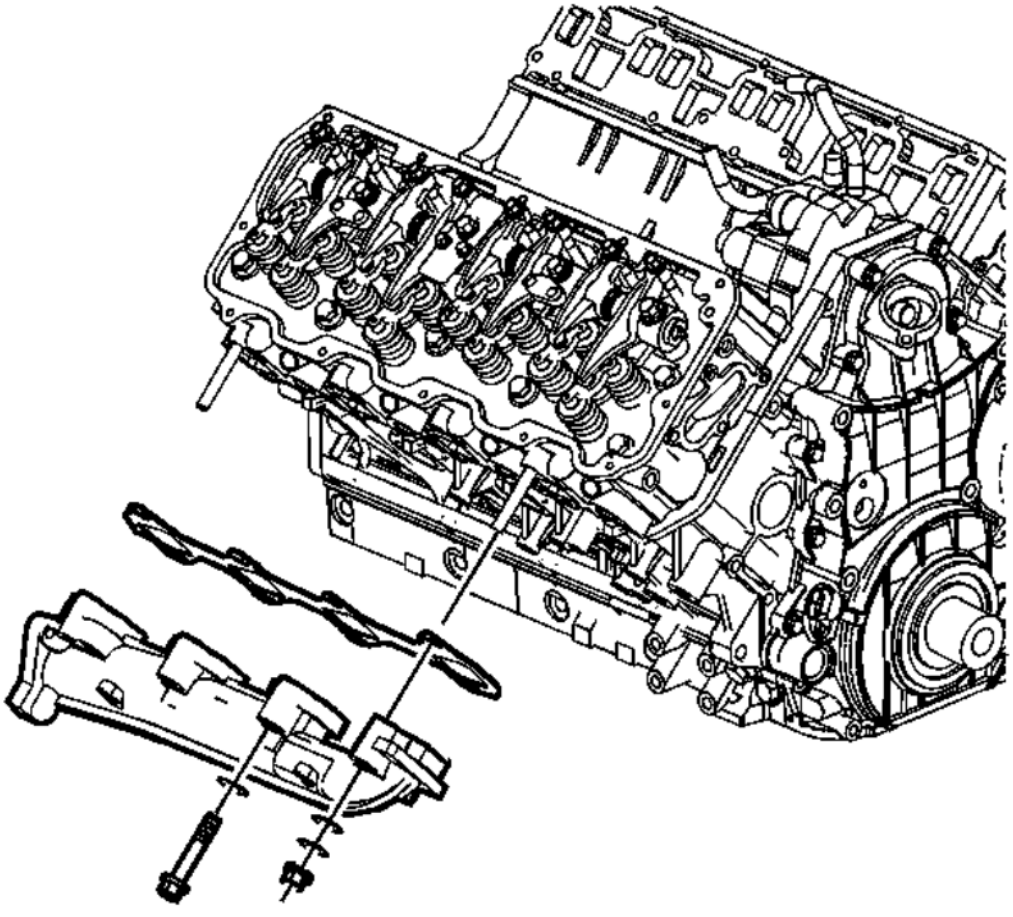


Fig. 126: View Of Right Exhaust Manifold & Gasket
Courtesy of GENERAL MOTORS CORP.

4. Remove the right exhaust manifold and gasket.

CYLINDER HEAD REMOVAL - LEFT SIDE

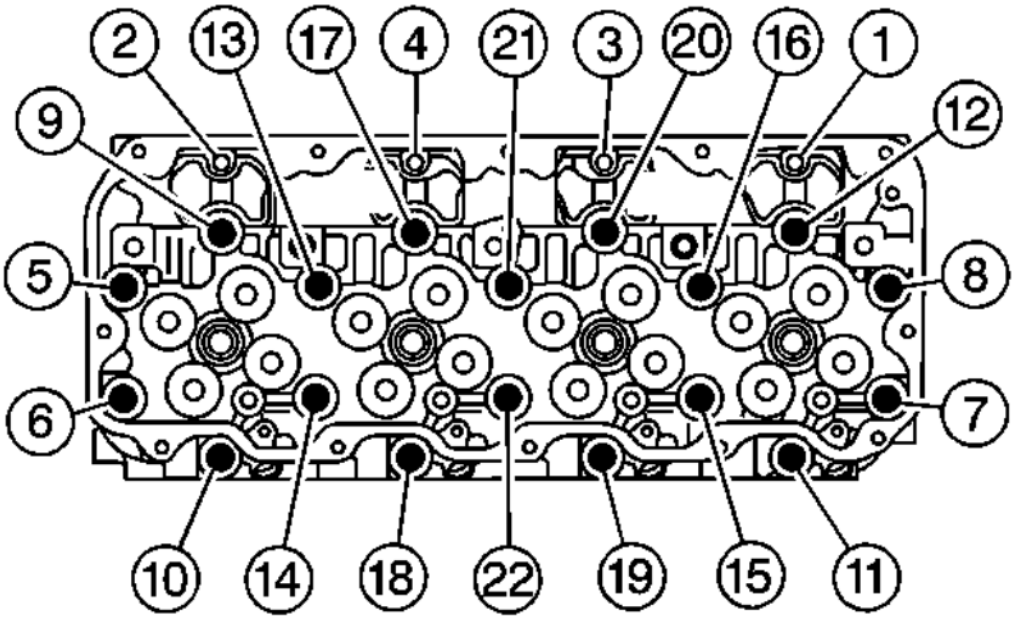


Fig. 127: Cylinder Head Bolt Removal Sequence
Courtesy of GENERAL MOTORS CORP.

1. Remove the cylinder head bolts in the proper sequence.
2. Discard the large M12 bolts.

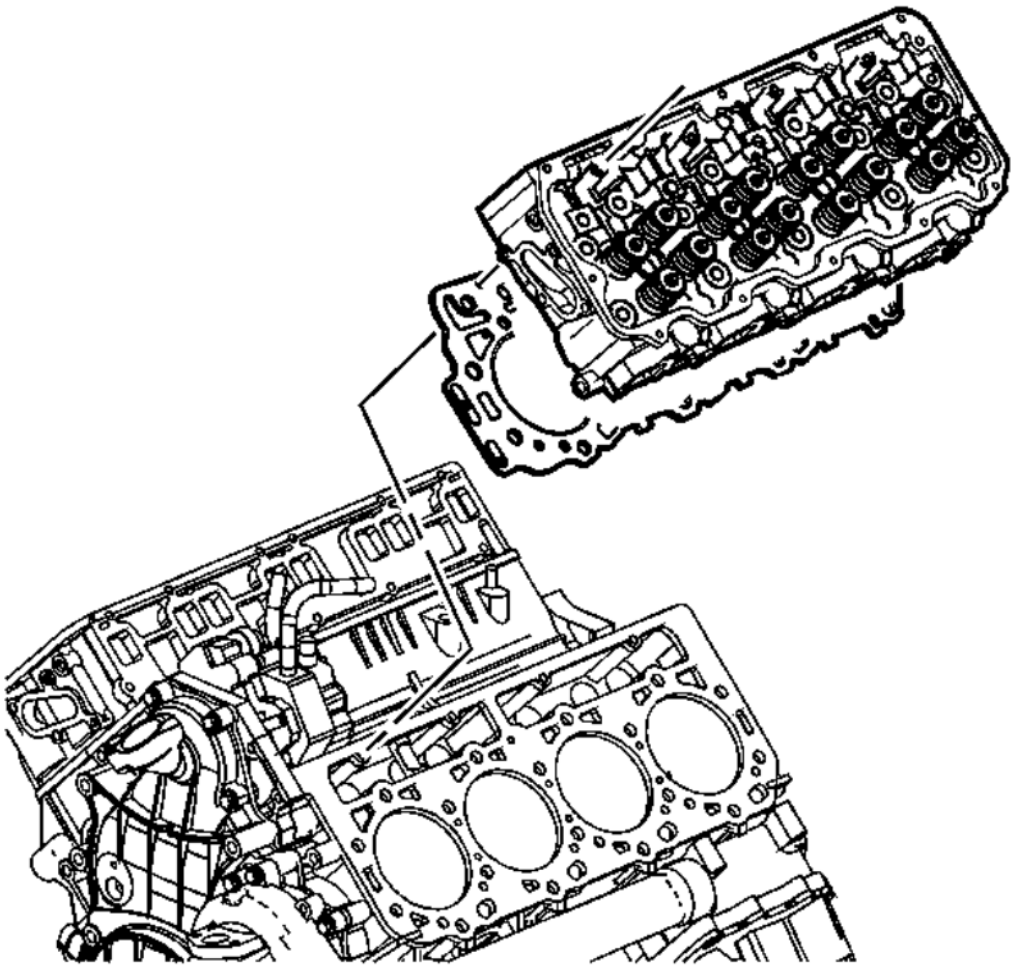


Fig. 128: View Of Left Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

3. Remove the left cylinder head assembly.
4. Remove the left cylinder head gasket.

CYLINDER HEAD REMOVAL - RIGHT SIDE

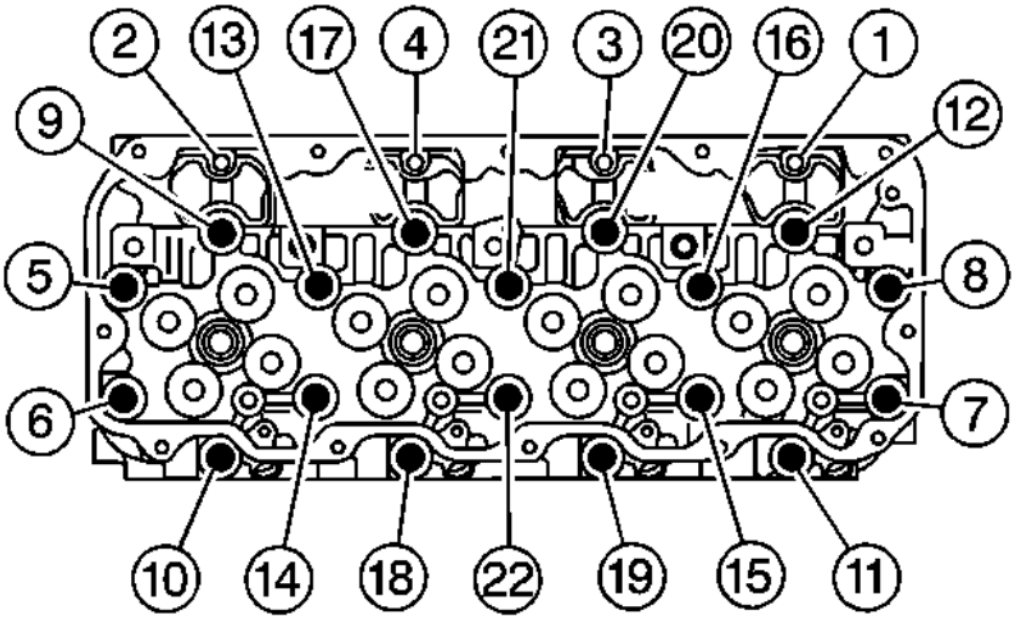


Fig. 129: Cylinder Head Bolt Removal Sequence
Courtesy of GENERAL MOTORS CORP.

1. Remove the cylinder head bolts in the proper sequence.
2. Discard the large M12 bolts.

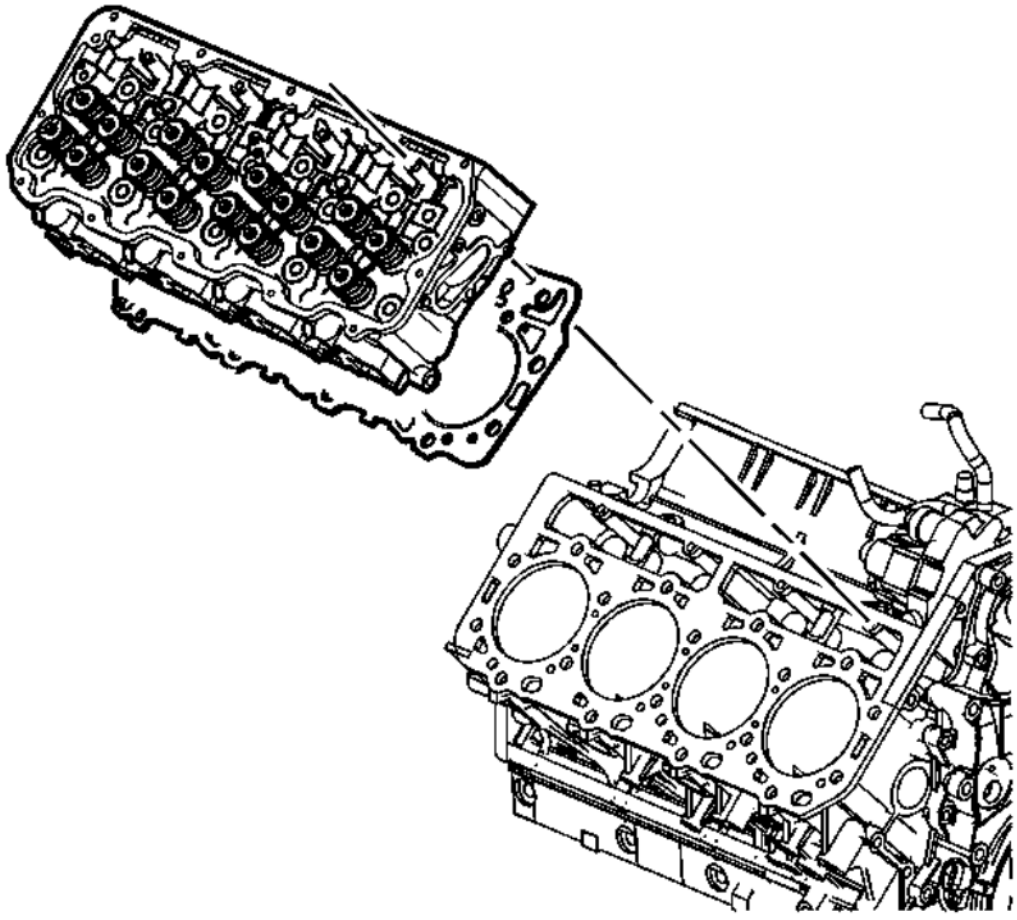


Fig. 130: View Of Cylinder Head & Gasket (Right)
Courtesy of GENERAL MOTORS CORP.

3. Remove the right cylinder head assembly.
4. Remove the right cylinder head gasket.

VALVE LIFTER REMOVAL

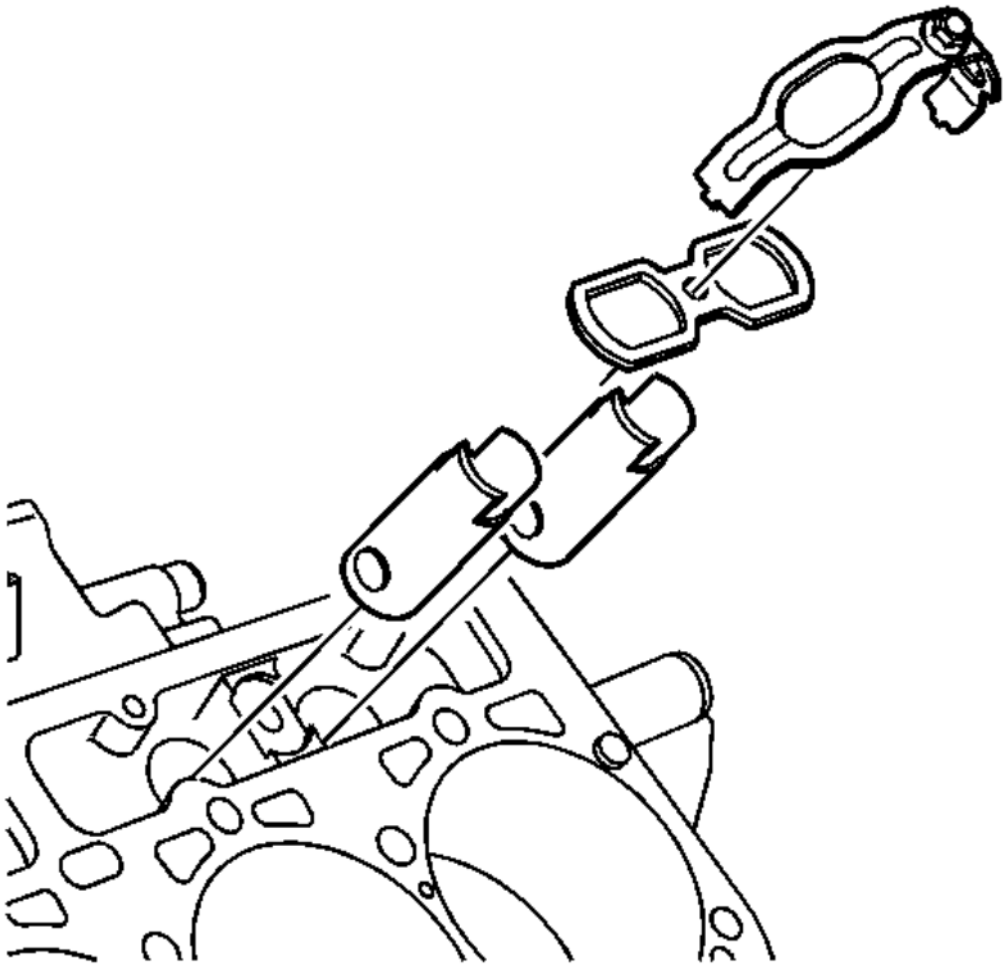


Fig. 131: View Of Valve Lifter, Guides, Retainers & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Loosen the valve lifter guide hold down bracket bolts.
2. Remove the valve lifter guide hold down brackets.
3. Remove the valve lifter guides.
4. Remove the valve lifters.

FUEL INJECTION PUMP REMOVAL

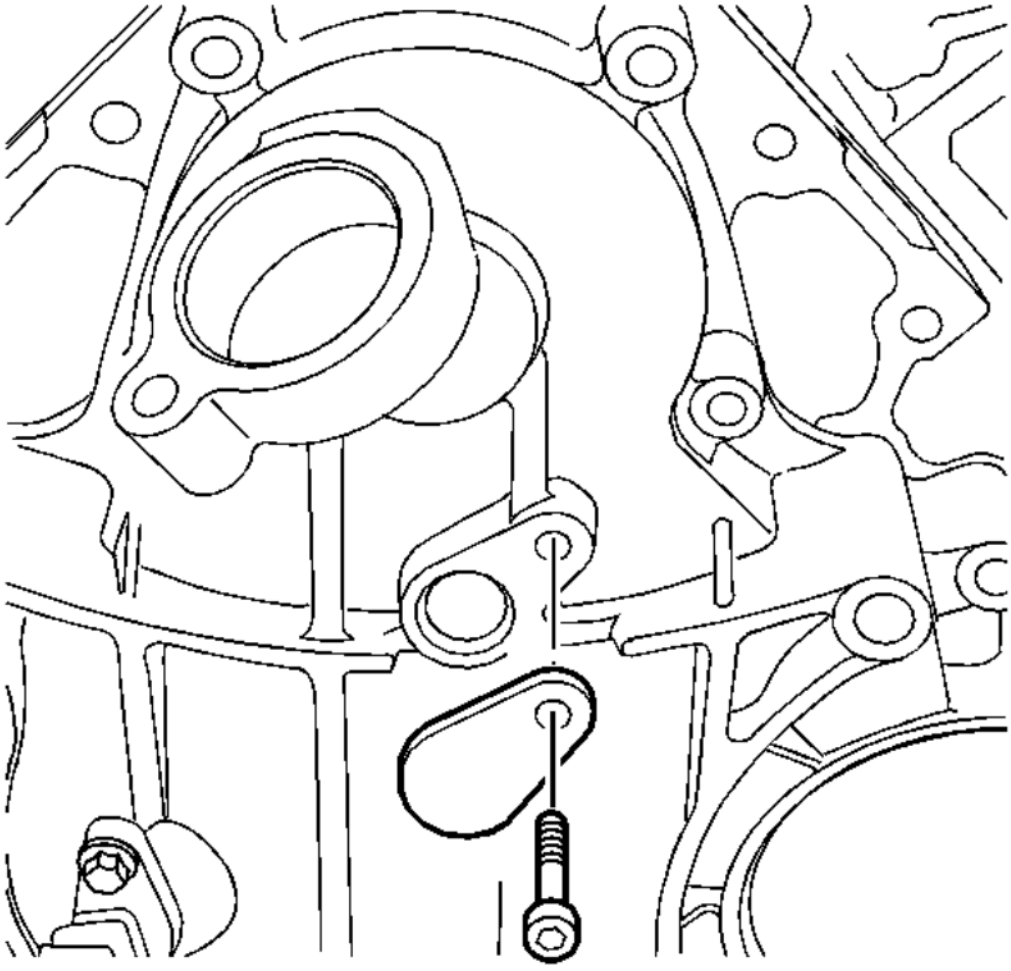


Fig. 132: Locating Camshaft Gear Access Cover
Courtesy of GENERAL MOTORS CORP.

1. Remove the camshaft gear access hole cover bolt.
2. Remove the camshaft gear access hole cover.

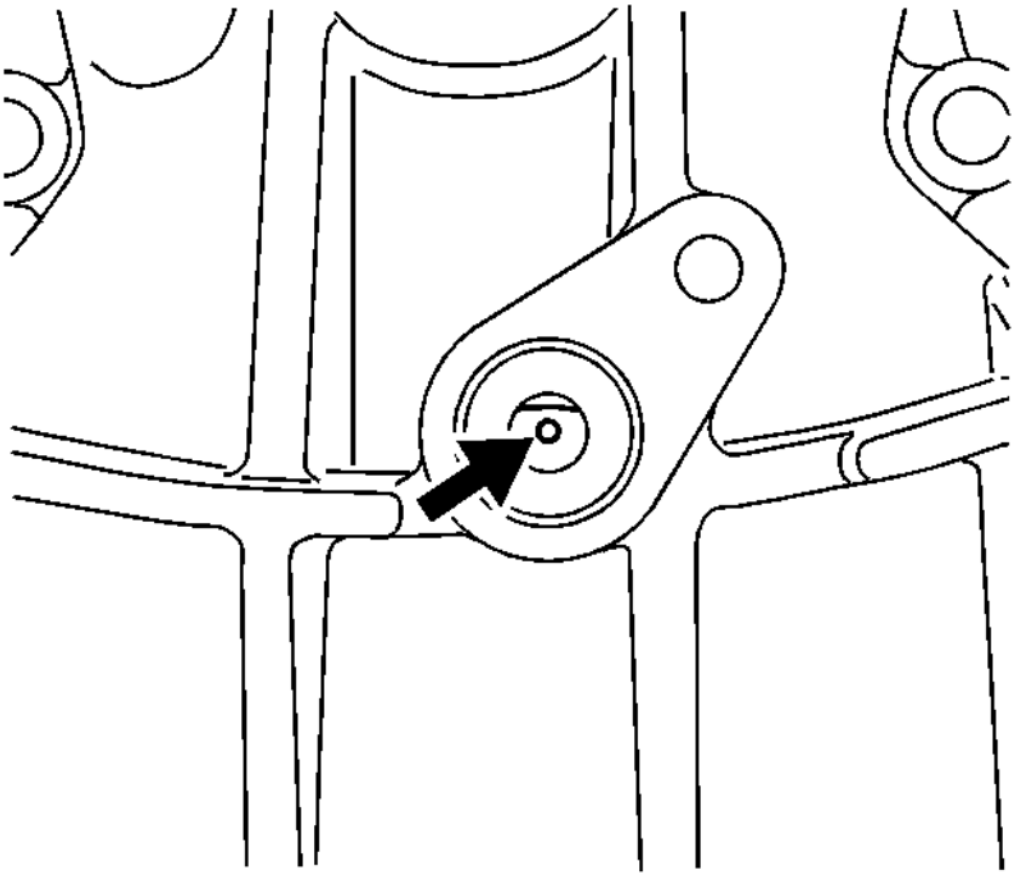


Fig. 133: Aligning Camshaft Gear Tension Relief Hole
Courtesy of GENERAL MOTORS CORP.

3. Rotate the crankshaft until the camshaft gear tension relief hole is in line with the front cover access hole.

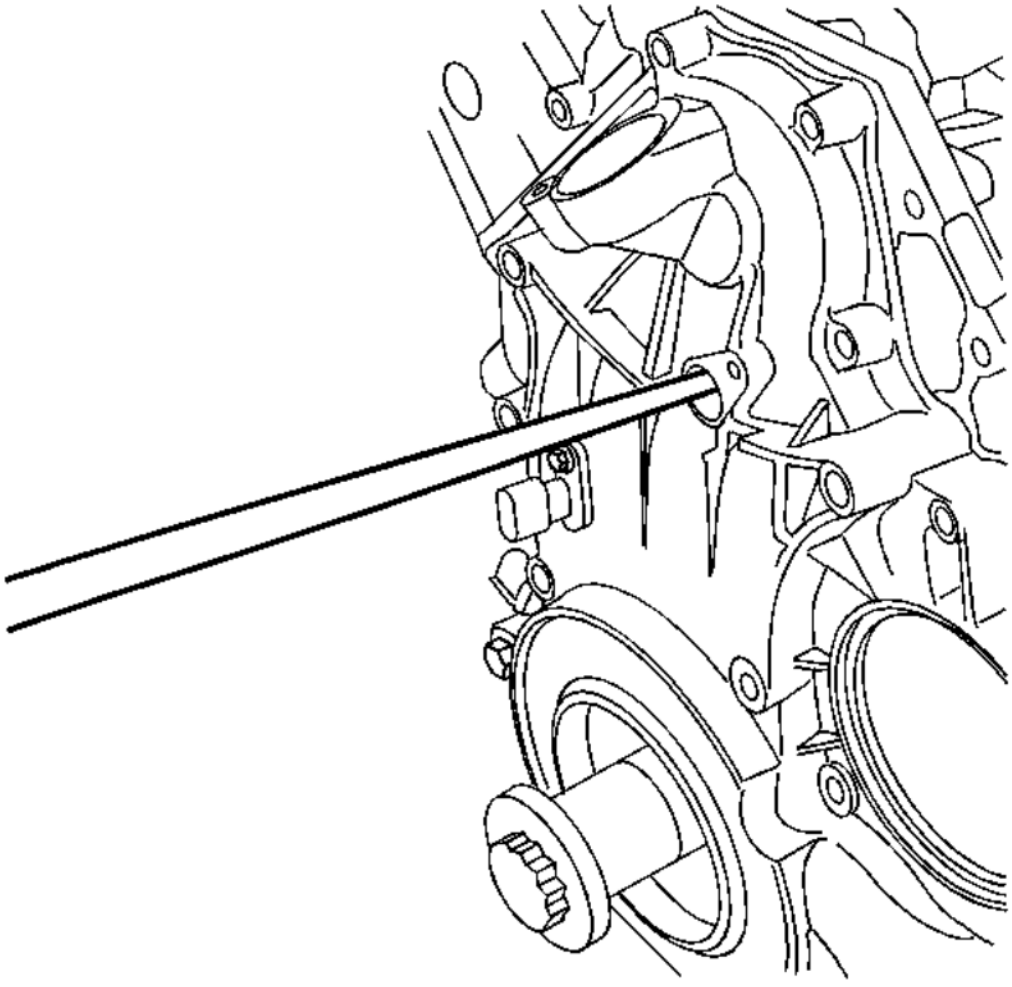


Fig. 134: Unloading Spring Tension From Two Piece Cam Gear
Courtesy of GENERAL MOTORS CORP.

4. Use a suitable tool to unload the spring tension from the two piece cam gear. Apply pressure towards the right side of the engine while removing the injection pump.

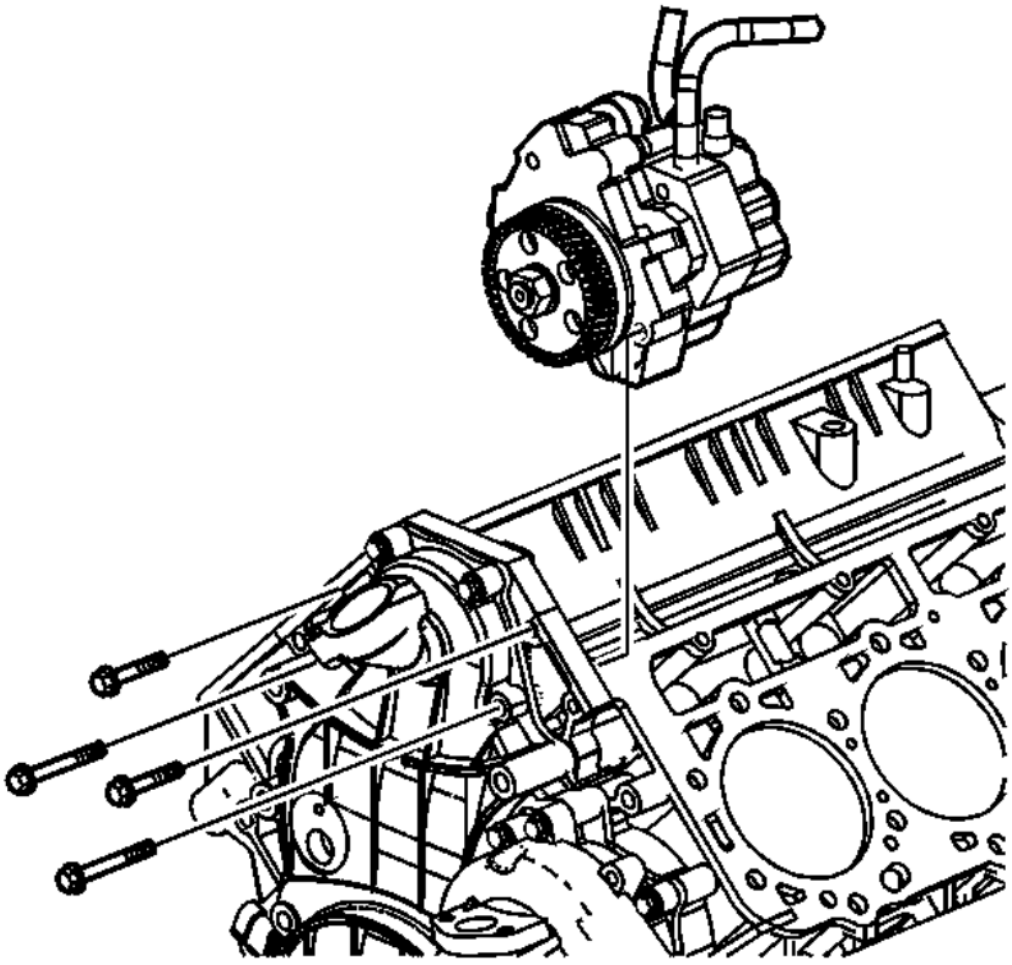


Fig. 135: View Of Fuel Injection Pump
Courtesy of GENERAL MOTORS CORP.

5. Remove the four fuel injection pump bolts.
6. Remove the fuel injection pump.

WATER PUMP REMOVAL

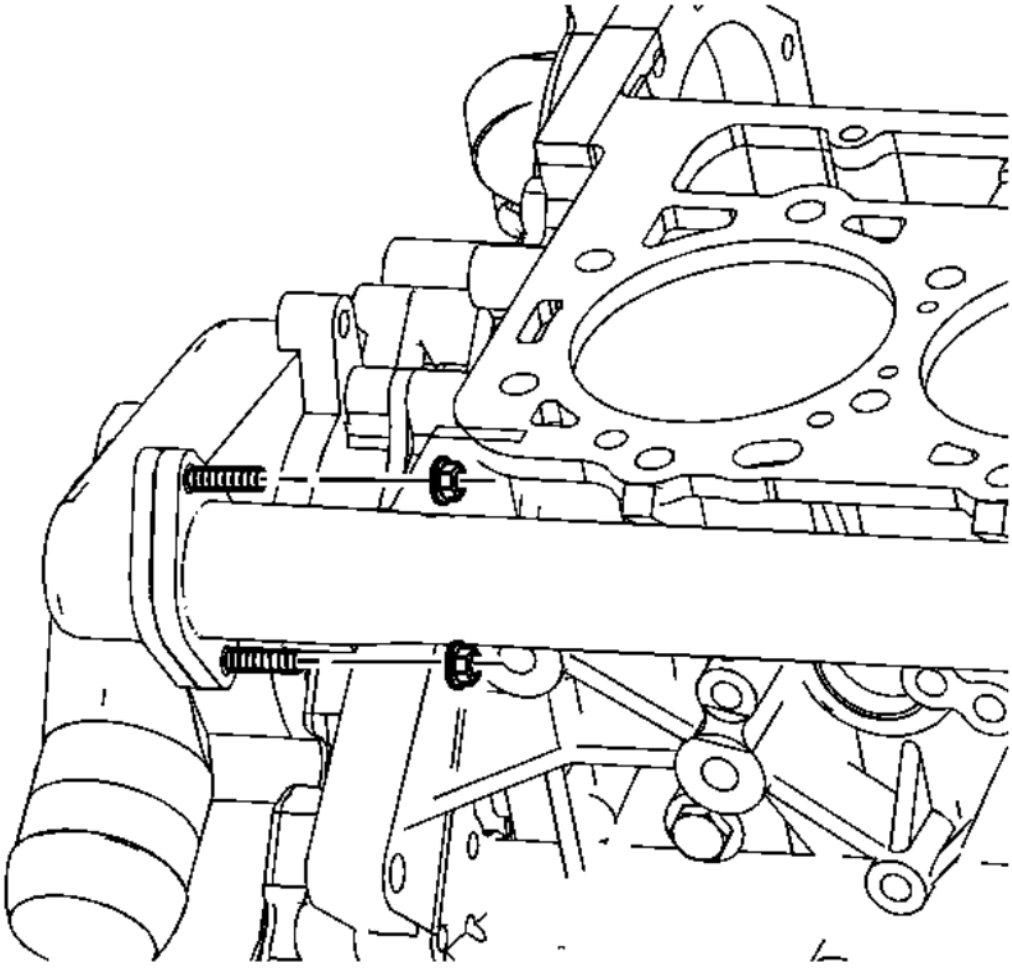


Fig. 136: View Of Water Pump Outlet Pipe Nuts
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine coolant pipe to water pump nuts.

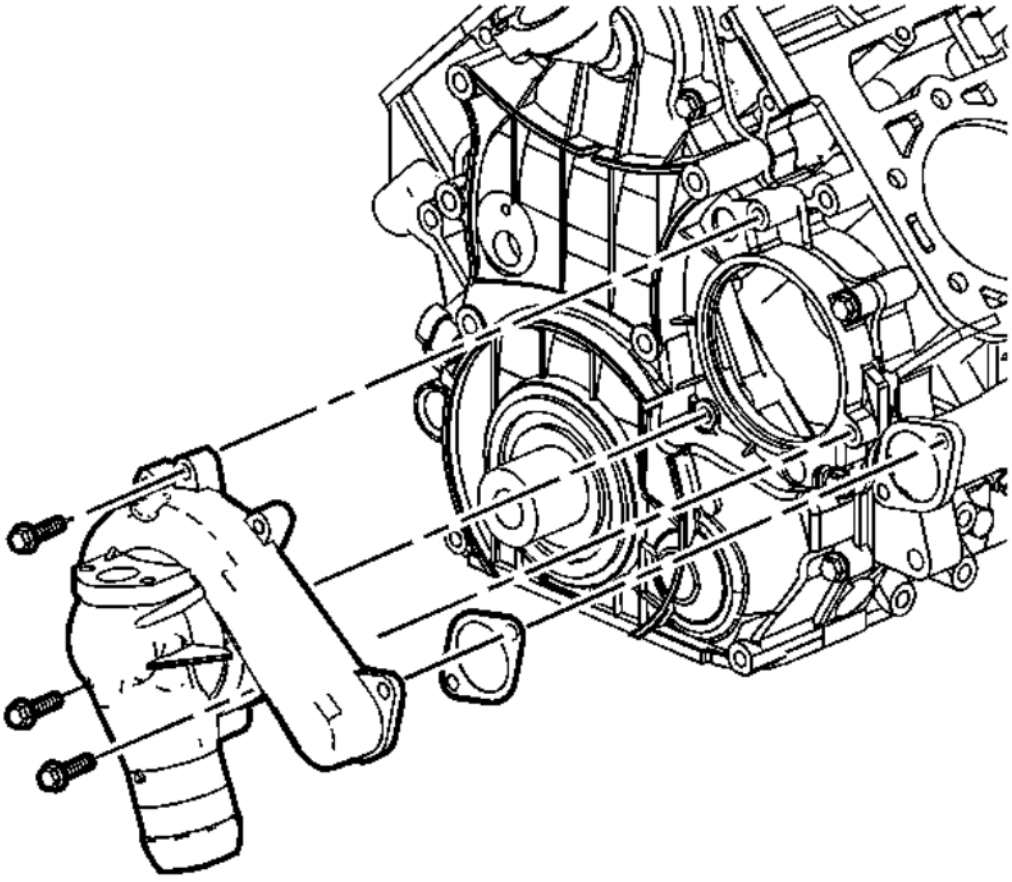


Fig. 137: View Of Engine Coolant Pipe & Gasket
Courtesy of GENERAL MOTORS CORP.

2. Remove the water pump bolts.
3. Remove the water pump assembly.
4. Remove the water pump seal and discard.
5. Remove the engine coolant pipe gasket and discard.

OIL FILTER ADAPTER AND OIL COOLER ASSEMBLY REMOVAL

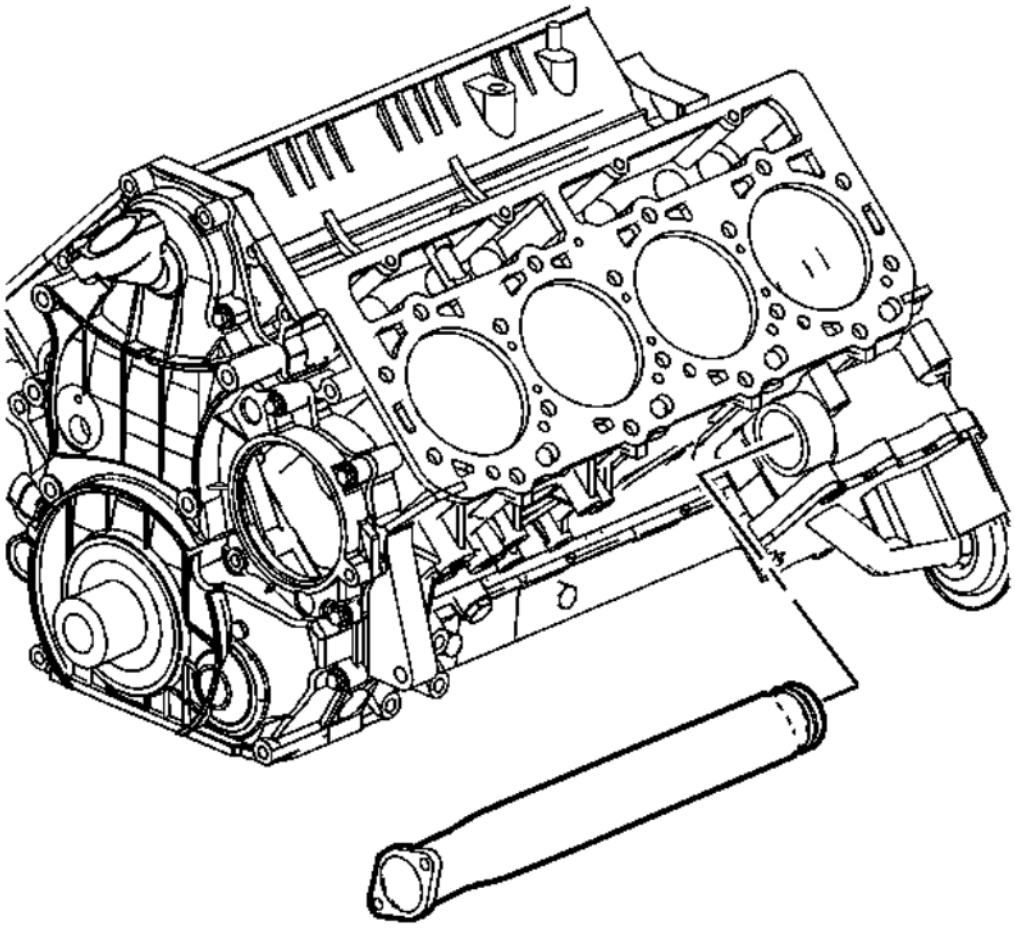


Fig. 138: View Of Engine Coolant Pipe
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine coolant pipe.
2. Remove the engine coolant pipe O-ring and discard.

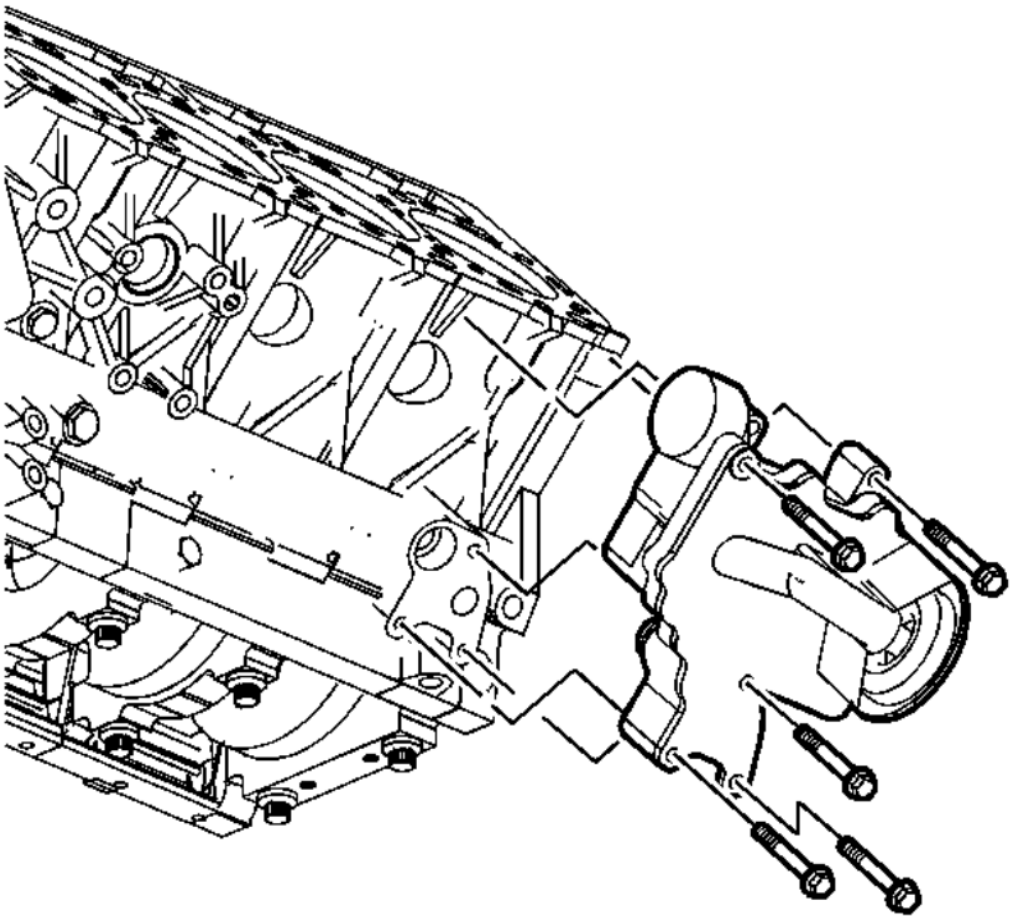


Fig. 139: View Of Oil Filter Adapter/Oil Cooler
Courtesy of GENERAL MOTORS CORP.

3. Remove the five oil filter adapter and oil cooler assembly bolts.
4. Remove the oil filter adapter and oil cooler assembly.

CRANKSHAFT FRONT OIL SEAL REMOVAL

Tools Required

J 44644 Crankshaft Front Oil Seal Remover. See **Special Tools** .

Removal

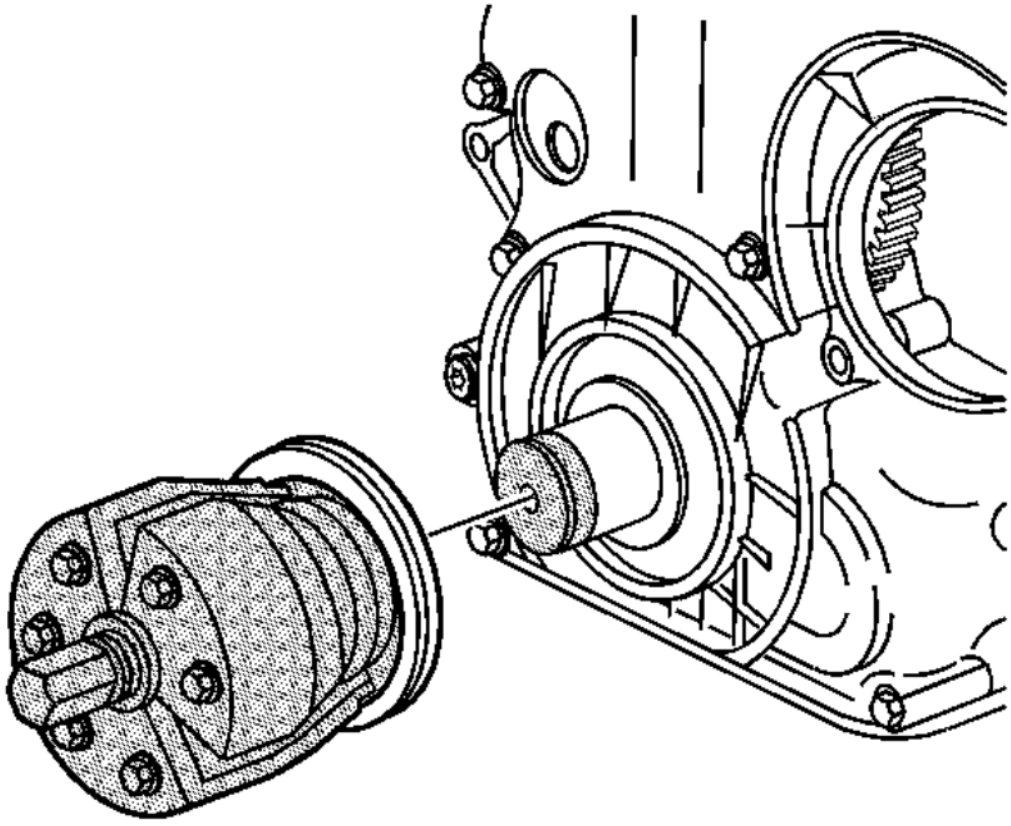


Fig. 140: Removing Crankshaft Front Oil Seal Using J 44644
Courtesy of GENERAL MOTORS CORP.

1. Install the **J 44644** to the crankshaft front oil seal. See **Special Tools** .
2. Remove crankshaft front oil seal using **J 44644** . See **Special Tools** .

ENGINE FRONT COVER REMOVAL

Tools Required

J 37228 Seal Cutter. See **Special Tools** .

Removal

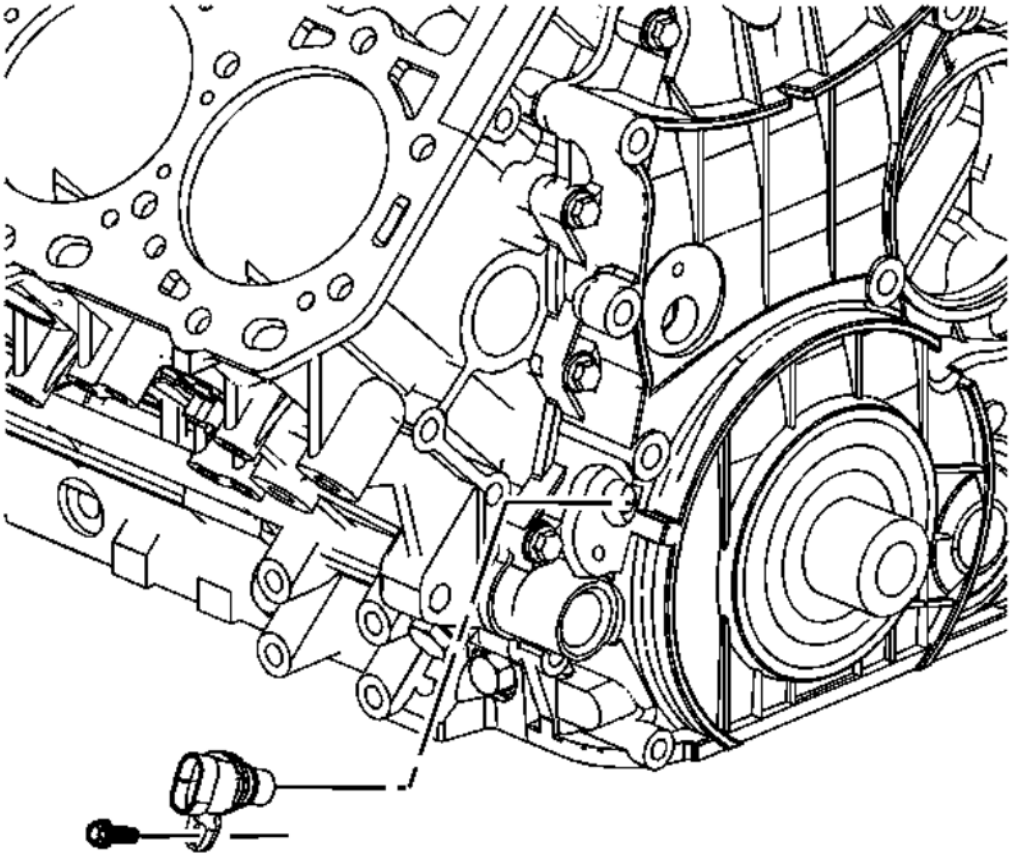


Fig. 141: View Of CKP Sensor & Bolt
Courtesy of GENERAL MOTORS CORP.

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

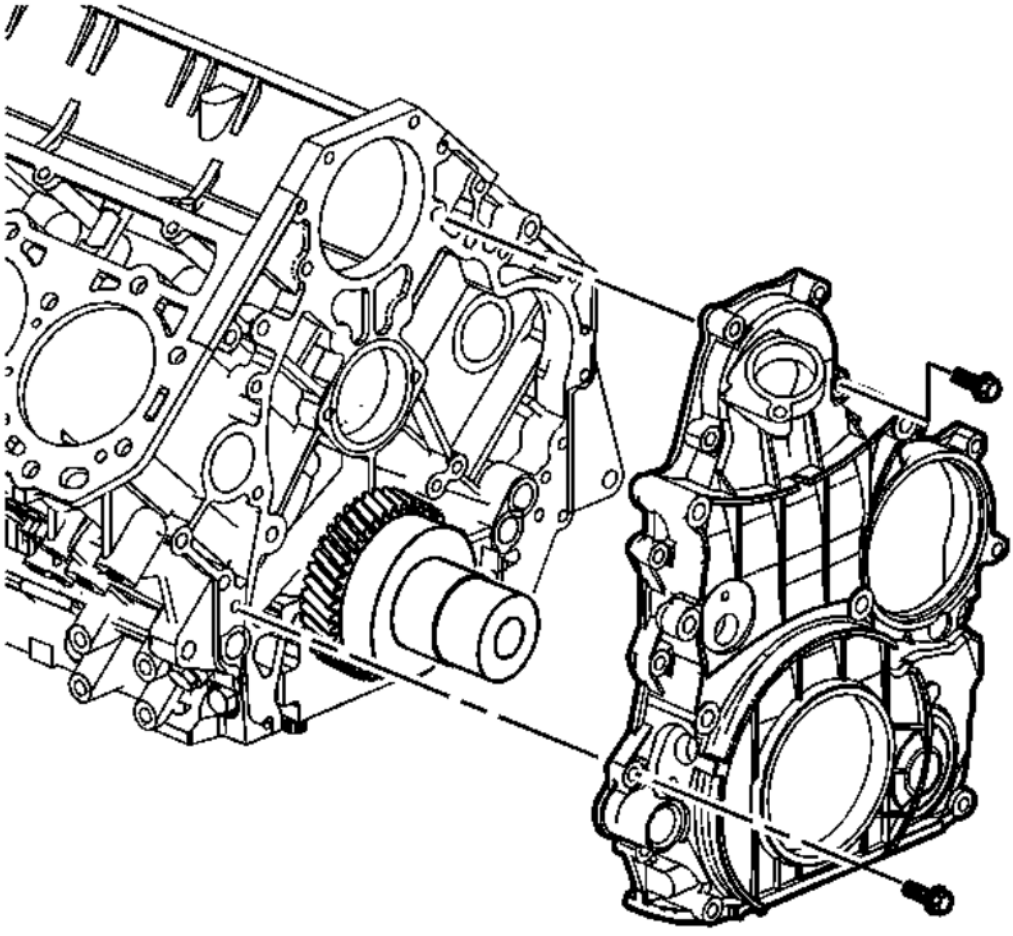


Fig. 142: View Of Engine Front Cover
Courtesy of GENERAL MOTORS CORP.

3. Remove the engine front cover bolts.
4. Separate the engine front cover from the cylinder block using **J 37228** . See **Special Tools** .
5. Remove the engine front cover.

OIL PUMP SUCTION PIPE AND SCREEN ASSEMBLY REMOVAL

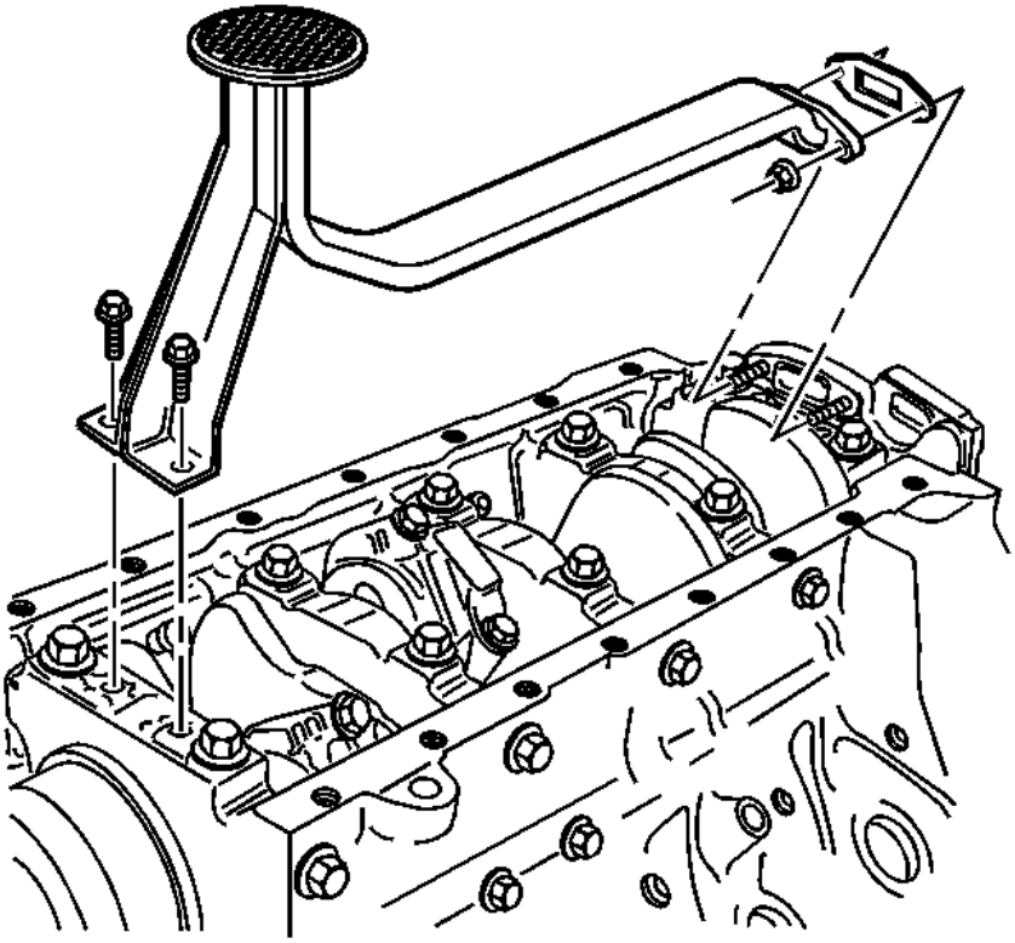


Fig. 143: View Of Oil Pump Pipe, Screen Assembly & Gasket
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil pump pipe and screen assembly bolts and nuts.
2. Remove the oil pump pipe and screen assembly.
3. Remove the oil pump pipe and screen assembly gasket and discard.

PISTON OIL COOLING NOZZLE REMOVAL

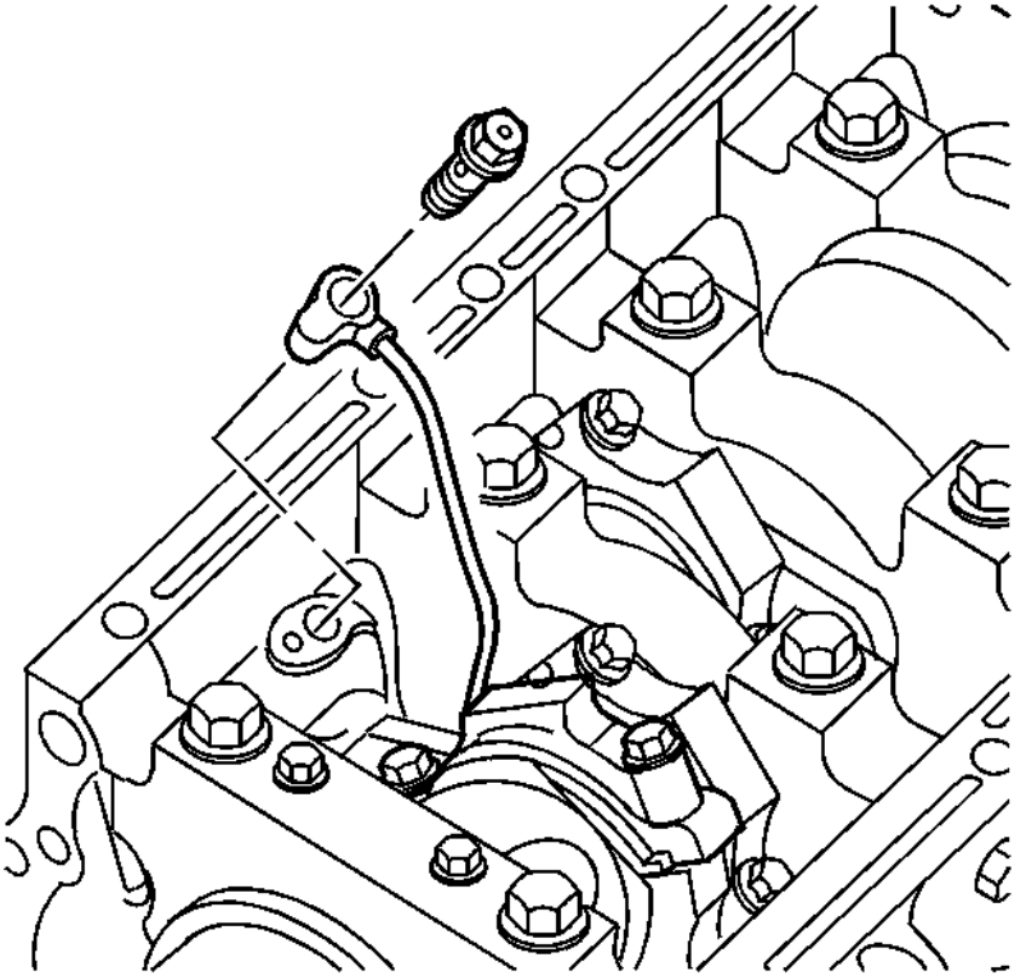


Fig. 144: View Of Piston Oil Cooling Nozzle
Courtesy of GENERAL MOTORS CORP.

1. Rotate crankshaft as necessary to obtain access to piston oil cooling nozzles.
2. Remove the piston oil cooling nozzle eye bolt.
3. Remove the piston oil cooling nozzle.

PISTON, CONNECTING ROD, AND BEARING REMOVAL

Tools Required

J 24270 Ridge Reamer

Removal

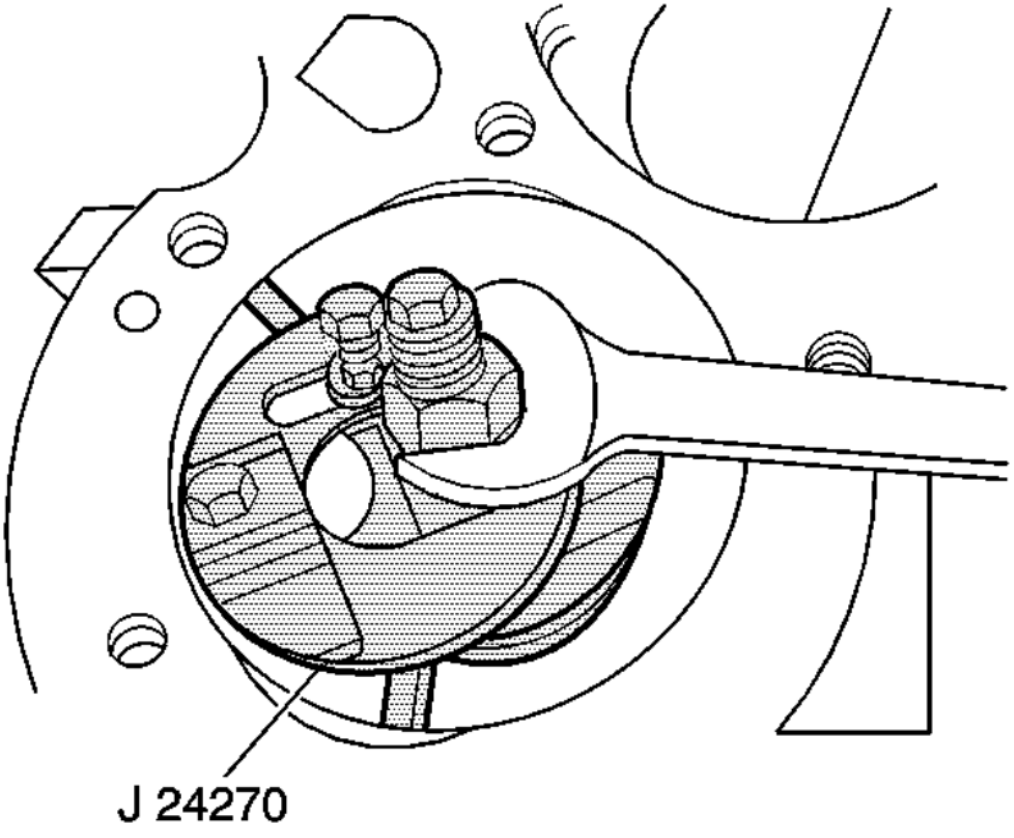


Fig. 145: Removing Cylinder Bore Ring Ridge
Courtesy of GENERAL MOTORS CORP.

1. Rotate the crankshaft to place the piston at the bottom of the piston stroke.
2. Place a cloth on top of the piston.
3. Use the **J 24270** to remove the ridge at the top of the cylinder bore.
4. Remove cloth.
5. Remove cutting debris from the cylinder and piston.

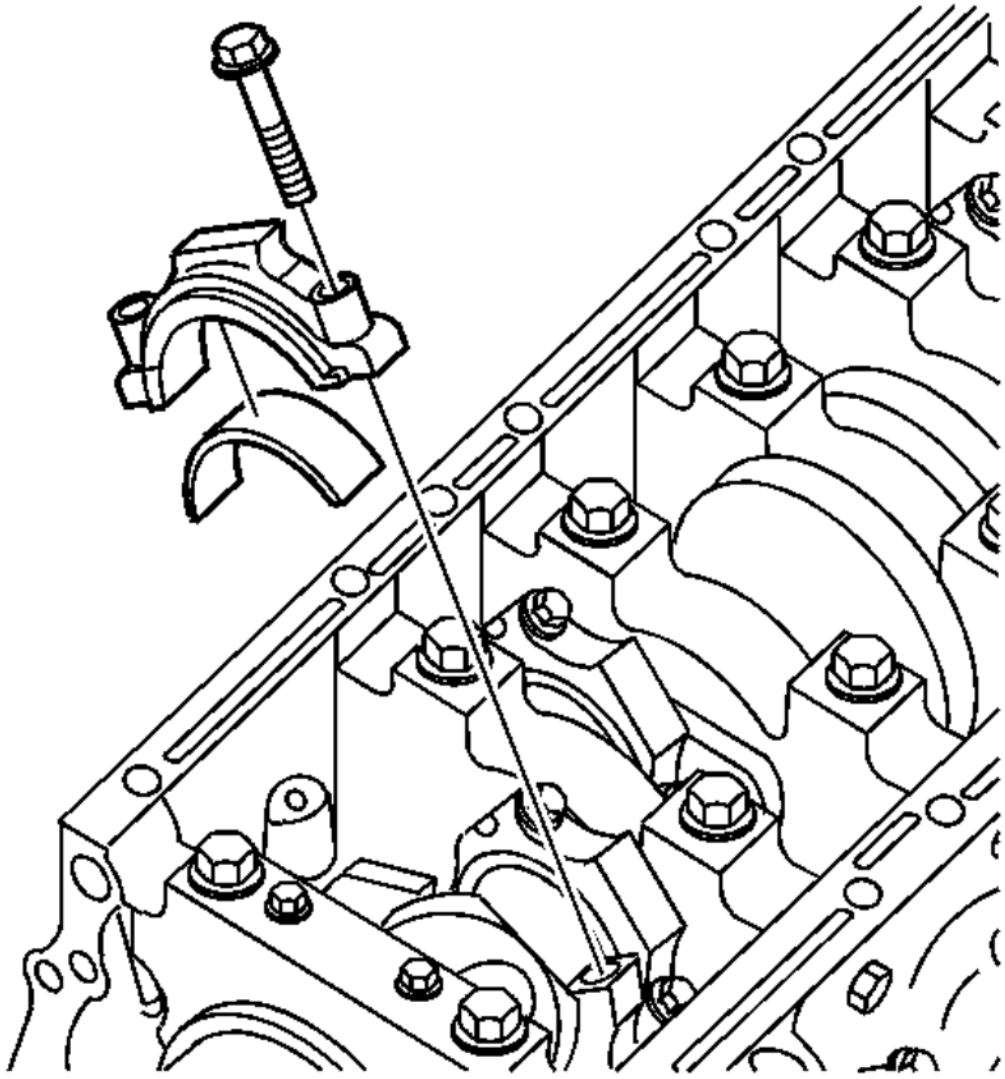


Fig. 146: View Of Connecting Rod Cap & Bearing Insert
Courtesy of GENERAL MOTORS CORP.

6. Remove the connecting rod cap bolts. Set the bolts aside for use in plastic gauging if needed. New bolts will be used for final assembly.
7. Remove the connecting rod cap.
8. Remove the bearing insert from connecting rod.

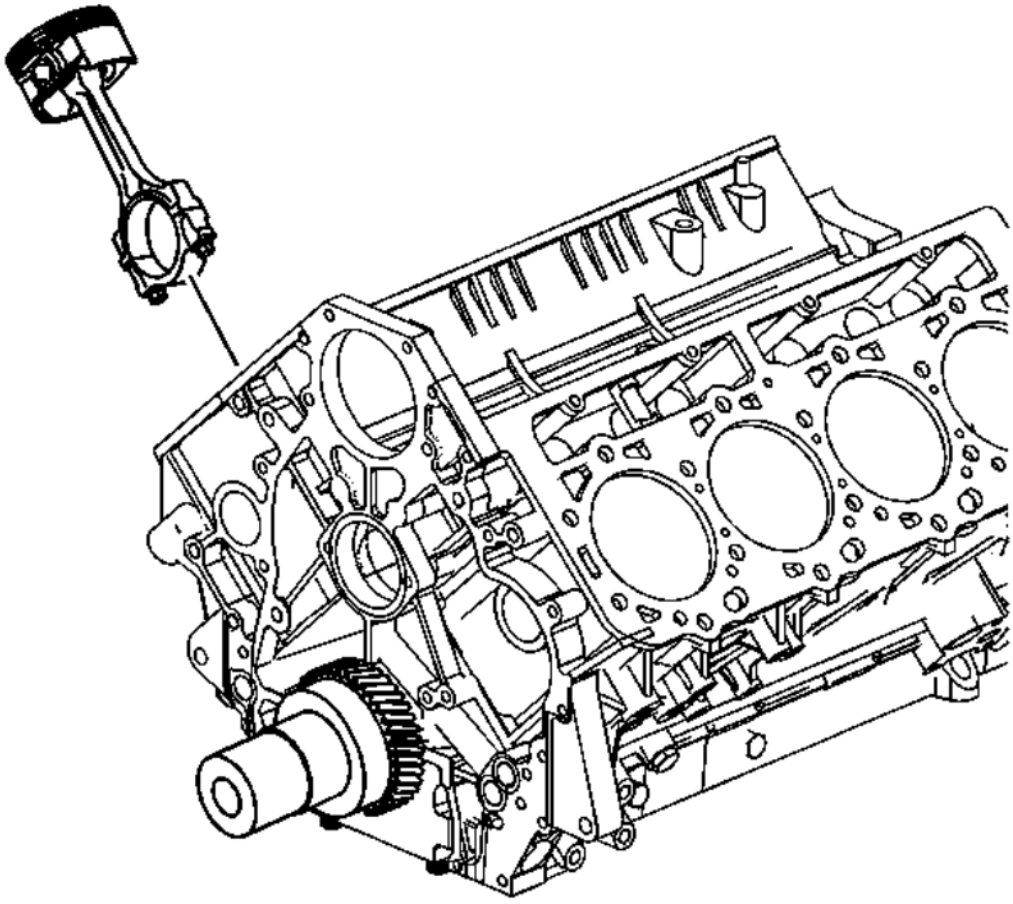


Fig. 147: View Of Piston Assembly
Courtesy of GENERAL MOTORS CORP.

9. Push piston assembly out of cylinder.
10. Reassemble the connecting rod bearing, cap, and bolts upon removal.

CAMSHAFT REMOVAL

Tools Required

J 7872 Dial Indicator Set

Removal

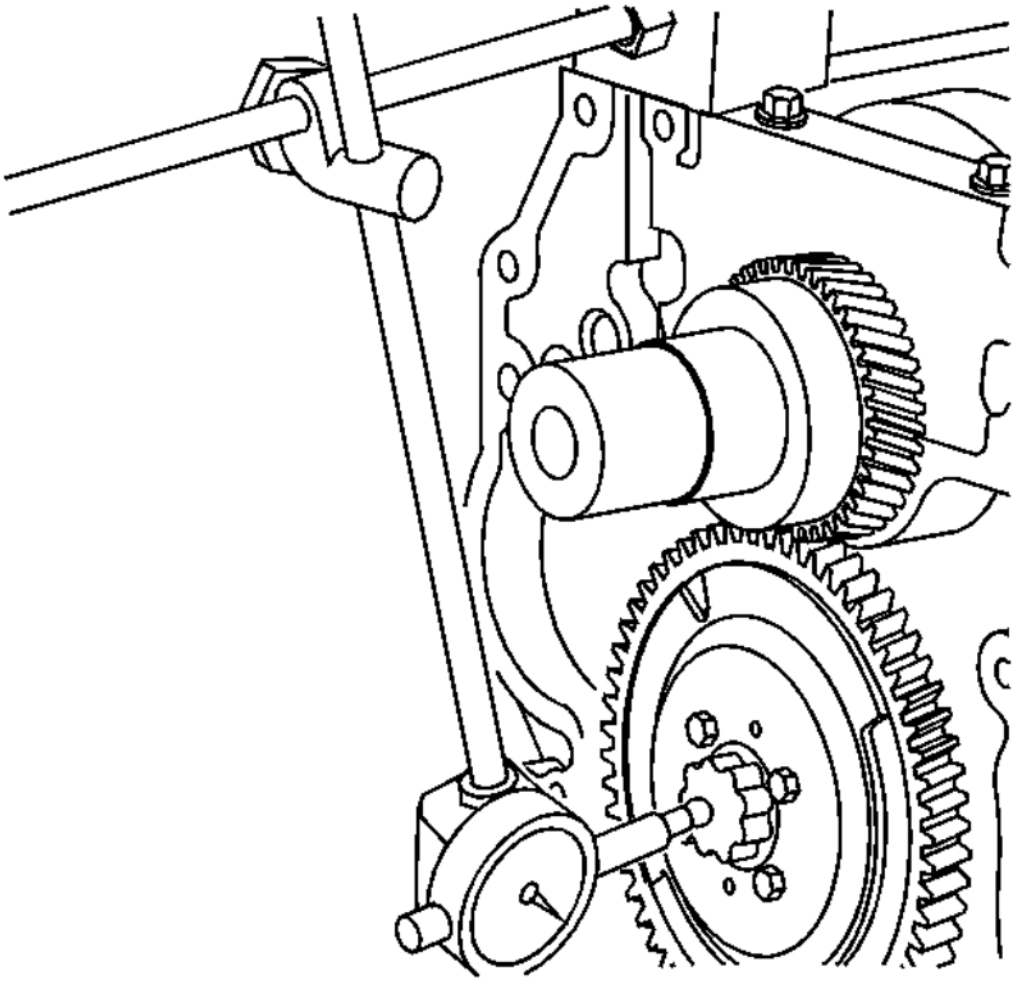


Fig. 148: Measuring Camshaft End Play Using J 7872
Courtesy of GENERAL MOTORS CORP.

1. Measure the camshaft end play using **J 7872** .
   - The production value is 0.050-0.114 mm (0.002-0.0045 in) and service limit is 0.20 mm (0.008 in).
   - Replace the camshaft or the camshaft thrust plate if the measured value exceeds the service limit.

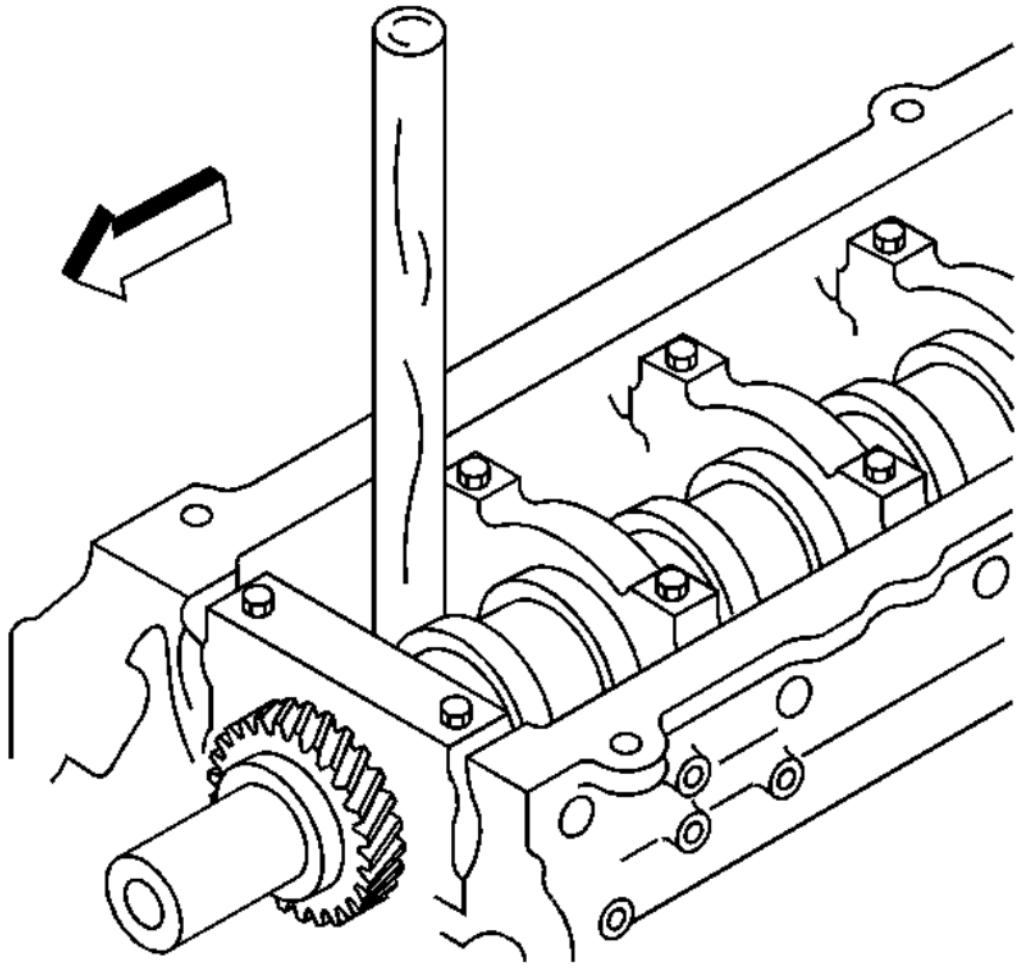


Fig. 149: Blocking Crankshaft From Turning Using Wooden Handle
Courtesy of GENERAL MOTORS CORP.

2. Block the crankshaft from turning with a wooden handle.
3. Loosen the camshaft gear bolt and leave the bolt finger tight.

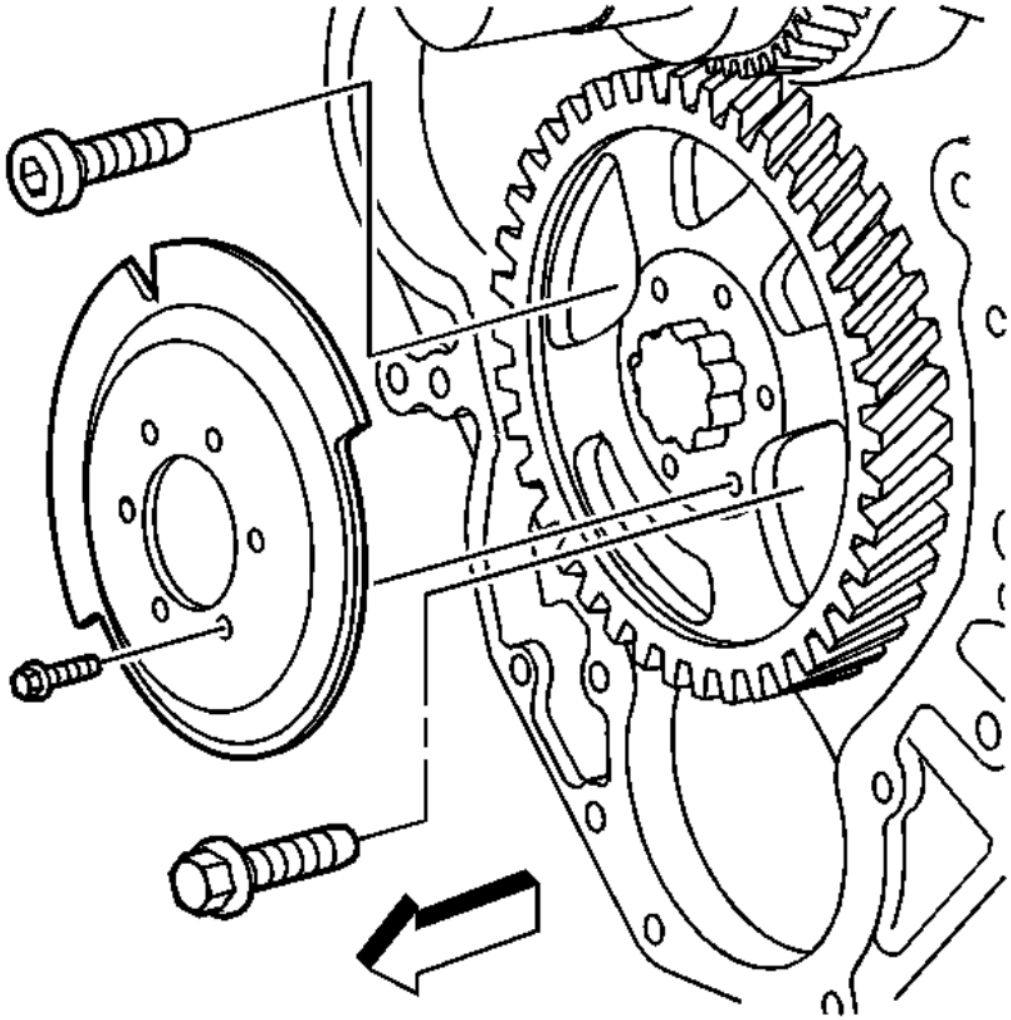


Fig. 150: View Of Camshaft Exciter Ring, Bolts & Thrust Plate Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the camshaft exciter ring bolts.

IMPORTANT: The two piece cam gear must be bolted together to prevent the spring tension from unloading upon removal.

5. Remove the camshaft exciter ring.

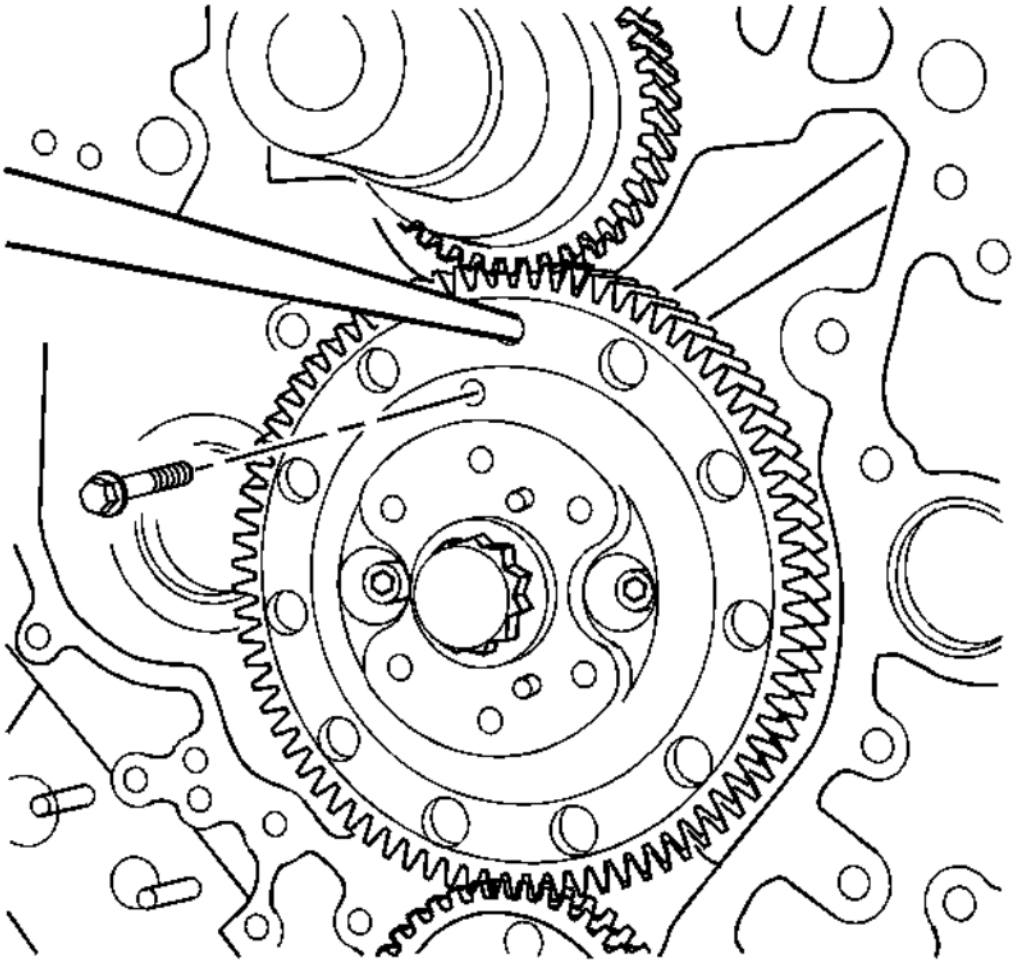


Fig. 151: Using Exciter Ring Bolt To Secure Spring Tension
Courtesy of GENERAL MOTORS CORP.

6. Align the threaded hole with a suitable tool and install an exciter ring bolt to secure the spring tension.
7. Remove the camshaft thrust plate bolts through the holes in the camshaft gear.

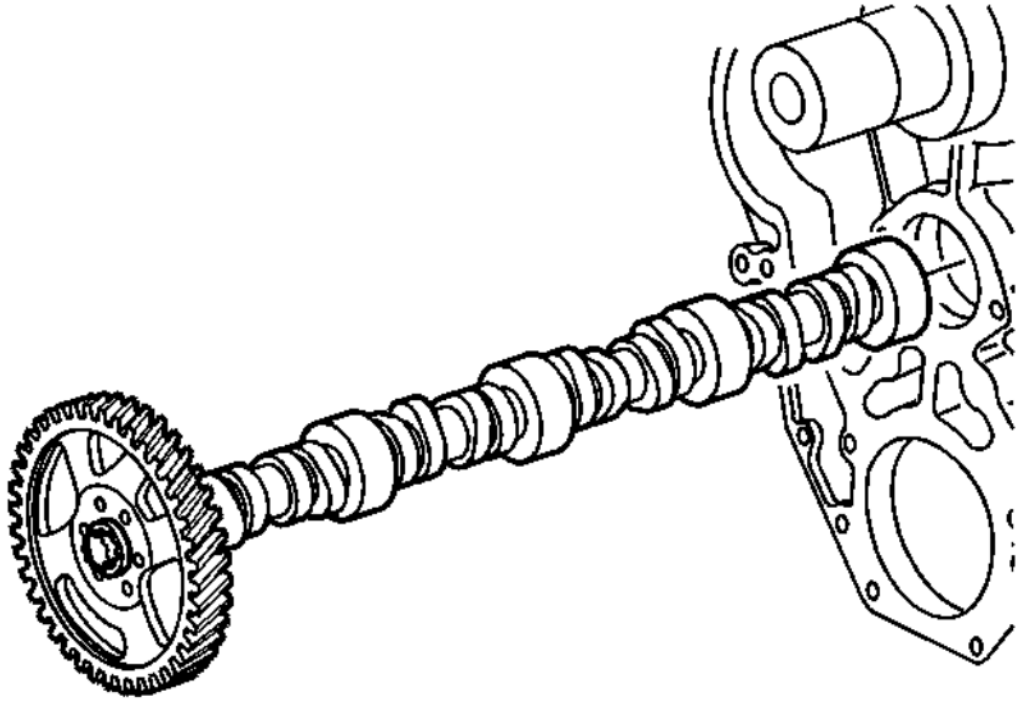


Fig. 152: View Of Camshaft With Camshaft Gear Attached
Courtesy of GENERAL MOTORS CORP.

8. Remove the camshaft with the camshaft gear attached.

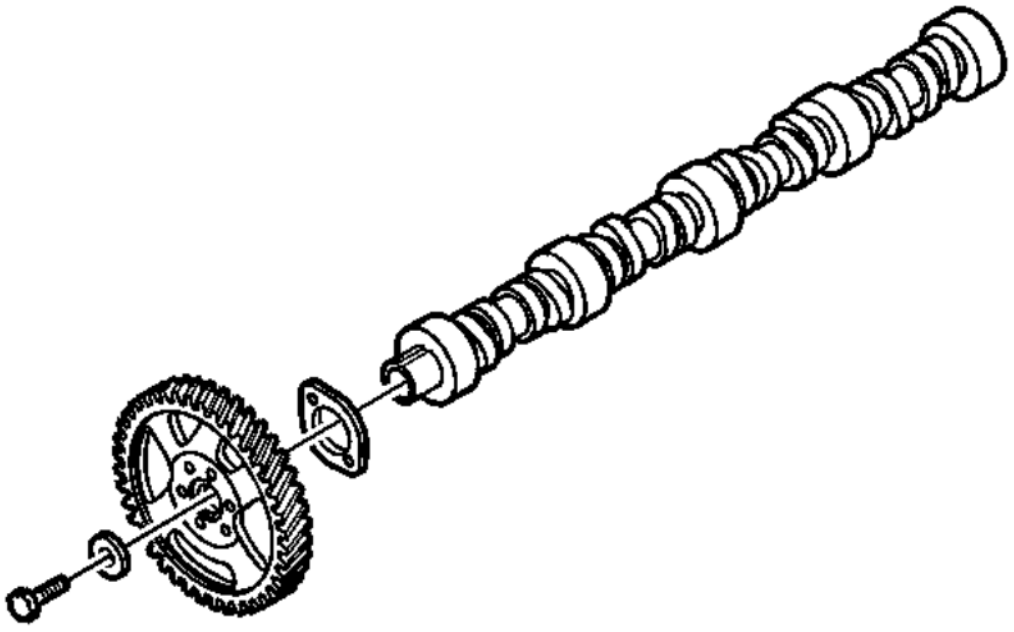


Fig. 153: View Of Camshaft, Camshaft Gear & Camshaft Thrust Plate
Courtesy of GENERAL MOTORS CORP.

9. Remove the camshaft gear bolt and washer.
10. Remove the camshaft gear.
11. Remove the camshaft thrust plate.

CRANKSHAFT AND BEARING REMOVAL

Tools Required

J 7872 Dial Indicator Set

Removal

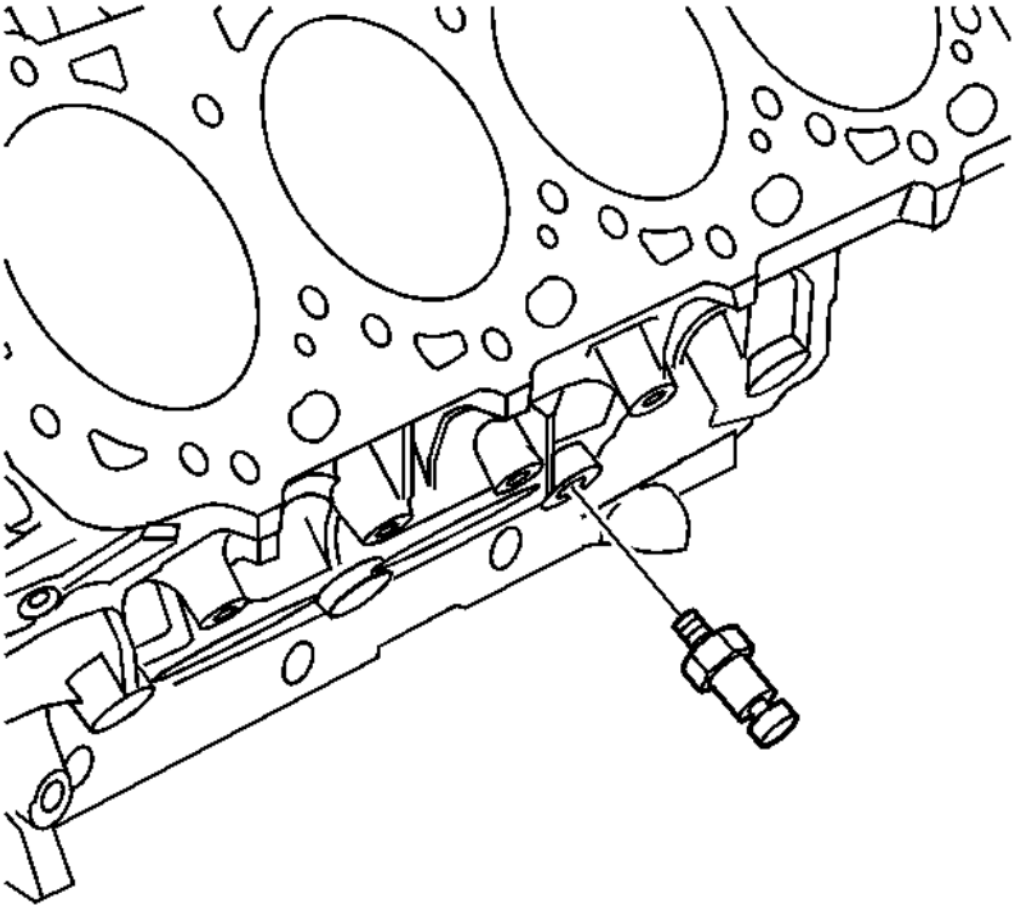


Fig. 154: View Of Oil Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil pressure sensor.

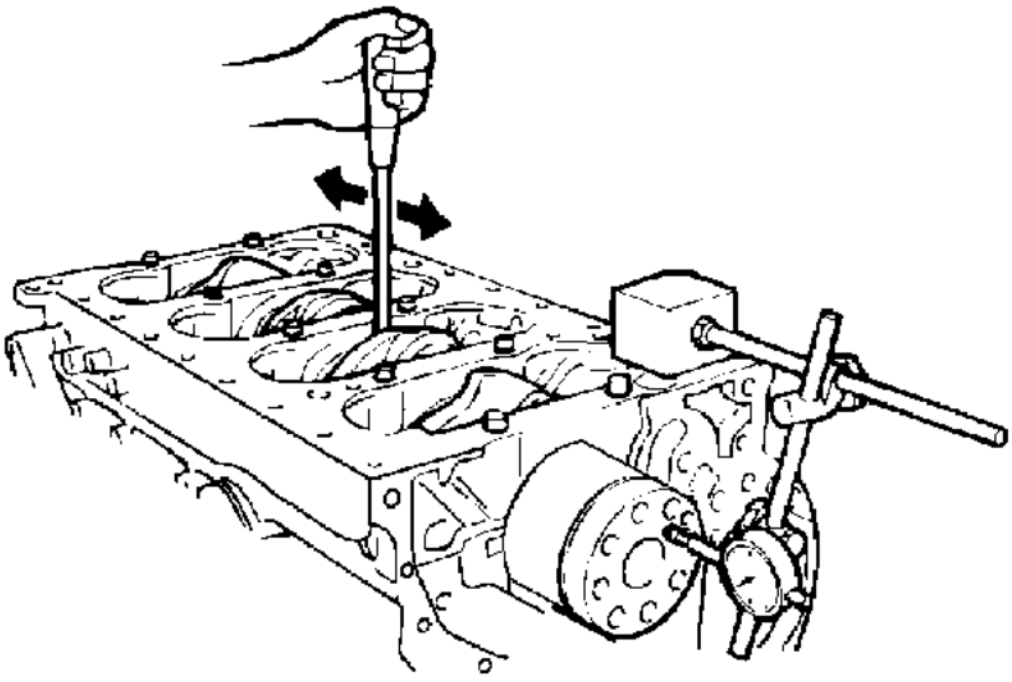


Fig. 155: Measuring Crankshaft End Play Using J 7872
Courtesy of GENERAL MOTORS CORP.

2. Measure crankshaft end play using **J 7872** . The production value is 0.04-0.205 mm (0.0016-0.0081 in) and the service limit is 0.54 mm (0.0213 in). Replace the thrust bearings upon reassembly if the measured value exceeds the service limit.

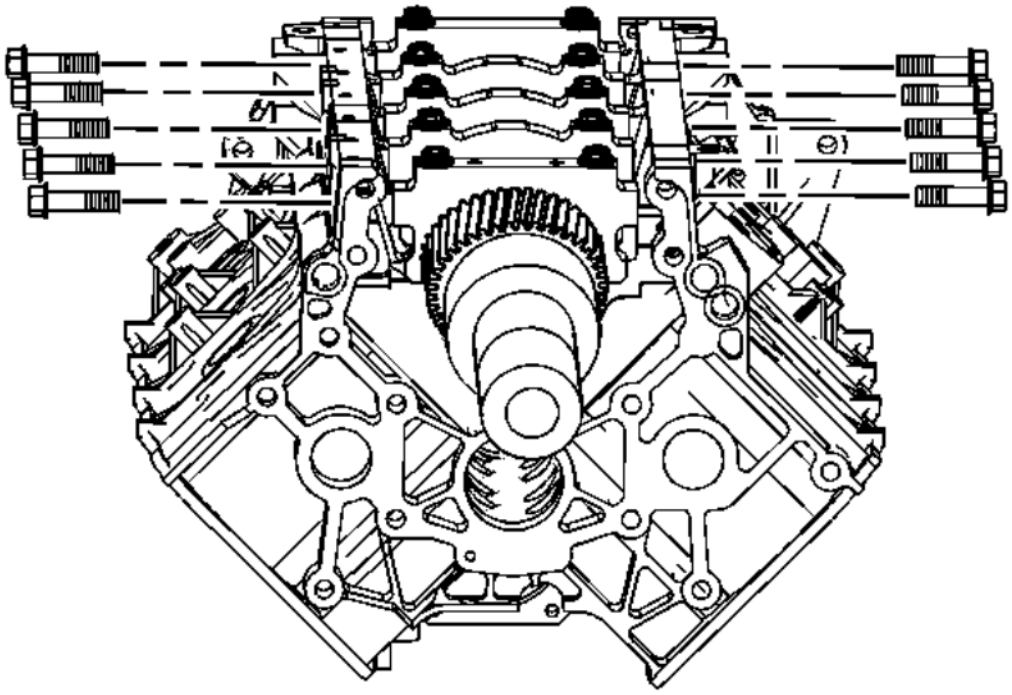


Fig. 156: View Of Crankshaft Bearing Cap Side Bolts
Courtesy of GENERAL MOTORS CORP.

3. Remove the crankshaft bearing cap side bolts.

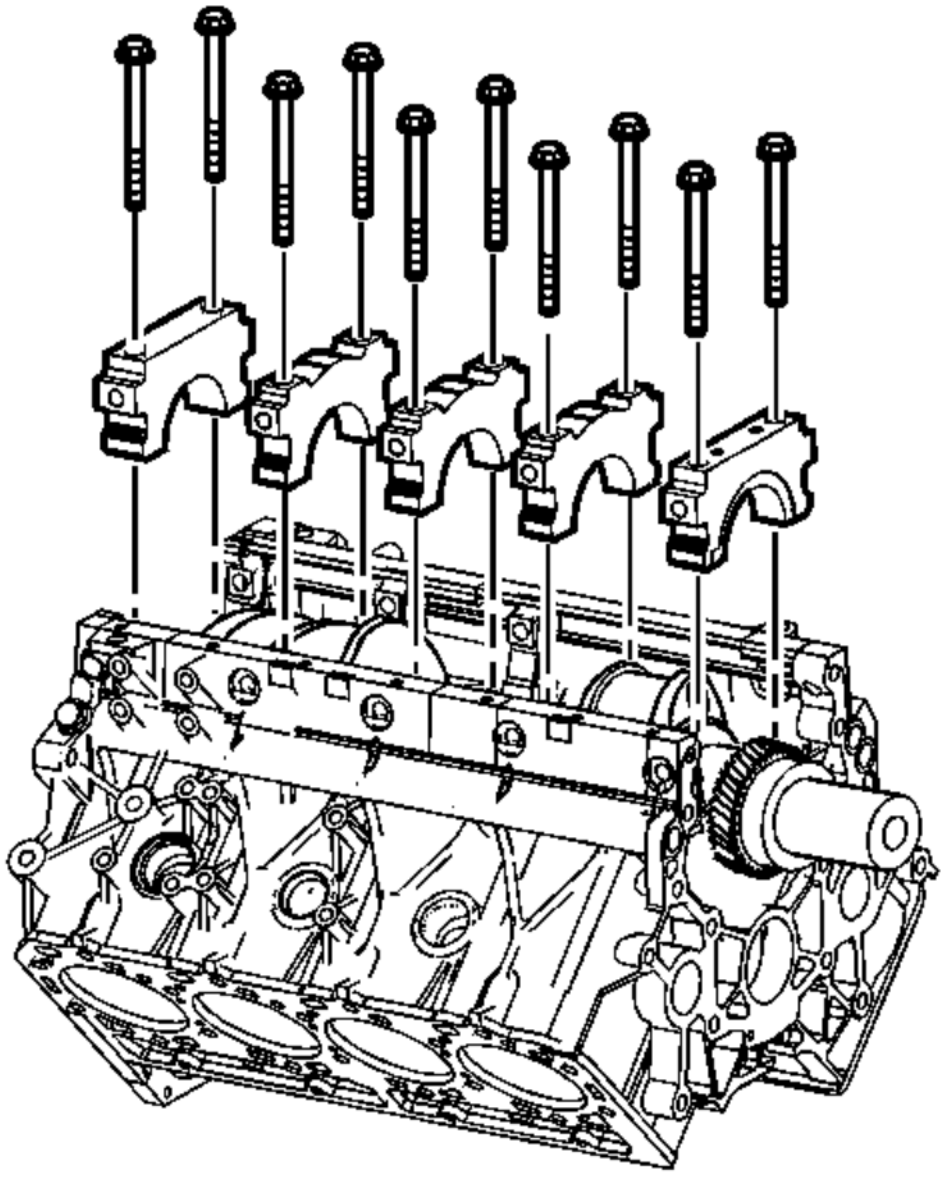


Fig. 157: View Of Crankshaft Bearing Cap & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the crankshaft bearing cap bolts.
5. Remove the crankshaft bearing caps.

6. Set the bolts aside for use in plastic gauging if needed.
7. Remove the crankshaft assembly.
8. Remove the crankshaft bearings from the engine block and the bearing caps.
9. Mark crankshaft bearings and caps so they may be installed in their original position.

ENGINE BLOCK CLEANING AND INSPECTION

IMPORTANT: All remanufactured cylinder blocks are steel stamped on both sides of the fuel pressure pump boss. The stamp indicates whether the cylinder is standard or over-bored, and if the deck is standard or has been milled.

Stamped ID	Cylinders Bore Size (in.)	Top Deck (STD or Milled)
SS	STD	STD
01S	0.010	STD
02S	0.020	STD
03S	0.030	STD
SM	STD	Milled
01M	0.010	Milled
02M	0.020	Milled
03M	0.030	Milled

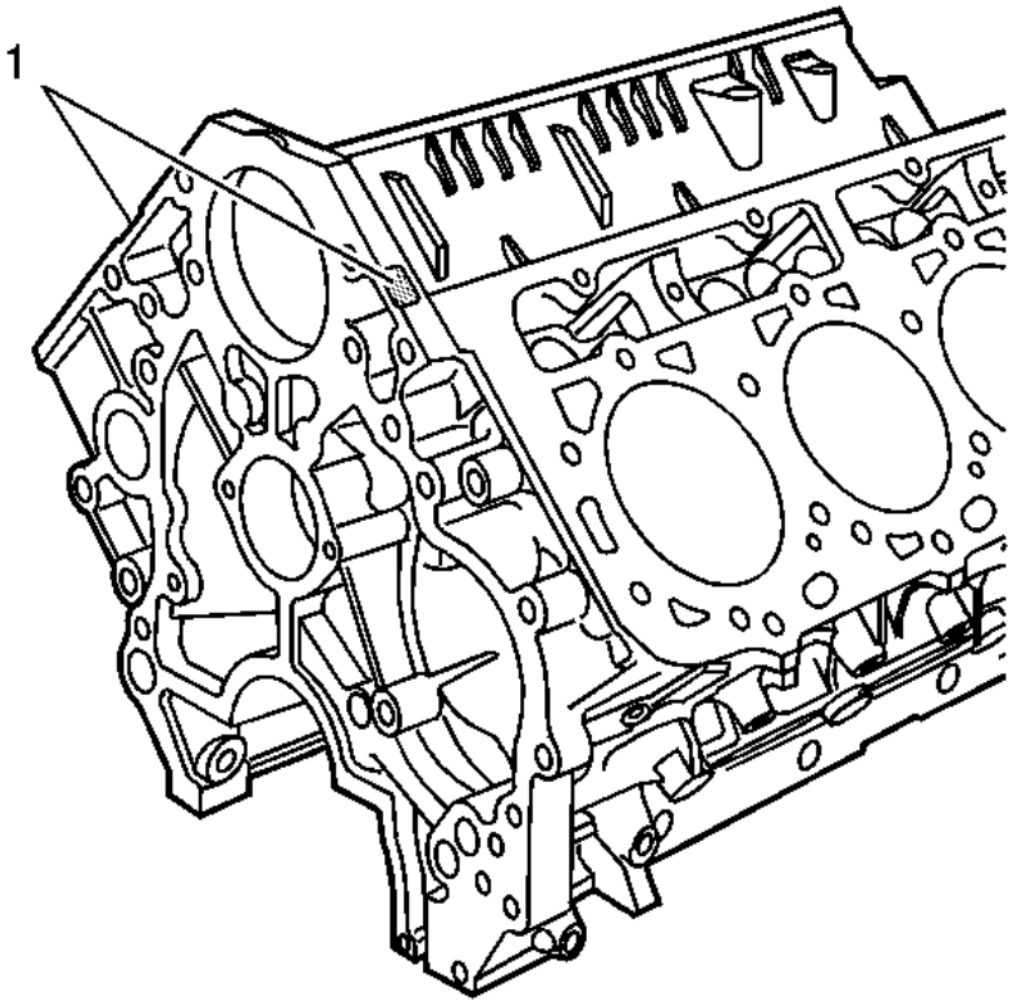


Fig. 158: Stampings
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: If the block has no stampings, the block has a standard bore and deck.

1. Inspect the block for stampings (1) indicating cylinder overbore or a milled deck.

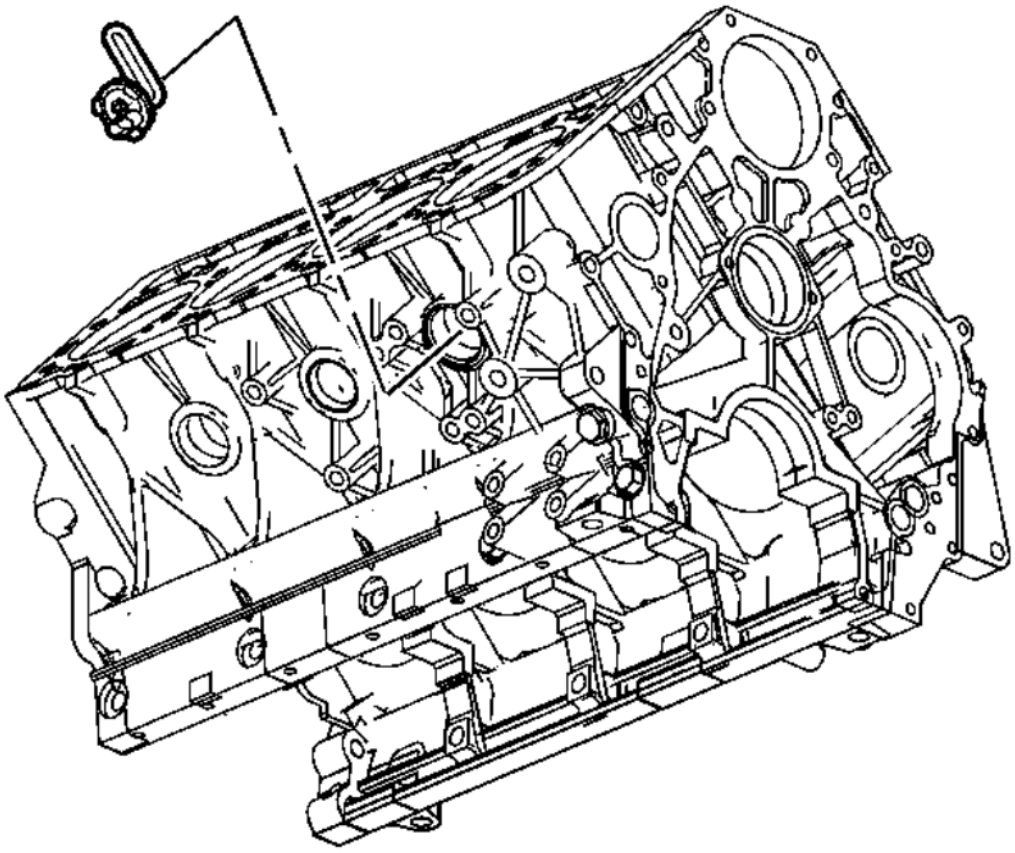


Fig. 159: View Of Engine Block Heater
Courtesy of GENERAL MOTORS CORP.

2. Remove the engine block heater.
3. Remove the O-ring from the block heater and discard.

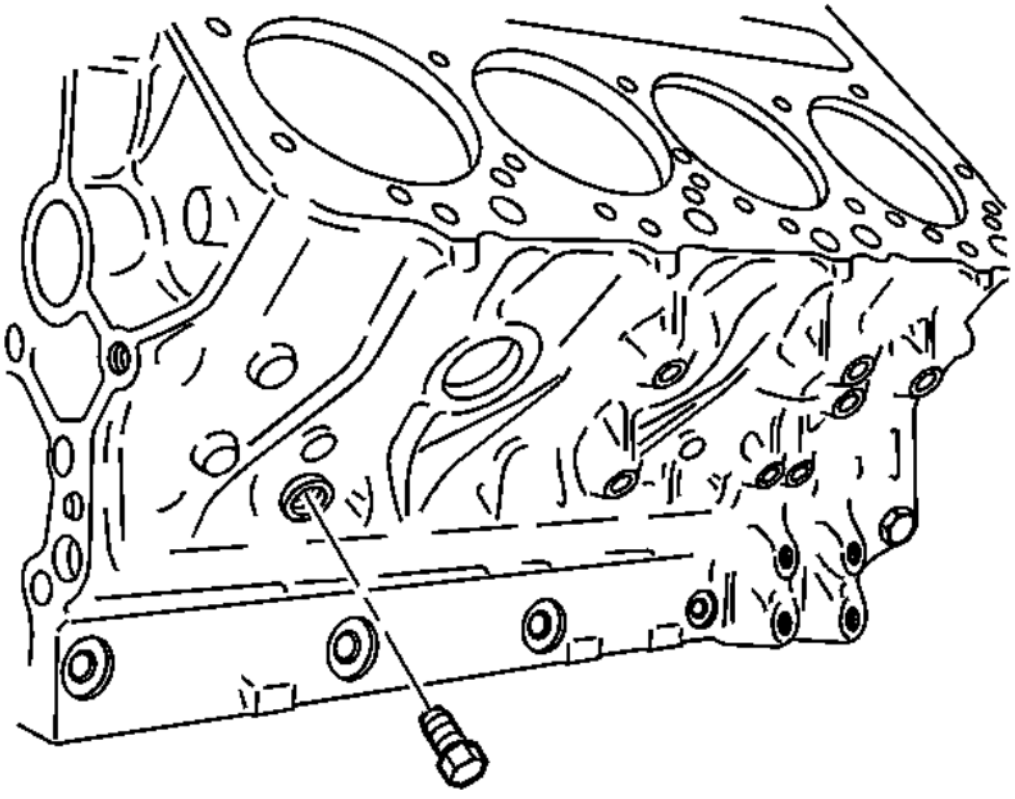


Fig. 160: View Of Oil Gallery Plug
Courtesy of GENERAL MOTORS CORP.

4. Remove the oil gallery plugs.

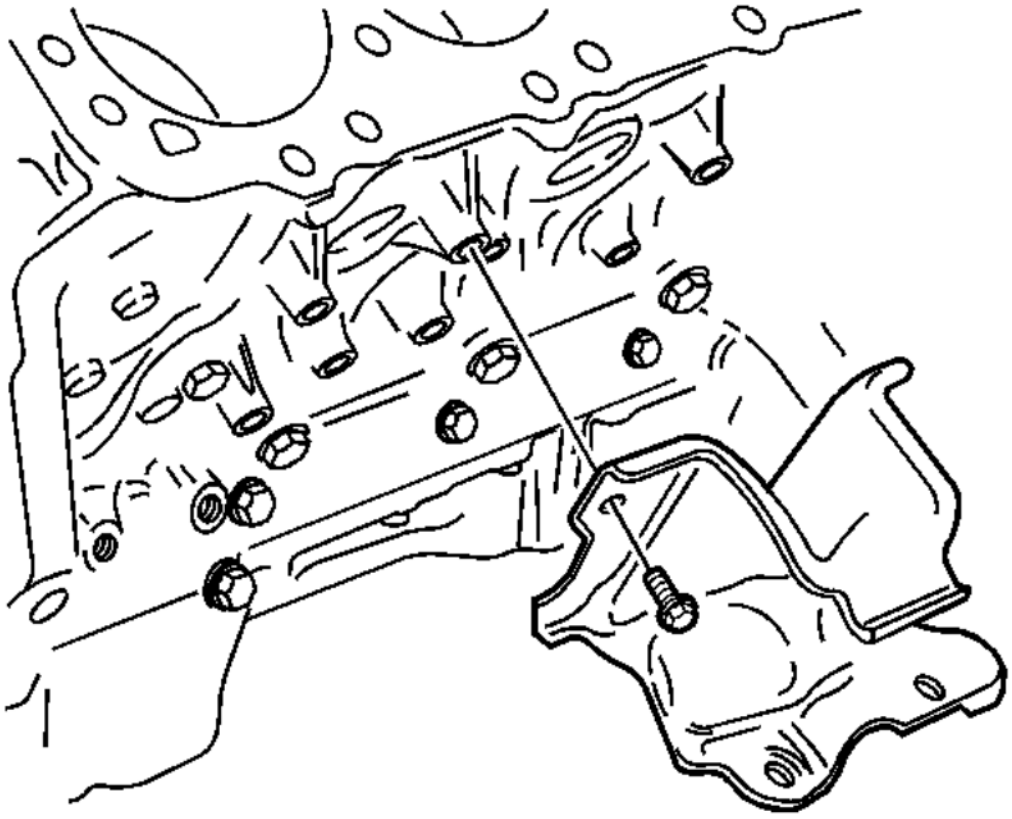


Fig. 161: View Of Left Engine Mount & Bolts
Courtesy of GENERAL MOTORS CORP.

5. Remove the left engine mount bolts.
6. Remove the left engine mount.

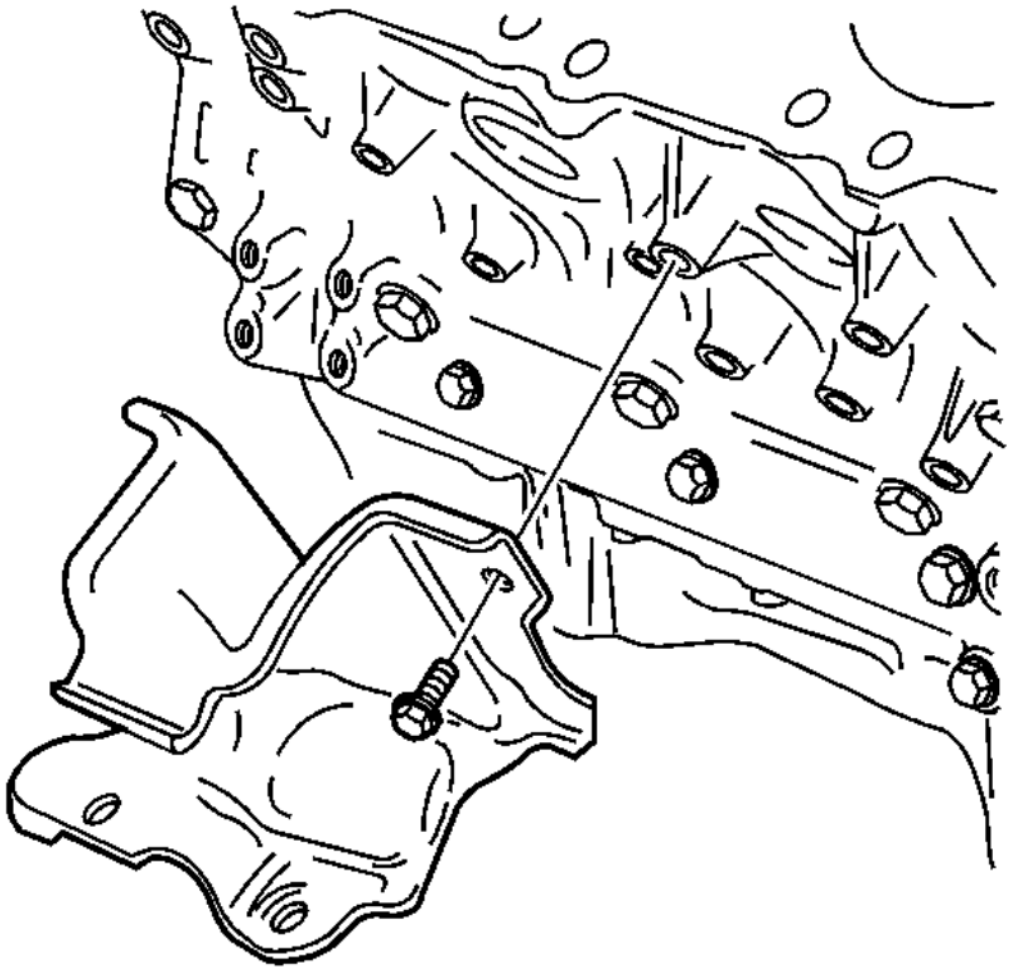


Fig. 162: View Of Right Engine Mount & Bolts
Courtesy of GENERAL MOTORS CORP.

7. Remove the right engine mount bolts.
8. Remove the right engine mount.
9. Clean the sealing material from the gasket mating surfaces of the block.
10. Clean the block in cleaning solvent.
11. Flush the engine block with clean water or steam.
12. Clean the oil passages.
13. Clean the cylinder bores.

14. Inspect the block for cracks. Use the Magnaflux Spot check dye method, or the equivalent.
    - Inspect the cylinder walls.
    - Inspect the coolant jackets.
    - Inspect the crankshaft bearing webs.

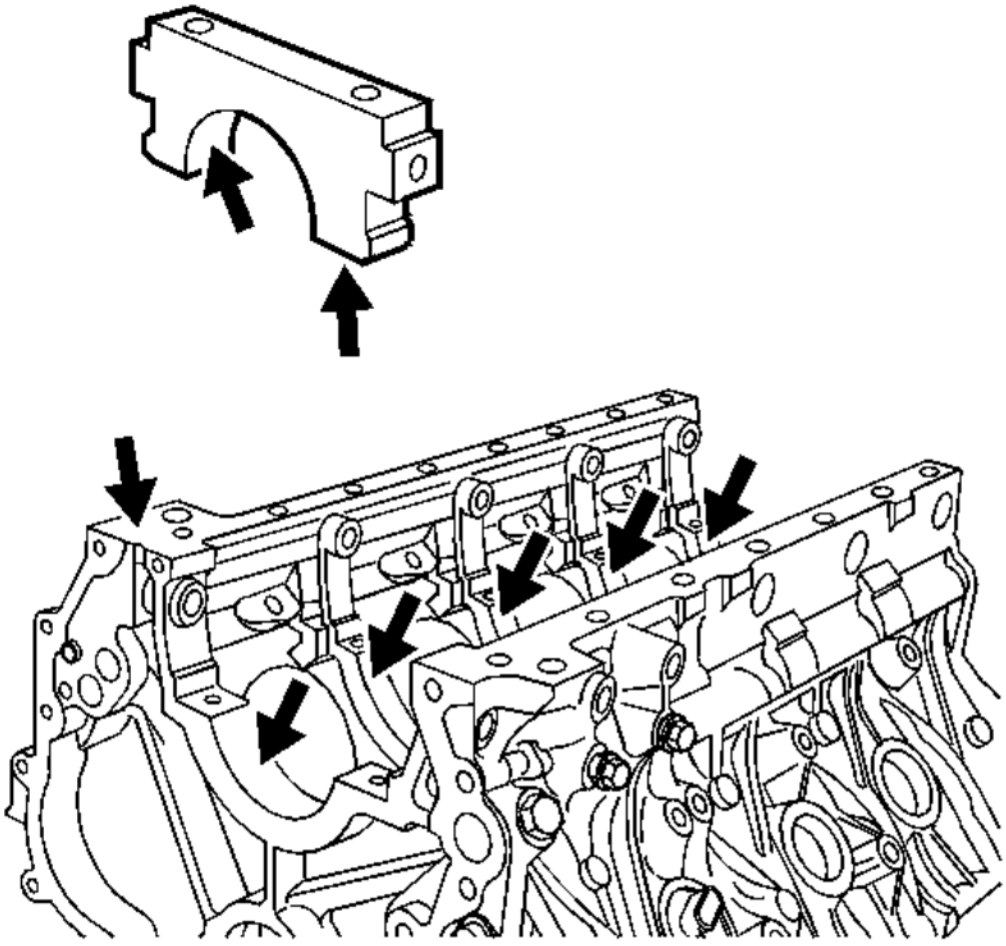


Fig. 163: View Of Crankshaft Bearing Bores & Caps
Courtesy of GENERAL MOTORS CORP.

15. Inspect the crankshaft bearing bores and caps. The crankshaft bearing bore inside diameters should be round and uniform at all of the bearing supports.

16. Inspect the area where the crankshaft bearing inserts contact the crankshaft bearing bore. This area must be free of burrs and scratches.
17. Inspect the engine mount bosses.
18. Inspect the cylinder head gasket mating surfaces for pitting.

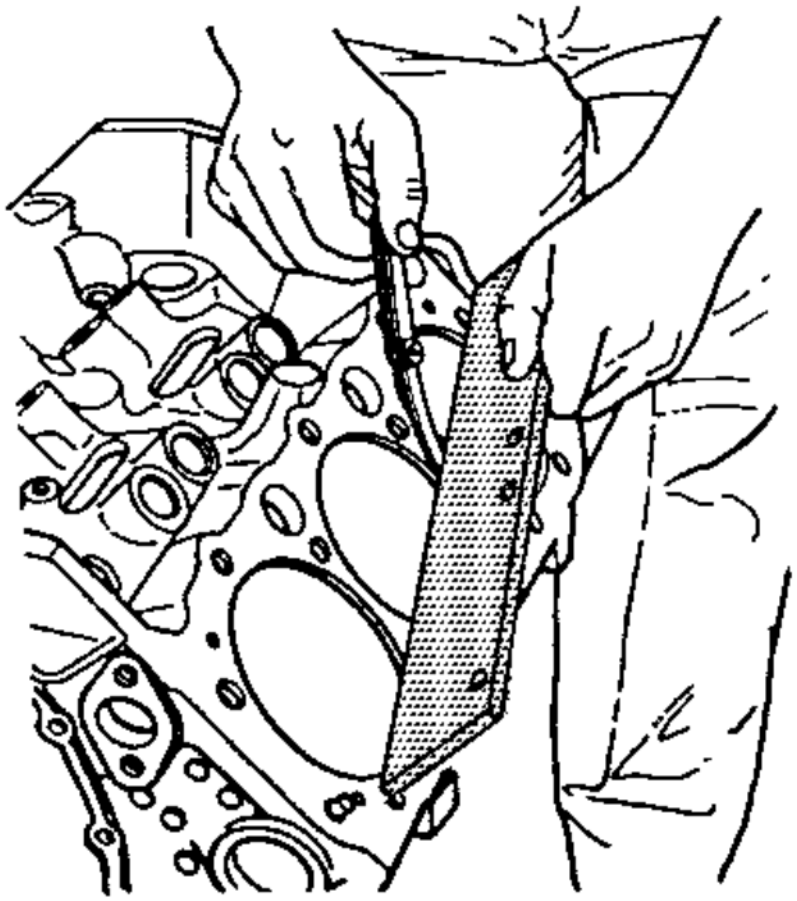


Fig. 164: Measuring Engine Block To Cylinder Head Gasket Surface Area
Courtesy of GENERAL MOTORS CORP.

19. Inspect the engine block to cylinder head gasket surface area for warping. Use a straight edge and feeler gauge. Replace the block if it is warped more than 0.15 mm (0.006 in) longitudinally or more than 0.08 mm (0.003 in) transversely.

20. Apply sealer to the oil gallery plugs.

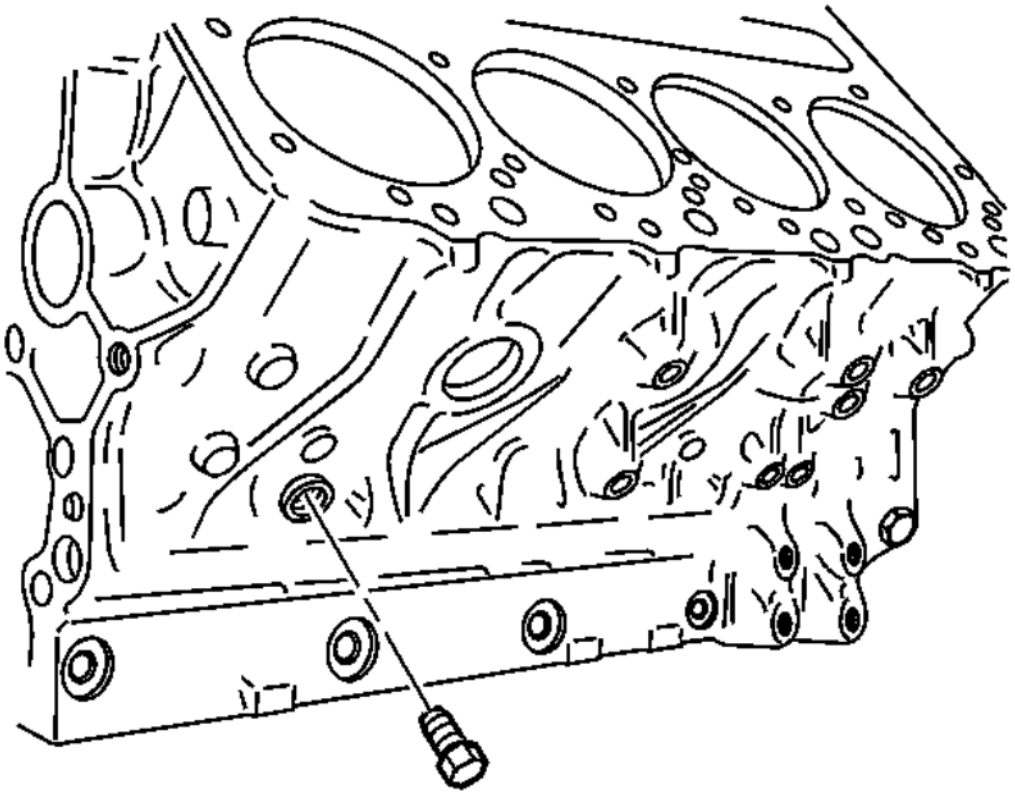


Fig. 165: View Of Oil Gallery Plug
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

21. Install the oil gallery plugs.

Tighten: Tighten the oil gallery plugs to 53 N.m (39 lb ft).

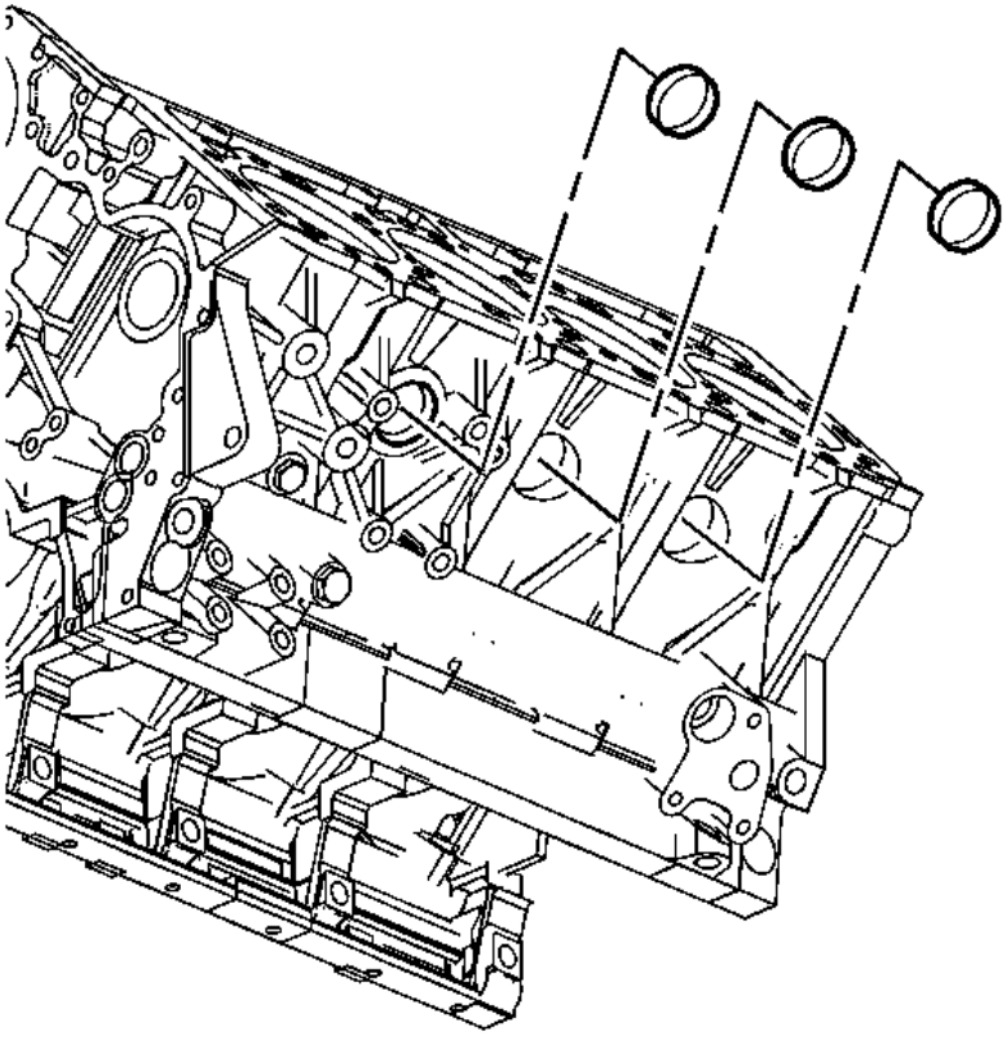


Fig. 166: View Of Left Engine Block Coolant Plugs
Courtesy of GENERAL MOTORS CORP.

22. Install the left engine block coolant plugs.

    Tighten: Tighten the left engine block coolant plugs to 18 N.m (13 lb ft).

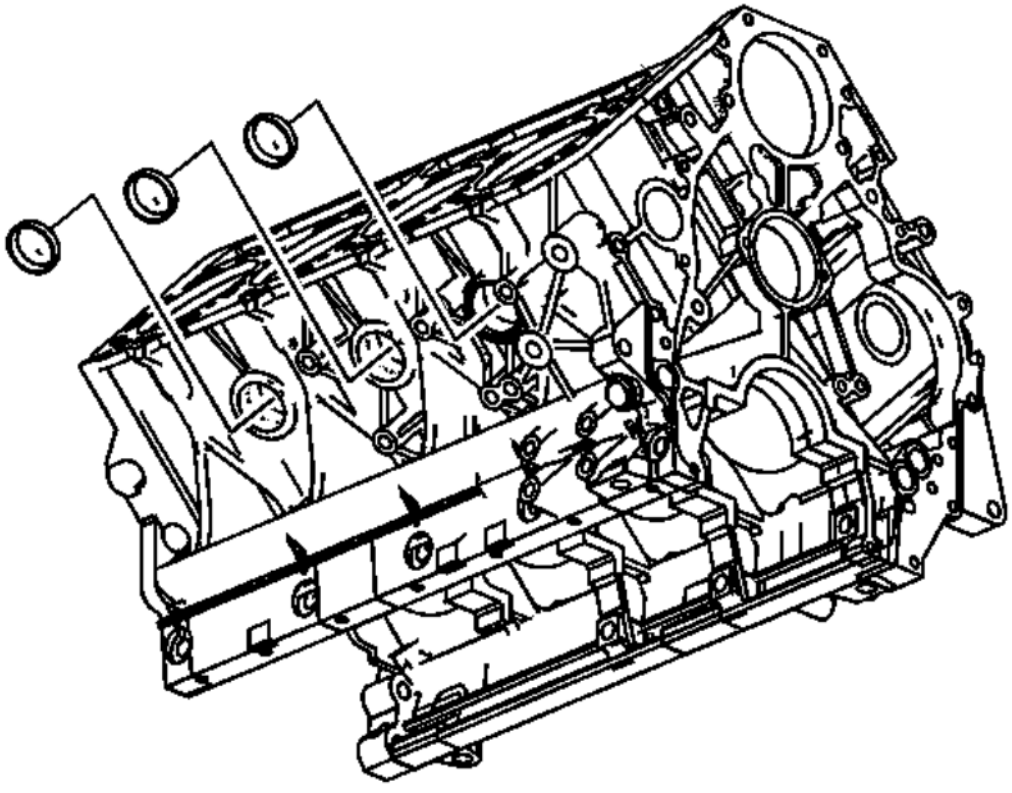


Fig. 167: View Of Right Engine Block Coolant Plugs
Courtesy of GENERAL MOTORS CORP.

23. Install the right engine block coolant plugs.

    Tighten: Tighten the right engine block coolant plugs to 18 N.m (13 lb ft).

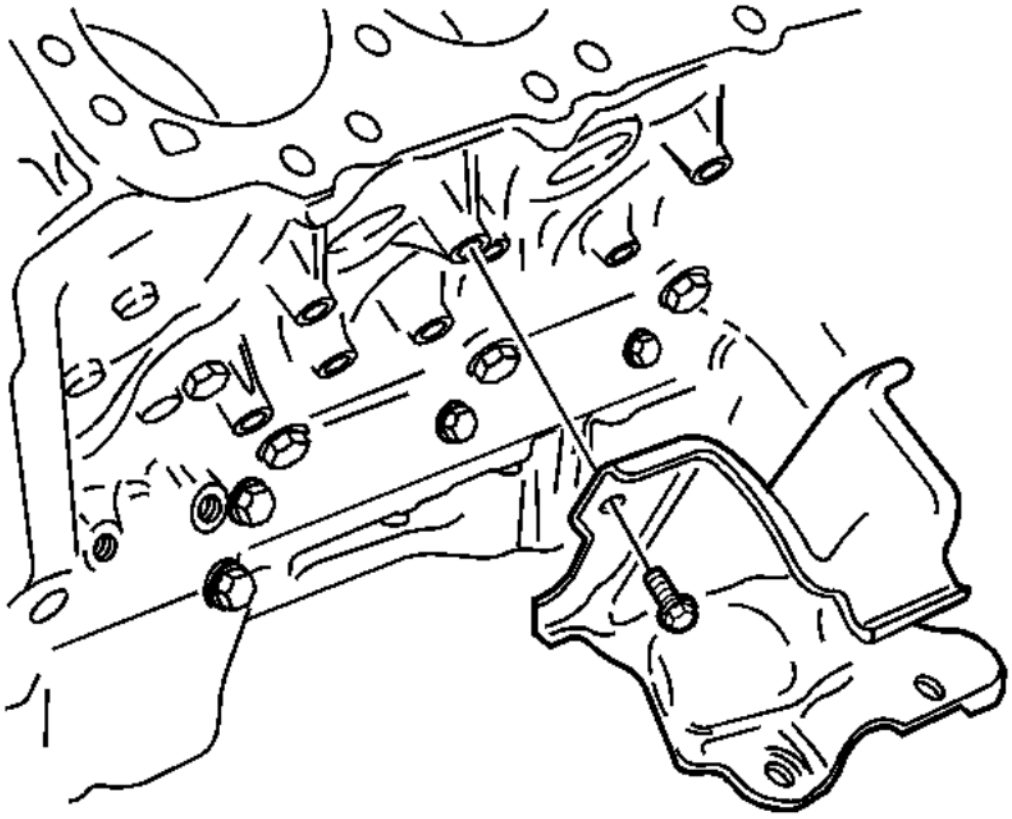


Fig. 168: View Of Left Engine Mount & Bolts
Courtesy of GENERAL MOTORS CORP.

24. Install the left engine mount and engine mount bolts.

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

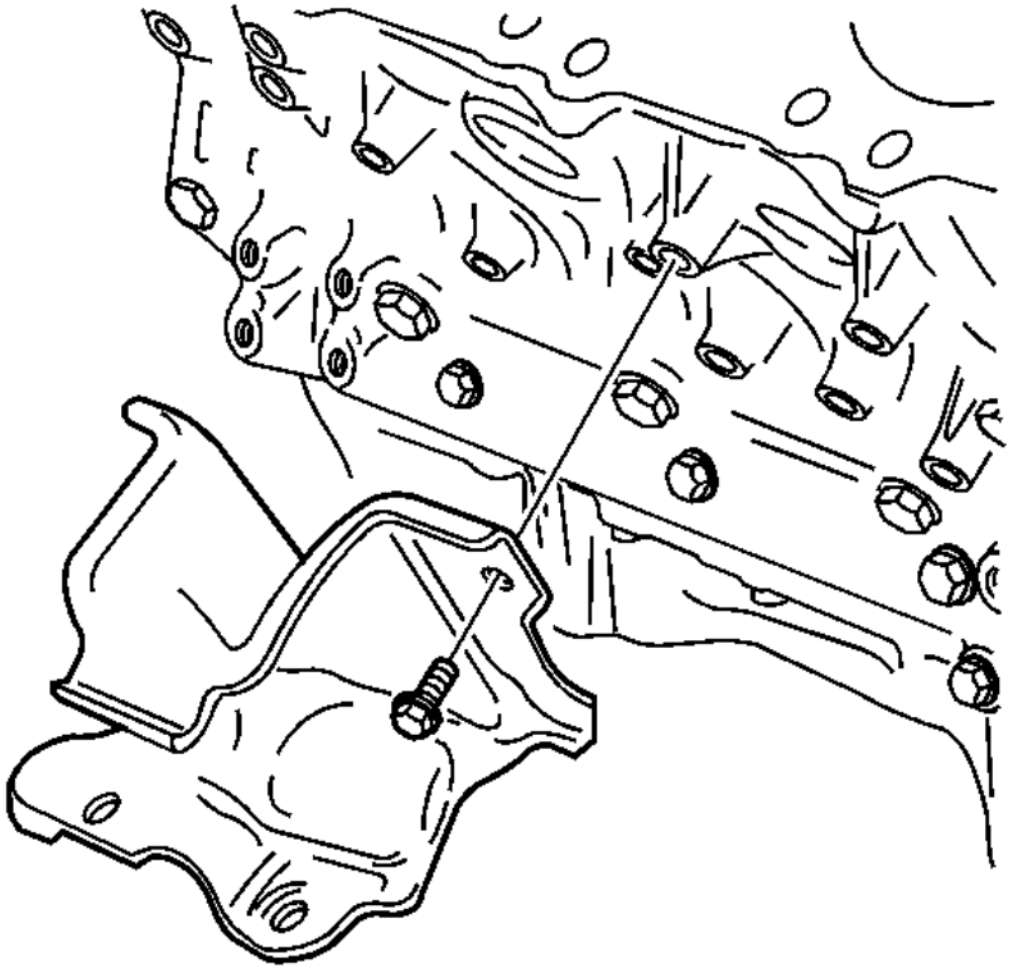


Fig. 169: View Of Right Engine Mount & Bolts
Courtesy of GENERAL MOTORS CORP.

25. Install the right engine mount and engine mount bolts.

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

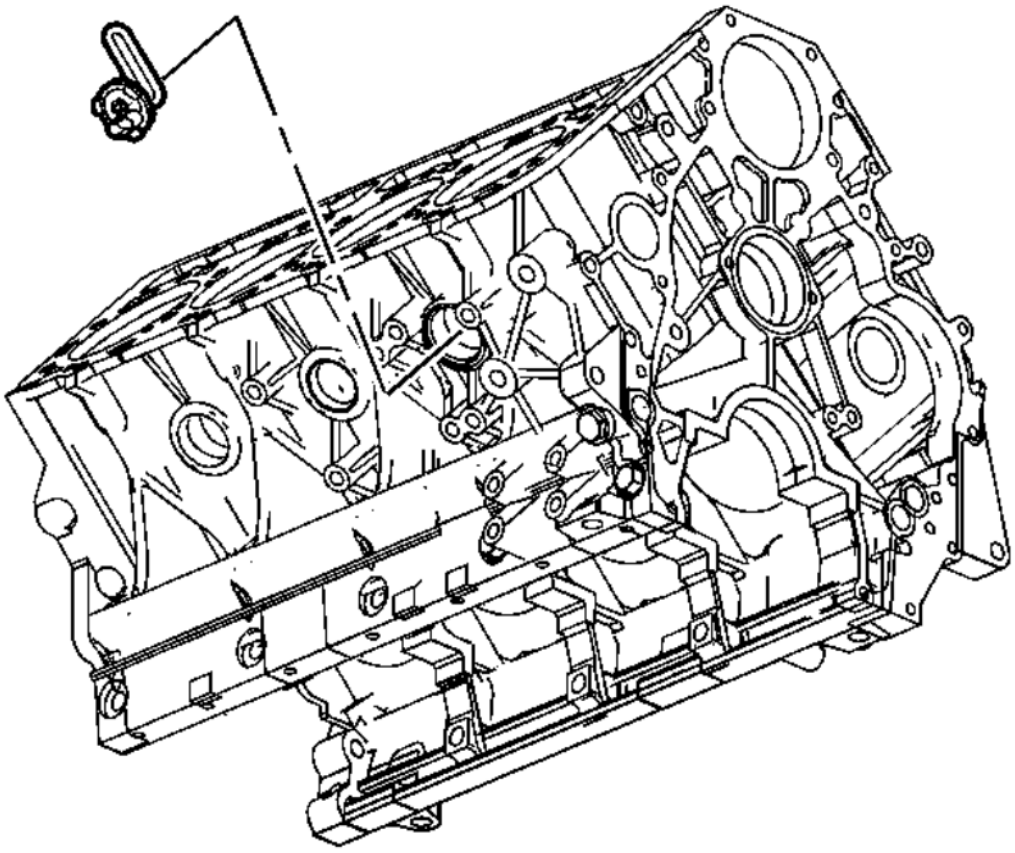


Fig. 170: View Of Engine Block Heater
Courtesy of GENERAL MOTORS CORP.

26. Install a new O-ring to the block heater.
27. Lubricate the O-ring with engine coolant.
28. Install the engine block heater.

UPPER OIL PAN CLEANING AND INSPECTION

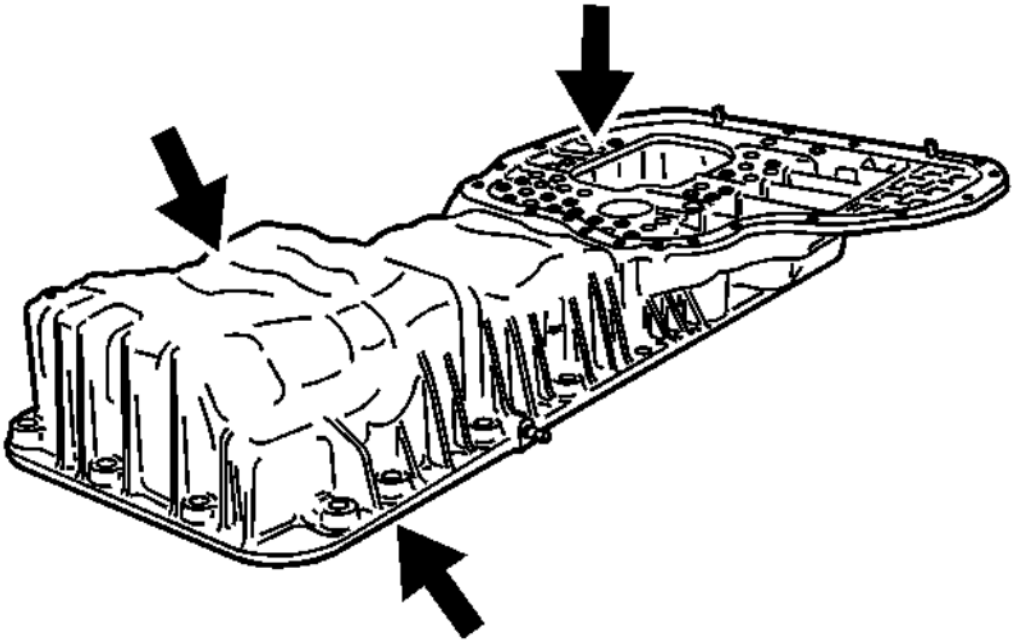


Fig. 171: View Of Upper Oil Pan
Courtesy of GENERAL MOTORS CORP.

1. Clean the upper oil pan.
2. Carefully clean the sealer from the threaded holes.
3. Inspect the upper oil pan for cracks.
4. Inspect the upper oil pan sealing surfaces for damage.
5. Replace the upper oil pan if any damage is found.

CAMSHAFT AND BEARINGS CLEANING AND INSPECTION

Tools Required

J 7872 Dial Indicator Set

Inspection

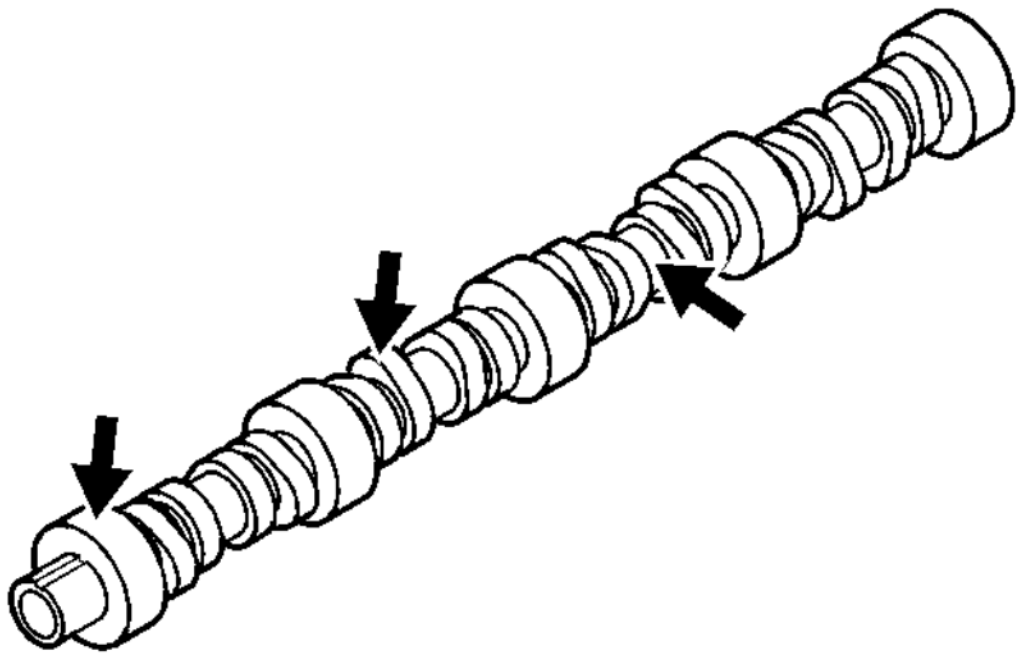


Fig. 172: View Of Camshaft Inspection Areas
Courtesy of GENERAL MOTORS CORP.

1. Clean the camshaft.

IMPORTANT: The camshaft bearings are not serviceable. If the camshaft bearings are damaged, the engine must be replaced.

2. Visually inspect the camshaft bearings in the engine block for the following conditions:
   - Scoring
   - Nicks
   - Damage caused by lack of lubrication
   - Misaligned oil feed holes

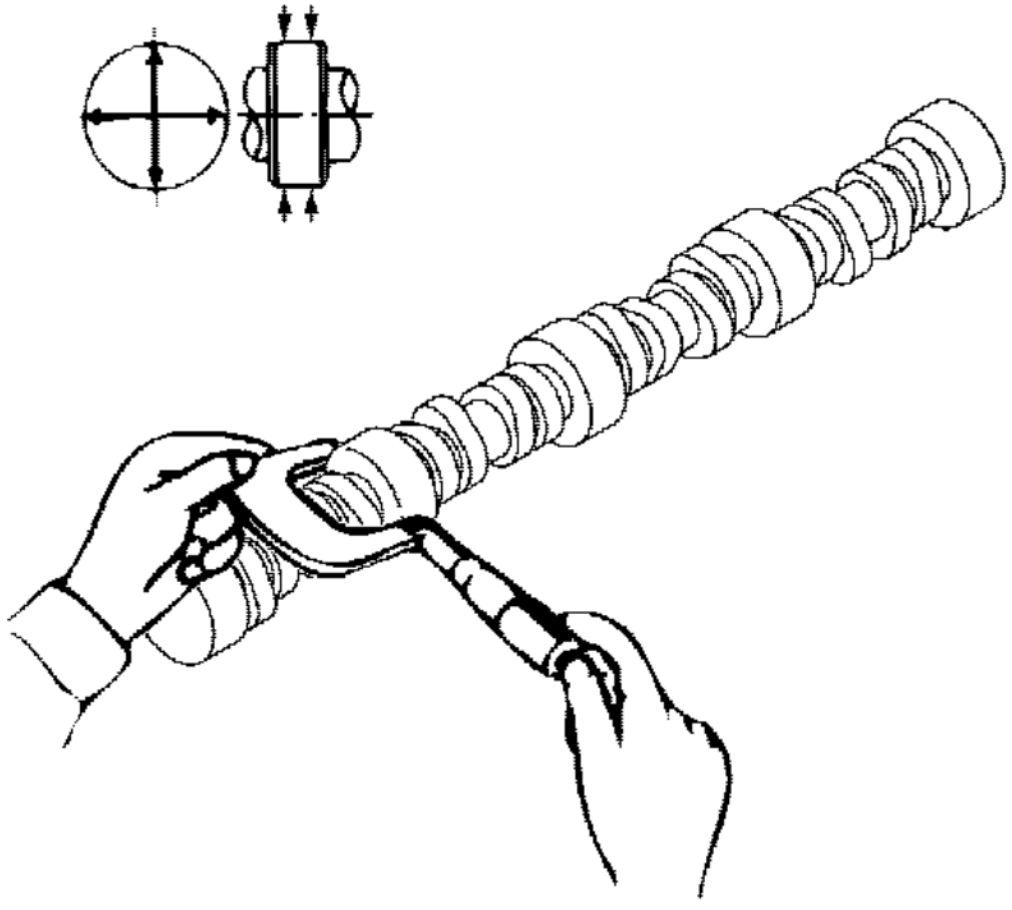


Fig. 173: Measuring Camshaft Journal Diameter
Courtesy of GENERAL MOTORS CORP.

3. Measure the camshaft journal diameter.
   - The production value is 60.932-60.962 mm (2.3990-2.4001 in) and service limit is 60.920 mm (2.3984 in).
   - Replace the camshaft if the measured value is less than service limit.

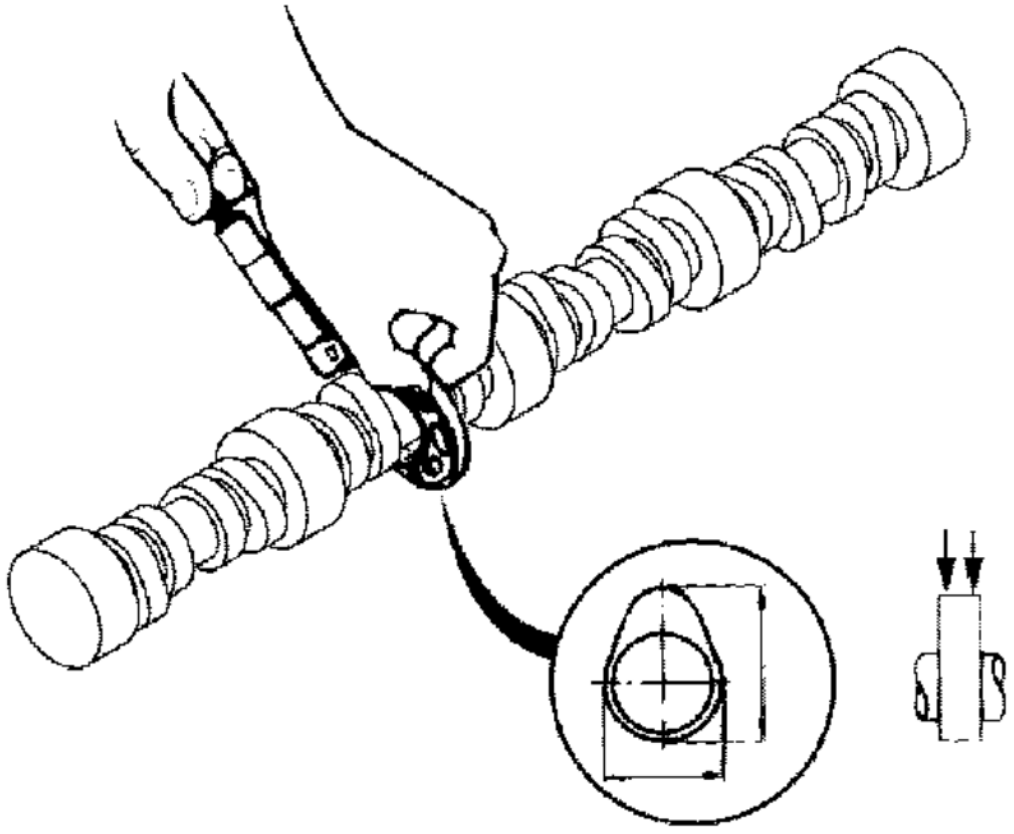


Fig. 174: Measuring Camshaft Lobe Lift
Courtesy of GENERAL MOTORS CORP.

4. Measure the camshaft lobe lift. The production value for intake is 7.273 mm (0.2863 in).
5. The production value for exhaust is 5.907 mm (0.2326 in).
6. Replace the camshaft if the measured value is less than the service limit.

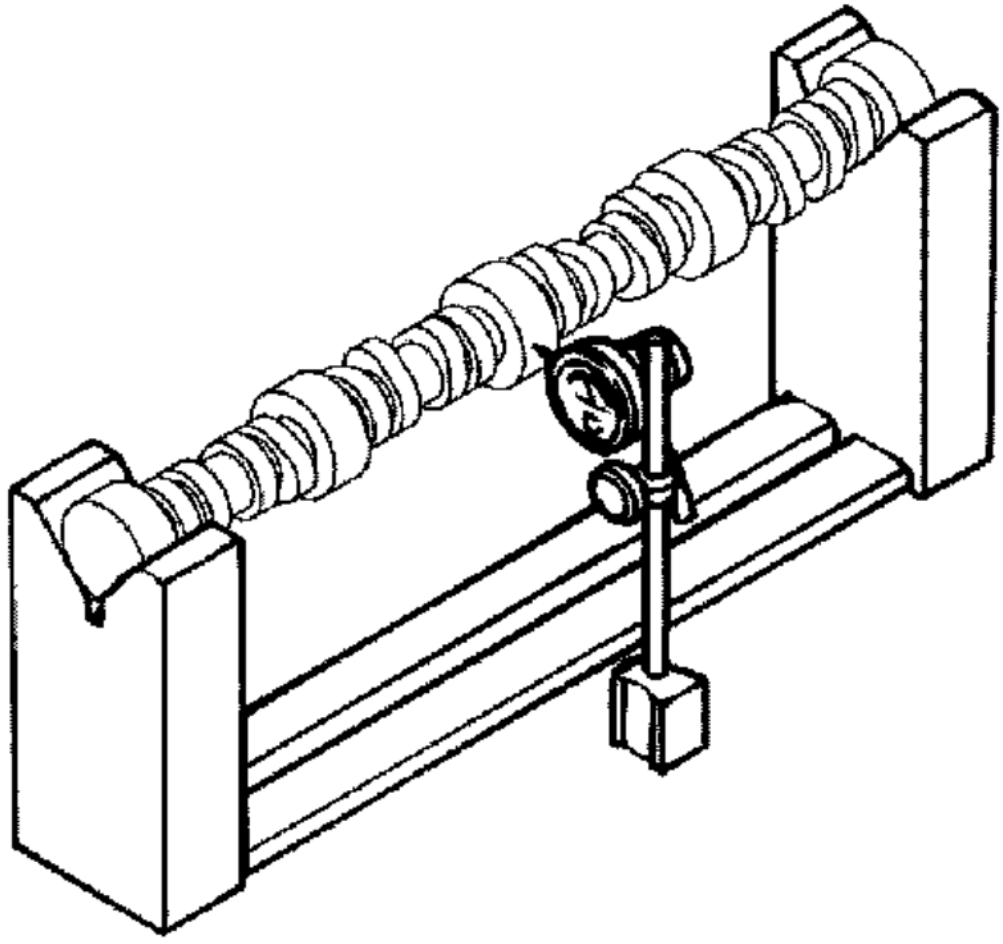


Fig. 175: Measuring Camshaft Runout
Courtesy of GENERAL MOTORS CORP.

7. Measure the camshaft runout.
   - Mount the camshaft on the V-blocks.
   - Use **J 7872** to measure the camshaft runout.
   - The runout service limit is 0.05 mm (0.0020 in).
8. Replace the camshaft if the run-out is over the service limit.

CRANKSHAFT AND BEARING CLEANING AND INSPECTION

Special Tools

- **J 7872** Dial Indicator Set
- **J 45059** Angle Meter

Inspection

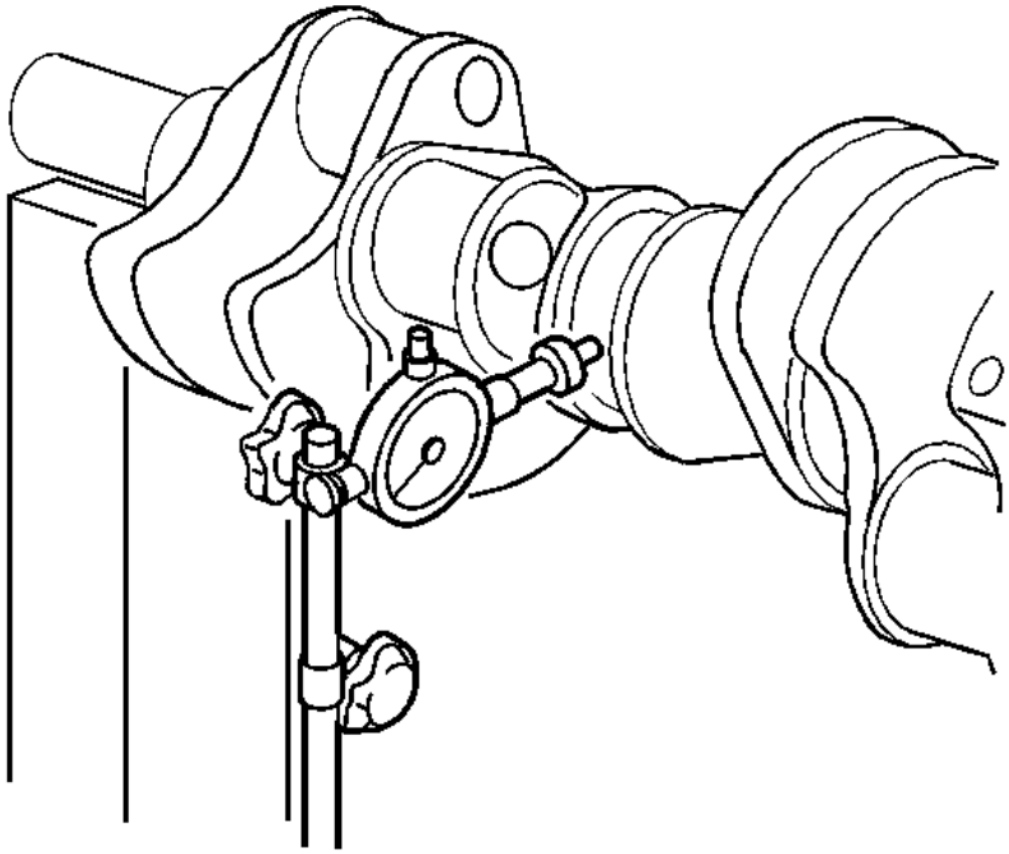


Fig. 176: Measuring Crankshaft Run Out
Courtesy of GENERAL MOTORS CORP.

1. Clean the crankshaft and bearings.
2. Inspect the crankshaft for the following conditions.
    - Excessive wear or damage on the surface of the crankshaft journals.

- Excessive wear or damage to the crankshaft gear.
- Excessive wear or damage on the oil seal fitting surface.
- Inspect the oil ports for obstructions.
- Replace the crankshaft if there is excessive wear or damage to the journals, oil seal fitting surface or to the crankshaft gear.

3. Measure the crankshaft run out.
   - Mount the crankshaft in wooden V-blocks.
   - Set **J 7872** on the center of the crankshaft journal.
   - Turn the crankshaft in the normal direction of rotation.
   - Record readings. The production value is 0.05 mm (0.0020 in) and the service limit is 0.44 mm (0.0173 in).

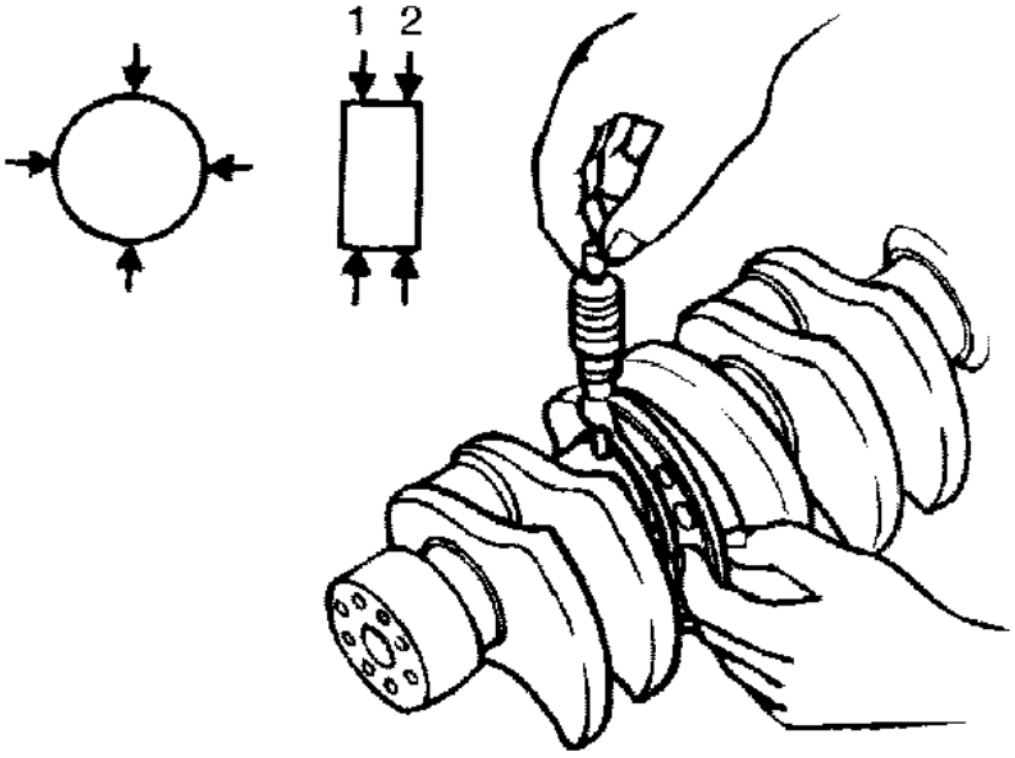


Fig. 177: Measuring Crankshaft Journal Diameter
Courtesy of GENERAL MOTORS CORP.

4. Measure the crankshaft journal diameter across four points.
   - The crankshaft journal outside diameter is 79.905-79.925 mm (3.1459-3.1466 in) and the service limit is 79.89 mm (3.1453 in).
   - Replace the crankshaft if the measured value is less than the service limit.
5. Measure the crankpin outside diameter across four points.
   - The crankpin outside diameter is 62.902-62.922 mm (2.4765-2.4772 in) and the service limit is 62.88 mm (2.4756 in).
   - Replace the crankshaft if the measured value is less than the service limit.

Crankshaft Bearing Selection

There are two methods for selecting the proper size crankshaft bearings. The first one is to select the bearing grade (color code) based on the cylinder block grade and the crankshaft journal grade from the Crankshaft Bearing Grade chart. The second is the plastic gauge method.

Crankshaft Bearing Selection Grade Chart Method

Stamp ID	Main Journal	Conn. Rod Journal
No Stamp	STD	STD
M20 R20	0.020 in	0.020 in

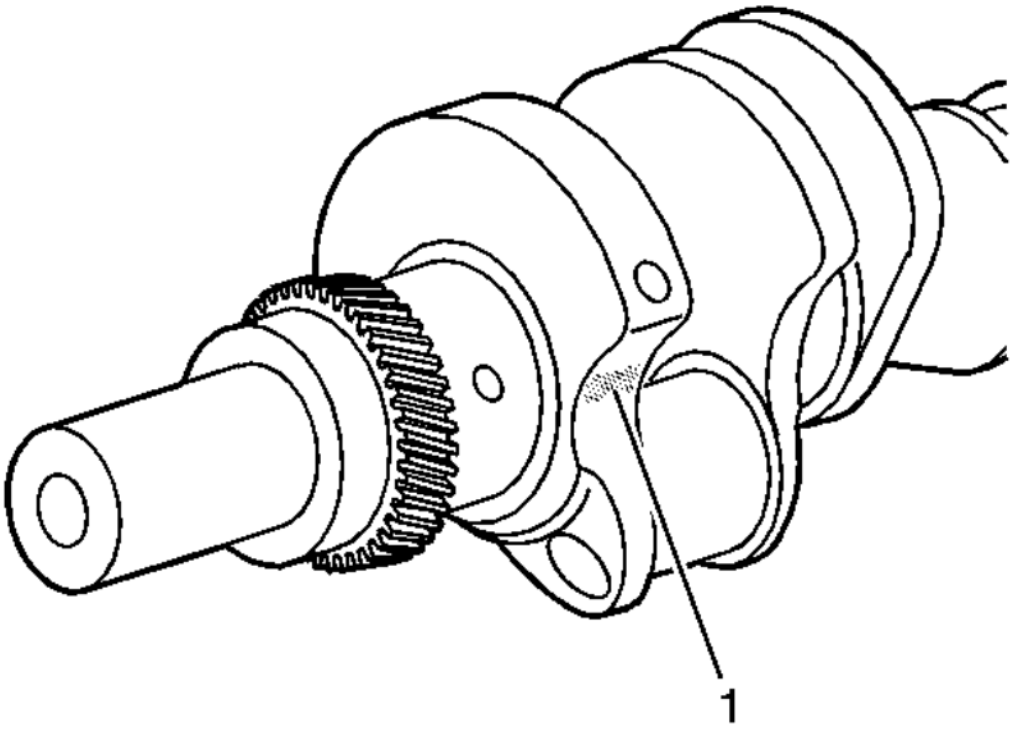


Fig. 178: Locating Crankshaft Stamping Marks (Undersized Main or Rod Journals)
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: All crankshafts that have been machined have a steel stamping (1) on the 1st counterweight.

1. Inspect the crankshaft for stamping (1) indicating undersized main and/or rod journals.

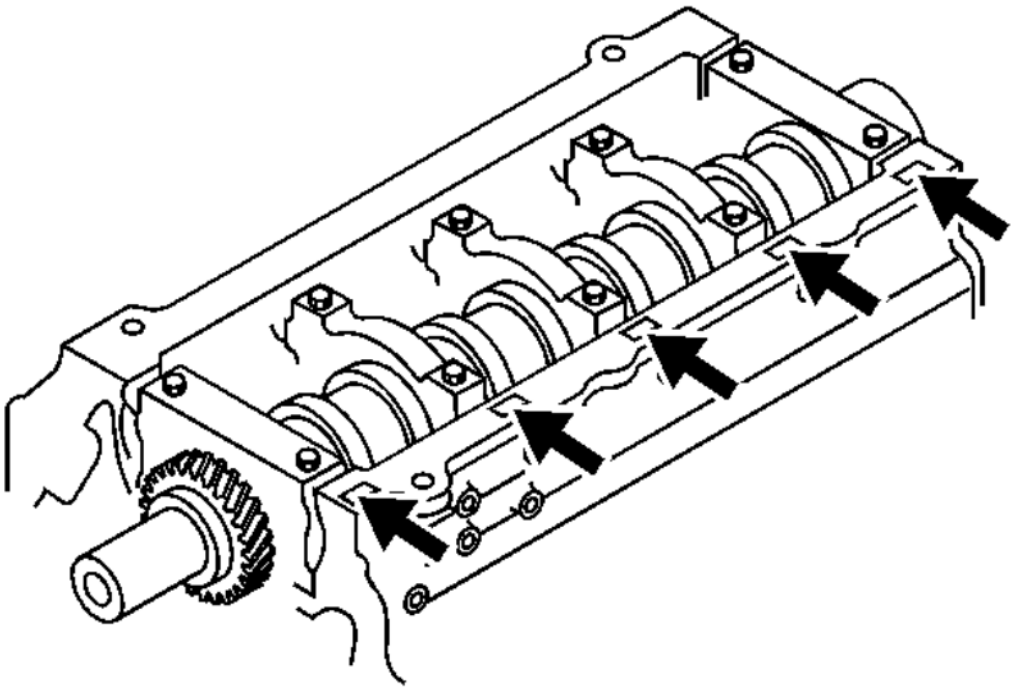


Fig. 179: View Of Cylinder Block Grade
Courtesy of GENERAL MOTORS CORP.

2. The cylinder block grade is indicated on the right lower portion of the cylinder block.

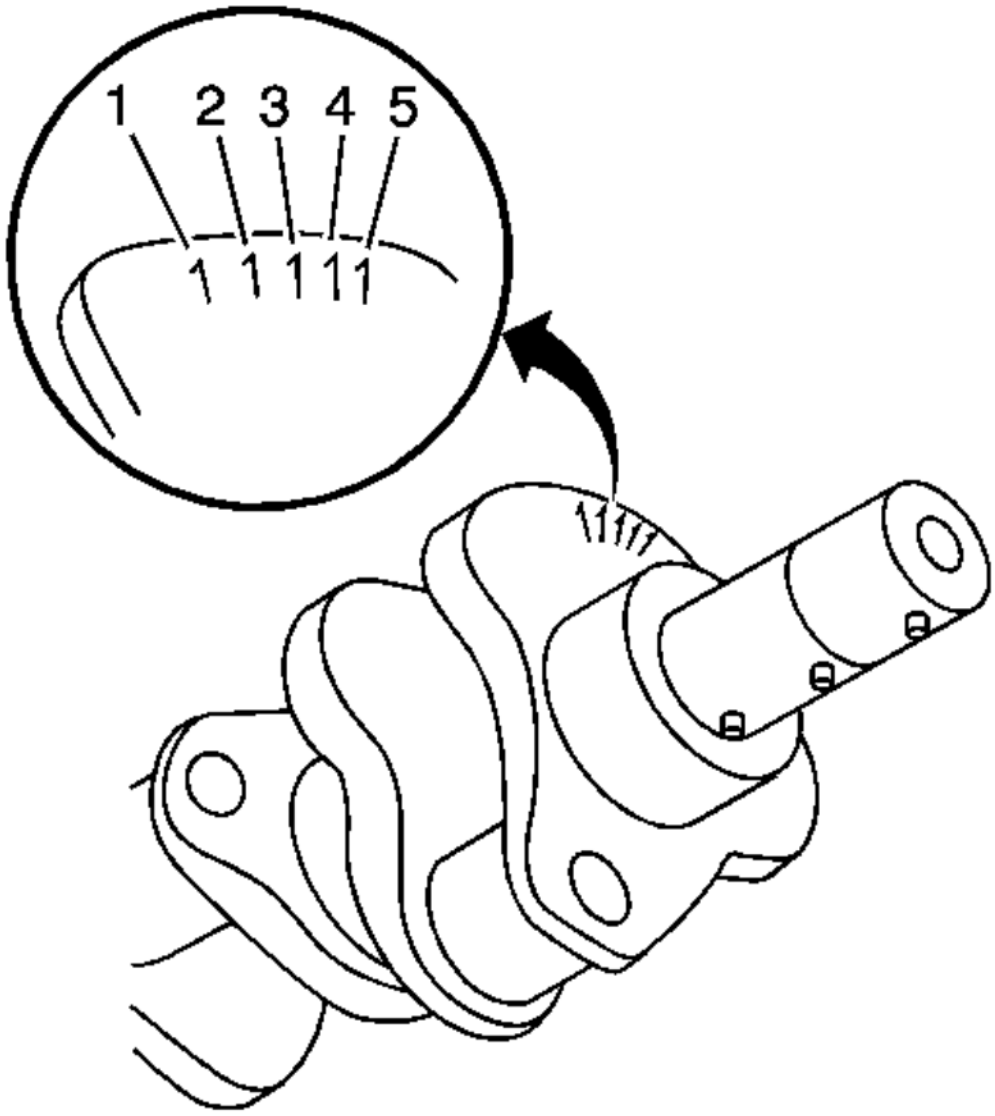


Fig. 180: View of Crankshaft Journal Grade
Courtesy of GENERAL MOTORS CORP.

3. The crankshaft journal grade is indicated on the number 1 crankshaft counterweight.
4. Match the cylinder block grade and the crankshaft journal grade, refer to **Crankshaft Bearing Selection Specifications** .

5. From the Crankshaft Bearing Grade chart, determine which bearing grade (color code) is required.
6. Verify the crankshaft bearing clearance using the plastic gage method.

Crankshaft Bearing Selection Plastic Gage Method

Special Tools

J 45059 Angle Meter

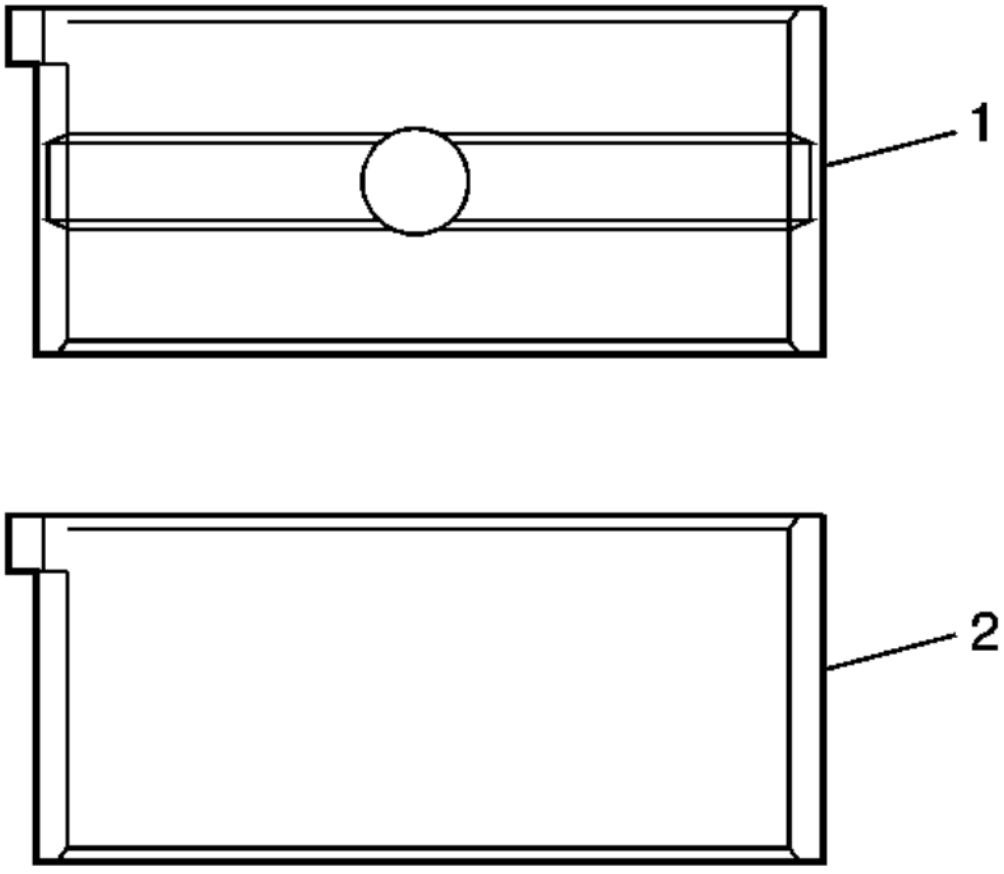


Fig. 181: View Of Crankshaft Upper & Lower Bearings
Courtesy of GENERAL MOTORS CORP.

1. Clean the cylinder block bearing fitting surfaces.
2. Clean the crankshaft and upper bearings (1) and lower bearings (2).
3. Install the bearings into the cylinder block and the bearing caps.

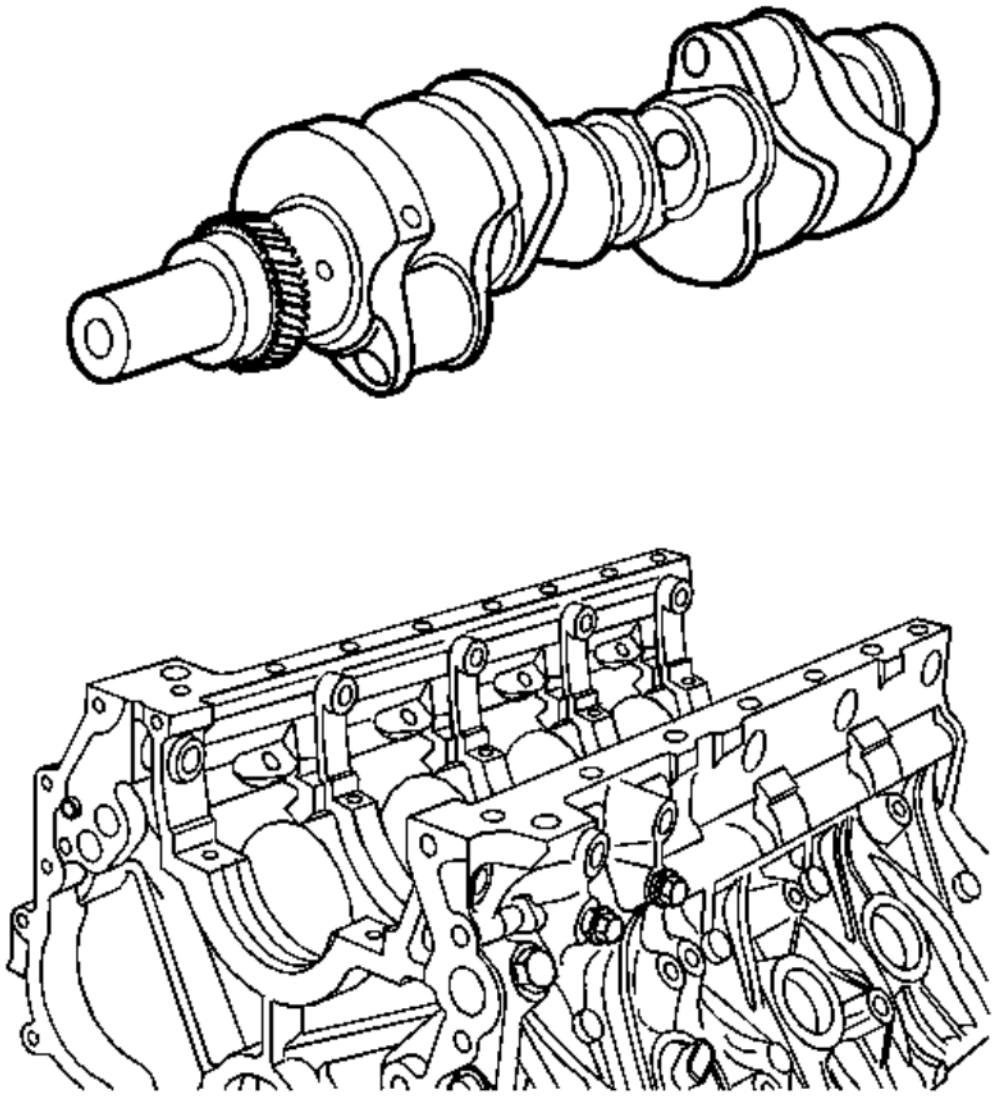


Fig. 182: View Of Crankshaft & Cylinder Block
Courtesy of GENERAL MOTORS CORP.

4. Install the crankshaft into the cylinder block.
5. Rotate the crankshaft approximately 30 degrees to seat the bearings.

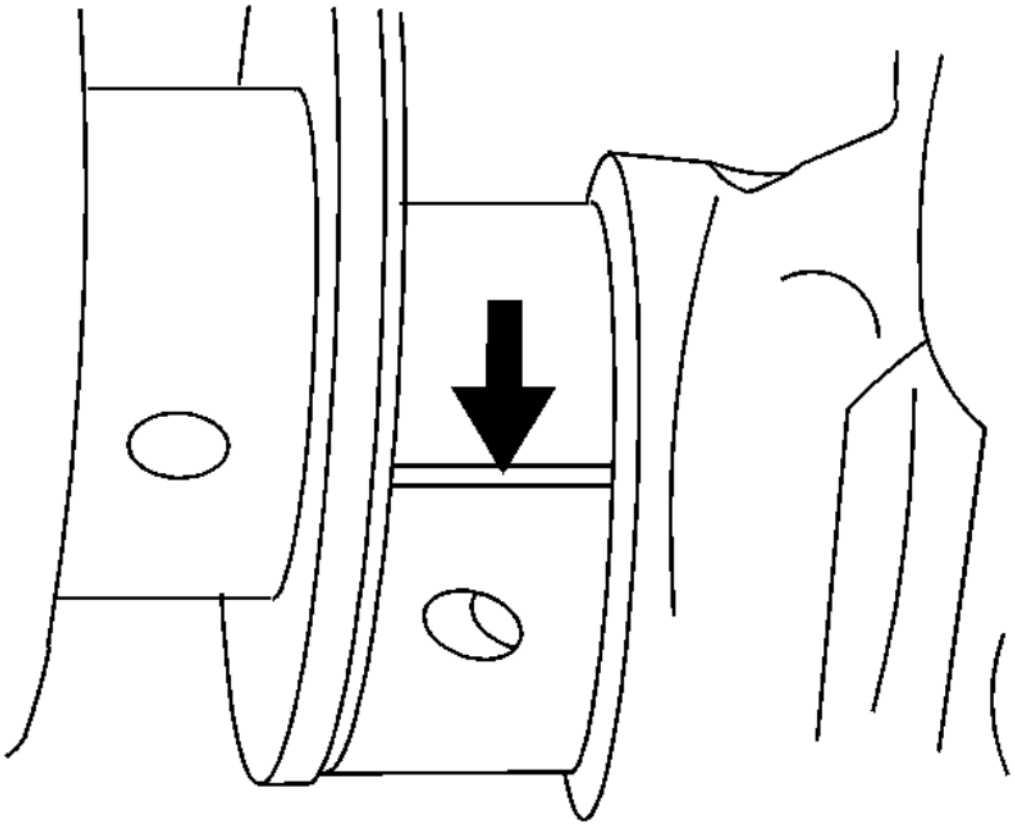


Fig. 183: Installing Gaging Plastic
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not allow the crankshaft to rotate at any time during bearing cap installation and tightening or the plastic gauge measurement will be inaccurate.

6. Place the plastic gage over the crankshaft journal across the full width of the bearing.

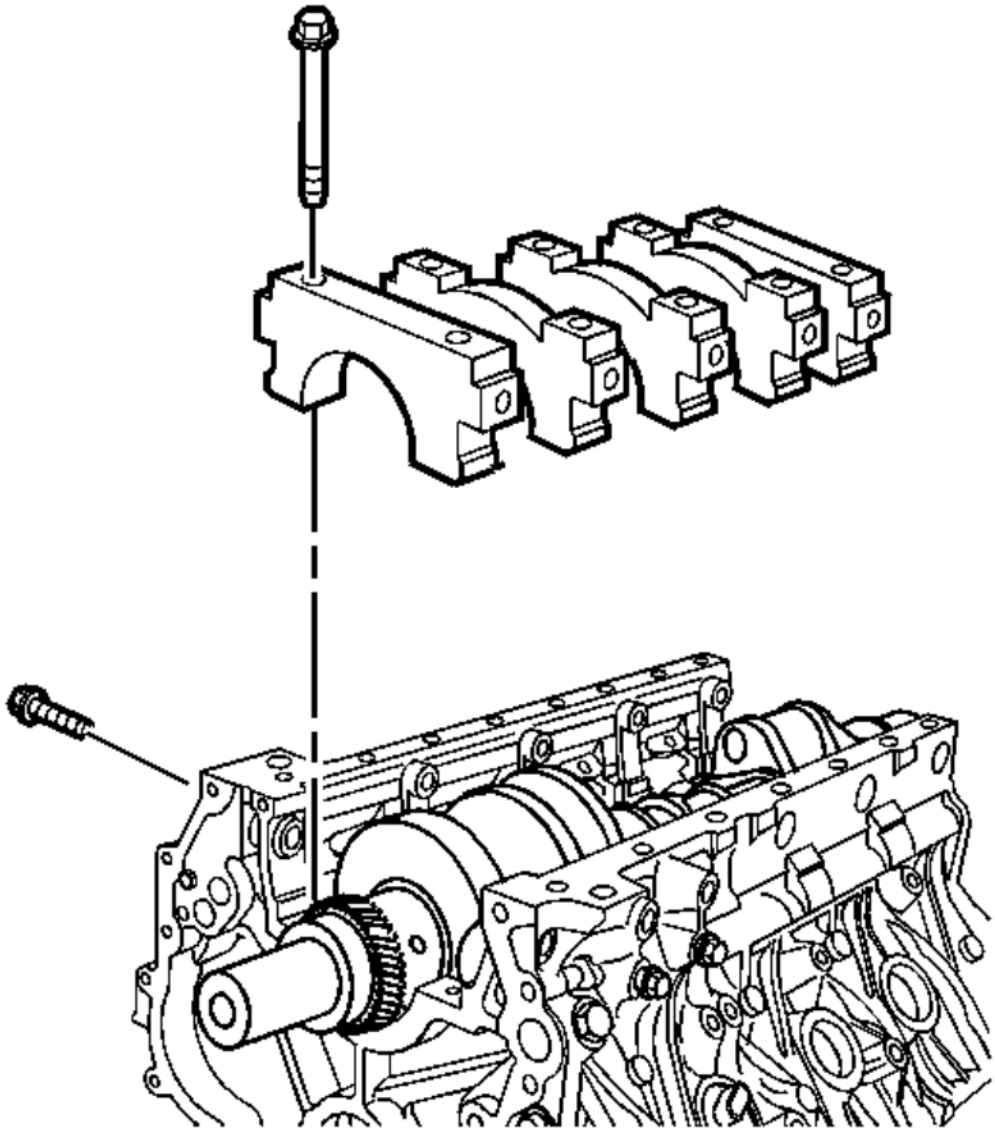


Fig. 184: View Of Crankshaft Bearing Caps
Courtesy of GENERAL MOTORS CORP.

7. Install the crankshaft bearing caps.

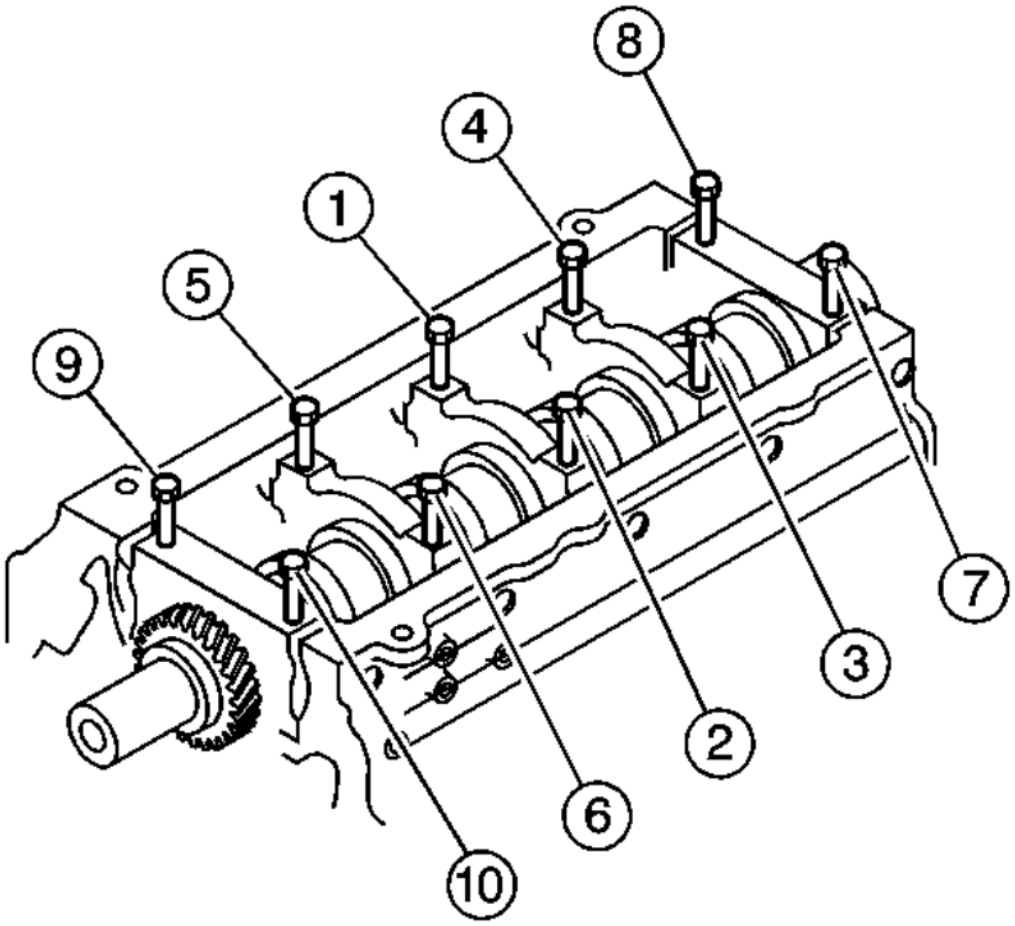


Fig. 185: Crankshaft Bearing Cap Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

8. Install the crankshaft bearing cap bolts.
9. Tighten the crankshaft bearing cap bolts in the proper sequence.

Tighten:

- 1st step 98 N.m (72 lb ft).
- 2nd step 132 N.m (97 lb ft).

- 3rd step 30 degrees using **J 45059** .

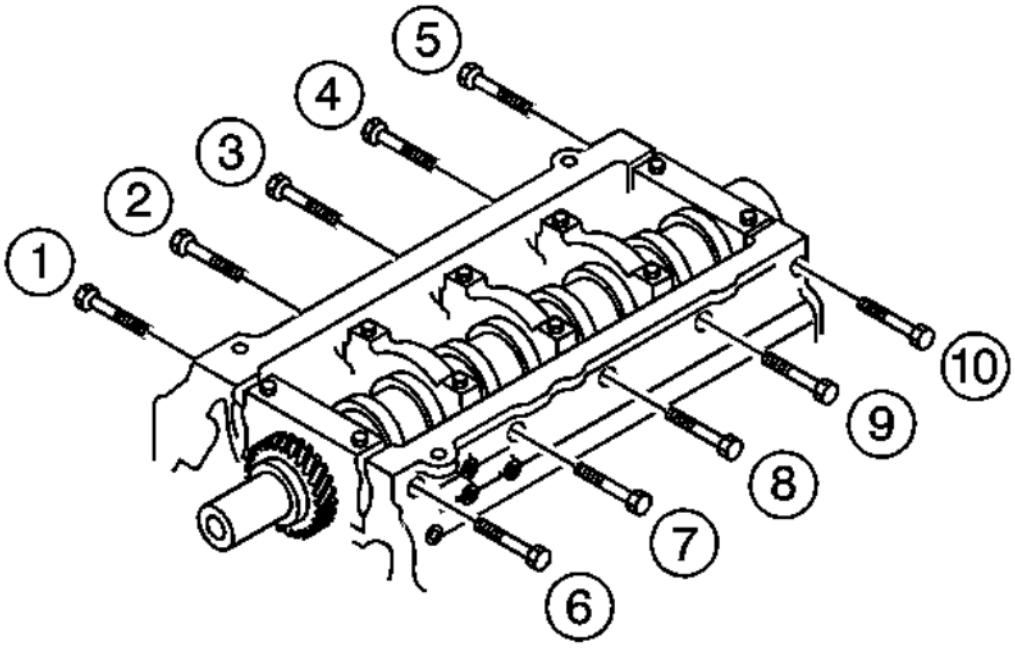


Fig. 186: Crankshaft Bearing Cap Side Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

10. Install the crankshaft bearing cap side bolts.

    Tighten: Tighten the crankshaft bearing cap side bolts in the proper sequence to 70 N.m (52 lb ft).

11. Remove the crankshaft bearing cap bolts.
12. Remove the crankshaft bearing caps.

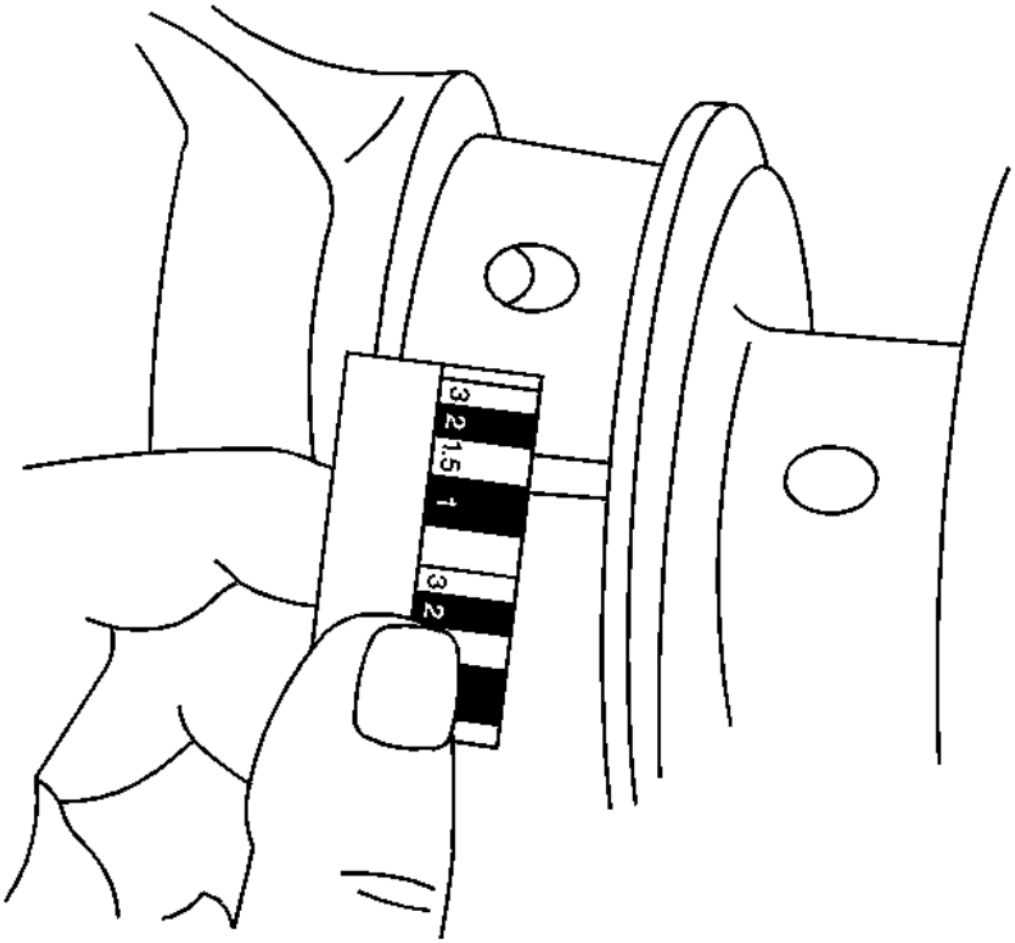


Fig. 187: Measuring Compressed Width
Courtesy of GENERAL MOTORS CORP.

13. Compare the width of the plastic gauge with the scale printed on the plastic gauge container.
14. Select the crankshaft bearing grade that provides the proper oil clearances. The production specification for crankshaft bearing clearance is 0.039-0.070 mm (0.0015-0.0028 in) and the service limit is 0.014 mm (0.0055 in).

CRANKSHAFT BALANCER CLEANING AND INSPECTION

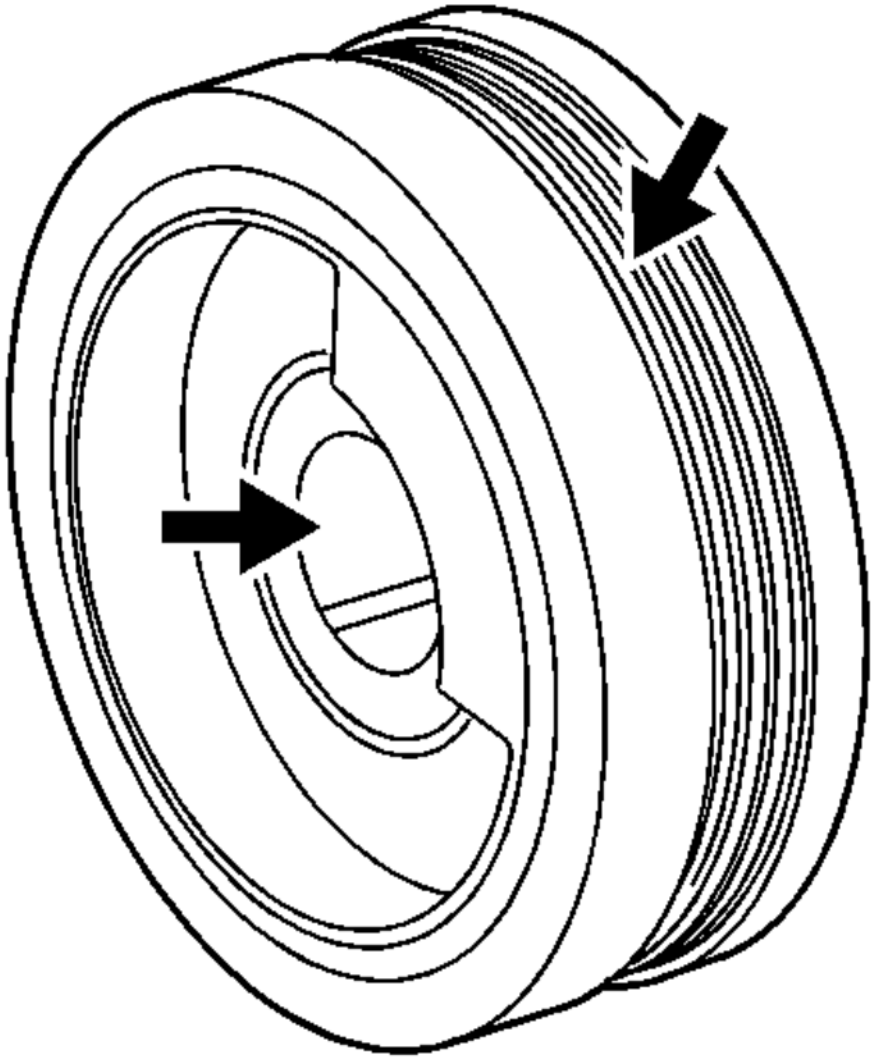


Fig. 188: View Of Crankshaft Balancer Inspection Area
Courtesy of GENERAL MOTORS CORP.

1. Clean the crankshaft balancer.
2. Inspect the crankshaft balancer for damage to belt drive surface and to crankshaft balancer hub.
3. Inspect the balancer hub groove for damage or wear.

4. Replace the crankshaft balancer if any concerns exist.

ENGINE FLYWHEEL CLEANING AND INSPECTION

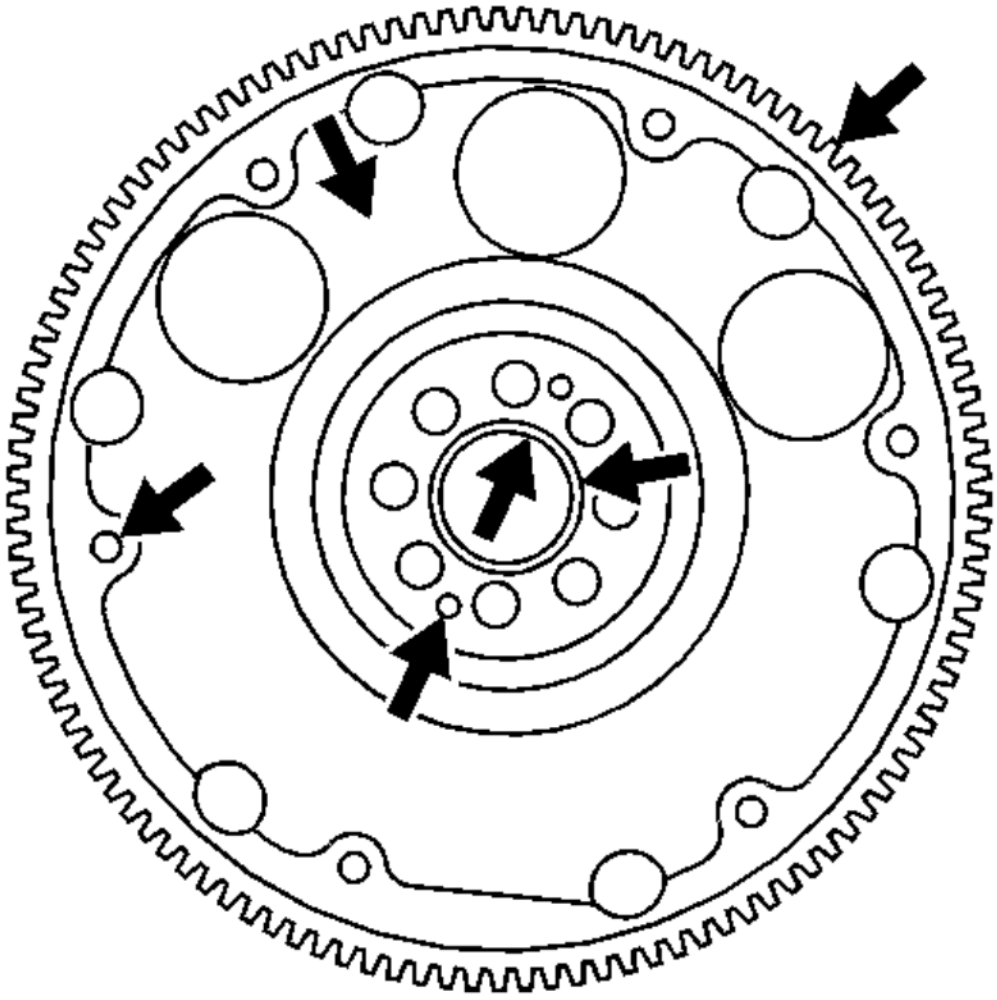


Fig. 189: View Of Engine Flywheel Inspection Areas
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: In order to maintain the proper component balance, contact surface taper, and heat transfer, manual transmission

flywheels are NOT to be machined.

1. Clean the flywheel assembly.
2. Inspect the flywheel assembly for cracks or excessive wear on the teeth.
3. Replace the flywheel assembly if any concerns exist.

PISTON AND CONNECTING ROD DISASSEMBLE

Tools Required

J 43654 Piston Pin Retainer Remover/Installer. See **Special Tools** .

Disassemble

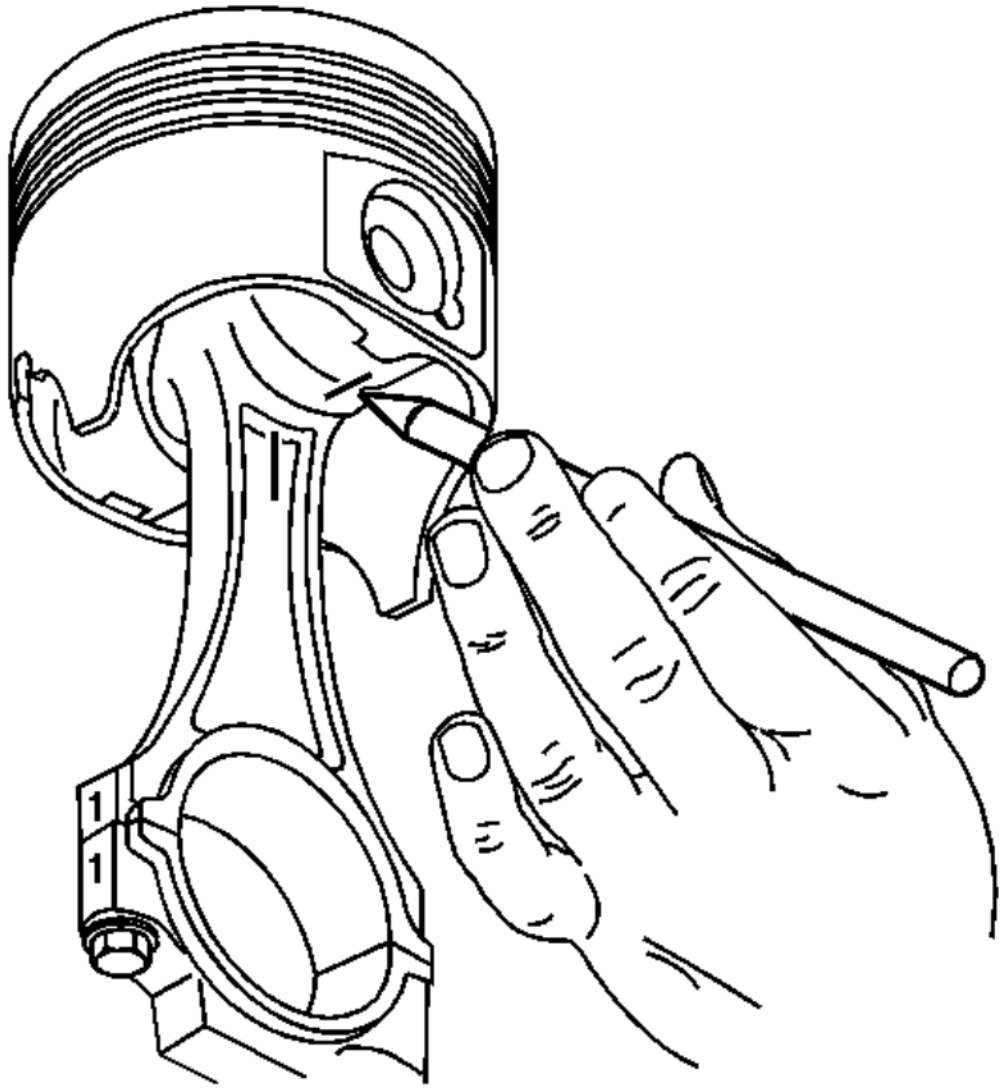


Fig. 190: Marking Orientation Of Piston To Connecting Rod
Courtesy of GENERAL MOTORS CORP.

1. Mark orientation of the piston to the connecting rod.

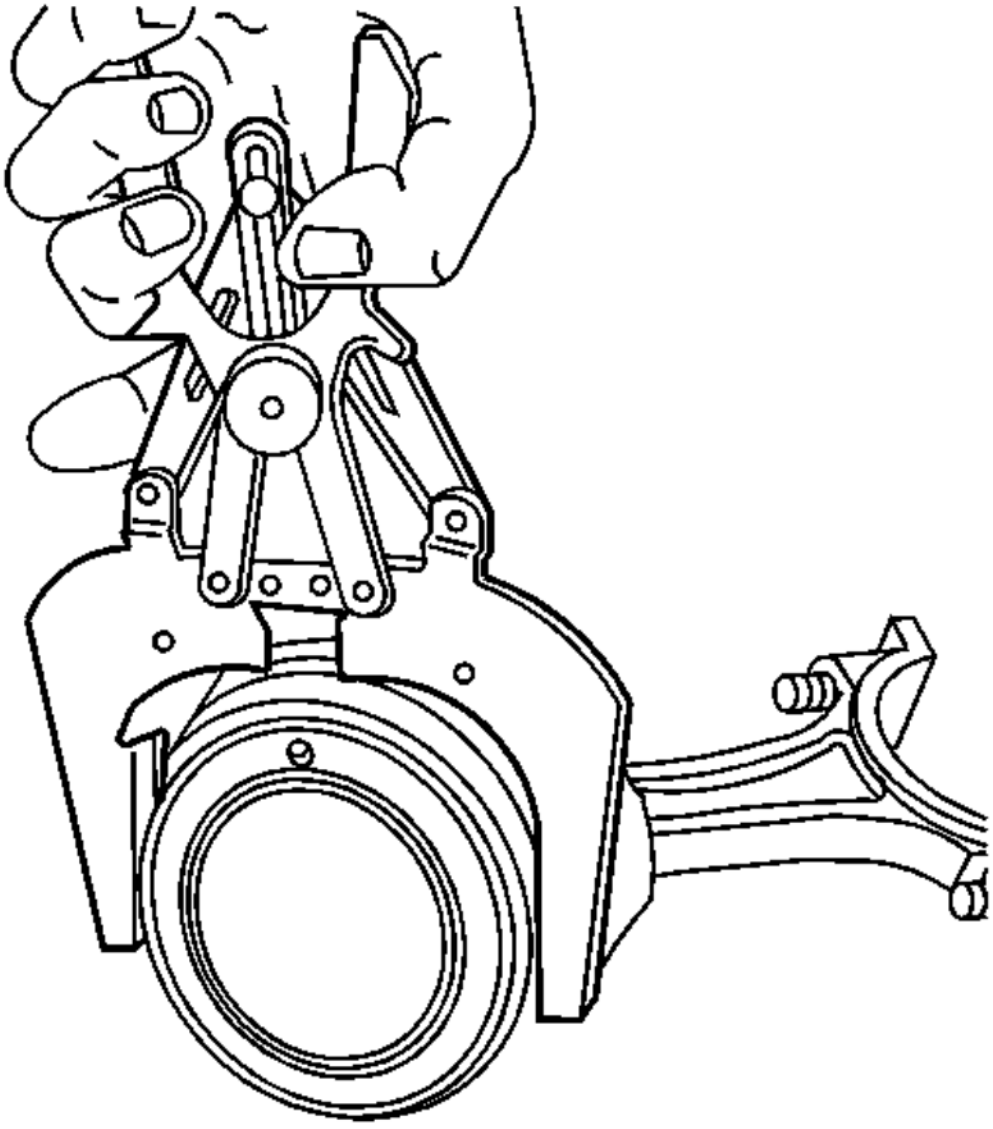


Fig. 191: View Of Piston Rings & Piston Expander
Courtesy of GENERAL MOTORS CORP.

2. Remove the piston rings using a piston ring expander.

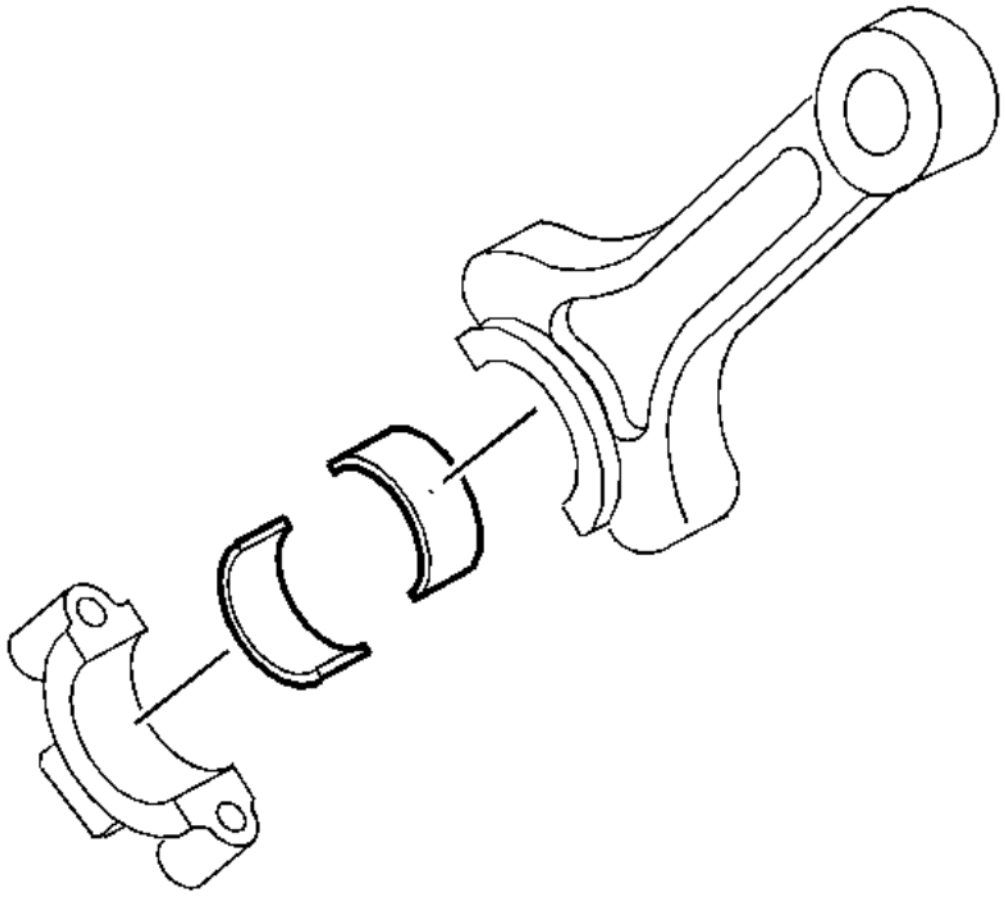


Fig. 192: View Of Connecting Rod Bearing Inserts
Courtesy of GENERAL MOTORS CORP.

3. Remove the connecting rod bearing inserts.

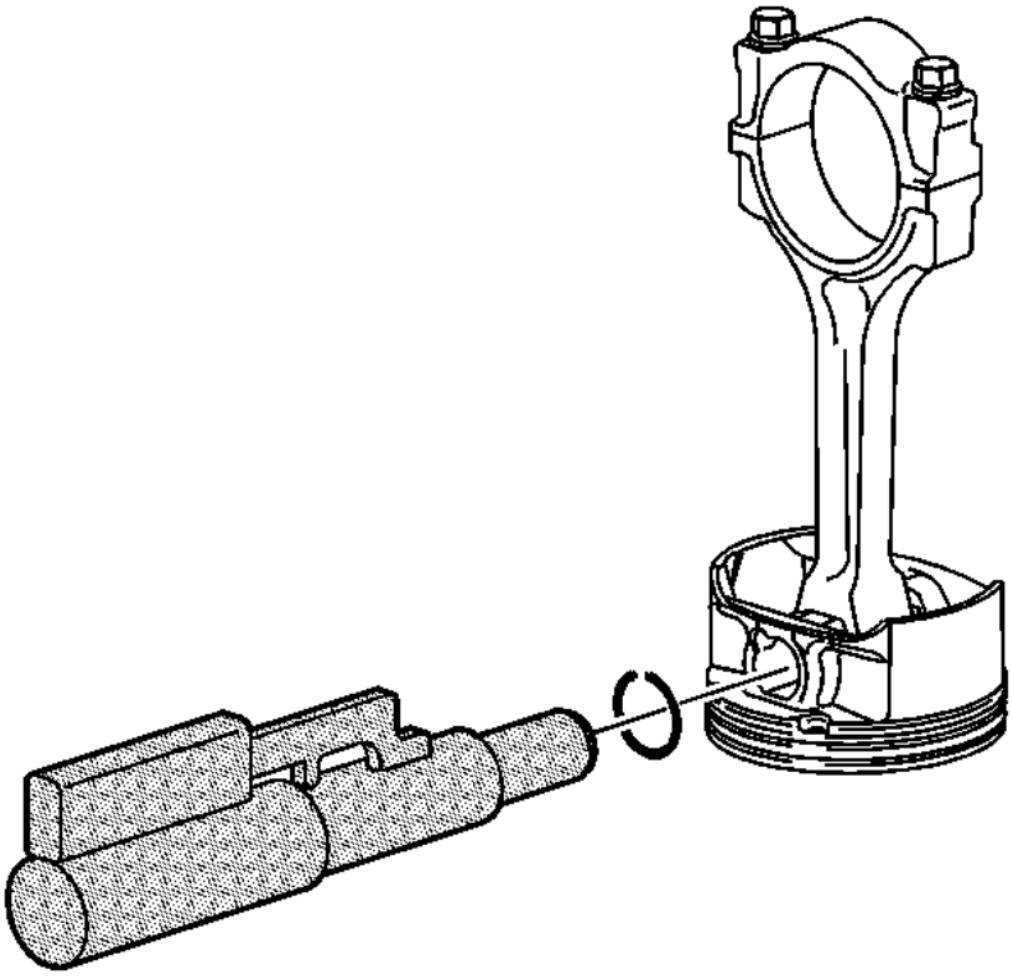


Fig. 193: View Of Piston Pin Retaining Clips
Courtesy of GENERAL MOTORS CORP.

4. Use **J 43654** to remove the piston pin retainers. See **Special Tools** .
5. Remove the piston pin. The pin is a full-floating style and should slide from the piston.
6. Remove the piston from the connecting rod.

2008 ENGINE

Engine Mechanical - 6.6L - Cab & Chassis Sierra, Cab & Chassis Silverado, Sierra & Silverado

OFF-VEHICLE REPAIR INSTRUCTIONS (CONT.)

PISTON, CONNECTING ROD, AND BEARING CLEANING AND INSPECTION

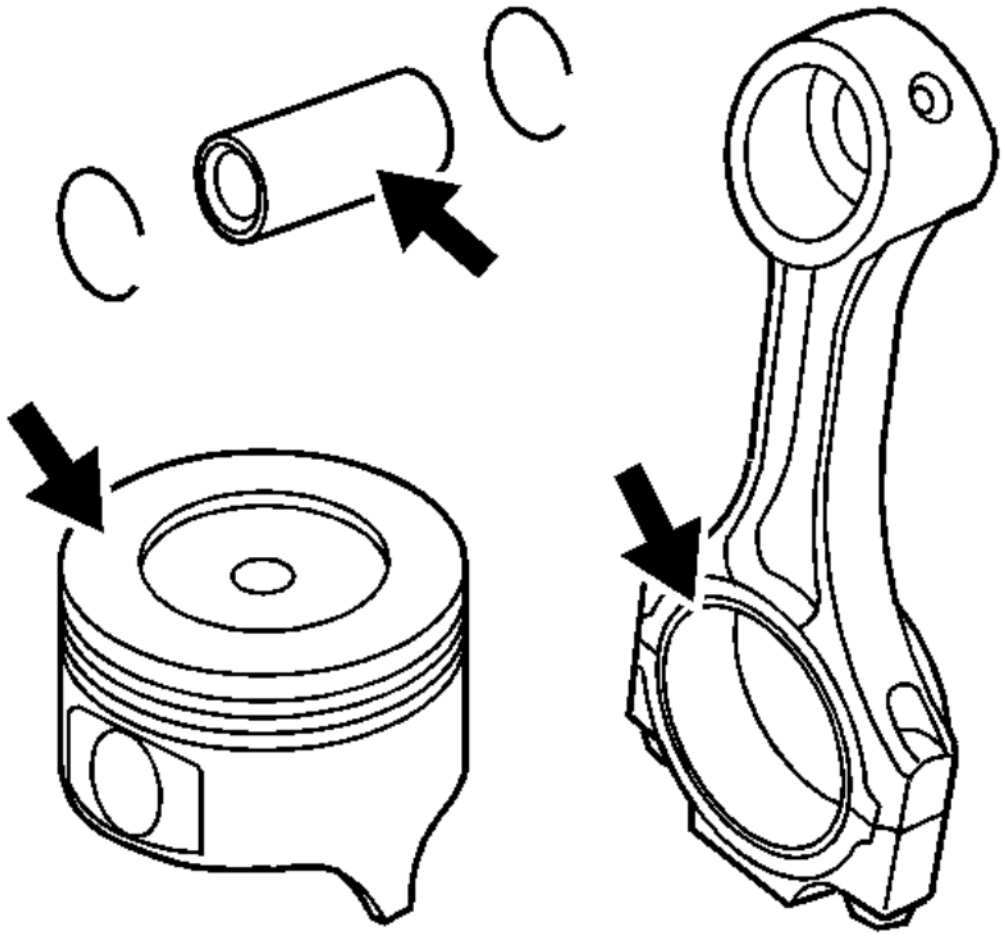


Fig. 1: View of Connecting Rod, Bearing, Piston & Piston Pin
Courtesy of GENERAL MOTORS CORP.

1. Clean the deposits from the following components:

- Connecting rod and bearings
- Piston
- Piston pin

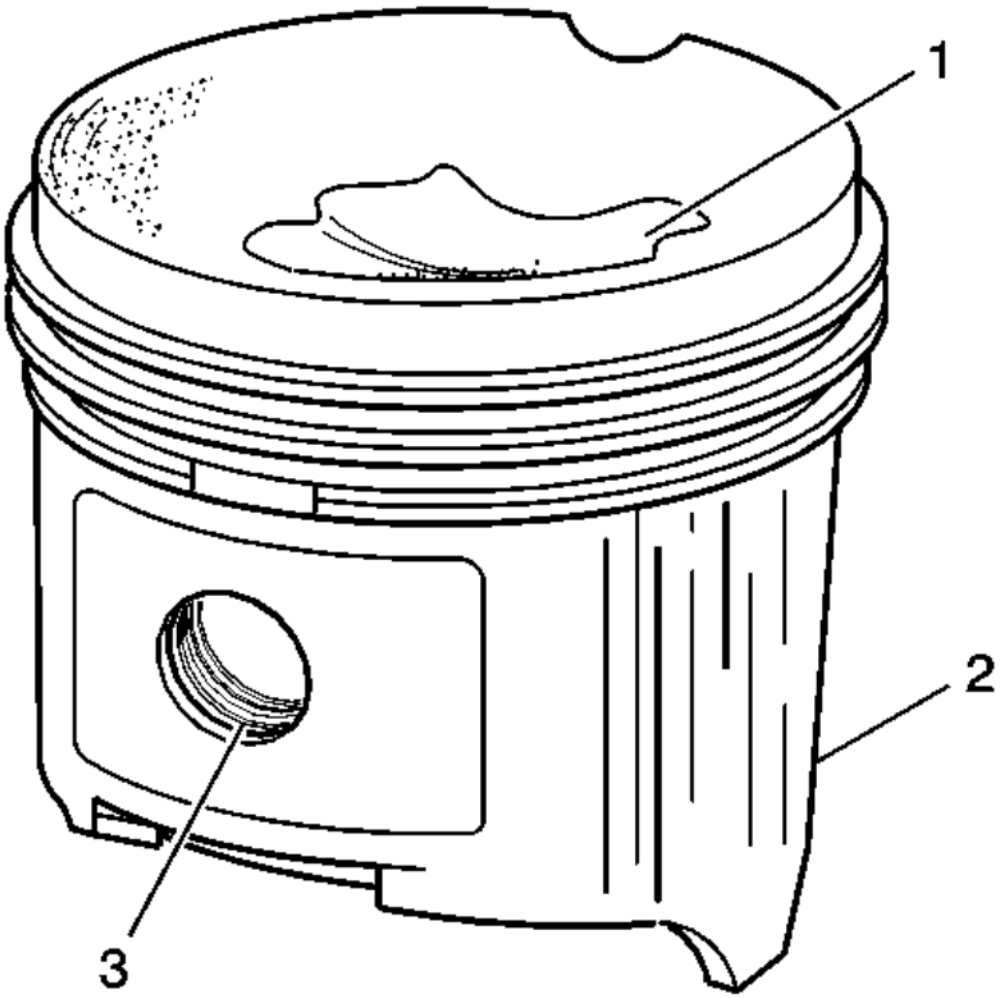


Fig. 2: Identifying Piston Damage Inspection Areas
Courtesy of GENERAL MOTORS CORP.

2. Inspect the piston for the following conditions:
   - Scoring on the piston skirt (2)

- Scoring in the piston pin area (3)
- Cracks (1)
- Broken ring groove lands

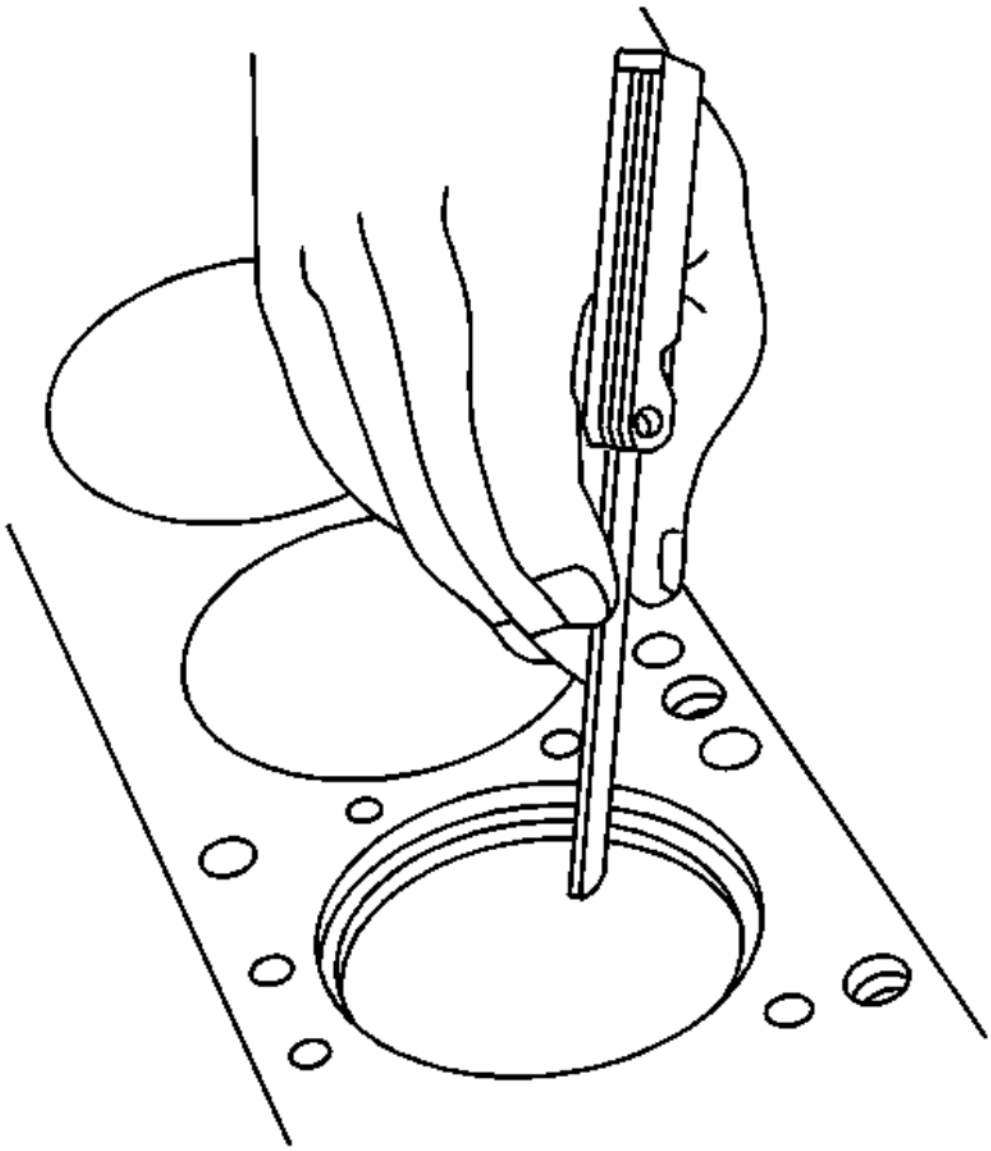


Fig. 3: Measuring Piston Ring End Gap

Courtesy of GENERAL MOTORS CORP.

3. Measure the piston ring end gap.
   - Use a piston to square the piston ring near the top of the cylinder.
   - Use a feeler gauge to measure the piston ring gap.
   - The 1st compression ring production gap is 0.30-0.45 mm (0.0118-0.0177 in) and the service limit is 1.37 mm (0.0539 in).
   - The 2nd compression ring production gap is 0.50-0.65 mm (0.0197-0.0256 in) and the service limit is 1.35 mm (0.0531 in).
   - The oil ring production gap is 0.15-0.35 mm (0.0059-0.0138 in) and the service limit is 1.20 mm (0.0472 in).
   - Replace the piston ring if the measured value exceeds the service limit.

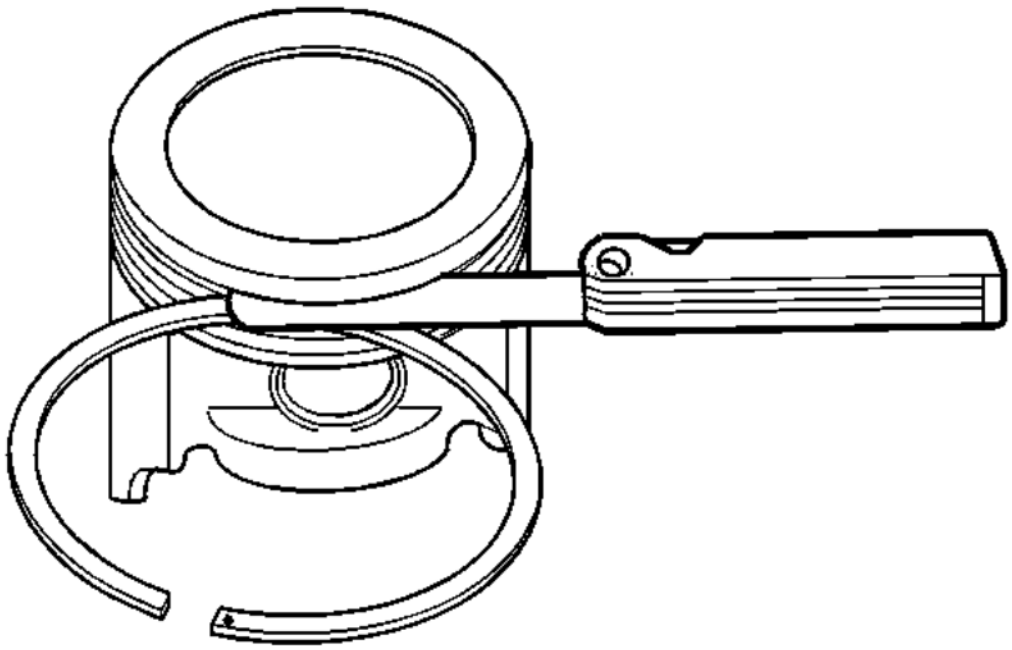


Fig. 4: Measuring Piston Ring Side Clearance
Courtesy of GENERAL MOTORS CORP.

4. Measure the piston ring to piston ring groove clearance.

- Use a feeler gauge to measure the clearance between the piston ring and the piston ring groove at several points around the piston.
- The 1st compression ring production clearance is 0.08-0.17 mm (0.0030-0.0007 in) and the service limit is 0.26 mm (0.0102 in).
- The 2nd compression ring production clearance is 0.01-0.03 mm (0.0004-0.0012 in) and the service limit is 0.10 mm (0.0039 in).
- The oil ring production clearance is 0.01-0.03 mm (0.0004-0.0012 in) and the service limit is 0.12 mm (0.0047 in).
- Replace the piston ring if the measured value exceeds the service limit.

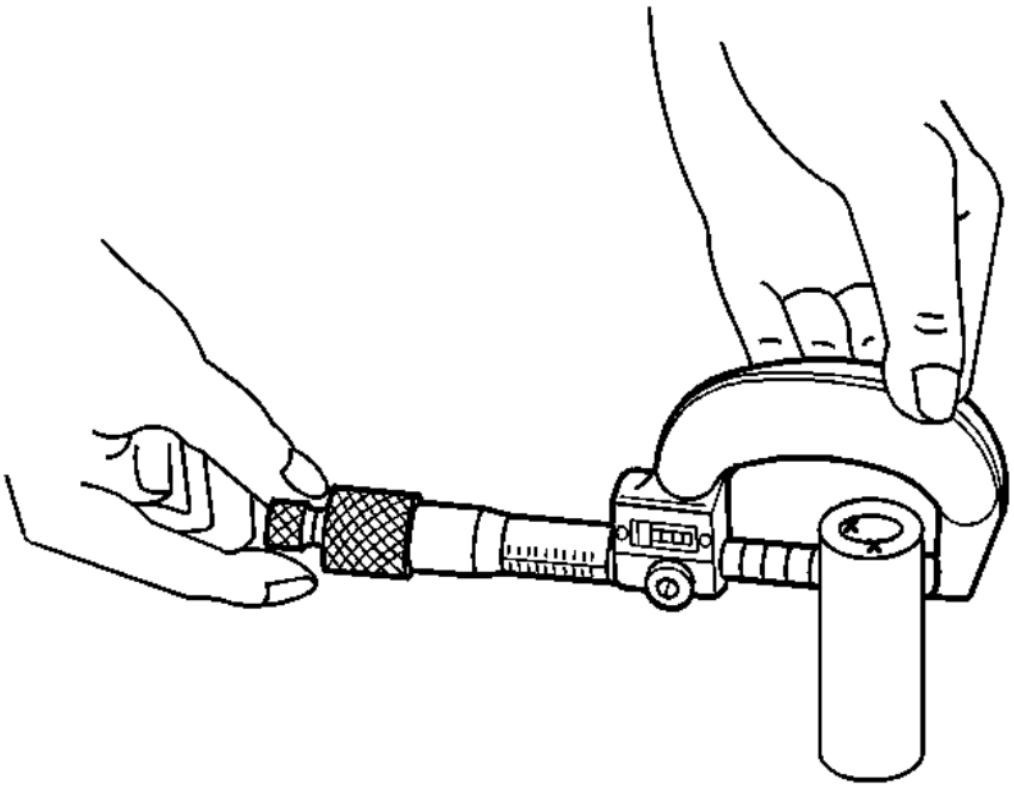


Fig. 5: Measuring Piston Pin Diameter
Courtesy of GENERAL MOTORS CORP.

5. Measure the piston pin outside diameter.

- Measure the piston pin outside diameter at several points.
- The production value is 34.495-34.50 mm (1.3581-1.3563 in) and the service limit is 34.450 mm (1.3563 in).
- Replace the piston pin if the measured value is less than the service limit.

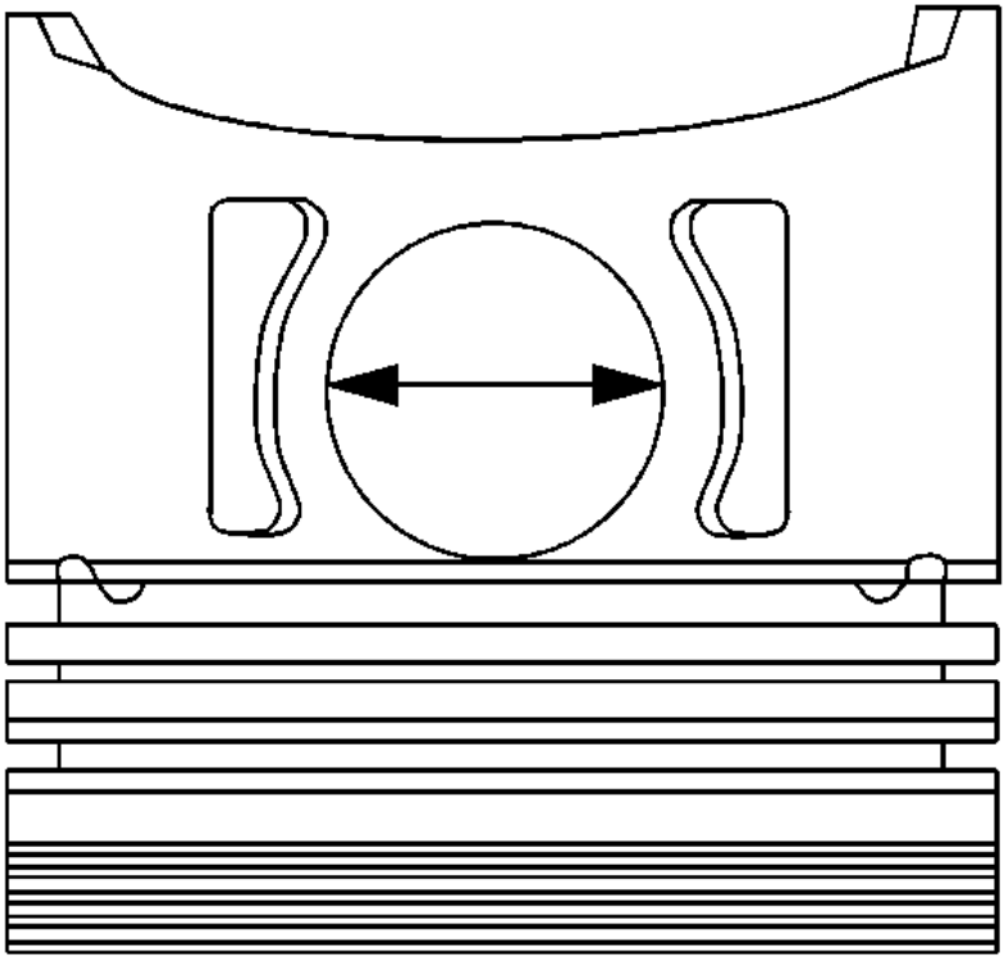


Fig. 6: Measuring Piston Pin Bore
Courtesy of GENERAL MOTORS CORP.

6. Measure the piston pin to piston pin bore clearance.
   - Measure the piston pin bore.

- Subtract the piston pin measurement that was taken previously from the piston pin bore measurement. The difference between these two measurements will be the piston pin to piston pin bore clearance.
- The production clearance is 0.004-0.017 mm (0.0002-0.0007 in) and the service limit is 0.017 mm (0.0007 in).
- If the piston pin to piston pin bore clearance is beyond specifications then replace the piston.

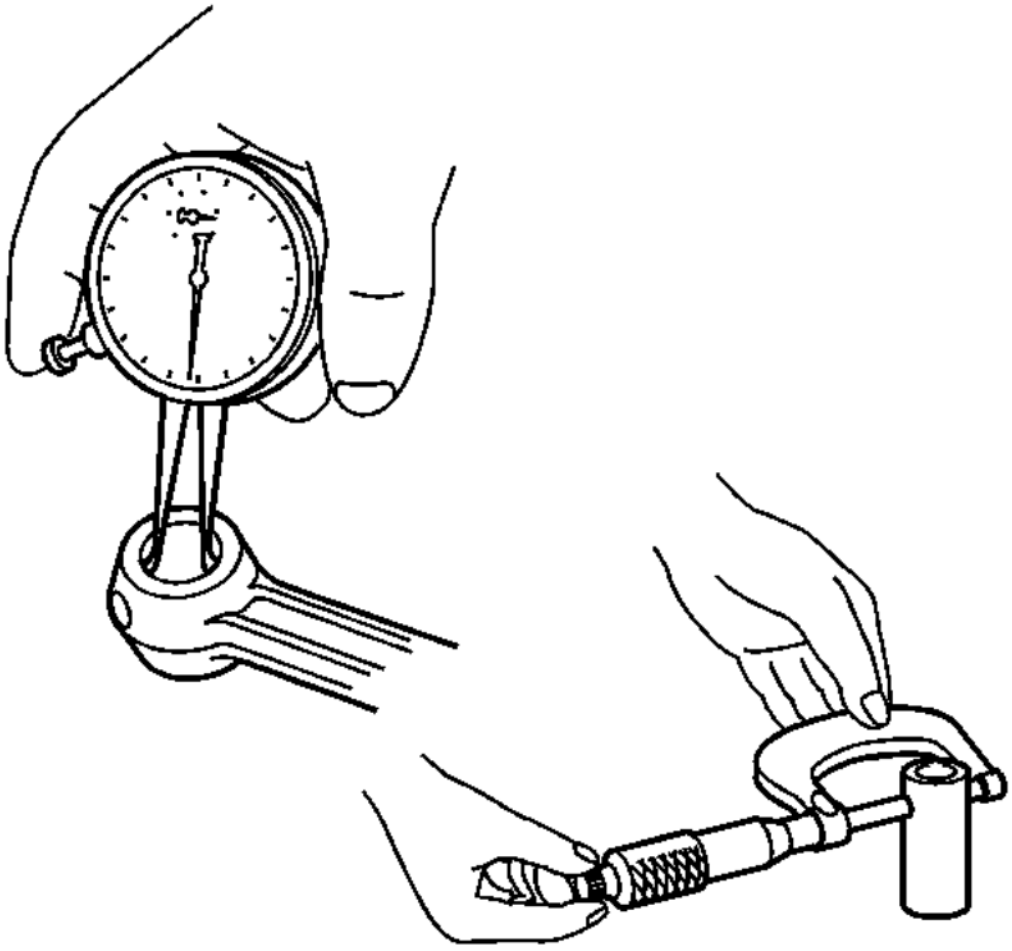


Fig. 7: Measuring Piston Pin To Connecting Rod Small End Clearance
Courtesy of GENERAL MOTORS CORP.

7. Measure the piston pin to connecting rod small end clearance.
    - Measure the inside diameter of the connecting rod small end.
    - Subtract the piston pin measurement that was taken previously from the connecting rod small end measurement. The difference between these two measurements will be the piston pin to connecting rod clearance.
    - The production clearance is 0.012-0.027 mm (0.0005-0.0011 in) and the service limit is 0.08 mm (0.0031 in).
    - Replace the connecting rod if the piston pin to connecting rod small end clearance is beyond specifications. The connecting rod small end bushing is not serviceable.

PISTON AND CONNECTING ROD ASSEMBLE

Tools Required

J 43654 Piston Pin Retainer Remover/Installer. See **Special Tools** .

Assemble

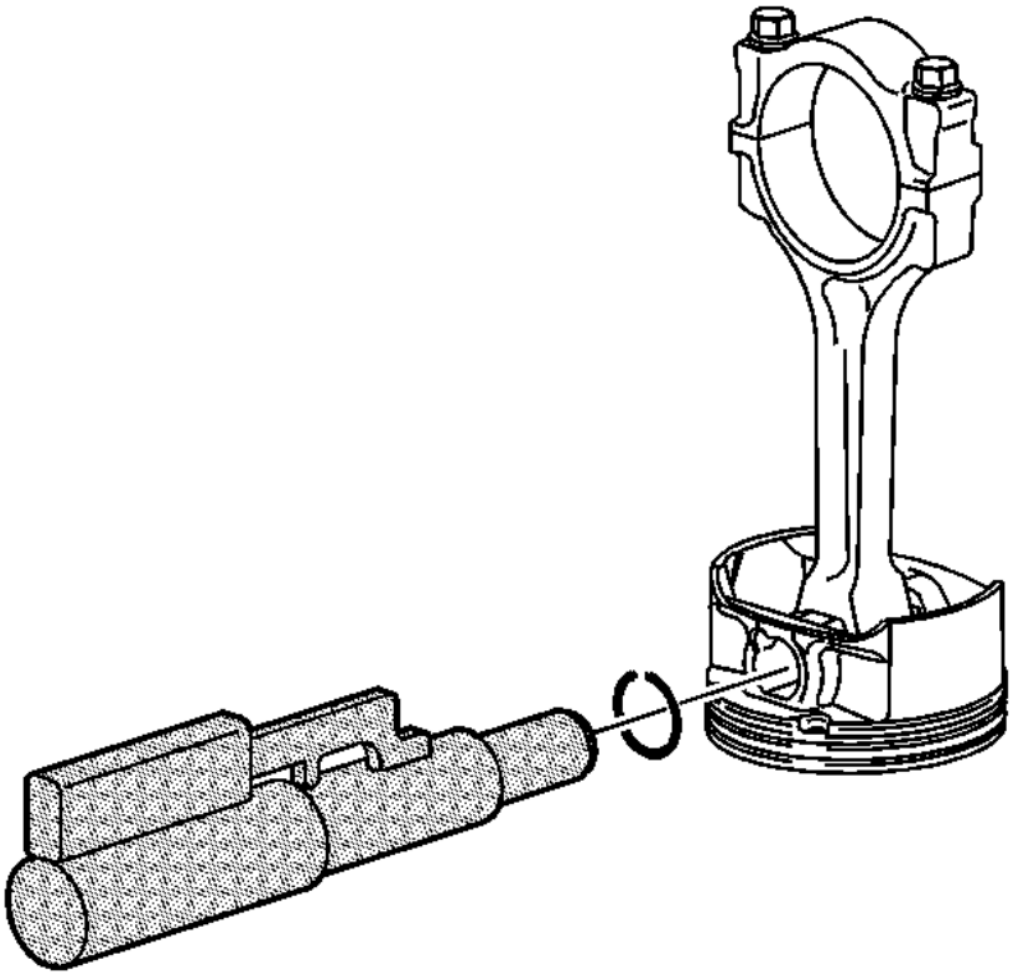


Fig. 8: View Of Piston Pin Retaining Clips
Courtesy of GENERAL MOTORS CORP.

1. Apply engine oil to the connecting rod small end bushing and to the piston pin bore of the piston.
2. Install the piston pin into the piston and connecting rod.

IMPORTANT:

- **For the right bank piston and connecting rod assemblies, reassemble so the grade mark on the connecting rod faces the right side of the engine and the**

piston front mark faces the front of the engine.

- **For the left bank piston and connecting rod assemblies, reassemble so the grade mark on the connecting rod faces the left side of the engine and the piston front mark faces the front of the engine.**

3. Install the piston pin retaining rings.

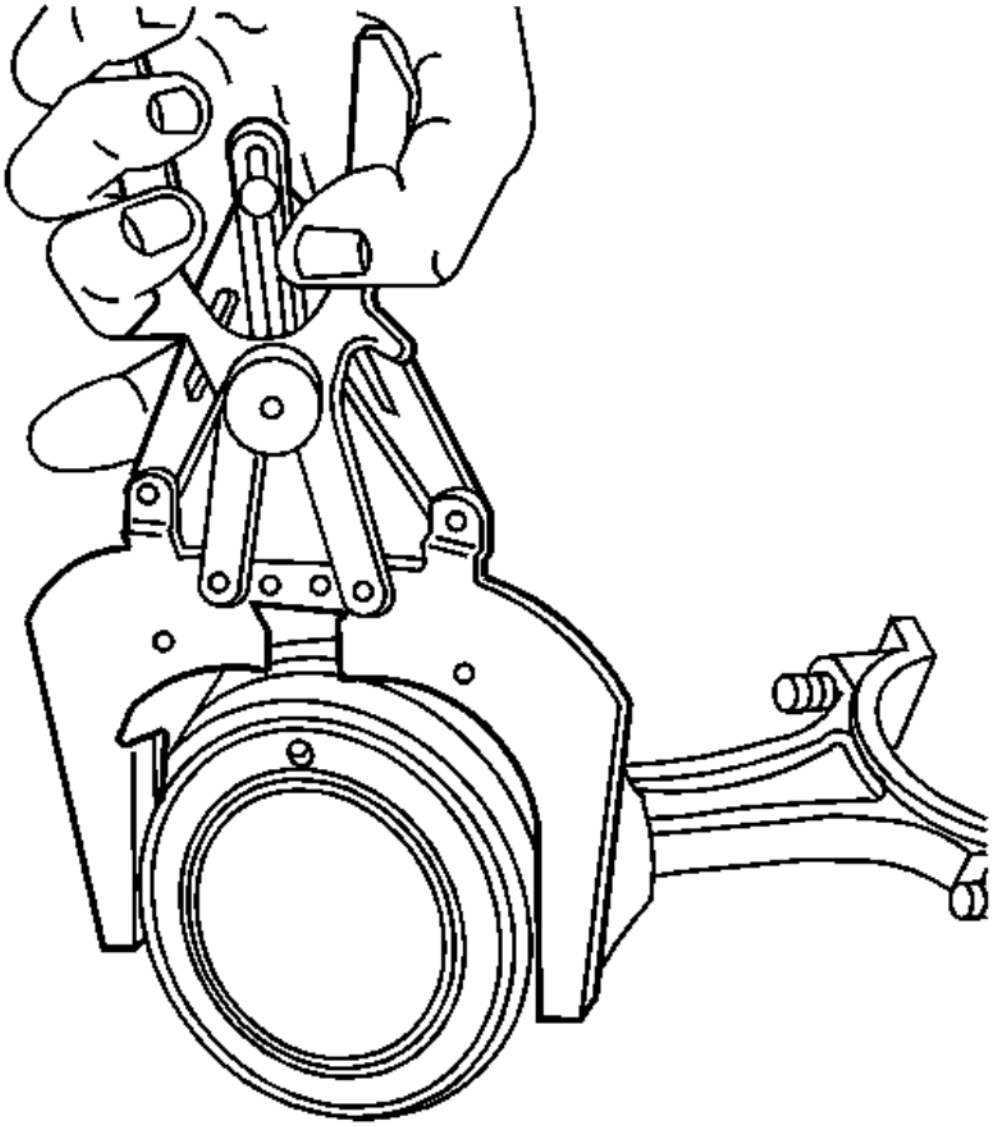


Fig. 9: View Of Piston Rings & Piston Expander
Courtesy of GENERAL MOTORS CORP.

4. Apply engine oil to the piston ring grooves.
5. Install the piston rings using a piston ring expander.

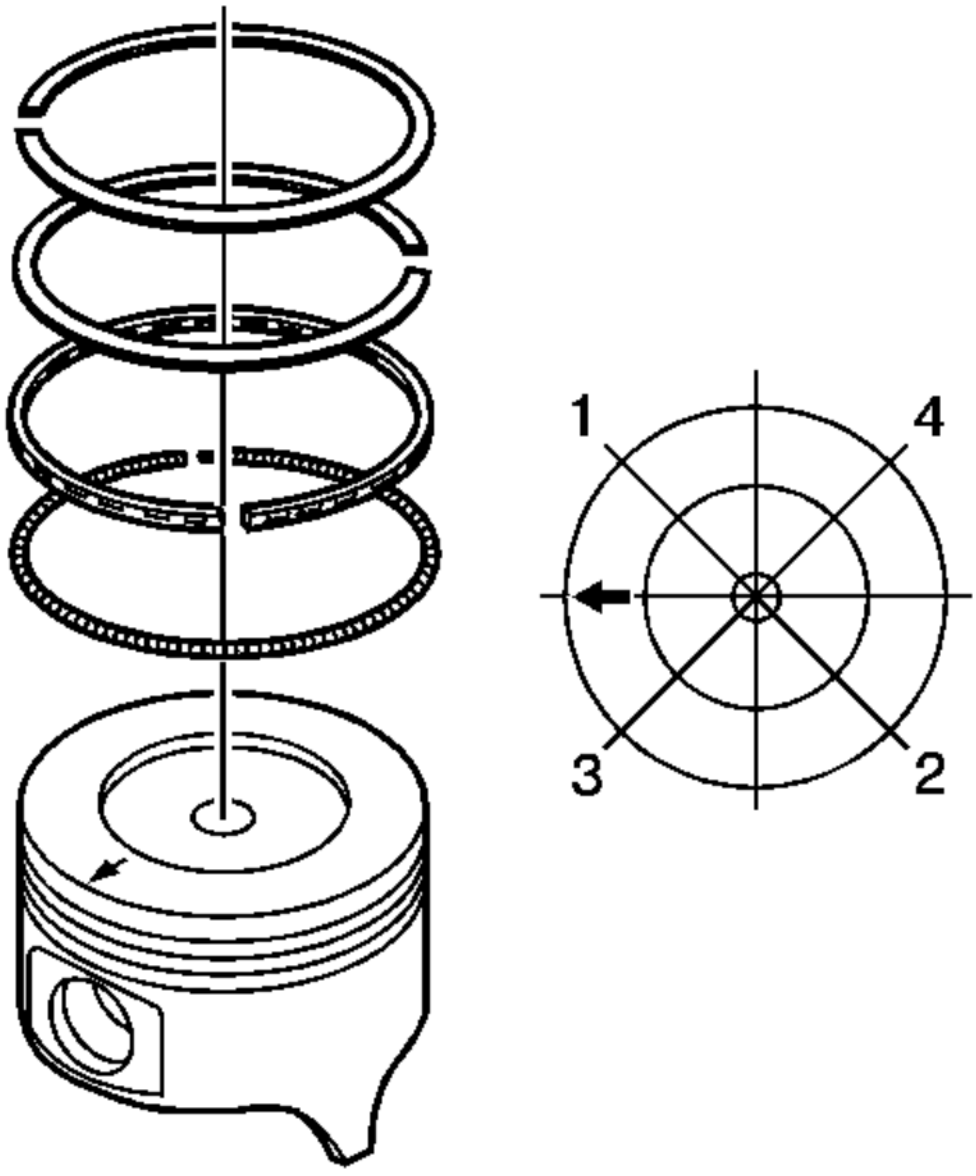


Fig. 10: Aligning Piston Ring End Gaps
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The 2N mark on the 2nd compression ring must face upwards. The piston has a groove between the 1st and the

2nd compression rings to allow for expansion of blowby gases. No ring is to be installed in this groove.

6. Orientate the piston ring end gaps as illustrated.

CYLINDER HEAD DISASSEMBLE

Tools Required

J 8062 Valve Spring Compressor

J 38820 Valve Stem Oil Seal Remover. See **Special Tools** .

Disassemble

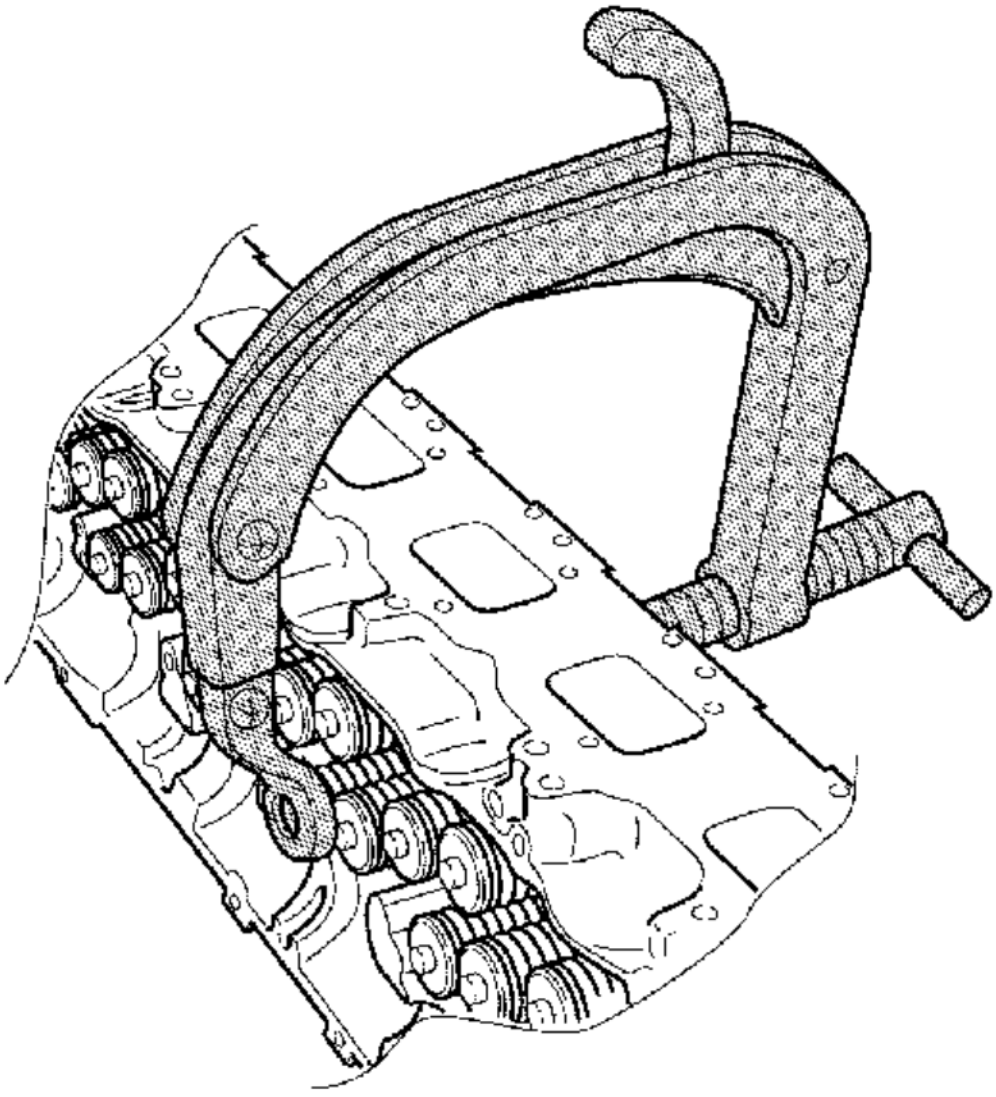


Fig. 11: Compressing Valve Spring Using J 8062
Courtesy of GENERAL MOTORS CORP.

1. Use the **J 8062** to compress the valve spring.

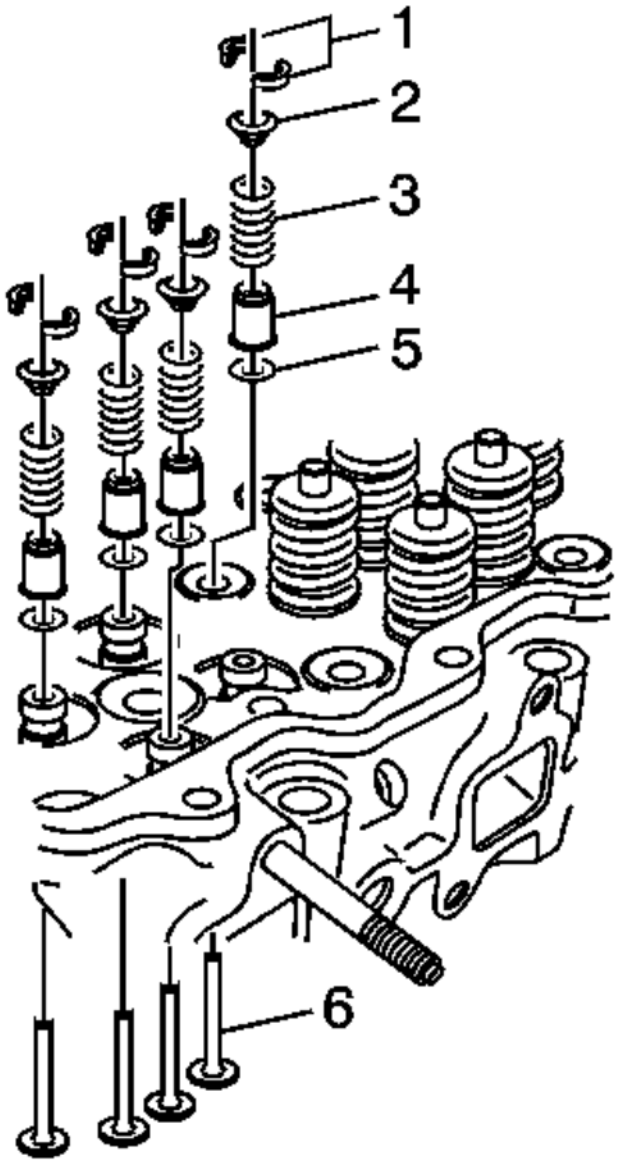


Fig. 12: View Of Valve Stem Oil Seal & Valve Spring
Courtesy of GENERAL MOTORS CORP.

2. Remove the valve keys (1).
3. Remove the **J 8062** from the cylinder head.

4. Remove the valve spring upper seat (2).
5. Remove the valve spring (3).
6. Remove the valve (6).
7. Remove the valve stem seal (4) using **J 38820** . See **Special Tools** .
8. Remove the valve spring lower seat (5).

CYLINDER HEAD CLEANING AND INSPECTION

Tools Required

- **J 9666** Valve Spring Tester
- **EN-47909** Injector Bore and Sleeve Cleaning Kit

Inspection

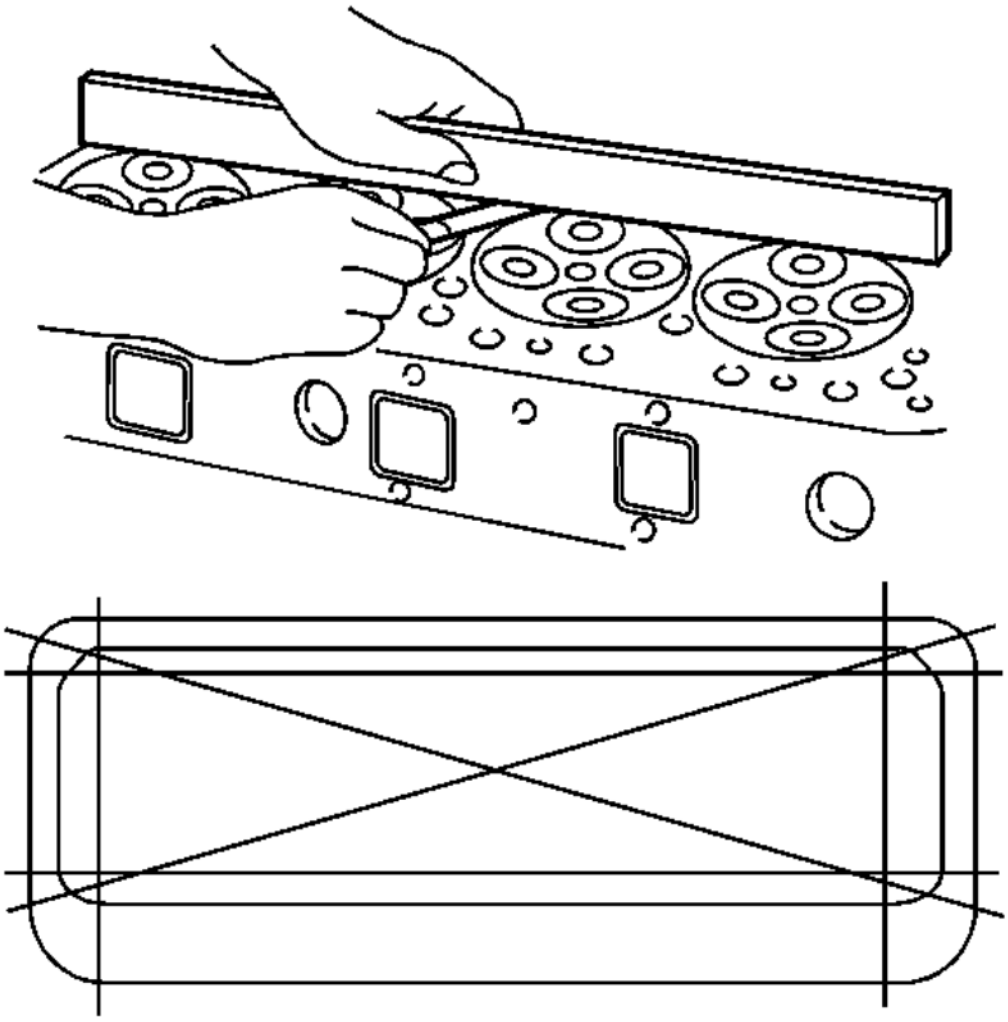


Fig. 13: Measuring Cylinder Head For Warpage
Courtesy of GENERAL MOTORS CORP.

1. Clean the cylinder head of all foreign material. Do not use a motorized wire brush on any gasket sealing surface.
2. Clean the threaded holes.
3. Clean the injector bores using **EN-47909** .
4. Inspect the cylinder head for the following:
   - Damage to the gasket surfaces

- Damage to the threaded bolt holes
- Cracks in the exhaust ports
- External cracks in the water chamber
- Cracks between the valve seats
- Restrictions in the intake or exhaust passages
- Restrictions in the cooling system passages
- Rusted, damaged or leaking core plugs

5. Measure the cylinder head for warpage with a straight edge and a feeler gauge. A cylinder head block deck with warpage in excess of 0.075 mm (0.0030 in) within a 516.5 mm (20.33 in) area must be replaced.

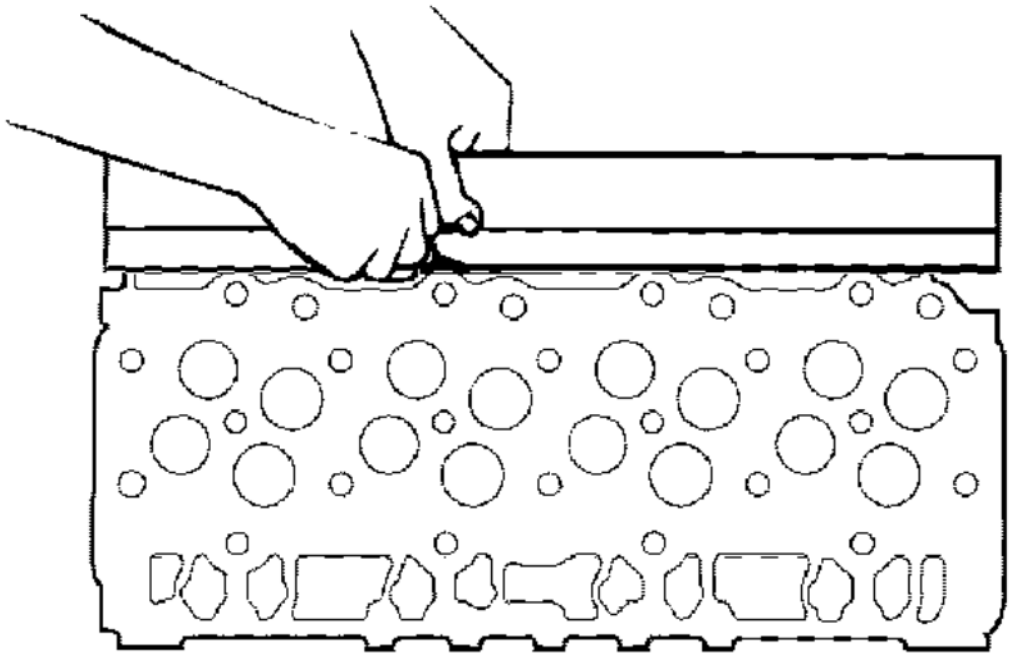


Fig. 14: Measuring Cylinder Head Exhaust Manifold Deck For Warpage
Courtesy of GENERAL MOTORS CORP.

6. Measure the cylinder head exhaust manifold deck for warpage. A cylinder head exhaust manifold deck with warpage in excess of 0.1 mm (0.0039 in) within a 453 mm (17.83 in) area must be replaced.

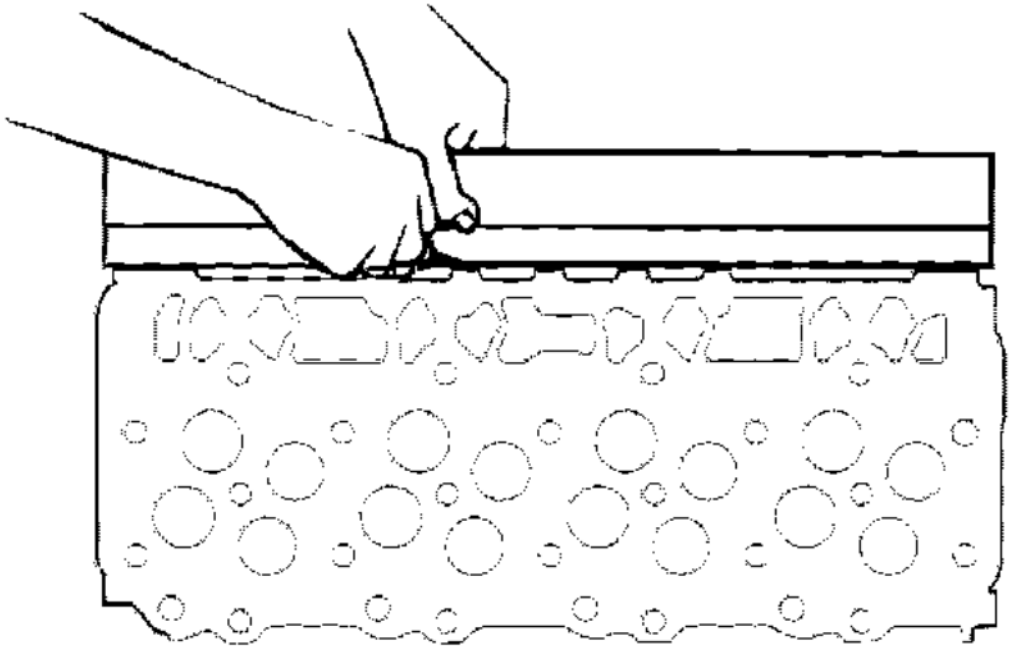


Fig. 15: Measuring Cylinder Head Intake Manifold Deck For Warpage
Courtesy of GENERAL MOTORS CORP.

7. Measure the cylinder head intake manifold deck for warpage. A cylinder head intake manifold deck with warpage in excess of 0.3 mm (0.011 in) within a 493 mm (19.41 in) area must be replaced.

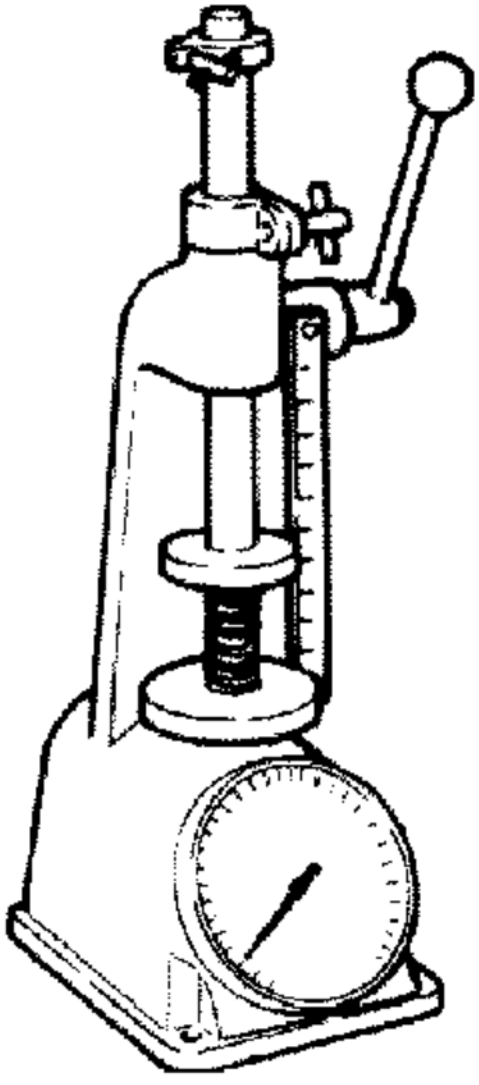


Fig. 16: Measuring Valve Spring Tension Using J 9666
Courtesy of GENERAL MOTORS CORP.

8. Measure the valve spring tension using **J 9666** . Replace the valve spring if the valve spring tension is less than 315.5 N (7.09 lb) at 41 mm (1.6142 in)

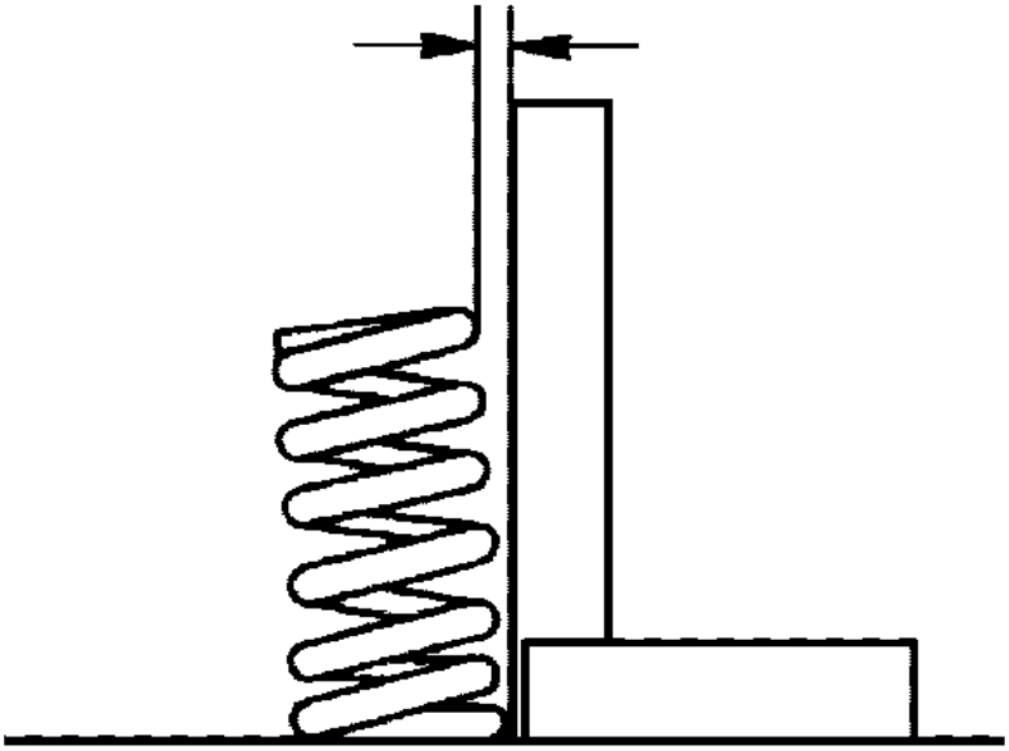


Fig. 17: Measuring Valve Spring For Squareness
Courtesy of GENERAL MOTORS CORP.

9. Measure the valve spring for squareness. Replace the valve spring if squareness is beyond 2.0 mm (0.0787 in).

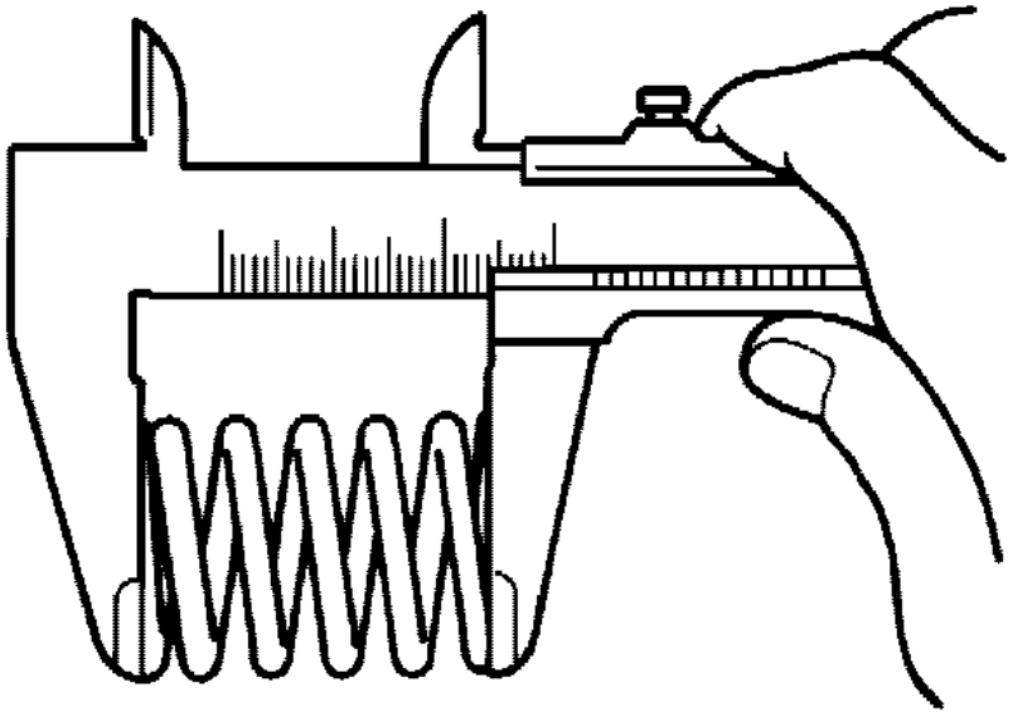


Fig. 18: Measuring Valve Spring Free Length
Courtesy of GENERAL MOTORS CORP.

10. Measure the valve spring free length. The production free length is 56.6 mm (2.2283 in).
11. Measure the valve stem to guide clearance.
    1. Set a dial indicator to the valve stem measuring point.
    2. Move the valve stem from side to side while reading the total movement on the dial indicator. If the measured valve exceeds 0.20 mm (0.0079 in), replace the cylinder head.

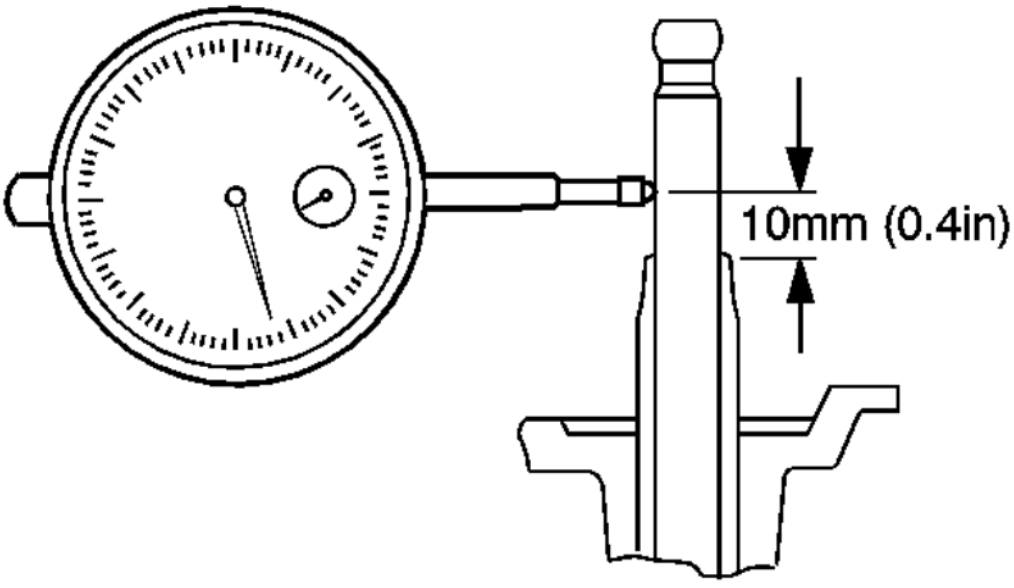


Fig. 19: Measuring Valve Stem To Guide Clearance
Courtesy of GENERAL MOTORS CORP.

12. If the valve stem to guide clearance is over 0.25 mm (0.098 in) for the exhaust valve guides or 0.20 mm (0.0079 in) for the intake valve guides, the cylinder head must be replaced.
13. Inspect the valves for the following:
    - Bent valve stem
    - Scored valve stem
    - Worn valve key grooves
    - Pitted surfaces

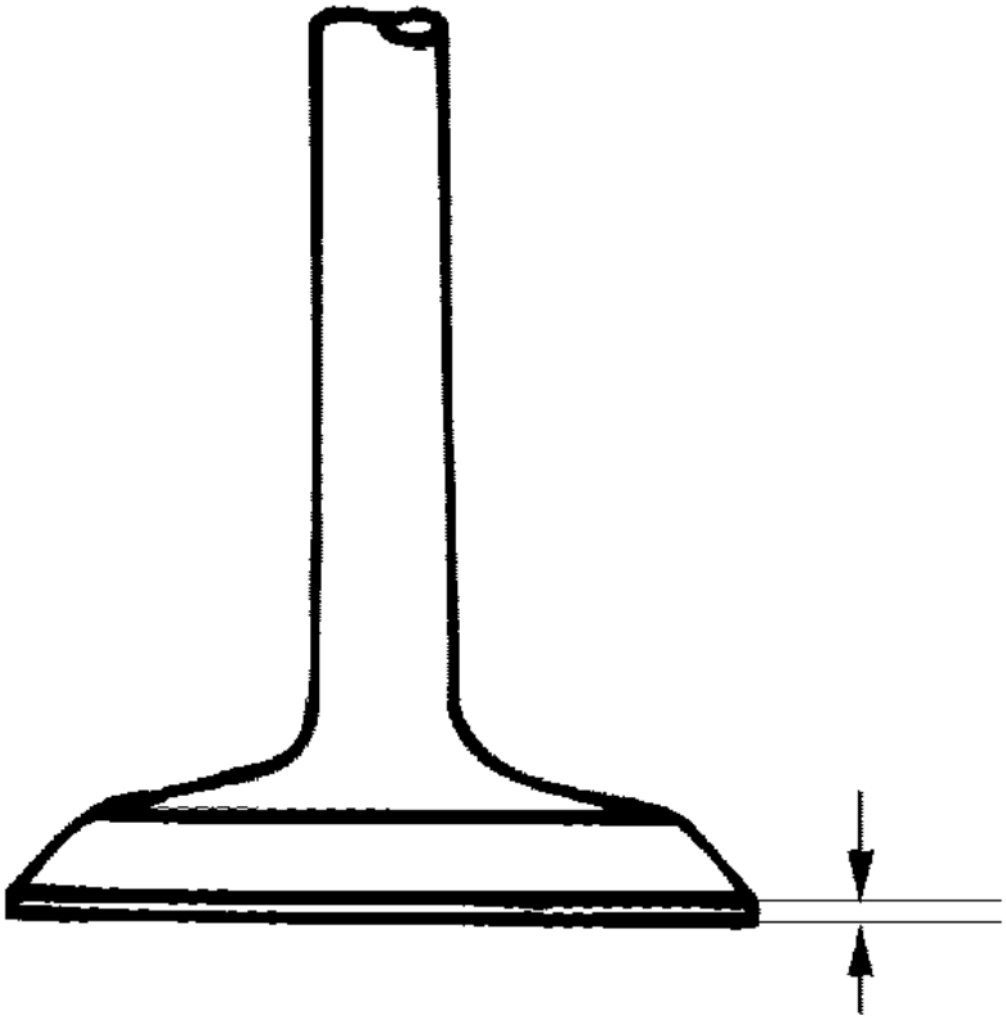


Fig. 20: Measuring Valve Margin
Courtesy of GENERAL MOTORS CORP.

14. Measure the valve margin. The intake valve production margin is 1.2 mm (0.0472 in) and the service limit is 0.88 mm (0.0346 in). The exhaust valve production margin is 1.0 mm (0.0394 in) and the service limit is 0.73 mm (0.0287 in). Replace the valve if the valve margin is below the service limit.

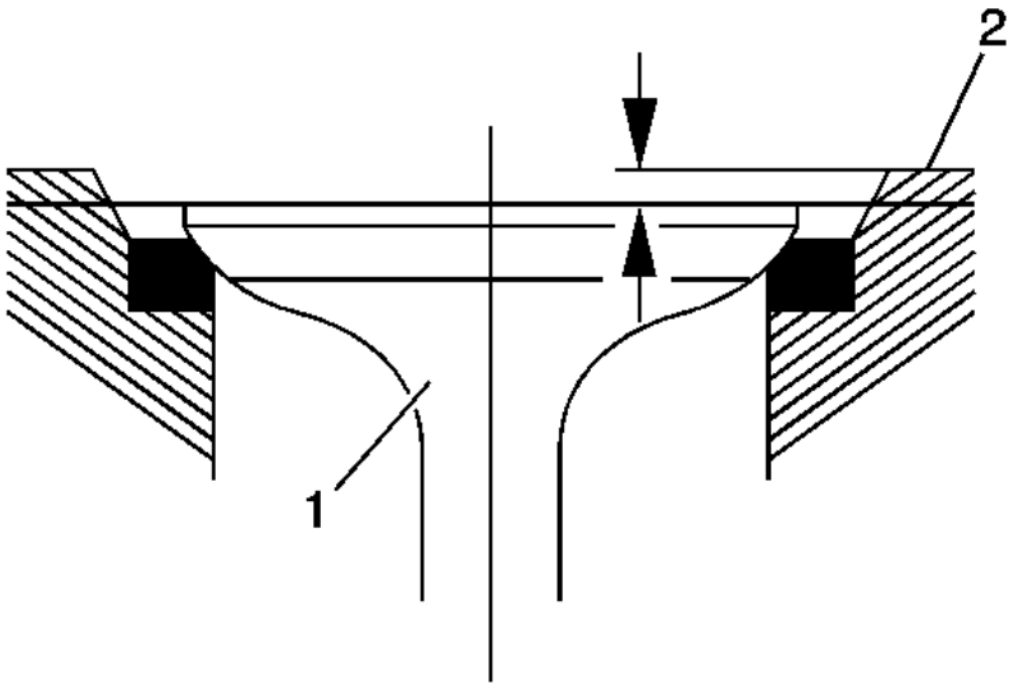


Fig. 21: Measuring Valve Depression
Courtesy of GENERAL MOTORS CORP.

15. Measure the valve depression.
    1. Insert a new valve into the cylinder head (1).
    2. Use a depth gage or a straight edge to measure the valve depression from the cylinder head gasket surface (2). The intake valve depression is 0.6 mm (0.0236 in) and the service limit is 2.5 mm (0.0984 in). The exhaust valve depression is 0.9 mm (0.0354 in) and the service limit is 2.0 mm (0.0787 in). Recondition the valve seat if the valve depression is above specifications.

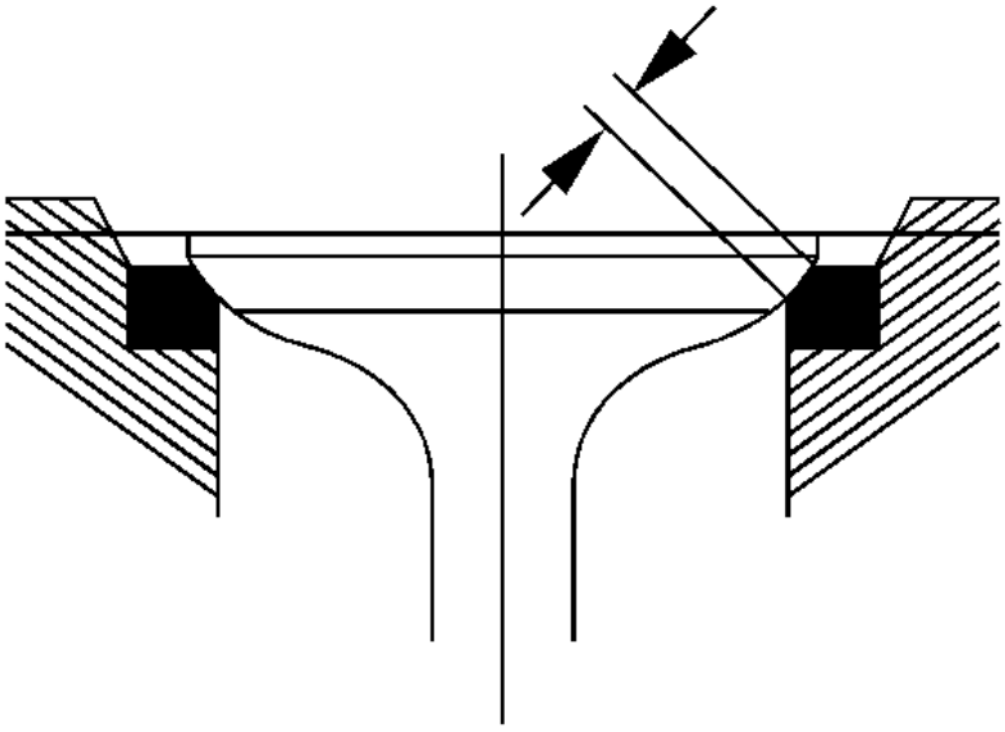


Fig. 22: Measuring Valve Contact Width
Courtesy of GENERAL MOTORS CORP.

16. Measure the valve contact width.
    - Inspect the valve contact area for roughness or unevenness.
    - The intake valve contact width is 2.1 mm (0.0827 in) and the service limit is 2.5 mm (0.0984 in).
    - The exhaust valve contact width is 2.1 mm (0.0827 in) and the service limit is 2.5 mm (0.0984 in).
    - Recondition the valve seats to bring the contact width into specifications.

VALVE AND SEAT GRINDING

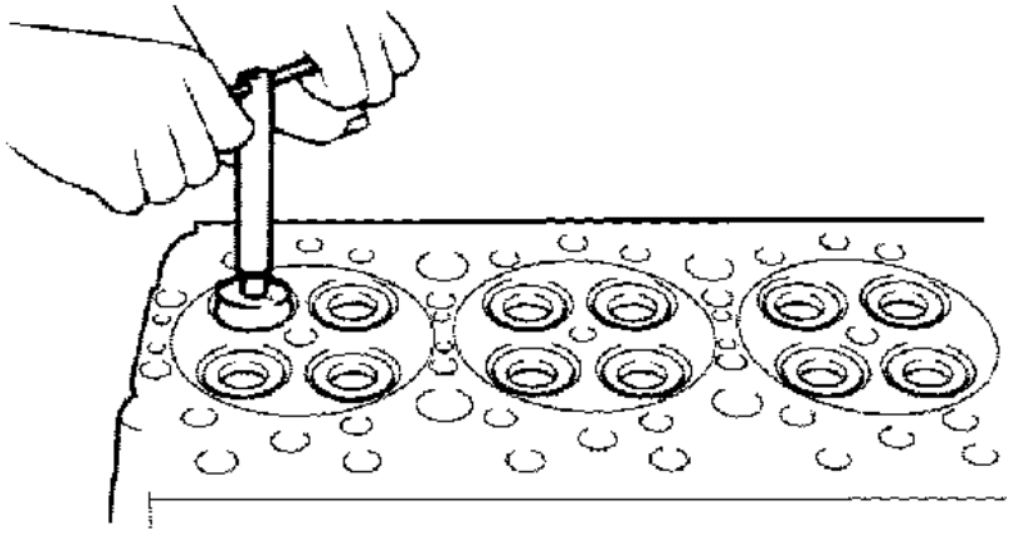


Fig. 23: Grinding Valve
Courtesy of GENERAL MOTORS CORP.

1. Remove the carbon from the valve guide and valve seat surface.
2. Resurface the valve face to 45 degrees. If valve margin falls below specifications after resurfacing then discard valve.
3. Use a suitable tool to bring the valve contact width to the standard value. The valve seat angle is 45 degrees.

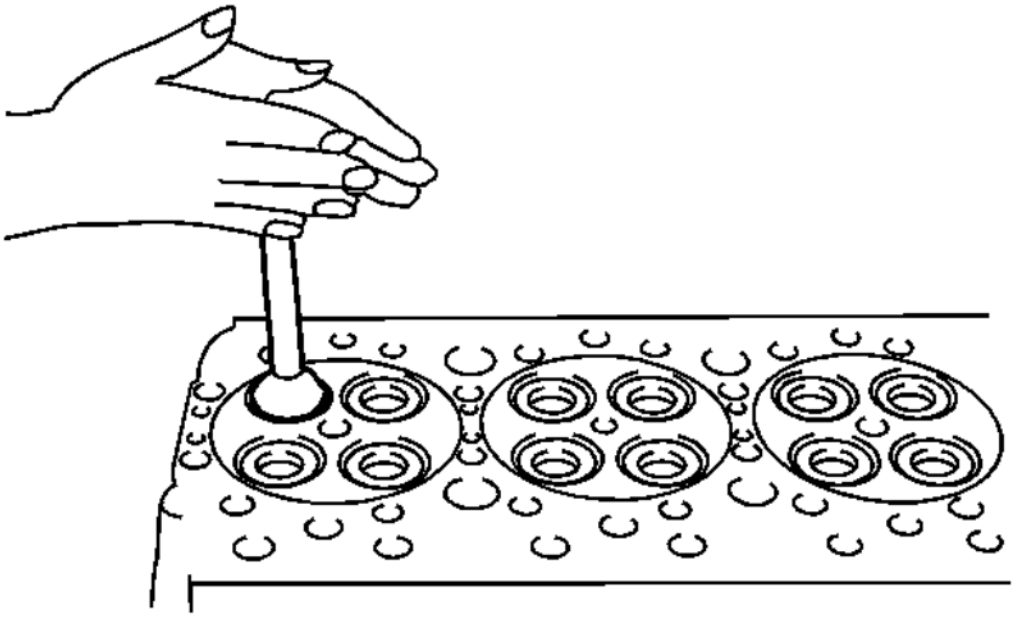


Fig. 24: Turning Valve Back & Forth
Courtesy of GENERAL MOTORS CORP.

4. Apply valve lapping compound to the valve seat surface.
5. Insert the valve into the cylinder head.
6. Turn the valve back and forth in its seat to lap the valve face to the valve seat.

CYLINDER HEAD ASSEMBLE

Tools Required

- **J 44640** Valve Stem Seal Installer. See **Special Tools** .
- **J 8062** Valve Spring Compressor

Assemble

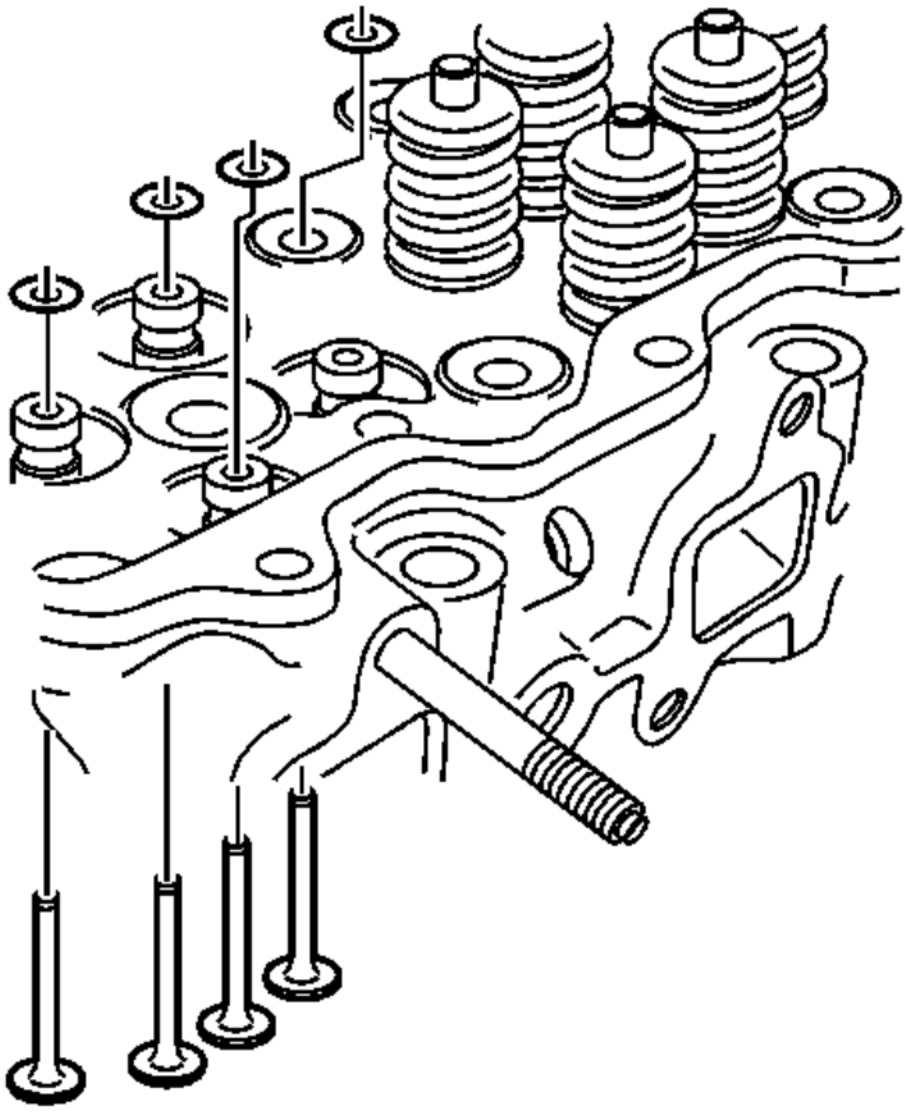


Fig. 25: View Of Valves & Cylinder Head
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Lubricate the valve stem with clean engine oil before installing.

1. Install the valves into the cylinder head.

2. Install the valve spring lower seat.

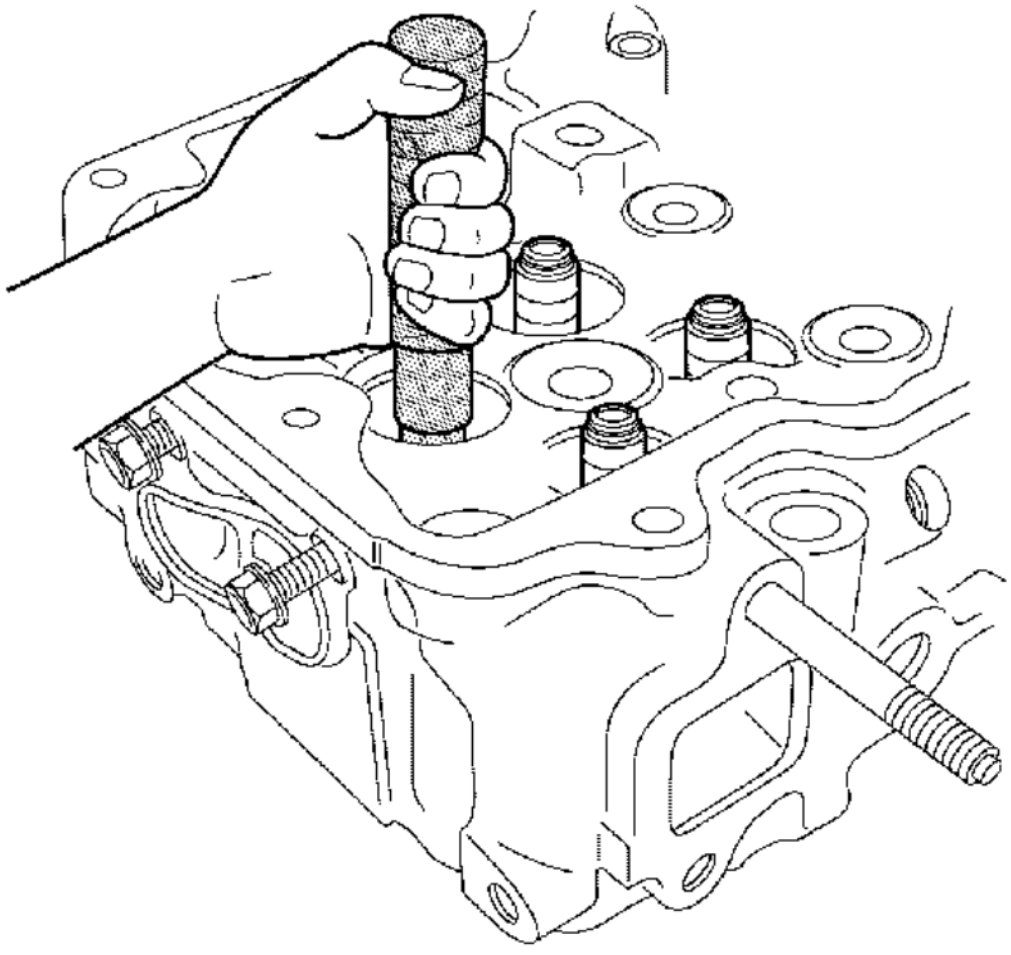


Fig. 26: Installing Valve Stem Using J 44640
Courtesy of GENERAL MOTORS CORP.

3. Install the valve stem seal using **J 44640** . See **Special Tools** .
4. Install the valve spring with the painted end towards the cylinder head.
5. Install the valve spring upper seat.

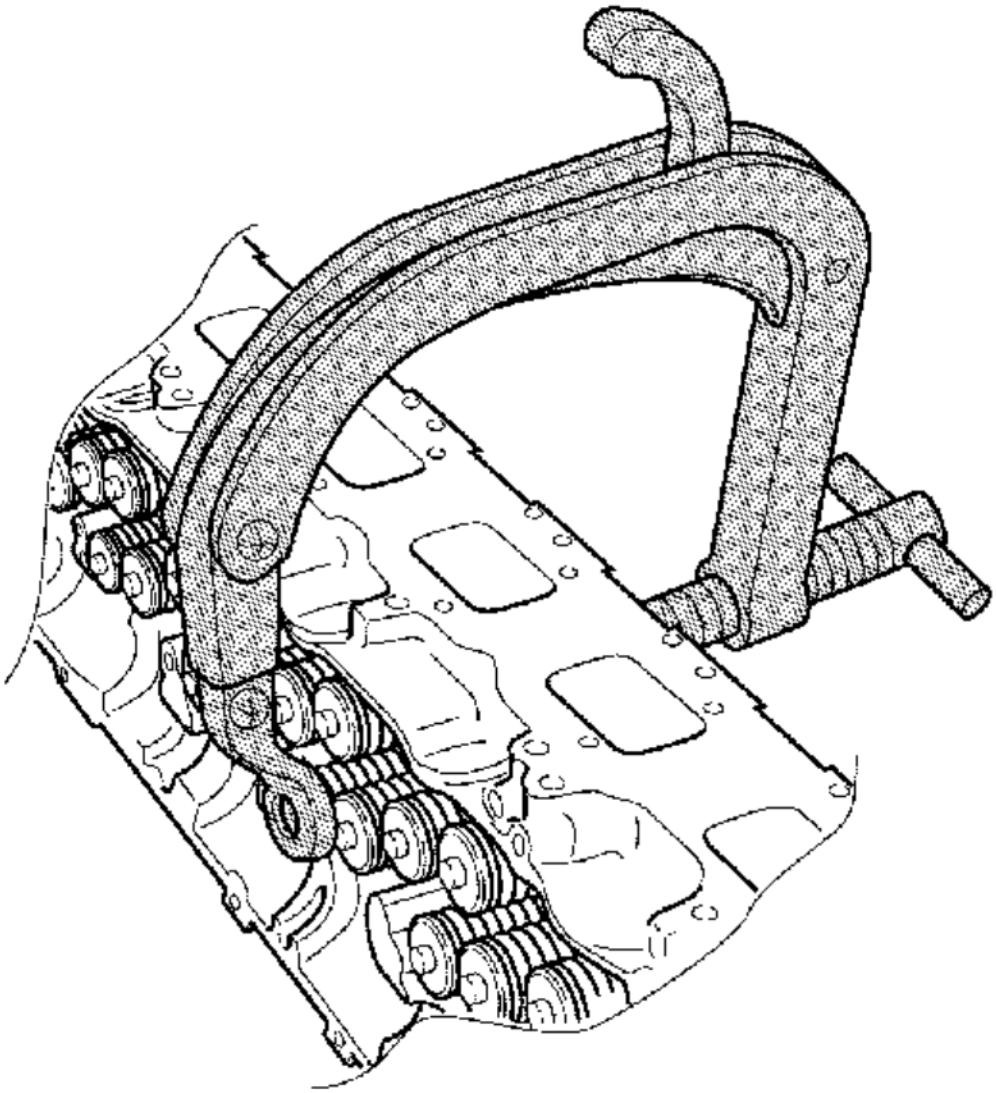


Fig. 27: Compressing Valve Spring Using J 8062
Courtesy of GENERAL MOTORS CORP.

6. Use the **J 8062** to compress the valve spring.
7. Install the valve keys.
8. Remove the **J 8062** from the cylinder head.

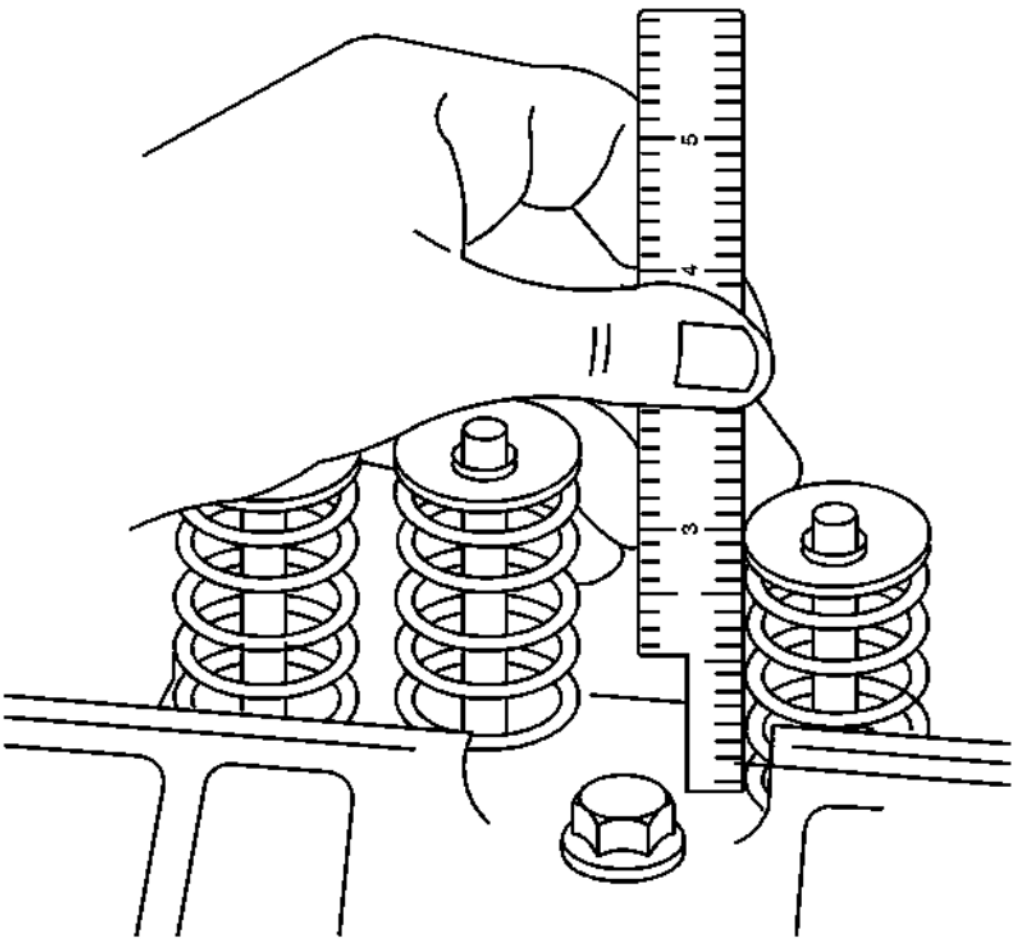


Fig. 28: Measuring Valve Spring Installed Height
Courtesy of GENERAL MOTORS CORP.

9. Measure the valve installed height using a ruler. Measure from the base of the valve spring to the top of the valve. Refer to **Engine Mechanical Specifications** .
10. Install the remaining valves, springs, and other components.

VALVE LIFTERS CLEANING AND INSPECTION

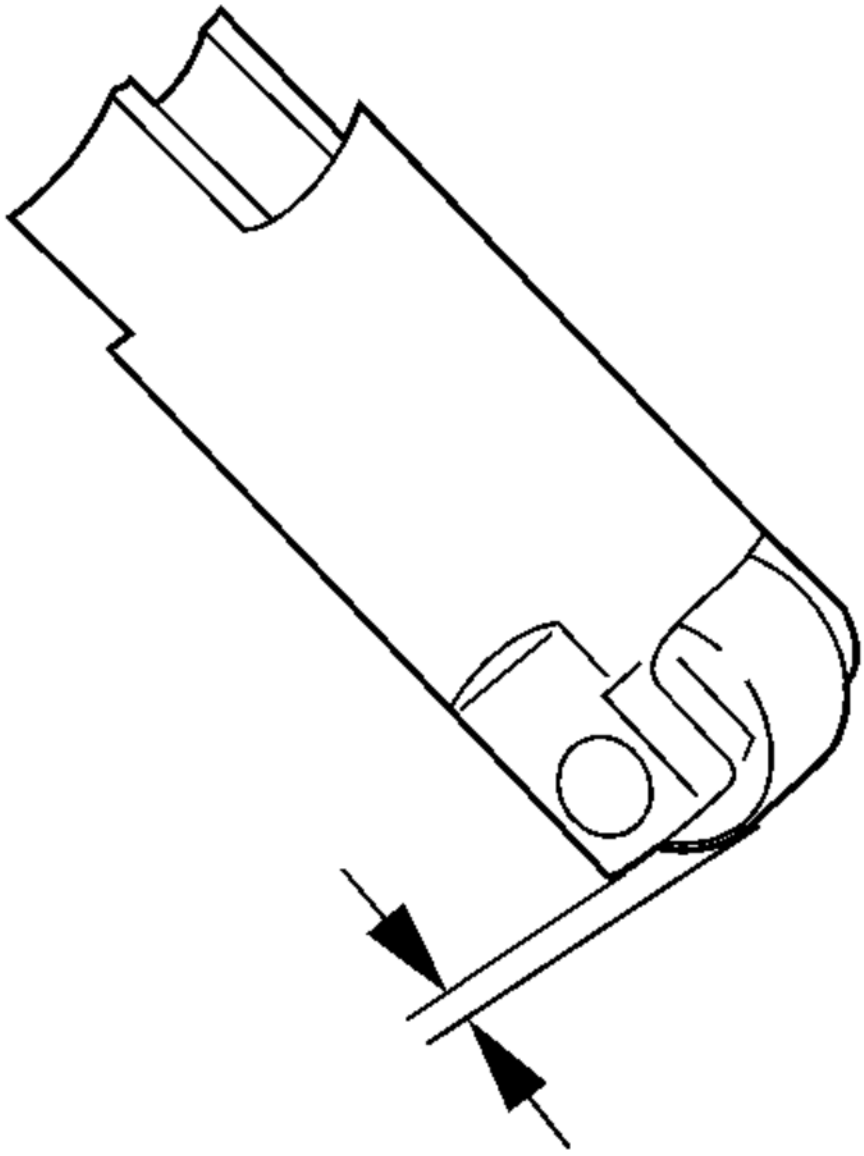


Fig. 29: View Of Distance Between Bottom Of Roller & Roller Lifter Body
Courtesy of GENERAL MOTORS CORP.

1. Push the roller towards the roller lifter body and measure the distance between the bottom of the roller and the roller lifter body. The production value is 0.989-1.0 mm (0.0389-0.0394 in) and the service limit is 0.9 mm (0.0354 in).

2. Replace the valve lifter if the measurement exceeds the service limit.
3. Inspect the valve lifters for the following:
   - The valve lifter body for scuffing and wear
   - The valve lifter roller assembly for wear
   - The valve lifter roller for smooth rotation

VALVE ROCKER ARM AND SHAFT CLEANING AND INSPECTION

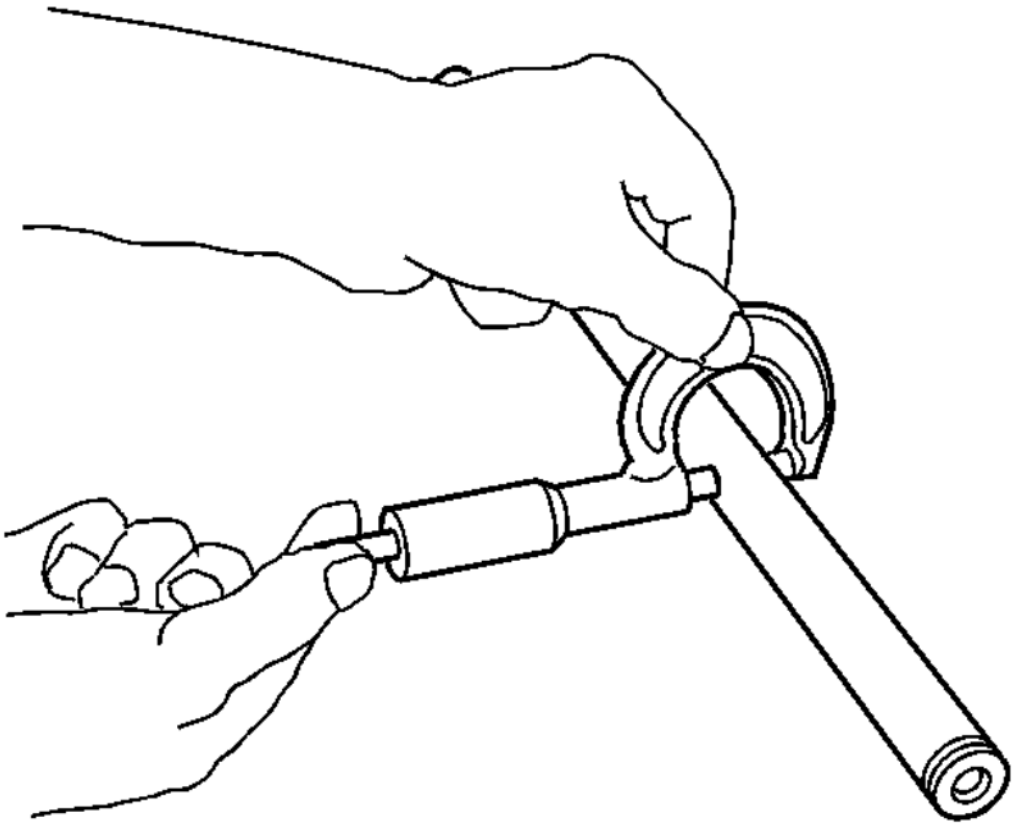


Fig. 30: Measuring Rocker Arm Shaft Outside Diameter
Courtesy of GENERAL MOTORS CORP.

1. Measure the rocker arm shaft outside diameter where the rocker arm is located. The production value is 21.979-22.0 mm (0.8653-0.8661 in) and the service limit is 21.85 mm (0.8602 in).

2. Replace the rocker arm shaft if the measured value is less than the service limit.

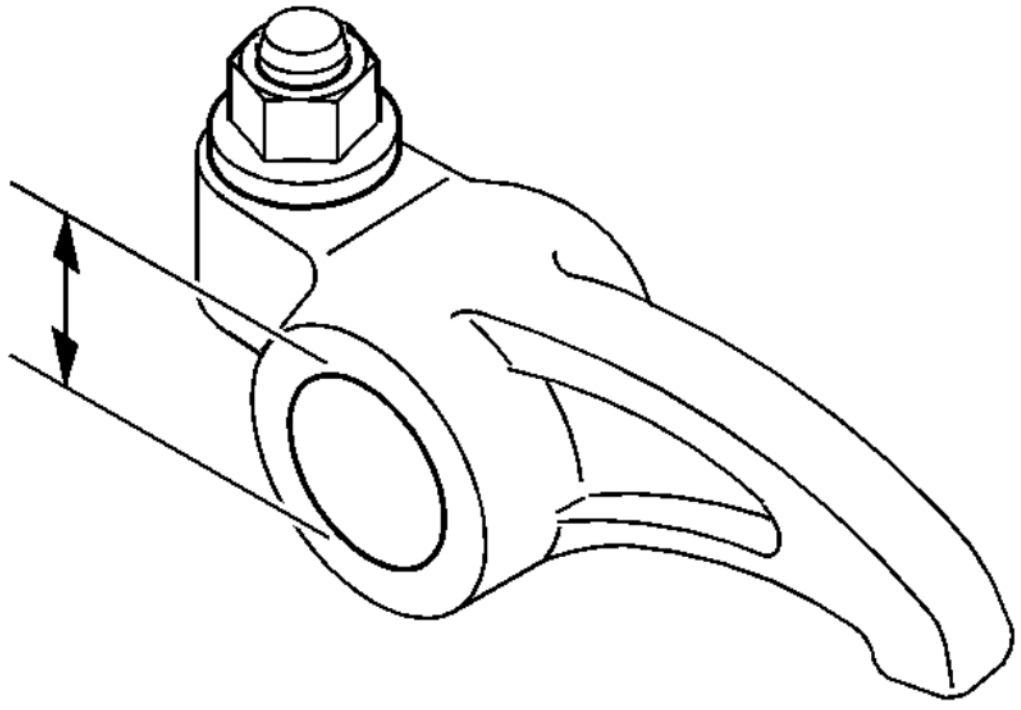


Fig. 31: Measuring Rocker Arm Shaft Inside Diameter
Courtesy of GENERAL MOTORS CORP.

3. Measure the rocker arm inside diameter. The production value is 22.01-22.035 mm (0.8665-0.8675 in).
4. Calculate the rocker arm shaft to rocker arm clearance.
    1. Subtract the rocker arm shaft outside diameter from the rocker arm inside diameter.
    2. Replace the rocker arm if the rocker arm shaft to rocker arm clearance is over 0.2 mm (0.0079 in).
5. Inspect the valve lash adjusting screw and lock nut for damage. Replace the valve lash adjusting screw if any damage is found.

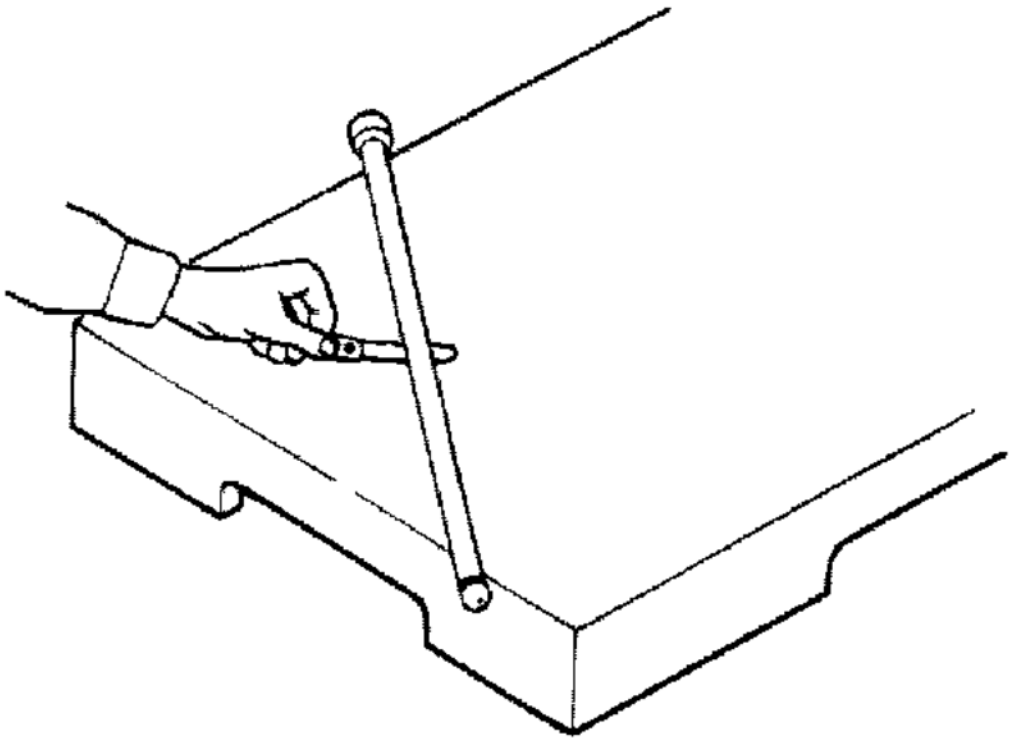


Fig. 32: Measuring Pushrod For Warpage
Courtesy of GENERAL MOTORS CORP.

6. Measure the pushrods for warpage.
7. Replace the pushrod if the warpage exceeds 0.8 mm (0.031 in).

PISTON OIL COOLING NOZZLE CLEANING AND INSPECTION

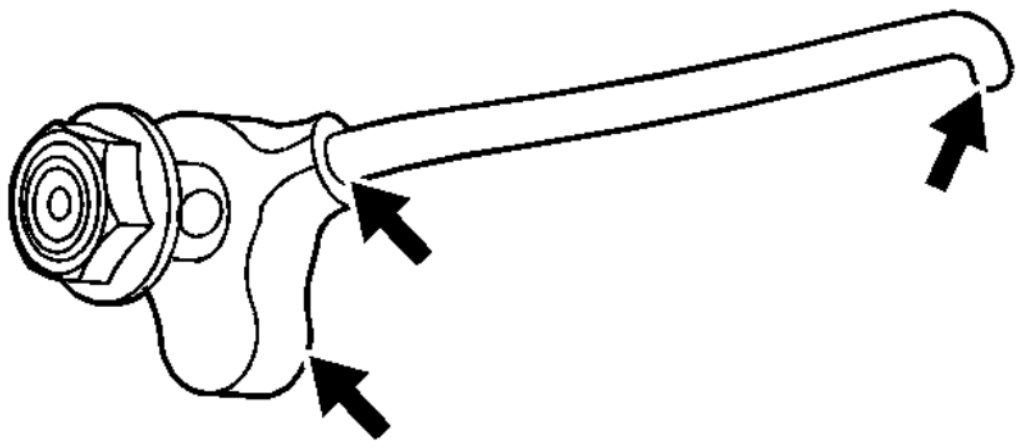


Fig. 33: View Of Piston Oil Cooling Nozzle Inspection Areas
Courtesy of GENERAL MOTORS CORP.

1. Inspect the piston oil cooling nozzle for damage.
2. Replace the piston oil cooling nozzle if any damage is found.

OIL PUMP CLEANING AND INSPECTION

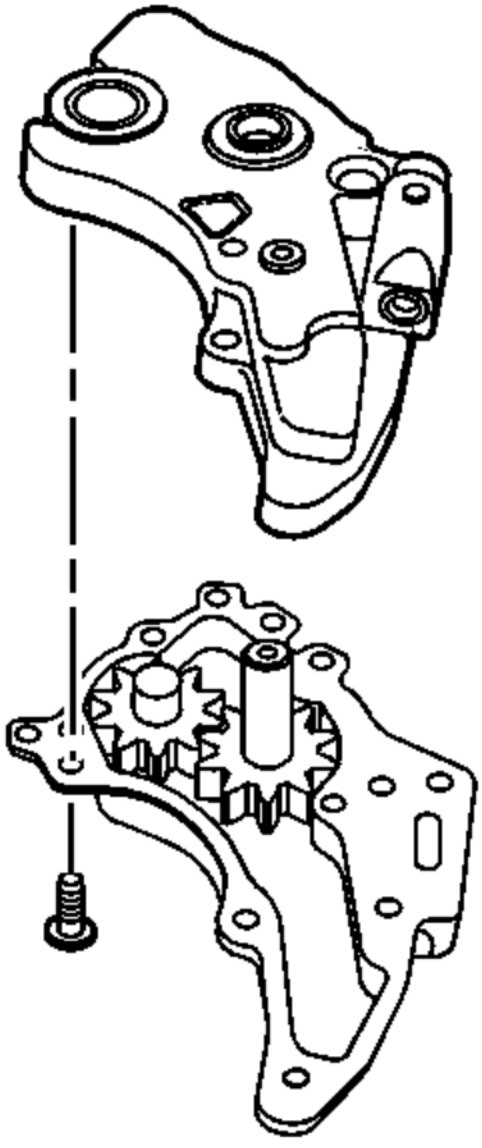


Fig. 34: View Of Oil Pump Gear Cover & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil pump gear cover bolts.
2. Remove the oil pump gear cover.

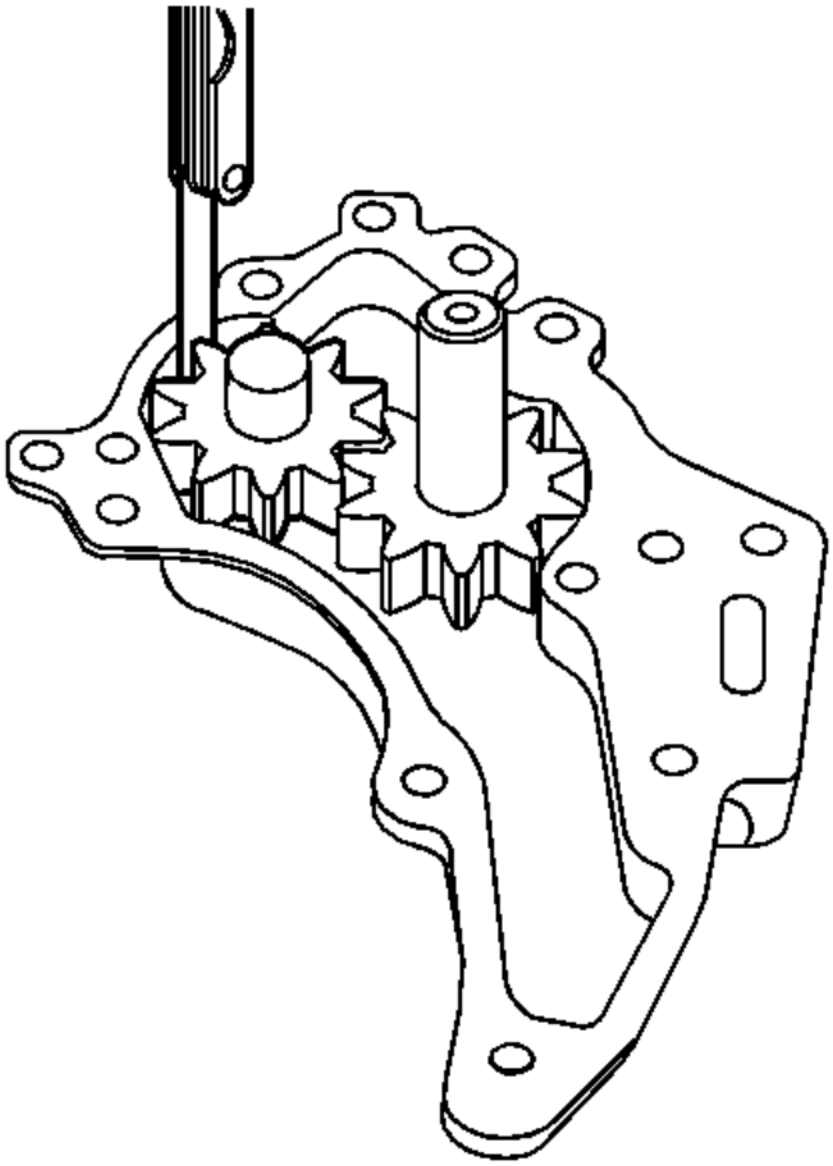


Fig. 35: Measuring Clearance Between Gear Teeth & Oil Pump Housing
Courtesy of GENERAL MOTORS CORP.

3. Use a feeler gauge to measure the clearance between the gear teeth and the oil pump housing. The production clearance is 0.125-0.221 mm (0.0049-0.0087 in) and the service

limit is 0.221 mm (0.0087 in).

4. Replace the oil pump assembly if the clearance exceeds the service limit.

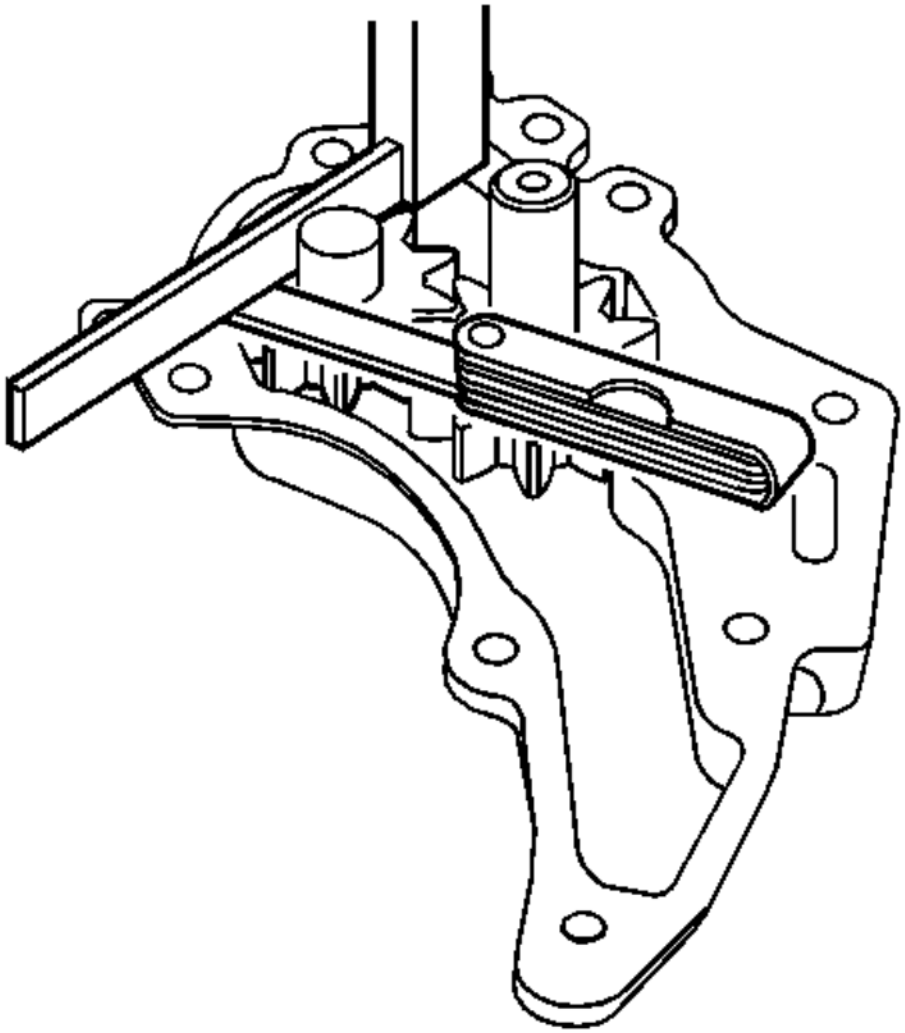


Fig. 36: Measuring Clearance Between Side Of Gear & Cover
Courtesy of GENERAL MOTORS CORP.

5. Use a feeler gauge and a straightedge to measure the clearance between the side of the gear and the cover. The production clearance is 0.064-0.109 mm (0.0025-0.0043 in) and the

service limit is 0.109 mm (0.0043 in).

6. Replace the oil pump assembly if the clearance exceeds the service limit.

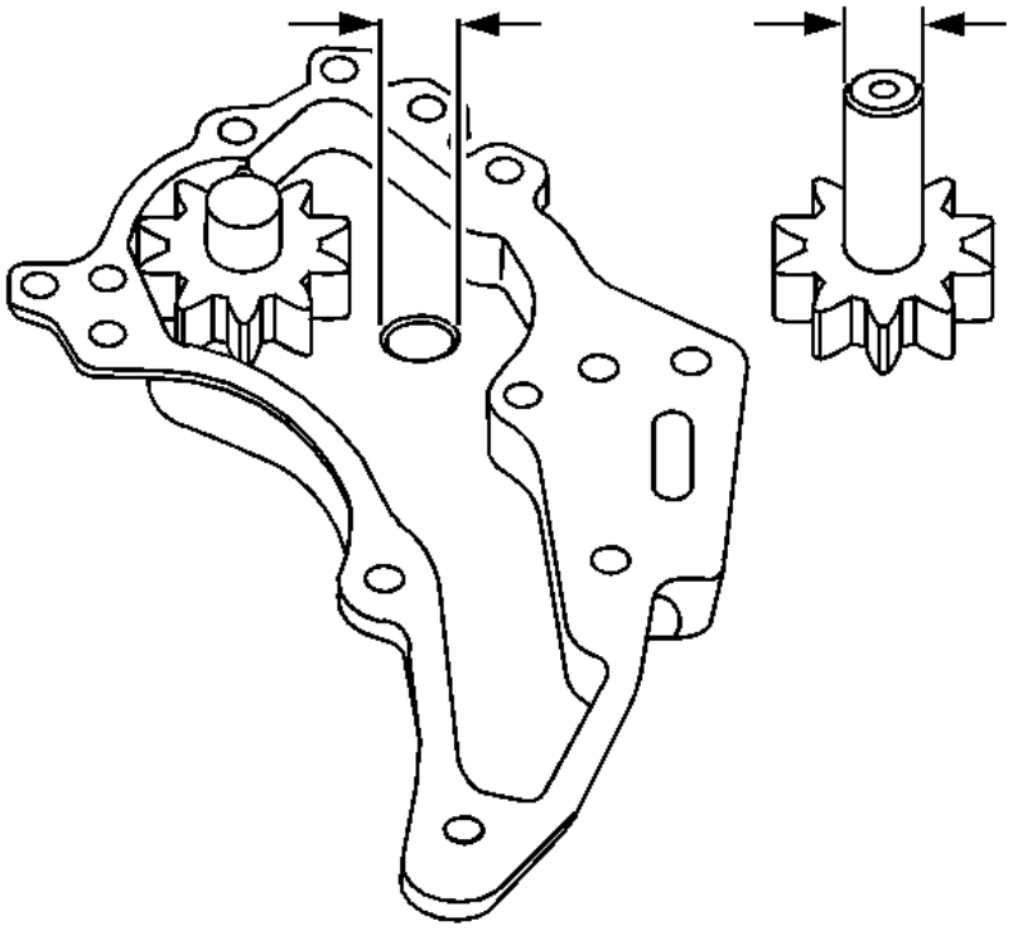


Fig. 37: View Of Driven Gear Shaft & Bushing Measurements
Courtesy of GENERAL MOTORS CORP.

7. Calculate the driven gear shaft to bushing clearance.
    1. Measure the driven gear shaft outside diameter. The production specification is 19.947-19.960 mm (0.7853-0.7858 in) and the service limit is 19.86 mm (0.7819 in).
    2. Measure the driven gear bushing inside diameter. The production value is 20 mm (0.7874 in).

3. Calculate the driven gear shaft to bushing clearance. The service limit is 0.14 mm (0.0055 in)

8. Replace the oil pump assembly if the clearance exceeds the service limit.

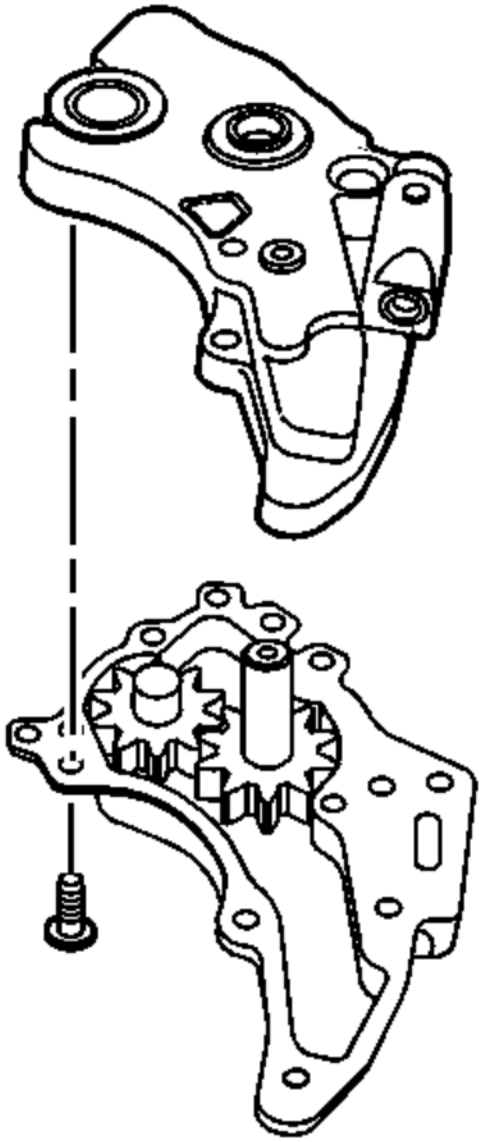


Fig. 38: View Of Oil Pump Gear Cover & Bolts
Courtesy of GENERAL MOTORS CORP.

9. Install the oil pump gear cover to the oil pump assembly.

NOTE: Refer to Fastener Notice .

10. Install the oil pump gear cover bolts.

Tighten: Tighten the oil pump gear cover bolts to 21 N.m (15 lb ft).

ENGINE FRONT COVER CLEANING AND INSPECTION

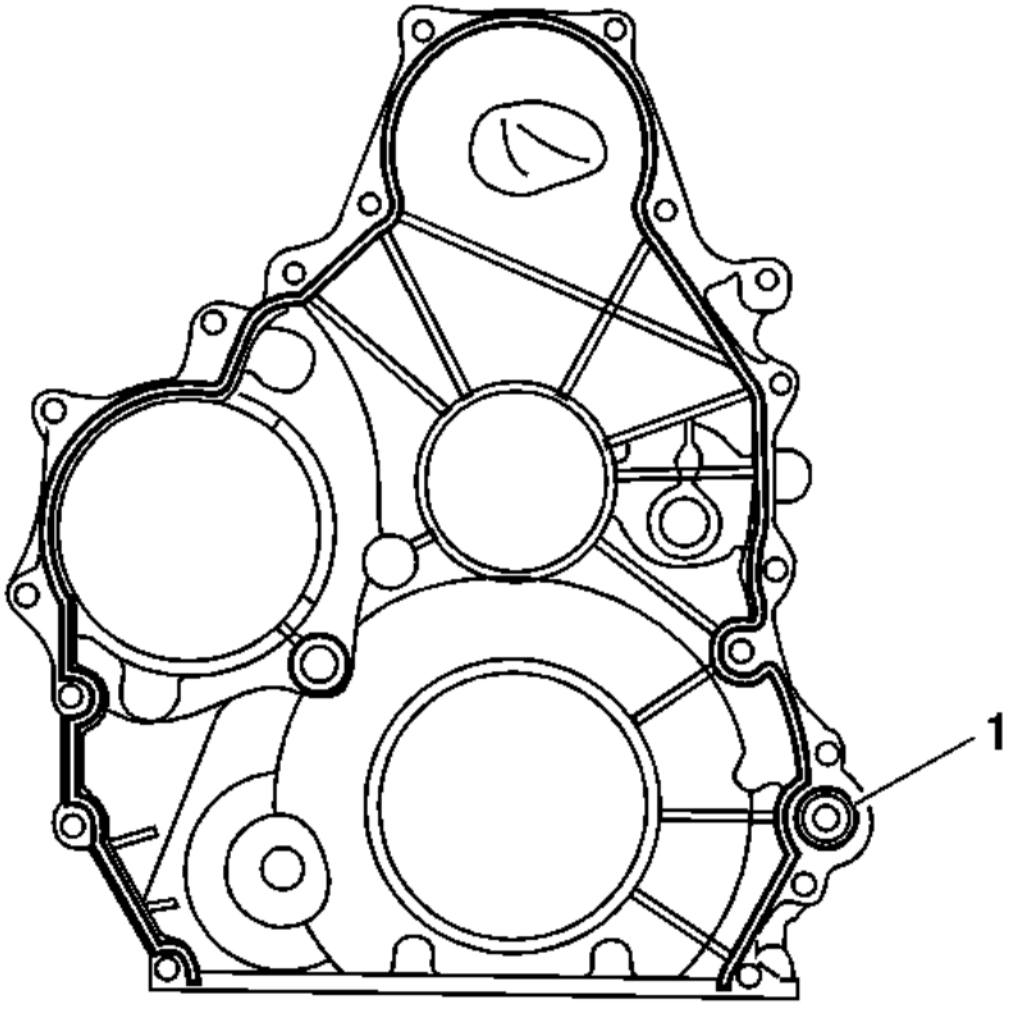


Fig. 39: View Of Engine Front Cover O-Ring
Courtesy of GENERAL MOTORS CORP.

1. Remove the O-ring (1) from the engine front cover.
2. Remove the oil pressure relief valve from the engine front cover.
3. Clean the engine front cover.
4. Clean the engine front cover mating surfaces.
5. Inspect the engine front cover mating surfaces for damage.
6. Inspect the engine front cover O-ring sealing surface for damage.
7. Inspect the crankshaft front oil seal bore for damage.
8. Replace the engine front cover if any damage is found.

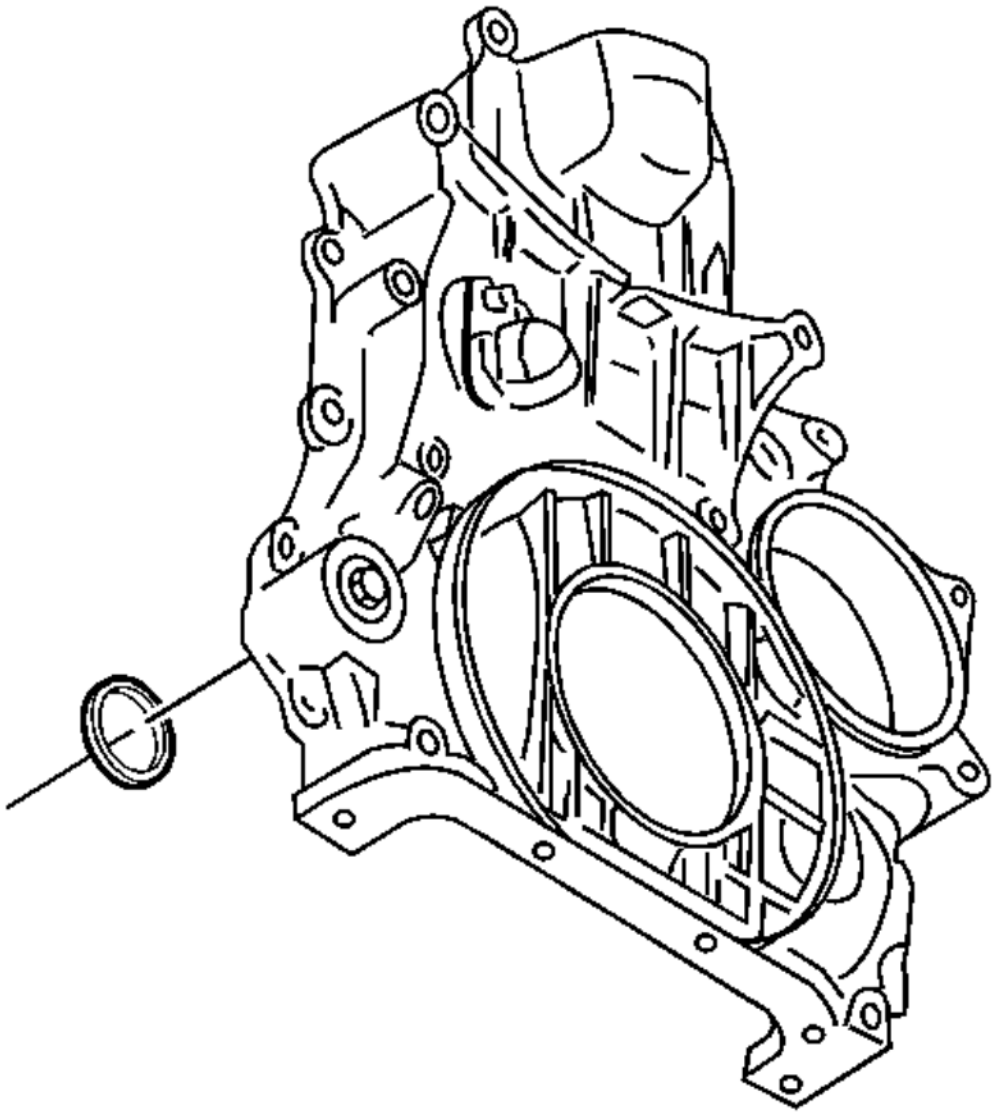


Fig. 40: View Of Pressure Relief Valve O-Ring
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

9. Install the oil pressure relief valve with a new O-ring.

Tighten: Tighten the oil pressure relief valve to 39 N.m (29 lb ft).

LOWER OIL PAN CLEANING AND INSPECTION

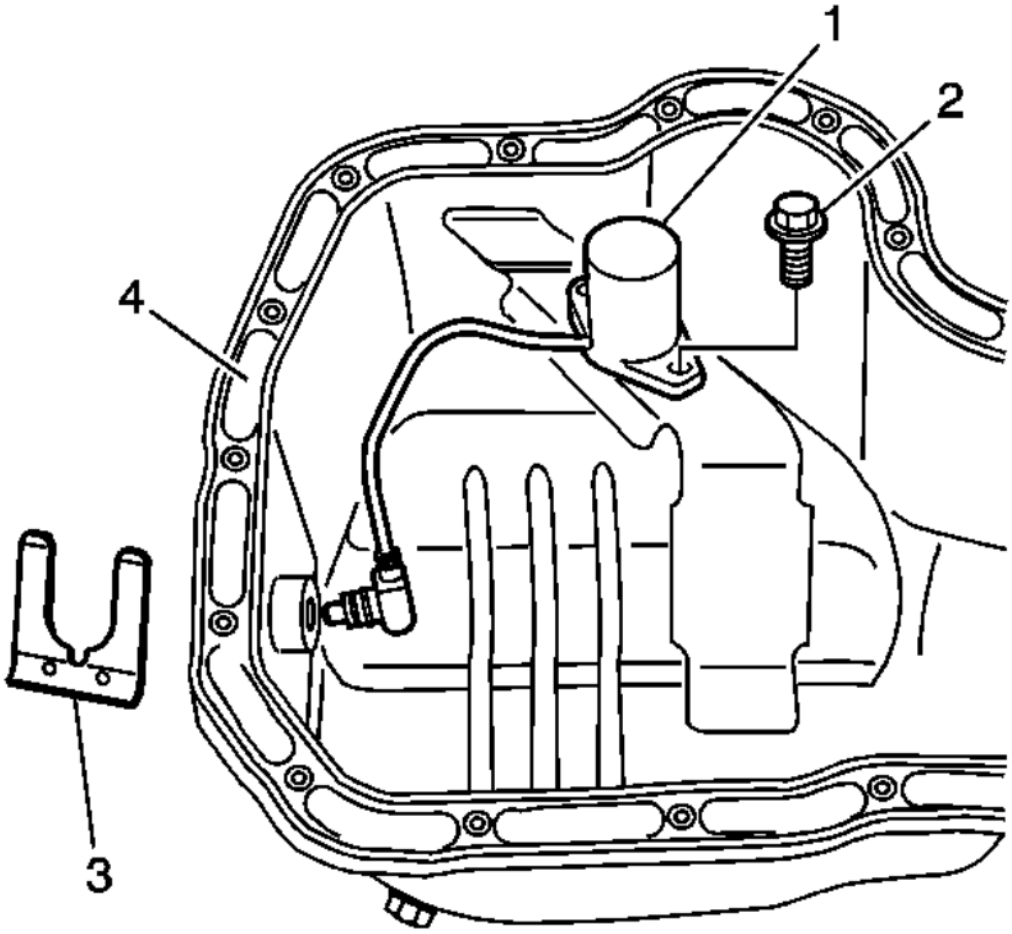


Fig. 41: View Of Oil Level Sensor, Clip, Bolt & Oil Pan Mating Surface
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil level sensor (1) and retaining clip (3).
2. Clean the lower oil pan (4). Remove any sludge or other deposits.
3. Clean the lower oil pan mating surface.
4. Inspect the lower oil pan (4) for dents or distortion.

5. Inspect the lower oil pan mating surface for damage.
6. Replace the lower oil pan (4) if any damage is found.
7. Install the oil level sensor (1) and retaining clip (3).

VALVE ROCKER ARM COVER CLEANING AND INSPECTION - LOWER

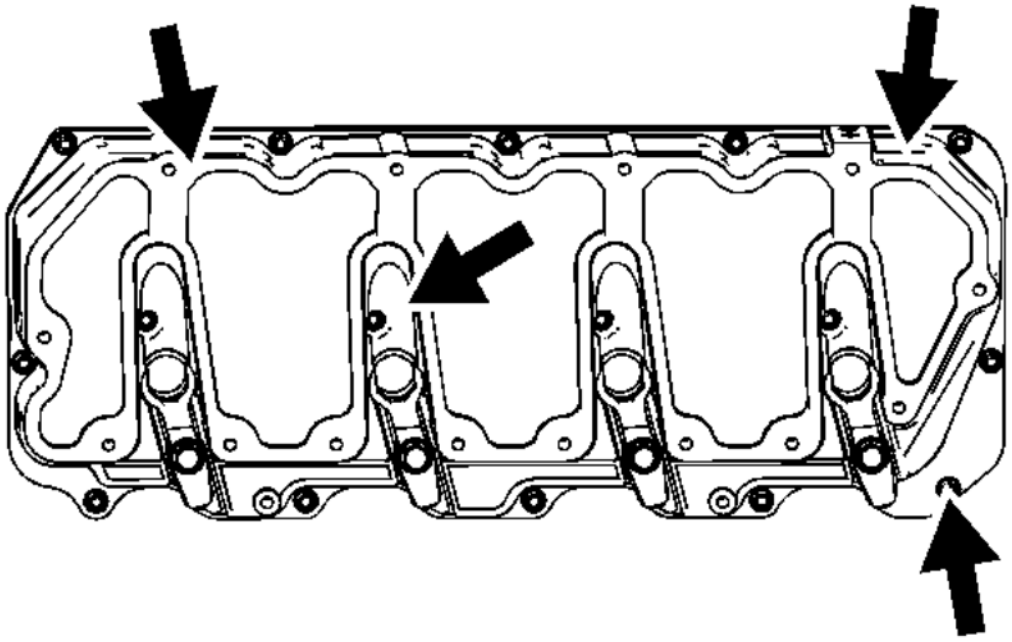


Fig. 42: Inspecting Lower Valve Rocker Arm Cover
Courtesy of GENERAL MOTORS CORP.

1. Remove the grommets.
2. Clean the lower valve rocker arm cover. Remove any sludge or other deposits.
3. Clean the lower valve rocker arm cover mating surfaces.
4. Inspect the lower valve rocker arm cover for cracks or other damage.
5. Inspect the lower valve rocker arm cover mating surfaces for damage.
6. Replace the lower valve rocker arm cover if any damage is found.
7. Inspect the grommets for damage.
8. Replace the grommets if any damage is found.

9. Install the grommets.

VALVE ROCKER ARM COVER CLEANING AND INSPECTION - UPPER

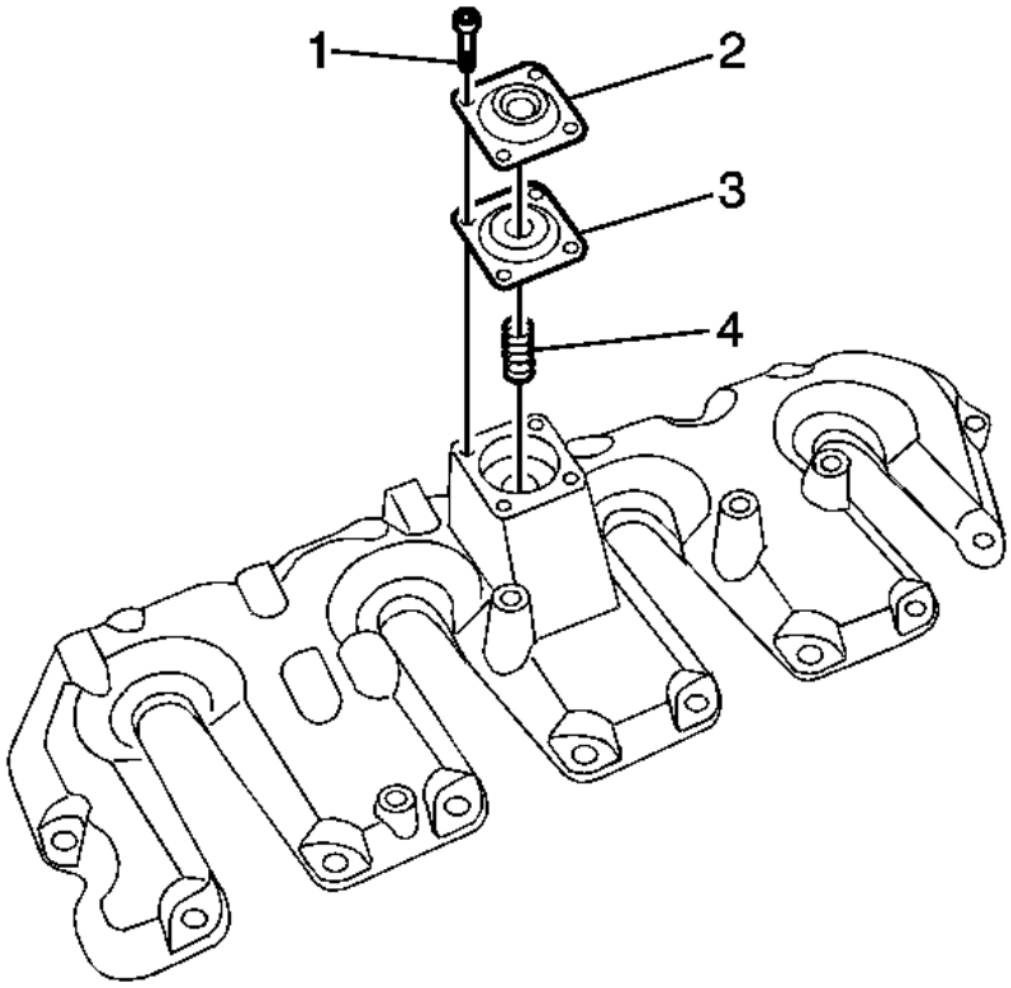


Fig. 43: View Of PCV Cover, Diaphragm & Spring
Courtesy of GENERAL MOTORS CORP.

1. Remove the PCV cover screws.
2. Remove the PCV cover, diaphragm, and spring.

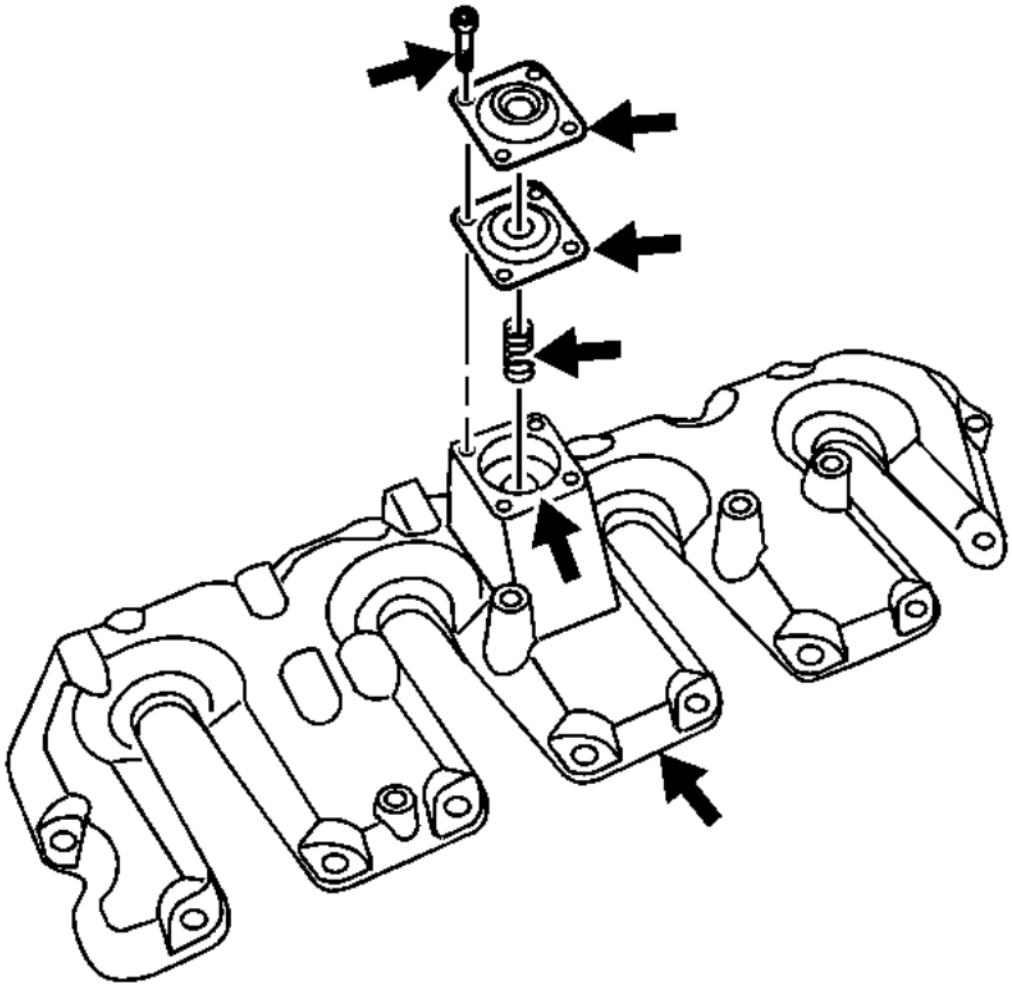


Fig. 44: View Of Upper Valve Rocker Arm Cover Components
Courtesy of GENERAL MOTORS CORP.

3. Clean the upper valve rocker arm cover. Remove any sludge or other deposits.
4. Clean the upper valve rocker arm cover mating surface.
5. Inspect the upper valve rocker arm cover for cracks or other damage.
6. Inspect the upper valve rocker arm cover mating surfaces for damage.
7. Replace the upper valve rocker arm cover if any damage is found.

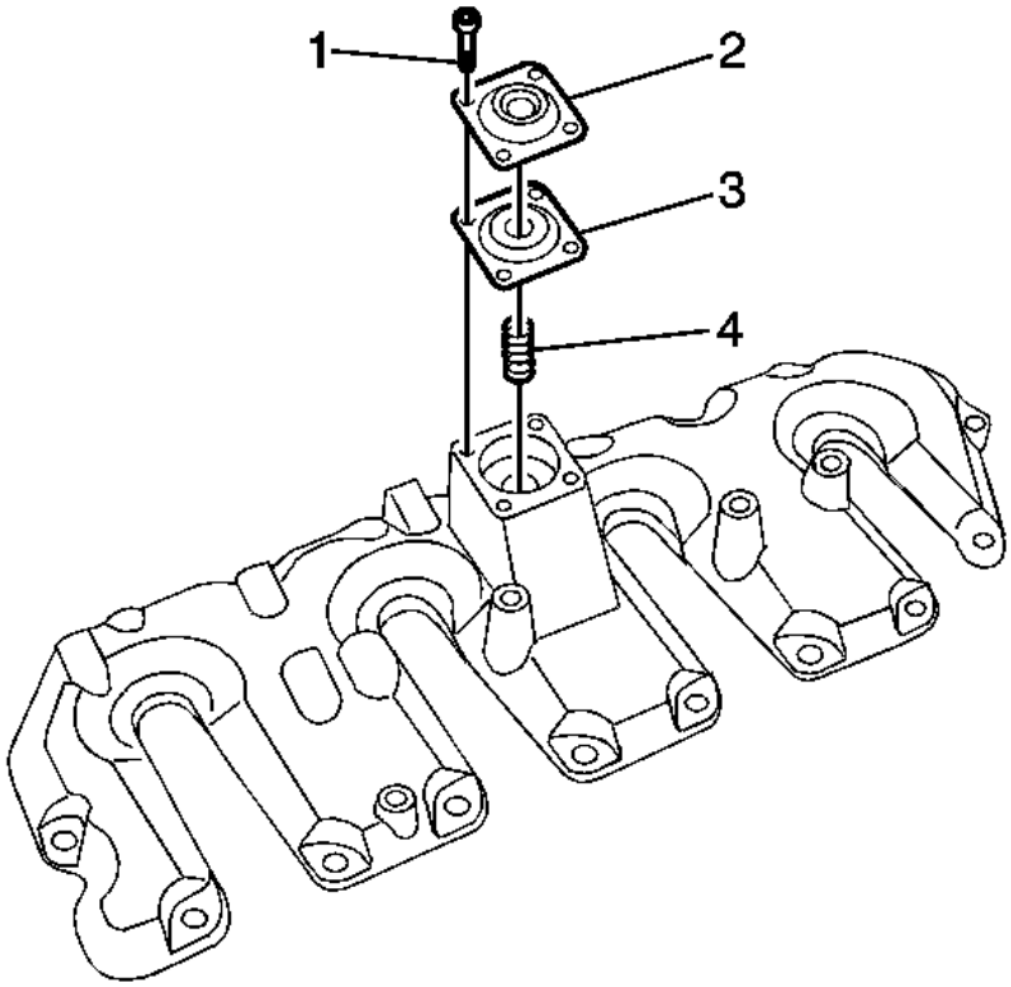


Fig. 45: View Of PCV Cover, Diaphragm & Spring
Courtesy of GENERAL MOTORS CORP.

8. Inspect the PCV cover, diaphragm, and spring for damage.
9. Install the PCV spring.
10. Install the PCV diaphragm.
11. Install the PCV cover.

NOTE: **Refer to Fastener Notice .**

12. Install the PCV cover screws.

    Tighten: Tighten the PCV cover screws to 4 N.m (35 lb in).

INTAKE MANIFOLD CLEANING AND INSPECTION

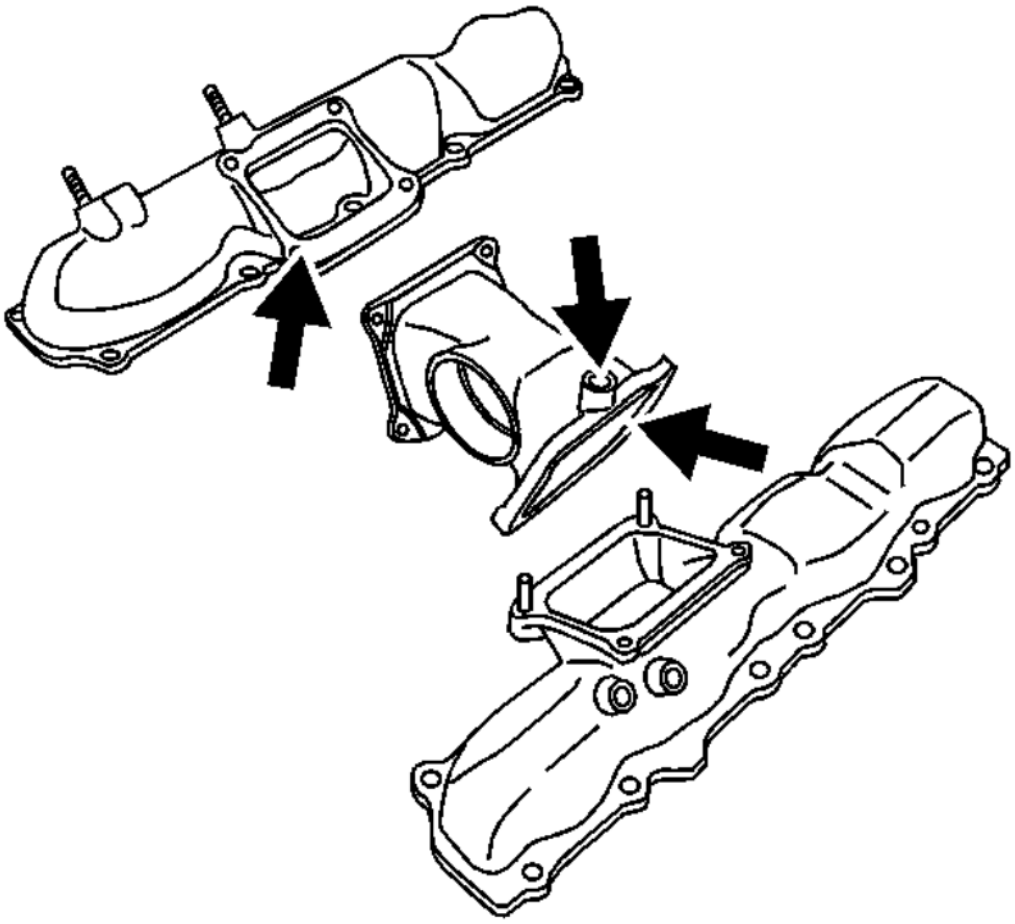


Fig. 46: View Of Intake Manifold Crossover Inspection Areas
Courtesy of GENERAL MOTORS CORP.

1. Clean the intake manifold crossover.
2. Clean the intake manifold mating surfaces.

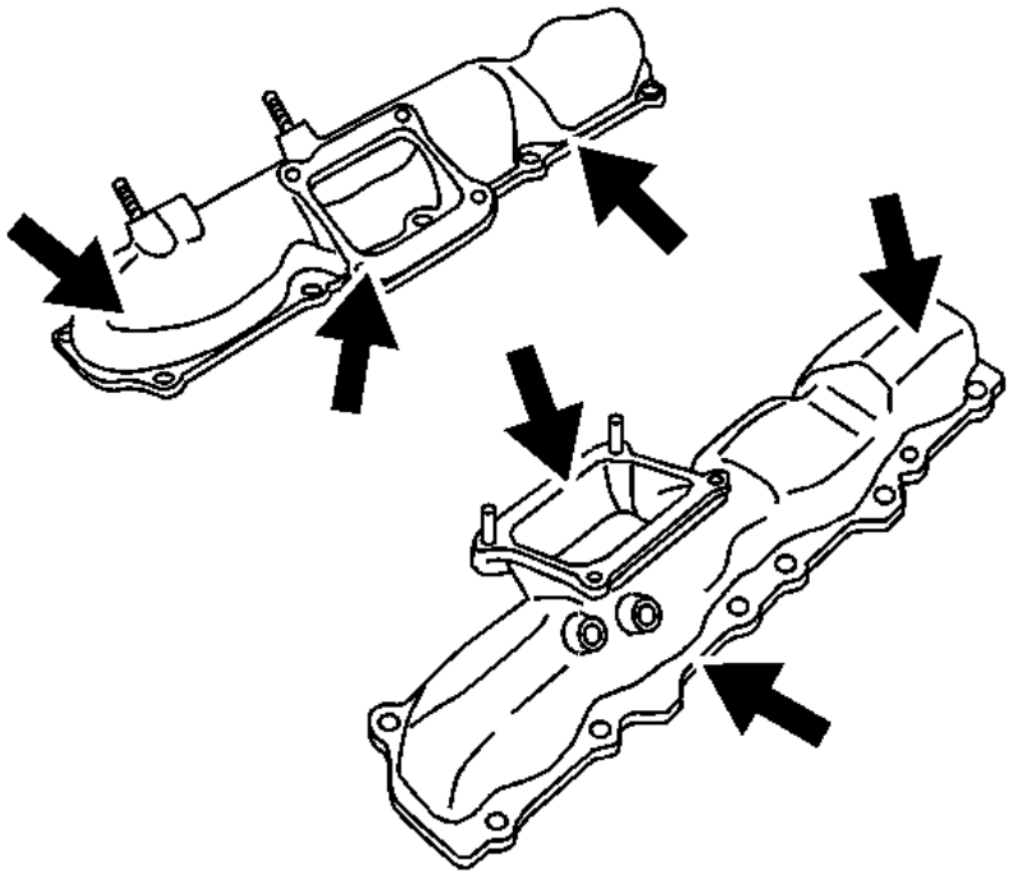


Fig. 47: View Of Intake Manifold Inspection Areas
Courtesy of GENERAL MOTORS CORP.

3. Clean the intake manifolds.
4. Clean the intake manifold mating surfaces.
5. Inspect the intake manifolds for cracks.
6. Inspect the intake manifold mating surfaces for damage.
7. Replace the intake manifolds if any damage is found.

OIL FILTER ADAPTER AND OIL COOLER ASSEMBLY CLEANING AND INSPECTION

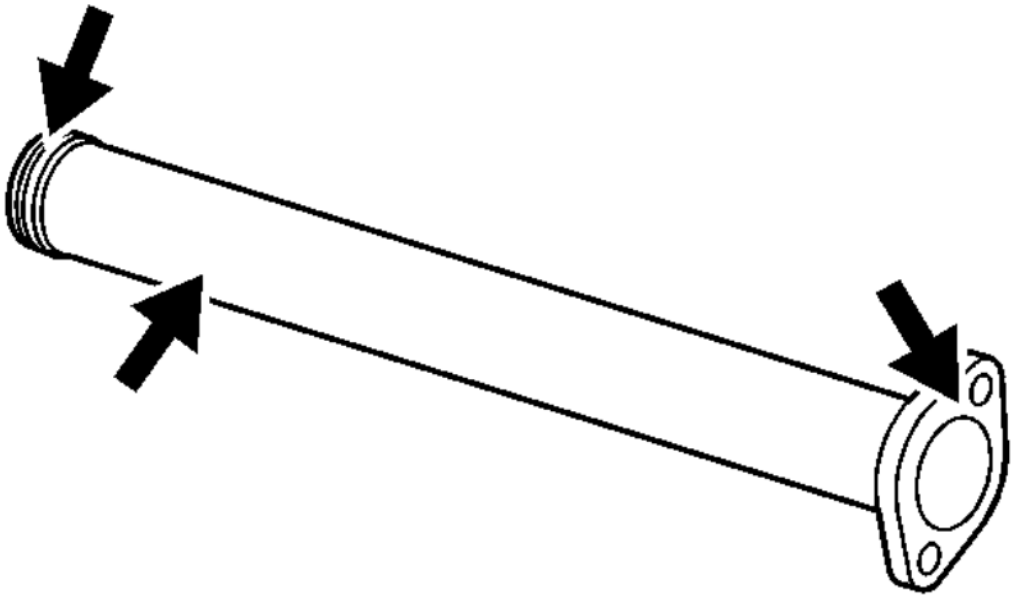


Fig. 48: View Of Coolant Tube Inspection Areas
Courtesy of GENERAL MOTORS CORP.

1. Clean the coolant tube.
2. Inspect the coolant tube for cracks.
3. Inspect the coolant tube mating surfaces for damage.

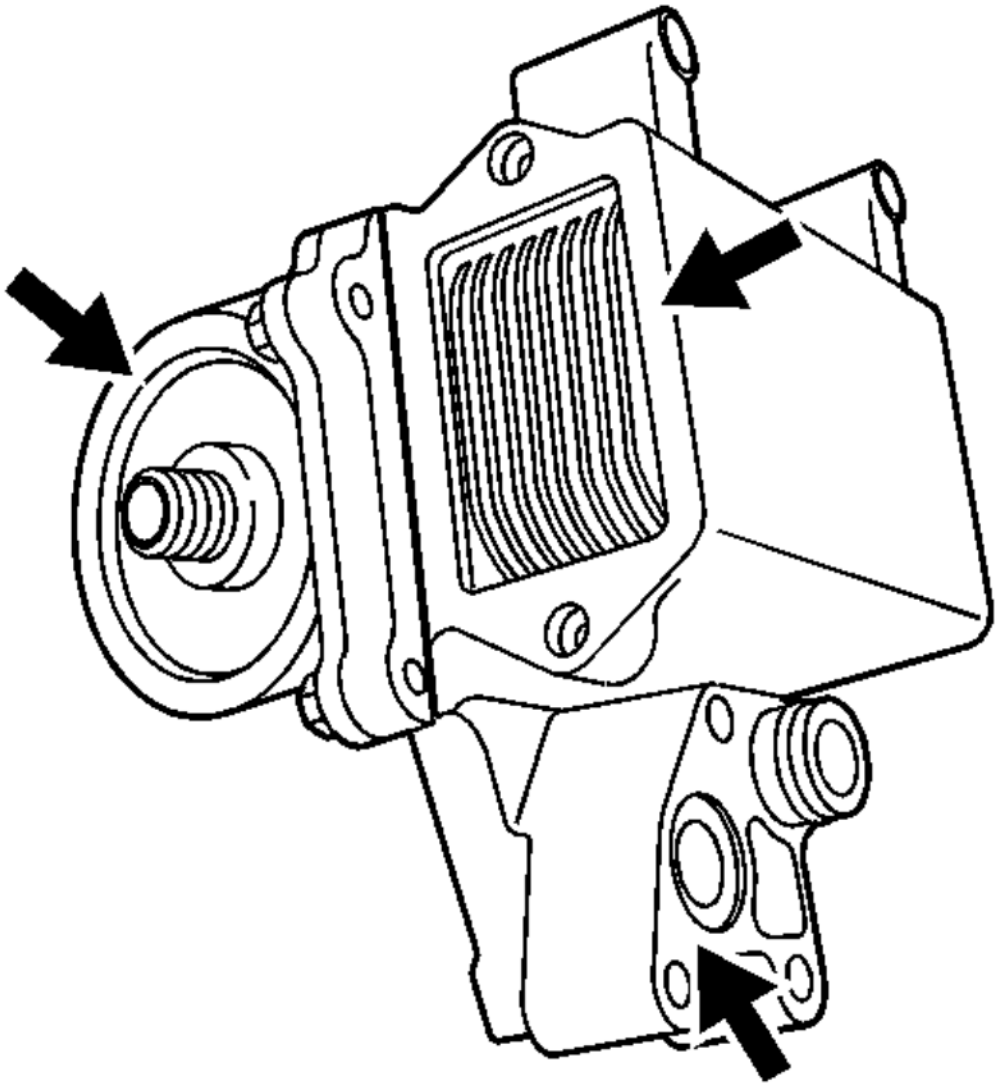


Fig. 49: View Of Oil Filter Adapter Inspection Areas
Courtesy of GENERAL MOTORS CORP.

4. Clean the oil filter adapter.
5. Inspect the oil filter adapter mating surfaces for damage.
6. Replace the O-rings.

ENGINE COOLANT THERMOSTAT HOUSING CLEANING AND INSPECTION

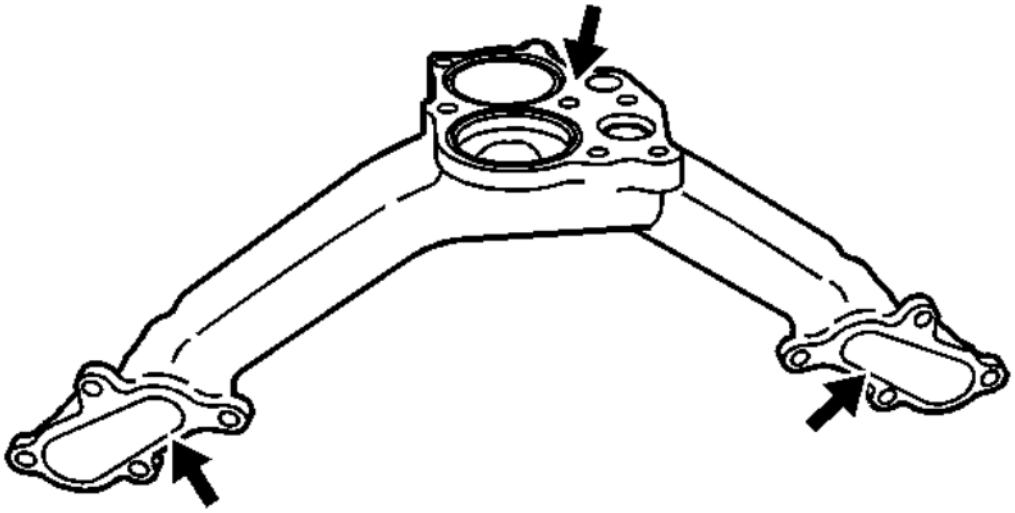


Fig. 50: View Of Thermostat Housing Inspection Areas
Courtesy of GENERAL MOTORS CORP.

1. Clean the thermostat housing.
2. Clean the thermostat housing mating surfaces.
3. Inspect the thermostat housing for cracks.
4. Inspect the thermostat housing mating surfaces for damage.
5. Replace the thermostat housing if any damage is found.

EXHAUST MANIFOLD CLEANING AND INSPECTION

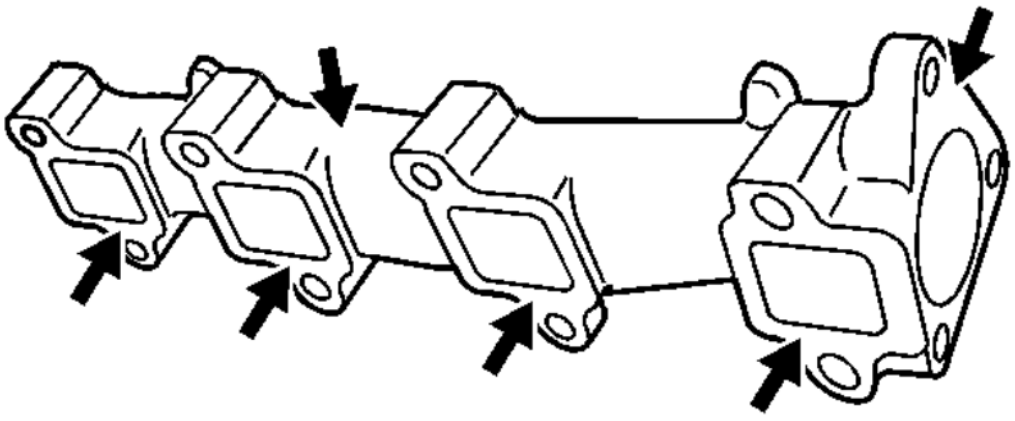


Fig. 51: View Of Exhaust Manifold Inspection Areas
Courtesy of GENERAL MOTORS CORP.

1. Clean the exhaust manifold.
2. Clean the exhaust manifold mating surfaces.
3. Inspect the exhaust manifold for cracks.
4. Inspect the exhaust manifold mating surfaces for damage.
5. Replace the exhaust manifold if any damage is found.

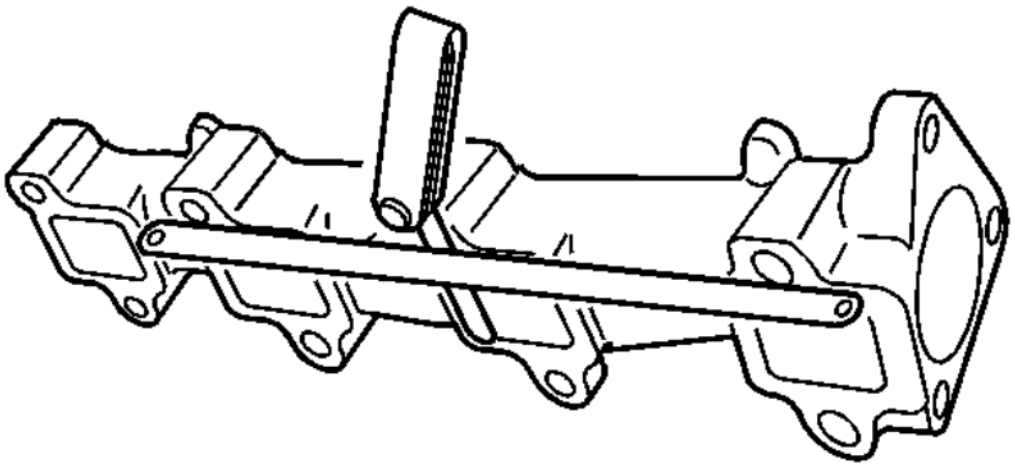


Fig. 52: Measuring Exhaust Manifold Flange For Warpage
Courtesy of GENERAL MOTORS CORP.

6. Measure the exhaust manifold flange for warpage with feeler gauge and a straightedge. Replace the exhaust manifold if the warpage is more than 0.3 mm (0.0118 in).
7. Install the exhaust manifold heat shield.

NOTE: Refer to Fastener Notice .

8. Install the exhaust manifold heat shield bolts.

Tighten: Tighten the exhaust manifold heat shield bolts to 8 N.m (71 lb in).

EXHAUST PIPE CLEANING AND INSPECTION

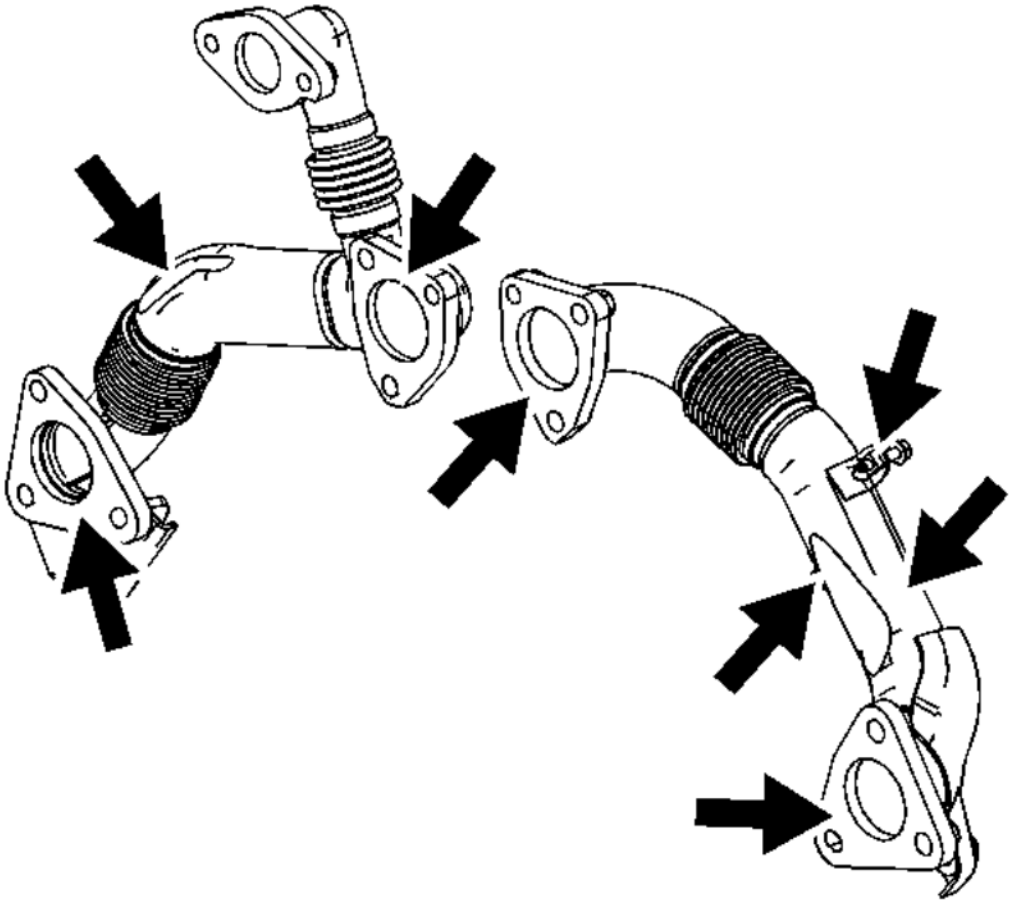


Fig. 53: View Of Exhaust Pipe Inspection Areas
Courtesy of GENERAL MOTORS CORP.

1. Clean the exhaust pipe.
2. Clean the exhaust pipe mating surfaces.
3. Inspect the exhaust pipe for dents or cracks.
4. Replace the exhaust pipe if any damage is found.

EXHAUST OUTLET CLEANING AND INSPECTION

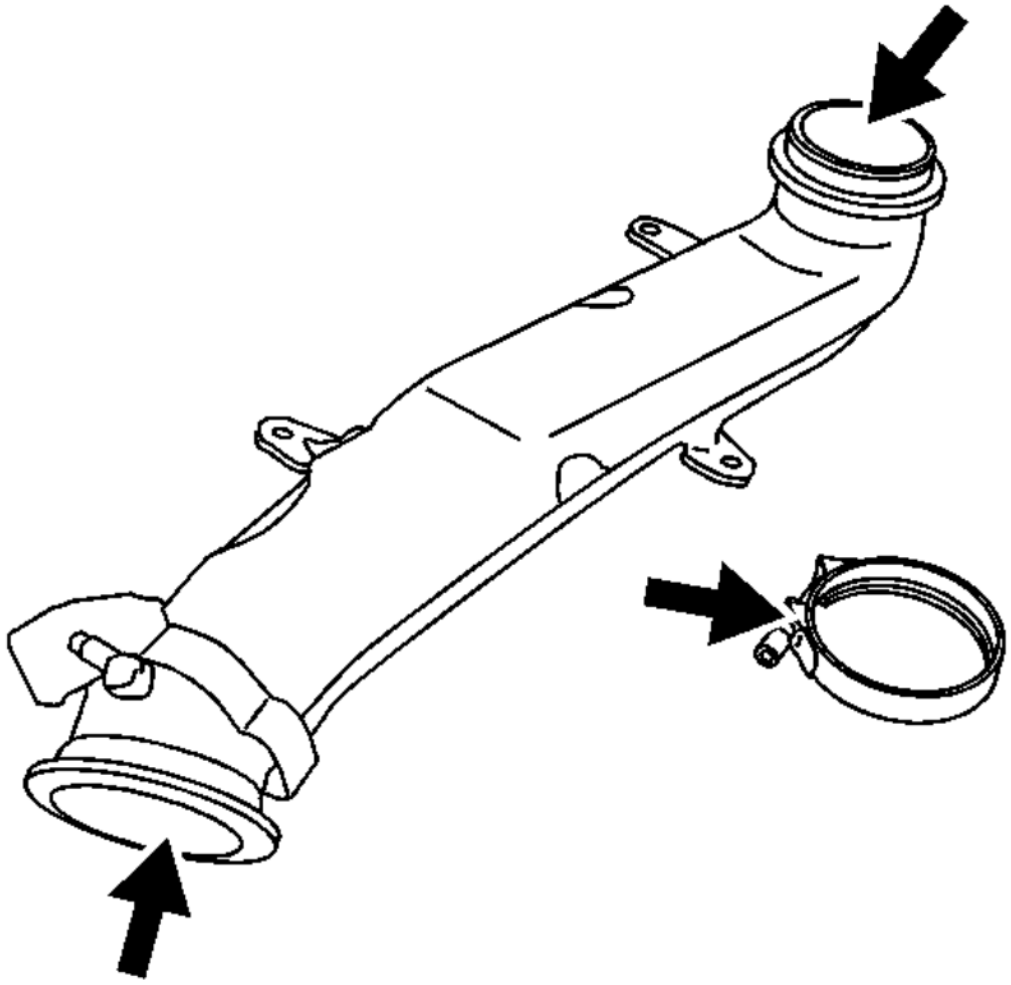


Fig. 54: View Of Exhaust Outlet Inspection Areas
Courtesy of GENERAL MOTORS CORP.

1. Clean the exhaust outlet.
2. Clean the exhaust outlet mating surfaces.
3. Inspect the exhaust outlet for dents or cracks.
4. Replace the exhaust outlet if any damage is found.

FUEL INJECTION PUMP CLEANING AND INSPECTION

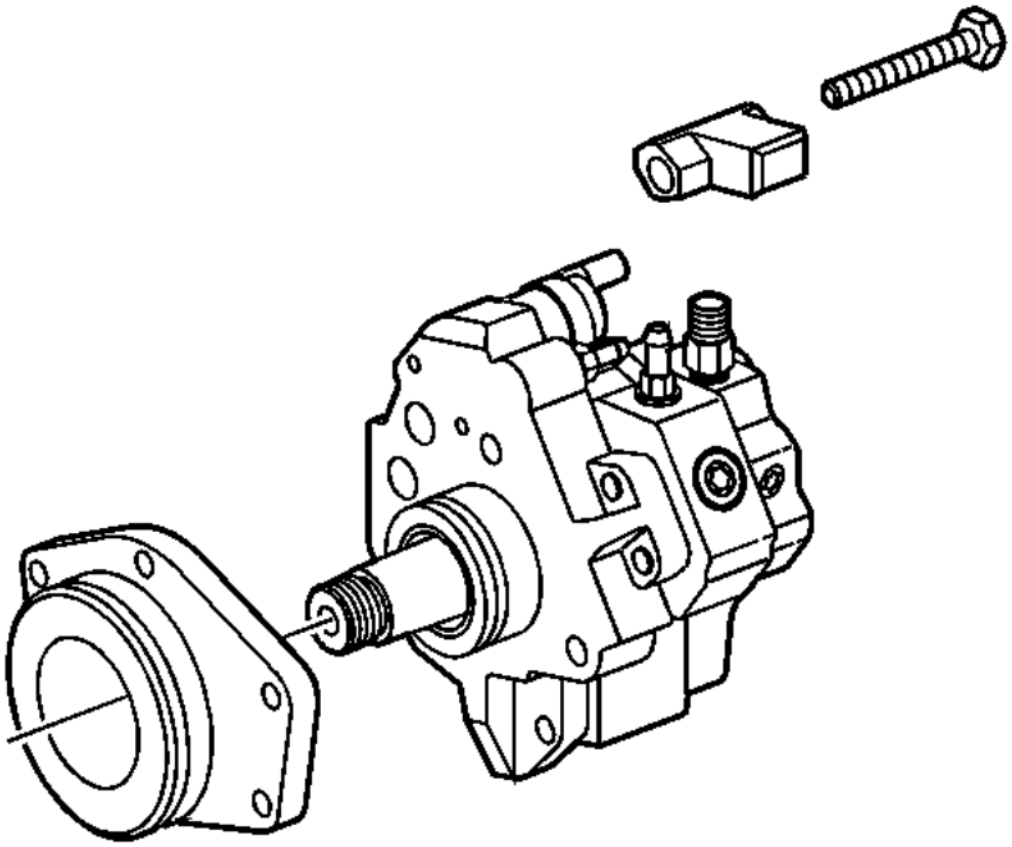


Fig. 55: View Of Fuel Injection Pump Adapter & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the fuel injection pump adapter bolts.
2. Remove the fuel injection pump adapter.

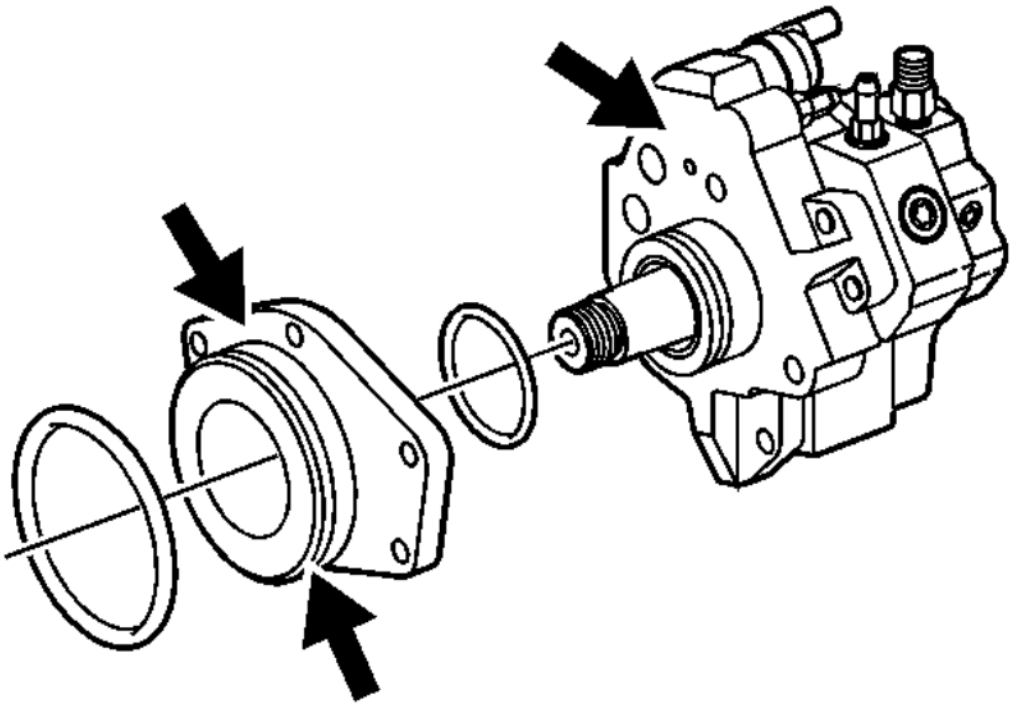


Fig. 56: View Of Fuel Injection Pump & Adapter O-Rings
Courtesy of GENERAL MOTORS CORP.

3. Remove the O-ring from the fuel injection pump and discard.
4. Remove the O-ring from the fuel injection pump adapter and discard.
5. Clean the fuel injection pump adapter mating surfaces.
6. Clean the fuel injection pump mating surfaces.
7. Inspect the fuel injection pump and adapter for damage.
8. Replace component if any damage is found.
9. Install a new O-ring onto fuel injection pump.
10. Install a new O-ring onto fuel injection pump adapter.
11. Lubricate the O-rings with engine oil.

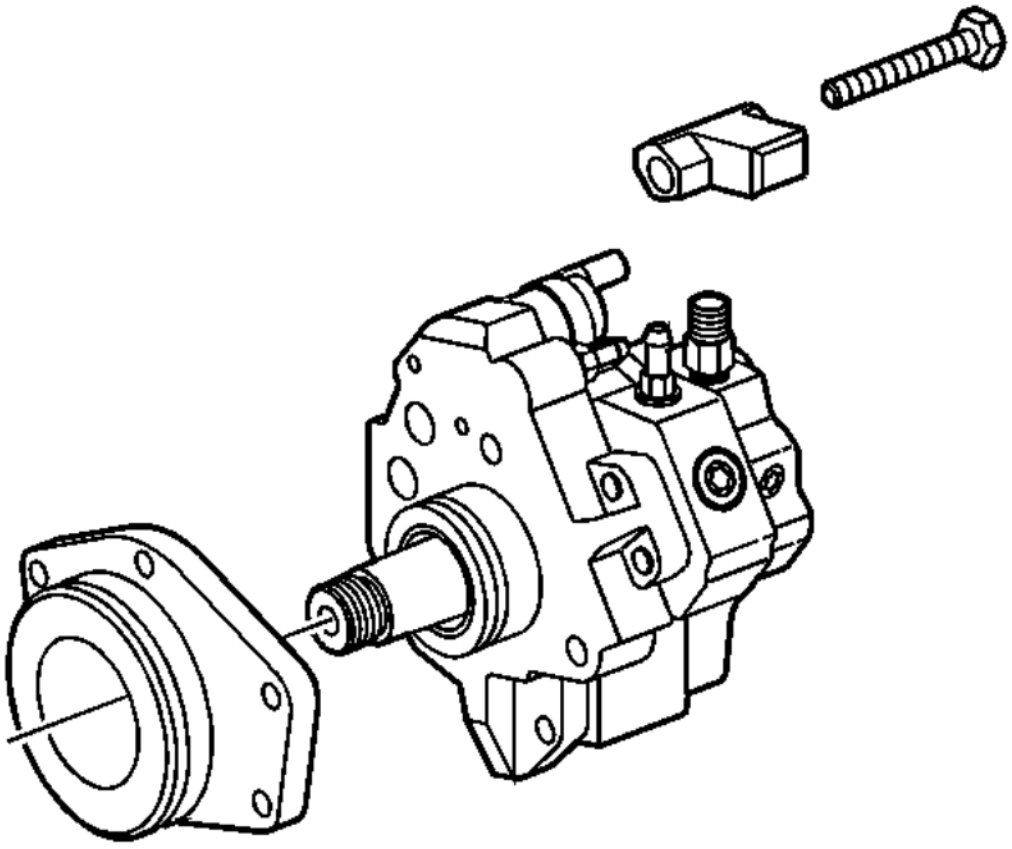


Fig. 57: View Of Fuel Injection Pump Adapter & Bolts
Courtesy of GENERAL MOTORS CORP.

12. Install the fuel injection pump adapter to the fuel injection pump.

NOTE: Refer to Fastener Notice .

13. Install the fuel injection pump adapter bolts.

Tighten: Tighten the fuel injection pump adapter bolts to 21 N.m (15 lb ft).

FUEL INJECTOR CLEANING AND INSPECTION

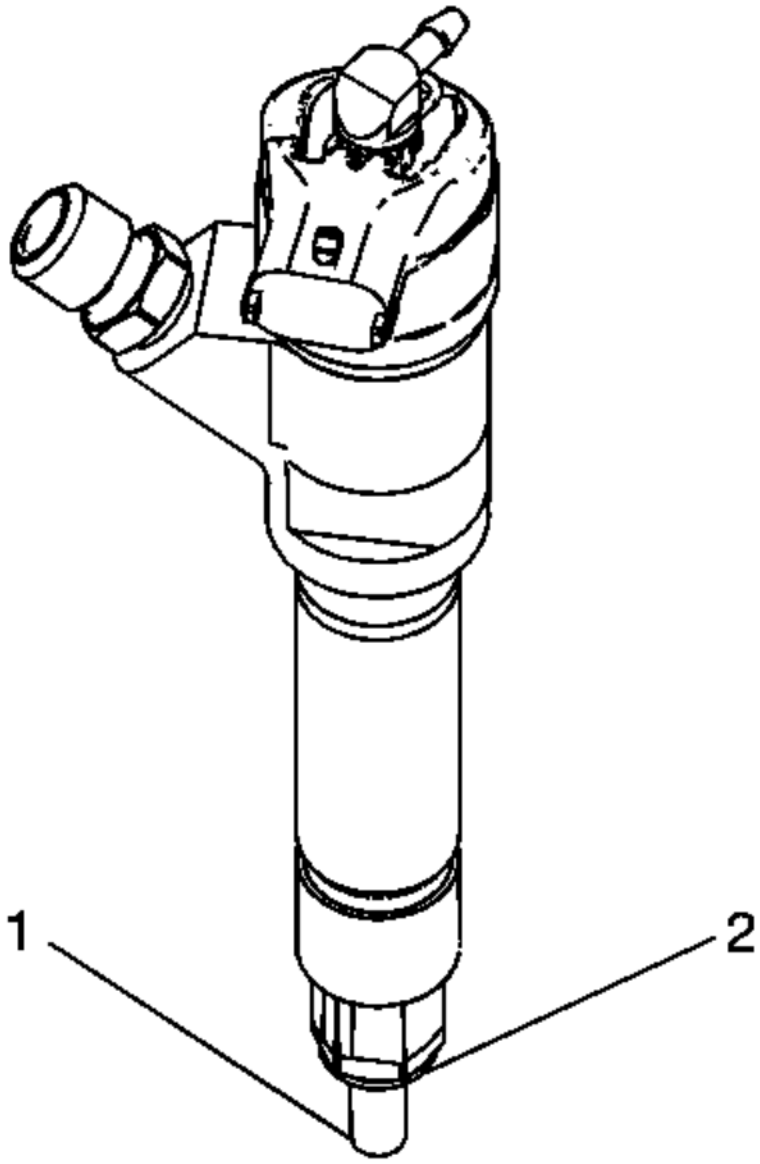


Fig. 58: View Of Fuel Injector Nozzle Tip & Copper Washer Sealing Area
Courtesy of GENERAL MOTORS CORP.

1. Use a soft bristle non-metallic brush and top engine cleaner, GM P/N 1052626 or equivalent, to remove any deposits from the nozzle tip (1) and the copper washer sealing area (2) before reinstallation.

NOTE: The fuel injector must be cleaned with the proper cleaning equipment. DO NOT use abrasive cleaning methods, such as a metallic brush, to remove deposits. Cleaning an injector with improper tools will damage the fuel injector.

2. Inspect the fuel injector nozzle tip (1) for cracks, dents, or other damage.
3. Inspect the nozzle tip (1) for any signs of discoloration - dark yellow, tan, or blue due to excessive heat.
4. Replace the injector if any damage is found.

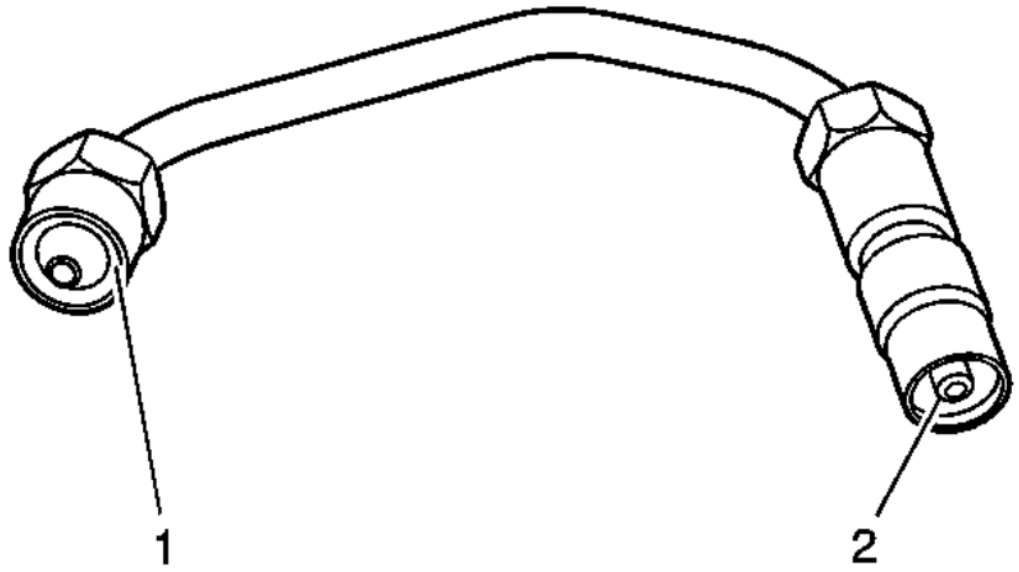


Fig. 59: View Of Fuel Injector Sealing Surfaces
Courtesy of GENERAL MOTORS CORP.

5. Clean the fuel injector high pressure line.
6. Inspect the fuel injector high pressure line for excessive corrosion or damage to the sealing surfaces (1, 2). Replace the line if any damage is found.

TURBOCHARGER CLEANING AND INSPECTION

Completely inspect the turbocharger and all other engine components that may cause similar

conditions before replacing the turbocharger.

Use the following information to diagnose problems caused by the turbocharger.

The turbocharger is serviced as a complete unit.

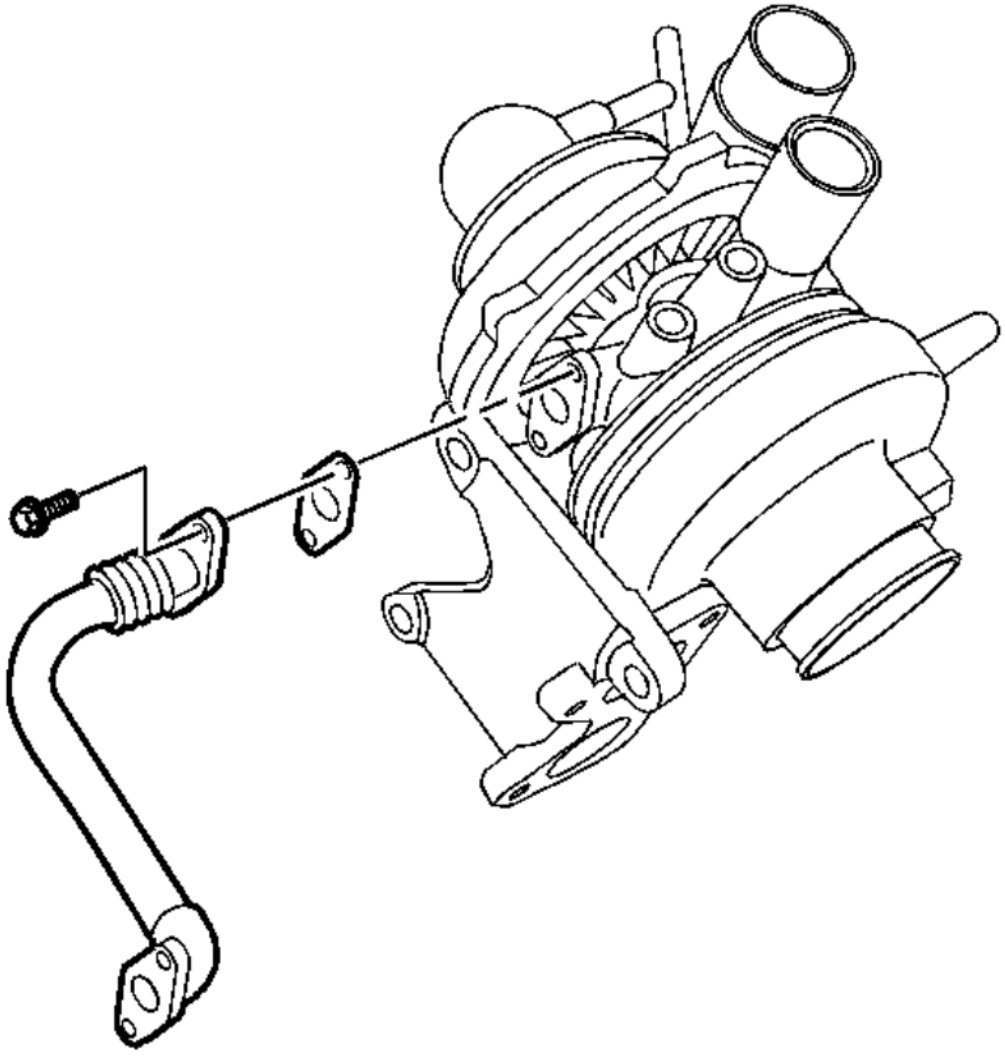


Fig. 60: View Of Oil Return Pipe Bolts
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Oil residue on the turbocharger compressor wheel is normal with a closed PCV system.

1. Remove the turbocharger oil return pipe bolts.
2. Remove the turbocharger oil return pipe and gasket.
3. Clean mating surfaces.

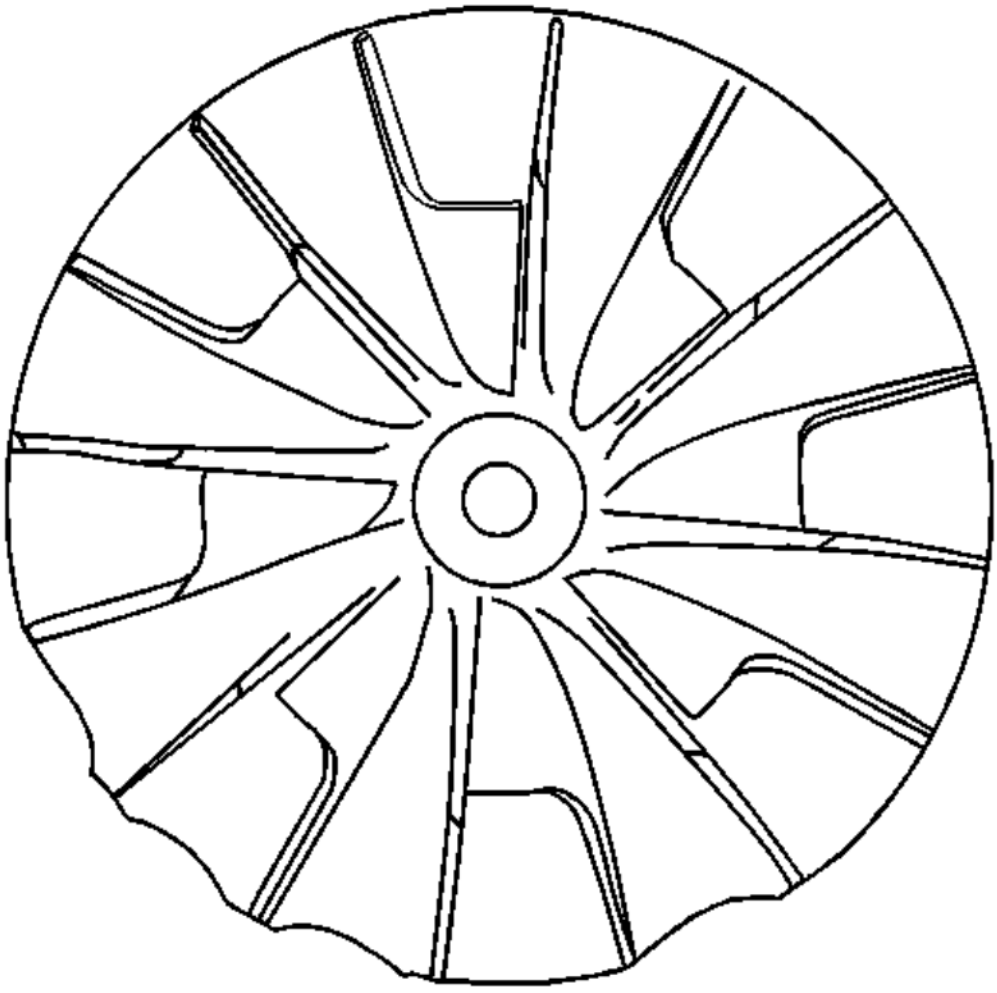


Fig. 61: View Of Compressor Wheel
Courtesy of GENERAL MOTORS CORP.

4. Inspect for damage to the compressor wheel, compared to a normal compressor wheel.

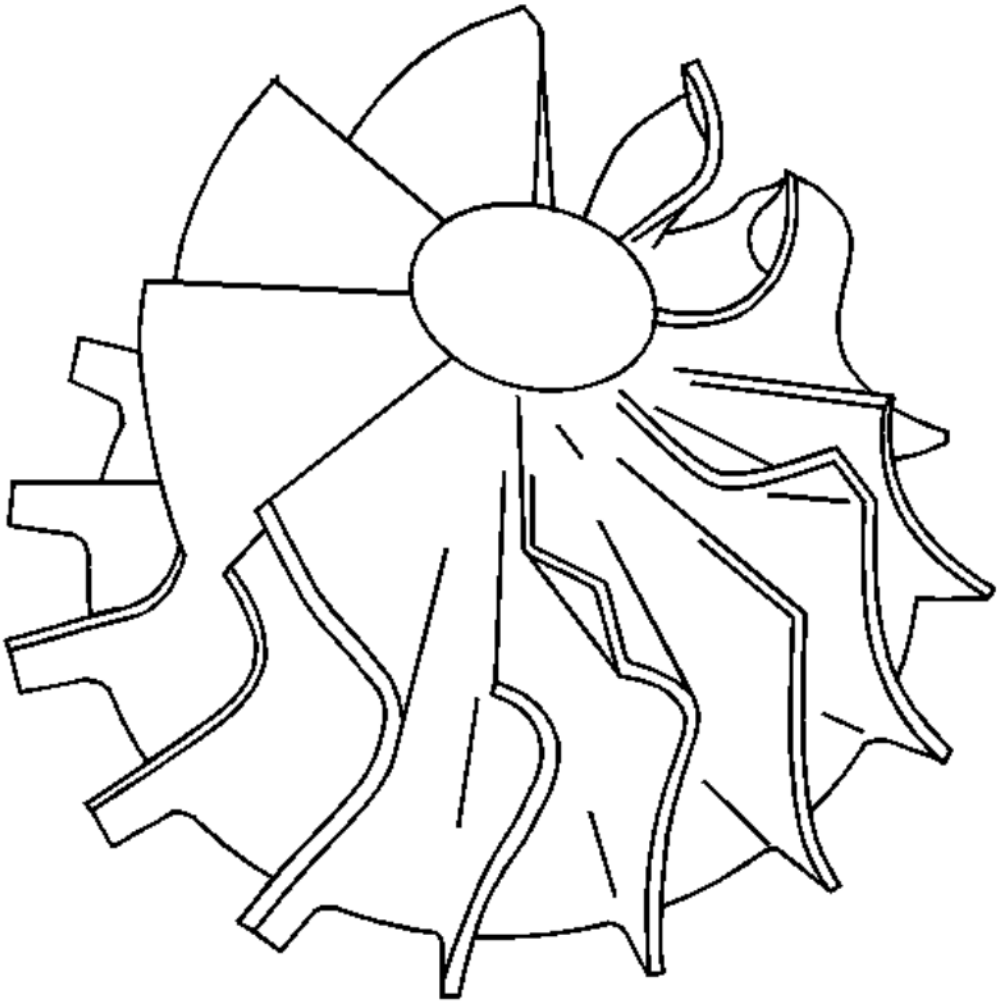


Fig. 62: View Of Damaged Compressor Wheel (Soft Object)
Courtesy of GENERAL MOTORS CORP.

5. Inspect for damage to the compressor wheel, by a soft object.

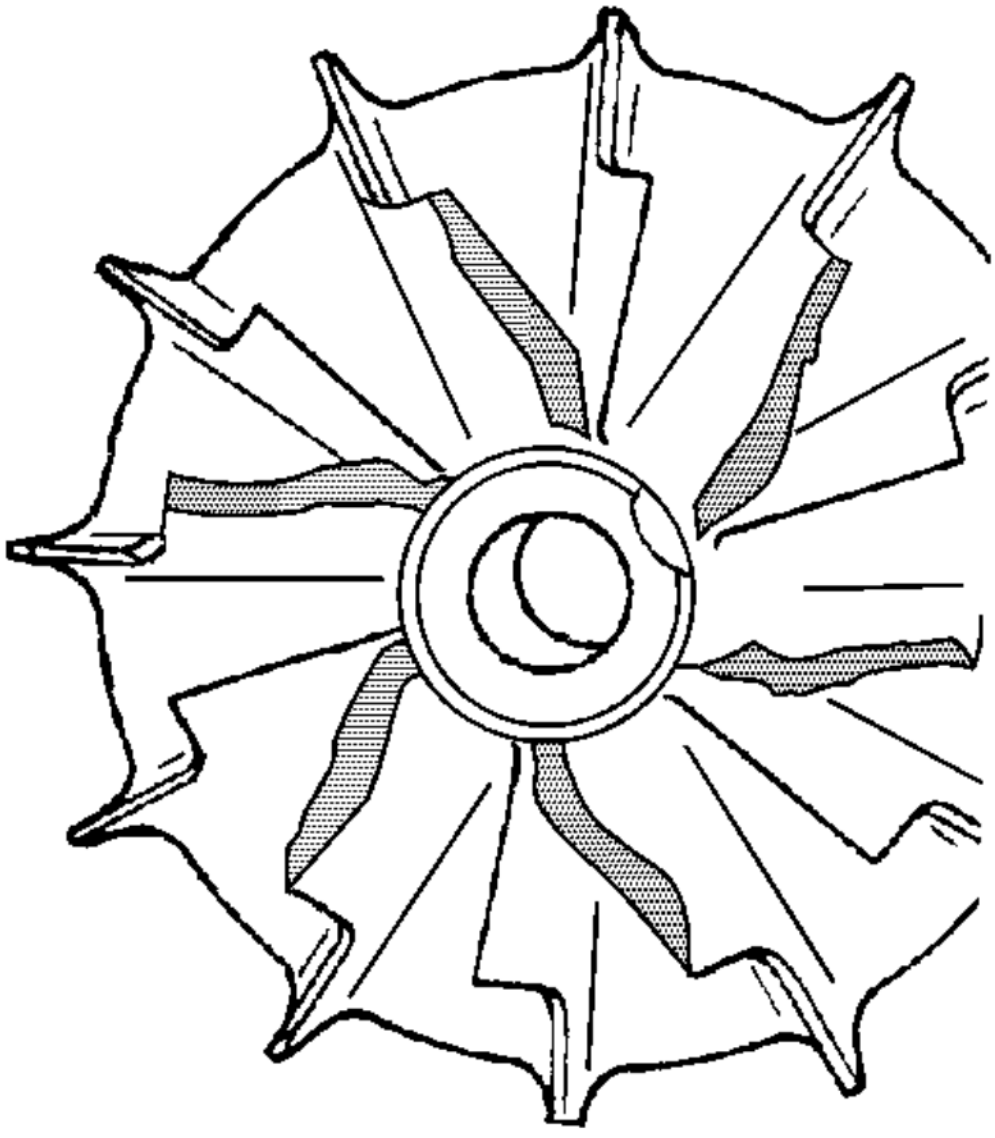


Fig. 63: View Of Damaged Compressor Wheel (Hard Object)
Courtesy of GENERAL MOTORS CORP.

6. Inspect for damage to the compressor wheel, by a hard object.

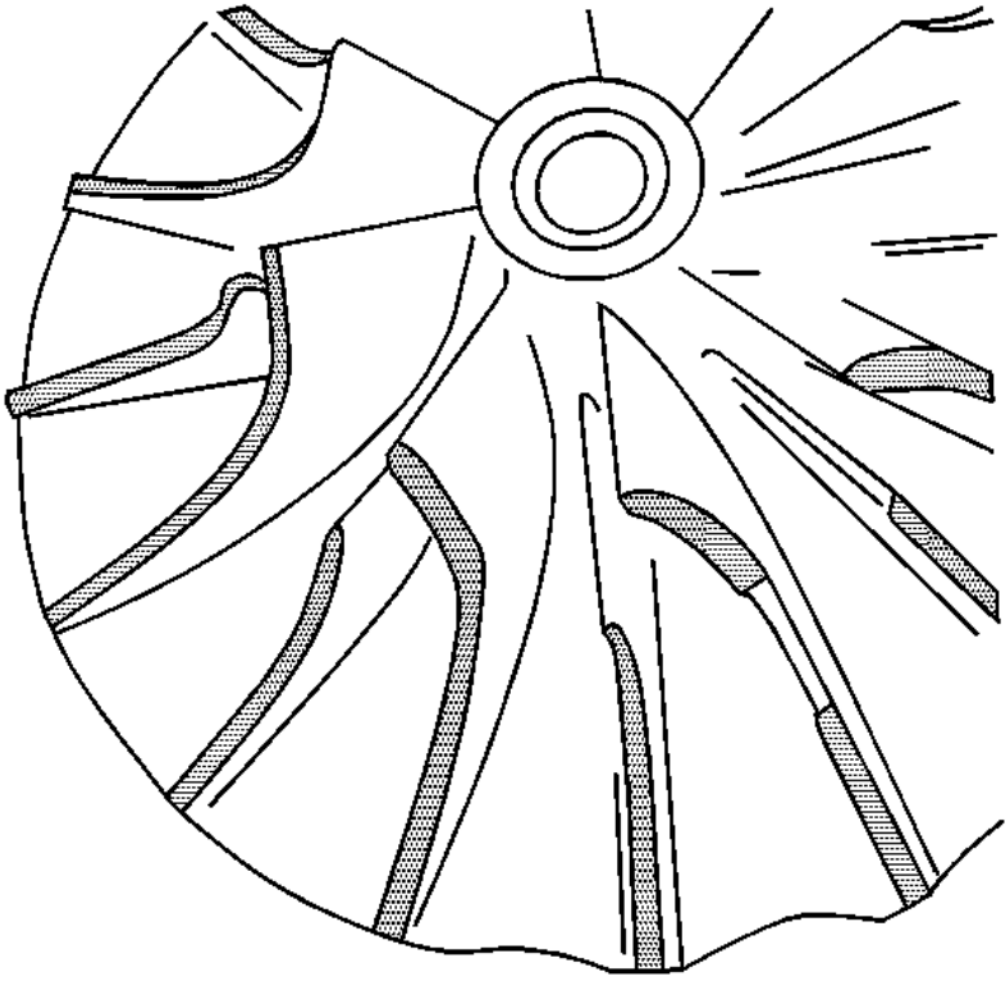


Fig. 64: View Of Compressor Blades (Heavy Rubbing)
Courtesy of GENERAL MOTORS CORP.

7. Inspect compressor blades for heavy rubbing.

   Ensure that the following conditions do not exist on the compressor wheel blades:

   - Cracks
   - Bends
   - Erosion of the blades

- Broken blades

8. Check the housing for signs of rubbing.

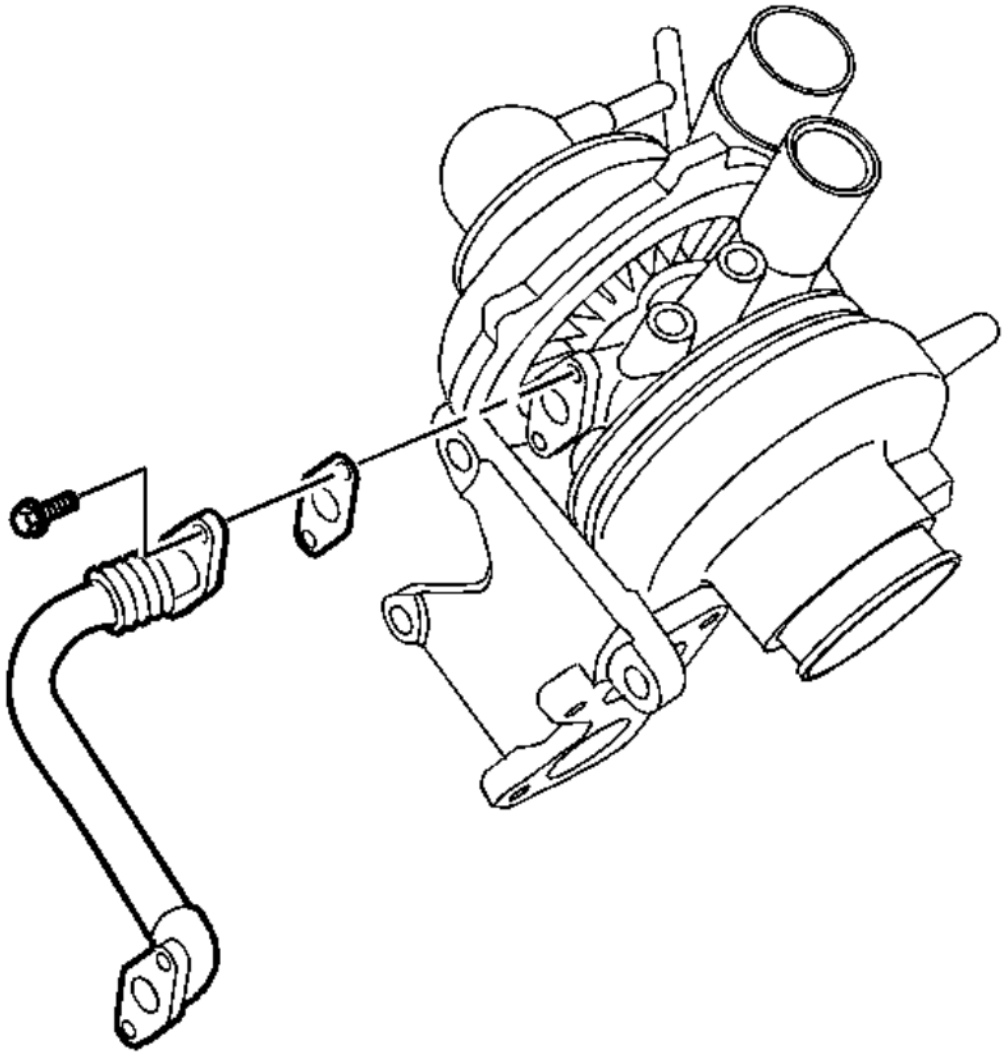


Fig. 65: View Of Oil Return Pipe Bolts
Courtesy of GENERAL MOTORS CORP.

9. Install the turbocharger oil return pipe and new gasket.
10. Install the turbocharger oil return pipe bolts.

Tighten: Tighten the turbocharger oil return pipe bolts to 21 N.m (15 lb ft).

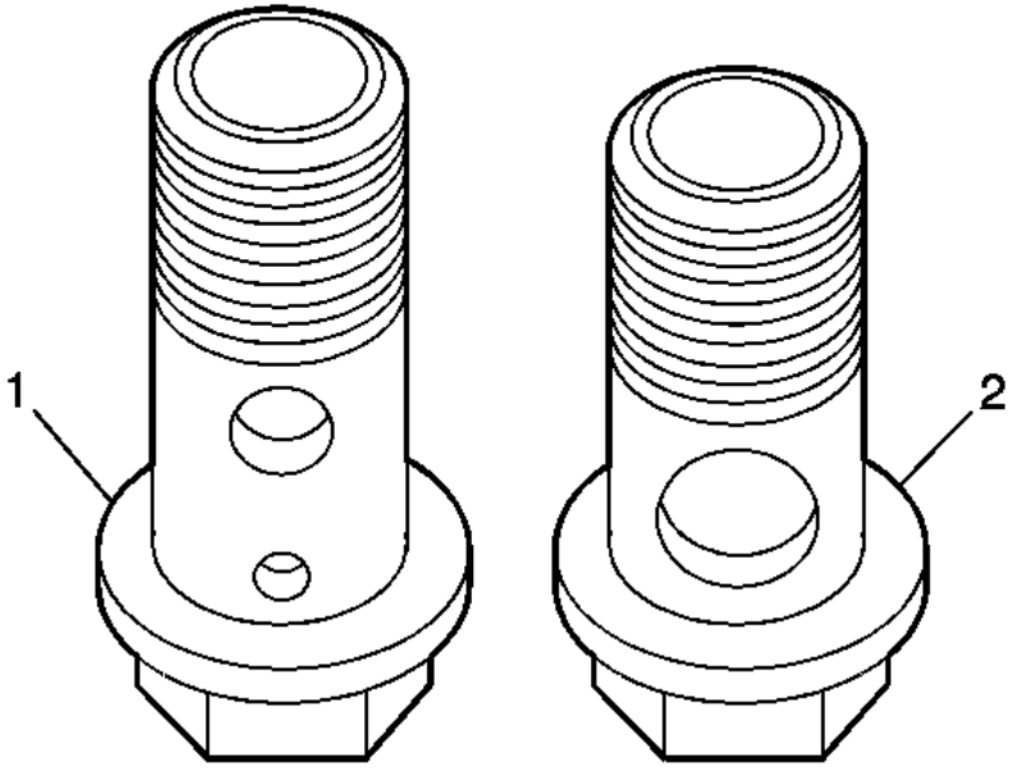


Fig. 66: View Of Cooling Outlet Hose Eye Bolts
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: If the cooling outlet hose eye bolts were removed, install the longer bolt (1) with two holes, in the top location. Install the shorter bolt (2) in the lower location.

11. Inspect the coolant outlet lines for damage.

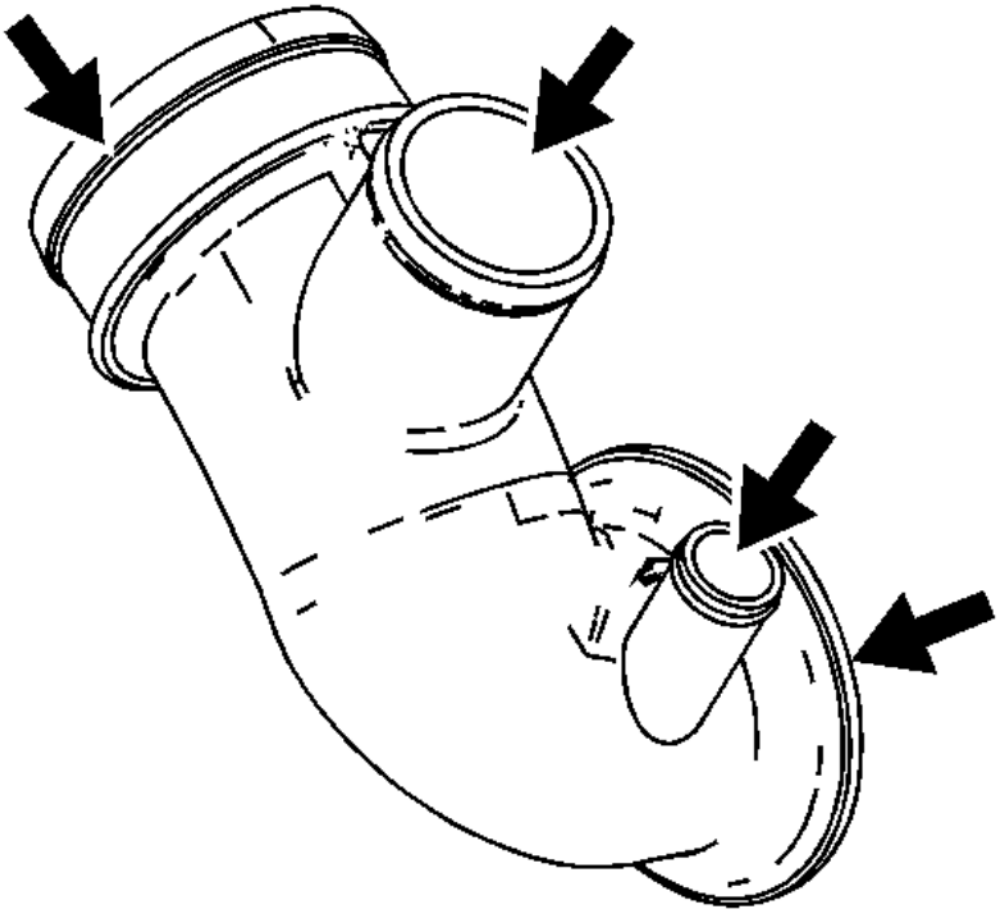


Fig. 67: View Of Turbocharger Inlet Duct Inspection Areas
Courtesy of GENERAL MOTORS CORP.

12. Clean the turbocharger inlet duct.
13. Clean the turbocharger inlet duct mating surfaces.
14. Inspect the turbocharger inlet duct for cracks.
15. Inspect the turbocharger inlet duct mating surfaces for damage.
16. Replace the turbocharger inlet duct if any damage is found.

Tighten: Tighten the inlet duct clamp to 5 N.m (44 lb in).

ENGINE FLYWHEEL HOUSING CLEANING AND INSPECTION

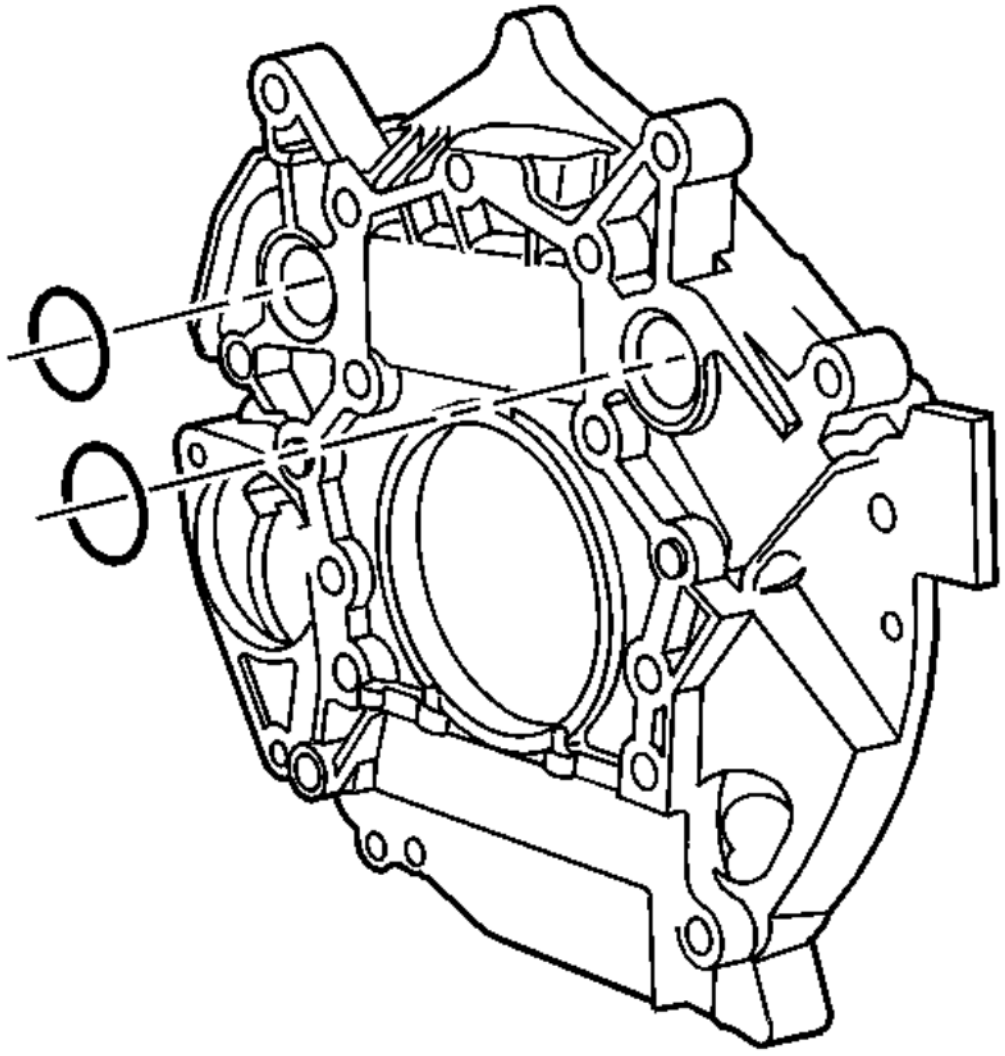


Fig. 68: View Of Flywheel Housing O-Ring Seals
Courtesy of GENERAL MOTORS CORP.

1. Remove the O-rings from the flywheel housing and discard.
2. Clean the flywheel housing.
3. Clean the flywheel housing mating surfaces.

4. Clean the flywheel housing O-ring sealing area.
5. Inspect the flywheel housing for cracks.
6. Inspect the flywheel housing mating surfaces for damage.
7. Inspect the crankshaft rear oil seal bore for damage.
8. Replace the flywheel housing if any damage is found.

WATER PUMP CLEANING AND INSPECTION

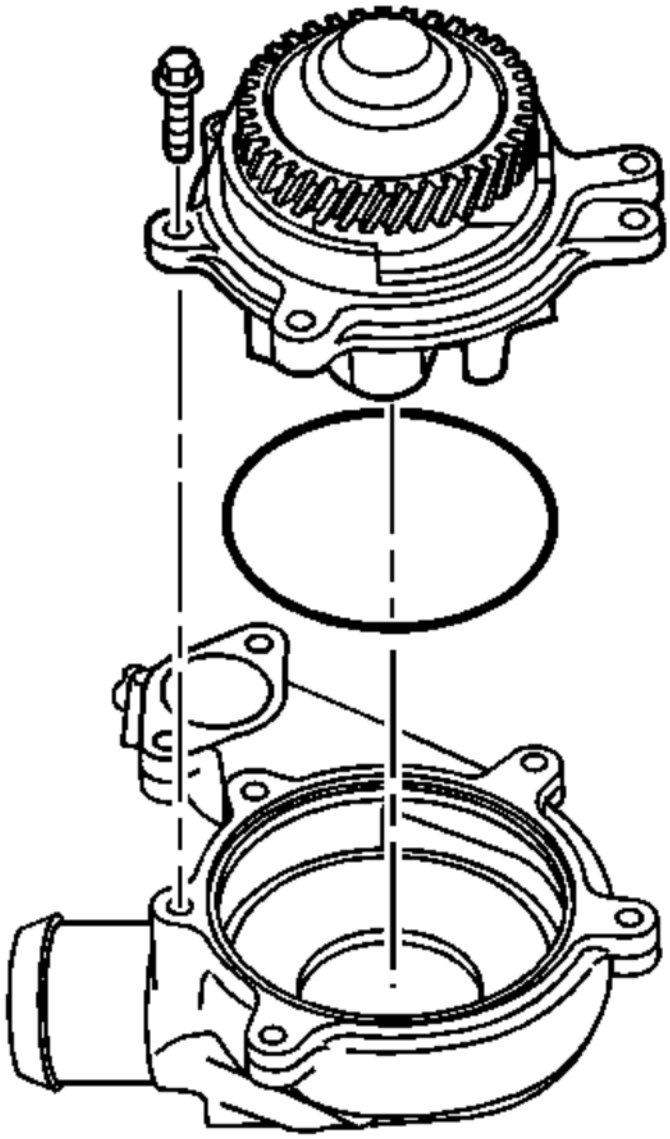


Fig. 69: View Of Water Pump, Housing & O-Ring
Courtesy of GENERAL MOTORS CORP.

1. Remove the O-ring from the water pump and discard.
2. Remove the water pump to water pump housing bolts.
3. Remove the water pump from the water pump housing.

4. Remove the O-ring from the water pump housing and discard.

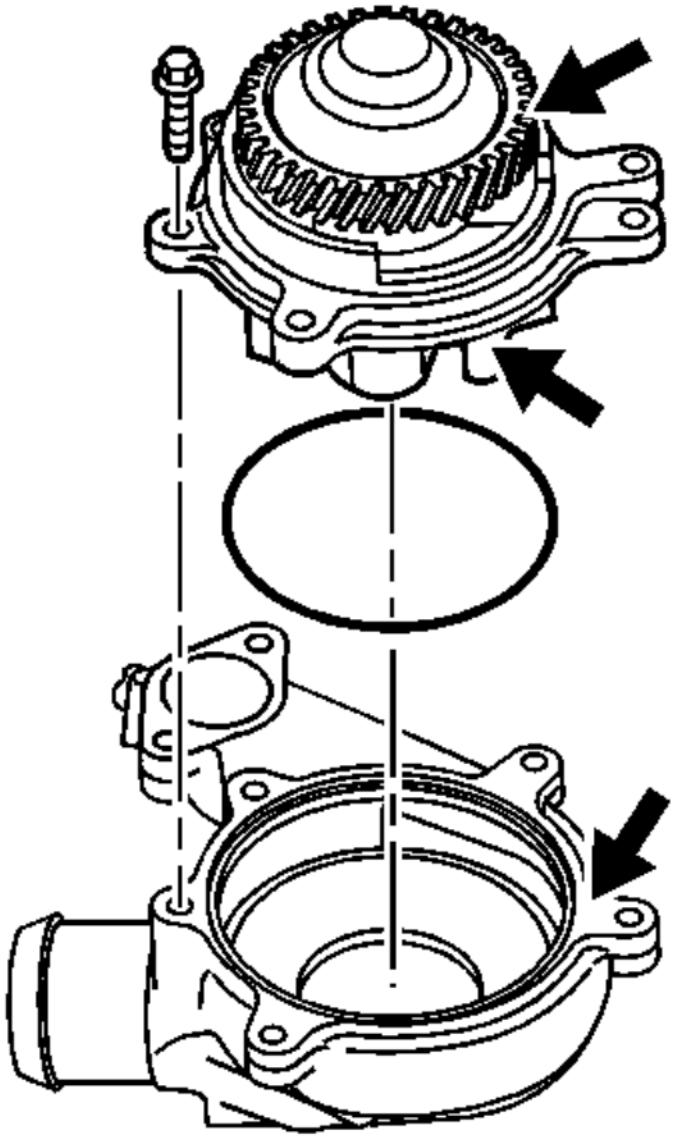


Fig. 70: View Of Water Pump Inspection Areas
Courtesy of GENERAL MOTORS CORP.

5. Clean the water pump assembly.

6. Clean the water pump mating surfaces.
7. Inspect the water pump gear for damage.
8. Inspect the water pump mating surfaces for damage.
9. Inspect the water pump shaft for looseness.
10. Inspect the water pump assembly for damage.
11. Replace the water pump if any damage is found.

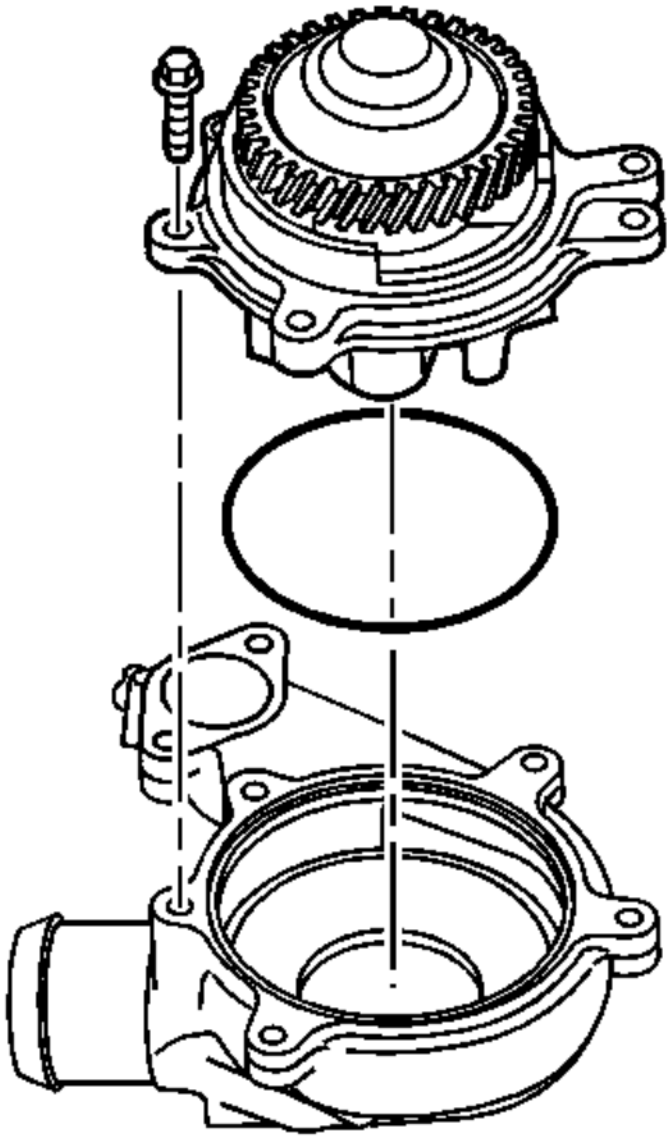


Fig. 71: View Of Water Pump, Housing & O-Ring
Courtesy of GENERAL MOTORS CORP.

12. Install a new O-ring to the water pump housing.
13. Lubricate the O-ring with engine coolant.
14. Install the water pump to the water pump housing.

NOTE: **Refer to Fastener Notice .**

15. Install the water pump to water pump housing bolts.

    Tighten: Tighten the water pump to water pump housing bolts to 21 N.m (15 lb ft).

16. Install a new O-ring to the water pump.

EXHAUST GAS RECIRCULATION COOLER CLEANING AND INSPECTION

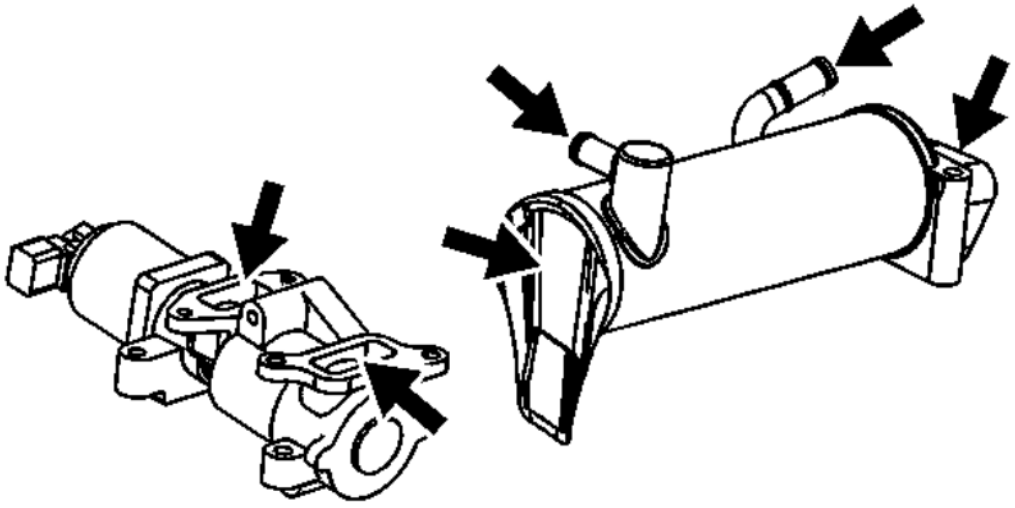


Fig. 72: EGR Cooling Hoses
Courtesy of GENERAL MOTORS CORP.

1. Remove the exhaust gas recirculation (EGR) cooling hoses.
2. Clean and inspect the EGR gasket surfaces.
3. Clean and inspect the EGR and cooler.
4. Replace the EGR or cooler if damaged.

THREAD REPAIR

General purpose thread repair kits are available commercially.

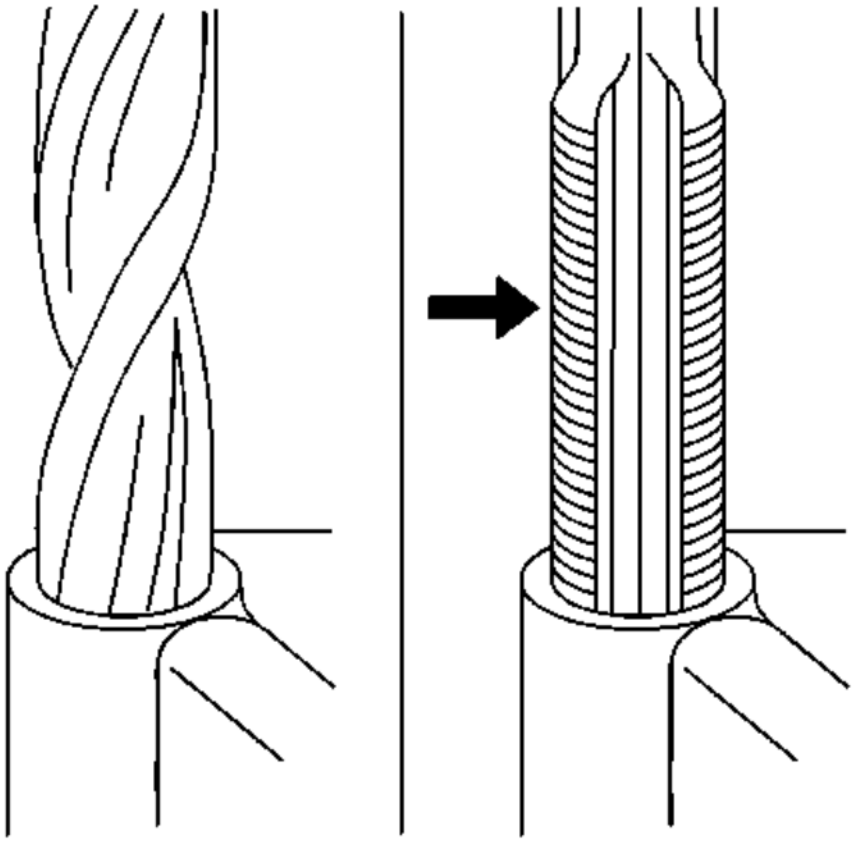


Fig. 73: Drilling & Tapping Damaged Threads
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to SAFETY GLASSES CAUTION .

IMPORTANT: Refer to the thread repair kit manufacturer's instructions regarding the size of the drill and which tap to use. Always avoid any buildup of chips. Back out the tap every few turns and remove the chips.

1. Determine the size, the pitch, and the depth of the damaged thread.

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

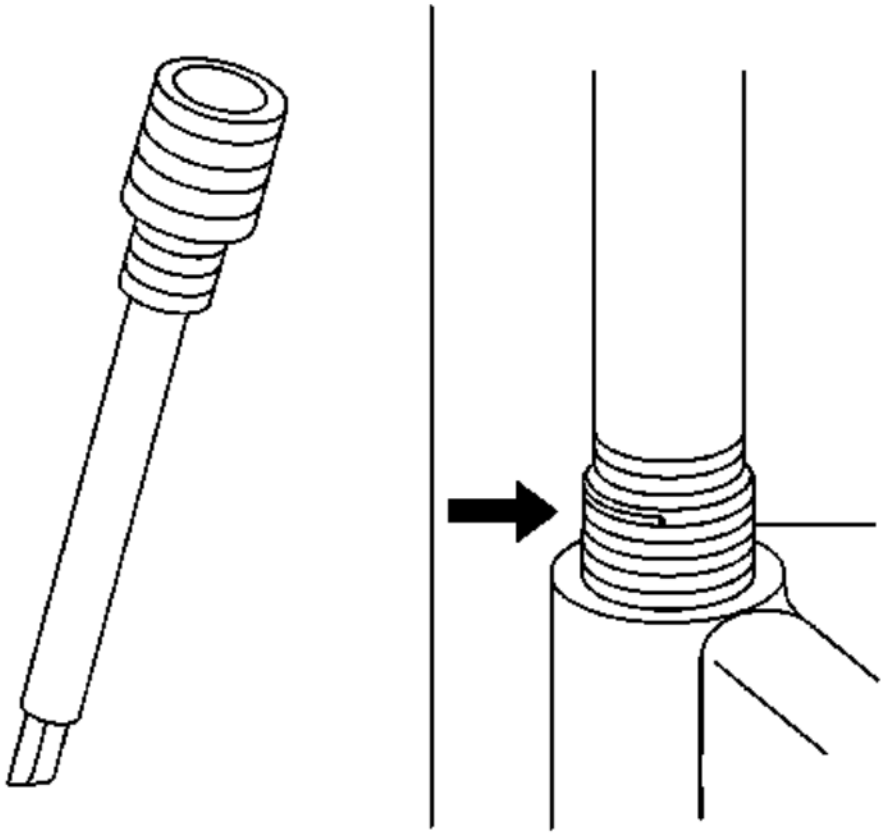


Fig. 74: Installing Thread Insert
Courtesy of GENERAL MOTORS CORP.

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

thread insert onto the end of the mandrel.

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

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

FUEL LINE TORQUING

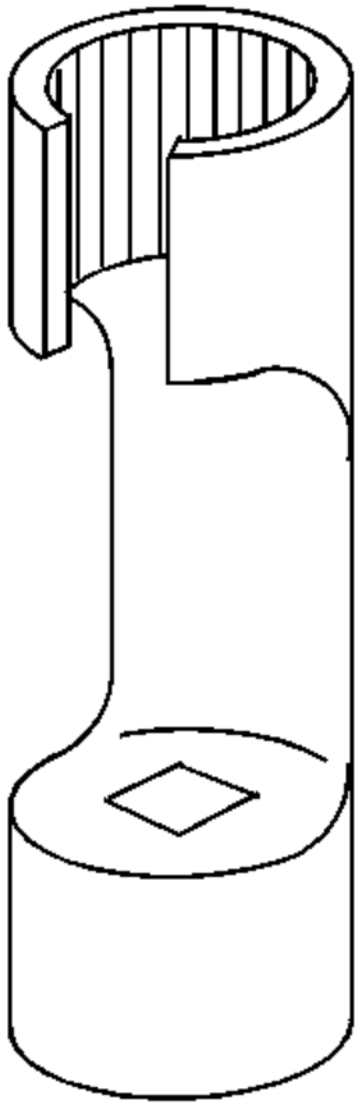


Fig. 75: View Of Flare Nut Socket
Courtesy of GENERAL MOTORS CORP.

The torque of a fuel line fitting is critical to prevent fuel leaks in a high pressure direct injection fuel system. The preferred method is through the use of a flare nut socket. With the use of a flare nut socket, the torque wrench can be set to the listed torque specification. Refer to **Fastener Tightening Specifications** .

If a crows foot is used to torque the fuel lines, then special attention to the position of the crows foot in relation to the torque wrench is required.

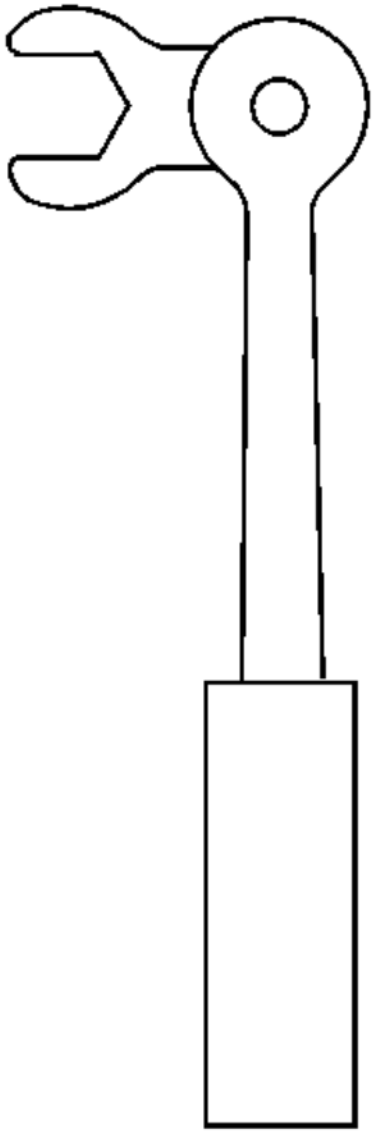


Fig. 76: View Of Crows Foot (90 Degrees)
Courtesy of GENERAL MOTORS CORP.

- If the crows foot is kept perpendicular (90 degrees) to the torque wrench during the entire tightening procedure, then the torque wrench can be set to the listed torque specification. Refer to **Fastener Tightening Specifications** .

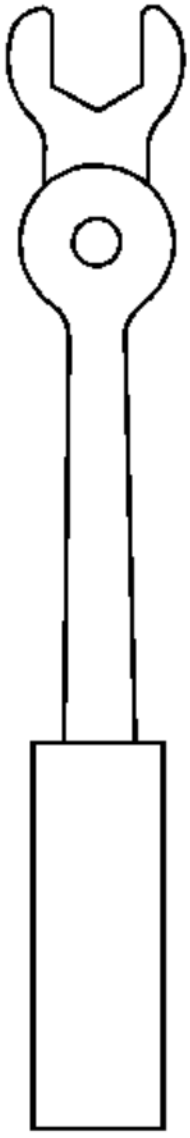


Fig. 77: View Of Crows Foot (Straight)
Courtesy of GENERAL MOTORS CORP.

- If the crows foot is positioned straight with the torque wrench, then the torque setting needs to be corrected to compensate for the increased leverage.
- If the crows foot is held at any position other than 90 degrees or inline to the wrench, more complex corrections of the torque setting are required, and therefore, positioning the crows foot in this manner is not recommended.

If it is necessary to position a crows foot in line with the torque wrench, the procedure for adjusting the torque specification is as follows:

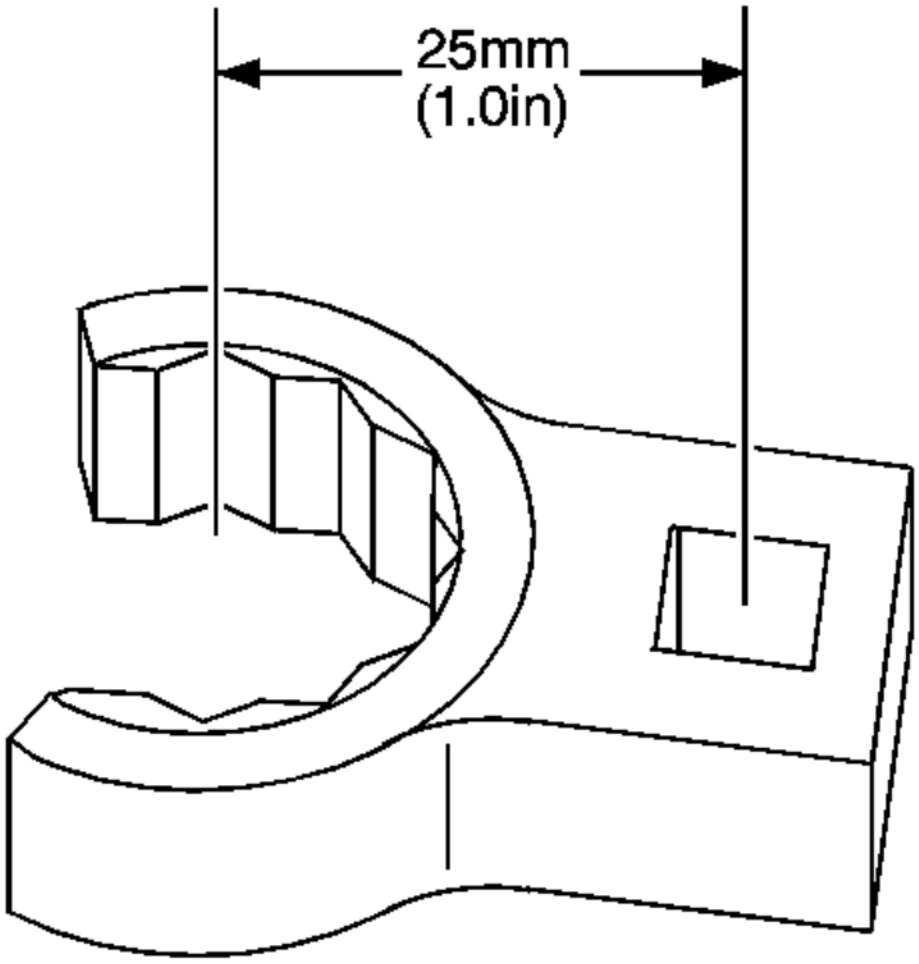


Fig. 78: Measuring Center Of Crows Foot Wrench End To Center Of Square Drive

Hole
Courtesy of GENERAL MOTORS CORP.

1. Measure the distance between the center of the crows foot wrench end to the center of the square drive hole.

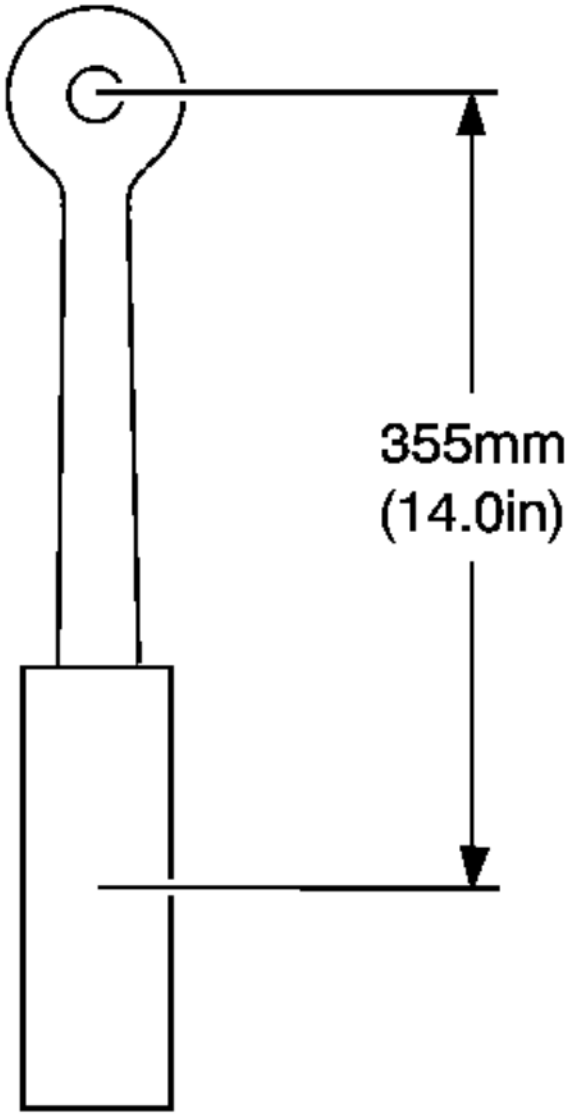


Fig. 79: Measuring Length Of Torque Wrench

Courtesy of GENERAL MOTORS CORP.

2. Measure the length of the torque wrench from the center of the square drive to the center of the handle.
3. Divide the measurement of the crows foot length by the torque wrench length. This figure is the percentage of additional torque, over the torque wrench setting, that will be applied to the fitting.
4. Subtract the results of step 3 from the number 1. This figure is the percentage of the listed torque specification that the torque wrench should be set to.
5. Multiply the results of step 4 by the listed torque setting. Refer to **Fastener Tightening Specifications** . This figure is the proper setting the torque wrench should be set at when using a crows foot in line with the torque wrench.

Example

1. Crows foot measurement = 25 mm (1.0 in)
2. Torque wrench measurement = 355 mm (14.0 in)
3. 25 mm / 355 mm (1.0 in / 14.0 in) = 0.07, or 7 %
4. 1 - 0.07 = 0.93, or 93 %
5. 0.93 x 41 N.m (30 lb ft) = 38 N.m (28 lb ft)

SERVICE PRIOR TO ASSEMBLY

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

CRANKSHAFT AND BEARING INSTALLATION

Tools Required

J 45059 Angle Meter

Installation

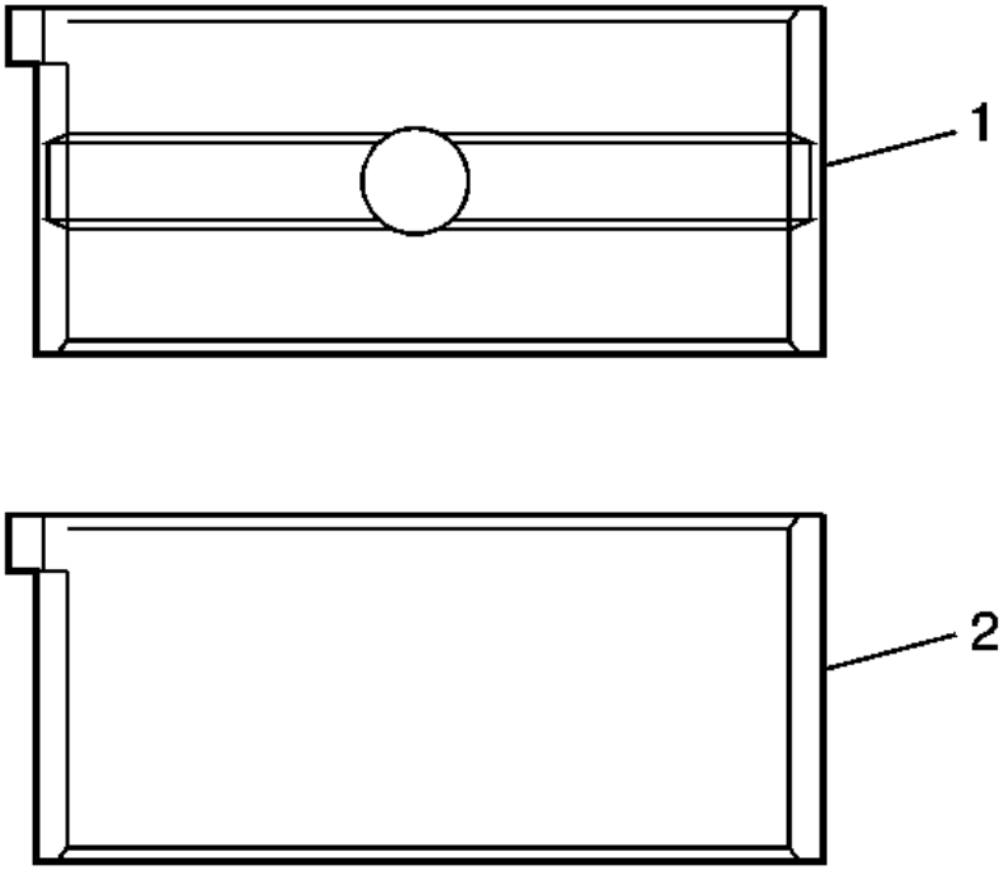


Fig. 80: View Of Crankshaft Upper & Lower Bearings
Courtesy of GENERAL MOTORS CORP.

1. Install the upper crankshaft bearings into the cylinder block. The bearing halves to be inserted into the crankshaft main bearing saddle have a wide groove and oil hole in the center of the bearing (1).
2. Install the lower crankshaft bearings into the crankshaft bearing caps. The bearing halves to be inserted into the crankshaft main bearing caps do NOT have an oil hole or groove in the bearing (2).

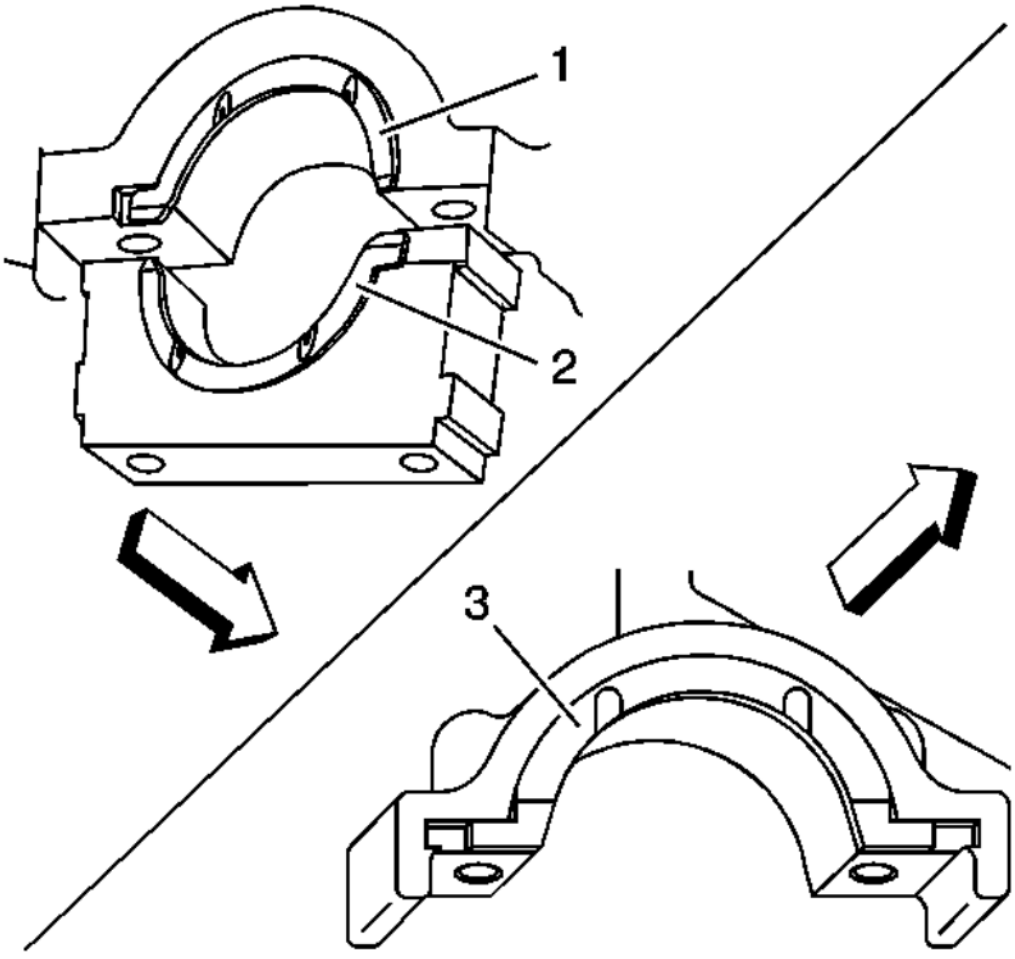


Fig. 81: View Of View Of Thrust Bearings
Courtesy of GENERAL MOTORS CORP.

3. Install the upper thrust bearings to the cylinder block. There are two thrust bearings (1 and 3) in the cylinder block and one lower thrust bearing in the No. 5 crankshaft bearing cap (2).
4. Lubricate the crankshaft bearing surfaces with engine oil.
5. Install the crankshaft into the cylinder block.
6. Install the No. 5 crankshaft bearing cap with the lower thrust bearing (2).

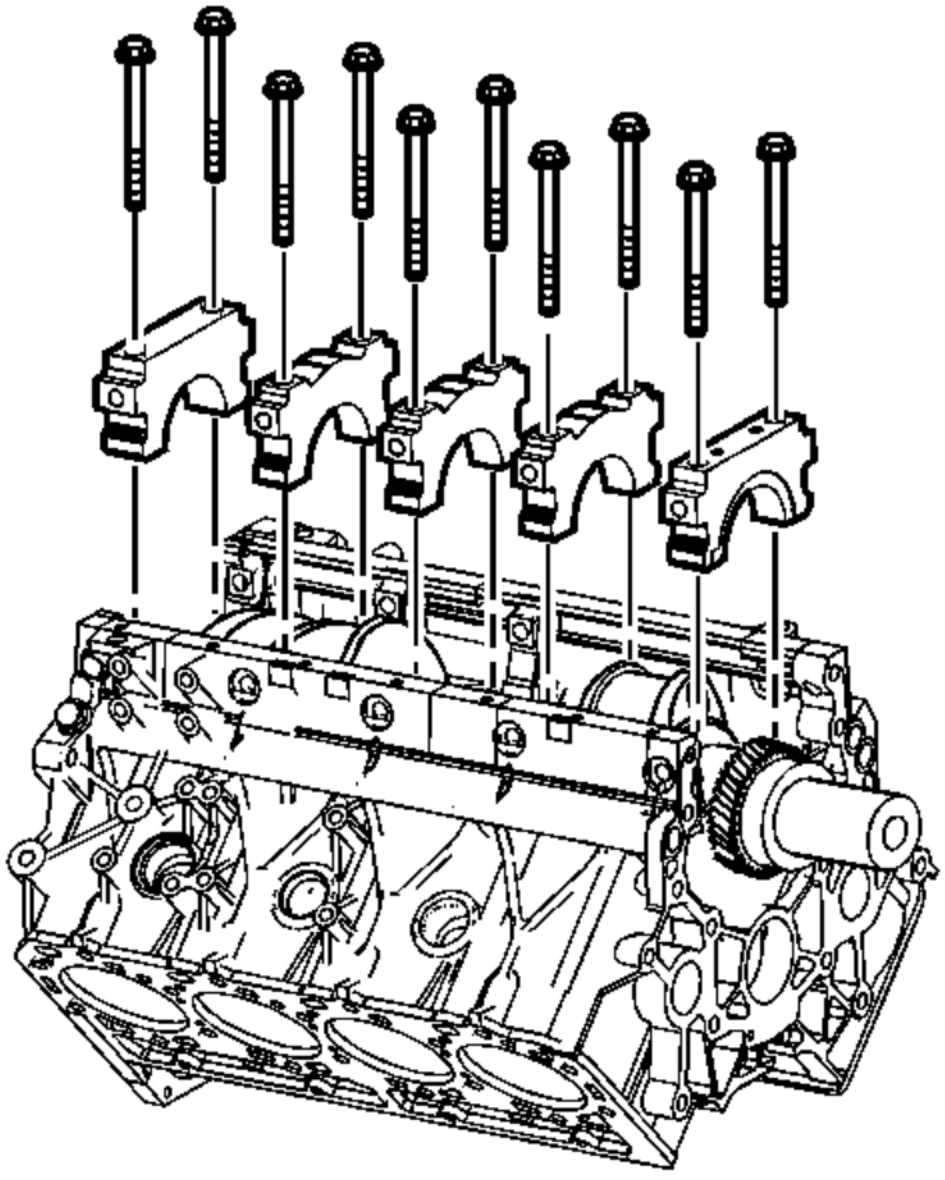


Fig. 82: View Of Crankshaft Bearing Cap & Bolts
Courtesy of GENERAL MOTORS CORP.

7. Install the remaining four crankshaft bearing caps.

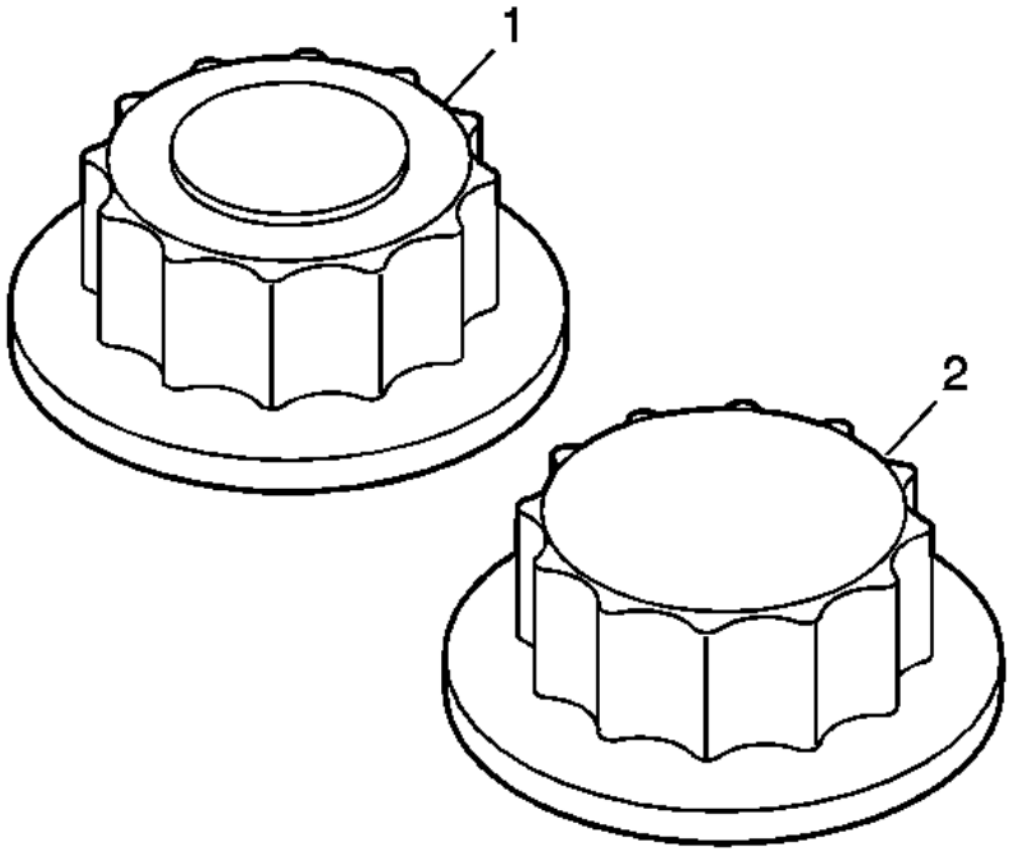


Fig. 83: Main Bearing Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: This component uses bolts with a preapplied molybdenum disulfide coating for thread lubrication. Do not remove the coating or use any additional lubricant. Improperly lubricated threads will adversely affect the bolt torque and clamp load. Improper bolt torque and clamp load can lead to engine damage.

NOTE: Refer to Fastener Notice .

IMPORTANT: There are two different length crankshaft bearing cap bolts in

production depending on the counter bore of the threaded hole/block. Using the wrong bolt may lead to improper thread engagement, bottoming out or improper clamp load. Look at the bolt head surface to determime which bolt was used in production. The bolt head will have either a raised circle (1) or it will be unmarked (2). Replace the bolt with the same type.

8. Install the NEW crankshaft bearing cap bolts.
9. Tighten the crankshaft bearing cap bolts in the proper sequence.

Tighten:

- 1st step 98 N.m (72 lb ft).
- 2nd step 132 N.m (97 lb ft).
- 3rd step 30 degrees using **J 45059** .

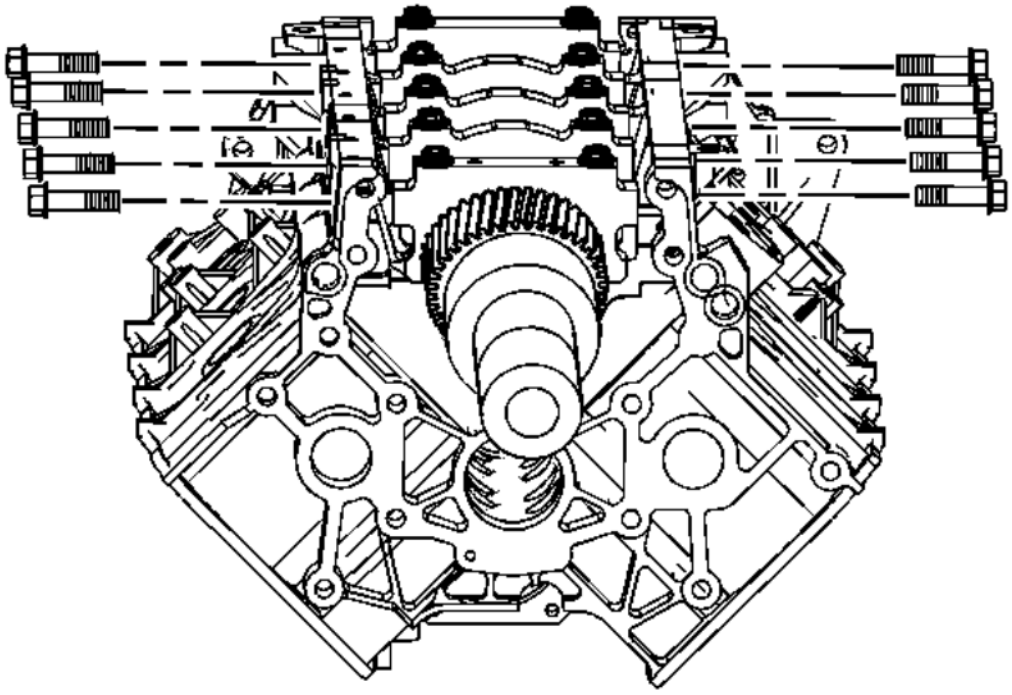


Fig. 84: View Of Crankshaft Bearing Cap Side Bolts
Courtesy of GENERAL MOTORS CORP.

10. Clean the crankshaft bearing side cap bolt threads, sealing flange and mounting holes with GM P/N 12377981 (Canadian P/N 10953463) or equivalent. Dry the bolts and mounting holes with compressed air.
11. Apply GM P/N 12346004 (Canadian P/N 10953480) to the threads and sealing flange of the bolts.
12. Install the ten bolts.

Tighten: Tighten the crankshaft bearing cap side bolts to 70 N.m (52 lb ft).

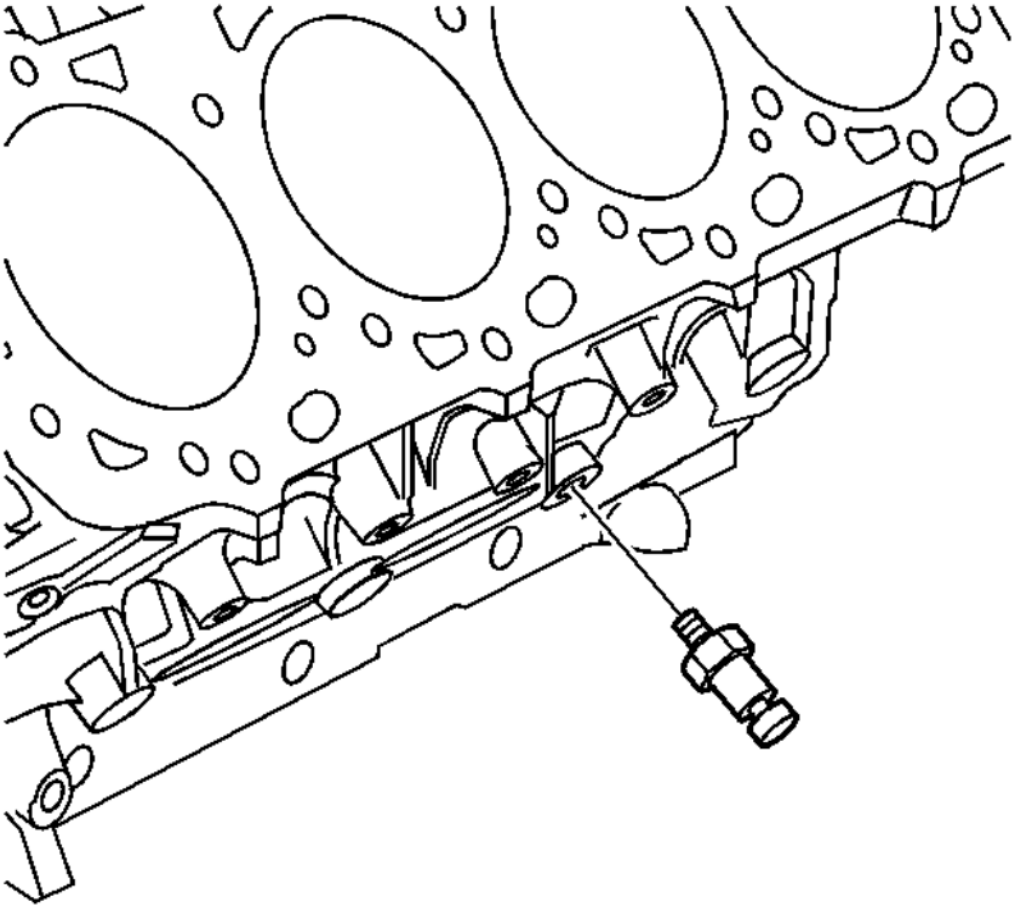


Fig. 85: View Of Oil Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

13. Install the oil pressure sensor.

    Tighten: Tighten the oil pressure sensor to 41 N.m (30 lb ft).

CAMSHAFT INSTALLATION

Tools Required

J 7872 Dial Indicator Set

Installation

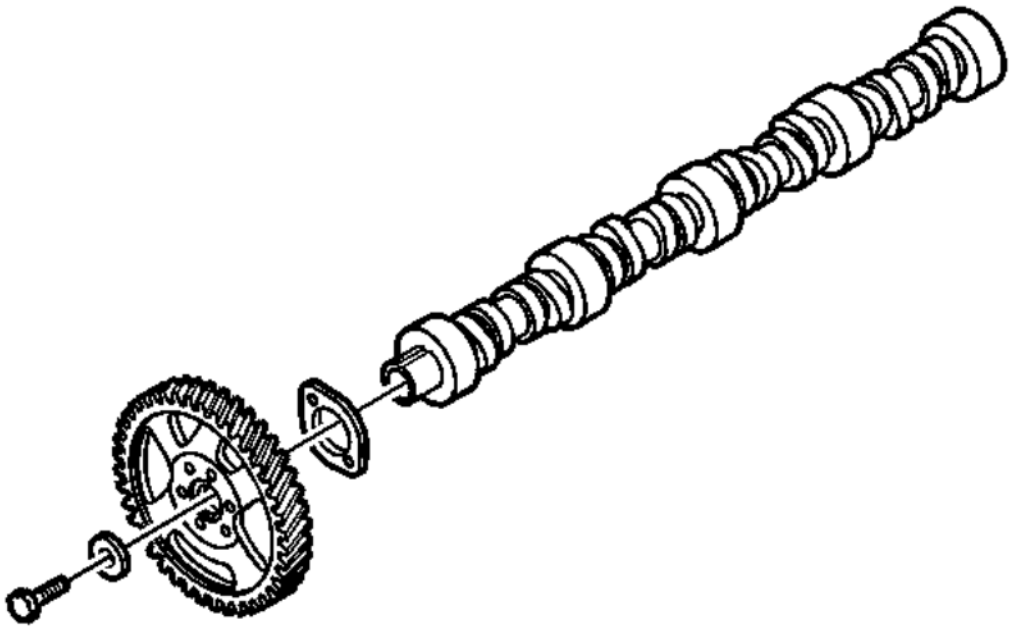


Fig. 86: View Of Camshaft, Camshaft Gear & Camshaft Thrust Plate
Courtesy of GENERAL MOTORS CORP.

1. Install the camshaft thrust plate to the camshaft.
2. Install the camshaft driven gear.

3. Install a new camshaft driven gear bolt.

   Leave the bolt finger tight.

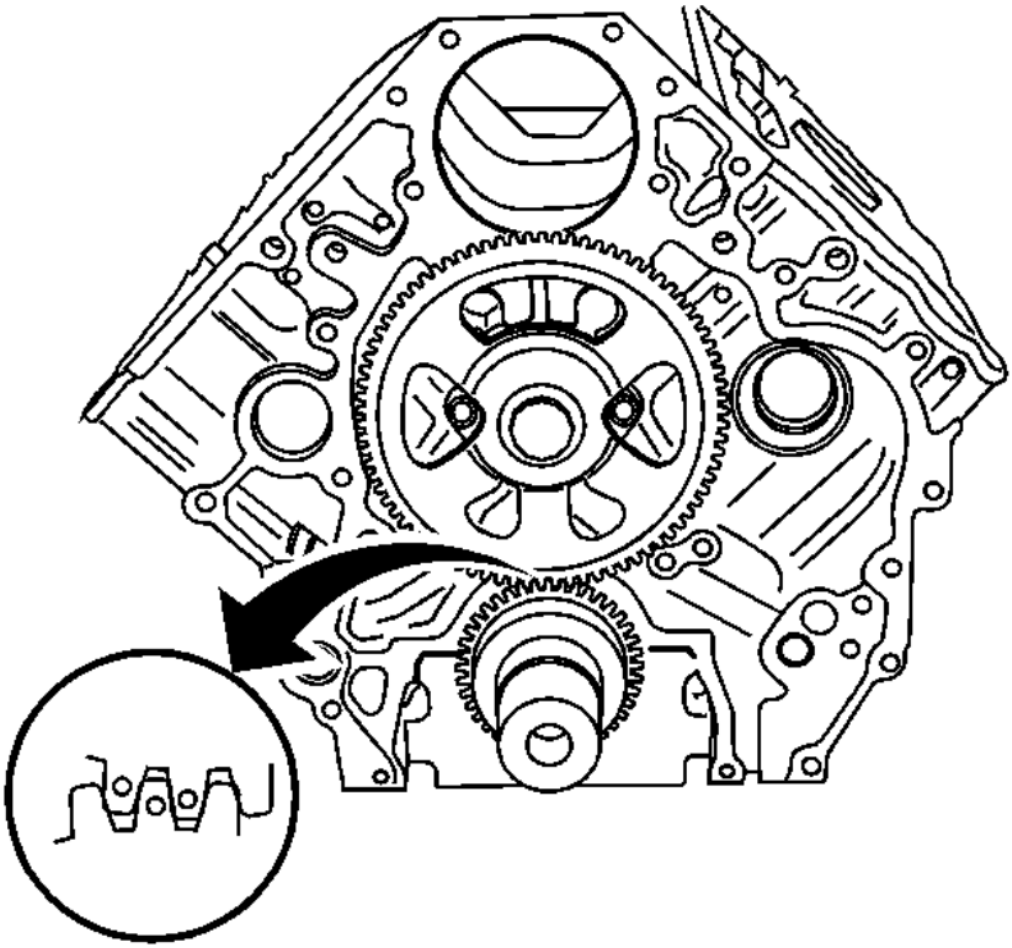


Fig. 87: View Of Camshaft Gear Aligned With Crankshaft Gear
Courtesy of GENERAL MOTORS CORP.

4. Install the camshaft and gear assembly into the cylinder block, aligning the camshaft gear to the crankshaft gear as shown.

NOTE: **Refer to Fastener Notice .**

5. Install the camshaft thrust plate bolts.

   Tighten: Tighten the camshaft thrust plate bolts to 22 N.m (16 lb ft).

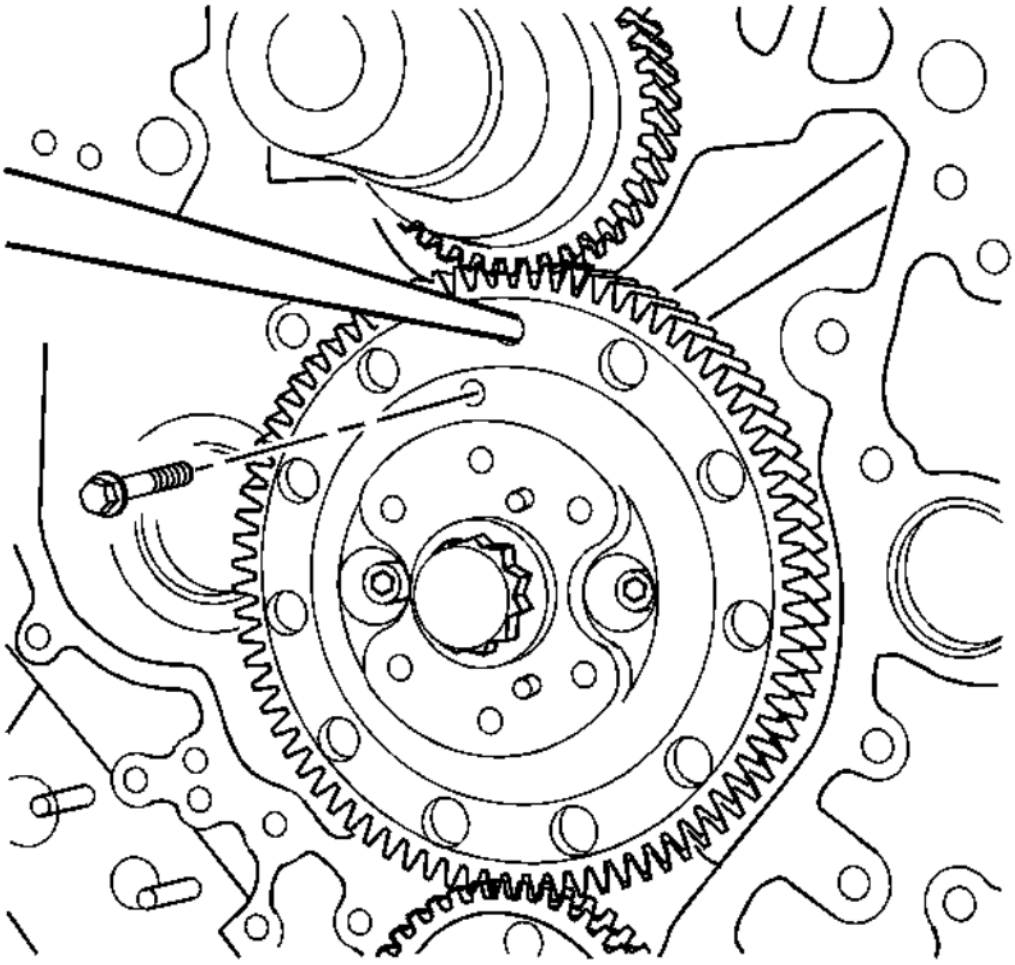


Fig. 88: Using Exciter Ring Bolt To Secure Spring Tension
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Use a suitable tool to relieve the spring tension while removing the locking bolt.

6. Remove the exciter ring bolt that was installed to hold the spring tension of the two piece

cam gear.

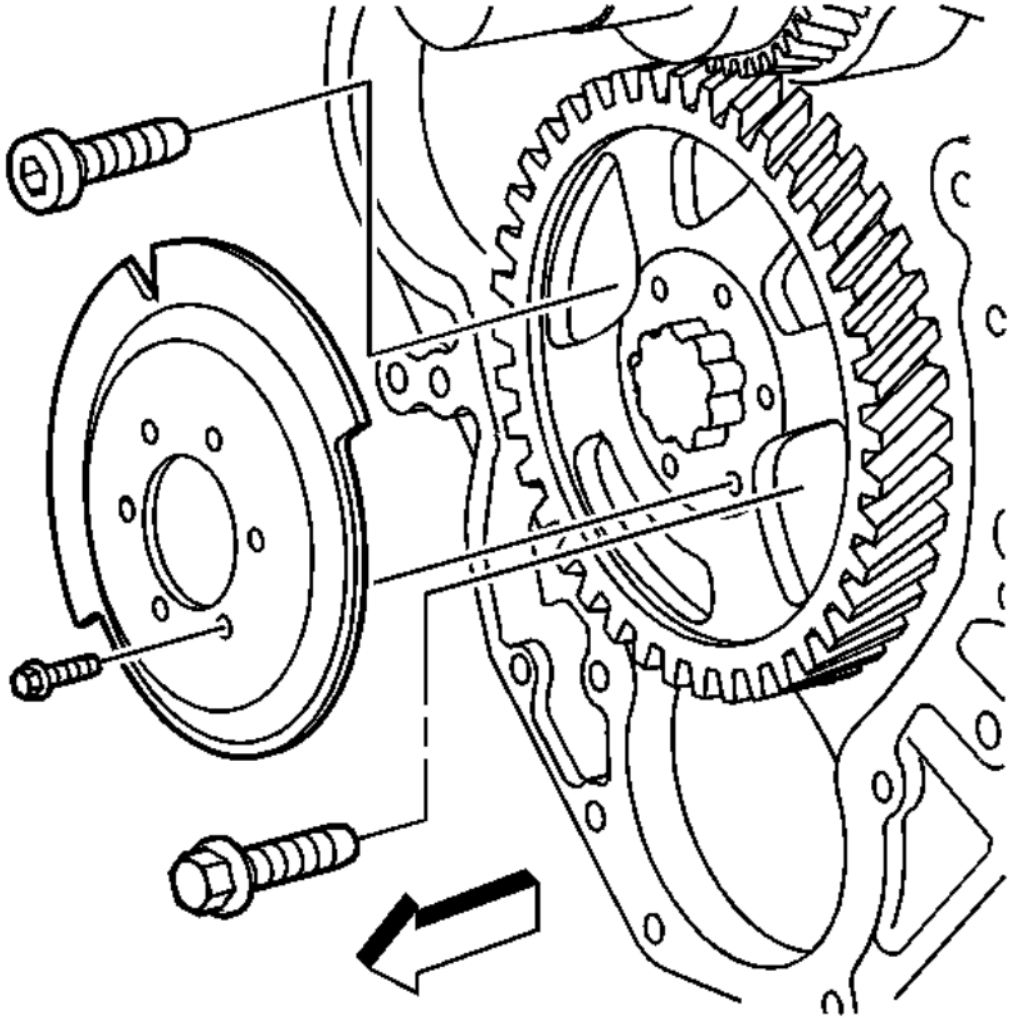


Fig. 89: View Of Camshaft Exciter Ring, Bolts & Thrust Plate Bolts
Courtesy of GENERAL MOTORS CORP.

7. Install the camshaft position sensor exciter ring to the camshaft gear.
8. Install the camshaft position sensor exciter ring bolts.

Tighten: Tighten the camshaft position sensor exciter ring bolts to 9 N.m (80 lb in).

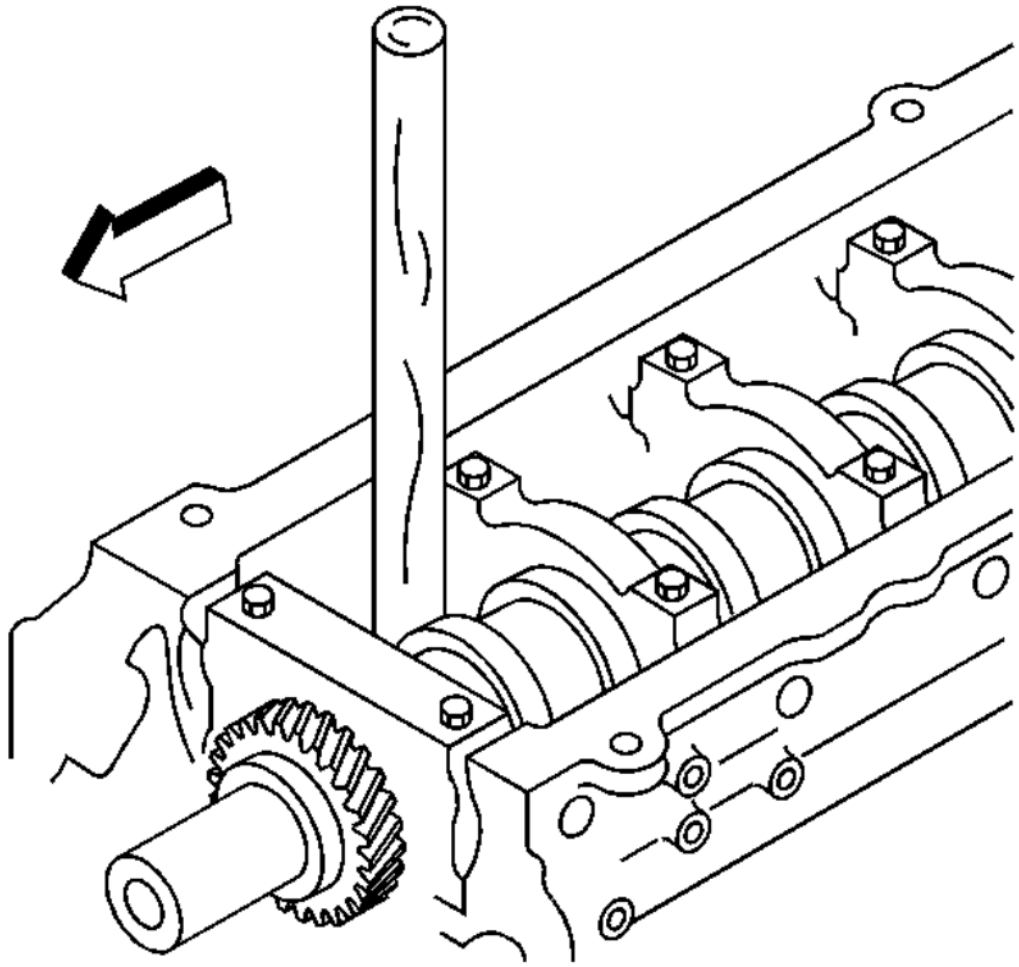


Fig. 90: Blocking Crankshaft From Turning Using Wooden Handle
Courtesy of GENERAL MOTORS CORP.

9. Block the crankshaft from turning using a wooden handle.
10. Install the new camshaft gear bolt.

Tighten: Tighten the new camshaft gear bolt to 234 N.m (173 lb ft).

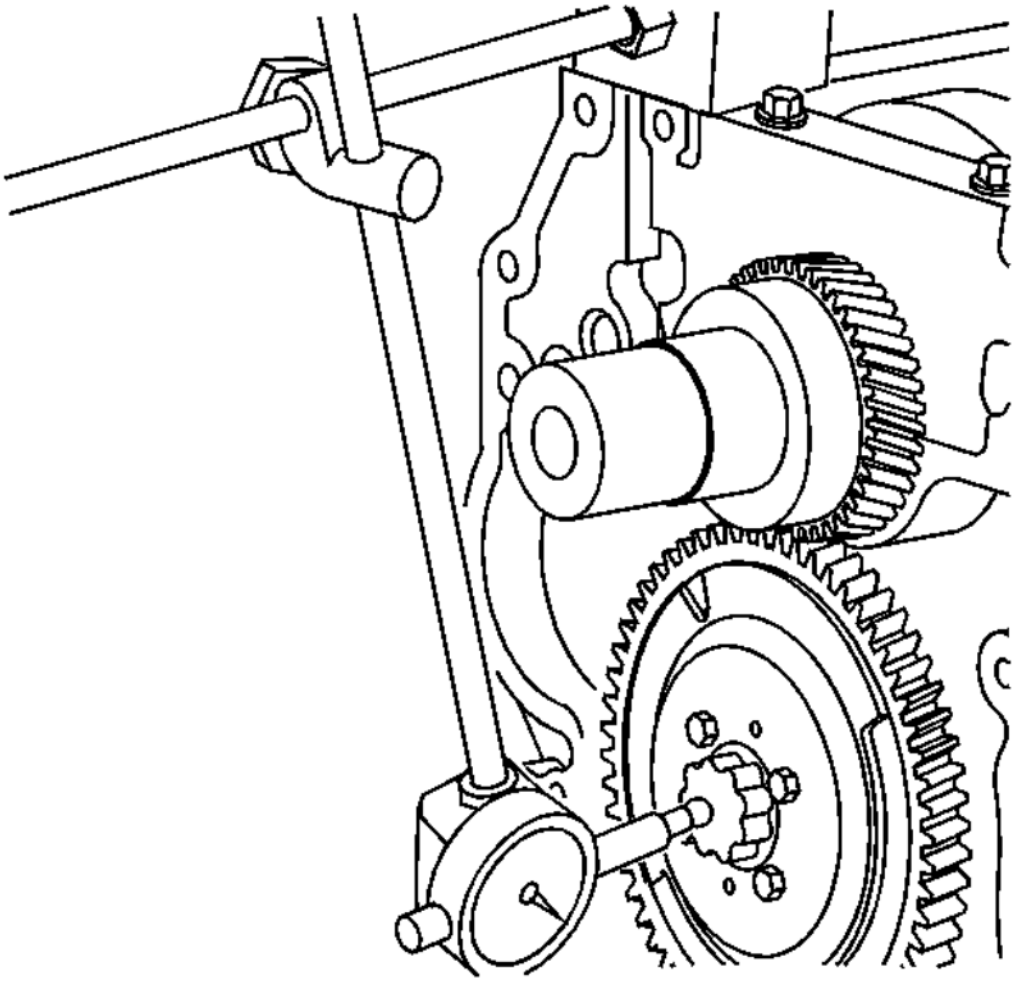


Fig. 91: Measuring Camshaft End Play Using J 7872
Courtesy of GENERAL MOTORS CORP.

11. Measure the camshaft end play with **J 7872** .
    - The production value is 0.050-0.114 mm (0.0020-0.0045 in) and service limit is 0.2 mm (0.0079 in).
    - Replace the camshaft gear or the camshaft thrust plate if measured value exceeds the service limit.

PISTON, CONNECTING ROD, AND BEARING INSTALLATION

Tools Required

- **J 8037** Piston Ring Compressor
- **J 45059** Angle Meter

Installation

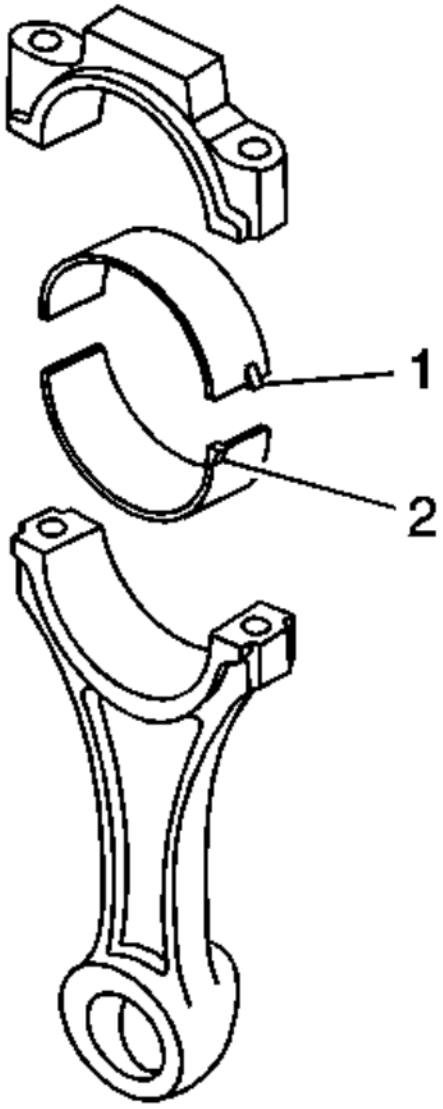


Fig. 92: View Of Connecting Rod Bearing & Connecting Rod Cap Bearing
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The connecting rod bearing with the notch all the way out against the edge of the bearing (2) is the connecting rod bearing. The connecting rod bearing with the notch "in board" (1) is the connecting rod cap bearing.

1. Select the connecting rod bearing according to the **Connecting Rod Bearings Selection Specifications** chart.
2. Position the crankshaft so the connecting rod journal is opposite the piston and connecting rod assembly being installed.

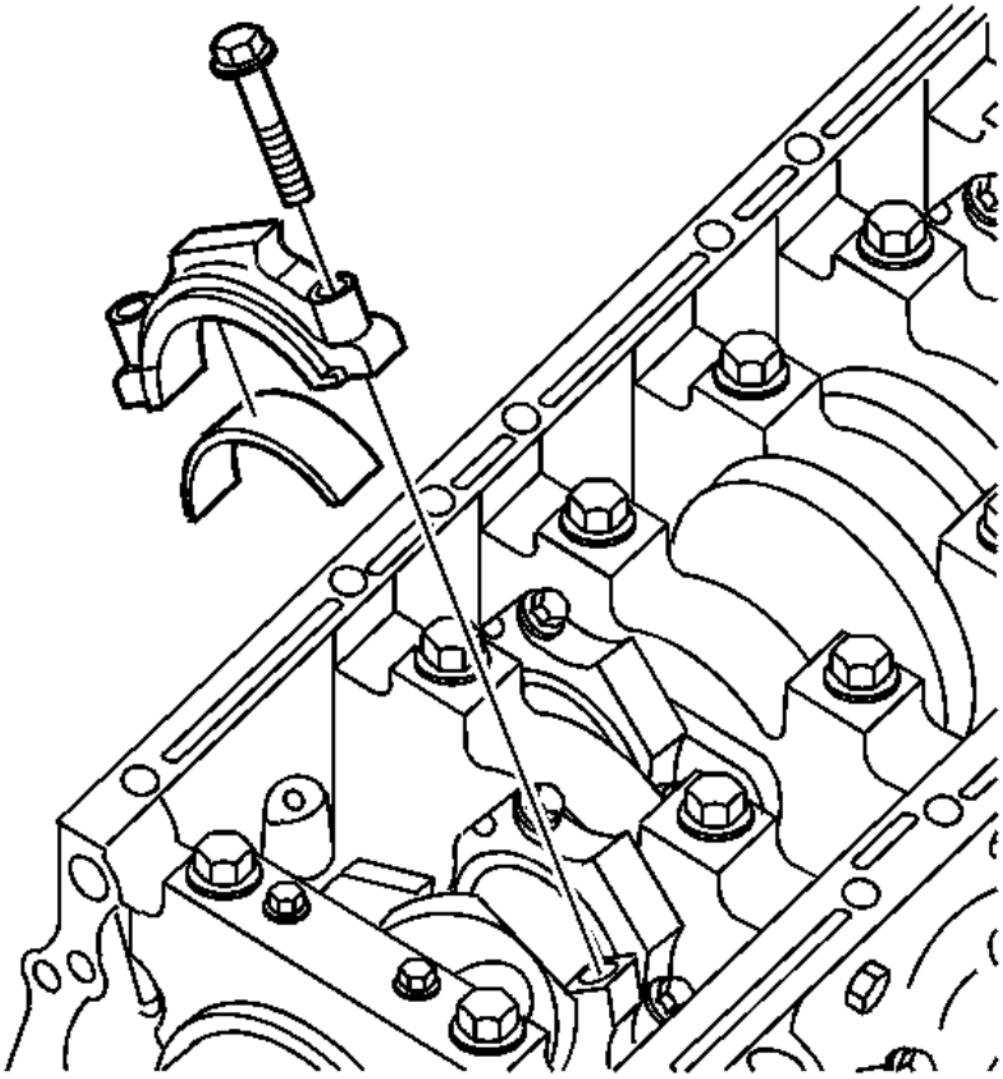


Fig. 93: View Of Connecting Rod Cap & Bearing Insert
Courtesy of GENERAL MOTORS CORP.

3. Install the connecting rod bearing inserts.
4. Lubricate the cylinder wall and piston rings with engine oil.
5. Install the **J 8037** to the piston to compress the piston rings.

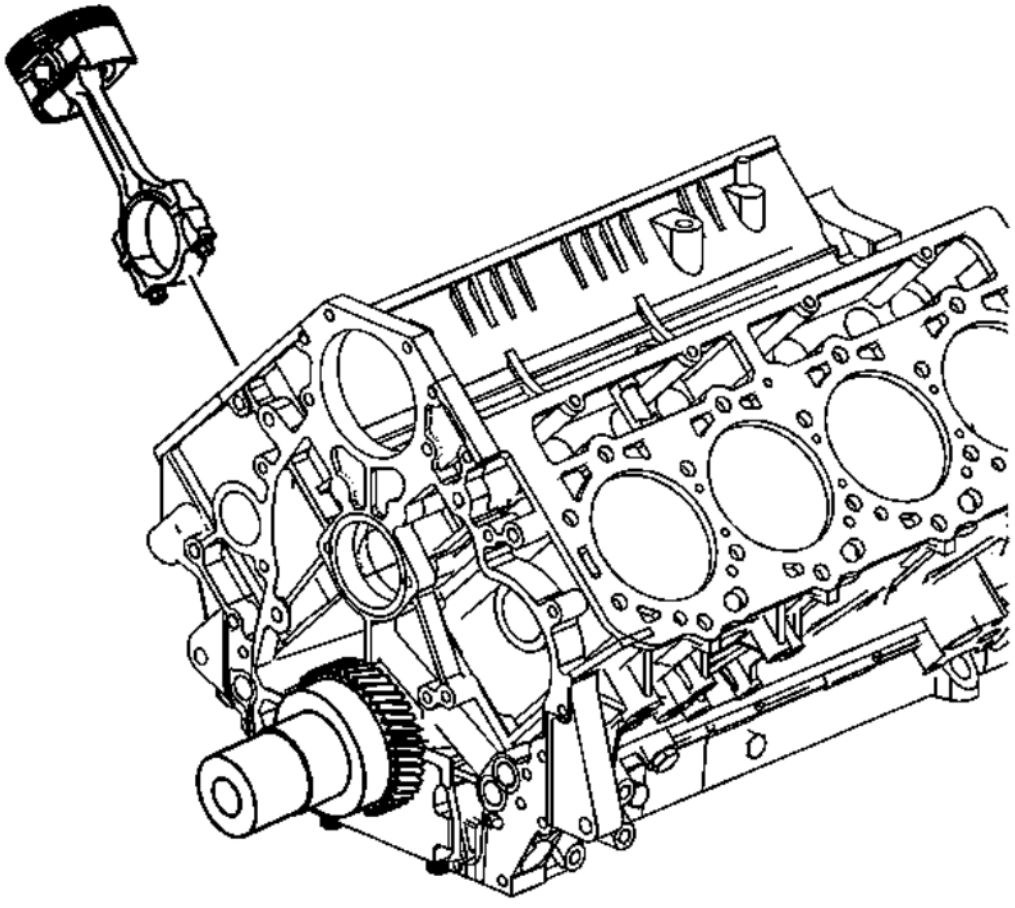


Fig. 94: View Of Piston Assembly
Courtesy of GENERAL MOTORS CORP.

6. Orientate the piston front mark and the piston inside mark to the engine block.

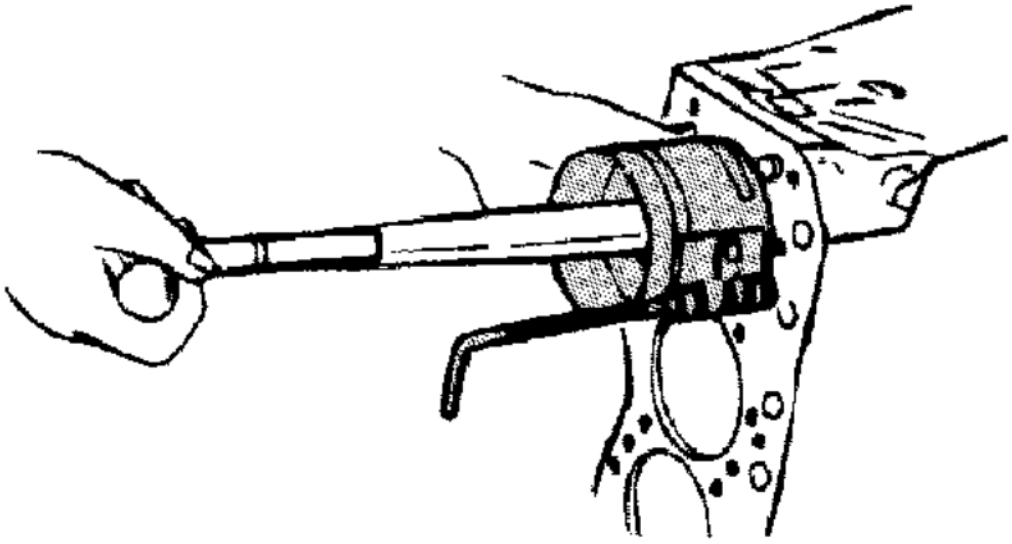


Fig. 95: Pushing Piston & Connecting Rod Assembly Into Engine
Courtesy of GENERAL MOTORS CORP.

NOTE: The chamfered side of the connecting rod large journal ends must face away from each other on a common crankshaft journal. Placement of the chamfered side of the connecting rod large journal ends in any other direction or combination will cause damage to the crankshaft, connecting rod and connecting rod bearing.

7. Push the piston and connecting rod assembly into the engine.

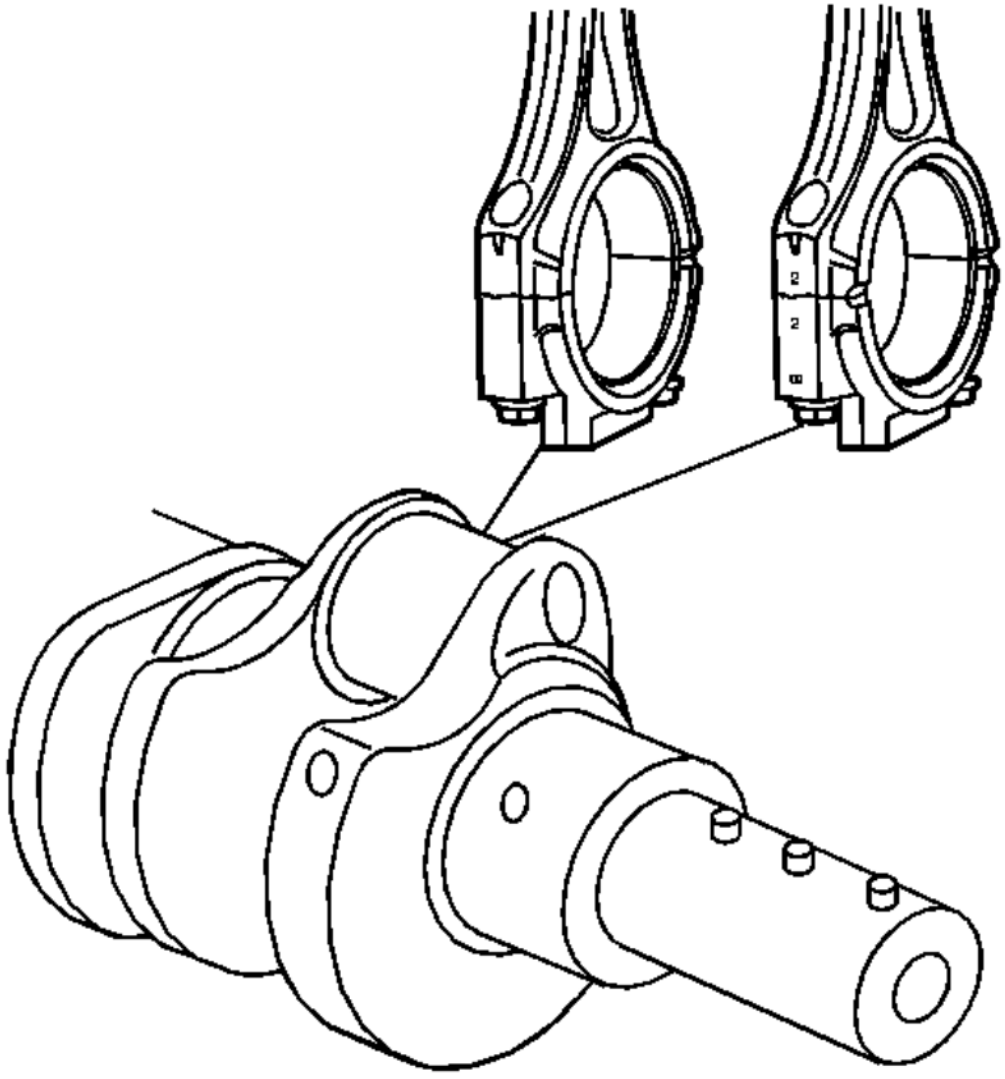


Fig. 96: View Of Connecting Rods
Courtesy of GENERAL MOTORS CORP.

8. Install the gauging plastic onto the connecting rod journal. Install the gauging plastic the full width of the journal.
9. Install the connecting rod cap with its stamped cylinder number aligned with the stamped cylinder number on the connecting rod.

NOTE: Refer to Fastener Notice .

10. Install the original connecting rod cap bolts for the plastic gauging. NEW bolts will be used for final assembly.
11. Tighten the bolts in three steps.

Tighten:

1. 1st step 64 N.m (47 lb ft)
2. 2nd step 30 degrees using **J 45059**
3. 3rd step 30 degrees using **J 45059**

12. Remove the connecting rod cap bolts.
13. Compare the width of the gauging plastic with the scale printed on the gauging plastic container. The connecting rod bearing clearance should be 0.10 mm (0.0039 in).
14. Discard the original connecting rod bolts once the plastic gauging is completed. NEW connecting rod bolts will be used for final assembly.
15. Carefully clean the gauging plastic from the bearing surface and the crankpin.
16. Lubricate the connecting rod bearing inserts with engine oil.
17. Install the connecting rod caps with the stamped cylinder number aligned with the stamped cylinder number on the connecting rods.

NOTE: This component uses bolts with a preapplied molybdenum disulfide coating for thread lubrication. Do not remove the coating or use any additional lubricant. Improperly lubricated threads will adversely affect the bolt torque and clamp load. Improper bolt torque and clamp load can lead to engine damage.

18. Install NEW connecting rod cap bolts.
19. Tighten the connecting rod cap bolts in three steps.

Tighten:

1. 1st step 64 N.m (47 lb ft)
2. 2nd step 30 degrees using **J 45059**
3. 3rd step 30 degrees using **J 45059**

PISTON OIL COOLING NOZZLE INSTALLATION

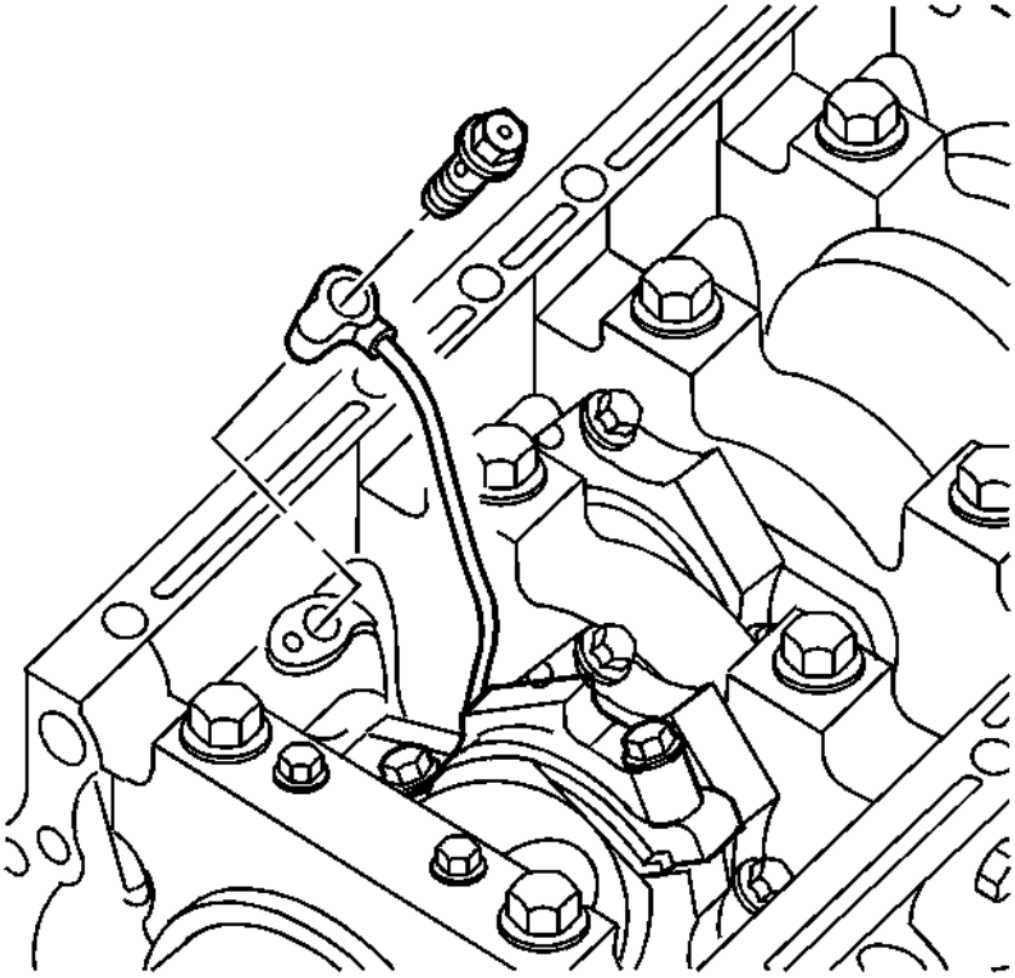


Fig. 97: View Of Piston Oil Cooling Nozzle
Courtesy of GENERAL MOTORS CORP.

1. Install the piston oil cooling nozzle.

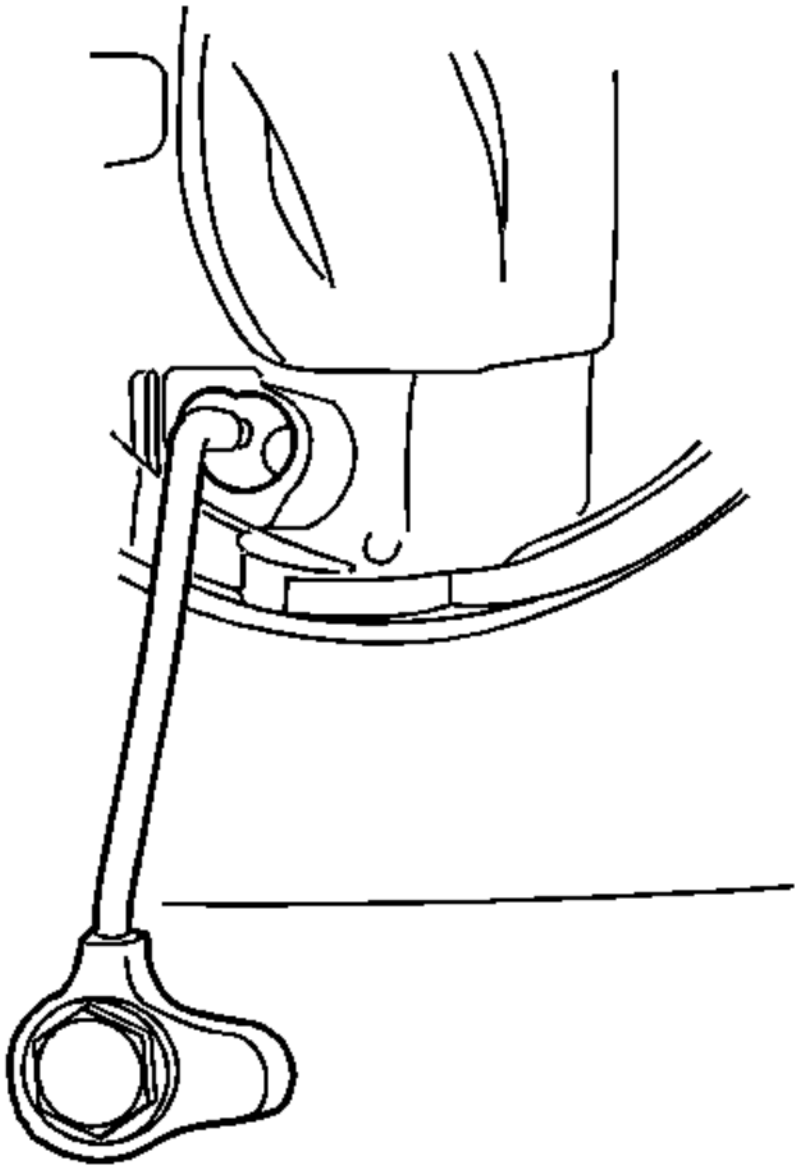


Fig. 98: Aligning Oil Cooling Nozzle
Courtesy of GENERAL MOTORS CORP.

NOTE: The piston oil cooling nozzle must be aligned to direct oil towards the oil inlet hole on the bottom of the piston. Improper

alignment of the piston oil cooling nozzle will allow insufficient oil lubrication to the piston and cause severe engine damage.

NOTE: Refer to Fastener Notice .

2. Install the piston oil cooling nozzle bolt.

Tighten: Tighten the piston oil cooling nozzle bolts to 21 N.m (15 lb ft).

OIL PUMP INSTALLATION

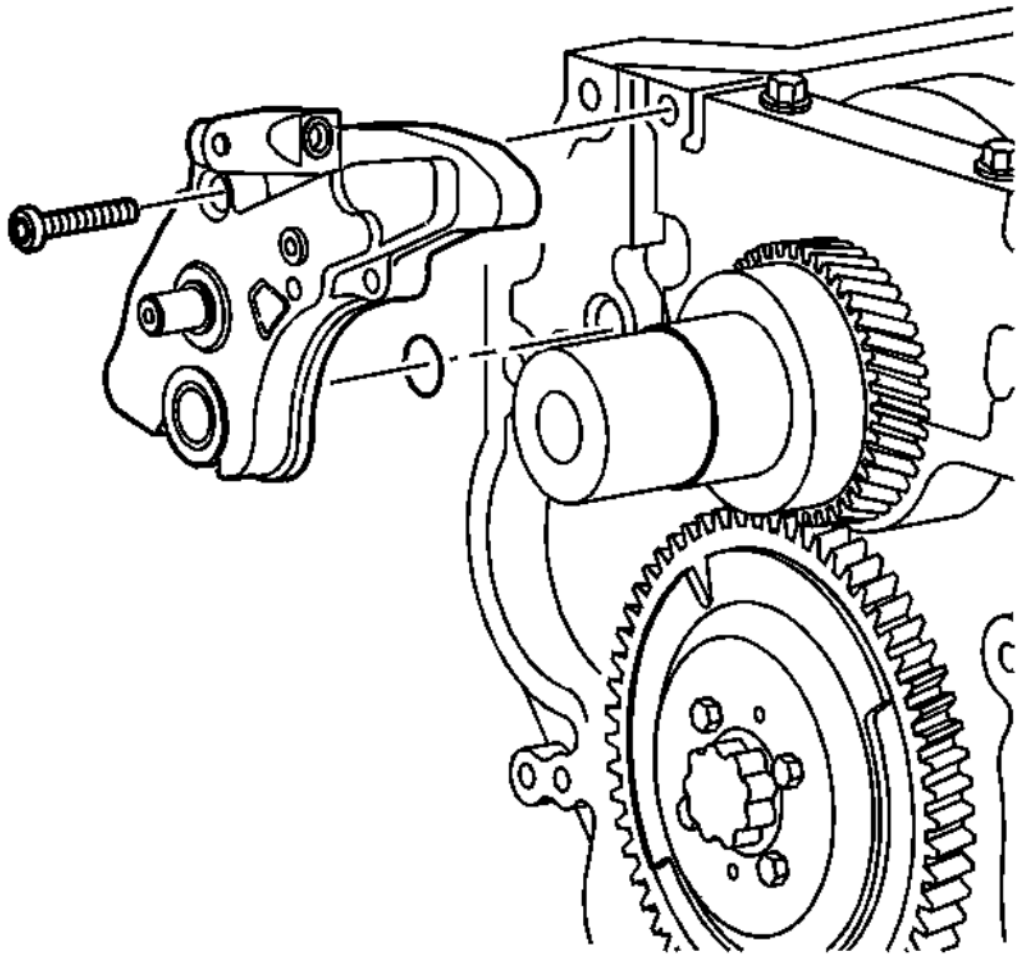


Fig. 99: View Of Oil Pump, Bolts & O-Ring

Courtesy of GENERAL MOTORS CORP.

1. Install a new O-ring to the engine block.
2. Lubricate the O-ring with engine oil.
3. Install the oil pump.

NOTE: Refer to Fastener Notice .

4. Install the oil pump bolts.

Tighten: Tighten the oil pump bolts to 21 N.m (15 lb ft).

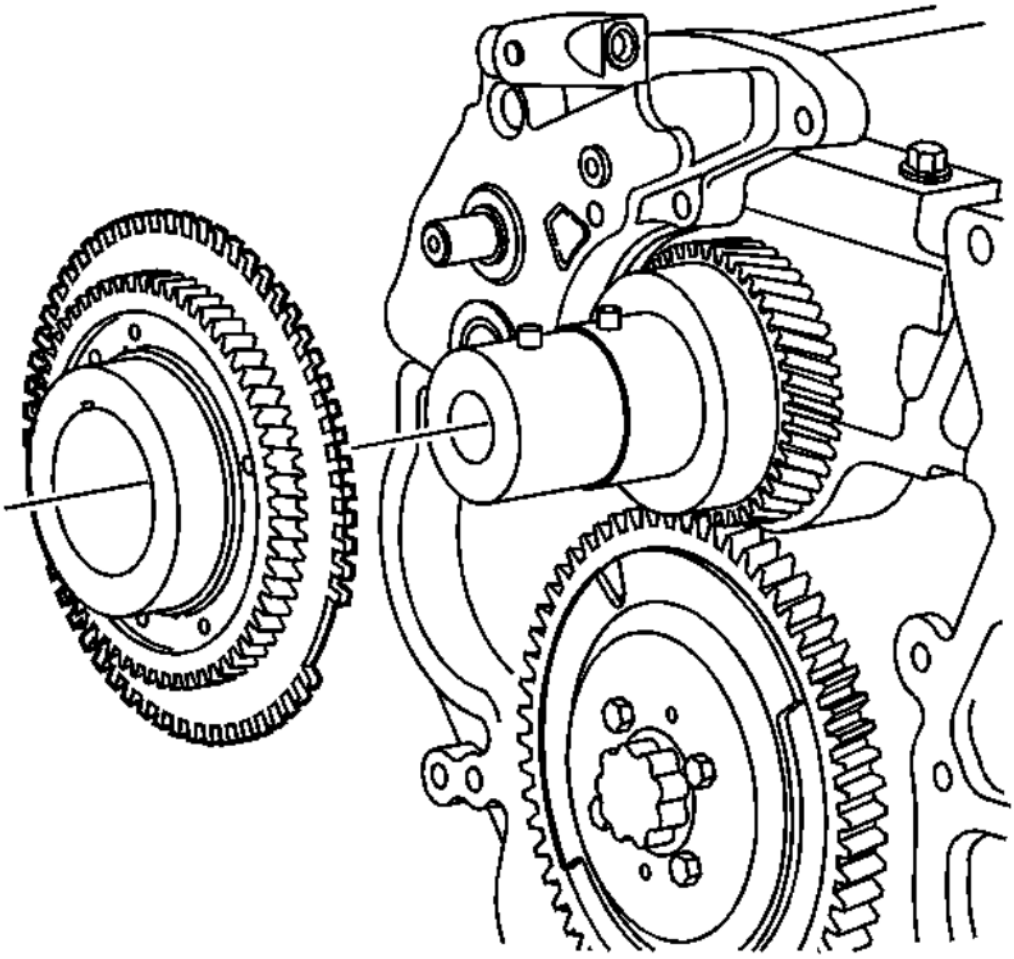


Fig. 100: View Of Oil Pump Drive Gear
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not damage the crankshaft sensor reluctor teeth.

5. Install the oil pump drive gear and crank sensor reluctor assembly.

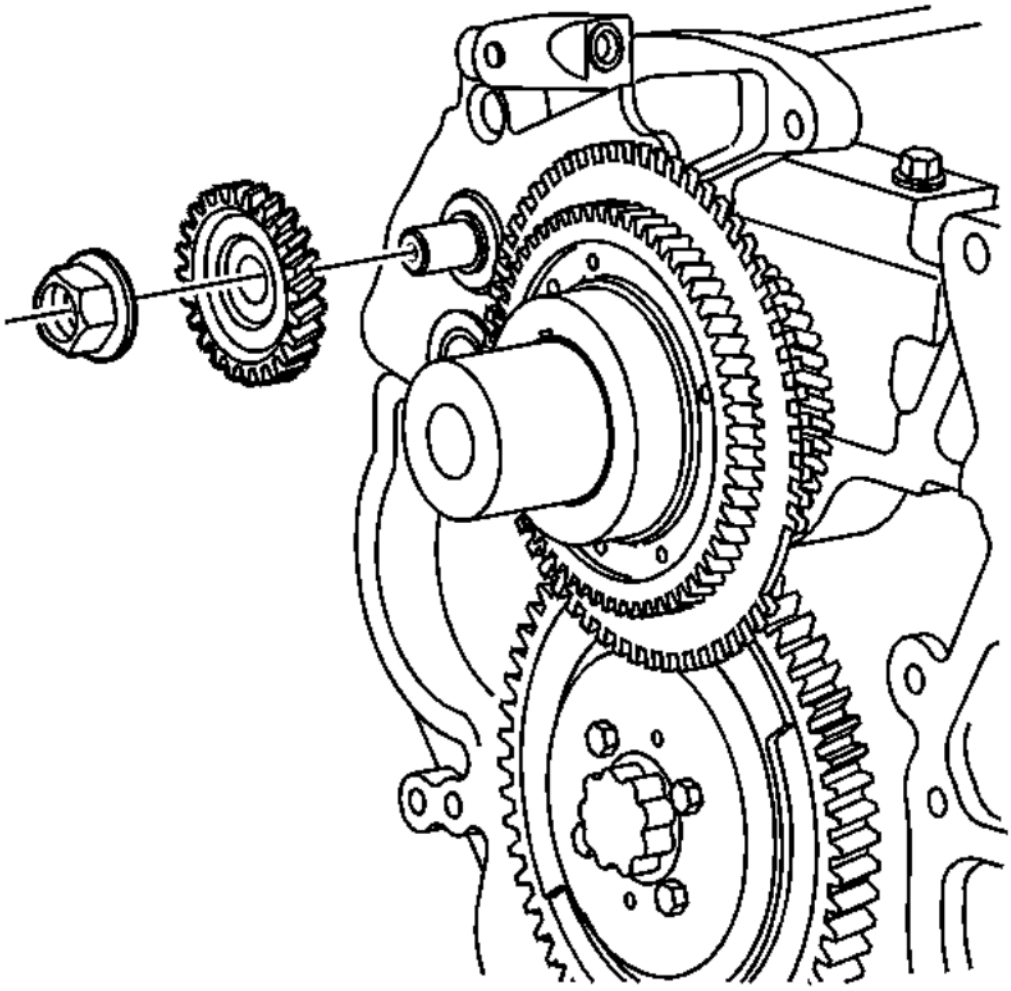


Fig. 101: View Of Oil Pump Driven Gear
Courtesy of GENERAL MOTORS CORP.

6. Install the oil pump driven gear.

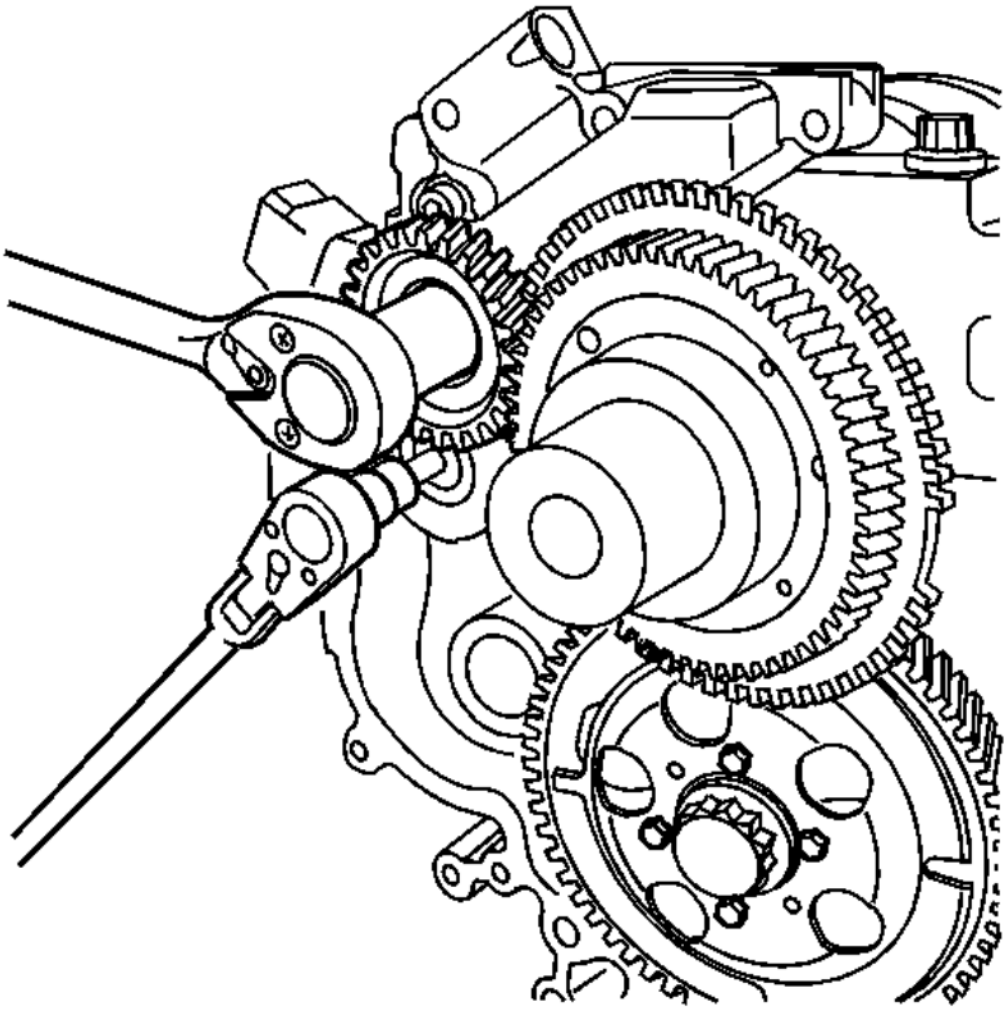


Fig. 102: Removing/Installing Secondary Oil Pump Driven Gear Nut While Holding Oil Pump Shaft
Courtesy of GENERAL MOTORS CORP.

NOTE: **Do not use an impact driver to remove or install the oil pump driven gear nut. Use of an impact driver may shear the oil pump drive gear pin in the crankshaft.**

IMPORTANT: Look for an "L" on the end of the oil pump shaft. If there is an

"L" present, the nut and shaft have left hand threads. Service the nut accordingly.

7. While holding the secondary oil pump shaft with a hex driver, install the oil pump driven gear nut.

   Tighten: Tighten the oil pump driven gear nut to 100 N.m (74 lb ft).

OIL PUMP SUCTION PIPE AND SCREEN ASSEMBLY INSTALLATION

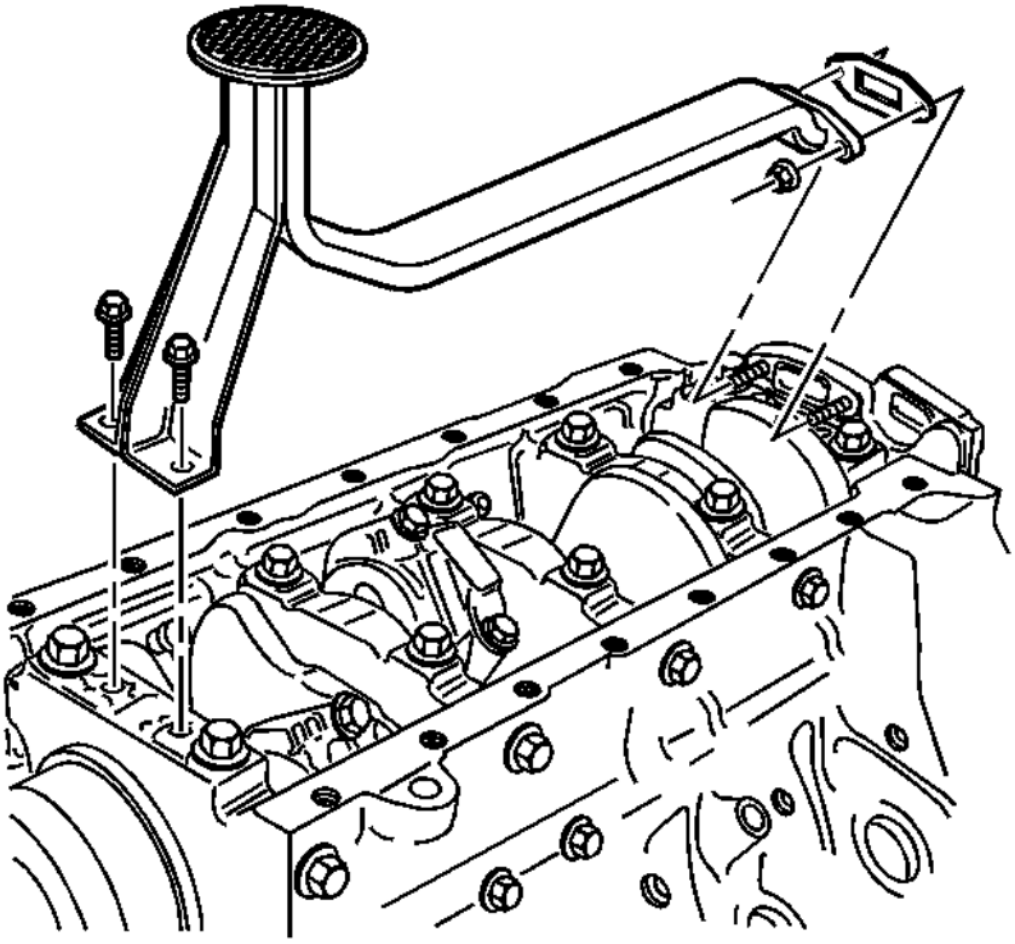


Fig. 103: View Of Oil Pump Pipe, Screen Assembly & Gasket
Courtesy of GENERAL MOTORS CORP.

1. Install the oil pump pipe and screen gasket.
2. Install the oil pump pipe and screen.

NOTE: Refer to Fastener Notice .

3. Install the oil pump pipe and screen assembly bolts and nuts.

Tighten:

- Tighten the oil pump pipe and screen assembly bolts to 25 N.m (18 lb ft).
- Tighten the oil pump pipe and screen assembly nuts to 25 N.m (18 lb ft).

ENGINE FRONT COVER INSTALLATION

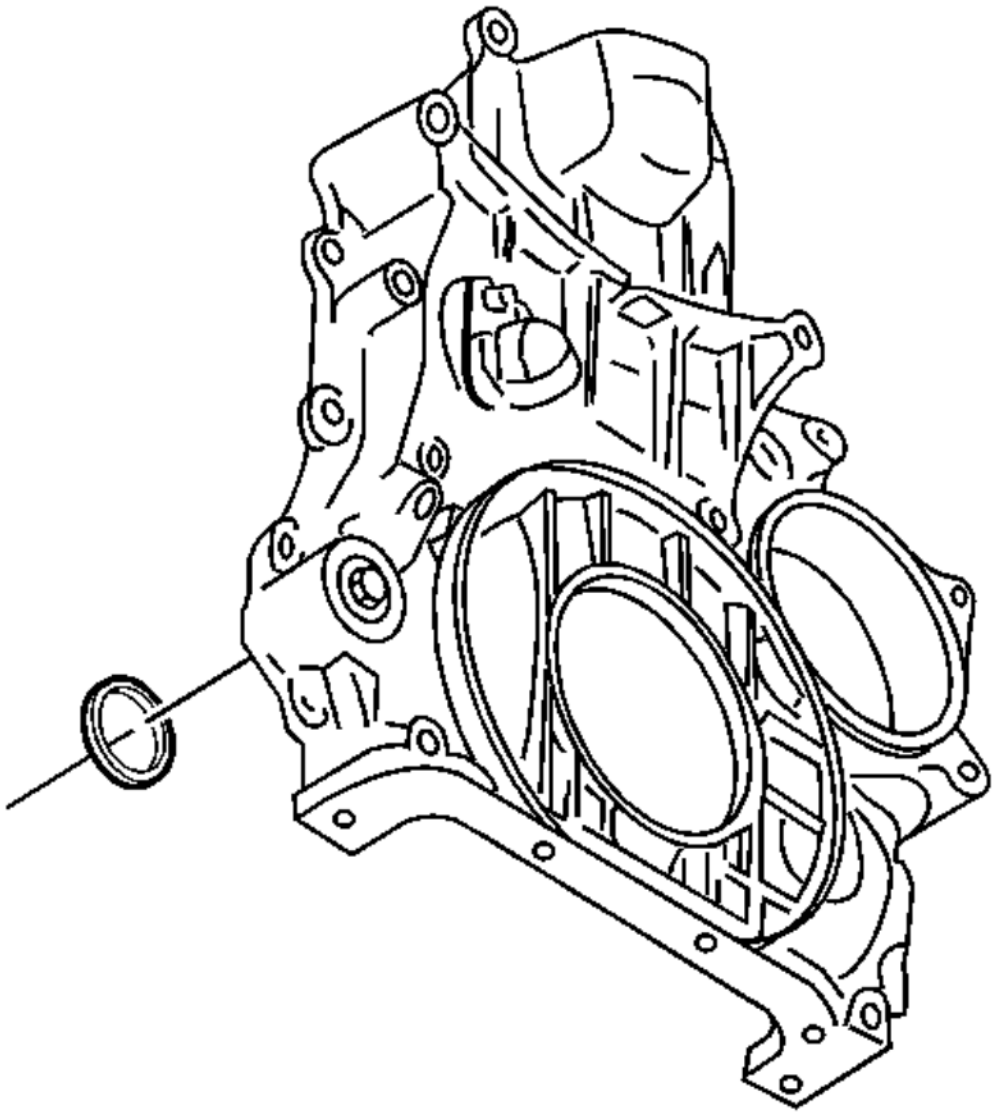


Fig. 104: View Of Pressure Relief Valve O-Ring
Courtesy of GENERAL MOTORS CORP.

1. Install the relief valve O-ring to the engine front cover.
2. Lubricate the O-ring with engine oil.

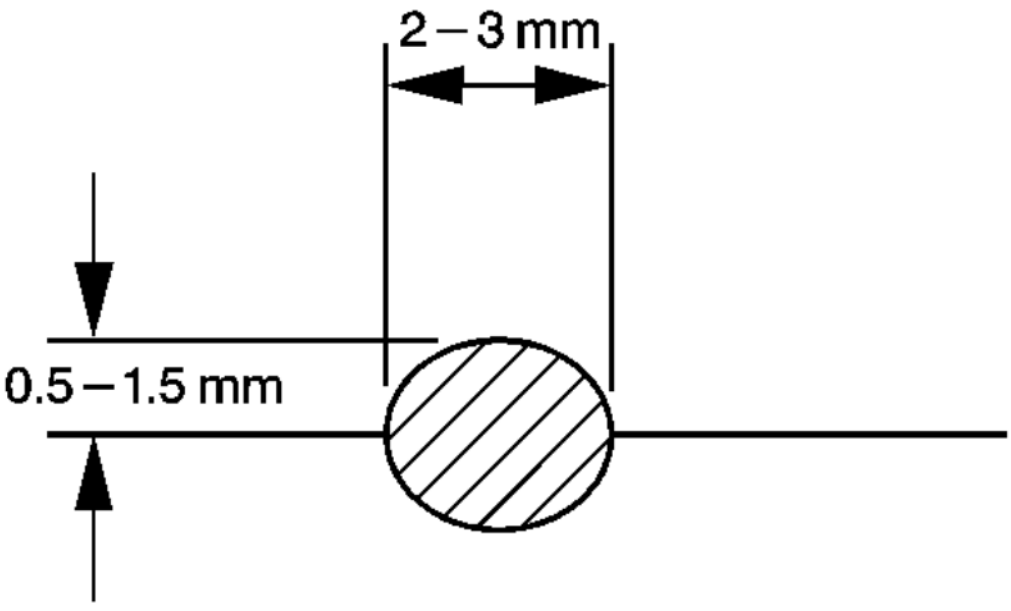


Fig. 105: Determining Sealant Bead Dimensions
Courtesy of GENERAL MOTORS CORP.

3. Apply a 2-3 mm wide and 0.5-1.5 mm high bead of GM P/N 12378521 (Canadian P/N 88901148) sealant to the mating surfaces of the engine front cover.

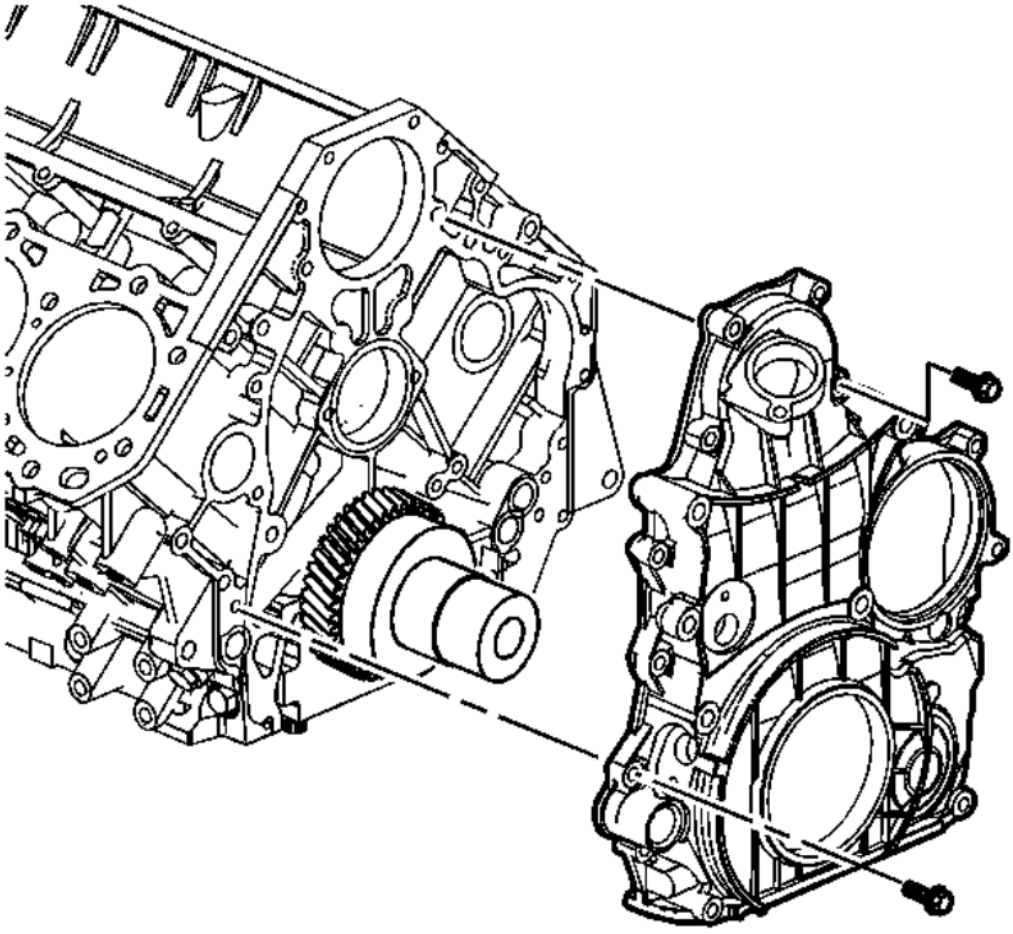


Fig. 106: View Of Engine Front Cover
Courtesy of GENERAL MOTORS CORP.

4. Install the engine front cover.

NOTE: **Refer to Fastener Notice .**

5. Install the engine front cover bolts.

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

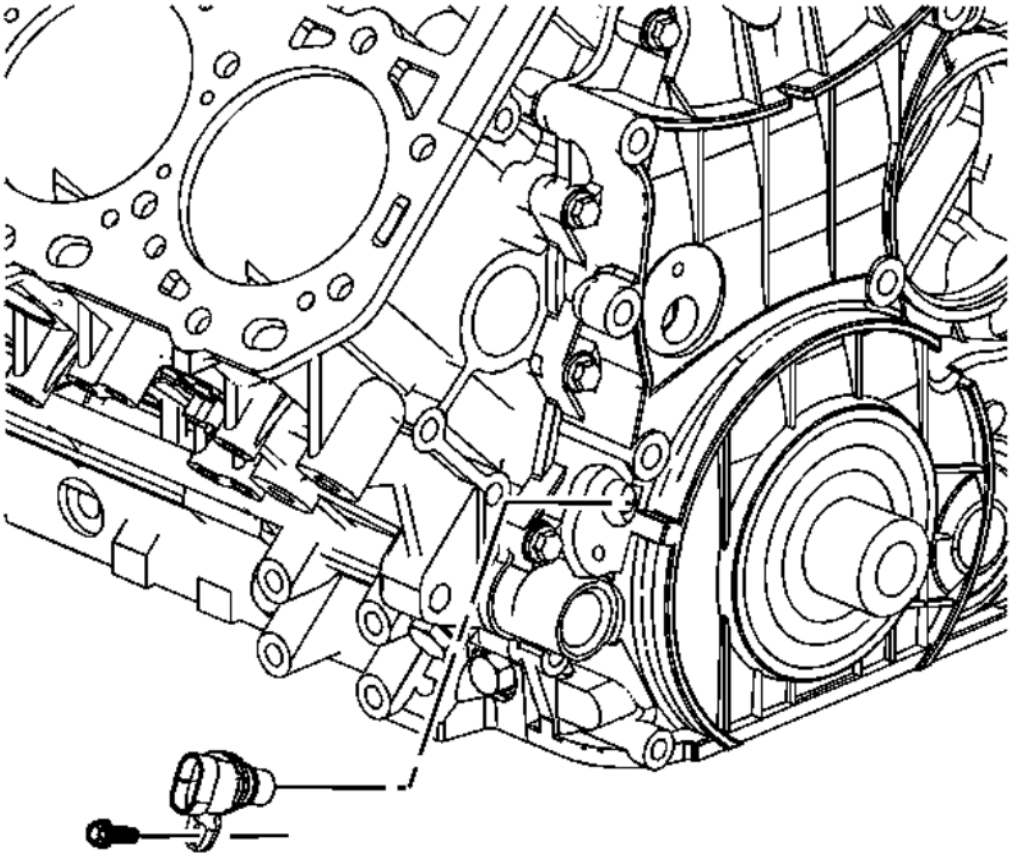


Fig. 107: View Of CKP Sensor & Bolt
Courtesy of GENERAL MOTORS CORP.

6. Install a new O-ring to the crankshaft position sensor spacer.
7. Lubricate the O-ring with engine oil.
8. Install the crankshaft position sensor spacer.
9. Install the crankshaft position sensor spacer bolts.

Tighten: Tighten the crankshaft position sensor spacer bolts to 10 N.m (89 lb in).

10. Install a new O-ring to the crankshaft position sensor.
11. Lubricate the O-ring with engine oil.
12. Install the crankshaft position sensor.

13. Install the crankshaft position sensor bolt.

    Tighten: Tighten the crankshaft position sensor bolt to 10 N.m (89 lb in).

CRANKSHAFT FRONT OIL SEAL INSTALLATION

Tools Required

J 44645 Crankshaft Front Oil Seal Installer. See **Special Tools** .

Installation

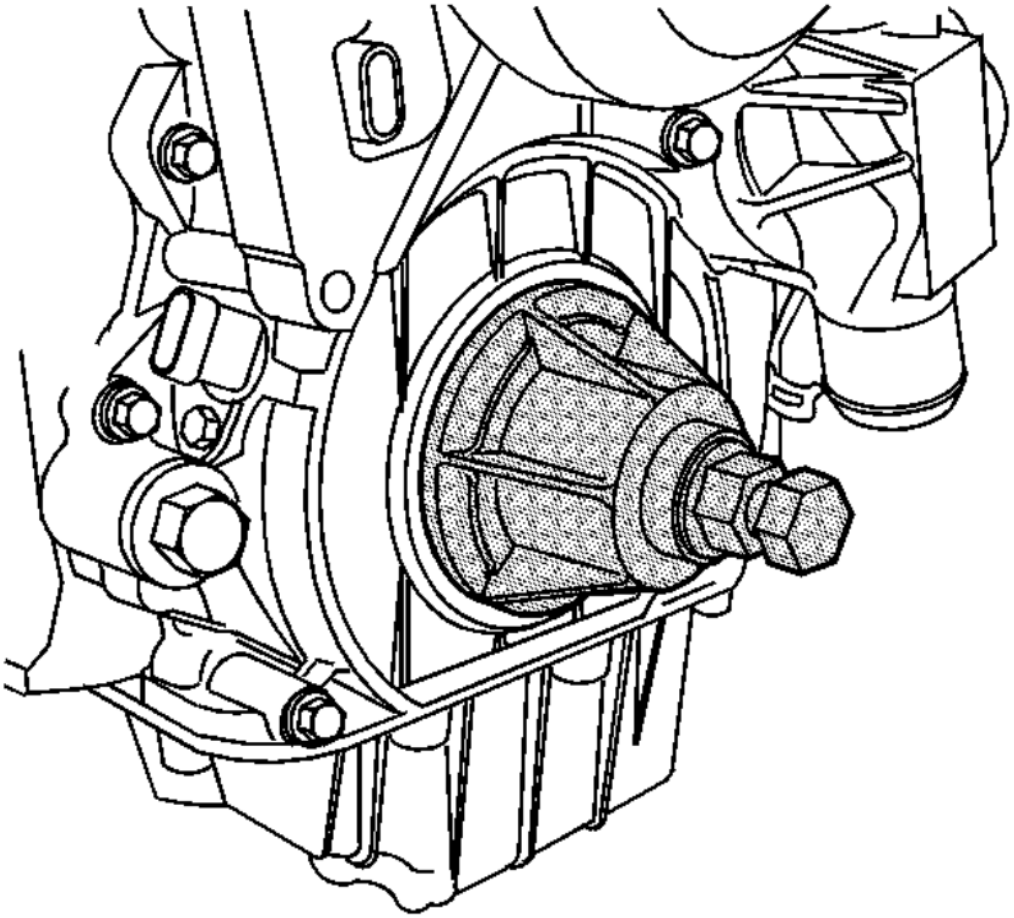


Fig. 108: Pressing Crankshaft Front Oil Seal On Using J 44645

Courtesy of GENERAL MOTORS CORP.

1. Lubricate the crankshaft sealing surface with engine oil.
2. Place the crankshaft front oil seal onto the crankshaft.
3. Install the **J 44645** to the crankshaft. See **Special Tools** .
4. Press the crankshaft front oil seal onto the crankshaft with the **J 44645** until the tool bottoms out. See **Special Tools** .
5. Remove the **J 44645** . See **Special Tools** .

OIL FILTER ADAPTER AND OIL COOLER ASSEMBLY INSTALLATION

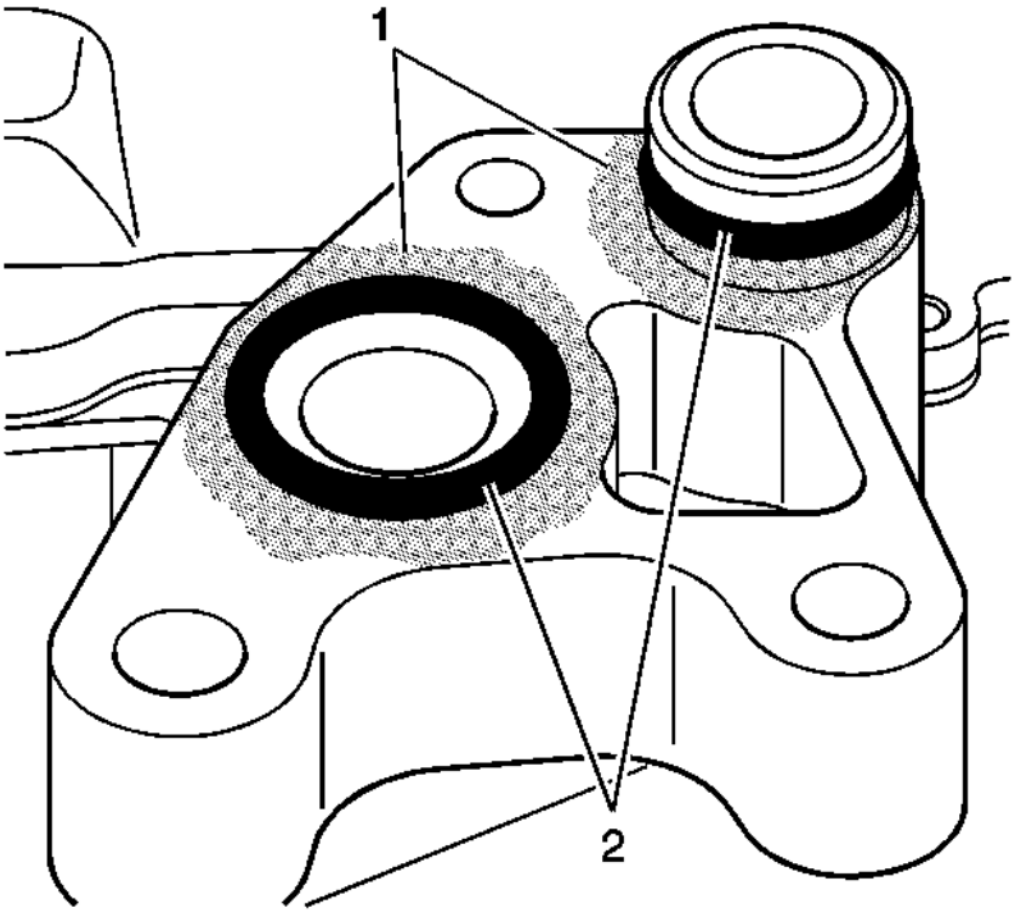


Fig. 109: Oil Cooler

Courtesy of GENERAL MOTORS CORP.

1. Install new O-rings (2) to the oil filter adapter and oil cooler assembly. Lubricate the O-rings with engine oil.
2. Apply sealer GM P/N 12378521 (Canadian P/N 88901148) to the O-ring sealing area (1).

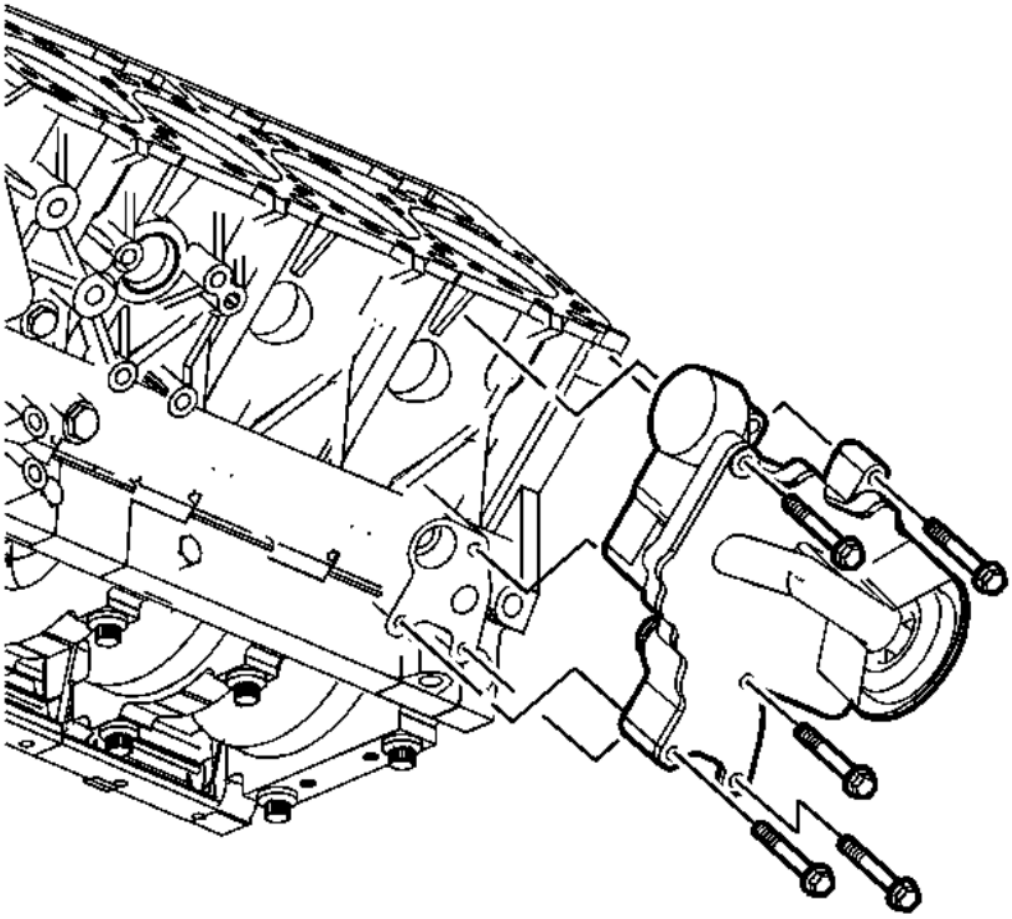


Fig. 110: View Of Oil Filter Adapter/Oil Cooler
Courtesy of GENERAL MOTORS CORP.

3. Install the oil filter adapter and oil cooler assembly.

NOTE: Refer to Fastener Notice .

4. Install the five oil filter adapter and oil cooler assembly bolts (1).

   Tighten: Tighten the oil filter adapter and oil cooler assembly bolts to 25 N.m (18 lb ft).

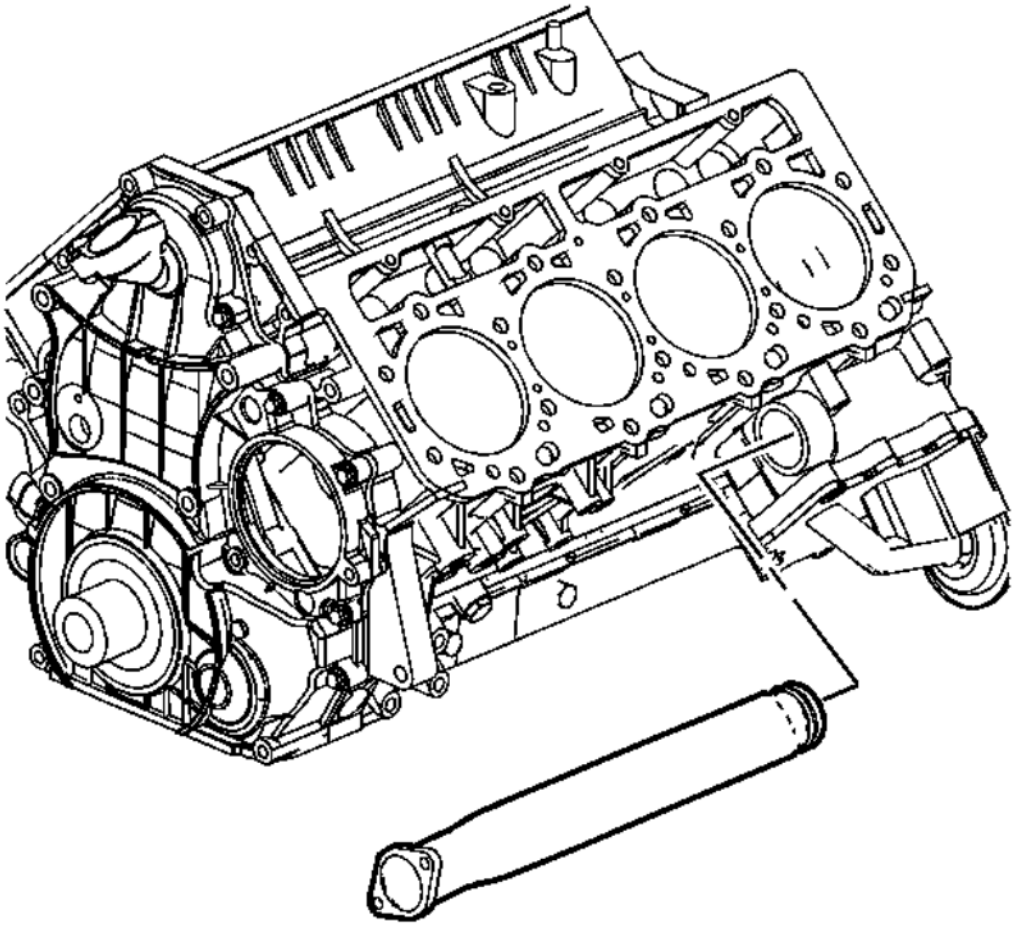


Fig. 111: View Of Engine Coolant Pipe
Courtesy of GENERAL MOTORS CORP.

5. Install a new O-ring onto the engine coolant pipe.
6. Lubricate the O-ring with engine coolant. Do not use oil or grease.
7. Install the engine coolant pipe to the oil filter adapter and oil cooler assembly.

WATER PUMP INSTALLATION

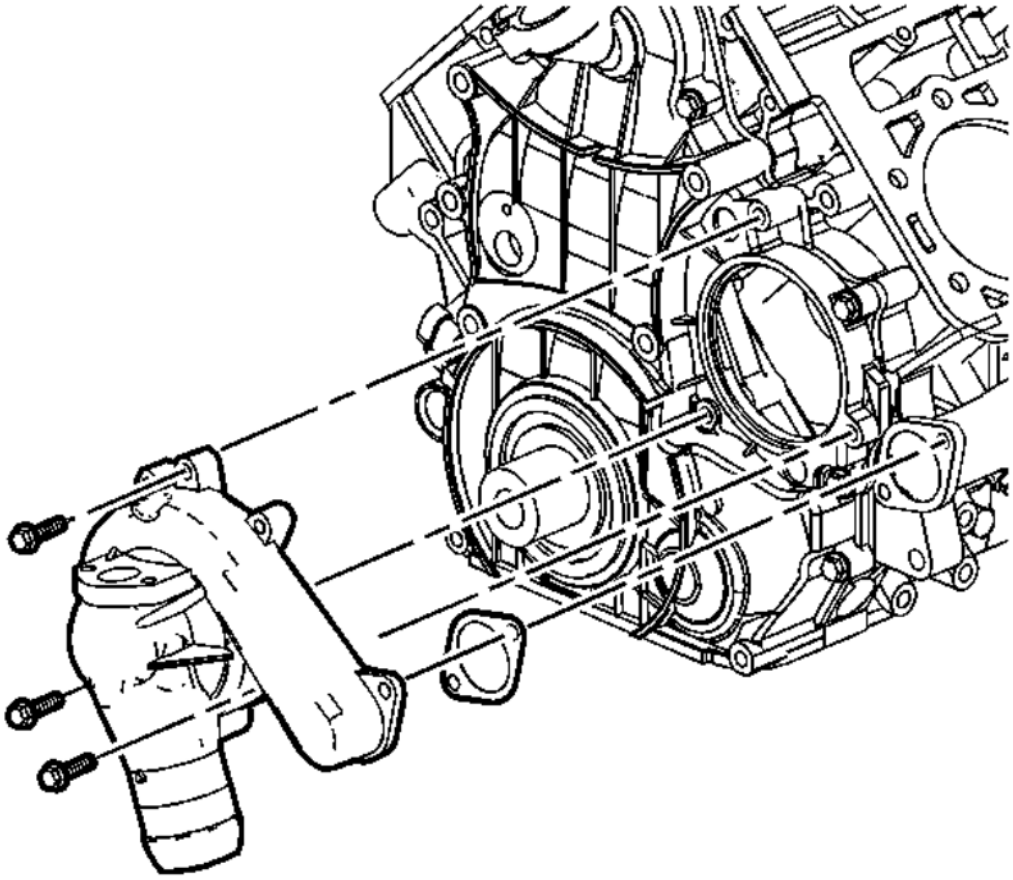


Fig. 112: View Of Engine Coolant Pipe & Gasket
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the water pump O-ring with engine oil.
2. Install the engine coolant pipe gasket.
3. Install the water pump seal.
4. Install the water pump. Be sure the water pump studs align with the coolant tube.

NOTE: **Refer to Fastener Notice .**

5. Install the water pump bolts.

Tighten: Tighten the water pump bolts to 25 N.m (18 lb ft).

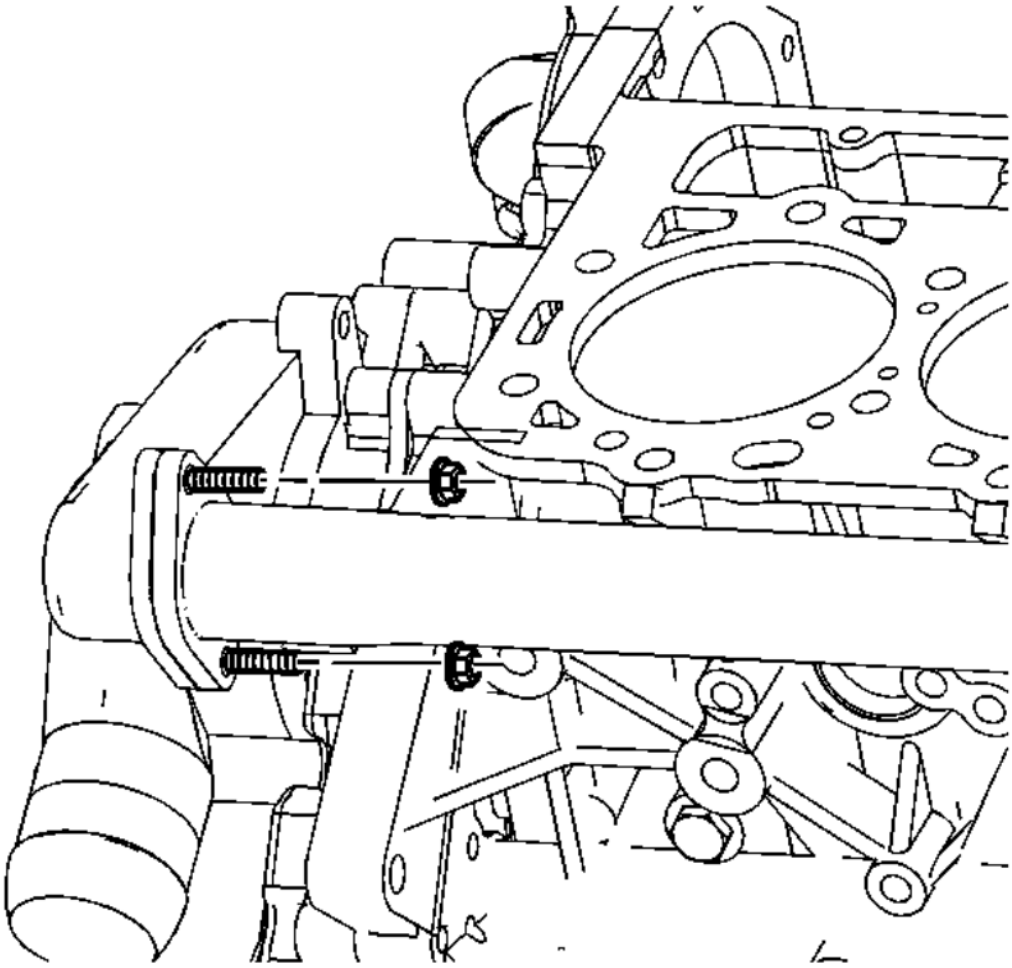


Fig. 113: View Of Water Pump Outlet Pipe Nuts
Courtesy of GENERAL MOTORS CORP.

6. Install the water pump to coolant tube nuts.

   Tighten: Tighten the water pump to coolant tube nuts to 25 N.m (18 lb ft).

FUEL INJECTION PUMP INSTALLATION

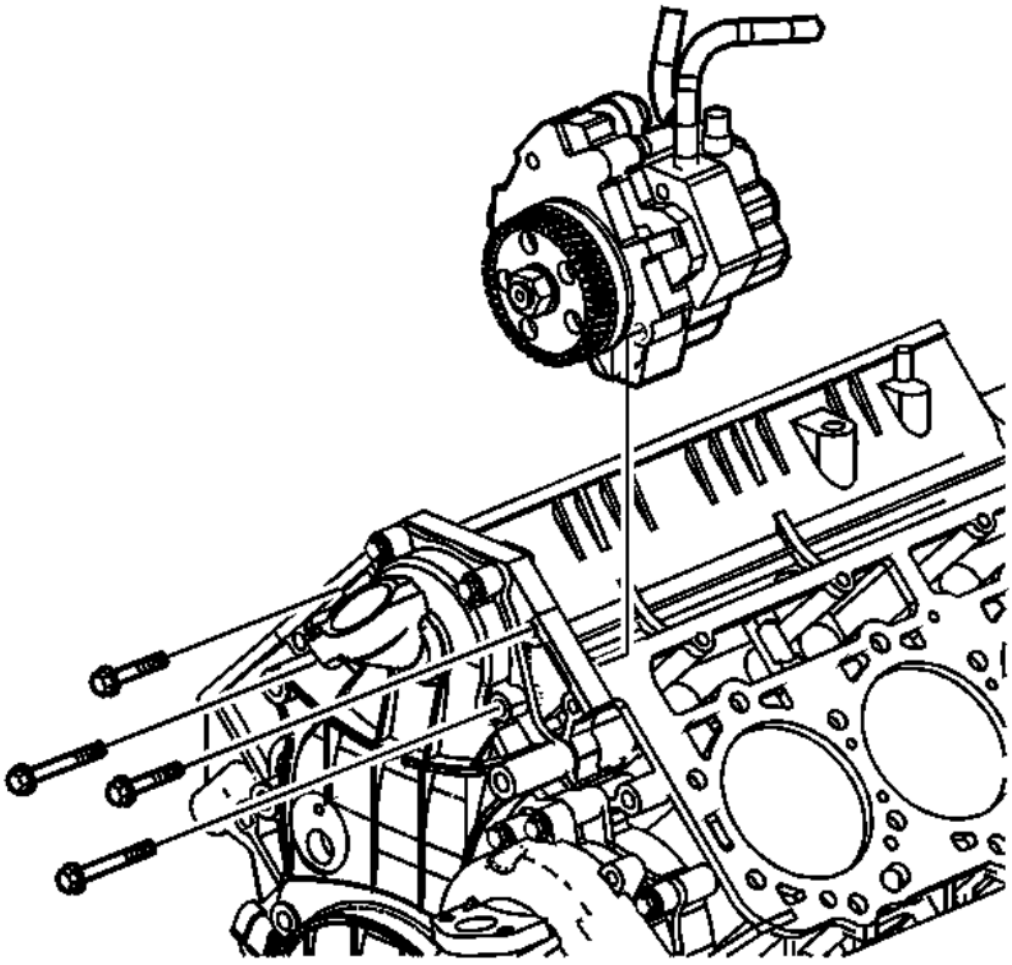


Fig. 114: View Of Fuel Injection Pump
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the O-ring on the fuel injection pump adapter with engine oil.

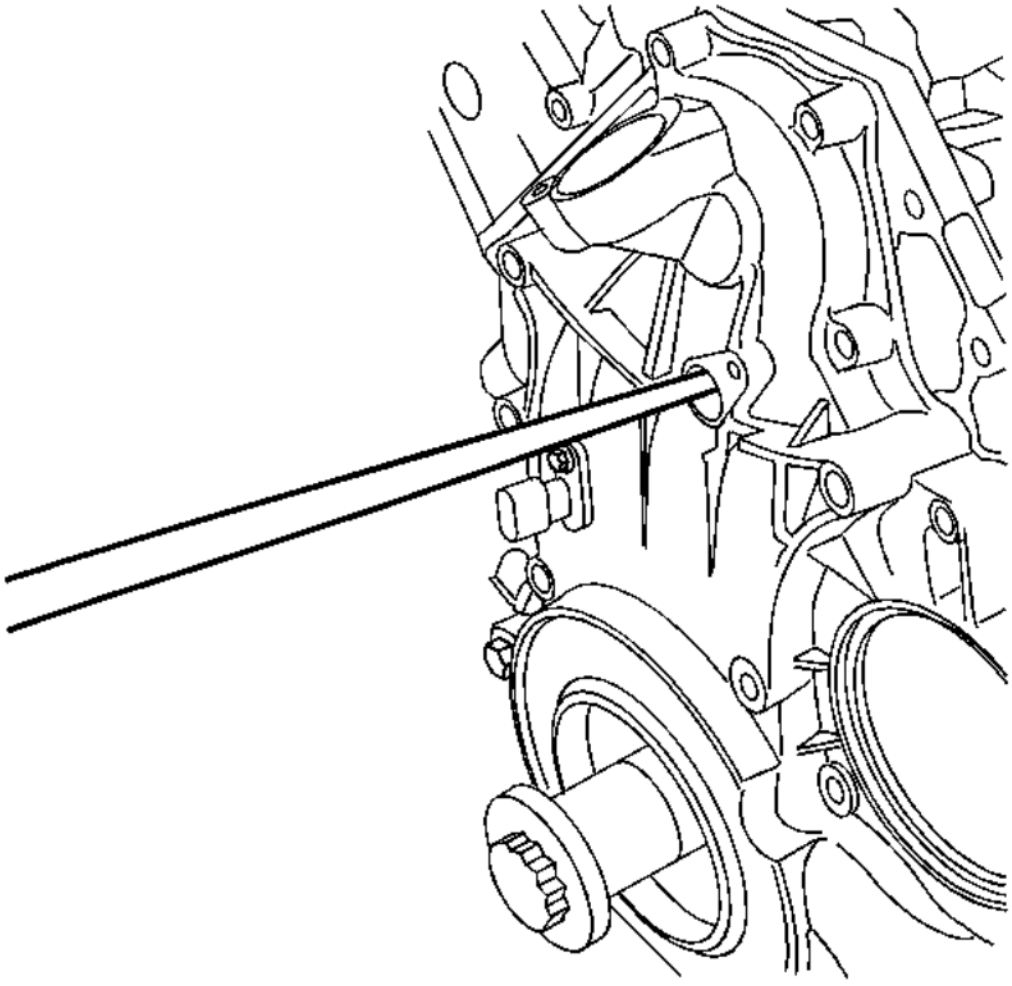


Fig. 115: Identifying Two Piece Cam Gear
Courtesy of GENERAL MOTORS CORP.

2. Use a suitable tool to unload the spring tension from the two piece cam gear. Apply pressure towards the right side of the engine while installing the fuel injection pump.
3. Install the fuel injection pump and adapter assembly.

NOTE: Refer to Fastener Notice .

4. Install the fuel injection pump bolts.

Tighten: Tighten the fuel injection pump bolts to 25 N.m (18 lb ft).

VALVE LIFTER INSTALLATION

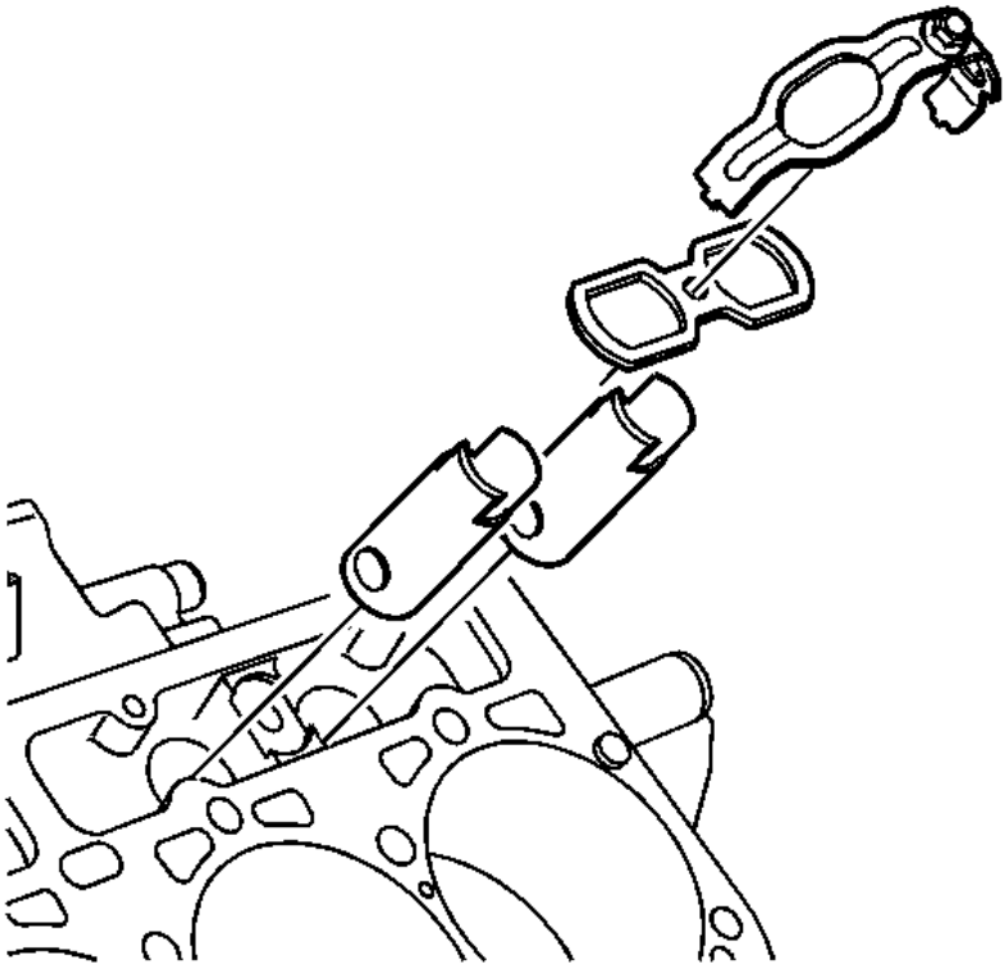


Fig. 116: View Of Valve Lifter, Guides, Retainers & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the valve lifter.
2. Install the valve lifter guides.
3. Install the valve lifter guide hold down bracket.

NOTE: Refer to Fastener Notice .

4. Install the valve lifter guide hold down bracket bolt.

   Tighten: Tighten the valve lifter guide hold down bracket bolt to 11 N.m (97 lb in).

CYLINDER HEAD GASKET SELECTION

Tools Required

J 7872 Dial Indicator Set

Selection

1. If a reciprocating component (crankshaft, connecting rod, piston, or bearings) has not been replaced, install the same grade head gasket that was removed.

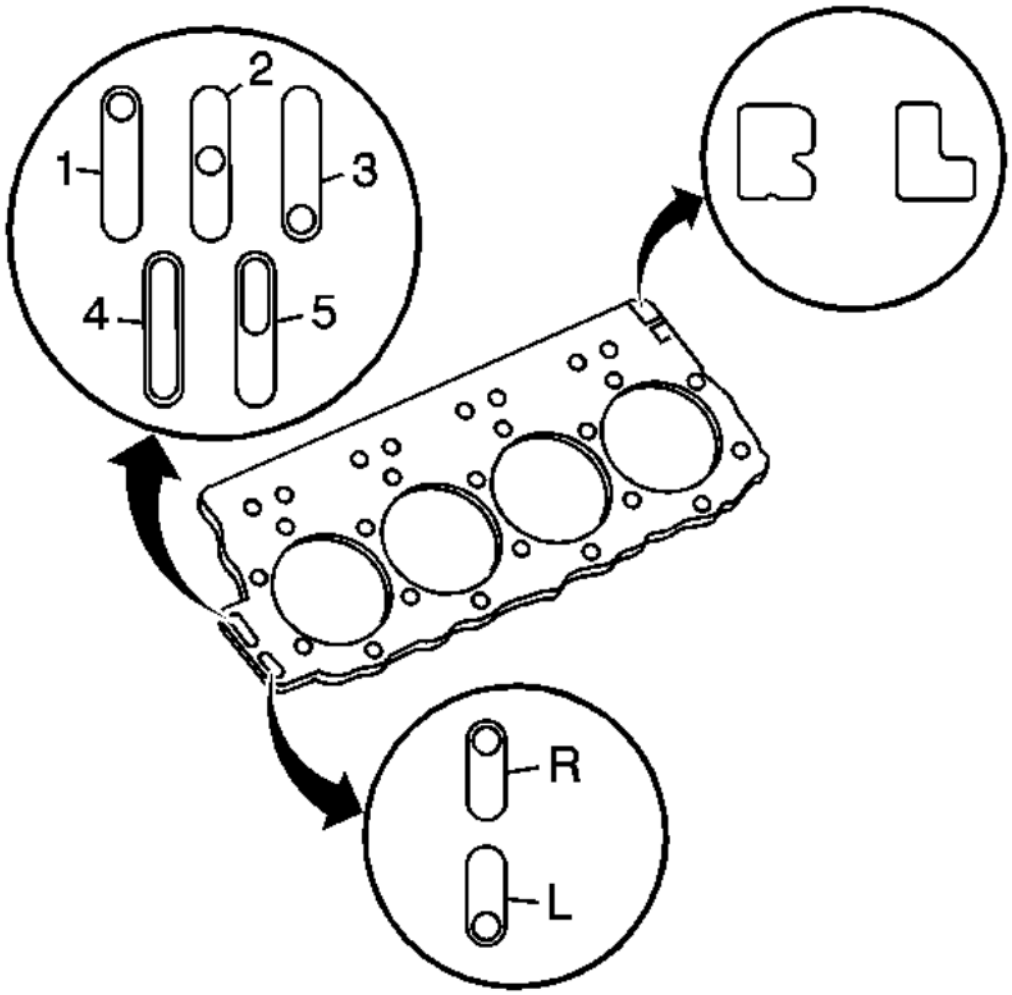


Fig. 117: View Of Cylinder Head Gasket Markings
Courtesy of GENERAL MOTORS CORP.

2. The markings on the gasket are as follows:
   - Grade A (1)
   - Grade B (2)
   - Grade C (3)
   - Block over-bored 0.010-0.030 in (0.254-0.762 mm) (4)
   - Block over-bored 0.010-0.030 in (0.254-0.762 mm) and deck milled 0.008 in (0.203

mm) (5)

3. The cylinder head gasket thickness is determined by the piston head projection from the cylinder block deck surface. There are cylinder head gaskets available in three different thicknesses. Follow the procedure below and refer to **Cylinder Head Gasket Selection Specifications** to determine what gasket to use for each bank of cylinders.
4. Be sure the piston and cylinder deck are free of carbon, gasket material, or other objects that may give you an erroneous measurement.

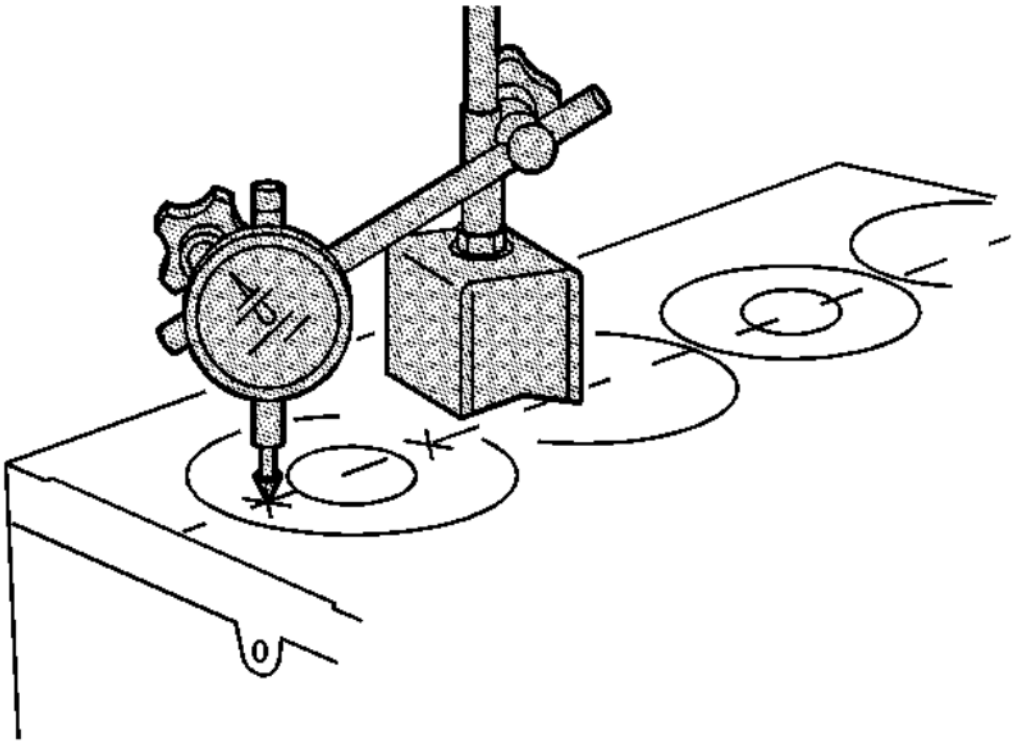


Fig. 118: Measuring Piston Projection Using J 7872
Courtesy of GENERAL MOTORS CORP.

5. Use **J 7872** to measure the piston projection across two different points on each piston.
    1. Zero the dial indicator to the cylinder deck surface.
    2. Place the dial indicator pointer on the piston top. Be sure the pointer is directly above the piston pin centerline to prevent inaccurate readings from piston rocking.

3. Rotate the engine to roll the piston through Top Dead Center while noting the maximum reading on the dial indicator.
4. Repeat procedure at the second measuring point on the piston.

6. Calculate the average value of piston projection for each cylinder.
7. Obtain the maximum piston projection value for that bank of cylinders.
8. Determine the gasket grade by the maximum piston projection value using the chart.
9. If the difference between the highest measured piston head projection and the lowest measured piston projection, within one bank of cylinders, exceeds 0.1 mm (0.0039 in), then the following items need to be checked.
   - Connecting rod to piston pin clearance
   - Piston to piston pin clearance

If any of the above clearances are beyond specifications, then refer to the appropriate section for repair. If all of the above clearances are within the service limits but the piston projection variation is over 0.1 mm (0.0039 in), then replace the connecting rod and piston assembly.

CYLINDER HEAD INSTALLATION - LEFT SIDE

Tools Required

J 45059 Angle Meter

Installation

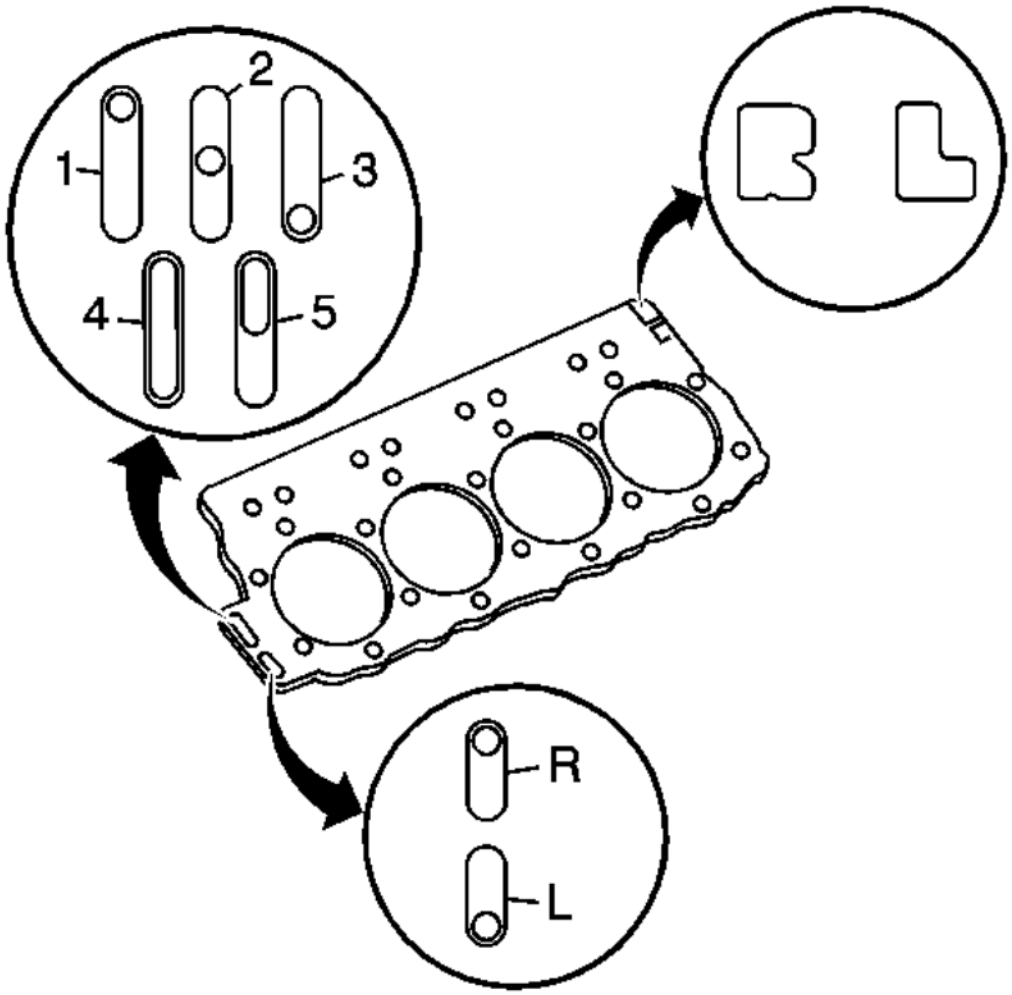


Fig. 119: View Of Cylinder Head Gasket Markings
Courtesy of GENERAL MOTORS CORP.

NOTE: **The left and right cylinder head gaskets are not interchangeable. Improper placement of the cylinder head gasket will block coolant and oil passages. Blocked coolant and oil passages will cause severe engine damage.**

IMPORTANT: The stamped letter, R or L, must face up. R is the right bank, L is the left bank.

1. The markings on the gasket are as follows:
   - Grade A (1)
   - Grade B (2)
   - Grade C (3)
   - Block over-bored 0.010-0.030 in (0.254-0.762 mm) (4)
   - Block over-bored 0.010-0.030 in (0.254-0.762 mm) and deck milled 0.008 in (0.203 mm) (5)
2. Install the left cylinder head gasket of the correct grade. The left and right cylinder head gaskets are not interchangeable. Refer to **Cylinder Head Gasket Selection**.

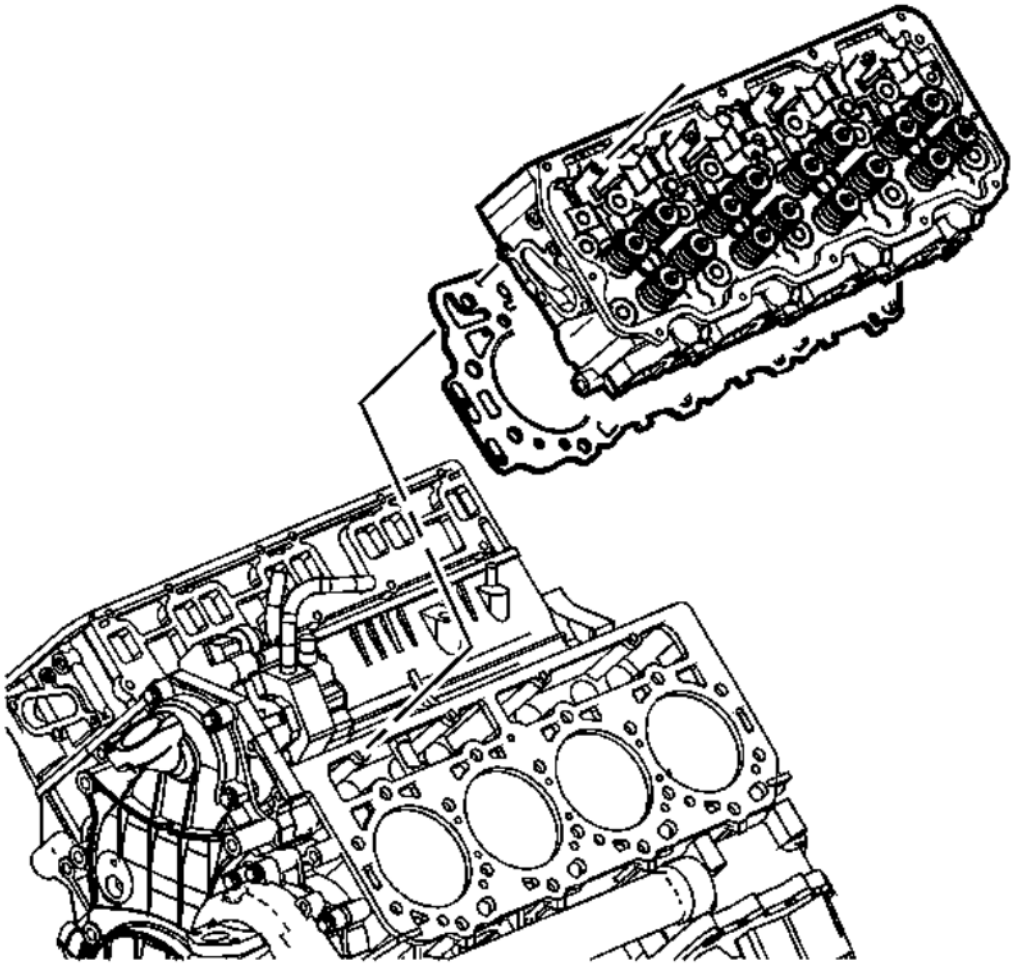


Fig. 120: View Of Left Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

3. Install the left cylinder head.

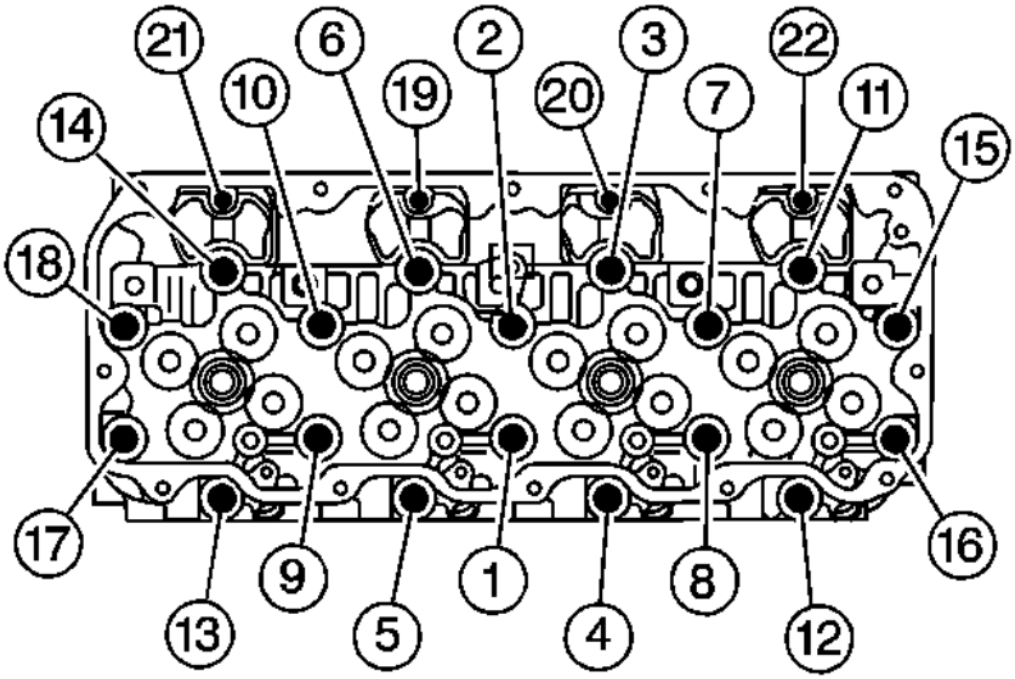


Fig. 121: Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: This component uses bolts with a preapplied molybdenum disulfide coating for thread lubrication. Do not remove the coating or use any additional lubricant. Improperly lubricated threads will adversely affect the bolt torque and clamp load. Improper bolt torque and clamp load can lead to engine damage.

NOTE: Refer to Fastener Notice .

4. Install the NEW M12 cylinder head bolts.

Tighten the M12 cylinder head bolts in three steps:

Tighten:

1. 1st step 50 N.m (37 lb ft)
2. 2nd step 80 N.m (59 lb ft)
3. 3rd step tighten 60 degrees using **J 45059**
4. 4th step tighten 60 degrees using **J 45059**

5. Reuse the M8 bolts. Install the M8 bolts.

Tighten: Tighten the M8 cylinder head bolts to 25 N.m (18 lb ft).

CYLINDER HEAD INSTALLATION - RIGHT SIDE

Tools Required

J 45059 Angle Meter

Installation

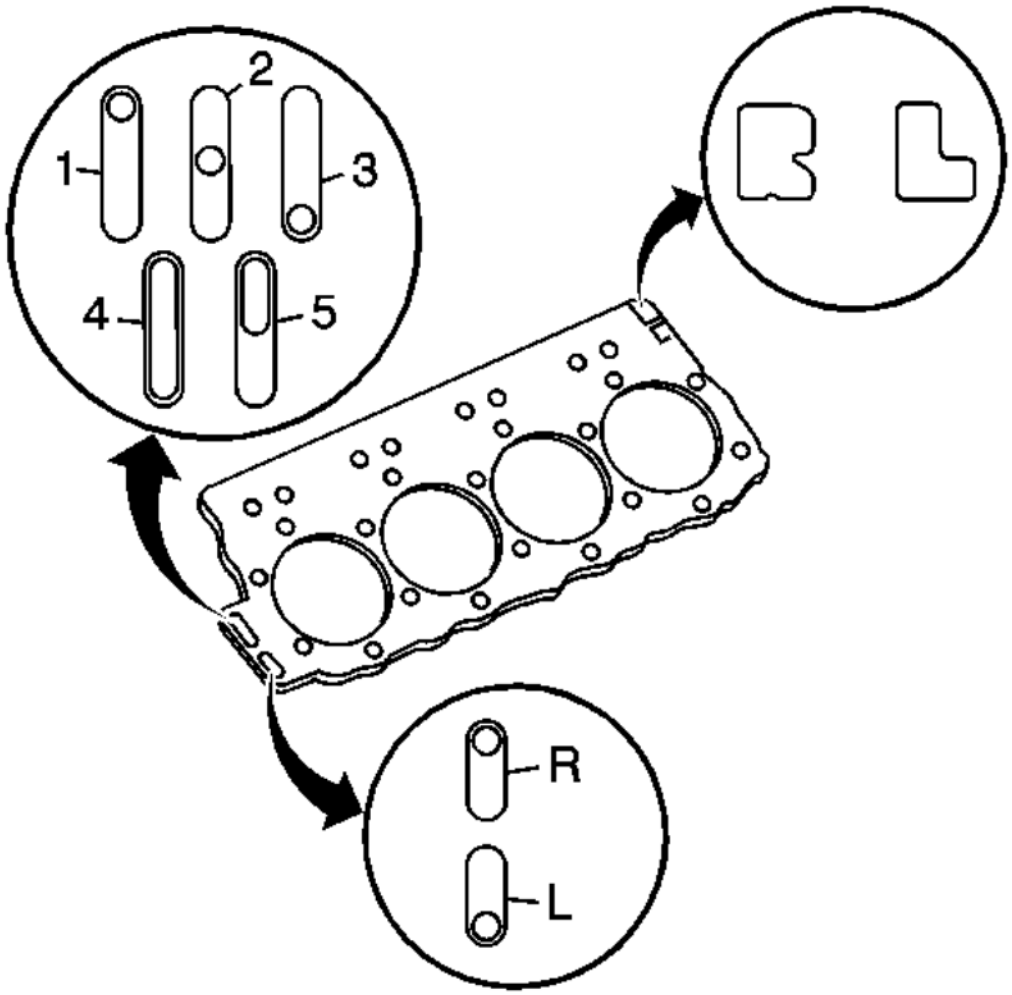


Fig. 122: View Of Cylinder Head Gasket Markings
Courtesy of GENERAL MOTORS CORP.

NOTE: **The left and right cylinder head gaskets are not interchangeable. Improper placement of the cylinder head gasket will block coolant and oil passages. Blocked coolant and oil passages will cause severe engine damage.**

IMPORTANT: The stamped letter, R or L, must face up. R is the right bank, L is the left bank.

1. The markings on the gasket are as follows:
   - Grade A (1)
   - Grade B (2)
   - Grade C (3)
   - Block over-bored 0.010-0.030 in (0.254-0.762 mm) (4)
   - Block over-bored 0.010-0.030 in (0.254-0.762 mm) and deck milled 0.008 in (0.203 mm) (5)
2. Install the right cylinder head gasket of the correct grade. The left and right cylinder head gaskets are not interchangeable. Refer to **Cylinder Head Gasket Selection**.

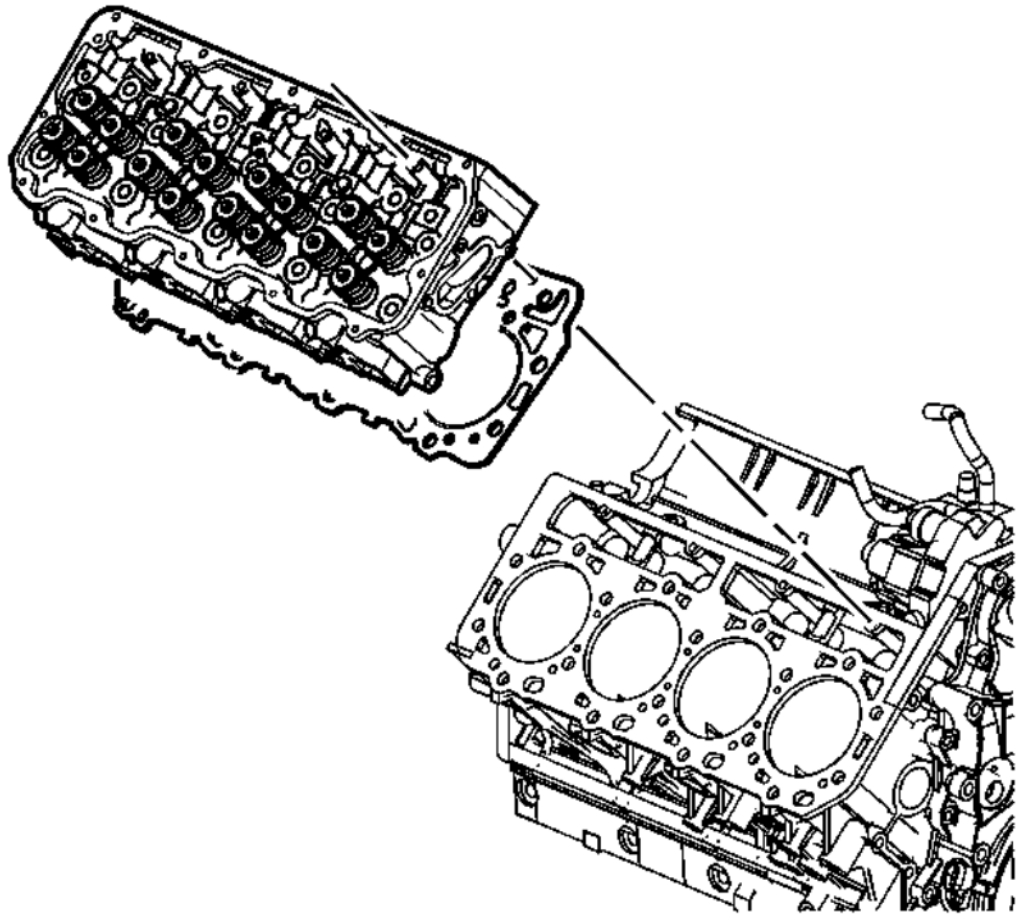


Fig. 123: View Of Cylinder Head & Gasket (Right)

Courtesy of GENERAL MOTORS CORP.

3. Install the right cylinder head.

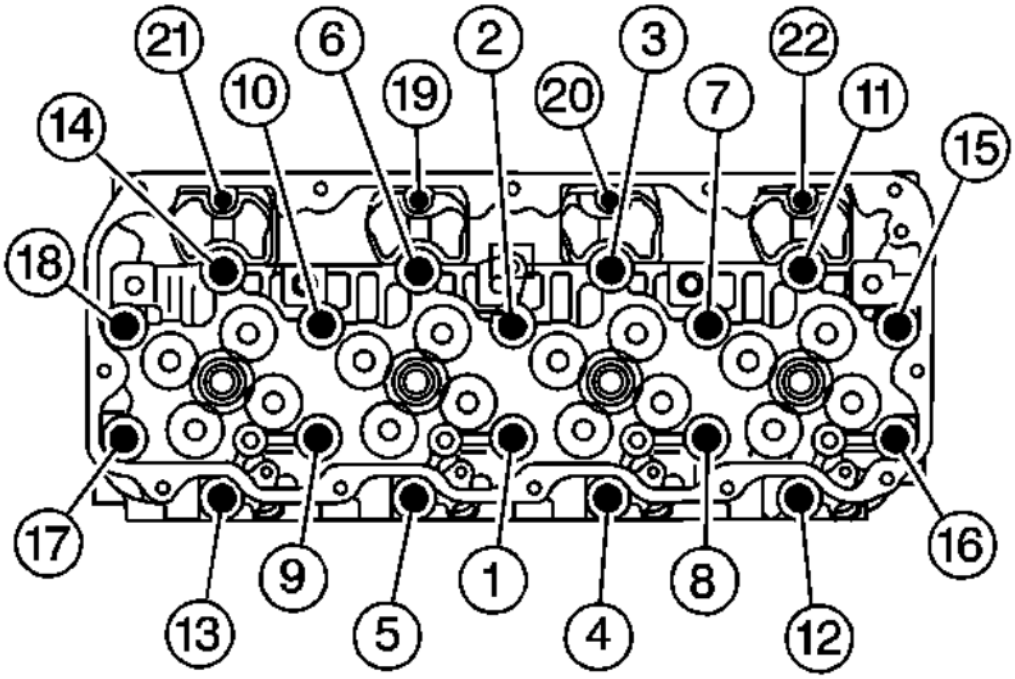


Fig. 124: Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: This component uses bolts with a preapplied molybdenum disulfide coating for thread lubrication. Do not remove the coating or use any additional lubricant. Improperly lubricated threads will adversely affect the bolt torque and clamp load. Improper bolt torque and clamp load can lead to engine damage.

NOTE: Refer to Fastener Notice .

4. Install the NEW M12 cylinder head bolts. Reuse the M8 bolts.

Tighten the M12 cylinder head bolts in three steps:

Tighten:

1. 1st step 50 N.m (37 lb ft)
2. 2nd step 80 N.m (59 lb ft)
3. 3rd step tighten 60 degrees using **J 45059**
4. 4th step tighten 60 degrees using **J 45059**

5. Install the M8 bolts.

Tighten: Tighten the M8 cylinder head bolts to 25 N.m (18 lb ft).

EXHAUST MANIFOLD INSTALLATION - LEFT SIDE

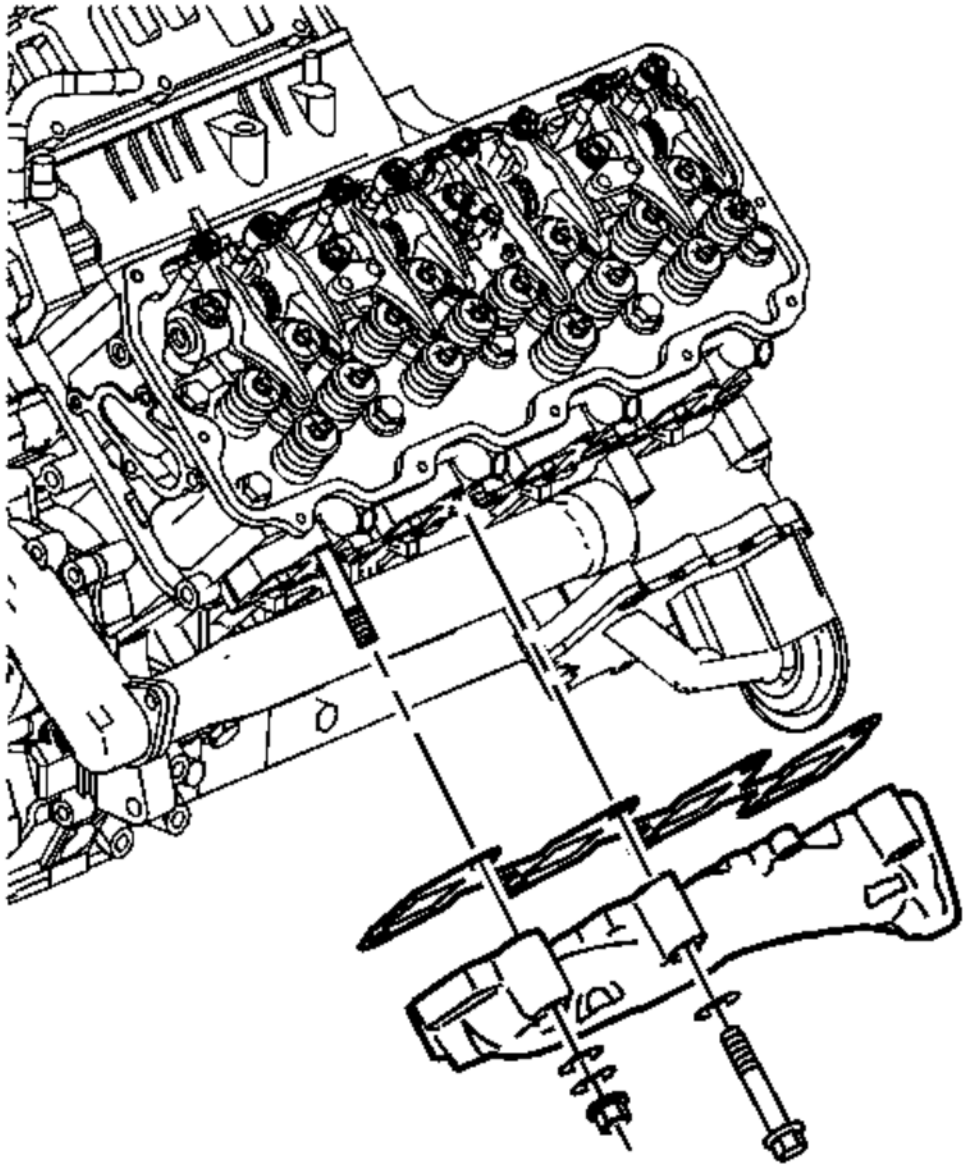


Fig. 125: View Of Left Exhaust Manifold & Gasket
Courtesy of GENERAL MOTORS CORP.

1. Install the exhaust manifold gasket.
2. Install the exhaust manifold.

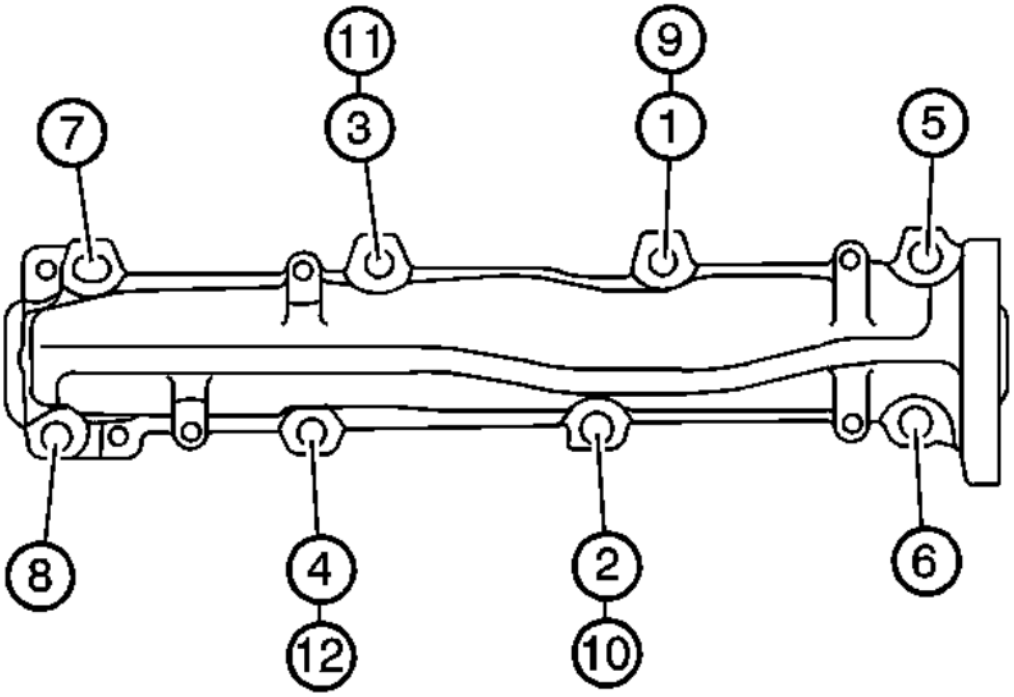


Fig. 126: Exhaust Manifold Bolt Tightening Sequence -- Left Side (6.6L)
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

3. Install the exhaust manifold bolts and nuts.

   Tighten: Tighten the exhaust manifold bolts and nuts to 57 N.m (42 lb ft) in the proper sequence.

   Tighten: Tighten the center exhaust manifold bolts and nuts an additional pass to 57 N.m (42 lb ft) in sequence.

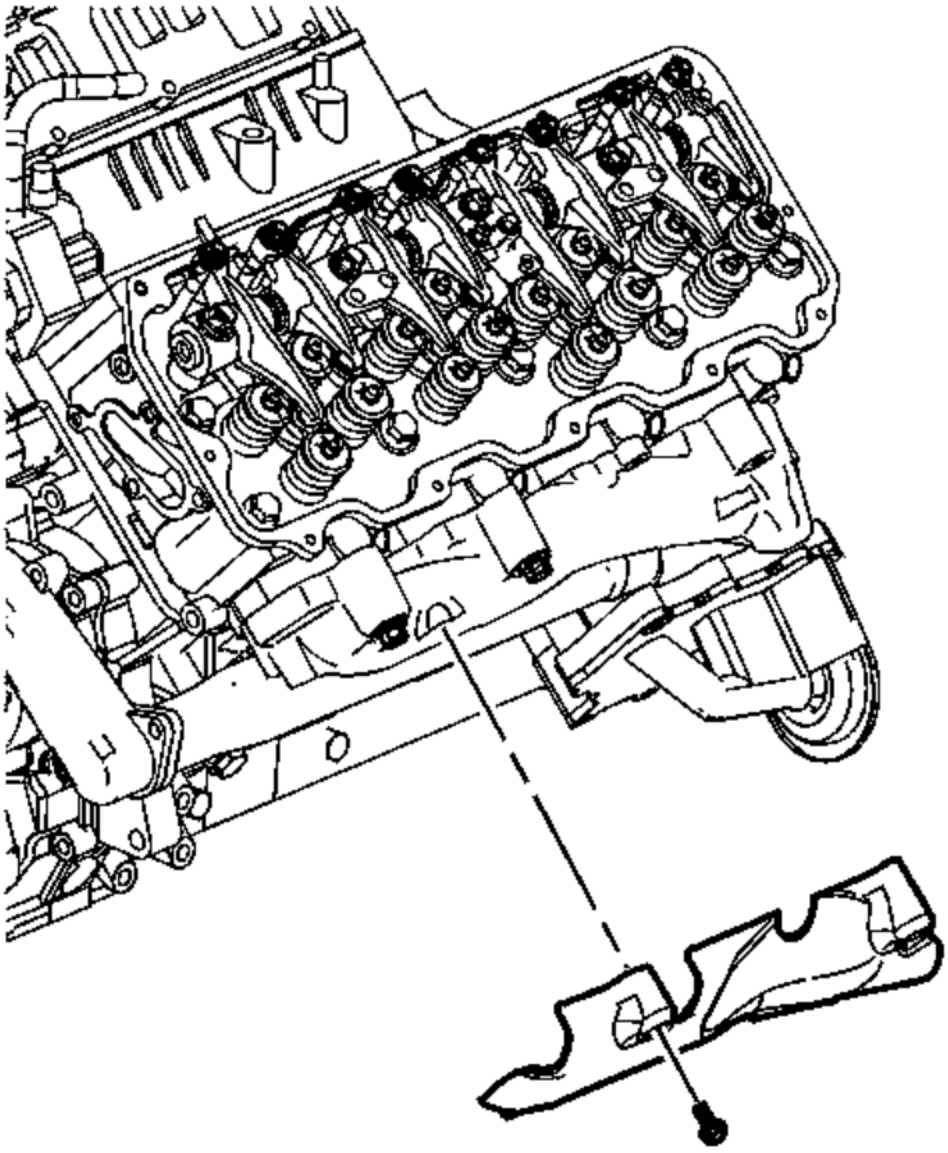


Fig. 127: View Of Exhaust Manifold Heat Shield (Left)
Courtesy of GENERAL MOTORS CORP.

4. Install the exhaust manifold heat shield.
5. Install the exhaust manifold heat shield bolts.

Tighten: Tighten the exhaust manifold heat shield bolts to 10 N.m (89 lb in).

EXHAUST MANIFOLD INSTALLATION - RIGHT SIDE

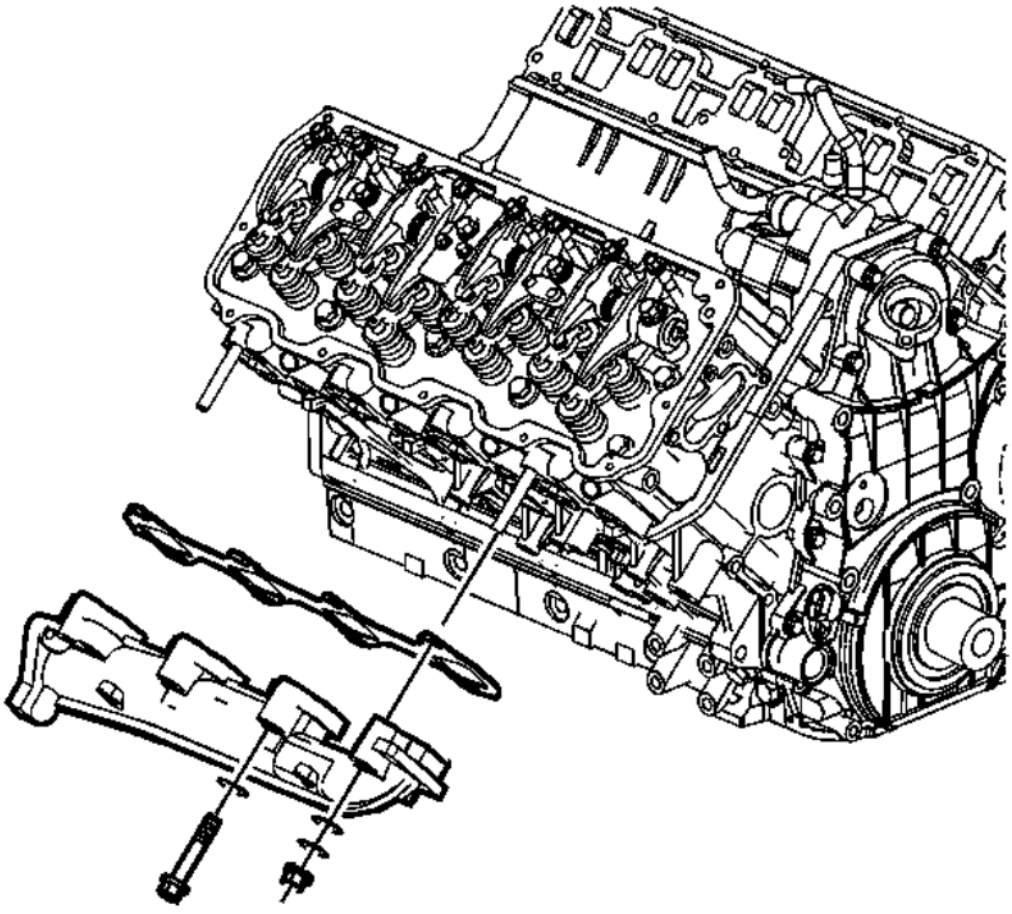


Fig. 128: View Of Right Exhaust Manifold & Gasket
Courtesy of GENERAL MOTORS CORP.

1. Install the exhaust manifold gasket.
2. Install the exhaust manifold.

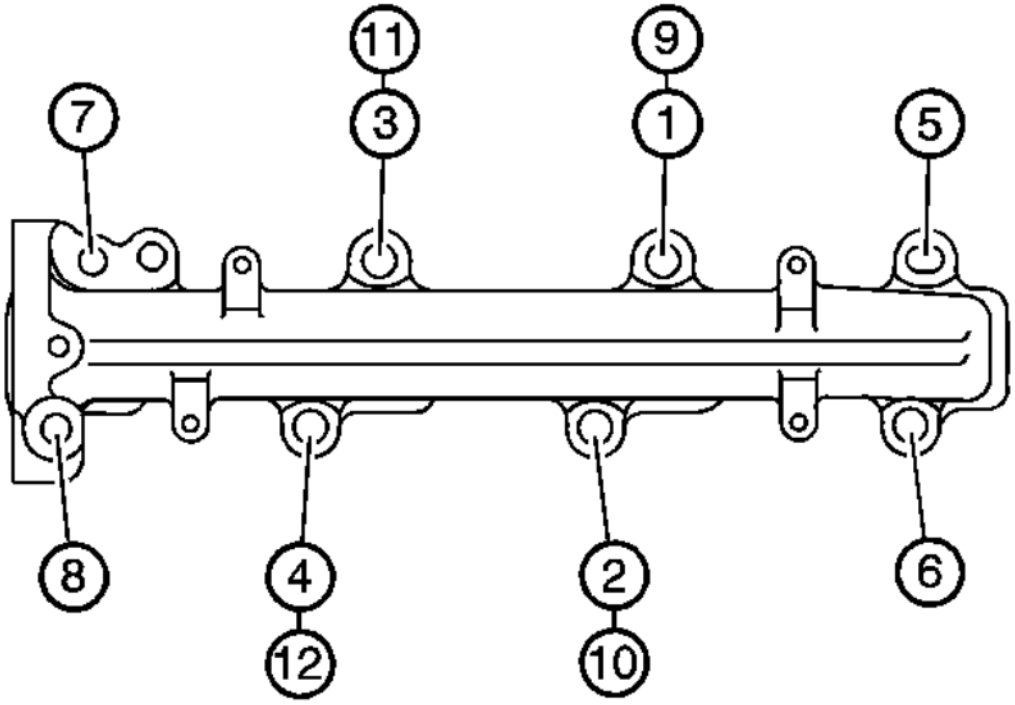


Fig. 129: Exhaust Manifold Bolt Tightening Sequence -- Right Side (6.6L)
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

3. Install the exhaust manifold bolts and nuts.

   Tighten: Tighten the exhaust manifold bolts and nuts to 57 N.m (42 lb ft) in the proper sequence.

   Tighten: Tighten the center exhaust manifold bolts and nuts an additional pass to 57 N.m (42 lb ft) in sequence.

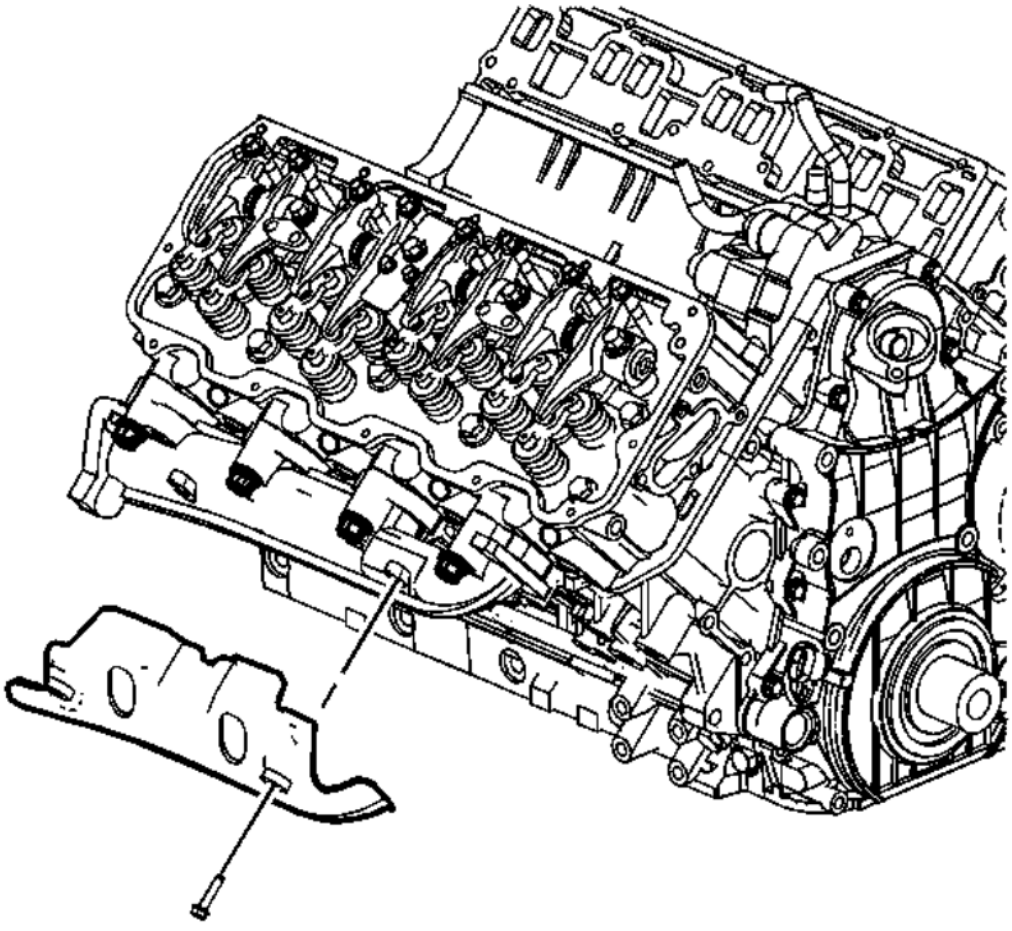


Fig. 130: View Of Exhaust Manifold Heat Shield (Right)
Courtesy of GENERAL MOTORS CORP.

4. Install the exhaust manifold heat shield.
5. Install the exhaust manifold heat shield bolts.

Tighten: Tighten the exhaust manifold heat shield bolts to 10 N.m (89 lb in).

VALVE ROCKER ARM, SHAFT, AND PUSH ROD INSTALLATION

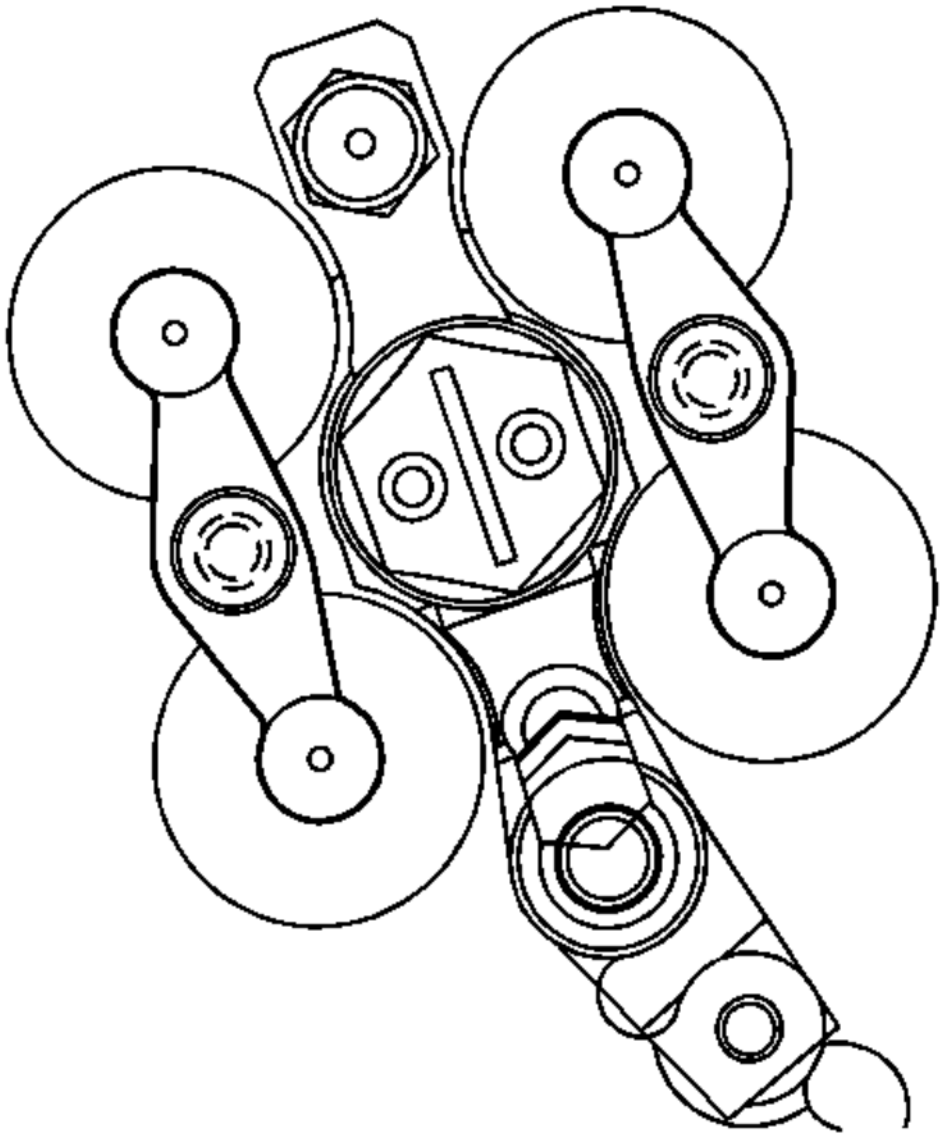


Fig. 131: View of Valve Bridge
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Install the valve bridge with the expansion side of bridge away from the injector.

1. Install the valve bridge.

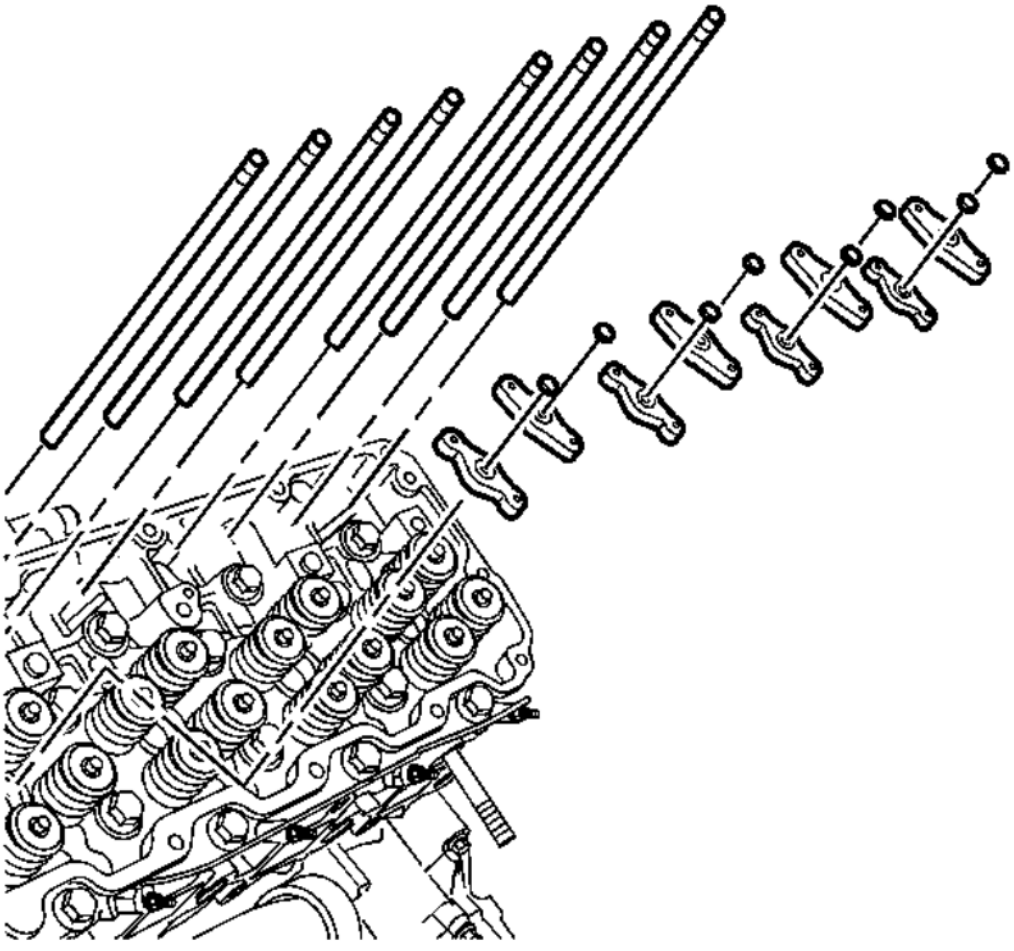


Fig. 132: View Of Pushrods, Valve Spring Caps & Valve Lifter Bridges
Courtesy of GENERAL MOTORS CORP.

2. Install the valve bridge pins.
3. Install the pushrods.

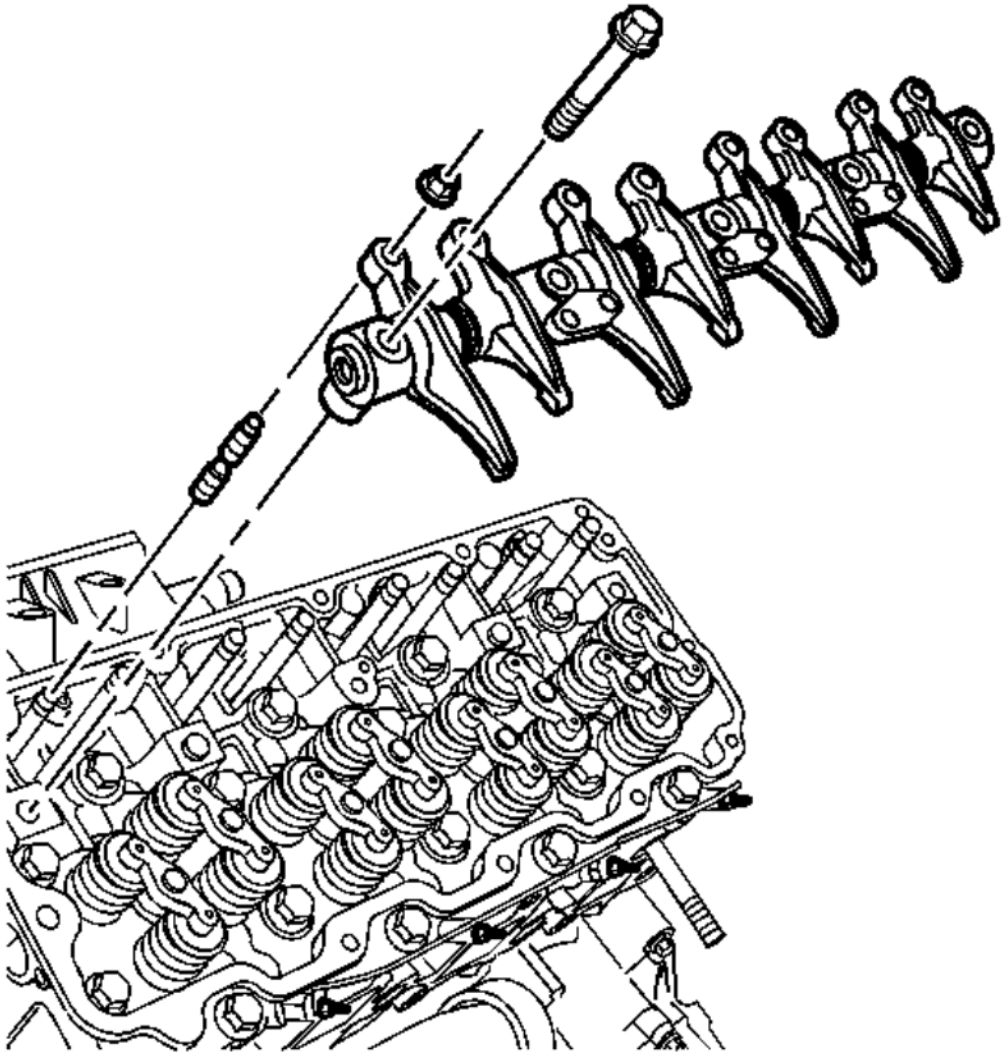


Fig. 133: View Of Rocker Arm Shaft
Courtesy of GENERAL MOTORS CORP.

NOTE: The pushrods must be correctly seated in the valve lifter and valve rocker arms before the rocker arm shaft assembly is torqued into place. Improper seating of the pushrods can cause damage to the pushrods or the valve rocker arm shaft assembly components.

4. Install the rocker arm shaft assembly.

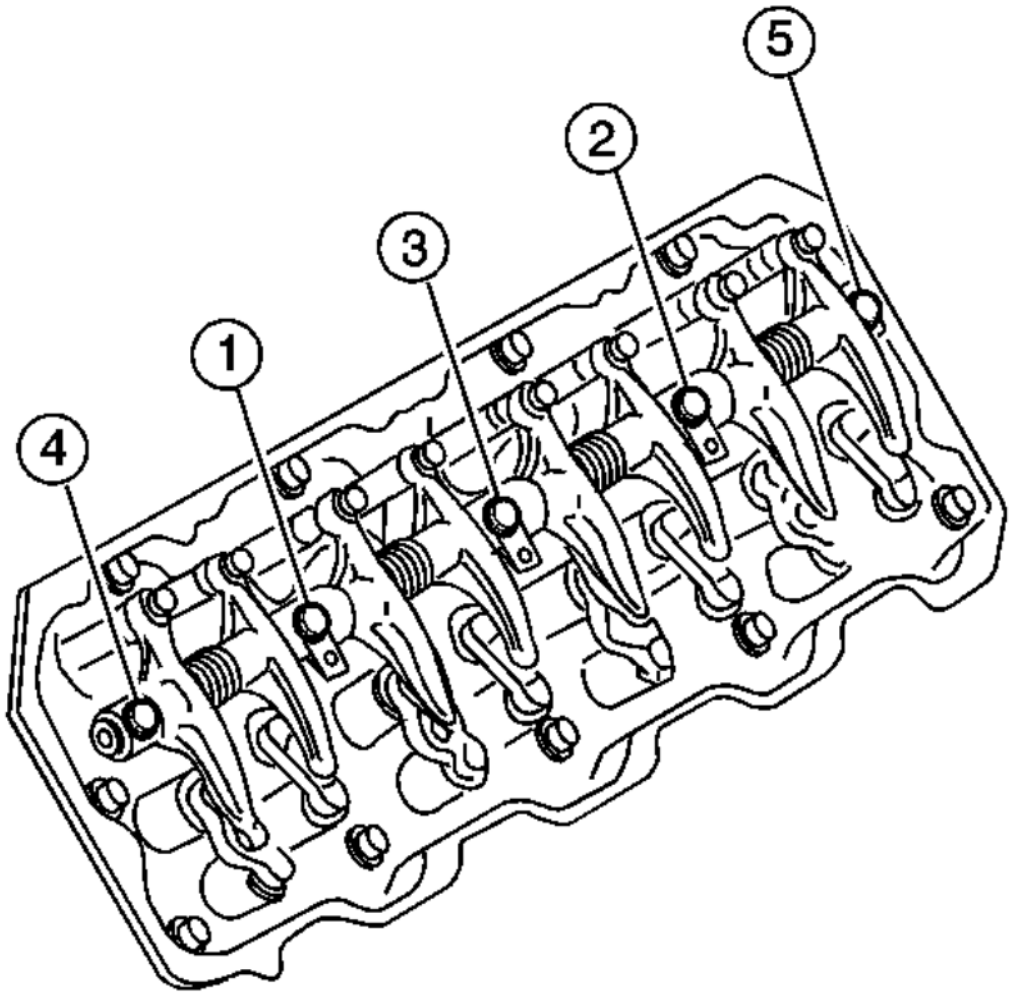


Fig. 134: Rocker Arm Shaft Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

5. Install the rocker arm shaft assembly bolts.

Tighten: Tighten the rocker arm shaft assembly bolts in the proper sequence. Tighten the

rocker arm shaft bolts to 41 N.m (30 lb ft).

VALVE LASH ADJUSTMENT

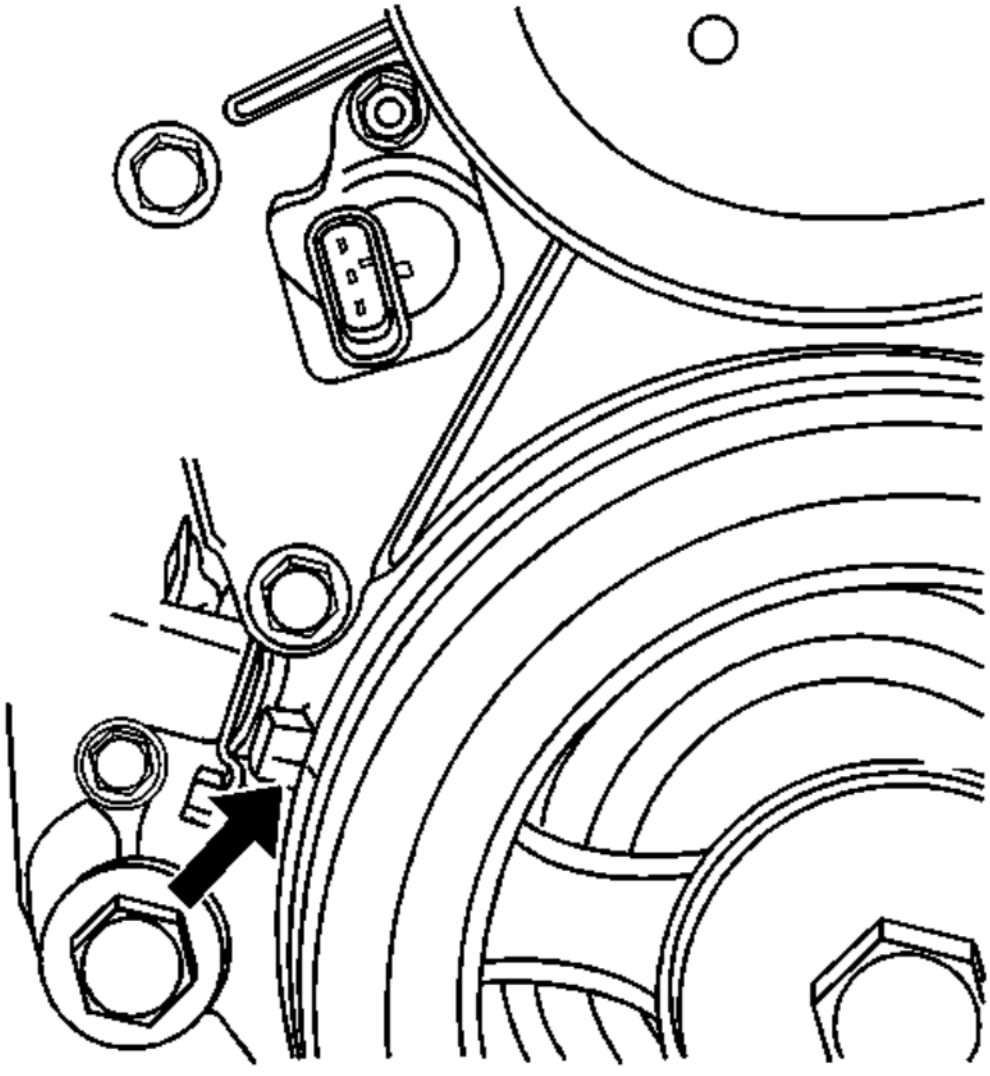


Fig. 135: View Of Crankshaft Balancer Mark Aligned With Engine Mark
Courtesy of GENERAL MOTORS CORP.

1. Rotate the crankshaft to bring the number 1 cylinder at the top dead center of the

compression stroke. The number 1 cylinder is the front cylinder on the right bank. The mark on the crankshaft balancer should be aligned with the mark on the engine.

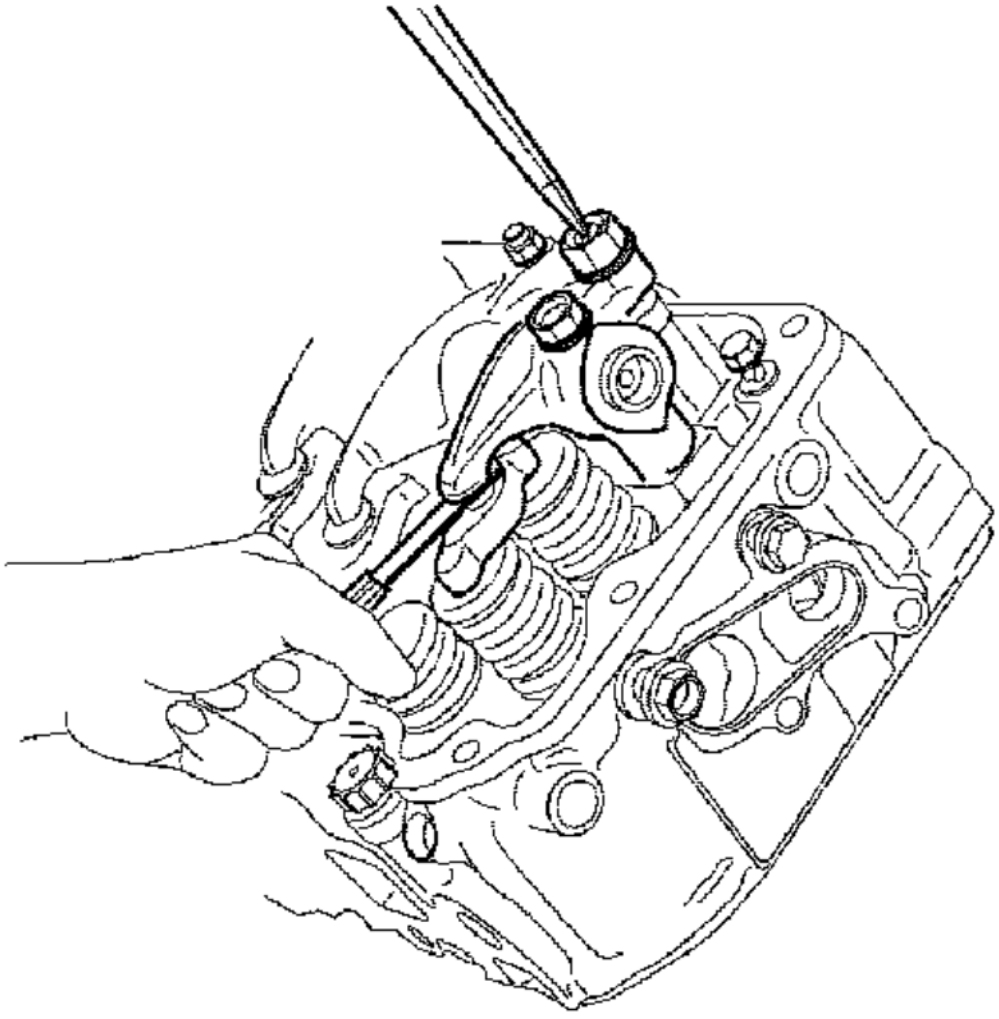


Fig. 136: View Of Feeler Gage Between Tip Of Rocker Arm & Valve Lifter Bridge
Courtesy of GENERAL MOTORS CORP.

2. Loosen the valve adjusting screws.
3. Insert a feeler gauge between the tip of the rocker arm and the valve bridge.

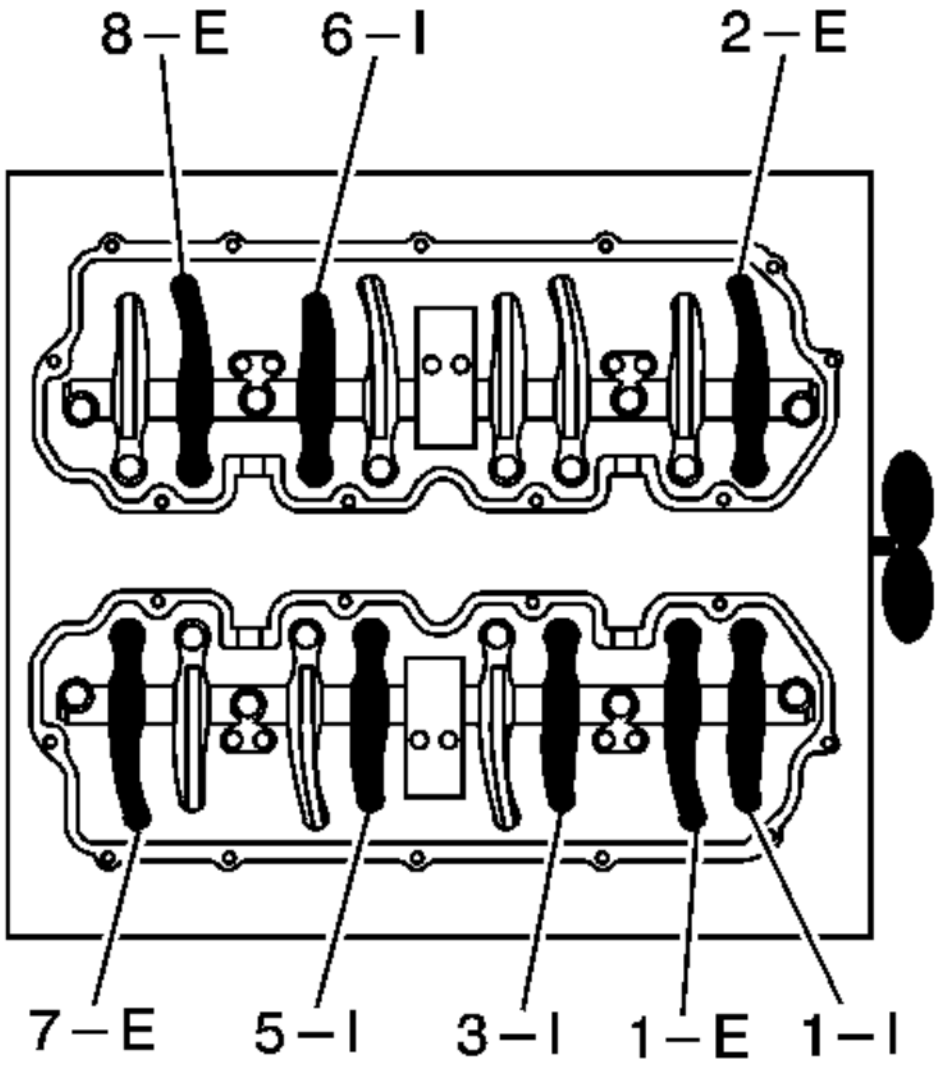


Fig. 137: Identifying Valves To Adjust When #1 Cylinder Is At TDC Of Compression Stroke
Courtesy of GENERAL MOTORS CORP.

NOTE: **Refer to Fastener Notice .**

4. Adjust the valve lash to 0.3 mm (0.012 in). Refer to **Valve Clearance Adjustment Specifications** to determine which valves that can be adjusted when the engine is at Top

Dead Center.

Tighten: Tighten the valve lash lock nut to 22 N.m (16 lb ft).

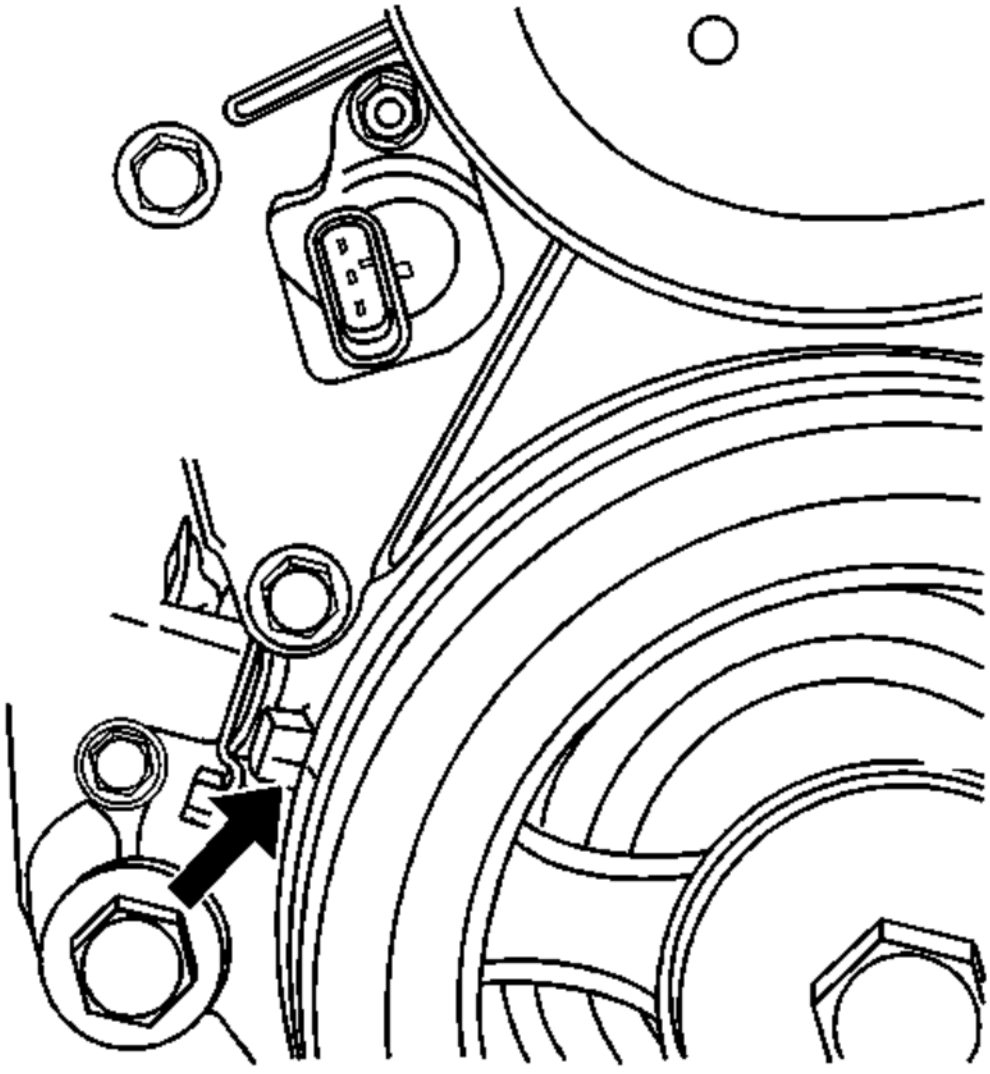


Fig. 138: View Of Crankshaft Balancer Mark Aligned With Engine Mark
Courtesy of GENERAL MOTORS CORP.

5. Rotate the crankshaft one revolution to bring the number 1 cylinder at Top Dead Center of

the exhaust stroke.

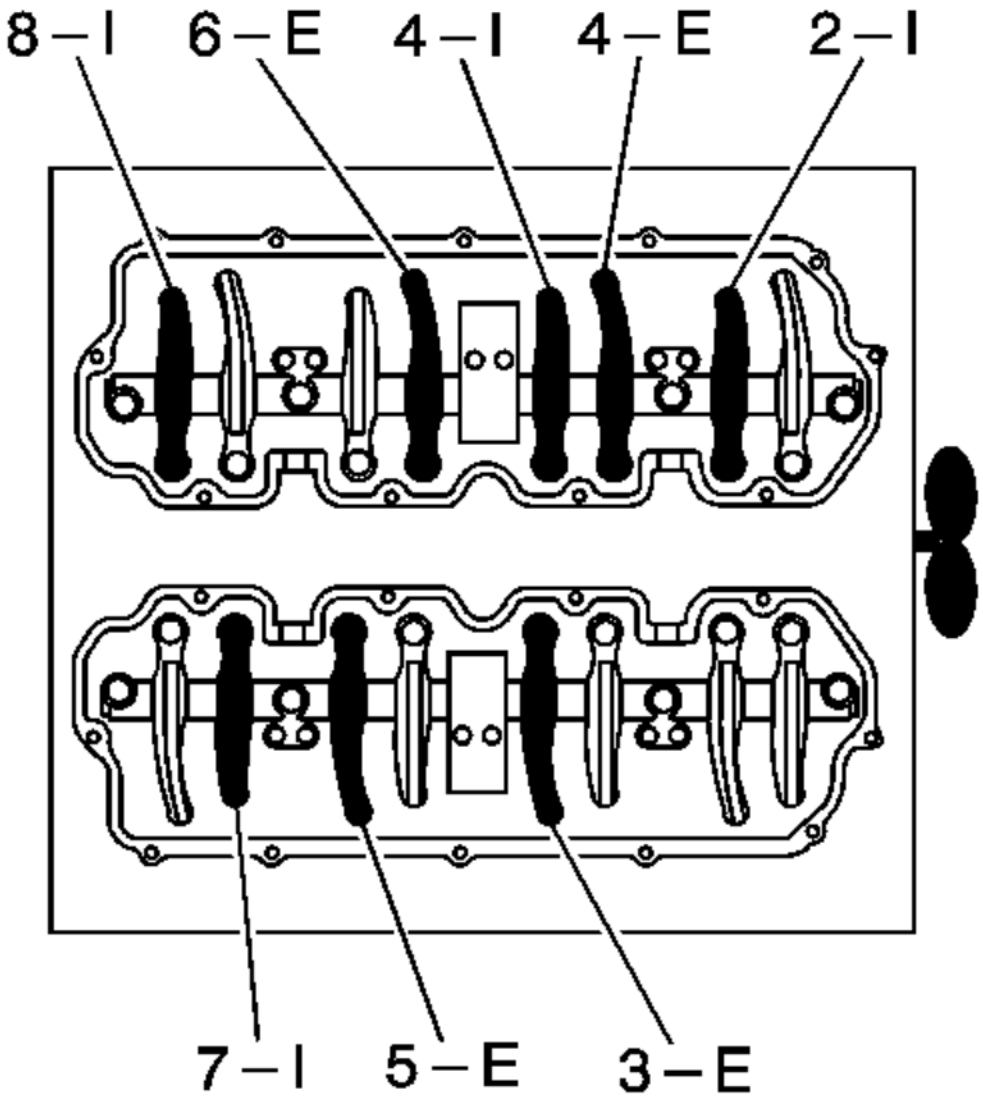


Fig. 139: Identifying Valves To Adjust When #1 Cylinder Is At TDC Of Exhaust Stroke
Courtesy of GENERAL MOTORS CORP.

6. Adjust the valve lash to 0.3 mm (0.012 in). Refer to **Valve Clearance Adjustment**

Specifications to determine which valves that can be adjusted when the engine is at Top Dead Center.

Tighten: Tighten the valve lash lock nut to 22 N.m (16 lb ft).

INTAKE MANIFOLD INSTALLATION - LEFT SIDE

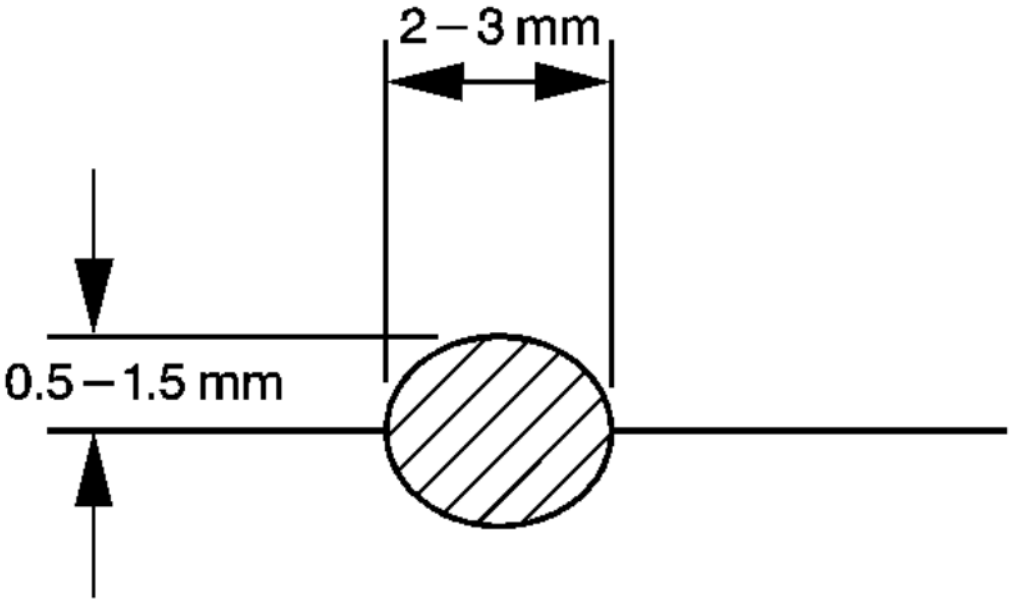


Fig. 140: Determining Sealant Bead Dimensions
Courtesy of GENERAL MOTORS CORP.

1. Apply a 2-3 mm wide by 0.5-1.5 mm high bead of GM P/N 12378521 (Canadian P/N 88901148) sealant on the intake manifold mating surface.

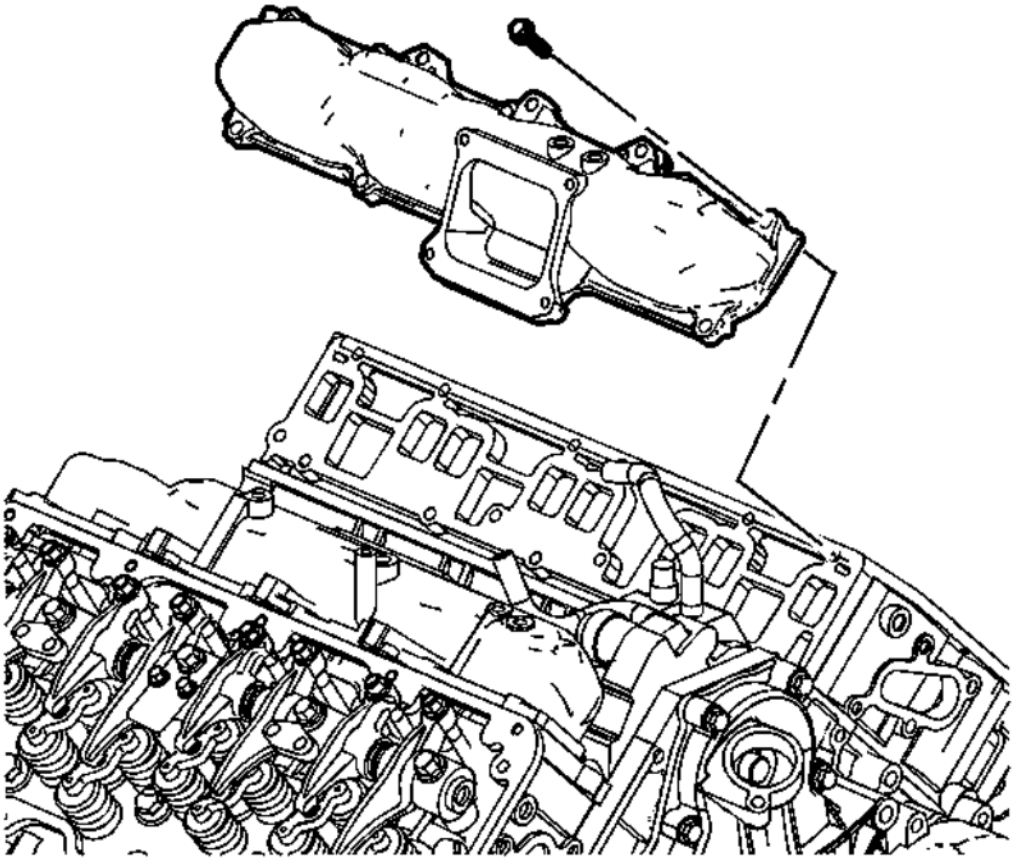


Fig. 141: View Of Intake Manifold (Left)
Courtesy of GENERAL MOTORS CORP.

2. Install the intake manifold.

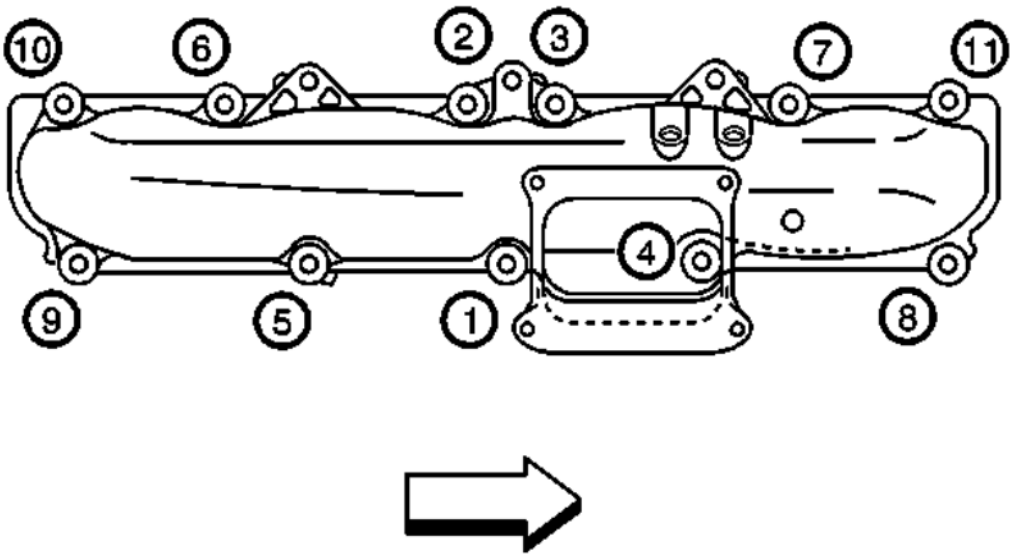


Fig. 142: Intake Manifold Bolt Tightening Sequence (Left)
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

3. Install the intake manifold bolts and nuts.

Tighten: Tighten the intake manifold bolts and nuts to 25 N.m (18 lb ft).

INTAKE MANIFOLD INSTALLATION - RIGHT SIDE

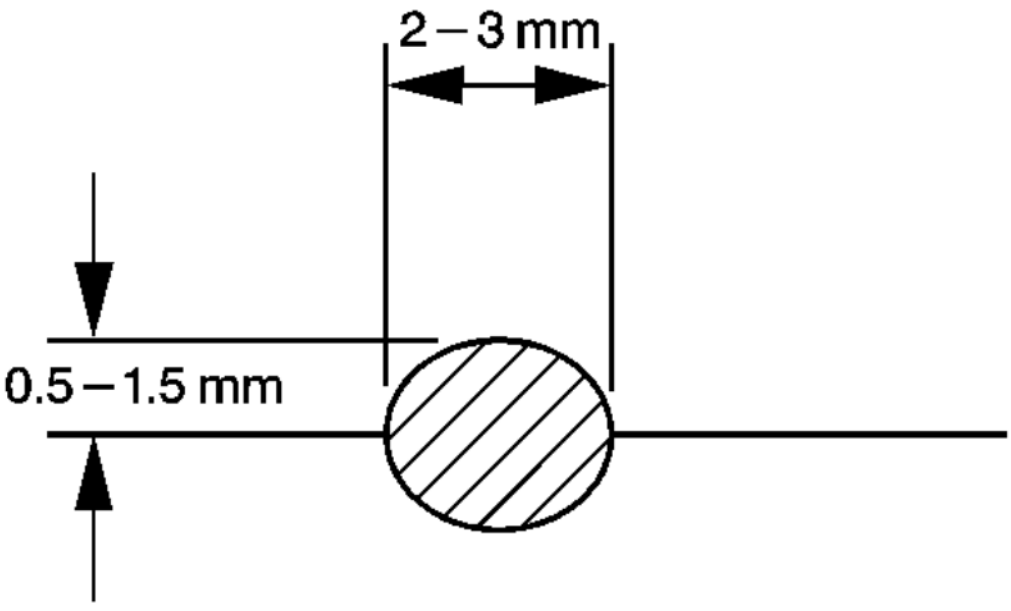


Fig. 143: Determining Sealant Bead Dimensions
Courtesy of GENERAL MOTORS CORP.

1. Apply a 2-3 mm wide by 0.5-1.5 mm high bead of GM P/N 12378521 (Canadian P/N 88901148) sealant on the intake manifold mating surface.

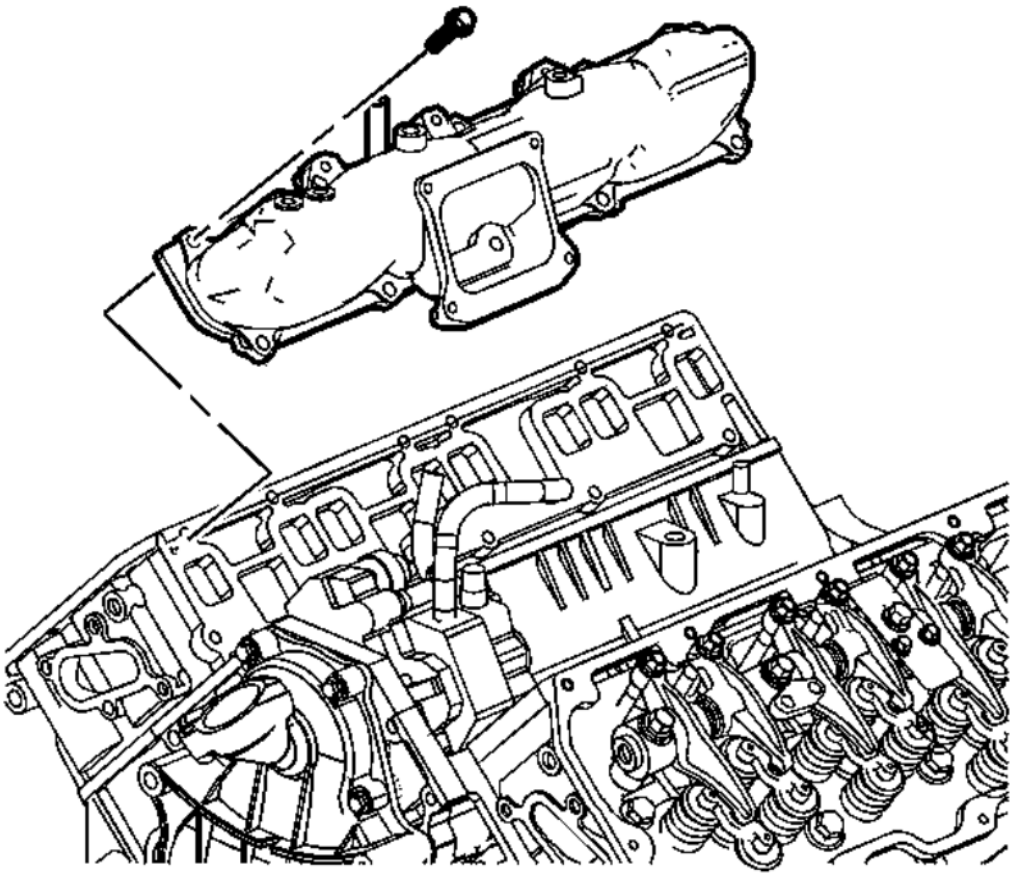


Fig. 144: View Of Intake Manifold (Right)
Courtesy of GENERAL MOTORS CORP.

2. Install the intake manifold.

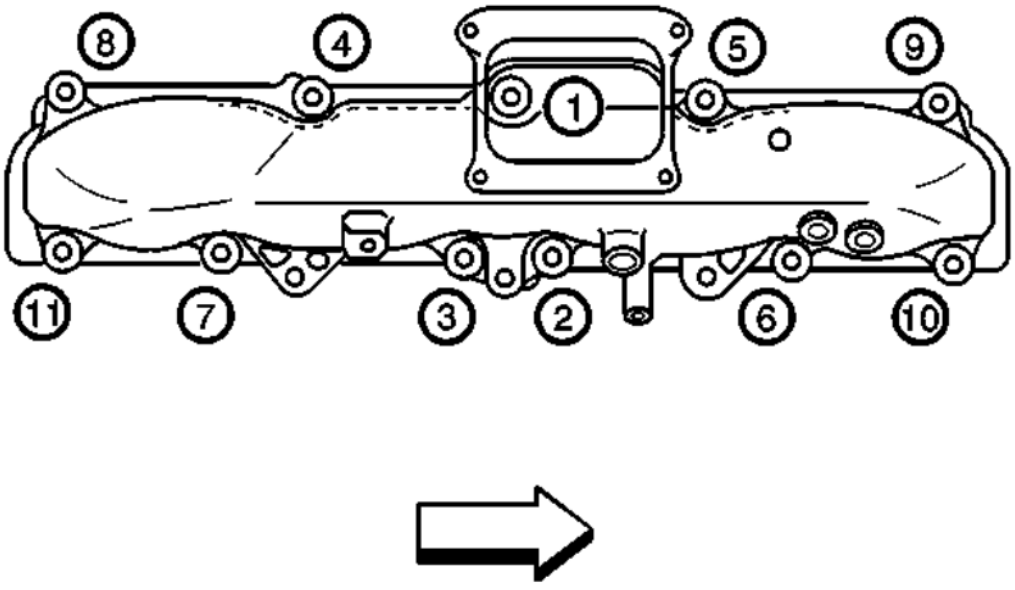


Fig. 145: Intake Manifold Bolt Tightening Sequence (Right)
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

3. Install the intake manifold bolts and nuts.

   Tighten: Tighten the intake manifold bolts and nuts to 25 N.m (18 lb ft).

2008 ENGINE

Engine Mechanical - 6.6L - Cab & Chassis Sierra, Cab & Chassis Silverado, Sierra & Silverado

OFF-VEHICLE REPAIR INSTRUCTIONS (CONT.)

INTAKE MANIFOLD CROSSOVER INSTALLATION

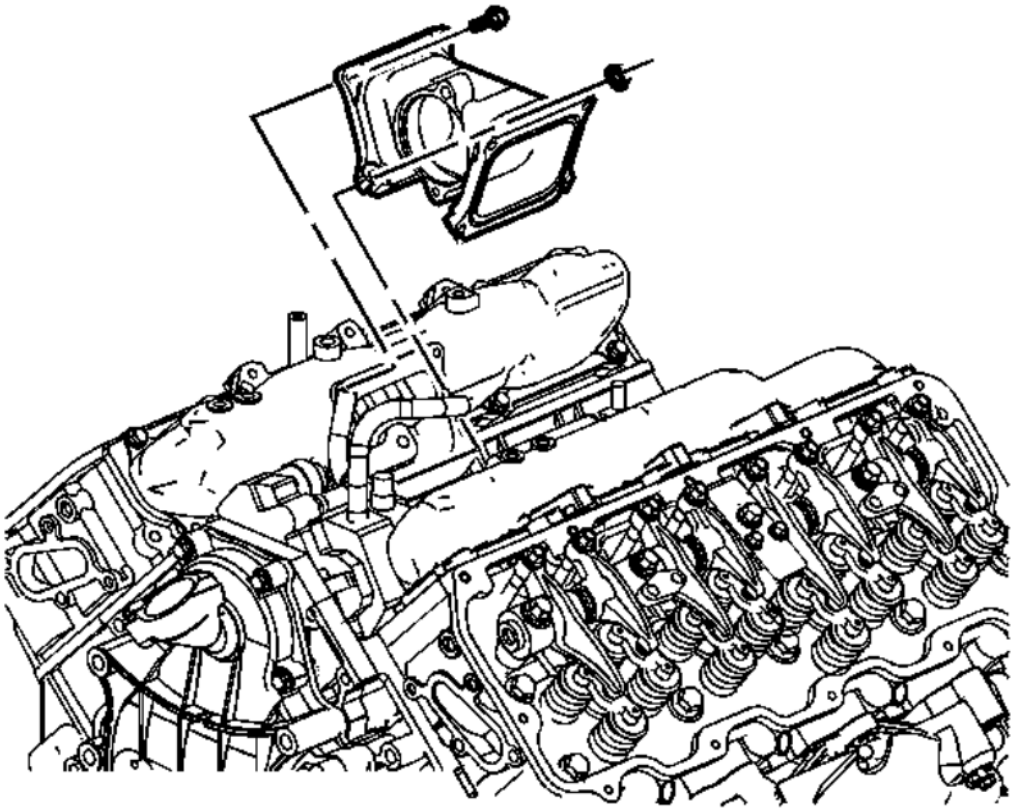


Fig. 1: View Of Center Intake Manifold
Courtesy of GENERAL MOTORS CORP.

1. Install the intake manifold crossover gaskets.
2. Install the intake manifold crossover.

NOTE: Refer to Fastener Notice .

3. Install the intake manifold crossover nuts and bolts in sequence.

   Tighten: Tighten the intake manifold crossover nuts and bolts to 10 N.m (89 lb in).

VALVE ROCKER ARM COVER INSTALLATION - LOWER LEFT SIDE

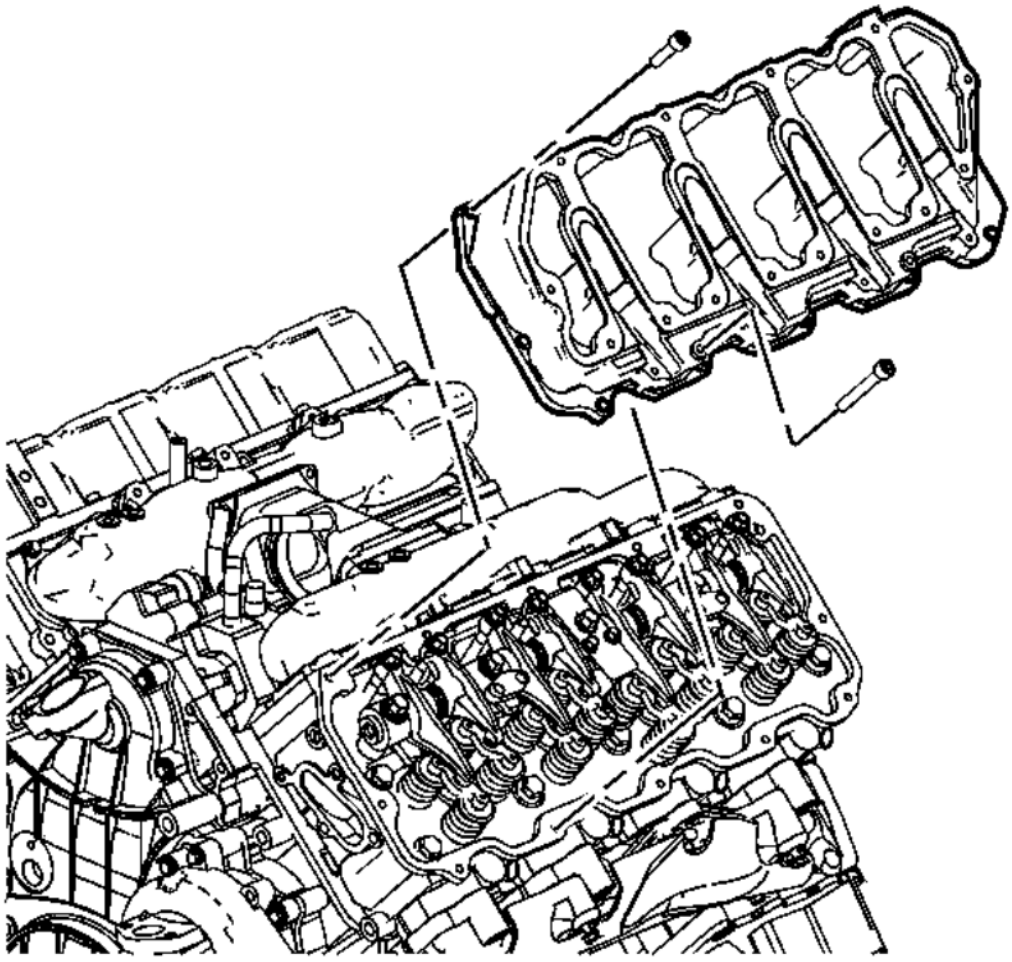


Fig. 2: View Of Lower Valve Rocker Arm Cover (Left)
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The gasket may be reused if it is not torn, cracked, stretched, or swollen.

1. Install the lower valve rocker arm cover.

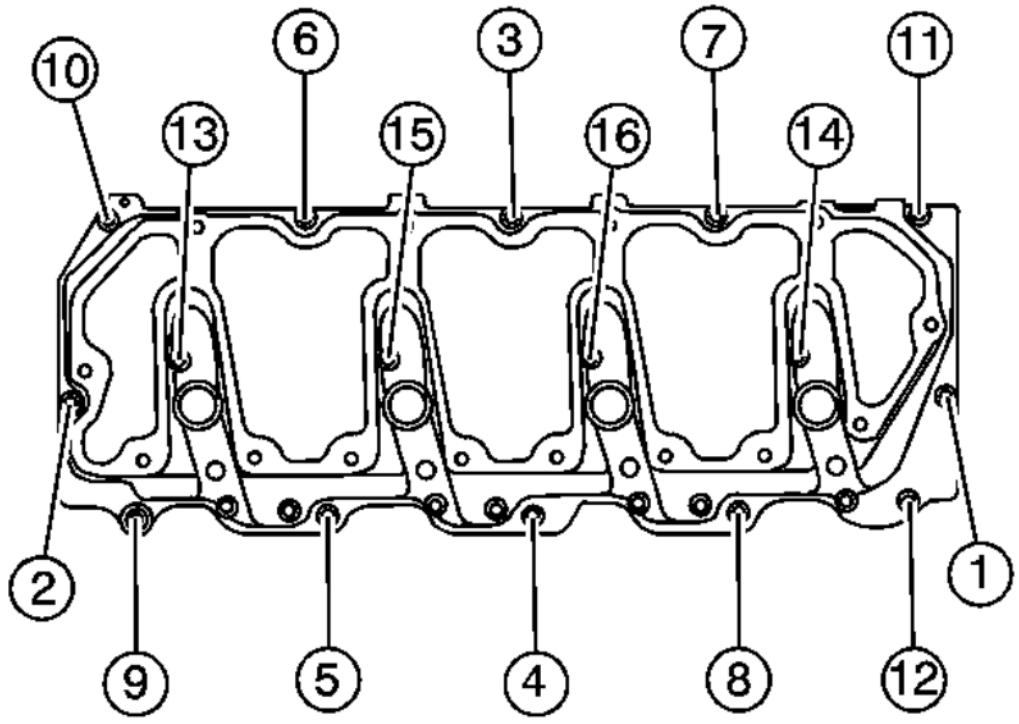


Fig. 3: Lower Valve Rocker Arm Cover Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice

2. Install the lower valve rocker arm cover bolts.

Tighten:

- Tighten the lower valve rocker arm cover bolts in the proper sequence to 10 N.m (89 lb in).
- Retighten the lower valve rocker arm cover bolts in the proper sequence to the same torque, 10 N.m (89 lb in).

VALVE ROCKER ARM COVER INSTALLATION - LOWER RIGHT SIDE

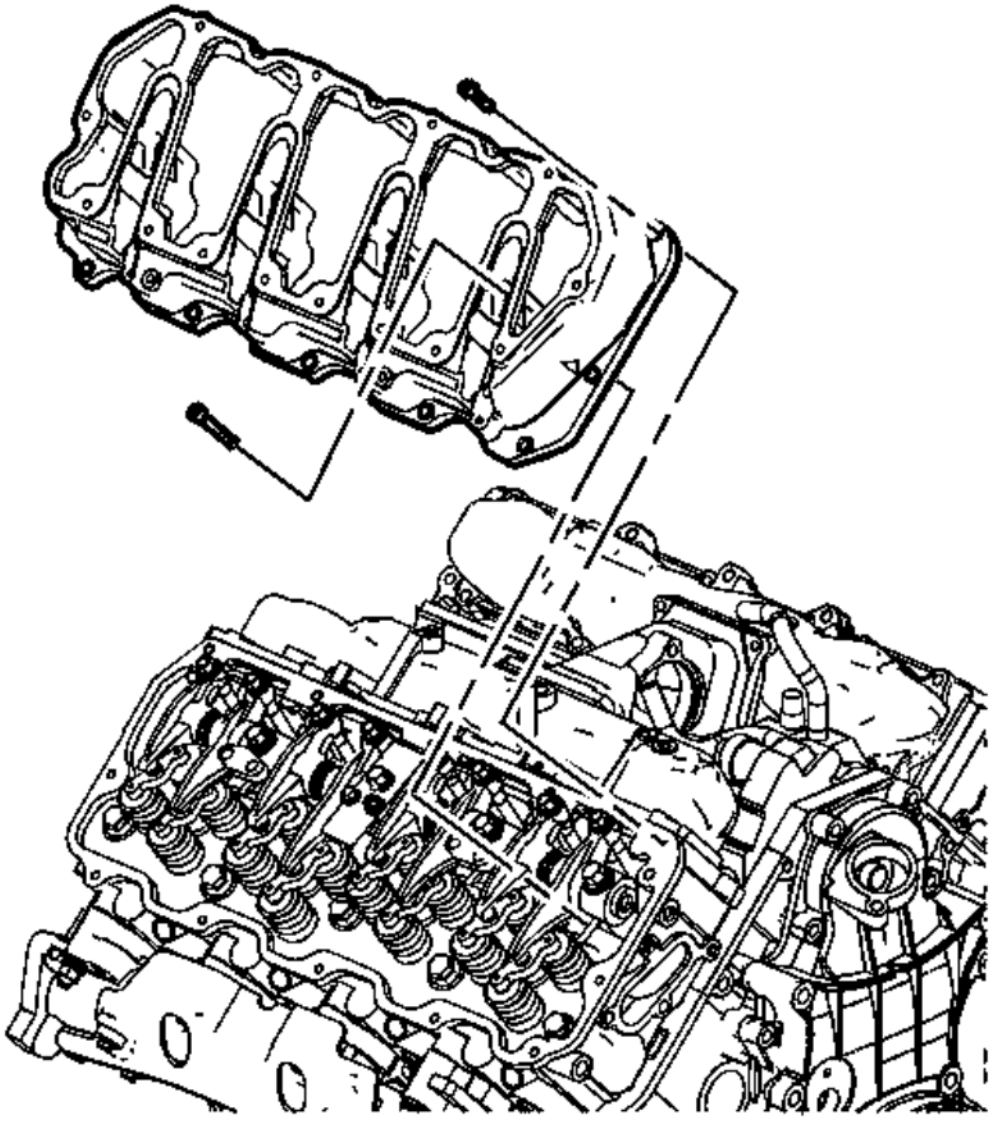


Fig. 4: View Of Lower Valve Rocker Arm Cover (Right)
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The gasket may be reused if it is not torn, cracked, stretched, or swollen.

1. Install the lower valve rocker arm cover.

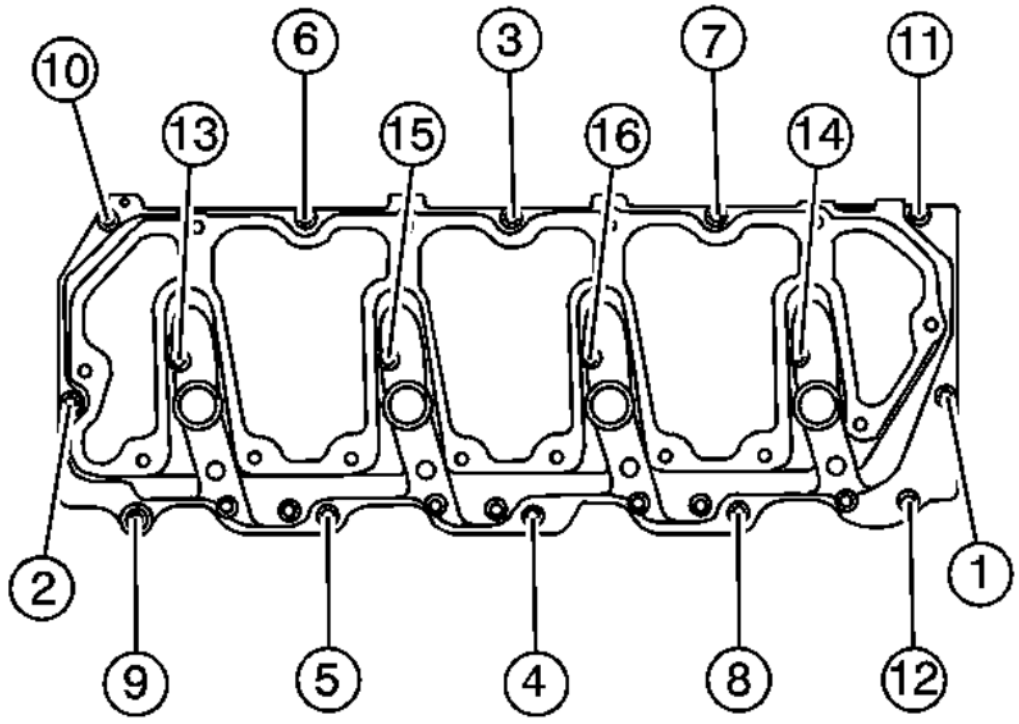


Fig. 5: Lower Valve Rocker Arm Cover Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

2. Install the lower valve rocker arm cover bolts.

Tighten:

- Tighten the lower valve rocker arm cover bolts in the proper sequence to 10 N.m (89 lb in).
- Retighten the lower valve rocker arm cover bolts in the proper sequence to the same torque, 10 N.m (89 lb in).

VALVE ROCKER ARM COVER INSTALLATION - UPPER LEFT SIDE

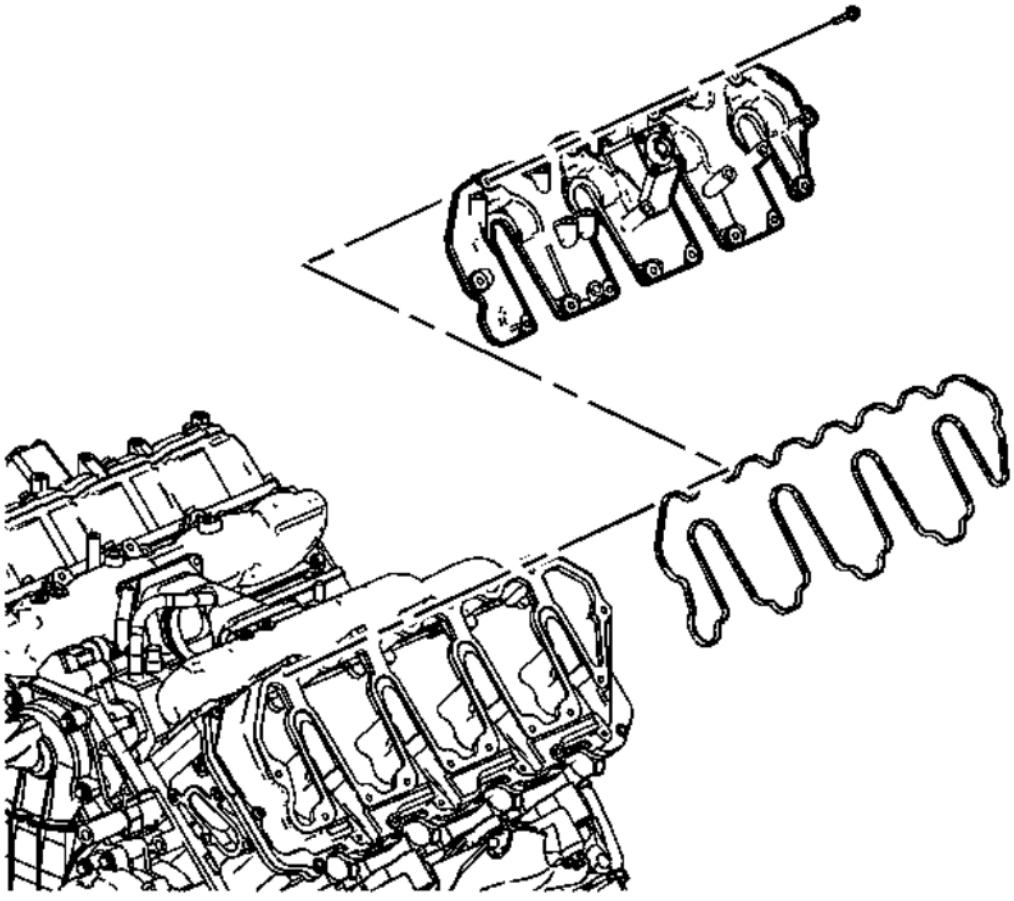


Fig. 6: View Of Upper Valve Rocker Arm Cover & Gasket
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The gasket may be reused if it is not torn, cracked, stretched, or swollen.

1. Install the upper valve rocker arm cover.

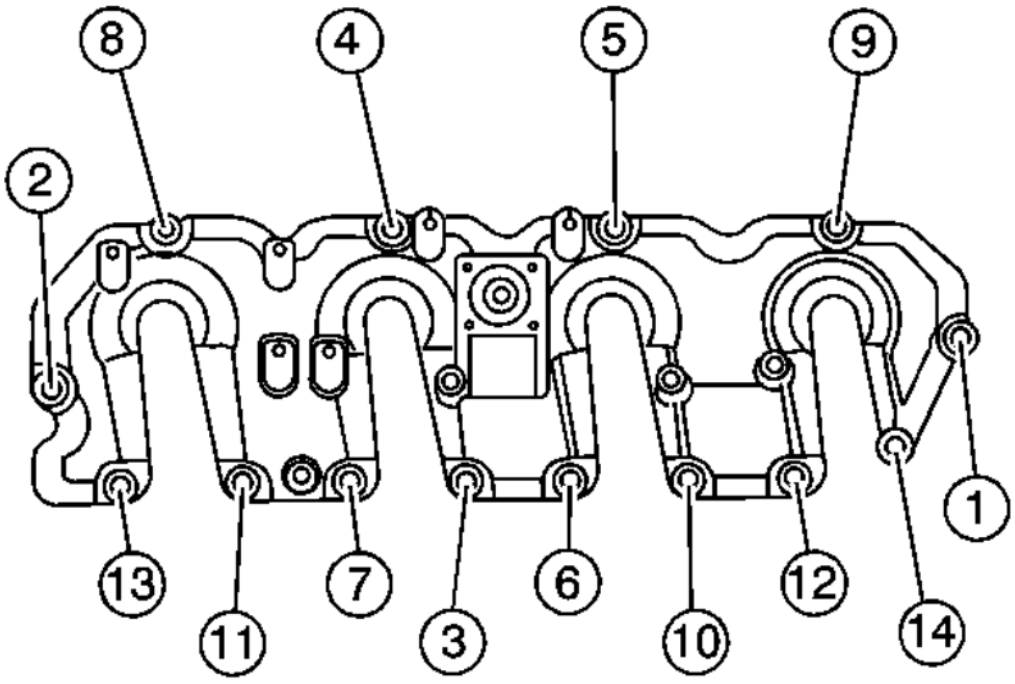


Fig. 7: Upper Valve Rocker Arm Cover Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

2. Install the upper valve rocker arm cover bolts.

Tighten: Tighten the upper valve rocker arm cover bolts to 8 N.m (71 lb in).

VALVE ROCKER ARM COVER INSTALLATION - UPPER RIGHT SIDE

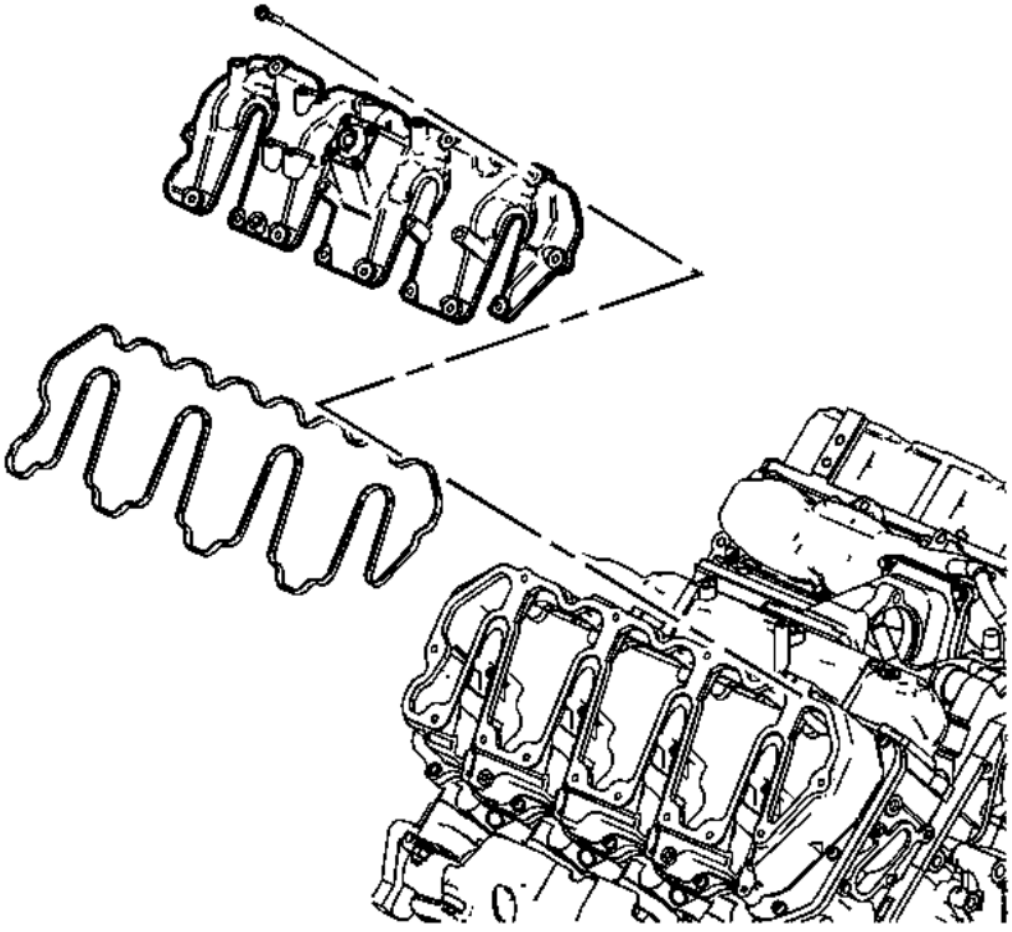


Fig. 8: View Of Upper Valve Rocker Arm Cover & Gasket
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The gasket may be reused if it is not torn, cracked, stretched, or swollen.

1. Install the upper valve rocker arm cover.

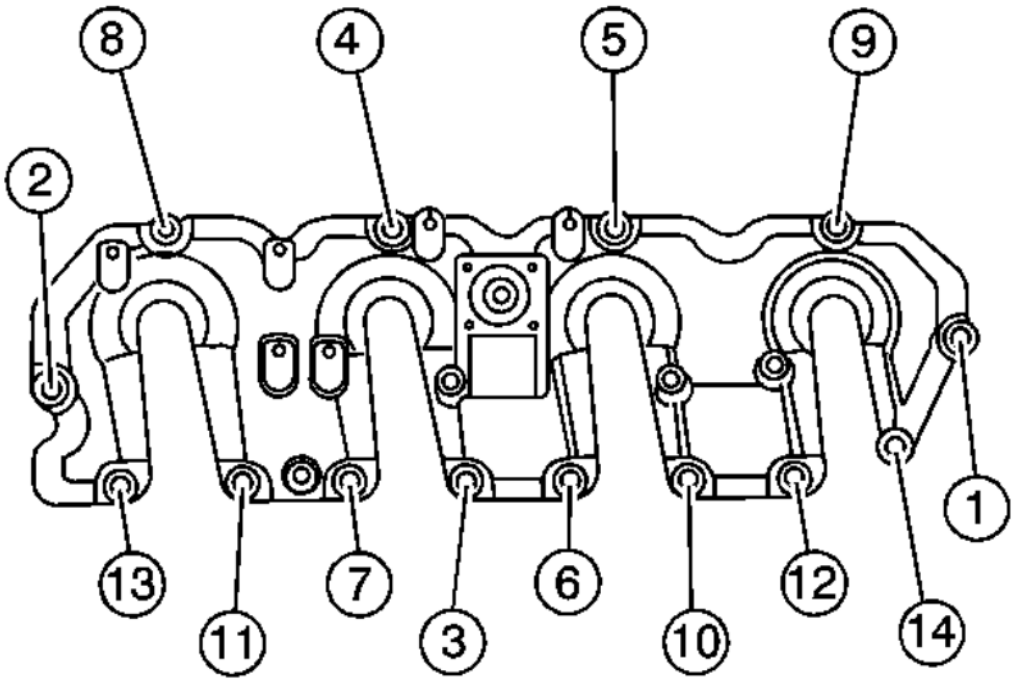


Fig. 9: Upper Valve Rocker Arm Cover Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

2. Install the upper valve rocker arm cover bolts.

   Tighten: Tighten the upper valve rocker arm cover bolts in the proper sequence to 8 N.m (71 lb in).

FUEL INJECTORS INSTALLATION

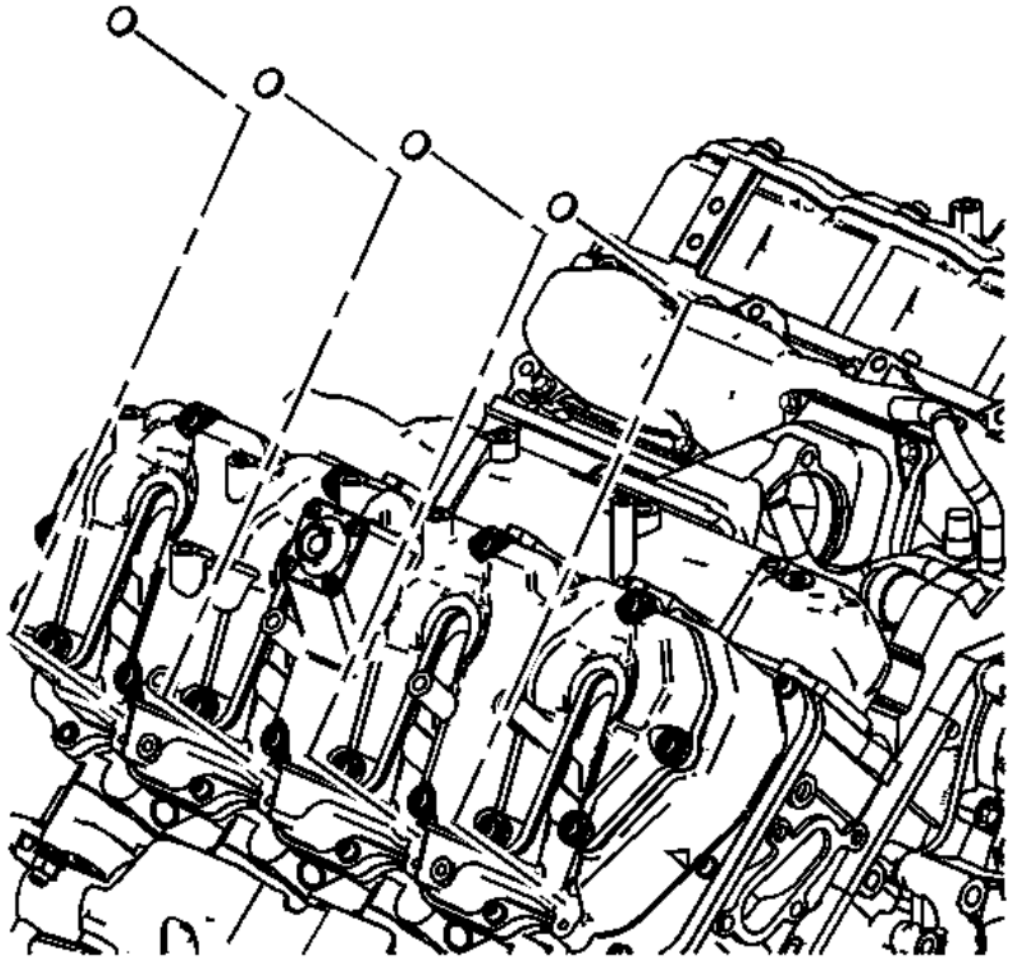


Fig. 10: Identifying Fuel Injector Copper Washers
Courtesy of GENERAL MOTORS CORP.

1. Install a new O-ring onto the fuel injector.
2. Lubricate the O-ring with engine oil.
3. Install a new copper washer into the fuel injector bore in the cylinder head.
4. Install the fuel injector right bracket pin.

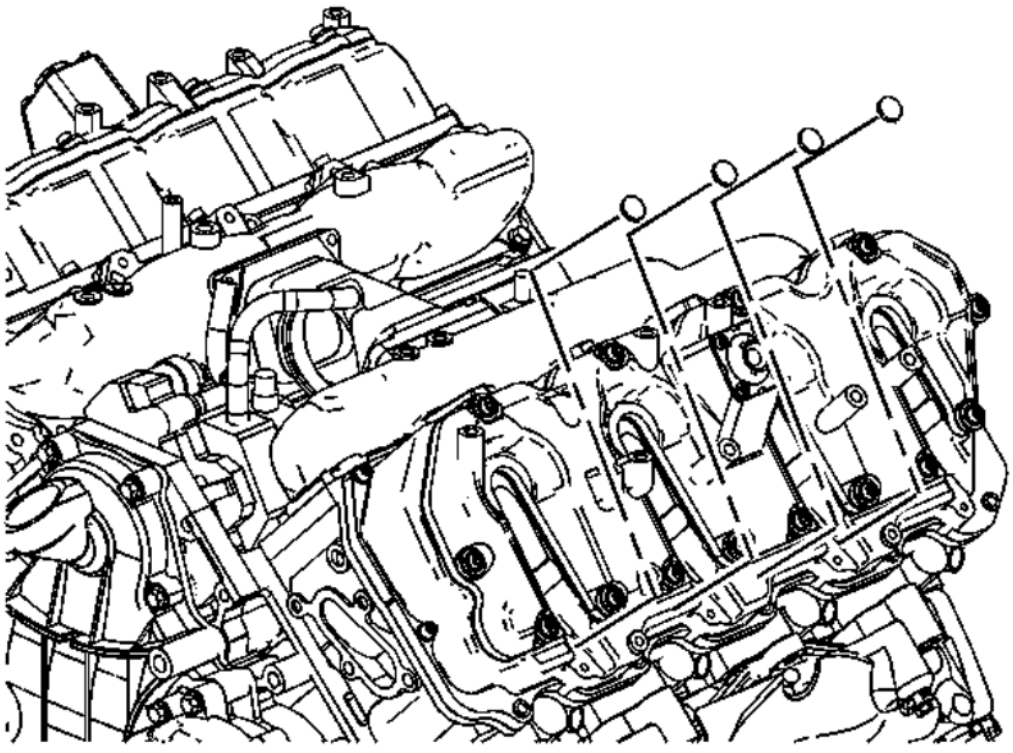


Fig. 11: View Of Left Injector Bracket Pins
Courtesy of GENERAL MOTORS CORP.

5. Install the fuel injector left bracket pin.

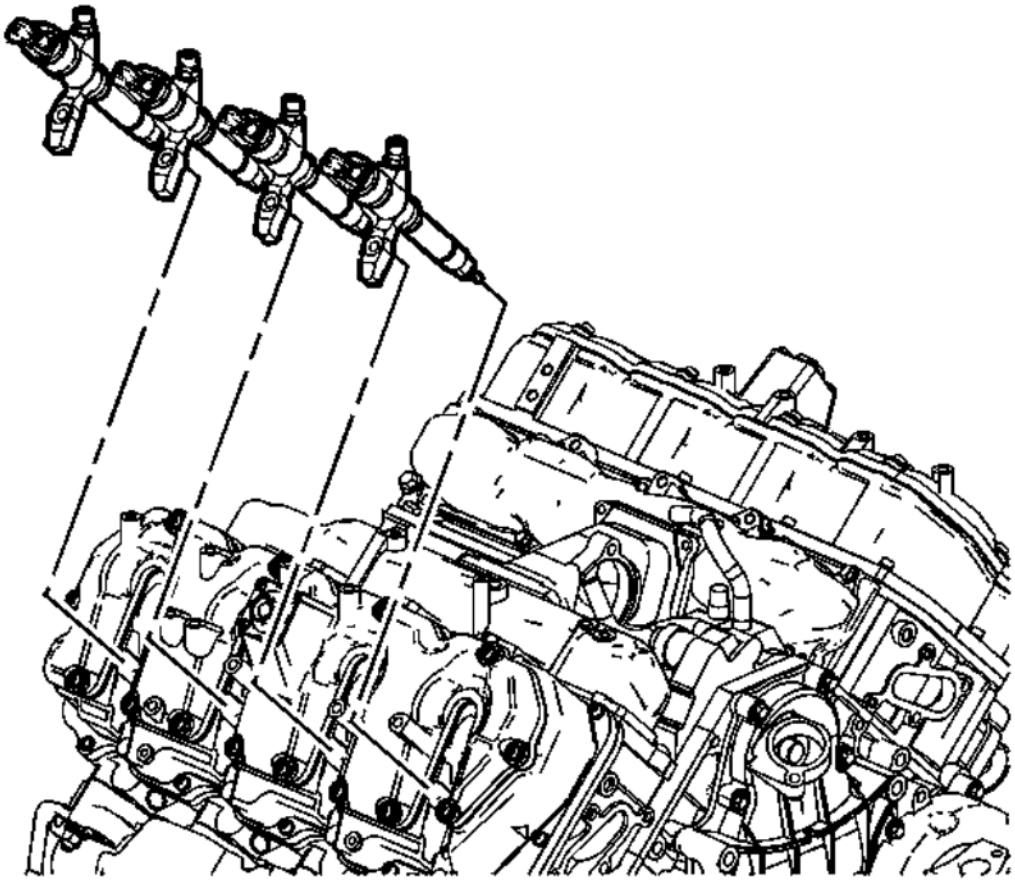


Fig. 12: View Of Right Fuel Injectors W/Brackets
Courtesy of GENERAL MOTORS CORP.

6. Install the right fuel injector with fuel injector bracket.

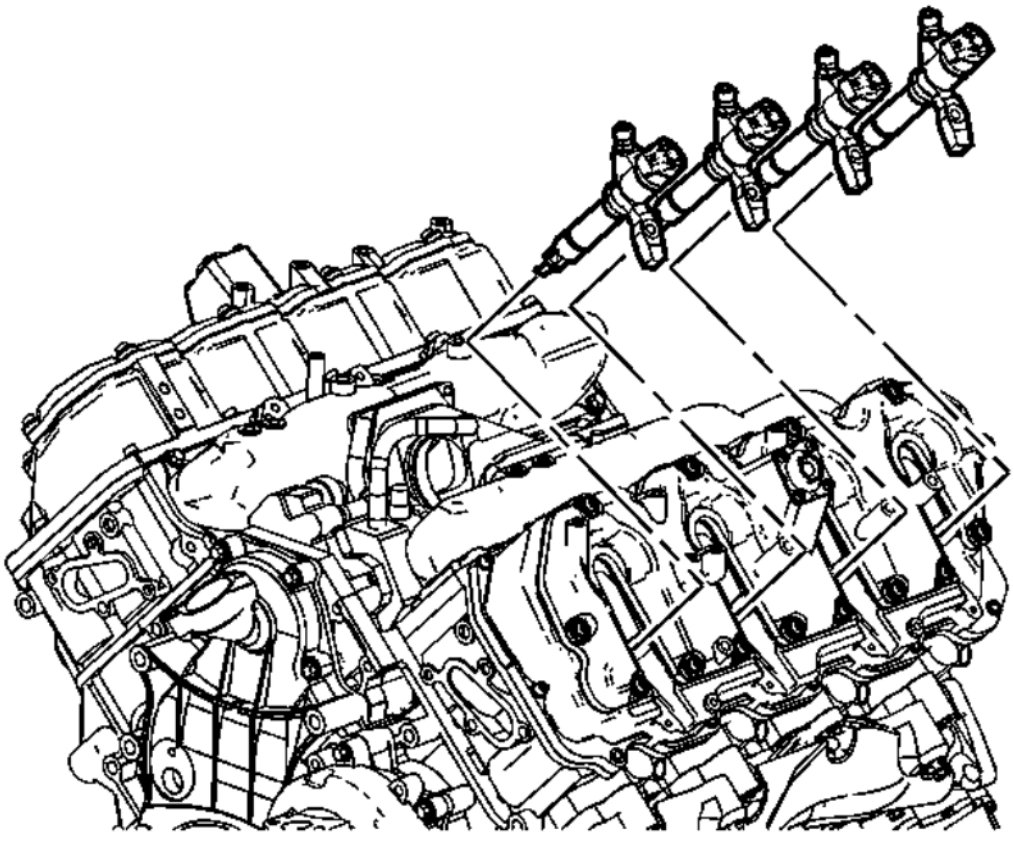


Fig. 13: View Of Left Fuel Injectors W/Brackets
Courtesy of GENERAL MOTORS CORP.

7. Install the left fuel injector with fuel injector bracket.

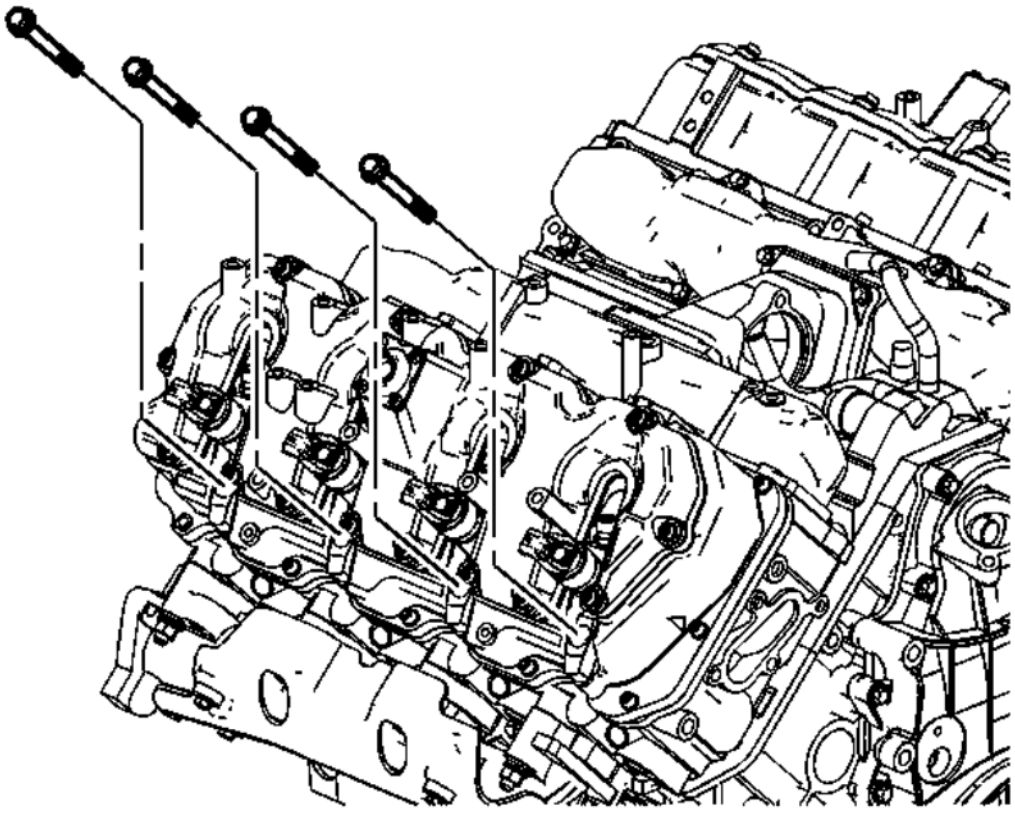


Fig. 14: View Of Right Fuel Injector Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

8. Install the right fuel injector bracket bolts.

   Tighten: Tighten the right fuel injector bracket bolts to 30 N.m (22 lb ft).

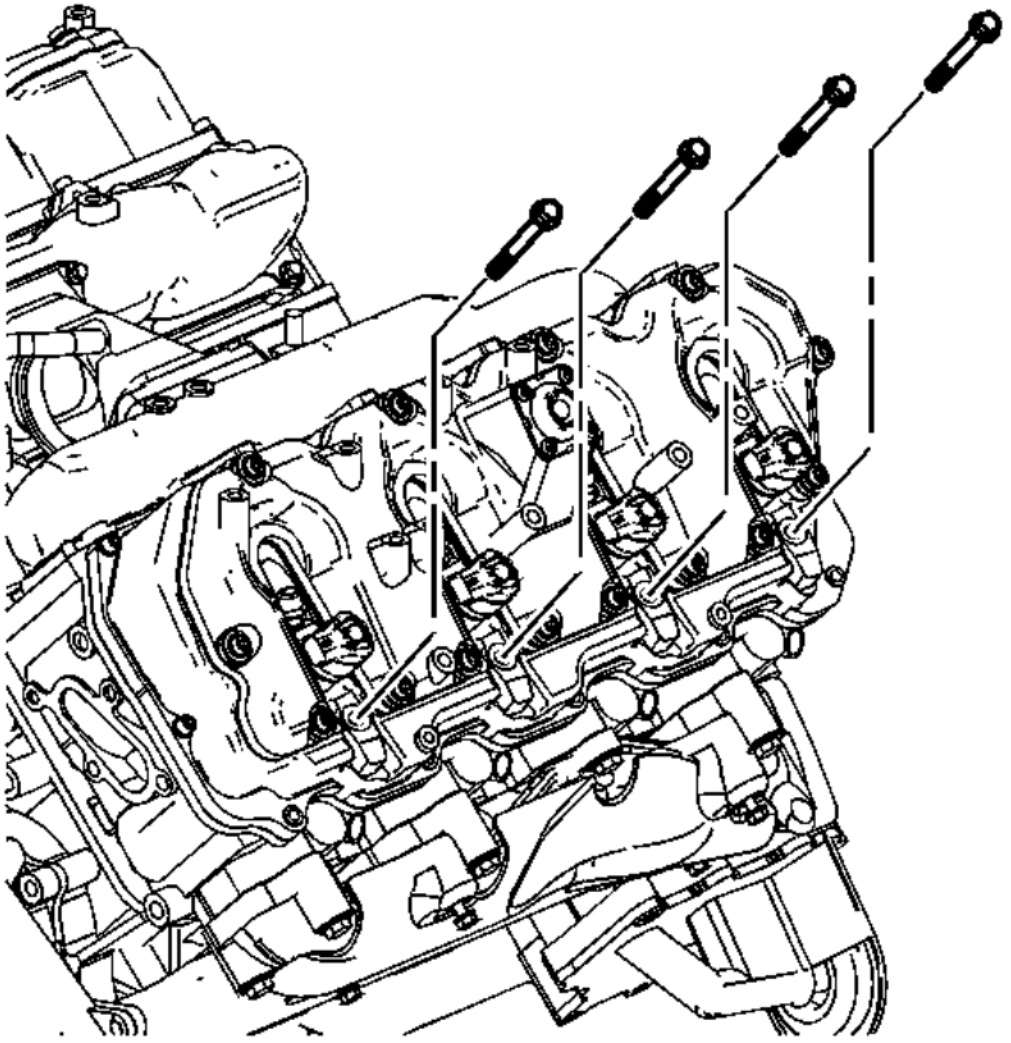


Fig. 15: View Of Left Fuel Injector Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

9. Install the left fuel injector bracket bolts.

   Tighten: Tighten the left fuel injector bracket bolts to 30 N.m (22 lb ft).

FUEL PIPES AND FUEL RAIL INSTALLATION

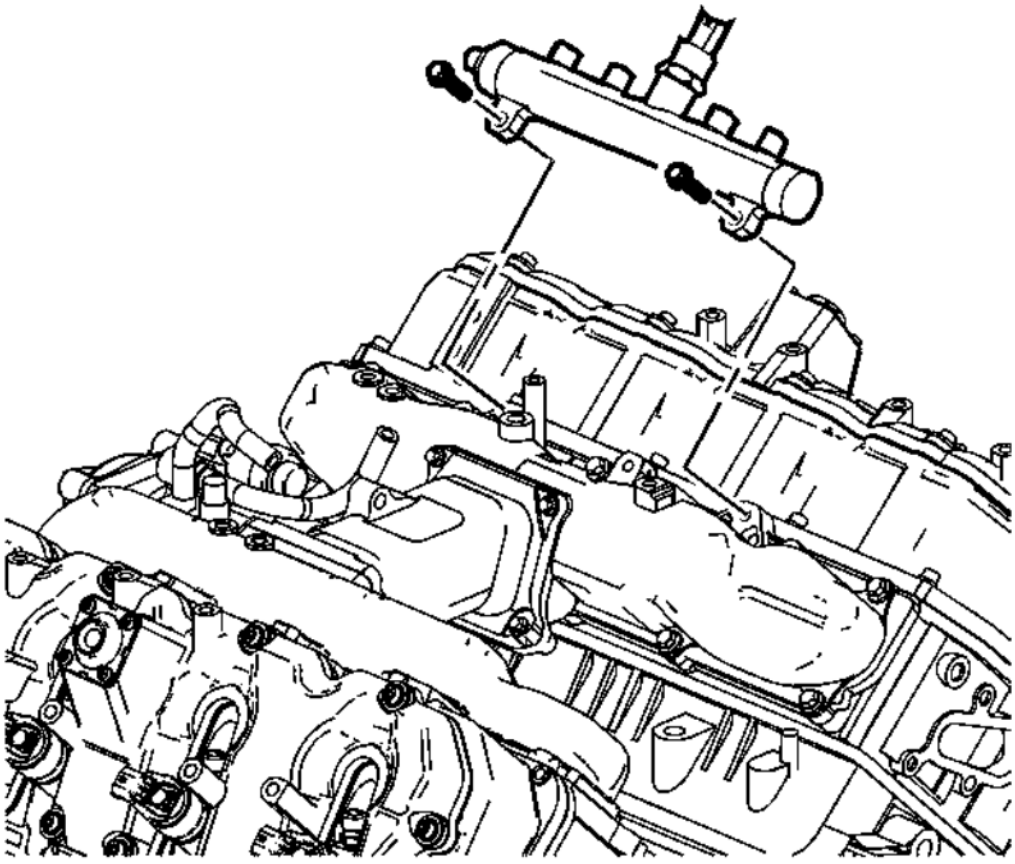


Fig. 16: View Of Right Fuel Rail
Courtesy of GENERAL MOTORS CORP.

1. Install the right fuel rail.

NOTE: **Refer to Fastener Notice .**

2. Install the right fuel rail mounting bolts.

Tighten: Tighten the right fuel rail mounting bolts to 25 N.m (18 lb ft).

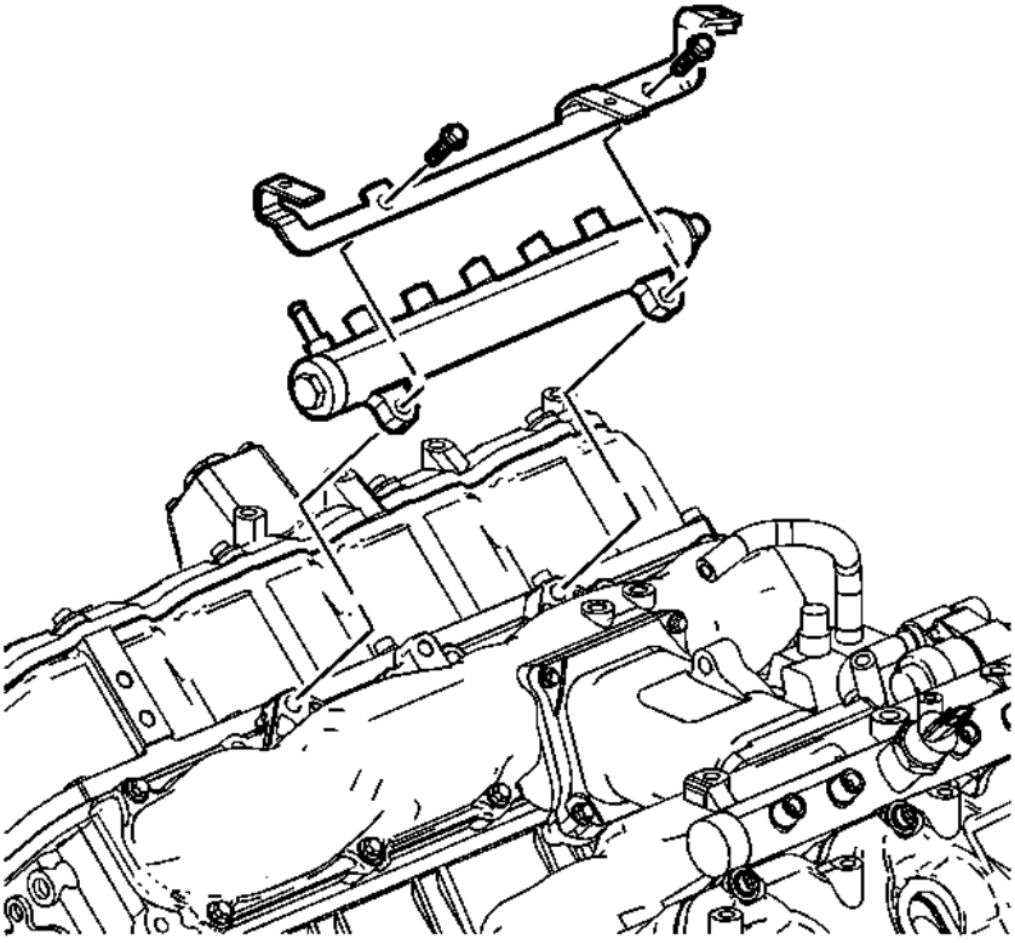


Fig. 17: View Of Left Fuel Rail And Bracket
Courtesy of GENERAL MOTORS CORP.

3. Install the left fuel rail.
4. Install the left fuel rail mounting bolts.

Tighten: Tighten the left fuel rail mounting bolts to 25 N.m (18 lb ft).

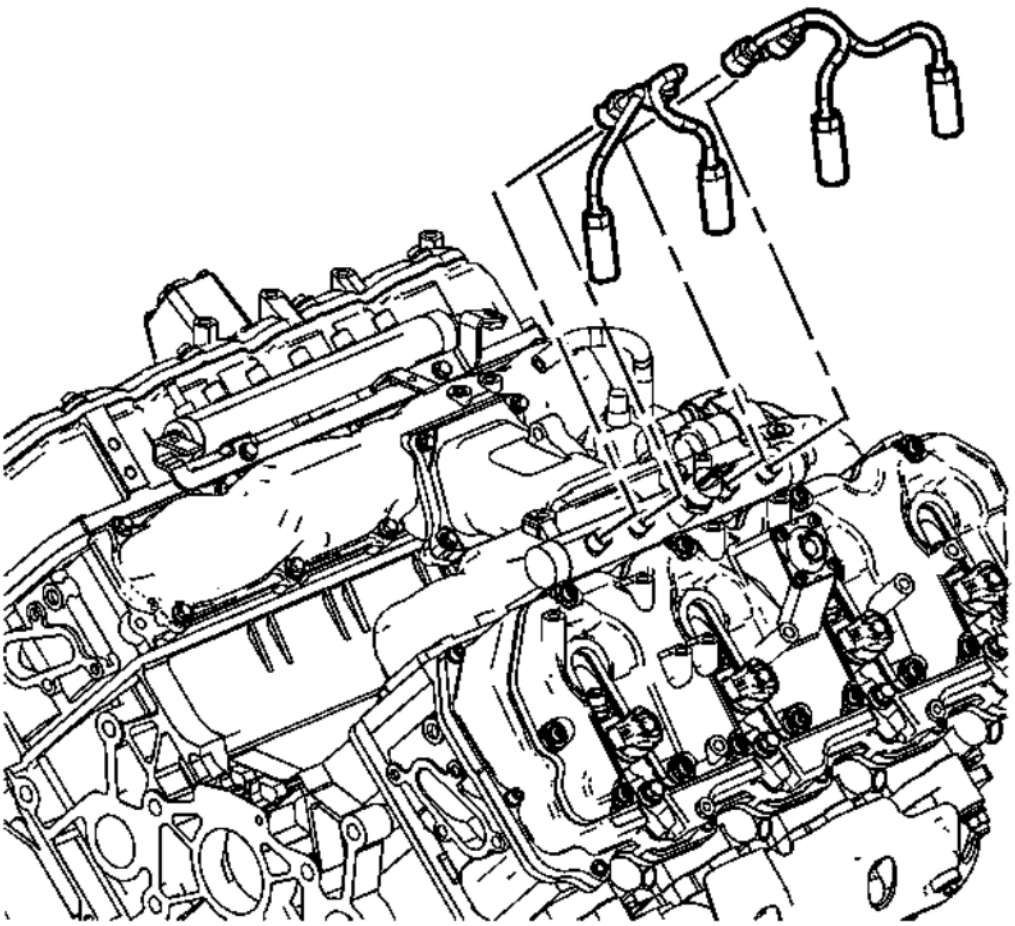


Fig. 18: View Of Fuel Injector Pipes
Courtesy of GENERAL MOTORS CORP.

CAUTION: Improper torque methods of the fuel lines will result in fuel leaks and possible damage to the engine. Failure to follow proper fuel line fitting torque methods could result in serious personal injury.

5. Install the injection pipes to the right bank.

Tighten: Tighten the injection pipes to 41 N.m (30 lb ft).

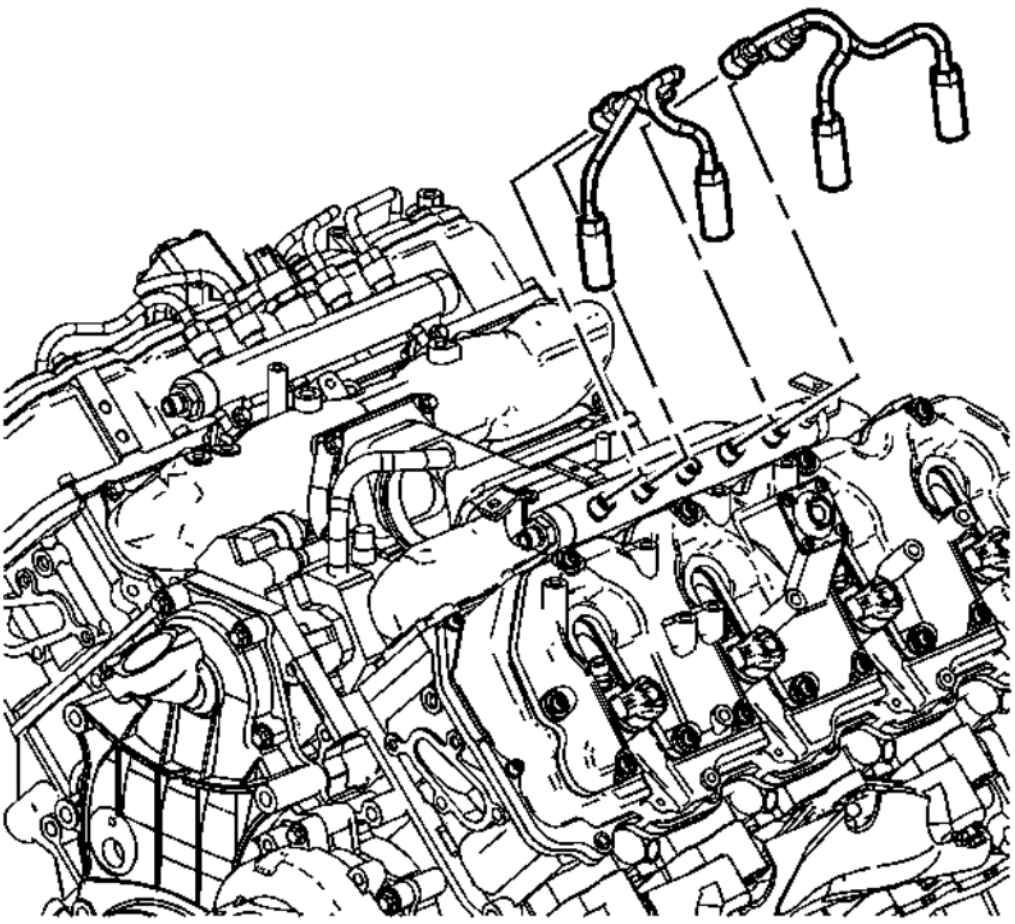


Fig. 19: View Of Left Fuel Injector Pipes
Courtesy of GENERAL MOTORS CORP.

CAUTION: Improper torque methods of the fuel lines will result in fuel leaks and possible damage to the engine. Failure to follow proper fuel line fitting torque methods could result in serious personal injury.

6. Install the injection pipes to the left bank.

Tighten: Tighten the injection pipes to 41 N.m (30 lb ft).

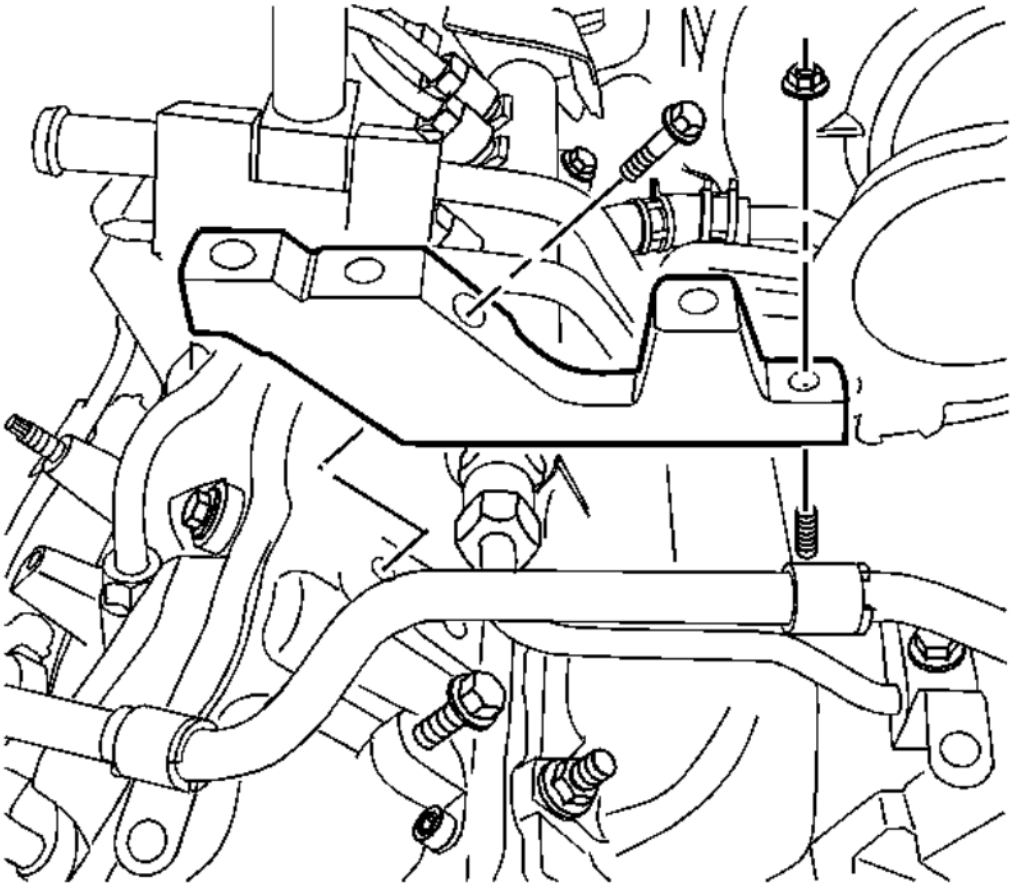


Fig. 20: Identifying EGR Mounting Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

7. Install the exhaust gas recirculation (EGR) mounting brackets.
8. Install the EGR mounting bracket bolts.

Tighten: Tighten the EGR mounting bracket bolts to 20 N.m (15 lb ft).

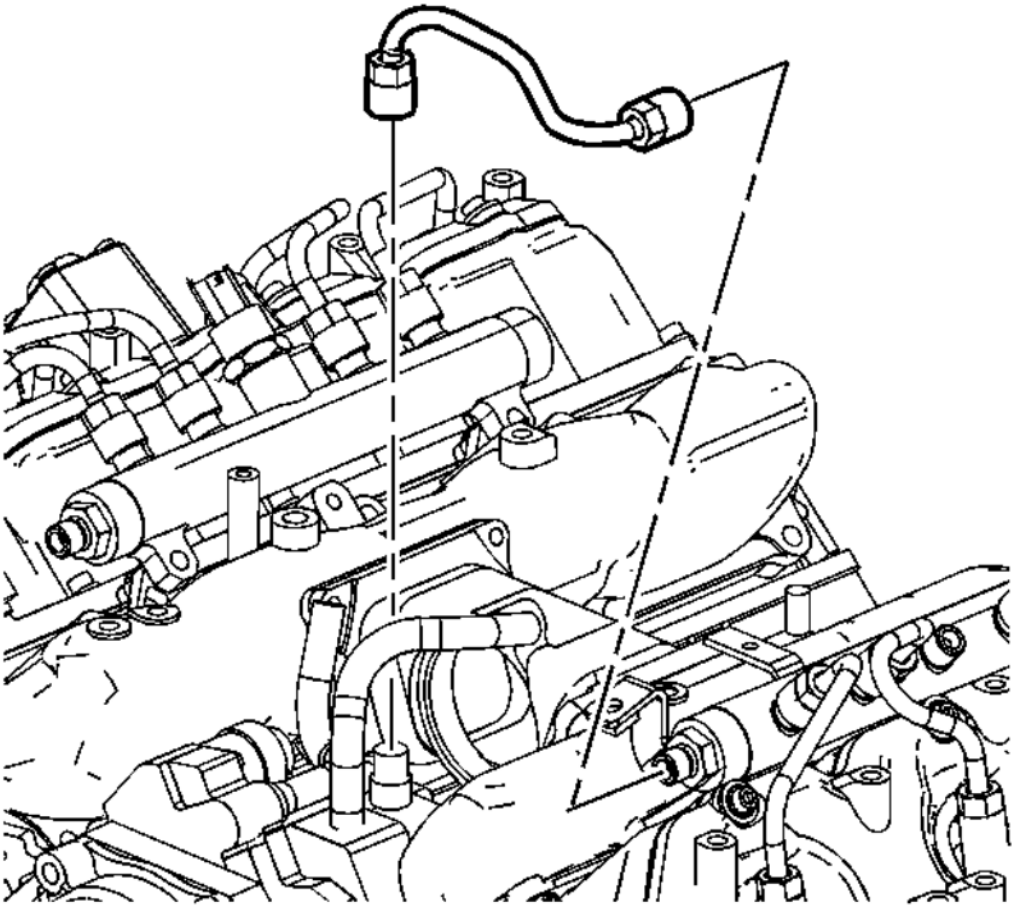


Fig. 21: View Of Left Fuel Rail At Pump Pipe
Courtesy of GENERAL MOTORS CORP.

9. Install the left fuel rail to pump pipe.

   Tighten: Tighten the fuel rail to pump pipe nut to 41 N.m (30 lb ft).

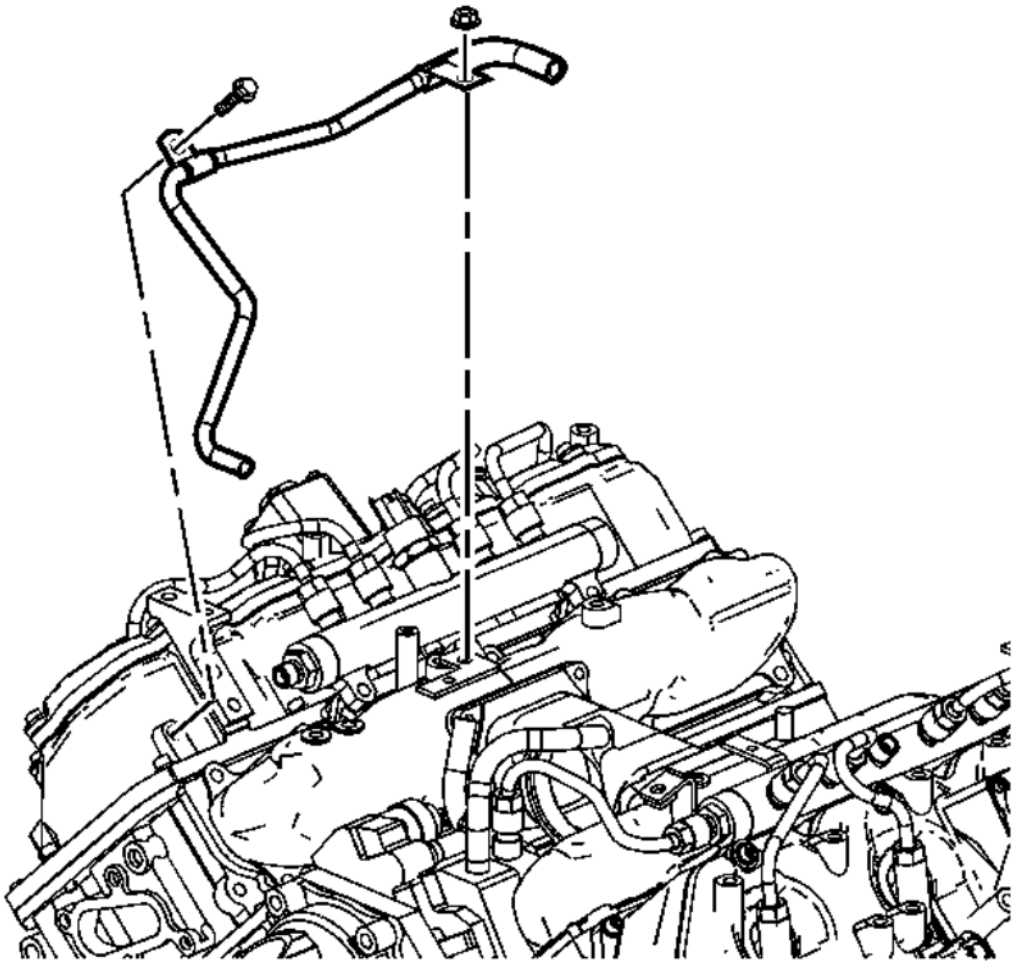


Fig. 22: View Of Coolant Pipe
Courtesy of GENERAL MOTORS CORP.

10. Install the coolant pipe.
11. Install the coolant pipe bolt and nut.

Tighten: Tighten the coolant pipe bolt and nut to 25 N.m (18 lb ft).

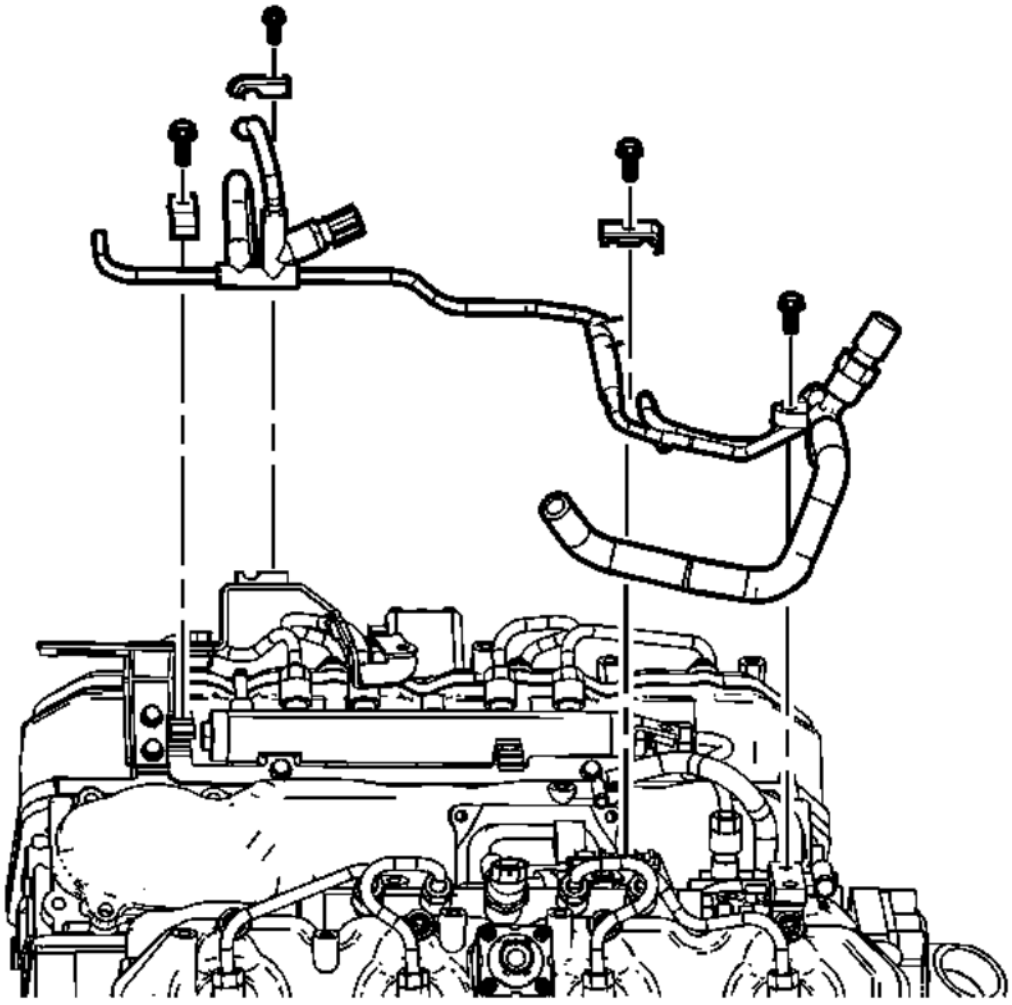


Fig. 23: View Of Distribution Block, Fuel Line Assembly & Bolts
Courtesy of GENERAL MOTORS CORP.

12. Install the distribution block and fuel line assembly.
13. Install the distribution block and fuel line assembly bolts.

Tighten: Tighten the fuel line assembly bolts to 25 N.m (18 lb ft).

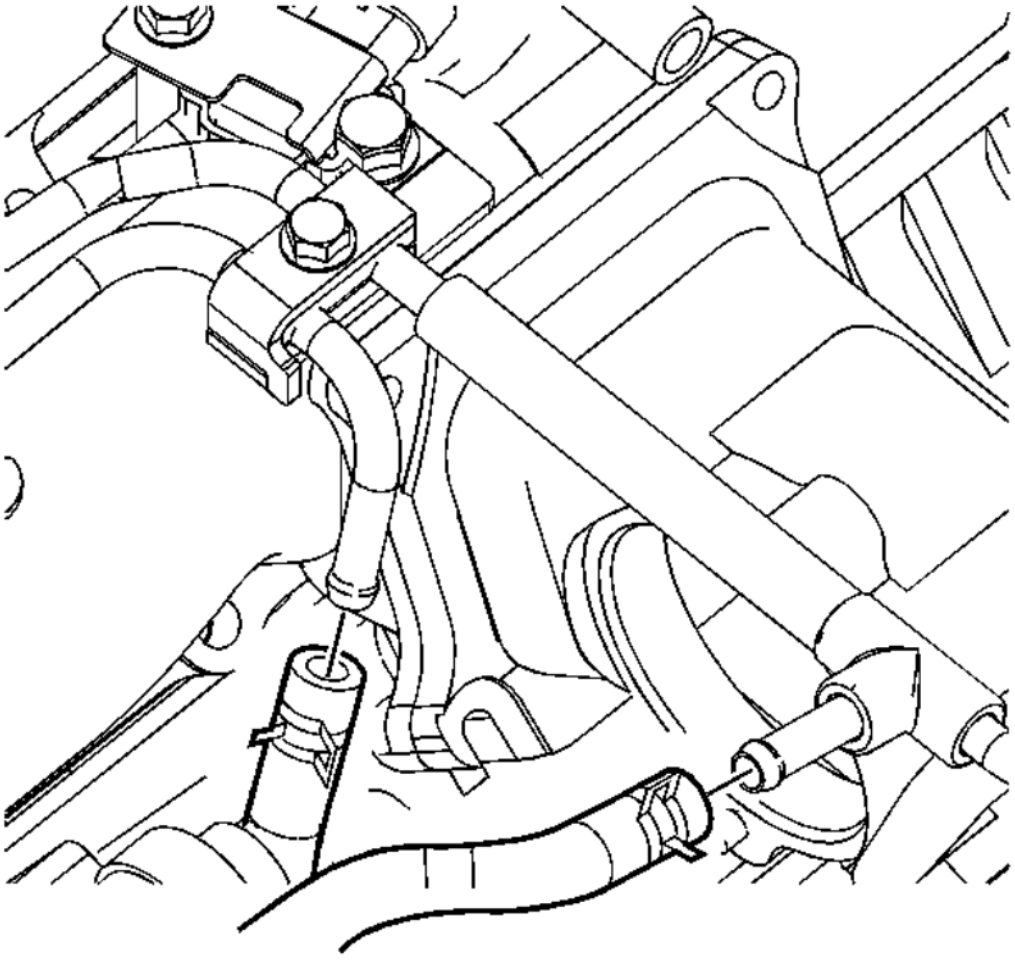


Fig. 24: View Of Fuel Hose Connections
Courtesy of GENERAL MOTORS CORP.

14. Connect the fuel hoses to the fuel injector pump.

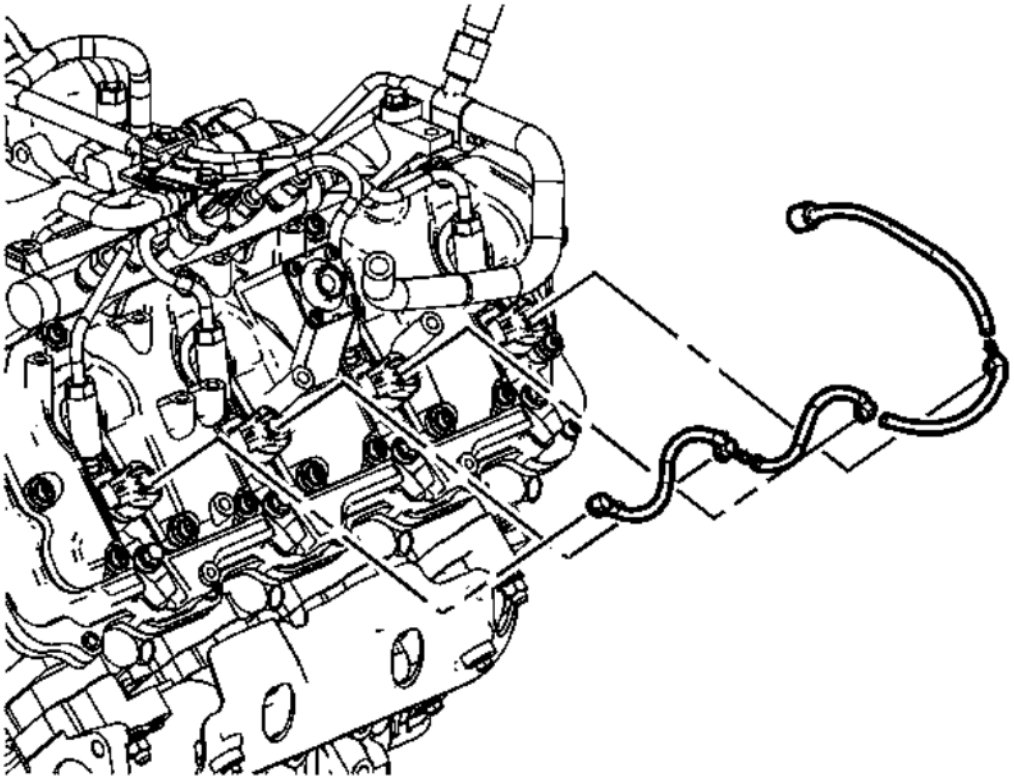


Fig. 25: View Of Right Fuel Return Hose & Injectors
Courtesy of GENERAL MOTORS CORP.

15. Install the right fuel return hose.

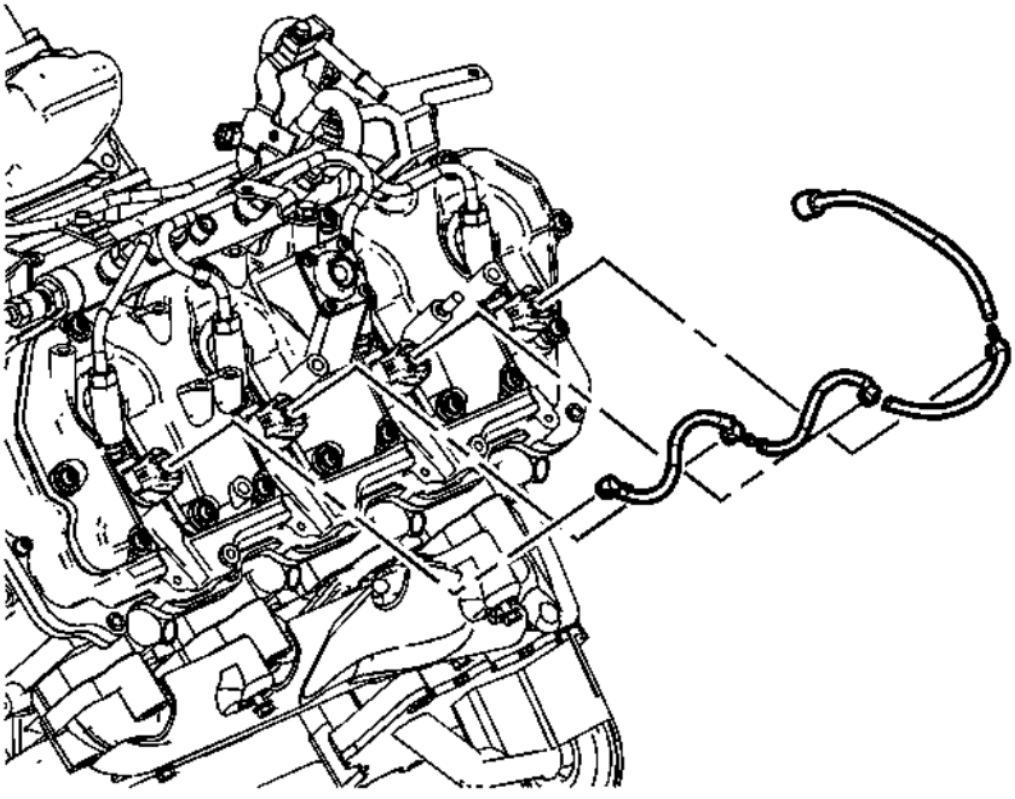


Fig. 26: View Of Fuel Return Hose & Injectors
Courtesy of GENERAL MOTORS CORP.

16. Install the left fuel return hose.

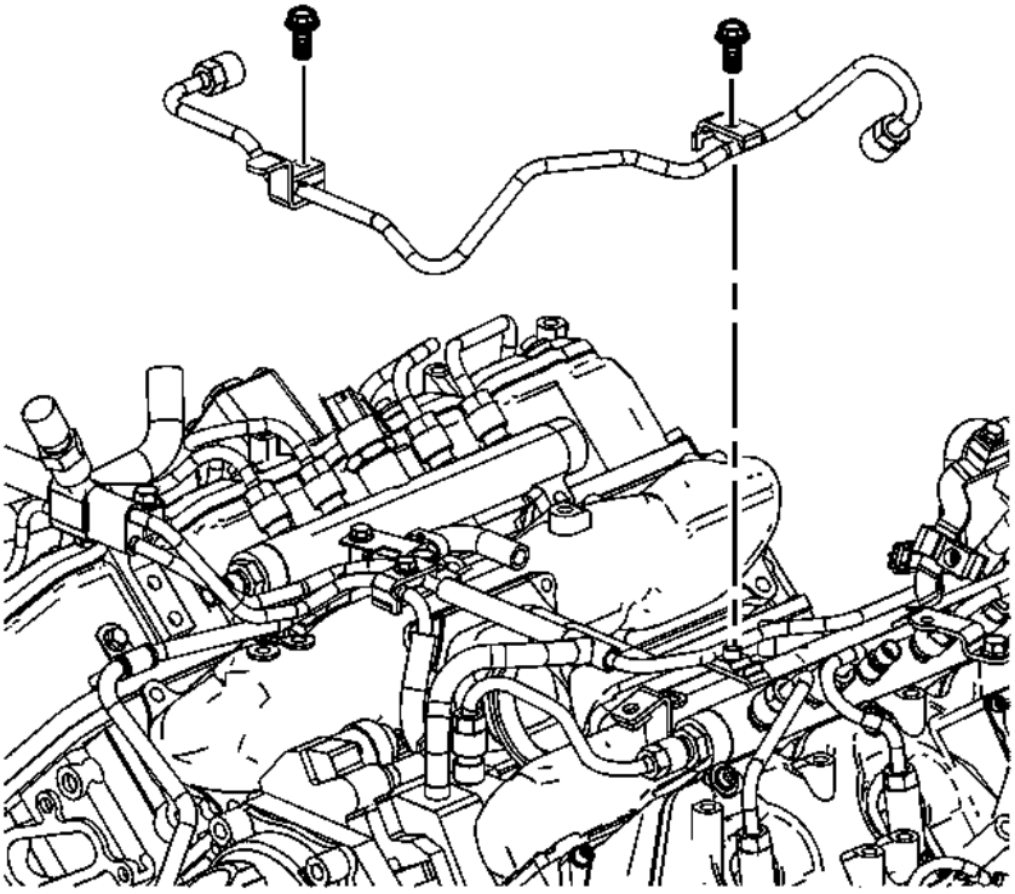


Fig. 27: View Of Fuel Rail Balance Pipe & Bolts
Courtesy of GENERAL MOTORS CORP.

17. Install the fuel rail balance pipe.
18. Install the fuel rail balance pipe bolts.

    Tighten: Tighten the fuel rail balance pipe bolts to 21 N.m (15 lb ft).

19. Connect the fuel rail balance pipe to the fuel rails.

    Tighten: Tighten the fuel rail balance pipe nuts to 41 N.m (30 lb ft).

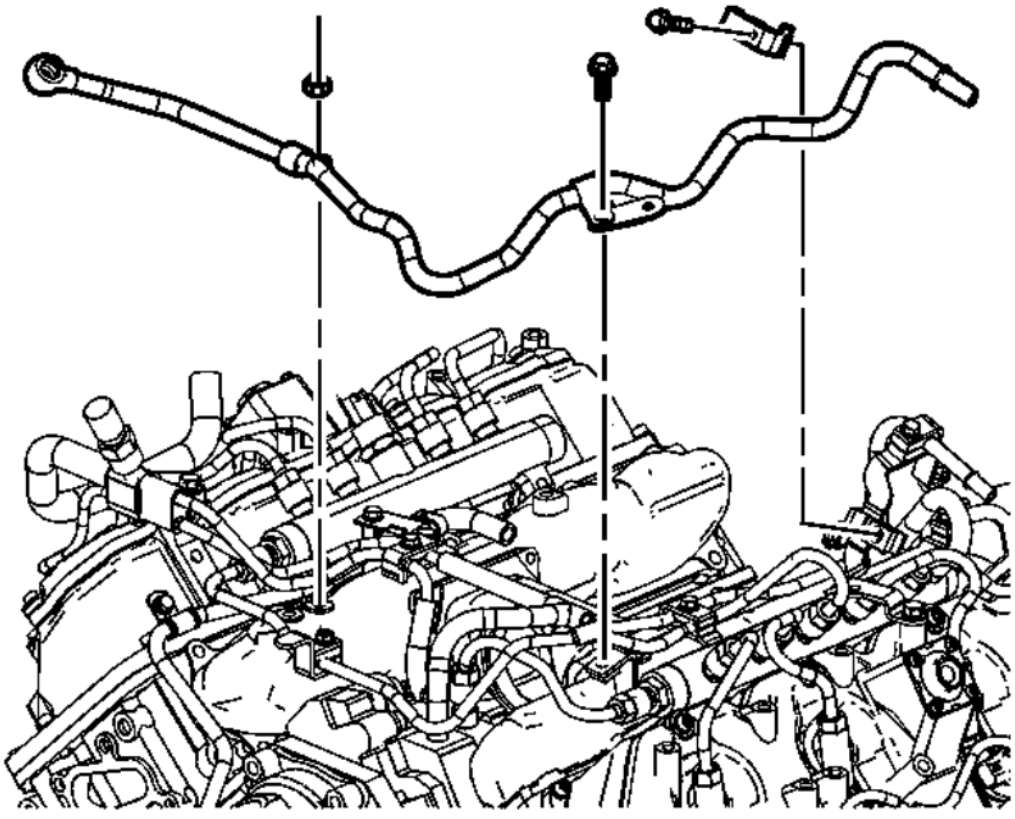


Fig. 28: View Of Fuel Feed Pipe & Bolts
Courtesy of GENERAL MOTORS CORP.

20. Install the fuel feed pipe.
21. Install the fuel feed pipe attaching nuts and bolts.

Tighten: Tighten the fuel feed pipe bolts and nut to 25 N.m (18 lb ft).

TURBOCHARGER INSTALLATION

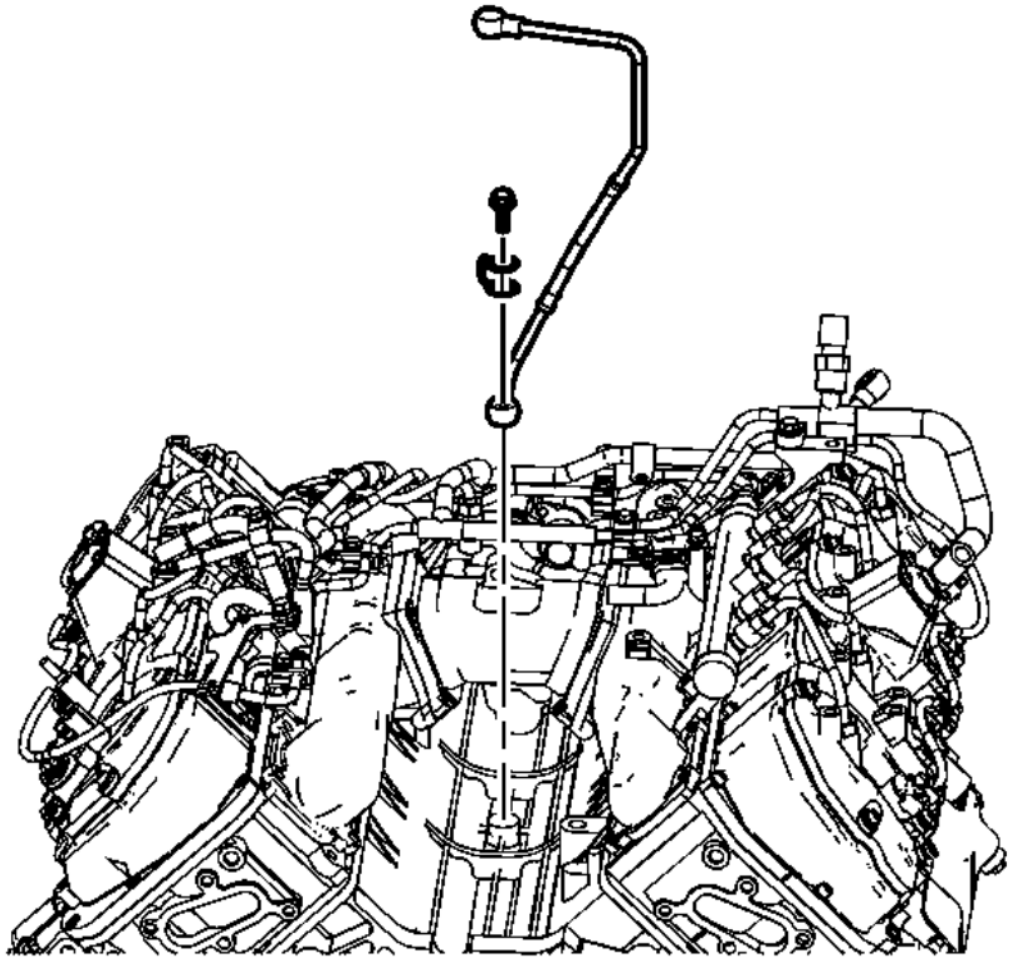


Fig. 29: View Of Oil Feed Pipe Bolt, Washer & Pipe
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not twist the turbocharger oil feed pipe. Twisting of the feed pipe will result in the collapse and deformation of the plastic pipe, restricting oil flow and causing turbocharger damage. During turbocharger replacement, gently push the oil feed pipe towards the front of the engine to clear the turbocharger. Assistance may be required to keep the pipes clear of the turbocharger during removal or installation.

1. Install the turbocharger oil supply line to the engine block.

   NOTE: Refer to Fastener Notice .

   IMPORTANT: Lubricate the washers with diesel fuel before installing.

2. Install the turbocharger oil supply line eye bolt and washers.

   Tighten: Tighten the turbocharger oil supply line eye bolt to 26 N.m (19 lb ft).

3. Install the turbocharger lower heat shield to the engine block.

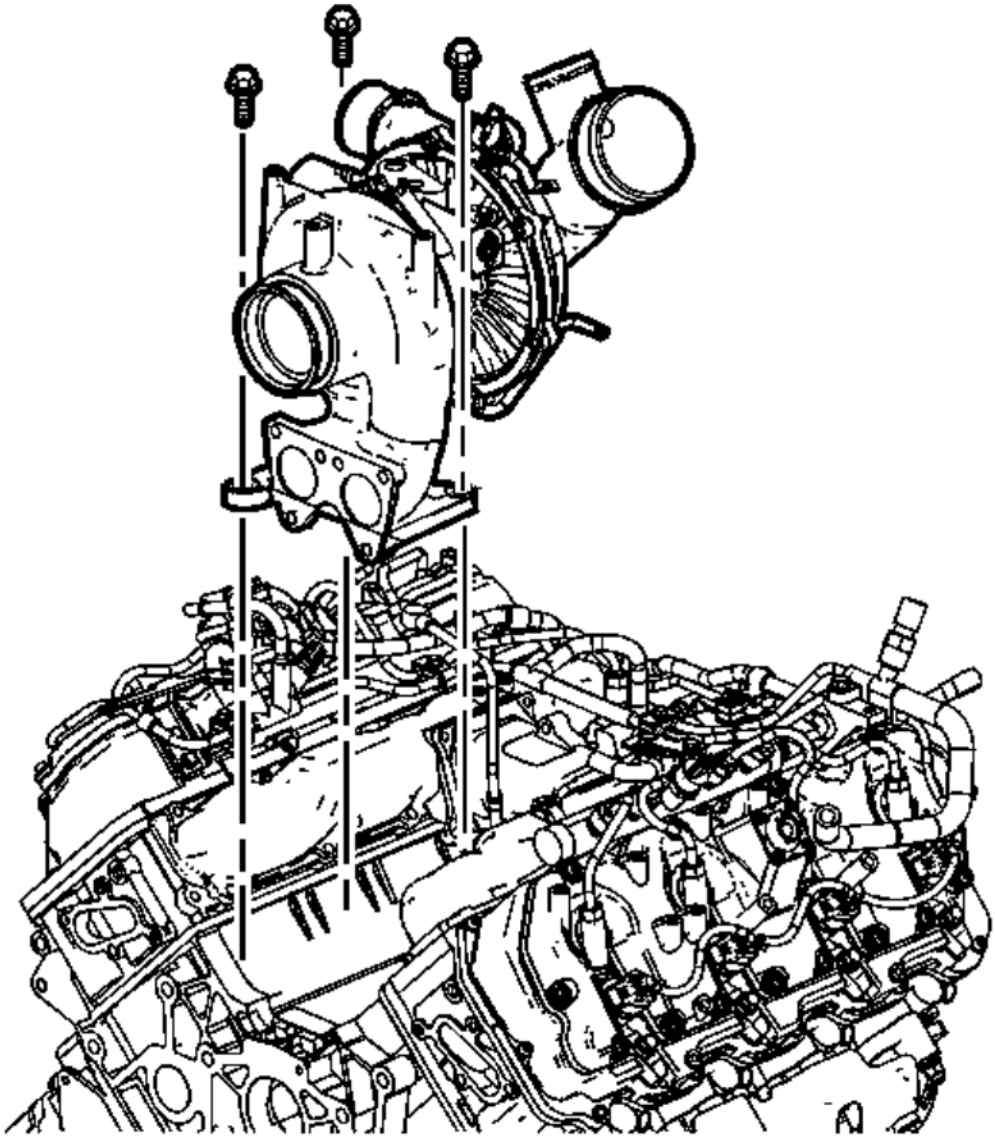


Fig. 30: View Of Turbocharger W/Oil Return Pipe
Courtesy of GENERAL MOTORS CORP.

4. Install the turbocharger assembly with the oil return pipe.
5. Install the turbocharger mounting bolts.

Tighten: Tighten the turbocharger mounting bolts to 108 N.m (80 lb ft).

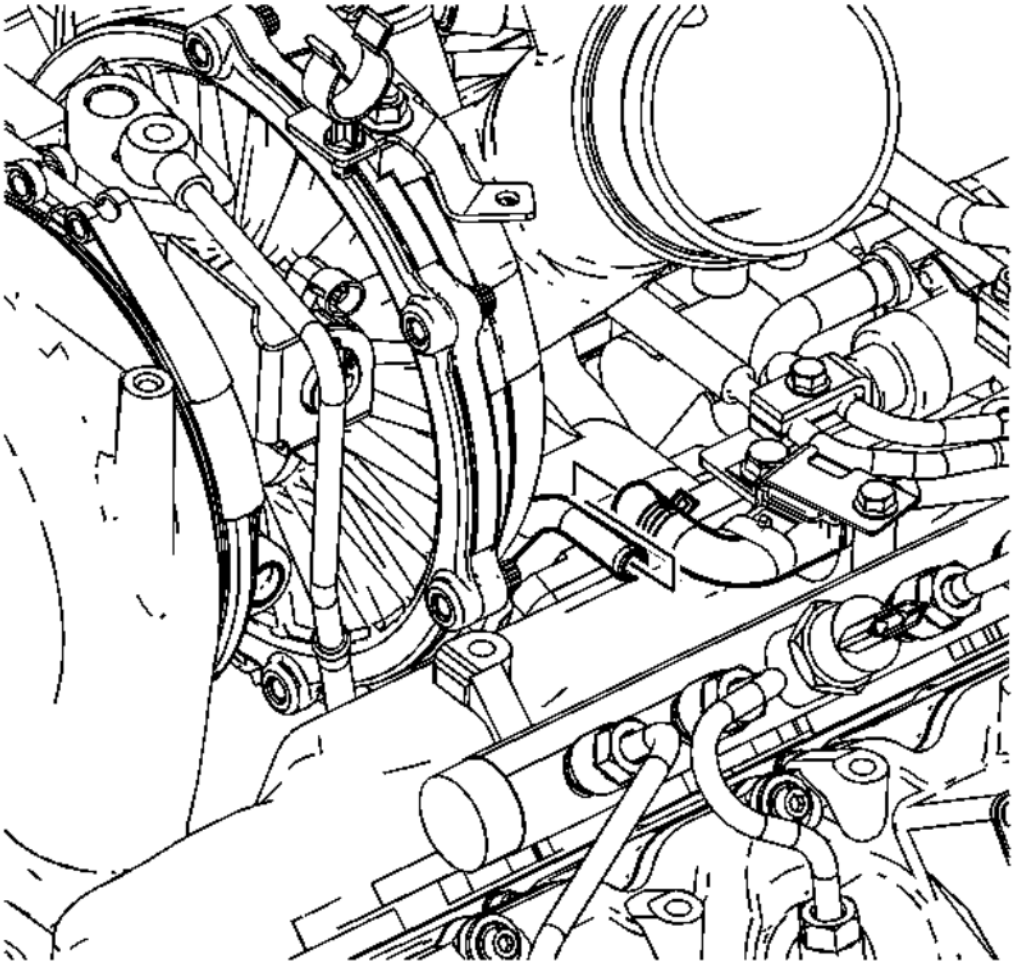


Fig. 31: View Of Turbocharger Outlet Coolant Pipe
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Use care not to damage this hose during the procedure.

6. Install the turbocharger cooling outlet hose and tighten hose clamp.

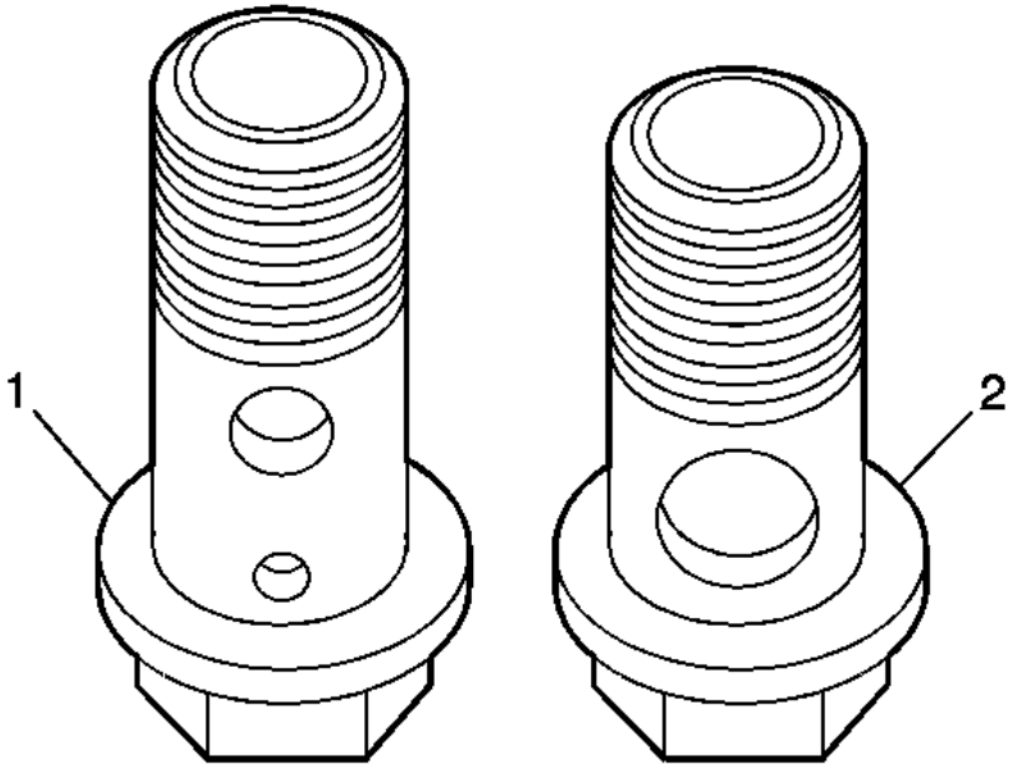


Fig. 32: View Of Cooling Outlet Hose Eye Bolts
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: If the cooling outlet hose eye bolts were removed, install the longer bolt (1) with two holes, in the top location. Install the shorter bolt (2) in the lower location.

7. Install the cooling outlet hose eye bolts.

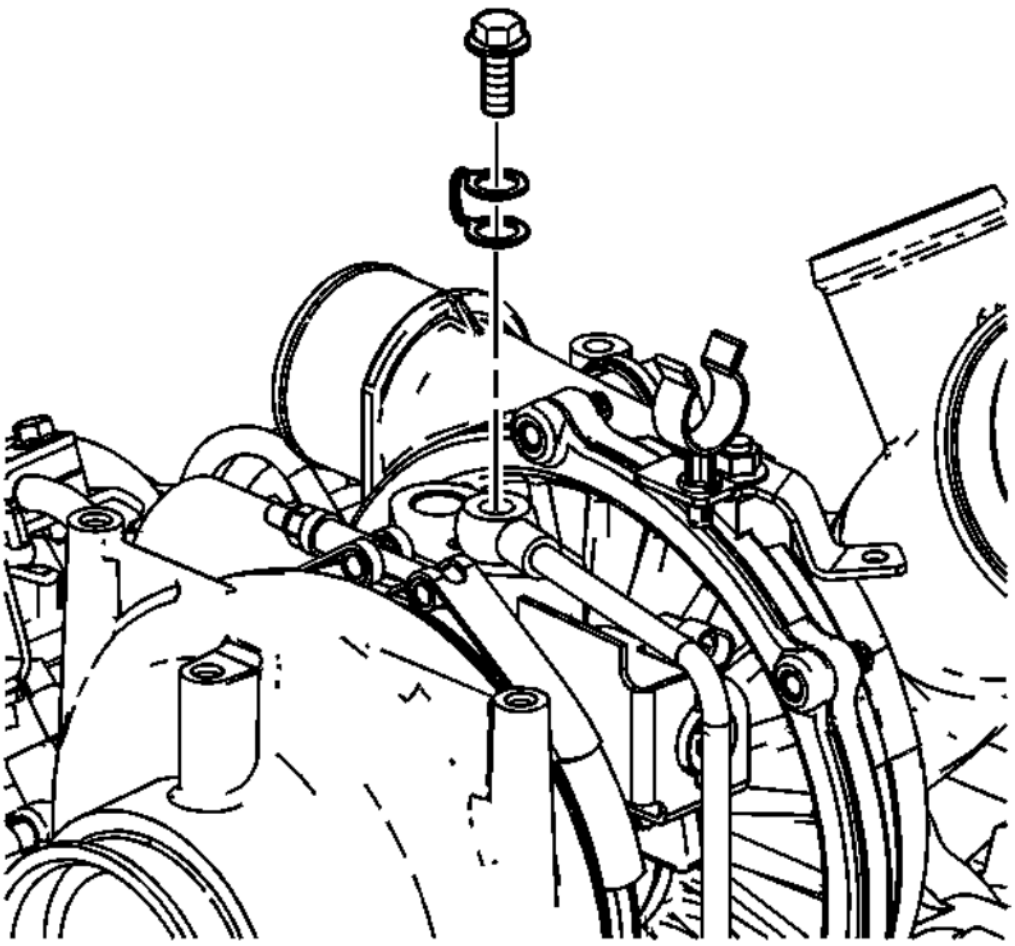


Fig. 33: View Of Turbocharger Oil Feed Pipe Banjo Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not twist the turbocharger oil feed pipe. Twisting of the feed pipe will result in the collapse and deformation of the plastic pipe, restricting oil flow and causing turbocharger damage. During turbocharger replacement, gently push the oil feed pipe towards the front of the engine to clear the turbocharger. Assistance may be required to keep the pipes clear of the turbocharger during removal or installation.

8. Install the oil supply line eye bolt and washers to the turbocharger.

Lubricate the washers with diesel fuel before installing.

Tighten: Tighten the oil supply hose eye bolt to 26 N.m (19 lb ft).

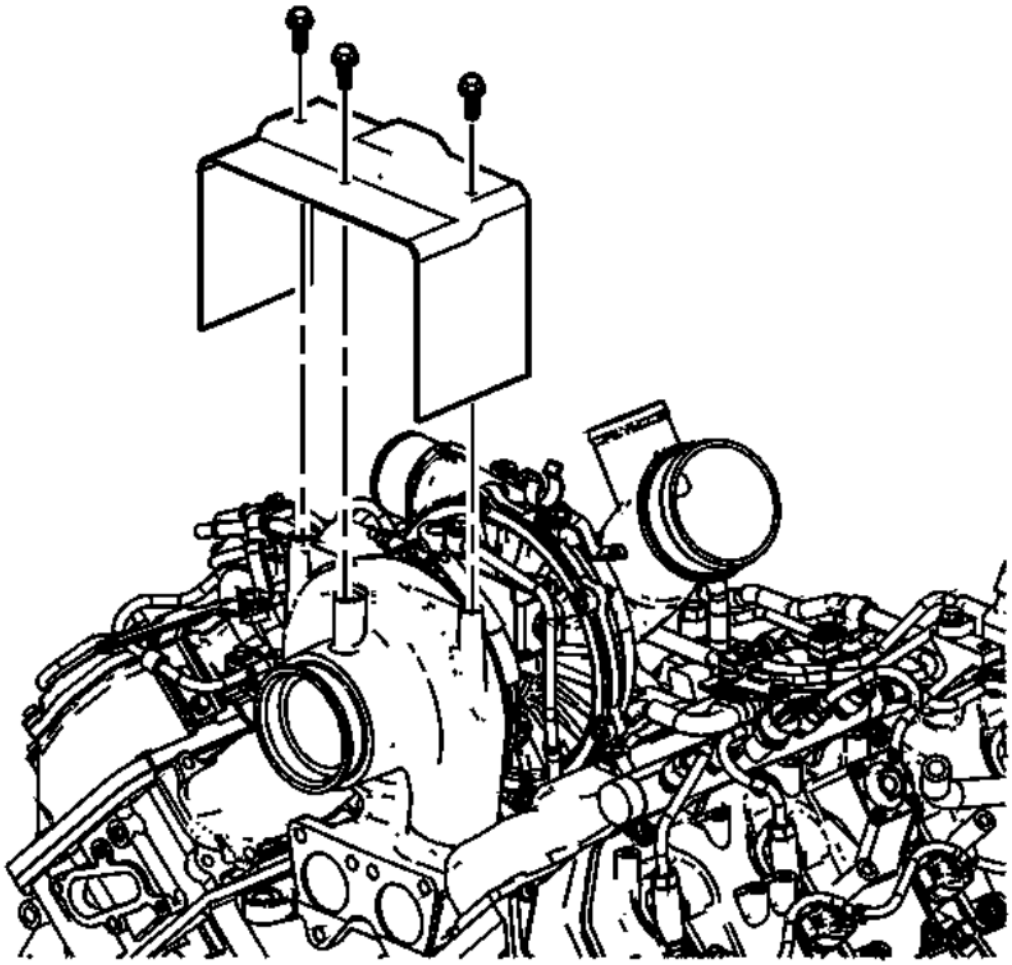


Fig. 34: View Of Turbocharger Upper Heat Shield
Courtesy of GENERAL MOTORS CORP.

9. Install the turbocharger heat shield.
10. Install the turbocharger upper heat shield bolts.

Tighten: Tighten the turbocharger upper heat shield bolts to 10 N.m (89 lb in).

EXHAUST GAS RECIRCULATION AND COOLER INSTALLATION

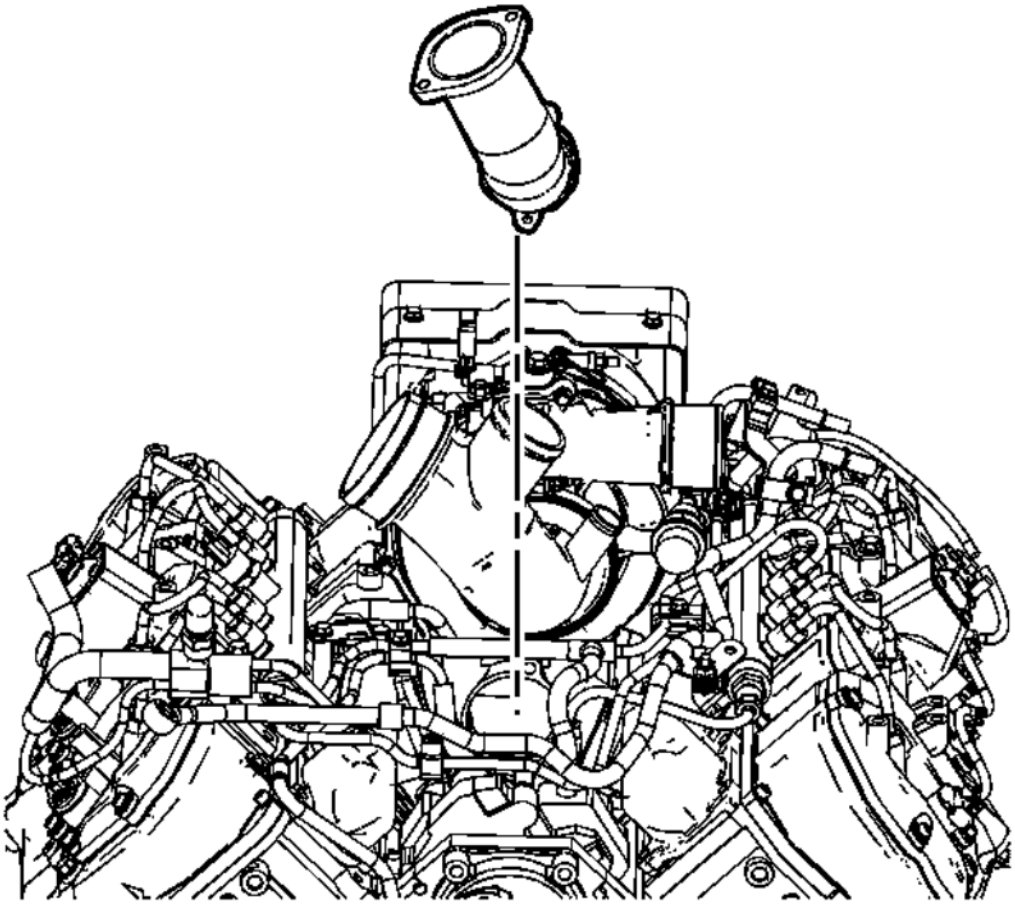


Fig. 35: View Of Intake Manifold Tube
Courtesy of GENERAL MOTORS CORP.

1. Install the intake manifold tube.

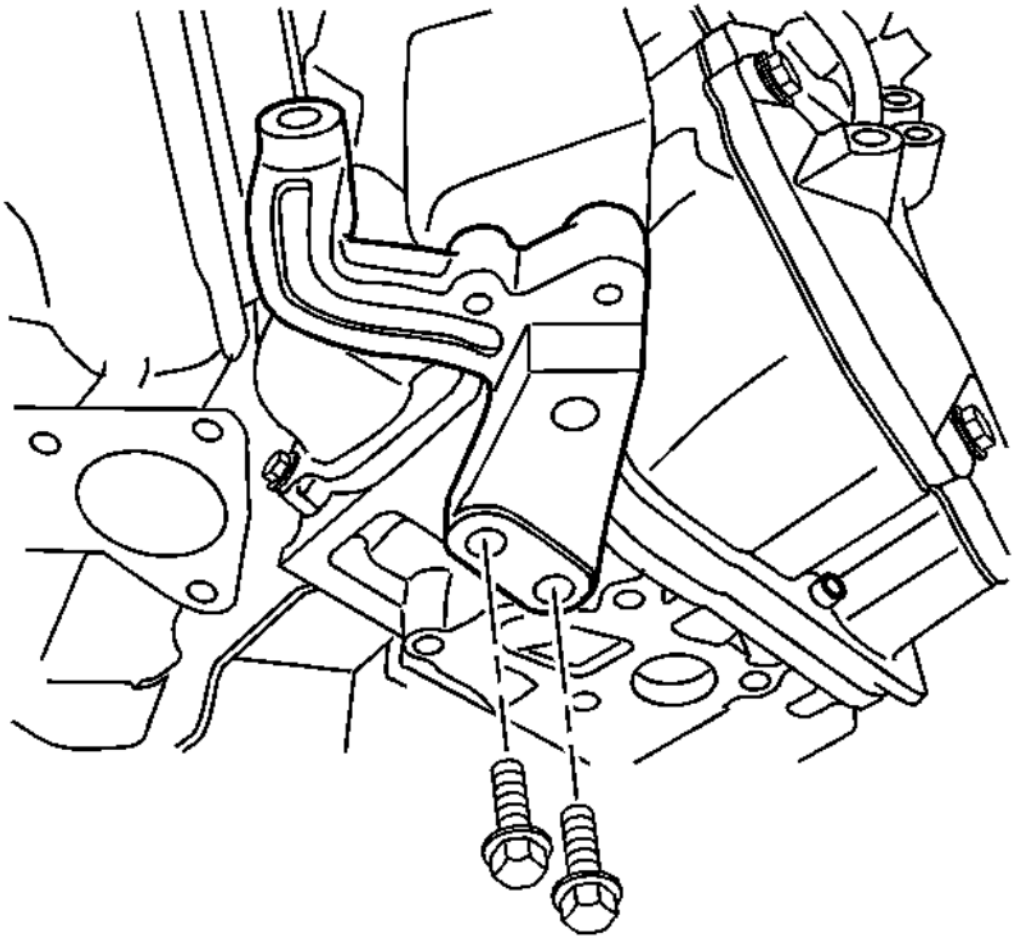


Fig. 36: Identifying EGR Cooler Bracket
Courtesy of GENERAL MOTORS CORP.

2. Install the exhaust gas recirculation (EGR) cooler bracket.

NOTE: Refer to Fastener Notice .

3. Install the EGR cooler bracket bolts.

Tighten: Tighten the EGR cooler bracket bolts to 25 N.m (18 lb ft).

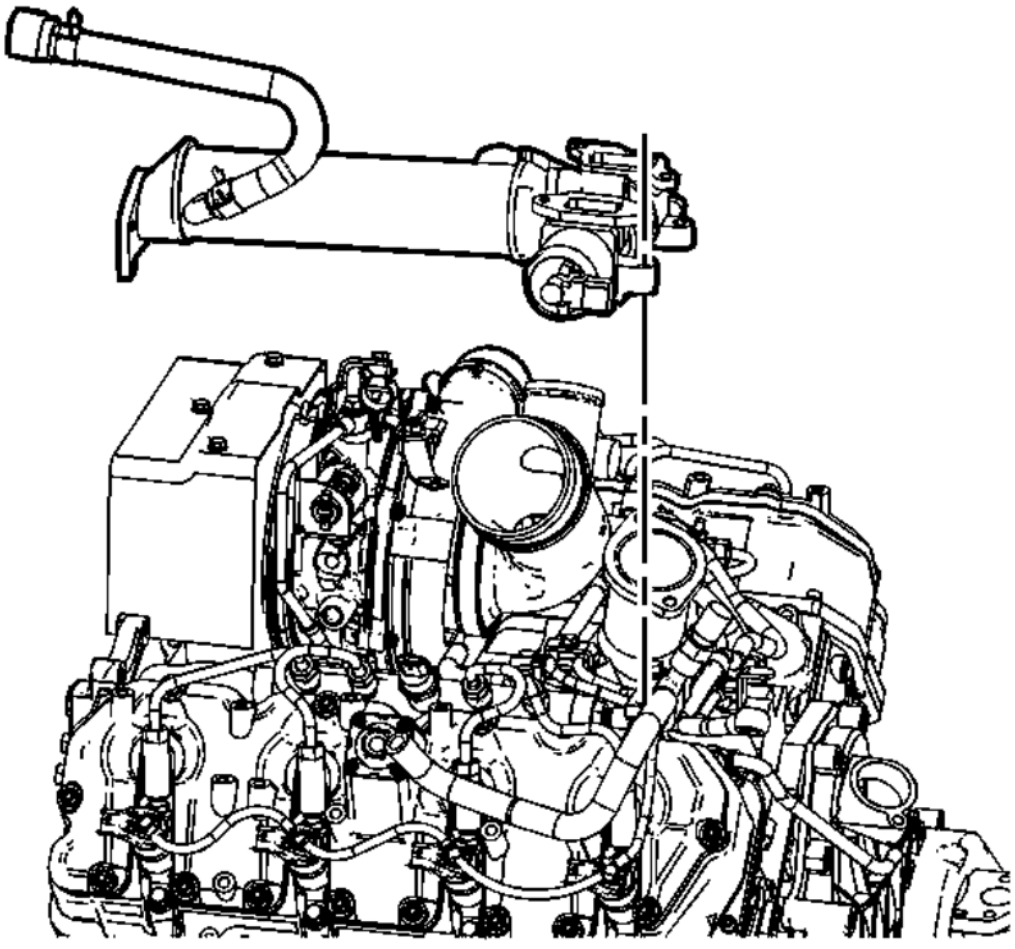


Fig. 37: View Of EGR & Cooler
Courtesy of GENERAL MOTORS CORP.

4. Install the EGR and cooler.

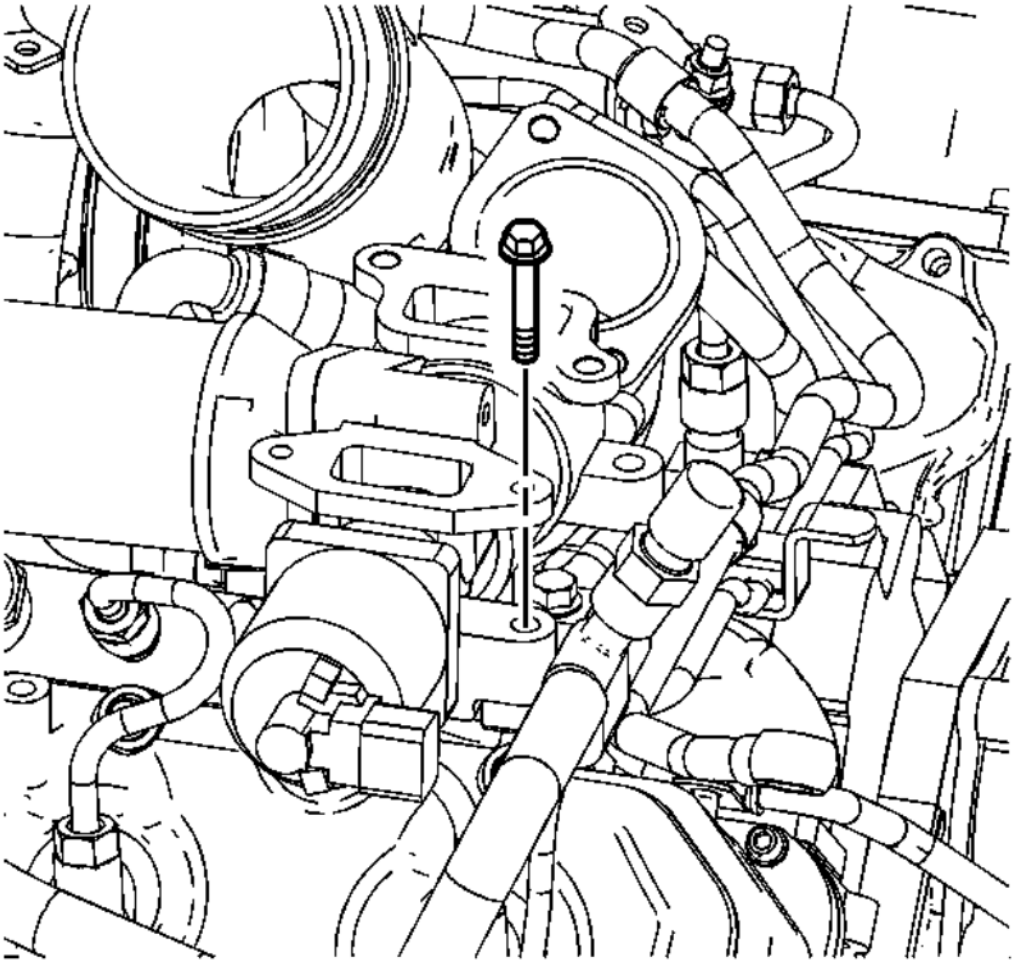


Fig. 38: View Of EGR Mount Bolt
Courtesy of GENERAL MOTORS CORP.

5. Install the EGR mount bolt.

   Tighten: Tighten the EGR mount bolt to 50 N.m (37 lb ft).

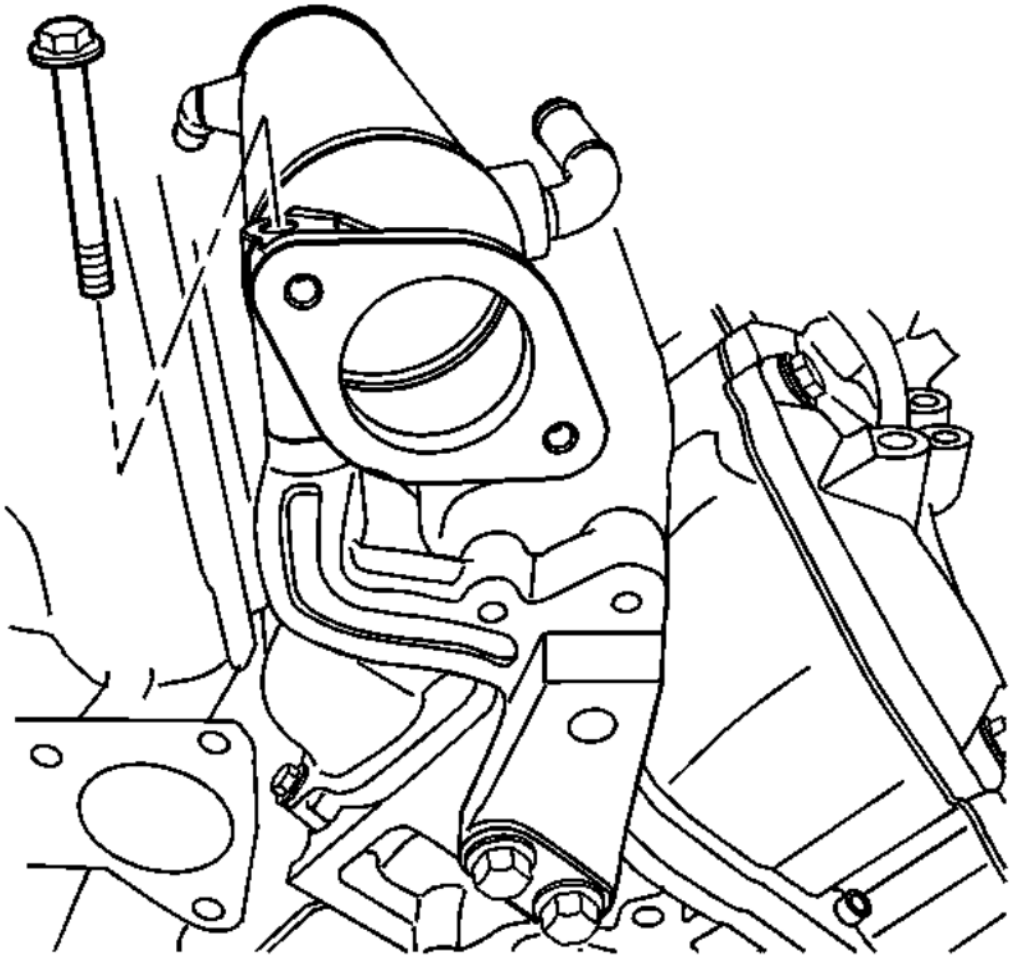


Fig. 39: View Of EGR Cooler
Courtesy of GENERAL MOTORS CORP.

6. Install the top EGR cooler bolts.

   Tighten: Tighten the top EGR cooler bolts to 25 N.m (18 lb ft).

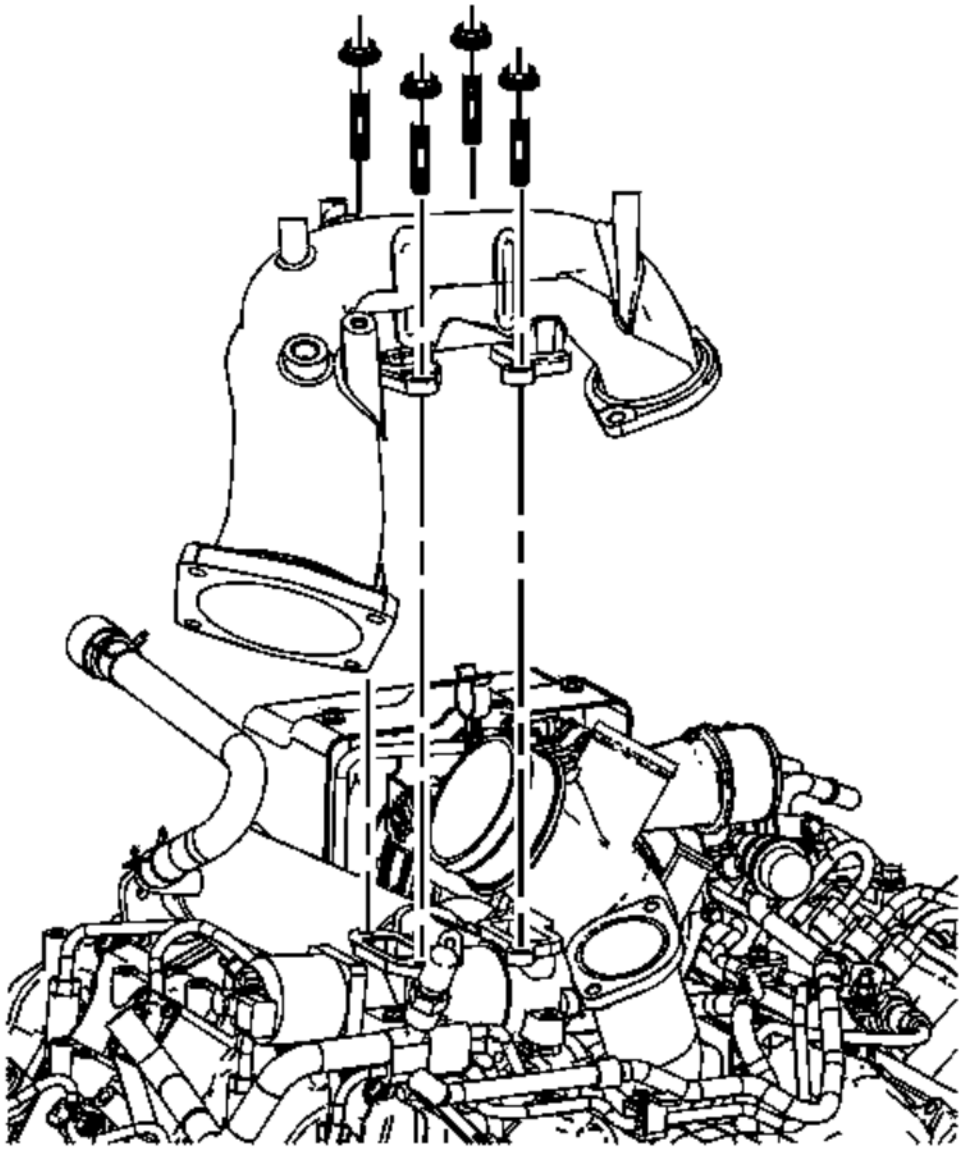


Fig. 40: View Of Air Inlet Tube
Courtesy of GENERAL MOTORS CORP.

7. Install the air inlet tube.
8. Install the air inlet tube nuts.

Tighten: Tighten the air inlet tube nuts to 25 N.m (18 lb ft).

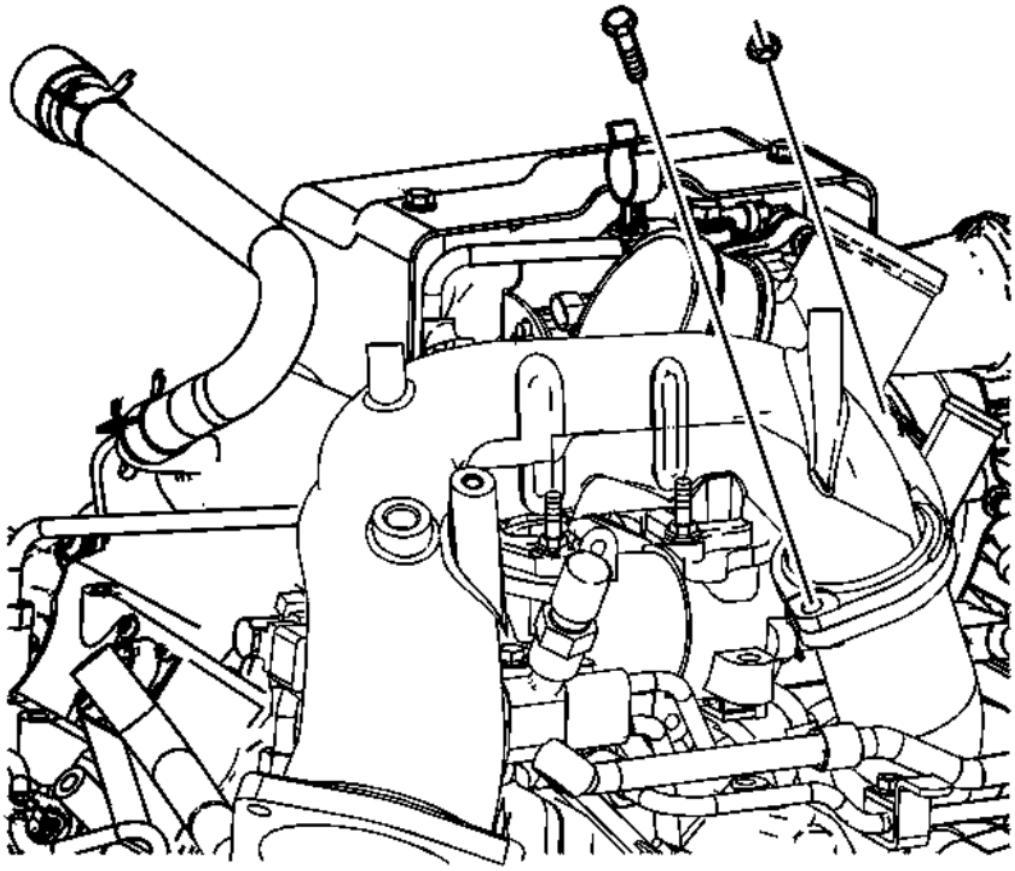


Fig. 41: View Of Air Inlet Tube Bolt And Nut
Courtesy of GENERAL MOTORS CORP.

9. Install the air inlet tube to intake manifold tube bolt and nut.

Tighten: Tighten the air inlet tube to intake manifold tube bolt and nut to 25 N.m (18 lb ft).

ENGINE WIRING HARNESS ASSEMBLY INSTALLATION

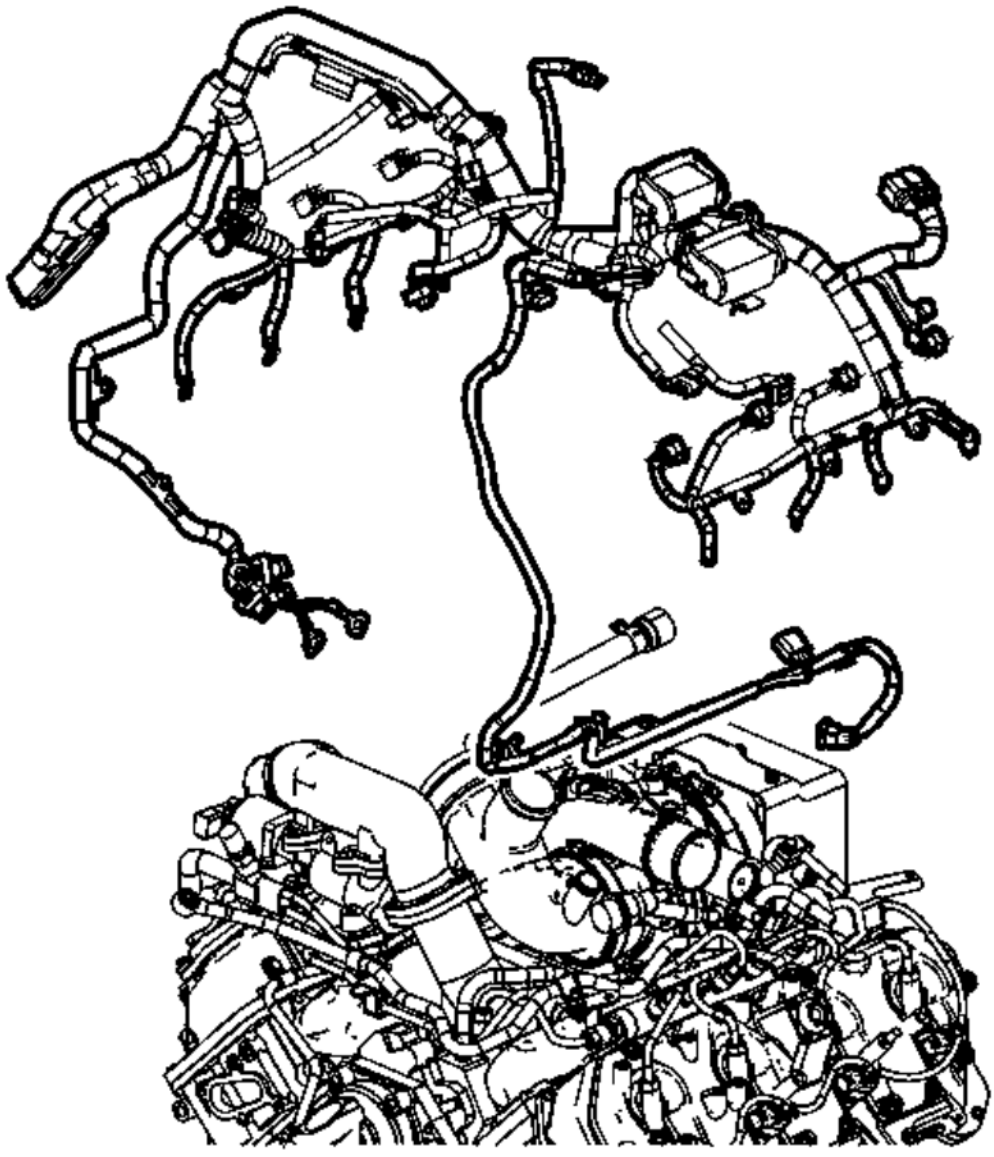


Fig. 42: View Of Fuel Injector Control Module Harness
Courtesy of GENERAL MOTORS CORP.

1. Install the engine wiring harness assembly.

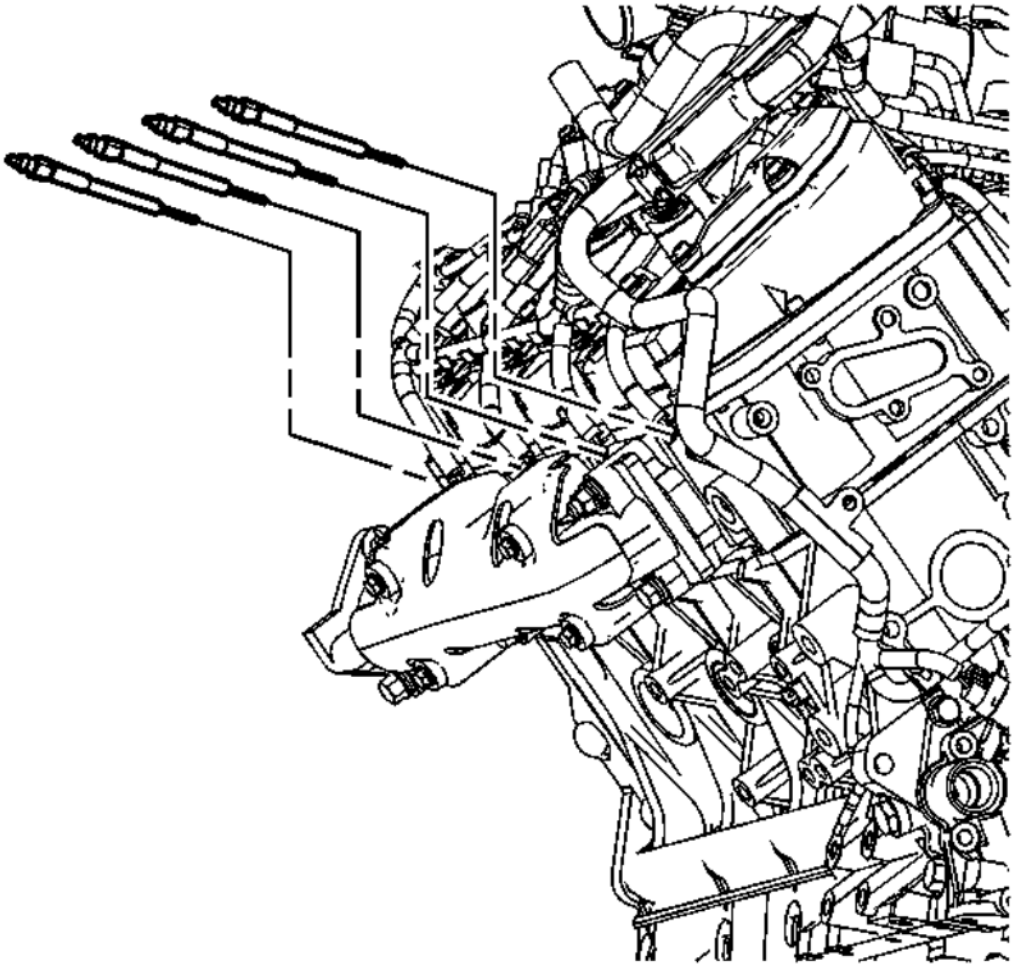


Fig. 43: View Of Right Glow Plugs
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

2. Install the right glow plugs.

   Tighten: Tighten the glow plugs to 18 N.m (13 lb ft).

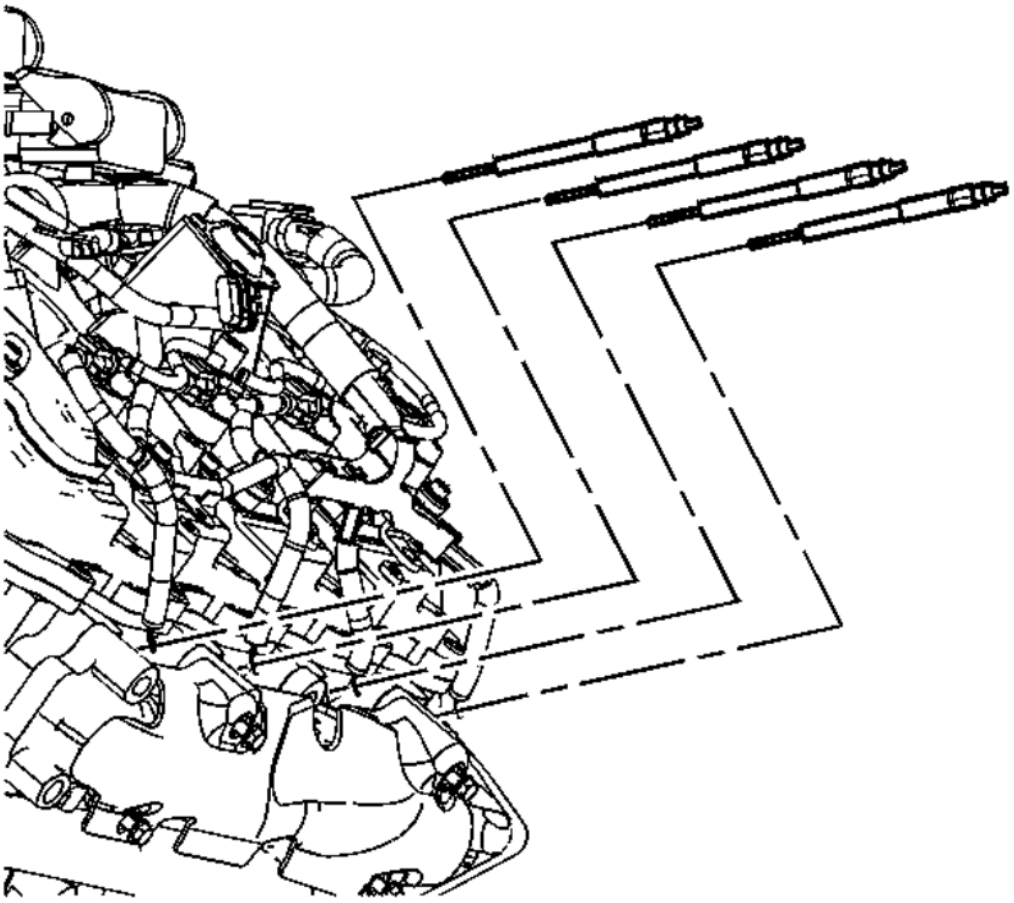


Fig. 44: View Of Left Glow Plugs
Courtesy of GENERAL MOTORS CORP.

3. Install the left glow plugs.

   Tighten: Tighten the glow plugs to 18 N.m (13 lb ft).

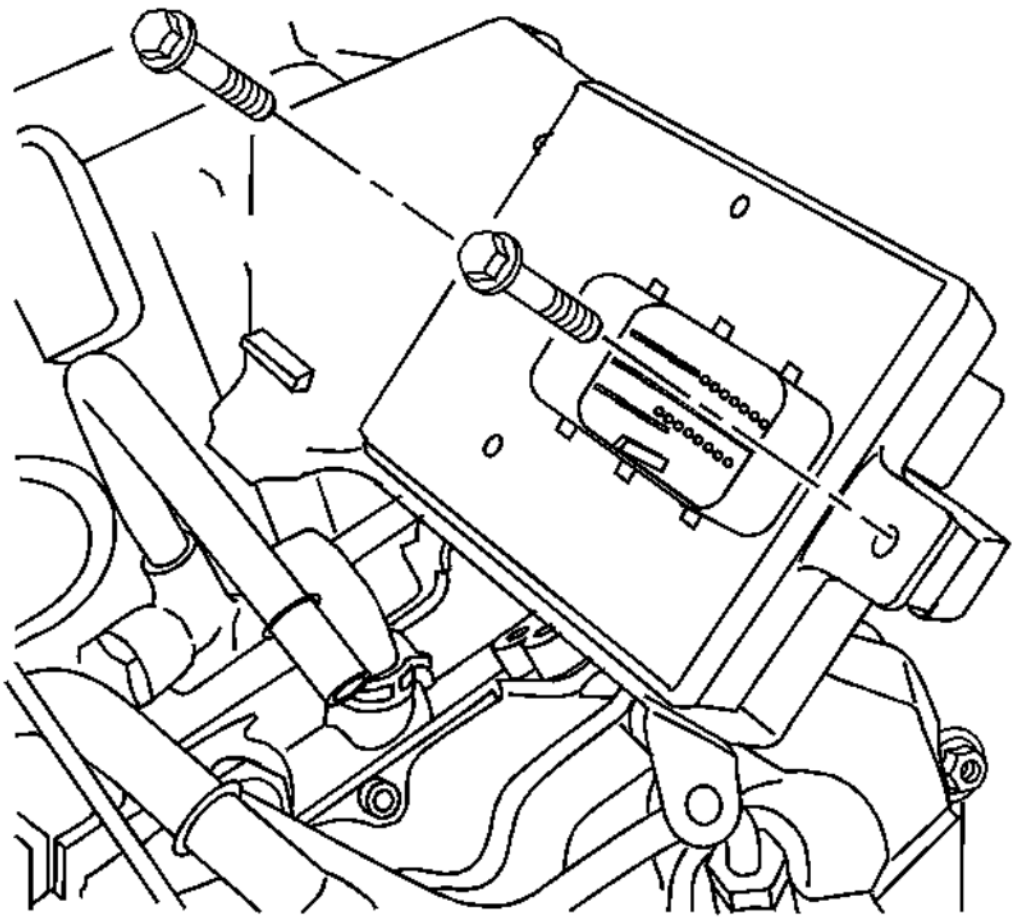


Fig. 45: Identifying glow Plug Controller Bolts
Courtesy of GENERAL MOTORS CORP.

4. Install the glow plug nuts.

   Tighten: Tighten the glow plug nuts to 2 N.m (18 lb in).

5. Install the glow plug controller.
6. Install the glow plug controller bolts.

   Tighten: Tighten the glow plug controller bolts to 10 N.m (89 lb in).

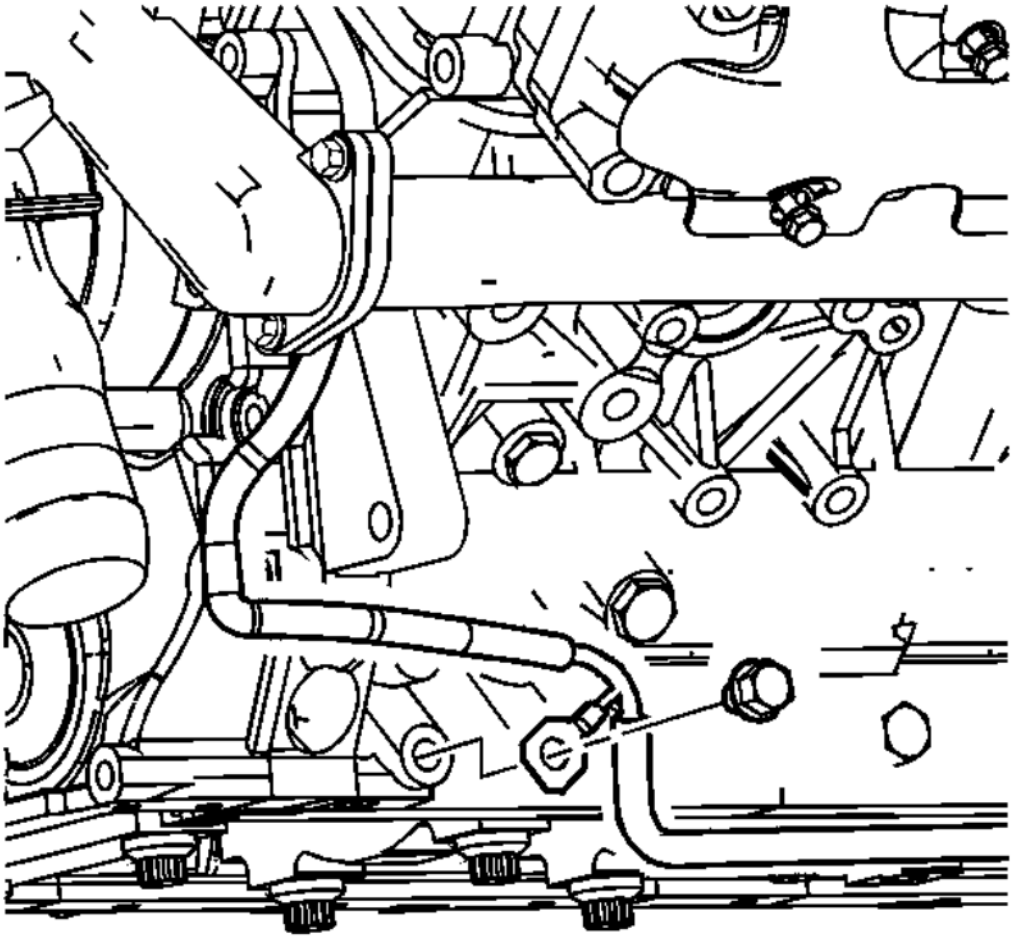


Fig. 46: View Of Oil Level Sensor Harness Bolt
Courtesy of GENERAL MOTORS CORP.

7. Install the oil level sensor harness bolt.

   Tighten: Tighten the oil level sensor harness bolt to 40 N.m (29 lb ft).

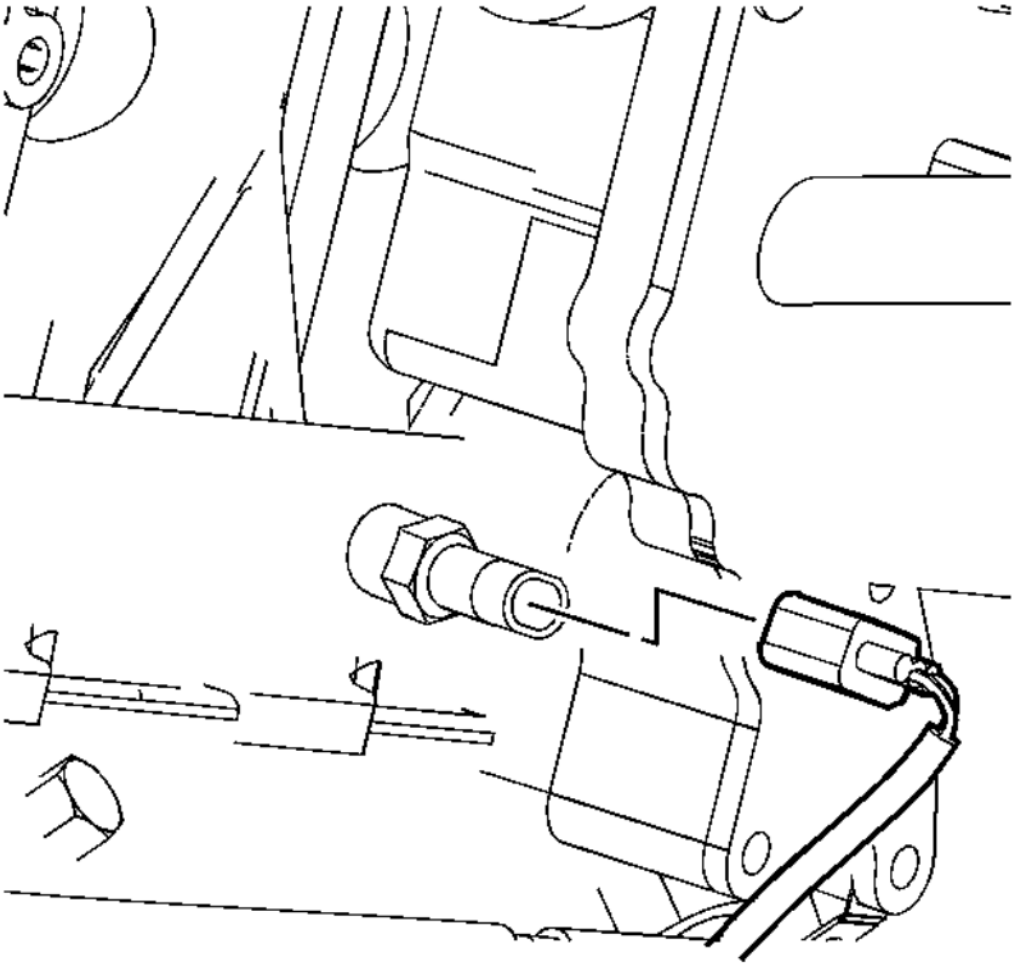


Fig. 47: View Of Oil Pressure Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

8. Connect the oil pressure sensor electrical connector.

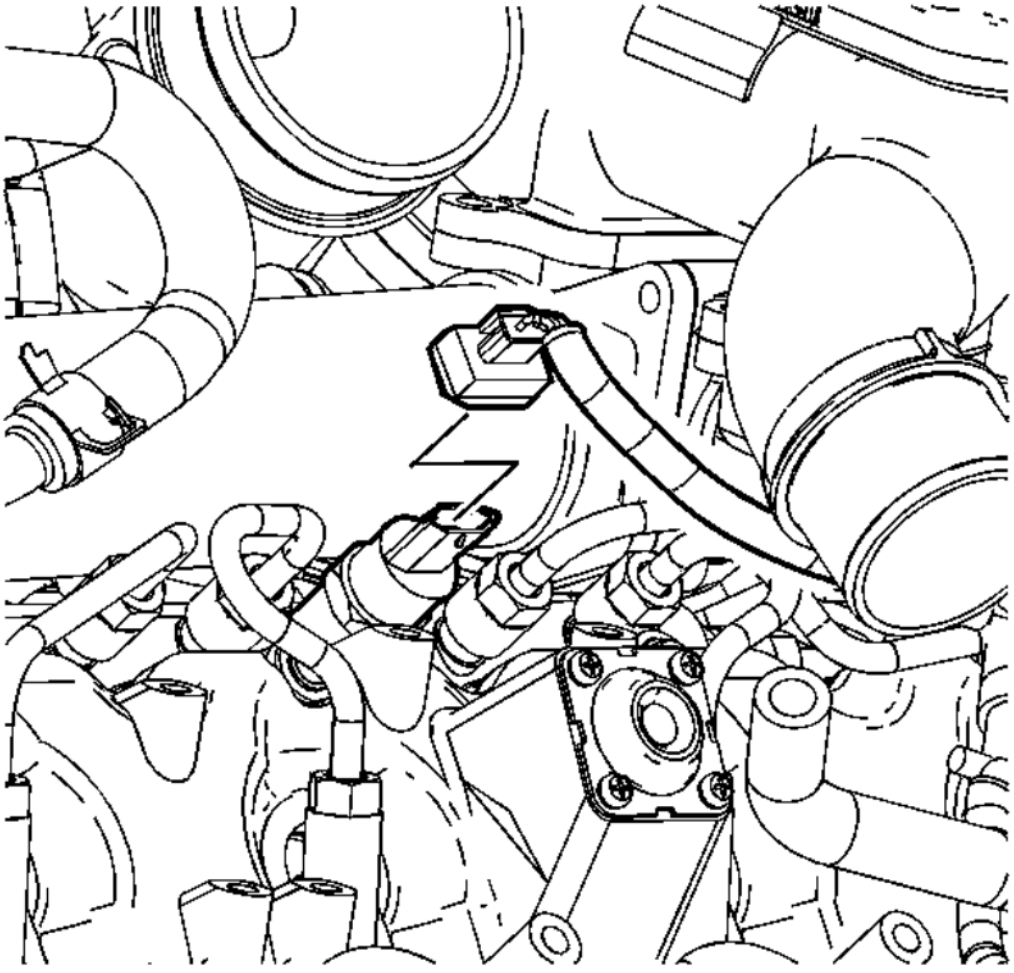


Fig. 48: View Of Fuel Rail Pressure Sensor And Electrical Connector
Courtesy of GENERAL MOTORS CORP.

9. Connect the fuel rail pressure sensor.

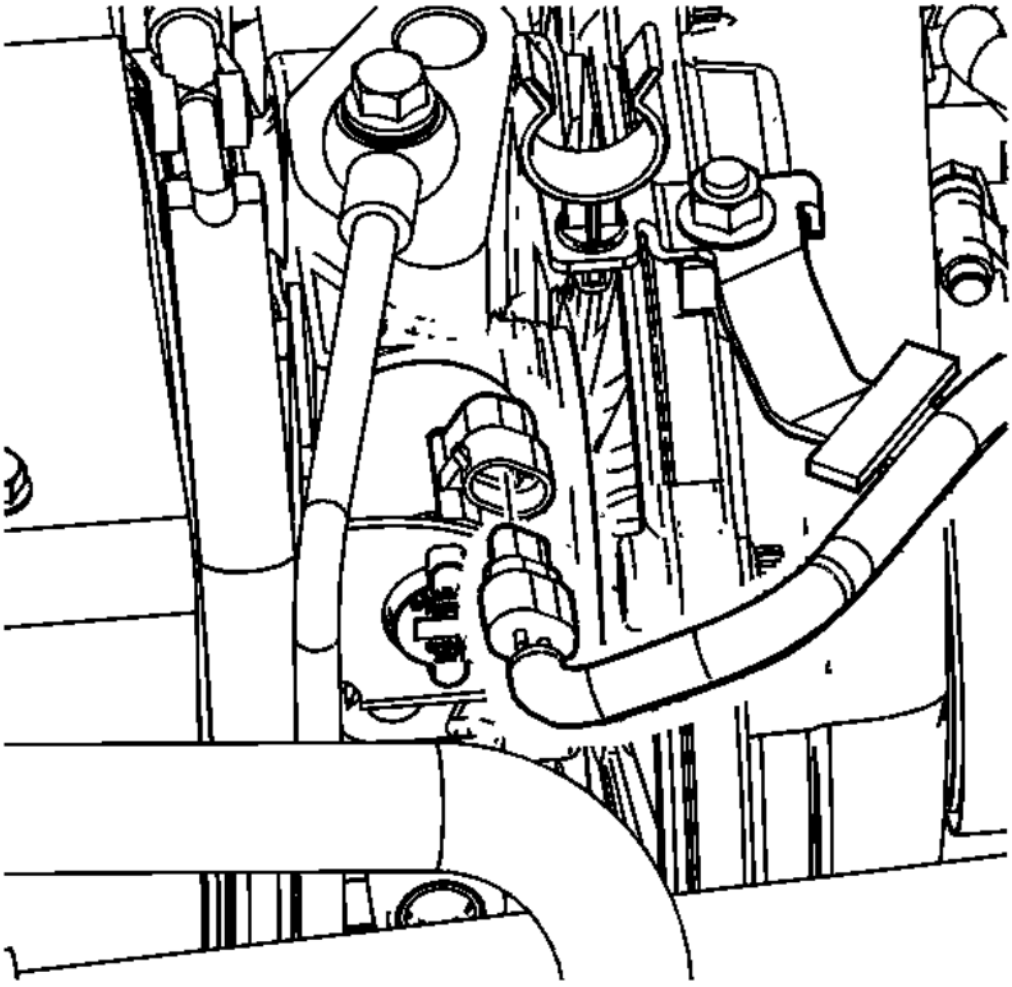


Fig. 49: View Of Turbocharger Vane Control Solenoid Valve & Electrical Connector
Courtesy of GENERAL MOTORS CORP.

NOTE: Label all the injector electrical connectors before the connectors are removed in order to prevent reconnecting to the wrong injector. Failure to properly connect the injectors in the correct sequence will cause severe engine damage.

10. Connect the turbocharger vane control solenoid valve.

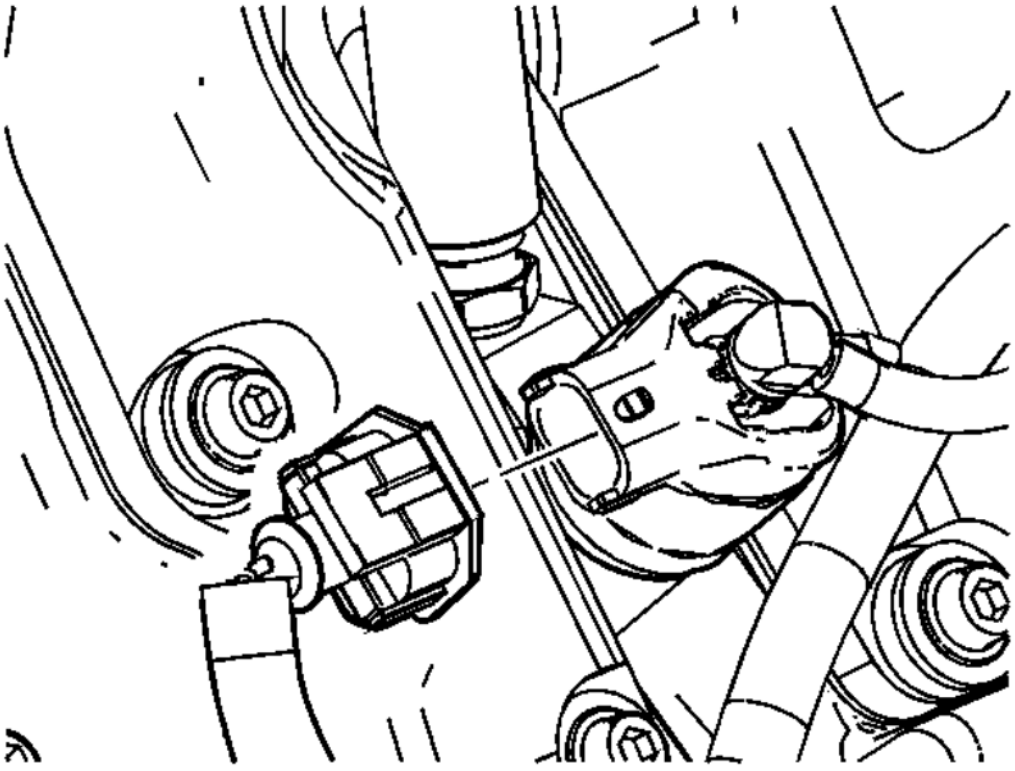


Fig. 50: View Of Fuel Injector Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

11. Connect the fuel injector electrical connections.

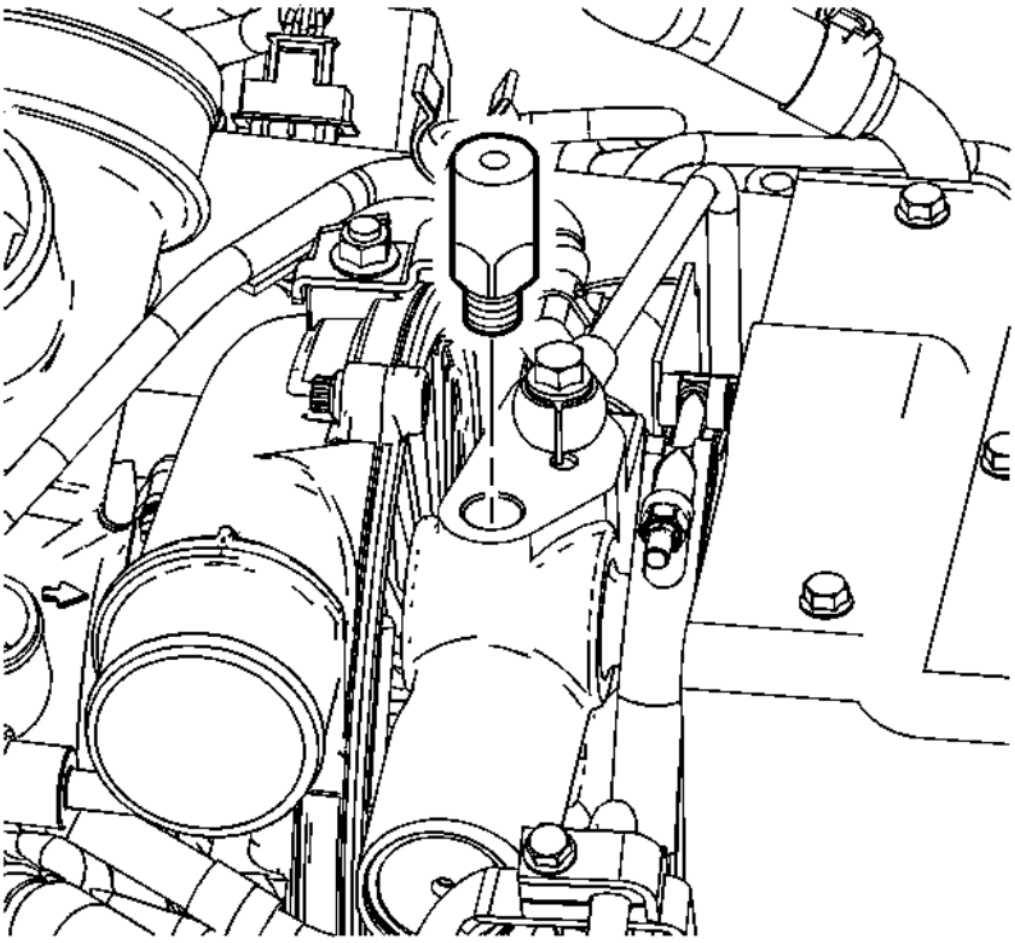


Fig. 51: View Of Turbocharger Vane Position Sensor
Courtesy of GENERAL MOTORS CORP.

12. Connect and install the turbocharger vane position sensor.

    Tighten: Tighten the turbocharger vane position sensor to 23 N.m (16 lb ft).

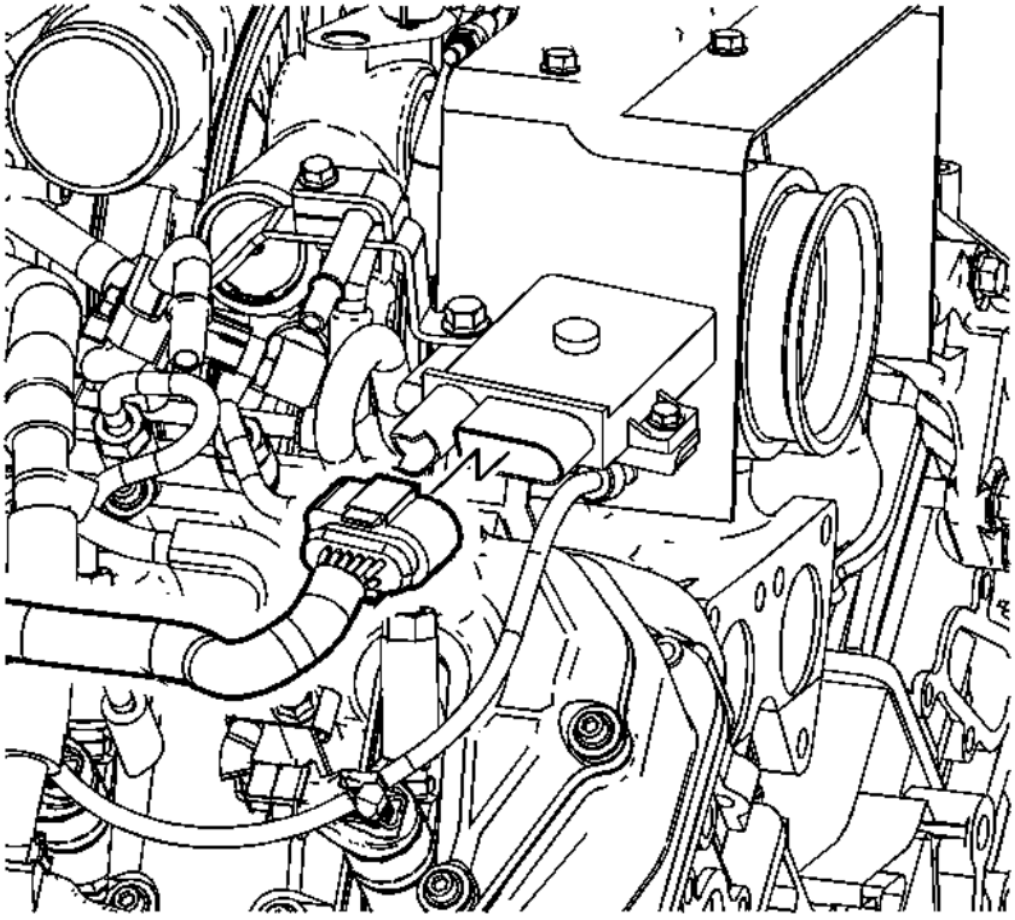


Fig. 52: View Of Glow Plug Controller Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

13. Connect the glow plug controller electrical connector.

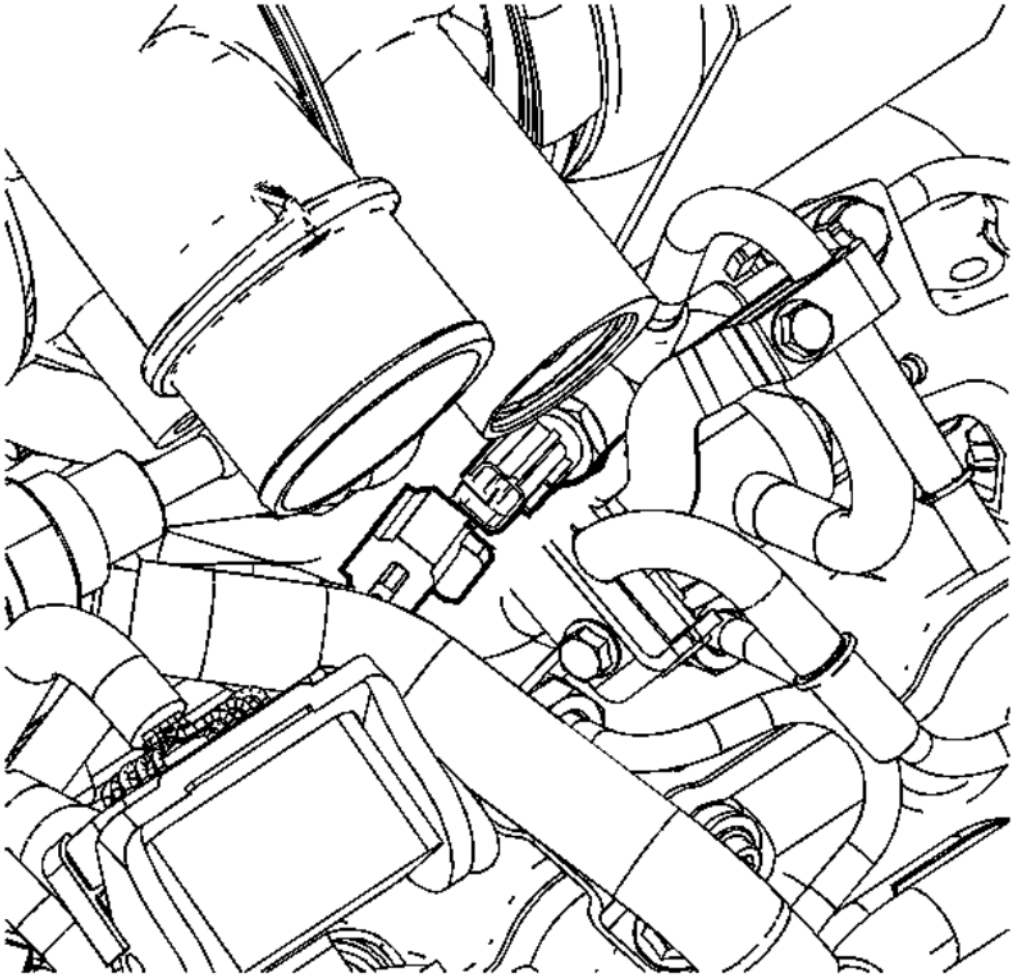


Fig. 53: View Of Fuel Temperature Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

14. Connect the fuel temperature sensor connector.

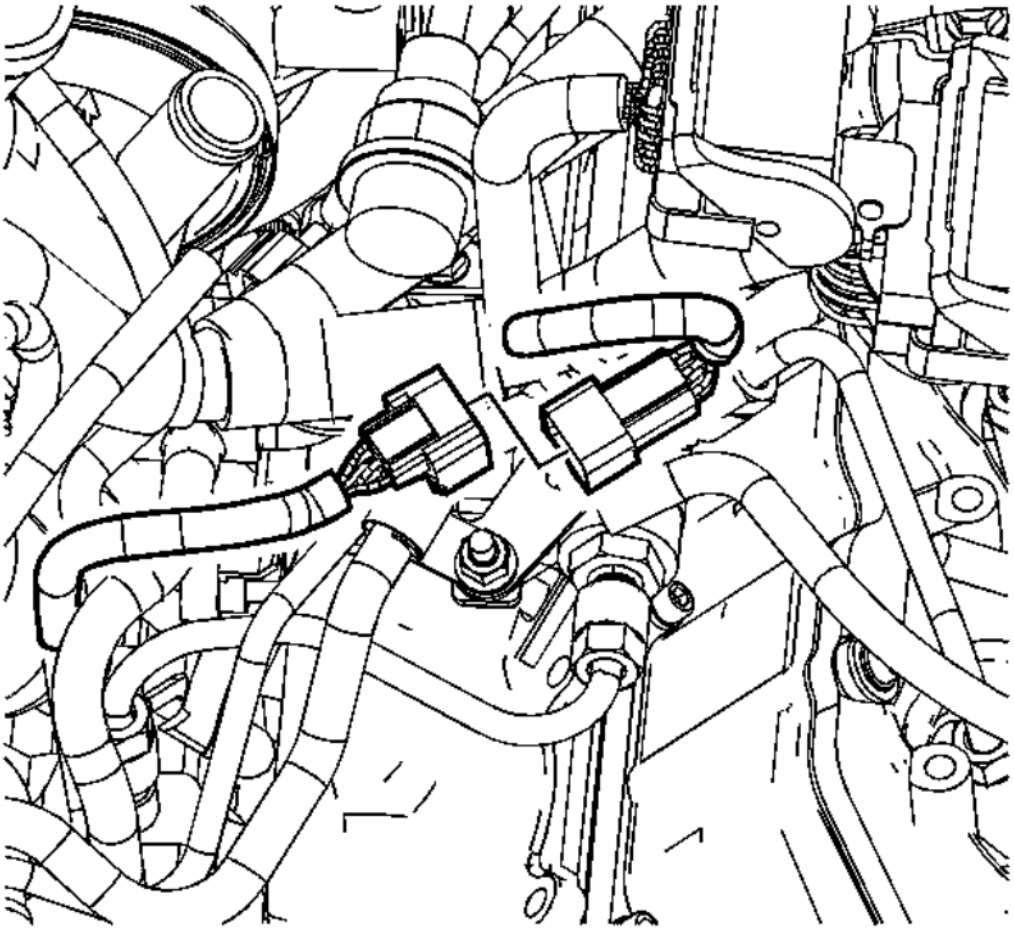


Fig. 54: View Of Oil Level Sensor Electrical Harness Connector
Courtesy of GENERAL MOTORS CORP.

15. Connect the oil level sensor electrical harness connector.

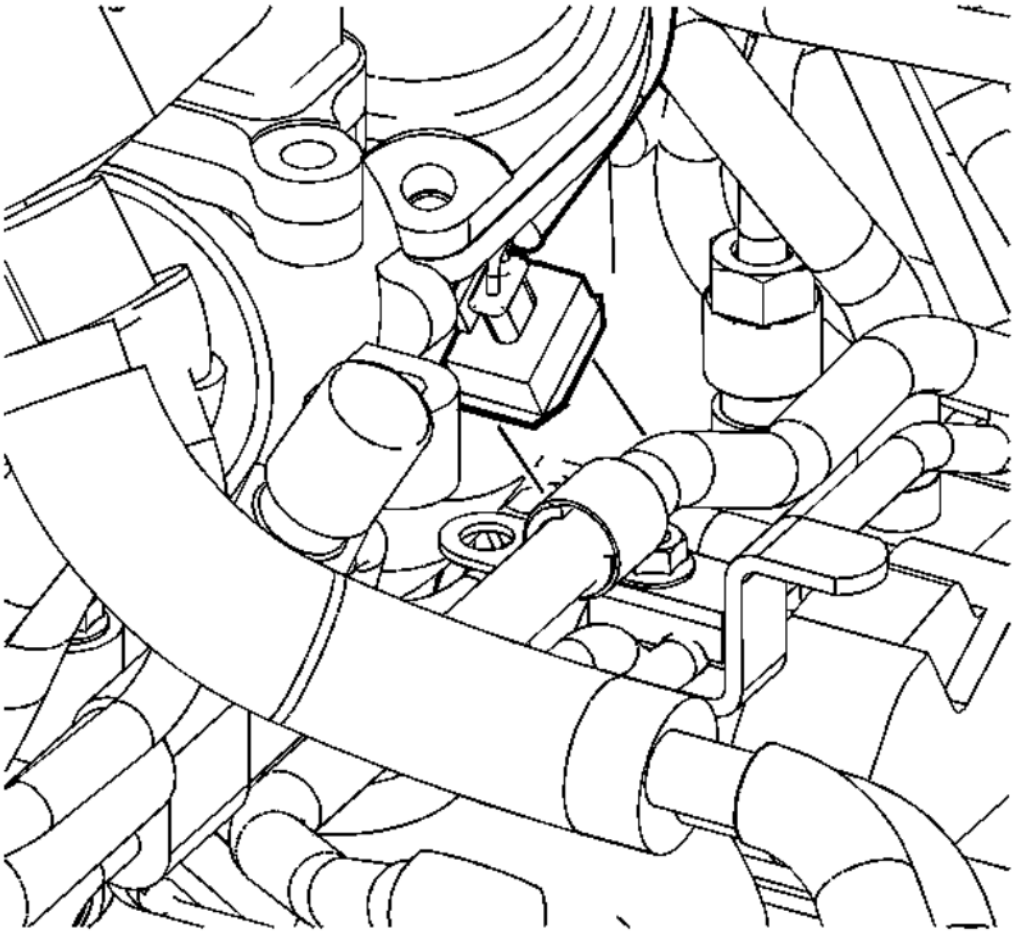


Fig. 55: View Of Fuel Pressure Control Valve Electrical Connector
Courtesy of GENERAL MOTORS CORP.

16. Connect the fuel pressure control valve electrical connector.

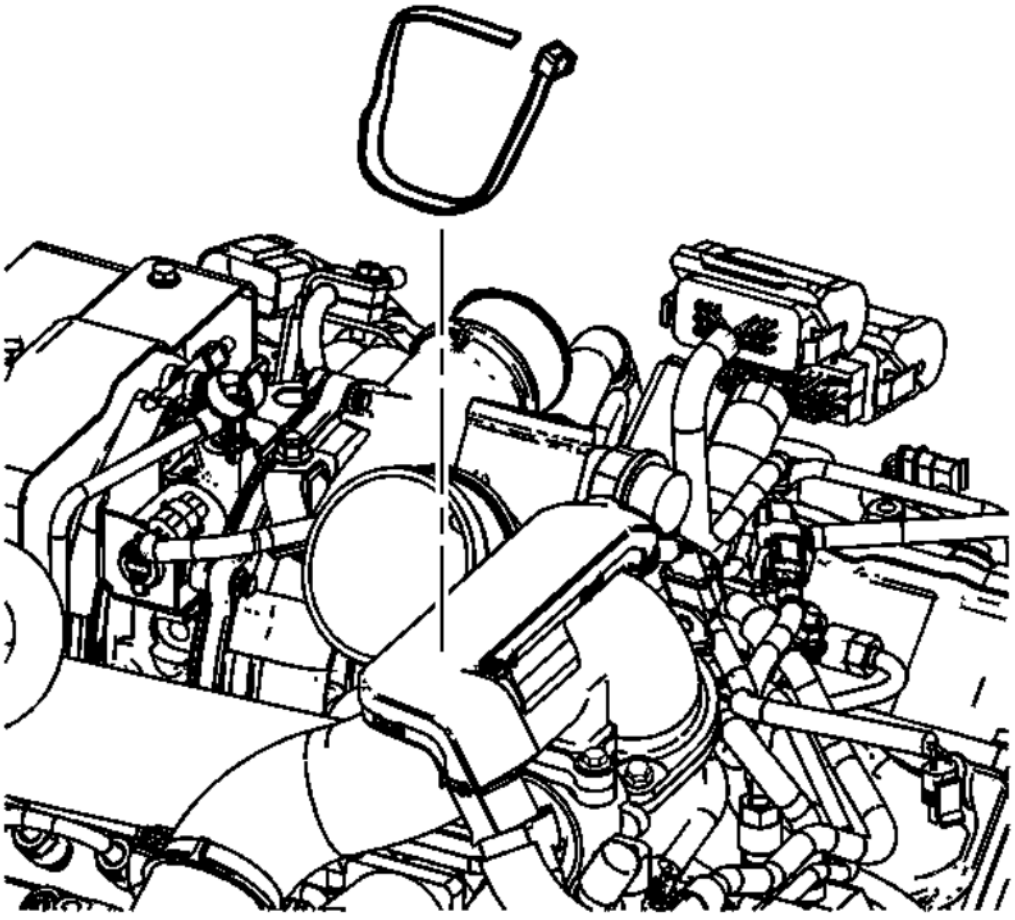


Fig. 56: View Of Electrical Harness Tie Strap
Courtesy of GENERAL MOTORS CORP.

17. Install the tie strap to the electrical harness.

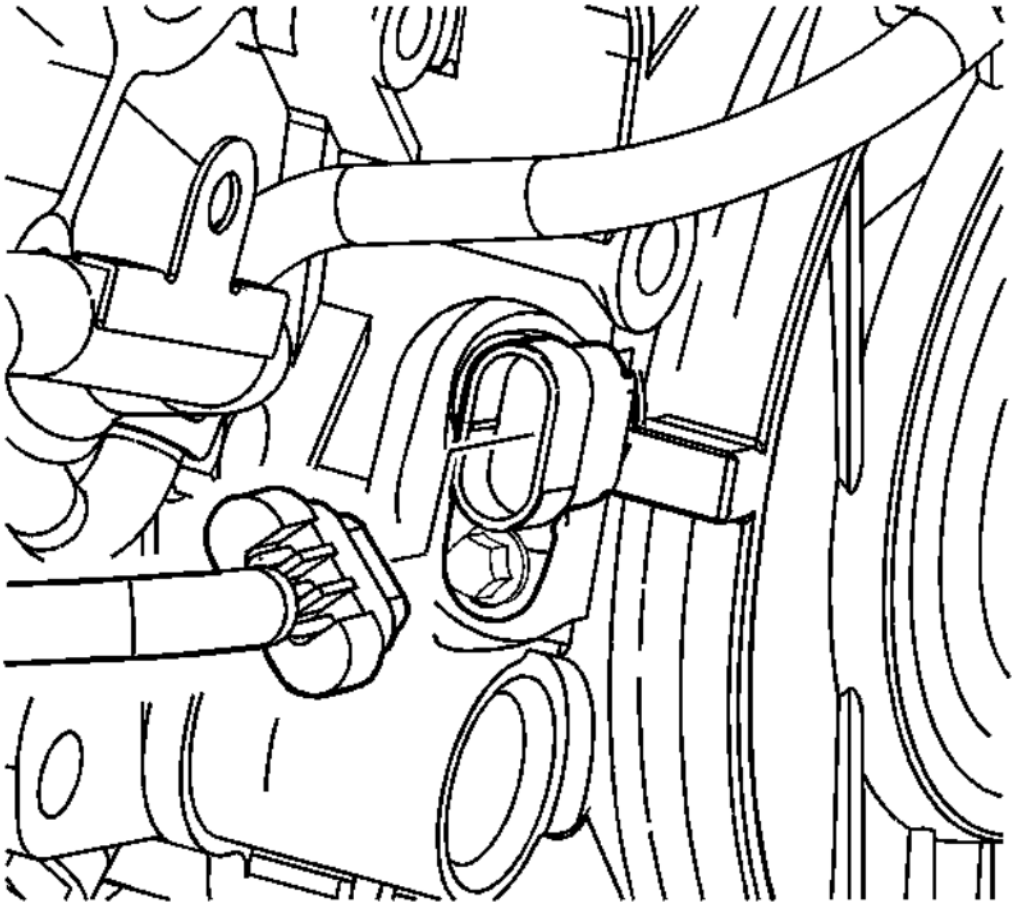


Fig. 57: View Of Crankshaft Position Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

18. Connect the crankshaft position sensor electrical connector.

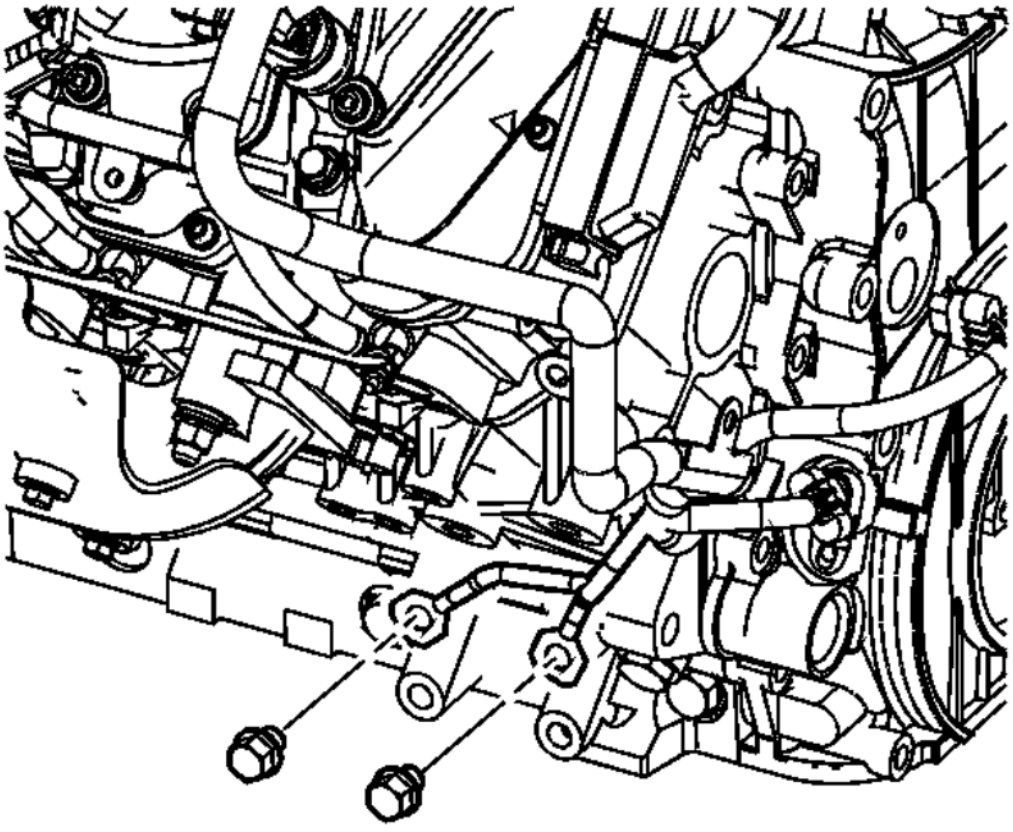


Fig. 58: View Of Ground Bolts
Courtesy of GENERAL MOTORS CORP.

19. Install the two ground bolts.

    Tighten: Tighten the ground bolts to 41 N.m (30 lb ft).

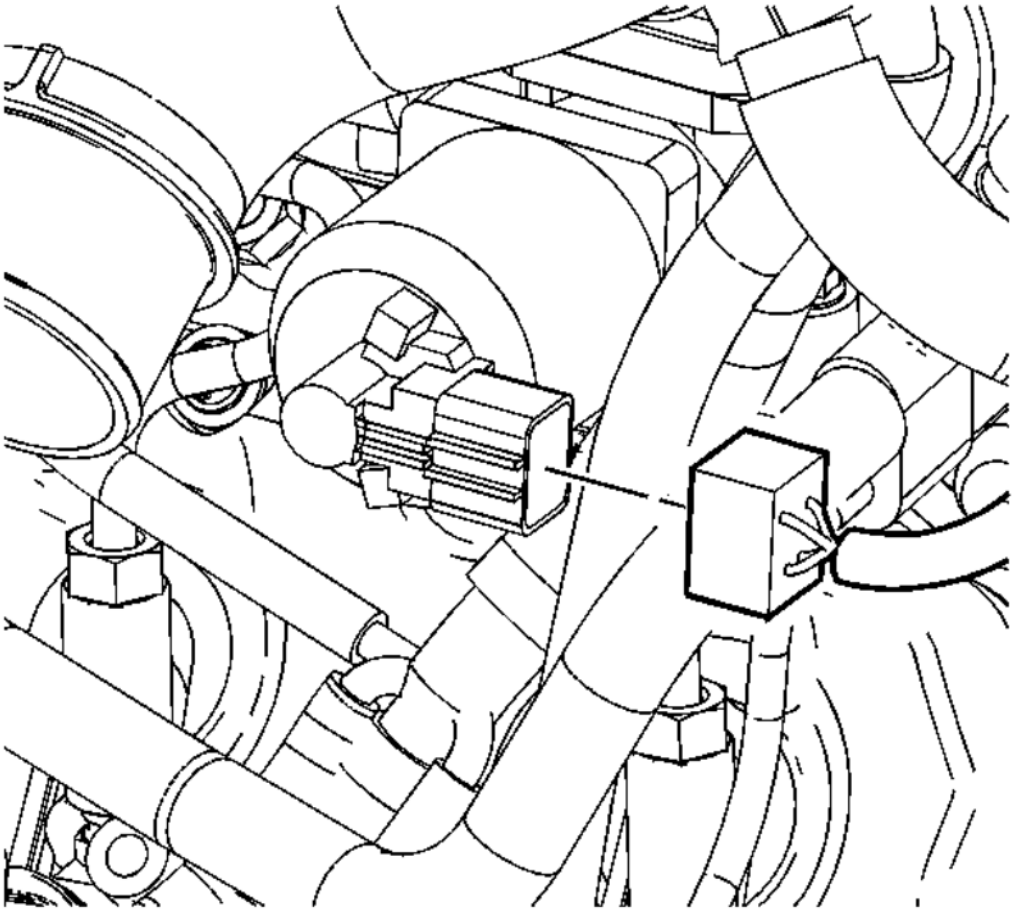


Fig. 59: View Of EGR Valve Electrical Connector
Courtesy of GENERAL MOTORS CORP.

20. Connect the EGR valve electrical connector.

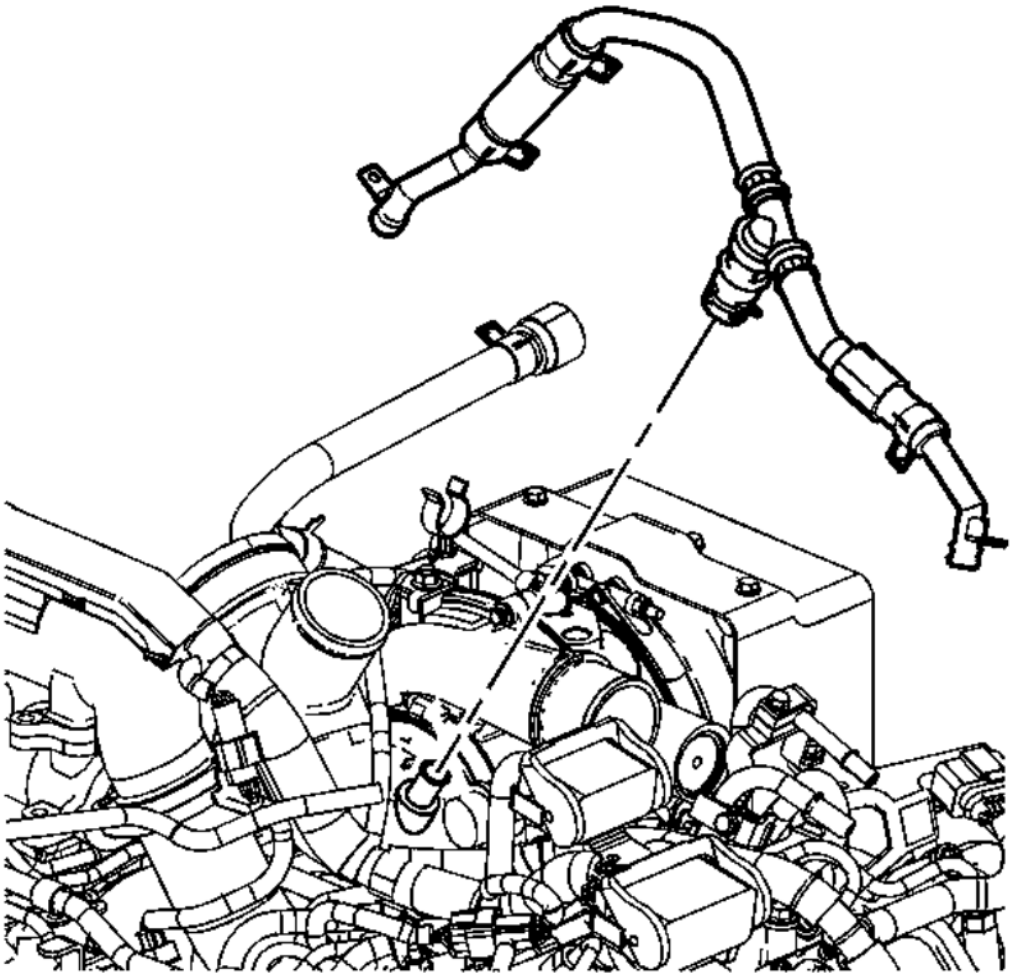


Fig. 60: View Of PCV Pipe
Courtesy of GENERAL MOTORS CORP.

21. Install the positive crankcase ventilation (PCV) pipe.

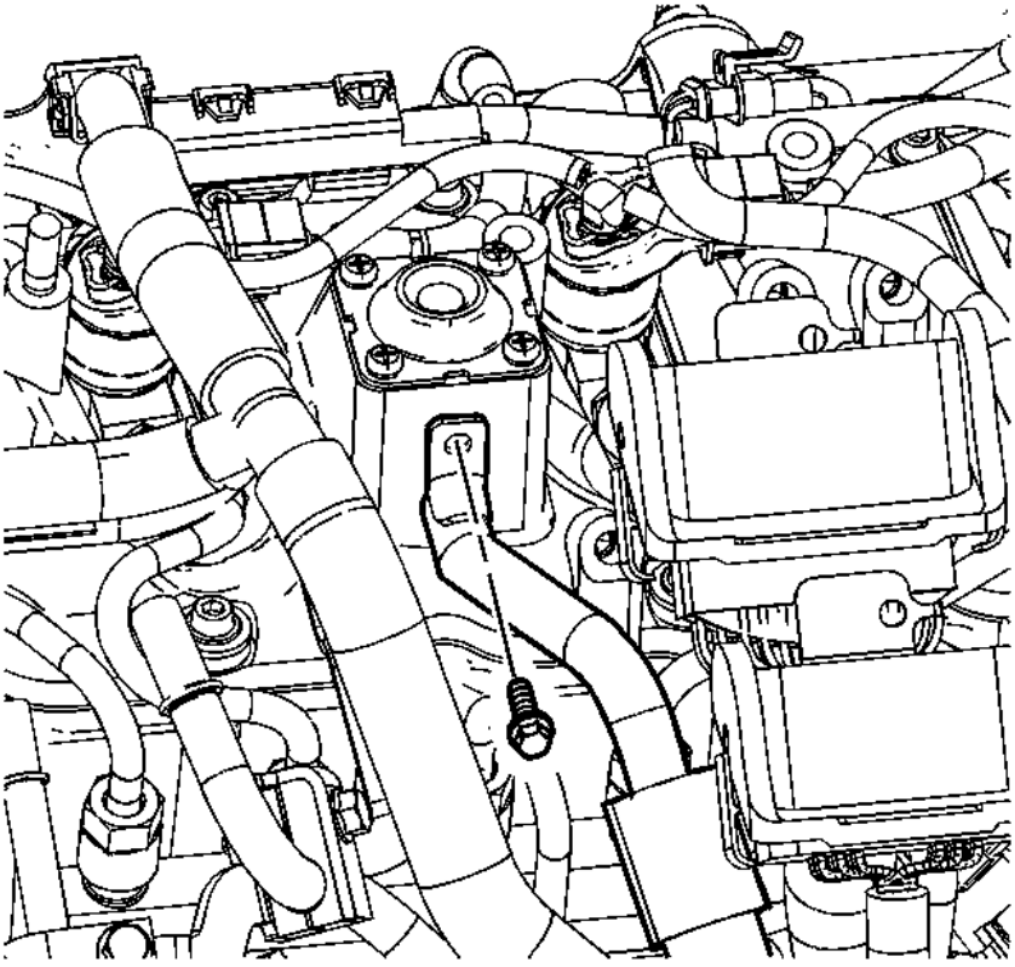


Fig. 61: View Of Left PCV Hose/Pipe Bolt
Courtesy of GENERAL MOTORS CORP.

22. Install the left PCV pipe bolt.

Tighten: Tighten the PCV pipe bolt to 25 N.m (18 lb ft).

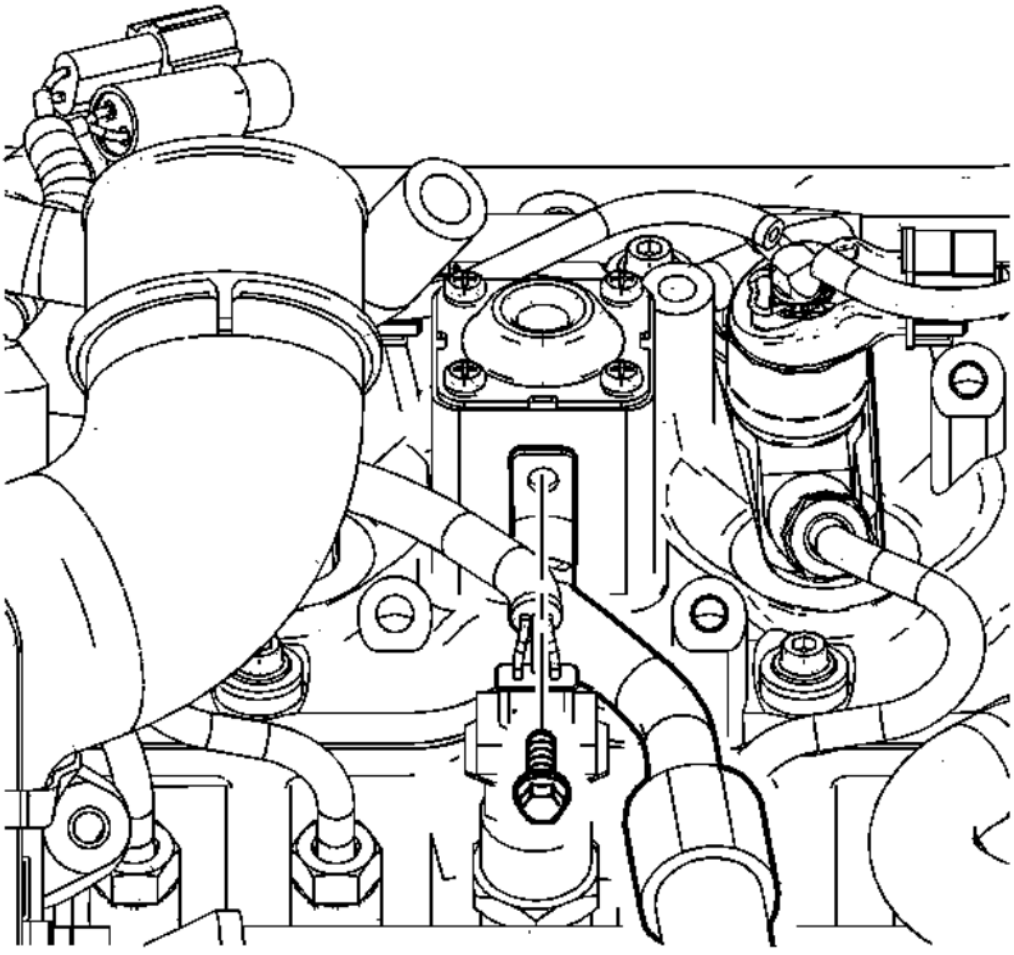


Fig. 62: View Of Right PCV Hose/Pipe Bolt
Courtesy of GENERAL MOTORS CORP.

23. Install the right PCV pipe bolt.

    Tighten: Tighten the PCV pipe bolt to 25 N.m (18 lb ft).

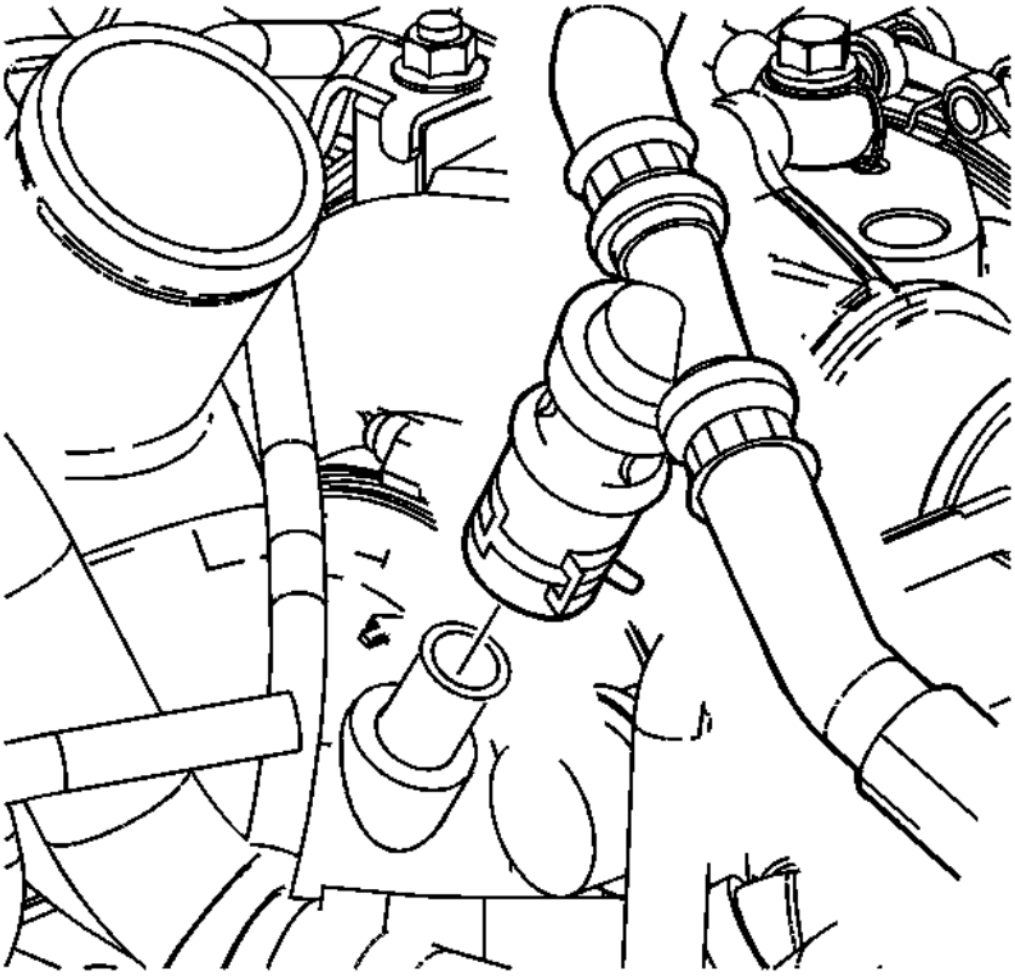


Fig. 63: View Of PCV Hose Clamp
Courtesy of GENERAL MOTORS CORP.

24. Connect the PCV hose clamp.

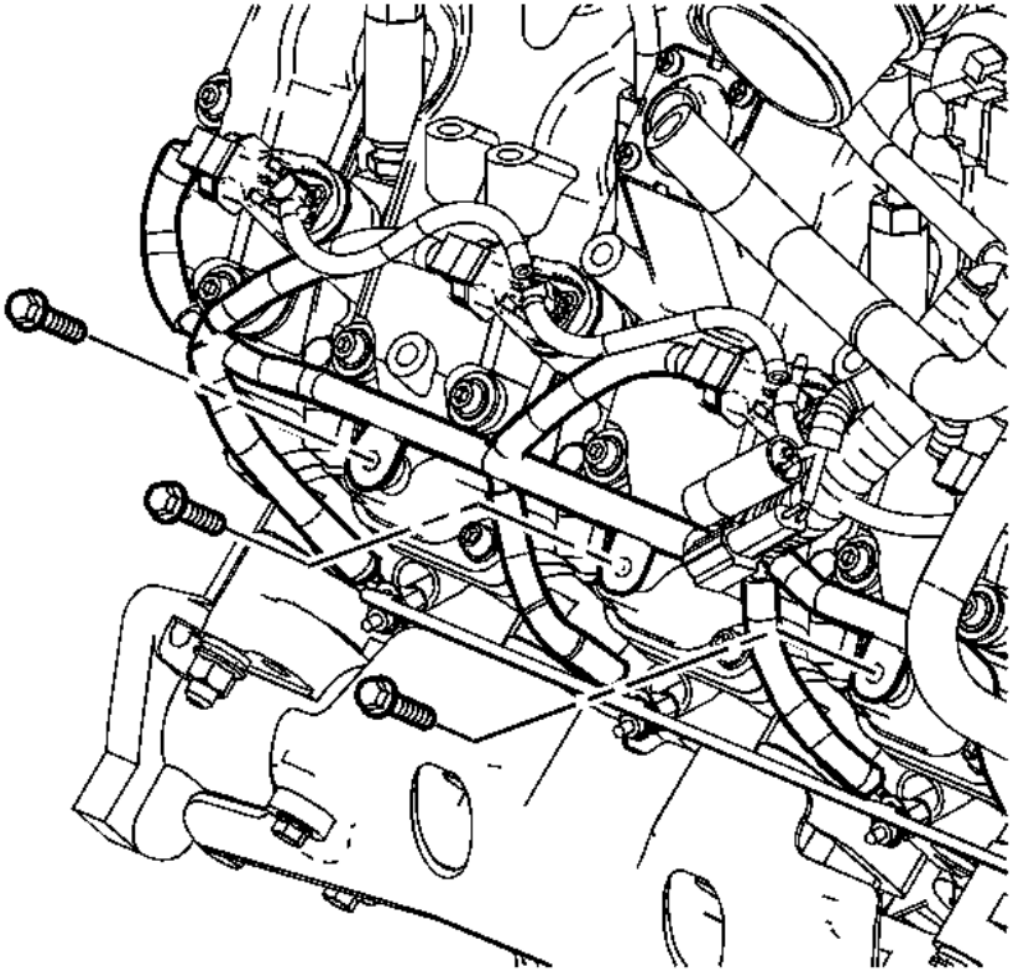


Fig. 64: View Of Right Glow Plug Harness Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

25. Install the right glow plug harness bracket bolts.

    Tighten: Tighten the glow plug harness bracket bolt to 10 N.m (89 lb in).

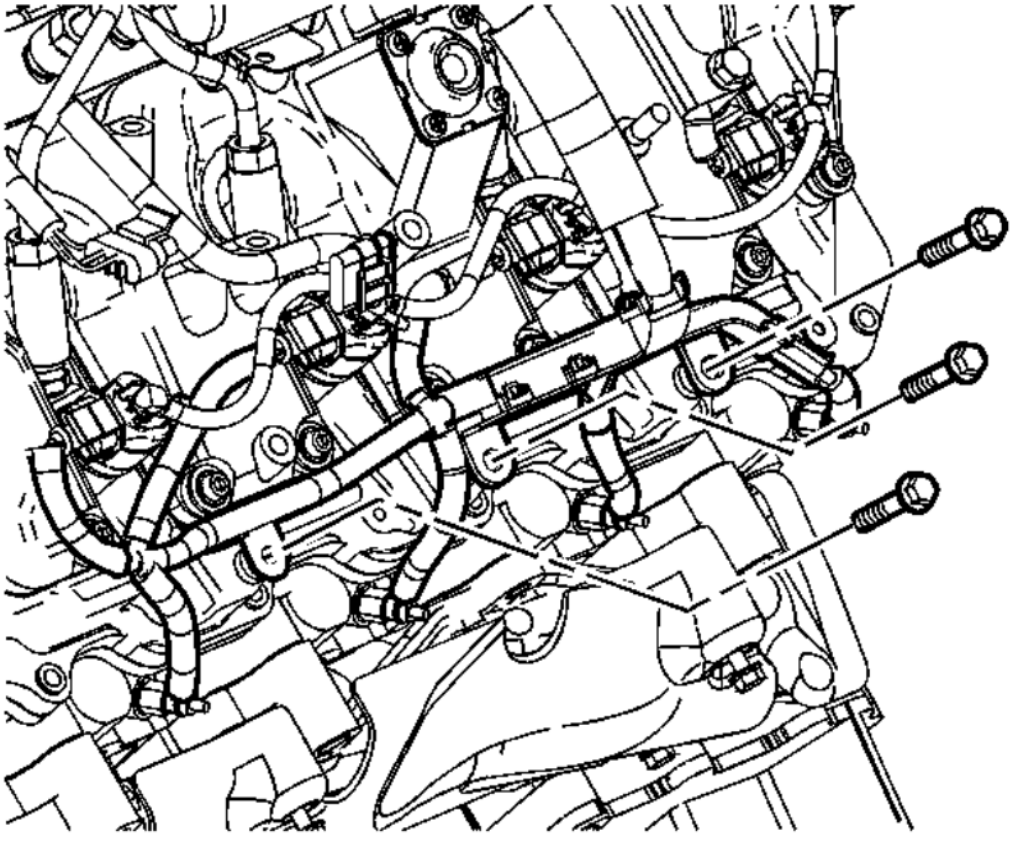


Fig. 65: View Of Left Glow Plug Harness Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

26. Install the left glow plug harness bracket bolts.

Tighten: Tighten the glow plug harness bracket bolt to 10 N.m (89 lb in).

ENGINE COOLANT THERMOSTAT HOUSING INSTALLATION

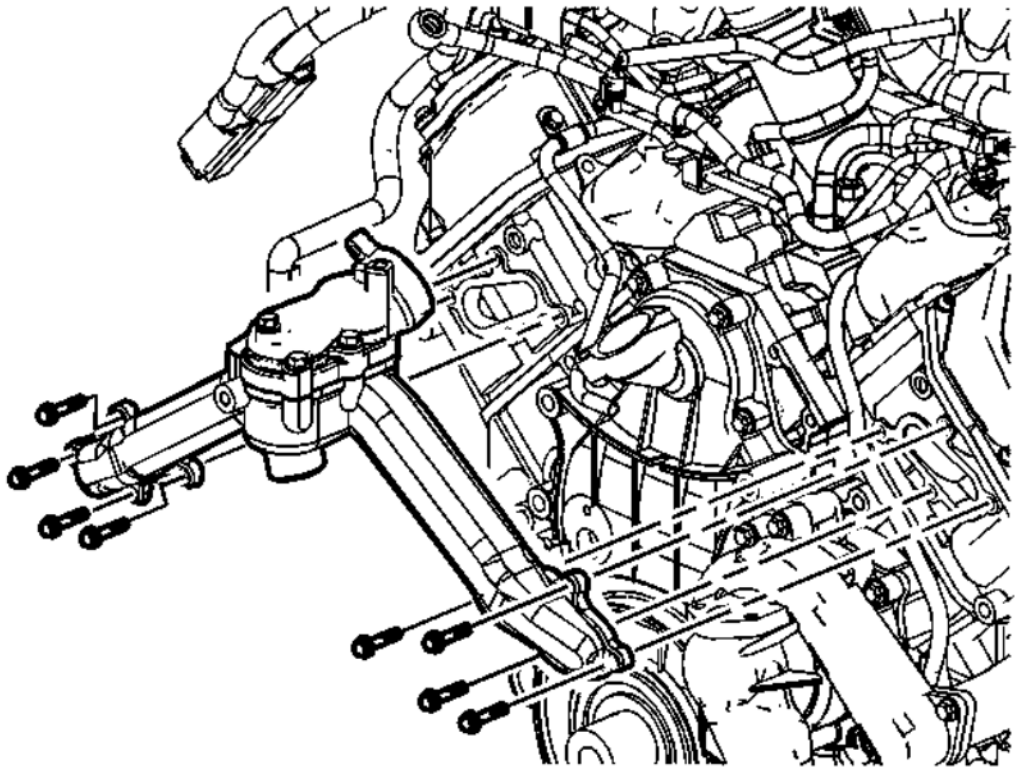


Fig. 66: View Of Thermostat Housing
Courtesy of GENERAL MOTORS CORP.

1. Install the thermostat housing.

NOTE: **Refer to Fastener Notice .**

2. Install the thermostat housing bolts and nuts.

Tighten: Tighten the thermostat housing bolts and nuts to 25 N.m (18 lb ft).

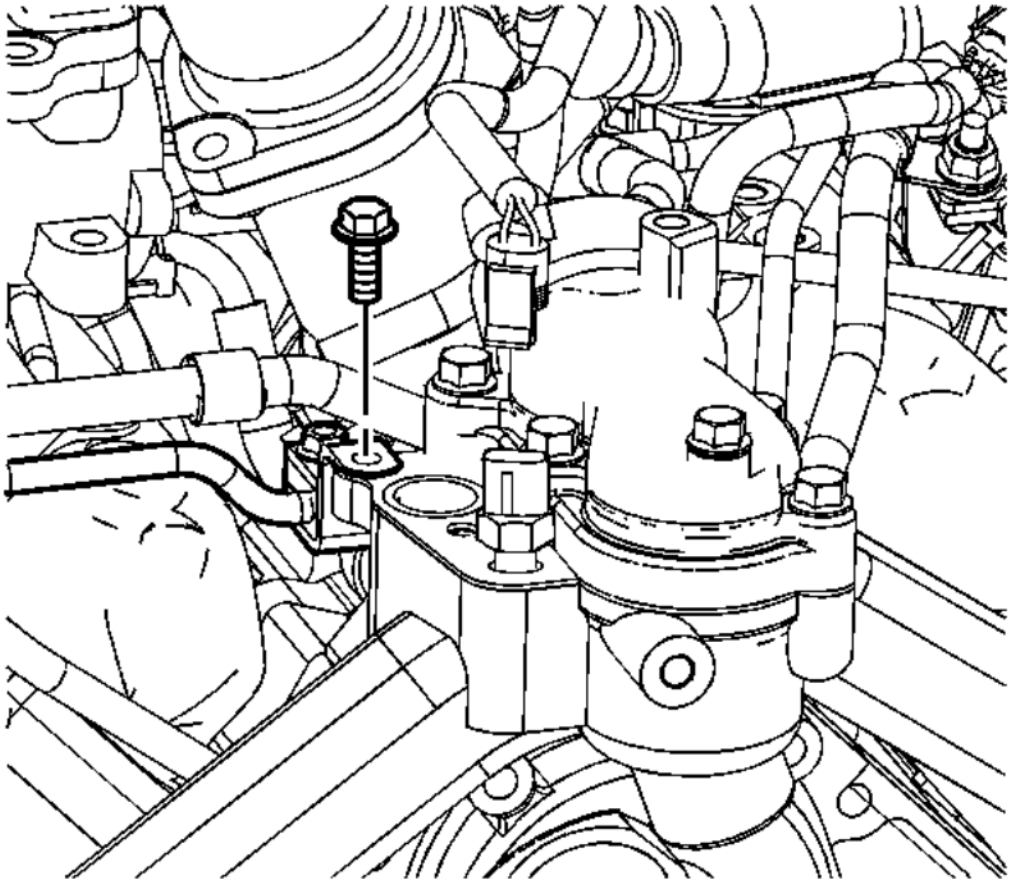


Fig. 67: View Of Fuel Pipe Bracket Bolt
Courtesy of GENERAL MOTORS CORP.

3. Install the fuel pipe bracket bolt.

   Tighten: Tighten the fuel pipe bracket bolt to 25 N.m (18 lb ft).

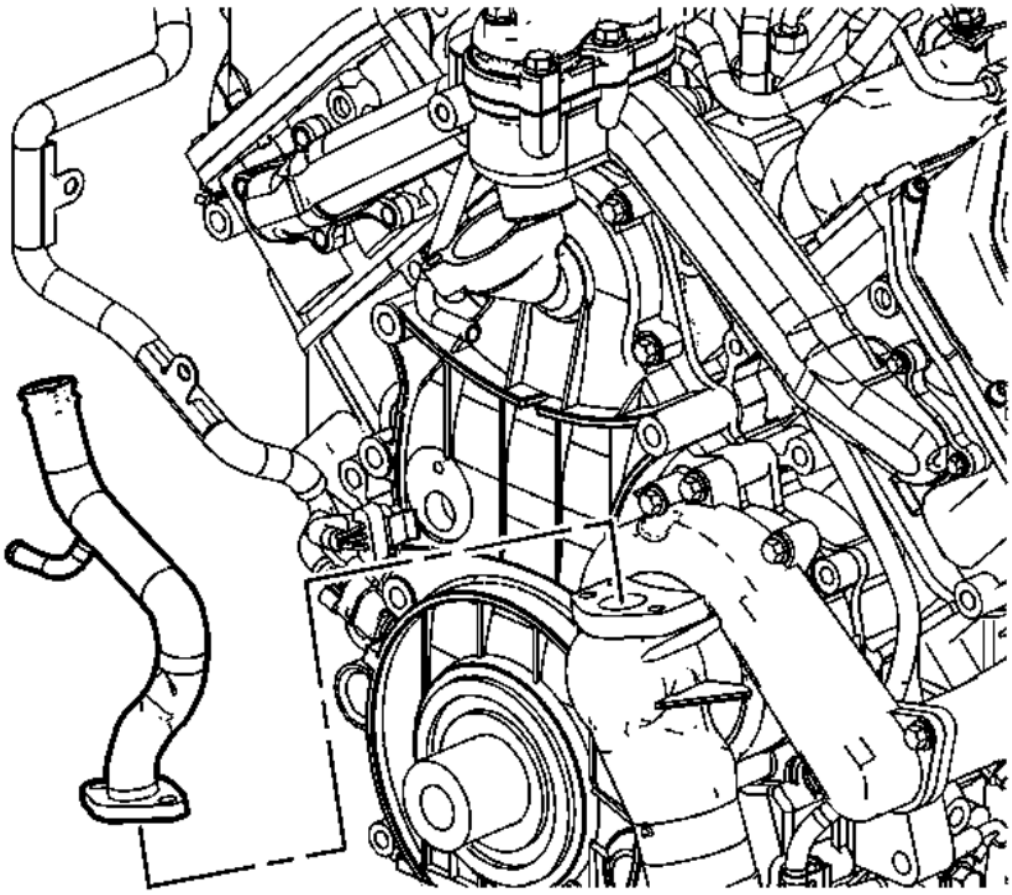


Fig. 68: View Of Water Pump Inlet Pipe
Courtesy of GENERAL MOTORS CORP.

4. Install the water pump inlet pipe.

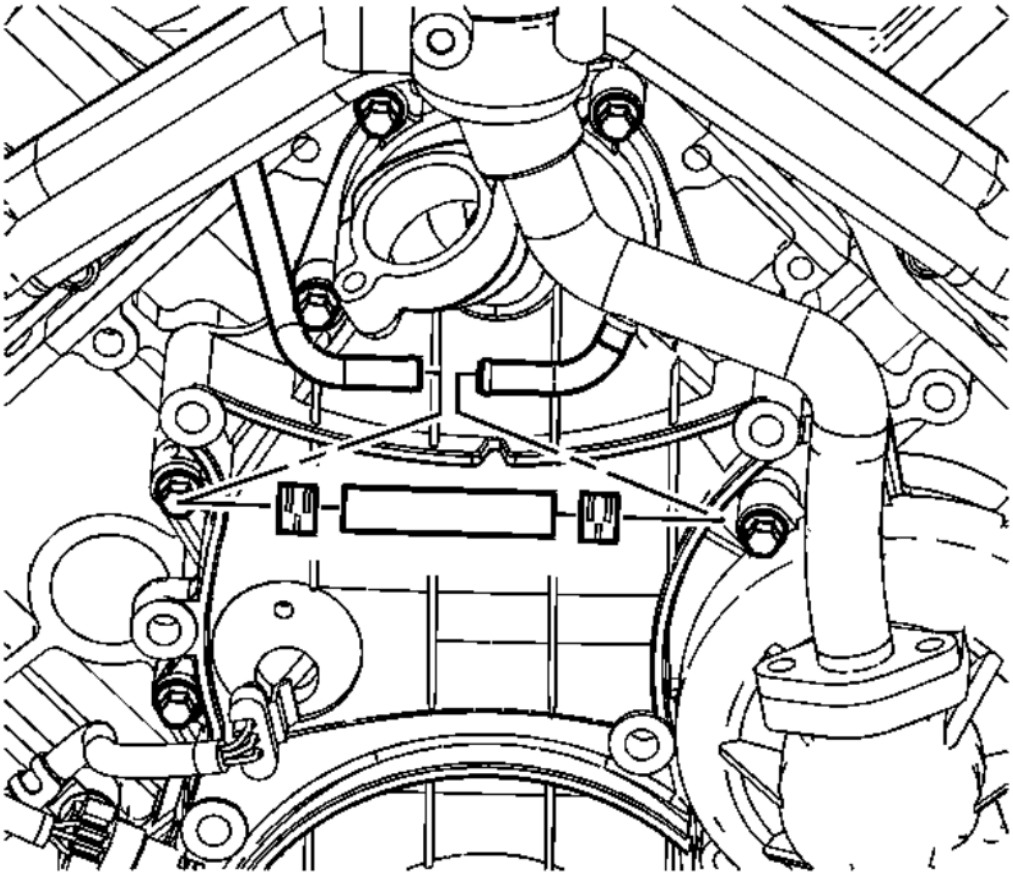


Fig. 69: View Of Turbocharger Coolant Outlet Hose & Clamps
Courtesy of GENERAL MOTORS CORP.

5. Install the turbocharger coolant outlet hose and clamps.

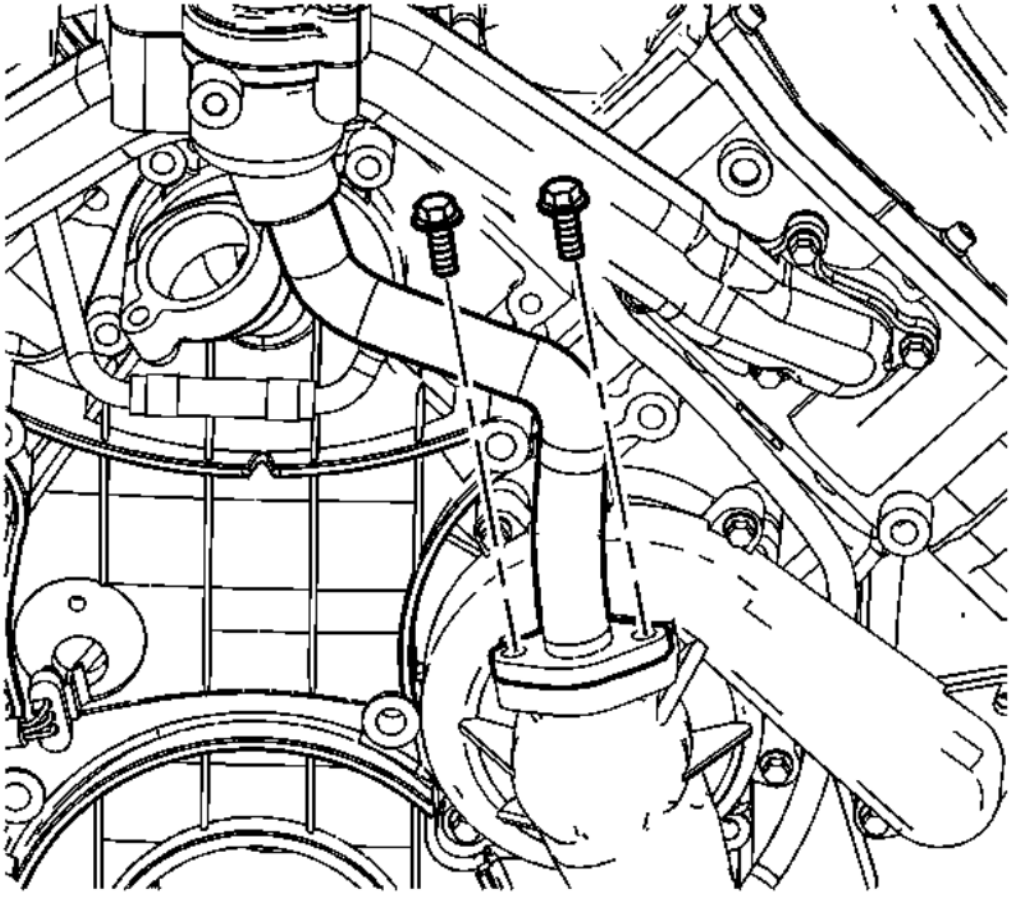


Fig. 70: View Of Water Pump Inlet Pipe Bolts
Courtesy of GENERAL MOTORS CORP.

6. Install the water pump inlet pipe bolts.

   Tighten: Tighten the water pump inlet pipe bolts to 25 N.m (18 lb ft).

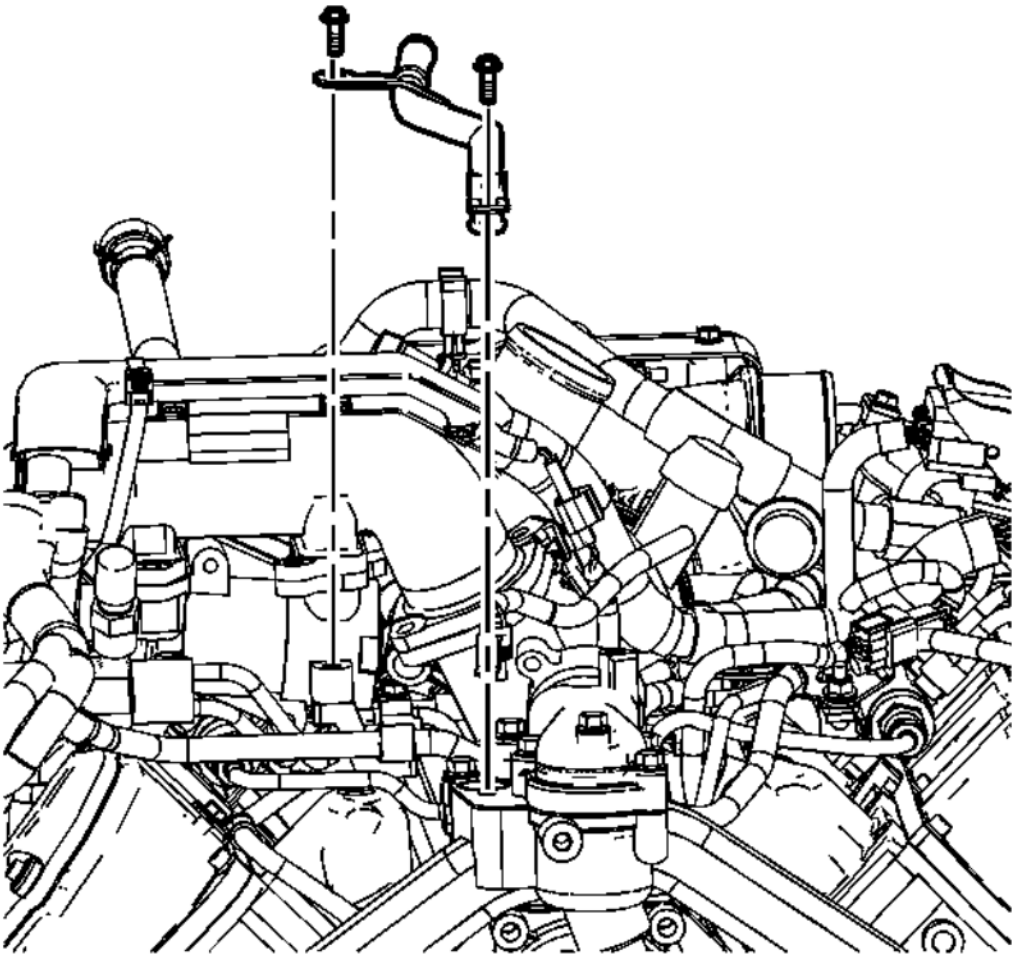


Fig. 71: View Of Exhaust Gas Recirculation (EGR) Coolant Pipe, Hose & Bolts
Courtesy of GENERAL MOTORS CORP.

7. Install the EGR coolant pipe.
8. Install the EGR coolant pipe bolts.

Tighten: Tighten the EGR coolant pipe bolts to 25 N.m (18 lb ft).

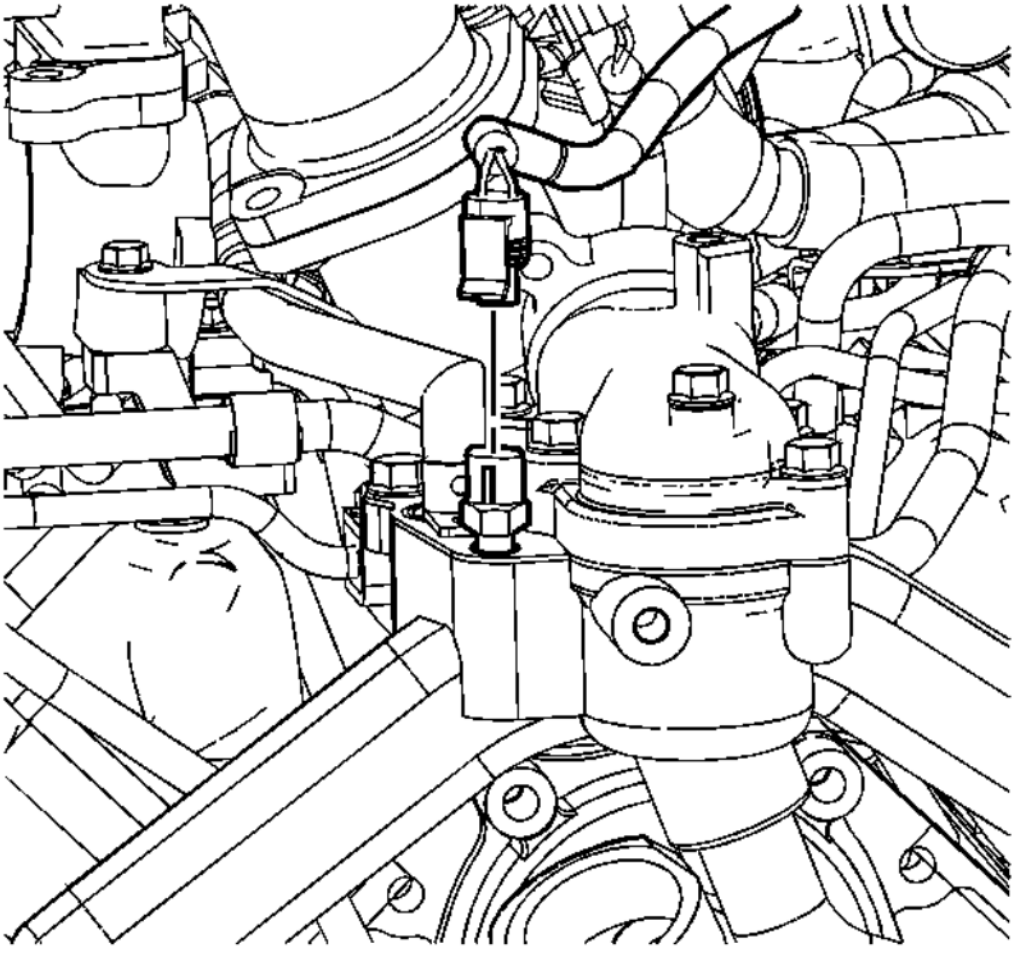


Fig. 72: View Of Engine Coolant Temperature Sensor And Electrical Connector
Courtesy of GENERAL MOTORS CORP.

9. Connect the coolant temperature sensor.

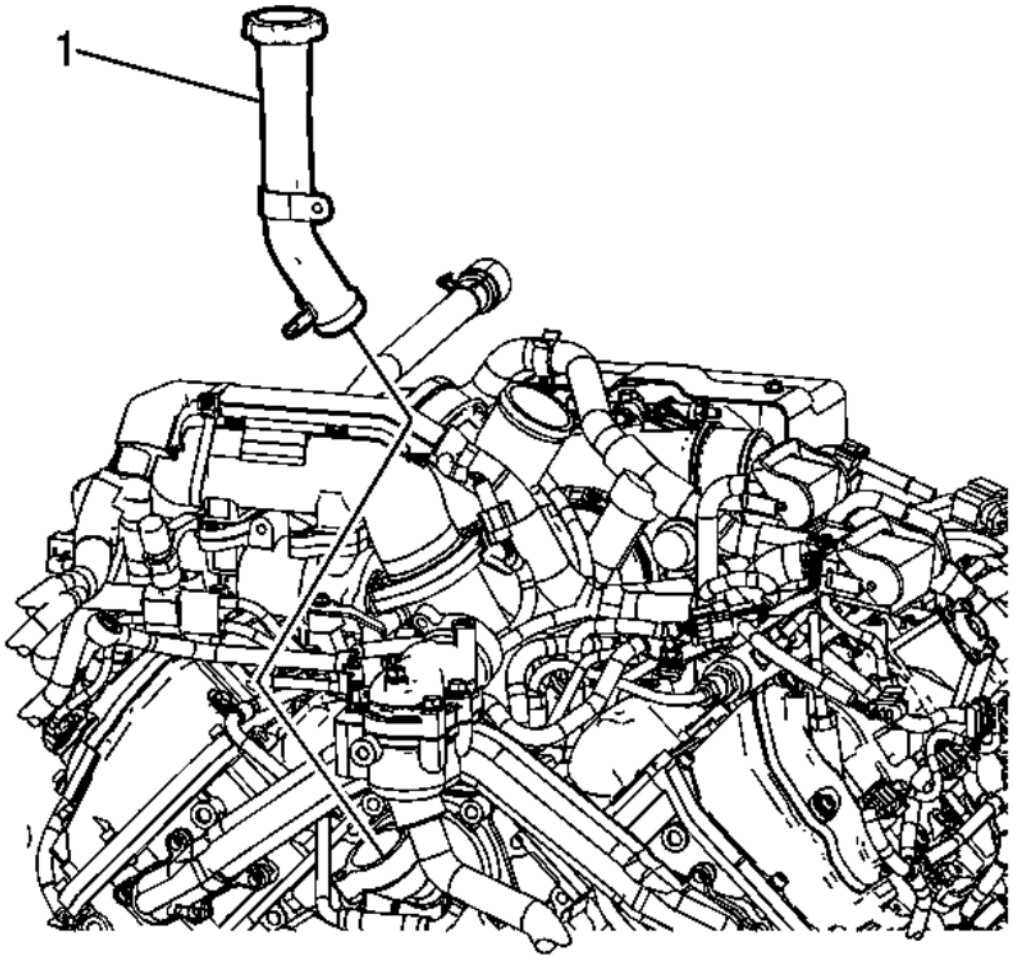


Fig. 73: View Of Oil Filler Tube
Courtesy of GENERAL MOTORS CORP.

10. Install the oil fill tube.

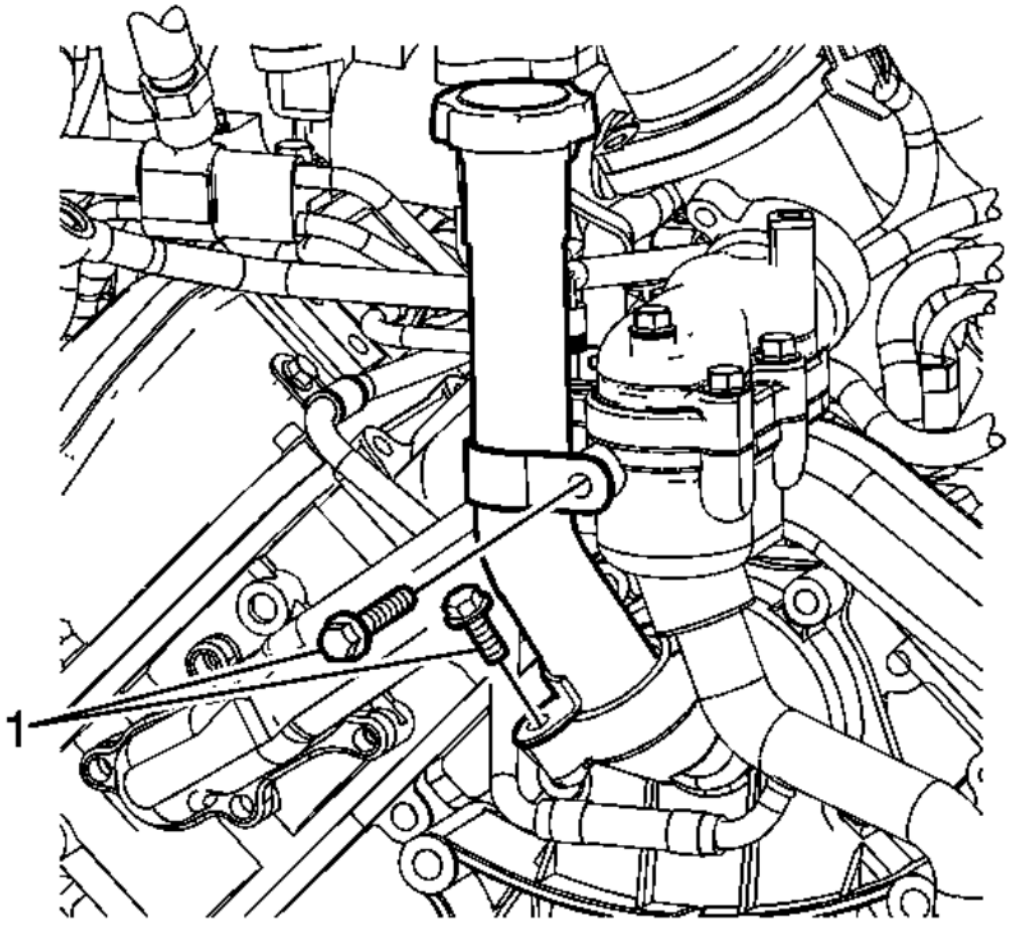


Fig. 74: View Of Oil Filler Tube Bolts
Courtesy of GENERAL MOTORS CORP.

11. Install the oil fill tube bolts.

    Tighten: Tighten the oil fill tube bolts to 25 N.m (18 lb ft).

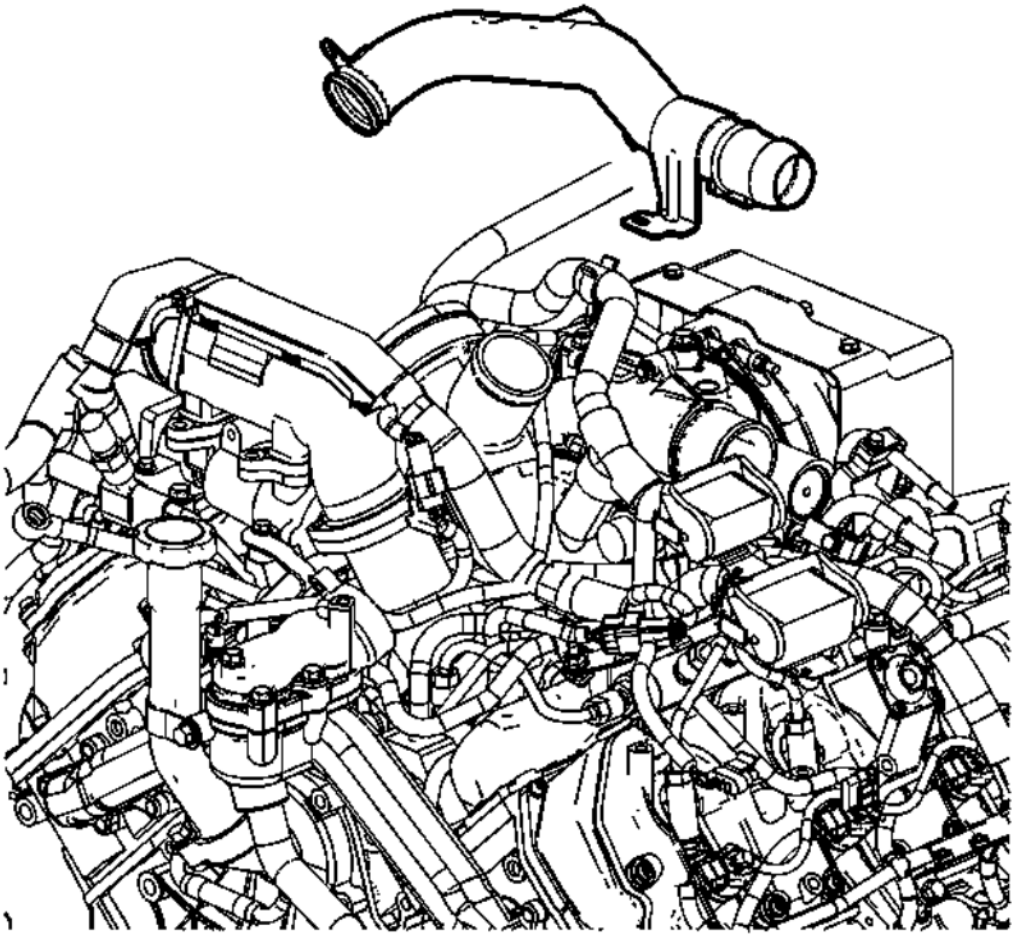


Fig. 75: View Of Water Outlet
Courtesy of GENERAL MOTORS CORP.

12. Install the water outlet.

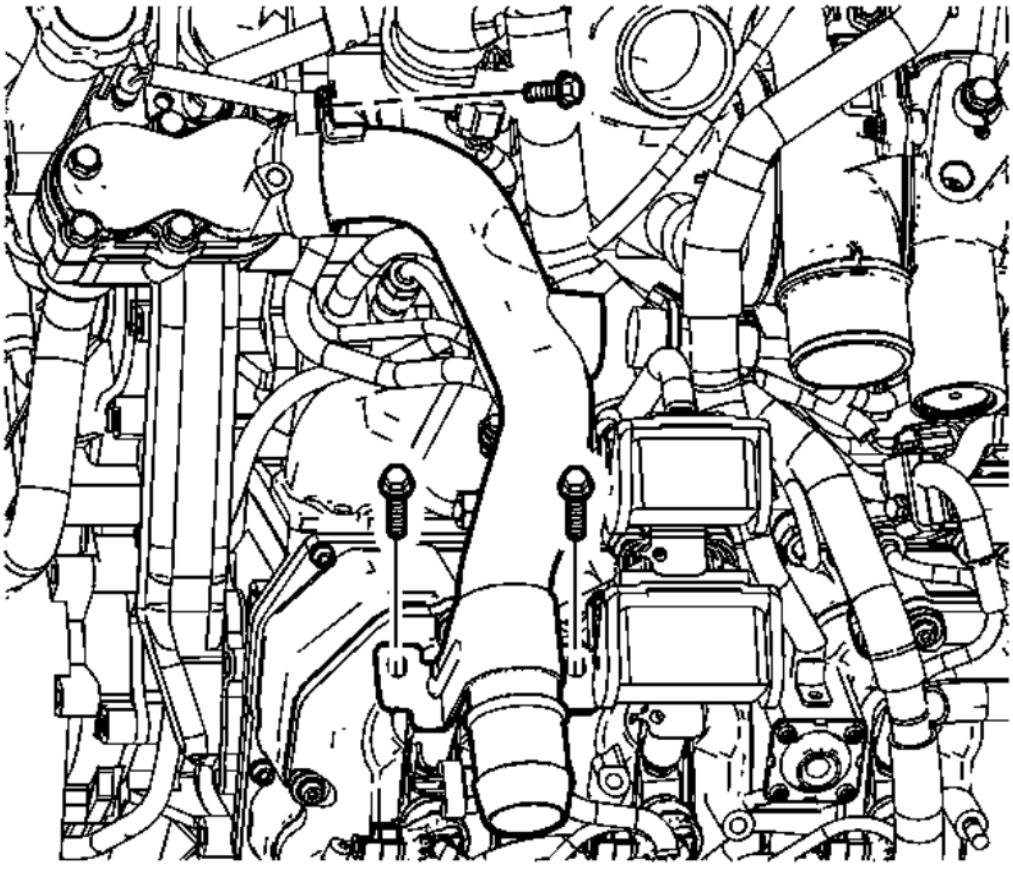


Fig. 76: View Of Water Outlet Bolts
Courtesy of GENERAL MOTORS CORP.

13. Install the water outlet bolts.

    Tighten: Tighten the water outlet bolts to 25 N.m (18 lb ft).

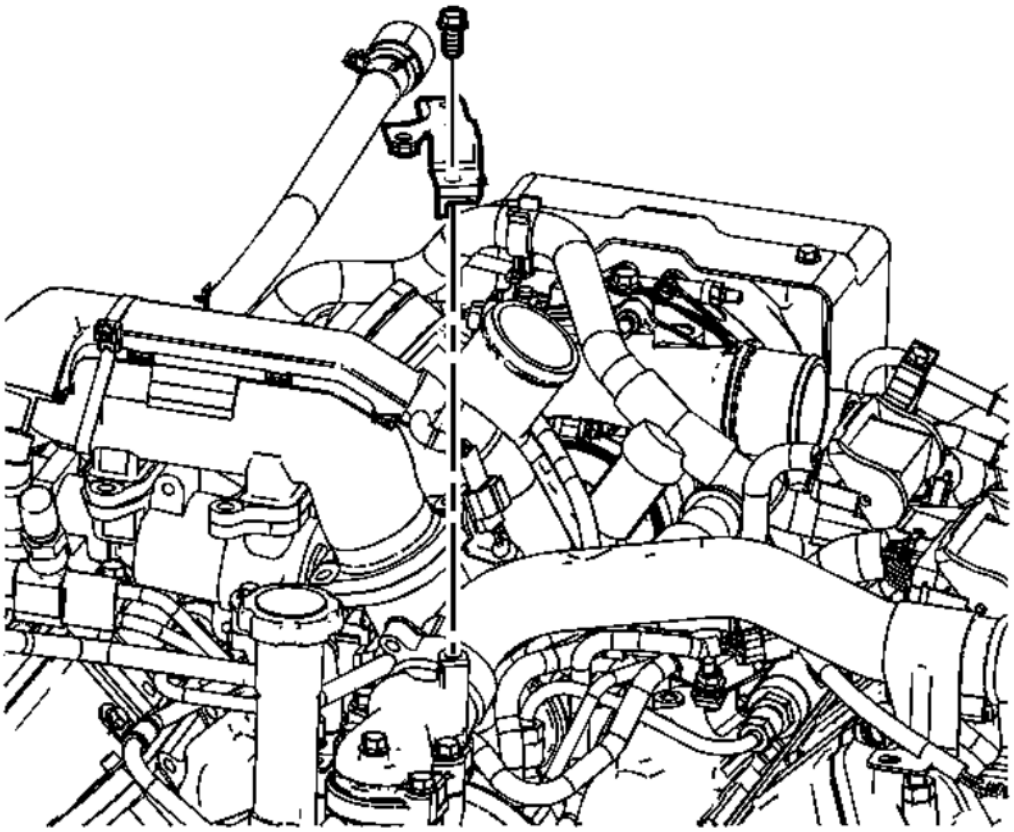


Fig. 77: View Of Electrical Harness Bracket Bolt
Courtesy of GENERAL MOTORS CORP.

14. Install the electrical harness bracket.
15. Install the electrical harness bracket bolt.

Tighten: Tighten the electrical harness bracket bolt to 10 N.m (89 lb in).

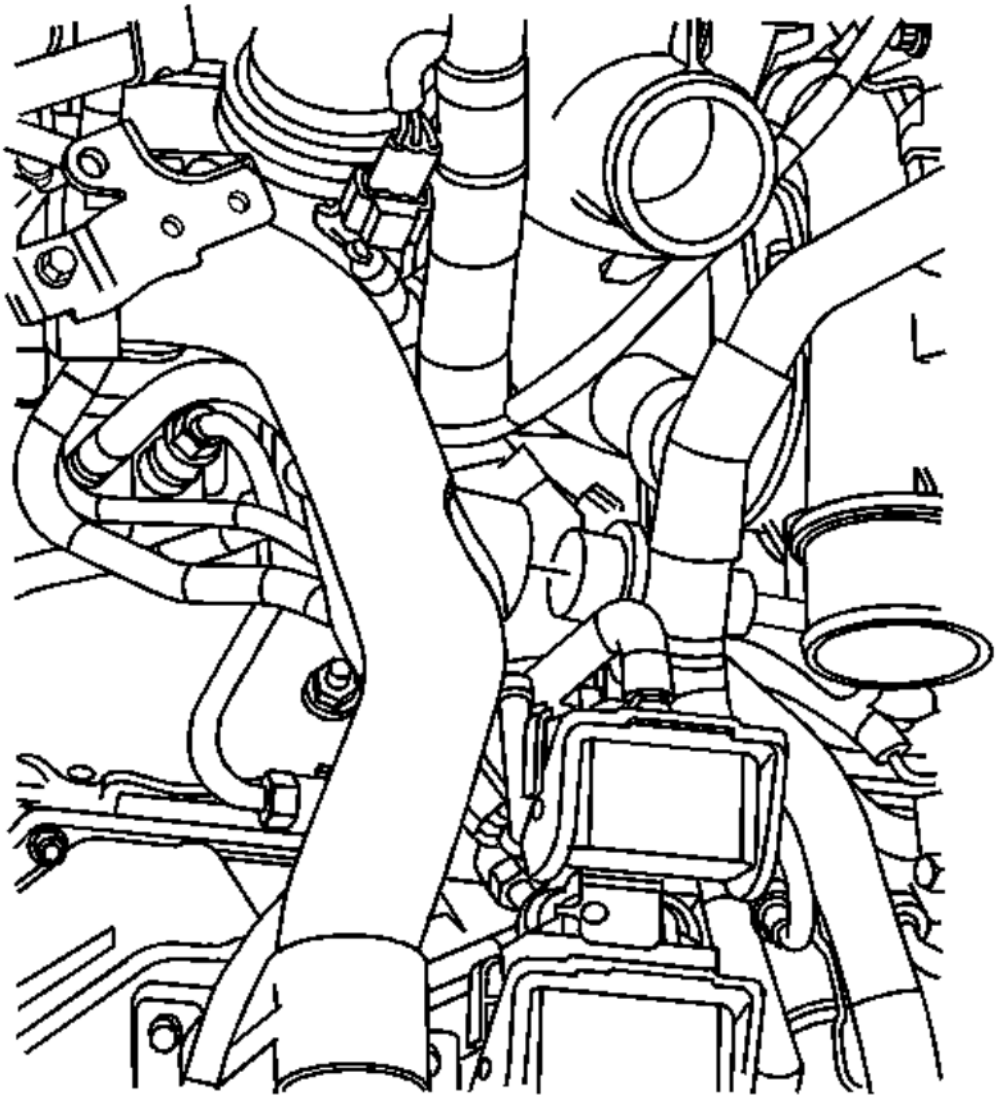


Fig. 78: View Of Turbocharger Inlet Coolant Hose At Turbocharger Coolant Bypass
Courtesy of GENERAL MOTORS CORP.

16. Connect the turbocharger coolant inlet hose.

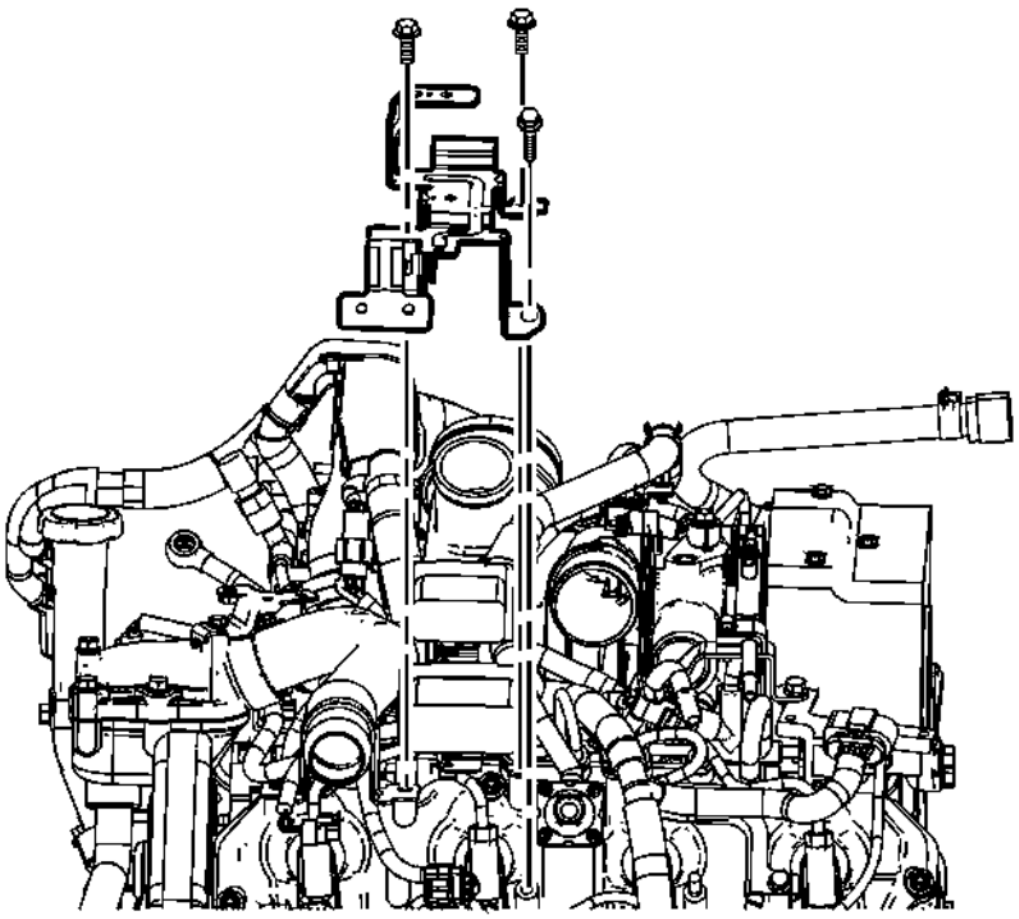


Fig. 79: View Of Main Electrical Connector Harness Bracket & Bolts
Courtesy of GENERAL MOTORS CORP.

17. Install the main electrical harness bracket.
18. Install the main electrical harness bracket bolts.

Tighten: Tighten the main electrical harness bracket bolts to 10 N.m (89 lb in).

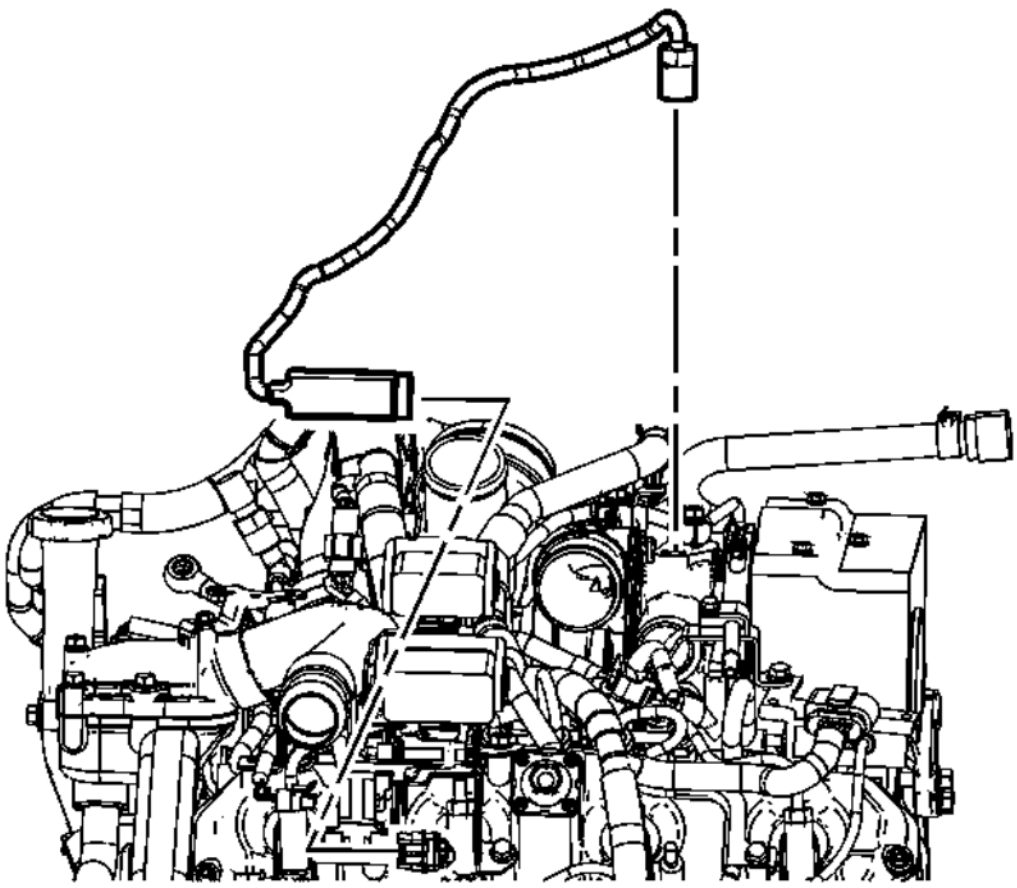


Fig. 80: View Of Turbocharger Vane Position Sensor And Electrical Connector
Courtesy of GENERAL MOTORS CORP.

19. Connect and install the turbocharger vane position sensor.

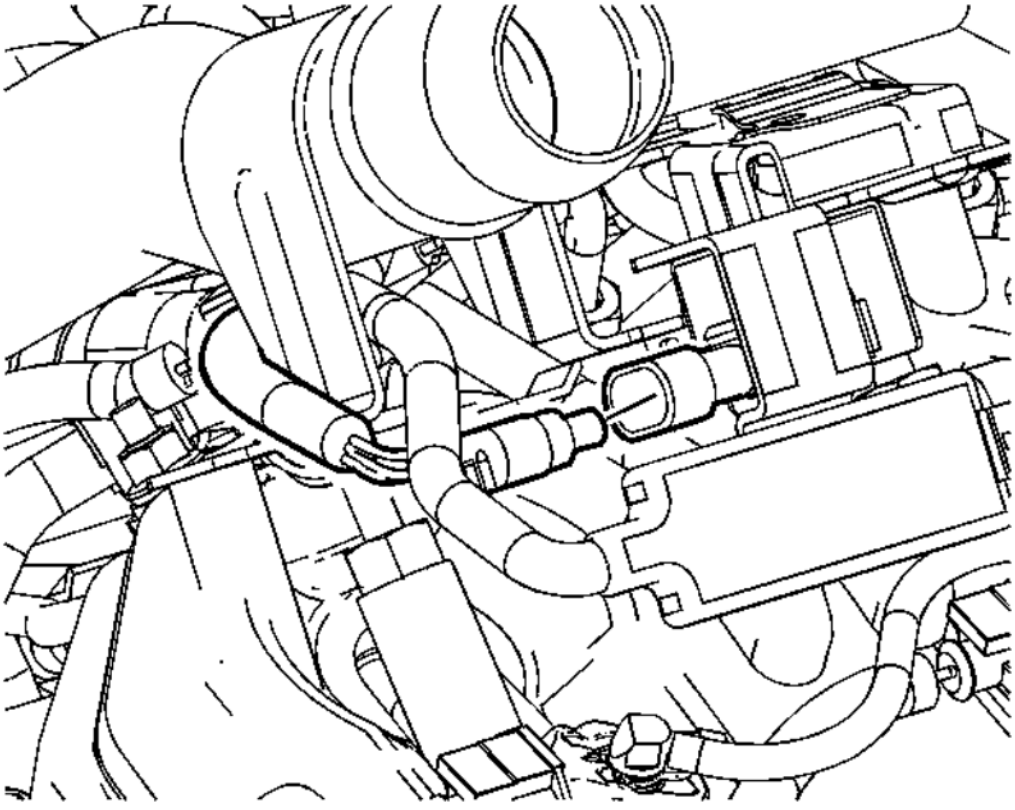


Fig. 81: View Of Barometric Pressure Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

20. Connect and install the barometric sensor.

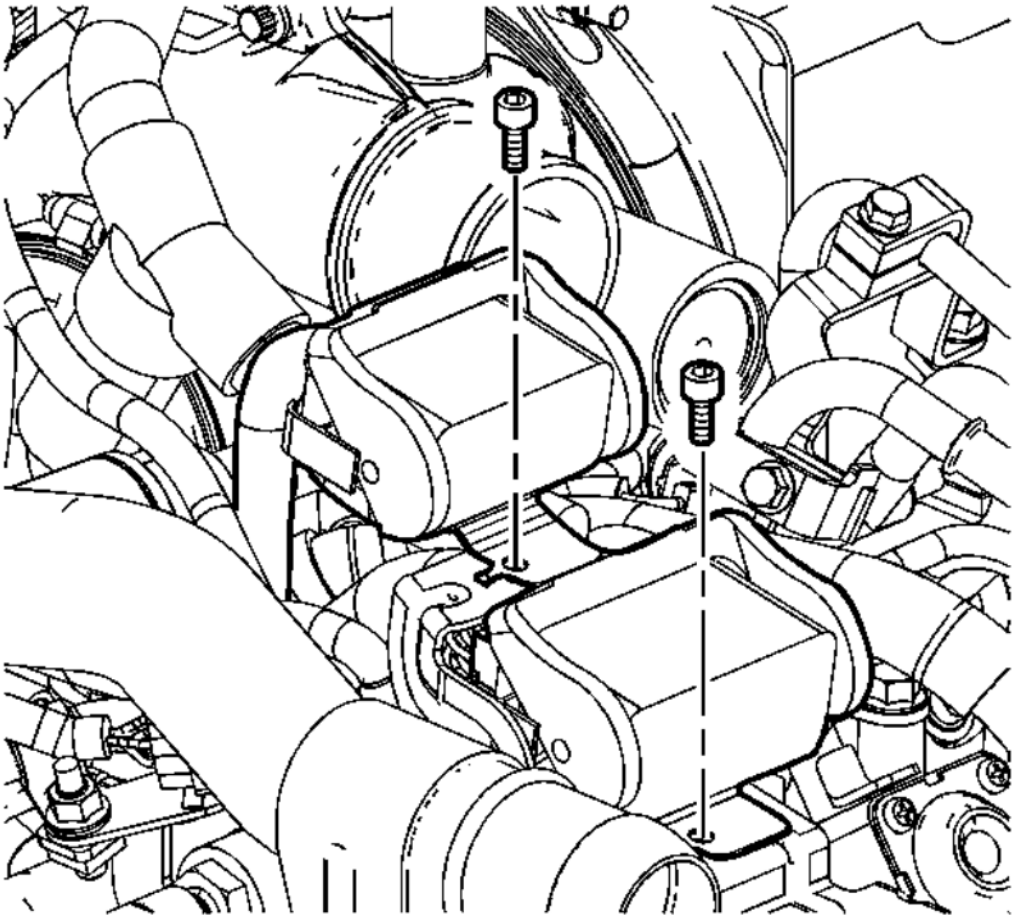


Fig. 82: View Of Main Engine Electrical Harness Connector Bolts
Courtesy of GENERAL MOTORS CORP.

21. Install the main engine electrical harness connector hold down bolts.

    Tighten: Tighten the main electrical harness connector hold down bolts to 10 N.m (89 lb in).

DRIVE BELT TENSIONER AND GENERATOR MOUNTING BRACKET INSTALLATION

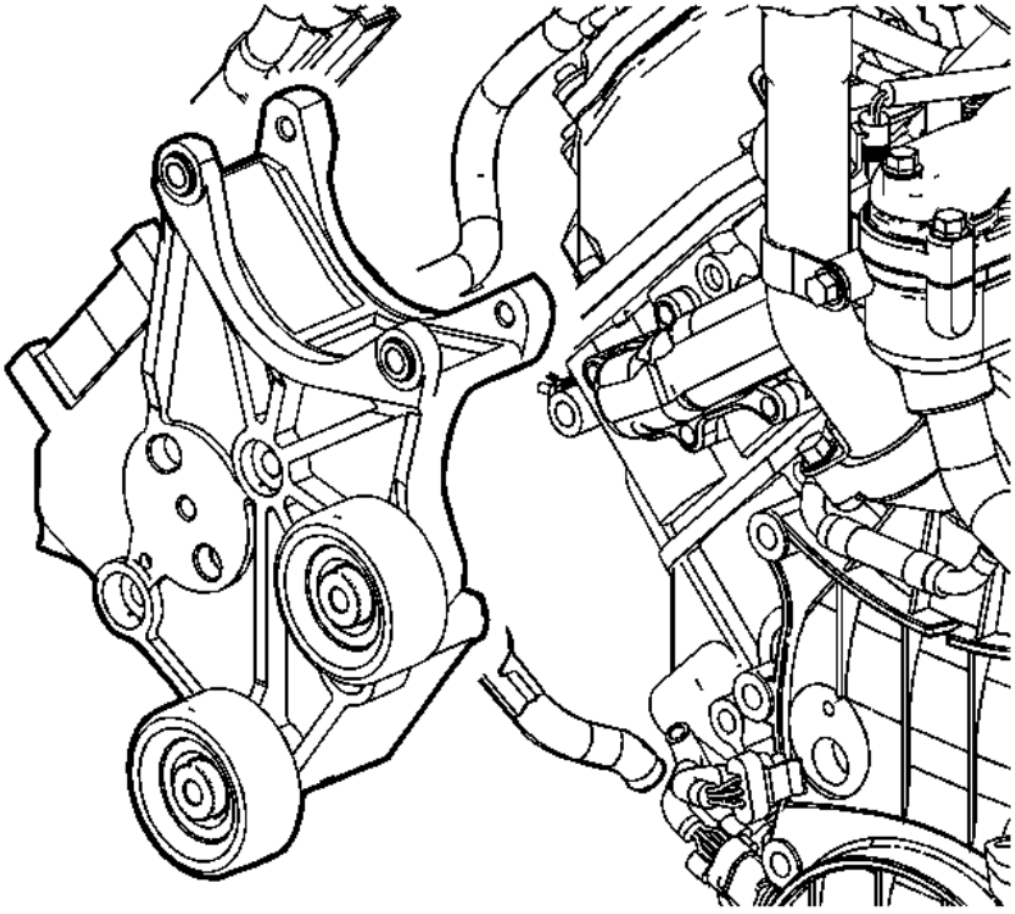


Fig. 83: View Of Generator Mounting Bracket
Courtesy of GENERAL MOTORS CORP.

1. Install the drive belt tensioner and generator mounting bracket.

NOTE: **Refer to Fastener Notice .**

2. Install the drive belt tensioner and generator mounting bracket bolts.

Tighten: Tighten the drive belt tensioner and generator mounting bracket bolts to 50 N.m (37 lb ft).

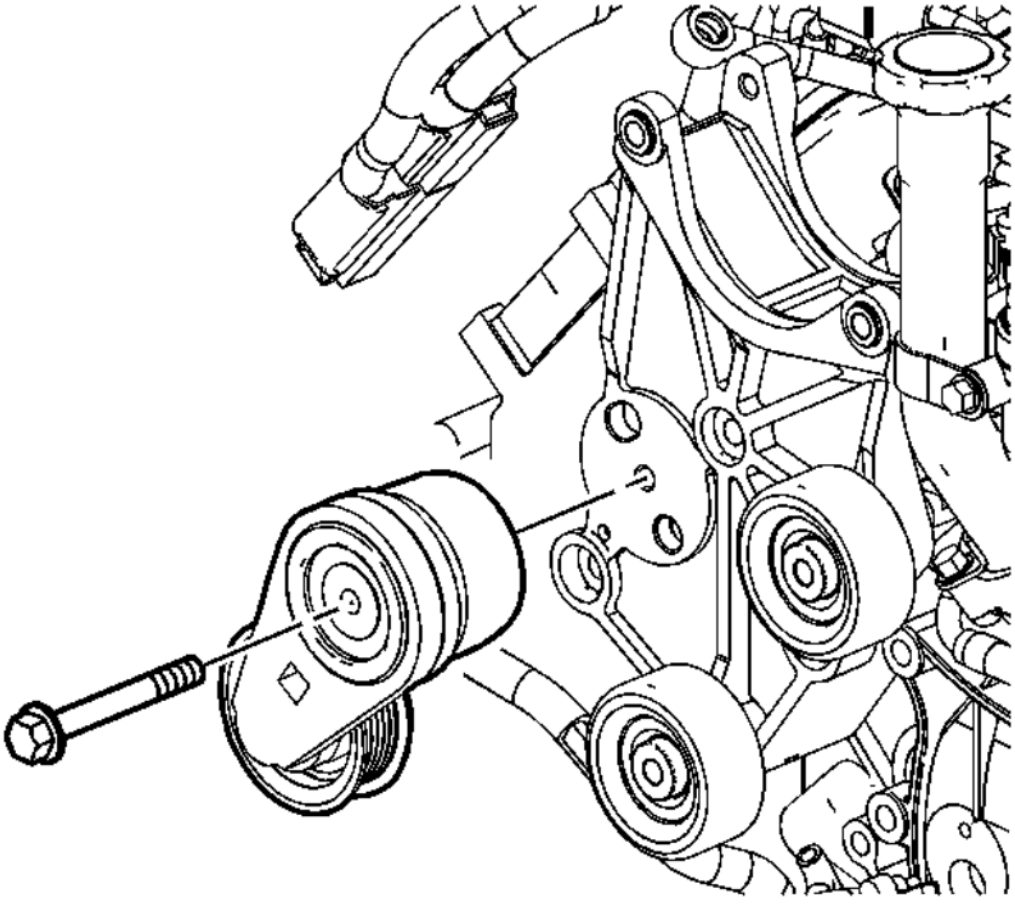


Fig. 84: View Of Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

3. Install the drive belt tensioner.
4. Install the drive belt tensioner bolt.

Tighten: Tighten the drive belt tensioner bolt to 50 N.m (37 lb ft).

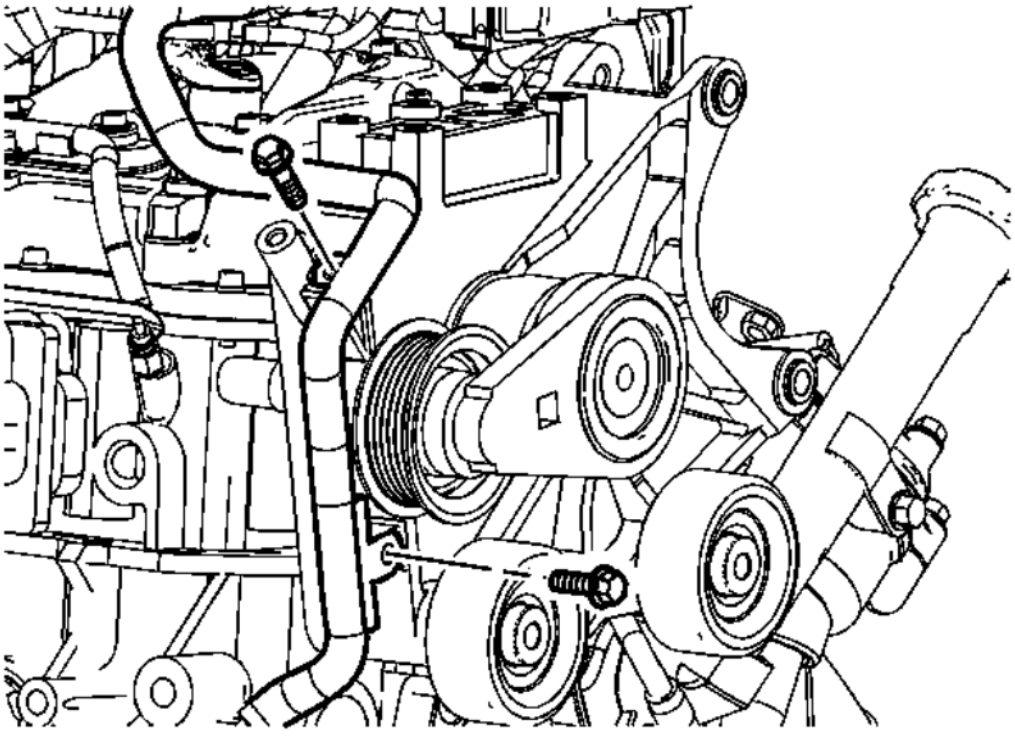


Fig. 85: View Of Electrical Harness Clip Bolts
Courtesy of GENERAL MOTORS CORP.

5. Install the electrical harness clip bolts.

   Tighten: Tighten the electrical harness clip bolts to 10 N.m (89 lb in).

FUEL FILTER ASSEMBLY INSTALLATION

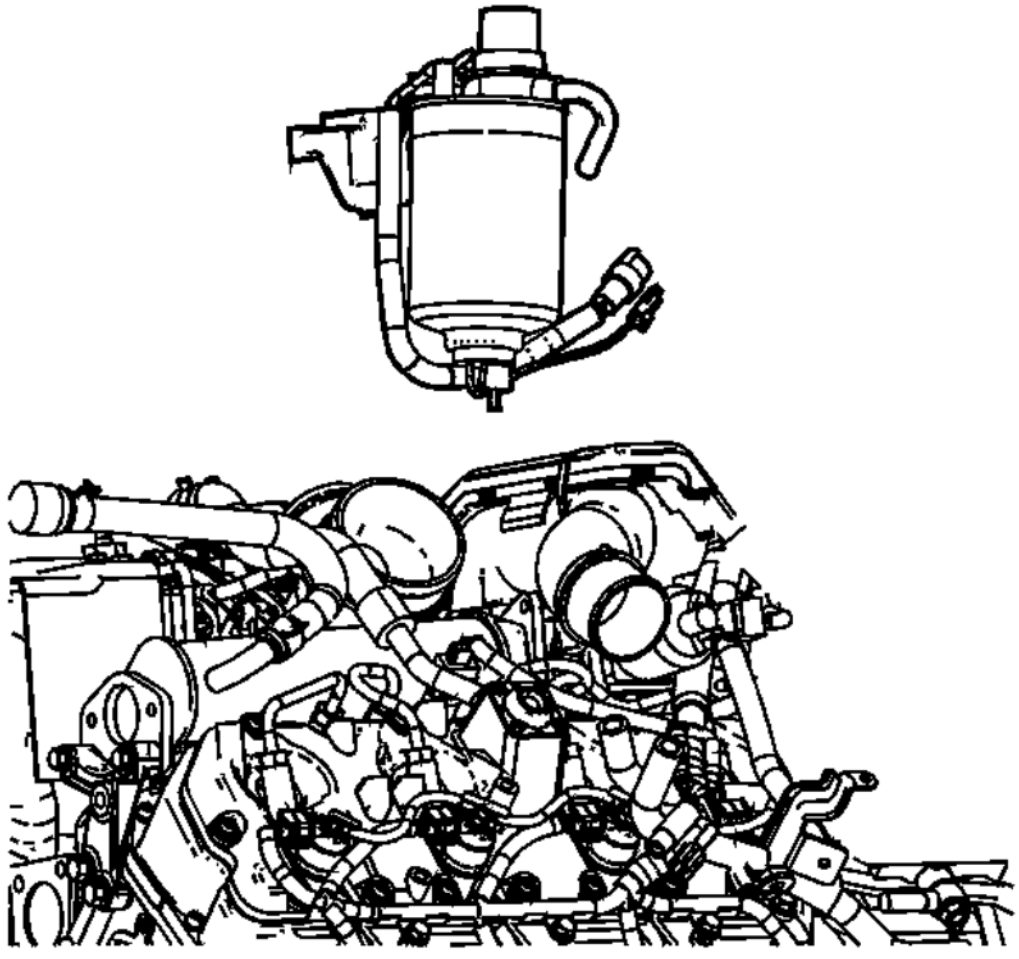


Fig. 86: Identifying Fuel Filter Assembly
Courtesy of GENERAL MOTORS CORP.

1. Install the fuel filter assembly.

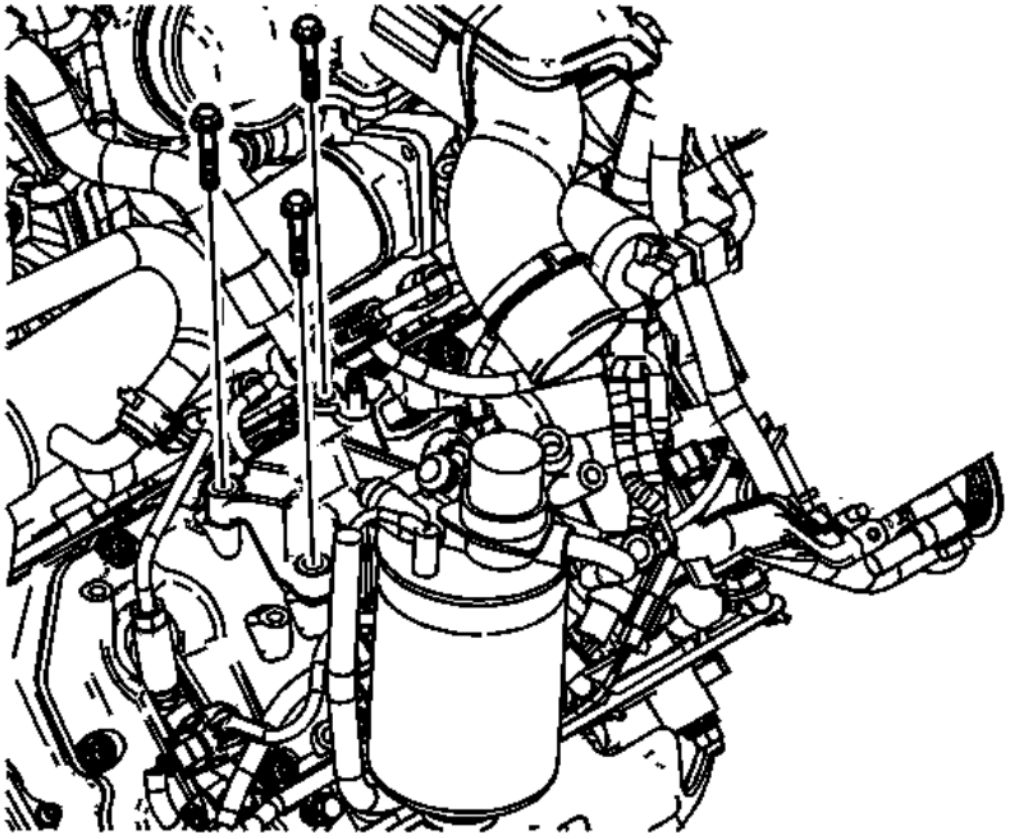


Fig. 87: Identifying Fuel Filter Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

2. Install the fuel filter bracket bolts.

   Tighten: Tighten the fuel filter bracket bolts to 21 N.m (15 lb ft).

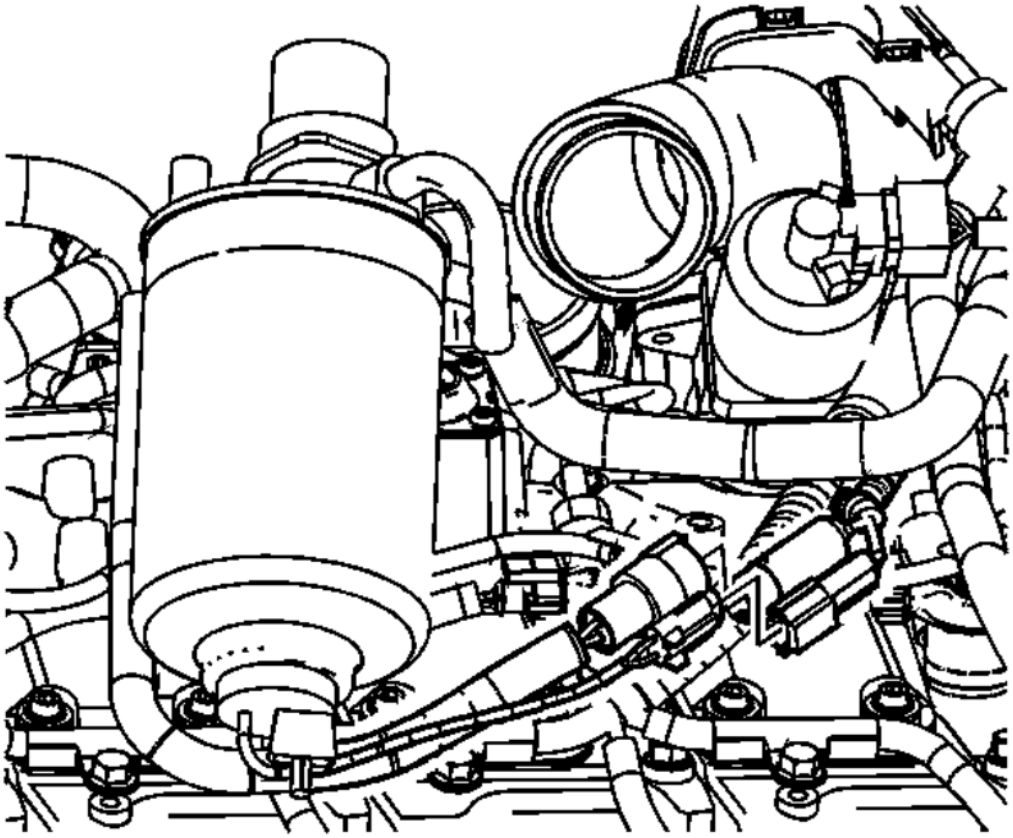


Fig. 88: View Of Fuel Filter Assembly Connectors
Courtesy of GENERAL MOTORS CORP.

3. Connect the fuel filter assembly connectors.

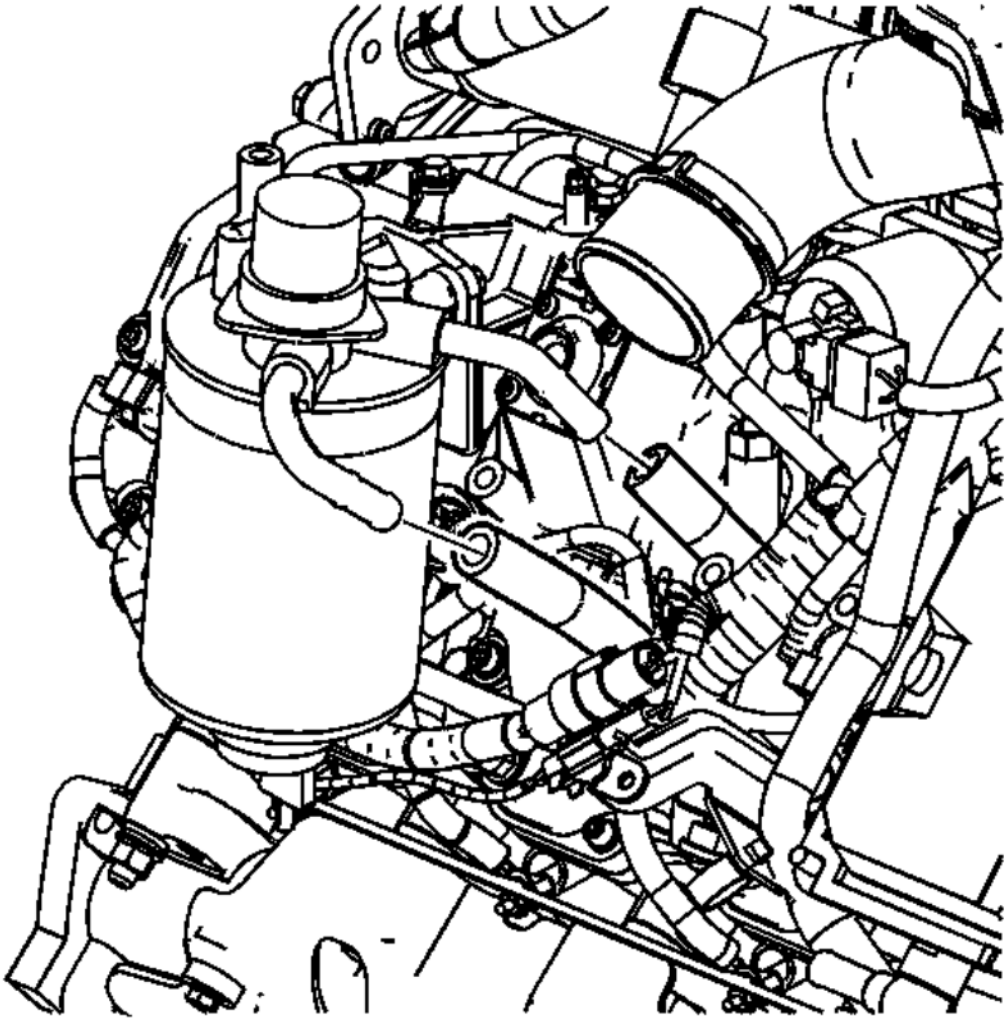


Fig. 89: View Of Fuel Hoses At Fuel Filter
Courtesy of GENERAL MOTORS CORP.

4. Install the fuel hoses.

POWER STEERING PUMP MOUNTING BRACKET INSTALLATION

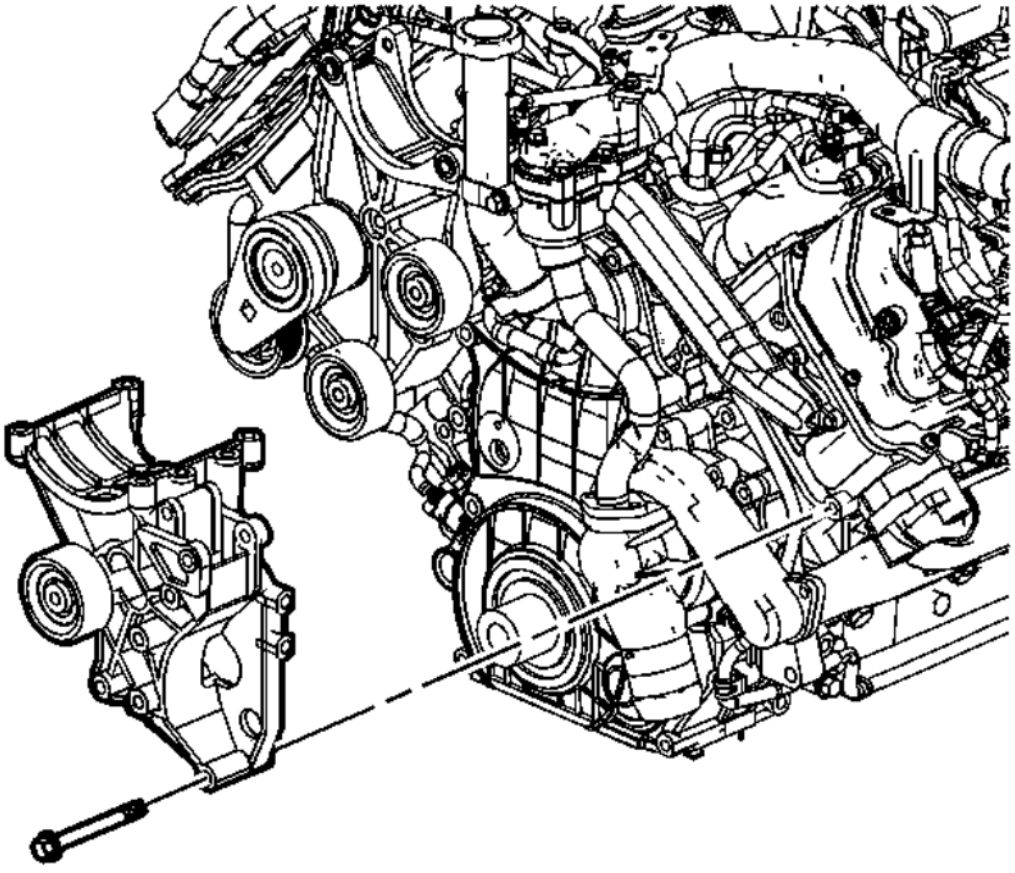


Fig. 90: View Of A/C Compressor & Power Steering Pump Bracket
Courtesy of GENERAL MOTORS CORP.

1. Install the power steering pump mounting bracket.

NOTE: **Refer to Fastener Notice .**

2. Install the power steering pump mounting bracket bolts.

Tighten: Tighten the power steering pump mounting bracket bolts to 46 N.m (34 lb ft).

COOLING FAN PULLEY INSTALLATION

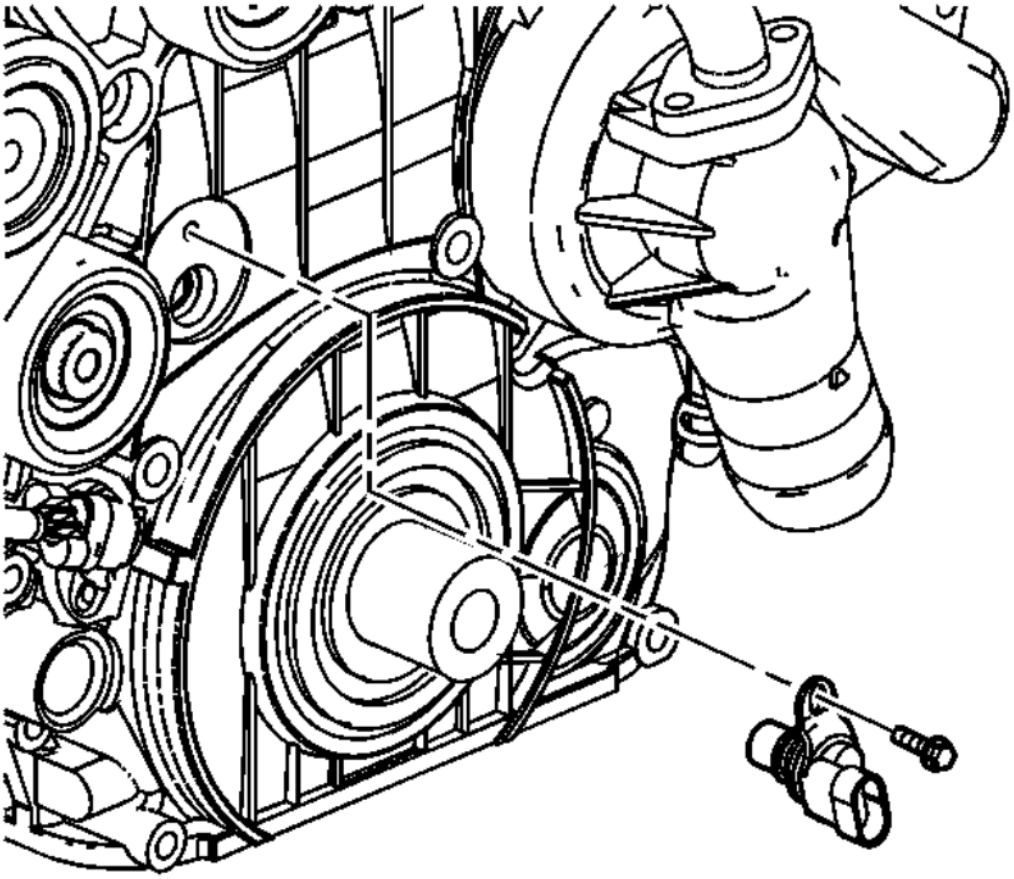


Fig. 91: View Of Camshaft Position Sensor
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the camshaft position sensor O-ring with engine oil.
2. Install the camshaft position sensor.

NOTE: **Refer to Fastener Notice .**

3. Install the camshaft position sensor retaining bolt.

Tighten: Tighten the camshaft position sensor retaining bolt to 10 N.m (89 lb in).

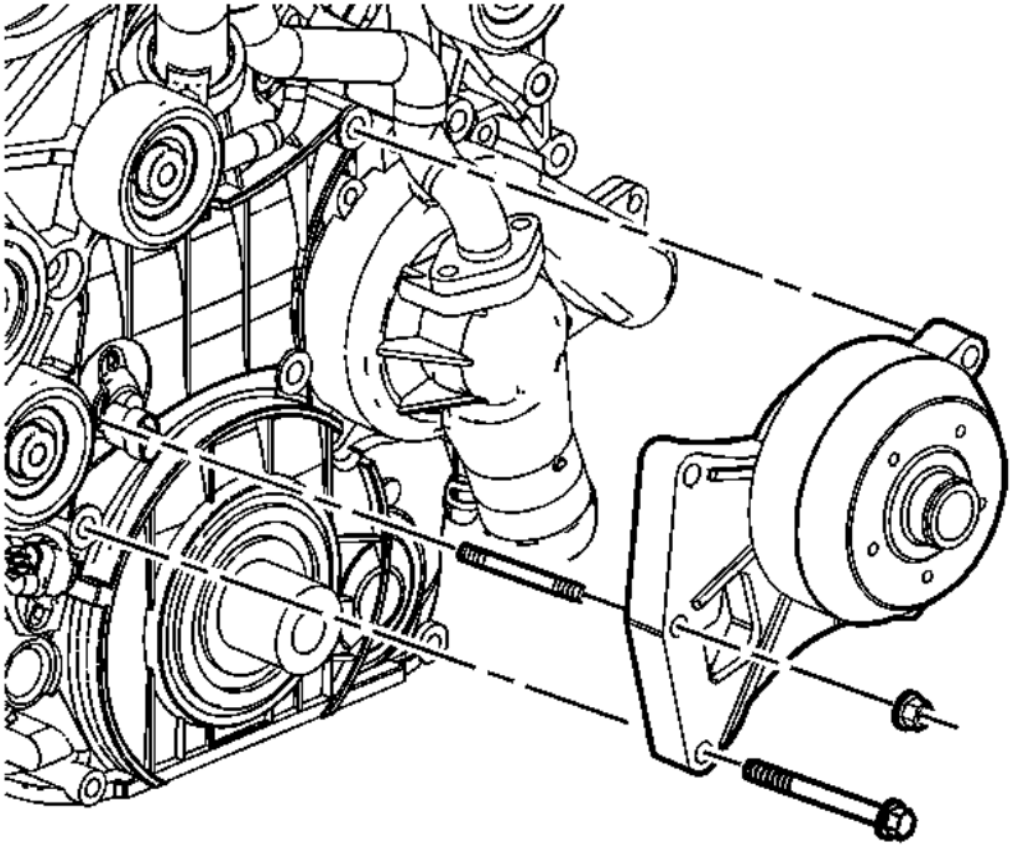


Fig. 92: View Of Cooling Fan Pulley
Courtesy of GENERAL MOTORS CORP.

4. Install the cooling fan pulley.
5. Install the cooling fan pulley bolts and nuts.

Tighten: Tighten the cooling fan pulley bolts and nuts to 41 N.m (30 lb ft).

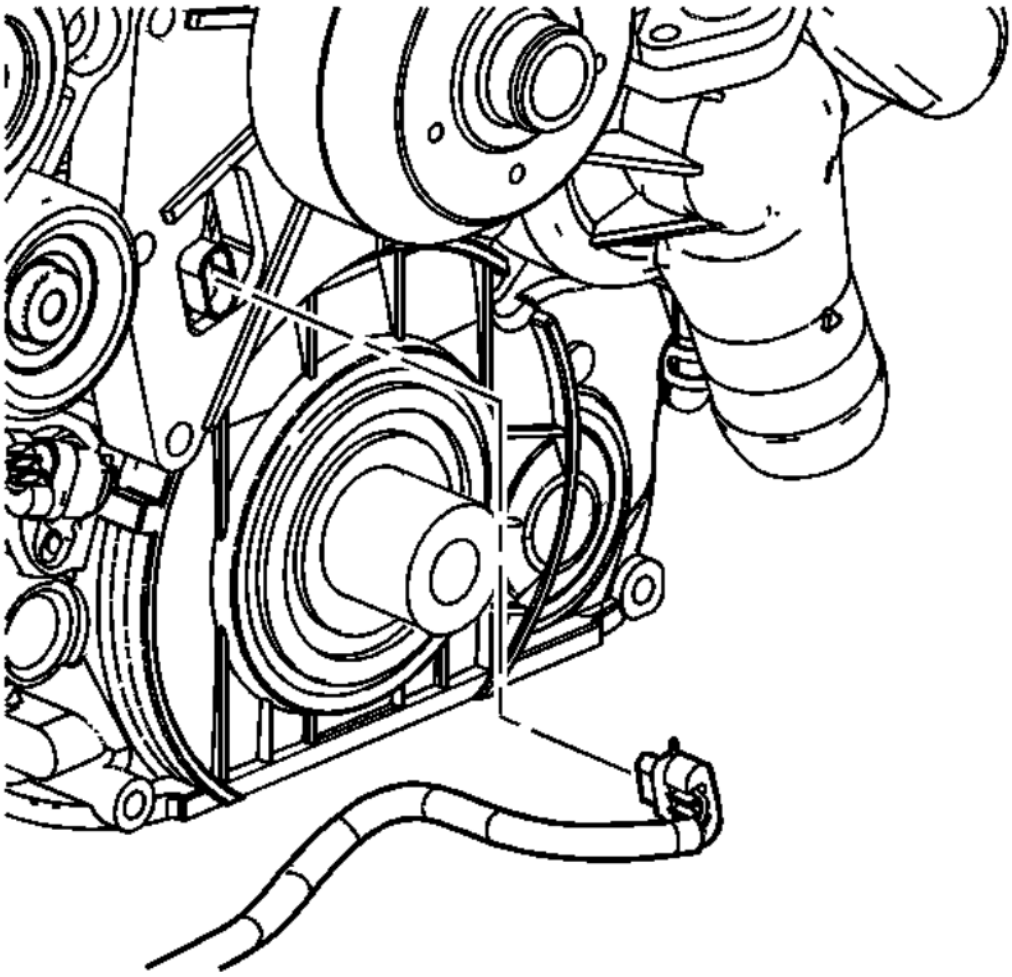


Fig. 93: View Of Camshaft Position Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

6. Connect the camshaft position sensor connector.

ENGINE REMOVAL FROM STAND

Tools Required

J 36857 Engine Lift Bracket. See **Special Tools** .

Removal

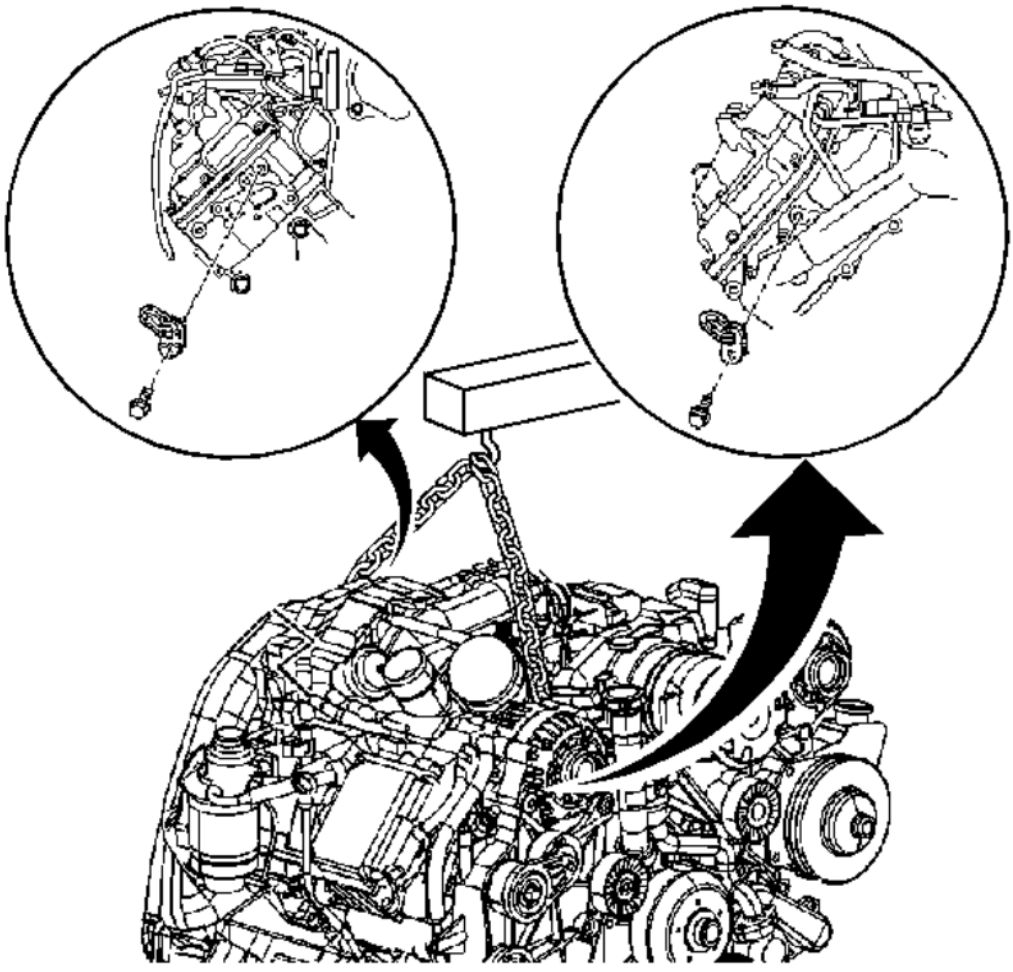


Fig. 94: View Of J 36857 Installation Positions
Courtesy of GENERAL MOTORS CORP.

1. Bolt **J 36857** to the ends of the cylinder heads. See **Special Tools** .

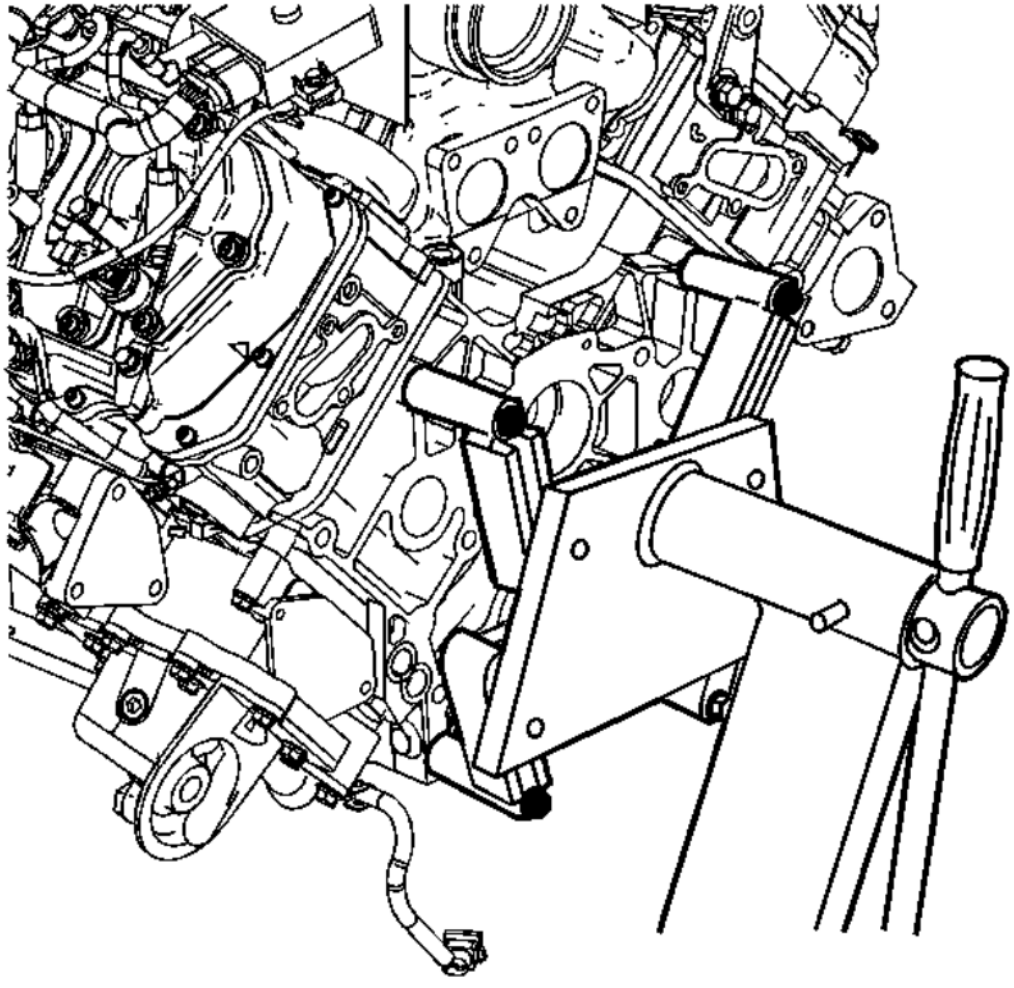


Fig. 95: Mounting Engine Block To Suitable Engine Stand
Courtesy of GENERAL MOTORS CORP.

2. Lift the engine and the engine stand with a suitable hoist.
3. Remove the engine stand from the engine adapter.
4. Lower the engine to the floor. Support the engine with blocks.
5. Remove the engine adapter.

ENGINE FLYWHEEL HOUSING INSTALLATION

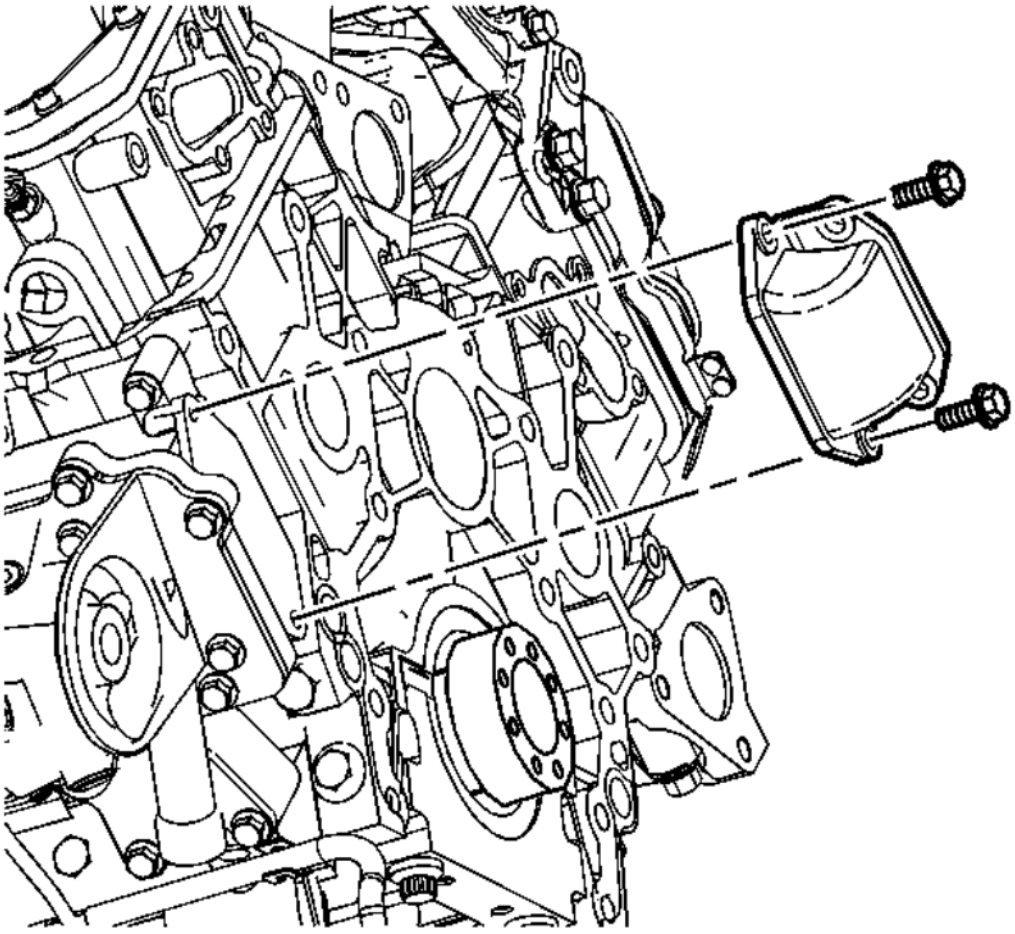


Fig. 96: View Of Oil Cooler Adapter
Courtesy of GENERAL MOTORS CORP.

1. Install the oil cooler adapter with gaskets to the oil cooler.

   NOTE: Refer to Fastener Notice .

2. Install the oil cooler adapter to oil cooler bolts.

   Tighten: Tighten the oil cooler adapter to oil cooler bolts to 21 N.m (15 lb ft).

3. Apply a 2-3 mm wide by 0.5-1.5 mm high bead of GM P/N 12378521 (Canadian P/N

88901148) sealant to the engine block mating surface.

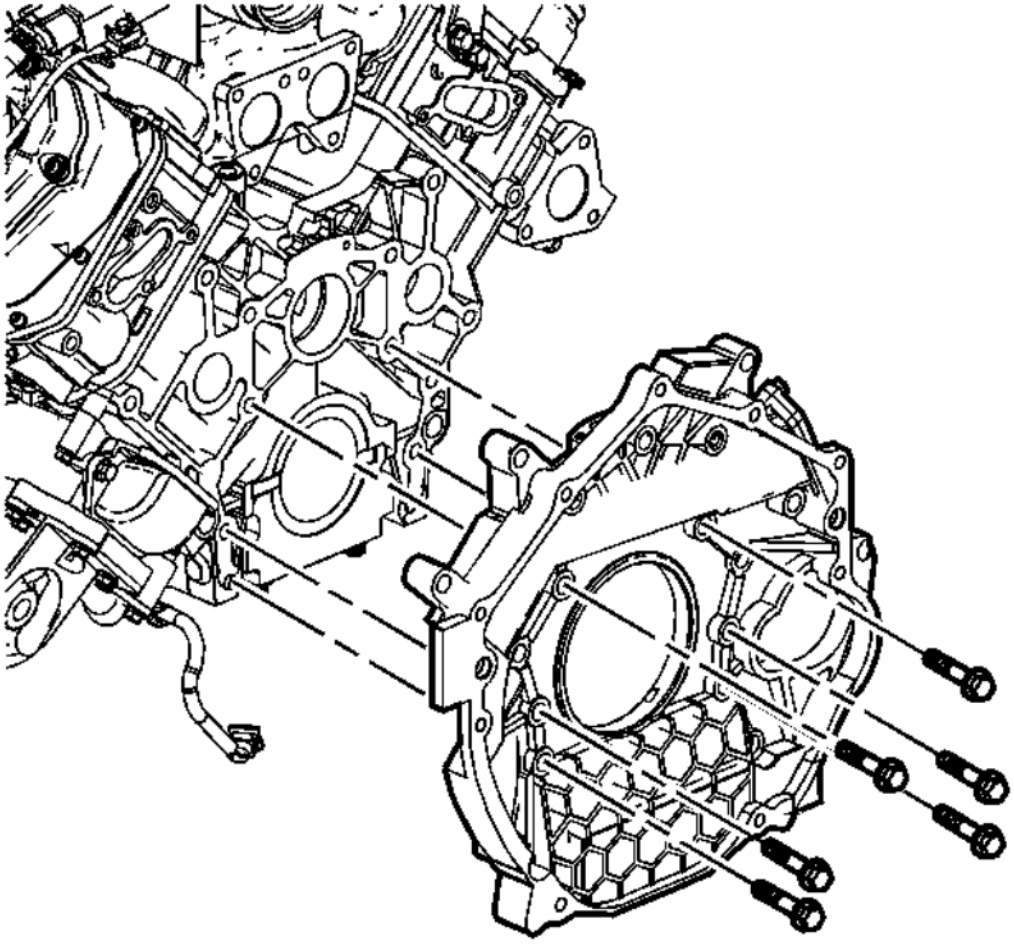


Fig. 97: View Of Flywheel Housing
Courtesy of GENERAL MOTORS CORP.

4. Install the flywheel housing to the cylinder block.
5. Install the flywheel housing bolts.

Tighten: Tighten the flywheel housing bolts to 80 N.m (60 lb ft)

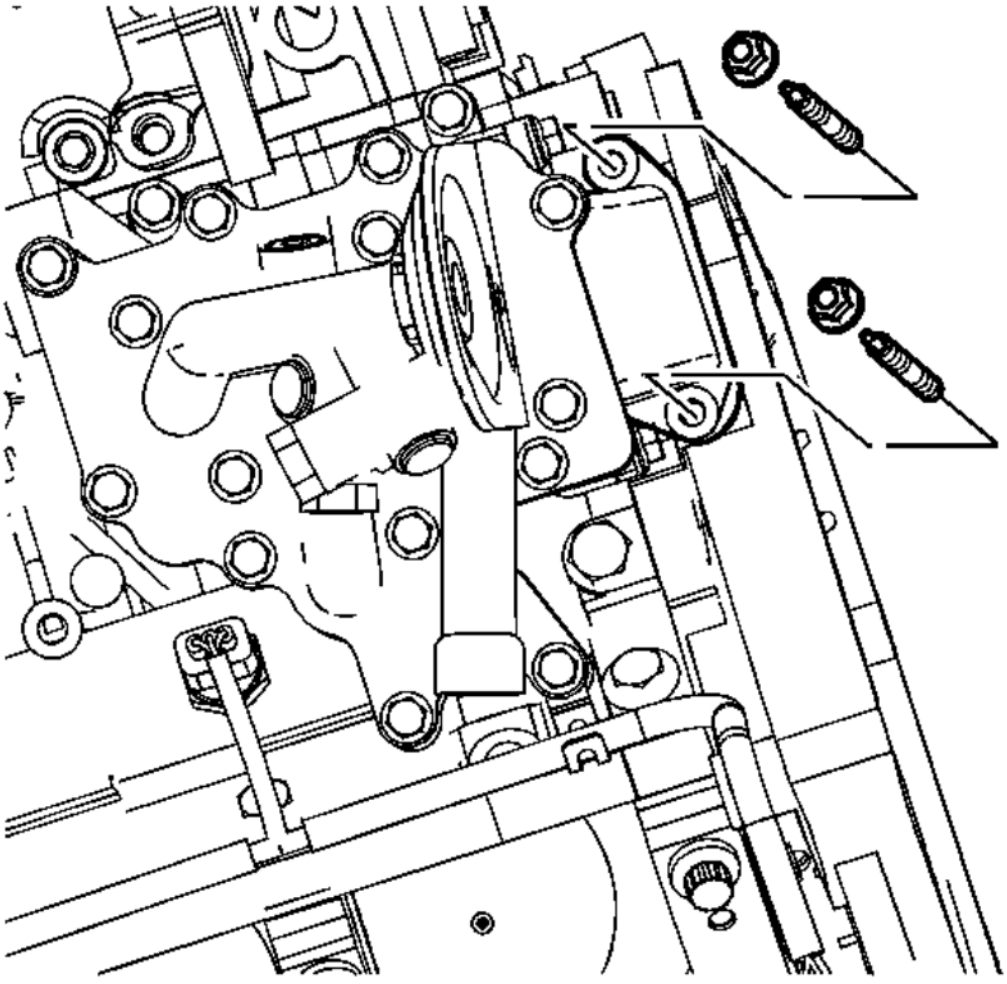


Fig. 98: View Of Turbocharger Oil Return Pipe Nuts
Courtesy of GENERAL MOTORS CORP.

6. Install a new gasket to the turbocharger oil return pipe.
7. Install the turbocharger oil return pipe to flywheel housing studs.

   Tighten: Tighten the turbocharger oil return pipe to flywheel housing studs to 10 N.m (89 lb in).

8. Install the turbocharger oil return pipe nuts.

Tighten: Tighten the turbocharger oil return pipe nuts to 25 N.m (18 lb ft).

UPPER OIL PAN INSTALLATION

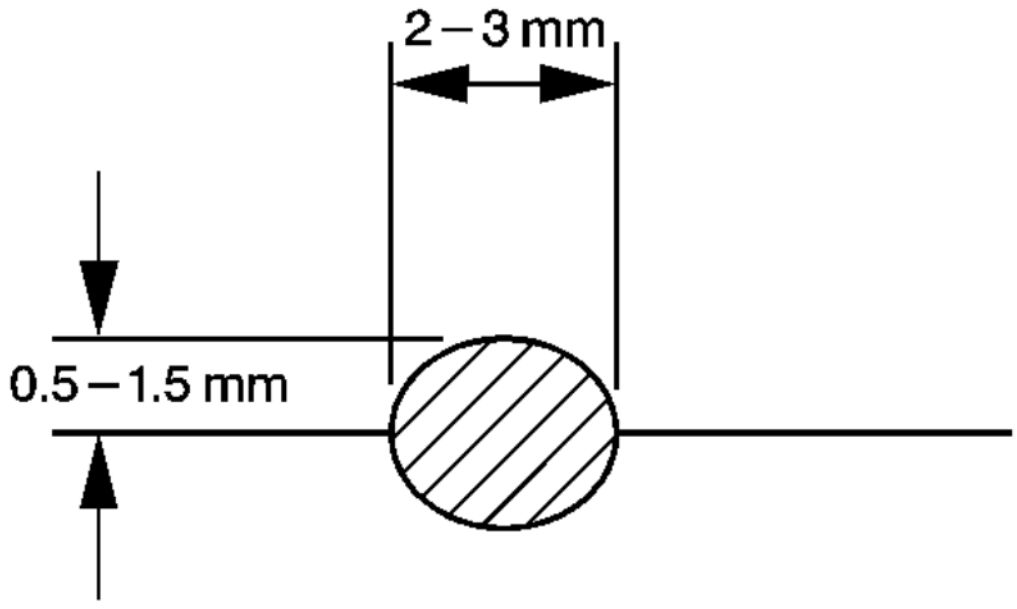


Fig. 99: Determining Sealant Bead Dimensions
Courtesy of GENERAL MOTORS CORP.

1. Apply a 2-3 mm wide by 0.5-1.5 mm bead of GM P/N 12378521 (Canadian P/N 88901148) sealant to the upper oil pan mating surfaces.

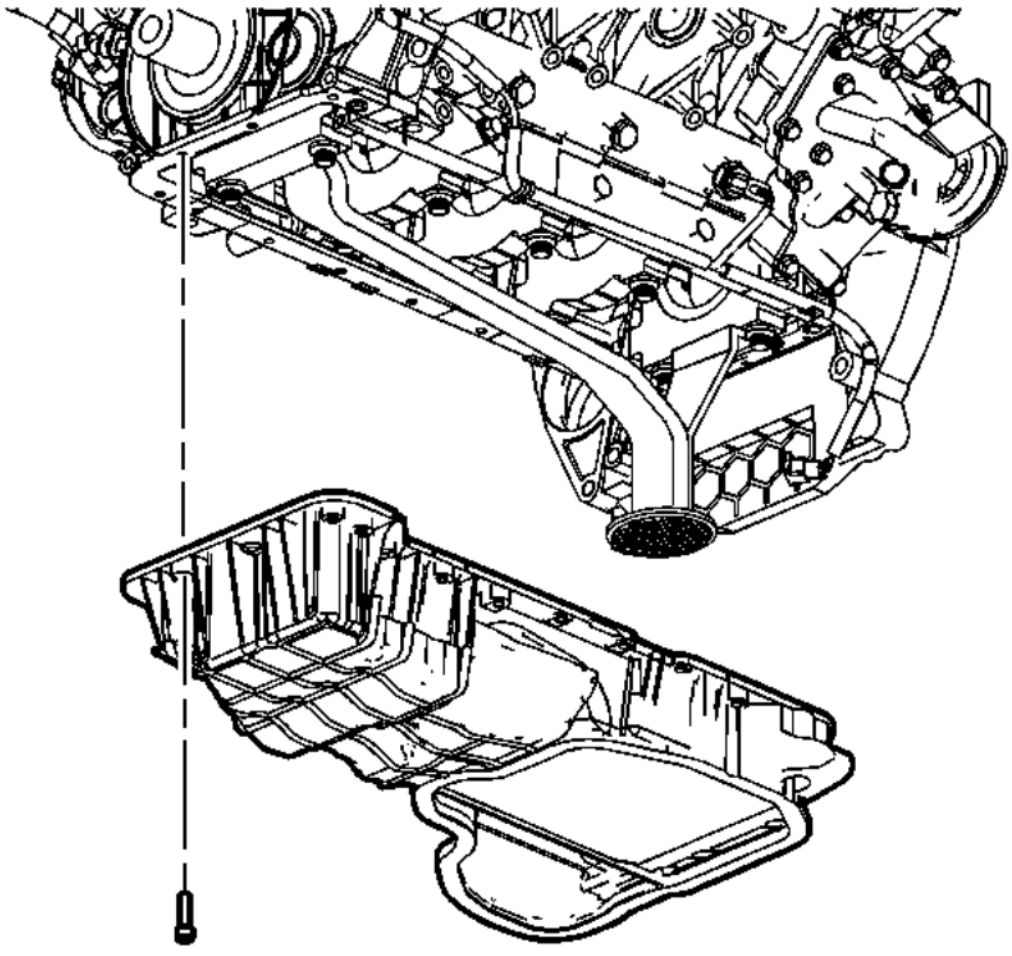


Fig. 100: View Of Upper Oil Pan
Courtesy of GENERAL MOTORS CORP.

2. Install the upper oil pan to the engine block.

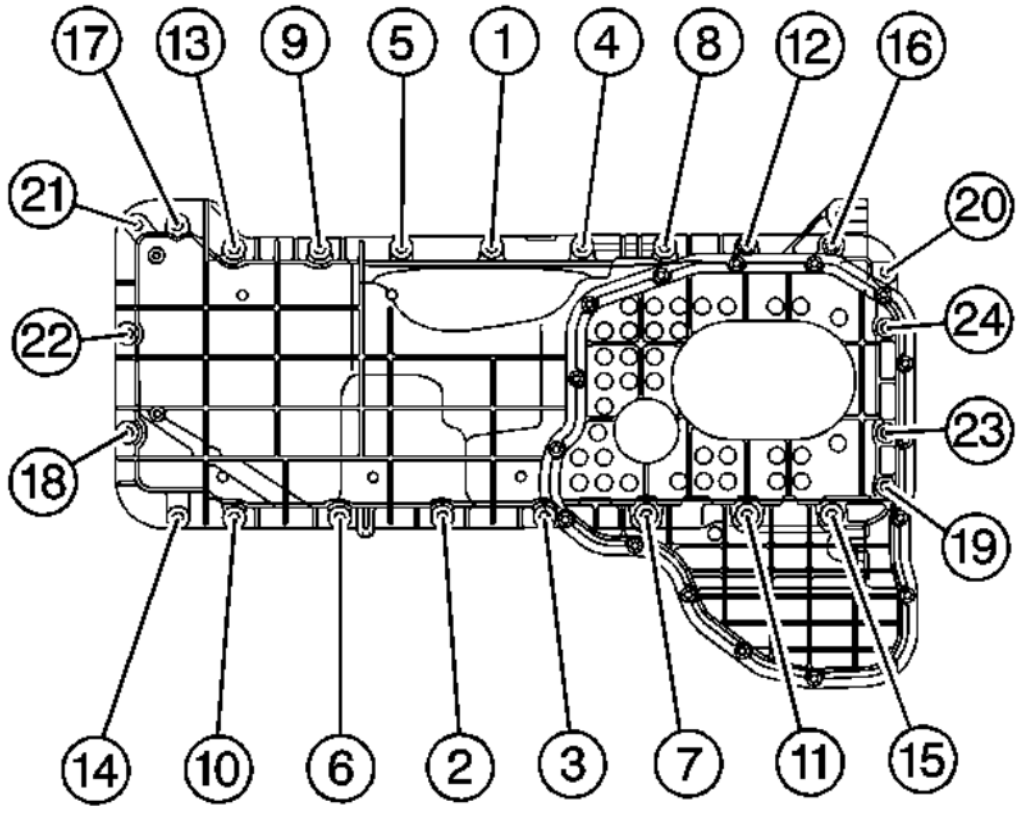


Fig. 101: Upper Oil Pan Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

3. Install the upper oil pan bolts.

   Tighten: Tighten the upper oil pan bolts in sequence to 20 N.m (15 lb ft).

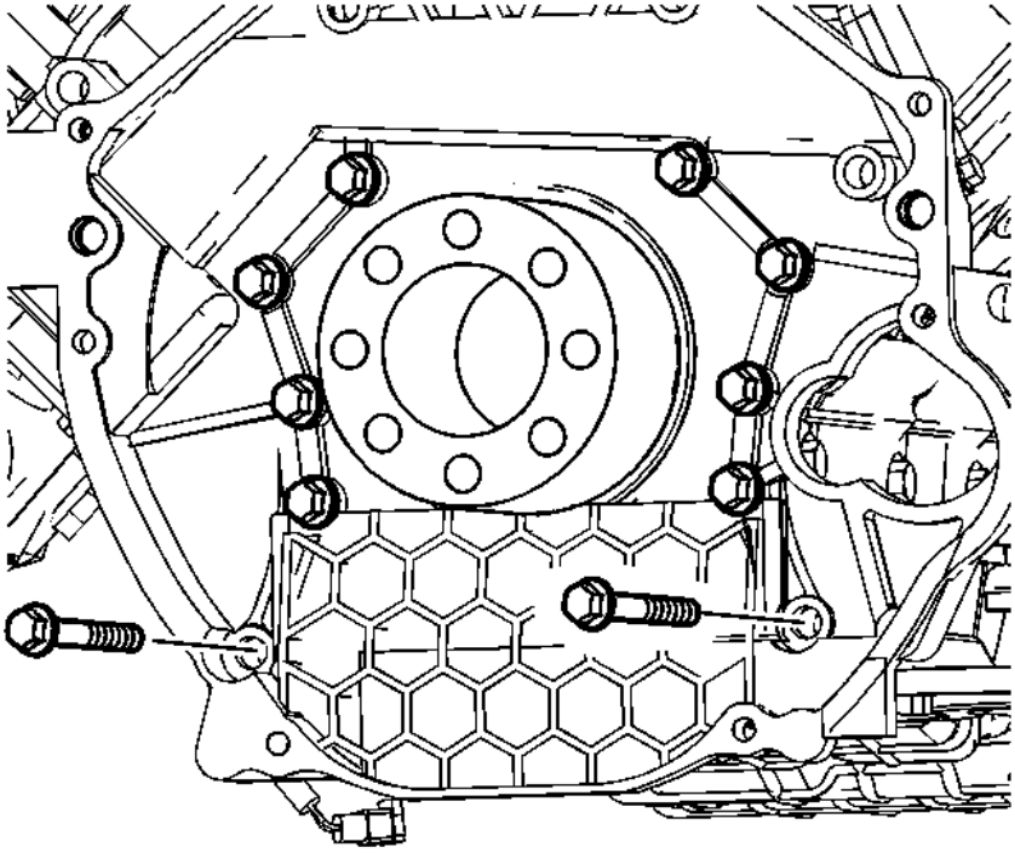


Fig. 102: View Of Flywheel Housing To Upper Oil Pan Bolts
Courtesy of GENERAL MOTORS CORP.

4. Install the two flywheel housing to upper oil pan bolts.

   Tighten: Tighten the two flywheel housing to upper oil pan bolts to 50 N.m (37 lb ft)

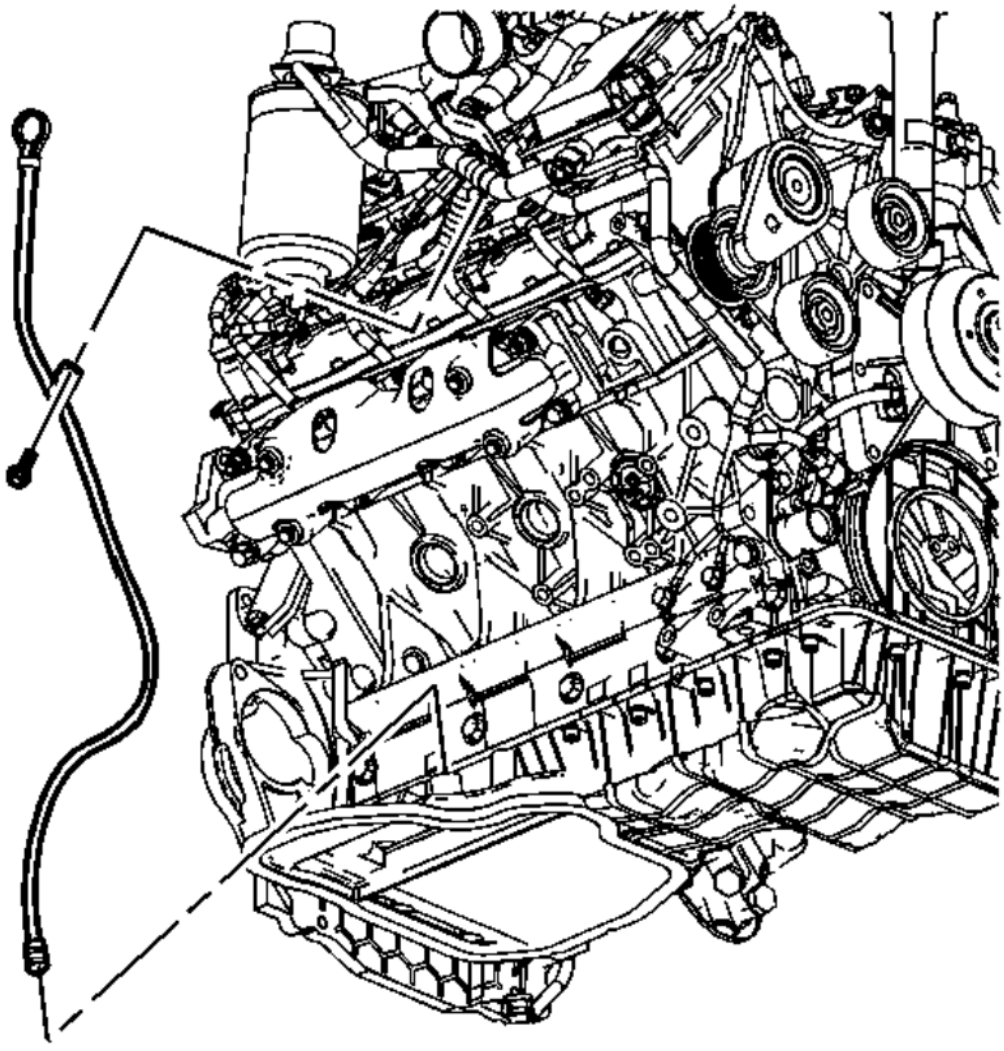


Fig. 103: View Of Oil Level Indicator
Courtesy of GENERAL MOTORS CORP.

5. Install the oil level indicator tube.
6. Install the oil level indicator tube bracket bolt.

Tighten: Tighten the oil level indicator tube bracket bolt to 21 N.m (15 lb ft).

LOWER OIL PAN INSTALLATION

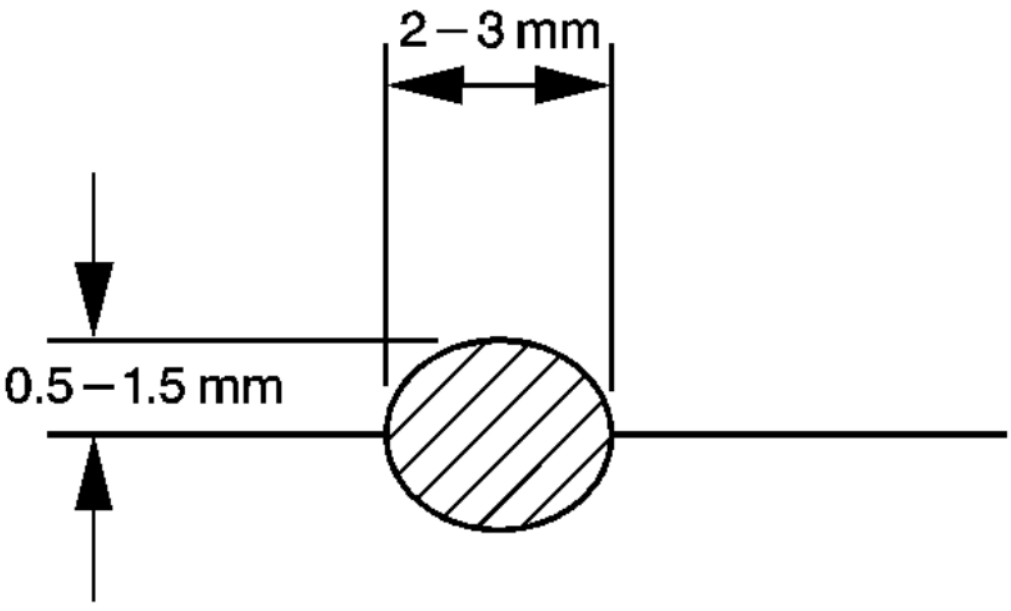


Fig. 104: Determining Sealant Bead Dimensions
Courtesy of GENERAL MOTORS CORP.

1. Apply a 2-3 mm wide by 0.5-1.5 mm high bead of GM P/N 12378521 (Canadian P/N 88901148) sealant to the lower oil pan mating surface.

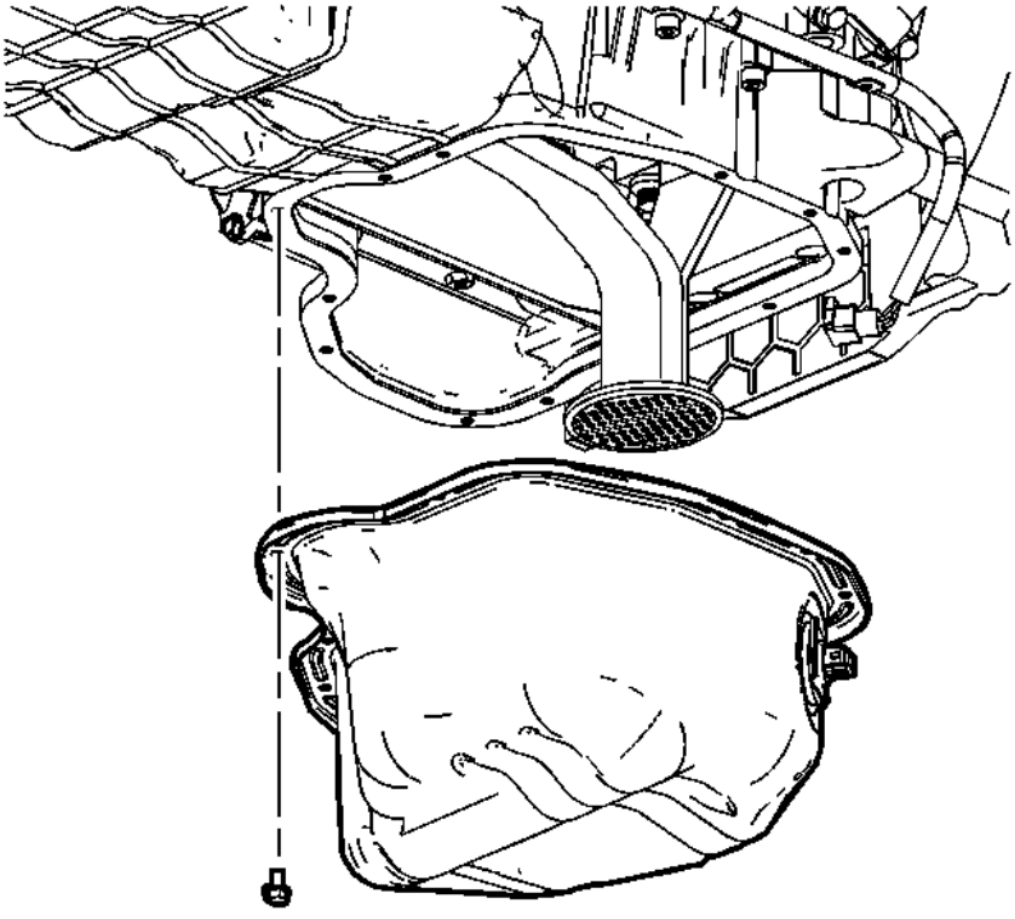


Fig. 105: View Of Lower Oil Pan & Bolts/Nuts
Courtesy of GENERAL MOTORS CORP.

2. Install the lower oil pan.

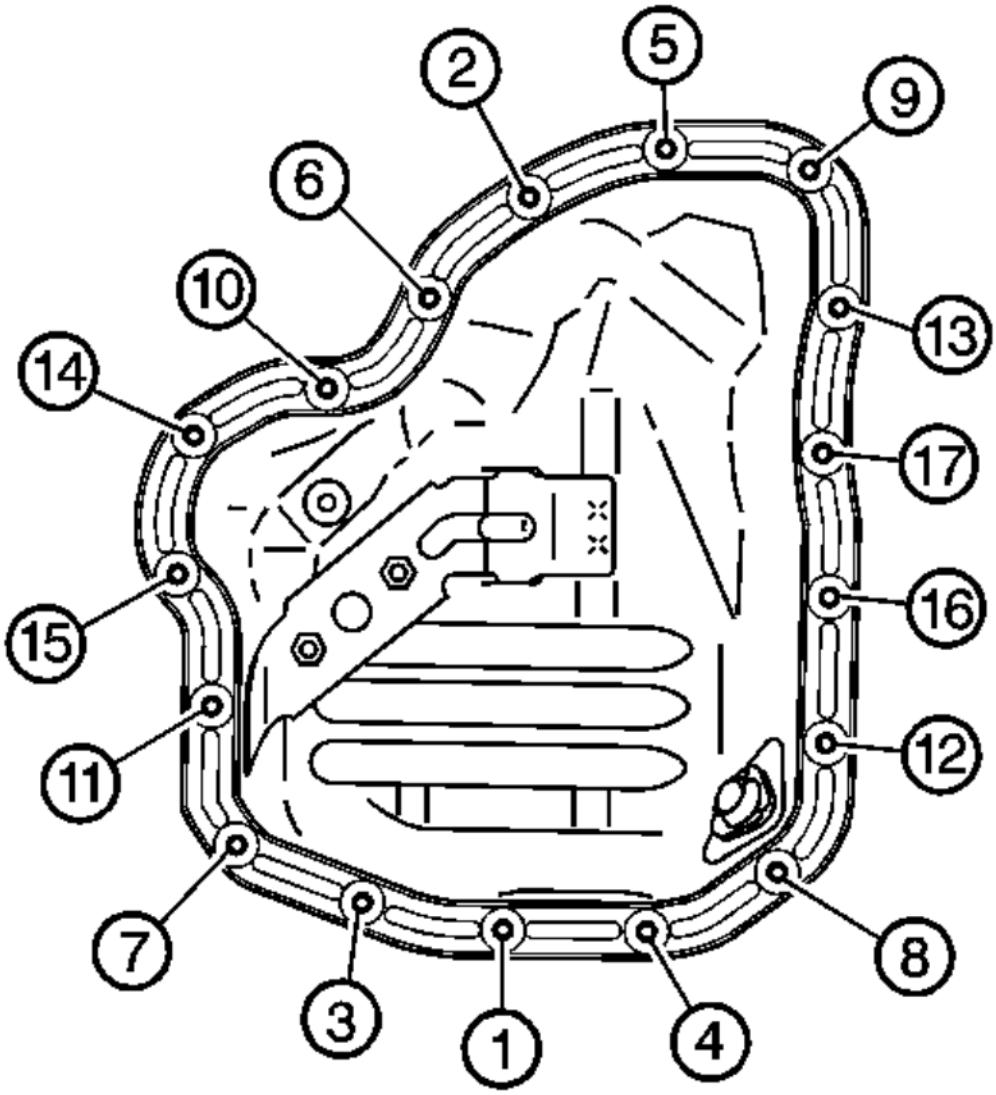


Fig. 106: Lower Oil Pan Bolts Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice

3. Install the lower oil pan bolts and nuts.

Tighten: Tighten the lower oil pan bolts and nuts in sequence to 10 N.m (89 lb in).

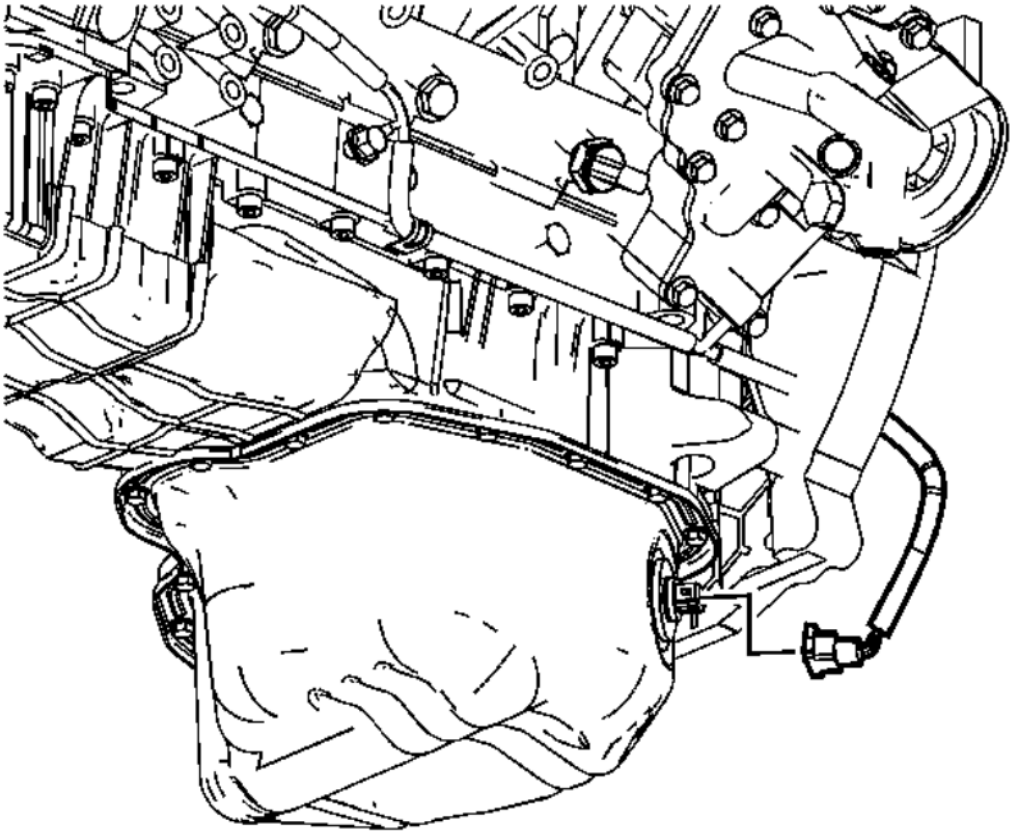


Fig. 107: View Of Oil Level Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

4. Connect the oil level sensor.

EXHAUST PIPE INSTALLATION - LEFT SIDE

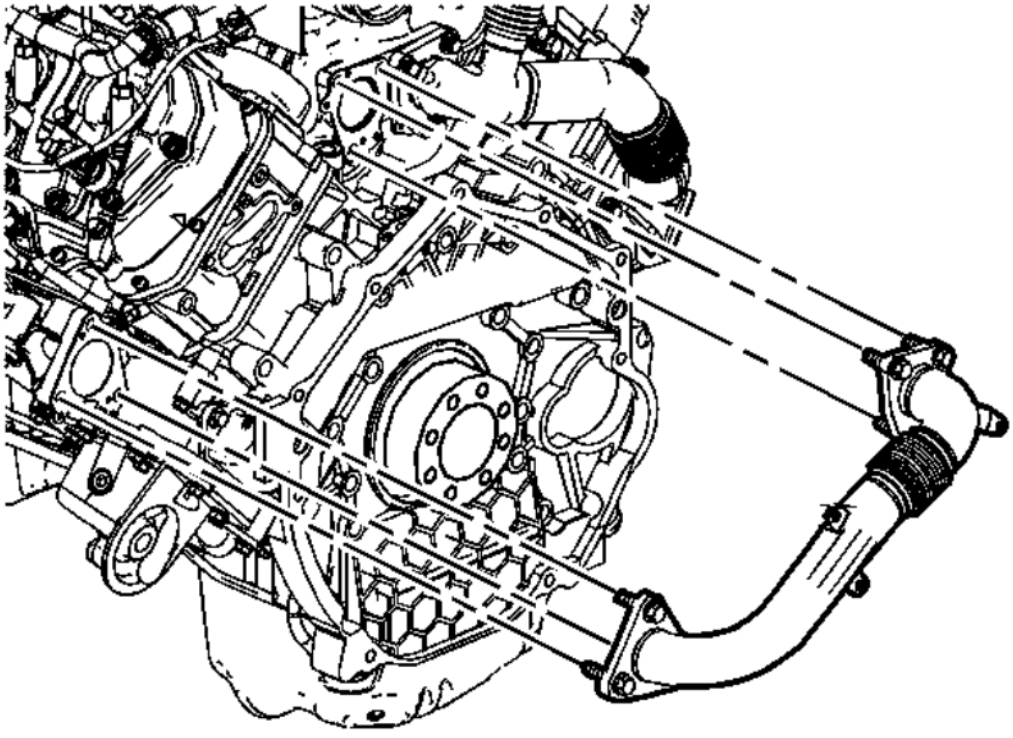


Fig. 108: View Of Left Exhaust Pipe
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Position the exhaust pipe gaskets with the tabs as shown. Failure to do so will cause improper alignment of the gaskets and result in exhaust leaks.

1. Install the exhaust pipe with gaskets.
2. Install the exhaust pipe to turbocharger bolts.

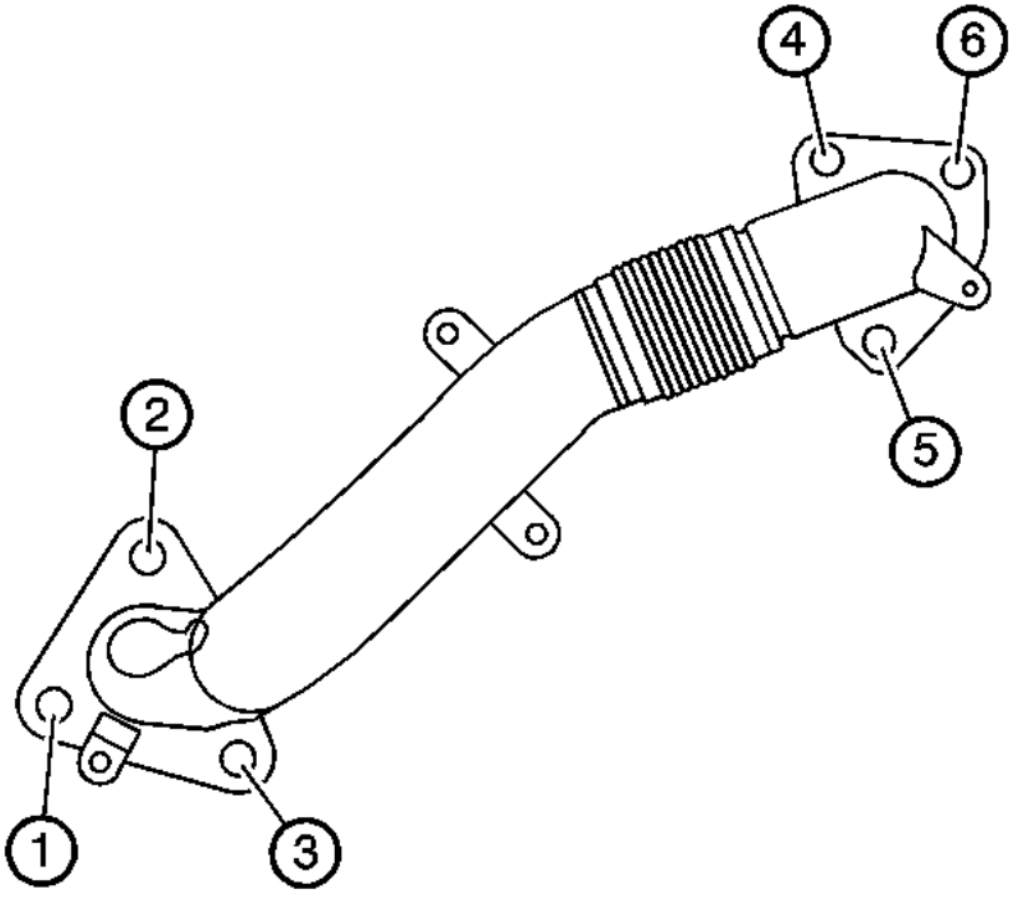


Fig. 109: Exhaust Pipe To Exhaust Manifold Bolt Tightening Sequence - Left Side
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

3. Install the exhaust pipe to exhaust manifold bolts.

   Tighten: Tighten the exhaust pipe bolts to 53 N.m (39 lb ft) in the proper sequence.

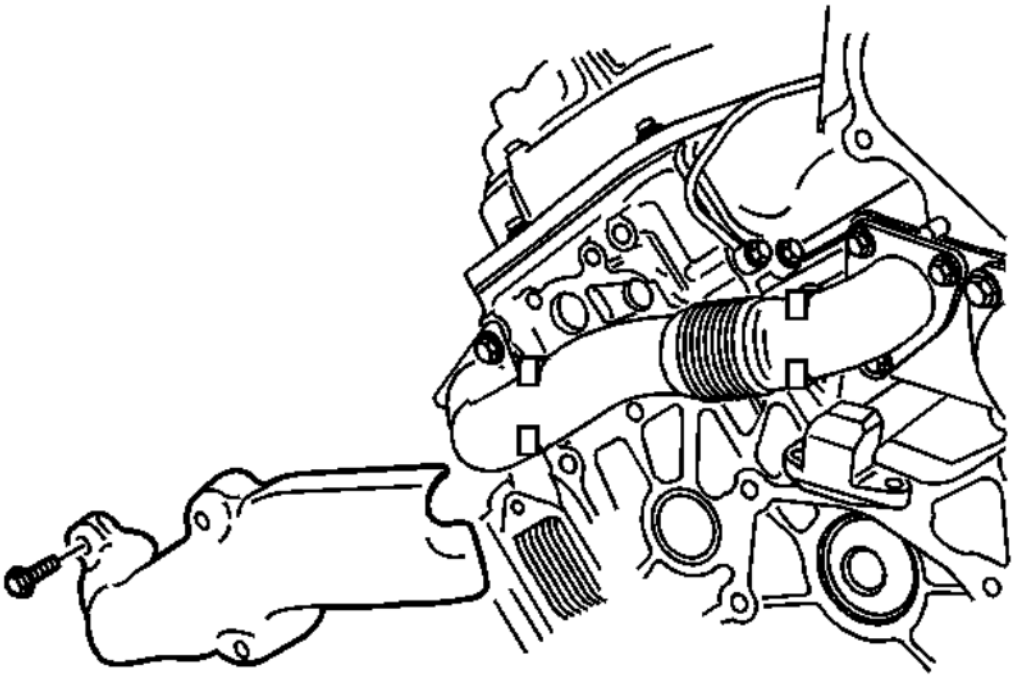


Fig. 110: View Of Left Exhaust Pipe Heat Shield & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Install the exhaust pipe heat shield.
5. Install the exhaust pipe heat shield bolts.

Tighten: Tighten the exhaust pipe heat shield bolts to 10 N.m (89 lb in).

EXHAUST PIPE INSTALLATION - RIGHT SIDE

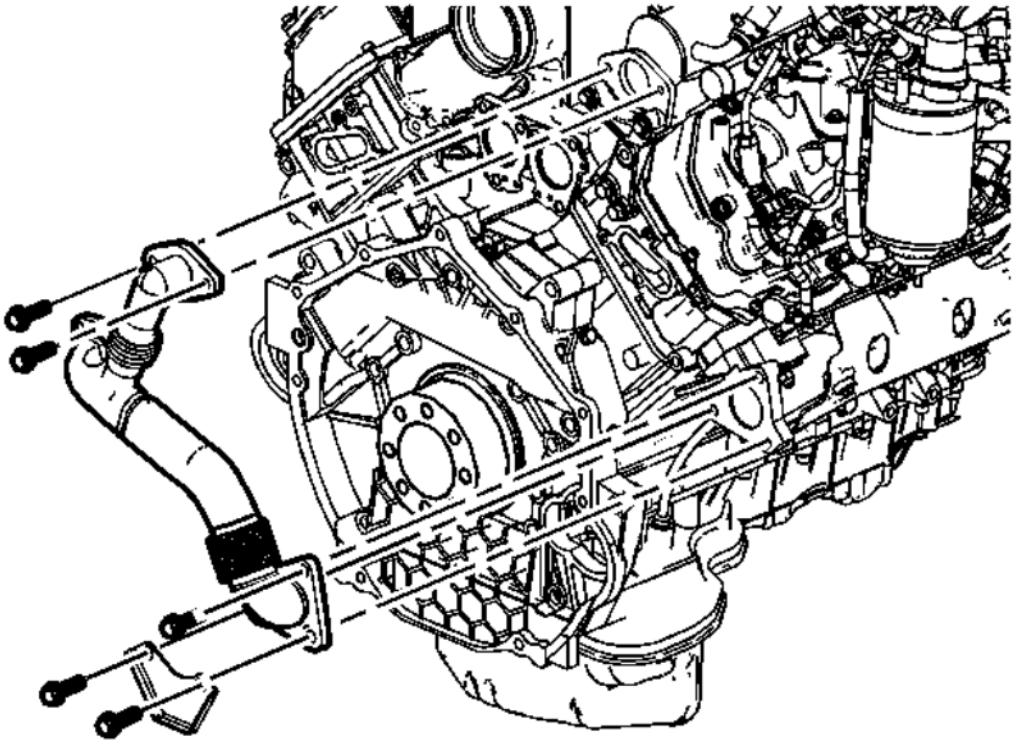


Fig. 111: View Of Right Exhaust Pipe
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Position the exhaust pipe gaskets with the tabs as shown. Failure to do so will cause improper alignment of the gaskets and result in exhaust leaks.

1. Install the exhaust pipe with gaskets.
2. Install the exhaust outlet bracket.
3. Install the exhaust pipe to turbocharger bolts.

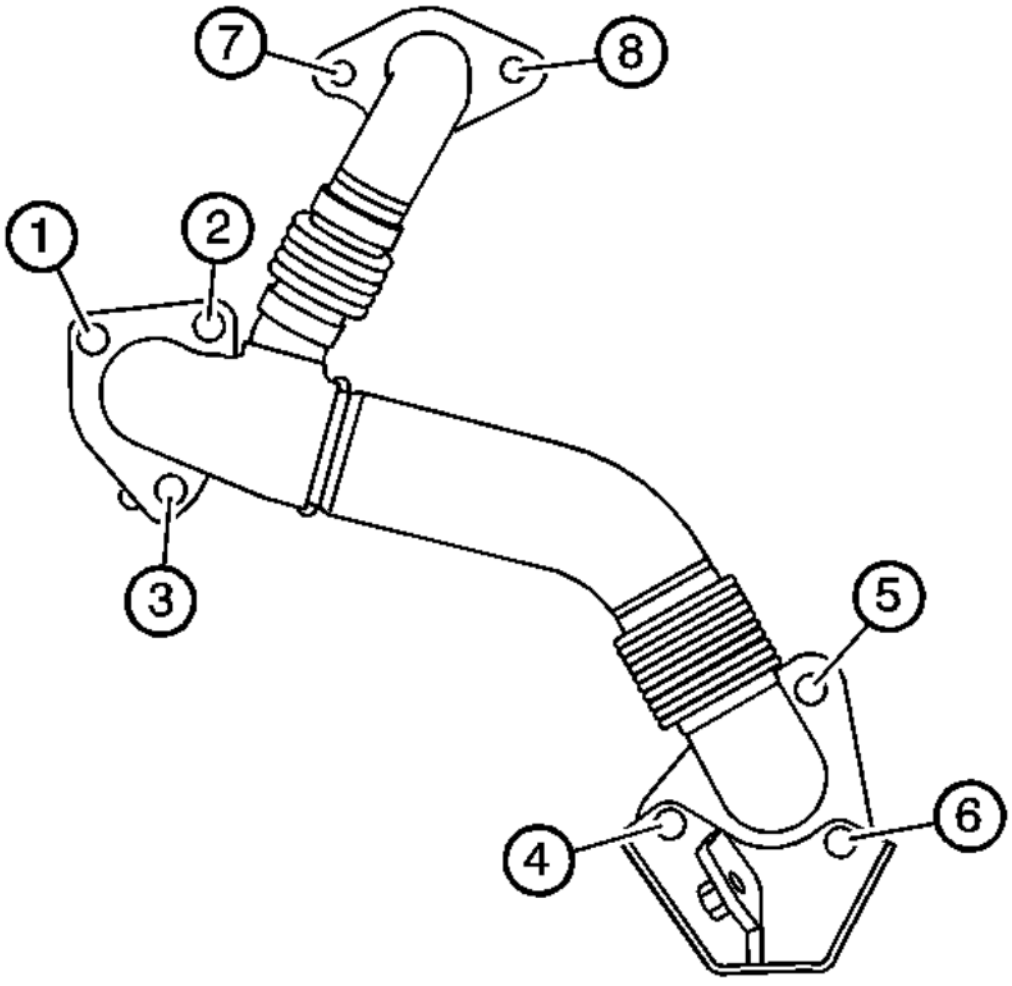


Fig. 112: Exhaust Pipe To Exhaust Manifold Bolt Tightening Sequence -- Right Side
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

4. Install the exhaust pipe to exhaust manifold bolts in sequence.

   Tighten: Tighten the exhaust pipe bolts to 53 N.m (39 lb ft) in sequence.

   Tighten: Tighten the exhaust pipe to EGR cooler nuts to 26 N.m (19 lb ft).

EXHAUST OUTLET INSTALLATION

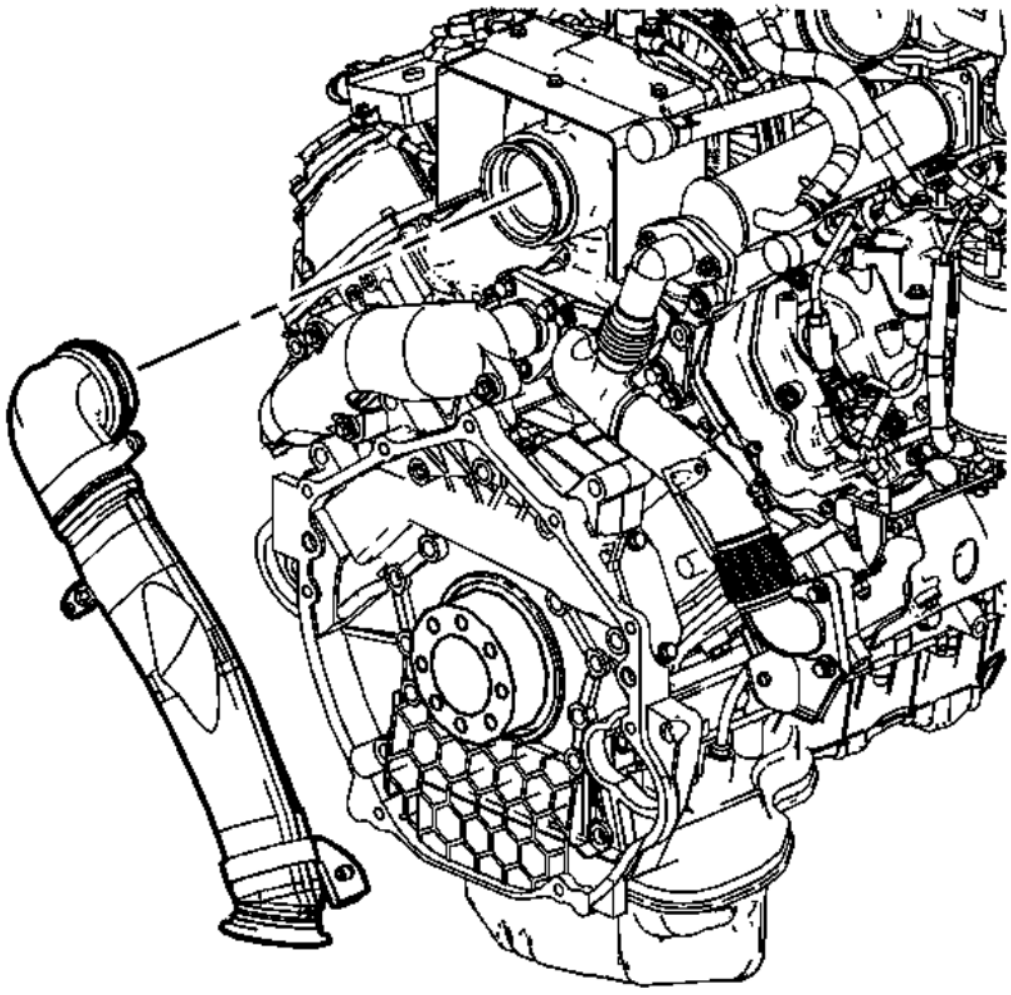


Fig. 113: View Of Exhaust Outlet
Courtesy of GENERAL MOTORS CORP.

1. Install the exhaust outlet.

NOTE: Refer to Fastener Notice .

2. Install the exhaust outlet clamp.

Tighten: Tighten the exhaust outlet clamp to 15 N.m (11 lb ft).

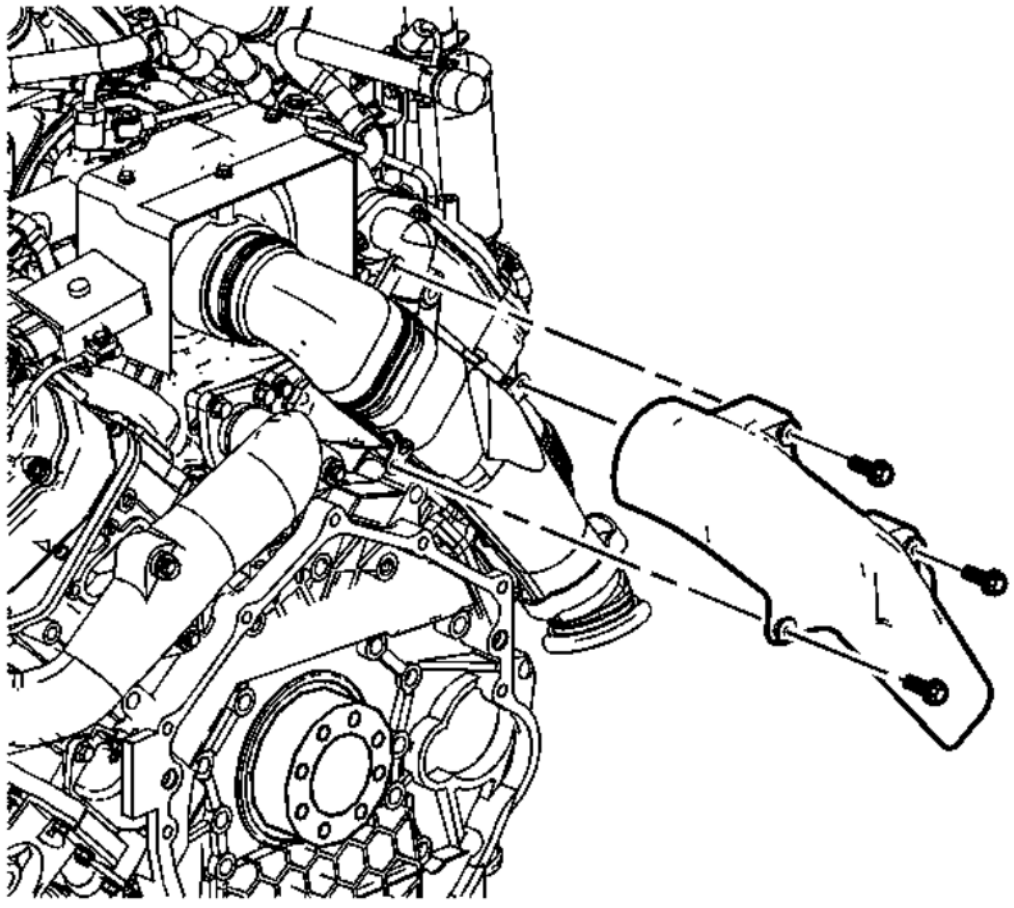


Fig. 114: View Of Exhaust Outlet Heat Shield
Courtesy of GENERAL MOTORS CORP.

3. Install the exhaust outlet to right exhaust pipe bracket bolt.

   Tighten: Tighten the exhaust outlet to right exhaust pipe bracket bolt to 34 N.m (25 lb ft).

4. Install the exhaust outlet heat shield.
5. Install the exhaust outlet heat shield bolts.

   Tighten: Tighten the exhaust outlet heat shield bolts to 10 N.m (89 lb in).

CRANKSHAFT REAR OIL SEAL INSTALLATION

Tools Required

Installation

J 44642 Crankshaft Rear Oil Seal Installer. See **Special Tools** .

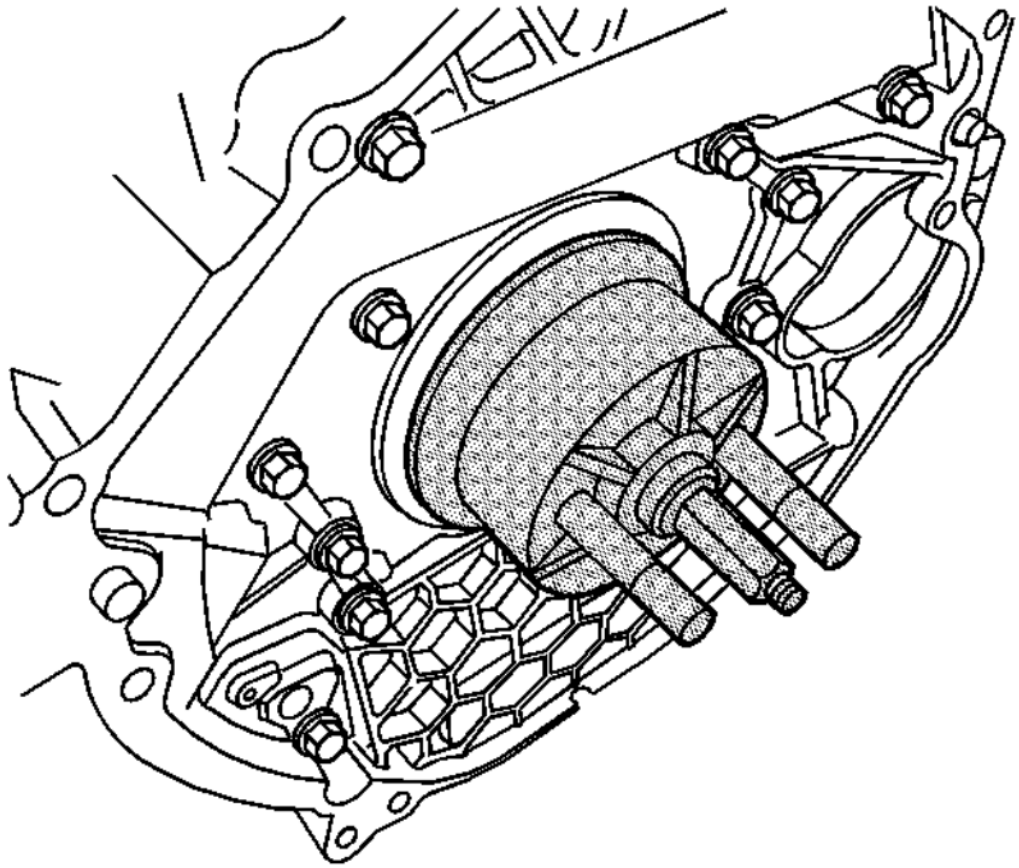


Fig. 115: Pressing Crankshaft Rear Oil Seal In Using J 44642
Courtesy of GENERAL MOTORS CORP.

1. Place the crankshaft rear oil seal onto the crankshaft.

IMPORTANT: The J 44642 must be fully secured to the crankshaft to ensure proper seal depth. See Special Tools .

2. Install the **J 44642** to the crankshaft. See **Special Tools** .
3. Press the crankshaft rear oil seal into position using the **J 44642** . See **Special Tools** . The **J 44642** will bottom out when the seal reaches the proper depth. See **Special Tools** .
4. Remove the **J 44642** . See **Special Tools** .

ENGINE FLYWHEEL INSTALLATION (AUTOMATIC TRANSMISSION)

Tools Required

- **J 44643** Flywheel Hold Tool. See **Special Tools** .
- **J 45059** Angle Meter

Installation

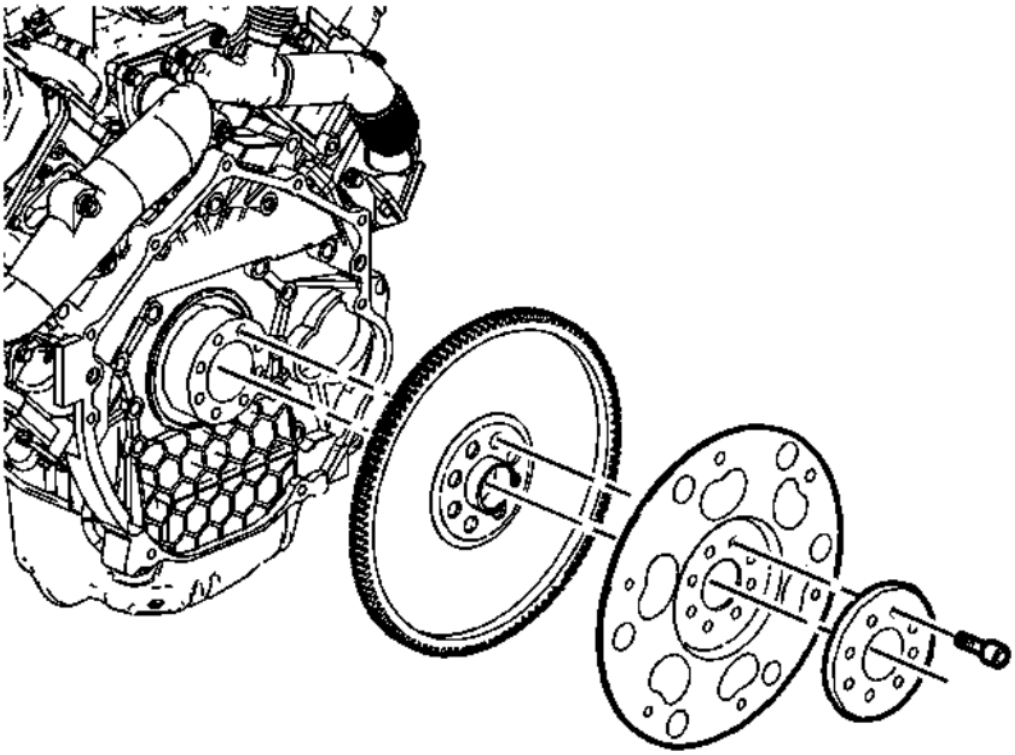


Fig. 116: View Of Flywheel & Washer (Automatic)
Courtesy of GENERAL MOTORS CORP.

1. Install the flywheel to the crankshaft.
2. Install the flywheel washer to the flywheel with the beveled side facing the engine.

NOTE: **This component uses bolts with a preapplied molybdenum disulfide coating for thread lubrication. Do not remove the coating or use any additional lubricant. Improperly lubricated threads will adversely affect the bolt torque and clamp load. Improper bolt torque and clamp load can lead to engine damage.**

3. Install NEW flywheel bolts.

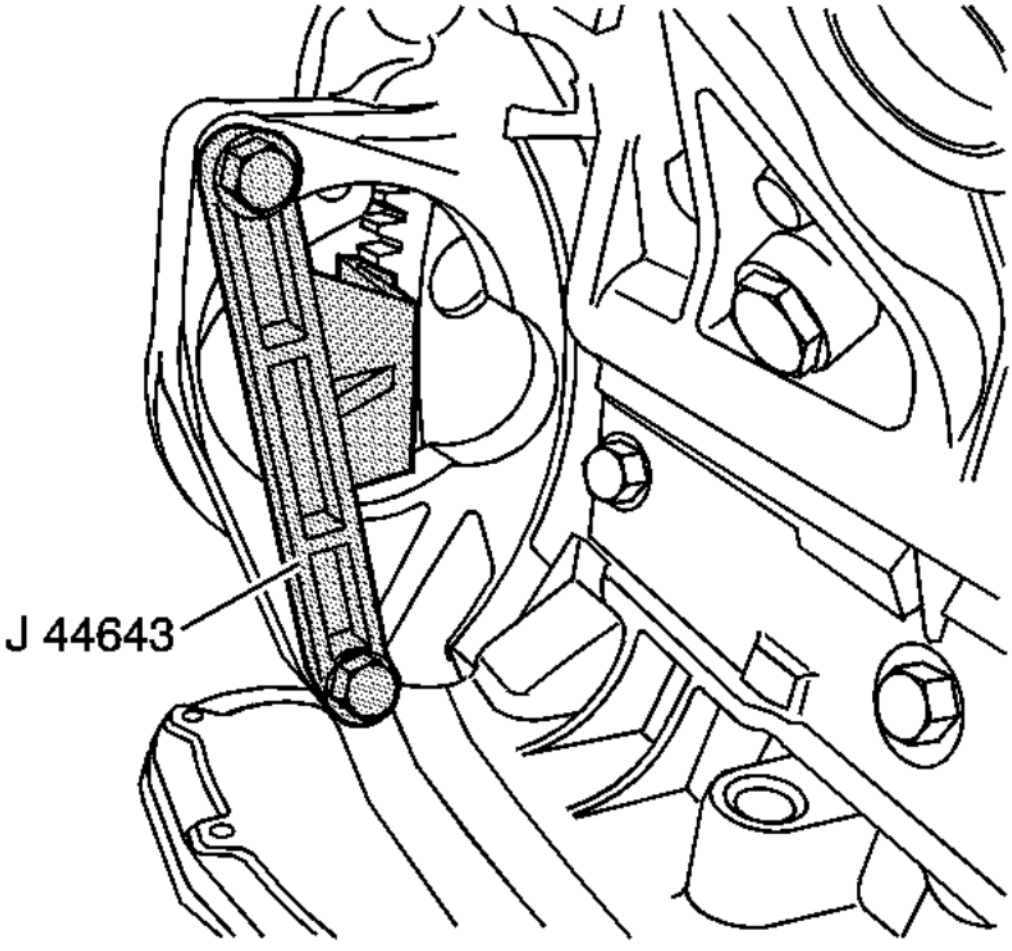


Fig. 117: Locking Flywheel Using J 44643
Courtesy of GENERAL MOTORS CORP.

4. Install the **J 44643** to lock the flywheel. See **Special Tools** .

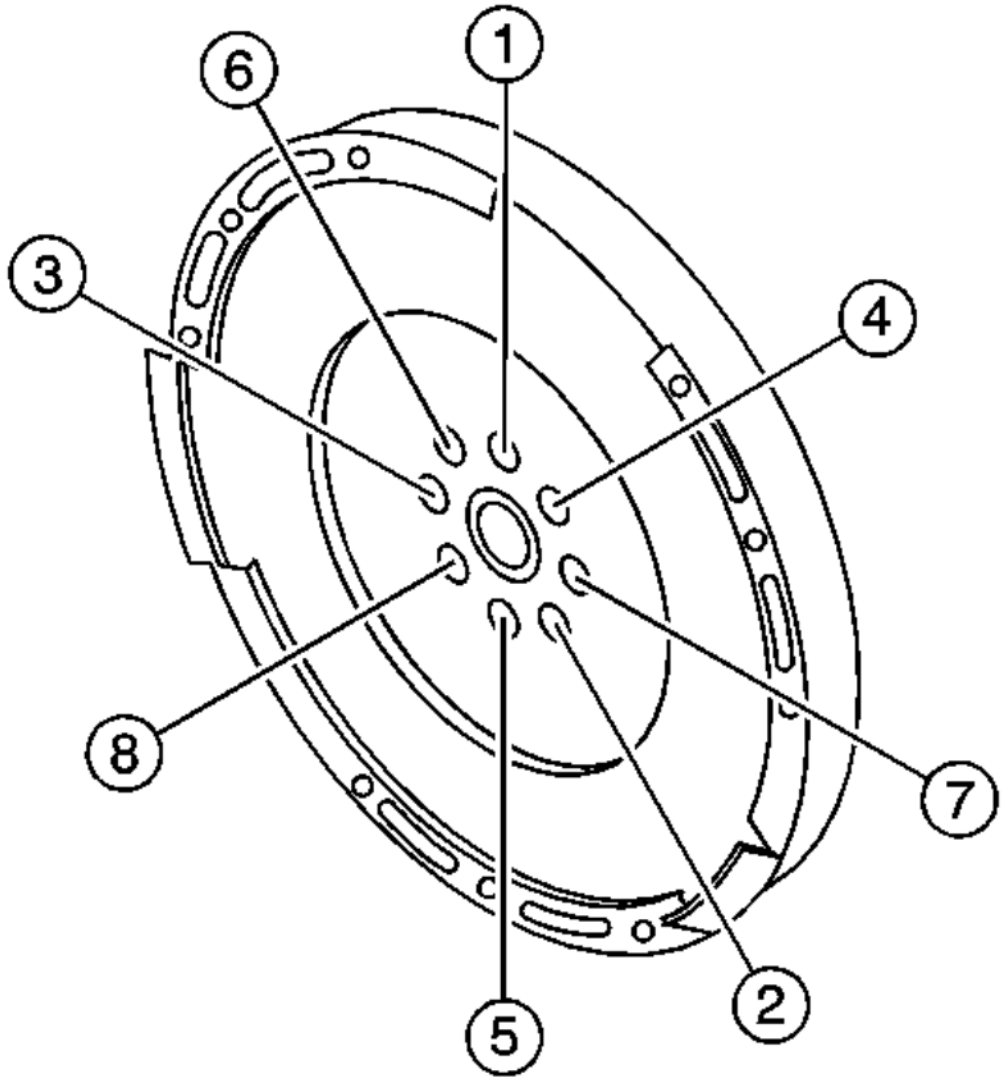


Fig. 118: Flywheel Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to Fastener Notice .

5. Tighten the flywheel bolts in the proper sequence.

Tighten:

- 1st step 79 N.m (59 lb ft).
- 2nd step 60 degrees using **J 45059** .
- 3rd step 60 degrees using **J 45059** .

ENGINE FLYWHEEL INSTALLATION (MANUAL TRANSMISSION)

Tools Required

- **J 44643** Flywheel Hold Tool. See **Special Tools** .
- **J 45059** Angle Meter

Installation

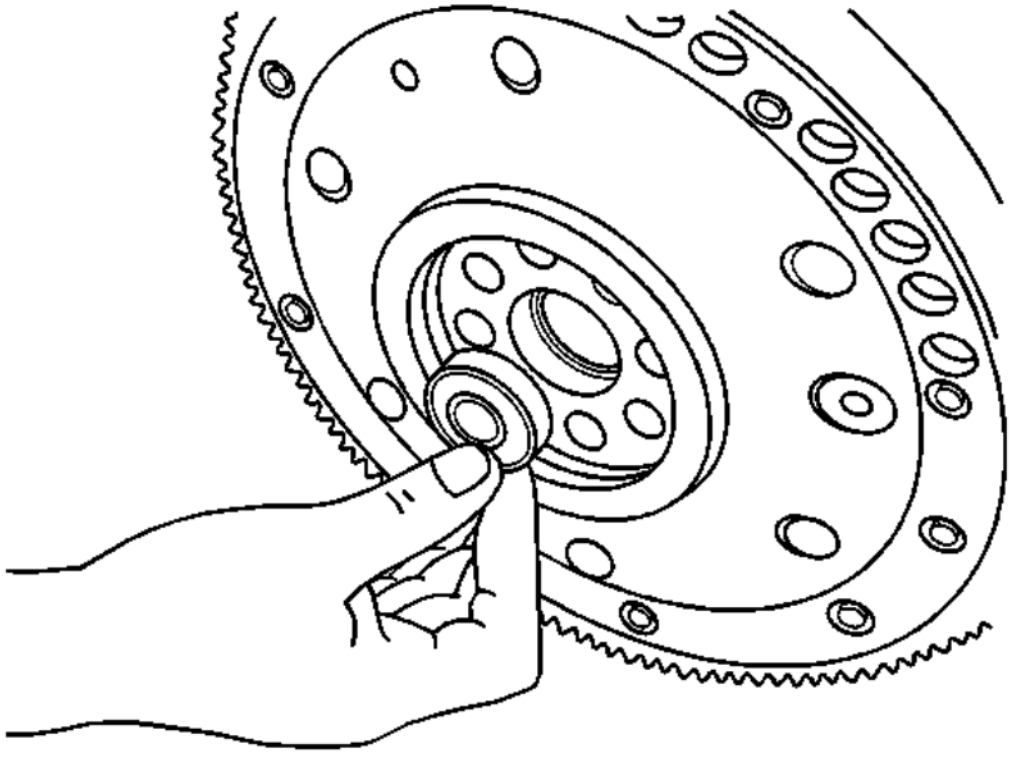


Fig. 119: View Of Engine Flywheel Pilot Bearing
Courtesy of GENERAL MOTORS CORP.

1. Install the pilot bearing.

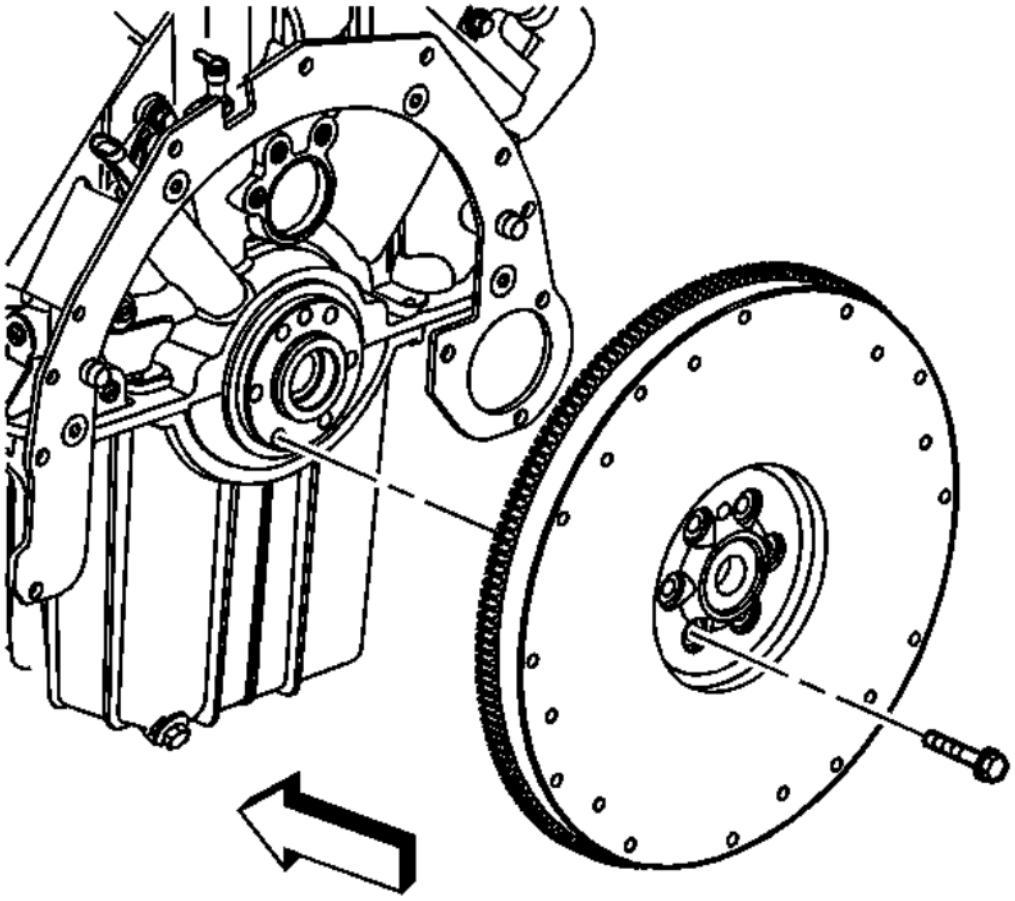


Fig. 120: View Of Flywheel & Mounting Bolts (Manual)
Courtesy of GENERAL MOTORS CORP.

CAUTION: When removing, handling or installing this component wear protective gloves. The sharp edges on the component may be very sharp and may cause injury.

2. Install the flywheel.

NOTE: This component uses bolts with a preapplied molybdenum

disulfide coating for thread lubrication. Do not remove the coating or use any additional lubricant. Improperly lubricated threads will adversely affect the bolt torque and clamp load. Improper bolt torque and clamp load can lead to engine damage.

NOTE: Refer to Fastener Notice .

3. Loosely install NEW flywheel bolts.

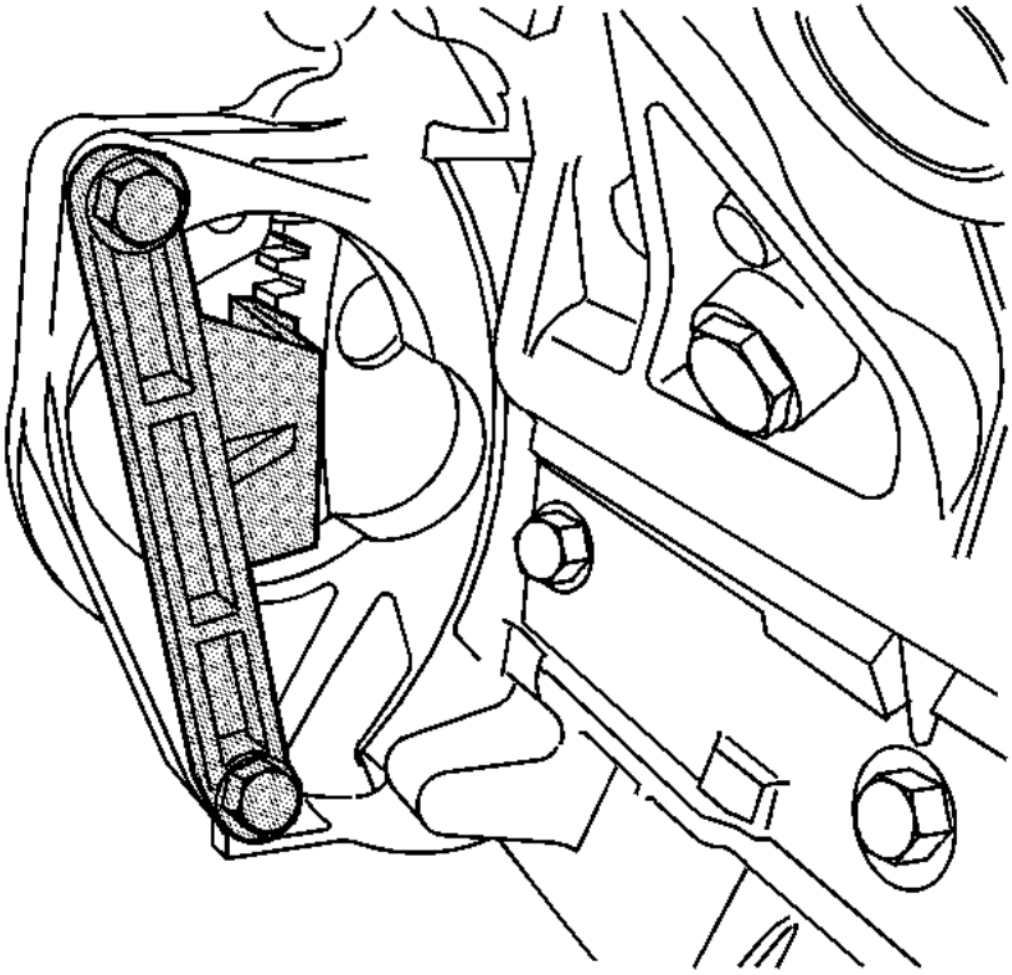


Fig. 121: Locking Flywheel Using J 44643 (Manual Transmission)
Courtesy of GENERAL MOTORS CORP.

4. Install **J 44643** to hold the flywheel from rotating. See **Special Tools** .

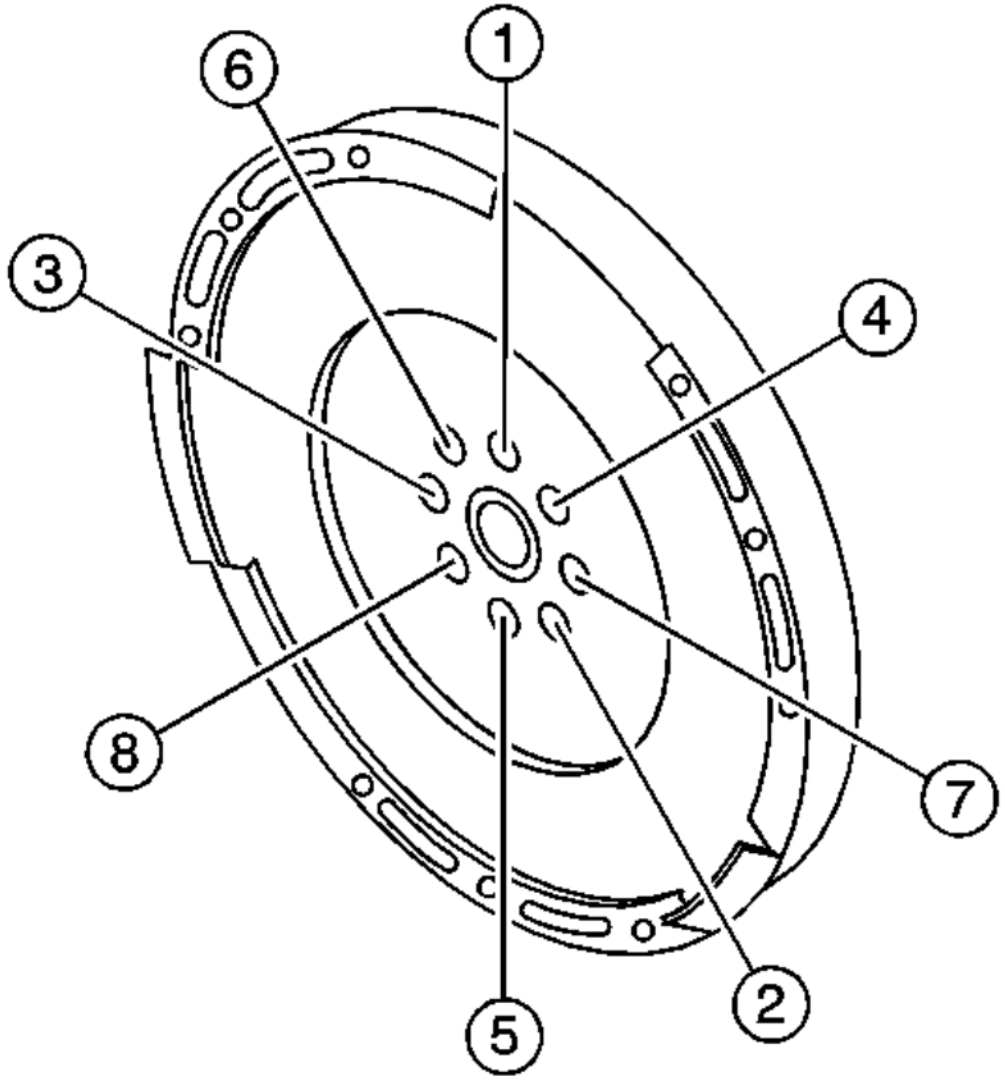


Fig. 122: Flywheel Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

5. Use the following steps and the proper sequence to tighten the flywheel bolts:

   Tighten:
   1. Tighten the flywheel bolts to 79 N.m (59 lb ft).
   2. Tighten the flywheel bolts to 60 degrees using the **J 45059** .
   3. Tighten the flywheel bolts again to 60 degrees using the **J 45059** .

6. Remove **J 44643** . See **Special Tools** .

CRANKSHAFT BALANCER INSTALLATION

Tools Required

J 44643 Flywheel Hold Tool. See **Special Tools** .

Installation

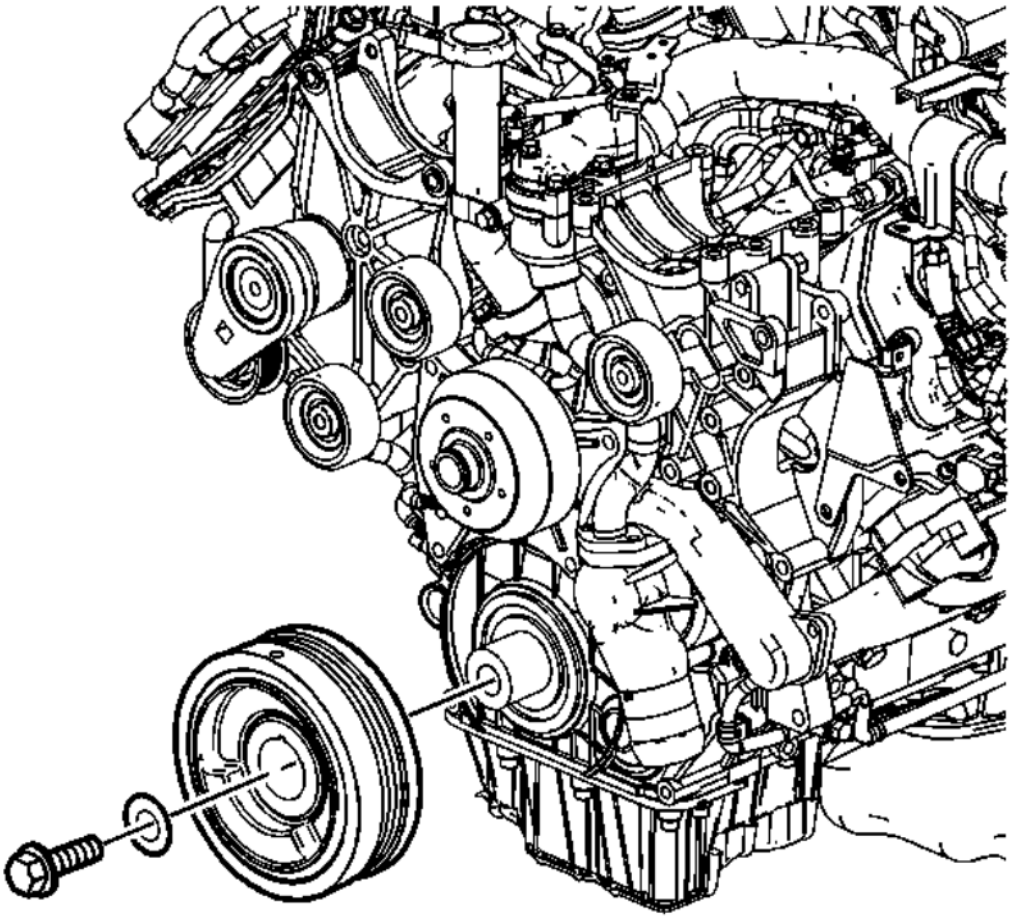


Fig. 123: View Of Crankshaft Balancer & Bolt
Courtesy of GENERAL MOTORS CORP.

1. Lightly lubricate the crankshaft balancer internal hub with engine oil.
2. Install the crankshaft balancer to the crankshaft.
3. Lightly lubricate the crankshaft balancer bolt with engine oil.

NOTE: Refer to Fastener Notice .

4. Install the crankshaft balancer bolt and washer.

Tighten:

1. Tighten the bolt to 100 N.m (74 lb ft) on the first pass.
2. Tighten the bolt an additional 105 degrees.

5. Remove the **J 44643** . See **Special Tools** .

STARTER INSTALLATION

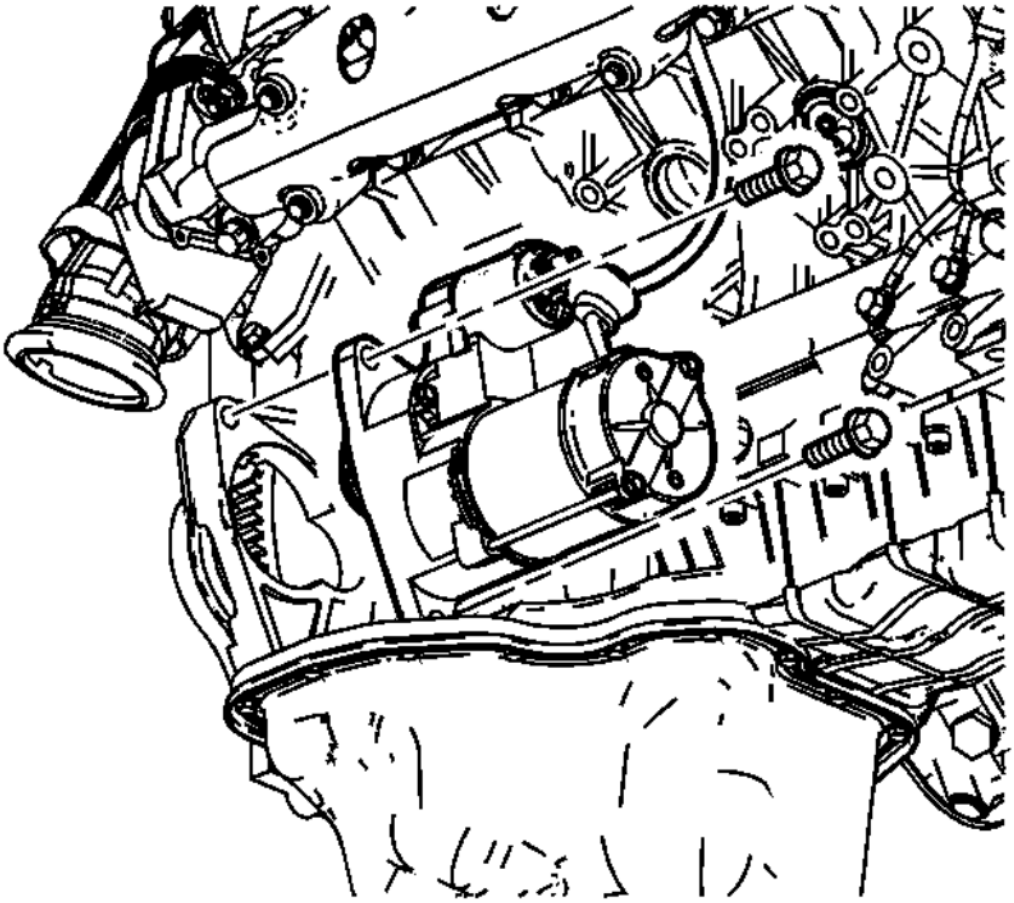


Fig. 124: View Of Starter
Courtesy of GENERAL MOTORS CORP.

1. Install the starter motor to the flywheel housing.

NOTE: Refer to Fastener Notice .

2. Install the starter motor bolts.

   Tighten: Tighten the starter bolts to 78 N.m (58 lb ft).

ENGINE PRELUBING

Special Tools

J 45299 Engine Preluber

Prelube

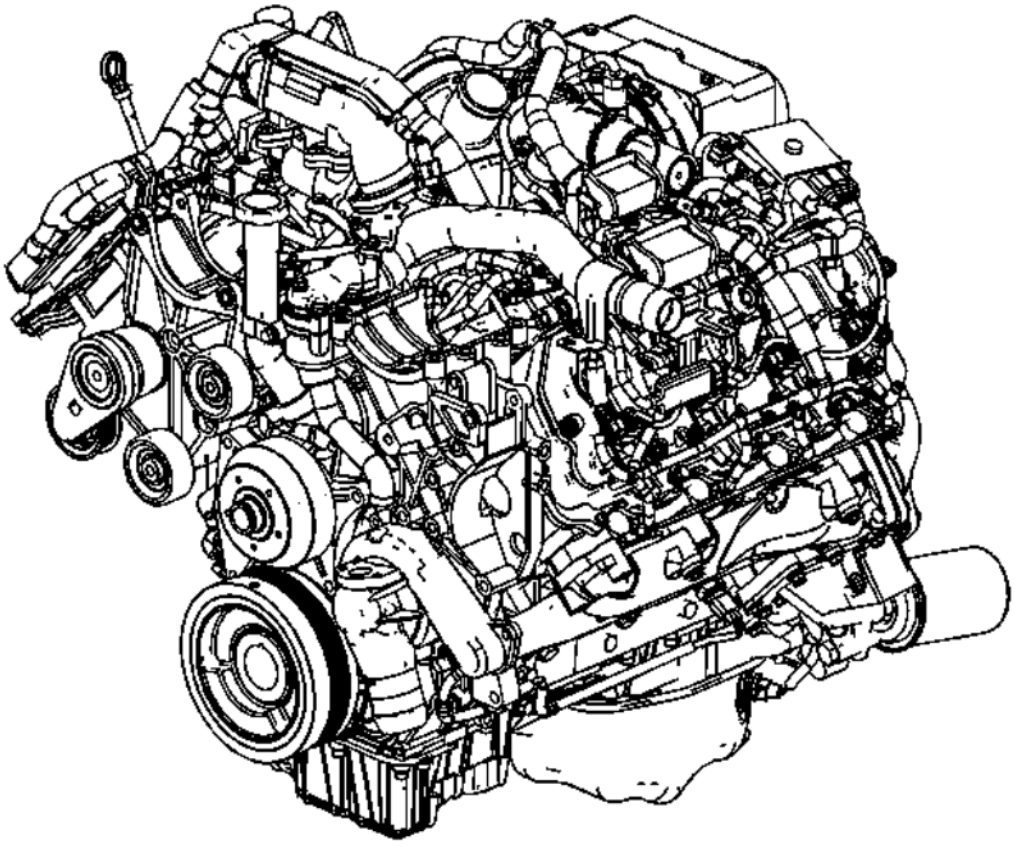


Fig. 125: View Of Engine Assembly
Courtesy of GENERAL MOTORS CORP.

NOTE: **Refer to Fastener Notice .**

IMPORTANT: A constant/continuous flow of clean engine oil is required to properly prime the engine. Be sure to use an approved engine oil as specified in the owners manual.

1. Remove the engine oil filter, fill with clean engine oil, and reinstall.

   Tighten: Tighten the oil filter to 24 N.m (18 lb ft).

2. Remove the oil pressure sensor.
3. Install the M16 x 1.5 adapter P/N 509375.

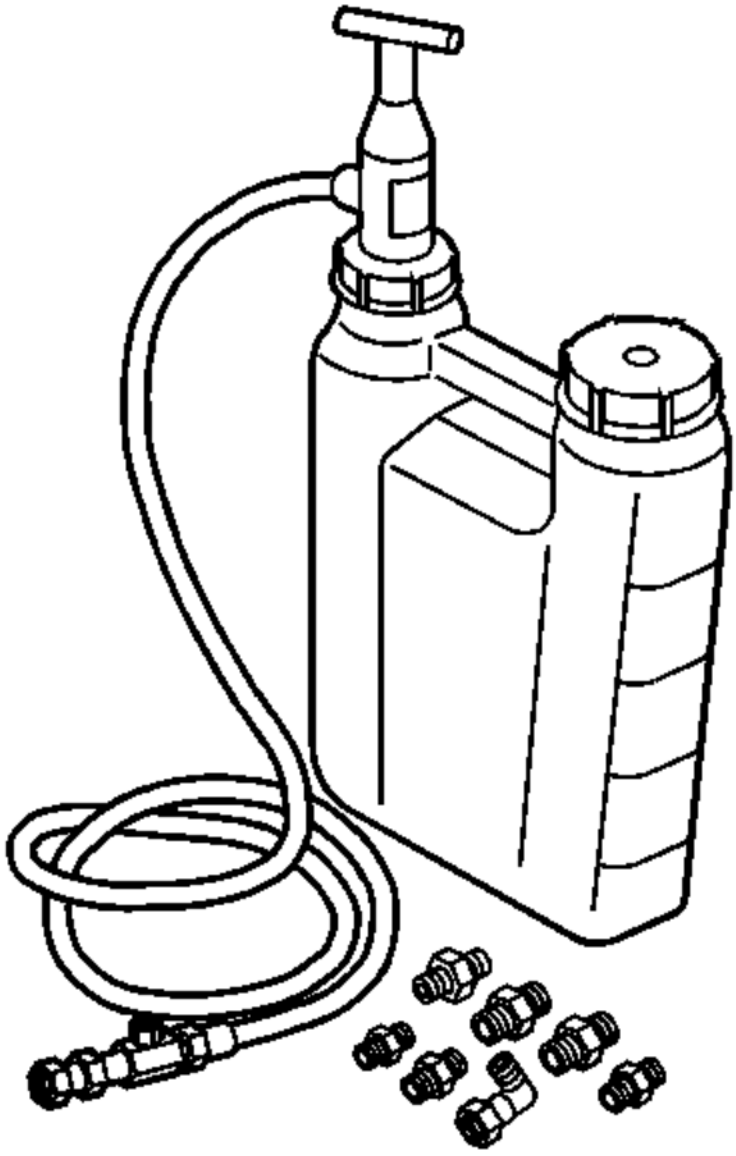


Fig. 126: Identifying Engine Preluber J 45299
Courtesy of GENERAL MOTORS CORP.

4. Install the flexible hose to the adapter and open the valve.
5. Pump the handle on **J 45299** to flow a minimum of 1-2 quarts of engine oil. Observe the

flow of engine oil through the flexible hose and into the engine assembly.

6. Close the valve and remove the flexible hose and adapter from the engine.
7. Install the oil pressure sensor.

   Tighten: Tighten the oil pressure sensor to 41 N.m (30 lb ft).

8. Top off the engine oil to the proper level.